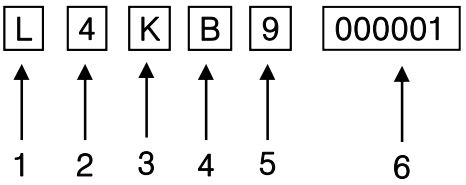


1. Engine fuel
   - D : Diesel
   - G : Gasoline
   - L : LPG
2. Engine range
   - 4 : 4 cycle 4 cylinder
   - 6 : 4 cycle 6 cylinder
3. Engine development order
   - KB : 2.4L Theta engine
5. Production year
   - 7 : 2007, 8 : 2008, 9 : 2009
6. Engine production sequence number
   - 000001 ~ 999999

Parts

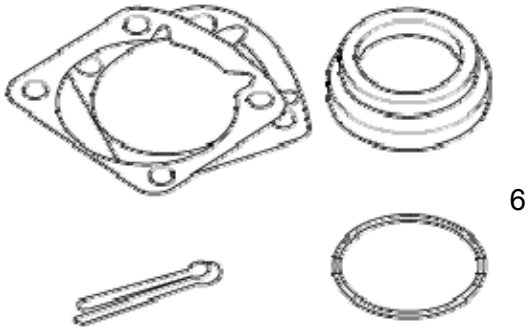
When replacing parts, use HYUNDAI genuine parts.

Replacement

Standard values, such as torques and certain adjustments, must be strictly observed in the reassembly of all parts

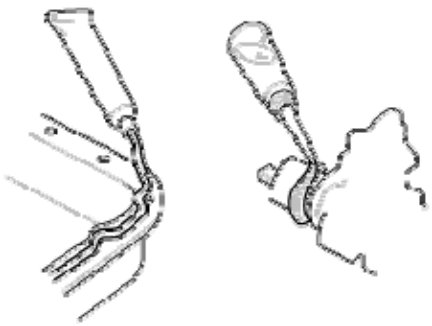
If removed, the following parts should always be replaced with new ones.

1. Oil seals
2. Gaskets
3. O-rings
4. Lock washers
5. Cotter pins (split pins)
6. Plastic nuts



Depending on their location.

7. Sealant should be applied to gaskets.
8. Oil should be applied to the moving components of parts.
9. Specified oil or grease should be applied to the prescribed locations (oil seals, etc) before assembly.



Adjustment

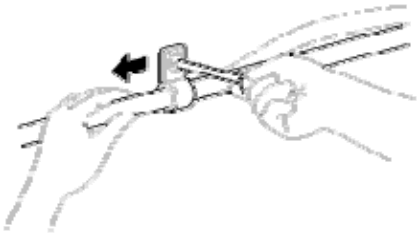
Use gauges and testers to adjust correclty the parts to standard values correctly

Electrical System

1. Be sure to disconnect the battery cable from the negative (-) terminal of the battery.
2. Never pull on the wires when disconnecting connectors.
3. Locking connectors will click when the connector is secure
4. Handle sensors and relays carefully. Be careful not to drop them against other parts
7. Check for incorrect wiring.
8. Check that the wiring is so clamped to prevent contact with sharp corners of the vehicle body, etc. or hot parts (exhaust manifold, etc.)
9. Check that the wiring is clamped firmy to provide enough clearance from the fan pulley, fan belt and other rotating or moving parts.
10. Check that the wiring has a little space so that it can vibrate between fixed and moving parts such as the vehicle body and the engine.

Ruber Parts And Tubes

Always prevent gasoline from touching rubber parts or tubing.

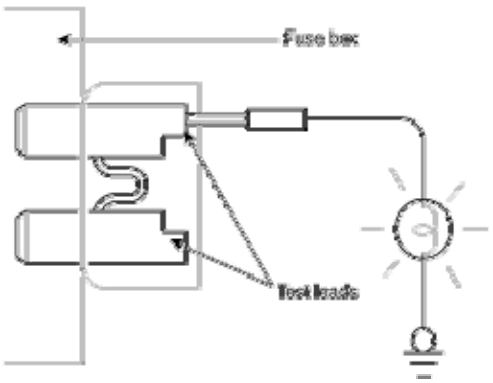


Checking Cables And Wires

1. Check the terminal for tightness.
2. Check terminals and wires for corrosion from battery electrolyte, etc
3. Check terminals and wires for open circuits.
4. Check wire insulation and coating for damage, cracks and degrading.
5. Check the conductive parts of terminals for contact other metallic parts (vehicle body and other parts).
6. Check grounded parts to verify that there is complete continuity between thier attaching bolt(s) and the vehicle's body.

Check Fuses

A blade type fuse test taps provided to allow checking the fuse itself without removing it from the fuse box. The fuse is good if the test lamp lights up when one lead is connected to the test taps (one at a time) and the other lead is grounded. (Turn the ignition switch so that the fuse circuit becomes operative)

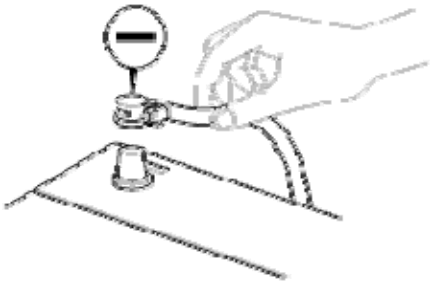


Serivicing The Electrical System

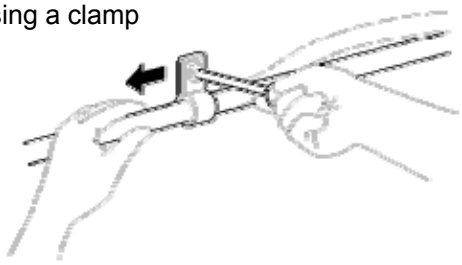
1. Prior to servicing the electrical system, be sure to turn off the ignition switch and disconnect the battery ground cable.

NOTE

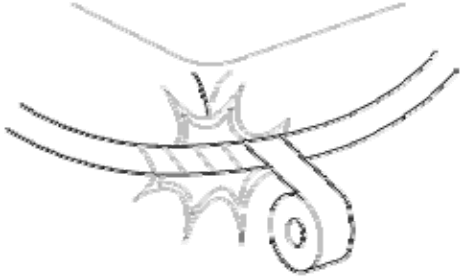
In the course of MFI or ELC system diagnosis, when the battery cable is removed, any diagnostic trouble code retained by the computer will be cleared. Therefore, if necessary, read the diagnostic before removing the battery cable.



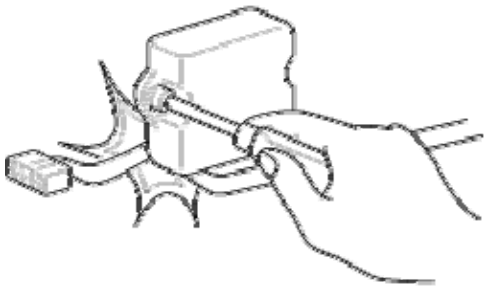
2. Attach the wiring harnesses with clamps so that there is no slack. However, for any harness which passes the engine or other vibrating parts of the vehicle, allow some slack within a range that does not allow the engine vibrations to cause the harness to come into contact with any of the surrounding parts and then secure the harness by using a clamp



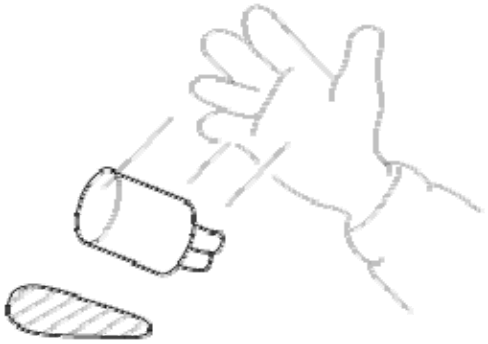
3. If any section of a wiring harness interferes with the edge of a parts, or a corner, wrap the section of the harness with tape or something similar in order to protect it from damage.



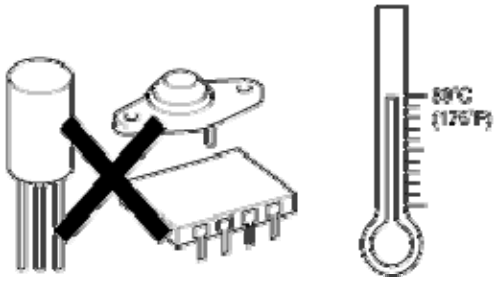
4. When installing any parts, be careful not to pinch or damage any of the wiring harness



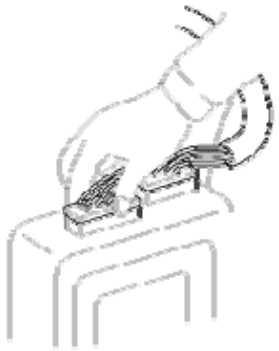
5. Never throw relays, sensors or electrical parts, or expose them to strong shock.



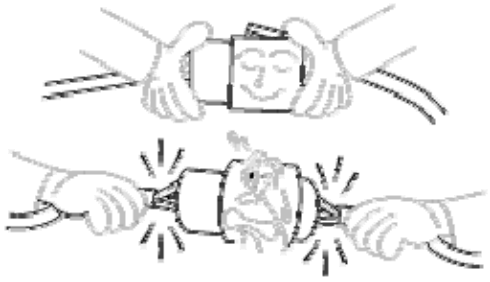
6. The electronlic parts used in the computer, relays, etc. are readily damaged by heat. If there is a need for service operations that may cause the temperature to exceed 80°C (176°F), remove the electronic parts before hand



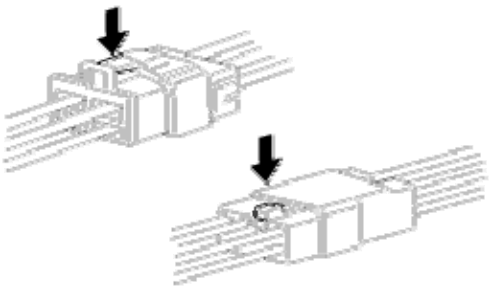
7. Loose connectors cause problems. Make sure that the connectors are always securely fastened.



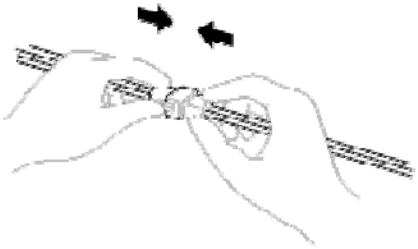
8. When disconnecting a connector, be sure to grip only the connector, not the wires.



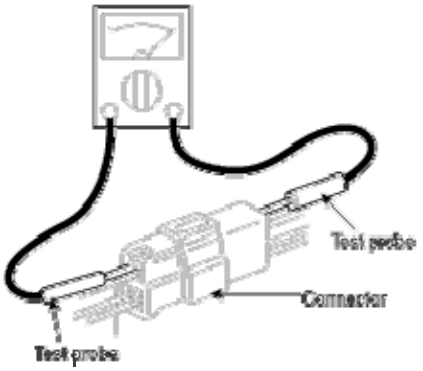
9. Disconnect connector which have catches by pressing in the direction of the arrows shown the illustration.



10. Connect connectors which have catches by inserting the connectors until they make a clicking sound



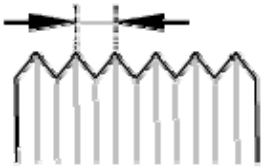
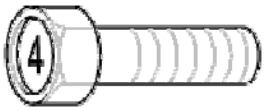
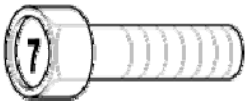
11. When using a circuit tester to check continuity or voltage on connector terminals, insert the test probe into the harness side. If the connector is a sealed connector, insert the test probe through the hole in the rubber cap until contacts the terminal, being careful not to damage the insulation of the wires.



12 To avoid overloading the wiring, take the electrical current load of the optional equipment into consideration, and determine the appropriate wire size.

Nominal size	SAE gauge No.	Permissible current	
		In engine compartment	Other areas
0.3mm²	AWG 22		5A
0.5mm²	AWG 20	7A	13A
0.85mm²	AWG 18	9A	17A
1.25mm²	AWG 16	12A	22A
2.0mm²	AWG 14	16A	30A
3.0mm²	AWG 12	21A	40A
5.0mm²	AWG 10	31A	54A

Tightening Torque Table Of Standard Parts

Bolt minimal diameter	Pitch (mm)	Torque Nm (kg.cm, lb.ft)	
		Head Mark 4	Head Mark 7
			
M5	0.8	3 ~ 4 (30 ~ 40, 2.2 ~ 2.9)	5 ~ 6 (50 ~ 60, 3.6 ~ 4.3)
M6	1.0	5 ~ 6 (50 ~ 50, 3.6 ~ 4.3)	9 ~ 11 (90 ~ 110, 6.5 ~ 8.0)
M8	1.25	12 ~ 15 (120 ~ 150, 9 ~ 11)	20 ~ 25 (200 ~ 250, 14.5 ~ 18.0)
M10	1.25	25 ~ 30 (250 ~ 300, 18 ~ 22)	30 ~ 50 (300 ~ 500, 22 ~ 36)
M12	1.25	35 ~ 45 (350 ~ 450, 25 ~ 33)	60 ~ 80 (600 ~ 800, 43 ~ 58)
M14	1.5	75 ~ 85 (750 ~ 850, 54 ~ 61)	120 ~ 140 (1,200 ~ 1,400, 85 ~ 100)
M16	1.5	110 ~ 130 (1,100 ~ 1,300, 80 ~ 94)	180 ~ 210 (1,800 ~ 2,100, 130 ~ 150)
M18	1.5	160 ~ 180 (1,600 ~ 1,800, 116 ~ 130)	260 ~ 300 (2,600 ~ 3,000, 190 ~ 215)
M20	1.5	220 ~ 250 (2,200 ~ 2,500, 160 ~ 180)	360 ~ 420 (3,600 ~ 4,200, 260 ~ 300)
M22	1.5	290 ~ 330 (2,900 ~ 3,300, 210 ~ 240)	480 ~ 550 (4,800 ~ 5,500, 350 ~ 400)
M24	1.5	360 ~ 420 (3,600 ~ 4,200, 260 ~ 300)	610 ~ 700 (6,100 ~ 7,000, 440 ~ 505)

NOTE

- The torques shown in the table are standard values under the following conditions :
- Nuts and bolts are made of galvanized steel bar.
- Galvanized plain steel washers are inserted.
- All nuts, bolts and plain washers are dry.

- The torques shown in the table are not applicable :
- When spring washers, toothed washers and the like are inserted.
- If plastic parts are fastened.
- If self-tapping screws or self-locking nuts are used.
- If threads and surfaces are coated with oil.

- If you reduce the torques in the table to the percentage indicated below, under the following conditions, it will be the standard value.
- If spring washers are used : 85%
- If threads and bearing sufaces are stained with oil : 85%

Lubricants

Recommended Lubricants

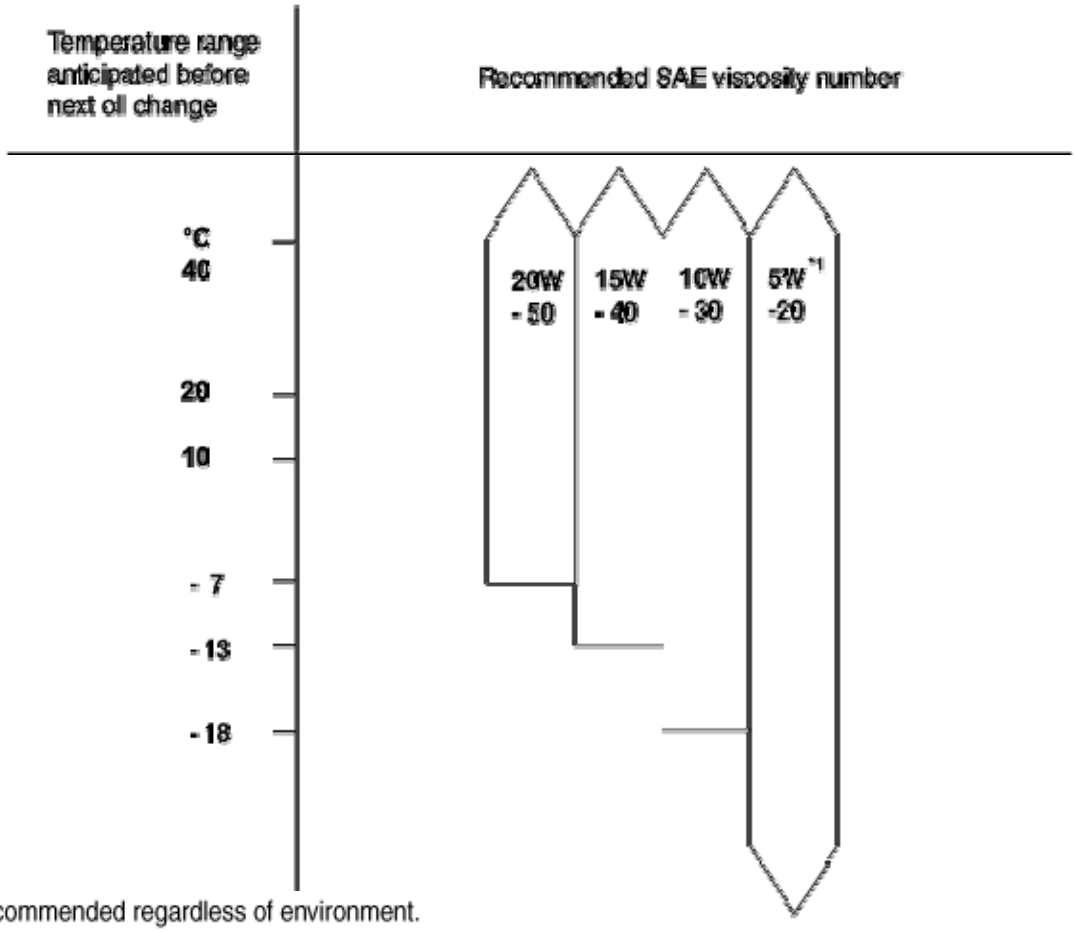
Description	OIL Q`TY(LITERS)		Oil & Grease standard
ENG OIL LPG 2.4L(L4KB)	TOTAL ENG OIL Q`TY	5.7 L	API SM or ABOVE / SAE 5W -20 *1, *2
	OIL PAN Q`TY	4.8 L	1. SAE 5W-20 engine oil is preferred regardless of regional option and engine variation. 2. If 5W-20 engine oil is not available, secondary recommended engine oil can be used for corresponding
	DRAIN AND REF OIL Q`TY	5.2L	
	CHANGE INTERVAL OF OIL & OIL FILTER	NORMAL DRIVE	15000km(9300 mile) or 375 hour
		SEVERE DRIVE	7500 km(4600 mile) or 188 hour

Selection Of Engine Oil

Recommended ILSAC classification : GF4 OR ABOVE

Recommended API classification : SM OR ABOVE

Recommended SAE viscosity grades :



*1 : Recommended regardless of environment.
If not available, refer to the recommended SAE viscosity numbers.

NOTE

For best performance and maximum protection of all types of operation, select only those lubricants which :

1) Satisfy the requirement of the API classification.

2) Have proper SAE grade number for expected ambient temperature range.

3) Lubricants that do not have both an SAE grade number and API service classification on the container should not be used.

Specifications

Specifications

Description		Specification	Limit
General			
Type		In-line, Double Overhead Camshaft	
Number of cylinder		4	
Bore		88mm	
Stroke		87mm	
Total displacement		2,359cc	
Compression ratio		10.5 : 1	
Firing order		1-3-4-2	
Valve timing			
Intake valve			
Opens (ATDC)		5°	
Closes (ABDC)		39°	
Exhaust			
Opens (ATDC)		42°	
Closes (ATDC)		6°	
Cylinder head			
Flatness of gasket surface		0.05mm or less (0.02mm or less / 100 X 100)	
Flatness of manifold mounting surface			
Intake manifold surface		0.1mm or less	
Exhaust manifold surface		0.1mm or less	
Camshaft			
Cam height			
Intake		42.70mm	
Exhaust		45.40mm	
Journal O.D	NO.1	Intake : Φ30mm, Exhaust : Φ40mm	
	NO.2 ~5	Intake, Exhaust : Φ24mm	
Bearing oil clearance	NO.1	Intake : 0.020 ~ 0.057mm	0.09mm
	NO.1	Exhaust : 0.045 ~ 0.082mm	0.12mm
	NO.2 ~5	Intake, Exhaust : 0.045 ~ 0.082mm	0.12mm
End play		0.04 ~ 0.16mm	0.24mm
Valve			
Valve length			
Intake		113.18mm	112.93mm min
Exhaust		105.79mm	105.74mm min
Stem O.D.			
Intake		5.465 ~ 5.480mm	
Exhaust		5.458 ~ 5.470mm	

Specifications

Description	Specification	Limit
Face angle	45.25° ~ 45.75°	
Valve head Margin		
Intake	1.02mm	
Exhaust	1.09mm	
Valve stem to valve guide clearance		
Intake	0.020 ~ 0.047mm	0.07mm max
Exhaust	0.030 ~ 0.054mm	0.09mm max
MLA out dia	31.964 ~ 31.980mm	
Tappet bore inner dia	32.000 ~ 32.025mm	
MLA & Tappet bore claearance	0.020 ~ 0.061mm	0.07mm max
Valve seat		
Width of seat contact		
Intake	1.16 ~ 1.46mm	
Exhaust	1.35 ~ 1.65mm	
Seat angle		
Intake	44.75° ~ 45.10°	
Exhaust	44.75° ~ 45.10°	
Valve Guide		
Length(In / Exhaust)	43.8 ~ 44.2mm	
In Dia	5.500 ~ 5.512mm	
Valve spring		
Free length	47.44mm	
Load	19.0 ± 0.6kg/35.0mm	
	39.8 ± 1.2kg/26.0mm	
Squareness	max 1.5°	
Valve clearance		
Cold (20°C[68°F])		
Intake	0.17 ~ 0.23mm	0.10 ~ 0.30mm
Exhaust	0.32~0.38mm	0.20 ~ 0.40mm
Cylinder block		
Cylinder bore	88.000 ~ 88.03mm	
Out-of-round and taper of cylinder bore	0.05mm or less (0.02mm or less/ 100 X 100)	
Piston		
O.D (To set limits to new parts)	87.975~ 88.005mm	
Clearance with cylinder bore	0.015 ~ 0.035mm	
Ring groove width		
No.1	1.235 ~ 1.25mm	1.26mm
No.2	1.23 ~ 1.25mm	1.26mm
No.3(oil ring)	2.01 ~ 2.03mm	2.05mm

Specifications

Description	Specification	Limit
Piston ring		
Side clearance		
No.1 Ring	0.03 ~ 0.08mm	0.1mm
No.2 Ring	0.05 ~ 0.08mm	0.1mm
Oil Ring	0.06 ~ 0.15mm	0.2mm
End gap		
No.1 Ring	0.15 ~ 0.30mm	0.6mm
No.2 Ring	0.37 ~ 0.52mm	0.7mm
Oil Ring	0.20 ~ 0.70mm	0.8mm
Piston Pin		
O.D Dia	21.001 ~ 21.006mm	
Piston Pin Hole Dia	21.016 ~ 21.024mm	
Piston Pin Hole Clearance	0.013 ~ 0.023mm	
Piston Pin Press Load	250 ~ 1250kg	
Connecting Rod		
Small end Dia	20.974 ~ 20.985mm	
Big end Dia	51.000 ~ 51.018mm	
Bending	0.05mm or less	
Twist	0.1mm or less	
Con rod big end to crankshaft side clearance	0.10 ~ 0.25mm	0.35mm
Connecting Rod Bearing Oil Clearance	0.027 ~ 0.045mm	0.05mm
Crankshaft		
Journal O.D.	51.942 ~ 51.960mm	
Pin O.D.	47.954 ~ 47.972mm	
Main Bearing Oil clearance	0.02~ 0.038mm	0.1mm
End play	0.07 ~ 0.25mm	
Cooling System		
Cooling method	Water cooled, pressurized,forced circulation with mechanical fan	
Coolant quantity	?	
Thermostat		
Type	Wax pellet type with jiggle valve	
Valve opening temperature	82 ± 1.5°C	
Valve Closing temperature	77°C	
Full-opening temperature	95°C	
Engine coolant temperature sensor		
Type	Heat-sensitive thermister type	
Resistance		
20°C	2.45 ± 0.14kΩ	
80°C	0.3222kΩ	

Specifications

Tightening Torque

Item	Q`TY	N.m	kgf.m	lb-ft
Upper oil pan bolt	9	23.5 ~ 27.4	2.4 ~ 2.8	17.4 ~ 20.2
Oil pump bolt	4	23.5 ~ 27.4	2.4 ~ 2.8	17.4 ~ 20.2
Timing chain cover bolt(M8)	9	18.6 ~ 22.5	1.9 ~ 2.3	13.7 ~ 16.6
Timing chain cover bolt(M6)	9	7.8 ~ 9.8	0.8 ~ 1.0	5.8 ~ 7.2
Oil pan bolt	16	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
camshaft bearing cap bolt (M6)	16	10.8 ~ 12.7	1.1 ~ 1.3	7.9 ~ 9.4
Camshaft bearing cap bolt (M8)	4	27.4 ~ 31.4	2.8 ~ 3.2	20.3 ~ 23.1
Cylinder Head bolt	10	34.3 + 90° + 90°	3.5 + 90° +90°	25.3 + 90° + 90°
Cylinder head cover bolt	18	7.8 ~ 9.8	0.8 ~ 1.0	5.8 ~ 7.2
Crankshaft pulley bolt	1	166.6 ~ 176.4	17.0 ~ 18.0	122.9 ~ 130.1
Flywheel bolt	7	117.6 ~ 127.4	12.0 ~ 13.0	86.8 ~ 93.9
Drive plate bolt	7	117.6 ~ 127.4	12.0 ~ 13.0	86.8 ~ 93.9
Timing chain tensioner bolt	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain tensioner arm bolt	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain guide bolt	3	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Camshaft sprocket bolt	2	53.9 ~ 63.7	5.5 ~ 6.5	39.7 ~ 47.0
Oil pump chain guide bolt	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Oil pump chain tensioner arm bolt	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Water pump bolt (8×95)	3	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Water pump bolt (8×70)	2	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Tensioner & idler bolt (10×75)	2	39.2 ~ 44.1	4.0 ~ 4.5	28.9 ~ 32.5
Tensioner & idler bolt (10×90)	3	39.2 ~ 44.1	4.0 ~ 4.5	28.9 ~ 32.5
Water temp control nut	2	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Water temp control bolt	2	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Oil level gauge assembly bolt	1	7.8 ~ 11.8	0.8 ~ 1.2	5.8 ~ 8.7
Ignition coil bolt	4	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Intake manifold bolt	3	18.6 ~ 27.5	1.9 ~ 2.8	13.7 ~ 20.3
Intake manifold nut	2	18.6 ~ 27.5	1.9 ~ 2.8	13.7 ~ 20.3
Intake manifold stay bolt (front/rear)	8	18.6 ~ 27.5	1.9 ~ 2.8	13.7 ~ 20.3
Exhaust manifold? heater protector bolt	3	7.8 ~ 11.8	0.8 ~ 1.2	5.8 ~ 8.7
Exhaust manifold nut	7	49.0 ~ 53.9	5.0 ~ 5.5	36.2 ~ 39.8
Crankshaft position sensor & cover bolt	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Oxygen sensor	1	39.2 ~ 49.0	4.0 ~ 5.0	28.9 ~ 36.1
Knock sensor bolt	1	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Oil temperature sensor	1	19.6~ 44.1	2.0 ~ 4.0	14.5
Cam position sensor	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Oil pressure switch	1	7.8 ~ 11.8	0.8 ~ 1.2	5.8 ~ 8.7
Main bearing cap bolt	10	29.4 + 120°	3.0 + 120°	21.7 +120°
Oil filter	1	11.8 ~ 15.7	1.2 ~ 1.6	8.7 ~ 11.6
Connecting rod bearing cap bolt	8	19.6 + 90°	2.0 + 90°	14.5 + 90°

Compression

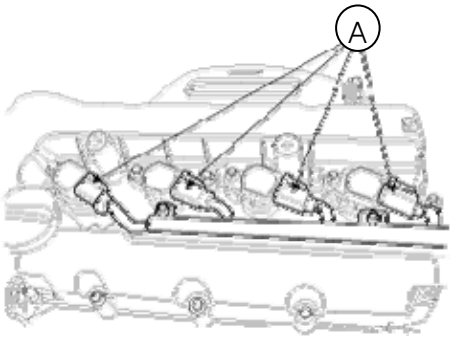
Inspection

Compression Pressure Inspection

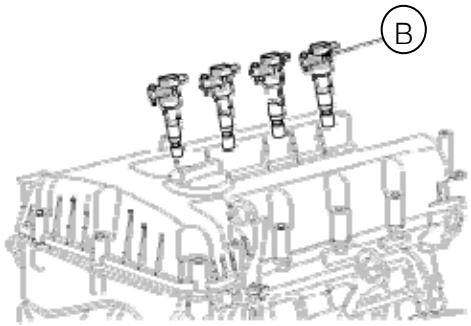
NOTE

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

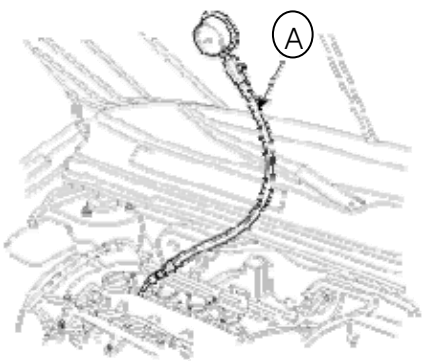
1. Warm up and stop engine.
   Allow the engine to warm up to normal operating temperature(water temp 80~90℃)
2. Disconnect the injector connectors (A)



3. Remove ignition coils(B).
   Remove spark plugs.
   Using a 16mm plug wrench, remove the 4 s/plugs.



4. Check cylinder compression pressure.
   1) Insert a compression gauge into the spark plug hole.



2) Fully open the throttle.

3) While cranking the engine, measure the compression pressure.

NOTE

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

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

NOTE

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

Compression pressure :

1,283kPa (13.0kgf/cm², 185psi)

Minimum pressure :

1,135kPa (11.5kgf/cm², 164psi)

Difference between each cylinder :

100kPa (1.0kgf/cm², 15psi) or less

5) If the cylinder compression in 1 or more cylinders is low, pour a small amount of engine oil into the cylinder through the spark plug hole and repeat steps (1) through (3) for cylinders with low compression.

- If adding oil helps the compression, it is likely that the piston rings and/or cylinder bore are worn or damaged.
- If pressure stays low, a valve may be sticking or seating is improper, or there may be leakage past the gasket.

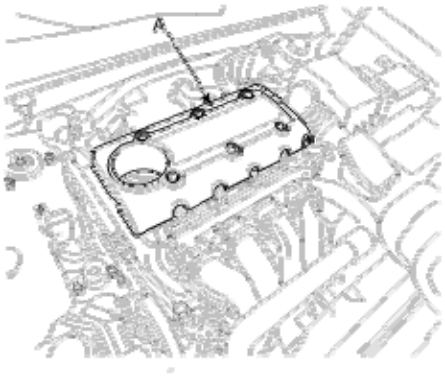
5. Reinstall spark plugs.
6. Install ignition coils.
7. Connect the injector connectors and ignition coil connectors.

Valve Clearance

NOTE

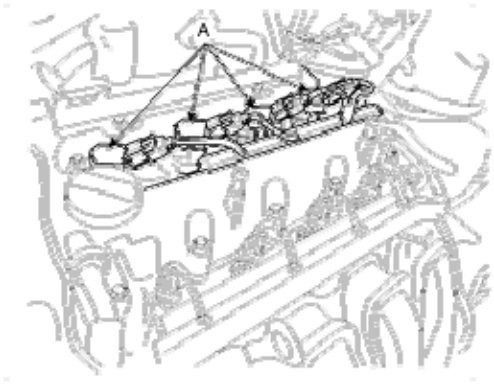
Inspect and adjust the valve clearance when the engine is cold
(Engine coolant temperature : 20°C (68°F)) and cylinder head is installed on the cylinder block.

1. Remove the engine cover(A).

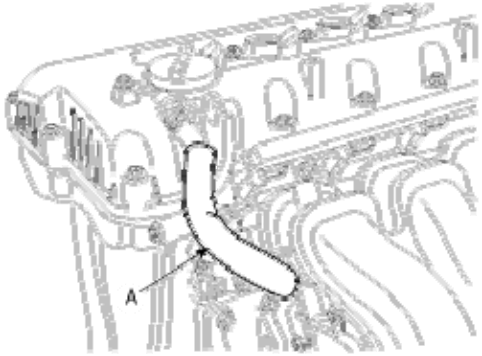


2 Remove the cylinder head cover.

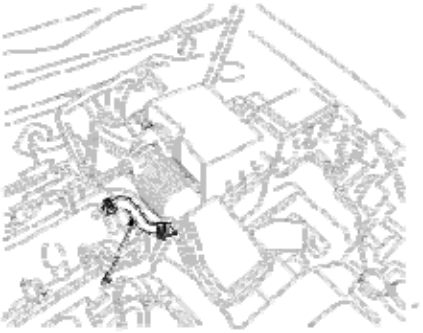
A. Disconnect the ignition coil connectors(A) and remove the ignition coils.



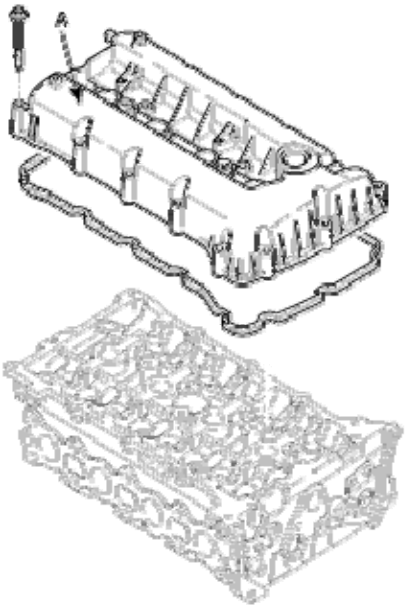
B. Disconnect the P.C.V hose(A).



C. Disconnect the breather hose (A).

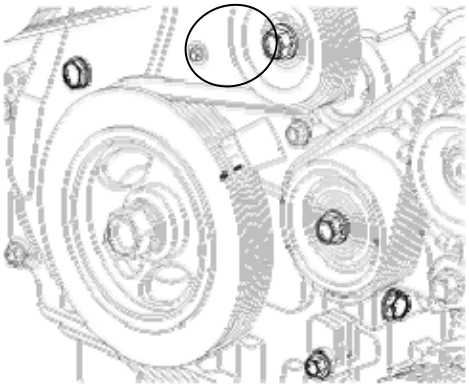


D. Loosen the cylinder head cover bolts and then remove the cover(A) and gasket.

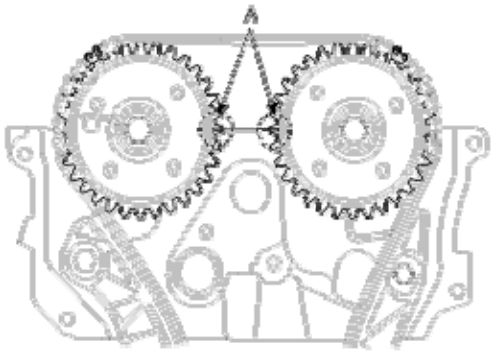


3. Set No.1 cylinder to TDC/compression.

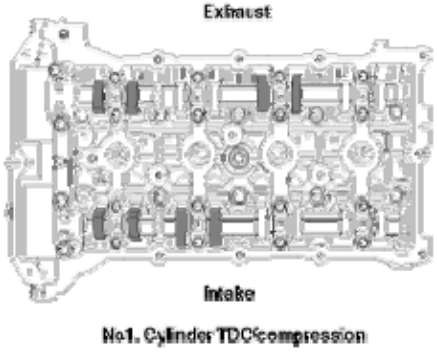
A. Turn the crankshaft pulley and align its groove with the timing mark "T" of the lower timing chain cover.



B. Check that the mark(A) of the camshaft timing sprocket are in straight line on the cylinder head surface as shown in the illustration.
If not, turn the crankshaft one revolution (360°)



4. Inspect the valve clearance.
A. Check only the valve indicated as shown.
[No. 1 cylinder : TDC/Compression] measure the valve clearance.
At this stage measure intake valve clearences on no.1 & no.2 cylinder and exhaust valve cleaences on no.1 & no.3 cylinder.



* Using a thickness gauge, measure the clearance between the tappet and the base circle of camshaft.
* Record the out-of-specification valve clearance measurements. They will be used later to determine the required replacement adjusting tappet.

Valve clearance

Specification

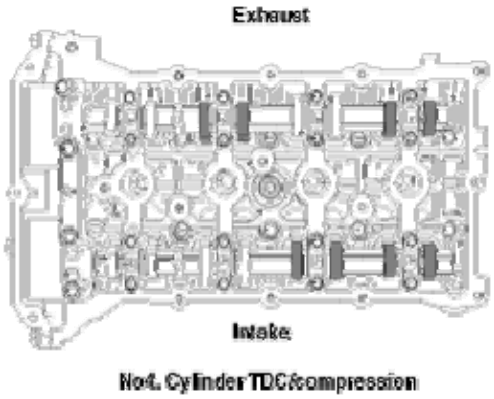
Engine coolant temperature : 20°C [68°F]

Limit

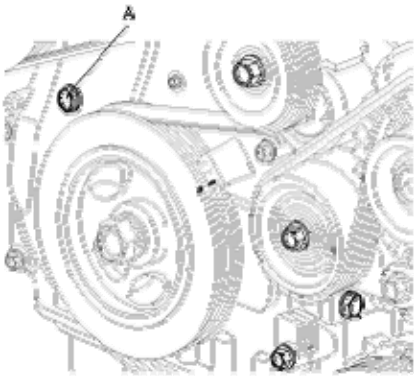
Intake : 0.10 ~ 0.30mm (0.0039 ~ 0.0118in.)

Exhaust : 0.20 ~ 0.40mm (0.0079 ~ 0.0157in.)

B. Turn the crankshaft pulley one revolution (360°) and align the groove with timing mark "T" of the lower chain cover.
C. Check only valves indicated as shown. [NO. 4 cylinder : TDC/compression]. Measure the valve clearence.



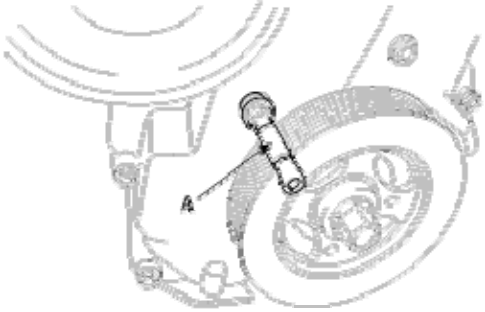
5. Adjust the intake and exhaust valve clearance.
A. Set the No.1 cylinder to the TDC/compression.
B. Marks on the timing chain and camshaft timing sprockets
C. Remove the service hole bolt(A) of the timing chain cover.



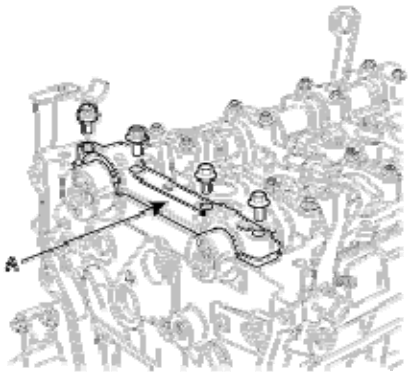
CAUTION

The bolt must not be reused once it has been assembled.

D. Insert the SST(A) (09240-2G000) in the service hole of the timing chain cover and release the ratchet.



E. Remove the front camshaft bearing cap(A).



F. Remove the exhaust camshaft bearing cap and exhaust camshaft

G. Remove the intake camshaft bearing cap and intake camshaft.

CAUTION

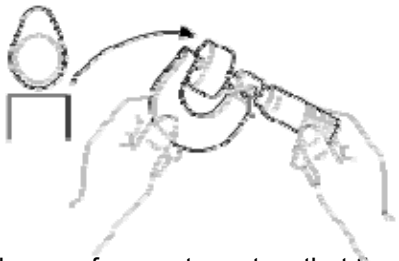
When disconnect the timing chain from the camshaft timing sprocket, hold the timing chain.

H. Tie down timing chain so that it dosen't move.

CAUTION

Be careful not to drop anything inside timing chain cover

I. Measure the thickness of the removed tappet using a micrometer.



J. 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 - 0.20mm(0.0079in.)]

Exhaust : N = T + [A-0.30mm (0.0118in.)]

K. Select a new tappet with a thickness as close as possible to the calculated value.

CAUTION

Shims are available in 47 size increments of 0.015mm (0.0006in.) from 3.00mm (0.118in.) to 3.690mm (0.1452in.)

L. Place a new tappet on the cylinder head.

M. Hold the timing chain, and install the intake camshaft and timing sprocket assembly.

N. Align the matchmarks on the timing chain and camshaft timing sprocket.

O. Install the intake and exhaust camshaft.

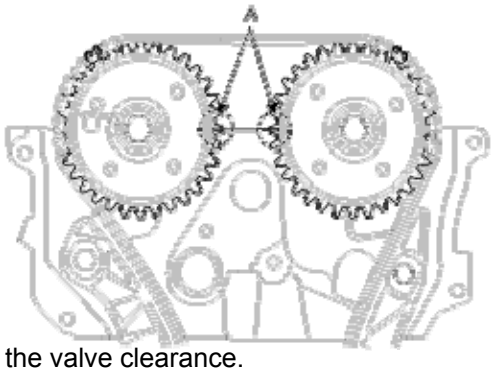
P. Install the front bearing cap.

Q. Install the sevice hole bolt.

Tightening torque :

11.8 ~ 14.7N.m (1.2 ~ 1.5kgf.m, 8.7 ~ 10.8lb-ft)

R. Turn the crankshaft two turns in the operating direction (clockwise) and realign crankshaft sprocket and camshaft sprocket timing marks(A).



S. Recheck the valve clearance.

Valve clearance (Engine coolant temperature : 20°C)

[Specification]

Intake : 0.17 ~ 0.23mm (0.0067 ~ 0.0090in.)

Exhaust : 0.32~0.38mm(0.0126~0.0149in.)

Troubleshooting

Symption	Suspect area	Remedy
Engine misfire with abnormal internal lower engine noises.	Worn crankshaft bearings	Replace the crankshaft and bearings as required
	Loose or improperly engine filwheel	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 buidup on the valve stem)	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 valve lifters.
Engine misfire with coolant consumption.	* Faulty or crank of cylinder head gasket or other damage to the cylinder head and engine block cooling system. * Coolant consumption may or may not cause the engine to overheat.	* Inspect the cylinder head and engine block for damage to the coolant passages and/or a faulty head gasket. * Repair or replace as required.
Engine 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.
	Stetched 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 timing camshaft and valve lifters as required.
	Worn valve guides or valve stems.	Inspect the valves and valve guides, then repair or replace 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 or replace as required.
	Worn drive belt, idler, tensioner and bearing.	Replace as required

Troubleshooting

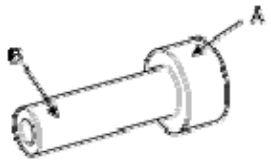
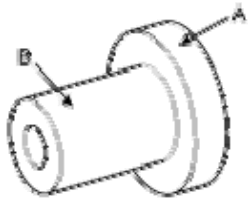
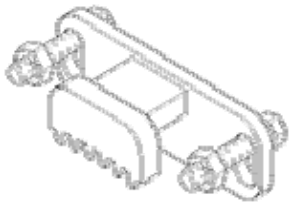
Symption	Suspect area	Remedy
Lower engine noise, regardless of engine speed	Low oil pressure	Repair or required
	Loose or damaged flywheel.	Repair or replace the flywheel.
	Damaged oil pan, contacting the oil pump screen.	* Inspect the oil pan. * Inspect the oil pump screen. * Repair or replace as required.
	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, piston pin and cylinder bore. * Repair or replace as required.
	Excessive piston pin-to-piston clearance	* Inspect the piston, piston pin and the con-rod. * Repair or replace as required.
	Excessive connecting rod bearing clearance	Inspect the following components and repair or replace as required. * The connecting rod bearings. * The connecting rods. * The crankshaft pin journals.
	Excessive crankshaft bearing clearance	Inspect the following components, and repair or replace as required. * The crankshaft bearings. * The crankshaft main journals. * The cylinder block
	Incorrect piston, piston pin and connecting rod installation	* Verify the piston pins and connecting rods are installed correctly. * Repair as required.
Engine noise under load	Low oil pressure	Repair or replace as required.
	Excessive connecting rod bearing clearance	Inspect the following components and repair or replace as required. * The connecting rod bearings. * The connecting rods. * The crankshaft
	Excessive crankshaft bearing clearance	Inspect the following components, and repair or replace as required. * The crankshaft bearings. * The crankshaft main journals. * The cylinder block.

Troubleshooting

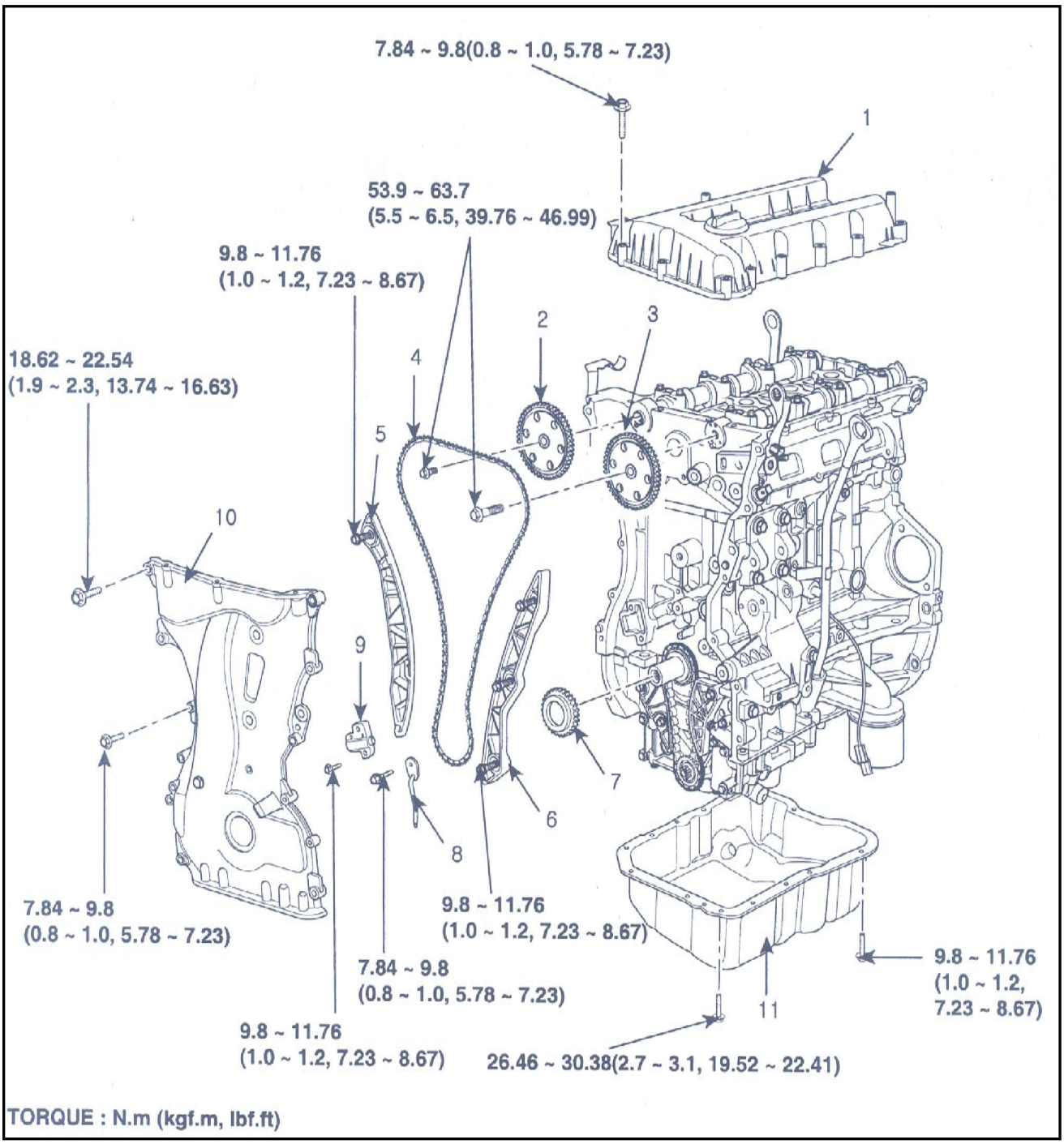
Symption	Suspect area	Remedy
Engine will not crank-crankshaft will not rotate	Hydraulically locked cylinder • Coolant/antifreeze in cylinder. • Oil in cylinder. • Fuel in cylinder	1. Remove spark plugs and check for fluid. 2. Inspect for broken head gasket. 3. Inspect for cracked engine block or cylinder head. 4. Inspect for a sticking fuel injector and/or leaking fuel regulator.
	Broken timing chain and/or timing chain gears.	1. Inspect timing chain and gears. 2. Repair as required.
	Material in cylinder • Broken valve • Piston material • Foreign material	1. Inspect cylinder for damaged components and/or foreign materials. 2. Repair or replace as required.
	Seized crankshaft or connecting rod bearings.	1. Inspect crankshaft and connecting rod bearing. 2. Repair as required.
	Bent or broken connecting rod.	1. Inspect connecing rods. 2. Repair as required.
	Broken crankshaft	1. Inspect crankshaft. 2. Repair as required.

Special tools

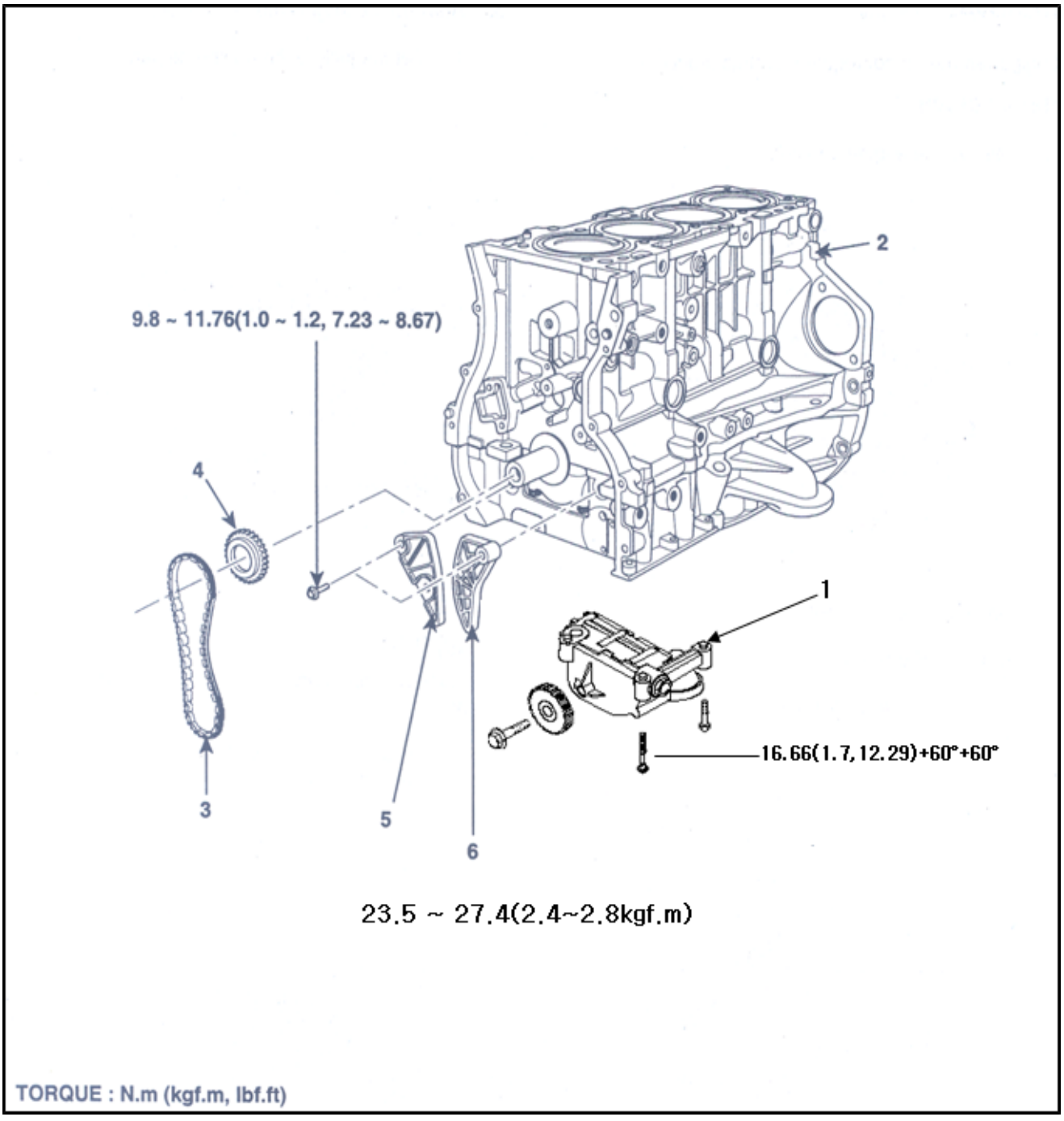
Special service tools

Tool (Number and name)	Illustration	Use
Crankshaft front oil seal installer (09214-3K000) (09231-H1100		Installation of the front oil seal A : 09214-3K000 B : 09231-H1100
Valve stem oil seal installer (09222-4A000)		Installation of the valve stem oil seal
Valve spring compressor & holder (09222-3K000) (09222=3K100)		Removal and installation of the intake or exhaust valve (09231-3K100)
Crankshaft rear oil seal installer (09214-3K100) (09231-H1100)		Installation of the crankshaft rear oil seal A : 09214-3K100 B : 09231-H1100
Flywheel stopper (09231-3K000)		Holds flywheel so that engine dosen't turn/move.
Torque angle adapter (09221-4A000)		Installtion of bolts & nuts needing an angular method of adjustment.
Oil pan remover (09215-3C000)		Oil pan separation/ removal

Component



1. Cylinder head cover	7. Crankshaft sprocket
2. Exhaust camshaft sprocket	8. Oil jet
3. Intake camshaft sprocket	9. Timing chain tensioner
4. Timing chain	10. Timing chain cover
5. Timing chain tensioner arm	11. Oil pan
6. Timing chain guide	

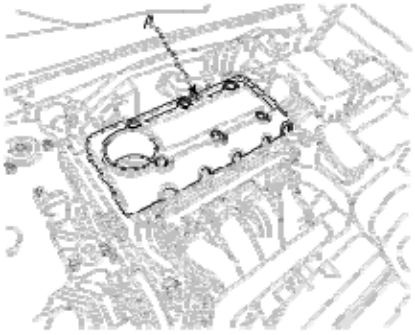


1. Oil pump module	4. Oil pump sproket
2. Cylinder block	5. Oil pump chain guide
3. Oil pump chain	6. Mechanical tensioner assy-o/p chain

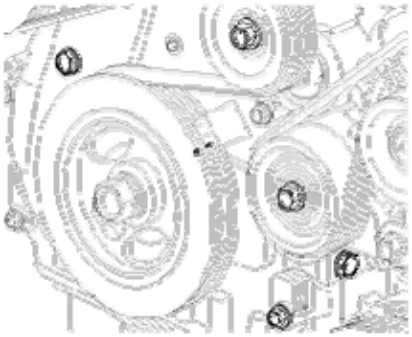
Removal

1 Disconnect the battery nagative cable.

2 Remove the engine cover (A).



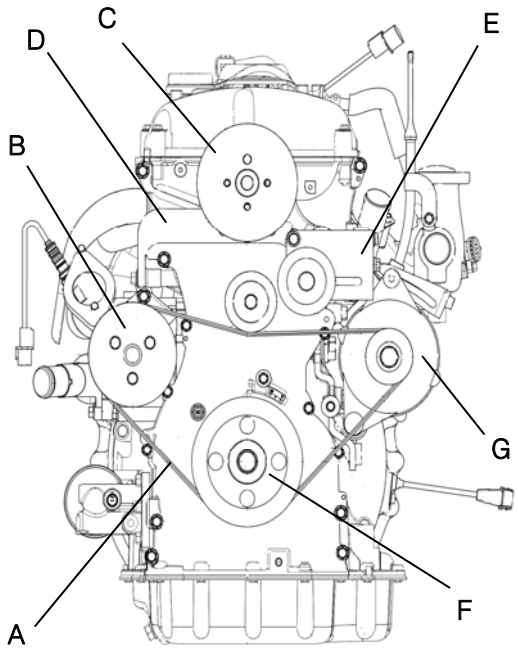
3 Set No.1 cylinder to TDC/compression



4 Drain the engine oil, and then set a jack to the oil pan.

CAUTION

Place wooden block between the jack and engine oil pan



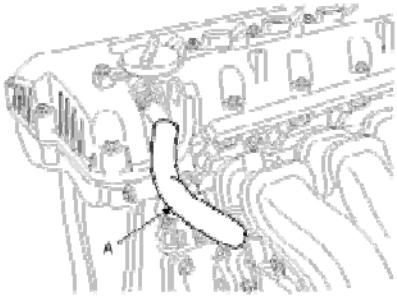
5 Remove the alternator & water pump pulley belt (A).

6 Remove the water pump pulley(B) & fan pulley(C).

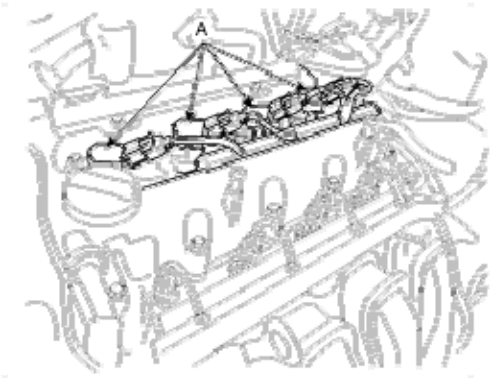
7 Remove the bracket(D) fan pulley & fan pulley tensioner(E).

8 Remove the crank pulley(F) & alternator(G).

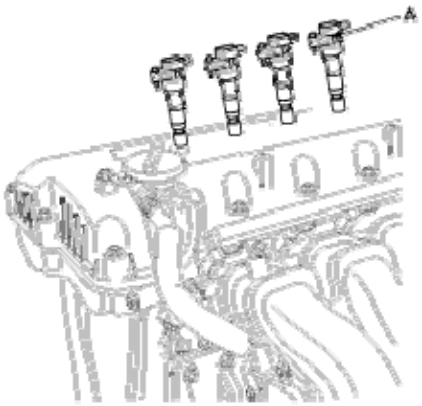
9 Remove the PCV hose (A)



10 Disconnect the ignition coil connectors (A).

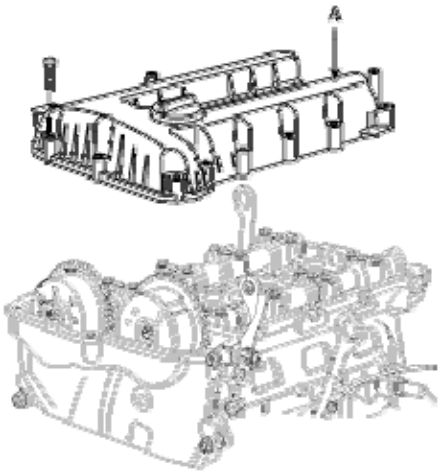


11 Remove the ignition coils (A).

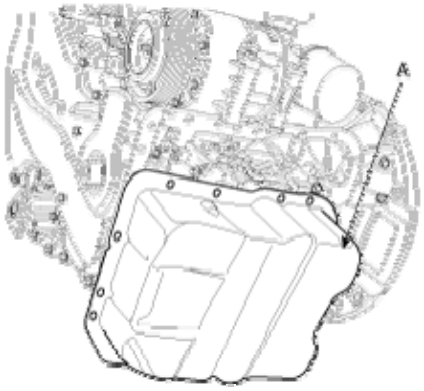


Removal

12 Remove the cylinder head cover (A).



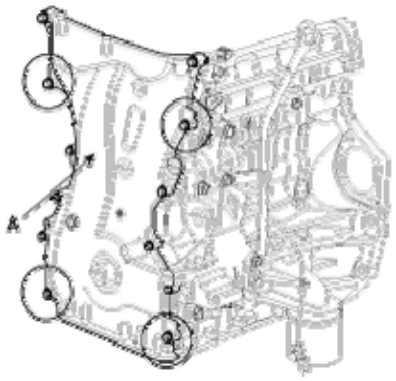
13 Remove the oil pan (A).



CAUTION

Be careful not to damage the contact surfaces of cylinder block and oil pan

14 Remove the timing chain cover (A) by gently prying the portions between the cylinder head and cylinder block.

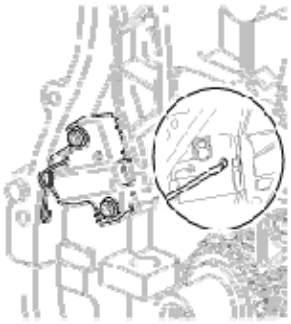


CAUTION

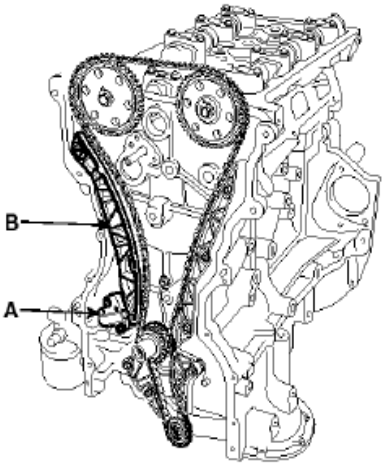
Be careful not to damage the contact surfaces of cylinder block, cylinder head and timing chain cover.

15 The key of crankshaft should be aligned with the mating face of main bearing cap. As a result of this, the piston of No.1 cylinder is placed at the top dead center on compression stroke.

16 Install a set pin after compressing the timing chain tensioner.

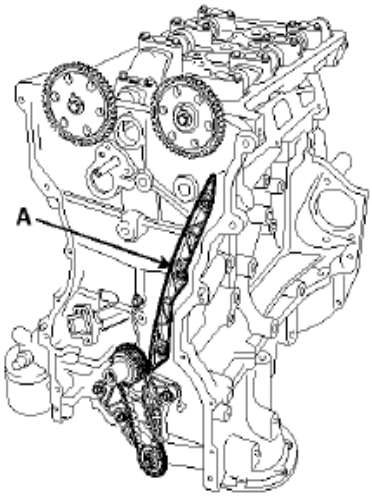


17 Remove the timing chain tensioner (A) and timing chain tensioner arm (B).



18 Remove the timing chain.

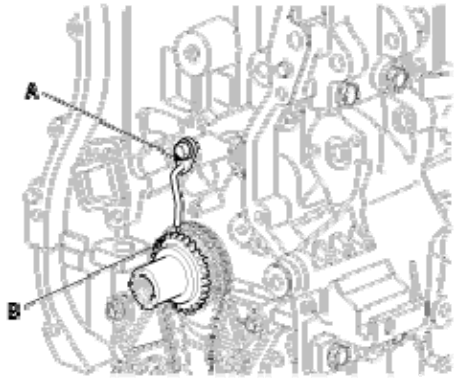
19 Remove the timing chain guide (A).



Removal / Inspection

20 Remove the timing chain oil jet (A).

21 Remove the crankshaft chain sprocket (B).



22 Remove the oil pump chain

(Refer to Lubrication system in this group)

Inspection

Sprockets, Hydraulic Tensioner, Chain Guide, Tensioner Arm

1 Check the cam 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.

Belt, Idler, Pulley

1 Check the idler for excessive oil leakage, abnormal rotation or vibration. Replace if necessary.

2 Check belt for maintenance and abnormal wear of V-ribbed part. Replace if necessary.

3 Check the pulleys for vibration in rotation, oil or dust deposit of V-ribbed part. Replace if necessary.

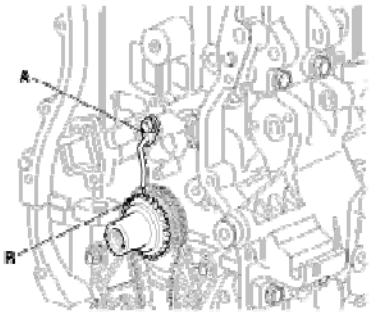
Installation

1 Install the crankshaft chain sprocket (B).

2 Install the timing chain oil jet (A).

Tightening torque :

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

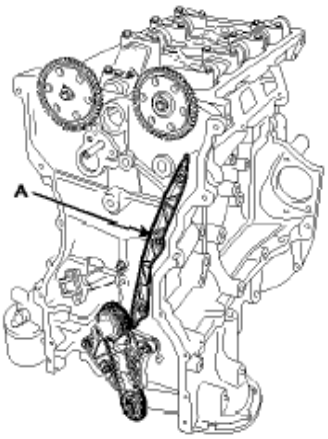


3 Set crankshaft that the key of crankshaft should be aligned with the mating surface of main bearing cap. Put the intake, exhaust camshaft assembly that the TDC mark of intake sprocket and exhaust sprocket should be aligned with the top surface of cylinder head. As a result of this, place the piston on No.1 cylinder at the top dead center on compression stroke.

4 Install the timing chain guide (A).

Tightening torque :

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

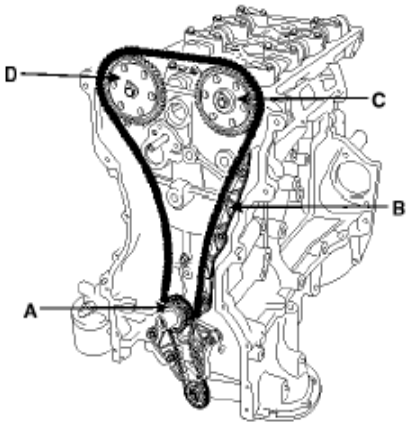


5 Install the tir

To install the timing chain with no slack between each shaft (cam, crank), follow the below procedure.

Crankshaft sprocket (A) → Timing chain guide (B) → Intake Camsprocket ©→ Exhaust cam sprocket assembly (D).

The timing mark of each sprockets should be matched with timing mark (color link) of timing chain at installing timing chain.



6 Install the timing chain tensioner arm (B).

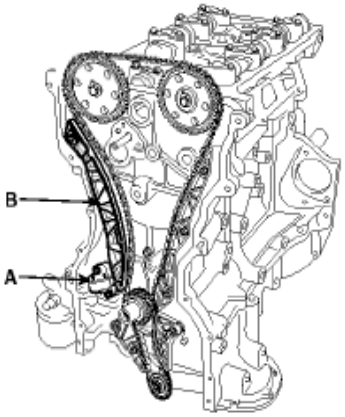
Tightening torque :

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

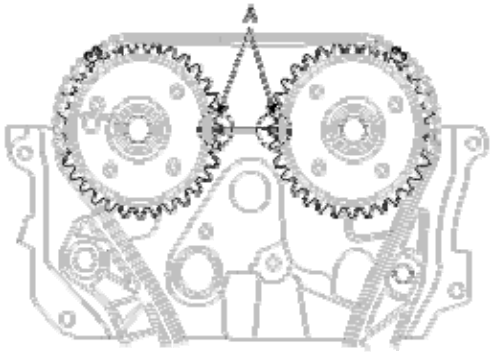
7 Install the timing chain auto tensioner (A) and remove the set pin.

Tightening torque :

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



8 After rotating crankshaft 2 revolutions in regular direction (clockwise viewed from front), confirm the timing mark.



Installation

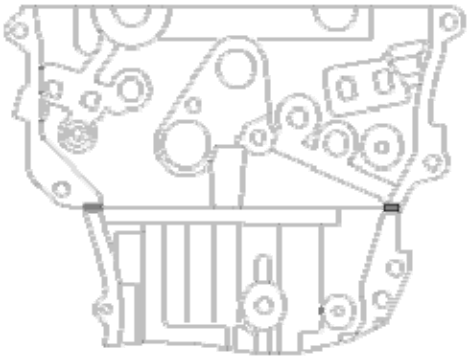
9 Install timing chain cover.

A. Using a gasket scraper, remove all the old packing material from the gasket surfaces.

B. The sealant locations on chain cover and on counter parts (cylinder head, cylinder block, and ladder frame) must be free of engine oil and ETC.

C. Before assembling the timing chain cover, the liquid sealant Loctite 5900H or THREEBOND 1217H should be applied on the gap between cylinder head and cylinder block.
The part must be assembled within 5 minutes after sealant was applied.

Bead width : 3.0mm(0.12in.)



D. After applying liquid sealant Loctite 5900H on timing chain cover. The part must be assembled within 5 minutes after sealant was applied. Sealant should be applied without discontinuity.

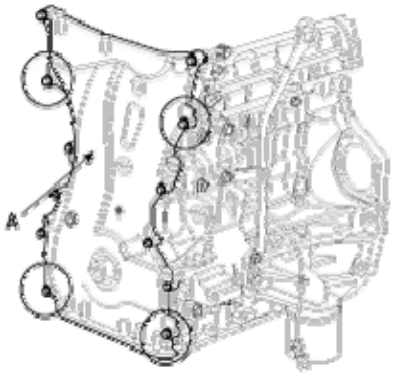
Bead width : 3.0mm(0.12in.)

E. The dowel pins on the cylinder block and holes on the timing chain cover should be used as a reference in order to assemble the timing chain cover to be in exact position.

Tightening torque :

M6 : 7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)

M8 : 18.6 ~ 22.5N.m(1.9 ~2.3kgf.m, 13.7 ~16.6lb-ft)

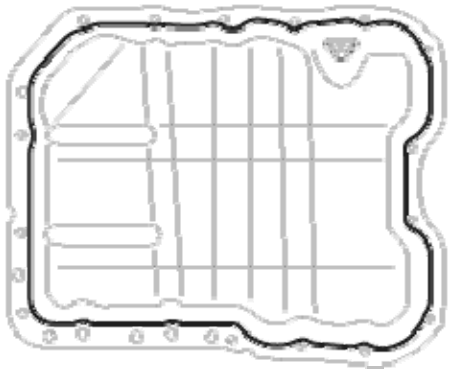


F. The firing and/or blow out test should not be performed within 30 minutes after the timing chain cover was assembled.

10 Install the oil pan

A. Using a gasket scraper, remove all the old packing material from the gasket surfaces.

B. Before assembling the oil pan, the liquid sealant Loctite 5900H or THREEBOND 1217H should be applied on oil pan. The part must be assembled within 5 minutes after the sealant was applied.



CAUTION

When applying sealant gasket, sealant must not be protruded into the inside of oil pan.
To prevent leakage of oil, apply sealant gasket to the inner threads of the bolt holes

C. Install the oil pan (A).
Uniformly tighten the bolts

Tightening torque :

M8 (B) : 26.5~30.4N.m(2.7~3.1kgf.m, 19.5~22.4lb-ft)

M6 (C) : 9.8 ~ 1.8N.m (1.0 ~1.2kgf.m, 7.2 ~8.7lb-ft)

Installation

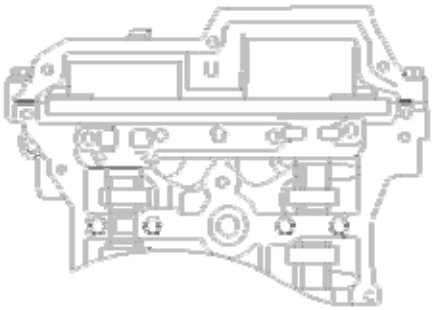
D. After assembly, wait at least 30 minutes before filling the engine with oil.

11 Install the cylinder head cover.

A. The hardened sealant located on the upper area between timing chain cover and cylinder head should be removed before assembling cylinder head cover.

B. After applying sealant (Loctite 5900H), it should be assembled within 5 minutes.

Bead width : 2.5mm(0.1in.)



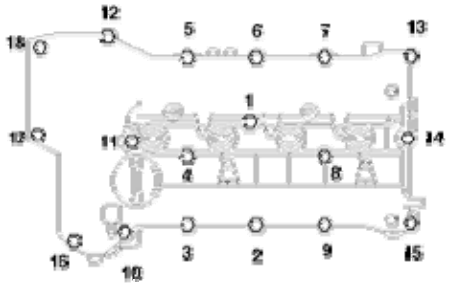
C. The firing and/or blow out test should not be performedassembled. within 30 minutes after the cylinder head cover was assembled.

D. Install the cylinder head cover bolts as following method

Tightening torque :

Step 1 : 3.9 ~ 5.9N.m (0.4 ~ 0.6kgf.m, 2.9 ~ 4.3lb-ft)

Step 2 : 7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)



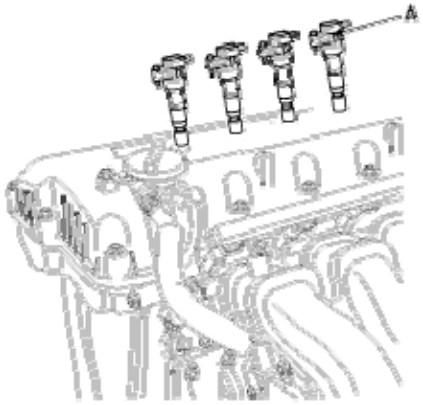
CAUTION

Do not reuse cylinder head cover gasket.

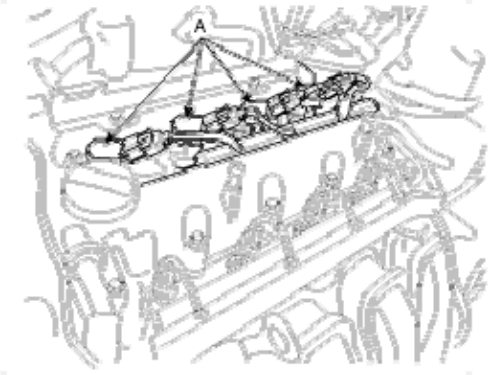
12 Install the ignition coils (A).

Tightening torque :

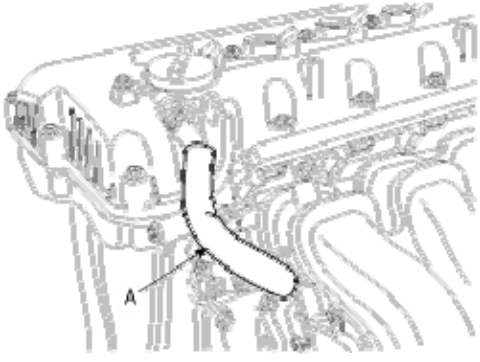
3.9 ~ 5.9N.m (0.4 ~ 0.6kgf.m, 2.9 ~ 4.3lb-ft



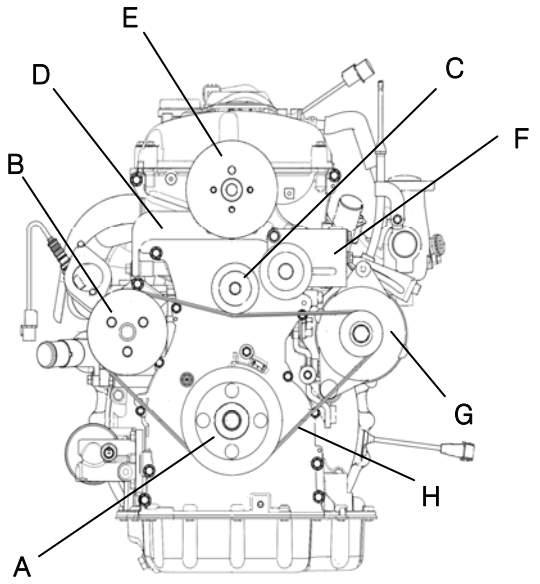
13 Connect the ignition coil connectors (A).



14 Install the PCV hose (A).



Installation



15 Install the crankshaft pulley (A).

Tightening torque :

166.6 ~ 176.4N.m (17.0 ~ 18.0kgf.m, 122.9 ~ 130.1lb-ft)

CAUTION

Use the SST(flywheel stopper, 09231-3K000) to install the crankshaft pulley bolt, after remove the starter.

16 Install the water pump pulley (B).

Tightening torque :

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

17 Install the idler (C).

Tightening torque :

53.9 ~ 63.7N.m (5.5 ~ 6.5kgf.m, 39.7 ~ 47.0lb-ft)

18 Install the fan pulley bracket (D).

Tightening torque :

42.14 ~ 53.9N.m (4.3 ~ 5.5kgf.m, 30.96 ~ 39.60lb-ft)

19 Install the fan pulley (E).

Tightening torque :

18.6 ~ 22.5N.m (1.9 ~ 2.3kgf.m, 13.7 ~ 16.6lb-ft)

20 Install the fan pulley tensioner (F).

Tightening torque :

18.6 ~ 22.5N.m (1.9 ~ 2.3kgf.m, 13.7 ~ 16.6lb-ft)

21 Install the alternator (G).

22 Install the alternator & water pump pulley belt (H).

Belt tension gauge method :

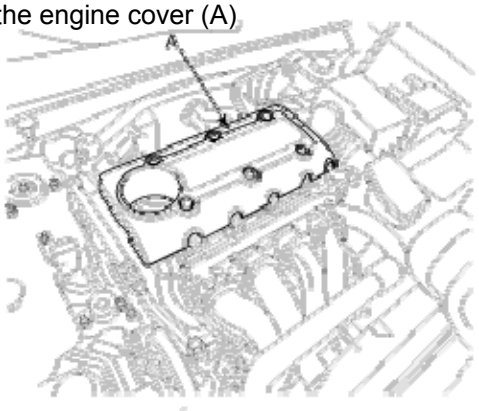
Attach the belt tension gauge to the belt and measure the tension. Follow the gauge manufacturer's instructions.

Tension

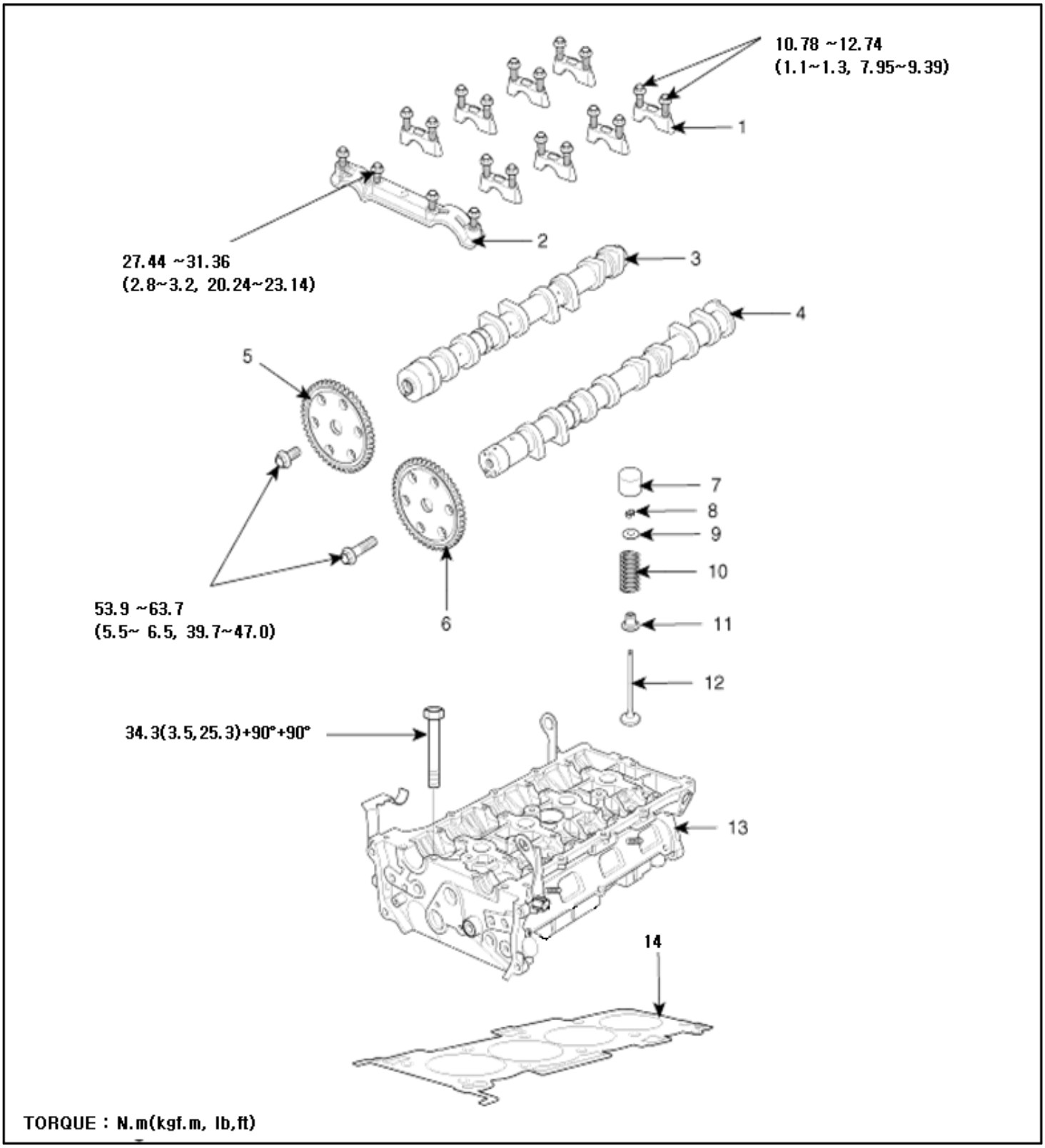
Used Belt : 340~490 N (35~50 kgf, 77~110 lbf)

New Belt : 690~880 N (70~90 kgf, 150~200 lbf)

23 Install the engine cover (A)



Components



1. Camshaft bearing cap	6. Intake camshaft sprocket	11.Valve stem seal
2. Camshaft front bearing cap	7. MLA	12. Valve
3. Exhaust camshaft	8. Retainer	13. Cylinder head
4. Intake camshaft	9. Retainer lock	14. Cylinder head gasket
5. Exhaust camshaft sprocket	10. Valve spring	

Removal

Engine removal is not required for this procedure

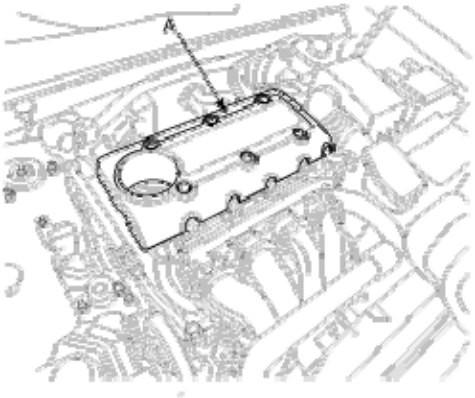
CAUTION

* 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.

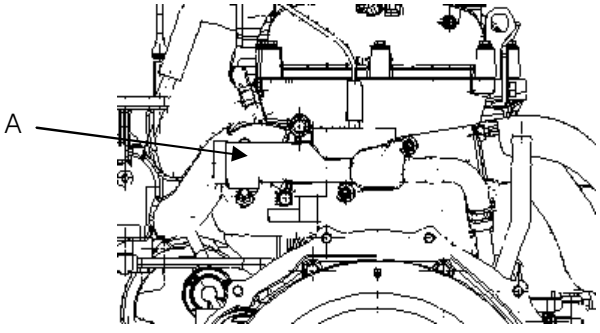
NOTE

* Mark all wiring and hoses to avoid misconnection.
* Turn the crankshaft pulley so that the No1 piston is at top dead center(See page timing)

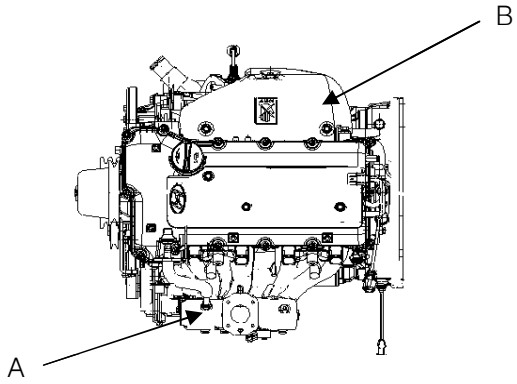
1 Remove the engine cover (A).



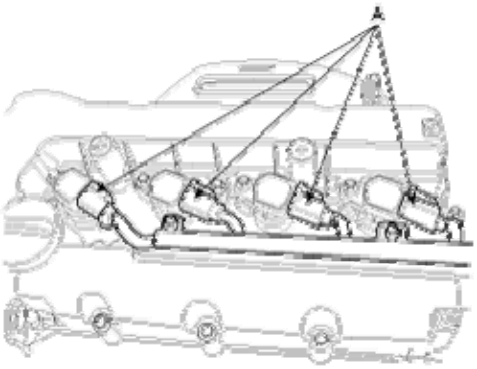
2 Remove the water temp control assembly (A).



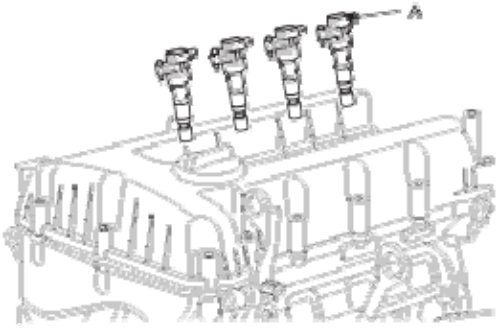
3 Remove the intake manifold(A), Exhaust manifold(B)



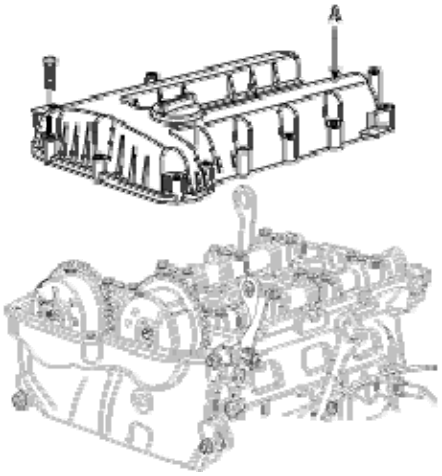
4 Disconnect the ignition coil connectors (A).



5 Remove the ignition coil 4ea (A)



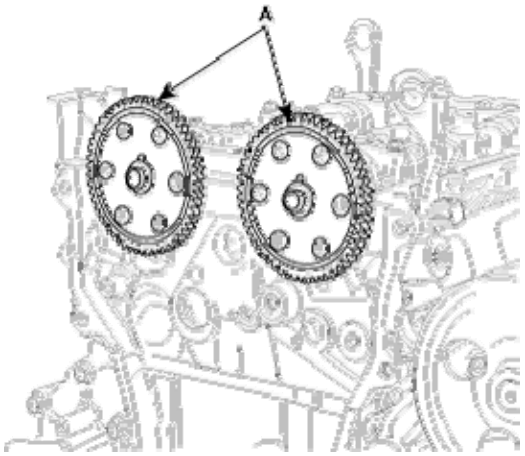
6 Remove the cylinder head cover (A).



Removal

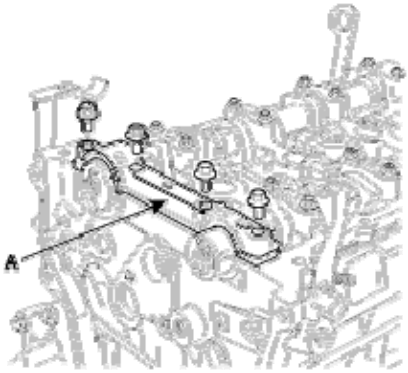
7 Remove the timing chain.
(Refer to Timing system in this group)

8 Remove the intake & exhaust camsprocket.

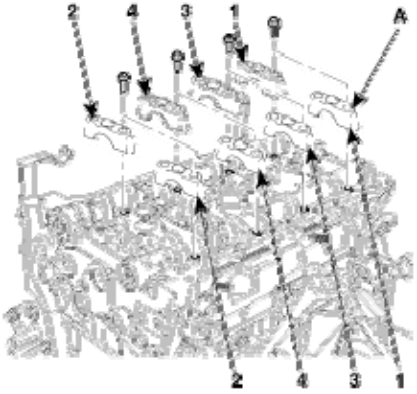


9 Remove the cam shaft.

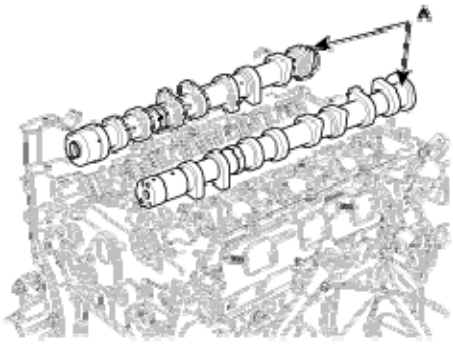
1) Remove the front cam shaft bearing cap (A).



2) Remove camshaft bearing cap (A), in the sequence shown.

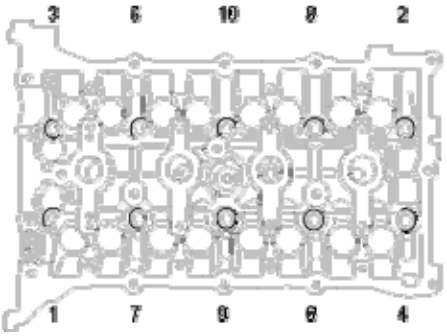


3) Remove the cam shaft (A).



10 Remove the cylinder head bolts, then remove the cylinder head.

1) Using triple square wrench, uniformly loosen and remove the 10 cylinder head bolts, in several passes, in the sequence shown.Remove the 10 cylinder head bolt and plat washers



CAUTION

Head warpage or crack could result from removing bolts in an incorrect order.

2) Lift the cylinder head from the dowels on the cylinder block and place the cylinder head on wooden blocks on a bench.

CAUTION

Be careful not to damage the contact surfaces of the cylinder head and cylinder block

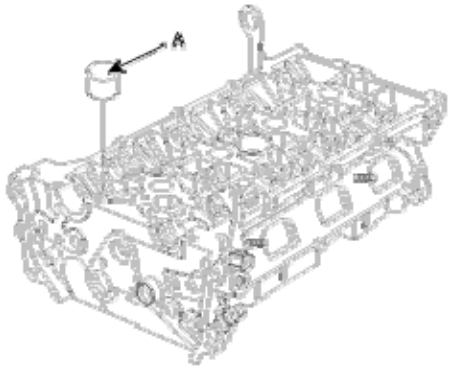
11 Remove the cylinder head gasket

Disassembly / Inspection

NOTE

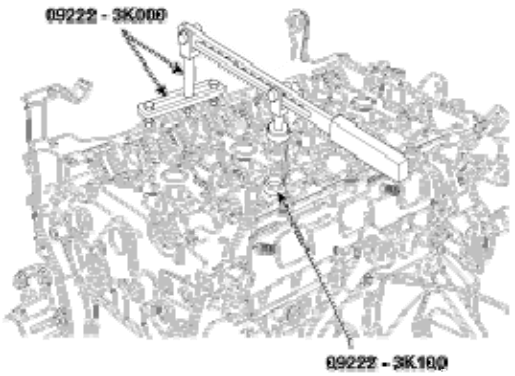
Identify MLA(Mechanical Lash Adjuster), valves, valve springs as they are removed so that each item can be reinstalled in its original position.

1 Remove MLAs(A).



2 Remove valves.

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



2) Remove the spring retainer.

3) Remove the valve spring.

4) Remove the valve.

5) Using needle-nose pliers, remove the valve stem seal.

Inspection

Cylinder Head

1 Inspect for flatness.

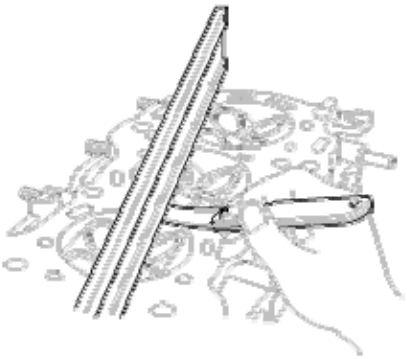
Using a precision straight edge and feeler gauge, measure the surface the contacting the cylinder block and the manifolds for warpage.

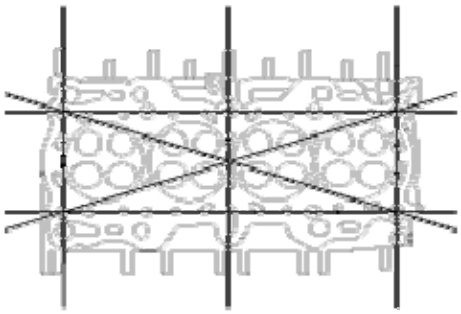
Flatness of cylinder head gasket surface

Standard : Less than 0.05mm(0.002in.)

Flatness of manifold gasket surface

Standard : Less than 0.10mm(0.004in.)





2 Inspect for cracks.

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

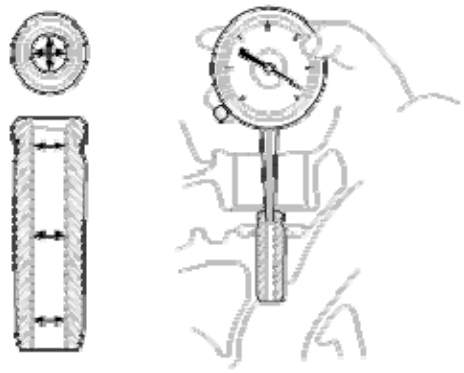
Valve And Valve Spring

1 Inspect valve stems and valve guides.

1) Using a caliper gauge, measure the inside diameter of the valve guide.

Valve guid I.D.

Intake / Exhaust : 5.500 ~ 5.512mm (0.216 ~ 0.217in.)

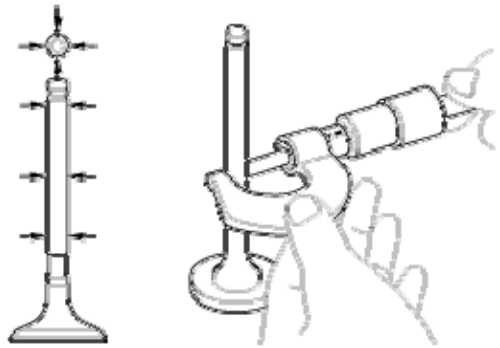


2) Using a micrometer, measure the diameter of the valve stem.

Valve stem O.D.

Intake : 5.465 ~ 5.480mm (0.2151 ~ 0.2157in.)

Exhaust : 5.458 ~ 5.470mm (0.2149 ~ 0.2153in)



3) Subtract the valve stem diameter measurement from the valve guide inside diameter measurement

Valve stem-to-guide clearance

[Standard]

Intake : 0.020 ~ 0.047mm (0.0008 ~ 0.0018in.)

Exhaust : 0.030 ~ 0.054mm (0.0012 ~ 0.0021in.)

[Limit]

Intake : 0.07mm (0.0027in.)

Exhaust : 0.09mm (0.0035in.)

If the clearance is greater than maximum, replace the valve and valve guide.

2 Inspect valves.

1) Check the valve is ground to the correct valve face angle.

2) Check that the surface of the valve for wear.
If the valve face is worn, replace the valve.

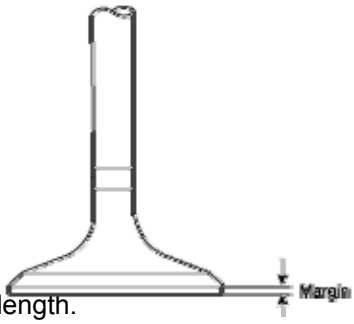
3) Check the valve head margin thickness.
If the margin thickness is less than minimum, replace the valve.

Margin

[Standard]

Intake : 1.02mm(0.0401in.)

Exhaust : 1.09mm(0.0429in.)



4) Check the valve length.

Valve length

[Standard]

Intake : 113.18mm (4.456in.)

Exhaust : 105.79mm (4.165in.)

[Limit]

Intake : 112.93mm (4.446in.)

Exhaust : 105.64mm (4.159in.)

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

3 Inspect valve seats

Check the valve seat for evidence of overheating and improper contact with the valve face.

Replace the seat if necessary.

Before reconditioning the seat, check the valve guide for wear. If the valve guide is worn, replace it, then recondition the seat. Recondition the valve seat with a valve seat grinder or cutter. The valve seat contact width should be within specifications and centered on the valve face.

Inspection

4 Inspect valve springs

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

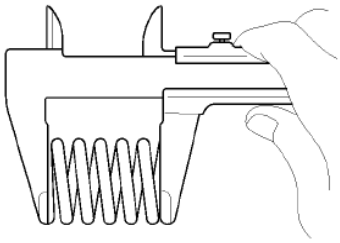
2) Using a vernier calipers, measure the free length of the valve spring.

Valve spring

[Standard]

Free height : 47.44mm (1.8677in.)

Out-of-square : 1.5°



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If the free length is not as specified, replace the valve spring.

MLA

1 Inspect MLA.

Using a micrometer, measure the MLA outside diameter.

MLA O.D.

Intake/Exhaust : 31.964 ~ 31.980mm(1.2584 ~ 1.2590in.)

2 Using a caliper gauge, measure MLA tappet bore inner diameter of cylinder head.

Tappet bore I.D.of cylinder head

Intake/Exhaust : 32.000 ~ 32.025mm(1.2598 ~ 1.2608in.)

3 Subtract MLA outside diameter measurement from tappet bore inside diameter measurement.

MLA to tappet bore clearance

[Standard]

Intake/Exhaust : 0.020 ~ 0.061mm(0.0008 ~ 0.0024in.)

[Limit]

Intake/Exhaust : 0.07mm(0.0027in.)

Camshaft

1 Inspect cam lobes.

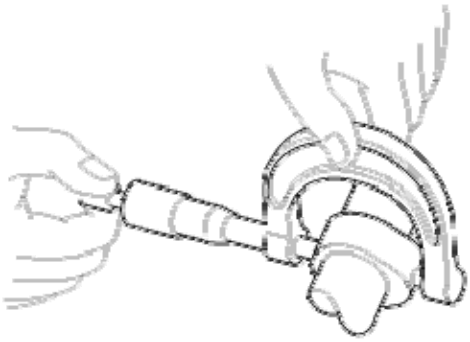
Using a micrometer, measure the cam lobe height.

Cam height

[Standard value]

Intake : 42.6~42.8mm (1.6771 ~ 1.1.6850in.)

Exhaust : 45.3~45.5mm (1.7834 ~ 1.7913in.)



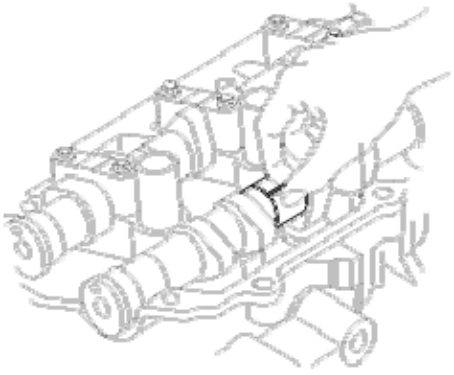
If the cam lobe height is less than standard, replace the camshaft.

2 Inspect 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.

CAUTION

Do not turn the camshaft.

5) Remove the bearing caps.

6) Measure the plastigage at its widest point.

Inspection

Bearing oil clearance

[Standard value]

Intake

No.1.2,3,4,5, journal : 0.045 ~ 0.082mm (0.0018 ~ 0.0032in.)

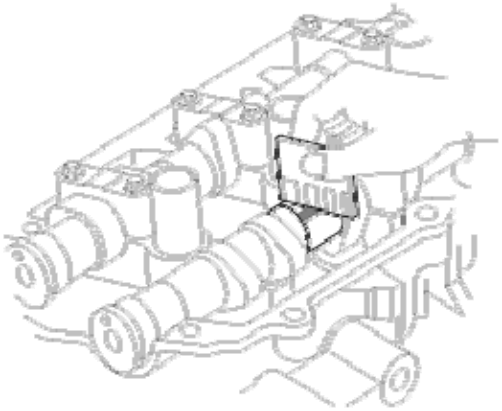
Exhaust

No.1. 2,3,4,5, journal : 0.045 ~ 0.082mm (0.0017 ~ 0.0032in.)

[Limit] :

Intake / Exhaust

No.1.2,3,4,5 journal : 0.12mm (0.0047in.)



If the oil clearance is greater than maximum, replace the camshaft. If necessary, replace cylinder head.

7) Completely remove the plastigage.

8) Remove the camshafts.

3 Inspect camshaft end play.

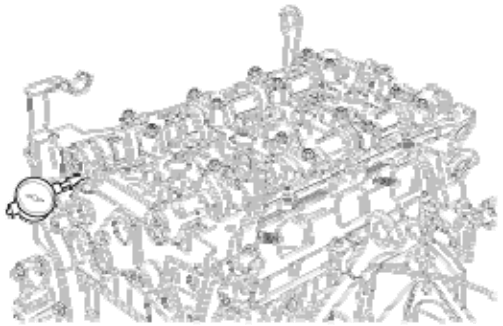
1) Install the camshafts.

2) Using a dial indicator, measure the end play while moving the camshaft back and forth.

Camshaft end play

[Standard value] : 0.04~0.16mm(0.0016 ~ 0.0063)

[Limit] : 0.18mm (0.007087in.)



If the end play is greater than maximum, replace the camshaft. If necessary, replace cylinder head

3) Remove the camshafts.

Reassembly

NOTE

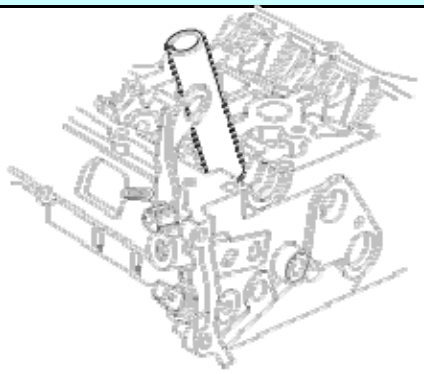
* Thoroughly clean all parts to be assembled.
* Before installing the parts, apply fresh engine oil to all sliding and rotating surfaces.
* Replace oil seals with new ones.

1 Install valves.

1) Using SST(09222-4A000), push in a new oil seal.

CAUTION

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

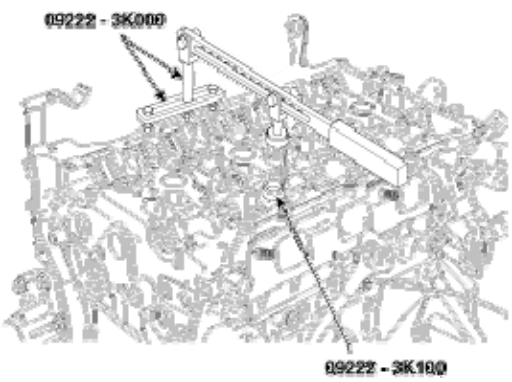


2) Install the valve, valve spring and spring retainer.

CAUTION

* Place valve springs so that the side coated with enamel faces toward the valve spring retainer and then installs the retainer.

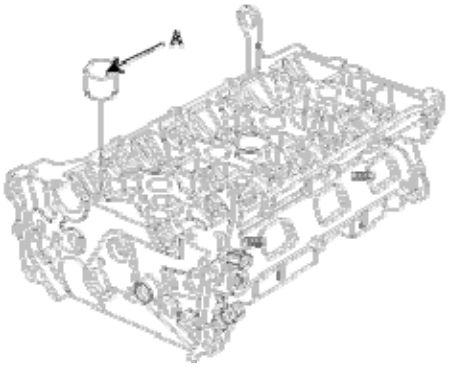
3) Using the SST(09222-3K000, 09222-3K100), compress the spring and install the retainer locks. After installing the valves, ensure that the retainer locks are correctly in place before releasing the valve spring compressor.



4) 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.

2 Install MLAs.

Check that the MLA rotates smoothly by hand.



CAUTION

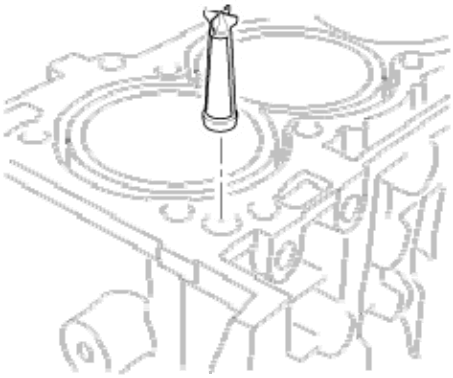
MLA can be reinstalled in its original position.

Installation

CAUTION

* Thoroughly clean all parts to be assembled.
* Always use a new head and manifold gasket.
* The cylinder head gasket is a metal gasket. Take care not to bend it.
* Rotate the crankshaft, set the No.1 piston at TDC.

3 Install OCV filter



CAUTION

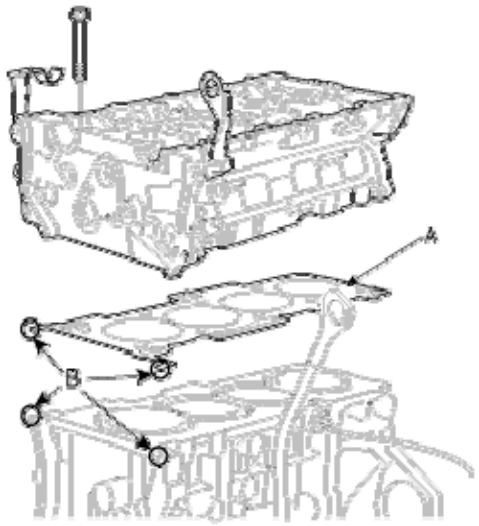
Keep the OCV filter clean.

Installation

4 Install the cylinder head gasket(A) on the cylinder block.

CAUTION

* Be careful of the installation direction.
* Apply liquid gasket (Loctite 5900H) on the mark (B).
* After applying sealant, assemble the cylinder head in five minutes.



5 Place the cylinder head carefully in order not to damage the gasket with the bottom part of the end.

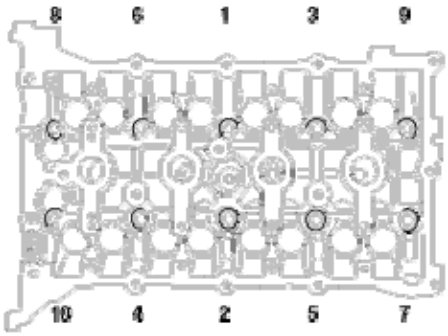
6 Install cylinder head bolts.

A) Apply a light coat if engine oil on the threads and under the heads of the cylinder head bolts.

B) Using hexagon wrench, install and tighten the 10 cylinder head bolts and plate washers, in several passes, in the sequence shown.

Tightening torque :

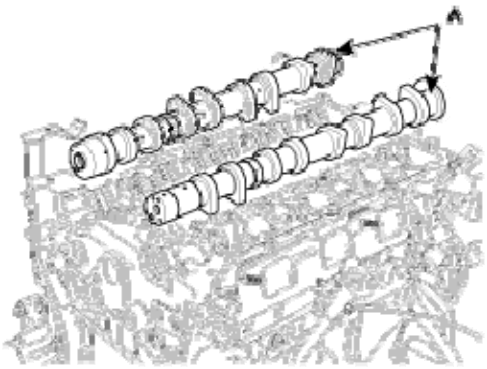
34.3N.m (3.5kgf.m, 25.3lb-ft) + 90° + 90°



CAUTION

Always use new cylinder head bolt.

6 Install the camshafts (A)



CAUTION

Apply a light coat of engine oil on camshaft journals

7 Install camshaft bearing caps in their proper locations,

Tightening order: Group (A)->Group(B)->Group(C)

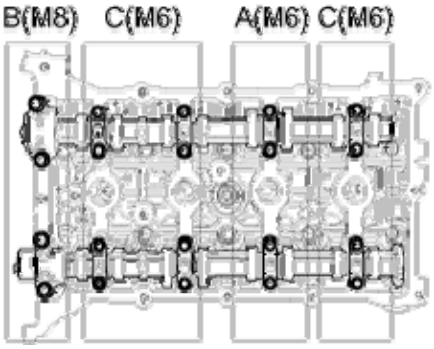
Tightening torque

Step 1 : M6 : 5.9N.m(0.6kgf.m, 4.3lb-ft)

M8 : 14.7N.m(1.5kgf.m, 10.8lb-ft)

Step 2 : M6 : 10.8 ~ 12.7N.m(1.1 ~ 1.3kgf.m, 7.9 ~ 9.4lb-ft)

M8 : 27.5~31.4N.m(2.8 ~ 3.2kgf.m, 20.3~23.1lb-ft)



8 Install the timing chain.(see → timing system)

9 Check and adjust valve clearance

(see → general adjustment).

10 Install the spark plug 4ea

Tightening torque :

19.6 ~ 29.4N.m (2.0 ~ 3.0 kgf.m,14.46 ~ 21.7 lb-ft)

Installation

11 Install the cylinder head cover bolts as following method.

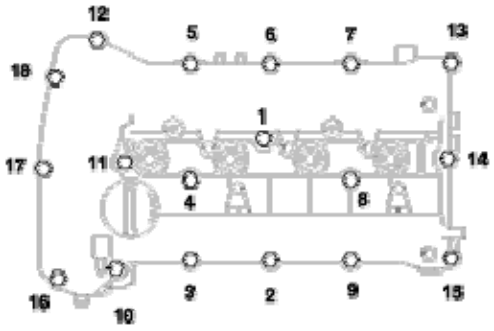
Tightening torque :

Step 1 :

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

Step 2 :

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



12 Install the intake manifold(A)

Tightening torque :

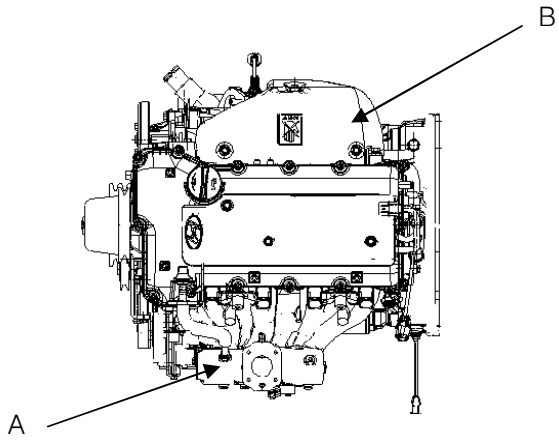
Bolt : 18.6~ 27.4Nm(1.9 ~ 2.8kgf.m.13.7 ~ 20.2lbf.ft)

Nut : 18.6~ 27.4Nm(1.9 ~ 2.8kgf.m.13.7 ~ 20.2lbf.ft)

13 Install the exhaust manifold(B)

Tightening torque :

Nut : 49~ 53.9Nm(5.0~ 5.5kgf.m.36.2 ~ 39.8lbf.ft)

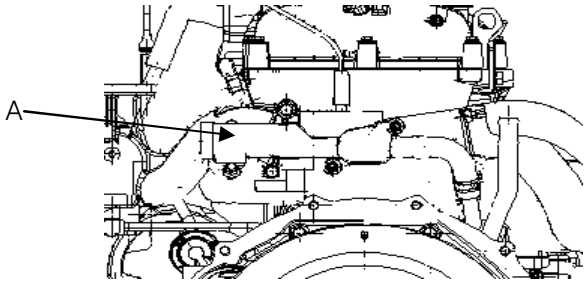


14 Install the water temp control assembly (A).

Tightening torque :

Bolt : 14.7 ~21.56Nm(1.5~2.2kgf.m.10.84~15.9lbf.ft)

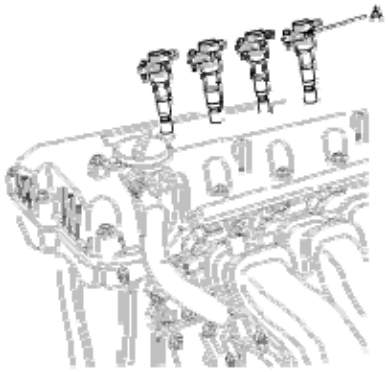
Nut : 19.6 ~ 26.4N.m (2.0 ~ 2.7 kgf.m,14.46 ~ 19.52 lb-ft)



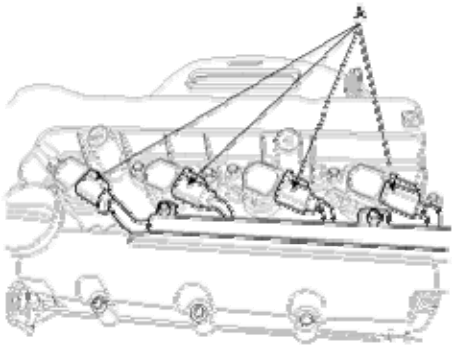
15 Install the ignition coils (A).

Tightening torque :

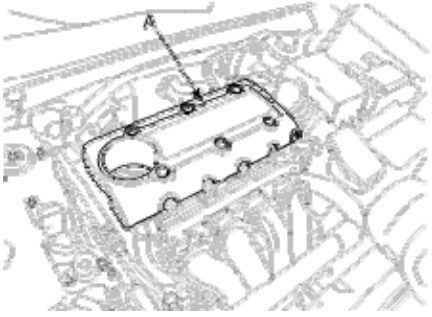
3.9 ~ 5.9N.m (0.4 ~ 0.6kgf.m, 2.9 ~ 4.3lb-ft)



16 Connect the ignition coil connectors (A).



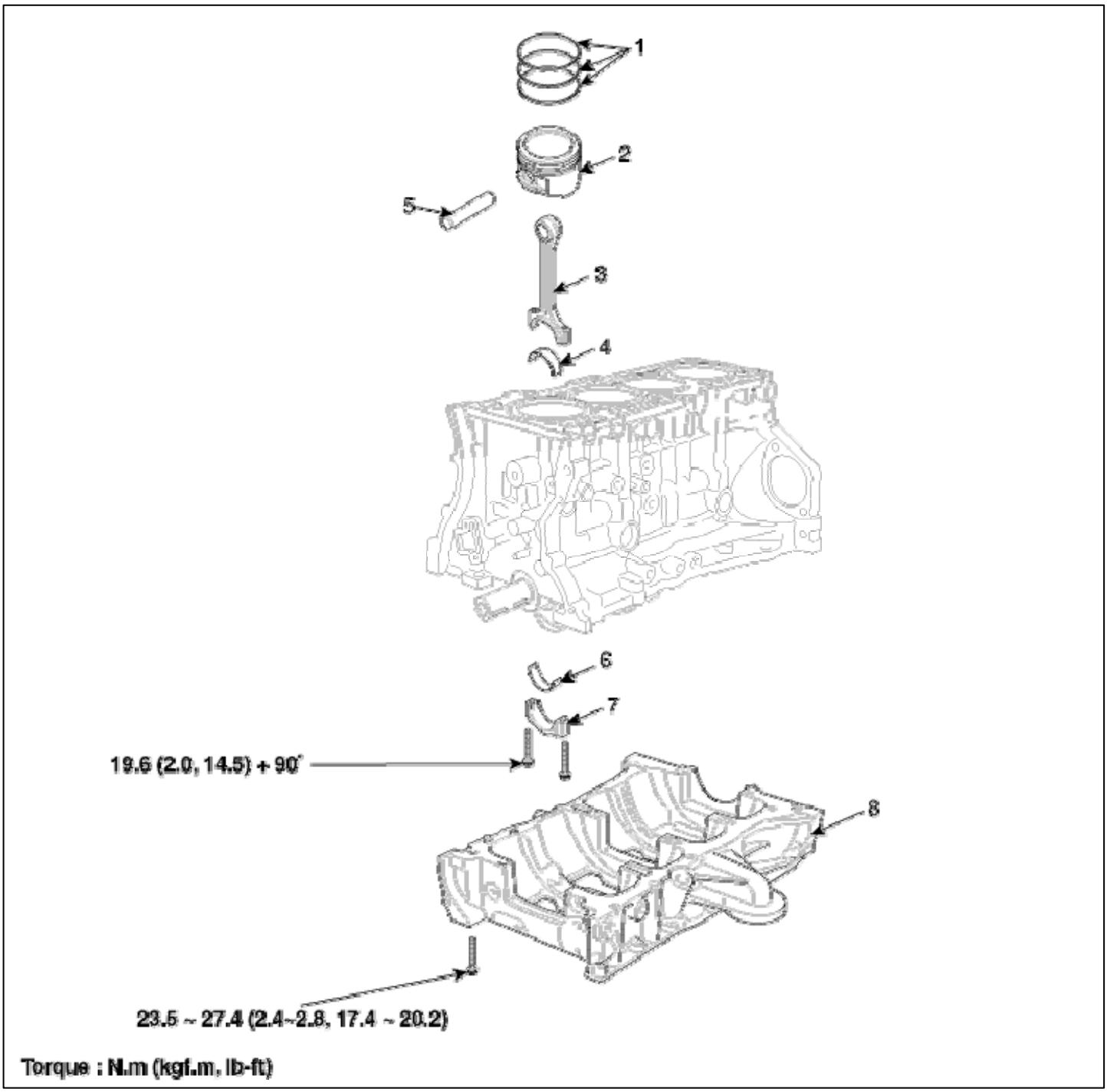
17 Install the engine cover (A).



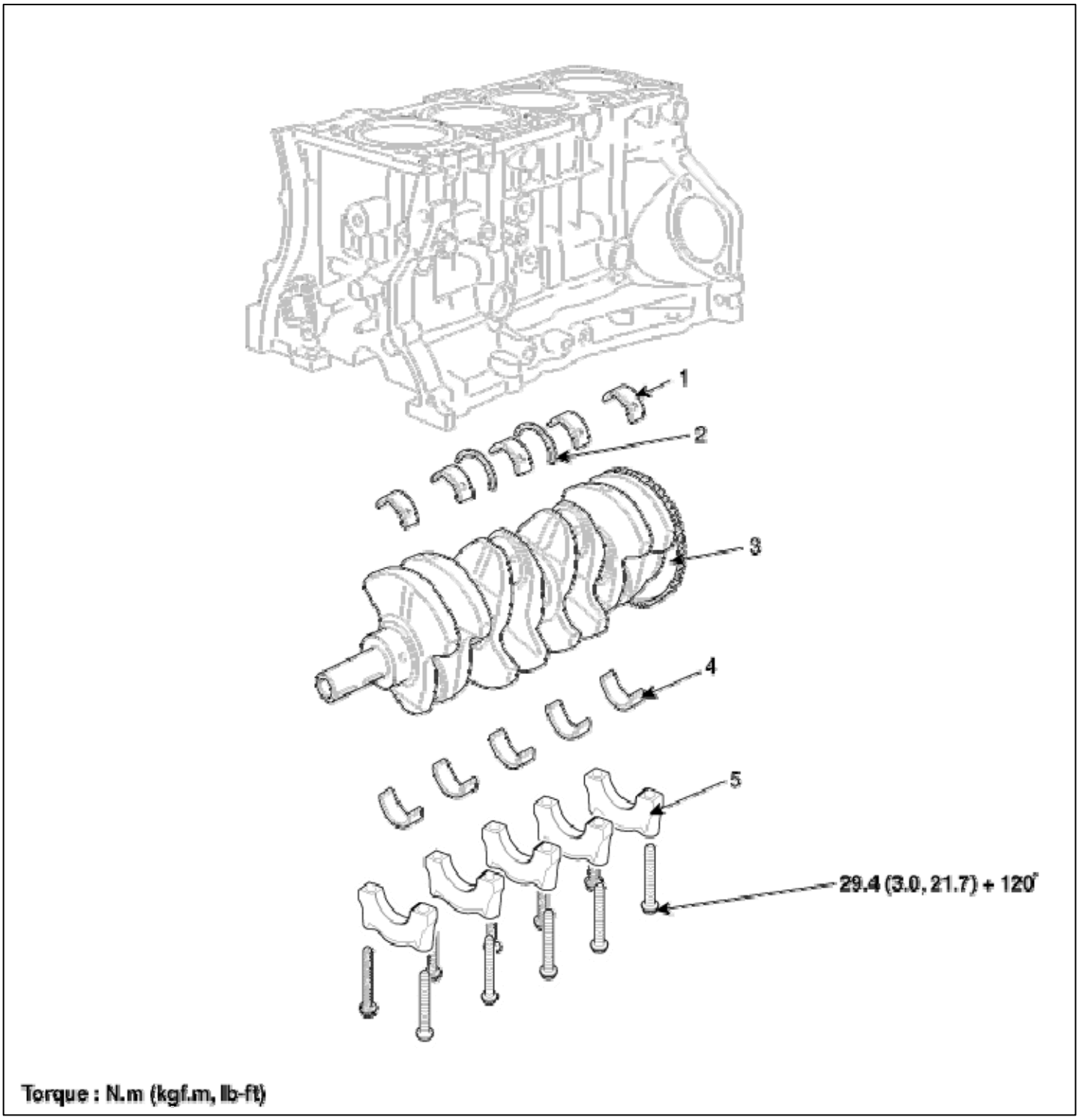
Tightening torque :

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

CYLINDER BLOCK ASSEMBLY



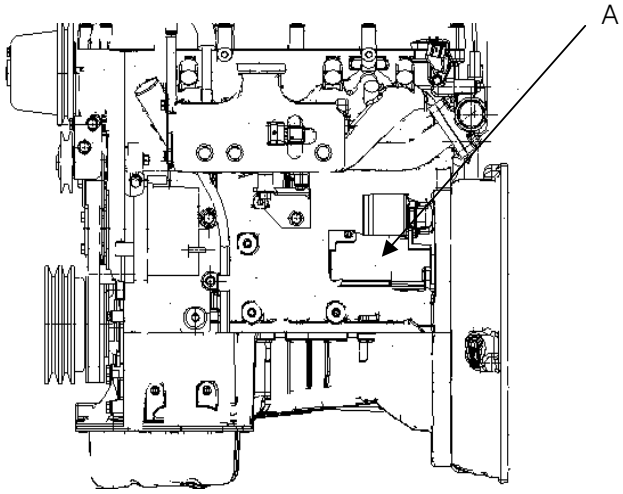
1. Piston ring	5. Piston pin
2. Piston	6. Connecting rod lower bearing
3. Connecting rod	7. Connecting rod bearing cap
4. Connecting rod upper bearing	8. Ladder frame



1. Crankshaft upper bearing	4. Crankshaft lower bearing
2. Thrust bearing	5. Main bearing cap
3. Crankshaft	

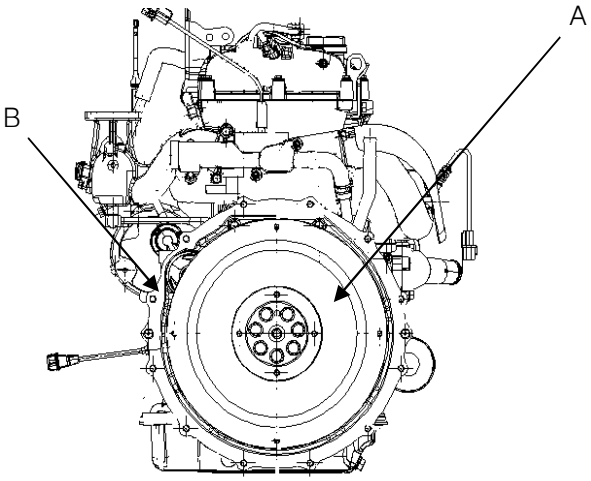
Disassembley

1 Remove the start motor (A).



2 Remove the flywheel (A).

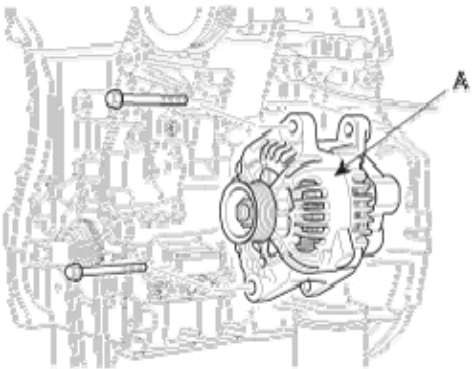
3 Remove the flywheel housing (B).



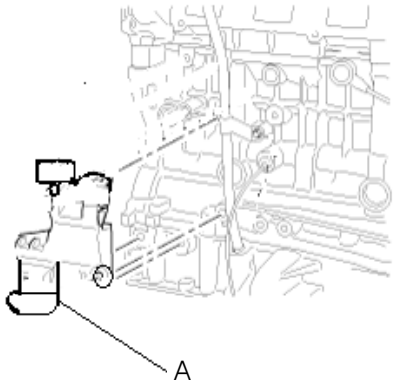
4 Remove the timing systems(see : timing system)

5 Remove the cylinder head(see : cylinder head assembly)

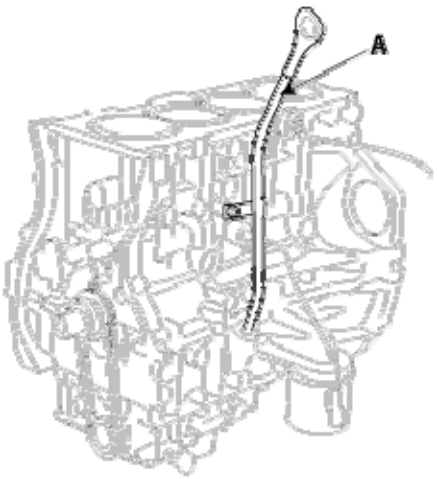
6 Remove the alternator(A).



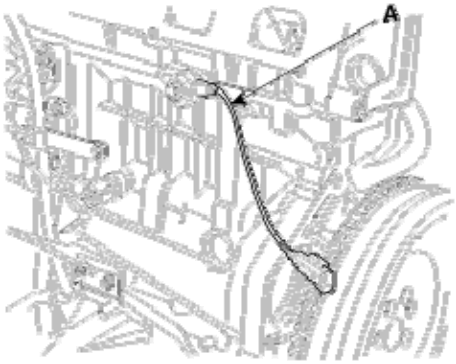
7 Remove the alternator bracket (A).



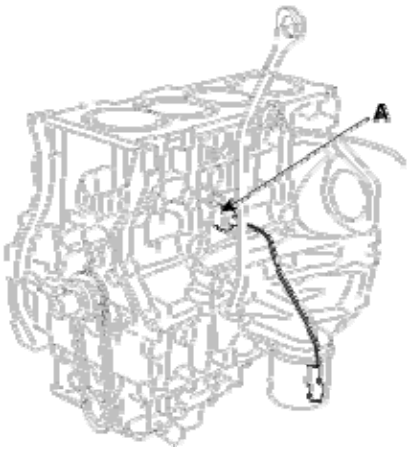
8 Remove oil level gauge assembly(A).



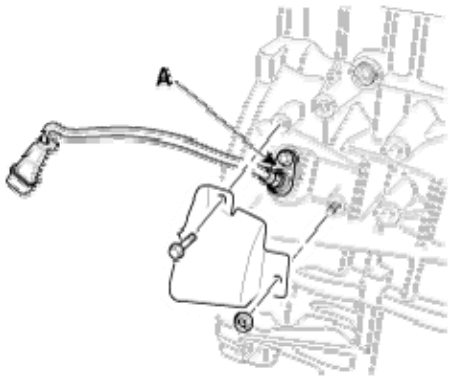
9 Remove knock sensor(A).



10 Remove oil pressure sensor(A).



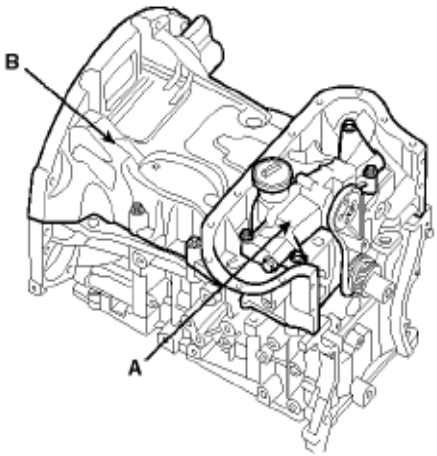
11 Remove CKP sensor(A).



12 Remove the water pump(A)

STQM39125D

13 Remove the oil pump(A) and ladder frame(B).



STQM28021L

14 Check the connecting rod end play.

15 Remove the connecting rod caps and check oil clearance.

16 Remove piston and connecting rod assemblies.

1) Using a ridge reamer, remove all the carbon from the top of the cylinder.

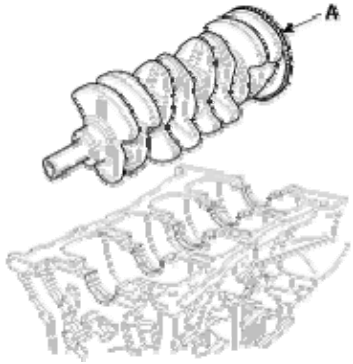
2) Push the piston, connecting rod assembly and upper bearing through the top of the cylinder block

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

17 Remove 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 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.

21 Remove piston rings.

1) Using a piston ring expander, remove the 2 compression rings.

2) Remove 2 side rails and the spacer by hand.

NOTE

Arrange the piston rings in the correct order only.

22 Disconnect connecting rod from piston.

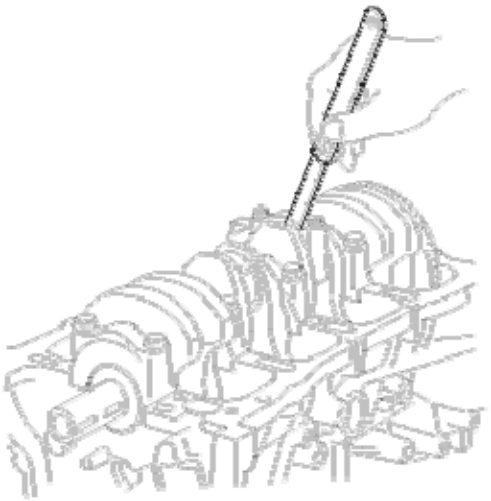
Connecting Rod And Crankshaft

1 Check the connecting rod end play.

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

Standard end play : 0.1~ 0.25mm(0.004 ~ 0.010in.)

Maximum end play : 0.35mm(0.0138in.)



A) If out-of-tolerance, install a new connecting rod.

B) If still out-of-tolerance, replace the crankshaft.

2 Check the connecting road bearing oil clearance.

1) Check the matchmarks on the connecting rod and cap are aligned to ensure correct reassembly.

2) Remove 2 connecting rod cap bolts.

3) Remove the connecting rod cap and bearing half.

4) Clean the crank pin and bearing.

5) Place plastigage across the crank pin.

6) Reinstall the bearing half and cap, and torque the bolts.

7) Remove 2 bolts, connecting rod cap and bearing half.

Tightening torque

19.6N.m (2.0kgf.m, 14.46lb-ft) + 90°

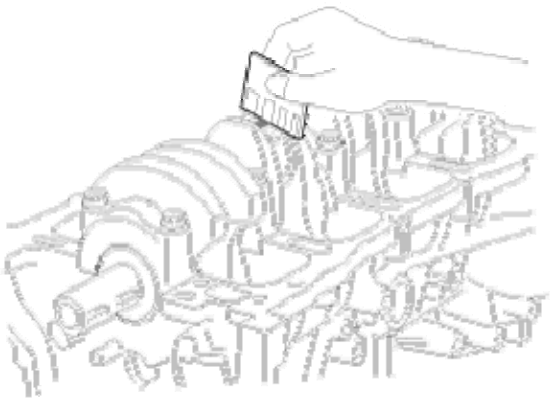
NOTE

Do not turn the crankshaft.

8) Measure the plastigage at its widest point.

Standard oil clearance

0.028 ~ 0.046mm(0.0011 ~ 0.0018in.)



9) If the plastigage measures too wide or too narrow, remove the upper half of the bearing, install a new, complete bearing with the same color mark (select the color as shown in the next column), and recheck the 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 (the color listed above or below that one), and check clearance again.

NOTE

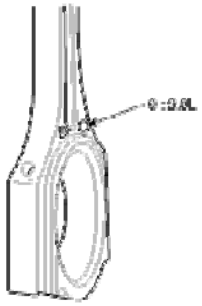
If the proper clearance cannot be obtained by using the appropriate larger or smaller bearings, replace the crankshaft and start over.

CAUTION

If the marks are indecipherable because of an accumulationof dirt and dust, do not scrub them with a wire brush or scraper.

Clean them only with solvent or detergent.

Connecting Rod Mark Location

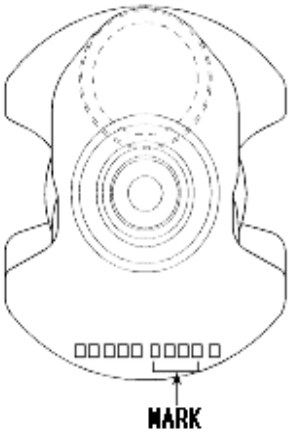


Discrimination Of Connecting Rod

Class	Mark	Inside Diameter
a	A	51.000 ~ 51.006mm (2.0079 ~ 2.0081in.)
b	B	51.006 ~ 51.012mm (2.0081 ~ 2.0083in.)
c	C	51.012 ~ 51.018mm (2.0083 ~ 2.0085in.)

Crankshaft Pin Mark Location

Discrimination Of Crankshaft



NOTE

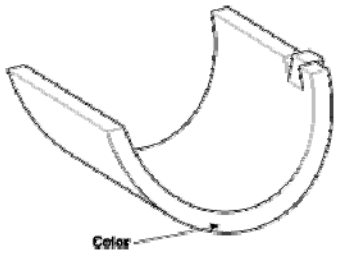
Conform to read stamping order as shown arrow direction from #1

Discrimination Of Crankshaft

Class	Mark	Outside Diameter Of Pin
I	1	47.966 ~ 47.972mm (1.8884 ~ 1.8886in.)
II	2	47.960 ~ 47.966mm (1.8881 ~ 1.8884in.)
III	3	47.954 ~ 47.960mm (1.8879 ~ 1.8881in.)

Place Of Identification Mark (Connecting Rod Bearing)

Discrimination Of Connecting Rod Bearing



Class	Mark	Thickness Of Bearing
AA	BLUE	1.517 ~ 1.520mm (0.0597 ~ 0.0598in.)
A	BLACK	1.514 ~ 1.517mm (0.0596 ~ 0.0597in.)
B	NONE	1.511 ~ 1.514mm (0.0595 ~ 0.0596in.)
C	GREEN	1.508 ~ 1.511mm (0.0594 ~ 0.0595in.)
D	YELLOW	1.505 ~ 1.508mm (0.0593 ~ 0.0594in

11) Selection

Crankshaft Indentification Mark	Connecting Rod Identification Mark	Assembing Classification Of Bearing
I (1)	a (A)	D (YELLOW)
	b (B)	C (GREEN)
	c (C)	B (NONE)
II (2)	a (A)	C (GREEN)
	b (B)	B (NONE)
	c (C)	A (BLACK)
III (3)	a (A)	B (NONE)
	b (B)	A (BLACK)
	c (C)	AA (BLUE)

3 Check the crankshaft bearing oil clearance.

1) To check main bearing-to-journal oil clearance, remove the main caps and bearing halves.

2) Clean each main journal and bearing half with a clean shop tower.

3) Place one strip of plastigage across each main journal.

4) Reinstall the bearings and caps, then torque the bolts.

Tightening torque

29.4N.m(3.0kgf.m,21.7)+120°?

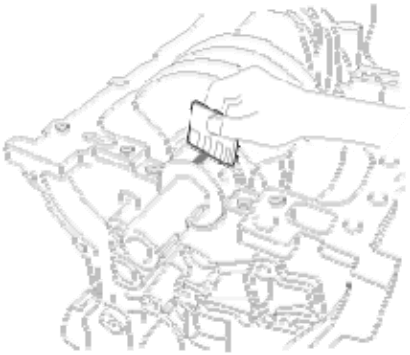
NOTE

Do not turn the crankshaft.

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

Standard oil clearance

0.02~0.048mm(0.0008 ~ 0.0015in.)



6) If the plastigage measures too wide or too narrow, remove the upper half of the bearing, install a new, complete bearing with the same color mark (select the color as shown in the next column), and recheck the clearance.

CAUTION

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

7) If the plastigage shows the clearance is still incorrect, try the next larger or smaller bearing (the color listed above or below that one), and check clearance again.

NOTE

If the proper clearance cannot be obtained by using the appropriate larger or smaller bearings, replace the crank-shaft 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.

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 side.the notches for holding the bearing in place are on the same

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 :

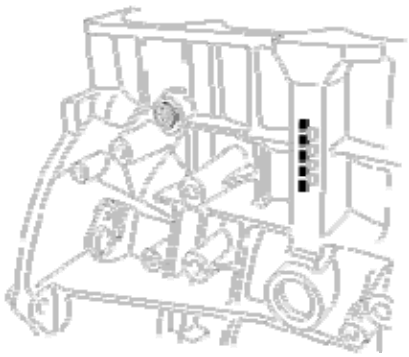
0.05mm / 100mm (0.0020 in./3.94 in.) or less

Allowable twist of connecting rod :

0.1mm / 100mm (0.0039 in./3.94 in.) or less

Crankshaft bore mark location

* Letters have been stamped on the block as a mark for the size of each of the 5 main journal bores.
* Use them, and the numbers or bar stamped on the crank (marks for main journal size), to choose the correct bearings

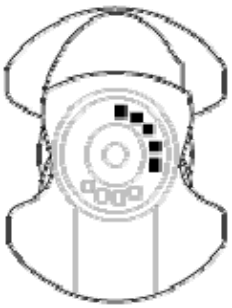


Discrimination Of Cylinder Block

Calss	Mark	Inside Diameter
a	A	56.000 ~ 56.006mm (2.2047 ~ 2.2049in.)
b	B	56.006 ~ 56.012mm (2.2049 ~ 2.2052in.)
c	C	56.012 ~ 56.018mm (2.2052 ~ 2.2054in.)

Crankshaft Journal Mark Location

Discrimination Of Crankshaft



NOTE

Conform to read stamping order as shown arrow direction from #1.

Selection

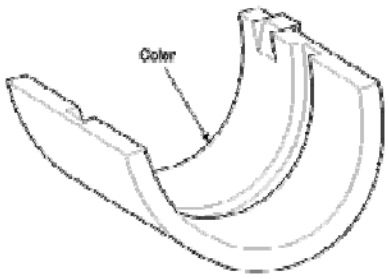
Crankshaft Identification Mark	Crankshaft Bore Identification Mark	Assembling Classification Of Bearing
I (1)	a (A)	D (Yellow)
	b (B)	C (Green)
	c (C)	B (None)
II (2)	a (A)	C (Green)
	b (B)	B (None)
	c (C)	A (Black)
III (3)	a (A)	B (None)
	b (B)	A (Black)
	c (C)	AA (Blue)

Discrimination Of Crankshaft

Class	Mark	Outside Diameter Of Journal
I	1	51.954 ~ 51.960mm (2.0454 ~ 2.0456in.)
II	2	51.948 ~ 51.954mm (2.0452 ~ 2.0454.)
III	3	51.942 ~ 51.948mm (2.0449 ~ 2.0452in.)

Place Of Identification Mark (Crankshaft Bearing)

Discrimination Of Crankshaft Bearing



Discrimination Of Crankshaft Bearing

Class	Mark	Thickness Of Bearing
AA	Blue	2.026 ~ 2.029mm (0.0797 ~ 0.0798in.)
A	Black	2.023 ~ 2.026mm (0.0796 ~ 0.0797in.)
B	None	2.020 ~ 2.023mm (0.0795 ~ 0.0796in.)
C	Green	2.017 ~ 2.020mm (0.0794 ~ 0.795in.)
D	Yellow	2.014 ~ 2.017mm (0.0793 ~ 0.0794in.)

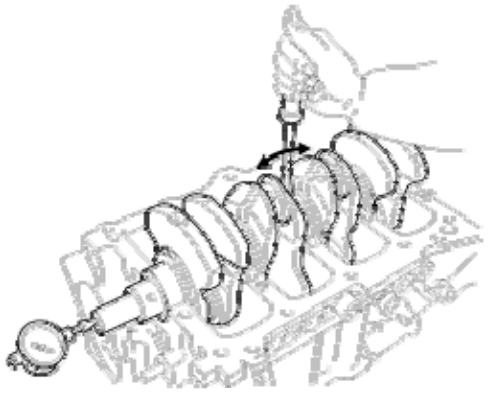
4 Check crankshaft end play.

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

Standard end play

0.07 ~ 0.25mm (0.0027 ~ 0.0098in.)

Limit : 0.30mm (0.0118in.)



If the end play is greater than maximum, replace the thrust bearings as a set.

Thrust bearing thickness

1.925 ~ 1.965mm(0.0758 ~ 0.07736in.)

5 Inspect main journals and crank pins

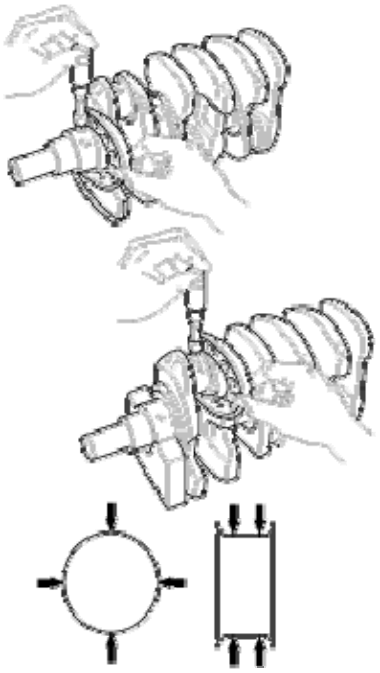
Using a micrometer, measure the diameter of each main journal and crank pin.

Main journal diameter :

51.942 ~ 51.960mm (2.0449 ~ 2.0456in.)

Crank pin diameter :

47.954 ~ 47.972mm (1.8879 ~ 1.8886in.)



Cylinder Block

1 Remove gasket material.

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

2 Clean cylinder block

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

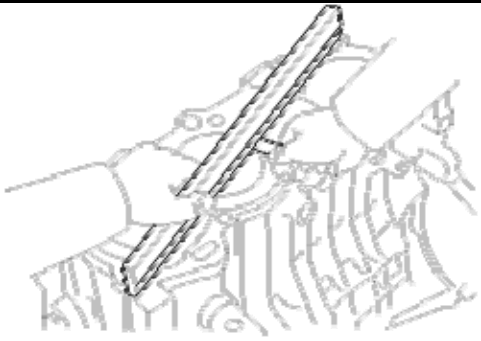
3 Inspect top surface of cylinder block for flatness.

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(max 0.02mm /100 ×100mm)

(max 0.000787in/ 3.937 × 3.937in)



4 Inspect cylinder bore diameter

Visually check the cylinder for vertical scratchs.

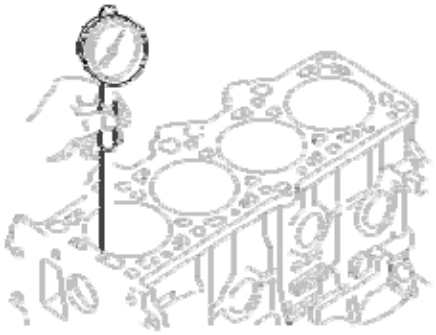
If deep scratches are present, replace the cylinder block.

Inspect cylinder bore diameter

5 Using a cylinder bore gauge, measure the cylinder bore diameter at position in the thrust and axial directions

Standard diameter

88.00 ~ 88.03mm (3.4645 ~ 3.4657in.)



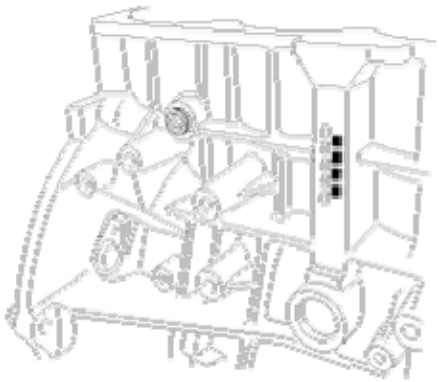
NOTE

Measure position(from the bottom of the cylinder block)

: 110.7mm(4.3582in.) / 160mm(6.2992in.)

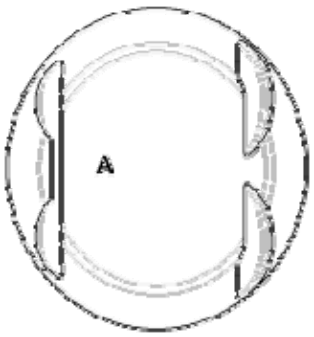
/ 210mm(8.2677in.)

6 Check the cylinder bore size code on the cylinder block.



Class	Cylinder bore inner diameter	Size code
A	88.00 ~ 88.01mm (3.4645~ 3.4649in.)	
B	88.01 ~ 88.02mm (3.4649~ 3.4653in.)	
C	88.02 ~ 88.03mm (3.4653~ 3.4657in	

7 Check the piston size code on the piston top face.



NOTE

Stamp the grade mark of basic diameter with rubber stamp.

Piston Outer Diameter

Class	Piston outer diameter	Size code
A	87.97 ~ 87.98mm (3.4633~ 3.4637in.)	A
B	87.98 ~ 87.99mm (3.4637~ 3.4664in.)	None
C	87.99 ~ 88.00mm (3.4641~ 3.4645in	C

8 Select the piston related to cylinder bore class.

Clearance : 0.015 ~ 0.035mm (0.00059 ~ 0.00137in.)

Piston And Rings

1 Clean 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.

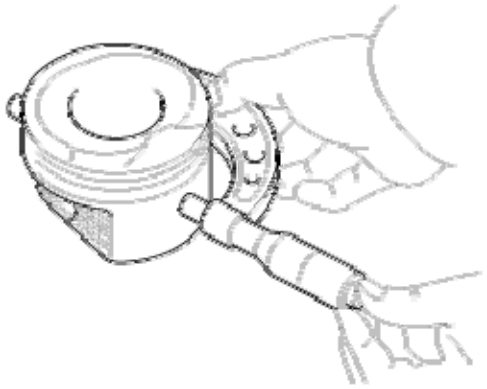
NOTE

Do not use a wire brush

2 The standard measurement of the piston outside diameter is taken 14 mm (0.55 in.) from the top land of the piston

Standard diameter

87.975 ~ 88.005mm (3.4635 ~ 3.4647in.)



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

Piston-to-cylinder clearance

0.015 ~ 0.035mm(0.00059 ~ 0.00137in.)

4 Inspect the piston ring side clearance.

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

Piston ring side clearance

Standard

No.1 : 0.05 ~ 0.08mm (0.0019 ~ 0.0031in.)

No.2 : 0.05 ~ 0.08mm (0.0019 ~ 0.0031in.)

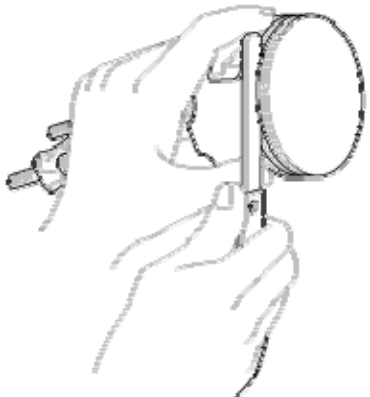
Oil ring : 0.06 ~ 0.15mm (0.0023 ~ 0.0059in.)

Limit

No.1 : 0.1mm (0.004in.)

No.2 : 0.1mm (0.004in.)

Oil ring : 0.2mm (0.008in.)



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

Inspection

5 Inspect 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 ring.

If the gap is too large, recheck the cylinder bore diameter the wear limits, If the bore is over the service limit, the cylinder block must be rebored.

Piston ring end gap

Standard

No.1 : 0.15 ~ 0.30mm (0.0059 ~ 0.0118in.)

No.2 : 0.37 ~ 0.52m (0.0145 ~ 0.0204in.)

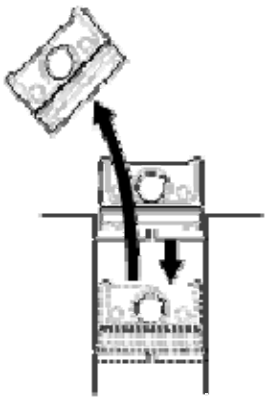
Oil ring : 0.20 ~ 0.70mm (0.0079 ~ 0.0275in.)

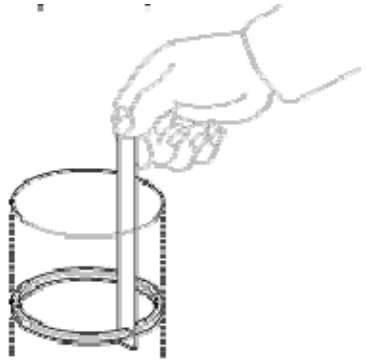
Limit

No.1 : 0.6mm (0.0236in.)

No.2 : 0.7mm (0.0275in.)

Oil ring : 0.8mm (0.0315in.)



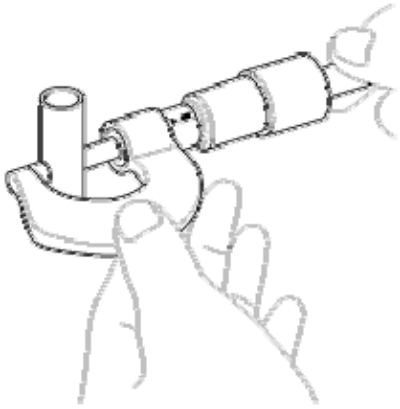


Piston Pins

1 1Measure the diameter of the piston pin.

Piston pin diameter

21.001 ~ 21.006mm (0.8268 ~ 0.8270in.)



2 Measure the piston pin-to-piston clearance.

Piston pin-to-piston clearance

0.01 ~ 0.02mm (0.0004 ~ 0.0008in.)

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

Piston pin-to-connecting rod interference

0.016 ~ 0.032mm (0.00063 ~ 0.00126in.)

Reassembly

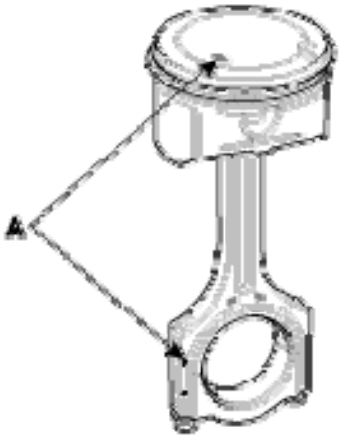
NOTE

* 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 Assemble piston and connecting rod.

1) Use a hydraulic press for installation.

2) The piston front mark and the connecting rod front mark must face the timing belt side of the engine.

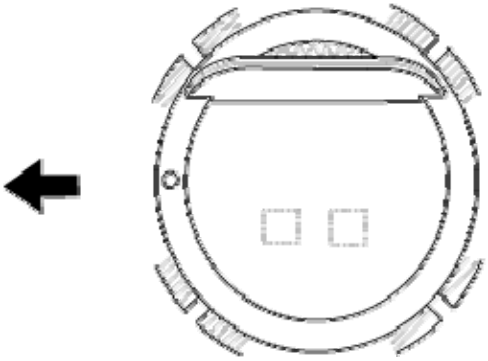


2 Install piston rings.

1) Install the oil ring spacer and 2 side rails by hand.

2) Using a piston ring expander, install the 2 compression rings with the code mark facing upward.

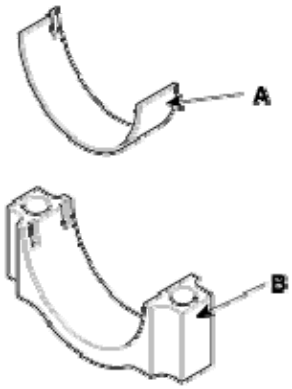
3) Position the piston rings so that the ring ends are as shown.



3 Install connecting rod bearings.

1) Align the bearing claw with the groove of the connecting rod or connecting rod cap

2) Install the bearings(A) in the connecting rod and connecting rod cap(B).

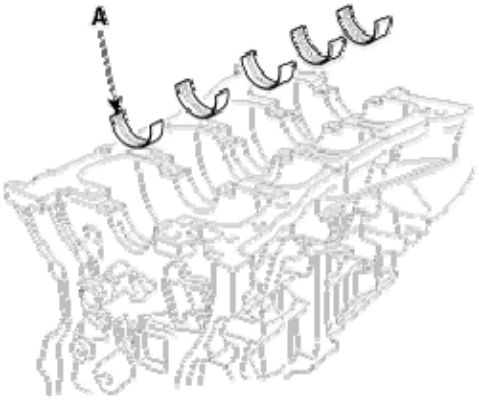


4 Install main bearings.

NOTE

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

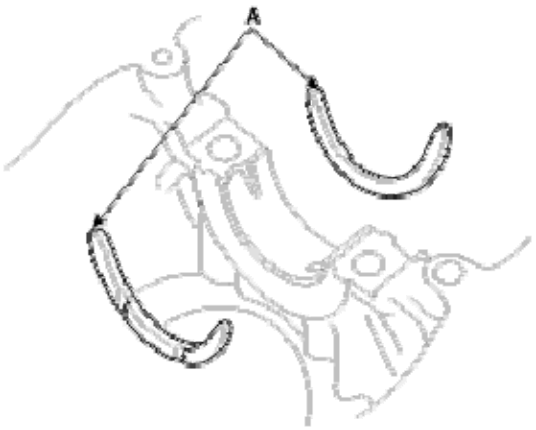
1) Align the bearing claw with the claw groove of the cylinder block, push in the 5 upper bearings(A).



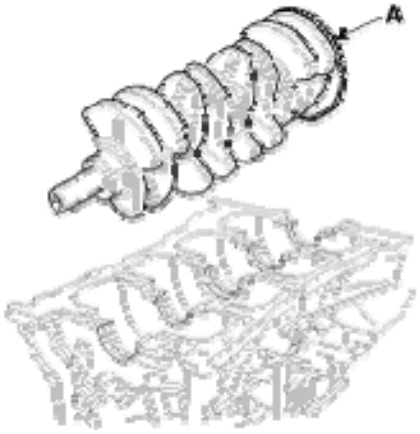
2) Align the bearing claw with the claw groove of the main bearing cap, and push in the 5 lower bearings.

5 Install thrust bearings.

Install the 2 thrust bearings(A) under the No.3 journal position of the cylinder block with the oil grooves facing outward.



6 Place crankshaft(A) on the cylinder block.



7 Place main bearing caps on cylinder block.

8 Install main bearing cap bolts.

Tightening torque

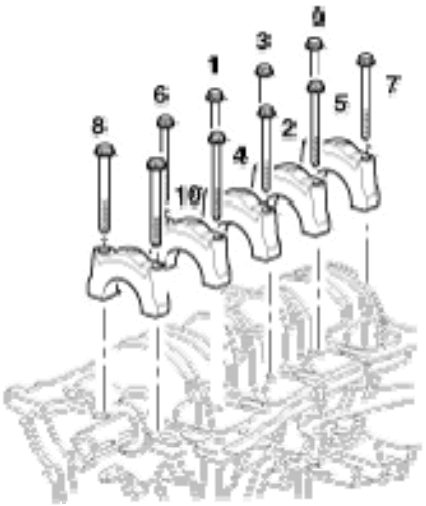
Main bearing cap bolt

29.4N.m (3.0kgf.m, 21.7lb-ft) + 120°

NOTE

* The main bearing cap bolts are tightened in 2 progressive steps.
* If any of the bearing cap bolts in 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(A), in several passes, in the sequence shown.



3) Retighten the bearing cap bolts by 120° in the numerical order shown.
4) Check that the crankshaft turns smoothly

9 Check crankshaft end play.

10 Install piston and connecting rod assemblies.

NOTE

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

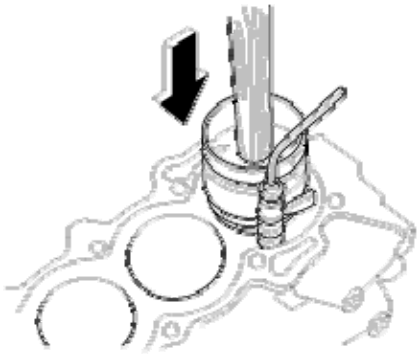
1) Remove the connecting rod caps, and slip short sections of rubber hose over the threaded ends of the connecting rod bolts.
2) Install the ring compressor, check that the bearing is securely in place, then position the piston in the cylinder, and tap it in using the wooden handle of a hammer.
3) Stop after the ring compressor pops free, and check the connecting rod-to-check journal alignment before pushing the piston into place.
4) Apply engine oil to the bolt threads. Install the rod caps with bearings, and torque the bolts.

Tightening torque

19.6N.m (2.0kgf.m, 14.46lb-ft) + 90°

NOTE

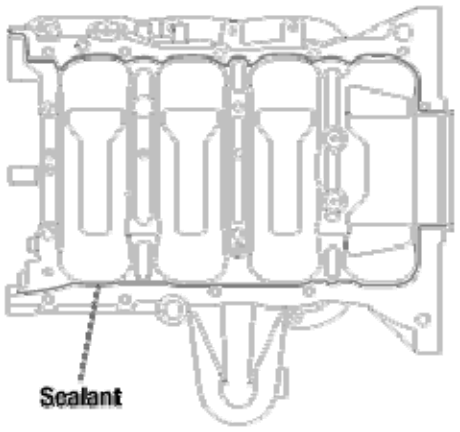
Maintain downward force on the ring compressor to prevent the rings from expanding before entering the cylinder bore.



11 Apply liquid gasket to the mating surface of cylinder block and ladder frame

NOTE

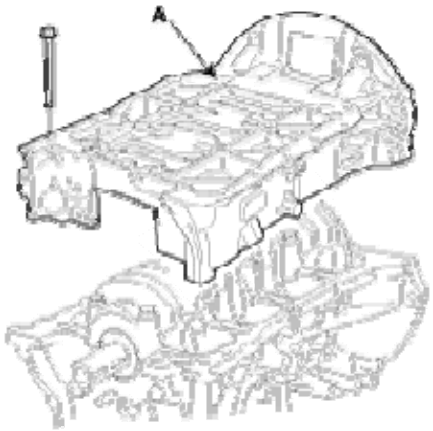
* Be assembling ladder frame, the liquid sealant Loctite 5900 or THREEBOND 1217H should be applied ladder frame.
* The part must be assembled within 5 minutes after sealant was applied.
* Apply sealant to the inner threads of the bolt holes.



12 Install ladder frame(A) with 10 bolts in several passes in sequence shown

Tightening torque

Step 1 : 7.8 ~ 8.8N.m
(0.8 ~ 0.9kgf.m, 5.8 ~ 6.5lb-ft)
Step 2 : 15.7 ~18.6N.m
(1.6 ~ 1.9kgf.m, 11.6 ~ 13.7lb-ft)
Step 3 : 23.5 ~ 27.5N.m
(2.4 ~ 2.8kgf.m, 17.4 ~ 20.3lb-ft)



13 Install rear oil seal.
1) Apply engine oil to a new oil seal lip
2) Using SST(09231-H1100, 09214-3K100) and a hammer, tap in the oil seal until its surface is flush with the rear oil seal retainer edge.

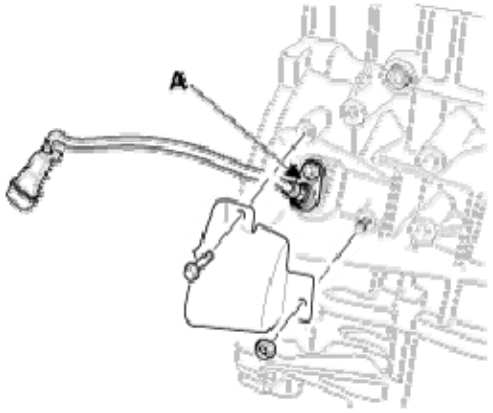
Reassembly

14 Install oil pump.

15 Install CKP sensor(A) and sensor cover.

Tightening torque

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



16 Install oil pressure sensor(A).

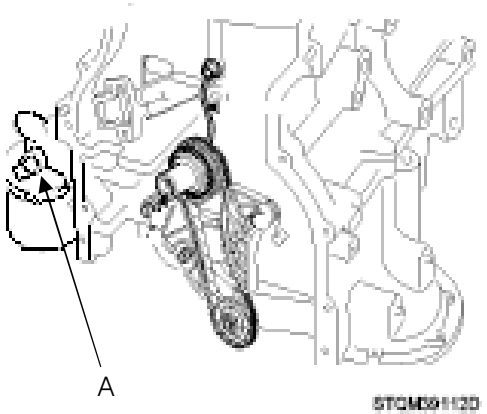
1) Apply adhesive to 2 or 3 threads.

Adhesive : MS 721-39(B) or equivalent.

2) Install the oil pressure sensor (A).

Tightening torque

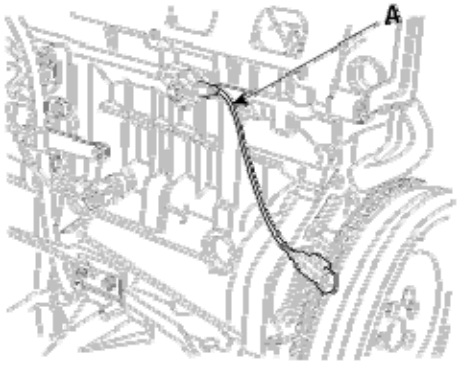
7.8 ~ 11.8N.m (0.8 ~ 1.2kgf.m, 5.8 ~ 8.7lb-ft)



17 Install knock sensor(A).

Tightening torque

16.7 ~ 25.5N.m (1.7 ~ 2.6kgf.m, 12.3 ~ 18.8lb-ft)



18 Install oil level gauge assembly.

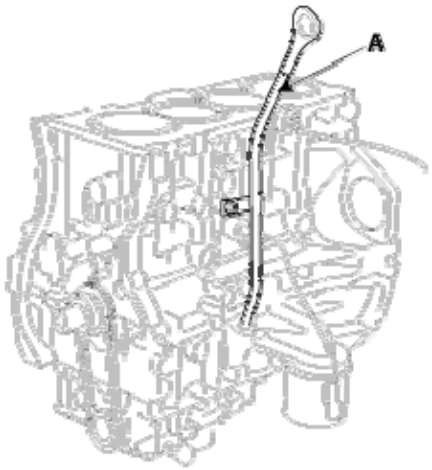
1) Install a new O-ring on the oil level gauge.

2) Apply engine oil on the O-ring.

3) Install the oil level gauge assembly(A) with the bolt.

Tightening torque

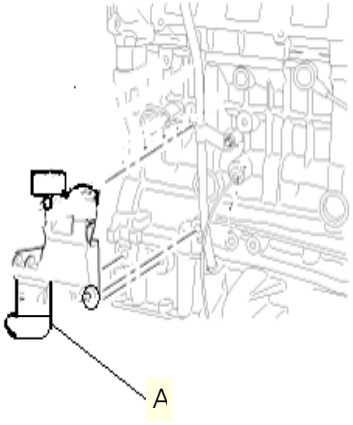
7.8 ~ 11.8N.m (0.8 ~ 1.2kgf.m, 5.8 ~ 8.7lb-ft)



19 Install the alternator bracket (A).

Tightening torque

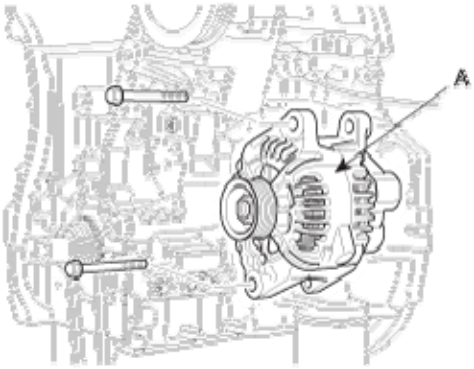
39.2 ~ 44.1N.m (4.0 ~ 4.5kgf.m, 28.9 ~ 32.5lb-ft)



20 Install the alternator.

Tightening torque

19.6 ~ 24.6N.m (2.0 ~ 2.5kgf.m, 14.5 ~18.lb-ft)



21 Install the cylinder head (see : cylinder head assembly).

22 Install the timing chain (see : timing system).

23 Install the oil pan.

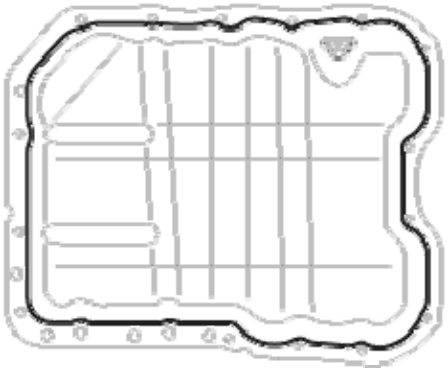
1) Using a razor blade and gasket scraper, remove all the old gasket material from the gasket surfaces.

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.

Use liquid gasket LOCTITE5900H or THREEBOND 1217H or equivalent(MS721-40).



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.

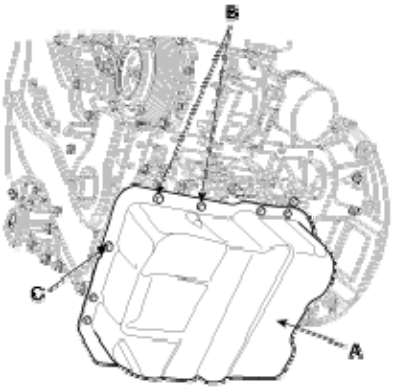
3) Install the oil pan(A).

Uniformly tighten the bolts in several passes.

Tightening torque

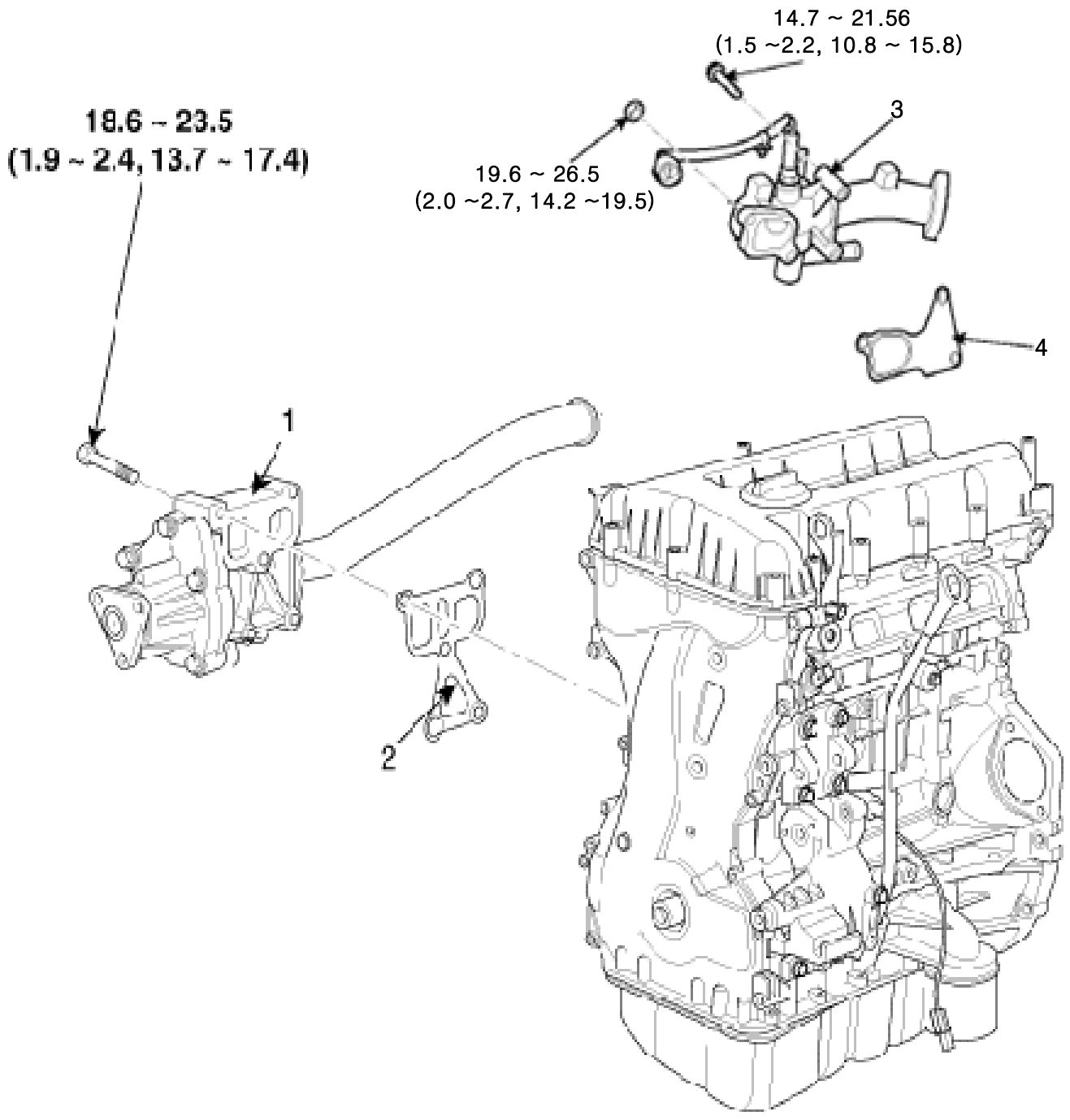
M8(B):26.5 ~30.4N.m (2.7 ~3.1kgf.m, 19.5 ~22.4lb-ft)

M6(C):9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



Components

Components



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

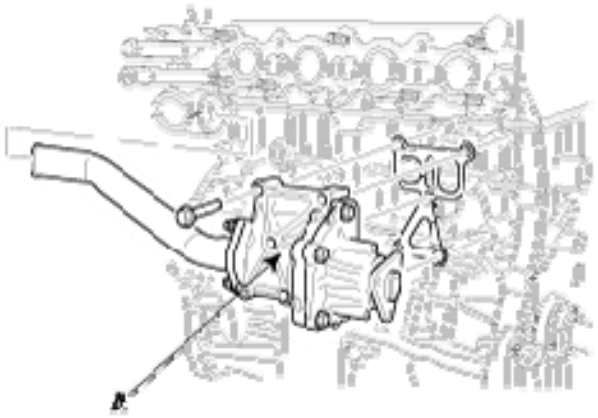
1. Water pump	3. Water outlet fitting
2. Water outlet gasket	4. Water outlet gasket

Water pump / Thermostat

Removal

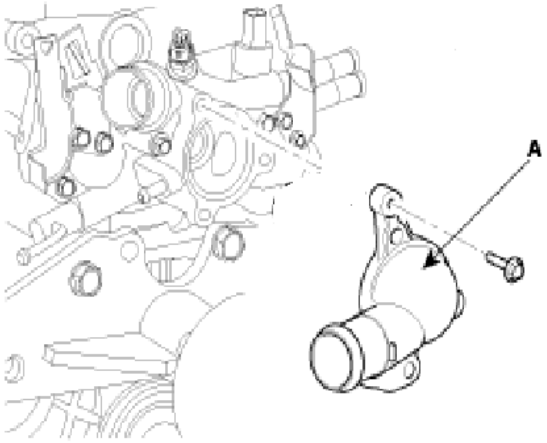
Water pump

1. Remove the water inlet pipe nut.
2. Remove the water pump (A). and watwer pump gasket.



Thermostat

2. Remove the water inlet fittingt(A)



Inspection

Water pump

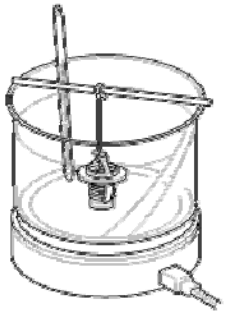
1. Check each part for cracks, damage or wear, and replacethe coolant pump assembly if necessary.
2. Check the bearing for damage, abnormal noise and sluggish rotation, and replace the coolant pump assembly if necessary.
3. Check for coolant leakage. If coolant leaks from hole, the seal is defective.Replace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

NOTE

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

Thermostat

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



2. Check the valve opening temperature.

Valve opening temperature : 82°C (177°F)

Full opening temperature : 95°C (205°F)

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

3. Check the valve lift.

Valve lift : 8mm (0.3in.) or more at 95°C (205°F)

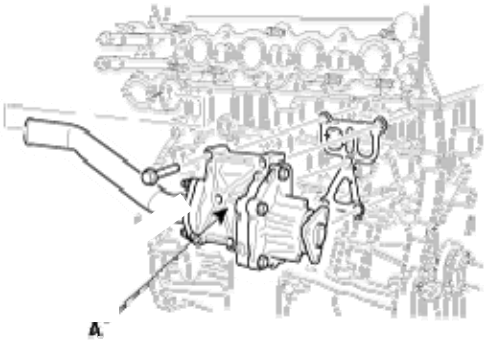
If the valve lift is not as specified, replace the thermostat.

Installation

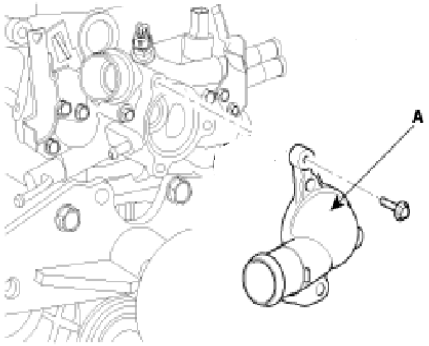
1. Install the water pump (A) with a new gasket.

Tightening torque :

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



1. Install the thermostat housing



2. Install the water inlet fitting (A).

Tightening torque :

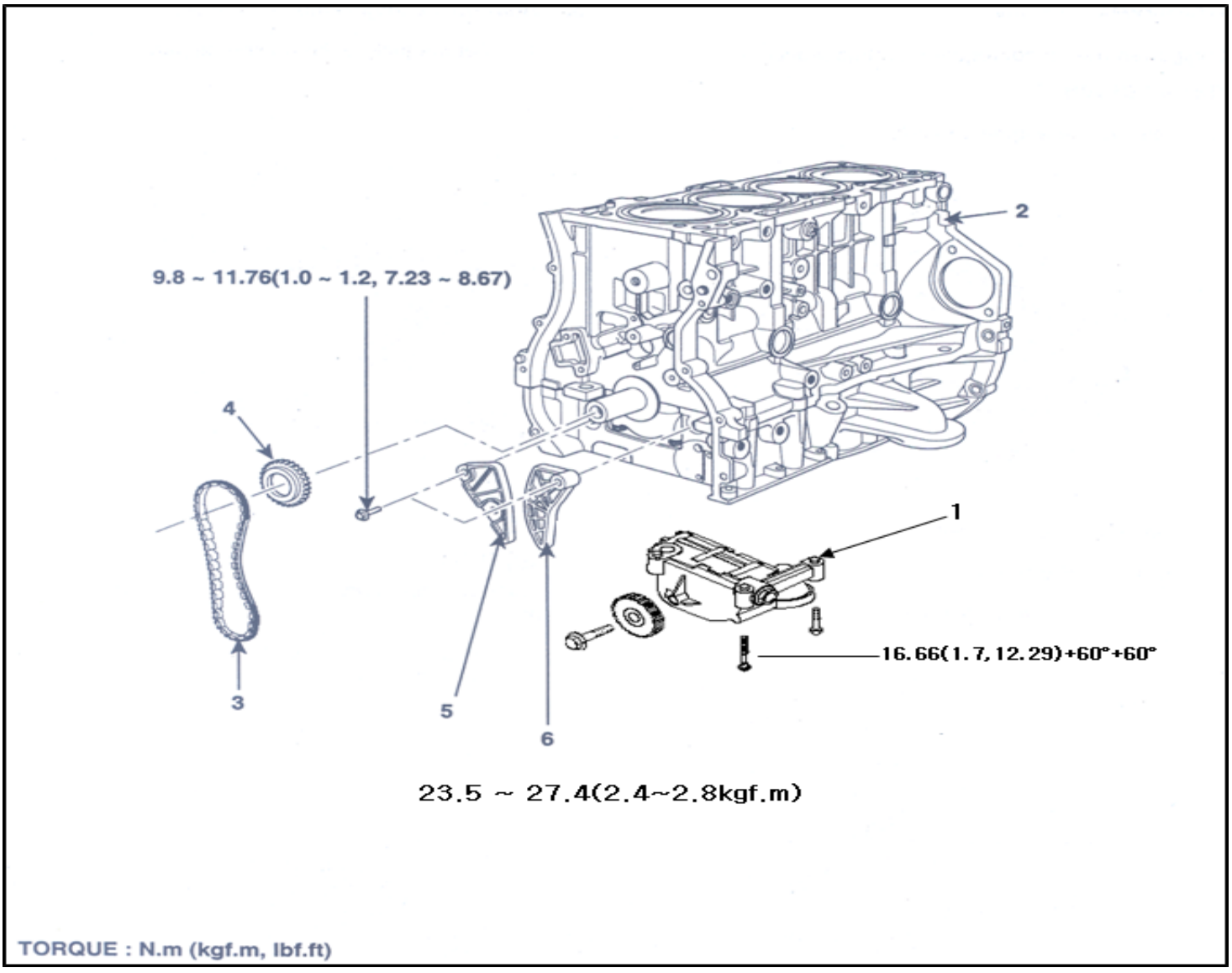
7.8 ~ 11.08 N.m (0.8 ~ 1.2 kgf.m, 5.8 ~ 8.7 lb-ft)

Water pump

Symptoms		Possible causes		Remedy
Coolant leakage	- From the bleed hole of the water pump	Naked eyes observation	- Check leaks after about ten-minute warming up	- if coolant still leaks, replace a water pump - If leakage stops, reuse the water pump (do not replace the pump with a new one)
	- From gaskets or bolts		- Check the tightening of the water pump mounting bolts	- Retighten the mounting bolts
			- Check damage of gaskets or inflow of dust	- Replace the gasket and clean dust off
	- From outer surface of water pump		- Check the material or any cracks of the water pump	- Poor material, If any cracks found, replace the water pump
Noise	- From bearings	Inspection with a stethoscope	- After starting the engine, check noise with a stethoscope	- If there is any noise reuse the water pump,(do not replace it)
	- From mechanical seals	Inspection after removing a drive belt	- After removing a water pump and a drive belt, check noise again	- If there is any noise from the water pump, remove the drive belt and recheck
	- Impeller interference	Check again after removing water pump	- check interference of body body and impeller of water pump	- exchange the water pump in case of occurring interference

thermostat

Symptoms		Possible causes		Remedy
Coolant leakage	- From the thermostat gasket	Check the mounting bolts	- Check the torque of the mounting bolts	- Retighten the bolts and check leakage again
		Check the gasket fordamage	- Check gasket or seal for damage	- Replace gaskets and reuse the thermostat
Cooled excessively	- Low heater performance (cooled air blowed-out) - Thermo gauge indicates "LOW"	Visually check eyes observation after removing the radiator cap	- Insufficient coolant or leakage	- After refilling coolant, recheck
		GDS check & starting engine	- Check DTCs - Check connection of the fan clutch or the fan motor ※ If fan clutch is always connected, there will be a noise at idle	- Check the engine coolant sensor, wiring and connectors - Replace the components
		Remove the thermostat and inspect	- Check if there are dusts or chips in the thermostat valve - Check adherence of the thermostat	- Clean the thermostat valve and reuse the thermostat - Replace the thermostat, if it doesn't work properly
Heated excessively	- Engine overheated	Naked eyes observation after removing the radiator cap	- Insufficient coolant or leakage ※ Be careful when removing a radiator cap of the overheated vehicle - Check air in cooling system	- After refilling coolant, recheck - Check the cylinder head gaskets for damage and the tightening torque of the mounting bolts
	- Thermo gauge indicates "HI"	GDS check & starting engine	- Check DTCs - Check the fan motor performance as temperature varies - Check if the fan clutch slips - Check the water pump adherence or impeller damaged	- Check the engine coolant sensor, wiring and connectors - Check the fan motor, the relay and connector - Replace the fan clutch, If doesn't work properly - Replace the water pump, if it work properly
		Immerse the thermostat in boiling water and inspection	- After removing the thermostat, check it works properly ※ Check the thermostat opens at the valve opening temperature	- Replace the thermostat, if it doesn't work properly

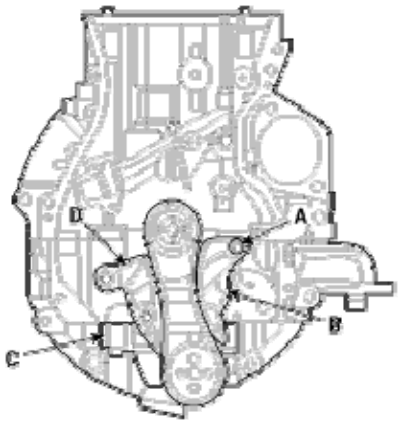


1. Oil pump module	4. Oil pump chain sprocket
2. Cylinder block	5. Oil pump chain guide
3. Oil pump chain	6. Oil pump chain tensioner arm

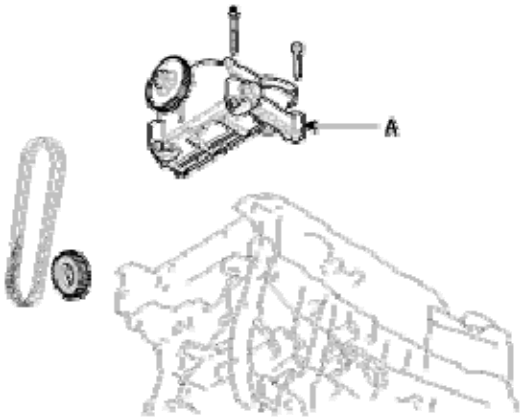
Oil pump

Oil pump

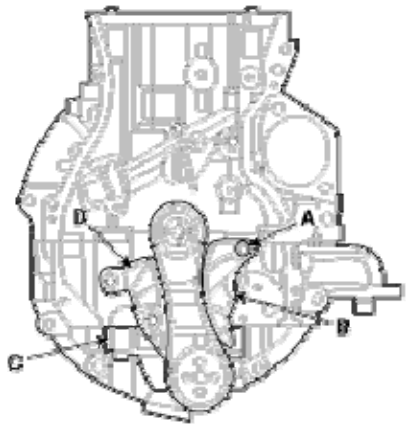
1. Remove the timing chain.
   (Refer to timing system in this group)
2. Remove the oil pump mechanical tensioner (B).
3. Remove the oil pump chain guide (D).



4. Remove the oil pump (A) and oil pump chain.



Installation



1. The key of crankshaft should be aligned with the mating face of main bearing cap. As a result of this, the piston of No.1 cylinder is placed at the top dead center on compression stroke.
2. Assemble the crankshaft sprocket on the crankshaft as the front mark on the crankshaft sprocket to be outward
3. Tighten the oil pump tensioner bolt(A) after placing the tensioner spring on the dowel pin located in ladder frame, and then insert stopper pin to fix the tensioner(B).

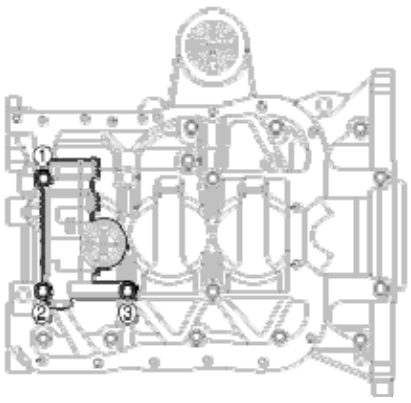
Tightening torque :

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

4. Assemble the oil pump chain on the crankshaft sprocket.
5. Assemble the oil pump assembly (C) on the ladder frame as placing oil pump sprocket in to oil pump.

Tightening torque :

8.8(1'st) -> 16.7(2'nd) -> 25.5(3'rd)N.m
(0.9 + 1.7 + 2.6kgf.m, 6.5 + 12.3 + 18.8lb-ft)



Bolting order

a) Assemble the bolts in order number as shown with seating torque 25.5 N.m (2.6kgf.m, 18.8 lb-ft)
b) Unfasten the bolts as reverse bolting order. (3-2-1)
C) Assemble the bolts as specified bolting order in same increments as follows.

6. Install the oil pump chain guide (D) then remove the stopper pin.

Tightening torque :

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

Oil pump

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.

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. Replace the oil filter.
   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 :

39.2 ~ 49.0N.m (4.0 ~ 5.0kgf.m, 28.9 ~ 36.2lb-ft)

   2) Fill with fresh engine oil.

Capacity :

Total : 5.7 L

Oil pan : 4.8 L

Drain and refill including oil filter : 5.2L

   3) Install the oil filler cap.
4. Start engine and check for oil leaks and check the oil gauge or light for an indication of oil pressure.
5. Recheck the engine oil level.

Inspection

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

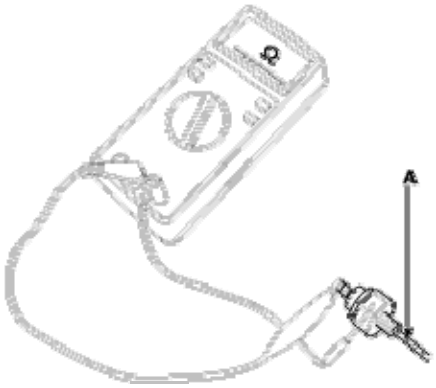
NOTE

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

Oil pressure switch

1. Remove the oil pressure switch from the oilfilter bracket
2. Connect a tester (ohm range) between the terminal and the body of the switch to check for continuity. The switch is normal if there is continuity. If they is no continuity, replace the switch.

3. Insert a thin rod in the oil hole of the switch and push it in lightly. The switch is normal of no continuity as detected (infinite resistance on the tester). If there is continuity, replace the switch.

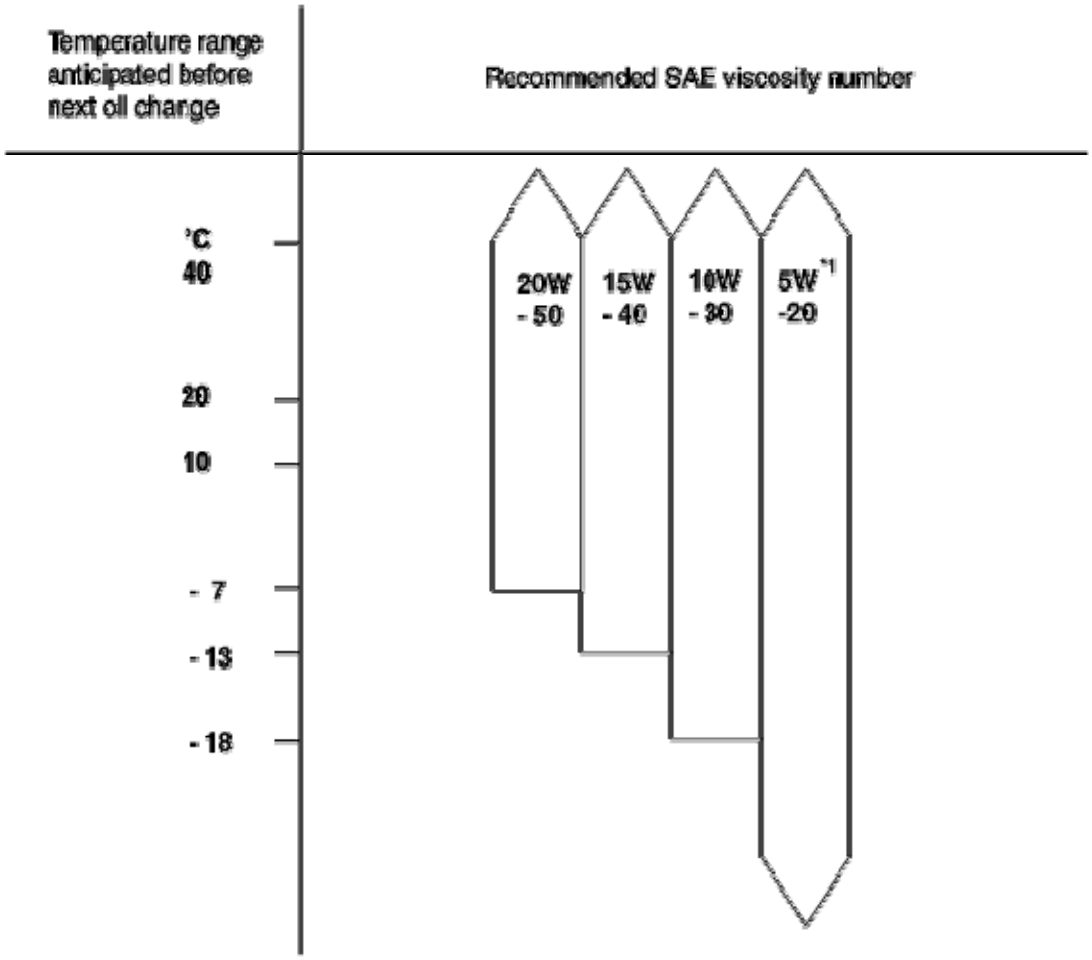


Selection Of Engine Oil

Recommended ILSAC classification : GF4 OR ABOVE

Recommended API classification : SM OR ABOVE

Recommended SAE viscosity grades : 5W-20



*1 : Recommended regardless of environment.
If not available, refer to the recommended SAE viscosity numbers.

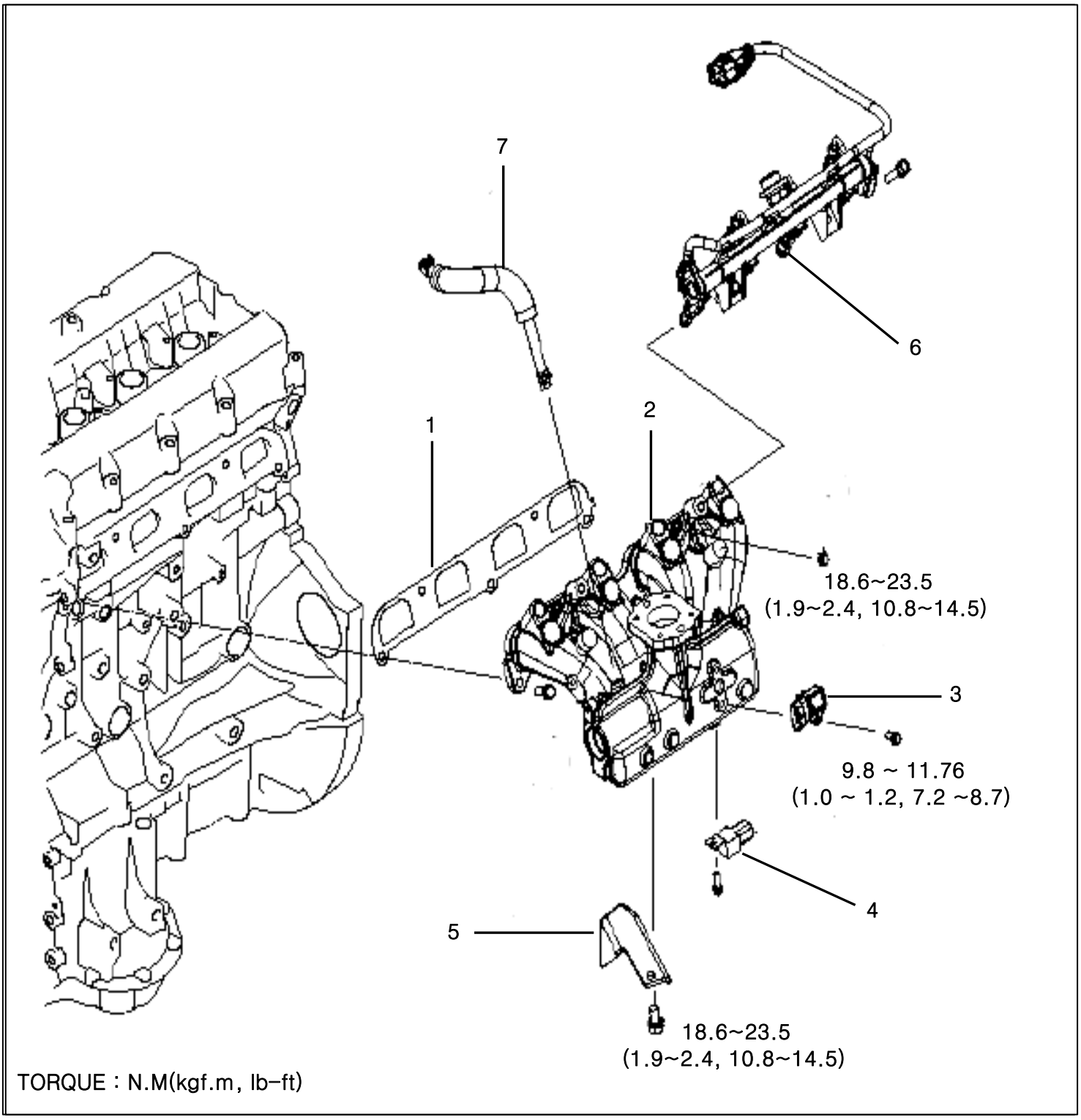
NOTE

For best performance and maximum protection of all types of operation, select only those lubricants which :

1. Satisfy the requirement of the API classification.
2. Have proper SAE grade number for expected ambient temperature range.
3. Lubricants that do not have both an SAE grade number and API service classification on the container should not be used.

Intake manifold

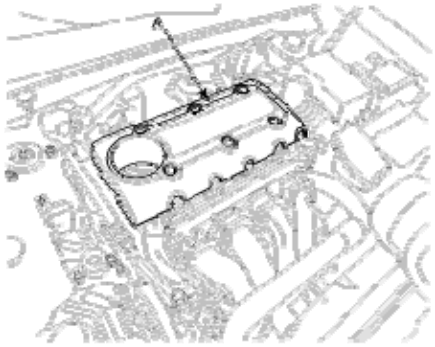
Components



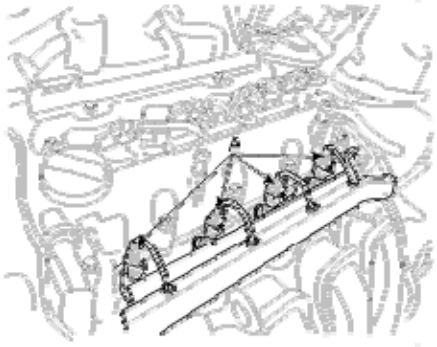
1. Intake manilod gasket	5. Intake manilod stay
2. Intake manilod	6. Delivery pipe & injector assy
3. Mapsensor	7. P.C.V hose assy
4. Condensor	

Intake manifold

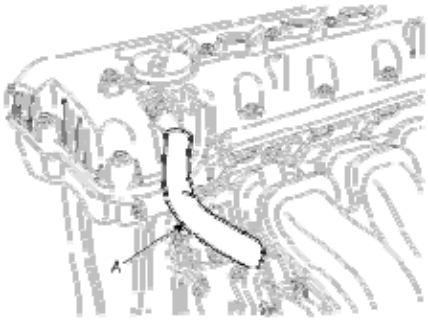
1. Remove the engine cover (A).



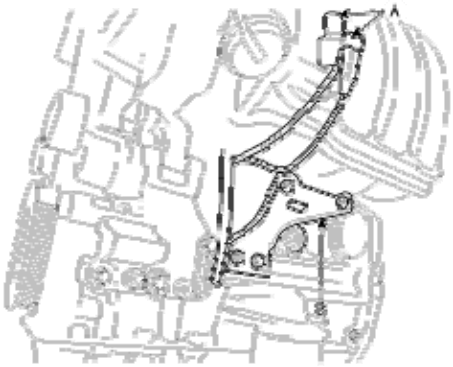
2. Disconnect the injector connectors (A).



3. Remove the PCV hose (A).

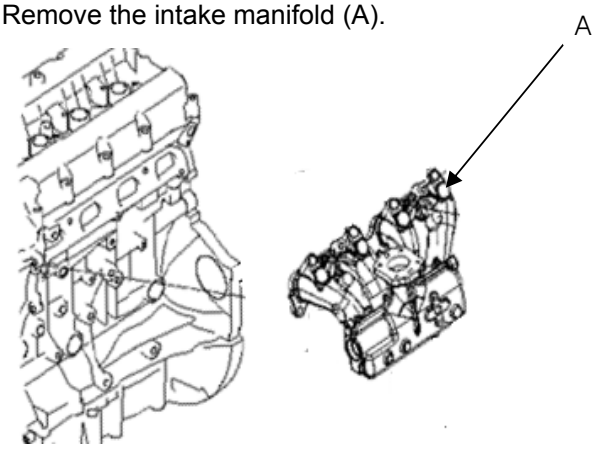


4. Remove the sensor connectors (A) from the bracket and then remove the intake manifold stay (B).



4. Remove the oil level gauge.

5. Remove the intake manifold (A).

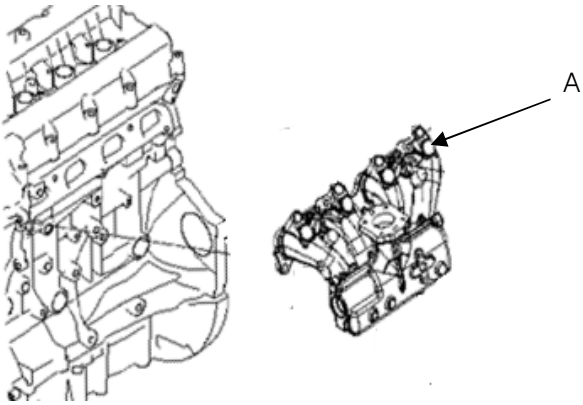


Installation

1. Install the intake manifold (A).

Tightening torque :

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

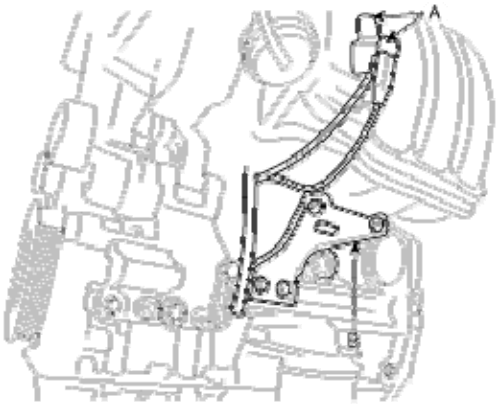


2. Install the oil level gauge.

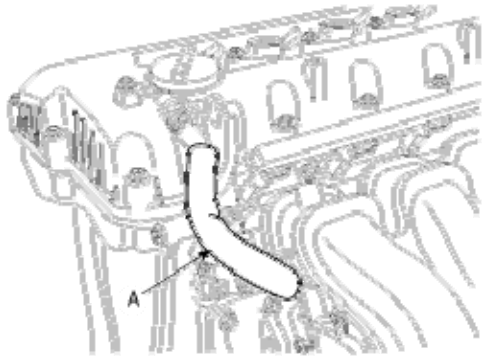
3. Install the intake manifold stay (B) and then install the sensor connectors (A).

Tightening torque :

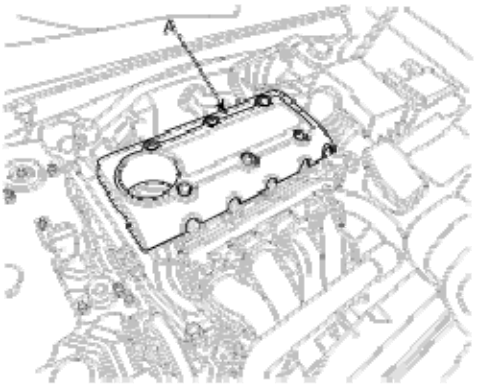
18.6 ~ 23.5N.m (1.9 ~ 2.4kgf.m,13.7 ~ 17.4lb-ft)



4. Install the PCV hose (A).

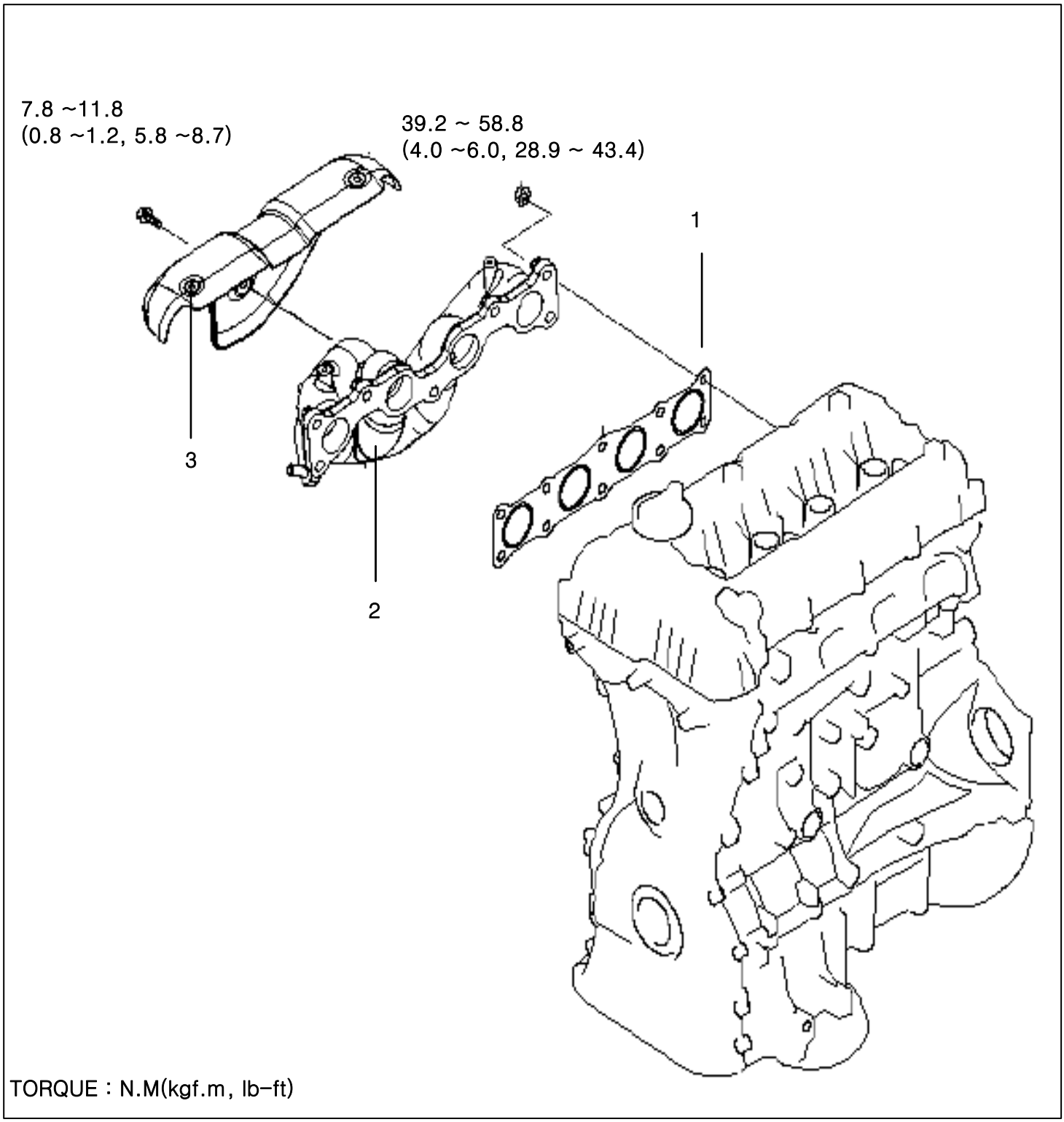


5. Install the engine cover (A).



Exaust manifold

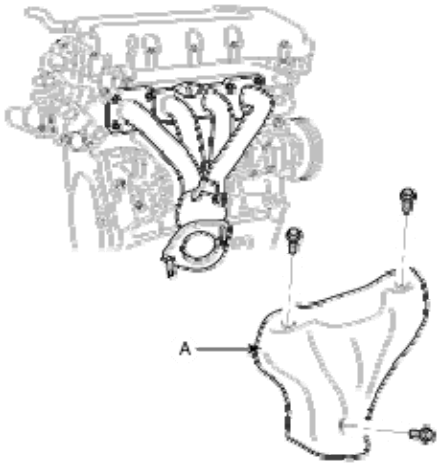
Components



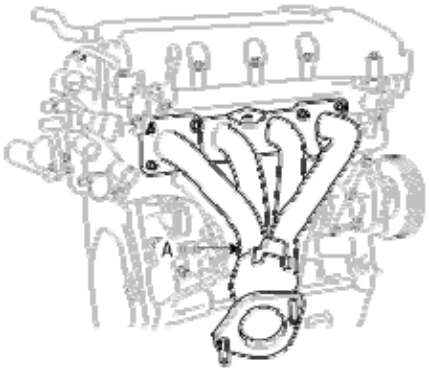
1. Exhaust manilod gasket	3. Heater protector
2. Exhaust manilod	

Exaust manifold

1. Remove the heat protector (A).



2. Remove the exhaust manifold (A) and gasket.

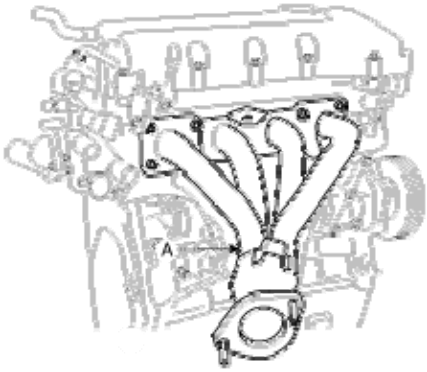


Installation

1. Install the exhaust manifold (A) with a new gasket

Tightening torque :

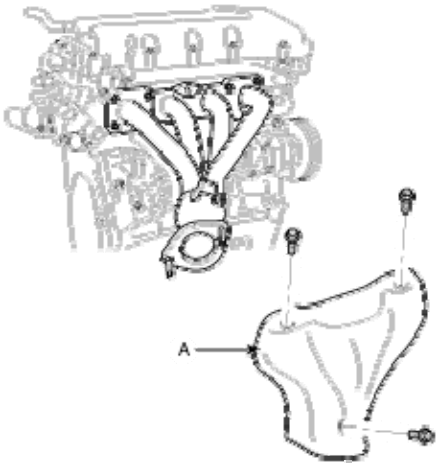
39.2 ~ 44.1N.m (4.0 ~ 4.5kgf.m, 28.9 ~ 32.5lb-ft)



2. Install the heat protector (A).

Tightening torque :

7.8 ~ 11.8N.m (0.8 ~ 1.2kgf.m, 5.8 ~ 8.7lb-ft)



Specification

Ignition System

ITEM			SPECIFICATION
Ignition coil	Primary resistance		0.62 ± 10%(Ω)
	Secondrry resistance		7.0 ± 15%(kΩ)
Spark plug	Leaded	NGK	LFR6A
		Gap	0.8 ~0.9mm(0.0315 ~0.0354 in)

Starting System

ITEM			SPECIFICATION
Starter	Rated voltage		12V, 1.4kw
	No.of pinion teeth		11
	No-load charateristics	Voltage	11.5v
		Ampere	90A, MAX
		Speed	2600rpm, MIN

Charging System

ITEM		SPECIFICATION
Alternator	Type	Battery voltage senksing
	Rate voltage	13.5V, 90A
	Speed in use	1000rpm ~ 18000rpm
	Voltage requlator	IC regulator built - in type
	Regulator setting voltage	14.4 ± 0.3v/20℃
	Temperature compensation	-10 ± 0.3mv/℃

Ignition System

Symptom	Suspect area	Remedy
Engine will not start or is hard to start (Cranks OK)	Ignition lock switch	Inspect ignition lock switch, or replace as required
	Ignition coil	Inspect ignition coil, or replace as required
	Spark plugs	Inspect spark plugs, or replace as required
	Ignition wiring disconnected or broken	Repair wiring, or replace as required
Rough idle or stalls	Ignition wiring	Repair wiring, or replace as required
	Ignition coil	Inspect ignition coil, or replace as required
Engine hesitates/poor acceleration	Spark plugs and spark plug cables	Inspect spark plugs / cable, or replace as required
	Ignition wiring	Repair wiring, or replace as required
Poor mileage	Spark plugs and spark plug cables	Inspect spark plugs / cable, or replace as required

Starting System

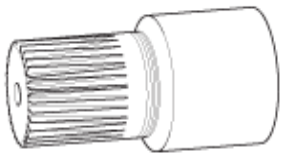
Symptom	Suspect area	Remedy
Engine will not crank	Battery charge low	Charge or replace battery
	Battery cables loose, corroded or worn out	Repair or replace cables
	Transaxle range switch (Vehicle with automatic transaxle only)	Refer to AT group-automatic transaxle
	Fuse blown	Replace fuse
	Starter faulty	Replace
	Ignition switch faulty	Replace
Engine cranks slowly	Battery charge low	Charge or replace battery
	Battery cables loose, corroded or worn out	Repair or replace cables
	Starter faulty	Replace
Starter keeps running	Starter	Replace
	Ignition switch	Replace
Starter spins but engine will not crank	Short in wiring	Repair wiring
	Pinion gear teeth broken or Starter	Replace
	Ring gear teeth broken	Replace fly wheel or torque converter

Trouble Shooting

Charging System

Charging warning indicator does not go out with engine running. (Battery requires frequent recharging)	Drive belt loose or worn	Adjust belt tension or replace belt
	Battery cable loose, corroded or worn	Inspect cable connection, repair or replace cable
	Electronic voltage regulator or alternator	Replace voltage regulator or alternator
	Wiring	Repair or replace wiring
Overcharge	Electronic voltage regulator	Replace voltage regulator
	Voltage sensing wire	Repair or replace wiring
Discharge	Drive belt loose or worn	Adjust belt tension or replace belt
	Wiring connection loose or short circuit	Inspect wiring connection, repair or replace wiring
	Electronic voltage regulator or alternator	Replace voltage regulator or alternator
	Poor grounding	Inspect ground or repair
	Worn battery	Replace battery

Special Service Tool

Tool (Number and name)	Illustration	Use
Alternator pulley remover wrench		Removal and installation of alternator pulley

Description

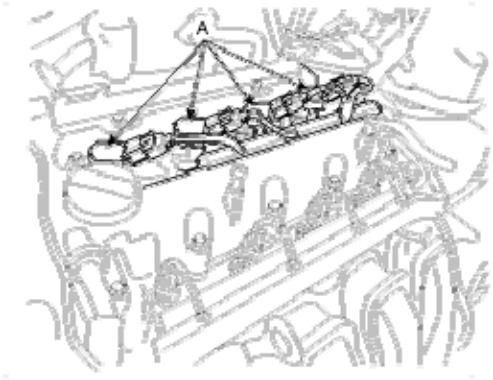
Ignition timing is controlled by the electronic control ignition timing system. The standard reference ignition timing data for the engine operating conditions are preprogrammed in the memory of the ECM (Engine Control Module).

The engine operating conditions (speed, load, warm-up condition, etc.) are detected by the various sensors. Based on these sensor signals and the ignition timing data, signals to interrupt the primary current are sent to the ECM. The ignition coil is activated, and timing is controlled.

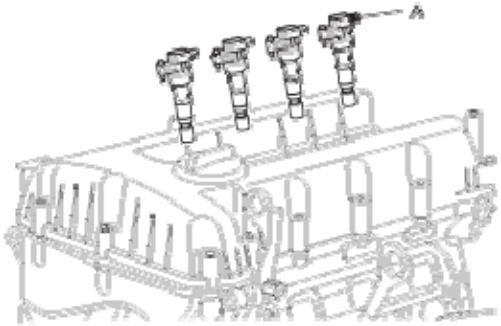
Repair procedures

Spark Test

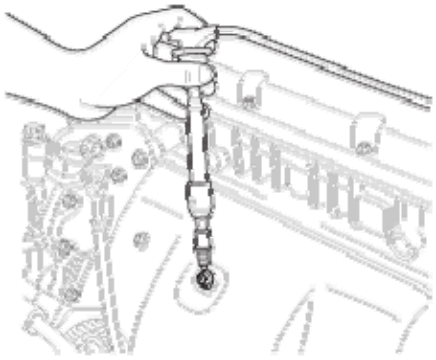
1. Remove the ignition coil connector(A).



2. Remove the ignition coil(A).



3. Using a spark plug socket, remove the spark plug.
4. Install the spark plug to the ignition coil.
5. Ground the spark plug to the engine.

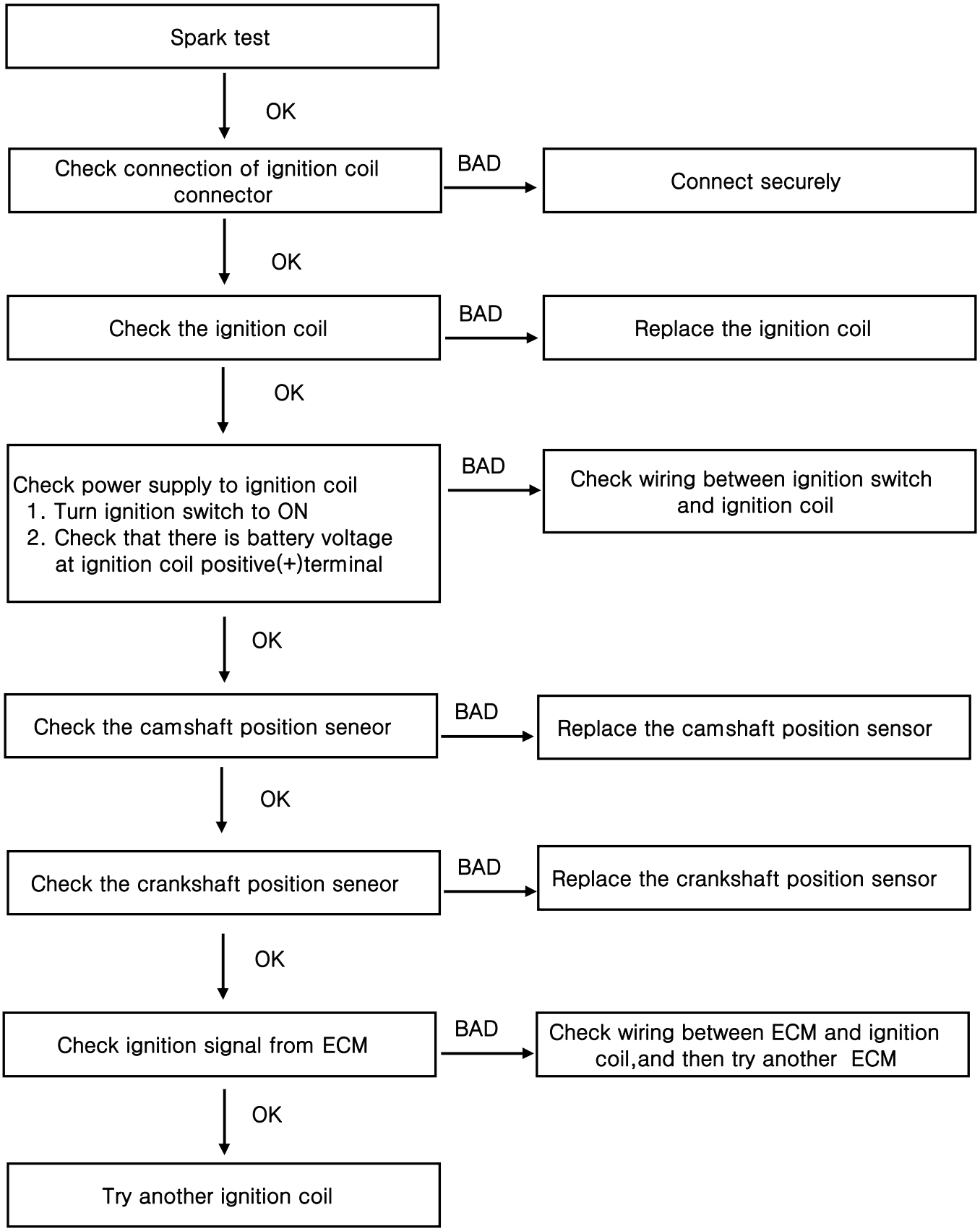


6. Check if spark occurs while engine is being cranked.

NOTE

To prevent fuel being injected from injectors while the engine is being cranked, remove the fuel pump relay from the fuse box.
Crank the engine for no more than 5 ~ 10 seconds.

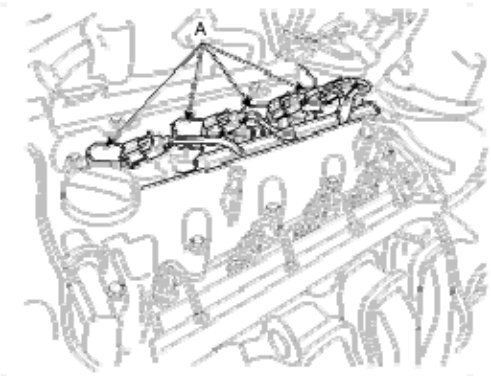
7. Inspect all the spark plugs
8. Using a spark plug socket, install the spark plug
9. Install the ignition coil.
10. Reconnect the ignition coil connector.


Spark test
OK
Check connection of ignition coil connector
BAD
Connect securely
OK
Check the ignition coil
BAD
Replace the ignition coil
OK
Check power supply to ignition coil
1. Turn ignition switch to ON
2. Check that there is battery voltage at ignition coil positive(+)terminal
BAD
Check wiring between ignition switch and ignition coil
OK
Check the camshaft position seneor
BAD
Replace the camshaft position sensor
OK
Check the crankshaft position seneor
BAD
Replace the crankshaft position sensor
OK
Check ignition signal from ECM
BAD
Check wiring between ECM and ignition coil,and then try another ECM
OK
Try another ignition coil

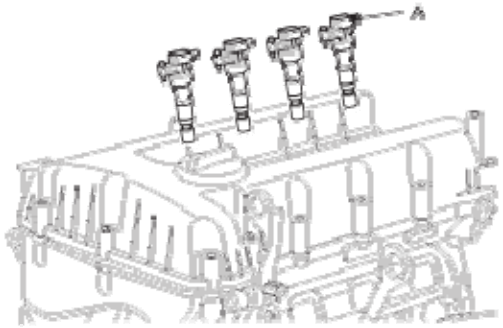
On-vehicle Inspection

Inspect Spark Plug

1. Remove the ignition coil connector(A).



2. Remove the ignition coil(A).

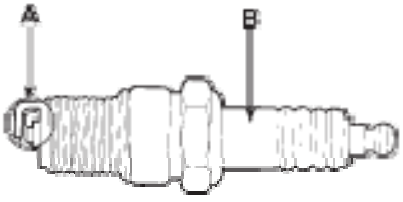


3. Using a spark plug socket, remove the spark plug.

CAUTION

Be careful that no contaminates enter through the spark plug holes.

4. Inspect the electrodes (A) and ceramic insulator (B).

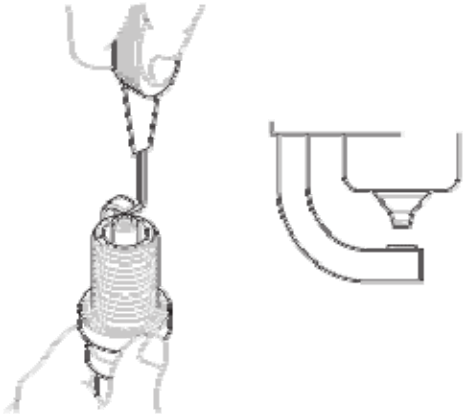


Condition	Dark deposits	White deposits
Description	* Fuel mixture too rich * Low air intake	* Fuel mixture too lean * Advanced ignition timing * Insufficient plug tightening torque

5. Check the electrode gap (A).

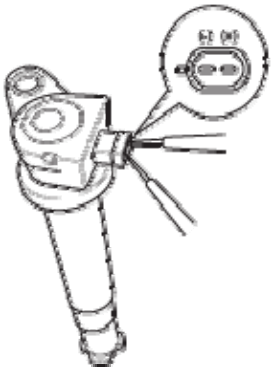
Standard value

Leaded : 0.8 ~ 0.9 mm (0.0275 ~ 0.0315 in.)



Inspect Ignition Coil

1. Measure the primary coil resistance between terminals (+) and (-).



Standard value: 0.62Ω ± 11%

Charging system

Description

The charging system includes a battery, an alternator with a built-in regulator, and the charging indicator light and wire.

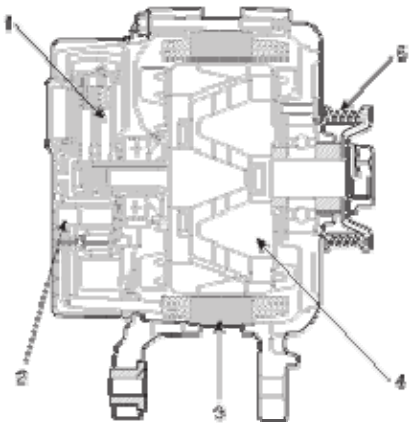
The Alternator has built-in diodes, each rectifying AC current to DC current.

Therefore, DC current appears at alternator "B" terminal.

In addition, the charging voltage of this alternator is regulated by the battery voltage detection system.

The main components of the alternator are the rotor, stator, rectifier, capacitor brushes, bearings and V-ribbed belt pulley.

The brush holder contains a built-in electronic voltage regulator.



1. Brush
2. Rectifier
3. Stator
4. Rotor
5. Drive belt pulley

On-vehicle Inspection

CAUTION

* Check that the battery cables are connected to the correct terminals
* Disconnect the battery cables when the battery is given a quick charge.
* Never disconnect the battery while the engine is running.

Check The Battery Terminals And Fuses

1. Check that the battery terminals are not loose or corroded.
2. Check the fuses for continuity

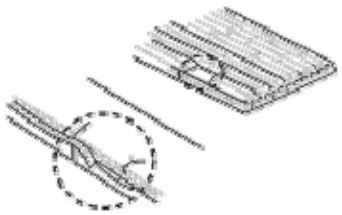
Inspect Drive Belt

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.



Visually Check Alternator Wiring And Listen For Abnormal Noises

1. Check that the wiring is in good condition.
2. Check that there is no abnormal noise from the alternator while the engine is running

Check Discharge Warning Light Circuit

1. Warm up the engine and then turn it off.
2. Turn off all accessories.
3. Turn the ignition switch "ON". Check that the discharge warning light is lit.
4. Start the engine and check that the light goes off.

If the light does not go off as specified, troubleshoot the discharge light circuit

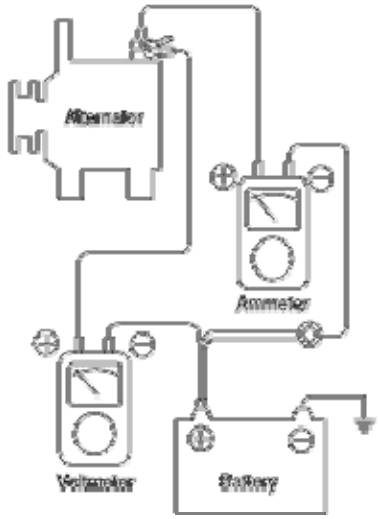
Inspect Charging System

Voltage Drop Test Of Alternator Output Wire

This test determines whether or not the wiring between the alternator "B" terminal and the battery (+) terminal is good by the voltage drop method.

Preparation

1. Turn the ignition switch to "OFF".
2. Disconnect the output wire from the alternator "B" terminal. Connect the (+) lead wire of ammeter to the "B" terminal of alternator and the (-) lead wire of ammeter to the output wire. Connect the (+) lead wire of voltmeter to the "B" terminal of alternator and the (-) lead wire of voltmeter to the (+) terminal of battery.



Test

1. Start the engine.
2. Turn on the headlamps and blower motor, and set the engine speed until the ammeter indicates 20A.And then, read the voltmeter at this time.

Result

1. The voltmeter may indicate the standard value.

Standard value: 0.2V max

2. If the value of the voltmeter is higher than expected (above 0.2V max.), poor wiring is suspected. In this case check the wiring from the alternator "B" terminal to the battery (+) terminal. Check for loose connections, color change due to an over-heated harness, etc. Correct them before testing again.
3. Upon completion of the test, set the engine speed at idle. Turn off the headlamps, blower motor and the ignition switch.

Output Current Test

This test determines whether or not the alternator gives an output current that is equivalent to the normal output.

Preparation

1. Prior to the test, check the following items and correct as necessary.

Check the battery installed in the vehicle to ensure that it is in good condition. The battery checking method is described in the section "Battery".

Check the battery installed in the vehicle to ensure that it is in good condition. The battery checking method is described in the section "Battery".

Check the battery installed in the vehicle to ensure that it is in good condition. The battery checking method is described in the section "Battery".

The battery that is used to test the output current should be one that has been partially discharged. With a fully charged battery, the test may not be conducted correctly due to an insufficient load.

Check the tension of the alternator drive belt.

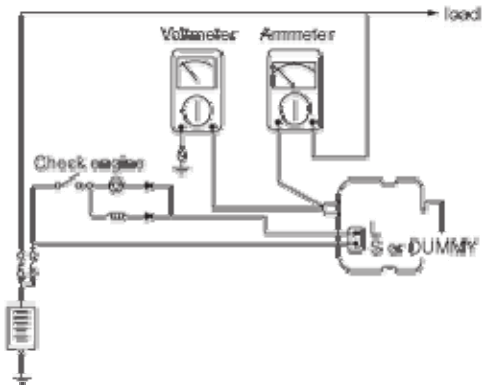
The belt tension check method is described in the section "Inspect drive belt".

2. Turn off the ignition switch.
3. Disconnect the battery ground cable.
4. Disconnect the alternator output wire from the alternator "B" terminal.
5. Connect a DC ammeter (0 to 150A) in series between the "B" terminal and the disconnected output wire. Be sure to connect the (-) lead wire of the ammeter to the disconnected output wire.

NOTE

Tighten each connection securely, as a heavy current will flow. Do not rely on clips.

6. Connect a voltmeter (0 to 20V) between the "B" terminal and ground. Connect the (+) lead wire to the alternator B terminal and (-) lead wire to a good ground.
7. Attach an engine tachometer and connect the battery ground cable.
8. Leave the engine hood open.



Test

1. The maximum reading must be higher than the limit value.If it is lower but the alternator output wire is in good condition, remove the alternator from the vehicle and test it.
2. Start the engine and turn on the headlamps.
3. Set the headlamps to high beam and the heater blower switch to HIGH, quickly increase the engine speed to 2,500 rpm and read the maximum output current value indicated by the ammeter.

NOTE

After the engine start up, the charging current quickly drops. Therefore, the above operation must be done quickly to read the maximum current value correctly.

Result

1. The maximum reading must be higher than the limit value.
   If it is lower but the alternator output wire is in good condition, remove the alternator from the vehicle and test it.

Limit value : 70% of the rate voltage

NOTE

* The nominal output current value is shown on the nameplate affixed to the alternator body.
* The output current value changes with the electrical load and the temperature of the alternator itself. Therefore, the nominal output current may not be obtained. If such is the case, keep the headlamps on the cause discharge of the battery, or use the lights of another vehicle to increase the electrical load.

2. Upon completion of the output current test, lower the engine speed to idle and turn off the ignition switch.
3. Disconnect the battery ground cable
4. Remove the ammeter and voltmeter and the engine tachometer.
5. Connect the alternator output wire to the alternator "B" terminal.
6. Connect the battery ground cable.

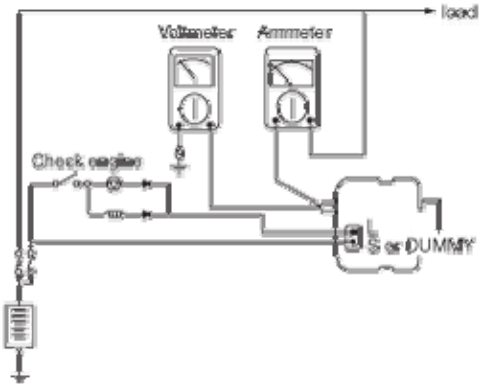
Regulated Voltage Test

The purpose of this test is to check that the electronic voltage regulator controls voltage correctly.

Preparation

1. Prior to the test, check the following items and correct if necessary.
   Check that the battery installed on the vehicle is fully charged. The battery checking method is described in the section "Battery".
   Check the alternator drive belt tension. The belt tension check method is described in the section "Inspect drive belt".
2. Turn ignition switch to "OFF".
3. Disconnect the battery ground cable.
4. Connect a digital voltmeter between the "B" terminal of the alternator and ground. Connect the (+) lead of the voltmeter to the "B" terminal of the alternator. Connect the (-) lead to good ground or the battery (-) terminal.
5. Disconnect the alternator output wire from the alternator "B" terminal.

6. Connect a DC ammeter (0 to 150A) in series between the "B" terminal and the disconnected output wire. Connect the (-) lead wire of the ammeter to the disconnected output wire.
7. Attach the engine tachometer and connect the battery ground cable.



Test

1. Turn on the ignition switch and check to see that the voltmeter indicates the following value.

Voltage: Battery voltage

If it reads 0V, there is an open circuit in the wire between the alternator "B" terminal and the battery and the battery (-) terminal.

2. Start the engine. Keep all lights and accessories off.
3. Run the engine at a speed of about 2,500 rpm and read the voltmeter when the alternator output current drops to 10A or less

Result

1. If the voltmeter reading agrees with the value listed in the regulating voltage table below, the voltage regulator is functioning correctly. If the reading is other than the standard value, the voltage regulator or the alternator is faulty.

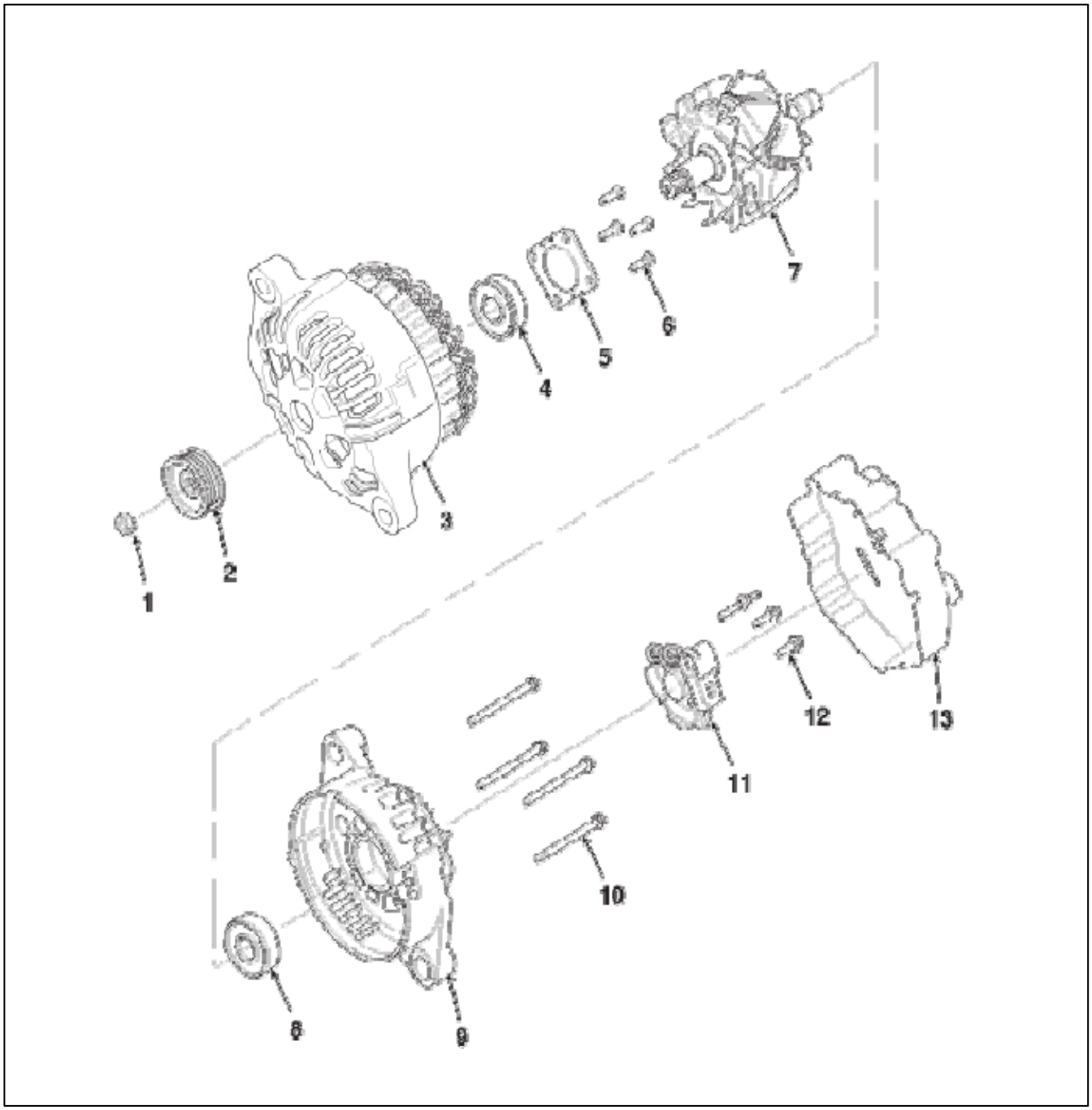
Regulating Voltage Table

Voltage regulator ambient temperature °C (°F)	Regulating voltage (V)
-30 (-22)	14.2 ~ 15.3
25 (77)	14.2 ~ 14.8
135 (275)	13.3 ~ 14.8

2. Upon completion of the test, reduce the engine speed to idle, and turn off the ignition switch.
3. Disconnect the battery ground cable
4. Remove the voltmeter and ammeter and the engine tachometer.
5. Connect the alternator output wire to the alternator B terminal
6. Connect the battery ground cable.

Alternator

Component

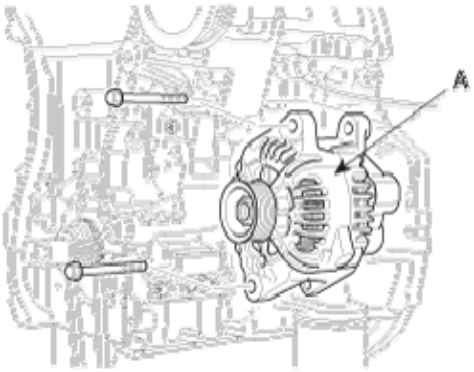


1. Nut	8. Rear bearing
2. Pulley	9. Rear bracket
3. Front bracket	10. Through bolt
4. Front bearing	11. Brush holder assembly
5. Bearing cover	12. Brush holder bolt
6. Bearing cover bolt	13. Rear cover
7. Rotor coil	

Alternator

Replacement

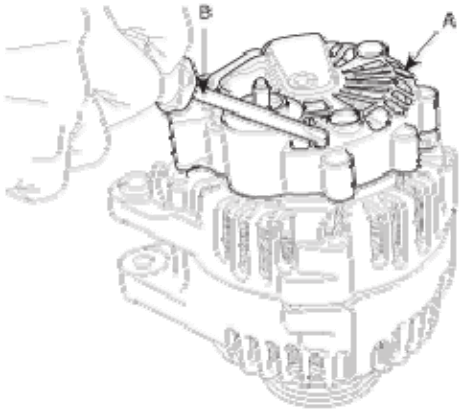
1. Disconnect the battery negative terminal first, then the positive terminal.
2. Disconnect the alternator connector, and remove the cable from alternator "B" terminal.
3. Remove the drive belt.
4. Pull out the through bolt and then remove the alternator(A).



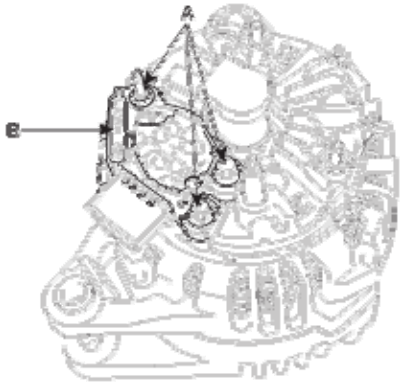
5. Installation is the reverse order of removal.

Disassembly

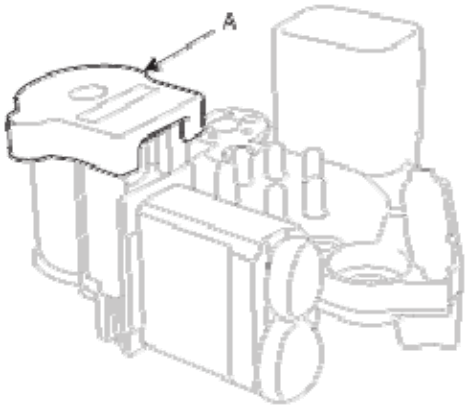
1. Remove the alternator cover(A) using a screw driver(B).



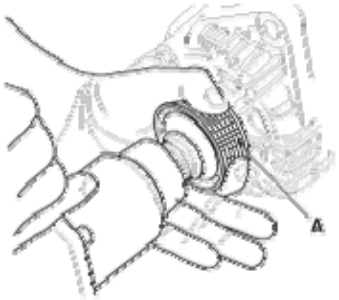
2. Loosen the mounting bolts(A) and disconnect the brush holder assembly(B).



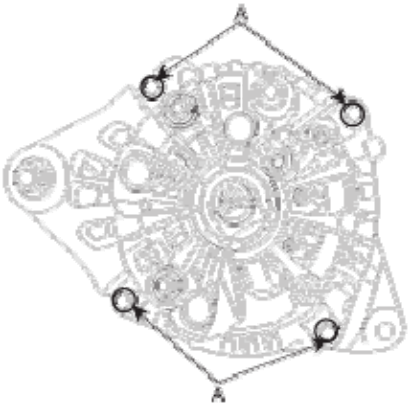
3. Remove the slip ring guide(A).



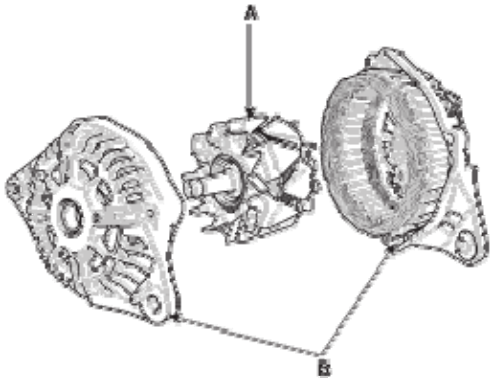
4. Remove the nut, pulley(A) and spacer.



5. Loosen the 4 through bolts(A).



6. Disconnect the rotor(A) and cover(B).

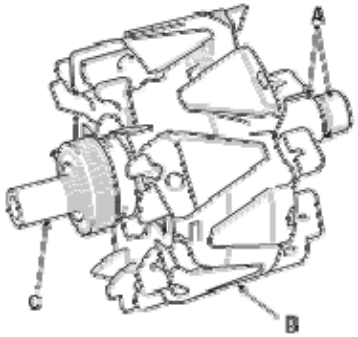


7. Reassembly is the reverse order of disassembly.

Inspection

Inspect Rotor

1. Check that there is continuity between the slip rings (A).



2. Check that there is no continuity between the slip rings and the rotor (B) or rotor shaft (C).
3. If the rotor fails either continuity check, replace the alternator.

Inspect Stator

1. Check that there is continuity between each pair of leads (A).

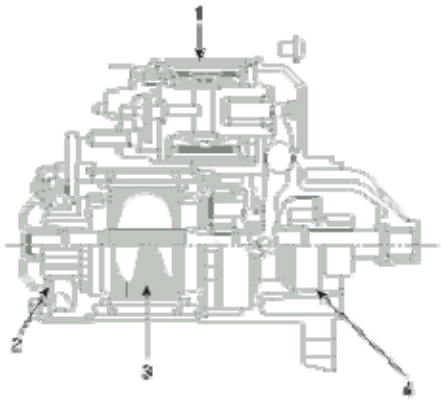
2. Check that there is no continuity between each lead and the coil core
3. If the coil fails either continuity check, replace the alternator.

Description

The starting system includes the battery, starter, solenoid switch, ignition switch, inhibitor switch (A/T), ignition lock switch, connection wires and the battery cable.

When the ignition key is turned to the start position, current flows and energizes the starter motor's solenoid coil. The solenoid plunger and clutch shift lever are activated, and the clutch pinion engages the ring gear.

The contacts close and the starter motor cranks. In order to prevent damage caused by excessive rotation of the starter armature when the engine starts, the clutch pinion gear overruns.



1. Solenoid
2. Brush assembly
3. Armature
4. Overrun clutch

Starter Circuit Troubleshooting

NOTE

The battery must be in good condition and fully charged

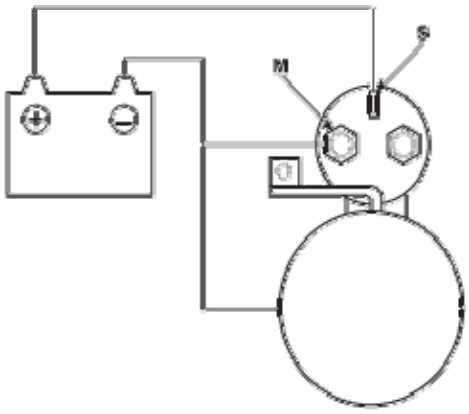
1. Remove the fuel pump relay
2. With the shift lever in N or P (A/T) or clutch pedal pressed (M/T), turn the ignition switch to "START"
   If the starter normally cranks the engine, starting system is OK. If the starter will not crank the engine at all, go to next step.
   If it won't disengage from the ring gear when you release key, check for the following until you find the cause.

A. Solenoid plunger and switch malfunction.
B. Dirty pinion gear or damaged overrunning clutch.

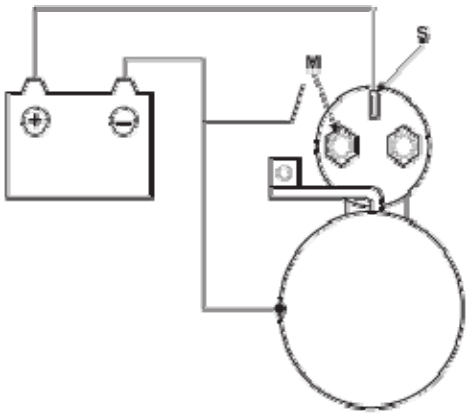
3. Check the battery condition. Check electrical connections at the battery, battery negative cable connected to the body, engine ground cables, and the starter for looseness and corrosion. Then try starting the engine again.
If the starter cranks normally the engine, repairing the loose connection repaired the problem. The starting system is now OK.
If the starter still does not crank the engine, go to next step.
4. Disconnect the connector from the S-terminal of solenoid. Connect a jumper wire from the B-terminal of solenoid to the S-terminal of solenoid.
If the starter cranks the engine, go to next step.
If the starter still does not crank the engine, remove the starter, and repair or replace as necessary.
5. Check the following items in the order listed until you find the open circuit.
A.Check the wire and connectors between the driver's under-dash fuse/relay box and the ignition switch, and between the driver's under-dash fuse/relay box and the starter.
B. Check the ignition switch (Refer to BE group - ignition system
C. Check the transaxle range switch connector or ignition lock switch connector.
D. Inspect the starter relay.

Starter Solenoid Test

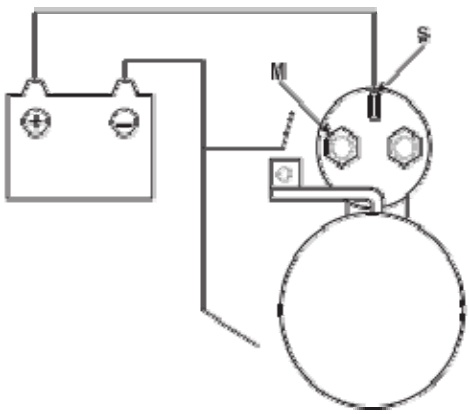
1. Disconnect the field coil wire from the M-terminal of solenoid switch.
2. Connect the battery as shown. If the starter pinion pops out, it is working properly. To avoid damaging the starter, do not leave the battery connected for more than 10 seconds.



3. Disconnect the battery from the M terminal.
If the pinion does not retract, the hold-in coil is working properly. To avoid damaging the starter, do not leave the battery connected for more than 10 seconds.

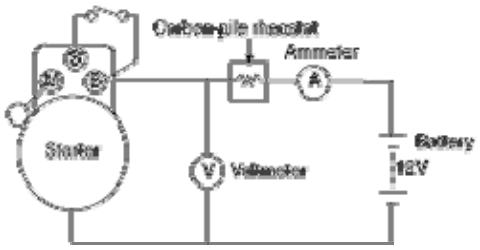


4. Disconnect the battery also from the body. If the pinion retracts immediately, it is working properly. To avoid damaging the starter, do not leave the battery connected for more than 10 seconds.



Free Running Test

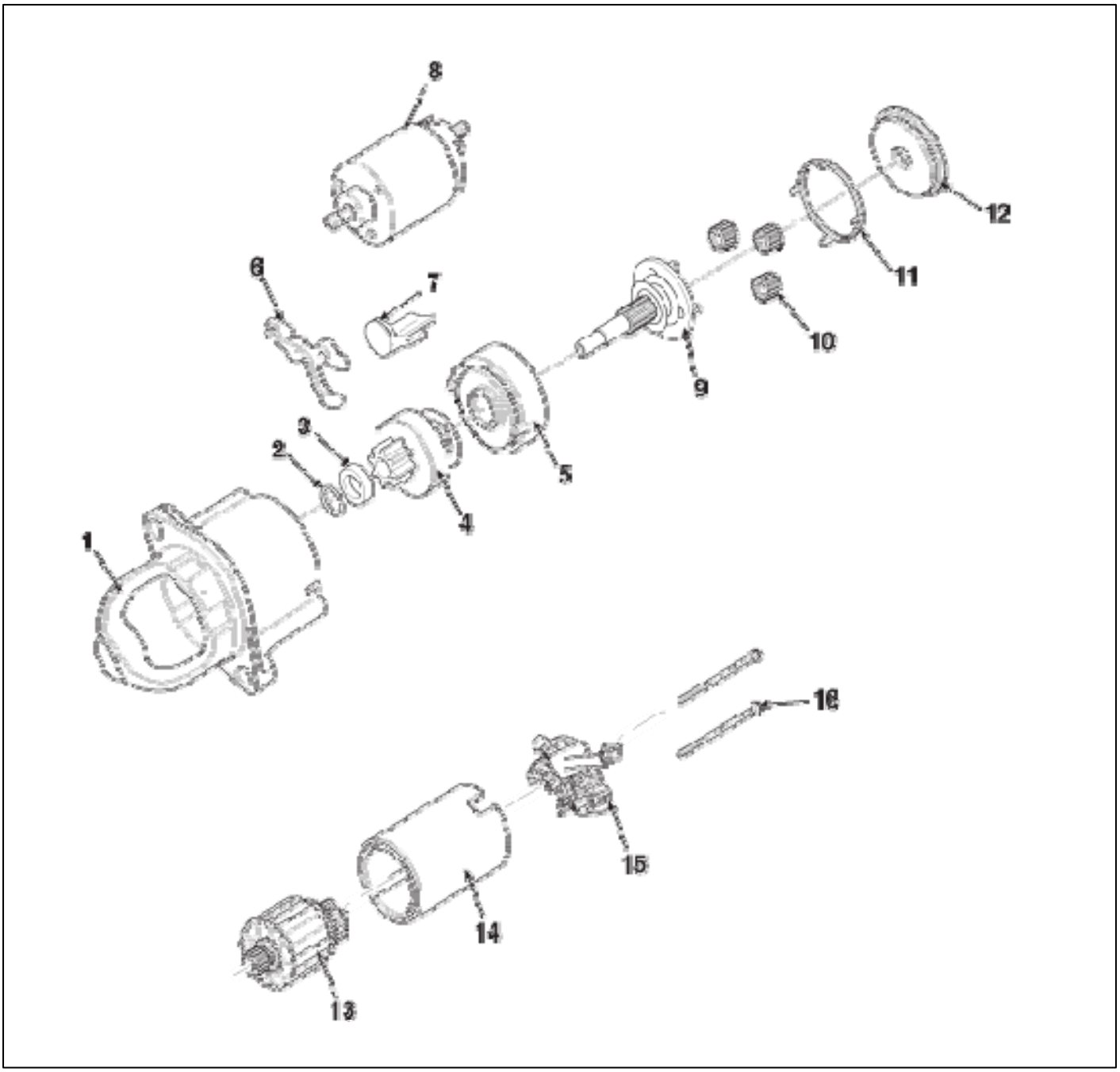
1. Place the starter motor in a vise equipped with soft jaws and connect a fully-charged 12-volt battery to starter motor as follows.
2. Connect a test ammeter (100-ampere scale) and carbon pile rheostats as shown in the illustration.
3. Connect a voltmeter (15-volt scale) across starter motor.



4. Rotate carbon pile to the off position
5. Connect the battery cable from battery's negative post to the starter motor body.
6. Adjust until battery voltage shown on the voltmeter reads 11volts.
7. Confirm that the maximum amperage is within the pecifications and that the starter motor turns smoothly and freely

Current : 90A max

Speed : 2,600 rpm

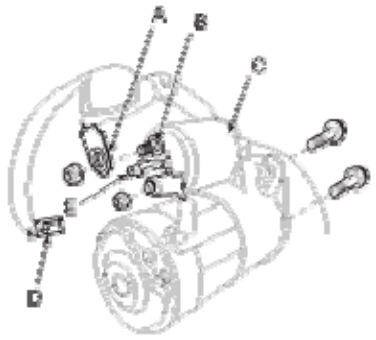


1. Front bracket	9. Planet shaft assembly
2. Stop ring	10. Planetary gear assembly
3. Stopper	11. Packing
4. Overrun clutch assembly	12. Shield
5. Internal gear assembly	13. Armature assembly
6. Lever	14. Yoke assembly
7. Lever packing	15. Brush holder assembly
8. Magnet switch assembly	16. Through bolt

Starter

Removal

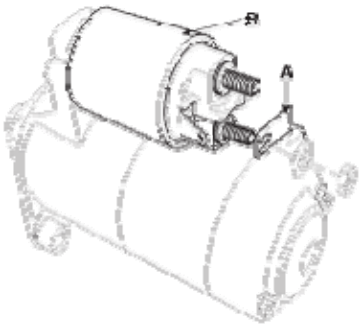
1. Disconnect the battery negative cable.
2. Disconnect the starter cable (A) from the B terminal (B) on the solenoid (C), then disconnect the connector (D) from the S terminal (E).



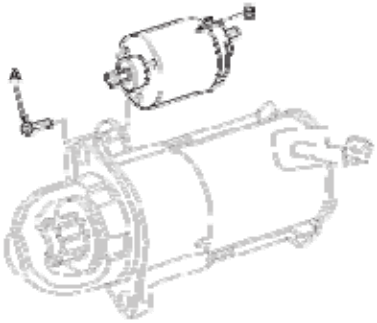
3. Remove the 2 bolts holding the starter, then remove the starter.
4. Installation is the reverse of removal.
5. Connect the battery negative cable to the battery.

Disassembly

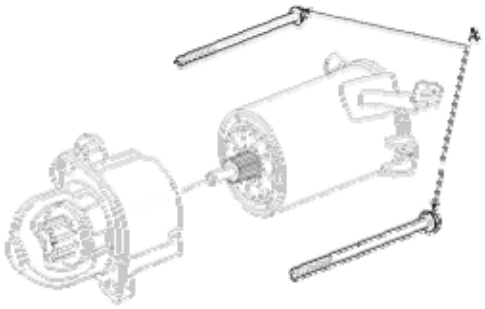
1. Disconnect the M-terminal (A) on the magnet switch assembly (B).



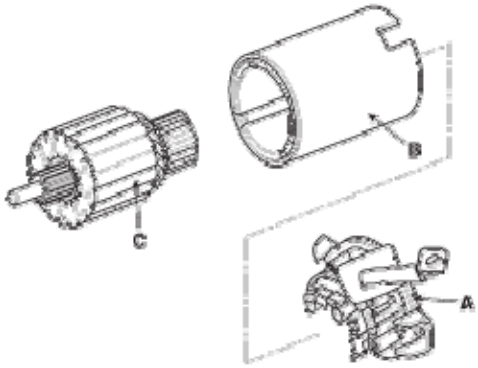
2. After loosening the 3 screws (A), detach the magnet switch assembly (B).



3. Loosen the through bolts (A).

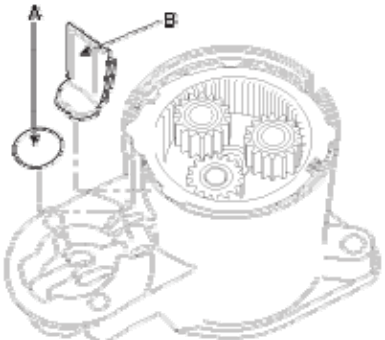


4. Remove the brush holder assembly (A), yoke (b) and armature (C).

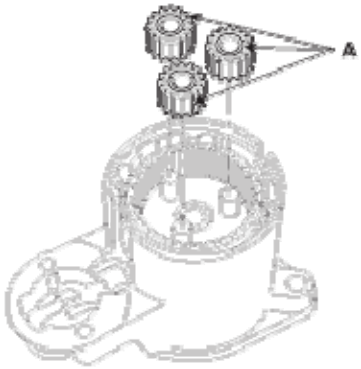


5.emove the shield (A) and packing (B).

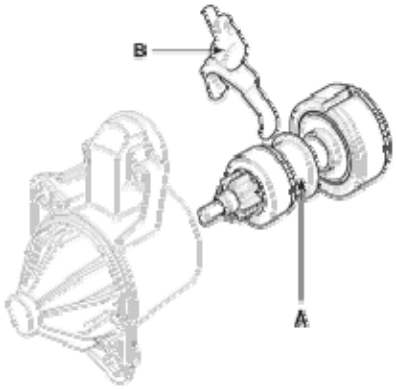
6. Remove the lever plate (A) and lever packing (B).



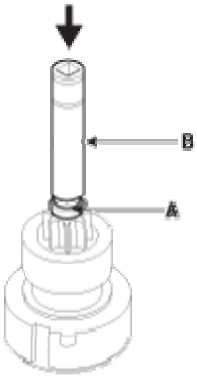
7. Disconnect the planet gear (A).



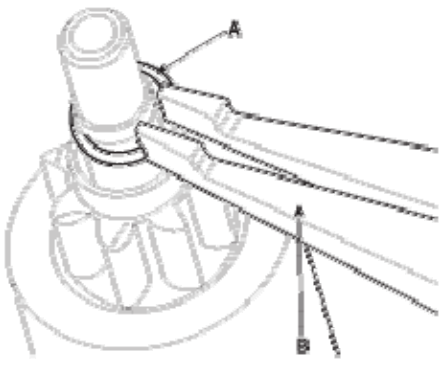
8. Disconnect the planet shaft assembly (A) and lever (B).



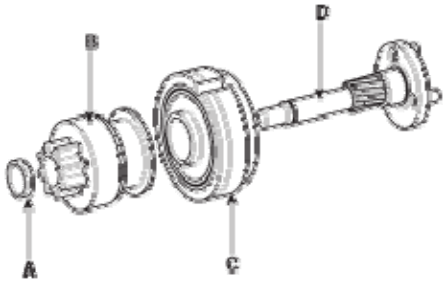
9. Press the stop ring (A) using a socket (B).



10. After removing the stopper (A) using stopper pliers (B).



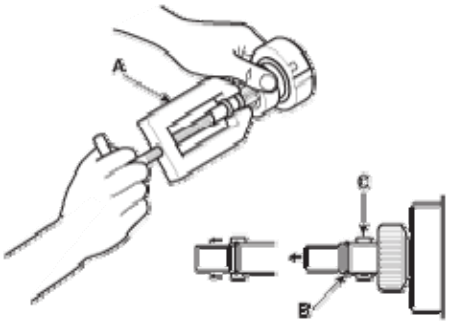
11. Disconnect the stop ring (A), overrunning clutch (B), internal gear (C) and planet shaft (D).



12. Reassembly is the reverse of disassembly.

NOTE

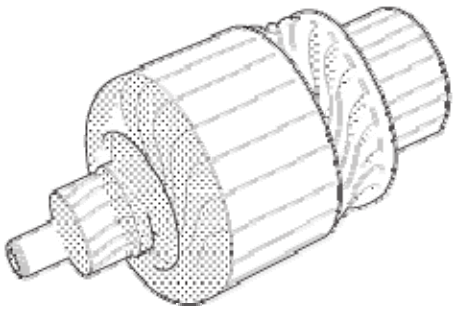
Using a suitable pulling tool (A), pull the overrunning clutch stop ring (B) over the stopper (C).



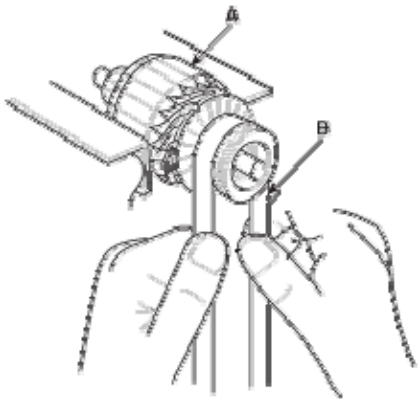
Inspection

Armature Inspection And Test

1. Remove the starter.
2. Disassemble the starter as shown at the beginning of this procedure.
3. Inspect the armature for wear or damage from contact with the permanent magnet. If there is wear or damage, replace the armature



4. Check the commutator (A) surface. If the surface is dirty or burnt, resurface with emery cloth or a lathe within the following specifications, or recondition with #500 or #600 sandpaper (B).



5. Measure the commutator (A) runout.

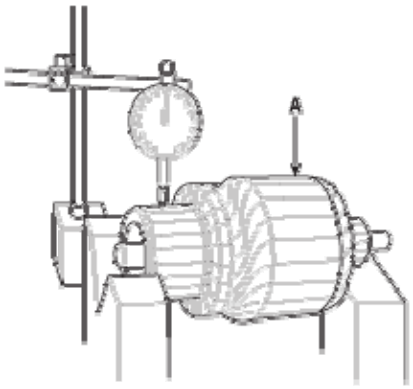
A. If the commutator runout is within the service limit, check the commutator for carbon dust or brass chips between the segments.

B.If the commutator run out is not within the service limit, replace the armature.

Commutator runout

Standard (New): 0.02mm (0.0008in.) max

Service limit: 0.05mm (0.0020in.)

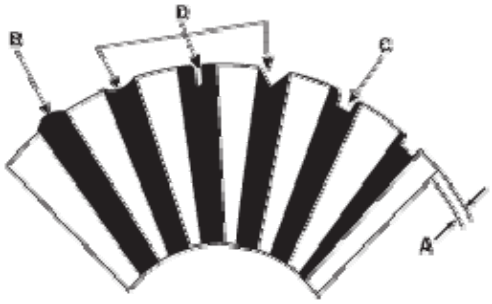


6. Check the mica depth (A). If the mica is too high (B), undercut the mica with a hacksaw blade to the proper depth. Cut away all the mica (C) between the commutator segments. The undercut should not be too shallow, too narrow, or v-shaped (D).

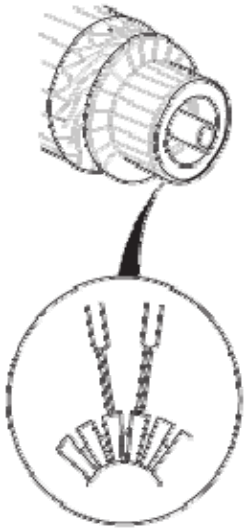
Commutator mica depth

Standard (New) : 0.5 mm (0.0197 in.)

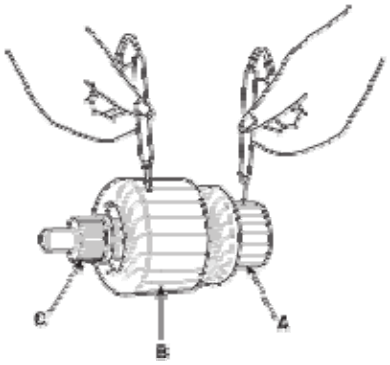
Limit : 0.2mm (0.0079 in.)



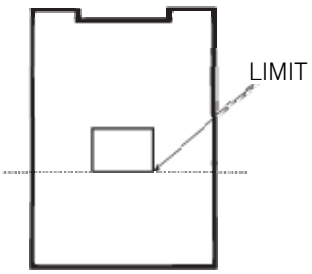
7. Check for continuity between the segments of the commutator. If an open circuit exists between any segments, replace the armature.



8. Check with an ohmmeter that no continuity exists between the commutator (A) and armature coil core (B), and between the commutator and armature shaft (C). If continuity exists, replace the armature.

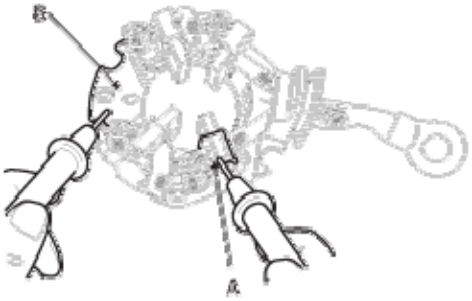


Inspect Starter Brush

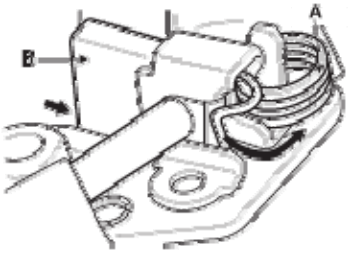


Starter Brush Holder Test

1. Check that there is no continuity between the (+) brush holder (A) and (-) brush holder (B). If there is no continuity, replace the brush holder assembly.



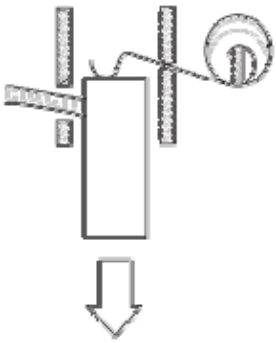
2. Pry back each brush spring (A) with a screwdriver, then position the brush (B) about halfway out of its holder, and release the spring to hold it there.



3. Install the armature in the housing, and install the brush holder. Next, pry back each brush spring again, and push the brush down until it seats against the commutator, then release the spring against the end of the brush.

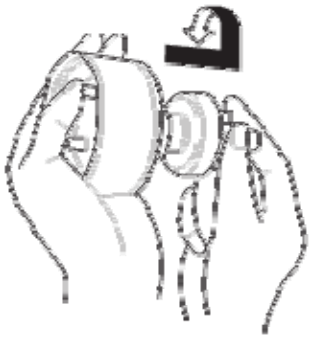
NOTE

To seat new brushes, slip a strip of #500 or #600 sandpaper, with the grit side up, between the commutator and each brush, and smoothly rotate the armature.
The contact surface of the brushes will be sanded to the same contour as the commutator.



Inspect Overrunning Clutch

1. Slide the overrunning clutch along the shaft. Replace it if does not slide smoothly.
2. Rotate the overrunning clutch both ways. Does it lock in one direction and rotate smoothly in reverse? If it does not lock in either direction or it locks in both directions, replace it.



3. If the starter drive gear is worn or damaged, replace the overrunning clutch assembly.
(the gear is not available separately).
Check the condition of the flywheel or torque converter ring gear if the starter drive gear teeth are damaged

Cleaning

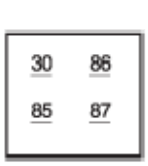
1. Do not immerse parts in cleaning solvent. Immersing the yoke assembly and/or armature will damage the insulation. Wipe these parts with a cloth only.
2. Do not immerse the drive unit in cleaning solvent. The overrun clutch is pre-lubricated at the factory and solvent will wash lubrication from the clutch.
3. The drive unit may be cleaned with a brush moistened with cleaning solvent and wiped dry with a cloth.

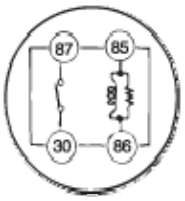
Starter relay

1. Remove the starter relay
2. Using an ohmmeter, check that there is continuity between each terminal.

Terminal	Continuity
30 - 87	NO
85 - 86	YES

3. Apply 12V to terminal 85 and ground to terminal 86. Check for continuity between terminals 30 and 87.





4. If there is no continuity, replace the starter relay.

PCV(positive crankcase ventilation) VALVE

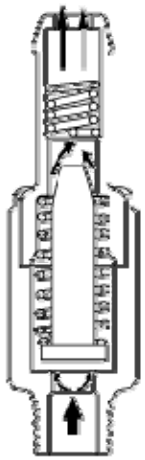
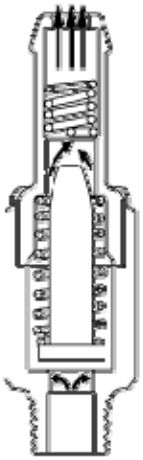
Inspection

1. Disconnect the ventilation hose from the positive crankcase ventilation (PCV) valve. Remove the PCV valve from the rocker cover and reconnect it to the ventilation hose.

NOTE

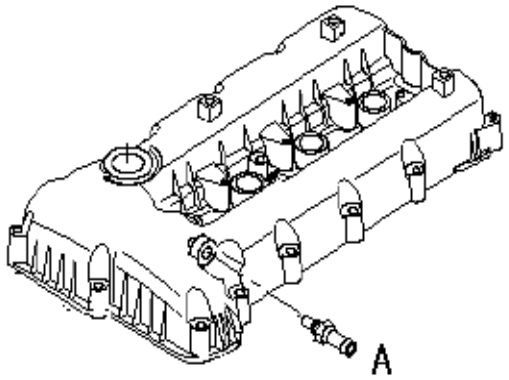
The plunger inside the PCV valve will move back and forth.

Operation

<table>
<tr><td colspan="2">Intake manifold side (No vacuum)
 
Rocker cover side</td><td colspan="2">Intake manifold side (High vacuum)
 
Rocker cover side</td></tr>
<tr><td>Engine condition</td><td>Not running</td><td>Engine condition</td><td>Idling or decelerating</td></tr>
<tr><td>PCV valve</td><td>Not operating</td><td>PCV valve</td><td>Fully operating</td></tr>
<tr><td>Vacuum passage</td><td>Restricted</td><td>Vacuum passage</td><td>Small</td></tr>
<tr><td colspan="2">Intake manifold side (Moderate vacuum)
 
Rocker cover side</td><td colspan="2">Intake manifold side (Low vacuum)
 
Rocker cover side</td></tr>
<tr><td>Engine condition</td><td>Normal operation</td><td>Engine condition</td><td>Accelerating and high load</td></tr>
<tr><td>PCV valve</td><td>Properly operating</td><td>PCV valve</td><td>Slightly operating</td></tr>
<tr><td>Vacuum passage</td><td>Large</td><td>Vacuum passage</td><td>Very large</td></tr>
</table>

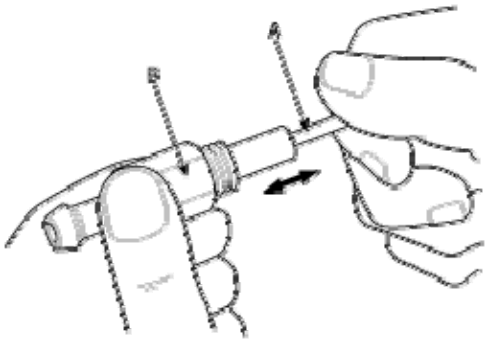
Removal

1. Disconnect the vacuum hose and remove the PCV valve(A)



Inspection

1. Remove the PCV valve.
2. Insert a thin stick(A) into the PCV valve(B) from the threaded side to check that the plunger moves.
3. If the plunger does not move, the PCV valve is clogged. Clean it or replace.



Installation

Install the PCV valve and tighten to the specified torque.

PCV valve installation

: 7.8 ~ 11.8 N·m (0.8 ~ 1.2 kgf.m, 5.8 ~ 8.7lb-ft)

FUEL SYSTEM

Specifications

Sensor

MAPS (Manifold Absolute Pressure Sensor)

- Type: Piezo-resistive pressure sensor type
- Specification

Pressure (kPa)	Output voltage (V)
20	0.79
46.7	1.84
101.32	4

IATS (Intake Air Temperature Sensor)

- Type: Thermistor type
- Specification

Temperature [°C(°F)]	Resistance (kΩ)
-40(-40)	40.93 ~ 48.35
-30(-22)	23.43 ~ 27.34
-20(-4)	13.89 ~ 16.03
-10(14)	8.50 ~ 9.71
0(32)	5.38 ~ 6.09
10(50)	3.48 ~ 3.90
20(68)	2.31 ~ 2.57
25(77)	1.90 ~ 2.10
30(86)	1.56 ~ 1.74
40(104)	1.08 ~ 1.21
60(140)	0.54 ~ 0.62
80(176)	0.29 ~ 0.34

ECTS (Engine Coolant Temperature Sensor)

- Type: Thermistor type
- Specification

Temperature [°C(°F)]	Resistance(kΩ)
-40(-40)	48.14
-20(-4)	14.13 ~ 16.83
0(32)	5.79
20(68)	2.31 ~ 2.59
40(104)	1.15
60(140)	0.59
80(176)	0.32

HO2S (Heated Oxygen Sensor)

- Type: Zirconia (ZrO2) type
- Specification

A/F Ratio	Output Voltage (V)
Rich	0.6 ~ 1.0
Lean	0 ~ 0.4

Items	Specification
Heater Resistance (Ω)	3.1 ~ 4.1 [20°C(68°F)]

CMPS (Camshaft Position Sensor)

CKPS (Crankshaft Position Sensor)

KS (Knock Sensor)

Items	Specification
Capacitance (pF)	1,480 ~ 2,200
Resistance(MΩ)	1

Actuators

Injector (gasoline fuel system only)

- Number: 4
- Specification

Items	Specification
Coil Resistance	14.0 ~15.4[20℃(68℉)]

Ignition Coil

- Type: Stick type
- Specification

Items	Specification
Primary Coil Resistance (Ω)	0.62 ± 10%[20°C(68°F)]
Secondary Coil Resistance (kΩ)	7.0 ± 15%[20°C(68°F)]

Tightening torques

Engine control system

Item	Kgf.m	N.m	lb·ft
Manifold absolute pressure sensor installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Engine coolant temperature sensor installation	3.0 ~ 4.0	29.4 ~ 39.2	21.7 ~ 28.9
Crankshaft position sensor installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Camshaft position sensor	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Knock sensor installation bolt	1.9 ~ 2.4	18.6 ~ 23.5	13.7 ~ 17.4
Heated oxygen sensor installation	3.5 ~ 4.5	34.3 ~ 44.1	25.3 ~ 32.6
Ignition coil assembly installation bolts	0.4 ~0.6	3.9 ~ 5.9	2.9 ~ 4.3

Basic inspection procedure

Measuring condition of electronic parts' resistance

The measured resistance at high temperature after vehicle running may be high or low. So all resistance must be measured at ambient temperature (20°C, 68°F), unless stated otherwise.

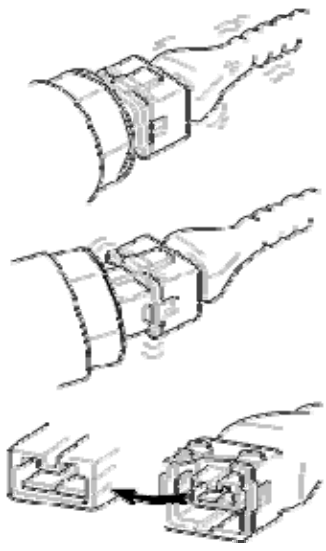
NOTE

The measured resistance in except for ambient temperature (20°C, 68°F) is reference value.

Intermittent problem inspection procedure

Sometimes the most difficult case in troubleshooting is when a problem symptom occurs but does not occur again during testing. An example would be if a problem appears only when the vehicle is cold but has not appeared when warm. In this case, the technician should thoroughly make out a "CUSTOMER PROBLEM ANALYSIS SHEET" and recreate (simulate) the environment and condition which occurred when the vehicle was having the issue.

1. Clear Diagnostic Trouble Code (DTC).
2. Inspect connector connection, and check terminal for poor connections, loose wires, bent, broken or corroded pins, and then verify that the connectors are always securely fastened.



3. Slightly shake the connector and wiring harness vertically and horizontally.
4. Repair or replace the component that has a problem.
5. Verify that the problem has disappeared with the road test.

● Simulating vibration

1) Sensors and Actuators
Slightly vibrate sensors, actuators or relays with finger.

WARNING

Strong vibration may break sensors, actuators or relays

2) Connectors and Harness
Lightly shake the connector and wiring harness vertically and then horizontally

● Simulating heat

1) Heat components suspected of causing the malfunction with a hair dryer or other heat source.

WARNING

- DO NOT heat components to the point where they may be damaged.
- DO NOT heat the ECM directly.

● Simulating water sprinkling

1) Sprinkle water onto vehicle to simulate a rainy day or a high humidity condition.

WARNING

- DO NOT sprinkle water directly into the engine compartment or electronic components.

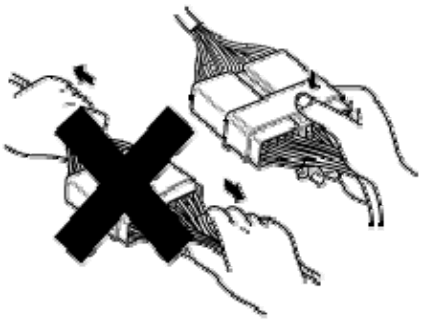
● Simulating electrical load

1) Turn on all electrical systems to simulate excessive electrical loads (Radios, fans, lights, rear window defogger, etc.).

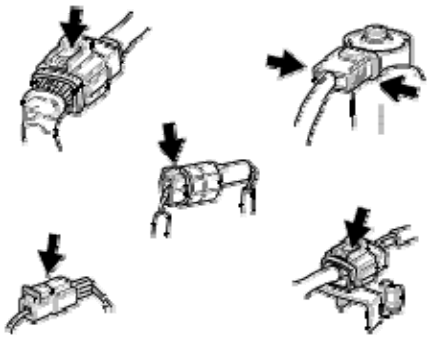
Connector inspection procedure

1. Handling of Connector

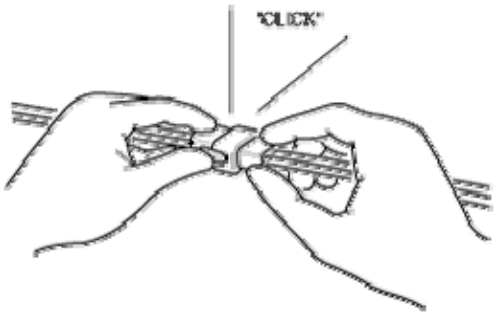
A) Never pull on the wiring harness when disconnecting connectors.



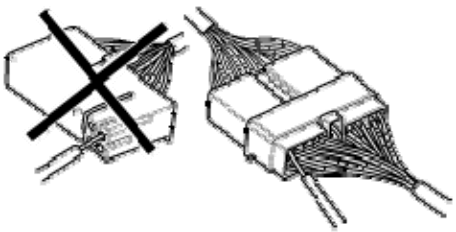
B) When removing the connector with a lock, press or pull locking lever.



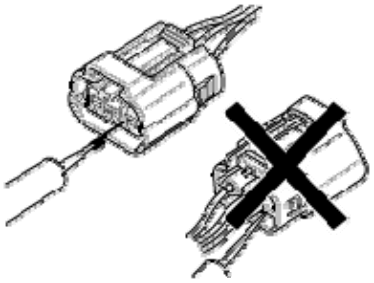
C) Listen for a click when locking connectors.
This sound indicates that they are securely locked



D) When a tester is used to check for continuity, or to measure voltage, always insert tester probe from wire harness side.



E) Check waterproof connector terminals from the connector side. Waterproof connectors cannot be accessed from harness side.



NOTE

- Use a fine wire to prevent damage to the terminal.
- Do not damage the terminal when inserting the tester lead.

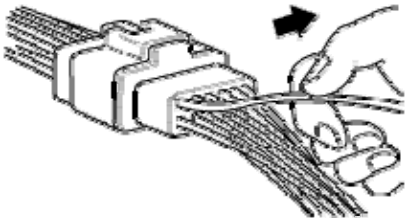
2. Checking Point for Connector

A. While the connector is connected:
Hold the connector, check connecting condition and locking efficiency.

B. When the connector is disconnected:
Check missed terminal, crimped terminal or broken core wire by slightly pulling the wire harness.
Visually check for rust, contamination, deformation and bend.

C. Check terminal tightening condition:
Insert a spare male terminal into a female terminal, and then check terminal tightening conditions

D. Pull lightly on individual wires to ensure that each wire is secured in the terminal.



3. Repair Method of Connector Terminal

A. Clean the contact points using air gun and/or shop rag.

NOTE

Never use sand paper when polishing the contact points, otherwise the contact point may be damaged.

B. In case of abnormal contact pressure, replace the female terminal.

Wire harness inspection procedure

1. Before removing the wire harness, check the wire har - ness position and crimping in order to restore it correctly
2. Check whether the wire harness is twisted, pulled or loosened.
3. Check whether the temperature of the wire harness is abnormally high.
4. Check whether the wire harness is rotating, moving or vibrating against the sharp edge of a part.
5. Check the connection between the wire harness and any installed part.
6. If the covering of wire harness is damaged; secure, repair or replace the harness.

Electrical circuit inspection procedure

● CHECK OPEN CIRCUIT

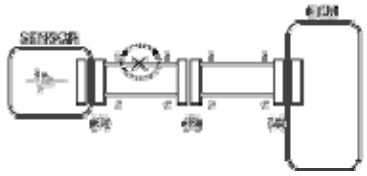
1. Procedures for Open Circuit

A. Continuity Check

B. Voltage Check

If an open circuit occurs (as seen in [FIG. 1]), it can be found by performing Step 2 (Continuity Check Method) or Step 3 (Voltage Check Method) as shown below.

FIG 1



2. Continuity Check Method

NOTE

When measuring for resistance, lightly shake the wire harness above and below or from side to side

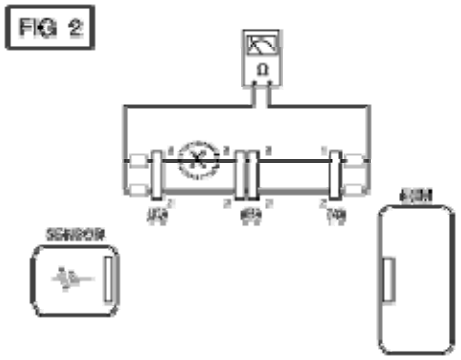
Specification (Resistance)

1Ω or less → Normal Circuit

1MΩ or Higher → Open Circuit

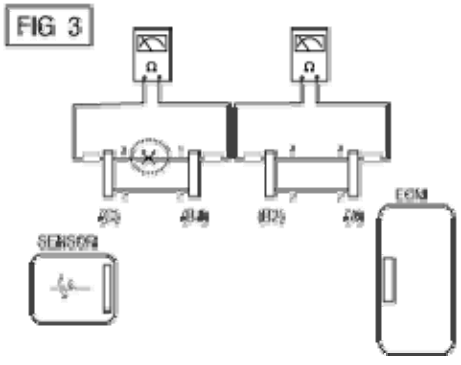
A. Disconnect connectors (A), (C) and measure resistance between connector (A) and (C) as shown in [FIG. 2]. In [FIG.2.] the measured resistance of line 1 and 2 is higher than 1MΩ and below 1 Ω respectively Specifically the open circuit is line 1 (Line 2 is normal). To find exact break point, check sub line of line 1 as described in next step

FIG 2



B. Disconnect connector (B), and measure for resistance between connector (C) and (B1) and between (B2) and (A) as shown in [FIG. 3]. In this case the measured resistance between connector (C) and (B1) is higher than 1MΩ and the open circuit is between terminal 1 of connector (C) and terminal 1 of connector (B1).

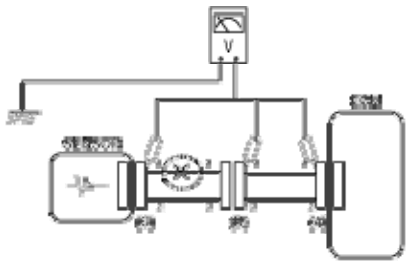
FIG 3



3. Voltage Check Method

A. With each connector still connected, measure the voltage between the chassis ground and terminal 1 of each connectors (A), (B) and (C) as shown in [FIG. 4]. The measured voltage of each connector is 5V, 5V and 0V respectively. So the open circuit is between connector (C) and (B).

FIG 4



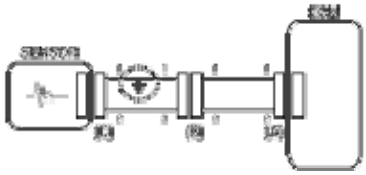
● CHECK SHORT CIRCUIT

1. Test Method for Short to Ground Circuit

A. Continuity Check with Chassis Ground

If short to ground circuit occurs as shown in [FIG. 5], the broken point can be found by performing Step 2 (Continuity Check Method with Chassis Ground) as shown below.

FIG 5



2. Continuity Check Method (with Chassis Ground

NOTE

Lightly shake the wire harness above and below, or from side to side when measuring the resistance

Specification (Resistance)

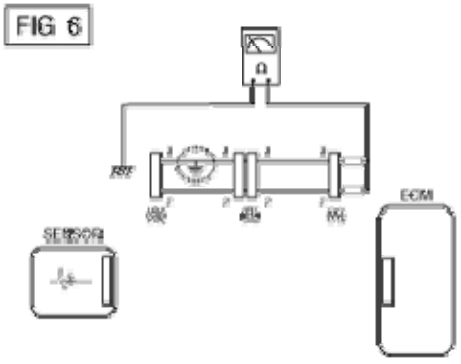
1Ω or less → Short to Ground Circuit

1MΩ or Higher → Normal Circuit

A. Disconnect connectors (A), (C) and measure for resistance between connector (A) and Chassis Ground as shown in [FIG. 6].

The measured resistance of line 1 and 2 in this example is below 1 Ω and higher than 1MΩ respectively. Specifically the short to ground circuit is line 1 (Line 2 is normal). To find exact broken point, check the sub line of line 1 as described in the following step.

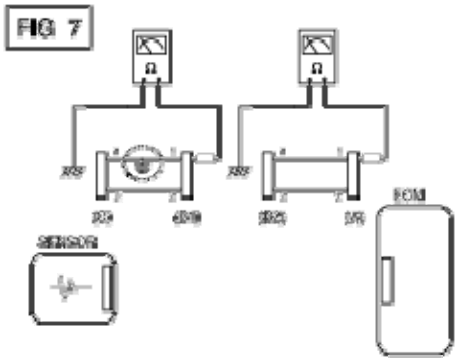
FIG 6



B. Disconnect connector (B), and measure the resistance between connector (A) and chassis ground, and between (B1) and chassis ground as shown in [FIG. 7].

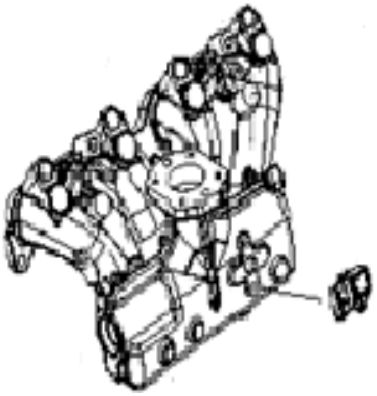
The measured resistance between connector (B1) and chassis ground is 1Ω or less. The short to ground circuit is between terminal 1 of connector (C) and terminal 1 of connector (B1).

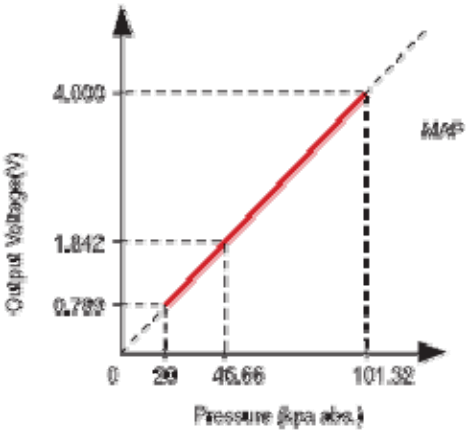
FIG 7



Main symptom	Diagnostic procedure	Also check for
Unable to start (Engine does not turn over)	1 Test the battery 2 Test the starter	
Unable to start (Incomplete combustion)	1 Test the battery 2 Check the fuel pressure 3 Check the ignition circuit	• DTC • Low compression • Intake air leaks • Slipped or broken timing belt • Contaminated fuel
Difficult to start	1 Test the battery 2 Check the fuel pressure 3 Check the ECT sensor and circuit (Check DTC) 4 Check the ignition circuit	• DTC • Low compression • Intake air leaks • Contaminated fuel • Weak ignition spark
Poor idling (Rough, unstable or incorrect Idle)	1 Check the fuel pressure 2 Check the Injector 3 Check the long term fuel trim and short term fuel trim (Refer to CUSTOMER DATASTREAM) 4 Check the idle speed control circuit (Check DTC) 5 Inspect and test the Throttle Body 6 Check the ECT sensor and circuit (Check DTC)	• DTC • Low compression • Intake air leaks • Contaminated fuel • Weak ignition spark
Engine stall	1 Test the Battery 2 Check the fuel pressure 3 Check the idle speed control circuit (Check DTC) 4 Check the ignition circuit 5 Check the CKPS Circuit (Check DTC)	• DTC • Intake air leaks • Contaminated fuel • Weak ignition spark
Poor driving (Surge)	1 Check the fuel pressure 2 Inspect and test Throttle Body 3 Check the ignition circuit 4 Check the ECT Sensor and Circuit (Check DTC) 5 Check the long term fuel trim and short term fuel trim (Refer to CUSTOMER DATASTREAM)	• DTC • Low compression • Intake air leaks • Contaminated fuel • Weak ignition spark
Knocking	1 Check the fuel pressure 2 Inspect the engine coolant 3 Inspect the radiator and the cooling fan 4 Check the spark plugs	• DTC • Contaminated fuel
Poor fuel economy	1 Check the fuel pressure 2 Check the injector 3 Test the exhaust system for a possible restriction 4 Check the ECT sensor and circuit	• DTC • Low compression • Intake air leaks • Contaminated fuel • Weak ignition spark

MAPS (Manifold Absolute Pressure Sensor)



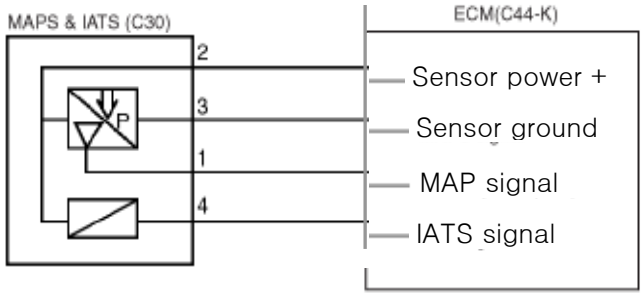


Manifold Absolute Pressure Sensor (MAPS) is speed-density type sensor and is installed on the surge tank. This MAPS senses absolute pressure in surge tank and transfers this analog signal proportional to the pressure to the PCM.
The PCM calculates the intake air quantity and engine speed based on this signal. This MAPS consists of piezo-electric element and hybrid IC that amplifies the element output signal. The element is silicon diaphragm type and adapts pressure sensitive variable resistor effect of semi-conductor. 100% vacuum and the manifold pressure applies to both sides of it respectively. That is, this sensor outputs the silicon variation proportional to pressure change by voltage.

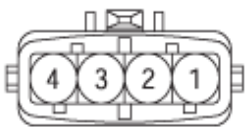
Specification

Pressure(kPa)	Output Voltage (V)
20	0.79
46.66	1.84
101.32	4

Circuit diagram



[Harness Connectors]



MAPS

Connection Information

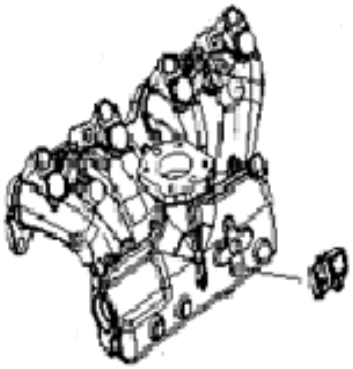
Terminal	Connected	Function
1	each pin no of ecu(ecm)	MAPS signal
2		Sensor power(+5v)
3		Sensor ground
4		IATS signal

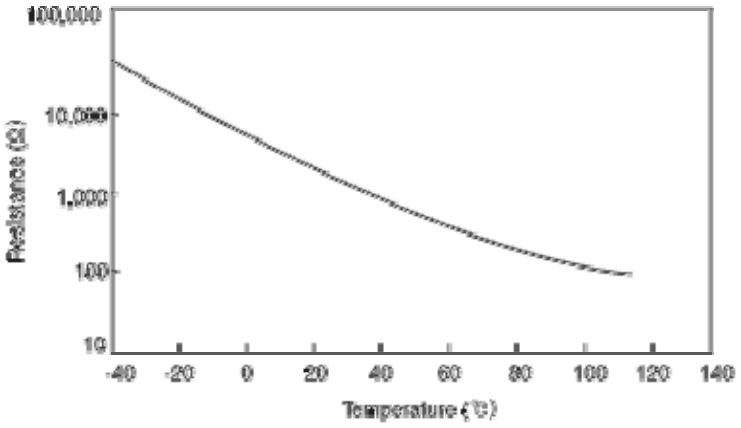
Condition	Output Voltage (V)
Idle	0.8V ~ 1.6V
IG ON	3.9V ~ 4.1V

Component inspection

1. Connect a scantool on Diagnisis Link Connector (DLC).
2. Check MAPS output voltage at idle and IG ON.

IATS (Intake Air Temperature Sensor)

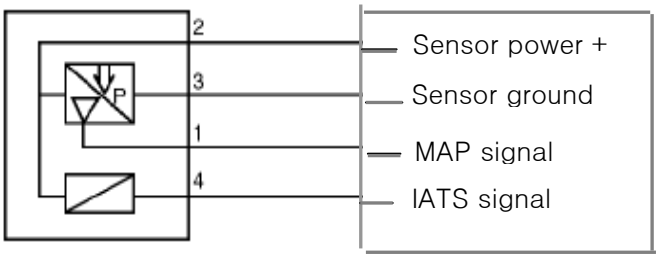




Temperature [°C (°F)]	Resistance (kΩ)
-40 (-40)	40.93 ~ 48.35
-30 (-22)	23.43 ~ 27.34
-20 (-4)	13.89 ~ 16.03
-10 (14)	8.50 ~ 9.71
0 (32)	5.38 ~ 6.09
10 (50)	3.48 ~ 3.90
20 (68)	2.31 ~ 2.57
25 (77)	1.90 ~ 2.10
30 (86)	1.56 ~ 1.74
40 (104)	1.08 ~ 1.21
60 (140)	0.54 ~ 0.62
80 (176)	0.29 ~ 0.34

Intake Air Temperature Sensor (IATS) is installed inside the Manifold Absolute Pressure Sensor (MAPS) and detects the intake air temperature. To calculate precise air quantity, correction of the air temperature is needed because air density varies according to the temperature. So the PCM uses not only MAPS signal but also IATS signal. This sensor has a Negative Temperature Coefficient (NTC) and its resistance is in inverse proportion to the temperature.

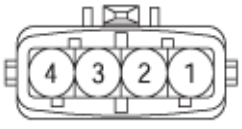
Circuit diagram



Connection Information

Terminal	Connected	Function
1	each pin no of ecu(ecm)	MAPS signal
2		Sensor power(+5v)
3		Sensor ground
4		IATS signal

Haness Connector



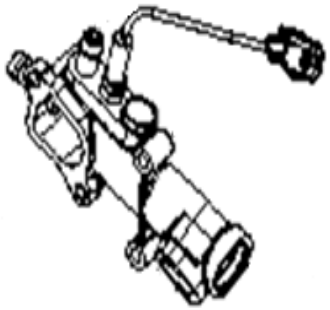
MAPS

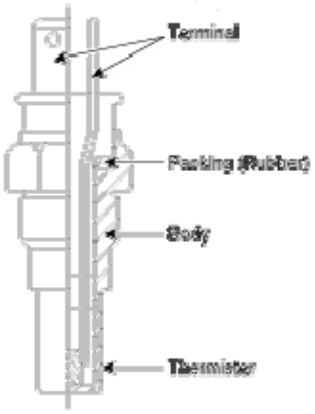
Component inspection

1. Turn ignition switch OFF.
2. Disconnect IATS connector.
3. Measure resistance between IATS terminals 3 and 4.
4. Check that the resistance is within the specification

Specification: Refer to SPECIFICATION

ECTS(Engine Coolant Temperature Sensor)

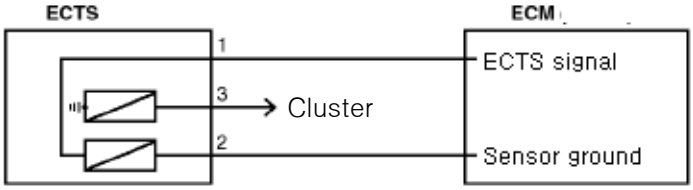




Function and operation priciple

Engine Coolant Temperature Sensor (ECTS) is located in the engine coolant passage of the cylinder head for detecting the engine coolant temperature. The ECTS uses a thermistor whose resistance changes with the temperature. The electrical resistance of the ECTS decreases as the temperature increases, and increases as the temperature decreases. The reference 5 V in the ECM is supplied to the ECTS via a resistor in the ECM.That is, the resistor in the ECM and the thermistor in the ECTS are connected in series. When the resistance value of the thermistor in the ECTS changes according to the engine coolant temperature, the output voltage also changes. During cold engine operation the ECM increases the fuel injection duration and controls the ignition timing using the information of engine coolant temperature to avoid engine stalling and improve drivability.

Circuit diagram



Connection Information

Terminal	Connect to	Funcition
1	each pin no of ecu(ecm)	ECTS signal
2		Sensor ground
3	Cluster	-

Haness Connector

CTL08
ECTS

Specification

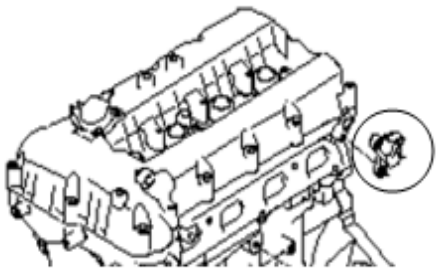
Temperature [°C(°F)]	Resistance(kΩ)
-40(-40)	48.14
-20(-4)	14.13 ~ 16.83
0(32)	5.79
20(68)	2.31 ~ 2.59
40(104)	1.15
60(140)	0.59
80(176)	0.32

Component inspection

1. Turn ignition switch OFF.
2. Disconnect ECTS connector.
3. Remove the ECTS.
4. After immersing the thermistor of the sensor into engine coolant, measure resistance between ECTS terminals 3 and 4.
5. Check that the resistance is within the specification.

Specification: Refer to Specification.

CMPS(Camshaft Position Sensor)



Camshaft Position Sensor (CMPS) is a hall sensor and detects the camshaft position by using a hall element. It is related with Crankshaft Position Sensor (CKPS) and detects the piston position of each cylinder which the CKPS can't detect. The CMPS are installed on engine head cover and uses a target wheel installed on the camshaft. This sensor has a hall-effect IC which output voltage changes when magnetic field is made on the IC with current flow.

Troubleshooting

Waveform

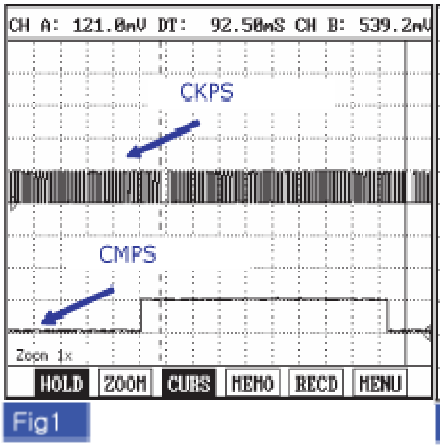


Fig1

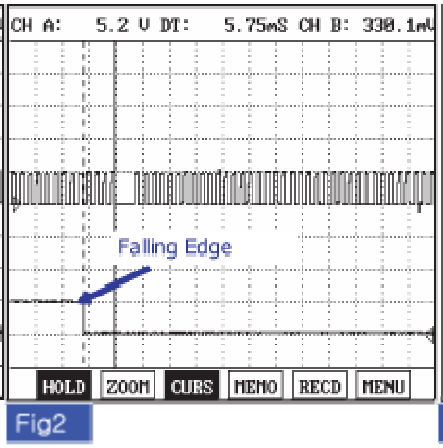


Fig2

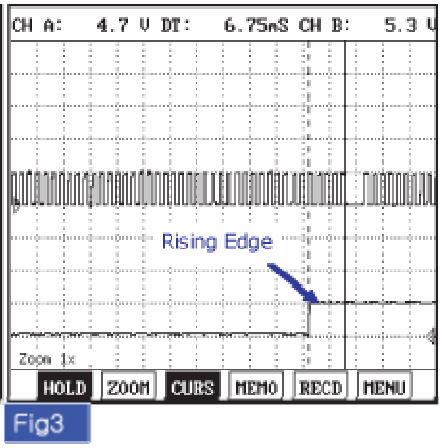
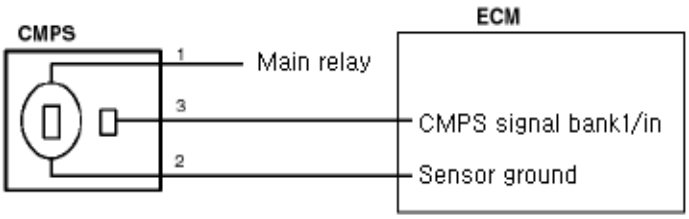


Fig3

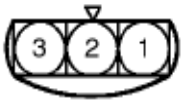
Circuit diagram



Connection Information

Terminal	Connect to	Funcition
1	Main relay	Power(b+)
2	each pin no of ecu(ecm)	Sensor ground
3		CMPS bank1/in signal

Haness Connector



CMPS

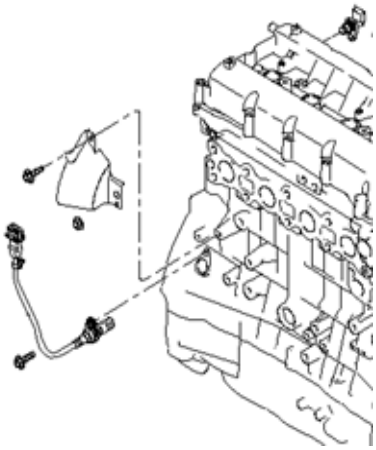
Component inspection

Check signal waveform of CMPS and CKPS using a scantool

Specification : Refer to "WAVE FORM"

CKPS (Crankshaft Position Sensor)

Crankshaft Position Sensor (CKPS) detects the crankshaft position and is one of the most important sensors of the engine control system. If there is no CKPS signal input, fuel is not supplied. That is, vehicle can't run without CKPS signal. This sensor is installed on transaxle housing and generates alternating current by magnetic flux field which is made by the sensor and the target wheel when engine runs. The target wheel consists of 58 slots and 2 missing slots on 360 degrees CA (Crank Angle).



Troubleshooting

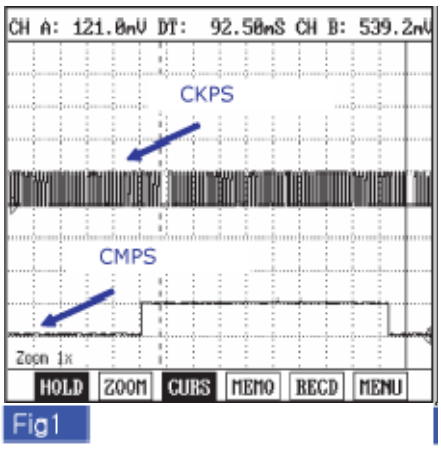
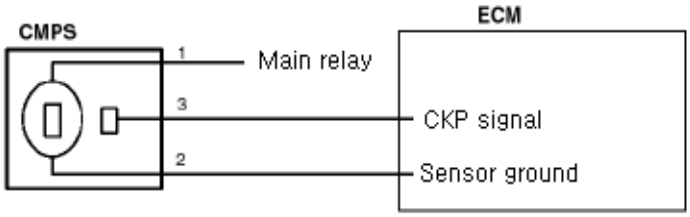


Fig1

Fig.1) The square wave signal should be smooth and without any distortion.

Fig.2,3) The CMPS falling(rising) edge is coincided with 3~5 tooth of the CKP from one longer signal(missing tooth)

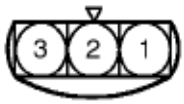
Circuit diagram



Connection Information

Terminal	Connect to	Funcition
1	Main relay	Power(b+)
2	each pin no of ecu(ecm)	CKP Signal
3		Sensor ground

Haness Connector



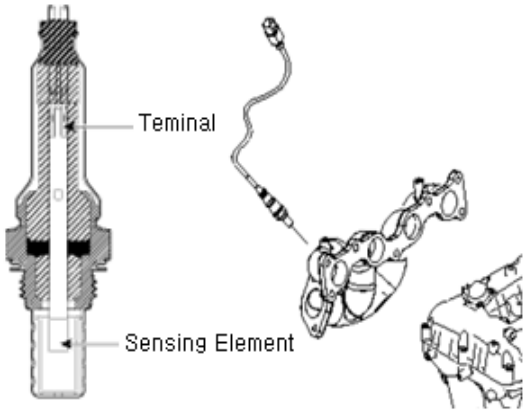
CKPS

Check signal waveform of CKPS and CMPS using a scantool.

Specification : Refer to "WAVE FORM"

HO2S (Heated Oxygen Sensor)

Heated Oxygen Sensor (HO2S) consists of zirconium and alumina and is installed on downstream of the Exhaust Manifold After it compares oxygen consistency of the atmosphere with the exhaust gas, it transfers the oxygen consistency of the exhaust gas to the ECM. When A/F ratio is rich or lean, it generates approximately 1V or 0V respectively. In order that this sensor normally operates, the temperature of the sensor tip is higher than 370°C (698°F). So it has a heater which is controlled by the ECM duty signal. When the exhaust gas temperature is lower than thesensor tip. specified value, the heater warms the

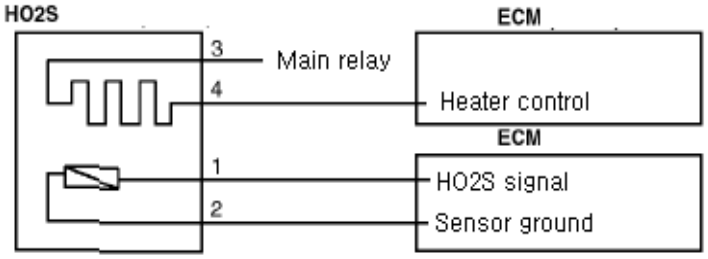


Specification

A/F Ratio	Output Voltage (V)
RICH	0.6 ~ 1.0
LEAN	0.1 ~ 0.4

Item	Specification
Heater Resistance (Ω)	3.1 ~ 4.1 Ω at 20°C (68°F)

Circuit Diagram



Connection Information

HO2S

Terminal	Connect to	Funcition
1	each pin no of ecu(ecm)	HO2S signal
2		Sensor ground
3	Main relay	Battery (b+)
4	each pin no of ecu(ecm)	Heater control

Haness Connector

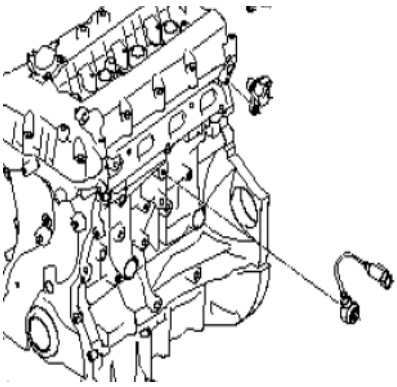
Component Inspection

1. Disconnet the HO2S connector.
2. Measure resistance between HO2S heater terminals 3 and 4.
3. Check that the resistance is within the specification.

Specification: Refer to Specification.

KS (Knock Sensor)

Function and operation priciple

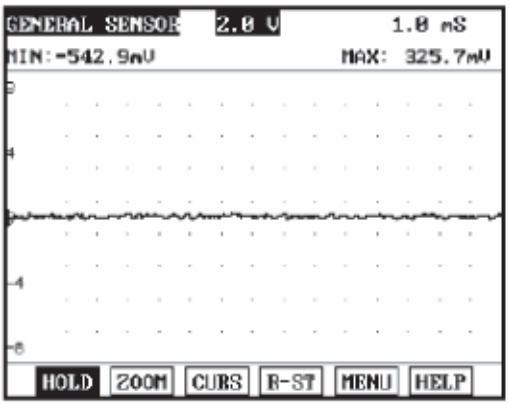


Knocking is a phenomenon characterized by undesirable vibration and noise and can cause engine damage. Knock Sensor (KS) senses engine knocking and the cylinder block. When knocking occurs, the vibration from the cylinder block is applied as pressure to the piezoelectric element. At this time, this sensor transfers the voltage signal higher than the specified value to the ECM and the knocking ECM retards the ignition timing. If the disappears after retarding the ignition timing, the ECM will advance the ignition timing. This sequential control can improve engine power, torque and fuel economy.

Specification

Item	Specification
Capacitance (pF)	1,480 ~ 2,220
Resistance (MΩ)	1

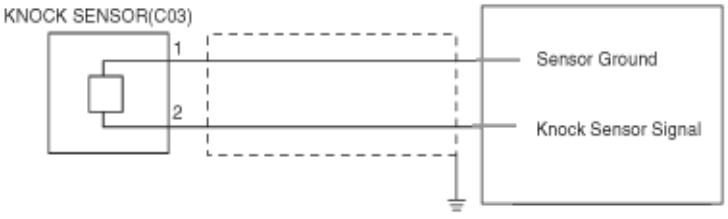
Troubleshooting



The knock sensor is installed at cylinder block to detect the vibration effectively during engine running.

The above waveform shows the signal waveform of knock sensor when knock dosen't happen. Generally, knock signal has more noise than other sensor.

Circuit diagram



Connection Information

Terminal	Connected to	Function
1	each pin no of ecu(ecm)	Sensor ground
2		Knock Sensor Signal

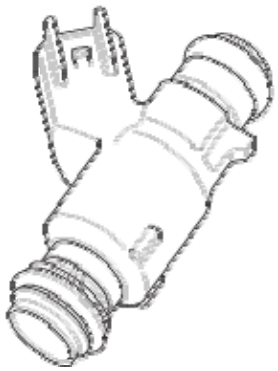
Haness Connector

KNOCK SENSOR

Engine control system

Function and operation principle

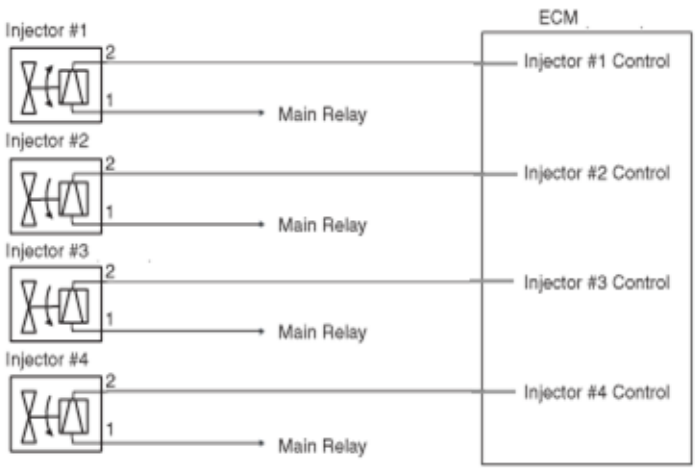
Based on information from various sensors, the ECM measures the fuel injection amount. The fuel injector is a solenoid-operated valve and the fuel injection amount is controlled by length of time that the fuel injector is held open. The ECM controls each injector by grounding the control circuit. When the ECM energizes the injector by grounding the control circuit, the circuit voltage s hould be low (theoretically 0V) and the fuel is injected. When the ECM de-energizes the injector by opening control circuit, the fuel injector is closed and circuit voltage should momentarily peak.



Specification

Item	Specification
Coil Resistance	14 ~15.4 at 20℃(68℉)

Circuit diagram



Haness Connector

INJECTOR #1,2,3,4

Component inspection

1. Turn ignition switch OFF.
2. Disconnect injector connector.
3. Measure resistance between injector terminals 1 and 2.
4. Check that the resistance is within the specification.

Specification: Refer to SPECIFICATION.

Connection Information

Injector #1

Terminal	Connected to	Function
1	Main Relay	Power Supply(B+)
2	each pin no of ecu(ecm)	Injector Control

Injector #2

Terminal	Connected to	Function
1	Main Relay	Power Supply(B+)
2	each pin no of ecu(ecm)	Injector Control

Injector #3

Terminal	Connected to	Function
1	Main Relay	Power Supply(B+)
2	each pin no of ecu(ecm)	Injector Control

Injector #4

Terminal	Connected to	Function
1	Main Relay	Power Supply(B+)
2	each pin no of ecu(ecm)	Injector Control