



HYUNDAI

REPAIR

SERVICE

MANUAL

Third Generation DM
(2013–2018) Santa Fe

VOLUME 4

(Addendum 3.3L GDI Engine)

INDEX

3.3L V-6 GDI Engine

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Specifications

Description		Specifications		Limit
General				
Type		V-type, DOHC		
Number of cylinders		6		
Bore		92 mm (3.6220 in.)		
Stroke		83.8 mm (3.2992 in.)		
Total displacement		3,342 cc (203.94 cu.in.)		
Compression ratio		11.5 : 1		
Firing order		1-2-3-4-5-6		
Valve timing				
Intake	Opens(ATDC)	10°		
	Closes(ABDC)	70°		
Exhaust	Opens(BBDC)	52°		
	Closes(ATDC)	0°		
Cylinder head				
Flatness of gasket surface		Less than 0.05 mm (0.0019 in.) [Less than 0.02 mm (0.0008 in.) / 150x150]		
Flatness of manifold mounting	Intake	Less than 0.1 mm (0.0039 in.) [Less than 0.03 mm (0.001 in.) / 110x110]		
	Exhaust	Less than 0.1 mm (0.0039 in.) [Less than 0.03 mm (0.001 in.) / 110x110]		
Camshaft				
Cam height	LH Camshaft	Intake	46.6 mm (1.835 in.)	
		Exhaust	45.8 mm (1.8031 in.)	
	RH Camshaft	Intake	46.6 mm (1.835 in.)	
		Exhaust	45.8 mm (1.8031 in.)	
Journal outer diameter	LH, RHcamshaft	Intake	No.1: 27.964 ~ 27.978 mm (1.1009 ~ 1.1015 in.) No.2,3,4: 23.954 ~ 23.970 mm (0.9430 ~ 0.9437 in.)	
		Exhaust	No.1: 27.964 ~ 27.978 mm (1.1009 ~ 1.1015 in.) No.2,3,4: 23.954 ~ 23.970 mm (0.9430 ~ 0.9437 in.)	
Bearing oil clearance	LH, RHcamshaft	Intake	No.1: 0.027 ~ 0.057 mm (0.0011 ~ 0.0022 in.) No.2,3,4: 0.030 ~ 0.067 mm (0.0012 ~ 0.0026 in.)	
		Exhaust	No.1: 0.027 ~ 0.057 mm (0.0011 ~ 0.0022 in.) No.2,3,4: 0.030 ~ 0.067 mm (0.0012 ~ 0.0026 in.)	
End play		0.02 ~ 0.18 mm (0.0008 ~ 0.0071 in.)		
Valve				
Valve length	Intake	105.27 mm (4.1445 in.)		
	Exhaust	105.50 mm (4.1535 in.)		
Stem outer diameter	Intake	5.465 ~ 5.480 mm (0.2151 ~ 0.2157 in.)		
	Exhaust	5.458 ~ 5.470 mm (0.2149 ~ 0.2153 in.)		
Face angle		45.25° ~ 45.75°		
Thickness of valvehead (margin)	Intake	1.56 ~ 1.86 mm (0.06142 ~ 0.07323 in.)		
	Exhaust	1.73 ~ 2.03 mm (0.06811 ~ 0.07992 in.)		
Valve stem to valve guide clearance	Intake	0.020 ~ 0.047 mm (0.00078 ~ 0.00185 in.)		0.07 mm (0.00275 in.)
	Exhaust	0.030 ~ 0.054 mm (0.00118 ~ 0.00212 in.)		0.09 mm (0.00354 in.)
Valve guide				
Inner diameter	Intake	5.500 ~ 5.512 mm (0.2165 ~ 0.2170 in.)		
	Exhaust	5.500 ~ 5.512 mm (0.2165 ~ 0.2170 in.)		
Length	Intake	41.8 ~ 42.2 mm (1.6457 ~ 1.6614 in.)		
	Exhaust	41.8 ~ 42.2 mm (1.6457 ~ 1.6614 in.)		
Valve seat				
Width of seat contact	Intake	1.15 ~ 1.45 mm (0.05118 ~ 0.05709 in.)		
	Exhaust	1.35 ~ 1.65 mm (0.05315 ~ 0.06496 in.)		
Seat angle	Intake	44.75° ~ 45.20°		
	Exhaust	44.75° ~ 45.20°		
Valve spring				
Free length		45.5 mm (1.7913 in.)		

Load		19.0±0.8 kg / 34.0 mm (41.9±1.8 lb / 1.3386 in.)	
		42.3±1.3 kg / 23.8 mm (93.3±2.9 lb / 0.9370 in.)	
Out of squareness		Less than 1.5°	
MLA			
MLA outer diameter	Intake	34.964 ~ 34.980 mm (1.3765 ~ 1.3772 in.)	
	Exhaust	34.964 ~ 34.980 mm (1.3765 ~ 1.3772 in.)	
Cylinder head tappet bore inner diameter	Intake	35.000 ~ 35.025 mm (1.3779 ~ 1.3789 in.)	
	Exhaust	35.000 ~ 35.025 mm (1.3779 ~ 1.3789 in.)	
MLA to tappet bore clearance	Intake	0.020 ~ 0.061 mm (0.0008 ~ 0.0024 in.)	0.07 mm (0.0027 in.)
	Exhaust	0.020 ~ 0.061 mm (0.0008 ~ 0.0024 in.)	0.07 mm (0.0027 in.)
Valve clearance (At 20°C [68°F])			
Intake		0.17 ~ 0.23 mm (0.0067 ~ 0.0090 in.)	0.10 ~ 0.30 mm
Exhaust		0.27 ~ 0.33 mm (0.0106 ~ 0.0129 in.)	0.20 ~ 0.40 mm
Cylinder block			
Cylinder bore		92.00 ~ 92.03 mm (3.6220 ~ 3.6232 in.)	
Flatness of gasket surface		Less than 0.05 mm (0.0019 in.) [Less than 0.02 mm (0.0008 in.) / 150x150]	
Piston			
Piston outer diameter		91.96 ~ 91.99 mm (3.6204 ~ 3.6216 in.)	
Piston to cylinder clearance		0.03 ~ 0.05 mm (0.0012 ~ 0.0020 in.)	
Ring groove width	No. 1 ring groove	1.23 ~ 1.25 mm (0.0484 ~ 0.0492 in.)	
	No. 2 ring groove	1.23 ~ 1.25 mm (0.0484 ~ 0.0492 in.)	
	Oil ring groove	2.01 ~ 2.03 mm (0.0791 ~ 0.0797 in.)	
Piston ring			
Side clearance	No. 1 ring	0.04 ~ 0.08 mm (0.0015 ~ 0.0031 in.)	0.1 mm (0.004 in.)
	No. 2 ring	0.04 ~ 0.08 mm (0.0015 ~ 0.0031 in.)	0.1 mm (0.004 in.)
	Oil ring	0.02 ~ 0.06 mm (0.0008 ~ 0.0024 in.)	0.2 mm (0.008 in.)
End gap	No. 1 ring	0.17 ~ 0.32 mm (0.0067 ~ 0.0126 in.)	0.6 mm (0.0236 in.)
	No. 2 ring	0.37 ~ 0.52 mm (0.0145 ~ 0.0204 in.)	0.7 mm (0.0275 in.)
	Oil ring	0.20 ~ 0.40 mm (0.0078 ~ 0.0157 in.)	0.8 mm (0.0315 in.)
Piston pin			
Piston pin outer diameter		21.097 ~ 22.000 mm (0.8305 ~ 0.8661 in.)	
Piston pin hole inner diameter		22.004 ~ 22.010 mm (0.8662 ~ 0.8665 in.)	
Piston pin hole clearance		0.004 ~ 0.013 mm (0.00015 ~ 0.00051 in.)	
Connecting rod small end inner diameter		22.005 ~ 22.016 mm (0.8663 ~ 0.8667 in.)	
Connecting rod small end hole clearance		0.005 ~ 0.019 mm (0.00019 ~ 0.00074 in.)	
Connecting rod			
Connecting rod big end inner diameter		58.000 ~ 58.018 mm (2.2834 ~ 2.2842 in.)	
Connecting rod bearing oil clearance		0.040 ~ 0.062 mm (0.0016 ~ 0.0024 in.)	
Side clearance		0.1 ~ 0.25 mm (0.0039 ~ 0.0098 in.)	
Crankshaft			
Main journal outer diameter		68.942 ~ 68.960 mm (2.7142 ~ 2.7149 in.)	
Pin journal outer diameter		54.954 ~ 54.972 mm (2.1635 ~ 2.1642 in.)	
Main bearing oil clearance		0.022 ~ 0.040 mm (0.0008 ~ 0.0016 in.)	
End play		0.10 ~ 0.28 mm (0.0039 ~ 0.0110 in.)	
Oil pump			
Regulating pressure		5.0 ~ 5.5 bar	
Engine oil			
Oil quantity	Total	6.5 L (6.87 U.S. qt., 5.71 Imp.qt., 1.71 U.S.gal.)	Total Engine oil
	Oil pan	6.0 L (6.34 U.S. qt., 5.28 Imp.qt., 1.58 U.S.gal.)	
	Drain and refill	5.7 L (6.02 U.S.qt., 5.01 Imp.qt., 1.50 U.S.gal.)	Including oil filter
Oil grade	Recommendation	5W-30 / ACEA A5	If not available, refer to the recommended API, ILSAC or ACEA classification and SAE viscosity number.
	Classification	ACEA A3 or above (Only approved engine oil by Hyundai)	If not available, API SL, ILSAC GF3, ACEA A3 can be used.
	SAE viscosity grade	Recommended SAE viscosity number	Refer to the "Lubrication System"
Oil pressure (at 1000rpm)		130 kPa(1.32 kgf/cm², 18.77 psi) [at 1000 rpm, 110°C (230°F)]	Oil temperature (oil pan): 110±2°C (230±35.6°F)
Cooling system			
Cooling method		Forced circulation with water pump	
Coolant quantity		9.1 L (9.6 Us.qts, 8.0 Imp, 2.4 qts)	
Thermostat	Type	Wax pellet type	
	Opening temperature	88±2°C (190.4±3.6°F)	

Radiator cap	Fully opened temperature	100°C (212°F)	
	Full lift	10 mm (0.3937 in.) MIN	
	Main valve opening pressure	79.43 ~ 122.58 kpa (0.81 ~ 1.25 kg/cm², 11.52 ~ 17.78 psi)	
	Vacuum valve opening pressure	0 ~ 6.86 kpa (0 ~ 0.07 kg/cm², 0 ~ 0.99 psi)	
Water temperature sensor			
Type		Thermister type	
Resistance	20°C (68°F)	2.31 ~ 2.59 KΩ	
	80°C(176°F)	0.3222 KΩ	

Sealant

Description	Specifications
Cylinder head and cylinder block between gap	THREE BOND 1217H
Timing chain cover	
Cylinder head cover	
Cylinder head	
Oil seal case	
Lower oil pan	
Upper oil pan	
Oil pressure switch	THREE BOND 2403

Tightening Torques

Item	Quantity	N.m	kgf.m	lb-ft
Engine Mounting				
Engine mounting bracket to body fixing bolts	4	63.7 ~ 83.4	6.5 ~ 8.5	47.0 ~ 61.5
Engine mounting support bracket to engine mounting insulator fixing nut	1	88.3 ~ 107.9	9.0 ~ 11.0	65.1 ~ 79.6
Engine mounting support bracket to engine support bracket fixing bolts	2	88.3 ~ 107.9	9.0 ~ 11.0	65.1 ~ 79.6
Engine mounting support bracket to engine support bracket fixing nut	1	88.3 ~ 107.9	9.0 ~ 11.0	65.1 ~ 79.6
Transaxle mounting bracket to body fixing bolts	3	63.7 ~ 83.4	6.5 ~ 8.5	47.0 ~ 61.5
Transaxle mounting bracket to body fixing nut	1	63.7 ~ 83.4	6.5 ~ 8.5	47.0 ~ 61.5
Transaxle support bracket to transaxle mounting bracket fixing bolts	2	88.3 ~ 107.9	9.0 ~ 11.0	65.1 ~ 79.6
Roll rod bracket to sub frame fixing bolts	2	49.0 ~ 63.7	5.0 ~ 6.5	36.2 ~ 47.0
Roll rod insulator to roll rod mounting support bracket fixing nut	1	107.9 ~ 127.5	11.0 ~ 13.0	79.6 ~ 94.0
Timing system				
Drive belt idler bolt	1	53.9 ~ 57.9	5.5 ~ 5.9	39.8 ~ 42.7
Drive belt auto tensioner bolt (M12)	1	81.4 ~ 85.3	8.3 ~ 8.7	60.0 ~ 62.9
Drive belt auto tensioner bolt (M8)	1	17.7 ~ 21.6	1.8 ~ 2.2	13.0 ~ 15.9
Crankshaft pulley bolt	1	284.5 ~ 304.1	29 ~ 31	209.8 ~ 224.2
Timing chain cover bolts A	17	18.6 ~ 21.6	1.9 ~ 2.2	13.7 ~ 15.9
Timing chain cover bolts B	2	24.5 ~ 26.5	2.5 ~ 2.7	18.1 ~ 19.5
Timing chain cover bolt C	1	58.8 ~ 68.6	6.0 ~ 7.0	43.4 ~ 50.6
Timing chain cover bolt D	1	58.8 ~ 68.6	6.0 ~ 7.0	43.4 ~ 50.6
Timing chain cover bolts E	3	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain auto tensioner bolts	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain auto tensioner nuts	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain auto tensioner arm bolts	2	18.6 ~ 21.6	1.9 ~ 2.2	13.7 ~ 15.9
Timing chain guide bolts	4	19.6 ~ 24.5	2.0 ~ 2.5	14.5 ~ 18.1
Timing chain cam to cam guide bolts	4	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Cylinder head				
Cylinder head cover bolts (LH/RH)	38	[4.9~5.9] + [9.8~11.8]	[0.5~0.6] + [1.0~1.2]	[3.6~4.3] + [7.2~8.7]
Continuous variable valve timing (CVVT) bolts (LH/RH)	4	64.7 ~ 76.5	6.6 ~ 7.8	47.7 ~ 56.4
Camshaft bearing cap bolts (LH/RH)	32	[5.8] + [9.8~11.8]	[0.6] + [1.0~1.2]	[4.3] + [7.2~8.7]
Cylinder head bolts (LH/RH)	16	[37.3~41.2] + [118~122°] + [88~92°]	[3.8~4.2] + [118~122°] + [88~92°]	[27.5~30.4] + [118~122°] + [88~92°]
Cylinder head bolt (RH rear)	1	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Engine hanger bolts (Front)	1	44.1 ~ 53.6	4.5 ~ 5.5	32.5 ~ 39.8
Engine hanger bolts (Rear)	2	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Exhaust OCV(oil control valve) bolts (LH/RH)	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Intake OCV(oil control valve) bolts (LH/RH)	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7

Fuel pump bracket bolt	4	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Cylinder block				
Connecting rod bolts	12	[27.5~31.3] + [68~72°]	[2.8~3.2] + [68~72°]	[20.2~23.1] + [68~72°]
Main bearing cap inner bolts (M11)	8	[49.0] + [90°]	[5.0] + [90°]	[36.2] + [90°]
Main bearing cap outer bolts (M8)	8	[19.6] + [120°]	[2.0] + [120°]	[14.5] + [120°]
Main bearing cap side bolts (M8)	8	29.4 ~ 31.4	3.0 ~ 3.2	21.7 ~ 23.1
Oil drain cover bolts	6	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Oil jet bolts	3	27.5 ~ 31.3	2.8 ~ 3.2	20.2 ~ 23.1
Rear oil seal case bolts	6	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Baffle plate bolts	6	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Knock sensor bolts (LH/RH)	2	15.7 ~ 23.5	1.6 ~ 2.4	11.6 ~ 17.4
Drive plate bolts	8	71.54 ~ 75.46	7.3 ~ 7.7	52.80 ~ 55.69
Upper oil pan bolts	18	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Lubrication system				
Oil drain bolt	1	34.3 ~ 44.1	3.5 ~ 4.5	25.3 ~ 32.5
Oil pump bolts	3	20.6 ~ 22.6	2.1 ~ 2.3	15.2 ~ 16.6
Oil filter body bolts	4	19.6 ~ 21.6	2.0 ~ 2.2	14.5 ~ 15.9
Oil filter cap	1	34.3	3.5	25.3
Oil level gauge bolt	1	18.6 ~ 22.6	1.9 ~ 2.3	13.7 ~ 16.6
Lower oil pan bolts	13	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Oil pump chain cover bolts	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Oil pump chain tensioner bolt	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Oil pump chain sprocket bolt	1	18.6 ~ 21.6	1.9 ~ 2.2	13.7 ~ 15.9
Cooling system				
Water pump bolts A	3	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Water pump bolt B	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Water pump bolt C	1	21.6 ~ 26.5	2.2 ~ 2.7	15.9 ~ 19.5
Water pump bolt D	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Water pump bolt E	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Water pump bolt F	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Water pump bolts G	4	21.6 ~ 23.5	2.2 ~ 2.4	15.9 ~ 17.4
Water pump pulley bolts	4	7.8 ~ 9.8	0.8 ~ 1.0	5.8 ~ 7.2
Water temp. control nuts	4	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Water temp. control bolts	2	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Water center pipe bolt	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Intake and exhaust system				
Intake air hose clamp bolt	1	2.9 ~ 4.9	0.3 ~ 0.5	2.2 ~ 3.6
Air cleaner assembly bolts	2	7.8 ~ 9.8	0.8 ~ 1.0	5.8 ~ 7.2
Intake manifold bolts	6	[3.9 ~ 5.9] + [26.5 ~ 31.4]	[0.4 ~ 0.6] + [2.7 ~ 3.2]	[2.9 ~ 4.3] + [19.5 ~ 23.1]
Intake manifold nuts	2	[3.9 ~ 5.9] + [18.62 ~ 23.52]	[0.4 ~ 0.6] + [1.9 ~ 2.4]	[2.9 ~ 4.3] + [13.74 ~ 17.36]
Surge tank bolts	4	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Surge tank grommet bolts	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Surge tank nuts	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Surge tank stay bolts	2	27.5 ~ 31.3	2.8 ~ 3.2	20.2 ~ 23.1
Exhaust manifold nuts (LH/RH)	16	49.0 ~ 53.9	5.0 ~ 5.5	36.2 ~ 39.8
Exhaust manifold stay bolts	4	24.5 ~ 35.3	2.5 ~ 3.6	18.1 ~ 26.0
Heat protector bolt (LH/RH)	6	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Front muffler pipe nuts (LH/RH)	4	39.2 ~ 58.8	4.0 ~ 6.0	28.9 ~ 43.4
Front muffler bolts	2	39.2 ~ 58.8	4.0 ~ 6.0	28.9 ~ 43.4
Front muffler nuts	4	39.2 ~ 58.8	4.0 ~ 6.0	28.9 ~ 43.4
Center muffler and rear muffler mounting nuts	2	39.2 ~ 58.8	4.0 ~ 6.0	28.9 ~ 43.4

Engine Mechanical System



Inspection

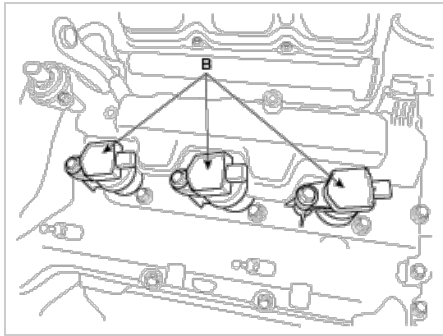
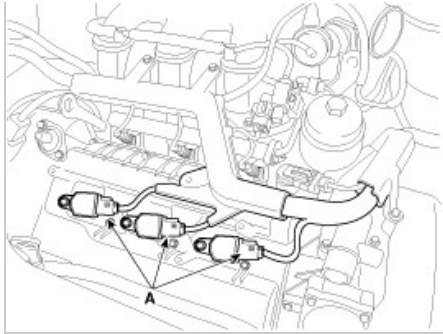
Compression Pressure

NOTICE

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

1. Warm up engine until the normal operating temperature(80~95°C(176-203°F)).
2. Remove the surge tank.
(Refer to Intake And Exhaust System - "Surge Tank")

3. Remove the ignition coil connectors (A) and ignition coils (B).
(Refer to Engine Electrical System - "Ignition Coil")



4. Remove the spark plugs.
Using a 16mm plug wrench, remove the 6 spark plugs.
5. Check cylinder compression pressure.
 - (1) Insert a compression gauge into the spark plug hole.
 - (2) Fully open the throttle.
 - (3) Crank the engine over 7 times to measure compression pressure.

NOTICE

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

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

NOTICE

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

Compression pressure :

1,029 kPa (10.5 kgf/cm², 149 psi) (250 ~ 400 rpm)

Minimum pressure :

882 kPa (9.0 kgf/cm², 128 psi)

Difference between each cylinder :

98 kPa (1.0 kg/cm², 14 psi) 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 step 1) through 3) for cylinders with low compression.
 - a. If adding oil helps the compression, it is likely that the piston rings and/or cylinder bore are worn or damaged.
 - b. If pressure stays low, a valve may be sticking or seating is improper, or there may be leakage past the gasket.

6. Reinstall the spark plugs.
7. Install the ignition coils and ignition connectors.
8. Install the surge tank.
(Refer to Intake And Exhaust System - "Surge Tank")

Engine Mechanical System



Troubleshooting

Symptom	Suspect area	Remedy
Engine misfire with abnormal internal lower engine noises.	Worn crankshaft bearings.	Replace the crankshaft and bearings as required.
	Loose or damaged engine drive plate.	Repair or replace the drive plate as required.
	Worn piston rings. (Oil consumption may or may not cause the engine to misfire.)	Inspect the cylinder for a loss of compression. Repair or replace as required.

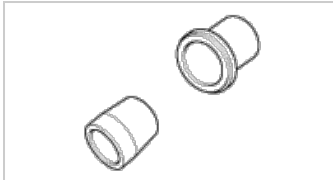
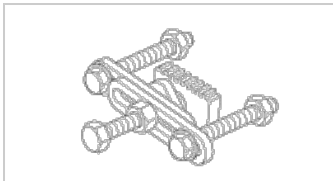
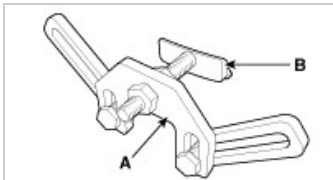
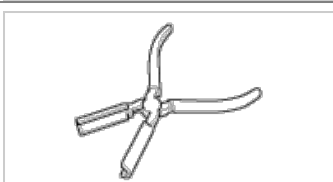
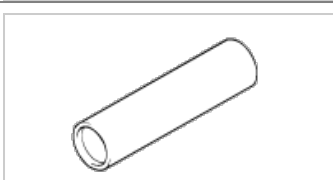
	Worn crankshaft thrust bearings	Replace the crankshaft and bearings as required.
Engine misfire with abnormal valve train noise.	Stuck valves. (Carbon buildup on the valve stem)	Repair or replace as required.
	Excessive worn or mis-aligned timing chain.	Replace the timing chain and sprocket as required.
	Worn camshaft lobes.	Replace the camshaft and valve lifters.
Engine misfire with coolant consumption.	- Faulty cylinder head gasket and/or cranking or other damage to the cylinder head and engine block cooling system - Coolant consumption may or may not cause the engine to overheat.	- Inspect the cylinder head and engine block for damage to the coolant passages and/or a faulty head gasket. - Repair or replace as required.
Engine misfire with excessive oil consumption.	Worn valves, guides and/or valve stem oil seals.	Repair or replace as required.
	Worn piston rings. (Oil consumption may or may not cause the engine to misfire)	- Inspect the cylinder for a loss of compression. - Repair or replace as required.
Engine noise on start-up, but only lasting a few seconds. NOTE : Minor engine clatter sound immediately upon cold start for very brief period may be normal.	Incorrect oil viscosity.	- Drain the oil. - Install the correct viscosity oil.
Upper engine noise, regardless of engine speed.	Low oil pressure.	Repair or replace as required.
	Broken valve spring.	Replace the valve spring.
	Worn or dirty valve lifters.	Replace the valve lifters.
	Stretched or broken timing chain and/or damaged sprocket teeth.	Replace the timing chain and sprockets.
	Worn timing chain tensioner, if applicable.	Replace the timing chain tensioner as required.
	Worn camshaft lobes.	- Inspect the camshaft lobes. - Replace the timing camshaft and valve lifters as required.
	Worn valve guides or valve stems.	Inspect the valves and valve guides, then repair as required.
	Stuck valves. Carbon on the valve stem or valve seat may cause the valve to stay open.	Inspect the valves and valve guides, then repair as required.
Lower engine noise, regardless of engine speed.	Worn drive belt, idler, tensioner and bearing.	Replace as required.
	Low oil pressure.	Repair as required.
	Loose or damaged drive plate.	Repair or replace the drive plate.
	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 as required.
	Excessive piston pin-to-piston clearance.	- Inspect the piston, piston pin and the connecting rod. - Repair or replace as required.
	Excessive connecting rod bearing clearance	Inspect the following components and repair as required. - The connecting rod bearings. - The connecting rods. - The crankshaft pin journals.
Engine noise under load.	Excessive crankshaft bearing clearance.	Inspect the following components, and repair 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.
	Low oil pressure	Repair or replace as required.
	Excessive connecting rod bearing clearance .	Inspect the following components and repair as required : - The connecting rod bearings. - The connecting rods. - The crankshaft.
	Excessive crankshaft bearing clearance.	Inspect the following components, and repair as required. - The crankshaft bearings. - The crankshaft main journals. - The cylinder block.

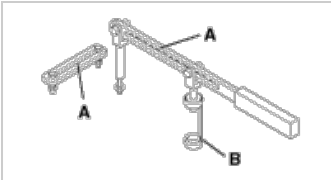
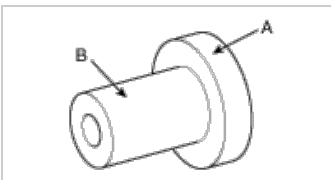
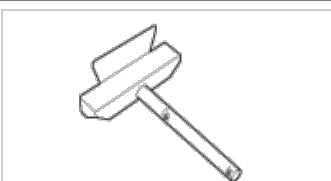
Engine will not crank-crankshaft will not rotate.	Hydraulically locked cylinder. • Coolant/antifreeze in cylinder. • Oil in cylinder. • Fuel in cylinder.	1) Remove spark plugs and check for fluid. 2) Inspect for broken head gasket. 3) Inspect for cracked engine block or cylinder head. 4) Inspect for a sticking fuel injector and/or leaking fuel regulator.
	Broken timing chain and/or timing chain 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 connecting rods. 2) Repair as required.
	Broken crankshaft.	1) Inspect crankshaft. 2) Repair as required.

Engine Mechanical System



Special Service Tools

Tool (Number and name)	Illustration	Use
Crankshaft front oil seal installer (09231-3C100)		Installation of the front oil seal
Ring gear stopper (09231-2B100)		Removal and installation of crankshaft pulley bolt.
Ring gear stopper (09231-3D100) : A (09231-2W100) : B		Removal and installation of crankshaft pulley bolt.
Torque angle adapter (09221-4A000)		Installation of bolts & nuts needing an angular method
Valve stem seal remover (09222-29000)		Removal of the valve stem seal
Valve stem seal installer (09222-2W100)		Installation of the valve stem seal
Valve spring compressor & holder (09222-3K000) (09222-3K100)		Removal and installation of the intake or exhaust valves A : 09222-3K000 B : 09222-3K100 (holder)

		
Crankshaft rear oil seal installer (09231-3C200) (09231-H1100)		Installation of the crankshaft rear oil seal A : 09231-3C200 B : 09231-H1100
Oil pan remover (09215-3C000)		Removal of oil pan

Engine Mechanical System



Removal and Installation

1. Remove the engine cover (A).



NOTICE

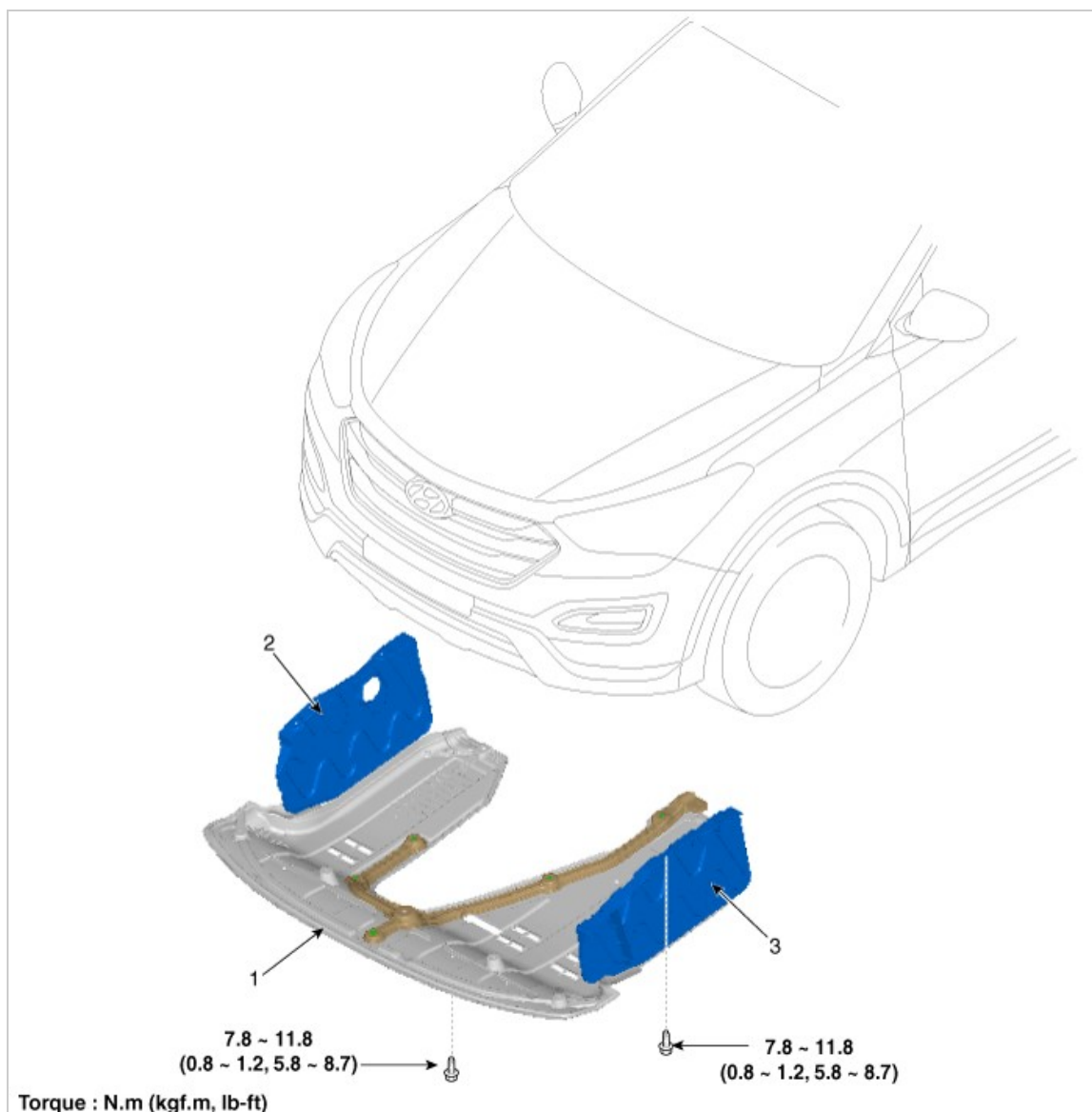
- Lift up the lower end of engine cover, then left and right alternately.
- When installing, confirm that the mounting rubber insulators has been installed.

2. Install in the reverse order of removal.

Engine Mechanical System



Components



1. Engine room front under cover
2. Engine room RH Under cover

3. Engine room LH Under cover

Engine Mechanical System

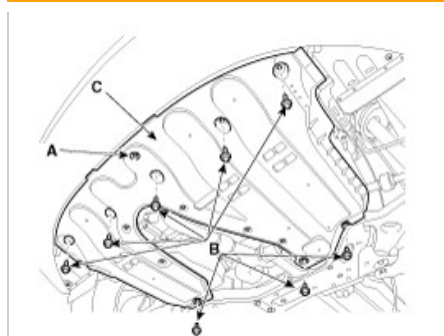


Removal and Installation

1. Remove the engine room under cover (C) after loosen the fastener (A) and bolts (B).

Tightening torque:

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

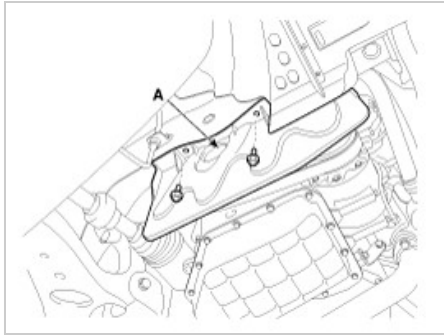


2. Remove the engine room side cover (A).

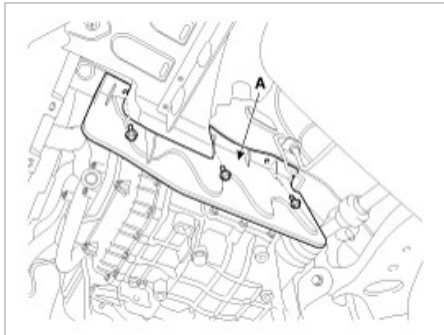
Tightening torque:

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

[RH]



[LH]

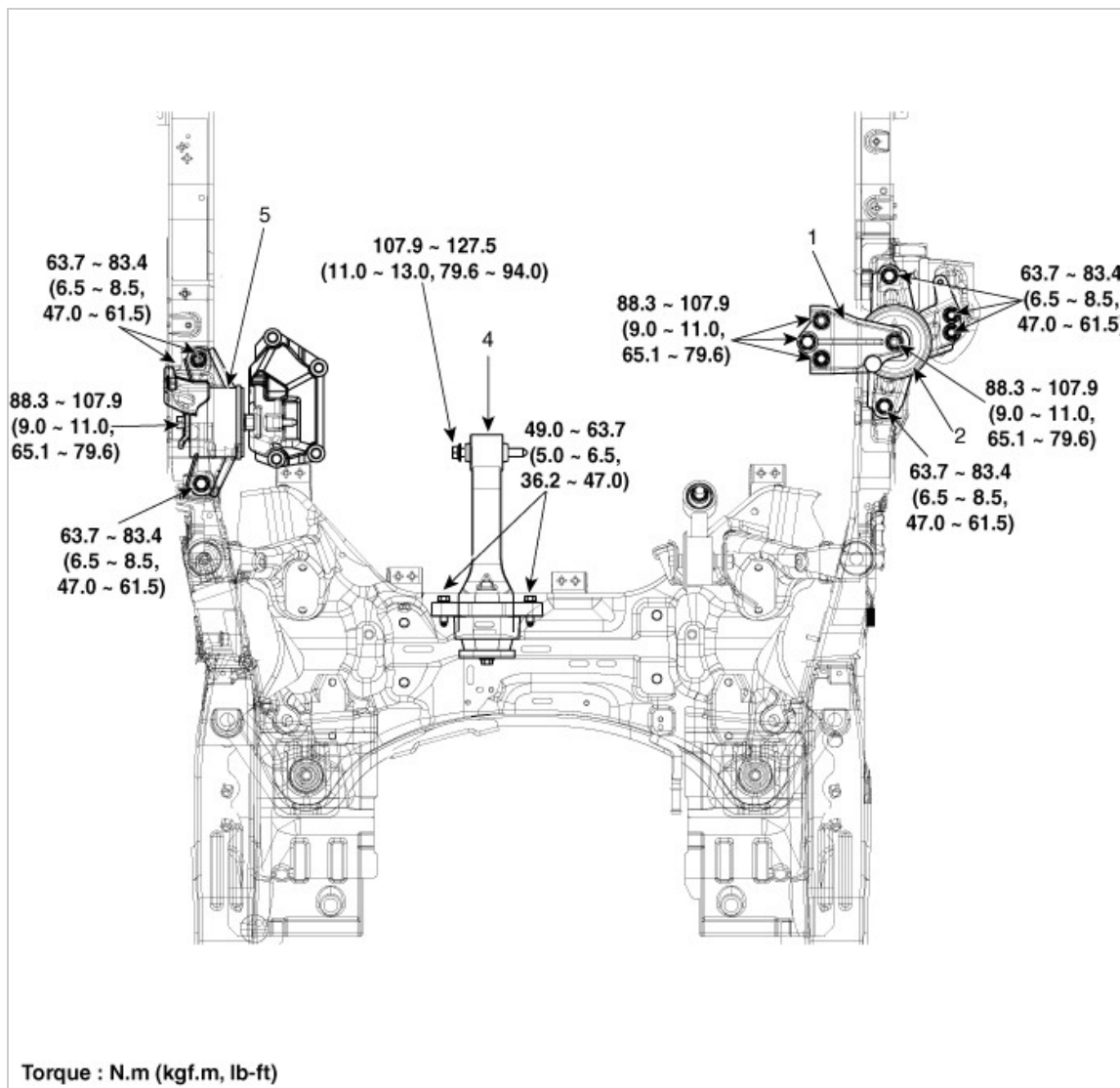


3. Install in the reverse order of removal.

Engine Mechanical System



Components



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

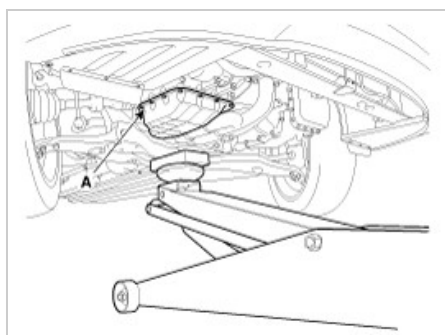
Engine Mechanical System



Removal and Installation

Engine Mounting Bracket

1. Disconnect the battery "-" terminal.
2. Install the jack to the edge of the upper oil pan to support the engine.



NOTICE

Insert the rubber block between jack and upper oil pan.

3. Disconnect the engine earth cable, and then remove the engine mounting support bracket (A).

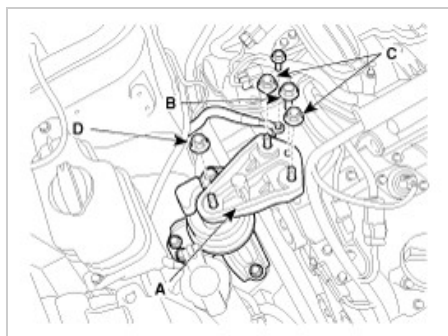
Tightening torque

Bolts (B) & Nut (C):

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

Nut (D):

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



4. Remove the engine mounting bracket (A).

Tightening torque :

63.7 ~ 83.3 N.m (6.5 ~ 8.5 kgf.m, 47.0 ~ 61.5 lb-ft)



5. Install in the reverse order of removal.

Roll road Bracket

1. Remove the roll road bracket (A).

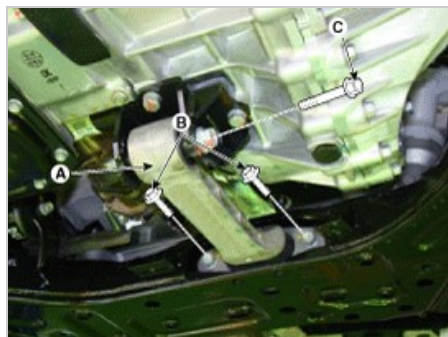
Tightening torque

Bolt (B) :

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

Bolt (C) :

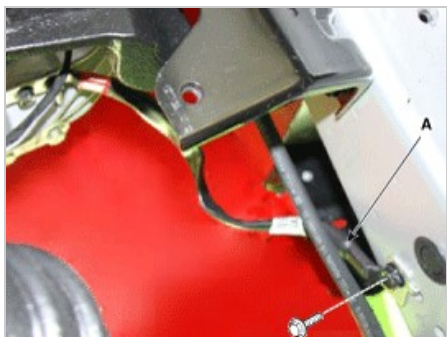
107.9 ~ 127.5 N.m (11.0 ~ 13.0 kgf.m, 79.6 ~ 94.0 lb-ft)



2. Install in the reverse order of removal.

Transaxle Mounting Bracket

1. Disconnect the earth cable (A).

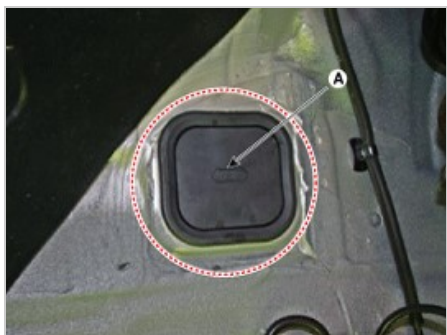


2. Install the jack to the transaxle lower.

NOTICE

Insert the rubber block between jack and transaxle for the transaxle protect form damage.

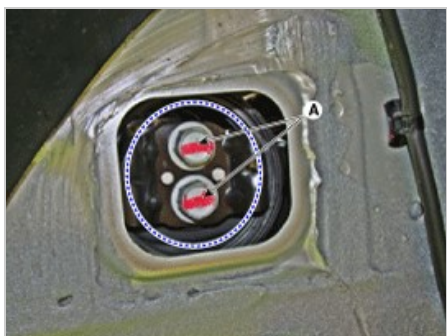
3. Remove the service cover (A).



4. Remove the transaxle mounting fixing bolt (A).

Tightening torque:

88.4 ~ 107.9 N.m (9.0 ~ 11.0 kgf.m, 65.1 ~ 79.6 lb-ft)



5. Remove the transaxle mounting bracket (A).

Tightening torque :

63.7 ~ 83.3 N.m (6.5 ~ 8.5 kgf.m, 47.0 ~ 61.5 lb-ft)



6. Install in the reverse order of removal.

Engine Mechanical System



Removal

CAUTION

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

NOTICE

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

1. Disconnect the battery "-" terminal.
2. Remove the engine cover.
3. Remove the air duct.
(Refer to Intake and Exhaust System - "Air cleaner")
4. Remove the battery and battery tray.
(Refer to Engine Electrical System - "Battery")
5. Disconnect the brake vacuum hose (A).

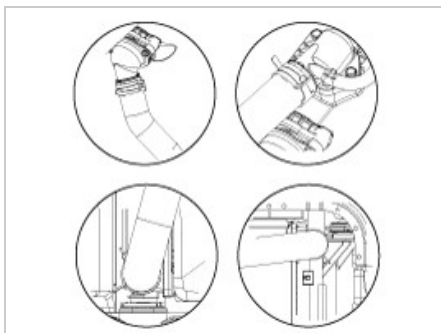


6. Remove the air cleaner assembly.
(Refer to Intake and Exhaust System - "Air cleaner")
7. Remove the engine room under cover.
8. Loosen the drain plug, and drain the coolant. Remove the radiator cap to speed draining.
(Refer to Cooling System - "Coolant")
9. Remove the radiator upper hose (A) and lower hose (B).

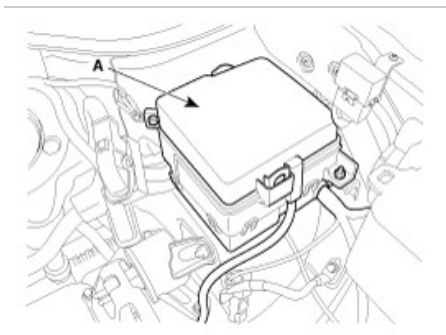


NOTICE

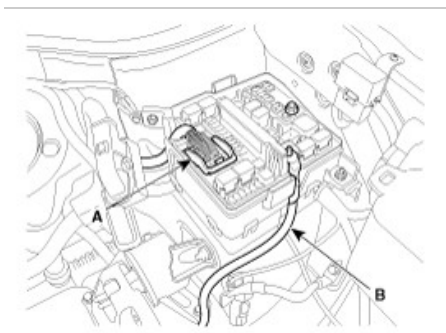
When installing radiator hoses, install as shown in illustrations.



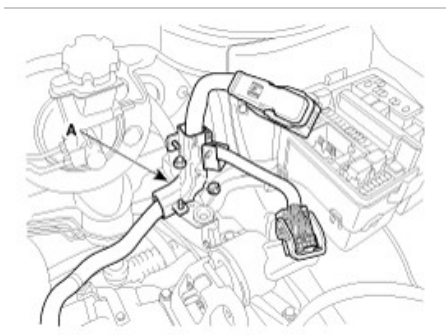
10. Remove the engine control module (ECM) assembly.
(Refer to Engine Control/Fuel System - "Engine Control Module (ECM)")
11. Remove the fuse box cover (A).



12. Disconnect the fuse box main wiring connector (A) and battery "+" cable (B).



13. Remove mounting nuts of the main wiring protector (A).



14. Disconnect the front connector (A).

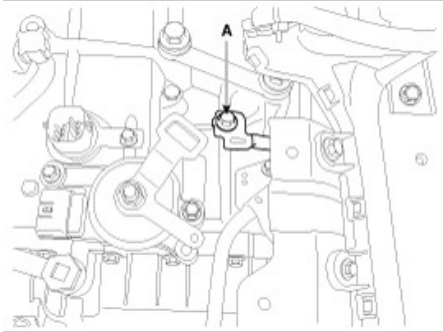


15. Remove the battery wiring protector (A).



16. Remove the transaxle wire harness connectors and control cable from the transaxle.
(Refer to Automatic Transaxle System - "Automatic Transaxle")

17. Remove the transaxle earth cable (A).



18. Disconnect the ATF cooler hose.

(Refer to Automatic Transaxle System - "Automatic Transaxle")

19. Disconnect the purge control solenoid valve (PCSV) hose (A), fuel hose (B) and the heater hoses (C).



20. Recover the refrigerant and then remove the high pressure pipe and low pressure pipe.

(Refer to Heating, Ventilation, Air Conditioning - "Compressor")

21. Remove the propeller shaft in case of the 4WD vehicle type.

(Refer to 4 Wheel Drive System - "Front Wheel Transfer Assembly")

22. Remove the front muffler.

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

23. Remove the front wheels.

24. Remove the shock absorbers, the stabilizer bar links and the tie rod ends.

(Refer to Suspension System - "Front Stabilizer Bar")

25. Disconnect the drive shafts from the axle hub.

(Refer to Drive Shaft and Axle - "Front Driveshaft")

26. In case of the hydraulic power steering (HPS) type, disconnect the power steering oil return hose for drain the oil, and then remove the hose that connecting between the power steering oil pump assembly and the reservoir tank.

(Refer to Steering System - "Steering Gear Box")

27. Support the sub frame with a floor jack, and then remove the sub frame mounting bolts.

(Refer to Suspension System - "Sub Frame")

28. Disconnect the engine earth cable, and then remove the engine mounting support bracket (A).

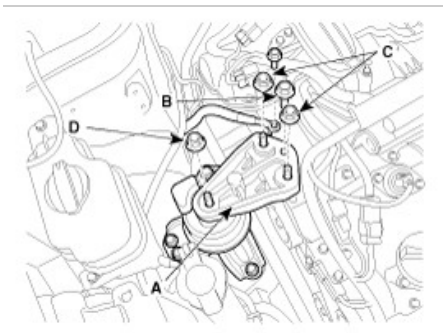
Tightening torque

Bolts (B) & Nut (C):

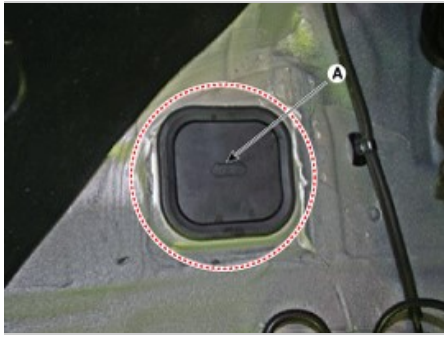
88.3 ~ 107.9 N.m (9.0 ~ 11.0 kgf.m, 65.1 ~ 79.6 lb-ft)

Nut (D):

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



29. Remove the service cover (A).



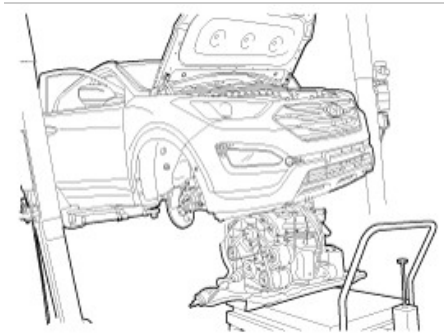
30. Remove the transaxle mounting fixing bolt (A).

Tightening torque:

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



31. Remove the engine and transaxle assembly by lifting vehicle.



CAUTION

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

Installation

Install in the reverse order of removal.

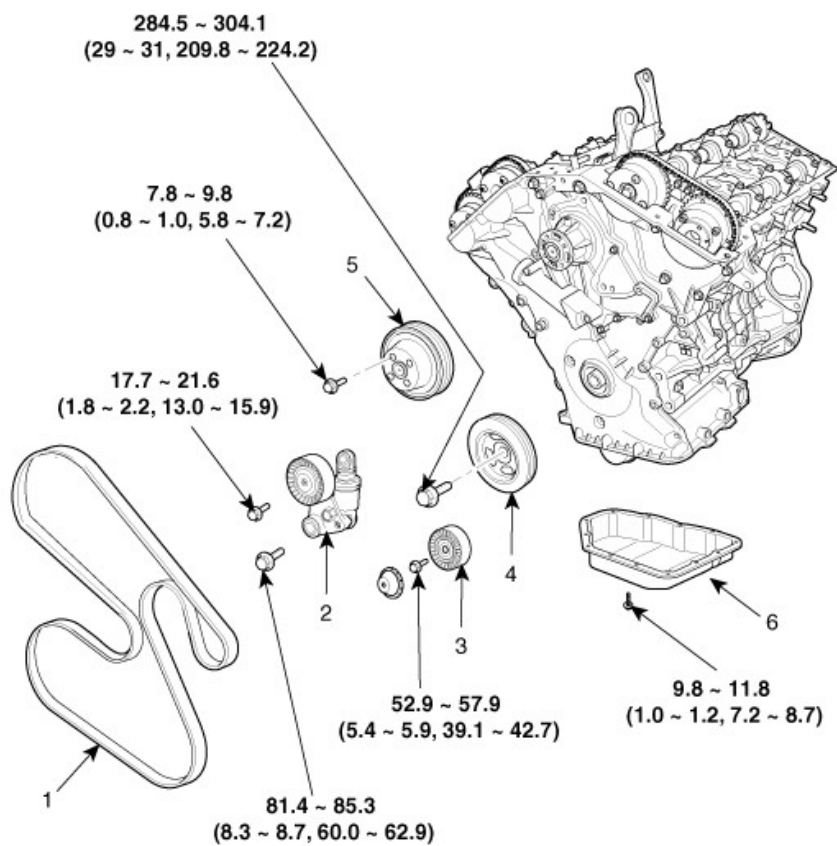
Perform the following :

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

Engine Mechanical System

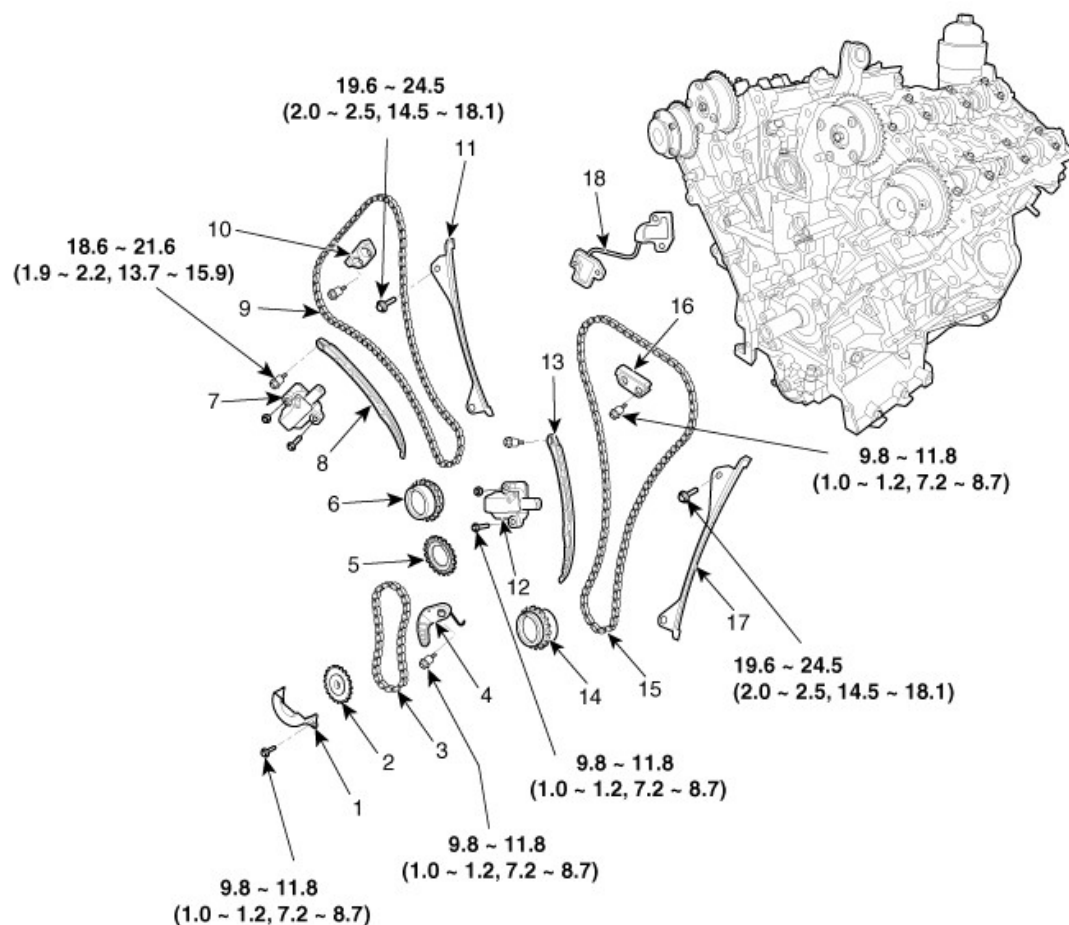


Components



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

- | | |
|-------------------------|-----------------------|
| 1. Drive belt | 4. Crank shaft pulley |
| 2. Drive belt tensioner | 5. Water pump pulley |
| 3. Idler | 6. Oil pan |



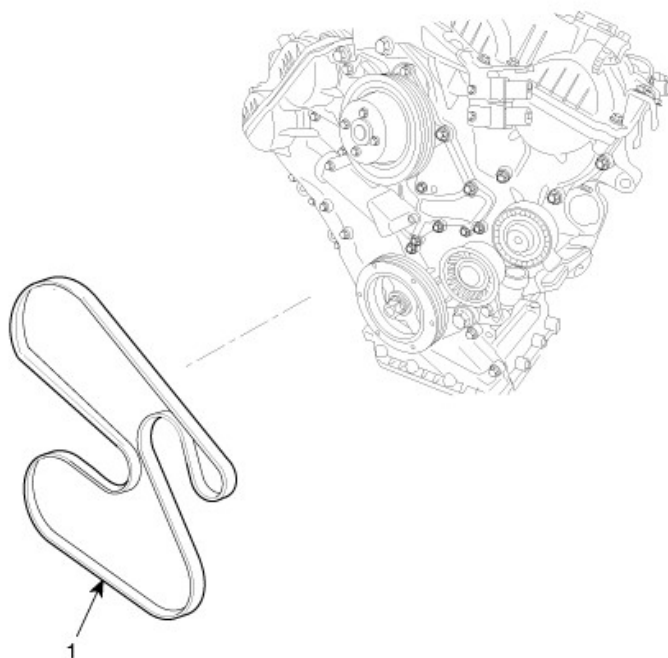
Torque : N.m (kgf.m, lb-ft)

- | | | |
|---------------------------------|--------------------------------------|--------------------------------------|
| 1. Oil pump chain cover | 7. RH Timing chain auto tensioner | 13. LH Timing chain tensioner arm |
| 2. Oil pump sprocket | 8. RH Timing chain tensioner arm | 14. Crankshaft LH chain sprocket |
| 3. Oil pump chain | 9. RH Timing chain | 15. LH Timing chain |
| 4. Oil pump tensioner assembly | 10. RH Timing chain cam to cam guide | 16. LH Timing chain cam to cam guide |
| 5. Crankshaft oil pump sprocket | 11. RH Timing chain guide | 17. LH Timing chain guide |
| 6. Crankshaft RH chain sprocket | 12. LH Timing chain auto tensioner | 18. Tensioner adapter |

Engine Mechanical System



Components



1. Drive belt

Engine Mechanical System



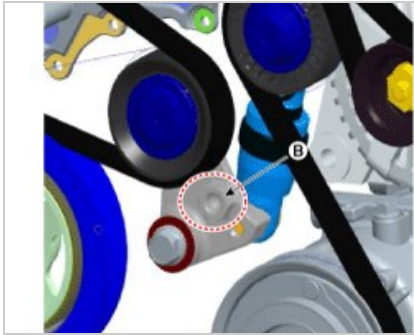
Removal and Installation

1. Disconnect the battery "-" terminal.
2. To release the tension, turn the drive belt tensioner counterclockwise then remove the drive belt (A).



NOTICE

When installing the drive belt, follow the below order. crankshaft pulley → A/C compressor pulley → Idler Pulley → alternator pulley → water pump pulley → (power steering oil pump pulley [HPS type]) → drive belt auto tensioner pulley.



Rotate the auto tensioner arm by turning the auto tensioner arm boss (B) counterclockwise using a wrench.
After installing the drive belt to the auto tensioner pulley, slowly release the auto tensioner arm.

3. Install in the reverse order of removal.

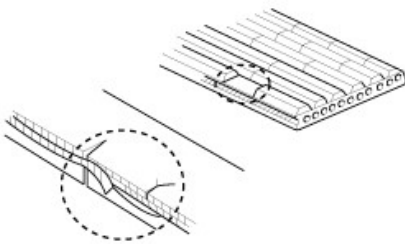
Inspection

Inspect Drive Belt

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

NOTICE

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



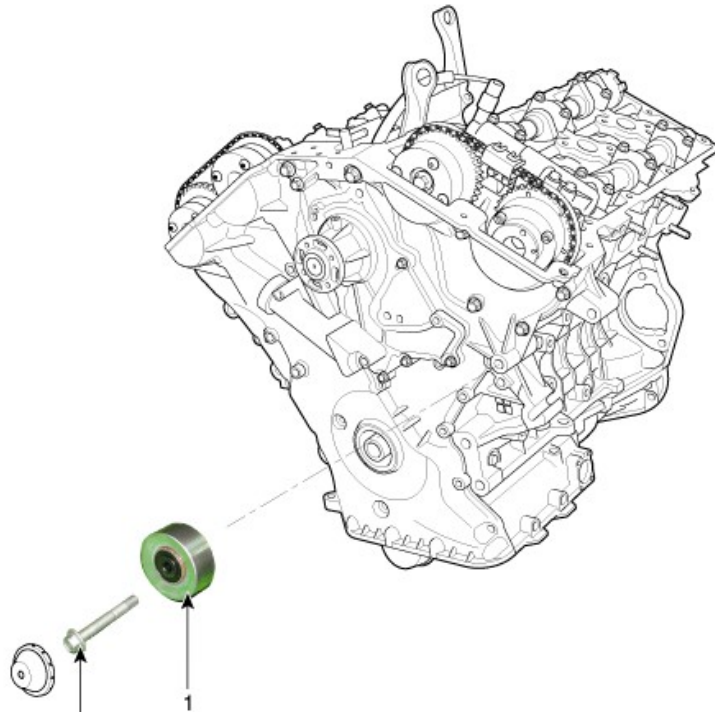
Drive belt, Idler, Belt tensioner pulley

Check the idler for excessive oil leakage, abnormal rotation or vibration. Replace if necessary.
Check the belt tensioner for excessive dust, crack, and damage. Replace if necessary.
Check the pulleys for vibration in rotation, oil or dust deposit of V-ribbed part. Replace if necessary.

Engine Mechanical System



Components



52.9 ~ 57.9 (5.4 ~ 5.9, 39.1 ~ 42.7)

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

1. Idler

Engine Mechanical System

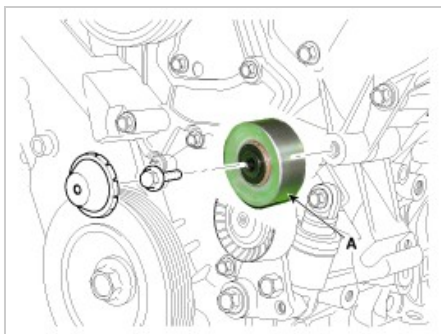


Removal and Installation

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

Tightening torque :

53.9 ~ 57.9 N.m (5.5 ~ 5.9 kgf.m, 39.8 ~ 42.7 lb-ft)



3. Install in the reverse order of removal.

Inspection

Drive belt, Idler, Belt tensioner pulley

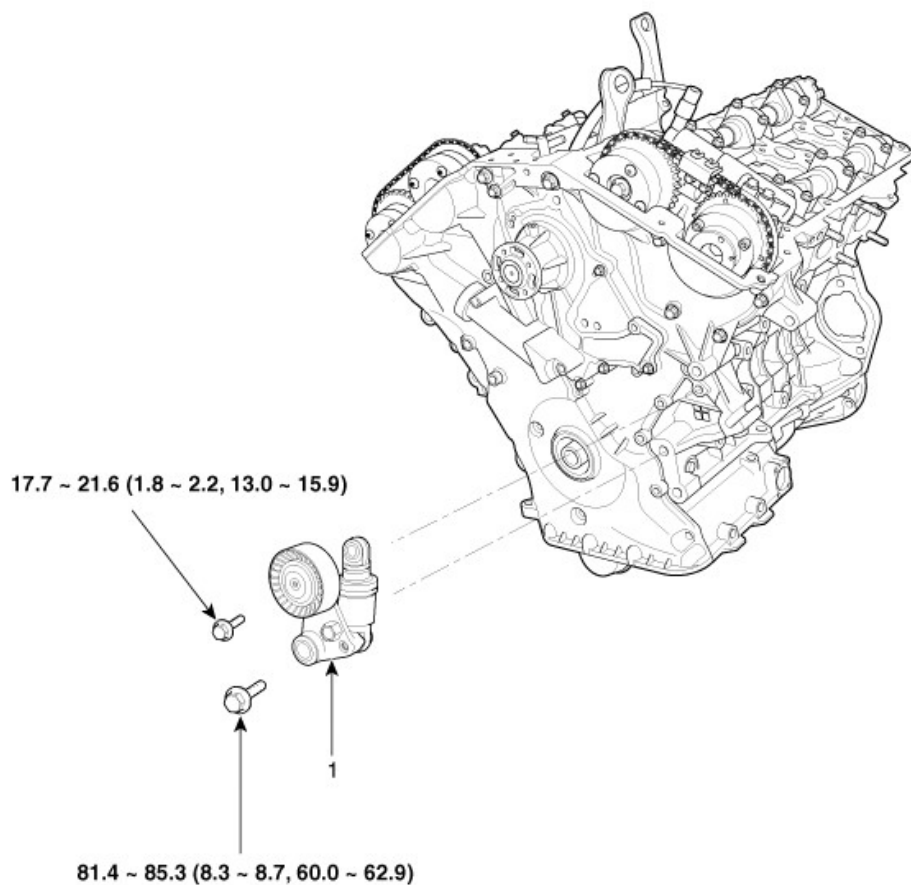
1. Check the idler for excessive oil leakage, abnormal rotation or vibration. Replace if necessary.

2. Check the belt tensioner for excessive dust, crack, and damage. Replace if necessary.
3. Check belt for maintenance and abnormal wear of V-ribbed part. Replace if necessary.
4. Check the pulleys for vibration in rotation, oil or dust deposit of V-ribbed part. Replace if necessary.

Engine Mechanical System



Components



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

1. Drive belt tensioner

Engine Mechanical System



Removal and Installation

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

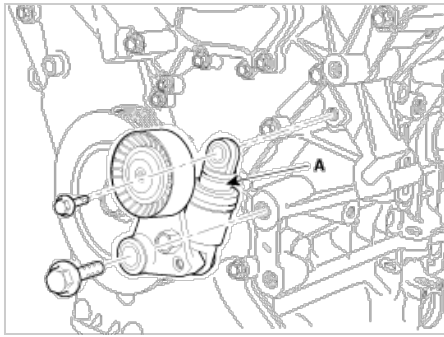
Tightening torque

Bolt (B) :

81.4 ~ 85.3 N.m (8.3 ~ 8.7 kgf.m, 60.0 ~ 62.9 lb-ft)

Bolt (C) :

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



3. Install in the reverse order of removal.

Inspection

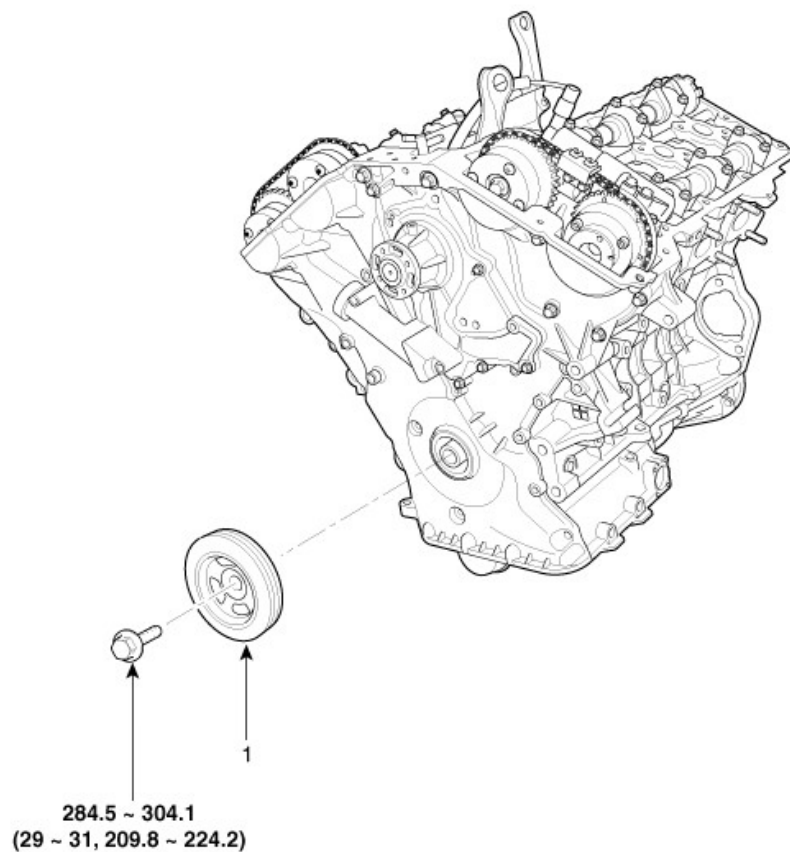
Drive belt, Idler, Belt tensioner pulley

1. Check the idler for excessive oil leakage, abnormal rotation or vibration. Replace if necessary.
2. Check the belt tensioner for excessive dust, crack, and damage. Replace if necessary.
3. Check belt for maintenance and abnormal wear of V-ribbed part. Replace if necessary.
4. Check the pulleys for vibration in rotation, oil or dust deposit of V-ribbed part. Replace if necessary.

Engine Mechanical System



Components



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

1. Crankshaft damper pulley

Engine Mechanical System



Removal and Installation

⚠ CAUTION

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

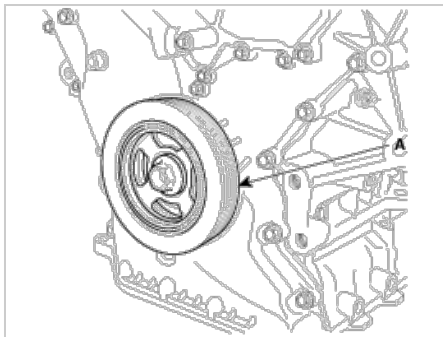
NOTICE

Mark all wiring and hoses to avoid misconnection.

1. Remove the battery and battery tray.
2. Remove the engine cover.
3. Remove the air duct and air cleaner assembly.
(Refer to Intake and Exhaust System - "Air cleaner")
4. Remove the engine room under cover.
5. Remove the front muffler.
(Refer to Intake And Exhaust System - "Muffler")
6. Remove the crankshaft pulley (A).

Tightening torque :

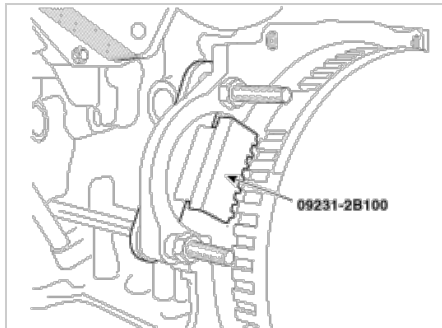
284.5 ~ 304.1 N.m (29 ~ 31 kgf.m, 209.8 ~ 224.2 lb-ft)



NOTICE

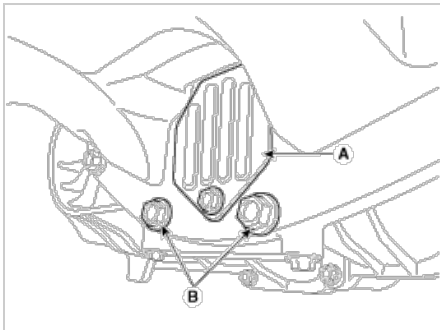
There are two methods to hold the ring gear when installing or removing the crankshaft damper pulley.

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

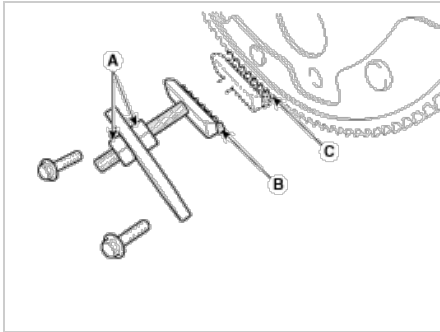


- Install the SST (09231-3D100, 09231-2W100) to hold the ring gear after removing the dust cover.

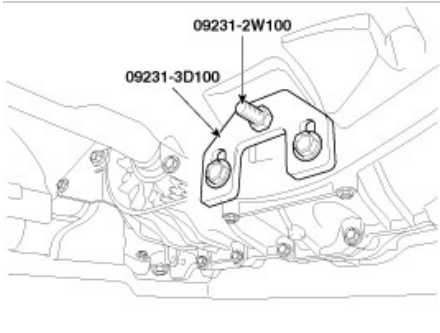
- 1) Remove the front muffler.
(Refer to Intake And Exhaust System - "Muffler")
- 2) Remove the dust cover (A) on the bottom of the upper oil pan and unfasten the two transaxle mounting bolts (B).



- 3) Adjust the length of the holder nuts (A) so that the front plate of the holder (B) puts in the ring gear (C) teeth.
- 4) Fasten the two transaxle mounting bolts in the original mounted holes.



5) Install the SST (09231-3D100, 09231-2W100) using the two mounting bolts. Tighten the bolts and nuts of the holder securely.



7. Install in the reverse order of removal.

Inspection

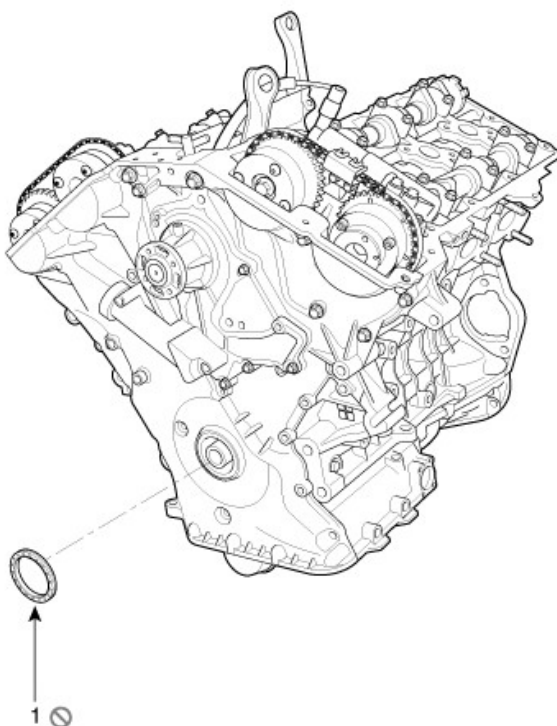
Drive belt, Idler, Belt tensioner pulley

1. Check the idler for excessive oil leakage, abnormal rotation or vibration. Replace if necessary.
2. Check the belt tensioner for excessive dust, crack, and damage. Replace if necessary.
3. Check belt for maintenance and abnormal wear of V-ribbed part. Replace if necessary.
4. Check the pulleys for vibration in rotation, oil or dust deposit of V-ribbed part. Replace if necessary.

Engine Mechanical System



Components



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

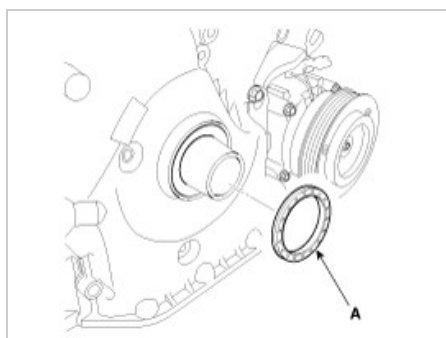
1. Front oil seal

Engine Mechanical System



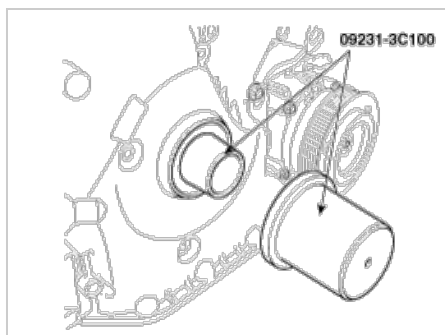
Removal

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



Installation

1. Using SST(09231-3C100), install timing chain cover oil seal.



NOTICE

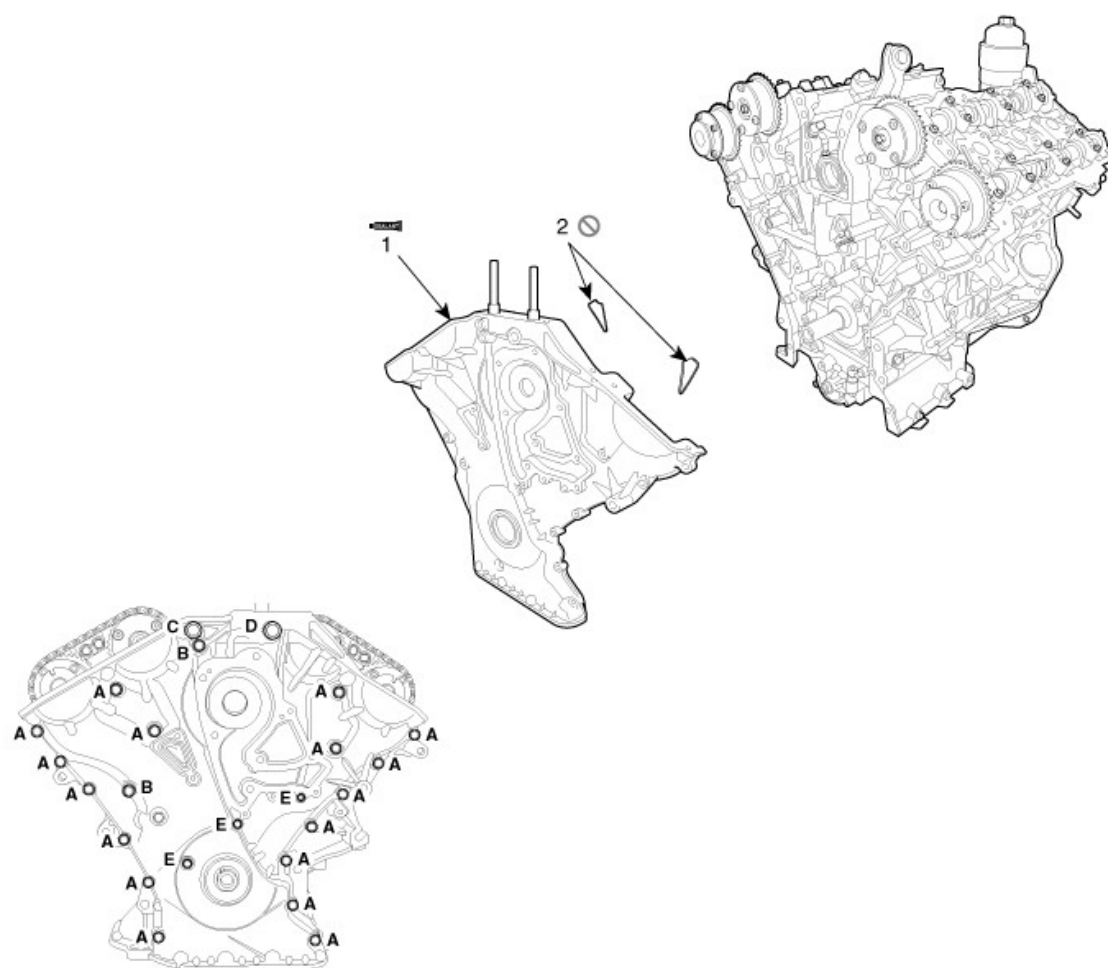
Always use new oil seal.

2. Install the crankshaft damper pulley.
(Refer to Timing System - "Crankshaft Damper Pulley")

Engine Mechanical System



Components



Torque : Refer to Installation procedure

1. Timing chain cover

2. Gasket

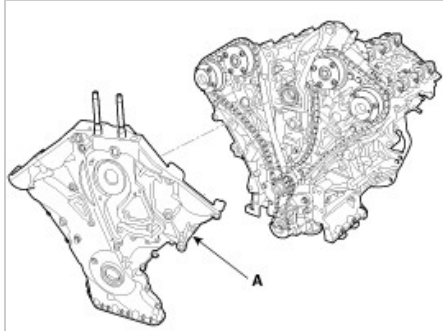
Engine Mechanical System



Removal

1. Remove the LH/RH cylinder head cover.
(Refer to Cylinder Head Assembly - "Cylinder Head Cover")
2. Remove the lower oil pan.
(Refer to Lubrication System - "Oil Pan")

3. Remove the drive belt auto tensioner.
(Refer to Timing System - "Drive Belt Tensioner")
4. Remove the crankshaft damper pulley.
(Refer to Timing System - "Crankshaft Damper Pulley")
5. Remove the engine mounting support bracket.
(Refer to Engine And Transmission Assembly - "Engine Mounting")
6. Lift up the engine assembly slightly by using a jack to get access to the side of engine.
7. Remove the water pump and gasket.
(Refer to Cooling System - "Water Pump")
8. Remove the timing chain cover (A).



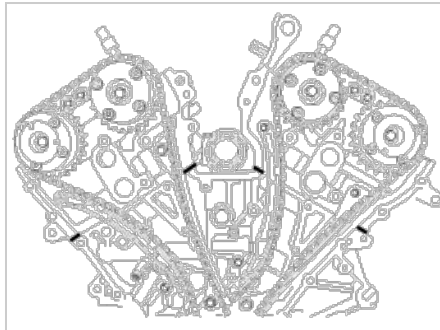
CAUTION

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

Installation

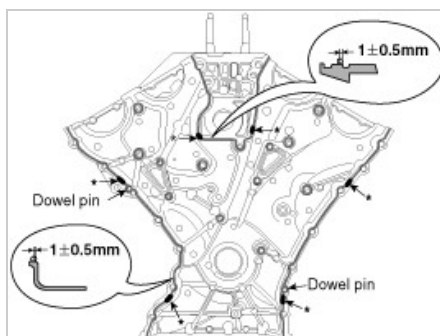
1. Install the timing chain cover.
 - (1) The sealant locations on chain cover and on counter parts (cylinder head, cylinder block, and lower oil pan) must be free of engine oil and etc.
 - (2) Before assembling the timing chain cover, the liquid sealant THREE BOND 1217H (Hyundai Gray RTV) should be applied on the gap between cylinder head and cylinder block. The part must be assembled within 5 minutes after sealant was applied.

Bead width :2.5 mm (0.1 in.)



- (3) After applying liquid sealant THREE BOND 1217H (Hyundai Gray RTV) on timing chain cover. The part must be assembled within 5 minutes after sealant was applied.

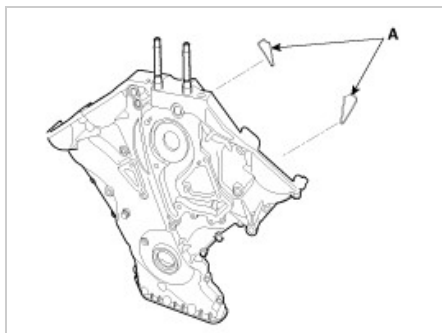
Sealant should be applied without discontinuity.



NOTICE

- Fill the T-joint area (6EA *) with sealant.
- Apply sealant all around the dowel pin hole (2EA).

- (4) Install the new gasket (A) to the timing chain cover.



NOTICE

During timing cover installation, care not to take off applied sealant on the timing cover by contact with other parts.

- (5) 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

A (17EA) :

18.6 ~ 21.6 N.m (1.9 ~ 2.2 kgf.m, 13.7 ~ 15.9 lb-ft)

B (2EA) :

24.5 ~ 26.5 N.m (2.5 ~ 2.7 kgf.m, 18.1 ~ 19.5 lb-ft)

C (1EA) :

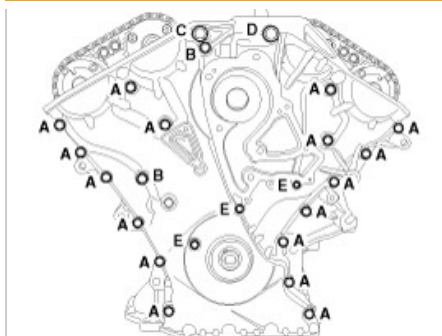
58.8 ~ 68.8 N.m (6.0 ~ 7.0 kgf.m, 43.4 ~ 50.6 lb-ft)

D (1EA) :

58.8 ~ 68.8 N.m (6.0 ~ 7.0 kgf.m, 43.4 ~ 50.6 lb-ft)

E (3EA) :

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



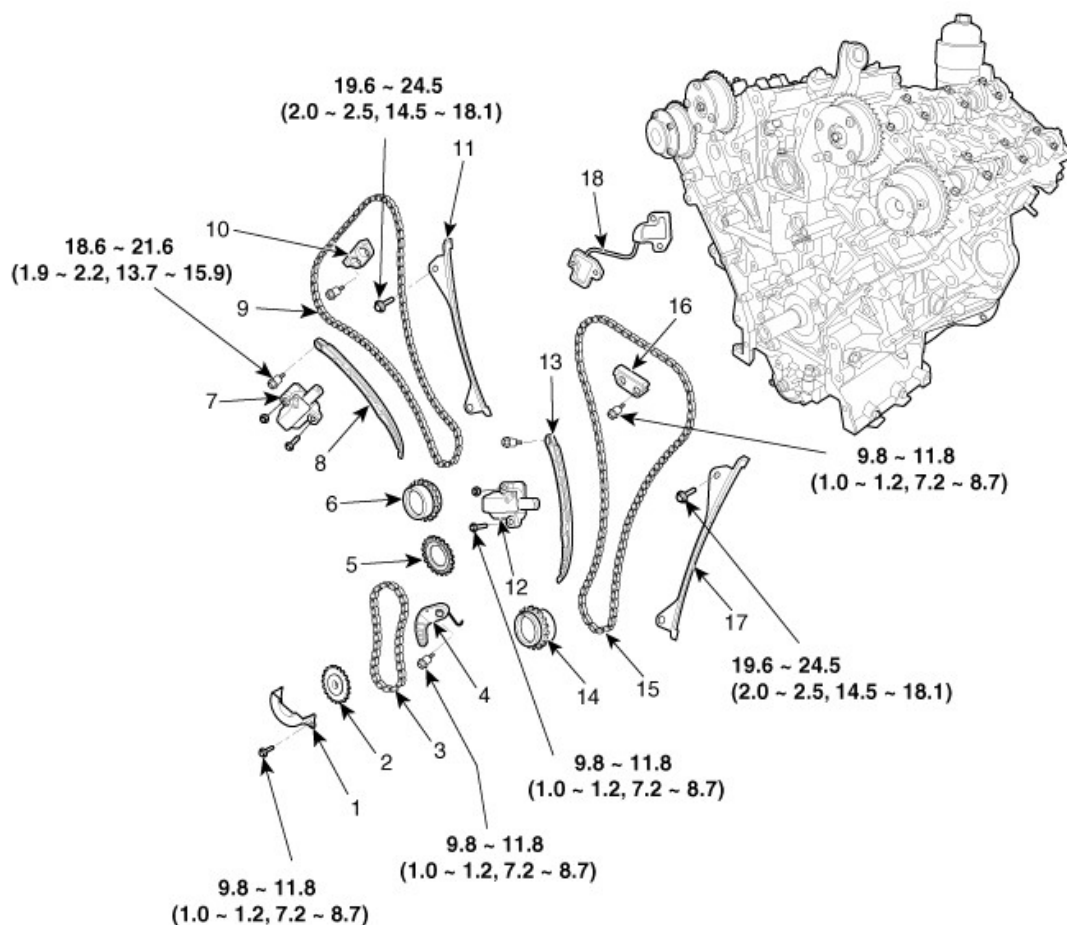
- (6) Running the engine or performing a pressure test should not be performed within 30 minutes of assembly.

2. Install the front oil seal.
(Refer to Timing System - "Front Oil Seal")
3. Install all other parts in reverse order of removal.

NOTICE

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





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

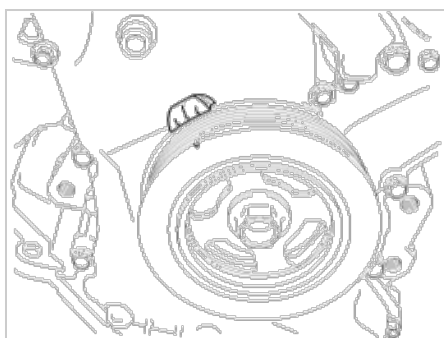
- | | | |
|---------------------------------|--------------------------------------|--------------------------------------|
| 1. Oil pump chain cover | 7. RH Timing chain auto tensioner | 13. LH Timing chain tensioner arm |
| 2. Oil pump sprocket | 8. RH Timing chain tensioner arm | 14. Crankshaft LH chain sprocket |
| 3. Oil pump chain | 9. RH Timing chain | 15. LH Timing chain |
| 4. Oil pump tensioner assembly | 10. RH Timing chain cam to cam guide | 16. LH Timing chain cam to cam guide |
| 5. Crankshaft oil pump sprocket | 11. RH Timing chain guide | 17. LH Timing chain guide |
| 6. Crankshaft RH chain sprocket | 12. LH Timing chain auto tensioner | 18. Tensioner adapter |

Engine Mechanical System

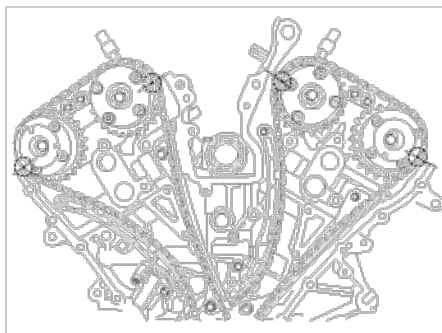


Removal

- Set No.1 cylinder to TDC/compression.
 - Turn the crankshaft pulley clockwise and align its groove with the timing mark "T" of the lower timing chain cover.



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



NOTICE

Do not rotate engine counterclockwise.

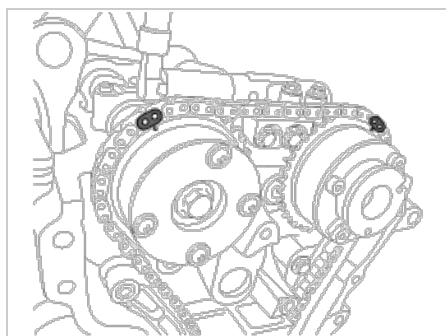
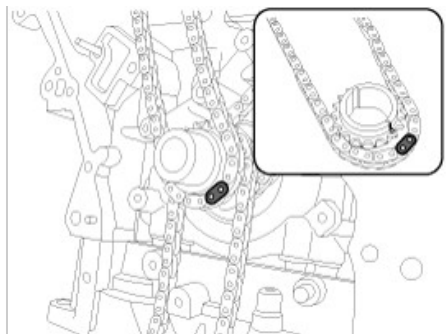
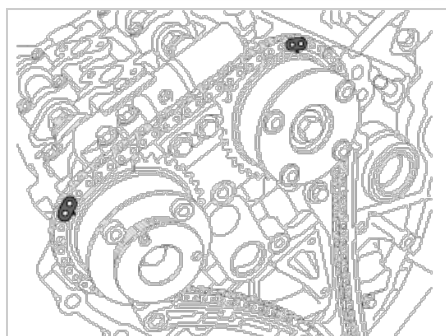
2. Remove the timing chain cover.
(Refer to Timing System - "Timing Chain Cover")

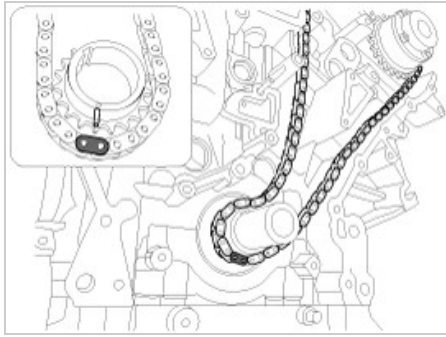
CAUTION

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

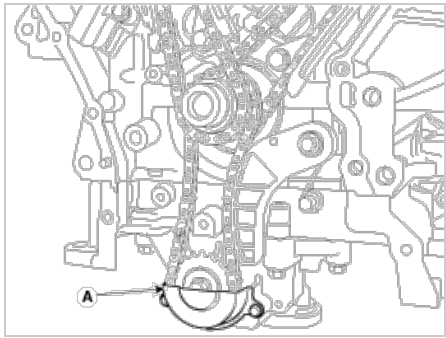
NOTICE

Before removing the timing chain, mark the RH/LH timing chain with an identification based on the location of the sprocket because the identification mark on the chain for TDC (Top Dead Center) can be erased.

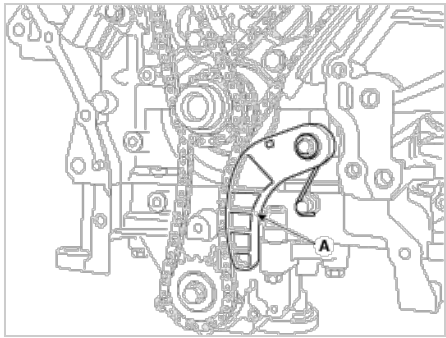




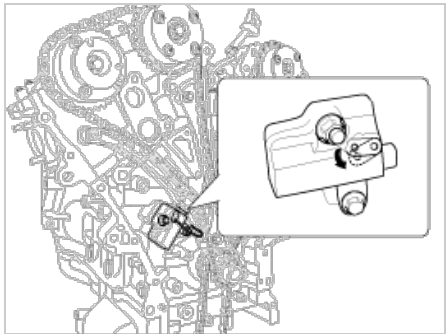
3. Remove the oil pump chain cover (A).



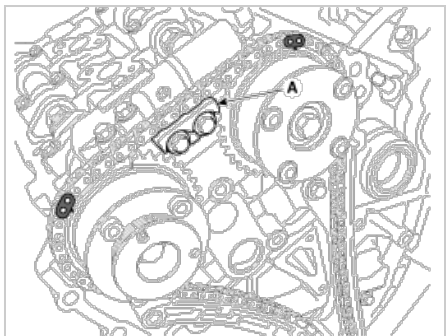
4. Remove the oil pump chain tensioner assembly (A).



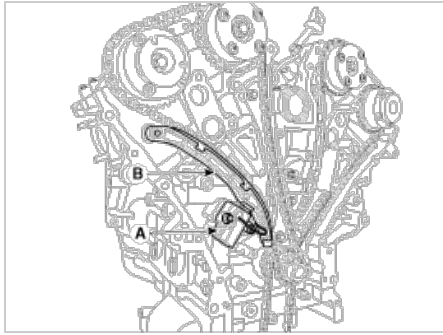
5. Release the ratchet by pulling the link down using a thin rod. Compress the piston and then insert a stopper pin into the hole on the ratchet to hold the compressed piston.



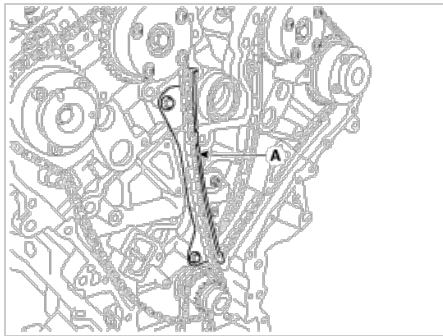
6. Remove the RH timing chain cam to cam guide (A).



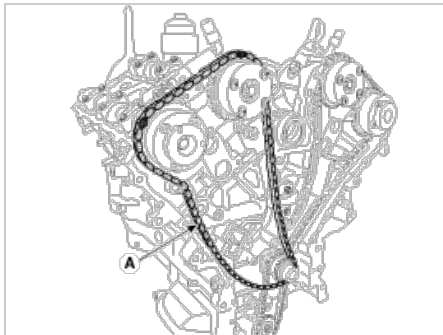
7. Remove the RH timing chain auto tensioner (A) and the RH timing chain tensioner arm (B).



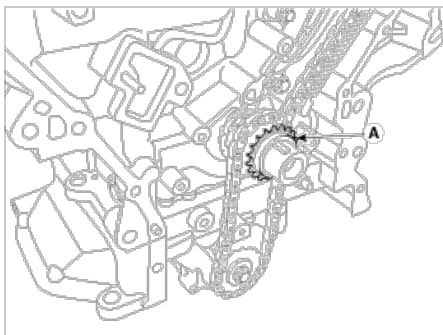
8. Remove the RH timing chain guide (A).



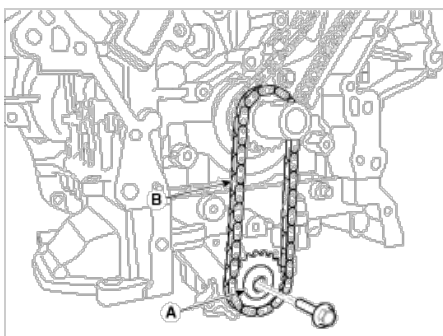
9. Remove the RH timing chain (A).



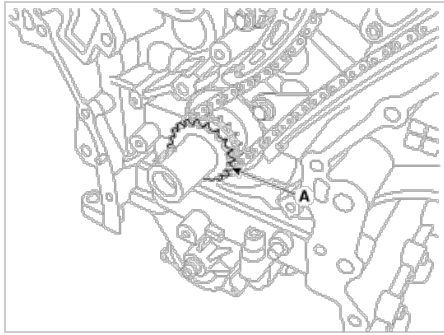
10. Remove the crankshaft sprocket (A) (RH camshaft drive).



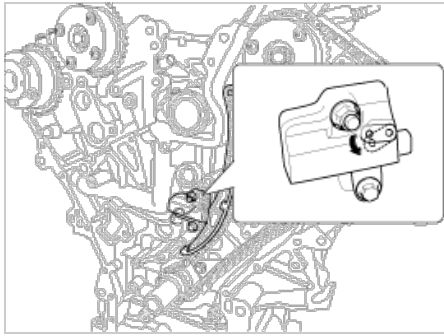
11. Remove the oil pump chain sprocket (A) and oil pump chain (B).



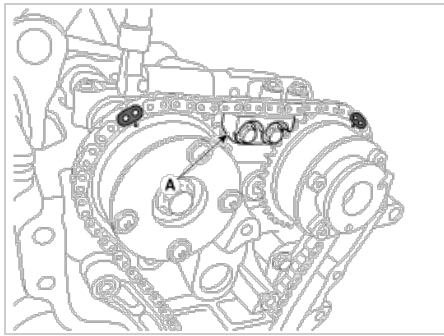
12. Remove the crankshaft sprocket (A) (Oil pump drive).



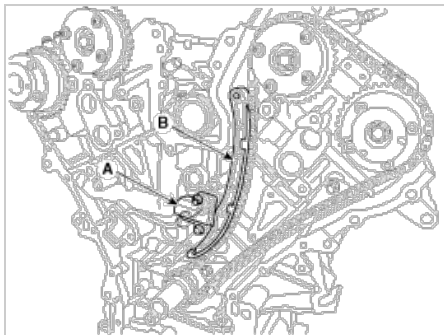
13. Release the ratchet by pulling the link down using a thin rod. Compress the piston and then insert a stopper pin into the hole on the ratchet to hold the compressed piston.



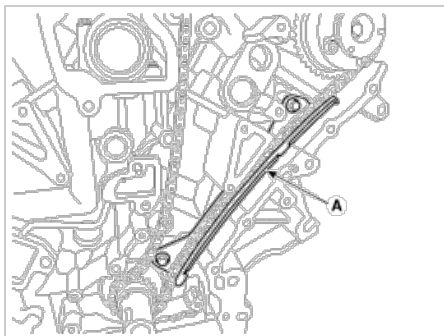
14. Remove the LH timing chain cam to cam guide (A).



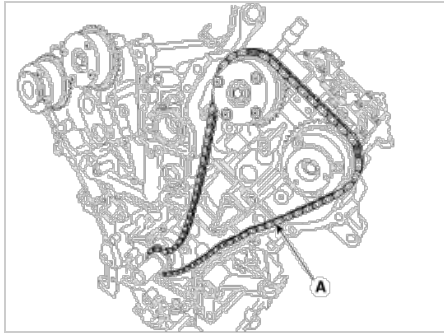
15. Remove the LH timing chain auto tensioner (A) and LH timing chain tensioner arm (B).



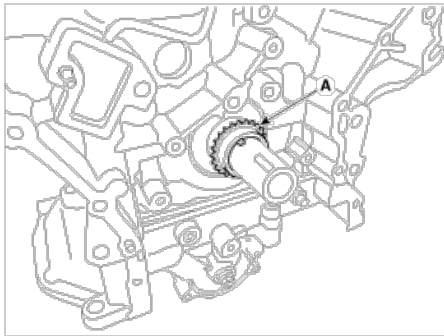
16. Remove the LH timing chain guide (A).



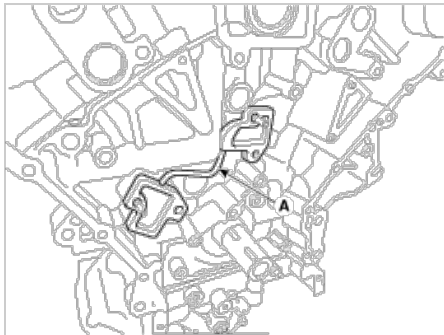
17. Remove the LH timing chain (A).



18. Remove the crankshaft sprocket (A). (LH camshaft drive).



19. Remove the tensioner adapter assembly (A).



Inspection

Sprockets, Chain Tensioner, Chain Guide, Chain Tensioner Arm

1. Check the camshaft sprocket and crankshaft sprocket for abnormal wear, cracks, or damage. Replace as necessary.
2. Inspect the tensioner arm and chain guide for abnormal wear, cracks, or damage. Replace as necessary.
3. Check that the tensioner piston moves smoothly when the ratchet pawl is released with thin rod.

Drive belt, Idler, Belt tensioner pulley

1. Check the idler for excessive oil leakage, abnormal rotation or vibration. Replace if necessary.
2. Check the belt tensioner for excessive dust, crack, and damage. Replace if necessary.
3. Check belt for maintenance and abnormal wear of V-ribbed part. Replace if necessary.
4. Check the pulleys for vibration in rotation, oil or dust deposit of V-ribbed part. Replace if necessary.

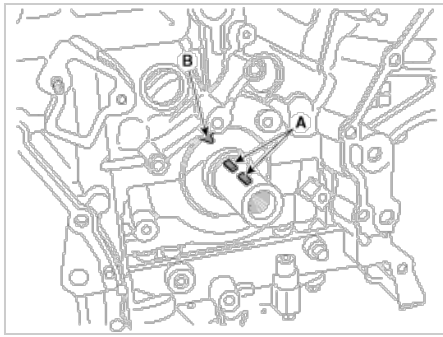
Installation

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

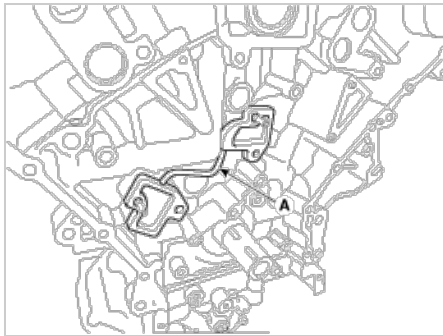
NOTICE

Insert the rubber block between jack and upper oil pan.

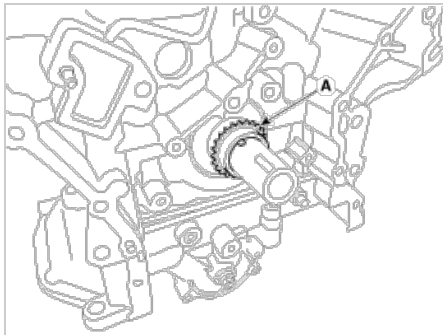
2. The key (A) of crankshaft should be aligned with the timing mark (B) of block. As a result of this, the piston of No.1 cylinder is placed at the top dead center on compression stroke.



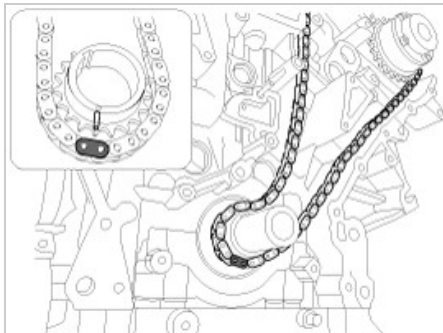
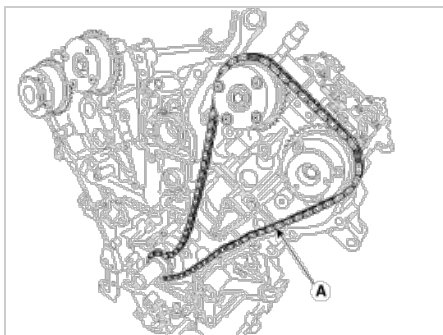
3. Install the tensioner adapter assembly (A).



4. Install the crankshaft sprocket (A). (LH camshaft drive).



5. Install the LH timing chain (A).



NOTICE

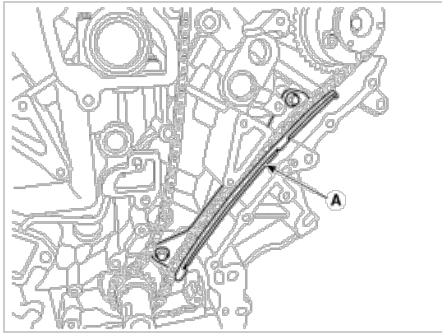
To install the timing chain with no slack between each shaft (cam, crank), follow the below procedure.
Crankshaft sprocket → Timing chain guide → Exhaust camshaft sprocket → Intake camshaft sprocket.

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

6. Install the LH timing chain guide (A).

Tightening torque :

19.6 ~ 24.5N.m (2.0 ~ 2.5kgf.m, 14.5 ~ 18.1lb-ft)

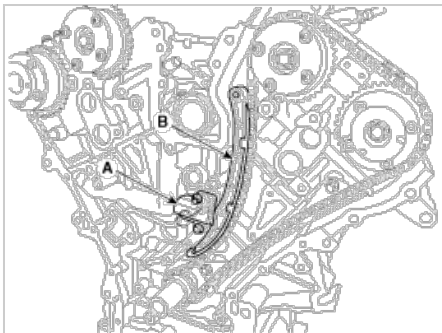


7. Install the LH timing chain auto tensioner (A) and LH timing chain tensioner arm (B).

Tightening torque

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

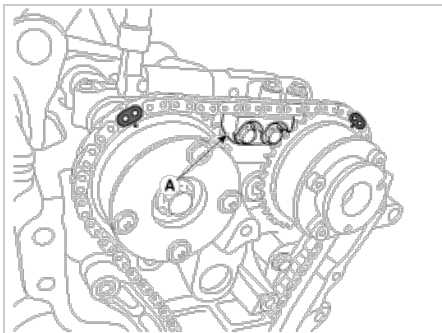
B : 18.6 ~ 21.6N.m (1.9 ~ 2.2kgf.m, 13.7 ~ 15.9lb-ft)



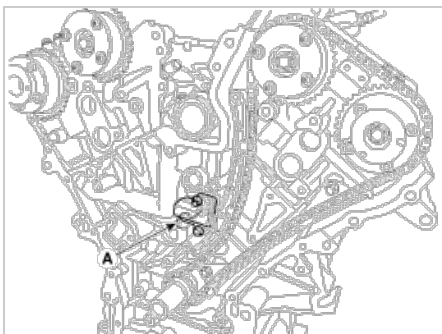
8. Install the LH timing chain cam to cam guide (A).

Tightening torque :

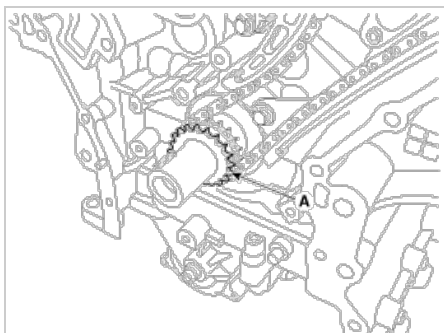
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



9. Pull out the pins of LH timing chain auto tensioner.



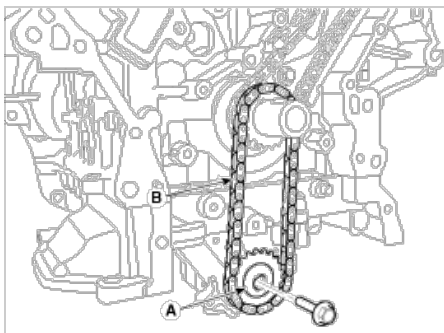
10. Install the crankshaft sprocket (A) (Oil pump drive).



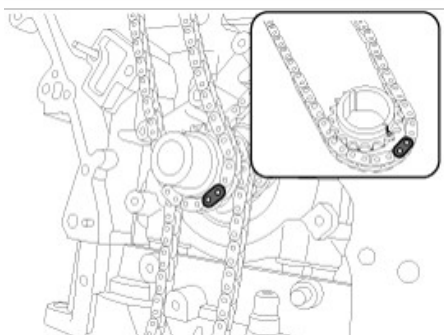
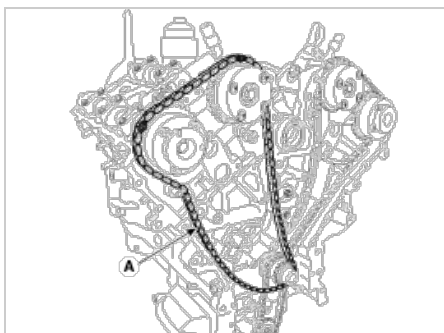
11. Install the oil pump chain sprocket (A) and oil pump chain (B).

Tightening torque :

18.6 ~ 21.6N.m (1.9 ~ 2.2kgf.m, 13.7 ~ 15.9lb-ft)



12. Install the RH timing chain (A).



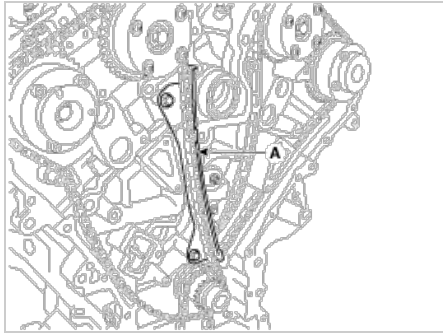
NOTICE

To install the timing chain with no slack between each shaft (cam, crank), follow the below procedure.
Crankshaft sprocket → Timing chain guide → Intake camshaft sprocket → Exhaust camshaft sprocket.
The timing mark of each sprockets should be matched with timing mark (color link) of timing chain at installing timing chain.

13. Install the RH timing chain guide (A).

Tightening torque :

A : 19.6 ~ 24.5N.m (2.0 ~ 2.5kgf.m, 14.5 ~ 18.1lb-ft)

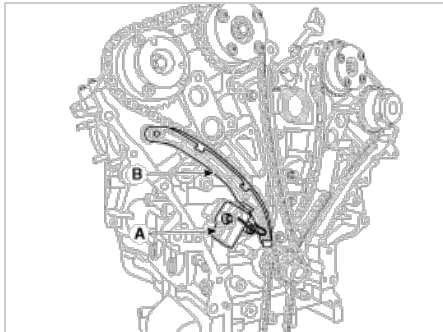


14. Install the RH timing chain auto tensioner (A) and the RH timing chain tensioner arm (B).

Tightening torque

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

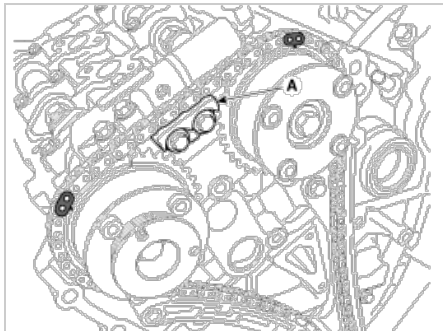
B : 18.6 ~ 21.6N.m (1.9 ~ 2.2kgf.m, 13.7 ~ 15.9lb-ft)



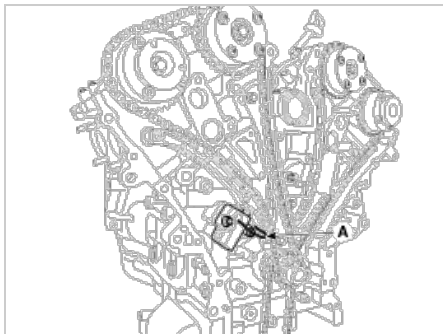
15. Install the RH timing chain cam to cam guide (A).

Tightening torque :

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



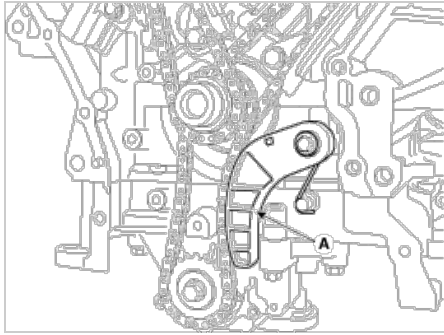
16. Pull out the pins of RH timing chain auto tensioner.



17. Install the oil pump chain tensioner assembly (A).

Tightening torque :

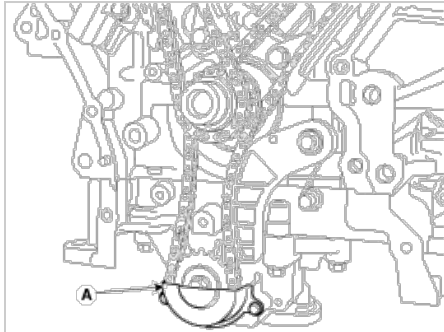
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



18. Install the oil pump chain cover (A).

Tightening torque :

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



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

NOTICE

Always turn the crankshaft clockwise.

Turning the crankshaft counter clockwise before building up oil pressure in the hydraulic timing chain tensioner may result in the chain disengaging from the sprocket teeth.

20. Install the timing chain cover.

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

21. Install the other parts reverse order of removal.

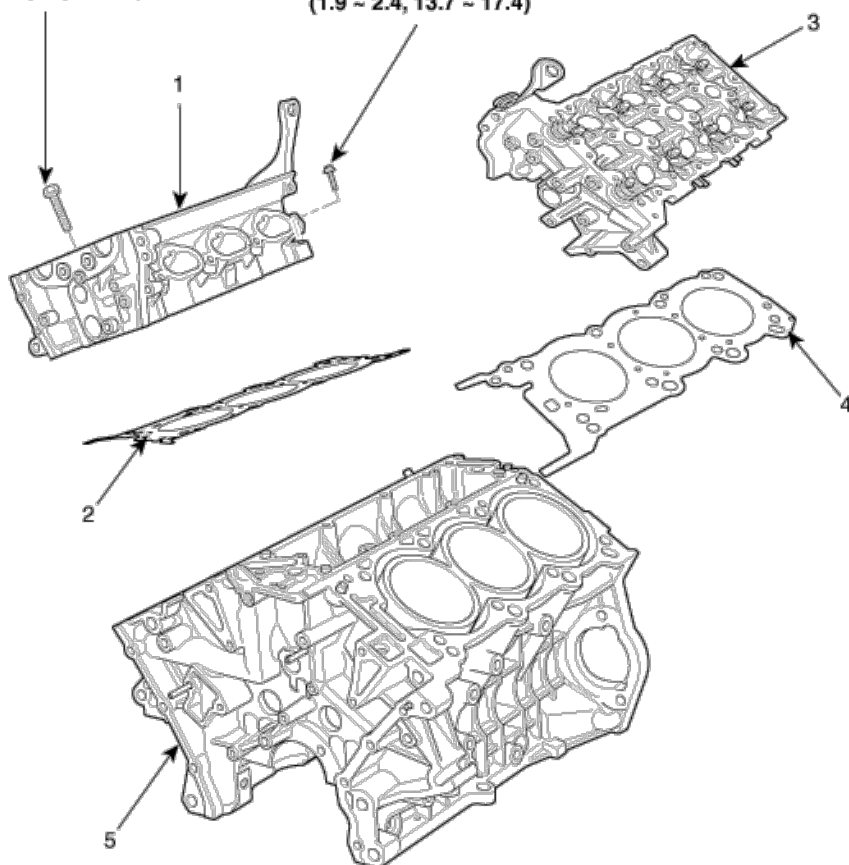
NOTICE

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



37.3~41.2 (3.8~4.2, 27.5~30.4)
+ (118~122°) + (88~92°)

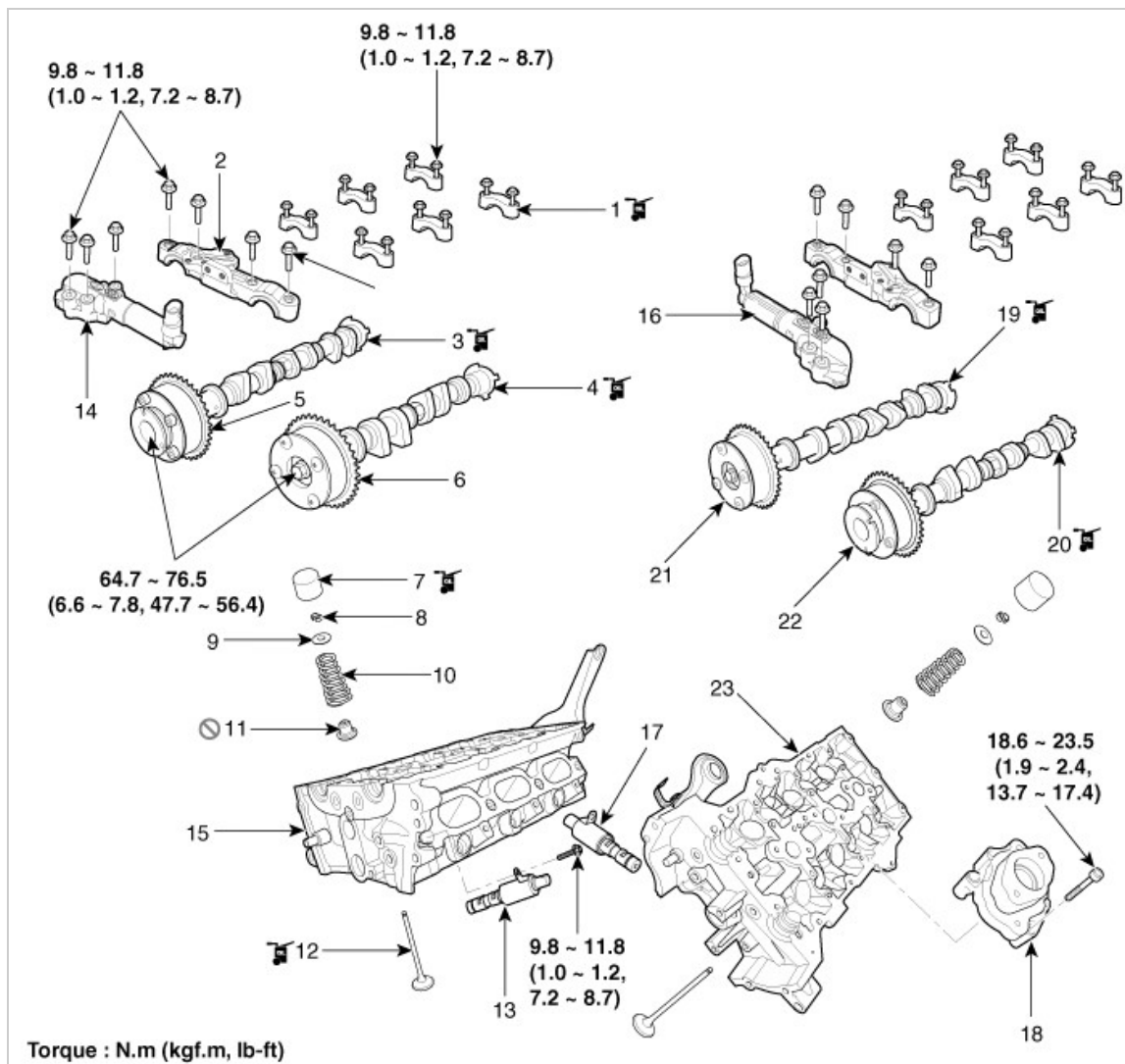
18.6 ~ 23.5
(1.9 ~ 2.4, 13.7 ~ 17.4)



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

- 1. RH Cylinder head
- 2. RH Cylinder head gasket
- 3. LH Cylinder head

- 4. LH Cylinder head gasket
- 5. Cylinder block



- | | | |
|-----------------------------------|-----------------------------|-----------------------------|
| 1. Camshaft bearing cap | 9. Retainer | 17. LH Intake camshaft OCV |
| 2. Camshaft thrust bearing cap | 10. Valve spring | 18. Fuel pump bracket |
| 3. RH Exhaust camshaft | 11. Valve stem seal | 19. LH Intake camshaft |
| 4. RH Intake camshaft | 12. Valve | 20. LH Exhaust camshaft |
| 5. RH Exhaust CVVT assembly | 13. RH Intake camshaft OCV | 21. LH Intake CVVT assembly |
| 6. RH Intake CVVT assembly | 14. RH Exhaust camshaft OCV | 22. LH Intake CVVT assembly |
| 7. Mechanical lash adjuster (MLA) | 15. RH Cylinder head | 23. LH Cylinder head |
| 8. Retainer lock | 16. LH Exhaust camshaft OCV | |

Engine Mechanical System



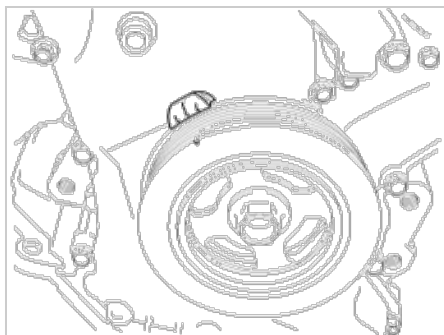
Inspection

Valve Clearance Inspection And Adjustment

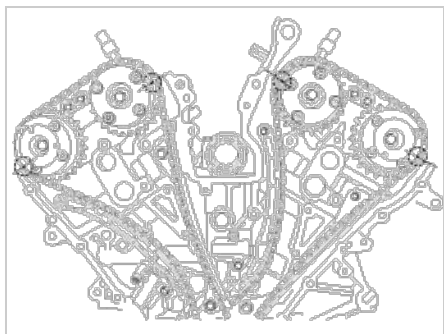
NOTICE

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.

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



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

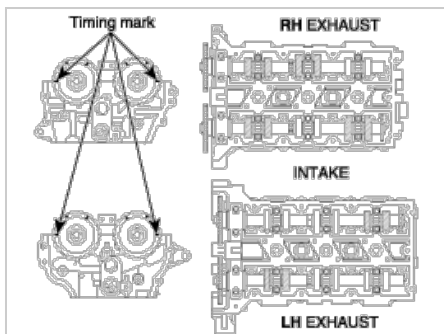


NOTICE

Do not rotate engine counterclockwise.

3. Inspect the valve clearance.

- (1) With No.1 cylinder at TDC inspect clearances only on the valves shown in diagram below.



Measurement method.

- 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

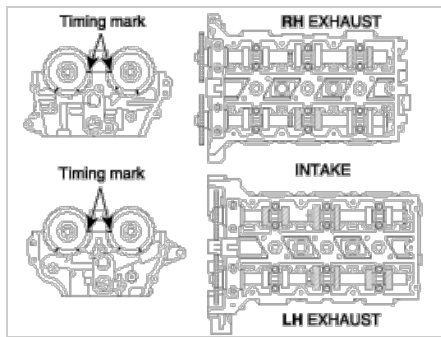
Engine coolant temperature : 20°C [68°F]

Limit

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

Exhaust : 0.20 ~ 0.40mm (0.0078 ~ 0.0157in.)

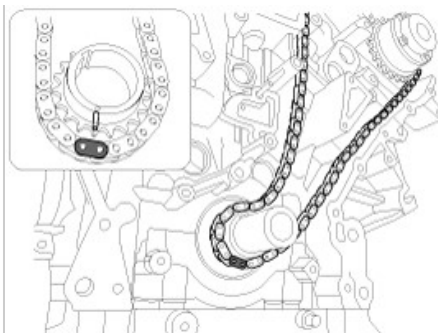
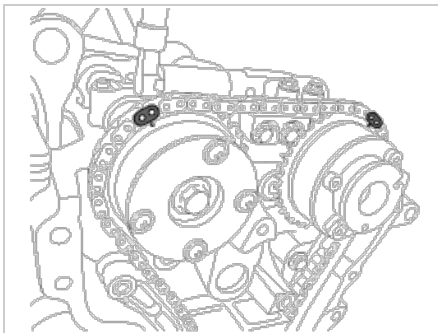
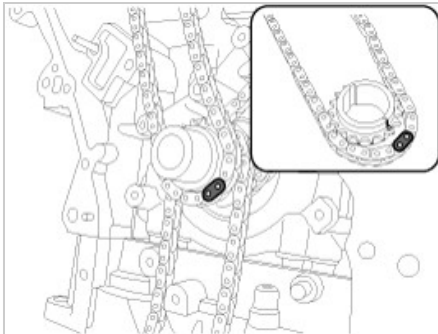
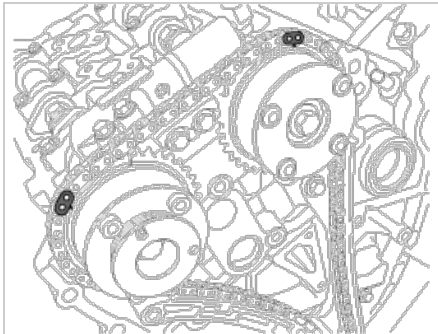
- (2) Turn the crankshaft pulley clockwise one revolution (360°) and align the groove with timing mark "T" of the lower timing chain cover.
- (3) With No.4 cylinder at TDC inspect clearances only the valves shown in diagram below. (Refer to procedure step 1.)



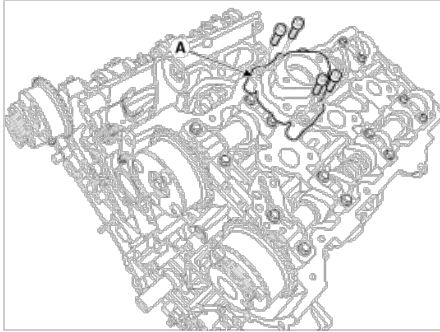
4. Adjust the intake and exhaust valve clearance.
 - (1) Set the No.1 cylinder to the TDC/compression.
 - (2) Remove the timing chain.

NOTICE

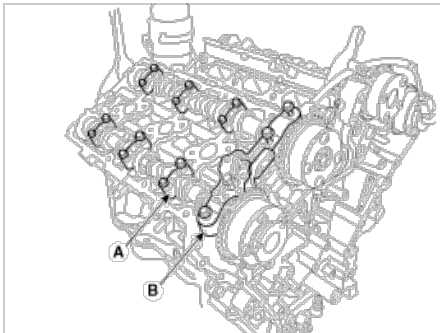
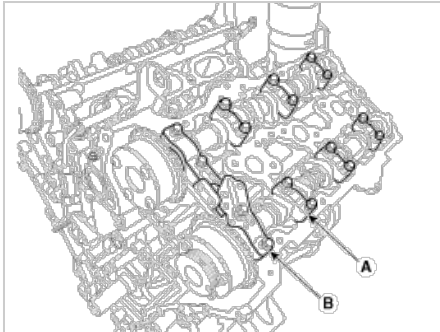
Before removing the timing chain, mark the RH/LH timing chain with an identification based on the location of the sprocket because the identification mark on the chain for TDC (Top Dead Center) can be erased.



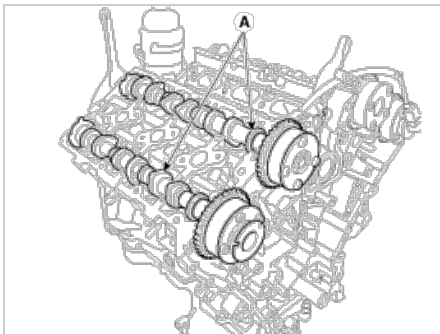
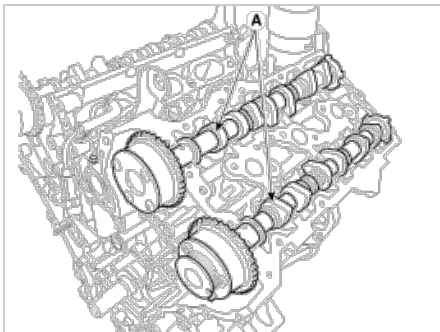
(3) Remove the fuel pump bracket (A).



(4) Remove the LH/RH camshaft bearing cap (A) and thrust bearing cap (B).

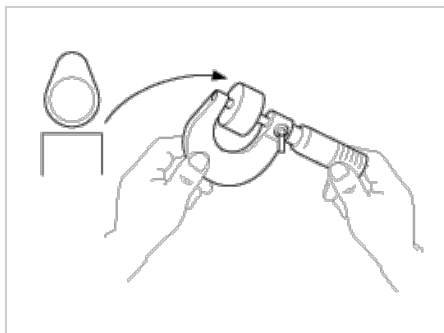


(5) Remove the LH/RH camshaft assembly (A).



(6) Remove the tappets.

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



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

T :Thickness of removed tappet

A :Measured valve clearance

N :Thickness of new tappet

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

Exhaust : $N = T + [A - 0.30\text{mm}(0.0118\text{in.})]$

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

NOTICE

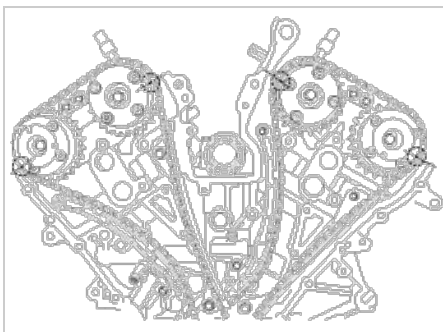
Shims are available in 41 size increments of 0.015mm (0.0006in.) from 3.00mm (0.118in.) to 3.600mm (0.1417in.)

- (10) Place a new tappet on the cylinder head.

NOTICE

Apply engine oil at the selected tappet on the side and top surface.

- (11) Install the intake and exhaust camshaft.
 (12) Install the bearing caps.
 (Refer to Cylinder Head Assembly - "CVVT & Camshaft")
 (13) Install the timing chain.
 (Refer to Timing System - "Timing Chain")
 (14) Turn the crankshaft two turns in the operating direction (clockwise) and realign crankshaft sprocket and camshaft sprocket timing marks.



- (15) Recheck the valve clearance.

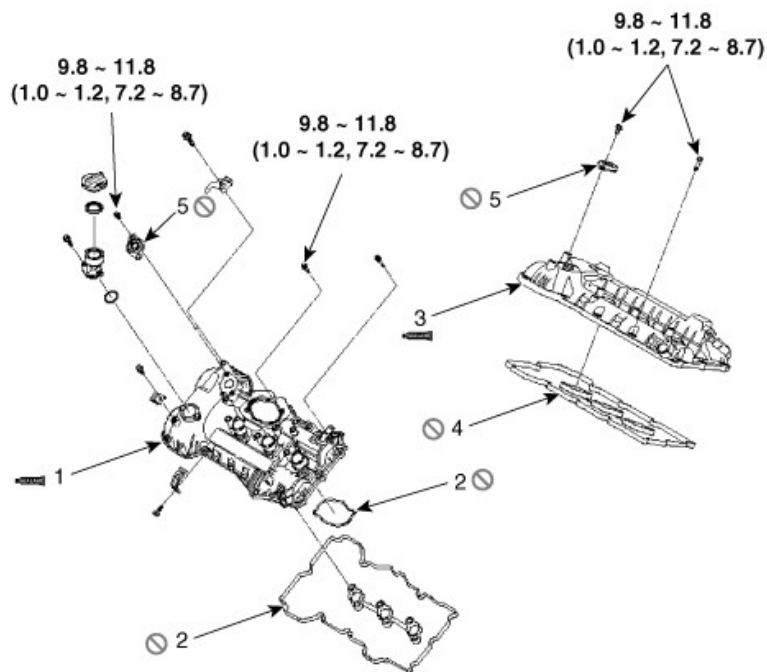
Valve clearance (Engine coolant temperature : 20°C [68°F])

[Specification]

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

Exhaust : 0.27 ~ 0.33mm (0.0106 ~ 0.0129in.)





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

- | | |
|----------------------------------|----------------------------------|
| 1. LH cylinder head cover | 4. RH cylinder head cover gasket |
| 2. LH cylinder head cover gasket | 5. Exhaust CVVT OCV cap |
| 3. RH cylinder head cover | |

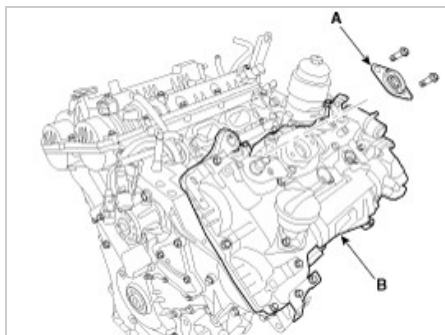
Engine Mechanical System



Removal

[LH]

1. Remove the Intake manifold.
(Refer to Intake And Exhaust System - "Intake Manifold")
2. Remove the high pressure fuel pump.
(Refer to Engine Control/Fuel System - "High Pressure Fuel Pump")
3. Remove the LH ignition coils.
(Refer to Engine Electrical System - "Ignition Coil")
4. Remove the front engine hanger.
5. Remove the LH cylinder head cover.
(1) Remove the LH exhaust CVVT oil control valve cap (A).
(2) Remove the LH cylinder head cover (B) and gasket.

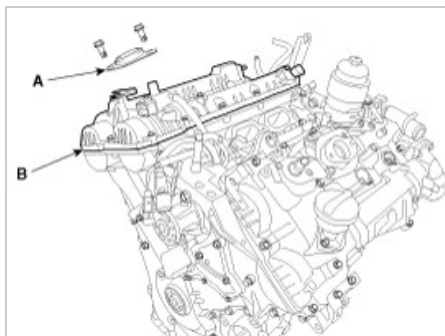


NOTICE

Cover the cylinder head with a clean woven stuff or vinyl cover to prevent foreign materials from entering.

[RH]

1. Remove the surge tank.
(Refer to Intake And Exhaust System - "Surge Tank")
2. Remove the RH ignition coils.
(Refer to Engine Electrical System - "Ignition Coil")
3. Remove the RH cylinder head cover.
 - (1) Remove the RH exhaust CVVT oil control valve cap (A).
 - (2) Remove the RH cylinder head cover (B) and gasket.



NOTICE

Cover the cylinder head with a clean woven stuff or vinyl cover to prevent foreign materials from entering.

Installation

[LH]

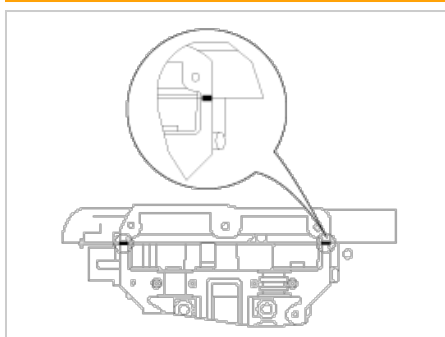
1. Install the LH cylinder head cover.

CAUTION

- Install the cylinder head cover under the exhaust OCV Cap is removed.
- To prevent engine oil leakage, surely install the exhaust OCV cap after installing the cylinder head cover.

- (1) The hardening sealant located on the upper area between timing chain cover and cylinder head should be removed before assembling cylinder head cover.
- (2) After applying TB 1217H (Hyundai Gray RTV) sealant, it should be assembled within 5 minutes.

Bead width :2.5mm(0.1in.)



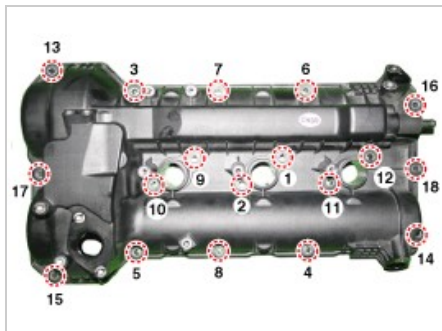
- (3) The firing and/or blow out test should not be performed within 30 minutes after the cylinder head cover was assembled.
- (4) Install the LH cylinder head cover bolts as following method.

Tightening torque :

1st step: 4.9 ~ 5.9N.m (0.5 ~ 0.6kgf.m, 3.6 ~ 4.3lb-ft)
 2nd step: 9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)

CAUTION

Do not reuse cylinder head cover gasket.



- (5) Install the LH exhaust CVVT oil control valve cap.

Tightening torque :

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

NOTICE

- Remove on the exhaust OCV cap, and then install the cylinder head cover.
- After reinstalling the cylinder head cover, install the exhaust OCV cap. otherwise, it may cause leakage to engine oil through the sealing side of OCV cap.
- If the seal have been damaged in the removal and installation procedures, replace the exhaust OCV cap with a new one.

2. Install the other parts reverse order of removal.

[RH]

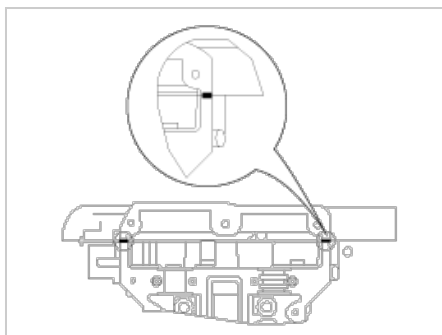
1. Install the RH cylinder head cover.

CAUTION

- Install the cylinder head cover under the exhaust OCV cap is removed.
- To prevent engine oil leakage, surely install the exhaust OCV cap after installing the cylinder head cover.

- (1) The hardening sealant located on the upper area between timing chain cover and cylinder head should be removed before assembling cylinder head cover.
- (2) After applying TB 1217H (Hyundai Gray RTV) sealant, it should be assembled within 5 minutes.

Bead width :2.5mm(0.1in.)



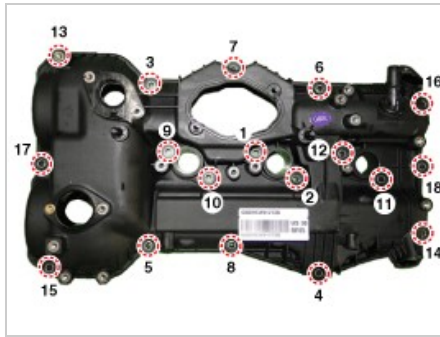
- (3) The firing and/or blow out test should not be performed within 30 minutes after the cylinder head cover was assembled.
- (4) Install the RH cylinder head cover bolts as following method.

Tightening torque :

1st step: 4.9 ~ 5.9N.m (0.5 ~ 0.6kgf.m, 3.6 ~ 4.3lb-ft)
 2nd step: 9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)

CAUTION

Do not reuse cylinder head cover gasket.



(5) Install the RH exhaust CVVT oil control valve cap.

Tightening torque :

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

NOTICE

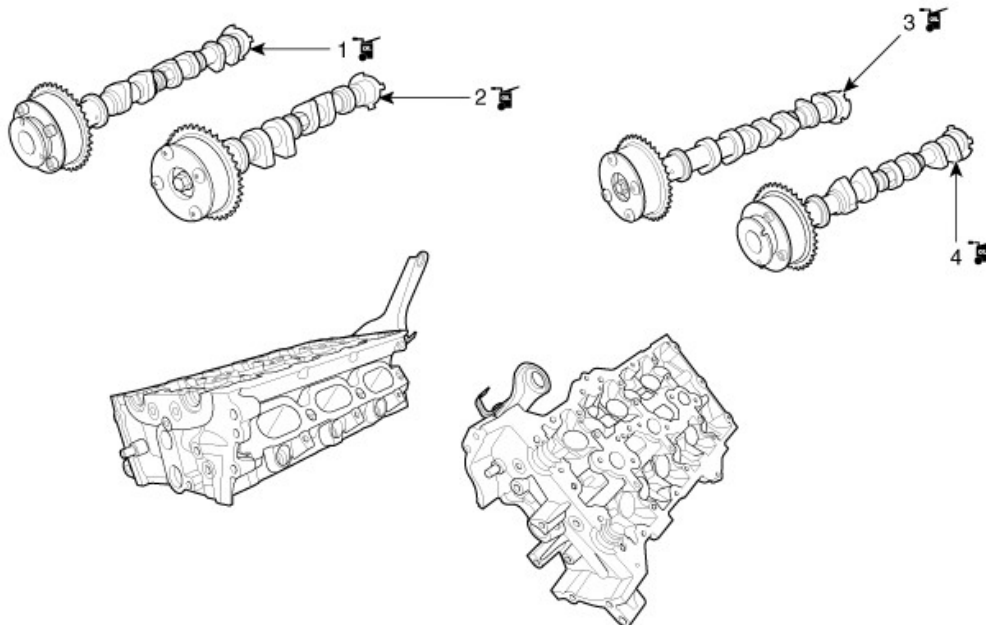
- Remove on the exhaust OCV cap, and then install the cylinder head cover.
- After reinstalling the cylinder head cover, install the exhaust OCV cap. otherwise, it may cause leakage to engine oil through the sealing side of OCV cap.
- If the seal have been damaged in the removal and installation procedures, replace the exhaust OCV cap with a new one.

2. Install the other parts reverse order of removal.

Engine Mechanical System

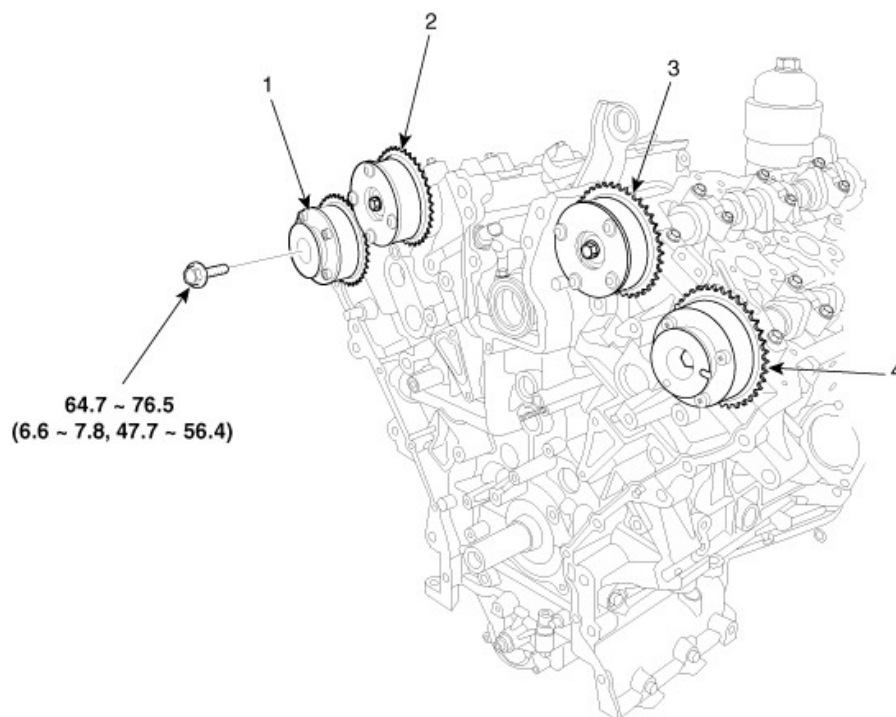


Components



1. RH exhaust camshaft
2. RH intake camshaft

3. LH intake camshaft
4. LH exhaust camshaft



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

- 1. RH exhaust CVVT
- 2. RH intake CVVT

- 3. LH intake CVVT
- 4. LH exhaust CVVT

Engine Mechanical System



Description

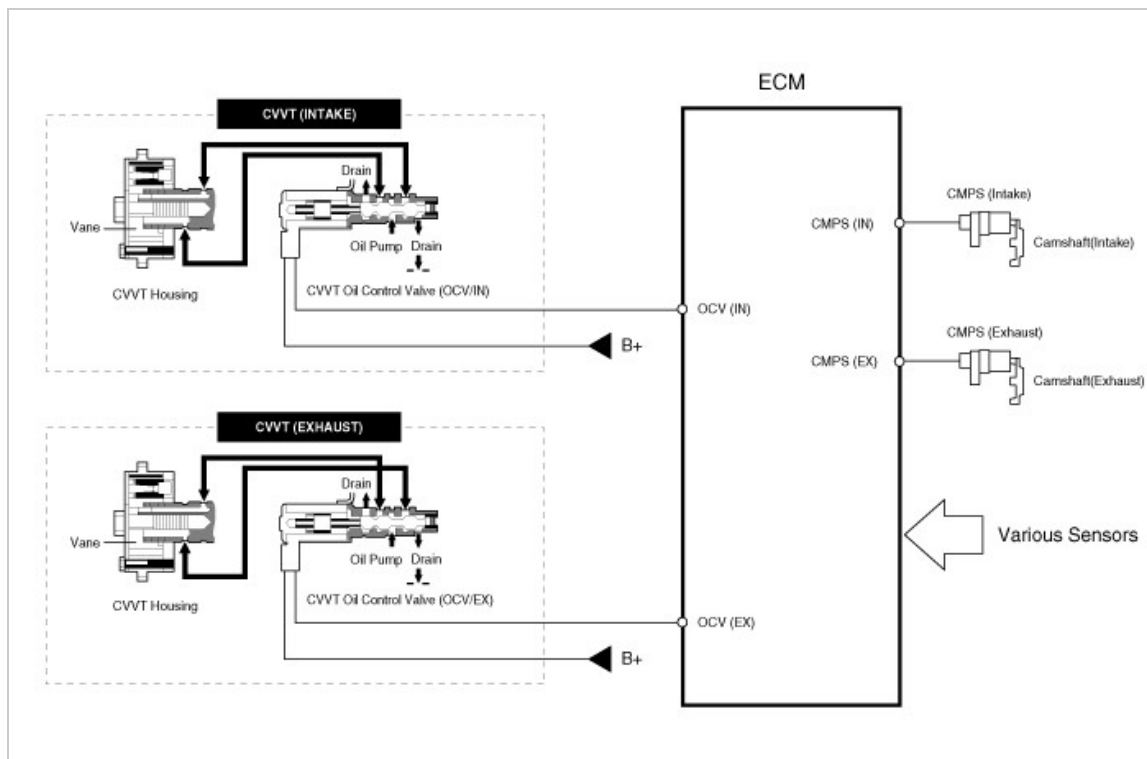
Continuous Variable Valve Timing (CVVT) system advances or retards the valve timing of the intake and exhaust valve in accordance with the ECM control signal which is calculated by the engine speed and load.

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

This system consist of

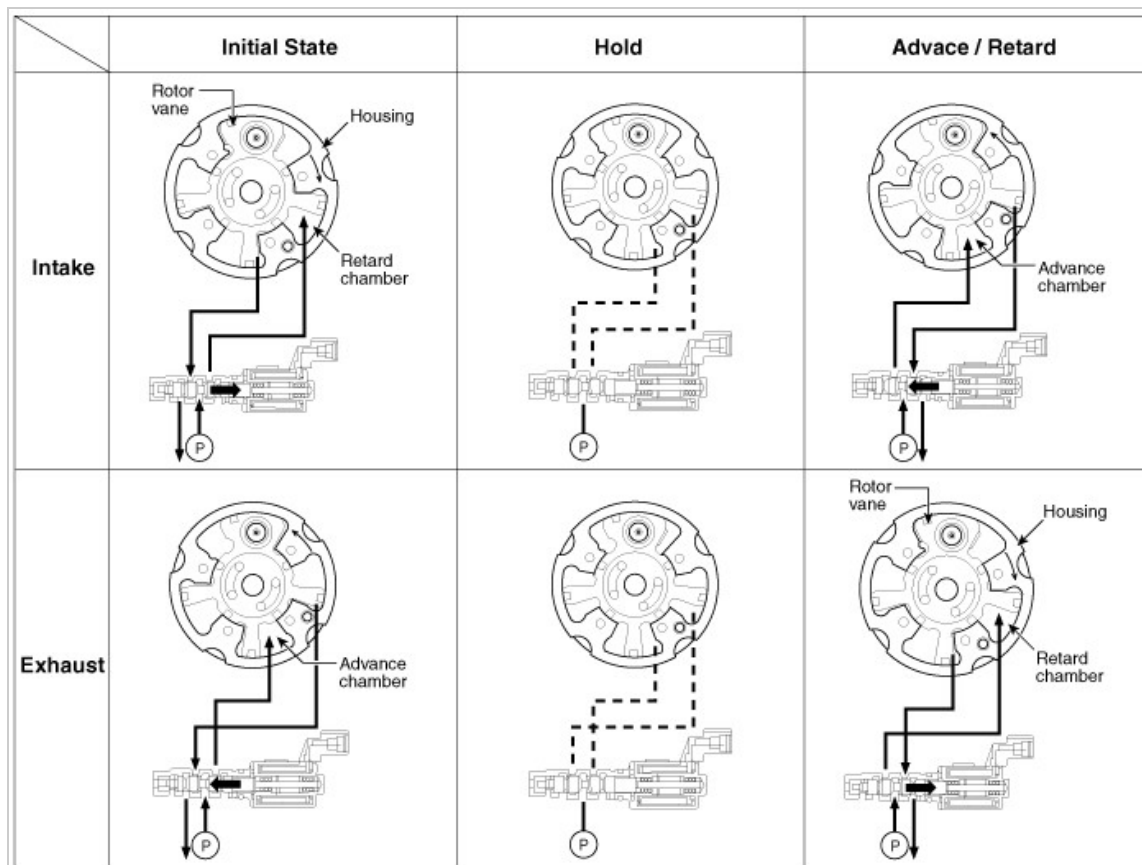
- the CVVT Oil Control Valve (OCV) which supplies the engine oil to the cam phaser or runs out the engine oil from the cam phaser in accordance with the ECM PWM (Pulse With Modulation) control signal,
- the CVVT Oil Temperature Sensor (OTS) which measures the engine oil temperature,
- and the Cam Phaser which varies the cam phase by using the hydraulic force of the engine oil.

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

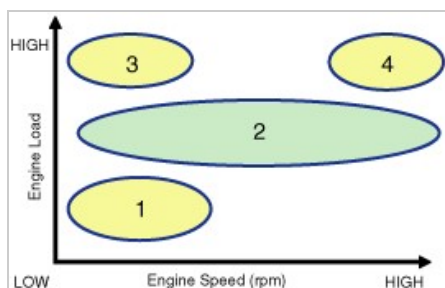


Operation Principle

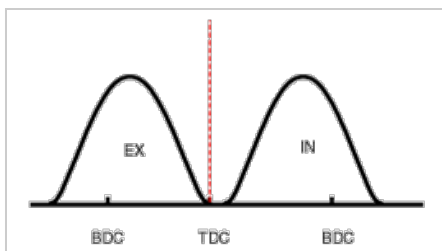
The CVVT has the mechanism rotating the rotor vane with hydraulic force generated by the engine oil supplied to the advance or retard chamber in accordance with the CVVT oil control valve control.



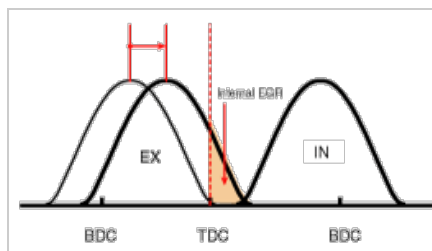
[CVVT System Mode]



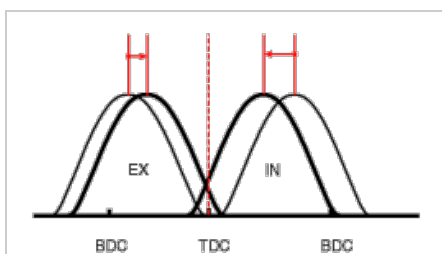
(1) Low Speed / Low Load



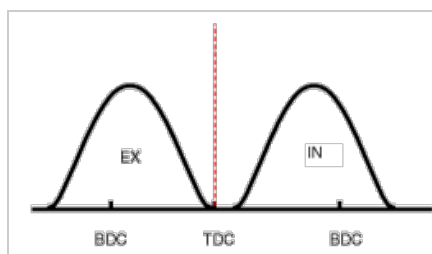
(2) Part Load



(3) Low Speed / High Load



(4) High Speed / High Load



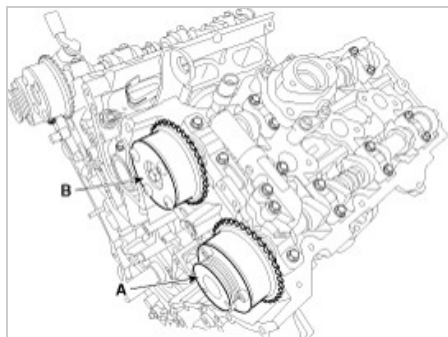
Driving Condition	Exhaust Valve		Intake Valve	
	Valve Timing	Effect	Valve Timing	Effect
(1) Low Speed / Low Load	Completely Advance	* Valve Under-lap * Improvement of combustion stability	Completely Retard	* Valve Under-lap * Improvement of combustion stability
(2) Part Load	Retard	* Increase of expansion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



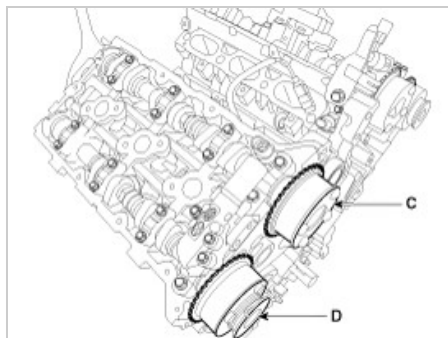
Removal

CVVT(Continuously Variable Valve Timing) Assembly

- Remove the timing chain.
(Refer to Timing System - "Timing Chain")
- Remove the continuous variable valve timing (CVVT) assembly.
 - A: LH exhaust CVVT
 - B: LH intake CVVT

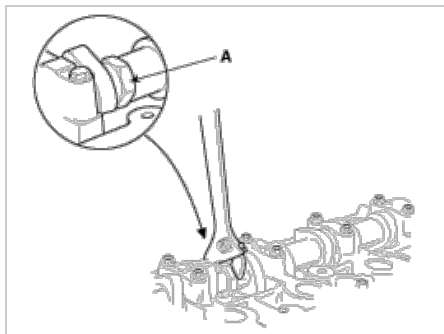


- C: RH intake CVVT
- D: RH exhaust CVVT



NOTICE

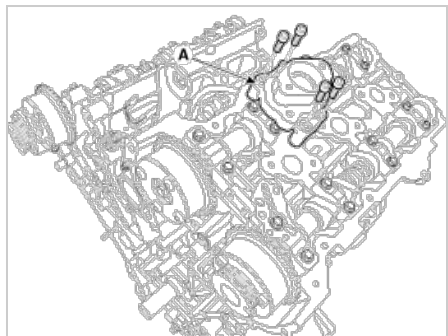
When removing the CVVT assembly bolt, prevent the camshaft from rotating by using a wrench at position (A).



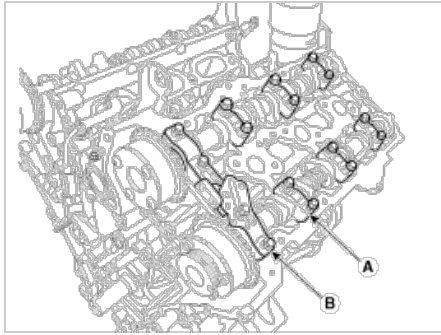
Camshaft

LH Intake and Exhaust camshaft

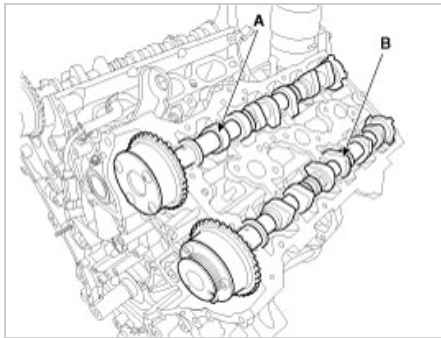
1. Remove the timing chain.
(Refer to Timing System - "Timing Chain")
2. Remove the LH exhaust camshaft oil control valve (OCV).
(Refer to Engine Control/Fuel System - "CVVT Oil Control Valve (OCV)")
3. Remove the fuel pump bracket (A).



4. Remove the LH camshaft bearing cap (A) and thrust bearing cap (B).

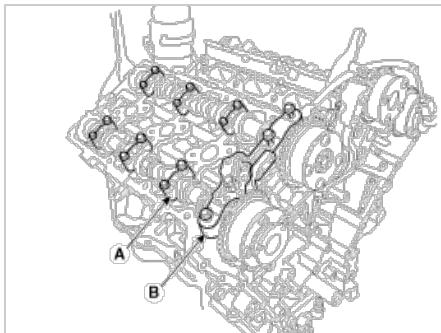


5. Remove the LH camshaft assembly (A).

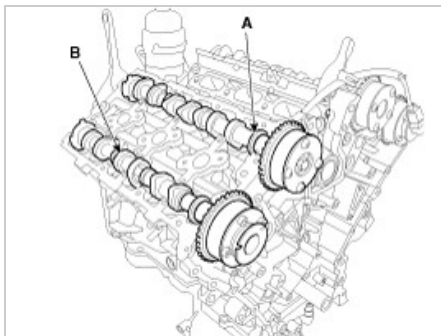


RH Intake and Exhaust camshaft

1. Remove the timing chain.
(Refer to Timing System - "Timing Chain")
2. Remove the RH exhaust camshaft oil control valve (OCV).
(Refer to Engine Control/Fuel System - "CVVT Oil Control Valve (OCV)")
3. Remove the RH camshaft bearing cap (A) and thrust bearing cap (B).



4. Remove the RH camshaft assembly (A).

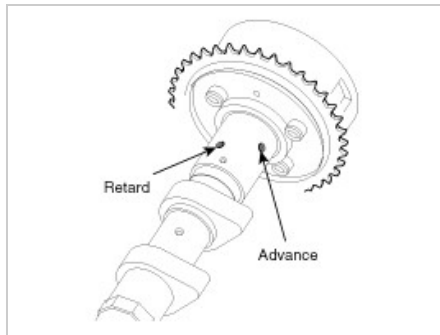


Inspection

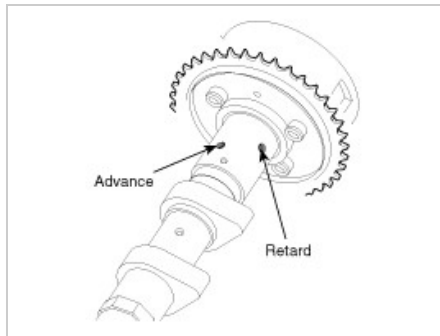
CVVT(Continuously Variable Valve Timing) Assembly

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

[Intake CVVT]



[Exhaust CVVT]



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

Information

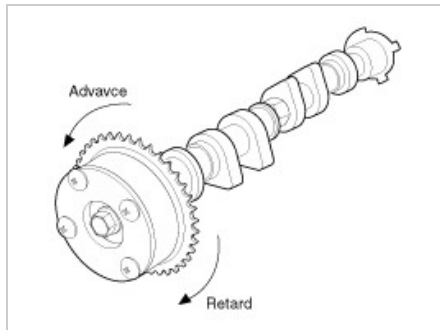
Cover the oil paths with a piece of cloth when applying compressed air to prevent oil from spraying.

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

CVVT phasing range

Intake : 25° ± 0°30" (from the most retarded position to the most advanced position)

Exhaust : 25° ± 0°30" (from the most advanced position to the most retarded position)



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

Camshaft

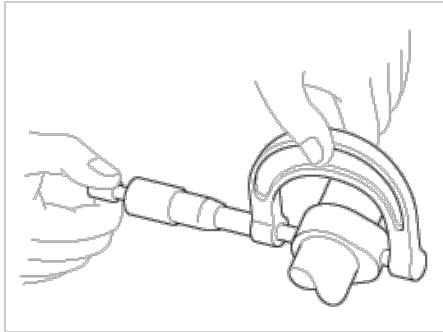
1. Using a micrometer, measure the cam lobe height.

Cam height

[Standard value]

Intake : 46.6 mm (1.835 in.)

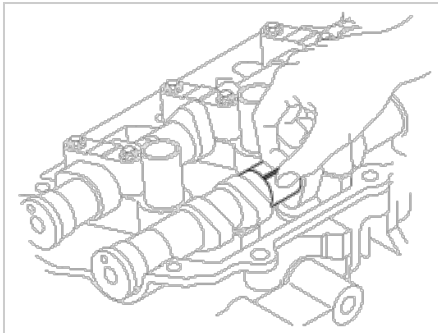
Exhaust : 45.8 mm (1.8031 in.)



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

2. Inspect the camshaft journal clearance.

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



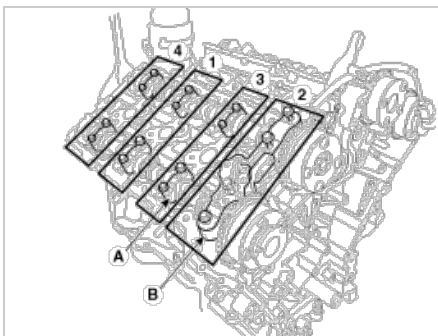
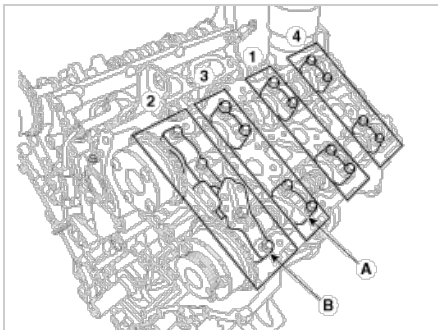
(4) Install the bearing cap (A) and thrust bearing cap (B) with specified torque.

Tightening torque :

1st step : 5.8 N.m (0.6 kgf.m, 4.3 lb-ft)

2nd step :

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



CAUTION

Do not turn the camshaft.

(5) Remove the bearing caps.

(6) Measure the plastigage at its widest point.

Bearing oil clearance

[Standard value]

Intake

No.1 journal : 0.020 ~ 0.057 mm (0.0008 ~ 0.0022 in.)

No.2,3,4 journal :

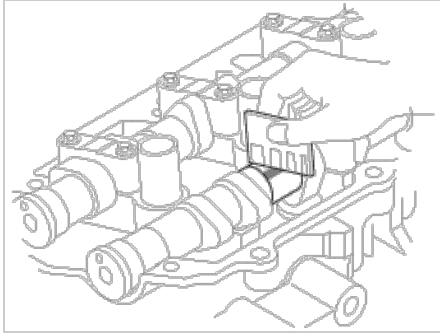
0.030 ~ 0.067 mm (0.0012 ~ 0.0026 in.)

Exhaust

No.1 journal : 0.027 ~ 0.057 mm (0.0010 ~ 0.0022 in.)

No.2,3,4 journal :

0.030 ~ 0.067 mm (0.0012 ~ 0.0026 in.)



- If the oil clearance is greater than specification, replace the camshaft.
- If the oil clearance is still greater than specification after camshaft replacement, replace the bearing caps and cylinder head as a set.

(7) Completely remove the plastigage.

(8) Remove the camshafts.

3. Inspect the camshaft end play.

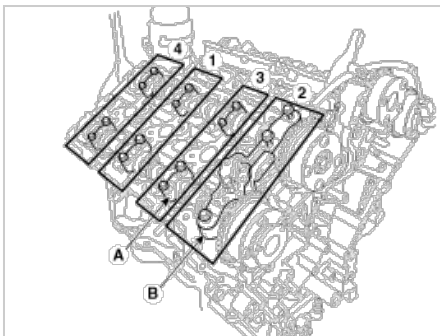
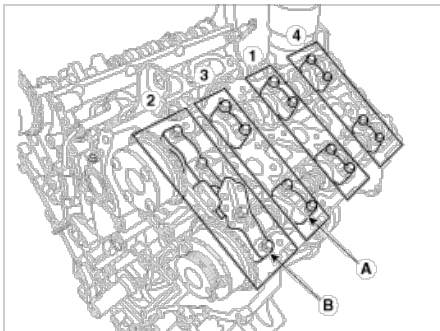
(1) Install the camshafts.

(2) Install the bearing cap (A) and thrust bearing cap (B) with specified torque.

Tightening torque :

1st step : 5.8 N.m (0.6 kgf.m, 4.31 lb-ft)

2st step : 9.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)

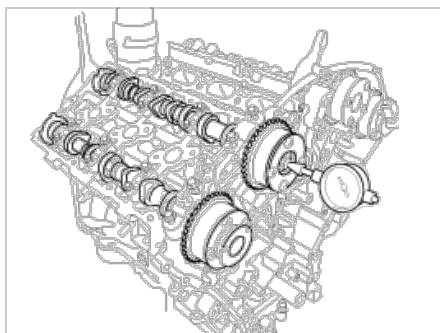
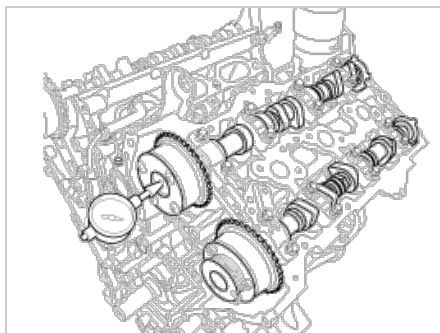


(3) Using a dial indicator, measure the end play while moving the camshaft back and forth.

Camshaft end play

[Standard value] :

0.02 ~ 0.18 mm (0.0008 ~ 0.0071 in.)



- If the end play is greater than specification, replace the camshaft.
- If the end play is still greater than specification after camshaft replacement, replace the bearing caps and cylinder head as a set.

(4) Remove the camshafts.

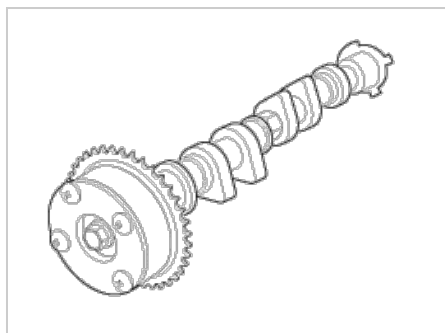
Installation

CVVT(Continuously Variable Valve Timing) Assembly

1. Install the continuous variable valve timing (CVVT) assembly.

Tightening torque :

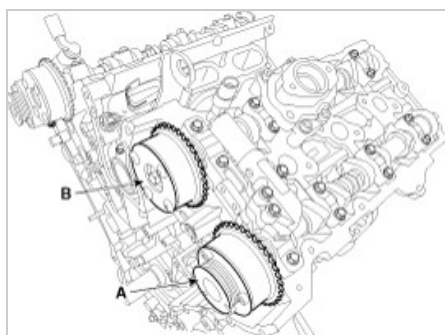
64.7 ~ 76.5 N.m (6.6 ~ 7.8 kgf.m, 47.7 ~ 56.4 lb-ft)



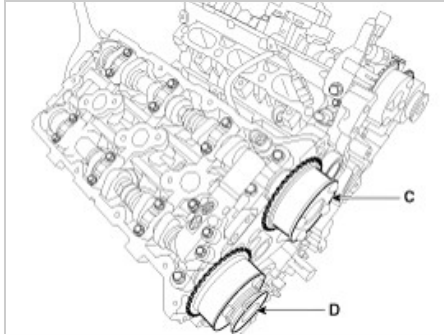
⚠ CAUTION

- Install camshaft-inlet to dowel pin of CVVT assembly.
At this time, attend not to be installed to oil hole of camshaft-inlet.
- Hold the hexagonal head wrench portion of the camshaft with a vise, and install the bolt and CVVT assembly.
- Do not rotate CVVT assembly when camshaft is installed to dowel pin of CVVT assembly.

- A: LH exhaust CVVT
- B: LH intake CVVT

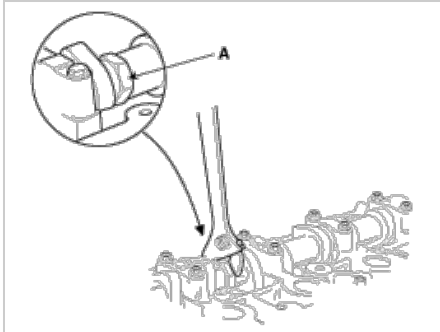


- C: RH intake CVVT
- D: RH exhaust CVVT



NOTICE

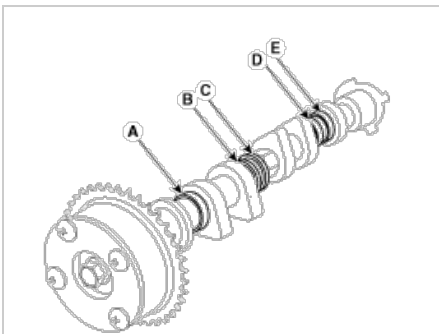
When installing the CVVT assembly bolt, prevent the camshaft from rotating by using a wrench at position (A).



2. Install the timing chain.
(Refer to Timing System - "Timing Chain")

Camshaft Identification

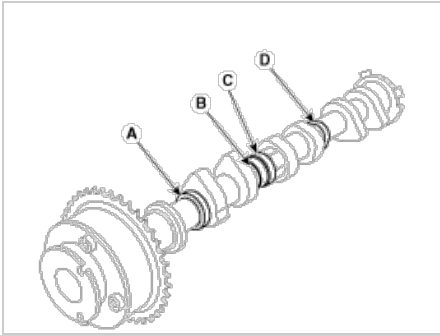
[Intake Camshaft]



As for camshaft identification, refer to the table below.

Displacement	Outer diameter	
	LH	RH
Intake camshaft	-	A : 30 mm (1.1811 in.)
	A : 30 mm (1.1811 in.)	B : 27 mm (1.0630 in.)
	B : 27 mm (1.0630 in.)	C : 30 mm (1.1811 in.)
	C : 30 mm (1.1811 in.)	D : 30 mm (1.1811 in.)
	D : 27 mm (1.0630 in.)	E : 30 mm (1.1811 in.)

[Exhaust Camshaft]



As for camshaft identification, refer to the table below.

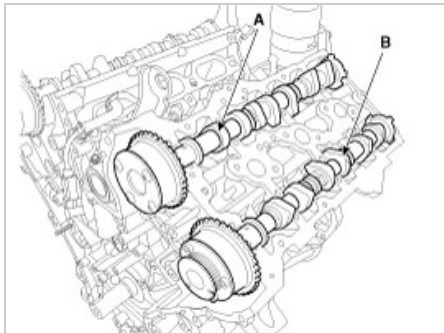
Displacement	Outer diameter	
	LH	RH
Exhaust camshaft	A : 27m m (1.0630 in.)	A : 27m m (1.0630 in.)
	B : 27m m (1.0630 in.)	B : 27m m (1.0630 in.)
	C : 30 mm (1.1811 in.)	C : 30 mm (1.1811 in.)
	D : 27m m (1.0630 in.)	D : 30 mm (1.1811 in.)

LH Intake and Exhaust camshaft

⚠ CAUTION

- Be careful the right, left bank, intake, exhaust side before assembling.
- Assemble the key groove of camshaft rear side to the same level of head top surface.
- Apply a light coat of engine oil on camshaft journals.

1. Install the LH intake camshaft (A) and exhaust camshaft (B).



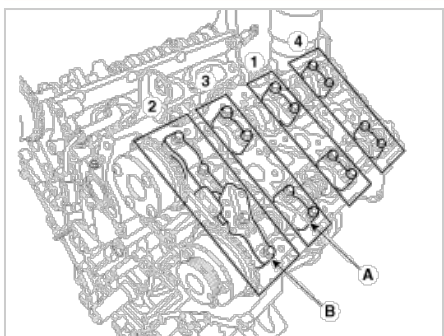
2. Install the LH camshaft bearing cap (A) and thrust bearing cap (B).

Tightening torque

1st step : 5.8 N.m (0.6 kgf.m, 4.3 lb-ft)

2nd step :

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

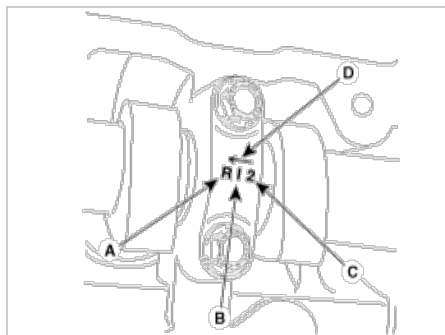


⚠ CAUTION

Be sure to install the thrust bearing cap bolts and the bearing cap bolts in the correct place.

NOTICE

Be careful the right, left bank, intake, exhaust side before assembling.



A : L(LH),R(RH)
 B : I(Intake), E(Exhaust)
 C : Journal number
 D : Front mark

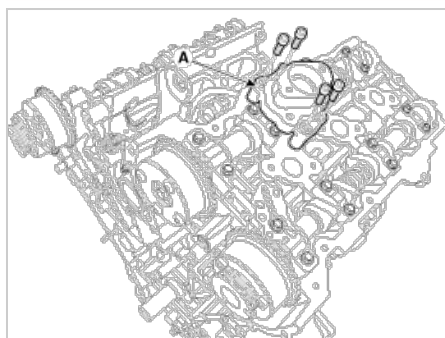
CAUTION

Rotate the crankshaft not to contact the valves to the pistons by making the pistons below 10mm(0.3937in.) from the top of cylinder block.

3. Install the fuel pump bracket (A).

Tightening torque :

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



4. Install the RH exhaust camshaft oil control valve (OCV).
 (Refer to Engine Control/Fuel System - "CVVT Oil Control Valve (OCV)")

Tightening torque :

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

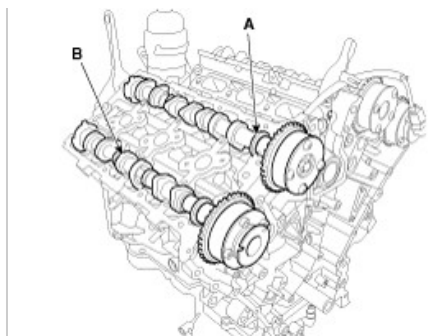
5. Install the timing chain.
 (Refer to Timing System - "Timing Chain")

RH Intake and Exhaust camshaft

CAUTION

- Be careful the right, left bank, intake, exhaust side before assembling.
- Assemble the key groove of camshaft rear side to the same level of head top surface.
- Apply a light coat of engine oil on camshaft journals.

1. Install the RH intake camshaft (A) and exhaust camshaft (B).



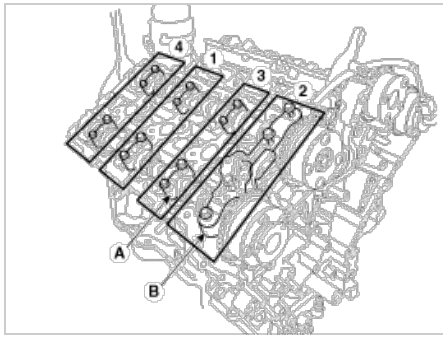
2. Install the RH camshaft bearing cap (A) and thrust bearing cap (B).

Tightening torque

1st step : 5.8 N.m (0.6 kgf.m, 4.3 lb-ft)

2nd step :

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

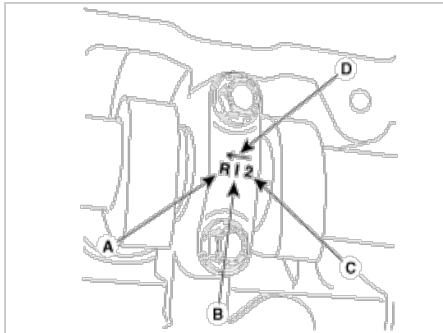


CAUTION

Be sure to install the thrust bearing cap bolts and the bearing cap bolts in the correct place.

NOTICE

Be careful the right, left bank, intake, exhaust side before assembling.



A : L(LH),R(RH)
B : I(Intake), E(Exhaust)
C : Journal number
D : Front mark

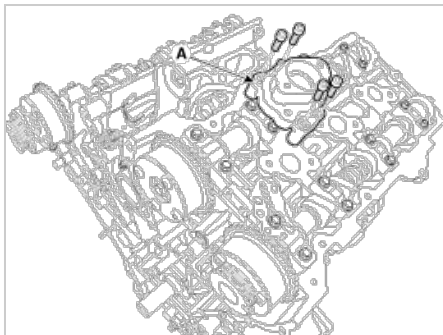
CAUTION

Rotate the crankshaft not to contact the valves to the pistons by making the pistons below 10mm(0.3937in.) from the top of cylinder block.

3. Install the fuel pump bracket (A).

Tightening torque :

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



4. Install the RH exhaust camshaft oil control valve (OCV).
(Refer to Engine Control/Fuel System - "CVVT Oil Control Valve (OCV)")

Tightening torque :

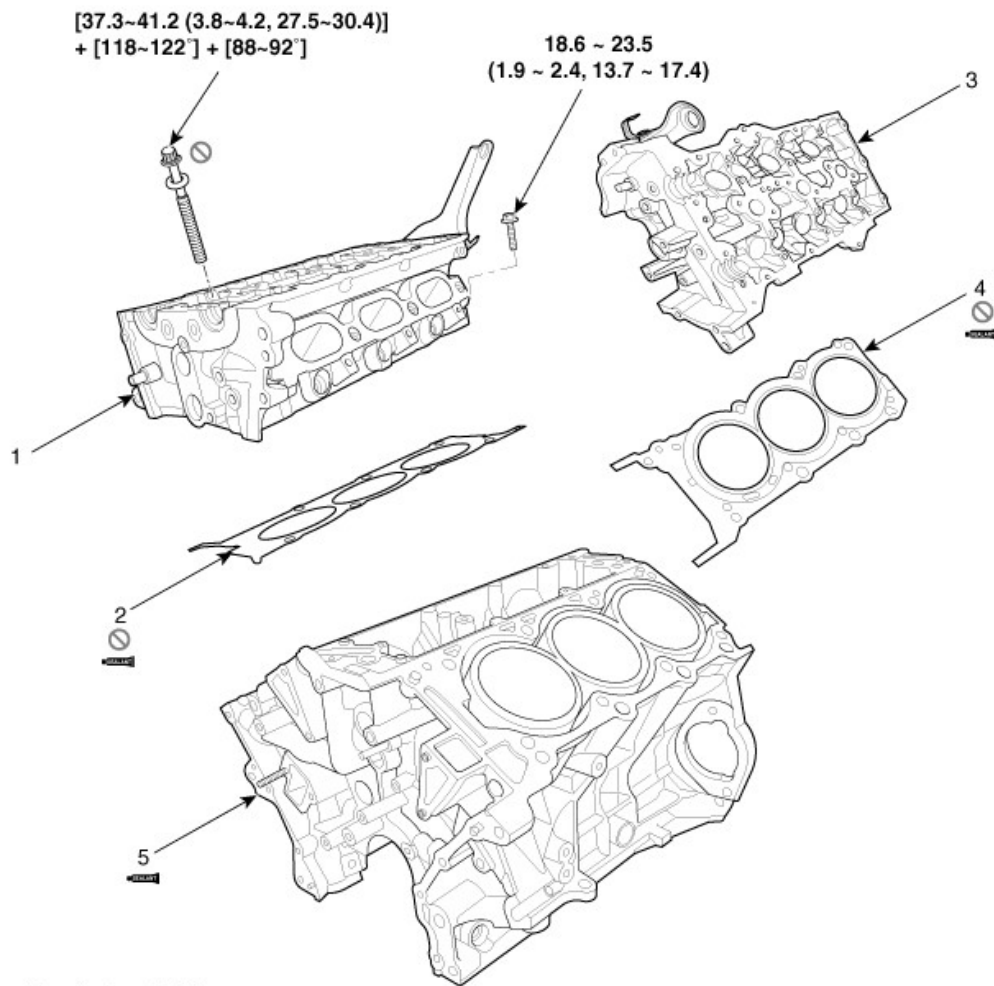
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)

5. Install the timing chain.
(Refer to Timing System - "Timing Chain")

Engine Mechanical System



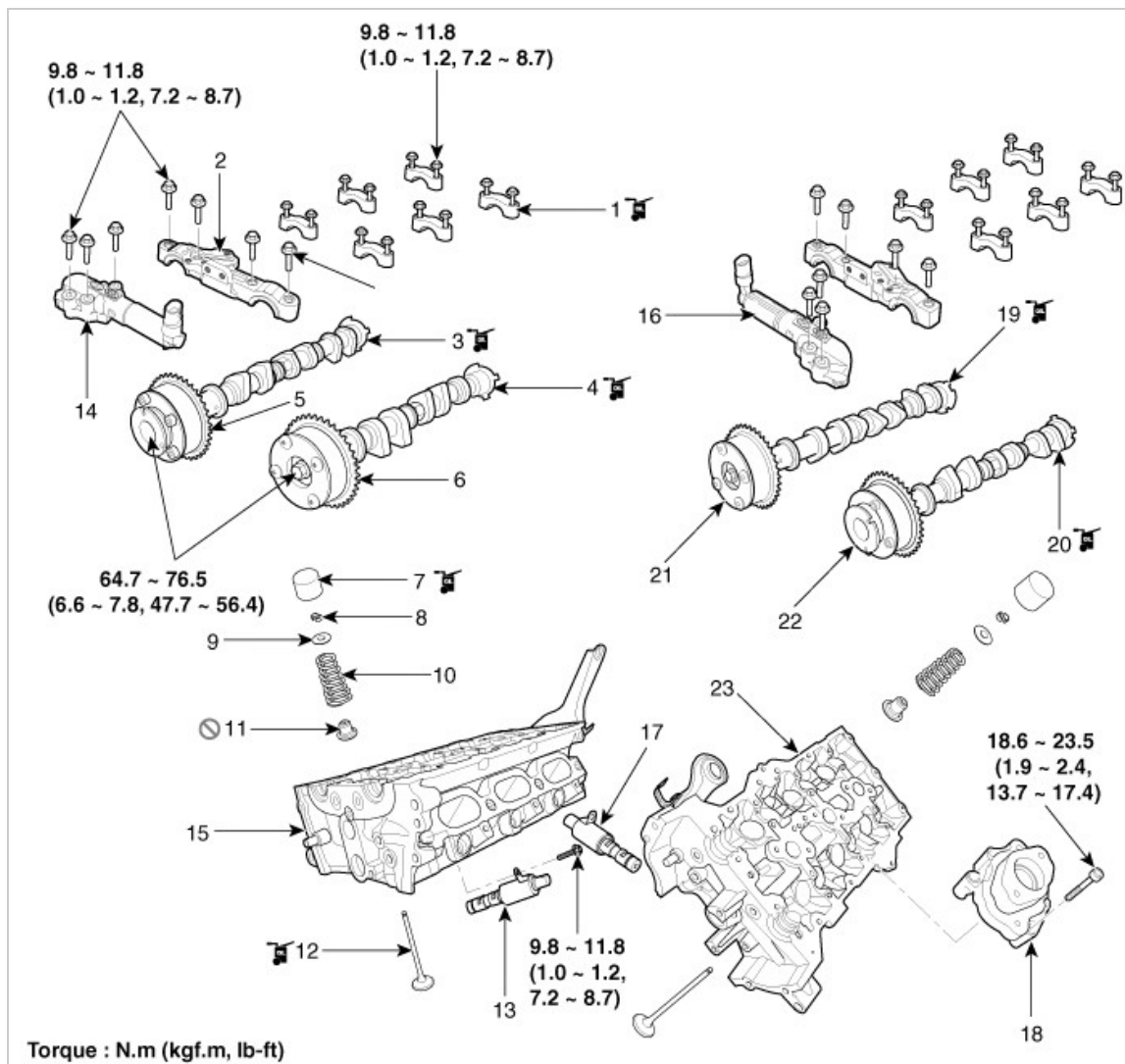
Components



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

- 1. RH Cylinder head
- 2. RH Cylinder head gasket
- 3. LH Cylinder head

- 4. LH Cylinder head gasket
- 5. Cylinder block



- | | | |
|-----------------------------------|-----------------------------|-----------------------------|
| 1. Camshaft bearing cap | 9. Retainer | 17. LH Intake camshaft OCV |
| 2. Camshaft thrust bearing cap | 10. Valve spring | 18. Fuel pump bracket |
| 3. RH Exhaust camshaft | 11. Valve stem seal | 19. LH Intake camshaft |
| 4. RH Intake camshaft | 12. Valve | 20. LH Exhaust camshaft |
| 5. RH Exhaust CVVT assembly | 13. RH Intake camshaft OCV | 21. LH Intake CVVT assembly |
| 6. RH Intake CVVT assembly | 14. RH Exhaust camshaft OCV | 22. LH Intake CVVT assembly |
| 7. Mechanical lash adjuster (MLA) | 15. RH Cylinder head | 23. LH Cylinder head |
| 8. Retainer lock | 16. LH Exhaust camshaft OCV | |

Engine Mechanical System



Removal

CAUTION

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

NOTICE

- Mark all wiring and hoses to avoid misconnection.
- Turn the crankshaft pulley so that the No. 1 piston is at top dead center.

[RH]

1. Remove the RH camshafts.
(Refer to Cylinder Head Assembly - "CVVT & Camshaft")
2. Remove the water temperature control assembly.

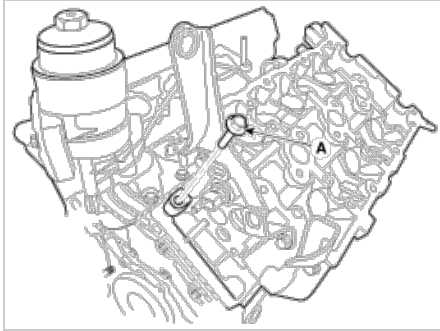
(Refer to Cooling System - "Water Temperature Control Assembly")

3. Remove the RH exhaust manifold.

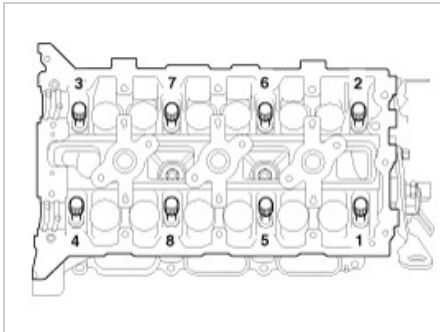
(Refer to Intake And Exhaust System - "Exhaust Manifold")

4. Remove the RH cylinder head.

- (1) Remove the RH cylinder head rear bolt (A).



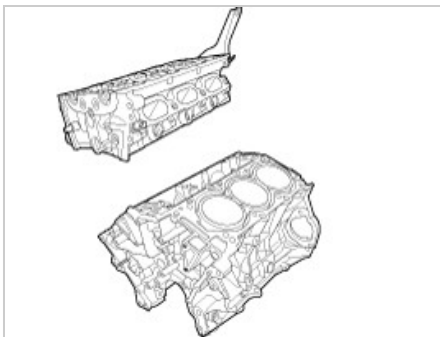
- (2) Uniformly loosen and remove the cylinder head bolts, in several passes, in the sequence shown.



CAUTION

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

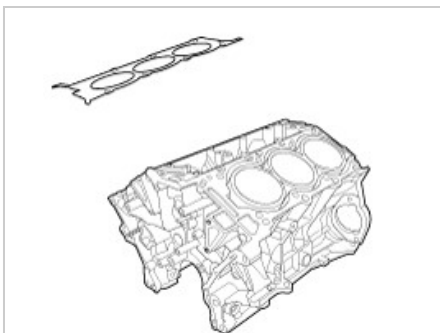
- (3) Lift the RH cylinder head from the dowels on the cylinder block and place the cylinder head on wooden blocks on a bench.



CAUTION

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

- (4) Remove the RH cylinder head gasket.

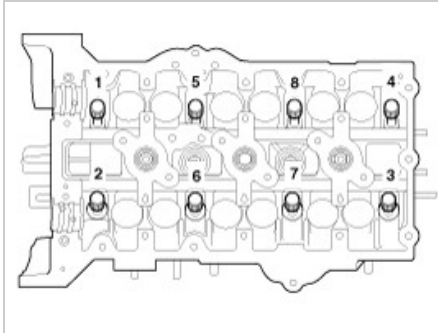


[LH]

1. Remove the LH camshafts.

(Refer to Cylinder Head Assembly - "CVVT & Camshaft")

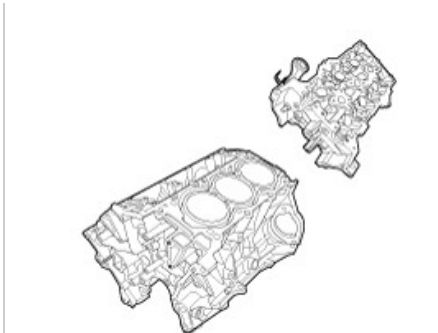
2. Remove the water temperature control assembly.
(Refer to Cooling System - "Water Temperature Control Assembly")
3. Remove the LH exhaust manifold.
(Refer to Intake And Exhaust System - "Exhaust Manifold")
4. Remove the LH cylinder head.
 - (1) Uniformly loosen and remove the cylinder head bolts, in several passes, in the sequence shown.



CAUTION

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

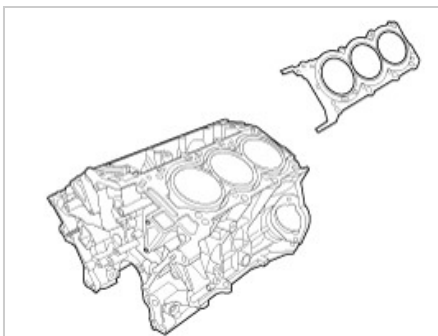
- (2) Lift the LH cylinder head from the dowels on the cylinder block and place the cylinder head on wooden blocks on a bench.



CAUTION

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

- (3) Remove the LH cylinder head gasket.

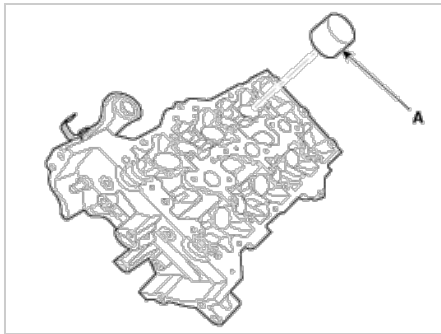


Disassembly

NOTICE

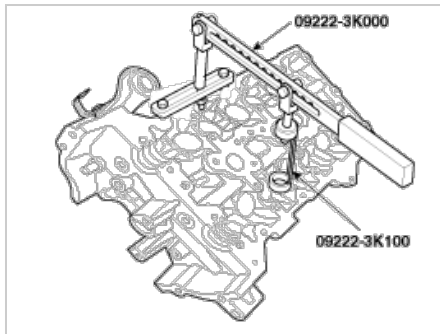
Identify MLA, valves and valve springs as they are removed so that each item can be reinstalled in its original position.

1. Remove the MLAs (A).



2. Remove the valves.

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

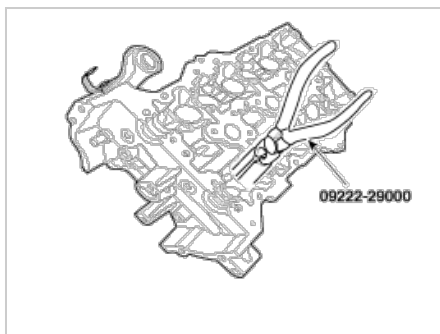


- (2) Remove the spring retainer.

- (3) Remove the valve spring.

- (4) Remove the valve.

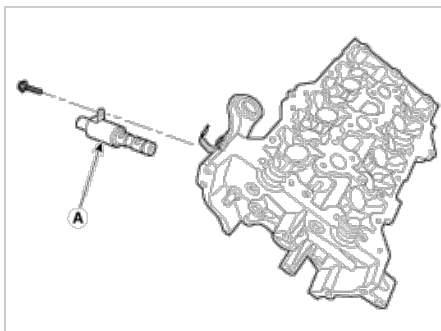
- (5) Using the SST(09222-29000), remove the valve stem seal.

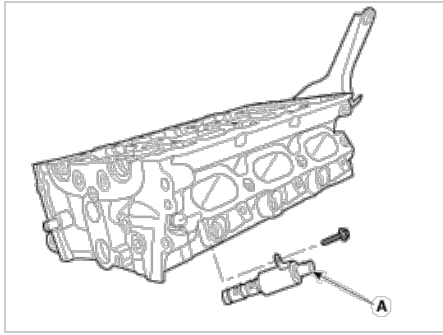


NOTICE

Do not reuse old valve stem seals.

3. Remove the LH/RH intake camshaft OCV (A).





Inspection

Cylinder Head

1. Inspect for flatness.

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

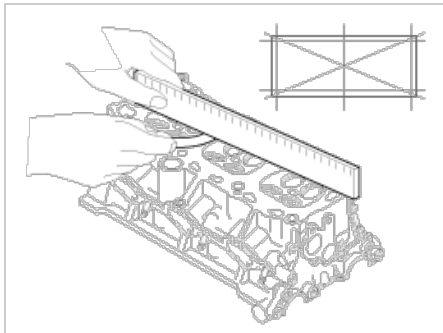
Flatness of cylinder head gasket surface

Standard : Less than 0.05mm(0.002in.)

[Less than 0.02mm(0.0008in.)/150x150]

Flatness of manifold gasket surface

Standard : Less than 0.03mm(0.001in)/110x110



2. Inspect for cracks.

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

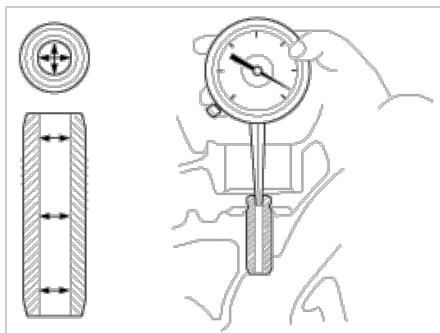
Valve And Valve Spring

1. Inspect valve stems and valve guides.

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

Valve guide I.D.

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

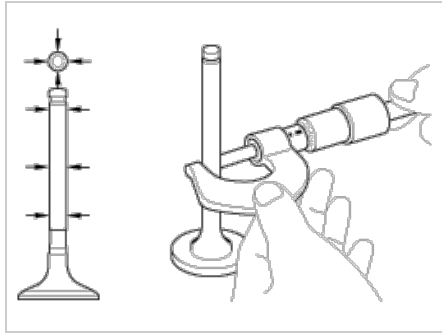


- (2) Using a micrometer, measure the diameter of the valve stem.

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.)

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.

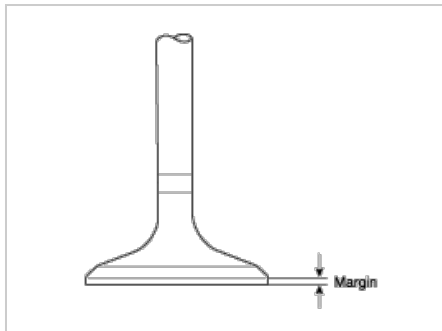
If the margin thickness is less than minimum, replace the valve.

Margin

[Standard]

Intake : 1.56 ~ 1.86mm (0.06142 ~ 0.07323in.)

Exhaust : 1.73 ~ 2.03mm (0.06811 ~ 0.07992in.)



- (4) Check the valve length.

Length

Intake : 105.27mm (4.1445in)

Exhaust : 105.50mm (4.1535in)

- (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.

If the valve seat is worn, replace cylinder head.

Before reconditioning the seat, check the valve guide for wear. If the valve guide is worn, replace cylinder head. 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.

4. Inspect valve springs.

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

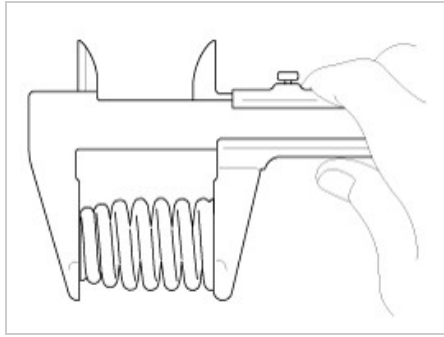
- (2) Using vernier calipers, measure the free length of the valve spring.

Valve spring

[Standard]

Free height : 45.5mm (1.7913in.)

Out-of-square : 1.5°



MLA

1. Inspect MLAs.

Using a micrometer, measure the MLA outside diameter.

MLA O.D.

Intake/Exhaust :

34.964 ~ 34.980mm(1.3765 ~ 1.3771in.)

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

Tappet bore I.D.

Intake/Exhaust :

35.000 ~ 35.025mm(1.3779 ~ 1.3789in.)

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.

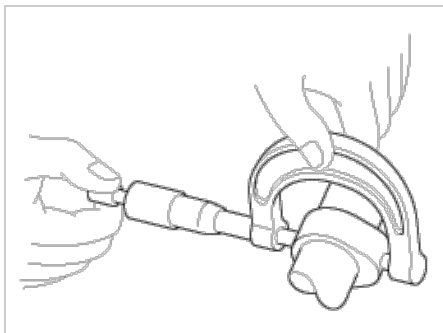
Using a micrometer, measure the cam lobe height.

Cam height

[Standard value]

Intake : 46.6mm (1.835in.)

Exhaust : 45.8mm (1.8031in.)



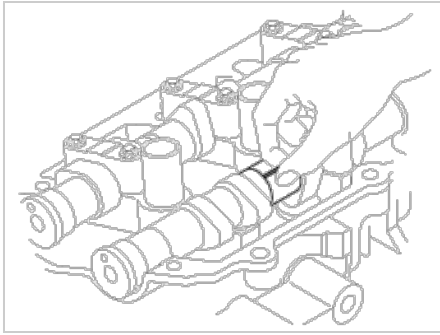
If the cam lobe height is less than standard, replace the camshaft.

2. Inspect the camshaft journal clearance.

(1) Clean the bearing caps and camshaft journals.

(2) Place the camshafts on the cylinder head.

(3) Lay a strip of plastigage across each of the camshaft journals.

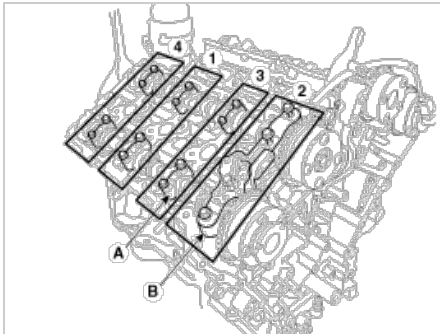
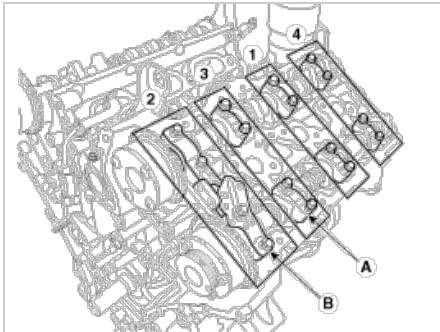


- (4) Install the bearing cap (A) and thrust bearing cap (B) with specified torque. (Refer to Cylinder head in this group)

Tightening torque :

1st step : 5.8N.m (0.6kgf.m, 4.3lb-ft)

2nd step : 9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



CAUTION

Do not turn the camshaft.

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

Bearing oil clearance

[Standard value]

Intake

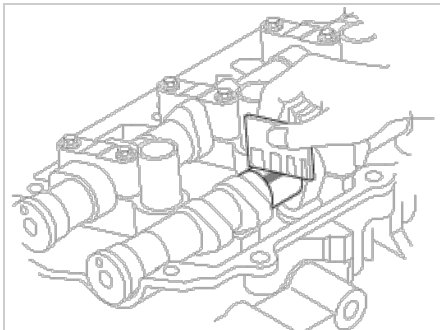
No.1 journal : 0.020 ~ 0.057mm (0.0008 ~ 0.0022in.)

No.2,3,4 journal : 0.030 ~ 0.067mm (0.0012 ~ 0.0026in.)

Exhaust

No.1 journal : 0.027 ~ 0.057mm (0.0010 ~ 0.0022in.)

No.2,3,4 journal : 0.030 ~ 0.067mm (0.0012 ~ 0.0026in.)



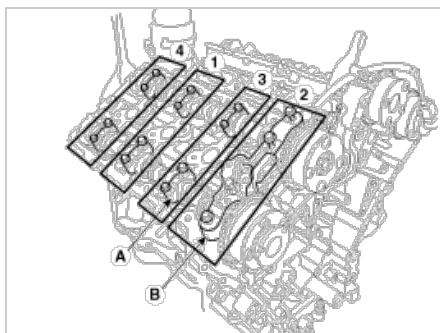
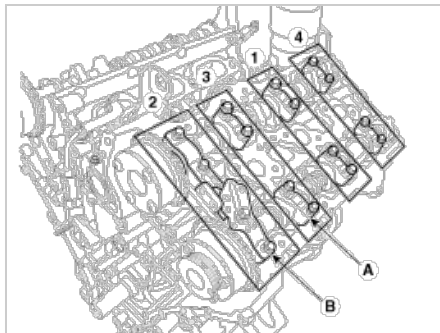
If the oil clearance is greater than maximum, replace the camshaft. If necessary, replace cylinder head.

- (7) Completely remove the plastigage.
 - (8) Remove the camshafts.
3. Inspect the camshaft end play.
- (1) Install the camshafts.
 - (2) Install the bearing cap (A) and thrust bearing cap (B) with specified torque.

Tightening torque :

1st step : 5.8N.m (0.6kgf.m, 4.31lb-ft)

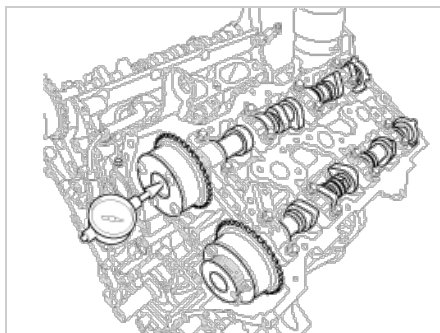
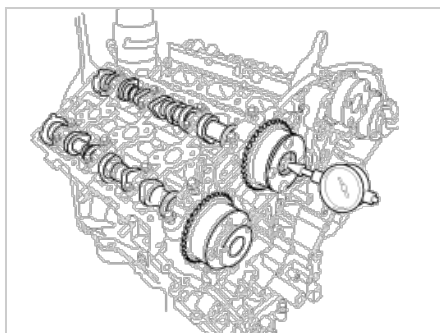
2st step : 9.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



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

Camshaft end play

[Standard value] : 0.02 ~ 0.18mm(0.0008 ~ 0.0071in.)



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

- (4) Remove the camshafts.

Reassembly

NOTICE

Thoroughly clean all parts to be assembled.

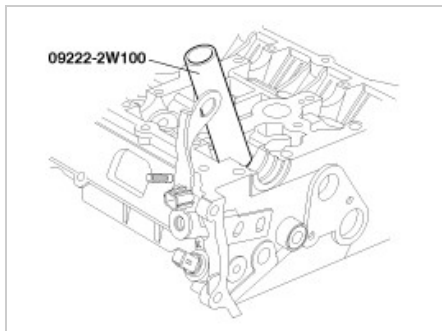
Before installing the parts, apply fresh engine oil to all sliding and rotating surfaces.
Replace oil seals with new ones.

1. Install the valves.

- (1) Using the SST(09222-2W100), push in a new oil seal.

NOTICE

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

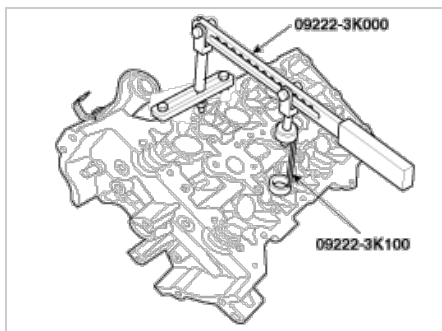


- (2) Install the valve, valve spring and spring retainer.

NOTICE

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

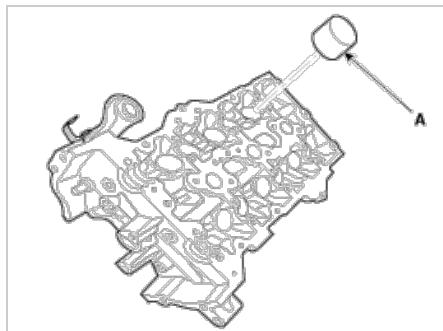
- (3) Using the SST(09222 - 3K000, 09222-3K100), compress the spring and install the retainer locks. After installing the valves, ensure that the retainer locks are correctly in place before releasing the valve spring compressor.



- (4) Lightly tap the end of each valve stem two or three times with a soft hammer or the wooden handle of a hammer to ensure proper seating of the valve and retainer lock.

2. Install the MLAs.

Check that the MLA rotates smoothly by hand.



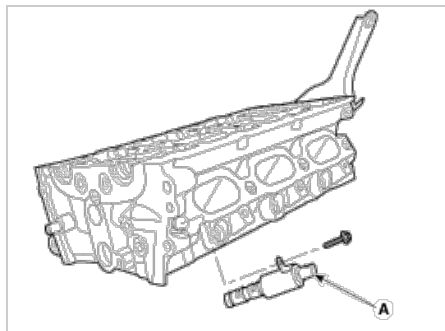
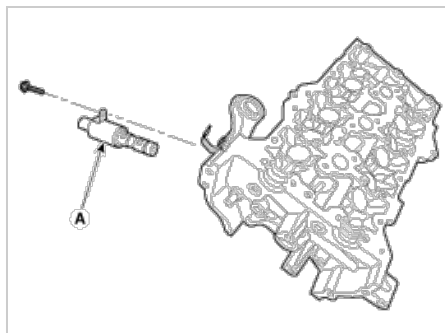
NOTICE

MLA can be reinstalled in its original position.
However, the valve lash clearances must be rechecked and adjusted accordingly before the cylinder head is installed onto the cylinder block.
Refer to General information in EM section for Valve Clearance checking and adjustment procedure.

3. Install the LH/RH intake camshaft CVVT OCV (A).

Tightening torque

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



NOTICE

- Install OCV with gray colored connector into RH bank.
- Install OCV with black colored connector into LH bank.

CAUTION

- Do not reuse the OCV when dropped.
- Keep the OCV clean.
- Do not hold the OCV sleeve during servicing.
- When the OCV is installed on the engine, do not move the engine while holding the OCV yoke.

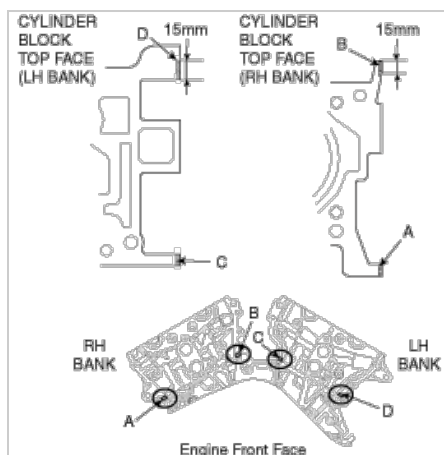
Installation

NOTICE

- 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.

[RH]

1. Install the cylinder RH head.
 - a. The sealant locations on cylinder head and cylinder block must be free of engine oil and ETC.
 - b. Apply TB 1217H (Hyundai Gray RTV) sealant on cylinder block top face before assembling cylinder head gaskets.
The part must be assembled within 5 minutes after sealant was applied.



NOTICE

Refer to below illustration to apply the sealant.

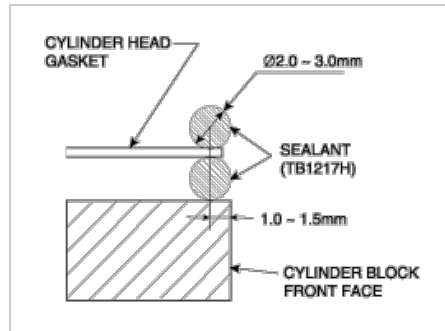
Bead width :

2.0~3.0 mm (0.078 ~ 0.118 in.)

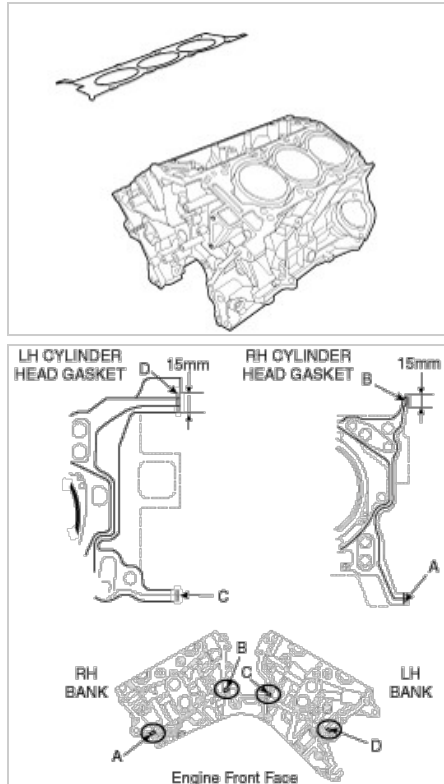
Sealant locations :

1.0~1.5mm (0.039 ~ 0.059 in.) from block surface

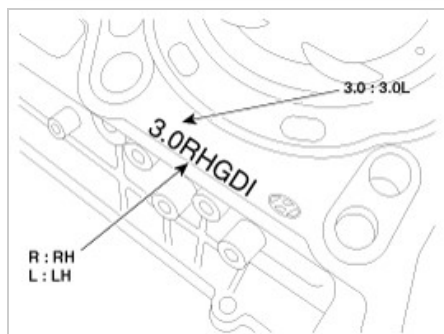
Recommended sealant : TB 1217H (Hyundai Gray RTV) Liquid sealant



- c. Apply TB 1217H (Hyundai Gray RTV) sealant on cylinder head gaskets after assembling cylinder head gaskets on cylinder block. The part must be assembled within 5 minutes after sealant was applied.

**NOTICE**

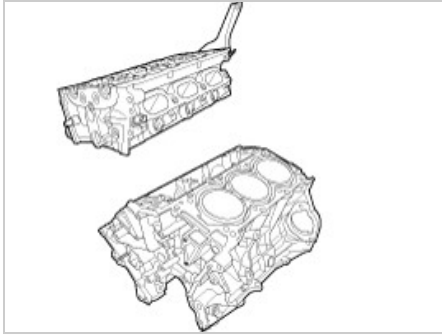
Be careful of the installation direction.



- d. Install the RH cylinder head.

NOTICE

Remove the extruded sealant after assembling cylinder heads.



2. Install the RH cylinder head bolts.

- (1) Do not apply engine oil on the threads and under the heads of the cylinder head bolts.
- (2) Using SST(09221-4A000), install and tighten the cylinder head bolts and plate washers, in several passes, in the sequence shown.

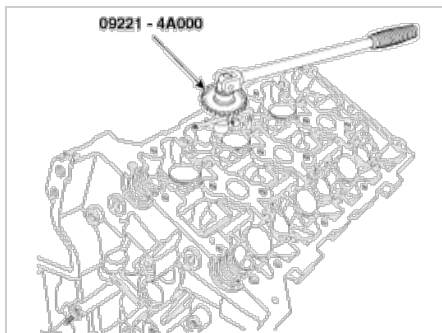
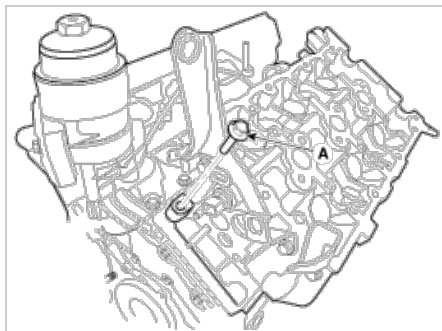
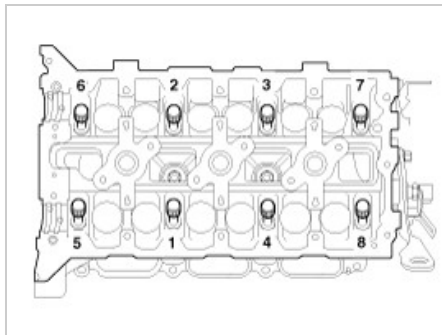
CAUTION

Always use a new cylinder head bolts.

Tightening torque

Head bolt: 37.3~41.2N.m (3.8~4.2kgf.m, 27.5~30.4lb-ft) + (118~122°) + (88~92°)

Bolt (A): 18.6 ~ 23.5Nm (1.9 ~ 2.4kgf.m, 13.7 ~ 17.4lb-ft)



3. Install the other parts reverse order of removal.

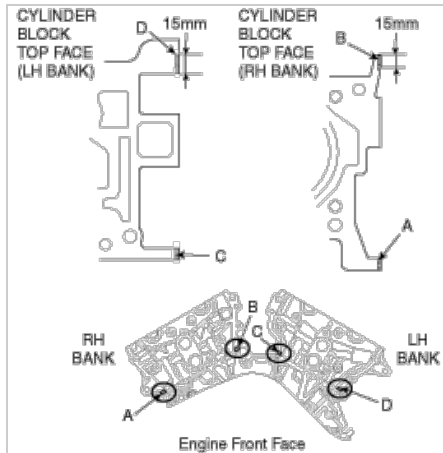
NOTICE

- Refill engine oil.
- Clean the battery posts and cable terminals with sandpaper. Assemble and then apply grease to prevent corrosion.
- Inspect for fuel leakage.

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

[LH]

1. Install the cylinder LH head.
 - a. The sealant locations on cylinder head and cylinder block must be free of engine oil and ETC.
 - b. Apply TB 1217H (Hyundai Gray RTV) sealant on cylinder block top face before assembling cylinder head gaskets. The part must be assembled within 5 minutes after sealant was applied.



NOTICE

Refer to below illustration to apply the sealant.

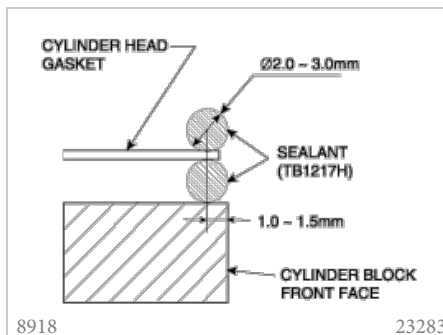
Bead width :

2.0~3.0 mm (0.078 ~ 0.118 in.)

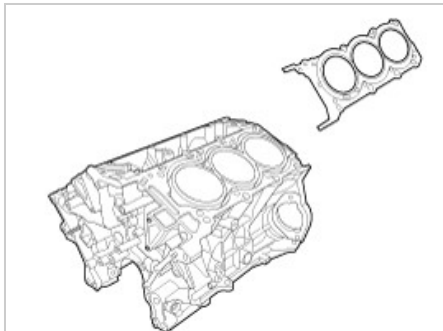
Sealant locations :

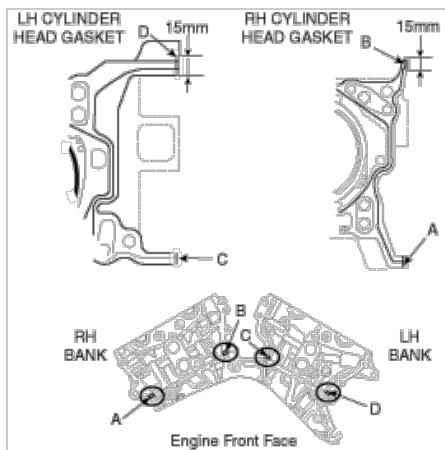
1.0~1.5mm (0.039 ~ 0.059 in.) from block surface

Recommended sealant : TB 1217H (Hyundai Gray RTV) Liquid sealant



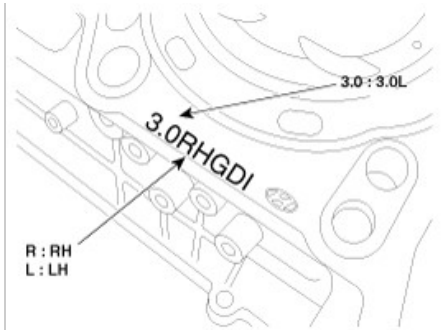
- c. Apply TB 1217H (Hyundai Gray RTV) sealant on cylinder head gaskets after assembling cylinder head gaskets on cylinder block. The part must be assembled within 5 minutes after sealant was applied.





NOTICE

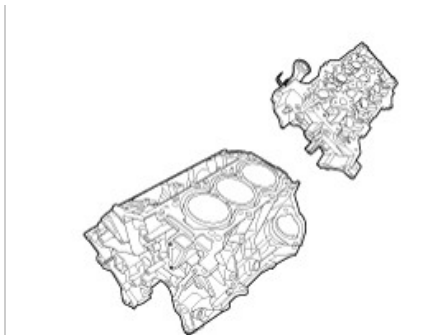
Be careful of the installation direction.



d. Install the LH cylinder head.

NOTICE

Remove the extruded sealant after assembling cylinder heads.



2. Install the LH cylinder head bolts.

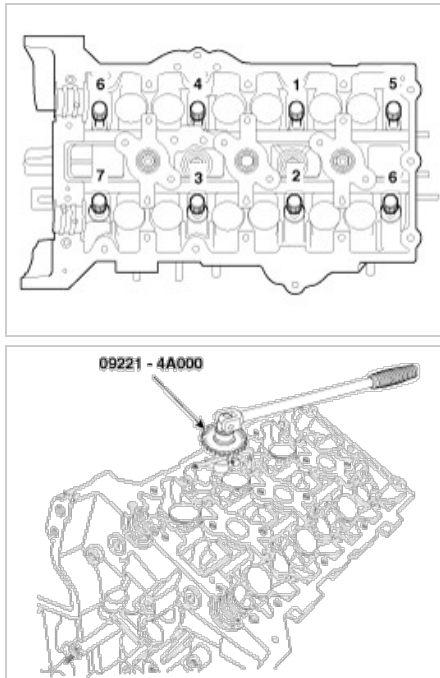
- (1) Do not apply engine oil on the threads and under the heads of the cylinder head bolts.
- (2) Using SST(09221-4A000), install and tighten the cylinder head bolts and plate washers, in several passes, in the sequence shown.

CAUTION

Always use a new cylinder head bolts.

Tightening torque

Head bolt: 37.3~41.2N.m (3.8~4.2kgf.m, 27.5~30.4lb-ft) + (118~122°) + (88~92°)

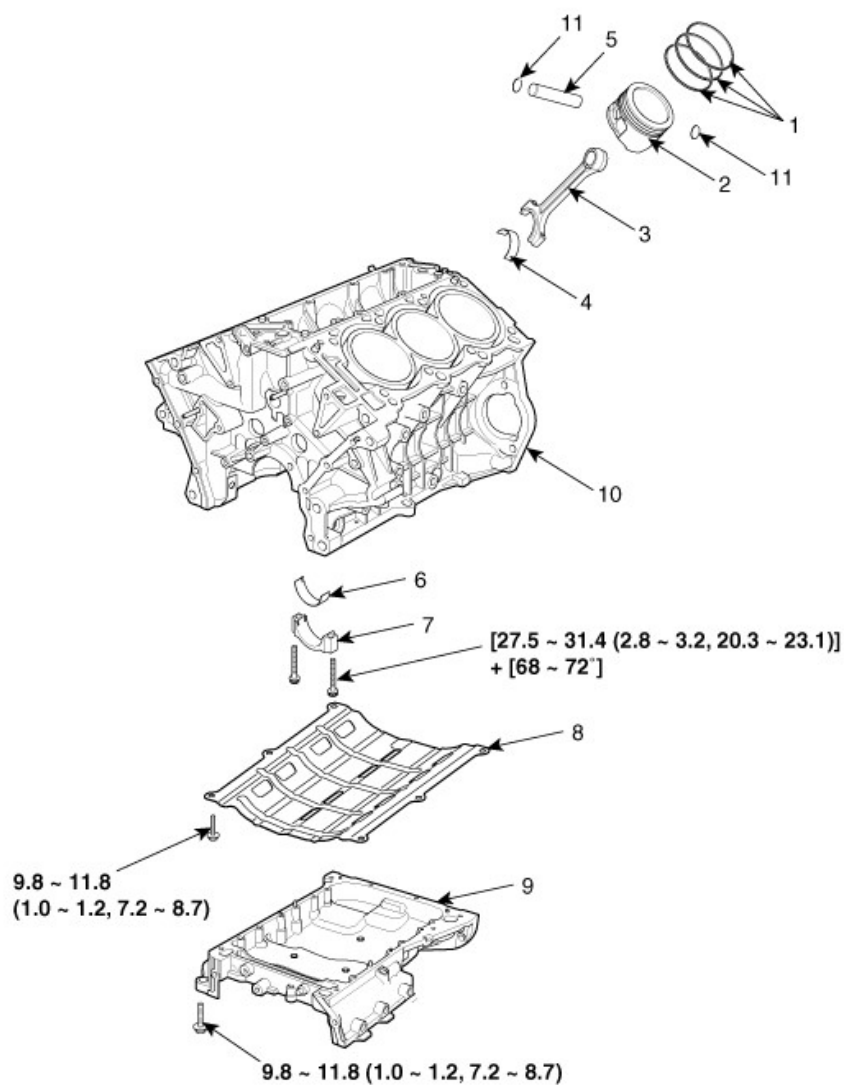


3. Install the other parts reverse order of removal.

NOTICE

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



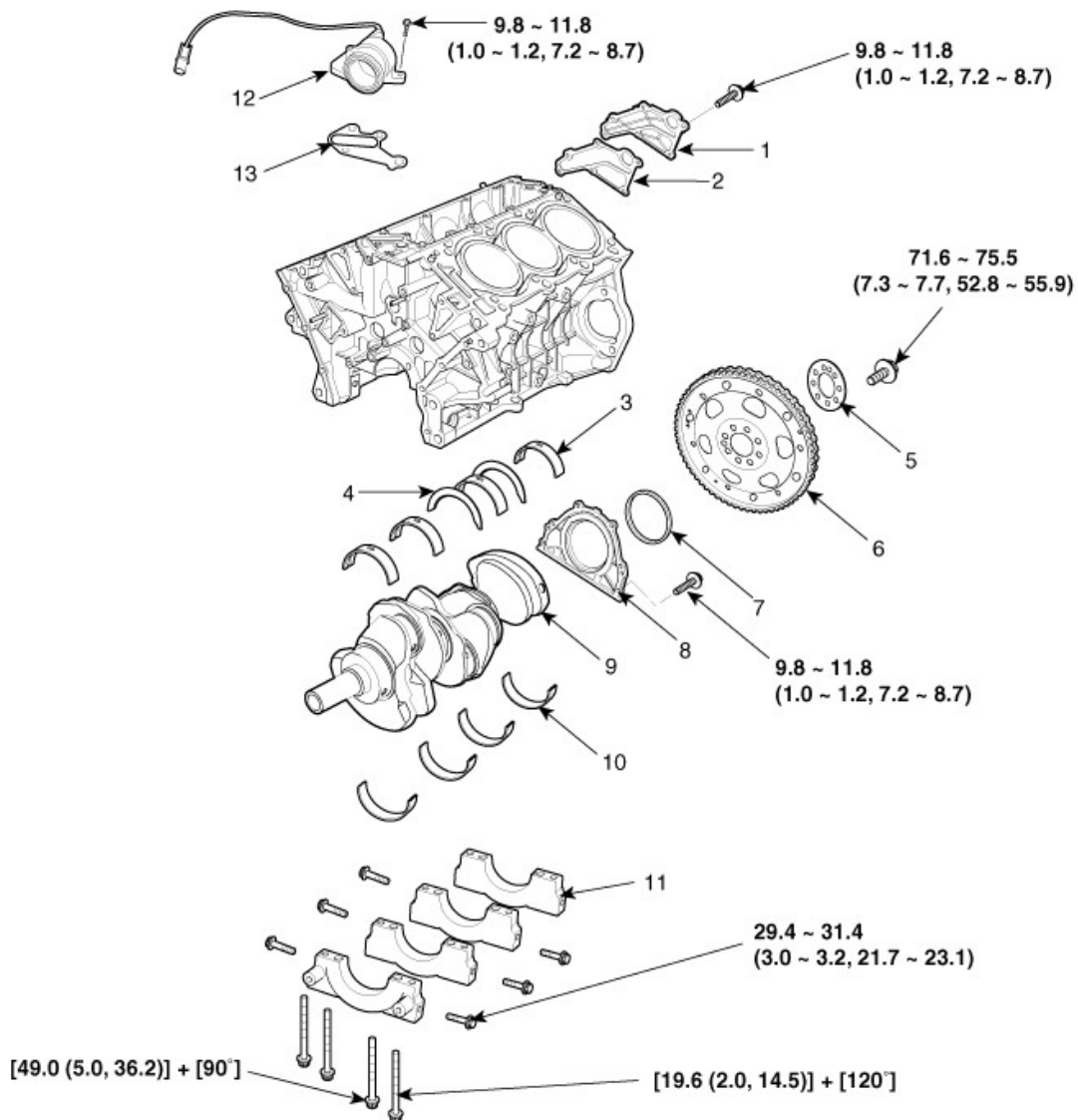


Torque : N.m (kgf.m, lb-ft)

1. Piston ring
2. Piston
3. Connecting rod
4. Connecting rod upper bearing

5. Piston pin
6. Connecting rod lower bearing
7. Connecting rod bearing cap
8. Baffle plate

9. Upper oil pan
10. Cylinder block
11. Snap ring



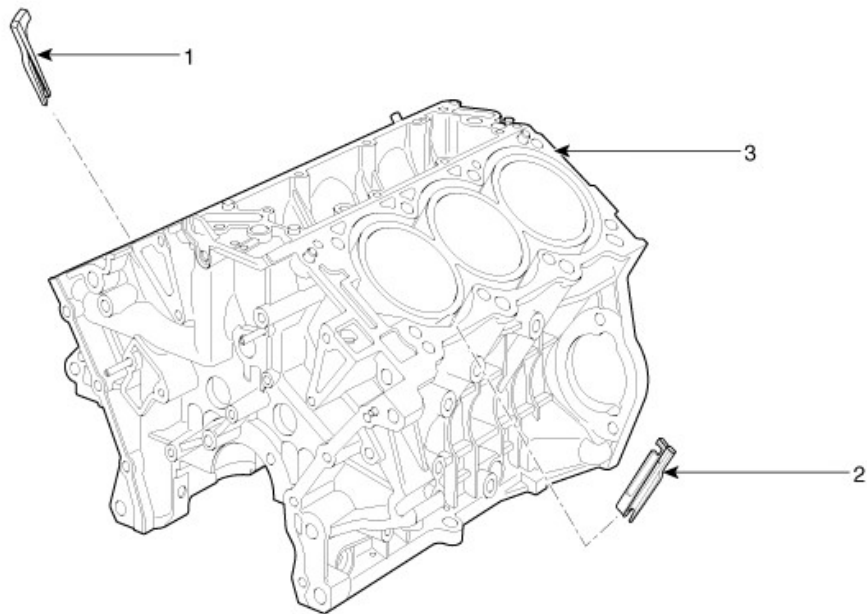
Torque : N.m (kgf.m, lb-ft)

- | | | |
|------------------------------|-----------------------|------------------------------|
| 1. Oil drain cover | 5. Adapter plate | 9. Crankshaft |
| 2. Oil drain cover gasket | 6. Drive plate | 10. Crankshaft lower bearing |
| 3. Crank shaft upper bearing | 7. Rear oil seal | 11. Main bearing cap |
| 4. Thrust bearing | 8. Rear oil seal case | 12. Oil cover |
| | | 13. Oil cover gasket |

Engine Mechanical System



Components



- 1. Water jacket separator 1#
- 2. Water jacket separator 2#

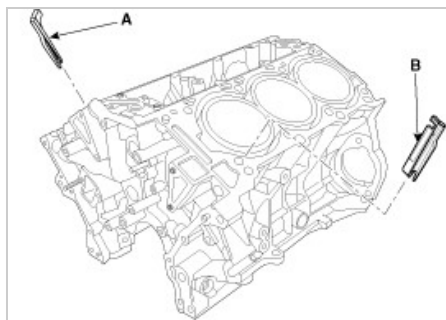
- 3. Cylinder block

Engine Mechanical System



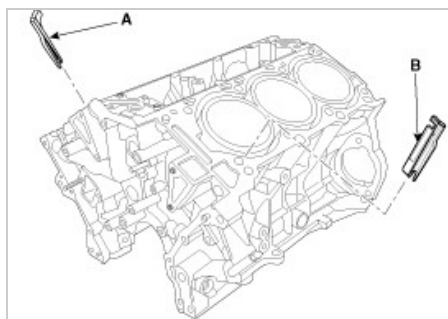
Removal

- 1. Remove the LH/RH cylinder head assembly and gasket.
(Refer to Cylinder Head Assembly - "Cylinder Head")
- 2. Remove the water jacket separator 1# (A) and 2# (B).



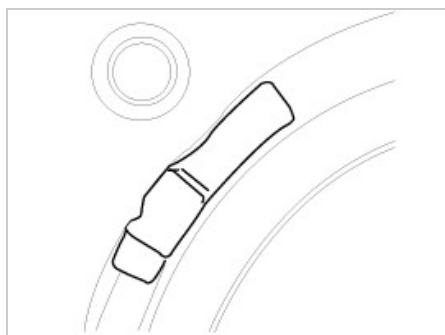
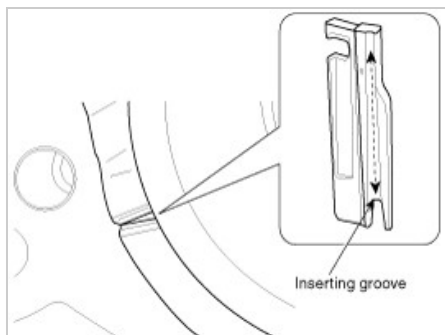
Installation

- 1. Install the water jacket separator 1# (A) and 2# (B).



NOTICE

Insert the separator align with block inner side protrusion, and it must be located under the cylinder head installing surface.

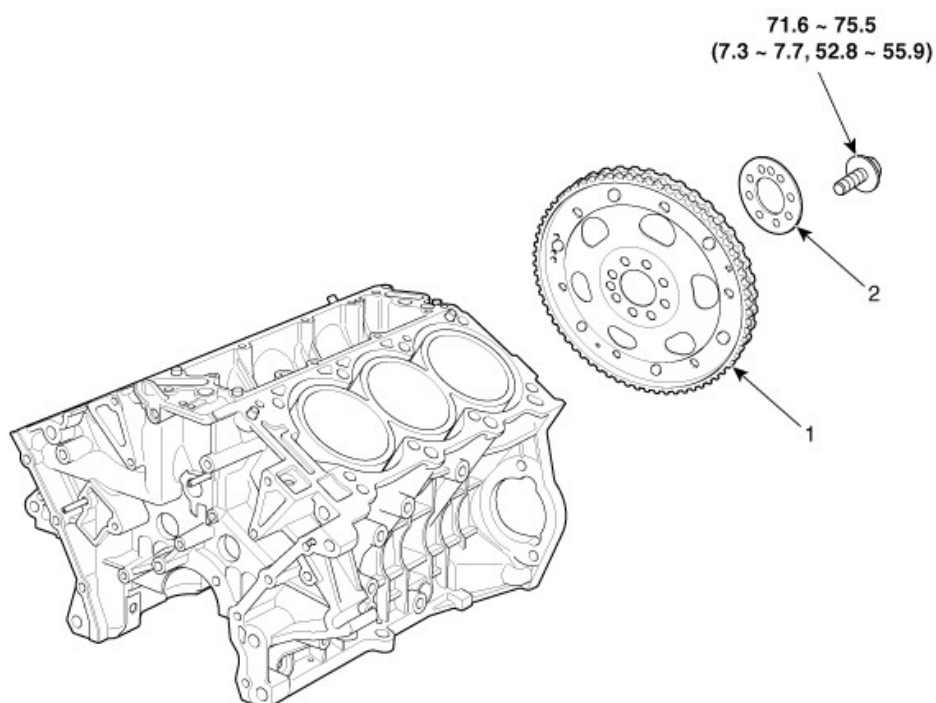


2. Install the LH/RH cylinder head assembly and gasket.
(Refer to Cylinder Head Assembly - "Cylinder Head")

Engine Mechanical System



Components



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

1. Drive plate

2. Adapter plate

Engine Mechanical System

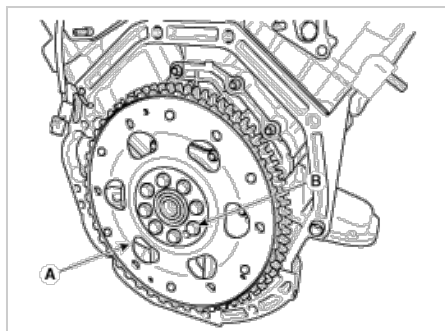


Removal and Installation

1. Disconnect the battery "-" terminal.
2. Remove the automatic transaxle .
(Refer to Automatic Transaxle System - "Automatic Transaxle")
3. Remove the adapter plate (B) and the drive plate (A).

Tightening torque :

71.6 ~ 75.5 N.m (7.3 ~ 7.7 kgf.m, 52.8 ~ 55.7 lb-ft)

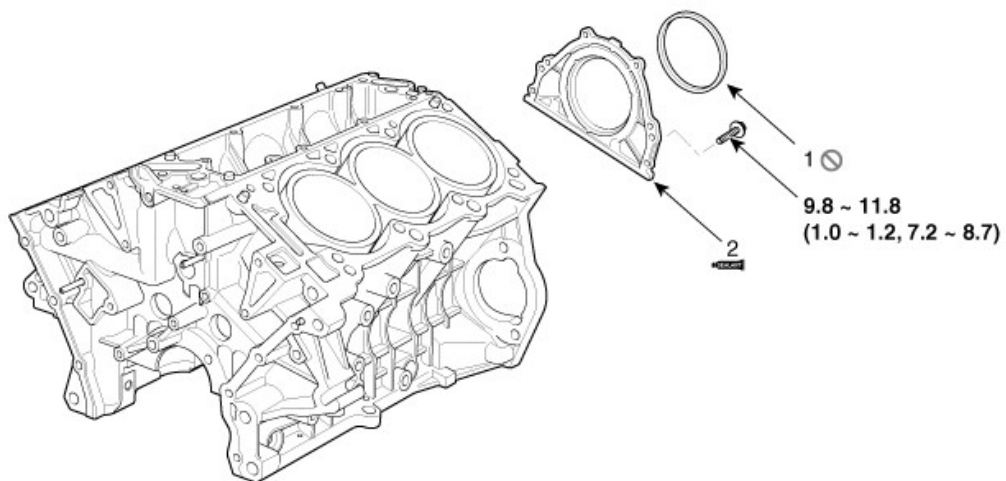


4. Install in the reverse order of removal.

Engine Mechanical System



Components



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

1. Rear oil seal

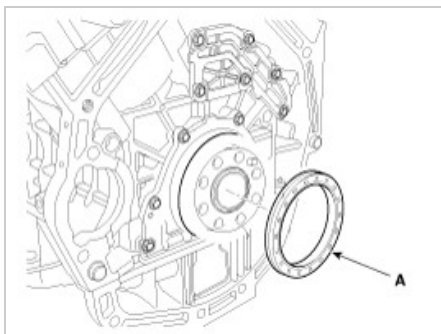
2. Oil seal case

Engine Mechanical System



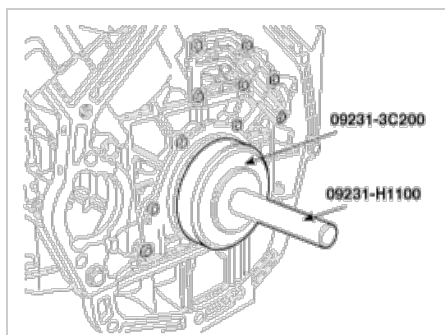
Removal

1. Remove the drive plate.
(Refer to Cylinder Block - "Drive Plate")
2. Remove the rear oil seal (A).



Installation

1. Using SST(09231-3C200, 09231-H1100), install the rear oil seal.



NOTICE

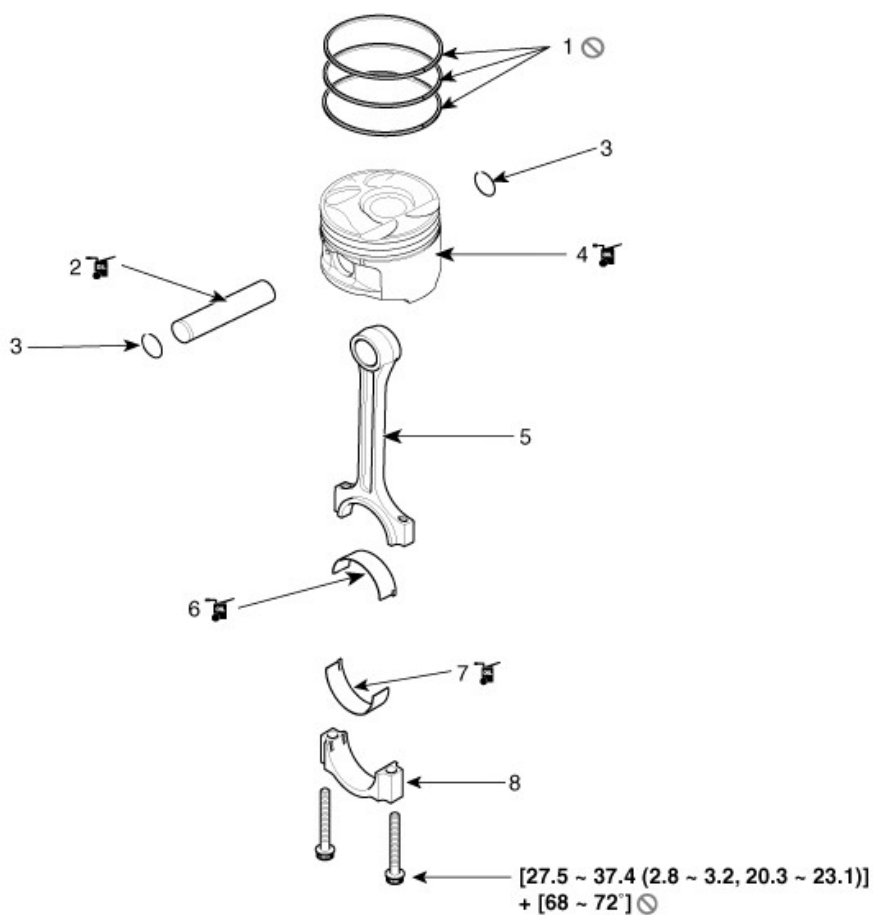
Always use new oil seal.

2. Install the drive plate.
(Refer to Cylinder Block - "Drive Plate")

Engine Mechanical System



Components



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

- | | |
|----------------|---------------------------------|
| 1. Piston ring | 5. Connecting rod |
| 2. Piston pin | 6. Connecting rod upper bearing |
| 3. Snap ring | 7. Connecting rod lower bearing |
| 4. Piston | 8. Connecting rod bearing cap |

Engine Mechanical System



Disassembly

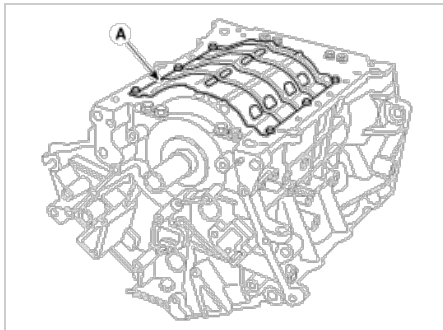
CAUTION

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

NOTICE

- Mark all wiring and hoses to avoid misconnection.
- Inspect the timing chain before removing the cylinder head.
- Turn the crankshaft pulley so that the No.1 piston is at top dead center (TDC).

1. Remove the engine assembly from the vehicle.
(Refer to Engine And Transmission Assembly - "Engine And Transmission Assembly")
2. Remove the drive plate and adapter plate.
(Refer to Cylinder Block - "Drive Plate")
3. Attach the engine to engine stand for disassembly.
4. Remove the exhaust manifold.
(Refer to Intake And Exhaust System - "Exhaust Manifold")
5. Remove the intake manifold.
(Refer to Intake And Exhaust System - "Intake Manifold")
6. Remove the timing chain.
(Refer to Timing System - "Timing Chain")
7. Remove the water temperature control assembly.
(Refer to Cooling System - "Water Temperature Control Aassembly")
8. Remove the cylinder head.
(Refer to Cylinder Head Assembly - "Cylinder Head")
9. Remove the oil pump.
(Refer to Lubrication System - "Oil Pump")
10. Remove the oil filter body.
(Refer to Lubrication System - "Oil filter body")
11. Remove the upper oil pan.
(Refer to Lubrication System - "Oil Pan")
12. Remove the baffle plate (A).



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

NOTICE

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

16. Remove the piston rings.
 - (1) Using a piston ring expander, remove the 2 compression rings.
 - (2) Remove the oil ring and coil spring by hand.

NOTICE

Arrange the piston rings in the correct order only.

17. Disconnect the connecting rod from piston. Remove the snap ring at both ends of piston pin. And push the piston pin to separate and connecting rod.

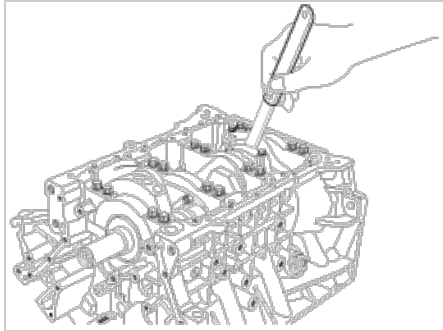
Inspection

Connecting Rod

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 ~ 0.25 mm (0.004 ~ 0.010 in.)



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

2. Check the connecting rod bearing oil clearance.

(1) Check the 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.

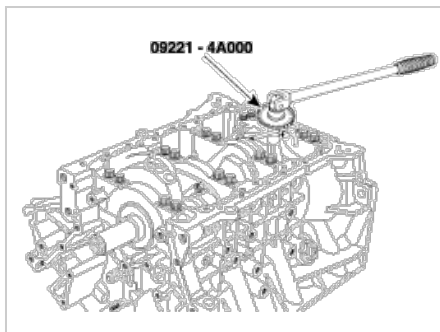
(4) Clean the crank pin and bearing.

(5) Place plastigage across the crank pin.

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

Tightening torque:

[27.5 ~ 31.4 N.m (2.8 ~ 3.2 kgf.m, 20.3 ~ 23.1 lb-ft)] + [68 ~ 72°]



NOTICE

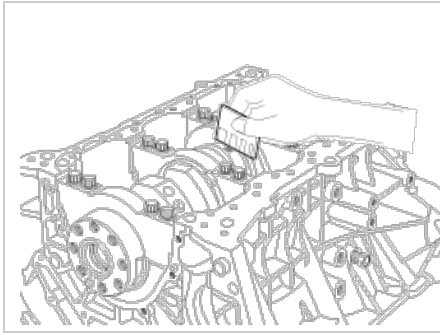
Do not turn the crankshaft.

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

(8) Measure the plastigage at its widest point.

Standard oil clearance:

0.040 ~ 0.062 mm (0.0016 ~ 0.0024 in.)



- (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.

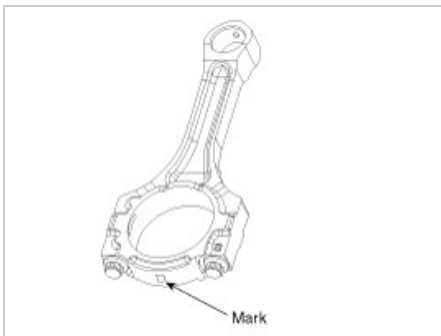
NOTICE

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

CAUTION

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

Connecting Rod Mark Location

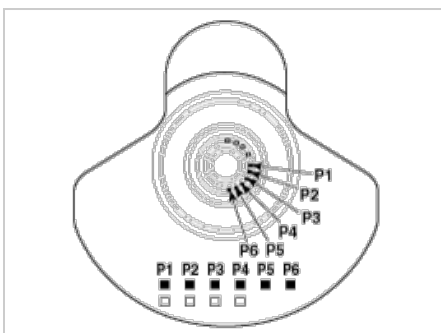


Identification Of Connecting Rod

Class	Mark	Inside Diameter
0	a	58.000 ~ 58.006 mm (2.2834 ~ 2.2837 in.)
1	b	58.006 ~ 58.012 mm (2.2837 ~ 2.2839 in.)
2	c	58.012 ~ 58.018 mm (2.2839 ~ 2.2842 in.)

Crankshaft Pin Mark Location

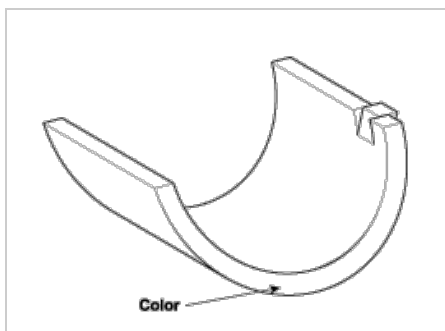
Identification Of Crankshaft



Discrimination Of Crankshaft

Class	Mark	Outside Diameter Of Pin
I	1 or A	54.966 ~ 54.972 mm (2.1640 ~ 2.1642 in.)
II	2 or B	54.960 ~ 54.966 mm (2.1638 ~ 2.1640 in.)
III	3 or C	54.954 ~ 54.960 mm (2.1635 ~ 2.1638 in.)

Place Of Identification Mark (Connecting Rod Bearing)



Identification Of Connecting Rod Bearing

Class	Mark	Thickness Of Bearing
E	Blue	1.509 ~ 1.512 mm (0.0594 ~ 0.0595 in.)
D	Black	1.506 ~ 1.509 mm (0.0592 ~ 0.0594 in.)
C	Red	1.503 ~ 1.506 mm (0.0591 ~ 0.0592 in.)
B	Green	1.500 ~ 1.503 mm (0.0590 ~ 0.0591 in.)
A	Yellow	1.497 ~ 1.500 mm (0.0589 ~ 0.0590 in.)

(11) Selection

		Connecting Rod Identification Mark		
		0(a)	1(b)	2(c)
Crankshaft Identification Mark	1 or A	A (Yellow)	B (Green)	C (Red)
	2 or B	B (Green)	C (Red)	D (Black)
	3 or C	C (Red)	D (Black)	E (Blue)

3. Check the connecting rod.

- (1) When reinstalling, check the cylinder numbers on the connecting rods and the caps. When installing a new connecting rod, the notches for bearing fixing on the connecting rods and caps should face the same direction.
- (2) If one or both edge of the connecting rod thrust surface is damaged, replace the rod. If the inner surface of the rod is damaged or rough, also replace it.
- (3) Using a connecting rod aligner, measure the bent or torsion of the rod. If the measurement is near the specification, adjust the rod with a press. If the rod is bent or twisted excessively, replace it.

Allowable bend of connecting rod:

0.05 mm/100 mm (0.0020 in./3.9370 in.)

Allowable twist of connecting rod:

0.1 mm/100 mm (0.0039 in./3.9370 in.)

NOTICE

When assembling the rod without a bearing, there should be no difference.

Piston

1. Clean piston

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

NOTICE

Do not use a wire brush.

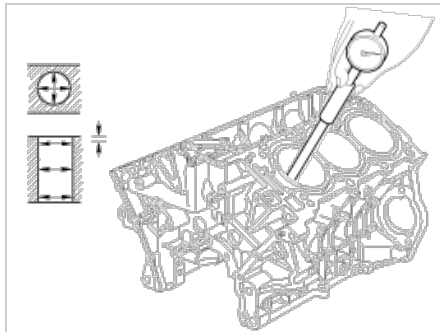
2. Check the piston-to-cylinder clearance by calculating the difference between the cylinder bore inner diameter and the piston outer diameter.

Clearance :0.03 ~ 0.05 mm (0.0012 ~ 0.0020 in.)

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

Standard diameter :

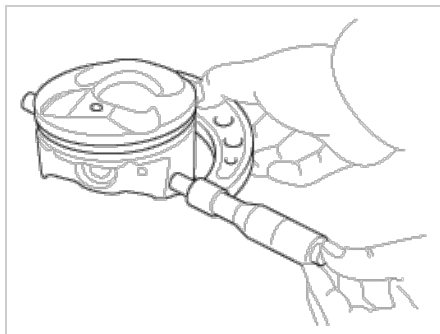
92.00 ~ 92.03 mm (3.6220 ~ 3.6232 in.)



- (2) Measure the piston outside diameter at 14 mm (0.55118 in.) from bottom land of the piston.

Standard diameter :

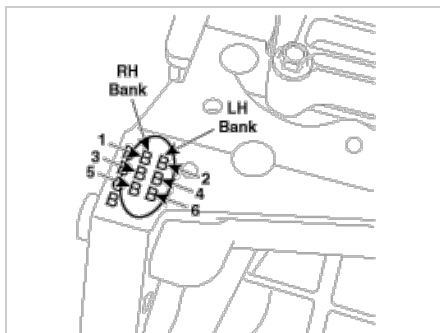
91.96 ~ 91.99 mm (3.6204 ~ 3.6216 in.)



3. Select the piston matching with cylinder bore class.

Clearance :0.03 ~ 0.05 mm (0.0012 ~ 0.0020 in.)

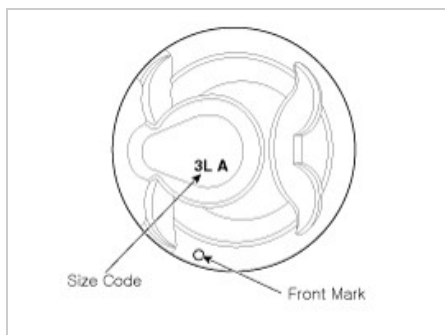
- (1) Check the cylinder bore size code on the cylinder block.



Discrimination Of Cylinder Bore

Class	Size code	Cylinder bore inner diameter
A	A	92.00 ~ 92.01 mm (3.6220 ~ 3.6224 in.)
B	B	92.01 ~ 92.02 mm (3.6224 ~ 3.6228 in.)
C	C	92.02 ~ 92.03 mm (3.6228 ~ 3.6232 in.)

- (2) Check the piston size code (A) and the front mark (B) on the piston top face.



Discrimination Of Piston Outer Diameter

Class	Size code	Piston outer diameter
A	A	91.96 ~ 91.97 mm (3.6204 ~ 3.6208 in.)
B	B	91.97 ~ 91.98 mm (3.6208 ~ 3.6212 in.)
C	C	91.98 ~ 91.99 mm (3.6212 ~ 3.6216 in.)

Piston Rings

1. Inspect the piston ring side clearance.

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

Piston ring side clearance

Standard

No.1 : 0.04 ~ 0.08 mm (0.0015 ~ 0.0031 in.)

No.2 : 0.04 ~ 0.08 mm (0.0015 ~ 0.0031 in.)

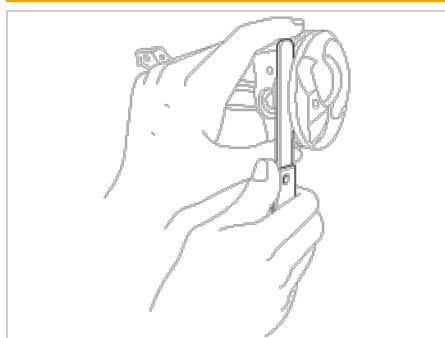
Oil ring : 0.02 ~ 0.06 mm (0.0008 ~ 0.0024 in.)

Limit

No.1 : 0.1 mm (0.004 in.)

No.2 : 0.1 mm (0.004 in.)

Oil ring : 0.2 mm (0.008 in.)



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

2. 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 against the wear limits. If the bore is over the service limit, the cylinder block must be replaced.

Piston ring end gap

Standard

No.1 : 0.17 ~ 0.32 mm (0.0067 ~ 0.0126 in.)

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

Oil ring :

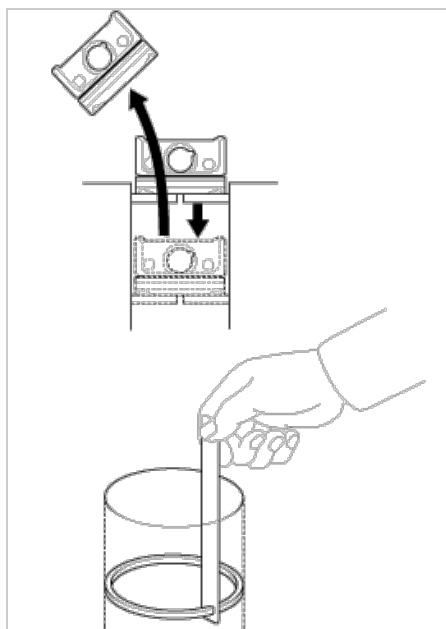
0.20 ~ 0.40 mm (0.0078 ~ 0.0157 in.)

Limit

No.1 : 0.6 mm (0.0236 in.)

No.2 : 0.7 mm (0.0275 in.)

Oil ring : 0.8 mm (0.0315 in.)

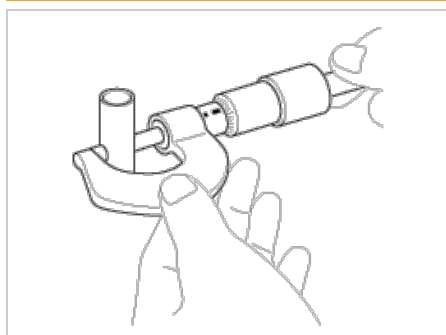


Piston Pins

1. Measure the diameter of the piston pin.

Piston pin diameter :

21.097 ~ 22.000 mm (0.8305 ~ 0.8661 in.)



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

Piston pin-to-piston clearance :

0.004 ~ 0.013 mm (0.00015 ~ 0.00051 in.)

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

Piston pin-to-connecting rod interference :

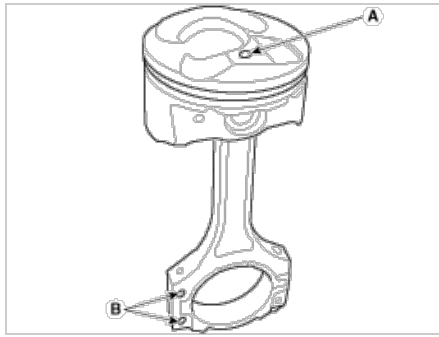
0.005 ~ 0.019 mm (0.00019 ~ 0.00074 in.)

Reassembly

NOTICE

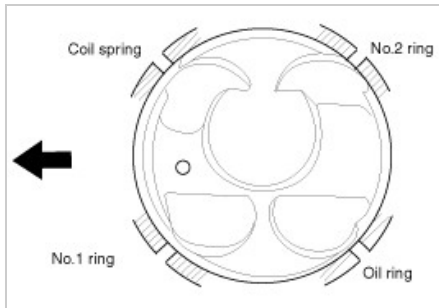
- Thoroughly clean all parts to be assembled.
- Before installing the parts, apply fresh engine oil to all sliding and rotating surfaces.
- Replace all gaskets, O-rings and oil seals with new parts.

1. Assemble the piston and the connecting rod.
 - (1) Install the piston pin with snap ring 2EA and check the snap ring assembly thoroughly.
 - (2) The piston front mark and the connecting rod front mark must face the timing belt side of the engine.



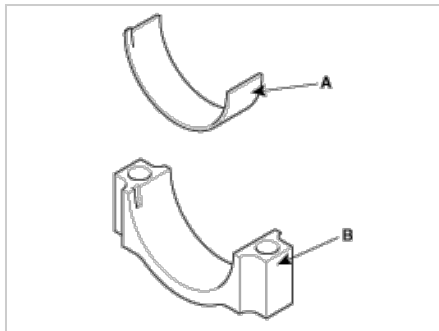
2. Install the piston rings.

- (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 the 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).



CAUTION

When reassembling the connecting rods and the caps, ensure the front marks on them and the number of cylinder.

4. Attach the piston and connecting rod assemblies from the cylinder block.

NOTICE

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

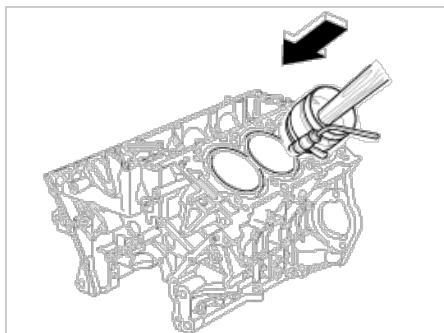
- (1) Install the ring compressor, check that the bearing is securely in place, then position the piston in the cylinder, and tap it in using the wooden handle of a hammer.
- (2) Stop after the ring compressor pops free, and check the connecting rod-to-check journal alignment before pushing the piston into place.
- (3) Install the rod caps with bearings, and torque the bolts.

Tightening torque :

[27.5 ~ 31.4 N.m (2.8 ~ 3.2 kgf.m, 20.3 ~ 23.1 lb-ft)] + [68 ~ 72°]

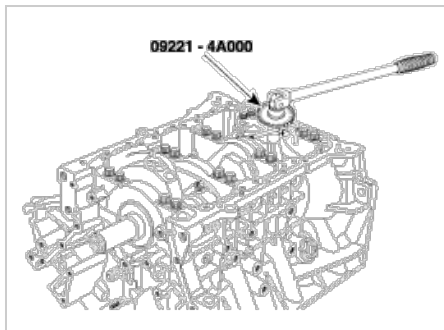
NOTICE

- Always use new connecting rod bearing cap bolts.
- Maintain downward force on the ring compressor to prevent the rings from expanding before entering the cylinder bore.



NOTICE

Use SST(09221-4A000), install connecting rod bearing cap bolts.

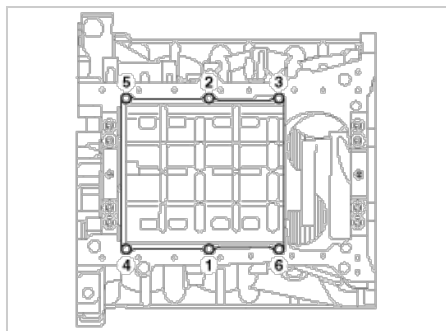


5. Install the baffle plate.

Install and uniformly tighten the baffle plate bolts, in several passes, in the sequence shown.

Tightening torque :

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

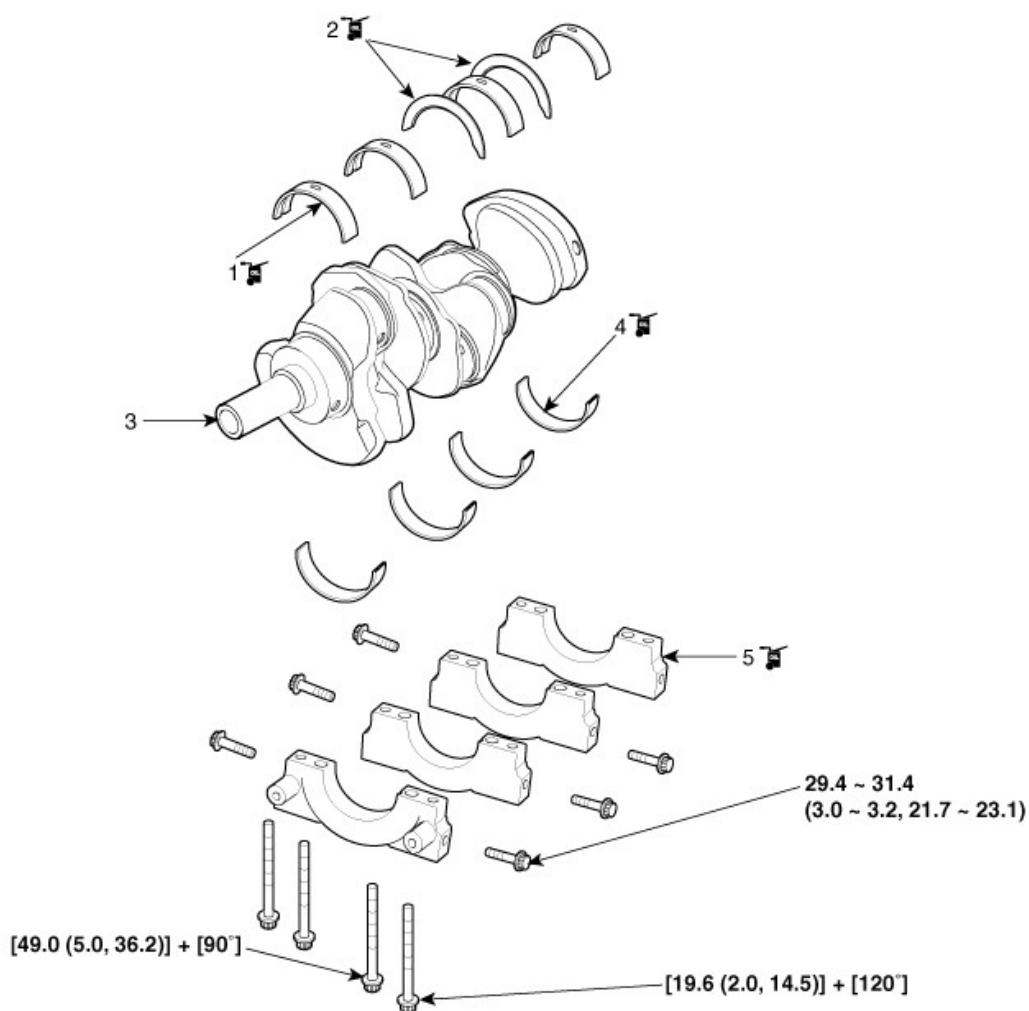


6. Install all other parts in reverse order of removal.

Engine Mechanical System



Components



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

- | | |
|------------------------------|-----------------------------|
| 1. Crank shaft upper bearing | 4. Crankshaft lower bearing |
| 2. Thrust bearing | 5. Main bearing cap |
| 3. Crankshaft | |

Engine Mechanical System



Disassembly

CAUTION

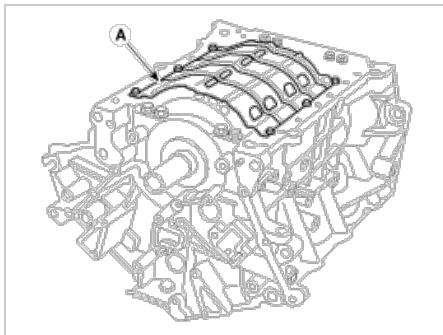
- Use fender covers to avoid damaging painted surfaces.
- To avoid damage, unplug the wiring connectors carefully while holding the connector portion.

NOTICE

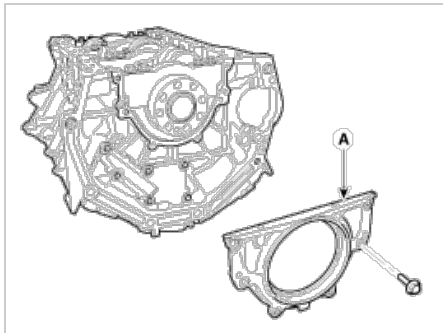
- Mark all wiring and hoses to avoid misconnection.
- Inspect the timing chain before removing the cylinder head.
- Turn the crankshaft pulley so that the No.1 piston is at top dead center (TDC).

1. Remove the engine assembly from the vehicle.
(Refer to Engine And Transmission Assembly - "Engine And Transmission Assembly")
2. Remove the drive plate and adapter plate.
(Refer to Cylinder Block - "Drive Plate")
3. Attach the engine to engine stand for disassembly.
4. Remove the exhaust manifold.
(Refer to Intake And Exhaust System - "Exhaust Manifold")

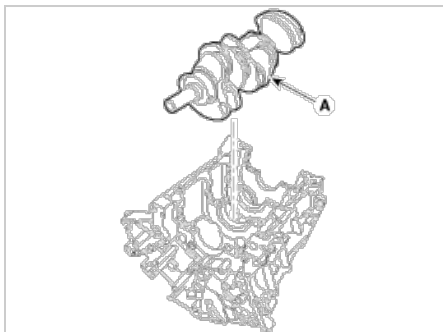
5. Remove the intake manifold.
(Refer to Intake And Exhaust System - "Intake Manifold")
6. Remove the timing chain.
(Refer to Timing System - "Timing Chain")
7. Remove the water temperature control assembly.
(Refer to Cooling System - "Water Temperature Control Aassembly")
8. Remove the cylinder head.
(Refer to Cylinder Head Assembly - "Cylinder Head")
9. Remove the oil pump.
(Refer to Lubrication System - "Oil Pump")
10. Remove the oil filter body.
(Refer to Lubrication System - "Oil filter body")
11. Remove the upper oil pan.
(Refer to Lubrication System - "Oil Pan")
12. Remove the baffle plate (A).



13. Remove the rear oil seal case (A).



14. Check the connecting rod end play.
(Refer to Cylinder Block - "Piston and Connecting Rod")
15. Check the connecting rod cap oil clearance.
(Refer to Cylinder Block - "Piston and Connecting Rod")
16. Remove the piston and connecting rod assemblies.
(Refer to Cylinder Block - "Piston and Connecting Rod")
17. Remove the crankshaft main bearing cap and check oil clearance.
18. Check the crankshaft end play.
19. Remove the crankshaft.
Lift the crankshaft (A) out of engine, being careful not to damage journals.



NOTICE

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

Inspection

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

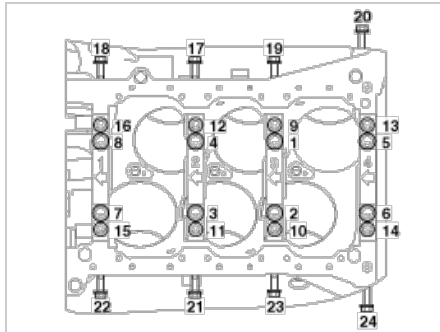
Tightening torque

No. 1~8 : 49.0 N.m (5.0 kgf.m, 36.2 lb-ft) + 90°

No. 9~16 : 19.6 N.m (2.0 kgf.m, 14.5 lb-ft) + 120°

No. 17~24 :

29.4 ~ 31.4 N.m (3.0 ~ 3.2 kgf.m, 21.7 ~ 23.1 lb-ft)



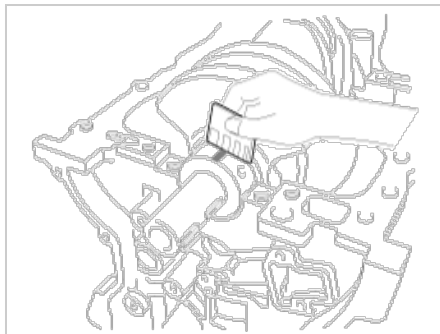
NOTICE

Do not turn the crankshaft.

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

Standard oil clearance :

0.022 ~ 0.040 mm (0.0009 ~ 0.0016 in.)



- (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.

NOTICE

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

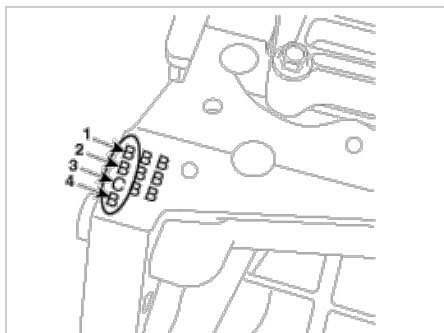
CAUTION

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

Crankshaft bore mark location

Letters have been stamped on the block as a mark for the size of each of the 4 main journal bores.

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

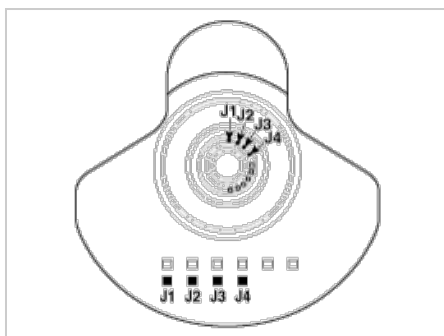


Discrimination Of Cylinder Block

Class	Mark	Inside Diameter
a	A	73.500 ~ 73.506 mm (2.8937 ~ 2.8939 in.)
b	B	73.506 ~ 73.512 mm (2.8939 ~ 2.8942 in.)
c	C	73.512 ~ 73.518 mm (2.8942 ~ 2.8944 in.)

Crankshaft Journal Mark Location

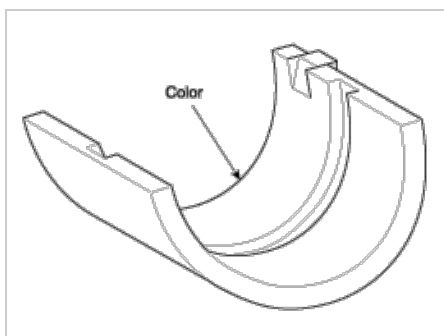
Discrimination Of Crankshaft



Discrimination Of Crankshaft

Class	Mark	Outside Diameter Of Journal
I	1 or A	68.954 ~ 68.960 mm (2.7147 ~ 2.7150 in.)
II	2 or B	68.948 ~ 68.954 mm (2.7145 ~ 2.7147 in.)
III	3 or C	68.942 ~ 68.948 mm (2.7142 ~ 2.7145 in.)

Place Of Identification Mark (Crankshaft Bearing)



Discrimination Of Crankshaft Bearing

Class	Mark	Thickness Of Bearing
E	Blue	2.277 ~ 2.280 mm (0.0896 ~ 0.0897 in.)
D	Black	

		2.274 ~ 2.277 mm (0.0895 ~ 0.0896 in.)
C	Red	2.271 ~ 2.274 mm (0.0894 ~ 0.0895 in.)
B	Green	2.268 ~ 2.271 mm (0.0893 ~ 0.0894 in.)
A	Yellow	2.265 ~ 2.268 mm (0.0892 ~ 0.0893 in.)

Selection

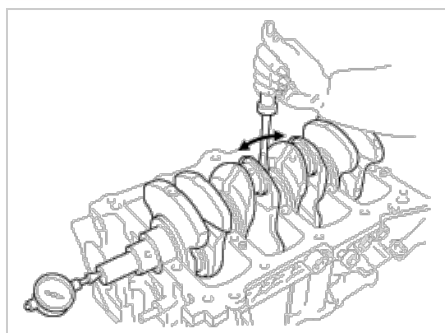
		Crankshaft Bore Identification Mark		
		a(A)	b(B)	c(C)
Crankshaft Identification Mark	1 or A	A (Yellow)	B (Green)	C (Red)
	2 or B	B (Green)	C (Red)	D (Black)
	3 or C	C (Red)	D (Black)	E (Blue)

2. 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 :

0.10 ~ 0.28 mm (0.0039 ~ 0.0110 in.)



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

Thrust bearing thickness :

2.41 ~ 2.45 mm (0.0949 ~ 0.0964 in.)

3. Inspect main journals and crank pins

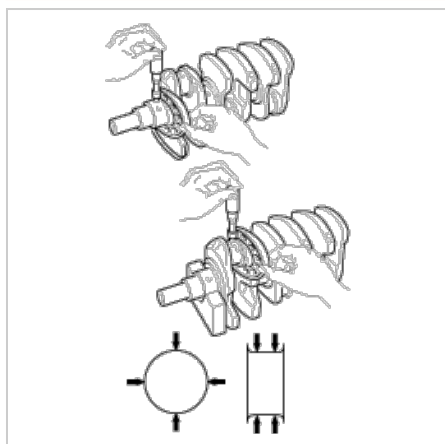
Using a micrometer, measure the diameter of each main journal and crank pin.

Main journal diameter :

68.942 ~ 68.960 mm (2.7142 ~ 2.7149 in.)

Crank pin diameter :

54.954 ~ 54.972 mm (2.1635 ~ 2.1642 in.)



Reassembly

NOTICE

- Thoroughly clean all parts to be assembled.
- Before installing the parts, apply fresh engine oil to all sliding and rotating surfaces.

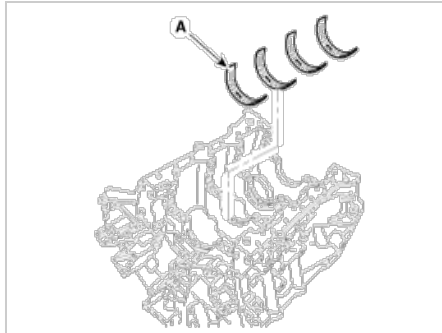
- Replace all gaskets, O-rings and oil seals with new parts.

1. Install the main bearings.

NOTICE

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

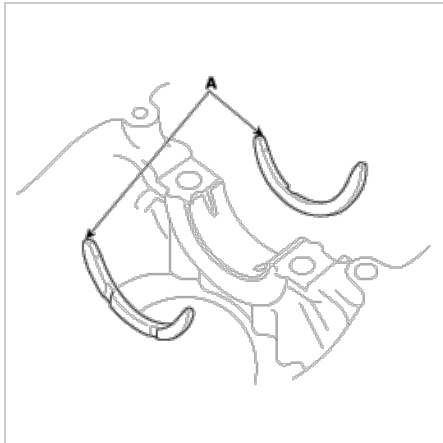
- (1) Align the bearing claw with the claw groove of the cylinder block, push in the 4 upper bearings (A).



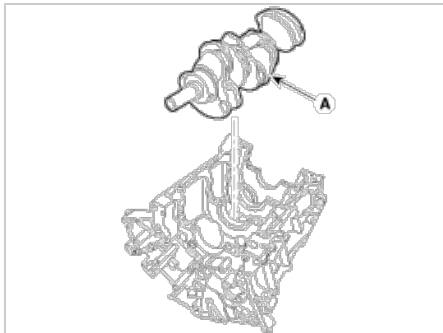
- (2) Align the bearing claw with the claw groove of the main bearing cap, and push in the 4 lower bearings.

2. Install the thrust bearings.

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



3. Place the crankshaft (A) on the cylinder block.



4. Place the main bearing caps on cylinder block.

5. Install the main bearing cap bolts.

- (1) Install and uniformly tighten the bearing cap bolts, in several passes, in the sequence shown.

Tightening torque

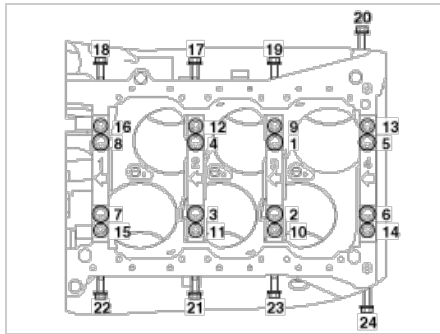
Main bearing cap bolt

No. 1~8 : 49.0 N.m (5.0 kgf.m, 36.2 lb-ft) + 90°

No. 9~16 : 19.6 N.m (2.0 kgf.m, 14.5 lb-ft) + 120°

No. 17~24 :

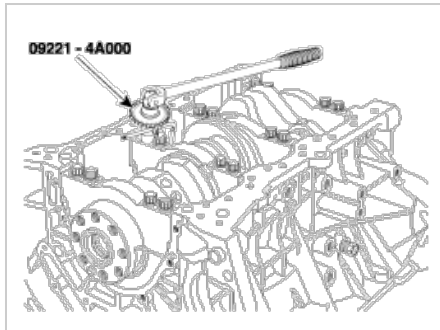
29.4 ~ 31.4 N.m (3.0 ~ 3.2 kgf.m, 21.7 ~ 23.1 lb-ft)



NOTICE

- Always use new main bearing cap bolts.
- If any of the bearing cap bolts are broken or deformed, replace it.

Use the SST(09221-4A000), install main bearing cap bolts.

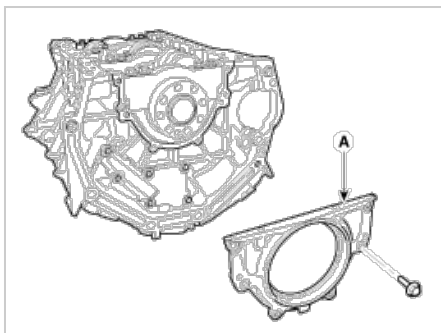


(2) Check that the crankshaft turns smoothly.

6. Check crankshaft end play.
7. Install the piston and connecting rod assemblies.
(Refer to Cylinder Block - "Piston and Connecting Rod")
8. Install the rear oil seal case (A).

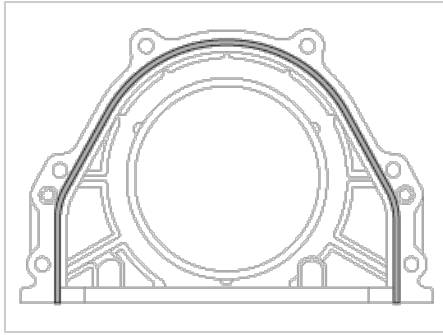
Tightening torque :

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



NOTICE

- Clean the sealing face before assembling two parts.
- Remove harmful foreign materials on the sealing face before applying sealant
- Before assembling rear oil seal case, the liquid sealant THREE BOND 1217H should be applied to the rear oil seal case.
- The part must be assembled within 5 minutes after sealant was applied.
- Apply sealant to the inner threads of the bolt holes.

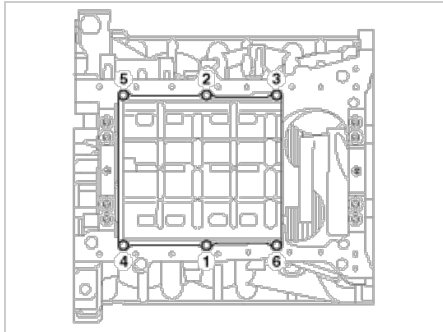


9. Install the rear oil seal.
(Refer to Cylinder Block - "Rear Oil Seal")

10. Install the baffle plate.
Install and uniformly tighten the baffle plate bolts, in several passes, in the sequence shown.

Tightening torque :

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



11. Install all other parts in reverse order of removal.

Information

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

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

Engine Mechanical System



Disassembly

CAUTION

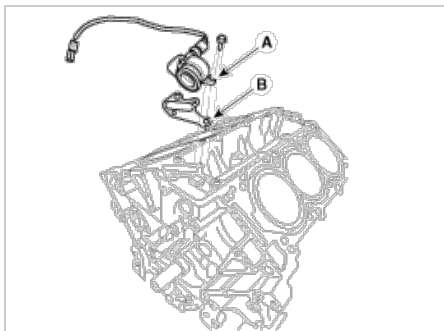
- Use fender covers to avoid damaging painted surfaces.
- To avoid damage, unplug the wiring connectors carefully while holding the connector portion.

NOTICE

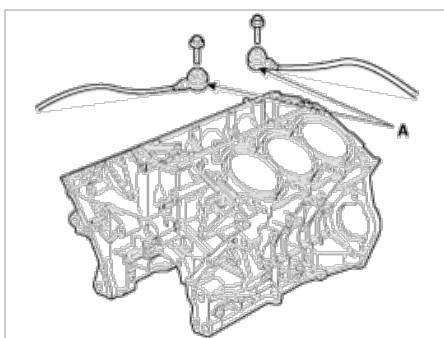
- Mark all wiring and hoses to avoid misconnection.
- Inspect the timing chain before removing the cylinder head.
- Turn the crankshaft pulley so that the No.1 piston is at top dead center (TDC).

1. Remove the engine assembly from the vehicle.
(Refer to Engine And Transmission Assembly - "Engine And Transmission Assembly")
2. Remove the drive plate and adapter plate.
(Refer to Cylinder Block - "Drive Plate")
3. Attach the engine to engine stand for disassembly.
4. Remove the exhaust manifold.
(Refer to Intake And Exhaust System - "Exhaust Manifold")
5. Remove the intake manifold.
(Refer to Intake And Exhaust System - "Intake Manifold")
6. Remove the timing chain.
(Refer to Timing System - "Timing Chain")
7. Remove the water temperature control assembly.
(Refer to Cooling System - "Water Temperature Control Aassembly")

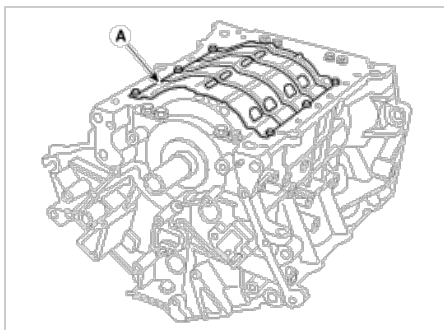
8. Remove the cylinder head.
(Refer to Cylinder Head Assembly - "Cylinder Head")
9. Remove the oil pump.
(Refer to Lubrication System - "Oil Pump")
10. Remove the oil filter body.
(Refer to Lubrication System - "Oil filter body")
11. Remove the oil cover (A) and gasket (B).



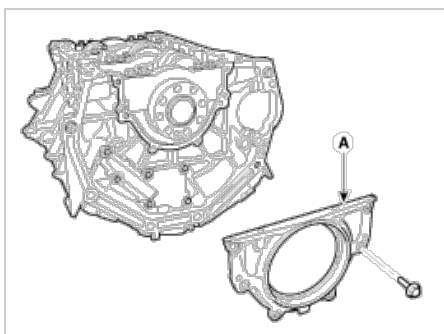
12. Remove the water jacket separator.
(Refer to Cylinder Block - "Water Jacket Separator")
13. Remove the knock sensor (A).



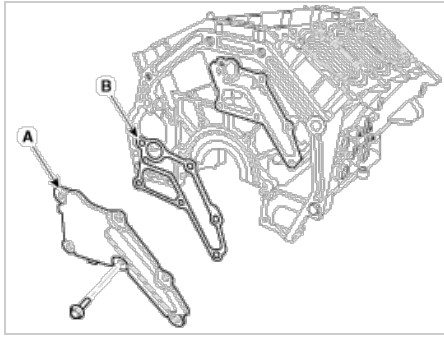
14. Remove the upper oil pan.
(Refer to Lubrication System - "Oil Pan")
15. Remove the baffle plate (A).



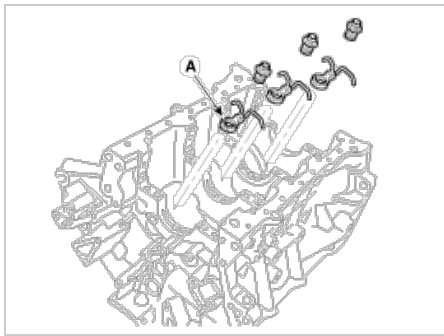
16. Remove the rear oil seal case (A).



17. Remove the oil drain cover (A) and gasket (B).



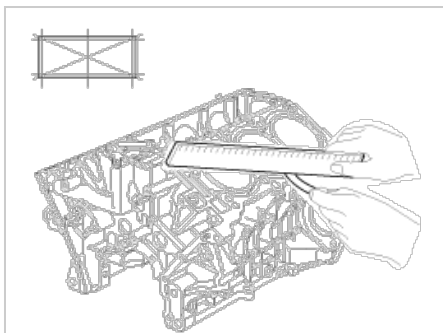
18. Check the connecting rod end play.
(Refer to Cylinder Block - "Piston and Connecting Rod")
19. Check the connecting rod cap oil clearance.
(Refer to Cylinder Block - "Piston and Connecting Rod")
20. Remove the piston and connecting rod assemblies.
(Refer to Cylinder Block - "Piston and Connecting Rod")
21. Remove the crankshaft main bearing cap and check oil clearance.
(Refer to Cylinder Block - "Crankshaft")
22. Check the crankshaft end play.
(Refer to Cylinder Block - "Crankshaft")
23. Remove the crankshaft.
(Refer to Cylinder Block - "Crankshaft")
24. Remove the oil jets (A).



Inspection

Cylinder Block

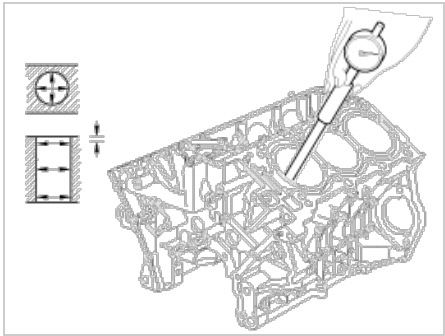
1. Remove the gasket material.
Using a gasket scraper, remove all the gasket material from the top surface of the cylinder block.
2. Clean the cylinder block
Using a soft brush and solvent, thoroughly clean the cylinder block.
3. Inspect the top surface of the cylinder block for flatness.
Using a precision straight edge and feeler gauge, measure the surface contacting the cylinder head gasket for warpage.
Flatness of cylinder block gasket surface
Standard : Less than 0.05 mm (0.0020 in.),
Less than 0.02 mm (0.0008 in.) / 150 x 150



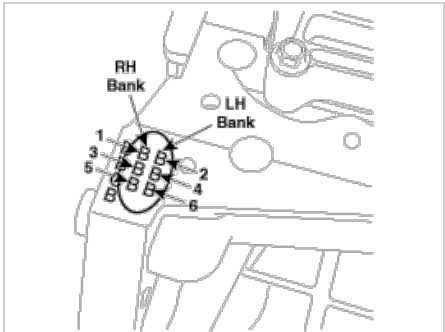
4. Inspect cylinder bore diameter.
Visually check the cylinder for vertical scratches.
If deep scratches are present, replace the cylinder block.

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

Standard diameter :
92.00 ~ 92.03 mm (3.6220 ~ 3.6232 in.)



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



Class	Size code	Cylinder bore inner diameter
A	A	92.00 ~ 92.01 mm (3.6220 ~ 3.6224 in.)
B	B	92.01 ~ 92.02 mm (3.6224 ~ 3.6228 in.)
C	C	92.02 ~ 92.03 mm (3.6228 ~ 3.6232 in.)

Cylinder boring

1. Oversize pistons should be selected according to the largest bore cylinder.

Identification Mark	Size
0.1	0.1 mm (0.004 in)
0.25	0.25 mm (0.010 in)

NOTICE
The size of piston is stamped on top of the piston.

2. Measure the outside diameter of the piston to be used.
3. According to the measured O.D(Outer Diameter), calculate the new bore size.
New bore size = piston O.D + 0.03 to 0.05 mm (0.0012 to 0.0020 in) (clearance between piston and cylinder) - 0.01 mm (0.0004 in) (honing margin.)

4. Bore each of the cylinders to the calculated size.

CAUTION
To prevent distortion that may result from temperature rise during honing, bore the cylinder holes in the firing order.

- 5.hone the cylinders, finishing them to the proper dimension (piston outside diameter + gap with cylinder).
6. Check the clearance between the piston and cylinder.
Standard :0.03 ~ 0.05 mm (0.0012 ~ 0.0020 in)

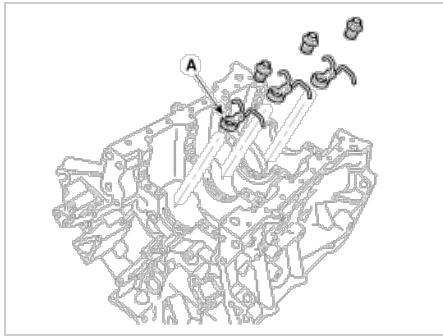
NOTICE
When boring the cylinders, finish all of the cylinders to the same oversize. Do not bore only one cylinder to the oversize.

Reassembly

1. Install the oil jets (A).

Tightening torque

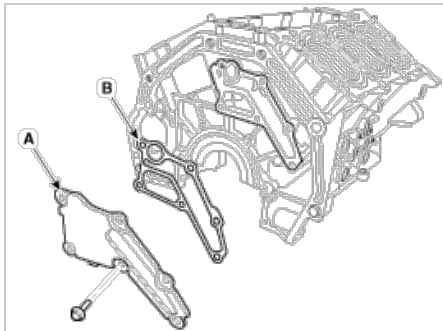
27.5 ~ 31.3 N.m (2.8 ~ 3.2kgf.m, 20.2 ~ 23.1lb-ft)



2. Install the crankshaft.
(Refer to Cylinder Block - "Crankshaft")
3. Install the crankshaft main bearing cap and check oil clearance.
(Refer to Cylinder Block - "Crankshaft")
4. Check the crankshaft end play.
(Refer to Cylinder Block - "Crankshaft")
5. Install the piston and connecting rod assemblies.
(Refer to Cylinder Block - "Piston and Connecting Rod")
6. Check the connecting rod end play.
(Refer to Cylinder Block - "Piston and Connecting Rod")
7. Install the oil drain cover (A) with a new gasket (B).

Tightening torque :

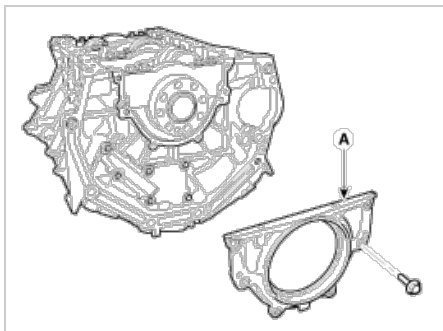
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)



8. Install the rear oil seal case (A).

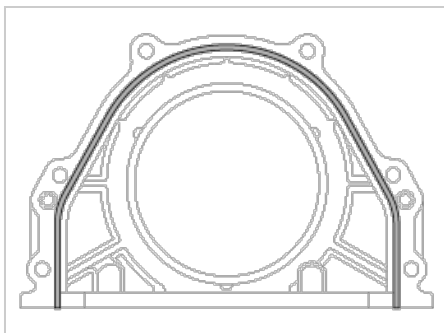
Tightening torque :

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



NOTICE

- Clean the sealing face before assembling two parts.
- Remove harmful foreign materials on the sealing face before applying sealant
- Before assembling rear oil seal case, the liquid sealant THREE BOND 1217H should be applied to the rear oil seal case.
- The part must be assembled within 5 minutes after sealant was applied.
- Apply sealant to the inner threads of the bolt holes.

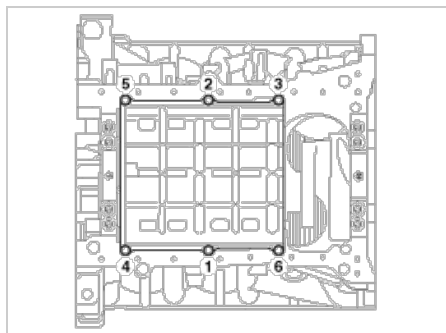


9. Install the rear oil seal.
(Refer to Cylinder Block - "Rear Oil Seal")

10. Install the baffle plate.
Install and uniformly tighten the baffle plate bolts, in several passes, in the sequence shown.

Tightening torque :

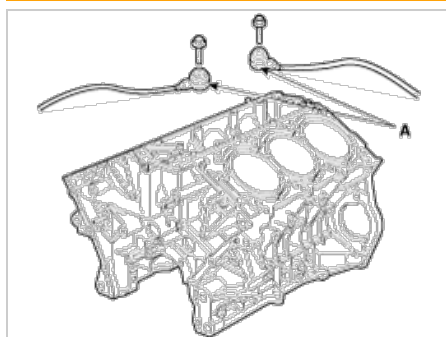
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)



11. Install the upper oil pan.
(Refer to Lubrication System - "Oil Pan")
12. Install the knock sensor (A).

Tightening torque :

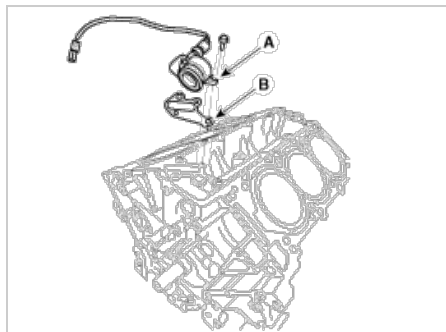
15.7 ~ 23.5 N.m (1.6 ~ 2.4 kgf.m, 11.6 ~ 17.3 lb-ft)



13. Install the water jacket separator.
(Refer to Cylinder Block - "Water Jacket Separator")
14. Remove the oil cover (A) and gasket (B).

Tightening torque :

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



15. Install all other parts in reverse order of removal.

Information

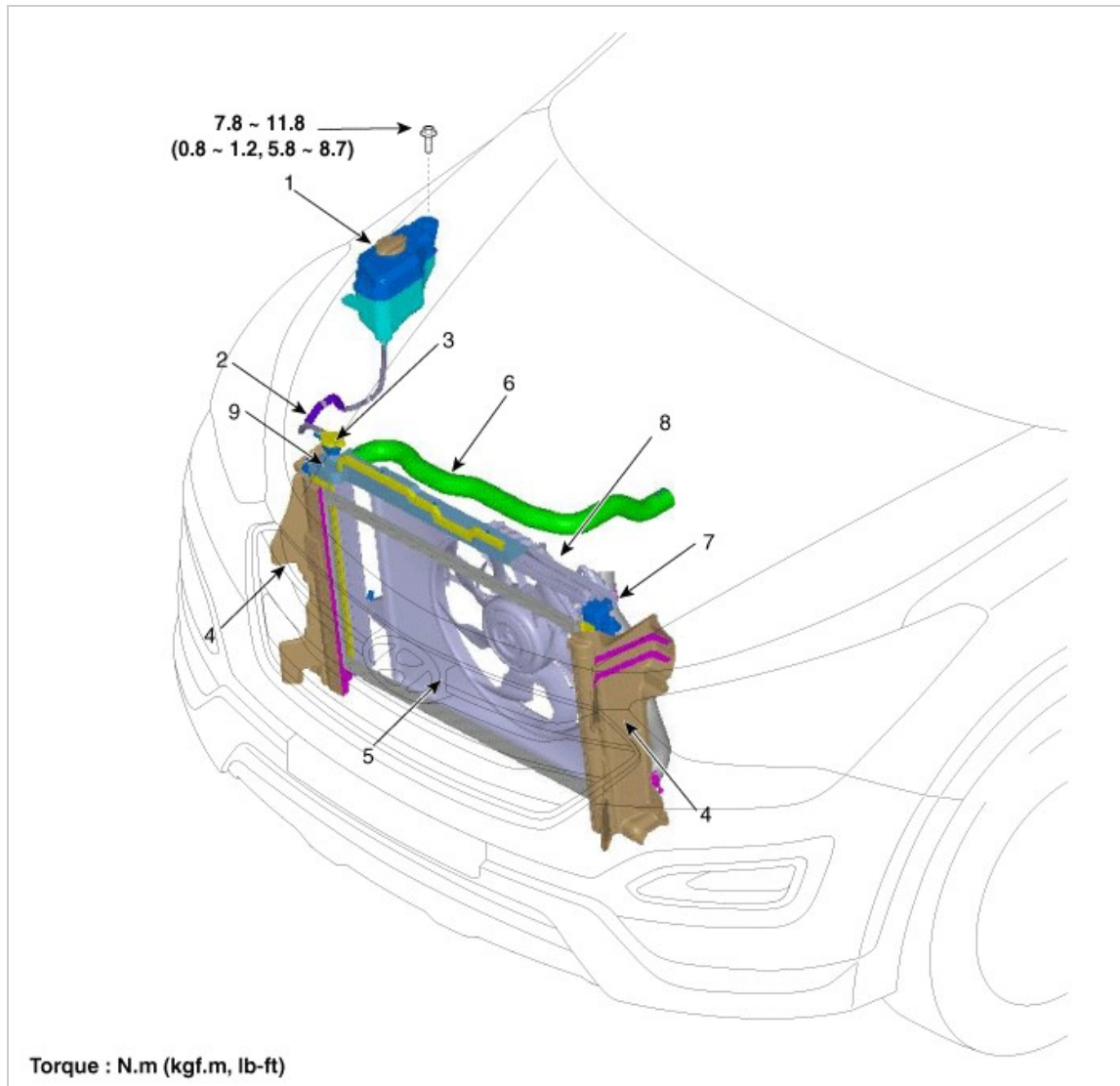
In case the cylinder block is replaced with a new one, select the proper crankshaft main bearing and the piston according to the crankshaft journal bore mark and the cylinder bore mark on the cylinder block.

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

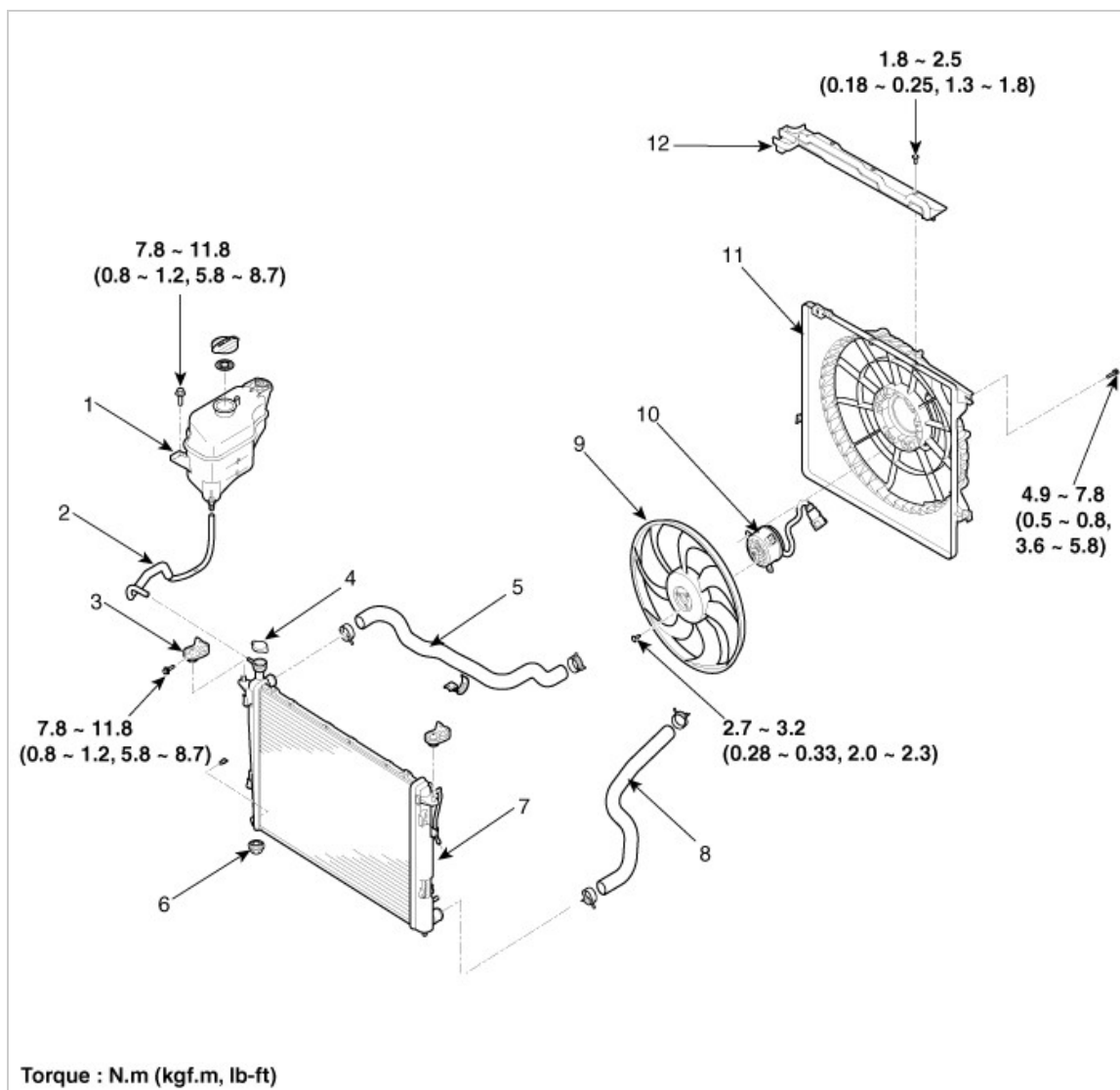
Engine Mechanical System



Components



- | | |
|-------------------|------------------------|
| 1. Reservoir tank | 6. Radiator upper hose |
| 2. Over flow hose | 7. Radiator lower hose |
| 3. Radiator cap | 8. Cooling fan |
| 4. Side air guard | 9. Upper air guard |
| 5. Radiator | |



- | | |
|---------------------------|------------------------|
| 1. Reservoir tank | 7. Radiator |
| 2. Over flow hose | 8. Radiator lower hose |
| 3. Radiator upper bracket | 9. Cooling fan |
| 4. Radiator cap | 10. Cooling fan motor |
| 5. Radiator upper hose | 11. Cooling fan shroud |
| 6. Radiator lower barcket | 12. Upper air guard |

Engine Mechanical System



Replacement And Air Bleeding

CAUTION

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

NOTICE

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

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



3. Loosen the drain plug (A), and drain the coolant.



4. Tighten the radiator drain plug securely.
5. Remove, drain and reinstall the reservoir. Fill the tank halfway to the MAX mark with water, then up to the MAX mark with antifreeze.
6. Fill the radiator with water through the radiator cap and tighten the cap.

NOTICE

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

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

NOTICE

- Use only genuine antifreeze/coolant.
- For best corrosion protection, the coolant concentration must be maintained year-round at 45 ~ 60% minimum. Coolant concentrations less than 45 ~ 60% may not provide sufficient protection against corrosion or freezing.
- Coolant concentrations greater than 60% will impair cooling efficiency and are not recommended.

CAUTION

- Do not mix different brands of antifreeze/coolants.
- Do not use additional rust inhibitors or antirust products; they may not be compatible with the coolant.

11. Start the engine and run coolant circulates.
12. When the cooling fan operates and coolant circulates, refill coolant through the radiator cap.
13. Repeat step.11 until the cooling fan 3 ~ 5times and bleed air sufficiently out of the cooling system.
14. Install the radiator cap and fill the reservoir tank to the "MAX"(or "F") line (A) with coolant.



15. Run the vehicle under idle until the cooling fan operates 2 ~ 3 times.
16. Stop the engine and wait coolant gets cool.
17. Repeat 10 to 15 until the coolant level doesn't fall any more, bleed air out of the cooling system.

NOTICE

As it is to bleed air out to the cooling system and refill coolant when coolant gets cool completely, recheck the coolant level in the reservoir tank for 2 ~ 3 days after replacing coolant.

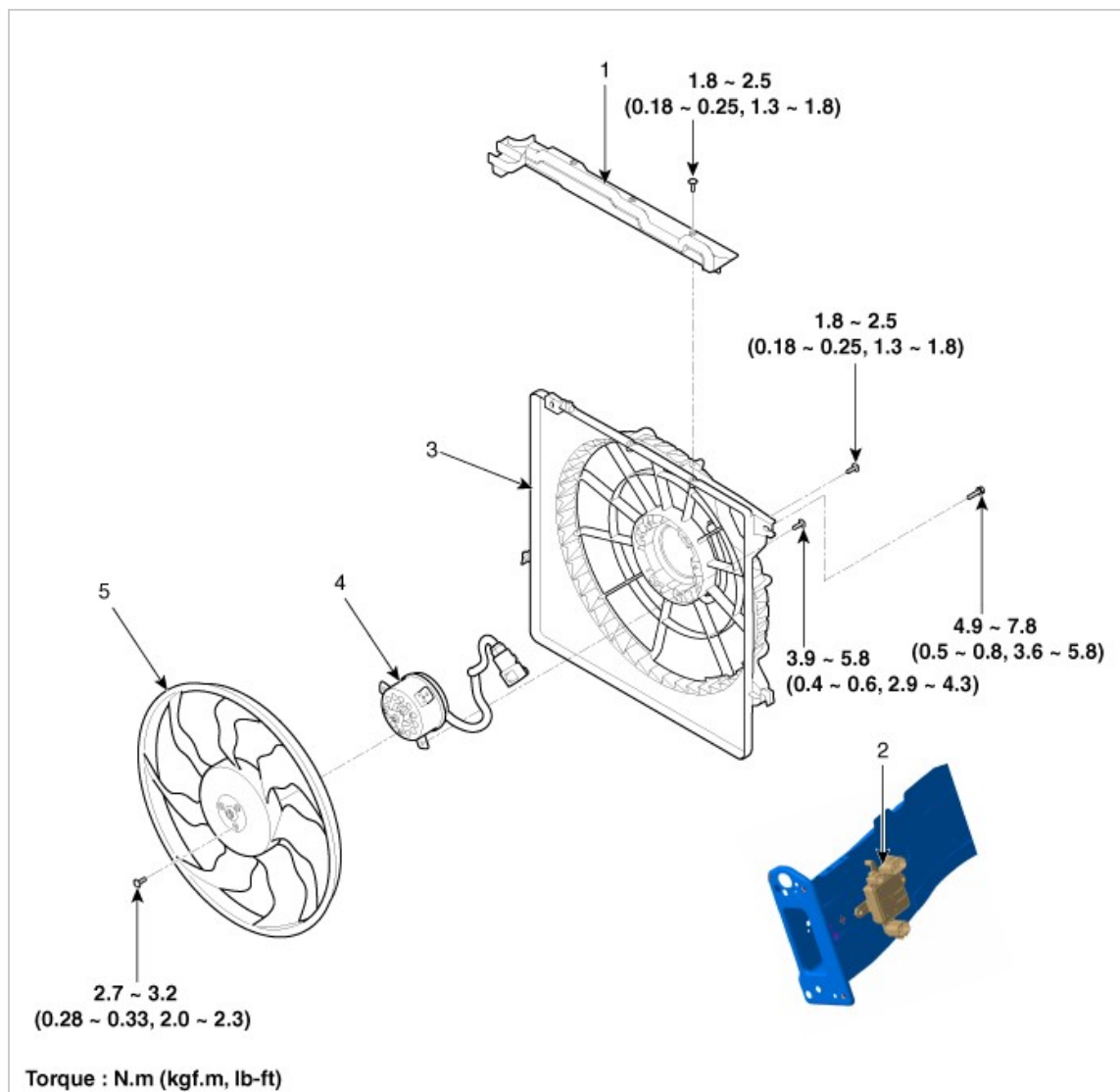
Coolant capacity :

9.1 L (9.6 Us.qts, 8.0 Imp, 2.4 qts)

Engine Mechanical System



Components



1. Upper air guard
2. PWM module
3. Cooling fan shroud

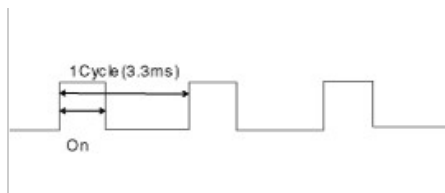
4. Fan motor
5. Cooling fan



Description

Control the cooling motor voltage in according to the duty(300Hz) of ECM.

[ECU → PWM Input Signal(SI : 300Hz)]



SI Duty	Motor Voltage (V)	
10%	0	—
30%	4.1	± 0.65
60%	8.2	± 0.66
70%	9.57	± 0.67
90%	12.5	—

[Cooling Fan Operation Condition]

A/C Switch	A/C Pressure (Kgf/cm ² G)	Vehicle Speed (Km/h)	Coolant Temp (°C)	Duty (%)
OFF	—	V < 45	98 above	35
		45 ≤ V < 80	101 above	40
		80 ≤ V	105 above	80
ON	A/C Pressure < 6	ALL	105 above	90
	6 ≤ A/C Pressure < 12	V < 45	82 above	30
		45 ≤ V < 80	96 above	40
		80 ≤ V	96 above	60
	12 ≤ A/C Pressure < 15.5	V < 45	101 above	70
		45 ≤ V < 80	-30 above	40
		80 ≤ V	82 above	60
	15.5 ≤ A/C Pressure	V = 0	-30 above	60
		0 < V	-30 above	90

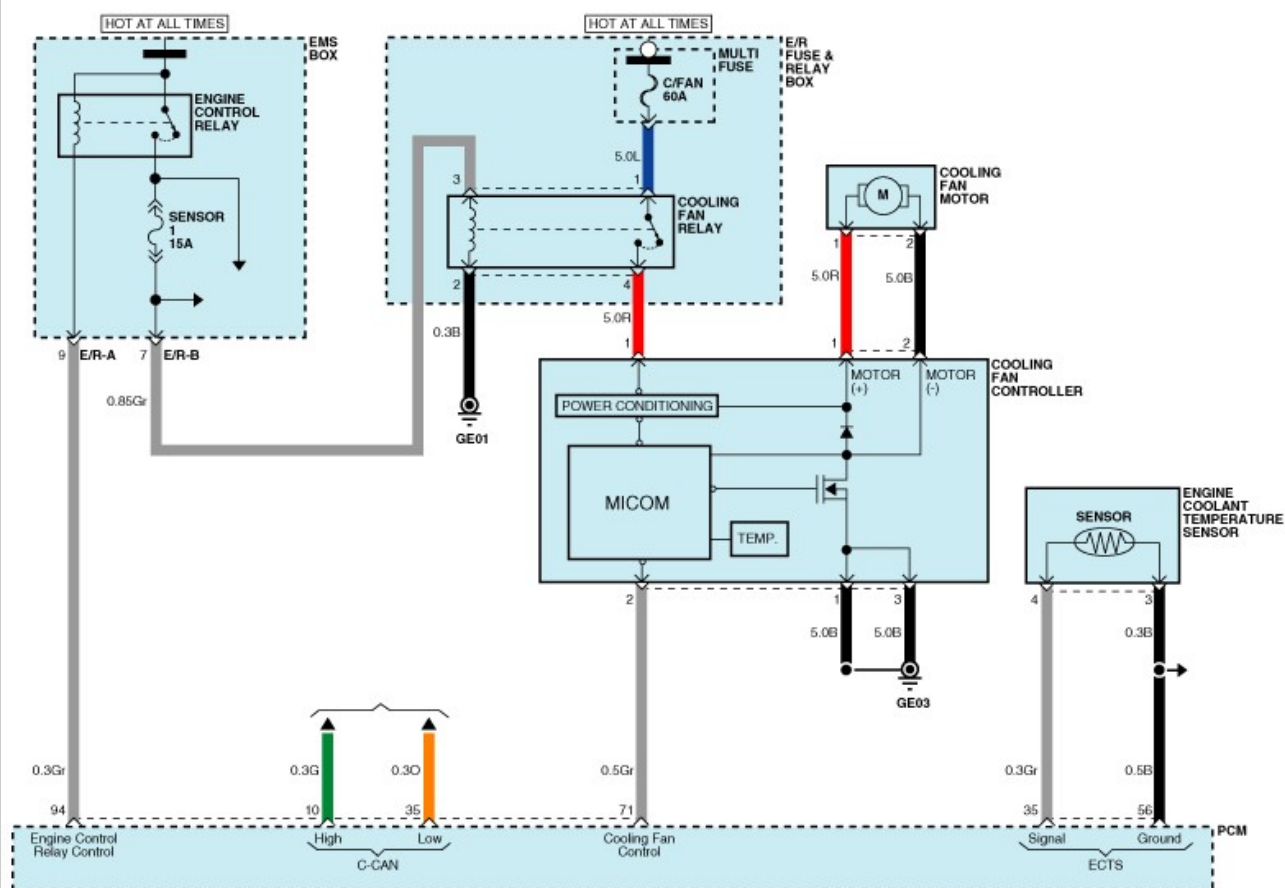


Specifications

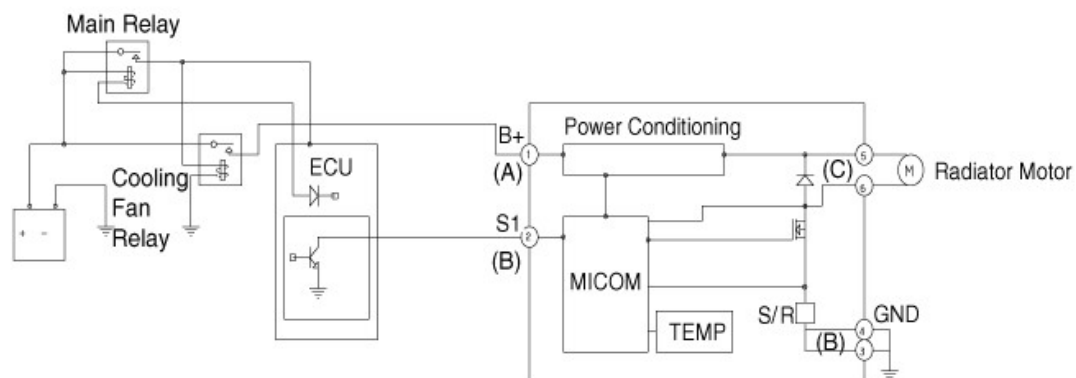
Items	Specification
Fan type	PULLER
Fan speed control method	PWM
Air flow rate [m ³ /h (yd ³ /h)]	2,850 (3,728) - 10% min.
Fan speed (rpm)	1,970 ± 10%
Current (A)	20.8 + 10% max.



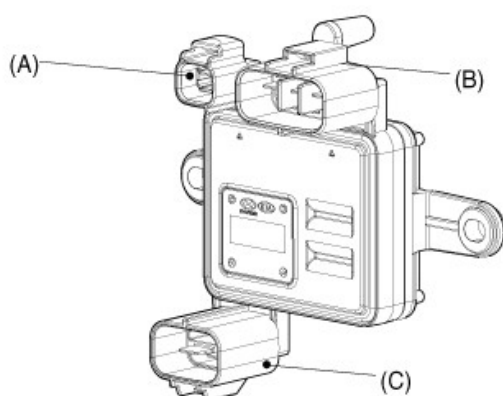
Circuit Diagram



[Circuit Diagram]



[Connector]



Power Connector (A)



No.	Function
①	BATT

Main Connector (B)



No.	Function
①	GND (-)
②	SIGNAL
③	GND (-)

Motor Connector (C)



No.	Function
①	Motor (+)
②	Motor (-)

Engine Mechanical System



Removal And Installaion

Cooling fan assembly

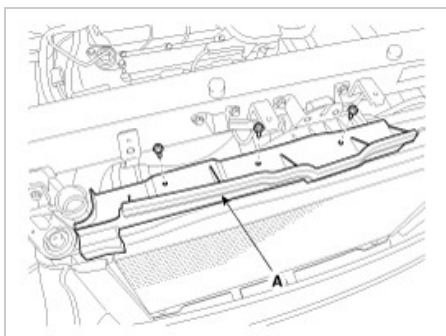
1. Disconnect the battery "-" terminal.
2. Remove the air cleaner assembly.
(Refer to Intake and Exhaust System - "Air cleaner")
3. Remove the engine room under cover.
4. Remove the front bumper cover.
(Refer to Body - "Front Bumper Cover")
5. Disconnect the fan motor connector (A).



6. Remove the air intake shield (A).



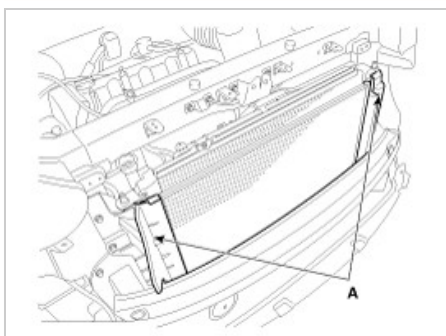
7. Remove the upper air guard (A).



8. Remove the horn.
(Refer to Body Electrical System - "Horn")
9. Remove the side air guard (A).

Tightening toraue :

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



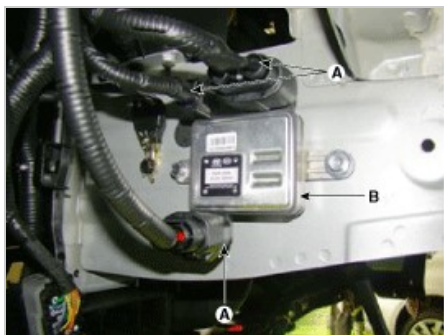
10. Loosen the cooling fan mounting bolts and then disconnect the cooling fan assembly (A) from radiator.



11. Install in the reverse order of removal.

PWM Module

1. Disconnect the battery "-" terminal.
2. Remove the LH front wheel guard.
(Refer to Body - "Front Wheel Guard")
3. Disconnect the connectors (A) and then remove the PWM (B).



4. Install in the reverse order of removal.

Disassembly

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

Tightening torque:

2.7 ~ 3.2 N.m (0.28 ~ 0.33 kgf.m, 2.0 ~ 2.4 lb-ft)



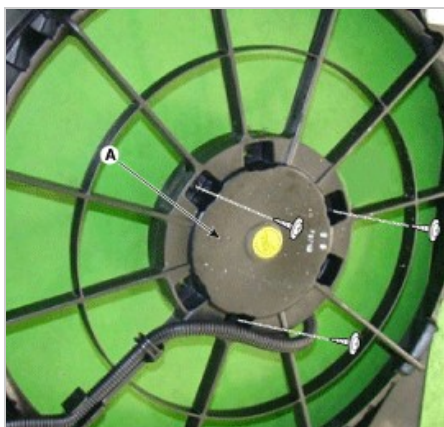
2. Disconnect the fan motor connector (A) from the resistor.



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

Tightening torque:

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





4. Assemble in the reverse order of disassembly.

Inspection

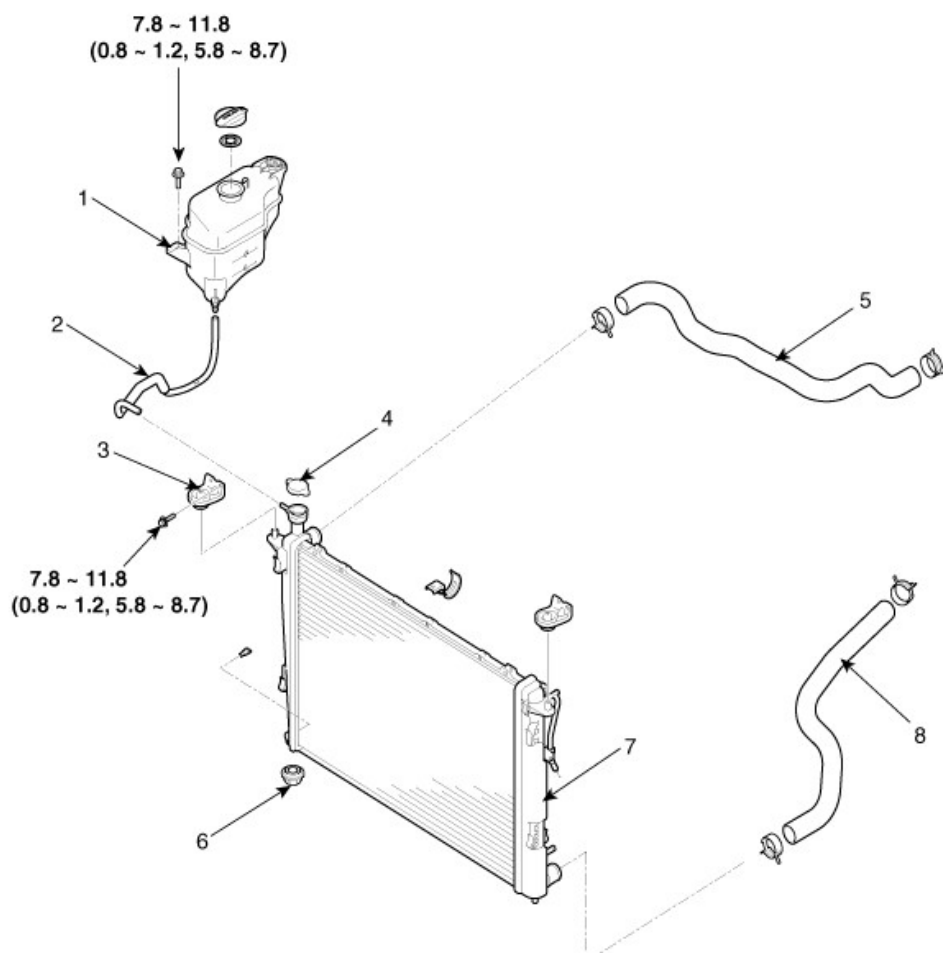
Fan Motor

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

Engine Mechanical System



Components



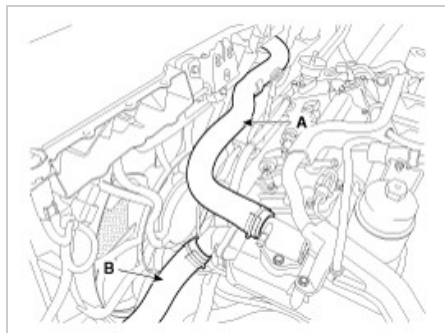
Torque : N.m (kgf.m, lb-ft)

- | | |
|---------------------------|---------------------------|
| 1. Reservoir tank | 5. Radiator upper hose |
| 2. Over flow hose | 6. Radiator lower barcket |
| 3. Radiator upper bracket | 7. Radiator |
| 4. Radiator cap | |



Removal And Installaion

1. Disconnect the battery "-" terminal.
2. Remove the air cleaner assembly.
(Refer to Intake and Exhaust System - "Air cleaner")
3. Remove the engine room under cover.
4. Loosen the drain plug and drain the engine coolant.
(Refer to Cooling System - "Coolant")
5. Remove the front bumper cover.
(Refer to Body - "Front Bumper Cover")
6. Disconnect the radiator upper hose (A) and lower hose (B).



NOTICE

When installing radiator hoses, install as shown in illustrations.



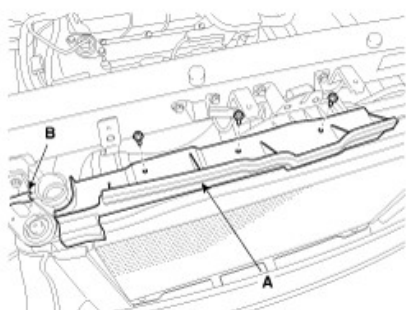
7. Disconnect the fan motor connector (A) beside the wiring harness.



8. Remove the air intake shield (A).



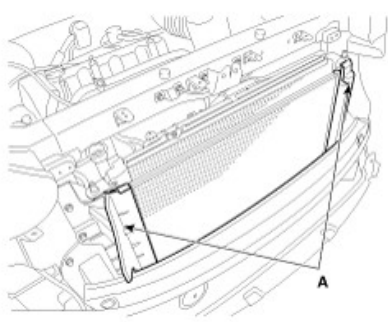
9. Disconnect the ATF cooler hose.
(Refer to Automatic Transaxle System - "Automatic Transaxle")
10. Remove the upper air guard (A) and radiator over flow hose (B).



11. Remove the horn.
(Refer to Body Electrical System - "Horn")
12. Remove the side air guard (A).

Tightening toraue :

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



13. Loosen the cooling fan mounting bolts and then disconnect the cooling fan assembly (A) from radiator.



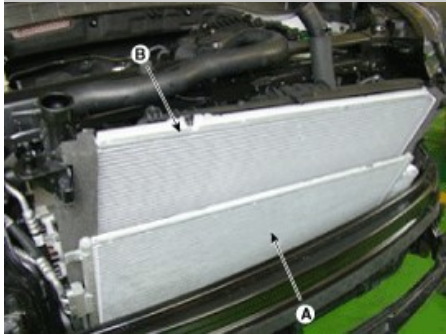
14. Remove the radiator upper bracket (A).

Tightening toraue :

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



15. Separate the A/C condenser (A) from the radiator assembly (B).



16. Pull the radiator up and then remove the radiator from the vehicle.

17. Install in the reverse order of removal.

18. Fill the radiator with coolant.

(Refer to Cooling System - "Coolant")

19. Start the engine and check for leaks.

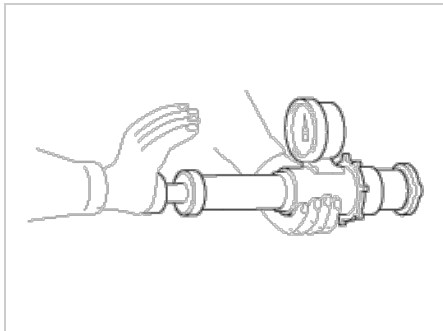
NOTICE

- Bleed air from the cooling system.
- Start engine and let it run until it warms up. (Until the radiator fan operates 3 or 4 times.)
- Turn off engine. Check the coolant level and add coolant if needed.
- This will allow trapped air to be removed from the cooling system.
- Put the radiator cap on tightly, then run engine again and check for leaks.

Inspection

Radiator Cap Testing

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



2. Apply a pressure of 79.43 ~ 122.58 kpa (0.81 ~ 1.25 kg/cm², 11.52 ~ 17.78 psi).

3. Check for a drop in pressure.

4. If the pressure drops, replace the cap.

Radiator Leakage Test

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

2. Apply a pressure tester to the radiator and apply a pressure of 79.43 ~ 122.58 kpa (0.81 ~ 1.25 kg/cm², 11.52 ~ 17.78 psi).



3. Inspect for engine coolant leaks and a drop in pressure.
4. Remove the tester and reinstall the radiator cap.

NOTICE

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

Engine Mechanical System



Removal and Installation

1. Disconnect the battery "-" terminal.
2. Disconnect the over flow hose (A).
3. Remove the reservoir tank (B).

Tightening torque:

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

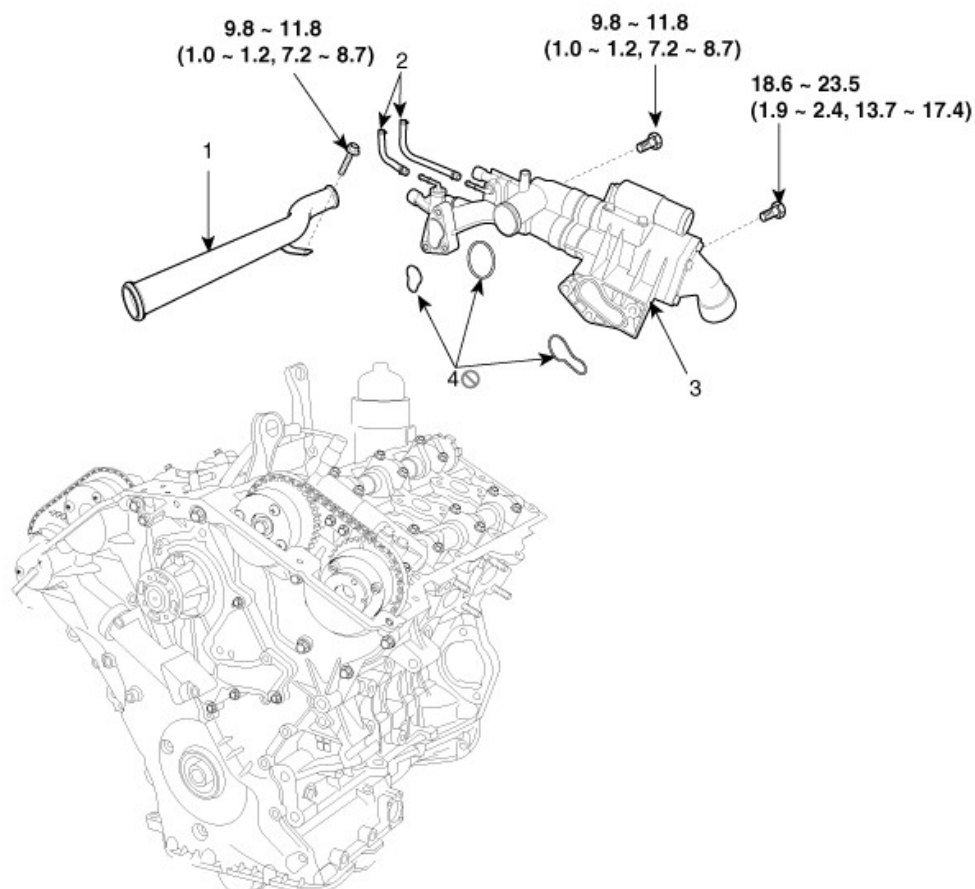


4. Install in the reverse order of removal.
5. Recheck the coolant level.
(Refer to Cooling System - "Coolant")

Engine Mechanical System



Components



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

- | | |
|--------------------------------------|---------------------------------------|
| 1. Water pipe | 3. Water temperature control assembly |
| 2. Throttle body coolant hose & pipe | 4. O-ring |

Engine Mechanical System



Removal and Installation

CAUTION

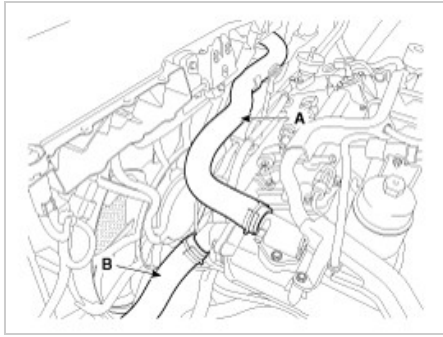
- To avoid damage, unplug the wiring connectors carefully while holding the connector portion.

NOTICE

- Mark all wiring and hoses to avoid misconnection.

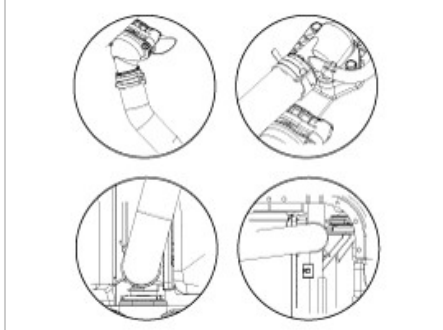
Water Temperature Control Assembly

- Disconnect the battery "-" terminal.
- Remove the engine under cover.
- Loosen the drain plug and drain the engine coolant.
(Refer to Cooling System - "Coolant")
- Remove the air cleaner assembly.
(Refer to Intake and Exhaust System - "Air cleaner")
- Disconnect the radiator upper hose (A) and lower hose (B).

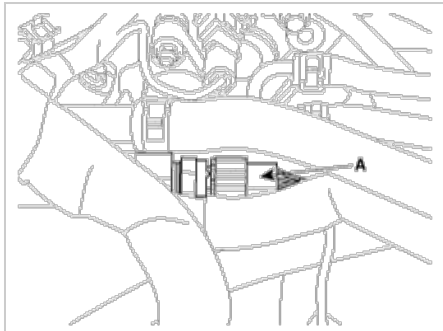


NOTICE

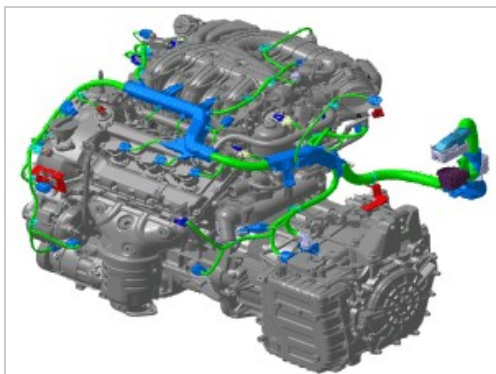
When installing radiator hoses, install as shown in illustrations.



6. Disconnect the WTS & gauge unit connector (A).



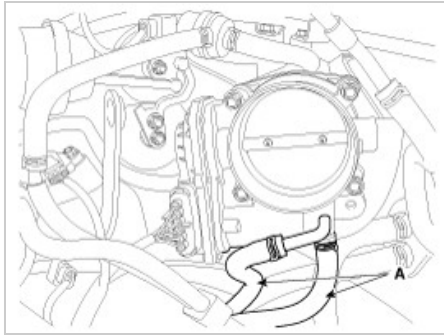
7. Separate the engine wiring protector mounted on the water temperature control assembly.
(Refer to Engine Control/Fuel System - "Engine Control System Components")



CAUTION

When installing, be sure to install the wiring protector mounting bolts of the original.
If other bolts(longer or larger) has been installed, this can damage the water temperature control assembly and coolant may be leak.

8. Disconnect the throttle body coolant hoses (A).



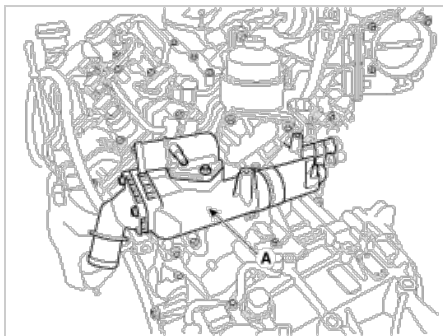
9. Disconnect the heater hoses (B).



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

Tightening torque :

19.6 ~ 23.5 N.m (2.0 ~ 2.4 kgf.m, 14.5 ~ 17.4 lb-ft)



11. Install in the reverse order of removal.

12. Fill the radiator with coolant and check for leaks.
(Refer to Cooling System - "Coolant")

NOTICE

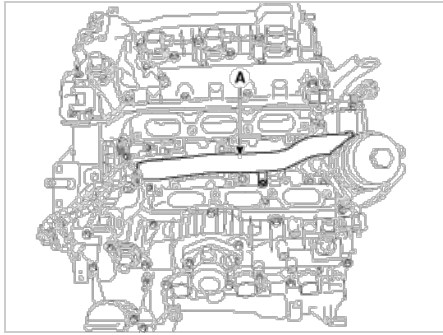
- Refill engine coolant.
- Refill radiator and reservoir tank with engine coolant.
- Bleed air from the cooling system.
- Start engine and let it run until it warms up. (Until the radiator fan operates 3 or 4 times.)
- Turn Off the engine. Check the level in the radiator, add coolant if needed. This will allow trapped air to be removed from the cooling system.
- Put radiator cap on tightly, then run the engine again and check for leaks.
- Clean the battery posts and cable terminals with sandpaper assemble them, then apply grease to prevent corrosion.

Water Center Pipe

1. Remove the intake manifold.
(Refer to Intake And Exhaust System - "Intake Manifold")
2. Remove the water temperature control assembly.
(Refer to Cooling System - "Water Temperature Control Assembly")
3. Remove the water center pipe (A).

Tightening torque:

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



NOTICE

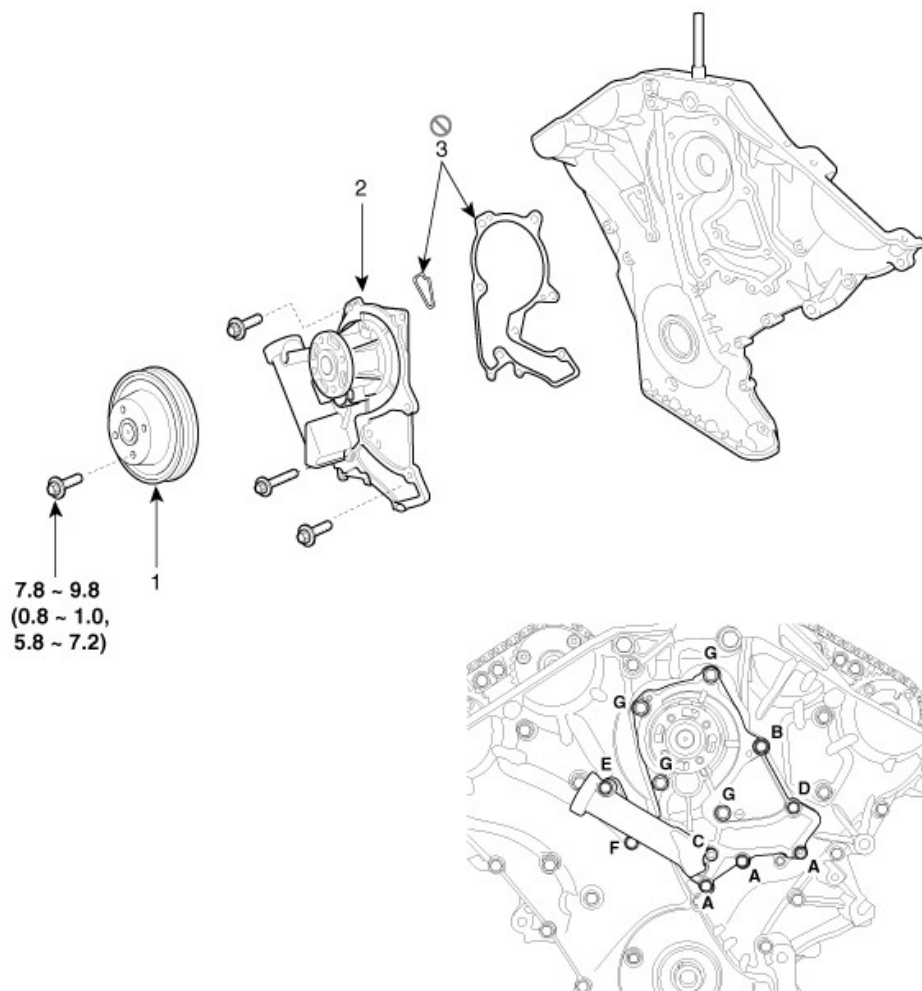
Do not reuse water pipe O-ring.

4. Install in the reverse order of removal.

Engine Mechanical System



Components



Torque : Refer to Installation procedure

1. Water pump pulley
2. Water pump
3. Water pump gasket

Engine Mechanical System



Removal and Installation

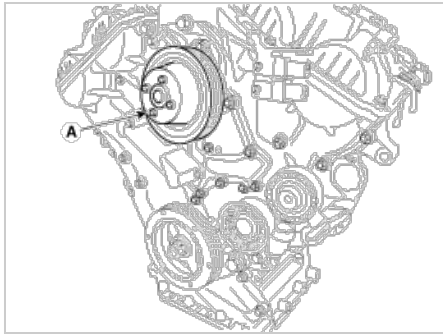
1. Disconnect the battery "-" terminal.
2. Remove the engine under cover.
3. Drain the engine coolant.

(Refer to Cooling System - "Coolant")

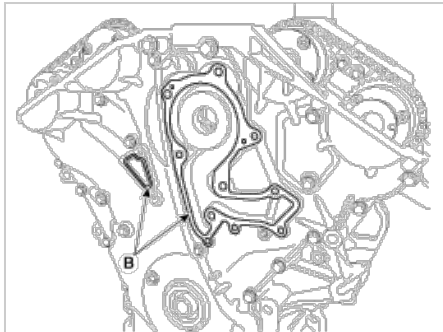
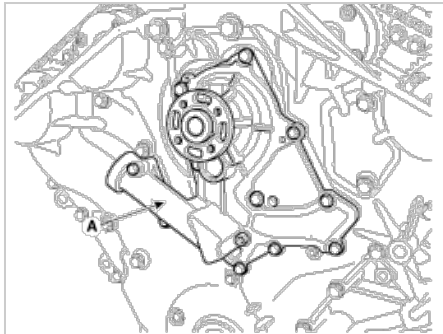
4. Remove the drive belt.
(Refer to Timing System - "Drive Belt")
5. Remove the water pump pulley (A).

Tightening torque :

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



6. Remove the water pump (A) and gasket (B).

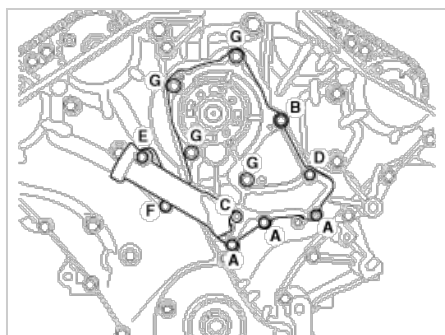


NOTICE

- Clean the contact face before assemble.
- Always use a new gaskets.
- Always use a new seal bolt (Bolt L)

Tightening torque

A(3EA): 9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)
B(1EA): 9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)
C(1EA): 21.6 ~ 26.5N.m (2.2 ~ 2.7kgf.m, 15.9 ~ 19.5lb-ft)
D(1EA): 9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)
E(1EA): 9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)
F(1EA): 9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)
G(4EA) :21.6 ~ 23.5N.m (2.2 ~ 2.4kgf.m, 15.9 ~ 17.4lb-ft)



7. Install in the reverse order of removal.
8. Fill the radiator with coolant and check for leaks.
(Refer to Cooling System - "Coolant")

Inspection

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

NOTICE

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

Engine Mechanical System



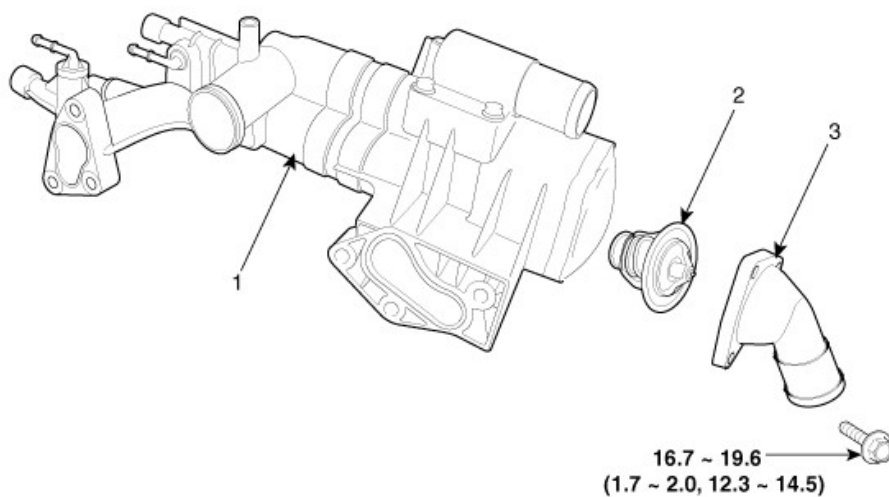
Troubleshooting

Symptoms		Possible Causes		Remedy
Coolant leakage	• From the bleed hole of the water pump	Visually check	• Check leaks after about ten-minute warming up.	• If coolant still leaks, replace a water pump.
	• From gaskets or bolts		• Check the tightening of the water pump mounting bolts.	• If leakage stops, reuse the water pump (Do not replace the pump with a new one).
	• From outer surface of water pump		• Check damage of gaskets or inflow of dust.	• Retighten the mounting bolts.
Noise	• From bearings • From mechanical seals • Impeller interference	Inspection with a stethoscope	• Check the material or any cracks of the water pump.	• Replace the gasket and clean dust off.
		Inspection after removing a drive belt	• After starting the engine, check noise with a stethoscope.	• Poor material. If any crack found, replace the water pump.
		Inspection after removing a water pump	• After removing a water pump and a drive belt, check noise again.	• If there is no noise, reuse the water pump (do not replace it).
Overheating	• Damaged impeller • Loosened impeller	Loosened impeller	• 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.
			• Corrosion of the impeller wing	• If there is noise, reuse the water pump. Check other drive line parts.
			• Impeller separation from the shaft	• If there is no noise, replace the water pump with a new one.
				• If there is any interference between them, replace the water pump with a new one.
				• Check engine coolant.
				• Poor coolant quality / Maintenance check
				• Replace the water pump.

Engine Mechanical System



Components



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

- 1. Water temperature control Assembly
- 2. Thermostat

- 3. Water inlet fitting pipe

Engine Mechanical System

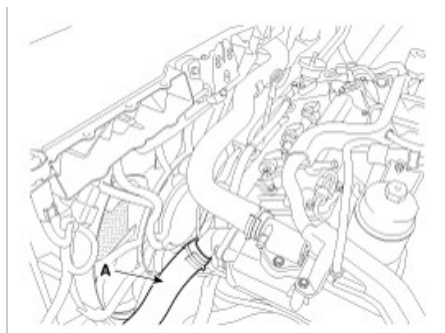


Removal and Installation

NOTICE

Removal of the thermostat would have an adverse effect, causing a lowering of cooling efficiency. Do not remove the thermostat, even if the engine tends to overheat.

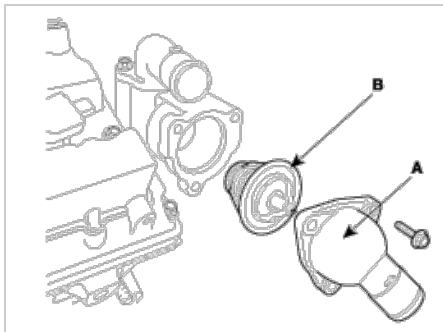
1. Disconnect the battery "-" terminal.
2. Remove the engine under cover.
3. Drain engine coolant so its level is below thermostat.
(Refer to Cooling System - "Coolant")
4. Remove the radiator lower hose (A).



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

Tightening torque :

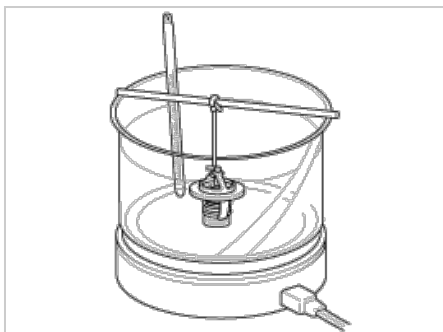
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)



6. Install in the reverse order of removal.
7. Fill the radiator with coolant and check for leaks.
(Refer to Cooling System - "Coolant")

Inspection

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



2. Check the valve opening temperature.

Valve opening temperature:

88±2°C (109.4±3.6°F)

Full opening temperature:100°C (212°F)

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

3. Check the valve lift.

Valve lift :10 mm (0.3937 in.) or more at 100°C (212°F)

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

Engine Mechanical System**Troubleshooting**

Symptoms		Possible Causes		Remedy
Coolant leakage	From the thermostat gasket	Check the mounting bolts	Check the torque of the mounting bolts	Retighten the bolts and check leakage again.
		Check the gasket for damage	Check gasket or seal for damage	Replace gaskets and reuse the thermostat.
Cooled excessively	- Low heater performance (cool air blown-out) - Thermogauge indicates "LOW"	Visually check after removing the radiator cap.	Insufficient coolant or leakage.	After refilling coolant, recheck.
		GDS check & Starting engine	- Check DTCs - Check connection of the fan clutch or the fan motor. ※ If the fan clutch is always connected, there will be a noise at idle.	- Check the engine coolant sensor, wiring and connectors. - Replace the 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 - Thermogauge indicates "HI"	Visually check after removing the radiator cap.	- Insufficient coolant or leakage. ※ Be careful when removing a radiator cap of the overheated vehicle. - Check air in cooling system.	- After refilling coolant, recheck. - Check the cylinder head gaskets for damage and the tightening torque of the mounting bolts.
		GDS check & Starting engine	Check DTCs	Check the engine coolant sensor, wiring and connectors.

			Check the fan motor performance as temperature varies. • Check if the fan clutch slips. • Check the water pump adherence or impeller damaged.	• Check the fan motor, the relay and the connector. • Replace the fan clutch, if it doesn't work properly. • Replace the water pump, if it doesn't work properly.
		Immerse the thermostat in boiling water and inspection.	• After removing the thermostat, check it works properly. ※ Check the thermostat opens at the valve opening temperature.	• Replace the thermostat, if it doesn't work properly.

Engine Mechanical System

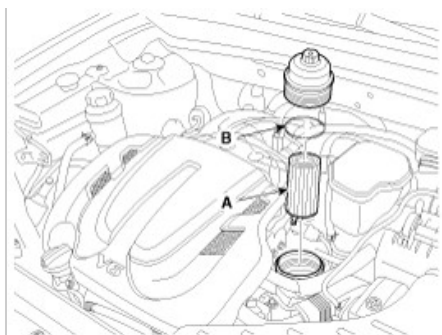


Replacement

⚠ CAUTION

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

1. Park the car on level ground.
Start the engine and let it warm up.
2. Turn the engine off and open the hood.
Remove the engine cover.
3. Wait for 5 minutes after loosening the oil filter cap to drain fully the oil in the oil filter.
4. Drain engine oil.
(1) Remove the oil filler cap.
(2) After lifting the car, remove the oil drain plug and drain oil into a container.
5. Replace the oil filter.
(1) Disconnect the oil filter cap from the oil filter body.
(2) Remove the oil filter element.
(3) Check and clean the oil filter installation surface.
(4) Check the part number and shape of a new oil filter is same as old one.
(5) Install a new oil filter element (A) and a new O-ring (B).



- (6) Apply clean engine oil to the new O-rings.
Lightly screw the oil filter cap into place, and tighten it until the O-ring contacts the seat.
- (7) Finally tighten it again by specified tightening torque.

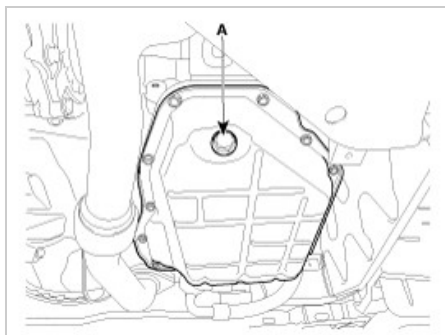
Tightening torque :

24.5 N.m (2.5 kgf.m, 18.1 lb-ft)

6. Fill new engine oil.
(1) Install the oil drain plug (A) with a new gasket.

Tightening torque :

34.3 ~ 44.1N.m (3.5 ~ 4.5kgf.m, 25.3 ~ 32.5lb-ft)



(2) Fill with new engine oil, after removing the engine oil level gauge.

Capacity

Total : 6.5 L (6.87 U.S qt., 5.71 Imp.qt., 1.71 U.S.gal.)

Oil pan : 6.0 L (6.34 U.S qt., 5.28 Imp.qt., 1.58 U.S.gal.)

Drain and refill including oil filter :

5.7 L (6.02 U.S.qt., 5.01 Imp.qt., 1.50 U.S.gal.)

CAUTION

- Fill the crankcase to about half the capacity and then fill the remainder after waiting about one minute.
- Do not fill oil over the "F" line, checking the level with the oil level gauge frequently to ensure no over filling.

(3) Install the oil filler cap and oil level gauge.

7. Start the engine and check to be sure no oil is leaking from the drain plug or oil filter.

8. Recheck the engine oil level.

Inspection

1. Check the engine oil quality. Check the oil deterioration, addition of water or coolant, discoloring or thinning. If the quality is visibly poor, replace the oil.

2. Check the engine oil level.

After warming up the engine and then 5 minutes after the engine stop, oil level should be between the "L" and "F" marks in the dipstick.

If low, check for leakage and add oil up to the "F" mark.

NOTICE

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

Selection Of Engine Oil

Recommendation :

- 5W-30 / ACEA A5

(If not available, refer to the recommended API, ILSAC or ACEA and SAE classification).

ACEA classification : A3 or above

SAE viscosity grade: Refer to the recommended SAE viscosity number

TEMPERATURE RANGE OF SAE VISCOSITY NUMBERS										
Temperature	°C	-30	-20	-10	0	10	20	30	40	50
	°F	-10	0	20	40	60	80	100	120	
North America										
						10W-30				
					5W-30					

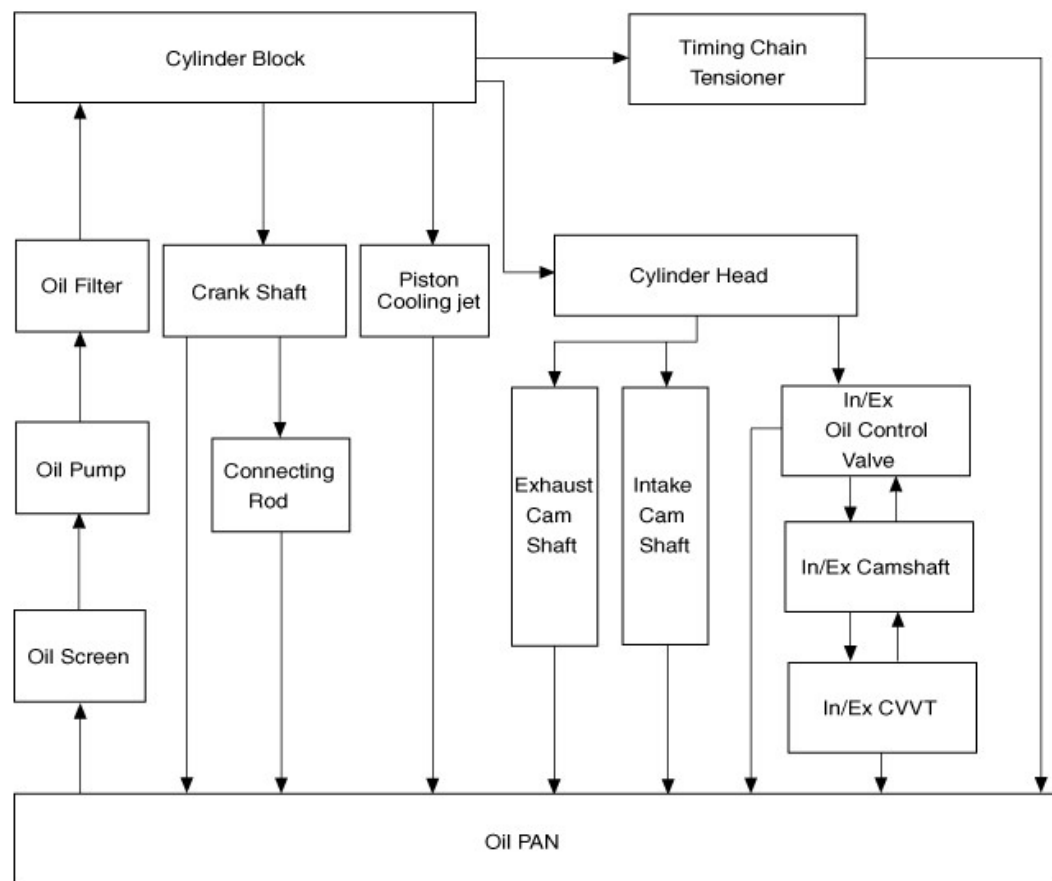
NOTICE

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

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



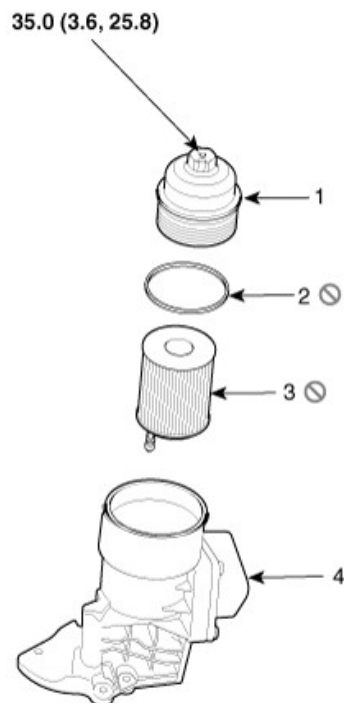
Engine oil flow diagram



Engine Mechanical System



Components



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

- 1. Oil filter cap
- 2. O-ring

- 3. Oil filter element
- 4. Oil filter body

Engine Mechanical System



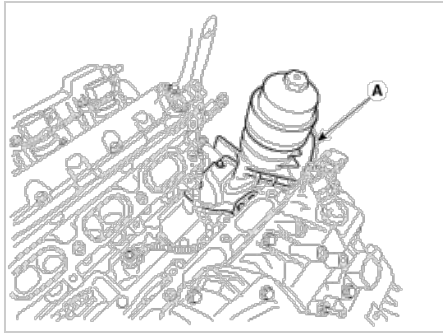
Removal And Installaion

Oil filter body

1. Disconnect the battery "-" terminal.
2. Remove the engine under cover.
3. Drain engine oil.
(Refer to Lubrication System - "Engine Oil")
4. Remove the water center pipe.
(Refer to Cooling System - "Water Temperature Control Aassembly")
5. Wait for 5 minutes after loosening the oil filter cap to drain well the oil in the oil filter.
6. Remove the oil filter body (A).

Tightening torque :

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



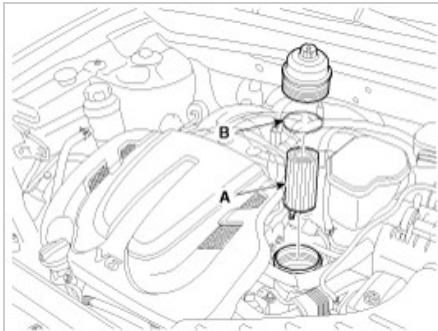
NOTICE

- All rubber gaskets must not be damaged by assembling parts.
- Do not reuse oil filter body O-ring.

7. Install in the reverse order of removal.
8. Start engine and check for oil leaks.
9. Recheck the engine oil level.

Oil filter

1. Disconnect the battery "-" terminal.
2. Replace the oil filter.
 - (1) Disconnect the oil filter cap from the oil filter body.
 - (2) Remove the oil filter element.
 - (3) Check and clean the oil filter installation surface.
 - (4) Check the part number and shape of a new oil filter is same as old one.
 - (5) Install a new oil filter element (A) and a new O-ring (B).



- (6) Apply clean engine oil to the new O-rings. Lightly screw the oil filter cap into place, and tighten it until the O-ring contacts the seat.
- (7) Finally tighten it again by specified tightening torque.

Tightening torque :

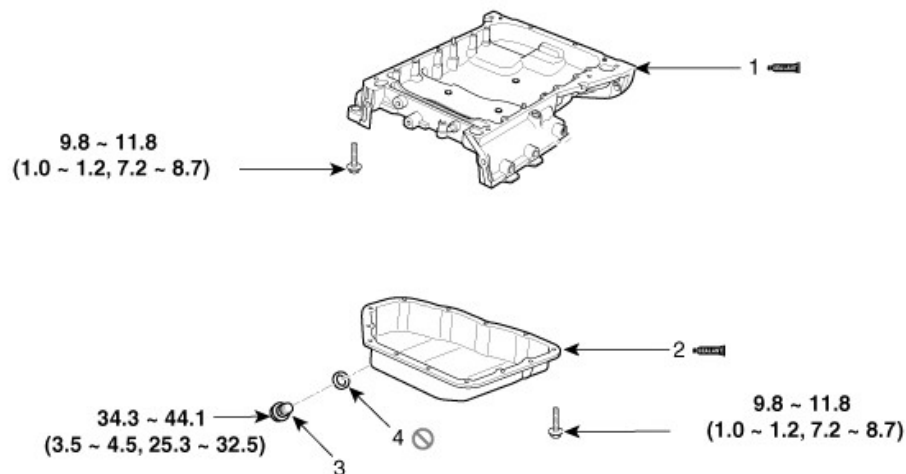
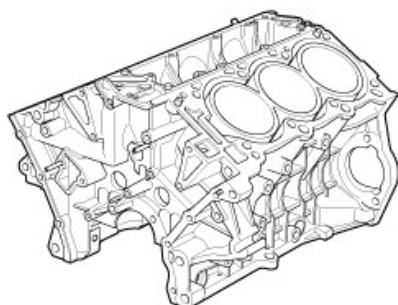
24.5 N.m (2.5 kgf.m, 18.1 lb-ft)

3. Fill new engine oil.
(Refer to Lubrication System - "Engine Oil")
4. Install in the reverse order of removal.
5. Start engine and check for oil leaks.
6. Recheck the engine oil level.

Engine Mechanical System



Components



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

1. Upper oil pan
2. Lower oil pan

3. Drain plug
4. Drain plug gasket

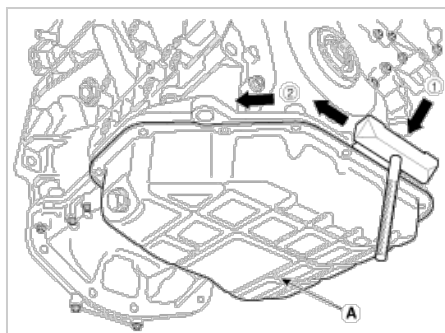
Engine Mechanical System



Removal

Lower oil pan

1. Disconnect the battery "-" terminal.
2. Remove the engine under cover.
3. Drain the engine oil.
(Refer to Lubrication System - "Engine Oil")
4. Remove the lower oil pan (A).

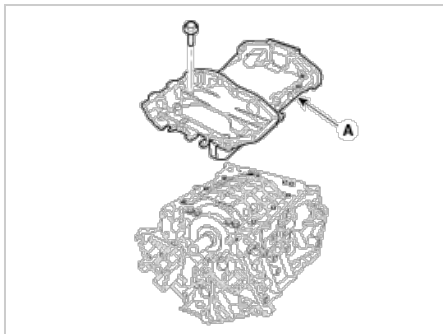


NOTICE

- Insert the blade of SST(09215-3C000) between the upper oil pan and lower oil pan.
Cut off applied sealer and remove the lower oil pan.
- Insert the SST between the oil pan and the ladder frame by tapping it with a plastic hammer in the direction of arrow.
- After tapping the SST with a plastic hammer along the direction of arrow around more than 2/3 edge of the oil pan, remove it from the ladder frame.
- Do not use the SST as a prybar.
Hold the tool in position (on the gasket line) and tap in with a light hammer.
- Be careful not to damage the contact surfaces of Upper oil pan and lower oil pan.

Upper oil pan

1. Remove the engine assembly from the vehicle.
(Refer to Engine And Transmission Assembly - "Engine And Transmission Assembly")
2. Attach the engine to engine stand for disassembly.
3. Remove the timing chain.
(Refer to Timing System - "Timing Chain")
4. Remove the lower oil pan.
(Refer to Lubrication System - "Oil Pan")
5. Remove the oil pump.
(Refer to Lubrication System - "Oil Pump")
6. Remove the oil level gauge.
(Refer to Lubrication System - "Oil Level Gauge & Pipe")
7. Remove the air conditioning compressor.
(Refer to Heating, Ventilation, Air Conditioning - "Compressor")
8. Remove the LH/RH exhaust manifold stays.
(Refer to Intake And Exhaust System - "Exhaust Manifold")
9. Remove the upper oil pan (A).



NOTICE

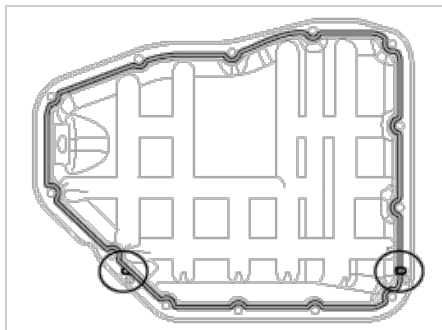
Insert the blade of SST(09215-3C000) between the upper oil pan and lower oil pan.
Cut off applied sealer and remove the lower oil pan.

Installation

Lower oil pan

1. Install the lower oil pan (A).
 - (1) Using a gasket scraper, remove all the old packing material from the gasket surfaces.
 - (2) Before assembling the oil pan, the liquid sealant THREE BOND 1217H should be applied on oil pan. The part must be assembled within 5 minutes after the sealant was applied.

Bead width :2.5 mm (0.1 in.)



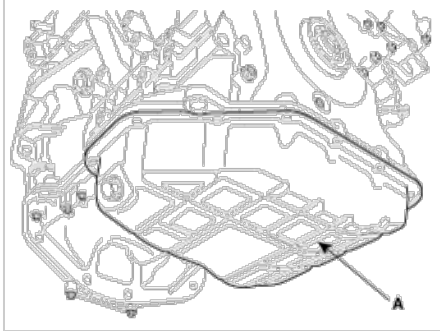
CAUTION

- Clean the sealing face before assembling two parts.
- Remove harmful foreign matters on the sealing face before applying sealant.
- When applying sealant gasket, sealant must not protrud into the inside of oil pan.
- To prevent leakage of oil, apply sealant gasket to the inner threads of the bolt holes.
- After assembly, wait at least 30 minutes before filling the engine with oil.

(3) Install the oil pan (A).

Tightening torque :

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

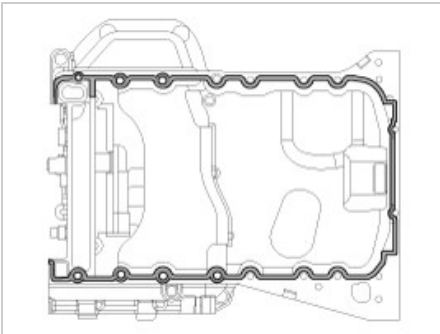


2. After assembly, wait at least 30 minutes before filling the engine with oil.
(Refer to Lubrication System - "Engine Oil")
3. Install all other parts in reverse order of removal.

Upper oil pan

1. Install the upper oil pan.
 - a. Using a gasket scraper, remove all the old gasket material from the gasket surfaces.
 - b. Before assembling the oil pan, the liquid sealant THREE BOND 1217H should be applied on upper oil pan.
The part must be assembled within 5 minutes after the sealant was applied.

Bead width :2.5 mm (0.1 in.)



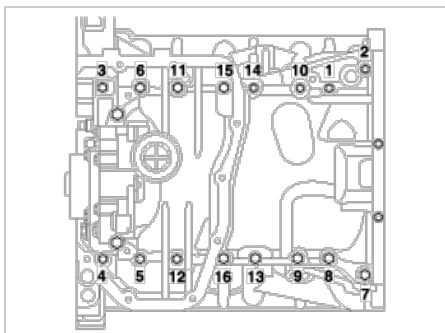
NOTICE

- Clean the sealing face before assembling two parts.
- Remove harmful foreign materials on the sealing face before applying sealant
- When applying sealant gasket, sealant must not protrud into the inside of oil pan.
- To prevent leakage of oil, apply sealant gasket to the inner threads of the bolt holes.
- After assembly, wait at least 30 minutes before filling the engine with oil.

- c. Install the upper oil pan.
Uniformly tighten the bolts in several passes.

Tightening torque :

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

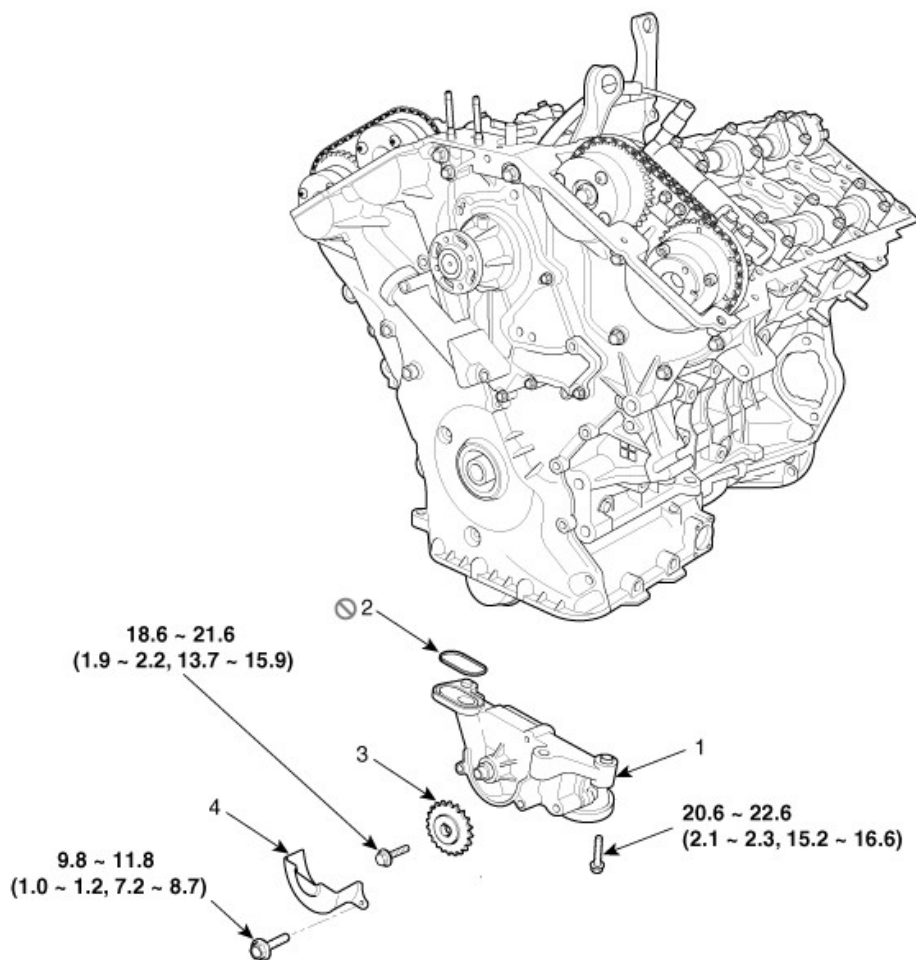


2. Install all other parts in reverse order of removal.

Engine Mechanical System



Components



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

- | | |
|-------------|-------------------------|
| 1. Oil pump | 3. Oil pump sprocket |
| 2. O-ring | 4. Oil pump chain cover |

Engine Mechanical System

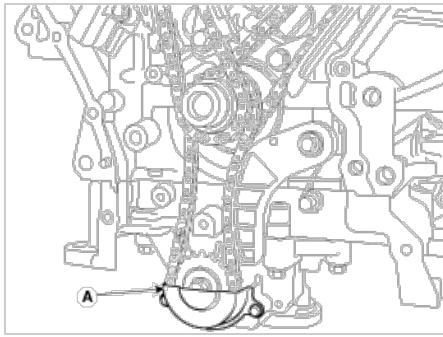


Removal

1. Remove the lower oil pan.
(Refer to Lubrication System - "Oil pan")
2. Remove the oil pump chain cover (A).

Tightening torque :

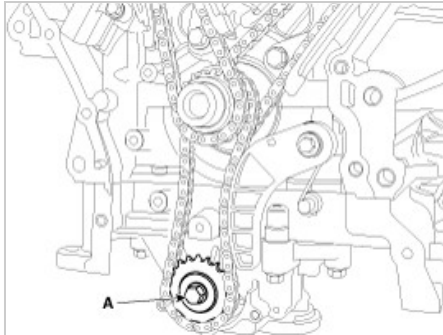
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)



3. Remove the bolt (A) and then separate the chain with sprocket from the oil pump.

Tightening torque :

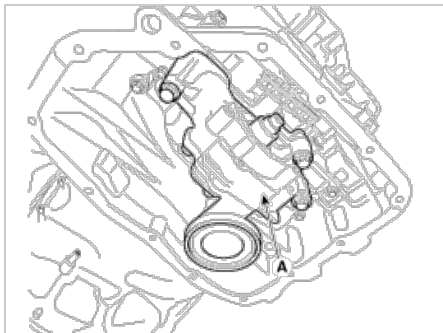
18.6 ~ 21.6 N.m (1.9 ~ 2.2 kgf.m, 13.7 ~ 15.9 lb-ft)



4. Remove the oil pump (A).

Tightening torque :

20.6 ~ 22.6 N.m (2.1 ~ 2.3 kgf.m, 15.2 ~ 16.6 lb-ft)



NOTICE

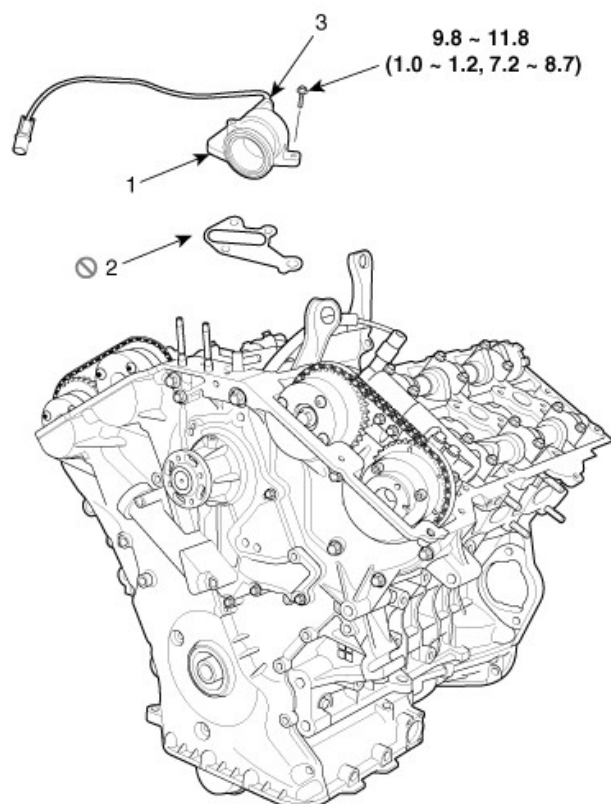
When installing, use a new O-ring (B).

5. After assembly, wait at least 30 minutes before filling the engine with oil.
(Refer to Lubrication System - "Engine Oil")
6. Install in the reverse order of removal.

Engine Mechanical System



Components



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

1. Oil cover
2. Oil cover gasket

3. Oil pressure switch

Engine Mechanical System



Removal and Installaion

1. Remove the intake manifold.
(Refer to Intake And Exhaust System - "Intake Manifold")
2. If necessary, remove the RH knock sensor.
(Refer to Engine Control/Fuel System - "Knock Sensor")
3. Remove the oil pressure switch (A).

Tightening torque:

34.3 ~ 44.1 N.m (3.5 ~ 4.5 kgf.m, 25.3 ~ 32.5 lb-ft)



NOTICE

To remove and install the oil pressure switch, use a deep socket (A) and a universal joint (B).



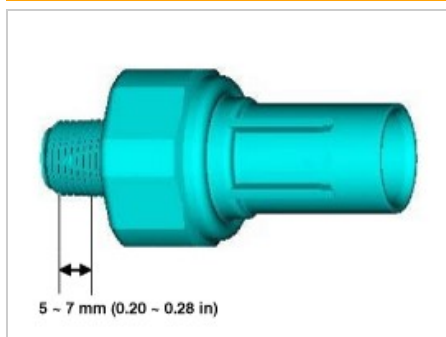
4. Install in the reverse order of removal.

NOTICE

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

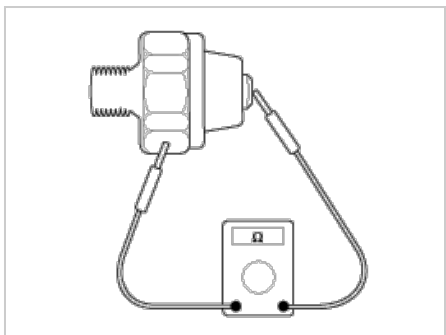
Seal lock :THREE BOND 2403

Thickness :0.2 ~ 0.4 mm (0.008 ~ 0.016 in)

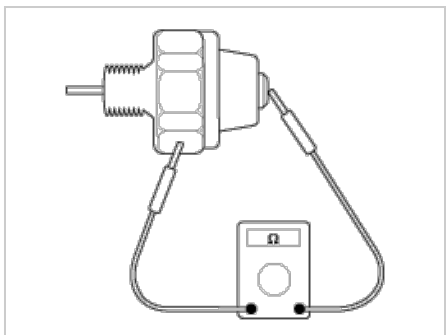


Inspection

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



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

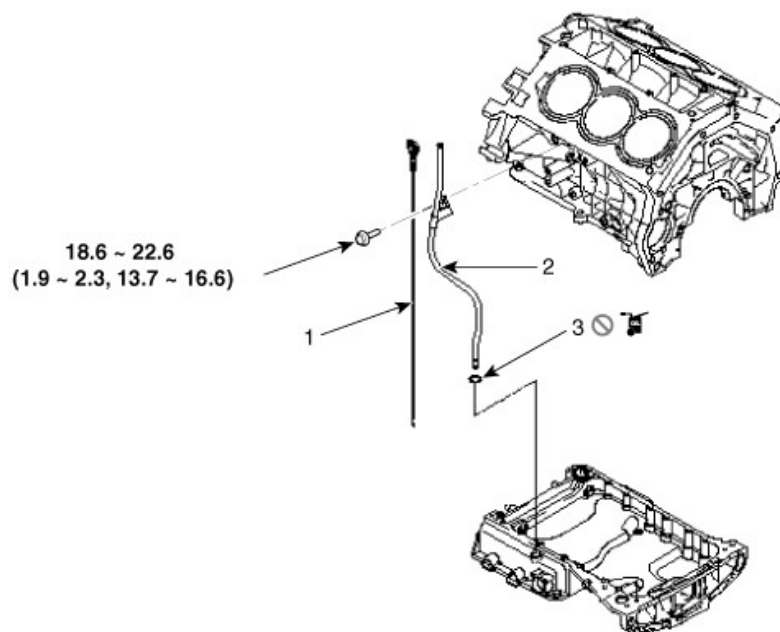


3. If there is no continuity when a 19.6 ~ 39.2 kpa (2.8 ~ 5.7psi) is applied through the oil hole the switch is operating properly.
Check for air leakage. If air leaks, the diaphragm is broken. Replace it.

Engine Mechanical System



Components



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

- | | |
|------------------------|-----------|
| 1. Oil level gauge | 3. O-ring |
| 2. Oil level gauge rod | |

Engine Mechanical System

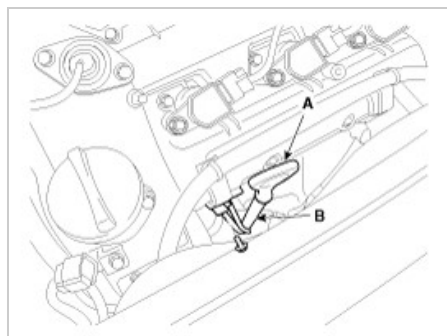


Removal And Installaion

1. Disconnect the battery "-" terminal.
2. Remove the engine oil level gauge (A) and oil level gauge rod (B).

Tightening torque:

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



NOTICE

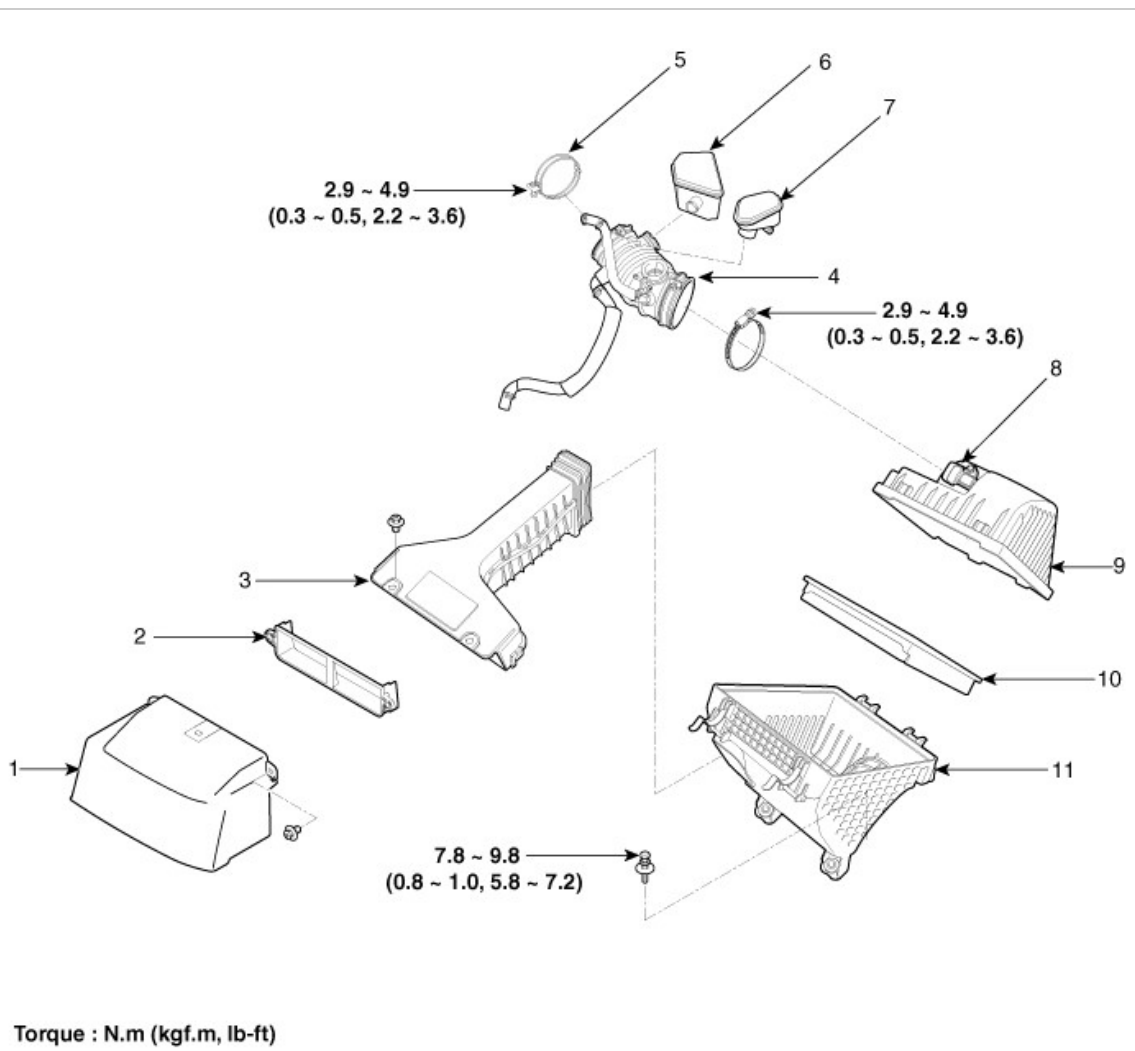
When installing, apply engine oil to the O-ring and take care the O-ring not to be damaged.
Always use a new O-ring.

3. Install in the reverse order of removal.

Engine Mechanical System



Components



1. Air intake shield
2. Air duct extension
3. Air duct
4. Air intake hose
5. Clamp
6. Resonator "B"

7. Resonator "A"
8. Barometric pressure sensor
9. Air cleaner cover
10. Air Cleaner element
11. Air Cleaner body

Engine Mechanical System



Removal and Installation

Air Cleaner Assembly

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



4. Remove the air cleaner assembly (A).
 - (1) Disconnect the barometric pressure sensor (BPS) connector (B).
 - (2) Disconnect the breather hose (C).

(3) Loosen the clamp (D) and then disconnect the air intake hose from the throttle body.

(4) Disconnect the brake vacuum hose (E).

Tightening torque

Hose clamp bolt:

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

Air cleaner assembly bolts:

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



5. Install in the reverse order of removal.

Air Cleaner Element

1. Open the service cover after pull the clamp of the air cleaner.



2. Replace new an air cleaner element (A).

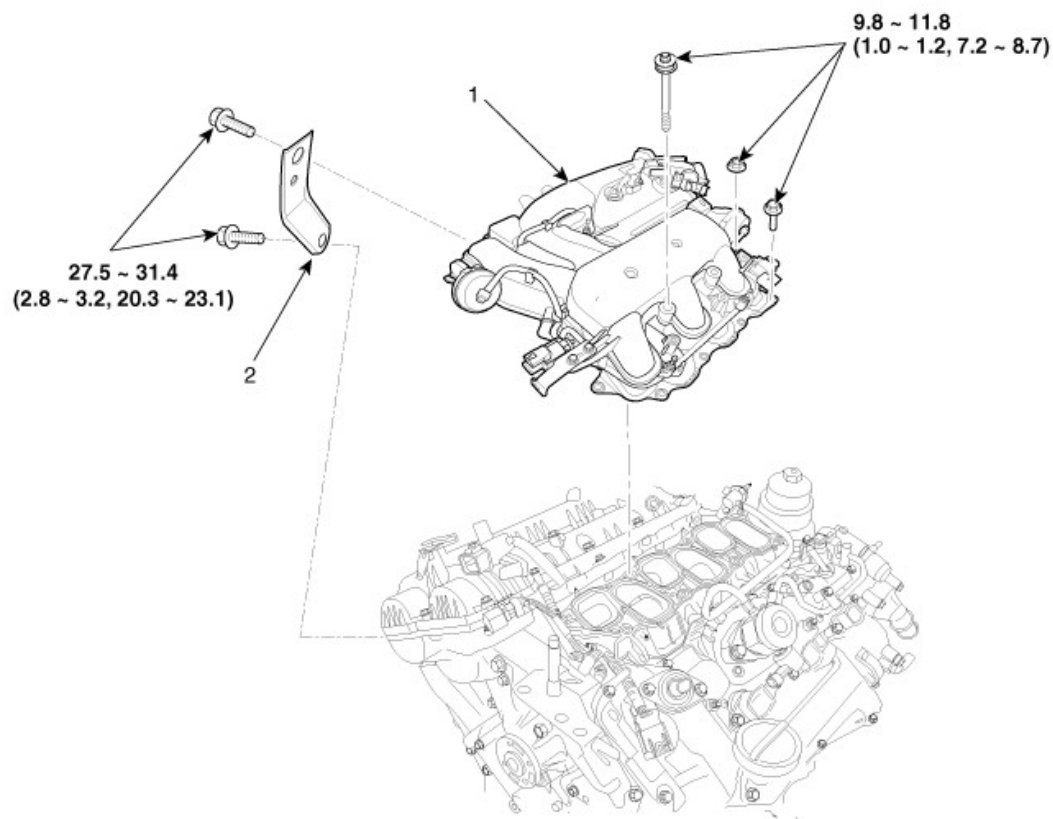


3. Close the service cover and then fix the clamp.

Engine Mechanical System



Components



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

1. Surge tank

2. Surge tank stay

Engine Mechanical System



Removal and Installation

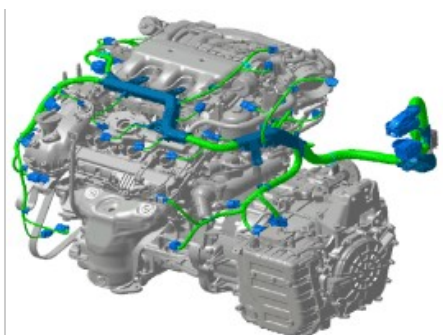
CAUTION

- To avoid damage, unplug the wiring connectors carefully while holding the connector portion.

NOTICE

- Mark all wiring and hoses to avoid misconnection.

1. Remove the Air cleaner assembly.
(Refer to Intake And Exhaust system - "Air Cleaner")
2. Disconnect the necessary parts like the engine wiring connector and harness clamp around the engine in order to remove the surge tank.
(Refer to Engine Control/Fuel System - "Engine Control System Components")



3. Disconnect the brake vacuum hose (A).



4. Disconnect the PCSV hose (A).



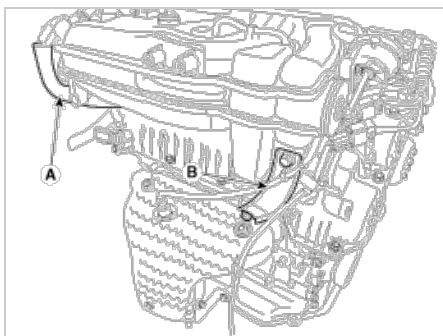
5. Remove the ETC module (A).



6. Disconnect the PCV hose (A), and then remove the surge tank stay (B).

Tightening torque :

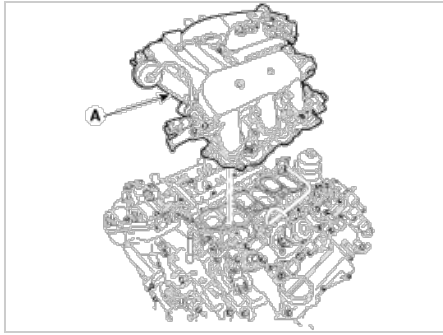
27.5 ~ 31.4N.m (2.8 ~ 3.2kgf.m, 20.3 ~ 23.1lb-ft)



7. Remove the surge tank (A).

Tightening torque :

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



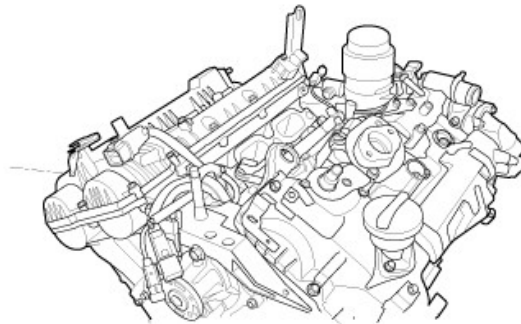
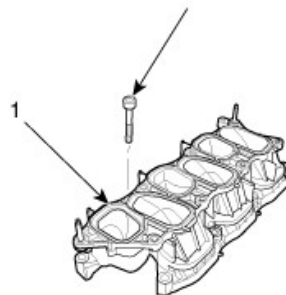
8. Install in the reverse order of removal.
9. Fill the engine coolant after check coolant level.

Engine Mechanical System



Components

1st step: 3.9 ~ 5.9 (0.4 ~ 0.6, 2.9 ~ 4.3)
2nd step: 26.5 ~ 31.4 (2.7 ~ 3.2, 19.5 ~ 23.1)



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

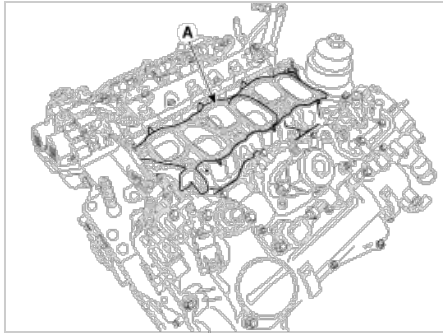
1. Intake manifold

Engine Mechanical System



Removal and Installation

1. Remove the surge tank.
(Refer to Intake And Exhaust System - "Surge Tank")
2. Remove the low pressure fuel line.
(Refer to Engine Control/Fuel System - "Fuel Line")
3. Remove the intake manifold (A).



NOTICE

- Cover the cylinder head intake port with a clean woven stuff or vinyl cover to prevent foreign materials from entering.
- Make sure the engine and radiator are cool to the touch.
- Remove radiator cap.
- Loosen the drain plug and drain the coolant.
- Tighten the radiator drain plug securely.

CAUTION

Drain the engine coolant before removing the intake manifold.

Otherwise, engine coolant may enter into the intake port from the vent holes of the cylinder head and this can cause problems in the engine combustion chambers.

4. Install in the reverse order of removal.

NOTICE

Tighten the intake manifold bolts and nuts, in several passes as below.

a ~ h : 1st step order

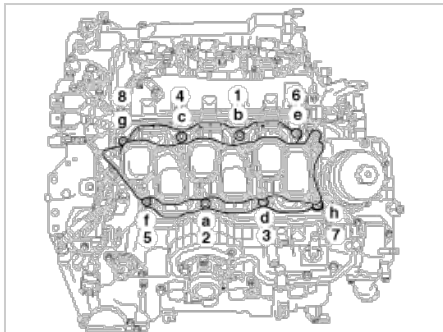
1 ~ 8 : 2nd step order

Tightening torque

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

Step 2: 26.5 ~ 31.4N.m (2.7~3.2kgf.m, 19.5~23.1lb-ft)

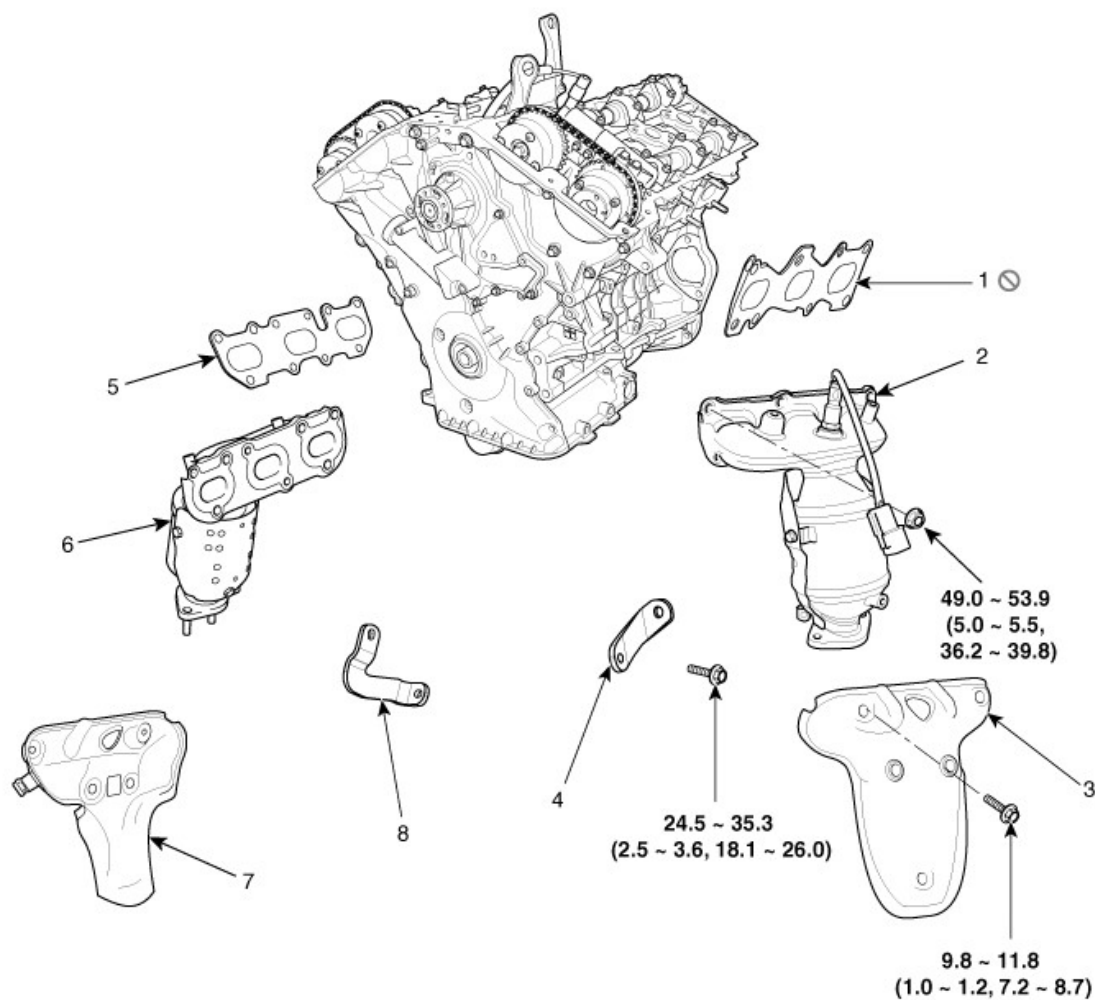
Step 3: Repeat 2nd step twice or more.



CAUTION

Fill the engine coolant after installing intake manifold and check coolant level.





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

- | | |
|-------------------------------|-------------------------------|
| 1. LH Exhaust manifold gasket | 5. RH Exhaust manifold gasket |
| 2. LH Exhaust manifold | 6. RH Exhaust manifold |
| 3. LH Heat protector | 7. RH Heat protector |
| 4. LH Exhaust manifold stay | 8. RH Exhaust manifold stay |

Engine Mechanical System



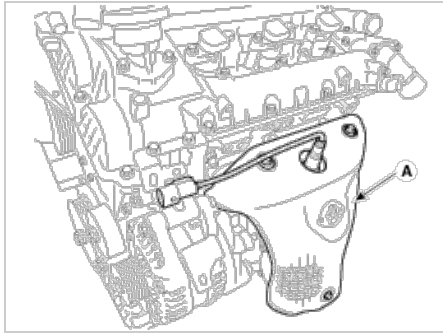
Removal and Installation

[LH]

1. Disconnect the LH front and rear heated oxygen sensor (HO2S) connector.
(Refer to Engine Control/Fuel System - "Heated Oxygen Sensor (HO2S)")
2. Remove the front muffler.
(Refer to Intake And Exhaust System - "Muffler")
3. Remove the cooling fan assembly.
(Refer to Cooling System - "Cooling Fan")
4. Remove oil level gauge assembly.
(Refer to Lubrication System - "Oil Level Gauge & Pipe")
5. Remove the LH exhaust manifold heat protector (A).

Tightening torque :

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



6. Remove the LH exhaust manifold stay (A), and then remove the LH exhaust manifold (B) and gasket.

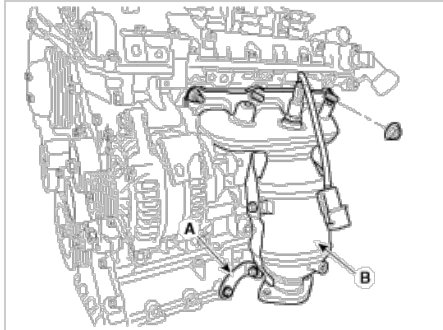
Tightening torque

Stay bolt :

24.5 ~ 35.3N.m (2.5 ~ 3.6kgf.m, 18.1 ~ 26.0lb-ft)

Manifold nuts :

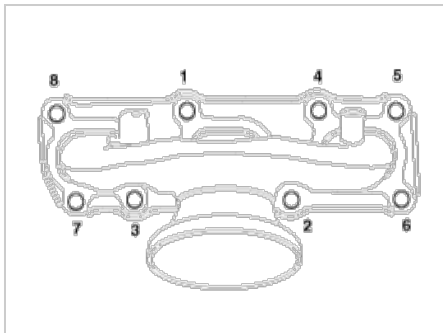
49.0 ~ 53.9N.m (5.0 ~ 5.5kgf.m, 36.2 ~ 39.8lb-ft)



7. Install in the reverse order of removal.

NOTICE

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

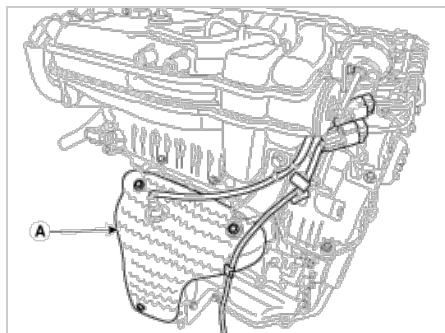


[RH]

1. Disconnect the RH front and rear heated oxygen sensor (HO2S) connector.
(Refer to Engine Control/Fuel System - "Heated Oxygen Sensor (HO2S)")
2. Remove the surge tank.
(Refer to Intake And Exhaust System - "Surge Tank")
3. Remove the front muffler.
(Refer to Intake And Exhaust System - "Muffler")
4. Remove the RH exhaust manifold heat protector (A).

Tightening torque :

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



5. Remove the RH exhaust manifold stay (A), and then remove the RH exhaust manifold (B) and gasket.

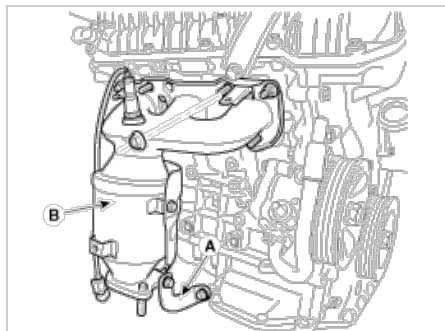
Tightening torque

Stay bolt :

24.5 ~ 35.3 N.m (2.5 ~ 3.6 kgf.m, 18.1 ~ 26.0 lb-ft)

Manifold nuts :

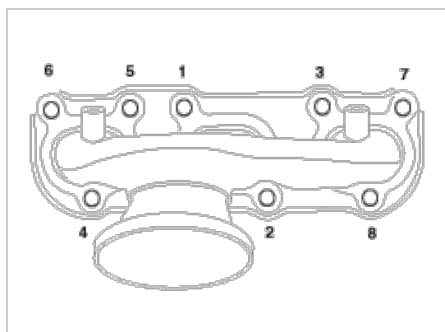
49.0 ~ 53.9 N.m (5.0 ~ 5.5 kgf.m, 36.2 ~ 39.8 lb-ft)



6. Install in the reverse order of removal.

NOTICE

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



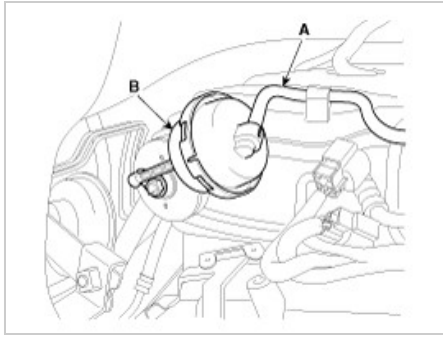
Removal and Installation

VIS 1 [Intake Manifold]

1. Disconnect the battery "-" terminal.
2. Remove the engine cover.
3. Disconnect the VIS actuator hose (A).
4. Remove the VIS actuator (B).

Tightening torque :

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



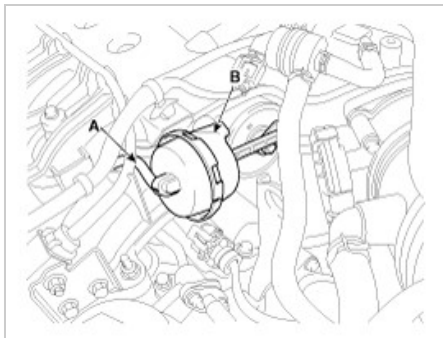
5. Install in the reverse order of removal.

VIS 2 [Surge Tank]

1. Disconnect the battery "-" terminal.
2. Remove the engine cover.
3. Disconnect the VIS actuator hose (A).
4. Remove the VIS actuator (B).

Tightening torque :

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

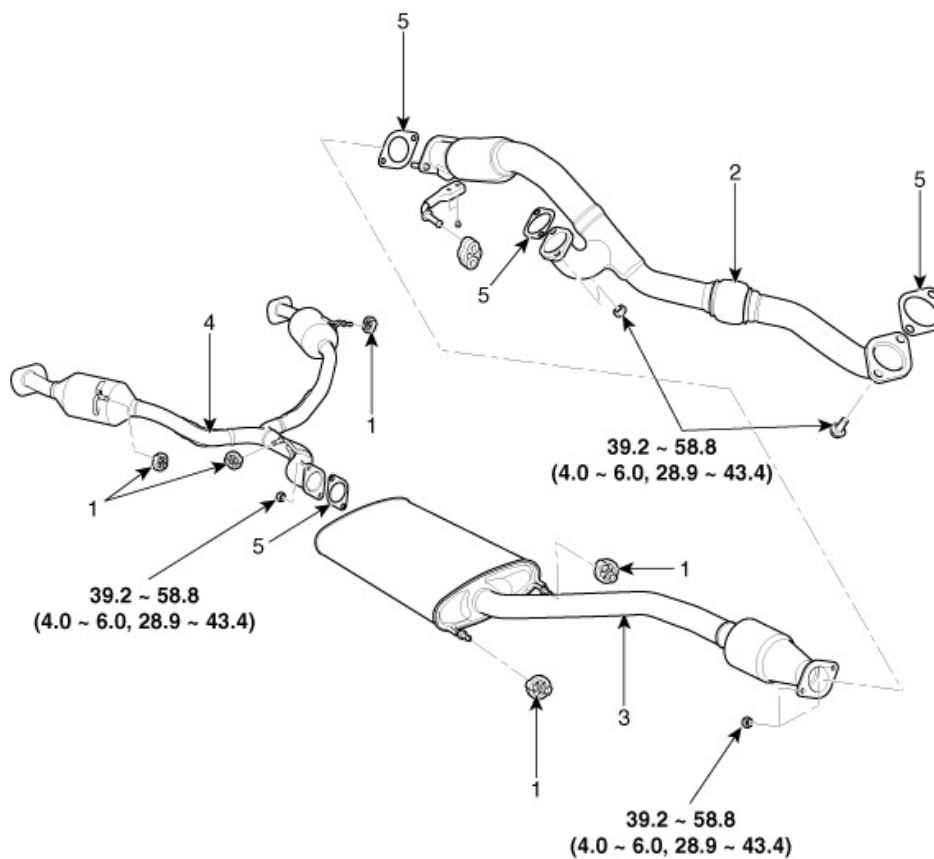


5. Install in the reverse order of removal.

Engine Mechanical System



Components



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

1. Rubber hanger
2. Front muffler

3. Center muffler
4. Rear muffler

Engine Mechanical System



Removal and Installation

Front Muffler

1. Disconnect the battery "-" terminal.
2. Remove the engine room under cover.
3. Remove the front muffler hanger (A) and bracket (B).

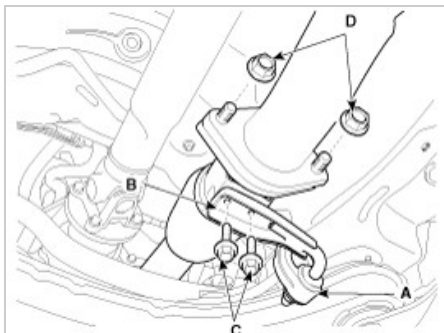
Tightening torque

Bolts (C) :

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

Nuts (D) :

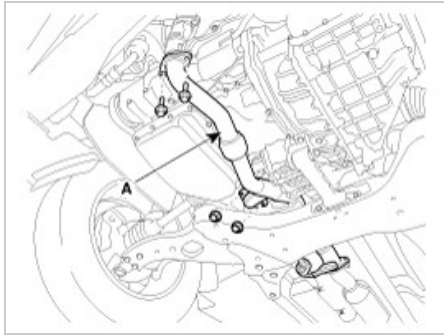
39.2 ~ 58.8 N.m (4.0 ~ 6.0 kgf.m, 28.9 ~ 43.4 lb-ft)



4. Remove the front muffler (A).

Tightening torque:

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



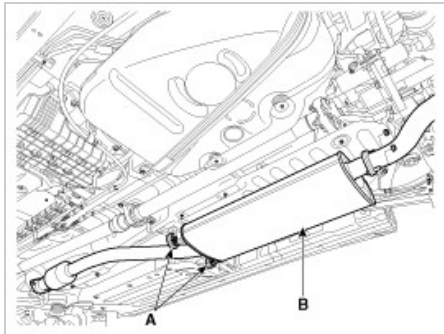
5. Install in the reverse order of removal.

Center Muffler

1. Disconnect the battery "-" terminal.
2. Remove the rubber hanger (A).
3. Remove the center muffler (B).

Tightening torque:

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



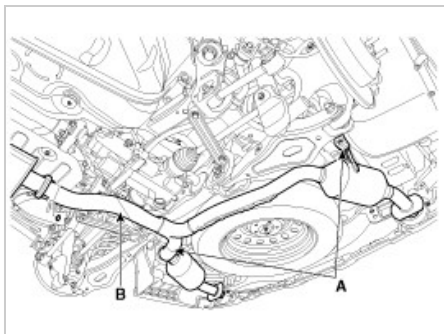
4. Install in the reverse order of removal.

Rear Muffler

1. Disconnect the battery "-" terminal.
2. Remove the rubber hanger (A) on the rear muffler.
3. Remove the rear muffler (B).

Tightening torque:

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



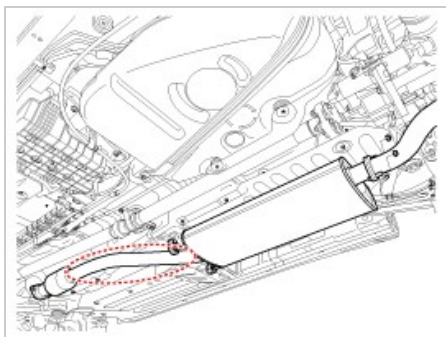
4. Install in the reverse order of removal.
(Refer to 4 Wheel Drive System - "Front Wheel Transfer Assembly")

Replacement procedure of center muffler using clamp

Under warranty : Replace the center muffler assembly.

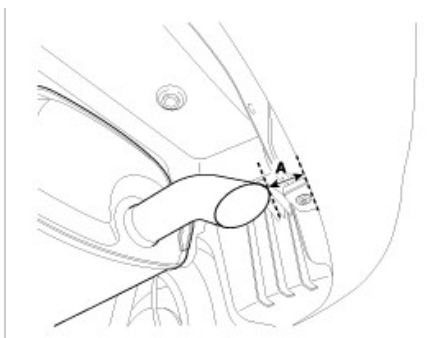
Out of warranty : It is available to replace the center muffler as the procedure below.

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

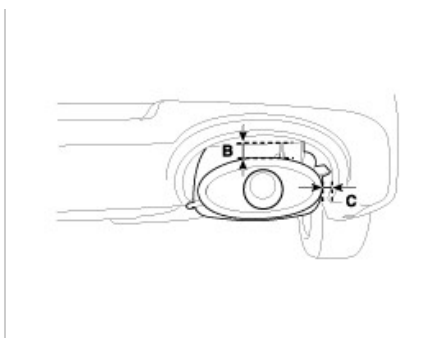


- Record the gap (A, B, C, D, E, F) between the tail pipe (or tail trim) and the rear bumper.

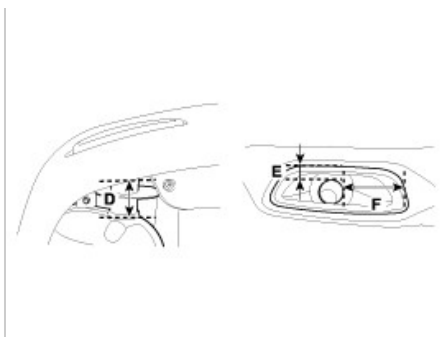
[Pipe type]



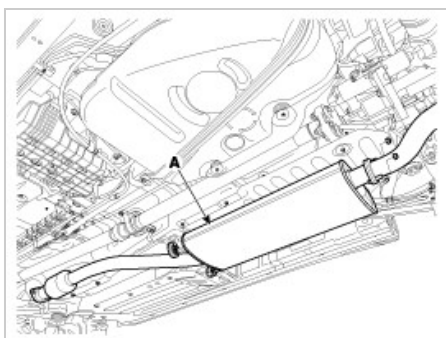
[Trim type]



[Bumper-integrated trim type]



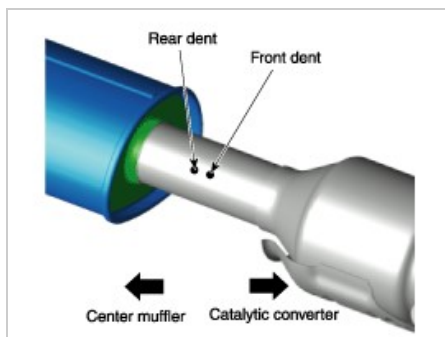
- Remove the catalytic converter & center muffler (A).



- Cut the center muffler as the instruction below.

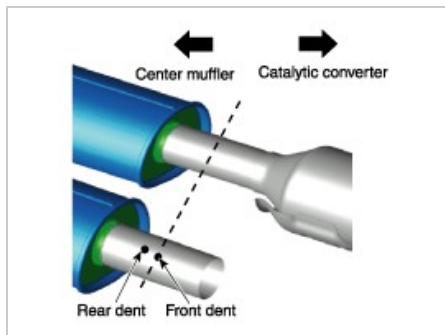
[With dent]

- Cut the front dent of the muffler.



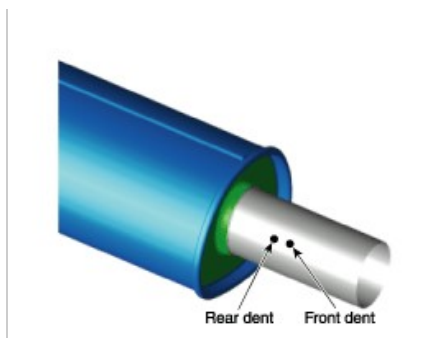
[Without dent]

- Cut the muffler by referring to the front dent of A/S muffler as shown in the image below.



[A/S muffler]

- Cut the rear dent of the A/S muffler.



NOTICE

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

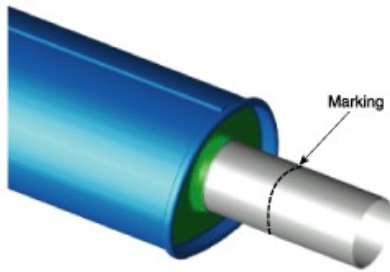
Information

- Pipe cutter available to cut the pipe vertically.

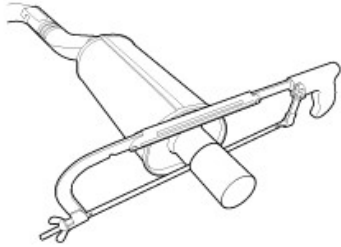


- Use a hacksaw as the procedure below, if a pipe cutter is unavailable.

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

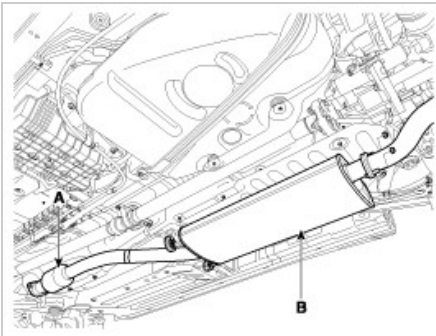


2) Cut the pipe along the marking line by using hacksaw.



5. Install the center muffler.

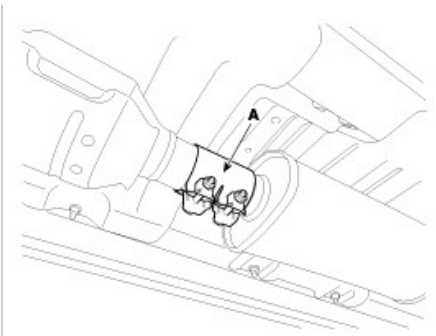
(1) Install the catalytic converter (A) and the center muffler (B) for A/S by tightening the nuts lightly, not completely.



NOTICE

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

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



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

Tightening torque :

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

(4) Compare the gap between the tail pipe(or tail trim) and the rear bumper with the record measured before removing the center muffler assembly.

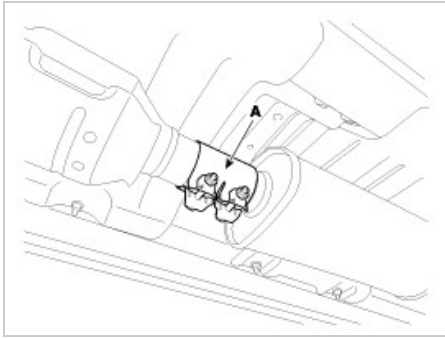
NOTICE

If the tail pipe is installed differently compared to the initial position, the bumper might be damaged by the pipe heat or interfere between the tail pipe and the rear bumper.

- (5) Do not tighten the clamp at a time. Tighten the clamp nuts to the specified torque, by turns.

Tightening torque :

17.6~23.5 N.m (1.8 ~ 2.4 kgf.m, 13.0~17.4lb-ft)



NOTICE

Do not reuse the clamp that was tightened completely. It may cause leak to reuse the clamp that was tightened completely.



Specification

Ignition System

Ignition Coil

Item	Specification
Primary Coil Resistance (Ω)	$0.62 \pm 10\%$ [20°C (68°F)]
Secondary Coil Resistance (k Ω)	$7.0 \pm 15\%$ [20°C (68°F)]

Spark plug

Item	Specification
Type	SILZKR7B11
Gap	1.0 ~ 1.1 mm (0.0394 ~ 0.0433 in.)

Condenser

Item	Specification
Capacitance (μ F)	0.47 [1KHz]
Insulation resistance (M Ω)	1,000 [DC 500 V/1 Min]

Charging System

Alternator

Item	Specification
Rated voltage	13.5V , 150A
Speed in use	1,500 ~ 18,000rpm
Voltage regulator	IC Regulator built in type
Default regulated voltage (V) [COM terminal]	14.0 ~ 15.5 (-35°C)
	14.0 ~ 15.0 (25°C)
	13.1 ~ 15.0 (140°C)
Regulated Voltage (V) [COM terminal]	11.6 ~ 15.4

Battery

Item	Specification
Model type	CMF80L-BCI
Capacity [20HR/5HR] (AH)	80/64
Cold Cranking Amperage (A)	660 (SAE) / 528 (EN)
Reserve Capacity (Min)	145

Information

- Model type description

Battery type notation : -

- ① : Battery specification
 - CMF : Closed Maintenance Free
 - MF : Maintenance Free
 - AGM : Absorbent Glass Mat
- ② : Battery capacity (20HR)
 - 68 : 68AH
- ③ : Terminal location
 - L : Positive terminal is left
 - R : Positive terminal is right
- ④ : Battery type
 - DIN: Deutsche Industrie Normen
 - BCI: Battery Council International

- Cold Cranking Ampere (CCA): Cold Cranking Amps is a rating used in the battery industry to define a battery's ability to start an engine in cold temperatures.
- The rating is the number of amps a new, fully charged battery can deliver at -18 °C(-0.4 °F) for 30 seconds, while maintaining a voltage of at least 7.2 volts for a 12 volt battery.

- The higher the CCA rating, the greater the starting power of the battery.
- RESERVE CAPACITY (RC) : Reserve Capacity is a battery industry rating, defining a battery's ability to power a vehicle with an inoperative alternator or fan belt.
- The rating is the number of minutes a battery at 26.7 °C(80 °F) can be discharged at 25 amps and maintain a voltage of 10.5 volts for a 12 volt battery.
- The higher the reserve rating, the longer your vehicle can operate should your alternator or fan belt fail.

Starting System

Starter

Item		Specification
Rated voltage		12 V, 1.7 kW
The number of pinion teeth		12
Performance [No-load, 11.5 V]	Ampere	Max. 85 A
	Speed	Min. 2,550 rpm

Tightening Torques

Item	N.m	kgf.m	lb-ft
Ignition coil installation bolt	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Spark plug installation	14.7 ~ 24.5	1.5 ~ 2.5	10.9 ~ 18.1
Condenser & Hanger bracket installation bolt	6.9 ~ 10.8	0.7 ~ 1.1	5.1 ~ 8.0
Alternator installation bolt	26.5 ~ 33.3	2.7 ~ 3.4	19.5 ~ 24.6
Battery (+) terminal tightening nut	7.8 ~ 9.8	0.8 ~ 1.0	5.2 ~ 8.7
Battery (-) terminal tightening nut	3.9 ~ 5.9	0.4 ~ 0.6	2.9 ~ 4.3
Battery mounting bracket installation bolt	8.8 ~ 13.7	0.9 ~ 1.4	6.5 ~ 10.1
Battery tray installation bolt	8.8 ~ 13.7	0.9 ~ 1.4	6.5 ~ 10.1
Battery sensor cable installation bolt	10.0 ~ 12.0	1.0 ~ 1.2	7.4 ~ 8.9
Starter installation bolt	49.0 ~ 63.7	5.0 ~ 6.5	36.2 ~ 47.0
Starter cover installation bolt	8.8 ~ 13.7	0.9 ~ 1.4	6.5 ~ 10.1

Engine Electrical System



Troubleshooting

Ignition System

Symptom	Suspect Area	Remedy
Engine will not start or is hard to start (Crank 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

Charging System

Symptom	Suspect Area	Remedy
Charging warning indicator does not light with ignition switch "ON" and engine off.	Fuse blown	Check fuses
	Light burned out	Replace light
	Wiring connection loose	Tighten loose connection
	Electronic voltage regulator	If light turns off, replace voltage regulator.
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	If light turns off, replace voltage regulator or alternator
	Wiring	Repair or replace wiring

Overcharge	Electronic voltage regulator	If light turns off, 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	If light turns off, replace voltage regulator or alternator
	Poor grounding	Inspect ground or repair
	Worn battery	Replace battery

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 motor 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 motor faulty	Replace
Starter keeps running	Starter motor faulty	Replace
	Ignition switch	Replace
Starter spins but engine will not crank	Short in wiring	Repair or replace wiring
	Pinion gear teeth broken or starter motor	Replace
	Ring gear teeth broken	Replace fly wheel or torque converter

Engine Electrical System



Description

Ignition timing is controlled by the electronic control ignition timing system.

The standard reference ignition timing data for the engine operating conditions are pre-programmed 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.

Engine Electrical System



On-vehicle Inspection

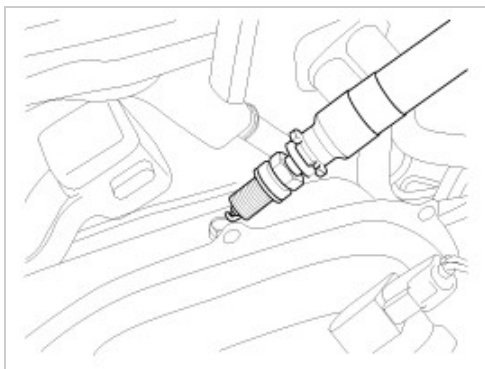
Inspect ignition coil assembly and Perform spark test

1. Check for DTCs.

NOTICE

- If a DTC is present, perform troubleshooting in accordance with the procedure for that DTC.
(Refer to DTC guide)

2. Check if sparks occur.
 - (1) Remove the engine cover.
 - (2) Remove the ignition coils.
 - (3) Using a spark plug wrench, remove the spark plugs.
 - (4) Disconnect the 6 injector extension connectors.
 - (5) Ground the spark plug to the engine.

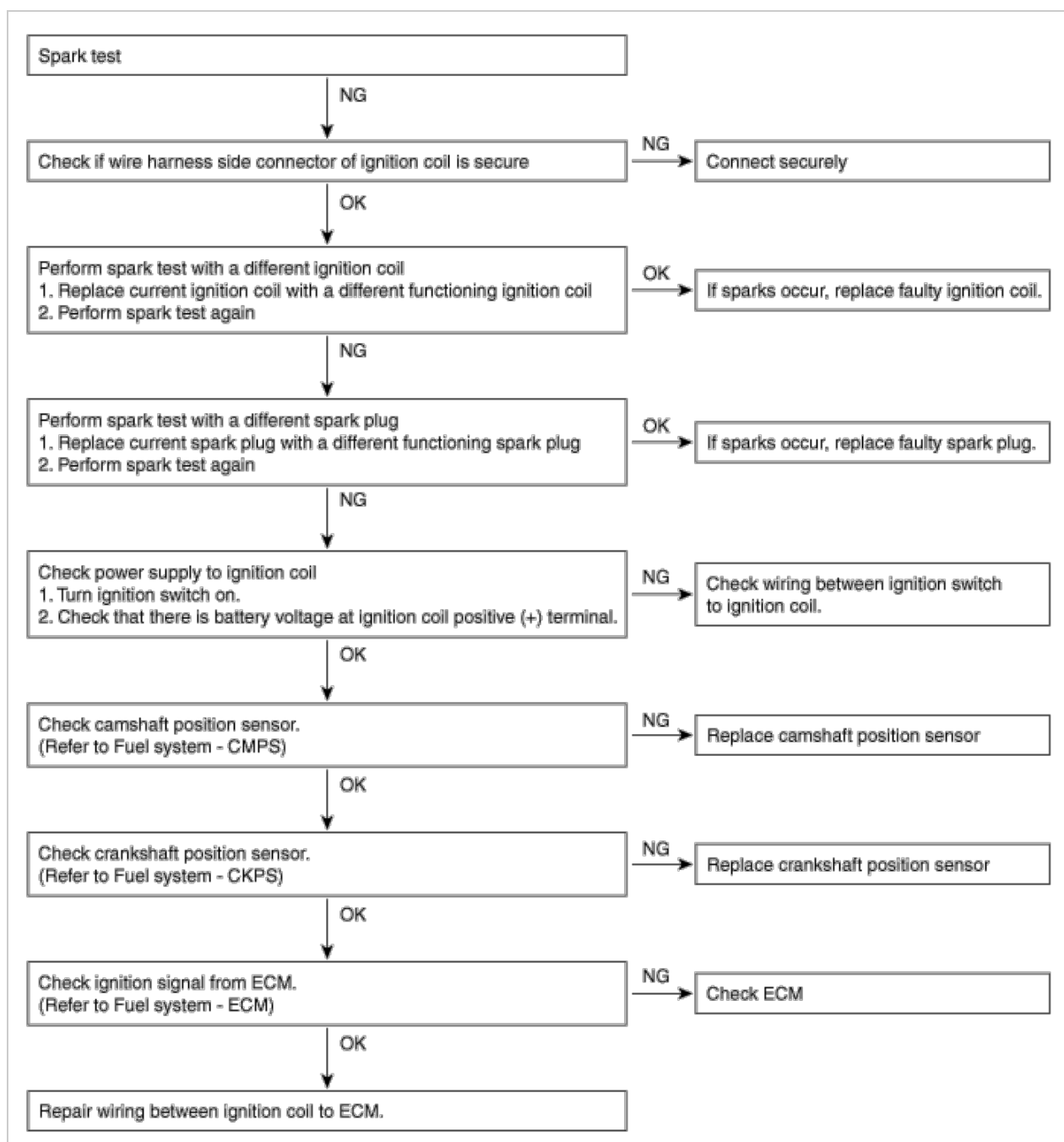


(6) Check if sparks occur at each spark plug while engine is being cranked.

NOTICE

- Do not crank the engine for more than 5 seconds.

3. If sparks do not occur, perform the following test.



- 4. Using a spark plug wrench, install spark plugs.
- 5. Install the ignition coils.
- 6. Install the engine cover.

Engine Electrical System



Description

An ignition coil is an induction coil in an engine's ignition system which transforms the battery's low voltage to the high voltage needed to create an electric spark in the spark plugs to ignite the fuel. Coils have an internal resistor while others rely on a resistor wire or an external resistor to limit the current flowing into the coil from the battery 12 V supply.

Engine Electrical System



Specification

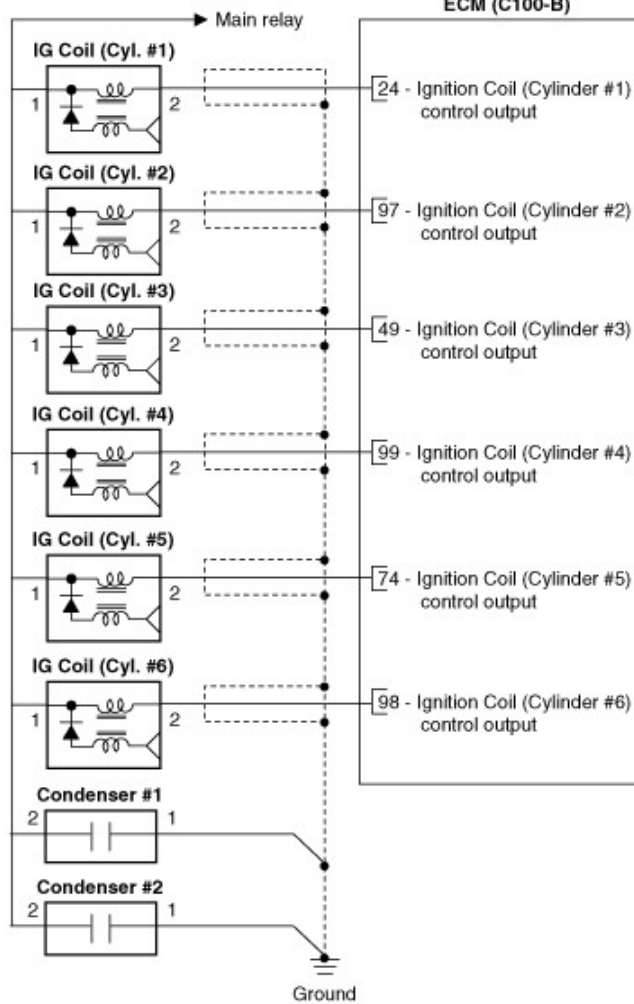
Item	Specification
Primary Coil Resistance (Ω)	$0.62 \pm 10\%$ [20°C (68°F)]
Secondary Coil Resistance (k Ω)	$7.0 \pm 15\%$ [20°C (68°F)]

Engine Electrical System



Circuit Diagram

[Circuit Diagram]



[Connection Information]

Ignition Coil #1 (C118-1)

Terminal	Connected to	Function
1	ECM C100-B (24)	Ignition Coil #1 control
2	Main relay	Battery power (B+)

Ignition Coil #2 (C118-2)

Terminal	Connected to	Function
1	ECM C100-B (97)	Ignition Coil #2 control
2	Main relay	Battery power (B+)

Ignition Coil #3 (C118-3)

Terminal	Connected to	Function
1	ECM C100-B (49)	Ignition Coil #3 control
2	Main relay	Battery power (B+)

Ignition Coil #4 (C118-4)

Terminal	Connected to	Function
1	ECM C100-B (99)	Ignition Coil #4 control
2	Main relay	Battery power (B+)

Ignition Coil #5 (C118-5)

Terminal	Connected to	Function
1	ECM C100-B (74)	Ignition Coil #3 control
2	Main relay	Battery power (B+)

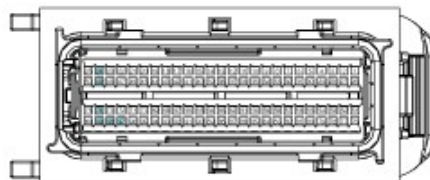
Ignition Coil #6 (C118-6)

Terminal	Connected to	Function
1	ECM C100-B (98)	Ignition Coil #4 control
2	Main relay	Battery power (B+)

[Harness Connector]



C118-1,2,3,4,5,6
Ignition Coil #1,2,3,4,5,6

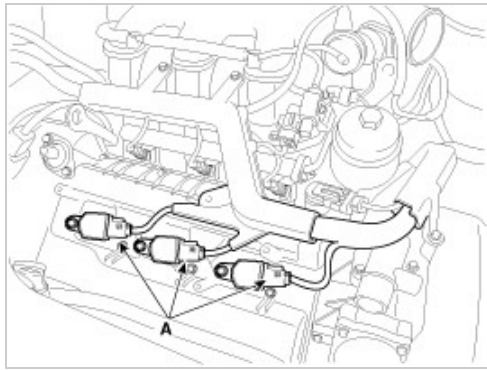


C100-B
ECM

Engine Electrical System

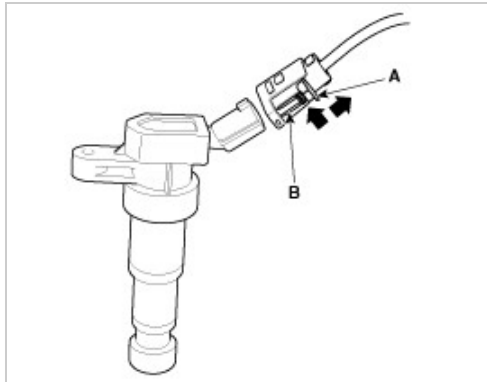
Removal

1. Disconnect the battery negative terminal.
2. Remove the engine cover.
3. Disconnect the ignition coil connector (A).

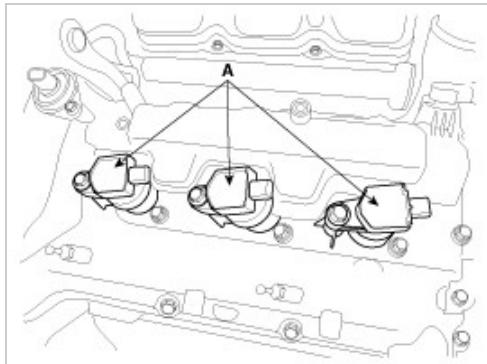


NOTICE

- When removing the ignition coil connector, pull the lock pin (A) and push the clip (B).



4. Remove the ignition coil (A).



Installation

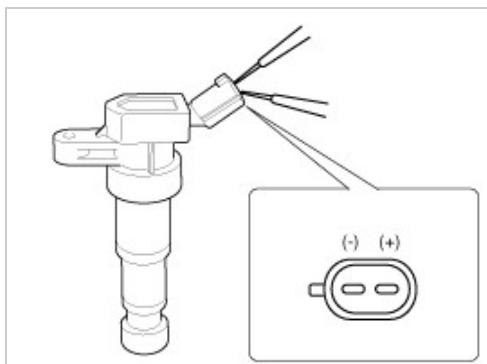
1. Install in the reverse order of removal.

Ignition coil installation bolts:

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

Inspection

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



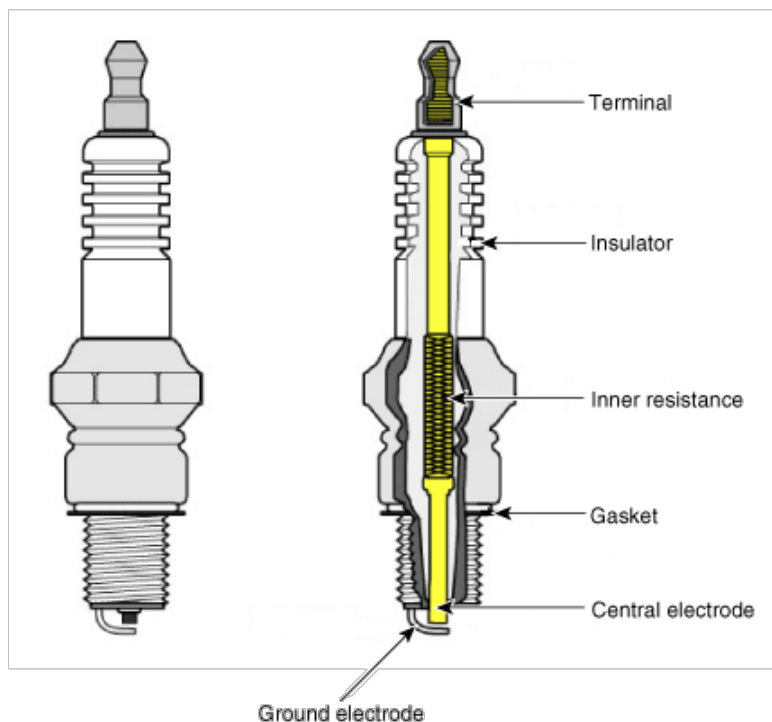
Standard value: $0.62\Omega \pm 10\%$

Engine Electrical System



Description

A spark plug is a device for delivering electric current from an ignition system to the combustion chamber of a spark-ignition engine to ignite the compressed fuel/air mixture therein by means of an electric spark, while containing combustion pressure within the engine. A spark plug has a metal threaded shell, electrically isolated from a central electrode by a porcelain insulator.



Engine Electrical System



Specification

Item	Specification
Type	SILZKR7B11
Gap	1.0 ~ 1.1 mm (0.0394 ~ 0.0433 in.)

Engine Electrical System



Inspection

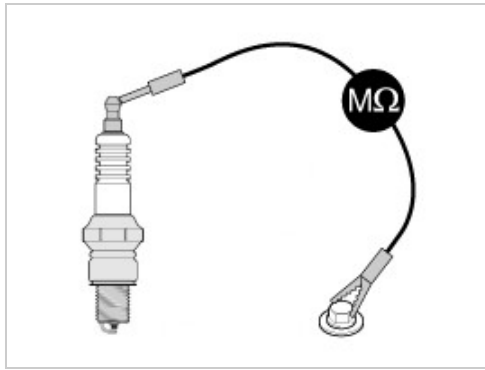
[On vehicle inspection]

1. Accelerate the engine to about 3,000 rpm 3 times or more.
2. Remove the spark plug.
3. Check the spark plug visually.
If the electrode is dry, the spark plug is normal.
If the electrode is wet, check the damage and electrode gap as below.

[Component Inspection]

1. Check the spark plug for any damage on its thread and insulator.
If there is damage, replace the spark plug.
2. Check the electrode. Measure the insulation resistance with an ohmmeter.
If the resistance is less than the specified value, adjust the electrode gap.

Specification: 10 M Ω or more



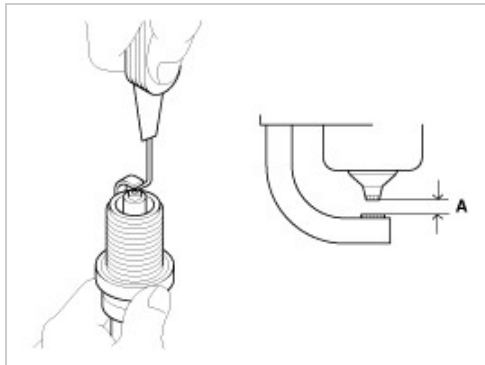
3. Check the spark plug electrode gap.

If the gap is greater than the maximum, replace the spark plug.

Specification: 1.0 ~ 1.1 mm (0.0394 ~ 0.0433 in.)

NOTICE

- If adjusting the gap of a new spark plug, bend only the base of the ground electrode. Do not touch the tip. Never attempt to adjust the gap on a used plug.

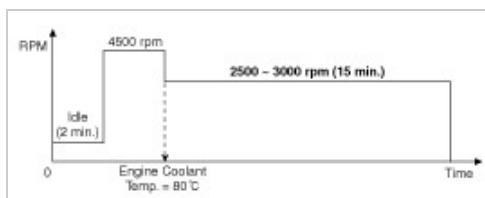


Cleaning

The combustion temporarily becomes unstable, due to the aged fuel and the carbon deposits accumulated on the spark plug(s) after long-term storage.

[1st Method]

1. Start the engine and keep the engine running at idle for 2 minutes.
2. Step on the accelerator pedal and hold it steady at 4500 rpm with the shift lever in N position to warm up the engine until the temperature of the engine coolant reaches 80°C.
3. Keep the engine running at 2500~3000 rpm in the N position for 15 minutes.



[2nd Method]

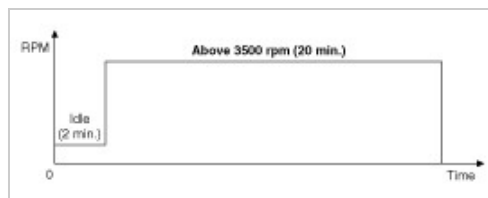
NOTICE

- The 2nd method should be performed only if the 1st method fails (the misfire-related codes recur).

1. Start the engine and keep the engine running at idle for 2 minutes.
2. Drive the vehicle for over 20 minutes, keeping the engine speed above 3500 rpm.

NOTICE

- If equipped with manual transaxle, shift the gear properly for keeping the engine speed above 3500 rpm.



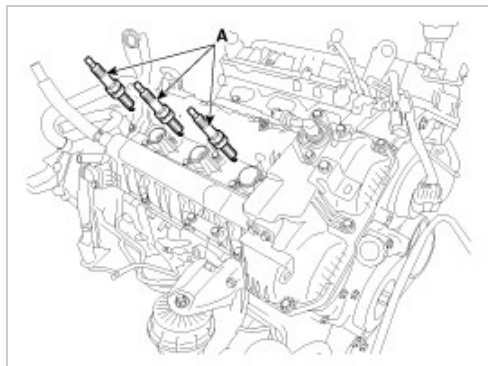
Removal

1. Remove the ignition coil.
(Refer to Ignition System - "Ignition Coil")
2. Using a spark plug wrench, remove the spark plug (A).

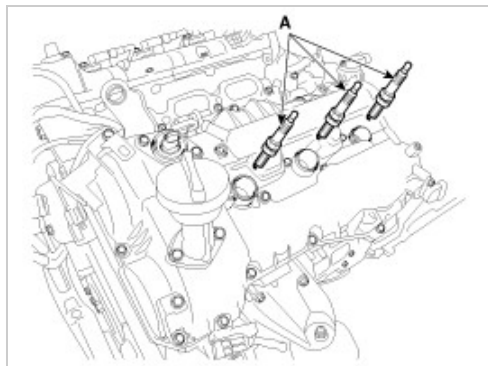
NOTICE

- Be careful that no contaminants enter into spark plug holes.

[Bank1]



[Bank2]



Installation

1. Install in the reverse order of removal.

Tightening torque:

14.7 ~ 24.5 N.m (1.5 ~ 2.5 kgf.m, 10.8 ~ 18.0 lb-ft)

Engine Electrical System



Description

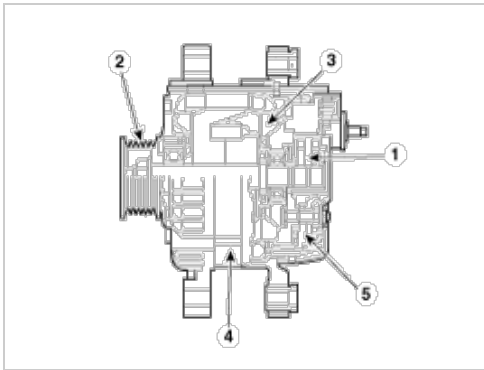
The charging system included a battery, an alternator with a built-in regulator, and the charging indicator light and wire.

The Alternator has eight 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 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. Drive belt pulley
3. Rotor
4. Stator
5. Rectifier

Alternator Management System

Alternator management system controls the charging voltage set point in order to improve fuel economy, manage alternator load under various operating conditions, keep the battery charged, and protect the battery from over-charging. ECM controls generating voltage by duty cycle (charging control, discharging control, normal control) based on the battery conditions and vehicle operating conditions.

The system conducts discharging control when accelerating a vehicle. Vehicle reduces an alternator load and consumes an electric power from a battery.

The system conducts charging control when decelerating a vehicle. Vehicle increases an alternator load and charges a battery.

Engine Electrical System



On-vehicle Inspection

i Information

- First of all, check for DTCs. If a DTC is present, perform troubleshooting in accordance with the procedure for that DTC. (Refer to DTC guide)

⚠ 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.

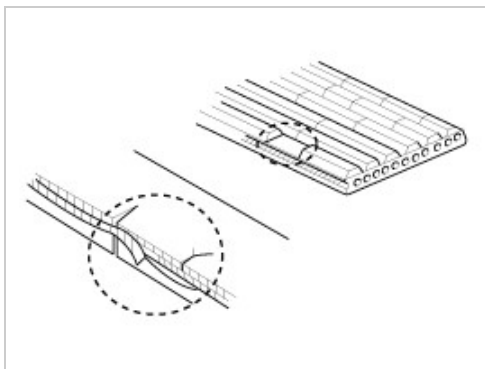
[General Inspection]

1. Check The Battery Terminals And Fuses
 - (1) Check that the battery terminals are not loose or corroded.
 - (2) Check the fuses for continuity.
2. Inspect Drive Belt
 - (1) Visually check the belt for excessive wear, frayed cords etc.

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

NOTICE

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



3. Drive belt tension measurement and adjustment
(Refer to Engine Mechanical System - "Drive Belt")
4. 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.
5. 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. Check that the light is lit.

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

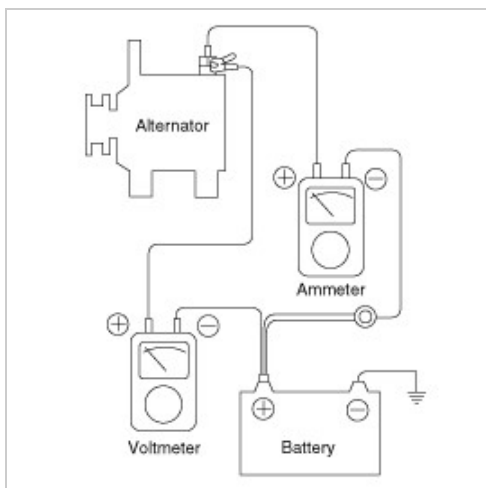
[Electrical Specified Value Inspection]

1. 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.

(1) Preparation

- a. Turn the ignition switch to "OFF".
- b. 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.



(2) Test

- a. Start the engine.
- b. 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.

(3) Result

- a. The voltmeter may indicate the standard value.

Standard value :0.2V max

- b. 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 overheated harness, etc. Correct them before testing again.
- c. Upon completion of the test, set the engine speed at idle.

Turn off the headlamps, blower motor and the ignition switch.

2. Output Current Test

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

(1) Preparation

- a. 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".

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.

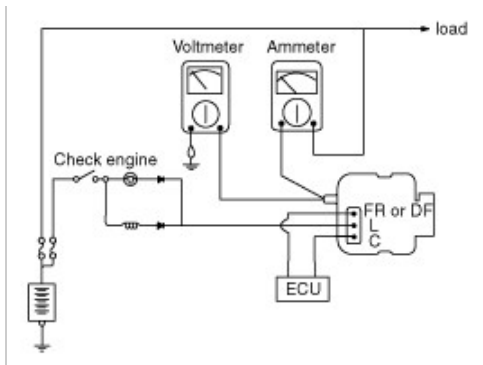
Check the tension of the alternator drive belt. The belt tension check method is described in the section "Inspect drive belt".

- b. Turn off the ignition switch.
c. Disconnect the battery ground cable.
d. Disconnect the alternator output wire from the alternator "B" terminal.
e. 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.

NOTICE

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

- f. 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.
g. Attach an engine tachometer and connect the battery ground cable.
h. Leave the engine hood open.



(2) Test

- a. Check to see that the voltmeter reads as the same value as the battery voltage. If the voltmeter reads 0V, and the open circuit in the wire between alternator "B" terminal and battery (+) terminal or poor grounding is suspected.
b. Start the engine and turn on the headlamps.
c. 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.

NOTICE

- 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.

(3) Result

- a. The ammeter 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 :60% of the voltage rate

NOTICE

- 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.
- The nominal output current may not be obtained if the temperature of the alternator itself or ambient temperature is too high. In such a case, reduce the temperature before testing again.

- b. Upon completion of the output current test, lower the engine speed to idle and turn off the ignition switch.
c. Disconnect the battery ground cable.
d. Remove the ammeter and voltmeter and the engine tachometer.

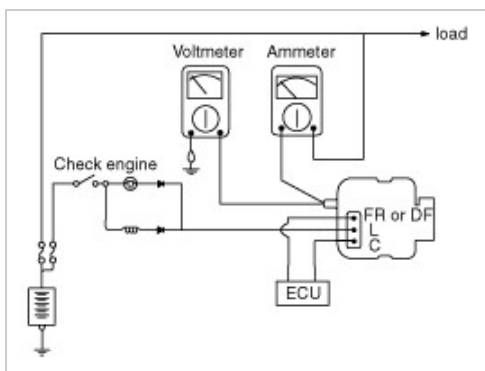
- e. Connect the alternator output wire to the alternator "B" terminal.
- f. Connect the battery ground cable.

3. Regulated Voltage Test

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

(1) Preparation

- a. 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".
- b. Turn ignition switch to "OFF".
- c. Disconnect the battery ground cable.
- d. 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.
- e. Disconnect the alternator output wire from the alternator "B" terminal.
- f. 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.
- g. Attach the engine tachometer and connect the battery ground cable.



(2) Test

- a. 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.
- b. Start the engine. Keep all lights and accessories off.
- c. 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

(3) Result

- a. If the voltmeter reading doesn't agree with the standard value, the voltage regulator or the alternator is faulty.
- b. Upon completion of the test, reduce the engine speed to idle, and turn off the ignition switch.
- c. Disconnect the battery ground cable.
- d. Remove the voltmeter and ammeter and the engine tachometer.
- e. Connect the alternator output wire to the alternator "B" terminal.
- f. Connect the battery ground cable.

Engine Electrical System



Description

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

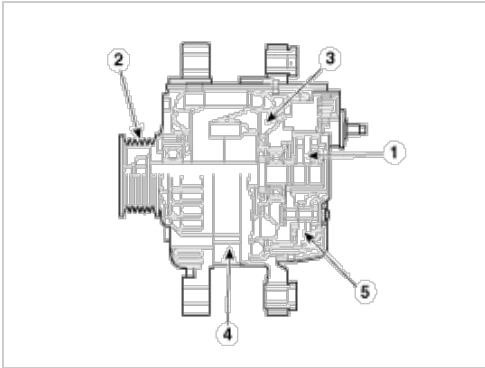
Therefore, DC current appears at alternator "B" terminal.

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

The 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. Drive belt pulley
- 3. Rotor
- 4. Stator
- 5. Rectifier

Engine Electrical System



Specification

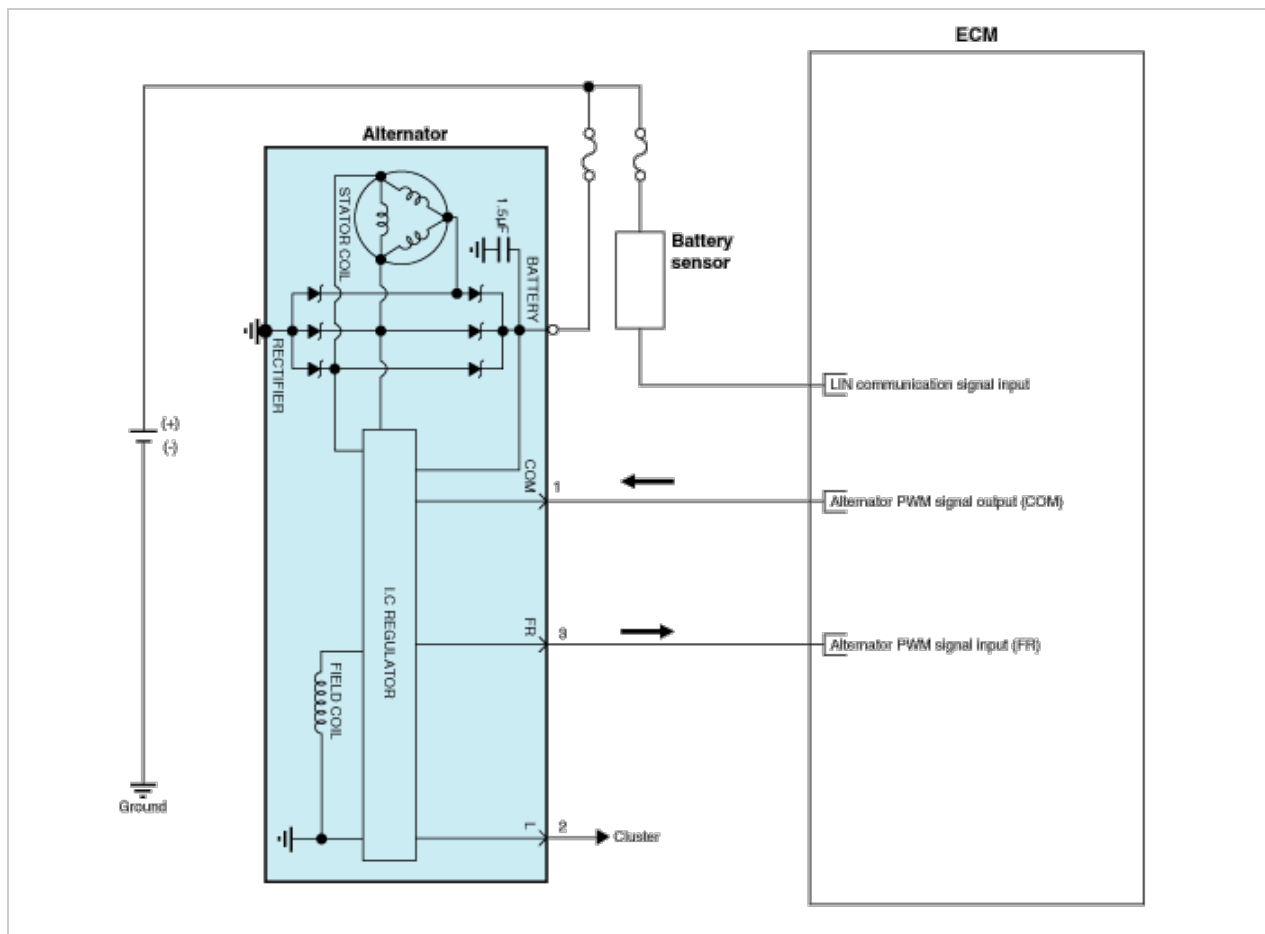
Alternator

Item	Specification
Rated voltage	13.5V , 150A
Speed in use	1,500 ~ 18,000rpm
Voltage regulator	IC Regulator built in type
Default regulated voltage (V) [COM terminal]	14.0 ~ 15.5 (-35°C)
	14.0 ~ 15.0 (25°C)
	13.1 ~ 15.0 (140°C)
Regulated Voltage (V) [COM terminal]	11.6 ~ 15.4

Engine Electrical System



Circuit Diagram



Information

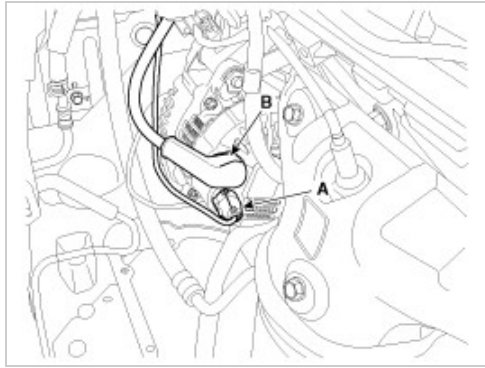
- **COM signal**
 - When controlling the voltage generated, the ECM sends the target voltage data to the alternator via a PWM signal. (High voltage: 4V or higher, low voltage: 2V or lower)
- **FR signal**
 - The transistor activation signal inside the alternator monitors the voltage generated by the alternator to control the excitation current before it sends the FR signal to the ECM. (At certain RPM/electric loads, the FR duty can remain static. However, more often, the RPM, electric load, target voltage, etc. are always changing in the vehicle, so the FR must also change constantly)
- **L signal**
 - Turns on the battery warning lamp on the dashboard when the battery charging system malfunctions. (Conditions for turning on the lamp - overcharge, over discharge, a field coil blown inside the alternator)
- **B+ terminal**- The output voltage from the generator travels to the battery via the B+ terminal.

Engine Electrical System

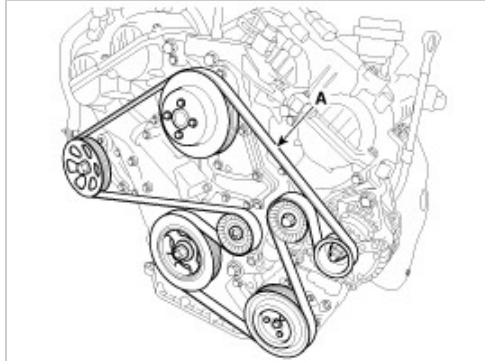


Removal

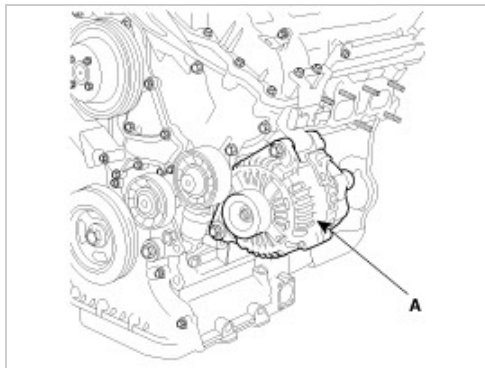
1. Disconnect the battery negative terminal.
2. Remove the engine cover.
3. Disconnect the alternator connector (A) and cable (B) from the "B" terminal.



4. To release the tension, turn the drive belt tensioner counterclockwise then remove the drive belt (A).



5. Remove the alternator (A).



Installation

1. Install in the reverse order of removal.
2. Adjust the alternator belt tension after installation.
(Refer to Engine Mechanical System - "Drive Belt")

Alternator installation bolt:

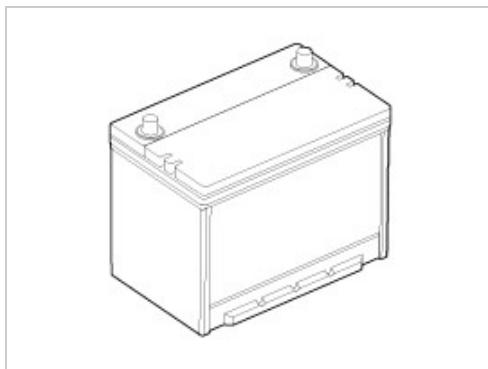
26.5 ~ 33.3 Nm (2.7 ~ 3.4 kgf.m, 19.5 ~ 24.6 lb-ft)

Engine Electrical System



Description

1. The MF(Maintenance Free) battery is, as the name implies, totally maintenance free and has no removable battery cell caps.
2. The MF(Maintenance Free) battery does not require water replenishment for the repair.
3. The battery is completely sealed, except for small vent holes in the cover.



Information

- After disconnecting then reconnecting the battery negative cable, reset some parts that require the reset procedures.
(Refer to Body Electrical System – "General Information")

Engine Electrical System



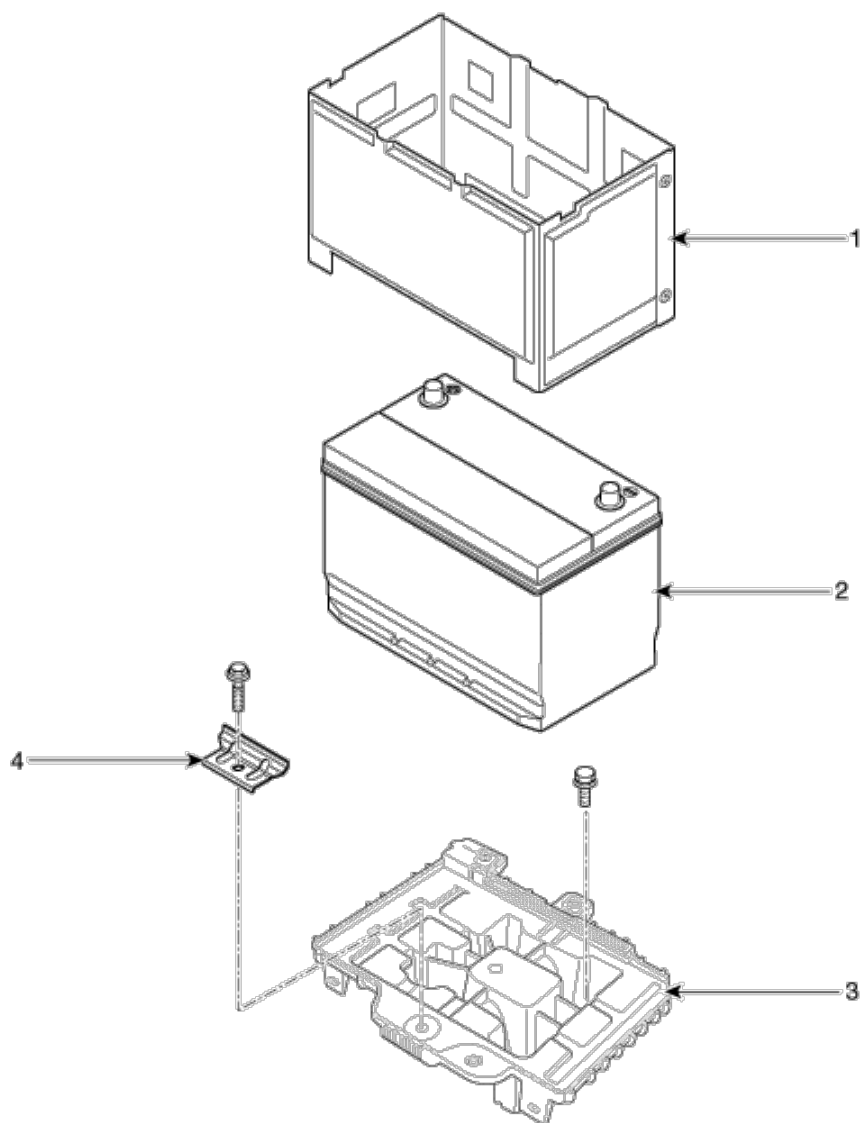
Specification

Item	Specification
Model type	CMF80L-BCI
Capacity [20HR/5HR] (AH)	80/64
Cold Cranking Amperage (A)	660 (SAE) / 528 (EN)
Reserve Capacity (Min)	145

Engine Electrical System



Components



- 1. Battery insulation pad
- 2. Battery

- 3. Battery tray
- 4. Battery mounting bracket

Engine Electrical System



Removal

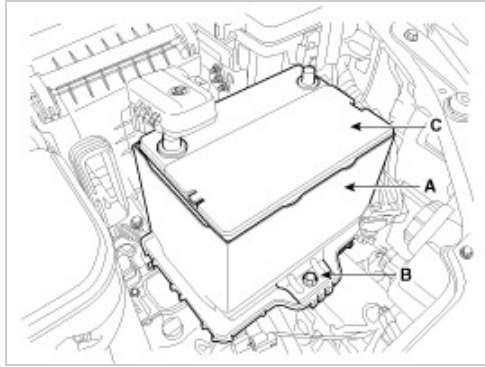
1. Disconnect the battery (-)terminal (A) and then (+)terminal (B).



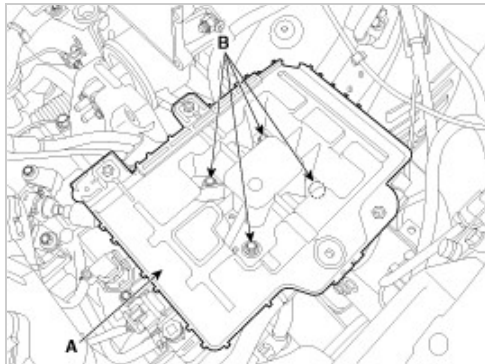
2. Remove the air duct and air cleaner assembly.

(Refer to Engine Mechanical System - "Air Cleaner")

3. Remove the battery mounting bracket (B) and the insulation pad (A), and then remove the battery (C).



4. Remove the battery tray (A) after removing the bolts (B).



Installation

1. Install in the reverse order of removal.

Battery (-)terminal installation:

4.0 ~ 6.0 N.m (0.4 ~ 0.6 kgf.m, 3.0 ~ 4.4 lb-ft)

Battery (+)terminal installation:

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

Battery mounting bracket and the insulation pad installation:

8.8 ~ 13.7 N.m (0.9 ~ 1.4 kgf.m, 6.5 ~ 10.1 lb-ft)

NOTICE

- When installing the battery, fix the mounting bracket on the tray correctly.

Vehicle parasitic current inspection

1. Turn the all electric devices OFF, and then turn the ignition switch OFF.
2. Close all doors except the engine hood, and then lock all doors.
 - (1) Disconnect the hood switch connector.
 - (2) Close the trunk lid.
 - (3) Close the doors or remove the door switches.
3. Wait a few minutes until the vehicle's electrical systems go to sleep mode.

NOTICE

- For an accurate measurement of a vehicle parasitic current, all electrical systems should go to sleep mode. (It takes at least one hour or at most one day.) However, an approximate vehicle parasitic current can be measured after 10~20 minutes.

4. Connect an ammeter in series between the battery (-) terminal and the ground cable, and then disconnect the clamp from the battery (-) terminal slowly.

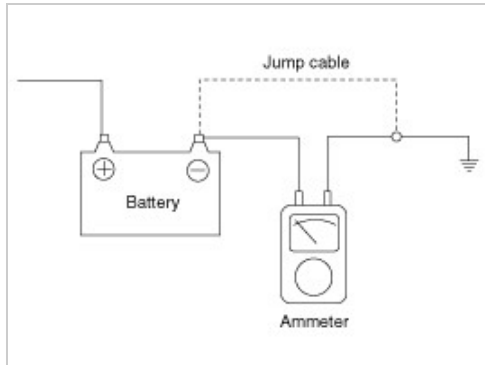
NOTICE

-

Be careful that the lead wires of an ammeter do not come off from the battery (-) terminal and the ground cable to prevent the battery from being reset. In case the battery is reset, connect the battery cable again, and then start the engine or turn the ignition switch ON for more than 10 sec. Repeat the procedure from No. 1.

To prevent the battery from being reset during the inspection,

- a. Connect a jump cable between the battery (-) terminal and the ground cable.
- b. Disconnect the ground cable from the battery (-) terminal.
- c. Connect an ammeter between the battery (-) terminal and the ground cable.
- d. After disconnecting the jump cable, read the current value of the ammeter.



5. Read the current value of the ammeter.

- If the parasitic current is over the limit value, search for abnormal circuit by removing a fuse one by one and checking the parasitic current.
- Reconnect the suspected parasitic current draw circuit fuse only and search for suspected unit by removing a compoconnected with the circuit one by one until the parasitic draw drops below limit value.

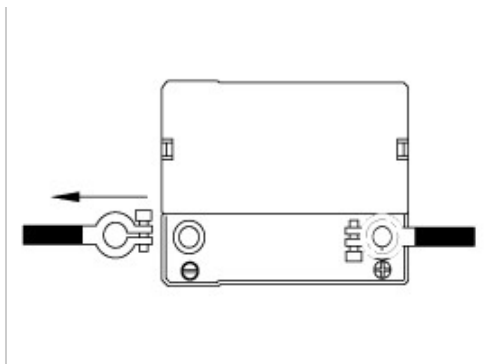
Limit value (after 10~20 min.) :Below 50mA

Cleaning

1. Make sure the ignition switch and all accessories are in the OFF position.
2. Disconnect the battery cables (negative first).
3. Remove the battery from the vehicle.

⚠ CAUTION

- Care should be taken in the event the battery case is cracked or leaking, to protect your skin from the electrolyte. Heavy rubber gloves (not the household type) should be wore when removing the battery.



4. Inspect the battery tray for damage caused by the loss of electrolyte. If acid damage is present, it will be necessary to clean the area with a solution of clean warm water and baking soda. Scrub the area with a stiff brush and wipe off with a cloth moistened with baking soda and water.
5. Clean the top of the battery with the same solution as described above.
6. Inspect the battery case and cover for cracks. If cracks are present, the battery must be replaced.
7. Clean the battery posts with a suitable battery post tool.
8. Clean the inside surface of the terminal clamps with a suitable battery cleaning tool. Replace damaged or frayed cables and broken terminal clamps.
9. Install the battery in the vehicle.
10. Connect the cable terminals to the battery post, making sure tops of the terminals are flush with the tops of the posts .
11. Tighten the terminal nuts securely.

12. Coat all connections with light mineral grease after tightening.

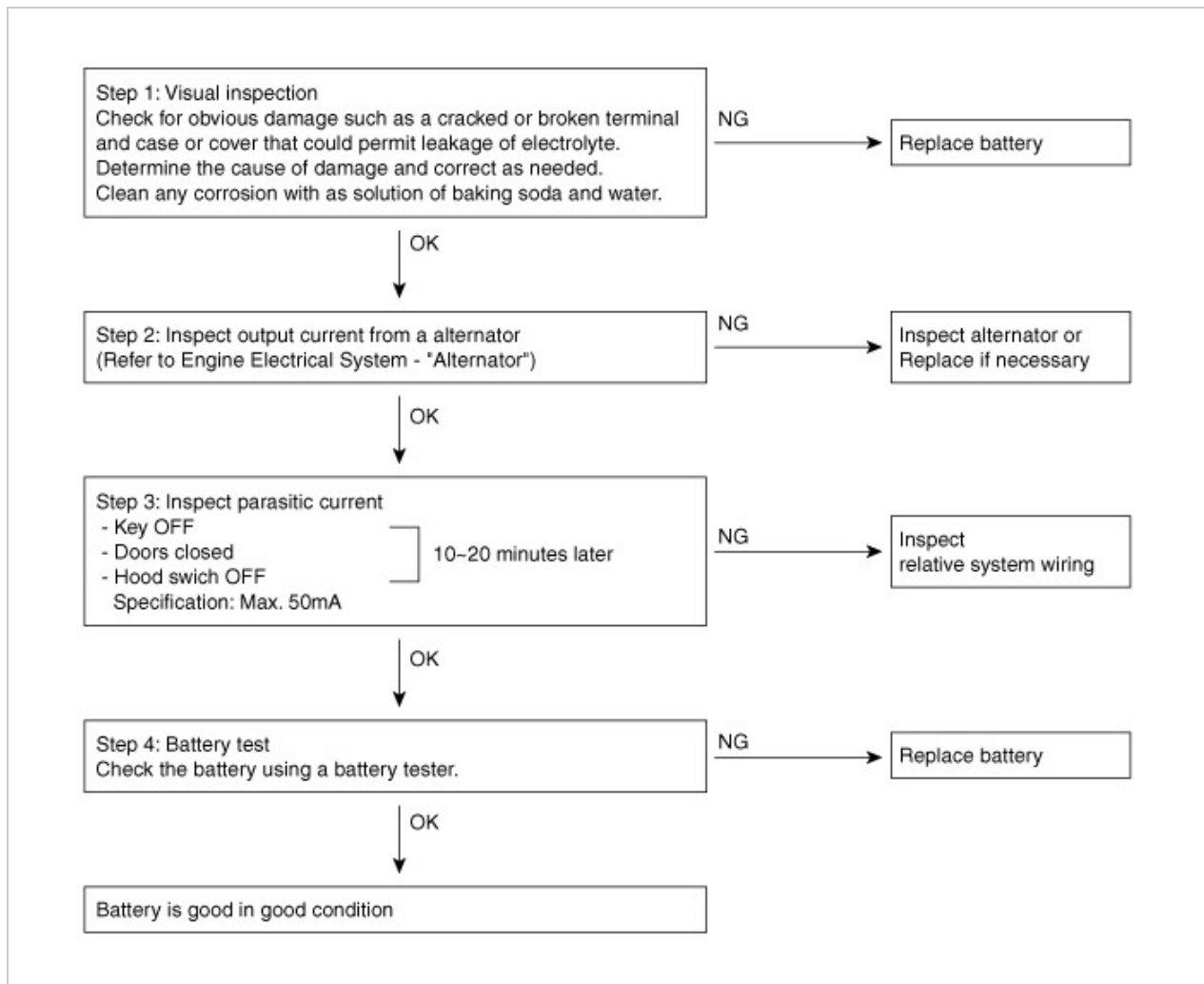
⚠ CAUTION

- When batteries are being charged, an explosive gas forms beneath the cover of each cell. Do not smoke near batteries being charged or which have recently been charged. Do not break live circuit at the terminals of batteries being charged. A spark will occur when the circuit is broken. Keep open flames away from battery.

Engine Electrical System



Troubleshooting



Engine Electrical System



Description

Vehicles have many control units that use more electricity. These units control their own system based on information from diverse sensors. It is important to have a stable power supply as there diverse sensors giving a variety of information. Battery sensor (A) is mounted on battery (-) terminal. It transmits battery voltage, current, temperature information to ECM. ECM controls generating voltage by duty cycle based on these signals.

Engine Electrical System



Removal

1. Disconnect the battery negative (-) cable.
2. Disconnect the battery sensor connector.
3. Remove the battery negative (-) cable (A) after removing the bolts.



Installation

1. Install in the reverse order of removal.

Battery sensor cable installation bolt:

10.0 ~ 12.0 N.m (1.01 ~ 1.22 kgf.m, 7.4 ~ 8.9 lb-ft)

Battery (-) terminal I tightening nut:

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

NOTICE

- For the vehicle equipped with a battery sensor, be careful not to damage the battery sensor when the battery is replaced or recharged.
- 1) When replacing the battery, it should be same one (type, capacity and brand) that is originally installed on your vehicle. If a battery of a different type is replaced, the battery sensor may recognize the battery to be abnormal.
 - 2) When installing the ground cable on the negative post of battery, tighten the clamp with specified torque. An excessive tightening torque can damage the PCB internal circuit and the battery terminal .
 - 3) When recharging the battery, ground the negative terminal of the booster battery to the vehicle body.

Engine Electrical System



Description

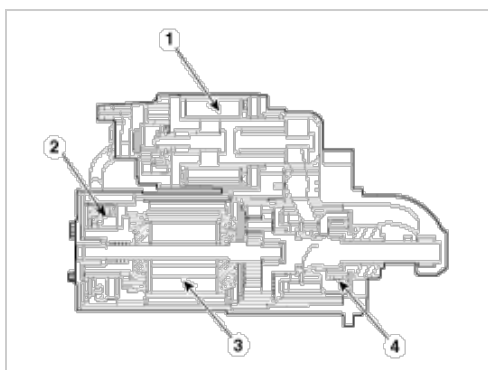
The starting system includes the battery, starter, solenoid switch, ignition switch, inhibitor switch (A/T), clutch pedal switch (M/T), ignition lock switch, connection wires and the battery cable.

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

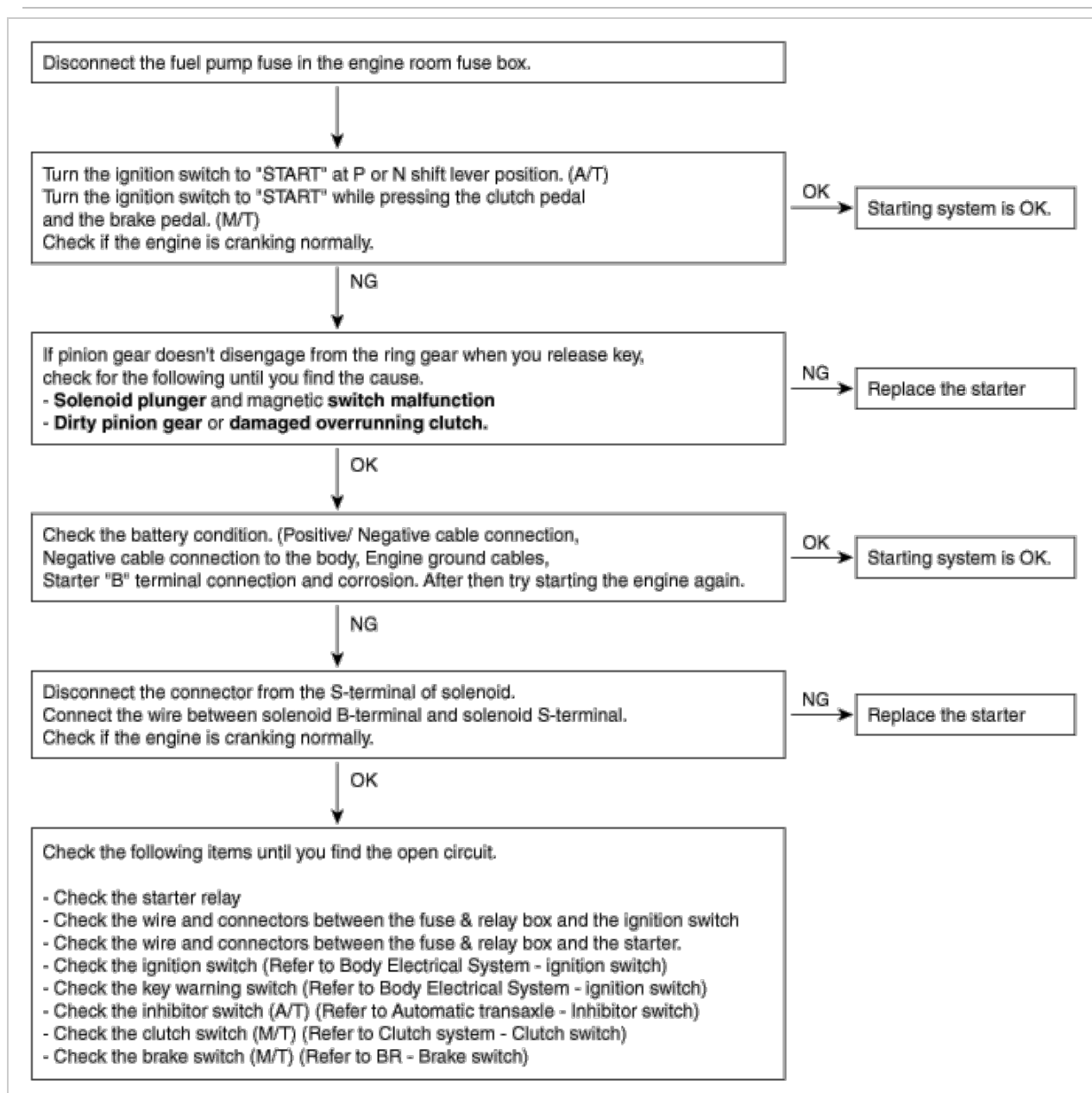
Engine Electrical System



Troubleshooting

NOTICE

- The battery must be in good condition and fully charged for this troubleshooting.



Engine Electrical System



Description

The starting system includes the battery, starter, solenoid switch, ignition switch, inhibitor switch (A/T), clutch pedal switch (M/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.

In conjunction with the ISG function, the starter motor must do a great deal more work. Therefore, the starter motor is configured for a significantly higher number of start cycles. The components of the starter motor have been adapted to the higher requirements.

Engine Electrical System



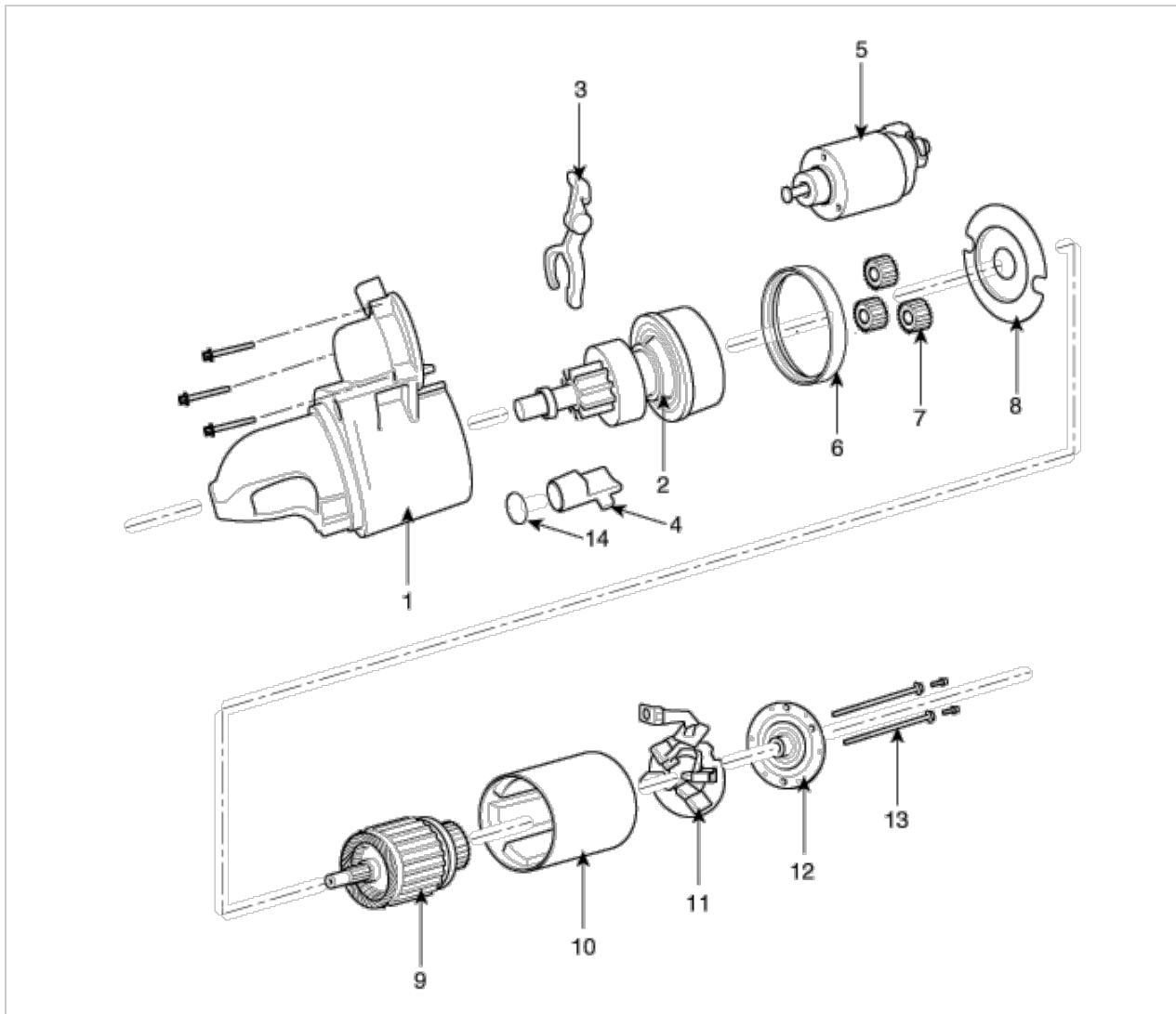
Specification

Starter

Item		Specification
Rated voltage		12 V, 1.7 kW
The number of pinion teeth		12
Performance [No-load, 11 V]	Ampere	Max.85 A
	Speed	Min. 2,550 rpm



Components

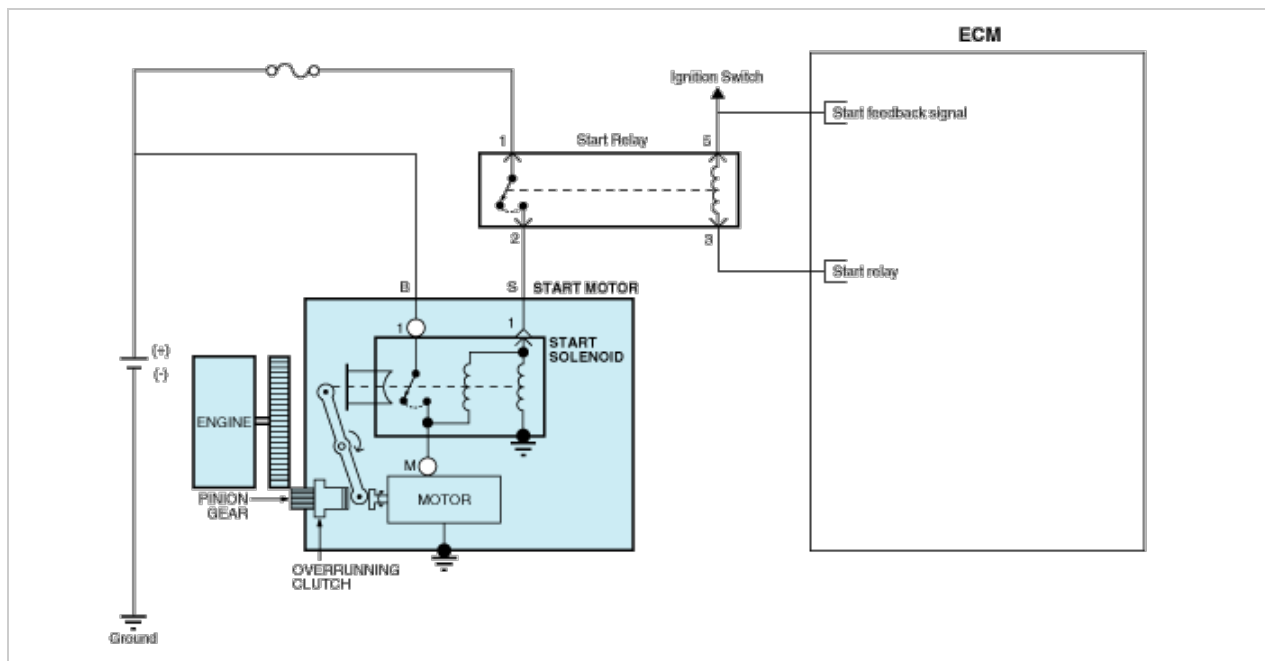


1. Front housing
2. Planet gear shaft assembly
3. Lever
4. Lever packing
5. Starter solenoid assembly
6. Packing
7. Planet gear

8. Shield
9. Armature assembly
10. York assembly
11. Brush holder assembly
12. Rear housing
13. Through bolt
14. Lever Plate

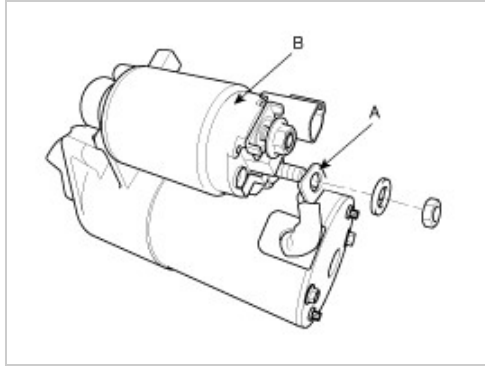


Circuit Diagram

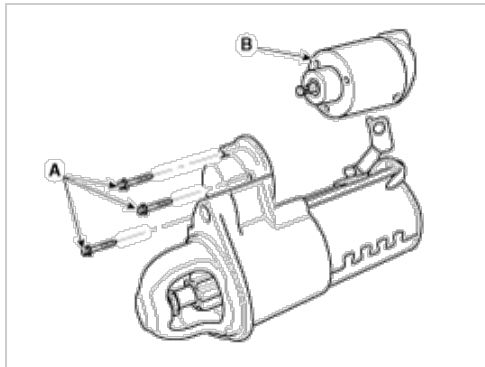


Disassembly

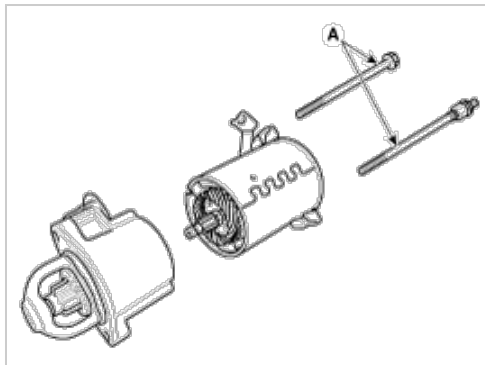
1. Disconnect the M-terminal on the starter solenoid assembly.



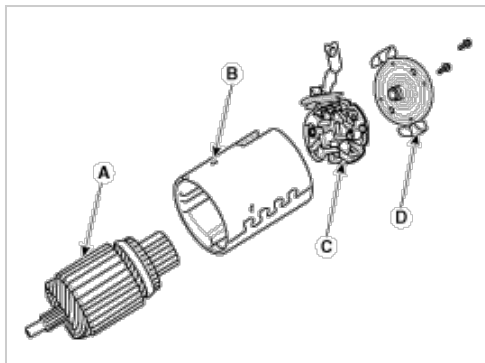
2. After loosening the 3 screws (A), detach the starter solenoid assembly (B).



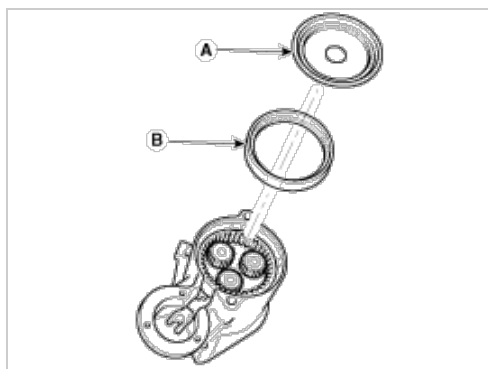
3. Loosen the through bolts (A).



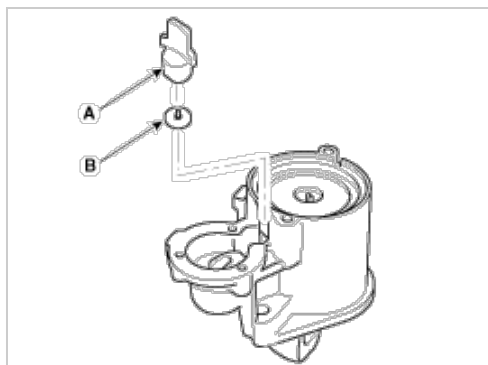
4. Remove the brush holder assembly (C) the yoke (B) the armature (A) and the rear housing (D).



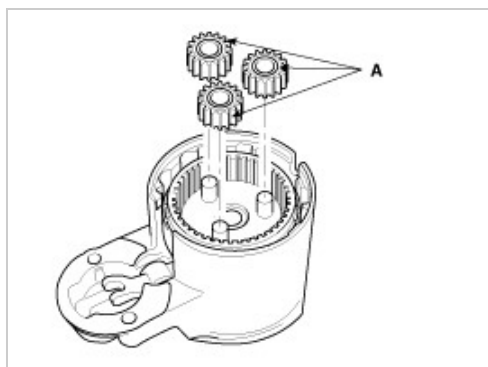
5. Remove the shield (A) and packing (B).



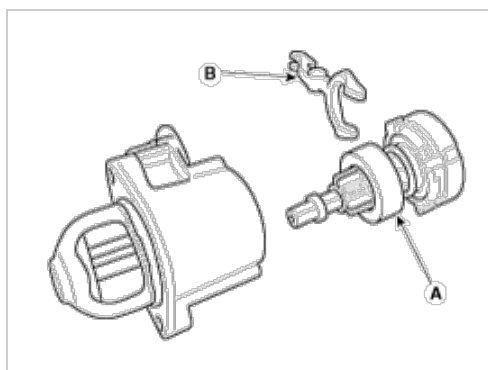
6. Remove the lever plate (A) and lever packing (B).



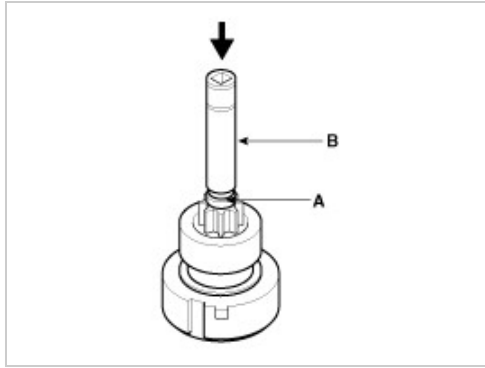
7. Disconnect the planet gear (A).



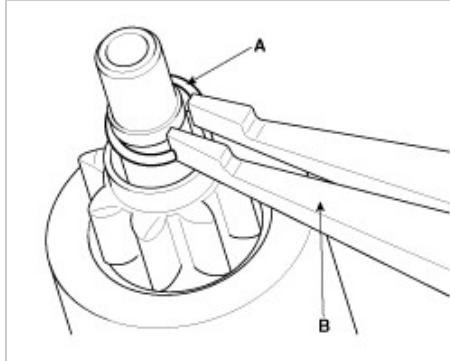
8. Remove the planet shaft assembly (A) and lever (B).



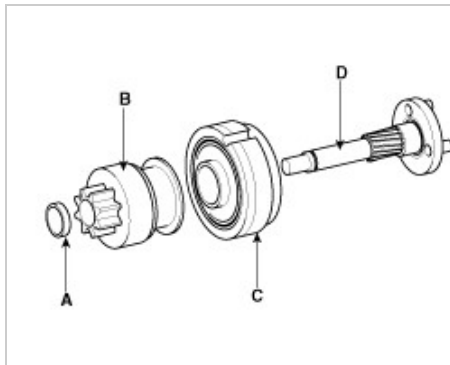
9. Press the stopper (A) using a socket (B).



10. After removing the stop ring (A) using stop ring pliers (B).

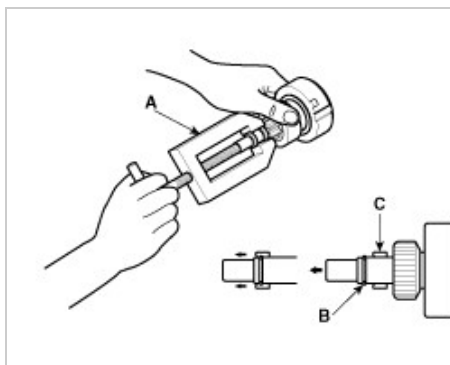


11. Disconnect the stopper (A), overrunning clutch (B), internal gear (C) and planet shaft (D).



NOTICE

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



12. Reassembly is the reverse of disassembly.

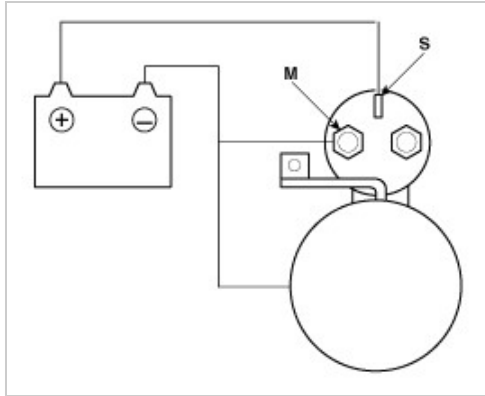
Inspection

Starter Solenoid Inspection

1. Disconnect the lead wire from the M-terminal of solenoid switch.
2. Connect the battery as shown. If the starter pinion pops out, it is working properly.

NOTICE

- To avoid damaging the starter, do not leave the battery connected for more than 10 seconds.

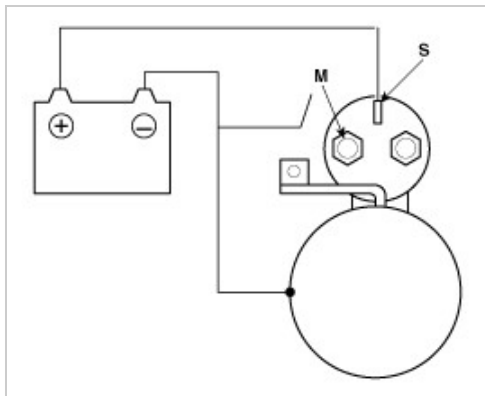


3. Disconnect the battery from the M terminal.

If the pinion does not retract, the hold-in coil is working properly.

NOTICE

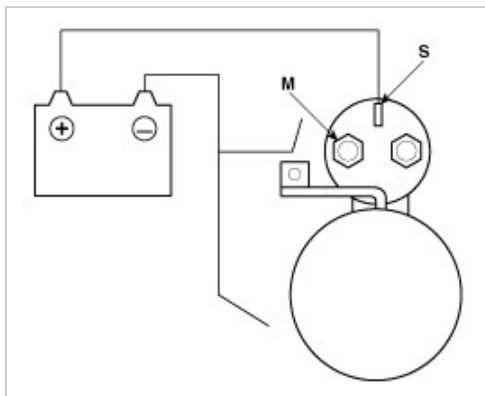
- To avoid damaging the starter, do not leave the battery connected for more than 10 seconds.



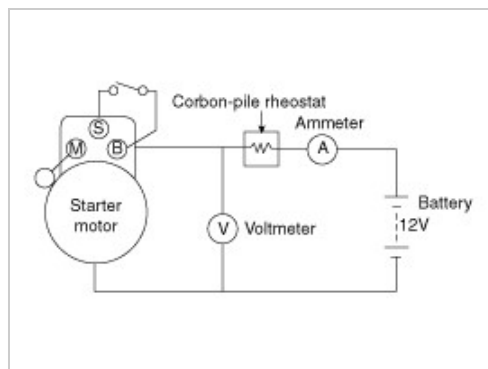
4. Disconnect the battery also from the body. If the pinion retracts immediately, it is working properly.

NOTICE

- To avoid damaging the starter, do not leave the battery connected for more than 10 seconds.

**Free Running Inspection**

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 (150-ampere scale) and carbon pile rheostats shown in the illustration.
3. Connect a voltmeter (15-volt scale) across starter motor.

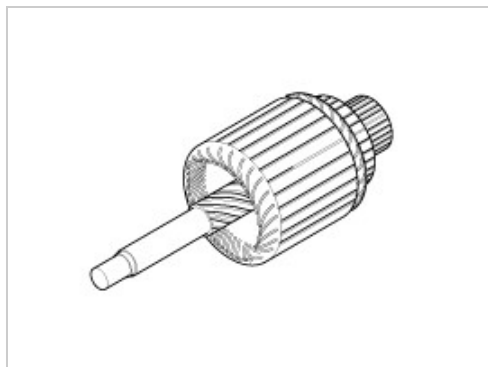


4. Rotate carbon pile to the off position.
5. Connect the battery cable from battery's negative post to the starter motor body.
6. Adjust until battery voltage shown on the voltmeter reads 11volts.
7. Confirm that the maximum amperage is within the specifications and that the starter motor turns smoothly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

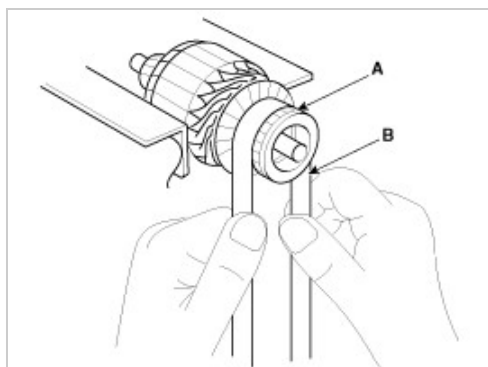
Items	Current (Max.)	Speed (Min.)
Non-ISG type	105 A	2,600 rpm

Armature

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).

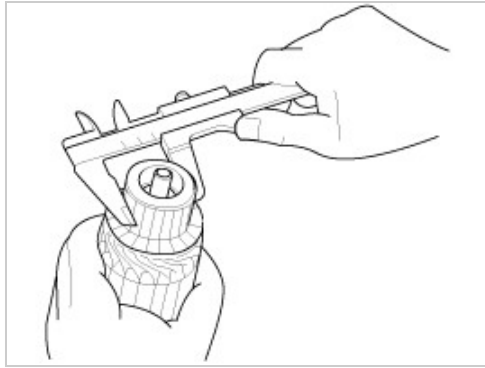


5. Check the commutator diameter. If the diameter is below the service limit, replace the armature.

Commutator diameter

Standard (New) : 29.4 mm (1.1575 in)

Service limit : 28.8 mm (1.1339 in)



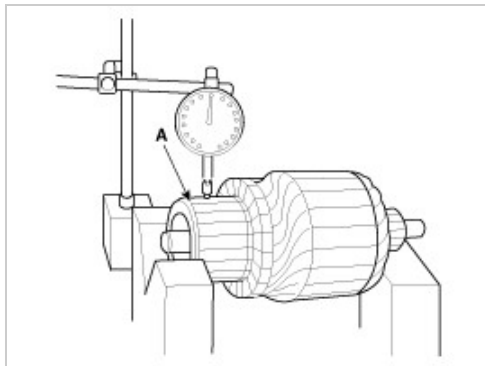
6. Measure the commutator (A) runout.

- If the commutator runout is within the service limit, check the commutator for carbon dust or brass chips between the segments.
- If the commutator run out is not within the service limit, replace the armature.

Commutator runout

Standard (New) : 0.05mm (0.0020in.) max

Service limit : 0.10mm (0.0039in.) max

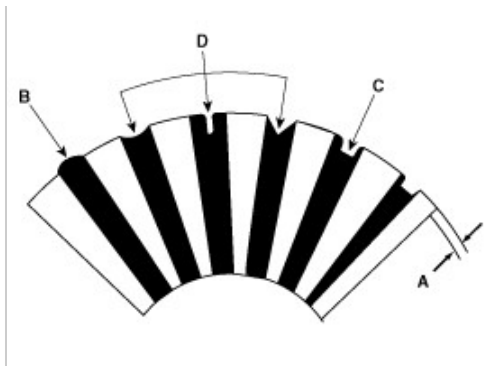


7. Check the mica depth (A). If the mica is too high (B), undercut the mica with a hacksaw blade to the proper depth. Cut away all the mica (C) between the commutator segments. The undercut should not be too shallow, too narrow, or v-shaped (D).

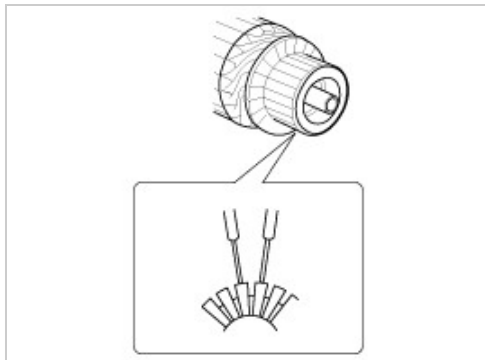
Commutator mica depth

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

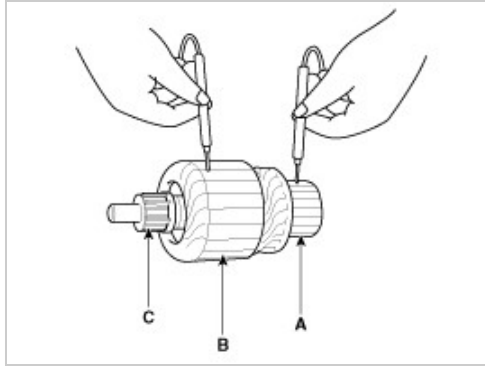
Limit : 0.2mm (0.0079 in.)



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



9. 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.



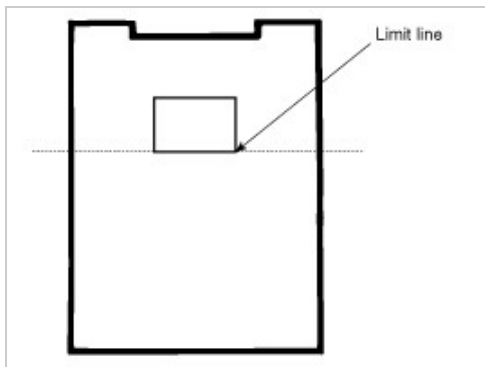
Starter Brush

1. Brushes that are worn out, or oil-soaked, should be replaced.

Brush length

Standard : 12.3 mm (0.4843 in)

Service limit : 5.5 mm (0.2165 in)

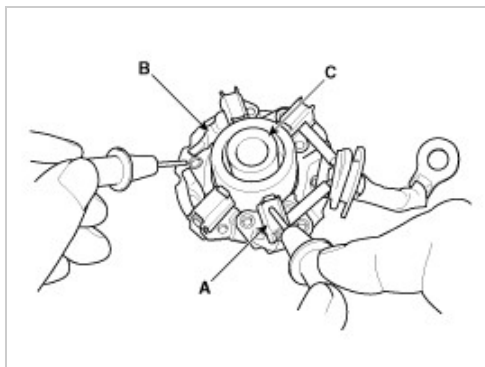


NOTICE

- 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.

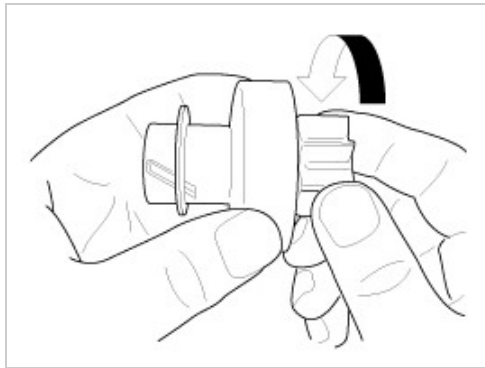
Starter Brush Holder

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



Overrunning Clutch

1. Slide the overrunning clutch along the shaft.
Replace it if it 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.

Engine Electrical System



Inspection

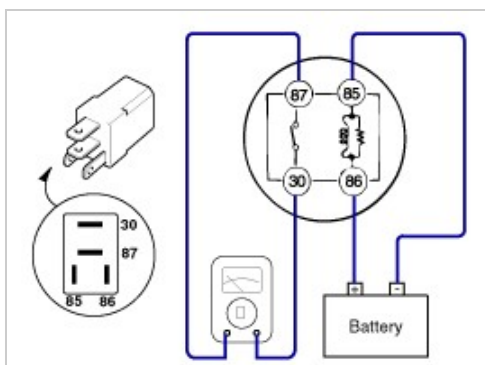
1. Disconnect the battery negative terminal.
2. Remove the fuse box cover.
3. Remove the starter relay(A).



4. Using an ohmmeter, check that there is continuity between each terminal.

Terminal	Continuity
30 - 87	NO
85 - 86	YES

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



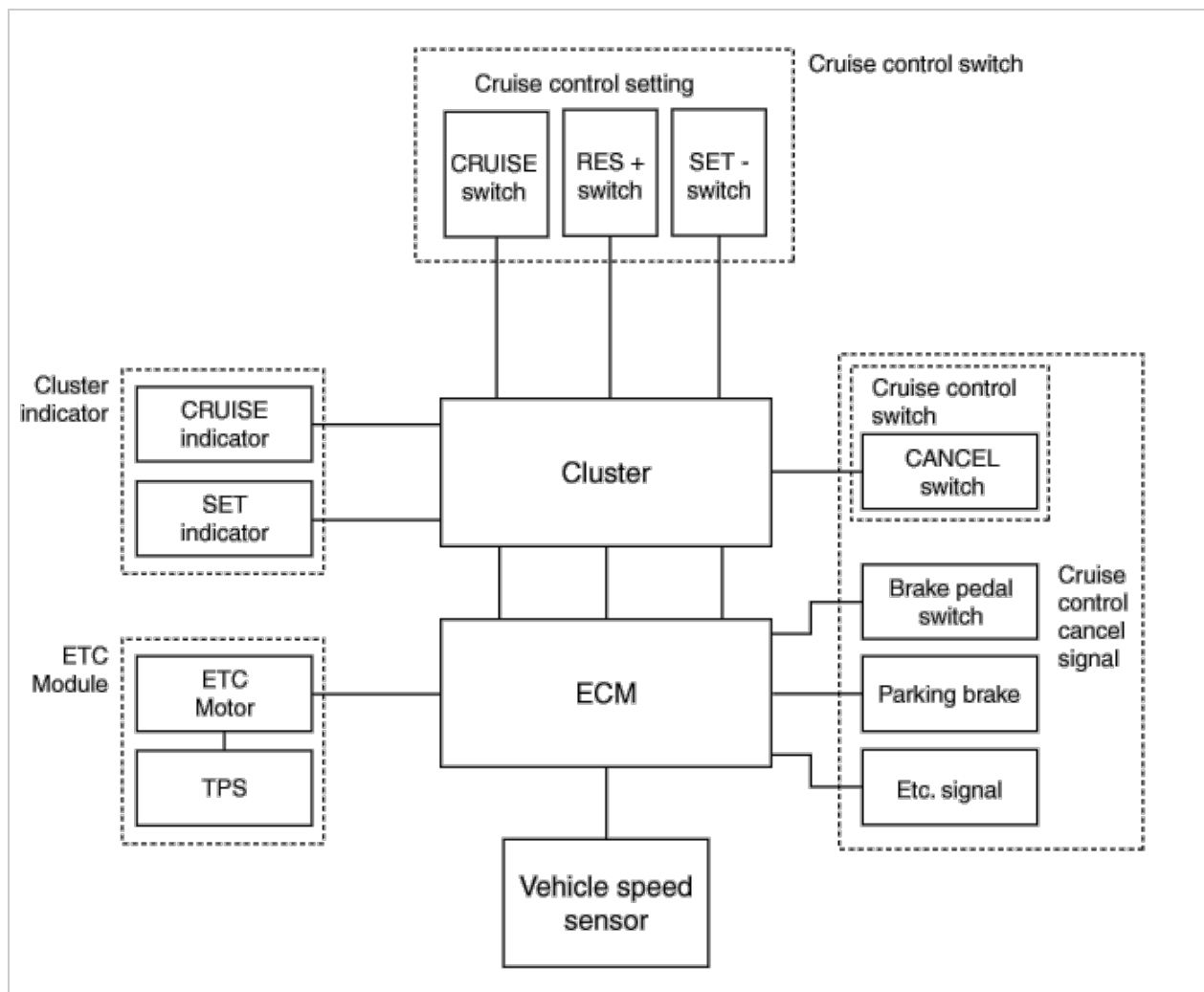
6. If there is no continuity, replace the starter relay.

7. Install the starter relay.
8. Install the fuse box cover.

Engine Electrical System



System Block Diagram



Component Parts And Function Outline

Component part		Function
Vehicle-speed sensor		Converts vehicle speed to pulse.
ECM		Receives signals from sensor and control switches.
Cruise control indicator		Illuminate when CRUISE switch is ON (Built into cluster)
Cruise Control switches	ON/OFF switch	Switch for automatic speed control power supply.
	RES+ switch	Controls automatic speed control functions by Resume/Accel switch (Set/Coast switch)
	SET- switch	
Cancel switches	Cancel switch	Sends cancel signals to ECM.
	Brake-pedal switch	
	Transaxle range switch (A/T)	
ETS motor		Regulates the throttle valve to the set opening by ECM.

* ETC System : Electronic Throttle Control System

Engine Electrical System



Cruise Control

The cruise control system is engaged by the cruise "ON/OFF" main switch located on right of steering wheel column. The system has the capability to cruise, coast, accelerate and resume speed. It also has a safety interrupt, engaged upon depressing brake or shifting select lever.

The ECM is the control module for this system. The main components of cruise control system are mode control switches, transmission range switch, brake switch, vehicle speed sensor, ECM and ETS motor that connect throttle body.

The ECM contains a low speed limit which will prevent system engagement below a minimum speed of 40km/h (25mph).

The operation of the controller is controlled by mode control switches located on steering wheel.

Transmission range switch and brake switch are provided to disengage the cruise control system. The switches are on brake pedal bracket and transmission. When the brake pedal is depressed or select lever shifted, the cruise control system is electrically disengaged and the throttle is returned to the idle position.

Cruise main switch (ON/OFF)

The cruise control system is engaged by pressing the cruise "ON/OFF" main switch. Pressing the cruise "ON/OFF" main switch again releases throttle, clears cruise memory speed, and puts vehicle in a non-cruise mode.

Set/Coast switch (SET/-)

The "SET/-" switch located on right of steering wheel column has two functions.

The set function - Push the "SET/-" switch and release it at the desired speed. The SET indicator light in the instrument cluster will illuminate. Release the accelerator pedal. The desired speed will automatically be maintained.

The coast function - Push the "SET/-" switch and hold it when the cruise control is on. The vehicle will gradually slow down. Release the switch at the desired speed. The desired speed will be maintained.

Push the "SET/-" switch and release it quickly. The cruising speed will decrease by 2.0km/h (1.2mph) or 1.6km/h (1.0mph).

Resume/Accel switch (RES/+)

The "RES/+" switch located on right of steering wheel column has two functions.

The resume function - If any method other than the cruise "ON/OFF" main switch was used to cancel cruising speed temporarily and the system is still activated, the most recent set speed will automatically resume when the "RES/+" switch is pushed. It will not resume, however, if the vehicle speed has dropped below approximately 40km/h (25mph).

The accel function - Push the "RES/+" switch and hold it when the cruise control is on. The vehicle will gradually accelerate. Release the switch at the desired speed. The desired speed will be maintained.

Push the "RES/+" switch and release it quickly. The cruising speed will increase by 2.0km/h (1.2mph) or 1.6km/h (1.0mph).

Cancel switch (CANCEL)

The cruise control system is temporarily disengaged by pushing the "CANCEL" switch.

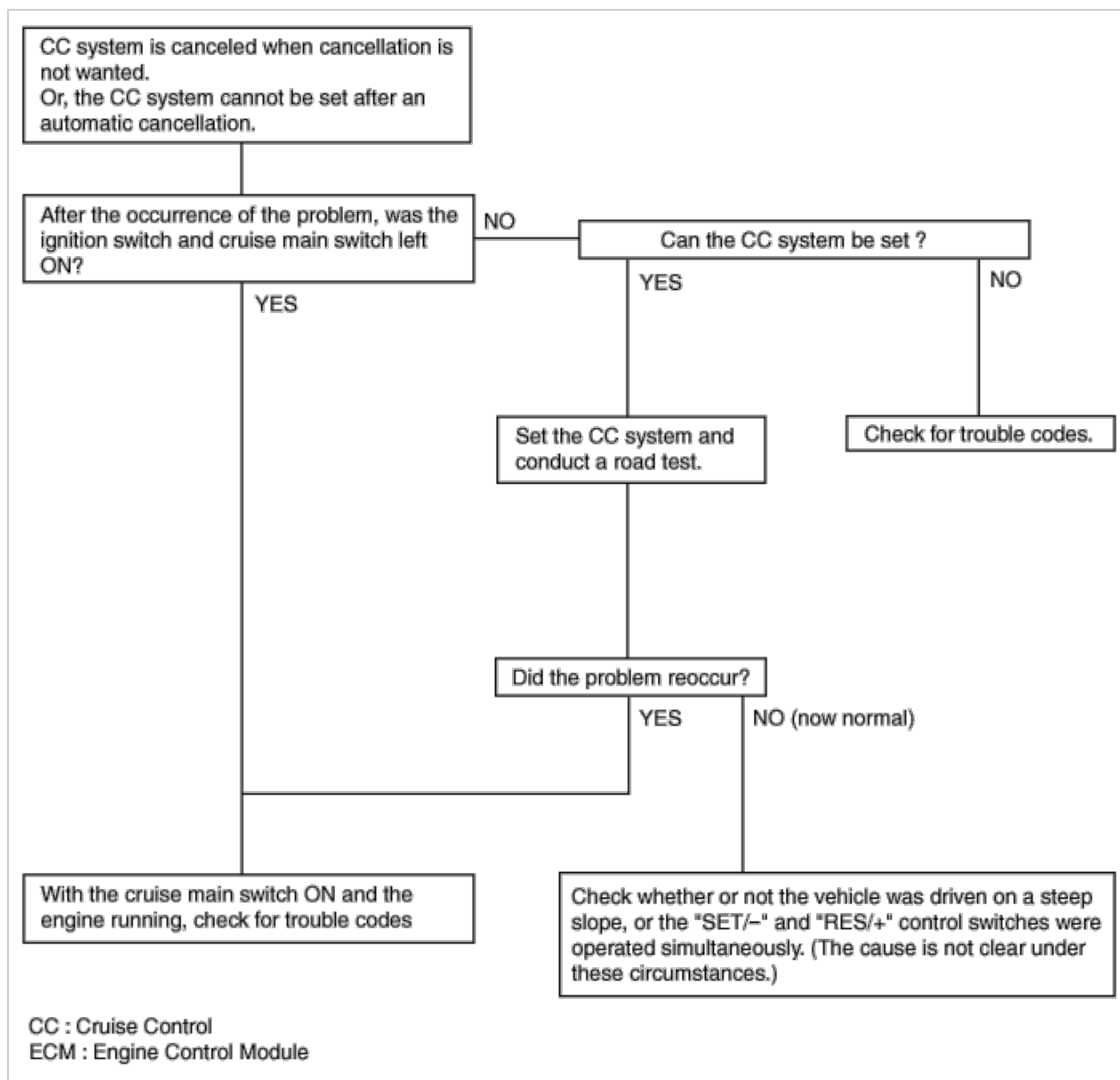
Cruise speed canceled by this switch can be recovered by pushing the "RES/+" switch.

Engine Electrical System



Trouble Symptom Charts

Trouble Symptom 1



Trouble Symptom 2

Trouble symptom	Probable cause	Remedy
The set vehicle speed varies greatly upward or downward	Malfunction of the vehicle speed sensor circuit	Repair the vehicle speed sensor system, or replace the part
"Surging" (repeated alternating acceleration and deceleration) occurs after setting	Malfunction of ECM	Check input and output signals at ECM

Trouble Symptom 3

Trouble symptom	Probable cause	Remedy
The CC system is not canceled when the brake pedal is depressed	Damaged or disconnected wiring of the brake pedal switch	Repair the harness or replace the brake pedal switch
	Malfunction of the ECM signals	Check input and output signals at ECM

Trouble Symptom 4

Trouble symptom	Probable cause	Remedy
The CC system is not canceled when the shift lever is moved to the "N" position (It is canceled, however, when the brake pedal is depressed)	Damaged or disconnected wiring of inhibitor switch input circuit	Repair the harness or repair or replace the inhibitor switch
	Improper adjustment of inhibitor switch	
	Malfunction of the ECM signals	Check input and output signals at ECM

Trouble Symptom 5

Trouble symptom	Probable cause	Remedy
Cannot decelerate (coast) by using the "SET/-" switch	Temporary damaged or disconnected wiring of "SET/-" switch input circuit	Repair the harness or replace the "SET/-" switch
	Malfunction of the ECM signals	Check input and output signals at ECM

Trouble Symptom 6

Trouble symptom	Probable cause	Remedy
Cannot accelerate or resume speed by using the "RES/+" switch	Damaged or disconnected wiring, or short circuit, or "RES/+" switch input circuit	Repair the harness or replace the "RES/+" switch
	Malfunction of the ECM signals	Check input and output signals at ECM

Trouble Symptom 7

Trouble symptom	Probable cause	Remedy
CC system can be set while driving at a vehicle speed of less than 40km/h (25mph), or there is no automatic cancellation at that speed	Malfunction of the vehicle-speed sensor circuit	Repair the vehicle speed sensor system, or replace the part
	Malfunction of the ECM signals	Check input and output signals at ECM

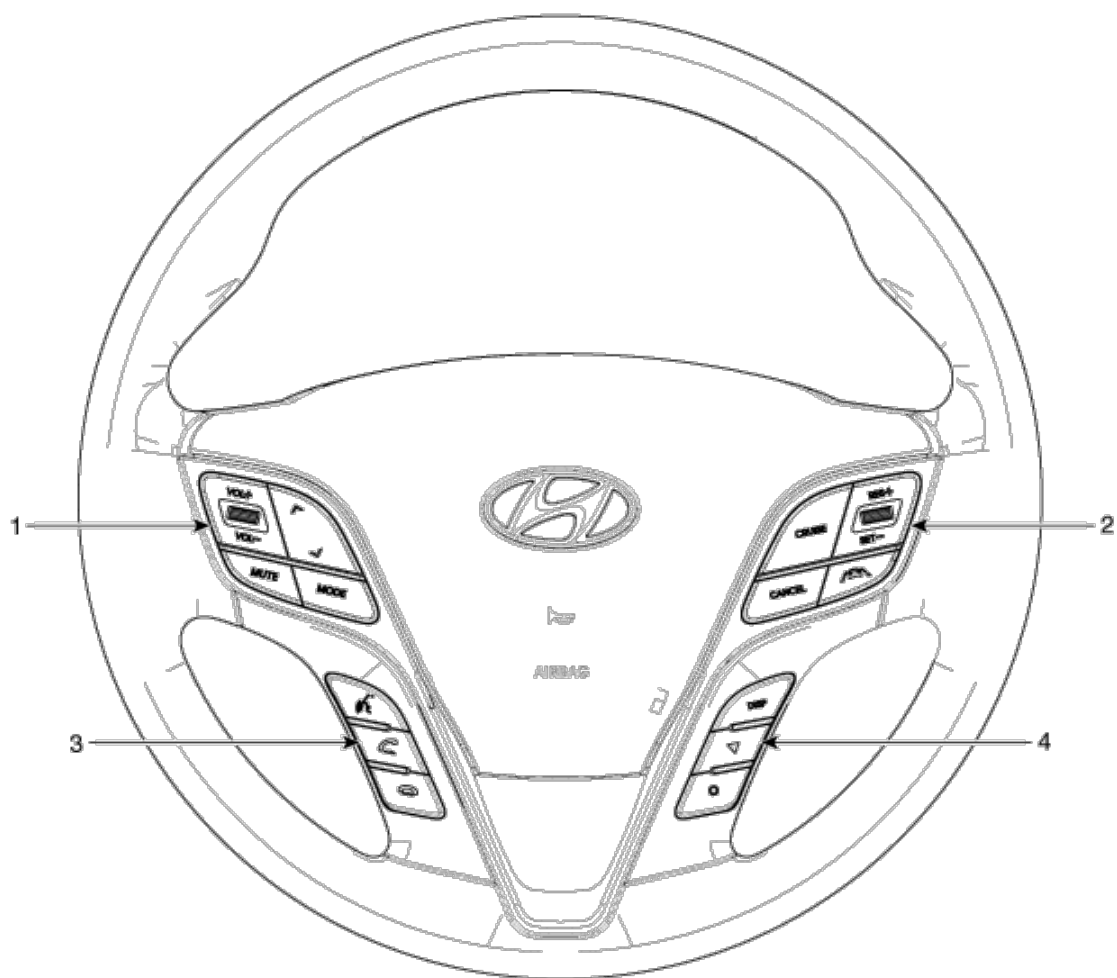
Trouble Symptom 8

Trouble symptom	Probable cause	Remedy
The cruise main switch indicator lamp does not illuminate (But CC system is normal)	Damaged or disconnected bulb of cruise main switch indicator lamp	Repair the harness or replace the part.
	Harness damaged or disconnected	

Engine Electrical System



Components



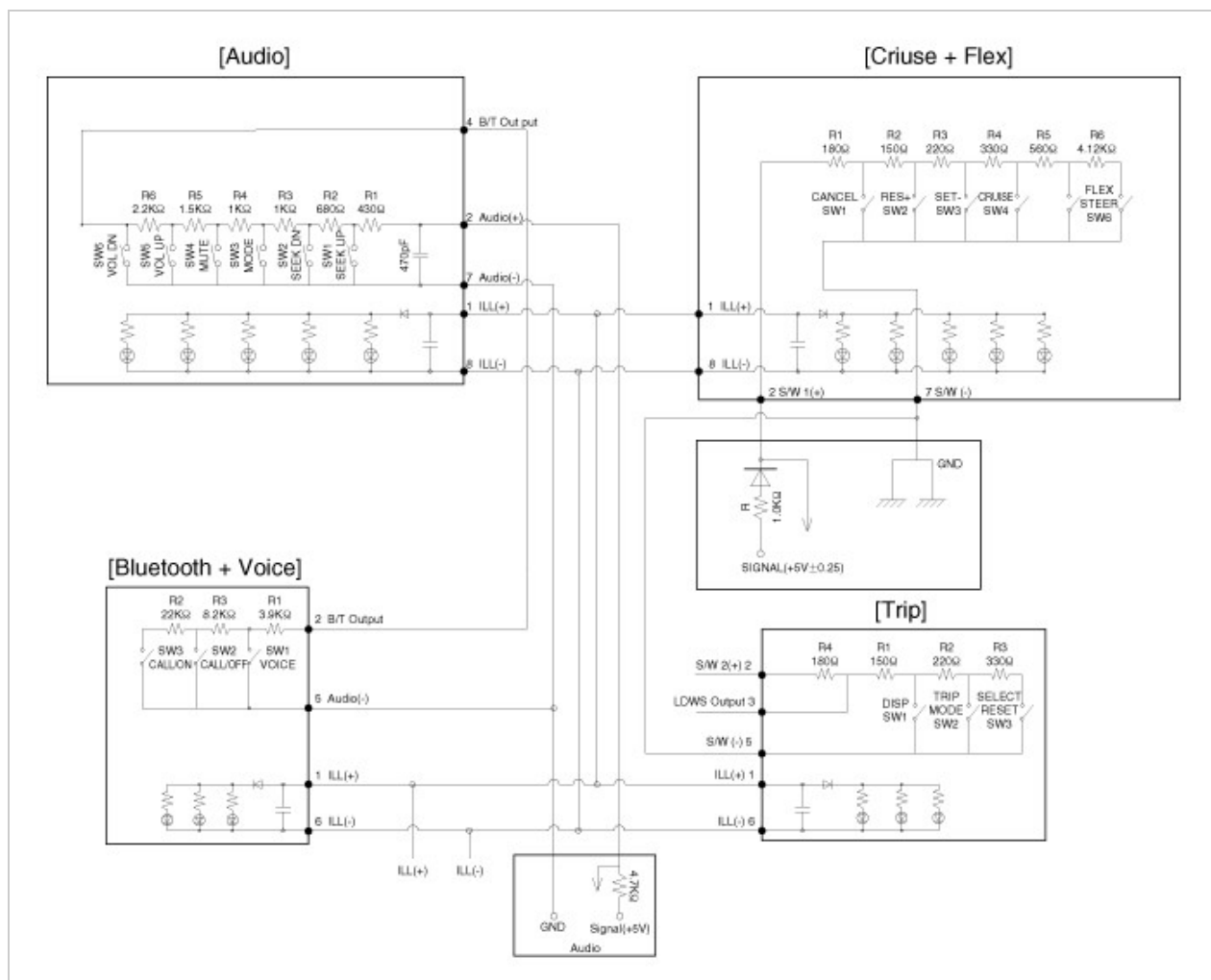
- 1. Remote control switch (LH: Audio)
- 2. Remote control switch (RH: Cruise + Flex)

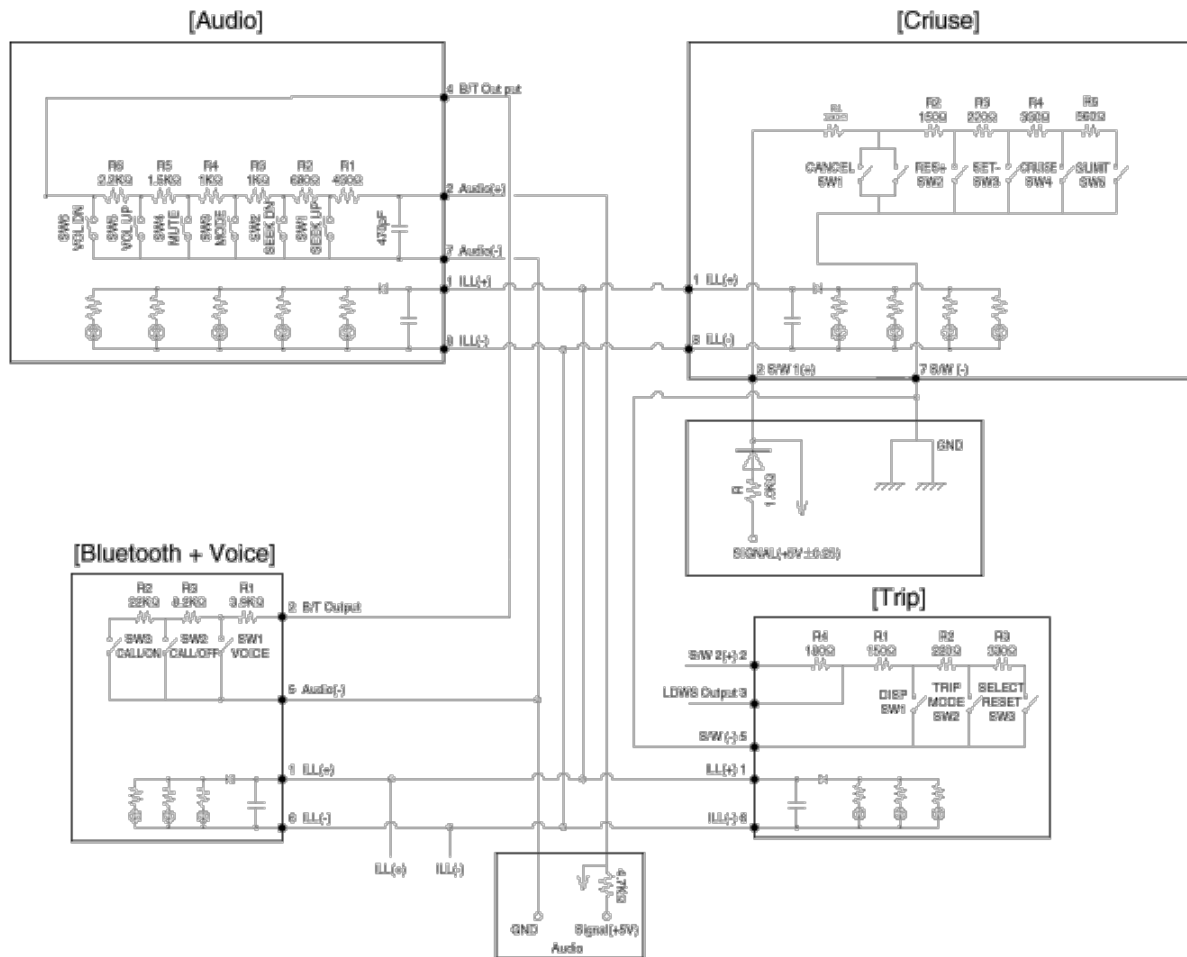
- 3. Bluetooth handfree switch
- 4. Trip switch

Engine Electrical System



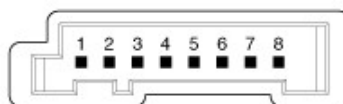
Circuit Diagram



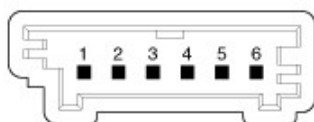


[Audio]

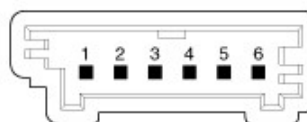
No.	Description
1	Illumination(+)
2	Audio(+)
3	-
4	Bluetooth input
5	-
6	-
7	Audio(-)
8	Illumination(-)

[Cruise + Flex]

No.	Description
1	Illumination(+)
2	Switch1(+)
3	-
4	-
5	-
6	-
7	Switch(-)
8	Illumination(-)

[Bluetooth + Voice]

No.	Description
1	Illumination(+)
2	Bluetooth input
3	-
4	-
5	Audio(-)
6	Illumination(-)

[Trip]

No.	Description
1	Illumination(+)
2	Switch2(+)
3	LDWS output
4	-
5	Switch(-)
6	Illumination(-)

Engine Electrical System**Removal**

1. Disconnect the negative (-) battery terminal.
2. Remove the driver airbag module.
(Refer to Restraint - "Driver Airbag (DAB) Module and Clock Spring")
3. Remove the steering wheel.
(Refer to Steering System - "Steering Column and Shaft")
4. Remove the steering wheel cover (A) after loosening the screws.





5. Loosen the screws after disconnecting the steering wheel remote control switch connector (A).



6. Remove the remote control switches (A).



Installation

1. Install in the reverse order of removal.

Inspection

[Measuring Resistance]

1. Disconnect the cruise control switch connector from the control switch.



2. Measure resistance between terminals on the control switch when each function switch is ON (switch is depressed).

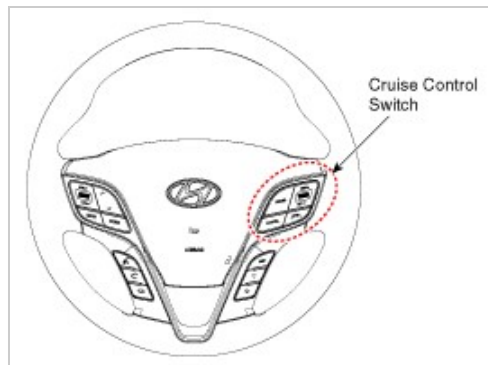
Function switch	Terminal	Resistance [$k\Omega \pm 5\%$]
CANCEL	2 - 7	0.18

RES+	2 - 7	0.33
SET-	2 - 7	0.55
CRUISE	2 - 7	0.88

3. If not within specification, replace switch.

[Measuring Voltage]

1. Connect the cruise control switch connector to the control switch.



2. Measure voltage between terminals on the harness side connector when each function switch is ON (switch is depressed).

Function switch	Terminal	Voltage (V)
CANCEL	2 - 7	0.76
RES+	2 - 7	1.41
SET-	2 - 7	2.05
CRUISE	2 - 7	2.66

3. If not within specification, replace switch.



Description

Emissions Control System consists of three major systems.

- Crankcase Emission Control System prevents blow-by gas from releasing into the atmosphere. This system recycles gas back into the intake manifold (Closed Crankcase Ventilation Type).
- Evaporative Emission Control System prevents evaporative gas from releasing into the atmosphere. This system burns gas at appropriate engine operating condition after gathering it in the canister.
- Exhaust Emission Control System converts the three pollutants [hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx)] into harmless substances by using the 3-way catalytic converter.

Emission Control System



Specifications

Purge Control Solenoid Valve (PCSV)

▷ Specification

Item	Specification
Coil Resistance (Ω)	22.0 ~ 26.0 [20°C(68°F)]

Fuel Tank Pressure Sensor (FTPS)

▷ Type: Piezo-Resistive Pressure Sensor

▷ Specification

Pressure (kPa)	Output Voltage (V)
-6.67	0.5
0	2.5
+6.67	4.5

Canister Close Valve (CCV)

▷ Specification

Item	Specification
Coil Resistance (Ω)	19.9 ~ 22.9 [20°C(68°F)]

Tightening Torques

Item	kgf.m	N.m	lb-ft
Positive Crankcase Ventilation (PCV) Valve installation	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7
Canister installation bolt	0.4 ~ 0.6	3.9 ~ 5.9	2.9 ~ 4.3
Canister protector installation bolt	0.4 ~ 0.6	3.9 ~ 5.9	2.9 ~ 4.3

Emission Control System



Troubleshooting

Symptom	Suspect area
Engine will not start or hard to start	Vapor hose damaged or disconnected
Engine hard to start	Malfunction of the Purge Control Solenoid Valve
Rough idle or engine stalls	Vapor hose damaged or disconnected
	Malfunction of the PCV valve
Rough idle	Malfunction of the Evaporative Emission Control System
Excessive oil consumption	Positive crankcase ventilation line clogged

Emission Control System

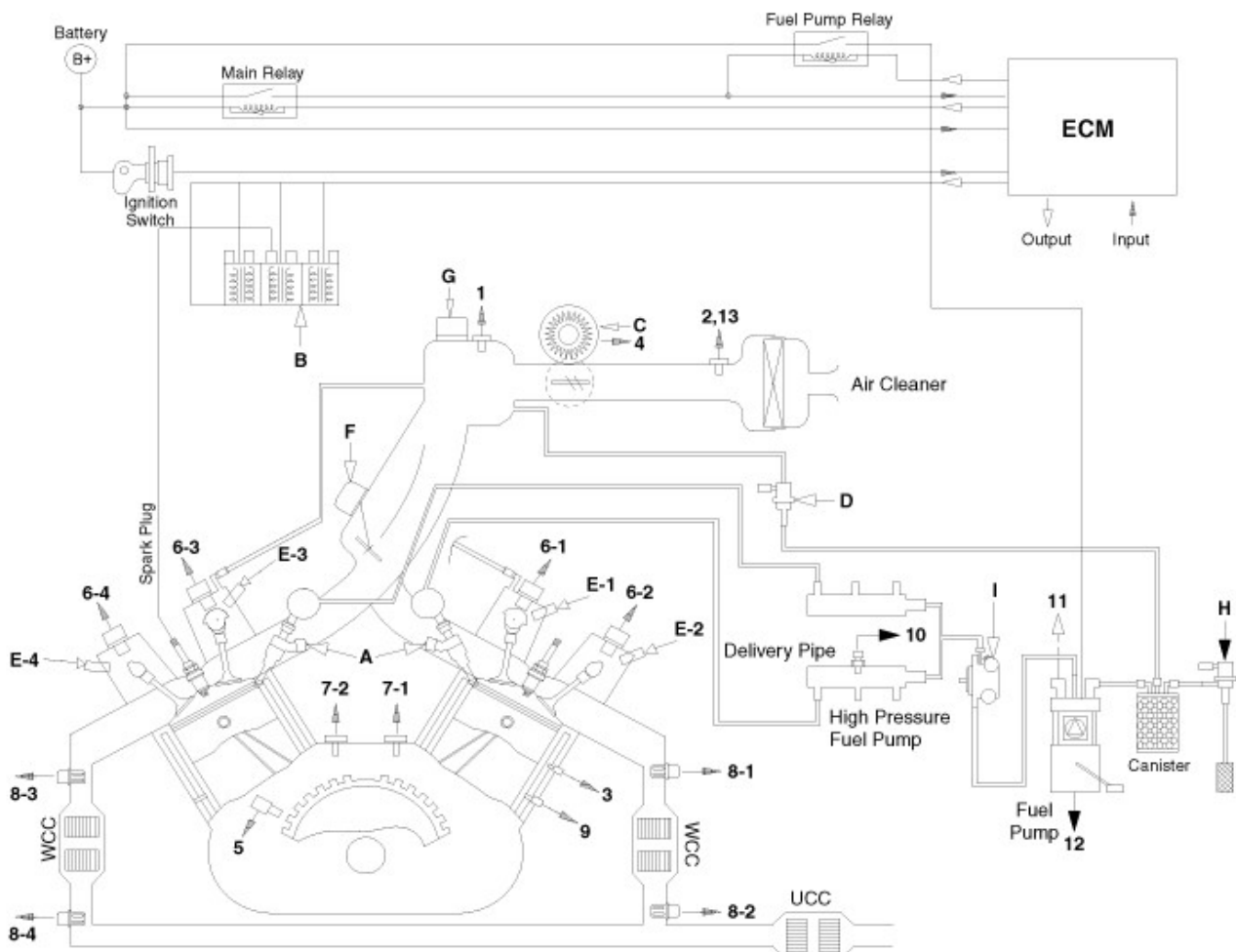


Schematic Diagram

1. Mass Air Flow Sensor (MAFS)
2. Intake Air Temperature Sensor (IATS)
3. Engine Coolant Temperature Sensor (ECTS)
4. Throttle Position Sensor (TPS) [integrated into ETC Module]
5. Crankshaft Position Sensor (CKPS)
- 6-1. Camshaft Position Sensor (CMPS) [Bank 1 / Intake]
- 6-2. Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust]
- 6-3. Camshaft Position Sensor (CMPS) [Bank 2 / Intake]
- 6-4. Camshaft Position Sensor (CMPS) [Bank 2 / Exhaust]
- 7-1. Knock Sensor (KS) [Bank 1 / Front]
- 7-2. Knock Sensor (KS) [Bank 1 / Rear]
- 8-1. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 1]
- 8-2. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 2]
- 8-3. Heated Oxygen Sensor (HO2S) [Bank 2 / Sensor 1]
- 8-4. Heated Oxygen Sensor (HO2S) [Bank 2 / Sensor 2]
9. CVVT Oil Temperature Sensor (OTS)
10. Rail Pressure Sensor (RPS)
11. Fuel Tank Pressure Sensor (FTPS)
12. Fuel Level Sensor (FLS)
- Accelerator Position Sensor (APS)
- A/C Pressure Transducer (APT)



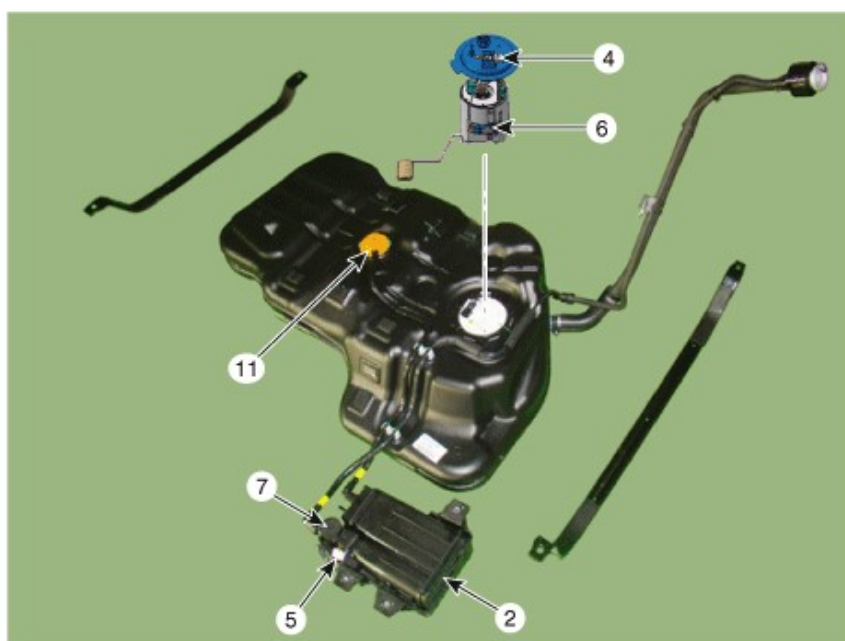
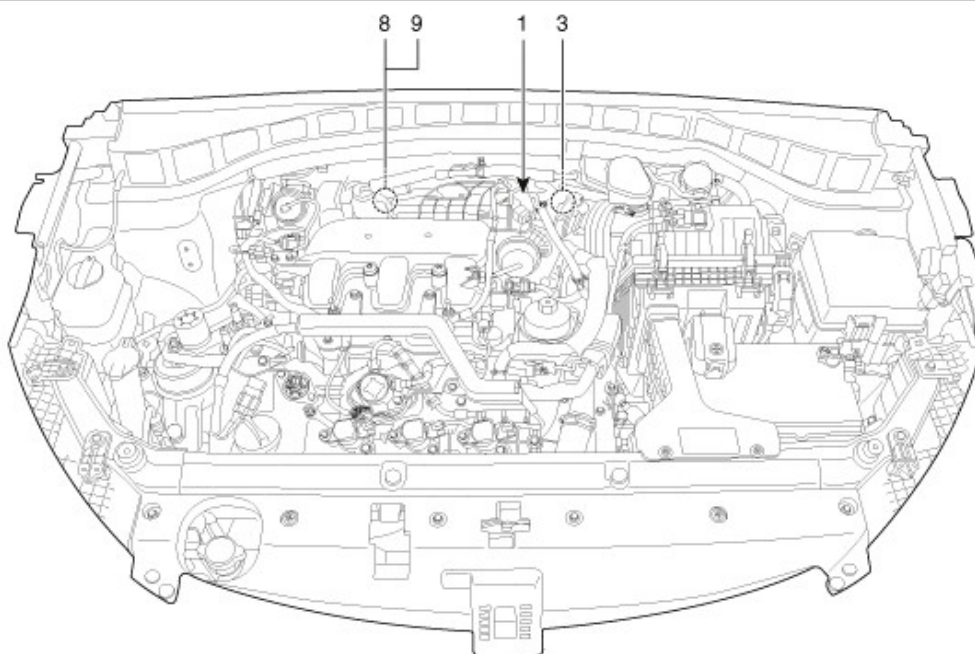
- A. Injector
- B. Ignition Coil
- C. ETC Motor [integrated into ETC Module]
- D. Purge Control Solenoid Valve (PCSV)
- E-1. CVVT Oil Control Valve (OCV) [Bank 1 / Intake]
- E-2. CVVT Oil Control Valve (OCV) [Bank 1 / Exhaust]
- E-3. CVVT Oil Control Valve (OCV) [Bank 2 / Intake]
- E-4. CVVT Oil Control Valve (OCV) [Bank 2 / Exhaust]
- F. Variable Intake Solenoid (VIS) Valve #1
- G. Variable Intake Solenoid (VIS) Valve #2
- H. Canister Close Valve (CCV)
- I. Fuel Pressure Control Valve (FPCV)
- Main Relay
- Fuel Pump Relay
- A/C Control Signal
- Diagnosis
- Fuel Pump Resister Relay



Emission Control System

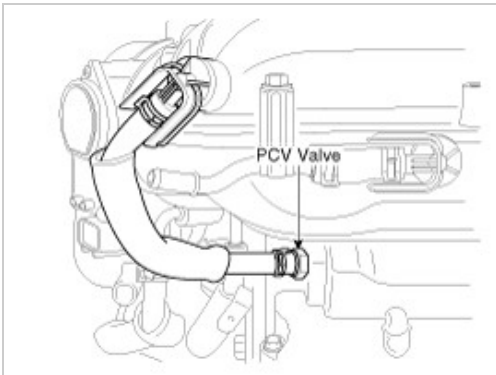


Components Location

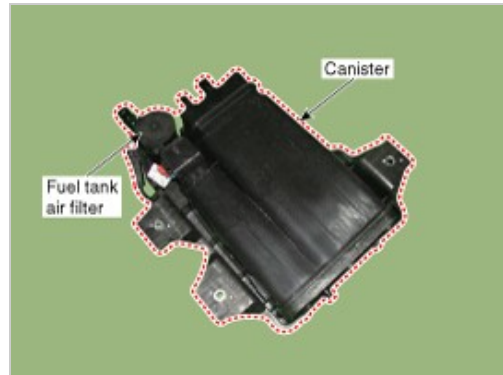


- | | |
|--|--|
| 1. PCV Valve | 7. Fuel Tank Air Filter |
| 2. Canister | 8. Catalytic Converter (WCC, Bank 1) |
| 3. Purge Control Solenoid Valve (PCSV) | 9. Catalytic Converter (WCC, Bank 2) |
| 4. Fuel Tank Pressure Sensor (FTPS) | 10. Catalytic Converter (UCC) |
| 5. Canister Close Valve (CCV) | 11. On-board Refueling Vapor Recovery (ORVR) Valve |
| 6. Fuel Level Sender (FLS) | |

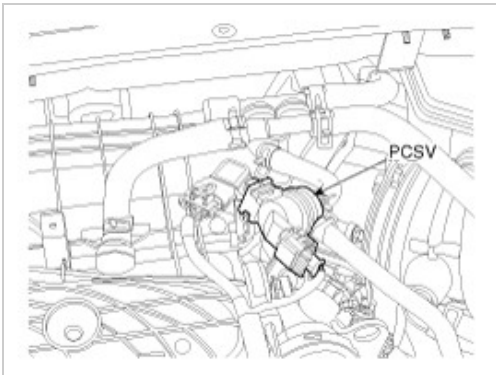
1. PCV Valve	2. Canister 7. Fuel Tank Air Filter



3. Purge Control Solenoid Valve (PCSV)



4. Fuel Tank Pressure Sensor (FTPS)



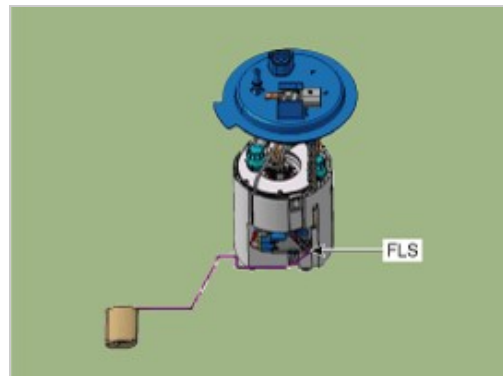
5. Canister Close Valve (CCV)



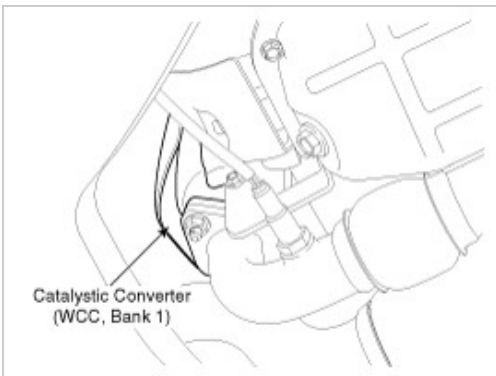
6. Fuel Level Sensor (FLS)



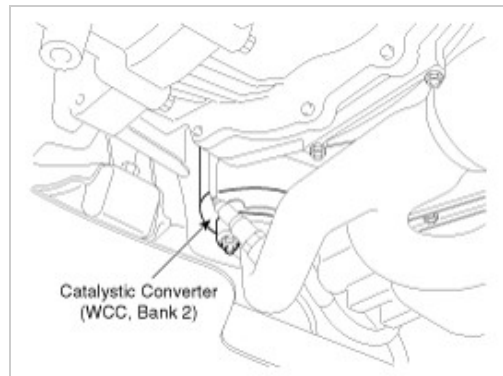
8. Catalytic Converter (WCC, Bank 1)



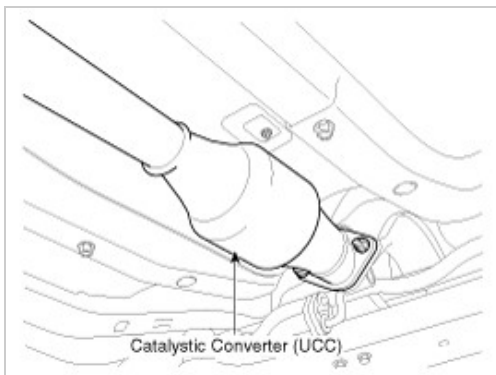
9. Catalytic Converter (WCC, Bank 2)



10. Catalytic Converter (UCC)



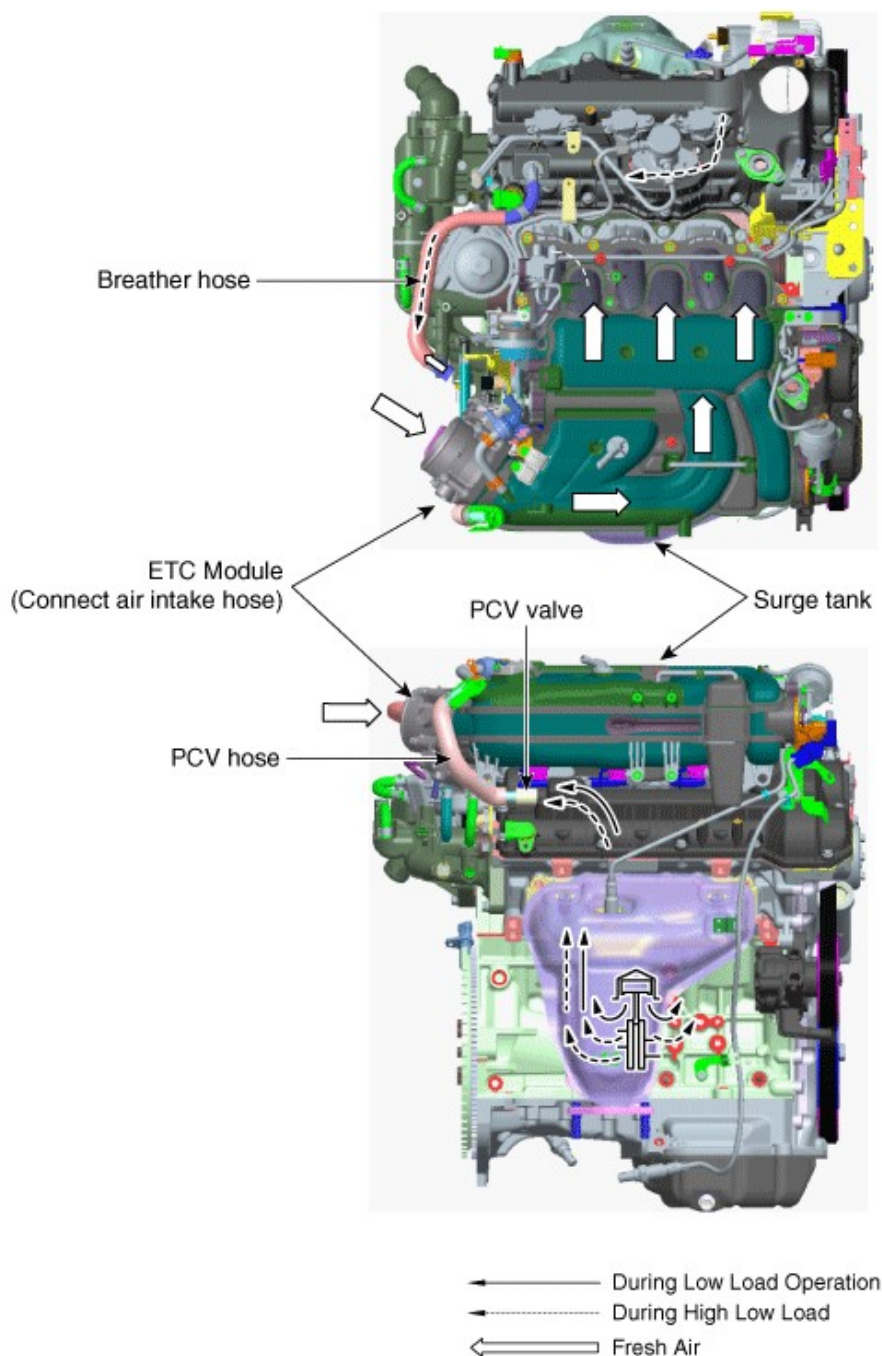
11. On-board Refueling Vapor Recovery (ORVR) Valve



Emission Control System



Schematic Diagram



Emission Control System

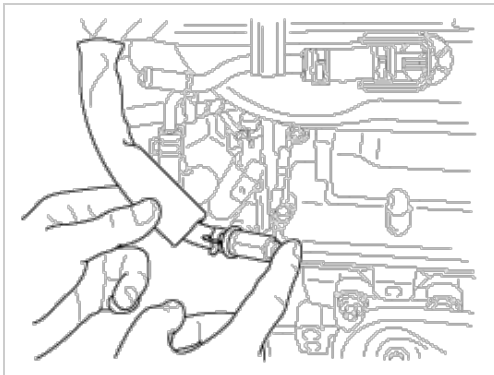


Inspection

1. After disconnecting the vapor hose from the PCV valve, remove the PCV valve.
2. Reconnect the PCV valve to the vapor hose.
3. Inspect the PCV valve operation.
 - (1) Run the engine at idle.
 - (2) Put a finger on the open end of the PCV valve.
 - (3) Make sure that intake manifold vacuum can be felt.

NOTICE

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



4. If the vacuum is not felt, clean or replace the vapor hose.

Emission Control System



Operation Principle

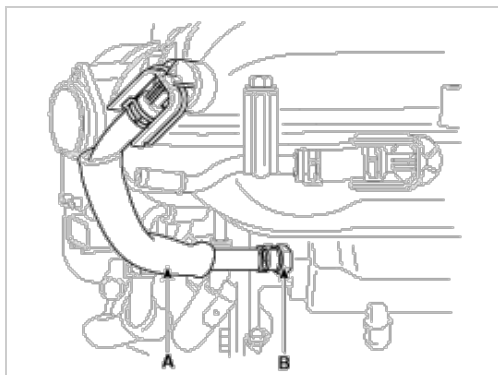
Engine Condition	Not Running	Idling or Decelerating	Normal Operation	Accelerating and High Load
Vacuum in Intake Manifold	0	High	Moderate	Low
PCV Valve	Close	Slightly Open	Properly Open	Fully Open
Blow-by Gas Flow	0	Small	Medium	Large
Schematic Diagram	Intake Manifold	Intake Manifold	Intake Manifold	Intake Manifold

Emission Control System



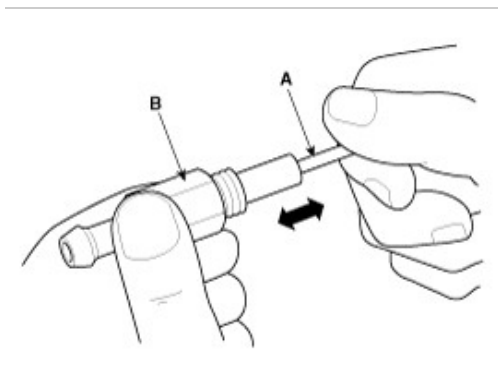
Removal

1. Disconnect the vapor hose (A).
2. Remove the PCV valve (B).



Inspection

1. Insert a thin stick (A) into the PCV valve (B) from the threaded side to check that the plunger moves.



NOTICE

If the plunger does not move (PCV valve is clogged), clean or replace the valve.

Installation

1. Installation is reverse of removal.

PCV Valve installation :

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

Emission Control System

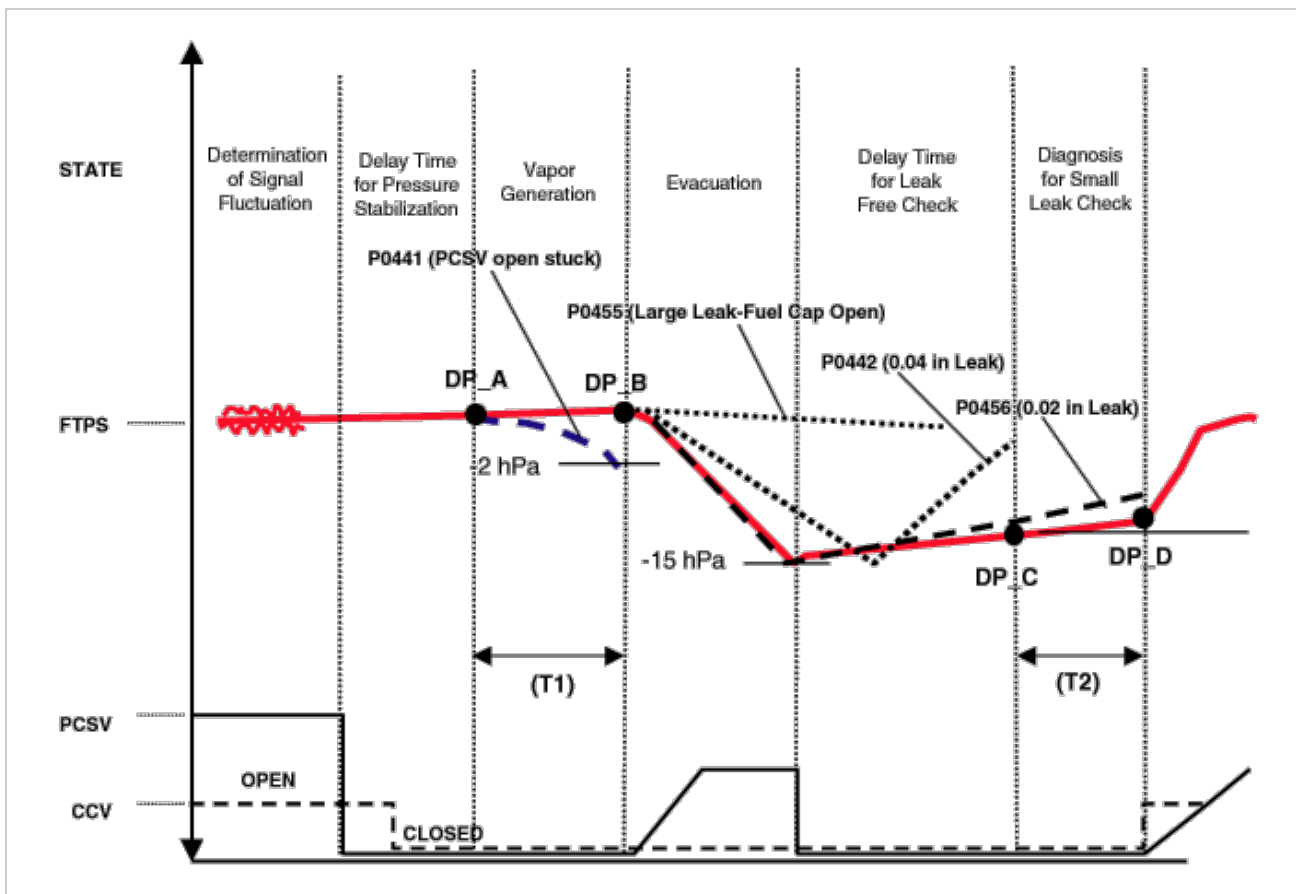


Description

Evaporative Emission Control System prevents fuel vapor stored in fuel tank from vaporizing into the atmosphere. When the fuel evaporates in the fuel tank, the vapor passes through vent hoses or tubes to canister filled with charcoal. The canister temporarily holds the vapor in the charcoal. If ECM determines to draw the gathered vapor into the combustion chambers during certain operating conditions, it will vacuum into intake manifold.

Operation

Evaporative System Monitoring



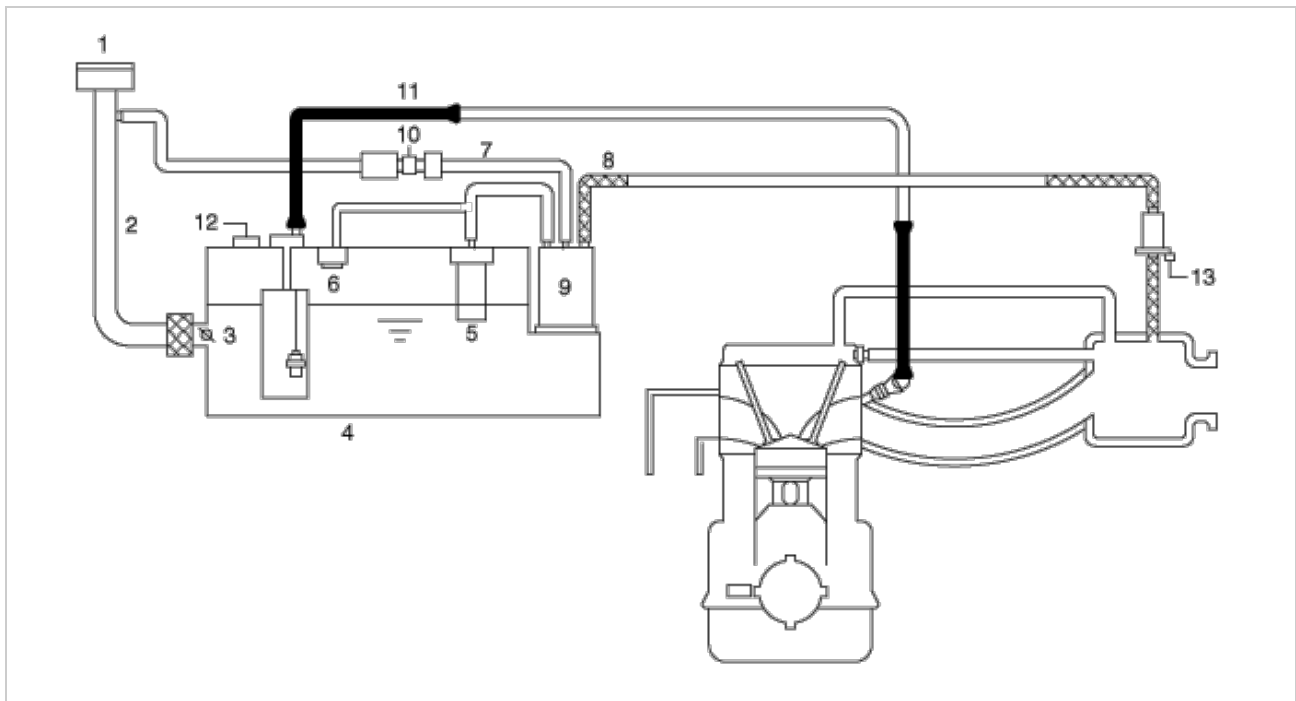
Evaporative And ORVR Emission Control System

This system consists of below items;

- Fill vent valve
- Fuel shut-off valve
- Fuel cut valve (for roll over)
- Two way valve (pressure/vacuum relief)
- Fuel liquid/vapor separator which is installed beside the filler pipe
- Charcoal canister which is mounted under the rear floor LH side member and protector
- Tubes and miscellaneous connections

While refueling, ambient air is drawn into the filler pipe so as not to emit fuel vapors in the air. The fuel vapor in the tank is then forced to flow into the canister via the fill vent valve. The fuel liquid/vapor separator isolates liquid fuel and passes the pure vapor to the charcoal canister.

While the engine is operating, the trapped vapor in the canister is drawn into the intake manifold and then into the engine combustion chamber. According to this purge process, the charcoal canister is purged and recovers its absorbing capability.

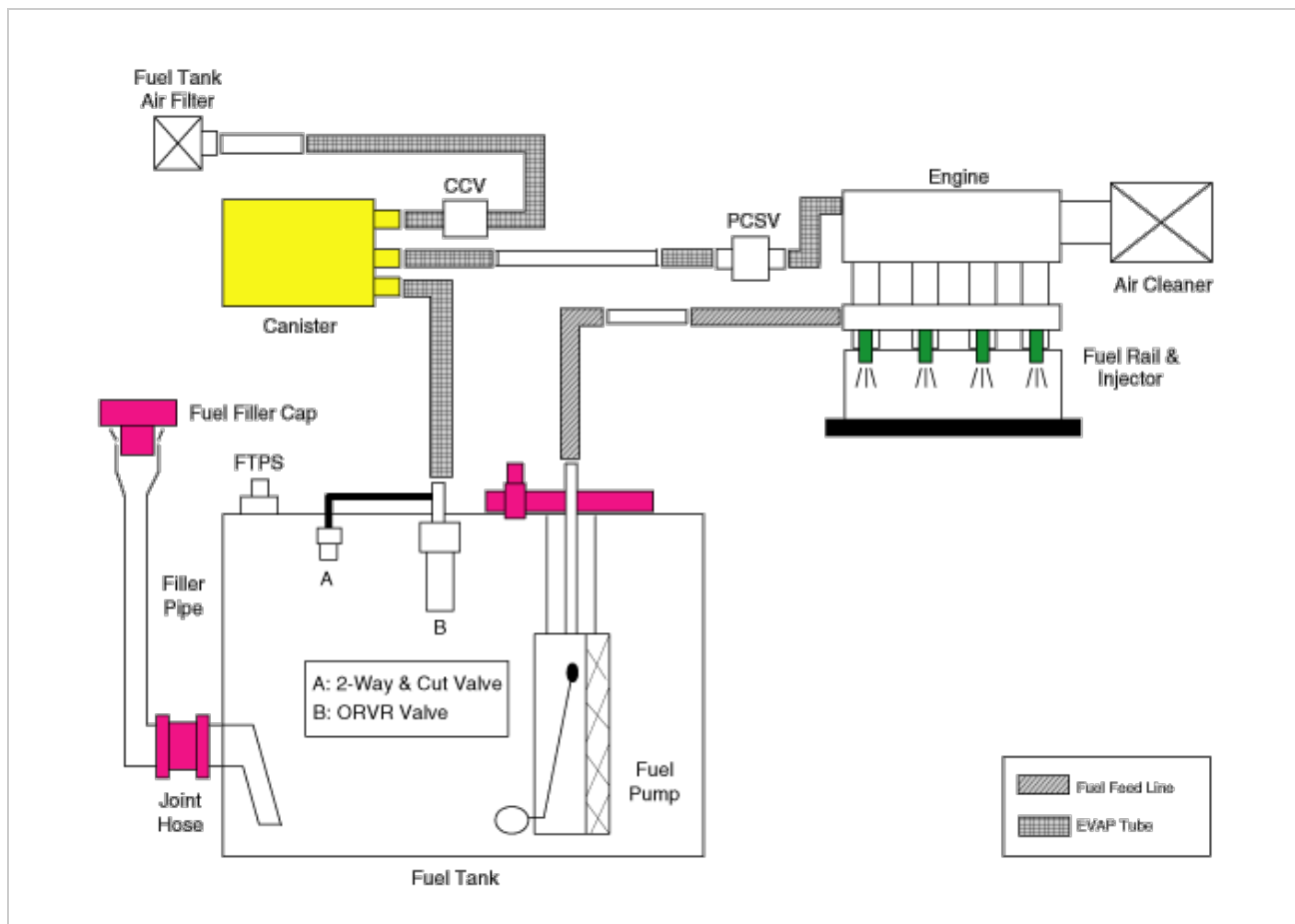


- | | |
|------------------------|---|
| 1. Fuel Filler Cap | 8. Evaporative Hose |
| 2. Fuel Filler Pipe | 9. Canister |
| 3. Fuel Shut-OFF Valve | 10. Canister Close Valve (CCV) |
| 4. Fuel Tank | 11. Fuel Feed Line |
| 5. ORVR Valve | 12. Fuel Tank Pressure Sensor (FTPS) |
| 6. 2-Way & Cut Valve | 13. Purge Control Solenoid Valve (PCSV) |
| 7. Evaporative Hose | |

Emission Control System



Schematic Diagram



Canister

Canister is filled with charcoal and absorbs evaporated vapor in fuel tank. The gathered fuel vapor in canister is drawn into the intake manifold by the ECM/PCM when appropriate conditions are set.

Purge Control Solenoid Valve (PCSV)

Purge Control Solenoid Valve (PCSV) is installed in the passage connecting canister and intake manifold. It is a duty type solenoid valve and is operated by ECM/PCM signal.

To draw the absorbed vapor into the intake manifold, the ECM/PCM will open the PCSV, otherwise the passage remains closed.

Fuel Filler Cap

A ratchet tightening device on the threaded fuel filler cap reduces the chances of incorrect installation, seals the fuel filler. After the gasket on the fuel filler cap and the fill neck flange make contact, the ratchet produces a loud clicking noise indicating the seal has been set.

Fuel Tank Pressure Sensor (FTPS)

The Fuel Tank Pressure Sensor (FTPS) is an integral part of the monitoring system. The FTPS checks Purge Control Solenoid Valve (PCSV) operation and leaks in the Evaporative Emission Control System by monitoring pressure and vacuum level in the fuel tank during PCSV operating cycles.

Canister Close Valve (CCV)

The Canister Close Valve (CCV) is located between the canister and the fuel tank air filter. It closes off the air inlet to the canister for the Evaporative Emissions System and also prevents fuel vapors from escaping from the Canister when the vehicle is not operating.

Evaporative System Monitoring

Evaporative Emission Control Monitoring System consists of fuel vapor generation, evacuation, and leakage check step. At first, the OBD-II system checks if vapor generation due to fuel temperature is small enough to start monitoring. Then it evacuates the evaporative system by means of PCSV with ramp in order to maintain a certain vacuum level. The final step is to check if there is vacuum loss by any leakage of the system.

Vapor Generation Checking

During stabilization period, the PCSV and the CCV are closed. The system pressure is measured as starting pressure (DP_A). After a certain defined period (T1), the system pressure (DP_B) is measured again and the difference from the starting pressure is calculated. If this difference (DP_B - DP_A) is bigger than a threshold, there should be excessive vapor and the monitor is aborted for next checking. On the contrary, if the difference is lower than another negative threshold, PCSV is regarded as malfunction such as clogged at open position.

Evacuation

PCSV is opened with a certain ramp for the pressure to reach down to a certain level. If pressure can't be lowered below a threshold, the system is regarded as fuel cap-opened or having a large leakage.

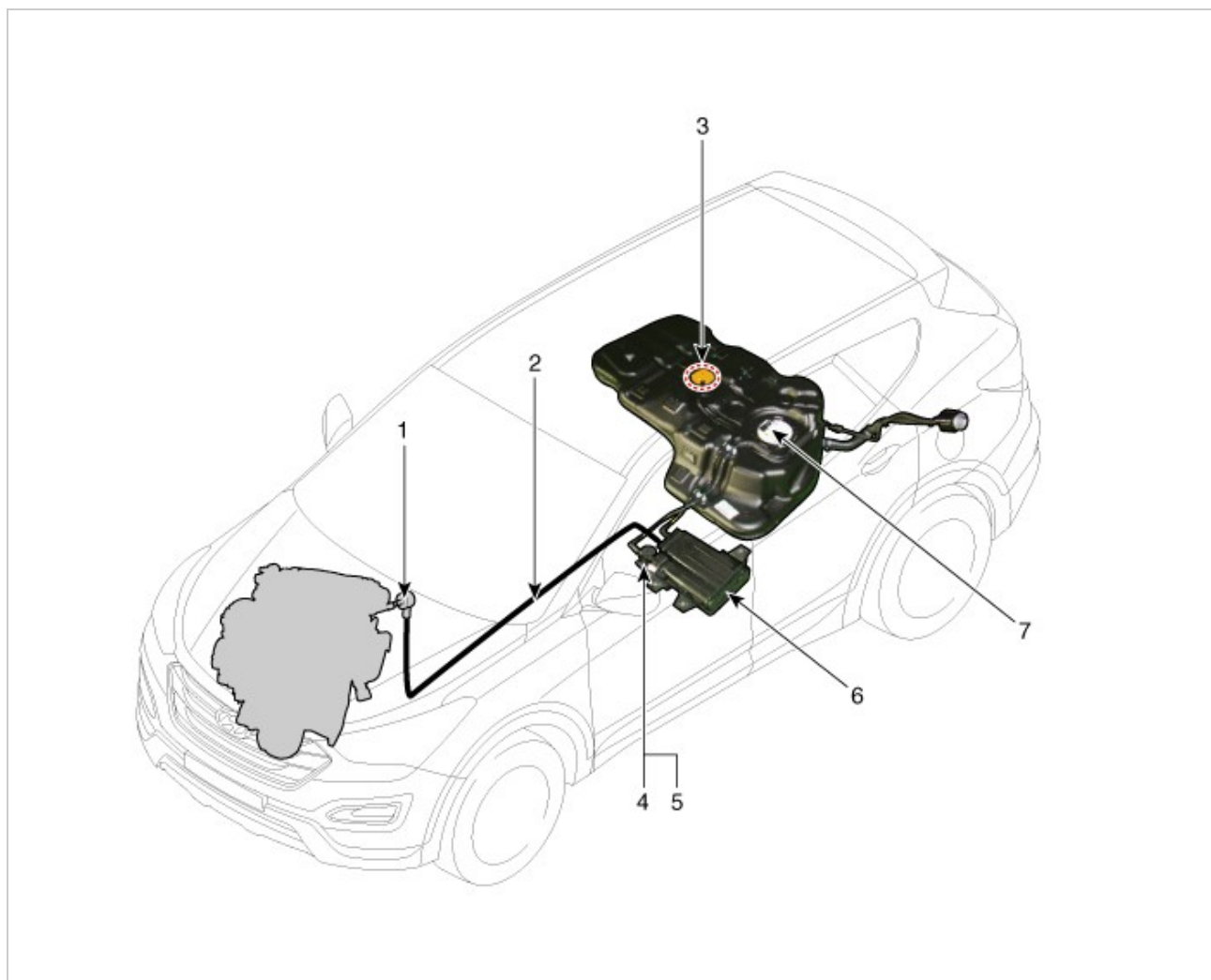
Leaking Checking

PCSV is closed and the system waits for a period to get stabilized pressure. During checking period (T2), the system measures the beginning and the end of the system pressure (DP_C, DP_D). The diagnosis value is the pressure difference corrected by natural vapor generation (DP_B - DP_A) rate from the vapor generation checking step.

Emission Control System



Components Location



1. Purge Control Solenoid Valve (PCSV)
2. Vapor line
3. ORVR valve
4. Fuel tank air filter

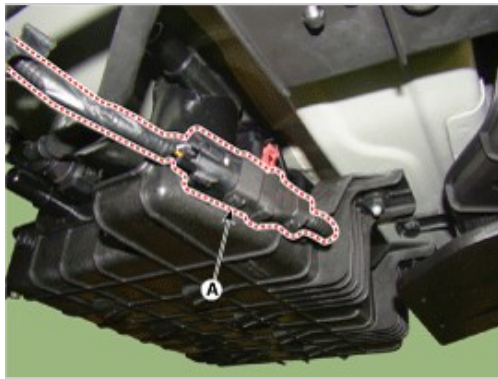
5. Canister Close Valve (CCV)
6. Canister
7. Fuel Tank Pressure Sensor (FTPS)

Emission Control System

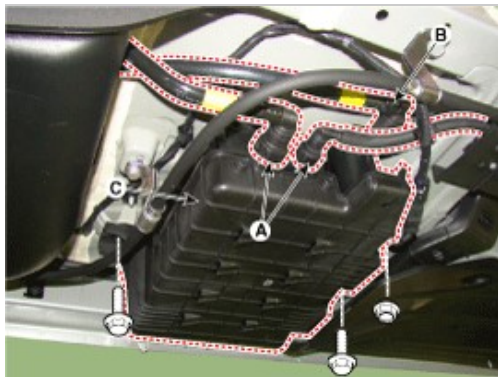


Removal

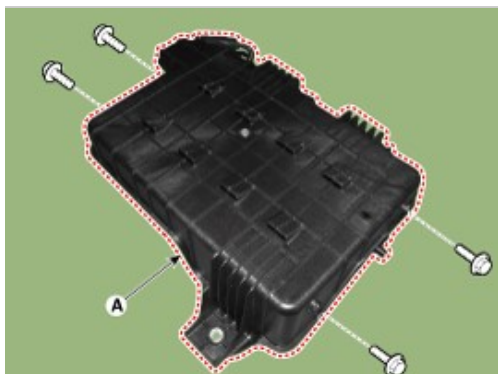
1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Lift the vehicle.
3. Disconnect the canister close valve extension connector (A).

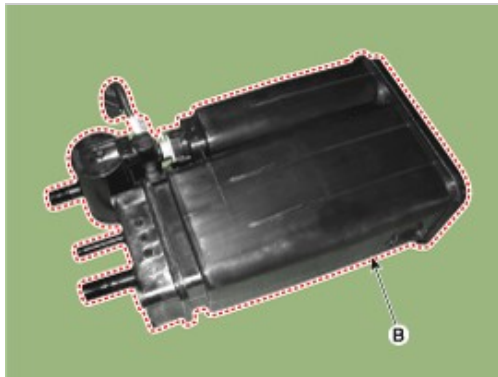


4. Disconnect the vapor tube quick-connector (A) from the canister.
5. Disconnect the ventilation tube quick-connector (B) from the fuel tank air filter.
6. Remove the canister assembly assembly (C) after removing the mounting bolts and nut.



7. Remove the canister protector (A) from the canister (B) after removing the installation 4 bolts.

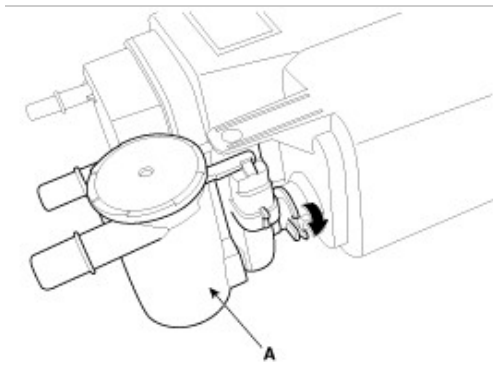




8. Remove the canister close valve connector (A).

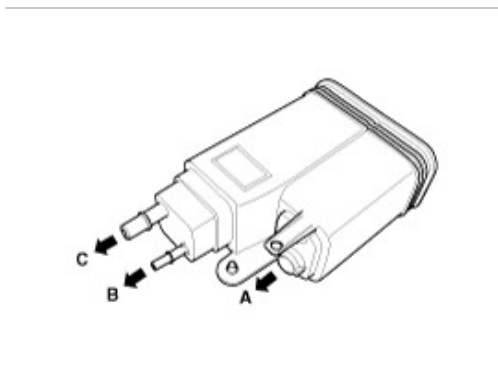


9. Remove the fuel tank air filter & canister close valve assembly (A) after rotating it in the direction of the arrow in the figure.



Inspection

1. Check for the following items visually.
 - Cracks or leakage of the canister
 - Loose connection, distortion, or damage of the vapor hose/tube



A: Canister ↔ Atmosphere

B: Canister ↔ Fuel Tank

C: Canister ↔ Intake Manifold

Installation

NOTICE

- Install the component with the specified torques.
- Note that internal damage may occur when the component is dropped. If the component has been dropped, inspect before installing.

1. Install in the reverse order of removal.

Canster protector installation bolt :

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

Canster assembly installation bolt/nut :

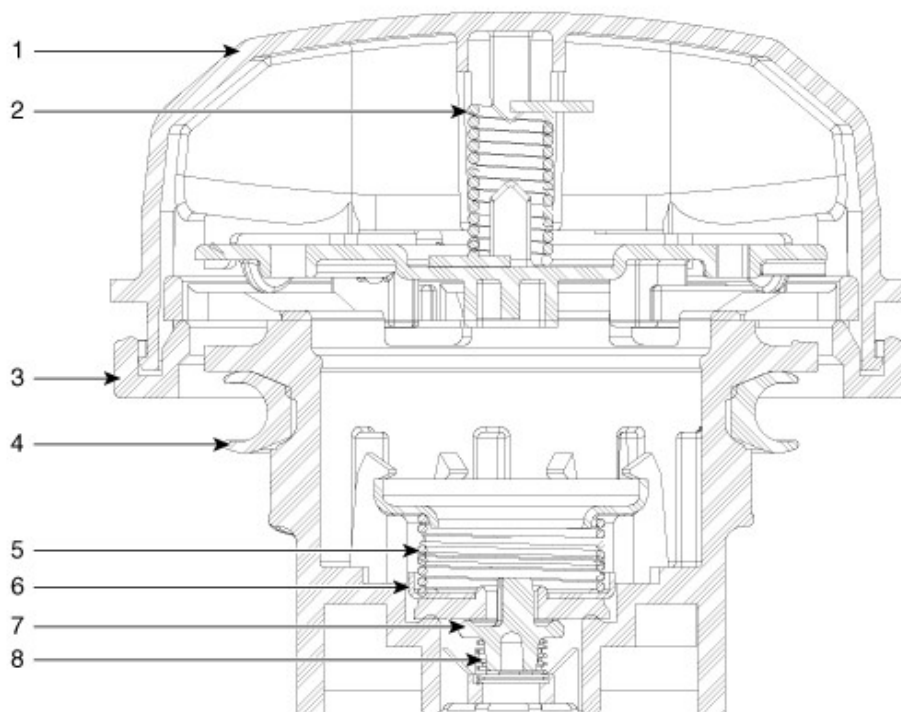
3.9 ~ 5.9 N.m (0.4 ~ 0.6 kgf.m, 2.9 ~ 4.3 lb-ft)

Emission Control System



Description

A ratchet tightening device on the threaded fuel filler cap reduces the chances of incorrect installation, which would seal the fuel filler. After the gasket on the fuel filler cap and the filler neck flange contact each other, the ratchet produces a loud clicking noise indicating the seal has been set.



1. Cover

2. Torsion spring

3. Retainer

4. Gasket seal

5. Spring

6. Plate seal

7. Vacuum valve

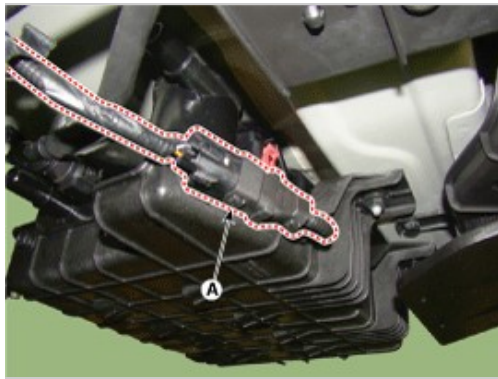
8. Spring

Emission Control System

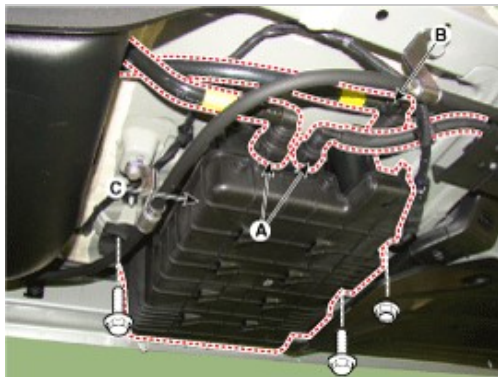


Removal

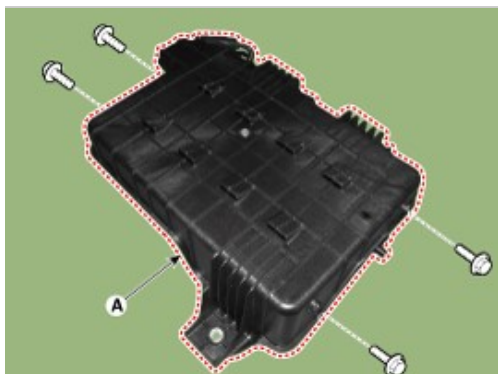
1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Lift the vehicle.
3. Disconnect the canister close valve extension connector (A).

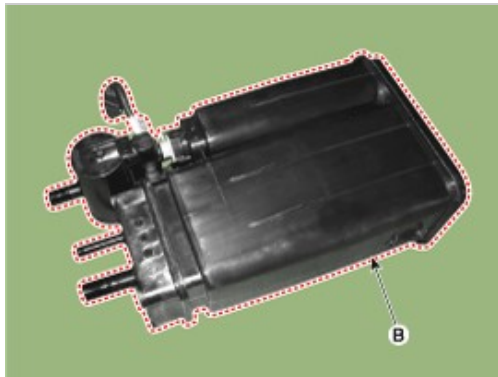


4. Disconnect the vapor tube quick-connector (A) from the canister.
5. Disconnect the ventilation tube quick-connector (B) from the fuel tank air filter.
6. Remove the canister assembly assembly (C) after removing the mounting bolts and nut.



7. Remove the canister protector (A) from the canister (B) after removing the installation 4 bolts.

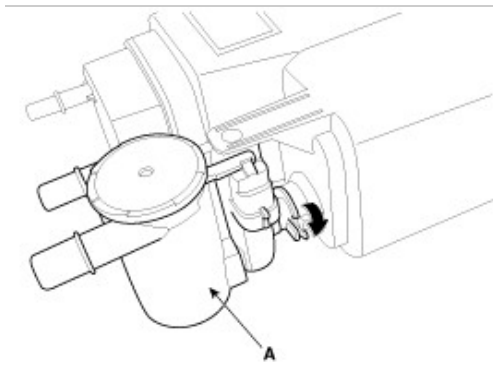




8. Remove the canister close valve connector (A).



9. Remove the fuel tank air filter & canister close valve assembly (A) after rotating it in the direction of the arrow in the figure.



10. Release the lever (A), and then separate the canister close valve (B) from the fuel tank air filter (C) after rotating it in the direction of the arrow in the figure.



Installation

NOTICE

- Install the component with the specified torques.
- Note that internal damage may occur when the component is dropped. If the component has been dropped, inspect before installing.

1. Install in the reverse order of removal.

Canster protector installation bolt :

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

Canster assembly installation bolt/nut :

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

Emission Control System**Description**

Exhaust emissions (CO, HC, NOx) are controlled by a combination of engine modifications and the addition of special control components.

Modifications to the combustion chamber, intake manifold, camshaft and ignition system form the basic control system.

These items have been integrated into a highly effective system which controls exhaust emissions while maintaining good drivability and fuel economy.

Air/Fuel Mixture Control System [Multiport Fuel Injection (MFI) System]

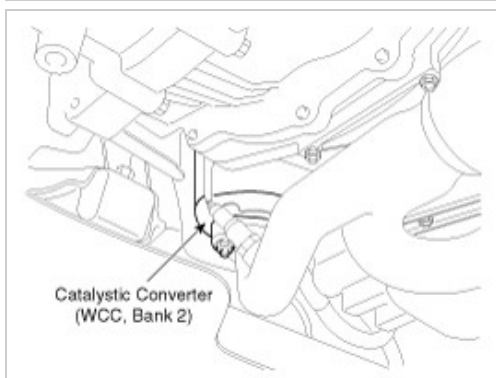
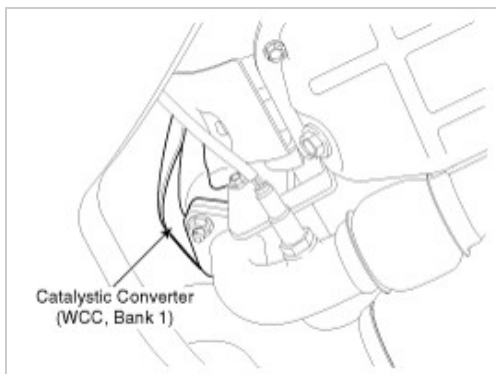
The MFI system uses signals from the heated oxygen sensor to activate and control the injector installed in the manifold for each cylinder, thus precisely regulating the air/fuel mixture ratio and reducing emissions.

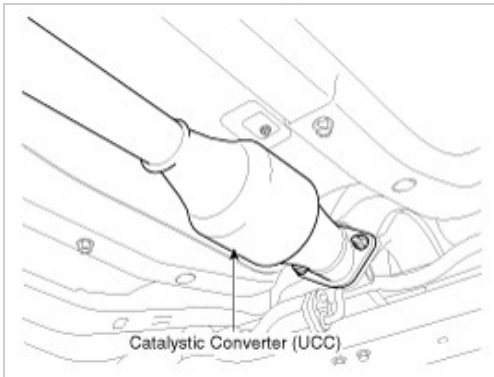
This in turn allows the engine to produce exhaust gas of the proper composition to permit the use of a three way catalyst. The three way catalyst is designed to convert the three pollutants [hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx)] into harmless substances. There are two operating modes in the MFI system.

1. Open Loop air/fuel ratio is controlled by information programmed into the ECM.
2. Closed Loop air/fuel ratio is adjusted by the ECM based on information supplied by the oxygen sensor.

Emission Control System**Description**

The catalytic converter of the gasoline engine is a three way catalyst. It oxidizes carbon monoxide and hydrocarbons (HC), and separates oxygen from the oxides of nitrogen (NOx).





Emission Control System



Removal

[Catalytic Converter (WCC)]

1. Remove the exhaust manifold.
(Refer to Engine Mechanical System - "Exhaust Manifold")

[Catalytic Converter (UCC)]

1. Remove the Center Muffler.
(Refer to Engine Mechanical System - "Center Muffler")

Installation

1. Install in the reverse order of removal.

Emission Control System



Description

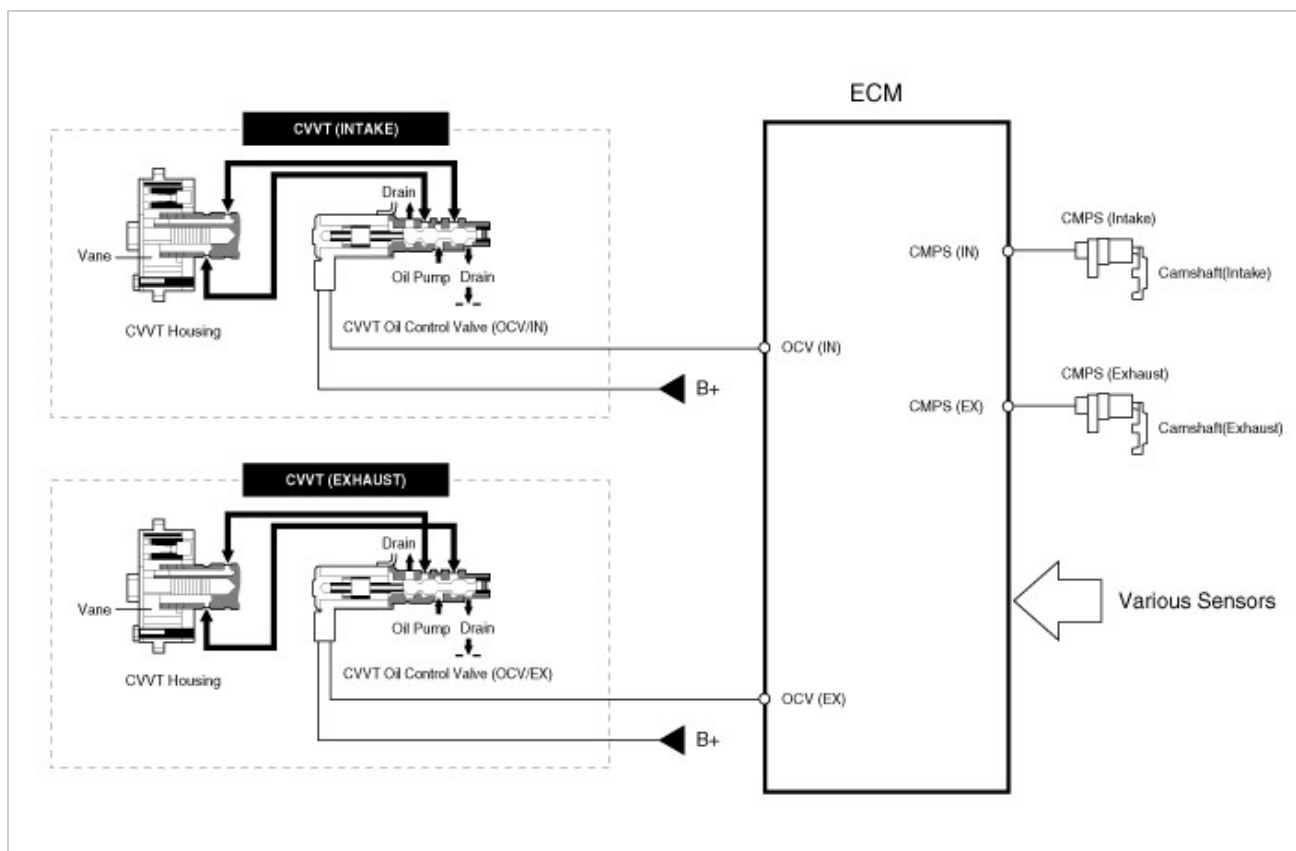
Continuous Variable Valve Timing (CVVT) system advances or retards the valve timing of the intake and exhaust valve in accordance with the ECM control signal which is calculated by the engine speed and load.

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

This system consist of

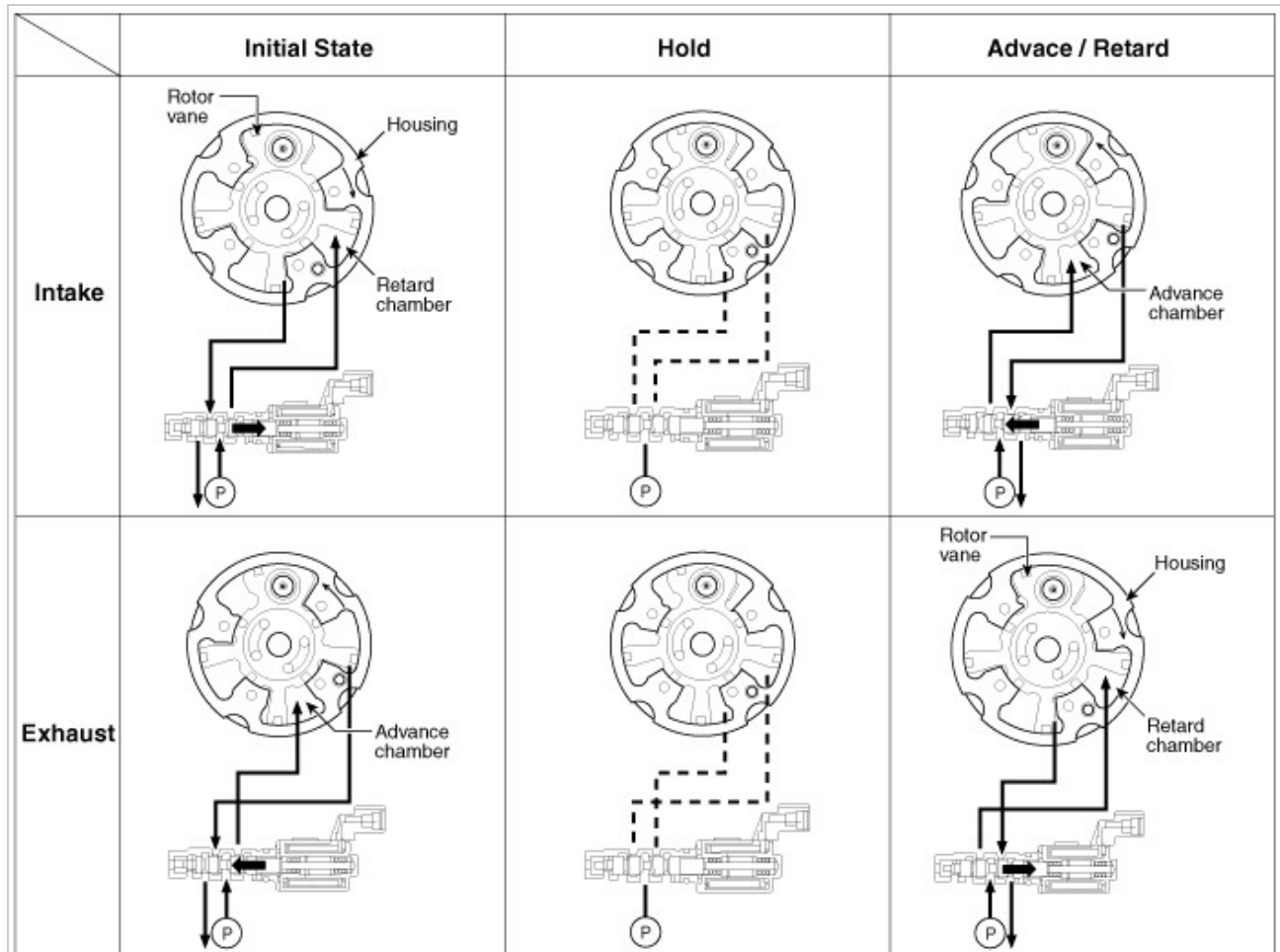
- the CVVT Oil Control Valve (OCV) which supplies the engine oil to the cam phaser or runs out the engine oil from the cam phaser in accordance with the ECM PWM (Pulse With Modulation) control signal,
- the CVVT Oil Temperature Sensor (OTS) which measures the engine oil temperature,
- and the Cam Phaser which varies the cam phase by using the hydraulic force of the engine oil.

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

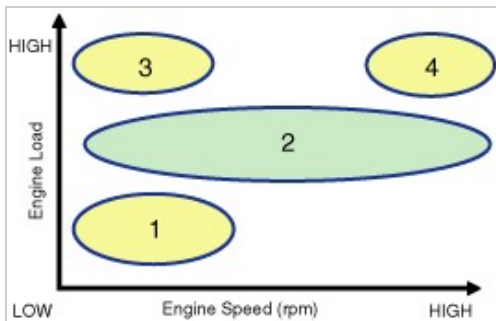


Operation Principle

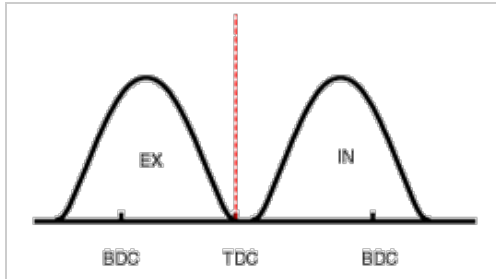
The CVVT has the mechanism rotating the rotor vane with hydraulic force generated by the engine oil supplied to the advance or retard chamber in accordance with the CVVT oil control valve control.



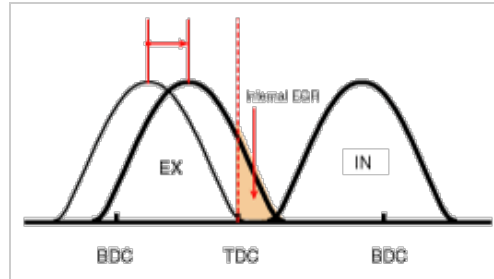
[CVVT System Mode]



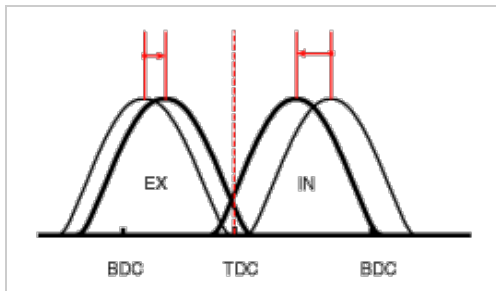
(1) Low Speed / Low Load



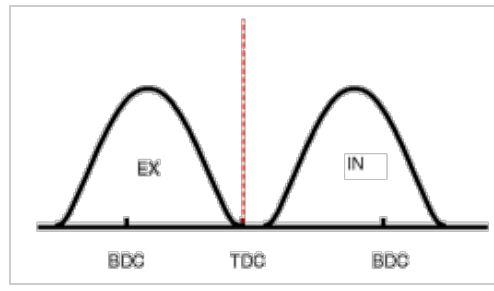
(2) Part Load



(3) Low Speed / High Load



(4) High Speed / High Load



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



Specifications

Fuel Delivery System

Items	Specification	
Fuel Tank	Capacity	71 lit. (18.7 U.S.gal., 75 U.S.qt., 62.4 Imp.qt.)
Fuel Filter	Type	Paper type
Fuel Pressure	Low Pressure Fuel Line	480 ~ 520 kPa (4.9 ~ 5.3 kgf/cm ² , 69.6 ~ 75.4 psi)
	High Pressure Fuel Line	2.0 ~ 14.7 MPa (20.0 ~ 150.0 kgf/cm ² , 284.5 ~ 2133.5 psi)
Fuel Pump	Type	Electrical, in-tank type
	Driven by	Electric motor
High Pressure Fuel Pump	Type	Mechanical type
	Driven by	Camshaft

Sensors

Barometric Pressure Sensor (BPS)

▷ Type: Piezo-resistive pressure sensor

▷ Specification

Pressure [kPa (kgf/cm ² , psi)]	Output Voltage (V)
10.0 (0.01, 0.15)	0.50
55.0 (0.56, 7.98)	2.21
100.0 (1.01, 14.5)	3.93
115.0 (1.17, 16.9)	4.50

Intake Air Temperature Sensor (IATS)

▷ Type: Thermistor type

▷ Specification

Temperature		Resistance (kΩ)
°C	°F	
-40	-40	40.93 ~ 48.35
-20	-4	13.89 ~ 16.03
0	32	5.38 ~ 6.09
10	50	3.48 ~ 3.90
20	68	2.31 ~ 2.57
40	104	1.08 ~ 1.21
60	140	0.54 ~ 0.66
80	176	0.29 ~ 0.34

Manifold Absolute Pressure Sensor (MAPS)

▷ Type: Piezo-resistive pressure sensor

▷ Specification

Pressure [kPa (kgf/cm ² , psi)]	Output Voltage (V)
20.0 (0.20, 2.90)	0.79
46.66 (0.47, 6.77)	1.84
101.32 (1.03, 14.7)	4.0

Engine Coolant Temperature Sensor (ECTS)

▷ Type: Thermistor type

▷ Specification

Temperature		Resistance (kΩ)
°C	°F	
-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

Throttle Position Sensor (TPS) [integrated into ETC module]

▷ Type: Hall IC Non-contact sensor type

▷ Specification

Throttle angle(°)	Output Voltage (V)	
	TPS1	TPS2
0	0.5	4.5
10	0.96	4.05
20	1.41	3.59
30	1.87	3.14
40	2.32	2.68
50	2.78	2.23
60	3.23	1.77
70	3.69	1.32
80	4.14	0.86
90	4.6	0.41
98	4.65	0.35
C.T (0)	0.5	4.5
W.O.T (86)	4.41	0.59

Crankshaft Position Sensor (CKPS)

▷ Type: Magnetic field sensitive sensor

▷ Specification

Item	Specification
Coil Resistance (Ω)	774 ~ 946 [20°C(68°F)]
Air Gap (mm)	0.5 ~ 1.5

Camshaft Position Sensor (CMPS)

▷ Type: Hall effect type

▷ Specification

Item	Specification
Output Voltage (V)	High: 5.0V
	Low: 0.7V
Air Gap (mm)	0.5 ~ 1.5

Knock Sensor (KS)

▷ Type: Piezo-electricity type

▷ Specification

Item	Specification
Capacitance (pF)	950 ~ 1,350
Resistance (M Ω)	4.87

Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 1, Bank 2/Sensor 1]

▷ Type: Zirconia (ZrO₂) [Binary] Type

▷ Specification

A/F Ratio (λ)	Output Voltage(V)
RICH	0.6 ~ 1.0
LEAN	0 ~ 0.4

Item	Specification
Heater Resistance (Ω)	about 9.0 [20°C(68°F)]

Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2, Bank 2/Sensor 2]

▷ Type: Zirconia (ZrO₂) [Binary] Type

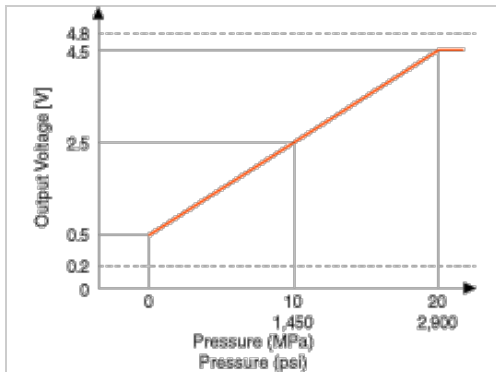
▷ Specification

A/F Ratio (λ)	Output Voltage(V)
RICH	Min. 0.8
LEAN	Max. 0.1

Item	Specification
Heater Resistance (Ω)	3.3 ~ 4.1[20°C(68°F)]

Rail Pressure Sensor (RPS)

- ▷ Type: Piezo-electricity type
- ▷ Specification



CVVT Oil Temperature Sensor (OTS)

- ▷ Type: Thermistor type
- ▷ Specification

Temperature		Resistance (kΩ)
°C	°F	
-40	-40	52.15
-20	-4	16.52
0	32	6.0
20	68	2.45
40	104	1.11
60	140	0.54
80	176	0.29

Accelerator Position Sensor (APS)

- ▷ Type: Variable resistor type
- ▷ Specification

Accelerator Position	Output Voltage (V)	
	APS1	APS2
C.T	0.7 ~ 0.8	0.275 ~ 0.475
W.O.T	3.8 ~ 4.4	1.75 ~ 2.35

Fuel Tank Pressure Sensor (FTPS)

- ▷ Type: Piezo - Resistivity type
- ▷ Specification

Pressure [kPa (kgf/cm ² , psi)]	Output Voltage (V)
-6.67 (-0.06, -0.97)	0.5
0	2.5
+6.67 (0.068, 0.97)	4.5

Actuators

Injector

- ▷ Specification

Item	Specification
Coil Resistance (Ω)	0.98 ~ 1.14 [20°C(68°F)]

ETC Motor [integrated into ETC Module]

- ▷ Specification

Item	Specification
Coil Resistance (Ω)	0.3 ~ 100 [20°C(68°F)]

Purge Control Solenoid Valve (PCSV)

▷ Specification

Item	Specification
Coil Resistance (Ω)	22.0 ~ 26.0 [20°C(68°F)]

CVVT Oil Control Valve (OCV)

▷ Specification

Item	Specification
Coil Resistance (Ω)	9.4 ~ 10.4 [20°C(68°F)]

Variable Intake Solenoid (VIS) Valve

▷ Specification

Item	Specification
Coil Resistance (Ω)	30.0 ~ 35.0 [20°C(68°F)]

Ignition Coil

▷ Type: Stick type

▷ Specification

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

Fuel Pressure Control Valve (FPCV)

▷ Specification

Item	Specification
Coil Resistance (Ω)	1.04 ~ 1.27 [23°C(73.4°F)]

Canister Close Valve (CCV)

▷ Specification

Item	Specification
Coil Resistance (Ω)	19.9 ~ 22.9 [20°C(68°F)]

Service Standard

Item		Specification	
Ignition Timing (°)		BTDC 5° ± 10°	
Idle Speed (rpm)	A/C OFF	Neutral, N, P-range	650 ± 100
		D-range	580 ± 100
	A/C ON	Neutral, N, P-range	650 ± 100
		D-range	600 ± 100

Tightening Torques

Engine Control System

Item	kgf.m	N.m	lb-ft
ECM installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
ECM bracket installation bolt / nut	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
IDB installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
IDB bracket installation bolt	1.9 ~ 2.4	18.6 ~ 23.5	13.7 ~ 17.4
Barometric pressure sensor installation bolt	0.4 ~ 0.6	3.9 ~ 5.9	2.9 ~ 4.3
Engine coolant temperature sensor installation	3.0 ~ 4.0	29.4 ~ 39.2	21.7 ~ 28.9
Manifold absolute pressure sensor installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Intake air temperature sensor installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Crankshaft position sensor installation bolt	0.7 ~ 1.0	6.9 ~ 9.8	5.1 ~ 7.2
Camshaft position sensor (Bank 1/Intake) installation bolt	0.7 ~ 1.0	6.9 ~ 9.8	5.1 ~ 7.2
Camshaft position sensor (Bank 1/Exhaust) installation bolt	0.7 ~ 1.0	6.9 ~ 9.8	5.1 ~ 7.2
Camshaft position sensor (Bank 2/Intake) installation bolt	0.7 ~ 1.0	6.9 ~ 9.8	5.1 ~ 7.2
Camshaft position sensor (Bank 2/Exhaust) installation bolt	0.7 ~ 1.0	6.9 ~ 9.8	5.1 ~ 7.2

Knock sensor #1 (Bank 1) installation bolt	1.6 ~ 2.4	15.7 ~ 23.5	11.6 ~ 17.4
Knock sensor #2 (Bank 2) installation bolt	1.6 ~ 2.4	15.7 ~ 23.5	11.6 ~ 17.4
Heated oxygen sensor (Bank 1 / sensor 1) installation	3.6 ~ 4.6	35.3 ~ 45.1	26.0 ~ 33.3
Heated oxygen sensor (Bank 1 / sensor 2) installation	3.6 ~ 4.6	35.3 ~ 45.1	26.0 ~ 33.3
Heated oxygen sensor (Bank 2 / sensor 1) installation	3.6 ~ 4.6	35.3 ~ 45.1	26.0 ~ 33.3
Heated oxygen sensor (Bank 2 / sensor 2) installation	3.6 ~ 4.6	35.3 ~ 45.1	26.0 ~ 33.3
Rail pressure sensor installation	3.0 ~ 3.5	29.4 ~ 34.3	21.7 ~ 25.3
CVVT oil temperature sensor installation	3.5 ~ 4.5	34.4 ~ 41.1	25.3 ~ 32.5
Electronic throttle body installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Purge control solenoid valve bracket installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
CVVT oil control valve (Bank 1 / Intake) installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
CVVT oil control valve (Bank 1 / Exhaust) installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
CVVT oil control valve (Bank 2 / Intake) installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
CVVT oil control valve (Bank 2 / Exhaust) installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Variable intake solenoid valve installation nut	0.6 ~ 0.9	5.9 ~ 8.8	4.3 ~ 6.5
Ignition coil installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7

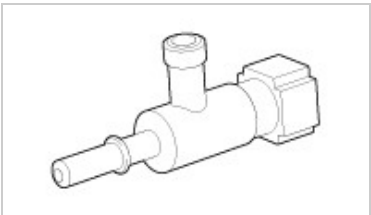
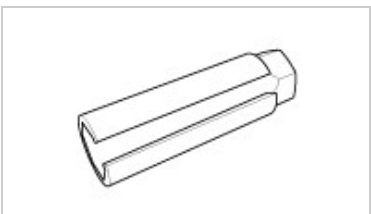
Fuel Delivery System

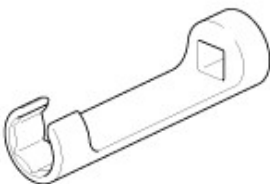
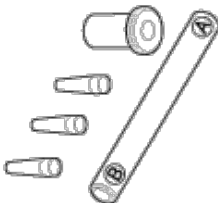
Item	kgf.m	N.m	lb-ft
Fuel tank band installation nut	4.0 ~ 5.5	39.2 ~ 54.0	28.9 ~ 39.8
Fuel tank band installation bolt	4.5 ~ 6.0	44.1 ~ 58.9	32.6 ~ 43.4
Fuel pump locking ring installation	13.7 ~ 41.4	135 ~ 406	99.6 ~ 299
Filler-neck assembly bracket installation nut	0.4 ~ 0.6	3.9 ~ 5.9	2.9 ~ 4.3
Accelerator pedal module installation bolt	0.9 ~ 1.4	8.8 ~ 13.7	6.5 ~ 10.1
Accelerator pedal module installation nut	1.7 ~ 2.6	11.7 ~ 25.5	12.3 ~ 18.8
Delivery pipe installation bolt	1.9 ~ 2.4	18.6 ~ 23.5	13.7 ~ 17.4
High pressure fuel pipe function block installation bolt	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7
High pressure fuel pump installation bolt	1.3 ~ 1.5	12.8 ~ 14.7	9.4 ~ 10.9
High pressure fuel pipe installation nut	3.0 ~ 3.6	29.4 ~ 35.3	21.7 ~ 26.0
High pressure fuel pipe bracket installation bolt	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7

Engine Control/Fuel System



Special Service Tools

Item	Illustration	Application
Fuel Pressure Gauge (09353-24100)		Measuring the fuel line pressure
Fuel Pressure Gauge Adapter (09353-02100)		Connection between the high pressure fuel pump and the fuel feed line
Heated Oxygen Sensor Socket Wrench (09392-1Y100)		Removal and installation of the heated oxygen sensor ※ SST No.09392-2H100 model also can be used for removing the Heated Oxygen Sensor.
Torque Wrench Socket (17mm) (09314-3V100)		Removal and installation of the high pressure fuel pipe

		
Injector Combustion Seal Guide & Sizing tool (09353-2B000)		Installation of the injector combustion seal

Engine Control/Fuel System



Basic Troubleshooting

Basic Troubleshooting Guide

1	Bring Vehicle to Workshop
2	Analyze Customer's Problem Ask the customer about the conditions and environment relative to the issue. (Use CUSTOMER PROBLEM ANALYSIS SHEET).
3	Verify Symptom, and then Check DTC and Freeze Frame Data - Connect the GDS to Diagnostic Link Connector (DLC). - Record the DTC and Freeze Frame Data.  Information To erase DTC and Freeze Frame Data, refer to Step 5.
4	Confirm the Inspection Procedure for the System or Part Using the SYMPTOM TROUBLESHOOTING GUIDE CHART, choose the correct inspection procedure for the system or part to be checked.
5	Erase the DTC and Freeze Frame Data NOTICE NEVER erase DTC and Freeze Frame Data before completing Step 2 : MIL/DTC in CUSTOMER PROBLEM ANALYSIS SHEET.
6	Inspect Vehicle Visually Go to Step 11, if you recognize the problem.
7	Recreate (Simulate) Symptoms of the DTC - Try to recreate or simulate the symptoms and conditions of the malfunction as described by customer. - If DTC(s) is/are displayed, simulate the condition according to troubleshooting procedure for the DTC.
8	Confirm Symptoms of Problem - If DTC(s) is/are not displayed, go to Step 9. - If DTC(s) is/are displayed, go to Step 11.
9	Recreate (Simulate) Symptom Try to recreate or simulate the condition of the malfunction as described by the customer.
10	Check the DTC - If DTC(s) does(do) not occur, refer to INTERMITTENT PROBLEM PROCEDURE in BASIC INSPECTION PROCEDURE. - If DTC(s) occur(s), go to Step 11.
11	Perform Troubleshooting Procedure for DTC
12	Adjust or repair the vehicle
13	Confirmation test
14	END

Customer Problem Analysis Sheet

1. VEHICLE INFORMATION

VIN No.		Transmission	☐ M/T ☐ A/T ☐ CVT ☐ etc.
Production date		Driving type	☐ 2WD (FF) ☐ 2WD (FR) ☐ 4WD
Odometer Reading	_____ km/mile	DPF (Diesel Engine)	☐ With DPF ☐ Without DPF

2. SYMPTOMS

☐ Unable to start	☐ Engine does not turn over ☐ Incomplete combustion ☐ Initial combustion does not occur
☐ Difficult to start	☐ Engine turns over slowly ☐ Other _____
☐ Poor idling	☐ Rough idling ☐ Incorrect idling ☐ Unstable idling (High: _____ rpm, Low: _____ rpm) ☐ Other _____
☐ Engine stall	☐ Soon after starting ☐ After accelerator pedal depressed ☐ After accelerator pedal released ☐ During A/C ON ☐ Shifting from N to D-range ☐ Other _____
☐ Others	☐ Poor driving (Surge) ☐ Knocking ☐ Poor fuel economy ☐ Back fire ☐ After fire ☐ Other _____

3. ENVIRONMENT

Problem frequency	☐ Constant ☐ Sometimes (_____) ☐ Once only ☐ Other _____
Weather	☐ Fine ☐ Cloudy ☐ Rainy ☐ Snowy ☐ Other _____
Outdoor temperature	Approx. _____ °C/°F
Place	☐ Highway ☐ Suburbs ☐ Inner City ☐ Uphill ☐ Downhill ☐ Rough road ☐ Other _____
Engine temperature	☐ Cold ☐ Warming up ☐ After warming up ☐ Any temperature
Engine operation	☐ Starting ☐ Just after starting (_____ min) ☐ Idling ☐ Racing ☐ Driving ☐ Constant speed ☐ Acceleration ☐ Deceleration ☐ A/C switch ON/OFF ☐ Other _____

4. MIL/DTC

MIL (Malfunction Indicator Lamp)	☐ Remains ON ☐ Sometimes lights up ☐ Does not light	
DTC	Normal check (Pre-check)	☐ Normal ☐ DTC (_____) ☐ Freeze Frame Data
	Check mode	☐ Normal ☐ DTC (_____) ☐ Freeze Frame Data

5. ECM/PCM INFORMATION

ECM/PCM Part No.	
ROM ID	

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.

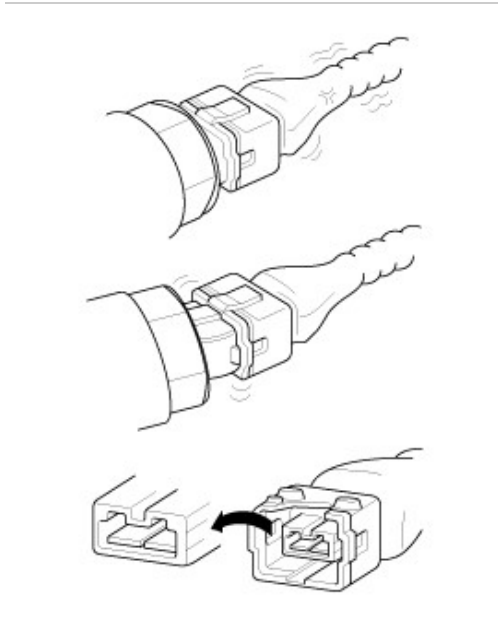
NOTICE

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

- a. Sensors and Actuators

: Slightly vibrate sensors, actuators or relays with finger.

⚠ WARNING

Strong vibration may break sensors, actuators or relays

- b. Connectors and Harness

: Lightly shake the connector and wiring harness vertically and then horizontally.

- Simulating Heat

- a. 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

- a. 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.

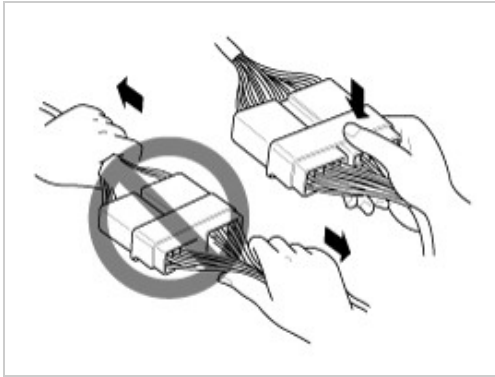
- Simulating Electrical Load

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

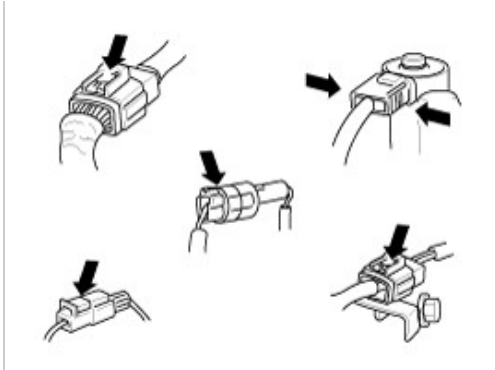
Connector Inspection Procedure

1. Handling of Connector

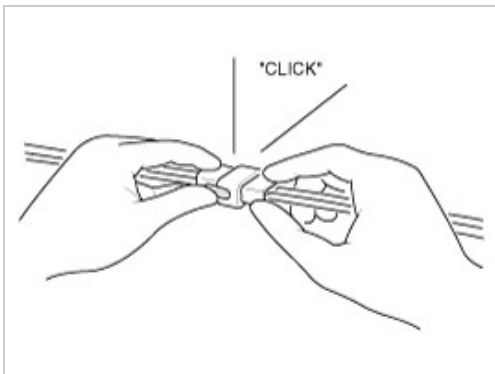
- a. Never pull on the wiring harness when disconnecting connectors.



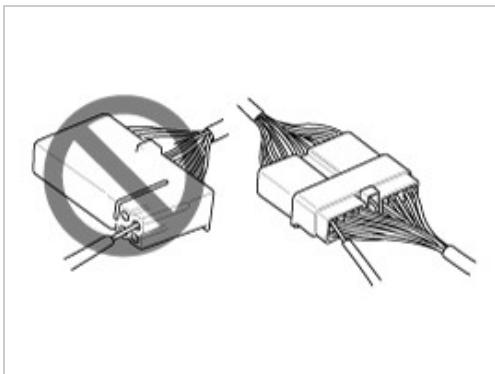
b. When removing the connector with a lock, press or pull locking lever.



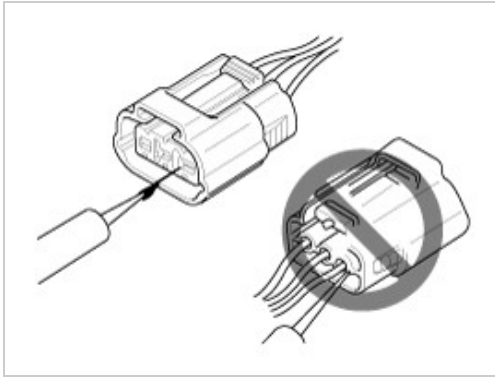
c. Listen for a click when locking connectors. This sound indicates that they are securely locked.



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.

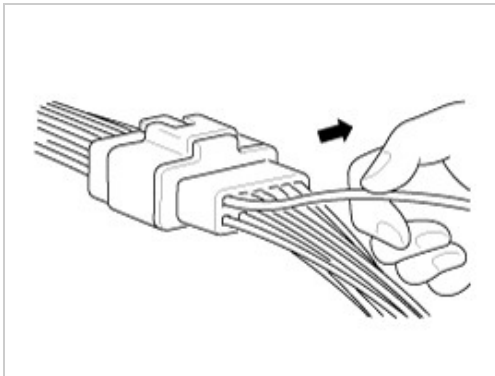


NOTICE

- 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

- While the connector is connected:
Hold the connector, check connecting condition and locking efficiency.
- 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.
- Check terminal tightening condition:
Insert a spare male terminal into a female terminal, and then check terminal tightening conditions.
- Pull lightly on individual wires to ensure that each wire is secured in the terminal.



3. Repair Method of Connector Terminal

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

NOTICE

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

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

Wire Harness Inspection Procedure

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

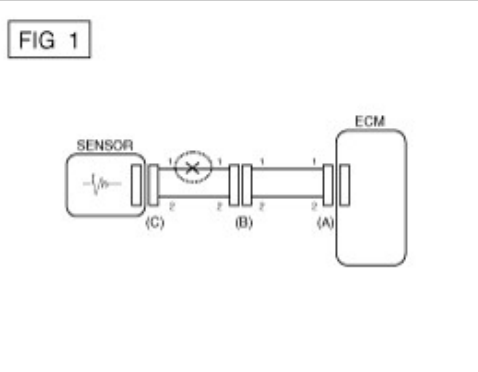
Electrical Circuit Inspection Procedure

- Check Open Circuit

- Procedures for Open Circuit

- Continuity Check
- 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.



2. Continuity Check Method

NOTICE

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

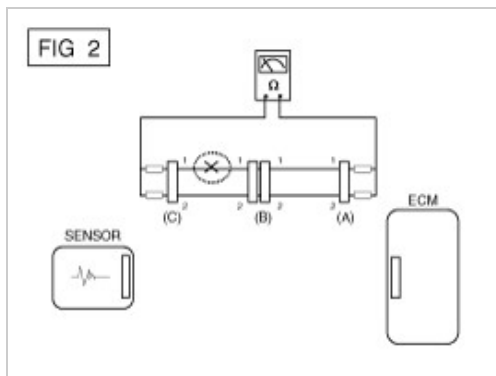
Specification (Resistance)

1Ω or less → Normal Circuit

1MΩ or Higher → Open Circuit

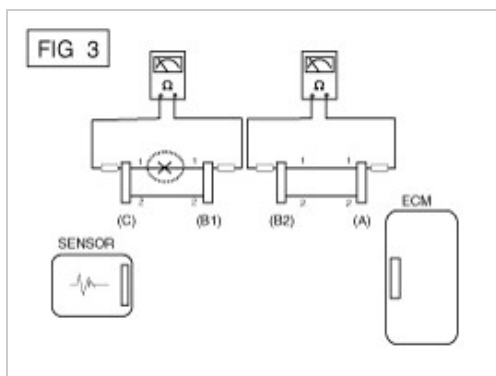
- Disconnect connectors (A), (C) and measure resistance between connector (A) and (C) as shown in [FIG. 2].

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.



- Disconnect connector (B), and measure for resistance between connector (C) and (B1) and between (B2) and (A) as shown in [FIG. 3].

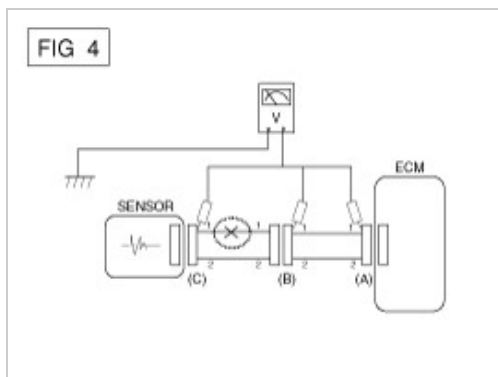
In this case the measured resistance between connector (C) and (B1) is higher than 1MΩ and the open circuit is between terminal 1 of connector (C) and terminal 1 of connector (B1).



3. Voltage Check Method

- 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).

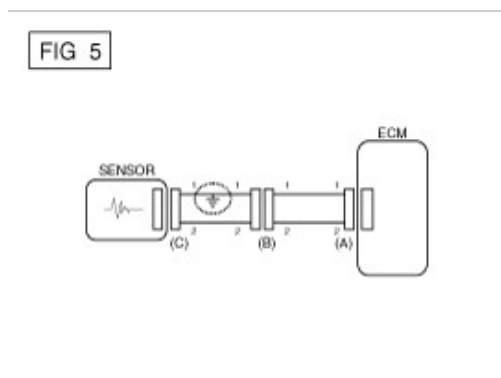


● Check Short Circuit

1. Test Method for Short to Ground Circuit

- 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.



2. Continuity Check Method (with Chassis Ground)

NOTICE

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

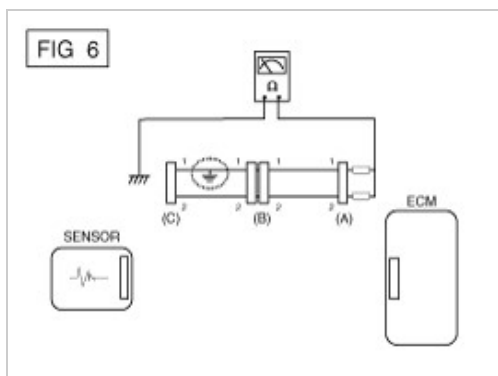
Specification (Resistance)

1Ω or less → Short to Ground Circuit

1MΩ or Higher → Normal Circuit

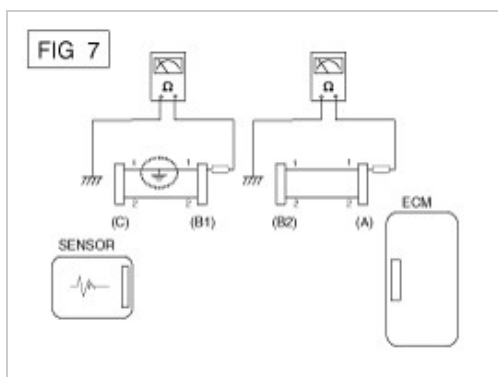
- Disconnect connectors (A), (C) and measure for resistance between connector (A) and Chassis Ground as shown in [FIG. 6].

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.



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

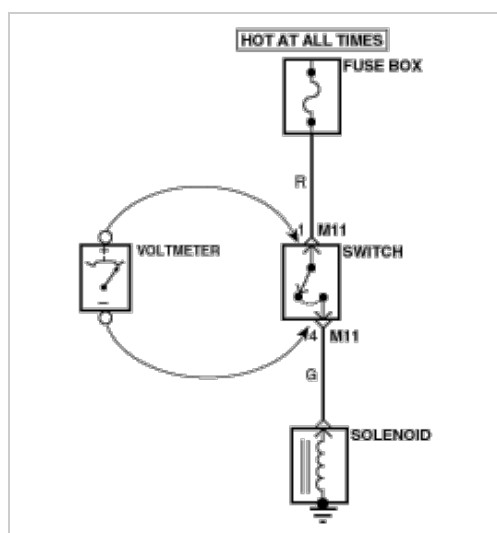
The measured resistance between connector (B1) and chassis ground is 1Ω or less. The short to ground circuit is between terminal 1 of connector (C) and terminal 1 of connector (B1).



● Testing For Voltage Drop

This test checks for voltage drop along a wire, or through a connection or switch.

- Connect the positive lead of a voltmeter to the end of the wire (or to the side of the connector or switch) closest to the battery.
- Connect the negative lead to the other end of the wire. (or the other side of the connector or switch)
- Operate the circuit.
- The voltmeter will show the difference in voltage between the two points. A difference, or drop of more than 0.1 volts (50mV in 5V circuits), may indicate a problem. Check the circuit for loose or dirty connections.



Symptom Troubleshooting Guide Chart

Main symptom	Diagnostic procedure	Also check for
Unable to start (Engine does not turn over)	- Test the battery. (Refer to Engine Electrical System - "Battery") - Test the starter. (Refer to Engine Electrical System - "Starter") - Inhibitor switch (A/T) or clutch start switch (M/T)	
Unable to start (Incomplete combustion)	- Test the battery. (Refer to Engine Electrical System - "Battery") - Check the fuel pressure. (Refer to Fuel Delivery System - "Fuel Pressure Test") - Check the ignition circuit. (Refer to Engine Electrical System - "Ignition System") - Troubleshooting the immobilizer system. (Refer to Body Electrical System - "Immobilizer System") (In case of immobilizer lamp flashing)	- DTC - Low compression - Intake air leaks - Slipped or broken timing belt - Contaminated fuel
Difficult to start	- Test the battery. (Refer to Engine Electrical System - "Battery") - Check the fuel pressure. (Refer to Fuel Delivery System - "Fuel Pressure Test") - Check the ECT sensor and circuit (Check DTC) - Check the ignition circuit.	- DTC - Low compression - Intake air leaks - Contaminated fuel - Weak ignition spark

	(Refer to Engine Electrical System - "Ignition System")	
Poor idling (Rough, unstable or incorrect Idle)	1) Check the fuel pressure. (Refer to Fuel Delivery System - "Fuel Pressure Test") 2) Check the Injector. (Refer to Engine Control System - "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. (Refer to Engine Electrical System - "Battery") 2) Check the fuel pressure. (Refer to Fuel Delivery System - "Fuel Pressure Test") 3) Check the idle speed control circuit (Check DTC) 4) Check the ignition circuit. (Refer to Engine Electrical System - "Ignition System") 5) Check the CKPS Circuit (Check DTC)	• DTC • Intake air leaks • Contaminated fuel • Weak ignition spark
Poor driving (Surge)	1) Check the fuel pressure. (Refer to Fuel Delivery System - "Fuel Pressure Test") 2) Inspect and test Throttle Body 3) Check the ignition circuit. (Refer to Engine Electrical System - "Ignition System") 4) Check the ECT Sensor and Circuit (Check DTC) 5) Test the exhaust system for a possible restriction. (Refer to Engine Mechanical System - "Intake Manifold") 6) 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. (Refer to Fuel Delivery System - "Fuel Pressure Test") 2) Inspect the engine coolant. (Refer to Engine Mechanical System - "Radiator") 3) Inspect the radiator and the electric cooling fan. (Refer to Engine Mechanical System - "Radiator") 4) Check the spark plugs. (Refer to Engine Electrical System - "Ignition System")	• DTC • Contaminated fuel
Poor fuel economy	1) Check customer's driving habits · A/C on full time or the defroster mode on? · Are tires at correct pressure? · Is excessively heavy load being carried? · Is acceleration too much, too often? 2) Check the fuel pressure. (Refer to Fuel Delivery System - "Fuel Pressure Test") 3) Check the injector. (Refer to Engine Control System - "Injector") 4) Test the exhaust system for a possible restriction 5) Check the ECT sensor and circuit	• DTC • Low compression • Intake air leaks • Contaminated fuel • Weak ignition spark
Hard to refuel (Overflow during refueling)	1) Test the canister close valve. (Refer to Engine Control System - "Canister Close Valve") 2) Inspect the fuel filler hose/pipe · Pinched, kinked or blocked? · Filler hose is torn 3) Inspect the fuel tank vapor vent hose between the EVAP. canister and air filter 4) Check the EVAP. canister	• Malfunctioning gas station filling nozzle (If this problem occurs at a specific gas station during refueling)



OBD-II review

1. Overview

The California Air Resources Board (CARB) began regulation of On Board Diagnostics (OBD) for vehicles sold in California beginning with the 1988 model year. The first phase, OBD-I, required monitoring of the fuel metering system, Exhaust Gas Recirculation (EGR) system and additional emission related components. The Malfunction Indicator Lamp (MIL) was required to light and alert the driver of the fault and the need for repair of the emission control system. Associated with the MIL was a fault code or Diagnostic Trouble Code (DTC) identifying the specific area of the fault.

The OBD system was proposed by CARB to improve air quality by identifying vehicle exceeding emission standards. Passage of the Federal Clean Air Act Amendments in 1990 has also prompted the Environmental Protection Agency (EPA) to develop On Board Diagnostic requirements. CARB OBD-II regulations were followed until 1999 when the federal regulations were used.

The OBD-II system meets government regulations by monitoring the emission control system. When a system or component exceeds emission threshold or a component operates outside tolerance, a DTC will be stored and the MIL illuminated.

The diagnostic executive is a computer program in the Engine Control Module (ECM) or Powertrain Control Module (PCM) that coordinates the OBD-II self-monitoring system. This program controls all the monitors and interactions, DTC and MIL operation, freeze frame data and scan tool interface.

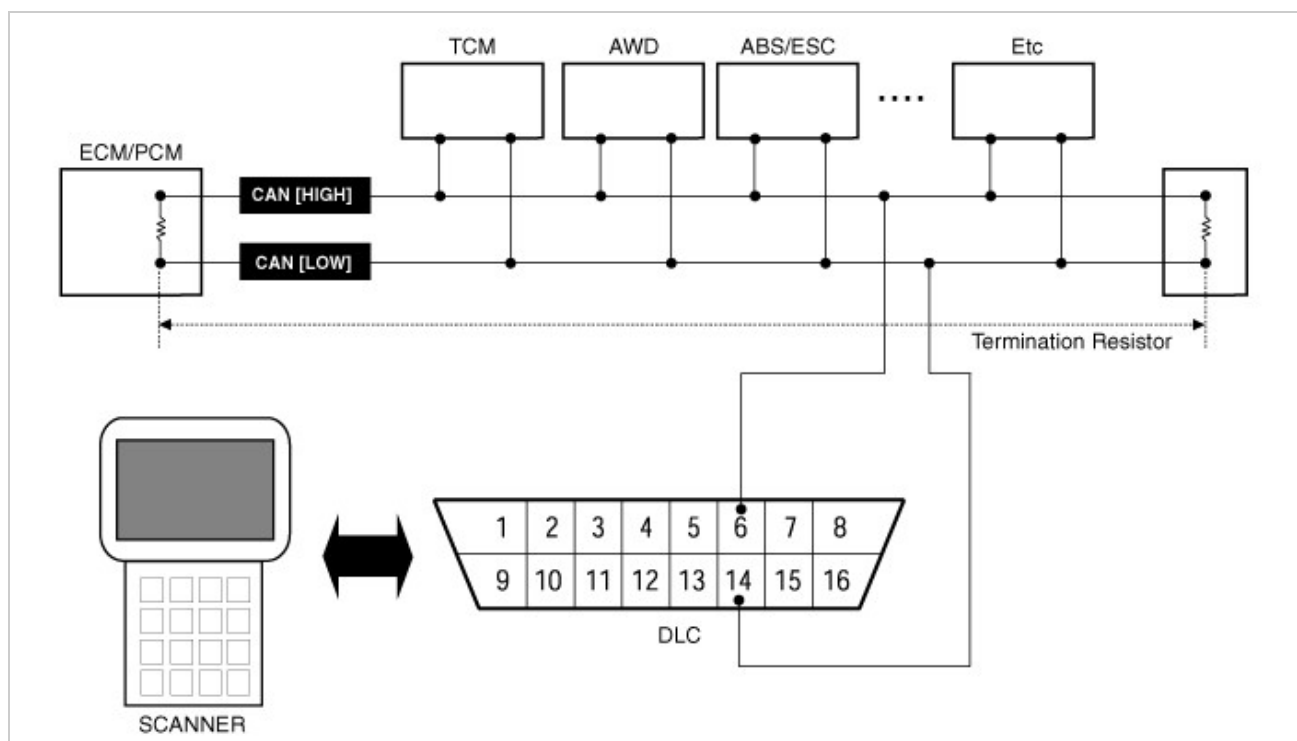
Freeze frame data describes stored engine conditions, such as state of the engine, state of fuel control, spark, RPM, load and warm status at the point the first fault is detected. Previously stored conditions will be replaced only if a fuel or misfire fault is detected. This data is accessible with the scan tool to assist in repairing the vehicle.

The center of the OBD-II system is a microprocessor called the Engine Control Module (ECM) or Powertrain Control Module (PCM).

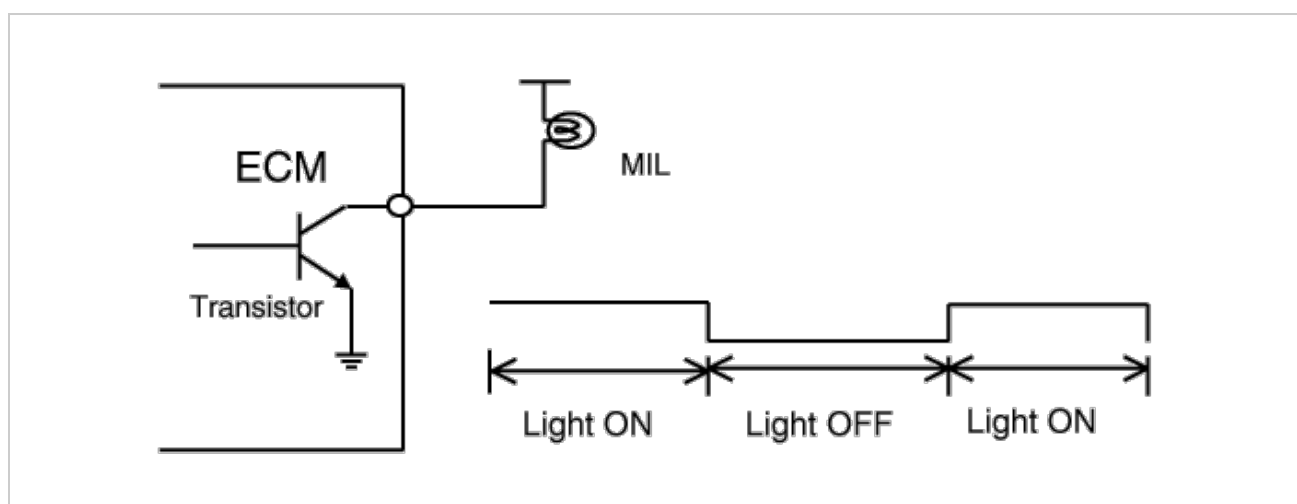
The ECM or PCM receives input from sensors and other electronic components (switches, relays, and others) based on information received and programmed into its memory (keep alive random access memory, and others), the ECM or PCM generates output signals to control various relays, solenoids and actuators.

2. Configuration of hardware and related terms

1) GST (Generic scan tool)



2) MIL (Malfunction indication lamp) - MIL activity by transistor



The Malfunction Indicator Lamp (MIL) is connected between ECM or PCM-terminal Malfunction Indicator Lamp and battery supply (open collector amplifier).

In most cars, the MIL will be installed in the instrument panel. The lamp amplifier can not be damaged by a short circuit.

Lamps with a power dissipation much greater than total dissipation of the MIL and lamp in the tester may cause a fault indication.

▷ At ignition ON and engine revolution (RPM) < MIN. RPM, the MIL is switched ON for an optical check by the driver.

3) MIL illumination

When the ECM or PCM detects a malfunction related emission during the first driving cycle, the DTC and engine data are stored in the freeze frame memory. The MIL is illuminated only when the ECM or PCM detects the same malfunction related to the DTC in two consecutive driving cycles.

4) MIL elimination

• Misfire and Fuel System Malfunctions:

For misfire or fuel system malfunctions, the MIL may be eliminated if the same fault does not reoccur during monitoring in three subsequent sequential driving cycles in which conditions are similar to those under which the malfunction was first detected.

• All Other Malfunctions:

For all other faults, the MIL may be extinguished after three subsequent sequential driving cycles during which the monitoring system responsible for illuminating the MIL functions without detecting the malfunction and if no other malfunction has been identified that would independently illuminate the MIL according to the requirements outlined above.

5) Erasing a fault code

The diagnostic system may erase a fault code if the same fault is not re-registered in at least 40 engine warm-up cycles, and the MIL is not illuminated for that fault code.

6) Communication Line (CAN)

- Bus Topology : Line (bus) structure
- Wiring : Twisted pair wire
- Off Board DLC Cable Length : Max. 5m
- Data Transfer Rate
 - Diagnostic : 500 kbps
 - Service Mode (Upgrade, Writing VIN) : 500 or 1Mbps)

7) Driving cycle

A driving cycle consists of engine start up, and engine shut off.

8) Warm-up cycle

A warm-up cycle means sufficient vehicle operation such that the engine coolant temperature has risen by at least 40 degrees Fahrenheit from engine starting and reaches a minimum temperature of at least 160 degrees Fahrenheit.

9) Trip cycle

A trip means vehicle operation (following an engine-off period) of duration and driving mode such that all components and systems are monitored at least once by the diagnostic system except catalyst efficiency or evaporative system monitoring when a steady-speed check is used, subject to the limitation that the manufacturer-defined trip monitoring conditions shall all be encountered at least once during the first engine start portion of the applicable FTP cycle.

10) DTC format

- Diagnostic Trouble Code (SAE J2012)
- DTCs used in OBD-II vehicles will begin with a letter and are followed by four numbers.

The letter of the beginning of the DTC identifies the function of the monitored device that has failed. A "P" indicates a powertrain device, "C" indicates a chassis device. "B" is for body device and "U" indicates a network or data link code. The first number indicates if the code is generic (common to all manufacturers) or if it is manufacturer specific. A "0" & "2" indicates generic, "1" indicates manufacturer-specific. The second number indicates the system that is affected with a number between 1 and 7.

The following is a list showing what numbers are assigned to each system.

- 1) Fuel and air metering
- 2) Fuel and air metering(injector circuit malfunction only)
- 3) Ignition system or misfire
- 4) Auxiliary emission controls
- 5) Vehicle speed controls and idle control system
- 6) Computer output circuits
- 7) Transmission

The last two numbers of the DTC indicates the component or section of the system where the fault is located.

11) Freeze frame data

When a freeze frame event is triggered by an emission related DTC, the ECM or PCM stores various vehicle information as it existed the moment the fault occurred. The DTC number along with the engine data can be useful in aiding a technician in locating the cause of the fault. Once the data from the 1st driving cycle DTC occurrence is stored in the freeze frame memory, it will remain there even when the fault occurs again (2nd driving cycle) and the MIL is illuminated.

- Freeze Frame List
 - a. Calculated Load Value
 - b. Engine RPM
 - c.

Fuel Trim

- d. Fuel Pressure (if available)
- e. Vehicle Speed (if available)
- f. Coolant Temperature
- g. Intake Manifold Pressure (if available)
- h. Closed-or Open-loop operation
- i. Fault code

3. OBD-II system readiness tests

1) Catalyst monitoring

The catalyst efficiency monitor is a self-test strategy within the ECM or PCM that uses the downstream Heated Oxygen Sensor (HO2S) to determine when a catalyst has fallen below the minimum level of effectiveness in its ability to control exhaust emission.

2) Misfire monitoring

Misfire is defined as the lack of proper combustion in the cylinder due to the absence of spark, poor fuel metering, or poor compression. Any combustion that does not occur within the cylinder at the proper time is also a misfire. The misfire detection monitor detects fuel, ignition or mechanically induced misfires. The intent is to protect the catalyst from permanent damage and to alert the customer of an emission failure or an inspection maintenance failure by illuminating the MIL . When a misfire is detected, special software called freeze frame data is enabled. The freeze frame data captures the operational state of the vehicle when a fault is detected from misfire detection monitor strategy.

3) Fuel system monitoring

The fuel system monitor is a self-test strategy within the ECM or PCM that monitors the adaptive fuel table. The fuel control system uses the adaptive fuel table to compensate for normal variability of the fuel system components caused by wear or aging. During normal vehicle operation, if the fuel system appears biased lean or rich, the adaptive value table will shift the fuel delivery calculations to remove bias.

4) Engine cooling system monitoring

The cooling system monitoring is a self-test strategy within the ECM or PCM that monitors ECTS (Engine Coolant Temperature Sensor) and thermostat about circuit continuity, output range, rationality faults.

5) O2 sensor monitoring

OBD-II regulations require monitoring of the upstream Heated O2 Sensor (H2OS) to detect if the deterioration of the sensor has exceeded thresholds. An additional HO2S is located downstream of the Warm-Up Three Way Catalytic Converter (WU-TWC) to determine the efficiency of the catalyst.

Although the downstream H2OS is similar to the type used for fuel control, it functions differently. The downstream HO2S is monitored to determine if a voltage is generated. That voltage is compared to a calibrated acceptable range.

6) Evaporative emission system monitoring

The EVAP. monitoring is a self-test strategy within the ECM or PCM that tests the integrity of the EVAP. system. The complete evaporative system detects a leak or leaks that cumulatively are greater than or equal to a leak caused by a 0.040 inch and 0.020 inch diameter orifice.

7) Air conditioning system monitoring

The A/C system monitoring is a self-test strategy within the ECM or PCM that monitors malfunction of all A/C system components at A/C ON.

8) Comprehensive components monitoring

The comprehensive components monitoring is a self-test strategy within the ECM or PCM that detects fault of any electronic powertrain components or system that provides input to the ECM or PCM and is not exclusively an input to any other OBD-II monitor.

9) A/C system component monitoring

Requirement:

If a vehicle incorporates an engine control strategy that alters off idle fuel and/or spark control when the A/C system is on, the OBD II system shall monitor all electronic air conditioning system components for malfunctions that cause the system to fail to invoke the alternate control while the A/C system is on or cause the system to invoke the alternate control while the A/C system is off.

Additionally, the OBD II system shall monitor for malfunction all electronic air conditioning system components that are used as part of the diagnostic strategy for any other monitored system or component.

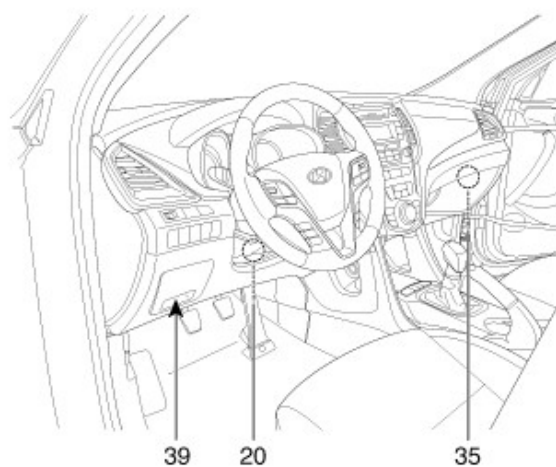
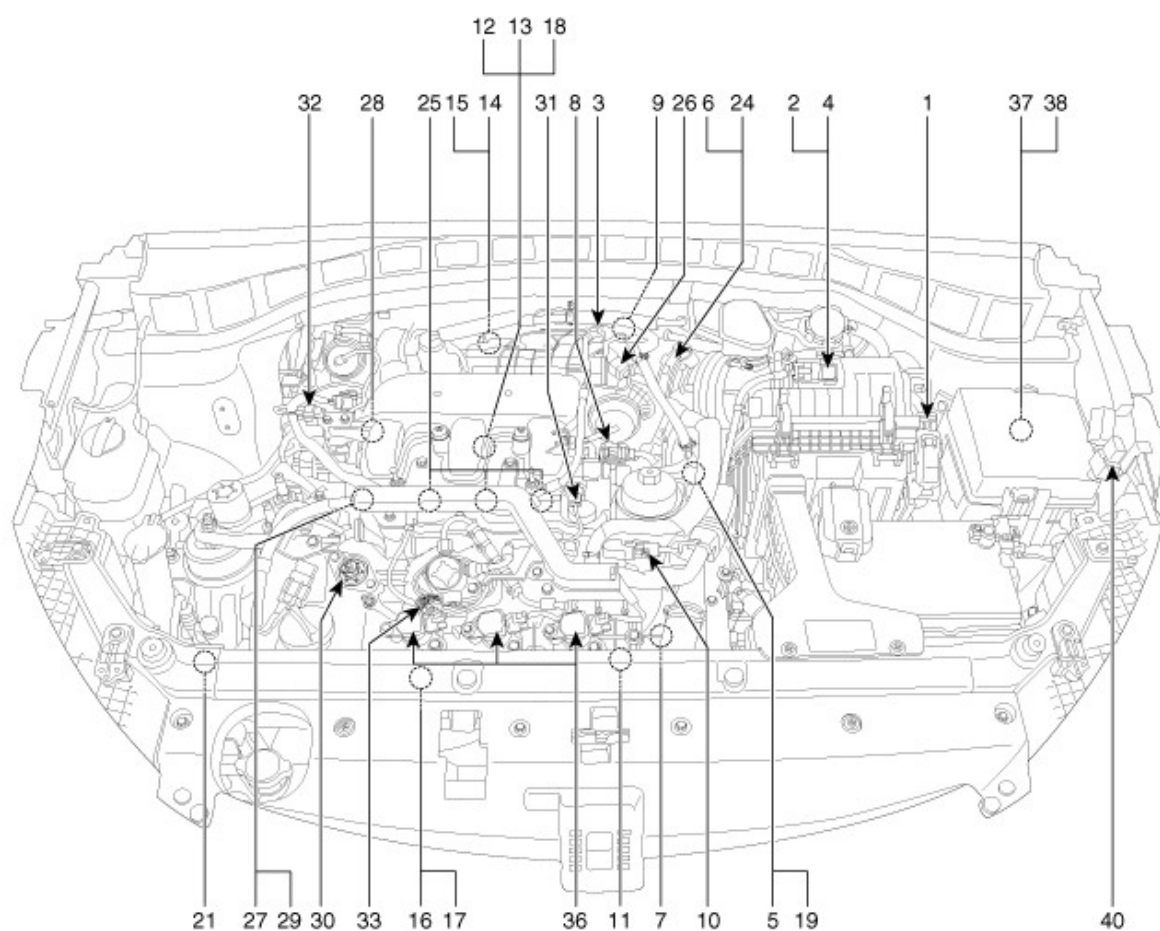
Implementation plan:

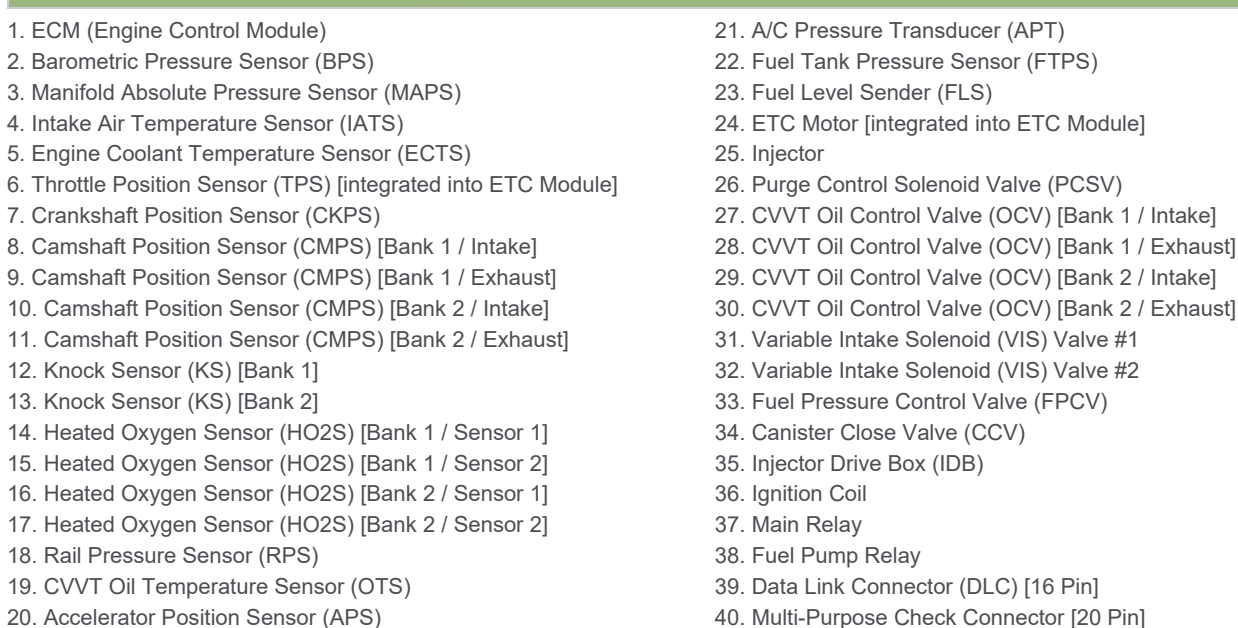
No engine control strategy incorporated that alters off idle fuel and/or spark control when A/C system is on. Malfunction of A/C system components is not used as a part of the diagnostic strategy for other monitored system or component.

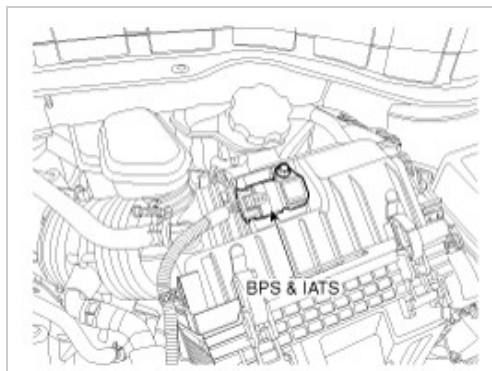
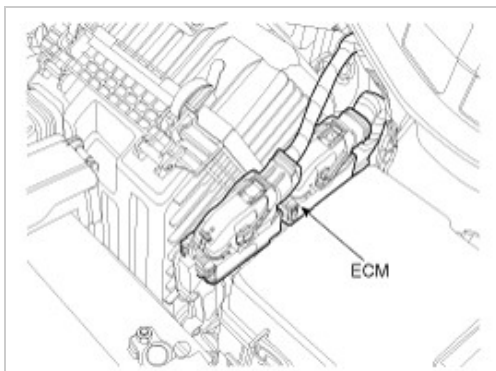
Engine Control/Fuel System



Components Location

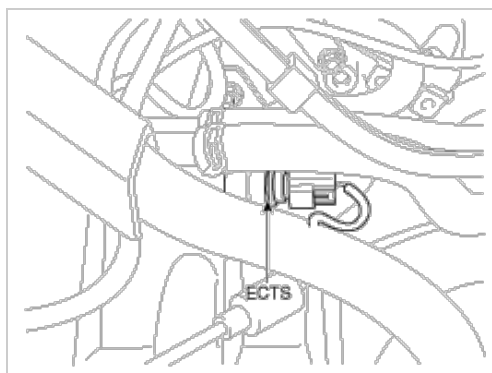
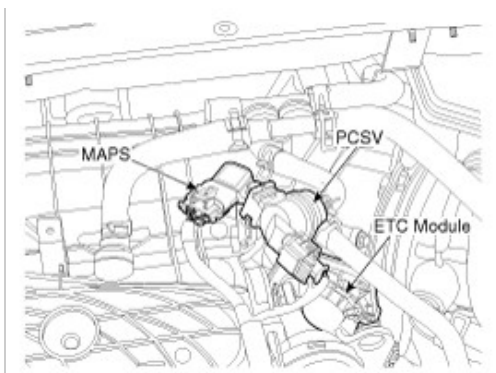


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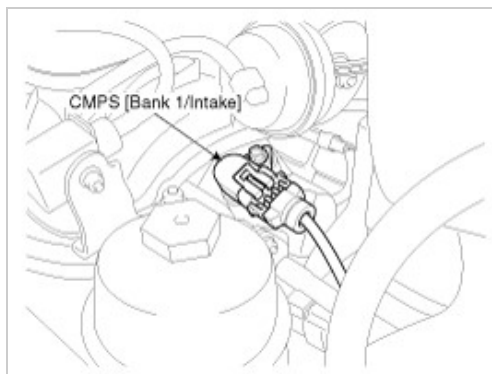
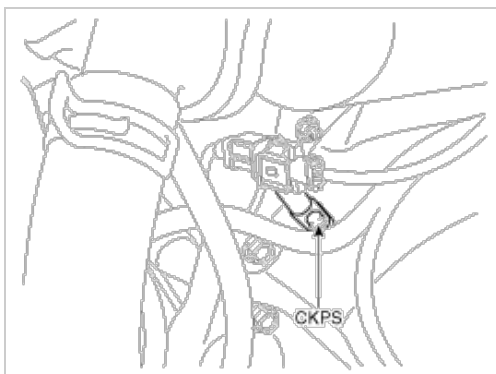
3. Manifold Absolute Pressure Sensor (MAPS)
 6. Throttle Position Sensor (TPS) [integrated into ETC Module]
 24. ETC Motor [integrated into ETC Module]
 26. Purge Control Solenoid Valve (PCSV)

5. Engine Coolant Temperature Sensor (ECTS)



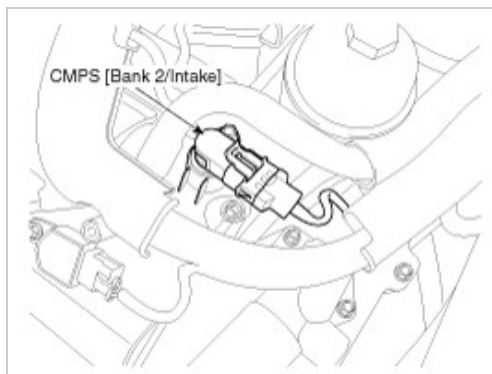
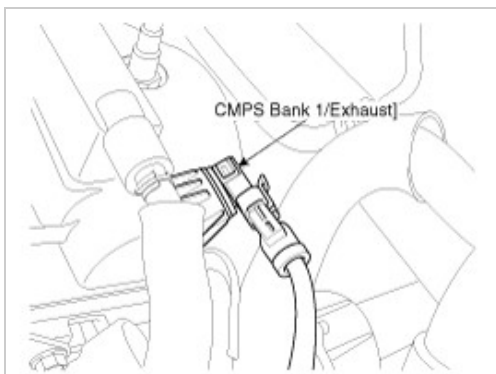
7. Crankshaft Position Sensor (CKPS)

8. Camshaft Position Sensor (CMPS) [Bank 1 / Intake]



9. Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust]

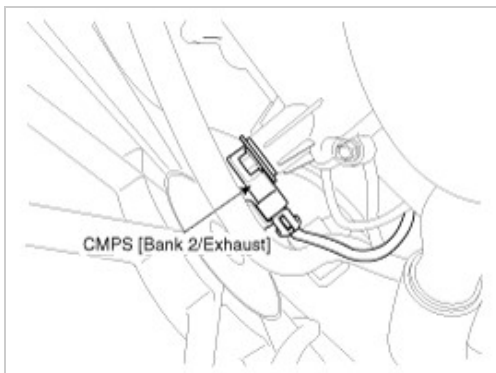
10. Camshaft Position Sensor (CMPS) [Bank 2 / Intake]



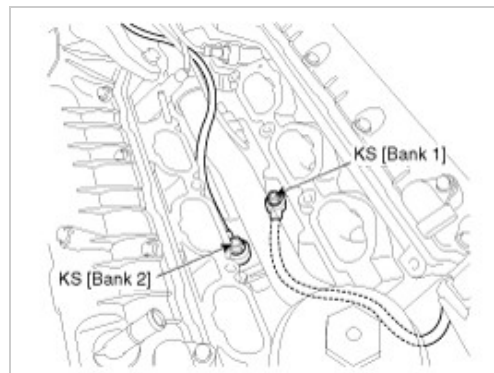
11. Camshaft Position Sensor (CMPS) [Bank 2 / Exhaust]

12. Knock Sensor (KS) [Bank 1]

13. Knock Sensor (KS) [Bank 2]



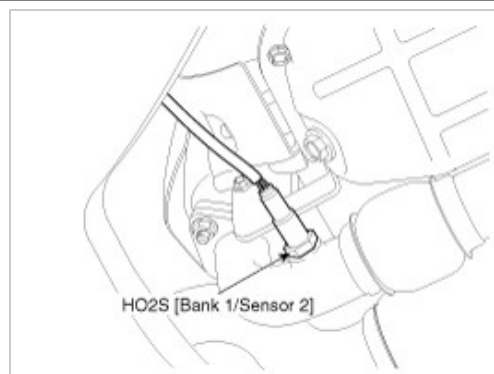
14. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 1]



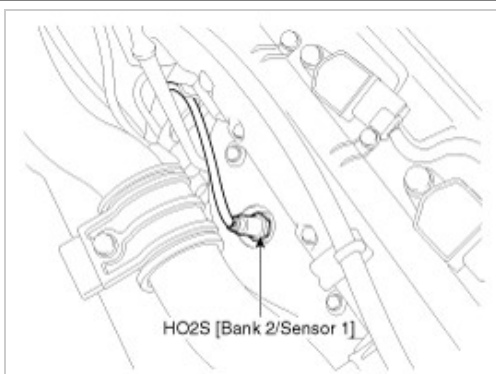
15. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 2]



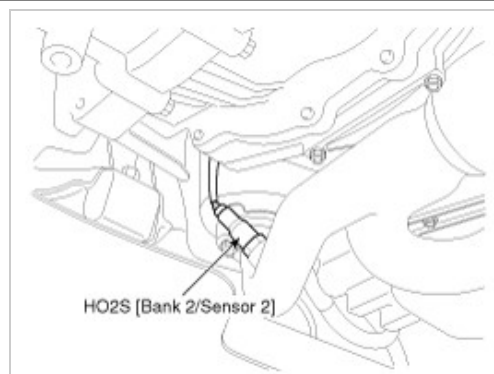
16. Heated Oxygen Sensor (HO2S) [Bank 2 / Sensor 1]



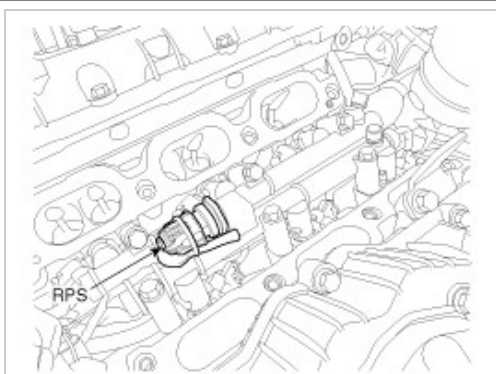
17. Heated Oxygen Sensor (HO2S) [Bank 2 / Sensor 2]



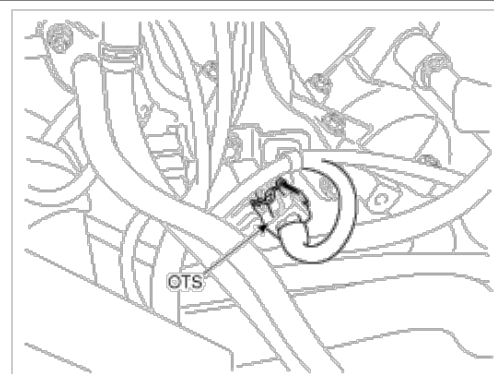
18. Rail Pressure Sensor (RPS)



19. CVVT Oil Temperature Sensor (OTS)



20. Accelerator Position Sensor (APS)



21. A/C Pressure Transducer (APT)



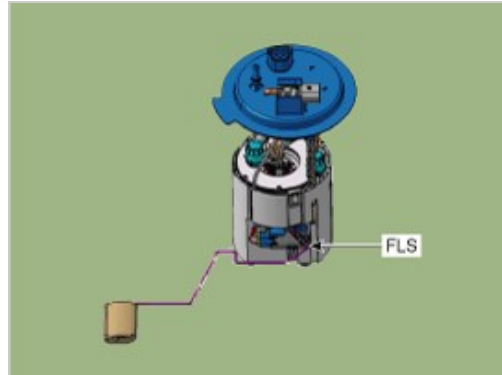
22. Fuel Tank Pressure Sensor (FTPS)



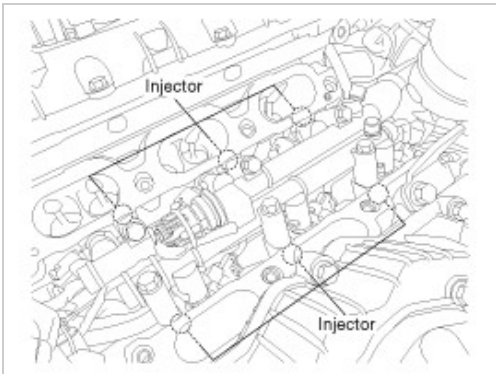
23. Fuel Level Sender (FLS)



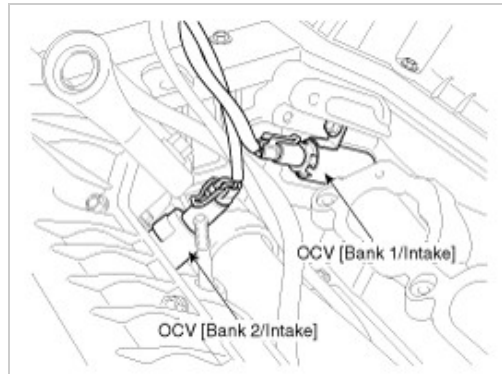
25. Injector



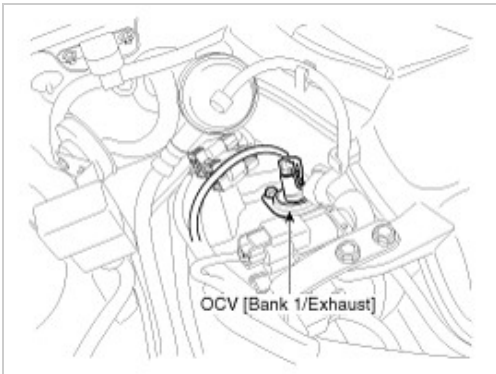
27. CVVT Oil Control Valve (OCV) [Bank 1 / Intake]
29. CVVT Oil Control Valve (OCV) [Bank 2 / Intake]



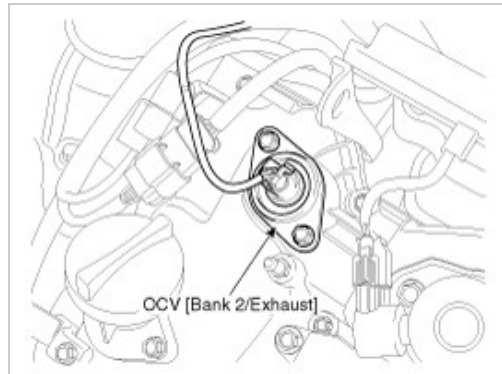
28. CVVT Oil Control Valve (OCV) [Bank 1 / Exhaust]



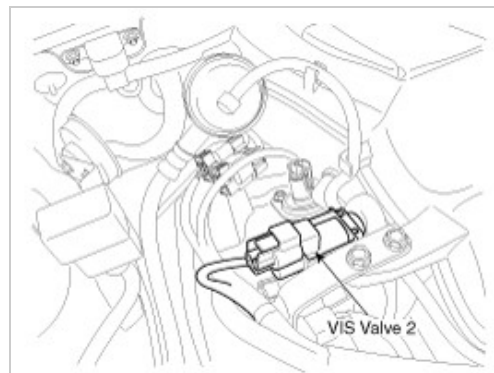
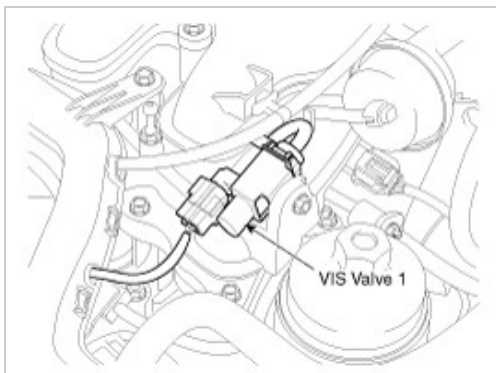
30. CVVT Oil Control Valve (OCV) [Bank 2 / Exhaust]



31. Variable Intake Solenoid (VIS) Valve #1

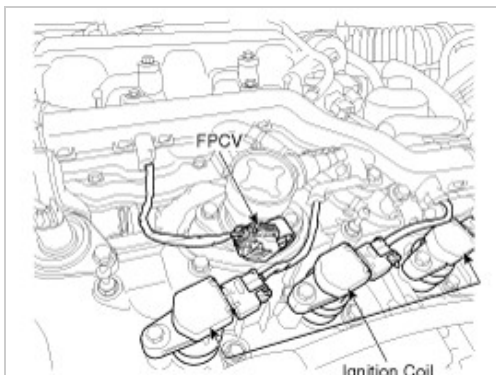


32. Variable Intake Solenoid (VIS) Valve #2



33. Fuel Pressure Control Valve (FPCV)
36. Ignition Coil

34. Canister Close Valve



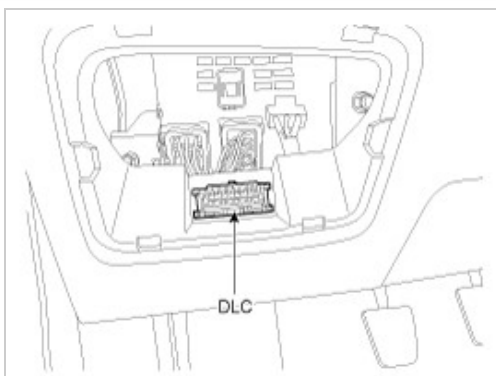
35. Injector Drive Box (IDB)

37. Main Relay
38. Fuel Pump Relay



39. Data Link Connector (DLC) [16 Pin]

40. Multi-Purpose Check Connector [20 Pin]

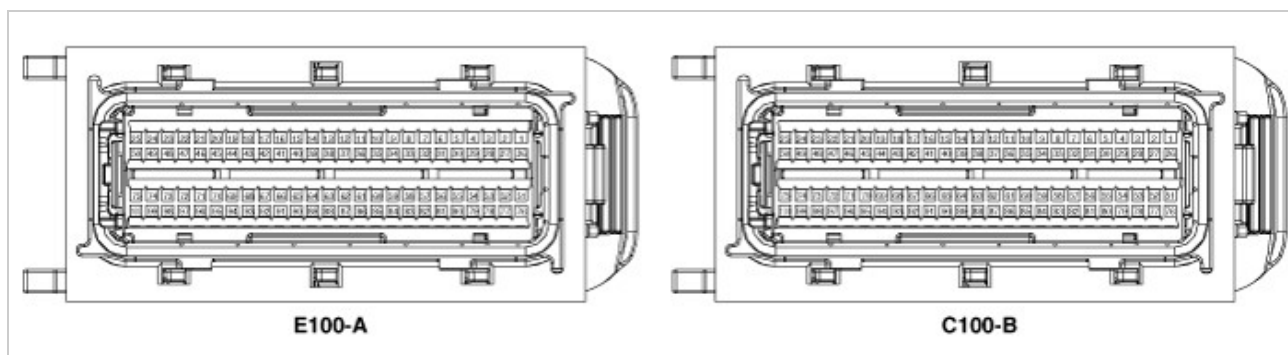


Engine Control/Fuel System



ECM Terminal And Input/Output signal

Harness Connector



ECM Terminal Function

Connector [E100-A]

Pin No.	Description	Connected to
1	-	
2	-	
3	-	
4	-	
5	Power ground	Chassis Ground
6	Power ground	Chassis Ground
7	-	
8	-	
9	2nd CAN [High]	Multi-Purpose Check Connector
10	CAN [High]	Other control module, Data Link Connector (DLC), Multi-Purpose Check Connector
11	Fuel Tank Pressure Sensor (FTPS) signal input	Fuel Tank Pressure Sensor (FTPS)
12	-	
13	-	
14	Sensor power (+5V)	Accelerator Position Sensor (APS) 1
15	Sensor power (+5V)	A/C Pressure Transducer (APT)
16	Fuel Level Sensor (FLS) signal input	Rail Pressure Sensor (RPS)
17	-	Fuel Level Sensor (FLS)
18	-	
19	-	
20	-	
21	Brake Switch 2 signal input	Brake Switch
22	-	
23	-	
24	Alternator (FR)	Alternator
25	-	
26	-	
27	Battery power (B+)	Ignition Switch
28	Rail Pressure Sensor (RPS) signal input	Rail Pressure Sensor (RPS)
29	-	
30	Power ground	Chassis Ground
31	-	
32	-	
33	-	
34	2nd CAN [Low]	Multi-Purpose Check Connector
35	CAN [Low]	Other control module, Data Link Connector (DLC), Multi-Purpose Check Connector
36	-	
37	Sensor ground	Rail Pressure Sensor (RPS)
38	Accelerator Position Sensor (APS) 1 signal input	Accelerator Position Sensor (APS) 1
39	-	
40	-	

41	-	
42	-	
43	Brake Switch 1 signal input	Brake Switch
44	-	
45	-	
46	-	
47	-	
48	-	
49	-	
50	-	
51	-	
52	Battery power (B+)	Battery
53	-	
54	-	
55	Power ground	Chassis Ground
56	-	
57	Fuel pump relay control output	A/C Control Module [Without Immobilizer]
58	-	
59	Sensor ground	Accelerator Position Sensor (APS) 2
60	Sensor ground	Accelerator Position Sensor (APS) 1
61	Sensor ground	Fuel Tank Pressure Sensor (FTPS)
62	-	
63	Sensor ground	A/C Pressure Transducer (APT)
64	-	
65	Sensor Power (+5V)	Fuel Tank Pressure Sensor (FTPS)
66	-	
67	A/C Pressure Transducer (APT) signal input	A/C Pressure Transducer (APT)
68	Accelerator Position Sensor (APS) 2 signal input	Accelerator Position Sensor (APS) 2
69	-	
70	Engine speed signal output	Power Distribution Module (PDM)
71	Cooling Fan Relay [High] control output	Cooling Fan Relay [High]
72	Alternator (COM)	Alternator
73	-	
74	Immobilizer communication line	Smart Key Control Module [With Button Engine Start System] Immobilizer Control Unit [Without Button Engine Start System]
75	Battery power (B+)	Main Relay
76	-	
77	Battery power (B+)	Battery
78	-	
79	-	
80	Power ground	Chassis ground
81	-	
82	-	
83	-	
84	-	
85	-	
86	-	
87	LIN (Local Interconnect Network) Serial Bus Line	Battery Sensor
88	-	
89	-	
90	Sensor power (+5V)	Accelerator Position Sensor (APS) 2
91	-	
92	-	
93	Starter Relay control output	Starter Relay
94	Main Relay control output	Main Relay
95	Fuel pump Relay control output	Fuel pump Relay [With Immobilizer]
96	Canister Close Valve (CCV) control output	Canister Close Valve (CCV)
97	-	

98	-	
99	Battery power (B+)	Main Relay
100	Battery power (B+)	Main Relay

Connector [C100-B]

Pin No.	Description	Connected to
1	-	
2	-	
3	-	
4	-	
5	Sensor power (+5V)	Camshaft Position Sensor (CMPS) [Bank 1/Intake] Camshaft Position Sensor (CMPS) [Bank 2/Exhaust]
6	Sensor power (+5V)	Throttle Position Sensor (TPS)
7	-	
8	Crank request signal output	Power Distribution Module (PDM) [With Button Engine Start System] Ignition Switch [Without Button Engine Start System]
9	Barometric Pressure Sensor (BPS) signal input	Barometric Pressure Sensor (BPS)
10	CVVT Oil Temperature Sensor (OTS) signal input	CVVT Oil Temperature Sensor (OTS)
11	-	
12	Throttle Position Sensor (TPS) 1 signal input	Throttle Position Sensor (TPS) 1
13	Manifold Absolute Pressure Sensor (MAPS) signal input	Manifold Absolute Pressure Sensor (MAPS)
14	Intake Air Temperature Sensor (IATS) signal input	Intake Air Temperature Sensor (IATS)
15	Vehicle speed signal input	Power Distribution Module (PDM) [With Button Engine Start System] ABS/ESP Control Module [Without Button Engine Start System]
16	Knock Sensor (KS) [Bank 2] [High] signal input	Knock Sensor (KS) [Bank 2]
17	Knock Sensor (KS) [Bank 1] [High] signal input	Knock Sensor (KS) [Bank 1]
18	Crankshaft Position Sensor (CKPS) [High] signal input	Crankshaft Position Sensor (CKPS)
19	Sensor ground	CVVT Oil Temperature Sensor (OTS)
20	-	
21	Camshaft Position Sensor (CMPS) [Bank 2/Intake] signal input	Camshaft Position Sensor (CMPS) [Bank 2/Intake]
22	Wiper motor signal input	Wiper motor
23	-	
24	Ignition Coil (Cylinder #1) control output	Ignition Coil (Cylinder #1)
25	-	
26	-	
27	-	
28	-	
29	-	
30	-	
31	Sensor ground	Throttle Position Sensor (TPS) 1
32	Sensor ground	Camshaft Position Sensor (CMPS) [Bank 1/Intake] Camshaft Position Sensor (CMPS) [Bank 2/Exhaust]
33	Sensor ground	Heated Oxygen Sensor (HO2S) [Bank 2/Sensor 2]
34	Throttle Position Sensor (TPS) 2 signal input	Throttle Position Sensor (TPS) 2
35	Engine Coolant Temperature Sensor (ECTS) signal input	Engine Coolant Temperature Sensor (ECTS)
36	-	
37	-	
38	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 1] signal input	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 1]
39	Sensor ground	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 1] Crankshaft Position Sensor (CKPS)
40	Sensor Shield	Knock Sensor (KS) #1 [Bank 1] Knock Sensor (KS) #2 [Bank 2]
41	Knock Sensor (KS) [Bank 2] [Low] signal input	Knock Sensor (KS) [Bank 2]
42	Knock Sensor (KS) [Bank 1] [Low] signal input	Knock Sensor (KS) [Bank 1]

43	Crankshaft Position Sensor (CKPS) [Low] signal input	Crankshaft Position Sensor (CKPS)
44	Sensor ground	Camshaft Position Sensor (CMPS) [Bank 1/Exhaust] Camshaft Position Sensor (CMPS) [Bank 2/Intake]
45	-	
46	Camshaft Position Sensor (CMPS) [Bank 2/Exhaust] signal input	Camshaft Position Sensor (CMPS) [Bank 2/Exhaust]
47	-	
48	Sensor power (+5V)	Barometric Pressure Sensor (BPS) Manifold Absolute Pressure Sensor (MAPS) VCM Position Sensor
49	Ignition Coil (Cylinder #3) control output	Ignition Coil (Cylinder #3)
50	-	
51	-	
52	-	
53	-	
54	-	
55	-	
56	Sensor ground	Barometric Pressure Sensor (BPS) Manifold Absolute Pressure Sensor (MAPS) Engine Coolant Temperature Sensor (ECTS)
57	-	
58	Heated Oxygen Sensor (HO2S) [Bank 2/Sensor 2] signal input	Heated Oxygen Sensor (HO2S) [Bank 2/Sensor 2]
59	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2] signal input	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2]
60	Sensor ground	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2]
61	-	
62	-	
63	Heated Oxygen Sensor (HO2S) [Bank 2/Sensor 1] signal input	Heated Oxygen Sensor (HO2S) [Bank 2/Sensor 1]
64	Sensor ground	Heated Oxygen Sensor (HO2S) [Bank 2/Sensor 1]
65	Variable Intake Solenoid (VIS) Valve 1 control output	Variable Intake Solenoid (VIS) Valve 1
66	Purge Control Solenoid Valve (PCSV) control output	Purge Control Solenoid Valve (PCSV)
67	-	
68	-	
69	Variable Intake Solenoid (VIS) Valve 2 control output	Variable Intake Solenoid (VIS) Valve 2
70	Camshaft Position Sensor (CMPS) [Bank 1/Exhaust] signal input	Camshaft Position Sensor (CMPS) [Bank 1/Exhaust]
71	Camshaft Position Sensor (CMPS) [Bank 1/Intake] signal input	Camshaft Position Sensor (CMPS) [Bank 1/Intake]
72	-	
73	Sensor Power (+5V)	Camshaft Position Sensor (CMPS) [Bank 1/Exhaust] Camshaft Position Sensor (CMPS) [Bank 2/Intake]
74	Ignition Coil (Cylinder #5) control output	Ignition Coil (Cylinder #5)
75	-	
76	-	
77	-	
78	-	
79	-	
80	ETC Motor [+] control output	ETC Motor
81	ETC Motor [-] control output	ETC Motor
82	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2] Heater control output	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2]
83	Heated Oxygen Sensor (HO2S) [Bank 2/Sensor 2] Heater control output	Heated Oxygen Sensor (HO2S) [Bank 2/Sensor 2]
84	Fuel Pressure Control Valve (FPCV) control output	Injector Drive Box (IDB)
85	Injector (Cylinder #2) control output	Injector Drive Box (IDB)
86	Injector (Cylinder #5) control output	Injector Drive Box (IDB)
87	Injector (Cylinder #3) control output	Injector Drive Box (IDB)
88	Injector (Cylinder #6) control output	Injector Drive Box (IDB)
89	Injector (Cylinder #4) control output	Injector Drive Box (IDB)
90	Injector (Cylinder #1) control output	Injector Drive Box (IDB)
91		Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 1]

	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 1] Heater control output	
92	Heated Oxygen Sensor (HO2S) [Bank 2/Sensor 1] Heater control output	Heated Oxygen Sensor (HO2S) [Bank 2/Sensor 1]
93	CVVT Oil Control Valve (OCV) [Bank 2/Exhaust] control output	CVVT Oil Control Valve (OCV) [Bank 2/Exhaust]
94	CVVT Oil Control Valve (OCV) [Bank 1/Exhaust] control output	CVVT Oil Control Valve (OCV) [Bank 1/Exhaust]
95	CVVT Oil Control Valve (OCV) [Bank 2/Intake] control output	CVVT Oil Control Valve (OCV) [Bank 2/Intake]
96	CVVT Oil Control Valve (OCV) [Bank 1/Intake] control output	CVVT Oil Control Valve (OCV) [Bank 1/Intake]
97	Ignition Coil (Cylinder #2) control output	Ignition Coil (Cylinder #2)
98	Ignition Coil (Cylinder #6) control output	Ignition Coil (Cylinder #6)
99	Ignition Coil (Cylinder #4) control output	Ignition Coil (Cylinder #4)
100	-	

ECM Terminal Input/Output Signal

Connector [E100-A]

Pin No.	Description	Condition	Type	Level
1	-			
2	-			
3	-			
4	-			
5	Power ground	Idle	DC	Max. 0.1V
6	Power ground	Idle	DC	Max. 0.1V
7	-			
8	-			
9	2nd CAN [High]	Recessive Dominant	Pulse	2.0 ~ 3.0V 2.75 ~ 4.5V
10	CAN [High]	Recessive Dominant	Pulse	2.0 ~ 3.0V 2.75 ~ 4.5V
11	Fuel Tank Pressure Sensor (FTPS) signal input	Idle	Analog	0.4 ~ 4.6V
12	-			
13	-			
14	Sensor power (+5V)	IG OFF IG ON	DC	Max. 0.5V 4.9 ~ 5.1V
15	Sensor power (+5V)	IG OFF IG ON	DC	Max. 0.5V 4.9 ~ 5.1V
16	Fuel Level Sensor (FLS) signal input	IG ON	Analog	0.88 ~ 8.45V
17	-			
18	-			
19	-			
20	-			
21	Brake Switch 2 signal input	Brake OFF Brake ON	DC	Battery Voltage Max. 0.5V
22	-			
23	-			
24	Alternator (FR)	Idle	PWM	High: Battery Voltage Low: Max. 2.0V 133 5
25	-			
26	-			
27	Battery power (B+)	IG OFF IG ON	DC	Battery Voltage Max. 1.0V
28	Rail Pressure Sensor (RPS) signal input	Idle	DC	1.0 ~ 2.0V
29	-			
30	Power ground	Idle	DC	Max. 0.1V
31	-			
32	-			

33	-			
34	2nd CAN [Low]	Recessive	Pulse	2.0 ~ 3.0V
		Dominant		0.5 ~ 2.25V
35	CAN [Low]	Recessive	Pulse	2.0 ~ 3.0V
		Dominant		0.5 ~ 2.25V
36	-			
37	Sensor ground	Idle	DC	Max. 0.1V
38	Accelerator Position Sensor (APS) 1 signal input	C.T	Analog	0.7 ~ 0.8V
		W.O.T		3.85 ~ 4.35V
39	-			
40	-			
41	-			
42	-			
43	Brake Switch 1 signal input	Brake OFF	DC	Max. 0.5V
		Brake ON		Battery Voltage
44	-			
45	-			
46	-			
47	-			
48	-			
49	-			
50	-			
51	-			
52	Battery power (B+)	Always (Without Ignition key)	DC	Battery Voltage
53	-			
54	-			
55	Power ground	Idle	DC	Max. 0.1V
56	-			
57	Fuel Pump Relay control output [Without Immobilizer]	Relay OFF	DC	Battery Voltage
				Max 1.1V
58	-			
59	Sensor ground	Idle	DC	Max. 0.1V
60	Sensor ground	Idle	DC	Max. 0.1V
61	Sensor ground	Idle	DC	Max. 0.1V
62	-			
63	Sensor ground	Idle	DC	Max. 0.1V
64	-			
65	Sensor Power (+5V)	IG OFF	DC	Max. 0.5V
		IG ON		4.75 ~ 5.25V
66	-			
67	A/C Pressure Transducer (APT) signal input	A/C ON	Analog	0.5 ~ 4.5V
68	Accelerator Position Sensor (APS) 2 signal input	C.T	Analog	0.29 ~ 0.46V
		W.O.T		1.93 ~ 2.18V
69	-			
70	Engine speed signal output	Engine Running	Pulse	High: Battery Voltage
				Low: Max. 1.1V
				0
				47.5
71	Cooling Fan Relay [High] control output	A/C ON	Pulse	High: Battery Voltage
				Low: Max. 1.1V
72	Alternator (COM)	IG ON	PWM	High: Min. 4.0V
				Low: Max. 2.0V
				Frequency = 125Hz
73	-			
74	Immobilizer communication line	Transmitting	DC	High: Min. Vbatt X 80%
		Receiving		Low: Max. Vbatt X 20%
				High: Min. Vbatt X 70%

				Low: Max. Vbatt X 30%
75	Battery power (B+)	IG OFF	DC	Battery Voltage
		IG ON		Max. 1.0V
76	-			
77	Battery power (B+)	Always (Without Ignition key)	DC	Battery Voltage
78	-			
79	-			
80	Power ground	Idle	DC	Max. 0.1V
81	-			
82	-			
83	-			
84	-			
85	-			
86	-			
87	LIN (Local Interconnect Network) Serial Bus Line	Transmitting	DC	High: Min. Vbatt X 80%
		Receiving		Low: Max. Vbatt X 20%
				High: Min. Vbatt X 70%
				Low: Max. Vbatt X 30%
88	-			
89	-			
90	Sensor power (+5V)	IG OFF	DC	Max. 0.5V
		IG ON		4.75 ~ 5.25V
91	Cooling Fan Relay [Low] control output	A/C ON	Pulse	High: Battery Voltage
				Low: Max. 1.1V
92	-			
93	Starter Relay control output	Relay OFF	DC	Battery Voltage
		Relay ON		Max 1.1V
94	Main Relay control output	Relay OFF	DC	Battery Voltage
		Relay ON		Max 1.7V
95	Fuel Pump Relay control output	Relay OFF	DC	Battery Voltage
		Relay ON		Max 1.1V
96	Canister Close Valve (CCV) control output	Active	Pulse	High: Battery Voltage
		Inactive		Low: Max. 1.0V
				Vpeak: Max. 70V
97	-			
98	-			
99	Battery power (B+)	IG OFF	DC	Battery Voltage
		IG ON		Max. 1.0V
100	Battery power (B+)	IG OFF	DC	Battery Voltage
		IG ON		Max. 1.0V

Connector [C100-B]

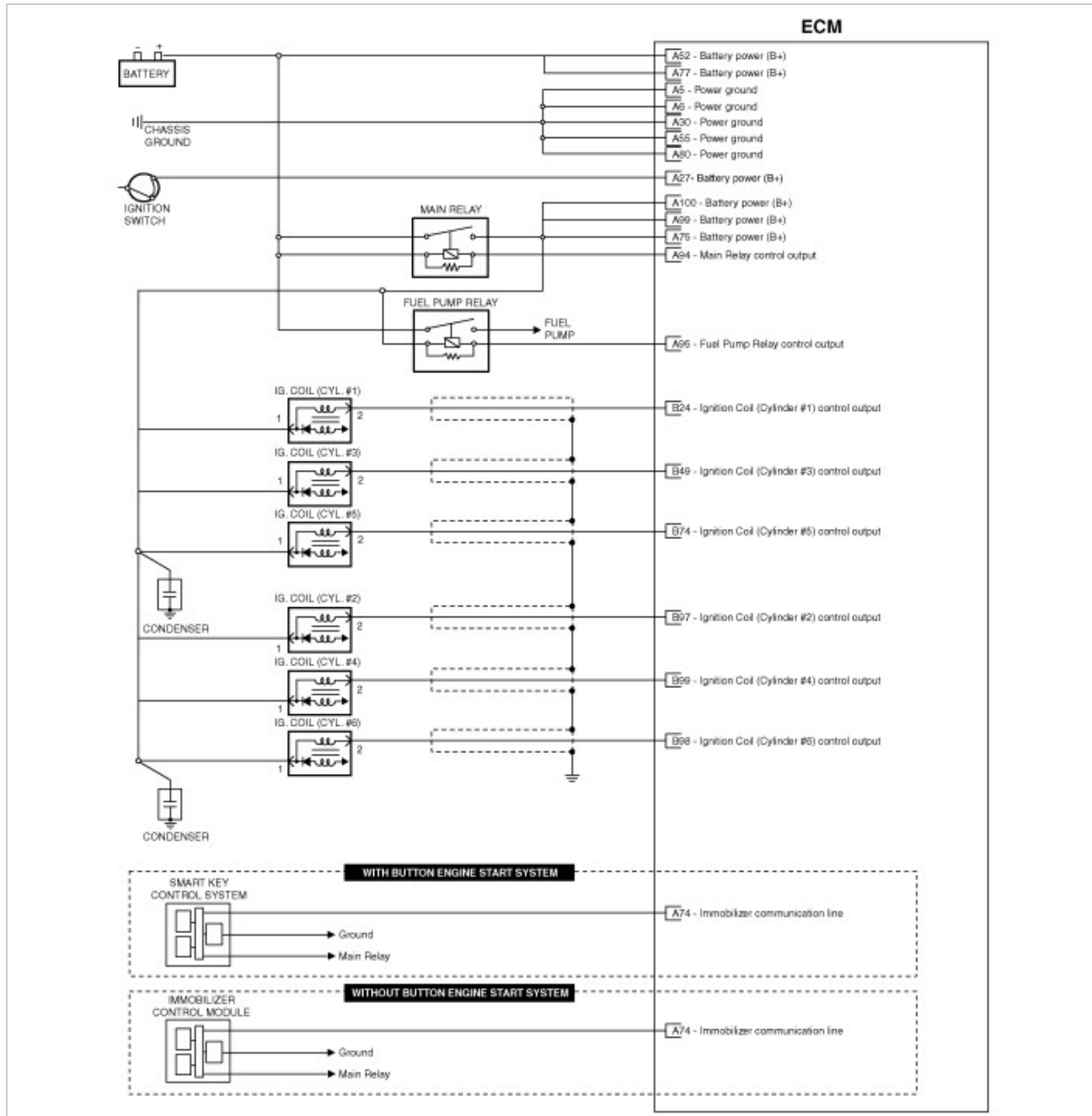
Pin No.	Description	Condition	Type	Level
1	-			
2	Variable Charge Motion Actuator (VCMA) PWM output	Engine Running	PWM	High: Battery Voltage
				Low: 1.1V
3	-			
4	-			
5	Sensor power (+5V)	IG OFF	DC	Max. 0.5V
		IG ON		4.75 ~ 5.25V
6	Sensor power (+5V)	IG OFF	DC	Max. 0.5V
		IG ON		4.75 ~ 5.25V
7	Throttle Position Sensor PWM signal output			
8	Crank request signal output	S/W OFF	DC	Max. 1.0V
		S/W ON		Battery Voltage
9	Barometric Pressure Sensor (BPS) signal input	IG ON	Analog	Approx. 4.0V

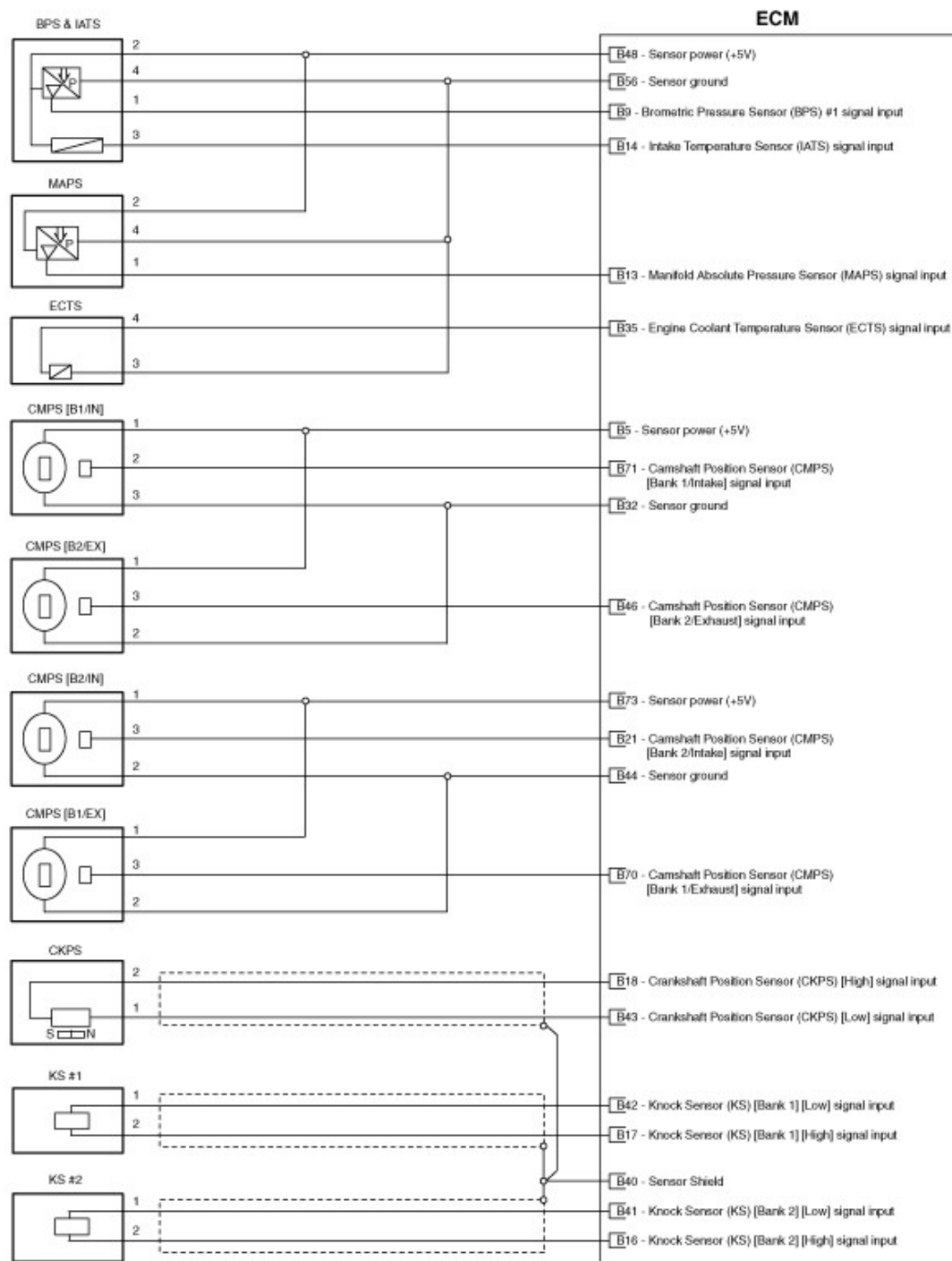
10	CVVT Oil Temperature Sensor (OTS) signal input	IG ON	Analog	3.2V at -40°C(-40°F) 0.1V at 150°C(302°F)
11	A/C Blower "MAX" signal input	IG ON	DC	High: Battery Voltage Low: 0V
12	Throttle Position Sensor (TPS) 1 signal input	C.T W.O.T	Analog	0.25 ~ 0.9V Min. 4.0V
13	Manifold Absolute Pressure Sensor (MAPS) signal input	IG ON Idle	Analog	Approx. 4.44V Approx. 0.75V
14	Intake Air Temperature Sensor (IATS) signal input	IG ON	Analog	3.2V at -40°C(-40°F) 0.05V at 125°C(257°F)
15	Vehicle speed signal input	Vehicle Running	Pulse	High: Battery Voltage Low: Max. 0.5V 0.7(1kph) 44
16	Knock Sensor (KS) [Bank 2] [High] signal input	Knocking Normal	Variable Frequency	-0.3 ~ 0.3V 0V
17	Knock Sensor (KS) [Bank 1] [High] signal input	Knocking Normal	Variable Frequency	-0.3 ~ 0.3V 0V
18	Crankshaft Position Sensor (CKPS) [High] signal input	Idle	SINE Wave	0.4 55
19	Sensor ground	Idle	DC	Max. 0.1V
20	-			
21	Camshaft Position Sensor (CMPS) [Bank 2/Intake] signal input	Idle	Pulse	High: 3.2 ~ Vcc Low: Max. 0.7V 0
22	-			
23	-			
24	Ignition Coil (Cylinder #1) control output	Engine Running	Pulse	Vpeak = 400V 0
25	-			
26	-			
27	-			
28	-			
29	-			
30	-			
31	Sensor ground	Idle	DC	Max. 0.1V
32	Sensor ground	Idle	DC	Max. 0.1V
33	Sensor ground	Idle	DC	Max. 0.1V
34	Throttle Position Sensor (TPS) 2 signal input	C.T W.O.T	Analog	Min. 4.0V 0.25 ~ 0.9V
35	Engine Coolant Temperature Sensor (ECTS) signal input	IG ON	Analog	3.22V at -40°C(-40°F) 0.29V at 125°C(257°F)
36	-			
37	-			
38	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 1] signal input	RICH LEAN	Analog	Min. 0.8V Max. 0.1V
39	Sensor ground	Idle	DC	Max. 0.1V
40	Sensor Shield	Idle	DC	Max. 0.1V
41	Knock Sensor (KS) [Bank 2] [Low] signal input	Knocking Normal	Variable Frequency	-0.3 ~ 0.3V 0V
42	Knock Sensor (KS) [Bank 1] [Low] signal input	Knocking Normal	Variable Frequency	-0.3 ~ 0.3V 0V
43	Crankshaft Position Sensor (CKPS) [Low] signal input	Idle	SINE Wave	0.4 55
44	Sensor ground	Idle	DC	Max. 0.1V
45	-			
46	Camshaft Position Sensor (CMPS) [Bank 2/Exhaust] signal input	Idle	Pulse	High: 3.2 ~ Vcc Low: Max. 0.7V

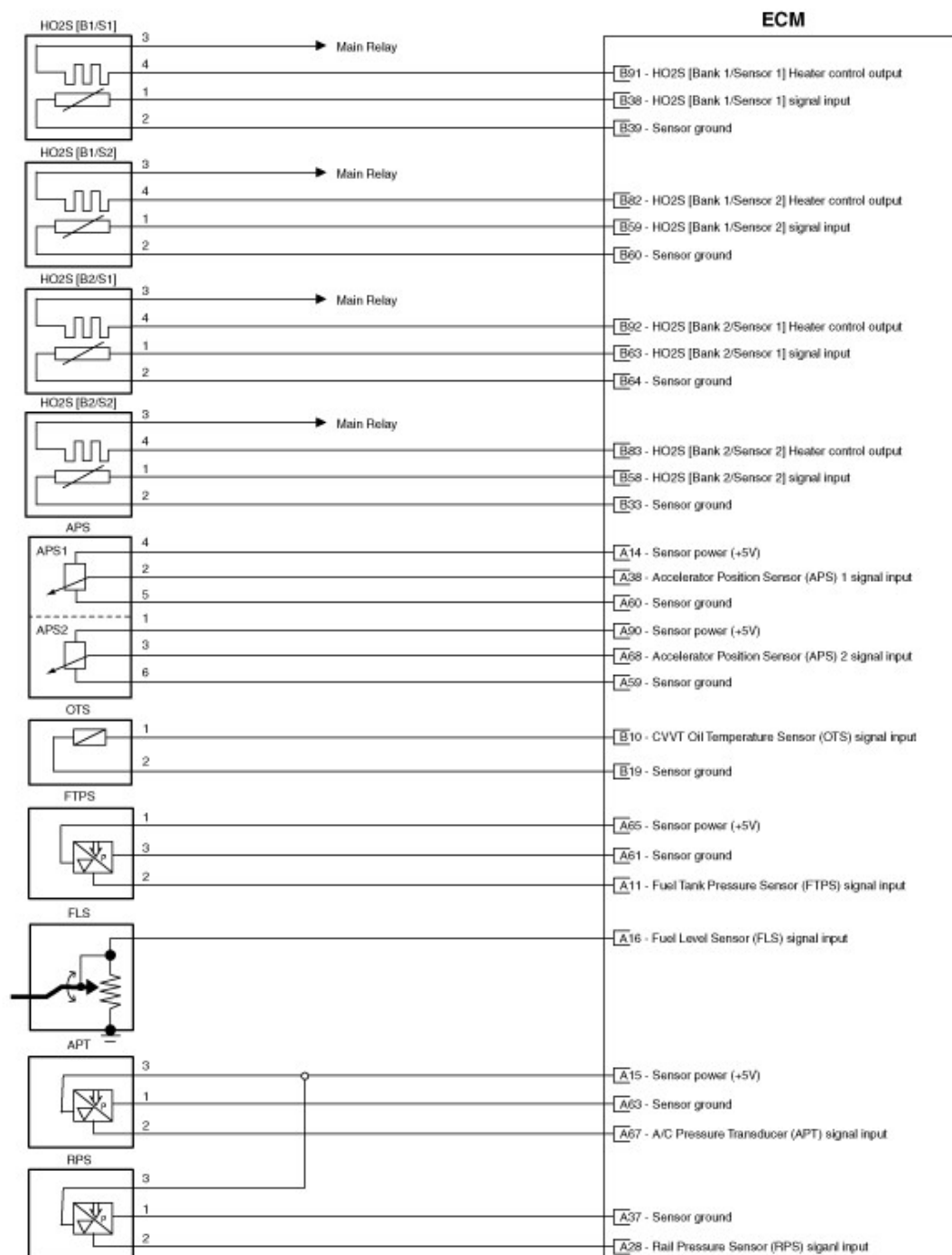
				0
47	-			
48	Sensor power (+5V)	IG OFF	DC	Max. 0.5V
		IG ON		4.75 ~ 5.25V
49	Ignition Coil (Cylinder #3) control output	Engine Running	Pulse	Vpeak = 400V
				0
50	-			
51	-			
52	-			
53	-			
54	-			
55	-			
56	Sensor ground	Idle	DC	Max. 0.1V
57	-			
58	Heated Oxygen Sensor (HO2S) [Bank 2/Sensor 2] signal input	RICH	Analog	Min. 0.8V
		LEAN		Max. 0.1V
59	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2] signal input	RICH	Analog	Min. 0.8V
		LEAN		Max. 0.1V
60	Sensor ground	Idle	DC	Max. 0.1V
61	-			
62	-			
63	Heated Oxygen Sensor (HO2S) [Bank 2/Sensor 1] signal input	RICH	Analog	Min. 0.8V
		LEAN		Max. 0.1V
64	Sensor ground	Idle	DC	Max. 0.1V
65	Variable Intake Solenoid (VIS) Valve 1 control output	Engine Running	PWM	High: Battery Voltage
				Low: Max. 1.1V
66	Purge Control Solenoid Valve (PCSV) control output	Engine Running	PWM	High: Battery Voltage
				Low: Max. 1.0V
67	-			
68	-			
69	Variable Intake Solenoid (VIS) Valve 2 control output	Engine Running	PWM	High: Battery Voltage
				Low: Max. 1.1V
70	Camshaft Position Sensor (CMPS) [Bank 1/Exhaust] signal input	Idle	Pulse	High: 3.2 ~ Vcc
				Low: Max. 0.7V
				0
71	Camshaft Position Sensor (CMPS) [Bank 1/Intake] signal input	Idle	Pulse	High: 3.2 ~ Vcc
				Low: Max. 0.7V
				0
72	-			
73	Sensor Power (+5V)	IG OFF	DC	Max. 0.5V
		IG ON		4.75 ~ 5.25V
74	Ignition Coil (Cylinder #5) control output	Engine Running	Pulse	Vpeak = 400V
				0
75	-			
76	-			
77	-			
78	-			
79	-			
80	ETC Motor [+] control output	Engine Running	PWM	High: Battery Voltage
				Low: Max. 1.0V
				1,500
				0
81	ETC Motor [-] control output	Engine Running	PWM	High: Battery Voltage
				Low: Max. 1.0V
				1,500
				0
82	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2] Heater control output	Engine Running	PWM	High: Battery Voltage
				Low: Max. 1.15V

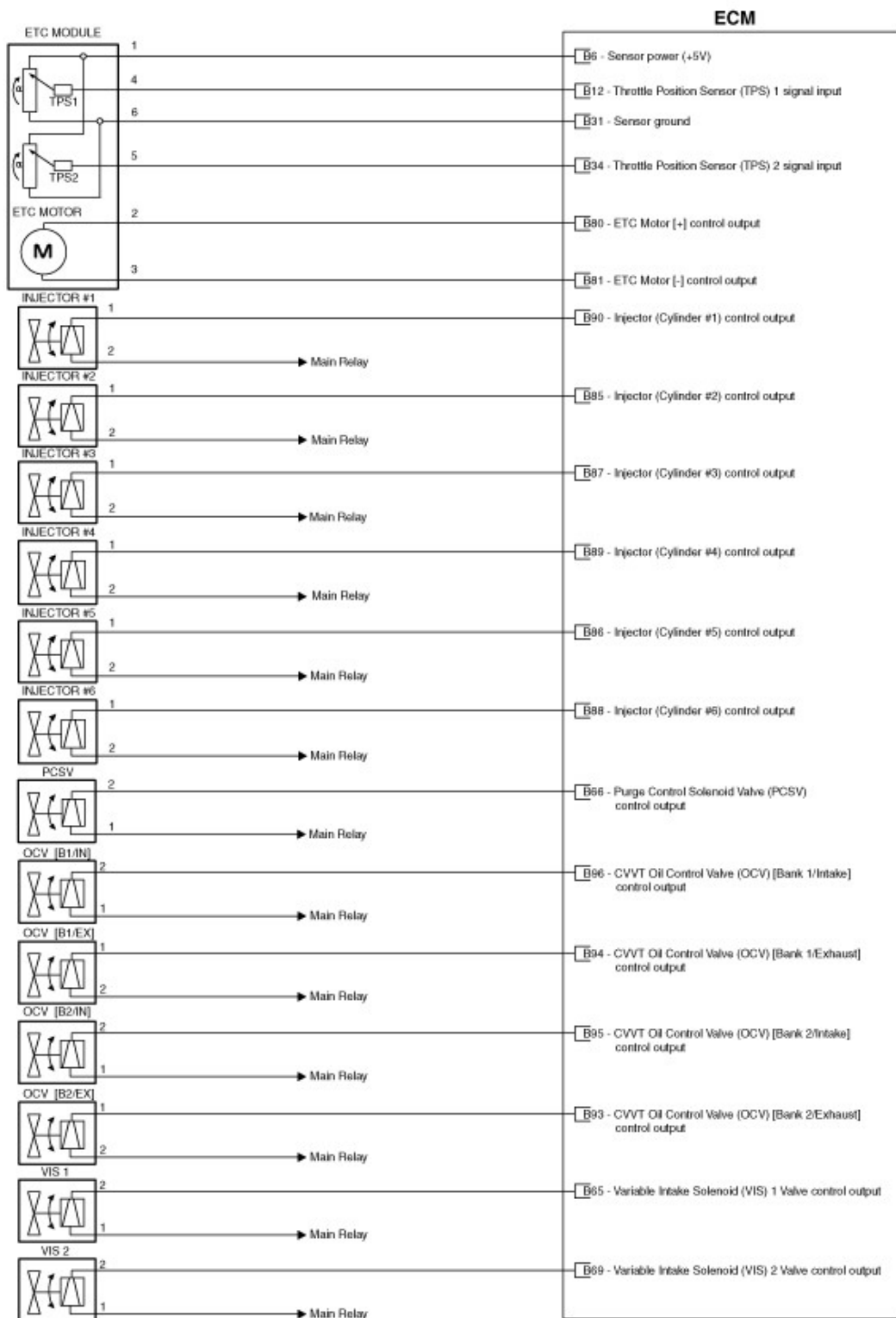
				0
83	Heated Oxygen Sensor (HO2S) [Bank 2/Sensor 2] Heater control output	Engine Running	PWM	High: Battery Voltage Low: Max. 1.15V 0
84	Fuel Pressure Control Valve (FPCV) control output			High: Battery Voltage Low: Max. 1.0V 0 47
85	Injector (Cylinder #2) control output	Engine Running	PWM	High: Battery Voltage Low: Max. 1.0V 0 47
86	Injector (Cylinder #5) control output	Engine Running	PWM	High: Battery Voltage Low: Max. 1.0V 0 47
87	Injector (Cylinder #3) control output	Engine Running	PWM	High: Battery Voltage Low: Max. 1.0V 0 47
88	Injector (Cylinder #6) control output	Engine Running	PWM	High: Battery Voltage Low: Max. 1.0V 0 47
89	Injector (Cylinder #4) control output	Engine Running	PWM	High: Battery Voltage Low: Max. 1.0V 0 47
90	Injector (Cylinder #1) control output	Engine Running	PWM	High: Battery Voltage Low: Max. 1.0V 0 47
91	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 1] Heater control output	Engine Running	PWM	High: Battery Voltage Low: Max. 1.15V 0
92	Heated Oxygen Sensor (HO2S) [Bank 2/Sensor 1] Heater control output	Engine Running	PWM	High: Battery Voltage Low: Max. 1.15V 0
93	CVVT Oil Control Valve (OCV) [Bank 2/Exhaust] control output	Engine Running	PWM	High: Battery Voltage Low: Max. 1.0V Frequency = 128Hz 0
94	CVVT Oil Control Valve (OCV) [Bank 1/Exhaust] control output	Engine Running	PWM	High: Battery Voltage Low: Max. 1.0V Frequency = 128Hz 0
95	CVVT Oil Control Valve (OCV) [Bank 2/Intake] control output	Engine Running	PWM	High: Battery Voltage Low: Max. 1.0V Frequency = 128Hz 0
96	CVVT Oil Control Valve (OCV) [Bank 1/Intake] control output	Engine Running	PWM	High: Battery Voltage Low: Max. 1.0V Frequency = 128Hz 0
97	Ignition Coil (Cylinder #2) control output	Engine Running	Pulse	Vpeak = 400V 0
98	Ignition Coil (Cylinder #6) control output	Engine Running	Pulse	Vpeak = 400V 0
99	Ignition Coil (Cylinder #4) control output	Engine Running	Pulse	Vpeak = 400V 0
100	-			

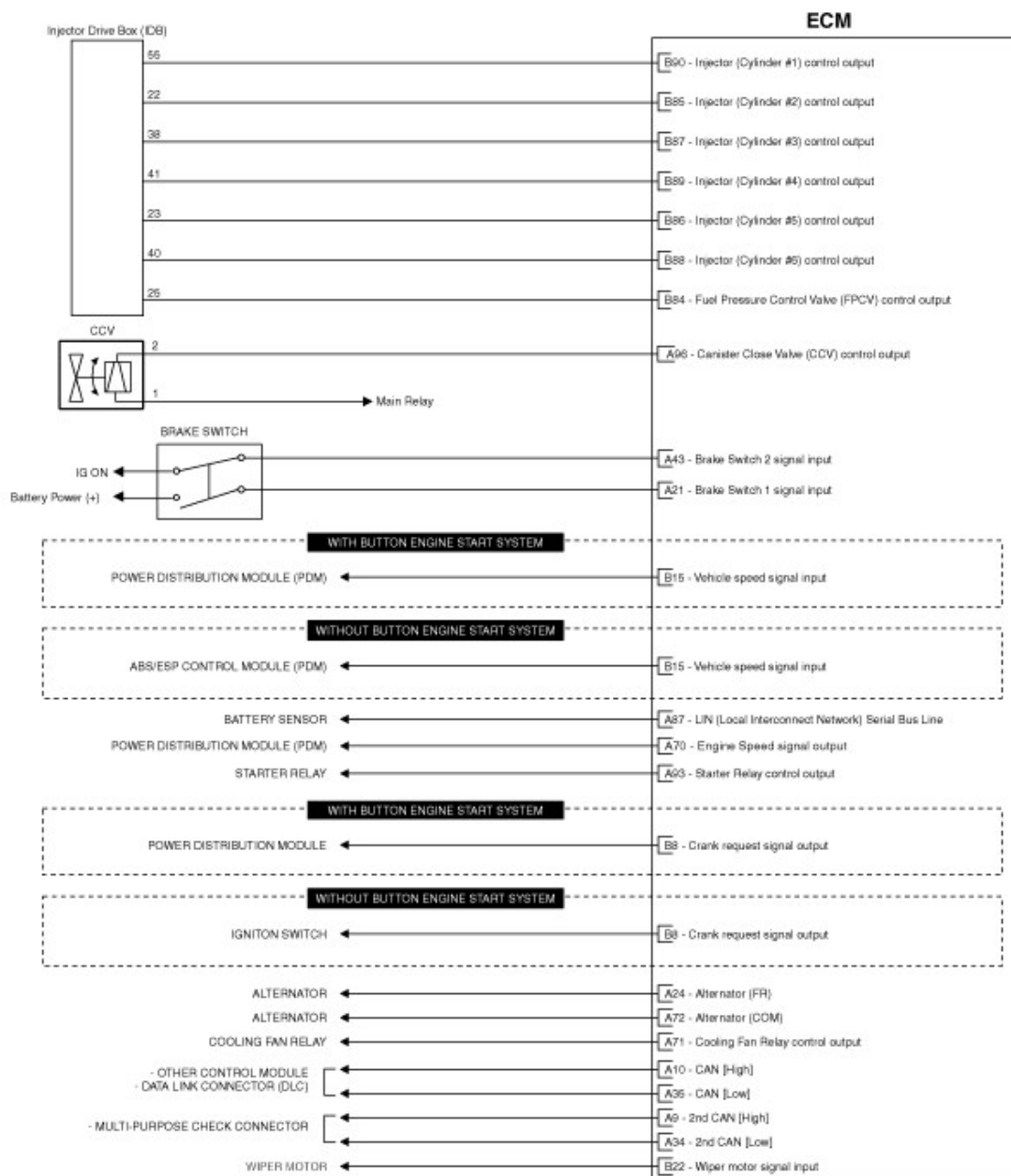
Circuit Diagram











Engine Control/Fuel System



Removal

NOTICE

When replacing the ECM, the vehicle equipped with the immobilizer must be performed procedure as below.

[In the case of installing used ECM]

- 1) Perform "ECM Neutral mode" procedure with GDS.
(Refer to Body Electrical System - "Immobilizer System")
- 2) After finishing "ECM Neutral mode", perform "Key teaching" procedure with GDS.
(Refer to Body Electrical System - "Immobilizer System")

[In the case of installing new ECM]

Perform "Key teaching" procedure with GDS.

(Refer to Body Electrical System - "Immobilizer System")

NOTICE

When replacing the ECM, the vehicle equipped with the smart key system (Button start) must be performed procedure as below.

[In the case of installing used ECM]

- 1) Perform "ECM Neutral mode" procedure with GDS.

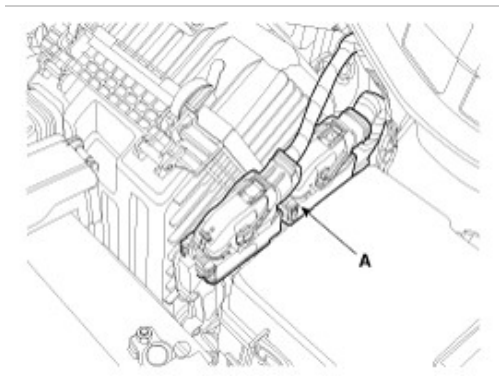
(Refer to Body Electrical System - "Immobilizer System")

- 2) After finishing "ECM Neutral mode", insert the key (or press the start button) and turn it to the IGN ON and OFF position. Then the ECM learns the smart key information automatically.

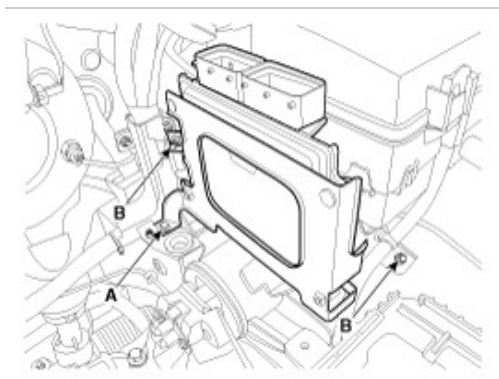
[In the case of installing new ECM]

Insert the key (or press the start button) and turn it to the IGN ON and OFF position. Then the ECM learns the smart key information automatically.

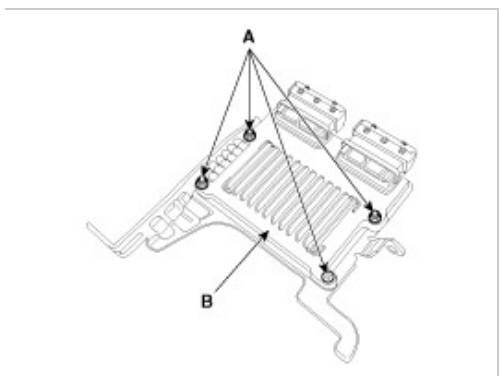
1. Turn ignition switch OFF and disconnect the negative (-) battery cable.
2. Remove the cover.
3. Disconnect the ECM connector (A).



4. Remove the battery tray.
(Refer to Engine Electrical System - "Battery")
5. Remove the ECM bracket installation bolts (A) and nut (B).



6. Remove the air cleaner assembly.
(Refer to Engine Mechanical System - "Air Cleaner")
7. After removing the installation bolts (A), remove the ECM (B) from the bracket.



Installation

NOTICE

When replacing the ECM, the vehicle equipped with the immobilizer must be performed procedure as below.

[In the case of installing used ECM]

- 1) Perform "ECM Neutral mode" procedure with GDS.

(Refer to Body Electrical System - "Immobilizer System")

- 2) After finishing "ECM Neutral mode", perform "Key teaching" procedure with GDS.

(Refer to Body Electrical System - "Immobilizer System")

[In the case of installing new ECM]

Perform "Key teaching" procedure with GDS.

(Refer to Body Electrical System - "Immobilizer System")

NOTICE

When replacing the ECM, the vehicle equipped with the smart key system (Button start) must be performed procedure as below.

[In the case of installing used ECM]

- 1) Perform "ECM Neutral mode" procedure with GDS.

(Refer to Body Electrical System - "Immobilizer System")

- 2) After finishing "ECM Neutral mode", insert the key (or press the start button) and turn it to the IGN ON and OFF position. Then the ECM learns the smart key information automatically.

[In the case of installing new ECM]

Insert the key (or press the start button) and turn it to the IGN ON and OFF position. Then the ECM learns the smart key information automatically.

NOTICE

This ECM is a PCM type that includes a Transaxle Control Module (TCM).

Therefore TCM must be performed TCM learning procedure after replacing or re-installing a TCM.

(Refer to Automatic Transaxle System - "Automatic Transaxle Control System")

1. Installation is reverse of removal.

ECM installation nut:

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

ECM installation screw:

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

ECM bracket installation bolt/nut:

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

ECM Problem Inspection Procedure

1. TEST ECM GROUND CIRCUIT: Measure resistance between ECM and chassis ground using the backside of ECM harness connector as ECM side check point. If the problem is found, repair it.

Specification: Below 1Ω

2. TEST ECM CONNECTOR: Disconnect the ECM connector and visually check the ground terminals on ECM side and harness side for bent pins or poor contact pressure. If the problem is found, repair it.
3. If problem is not found in Step 1 and 2, the ECM could be faulty. If so, replace the ECM with a new one, and then check the vehicle again. If the vehicle operates normally then the problem was likely with the ECM.
4. RE-TEST THE ORIGINAL ECM: Install the original ECM (may be broken) into a known-good vehicle and check the vehicle. If the problem occurs again, replace the original ECM with a new one. If problem does not occur, this is intermittent problem.
(Refer to "Intermittent Problem Inspection Procedure" in Basic Inspection Procedure)

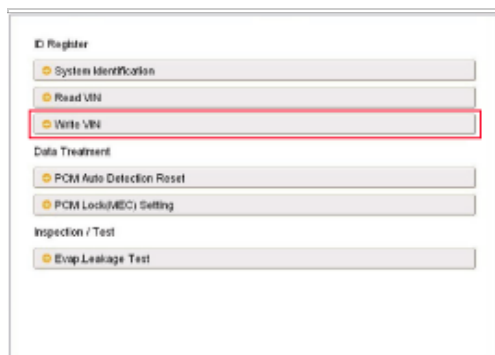
VIN Programming Procedure

VIN (Vehicle Identification Number) is a number that has the vehicle's information (Maker, Vehicle Type, Vehicle Line/Series, Body Type, Engine Type, Transmission Type, Model Year, Plant Location and so forth. For more information, please refer to the group "GI" in this SERVICE MANUAL). When replacing an ECM, the VIN must be programmed in the ECM. If there is no VIN in ECM memory, the fault code (DTC P0630) is set.

CAUTION

The programmed VIN cannot be changed. When writing the VIN, confirm the VIN carefully

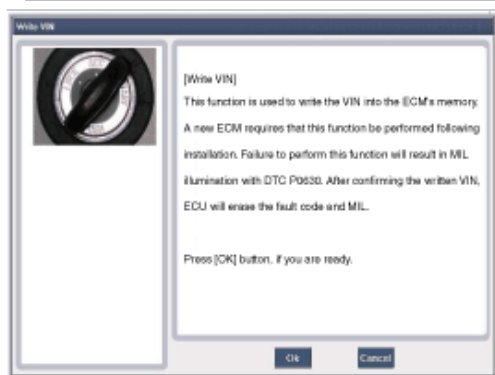
1. Select "VIN Writing" function in "Vehicle S/W Management".
2. Select "Write VIN" in "ID Register".



3. Input the VIN.

⚠ WARNING

Before inputting the VIN, confirm the VIN again because the programmed VIN cannot be changed.



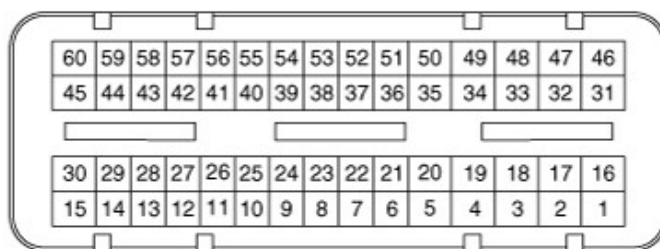
4. Turn the ignition switch OFF, then back ON.

Engine Control/Fuel System



IDB terminal and Inoutput

Harness Connector



E100-IDB

IDB terminal function

Connector [E100-IDB]

Pin No.	Description	Connected to
1	-	
2	-	
3	-	
4	-	
5	-	
6	-	
7	-	
8	-	
9	-	

10	-	
11	-	
12	-	
13	-	
14	-	
15	-	
16	Injector (Cylinder #3) [Low] control output	Injector (Cylinder #3)
17	Injector (Cylinder #6) [Low] control output	Injector (Cylinder #6)
18	Injector (Cylinder #6) [High] control output	Injector (Cylinder #6)
19	Injector (Cylinder #2) [Low] control output	Injector (Cylinder #2)
20	Injector (Cylinder #5) [Low] control output	Injector (Cylinder #5)
21	-	
22	Injector (Cylinder #2) signal input	Engine Control Module (ECM)
23	Injector (Cylinder #5) signal input	Engine Control Module (ECM)
24	-	
25	Fuel Pressure Control Valve (FPRV) logic input	Engine Control Module (ECM)
26	CCP-CAN [Low]	Other control module, Data Link Connector (DLC), Multi-purpose check connector
27	CCP-CAN [High]	Other control module, Data Link Connector (DLC), Multi-purpose check connector
28	Battery power (B+)	Ignition switch
29	Battery power (B+)	Main relay
30	Battery power (B+)	Main relay
31	Injector (Cylinder #4) [High] control output	Injector (Cylinder #4)
32	Injector (Cylinder #1) [High] control output	Injector (Cylinder #1)
33	Injector (Cylinder #3) [High] control output	Injector (Cylinder #3)
34	Injector (Cylinder #2) [High] control output	Injector (Cylinder #2)
35	Injector (Cylinder #5) [High] control output	Injector (Cylinder #5)
36	-	
37	-	
38	Injector (Cylinder #3) signal input	Engine Control Module (ECM)
39	-	
40	Injector (Cylinder #6) signal input	Engine Control Module (ECM)
41	Injector (Cylinder #4) signal input	Engine Control Module (ECM)
42	Battery power (B+)	Ignition switch
43	Battery power (B+)	Main relay
44	Battery power (B+)	Main relay
45	Fuel Pressure Control Valve (FPRV) [High] control output	Fuel Pressure Control Valve (FPRV)
46	Injector (Cylinder #4) [Low] control output	Injector (Cylinder #4)
47	Injector (Cylinder #1) [Low] control output	Injector (Cylinder #1)
48	ECM ground	Chassis ground
49	ECM ground	Chassis ground
50	ECM ground	Chassis ground
51	-	
52	ECM ground	Chassis ground
53	ECM ground	Chassis ground
54	-	
55	Injector (Cylinder #1) signal input	Engine Control Module (ECM)
56	-	
57	-	
58	-	
59	Battery power (B+)	Main relay
60	Fuel Pressure Control Valve (FPRV) [Low] control output	Fuel Pressure Control Valve (FPRV)

IDB Terminal input/output signal

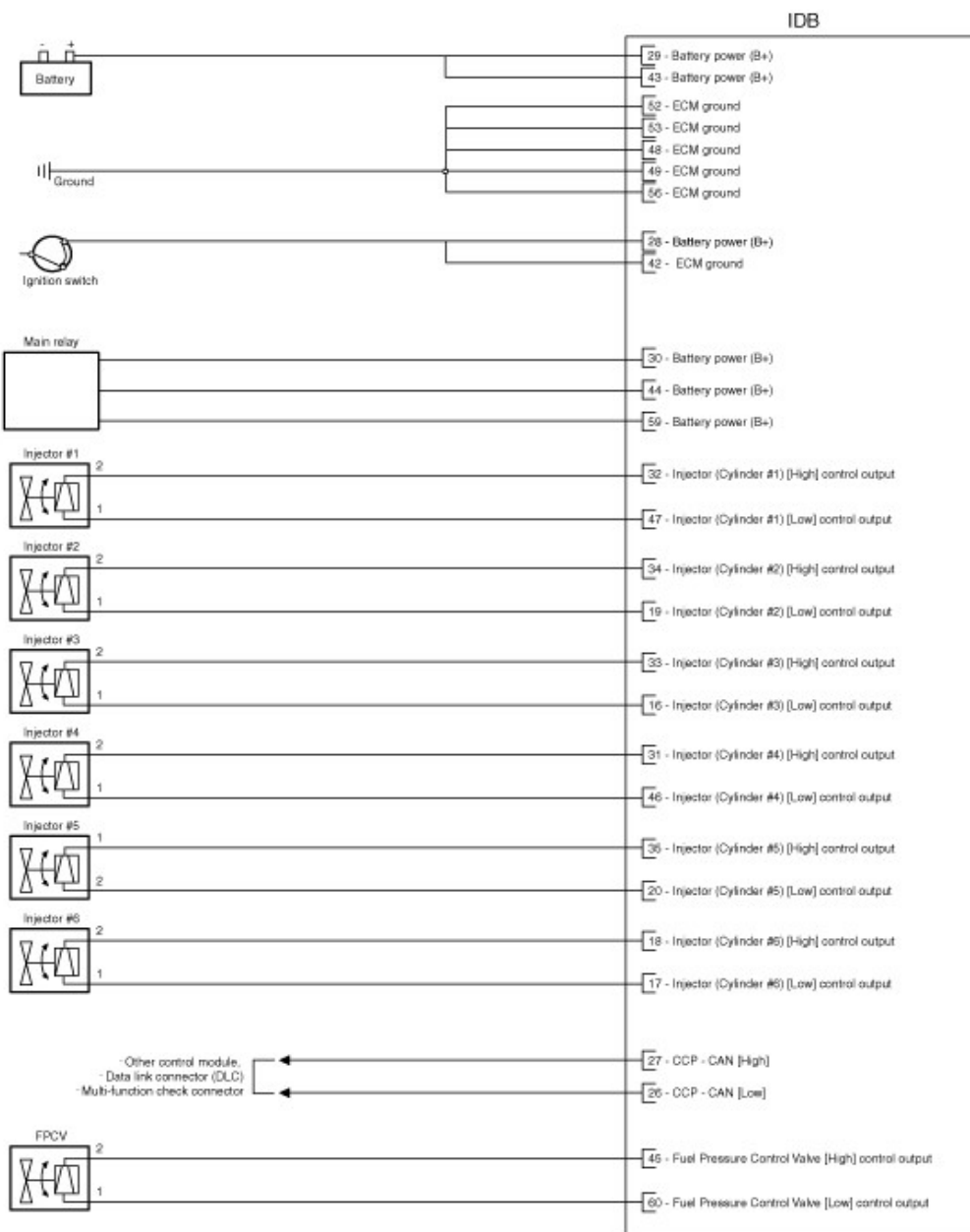
Connector [E100-IDB]

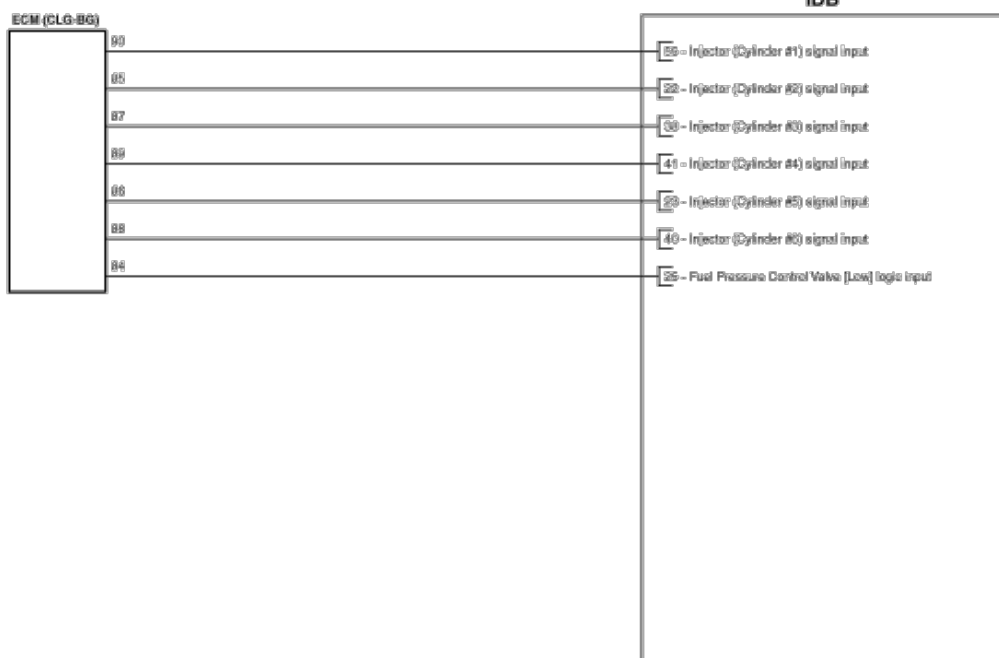
Pin No.	Description	Condition	Type	Level
---------	-------------	-----------	------	-------

1	-			
2	-			
3	-			
4	-			
5	-			
6	-			
7	-			
8	-			
9	-			
10	-			
11	-			
12	-			
13	-			
14	-			
15	-			
16	Injector (Cylinder #3) [Low] control output	Idle	Pulse	High: Battery voltage
		Relay ON		Low: Max. 1.0V
17	Injector (Cylinder #6) [Low] control output	Idle	Pulse	High: Battery voltage
		Relay ON		Low: Max. 1.0V
18	Injector (Cylinder #6) [High] control output	Idle	Pulse	High: Battery voltage ~ 80V
		Relay ON		Low: Battery voltage
19	Injector (Cylinder #2) [Low] control output	Idle	Pulse	High: Battery voltage
		Relay ON		Low: Max. 1.0V
20	Injector (Cylinder #5) [Low] control output	Idle	Pulse	High: Battery voltage
		Relay ON		Low: Max. 1.0V
21	-			
22	Injector (Cylinder #2) signal input	Idle	Pulse	High: Battery voltage
				Low: Max. 1.0V
23	Injector (Cylinder #5) signal input	Idle	Pulse	High: Battery voltage
				Low: Max. 1.0V
24	-			
25	Fuel Pressure Control Valve (FPRV) logic input			
26	CCP-CAN [Low]	Recessive	Pulse	2.0 ~ 3.0V
		Dominant		2.75 ~ 4.5V
27	CCP-CAN [High]	Recessive	Pulse	2.0 ~ 3.0V
		Dominant		2.75 ~ 4.5V
28	Battery power (B+)	IG OFF	DC voltage	Max. 0.5V
		IG ON		Battery voltage
29	Battery power (B+)	IG OFF	DC voltage	Max. 0.5V
		IG ON		Battery voltage
30	Battery power (B+)	IG OFF	DC voltage	Max. 0.5V
		IG ON		Battery voltage
31	Injector (Cylinder #4) [High] control output	Idle	Pulse	High: Battery voltage ~ 80V
		Relay ON		Low: Battery voltage
32	Injector (Cylinder #1) [High] control output	Idle	Pulse	High: Battery voltage ~ 80V
		Relay ON		Low: Battery voltage
33	Injector (Cylinder #3) [High] control output	Idle	Pulse	High: Battery voltage ~ 80V
		Relay ON		Low: Battery voltage
34	Injector (Cylinder #2) [High] control output	Idle	Pulse	High: Battery voltage ~ 80V
		Relay ON		Low: Battery voltage
35	Injector (Cylinder #5) [High] control output	Idle	Pulse	High: Battery voltage ~ 80V
		Relay ON		Low: Battery voltage
36	-			
37	-			
38	Injector (Cylinder #3) signal input	Idle	Pulse	High: Battery voltage
				Low: Max. 1.0V
39	-			

40	Injector (Cylinder #6) signal input	Idle	Pulse	High: Battery voltage Low: Max. 1.0V
41	Injector (Cylinder #4) signal input	Idle	Pulse	High: Battery voltage Low: Max. 1.0V
42	Battery power (B+)	IG OFF	DC voltage	Max. 0.5V
		IG ON		Battery voltage
43	Battery power (B+)	IG OFF	DC voltage	Max. 0.5V
		IG ON		Battery voltage
44	Battery power (B+)	IG OFF	DC voltage	Max. 0.5V
		IG ON		Battery voltage
45	Fuel Pressure Control Valve (FPRV) [High] control output	Idle	DC voltage	Battery voltage Max. 1.0V
46	Injector (Cylinder #4) [Low] control output	Idle	Pulse	High: Battery voltage
		Relay ON		Low: Max. 1.0V
47	Injector (Cylinder #1) [Low] control output	Idle	Pulse	High: Battery voltage
		Relay ON		Low: Max. 1.0V
48	ECM ground	Idle	DC voltage	Max. 50mV
49	ECM ground	Idle	DC voltage	Max. 50mV
50	ECM ground	Idle	DC voltage	Max. 50mV
51	-			
52	ECM ground	Idle	DC voltage	Max. 50mV
53	ECM ground	Idle	DC voltage	Max. 50mV
54	-			
55	Injector (Cylinder #1) signal input	Idle	Pulse	High: Battery voltage Low: Max. 1.0V
56	-			
57	-			
58	-			
59	Battery power (B+)	IG OFF	DC voltage	Max. 0.5V
		IG ON		Battery voltage
60	Fuel Pressure Control Valve (FPRV) [Low] control output	Idle	DC voltage	Battery voltage Max. 1.0V

Circuit Diagram



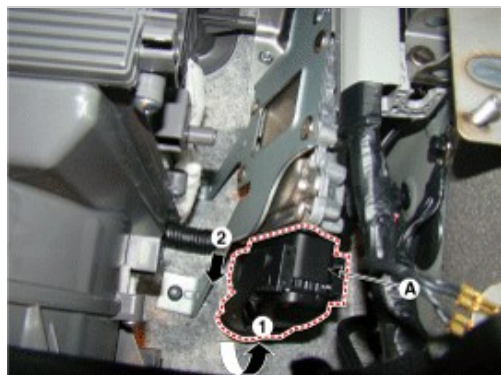


Engine Control/Fuel System



Removal

1. Turn the ignition switch off and disconnect the battery negative (-) cable.
2. Remove the glove box housing.
(Refer to Body - "Glove Box Housing")
3. Disconnect the injector drive box (IDB) connector (A).



4. Remove the IDB bracket assembly (A) after removing the bolt and nuts.



Installation

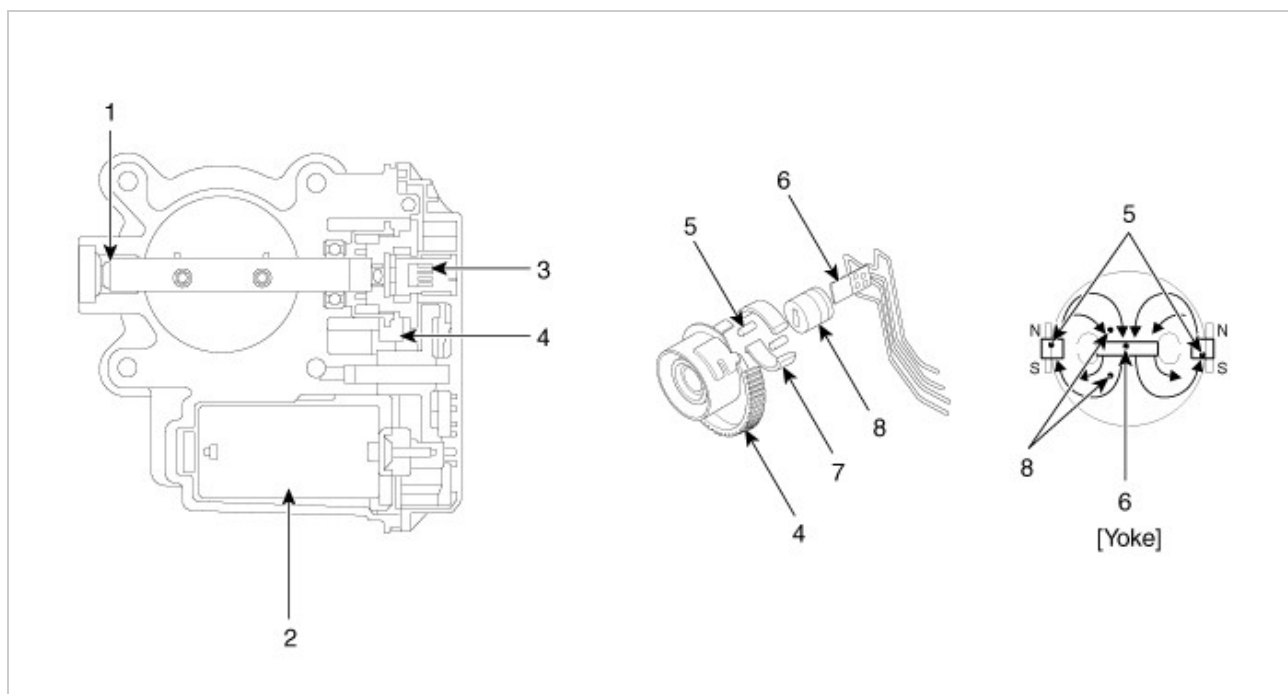
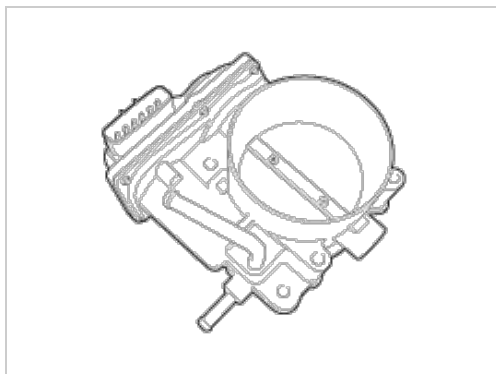
1. Install in the reverse order of removal.

IDB bracket installation bolt/nut :



Description

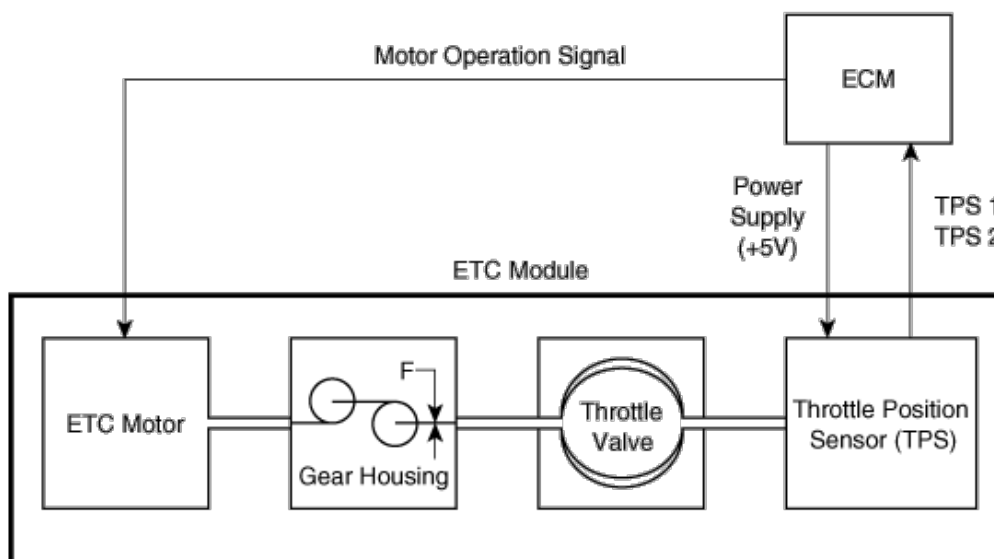
The Electronic Throttle Control (ETC) System consists of a throttle body with an integrated control motor and throttle position sensor (TPS). Instead of the traditional throttle cable, an Accelerator Position Sensor (APS) is used to receive driver input. The ECM uses the APS signal to calculate the target throttle angle; the position of the throttle is then adjusted via ECM control of the ETC motor. The TPS signal is used to provide feedback regarding throttle position to the ECM. Using ETC, precise control over throttle position is possible; the need for external cruise control modules/cables is eliminated.



1. Dry bearing
2. DC motor
3. Non-contact hall sensor
4. Gear

5. Magnet
6. Hall IC
7. Yoke
8. Stator

Schematic Diagram



Engine Control/Fuel System



Fail-Safe Mode

Item	Fail-Safe	
ETC Motor	Throttle valve stuck at 7°	
TPS	TPS 1 fault	ECM looks at TPS2
	TPS 2 fault	ECM looks at TPS1
	TPS 1,2 fault	Throttle valve stuck at 7°
APS	APS 1 fault	ECM looks at APS 2
	APS 2 fault	ECM looks at APS 1
	APS 1,2 fault	Engine idle state

NOTICE

When throttle value is stuck at 7°, engine speed is limited at below 1,500rpm and vehicle speed at maximum 40 ~ 50 km/h (25 ~ 31 mph)

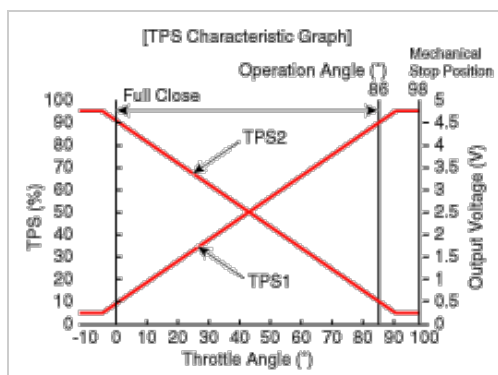
Engine Control/Fuel System



Specification

[Throttle Position Sensor (TPS)]

Throttle angle(°)	Output Voltage (V)	
	TPS1	TPS2
0	0.5	4.5
10	0.96	4.05
20	1.41	3.59
30	1.87	3.14
40	2.32	2.68
50	2.78	2.23
60	3.23	1.77
70	3.69	1.32
80	4.14	0.86
90	4.6	0.41
98	4.65	0.35
C.T (0)	0.5	4.5
W.O.T (86)	4.41	0.59



[ETC Motor]

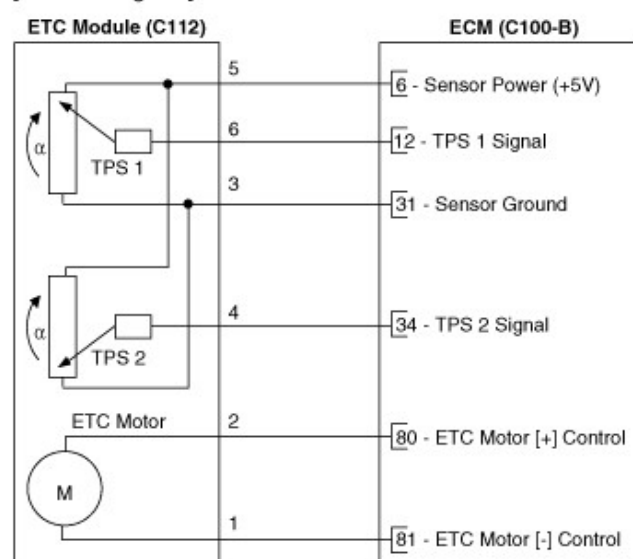
Item	Specification
Coil Resistance (Ω)	0.3 ~100 [20°C(68°F)]

Engine Control/Fuel System



Circuit Diagram

[Circuit Diagram]



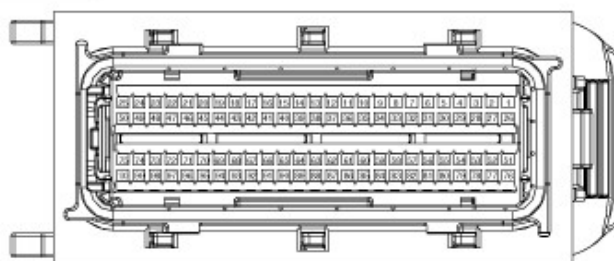
[Connection Information]

Terminal	Connected to	Function
1	ECM C100-B (81)	ETC Motor [-] Control
2	ECM C100-B (80)	ETC Motor [+] Control
3	ECM C100-B (31)	Sensor Ground
4	ECM C100-B (34)	TPS 2 Signal
5	ECM C100-B (6)	Sensor Power (+5V)
6	ECM C100-B (12)	TPS 1 Signal

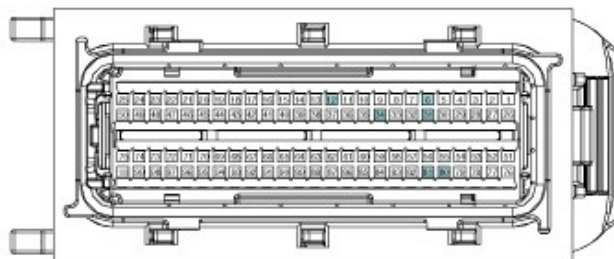
[Harness Connector]



C112
ETC Module



E100-A



C100-B

Engine Control/Fuel System



Inspection

Throttle Position Sensor (TPS)

1. Connect the GDS on the Data Link Connector (DLC).
2. Start the engine and measure the output voltage of TPS 1 and 2 at C.T. and W.O.T.

Throttle angle(°)	Output Voltage (V)	
	TPS1	TPS2
C.T	0.5	4.5
W.O.T	4.41	0.59

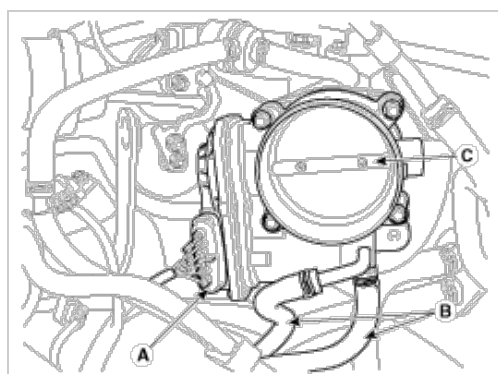
ETC Motor

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

Specification: Refer to "Specification"

Removal

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Remove the air intake hose.
(Refer to Engine Mechanical System - "Air Cleaner")
3. Disconnect the ETC module connector (A).
4. Disconnect the coolant hoses (B).
5. Remove the installation bolts, and then remove the ETC module (C) from the engine.



Installation

CAUTION

- Install the component with the specified torques.
- Note that internal damage may occur when the component is dropped. If the component has been dropped, inspect before installing.

1. Installation is reverse of removal.

Electronic throttle body Installation bolt:

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

Adjustment

ETC module learning procedure

When installing new ETC module or re-installing it, ETC module learning procedure must be performed.

1. Hold the ignition key or the start button at the IG ON position during 5 seconds.
2. Turn ignition switch OFF and then start the engine.

CAUTION

DTC codes (P0638, P2110) might be displayed if ETC module learning procedure does not performed after replacing ETC module.

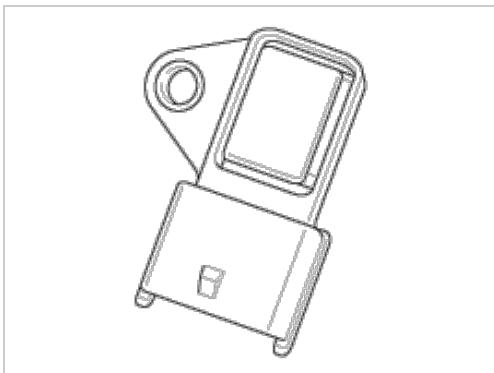
Engine Control/Fuel System



Description

Barometric Pressure Sensor (BPS) is a speed-density type sensor and is installed on the air cleaner assembly. It senses absolute pressure of the air cleaner assembly and transfers the analog signal proportional to the pressure to the ECM. By using this signal, the ECM calculates the intake air quantity and engine speed.

The BPS consists of a piezo-electric element and a hybrid IC amplifying the element output signal. The element is silicon diaphragm type and adapts pressure sensitive variable resistor effect of semi-conductor. Because 100% vacuum and the manifold pressure apply to both sides of the sensor respectively, this sensor can output analog signal by using the silicon variation proportional to pressure change.

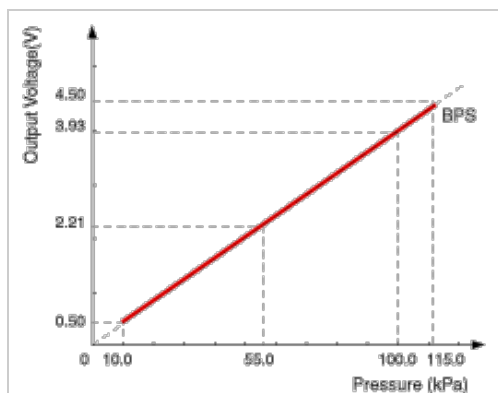


Engine Control/Fuel System



Specification

Pressure [kPa (kgf/cm ² , psi)]	Output Voltage (V)
10.0 (0.01, 0.15)	0.50
55.0 (0.56, 7.98)	2.21
100.0 (1.01, 14.5)	3.93
115.0 (1.17, 16.9)	4.50



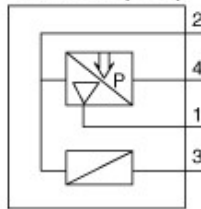
Engine Control/Fuel System



Circuit Diagram

[Circuit Diagram]

BPS & IATS (C132)



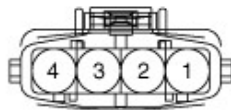
ECM (C100-B)

48 - Sensor Power (+5V)
56 - Sensor Ground
9 - BPS Signal
14 - IATS Signal

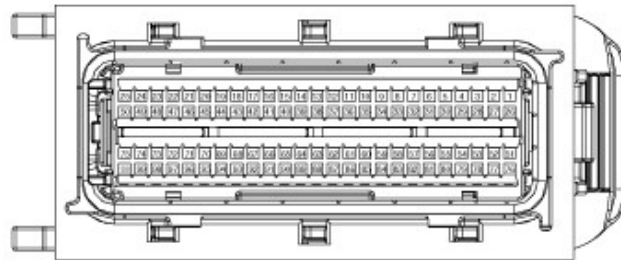
[Connection Information]

Terminal	Connected to	Function
1	ECM C100-B (9)	BPS Signal
2	ECM C100-B (48)	Sensor Power (+5V)
3	ECM C100-B (14)	IATS Signal
4	ECM C100-B (56)	Sensor Ground

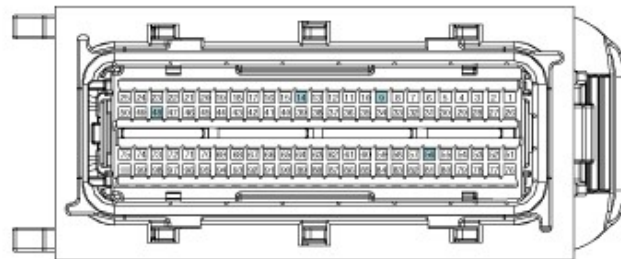
[Harness Connector]



**C132
BPS & IATS**



E100-A



C100-B

Engine Control/Fuel System



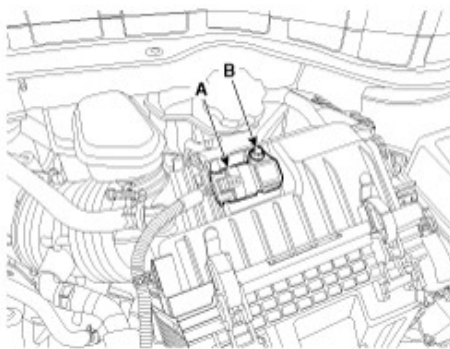
Inspection

1. Connect the GDS on the Data Link Connector (DLC).
2. Measure the output voltage of the BPS at idle and IG ON.

Specification: Refer to "Specification"

Removal

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Disconnect the barometric pressure sensor connector (A).
3. Remove the installation bolt (B), and then remove the sensor from the air cleaner assembly.



Installation

CAUTION

- Install the component with the specified torques.
-

Note that internal damage may occur when the component is dropped. If the component has been dropped, inspect before installing.

⚠ CAUTION

- Insert the sensor in the installation hole and be careful not to damage when installation.

1. Installation is reverse of removal.

Barometric pressure sensor installation bolt:

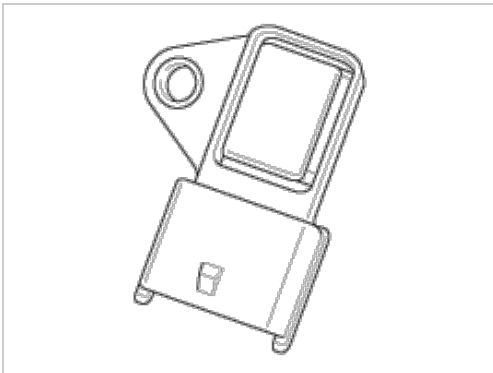
3.9 ~ 5.9 N.m (0.4 ~ 0.6 kgf.m, 2.9 ~ 4.3 lb-ft)

Engine Control/Fuel System



Description

Intake Air Temperature Sensor (IATS) is included inside Barometric Pressure Sensor (BPS) 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 ECM uses not only BPS signal but also IATS signal. This sensor has a Negative Temperature Coefficient (NTC) thermistor and its resistance changes in reverse proportion to the temperature.



Engine Control/Fuel System



Specification

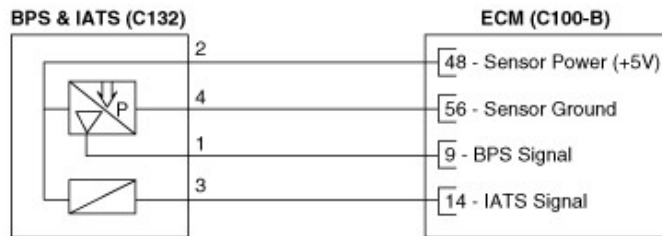
Temperature		Resistance (kΩ)
°C	°F	
-40	-40	40.93 ~ 48.35
-20	-4	13.89 ~ 16.03
0	32	5.38 ~ 6.09
10	50	3.48 ~ 3.90
20	68	2.31 ~ 2.57
40	104	1.08 ~ 1.21
60	140	0.54 ~ 0.66
80	176	0.29 ~ 0.34

Engine Control/Fuel System



Circuit Diagram

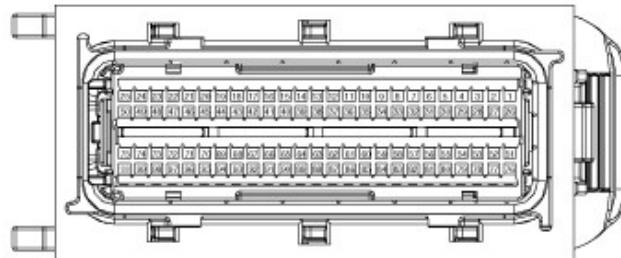
[Circuit Diagram]



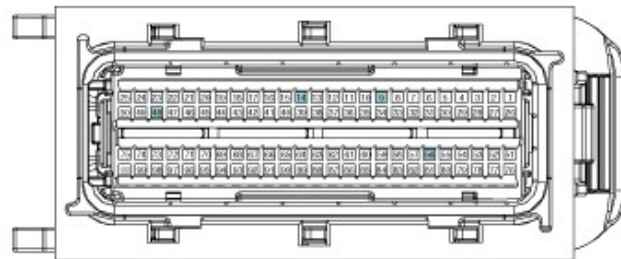
[Connection Information]

Terminal	Connected to	Function
1	ECM C100-B (9)	BPS Signal
2	ECM C100-B (48)	Sensor Power (+5V)
3	ECM C100-B (14)	IATS Signal
4	ECM C100-B (56)	Sensor Ground

[Harness Connector]



E100-A



C100-B

Engine Control/Fuel System

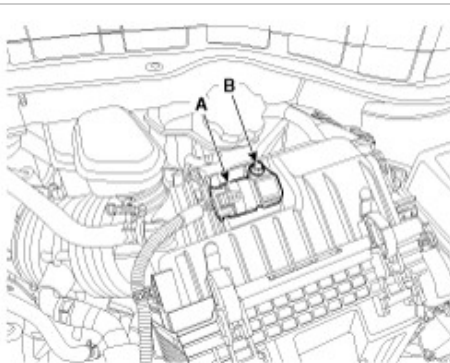
Inspection

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

Specification: Refer to "Specification"

Removal

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Disconnect the intake air temperature sensor connector (A).
3. Remove the installation bolts (B), and then vertically remove the sensor from the air cleaner assembly.



Installation

CAUTION

- Install the component with the specified torques.
- Note that internal damage may occur when the component is dropped. If the component has been dropped, inspect before installing.

CAUTION

- Insert the sensor in the installation hole and be careful not to damage when installation.

1. Installation is reverse of removal.

Intake air temperature sensor:

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

Engine Control/Fuel System



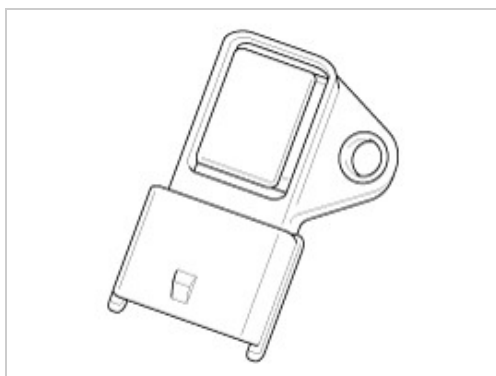
Description

Manifold Absolute Pressure Sensor (MAPS) is a speed-density type sensor and is installed on the surge tank. It senses absolute pressure of the surge tank and transfers the analog signal proportional to the pressure to the ECM.

By using this signal, the ECM calculates the intake air quantity and engine speed.

The MAPS consists of a piezo-electric element and a hybrid IC amplifying the element output signal. The element is silicon diaphragm type and adapts pressure sensitive variable resistor effect of semi-conductor.

Because 100% vacuum and the manifold pressure apply to both sides of the sensor respectively, this sensor can output analog signal by using the silicon variation proportional to pressure change.

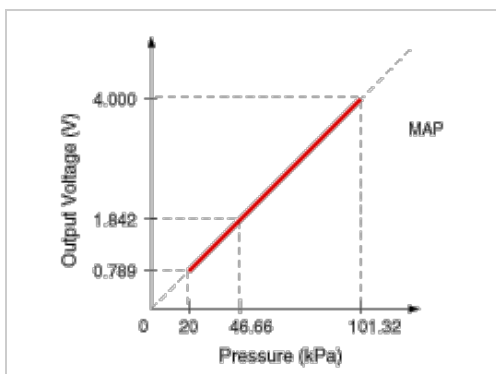


Engine Control/Fuel System



Specification

Pressure [kPa (kgf/cm ² , psi)]	Output Voltage (V)
20.0 (0.20, 2.90)	0.79
46.66 (0.47, 6.77)	1.84
101.32 (1.03, 14.7)	4.0

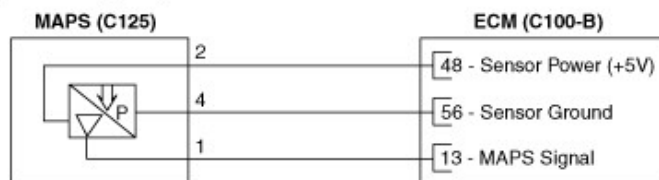


Engine Control/Fuel System



Circuit Diagram

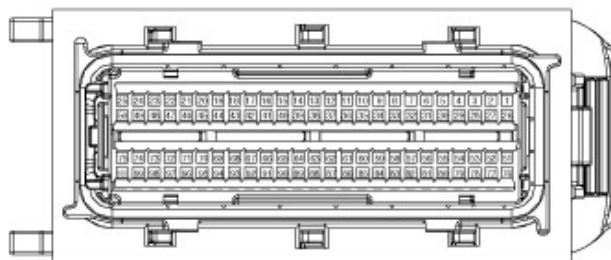
[Circuit Diagram]



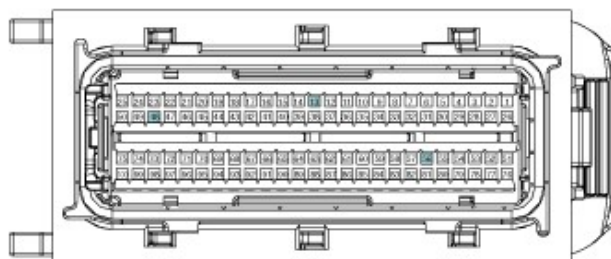
[Connection Information]

Terminal	Connected to	Function
1	ECM C100-B (13)	MAPS Signal
2	ECM C100-B (48)	Sensor Power (+5V)
3	-	-
4	ECM C100-B (56)	Sensor Ground

[Harness Connector]



E100-A



C100-B

Engine Control/Fuel System



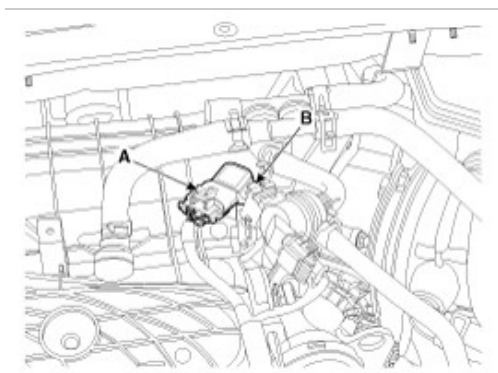
Inspection

1. Connect the GDS on the Data Link Connector (DLC).
2. Measure the output voltage of the MAPS at idle and IG ON.

Condition	Output Voltage (V)
IG ON	Approx. 4.44V
Idle	Approx. 0.75V

Removal

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Disconnect the manifold absolute pressure sensor connector (A).
3. Remove the installation bolt (B), and then vertically remove the sensor from the surge tank.



Installation

CAUTION

•

Install the component with the specified torques.

- Note that internal damage may occur when the component is dropped. If the component has been dropped, inspect before installing.

CAUTION

- Insert the sensor in the installation hole and be careful not to damage when installation.

1. Installation is reverse of removal.

Manifold absolute pressure sensor Installation bolt:

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

Engine Control/Fuel System

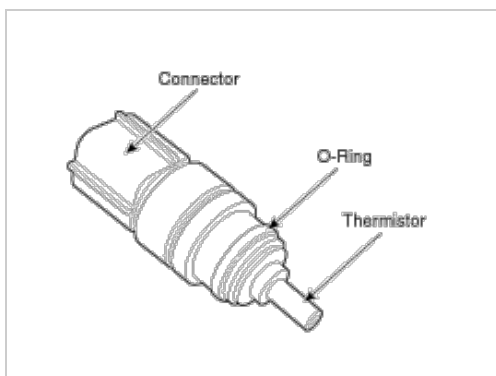


Description

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 +5V 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.ion duration and controls the ignition timing using the information of engine coolant temperature to avoid engine stalling and improve drivability.

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.



Engine Control/Fuel System



Specification

Temperature		Resistance (kΩ)
°C	°F	
-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

Engine Control/Fuel System



Circuit Diagram

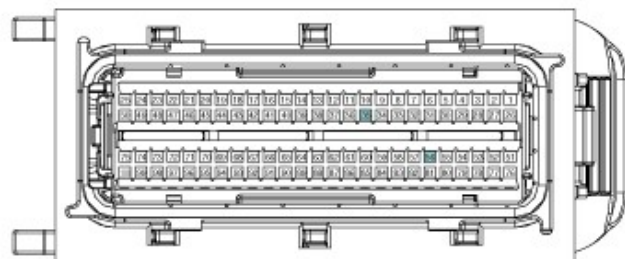
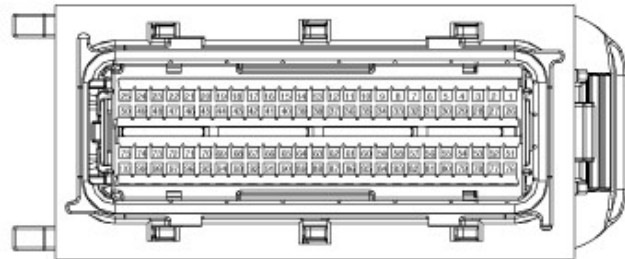
[Circuit Diagram]



[Connection Information]

Terminal	Connected to	Function
1	-	-
2	-	-
3	ECM C100-B (56)	Sensor Ground
4	ECM C100-B (35)	ECTS Signal

[Harness Connector]



Engine Control/Fuel System



Inspection

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

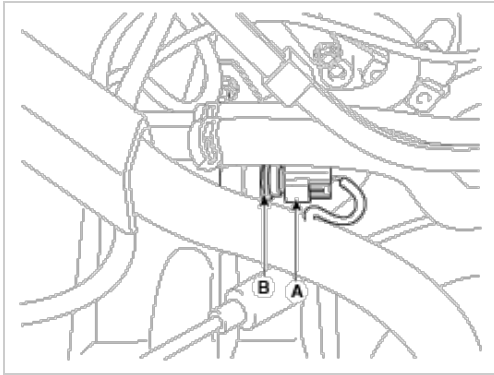
Specification: Refer to "Specification"

Removal

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Remove the air cleaner assembly.
(Refer to Engine Mechanical System - "Air Cleaner")
3. Disconnect the engine coolant temperature sensor connector (A).
4. Remove the spring clip (B), and then pull the sensor from the water temperature control assembly.

CAUTION

- Note that engine coolant may be flowed out from the water temperature control assembly when removing the sensor.



5. Supplement the engine coolant.
(Refer to Engine Mechanical System - "Coolant")

Installation

⚠ CAUTION

- Install the component with the specified torques.
- Note that internal damage may occur when the component is dropped. If the component has been dropped, inspect before installing.

⚠ CAUTION

- Apply the engine coolant to the O-ring.

⚠ CAUTION

- Insert the sensor in the installation hole and be careful not to damage when installation.

1. Installation is reverse of removal.

Engine coolant temperature sensor installation:

29.4 ~ 39.2 N.m (3.0 ~ 4.0 kgf.m, 21.7 ~ 28.9 lb-ft)

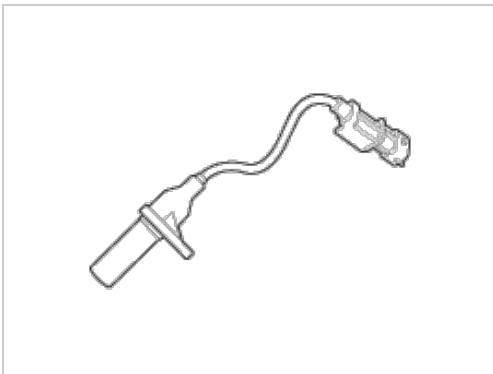
Engine Control/Fuel System



Description

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, the engine may stop because of CKPS signal missing. This sensor is installed on the cylinder block or the 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).



Engine Control/Fuel System



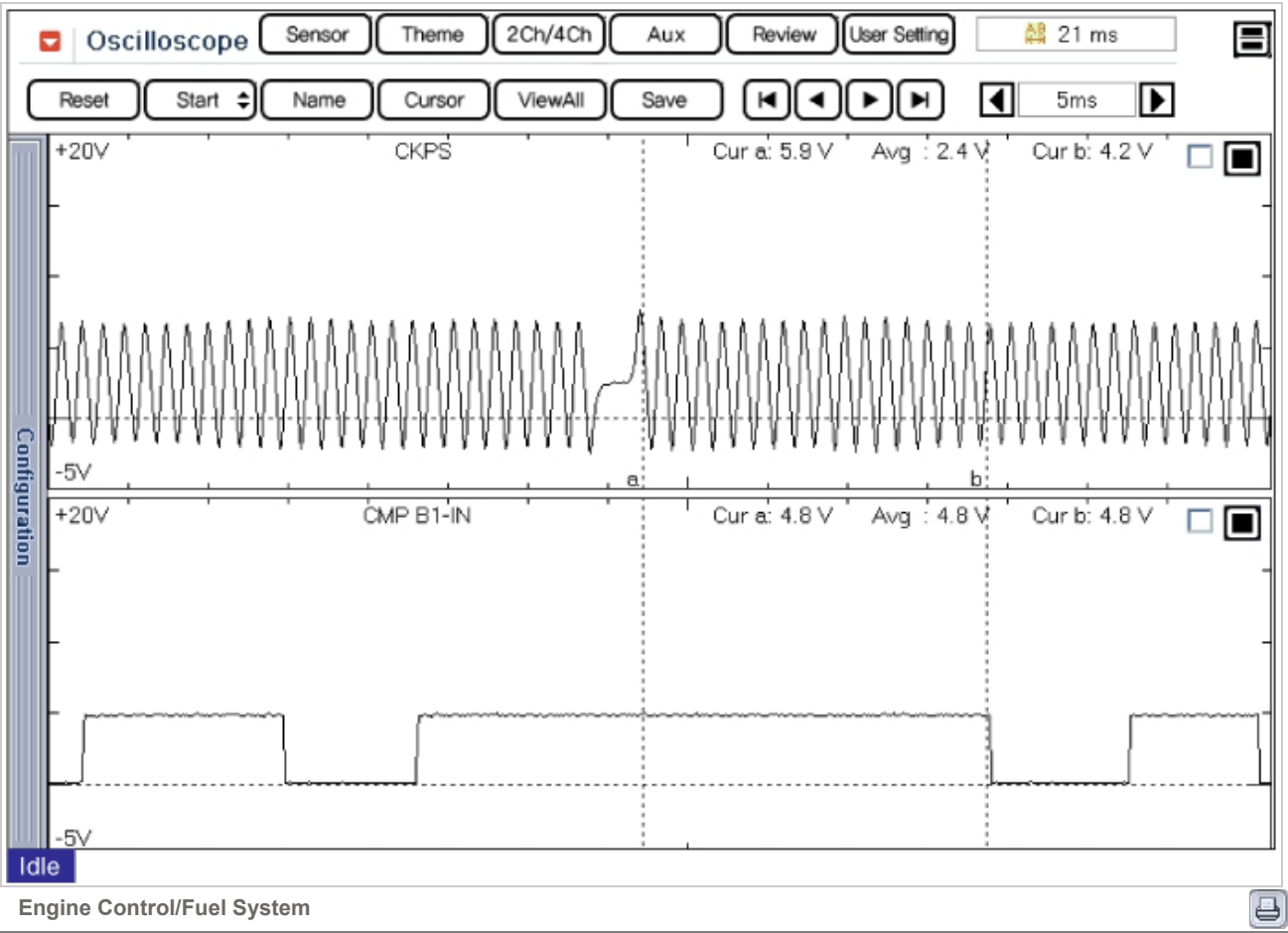
Specification

Item	Specification
Coil Resistance (Ω)	774 ~ 946 [20°C(68°F)]
Air Gap (mm)	0.5 ~ 1.5

Engine Control/Fuel System

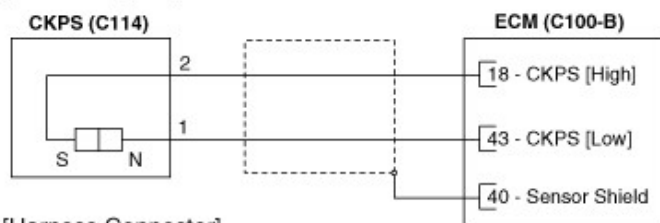


Signal Waveform



Circuit Diagram

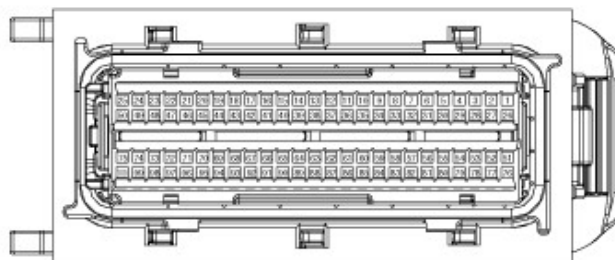
[Circuit Diagram]



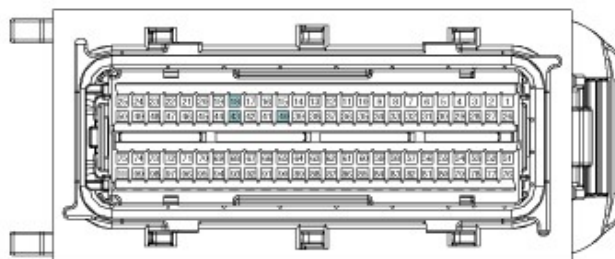
[Connection Information]

Terminal	Connected to	Function
1	ECM C100-B (43)	CKPS [Low] Signal
2	ECM C100-B (18)	CKPS [High] Signal

[Harness Connector]



E100-A



C100-B

Engine Control/Fuel System

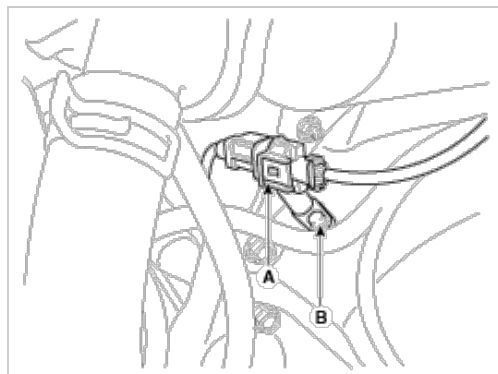
Inspection

1. Check the signal waveform of the CMPS and CKPS using the GDS.

Specification: Refer to "Wave Form"

Removal

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Remove the air cleaner assembly.
(Refer to Engine Mechanical System - "Air Cleaner")
3. Disconnect the crankshaft position sensor connector (A).
4. Remove the installation bolt (B), and then vertically remove the sensor from the transaxle housing.



Installation

CAUTION

- Install the component with the specified torques.
-

Note that internal damage may occur when the component is dropped. If the component has been dropped, inspect before installing.

CAUTION

- Apply the engine oil to the O-ring.

CAUTION

- Insert the sensor in the installation hole and be careful not to damage when installation.

1. Installation is reverse of removal.

Crankshaft position sensor installation bolt:

6.9 ~ 9.8 N.m (0.7 ~ 1.0 kgf.m, 5.1 ~ 7.2 lb-ft)

Engine Control/Fuel System



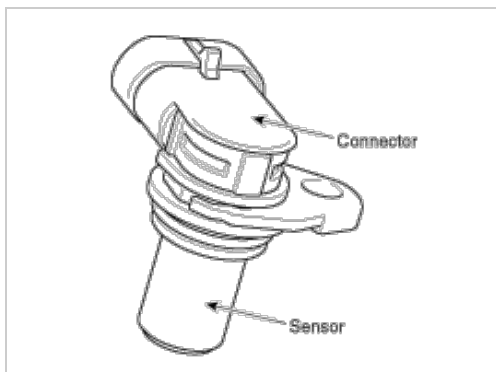
Description

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 two CMPS are installed on engine head cover of bank 1 and 2 respectively and uses a target wheel installed on the camshaft.

The Cam Position sensor is a hall-effect type sensor. As the target wheel passes the Hall sensor, the magnetic field changes in the sensor. The sensor then switches a signal which creates a square wave.



Engine Control/Fuel System



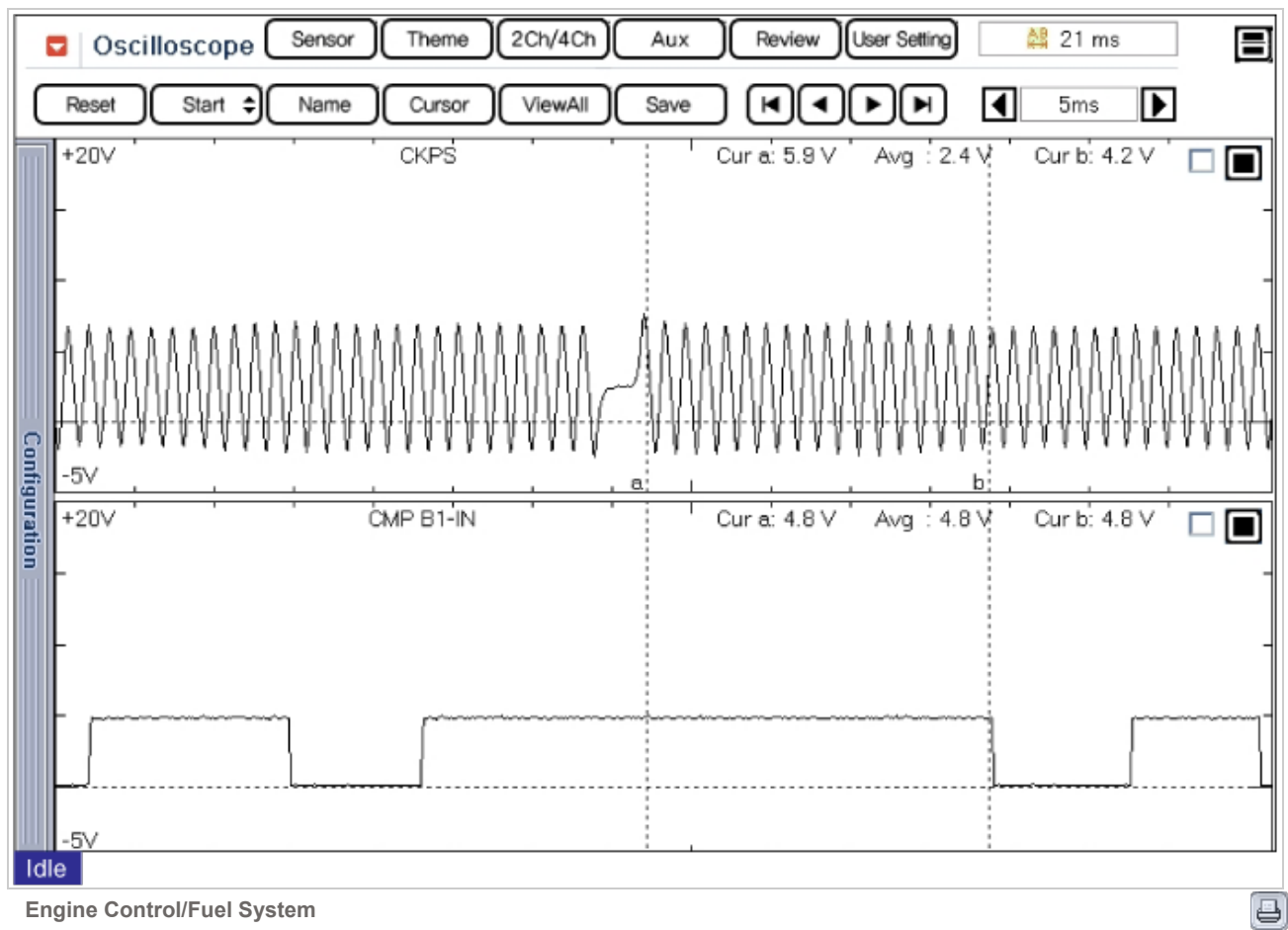
Specification

Item	Specification
Output Voltage (V)	High: 5.0V
	Low: 0.7V
Air Gap (mm)	0.5 ~ 1.5

Engine Control/Fuel System

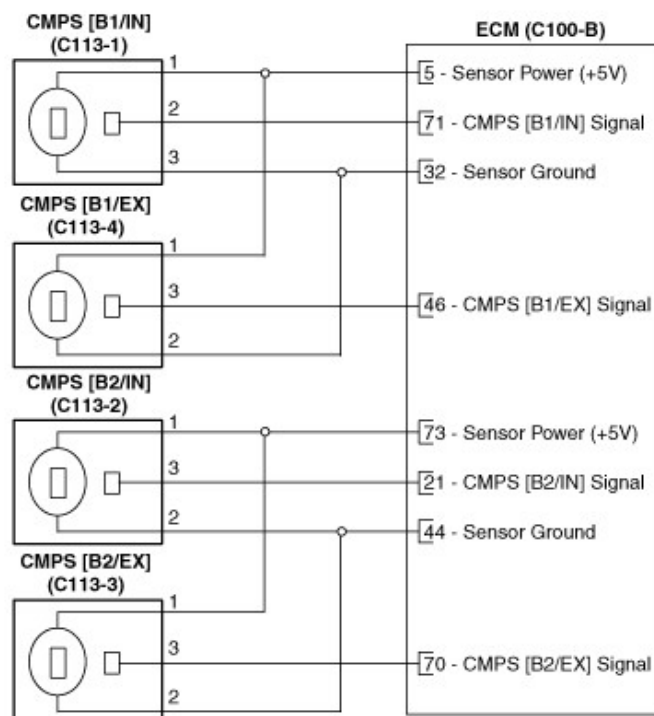


Signal Waveform



Circuit Diagram

[Circuit Diagram]



[Connection Information]

CMPS [BANK 1/INTAKE] (C113-1)

Terminal	Connected to	Function
1	ECM C100-B (5)	Sensor Power (+5V)
2	ECM C100-B (71)	CMPS [B1/IN] Signal
3	ECM C100-B (32)	Sensor Ground

CMPS [BANK 1/EXHAUST] (C113-4)

Terminal	Connected to	Function
1	ECM C100-B (5)	Sensor Power (+5V)
2	ECM C100-B (32)	Sensor Ground
3	ECM C100-B (46)	CMPS [B2/EX] Signal

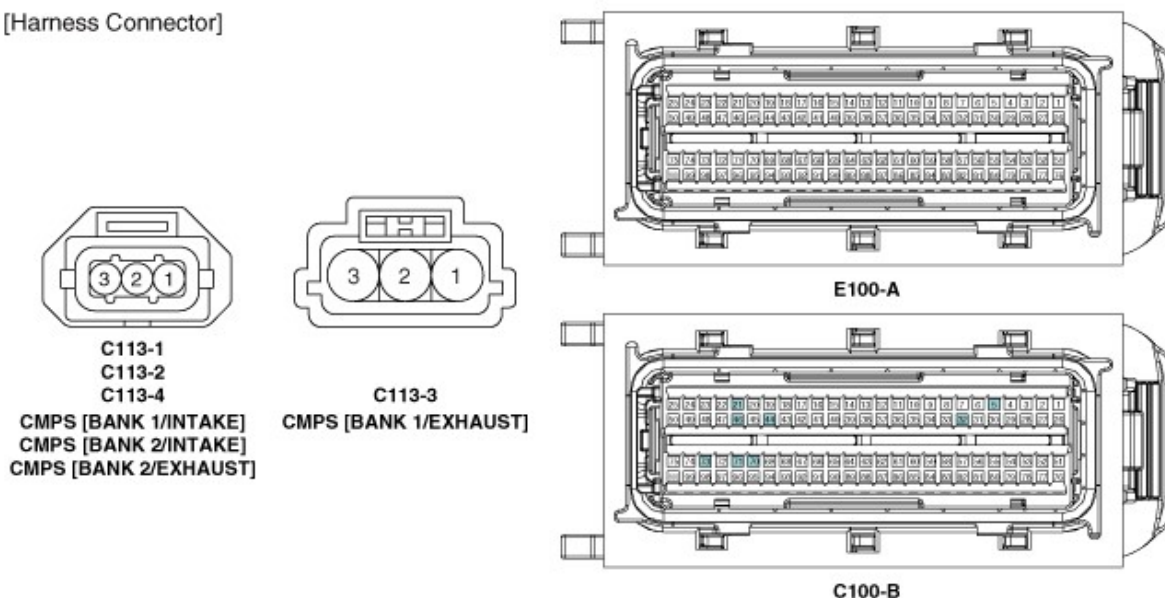
CMPS [BANK 2/INTAKE] (C113-2)

Terminal	Connected to	Function
1	ECM C100-B (73)	Sensor Power (+5V)
2	ECM C100-B (44)	Sensor Ground
3	ECM C100-B (21)	CMPS [B2/IN] Signal

CMPS [BANK 2/EXHAUST] (C113-3)

Terminal	Connected to	Function
1	ECM C100-B (73)	Sensor Power (+5V)
2	ECM C100-B (44)	Sensor Ground
3	ECM C100-B (70)	CMPS [B1/EX] Signal

[Harness Connector]



Engine Control/Fuel System



Inspection

1. Check the signal waveform of the CMPS and CKPS using the GDS.

Specification: Refer to "Wave Form"

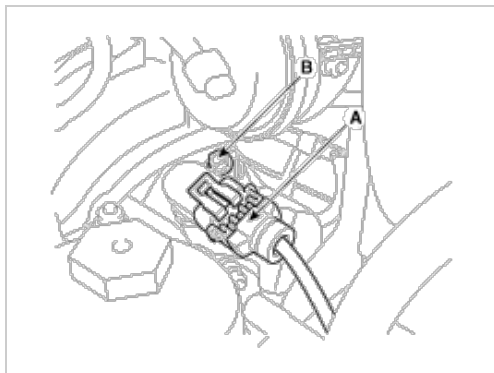
Removal

WARNING

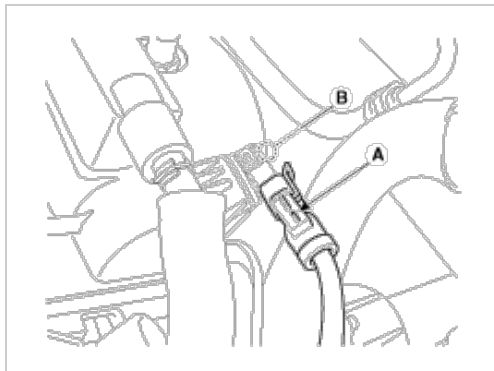
- DON'T remove the camshaft position sensor while the engine is running or right after engine is turned off. The part and engine oil is hot and can cause burns.

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Disconnect the camshaft position sensor connector (A).
3. Remove the installation bolt (B), and then vertically remove the sensor from the cylinder head.

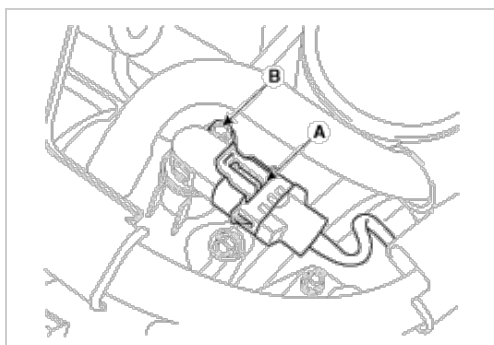
[Bank 1/Intake]



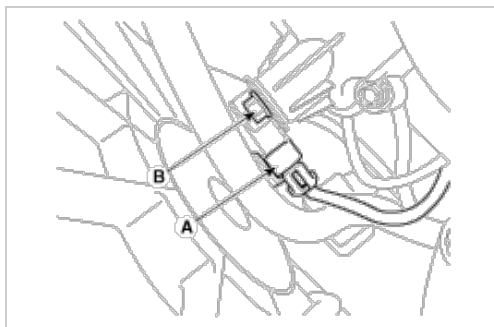
[Bank 1/Exhaust]



[Bank 2/Intake]



[Bank 2/Exhaust]



Installation

CAUTION

- Install the component with the specified torques.
- Note that internal damage may occur when the component is dropped. If the component has been dropped, inspect before installing.

CAUTION

- Apply the engine oil to the O-ring.

CAUTION

- Insert the sensor in the installation hole and be careful not to damage when installation.

CAUTION

- Be careful not to damage the sensor housing and the connector.
- Be careful not to damage the O-ring.

1. Installation is reverse of removal.

Camshaft position sensor installation bolt:

6.9 ~ 9.8N.m (0.7 ~ 1.0kgf.m, 5.1 ~ 7.2lb-ft)

Engine Control/Fuel System

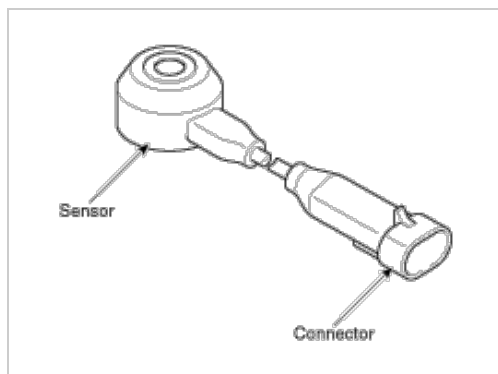


Description

Knocking is a phenomenon characterized by undesirable vibration and noise and can cause engine damage. The two Knock Sensor (KS) are installed inside the V-valley of the cylinder block and senses engine knocking.

When knocking occurs, the vibration from the cylinder block is applied as pressure to the piezoelectric element.

When a knock occurs, the sensor produces voltage signal. The ECM retards the ignition timing when knocking occurs. If the knocking disappears after retarding the ignition timing, the ECM will advance the ignition timing. This sequential control can improve engine power, torque and fuel economy.



Engine Control/Fuel System



Specification

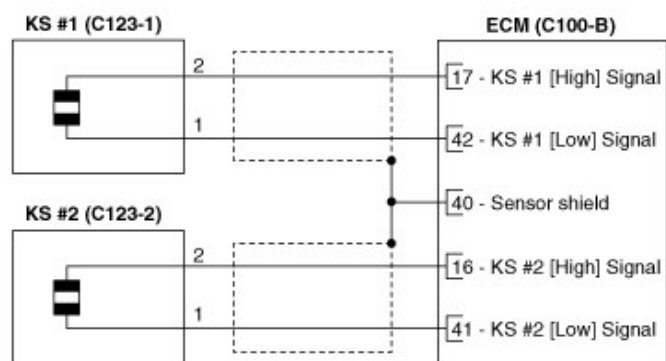
Item	Specification
Capacitance (pF)	950 ~ 1,350
Resistance (MΩ)	4.87

Engine Control/Fuel System



Circuit Diagram

[Circuit Diagram]



[Connection Information]

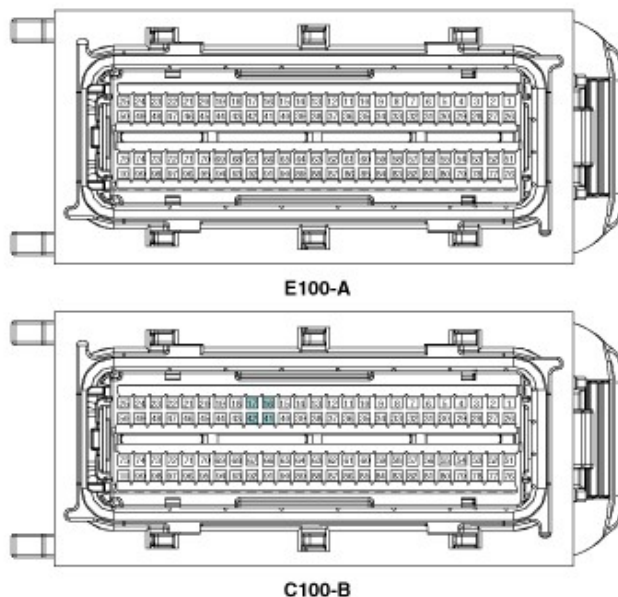
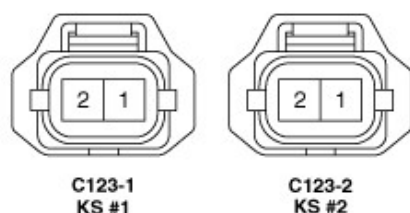
Knock Sensor #1 (C123-1)

Terminal	Connected to	Function
1	ECM C100-B (42)	KS #1 [Low] Signal
2	ECM C100-B (17)	KS #1 [High] Signal

Knock Sensor #2 (C123-2)

Terminal	Connected to	Function
1	ECM C100-B (41)	KS #2 [Low] Signal
2	ECM C100-B (16)	KS #2 [High] Signal

[Harness Connector]



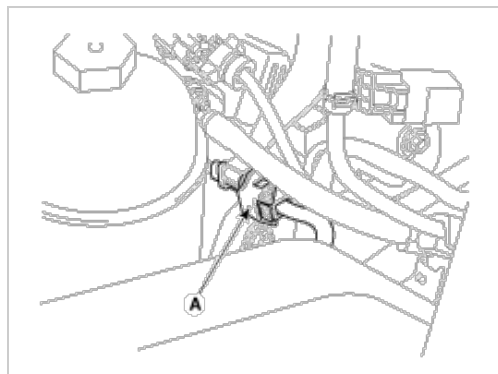
Engine Control/Fuel System



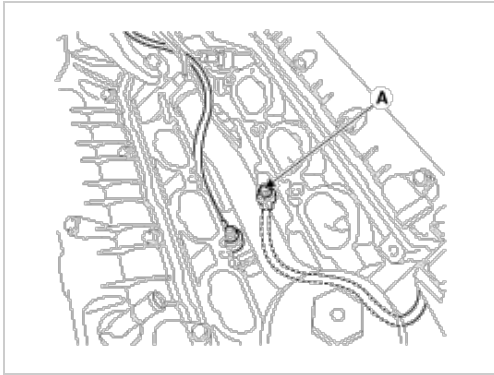
Removal

[Knock Sensor #1 (Bank 1)]

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Disconnect the knock sensor connector (A).

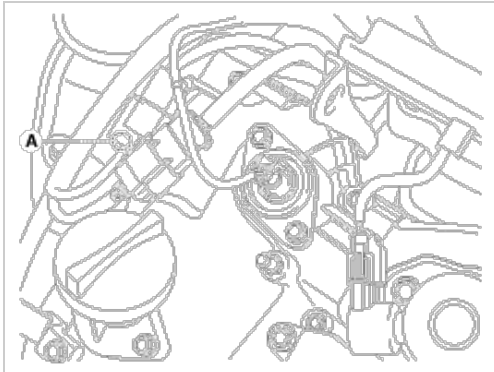


3. Remove the intake manifold.
(Refer to Engine Mechanical System - "Intake Manifold")
4. Remove the installation bolt (A), and then remove the sensor from the cylinder block.

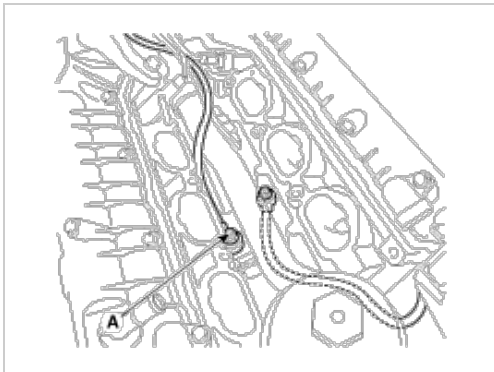


[Knock Sensor #2 (Bank 2)]

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Disconnect the knock sensor connector (A).



3. Remove the intake manifold.
(Refer to Engine Mechanical System - "Intake Manifold")
4. Remove the installation bolt (A), and then remove the sensor from the cylinder block.



Installation

⚠ CAUTION

- Install the component with the specified torques.
- Note that internal damage may occur when the component is dropped. In this case, use it after inspecting.

⚠ CAUTION

- The sensor connector must be installed parallel to the direction of the engine.

1. Installation is reverse of removal.

Knock sensor installation bolt:

15.7 ~ 23.5 N.m (1.6 ~ 2.4 kgf.m, 11.6 ~ 17.4 lb-ft)

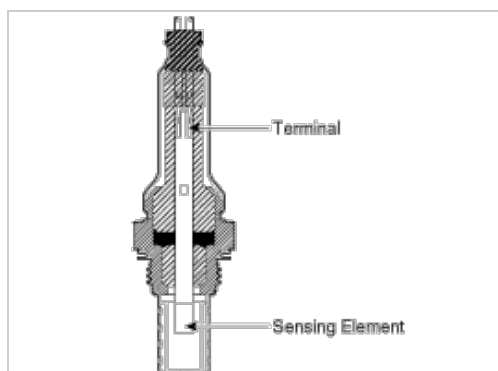


Description

Heated Oxygen Sensor (HO2S) consists of the zirconium and the alumina and is installed on upstream and downstream of the Warm-up Catalytic Converter (WCC).

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 the specified value, the heater warms the sensor tip.



Engine Control/Fuel System



Specification

[Bank 1 / sensor 2, Bank 2 / sensor 2]

A/F Ratio (λ)	Output Voltage(V)
RICH	Min. 0.8
LEAN	Max. 0.1

Item	Specification
Heater Resistance (Ω)	3.3 ~ 4.1[20°C(68°F)]

[Bank 1 / sensor 1, Bank 2 / sensor 1]

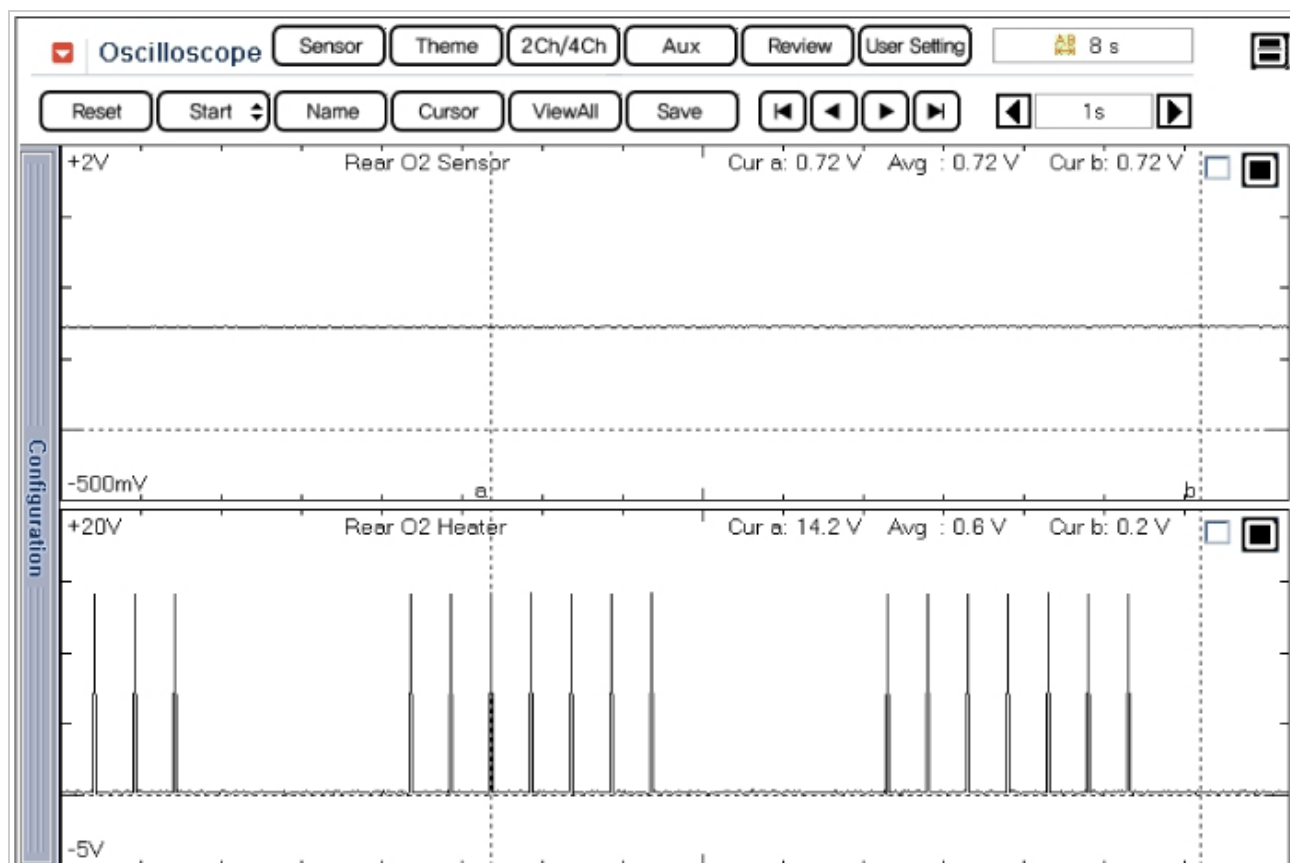
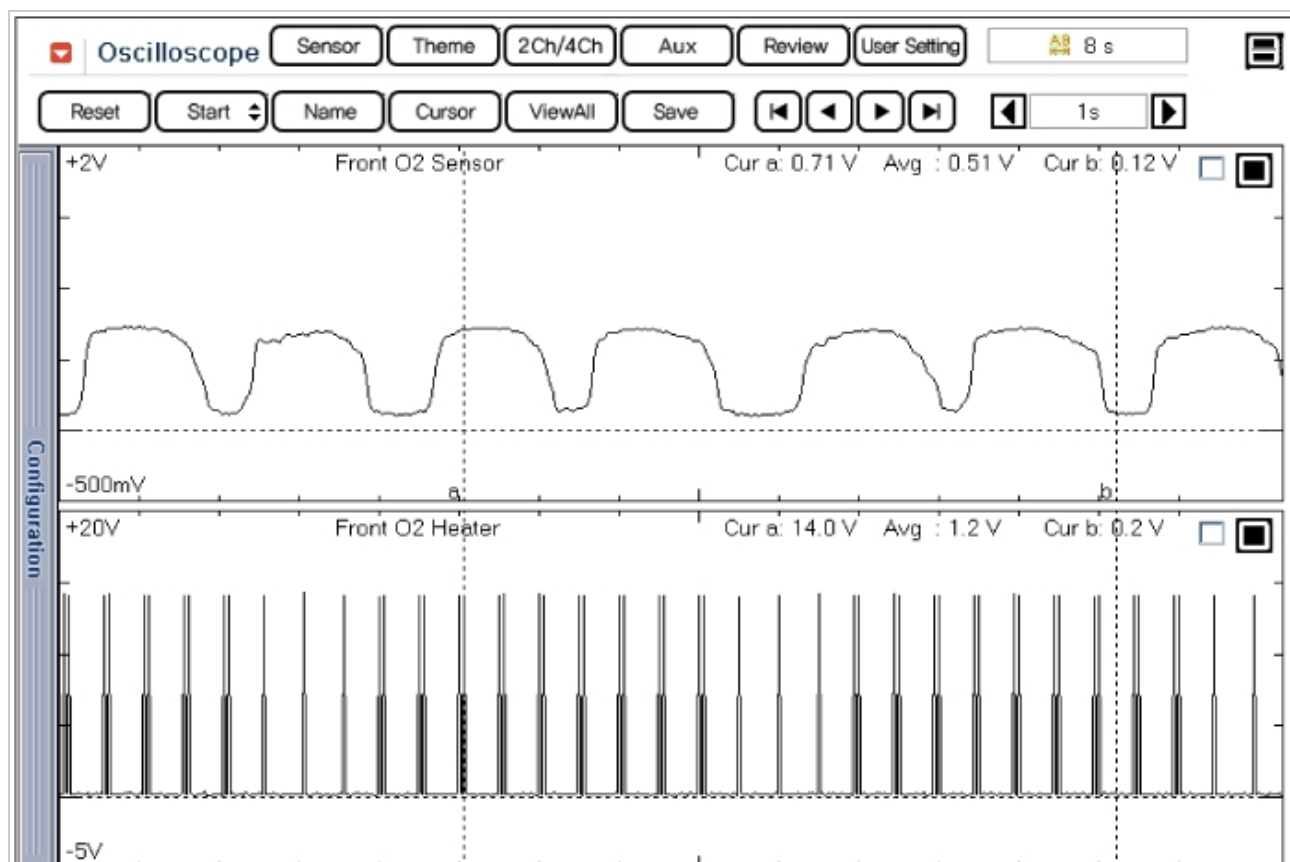
A/F Ratio (λ)	Output Voltage(V)
RICH	0.6 ~ 1.0
LEAN	0 ~ 0.4

Item	Specification
Heater Resistance (Ω)	About 9.0[20°C(68°F)]

Engine Control/Fuel System



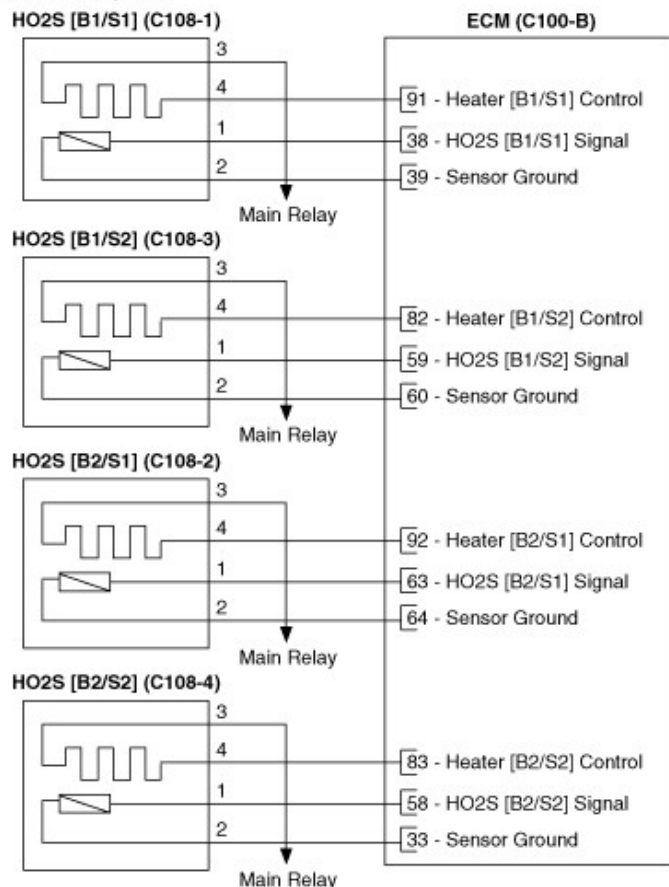
Signal Waveform



Engine Control/Fuel System

Circuit Diagram

[Circuit Diagram]



[Connection Information]

HO2S [Bank 1/Sensor 1] (C108-1)

Terminal	Connected to	Function
1	ECM C100-B (38)	HO2S [B1/S1] Signal
2	ECM C100-B (39)	Sensor Ground
3	Main Relay	Battery Power (B+)
4	ECM C100-B (91)	Heater [B1/S1] Control

HO2S [Bank 1/Sensor 2] (C108-3)

Terminal	Connected to	Function
1	ECM C100-B (59)	HO2S [B1/S2] Signal
2	ECM C100-B (60)	Sensor Ground
3	Main Relay	Battery Power (B+)
4	ECM C100-B (82)	Heater [B1/S2] Control

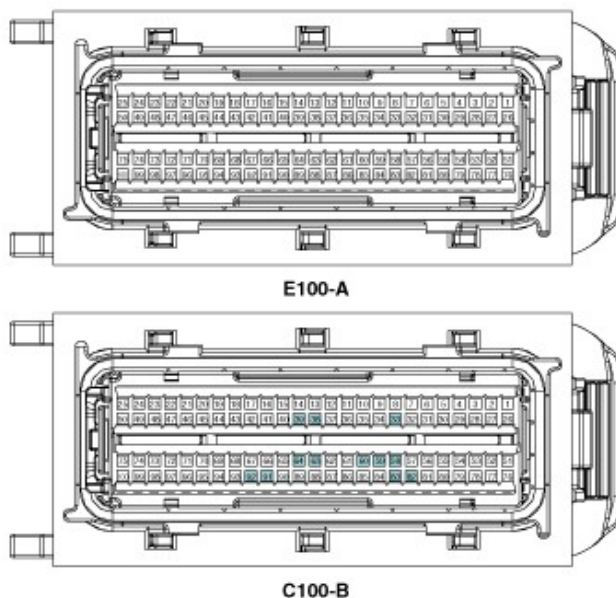
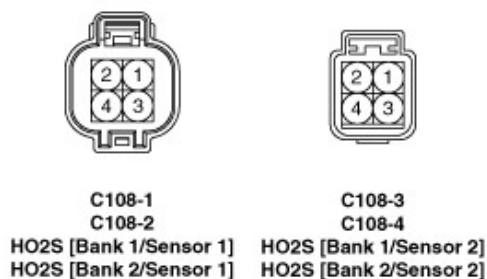
HO2S [Bank 2/Sensor 1] (C108-2)

Terminal	Connected to	Function
1	ECM C100-B (63)	HO2S [B2/S1] Signal
2	ECM C100-B (64)	Sensor Ground
3	Main Relay	Battery Power (B+)
4	ECM C100-B (92)	Heater [B2/S1] Control

HO2S [Bank 2/Sensor 2] (C108-4)

Terminal	Connected to	Function
1	ECM C100-B (58)	HO2S [B2/S2] Signal
2	ECM C100-B (33)	Sensor Ground
3	Main Relay	Battery Power (B+)
4	ECM C100-B (83)	Heater [B2/S2] Control

[Harness Connector]



Engine Control/Fuel System

Inspection

1. Turn the ignition switch OFF.
2. Disconnect the HO2S connector.
3. Measure resistance between the HO2S terminals 3 and 4.
4. Check that the resistance is within the specification.

Specification: Refer to "Specification"

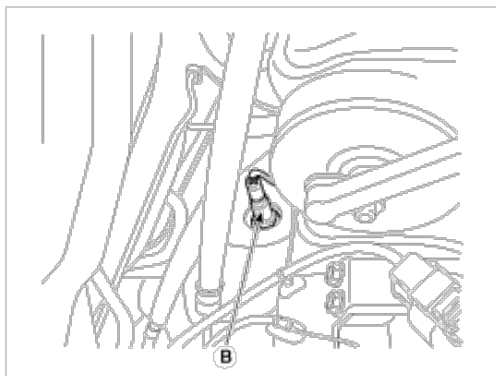
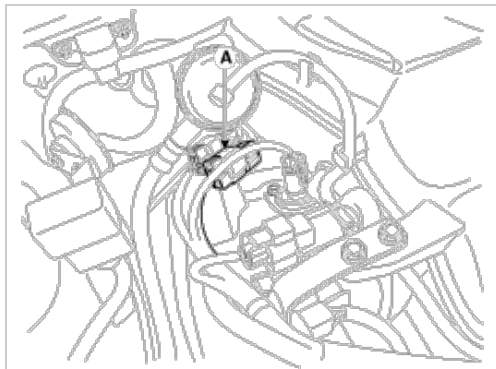
Removal

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Disconnect the connector (A), and then remove the sensor (B).

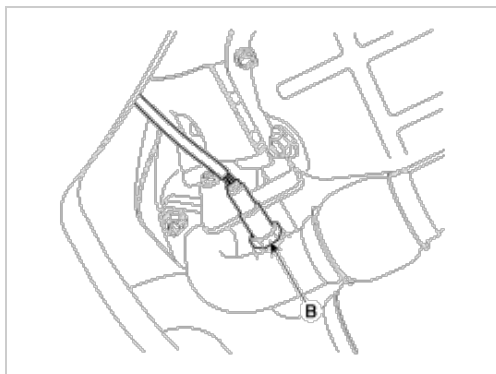
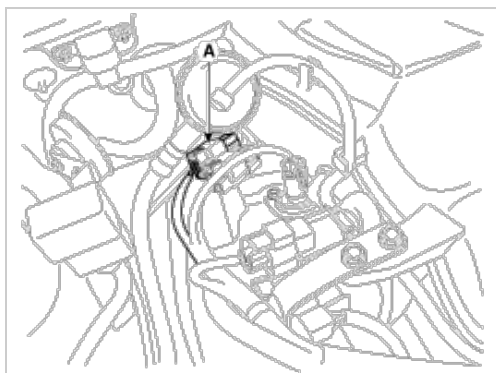
NOTICE

Note that the SST (Part No.: 09392-2H100) is useful when removing the heated oxygen sensor.

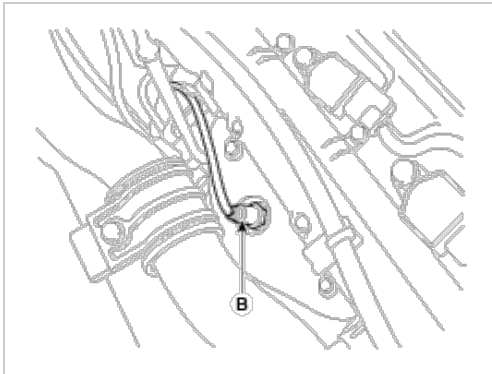
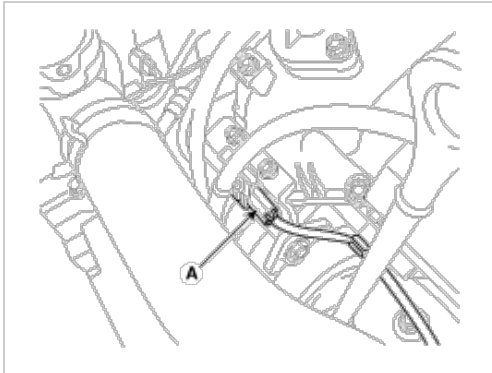
[Bank 1/Sensor 1]



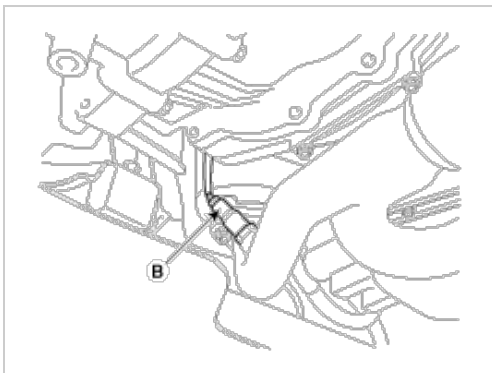
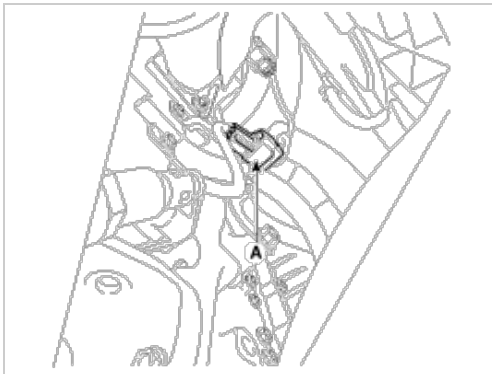
[Bank 1/Sensor 2]



[Bank 2/Sensor 1]



[Bank 2/Sensor 2]



Installation

⚠ CAUTION

- Install the component with the specified torques.
- Note that internal damage may occur when the component is dropped. In this case, use it after inspecting.

⚠ CAUTION

- DON'T use a cleaner, spray, or grease to sensing element and connector of the sensor because oil component in them may malfunction the sensor performance.
-

Sensor and its wiring may be damaged in case of contacting with the exhaust system (Exhaust Manifold, Catalytic Converter, and so on).

1. Installation is reverse of removal.

Heated oxygen sensor installation:

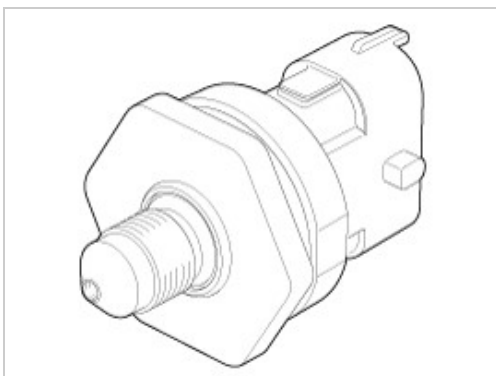
35.3 ~ 45.1 N.m (3.6 ~ 4.6 kgf.m, 26.0 ~ 33.3 lb-ft)

Engine Control/Fuel System



Description

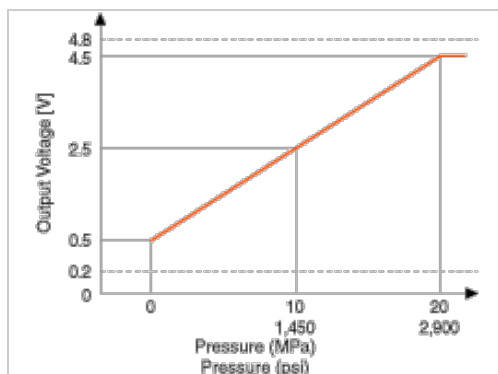
Rail Pressure Sensor (RPS) is installed on the delivery pipe and measures the instantaneous fuel pressure in the delivery pipe. The sensing element (Semiconductor element) built in the sensor converts the pressure to voltage signal. By using this signal, the ECM can control correct injection amount and timing and adjusts the fuel pressure with the fuel pressure regulator valve if the target pressure and the actual pressure calculated by the RPS output signal are different.



Engine Control/Fuel System



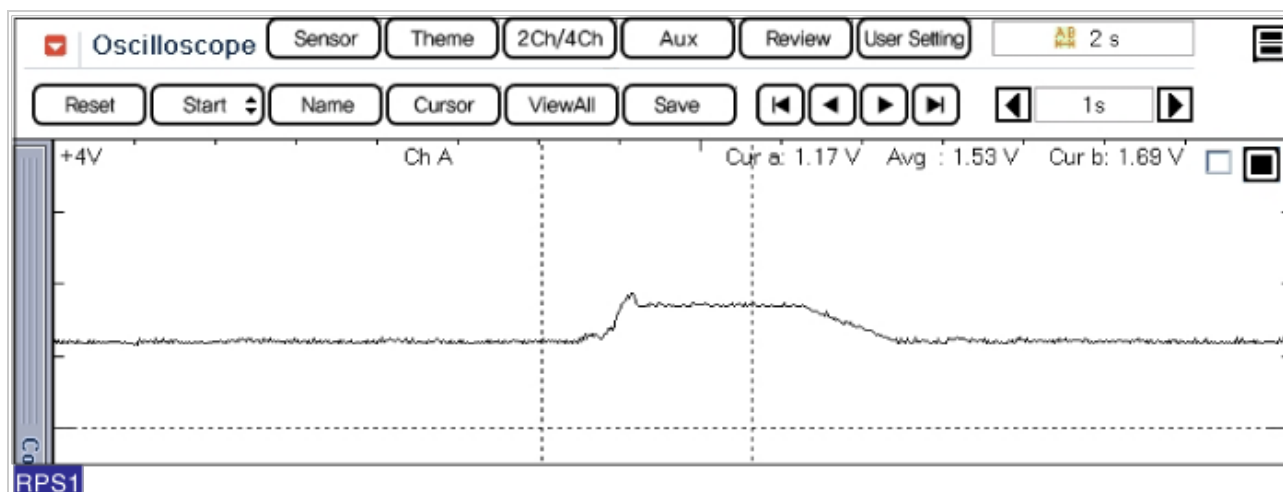
Specification



Engine Control/Fuel System



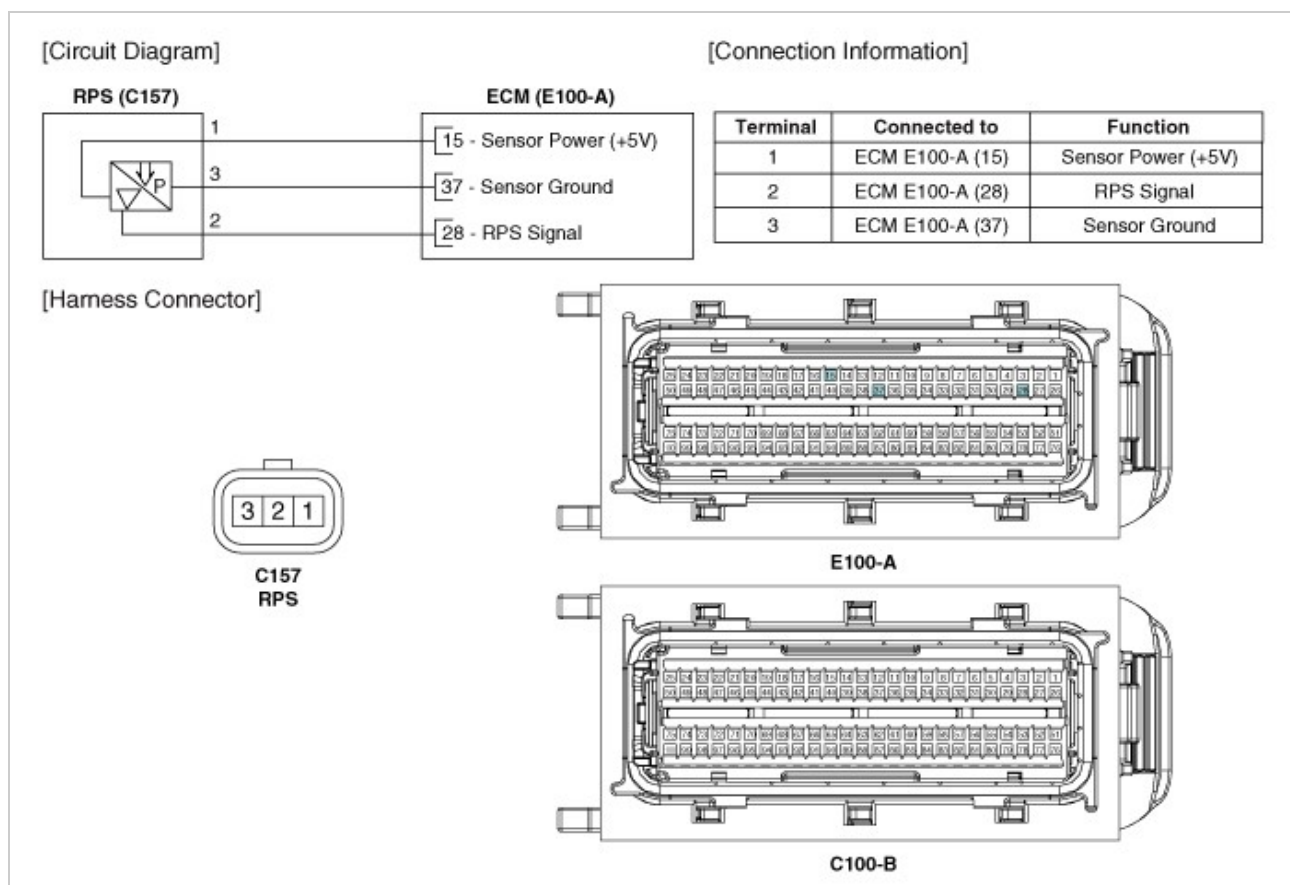
Signal Waveform



Engine Control/Fuel System



Circuit Diagram



Engine Control/Fuel System



Inspection

1. Connect the GDS on the Data Link Connector (DLC).
2. Measure the output voltage of the RPS at idle and various engine speed.

Condition	Output Voltage (V)
Idle	Approx. 1.2
1,500 rpm	2.0 ~ 2.2
6,300 rpm	Approx. 2.8

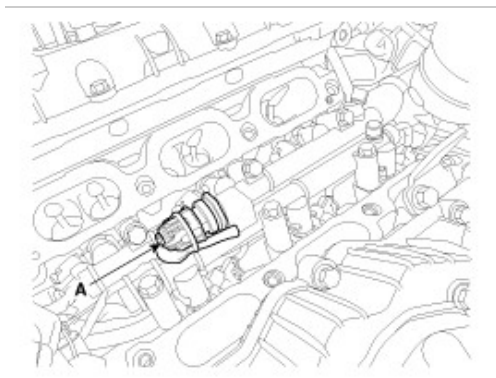
Removal

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Release the residual pressure in fuel line.
(Refer to Fuel Delivery System - "Release Residual Pressure in Fuel Line")

CAUTION

When removing the fuel pump relay, a Diagnostic Trouble Code (DTC) may occur. Delete the code with the GDS after completion of "Release Residual Pressure in Fuel Line" work.

3. Remove the intake manifold.
(Refer to Engine Mechanical System - "Intake Manifold")
4. Disconnect the rail pressure sensor connector (A), and then remove the sensor from the delivery pipe.



Installation

⚠ CAUTION

- Install the component with the specified torques.
- Note that internal damage may occur when the component is dropped. If the component has been dropped, inspect before installing.

1. Installation is reverse of removal.

Rail Pressure Sensor Installation:

29.4 ~ 34.3 N.m (3.0 ~ 3.5 kgf.m, 21.7 ~ 25.3 lb-ft)

Engine Control/Fuel System



Description

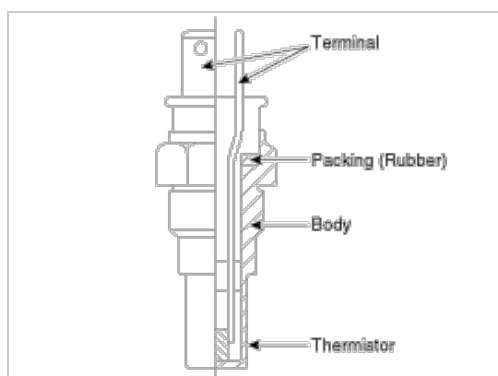
Continuous Variable Valve Timing (CVVT) system advances or retards the valve timing of the intake and exhaust valve in accordance with the ECM control signal which is calculated by the engine speed and load.

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

This system consist of

- the CVVT Oil Control Valve (OCV) which supplies the engine oil to the cam phaser or cuts the engine oil from the cam phaser in accordance with the ECM PWM (Pulse With Modulation) control signal,
- the CVVT Oil Temperature Sensor (OTS) which measures the engine oil temperature,
- and the Cam Phaser which varies the cam phase by using the hydraulic force of the engine oil.

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



Engine Control/Fuel System



Specification

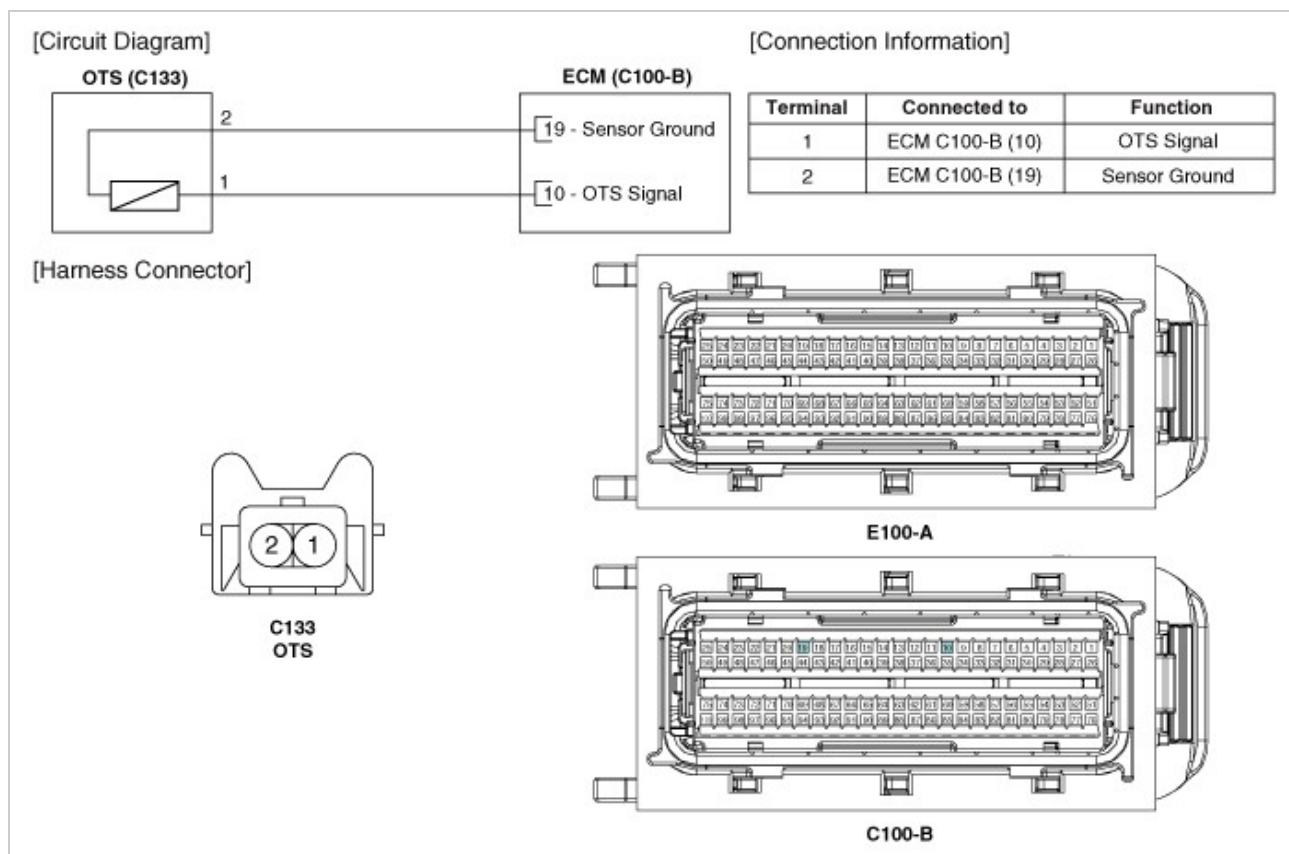
Temperature		Resistance (kΩ)
°C	°F	
-40	-40	52.15
-20	-4	16.52
0	32	6.0
20	68	2.45
40	104	1.11

60	140	0.54
80	176	0.29

Engine Control/Fuel System



Circuit Diagram



Engine Control/Fuel System



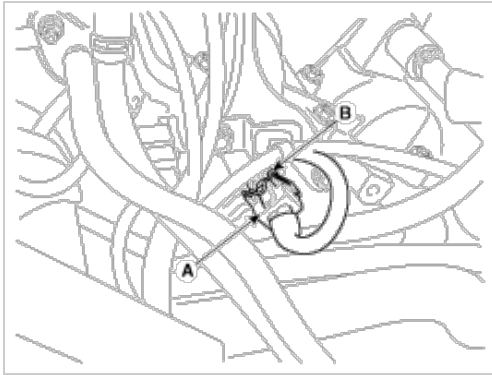
Inspection

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

Specification: Refer to "Specification"

Removal

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Remove the air cleaner assembly.
(Refer to Engine Mechanical System - "Air Cleaner")
3. Disconnect the connector (A), and then remove the CVVT oil temperature sensor (B).



Installation

⚠ CAUTION

- Install the component with the specified torques.
- Note that internal damage may occur when the component is dropped. If the component has been dropped, inspect before installing.

⚠ CAUTION

- Apply the sealant (LOCTITE FED546 or equivalent) to the sensor.

⚠ CAUTION

- Insert the sensor in the installation hole and be careful not to damage when installation.

1. Installation is reverse of removal.

CVVT oil temperature sensor installation:

34.3 ~ 41.1 N.m (3.5 ~ 4.5 kgf.m, 25.3 ~ 32.5 lb-ft)

Engine Control/Fuel System



Description

Accelerator Position Sensor (APS) is installed on the accelerator pedal module and detects the rotation angle of the accelerator pedal. The APS is one of the most important sensors in engine control system, so it consists of the two sensors which adapt individual sensor power and ground line. The second sensor monitors the first sensor and its output voltage is half of the first one. If the ratio of the sensor 1 and 2 is out of the range (approximately 1/2), the diagnostic system judges that it is abnormal.

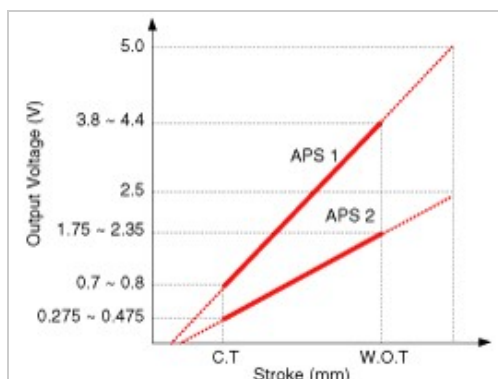


Engine Control/Fuel System



Specification

Accelerator Position	Output Voltage (V)	
	APS1	APS2
C.T	0.7 ~ 0.8	0.275 ~ 0.475
W.O.T	3.8 ~ 4.4	1.75 ~ 2.35

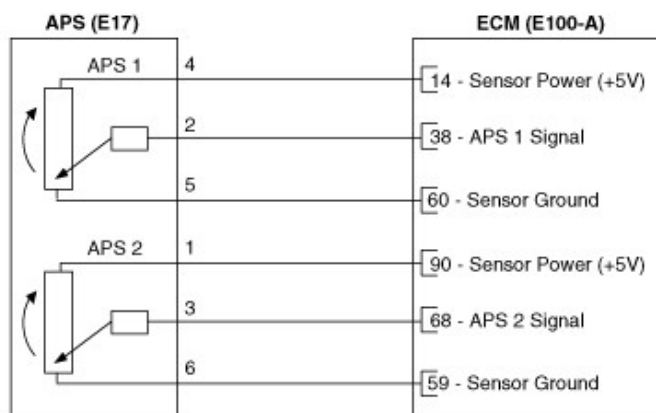


Engine Control/Fuel System



Circuit Diagram

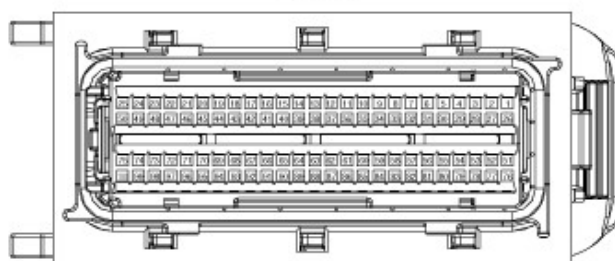
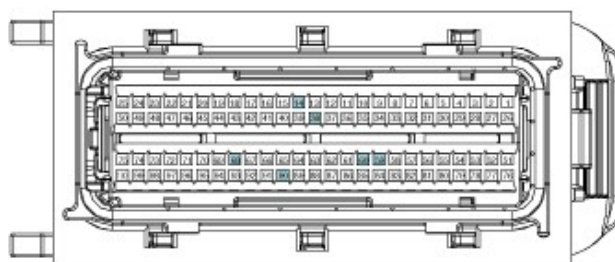
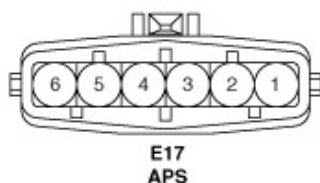
[Circuit Diagram]



[Connection Information]

Terminal	Connected to	Function
1	ECM E100-A (90)	APS 2 Sensor Power (+5V)
2	ECM E100-A (38)	APS 1 Signal
3	ECM E100-A (68)	APS 2 Signal
4	ECM E100-A (14)	APS 1 Sensor Power (+5V)
5	ECM E100-A (60)	APS 1 Sensor Ground
6	ECM E100-A (59)	APS 2 Sensor Ground

[Harness Connector]



Engine Control/Fuel System



Inspection

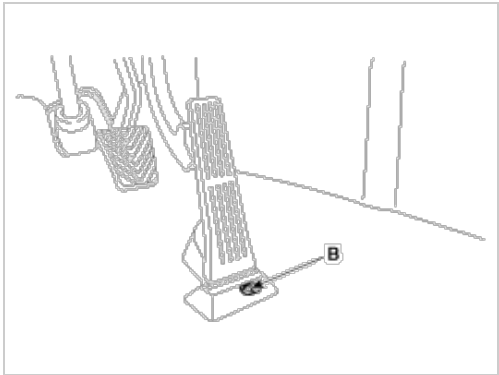
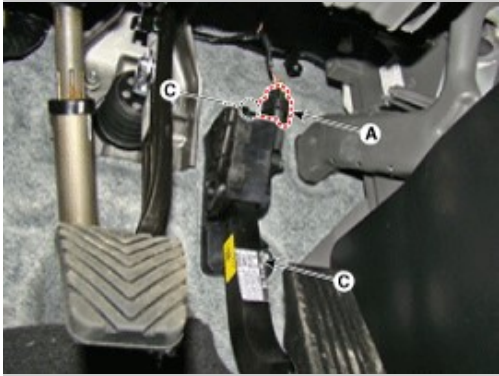
1. Connect the GDS on the Data Link Connector (DLC).
2. Turn the ignition switch ON.
3. Measure the output voltage of the APS 1 and 2 at C.T and W.O.T.

Specification: Refer to "Specification"

Removal

1. Turn the ignition switch OFF and disconnect the negative (-) battery cable.

- 2. Disconnect the accelerator position sensor connector (A).
- 3. Remove the installation bolt (B) and nuts (C), and the remove the accelerator pedal module.



Installation

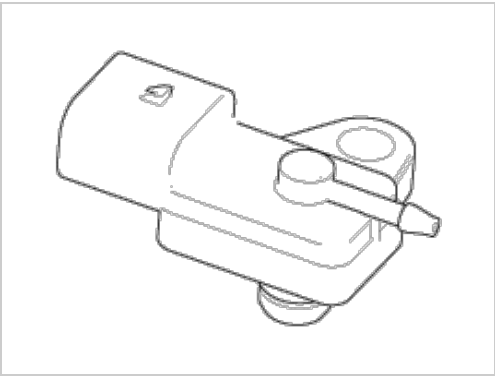
- 1. Installation is reverse of removal.
Accelerator pedal module installation bolt:
8.8 ~ 13.7 N.m (0.9 ~ 1.4 kgf.m, 6.5 ~ 10.1 lb-ft)
Accelerator pedal module installation nut:
16.7 ~ 25.5 N.m (1.7 ~ 2.6 kgf.m, 12.3 ~ 18.8 lb-ft)

Engine Control/Fuel System



Description

Fuel Tank Pressure Sensor (FTPS) is a component of the evaporative emission control system and is installed on the fuel tank, the fuel pump, or the canister. It checks the purge control solenoid valve operation and detects a leakage of the system.

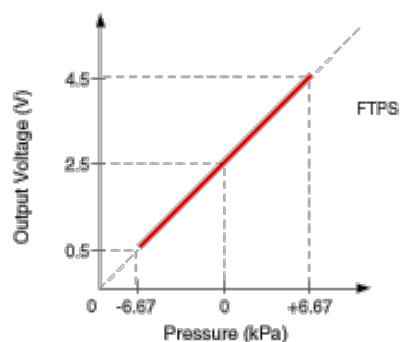


Engine Control/Fuel System



Specification

Pressure [kPa (kgf/cm², psi)]	Output Voltage (V)
-6.67 (-0.06, -0.97)	0.5
0	2.5
+6.67 (0.068, 0.97)	4.5

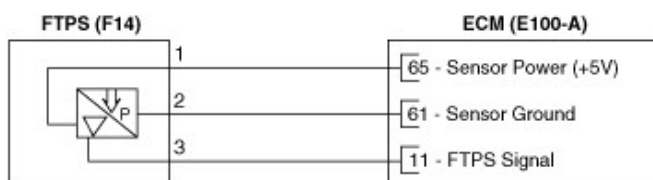


Engine Control/Fuel System



Circuit Diagram

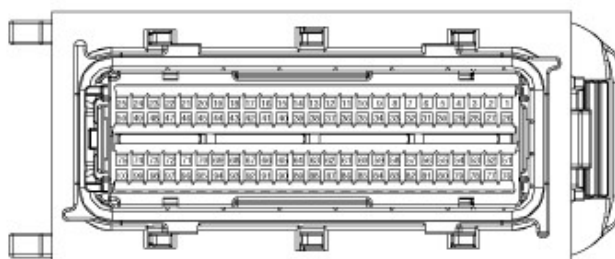
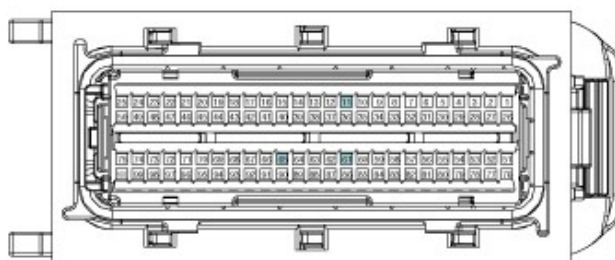
[Circuit Diagram]



[Connection Information]

Terminal	Connected to	Function
1	ECM E100-A (65)	Sensor Power (+5V)
2	ECM E100-A (61)	Sensor Ground
3	ECM E100-A (11)	FTP Signal

[Harness Connector]



Engine Control/Fuel System



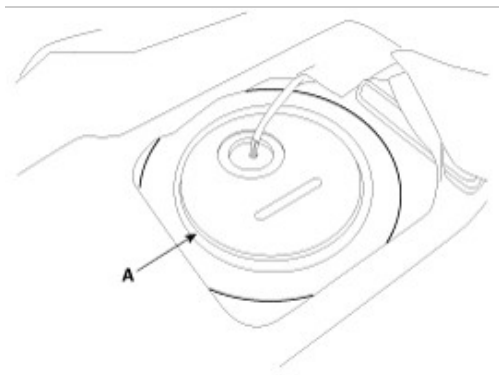
Inspection

1. Connect the GDS on the Data Link Connector (DLC).
2. Measure the output voltage of the FTPS.

Specification: Refer to "Specification"

Removal

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Remove the rear seat.
(Refer to Body - "Rear Seat Assembly")
3. Remove the fuel pump service cover (A).



4. Disconnect the fuel tank pressure sensor connector (A).
5. Remove the fuel tank pressure sensor (B) after releasing the hooks vertically.



Installation

CAUTION

- Install the component with the specified torques.
- Note that internal damage may occur when the component is dropped. If the component has been dropped, inspect before installing.

CAUTION

- Insert the sensor in the installation hole and be careful not to damage when installation.

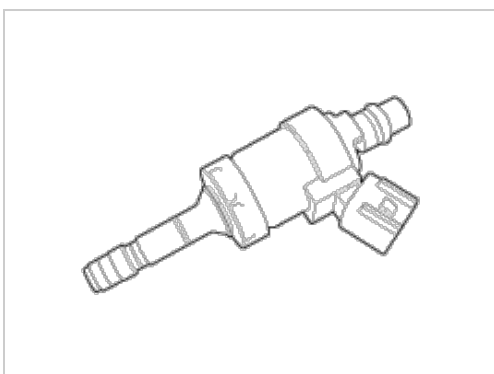
1. Installation is reverse of removal.

Engine Control/Fuel System



Description

Based on information from various sensors, the ECM can calculate the fuel amount to be injected. The fuel injector is a solenoid-operated valve and the fuel injection amount is controlled by length of injection time. The ECM controls each injector by grounding the control circuit. When the ECM energizes the injector by grounding the control circuit, the circuit voltage should 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, and then settle at system voltage.



Engine Control/Fuel System



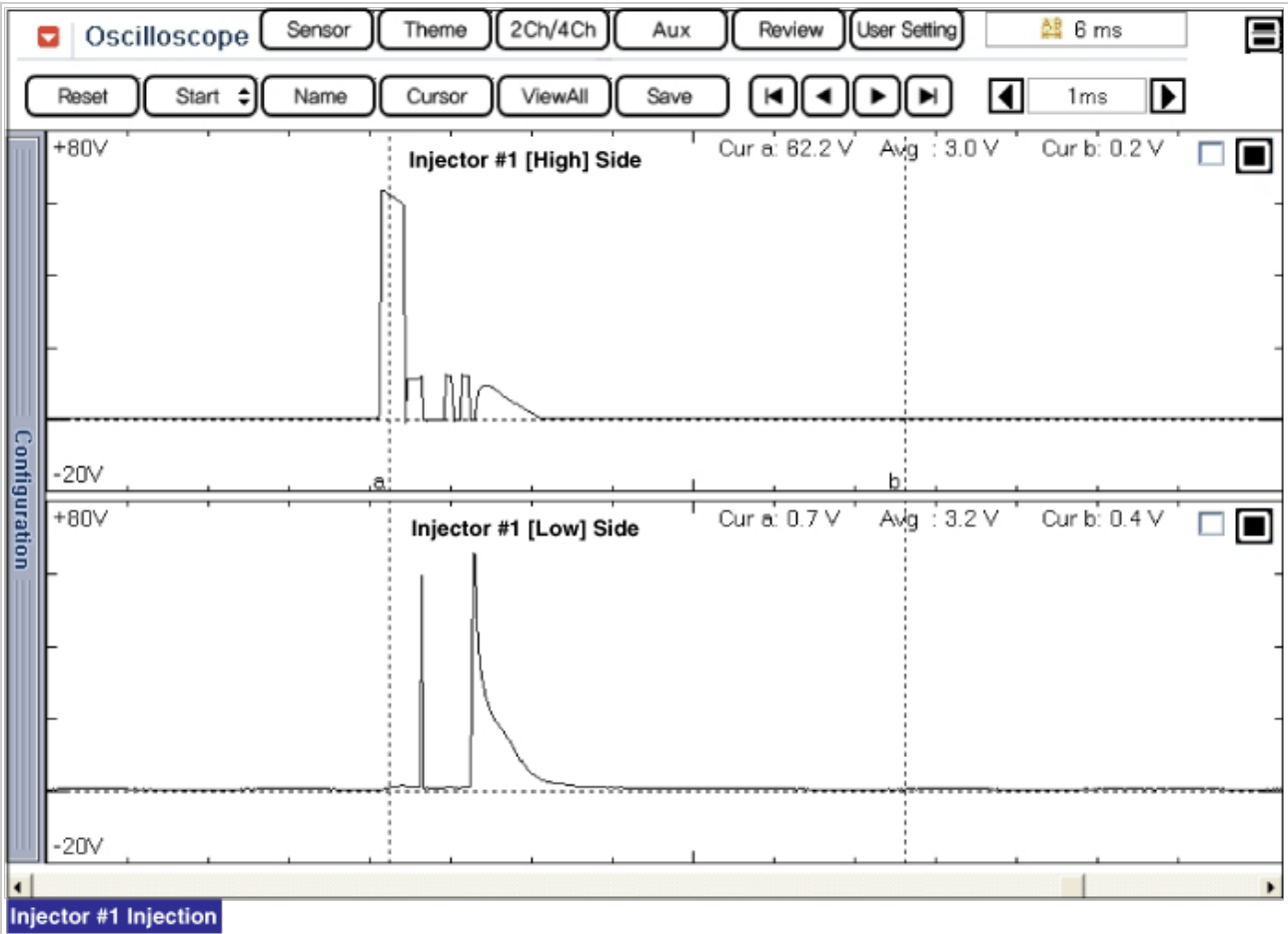
Specification

Item	Specification
Coil Resistance (Ω)	0.98 ~ 1.14 [20°C(68°F)]

Engine Control/Fuel System



Signal Waveform

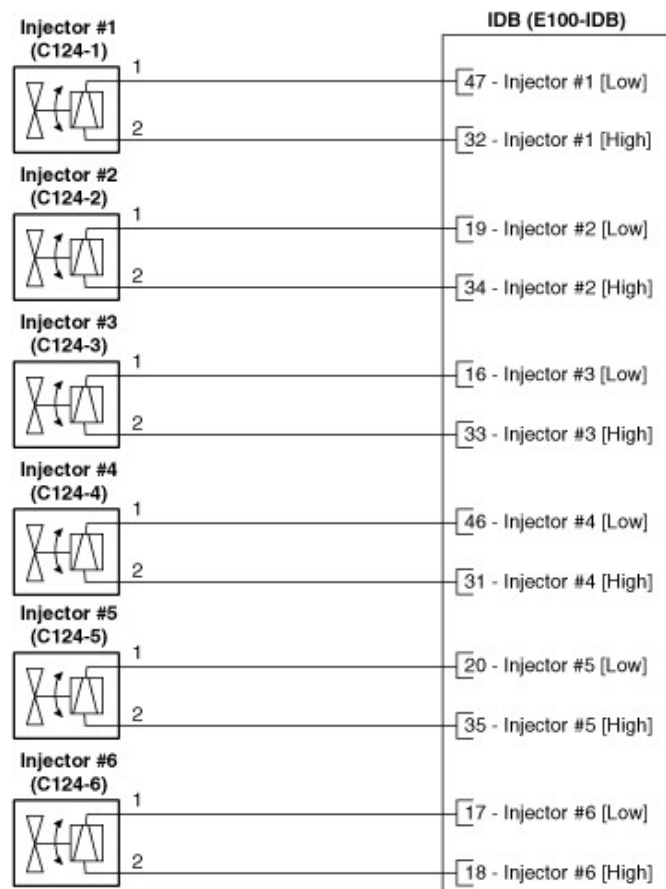


Engine Control/Fuel System



Circuit Diagram

[Circuit Diagram]



[Connection Information]

Injector #1 (C124-1)

Terminal	Connected to	Function
1	IDB E100-IDB (47)	Injector #1 [Low] Control
2	IDB E100-IDB (32)	Injector #1 [High] Control

Injector #2 (C124-2)

Terminal	Connected to	Function
1	IDB E100-IDB (19)	Injector #2 [Low] Control
2	IDB E100-IDB (34)	Injector #2 [High] Control

Injector #3 (C124-3)

Terminal	Connected to	Function
1	IDB E100-IDB (16)	Injector #3 [Low] Control
2	IDB E100-IDB (33)	Injector #3 [High] Control

Injector #4 (C124-4)

Terminal	Connected to	Function
1	IDB E100-IDB (46)	Injector #4 [Low] Control
2	IDB E100-IDB (31)	Injector #4 [High] Control

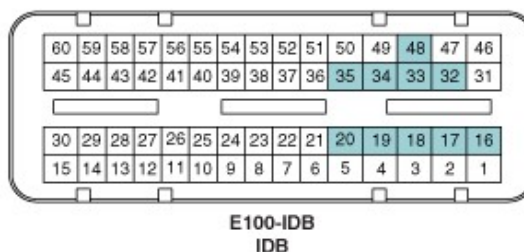
Injector #5 (C124-5)

Terminal	Connected to	Function
1	IDB E100-IDB (20)	Injector #5 [Low] Control
2	IDB E100-IDB (35)	Injector #5 [High] Control

Injector #6 (C124-6)

Terminal	Connected to	Function
1	IDB E100-IDB (17)	Injector #6 [Low] Control
2	IDB E100-IDB (18)	Injector #6 [High] Control

[Harness Connector]



Engine Control/Fuel System



Inspection

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

Specification: Refer to "Specification"

Removal

⚠ WARNING

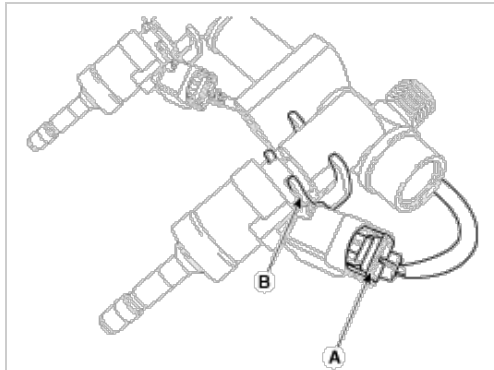
In case of removing the high pressure fuel pump, high pressure fuel pipe, delivery pipe, and injector, there may be injury caused by leakage of the high pressure fuel. So don't do any repair work right after engine stops.

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Release the residual pressure in fuel line.
(Refer to Fuel Delivery System - "Release Residual Pressure in Fuel Line")

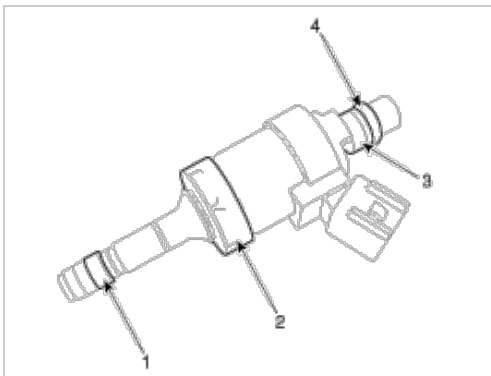
⚠ CAUTION

When removing the fuel pump relay, a Diagnostic Trouble Code (DTC) may occur. Delete the code with the GDS after completion of "Release Residual Pressure in Fuel Line" work.

3. Remove the delivery pipe & injector assembly.
(Refer to Fuel Delivery System - "Delivery Pipe")
4. Remove the connector (A) and the fixing clip (B), and then separate the injector from the delivery pipe.



Installation



- 1) Combustion seal
- 2) Rubber washer
- 3) Support disc
- 4) O-ring

⚠ CAUTION

- Do not reuse the used injector fixing clip.

⚠ CAUTION

- Install the component with the specified torques.
- Note that internal damage may occur when the component is dropped. If the component has been dropped, inspect before installing.

⚠ CAUTION

- Apply engine oil to the injector O-ring.
- Do not reuse the used injector O-ring.

⚠ CAUTION

- Do not reuse the used bolt.

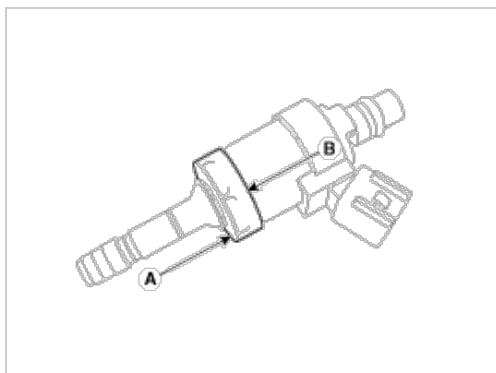
⚠ CAUTION

- When inserting the injector, be careful not to damage the injector tip.

⚠ CAUTION

- Do not reuse the support disc.

- Do not reuse the injector rubber washer.
- When replacing the rubber washer, the rounded edge (A) part should be faced the cylinder installation part and the angulated edge (B) part should be faced the injector body part.



CAUTION

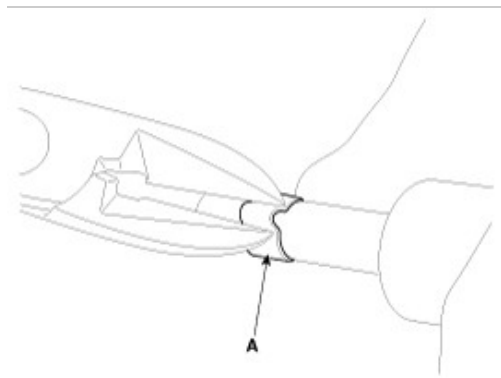
- Do not reuse the combustion seal.

1. Installation is reverse of removal.

Replacement

The injector combustion seal should be replaced new one to prevent leakage after removing the injector.

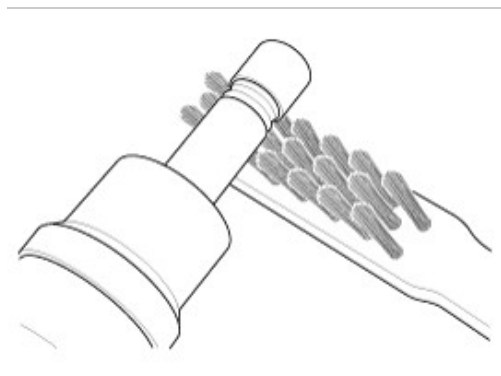
1. Remove the combustion seal (A) with a wire cutter.



CAUTION

Grip the sealing ring carefully, pull it to form a small loop and then cut it.
Be careful not to damage the surface of the valve sleeve with the wire cutter.

2. Before the assembly of the sealing ring the groove must be cleaned using a clean cloth.
Any coking of the injector sealing surface must be carefully removed with a brass-wire brush.

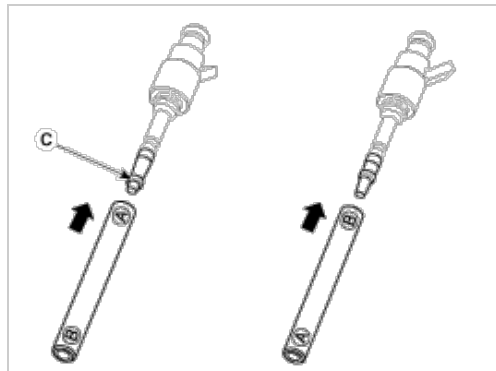
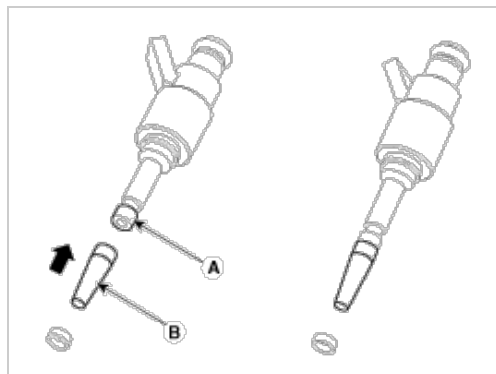


CAUTION

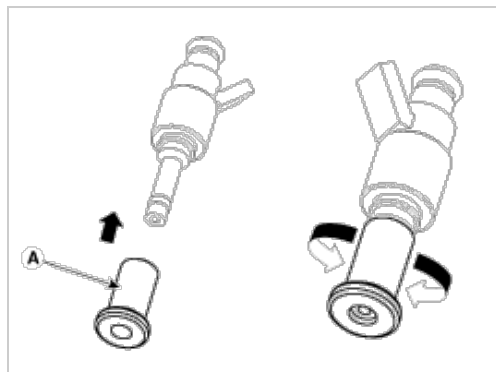
The surfaces of the new sealing ring must be clean and free of grease.

3. Place the seal installing guide (B) (SST No.: 09353-2B000) on the tip of the injector not to damage the injector tip (A).

Push the sealing ring (C) with thumb and index finger over the conical assembly tool until it snaps into the groove. The complete assembly must not take longer than 2 to 3 seconds.



4. To size the sealing ring the injector is first introduced into the sizing tool (A) (SST No.: 09353-2B000) and then pressed and at the same time rotated 180° into the sizing tool.



5. Pull the injector out of the sizing tool by turning it in the reverse direction to that used for the press-in process.

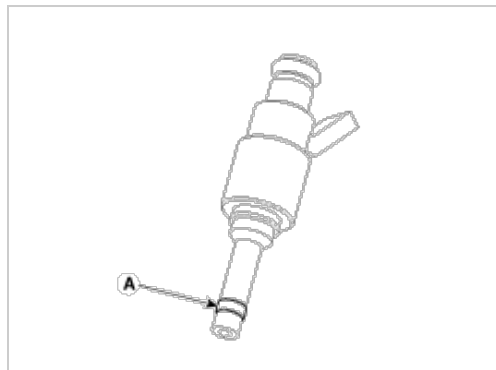
CAUTION

Check that the seal ring has not been damaged during assembly to the injector and that no circumferential scratches are present.

Do not reuse the combustion seal.

The seal must be completely free of grease and oil.

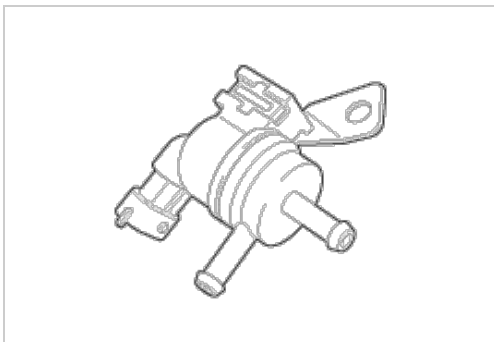
6. Check the combustion seal (A) installation.





Description

Purge Control Solenoid Valve (PCSV) is installed on the surge tank and controls the passage between the canister and the intake manifold. It is a solenoid valve and is open when the ECM grounds the valve control line. When the passage is open (PCSV ON), fuel vapor stored in the canister is transferred to the intake manifold.



Engine Control/Fuel System



Specification

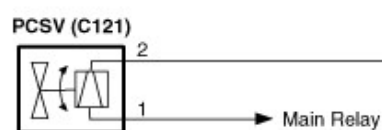
Item	Specification
Coil Resistance (Ω)	22.0 ~ 26.0 [20°C(68°F)]

Engine Control/Fuel System



Circuit Diagram

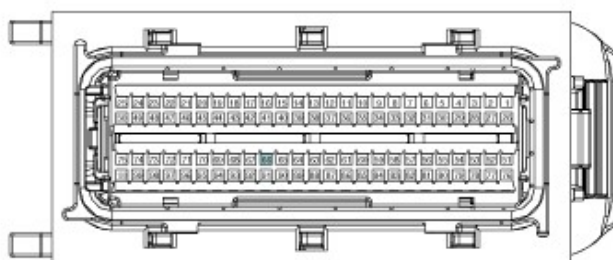
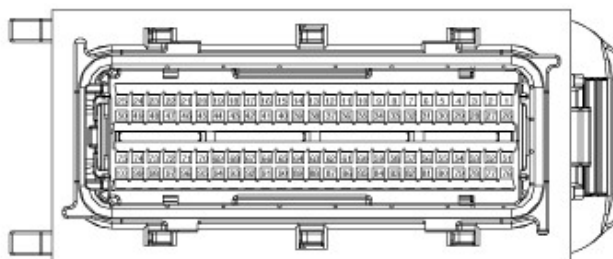
[Circuit Diagram]



[Connection Information]

Terminal	Connected to	Function
1	Main Relay	Battery Power(B+)
2	ECM C100-B (66)	PCSV Control

[Harness Connector]



Engine Control/Fuel System



Inspection

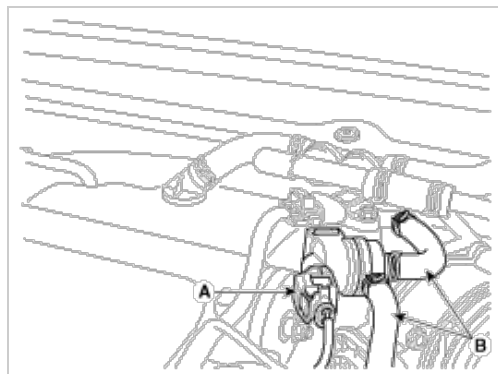
1. Turn the ignition switch OFF.
2. Disconnect the PCSV connector.

3. Measure resistance between the PCSV terminals 1 and 2.
4. Check that the resistance is within the specification.

Specification: Refer to "Specification"

Removal

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Disconnect the purge control solenoid valve connector (A).
3. Disconnect the vapor hoses (B) from the purge control solenoid valve.
4. Remove the valve from the bracket.



Installation

⚠ CAUTION

- Install the component with the specified torques.
- Note that internal damage may occur when the component is dropped. If the component has been dropped, inspect before installing.
- Be sure not to apply oil or lubricant to the end of the hoses when connecting the PCSV hose.

⚠ CAUTION

- Be careful of foreign material not to flow into the valve.

1. Installation is reverse of removal.

Purge control solenoid valve bracket installation bolt:

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

Engine Control/Fuel System



Description

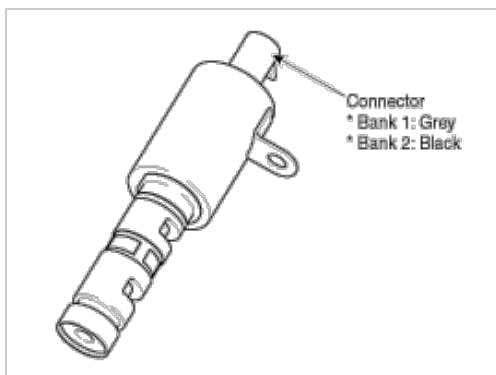
Continuous Variable Valve Timing (CVVT) system advances or retards the valve timing of the intake and exhaust valve in accordance with the ECM control signal which is calculated by the engine speed and load.

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

This system consist of

- the CVVT Oil Control Valve (OCV) which supplies the engine oil to the cam phaser or runs out the engine oil from the cam phaser in accordance with the ECM PWM (Pulse With Modulation) control signal,
- the CVVT Oil Temperature Sensor (OTS) which measures the engine oil temperature,
- and the Cam Phaser which varies the cam phase by using the hydraulic force of the engine oil.

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



Engine Control/Fuel System



Specification

Item	Specification
Coil Resistance (Ω)	9.4 ~ 10.4 [20°C(68°F)]

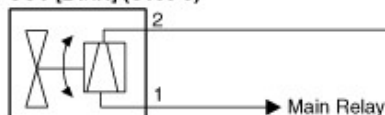
Engine Control/Fuel System



Circuit Diagram

[Circuit Diagram]

OCV [B1/IN] (C105-3)



OCV [B1/EX] (C105-1)



OCV [B2/IN] (C105-4)



OCV [B2/EX] (C105-2)



ECM (C100-B)

[Connection Information]

OCV [Bank 1/Intake] (C105-3)

Terminal	Connected to	Function
1	Main Relay	Battery Power (B+)
2	ECM C100-B (96)	OCV [B1/IN] Control

OCV [Bank 1/Exhaust] (C105-1)

Terminal	Connected to	Function
1	ECM C100-B (94)	OCV [B1/EX] Control
2	Main Relay	Battery Power (B+)

OCV [Bank 2/Intake] (C105-4)

Terminal	Connected to	Function
1	Main Relay	Battery Power (B+)
2	ECM C100-B (95)	OCV [B2/IN] Control

OCV [Bank 2/Exhaust] (C105-2)

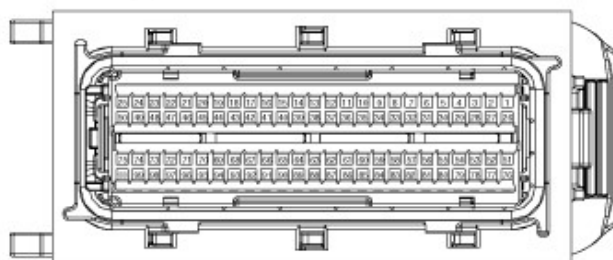
Terminal	Connected to	Function
1	ECM C100-B (93)	OCV [B2/EX] Control
2	Main Relay	Battery Power (B+)

[Harness Connector]

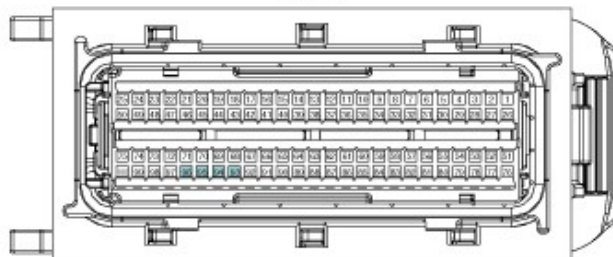


C105-1
C105-2
C105-3
C105-4

OCV [Bank 1/Exhaust]
OCV [Bank 2/Exhaust]
OCV [Bank 1/Intake]
OCV [Bank 2/Intake]



E100-A



C100-B

Engine Control/Fuel System

Inspection

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

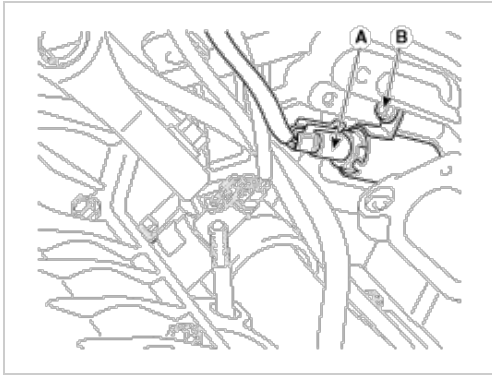
Specification: Refer to "Specification"

Removal

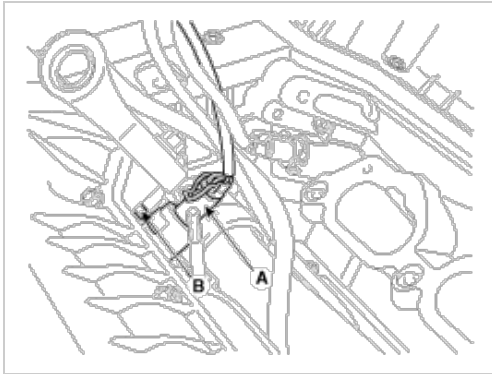
[CVVT Oil Control Valve (Intake)]

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Remove the intake manifold.
(Refer to Engine Mechanical System - "Intake Manifold")
3. Disconnect the CVVT oil control valve connector (A).
4. Remove the installation bolt (B), and then remove the valve from the engine.

[Bank 1]



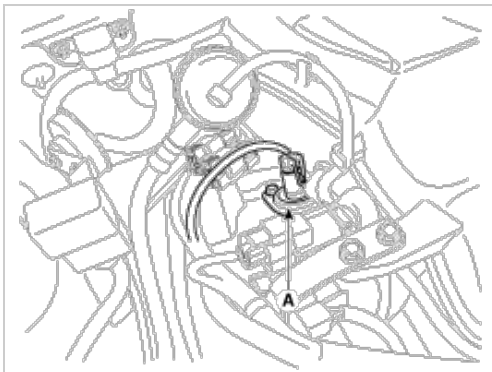
[Bank 2]



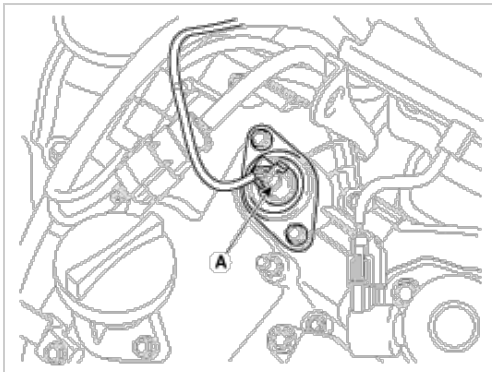
[CVVT Oil Control Valve (Exhaust)]

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Disconnect the CVVT oil control valve connector (A).

[Bank 1]

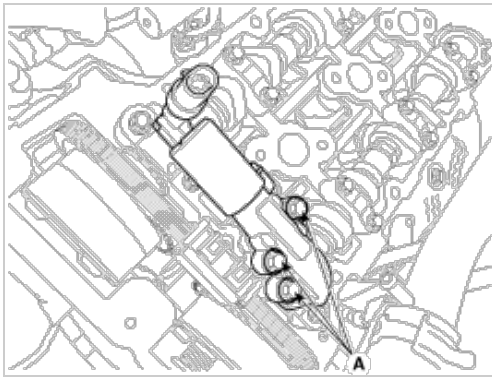


[Bank 2]

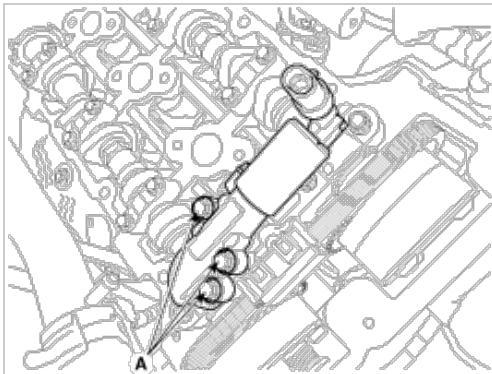


3. Remove the cylinder head cover.
(Refer to Engine Mechanical System - "Cylinder Head Cover")
4. Remove the installation bolt (A), and then remove the valve from the engine.

[Bank 1]



[Bank 2]



Inatallation

⚠ CAUTION

- Install the component with the specified torques.
- Note that internal damage may occur when the component is dropped. If the component has been dropped, inspect before installing.

⚠ CAUTION

- Apply the engine oil to the valve O-ring.

⚠ CAUTION

- Exactly distinguish the color of the valve and harness connectors in bank 1 and 2 when installing, or the engine will operate abnormally (Refer to the table below).

Items	Component Side	Harness Side
Bank 1 (RH)		Grey
Bank 2 (LH)		Black

1. Installation is reverse of removal.

CVVT oil control valve installation bolt:

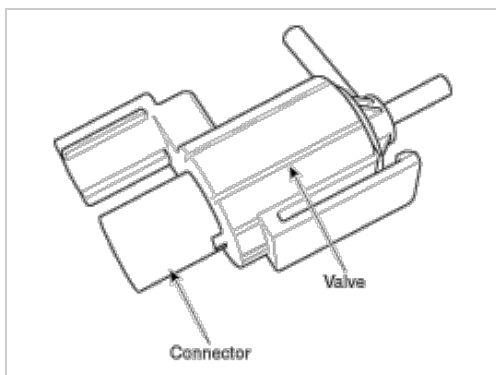
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)

Engine Control/Fuel System



Description

Variable Intake manifold Solenoid (VIS) valves are installed on the intake manifold (VIS Valve 1) and the surge tank (VIS Valve 2). These VIS valve 1 and 2 control vacuum modulators which activate valves in the intake manifold and the surge tank. These valves are opened or closed by ECM according to engine condition (Refer to below table).



Engine Control/Fuel System



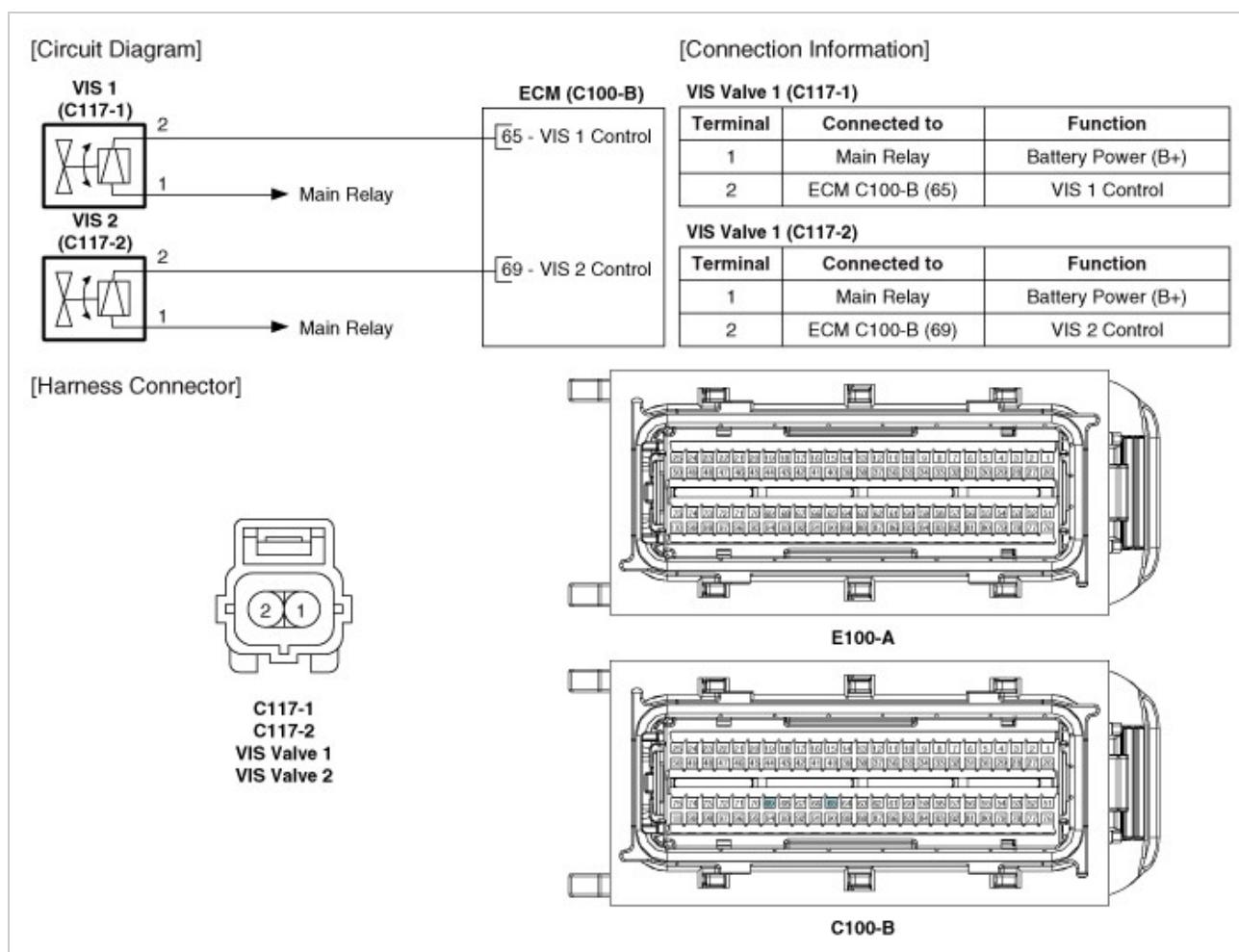
Specification

Item	Specification
Coil Resistance (Ω)	30.0 ~ 35.0 [20°C(68°F)]

Engine Control/Fuel System



Circuit Diagram



Engine Control/Fuel System



Inspection

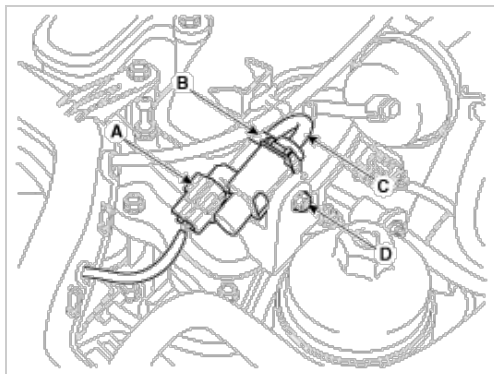
1. Turn the ignition switch OFF.
2. Disconnect the VIS valve connector.
3. Measure resistance between the VIS valve terminals 1 and 2.
4. Check that the resistance is within the specification.

Specification: Refer to "Specification"

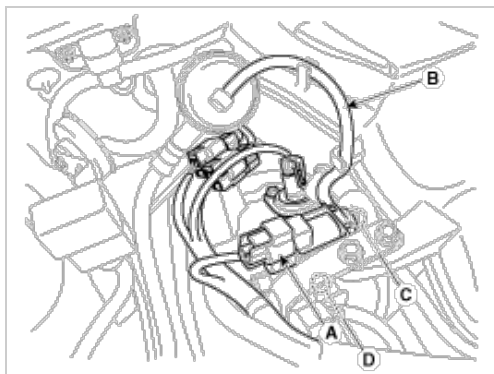
Removal

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Disconnect the variable intake solenoid valve connector (A).
3. Disconnect the vacuum hoses (B, C) from the valve.
4. Remove the installation nut (D), and then remove the valve.

[Vave 1 (Intake manifold)]



[Vave 2 (Surge tank)]



Installation

CAUTION

- Install the component with the specified torques.
- Note that internal damage may occur when the component is dropped. If the component has been dropped, inspect before installing.

CAUTION

- Be careful of foreign material not to flow into the valve.

1. Installation is reverse of removal.

Variable intake solenoid valve installation nut:

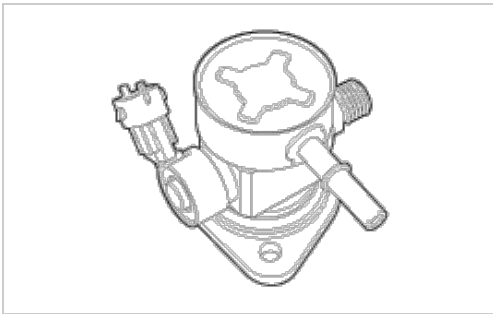
5.9 ~ 8.8 N.m (0.6 ~ 0.9 kgf.m, 4.3 ~ 6.5 lb-ft)

Engine Control/Fuel System



Description

Fuel Pressure Regulator Valve is installed on the high pressure fuel pump and controls fuel flow flowing into the injectors in accordance with the ECM signal calculated based on various engine condition.



Engine Control/Fuel System



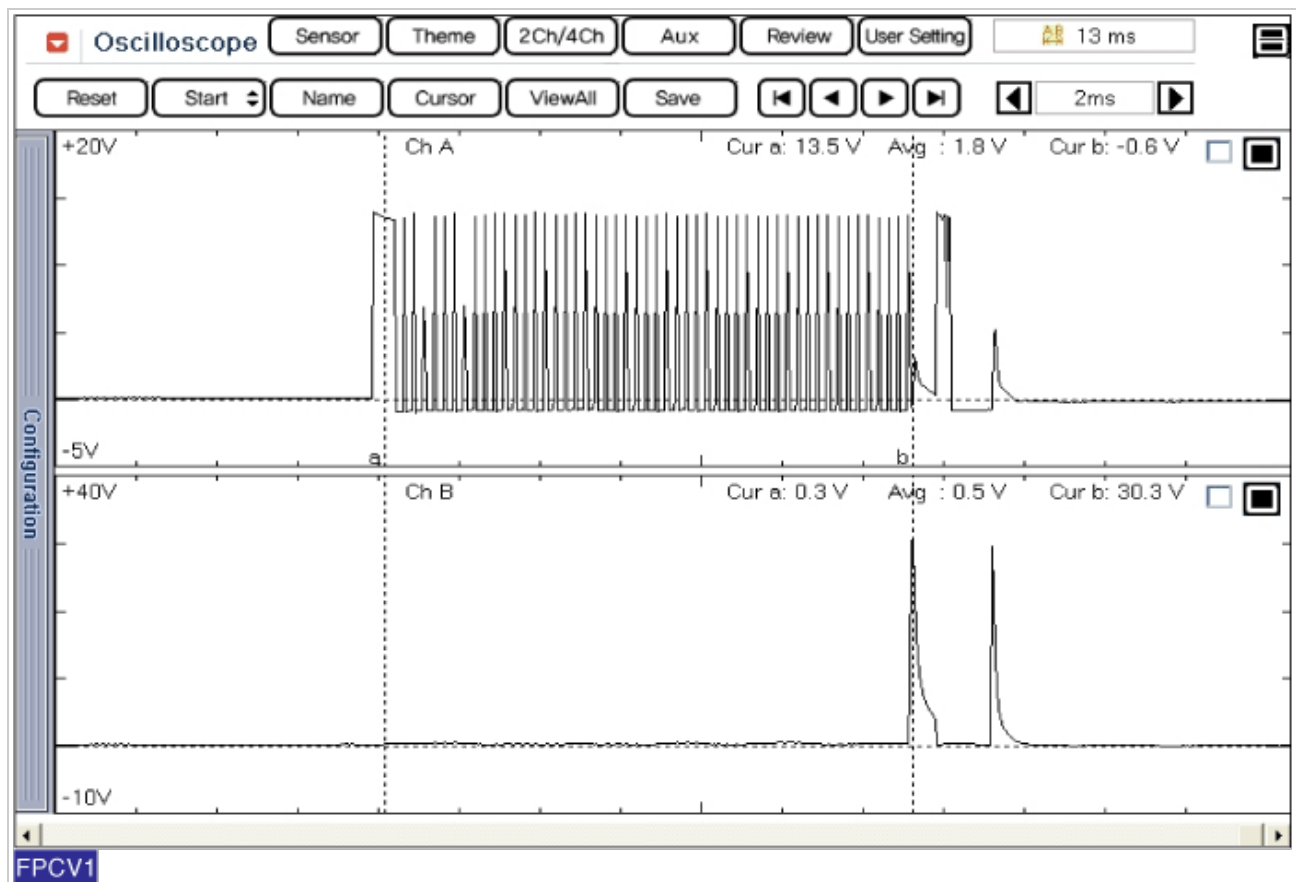
Specification

Item	Specification
Coil Resistance (Ω)	1.04 ~ 1.27 [23°C(73.4°F)]

Engine Control/Fuel System



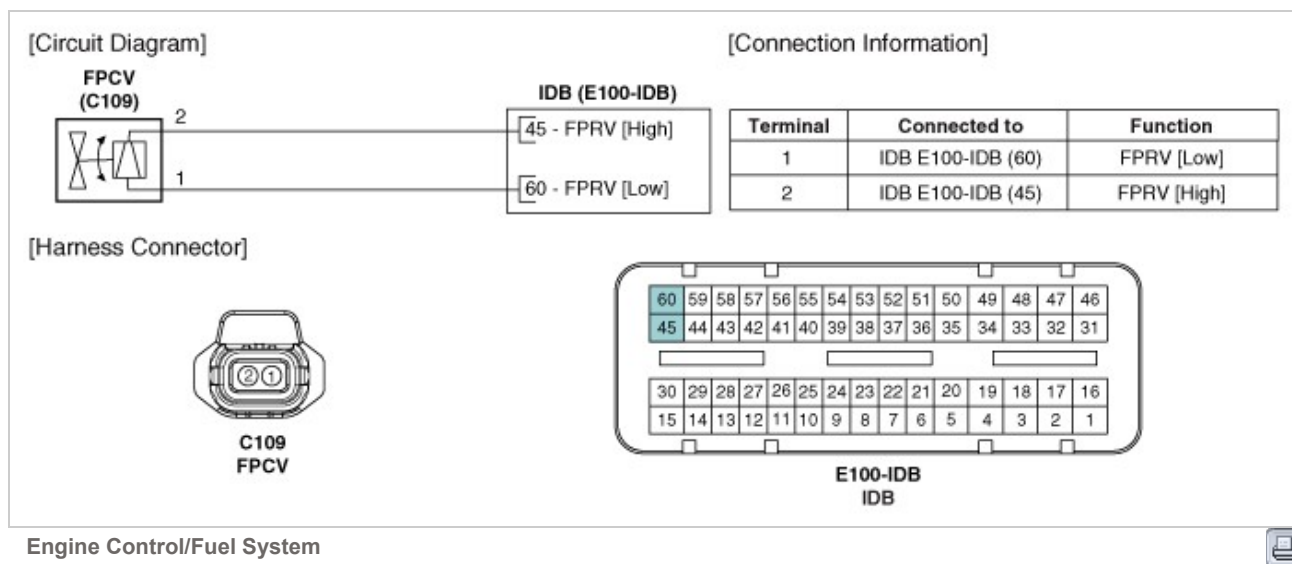
Signal Waveform



Engine Control/Fuel System



Circuit Diagram



Inspection

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Disconnect the fuel pressure regulator valve connector.
3. Measure resistance between the fuel pressure regulator valve terminals 1 and 2.
4. Check that the resistance is within the specification.

Specification:Refer to "Specification"

Removal

(Refer to Fuel Delivery System - "High Pressure Fuel Pump")

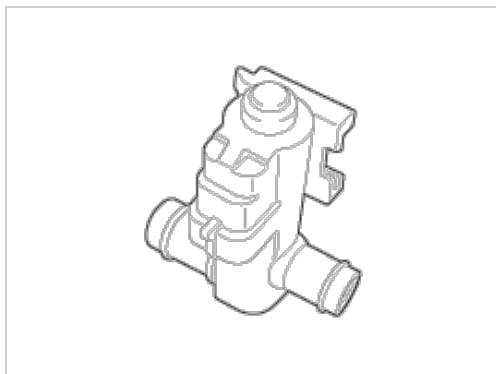
Installation

(Refer to Fuel Delivery System - "High Pressure Fuel Pump")

Engine Control/Fuel System

Description

Canister Close Valve (CCV) is installed on the canister ventilation line. It seals evaporative emission control system by shutting the canister from the atmosphere when leakage detecting system operates.



Engine Control/Fuel System

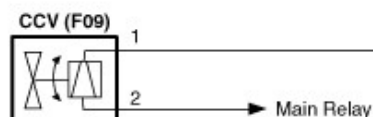
Specification

Item	Specification
Coil Resistance (Ω)	19.9 ~ 22.9 [20°C(68°F)]

Engine Control/Fuel System

Circuit Diagram

[Circuit Diagram]



[Harness Connector]

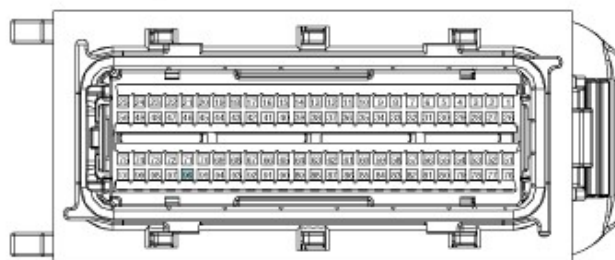


ECM (E100-A)

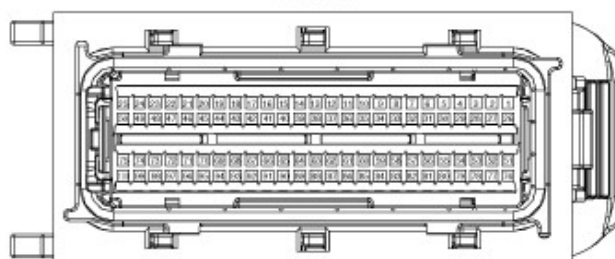
96 - CCV Control

[Connection Information]

Terminal	Connected to	Function
1	ECM E100-A (96)	CCV Control
2	Main Relay	Battery Power (B+)



E100-A



C100-B

Engine Control/Fuel System



Inspection

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

Specification: Refer to "Specification"

5. Disconnect the vapor hose connected with the canister from the CCV.
6. Connect a vacuum pump to the nipple.
7. Ground the CCV control line and apply battery voltage to the CCV power supply line.
8. Apply vacuum and check the valve operation.

Specification: Vacuum maintained

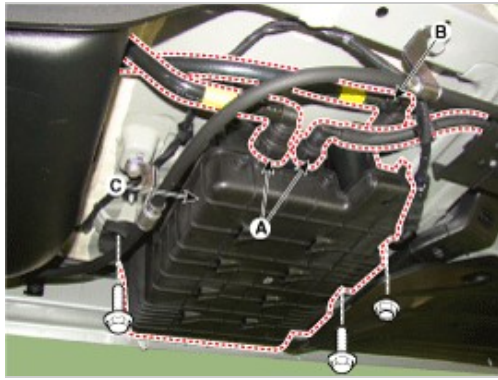
Removal

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Lift the vehicle.
3. Disconnect the canister close valve extension connector (A).

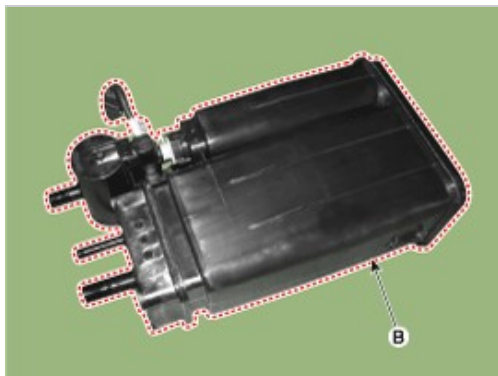
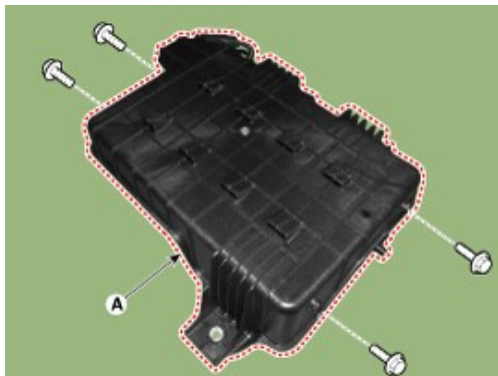


4. Disconnect the vapor tube quick-connector (A) from the canister.

5. Disconnect the ventilation tube quick-connector (B) from the fuel tank air filter.
6. Remove the canister assembly (C) after removing the mounting bolts and nut.



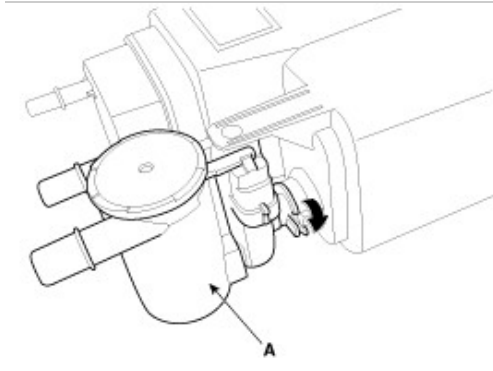
7. Remove the canister protector (A) from the canister (B) after removing the installation 4 bolts.



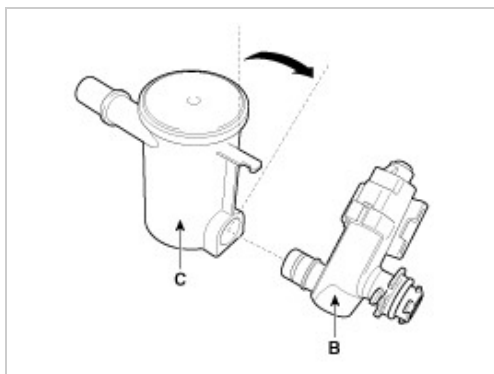
8. Remove the canister close valve connector (A).



9. Remove the fuel tank air filter & canister close valve assembly (A) after rotating it in the direction of the arrow in the figure.



10. Release the lever (A), and then separate the canister close valve (B) from the fuel tank air filter (C) after rotating it in the direction of the arrow in the figure.



Installation

NOTICE

- Install the component with the specified torques.
- Note that internal damage may occur when the component is dropped. If the component has been dropped, inspect before installing.

1. Install in the reverse order of removal.

Canster protector installation bolt :

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

Canster assembly installation bolt/nut :

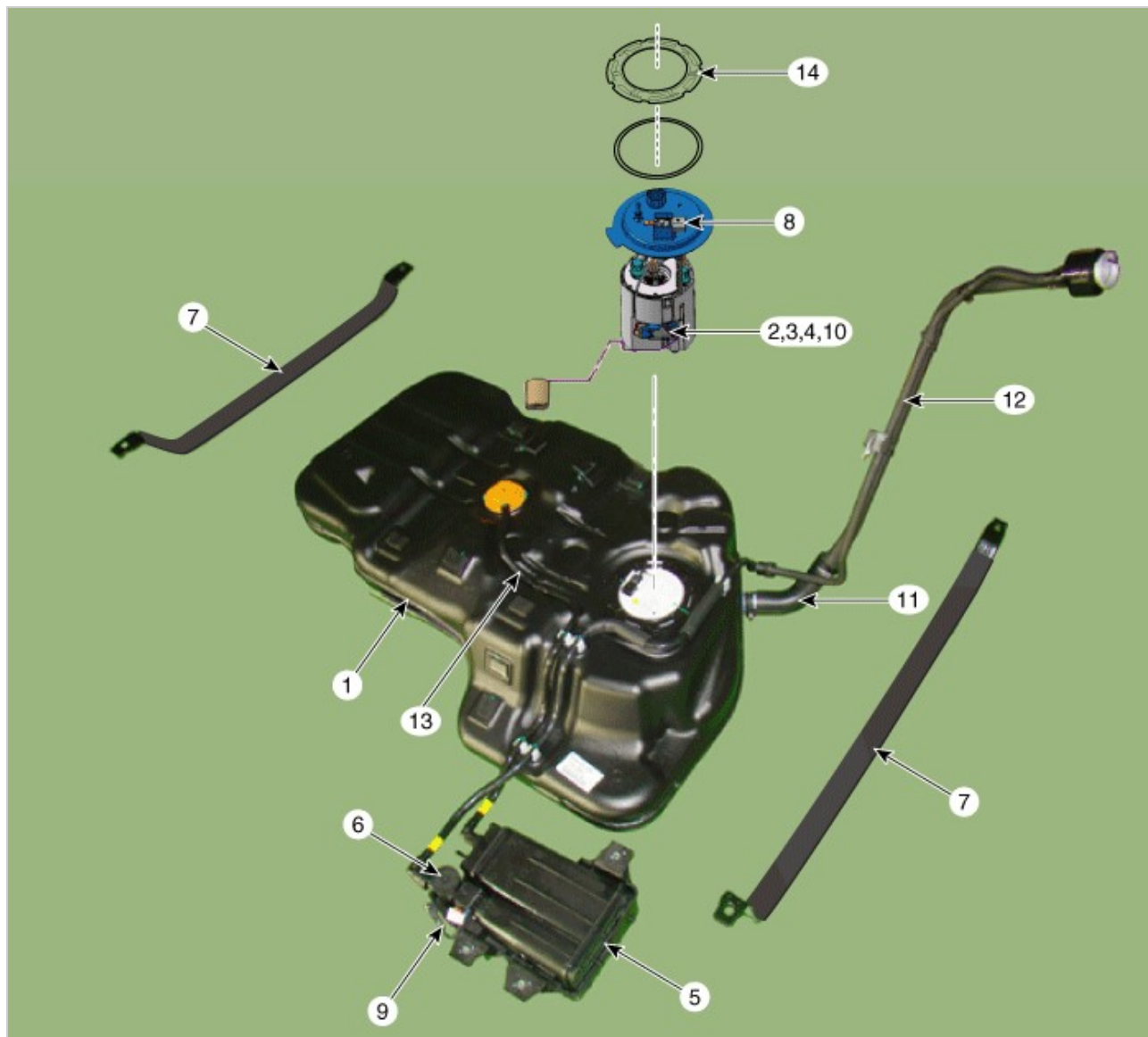
3.9 ~ 5.9 N.m (0.4 ~ 0.6 kgf.m, 2.9 ~ 4.3 lb-ft)

Engine Control/Fuel System



Components Location

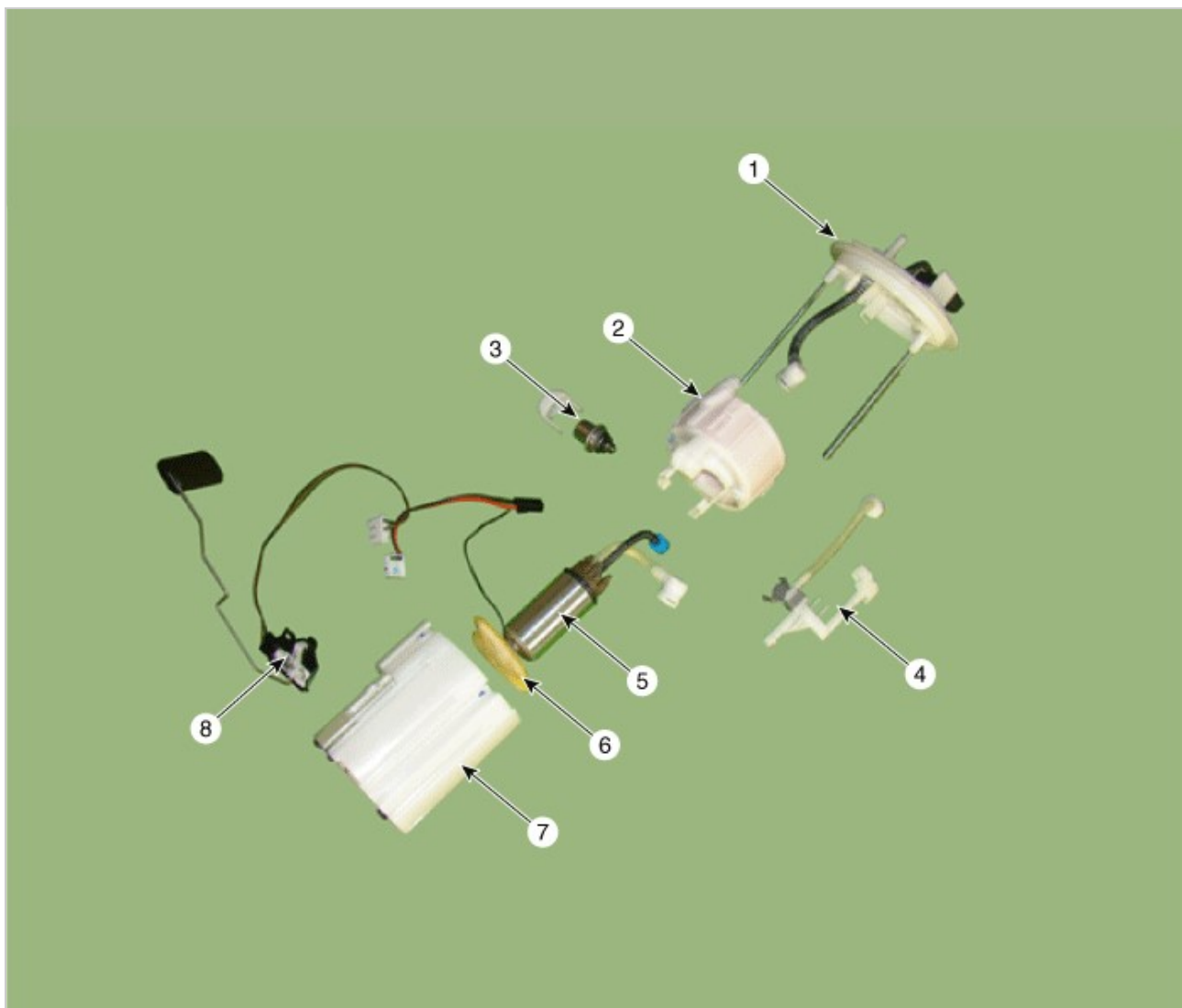
[Fuel Tank]



- 1. Fuel tank
- 2. Fuel pump
- 3. Fuel filter
- 4. Fuel pressure regulator
- 5. Canister
- 6. Fuel tank air filter
- 7. Fuel tank band

- 8. Fuel tank pressure sensor (FTPS)
- 9. Canister close valve (CCV)
- 10. Fuel level sender (FLS)
- 11. Fuel filler hose
- 12. Ventilation tube
- 13. Vapor tube
- 14. Fuel pump locking ring

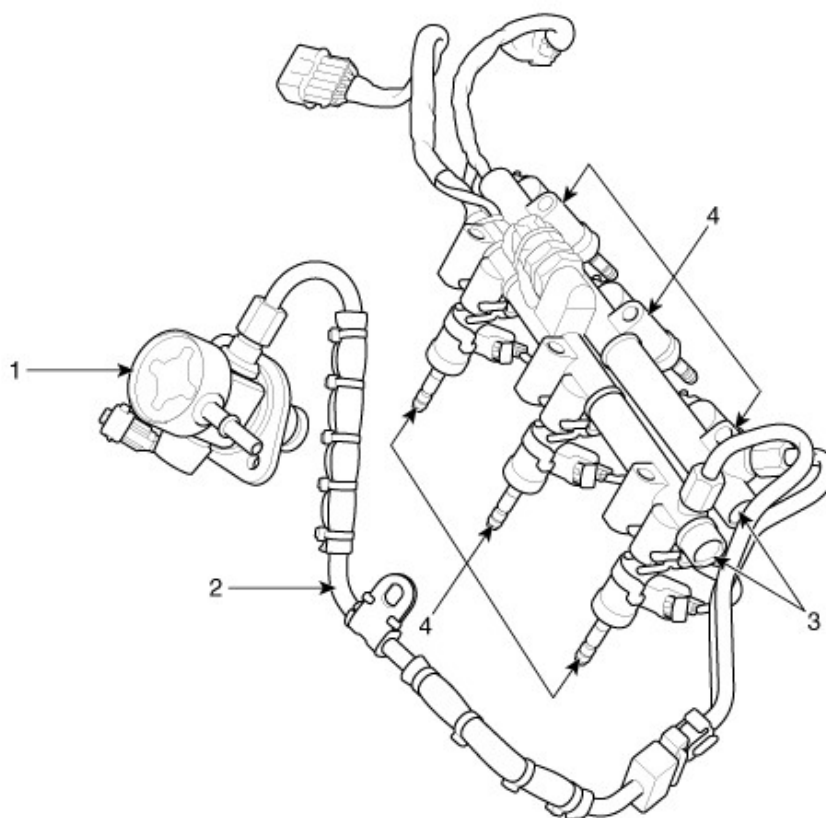
[Fuel Pump]



- 1. Fuel pump head assembly
- 2. Fuel filter
- 3. Fuel pressure regulator
- 4. Assist pump

- 5. Fuel pump motor
- 6. Pre-filter
- 7. Reservoir cup
- 8. Fuel sender

[High Pressure Fuel Line]



1. High Pressure Fuel Pump
2. High Pressure Fuel Pipe

3. Delivery Pipe
4. Injector

⚠ WARNING

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

Engine Control/Fuel System



Fuel Pressure Test

1. Release the residual pressure in fuel line.
(Refer to Fuel Delivery System - "Release Residual Pressure in Fuel Line")

⚠ CAUTION

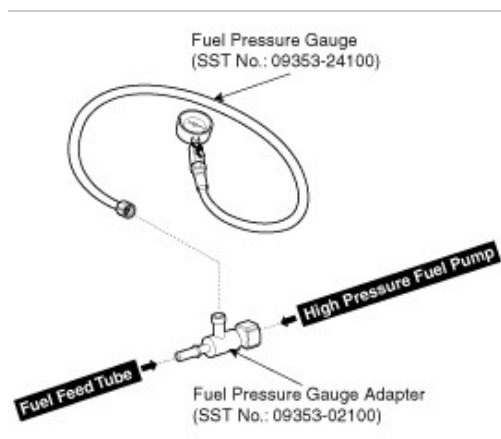
When removing the fuel pump relay, a Diagnostic Trouble Code (DTC) may occur. Delete the code with the GDS after completion of "Release Residual Pressure in Fuel Line" work.

2. Install the Special Service Tool (SST).
(1) Disconnect the fuel feed tube from the high pressure fuel pump.

⚠ CAUTION

There may be some residual pressure even after "Release Residual Pressure in Fuel Line" work, so cover the hose connection with a shop towel to prevent residual fuel from spilling out before disconnecting any fuel connection.

- (2) Install the special service tool for measuring the fuel pressure in between the fuel feed tube and the high pressure fuel pump
(Refer to the figure below).



3. Inspect fuel leakage on connections among the fuel feed tube, the high pressure fuel pump, and the SST components with IG ON.

4. Measure Fuel Pressure.

(1) Start the engine and measure the fuel pressure at idle.

Fuel Pressure:

480 ~ 520 kPa (4.9 ~ 5.3 kgf/cm², 69.6 ~ 75.4 psi)

NOTICE

If the fuel pressure differs from the standard value, repair or replace the related part (Refer to the table below).

Fuel Pressure	Cause	Related Part
Too Low	Fuel filter clogged	Fuel Filter
	Fuel leakage	Fuel Pressure Regulator
Too High	Fuel pressure regulator stuck	Fuel Pressure Regulator

(2) Stop the engine, and then check for the change in the fuel pressure gauge reading.

Standard Value: The gauge reading should hold for about 5 minutes after the engine stops

NOTICE

If the gauge reading should not be held, repair or replace the related part (Refer to the table below).

Fuel Pressure (After Engine Stops)	Cause	Related Part
Fuel Pressure Drops Slowly	Leakage on injector	Injector
Fuel Pressure Drops Immediately	Check valve of fuel pump stuck open	Fuel Pump

(3) Turn the ignition switch OFF.

5. Release the residual pressure in fuel line.

(Refer to Fuel Delivery System - "Release Residual Pressure in Fuel Line")

CAUTION

When removing the fuel pump relay, a Diagnostic Trouble Code (DTC) may occur. Delete the code with the GDS after completion of "Release Residual Pressure in Fuel Line" work.

6. Test End

(1) Remove the Special Service Tool (SST) from the fuel feed tube and the high pressure fuel pump.

(2) Connect the fuel feed tube and the high pressure fuel pump.

Release Residual Pressure in Fuel Line

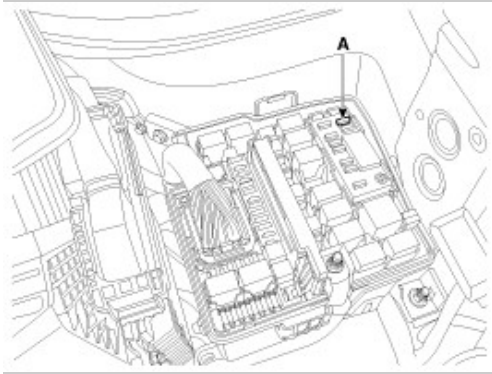
CAUTION

Whenever the high pressure fuel pump, fuel pipe, delivery pipe, or injector is removed immediately after shutting off the engine, an injury may be caused by the release of highly pressurized fuel. Release the residual pressure in the high pressure fuel line by referring to the "Residual fuel pressure release procedure" below before removing any high pressure fuel system components.

NOTICE

Wear safety glasses and fuel resistant gloves.

1. Turn the ignition off and disconnect the battery negative cable.
2. Remove the fuel pump fuse (A).



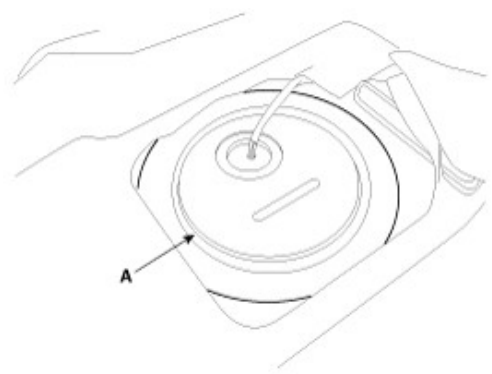
3. Disconnect the electrical connector from the high pressure fuel pump.
4. Reconnect the battery negative cable.
5. Run the engine for about 20 seconds to lower the pressure in both the high or low pressure lines. The engine may shut off within the 20 second period. If not, turn the engine off.
6. Proceed with the service or repair. Use rags to cover opening and catch spills when opening up the high pressure system.
7. Reinstall / re-connect all components in reverse order of removal. Start engine and confirm proper operation, and make sure there are no fuel leaks.
8. After completing, clear DTC(s) using GDS scan tool (the procedure described above will cause DTC to set).

Engine Control/Fuel System

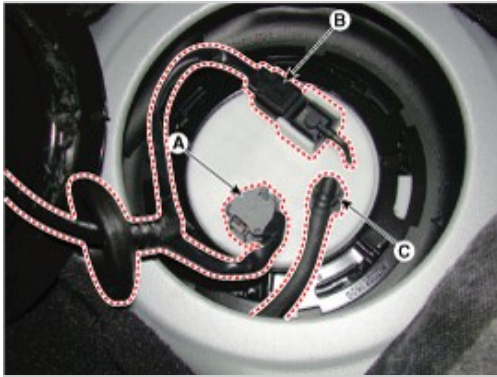


Removal

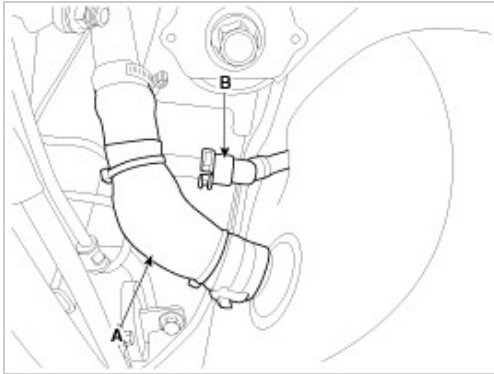
1. Release the residual pressure in fuel line.
(Refer to Fuel Delivery System - "Release Residual Pressure in Fuel Line")
2. Remove the rear seat assembly.
(Refer to Body - "Rear Seat Assembly")
3. Remove the fuel pump service cover (A).



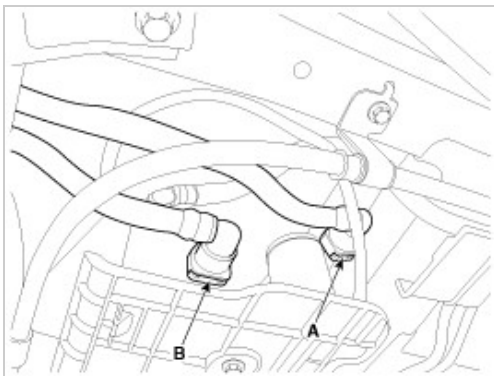
4. Disconnect the fuel pump connector (A) and the fuel tank pressure sensor connector (B).
5. Disconnect the fuel feed tube quick connector (C).



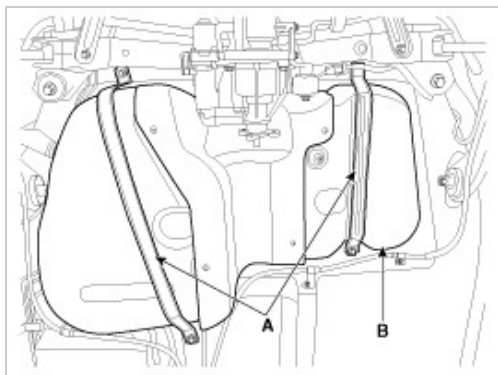
6. Remove the rear - LH wheel & tire.
7. Lift the vehicle and support the fuel tank with a jack.
8. Remove the center & rear muffler assembly.
[4 WD]
(Refer to Engine Mechanical System - "Muffler")
9. Remove the propeller shaft.
[4WD]
(Refer to Driveshaft and axle - "Propeller Shaft")
10. Disconnect the fuel filler hose (A) and the ventilation tube quick-connector (B).



11. Disconnect the ventilation tube quick-connector (A).
12. Disconnect the vapor tube quick-connector (B).



13. Remove the fuel tank (B) from the vehicle after removing the fuel tank band (A).



NOTICE

When removing the fuel tank, the fuel tank must be tilted because of interfering with coupling.

Installation

1. Install in the reverse order of removal.

Fuel tank band installation bolt:

44.1 ~ 58.8 N.m (4.5 ~ 6.0 kgf.m, 32.6 ~ 43.4 lb-ft)

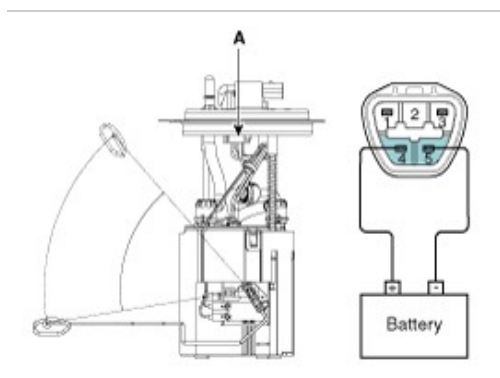
Engine Control/Fuel System



Inspection

[Fuel pump motor]

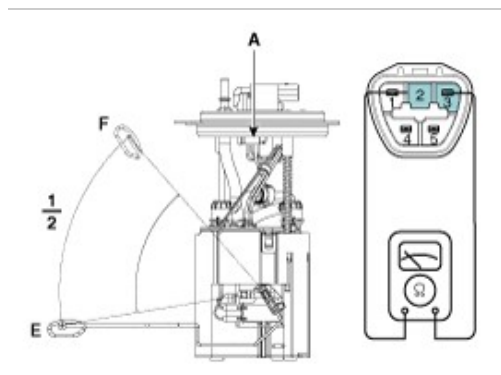
1. Turn the ignition switch OFF, and then remove battery (-) cable.
2. Remove the fuel pump assembly.
3. Check motor operation by fuel pump connector (A) connecting power (No.4) and ground (No.5).



Pin No.	Description
1	-
2	Fuel sender signal
3	Fuel sender ground
4	Fuel pump motor (+)
5	Fuel pump motor ground

[Fuel sender]

1. Turn the ignition switch OFF, and then remove battery (-) cable.
2. Remove the fuel pump assembly.
3. Using an ohmmeter, measure the resistance between terminals 2 and 3 of sender connector (A) at each float level.



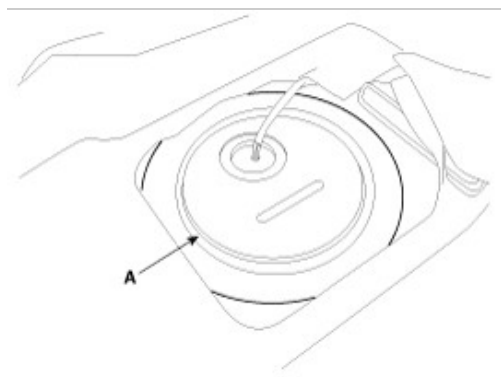
Pin No.	Description
1	-
2	Fuel sender signal
3	Fuel sender ground
4	Fuel pump motor (+)
5	Fuel pump motor ground

4. Also check that the resistance changes smoothly when the float is moved from "E" to "F".

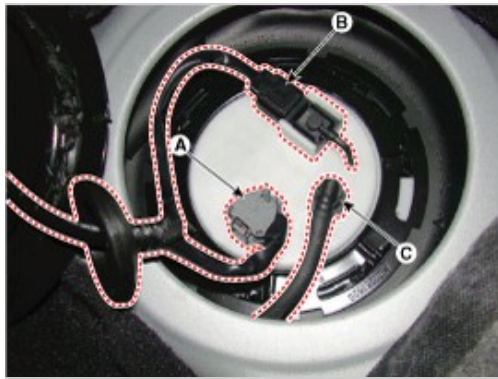
Position	Resistance(Ω)
E	197 ~ 203
Warning lamp	168 ~ 172
1/2	64.2 ~ 68.2
Sender (F)	6 ~ 10

Removal

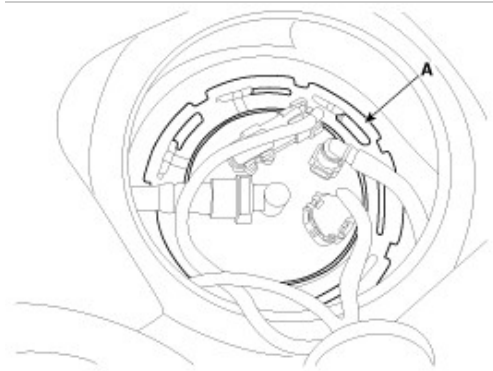
1. Release the residual pressure in fuel line.
(Refer to Fuel Delivery System - "Release Residual Pressure in Fuel Line")
2. Remove the rear seat.
(Refer to Body - "Rear Seat Assembly")
3. Remove the fuel pump service cover (A).



4. Disconnect the fuel pump connector (A) and the fuel tank pressure sensor connector (B).
5. Disconnect the fuel feed tube quick connector (C).



6. Remove locking ring (A) by using the special service tool.



Information

The locking ring should be removed by a locking ring remover as below.
This tool can be purchased from a common tool supplier.



Installation

1. Install in the reverse order of removal.

CAUTION

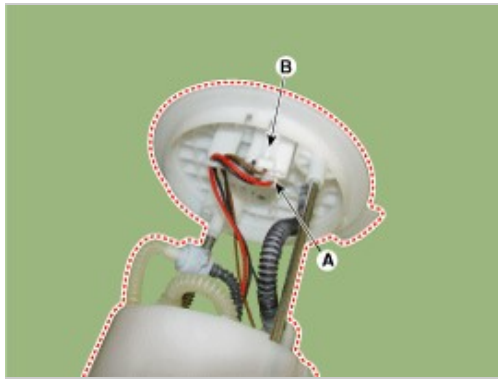
Be careful of fuel pump direction when installing (Refer to the groove in the fuel tank).

Engine Control/Fuel System

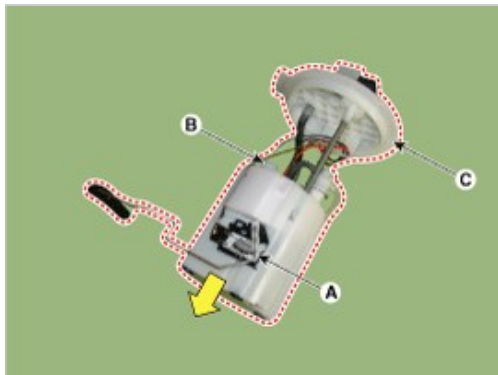


Removal

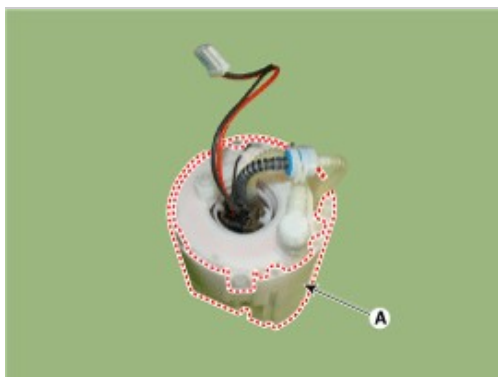
1. Remove the fuel pump.
(Refer to Fuel Delivery System - "Fuel Pump")
2. Disconnect the electric pump wiring connector (A) and the fuel sender connector (B).



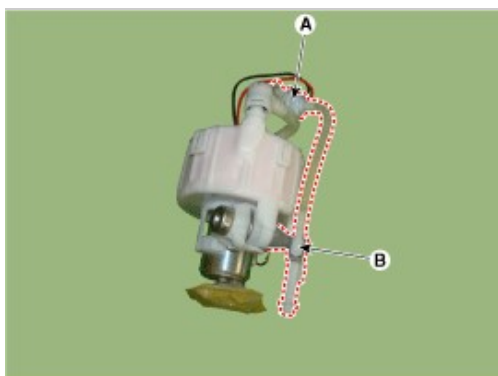
3. Remove the fuel sender (A) after releasing the fix hook.
4. Remove the fixing clip, and then disconnect the fuel feed tube quick-connector (B).
5. Remove the head assembly (C) after releasing the fixing hooks.



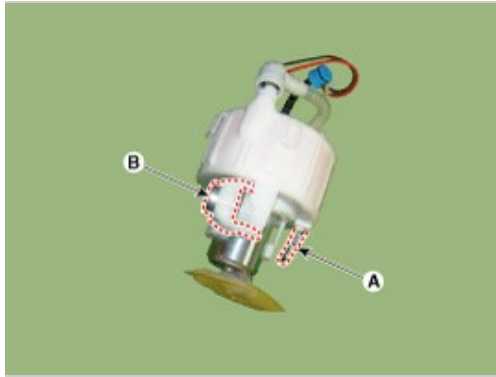
6. Remove the reservoir-cup (A) after releasing the fixing hooks.



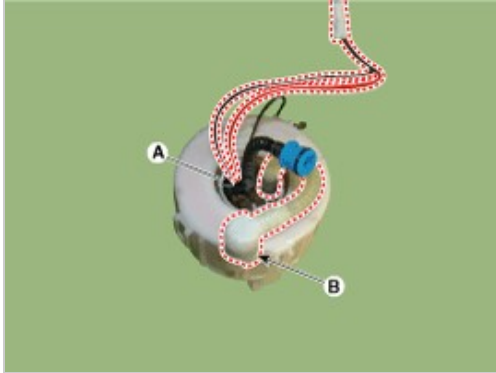
7. Remove the cap (A), and then remove the assist pump (B).



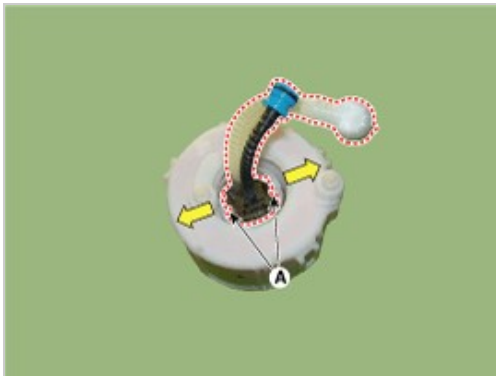
8. Disconnect the ground cable (A).
9. Remove the fuel pressure regulator (B) after releasing the fixing hooks.



10. Disconnect the ground cable connector (A) and the fuel pump tube cap (B).



11. Separate the electric pump motor from the fuel filter after releasing the fixing hooks (A).



Installation

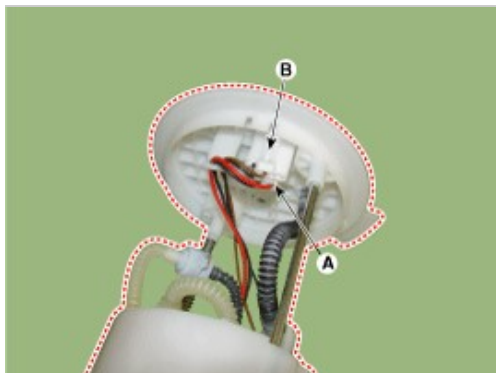
1. Install in the reverse order of removal.

Engine Control/Fuel System

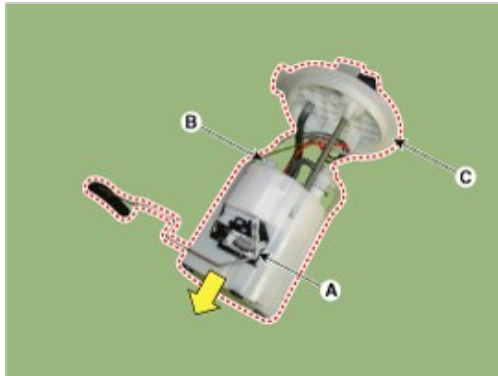


Removal

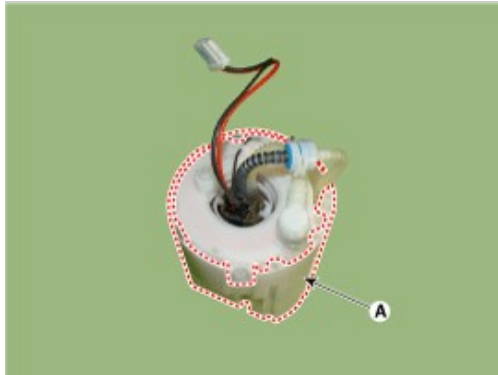
1. Remove the fuel pump.
(Refer to Fuel Delivery System - "Fuel Pump")
2. Disconnect the electric pump wiring connector (A) and the fuel sender connector (B).



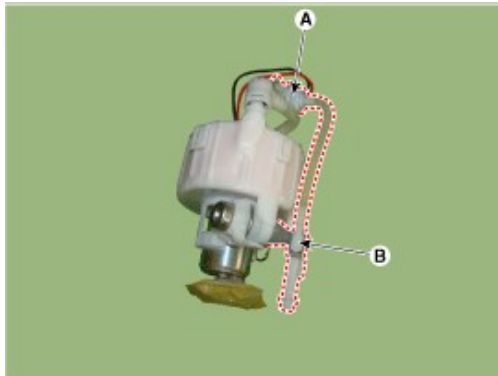
3. Remove the fuel sender (A) after releasing the fix hook.
4. Remove the fixing clip, and then disconnect the fuel feed tube quick-connector (B).
5. Remove the head assembly (C) after releasing the fixing hooks.



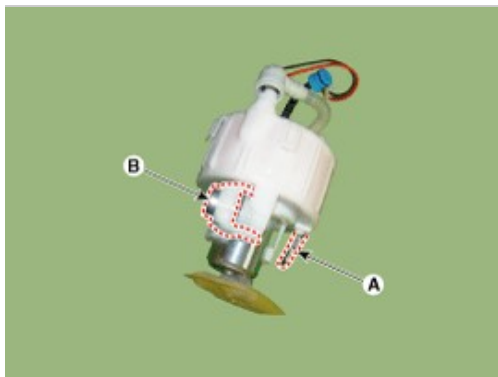
6. Remove the reservoir-cup (A) after releasing the fixing hooks.



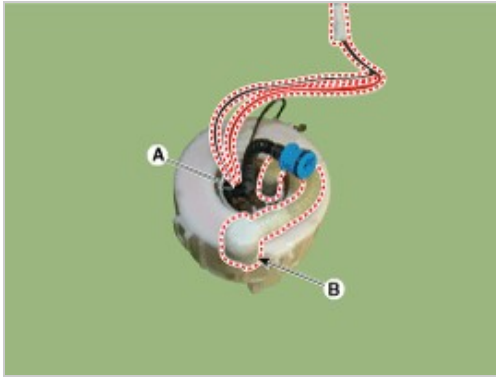
7. Remove the cap (A), and then remove the assist pump (B).



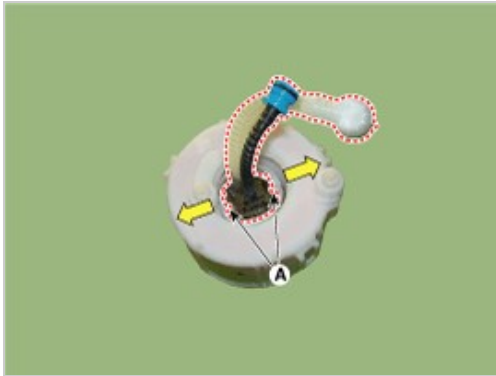
8. Disconnect the ground cable (A).
9. Remove the fuel pressure regulator (B) after releasing the fixing hooks.



10. Disconnect the ground cable connector (A) and the fuel pump tube cap (B).



11. Separate the electric pump motor from the fuel filter after releasing the fixing hooks (A).



Installation

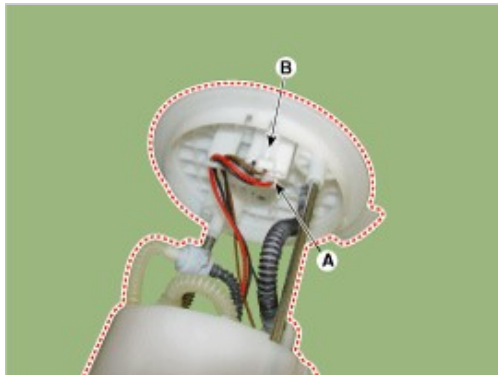
1. Install in the reverse order of removal.

Engine Control/Fuel System

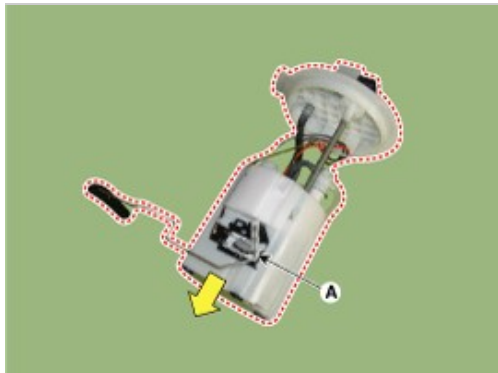


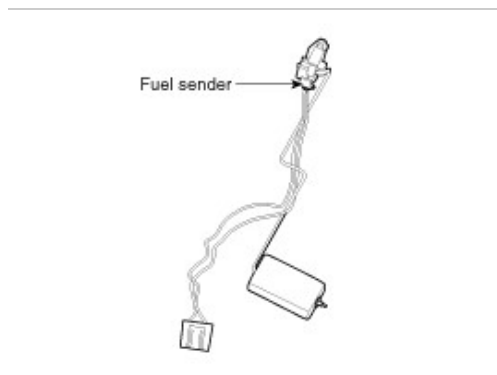
Removal

1. Remove the fuel pump.
(Refer to Fuel Delivery System - "Fuel Pump")
2. Disconnect the electric pump wiring connector (A) and the fuel sender connector (B).



3. Remove the fuel sender (A) after releasing the fix hook.





Installation

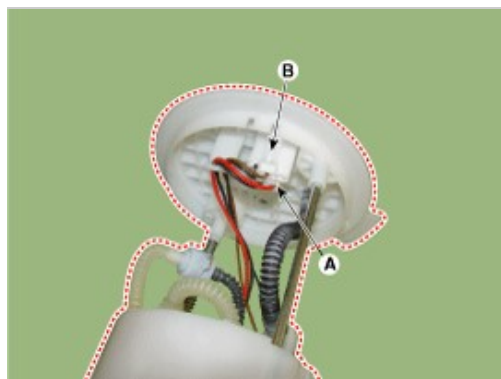
1. Install in the reverse order of removal.

Engine Control/Fuel System

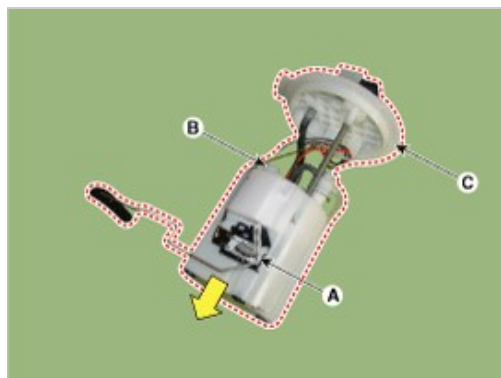


Removal

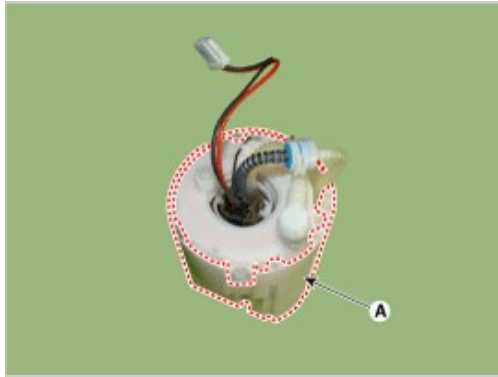
1. Remove the fuel pump.
(Refer to Fuel Delivery System - "Fuel Pump")
2. Disconnect the electric pump wiring connector (A) and the fuel sender connector (B).



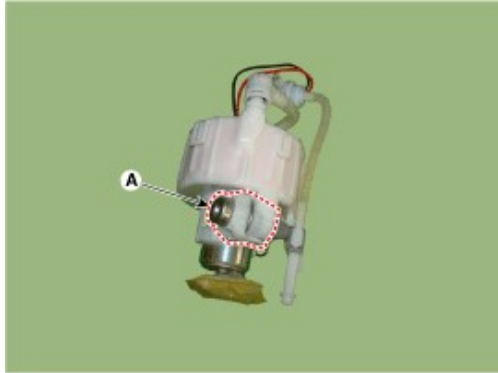
3. Remove the fuel sender (A) after releasing the fix hook.
4. Remove the fixing clip, and then disconnect the fuel feed tube quick-connector (B).
5. Remove the head assembly (C) after releasing the fixing hooks.



6. Remove the reservoir-cup (A) after releasing the fixing hooks.



7. Remove the fuel pressure regulator (A) after releasing the fixing hooks.



Installation

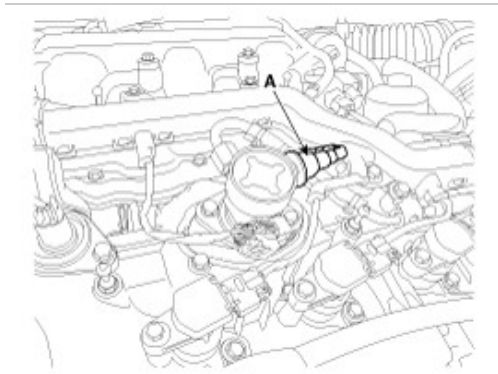
1. Install in the reverse order of removal.

Engine Control/Fuel System

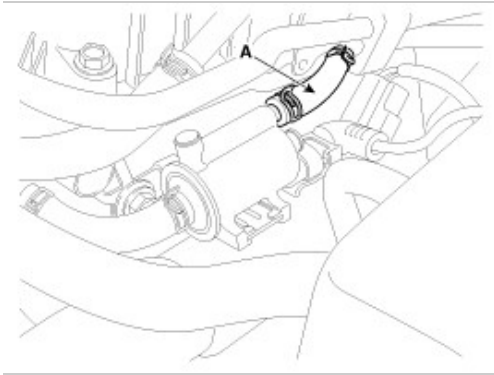


Removal

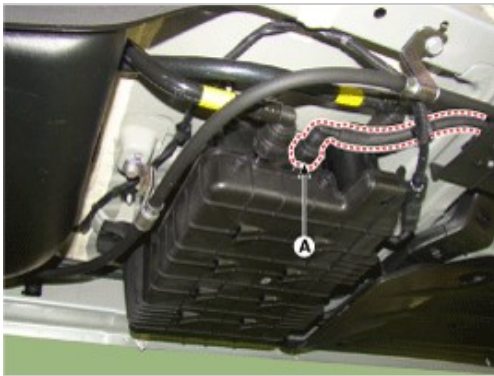
1. Turn the ignition switch OFF, and then remove battery (-) cable.
2. Release the residual pressure in fuel line.
(Refer to Fuel Delivery System - "Release Residual Pressure in Fuel Line")
3. Disconnect the low pressure fuel quick-connector (A).



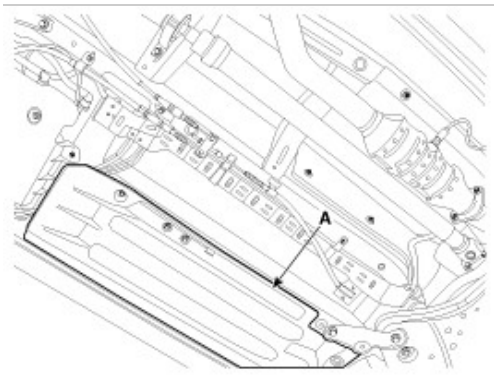
4. Disconnect the vapor hose (A) which is connected from the PCSV.



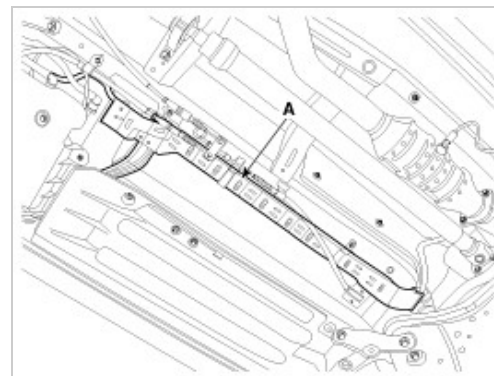
5. Lift the vehicle.
6. Remove the fuel tank.
(Refer to Fuel Delivery System - "Fuel Tank")
7. Disconnect the vapor tube quick-connector (A).



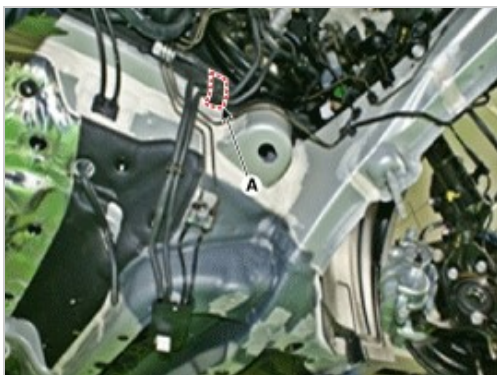
8. Open the vapor tube and low fuel line fixing clip to using driver.
9. Release the under cover (A) after remove the mounting bolts.



10. Disconnect the fuel & brake line protect (A) from the fixing clip.



11. Disconnect the fuel line fixing bracket (A) to engine room low.



12. Remove the fuel line.

Installation

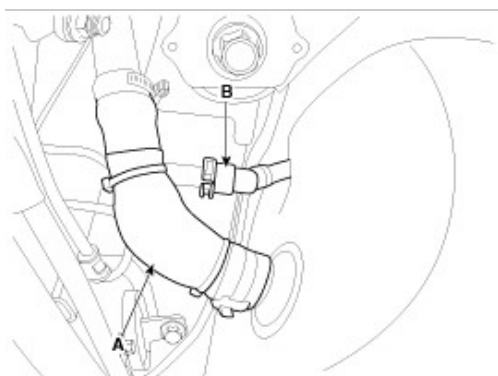
1. Install in the reverse order of removal.

Engine Control/Fuel System



Removal

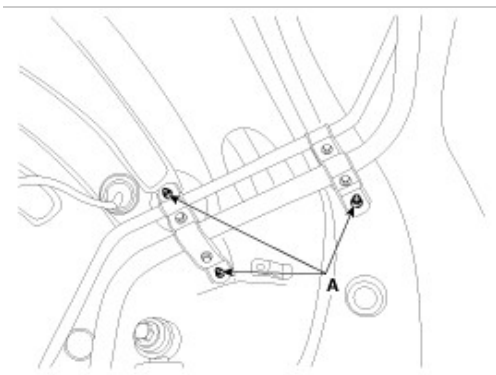
1. Lift the vehicle.
2. Disconnect the fuel filler hose (A).
3. Disconnect the ventilation tube quick-connector (B).



4. Open the fuel filler door and unfasten the filler-neck assembly mounting screw (A).



5. Remove the rear-LH wheel, tire and the inner wheel house.
6. Remove the filler-neck assembly from the vehicle after removing the bracket mounting nut (A).



Installation

1. Install in the reverse order of removal.

Filler-neck assembly bracket installation nut :

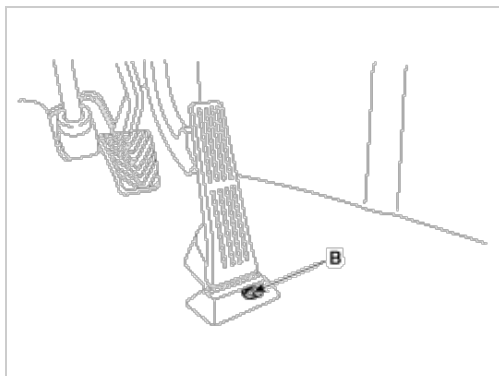
3.9 ~ 5.9 N.m (0.4 ~ 0.6 kgf.m, 2.9 ~ 4.3 lb-ft)

Engine Control/Fuel System



Removal

1. Turn the ignition switch OFF and disconnect the negative (-) battery cable.
2. Disconnect the accelerator position sensor connector (A).
3. Remove the installation nuts (C), the bolt (B) and then remove the accelerator pedal module.



Installation

1. Install in the reverse order of removal.

Accelerator pedal module installation nut:

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

Accelerator pedal module installation bolt:

8.8 ~ 13.7 N.m (0.9 ~ 1.4 kgf.m, 6.5 ~ 10.1 lb-ft)

Engine Control/Fuel System



Removal

⚠ WARNING

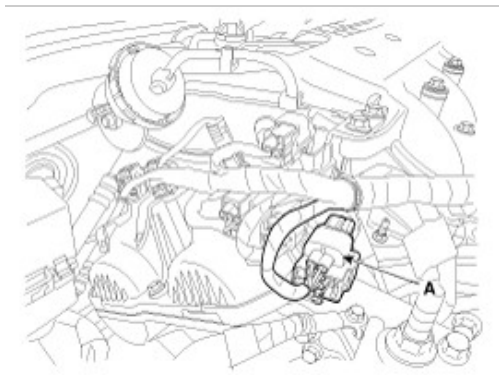
In case of removing the high pressure fuel pump, high pressure fuel pipe, delivery pipe, and injector, there may be injury caused by leakage of the high pressure fuel. So don't do any repair work right after engine stops.

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Release the residual pressure in fuel line.
(Refer to Fuel Delivery System - "Release Residual Pressure in Fuel Line")

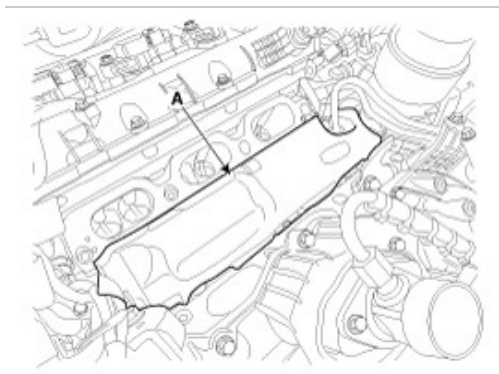
⚠ CAUTION

When removing the fuel pump relay, a Diagnostic Trouble Code (DTC) may occur. Delete the code with the GDS after completion of "Release Residual Pressure in Fuel Line" work.

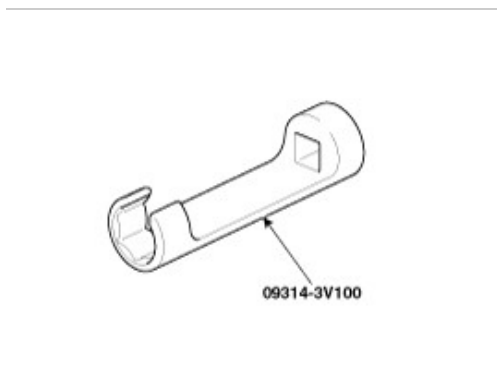
3. Disconnect the injectors & rail pressure sensor connector (A).

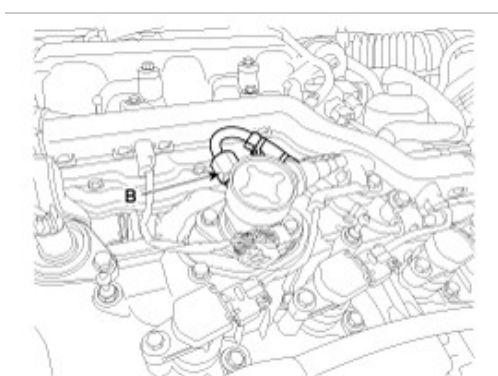
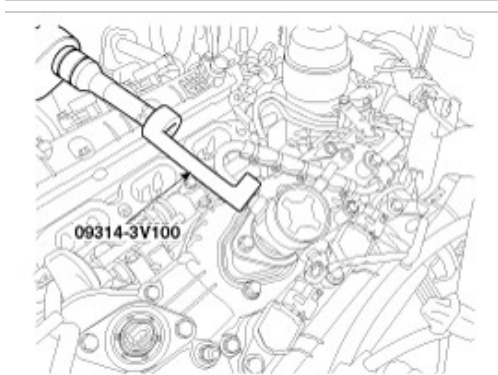
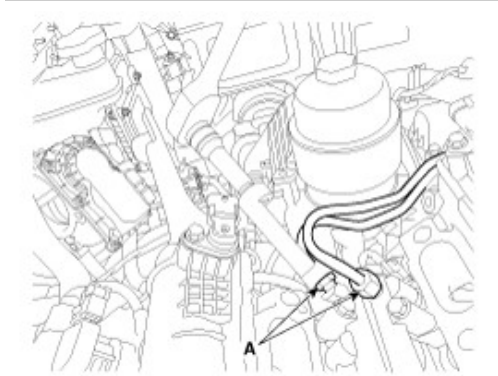
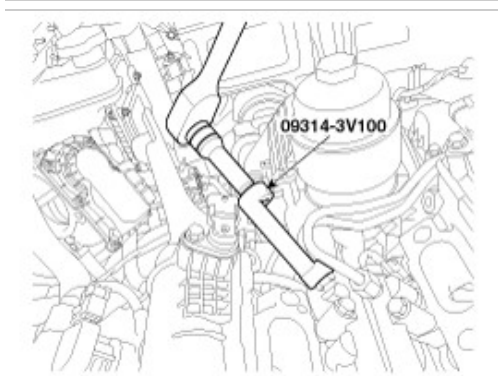
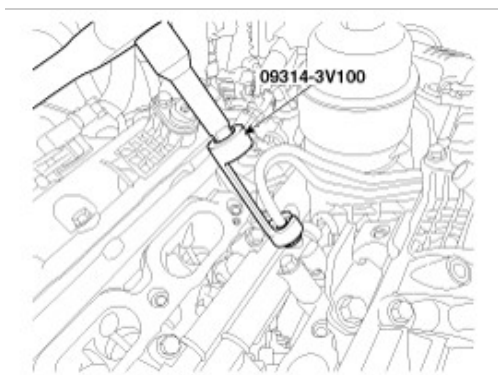


4. Remove the intake manifold.
(Refer to Engine Mechanical System - "Intake Manifold")
5. Remove the injector foam (A).

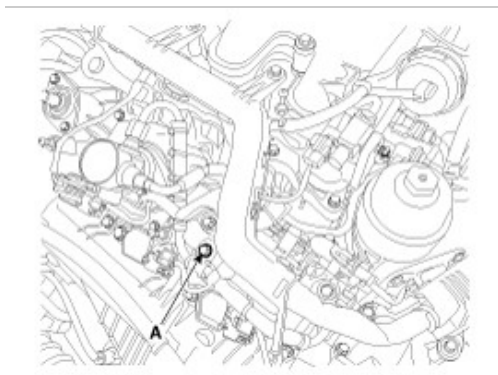


6. Remove the high pressure fuel pipe.
(1) Loosen the flange nut in the order of A,B with SST(09314-3V100).

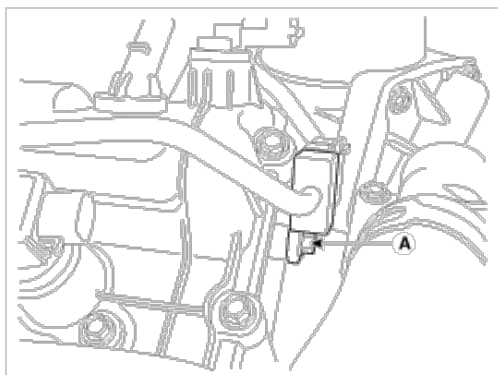




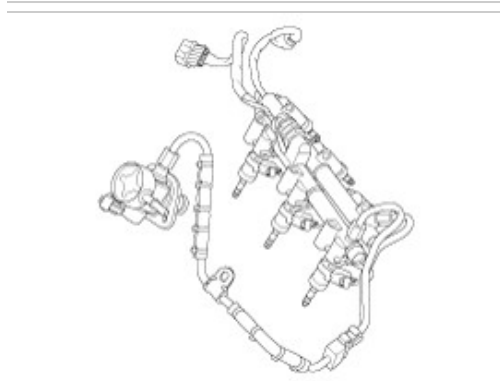
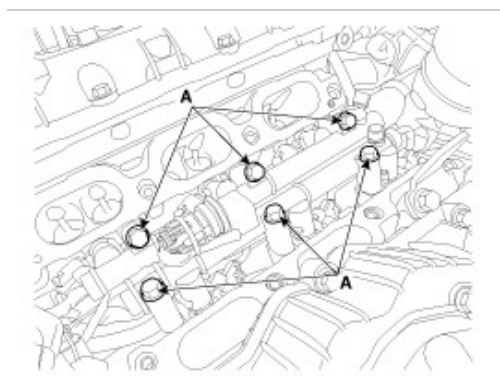
(2) Remove the high pressure pipe bracket bolt (A).



(3) Remove the function block installation bolt (A).



7. Remove the installation bolt (A), and then remove the delivery pipe and injector assembly from the engine.



Installation

⚠ CAUTION

- Do not use already used injector fixing clip again.

⚠ CAUTION

- Install the component with the specified torques.
- Note that internal damage may occur when the component is dropped. In this case, use it after inspecting.

⚠ CAUTION

- Apply engine oil to the injector O-ring.
- Do not use already used injector O-ring again.

⚠ CAUTION

- Do not use already used bolt again.

⚠ CAUTION

- When insert the injector, be careful not to damage the injector tip.

1. Installation is reverse of removal.

Delivery pipe installation bolt:

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

High pressure fuel pipe installation nut:

29.4 ~ 35.3 N.m (3.0 ~ 3.6 kgf.m, 21.7 ~ 26.0 lb-ft)

High pressure fuel pipe function block installation bolt:

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

High pressure fuel pipe bracket installation bolt:

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

Engine Control/Fuel System



Removal

⚠ WARNING

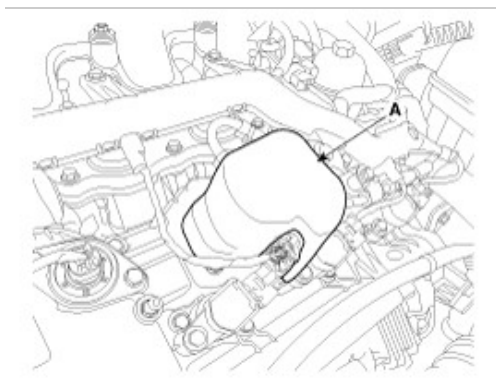
In case of removing the high pressure fuel pump, high pressure fuel pipe, delivery pipe, and injector, there may be injury caused by leakage of the high pressure fuel. So don't do any repair work right after engine stops.

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Release the residual pressure in fuel line.
(Refer to Fuel Delivery System - "Release Residual Pressure in Fuel Line")

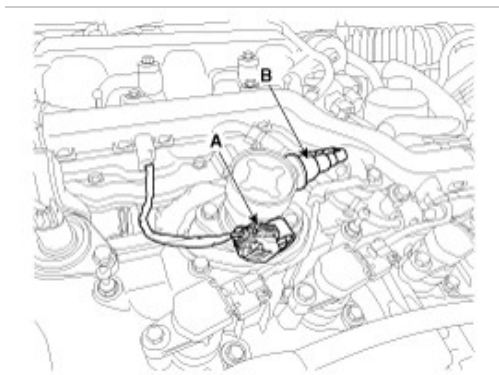
⚠ CAUTION

When removing the fuel pump relay, a Diagnostic Trouble Code (DTC) may occur.
Delete the code with the GDS after completion of "Release Residual Pressure in Fuel Line" work.

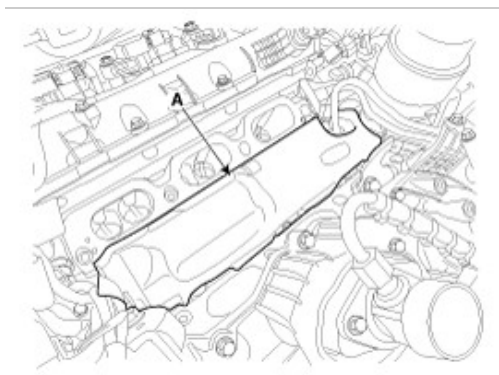
3. Remove the pump foam (A).



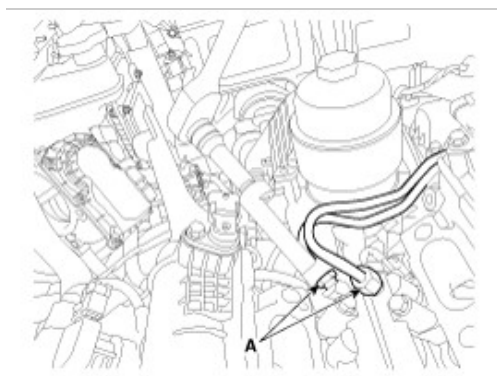
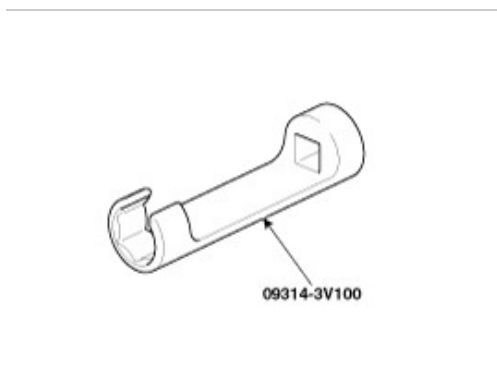
4. Disconnect the fuel pressure control valve connector (A) and the fuel feed tube quick-connector (B).

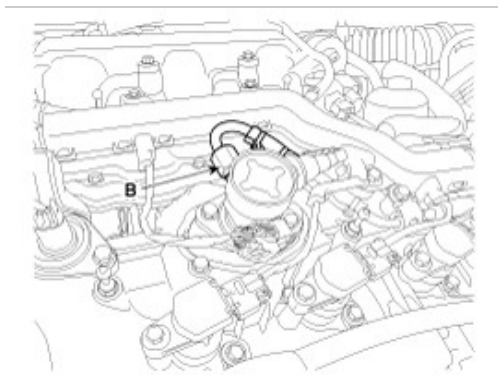


5. Remove the intake manifold.
(Refer to Engine Mechanical System - "Intake Manifold")
6. Remove the injector foam (A).

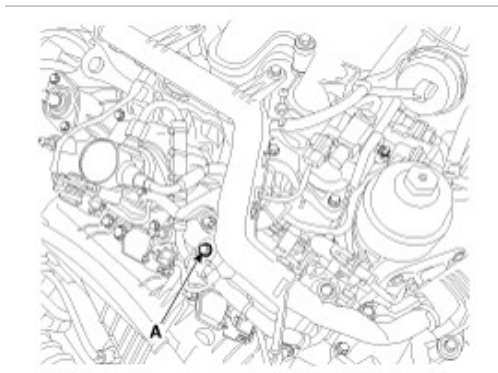


7. Remove the high pressure fuel pipe.
(1) Remove the high pressure pipe flange nut in order of A,B with the special service tool [SST No.: 09314-3V100]

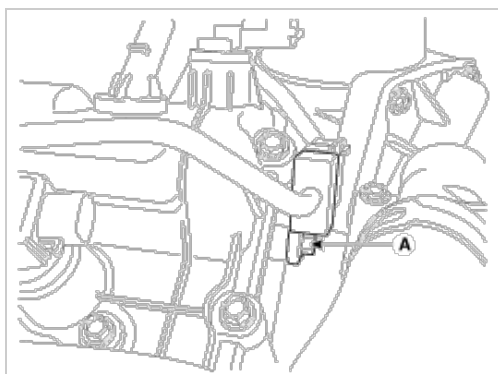




(2) Remove the high pressure pipe bracket bolt (A).



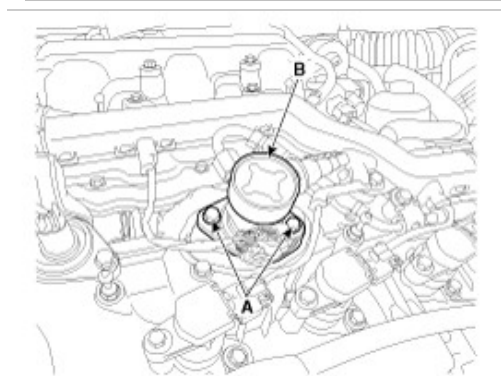
(3) Remove the function block installation bolt (A).



8. Remove the installation bolts (A), and then remove the high pressure fuel pump (B) from the cylinder head assembly.

CAUTION

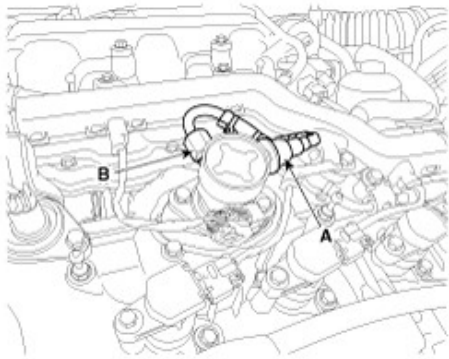
Unscrew in turn the two bolts in small step (0.5 turns). In case of fully unscrewing one of the two bolts with the other bolt installed, the housing surface of the cylinder head may be broken because of tension of the pump spring.



Installation

WARNING

- Be sure to check the low pressure fuel hose quick-connector (A) is completely connected to the high pressure fuel pump until a confirmation "click" sound is heard.
- Be sure to re-check the low pressure fuel hose is completely connected to the high pressure fuel pump by pulling it after connecting.
- Be sure to install the high pressure fuel pipe (B) with the specified torques.
- Because fuel leak may cause fire, securely inspect leakage of all fuel line connection parts at engine start condition.



⚠ CAUTION

- Before installing the high pressure fuel pump, position the roller tappet in the lowest position by rotating the crankshaft. Otherwise the installation bolts may be broken because of tension of the pump spring.

⚠ CAUTION

- Do not reuse the used bolt.

⚠ CAUTION

- Do not reuse the used high pressure fuel pipe.

⚠ CAUTION

- When tightening the installation bolts of the high pressure fuel pump, tighten in turn the bolts in small step (0.5 turns) after tightening them with hand-screwed torque.

⚠ CAUTION

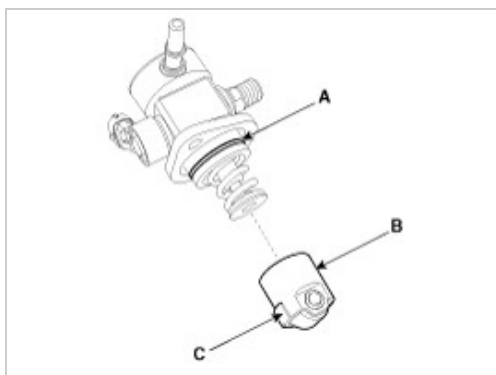
- Install the component with the specified torques.
 - First hand-tighten the fasteners fully until they are not fastened any more in order to have them inserted in place and then completely tighten to the specified torque using a torque wrench.
- If not tightening the bolts or nuts in a straight line with the mating bolt holes or fittings, it may cause a fuel leak due to broken threads.

⚠ CAUTION

- Note that internal damage may occur when the component is dropped. In this case, use it after inspecting.

⚠ CAUTION

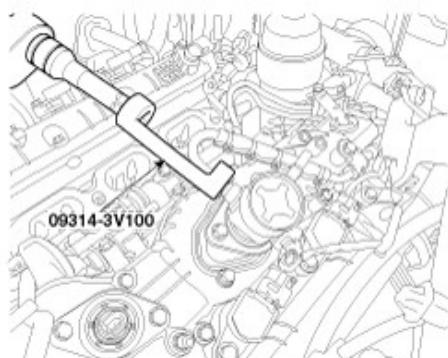
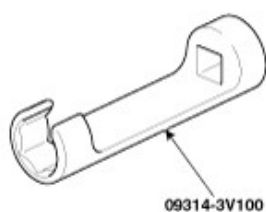
- Apply engine oil to the O-ring (A) of the high pressure fuel pump, the roller tappet (B), and the protrusion (C). Also apply engine oil to the groove on the location where the protrusion (C) is installed.



1. Installation is reverse of removal.

NOTICE

Use the special service tool [SST No.: 09314-3V100] to install the high pressure fuel pipe.



High pressure fuel pump installation bolt:

12.8 ~ 14.7 N.m (1.3 ~ 1.5 kgf.m, 9.4 ~ 10.9 lb-ft)

High pressure fuel pipe installation nut:

29.4 ~ 35.3 N.m (3.0 ~ 3.6 kgf.m, 21.7 ~ 26.0 lb-ft)

High pressure fuel pipe function block installation bolt:

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

High pressure fuel pipe bracket installation bolt:

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

