HYUNDAI

REPAIR SERVICE MANUAL

Third Generation DM (2013–2018) Santa Fe

VOLUME 1

INDEX

General Information

Important Safety Notice

Proper service methods and repair procedures are essential for safe, reliable operation of all motor vehicles as well as personal safety of the operator. The service procedures and descriptions in this shop manual provide general directions for a service and repair. Procedure, techniques, tools, and parts for service including the skill of the technician vary. It is impossible to provide advice or caution as to each case in this manual.

Accordingly, anyone who intends to use a replacement part, service procedure, or tool, which is not recommended by the vehicle manufacturer, must first assure thoroughly that neither their personal safety nor the safe operation of the vehicle will be first jeopardized by the replacement part, service procedure, or tool they select.

CAUTION

Reminds you to be especially careful in those areas where carelessness will cause death or serious injury.

WARNING

Reminds you to be especially careful in those areas where carelessness may cause death or serious injury.

CAUTION

Reminds you to be especially careful in those areas where carelessness may cause personal injury.

NOTE

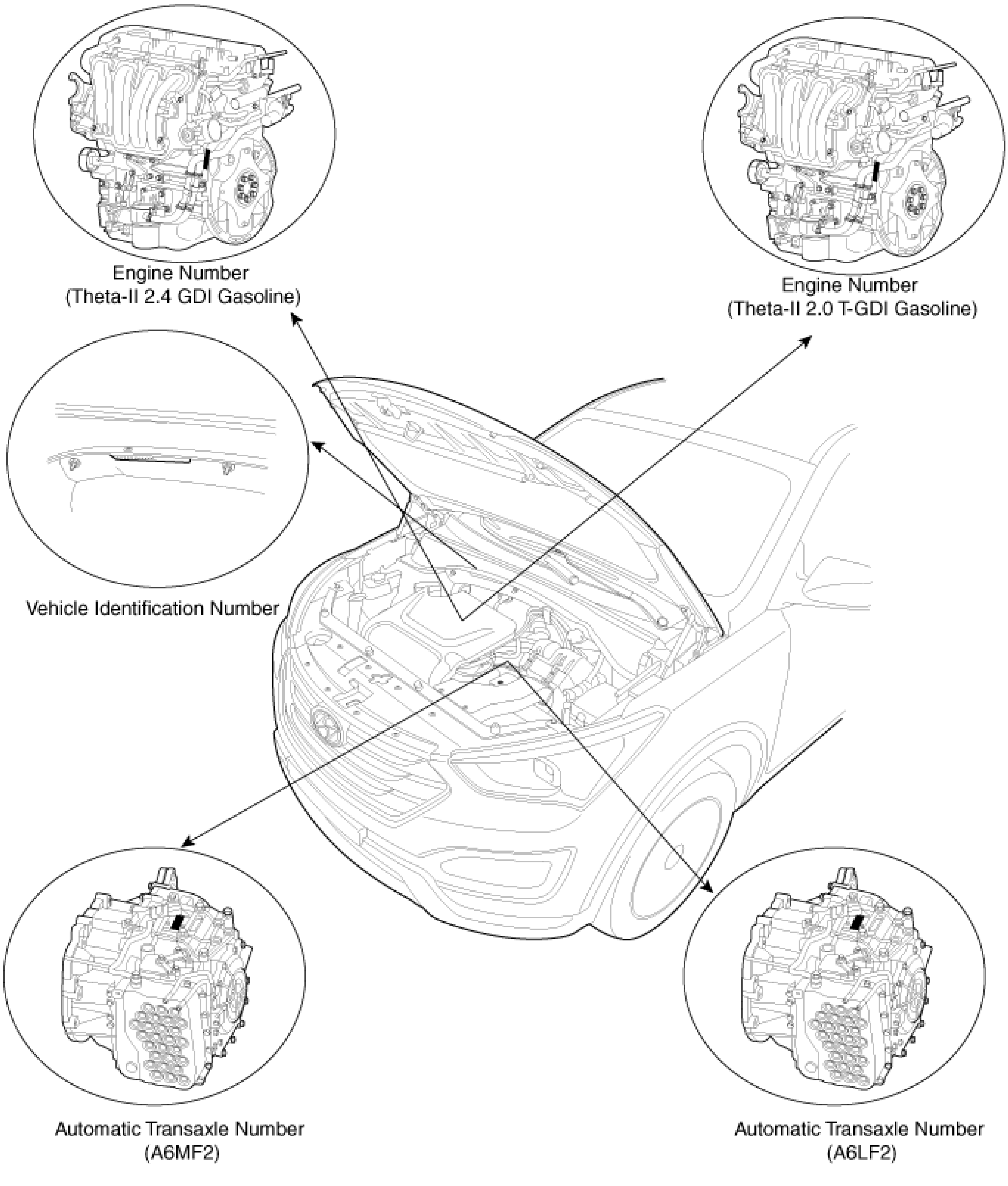
Gives you information that will prevent you from making errors that could damage the vehicle.

CAUTION

Gives you added information that will help you complete a particular procedure.

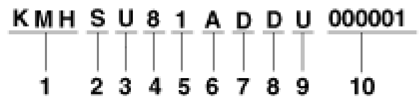
The following list contains some general WARNINGS that you should follow while working on a vehicle.

- Always wear safety glasses for eye protection.
- Use safety stands whenever a procedure requires you to be under the vehicle.
- Make sure that the ignition switch is always in the OFF position, unless otherwise required by the procedure.
- Set the parking brake when working on the vehicle. If you have an automatic transaxle, set in park unless instructed otherwise for a specific operation.
- Place supporters against the front and rear surfaces of the tires to help prevent the vehicle from moving.
- Operate the engine only in a well-ventilated area to avoid the danger of carbon monoxide poisoning.
- Keep yourself and your clothing away from moving parts when the engine is running, especially the drive belts.
- To prevent serious burns, avoid contact with hot metal parts such as the radiator, exhaust manifold, tail pipe, catalytic converter and muffler.
- Do not smoke while working on a vehicle.
- To avoid injury, always remove rings, watches, loose hanging jewelry, and loose clothing before beginning to work on a vehicle.
- When it is necessary to work under the hood, keep hands and other objects clear of the radiator fan blades! Your vehicle may be equipped with a cooling fan that may turn on, even though the ignition switch is in the OFF position. For this reason care should be taken to ensure that the radiator fan electric motor is completely disconnected when working under the hood and the engine is not running.


Engine Number
(Theta-II 2.4 GDI Gasoline)
Engine Number
(Theta-II 2.0 T-GDI Gasoline)
Vehicle Identification Number
Automatic Transaxle Number
(A6MF2)
Automatic Transaxle Number
(A6LF2)

Identification Number Description

Vehicle Identification Number



1. World Manufacturer Identifier (WMI)
- KMF : Commercial vehicle (Van)
- KMH : Passenger vehicle or MPV(Multipurpose Passenger Vehicle)/SUV(Sports Utility Vehicle)/RV(Recreational Vehicle)
- KMJ : Van
- KM8 : MPV/SUV/RV (For U.S.A, Canada, Mexico only)

2. Vehicle line
- S : SANTAFE

3. Model & Series
- S : Low grade (L)
- T : Middle-Low grade (GL)
- U : Middle grade (GLS, JSL, TAX)
- V : Middle-High grade (HGS)
- W : High grade (TOP)

4. Body/Cabin type, Gross Vehicle Weight Rating
KMF (Commercial vehicle / Van)
Except U.S.A, Canada, Mexico, Gulf Cooperation Council, China
- X : Standard Cabin / Semi-Bonnet
- Y : Double Cabin / Bonnet
- Z : Super Cabin / Box

For U.S.A, Canada, Mexico, Gulf Cooperation Council, China
- 3 : Standard Cabin Class-E 4×2 / Semi-Bonnet Class-E 4×2
- 4 : Standard Cabin Class-E 4×4 / Semi-Bonnet Class-E 4×4
- 5 : Standard Cabin Class-F 4×2 / Semi-Bonnet Class-F 4×2
- 6 : Standard Cabin Class-F 4×4 / Semi-Bonnet Class-F 4×4
- 7 : Double Cabin Class-E 4×2 / Bonnet Class-E 4×2
- 8 : Double Cabin Class-E 4×4 / Bonnet Class-E 4×4
- 9 : Double Cabin Class-F 4×2 / Bonnet Class-F 4×2
- 0 : Double Cabin Class-F 4×4 / Bonnet Class-F 4×4
- A : Super Cabin Class-E 4×2 / Box Class-E 4×2
- B : Super Cabin Class-E 4×4 / Box Class-E 4×4
- C : Super Cabin Class-F 4×2 / Box Class-F 4×2
- D : Super Cabin Class-F 4×4 / Box Class-F 4×4

KMH
- 1 : Limousine
- 2 : Sedan - 2 door
- 3 : Sedan - 3 door
- 4 : Sedan - 4 door
- 5 : Sedan - 5 door
- 6 : Coupe

- 7 : Convertible
- 8 : Wagon
- 9 : Commercial Van
- 0 : Pick-Up

KMJ

- 1 : Box
- 2 : Bonnet
- 3 : Semi-Bonnet

KM8

- 1 : Wagon 4×2 Class-A
- 2 : Wagon 4×2 Class-B
- 3 : Wagon 4×2 Class-C
- 4 : Wagon 4×2 Class-D
- 5 : Wagon 4×2 Class-E
- 6 : Wagon 4×2 Class-F
- 7 : Wagon 4×2 Class-G
- A : Wagon 4×4 Class-A
- B : Wagon 4×4 Class-B
- C : Wagon 4×4 Class-C
- D : Wagon 4×4 Class-D
- E : Wagon 4×4 Class-E
- F : Wagon 4×4 Class-F
- G : Wagon 4×4 Class-G

5. Restraint system, Brake system

KMH, KM8

Except U.S.A, Canada, Mexico

- 0 : Both side - None
- 1 : Both side - Active belt
- 2 : Both side - Passive belt

For U.S.A, Canada, Mexico

Code	Seat belt	Front air bag		Knee air bag		Side air bag			Curtain air bag		
		Driver's	Passenger's	Driver's	Passenger's	1st row	2nd row	3rd row	1st row	2nd row	3r
A	○	○	○	×	×	○	×	×	○	○	
B	○	○	○	×	×	×	×	×	×	×	
C	○	○	○	×	×	○	×	×	○	○	
D	○	○	○	×	×	○	○	×	○	○	
E	○	○	×	×	×	×	×	×	×	×	
F	○	○	○	×	×	○	×	×	×	×	
J	○	○	○	○	×	○	○	×	○	○	
L	○	○	○	○	×	○	×	×	○	○	
N	○	×	×	×	×	×	×	×	×	×	

KMJ

Except U.S.A, Canada, Mexico

- 7 : Hydraulic brake system
- 8 : Pneumatic brake system
- 9 : Mixed brake system

For U.S.A, Canada, Mexico

- X : Hydraulic brake system
- Y : Pneumatic brake system
- Z : Mixed brake system

KMF

Except U.S.A, Canada, Mexico

- 7 : Hydraulic brake system
- 8 : Pneumatic brake system
- 9 : Mixed brake system

For U.S.A, Canada, Mexico

Code	Restraint system											Brake system		
	Seat belt	Front air bag		Knee air bag		Side air bag			Curtain air bag			Hydraulic	Pneumatic	M
		Driver's	Passenger's	Driver's	Passenger's	1st row	2nd row	3rd row	1st row	2nd row	3rd row			
X	○	×	×	×	×	×	×	×	×	×	×	○	-	
V	○	○	×	×	×	×	×	×	×	×	×	○	-	
W	○	○	○	×	×	×	×	×	×	×	×	○	-	

6. Engine type

- A : Gasoline engine 2.4 (Theta-II GDI)
- B : Gasoline engine 2.0 (Theta-II T-GDI)

7. Check digit or Driver’s side & Transmission

Except U.S.A, Canada, Mexico, Gulf Cooperation Council, China, Yemen

- A : LHD & MT
- B : LHD & AT
- C : LHD & MT+Transfer
- D : LHD & AT+Transfer
- E : LHD & CVT
- L : RHD & MT
- M : RHD & AT
- N : RHD & MT+Transfer
- S : RHD & AT+Transfer
- T : RHD & CVT

For U.S.A, Canada, Mexico, Gulf Cooperation Council, China, Yemen

- Check digit : 0 ~ 9, ×

8. Model year

- D : 2013, E : 2014, F : 2015, G : 2016...

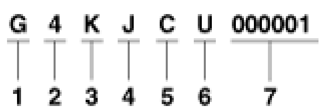
9. Plant of production

- A : Asan (Korea)
- B : Beijing (China)
- C : Cheonju (Korea)
- H : Alabama (U.S.A)

- M : Chennai (India)
- U : Ulsan (Korea)
- Z : Izmit (Turkey)
- J : Ostrava (Czech)
- R : Saint Petersburg (Russia)

10. Vehicle production sequence number
- 000001 ~ 999999

Engine Number



1. Engine fuel
- G : Gasoline

2. Engine range
- 4 : 4 cycle 4 cylinder

3. Engine development order and capacity
- K : Theta engine (Gasoline)

4. Engine Capacity
- H : 1998 cc (Theta-II T GDI engine)
- J : 2359 cc (Theta-II GDI engine)

5. Production year
- C : 2012, D : 2013, E : 2014, F : 2015...

6. Plant of production
- A : Asan (Korea)
- B : Beijing (China)
- H : Hwasung (Korea)
- K : Montgomery (U.S.A)
- M : Chennai (India)
- P : Poseung (Korea)
- S : Sohari (Korea)
- T : Izmit (Turkey)
- U : Ulsan (Korea)
- W : Shandong (China)
- Z : Zilina (Slovakia)
- 1 : Yancheng (China)

7. Engine production sequence number
- 000001 ~ 999999

Transaxle Number
Automatic (A6MF2, A6LF2)

FB	C	H	C	□	000001
1	2	3	4	5	6

1. Model
- BB : A6FL2 (Theta-II 2.0 T GDI 2WD)
- BD : A6FL2 (Theta-II 2.0 T GDI 4WD)
- FB : A6MF2 (Theta-II 2.4 2WD)
- FD : A6MF2 (Theta-II 2.4 4WD)

2. Production year
- C : 2012, D : 2013, E : 2014, F : 2015...

3. Final gear ratio
- G : 3.510 (A6LF2 - Theta-II 2.0 T GDI 2WD, 4WD)
- H : 3.648 (A6MF2 - Theta-II 2.4 GDI 2WD)
- V : 3.648 (A6MF2 - Theta-II 2.4 GDI 4WD)

4. Detailed classification
- A : Theta-II 2.0 T GDI 2WD, 4WD, 2.4 GDI 4WD
- D : Theta-II 2.4 T GDI 2WD

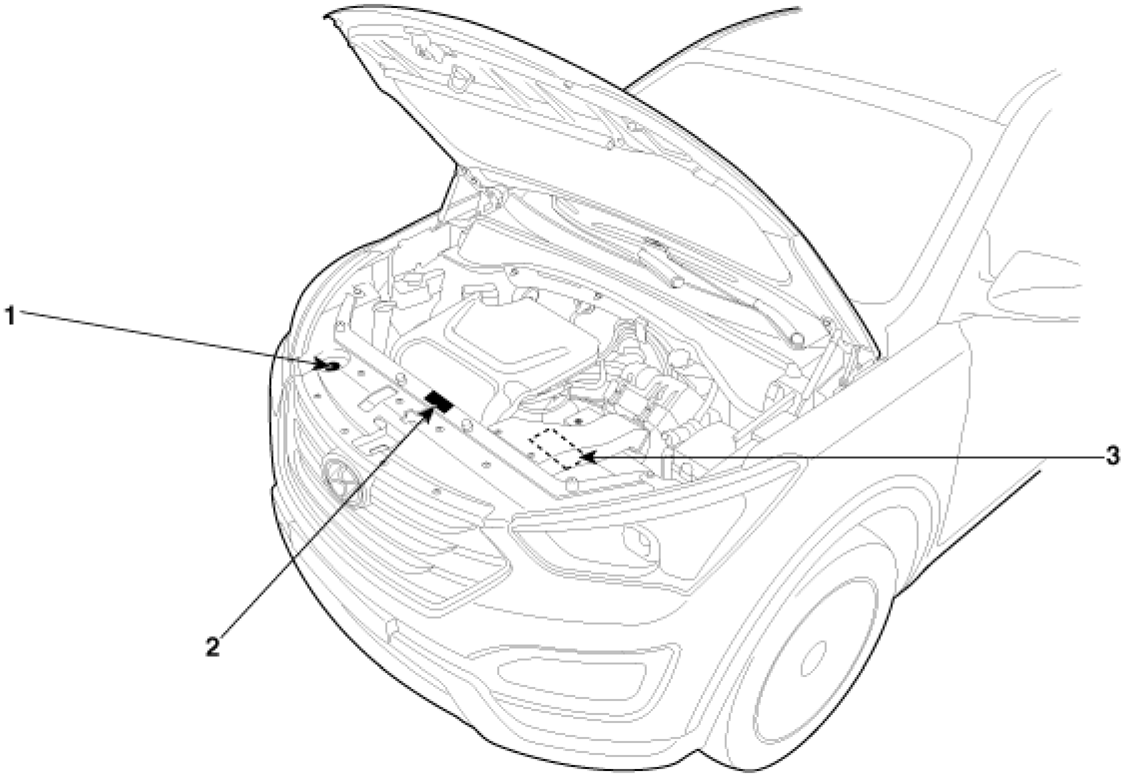
5. Spare

6. Transaxle production sequence number
- 000001 ~ 999999

Paint Code

Code	Color
3M	Vanilla White
NKA	Phantom Black
NCW	Creamy White
PW6	White Crystal
N3S	Sleek Silver
T6S	Titanium Silver
VR6	Red Awesome
Y8Y	Mystic Beige
S8N	Beach Sand
N8N	Arabian Mocha
N8U	Glacier
W8U	Ocean View

Warning / Caution Label



1. Radiator cap caution 2. Fan caution	3. Battery caution

Battery Caution Label

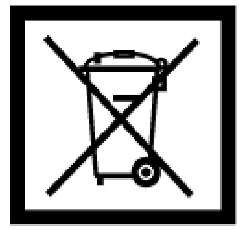

[A]

[B]

[C]


[D]

[E]

[F]

[G]

Warning / Caution Label (Cont'd)

Keep lighted cigarettes and all other flames or sparks away from the battery.
Wear eye protection when charging or working near a battery. Always provide ventilation when working in an enclosed space. • When lifting a plastic-cased battery, excessive pressure on acid to leak resulting in personal injury. Lift with a battery carrier or with your hands on opposite corners. • Never attempt to change the battery when the battery cables are connected. • The electrical ignition system works with high voltage. Never touch these components with the engine running or the ignition switched on.
Keep batteries out of the reach of children because batteries contain highly corrosive SULFURIC ACID. Do not allow battery acid to contact your skin, eyes, clothing or paint finish.
If any electrolyte gets into your eyes, flush your eyes with clean water for at least 15 minutes and get immediate medical attention. If possible, continue to apply water with a sponge or cloth until medical attention is received. If electrolyte gets on your skin, thoroughly wash the contacted area. If you feel a pain or a burning sensation, get medical attention immediately.
Always read the following instructions carefully when handing a battery.
Hydrogen, which is a highly combustible gas, is always presents in battery cells and may explode if ignited.
An improperly disposed battery can be harmful to the environment and human health. Always confirm local regulations for battery disposal.

Handling and Storage the Battery

Battery Itself	• Batteries should be stored in cool, dry (27°C / 80.6°F) places and out of direct sunlight. • MF batteries are tightly sealed to prevent acid leakage. However, tilting the battery to an angle of 45 degrees can cause acid to leak through the vents on the sides. Therefore, batteries should always be stored in their upright positions. Prevent placing any aqueous or solid (i.e. conductors) bodies on top of the battery. • It is extremely dangerous to use tools, such as hammers, on the battery terminals

	when connecting cables to the mounted battery.
Battery on Vehicle	• When storing the vehicle for long periods of time, make sure to remove the memory fuse at junction box to prevent natural discharging. • Also, run the engine for battery charging within 1 month if the memory fuse wasn't removed from the start of vehicle storing. If the memory fuse was removed, run the engine for battery charging within 3 months from the start of vehicle storing.

NOTE

After reconnecting or recharging a discharged battery, the ESP OFF indicator may illuminate.
In this case, turn the handle half way to the left and right whilst the ignition switch is in the ON position.
Then, restart the engine after the ignition is OFF. The ESP OFF indicator may turn OFF. If the ESP OFF indicator does not turn OFF, have the system checked. (Refer to the DTC guide)

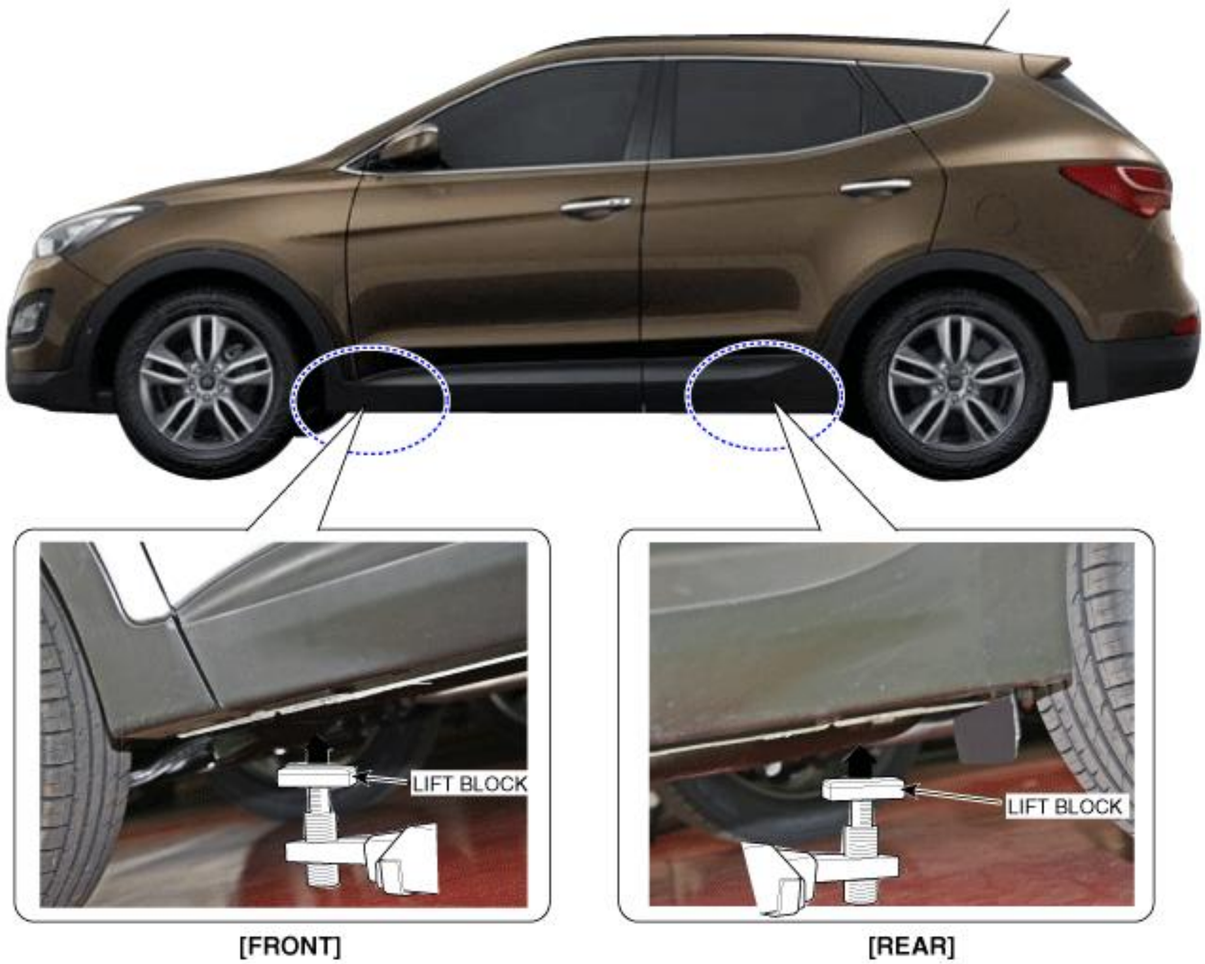
WARNING

When heavy rear components such as suspension, fuel tank, spare tire, tailgate and trunk lid are to be removed, place additional weight in the luggage area before hoisting. When substantial weight is removed from the rear of the vehicle, the center of gravity may change and can cause the vehicle to tip forward on the hoist.

NOTE

- Since each tire/wheel assembly weights approximately 30lbs (14kg), placing the front wheels in the luggage area can assist with the weight distribution.
- Use the same support points to support the vehicle on safety stands.

1. Place the lift blocks under the support points as shown in the illustration.
2. Raise the hoist a few inches (centimeters) and rock the vehicle to be sure it is firmly supported.
3. Raise the hoist to full height to inspect the lift points for secure support.



If the vehicle needs to be towed, call a professional towing service. Never tow vehicle with just a rope or chain. It is very dangerous.

[Front]

[Rear]

Emergency Towing

There are three popular methods of towing a vehicle:

- The operator loads the vehicle on the back of truck. This is best way of transporting the vehicle.
- The tow truck uses two pivoting arms that go under the tires of the driving axle and lift them off the ground. The other two wheels remain on the ground.
- The tow truck uses metal cables with hooks on the ends. These hooks go around parts of the frame or suspension, and the cables lift that end of the vehicle off the ground. The vehicle's suspension and body can be seriously damaged if this method of towing is attempted.

If the vehicle cannot be transported by flat-bed, should be towed with the wheels of the driving axle off the ground and do the following :

Manual Transaxle

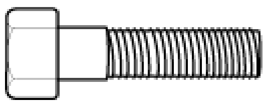
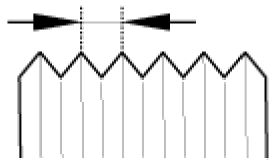
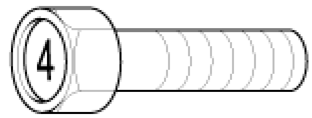
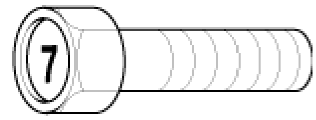
- Release the parking brake.
- Shift the Transaxle to neutral

Automatic Transaxle

- Release the parking brake.
- Start the engine.
- Shift to [D] position, then [N] position.
- Turn off the engine.

CAUTION

- The vehicle equipped with full-time 4WD should be only transported on a flat-bed.
- Improper towing preparation will damage the transaxle. Follow the above procedure exactly. If you cannot shift the transaxle or start the engine (automatic transaxle), your vehicle must be transported on a flatbed.
- It is the best to tow vehicle no farther than 30 km (19 miles), and keep the speed below 50 km/h (30 mph). (For the full-time 4WD vehicle, limit the towing to 1.5 km (1 mile) and 15 km/h (10 mph)
- Trying to lift or tow your vehicle by the bumpers will cause serious damage. The bumpers are not designed to support the vehicle's weight.

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

NOTE

1. The torques shown in the table are standard values under the following conditions.
   - Nuts and bolts are made of galvanized steel bar.
   - Galvanized plain steel washers are inserted.
   - All nuts, bolts and plain washers are dry.
2. The torques shown in the table are not applicable.
   - When spring washers, toothed washers and the like are inserted.
   - If plastic parts are fastened.
   - If self-tapping screws or self-locking nuts are used.
   - If threads and surfaces are coated with oil.
3. Reduce the torque values to the indicated percentage of the standard value under the following conditions.
   - If spring washers are used : 85%
   - If threads and bearing surfaces are stained with oil : 85%

There are five primary symbols used to complement illustrations. These symbols indicate the part to apply such materials during service.

Symbol	Meaning
	Do not reuse the part. Replace a new one.
	Apply engine oil or transmission oil to the part.
	Apply automatic transmission fluid (ATF) to the part.
	Apply grease to the part.
	Apply sealant to the part.

Protection of the Vehicle

Always be sure to cover fenders, seats, and floor areas before starting work.

CAUTION

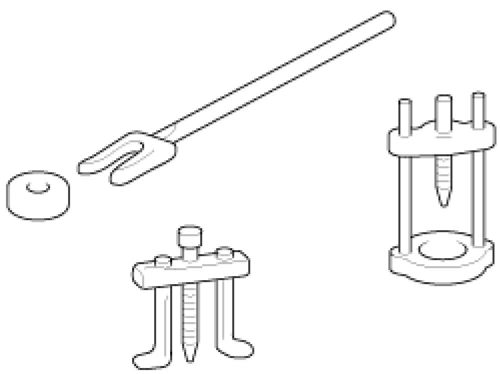
The support rod must be inserted into the hole near the edge of the hood whenever you inspect the engine compartment to prevent the hood from falling and causing possible injury.
Make sure that the support rod has been released prior to closing the hood. Always check to be sure the hood is firmly latched before driving the vehicle.

Preparation of Tools and Measuring Equipment

Be sure that all necessary tools and measuring equipment are available starting work.

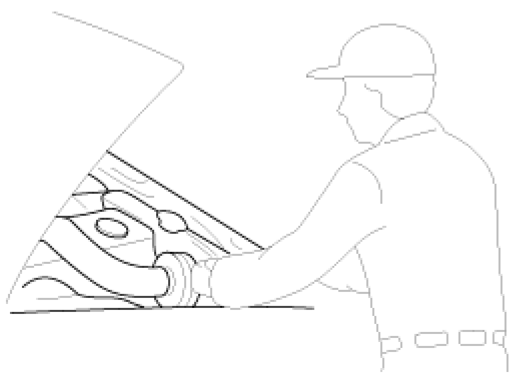
Special Tools

Use special tools when they are required.



Removal of Parts

First find the cause of the problem and then determine whether removal or disassembly before starting the job.

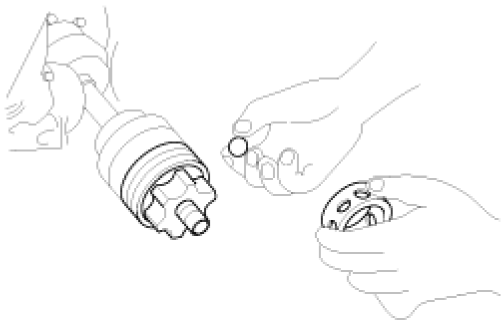


Disassembly

If the disassembly procedure is complex, requiring many parts to be disassembled, all parts should be disassembled in a way that will not affect their performance or external appearance.

Inspection of parts

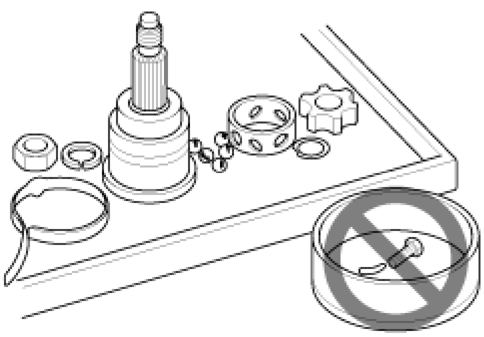
Each part, when removed, should be carefully on suspected for malfunction, deformation, damage, and other problems.



Arrangement of parts

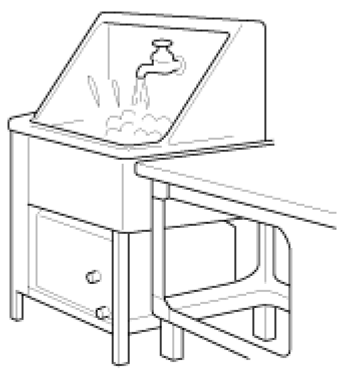
All disassembled parts should be carefully arranged for effective reassembly.

Be sure to separate and correctly identify the parts to be replaced from those that will be used again.



Cleaning parts for reuse

All parts to be used again should be carefully and thoroughly cleaned by an appropriate method.



Parts

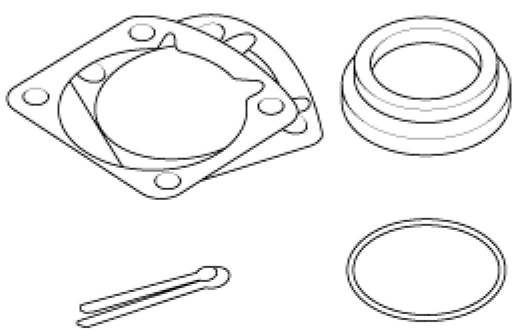
When replacing parts, use HYUNDAI genuine parts.

Replacement

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

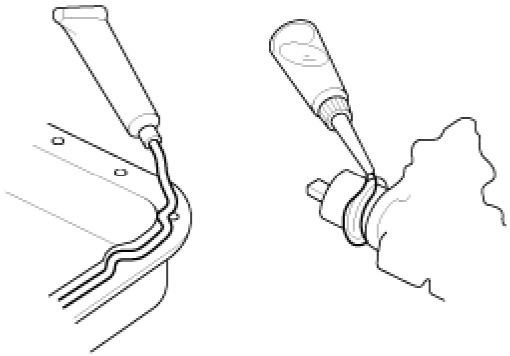
If removed, the following parts should always be replaced with new ones.

- Oil seals
- Gaskets
- O-rings
- Lock washers
- Cotter pins (split pins)
- Plastic nuts



Depending on their location.

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



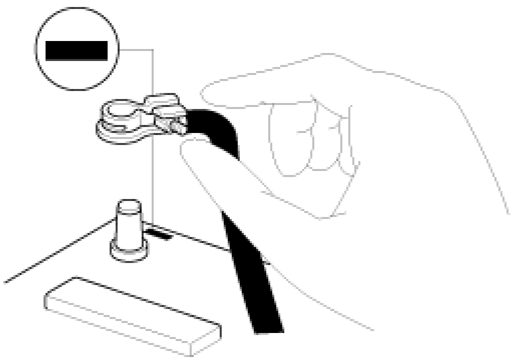
Adjustment
Use gauges and testers to adjust correctly the parts to standard values correctly.
Electrical System

Be sure to disconnect the battery cable from the negative (-) terminal of the battery.

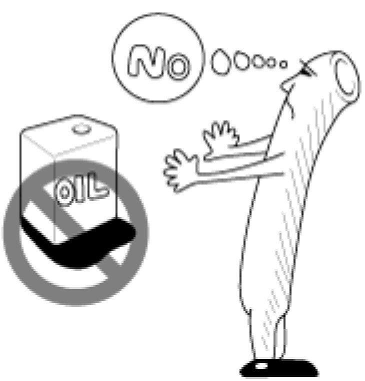
Never pull on the wires when disconnecting connectors.

Locking connectors will click when the connector is secure.

Handle sensors and relays carefully. Be careful not to drop them against other parts.



Rubber Parts and Tubes
Always prevent gasoline or oil from touching rubber parts or tubing.



Measuring Body Dimensions

Basically, all measurements in this manual are taken with a tracking gauge.

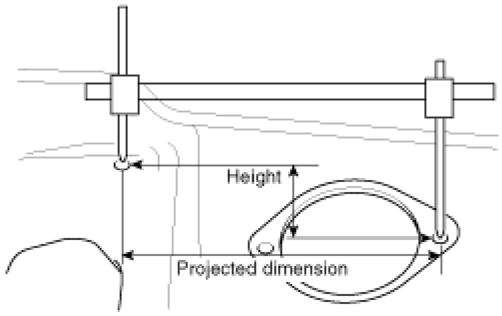
When a measuring tape is used, check to be sure there is no elongation, twisting or bending.

For measuring dimensions, both projected dimensions and actual - measurement dimensions are used in this manual.

Dimensions Projected

These are the dimensions measured when the measurement points are projected from the vehicle's surface, and are the reference dimensions used for used for body alterations.

If the length of the tracking gauge probes is adjustable, measure it by lengthening one of two probes as long as the different value in height of the two surfaces.



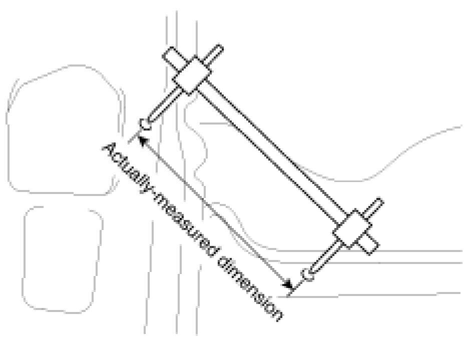
Measuring Actual Dimensions

These dimensions indicate the actual linear distance between measurement points, and are used as the reference dimensions when a tracking gauge is used for measurement.

First adjust both probes to the same length (A=A') before measurement.

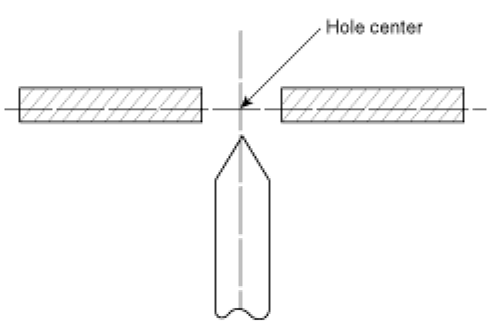
NOTE

Check the probes and gauge itself to make sure there is no free play.



Measurement Point

Measurements should be taken at the center of the hole.



Checking Cables and Wires

Check the terminal for tightness.

Check terminals and wires for corrosion from battery electrolyte, etc.

Check terminals and wires for open circuits.

Check wire insulation and coating for damage, cracks and degrading.

Check the conductive parts of terminals for contact with other metallic parts (vehicle body and other parts).

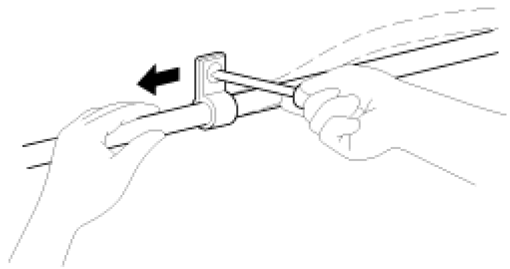
Check grounded parts to verify that there is complete continuity between their attaching bolt(s) and the vehicle's body.

Check for incorrect wiring.

Check that the wiring is so clamped to the prevent contact with sharp corners of the vehicle body, etc. or hot parts (exhaust manifold, etc.)

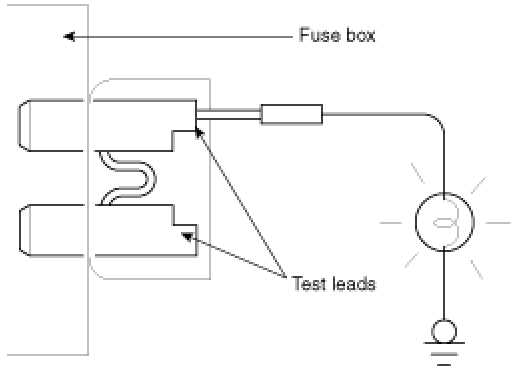
Check that the wiring is clamped firmly to provide enough clearance from the fan pulley, fan belt and other rotating or moving parts.

Check that the wiring has a little space so that it can vibrate between fixed and moving parts such as the vehicle body and the engine.



Check Fuses

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

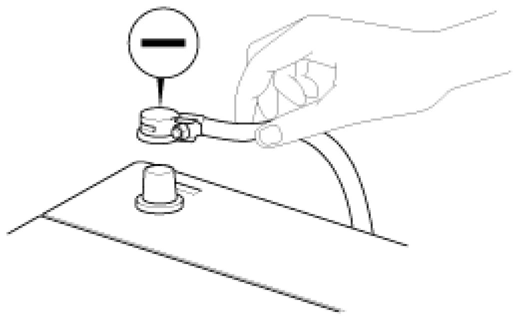


Servicing the Electrical System

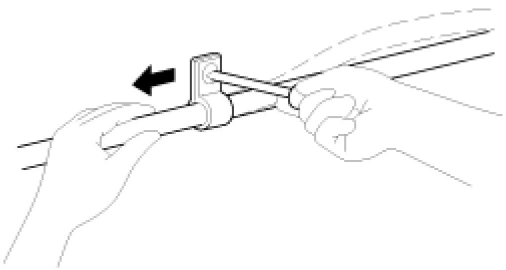
Prior to servicing the electrical system, be sure to turn off the ignition switch and disconnect the battery ground cable.

NOTE

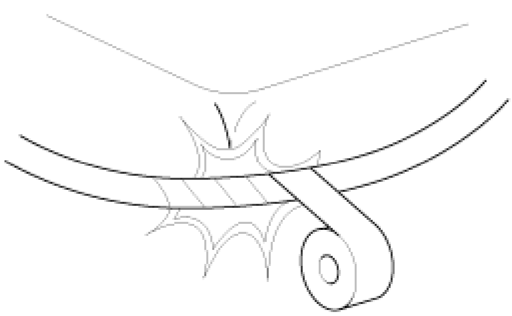
In the course of MFI or ELC system diagnosis, when the battery cable is removed, any diagnostic trouble code retained by the computer will be cleared. Therefore, if necessary, record the diagnostic data before removing the battery cable.



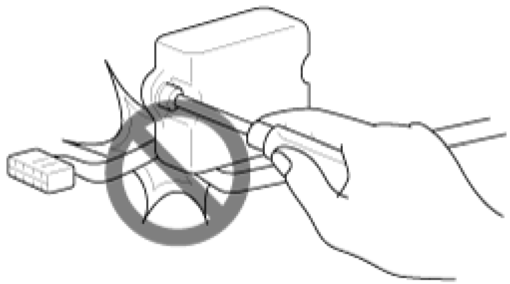
Attach the wiring harnesses with clamps so that there is no slack. However, for any harness which passes the engine or other vibrating parts of the vehicle, allow some slack within a range that does not allow the engine vibrations to cause the harness to come into contact with any of the surrounding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



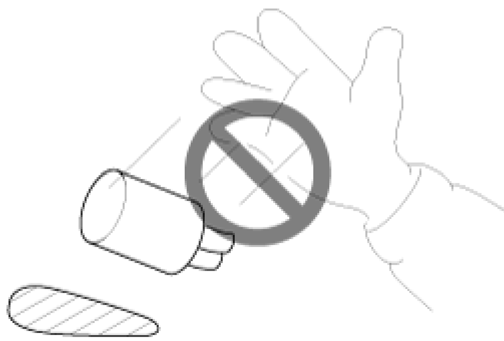
If any section of a wiring harness interferes with the edge of parts, or a corner, wrap the section of the harness with tape or something similar in order to protect it from damage.



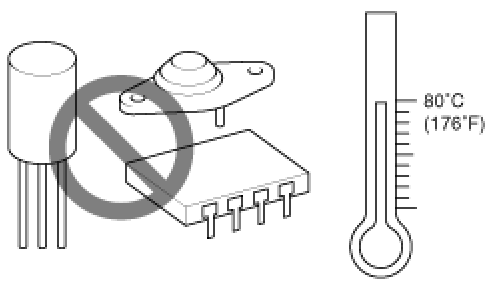
When installing any parts, be careful not to pinch or damage any of the wiring harness.



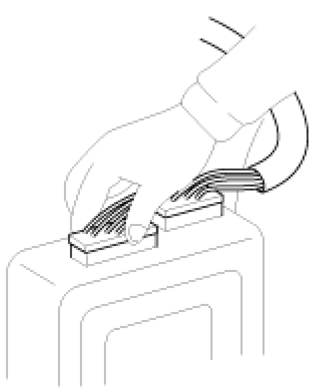
Never throw relays, sensors or electrical parts, or expose them to strong shock.



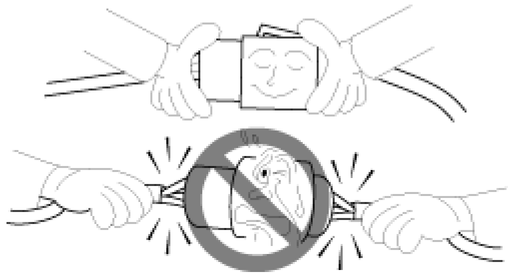
The electronic parts used in the computer, relays, etc. are readily damaged by heat. If there is a need for service operations that may cause the temperature to exceed 80°C (176°F), remove the electronic parts beforehand.



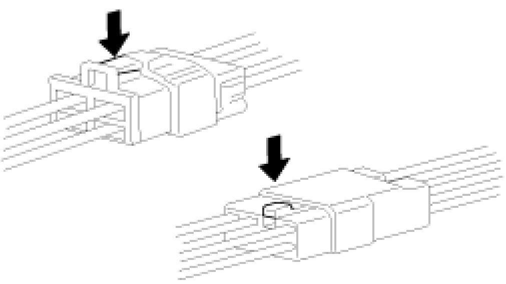
Loose connectors cause problems. Make sure that the connectors are always securely fastened.



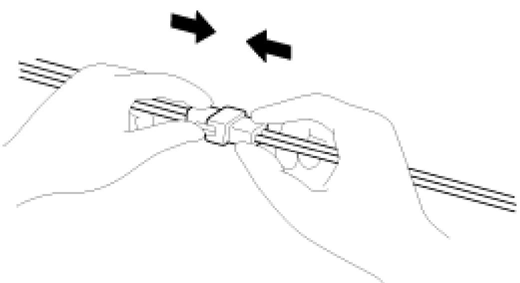
When disconnecting a connector, be sure to grip only the connector, not the wires.



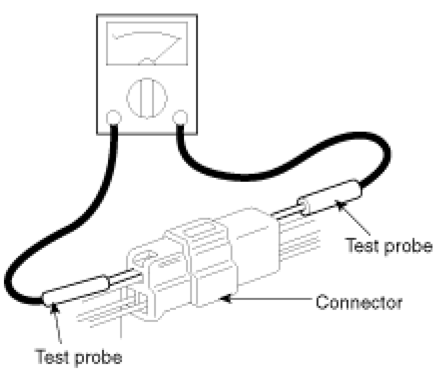
Disconnect connector which have catches by pressing in the direction of the arrows shown the illustration.



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



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



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

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

Precautions for Catalytic Converter

CAUTION

If a large amount of unburned gasoline flows into the converter, it may overheat and create a fire hazard. To prevent this observe the following precautions and explain them to your customer.

Use only unleaded gasoline.

Do not run the engine while the car is at rest for a long time. Avoid running the engine at fast idle for more than 10minutes and idle speed for more than 20 minutes.

Do not measure engine compression for an extended time. Engine compression tests must be made as rapidly as possible. Remove the fuel pump relay before performing a compression test.

Do not dispose of used catalytic converter together with parts contaminated with gasoline or oil.

Specifications

Description		Specifications	Limit
General			
Type		In-line, DOHC	
Number of cylinders		4	
Bore		88 mm (3.464 in)	
Stroke		97 mm (3.819 in)	
Total displacement		2359cc (143.90cu. in)	
Compression ratio		11.3 ± 0.3 : 1	
Firing order		1-3-4-2	
Valve timing			
Intake valve	Opens (ATDC/BTDC)	ATDC 7° ~ BTDC 38°	
	Closes (ABDC)	ABDC 67° ~ 22°	
Exhaust valve	Opens (BBDC)	BBDC 44° ~ 4°	
	Closes (BTDC)	ATDC 0° ~ 40°	
Valve clearance [Engine coolant temperature : 20°C (68°F)]			
Intake valve		0.17 ~ 0.23 mm (0.0067 ~ 0.0090 in.)	0.10 ~ 0.30 mm (0.0039 ~ 0.0118 in.)
Exhaust valve		0.27 ~ 0.33 mm (0.0106 ~ 0.0129 in.)	0.20 ~ 0.40 mm (0.0079 ~ 0.0157 in.)
Camshaft			
Cam height	Intake	44.2 mm (1.7401 in.)	
	Exhaust	45.0 mm (1.7716 in.)	
Journal outer diameter	Intake	No.1 : ¢ 30 mm (1.1811 in.) No.2,3,4,5 : ¢ 24 mm (0.9449 in.)	
	Exhaust	No.1 : ¢ 36 mm (1.4173 in.) No.2,3,4,5 : ¢ 24 mm (0.9449 in.)	
Bearing oil clearance	Intake	No.1 : 0.022 ~ 0.057 mm (0.00087 ~ 0.00224 in.) No.2,3,4,5 : 0.045 ~ 0.082 mm (0.00177 ~ 0.00323 in.)	No.1 : 0.090 mm (0.00354 in.) No.2,3,4,5 : 0.120 mm (0.00472 in.)
	Exhaust	No.1 : 0 ~ 0.032 mm (0 ~ 0.00126 in.) No.2,3,4,5 : 0.045 ~ 0.082 mm (0.00177 ~ 0.00323 in.)	

End play		0.04 ~ 0.16 mm (0.0016 ~ 0.0063 in.)	0.20 mm (0.0078 in.)
Valve			
Valve length	Intake	113.18 mm (4.4559 in.)	112.93 mm (4.4461 in)
	Exhaust	105.84 mm (4.1669 in.)	105.59 mm (4.1571 in)
Stem outer diameter	Intake	5.465 ~ 5.480 mm (0.21516 ~ 0.21575 in.)	
	Exhaust	5.458 ~ 5.470 mm (0.21488 ~ 0.21535 in.)	
Face angle		45.25° ~ 45.75°	
Thickness of valve head (margin)	Intake	1.02 mm (0.0401 in.)	
	Exhaust	1.09 mm (0.0429 in.)	
Valve stem to valve guide clearance	Intake	0.020 ~ 0.047 mm (0.00078 ~ 0.00185 in.)	0.070 mm (0.00275 in.)
	Exhaust	0.030 ~ 0.054 mm (0.00118 ~ 0.00212 in.)	0.090 mm (0.00354 in.)
MLA outer diameter		31.964 ~ 31.980 mm (1.2584 ~ 1.2590 in.)	
Tappet bore inner diameter		32.000 ~ 32.025 mm (1.2598 ~ 1.2608 in.)	
MLA to tappet bore clearance		0.020 ~ 0.061 mm (0.00078 ~ 0.00240 in.)	0.070 mm (0.00275 in.)
Valve guide			
Length	Intake	43.8 ~ 44.2 mm (1.7244 ~ 1.7401 in.)	
	Exhaust	43.8 ~ 44.2 mm (1.7244 ~ 1.7401 in.)	
Inner diameter	Intake	5.500 ~ 5.512 mm (0.21654 ~ 0.21701 in.)	
	Exhaust	5.500 ~ 5.512 mm (0.21654 ~ 0.21701 in.)	
Valve seat			
Width of seat contact	Intake	1.16 ~ 1.46 mm (0.0457 ~ 0.0575 in.)	
	Exhaust	1.35 ~ 1.65 mm (0.0531 ~ 0.0649 in.)	
Seat angle	Intake	44.75° ~ 45.10°	
	Exhaust	44.75° ~ 45.10°	
Valve spring			
Free length		47.44 mm (1.8677 in.)	
Load		19.0 ± 0.6 kg/35.0 mm (41.88 ± 1.32 lb/1.3779 in.) 39.8 ± 1.2 kg/26.0 mm (87.74 ± 2.64 lb/1.0236 in.)	
Out of squareness		Less than 1.5°	
Cylinder head			
Flatness of gasket surface		Less than 0.05 mm (0.0019 in.) for total area Less than 0.02 mm (0.0007 in.) for a section of 100 mm (3.9370 in.)×100 mm (3.9370 in.)	

Flatness of manifold mounting surface	Intake	Less than 0.10 mm (0.0039 in.)	
	Exhaust	Less than 0.10 mm (0.0039 in.)	
Piston			
Piston outer diameter		87.970 ~ 88.000 mm (3.46338 ~ 3.46456 in.)	
Piston to cylinder clearance		0.020 ~ 0.040 mm (0.00079 ~ 0.00157 in.)	
Ring groove width	No. 1 ring	1.235 ~ 1.250 mm (0.04862 ~ 0.04921 in.)	1.260 mm (0.04961 in.)
	No. 2 ring	1.230 ~ 1.250 mm (0.04843 ~ 0.04921 in.)	1.260 mm (0.04961 in.)
	Oil ring	2.010 ~ 2.025 mm (0.07913 ~ 0.07972 in.)	2.050 mm (0.08071 in.)
Piston ring			
Side clearance	No. 1 ring	0.050 ~ 0.080 mm (0.00197 ~ 0.00315 in.)	0.100 mm (0.00394 in.)
	No. 2 ring	0.040 ~ 0.080 mm (0.00157 ~ 0.00315 in.)	0.100 mm (0.00394 in.)
	Oil ring	0.020 ~ 0.055 mm (0.00079 ~ 0.00217 in.)	0.60 mm (0.0236 in.)
End gap	No. 1 ring	0.15 ~ 0.25 mm (0.0059 ~ 0.0098 in.)	0.60 mm (0.0236 in.)
	No. 2 ring	0.37 ~ 0.47 mm (0.0145 ~ 0.0185 in.)	0.70 mm (0.0275 in.)
	Oil ring	0.20 ~ 0.50 mm (0.0079 ~ 0.0197 in.)	0.80 mm (0.0315 in.)
Piston pin			
Piston pin outer diameter		21.997 ~ 22.000 mm (0.86602 ~ 0.86614 in.)	
Piston pin hole inner diameter		22.003 ~ 22.007 mm (0.86626 ~ 0.86642 in.)	
Piston pin hole clearance		0.003 ~ 0.010 mm (0.00012 ~ 0.00039 in.)	
Connecting rod small end hole inner diameter		22.005 ~ 22.011 mm (0.86634 ~ 0.86657 in.)	
Piston pin-to-connecting rod bushing oil clearance		0.005 ~ 0.014 mm (0.00020 ~ 0.00055 in.)	
Connecting rod			
Connecting rod big end inner diameter		51.000 ~ 51.018 mm (2.00787 ~ 2.00858 in.)	
Connecting rod bearing oil clearance		0.033 ~ 0.051 mm (0.00130 ~ 0.00201 in.)	0.050 mm (0.00197 in.)
Side clearance		0.10 ~ 0.25 mm (0.0039 ~ 0.0098 in.)	0.35 mm (0.0138 in.)
Crankshaft			
Main journal outer diameter		51.942 ~ 51.960 mm (2.04496 ~ 2.04567 in.)	
Pin journal outer diameter		47.954 ~ 47.972 mm (1.88795 ~ 1.88866 in.)	
Main bearing oil clearance		0.020 ~ 0.038 mm (0.00079 ~ 0.00150 in.)	0.100 mm (0.00394 inin.)
End play		0.07 ~ 0.25 mm (0.0028 ~ 0.0098 in.)	0.30 mm (0.0118 in.)
Cylinder block			
Cylinder bore		88.00 ~ 88.03 mm (3.4645 ~ 3.4657 in.)	

Flatness of gasket surface		Less than 0.05 mm (0.0019 in.) for total area Less than 0.02 mm (0.0007 in.) for a section of 100 mm (3.9370 in.)×100 mm (3.9370 in.)	
Engine oil			
Oil quantity	Total	5.5 L (1.45 U.S.gal., 5.81 U.S.qt., 4.84 lmp.qt.)	When replacing a short engine or block assembly
	Oil pan	4.2 L (1.11 U.S.gal., 4.44 U.S.qt., 3.70 lmp.qt.)	
	Drain and refill	4.6 L (1.22 U.S.gal., 4.86 U.S.qt., 4.05 lmp.qt.)	Including oil filter
Oil grade	Recommendation	5W-20 / API SM, ILSAC GF4	If not available, refer to the recommended API or ILSAC classification and SAE viscosity number.
	Classification	API SL, SM or above ILSAC GF3, GF4 or above ACEA A3, A5 or above	Satisfy the requirement of the API or ILSAC classification.
	SAE viscosity grade	Recommended SAE viscosity number	Refer to the "Lubrication System".
Oil pressure (at 1,000rpm)		117.68 kPa (1.2 kgf/cm², 17.06 psi) or above	Oil temperature (oil pan): 110±2°C (230±35.6°F)
Cooling system			
Cooling method		Forced circulation with cooling fan	
Coolant quantity		MT : 7.1 L (1.8 U.S.gal., 7.5 U.S.qt., 6.2 lmp.qt.) AT (For Europe, Australia) : 7.7 L (2.0 U.S.gal., 8.1 U.S.qt., 6.7 lmp.qt.) AT (Except Europe, Australia) : 7.4 L (1.9 U.S.gal., 7.8 U.S.qt., 6.5 lmp.qt.)	
Thermostat	Type	Wax pellet type	
	Opening temperature	82±1.5°C (179.6±2.7°F)	
	Full opening valve lift/temperature	More than 8 mm (0.3 in.) / 95°C (203°F)	
Radiator cap	Main valve opening pressure	93.16 ~ 122.58 kPa (0.95 ~ 1.25 kgf/cm², 13.51 ~ 17.78 psi)	
	Vacuum valve opening pressure	0 ~ 6.86 kPa (0 ~ 0.07 kgf/cm², 0 ~ 0.99 psi)	

Item	Quantity	N.m	kgf.m	lb-ft
Engine mounting				
Engine mounting bracket to body fixing bolt	4	63.7 ~ 83.3	6.5 ~ 8.5	47.0 ~ 61.5
Engine mounting insulator to engine mounting support bracket fixing nut	1	88.3 ~ 107.9	9.0 ~ 11.0	65.1 ~ 79.6
Engine mounting support bracket to engine support bracket fixing bolt	1	88.3 ~ 107.9	9.0 ~ 11.0	65.1 ~ 79.6
Engine mounting support bracket to engine support bracket fixing nut	2	88.3 ~ 107.9	9.0 ~ 11.0	65.1 ~ 79.6
Transaxle mounting bracket to body fixing bolt	3	63.7 ~ 83.3	6.5 ~ 8.5	47.0 ~ 61.5
Transaxle mounting bracket to body fixing nut	1	49.0 ~ 63.7	5.0 ~ 6.5	36.2 ~ 47.0
Transaxle mounting support bracket fixing bolt	4	58.8 ~ 78.5	6.0 ~ 8.0	43.4 ~ 57.9
Transaxle mounting bracket to transaxle mounting support bracket fixing bolt	2	88.3 ~ 107.9	9.0 ~ 11.0	65.1 ~ 79.6
Roll rod bracket to sub frame fixing bolt	2	49.0 ~ 63.7	5.0 ~ 6.5	36.2 ~ 47.0
Roll rod bracket to roll rod support bracket fixing bolt & nut	1	107.9 ~ 127.5	11.0 ~ 13.0	79.6 ~ 94.0
Timing system				
Idler bolt	2	53.9 ~ 63.7	5.5 ~ 6.5	39.7 ~ 47.0
Drive belt tensioner pulley bolt	1	53.9 ~ 63.7	5.5 ~ 6.5	

Compression Pressure Inspection

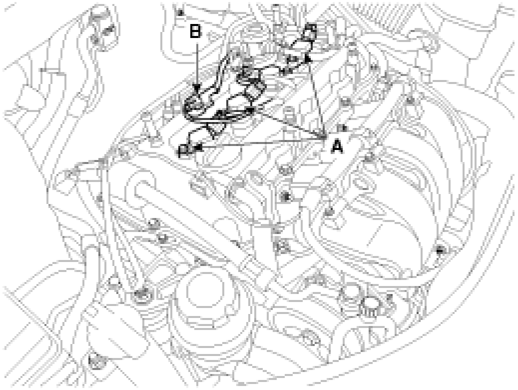
NOTE

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

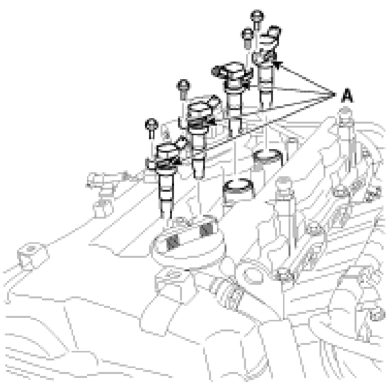
Warm up and stop engine.

Allow the engine to warm up to normal operating temperature.

Disconnect the injector extension connector (A) and ignition coil connectors (B).



Remove ignition coils (A).

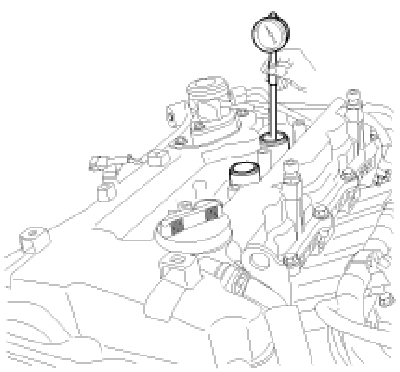


Remove spark plugs.

Using a 16mm plug wrench, remove the 4 spark plugs.

Check cylinder compression pressure.

Insert a compression gauge into the spark plug hole.



Fully open the throttle.

While cranking the engine, measure the compression pressure.

NOTE

Always use a fully charged battery to obtain engine speed of 200 rpm or more.

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

NOTE

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

Compression pressure :
1,324 kPa (13.5 kgf/cm², 192 psi) / 200 ~ 250 rpm
Minimum pressure :
1,177 kPa (12.0 kgf/cm², 171 psi)
Difference between each cylinder :
100 kPa (1.0 kgf/cm², 15 psi) or less

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

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.

Reinstall spark plugs.

Install ignition coils.

Connect the injector extension connector and ignition coil connectors.

Some DTC's may exist after the inspection test and may need to be manually cleared with GDS.

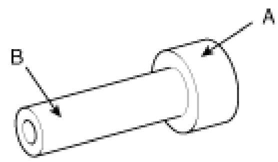
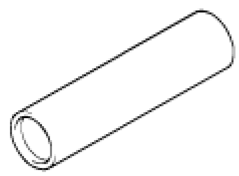
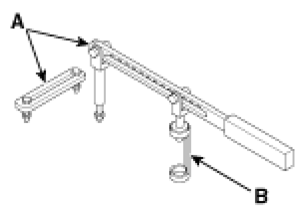
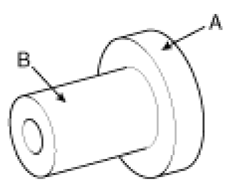
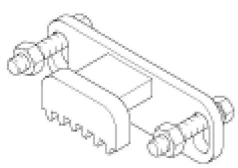
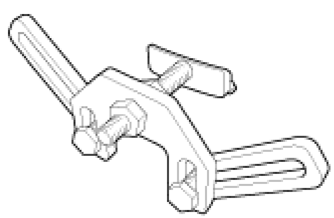
Troubleshooting

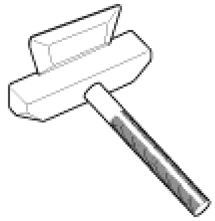
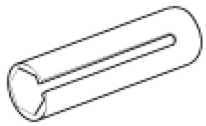
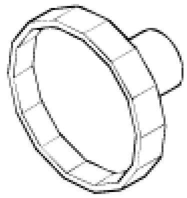
Symptom	Suspect area	Remedy
Engine misfire with abnormal internal lower engine noises.	Worn crankshaft bearings Loose or out of specification engine flywheel	Replace the crankshaft and bearings as required. Repair or replace the flywheel as required.
	Worn piston rings (Oil consumption may or may not cause the engine to misfire.)	Inspect the cylinder for a loss of compression. Repair or replace as required.
	Worn crankshaft thrust bearings	Replace the crankshaft and bearings as required
Engine misfire with abnormal valve train noise.	Stuck valves. (Carbon buildup on the valve stem)	Repair or replace as required
	Excessive worn or mis-aligned timing chain Out of specification valve clearances	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 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. (Check and compare with known good vehicle to determine normal condition.)	Incorrect oil viscosity	• Drain the oil. • Install the correct viscosity oil.
	Worn crankshaft thrust bearing.	• Inspect the thrust bearing and crankshaft. • Repair or replace as required.
Upper engine noise, regardless of engine speed.	Low oil pressure	Repair or replace as required.
	Broken valve spring.	Replace the valve spring.
	Worn or dirty valve lifters.	Replace the valve lifters.
	Stretched or broken timing chain and/or damaged sprocket teeth.	Replace the timing chain and sprockets.
	Worn timing chain tensioner, if applicable.	Replace the timing chain tensioner as required.

	Worn camshaft lobes.	• Inspect the camshaft lobes. • Replace the timing camshaft and valve lifters as required.
	Out of specification valve clearances Worn valve guides or valve stems.	Inspect the valves and valve guides, then repair or replace as required.
	Stuck valves. (Carbon on the valve stem or valve seat may cause the valve to stay open.	Inspect the valves and valve guides, then repair or replace as required.
	Worn drive belt, idler, tensioner and bearing.	Replace as required
Lower engine noise, regardless of engine speed	Low oil pressure	Repair or replace as required
	Loose or damaged flywheel.	Repair or replace the flywheel.
	Damaged oil pan, contacting the oil pump screen.	• Inspect the oil pan. • Inspect the oil pump screen. • Repair or replace as required.
	Oil pump screen loose, damaged or restricted.	• Inspect the oil pump screen. • Repair or replace as required.
	Excessive piston-to-cylinder bore clearance.	• Inspect the piston, piston pin and cylinder bore. • Repair or replace 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 or replace as required. • The connecting rod bearings. • The connecting rods. • The crankshaft pin journals.
	Excessive crankshaft bearing clearance	Inspect the following components, and repair or replace as required. • The crankshaft bearings. • The crankshaft main journals. • The cylinder block
	Incorrect piston, piston pin and connecting rod installation	• Verify the piston pins and connecting rods are installed correctly. • Repair as required.
Engine noise under load	Low oil pressure	Repair or replace as required.
	Excessive connecting rod bearing clearance	Inspect the following components and repair or replace as required :

		• The connecting rod bearings. • The connecting rods. • The crankshaft
	Excessive crankshaft bearing clearance	Inspect the following components, and repair or replace as required. • The crankshaft bearings. • The crankshaft main journals. • The cylinder block.
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.

Special Service Tools

Tool (Number and name)	Illustration	Use
Crankshaft front oil seal installer (09214-3K000) (09231-H1100)		Installation of the front oil seal A : 09214-3K000 (installer) B : 09231-H1100 (handle)
Valve stem seal installer (09222-4A000)		Installation of the valve stem oil seal
Valve spring compressor (09222-3K000) (09222-3K100)		Removal and installation of the intake or exhaust valve A : 09222-3K000 (compressor) B : 09222-3K100 (holder)
Crankshaft rear oil seal installer (09214-3K100) (09231-H1100)		Installation of the crankshaft rear oil seal A : 09214-3K100 (installer) B : 09231-H1100 (handle)
Ring gear stopper (09231-3K000)		Removal and installation of crankshaft pulley bolt.
Ring gear stopper (09231-3D100)		Removal and installation of crankshaft pulley bolt.
Torque angle adapter (09221-4A000)		Installation of bolts & nuts needing an angular method of adjustment.

Oil pan remover (09215-3C000)		Removal of oil pan
Oxygen sensor socket wrench (09392-2H100)		Removal and installation of oxygen sensor
Oil filter wrench (09263-2E000)		Removal and installation of oil filter

Engine and Transmission Assembly

Engine Cover. Repair procedures

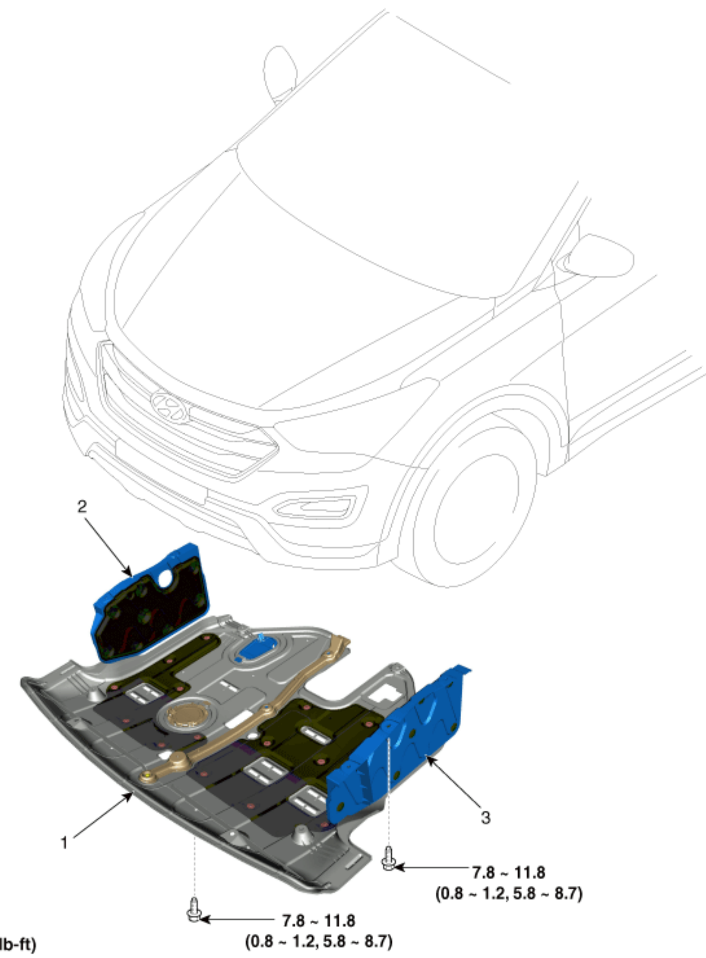
Removal and Installation

Remove the engine cover (A).

Install in the reverse order of removal.

Engine Room Under Cover. Components and Components Location

Components



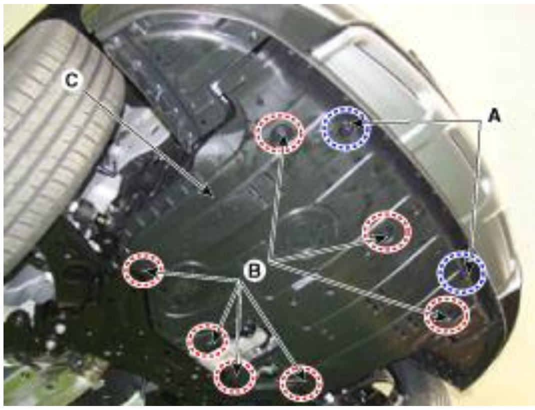
Torque : N.m (kgf.m, lb-ft)

1. Under Cover 2. Side Cover (RH)	3. Side Cover (LH)

Removal and Installation

Unfasten the fasteners (A) and bolts (B) then remove the engine room under cover (C).

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

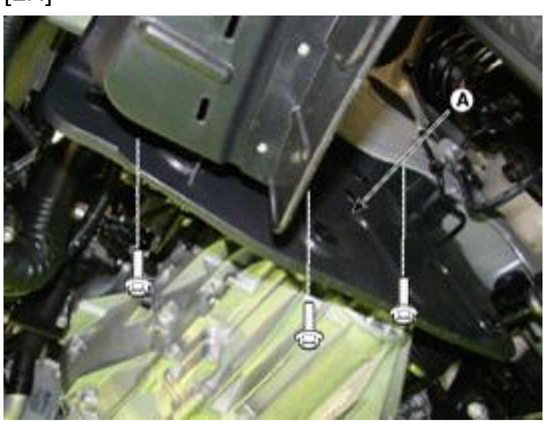


Remove the engine room side cover(A).

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

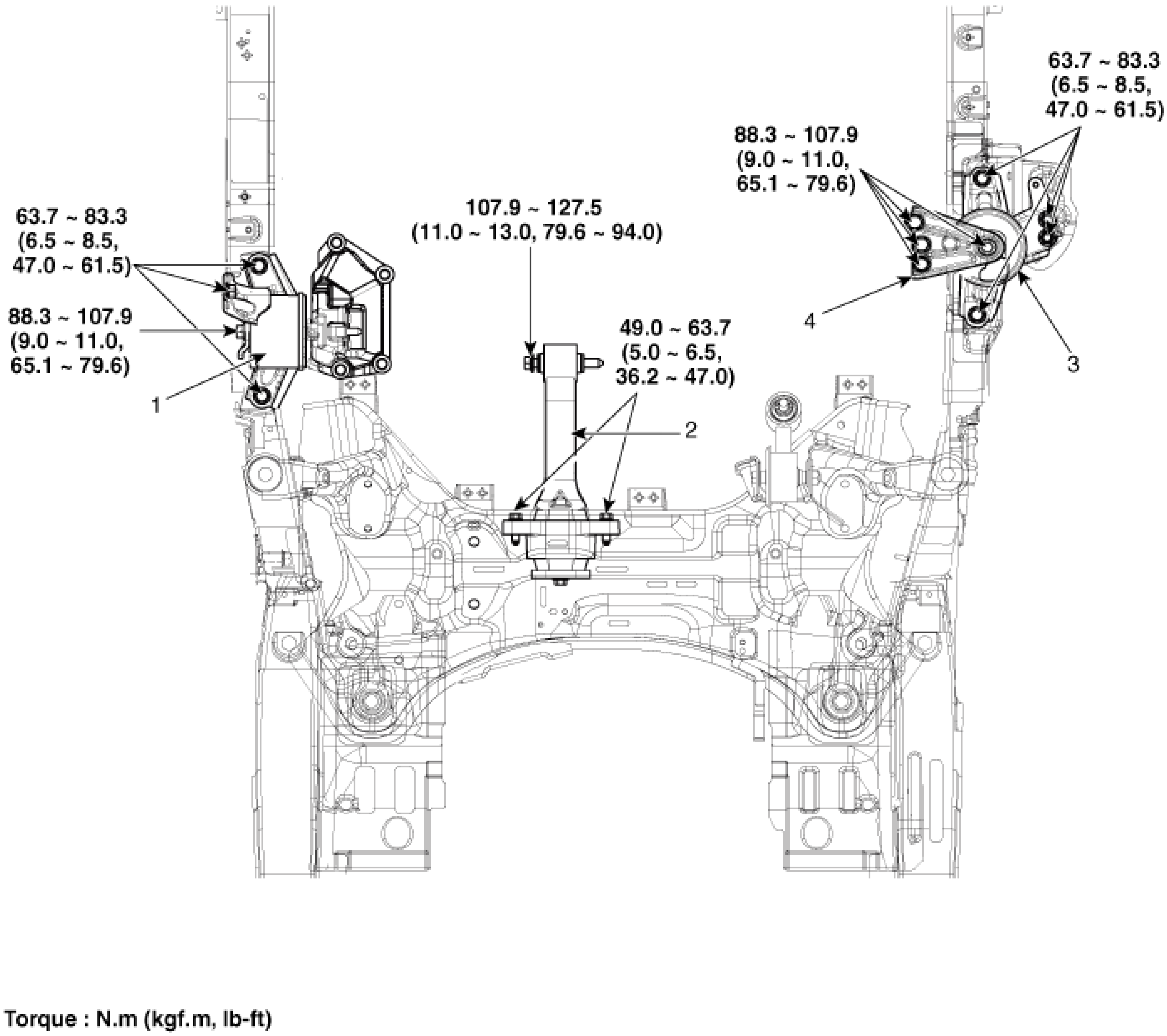
[RH]

[LH]



Install in the reverse order of removal.

Components



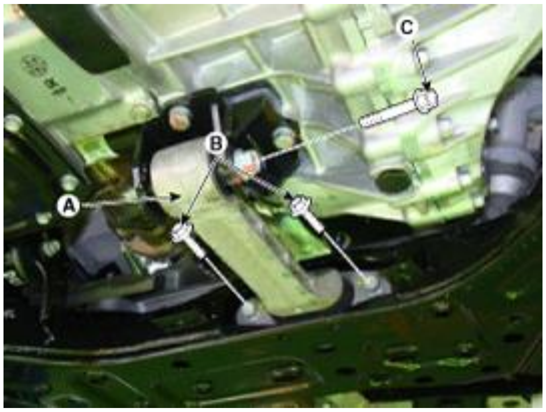
1. Transaxle mounting bracket 2. Roll rod bracket	3. Engine mounting bracket 4. Engine mounting support bracket

Removal and Installation

Roll road Bracket

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)



Install in the reverse order of removal.

Engine Mounting Bracket

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

NOTE

Insert the rubber block between jack and oil pan.

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)

Install in the reverse order of removal.

Remove the battery and tray.

Remove the air cleaner assembly.

Install the jack to the edge of transaxle.

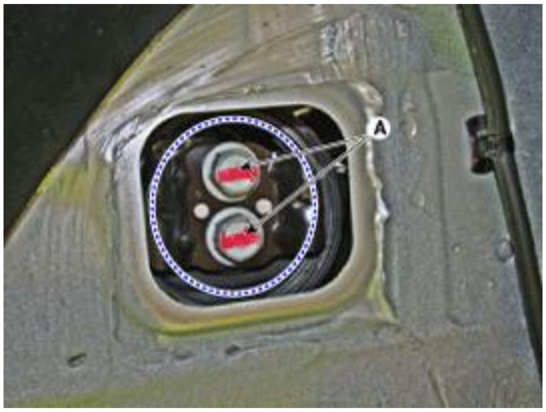
Disconnect the ground cable(A).

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

Remove the service cover(A).

Remove the transaxle mounting bolts(A).

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



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)

Install in the reverse order of removal.

Repair procedures

Removal

CAUTION

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

NOTE

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

Disconnect the battery negative terminal.

Remove the plastic engine cover.

Remove the air cleaner assembly.

Disconnect the battery positive terminal and then remove the battery.

Remove the battery tray.

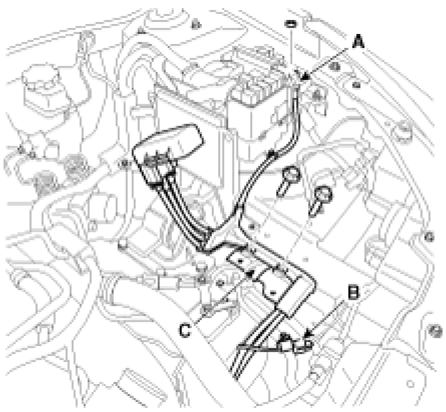
Remove the under cover.

Loosen the drain plug and drain the coolant. Remove the radiator cap to speed draining.

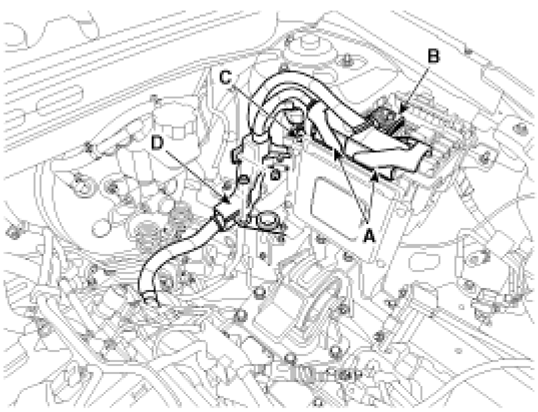
Remove the radiator upper hose and lower hose.

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

Disconnect the (+) cable (A) from the fuse/relay box and the front connector (B). Then remove the wiring protector (C).



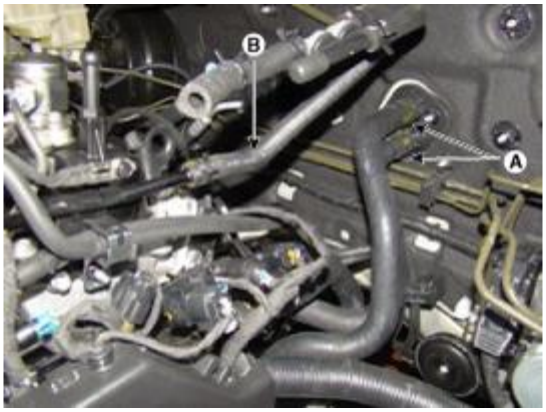
Disconnect the ECM connectors (A) from the ECM, the fuse box connector (B) from the fuse/relay box and the engine ground line (C). Then remove the wiring protector (D).



Remove the transaxle wire harness connectors and control cable from the transaxle.

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

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



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.(HPS type only)

Remove the front muffler.

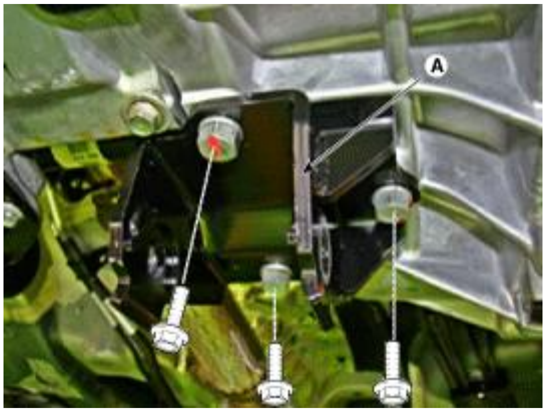
Remove the center muffler and the propeller shaft (4WD only).

Remove the roll road bracket(A).

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

Remove the roll road support bracket (A).

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



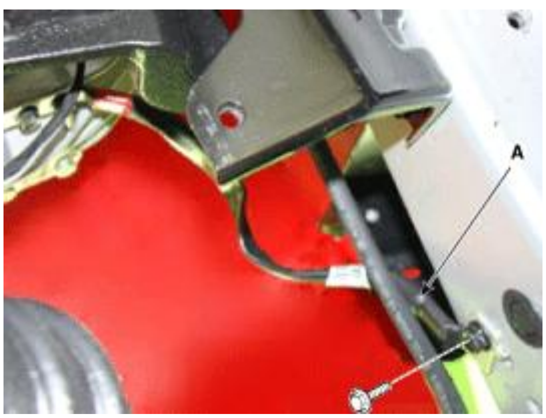
Support the sub frame with a jack, and then remove the sub frame assembly.

Disconnect the ground cable(A), and then remove the engine mounting bracket (B).

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

Disconnect the transaxle ground cable(A).

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

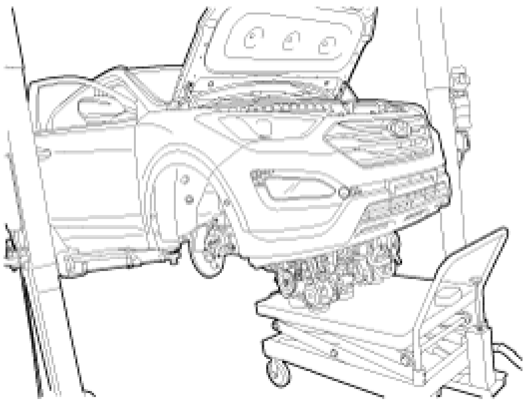


Remove the service cover(A).

Remove the transaxle mounting bracket through bolt(A).

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

Remove the engine and transaxle assembly by lifting vehicle.



NOTE

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

Installation

Install the other parts in reverse order of removal.

Perform the following :

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

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

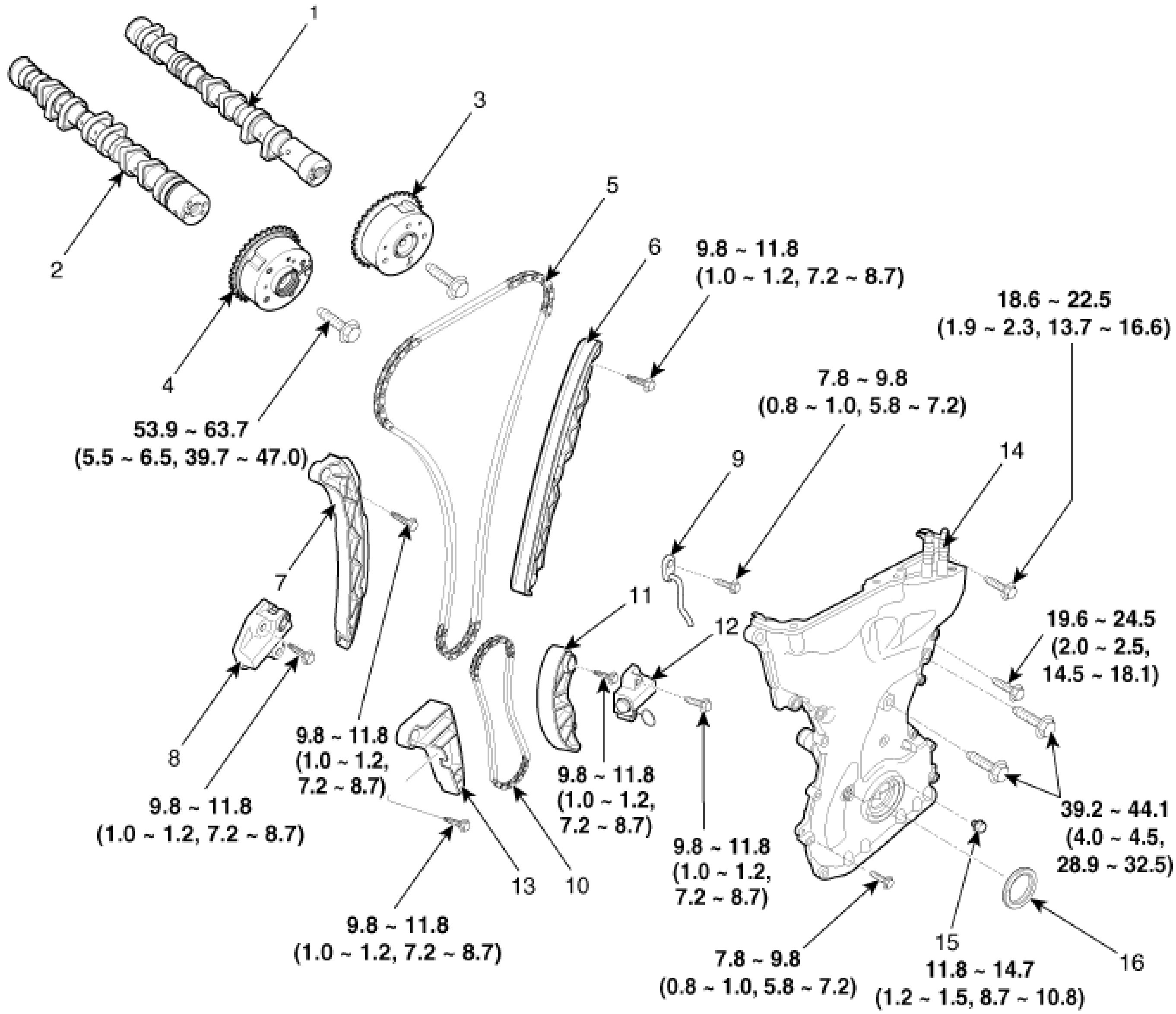
• Bleed air from the cooling system.

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

Timing System

Components and Components Location

Components

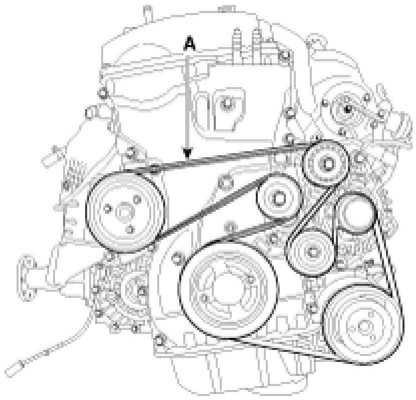


Torque : N.m (kgf.m, lb-ft)

1. Intake camshaft 2. Exhaust camshaft 3. Intake CVVT assembly 4. Exhaust CVVT assembly 5. Timing chain 6. Timing chain guide	7. Timing chain tensioner arm 8. Timing chain tensioner 9. Timing chain oil jet 10. Balance shaft chain 11. Balance shaft chain tensioner arm 12. Balance shaft chain tensioner	13. Balance shaft chain guide 14. Timing chain cover 15. Service hole bolt 16. Crankshaft front oil seal

Removal and Installation

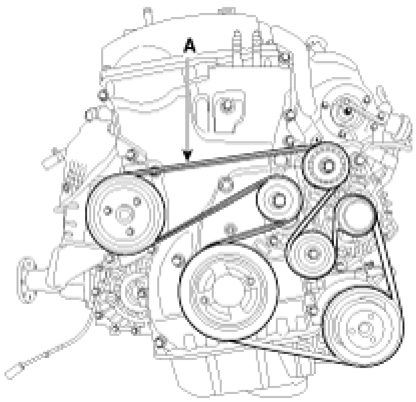
For release the tension, turn the drive belt tensioner counterclockwise then remove the drive belt (A).



Install the drive belt (A).

Rotate the drive belt tensioner arm (A) counterclockwise moving the tensioner pulley bolt with wrench. After putting the belt on the tensioner pulley, release the tensioner pulley slowly.

Crankshaft pulley → A/C pulley → Alternator pulley → Idler #1 pulley → Idler #2 pulley → Water pump pulley → Tensioner pulley.



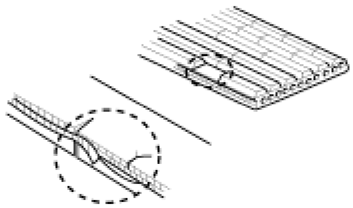
Inspection

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

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

NOTE

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

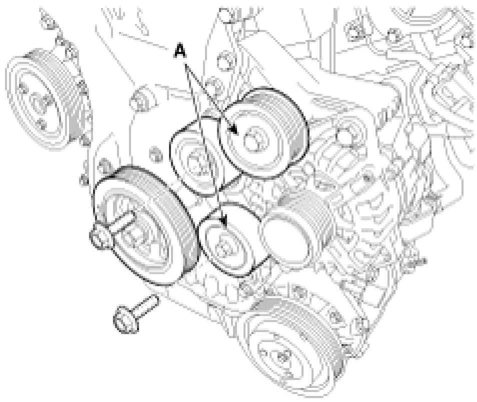


Idler. Repair procedures
Removal and Installation

Remove the drive belt.

Remove the idler(A).

Tightening torque :
53.9 ~ 63.7 N.m (5.5 ~ 6.5 kgf.m, 39.8 ~ 47.0 lb-ft)



NOTE

Check the idler. If it is grease leak or abnormal rotation, replace the idler.

Install in the reverse order of removal.

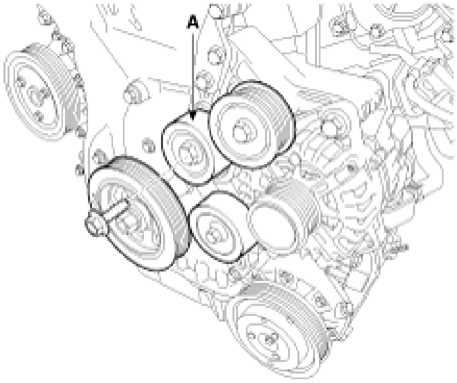
Drive Belt Tensioner. Repair procedures

Removal and Installation

Remove the drive belt.

Remove the drive belt auto tensioner(A).

Tightening torque :
53.9 ~ 63.7 N.m (5.5 ~ 6.5 kgf.m, 39.8 ~ 47.0 lb-ft)

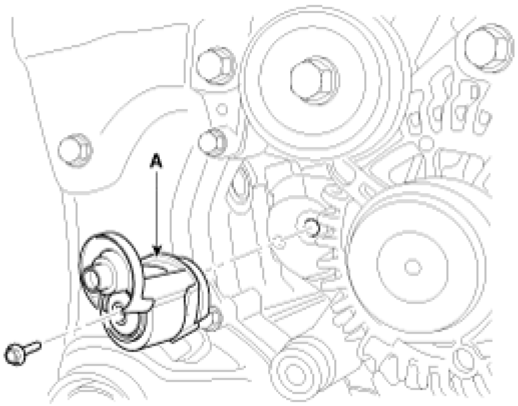


CAUTION

Tensioner pulley bolt is left-hands screw.

Remove the drive belt tensioner (A).

Tightening torque :
53.9 ~ 63.7 N.m (5.5 ~ 6.5 kgf.m, 39.8 ~ 47.0 lb-ft)



Install in the reverse order of removal.

Removal and Installation

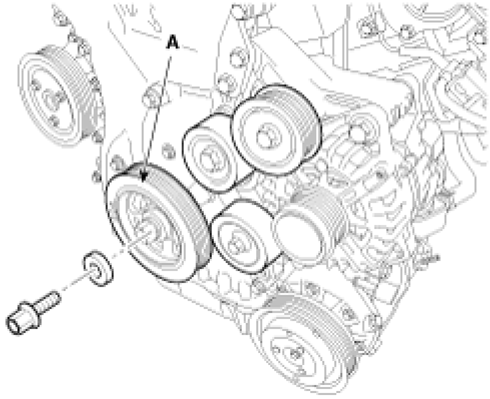
Remove the drive belt.

Remove the passenger engine room side cover.

Remove the passenger front tire.

Remove the crankshaft damper pulley(A).

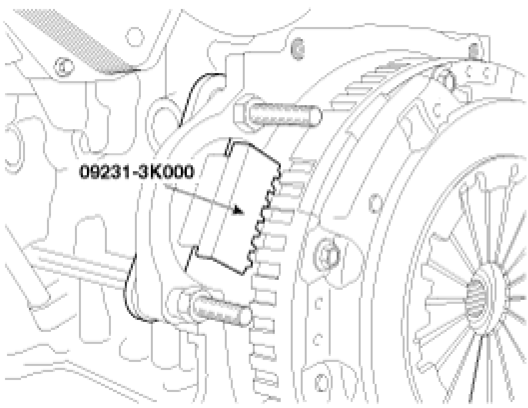
Tightening torque :
166.6 ~ 176.4 N.m (17.0 ~ 18.0 kgf.m, 122.9 ~ 130.1 lb-ft)



NOTE

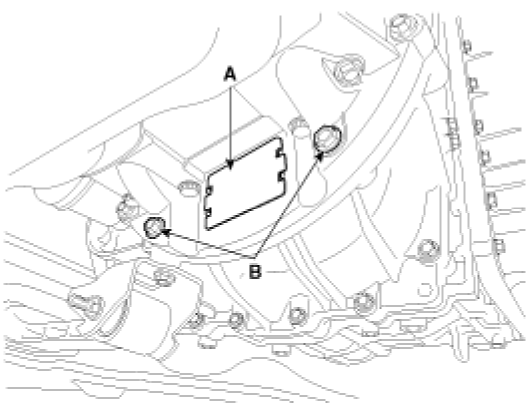
There are two methods to hold the ring gear when installing or removing the crankshaft damper pulley.

Install the SST (09231-3K000) to hold the ring gear after removing the starter.



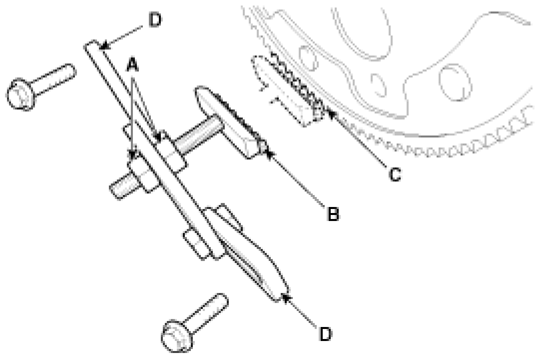
Install the SST (09231-3D100) to hold the ring gear after removing the dust cover.

Remove the dust cover (A) on the bottom of the ladder frame and unfasten the two transaxle mounting bolts (B).

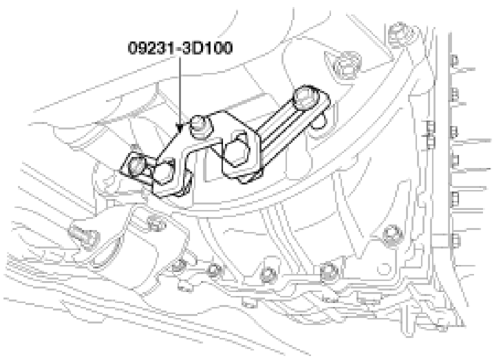


Adjust the length of the holder nuts (A) so that the front plate of the holder (B) puts in the ring gear (C) teeth.

Adjust the angle of the links (D) so that the two transaxle mounting bolts can be fastened to the original mounted holes.



Install the SST (09231-3D100) using the two transaxle mounting bolts and spacers. Tighten the bolts and nuts of the holder and links securely.

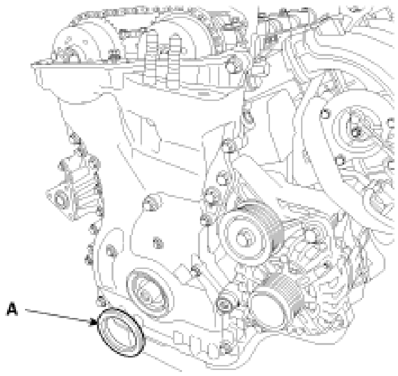


Install in the reverse order of removal.

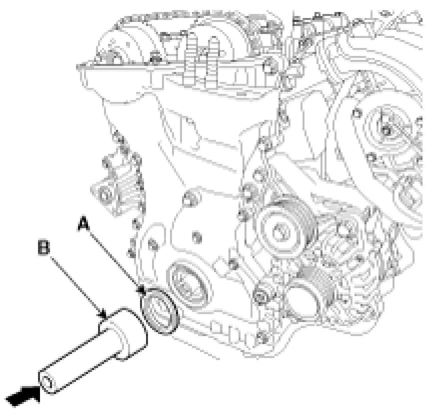
Removal and Installation

Remove the crankshaft damper pulley.

Remove the front oil seal(A).



Install the crankshaft front oil seal (A) using SST (09214-3K000, 09231-H1100) (B).



Removal

NOTE

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

CAUTION

Mark all wiring and hoses to avoid misconnection.

WARNING

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

Disconnect the battery negative terminal.

Remove the engine cover.

Remove the air duct.

Remove the air cleaner assembly.

Remove the RH front wheel.

Remove the under covers.

Remove the drive belt.

Remove the cylinder head cover.

Remove the A/C compressor lower bolts.

Remove the oil pan.

Set the jack to the edge of ladder frame.

NOTE

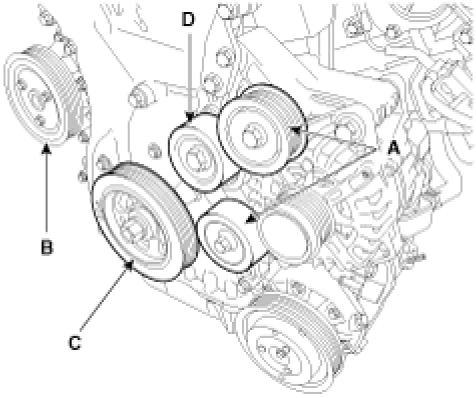
Put the wooden block between ladder frame and jack.

CAUTION

Be careful not to damage the balance shaft & oil pump module.

Disconnect the ground line, and then remove the engine mounting support bracket.

Remove the idler (A), the water pump pulley (B), the crankshaft pulley (C) and the drive belt tensioner pulley (D).

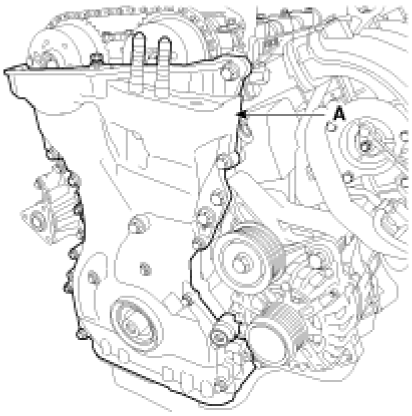


CAUTION

Tensioner pulley bolt is left-handed screw.

Remove the drive belt tensioner.

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



CAUTION

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

Installation

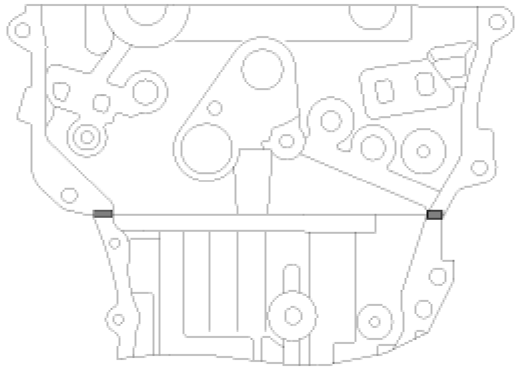
Install the timing chain cover.

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

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

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

Bead width: 3.0 mm (0.12 in.)

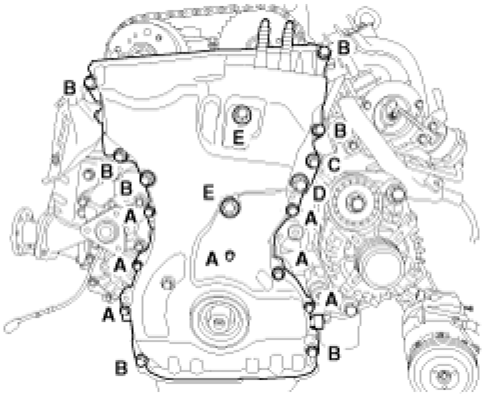


After applying liquid sealant Loctite 5900H or equivalent on the timing chain cover.
The part must be assembled within 5 minutes after sealant was applied. Continuous bead of sealant should be applied to prevent any path of oil leakage.

Bead width: 3.0 mm (0.12 in.)

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
Bolts A (M6 X 25) :
7.8 ~ 9.8 N.m (0.8 ~ 1.0 kgf.m, 5.8 ~ 7.2 lb-ft)
Bolts B (M8 X 28) :
18.6 ~ 22.6 N.m (1.9 ~ 2.3 kgf.m, 13.7 ~ 16.6 lb-ft)
Bolts C (M8 X 30) :
19.6 ~ 24.5 N.m (2.0 ~ 2.5 kgf.m, 14.5 ~ 18.1 lb-ft)
Bolts D (M10 X 40) :
39.2 ~ 44.1 N.m (4.0 ~ 4.5 kgf.m, 28.9 ~ 32.5 lb-ft)
Bolts E (M10 X 45) :
39.2 ~ 44.1 N.m (4.0 ~ 4.5 kgf.m, 28.9 ~ 32.5 lb-ft)



CAUTION

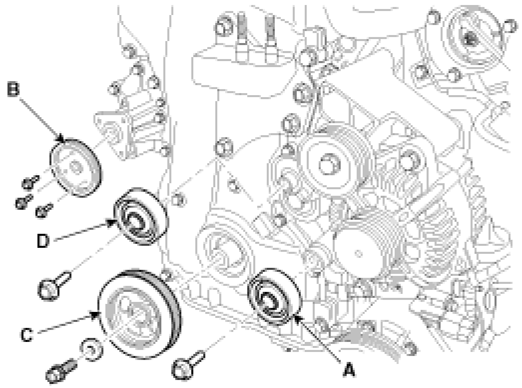
The engine starting or pressure tests should not be performed within 30 minutes after the timing chain cover was assembled.

Install the crankshaft front oil seal.

Install the drive belt tensioner.

Install the idler (A), the water pump pulley (B), the crankshaft pulley (C) and the drive belt tensioner pulley (D).

Tightening torque
Idler (A) :
53.9 ~ 63.7 N.m (5.5 ~ 6.5 kgf.m, 39.8 ~ 47.0 lb-ft)
Water pump pulley (B) :
7.8 ~ 9.8 N.m (0.8 ~ 1.0 kgf.m, 5.8 ~ 7.2 lb-ft)
Crankshaft pulley (C) :
166.6 ~ 176.4 N.m (17.0 ~ 18.0 kgf.m, 122.9 ~ 130.1 lb-ft)
Drive belt tensioner pulley (D) :
53.9 ~ 63.7 N.m (5.5 ~ 6.5 kgf.m, 39.8 ~ 47.0 lb-ft)



CAUTION

Tensioner pulley bolt is left-handed screw.

Install the engine mounting support bracket and connect the ground line.

Remove the jack from the ladder frame.

Install the oil pan.

Install the A/C compressor lower bolts.

Install the drive belt.

Install cylinder head cover.

Install the under cover.

Install the RH front wheel.

Install the air cleaner assembly.

Install the air duct.

Install the engine cover.

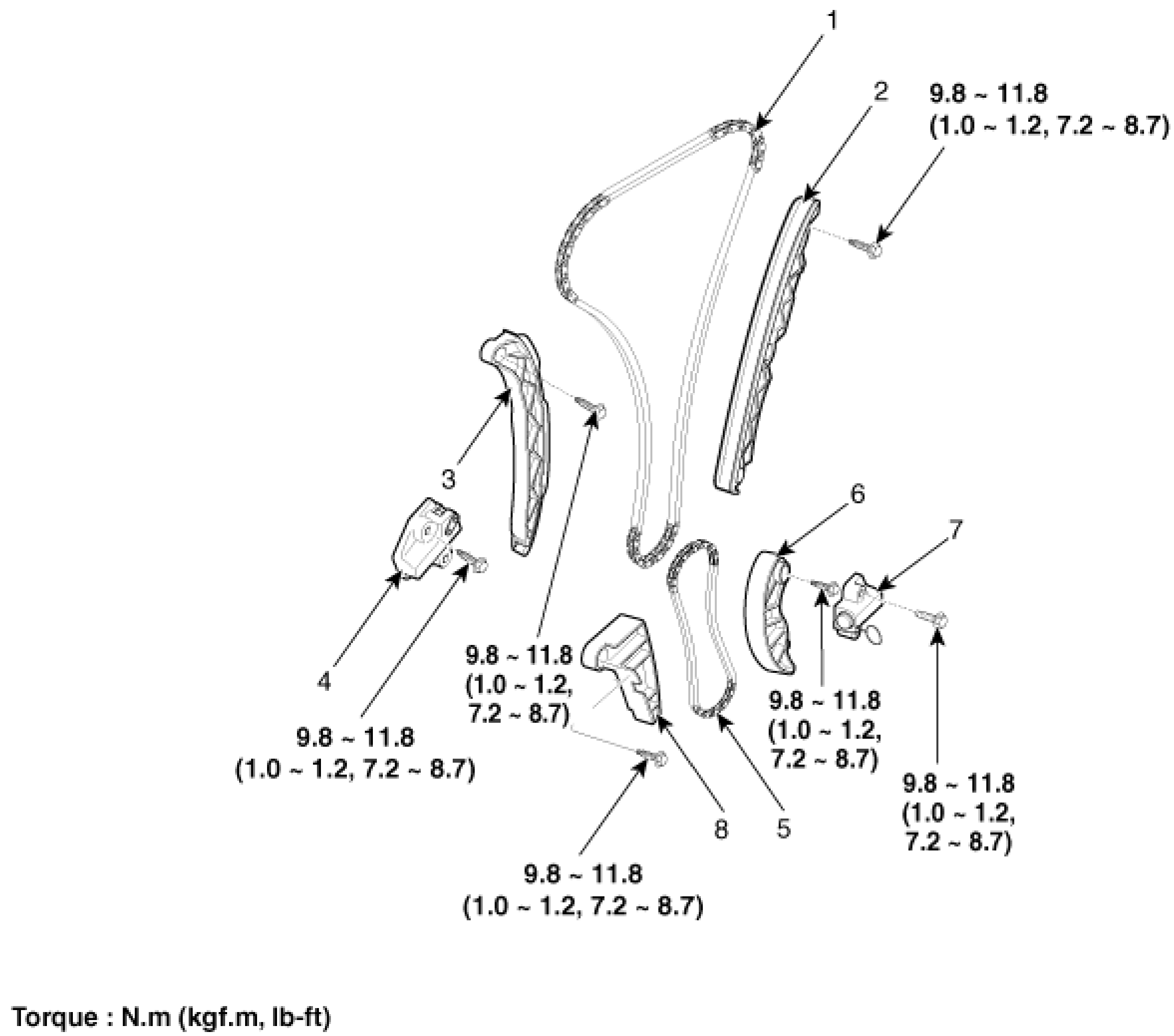
Connect the battery negative terminal.

Add all the necessary fluids and check for leaks. Connect GDS. Check for codes, note, and clear. Recheck.

NOTE

- Refill engine with engine oil.
- Refill a transaxle with fluid.
- Refill a radiator and a reservoir tank with engine coolant.
- 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.
- Refill radiator and reservoir tank with engine coolant.
- Bleed air from the cooling system.

Components

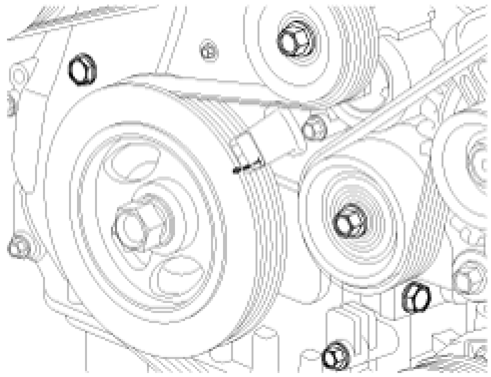


1. Timing chain 2. Timing chain guide 3. Timing chain tension arm 4. Timing chain tension	5. Balance shaft chain 6. Balance shaft chain tension arm 7. Balance shaft chain tension 8. Balance shaft chain guide

Removal

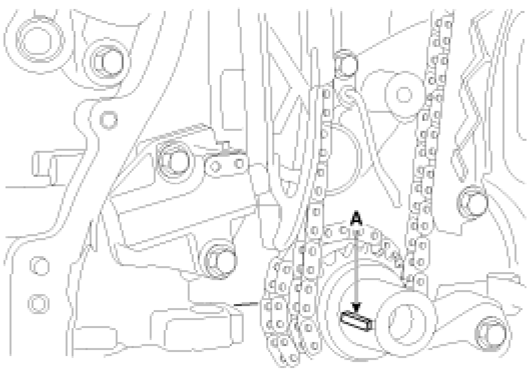
Remove the cylinder head cover.

Turn the crankshaft pulley and align its groove with the timing mark of the timing chain cover to set the piston of No.1 cylinder to the top dead center on compression stroke.

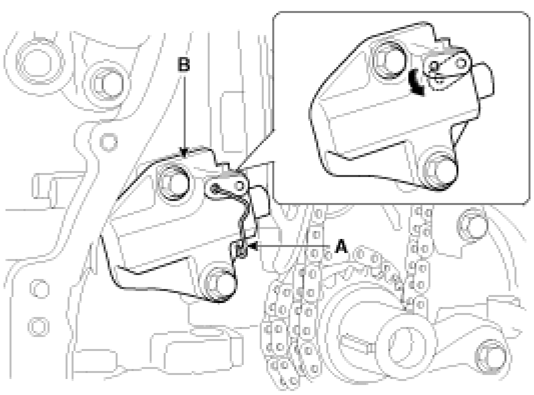


Remove the timing chain cover.

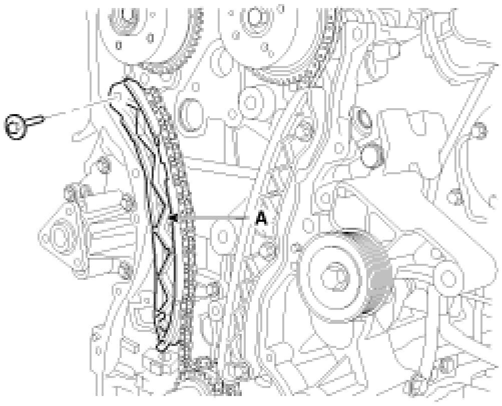
Make sure that the key (A) of crankshaft is aligned with the mating surface of main bearing cap. As a result of this, the piston of No.1 cylinder is placed at the top dead center on compression stroke.



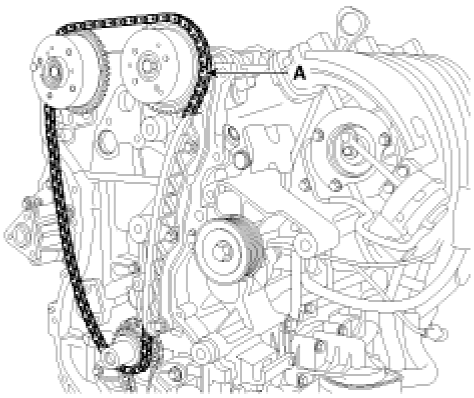
Release the ratchet by pulling the link down using a thin rod. Compress the piston and then insert a stopper pin (A) into the hole on the ratchet to hold the compressed piston. Remove the timing chain tensioner (B).



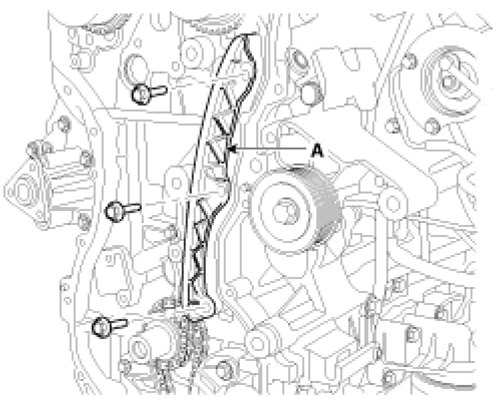
Remove the timing chain tensioner arm (A).



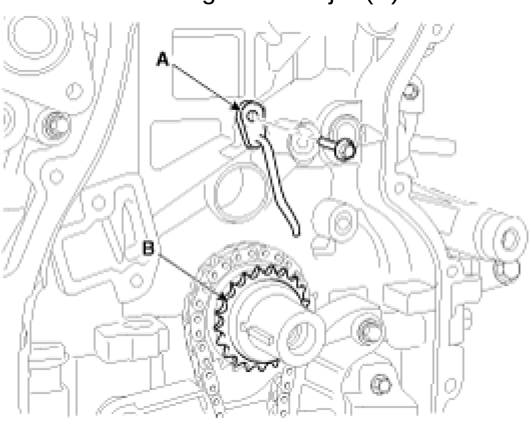
Remove the timing chain (A).



Remove the timing chain guide (A).



Remove the timing chain oil jet (A) and the crankshaft chain sprocket (B).



Remove the balance shaft chain.

Inspection

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

Check the CVVT sprocket, crankshaft sprocket teeth for abnormal wear, cracks or damage. Replace if necessary.

Check a contact surface of the chain tensioner arm and guide for abnormal wear, cracks or damage.
Replace if necessary.

Check the hydraulic tensioner for its piston stroke and ratchet operation. Replace if necessary.

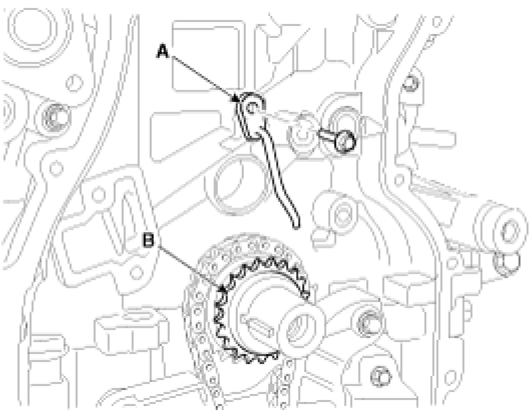
Check the timing chain for its elongation, abnormal wear or damage. Replace if necessary.

Installation

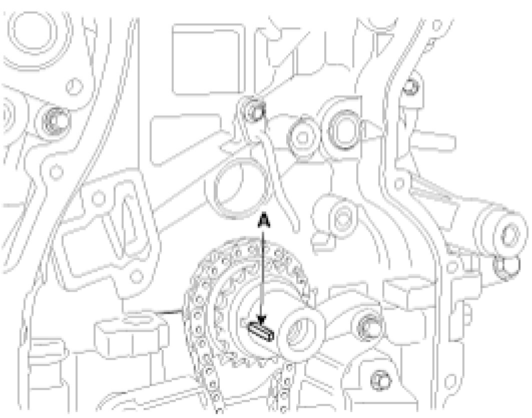
Install the balance shaft chain.

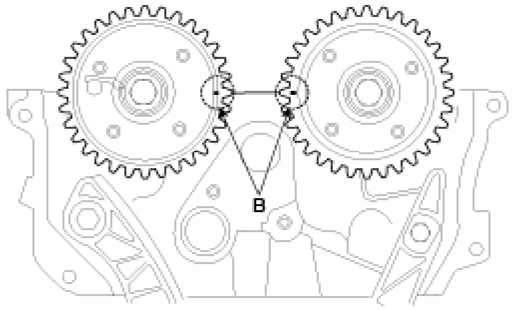
Install the crankshaft chain sprocket (B) and the timing chain oil jet (A).

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



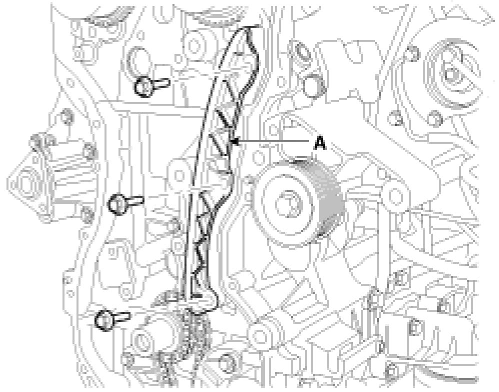
Set the crankshaft so that the key (A) of crankshaft will be aligned with the mating surface of main bearing cap. Put the intake and exhaust camshaft assembly so that the TDC marks (B) of the intake and exhaust CVVT sprockets will be aligned with the top surface of cylinder head. As a result of this, the piston of No.1 cylinder is placed at the top dead center on compression stroke.



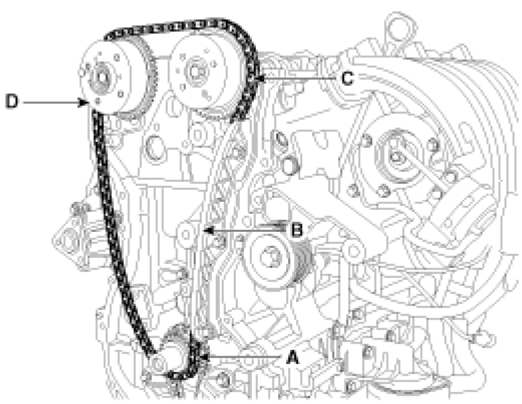


Install the timing chain guide (A).

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

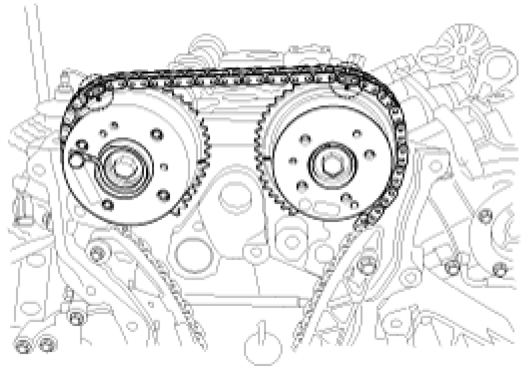


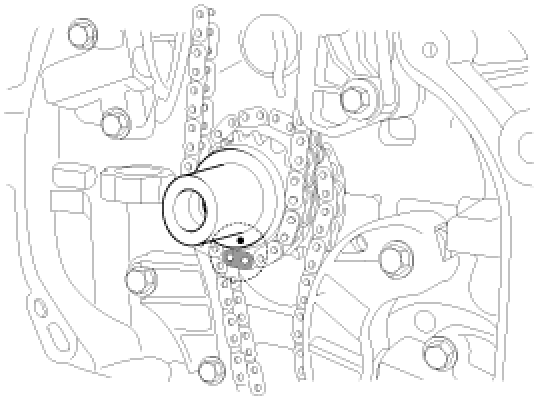
Install the timing chain. To install the timing chain with no slack between each shaft (cam, crank), follow the below procedure.
Crankshaft sprocket (A) → Timing chain guide (B) → Intake CVVT sprocket (C) → Exhaust CVVT sprocket (D).



NOTE

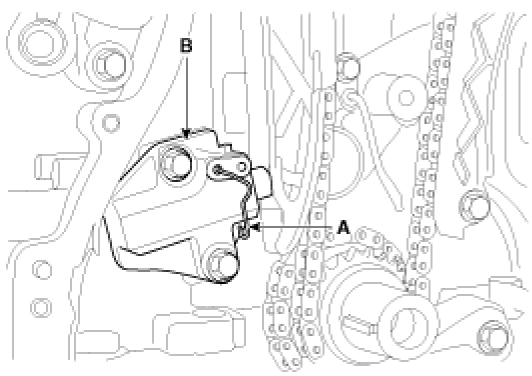
The timing marks of each sprocket should be matched with timing marks (color link) of timing chain when installing the timing chain.



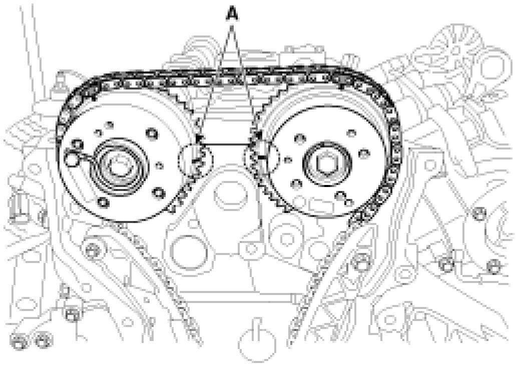


Install the timing chain auto tensioner (B) and remove the stopper pin (A).

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



After rotating crankshaft 2 revolutions in regular direction (clockwise viewed from front), confirm that the TDC marks (A) on the intake and exhaust CVVT sprockets aligned with the top surface of cylinder head.



Install the timing chain cover.

Install cylinder head cover.

Add all the necessary fluids and check for leaks. Connect GDS. Check for codes, note, and clear. Recheck.

NOTE

- Refill engine with engine oil.
- Refill a transaxle with fluid.
- Refill a radiator and a reservoir tank with engine coolant.
- Clean battery posts and cable terminals and assemble.
- Inspect for fuel leakage.

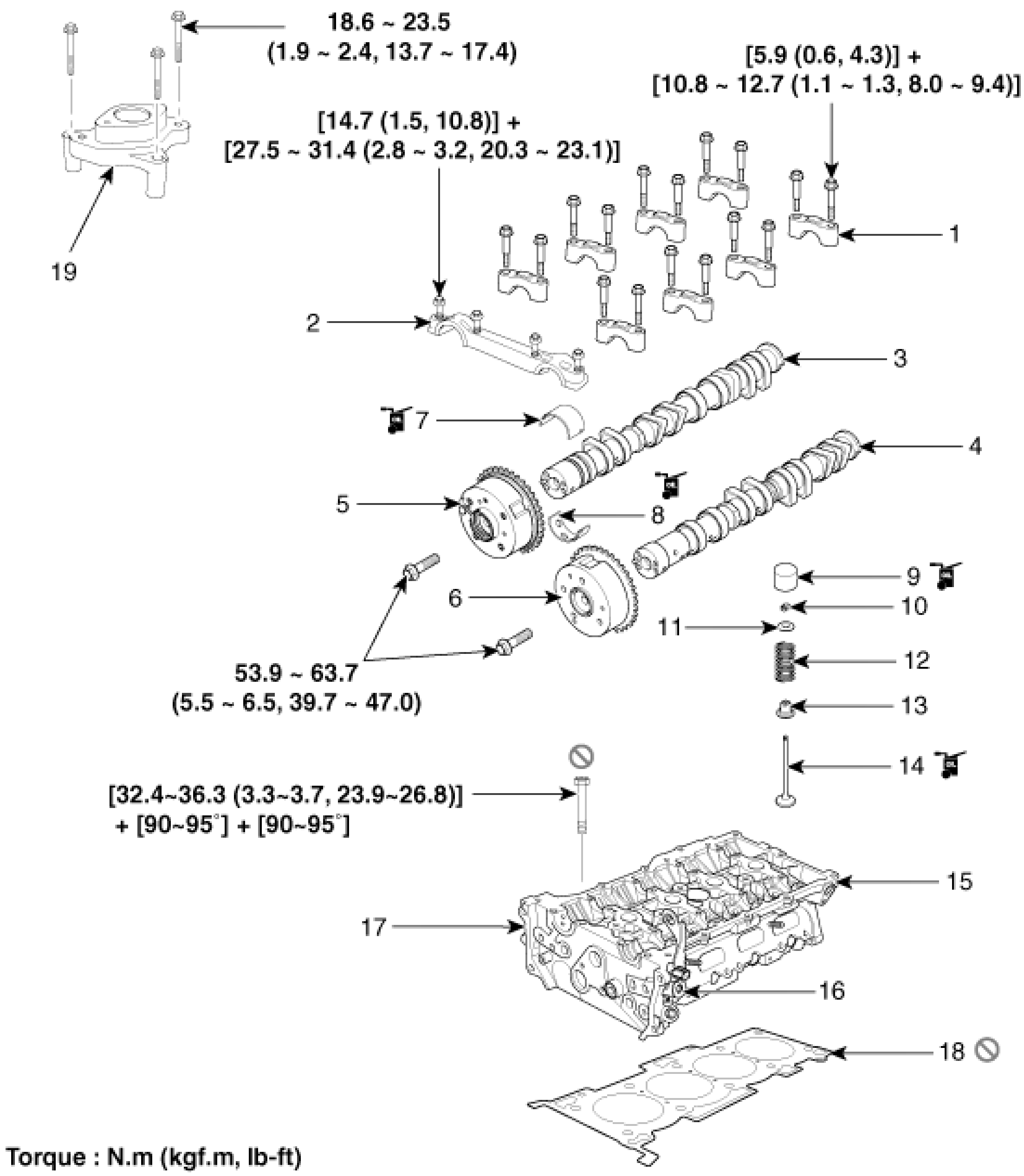
- After assemble the fuel line, turn on the ignition switch (do not operate the starter) so that the fuel pump runs for approximately two seconds and fuel line pressurizes.
- Repeat this operation two or three times, then check for fuel leakage at any point in the fuel line.

- Refill radiator and reservoir tank with engine coolant.
- Bleed air from the cooling system.

Cylinder Head Assembly

Components and Components Location

Components



1. Camshaft bearing cap 2. Camshaft front bearing cap 3. Exhaust camshaft 4. Intake camshaft 5. Exhaust CVVT assembly 6. Intake CVVT assembly	7. Exhaust camshaft upper bearing 8. Exhaust camshaft lower bearing 9. MLA 10. Retainer lock 11. Retainer 12. Valve spring	13. Valve stem seal 14. Valve 15. Cylinder head 16. Intake OCV (Oil control valve) 17. Exhaust OCV (Oil control valve) 18. Cylinder head gasket 19. Fuel pump bracket

Valve Clearance Inspection and Adjustment

NOTE

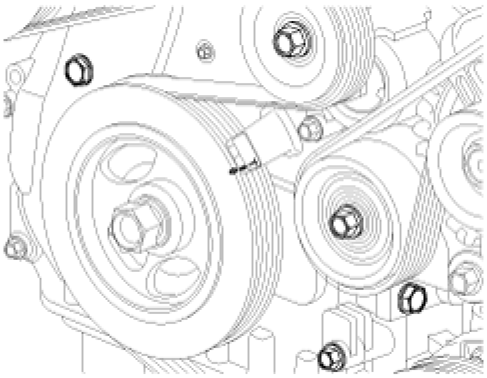
Inspect and adjust the valve clearance when the engine is cold (Engine coolant temperature : 20°C (68°F)) and cylinder head is installed on the cylinder block.

WARNING

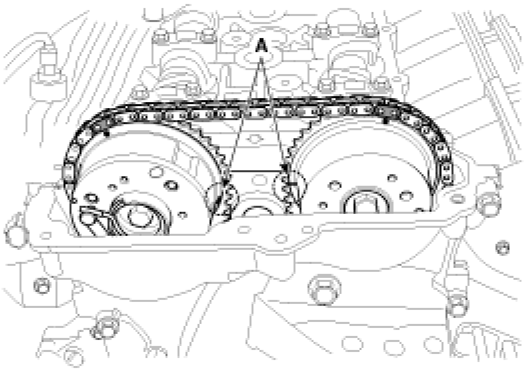
In case of removing the high pressure fuel pump, high pressure fuel pipe, delivery pipe, and injector, there may be injury caused by leakage of the high pressure fuel. So don’t do any repair work right after engine stops.

Set No.1 cylinder to TDC/compression.

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

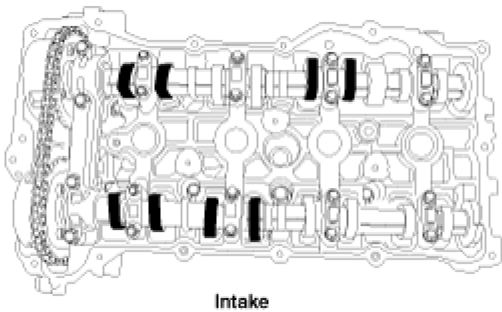


Check that the TDC marks (A) of the CVVT sprockets are in straight line on the cylinder head surface as shown in the illustration.
If not, turn the crankshaft one revolution (360°)



Inspect the valve clearance.

Check only the valve indicated as shown. Measure the valve clearance.



[No.1 cylinder : TDC/Compression]

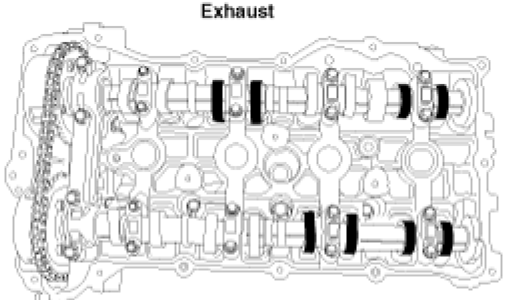
A. Using a thickness gauge, measure the clearance between the tappet and the base circle of camshaft.

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

Valve clearance
Specification
Engine coolant temperature : 20°C [68°F]
Limit
Intake : 0.10 ~ 0.30 mm (0.0039 ~ 0.0118 in.)
Exhaust : 0.20 ~ 0.40 mm (0.0079 ~ 0.0157in.)

Turn the crankshaft pulley one revolution (360°) and align the groove with timing mark "T" of the lower timing chain cover.

Check only valves indicated as shown. Measure the valve clearance.

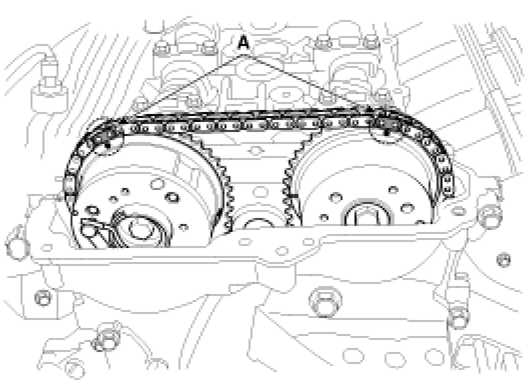


[No.4 cylinder : TDC/Compression]

Adjust the intake and exhaust valve clearance.

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

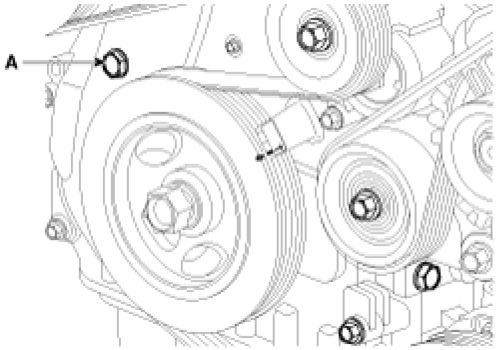
Mark the timing chains (A) on the timing marks of the CVVT sprockets.



Remove the front camshaft bearing cap.

Turn the crankshaft pulley 15° clockwise.

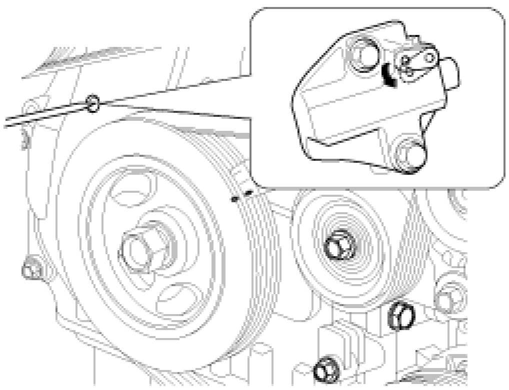
Remove the service hole bolt(A) of the timing chain cover.



CAUTION

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

Release the ratchet of the timing chain tensioner by pulling the link down using a thin rod.



Remove the exhaust camshaft bearing cap and exhaust camshaft.

Remove the intake camshaft bearing cap and intake camshaft.

CAUTION

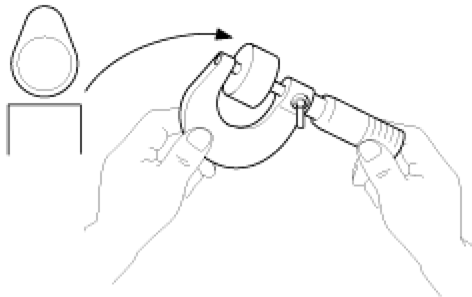
When disconnect the timing chain from the CVVT sprocket, hold the timing chain.

Tie down timing chain so that it doesn't move.

CAUTION

Be careful not to drop anything inside timing chain cover.

Measure the thickness of the removed tappet using a micrometer.



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

Valve clearance [Engine coolant temperature : 20°C(68°F)]
T : Thickness of removed tappet
A : Measured valve clearance
N : Thickness of new tappet
Intake : N = T + [A - 0.20 mm (0.0079 in.)]
Exhaust : N = T + [A - 0.30 mm (0.0118 in.)]

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

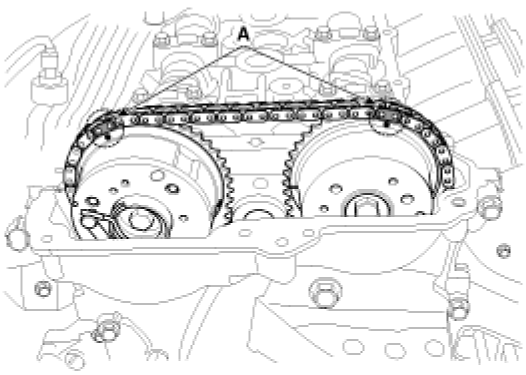
NOTE

Shims are available in 47 size increments of 0.015 mm (0.0006 in.) from 3.00 mm (0.11 in.) to 3.690 mm (0.1452 in.)

Place a new tappet on the cylinder head.

Hold the timing chain, and install the intake camshaft and CVVT assembly.

Align the timing marks (A) on the timing chains and CVVT sprockets.



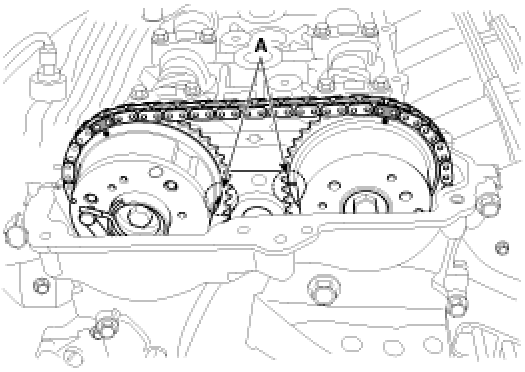
Install the exhaust camshaft and CVVT assembly after releasing the ratchet of the timing chain tensioner.

Install the front bearing cap.

Install the service hole bolt.

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

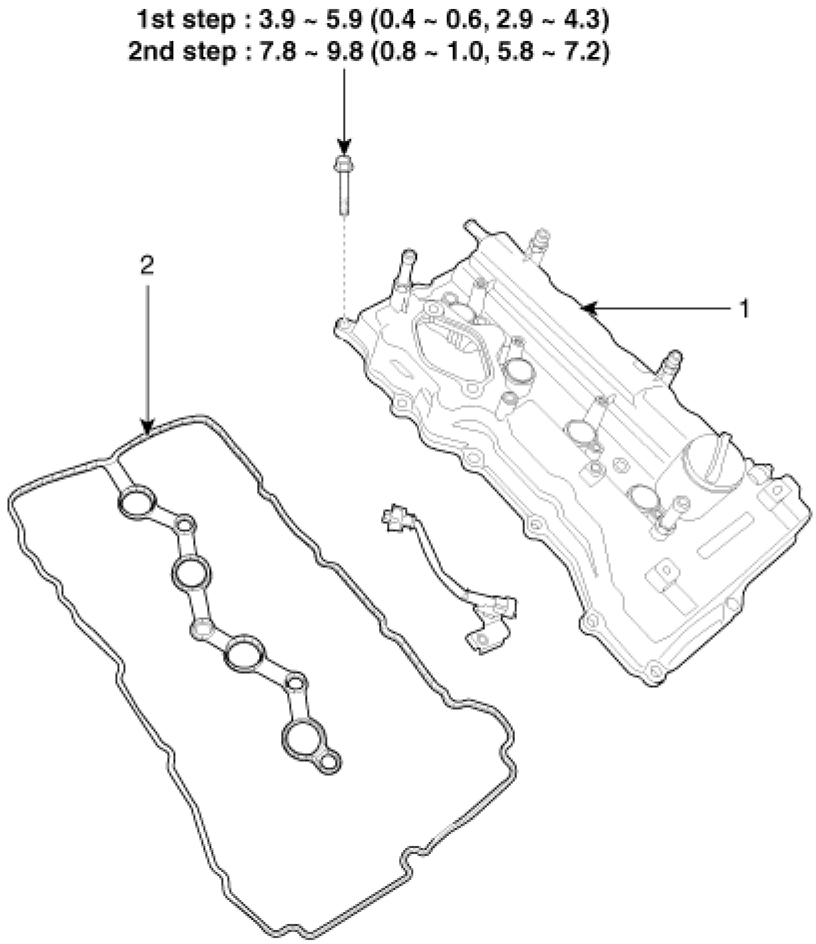
Turn the crankshaft two turns in the operating direction(clockwise), and then check that the TDC marks (A) of the CVVT sprockets are in straight line on the cylinder head surface.



Recheck the valve clearance.

Valve clearance [Engine coolant temperature : 20°C(68°F)]
[Specification]
Intake : 0.17 ~ 0.23 mm (0.0067 ~ 0.0090 in.)
Exhaust : 0.27 ~ 0.33 mm (0.0106 ~ 0.0129 in.)

Components



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

1. Cylinder head cover	2. Gasket

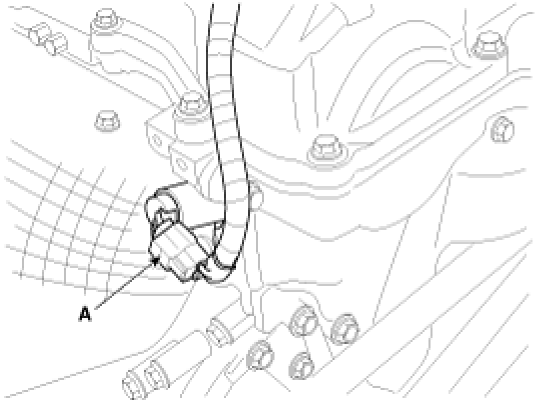
Removal

Disconnect the battery negative terminal.

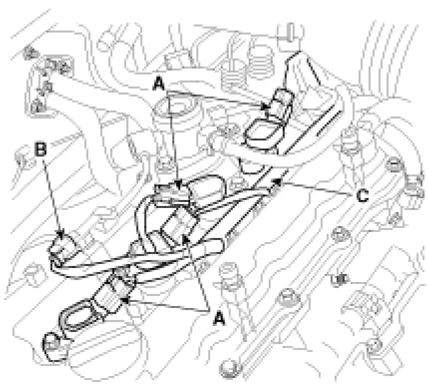
Remove the engine cover.

Remove the air duct and air cleaner assembly.

Disconnect the exhaust OCV (Oil control valve) connector (A).

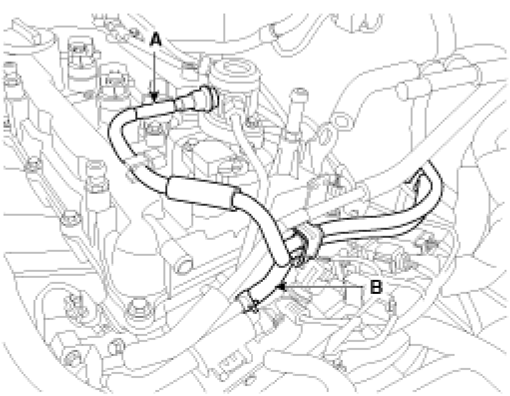


Disconnect the ignition coil connectors (A) and the fuel pump connector (B), then remove the wiring protector (C).

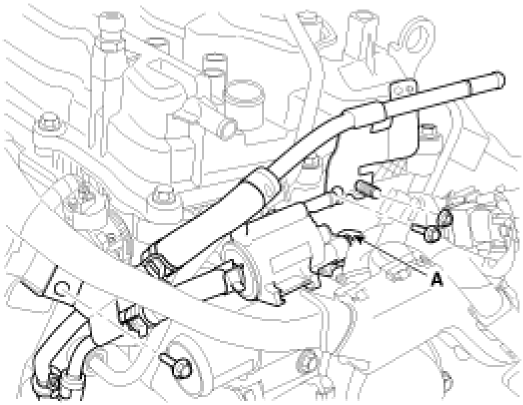


Remove the ignition coils.

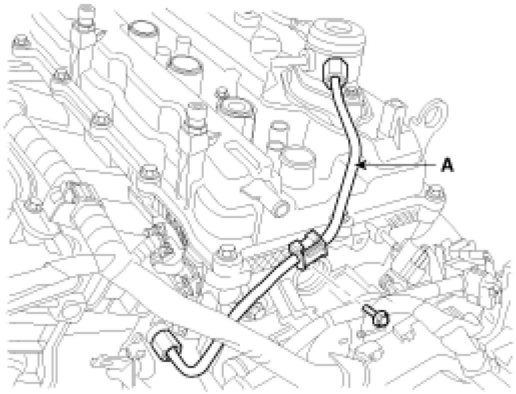
Disconnect the fuel hose (A) and PCSV (Purge control solenoid valve) hose (B).



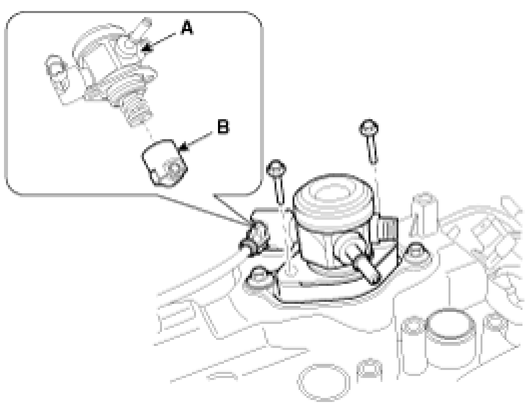
Disconnect PCSV (Purge control solenoid valve) connector (A) and loosen the vacuum & PCSV (Purge control solenoid valve) pipe assembly mounting bolts and nut.



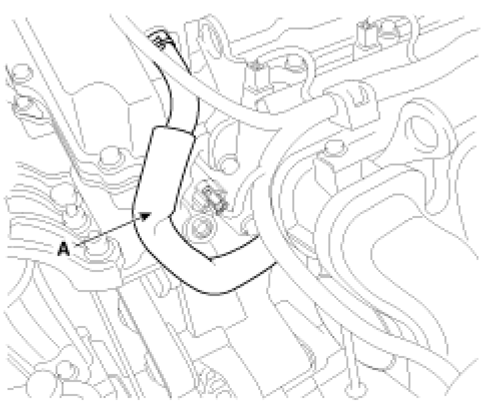
Remove the high pressure pipe (A).



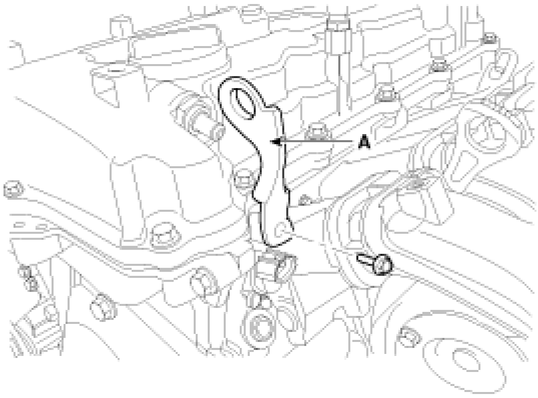
Remove the high pressure fuel pump (A) and the roller tappet (B).



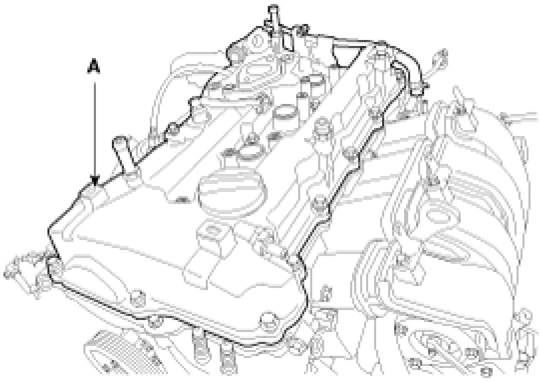
Disconnect the PCV (Positive crankcase ventilation) hose (A).



Remove the front engine hanger (A).



Remove the cylinder head cover (A).



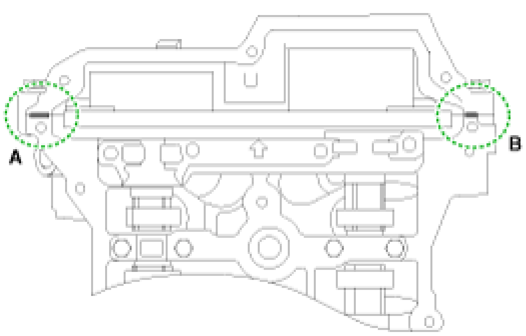
Installation

Install cylinder head cover.

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

After applying liquid gasket sealant to locations (A) and (B), it should be assembled within 5 minutes.

Bead width : 2.5 mm (0.10 in.)

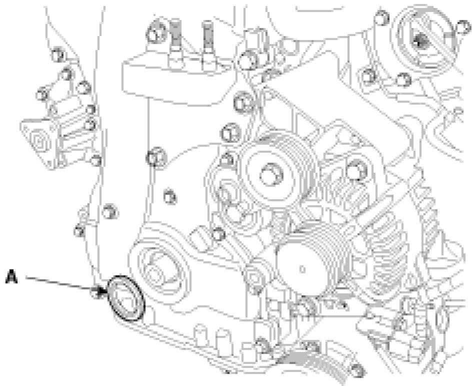


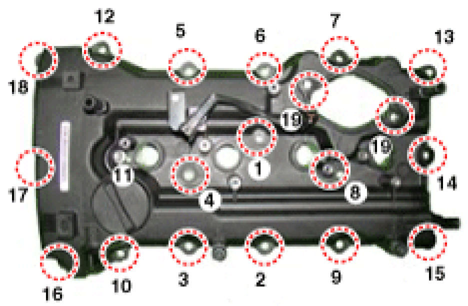
(2)

Install the cylinder head cover (A) by tightening the bolts as following method.

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

(3)



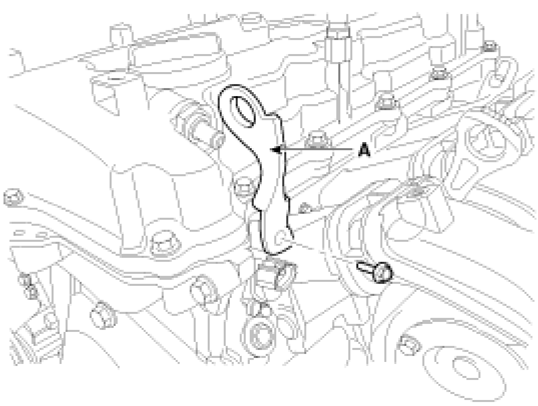


CAUTION

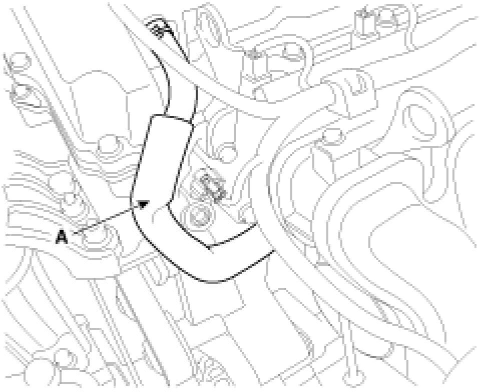
- Do not reuse cylinder head cover gasket.
- The firing and/or blow out test should not be performed within 30 minutes after the cylinder head cover was assembled.

Install the front engine hanger (A).

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



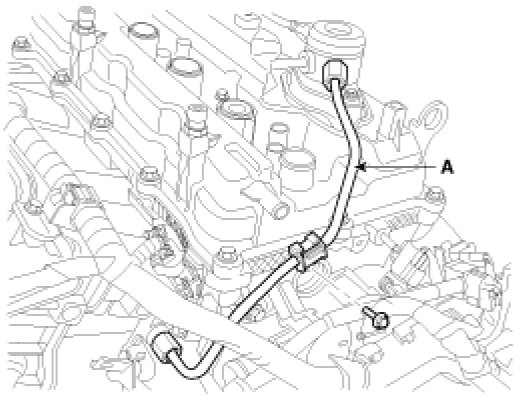
Connect the PCV (Positive crankcase ventilation) hose (A).



Install the high pressure fuel pump.

Install the high pressure pipe (A).

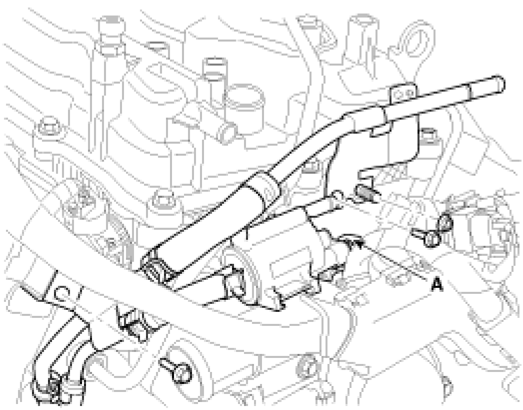
Tightening torque
Bolt :
7.8 ~ 11.8 N.m (0.8 ~ 1.2 kgf.m, 5.8 ~ 8.7 lb-ft)
Nuts :
26.5 ~ 32.4 N.m (2.7 ~ 3.3 kgf.m, 19.5 ~ 23.9 lb-ft)



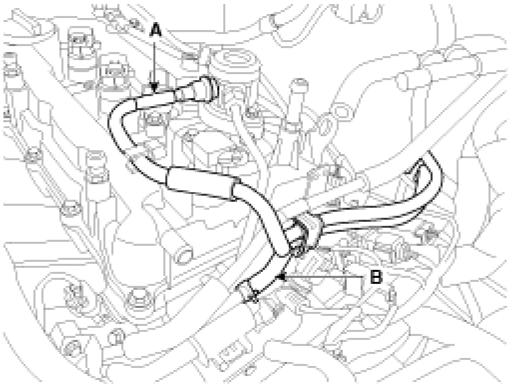
NOTE

Do not reuse the high pressure pipe.

Connect PCSV (Purge control solenoid valve) connector (A) and tighten the vacuum & PCSV (Purge control solenoid valve) pipe assembly mounting bolts and nut.

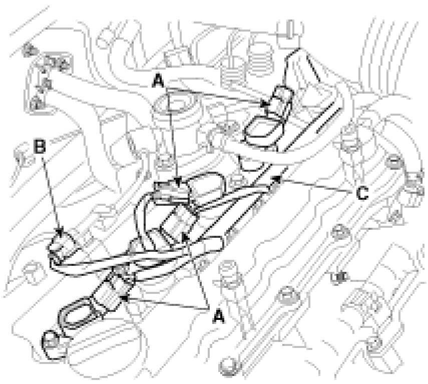


Connect the fuel hose (A) and PCSV (Purge control solenoid valve) hose (B).

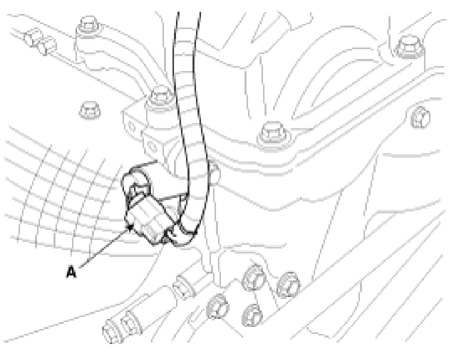


Install the ignition coils.

Connect the ignition coil connectors (A) and fuel pump connector (B) after installing the wiring protector (C).



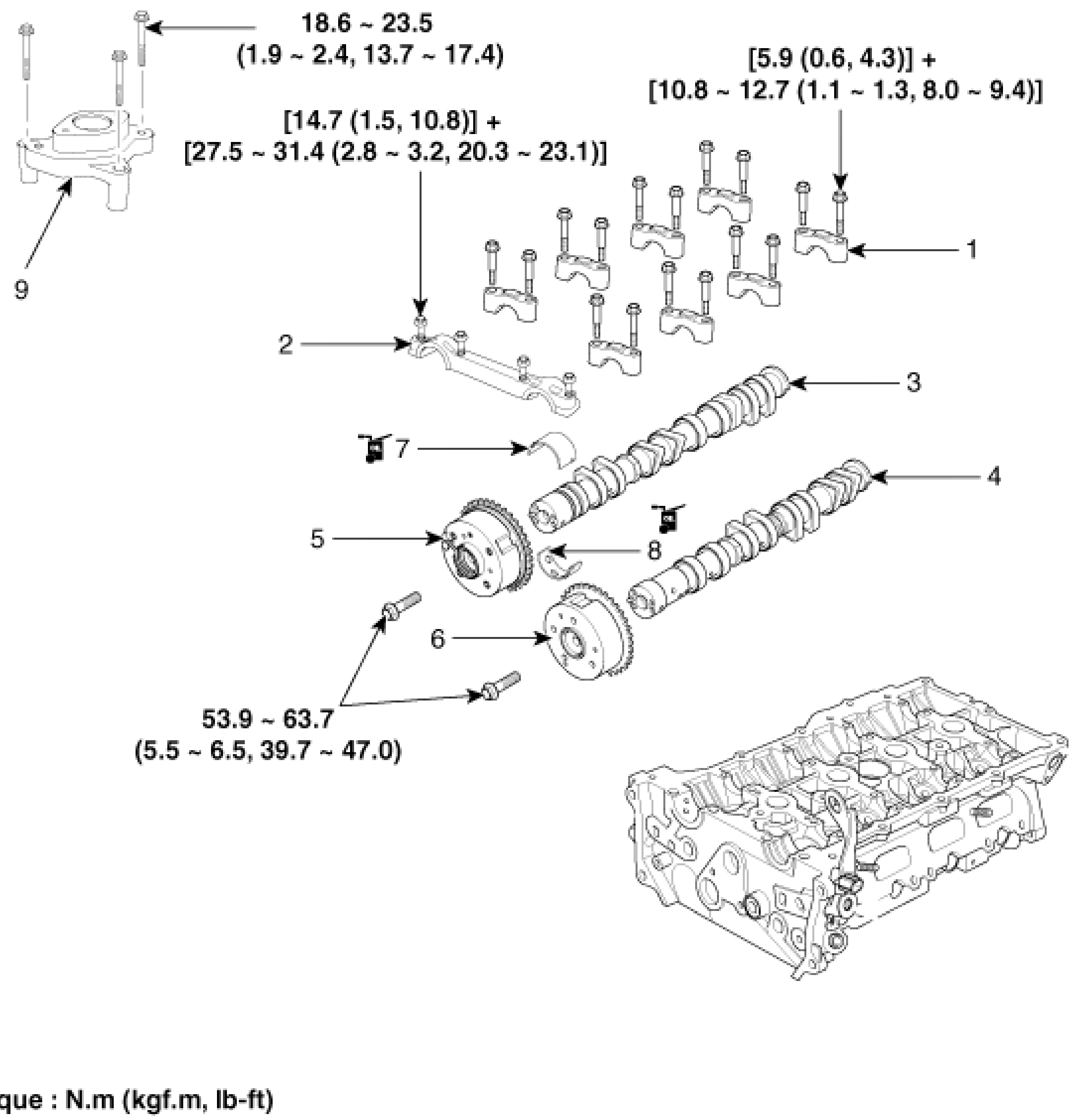
Connect the exhaust OCV (Oil control valve) connector (A).



Install the air cleaner assembly.

Install the engine cover.

Components



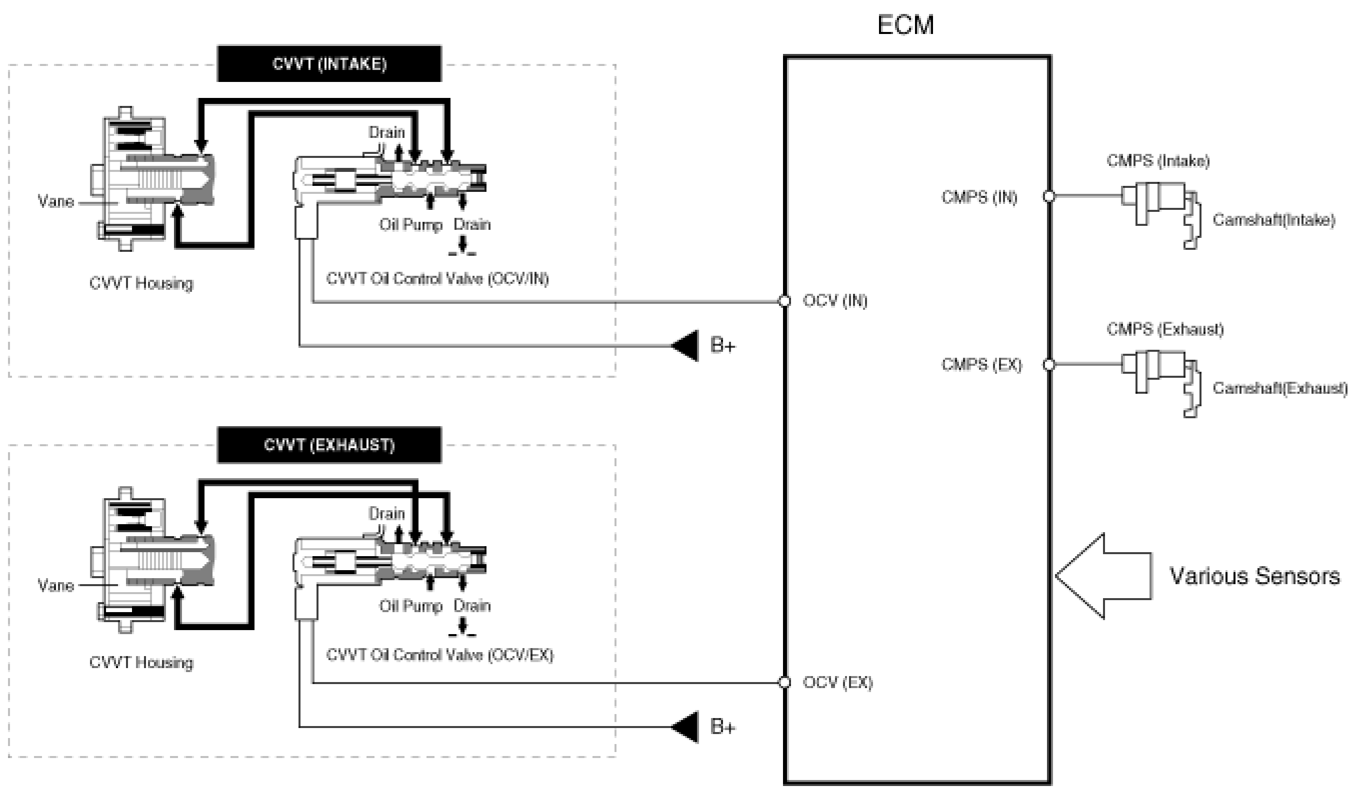
1. Camshaft bearing cap 2. Camshaft front bearing cap 3. Exhaust camshaft 4. Intake camshaft 5. Exhaust CVVT assembly	6. Intake CVVT assembly 7. Exhaust camshaft upper bearing 8. Intake camshaft lower bearing 9. Fuel pump bracket

Description

Continuous Variable Valve Timing (CVVT) system advances or retards the valve timing of the intake and exhaust valve in accordance with the ECM control signal which is calculated by the engine speed and load.
By controlling CVVT, the valve over-lap or under-lap occurs, which makes better fuel economy and reduces exhaust gases (NOx, HC) and improves engine performance through reduction of pumping loss, internal EGR effect, improvement of combustion stability, improvement of volumetric efficiency, and increase of expansion work.
This system consist of

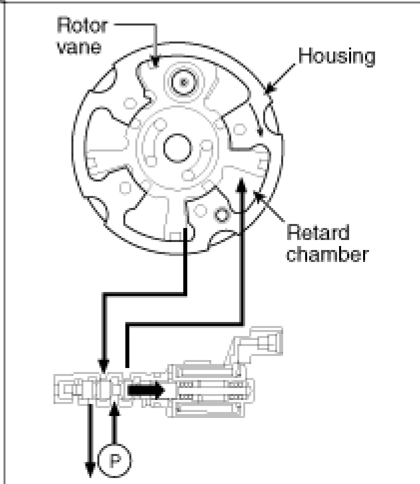
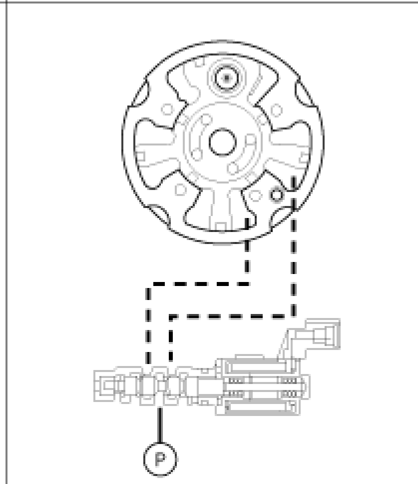
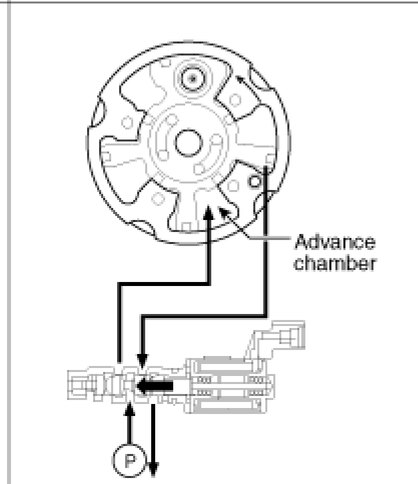
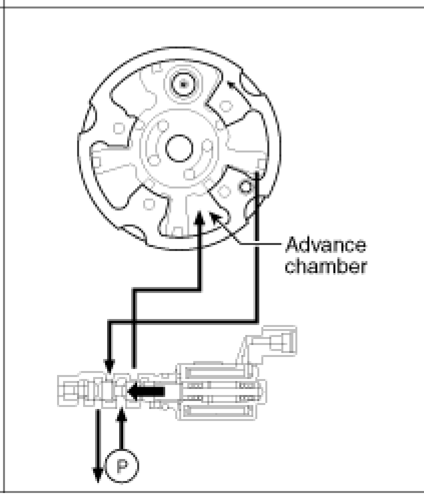
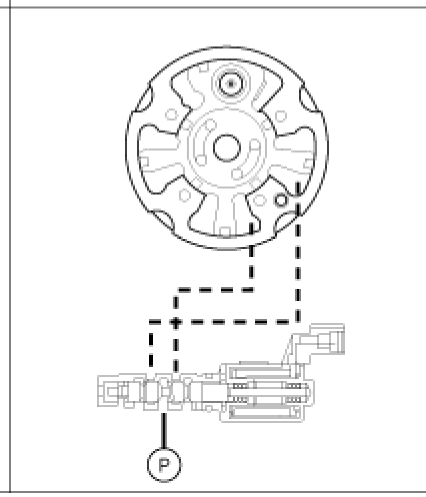
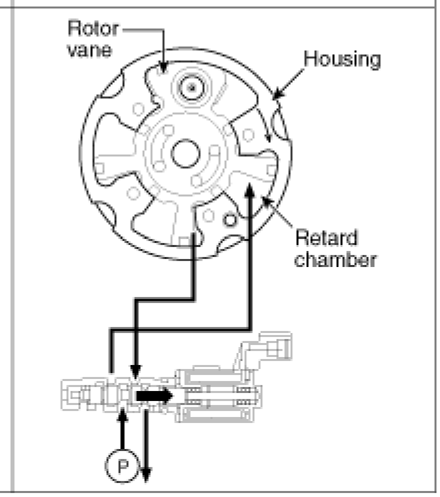
- the CVVT Oil Control Valve (OCV) which supplies the engine oil to the cam phaser or runs out the engine oil from the cam phaser in accordance with the ECM PWM (Pulse With Modulation) control signal,
- the CVVT Oil Temperature Sensor (OTS) which measures the engine oil temperature,
- and the Cam Phaser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

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

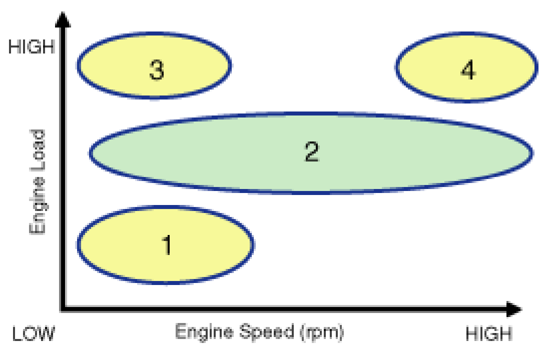


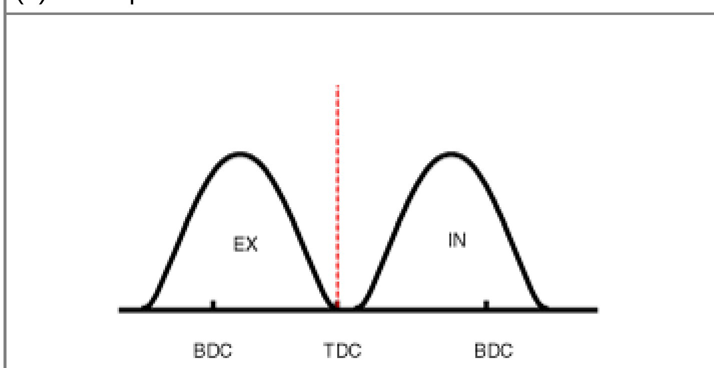
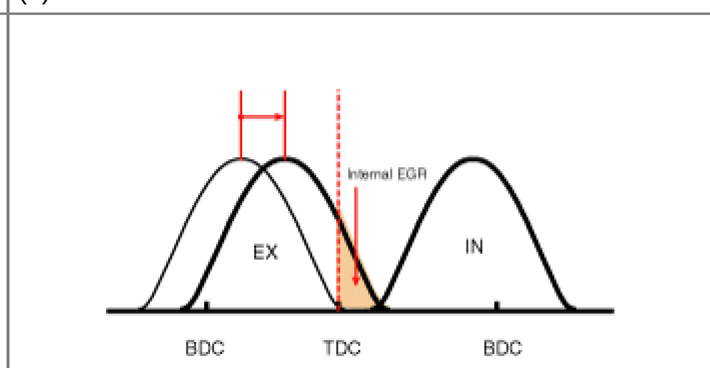
Operation Principle

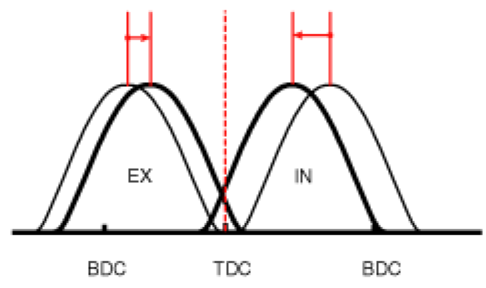
The CVVT has the mechanism rotating the rotor vane with hydraulic force generated by the engine oil supplied to the advance or retard chamber in accordance with the CVVT oil control valve control.

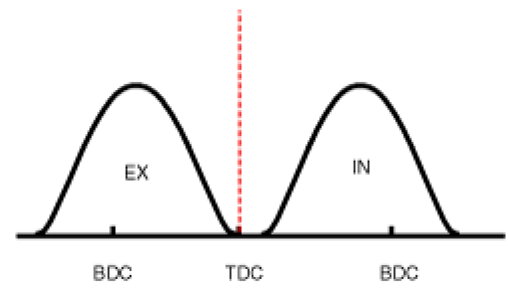
	Initial State	Hold	Advace / Retard
Intake			
Exhaust			

[CVVT System Mode]



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





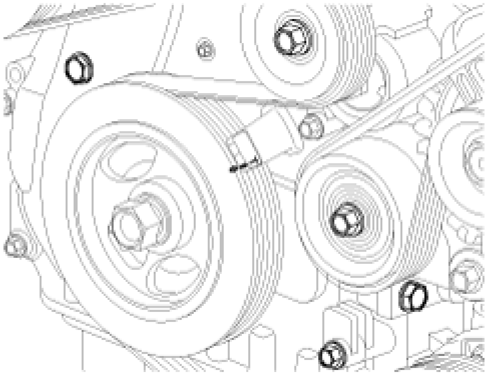
Driving Condition	Exhaust Valve		Intake Valve	
	Valve Timing	**Effect**	**Valve Timing**	**Effect**
(1) Low Speed /Low Load	Completely Advance	* Valve Under-lap * Improvement of combustion stability	Completely Retard	* Valve Under-lap * Improvement of combustion stability
(2) Part Load	Retard	* Increase 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

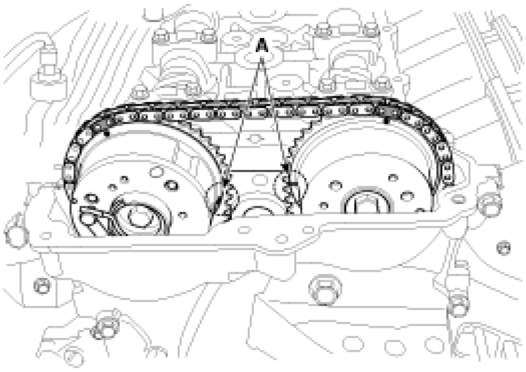
Remove the cylinder head cover.

Set No.1 cylinder to TDC/compression.

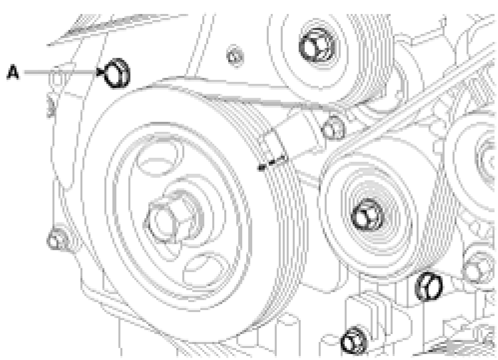
Turn the crankshaft pulley and align its groove with the timing mark "T" of the lower timing chain cover.

A. 

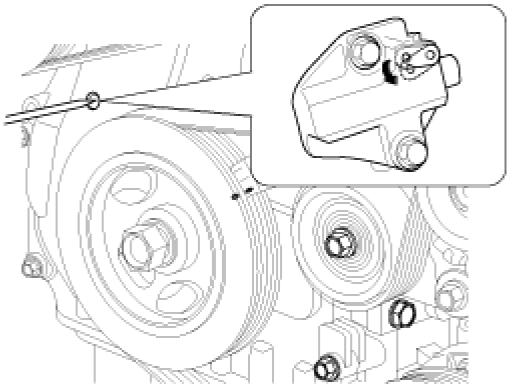
Check that the mark(A) of the CVVT sprockets are in straight line on the cylinder head surface as shown in the illustration.
If not, turn the crankshaft one revolution (360°)

B. 

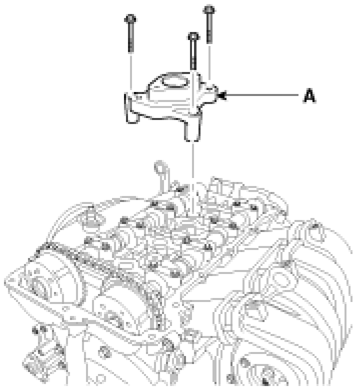
Remove the service hole bolt(A) of the timing chain cover.



Release the ratchet of the timing chain tensioner by pulling the link down using a thin rod.

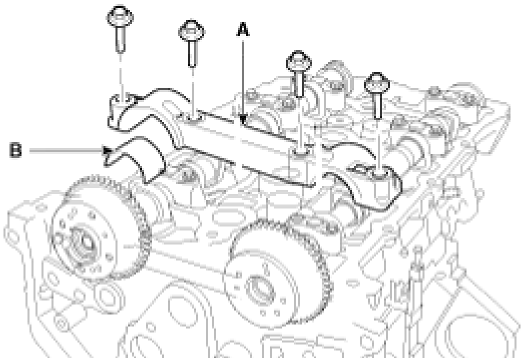


Remove the high pressure fuel pump bracket(A).

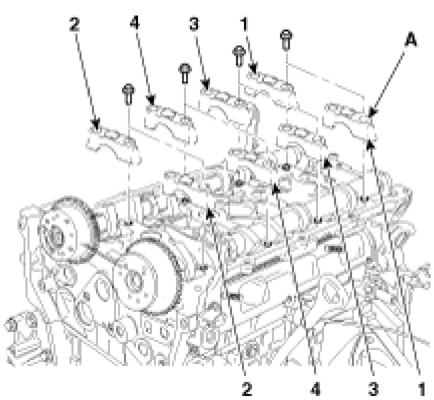


Remove the camshaft.

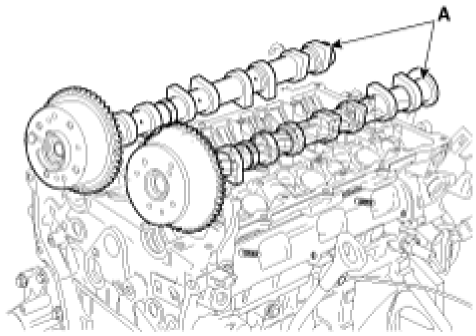
Remove the front camshaft bearing cap (A) with the upper bearing (B).



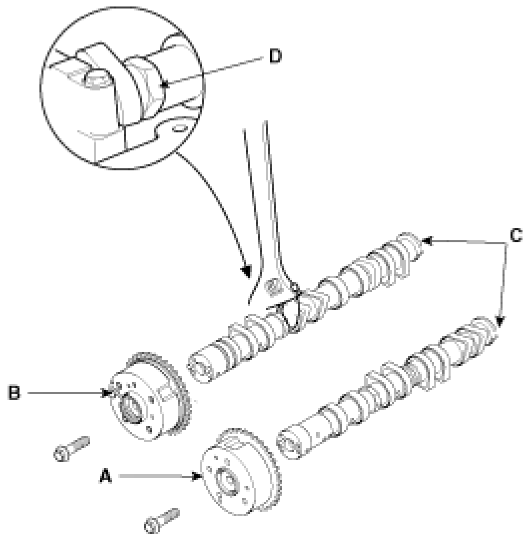
Remove the camshaft bearing cap (A) in the sequence shown.



Remove the camshafts (A).



Disconnect the intake CVVT assembly(A) and exhaust CVVT assembly(B) from camshaft(C).



NOTE

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

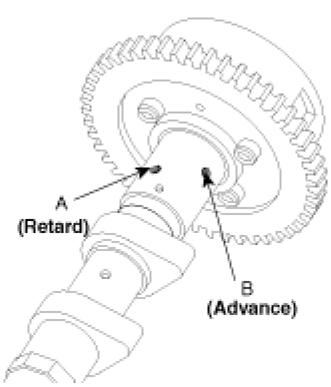
Inspection

CVVT Assembly

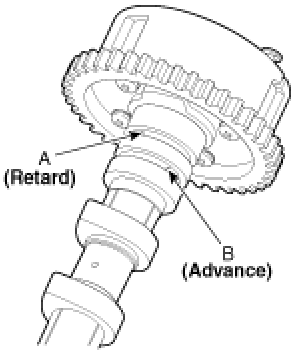
Inspect CVVT assembly.

Check that the CVVT assembly will not turn.

Apply vinyl tape to the retard hole like the one indicated by the arrow in the illustration.
Verify that the tape holds and put air through the port of the camshaft.
[Intake]



[Exhaust]

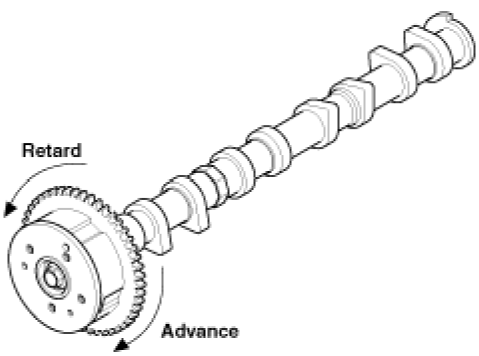


Wind tape around the tip of the air gun and apply air of approx. 150 kPa(1.5 kgf/cm², 21 psi) to the port of the camshaft. (Perform this in order to release the lock pin.)

NOTE

When the oil splashes, wipe it off with a shop rag and the likes.

With air applied, as in step(3), turn the CVVT assembly to the advance angle side (the arrow marked direction in the illustration) with your hand.
Depending on the air pressure, the CVVT assembly will turn to the advance side without applying force by hand. Also, under the condition that the pressure can be hardly applied because of the air leakage from the port, there may be the case that the lock pin could be hardly released.



Turn the CVVT assembly back and forth and check the movable range and that there is no disturbance.

Standard:
Should move smoothly in a range from about
22.5° (Intake) / 20.0° (Exhaust)

Turn the intake CVVT assembly with your hand and lock it at the maximum retard angle position (counter clockwise).

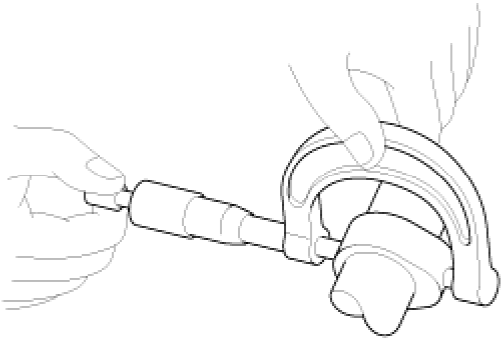
Turn the exhaust CVVT assembly with your hand and lock it at the maximum advance angle position (clockwise).

Camshaft

Inspect the cam lobes.

Using a micrometer, measure the cam lobe height.

Cam height
[Standard value]
Intake : 44.10 ~ 44.30 mm (1.7362 ~ 1.7440 in.)
Exhaust : 44.90 ~ 45.10 mm (1.7677 ~ 1.7756 in.)



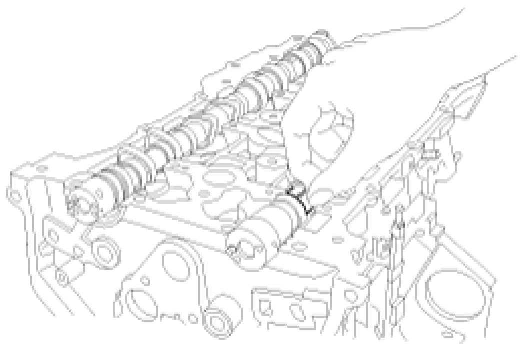
If the cam lobe height is less than standard, replace the camshaft.

Inspect the camshaft journal clearance.

Clean the bearing caps and camshaft journals.

Place the camshafts on the cylinder head.

Lay a strip of plastigage across each of the camshaft journal.



Install the bearing caps.

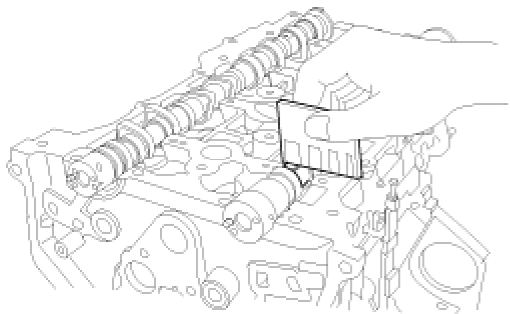
CAUTION

Do not turn the camshaft.

Remove the bearing caps.

Measure the plastigage at its widest point.

Bearing oil clearance
[Standard value]
Intake :
No.1 : 0.022 ~ 0.057 mm (0.00087 ~ 0.00224 in.)
No.2, 3, 4, 5 : 0.045 ~ 0.082 mm (0.00177 ~ 0.00323 in.)
Exhaust:
No.1 : 0 ~ 0.032 mm (0 ~ 0.00126 in.)
No.2, 3, 4, 5 : 0.045 ~ 0.082 mm (0.00177 ~ 0.00323 in.)
[Limit]
Intake:
No.1 : 0.090 mm (0.00354 in.)
No.2, 3, 4, 5 : 0.120 mm (0.00472 in.)
Exhaust :
No.1 : 0.090 mm (0.00354 in.)
No.2, 3, 4, 5 : 0.120 mm (0.00472 in.)



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

Completely remove the plastigage.

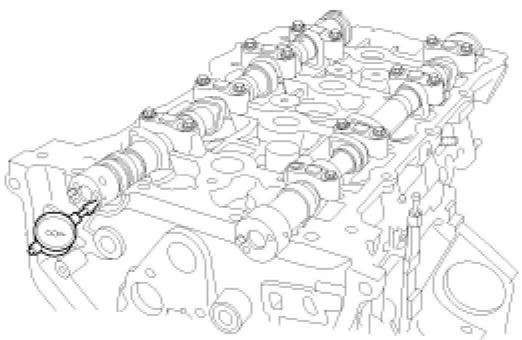
Remove the camshafts.

Inspect the camshaft end play.

Install the camshafts.

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

Camshaft end play
[Standard value] : 0.04 ~ 0.16 mm (0.0016 ~ 0.0063 in.)
[Limit] : 0.20 mm (0.0078 in.)



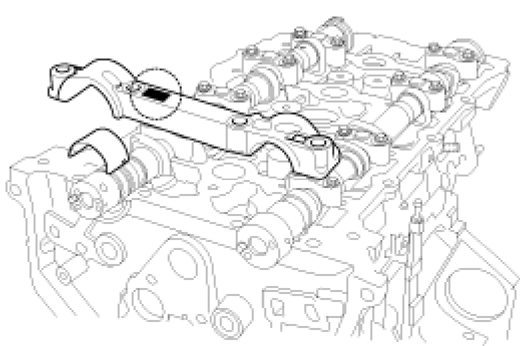
If the end play is greater than maximum, replace the camshaft. If necessary, replace cylinder head.

Remove the camshafts.

Exhaust Camshaft Bearing

Check the cylinder head bore mark.

Cylinder Head Bore Identification Mark

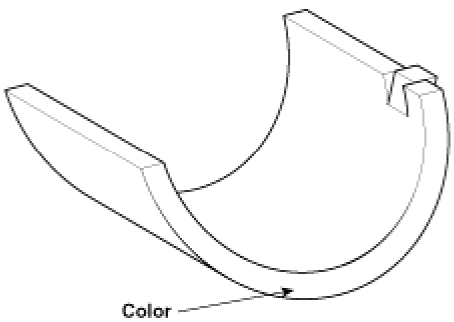


Cylinder Head Specifications

Class	Mark	Exhaust No.1 Inside Diameter Of Cylinder Head Bore
a	A	40.000 ~ 40.008 mm (1.57480 ~ 1.5751in.)
b	B	40.008 ~ 40.016 mm (1.57511 ~ 1.57543 in.)
c	C	40.016 ~ 40.021 mm (1.57543 ~ 1.57563 in.)

Select class of camshaft bearing same as class of cylinder head as shown on the table below.

Exhaust Camshaft Bearing Identification Mark



Exhaust Camshaft Bearing Specifications

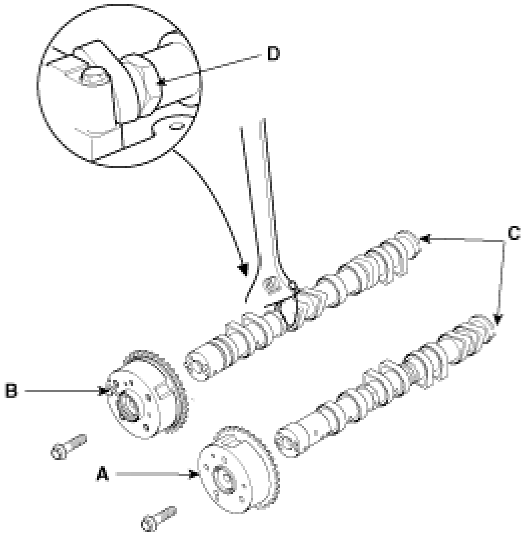
Cylinder Head Bore Class	Bearing Class For Installing (Color)	Thickness Of Bearing
a (A)	C (Green)	1.996~2.000 mm (0.07858~0.07874 in.)
b (B)	B (None color)	2.000~2.004 mm (0.07874~0.07890 in.)
c (C)	A (Black)	2.004~2.008 mm (0.07890~0.07905 in.)

Oil clearance : 0 ~ 0.032 mm (0 ~ 0.00126 in.)

Installation

Install the intake CVVT assembly(A), exhaust CVVT assembly(B) and camshaft(C).

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



NOTE

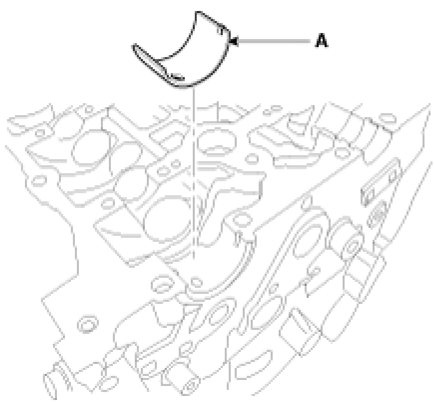
When installing the CVVT assembly bolt, fix the camshaft by wrench at position D.

Install the camshafts.

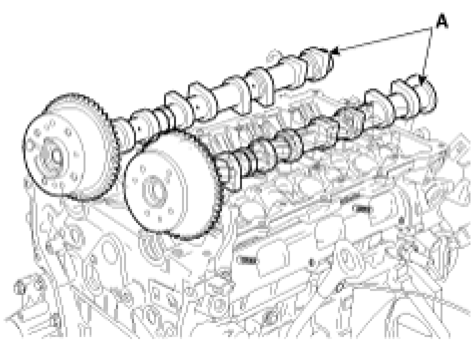
NOTE

Apply a light coat of engine oil on camshaft journals.

Install the exhaust camshaft lower bearing (A).

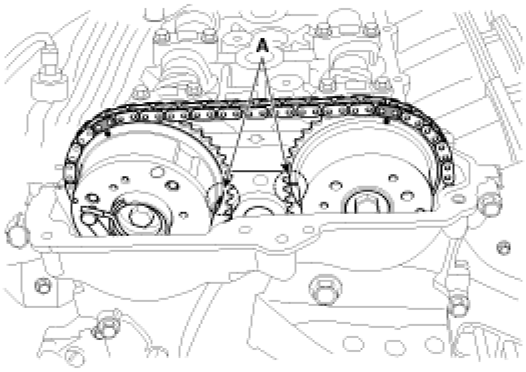


Install the camshafts (A).

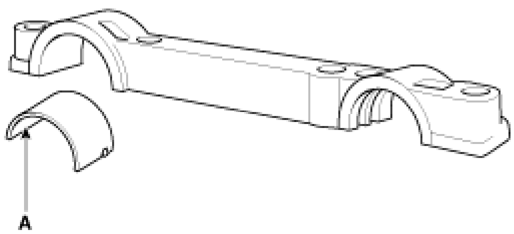


Install the timing chain

Check that the mark(A) of the CVVT sprockets are in straight line on the cylinder head surface as shown in the illustration.



Install the exhaust camshaft upper bearing (A) to the front bearing cap.

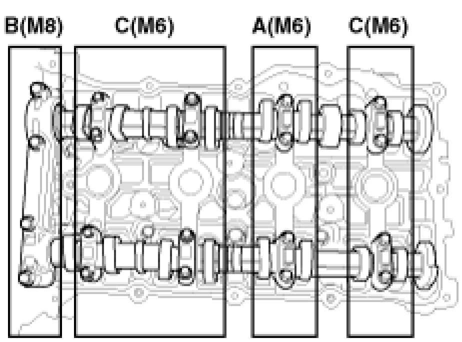


Install camshaft bearing caps (A) in their proper locations.

Tightening order

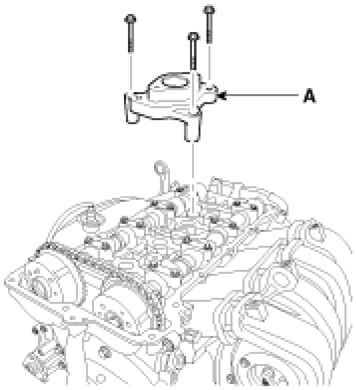
Group A → Group B → Group C.

Tightening torque :
Step 1
M6 : 5.9 N.m (0.6 kgf.m, 4.3 lb-ft)
M8 : 14.7 N.m (1.5 kgf.m, 10.8 lb-ft)
Step 2
M6 : 10.8 ~ 12.7 N.m (1.1 ~ 1.3 kgf.m, 8.0 ~ 9.4 lb-ft)
M8 : 27.5 ~ 31.4 N.m (2.8 ~ 3.2 kgf.m, 20.3 ~ 23.1 lb-ft)

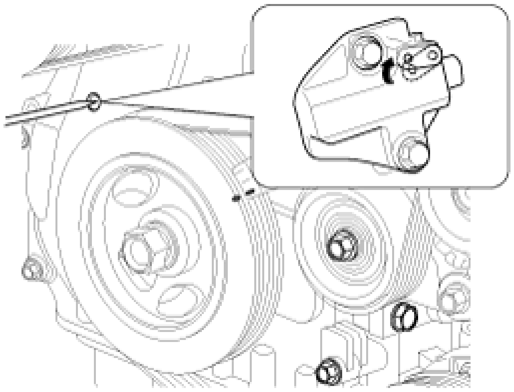


Install the high pressure fuel pump(A).

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

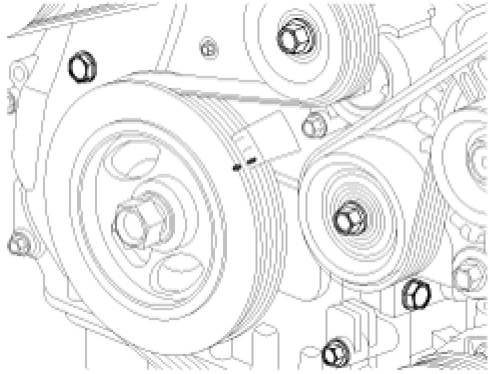


Install the ratchet of the timing chain tensioner by pushing the link up using a thin rod.



Install the service hole bolt of the timing chain cover.

Tightening torque :
11.7 ~ 14.7 N.m (1.2 ~ 1.5 kgf.m, 8.6 ~ 10.8 lb-ft)

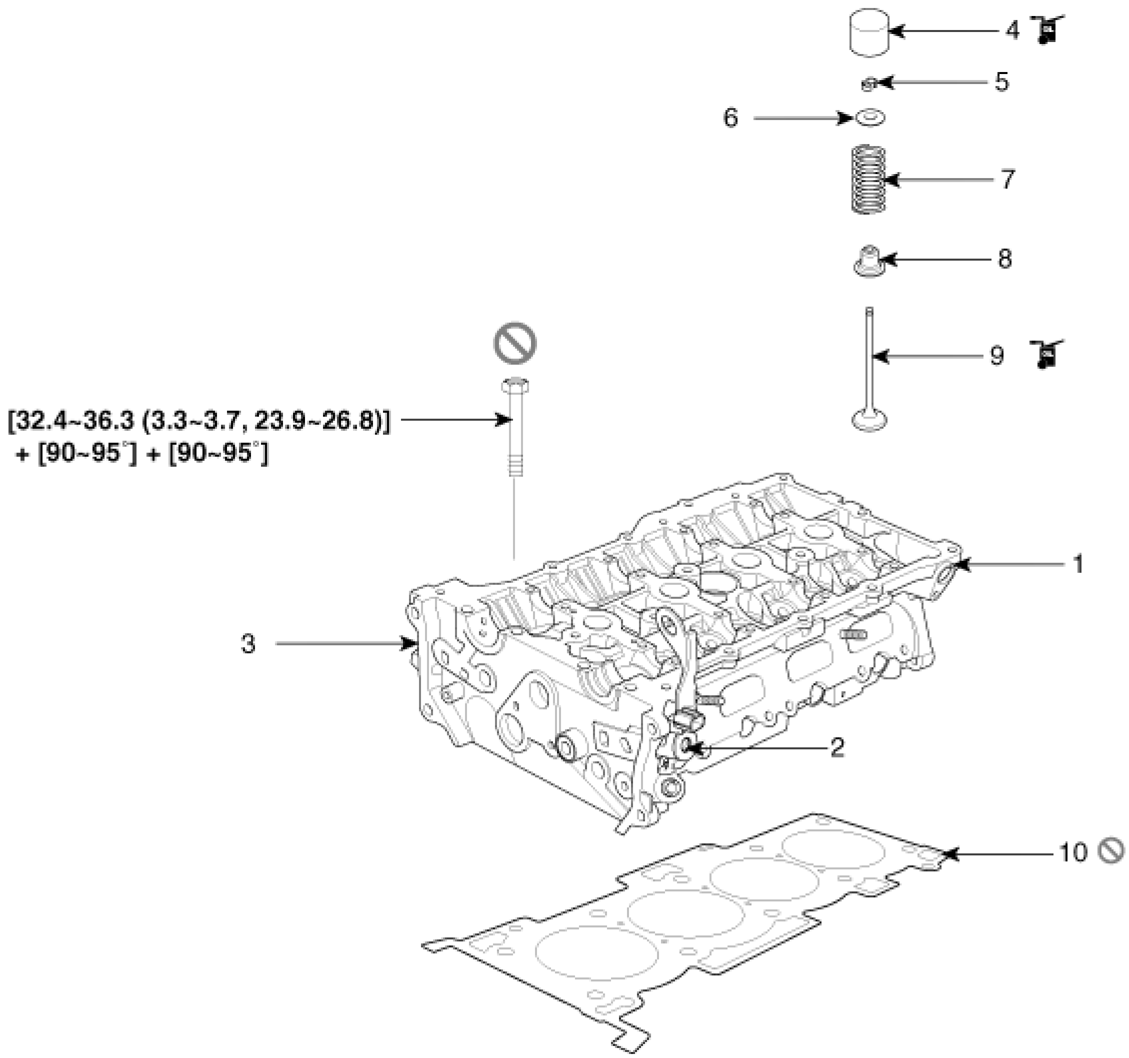


CAUTION

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

Install the cylinder head cover.

Components



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

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

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

NOTE

Mark all wiring and hoses to avoid misconnection.

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.

Remove the intake manifold.

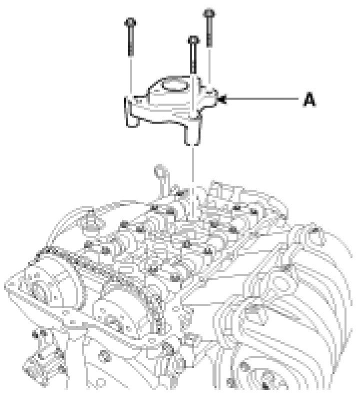
Remove the exhaust manifold.

Remove the cylinder head cover.

Remove the timing chain cover.

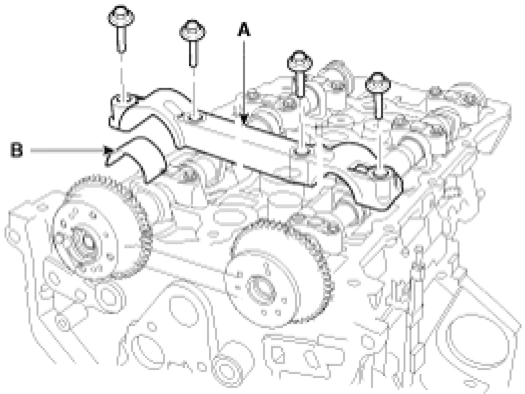
Remove the timing chain.

Remove the high pressure fuel pump bracket(A).

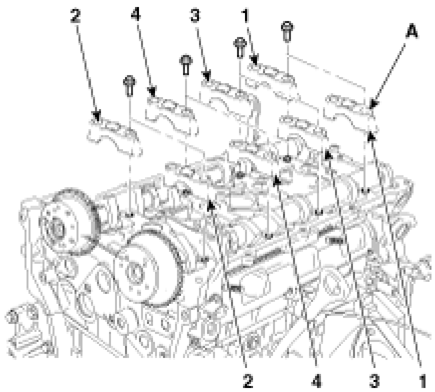


Remove the camshaft.

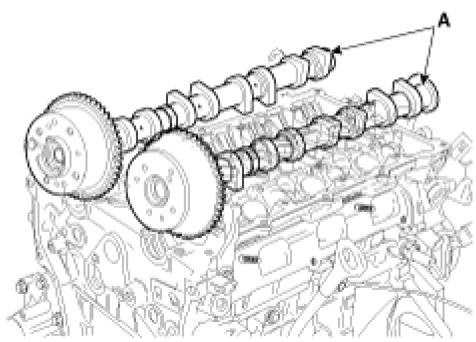
Remove the front camshaft bearing cap (A) with the upper bearing (B).



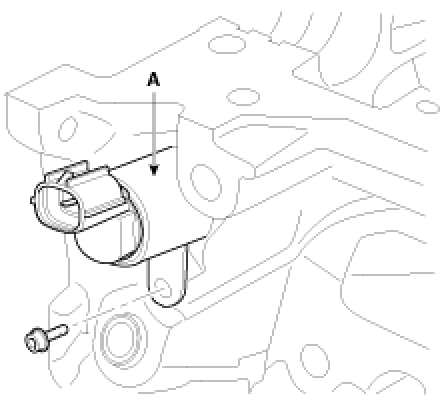
Remove the camshaft bearing cap (A) in the sequence shown.



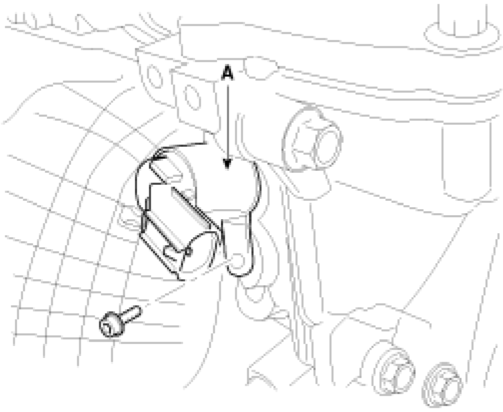
Remove the camshafts (A).



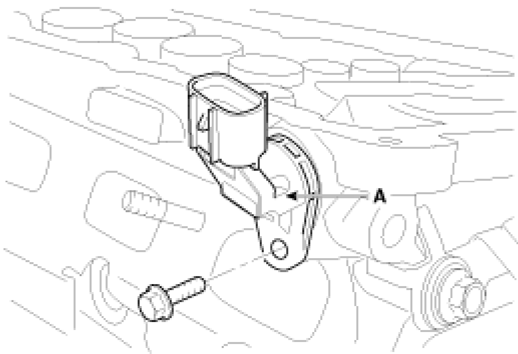
Remove the intake OCV (Oil control valve) (A) using a torx wrench.



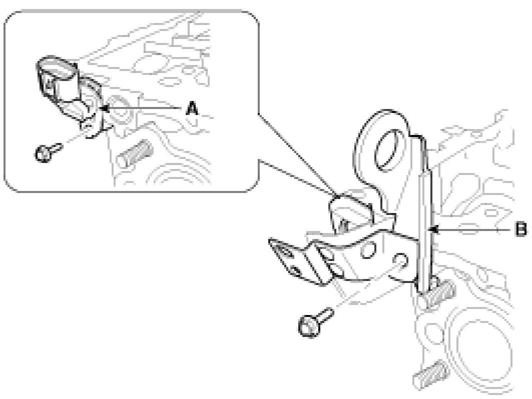
Remove the exhaust OCV (Oil control valve) (A) using a torx wrench.



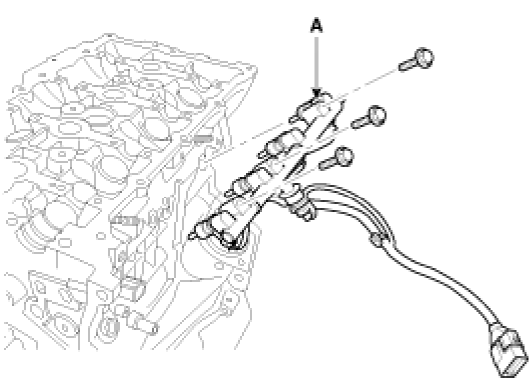
Remove the intake CMPS (Camshaft position sensor) (A).



Remove the exhaust CMPS (Camshaft position sensor) (A) after removing the engine hanger (B).

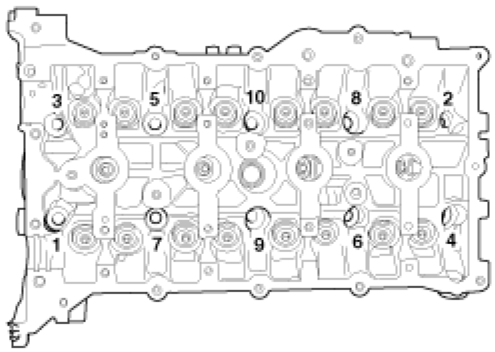


Remove the injector & rail module (A).



Remove the cylinder head.

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



CAUTION

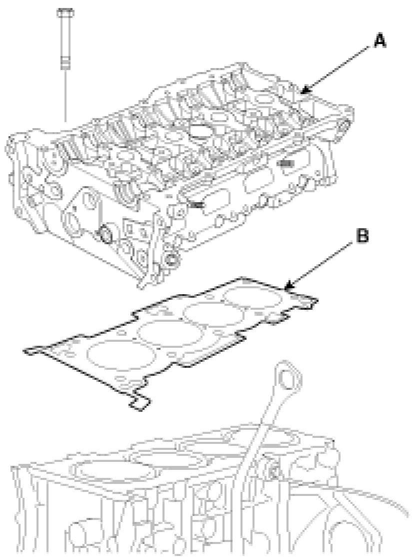
Head warpage or cracking could result from removing bolts in an incorrect order.

Lift the cylinder head (A) 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.

Remove the cylinder head gasket (B).

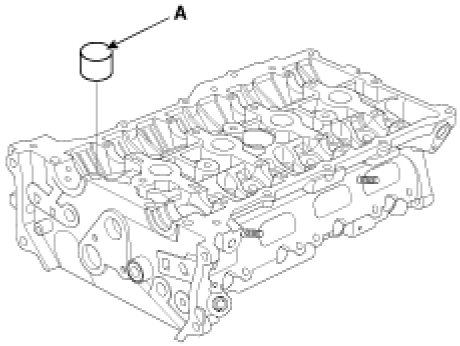


Disassembly

NOTE

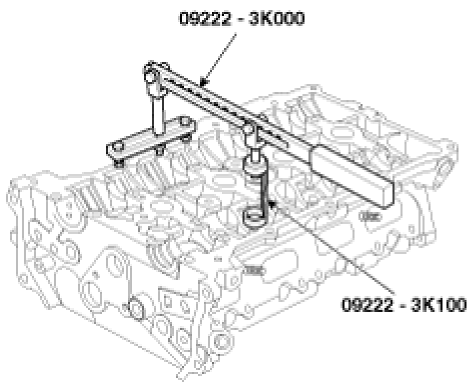
Identify MLA(Mechanical Lash Adjuster), valves, valve springs as they are removed so that each item can be reinstalled in its original position.

Remove the MLAs (A).



Remove the valves.

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



Remove the spring retainer.

Remove the valve spring.

Remove the valve.

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

NOTE

Do not reuse old valve stem seals.

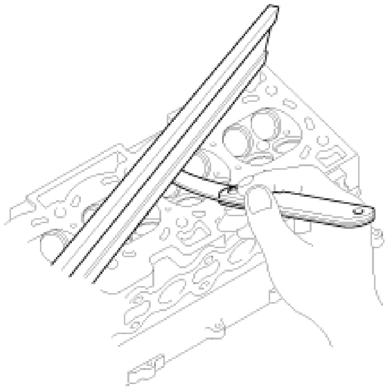
Inspection

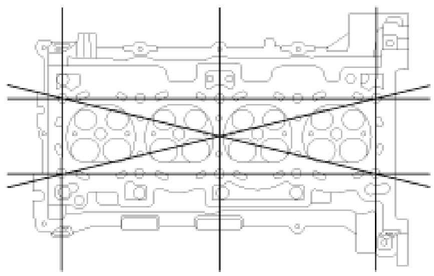
Cylinder Head

Inspect for flatness.

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

Flatness of cylinder head gasket surface
Standard : Less than 0.05 mm (0.0019 in.) for total area
Less than 0.02 mm (0.0007 in.) for a section of 100 mm (3.9370 in.) X 100 mm (3.9370 in.)
Flatness of manifold mounting surface (Intake/Exhaust)
Standard : Less than 0.10 mm (0.0039 in.)





Inspect for cracks.

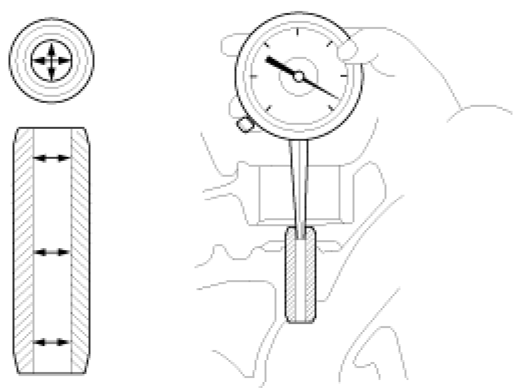
Check the combustion chamber, intake ports, exhaust ports and cylinder block surface for cracks. If cracked, replace the cylinder head.

Valve And Valve Spring

Inspect valve stems and valve guides.

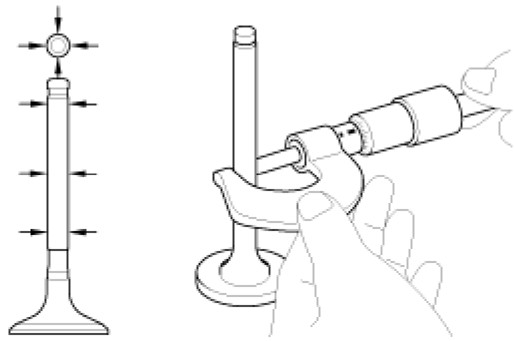
Using a caliper gauge, measure the inside diameter of the valve guide.

Valve guide inner diameter
Intake / Exhaust :
5.500 ~ 5.512 mm (0.21654 ~ 0.21701 in.)



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

Valve stem outer diameter
Intake : 5.465 ~ 5.480 mm (0.21516 ~ 0.21575 in.)
Exhaust : 5.458 ~ 5.470 mm (0.214988 ~ 0.21535 in.)



Subtract the valve stem diameter measurement from the valve guide inside diameter measurement.

Valve stem-to-guide clearance
[Standard]
Intake : 0.020 ~ 0.047 mm (0.00078 ~ 0.00185 in.)
Exhaust : 0.030 ~ 0.054 mm (0.00118 ~ 0.00212 in.)
[Limit]
Intake : 0.070 mm (0.00275 in.)
Exhaust : 0.090 mm (0.00354 in.)

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

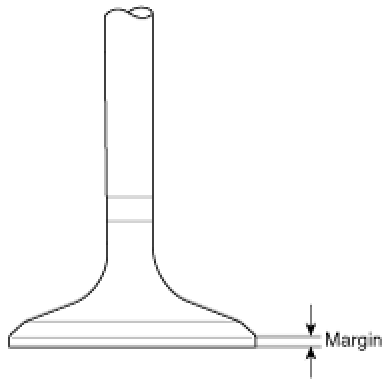
Inspect the valves.

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

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

Check the valve head margin thickness.

Valve head thickness (Margin)
[Standard]
Intake : 1.02 mm(0.0401 in.)
Exhaust : 1.09 mm(0.0429 in.)



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

Check the valve length.

Valve length
[Standard]
Intake : 113.18 mm (4.4559 in.)
Exhaust : 105.84 mm (4.1669 in.)
[Limit]
Intake : 112.93 mm (4.4461 in.)

Exhaust : 105.59 mm (4.1571 in.)

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

Inspect the valve seats

Check the valve seat for evidence of overheating and improper contact with the valve face. Replace the cylinder head if necessary.

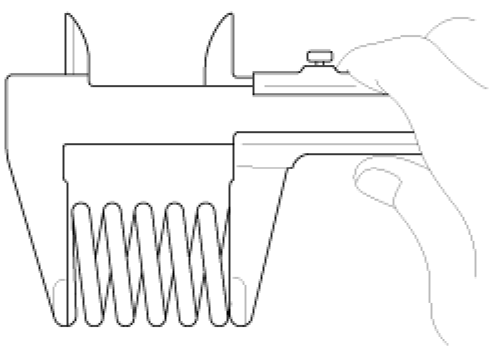
Check the valve guide for wear. If the valve guide is worn, replace the cylinder head.

Inspect the valve springs.

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

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

Valve spring
[Standard]
Free height : 47.44 mm (1.8677 in.)
Out-of-square : Less than 1.5°



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

MLA (Mechanical Lash Adjuster)

Inspect the MLA.

Using a micrometer, measure the MLA outside diameter.

MLA outer diameter :
31.964 ~ 31.980 mm (1.2584 ~ 1.2590 in.)

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

Tappet bore inner diameter :
32.000 ~ 32.025 mm (1.2598 ~ 1.2608 in.)

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

MLA to tappet bore clearance
[Standard] : 0.020 ~ 0.061 mm (0.00078 ~ 0.00240 in.)
[Limit] : 0.070 mm (0.00275 in.)

Reassembly

NOTE

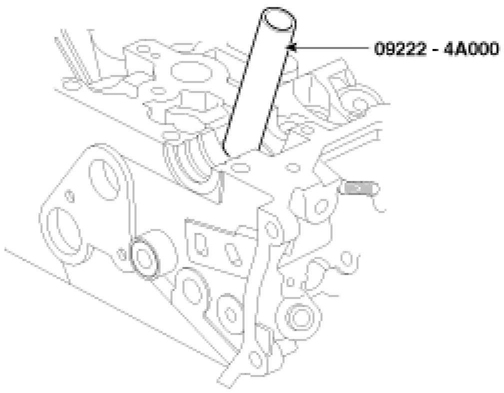
Thoroughly clean all parts to be assembled.
Before installing the parts, apply fresh engine oil to all sliding and rotating surfaces.
Replace oil seals with new ones.

Install valves.

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

NOTE

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

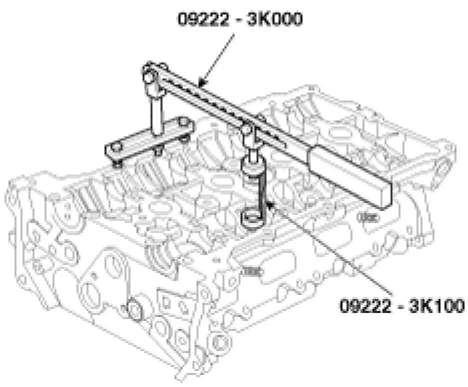


Install the valve, valve spring and spring retainer.

NOTE

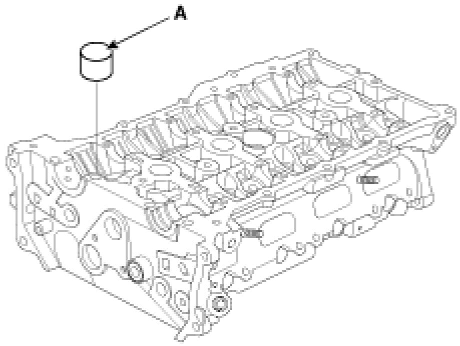
Place valve springs so that the side coated with enamel faces toward the valve spring retainer and then installs the retainer.

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.



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

Install the MLAs after applying engine oil.
Check that the MLA rotates smoothly by hand.



NOTE

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.

Installation

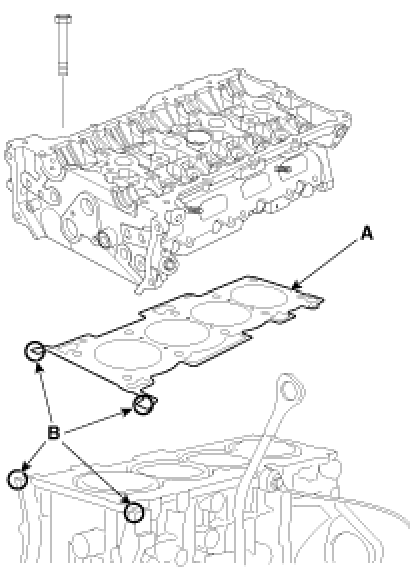
NOTE

- 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.

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

NOTE

- Be careful of the installation direction.
- Apply liquid gasket (Loctite 5900H or equivalent) on the edge of cylinder head gasket upside and downside. (At the position 'B')
- After applying sealant, assemble the cylinder head in five minutes.



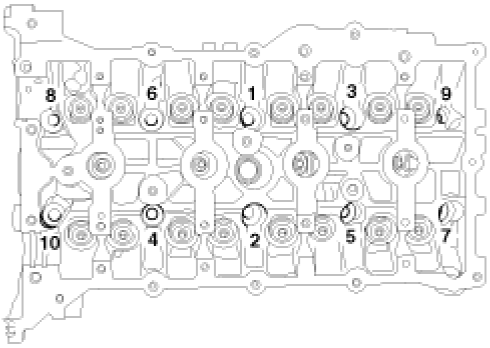
Place the cylinder head carefully in order not to damage the gasket with the bottom part of the end.

Install cylinder head bolts.

(1) Do not apply engine oil on the cylinder head bolts.

(2) Using the SST(09221-4A000), tighten the cylinder head bolts and plate washers, in several passes, in the sequence shown.

Tightening torque :
32.4 ~ 36.3 N.m (3.3 ~ 3.7 kgf.m, 23.9 ~ 26.8 lb-ft) + 90 ~ 95° + 90 ~ 95°



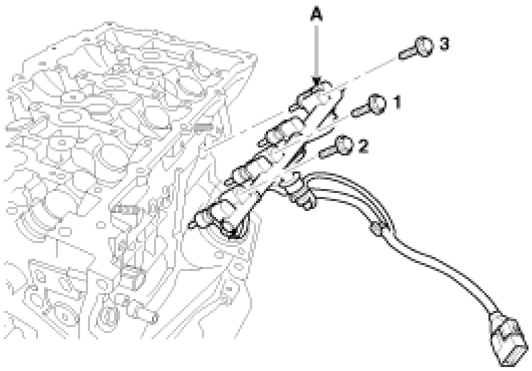
CAUTION

Always use new cylinder head bolt.

Install the injector & rail module (A).

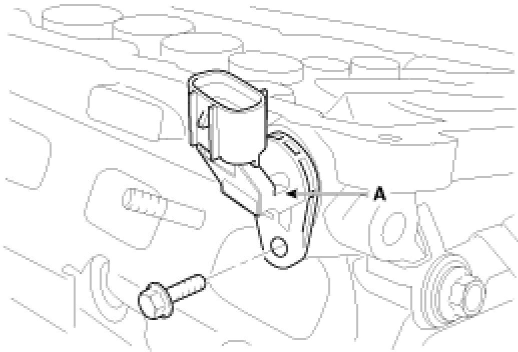
Pre-tighten the bolts and then tighten the bolts with the specified torque in the sequence shown.

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



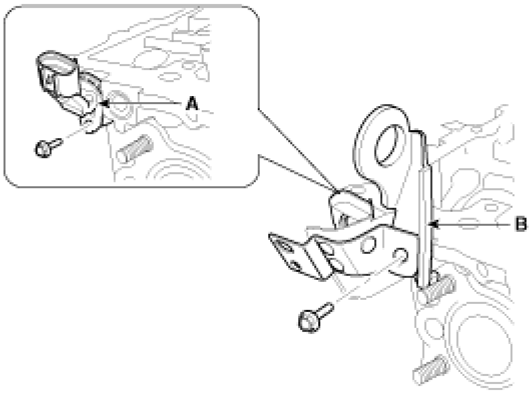
Install the intake CMPS (Camshaft position sensor) (A).

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



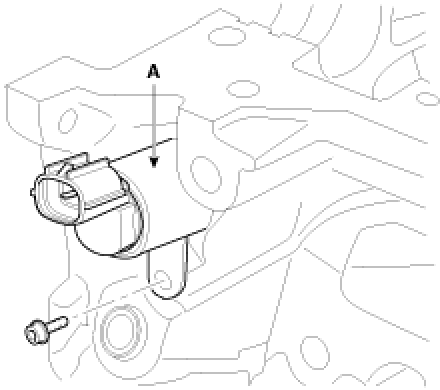
Install the exhaust CMPS (Camshaft position sensor) (A) and the engine hanger (B).

Tightening torque
Sensor bolt:
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)
Engine hanger bolt:
27.5 ~ 31.4 N.m (2.8 ~ 3.2 kgf.m, 20.3 ~ 23.1 lb-ft)



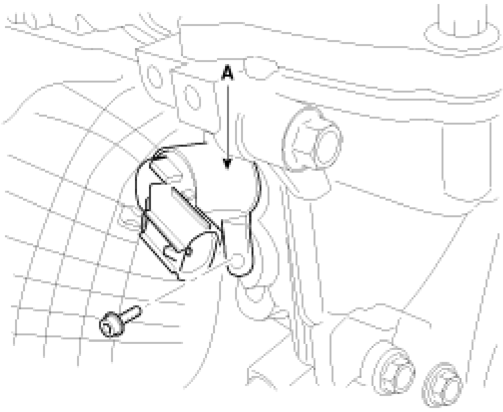
Install the intake OCV (Oil control valve) (A).

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



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

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

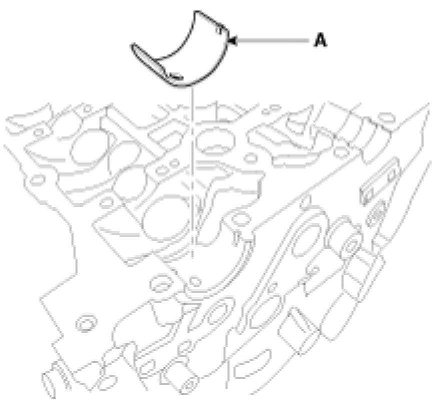


CAUTION

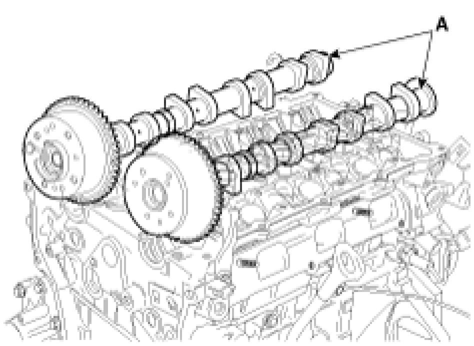
- Do not reuse the OCV when dropped.
- Keep the OCV filter clean.
- Do not hold the OCV sleeve during servicing.
- When the OCV is installed on the engine, do not move the engine with holding the OCV yoke.

Install the camshaft.

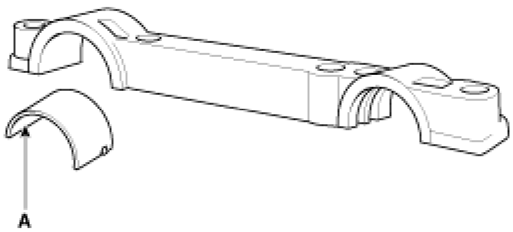
Install the exhaust camshaft lower bearing (A).



Install the camshafts (A).



Install the exhaust camshaft upper bearing (A) to the front bearing cap.



Install camshaft bearing caps (A) in their proper locations.

Tightening order

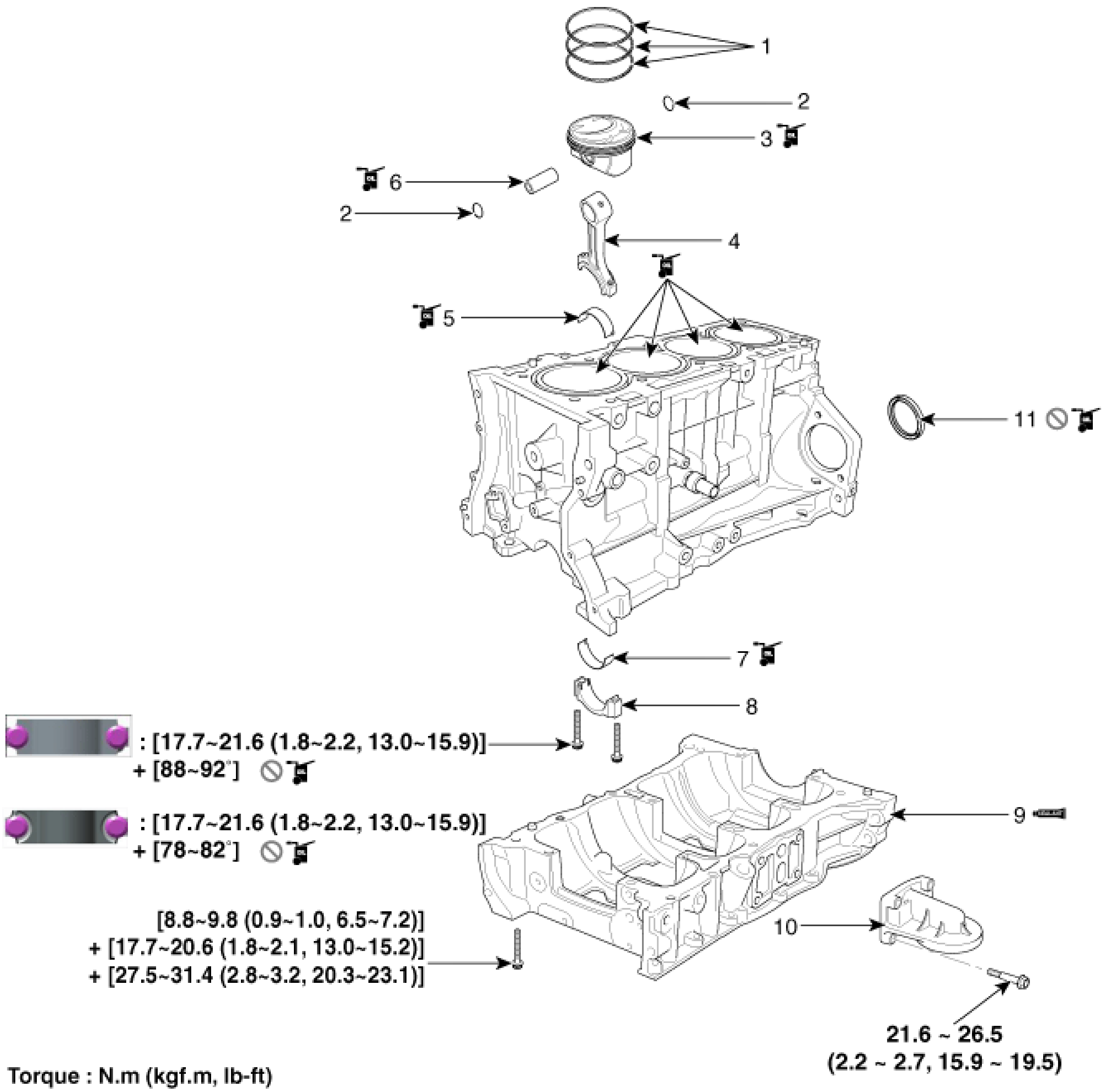
Group A → Group B → Group C.

Tightening torque :
Step 1
M6 : 5.9 N.m (0.6 kgf.m, 4.3 lb-ft)
M8 : 14.7 N.m (1.5 kgf.m, 10.8 lb-ft)
Step 2
M6 : 10.8 ~ 12.7 N.m (1.1 ~ 1.3 kgf.m, 8.0 ~ 9.4 lb-ft)

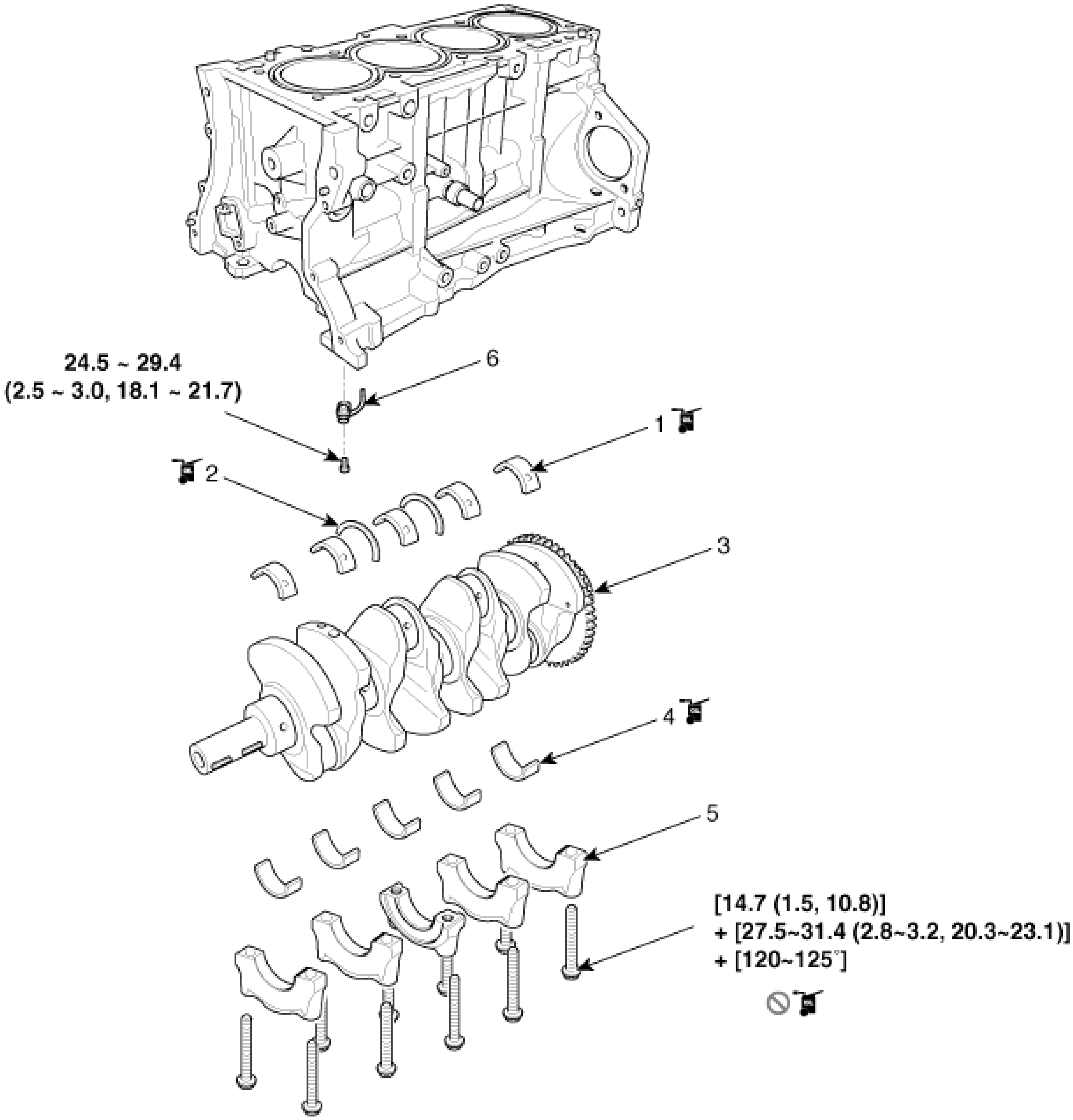
Cylinder Block

Components and Components Location

Components



	6. Piston pin
1. Piston ring	7. Connecting rod lower bearing
2. Snap ring	8. Connecting rod bearing cap
3. Piston	9. Ladder frame
4. Connecting rod	10. Oil filter bracket
5. Connecting rod upper bearing	11. Crankshaft rear oil seal



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

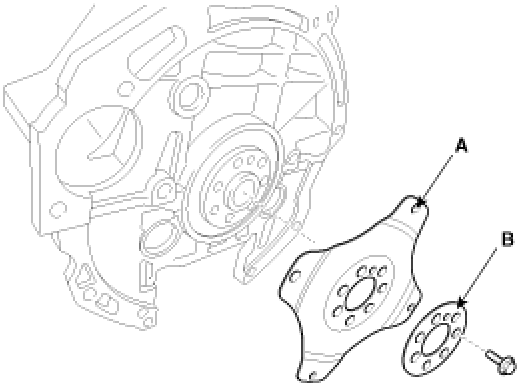
1. Crankshaft upper bearing 2. Thrust bearing 3. Crankshaft	4. Crankshaft lower bearing 5. Main bearing cap 6. Piston cooling oil jet

Removal and Installation

Remove the automatic transaxle .

Remove the drive plate (A) and the adapter plate (B).

Tightening torque :
117.7 ~ 127.5 N.m (12 ~ 13 kgf.m, 86.8 ~ 94.0 lb-ft)



NOTE

- Always use new drive plate (or flywheel) bolts.

  Apply sealant to the screw part (10mm from the end of the bolt) when reusing the drive plate bolts.

- **Sealant:** Three bond 2403, Loctite 200 or 204

- Install and uniformly tighten the 7 bolts, in several passes.

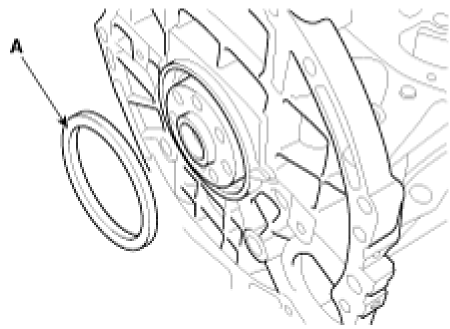
Install in the reverse order of removal.

Removal

Remove the automatic transaxle.

Remove the drive plate.

Remove the rear oil seal (A).

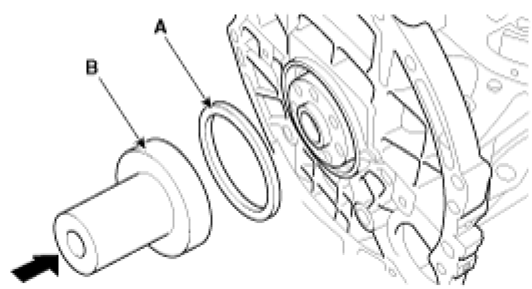


Installation

Install rear oil seal.

Apply engine oil to a new oil seal lip.

Using SST(09231-H1100, 09214-3K100) (B) and a hammer, tap in the oil seal (A) until its surface is flush with the rear oil seal retainer edge.



Install the drive plate.

Install the automatic transaxle.

Removal

CAUTION

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

NOTE

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

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.

Remove the engine assembly from the vehicle.

Disconnect the transaxle assembly from engine assembly.

Install the engine to an engine stand for disassembly.

Remove the intake manifold.

Remove the exhaust manifold.

Remove the timing chain.

Remove the cylinder head assembly.

Remove the drive plate and the adapter plate.

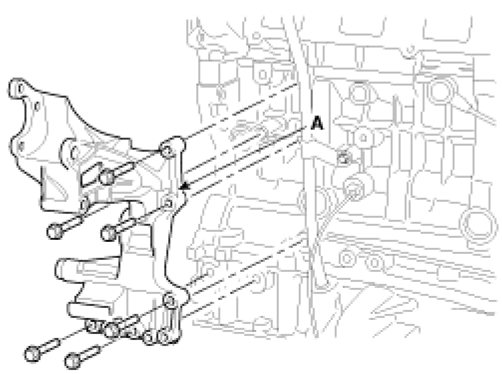
Remove the balance shaft & oil pump assembly.

Remove the A/C compressor.

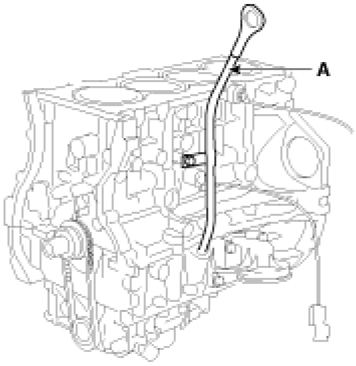
Remove the alternator.

Remove the water pump assembly.

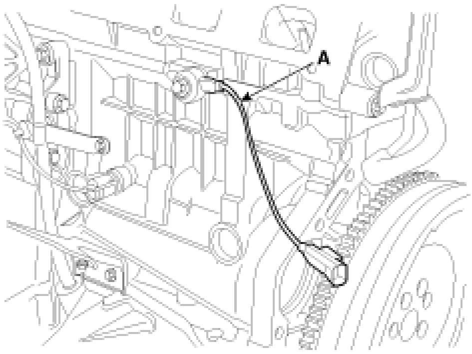
Remove the tensioner assembly integrated bracket (A).



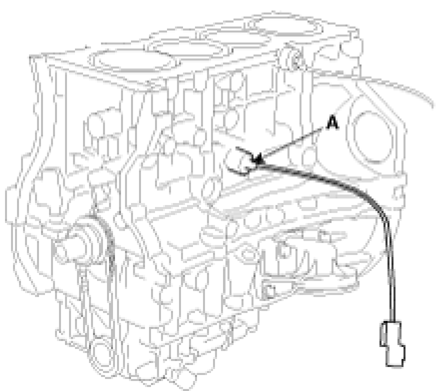
Remove the oil level gauge tube (A).



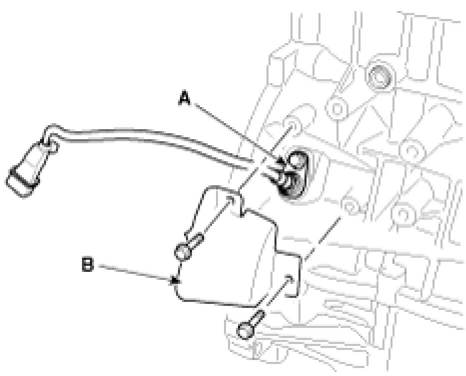
Remove the knock sensor (A).



Remove the oil pressure sensor (A).

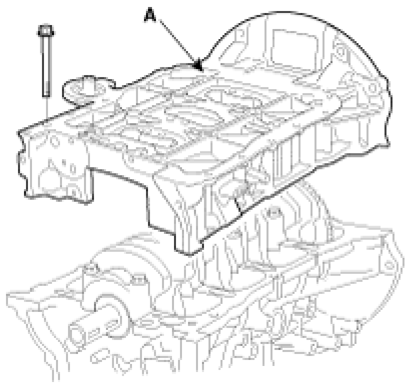


Remove the cover (B) and the CKPS (Crankshaft position sensor) (A).



Remove the balance shaft module.

Remove the ladder frame (A).

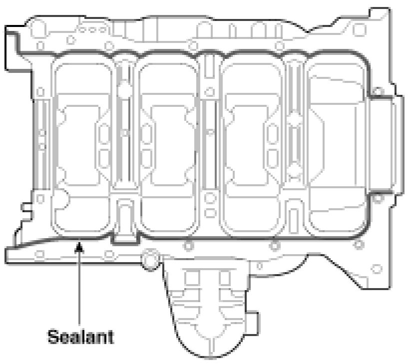


Installation

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

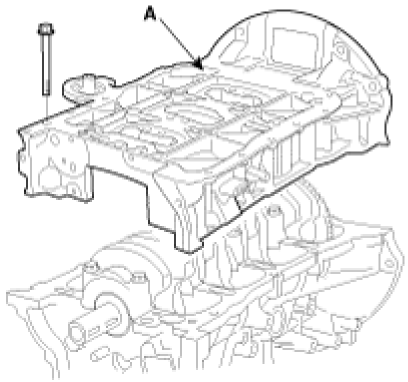
NOTE

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



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

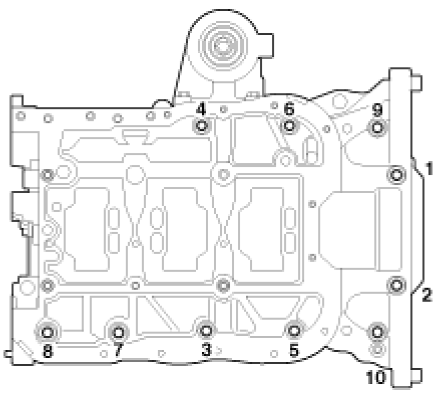
Tightening torque
Step 1 :
8.8 ~ 9.8 N.m (0.9 ~ 1.0 kgf.m, 6.5 ~ 7.2 lb-ft)
Step 2 :
17.7 ~ 20.6 N.m (1.8 ~ 2.1 kgf.m, 13.0 ~ 15.2 lb-ft)
Step 3 :
27.5 ~ 31.4 N.m (2.8 ~ 3.2 kgf.m, 20.3 ~ 23.1 lb-ft)



(1) Tighten the bolts in order number as shown with the 3 steps.

(2) Loosen the bolts as reverse tightening order.

(3) Tighten the bolts in order number as shown with the 3 steps.



Install the other parts in reverse order of removal.

Disassembly

CAUTION

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

NOTE

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

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.

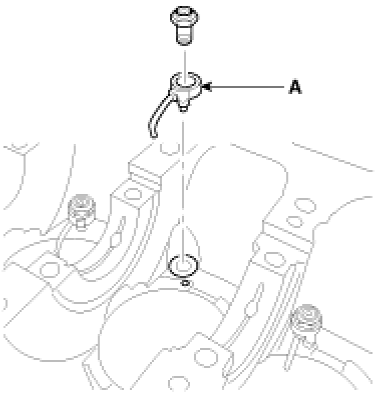
Remove the balance shaft module.

Remove the ladder frame.

Remove the piston & connecting rod assembly.

Remove the crankshaft.

Remove the oil jet (A).



Inspection

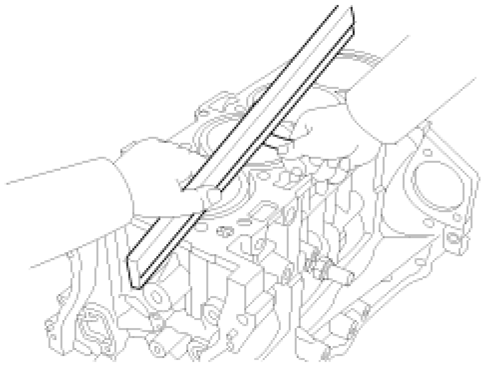
Remove gasket material.
Using a gasket scraper, remove all the gasket material from the top surface of the cylinder block.

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

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

Flatness of cylinder block gasket surface
Standard : Less than 0.05 mm (0.0019 in.) for all

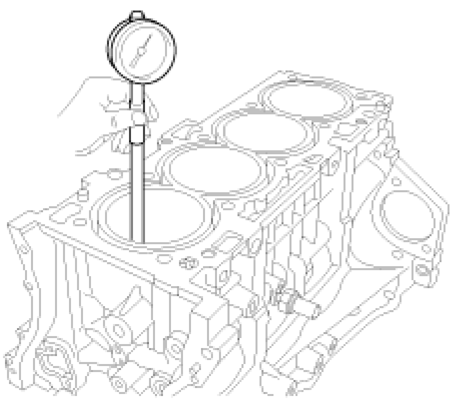
Less than 0.02 mm (0.0007 in.) for 100 mm (3.9370 in.) x 100 mm (3.9370 in.)



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

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

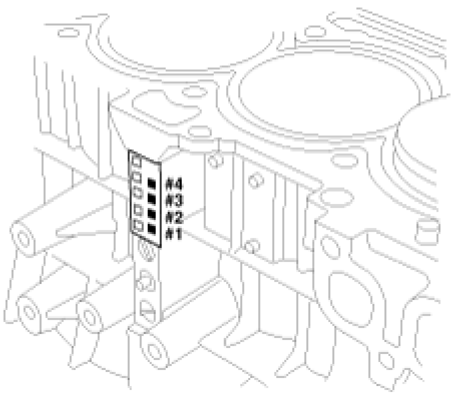
Standard diameter :
88.00 ~ 88.03 mm (3.4645 ~ 3.4657 in.)



NOTE

Measure position points (from the bottom of the cylinder block)
: 110.7 mm (4.3582 in.) / 160 mm (6.2992 in.) / 210 mm (8.2677 in.)

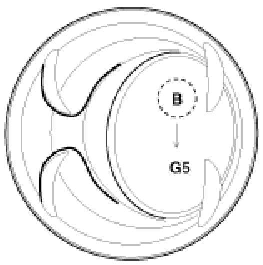
Check the cylinder bore size code on the cylinder block.



Cylinder Bore Inner Diameter

Size Code	Cylinder Bore Inner Diameter
A	88.00 ~ 88.01 mm (3.4645 ~ 3.4649 in.)
B	88.01 ~ 88.02 mm (3.4649 ~ 3.4653 in.)
C	88.02 ~ 88.03 mm (3.4653 ~ 3.4657 in.)

Check the piston size code on the piston top face.



NOTE

Stamp the grade mark of basic diameter with rubber stamp.

Piston Outer Diameter

Size Code	Piston Outer Diameter
A	87.970 ~ 87.980 mm (3.46338 ~ 3.46377 in.)
B	87.980 ~ 87.990 mm (3.46377 ~ 3.46417 in.)
C	87.990 ~ 88.000 mm (3.46417 ~ 3.46456 in.)

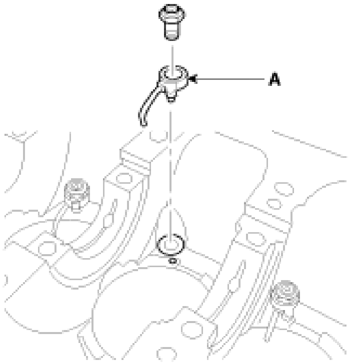
Select the piston related to cylinder bore class.

Clearance : 0.020 ~ 0.040 mm (0.00079 ~ 0.00157 in.)

Reassembly

Install the oil jet (A).

Tightening torque :
24.5 ~ 29.4 N.m (2.5 ~ 3.0 kgf.m, 18.1 ~ 21.7 lb-ft)



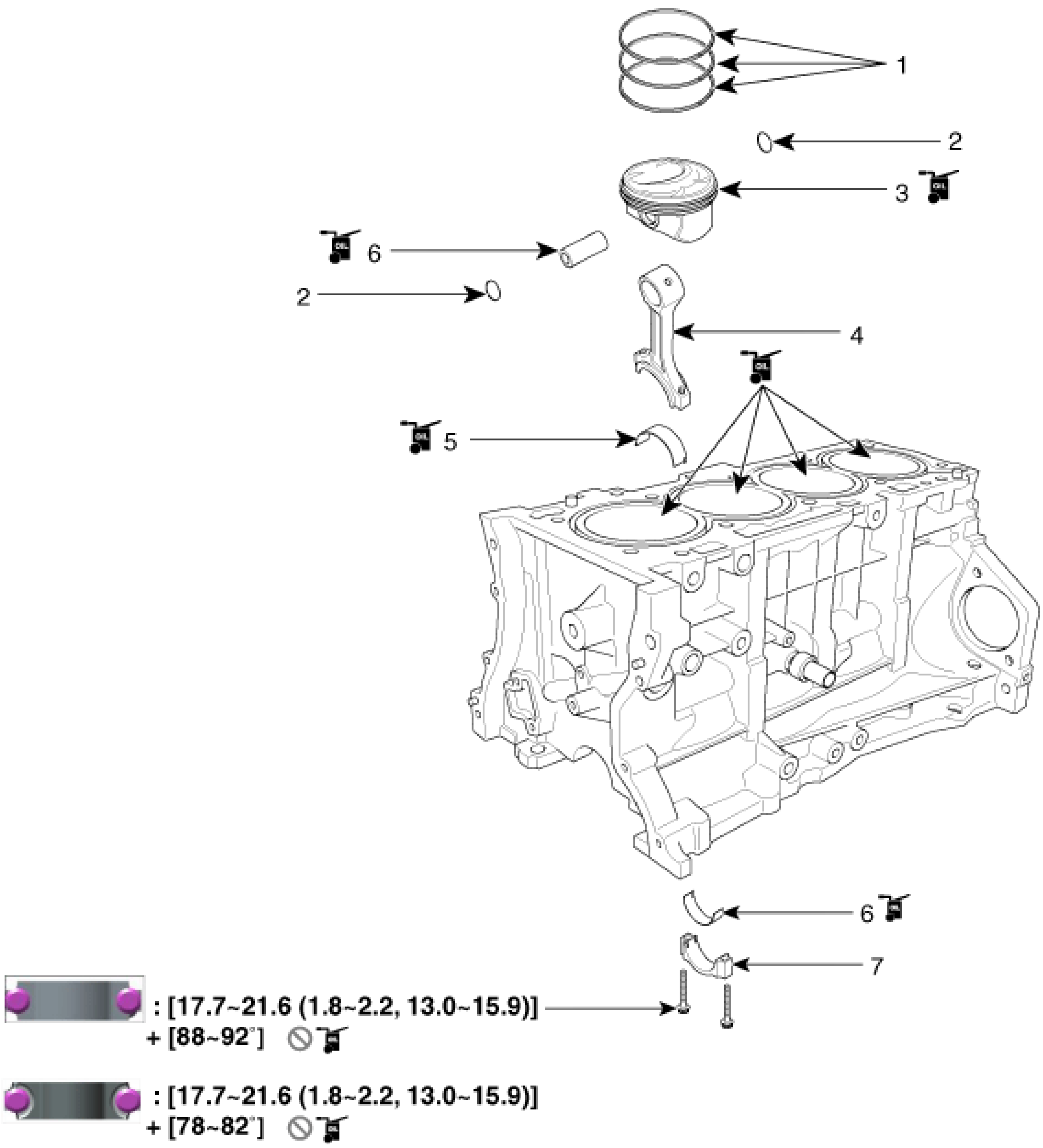
Install the crankshaft.

Install the piston & connecting rod assembly.

Install the ladder frame.

Piston and Connecting Rod. Components and Components Location

Components



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

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

Disassembly

CAUTION

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

NOTE

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

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.

Remove the ladder frame.

Check the connecting rod end play.

Remove the connecting rod caps and check oil clearance.

Remove piston and connecting rod assemblies.

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

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

NOTE

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

Check fit between piston and piston pin.

Try to move the piston back and forth on the piston pin. If any movement is felt, replace the piston and pin as a set.

Remove piston rings.

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

(2) Remove oil ring.

NOTE

Arrange the piston rings in the correct order only.

Inspection

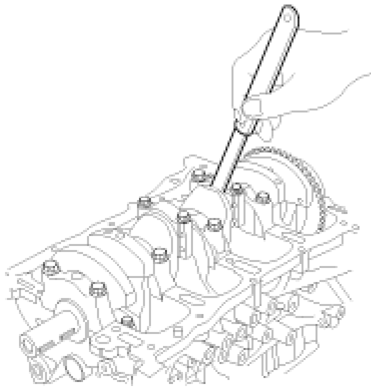
Connecting Rod

Check the connecting rod end play.

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

End play :

Standard : 0.10~ 0.25 mm (0.0039 ~ 0.0098 in.)
Limit : 0.35 mm (0.0138 in.)



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

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

Check the connecting road bearing oil clearance.

Check the match marks on the connecting rod and cap are aligned to ensure correct reassembly.

Remove 2 connecting rod cap bolts.

Remove the connecting rod cap and bearing half.

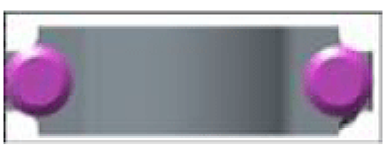
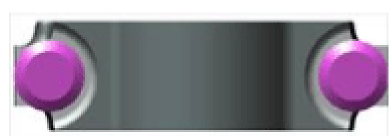
Clean the crank pin and bearing.

Place plastigage across the crank pin.

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

Tightening torque
A type :
17.7 ~ 21.6 N.m (1.8 ~ 2.2 kgf.m, 13.0 ~ 15.9 lb-ft) + 88 ~ 92°
B type :
17.7~21.6 N.m (1.8 ~ 2.2 kgf.m, 13.0 ~ 15.9 lb-ft) + 78 ~ 82°

NOTE

A Type	B Type
	

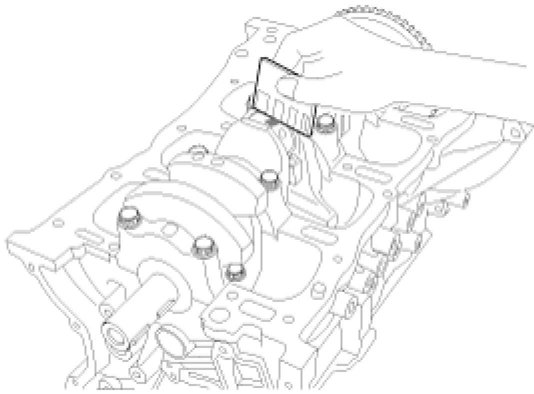
NOTE

Do not turn the crankshaft.

Remove 2 bolts, connecting rod cap and bearing half.

Measure the plastigage at its widest point.

Standard oil clearance :
0.033 ~ 0.051 mm (0.00130 ~ 0.00201 in.)



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.

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

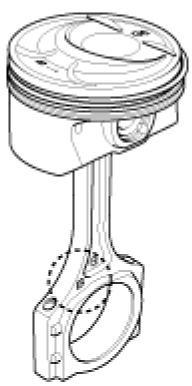
NOTE

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

CAUTION

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

Connecting Rod Identification Mark



Connecting Rod Specifications

Class	Mark	Inside Diameter
a	A	51.000 ~ 51.006 mm (2.00787 ~ 2.00811 in.)
b	B	51.006 ~ 51.012 mm (2.00811 ~ 2.00834 in.)
c	C	51.012 ~ 51.018 mm (2.00834 ~ 2.00858 in.)

Piston And Rings

Clean piston

(1) Using a gasket scraper, remove the carbon from the piston top.

(2) Using a groove cleaning tool or broken ring, clean the piston ring grooves.

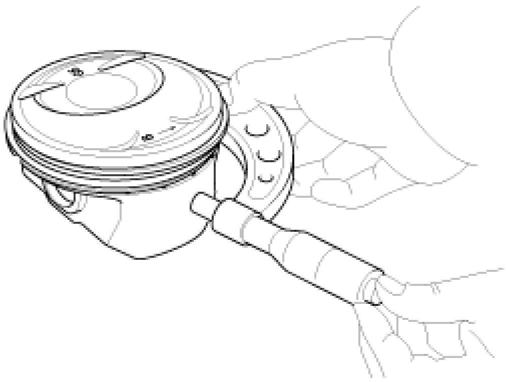
Using solvent and a brush, thoroughly clean the piston.

NOTE

Do not use a wire brush.

The standard measurement of the piston outside diameter is taken 17 mm (0.67 in.) from the top land of the piston.

Standard diameter :
87.970 ~ 88.000 mm (3.46338 ~ 3.46456 in.)



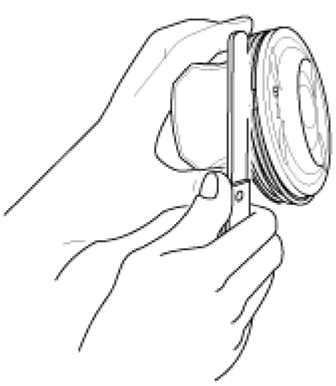
Calculate the difference between the cylinder bore diameter and the piston diameter.

Piston-to-cylinder clearance :
0.020 ~ 0.040 mm (0.00079 ~ 0.00157 in.)

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 : 0.050 ~ 0.080 mm (0.00197 ~ 0.00315 in.)
No.2 : 0.040 ~ 0.080 mm (0.00157 ~ 0.00315 in.)
Oil ring : 0.020 ~ 0.055 mm (0.00079 ~ 0.00217 in.)
Limit
No.1 : 0.100 mm (0.00394 in.)
No.2 : 0.100 mm (0.00394 in.)
Oil ring : 0.60 mm (0.0236 in.)

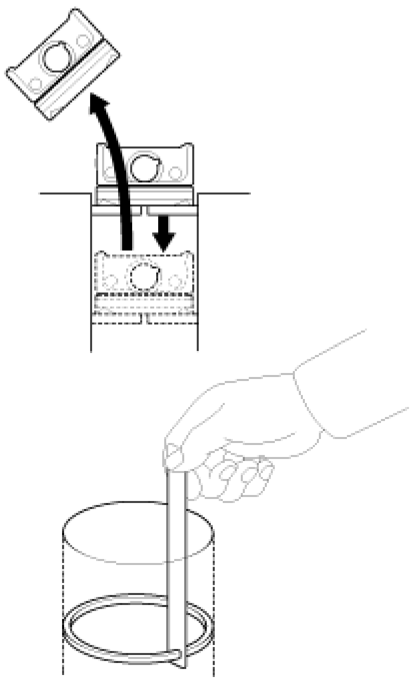


If the clearance is greater than maximum, replace the piston.

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.

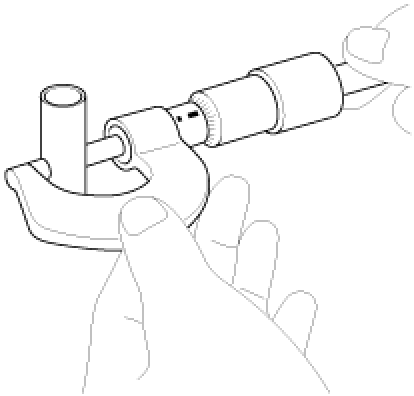
Piston ring end gap
Standard
No.1 : 0.15 ~ 0.25 mm (0.0059 ~ 0.0098 in.)
No.2 : 0.37 ~ 0.47 mm (0.0145 ~ 0.0185 in.)
Oil ring : 0.20 ~ 0.50 mm (0.0079 ~ 0.0197 in.)
Limit
No.1 : 0.60 mm (0.0236 in.)
No.2 : 0.70 mm (0.0275 in.)
Oil ring : 0.80 mm (0.0315 in.)



Piston Pins

Measure the diameter of the piston pin.

Piston pin diameter :
21.997 ~ 22.000 mm (0.86602 ~ 0.86614 in.)



Measure the piston pin-to-piston clearance.

Piston pin-to-piston clearance :
0.003 ~ 0.010 mm (0.00012 ~ 0.00039 in.)

Check the difference between the piston pin diameter and the connecting rod bushing oil clearance.

Piston pin-to-connecting rod interference :
0.005 ~ 0.014 mm (0.00020 ~ 0.00055 in.)

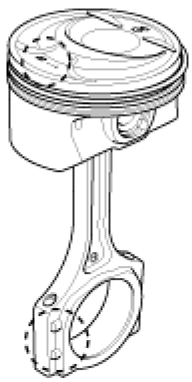
Reassembly

NOTE

- 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.

Assemble the piston and connecting rod.

The piston front mark and the connecting rod front mark must face the timing chain side of the engine.



Before pressing the piston pin, apply a coat of lubricant oil to the piston pin outer and connecting rod.

CAUTION

- Take care that piston pin is not damaged during reassemble .

  When replace the piston pin, check the piston pin outer diameter and connecting rod small end inner diameter as below.
  Piston pin outer diameter : 21.997 ~ 22.000 mm (0.8660 ~ 0.8661 in)
  Piston pin hole inner diameter : 22.003 ~ 22.007 mm (0.8662 ~ 0.8664 in)
  Connecting rod small end inner diameter : 22.005 ~ 22.011 mm (0.8663 ~ 0.8665 in)
- Interference : -0.014 ~ -0.005 mm (0.0006 ~ 0.0002 in)

Set the snap ring in one side of piston pin hole and insert the piston pin into the piston pin hole & the small end bore of connecting rod while meeting the front mark of connecting rod & piston.

CAUTION

Be sure to keep the small end bore, piston pin hole & piston pin from being damaged and scratched when inserting the piston pin.

NOTE

Assembling condition
Temperature : piston side 70 to 80C , connecting rod & pin is to be normal room temperature.

After inserting the piston pin, set the snap ring of the other side.

CAUTION

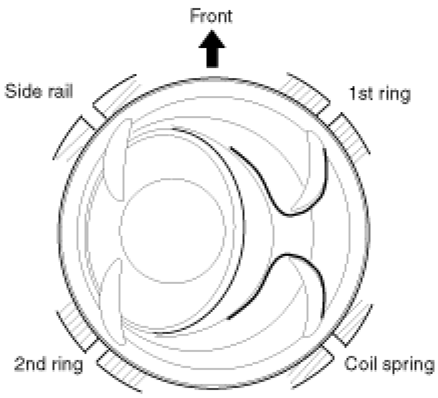
Set the snap ring so that it contacts completely with the groove of the piston pin hole.
The snap ring must not be deformed from the installation tooling method.

Install the piston rings .

Install the oil ring with coil spring by hand.

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

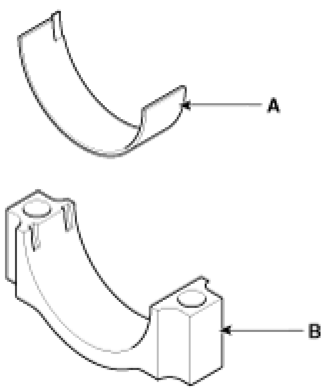
Position the piston rings so that the ring ends are as shown.



Install the connecting rod bearings.

Align the bearing claw with the groove of the connecting rod or connecting rod cap.

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



Remove the crankshaft.
(Refer to Cylinder Block - "Crankshaft")

Install piston and connecting rod assemblies.

NOTE

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

Remove the connecting rod caps, and slip short sections of rubber hose over the threaded ends of the connecting rod bolts.

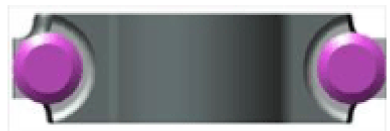
Install the ring compressor, check that the bearing is securely in place, then position the piston in the cylinder, and tap it in using the wooden handle of a hammer.

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

Apply engine oil to the bolt threads. Using the SST (09221-4A000), install the rod caps with bearings, and torque the bolts.

Tightening torque
A type :
17.7 ~ 21.6 N.m (1.8 ~ 2.2 kgf.m, 13.0 ~ 15.9 lb-ft) + 88 ~ 92°
B type :
17.7 ~ 21.6 N.m (1.8 ~ 2.2 kgf.m, 13.0 ~ 15.9 lb-ft) + 78 ~ 82°

NOTE

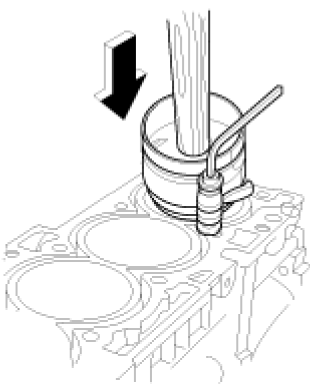
A Type	B Type
	

CAUTION

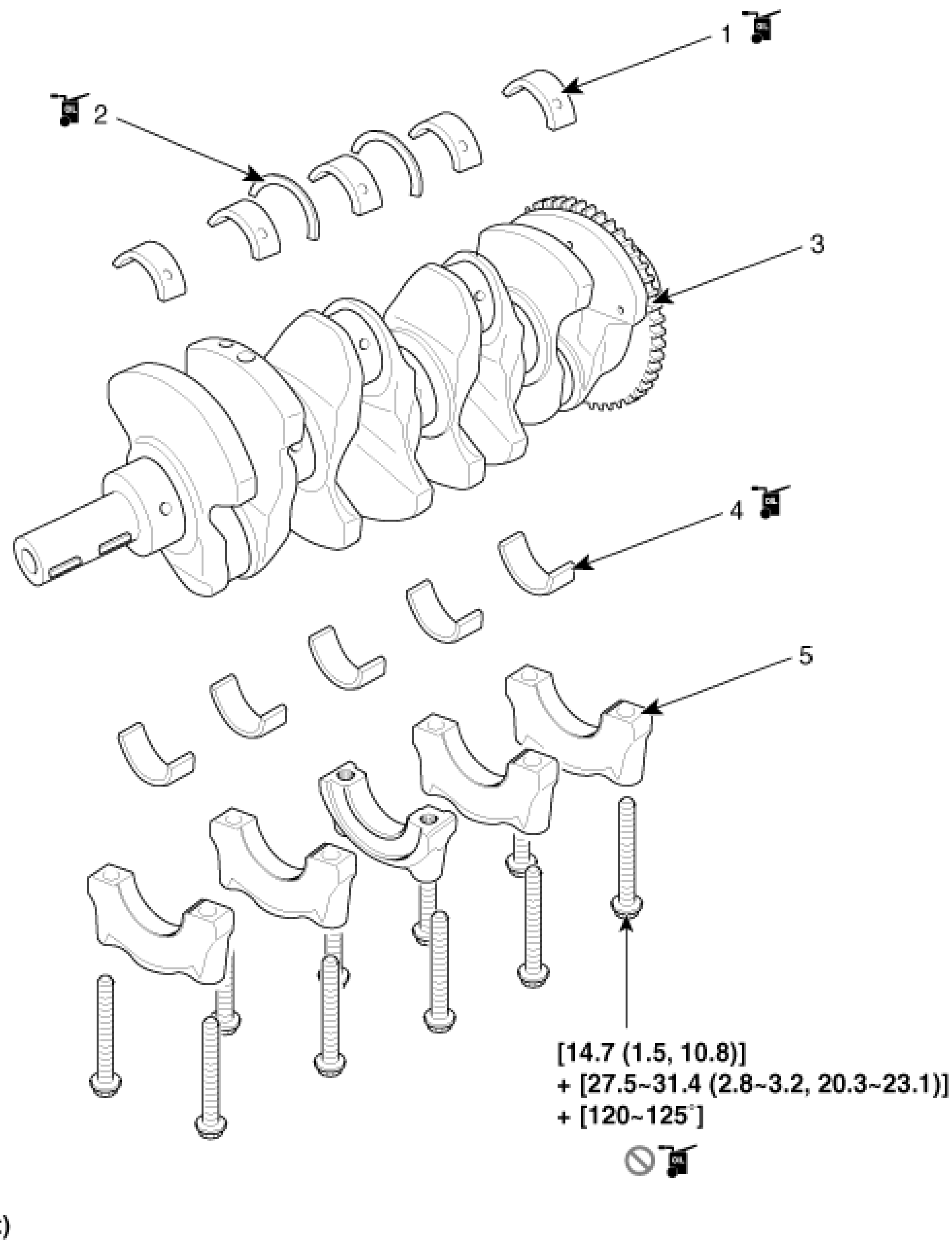
Always use new connecting rod cap bolts.

NOTE

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



Components



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

Disassembly

CAUTION

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

NOTE

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

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.

Remove the ladder frame.

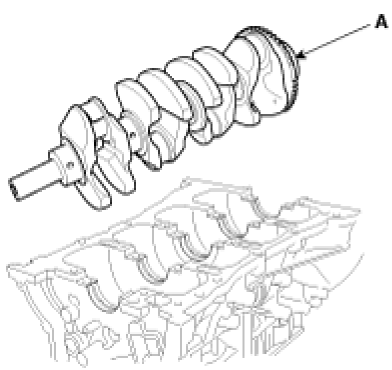
Check the connecting rod end play.

Remove piston and connecting rod assemblies.

Remove crankshaft bearing cap and check oil clearance.

Check the crankshaft end play.

Lift the crankshaft (A) out of the engine, being careful not to damage journals.



NOTE

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

Inspection

Check the crankshaft bearing oil clearance.

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

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

Place one strip of plastigage across each main journal.

Reinstall the bearings and caps, then torque the bolts.

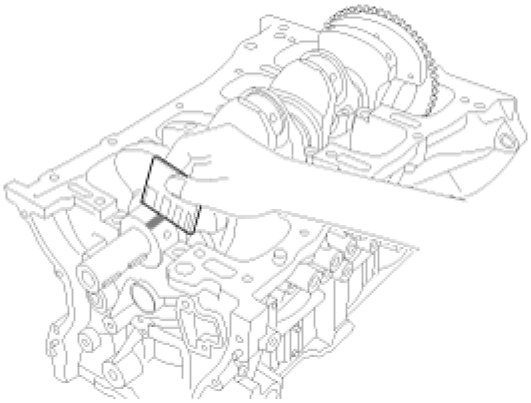
Tightening torque :
14.7 N.m (1.5 kgf.m, 10.8 lb-ft) + 27.5 ~ 31.4 N.m (2.8 ~ 3.2 kgf.m, 20.3 ~ 23.1 lb-ft) + 120 ~ 125°

NOTE

Do not turn the crankshaft.

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

Standard oil clearance :
0.020 ~ 0.038 mm (0.00079 ~ 0.00150 in.)



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.

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

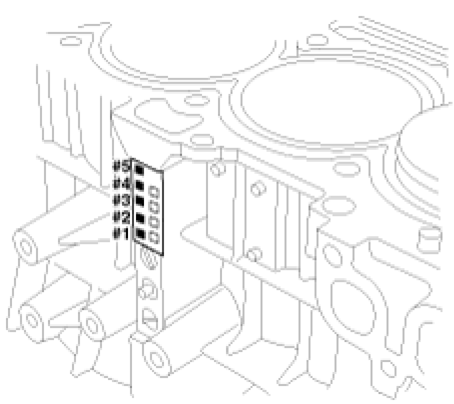
NOTE

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

CAUTION

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

Crankshaft Bore Identification Mark

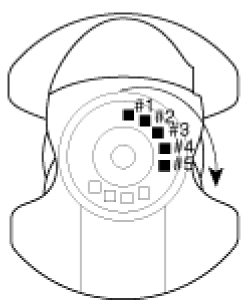


Letters have been stamped on the block as a mark for the size of each of the 5 main journal bores.
Use them, and the numbers or bar stamped on the crank (marks for main journal size), to choose the correct bearings.

Cylinder Block Specifications

Class	Mark	Inside Diameter
a	A	56.000 ~ 56.006 mm (2.20472 ~ 2.20496 in.)
b	B	56.006 ~ 56.012 mm (2.20496 ~ 2.20519 in.)
c	C	56.012 ~ 56.018 mm (2.20519 ~ 2.20543 in.)

Crankshaft Journal Identification Mark



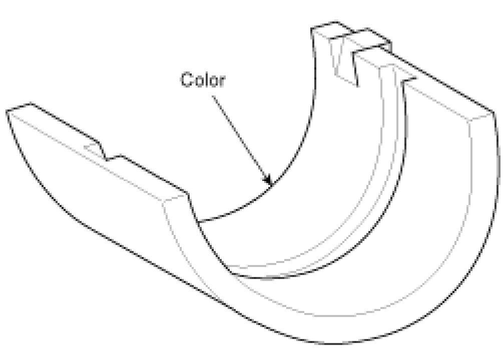
NOTE

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

Crankshaft Specifications

Class	Mark	Outside Diameter Of Journal
I	1	51.954 ~ 51.960 mm (2.04543 ~ 2.04567 in.)
II	2	51.948 ~ 51.954 mm (2.04519 ~ 2.04543 in.)
III	3	51.942 ~ 51.948 mm (2.04496 ~ 2.04519 in.)

Crankshaft Bearing Identification Mark



Crankshaft Bearing Specifications

Class	Mark	Thickness Of Bearing
AA	Blue	2.026 ~ 2.029 mm (0.07976 ~ 0.07988 in.)
A	Black	2.023 ~ 2.026 mm (0.07965 ~ 0.07976 in.)
B	None	2.020 ~ 2.023 mm (0.07953 ~ 0.07965 in.)
C	Green	2.017 ~ 2.020 mm (0.07941 ~ 0.7953 in.)
D	Yellow	2.014 ~ 2.017 mm (0.07929 ~ 0.07941 in.)

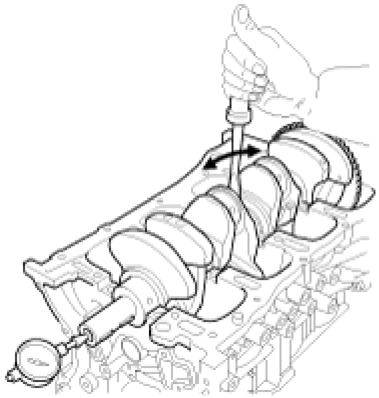
Selection Chart For Crankshaft Bearings

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

Check crankshaft end play.

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

End play
Standard : 0.07 ~ 0.25 mm (0.0028 ~ 0.0098 in.)
Limit : 0.30 mm (0.0118 in.)



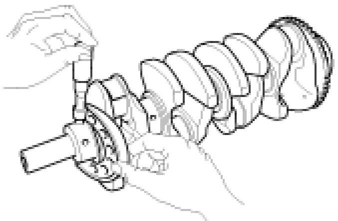
If the end play is greater than maximum, replace the thrust bearings as a set.

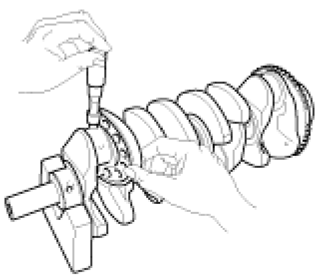
Thrust bearing thickness :
1.925 ~ 1.965 mm (0.07579 ~ 0.07736 in.)

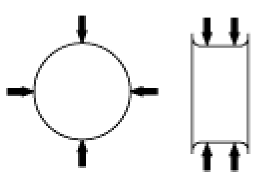
Inspect main journals and crank pins.

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

Main journal diameter :
51.942 ~ 51.960 mm (2.04496 ~ 2.04567 in.)
Crank pin diameter :
47.954 ~ 47.972 mm (1.88795 ~ 1.88866 in.)







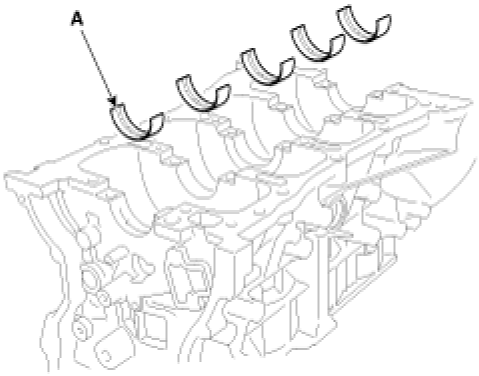
Reassembly

Install the main bearings.

NOTE

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

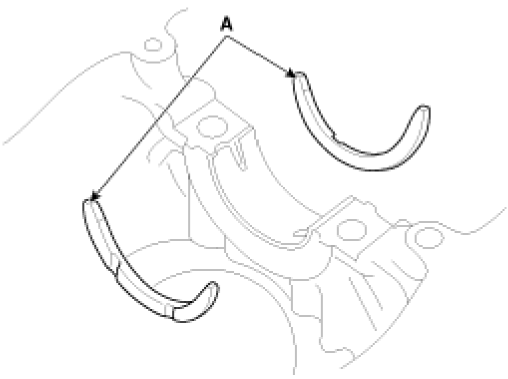
Align the bearing claw with the claw groove of the cylinder block, push in the 5 upper bearings(A).



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

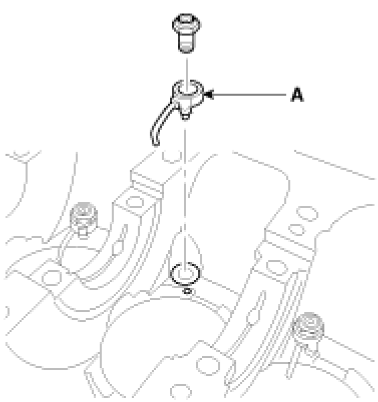
Install the thrust bearings.

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

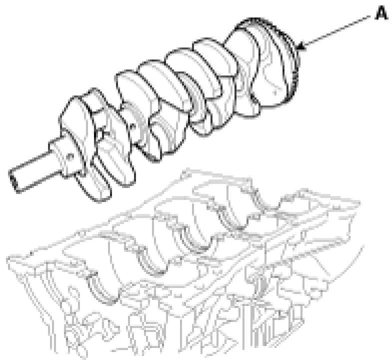


Install the oil jet (A).

Tightening torque :
24.5 ~ 29.4 N.m (2.5 ~ 3.0 kgf.m, 18.1 ~ 21.7 lb-ft)



Place the crankshaft(A) on the cylinder block.



Place the main bearing caps on cylinder block.

Install the main bearing cap bolts.

CAUTION

Always use new main bearing cap bolts.

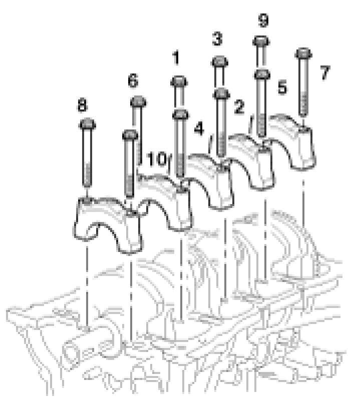
NOTE

- The main bearing cap bolts are tightened in 3 progressive steps.
- If any of the bearing cap bolts is broken or deformed, replace it.

(1) Apply a light coat of engine oil on the threads and under the bearing cap bolts.

Using the SST (09221-4A000), install and uniformly tighten the 10 bearing cap bolts, in several passes, in the sequence shown.

Tightening torque :
14.7 N.m (1.5 kgf.m, 10.8 lb-ft) + 27.5 ~ 31.4 N.m (2.8 ~ 3.2 kgf.m, 20.3 ~ 23.1 lb-ft) + 120 ~ 125°

(2) 

Check that the crankshaft turns smoothly.

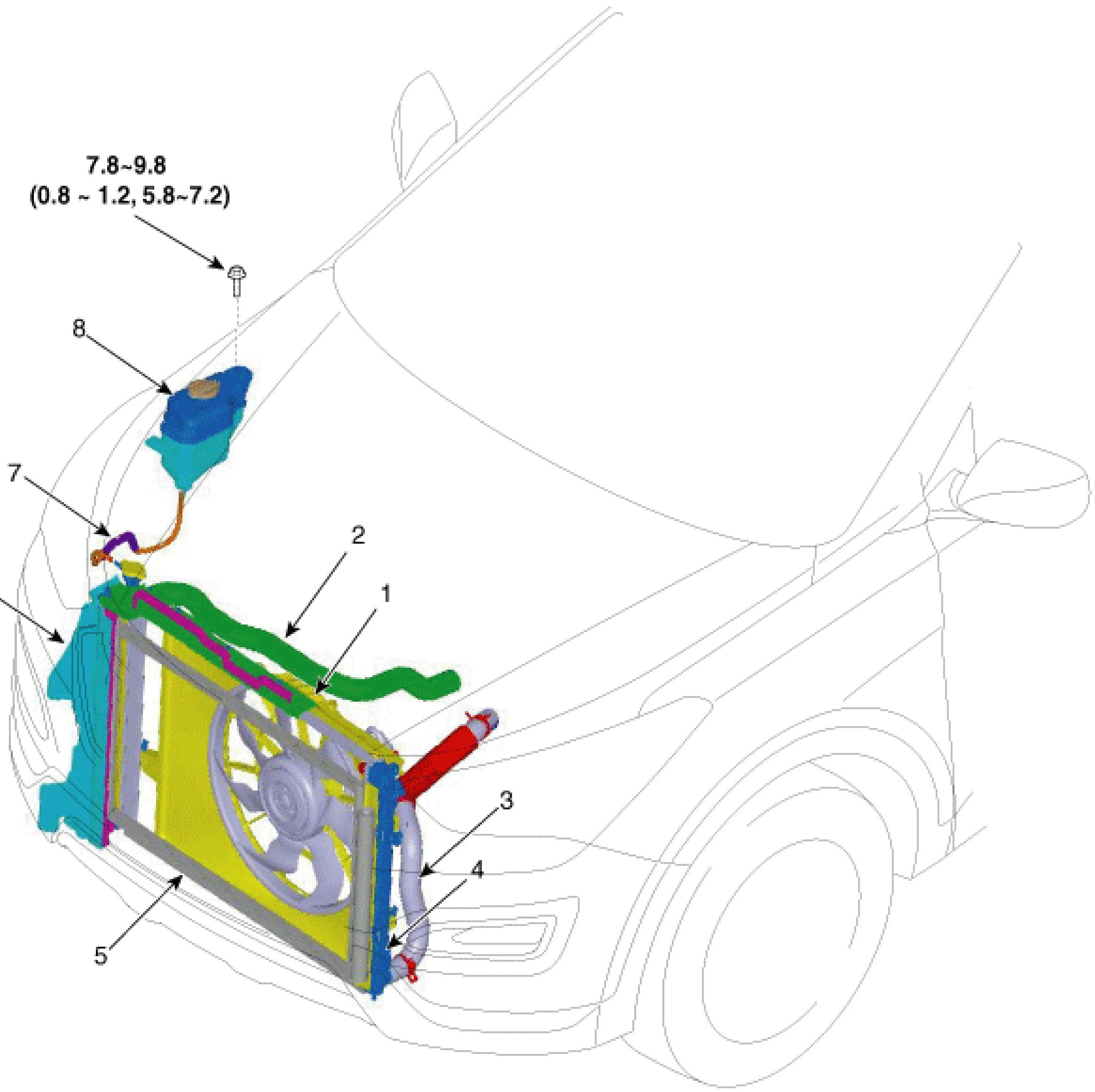
Check crankshaft end play.

Install piston and connecting rod assemblies.

Cooling System

Components and Components Location

Components



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

1. Cooling fan 2. Radiator upper hose 3. Radiator lower hose Radiator cap 4. Radiator	5. Condenser 6. Air guard 7. Over flow hose 8. Reservoir tank

Refilling And Bleeding

WARNING

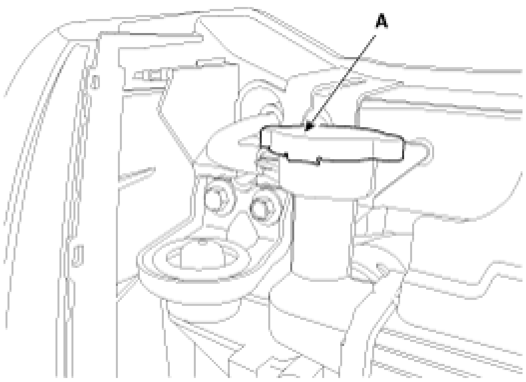
Never remove the radiator cap when the engine is hot. Serious scalding could be caused by hot fluid under high pressure escaping from the radiator.

CAUTION

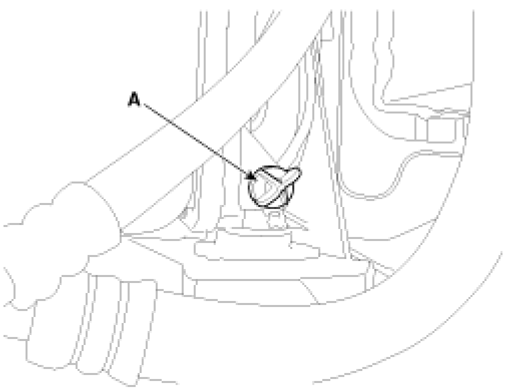
When pouring engine coolant, be sure to shut the relay box lid and not to let coolant spill on the electrical parts or the paint. If any coolant spills, rinse it off immediately.

Make sure the engine and radiator are cool to the touch.

Remove radiator cap (A).



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



Tighten the radiator drain plug securely.

After draining engine coolant in the reservoir tank, clean the tank.

Fill the radiator with water through the radiator cap and tighten the cap.

NOTE

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

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.

Wait until the engine is cool.

Repeat steps 1 to 8 until the drained water runs clear.

Fill fluid mixture with coolant and water(5 : 5) (Tropical region – 4:6) slowly through the radiator cap. Push the upper/lower hoses of the radiator so as bleed air easily.

NOTE

- Use only genuine antifreeze/coolant.

  For best corrosion protection, the coolant concentration must be maintained year-round at 35% minimum.
- Coolant concentrations less than 35% 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.

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

Repeat 11 until the cooling fan 3 ~ 5 times and bleed air sufficiently out of the

Install the radiator cap and fill the reservoir tank to the "MAX (or F)" line with coolant.

Run the vehicle under idle until the cooling fan operates 2 ~ 3 times.

Stop the engine and wait coolant gets cool.

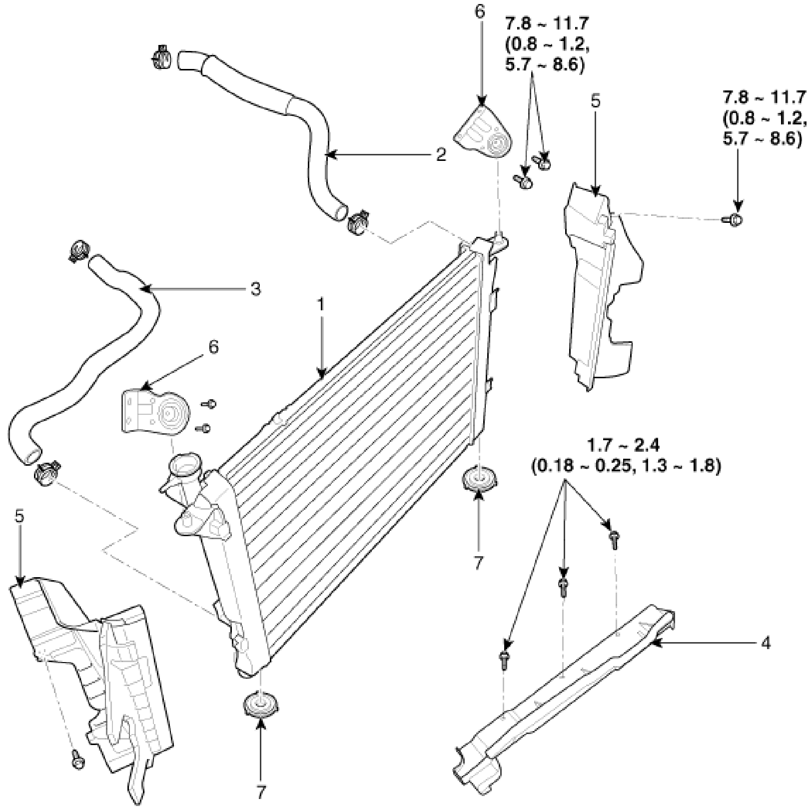
Repeat 10 to 15 until the coolant level doesn't fall any more, bleed air out of the cooling system.

NOTE

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

Coolant capacity
MT : 7.1 L (1.8 U.S.gal., 7.5 U.S.qt., 6.2 lmp.qt.)
AT (For Europe, Australia) :
7.7 L (2.0 U.S.gal., 8.1 U.S.qt., 6.7 lmp.qt.)
AT (Except Europe, Australia) :
7.4 L (1.9 U.S.gal., 7.8 U.S.qt., 6.5 lmp.qt.)

Components



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

1. Radiator 2. Radiator lower hose 3. Radiator upper hose 4. Radiator upper guard	5. Radiator side air guard 6. Radiator upper mounting bracket 7. Radiator lower mounting insulator

Removal and Installation

Disconnect the battery terminals.

Remove the air cleaner assembly.

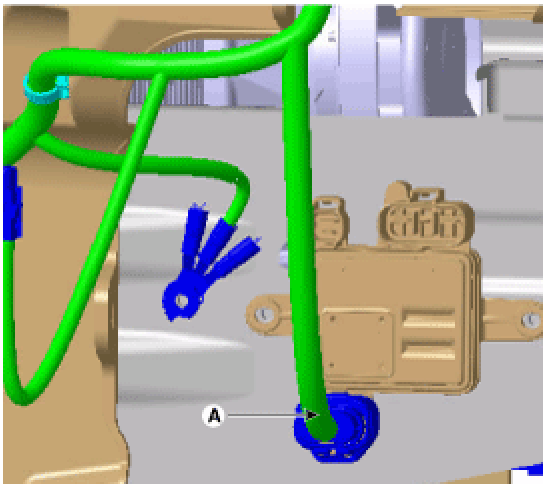
Remove the under cover.

Loosen the drain plug, and drain the coolant.
Remove the radiator cap to speed draining.

Remove the front bumper.

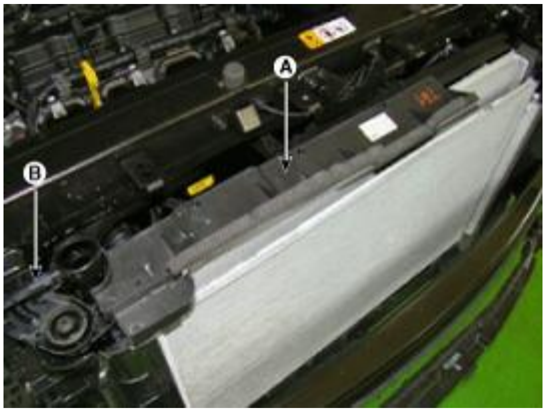
Remove the radiator upper hose (A) and lower hose (B).

Disconnect the PWM module connector (A).



Remove the air intake shield (A).

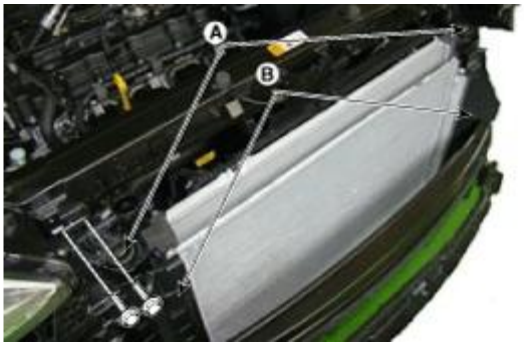
Remove the upper air guard (A) and radiator over flow hose (B).



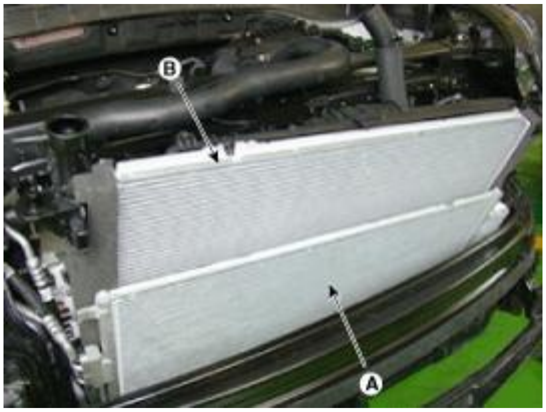
Remove the horn.

Remove the upper bracket (A) and air guard (B).

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



Separate the condenser (A) from the radiator (B) and then remove the radiator assembly.



Install in the reverse order of removal.

Fill the radiator with coolant and check for leaks.

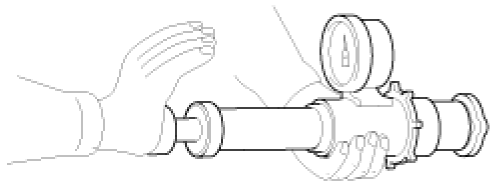
NOTE

- Bleed air from the
- 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
- Put the radiator cap on tightly, then run engine again and check for leaks.

Inspection

Radiator Cap Testing

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



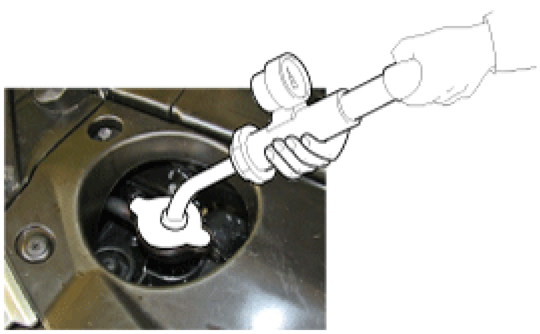
Apply a pressure of 79.4 ~ 122.58 kPa (0.95 ~ 1.25 kgf/cm², 11.5 ~ 17.78 psi).

Check for a drop in pressure.

If the pressure drops, replace the cap.

Radiator Leakage Test

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.



Apply a pressure tester to the radiator and apply a pressure of 93.16 ~ 122.58 kPa (0.95 ~ 1.25 kgf/cm², 13.51 ~ 17.78 psi).

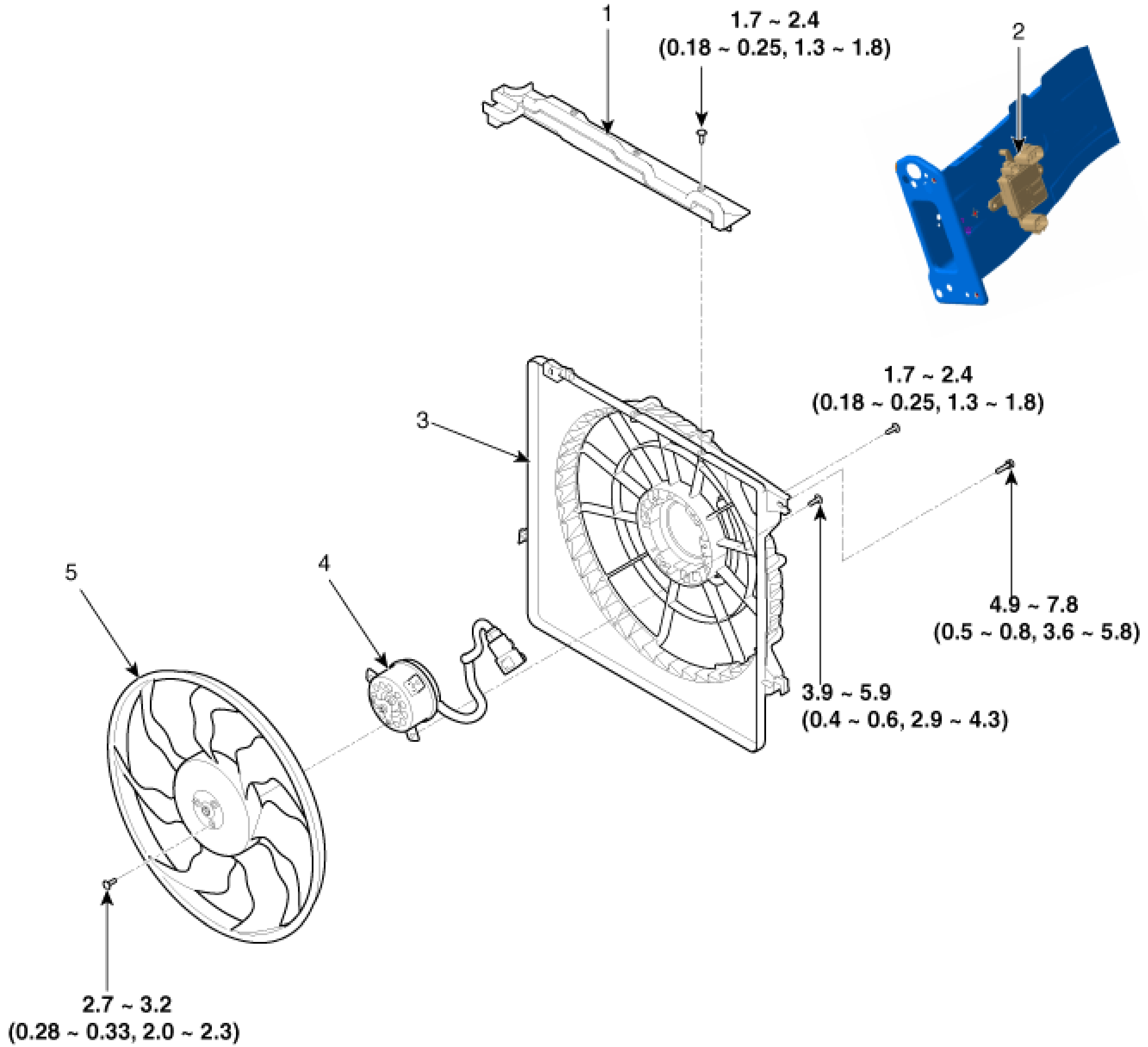
Inspect for engine coolant leaks and a drop in pressure.

Remove the tester and reinstall the radiator cap.

NOTE

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

Components

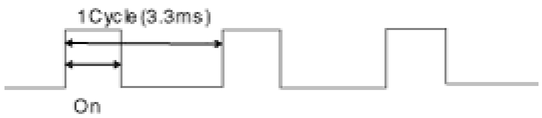


Torque : N.m (kgf.m, lb-ft)

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	–

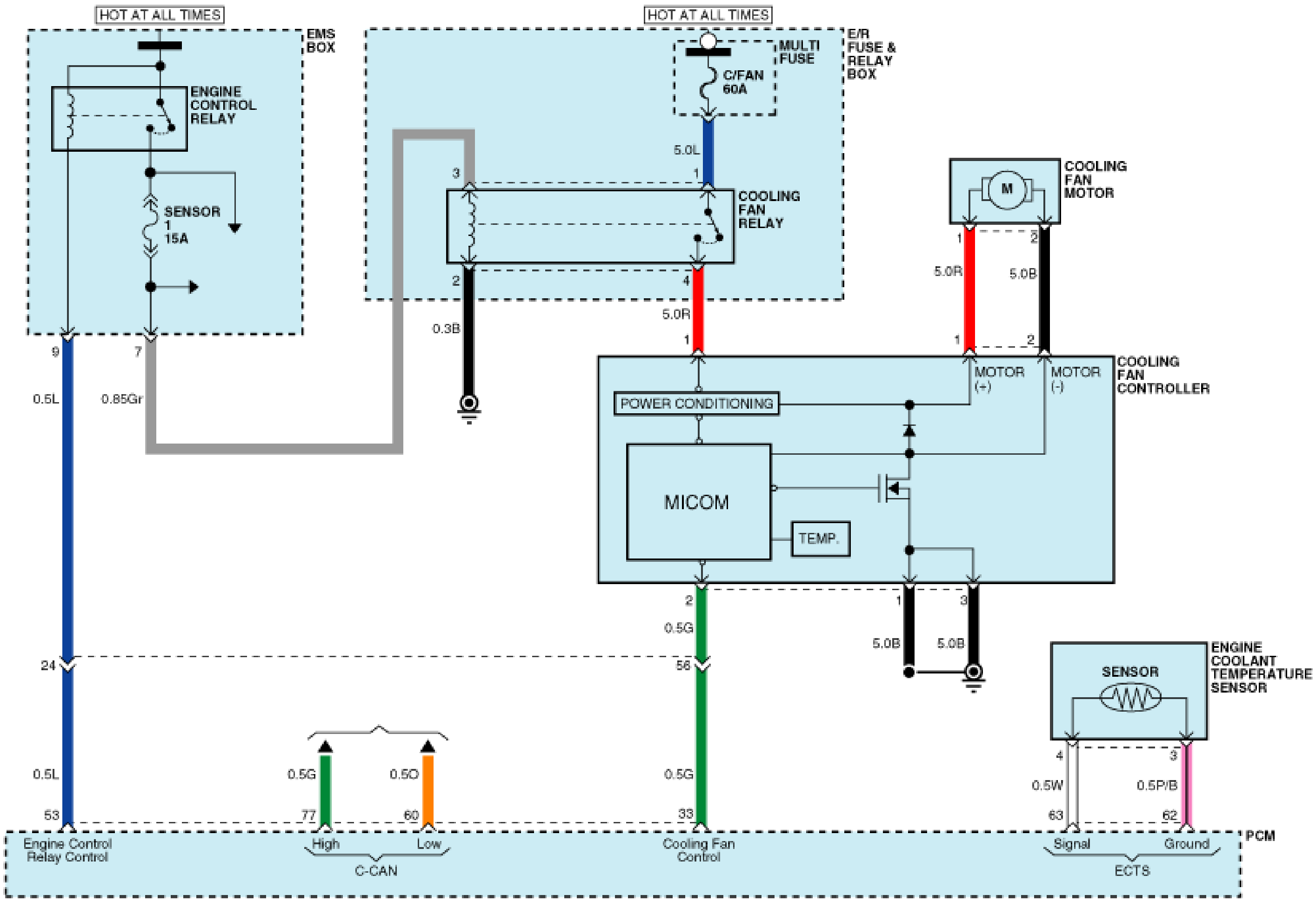
[Cooling Fan Operation Condition]

A/C Switch	A/C Pressure (Kgf/cm² G)	Vehicle Speed (Km/h)	Coolant Temp (°C)	Duty (%)
		V < 45	98 above	35
		45 ≤ V < 80	101 above	40
OFF	–	80 ≤ V	105 above	80
	A/C Pressure < 6	ALL	105 above	90
		V < 45	82 above	30
		45 ≤ V < 80	96 above	40
	6 ≤ A/C Pressure < 12	80 ≤ V	96 above	60
		V < 45	101 above	70
		45 ≤ V < 80	-30 above	40
	12 ≤ A/C Pressure < 15.5	80 ≤ V	82 above	60
		V = 0	-30 above	60
ON	15.5 ≤ A/C Pressure	0 < V	-30 above	90

Specification

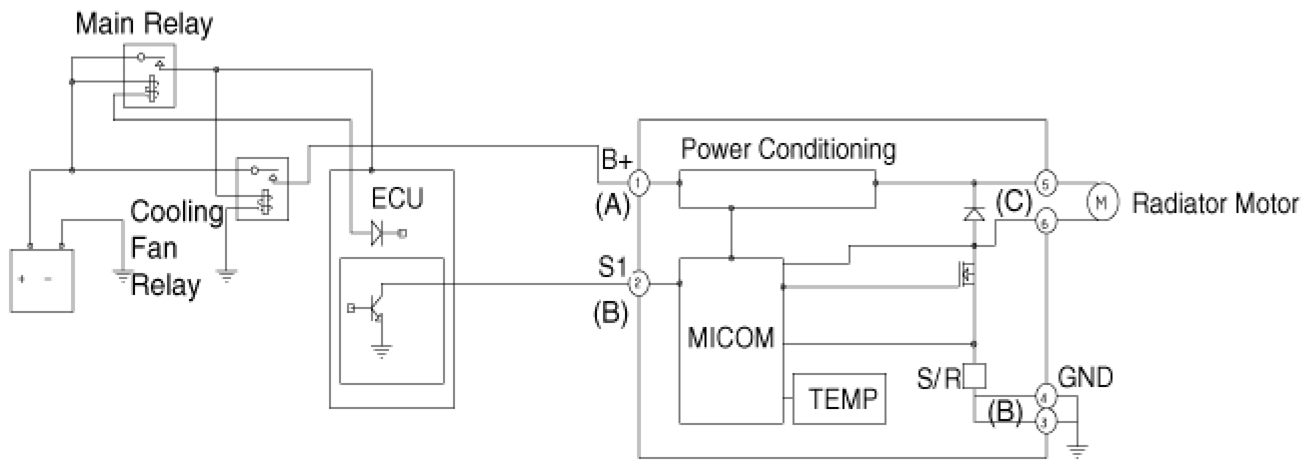
Function		Specification	
Maximum Drive Capability		250 W	21.0 + 10% A
Input	Signal Frequency	300 ± 5%	
	Duty	10, 30 ~ 90 %	
	Voltage level	HI	0.7 V above
		LOW	0 ~ 1.9 V

Circuit Diagram

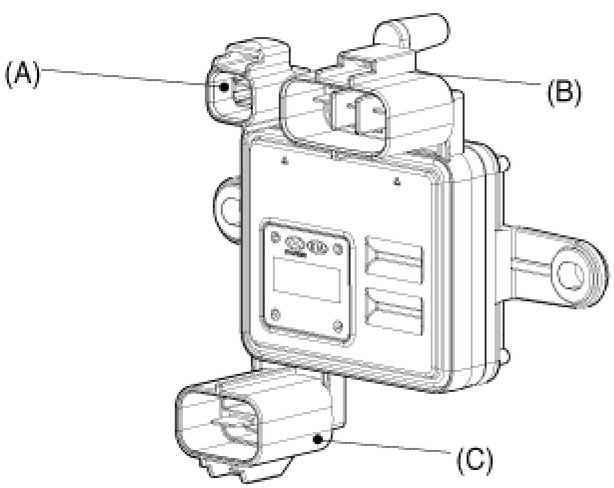


PWM Circuit Diagram

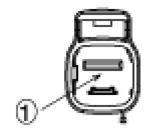
[Circuit Diagram]



[Connector]

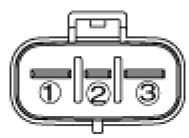


Power Connector (A)



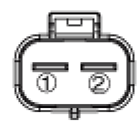
No.	Function
①	BATT

Main Connector (B)



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

Motor Connector (C)



No.	Function
①	Motor (+)
②	Motor (-)

Cooling Fan Assembly

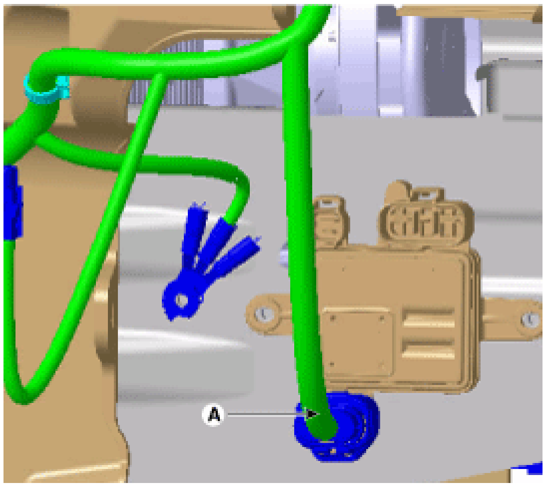
Disconnect the battery terminals.

Remove the air cleaner assembly.

Remove the under cover.

Remove the front bumper cover.

Disconnect the PWM module connector(A).



Remove the air intake shield(A).

Remove the radiator over flow hose (A) and upper bracket (B), air guard(C).

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

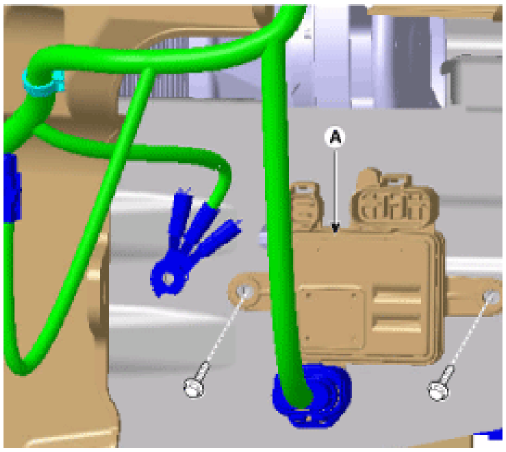
Install in the reverse order of removal.

PWM Module

Remove the LH wheel guard.

Disconnect the PWM connectors and then remove the PWM module(A).

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

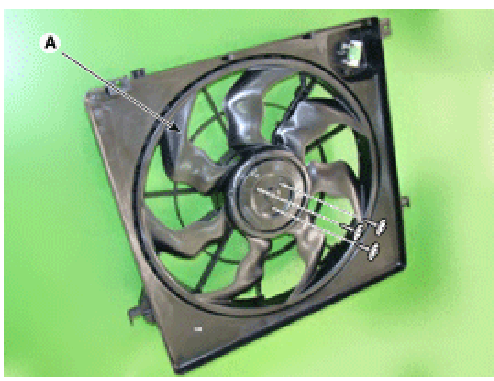


Install in the reverse order of removal.

Disassembly

Remove the cooling fan(A) from cooling assembly.

Tightening torque:
2.7 ~ 3.2 N.m (0.28 ~ 0.33 kgf.m, 2.0 ~ 2.3 lb-ft)



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

Tightening torque:
3.9 ~ 5.8 N.m (0.4 ~ 0.6 kgf.m, 2.8 ~ 4.3 lb-ft)

Install in the reverse order of removal.

Removal and Installation

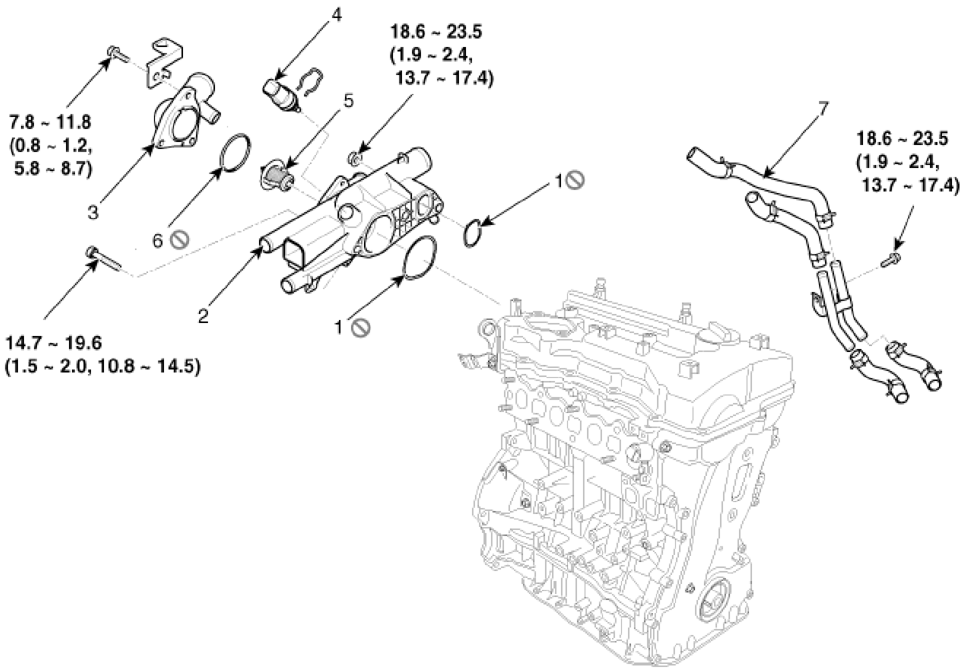
Remove the over flow hose (A).

Remove the reservoir tank (B).

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

Install in the reverse order of removal.

Components



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

1. O-ring 2. Water temperature control assembly 3. Water inlet fitting 4. Engine coolant temperature sensor	5. Thermostat 6. Thermostat gasket 7. Oil cooler coolant hose

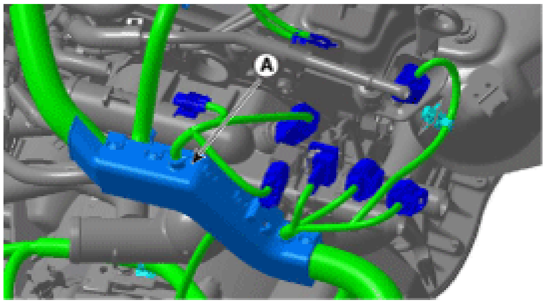
Removal

Disconnect the battery negative terminal.

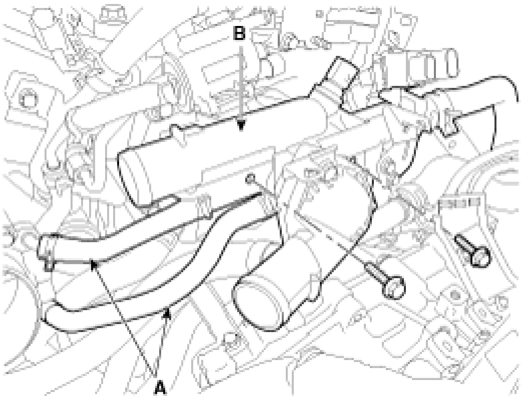
Loosen the drain plug and drain the engine coolant.

Remove the radiator upper hose and lower hose.

Disconnect the connectors and then remove the wiring protector (A).



Disconnect the E.T.C cooler hose (A) and the remove the water temperature control assembly(A).



Install in the reverse order of removal.

Removal and Installation

NOTE

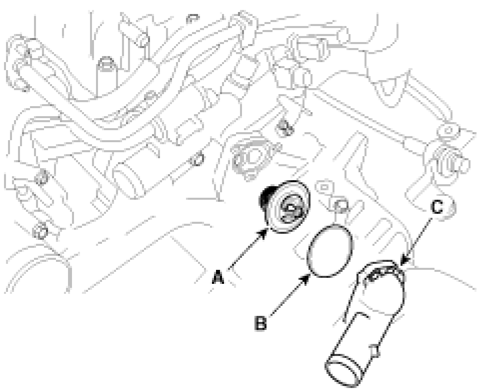
Removal of the thermostat would have an adverse effect, causing a lowering of cooling efficiency. Do not remove the thermostat, even if the engine tends to overheat.

Drain engine coolant so its level is below thermostat.

Remove the radiator lower hose (A).

Remove water inlet fitting (A), gasket (B) and thermostat (C).

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



Install in the reverse order of removal.

NOTE

Install the thermostat with the jiggle valve upward.

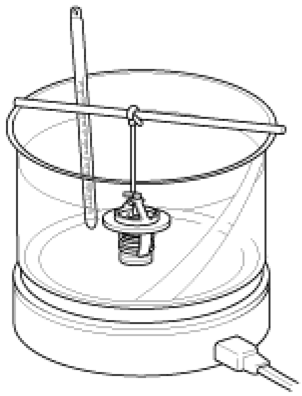
Fill the engine coolant.

Start the engine and check for leaks.

Recheck the coolant level.

Inspection

Immerse the thermostat in water and gradually heat the water.



Check the valve opening temperature.

Valve opening temperature: 82°C (177°F)
Full opening temperature: 95°C (205°F)

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

Check the valve lift.

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

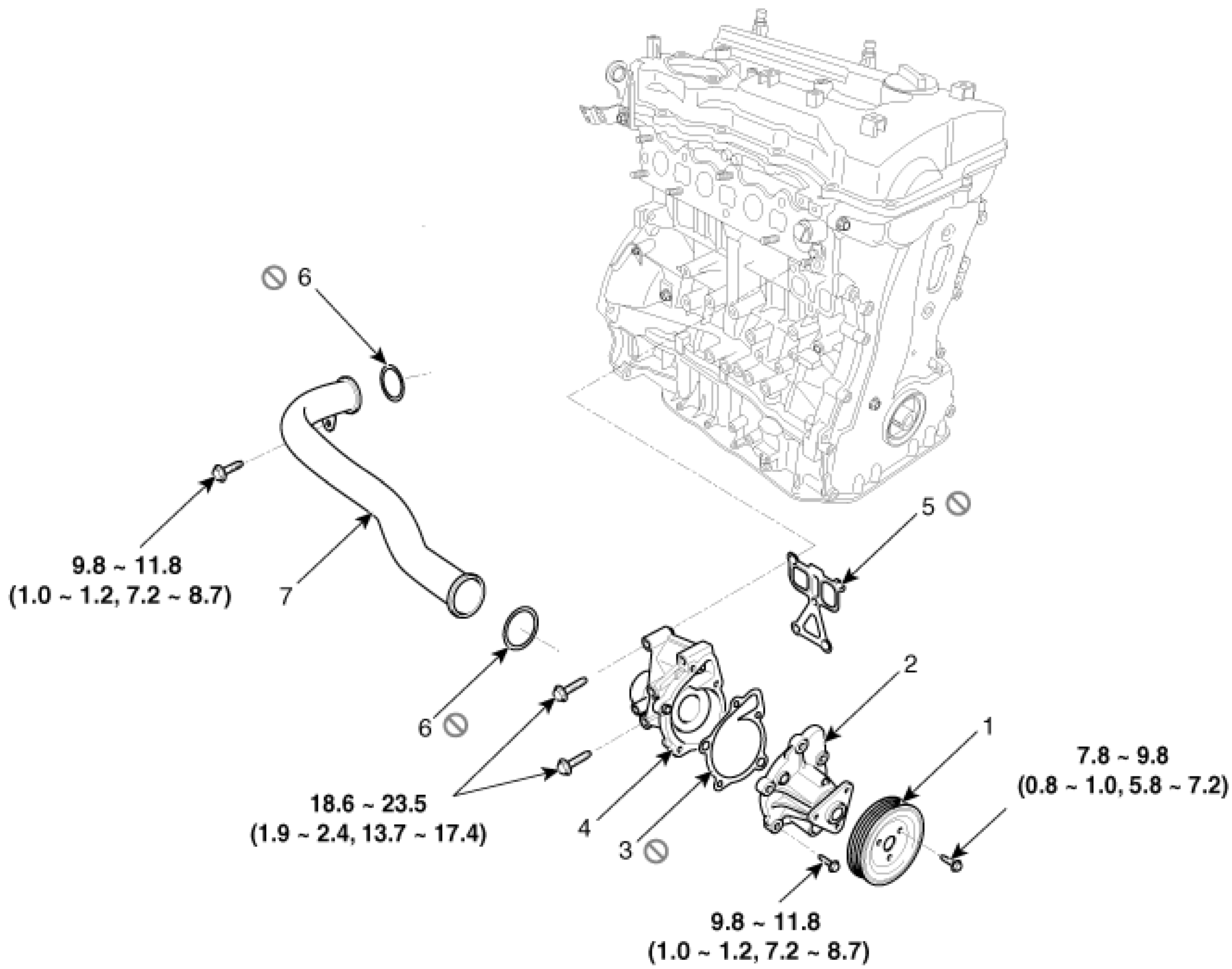
If the valve lift is not as specified, replace the thermostat.

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

Water pump. Components and Components Location

Components



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

1. Water pump pulley 2. Water pump 3. Water pump gasket	4. Water pump housing 5. Water pump housing gasket 6. O-ring 7. Water inlet pipe

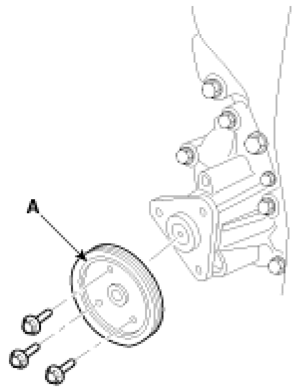
Removal and Installation

Loosen the drain plug, and then drain the engine coolant.
Remove the radiator cap to help drain the coolant faster.

Remove the drive belt after turning the drive belt tensioner counterclockwise.

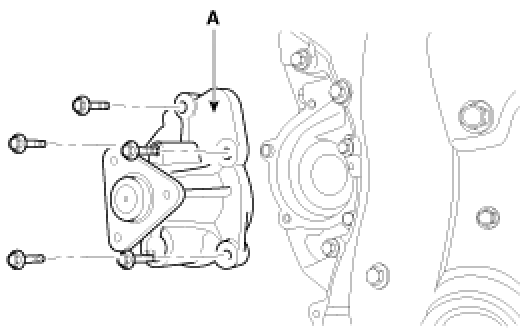
Remove the water pump pulley (A).

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



Remove the water pump sub assembly (A) with the gasket.

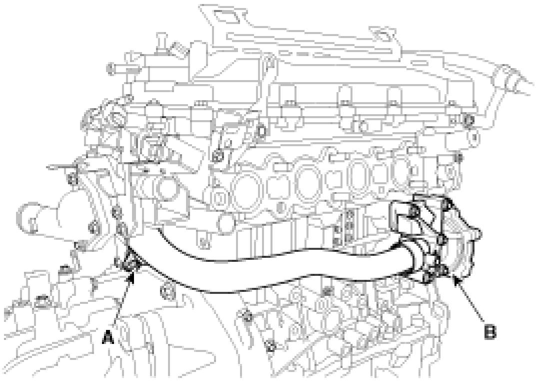
Tightening torque :
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)



Remove the exhaust manifold heat protector.

Remove the water pump housing (B) with the gasket and the water inlet pipe (A).

Tightening torque
Bolt (A) :
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)
Bolt (B) :
18.6 ~ 23.5 N.m (1.9 ~ 2.4 kgf.m, 13.7 ~ 17.4 lb-ft)



Install in the reverse order of removal with a new water pump gasket.

Fill the engine coolant.

Start the engine and check for leaks.

Recheck the coolant level.

Inspection

Check each part for cracks, damage or wear, and replace the coolant pump assembly if necessary.

Check the bearing for damage, abnormal noise and sluggish rotation, and replace the coolant pump assembly if necessary.

Check for coolant leakage. If coolant leaks from hole, the seal is defective.
Replace the coolant pump assembly.

NOTE

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

Troubleshooting

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

Engine Oil. Repair procedures – Revised

Oil and filter 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.

Park the car on level ground.
Start the engine and let it warm up.

Drain engine oil.

Remove the oil filler cap.

After lifting the car, remove the oil drain plug hole cover.

Remove the oil drain plug and drain oil into a container.

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

Remove the oil filter.

Check and clean the oil filter installation surface.

Check the part number of the new oil filter is as same as old one.

Apply clean engine oil to the gasket of a new oil filter.

Lightly screw the oil filter into place, and tighten it until the gasket contacts the seat.

Tighten it with the torque below.

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

Install the oil drain plug with a new gasket.

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

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

Capacity
Total
5.5 L (1.45 U.S.gal., 5.81 U.S.qt., 4.84 lmp.qt.)
Oil pan
4.2 L (1.11 U.S.gal., 4.44 U.S.qt., 3.70 lmp.qt.)
Drain and refill including oil filter
4.6 L (1.22 U.S.gal., 4.86 U.S.qt., 4.05 lmp.qt.)

Install the oil filler cap.

Start engine and check for oil leaks and check the oil gauge or light for an indication of oil pressure.

Recheck the engine oil level.

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.

Park the car on level ground.
Start the engine and let it warm up.

Drain engine oil.

Remove the oil filler cap.

After lifting the car, remove the oil drain plug hole cover.

Remove the oil drain plug and drain oil into a container.

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

Remove the oil filter.

Check and clean the oil filter installation surface.

Check the part number of the new oil filter is as same as old one.

Apply clean engine oil to the gasket of a new oil filter.

Lightly screw the oil filter into place, and tighten it until the gasket contacts the seat.

Tighten it with the torque below.

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

Install the oil drain plug with a new gasket.

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

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

Capacity
Total
6.1 L (1.61 U.S.gal., 6.44 U.S.qt., 5.36 lmp.qt.)
Oil pan
4.6 L (1.21 U.S.gal., 4.86 U.S.qt., 4.04 lmp.qt.)
Drain and refill including oil filter
5.0 L (1.32 U.S.gal., 5.28 U.S.qt., 4.39 lmp.qt.)

Install the oil filler cap.

Start engine and check for oil leaks and check the oil gauge or light for an indication of oil pressure.

Recheck the engine oil level.

Inspection

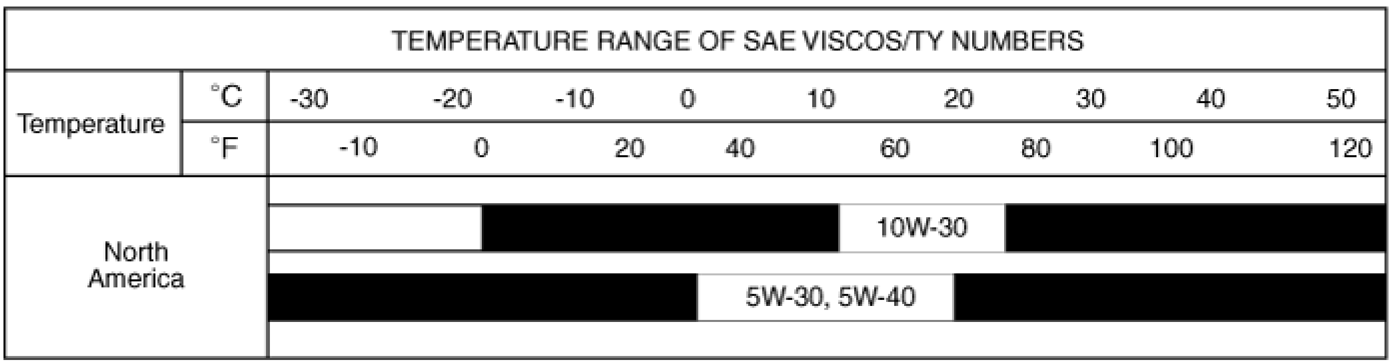
Check the engine oil quality.
Check the oil deterioration, entry of water, discoloring of thinning. If the quality is visibly poor, replace the oil.

Check the engine oil level.
After engine warm up stop the engine wait 5 minutes then check the oil level. Oil level should be between the "L" and "F" marks on the dipstick. If low check for leakage and add oil up to the "F" mark.

NOTE

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

Selection Of Engine Oil
Recommendation :
5W-20 / API SM, ILSAC GF4
(If not available, refer to the recommended API or ILSAC classification
API classification: SL, SM or above
ILSAC classification : GF3, GF4 or above
ACEA classification : A3, A5 or above
SAE viscosity grade : Refer to the recommended SAE viscosity number



NOTE

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

Satisfy the requirement of the API or ILSAC classification.

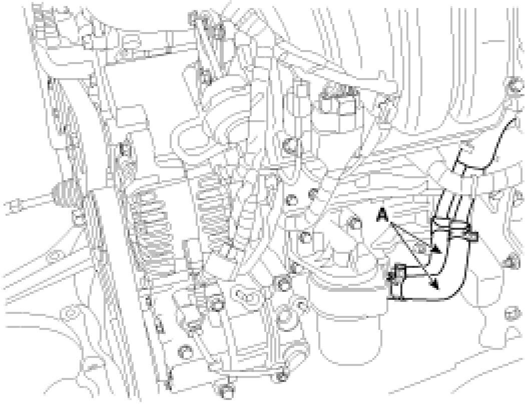
Have proper SAE grade number for expected ambient temperature range.

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

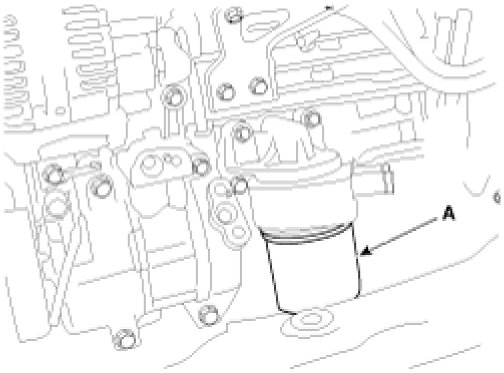
Removal

Loosen the drain plug, and drain the coolant. Remove the radiator cap to help drain the coolant faster.

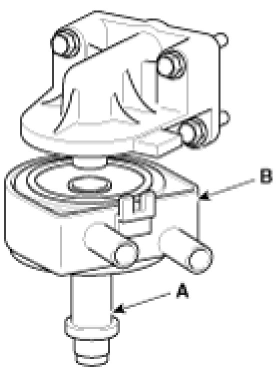
Disconnect the oil cooler coolant hoses (A).



Remove the oil filter (A).



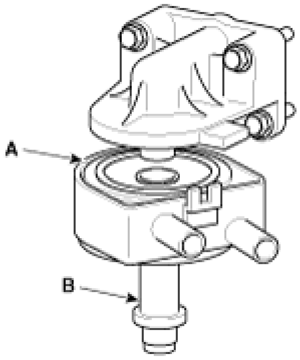
Loosen the mounting bolt (A) and remove the oil cooler assembly (B).



Installation

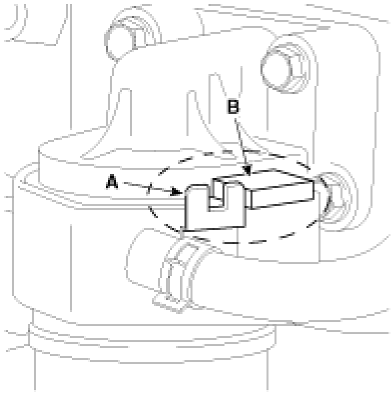
Apply a light coat of engine oil to the oil cooler packing surface (A), and then install the oil cooler with fix bolt (B).

Tightening torque:
44.1 ~ 53.9 N.m (4.5 ~ 5.5 kgf.m, 32.5 ~ 39.8 lb-ft)



CAUTION

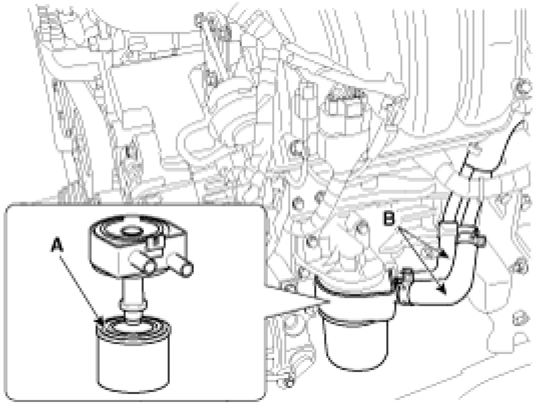
Fix position of oil cooler stopper(A) where oil cooler resists on ladder frame stopper (B).



Apply a light coat of engine oil to the oil filter packing surface (A), and then install the oil filter.

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

Connect the oil cooler coolant hoses (B).



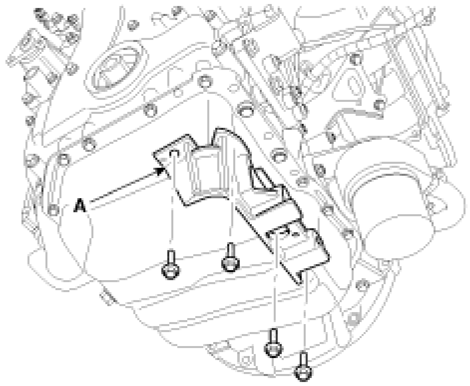
Fill the radiator with coolant and check for leaks.

Removal

Remove the drive belt.

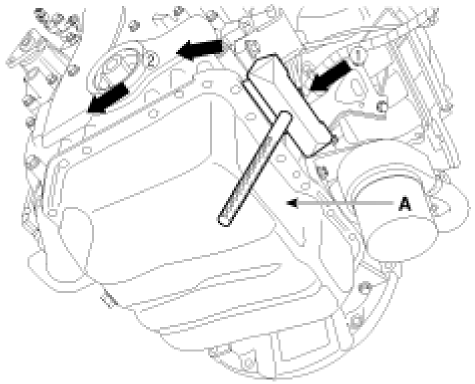
Remove the A/C compressor.

Remove the A/C compressor bracket (A).



Drain the engine oil.

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



NOTE

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

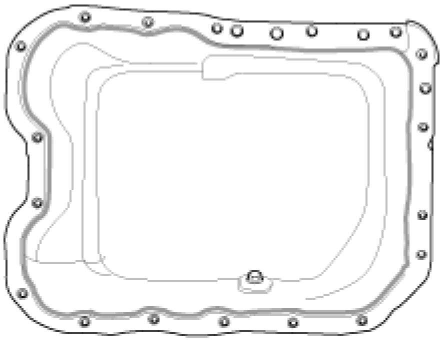
Installation

Install the oil pan.

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

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

Bead width : 3.0 mm (0.12 in.)

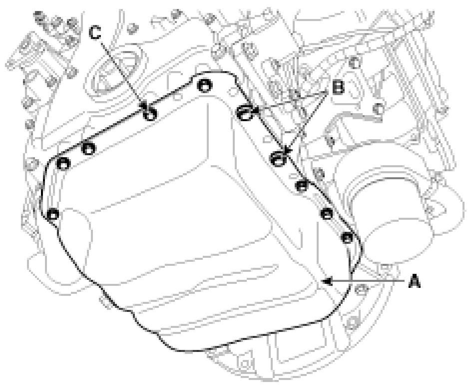


CAUTION

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

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

Tightening torque
Bolts B (M9) :
30.4 ~ 34.3 N.m (3.1 ~ 3.5 kgf.m, 22.4 ~ 25.3 lb-ft)
Bolts C (M6) :
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)



CAUTION

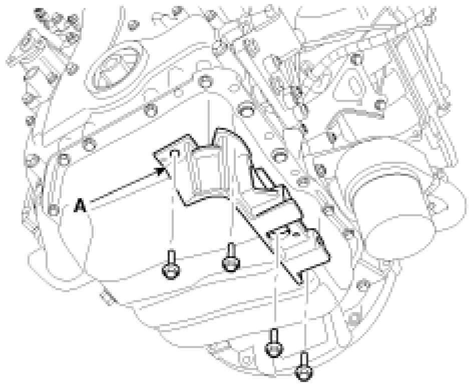
After assembly, wait at least 30 minutes before filling the engine with oil.

NOTE

Always use a new drain plug gasket.

Install the A/C compressor bracket (A).

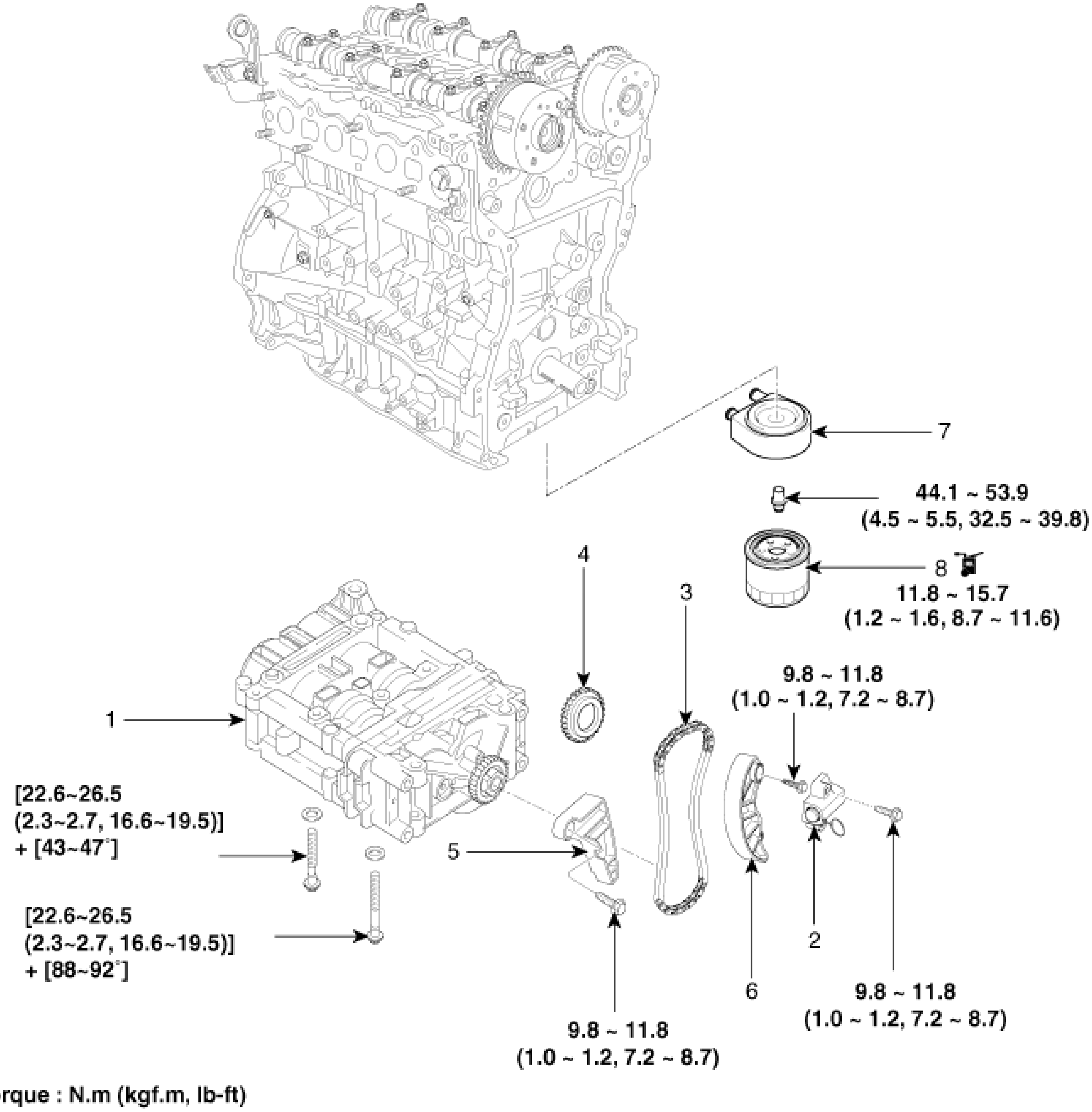
Tightening torque :
19.6 ~ 23.5 N.m (2.0 ~ 2.4 kgf.m, 14.5 ~ 17.4 lb-ft)



Install the A/C compressor lower bolts.

Refill engine with engine oil.

Components



1. Balance shaft & oil pump assembly 2. Balance shaft chain tensioner 3. Balance shaft chain 4. Balance shaft chain sprocket	5. Balance shaft chain guide 6. Balance shaft chain tensioner arm 7. Oil cooler 8. Oil filter

Removal

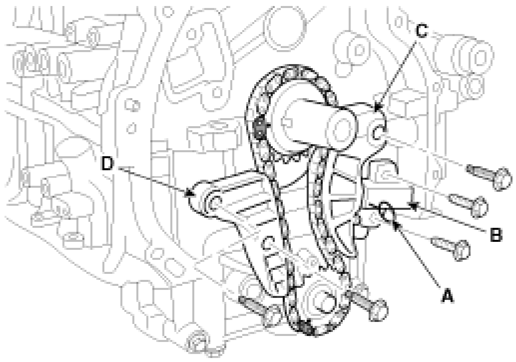
Remove the timing chain.

Install a stopper pin (A) after compressing the balance shaft chain tensioner.

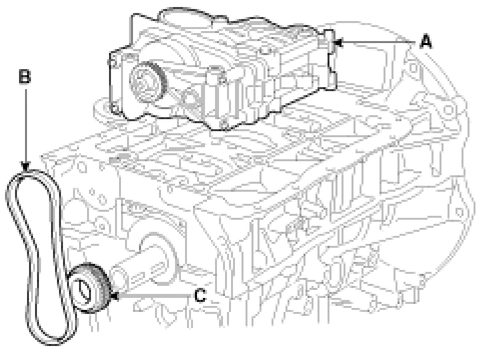
Remove the balance shaft chain hydraulic tensioner (B).

Remove the balance shaft chain tensioner arm (C).

Remove the balance shaft chain guide (D).



Remove the balance shaft & oil pump module (A), the balance shaft chain (B) and the sprocket (C).



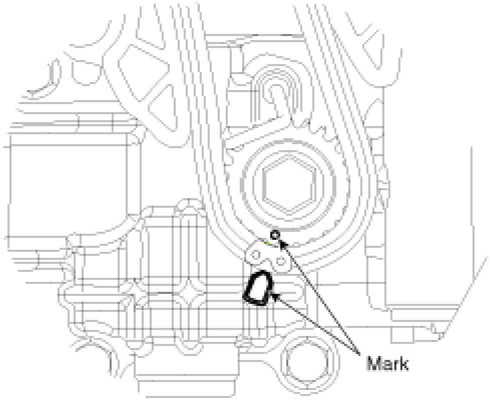
CAUTION

Do not disassemble the balance shaft & oil pump module.

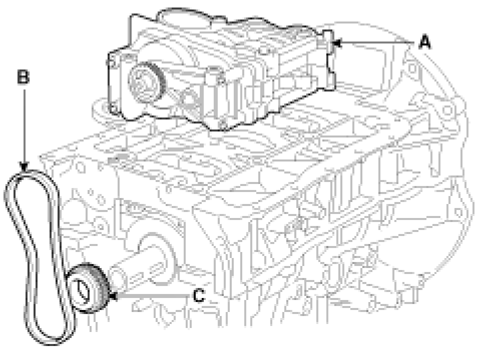
Installation

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

Confirm the balance shaft & oil pump module timing mark.
Timing marks to be visually aligned with centers of adjacent cast timing notches.

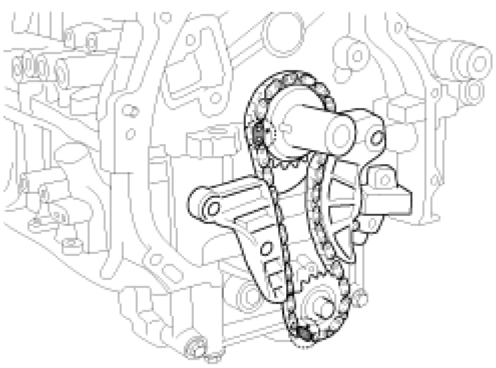


Install the balance shaft & oil pump module (A) with the chain (B) and the sprocket (C).



NOTE

The timing marks of balance shaft & oil pump module sprocket and crankshaft sprocket should be matched with the timing marks (color link) of balance shaft chain.

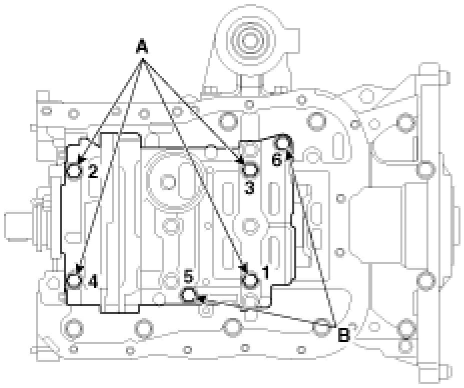


Tightening order

Tighten the bolts in order number as shown with seating torque 26.4 N.m (3.0kgf.m, 21.7 lb-ft) and then loosen the bolts as reverse tightening order. (6-5-4-3-2-1).

Using the SST (09221-4A000), tighten the bolts as specified tightening order in same increments as follows.

Tightening torque
Bolts (A) (M9x181.5) :
22.6 ~ 26.5 N.m (2.3 ~ 2.7 kgf.m, 16.6 ~ 19.5 lb-ft) + 88 ~ 92°
Bolts (B) (M9x95) :
22.6 ~ 26.5 N.m (2.3 ~ 2.7 kgf.m, 16.6 ~ 19.5 lb-ft) + 43 ~ 47°



Install the balance shaft chain guide (D).

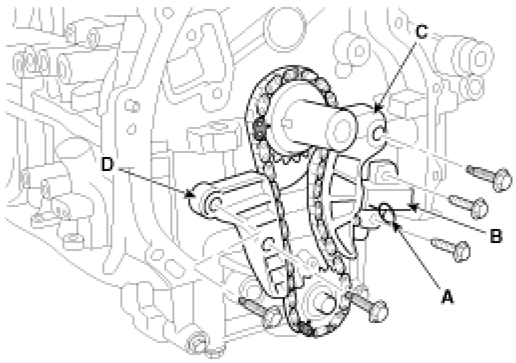
Tightening torque :
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)

Install the balance shaft chain tensioner arm (C).

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

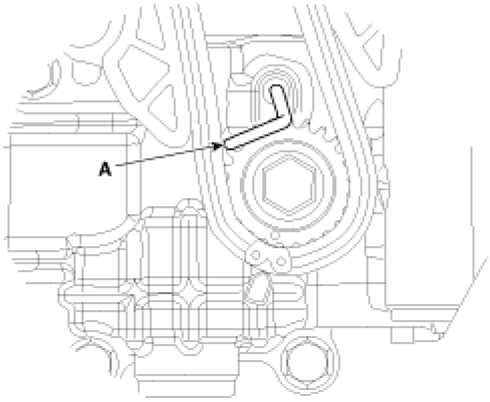
Install the balance shaft chain hydraulic tensioner (B) then remove the stopper pin (A).

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



Confirm the timing marks.

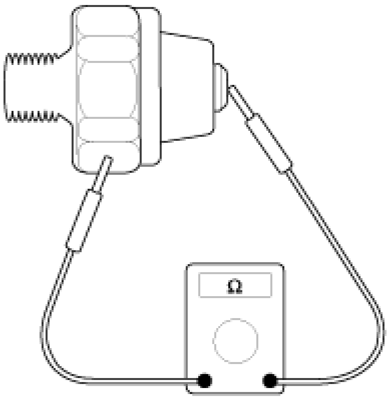
Remove the stopper pin (A) of balance shaft module.



Install the timing chain.

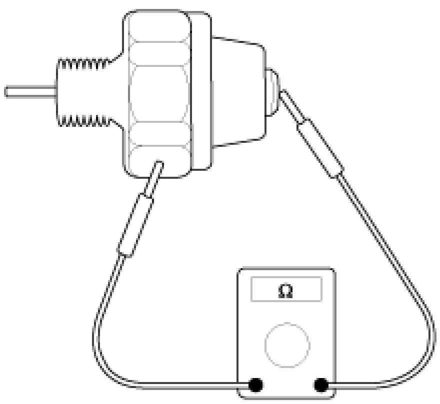
Inspection

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



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.

If there is no continuity when a 50kPa (0.50kgf/cm², 7.25psi) is applied through the oil hole, the switch is operating properly.
Check for air leakage. If air leaks, the diaphragm is broken. Replace it.



Removal and Installation

Remove the oil gauge(A).

Remove the intake manifold.

Remove the oil level pipe(A).

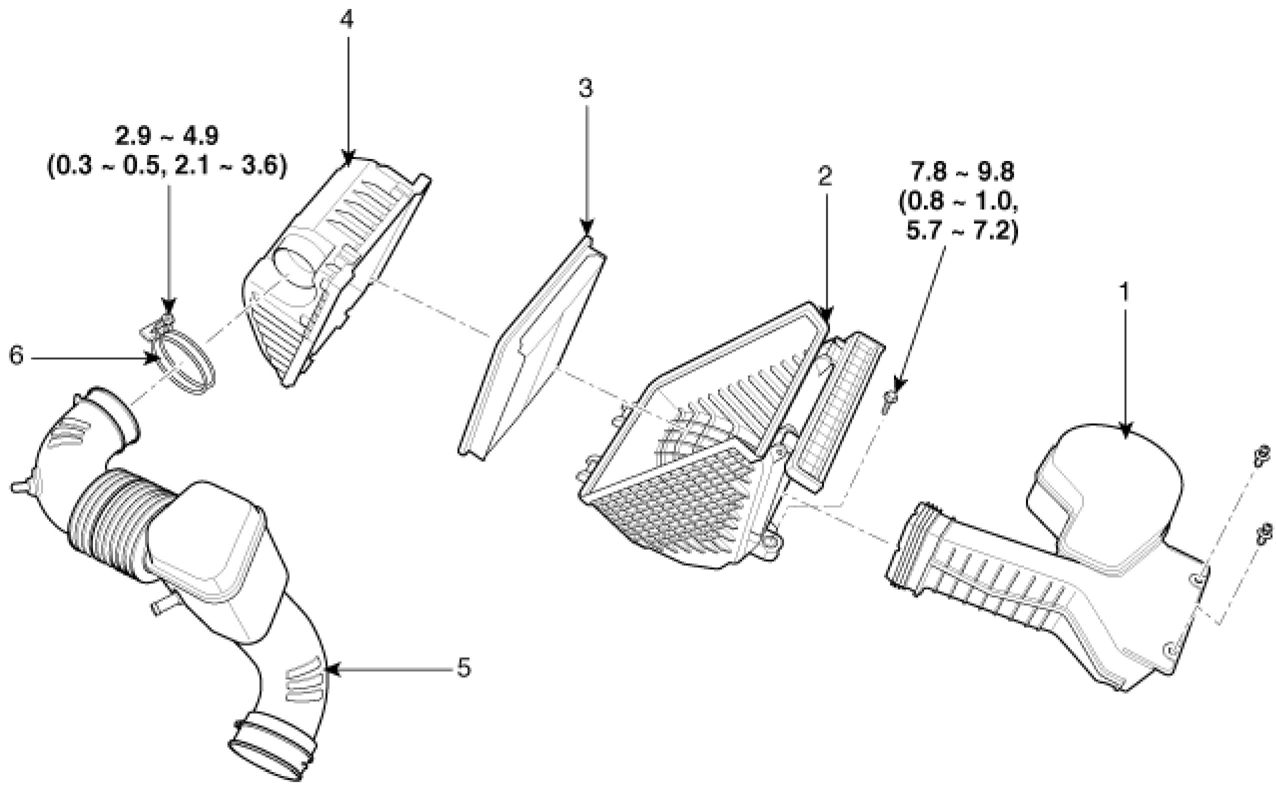
Tightening torque :
7.8 ~ 11.8 N.m (0.8 ~ 1.2 kgf.m, 5.8 ~ 8.7 lb-ft)

Install in the reverse order of removal.

Intake And Exhaust System

Air Cleaner. Components and Components Location

Components



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

1. Air duct 2. Air cleaner body 3. Air cleaner element	4. Air cleaner cover 5. Air intake hose 6. Clamp

Removal and Installation

Remove the engine cover.

Remove the air duct(A).

Remove the battery.

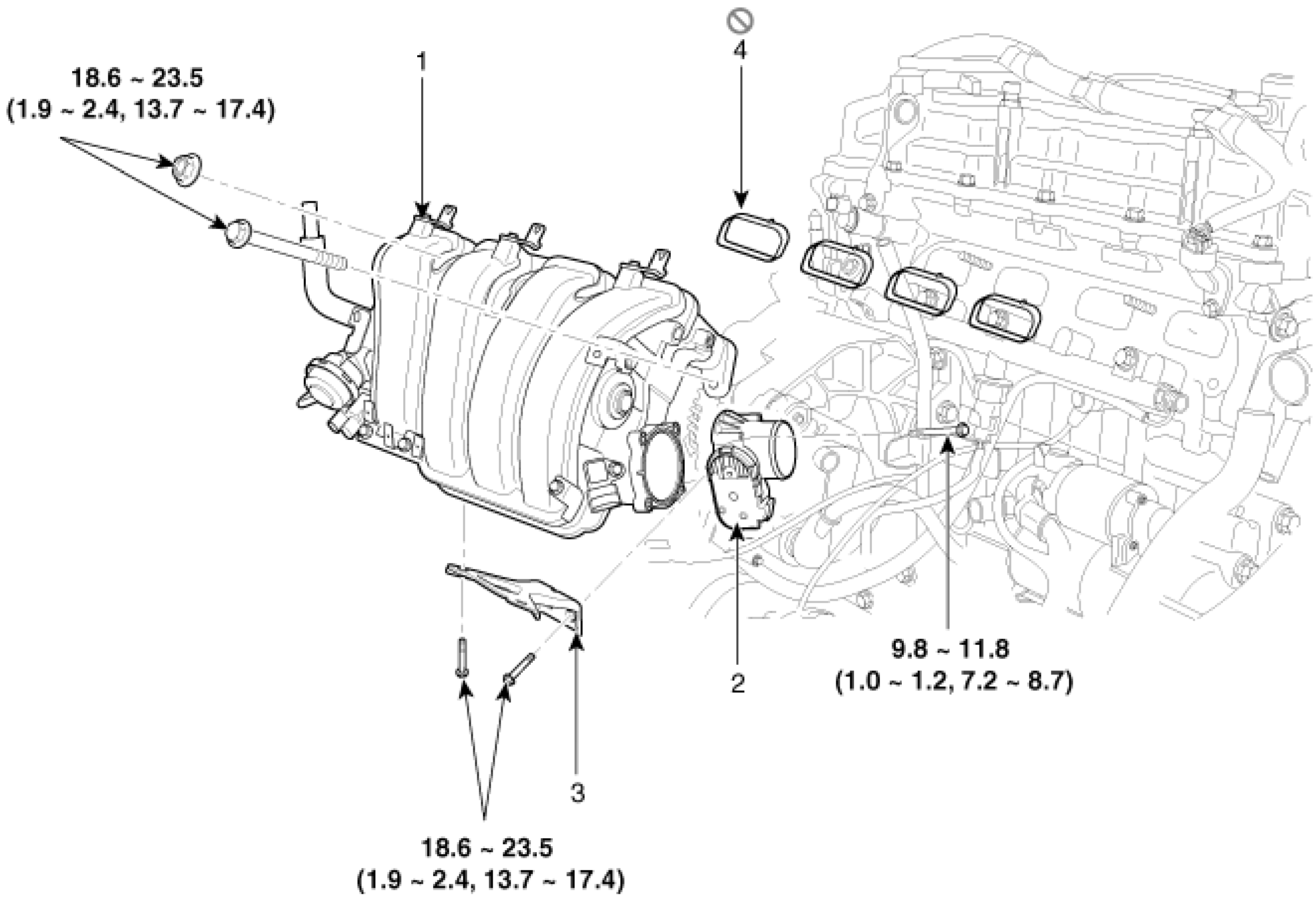
Remove the air cleaner assembly.

Disconnect the breather hose (A), the intensifier hose (B).

Disconnect the air intake hose (C) and then remove the air cleaner assembly (D).

Install in the reverse order of removal.

Components



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

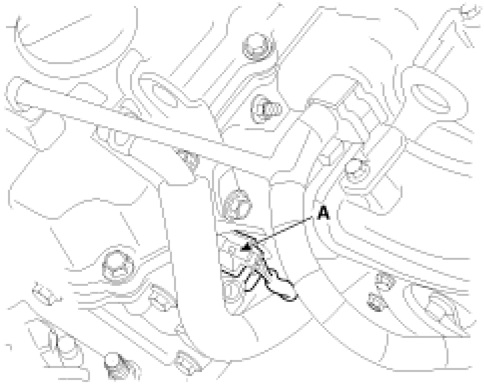
1. Intake manifold assembly 2. Electronic throttle body	3. Intake manifold stay 4. Intake manifold gasket

Removal and Installation

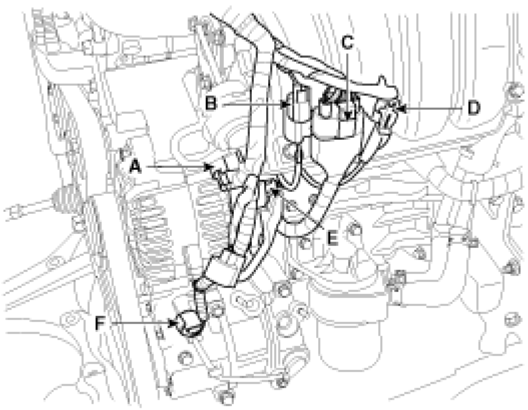
Disconnect the battery negative terminal.

Remove the air cleaner assembly.

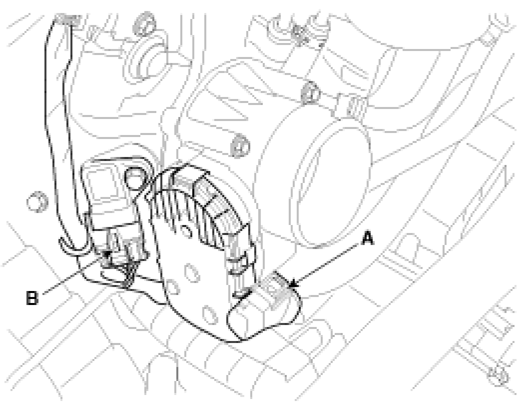
Disconnect the intake OCV (Oil control valve) connector (A).



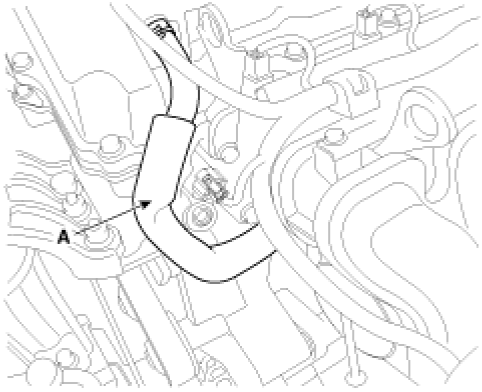
Disconnect the VIS (Variable intake system) connector (A), the OPS (Oil pressure switch) connector (B), the injector extension connector (C), the knock sensor connector (D), the alternator connector (E) and the air compressor connector (F).



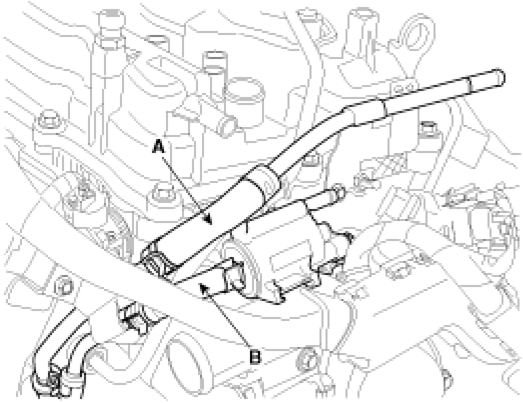
Disconnect the ETC (Electronic throttle control) connector (A) and MAPS (Manifold absolute pressure sensor) & IATS (Intake air temperature sensor) connector (B).



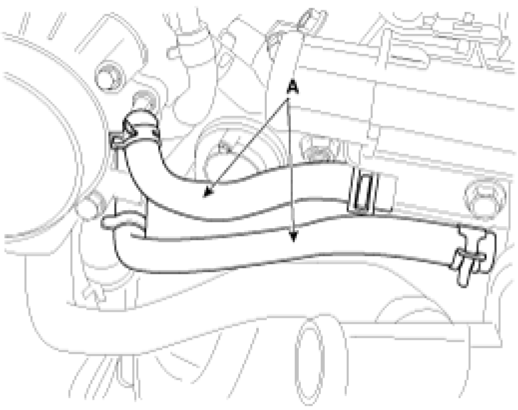
Disconnect the PCV (Positive crankcase ventilation) hose (A).



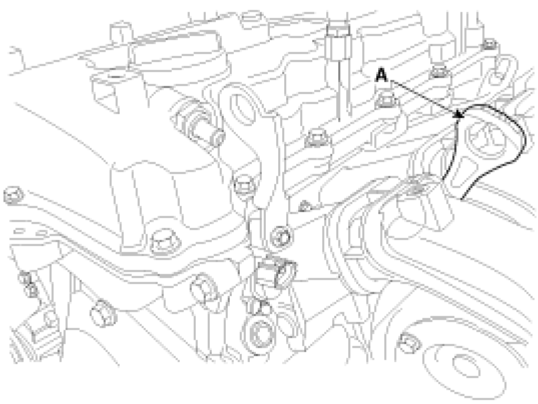
Disconnect the vacuum hose (A) and PCSV (Purge control solenoid valve) hose (B).



Disconnect the throttle body coolant hoses (A).

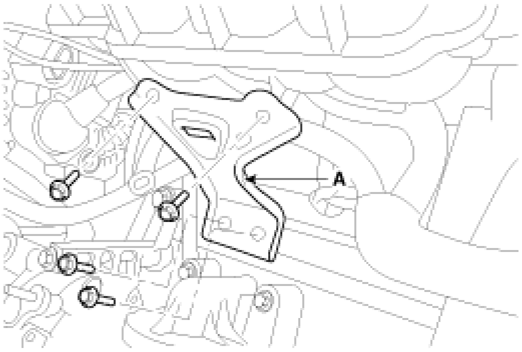


Remove the oil level gauge (A).



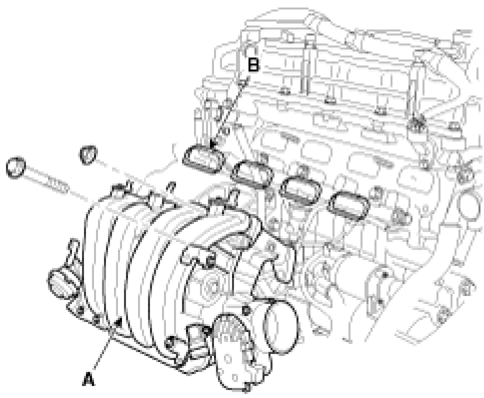
Remove the intake manifold stay (A).

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



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

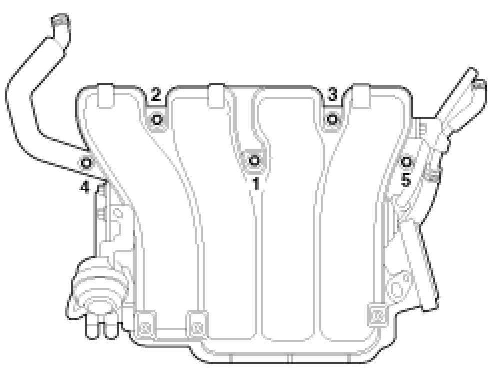
Tightening torque :
18.6 ~ 23.5 N.m (1.9 ~ 2.4 kgf.m, 13.7 ~ 17.4 lb-ft)



NOTE

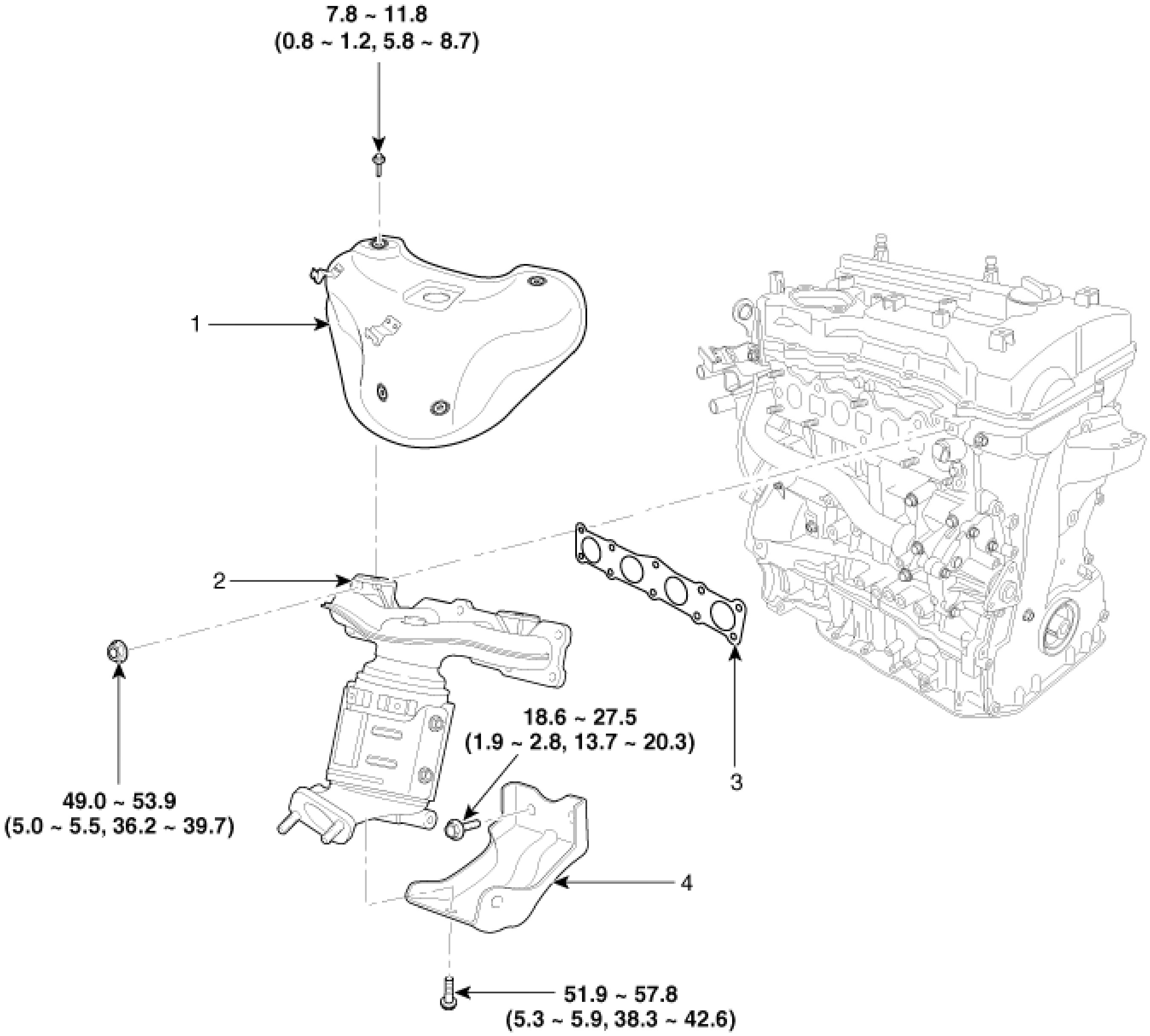
When installing, replace with new gaskets.

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



Install in the reverse order of removal.

Components



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

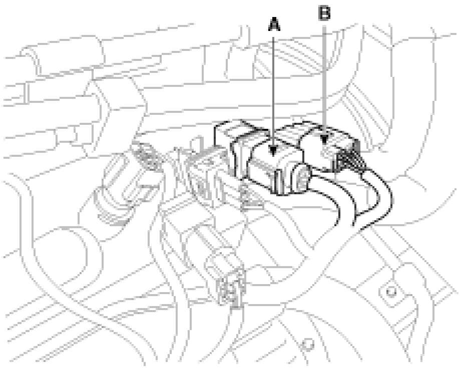
1. Heat protector 2. Exhaust manifold	3. Exhaust manifold gasket 4. Exhaust manifold stay

Removal and Installation

Remove the engine cover.

Disconnect the battery negative terminal.

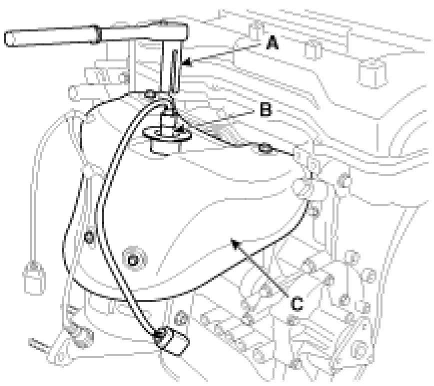
Disconnect the front oxygen sensor connector (A) and the rear oxygen sensor connector (B).



Remove the front muffler.

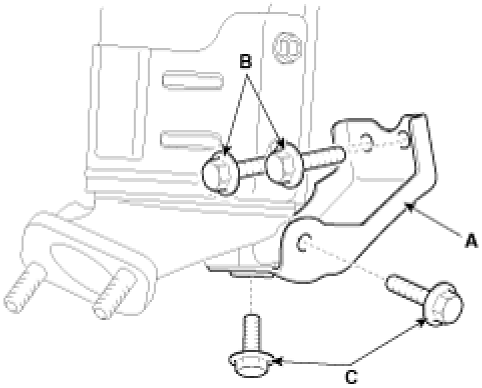
Using the SST (09392-2H100) (A), remove the front oxygen sensor (B) and the remove the exhaust manifold heat protector (C).

Tightening torque
Oxygen sensor:
39.2 ~ 49.0 N.m (4.0 ~ 5.0 kgf.m, 28.9 ~ 36.2 lb-ft)
Heat protector bolts:
7.8 ~ 11.8 N.m (0.8 ~ 1.2 kgf.m, 5.8 ~ 8.7 lb-ft)



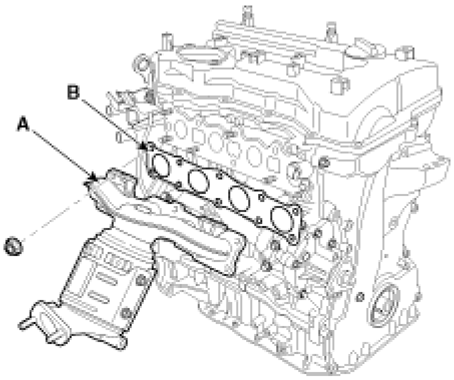
Remove the exhaust manifold stay (A).

Tightening torque :
M8 :
18.6 ~ 27.5 N.m (1.9 ~ 2.8 kgf.m, 13.7 ~ 20.3 lb-ft)
M10 :
51.9 ~ 57.8 N.m (5.3 ~ 5.9 kgf.m, 38.3 ~ 42.6 lb-ft)



Remove the exhaust manifold (A) with the gasket (B).

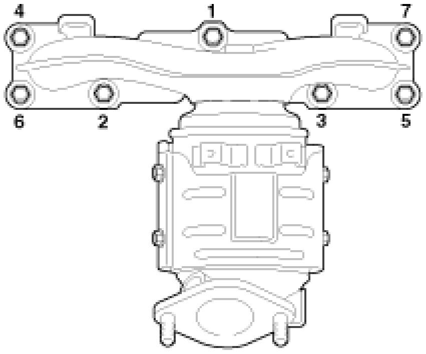
Tightening torque
49.0 ~ 53.9 N.m (5.0 ~ 5.5 kgf.m, 36.2 ~ 39.7 lb-ft)



NOTE

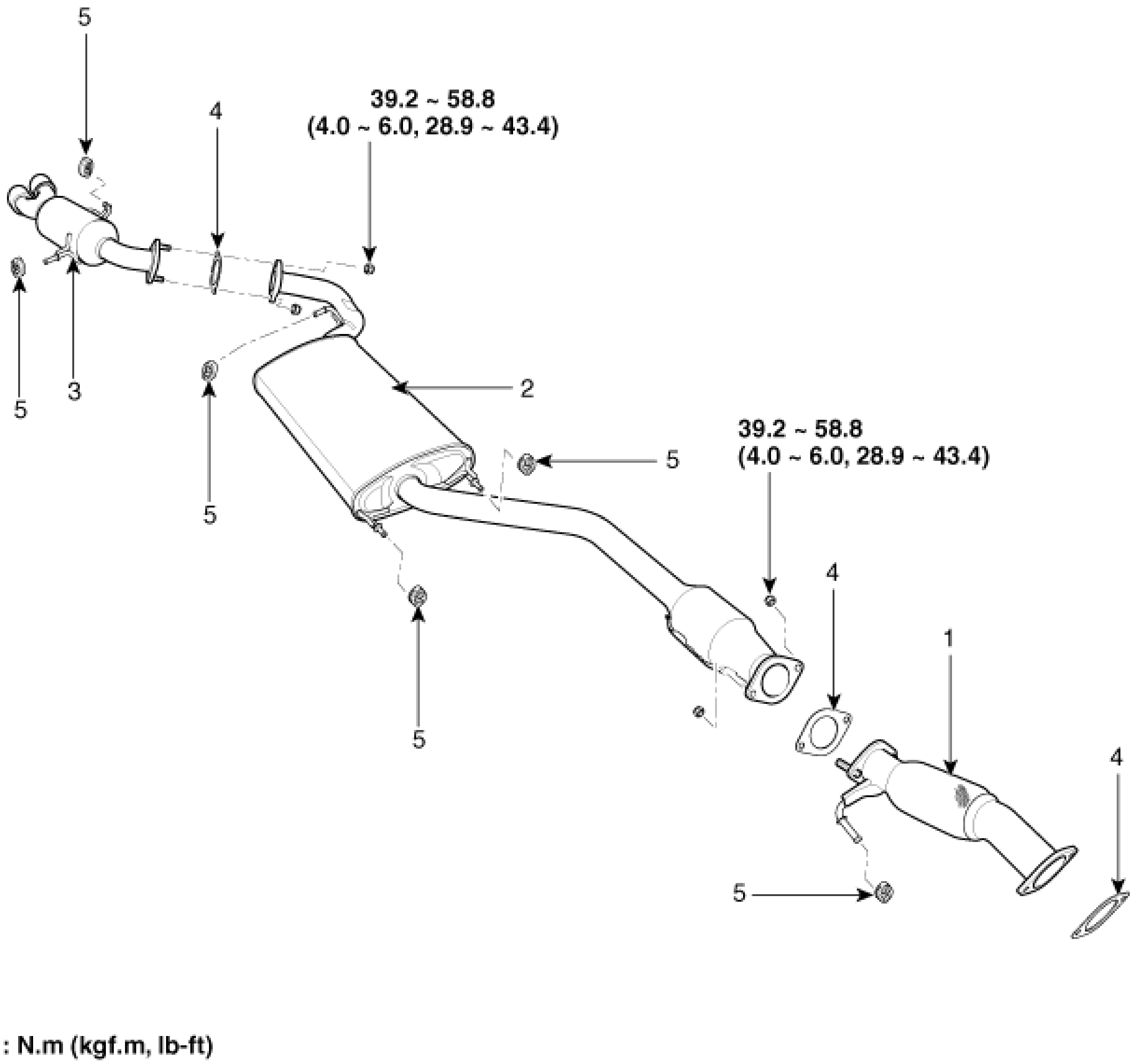
When installing, replace with a new gasket.

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



Install in the reverse order of removal.

Components

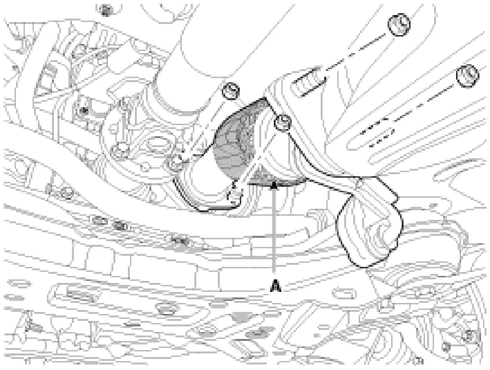


1. Front muffler 2. Catalytic converter	3. Center muffler 4. Main muffler

Removal and Installation

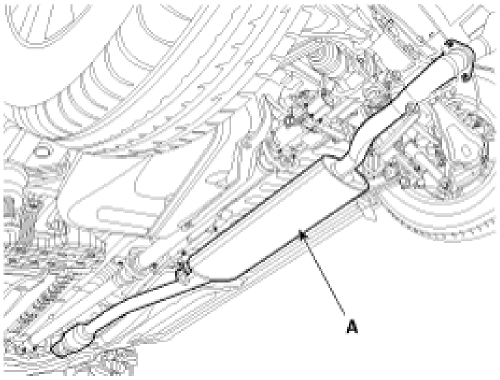
Remove the front muffler (A).

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



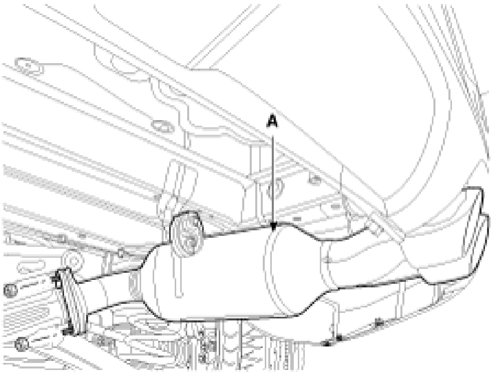
Remove the center muffler (A).

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



Remove the main muffler (A).

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



Install in the reverse order of removal.

NOTE

When installing, replace with new gaskets.

Specifications

Specifications

Ignition System

Ignition Coil

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

Spark plug

Item	Specification
Type	FXU16HR11
Gap	1.0 ~1.1 mm (0.0394 ~ 0.0433 in.)

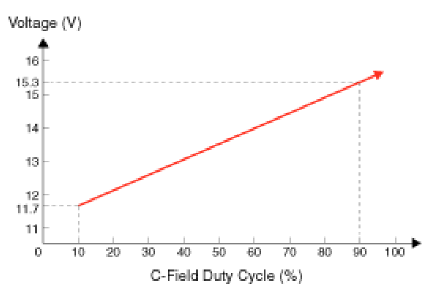
Condenser

Item	Specification
Capacitance (uF)	0.47 [1KHz]
Insulation resistance (mΩ)	1,000 [DC 500 V/1 Min]

Charging System

Alternator

Item		Specification
Rated voltage		13.5V, 130A
Speed in use		1,000 ~ 18,000 rpm
Voltage regulator		IC Regulator built-in type
Regulator Setting Voltage	External mode	Refer to below graph
	Internal mode	14.55 ± 0.3V
Temperature Gradient	External mode	0 ± 3 mV / °C
	Internal mode	-3.5 ± 2mV / °C



※ Regulator Setting Voltage (External mode)

Battery

Item	Specification
Model type	CMF68L-BCI
Capacity [20HR/5HR] (AH)	68 / 54
Cold Cranking Amperage (A)	600 (SAE) / 480 (EN)
Reserve Capacity (Min)	110

CAUTION

- Model type description

  · Battery type notation : □□□ □□ □ - □□□
  ① ② ③ ④

  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 Industric 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, 1.2 kW
The number of pinion teeth		11
Performance [No-load, 11 V]	Ampere	Max. 70 A
	Speed	Min. 2,400 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	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Alternator installation bolt	49.0 ~ 63.7	5.0 ~ 6.5	36.2 ~ 47.0
Battery (+) terminal installation nut	7.8 ~ 9.8	0.8 ~ 1.0	5.2 ~ 8.7
Battery (-) terminal l installation 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	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Starter installation bolt	49.0 ~ 63.7	5.0 ~ 6.5	36.2 ~ 47.0

Troubleshooting

Ignition System

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

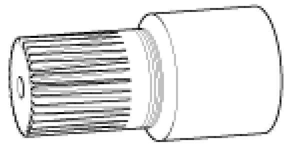
Charging System

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

Special Service Tools

Tool (Number and name)	Illustration	Use
Alternator pulley remover wrench (09373-27000)		Removal and installation of alternator pulley

Description and Operation

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.

Inspect ignition coil assembly and Perform spark test

Check for DTCs.

NOTE

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

Check if sparks occur.

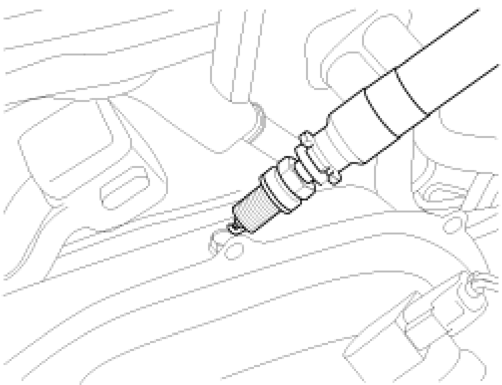
Remove the engine cover.

Remove the ignition coils.

Using a spark plug wrench, remove the spark plugs.

Disconnect the injector extension connectors.

Ground the spark plug to the engine.

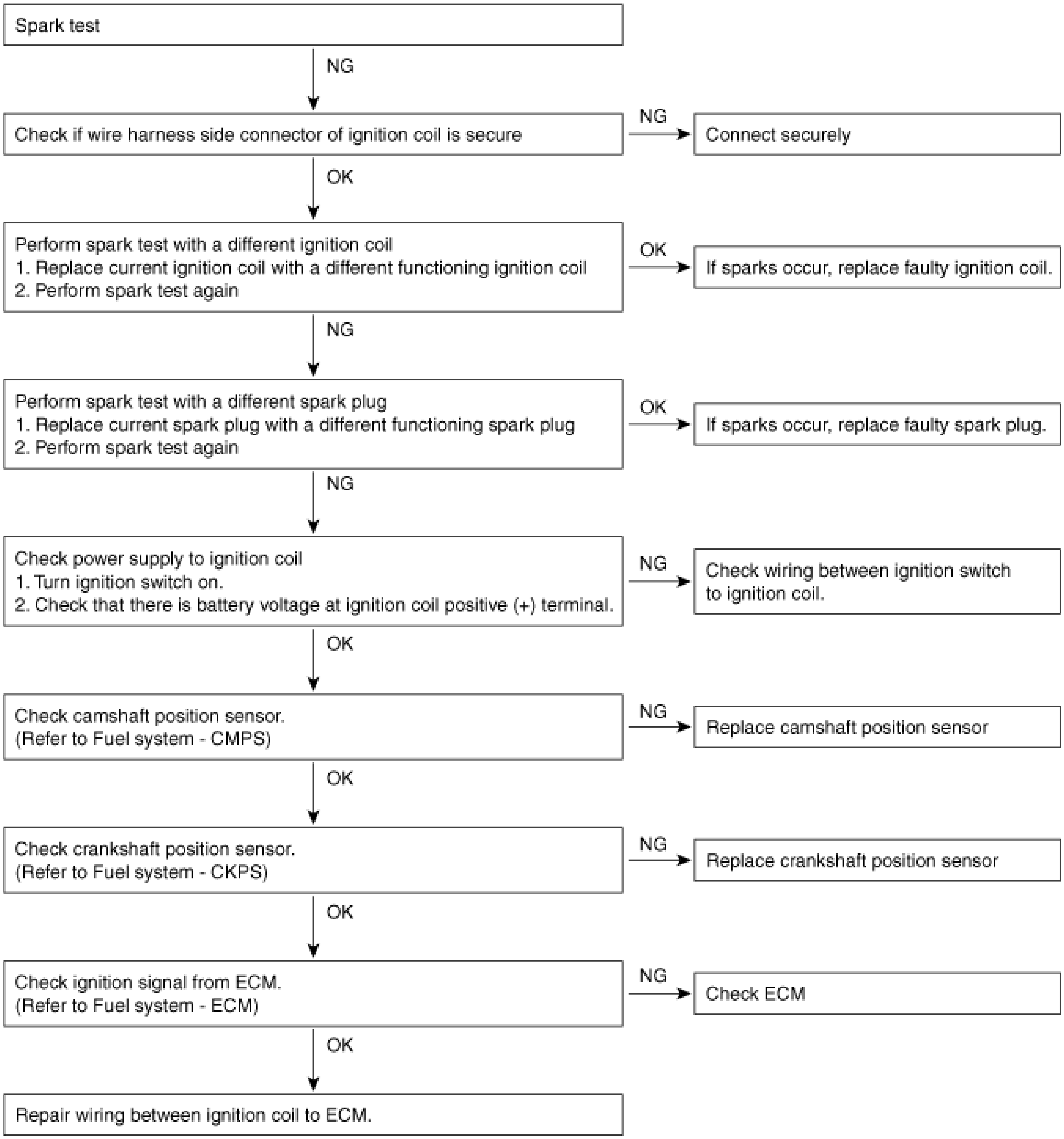


Check if sparks occur at each spark plug while engine is being cranked.

NOTE

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

If sparks do not occur, perform the following test.



Using a spark plug wrench, install spark plugs.

Install the ignition coils.

Description

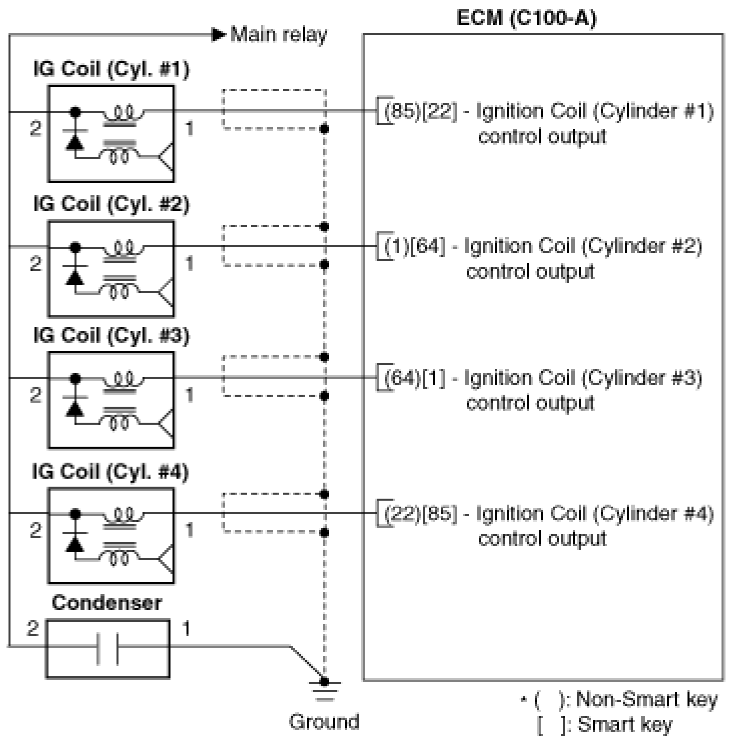
An ignition coil is an induction coil in an engine's ignition system which transforms the battery's low voltage to the high voltage needed to create an electric spark in the spark plugs to ignite the fuel. Coils have an internal resistor while others rely on a resistor wire or an external resistor to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

Specification

Item	Specification
Primary Coil Resistance (Ω)	0.79 ± 15% [20°C (68°F)]
Secondary Coil Resistance (kΩ)	7.0 ± 15% [20°C (68°F)]

Circuit Diagram

[Circuit Diagram]



* ( ): Non-Smart key
[ ]: Smart key

[Connection Information]

Ignition Coil #1 (C118-1)

Terminal	Connected to	Function
1	ECM C100-A (85)[22]	Ignition Coil #1 control
2	Main relay	Battery power (B+)

Ignition Coil #2 (C118-2)

Terminal	Connected to	Function
1	ECM C100-A (1)[64]	Ignition Coil #2 control
2	Main relay	Battery power (B+)

Ignition Coil #3 (C118-3)

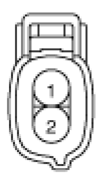
Terminal	Connected to	Function
1	ECM C100-A (64)[1]	Ignition Coil #3 control
2	Main relay	Battery power (B+)

Ignition Coil #4 (C118-4)

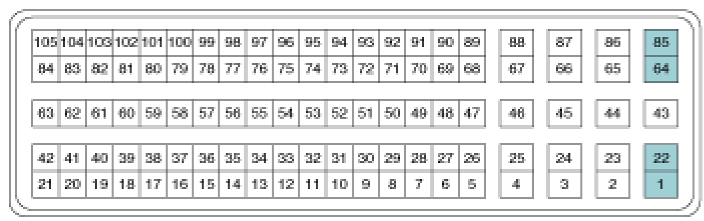
Terminal	Connected to	Function
1	ECM C100-A (22)[85]	Ignition Coil #4 control
2	Main relay	Battery power (B+)

* ( ): Non-Smart key
[ ]: Smart key

[Harness Connector]



C118-1,2,3,4
Ignition Coil #1,2,3,4



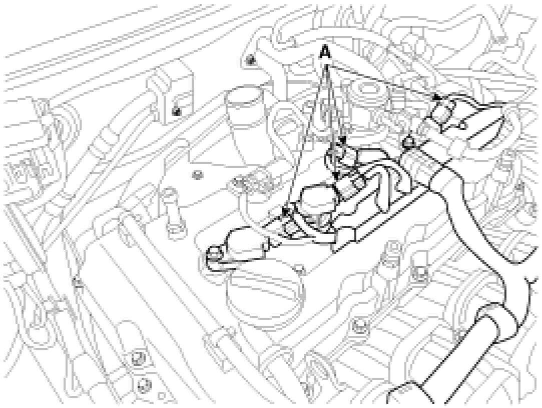
C100-A
ECM

Removal

Disconnect the battery negative terminal.

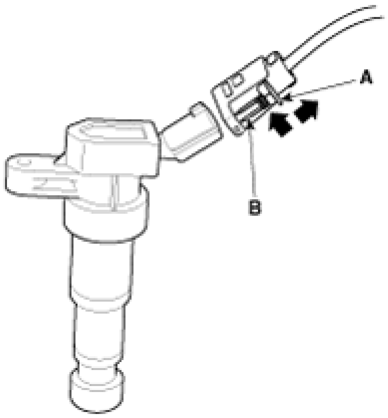
Remove the engine cover.

Disconnect the ignition coil connector (A).

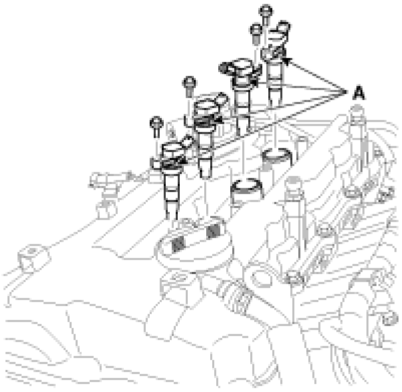


NOTE

- When removing the ignition coil connector, pull the lock pin (A) and push the clip (B).



Remove the ignition coil (A).



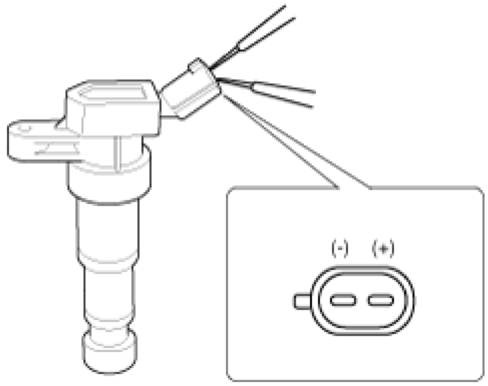
Installation

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

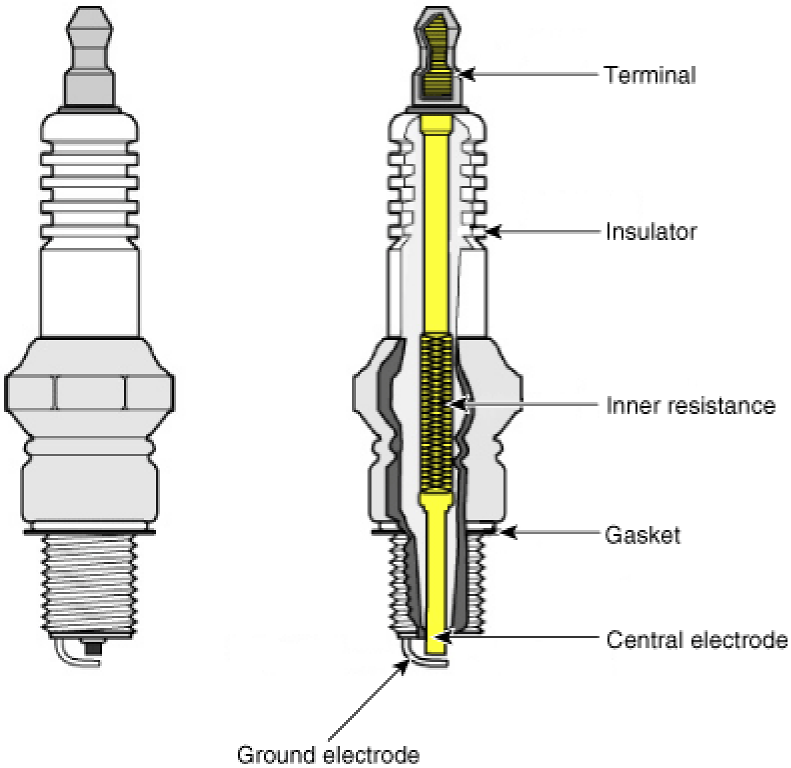
Measure the primary coil resistance between terminals (+) and (-).



Standard value: 0.62Ω ± 10%

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.



Specification

Item	Specification
Type	FXU16HR11
Gap	1.0 ~1.1 mm (0.0394 ~ 0.0433 in.)

Inspection

[On vehicle inspection]

Accelerate the engine to about 3,000 rpm 3 times or more.

Remove the spark plug.

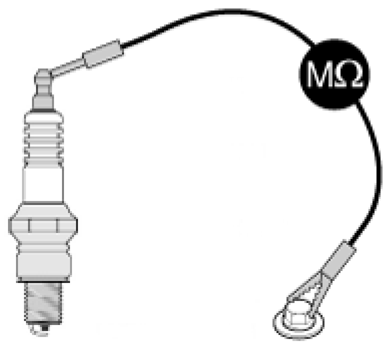
Check the spark plug visually.
If the electrode is dry, the spark plug is normal.
If the electrode is wet, check the damage and electrode gap as below.

[Component Inspection]

Check the spark plug for any damage on its thread and insulator.
If there is damage, replace the spark plug.

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 MΩ or more

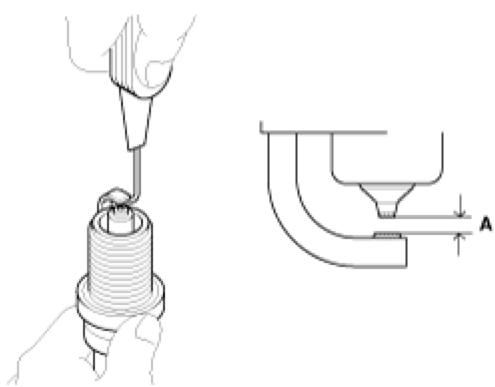


Check the spark plug electrode gap.
If the gap is greater than the maximum, replace the spark plug.

Specification: 0.7 ~ 0.8 mm (0.028 ~ 0.031 in.)

NOTE

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

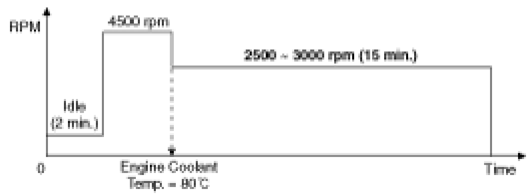
The combustion temporarily becomes unstable, due to the aged fuel and the carbon deposits accumulated on the spark plug(s) after long-term storage.

[1st Method]

Start the engine and keep the engine running at idle for 2 minutes.

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.

Keep the engine running at 2500~3000 rpm in the N position for 15 minutes.



[2nd Method]

NOTE

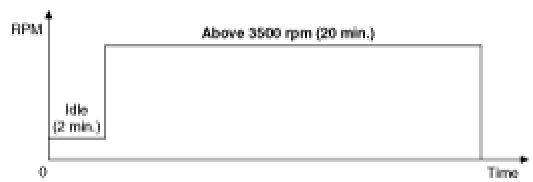
- The 2nd method should be performed only if the 1st method fails (the misfire-related codes recur).

Start the engine and keep the engine running at idle for 2 minutes.

Drive the vehicle for over 20 minutes, keeping the engine speed above 3500 rpm.

NOTE

- If equipped with manual transaxle, shift the gear properly for keeping the engine speed above 3500 rpm.



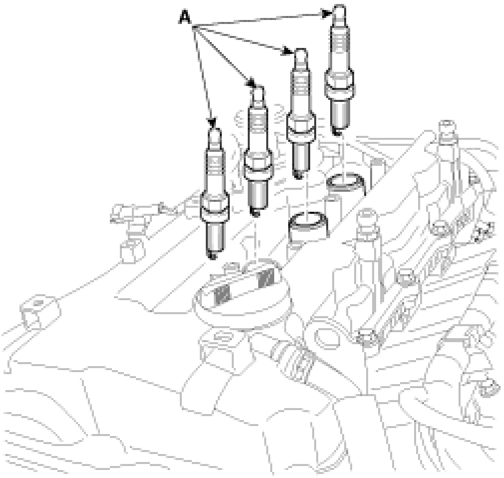
Removal

Remove the ignition coil.
(Refer to Ignition System - "Ignition Coil")

Using a spark plug wrench, remove the spark plug (A).

NOTE

- Be careful that no contaminates enter into spark plug holes.



Installation

Install in the reverse order of removal.

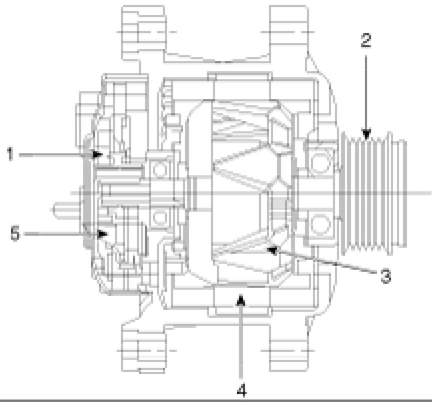
Tightening torque:
14.7 ~ 24.5 N.m (1.5 ~ 2.5 kgf.m, 10.8 ~ 18.0 lb-ft)

Charging System

Description and Operation

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 form a battery.
The system conducts charging control when decelerating a vehicle. Vehicle increases an alternator load and charges a battery.

On-vehicle Inspection

CAUTION

- 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]

Check The Battery Terminals And Fuses

Check that the battery terminals are not loose or corroded.

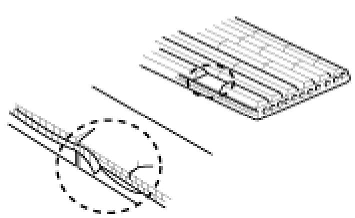
Check the fuses for continuity.

Inspect Drive Belt

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

NOTE

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



Drive belt tension measurement and adjustment
(Refer to Engine Mechanical System - "Drive Belt")

Visually Check Alternator Wiring And Listen For Abnormal Noises

Check that the wiring is in good condition.

Check that there is no abnormal noise from the alternator while the engine is running.

Check Discharge Warning Light Circuit

Warm up the engine and then turn it off.

Turn off all accessories.

Turn the ignition switch "ON". Check that the discharge warning light is lit.

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]

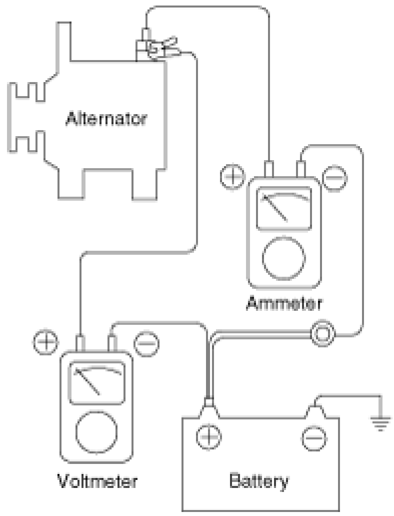
Voltage Drop Test Of Alternator Output Wire

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

Preparation

Turn the ignition switch to "OFF".

Disconnect the output wire from the alternator "B" terminal. Connect the (+) lead wire of ammeter to the "B" terminal of alternator and the (-) lead wire of ammeter to the output wire. Connect the (+) lead wire of voltmeter to the "B" terminal of alternator and the (-) lead wire of voltmeter to the (+) terminal of battery.



Test

Start the engine.

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

Result

The voltmeter may indicate the standard value.

Standard value : 0.2V max

If the value of the voltmeter is higher than expected (above 0.2V max.), poor wiring is suspected. In this case check the e wiring from the alternator "B" terminal to the battery (+) terminal. Check for loose connections, color change due to an over-heated harness, etc. Correct them before testing again.

Upon completion of the test, set the engine speed at idle.
Turn off the headlamps, blower motor and the ignition switch.

Output Current Test

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

Preparation

Prior to the test, check the following items and correct as necessary.
Check the battery installed in the vehicle to ensure that it is 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".

Turn off the ignition switch.

Disconnect the battery ground cable.

Disconnect the alternator output wire from the alternator "B" terminal.

Connect a DC ammeter (0 to 150A) in series between the "B" terminal and the disconnected output wire. Be sure to connect the (-) lead wire of the ammeter to the disconnected output wire.

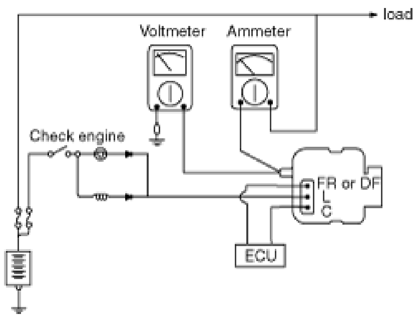
NOTE

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

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.

Attach an engine tachometer and connect the battery ground cable.

Leave the engine hood open.



Test

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.

Start the engine and turn on the headlamps.

Set the headlamps to high beam and the heater blower switch to HIGH, quickly increase the engine speed to 2,500 rpm and read the maximum output current value indicated by the ammeter.

NOTE

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

Result

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

NOTE

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

Upon completion of the output current test, lower the engine speed to idle and turn off the ignition switch.

Disconnect the battery ground cable.

Remove the ammeter and voltmeter and the engine tachometer.

Connect the alternator output wire to the alternator "B" terminal.

Connect the battery ground cable.

Regulated Voltage Test

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

Preparation

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".

Turn ignition switch to "OFF".

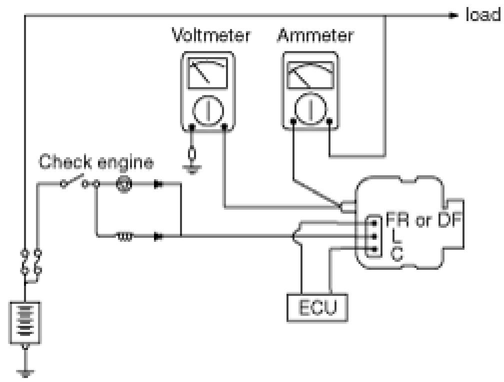
Disconnect the battery ground cable.

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.

Disconnect the alternator output wire from the alternator "B" terminal.

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.

Attach the engine tachometer and connect the battery ground cable.



Test

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.

Start the engine. Keep all lights and accessories off.

Run the engine at a speed of about 2,500 rpm and read the voltmeter when the alternator output current drops to 10A or less

Result

If the voltmeter reading doesn’t agree with the standard value, the voltage regulator or the alternator is faulty.

Upon completion of the test, reduce the engine speed to idle, and turn off the ignition switch.

Disconnect the battery ground cable.

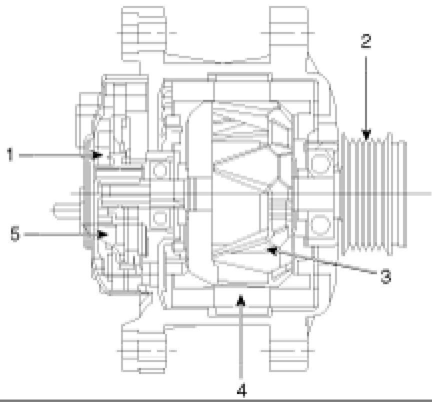
Remove the voltmeter and ammeter and the engine tachometer.

Connect the alternator output wire to the alternator "B" terminal.

Connect the battery ground cable.

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.

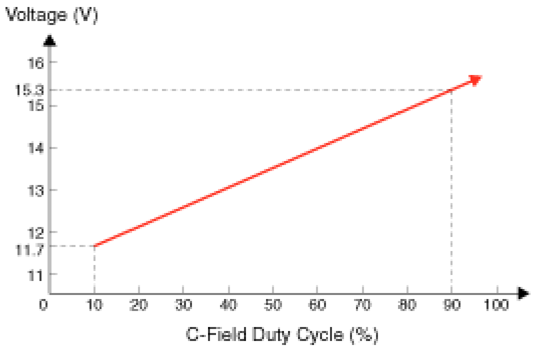


1. Brush 2. Drive belt pulley 3. Rotor 4. Stator 5. Rectifier

Specification

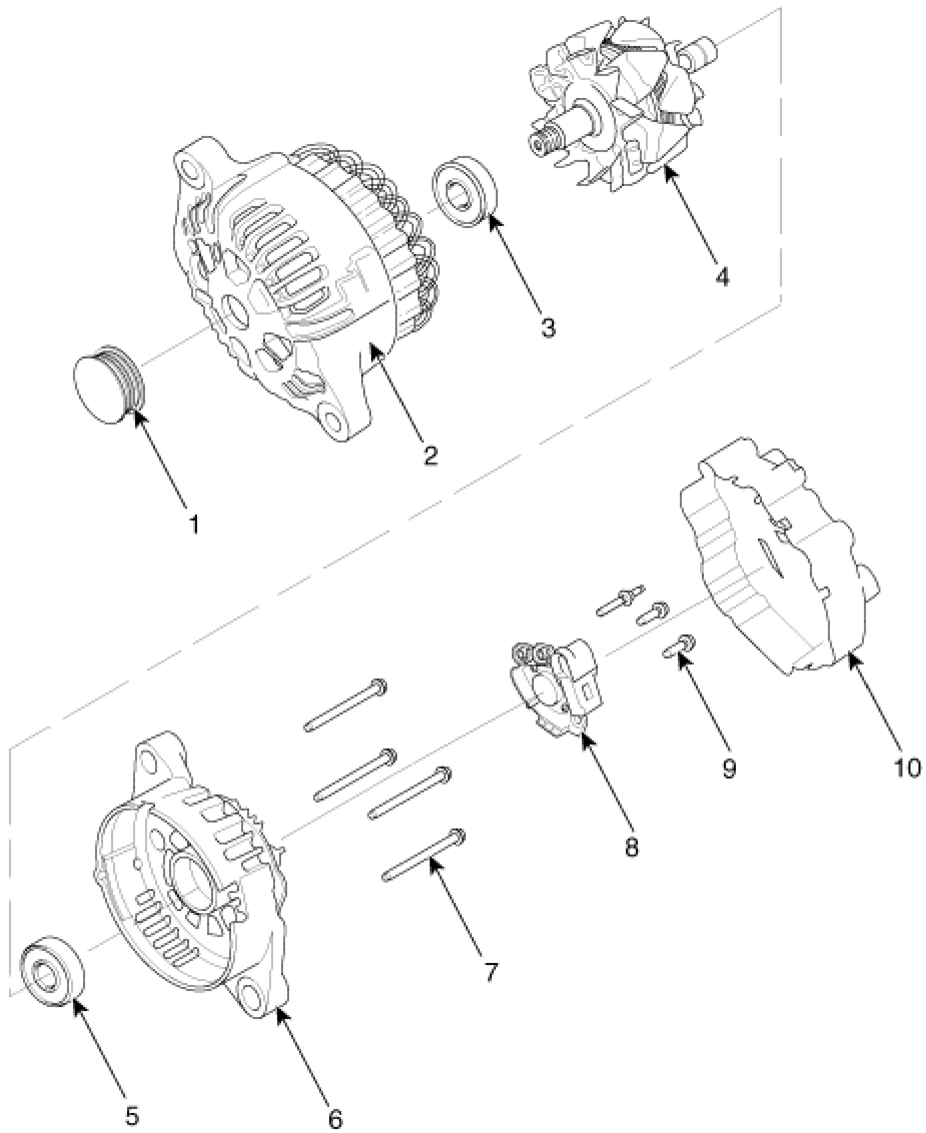
Alternator

Item		Specification
Rated voltage		13.5V, 130A
Speed in use		1,000 ~ 18,000 rpm
Voltage regulator		IC Regulator built-in type
Regulator Setting Voltage	External mode	Refer to below graph
	Internal mode	14.55 ± 0.3V
Temperature Gradient	External mode	0 ± 3 mV / °C
	Internal mode	-3.5 ± 2mV / °C



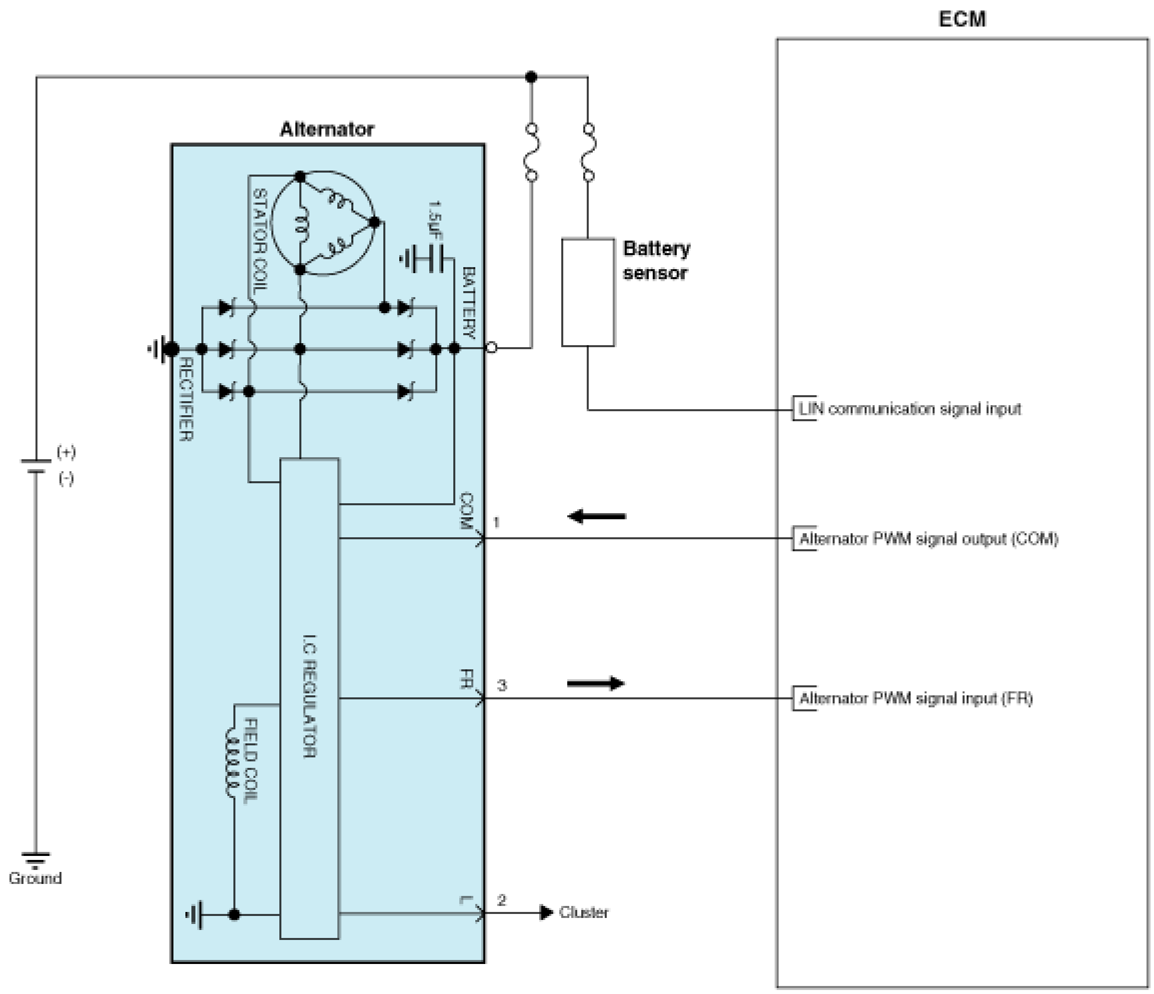
※ Regulator Setting Voltage (External mode)

Components



1. OAD (Overrunning Alternator Decouple) 2. Front bracket 3. Front bearing 4. Rotor 5. Rear bearing	6. Rear bracket 7. Through bolt 8. Regulator assembly 9. Regulator bolt 10. Rear cover

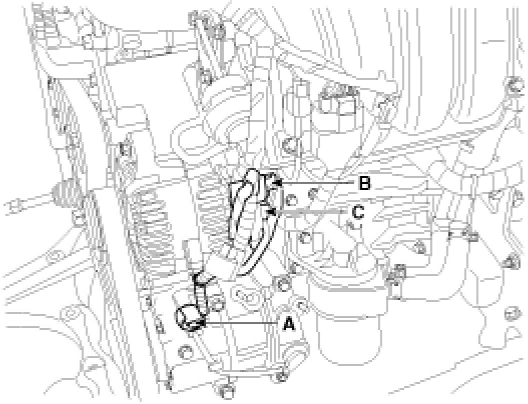
Circuit Diagram



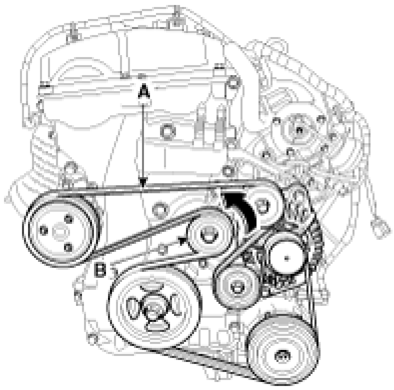
Removal

Disconnect the battery negative terminal.

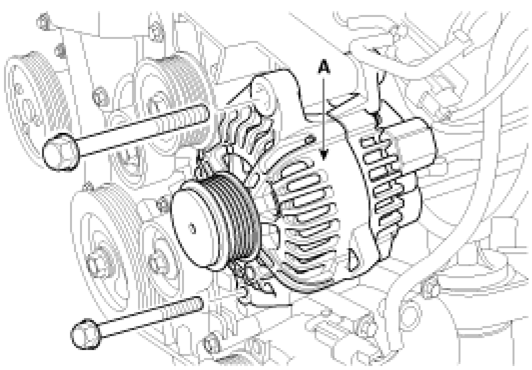
Disconnect the air compressor connector (A) and the alternator connector (B), and remove the cable from alternator "B" terminal (C).



Remove the drive belt (A) after turning the drive belt tensioner (B) counter clockwise.



Full out the through bolt and then remove the alternator (A).



Installation

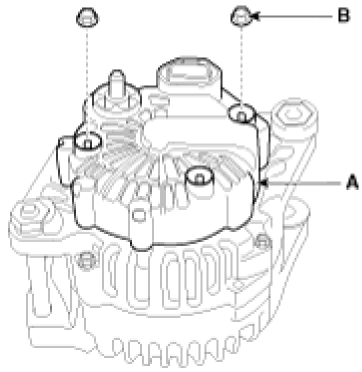
Install in the reverse order of removal.

Adjust the alternator belt tension after installation.
(Refer to Engine Mechanical System - "Drive Belt")

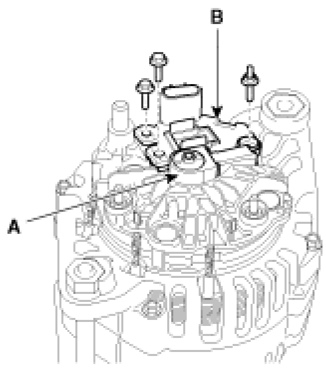
Alternator installation bolt:
49.0 ~ 63.7 N.m (5.0 ~ 6.5 kgf.m, 36.2 ~ 47.0 lb-ft)

Disassembly

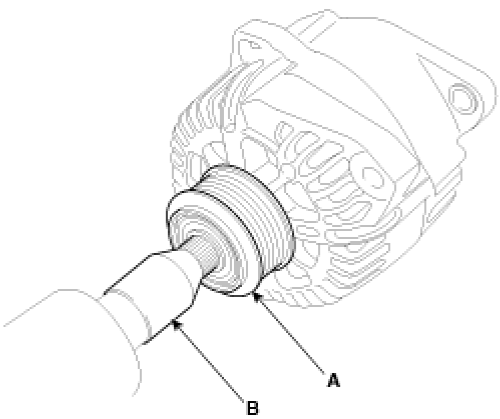
Remove the alternator cover (A) using a screw driver after loosening the nuts (B).



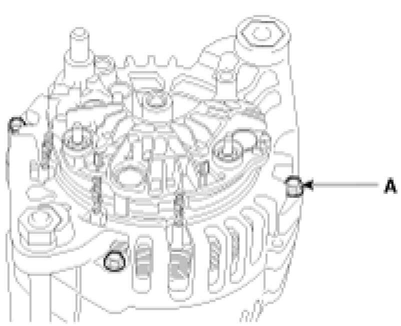
Remove the slip ring guide (A) and then loosen the mounting bolts and disconnect the brush holder assembly (B).



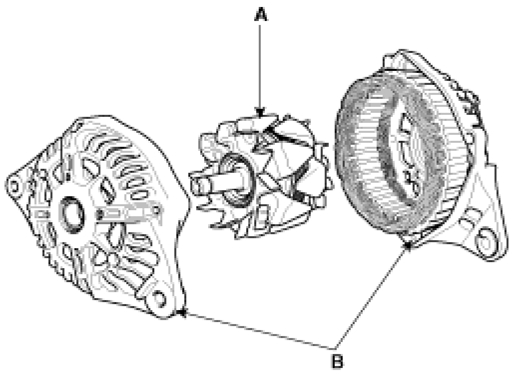
Remove the pulley (A) using the SST (09373-27000) (B).



Loosen the 4 through bolts (A).



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



Reassembly is the reverse order of disassembly.

Reassembly

Reassemble in the reverse order of disassembly.

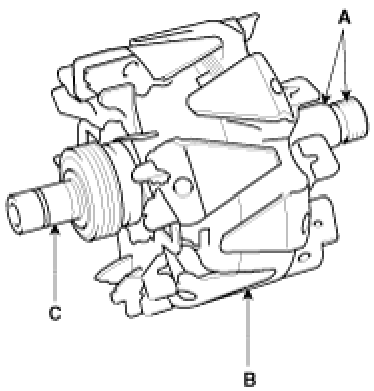
NOTE

- When reassembling OAD pulley, replace with new OAD cap.

Inspection

[Rotor]

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

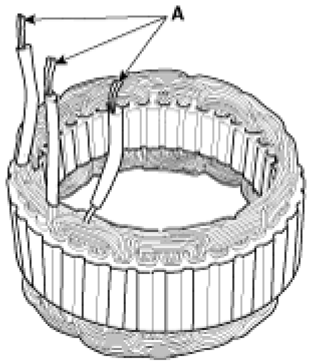


Check that there is no continuity between the slip rings and the rotor (B) or rotor shaft (A).

If the rotor fails either continuity check, replace the alternator.

[Stator]

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



Check that there is no continuity between each lead and the coil core.

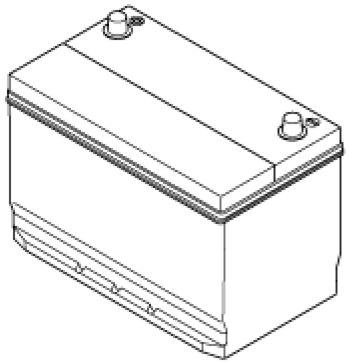
If the coil fails either continuity check, replace the alternator.

Description

The MF(Maintenance Free) battery is, as the name implies, totally maintenance free and has no removable battery cell caps.

The MF(Maintenance Free) battery does not require water replenishment for the repair.

The battery is completely sealed, except for small vent holes in the cover.



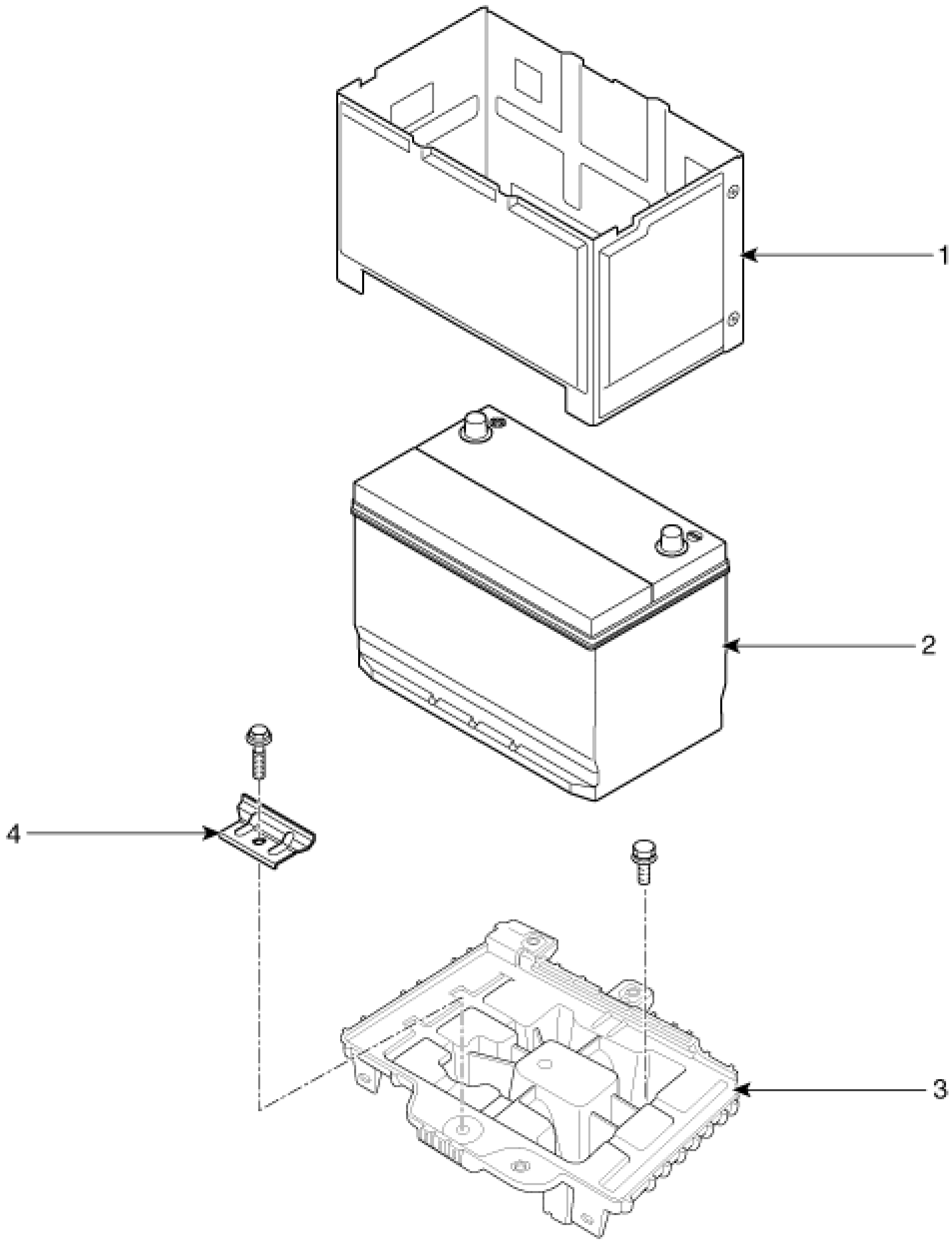
CAUTION

- After disconnecting then reconnecting the battery negative cable, reset some parts that require the reset procedures.

Specification

Item	Specification
Model type	CMF68L-BCI
Capacity [20HR/5HR] (AH)	68 / 54
Cold Cranking Amperage (A)	600 (SAE) / 480 (EN)
Reserve Capacity (Min)	110

Components

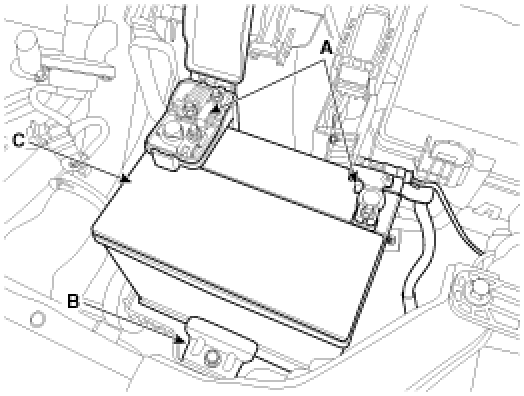


1. Battery insulation pad 2. Battery	3. Battery tray 4. Battery mounting bracket

Removal

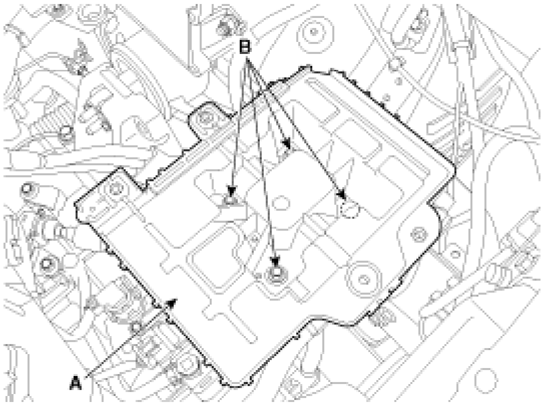
Disconnect the battery (-) terminal and (+) terminal (A).

Remove the battery mounting bracket (B) and the insulation pad and then remove the battery (C).



Remove the air cleaner.
(Refer to Engine Mechanical System - "Air Cleaner")

Remove the battery tray (A) after removing the bolts (B).



Installation

Install in the reverse order of removal.

Battery (-)terminal installation nut:
4.0 ~ 6.0 N.m (0.4 ~ 0.6 kgf.m, 3.0 ~ 4.4 lb-ft)
Battery (+)terminal installation nut:
7.8 ~ 9.8 N.m (0.8 ~ 1.0 kgf.m, 5.8 ~ 7.2 lb-ft)
Battery mounting bracket installation bolt:
8.8 ~ 13.7 N.m (0.9 ~ 1.4 kgf.m, 6.5 ~ 10.1 lb-ft)
Battery tray installation bolts:
8.8 ~ 13.7 N.m (0.9 ~ 1.4 kgf.m, 6.5 ~ 10.1 lb-ft)

NOTE

- When installing the battery, fix the mounting bracket on the tray correctly.

Vehicle parasitic current inspection

Turn the all electric devices OFF, and then turn the ignition switch OFF.

Close all doors except the engine hood, and then lock all doors.

Disconnect the hood switch connector.

Close the trunk lid.

Close the doors or remove the door switches.

Wait a few minutes until the vehicle's electrical systems go to sleep mode.

NOTE

- 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.

Connect an ammeter in series between the battery (-) terminal and the ground cable, and then disconnect the clamp from the battery (-) terminal slowly.

NOTE

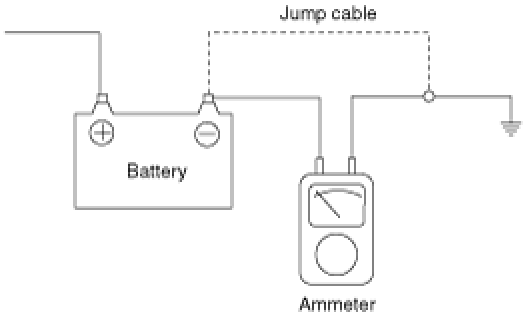
- Be careful that the lead wires of an ammeter do not come off from the battery (-) terminal and the ground cable to prevent the battery from being reset. In case the battery is reset, connect the battery cable again, and then start the engine or turn the ignition switch ON for more than 10 sec. Repeat the procedure from No. 1.
  To prevent the battery from being reset during the inspection,

Connect a jump cable between the battery (-) terminal and the ground cable.

Disconnect the ground cable from the battery (-) terminal.

Connect an ammeter between the battery (-) terminal and the ground cable.

After disconnecting the jump cable, read the current value of the ammeter.



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 component connected with the circuit one by one until the parasitic draw drops below limit value.

Limit value (after 10~20 min.) : Below 50mA

Cleaning

Make sure the ignition switch and all accessories are in the OFF position.

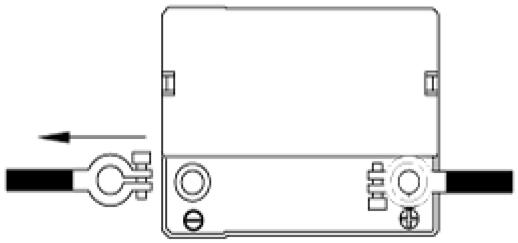
Disconnect the battery cables (negative first).

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.



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.

Clean the top of the battery with the same solution as described above.

Inspect the battery case and cover for cracks. If cracks are present, the battery must be replaced.

Clean the battery posts with a suitable battery post tool.

Clean the inside surface of the terminal clamps with a suitable battery cleaning tool. Replace damaged or frayed cables and broken terminal clamps.

Install the battery in the vehicle.

Connect the cable terminals to the battery post, making sure tops of the terminals are flush with the tops of the posts.

Tighten the terminal nuts securely.

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.

Troubleshooting

Step 1: Visual inspection
Check for obvious damage such as a cracked or broken terminal and case or cover that could permit leakage of electrolyte.
Determine the cause of damage and correct as needed.
Clean any corrosion with as solution of baking soda and water.

- NG → Replace battery
- OK ↓

Step 2: Inspect output current from a alternator
(Refer to Engine Electrical System - "Alternator")

- NG → Inspect alternator or Replace if necessary
- OK ↓

Step 3: Inspect parasitic current
- Key OFF
- Doors closed
- Hood swich OFF

10~20 minutes later

Specification: Max. 50mA

- NG → Inspect relative system wiring
- OK ↓

Step 4: Battery status test
Refer to the procedure with a micro-570 battery checker.
(For Canada only)
Refer go the procedure with a GR-8 battery tester/Diagnostic Charger.

- NG → Replace battery
- OK ↓

Battery is good in good condition

Description

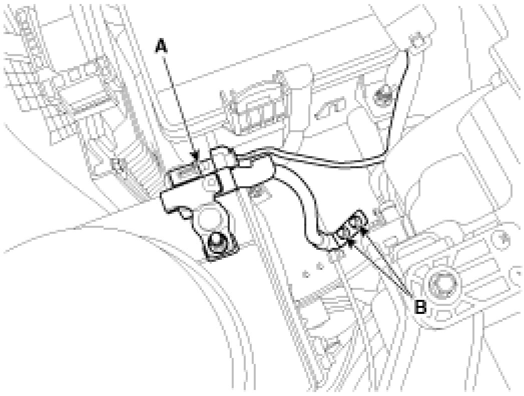
Vehicles have many control units that use more electricity. These units control their own system based on information from diverse sensors. It is important to have a stable power supply as there diverse sensors giving a variety of information. Battery sensor (A) is mounted on battery (-) terminal. It transmits battery voltage, current, temperature information to ECM. ECM controls generating voltage by duty cycle based on these signals.

Removal

Disconnect the battery negative (-) cable.

Disconnect the battery sensor connector (A).

Remove the battery negative (-) cable after removing the bolts (B).



Installation

Install in the reverse order of removal.

Battery sensor cable installation bolt:
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)
Battery (-) terminal l tightening nut:
3.9 ~ 9.9 N.m (0.4 ~ 0.6 kgf.m, 2.9 ~ 4.3 lb-ft)

NOTE

- For the vehicle equipped with a battery sensor, be careful not to damage the battery sensor when the battery is replaced or recharged.

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.

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 .

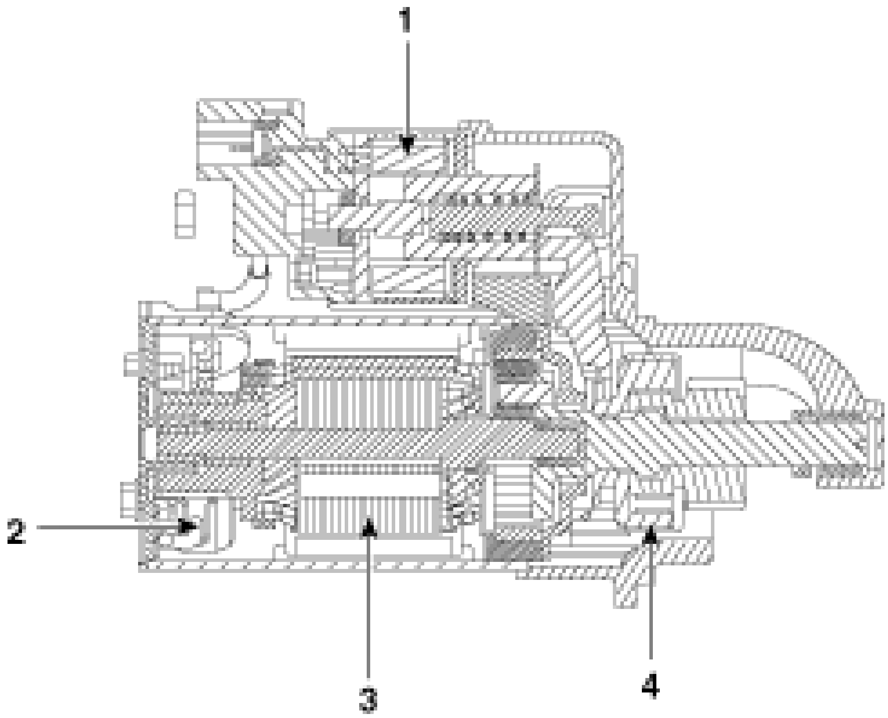
When recharging the battery, ground the negative terminal of the booster battery to the vehicle body.

Starting System

Description and Operation

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.

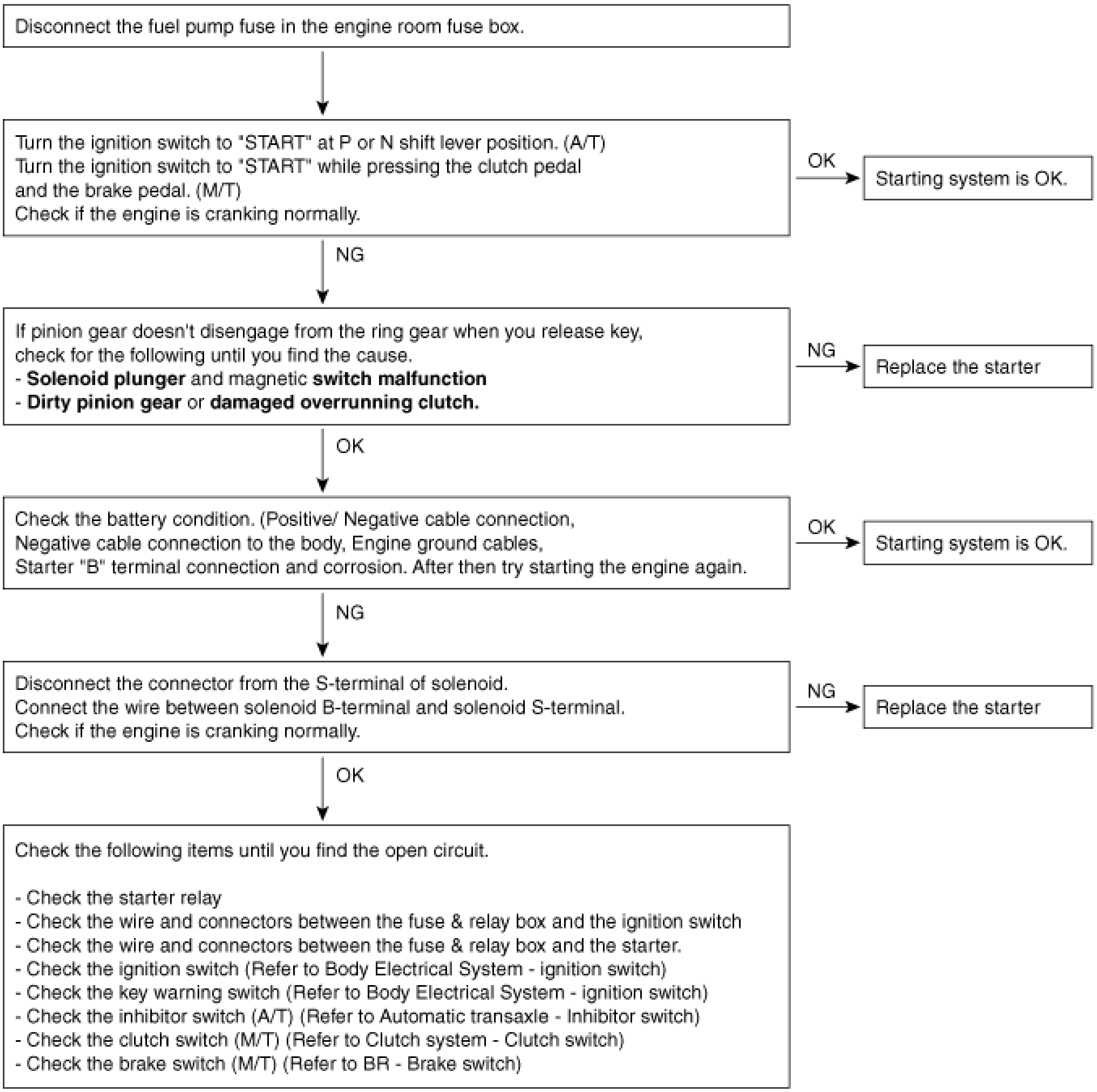


1. Solenoid 2. Brush assembly 3. Armature 4. Over running clutch

Troubleshooting

NOTE

- The battery must be in good condition and fully charged for this troubleshooting.



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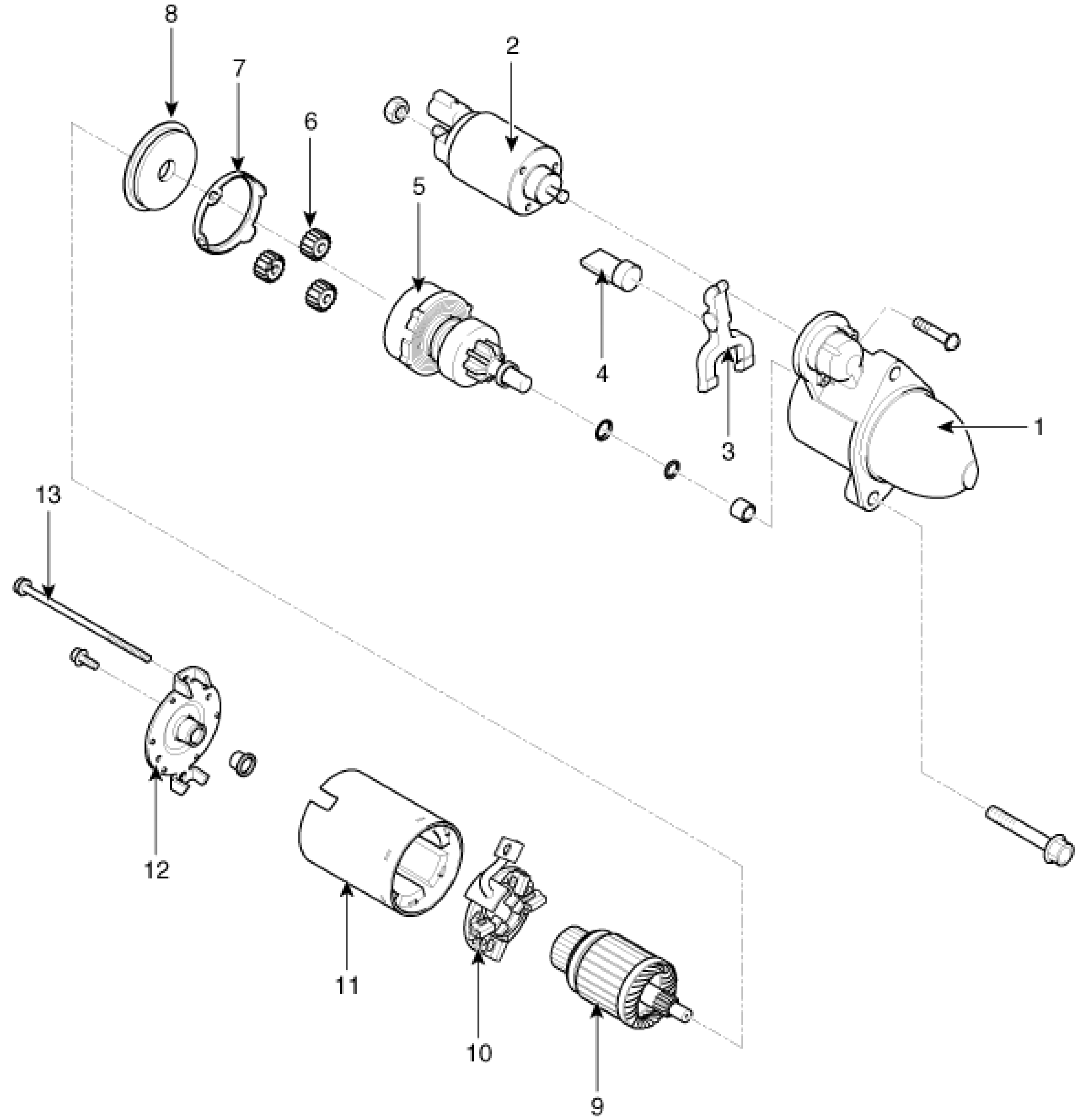
In order to prevent damage caused by excessive rotation of the starter armature when the engine starts, the clutch pinion gear overruns.

Specification

Starter

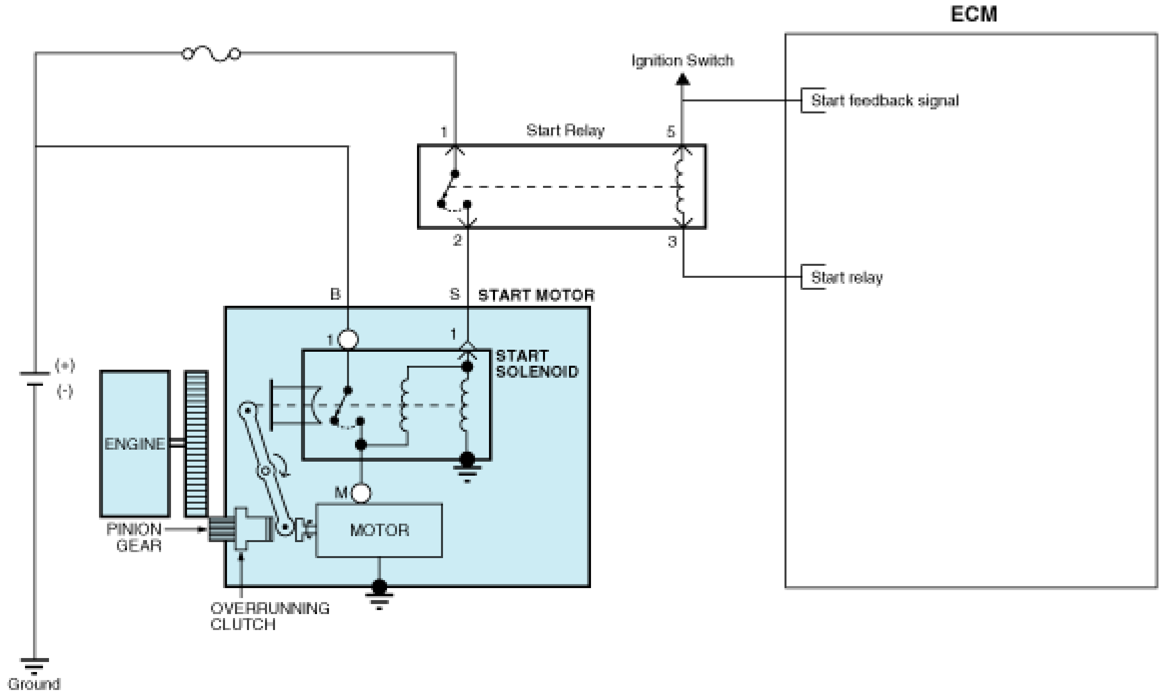
Item		Specification
Rated voltage		12 V, 1.2 kW
The number of pinion teeth		11
Performance [No-load, 11 V]	Ampere	Max. 70 A
	Speed	Min. 2,400 rpm

Components



1. Front housing 2. Starter solenoid assembly 3. Lever 4. Lever packing 5. Planet shaft assembly 6. Planetary gear assembly 7. Packing	8. Shield 9. Armature assembly 10. Brush holder assembly 11. Yoke assembly 12. Rear housing 13. Through bolt

Circuit Diagram



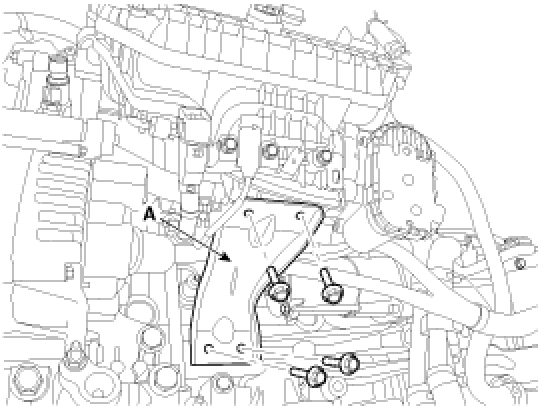
Removal

Disconnect the battery negative terminal.

Remove the air duct and air cleaner assembly.
(Refer to Engine Mechanical System - "Air Cleaner")

Remove the ETC module.
(Refer to Engine Control/Fuel System - "ETC")

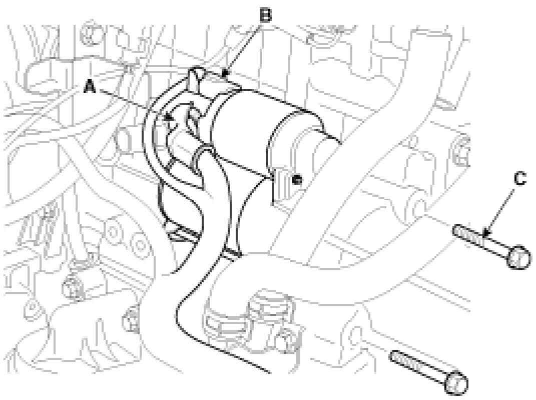
Remove the intake manifold stay (A).



Disconnect the starter cable (A) from the B terminal on the solenoid, then disconnect the connector (B) from the S terminal.

Remove the 2 bolts (C) holding the starter, then remove the starter.

Remove the 2 bolts holding the starter, then remove the starter (A).



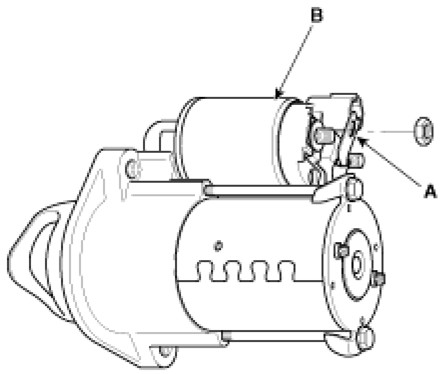
Installation

Install in the reverse order of removal.

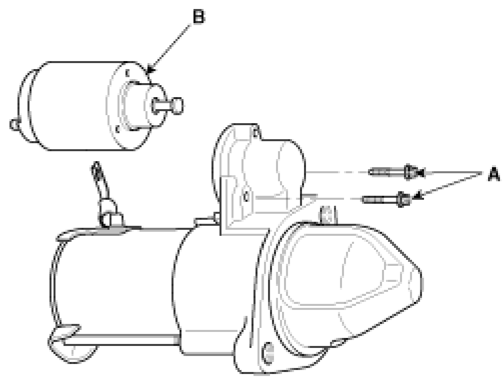
Starter installation bolt:
49.0 ~ 63.7 N.m (5.0 ~ 6.5 kgf.m, 36.2 ~ 47.0 lb-ft)

Disassembly

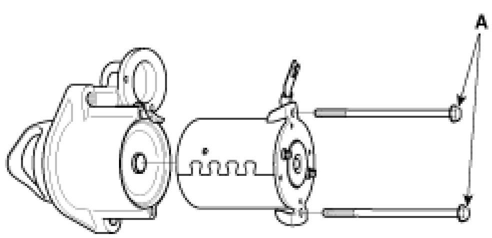
Disconnect the M-terminal (A) on the magnet switch assembly (B).



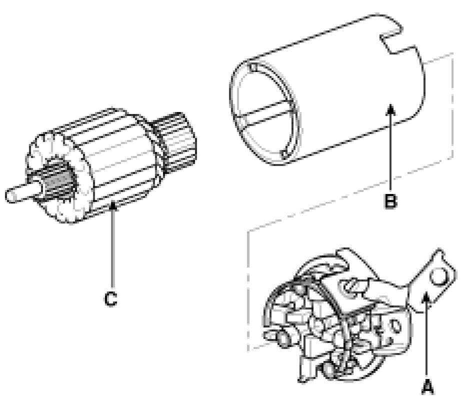
After loosening the screws (A), detach the magnet switch assembly (B).



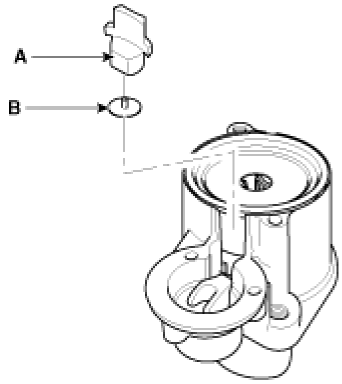
Loosen the through bolts (A).



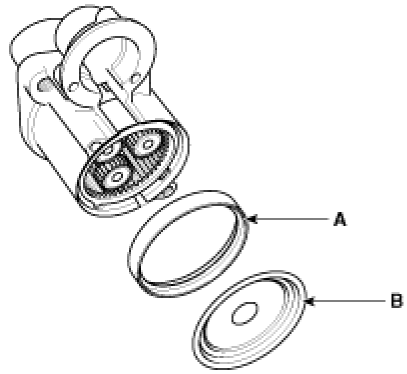
Remove the brush holder assembly (A), yoke (B) and armature (C).



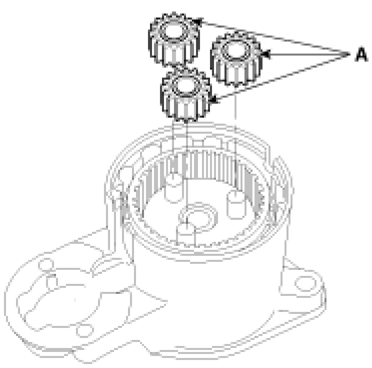
Remove the lever plate (B) and lever packing (A).



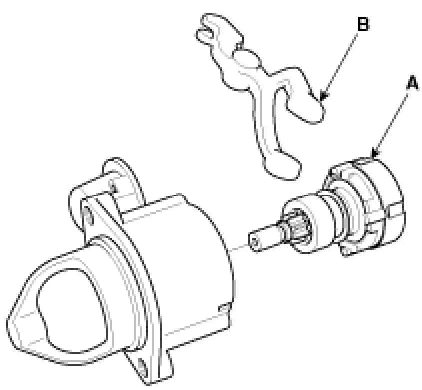
Remove the packing (A) and shield (B).



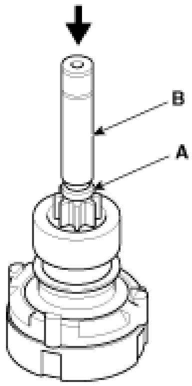
Disconnect the planet gear (A).



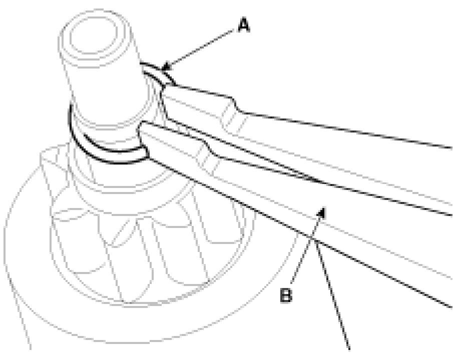
Disconnect the planet shaft assembly (or reducer assembly) (A) and lever (B).



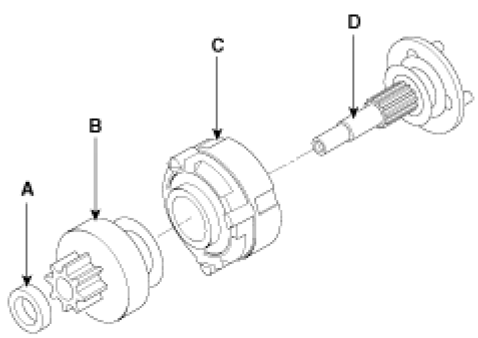
Press the stopper (A) using a socket (B).



After removing the stop ring (A) using stop ring pliers (B).



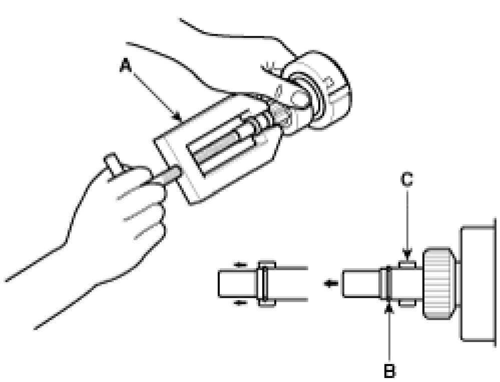
Disconnect the stopper (A), overrunning clutch (B), internal gear (C), planet shaft (D) and/or gasket sheet (E).



Reassembly is the reverse of disassembly.

NOTE

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



Reassembly

Reassemble in the reverse order of disassembly.

Inspection

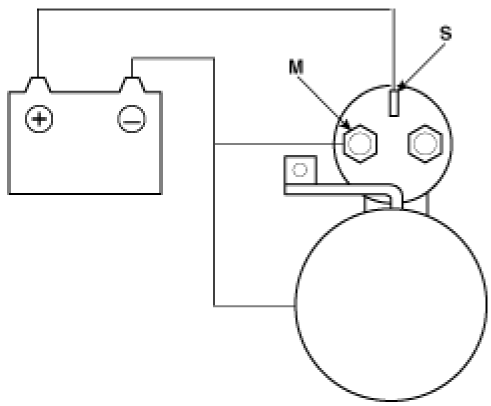
Starter Solenoid Inspection

Disconnect the lead wire from the M-terminal of solenoid switch.

Connect the battery as shown. If the starter pinion pops out, it is working properly.

NOTE

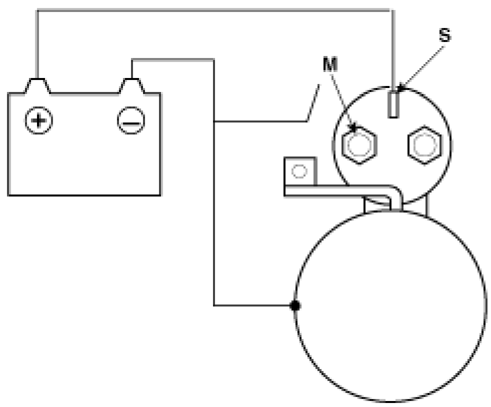
- To avoid damaging the starter, do not leave the battery connected for more than 10 seconds.



Disconnect the battery from the M terminal.
If the pinion does not retract, the hold-in coil is working properly.

NOTE

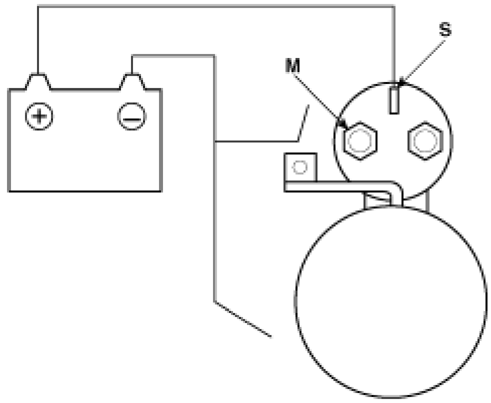
- To avoid damaging the starter, do not leave the battery connected for more than 10 seconds.



Disconnect the battery also from the body. If the pinion retracts immediately, it is working properly.

NOTE

- To avoid damaging the starter, do not leave the battery connected for more than 10 seconds.

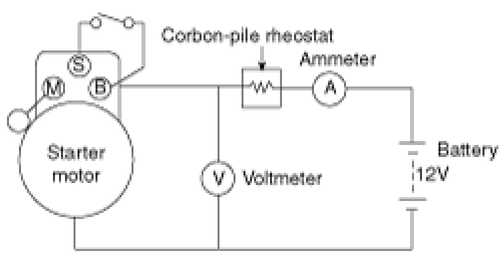


Free Running Inspection

Place the starter motor in a vise equipped with soft jaws and connect a fully-charged 12-volt battery to starter motor as follows.

Connect a test ammeter (150-ampere scale) and carbon pile rheostats shown is the illustration.

Connect a voltmeter (15-volt scale) across starter motor.



Rotate carbon pile to the off position.

Connect the battery cable from battery's negative post to the starter motor body.

Adjust until battery voltage shown on the voltmeter reads 11volts.

Confirm that the maximum amperage is within the specifications and that the starter motor turns smoothly and freely.

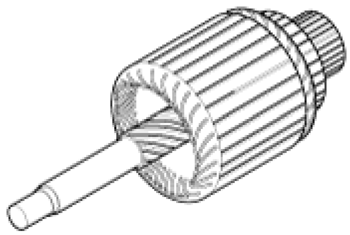
Items	Current (Max.)	Speed (Min.)
Non-ISG type	95 A	2,400 rpm

Armature

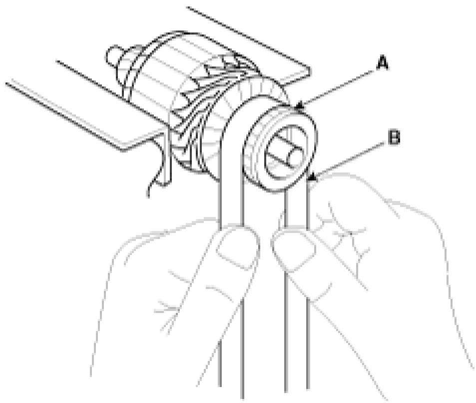
Remove the starter.

Disassemble the starter as shown at the beginning of this procedure.

Inspect the armature for wear or damage from contact with the permanent magnet. If there is wear or damage, replace the armature.

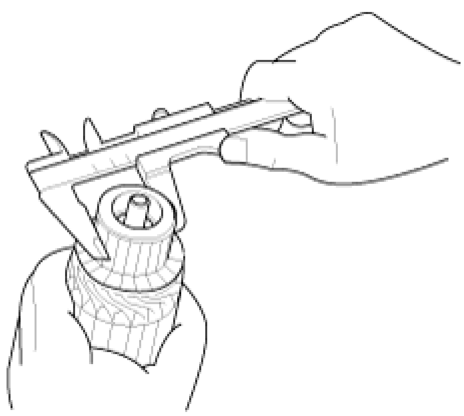


Check the commutator (A) surface. If the surface is dirty or burnt, resurface with emery cloth or a lathe within the following specifications, or recondition with #500 or #600 sandpaper (B).



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)

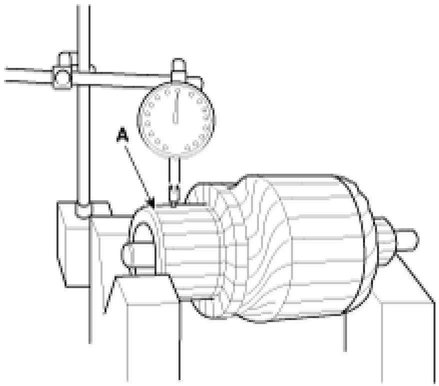


Measure the commutator (A) runout.

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

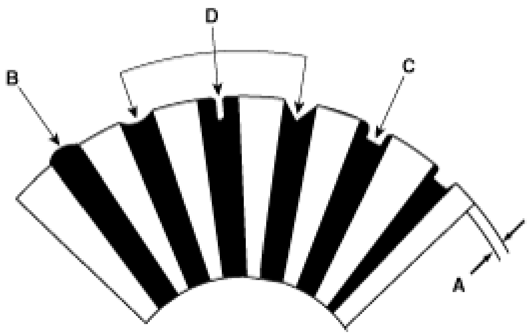
B. If the commutator run out is not within the service limit, replace the armature.

Commutator runout
Standard (New) : 0.05mm (0.0020in.) max
Service limit : 0.10mm (0.0039in.) max

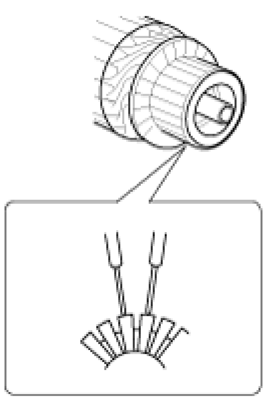


Check the mica depth (A). If the mica is too high (B), undercut the mica with a hacksaw blade to the proper depth. Cut away all the mica (C) between the commutator segments. The undercut should not be too shallow, too narrow, or v-shaped (D).

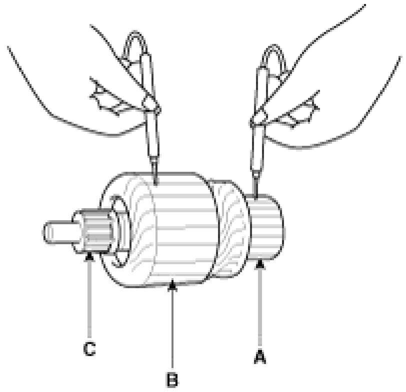
Commutator mica depth
Standard (New) : 0.5 mm (0.0197 in.)
Limit : 0.2mm (0.0079 in.)



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



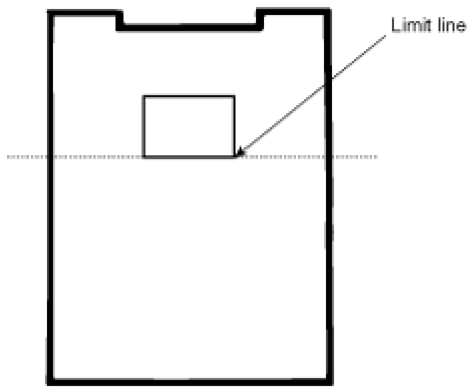
Check with an ohmmeter that no continuity exists between the commutator (A) and armature coil core (B), and between the commutator and armature shaft (C). If continuity exists, replace the armature.



Starter Brush

Brushes that are worm out, or oil-soaked, should be replaced.

Bruch length
Standard : 12.3 mm (0.4843 in)
Service limit : 5.5 mm (0.2165 in)

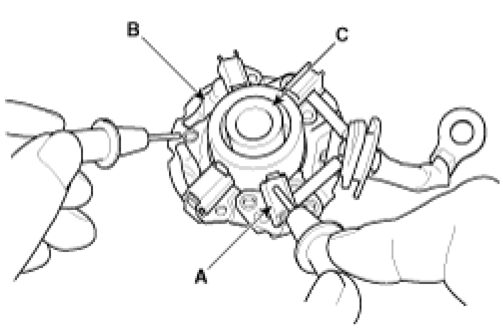


NOTE

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

Starter Brush Holder

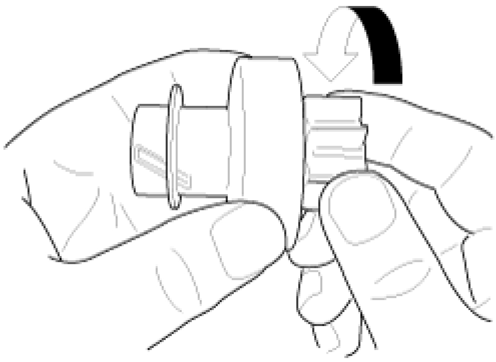
Check that there is no continuity between the (+) brush holder (A) and (-) plate (B).
If there is continuity, replace the brush holder assembly.



Overrunning Clutch

Slide the overrunning clutch along the shaft.
Replace it if does not slide smoothly.

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 of it locks in both directions, replace it.



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

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.

Do not immerse the drive unit in cleaning solvent.
The overrun clutch is pre-lubricated at the factory and sol-vent will wash lubrication from the clutch.

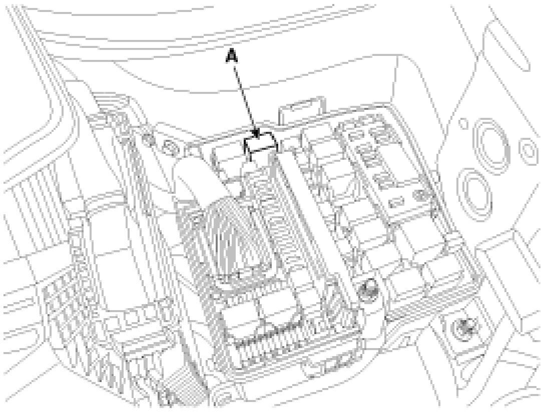
The drive unit may be cleaned with a brush moistened with cleaning solvent and wiped dry with a cloth.

Inspection

Disconnect the battery negative terminal.

Remove the fuse box cover.

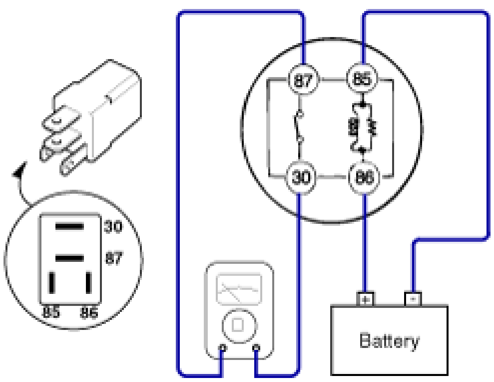
Remove the starter relay(A).



Using an ohmmeter, check that there is continuity between each terminal.

Terminal	Continuity
30 - 87	NO
85 - 86	YES

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



If there is no continuity, replace the starter relay.

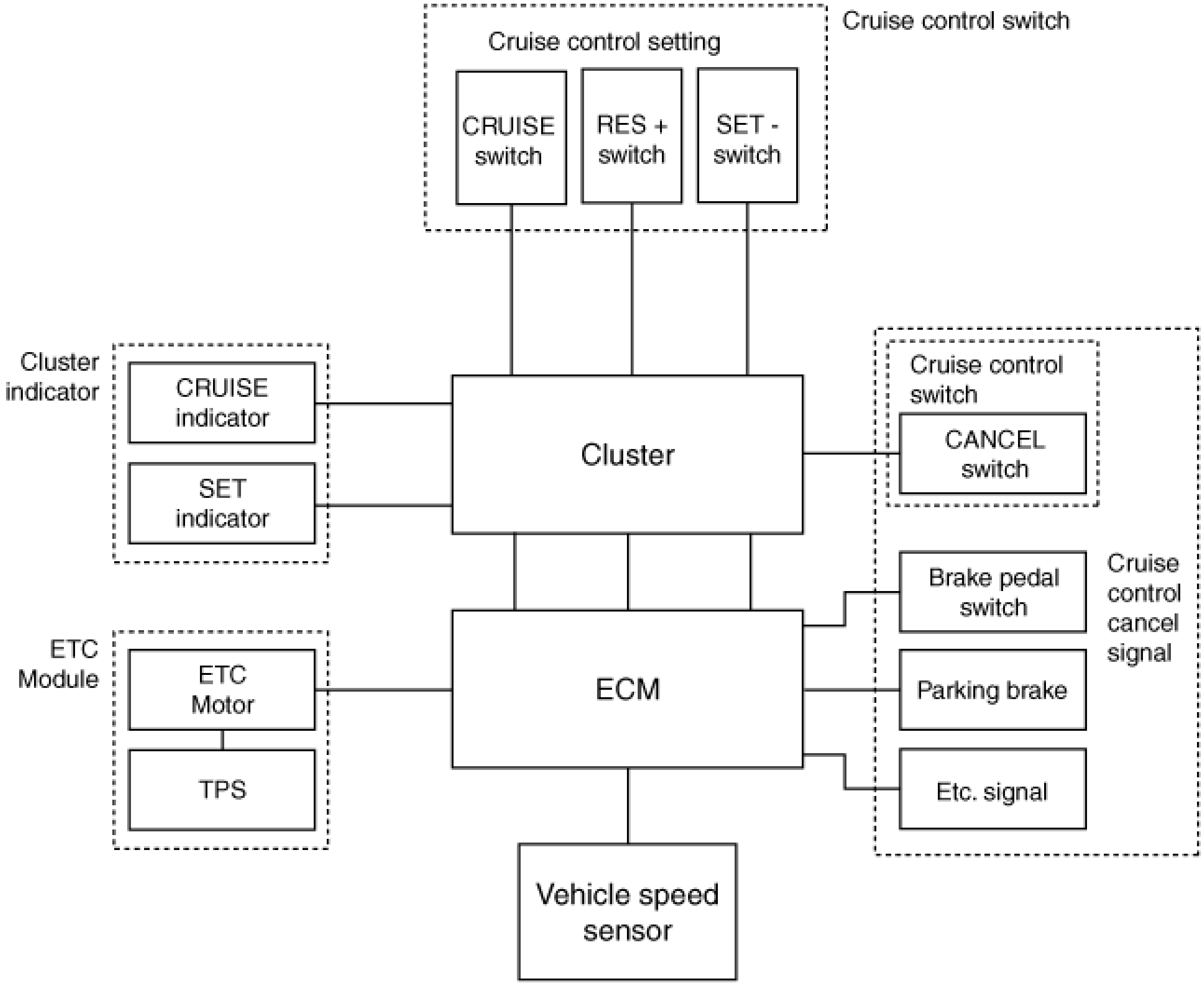
Install the starter relay.

Install the fuse box cover.

Cruise Control System

Schematic Diagrams

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)	
ETC motor		Regulates the throttle valve to the set opening by ECM.

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 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).

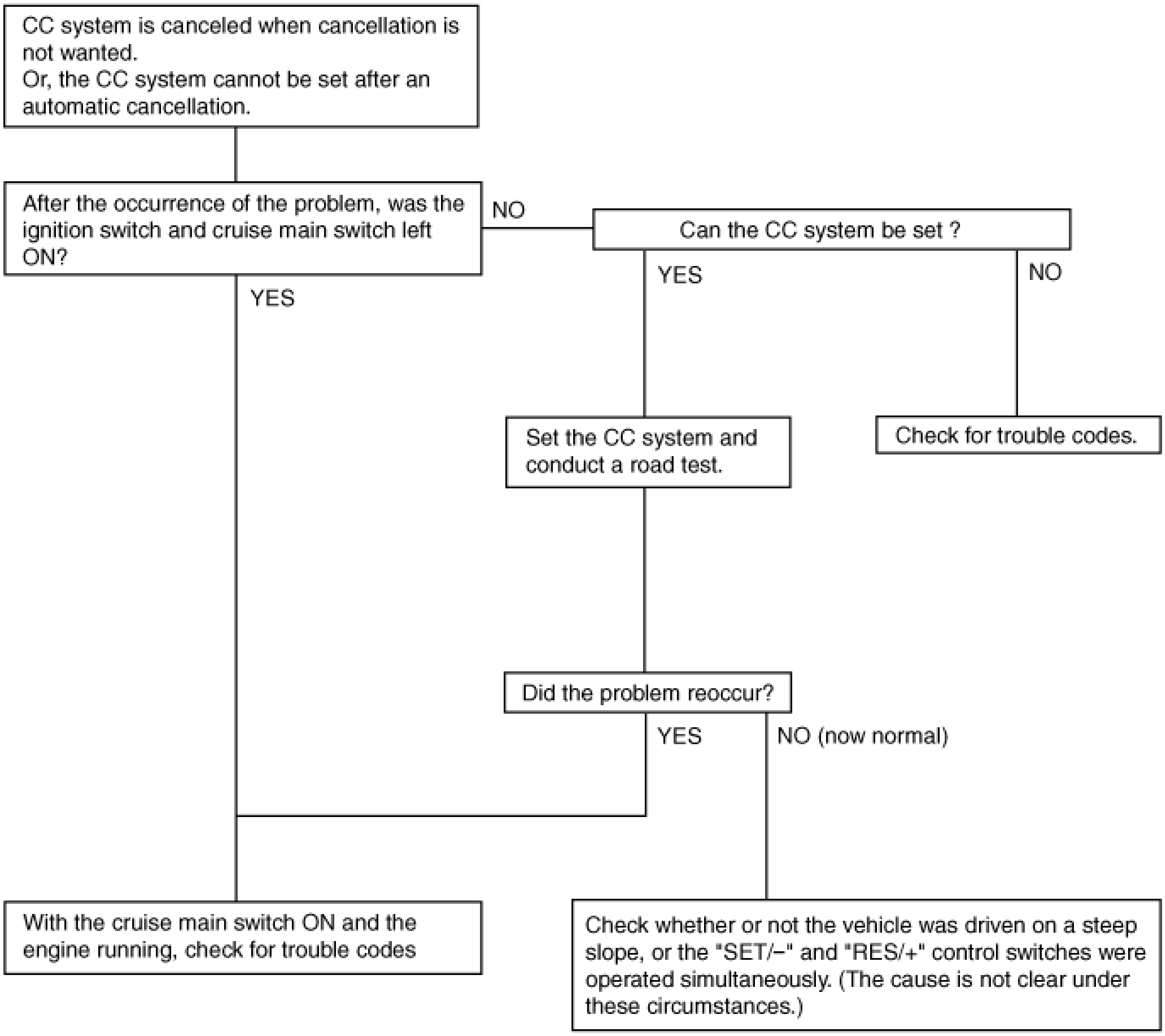
Resume/Accel switch (RES/+)

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.

Trouble Symptom 1



CC : Cruise Control
ECM : Engine Control Module

Trouble Symptom 2

Trouble symptom	Probable cause	Remedy
The set vehicle speed varies greatly upward or downward "Surging" (repeated alternating acceleration and deceleration) occurs after setting	Malfunction of the vehicle speed sensor circuit	Repair the vehicle speed sensor system, or replace the part
	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

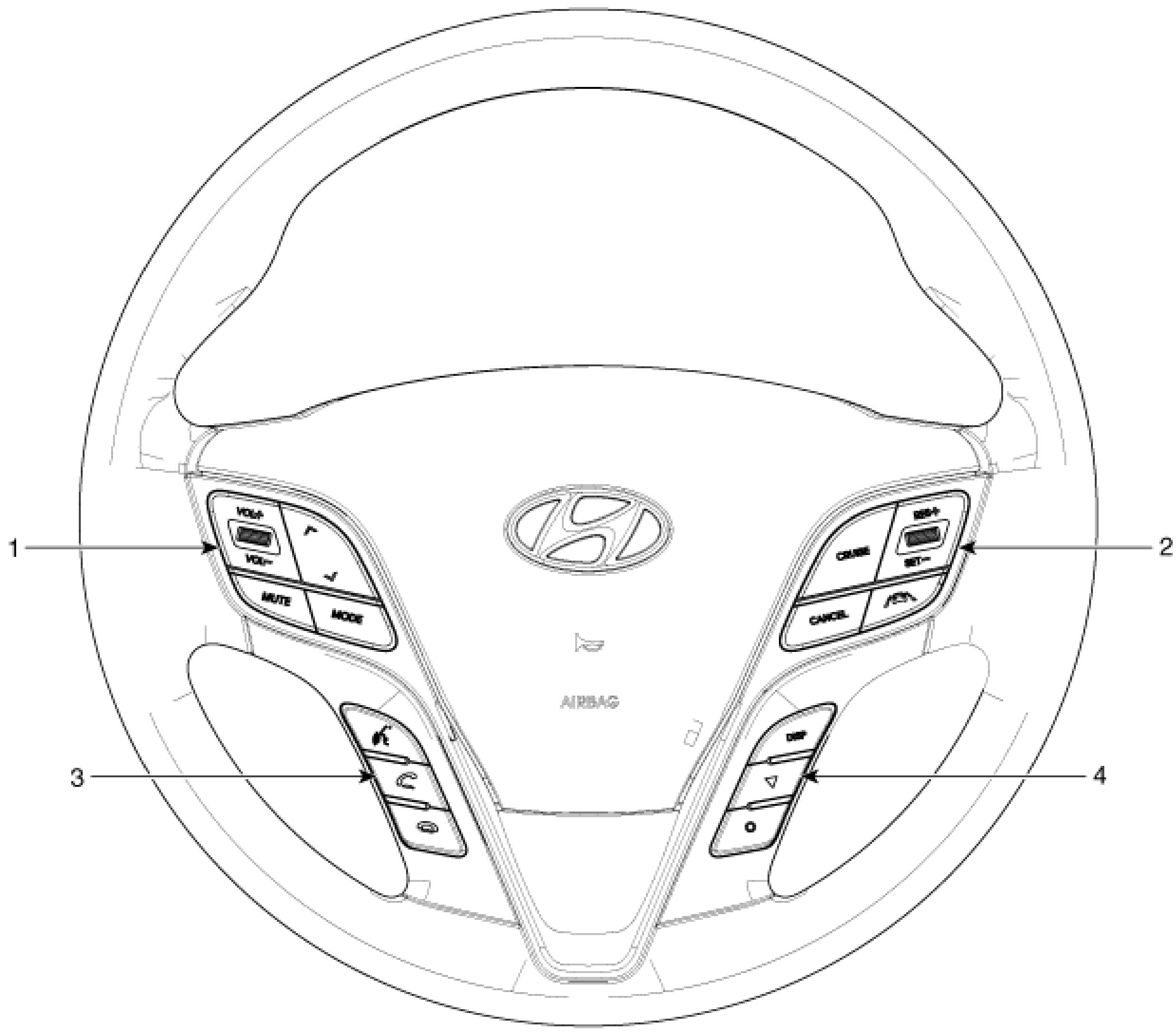
Trouble Symptom 7

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

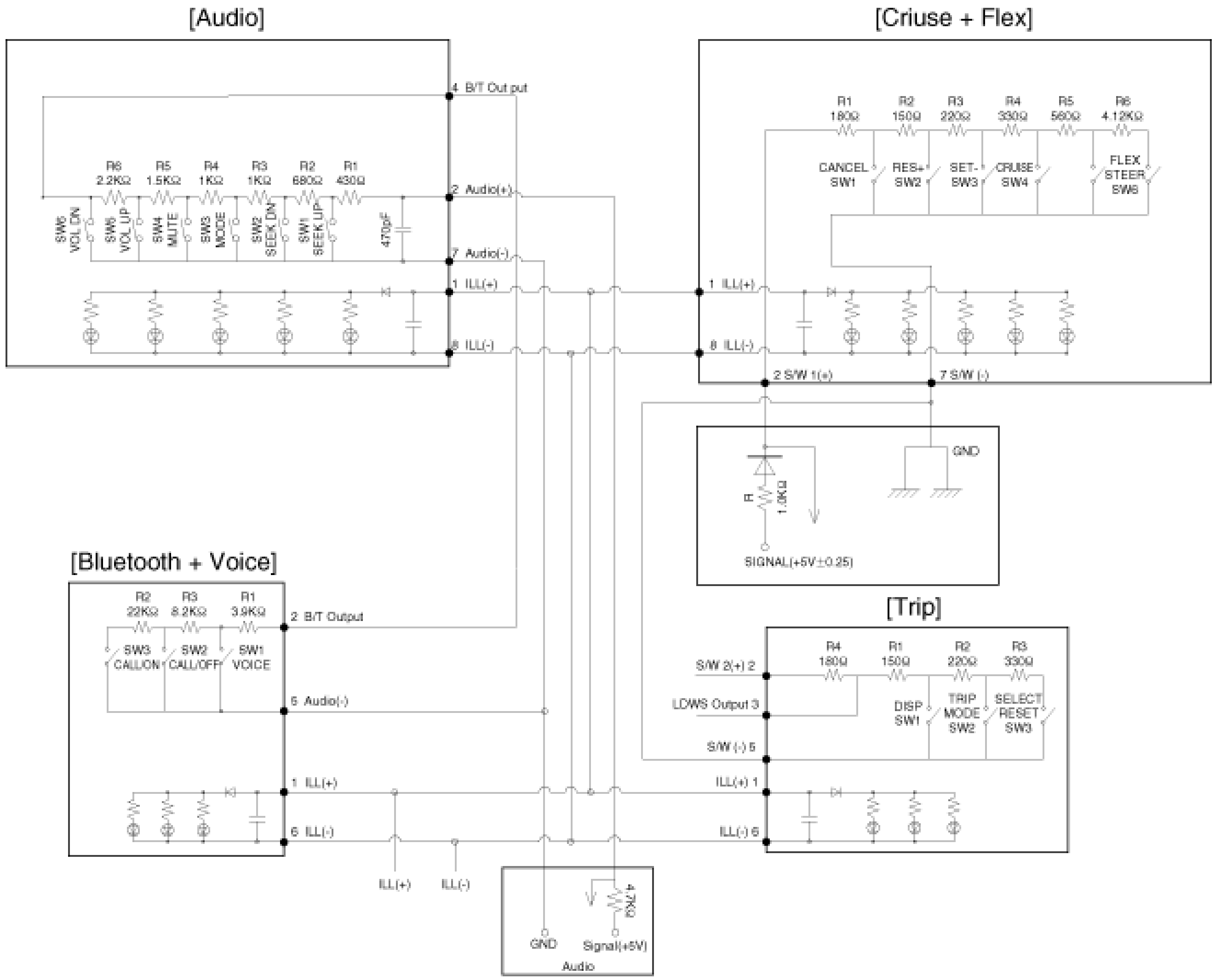
Trouble symptom	Probable cause	Remedy
The cruise main switch indicator lamp does not illuminate (But CC system is normal)	Damaged or disconnected bulb of cruise main switch indicator lamp	Repair the harness or replace the part.
	Harness damaged or disconnected	

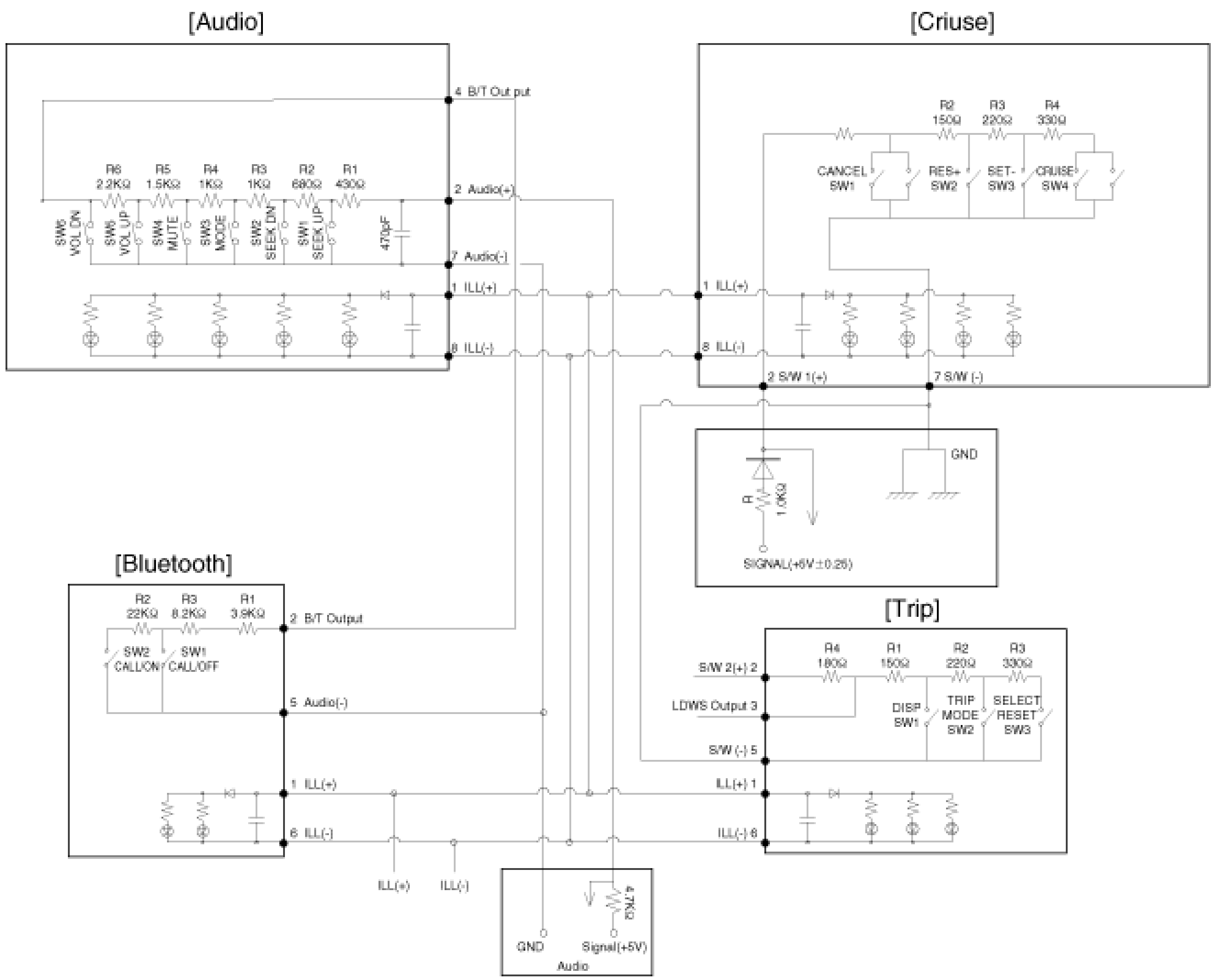
Components



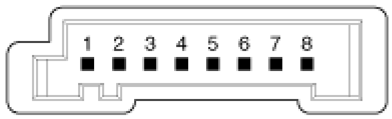
1. Remote control switch (LH: Audio) 2. Remote control switch (RH: Cruise + Flex)	3. Bluetooth handsfree switch 4. Trip switch

Circuit Diagram



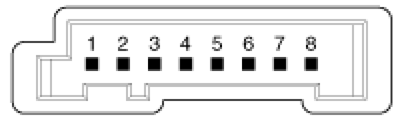

[Audio]
[Criuse]
4 B/T Out put
R6 2.2KΩ
R5 1.5KΩ
R4 1KΩ
R3 1KΩ
R2 680Ω
R1 430Ω
2 Audio(+)
SW6 VOL DN
SW5 VOL UP
SW4 MUTE
SW3 MODE
SW2 SEEK DN
SW1 SEEK UP
470pF
7 Audio(-)
1 ILL(+)
8 ILL(-)
R2 150Ω
R3 220Ω
R4 330Ω
CANCEL SW1
RES+ SW2
SET- SW3
CRUISE SW4
1 ILL(+)
8 ILL(-)
2 S/W 1(+)
7 S/W (-)
GND
R
1.0KΩ
SIGNAL(+5V±0.25)
[Bluetooth]
R2 22KΩ
R3 8.2KΩ
R1 3.9KΩ
2 B/T Output
SW2 CALL/ON
SW1 CALL/OFF
5 Audio(-)
1 ILL(+)
6 ILL(-)
[Trip]
R4 180Ω
R1 150Ω
R2 220Ω
R3 330Ω
S/W 2(+) 2
LDWS Output 3
DISP SW1
TRIP MODE SW2
SELECT RESET SW3
S/W (-) 5
ILL(+) 1
ILL(-) 6
ILL(+)
ILL(-)
4.7KΩ
GND
Signal(+5V)
Audio

[Audio]



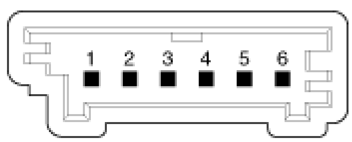
No.	Description
1	Illumination(+)
2	Audio(+)
3	-
4	Bluetooth input
5	-
6	-
7	Audio(-)
8	Illumination(-)

[Criuse + Flex]



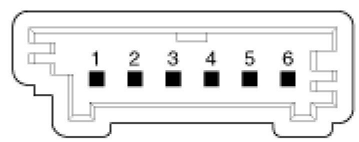
No.	Description
1	Illumination(+)
2	Switch1(+)
3	-
4	-
5	-
6	-
7	Switch(-)
8	Illumination(-)

[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(-)

Removal

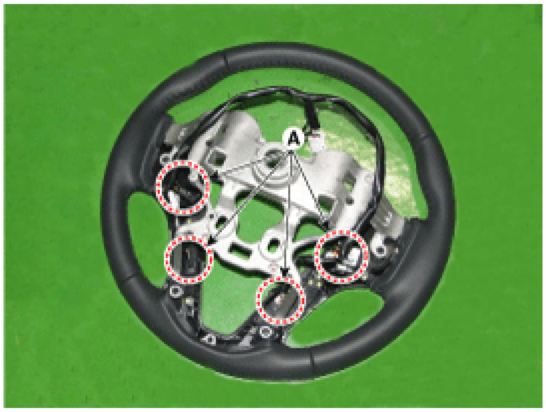
Disconnect the negative (-) battery terminal.

Remove the driver airbag module.
Refer to Restraint - "Driver Airbag (DAB) Module and Clock Spring")

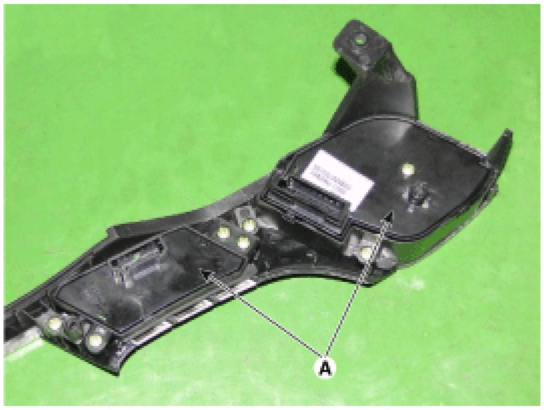
Remove the steering wheel.
(Refer to Steering System - "Steering Column and Shaft")

Remove the steering wheel cover (A) after loosening the screws.

Loosen the screws after disconnecting the steering wheel remote control switch connector (A).



Remove the remote control switches (A).



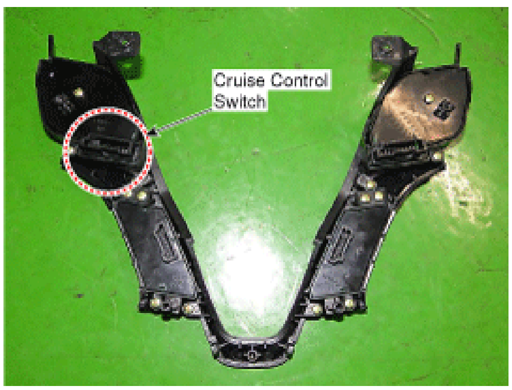
Installation

Install in the reverse order of removal.

Inspection

[Measuring Resistance]

Disconnect the cruise control switch connector from the control switch.



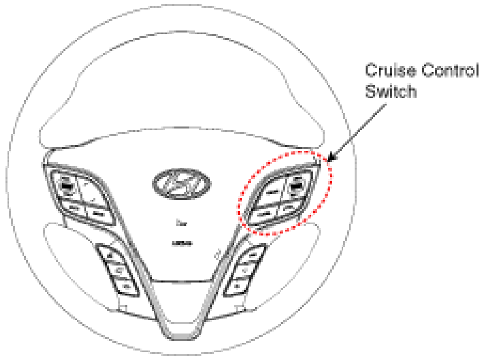
Measure resistance between terminals on the control switch when each function switch is ON (switch is depressed).

Function switch	Terminal	Resistance [kΩ ± 5%]
CANCEL	2 - 7	0.18
RES+	2 - 7	0.33
SET–	2 - 7	0.55
CRUISE	2 - 7	0.88

If not within specification, replace switch.

[Measuring Voltage]

Connect the cruise control switch connector to the control switch.



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

If not within specification, replace switch.

Emission Control System

Description and Operation

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.

Specifications

Purge Control Solenoid Valve (PCSV)
▷ Specification

Item	Specification
Coil Resistance (Ω)	19.0 ~ 22.0 [20°C(68°F)]

Fuel Tank Pressure Sensor (FTPS)
▷ Type: Piezo-Resistive Pressure Sensor
▷ Specification

Pressure [kPa (kgf/cm², in H2O)	Output Voltage (V)
-3.75 (-0.038, -15.05)	4.5
0	1.5
+1.25 (0.013, 5.02)	0.5

Canister Close Valve (CCV)
▷ Specification

Item	Specification
Coil Resistance (Ω)	19.8 ~ 21.8 [20°C(68°F)]

Tightening Torques

Item	kgf.m	N.m	lb-ft
Positive Crankcase Ventilation (PCV) Valve installation	0.19 ~ 0.29	1.9 ~ 2.8	1.4 ~ 2.1

Troubleshooting

Symptom	Suspect area
Engine will not start or struggle to start	Vapor hose damaged or disconnected
Engine struggle 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

Schematic Diagram

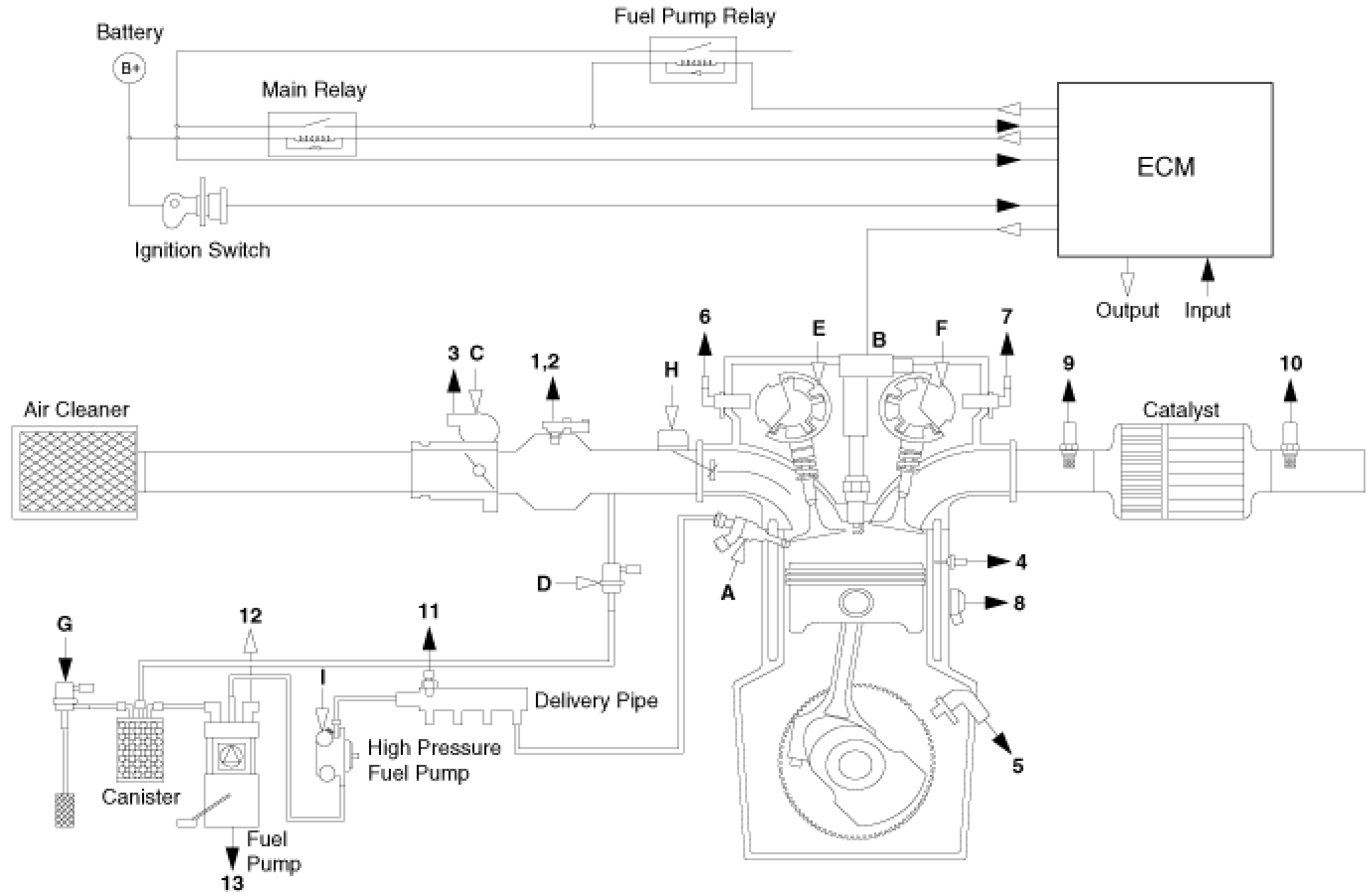
1. Manifold Absolute Pressure Sensor (MAPS)
2. Intake Air Temperature Sensor (IATS)
3. Throttle Position Sensor (TPS) [integrated into ETC Module]
4. Engine Coolant Temperature Sensor (ECTS)
5. Crankshaft Position Sensor (CKPS)
6. Camshaft Position Sensor (CMPS) [Bank 1 / Intake]
7. Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust]
8. Knock Sensor (KS)
9. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 1]
10. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 2]
11. Rail Pressure Sensor (RPS)
12. Fuel Tank Pressure Sensor (FTPS)
13. Fuel Level Sender (FLS)

· Accelerator Position Sensor (APS)
· A/C Pressure Transducer (APT)
· Ignition Switch Signal
· Battery Power Signal
· Vehicle Speed Signal
· Inhibitor Switch Signal
· Power Steering Switch Signal
· Brake Switch Signal

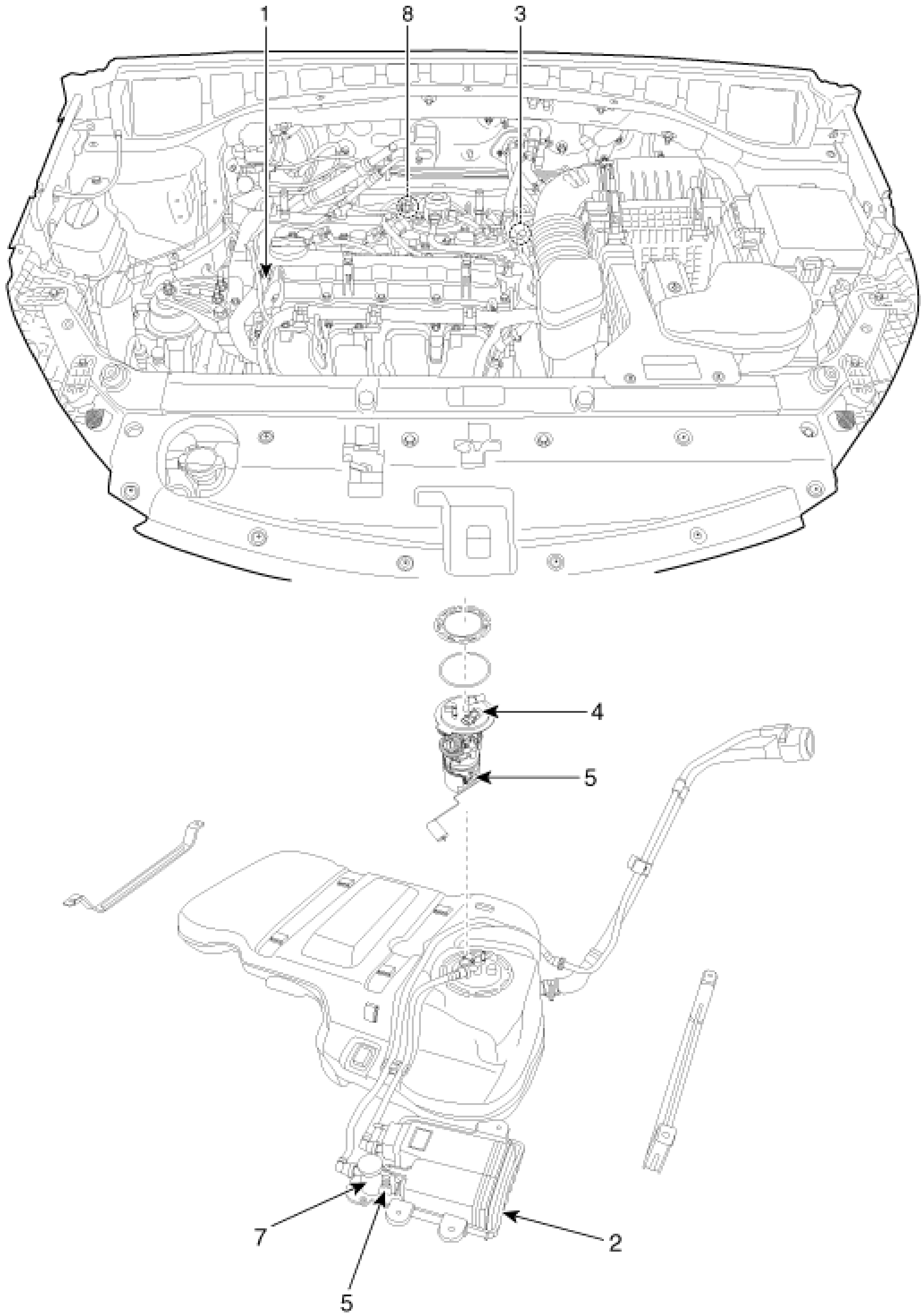
⇨ ECM ⇨

A. Injector
B. Ignition Coil
C. ETC Motor [integrated into ETC Module]
D. Purge Control Solenoid Valve (PCSV)
E. CVVT Oil Control Valve (OCV) [Bank 1 / Intake]
F. CVVT Oil Control Valve (OCV) [Bank 1 / Exhaust]
G. Canister Close Valve (CCV)
H. Vaiable Intake Solenoid (VIS) Valve
I. Fuel Pressure Regulator Valve

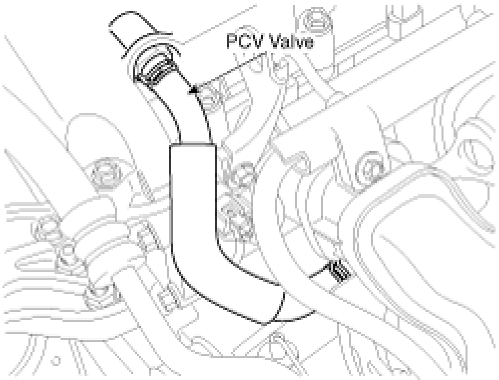
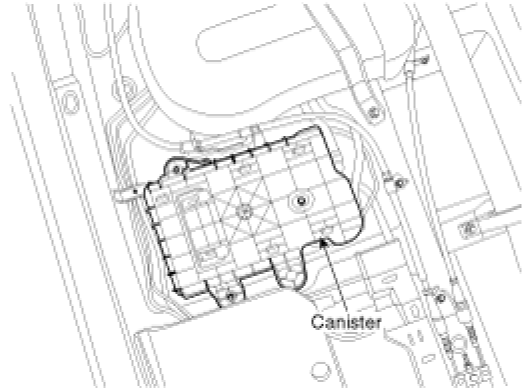
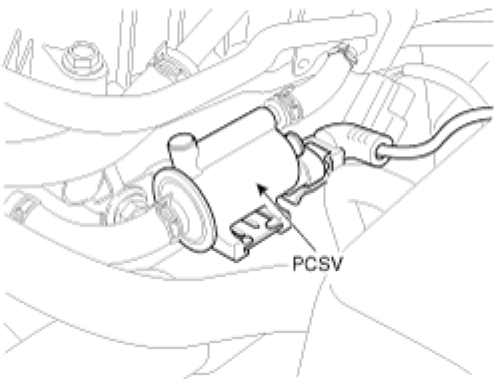
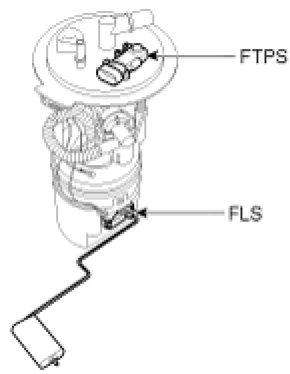
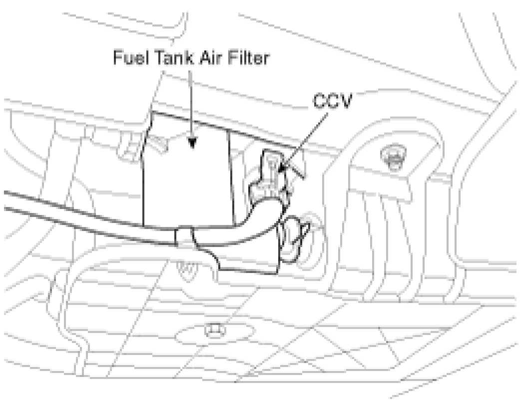
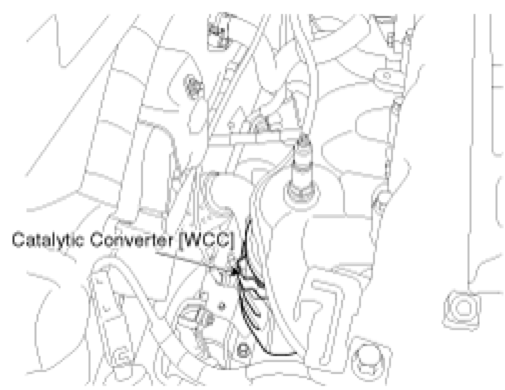
· Main Relay
· Fuel Pump Relay
· A/C Control
· Self Diagnosis

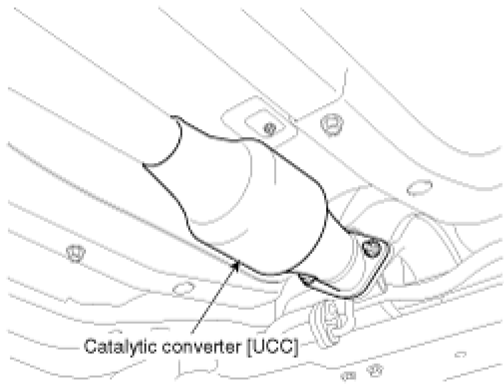


Components Location



1. PCV Valve	5. Canister Close Valve (CCV)
2. Canister	6. Fuel Level Sender (FLS)
3. Purge Control Solenoid Valve (PCSV)	7. Fuel Tank Air Filter
4. Fuel Tank Pressure Sensor (FTPS)	8. Catalytic Converter (WCC+UCC)

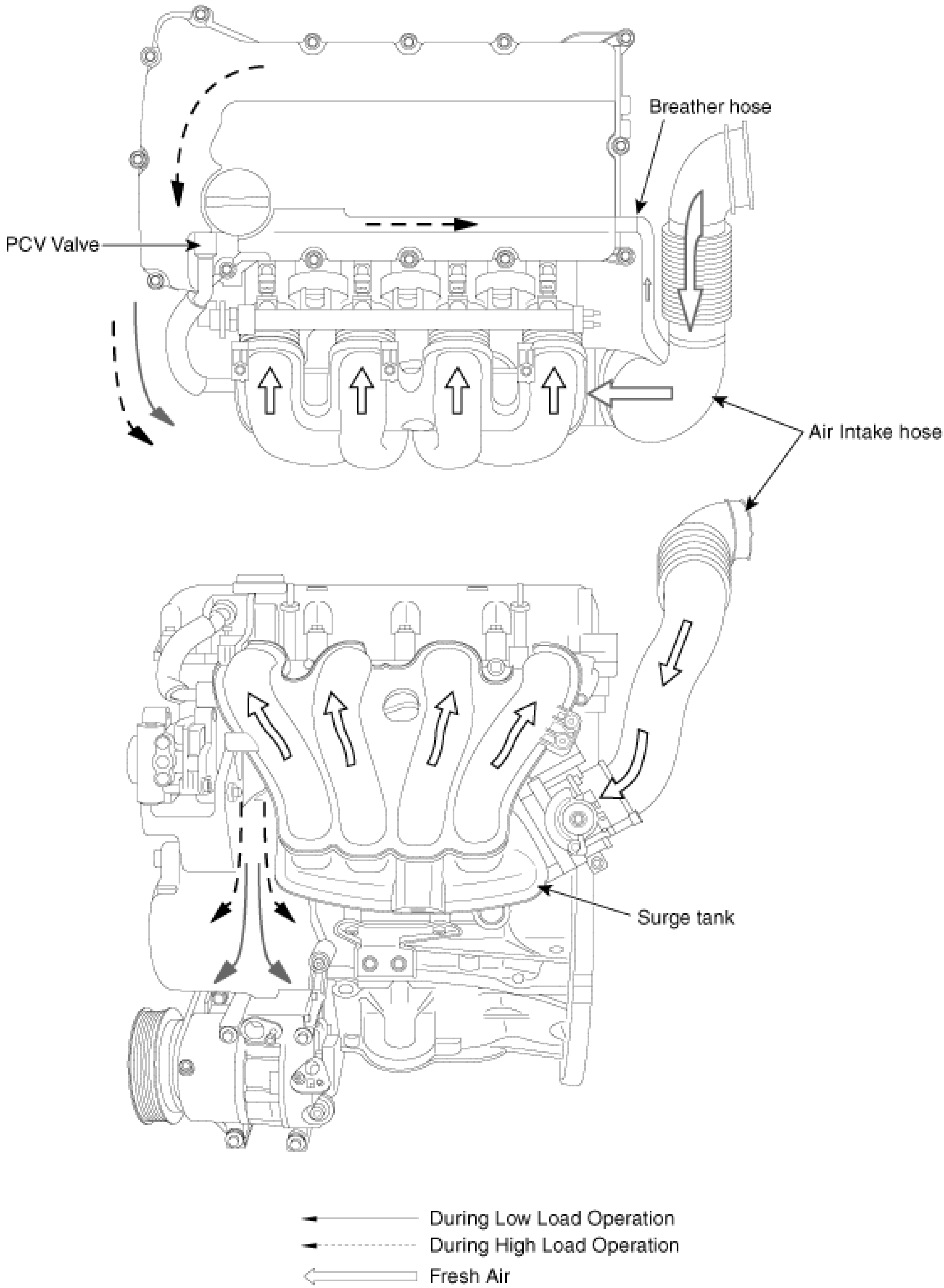
<table>
<tr><td>1. PCV Valve</td><td>2. Canister</td></tr>
<tr><td></td><td></td></tr>
<tr><td>3. Purge Control Solenoid Valve (PCSV)</td><td>4. Fuel Tank Pressure Sensor (FTPS)
6. Fuel Level Sender (FLS)</td></tr>
<tr><td></td><td></td></tr>
<tr><td>5. Canister Close Valve (CCV)
7. Fuel Tank Air Filter</td><td>8. Catalytic Converter (WCC)</td></tr>
<tr><td></td><td></td></tr>
<tr><td>8. Catalytic Converter (UCC)</td><td></td></tr>
</table>

Catalytic converter [UCC]	

Crankcase Emission Control System

Schematic Diagrams

Schematic Diagram



Inspection

After disconnecting the vapor hose from the PCV valve, remove the PCV valve.

Reconnect the PCV valve to the vapor hose.

Inspect the PCV valve operation.

Run the engine at idle.

Put a finger on the open end of the PCV valve.

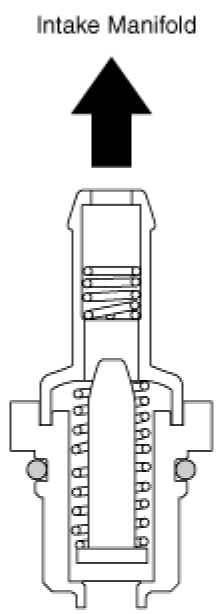
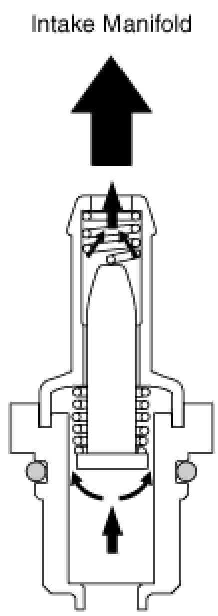
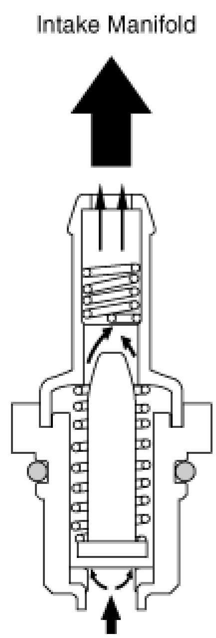
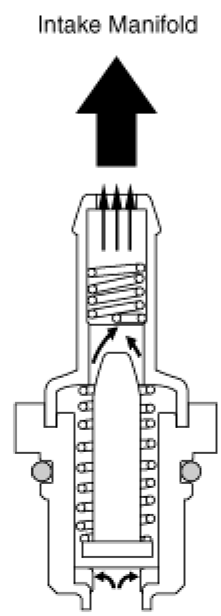
Make sure that intake manifold vacuum can be felt.

NOTE

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

If the vacuum is not felt, clean or replace the vapor hose.

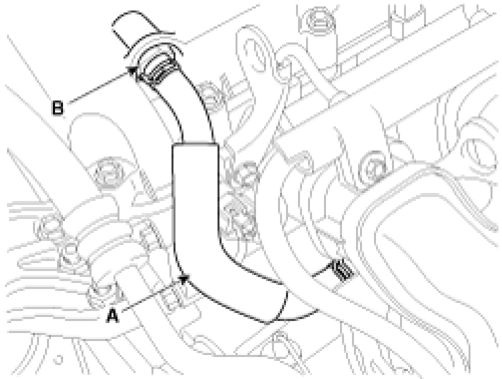
Operation Principle

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				

Removal

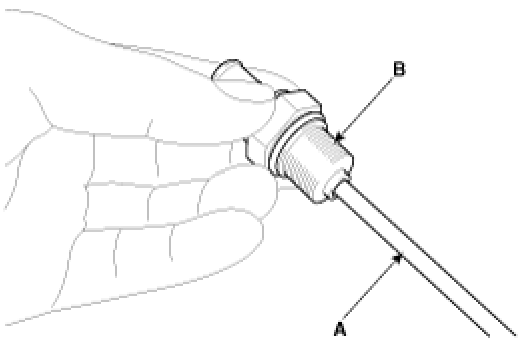
Disconnect the vapor hose (A).

Remove the PCV valve (B).



Inspection

Insert a thin stick (A) into the PCV valve (B) from the threaded side to check that the plunger moves.



NOTE

If the plunger does not move (PCV valve is clogged), clean or replace the valve.

Installation

Install in the reverse order of removal.

PCV Valve installation:
1.9 ~ 2.8 N.m (0.19 ~ 0.29 kgf.m, 1.4 ~ 2.1 lb-ft)

Evaporative Emission Control System

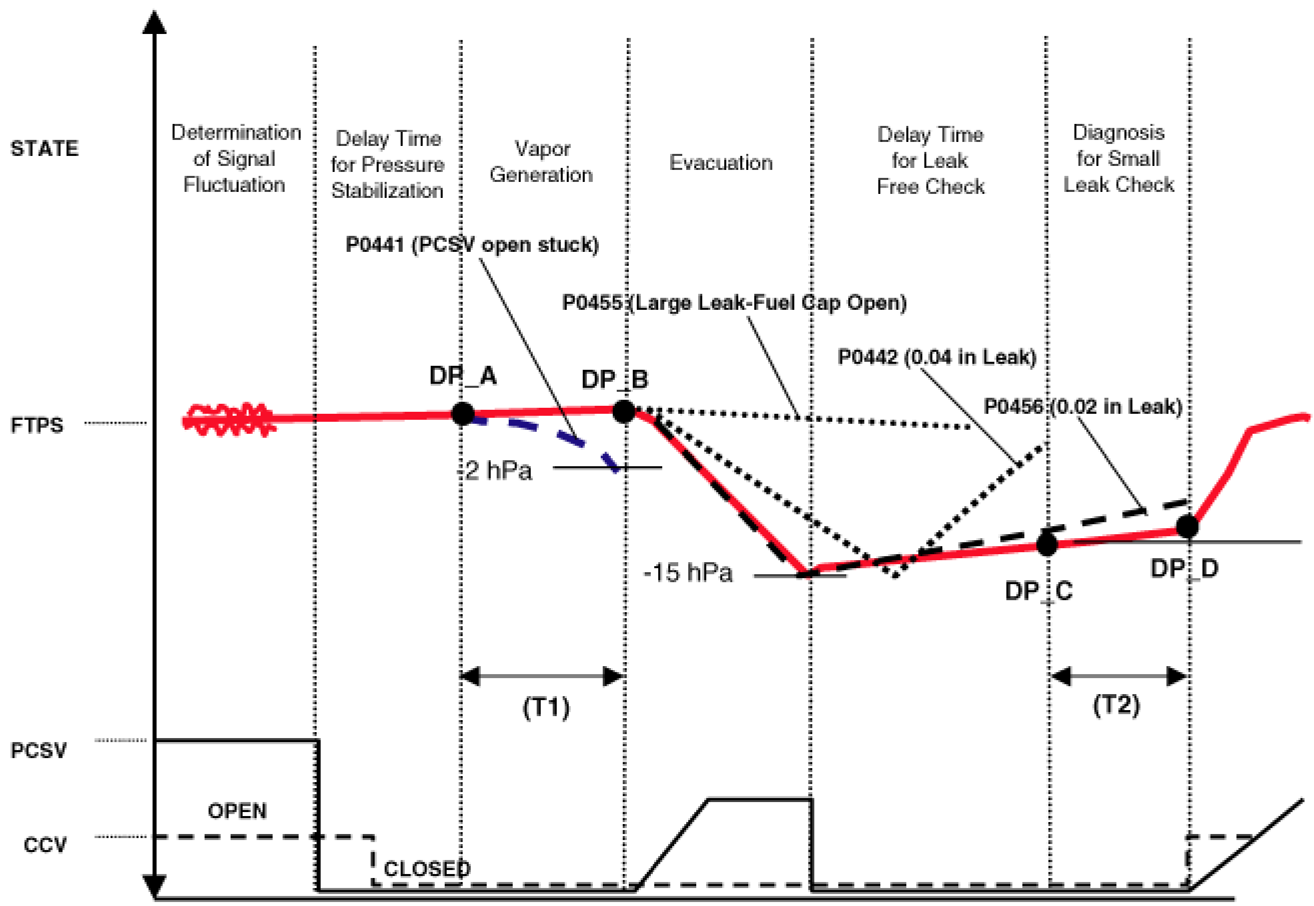
Description and Operation

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



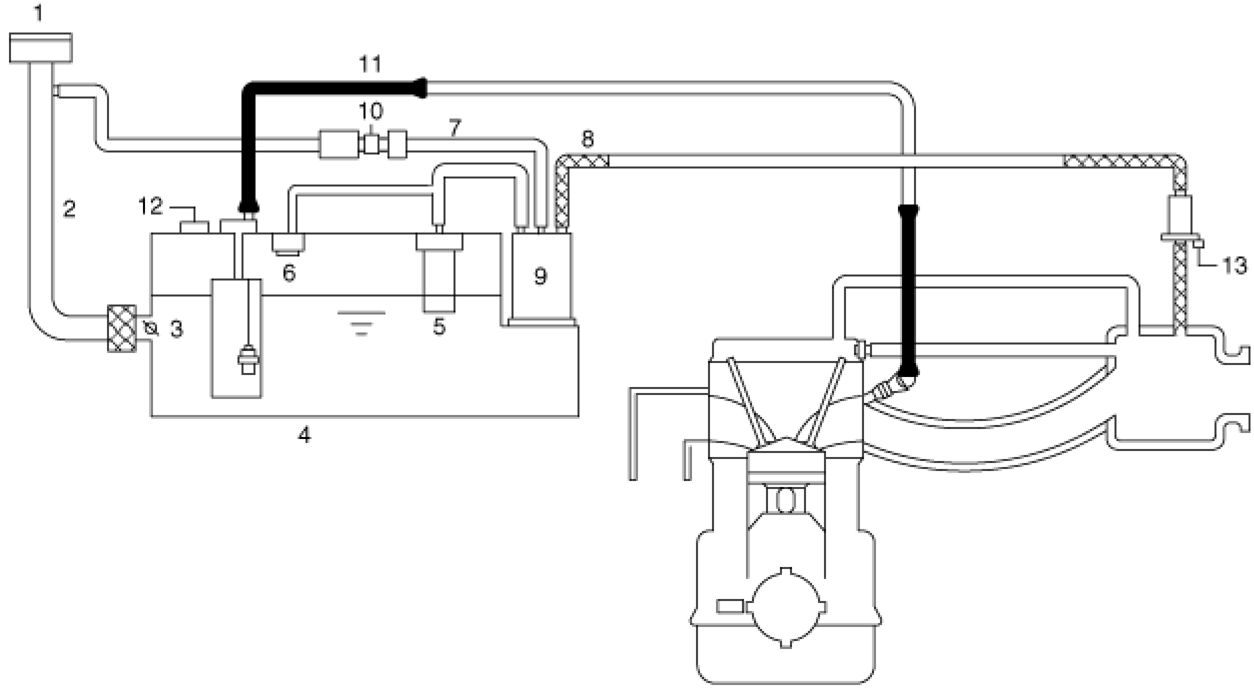
Evaporative And ORVR Emission Control System

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

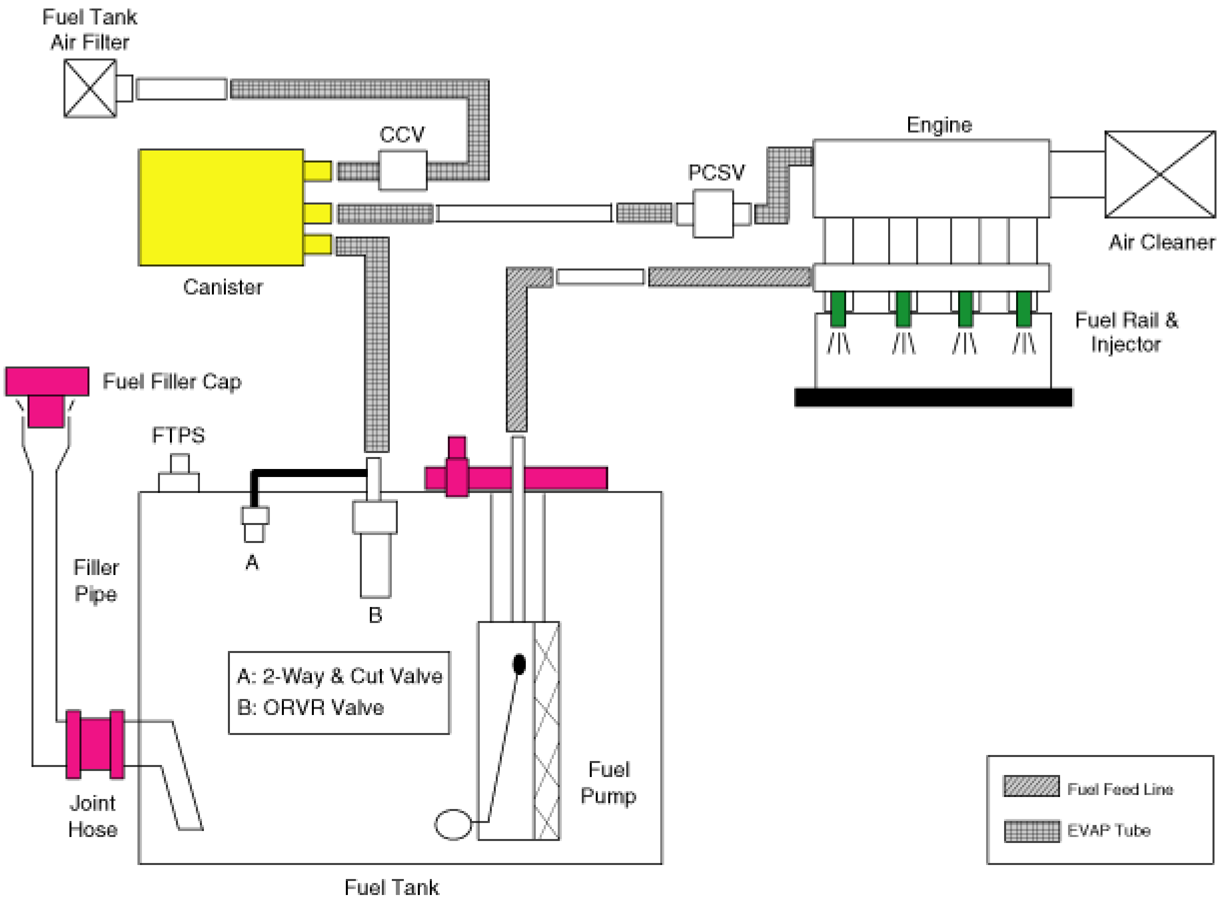
While refueling, ambient air is drawn into the filler pipe so as not to emit fuel vapors in the air. The fuel vapor in the tank is then forced to flow into the canister via the fill vent valve. The fuel liquid/vapor separator isolates liquid fuel and passes the pure vapor to the charcoal canister.

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	
2. Fuel Filler Pipe	8. Evaporative Hose
3. Fuel Shut-OFF Valve	9. Canister
4. Fuel Tank	10. Canister Close Valve (CCV)
5. ORVR Valve	11. Fuel Feed Line
6. 2-Way & Cut Valve	12. Fuel Tank Pressure Sensor (FTPS)
7. Evaporative Hose	13. Purge Control Solenoid Valve (PCSV)

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.

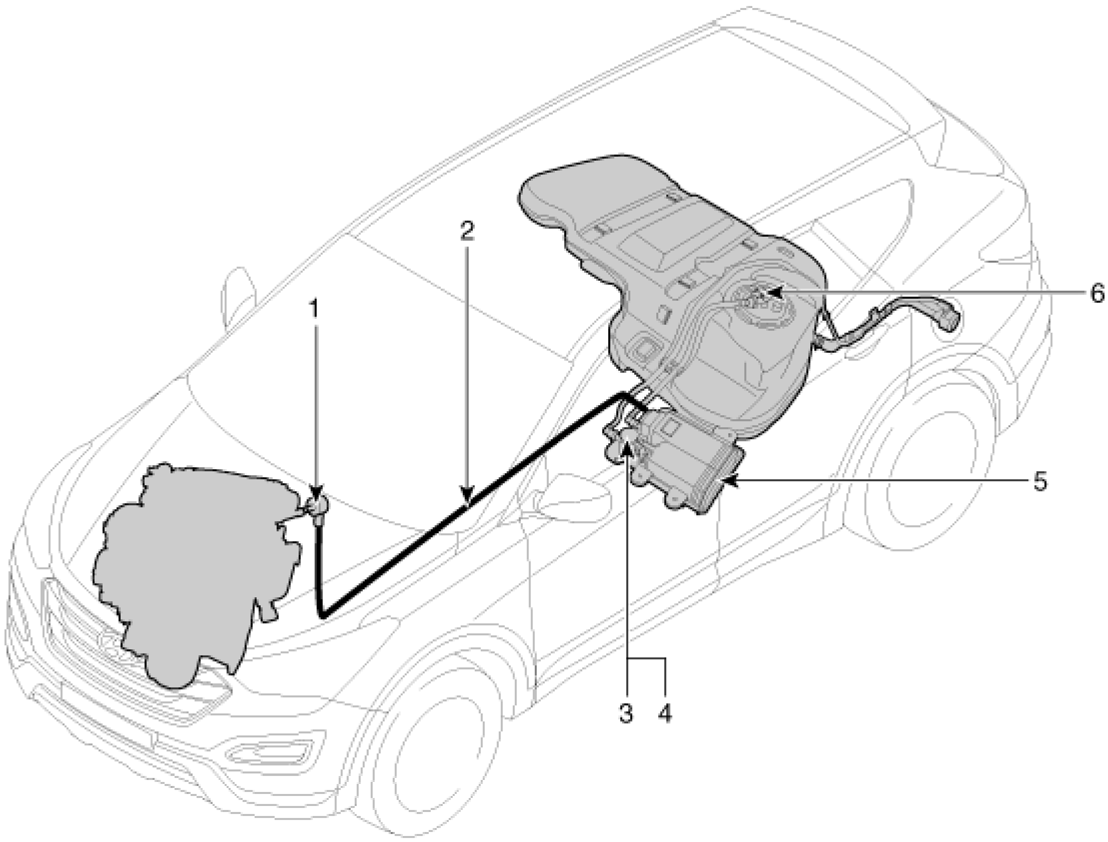
Evacuation

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.

Components Location



1. Purge Control Solenoid Valve (PCSV) 2. Vapor line 3. Fuel tank air filter	4. Canister Close Valve (CCV) 5. Canister 6. Fuel Tank Pressure Sensor (FTPS)

[Evap Leak Test]

Engine Control Module (ECM) controls Purge Control Solenoid Valve (PCSV) and Canister Close Valve (CCV) for EVAP System diagnosis if the conditions are satisfied.
ECM displays DTC codes after checking the leak rate through detecting change of FTPS signal. (Refer to the DTC guide manual for DTC codes.)In addition, EVAP Leak can be checked through the EVAP Leak Test function of the GDS diagnostic tool as shown below.

Turn ignition switch OFF.

Connect the GDS to Data Link Connector (DLC).

Start the engine.

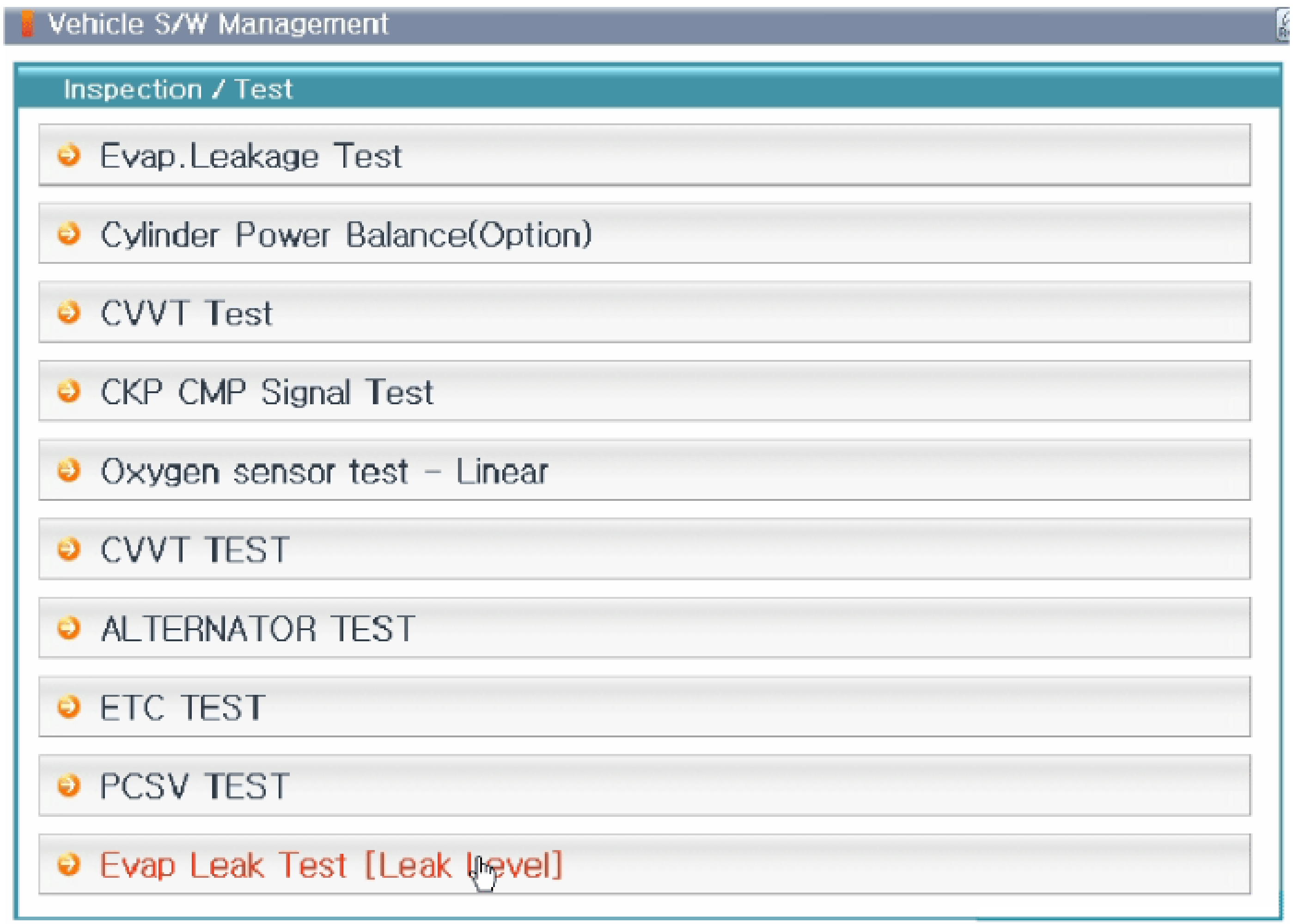
Select "Vehicle, Model year, Engine, System".

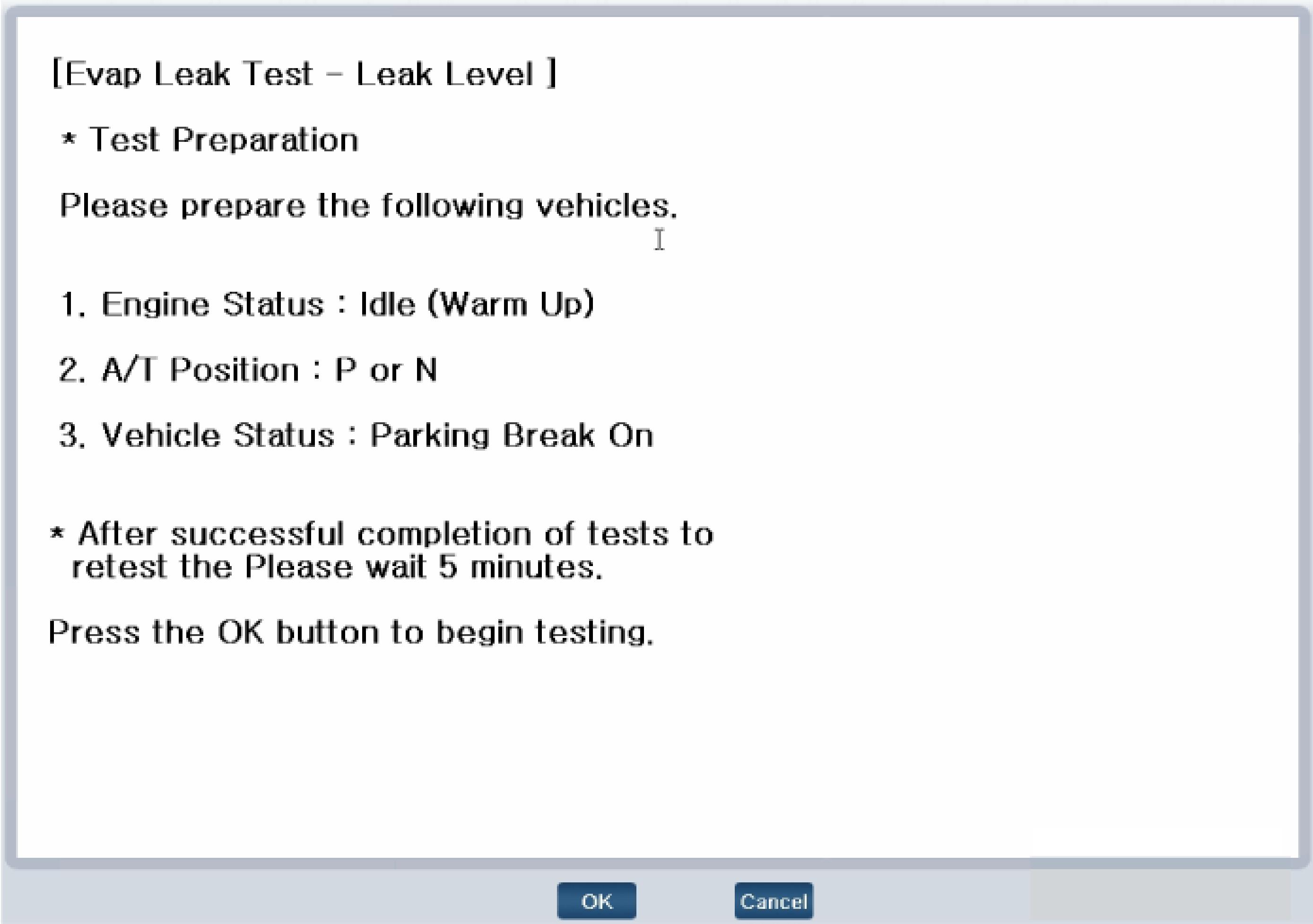
Select "Vehicle S/W Management".

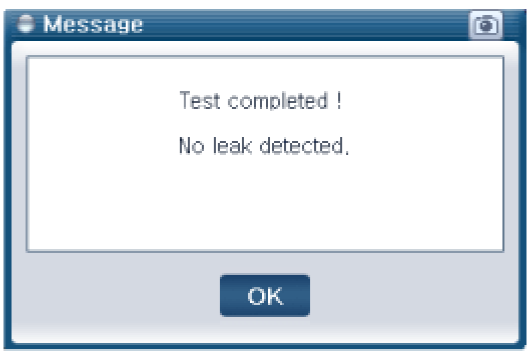
Select "Inspection / Test".

Select "Evap Leak Test".

Perform the procedure in accordance with the message.




[Evap Leak Test – Leak Level]
* Test Preparation
Please prepare the following vehicles.
1. Engine Status : Idle (Warm Up)
2. A/T Position : P or N
3. Vehicle Status : Parking Break On
* After successful completion of tests to retest the Please wait 5 minutes.
Press the OK button to begin testing.
OK
Cancel


Message
Test completed !
No leak detected.
OK

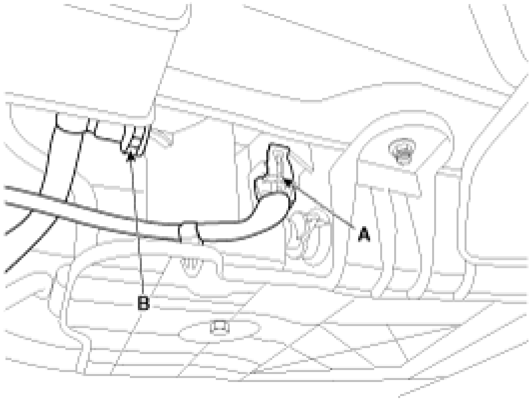
Removal

Turn the ignition switch OFF and disconnect the battery negative (-) cable.

Lift the vehicle.

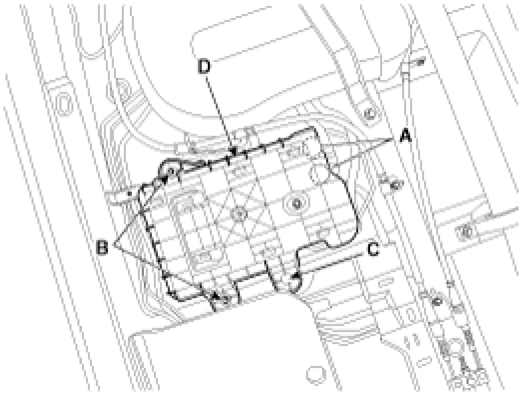
Disconnect the canister close valve connector (A).

Disconnect the ventilation tube quick-connector (B) from the fuel tank air filter and canister close valve.

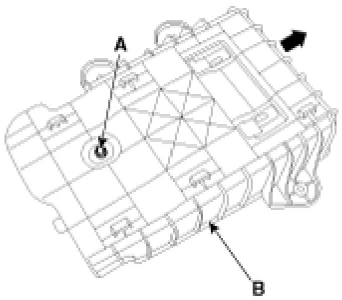


Disconnect the vapor tube quick-connector (A).

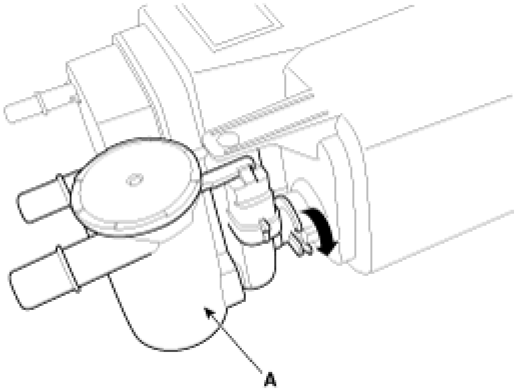
Remove the canister assembly bracket (D) after removing the mounting bolts (B) and nut (C).



Remove the canister bracket (B) installation bolt (A).



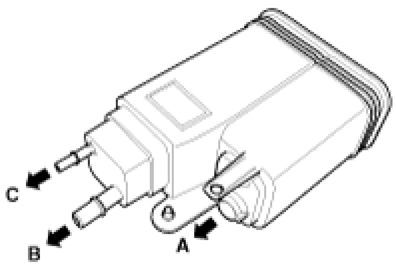
Remove the fuel tank air filter & canister close valve assembly (A) after rotating it in the direction of the arrow in the figure.



Inspection

Check for the following items visually.

- Cracks or leakage of the canister
- Loose connection, distortion, or damage of the vapor hose/tube



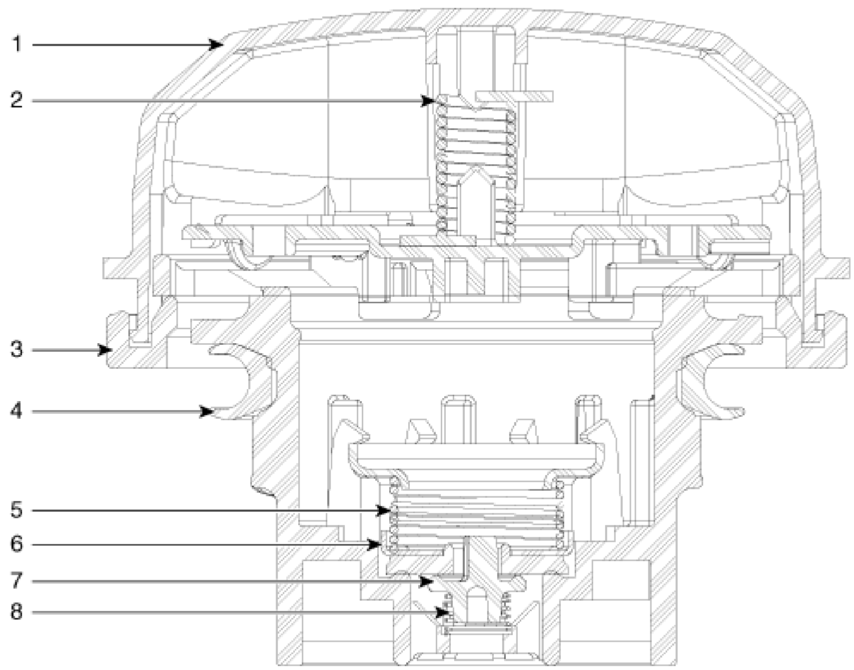
A: Canister ↔ Atmosphere
B: Canister ↔ Fuel Tank
C: Canister ↔ Intake Manifold

Installation

Install in the reverse order of removal.

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

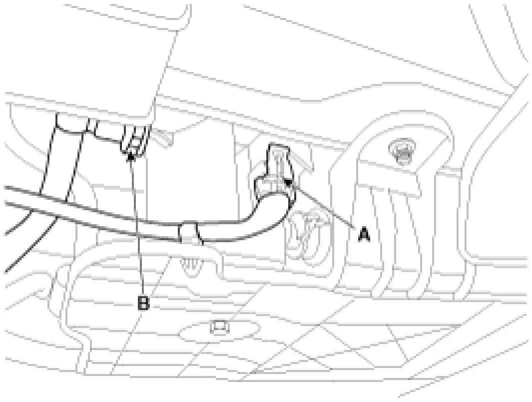
Removal

Turn the ignition switch OFF and disconnect the battery negative (-) cable.

Lift the vehicle.

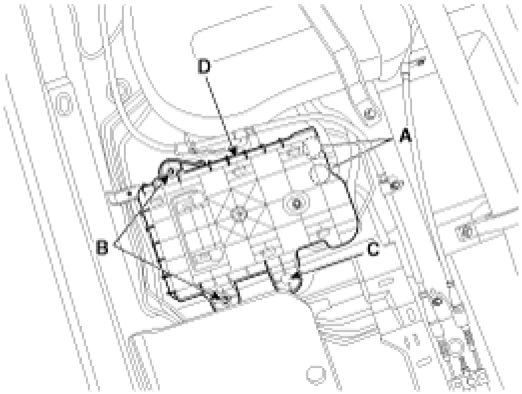
Disconnect the canister close valve connector (A).

Disconnect the ventilation tube quick-connector (B) from the fuel tank air filter and canister close valve.

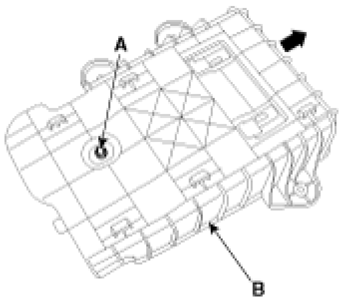


Disconnect the vapor tube quick-connector (A).

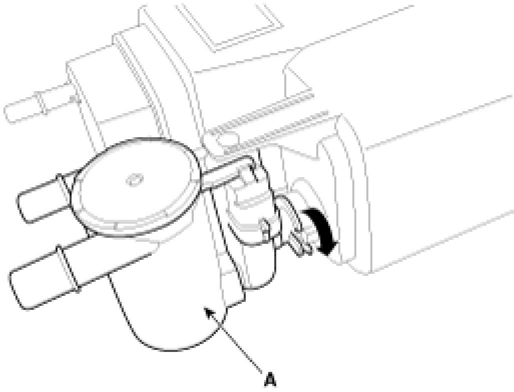
Remove the canister assembly bracket (D) after removing the mounting bolts (B) and nut (C).



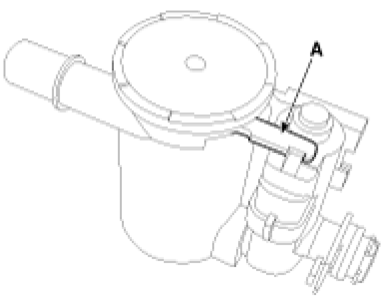
Remove the canister bracket (B) installation bolt (A).

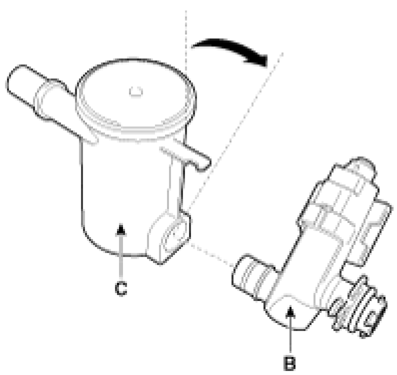


Remove the fuel tank air filter & canister close valve assembly (A) after rotating it in the direction of the arrow in the figure.



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

- 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.

Install in the reverse order of removal.

Exhaust Emission Control System

Description and Operation

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.

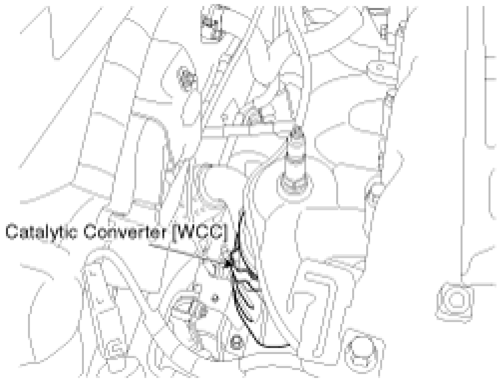
Open Loop air/fuel ratio is controlled by information programmed into the ECM.

Closed Loop air/fuel ratio is adjusted by the ECM based on information supplied by the oxygen sensor.

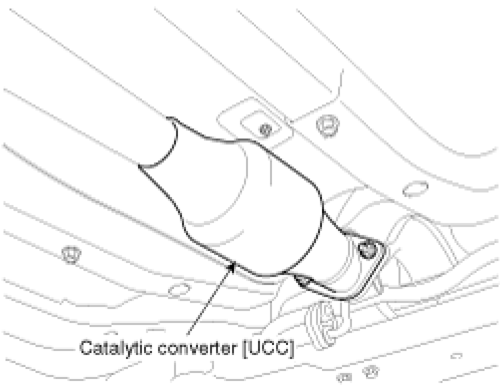
Description

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).

[WCC]



[UCC]



Removal

Remove the exhaust manifold.
(Refer to Engine Mechanical System - "Exhaust Manifold")

Installation

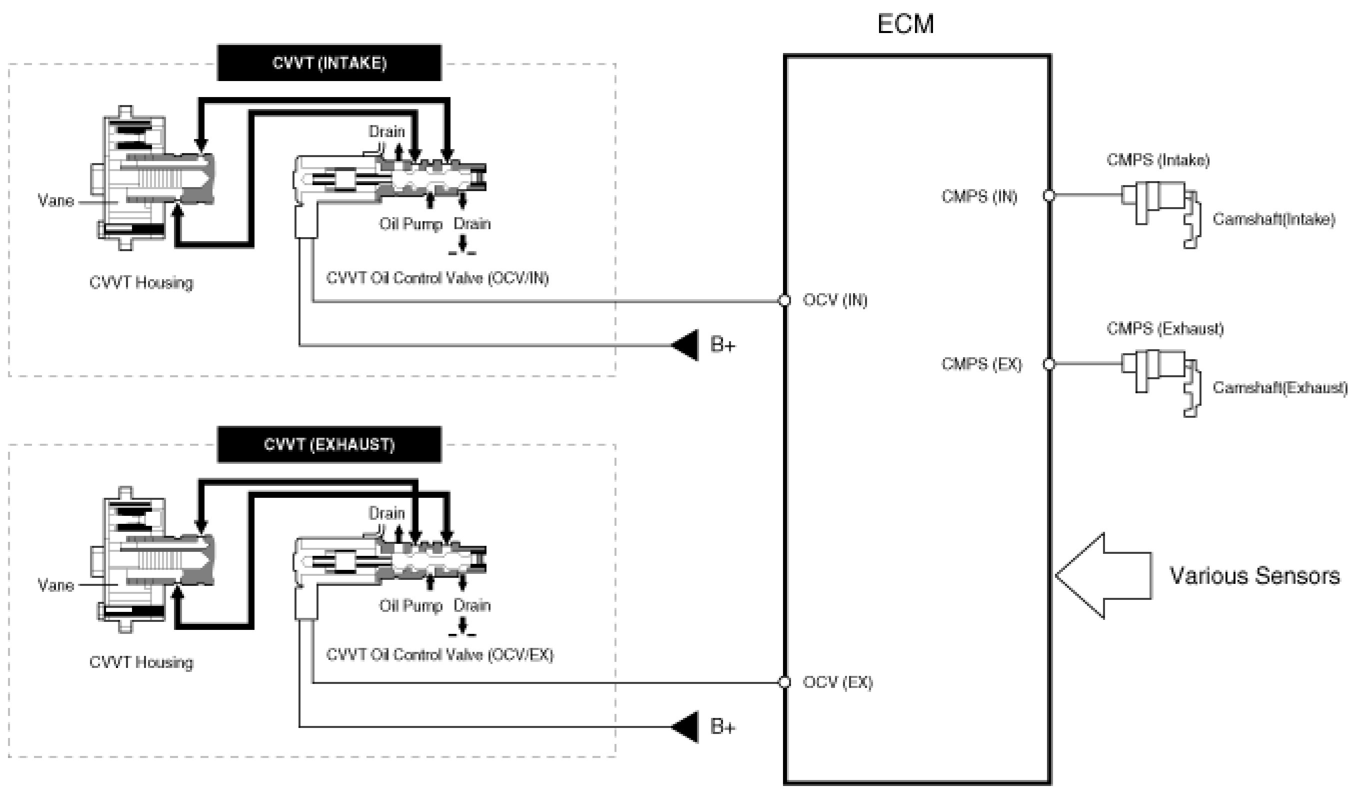
Install in the reverse order of removal.

Description

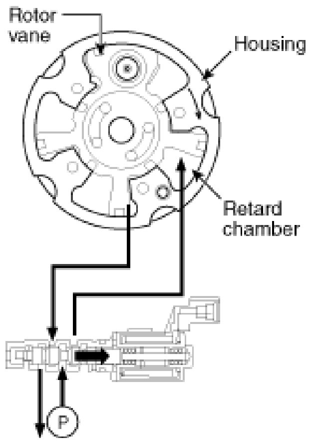
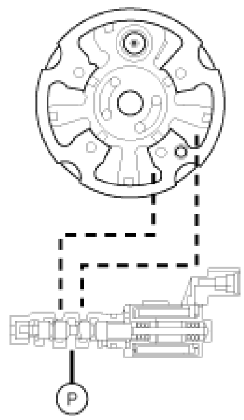
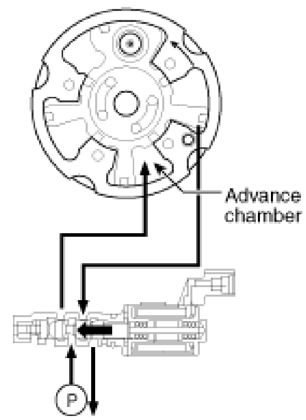
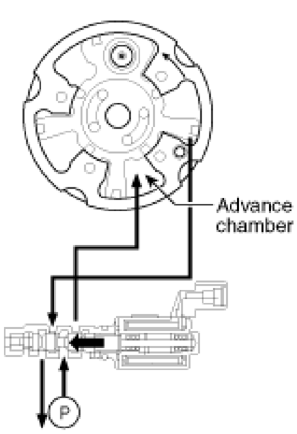
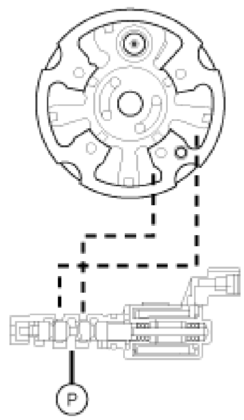
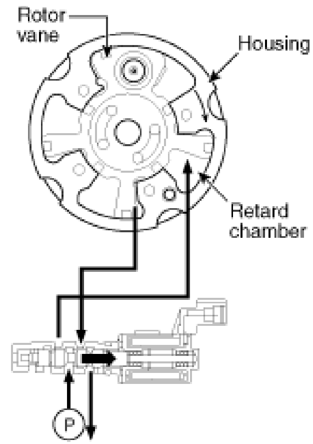
Continuous Variable Valve Timing (CVVT) system advances or retards the valve timing of the intake and exhaust valve in accordance with the ECM control signal which is calculated by the engine speed and load.
By controlling CVVT, the valve over-lap or under-lap occurs, which makes better fuel economy 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.

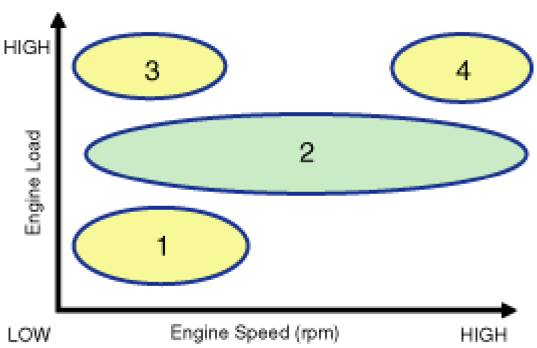
The engine oil getting out of the CVVT oil control valve varies the cam phase in the direction (Intake Advance/Exhaust Retard) or opposite direction (Intake Retard/Exhaust Advance) of the engine rotation by rotating the rotor connected with the camshaft inside the cam phaser.

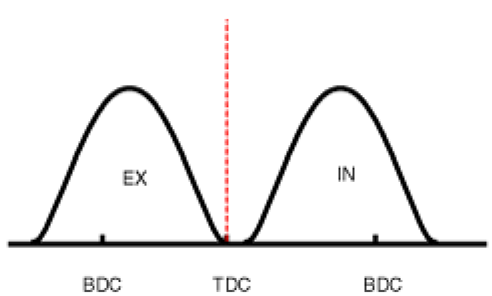
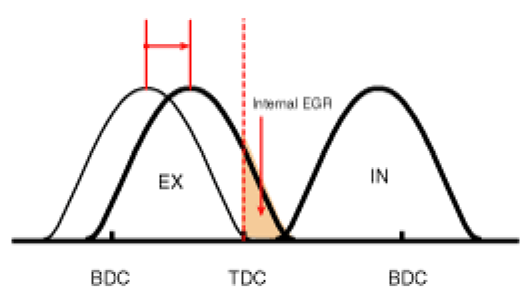


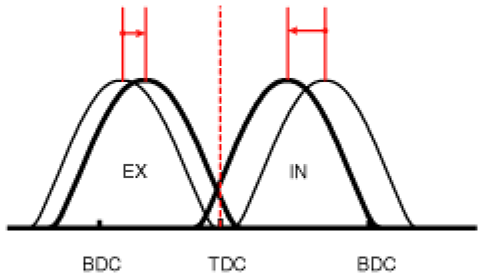
Operation Principle
The CVVT has the mechanism rotating the rotor vane with hydraulic force generated by the engine oil supplied to the advance or retard chamber in accordance with the CVVT oil control valve control.

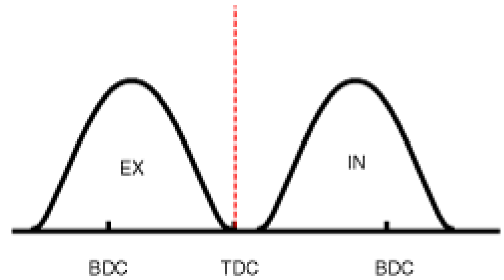
	Initial State	Hold	Advace / Retard
Intake			
Exhaust			

[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
Specifications

Fuel Delivery System

Items	Specification	
Fuel Tank	Capacity	66 lit. (17.4 U.S.gal., 69.7 U.S.qt., 58.0 Imp.qt.)
Fuel Filter	Type	Paper type
Fuel Pressure	Low Pressure Fuel Line	480 ~ 520 kPa (4.9 ~ 5.3 kgf/cm², 69.6 ~ 75.4 psi)
	High Pressure Fuel Line	3.0 ~ 15.0 MPa (30.6 ~ 153.0 kgf/cm², 435.1 ~ 2175.6 psi)
Fuel Pump	Type	Electrical, in-tank type
	Driven by	Electric motor
High Pressure Fuel Pump	Type	Mechanical type
	Driven by	Camshaft

Sensors

Manifold Absolute Pressure Sensor (MAPS)
▷ Type: Piezo-resistive pressure sensor type
▷ Specification

Pressure [kPa (kgf/cm², psi)]	Output Voltage (V)
20.0 (0.20, 2.9)	0.79
46.7 (0.47, 6.77)	1.84
101.3 (1.03, 14.7)	4.0

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 ~ 0.62
80	176	0.29 ~ 0.34

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
80	176	0.32

Throttle Position Sensor (TPS) [integrated into ETC Module]
▷ Type: Variable resistor type
▷ Specification

Throttle Angle(°)	Output Voltage (V)	
	TPS1	TPS2
0	0	5.0
10	0.48	4.52
20	0.95	4.05
30	1.43	3.57
40	1.90	3.10
50	2.38	2.62
60	2.86	2.14
70	3.33	1.67
80	3.81	1.19
90	4.29	0.71
100	4.76	0.24
105	5.0	0
C.T (6~15°)	0.29 ~ 0.71	4.29 ~ 4.71
W.O.T (93~102°)	4.43 ~ 4.86	0.14 ~ 0.57

Item	Resistance (kΩ)
TPS1	0.875 ~ 1.625 [20°C(68°F)]
TPS2	0.875 ~ 1.625 [20°C(68°F)]

Crankshaft Position Sensor (CKPS)
▷ Type: Hall effect type
Camshaft Position Sensor (CMPS)
▷ Type: Hall effect type
Knock Sensor (KS)
▷ Type: Piezo-electricity type
▷ Specification

Item	Specification
Capacitance (pF)	850 ~ 1,150

Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 1]
▷ Type: Zirconia (ZrO2) [Linear] Type
▷ Specification

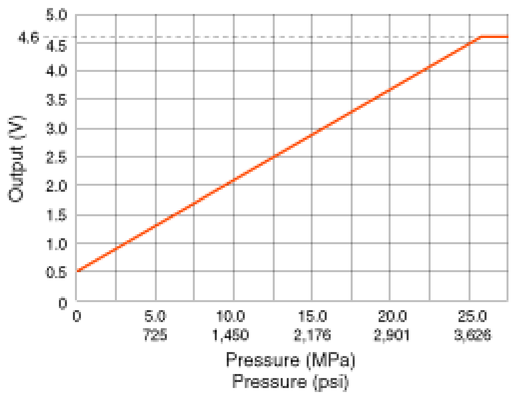
Item	Specification
Heater Resistance (Ω)	2.5 ~ 4.0 [20°C(69.8°F)]

Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2]
▷ Type: Zirconia (ZrO2) [Binary] Type
▷ Specification

A/F Ratio (λ)	Output Voltage(V)
RICH	Approx. 0.9
LEAN	Approx. 0.04

Item	Specification
Heater Resistance (Ω)	3.3 ~ 4.1 [21°C(69.8°F)]

Rail Pressure Sensor (RPS)
▷ Type: Piezo-electricity type
▷ Specification



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/cm², in H2O)]	Output Voltage (V)
-3.75 (-0.038, -15.05)	4.5
0	1.5
+1.25 (0.013, 5.02)	0.5

Actuators

Injector
▷ Specification

Item	Specification
Coil Resistance (Ω)	1.18 ~ 1.31 [20°C(68°F)]

ETC Motor [integrated into ETC Module]
▷ Specification

Item	Specification
Coil Resistance (Ω)	1.2 ~ 1.8 [20°C(68°F)]

Purge Control Solenoid Valve (PCSV)
▷ Specification

Item	Specification
Coil Resistance (Ω)	19.0 ~ 22.0 [20°C(68°F)]

CVVT Oil Control Valve (OCV)
▷ Specification

Item	Specification
Coil Resistance (Ω)	6.9 ~ 7.9 [20°C(68°F)]

Variable Intake Solenoid (VIS) Valve
▷ Specification

Item	Specification
Coil Resistance (Ω)	30.0 ~ 35.0 [20°C(68°F)]

Fuel Pressure Control Valve
▷ Specification

Item	Specification
Coil Resistance (Ω)	0.5 [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)]

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 6 ± 10	
Idle Speed (rpm)	A/C OFF	Neutral, N, P-range	680 ± 100
		D-range	680 ± 100
	A/C ON	Neutral, N, P-range	680 ± 100
		D-range	680 ± 100

Tightening Torques

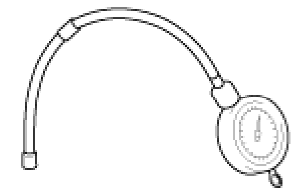
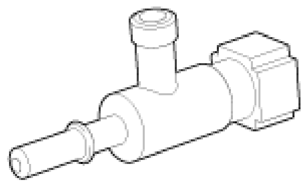
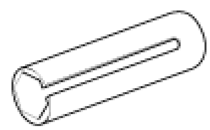
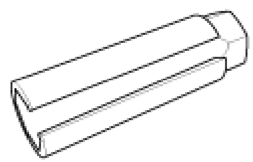
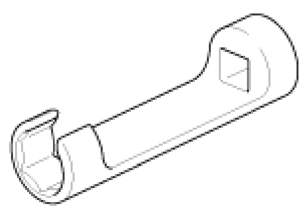
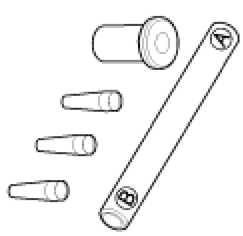
Engine Control System

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
Manifold absolute pressure sensor installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Crankshaft position sensor installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Crankshaft position sensor cover installation bolt (M6)	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Crankshaft position sensor cover installation bolt (M8)	1.9 ~ 2.4	18.6 ~ 23.5	13.7 ~ 17.4
Camshaft position sensor (Bank 1 / Intake) installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Camshaft position sensor (Bank 1 / Exhaust) installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Knock sensor installation bolt	1.9 ~ 2.4	18.6 ~ 23.5	13.7 ~ 17.4
Heated oxygen sensor (Bank 1 / sensor 1) installation	4.0 ~ 5.0	39.2 ~ 49.1	28.9 ~ 36.2
Heated oxygen sensor (Bank 1 / sensor 2) installation	4.0 ~ 5.0	39.2 ~ 49.1	28.9 ~ 36.2
Rail pressure sensor installation	1.8 ~ 2.2	18.0 ~ 22.0	13.3 ~ 16.2
Electronic throttle body installation bolt	0.8 ~ 1.0	7.8 ~ 9.8	5.8 ~ 7.2
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
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 installation bolt	4.5 ~ 6.0	44.1 ~ 58.8	32.5 ~ 43.4
Filler-neck assembly bracket installation bolt	0.4 ~ 0.6	3.9 ~ 5.9	2.9 ~ 4.3
Accelerator pedal module installation nut	1.7 ~ 2.6	9.8 ~ 14.7	7.2 ~ 10.8
Accelerator pedal module installation bolt	0.9 ~ 1.4	8.8 ~ 13.7	6.5 ~ 10.1
Delivery pipe installation bolt	1.9 ~ 2.4	18.6 ~ 23.5	13.7 ~ 17.4
High pressure fuel pump installation bolt	1.3 ~ 1.5	12.8 ~ 14.7	9.4 ~ 10.9
High pressure fuel pipe installation nut	2.7 ~ 3.3	26.5 ~ 32.4	19.5 ~ 23.9
High pressure fuel pipe function block installation bolt	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7

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 (09392-2H100)		Removal and installation of the heated oxygen sensor
Heated Oxygen Sensor Socket Wrench (09392-1Y100)		Removal and installation of the heated oxygen sensor
Torque Wrench Socket (09314-3Q100)		Removal and installation of the high pressure fuel pipe
Injector Combustion Seal Guide & Sizing tool (09353-2B000)		Installation of the injector combustion seal

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.
	NOTE *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**
	WARNING **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**

1. VEHICLE INFORMAITON

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.

NOTE

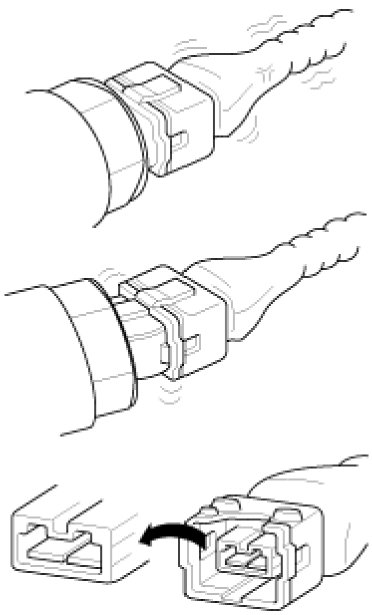
The measured resistance in except for ambient temperature (20°C, 68°F) is reference value.

Intermittent Problem Inspection Procedure

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

Clear Diagnostic Trouble Code (DTC).

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.



Slightly shake the connector and wiring harness vertically and horizontally.

Repair or replace the component that has a problem.

Verify that the problem has disappeared with the road test.

● Simulating Vibration

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

WARNING

Strong vibration may break sensors, actuators or relays

Connectors and Harness
: Lightly shake the connector and wiring harness vertically and then horizontally.

● Simulating Heat

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

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.

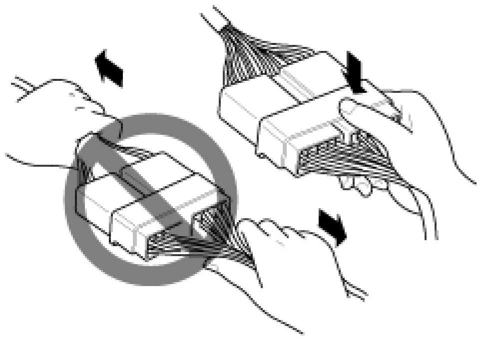
● Simulating Electrical Load

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

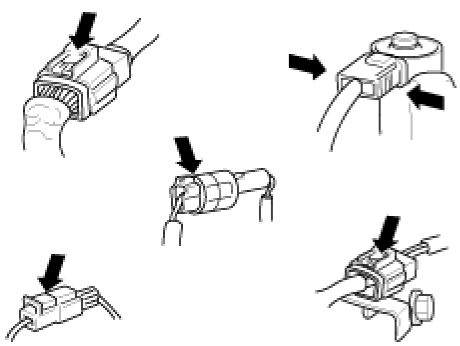
Connector Inspection Procedure

Handling of Connector

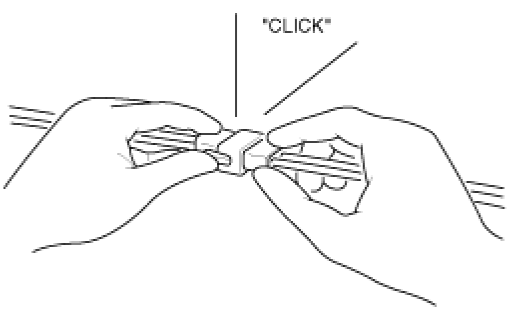
Never pull on the wiring harness when disconnecting connectors.



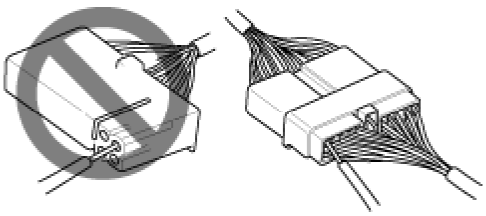
When removing the connector with a lock, press or pull locking lever.



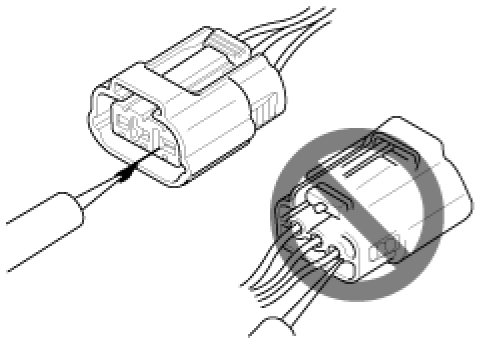
Listen for a click when locking connectors. This sound indicates that they are securely locked.



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



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



NOTE

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

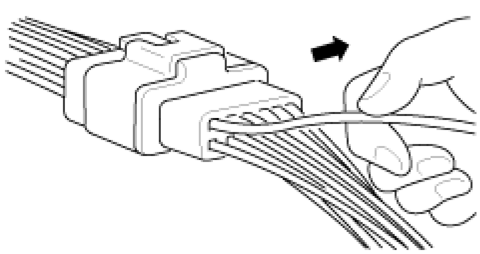
Checking Point for Connector

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.



Repair Method of Connector Terminal

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

NOTE

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

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

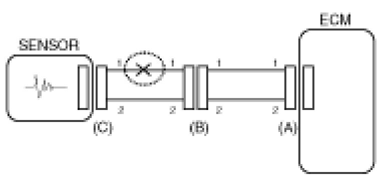
Procedures for Open Circuit

A. Continuity Check

B. Voltage Check

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

FIG 1



Continuity Check Method

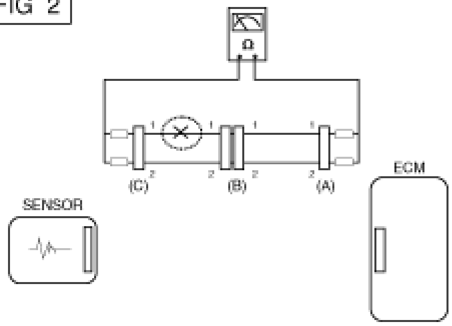
NOTE

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

Specification (Resistance)
1Ω or less → Normal Circuit
1MΩ or Higher → Open Circuit

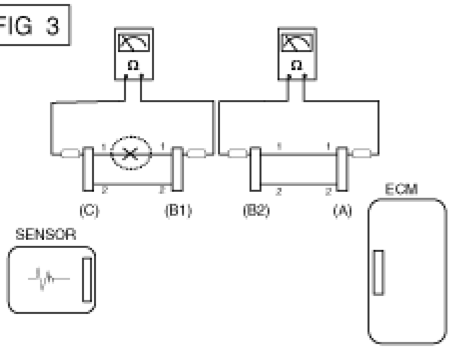
Disconnect connectors (A), (C) and measure resistance between connector (A) and (C) as shown in [FIG. 2].
In [FIG.2.] the measured resistance of line 1 and 2 is higher than 1MΩ and below 1 Ω respectively. Specifically the open circuit is line 1 (Line 2 is normal). To find exact break point, check sub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

FIG 2



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

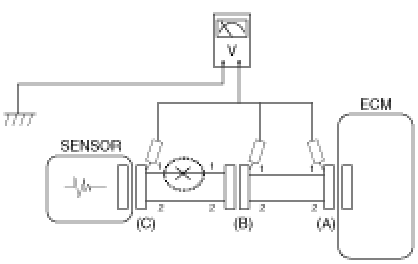
FIG 3



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).

FIG 4



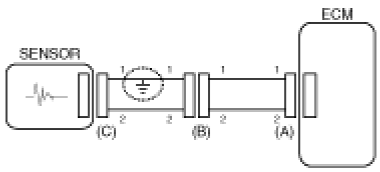
● Check Short Circuit

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.

FIG 5



Continuity Check Method (with Chassis Ground)

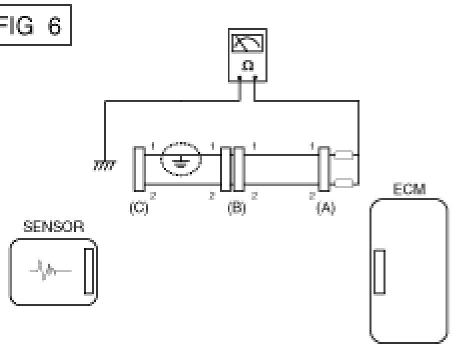
NOTE

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

Specification (Resistance)
1Ω or less → Short to Ground Circuit
1MΩ or Higher → Normal Circuit

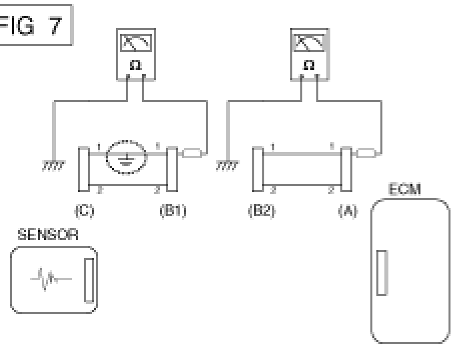
Disconnect connectors (A), (C) and measure for resistance between connector (A) and Chassis Ground as shown in [FIG. 6].
The measured resistance of line 1 and 2 in this example is below 1 Ω and higher than 1MΩ respectively. Specifically the short to ground circuit is line 1 (Line 2 is normal). To find exact broken point, check the sub line of line 1 as described in the following step.

FIG 6



Disconnect connector (B), and measure the resistance between connector (A) and chassis ground, and between (B1) and chassis ground as shown in [FIG. 7].
The measured resistance between connector (B1) and chassis ground is 1Ω or less. The short to ground circuit is between terminal 1 of connector (C) and terminal 1 of connector (B1).

FIG 7



● Testing For Voltage Drop

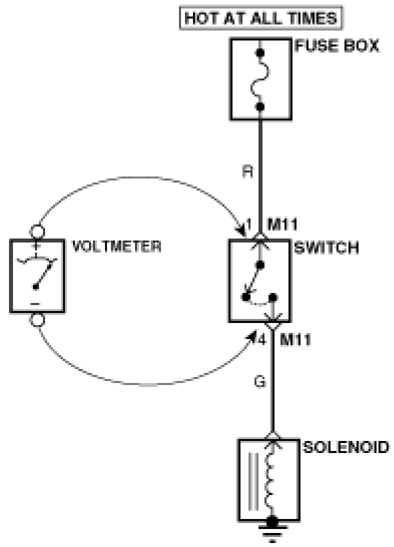
This test checks for voltage drop along a wire, or through a connection or switch.

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.



Main symptom	Diagnostic procedure	Also check for
Unable to start (Engine does not turn over)	1. Test the battery 2. Test the starter 3. Inhibitor switch (A/T) or clutch start switch (M/T)	
Unable to start (Incomplete combustion)	1. Test the battery 2. Check the fuel pressure 3. Check the ignition circuit 4. Troubleshooting the immobilizer system (In case of immobilizer lamp flashing)	• DTC • Low compression • Intake air leaks • Slipped or broken timing belt • Contaminated fuel
Difficult to start	1. Test the battery 2. Check the fuel pressure 3. Check the ECTS and circuit (Check DTC) 4. Check the ignition circuit	• DTC • Low compression • Intake air leaks • Contaminated fuel • Weak ignition spark
Poor idling (Rough, unstable or incorrect Idle)	1. Check the fuel pressure 2. Check the Injector 3. Check the long term fuel trim and short term fuel trim (Refer to CUSTOMER DATASTREAM) 4. Check the idle speed control circuit (Check DTC) 5. Inspect and test the Throttle Body 6. Check the ECTS and circuit (Check DTC)	• DTC • Low compression • Intake air leaks • Contaminated fuel • Weak ignition spark
Engine stall	1. Test the Battery 2. Check the fuel pressure 3. Check the idle speed control circuit (Check DTC) 4. Check the ignition circuit 5. Check the CKPS Circuit (Check DTC)	• DTC • Intake air leaks • Contaminated fuel • Weak ignition spark
Poor driving (Surge)	1. Check the fuel pressure 2. Inspect and test Throttle Body 3. Check the ignition circuit 4. Check the ECTS and Circuit (Check DTC) 5. Test the exhaust system for a possible restriction 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 2. Inspect the engine coolant 3. Inspect the radiator and the electric cooling fan 4. Check the spark plugs	• 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 3. Check the injector 4. Test the exhaust system for a possible restriction 5. Check the ECTS 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 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 canister and fuel tank air filter 4. Check the canister	• Malfunctioning gas station filling nozzle (If this problem occurs at a specific gas station during refueling)

Description and Operation

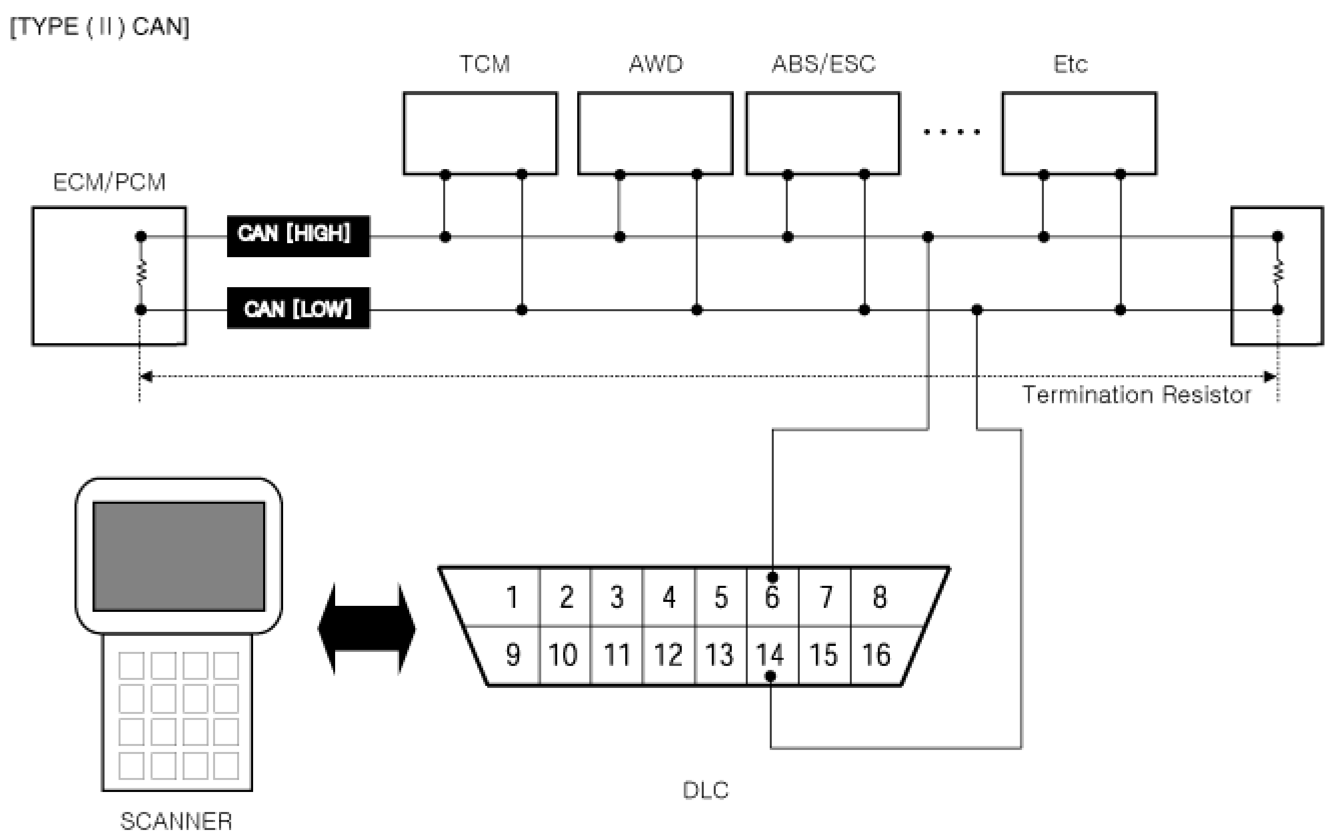
OBD-II review

1. Overview

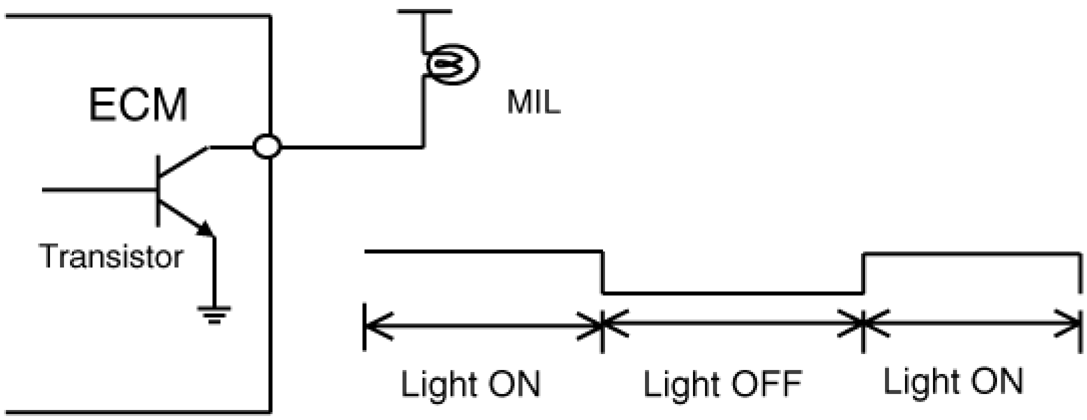
The California Air Resources Board (CARB) began regulation of On Board Diagnostics (OBD) for vehicles sold in California beginning with the 1988 model year. The first phase, OBD-I, required monitoring of the fuel metering system, Exhaust Gas Recirculation (EGR) system and additional emission related 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 cannot 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

1) Calculated Load Value
2) Engine RPM
3) Fuel Trim
4) Fuel Pressure (if available)
5) Vehicle Speed (if available)
6) Coolant Temperature
7) Intake Manifold Pressure (if available)
8) Closed-or Open-loop operation
9) 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

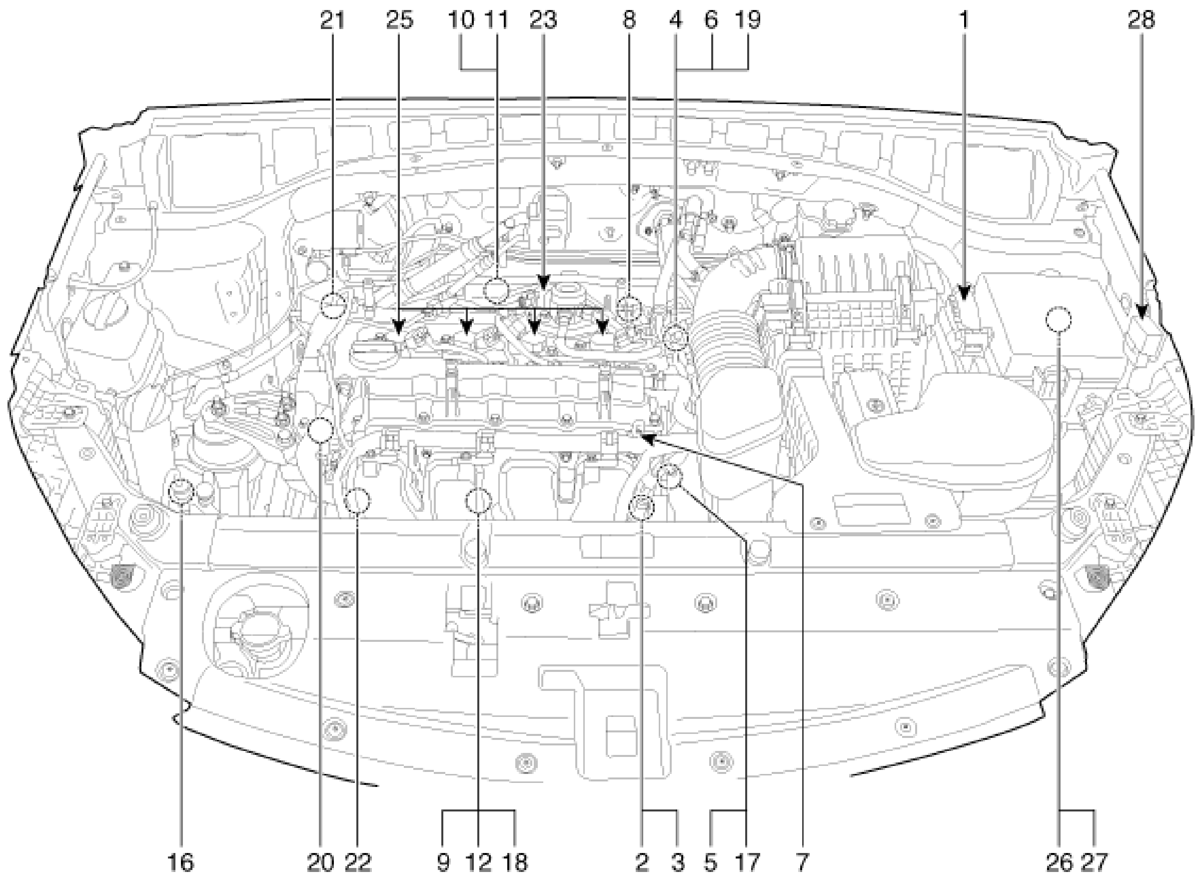
The EVAP. monitoring is a self-test strategy within the ECM or PCM that tests the integrity of the EVAP. system. The complete evaporative system detects a leak or leaks that cumulatively are greater than or equal to a leak caused by a 0.040 inch and 0.020 inch diameter orifice.
7) Air conditioning system monitoring

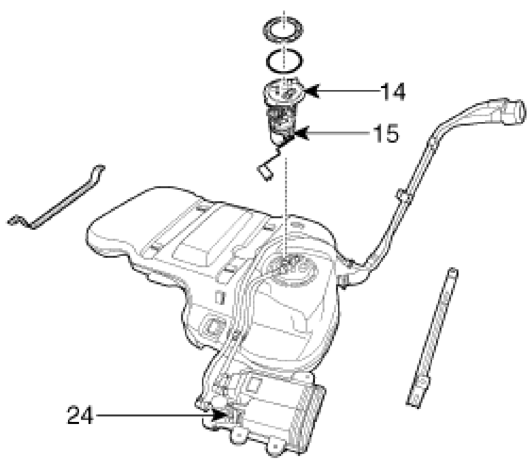
The A/C system monitoring is a self-test strategy within the ECM or PCM that monitors malfunction of all A/C system components at A/C ON.
8) Comprehensive components monitoring

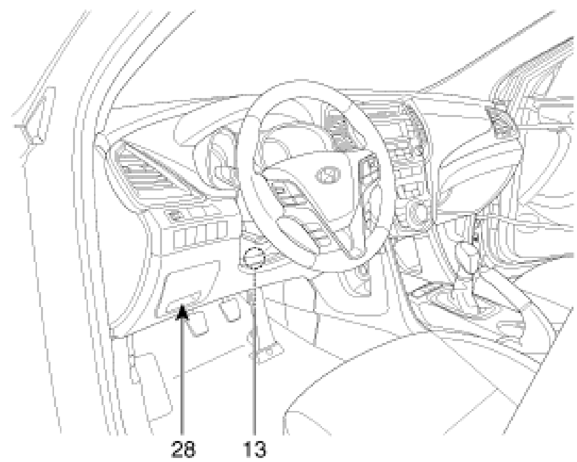
The comprehensive components monitoring is a self-test strategy within the ECM or PCM that detects fault of any electronic powertrain components or system that provides input to the ECM or PCM and is not exclusively an input to any other OBD-II monitor.
9) A/C system component monitoring

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.

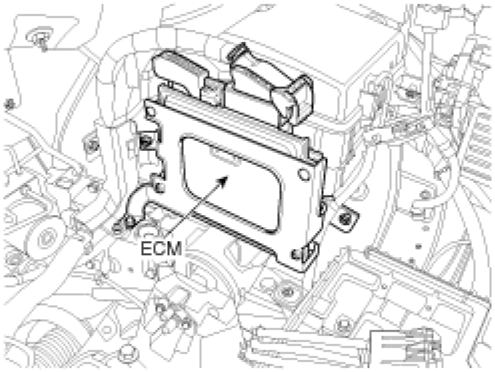
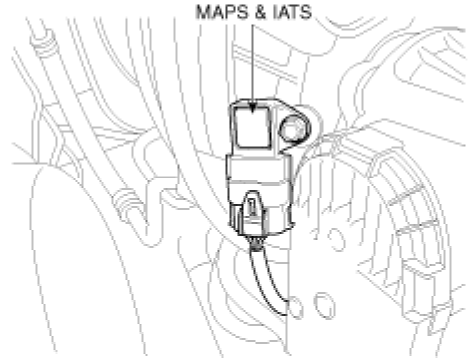
Components Location







1. Engine Control Module (ECM)	16. A/C Pressure Transducer (APT)
2. Manifold Absolute Pressure Sensor (MAPS)	17. ETC Motor [integrated into ETC Module]
3. Intake Air Temperature Sensor (IATS)	18. Injector
4. Engine Coolant Temperature Sensor (ECTS)	19. Purge Control Solenoid Valve (PCSV)
5. Throttle Position Sensor (TPS) [integrated into ETC Module]	20. CVVT Oil Control Valve (OCV) [Bank 1 / Intake]
6. Crankshaft Position Sensor (CKPS)	21. CVVT Oil Control Valve (OCV) [Bank 1 / Exhaust]
7. Camshaft Position Sensor (CMPS) [Bank 1 / Intake]	
8. Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust]	22. Variable Intake Solenoid (VIS) Valve
9. Knock Sensor (KS)	23. Fuel Pressure Regulator Valve
10. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 1]	24. Canister Close Valve (CCV)
11. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 2]	25. Ignition Coil
12. Rail Pressure Sensor (RPS)	26. Main Relay
13. Accelerator Position Sensor (APS)	27. Fuel Pump Relay
14. Fuel Tank Pressure Sensor (FTPS)	28. Data Link Connector (DLC) [16-Pin]
15. Fuel Level Sensor (FLS)	29. Multi-Purpose Check Connector [20-Pin]

<table>
<tr><td>1. Engine Control Module (ECM)</td><td>2. Manifold Absolute Pressure Sensor (MAPS)
3. Intake Air Temperature Sensor (IATS)</td></tr>
<tr><td>
</td><td>
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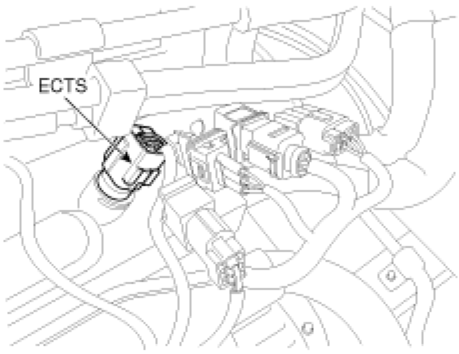
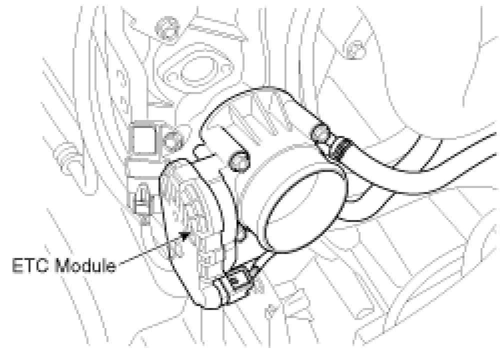
16. ETC Motor</td></tr>
<tr><td>
</td><td>
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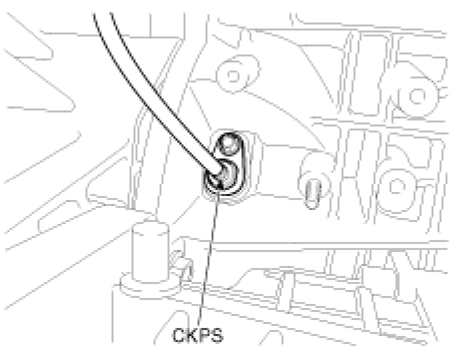
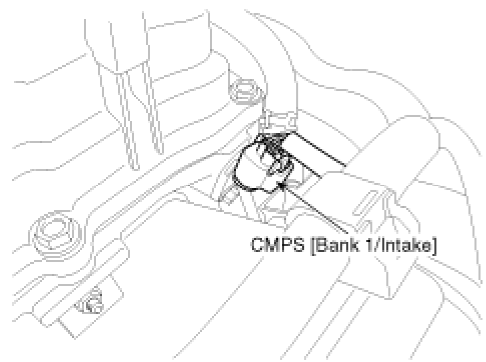
<tr><td>6. Crankshaft Position Sensor (CKPS)</td><td>7. Camshaft Position Sensor (CMPS) [Bank 1 / Intake]</td></tr>
<tr><td>
</td><td>
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<tr><td>8. Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust]</td><td>9. Knock Sensor (KS)</td></tr>
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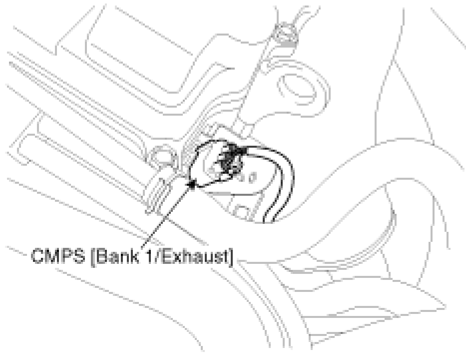
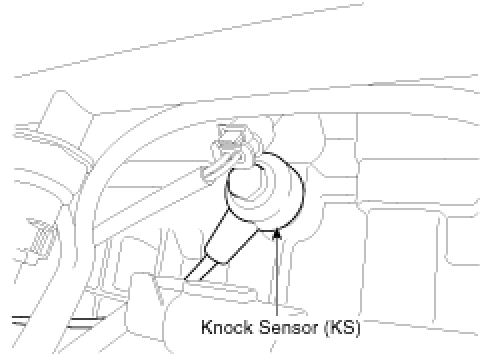
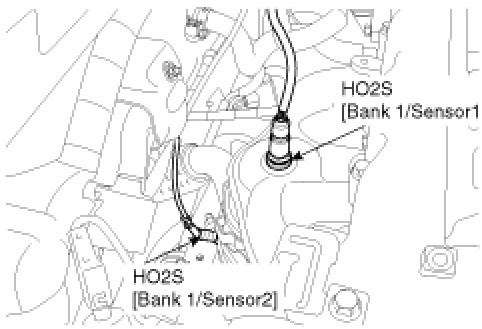
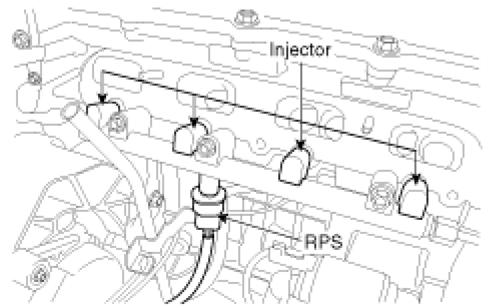
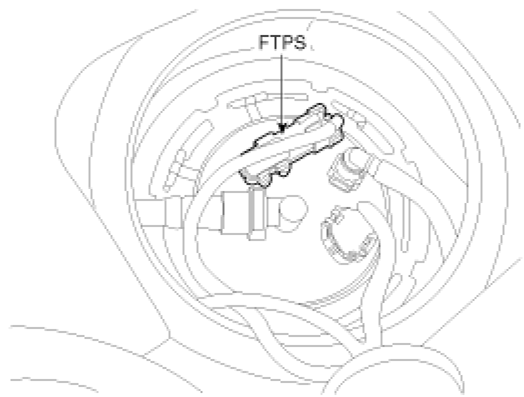
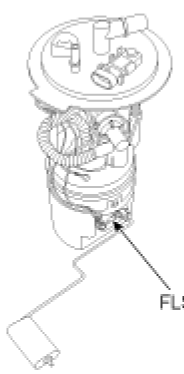
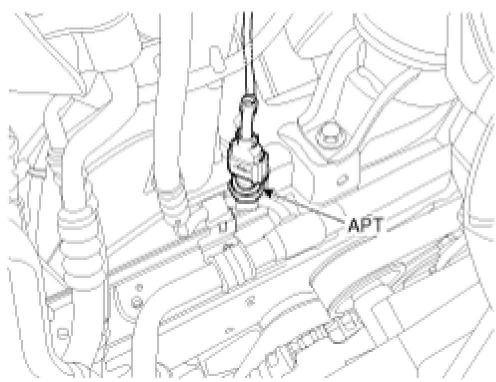
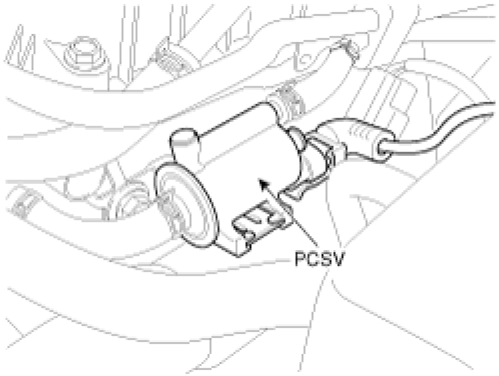
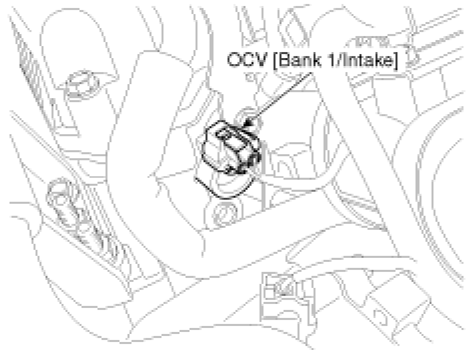
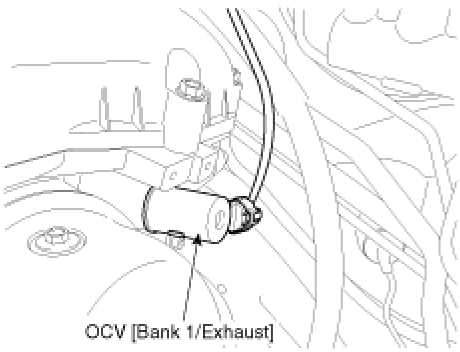
	
10. Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 1] 11. Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2]	12. Rail Pressure Sensor (RPS) 18. Injector
	
13. Accelerator Position Sensor (APS)	14. Fuel Tank Pressure Sensor (FTPS)
	
15. Fuel Level Sensor (FLS)	16. A/C Pressure Transducer (APT)
	
19. Purge Control Solenoid Valve (PCSV)	20. CVVT Oil Control Valve (OCV) [Bank 1 / Intake]

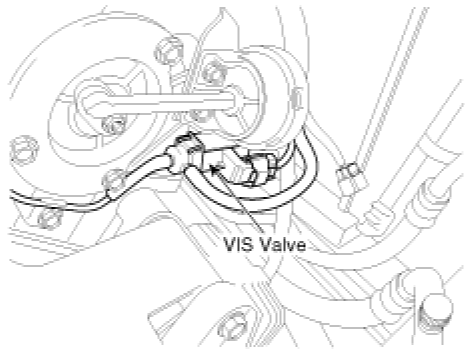




21. CVVT Oil Control Valve (OCV) [Bank 1 / Exhaust]

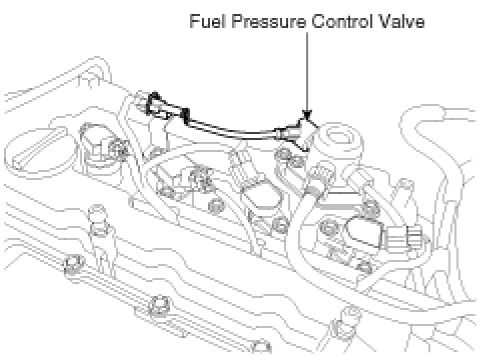
22. Variable Intake Solenoid (VIS) Valve

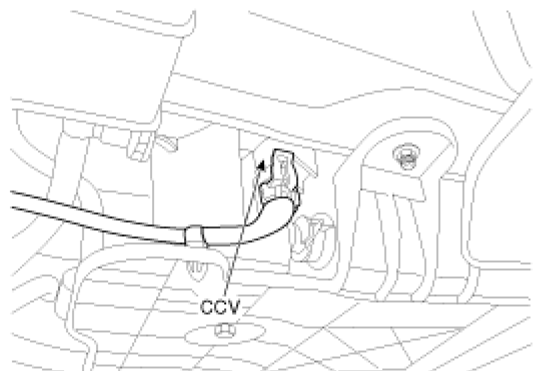




23. Fuel Pressure Control Valve

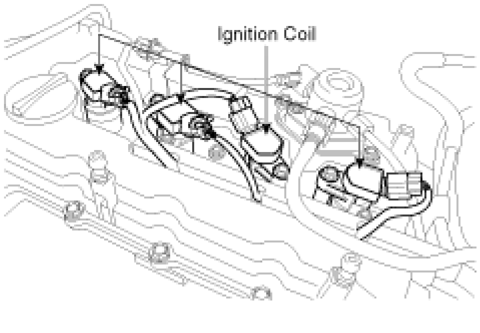
24. Canister Close Valve (CCV)

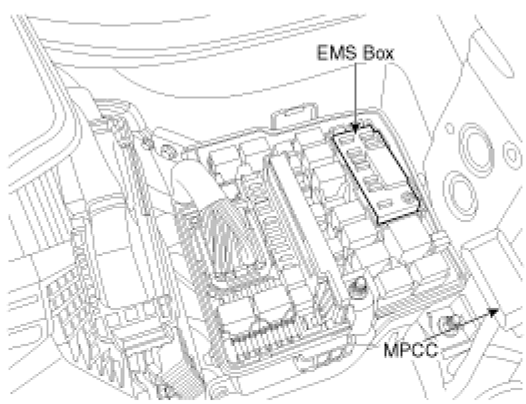


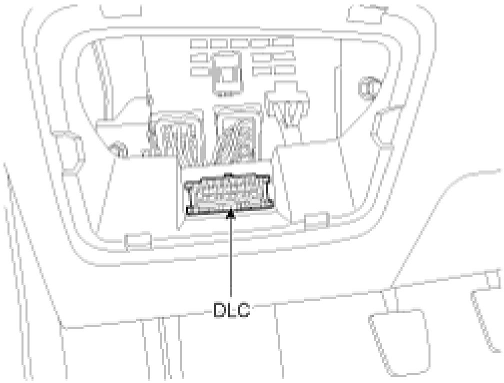


25. Ignition Coil

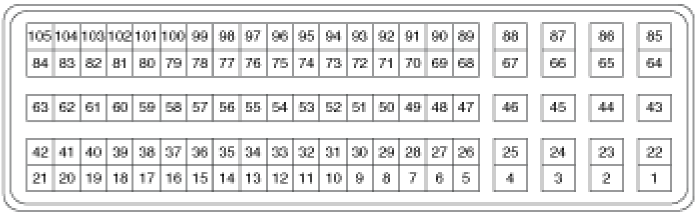
26. Main Relay
27. Fuel Pump Relay
29. Multi-Purpose Check Connector [20-pin]



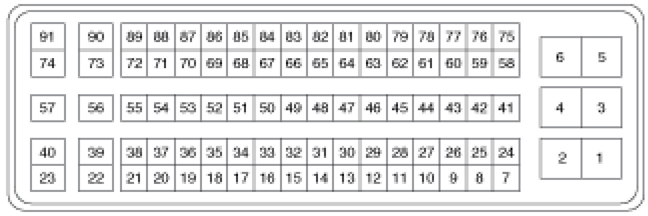


28. Data Link Connector (DLC) [16-Pin]	
	

ECM Terminal And Input/Output signal



Connector [C100-A]



Connector [C100-B]

ECM Terminal Function

Connector [C100-A]

Pin No.	Description	Connected to
1	Ignition Coil (Cylinder #2) control output [NON-smart key type]	Ignition Coil (Cylinder #2) [NON-smart key type]
	Ignition Coil (Cylinder #3) control output [smart key type]	Ignition Coil (Cylinder #3) [smart key type]
2	-	
3	-	
4	-	
5	ETC Motor [+] control output	ETC Motor
6	ETC Motor [-] control output	ETC Motor
7	-	
8	-	
9	-	
10	-	
11	-	
12	Sensor power (+5V)	Rail Pressure Sensor (RPS)
		A/C Pressure Transducer (APT)
		Fuel Tank Pressure Sensor (FTPS)
13	-	
14	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2] signal input	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2]
15	-	
16	-	
17	-	
18	-	
19	-	
20	Fuel Tank Pressure Sensor (FTPS) signal input	Fuel Tank Pressure Sensor (FTPS)
21	-	
22	Ignition Coil (Cylinder #4) control output [NON-smart key type]	Ignition Coil (Cylinder #4) [NON-smart key type]
	Ignition Coil (Cylinder #1) control output [smart key type]	Ignition Coil (Cylinder #1) [smart key type]
23	-	

24	-	
25	-	
26	-	
27	-	
28	-	
29	-	
30	-	
31	-	
32	-	
33	Sensor power (+5V)	Throttle Position Sensor (TPS) 1,2
34	-	
35	Sensor ground	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2]
36	-	
37	-	
38	-	
39	Rail Pressure Sensor (RPS) signal input	Rail Pressure Sensor (RPS)
40	-	
41	Sensor ground	Fuel Tank Pressure Sensor (FTPS)
42	-	
43	-	
44	-	
45	-	
46	-	
47	-	
48	-	
49	-	
50	-	
51	-	
52	-	
53	-	
54	Sensor ground	Throttle Position Sensor (TPS) 1,2
55	Sensor ground	Accelerator Position Sensor (APS) 2
56	Sensor ground	Accelerator Position Sensor (APS) 1
57	Immobilizer communication line	Smart Key Control Module [With Button Engine Start System] Immobilizer Control Module [Without Button Engine Start System]
58	-	
59	Intake Air Temperature Sensor (IATS) signal input	Intake Air Temperature Sensor (IATS)

60	Sensor ground	Rail Pressure Sensor (RPS)
61	Sensor ground	Manifold Absolute Pressure Sensor (MAPS)
		Intake Air Temperature Sensor (IATS)
62	Sensor ground	Engine Coolant Temperature Sensor (ECTS)
63	Engine Coolant Temperature Sensor (ECTS) signal input	Engine Coolant Temperature Sensor (ECTS)
64	Ignition Coil (Cylinder #3) control output [NON-smart key type]	Ignition Coil (Cylinder #3) [NON-smart key type]
	Ignition Coil (Cylinder #2) control output [smart key type]	Ignition Coil (Cylinder #2) [smart key type]
65	-	
66	-	
67	-	
68	-	
69	-	
70	-	
71	-	
72	-	
73	-	
74	-	
75	Throttle Position Sensor (TPS) 2 signal input	Throttle Position Sensor (TPS) 2
76	Accelerator Position Sensor (APS) 2 signal input	Accelerator Position Sensor (APS) 2
77	Accelerator Position Sensor (APS) 1 signal input	Accelerator Position Sensor (APS) 1
78	-	
79	-	
80	Sensor ground	A/C Pressure Transducer (APT)
81	-	
82	Manifold Absolute Pressure Sensor (MAPS) signal input	Manifold Absolute Pressure Sensor (MAPS)
83	Rc/Rp (Pump Cell Voltage)	Heated Oxygen Sensor [Bank 1/Sensor 1]
84	VS-/IP- (Common Ground for VS, IP)	Heated Oxygen Sensor [Bank 1/Sensor 1]
85	Ignition Coil (Cylinder #1) control output [NON-smart key type]	Ignition Coil (Cylinder #1) [NON-smart key type]
	Ignition Coil (Cylinder #4) control output [smart key type]	Ignition Coil (Cylinder #4) [smart key type]
86	-	
87	-	
88	-	
89	-	
90	-	
91	-	
92	-	
93	-	
94	-	

95	-	
96	Throttle Position Sensor (TPS) 1 signal input	Throttle Position Sensor (TPS) 1
97	Sensor power (+5V)	Accelerator Position Sensor (APS) 2
98	Sensor power (+5V)	Accelerator Position Sensor (APS) 1
99	-	
100	-	
101	A/C Pressure Transducer (APT) signal input	A/C Pressure Transducer (APT)
102	-	
103	Sensor power (+5V)	Manifold Absolute Pressure Sensor (MAPS)
104	Rc (Compensative Resistance)	Heated Oxygen Sensor [Bank 1/Sensor 1]
105	VS+ (NERNST Cell Voltage)	Heated Oxygen Sensor [Bank 1/Sensor 1]

Connector [C100-B]

Pin No.	Description	Connected to
1	ECM ground	Chassis ground
2	ECM ground	Chassis ground
3	Battery power (B+)	Main Relay
4	ECM ground	Chassis ground
5	Battery power (B+)	Main Relay
6	Battery power (B+)	Main Relay
7	-	
8	Crankshaft Position Sensor (CKPS) signal input	Crankshaft Position Sensor (CKPS)
9	-	
10	Brake Switch 2 signal input	Brake Switch
11	-	
12	-	
13	-	
14	-	
15	Electrical load signal input	Alternator
16	Alternator PWM signal output	Alternator
17	Electrical load [Wiper] signal input	Wiper Relay
18	-	
19	-	
20	-	
21	-	
22	Injector (Cylinder #2) [High] control output	Injector (Cylinder #2)
23	Injector (Cylinder #2) [Low] control output	Injector (Cylinder #2)
24	-	
25	Sensor ground	Crankshaft Position Sensor (CKPS)
26	-	
27	Brake Switch 1 signal input	Brake Switch

28	-	
29	Camshaft Position Sensor (CMPS) [Bank 1/Intake] signal input	Camshaft Position Sensor (CMPS) [Bank 1/Intake]
30	Camshaft Position Sensor (CMPS) [Bank 1/Exhaust] signal input	Camshaft Position Sensor (CMPS) [Bank 1/Exhaust]
31	-	
32	LIN communication signal input	Battery Sensor
33	Cooling Fan Relay control output	Cooling Fan Relay [Low]
34		

Removal

CAUTION

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 "Immobilizer" in BE group)

CAUTION

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 - "Smart key 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.

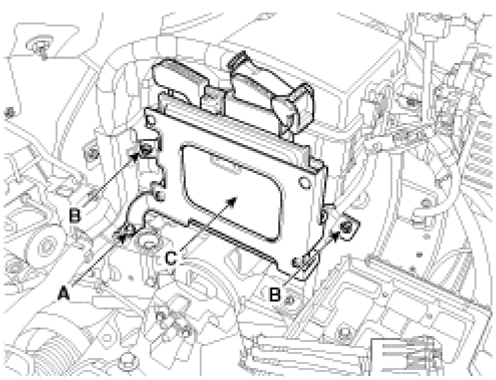
Turn ignition switch OFF and disconnect the negative (-) battery cable.

Disconnect the ECM Connector (A).

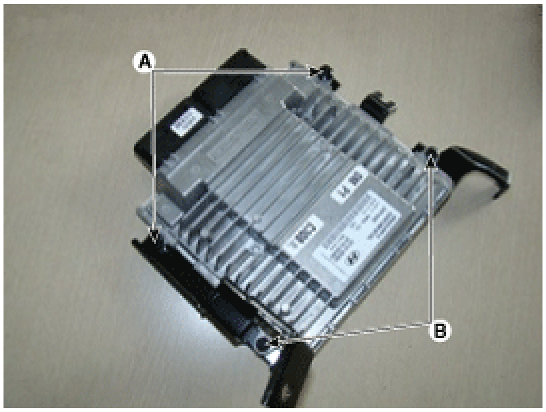
Remove the battery.
(Refer to Engine Electrical System - "Battery")

Remove the air cleaner assembly.
(Refer to Engine Mechanical System - "Air Cleaner")

Remove the mounting bolts (A) and nut (B), and then remove the ECM (C).



After removing the installation nuts (A) and screws (B), remove the ECM (C) from the bracket.



Installation

CAUTION

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 "Immobilizer" in BE group)

CAUTION

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 - "Smart key 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.

Install in the reverse order of removal.

ECM installation bolt:
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m,7.2 ~ 8.7 lb-ft)
ECM bracket installation bolt/nut:
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m,7.2 ~ 8.7 lb-ft)

ECM Problem Inspection Procedure

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

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.

If problem is not found in Step 1 and 2, the ECM could be faulty. If so, make sure there were no DTC's before swapping the ECM with a new one, and then check the vehicle again. If DTC's were found, examine this first before swapping ECM.

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

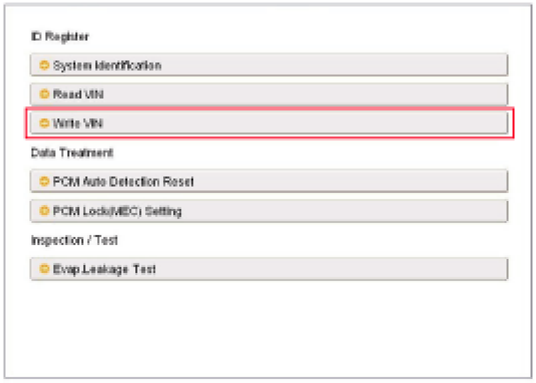
VIN (Vehicle Identification Number) is a number that has the vehicle's information (Maker, Vehicle Type, Vehicle Line/Series, Body Type, Engine Type, Transmission Type, Model Year, Plant Location and so forth. For more information, please refer to the group "GI" in this SERVICE MANUAL). When replacing 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

Select "VIN Writing" function in "Vehicle S/W Management".

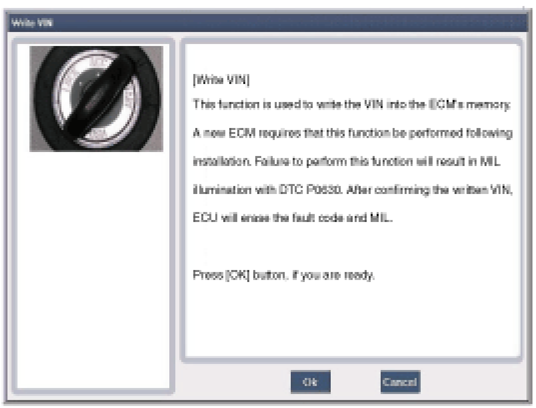
Select "Write VIN" in "ID Register".



Input the VIN.

WARNING

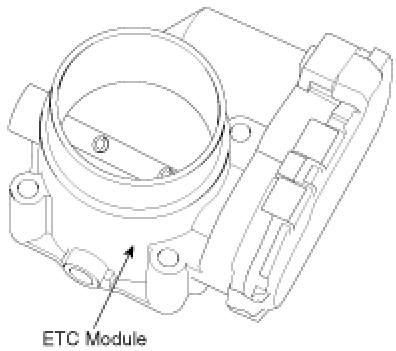
Before inputting the VIN, confirm the VIN again because the programmed VIN cannot be changed.

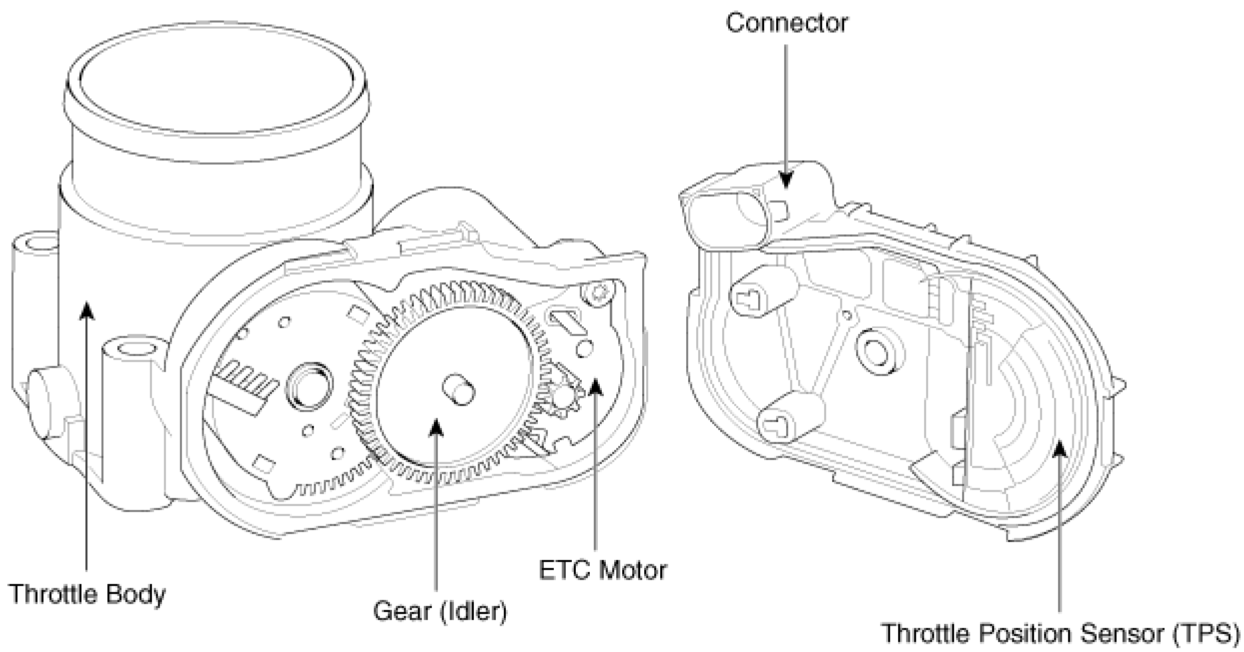


Turn the ignition switch OFF, then back ON.

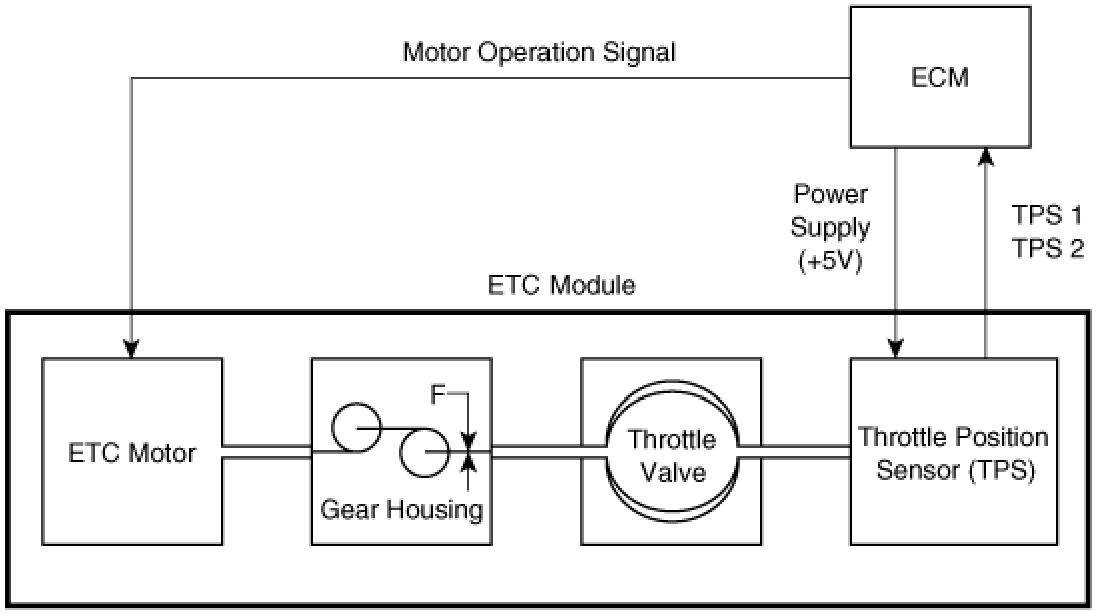
Description

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.





Schematic Diagram



Fail-Safe Mode

Item	Fail-Safe	
ETC Motor	Throttle valve stuck at 5°	
TPS	TPS 1 fault	ECM looks at TPS2
	TPS 2 fault	ECM looks at TPS1
	TPS 1,2 fault	Throttle valve stuck at 5°
APS	APS 1 fault	ECM looks at APS 2
	APS 2 fault	ECM looks at APS 1
	APS 1,2 fault	Throttle valve stuck at 5°

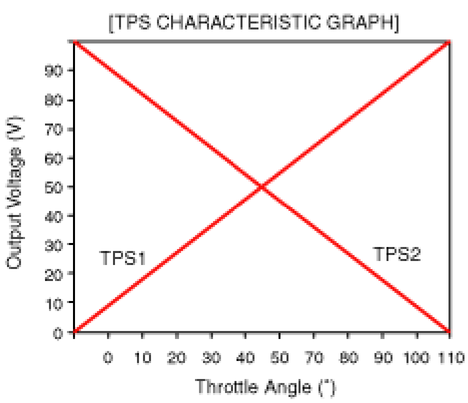
NOTE

When throttle value is stuck at 5°, engine speed is limited at below 1,500rpm and vehicle speed at maximum 40 ~ 50 km/h (25 ~ 31 mph)

Specification

[Throttle Position Sensor (TPS)]

Throttle Angle(°)	Output Voltage(V)	
	TPS1	TPS2
0	0.0	5.0
10	0.48	4.52
20	0.95	4.05
30	1.43	3.57
40	1.90	3.10
50	2.38	2.62
60	2.86	2.14
70	3.33	1.67
80	3.81	1.19
90	4.29	0.71
100	4.76	0.24
105	5.0	0
C.T (6 ~ 15°)	0.29 ~ 0.71	4.29 ~ 4.71
W.O.T (93 ~ 102°)	4.43 ~ 4.86	0.14 ~ 0.57



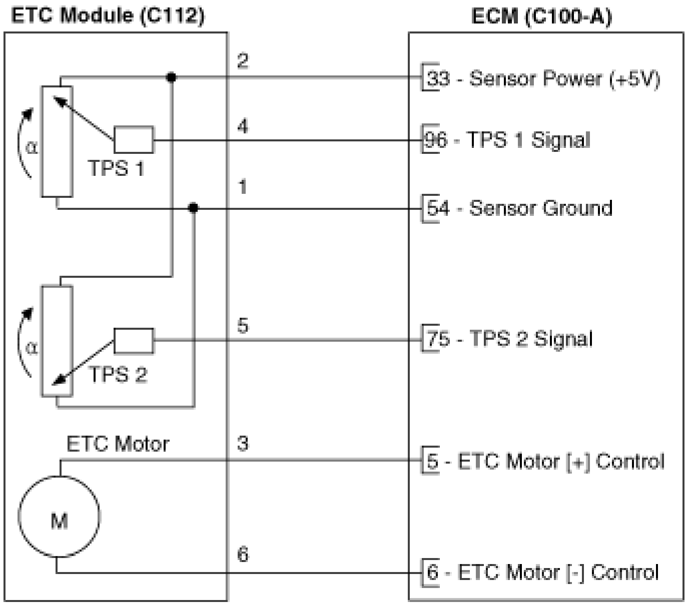
Item	Sensor Resistance(kΩ)
TPS1	0.875 ~ 1.625 [20°C(68°F)]
TPS2	0.875 ~ 1.625 [20°C(68°F)]

[ETC Motor]

Item	Specification
Coil Resistance (Ω)	1.2 ~ 1.8 [20°C(68°F)]

Circuit Diagram

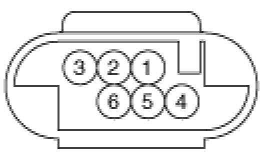
[Circuit Diagram]



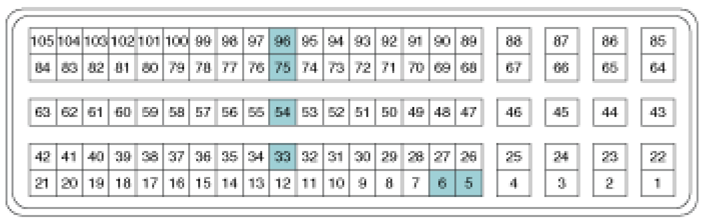
[Connection Information]

Terminal	Connected to	Function
1	ECM C100-A (54)	Sensor Ground
2	ECM C100-A (33)	Sensor Power (+5V)
3	ECM C100-A (5)	ETC Motor [+] Control
4	ECM C100-A (96)	TPS 1 Signal
5	ECM C100-A (75)	TPS 2 Signal
6	ECM C100-A (6)	ETC Motor [-] Control

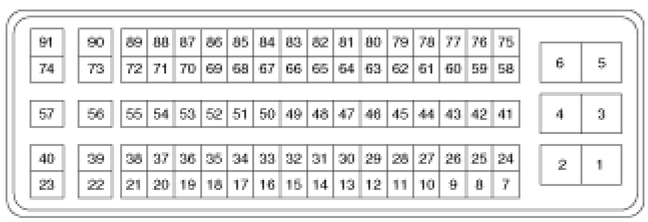
[Harness Connector]



C112
ETC Module



C100-A



C100-B
ECM

Inspection

Throttle Position Sensor (TPS)

Connect the GDS on the Data Link Connector (DLC).

Start the engine and measure the output voltage of TPS 1 and 2 at C.T. and W.O.T.

Specification: Refer to “Specification”

Turn the ignition switch OFF and disconnect the scan tool from the DLC.

Disconnect the ETC module connector and measure the resistance between the ETC module terminals 1 and 2.

Specification: Refer to “Specification”

ETC Motor

Turn the ignition switch OFF.

Disconnect the ETC module connector.

Measure resistance between the ETC module terminals 3 and 6.

Check that the resistance is within the specification.

Specification: Refer to “Specification”

Removal

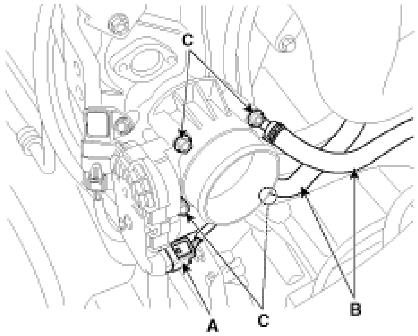
Turn the ignition switch OFF and disconnect the battery negative (-) cable.

Remove the resonator and the air intake hose.
(Refer to Engine Mechanical System - "Air Cleaner")

Disconnect the ETC module connector (A).

Disconnect the coolant hoses (B).

Remove the installation bolts (C), and then remove the ETC module 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.

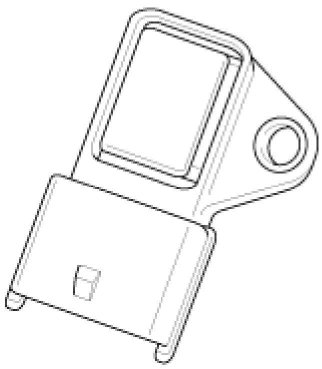
Install in the reverse order of removal.

Electronic throttle body Installation bolt:
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)

Manifold Absolute Pressure Sensor (MAPS). Description and Operation

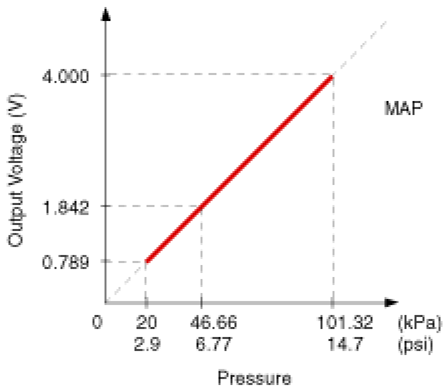
Description

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.



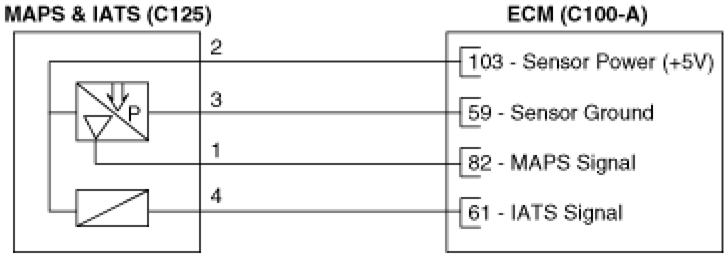
Specification

Pressure [kPa (kgf/cm², psi)]	Output Voltage (V)
20.0 (0.20, 2.9)	0.79
46.7 (0.47, 6.77)	1.84
101.3 (1.03, 14.7)	4.0



Circuit Diagram

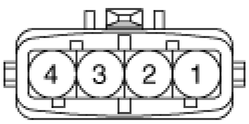
[Circuit Diagram]



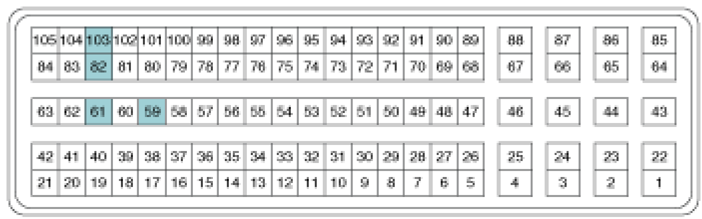
[Connection Information]

Terminal	Connected to	Function
1	ECM C100-A (82)	MAPS Signal
2	ECM C100-A (103)	Sensor Power (+5V)
3	ECM C100-A (59)	Sensor Ground
4	ECM C100-A (61)	IATS Signal

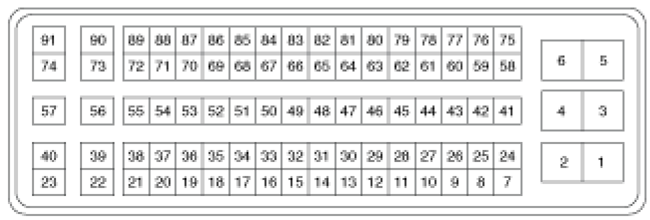
[Harness Connector]



C125
MAPS & IATS



C100-A



C100-B
ECM

Inspection

Connect the GDS on the Data Link Connector (DLC).

Measure the output voltage of the MAPS at idle and IG ON.

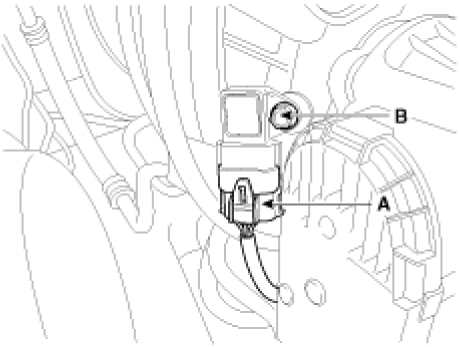
Specification: Refer to "Specification"

Removal

Turn the ignition switch OFF and disconnect the battery negative (-) cable.

Disconnect the manifold absolute pressure sensor connector (A).

Remove the installation bolt (B), and then 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

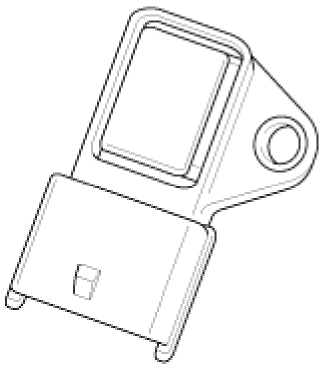
- Insert the sensor in the installation hole and be careful not to damage.

Install in the reverse order 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)

Description

Intake Air Temperature Sensor (IATS) is included inside Manifold Absolute Pressure Sensor 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 MAPS signal but also IATS signal. This sensor has a Negative Temperature Coefficient (NTC) Thermistor and it's resistance changes in reverse proportion to the temperature.

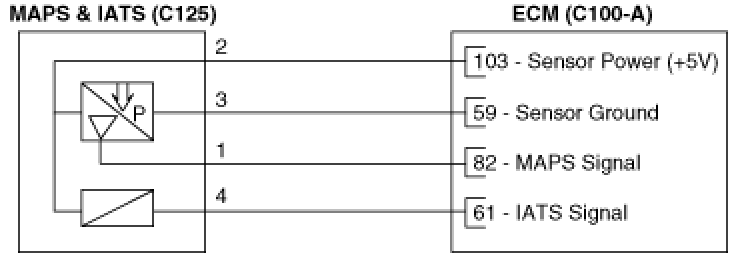


Specification

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 ~ 0.62
80	176	0.29 ~ 0.34

Circuit Diagram

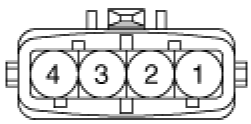
[Circuit Diagram]



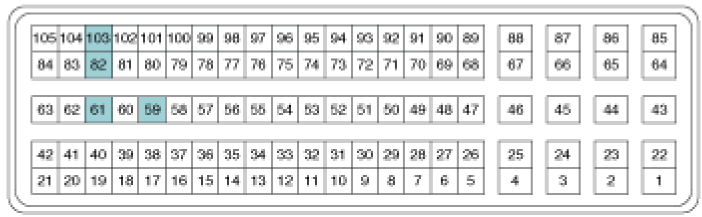
[Connection Information]

Terminal	Connected to	Function
1	ECM C100-A (82)	MAPS Signal
2	ECM C100-A (103)	Sensor Power (+5V)
3	ECM C100-A (59)	Sensor Ground
4	ECM C100-A (61)	IATS Signal

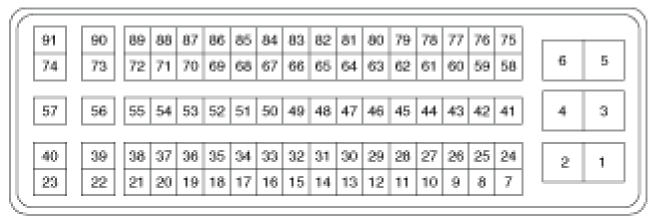
[Harness Connector]



C125
MAPS & IATS



C100-A



C100-B
ECM

Inspection

Turn the ignition switch OFF.

Disconnect the IATS connector.

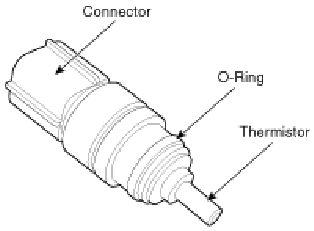
Measure resistance between the IATS terminals 3 and 4.

Check that the resistance is within the specification.

Specification: Refer to “Specification”

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 that changes resistance 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.
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.

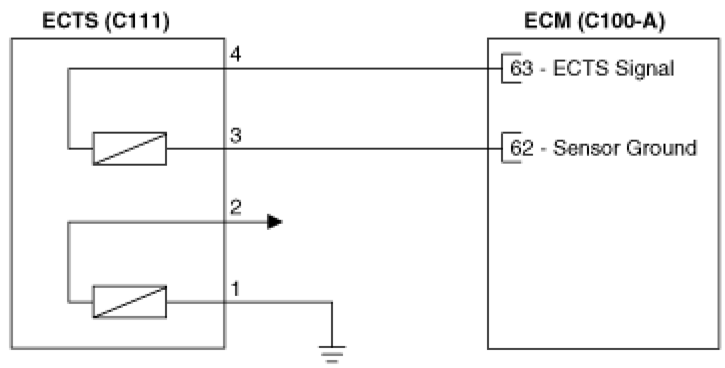


Specification

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

Circuit Diagram

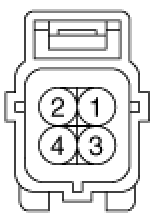
[Circuit Diagram]



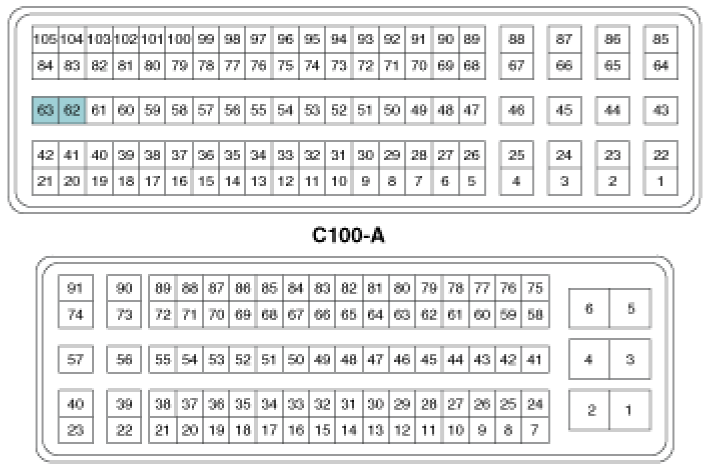
[Connection Information]

Terminal	Connected to	Function
1	Chassis Ground	Sensor Ground
2	-	-
3	ECM C100-A (62)	Sensor Ground
4	ECM C100-A (63)	ECTS Signal

[Harness Connector]



C111
ECTS



C100-A

C100-B
ECM

Engine Coolant Temperature Sensor (ECTS). Repair procedures

Inspection

Turn the ignition switch OFF.

Remove the ECTS (Refer to "Removal").

After immersing the thermistor of the sensor into engine coolant, measure resistance between the ECTS terminals 3 and 4.

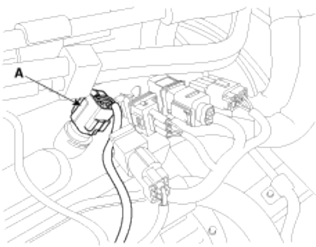
Check that the resistance is within the specification.

Specification: Refer to “Specification”

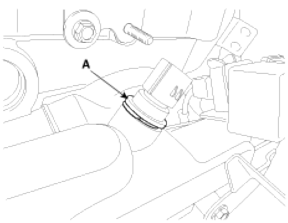
Removal

Turn the ignition switch OFF and disconnect the battery negative (-) cable.

Disconnect the engine coolant temperature sensor connector (A).



Remove the spring clip (A), 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.

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.

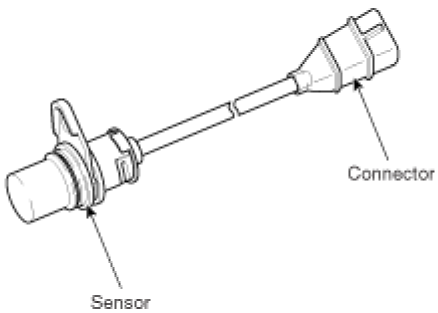
CAUTION

- Insert the sensor in the installation hole and be careful not to damage.

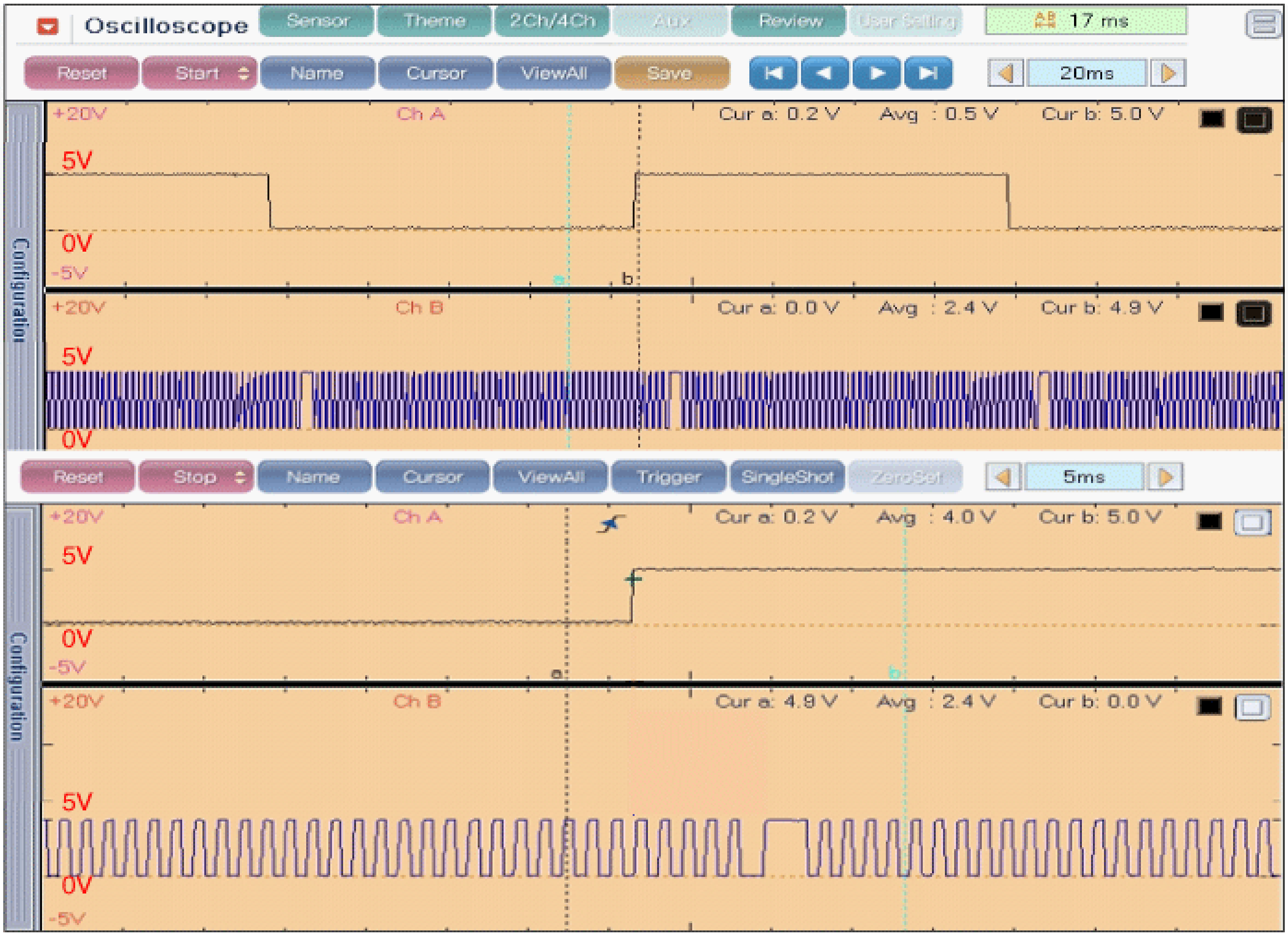
Install in the reverse order of removal.

Description

Crankshaft Position Sensor (CKPS) detects the crankshaft position and is one of the most important sensors of the 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).



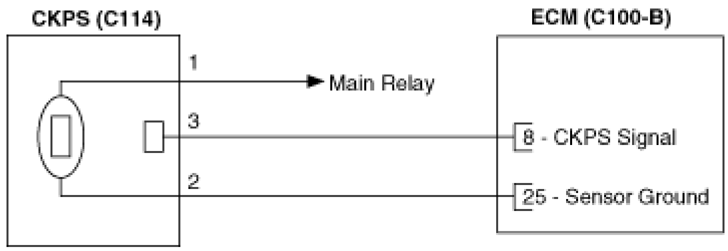
Wave Form



Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
17 ms
Reset
Start
Name
Cursor
ViewAll
Save
20ms
+20V
Ch A
Cur a: 0.2 V
Avg : 0.5 V
Cur b: 5.0 V
5V
0V
-5V
+20V
Ch B
Cur a: 0.0 V
Avg : 2.4 V
Cur b: 4.9 V
5V
0V
Configuration
Reset
Stop
Name
Cursor
ViewAll
Trigger
SingleShot
ZeroSet
5ms
+20V
Ch A
Cur a: 0.2 V
Avg : 4.0 V
Cur b: 5.0 V
5V
0V
-5V
+20V
Ch B
Cur a: 4.9 V
Avg : 2.4 V
Cur b: 0.0 V
5V
0V
-5V
Configuration

Circuit Diagram

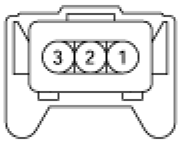
[Circuit Diagram]



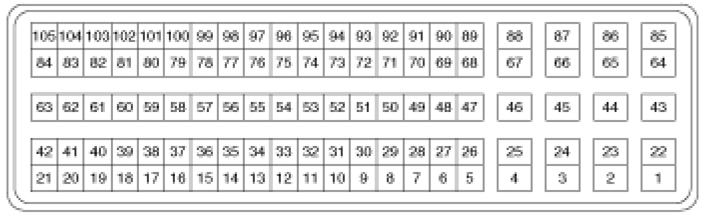
[Connection Information]

Terminal	Connected to	Function
1	Main Relay	Battery Power (B+)
2	ECM C100-B (25)	CKPS Signal
3	ECM C100-B (8)	Sensor Ground

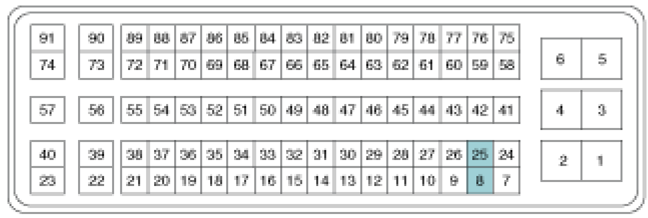
[Harness Connector]



C114
CKPS



C100-A

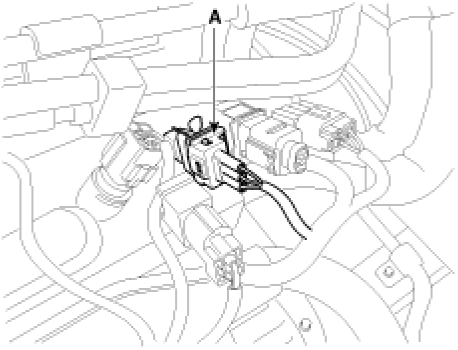


C100-B
ECM

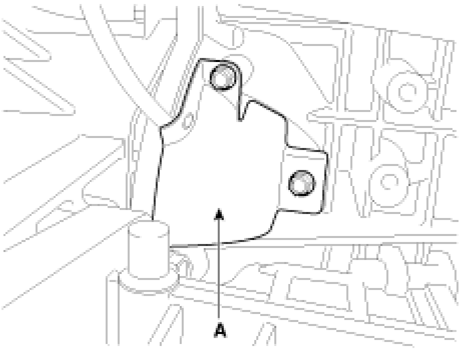
Removal

Turn the ignition switch OFF and disconnect the battery negative (-) cable.

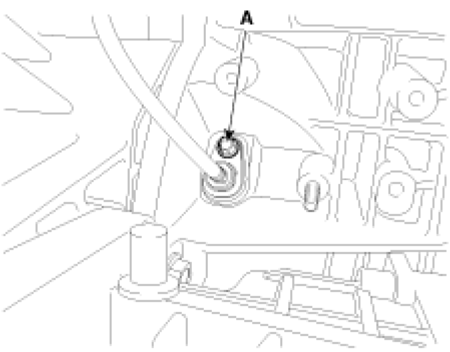
Disconnect the crankshaft position sensor connector (A).



Remove the protector (A).



Remove the installation bolt (A), and then remove the crankshaft position sensor.



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

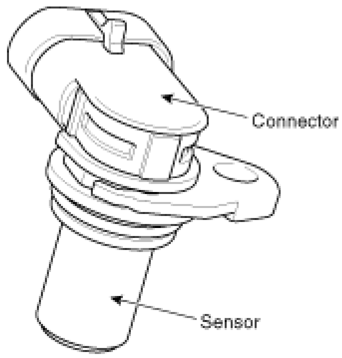
- Insert the sensor in the installation hole and be careful not to damage.

Install in the reverse order of removal.

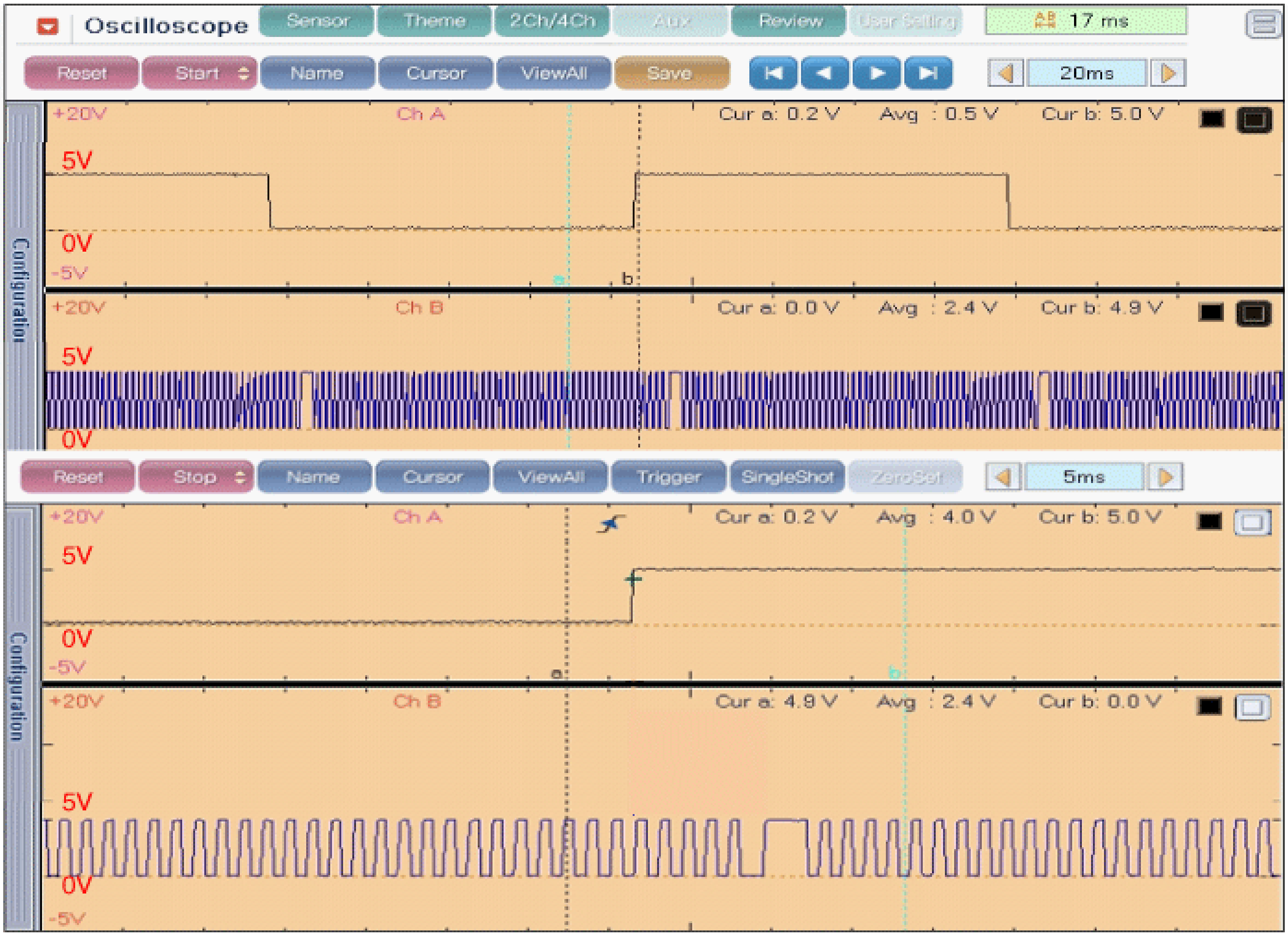
Crankshaft position sensor installation bolt: 9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)
Crankshaft position sensor protector installation bolt (M6): 9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)
Crankshaft position sensor protector installation bolt (M8): 18.6 ~ 23.5 N.m (1.9 ~ 2.4 kgf.m, 13.7 ~ 17.4 lb-ft)

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 CMPS is installed on engine head cover 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.

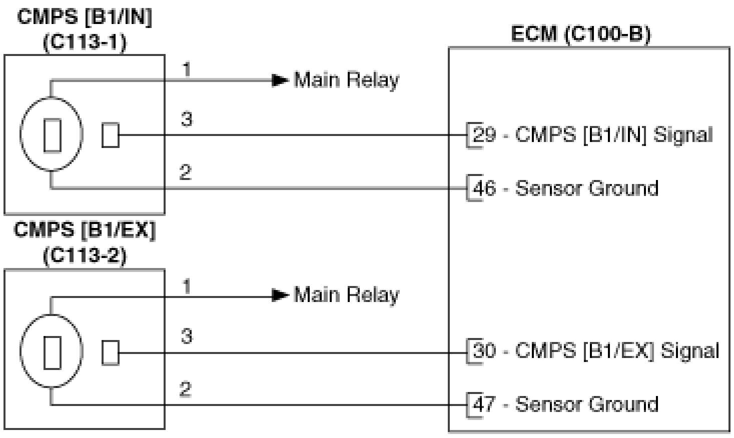


Wave Form


Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
17 ms
Reset
Start
Name
Cursor
ViewAll
Save
20ms
+20V
Ch A
Cur a: 0.2 V
Avg : 0.5 V
Cur b: 5.0 V
5V
0V
-5V
Ch B
Cur a: 0.0 V
Avg : 2.4 V
Cur b: 4.9 V
Configuration
Reset
Stop
Name
Cursor
ViewAll
Trigger
SingleShot
ZeroSet
5ms
Ch A
Cur a: 0.2 V
Avg : 4.0 V
Cur b: 5.0 V
Ch B
Cur a: 4.9 V
Avg : 2.4 V
Cur b: 0.0 V

Circuit Diagram

[Circuit Diagram]



[Connection Information]

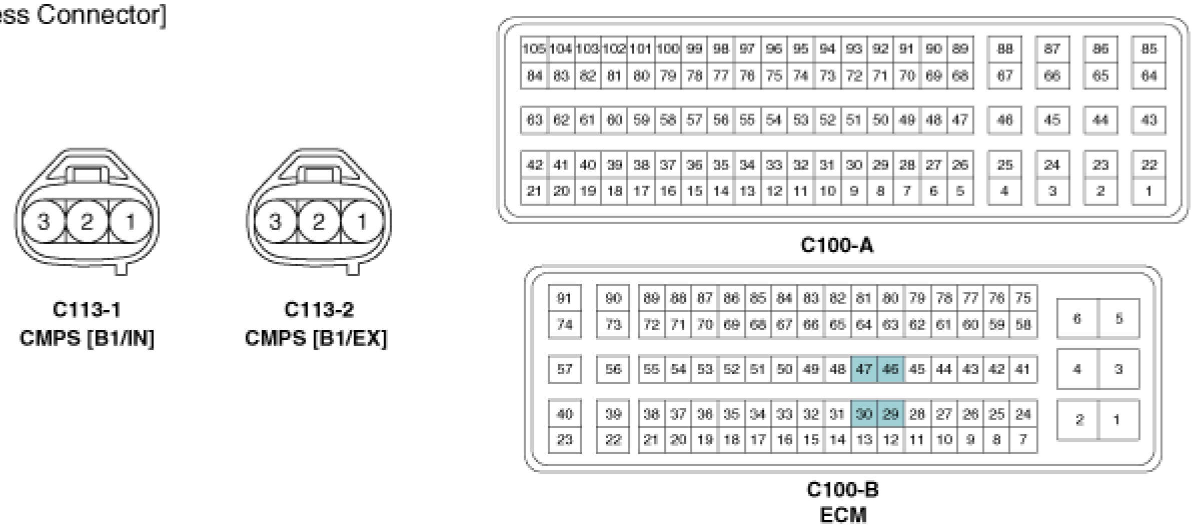
CMPS [B1/IN] (C113-1)

Terminal	Connected to	Function
1	Main Relay	Battery Power (B+)
2	ECM C100-B (46)	Sensor Ground
3	ECM C100-B (29)	CMPS [B1/IN] Signal

CMPS [B1/EX] (C113-2)

Terminal	Connected to	Function
1	Main Relay	Battery Power (B+)
2	ECM C100-B (47)	Sensor Ground
3	ECM C100-B (30)	CMPS [B1/EX] Signal

[Harness Connector]



Inspection

Check the signal waveform of the CMPS and CKPS using the GDS.

Specification: Refer to "Wave Form"

Removal

WARNING

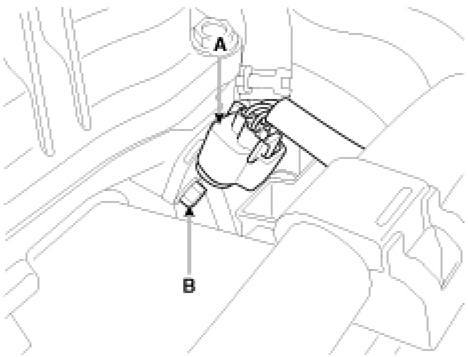
- DON'T remove the camshaft position sensor while the engine is running or right after engine is turned off. The part and engine oil is hot and can cause burns.

[Bank 1 / Intake]

Turn the ignition switch OFF and disconnect the battery negative (-) cable.

Disconnect the camshaft position sensor connector (A).

Remove the installation bolt (B), and then remove the sensor.



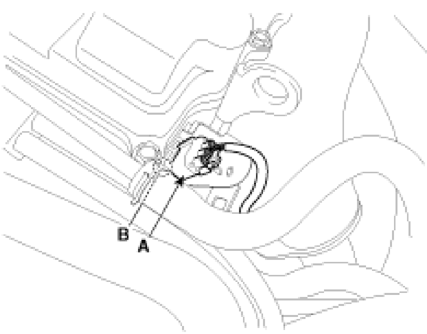
[Bank 1 / Exhaust]

Turn the ignition switch OFF and disconnect the battery negative (-) cable.

Disconnect the camshaft position sensor connector (A).

Remove the hanger and the protector.

Remove the installation bolt (B), and then remove the sensor.



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.

CAUTION

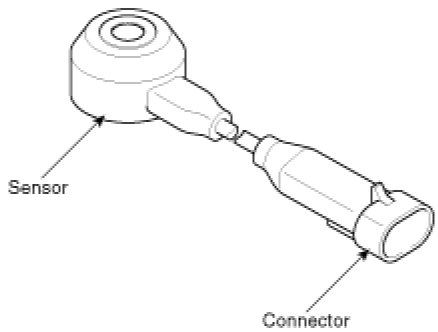
- Be careful not to damage the sensor housing and the connector.
- Be careful not to damage the O-ring.

Install in the reverse order of removal.

Camshaft position sensor installation bolt:
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)

Description

Knocking is a phenomenon characterized by undesirable vibration and noise and can cause engine damage. Knock Sensor (KS) is installed on 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.

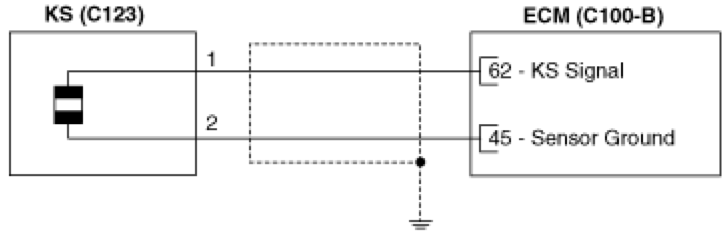


Specification

Item	Specification
Capacitance (pF)	850 ~ 1,150

Circuit Diagram

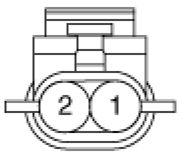
[Circuit Diagram]



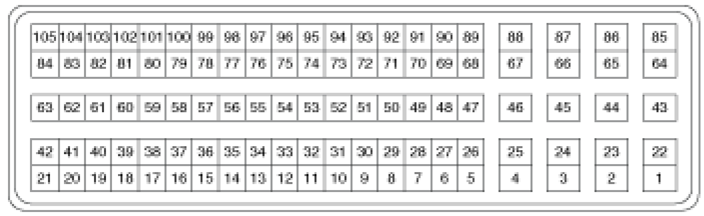
[Connection Information]

Terminal	Connected to	Function
1	ECM C100-B (62)	KS Signal
2	ECM C100-B (45)	Sensor Ground

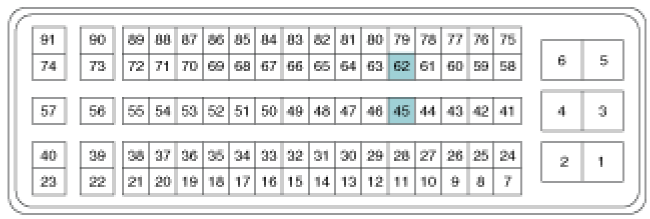
[Harness Connector]



C123
Knock Sensor



C100-A



C100-B
ECM

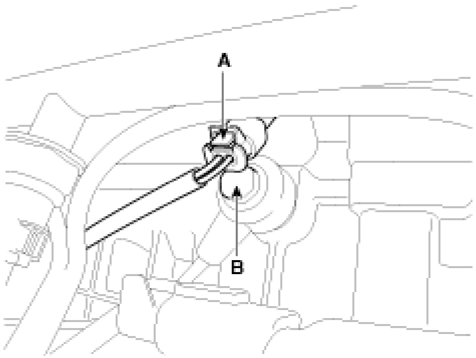
Removal

Turn the ignition switch OFF and disconnect the battery negative (-) cable.

Remove the intake manifold.
(Refer to Engine Mechanical System - "Intake Manifold")

Disconnect the injector connector (A).

Remove the installation bolt (B), and then remove the sensor from the cylinder block.



Installation

CAUTION

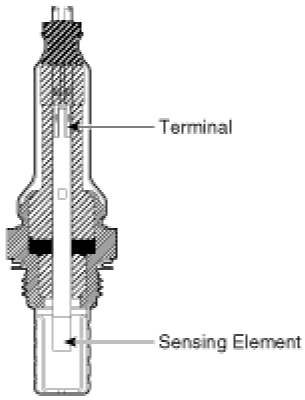
- Install the component with the specified torques.
- Note that internal damage may occur when the component is dropped. If the component has been dropped, inspect before installing.

Install in the reverse order of removal.

Knock sensor installation bolt:
18.6 ~ 23.5 N.m (1.9 ~ 2.4 kgf.m, 13.7 ~ 17.4 lb-ft)

Description

Heated Oxygen Sensor (HO2S) consists of zirconium and alumina and is installed both upstream and downstream of the Manifold Catalytic Converter. The sensor output voltage varies in accordance with the air/fuel ratio.
The sensor must be hot in order to operate normally. To keep it hot, the sensor has a heater which is controlled by the ECM via a duty cycle signal. When the exhaust gas temperature is lower than the specified value, the heater warms the sensor tip.



Specification

HO2S [Bank 1/Sensor 1]

Item	Specification
Heater Resistance (Ω)	2.5 ~ 4.0 [20°C(68°F)]

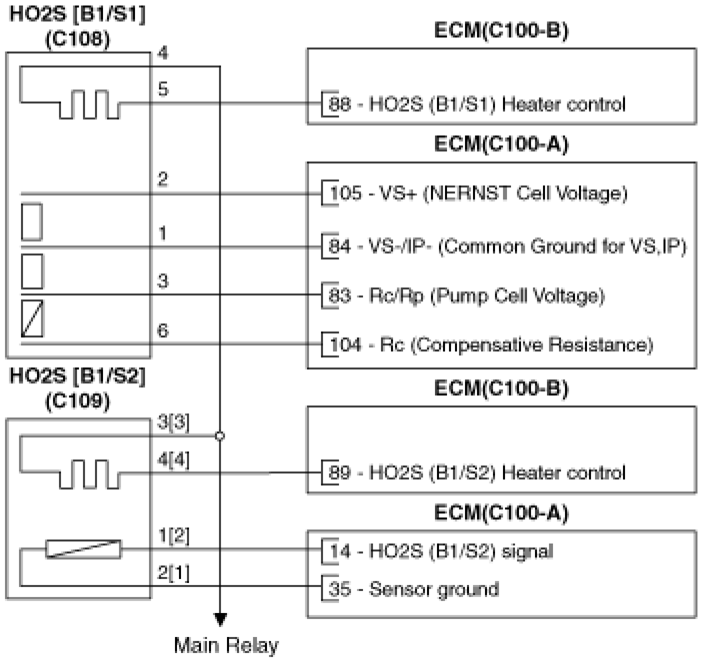
HO2S [Bank 1/Sensor 2]

A/F Ratio (λ)	Output Voltage(V)
RICH	Approx. 0.9
LEAN	Approx. 0.04

Item	Specification
Heater Resistance (Ω)	3.3 ~ 4.1Ω[21°C(69.8°F)]

Circuit Diagram

[Circuit Diagram]



[Connection Information]

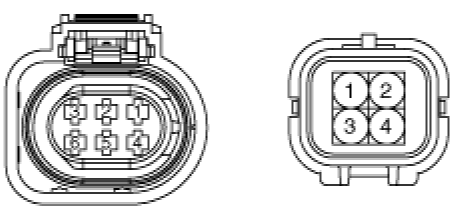
HO2S [B1/S1] (C108)

Terminal	Connected to	Function
1	ECM C100-A (84)	VS-/IP- (Common Ground for VS,IP)
2	ECM C100-A (105)	VS+ (NERNST Cell Voltage)
3	ECM C100-A (83)	Rc/Rp (Pump Cell Voltage)
4	Main Relay	Power Supply (B+)
5	ECM C100-B (88)	Heater control
6	ECM C100-A (104)	Rc (Compensative Resistance)

HO2S [B1/S2] (C109)

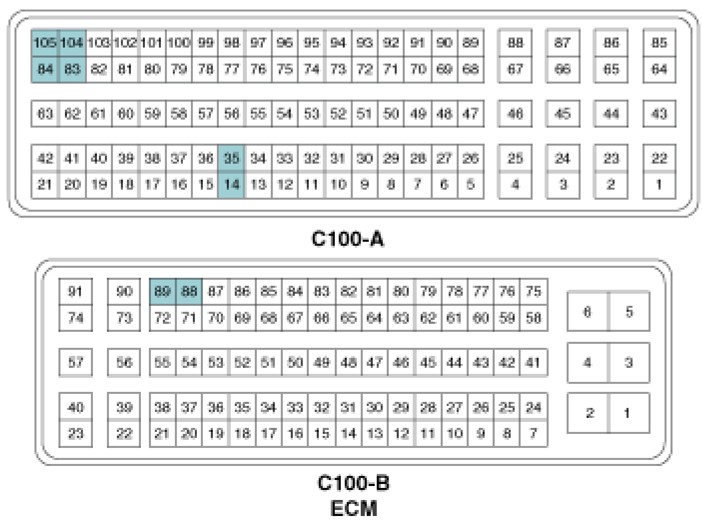
Terminal	Connected to	Function
1[2]	ECM C100-A (14)	HO2S (B1/S2) Signal
2[1]	ECM C100-A (35)	Sensor Ground
3[3]	Main Relay	Power Supply (B+)
4[4]	ECM C100-B (89)	Heater control

[Harness Connector]



C108
HO2S [B1/S1]

C109
HO2S [B1/S2]



Inspection

Turn the ignition switch OFF.

Disconnect the HO2S connector.

Measure resistance between the HO2S terminals 4 and 5 [B1/S1].

Measure resistance between the HO2S terminals 3 and 4 [B1/S2].

Check that the resistance is within the specification.

Specification: Refer to “Specification”

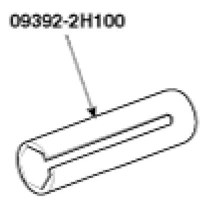
Removal

Turn the ignition switch OFF and disconnect the battery negative (-) cable.

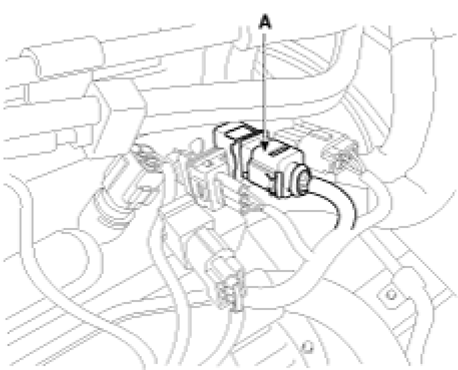
Disconnect the connector (A), and then remove the sensor (B).

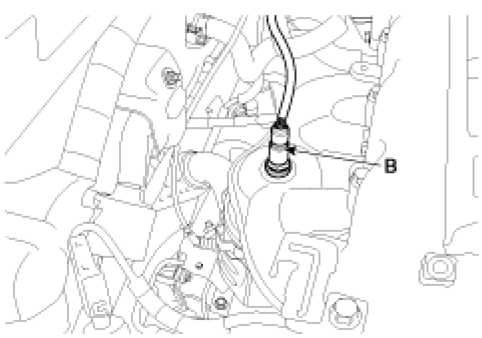
NOTE

Note that the SST (Part No.: 09392-2H100) is useful when removing the heated oxygen sensor.

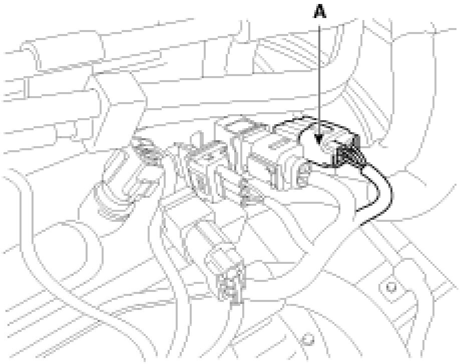


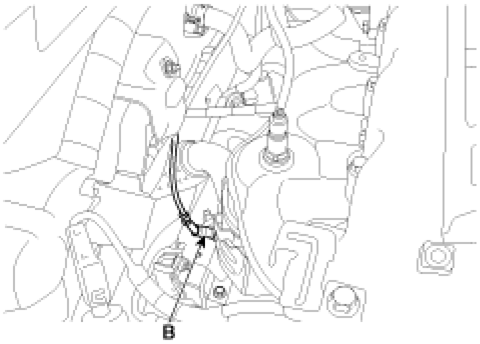
[Bank 1 / Sensor 1]





[Bank 1 / Sensor 2]





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

- 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).

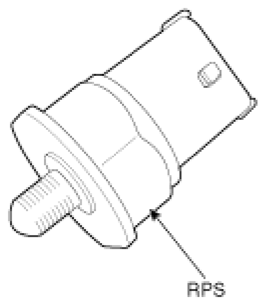
Install in the reverse order of removal.

Heated oxygen sensor installation:
39.2 ~ 49.1 N.m (4.0 ~ 5.0 kgf.m, 28.9 ~ 36.2 lb-ft)

Rail Pressure Sensor (RPS). Description and Operation

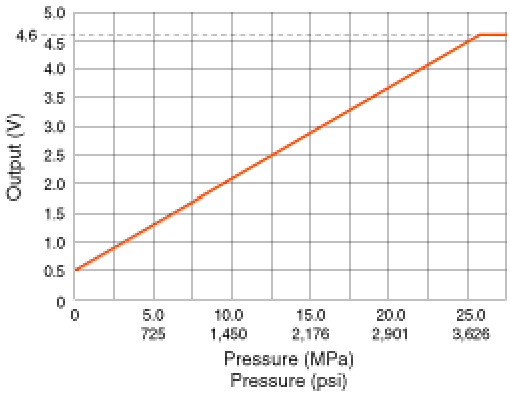
Description

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.



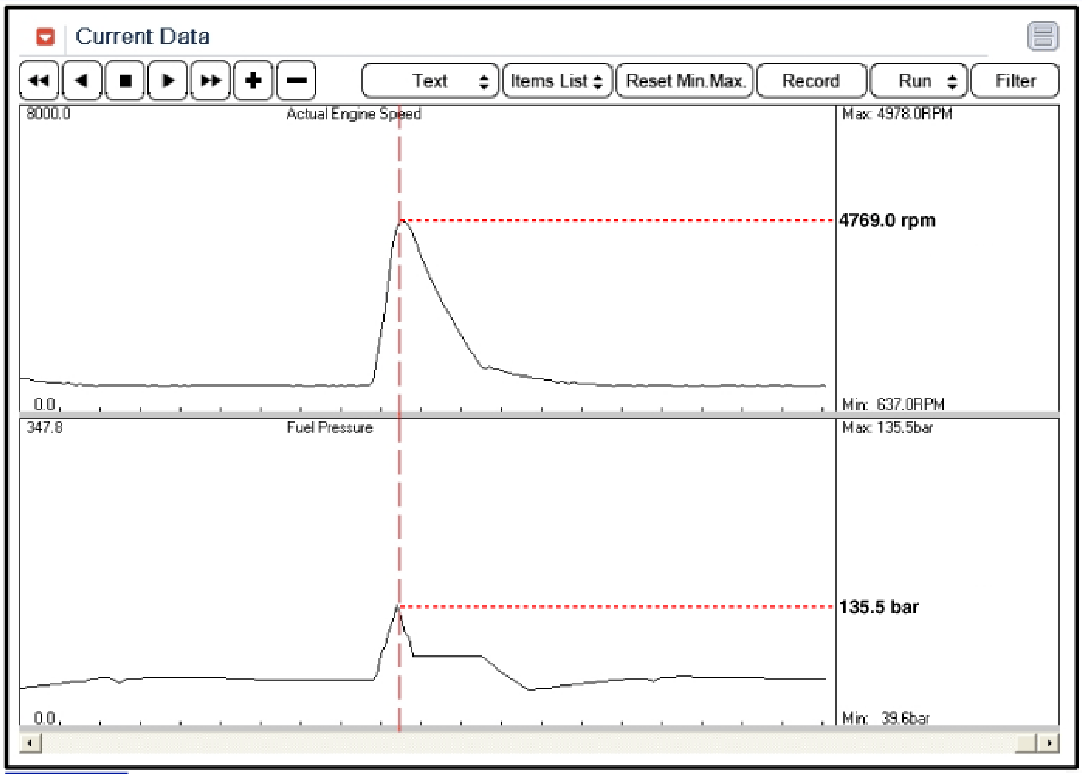
Rail Pressure Sensor (RPS). Specificatiotransaxle

Specification



Rail Pressure Sensor (RPS). Troubleshooting

Signal Waveform

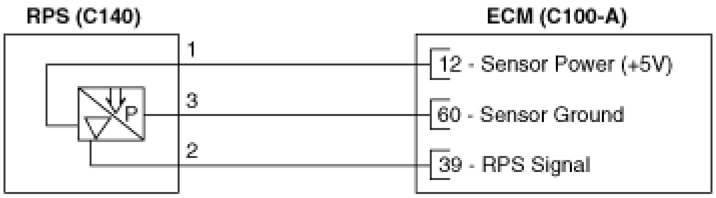


Acceleration

Rail Pressure Sensor (RPS). Schematic Diagrams

Circuit Diagram

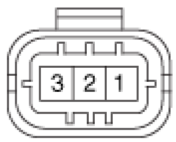
[Circuit Diagram]



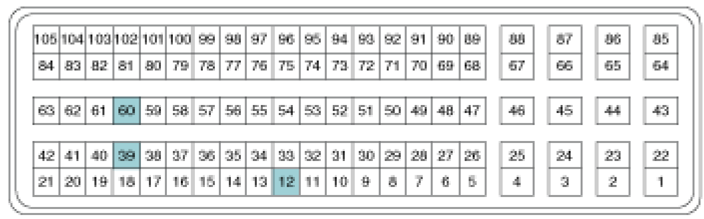
[Connection Information]

Terminal	Connected to	Function
1	ECM C100-A (12)	Sensor Power (+5V)
2	ECM C100-A (39)	RPS Signal
3	ECM C100-A (60)	Sensor Ground

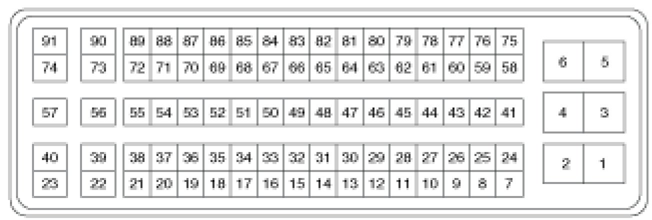
[Harness Connector]



C140
RPS



C100-A



C100-B
ECM

Inspection

Connect the GDS on the Data Link Connector (DLC).

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

Turn the ignition switch OFF and disconnect the battery negative (-) cable.

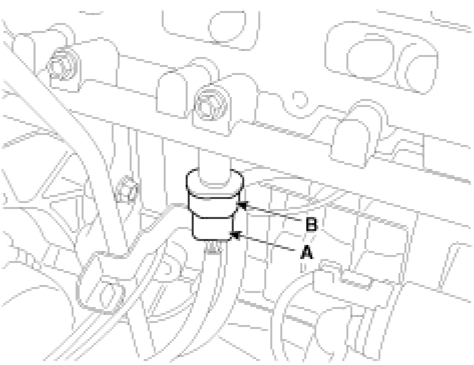
Release the residual pressure in fuel line.
(Refer to Fuel Delivery System - "Release Residual Pressure in Fuel Line")

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.

Remove the intake manifold.
(Refer to Engine Mechanical System - "Intake Manifold")

Disconnect the rail pressure sensor connector (A), and then remove the sensor (B) 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.

Install in the reverse order of removal.

Rail Pressure Sensor Installation: 18.0 ~ 22.0 N.m (1.8 ~ 2.2 kgf.m, 13.3 ~ 16.2 lb-ft)

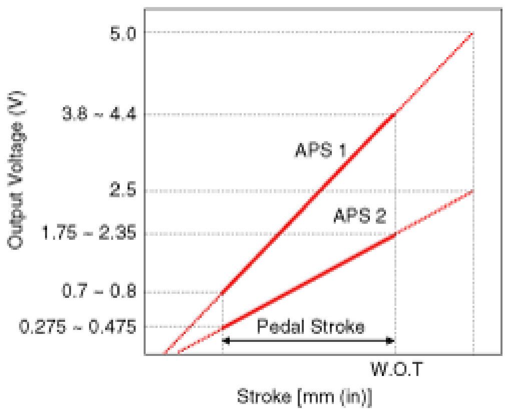
Description

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.

Accelerator Position Sensor (APS). Specifications

Specification

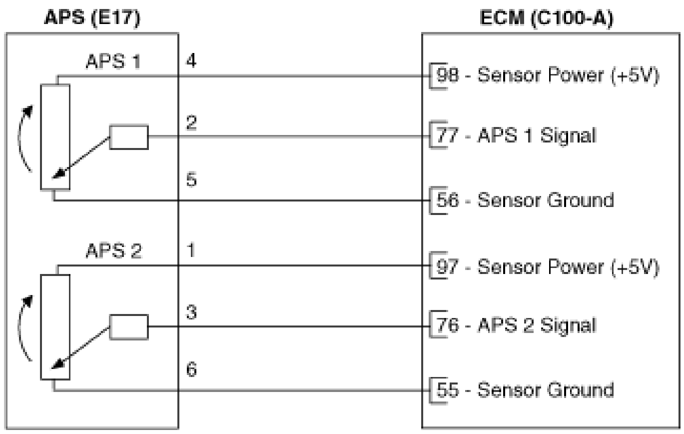
Accelerator Position	Output Voltage (V)	
	APS1	APS2
C.T	0.7 ~ 0.8	0.275 ~ 0.475
W.O.T	3.8 ~ 4.4	1.75 ~ 2.35



Accelerator Position Sensor (APS). Schematic Diagram

Circuit Diagram

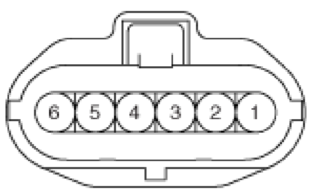
[Circuit Diagram]



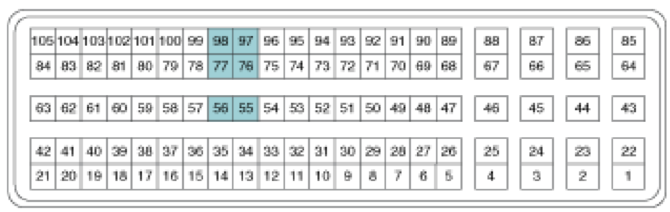
[Connection Information]

Terminal	Connected to	Function
1	ECM C100-A (97)	APS 2 Sensor Power (+5V)
2	ECM C100-A (77)	APS 1 Signal
3	ECM C100-A (76)	APS 2 Signal
4	ECM C100-A (98)	APS 1 Sensor Power (+5V)
5	ECM C100-A (56)	APS 1 Sensor Ground
6	ECM C100-A (55)	APS 2 Sensor Ground

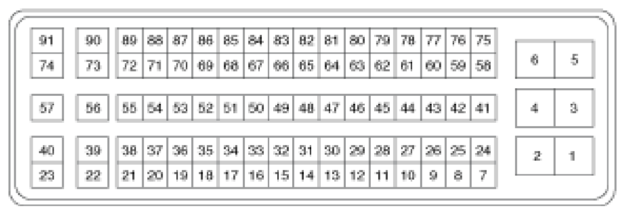
[Harness Connector]



E17
APS



C100-A



C100-B
ECM

Inspection

Connect the GDS on the Data Link Connector (DLC).

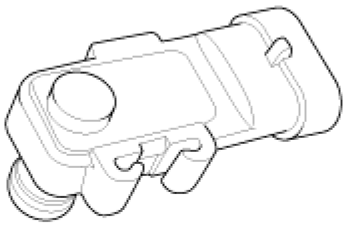
Turn the ignition switch ON.

Measure the output voltage of the APS 1 and 2 at C.T and W.O.T.

Specification: Refer to “Specification”

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.

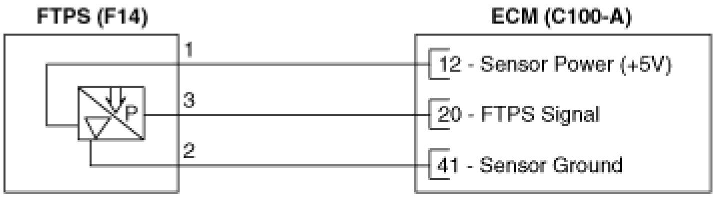


Specification

Pressure [kPa (kgf/cm², in H2O)	Output Voltage (V)
-3.75 (-0.038, -15.05)	4.5
0	1.5
+1.25 (0.013, 5.02)	0.5

Circuit Diagram

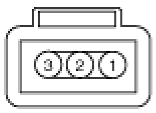
[Circuit Diagram]



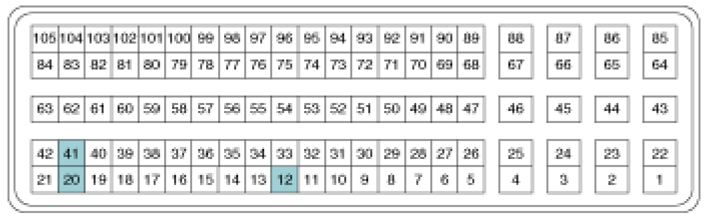
[Connection Information]

Terminal	Connected to	Function
1	ECM C100-A (12)	Sensor Power (+5V)
2	ECM C100-A (41)	Sensor Ground
3	ECM C100-A (20)	FTPS Signal

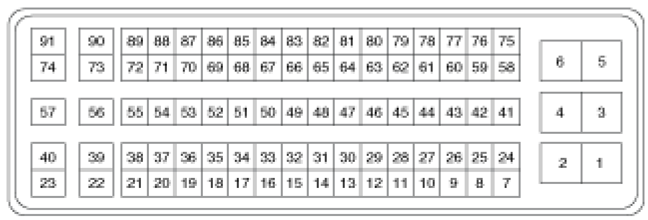
[Harness Connector]



F14
FTPS



C100-A



C100-B
ECM

Inspection

Connect the GDS on the Data Link Connector (DLC).

Measure the output voltage of the FTPS.

Specification: Refer to "Specification"

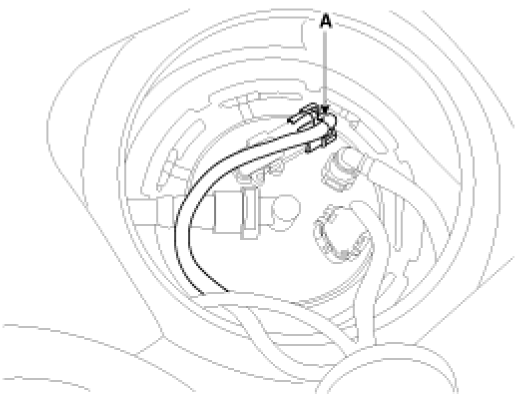
Removal

Turn the ignition switch OFF and disconnect the battery negative (-) cable.

Remove the rear seat.
(Refer to Body - "Rear Seat Assembly")

Remove the fuel pump service cover (A) in the trunk.

Disconnect the fuel tank pressure sensor connector (A), and then remove the fuel tank pressure sensor.



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

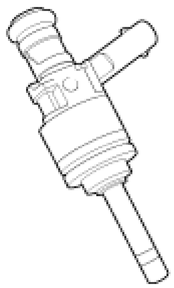
- Insert the sensor in the installation hole and be careful not to damage.

Install in the reverse order of removal.

Injector. Description and Operation

Description

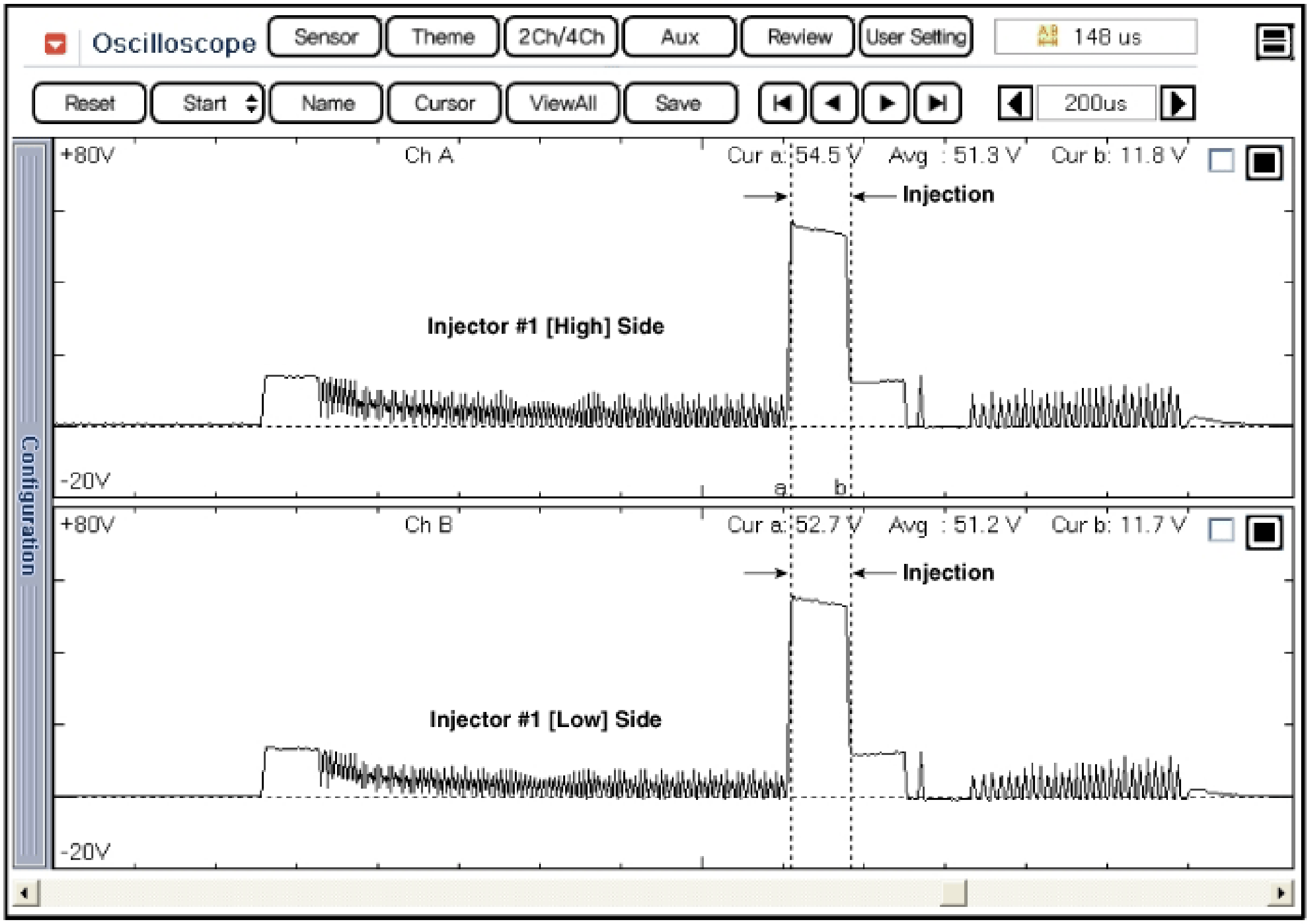
Based on information from various sensors, the ECM can calculate the fuel amount to be injected. The fuel injector is a solenoid-operated valve and the fuel injection amount is controlled by length of injection time. The ECM controls each injector by grounding the control circuit. When the ECM energizes 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.



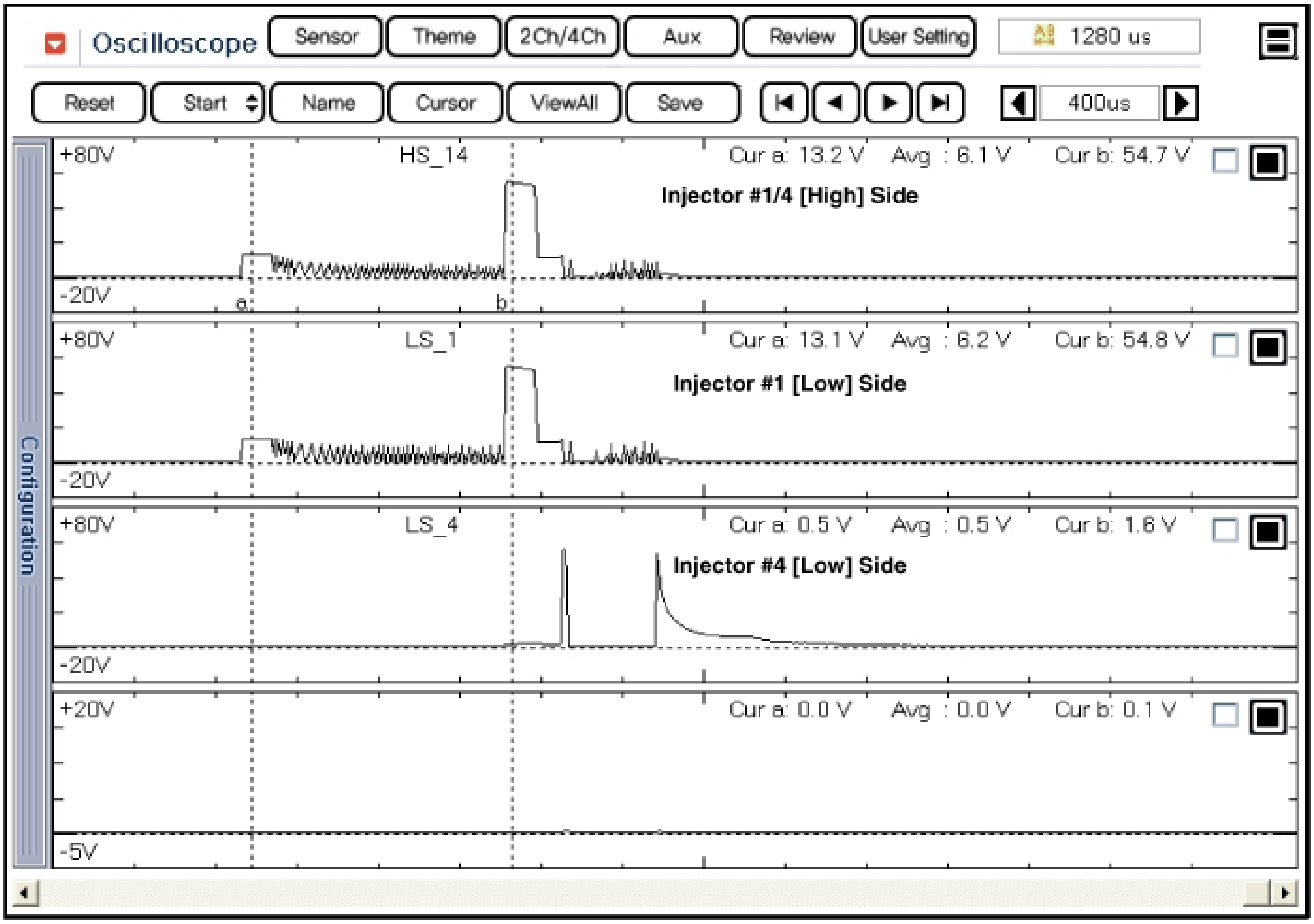
Specification

Item	Specification
Coil Resistance (Ω)	1.18 ~ 1.31 [20°C(68°F)]

Signal Waveform



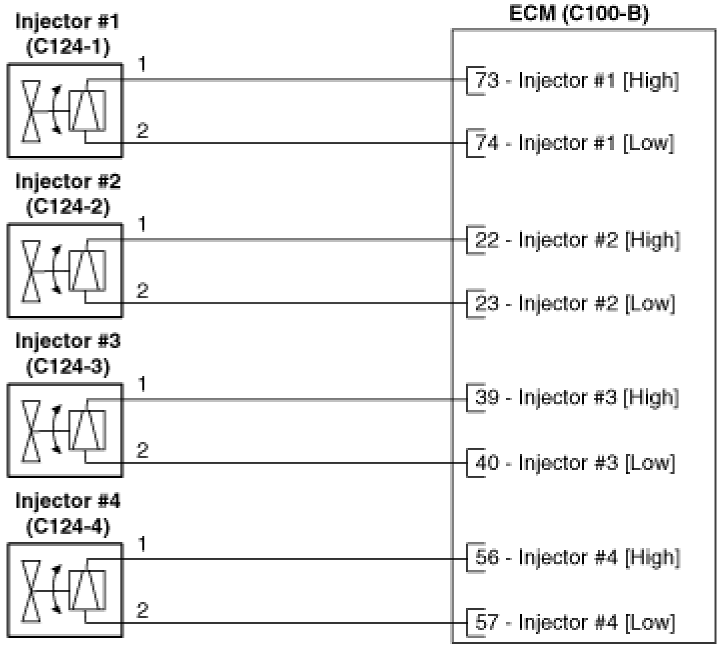
Injector #1 Injection



Injector #1 Injection

Circuit Diagram

[Circuit Diagram]



[Connection Information]

Injector #1 (C124-1)

Terminal	Connected to	Function
1	ECM C100-B (73)	Injector #1 [High] Control
2	ECM C100-B (74)	Injector #1 [Low] Control

Injector #2 (C124-2)

Terminal	Connected to	Function
1	ECM C100-B (22)	Injector #2 [High] Control
2	ECM C100-B (23)	Injector #2 [Low] Control

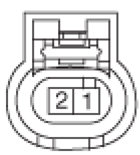
Injector #3 (C124-3)

Terminal	Connected to	Function
1	ECM C100-B (39)	Injector #3 [High] Control
2	ECM C100-B (40)	Injector #3 [Low] Control

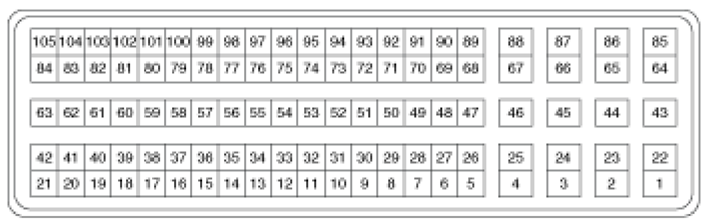
Injector #4 (C124-4)

Terminal	Connected to	Function
1	ECM C100-B (56)	Injector #4 [High] Control
2	ECM C100-B (57)	Injector #4 [Low] Control

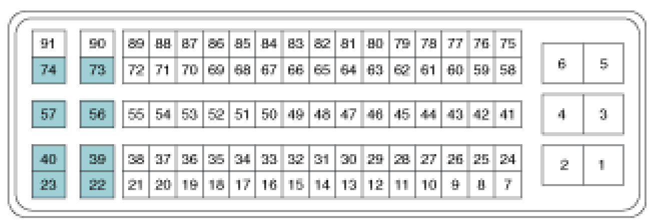
[Harness Connector]



C124-1,2,3,4
Injector #1,2,3,4



C100-A



C100-B
ECM

Inspection

Turn the ignition switch OFF.

Disconnect the injector connector.

Measure resistance between the injector terminals 1 and 2.

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.

Turn the ignition switch OFF and disconnect the battery negative (-) cable.

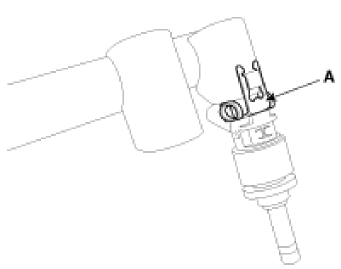
Release the residual pressure in fuel line.
(Refer to Engine Mechanical System - "Coolant")

CAUTION

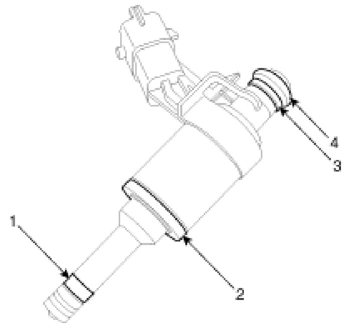
When removing the fuel pump relay, a Diagnostic Trouble Code (DTC) may occur. Delete the code with the GDS after completion of “Release Residual Pressure in Fuel Line” work.

Remove the delivery pipe & injector assembly.
(Refer to Fuel Delivery System - "Delivery Pipe")

Remove the fixing clip (A), 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

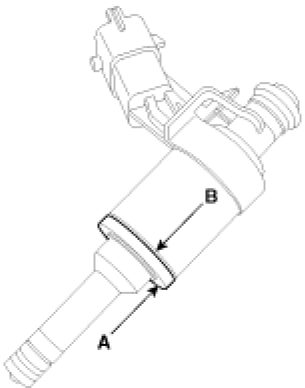
- Do not reuse the used bolt.

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 steel plate (A) part should be faced the cylinder installation part and the rubber plate (B) part should be faced the injector body part.

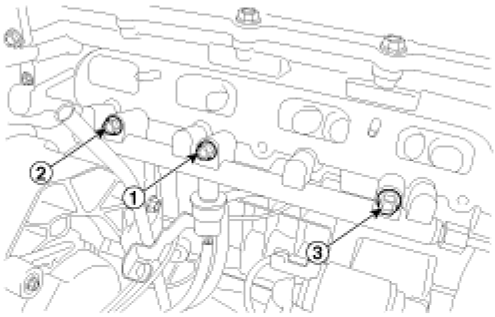


CAUTION

- Do not reuse the combustion seal.

CAUTION

- When tightening the delivery pipe installation bolts, tighten them in accordance with the order (① → ② → ③) after tightening with hand-screwed torque.

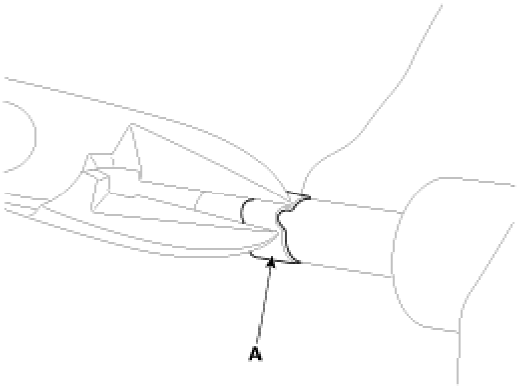


Install in the reverse order of removal.

Replacement

The injector combustion seal should be replaced new one to prevent leakage after removing the injector.

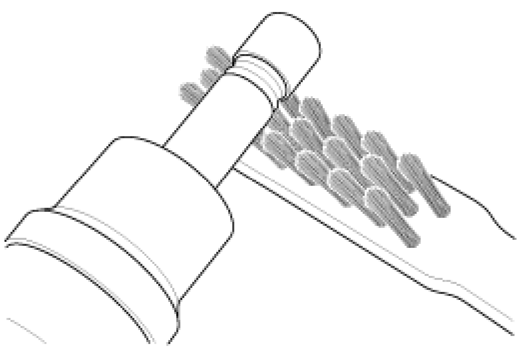
Remove the combustion seal (A) with a wire cutter.



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.

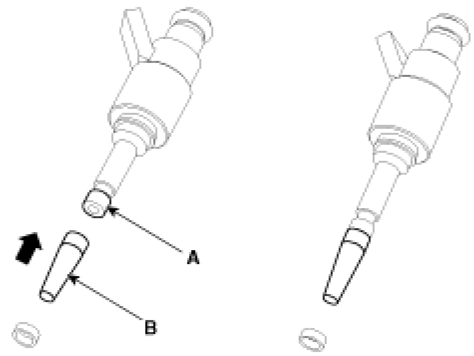
Before the assembly of the sealing ring the groove must be cleaned using a clean cloth.
Any coking of the injector sealing surface must be carefully removed with a brass-wire brush.

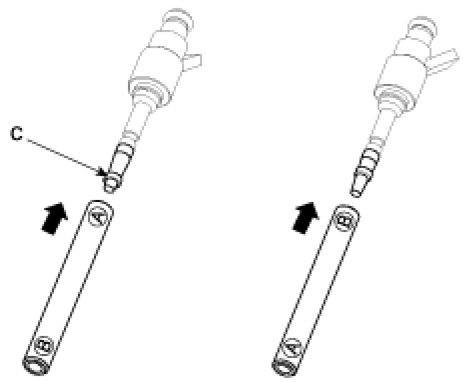


CAUTION

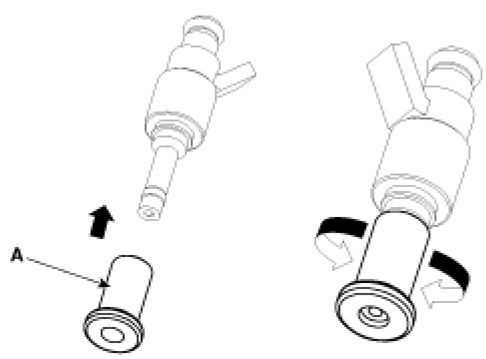
The surfaces of the new sealing ring must be clean and free of grease.

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.





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.

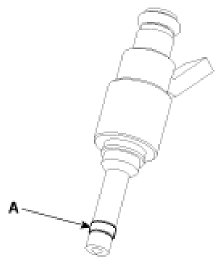


Pull the injector out of the sizing tool by turning it in the reverse direction to that used for the press-in process.

CAUTION

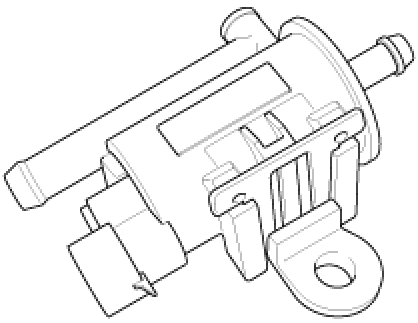
Check that the seal ring has not been damaged during assembly to the injector and that no circumferential scratches are present.
Do not reuse the combustion seal.
The seal must be completely free of grease and oil.

Check the combustion seal (A) installation.


A

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. This valve is normally closed when no voltage is applied.



Specification

Item	Specification
Coil Resistance (Ω)	19.0 ~ 22.0 [20°C(68°F)]

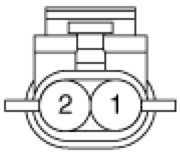
Circuit Diagram

[Circuit Diagram]

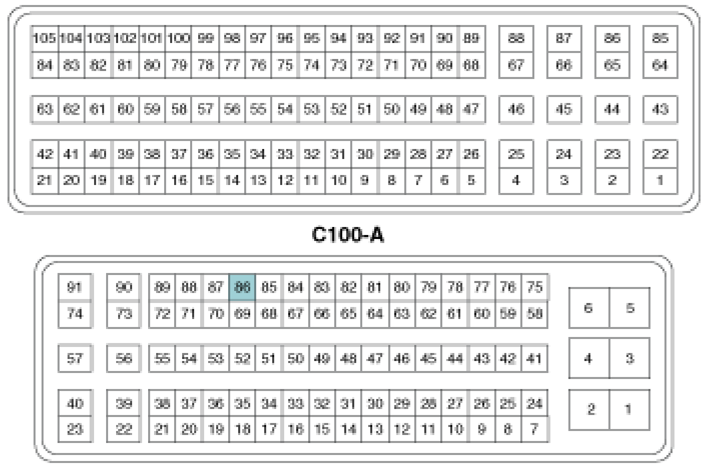
[Connection Information]

Terminal	Connected to	Function
1	Main Relay	Battery Power (B+)
2	ECM C100-B (86)	PCSV Control

[Harness Connector]



C121
PCSV



C100-A

C100-B
ECM

Inspection

Turn the ignition switch OFF.

Disconnect the PCSV connector.

Measure resistance between the PCSV terminals 1 and 2.

Check that the resistance is within the specification.

Specification: Refer to "Specification"

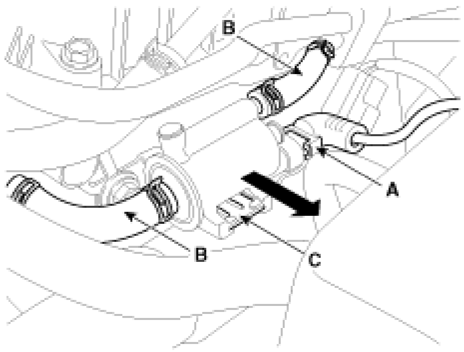
Removal

Turn the ignition switch OFF and disconnect the battery negative (-) cable.

Disconnect the purge control solenoid valve connector (A).

Disconnect the vapor hoses (B) from the purge control solenoid valve.

Remove the valve from the bracket (C) in the direction of the arrow.



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

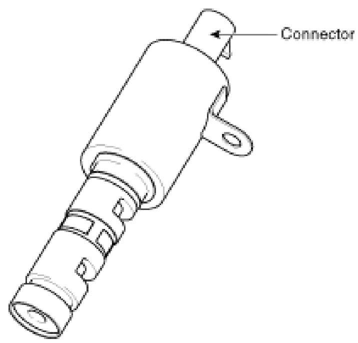
- Use care to keep foreign material out of the valve.

Install in the reverse order 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)

Description

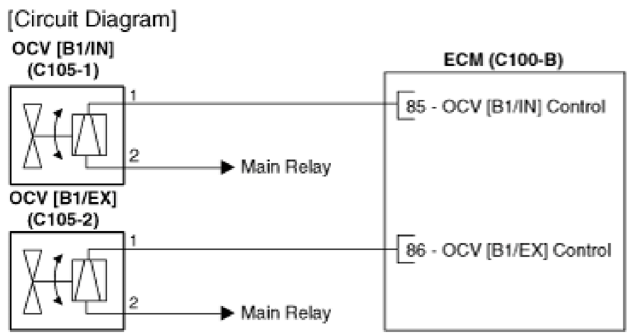
Continuous Variable Valve Timing (CVVT) system advances or retards the valve timing of the intake and exhaust valve in accordance with the ECM control signal which is calculated by the engine speed and load.
By controlling CVVT, the valve over-lap or under-lap occurs, which makes better fuel economy 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 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.



Specification

Item	Specification
Coil Resistance (Ω)	6.9 ~ 7.9 [20°C(68°F)]

Circuit Diagram



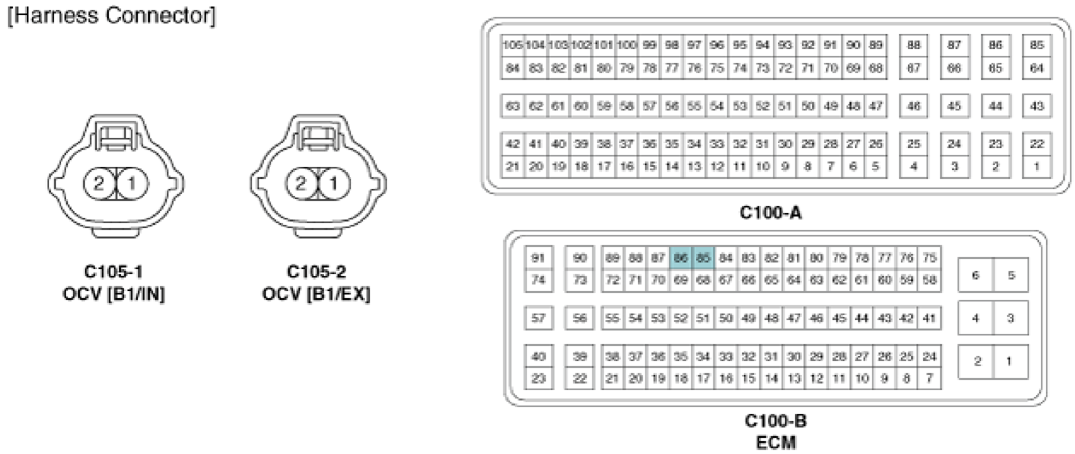
[Connection Information]

OCV [B1/IN] (C105-1)

Terminal	Connected to	Function
1	ECM C100-B (85)	OCV [B1/IN] Control
2	Main Relay	Battery Power (B+)

OCV [B1/EX] (C105-2)

Terminal	Connected to	Function
1	ECM C100-B (86)	OCV [B1/EX] Control
2	Main Relay	Battery Power (B+)



Inspection

Turn the ignition switch OFF.

Disconnect the OCV connector.

Measure resistance between the OCV terminals 1 and 2.

Check that the resistance is within the specification.

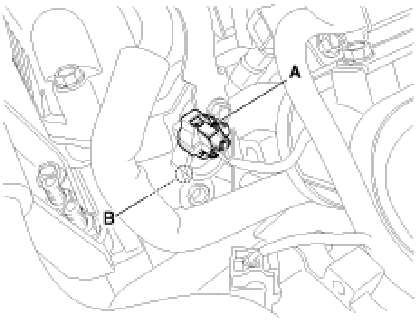
Specification: Refer to “Specification”

Removal

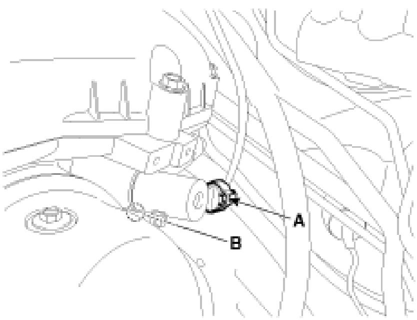
Turn the ignition switch OFF and disconnect the battery negative (-) cable.

Disconnect the CVVT oil control valve connector (A).

Remove the installation bolt (B), and then remove the valve from the engine.
[Bank 1 / Intake]



[Bank 1 / 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

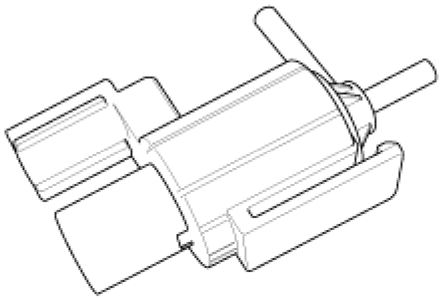
- Apply engine oil to the valve O-ring.

Install in the reverse order of removal.

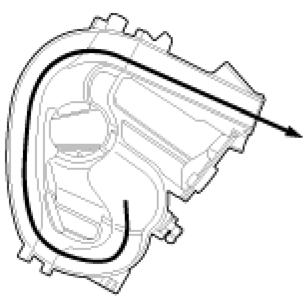
CVVT oil control valve installation bolt:
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lo-fi)

Description

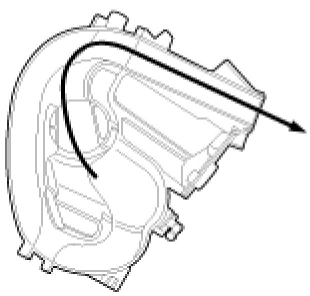
Variable Intake manifold Solenoid (VIS) valve is installed on the intake manifold. The VIS valve controls the vacuum modulator which activates a valve in the intake manifold. The ECM opens or closes this valve according to engine condition (Refer to below table).



Engine condition	VIS valve	Operation
Medium speed	Closed	Increasing engine performance in low engine speed by reducing intake interference among cylinders
Low / High speed	Open	Minimizing intake resistance by shortening intake manifold length and increasing area of air entrance



Medium speed



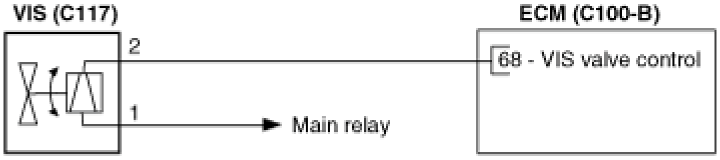
Low / High speed

Specification

Item	Specification
Coil resistance (Ω)	30.0 ~ 35.0 [20°C(68°F)]

Circuit Diagram

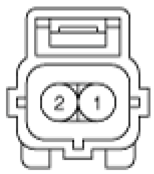
[Circuit Diagram]



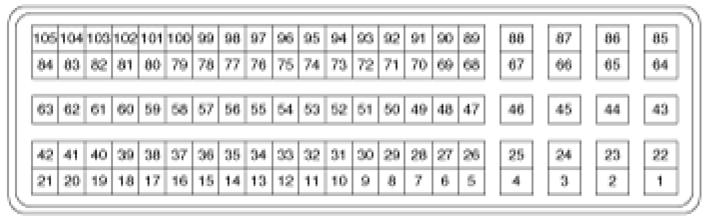
[Connection Information]

Terminal	Connected to	Function
1	Main relay	Power supply (B+)
2	ECM C100-B (68)	VIS valve control

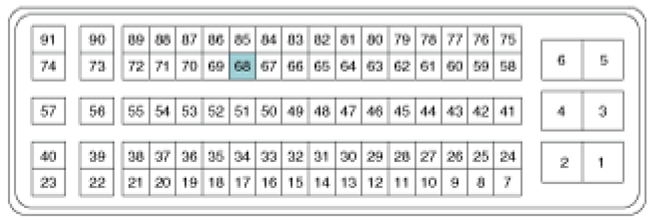
[Harness Connector]



C117
VIS Valve



C100-A



C100-B
ECM

Inspection

Turn the ignition switch OFF.

Disconnect the VIS valve connector.

Measure resistance between VIS valve terminals 1 and 2.

Specification: Refer to "Specification"

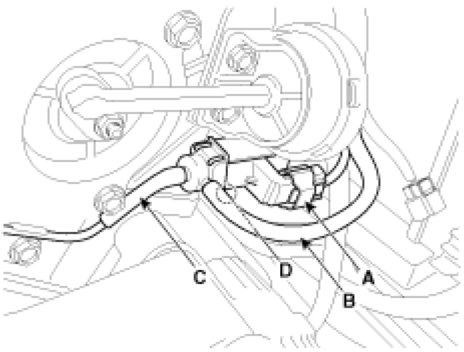
Removal

Turn the ignition switch OFF and disconnect the battery negative (-) cable.

Disconnect the variable intake solenoid valve connector (A).

Disconnect the vacuum hoses (B,C) from the valve.

Remove the installation bolt (D), and then remove the valve 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.

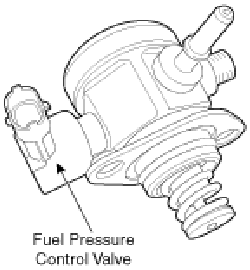
CAUTION

- Use care to keep foreign material out of the valve.

Install in the reverse order of removal.

Description

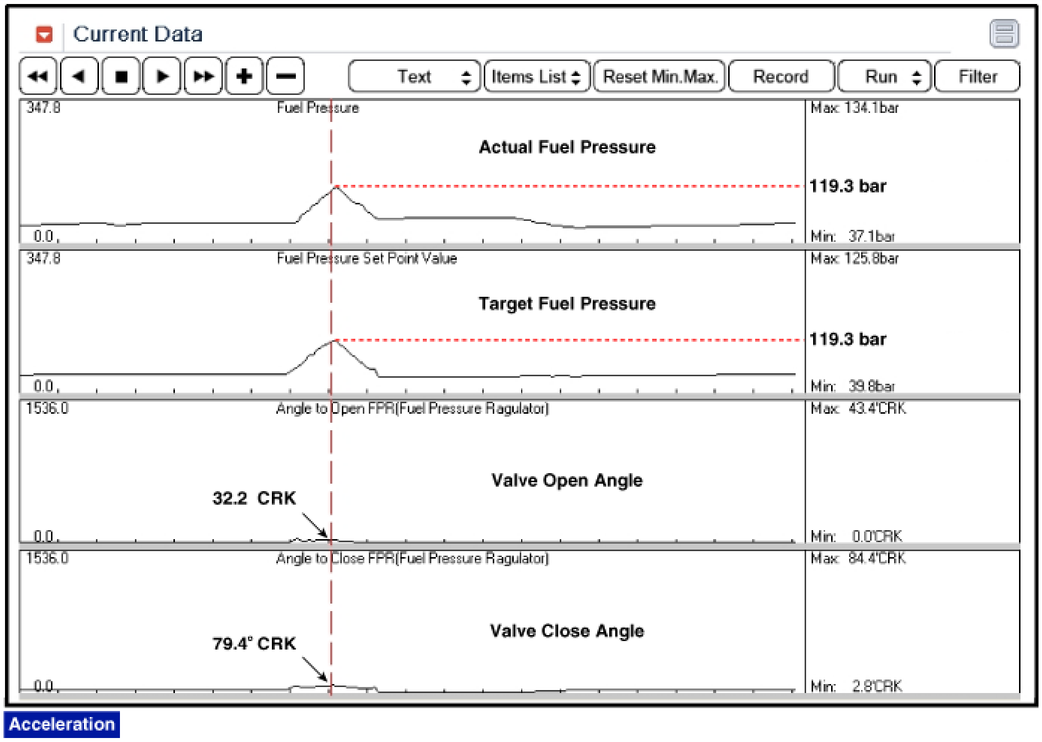
Fuel Pressure Control Valve is installed on the high pressure fuel pump and controls fuel flow flowing into the injectors in accordance with the ECM signal calculated based on various engine condition.



Specification

Item	Specification
Coil Resistance (Ω)	0.5 [20°C(68°F)

Signal Waveform



Inspection

Turn the ignition switch OFF and disconnect the battery negative (-) cable.

Disconnect the fuel pressure regulator valve connector.

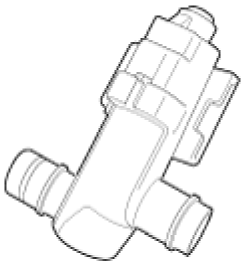
Measure resistance between the fuel pressure regulator valve terminals 1 and 2.

Check that the resistance is within the specification.

Specification: Refer to “Specification”

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. This valve is normally open when no voltage is applied.

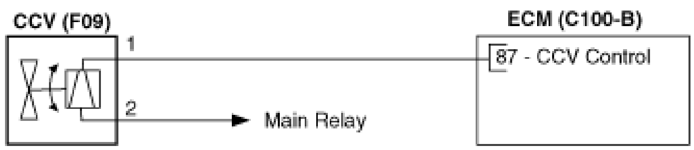


Specification

Item	Specification
Coil Resistance (Ω)	19.9 ~ 22.9 [20°C(68°F)

Circuit Diagram

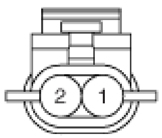
[Circuit Diagram]



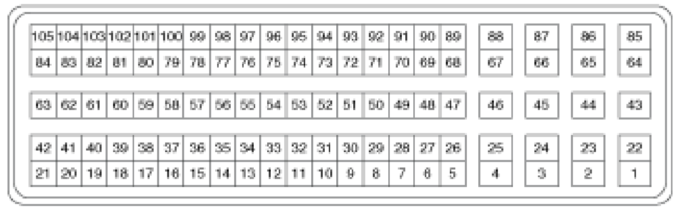
[Connection Information]

Terminal	Connected to	Function
1	ECM C100-B (87)	CCV Control
2	Main Relay	Battery Power (B+)

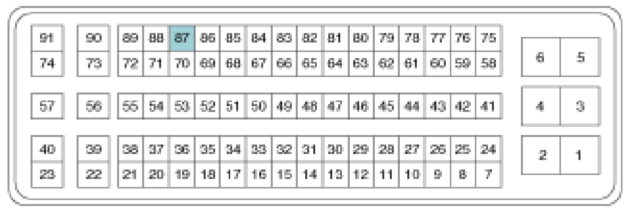
[Harness Connector]



F09
CCV



C100-A



C100-B
ECM

Inspection

Turn the ignition switch OFF.

Disconnect the CCV connector.

Measure resistance between the CCV terminal 1 and 2.

Check that the resistance is within the specification.

Specification: Refer to "Specification"

Disconnect the vapor hose connected with the canister from the CCV.

Connect a vacuum pump to the nipple.

Ground the CCV control line and apply battery voltage to the CCV power supply line.

Apply vacuum and check the valve operation.

Specification: Vacuum maintained

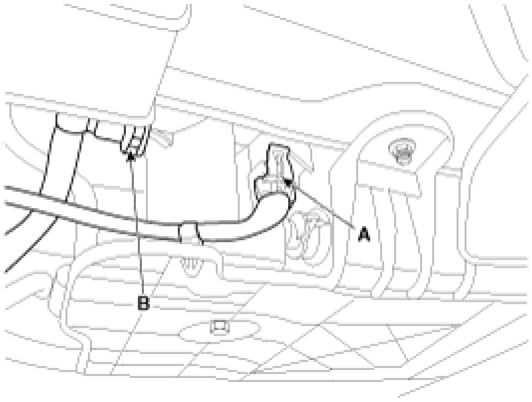
Removal

Turn the ignition switch OFF and disconnect the battery negative (-) cable.

Lift the vehicle.

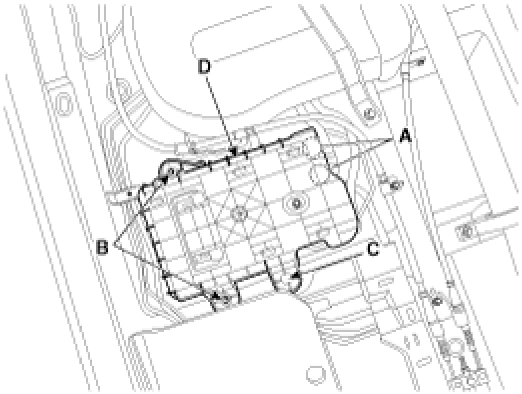
Disconnect the canister close valve connector (A).

Disconnect the ventilation tube quick-connector (B) from the fuel tank air filter and canister close valve.

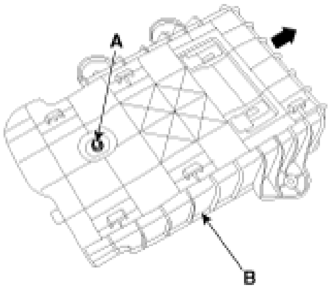


Disconnect the vapor tube quick-connector (A).

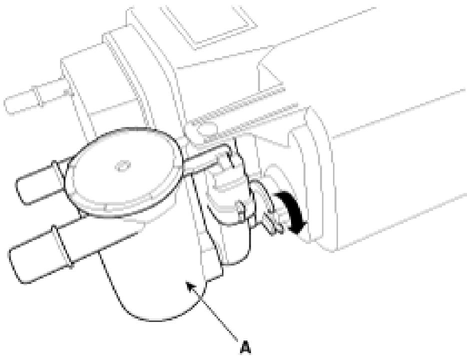
Remove the canister assembly bracket (D) after removing the mounting bolts (B) and nut (C).



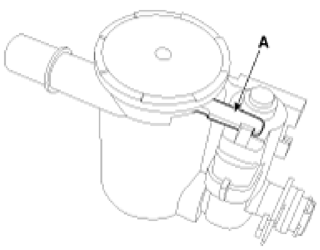
Remove the canister bracket (B) installation bolt (A).

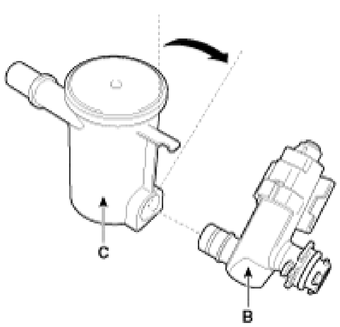


Remove the fuel tank air filter & canister close valve assembly (A) after rotating it in the direction of the arrow in the figure.



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.





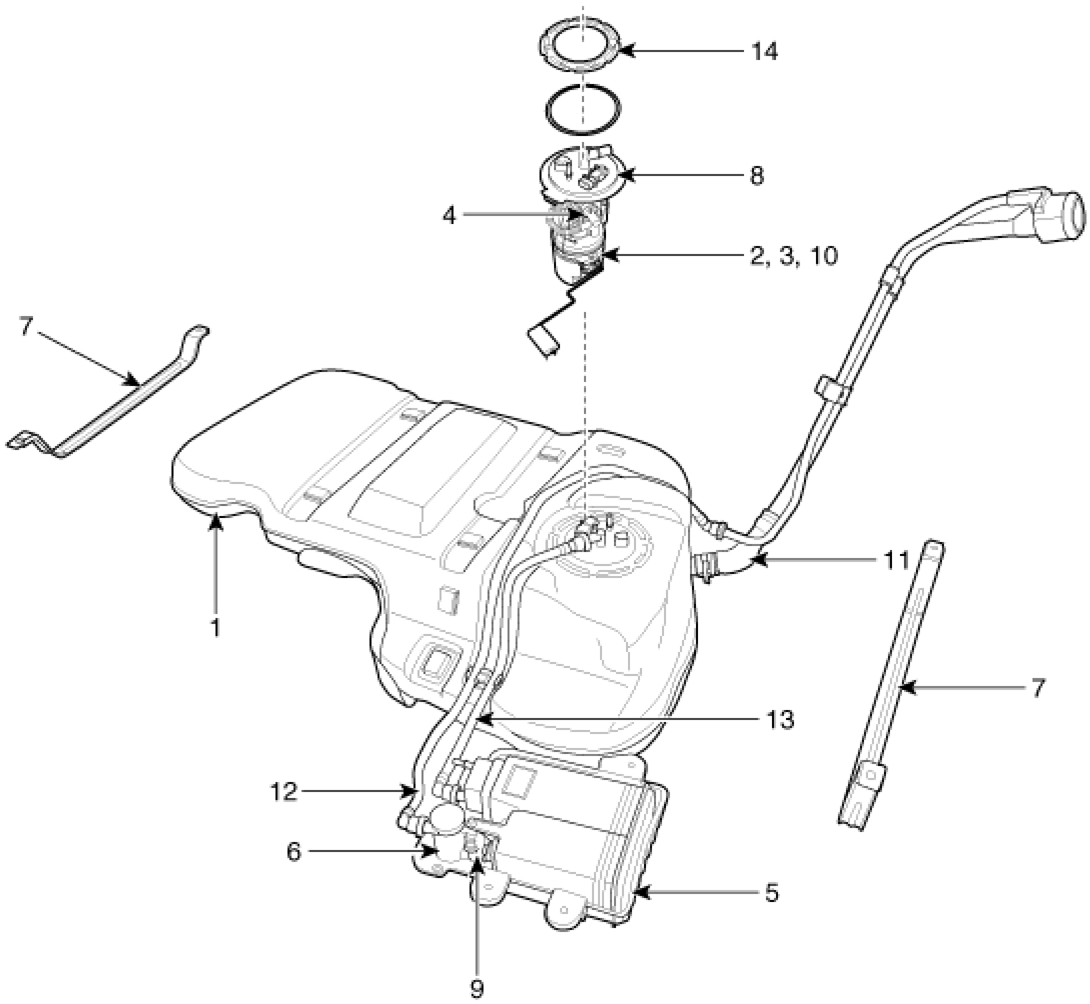
Installation

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.

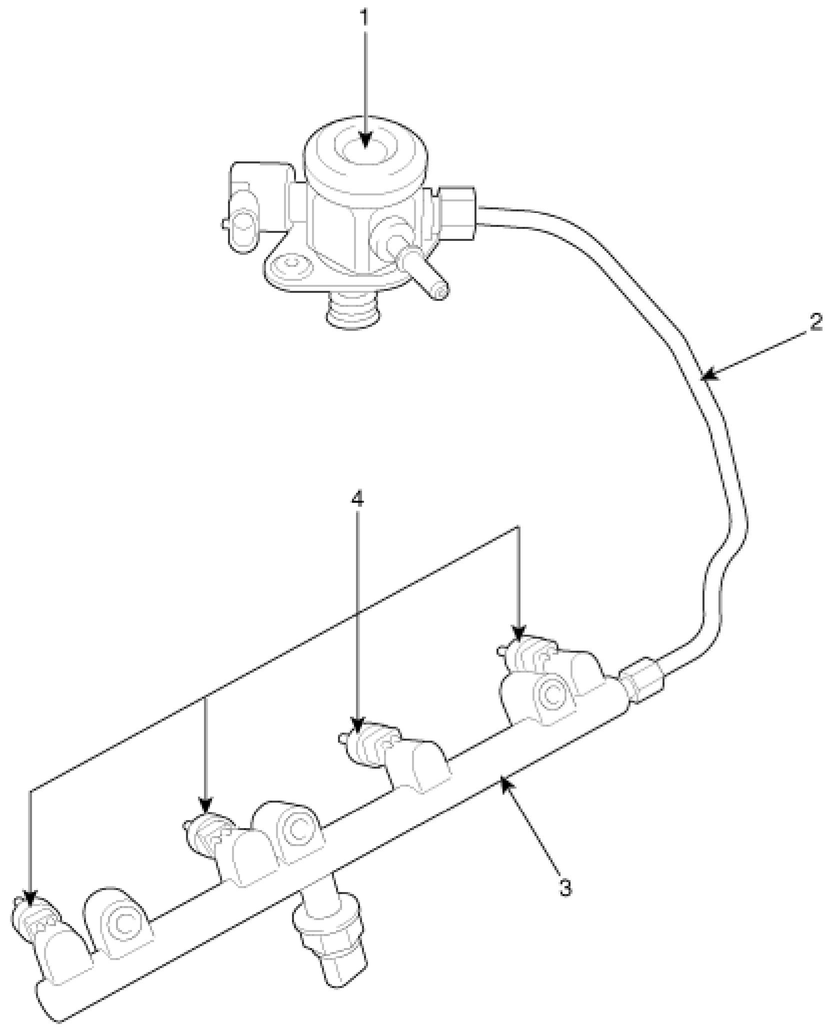
Install in the reverse order of removal.

Components Location



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

[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.

Repair procedures

Fuel Pressure Test

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.

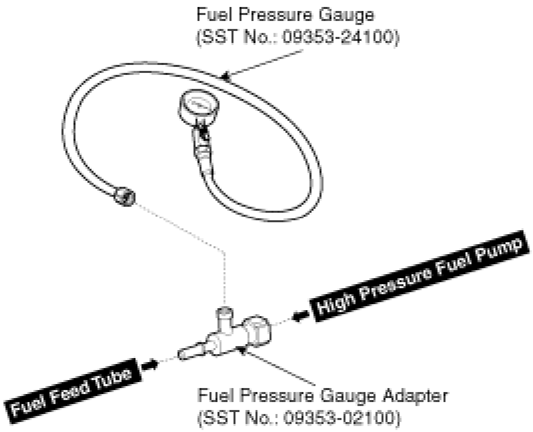
Install the Special Service Tool (SST).

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.

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).



Inspect fuel leakage on connections among the fuel feed tube, the high pressure fuel pump, and the SST components with IG ON.

Measure Fuel Pressure.

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)

NOTE

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

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

NOTE

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

Turn the ignition switch OFF.

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.

Test End

Remove the Special Service Tool (SST) from the fuel feed tube and the high pressure fuel pump.

Connect the fuel feed tube and the high pressure fuel pump.

Release Residual Pressure in Fuel Line

CAUTION

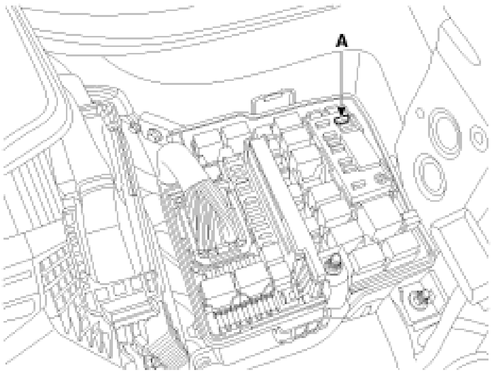
Whenever the high pressure fuel pump, fuel pipe, delivery pipe, or injector is removed immediately after shutting off the engine, an injury may be caused by the release of highly pressurized fuel. Release the residual pressure in the high pressure fuel line by referring to the "Residual fuel pressure release procedure" below before removing any high pressure fuel system components.

NOTE

Wear safety glasses and fuel resistant gloves.

Turn the ignition off and disconnect the battery negative cable.

Remove the fuel pump fuse (A).



Disconnect the electrical connector from the high pressure fuel pump.

Reconnect the battery negative cable.

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.

Proceed with the service or repair. Use rags to cover opening and catch spills when opening up the high pressure system.

Reinstall / re-connect all components in reverse order of removal. Start engine and confirm proper operation, and make sure there are no fuel leaks.

After completing, clear DTC(s) using GDS scan tool (the procedure described above will cause DTC to set).

Fuel Tank. Repair procedures

Removal

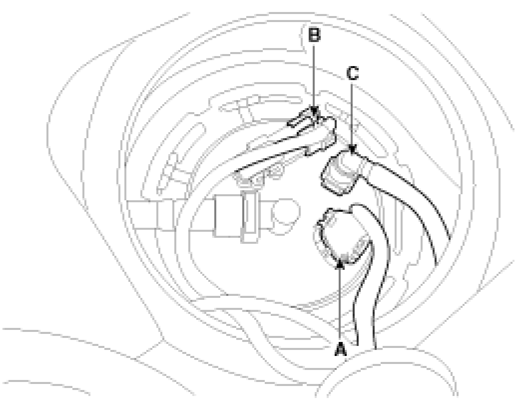
Release the residual pressure in fuel line.
(Refer to Fuel Delivery System - “Release Residual Pressure in Fuel Line”)

Remove the rear seat assembly.
(Refer to Body - “Rear Seat Assembly")

Remove the fuel pump service cover (A).

Disconnect the fuel pump connector (A) and the fuel tank pressure sensor connector (B).

Disconnect the fuel feed tube quick connector (C).



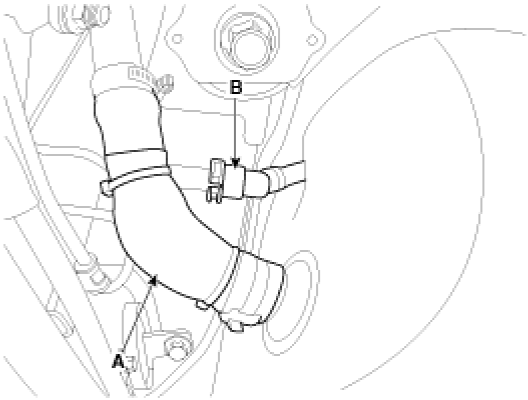
Remove the rear - LH wheel & tire.

Lift the vehicle and support the fuel tank with a jack.

Remove the center & rear muffler assembly.
(Refer to Engine Mechanical System - “Muffler”) [4 WD]

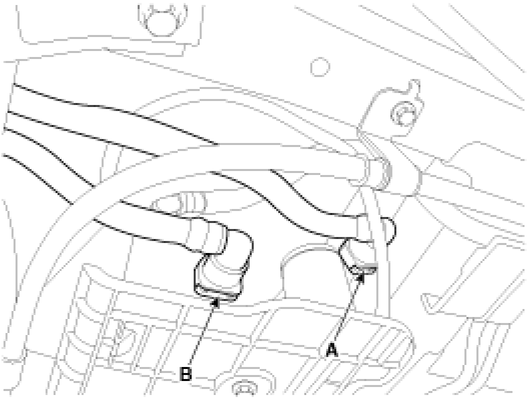
Remove the propeller shaft.
(Refer to Driveshaft and axle - “Propeller Shaft”) [4WD]

Disconnect the fuel filler hose (A) and the ventilation tube quick-connector (B).

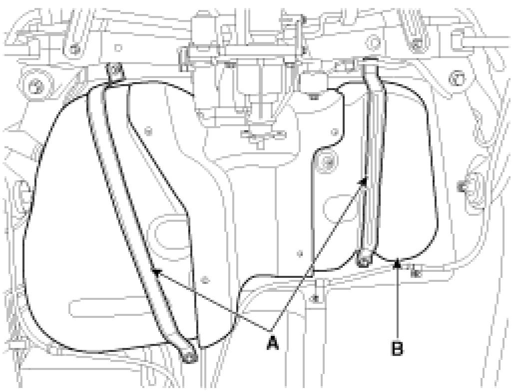


Disconnect the ventilation tube quick-connector (A).

Disconnect the vapor tube quick-connector (B).



Remove the fuel tank (B) from the vehicle after removing the fuel tank band (A).



NOTE

When removing the fuel tank, the fuel tank must be tilted because of interfering with coupling.

Installation

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)

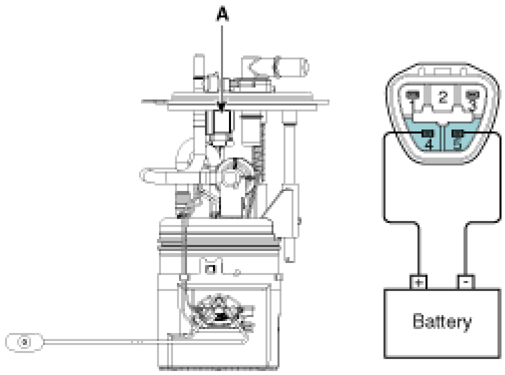
Inspection

[Fuel pump motor]

Turn the ignition switch OFF, and then remove battery (-) cable.

Remove the fuel pump assembly.

Check motor operation by fuel pump connector (A) connecting power (No.4) and ground (No.5).



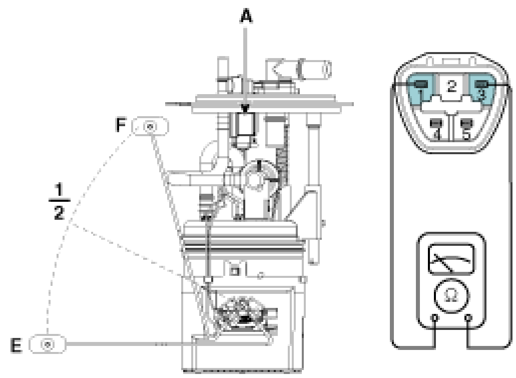
Pin No.	Description
1	Fuel sender signal
2	-
3	Fuel sender ground
4	Fuel pump motor (+)
5	Fuel pump motor ground

[Fuel sender]

Turn the ignition switch OFF, and then remove battery (-) cable.

Remove the fuel pump assembly.

Using an ohmmeter, measure the resistance between terminals 1 and 3 of sender connector (A) at each float level.



Pin No.	Description
1	Fuel sender signal
2	-
3	Fuel sender ground
4	Fuel pump motor (+)
5	Fuel pump motor ground

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

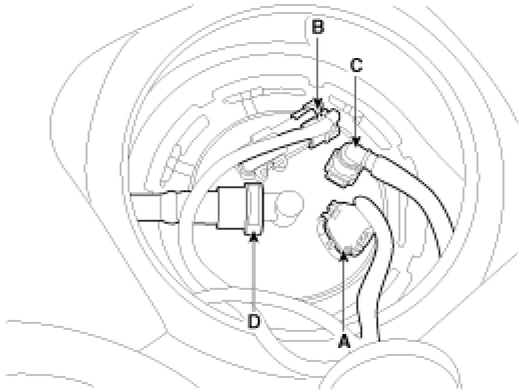
Release the residual pressure in fuel line.
(Refer to Fuel Delivery System - “Release Residual Pressure in Fuel Line”)

Remove the rear seat.
(Refer to Body - “Rear Seat Assembly”)

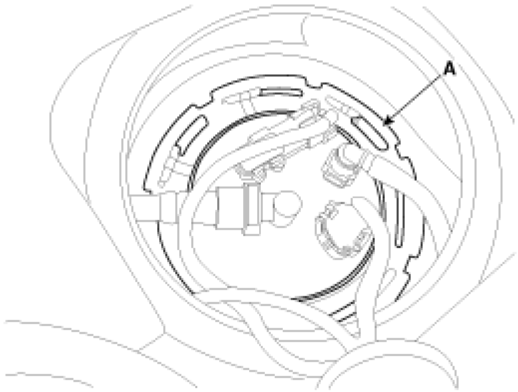
Remove the fuel pump service cover (A).

Disconnect the fuel pump connector (A) and the fuel tank pressure sensor connector (B).

Disconnect the fuel feed tube quick connector (C) and the vapor tube quick-connector (D).



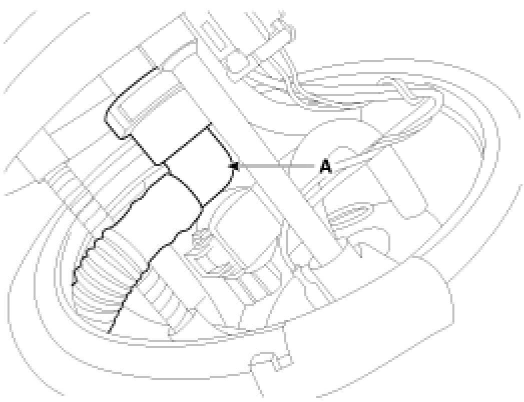
Remove locking ring (A) by using the special service tool.



Disconnect the vapor tube quick-connector (A) at the fuel pump, and then remove the fuel pump from the fuel tank.

NOTE

Fuel shouldn’t be come inside the vapor tube quick-connector while disconnecting the vapor tube quick-connector.



Installation

Install in the reverse order of removal.

CAUTION

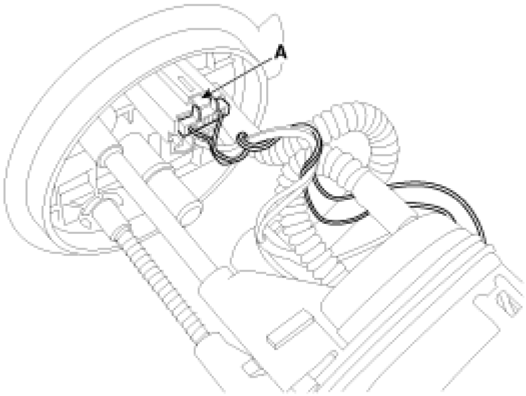
Be careful of fuel pump direction when installing (Refer to the groove in the fuel tank).

Fuel Filter. Repair procedures

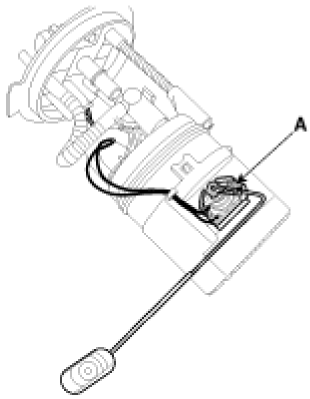
Removal

Remove the fuel pump.
(Refer to Fuel Delivery System - “Fuel Pump”)

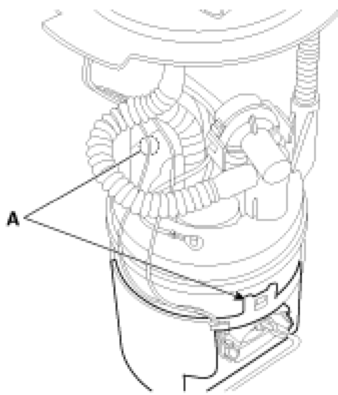
Disconnect the fuel sender connector (A).

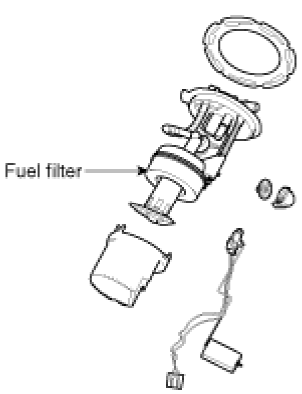


Release the fixing hooks, and then remove the fuel sender (A).



Release the fixing hooks (A), and then fuel filter & motor assembly from reservoir cup.





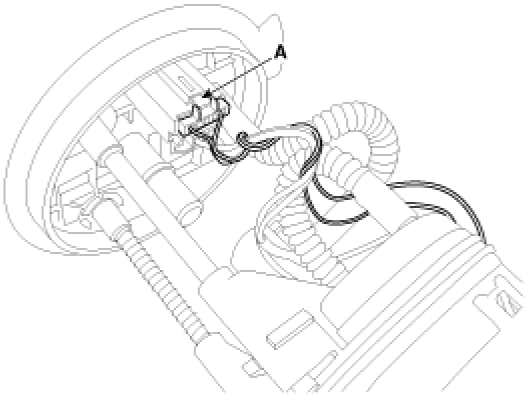
Installation

Install in the reverse order of removal.

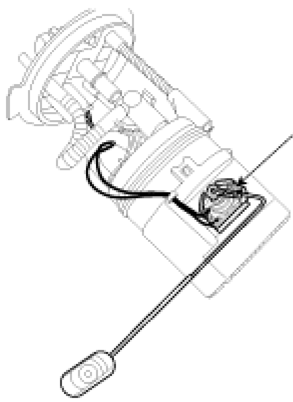
Removal

Remove the fuel pump.
(Refer to Fuel Delivery System - "Fuel Pump")

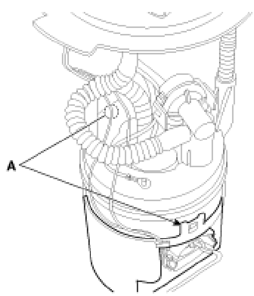
Disconnect the fuel sender connector (A).

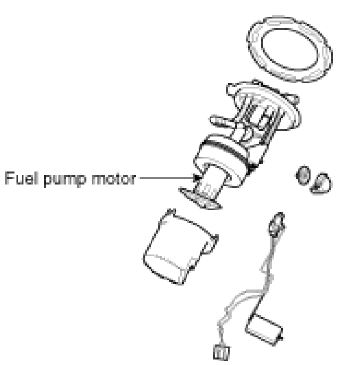


Release the fixing hooks, and then remove the fuel sender (A).



Release the fixing hooks (A), and then fuel filter & motor assembly from reservoir cup.





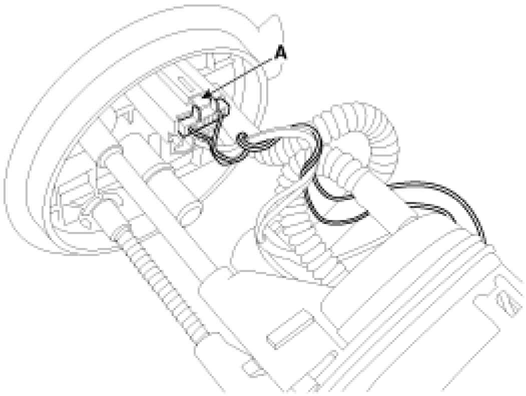
Installation

Install in the reverse order of removal.

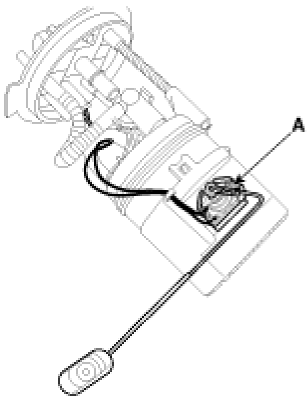
Removal

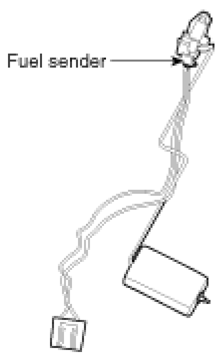
Remove the fuel pump.
(Refer to Fuel Delivery System - “Fuel Pump”)

Disconnect the fuel sender connector (A).



Release the fixing hooks, and then remove the fuel sender (A).





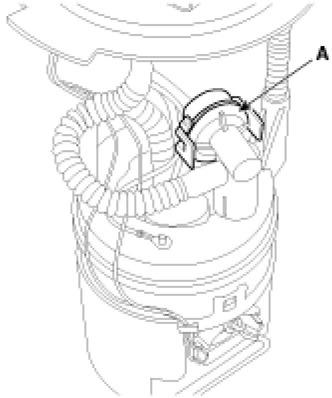
Installation

Install in the reverse order of removal.

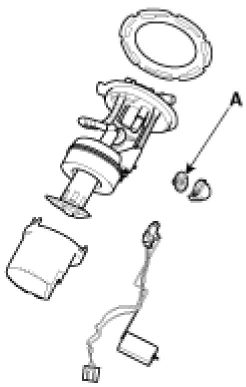
Removal

Remove the fuel pump.
(Refer to Fuel Delivery System - “Fuel Pump”)

Release the fixing hooks, and then remove the regulator cup (A).



Remove the fuel pressure regulator (A).



Installation

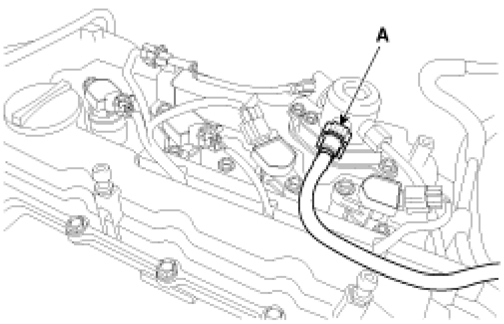
Install in the reverse order of removal.

Removal

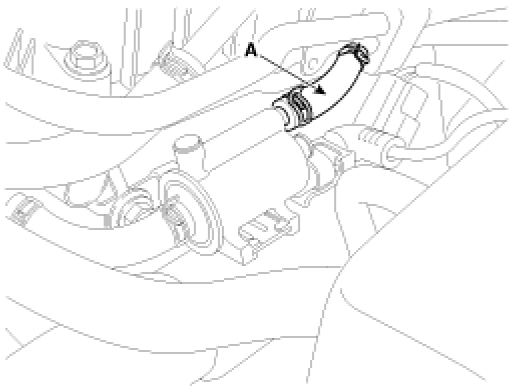
Turn the ignition switch OFF, and then remove battery (-) cable.

Release the residual pressure in fuel line.
(Refer to Fuel Delivery System - “Release Residual Pressure in Fuel Line”)

Disconnect the low pressure fuel quick-connector (A).



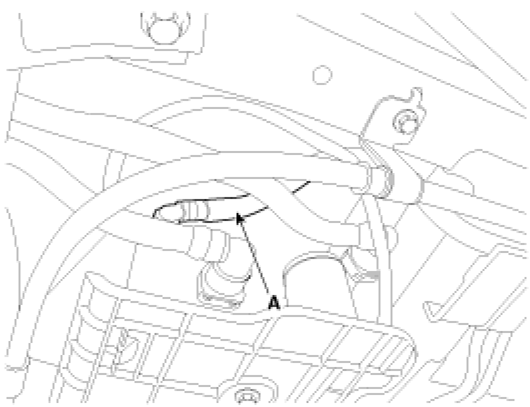
Disconnect the vapor hose (A) which is connected from the PCSV.



Lift the vehicle.

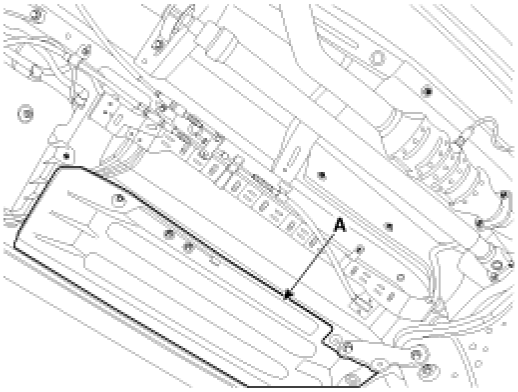
6. Remove the fuel tank.
(Refer to Fuel Delivery System - " Fuel Tank")

7. Disconnect the vapor tube quick-connector (A).

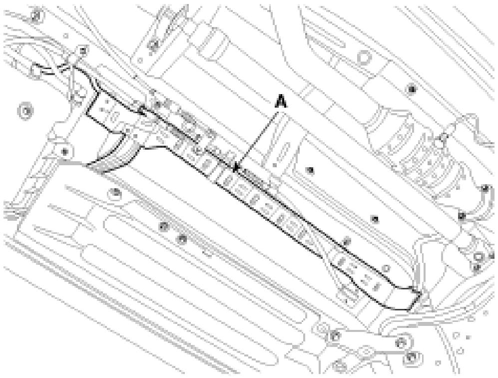


Open the vapor tube and low fuel line fixing clip to using driver.

Release the under cover (A) after remove the mounting bolts.



Disconnect the fuel & brake line protect (A) from the fixing clip.



Disconnect the fuel line fixing bracket (A) to engine room low.

Remove the fuel line.

Installation

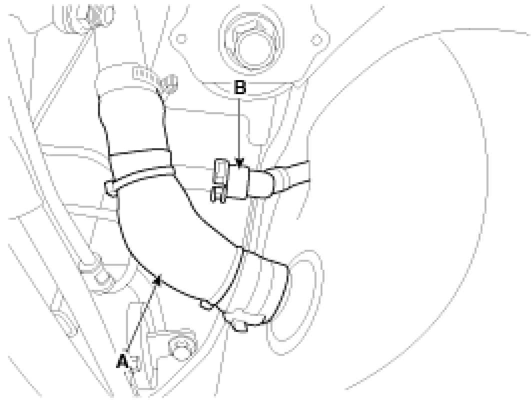
Install in the reverse order of removal.

Removal

Lift the vehicle.

Disconnect the fuel filler hose (A).

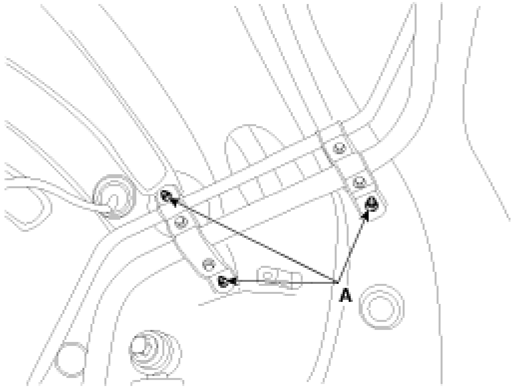
Disconnect the ventilation tube quick-connector (B).



Open the fuel filler door and unfasten the filler-neck assembly mounting screw (A).

Remove the rear-LH wheel, tire and the inner wheel house.

Remove the filler-neck assembly from the vehicle after removing the bracket mounting nut (A).



Installation

Install in the reverse order of removal.

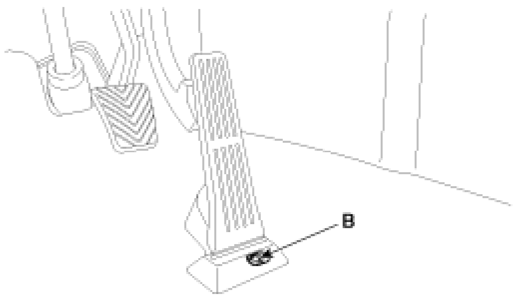
Filler-neck assembly bracket installation nut :
3.9 ~ 5.9 N.m (0.4 ~ 0.6 kgf.m, 2.9 ~ 4.3 lb-ft)

Removal

Turn the ignition switch OFF and disconnect the negative (-) battery cable.

Disconnect the accelerator position sensor connector (A).

Remove the installation nuts (C), the bolt (B) and then remove the accelerator pedal module.



Installation

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)

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.

Turn the ignition switch OFF and disconnect the battery negative (-) cable.

Release the residual pressure in fuel line.
(Refer to Fuel Delivery System - "Release Residual Pressure in Fuel Line")

CAUTION

When removing the fuel pump fuse, a Diagnostic Trouble Code (DTC) may occur. Delete the code with the GDS after completion of "Release Residual Pressure in Fuel Line" work.

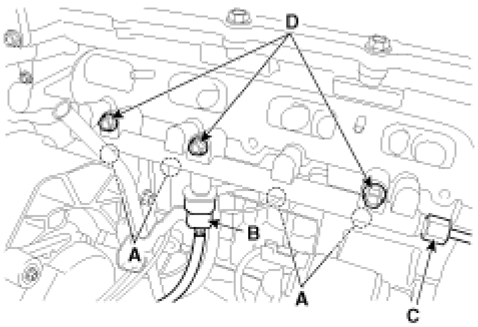
Remove the intake manifold.
(Refer to Engine Mechanical System - "Intake Manifold")

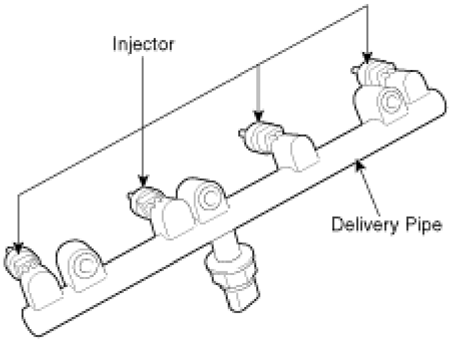
Remove the injector form (A).

Disconnect the injector connectors (A) and the rail pressure sensor connector (B).

Remove the high pressure fuel pipe (C).

Remove the installation bolt (D), and then remove the delivery pipe and injector assembly from the engine.





Installation

CAUTION

- Install the component with the specified torques.

CAUTION

- Apply engine oil to the injector O-ring.
- Do not use already used injector O-ring again.

CAUTION

- Do not reuse the bolts.

CAUTION

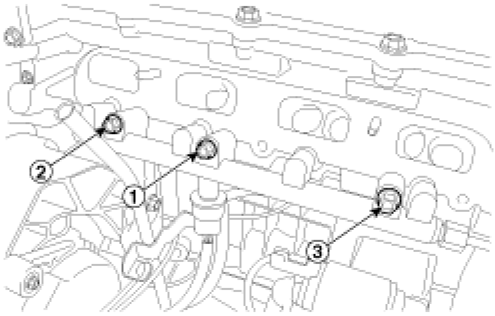
- When insert the injector, be careful not to damage the injector tip.

CAUTION

- Use proper tooling for change of combustion seal. Take proper precautions not to damage surface during assembly or disassembly.

CAUTION

- Avoid dropping the fuel pipe (including injectors) or bumping it into any hard objects since damage to the internal components may occur. If necessary, visually inspect and confirm proper operation with performance tests prior to reuse.
- Before installing the injector into the cylinder head, clean the injector hole and avoid contaminants from entering inside the injector hole. When installing the injector, avoid bumping the injector tip into any of the surrounding components since the tip may become damaged from the impact.
- When fastening the three fuel delivery pipe mounting bolts, fully hand-tighten first, and then tighten in the proper sequence (① → ② → ③) in several cycles up tithe specified torque. The delivery pipe should move less than 1/8 inch (approx.3mm), whenever each bolt is tightened.



Install in the reverse order 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:
26.5 ~ 32.4 N.m (2.7 ~ 3.3 kgf.m, 19.5 ~ 23.9 lb-ft)

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.

Turn the ignition switch OFF and disconnect the battery negative (-) cable.

Release the residual pressure in fuel line.
(Refer to Fuel Delivery System - "Release Residual Pressure in Fuel Line")

CAUTION

When removing the fuel pump fuse, a Diagnostic Trouble Code (DTC) may occur.
Delete the code with the GDS after completion of "Release Residual Pressure in Fuel Line" work.

Remove the air cleaner and the air intake hose
(Refer to Engine Mechanical System - "Intake And Exhaust System")

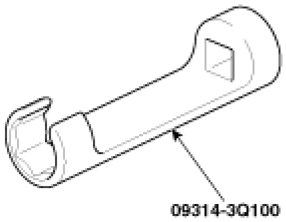
Disconnect the fuel pressure control valve connector (A).

Remove the ignition coil (B).

Disconnect the fuel feed tube quick-connector (A).

Remove the high pressure fuel pipe.

Remove the installation nut (B) from the high pressure fuel pump with the special service tool [SST No.: 09314-3Q100]



Remove the installation nut (C) from the delivery pipe with the special service tool [SST No.: 09314-3Q100]

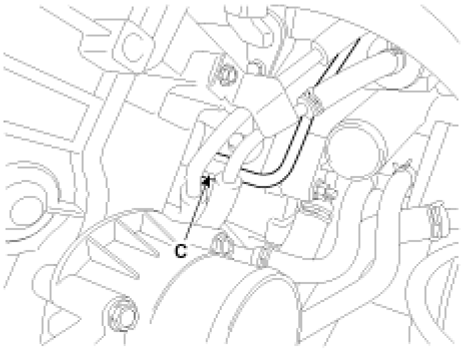
Remove the purge control solenoid valve.
(Refer to Engine Control System - "PCSV")

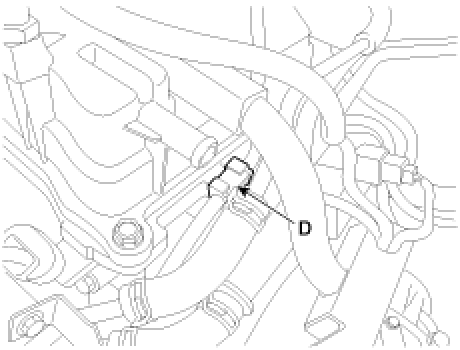
Remove the function block (D), and then remove the high pressure fuel pipe.

Remove the installation bolts (E), and then remove the high pressure fuel pump 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

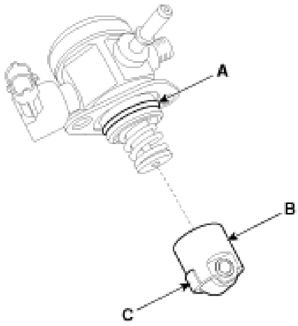
- Install the component with the specified torques.
- First hand-tighten the fasteners fully until they are not fastened any more in order to have them inserted in place and then completely tighten to the specified torque using a torque wrench. If not tightening the bolts or nuts in a straight line with 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

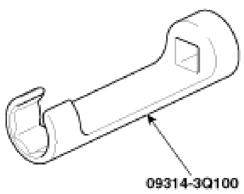
- Apply engine oil to the O-ring (A) of the high pressure fuel pump, the roller tappet (B), and the protrusion (C). Also apply engine oil to the groove on the location where the protrusion (C) is installed.



Install in the reverse order of removal.

NOTE

Use the special service tool [SST No.: 09314-3Q100] 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:
26.5 ~ 32.4 N.m (2.7 ~ 3.3 kgf.m, 19.5 ~ 23.9 lb-ft)
High pressure fuel pipe function block installation bolt:
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)

Specifications

Specifications

Item		Specifications
Transaxle type		A6MF2
Engine model		Gasoline 2.4GDI
Torque converter type		3-element, 1-stage, 2-phase type
Torque converter size		Ø236 mm (9.2913 in.)
Oil pump system		Parachoid
Friction elements		Clutch: 2EA
		Brake: 3EA
		OWC : 1EA
Planetary gear		3EA
Gear ration	1st	4.639
	2nd	2.826
	3rd	1.841
	4th	1.386
	5th	1.000
	6th	0.772
	Reverse	3.385
Final gear ratio		3.648
Fluid pressure balance piston		2EA
Accumulator		4EA
Solenoid valve		8EA (VFS:6EA, ON/OFF:2EA)
Shift lever position		4 Range (P,R,N,D)
Oil filter		1EA

VFS: Variable Force Solenoid

Sensors

Input Speed Sensor

▷ Type: Hall effect sensor

▷ Specifications

Operation condition (°C)°F		((-)40 ~ 150)) -40 ~ 302
Air gap(mm)in.		(0.95 ~ 1.65) 0.0374 ~ 0.0649
Output voltage(V)	High	1.18 ~ 1.68
	Low	0.59 ~ 0.84

Output Speed Sensor

▷ Type: Hall effect sensor

▷ Specifications

Operation condition (°C)°F	((-)40 ~ 150)) -40 ~ 302

Air gap(mm)in.		(0.25 ~ 0.70) 0.0098 ~ 0.0276
Output voltage (V)	High	1.18 ~ 1.68
	Low	0.59 ~ 0.84

Oil Temperature Sensor

▷ Type: Negative thermal coefficient type

▷ Specifications

Temp.(°C)°F	Resistance (kΩ)
(-40)-40	48.1
(-20)-4.0	15.6
(0)32.0	5.88
(20)68.0	2.51
(40)104.0	1.11
(60)140.0	0.61
(80)176.0	0.32
(100)212.0	0.18
(120)248.0	0.10
(140)284.0	0.06
(165)329.0	0.03

Inhibiter Switch

▷ Type: Combination of output signals from 4 terminals

▷ Specifications

Power supply (V)	12
Output type	Pin to Pin

Solenoid Valves

Direct control VFS[26/B, T/CON]

▷ Control type : Normal low type

Control Pressure kpa (kgf/cm², psi)	9.81 ~ 500.14 (0.1 ~ 5.1,1.42 ~ 72.54)
Current value(mA)	50 ~ 850
Internal resistance(Ω)	5.1

Direct control VFS[UD/B, OD/C, 35R/C]

▷ Control Type : Normal high type

Control Pressure kpa (kgf/cm², psi)	500.14 ~ 9.81 (5.1 ~ 0.1,72.54 ~ 1.42)
Current value(mA)	50 ~ 850
Internal resistance(Ω)	5.1

Line Pressure Control VFS

▷ Control type : Normal high type

Control Pressure kpa (kgf/cm², psi)	500.14 ~ 9.81 (5.1 ~ 0.1,72.54 ~ 1.42)
Current value(mA)	50 ~ 850
Internal resistance(Ω)	5.1

ON/OFF Solenoid Valve(SS-A, SS-B)

▷ Control type : Normal low type

Control pressure kpa (kgf/cm², psi)	490.33 (5.0, 71.12)
Internal resistance(Ω)	10 ~ 11

Solenoid Valve Operation Table

			UD/B-VFS	OD/C-VFS	35R/C-VFS	26/B-VFS
	SS-A	**SS-B**	**N/H**	**N/H**	**N/H**	**N/L**
N, P	●		●		●	
1	Δ			Δ	●	
2				●	●	●
3		●		●		
4					●	
5		●	●			
6			●		●	●
L	●				●	
R	●	●	●			

● : Connected status

Δ : Connected at vehicle speed above 8km/h

Tightening Torques

Item	N.m	Kgf.m	lb-ft
TCM installation mounting bolt/nut	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Shift cable bracket mounting bolt	14.7 ~ 21.6	1.5 ~ 2.2	10.9 ~ 15.9
Input shaft speed sensor mounting bolt	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Output shaft speed sensor mounting bolt	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Shift lever assembly bolt	8.8 ~ 13.7	0.9 ~ 1.4	9.4 ~ 10.8
Inhibitor switch mounting bolt	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Valve body cover mounting bolt	13.7 ~ 15.7	1.4 ~ 1.6	10.1 ~ 11.6
ATF Warmer mounting bolt	7.8 ~ 11.8	0.8 ~ 1.2	5.8 ~ 8.7
Injection hole (eyebolt)	2.9 ~ 4.9	0.3 ~ 0.5	2.2 ~ 3.6
Oil drain plug	38.2 ~ 48.1	3.9 ~ 4.9	28.2 ~ 35.4
Torque converter mounting bolt	45.1 ~ 52.0	4.6 ~ 5.3	33.3 ~ 38.3
Starter motor mounting bolts	42.2 ~ 53.9	4.3 ~ 5.5	31.1 ~ 39.8
Automatic transaxle upper mounting bolt (TM=>Eng)	42.2 ~ 53.9	4.3 ~ 5.5	31.1 ~ 39.8
Automatic transaxle lower mounting bolt (Eng=>TM)	42.2 ~ 48.1	4.3 ~ 4.9	31.1 ~ 35.4

	42.2 ~ 53.9	4.3 ~ 5.5	31.1 ~ 39..8
Automatic transaxle mounting support bracket bolt	58.8 ~ 78.5	6.0 ~ 8.0	43.4 ~ 57.9
Automatic transaxle mounting bracket bolt	88.3 ~ 107.9	9.0 ~ 11.0	65.1 ~ 79.6

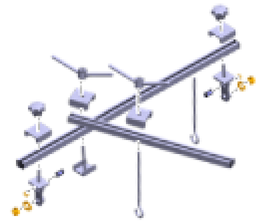
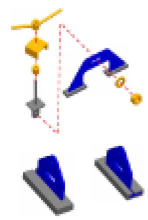
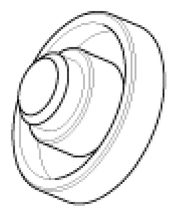
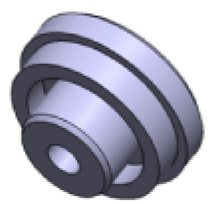
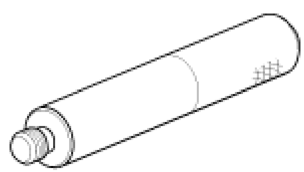
Lubricants

Item	Specified lubricant	Quantity
Transaxle fluid	SK ATF SP-IV, MICHANG ATF SP-IV,NOCA ATF SP-IV, Hyundai Genuine ATF SP-IV or other brands meeting the above specification approved by Hyundai Motors Corp.	7.1L (1.88 U.S gal., 7.50 U.S.qt., 6.24 Imp.qt.)

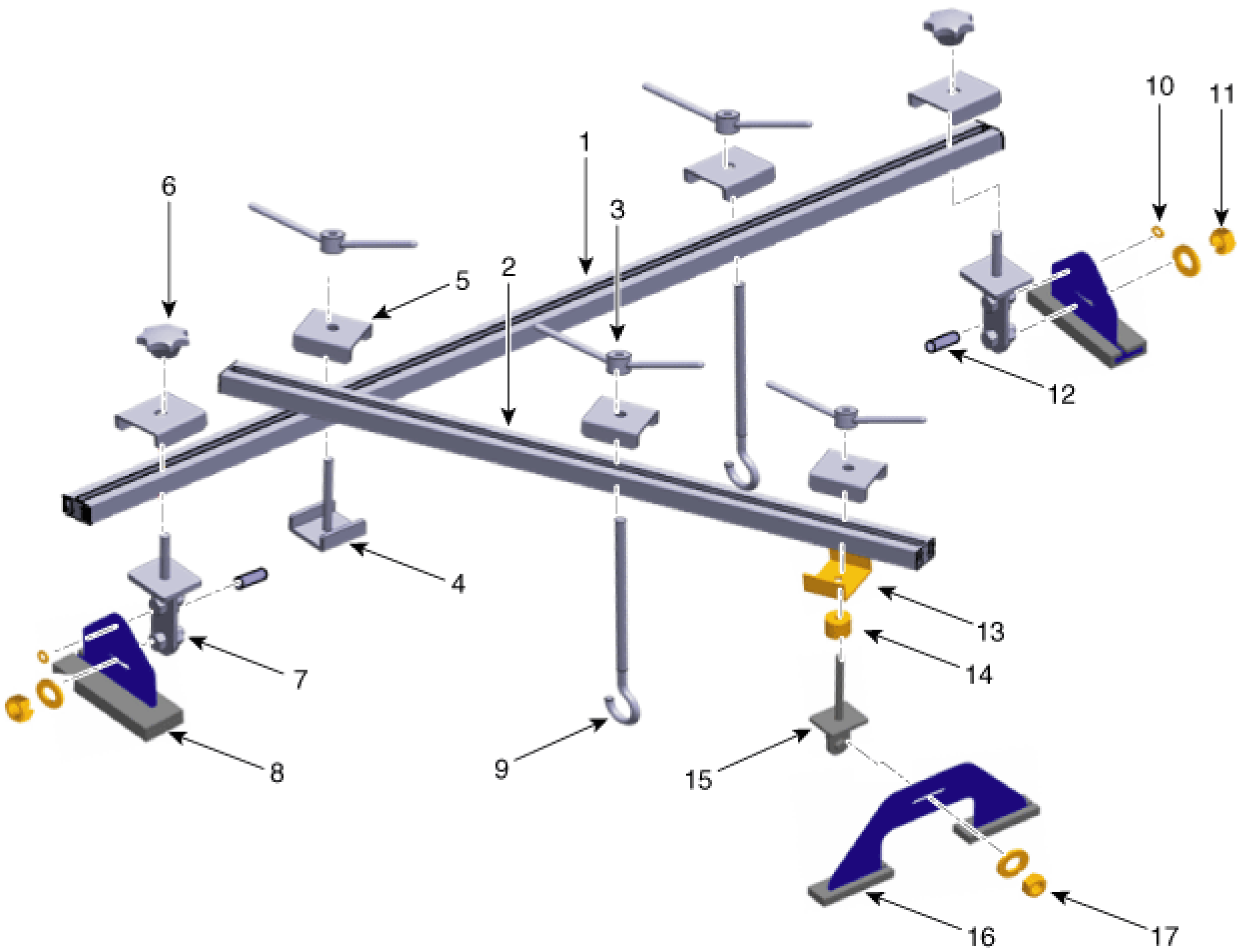
Sealant

Item	Specified sealant
Rear cover	LOCTITE FMD-546 or THREE-BOND TB1281B
Torque converter housing	

Special Service Tools

Tools (Number and name)	Illustration	Use
09200-3N000 Engine support fixture(Beam)		Removal and installation of the transaxle. Except lower supporter, use beam only with new engine support fixture supporter(SST No.:09200-2S000)
09200-2S000 Supporter		Removal and installation of the transaxle. Use this beam (SST No. : 09200-38001/3N000) with the supporter (SST No. : 09200-2S000)
09453-3L240 Oil seal installer(2WD)		Installation of transaxle case oil seal. [Using with bar (SST No.:09231-H1100)]
09453-2W100 Oil seal installer(4WD)		Installation of transaxle case oil seal. [Using with bar (SST No.:09231-H1100)]
09231-H1100 Bar		Installation of transaxle case oil seal. [Using with oil seal installer (SST No.:09453-3L241, 09453-2W100)]
09480-A3800 Inhibitor neutral fixed pin		Inhibitor neutral fixed.

※ Engine support fixture special tool assembly drawing



1. 09200-3N000(Main bar) 2. 09200-3N000(Sub bar) 3. 09200-3N000(Handle) 4. 09200-3N000(Stopper) 5. 09200-3N000(Stopper) 6. 09200-3N000(Knob) 7. 09200-3N000(Adapter) 8. 09200-2S000(Supporter) 9. 09200-3N000(Hanger)	10. 09200-3N000(Clip) 11. 09200-3N000(Nut) 12. 09200-3N000(Pin) 13. 09200-2S000(Stopper) 14. 09200-2S000(Spacer) 15. 09200-2S000(Adapter) 16. 09200-2S000(Nut) 17. 09200-2S000(Supporter)

Fault Diagnosis

Features a fail-safe mechanism that provides "limp-home" 4th gear hold to enable the vehicle to be driven to the owner's home or dealer shop.

Fail-Safe: The TCM provides 4th gear hold and Reverse gear in the event of a malfunction.

Limp Home: Maintains minimal functionality (Drive(4th gear hold), Reverse) in the event of a malfunction, making it possible for the vehicle to reach the dealer shop.

Self-diagnosis

Transaxle Control Module (TCM) is in constant communication with the control system's components (sensors and solenoids).

If an abnormal signal is received for longer than the predefined duration, TCM recognizes a fault, stores the fault code in memory, and then sends out a fault signal through the self-diagnosis terminal. Such fault codes are independently backed up and will not be cleared even if the ignition switch is turned off, the battery is disconnected, or the TCM connector is disconnected.

CAUTION

- Disconnecting a sensor or an actuator connector while the ignition switch is in the "On" position generates a Diagnostic Trouble Code (DTC) and commits the code to memory. In such event, disconnecting the battery will not clear the fault diagnosis memory. The diagnosis tool must be used to clear the fault diagnosis memory.
- Before removing or installing any part, read the diagnostic trouble codes and then disconnect the battery negative (-) terminal.
- Before disconnecting the cable from battery terminal, turn the ignition switch to OFF. Removal or connection of the battery cable during engine operation or while the ignition switch is ON could cause damage to the Transaxle Control Module (TCM).
- When checking the generator for the charging state, do not disconnect the battery '+' terminal to prevent the Engine Control Module (ECM) from damage due to the voltage.
- When charging the battery with the external charger, disconnect the vehicle side battery terminals to prevent damage to the TCM.

Checking Procedure (Self-diagnosis)

CAUTION

- When battery voltage is excessively low, diagnostic trouble codes cannot be read. Be sure to check the battery for voltage and the charging system before starting the test.

Inspection Procedure (Using the GDS)

1. Turn OFF the ignition switch.
2. Connect the GDS to the data link connector on the lower crash pad.
3. Turn ON the ignition switch.
4. Use the GDS to check the diagnostic trouble code.
5. Repair the faulty part from the diagnosis chart.
6. Erase the diagnostic trouble code.
7. Disconnect the GDS.

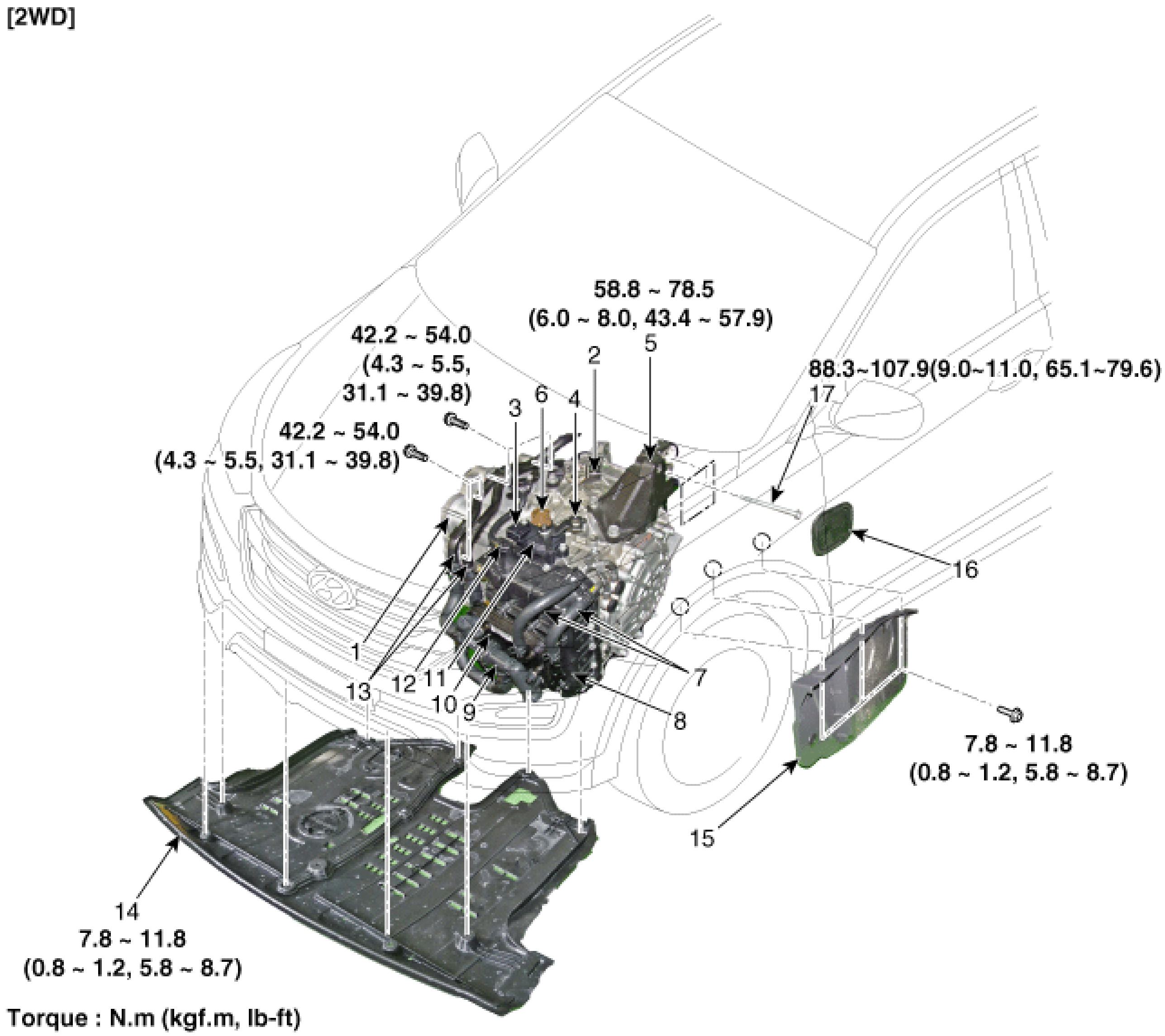
CAUTION

- After replacing the automatic transaxle, use the GDS to reset (erase the TCM learning values). Then perform Transaxle Control Module (TCM) learning to provide optimum shift quality.
(Refer to Automatic Transaxle Control System - "Repair procedures")
- Adding automatic transaxle fluid.
(Refer to Hydraulic System - "Fluid")
- After servicing the automatic transaxle or TCM, clear the Diagnostic Trouble Code (DTC) using the GDS tool.
Diagnostic Trouble Codes (DTC) cannot be cleared by disconnecting the battery.

Automatic Transaxle System

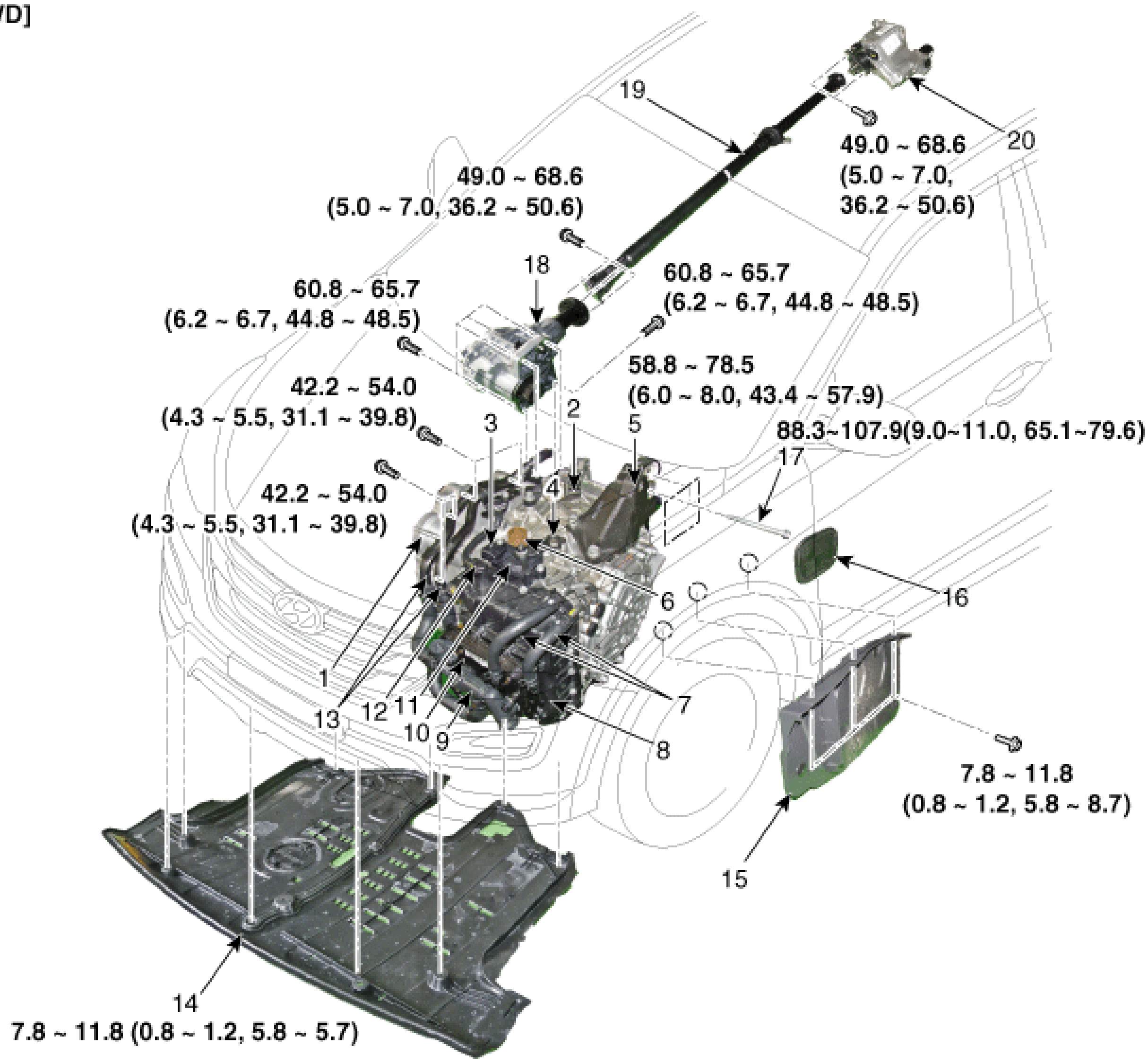
Automatic Transaxle. Components and Components Location

Components Location



1. Automatic transaxle 2. Shift cable bracket 3. Inhibitor switch connector 4. Manual control lever 5. Automatic transaxle mounting support bracket 6. Solenoid valve connector 7. ATF hose & pipe 8. Valve body cover 9. Bypass valve	10. ATF Warmer 11. Inhibitor switch 12. ATF Injection hole (eyebolt) 13. Coolant hose & pipe assembly 14. Under cover 15. Side cover 16. Automatic transaxle mounting bracket cover 17. Automatic transaxle mounting bracket bolt

[4WD]



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

1. Automatic transaxle 2. Shift cable bracket 3. Inhibitor switch connector 4. Manual control lever 5. Automatic transaxle mounting support bracket 6. Solenoid valve connector 7. ATF hosepipe 8. Valve body cover 9. Bypass valve 10. ATF Warmer	11. Inhibitor switch 12. ATF Injection hole (eyebolt) 13. Coolant hose & pipe assembly 14. Under cover 15. Side cover 16. Automatic transaxle mounting bracket cover 17. Automatic transaxle mounting bracket bolt 18. Transfer assembly 19. Propeller shaft 20. Coupling Assembly

Removal

Remove the engine cover.

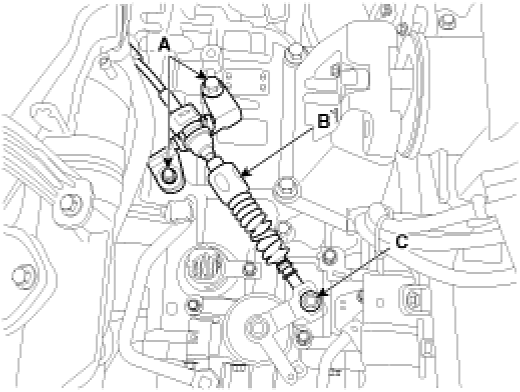
Remove the air cleaner assembly and air duct.

Remove the battery and battery tray.

Disconnect the inhibitor switch connect (A) and solenoid valve connector (B).

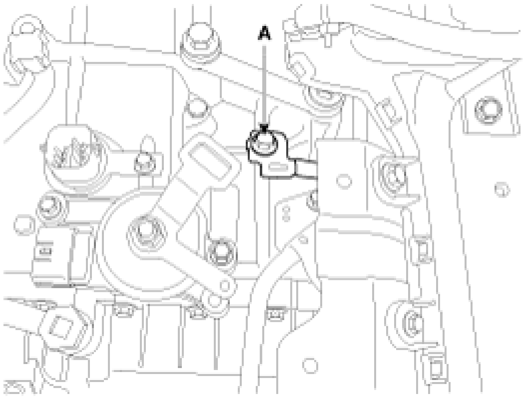
Remove the shift cable (B) after removing the nut (C) and the bolt (A).

Tightening torque:
(A) 14.7 ~21.6 N.m(1.5 ~2.2 kgf.m, 10.9 ~15.9 lb-ft)
(C) 7.8 ~ 11.8 N.m (0.8 ~ 1.2 kgf.m, 5.8 ~ 8.7 lb-ft)



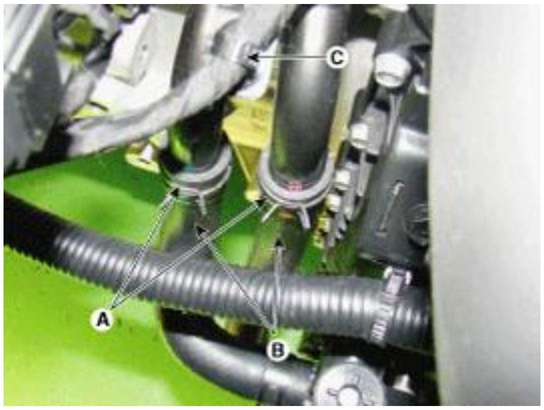
Remove the ground line after removing the bolt (A).

Tightening torque:
(A) 10.8~13.7N.m (1.1 ~ 1.4 kgf.m, 8.1~10.1lb-ft)



Disconnect the coolant hose (B) after removing the automatic transaxle coolant hose clamp (A).

Remove the wiring mounting clip (C).



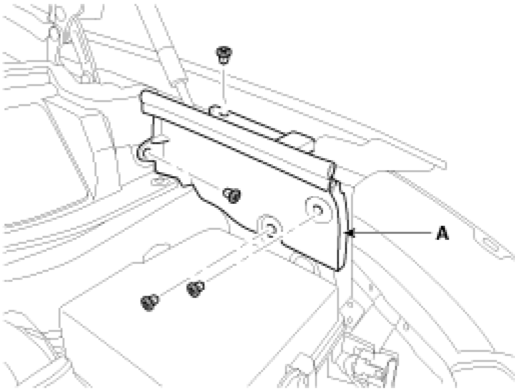
Remove the coolant pipe mounting bolts (A).

Remove the coolant pipe(B).

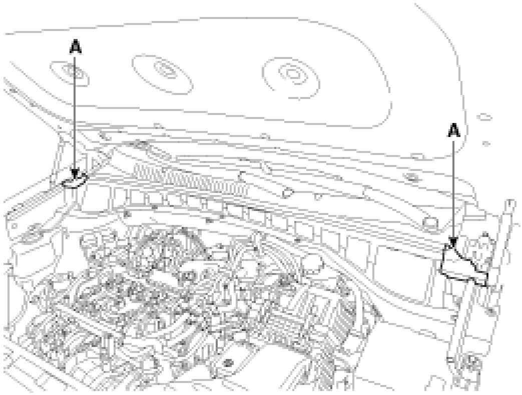
Tightening torque:
(A) 8.8~13.7N.m (0.9 ~ 1.4 kgf.m, 6.5~10.1lb-ft)

Remove the wiring bracket installation bolt (A).

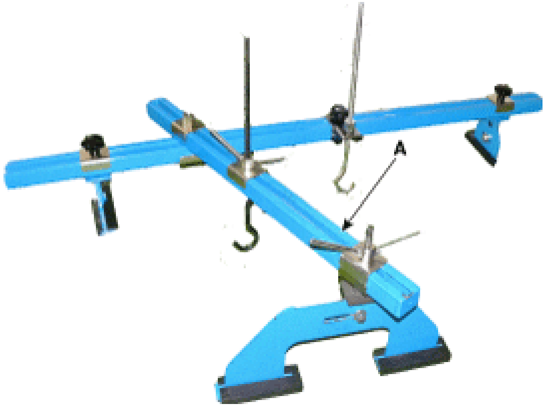
After loosening the mounting clips, then remove the fender side cover (A).



Disconnect the pad(A).

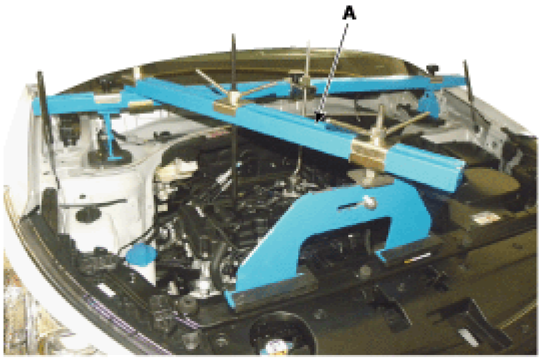


Assembled the engine support fixture (A).



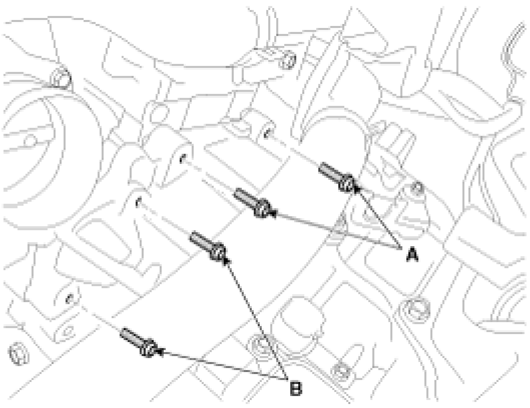
Remove the hood.

Using the engine support fixture (A) , hold the engine and transaxle assembly safely.



Remove the automatic transaxle upper mounting bolt (A-2ea) and the starter motor mounting bolt (B-2ea).

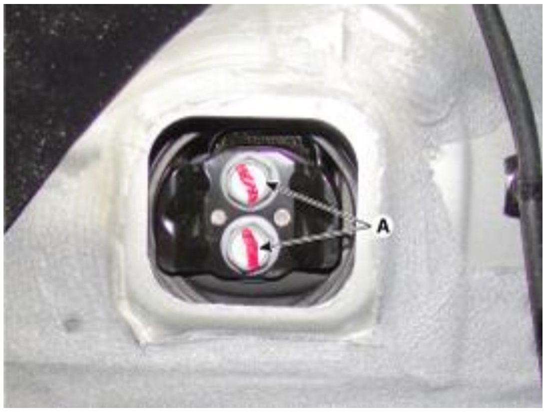
Tightening torque:
(A),(B) 42.2 ~ 54.0 N.m (4.3 ~5.5 kgf.m, 31.1 ~ 39.8 lb-ft)



Remove the mounting bracket cover (A).

Remove the automatic transaxle mounting bracket bolt (A).

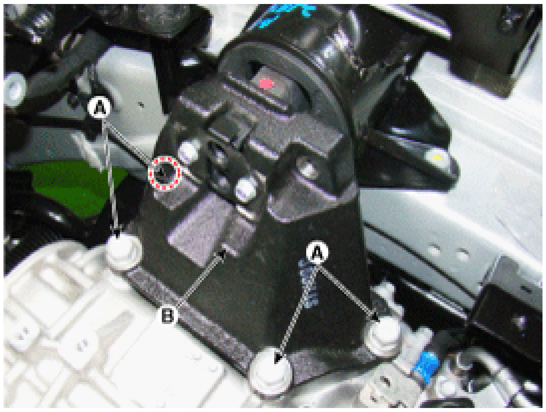
Tightening torque:
88.3~107.9 N.m (9.0~11.0 kgf.m, 65.1~79.6 lb-ft)



Remove the automatic transaxle mounting support bracket bolts (A).

Remove the automatic transaxle mounting support bracket (B).

Tightening torque:
58.8~78.5 N.m (6.0~ 8.0 kgf.m, 43.4~57.9 lb-ft)



Remove the under cover (A).

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

Remove the side cover (A).

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

Remove the following items;
2WD

A. Sub frame assembly.

B. Drive shaft assembly.

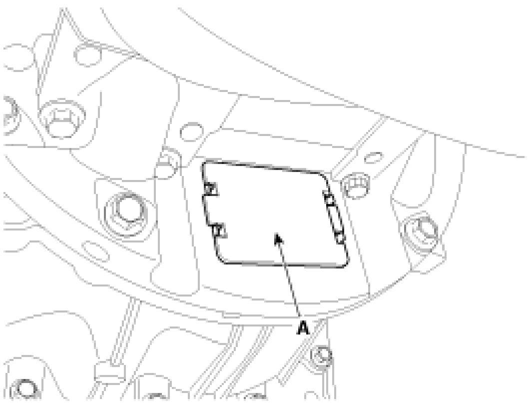
4WD

A. Sub frame assembly.

B. Drive shaft assembly.

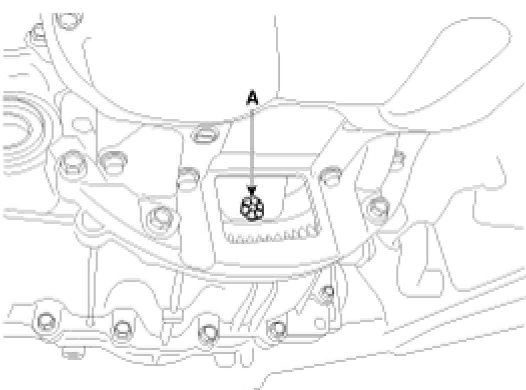
C. Transfer assembly.

Remove the dust cover (A).



Remove the torque converter mounting bolt (A) with rotating the crankshaft.

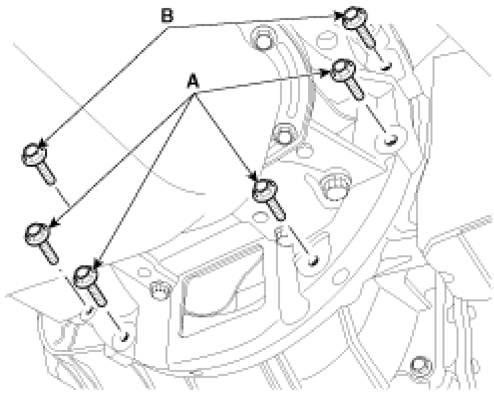
Tightening torque:
45.1 ~ 52.0 N.m (4.6 ~ 5.3 kgf.m, 33.3 ~ 38.3 lb-ft)



Remove the automatic transaxle with a jack after removing the mounting bolt (A-4ea, B-2ea).

Tightening torque:

(A) 42.2 ~ 48.1 N.m (4.3 ~ 4.9 kgf.m, 31.1 ~ 35.4 lb-ft)
(B) 42.2 ~ 54.0 N.m (4.3 ~5.5 kgf.m, 31.1 ~ 39.8 lb-ft)



Installation

Installation is the reverse of removal.

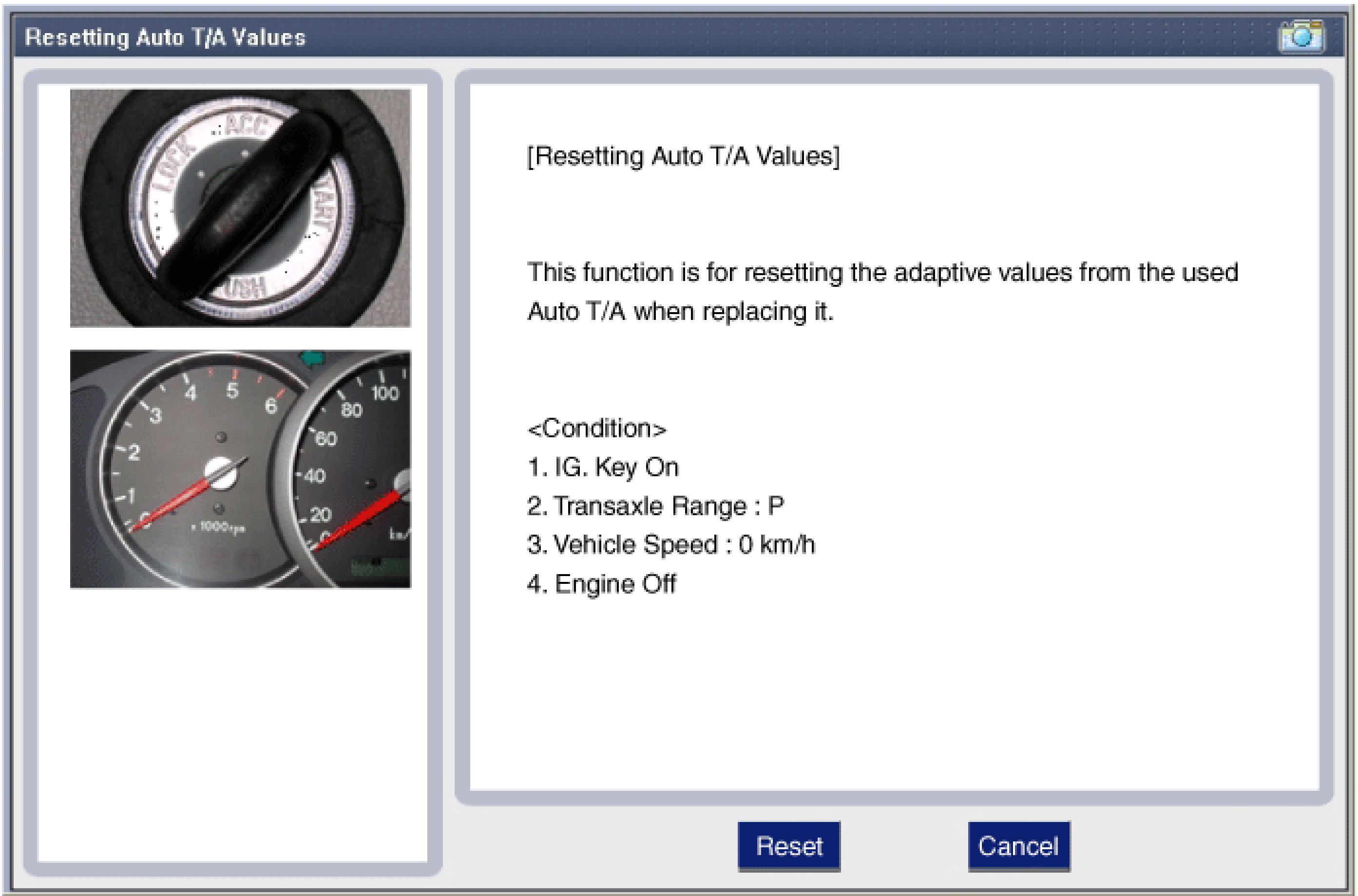
CAUTION

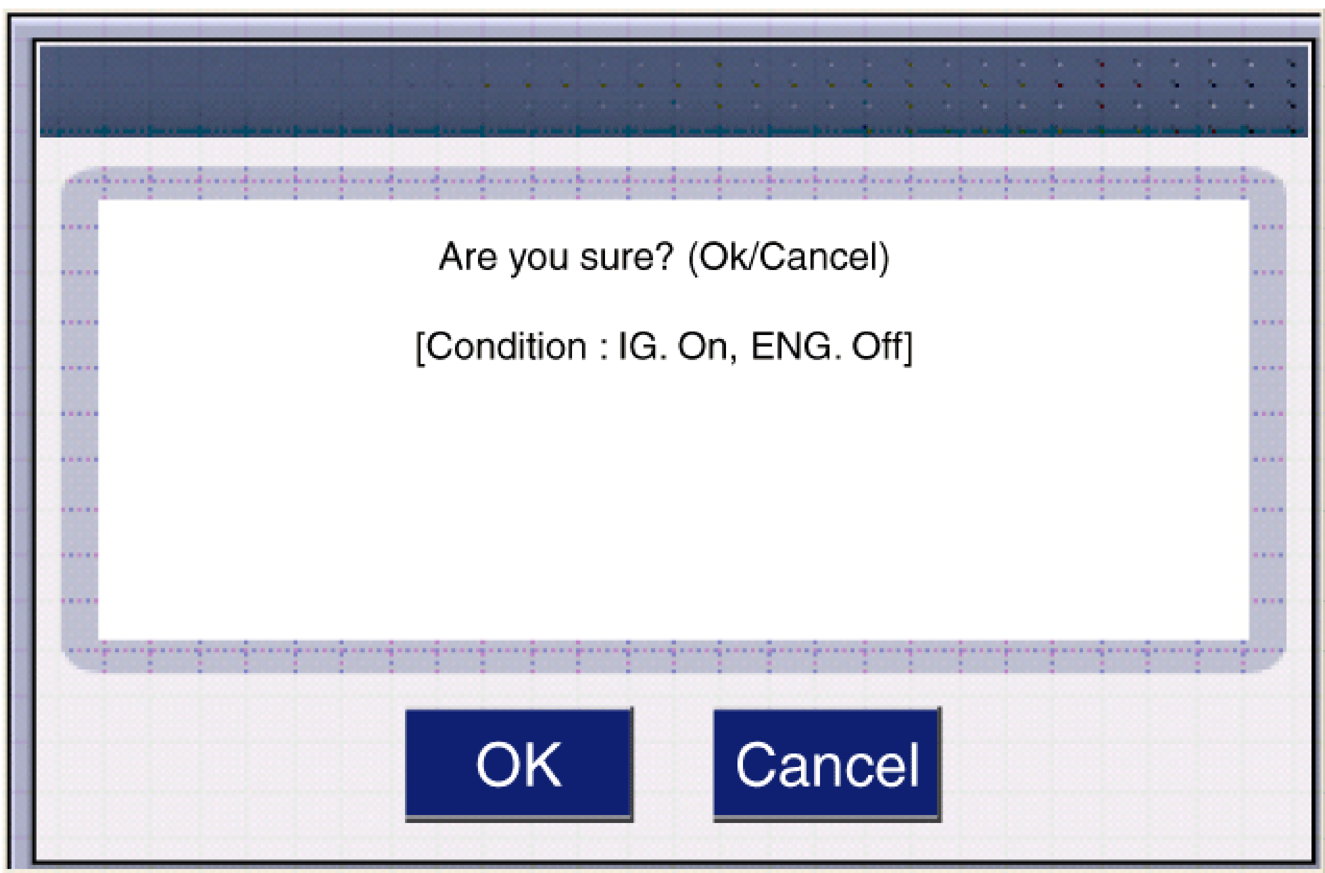
If the oil seal on the transaxle case side is damaged and fluid is leaking, replace the oil seal with a new unit.
When installing the new oil seal, use the specialized tool (oil seal installer, 09453-3L240).

NOTE

After replacement or reinstallation procedure of the automatic transaxle assembly, must perform procedures below.

- Adding automatic transaxle fluid.
- Adding coolant.
- After replacing the automatic transaxle, clear the Diagnostic Trouble Code(DTC) using the GDS tool. DTC cannot be cleared by disconnecting the battery.
- When replacing the automatic transaxle, reset the automatic transaxle's values by using the GDS.


Resetting Auto T/A Values
[Resetting Auto T/A Values]
This function is for resetting the adaptive values from the used Auto T/A when replacing it.
<Condition>
1. IG. Key On
2. Transaxle Range : P
3. Vehicle Speed : 0 km/h
4. Engine Off
Reset
Cancel


Are you sure? (Ok/Cancel)
[Condition : IG. On, ENG. Off]
OK
Cancel

- Perform TCM learning after replacing the transaxle to prevent slow transaxle response, jerky acceleration and jerky startup.

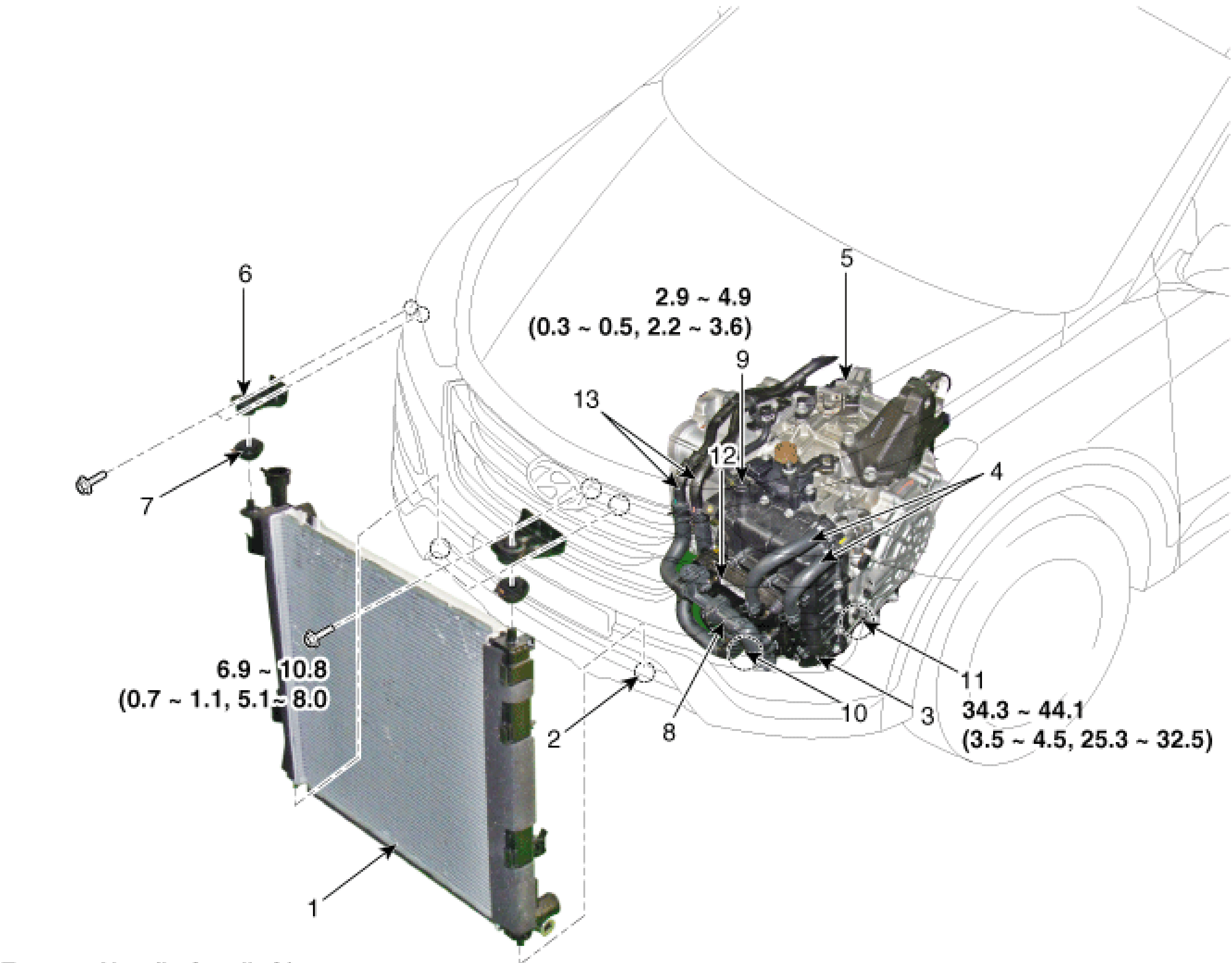
Hydraulic System

Description and Operation

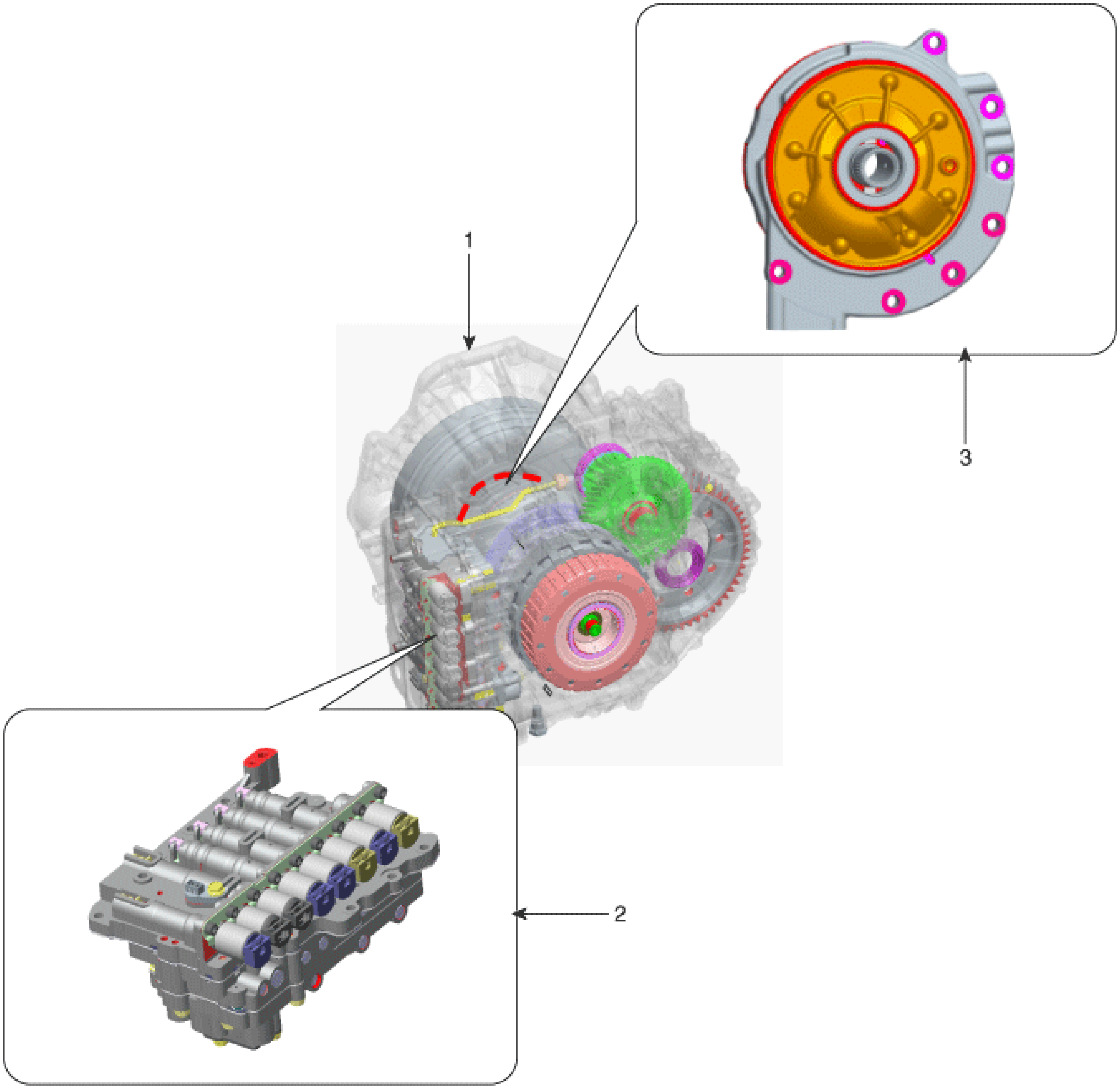
Description

The hydraulic system consists of oil, an oil filter, an oil pump, and a valve body (valves and solenoid valves).
The oil pump is powered by the engine. ATF passes through the oil filter and gets distributed along the oil channels.
The oil becomes highly pressurized as it exits the oil pump and passes through the line pressure valve before being fed to the clutch & brake control valve, clutch, and brakes. TCM controls the hydraulic pressure using solenoid valves and controls clutch and brake operations.

Component Location



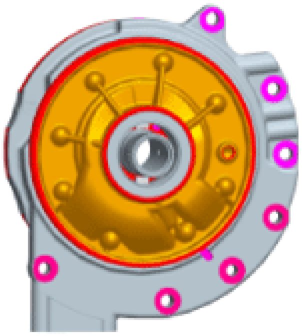
1. Radiator 2. Mounting insulator 3. Valve body cover 4. ATF hose & pipe 5. Automatic transaxle 6. Radiator (Automatic transaxle oil cooler) upper mounting bracket 7. Upper mounting insulator	8. Bypass valve 9. ATF injection hole (eyebolt) 10. Oil level plug 11. Oil drain plug 12. ATF Warmer 13. Coolant hose & pipe



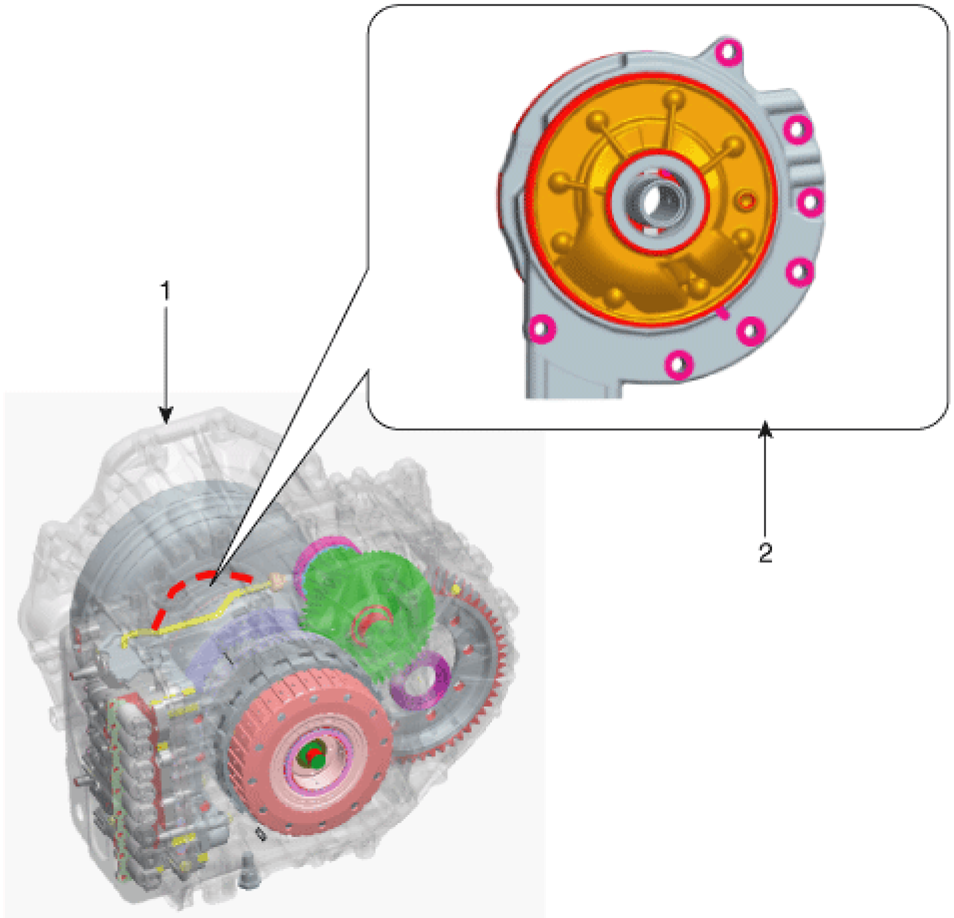
1. Automatic transaxle 2. Valve body assembly 3. Oil pump assembly

Description

The oil pump is built-in as a single unit with the 26Brake chamber. Rotation of the pump builds the hydraulic pressure needed for the lubrication of the various parts of the transaxle and operation of the clutch and brakes. The oil also circulates through the torque converter and the cooler.

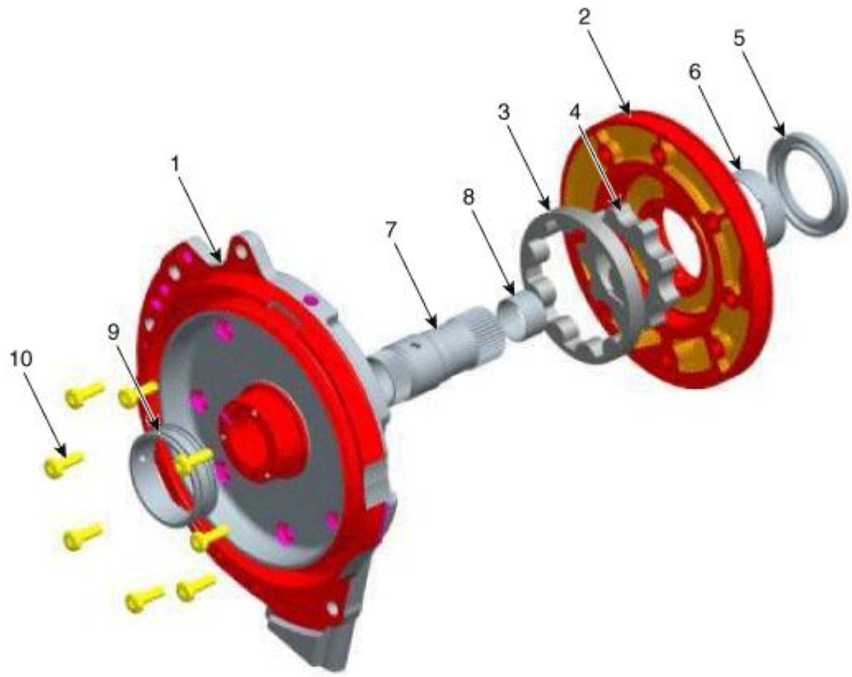


Component Location



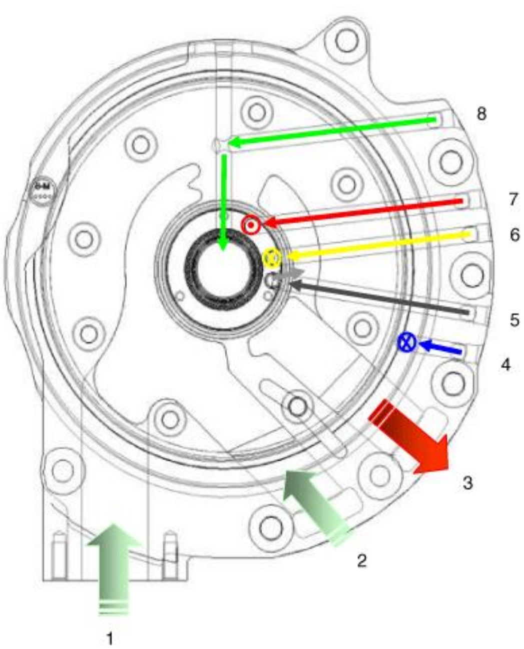
1. Automatic transaxle 2. Oil pump assembly	

Component



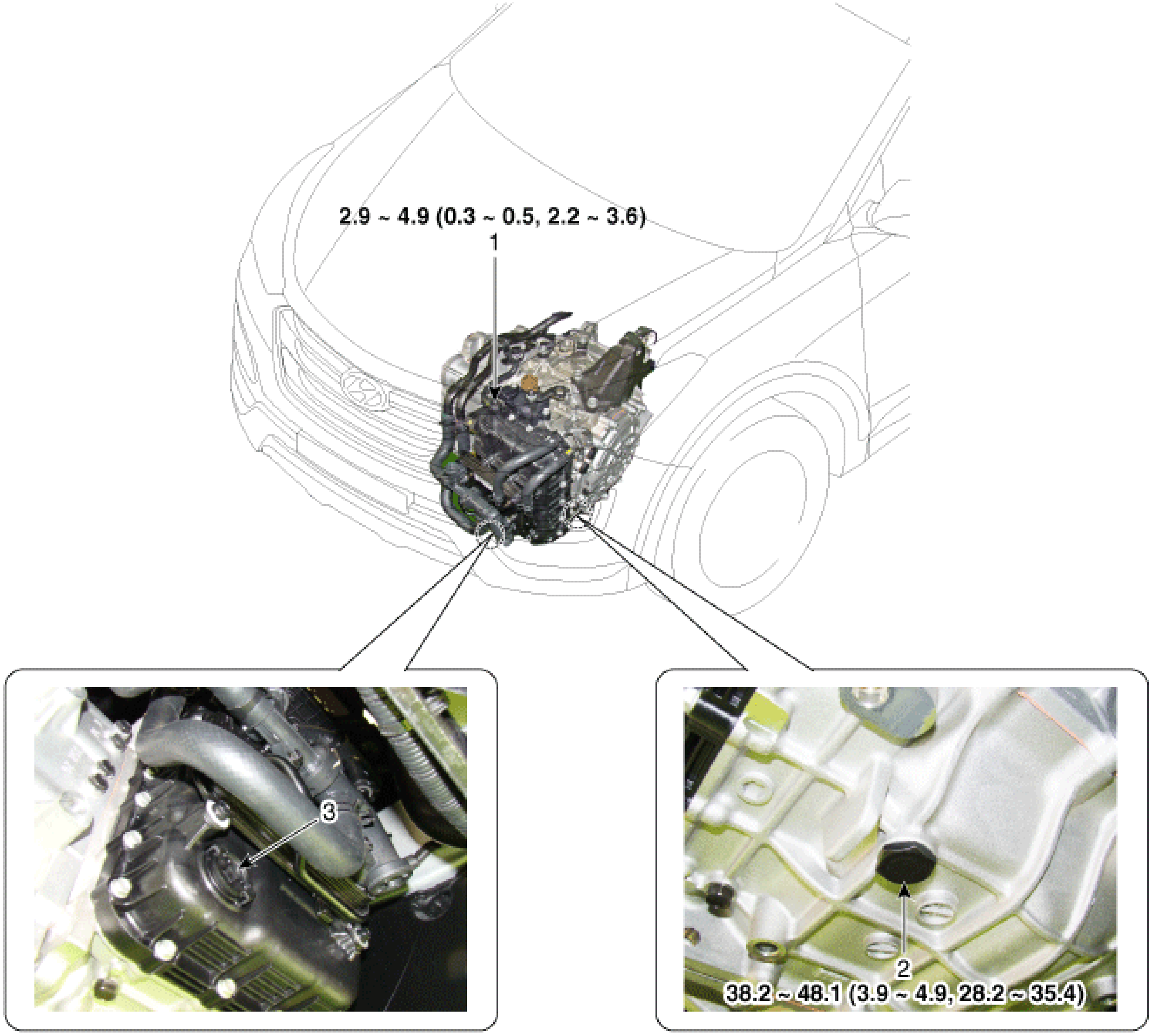
1. Reaction shaft support assembly 2. Oil pump housing 3. Driven gear 4. Drive gear 5. Oil seal	6. Bush-Housing 7. Reaction shaft 8. Bush- Reaction shaft 9. Sleeve 10. Flange bolt

Oil pump operation flow



1. Inhale (Oil filter) 2. Inhale (Valve body) 3. Outlet 4. 26/B operation pressure	5. 35R/C operation pressure 6. Lubrication 7. Lock up clutch operation pressure 8. Lock up clutch cancellation

Component Location



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

1. ATF Injection hole (eyebolt) 2. Oil level plug 3. Oil drain plug

Service Adjustment Procedure

Oil level Check

NOTE

A check of ATF level is not normally required during scheduled services. If an oil leak is found, perform the oil level check procedure after repairs are completed.

CAUTION

When checking the oil level, be careful not to enter dust, foreign matters, etc. from fill hole.

Remove the ATF Injection hole (eyebolt) (A).

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

CAUTION

Always replace the O-Ring (A) of the eyebolt use new one whenever loosening eyebolt.

Add ATF SP-IV 700cc to the ATF injection hole.

Start the engine. (Don't step on brake and accelerator simultaneously.

Confirm that the temperature of the A/T oil temperature sensor is 50~60°C(122~140°F) with the GDS.

Shift the select lever slowly from "P" to "D", then "D" to "P" and repeat one more at idle.

CAUTION

Stop in each gear position for 3 seconds.

Lift the vehicle, then remove the oil level plug (A) from the valve body cover.

CAUTION

At this time, the vehicle must be a horizontal state.

If the oil flows out of the overflow plug in thin steady stream, the oil level is correct.
Then finish the procedure and tighten the oil plug.

NOTE

Oil level check (excess or shortage) method

- Excess: Drain quantity exceed 900cc for tow minutes.{50~60°C(122~140°F)}
- Shortage: No drain.

CAUTION

If there is no damage at the automatic transaxle and the oil cooler, the oil cooler hose, transaxle case, valve body tightening state are normal, ATF must drop out after performing above 1 to 7 procedures. After performing above 1 to 7 procedures, if the oil doesn't drop out, inspect the automatic transaxle assembly for oil leaks.

CAUTION

Replace the gasket before reinstalling the oil level plug.

Oil level plug tightening torque:
Tightening up stopper

Lower the vehicle with the lift and then tighten the eyebolt.

Replacement

NOTE

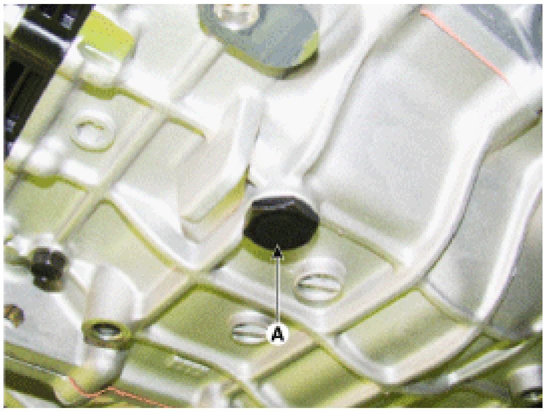
ATF of 6 speed automatic transaxle doesn't be replaced. But, if the vehicle is severe use or business use, replace ATF every 60,000 miles for severe usage.
Severe usage is defined as

- Driving in rough road (Bumpy, Gravel, Snowy, Unpaved road, etc.)
- Driving in mountain road, ascent/descent
- Repetition of short distance driving
- More than 50% operation in heavy city traffic during hot weather above 32°C (89.6°F) .

- Police, Taxi, Commercial type operation or trailer towing, etc

Remove the drain plug (A) and reinstall the drain plug after draining ATF totally.

Drain plug tightening torque:
38.2 ~ 48.1 N.m (3.9 ~ 4.9 kgf.m, 28.2 ~ 35.4 lb-ft)



CAUTION

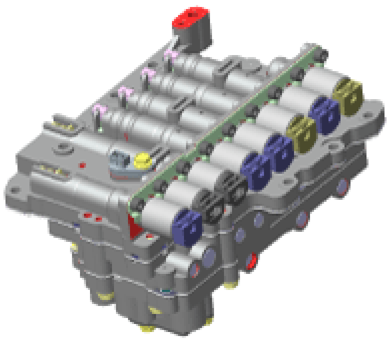
Replace the gasket before reinstalling the drain plug.

Fill the oil about 5 liters.

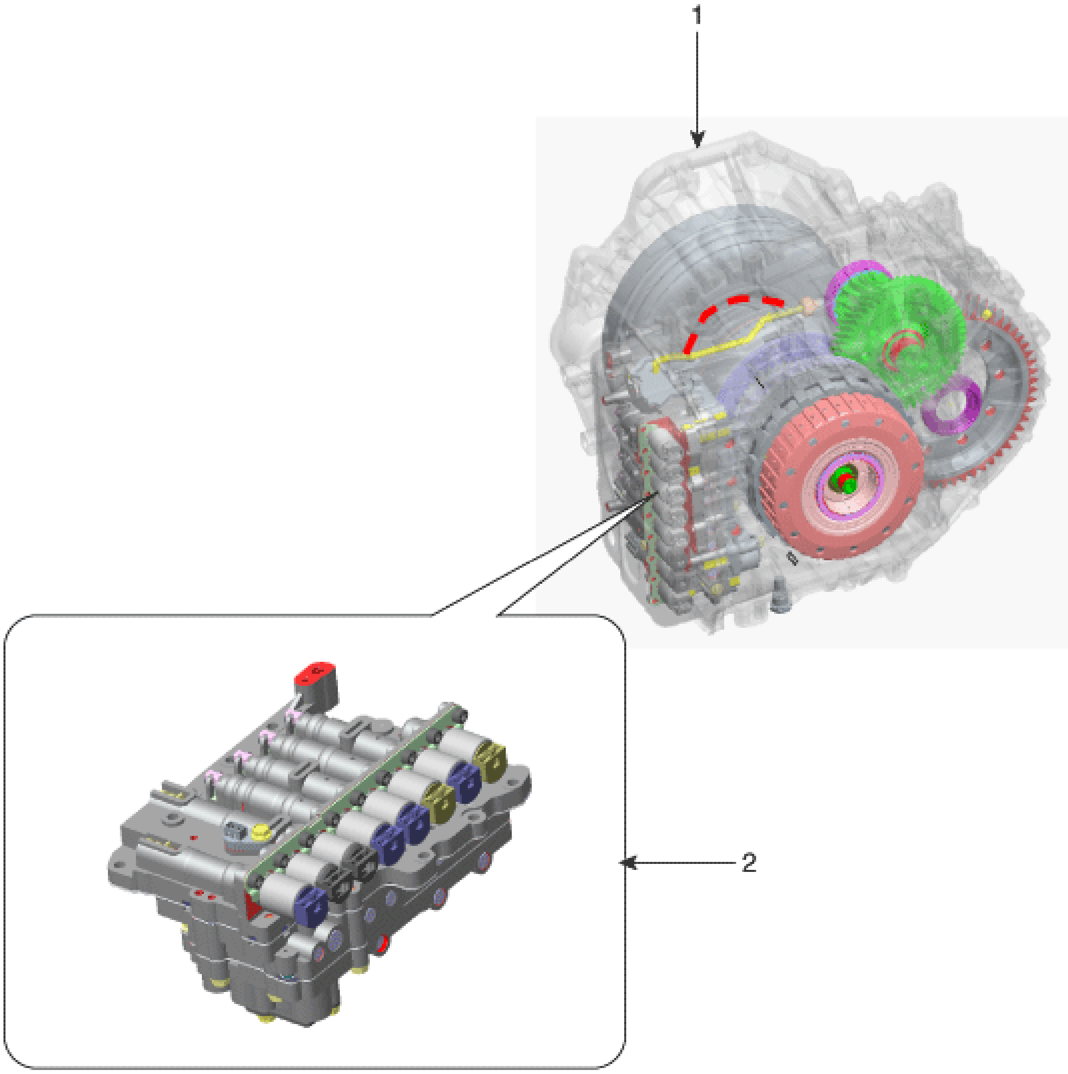
Check the oil level.

Description

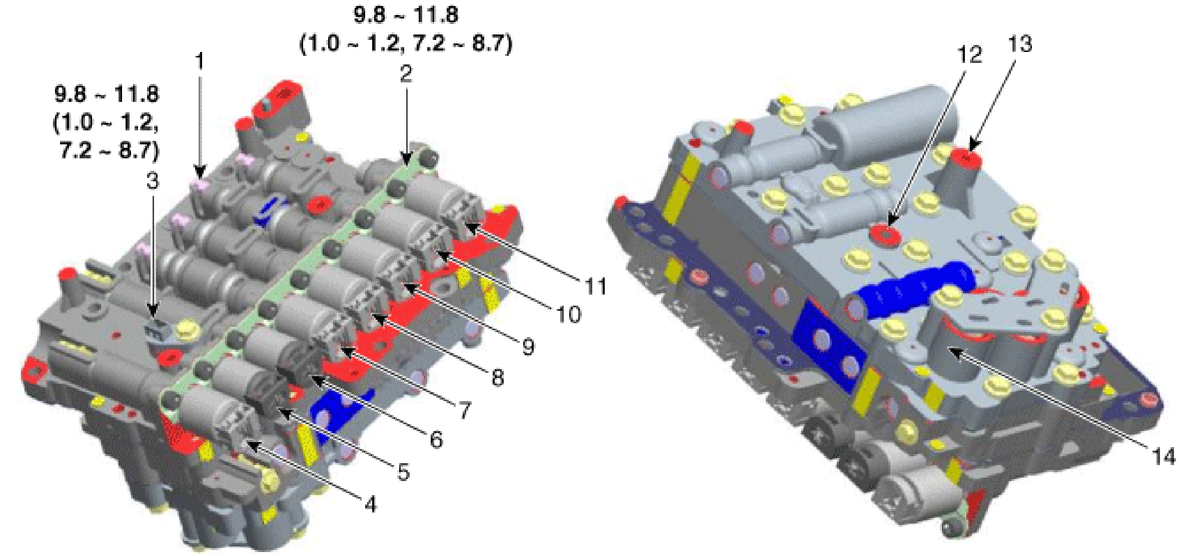
The valve body is essential to automatic transaxle control and consists of various valves used to control the oil feed from the oil pump. Specifically, these valves consist of pressure regulator valves, oil redirection valves, shift valves, and manual valves. The body also features electronic solenoid valves that ensure smooth gear changes.



Component Location



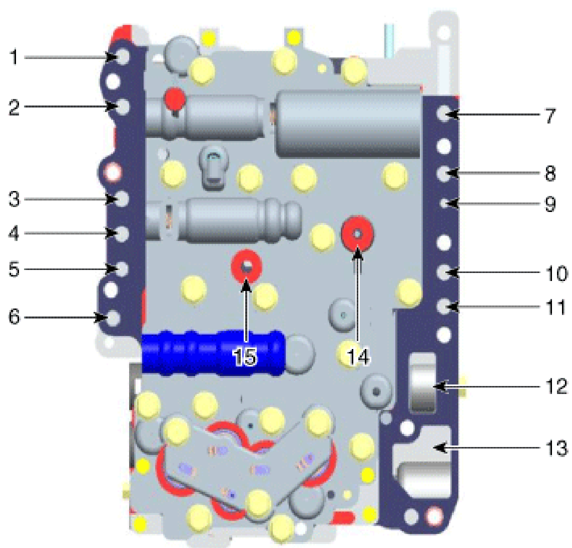
1. Automatic transaxle 2. Valve body assembly	



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

1. Pressure Control Valve (PCV) adjust screw	8. Underdrive Brake Control Solenoid Valve (UD/B)
2. Solenoid valve bracket	9. 26 Brake Control Solenoid Valve (26/B)
3. Oil temperature sensor	10. 35R Clutch Control Solenoid Valve (35R/C)
4. Line Pressure Control Solenoid Valve	11. Torque Converter Control Solenoid Valve (T/CON)
5. SS-A Solenoid Valve (ON/OFF)	12. Low & reverse brake (LR/B) pressure flow whole
6. SS-B Solenoid Valve (ON/OFF)	13. Under drive brake (UD/B) pressure flow hole
7. Overdrive Clutch Control Solenoid Valve(OD/C)	14. Accumulator

Valve Body Flow



1. To cooler	
2. From cooler	9. Lubrication (front)
3. Lubrication (rear)	10. 35R Clutch pressure
4. OD Clutch pressure	11. 26 Brake pressure
5. Reducing pressure (red2)	12. From oil pump
6. Reducing pressure (red1)	13. To oil pump
7. Damper release pressure	14. Underdrive (UD) Brake pressure
8. Damper apply pressure	15. Low & reverse pressure

Removal

Remove the air duct.

Remove the battery and the battery tray.

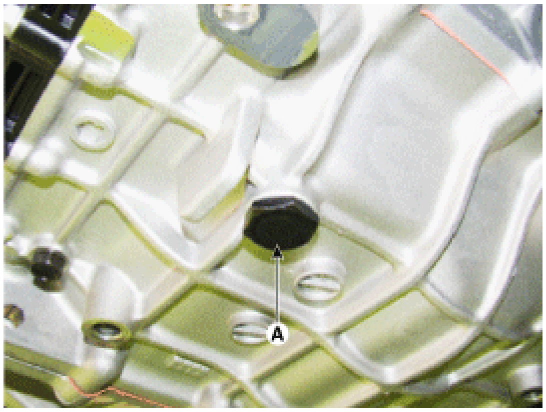
Remove the under cover (A).

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

Drain the coolant.

Remove the drain plug (A) and reinstall the drain plug after draining ATF totally.

Drain plug tightening torque:
38.2 ~ 48.1 N.m (3.9 ~ 4.9 kgf.m, 28.2 ~ 35.4 lb-ft)



CAUTION

Replace the gasket before reinstalling the drain plug.

Remove the wiring bracket installation bolt (A).

Remove the ATF Injection hole (eyebolt) (A).

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

CAUTION

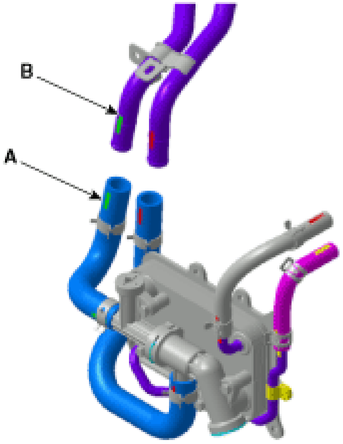
Replace the O-Ring (A) before reinstalling the eyebolt.

Disconnect the coolant hose (B) after removing the coolant hose clamp (A).

Disconnect the hose (B) after removing the automatic transaxle fluid cooler hose clamp (A).

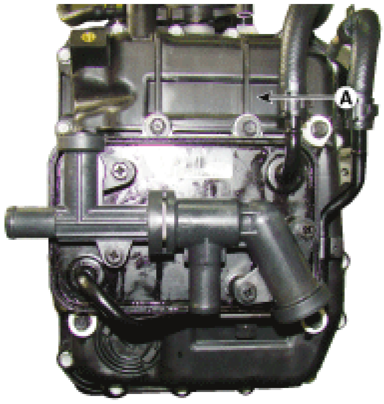
CAUTION

When hose & pipe assembly
Align marking of pipe (B), marking of hose (A), and matching color each other.

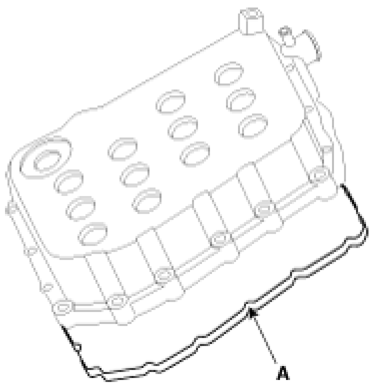


Remove the valve body cover (A).

Tightening torque:
(A) 13.7~ 15.7N.m (1.4 ~ 1.6 kgf.m, 10.1 ~ 11.6lb-ft)

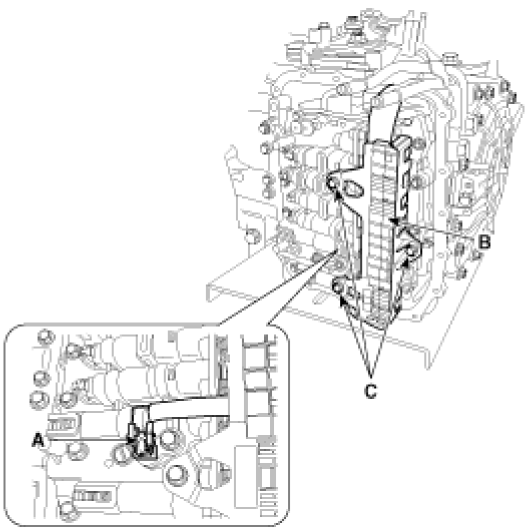


- Replace the gasket (A) before reinstalling the valve body cover.



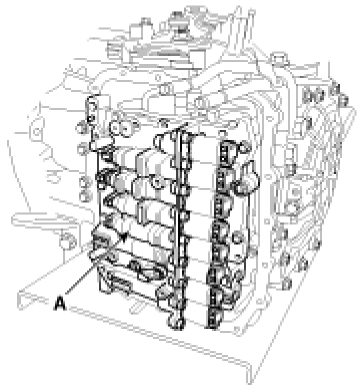
Remove the bolts (C) after disconnecting the solenoid valve connector (B) and the oil temperature sensor connector (A).

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



Remove the valve body assembly (A).

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



Installation

Installation is the reverse of removal.

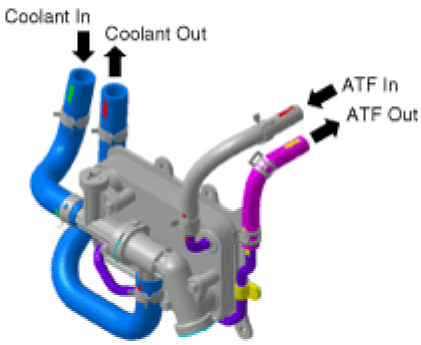
NOTE

- Adding coolant.
- Adding Automatic Transaxle Fluid (ATF).
- Perform Transaxle Control Module (TCM) learning after replacing the valve body to prevent slow transaxle response, jerky acceleration and jerky startup.

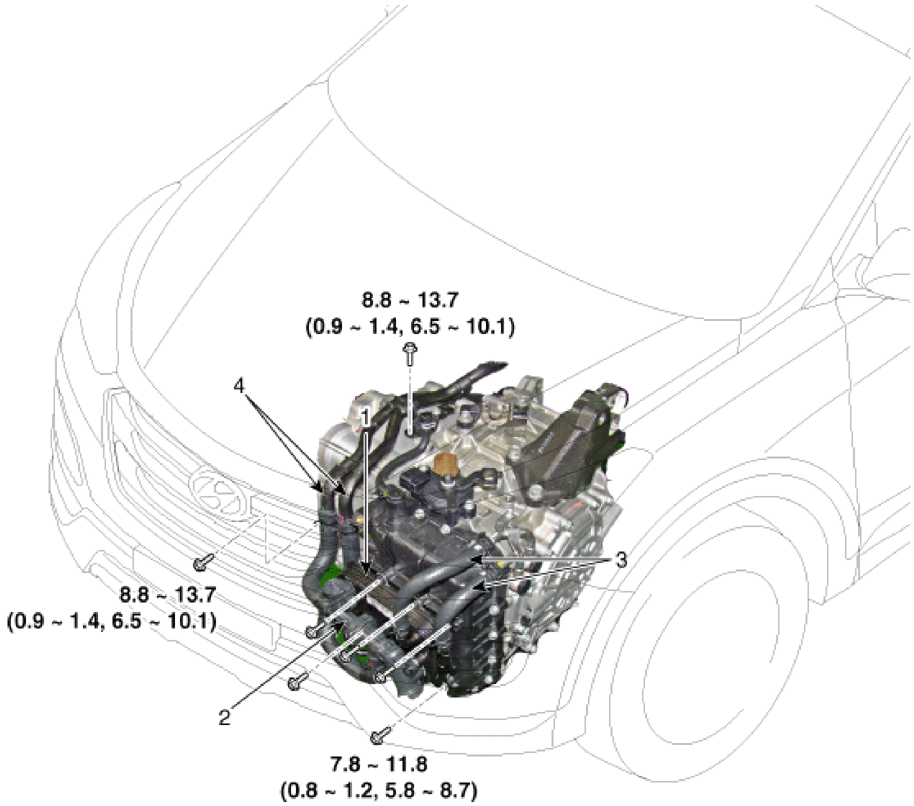
Description

The ATF warmer is mounted on the valve body cover to reduce oil viscosity friction by increasing oil temperature under cold condition, which in turn improves fuel efficiency. It is serial mounted on the entry of the Electronic Throttle Controller (ETC), as shown in the diagram, and minimizes the effects of cabin heating system.

- Engine coolant is used for circulating heat in order to heat and cool the transaxle oil.
- Rapidly elevates the transaxle oil temperature during the initial cold start of the engine.
- Prevents over heating of the transaxle oil while the vehicle is moving.
- Transaxle oil warm-up and cooling can be done with a single system.
- The water coolant and oil are separate in order to exchange heat



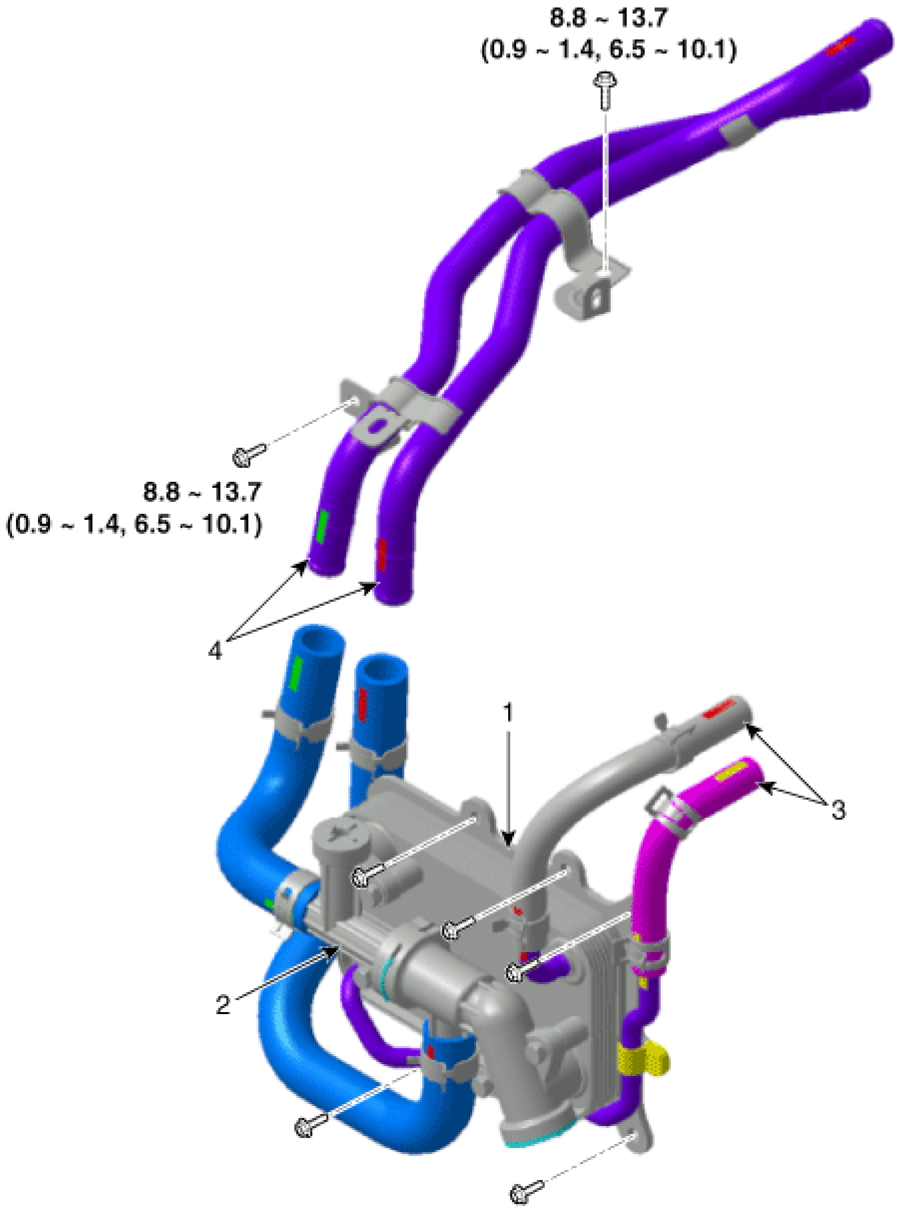
Component Location



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

1. ATF Warmer 2. Bypass valve	3. ATF hose & pipe 4. Coolant hose & pipe

Component



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

1. ATF Warmer 2. Bypass valve	3. ATF hose & pipe 4. Coolant hose & pipe

Removal

Drain the coolant.

Remove the air cleaner assembly and air duct.

Remove the battery and battery tray.

Remove the under cover (A).

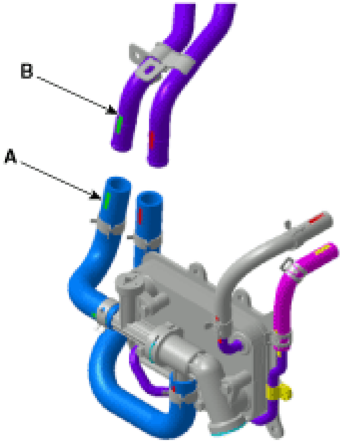
Tightening torque :
7.8 ~ 11.8 N.m (0.8 ~ 1.2 kgf.m, 5.8 ~ 8.7 lb-ft)

Disconnect the coolant hose (B) after removing the coolant hose clamp (A).

Disconnect the hose (B) after removing the automatic transaxle fluid cooler hose clamp (A).

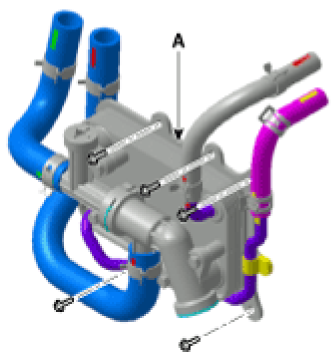
CAUTION

When hose & pipe assembly
Align marking of pipe (B), marking of hose (A), and matching color each other.



Remove the ATF Warmer (A).

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



Installation

Installation is the reverse of removal.

NOTE

- Adding automatic transaxle fluid.
- Adding coolant.

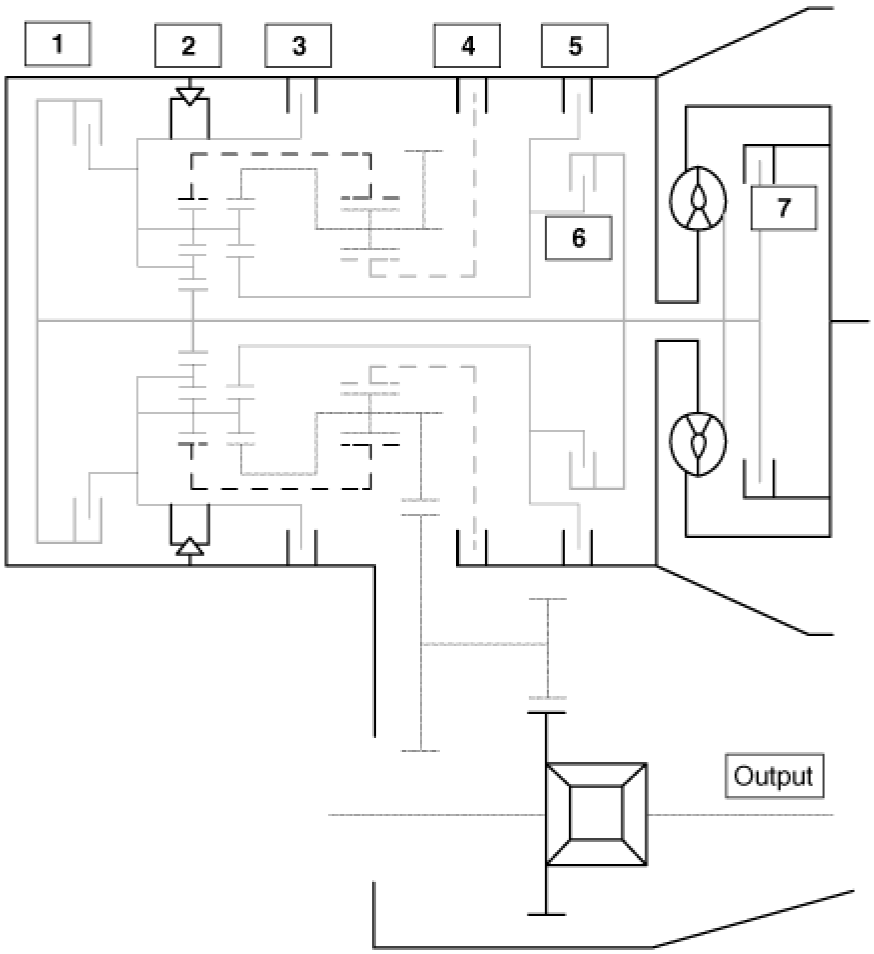
Clutch & Brake

Description and Operation

Description

The 6-speed automatic transaxle consists of an overdrive clutch (OD/C), a one-way clutch (OWC), a lower and reverse brake (LR/B), an underdrive brake (UD/B), a 26 brake (26/B), and a 35R clutch (35R/C). These clutches and brakes are operated by controlling the hydraulic pressure.

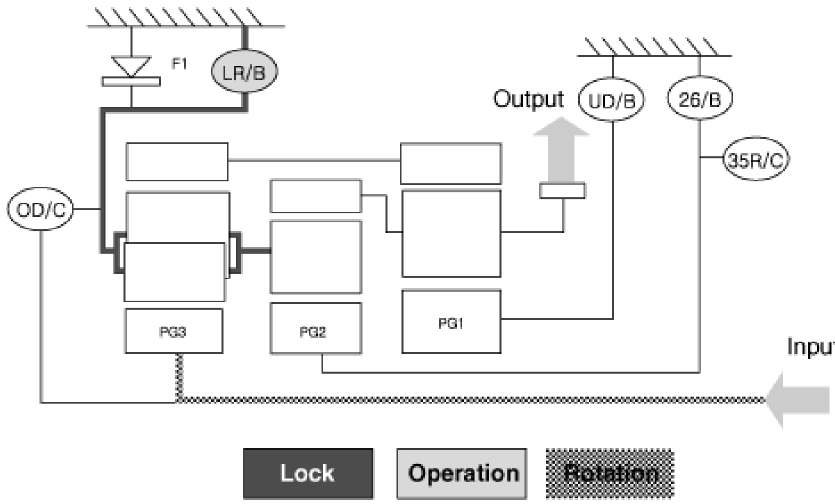
Component Location



1. Overdrive Clutch (OD/C) 2. One way Clutch (OWC) 3. Low & Reverse Brake (LR/B) 4. Underdrive Brake (UD/B)	5. 26 Brake (26/B) 6. 35R Clutch (35R/C) 7. Damper Clutch (D/C)

Power Flow Chart

P,N	UD/B	LR/B	26/B	35R/C	OD/C	OWC
		●				



◾ Direction of Rotation

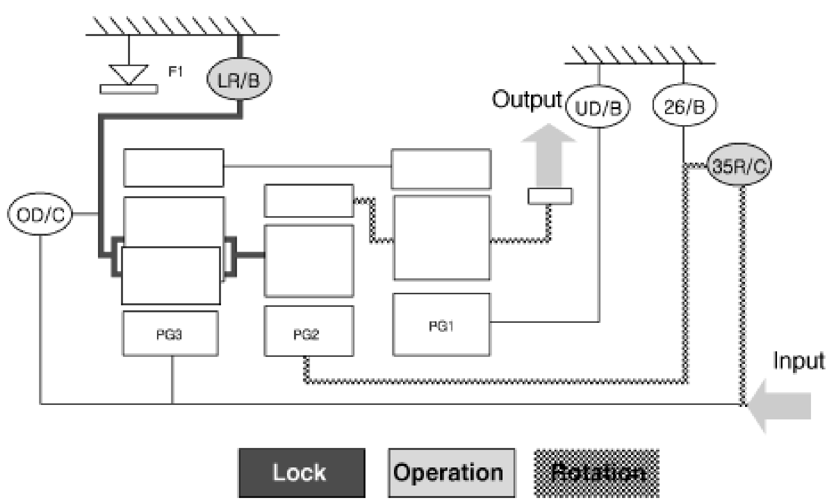
▸Lower & Reverse Brake (LR/B) Activation → Overdrive (O/D) Hub Lock → Mid & Rear P/C Lock

▸Input Shaft Rotation → Rear Sun Gear Rotation → Rear Inner Pinion Rotation (Reverse) → Rear Outer Pinion Rotation → Rear Annulus Gear Rotation → Front Annulus Gear Rotation → Front Pinion Rotation → Front Sun Gear Rotation (Reverse) → Underdrive (U/D) Hub Rotation (Reverse)

▸Input shaft rotation → Overdrive Clutch (OD/C) Retainer Rotation

▸Input shaft rotation → 35R Clutch Rotation

R	UD/B	LR/B	26/B	35R/C	OD/C	OWC
		●		●		



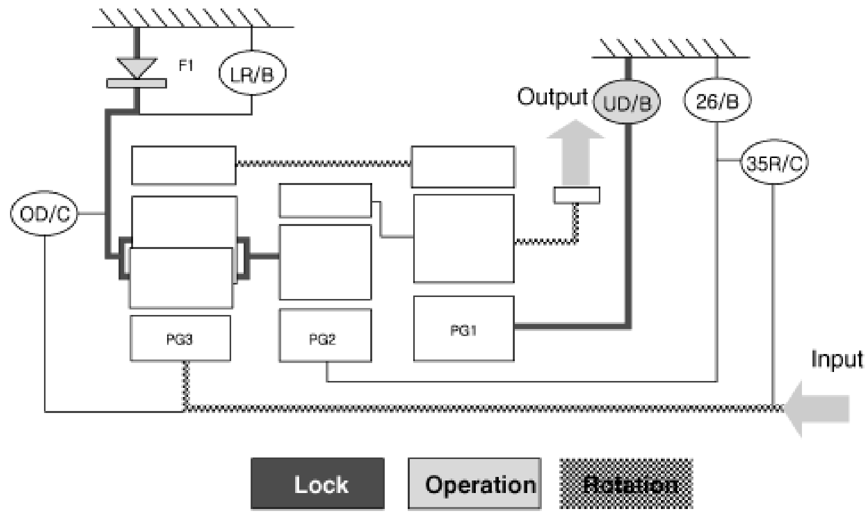
◾ Power Delivery Route

▸ Middle carrier locked and middle sun gear in rotation

▸ Rotating the middle planetary gear's sun gear while its carrier is locked in place slows down and reverse rotates the annulus gear (front carrier), resulting in power transfer to the front carrier.

▸ The rear planetary gear's rear and front annulus gears rotate at a reduced rate, resulting in reverse, zero load rotation of the front planetary gear's front sun gear.

	UD/B	LR/B	26/B	35R/C	OD/C	OWC
D1	●	(○)				●



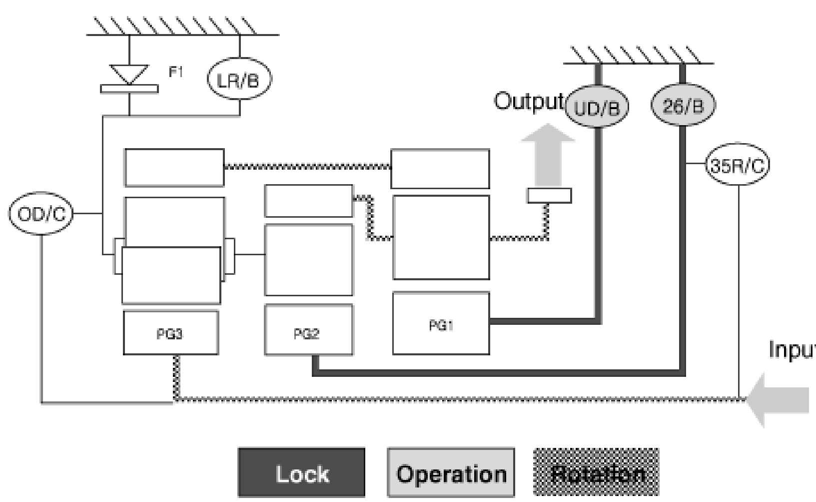
▣ Power Delivery Route

▸ Front sun gear and middle & rear carrier locked and rear sun gear in constant rotation

▸ When the rear sun gear is rotated, power is reduced at the rear planetary gear and then delivered to the rear and front annulus gears. The power is then reduced again at the front planetary gear, whose sun gear is locked in place, and then delivered to the front carrier.

▸ Here, the middle annulus gear, which comprises of a single unit with the front carrier, rotates and results in reverse, zero load rotation of the middle sun gear.

	UD/B	LR/B	26/B	35R/C	OD/C	OWC
D2	●		●			

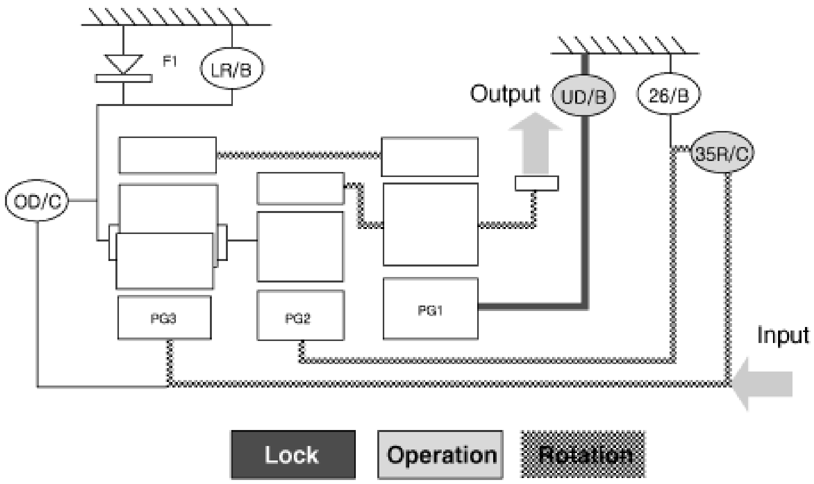


▣ Power Delivery Route

▸ Front sun gear and middle sun gear locked and rear sun gear in constant rotation

▸ Rotating the rear sun gear delivers power to the rear & front annulus gears, and reaction from the front carrier and the middle annulus gear, to which the sun gear is attached, transfers to the middle and rear carriers, resulting in power equilibrium and power transfer to the front carrier.

D3	UD/B	LR/B	26/B	35R/C	OD/C	OWC
	●			●		

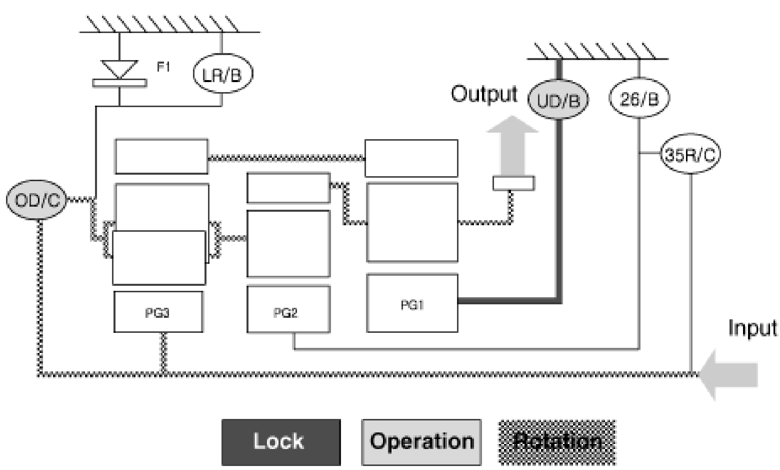


▣ Power Delivery Route

▸ Front sun gear locked and middle and rear sun gears in rotation

▸ Rotating the middle sun gear and the rear sun gear transfers power to the rear and front annulus gears, and reaction from the front carrier and the middle annulus gear, to which the sun gear is attached, transfers to the middle and rear carriers, resulting in power equilibrium and power transfer to the front carrier.

D4	UD/B	LR/B	26/B	35R/C	OD/C	OWC
	●				●	



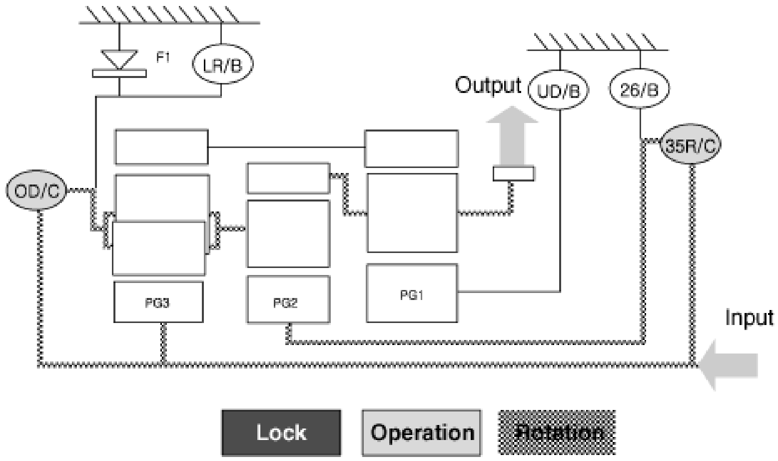
▣ Power Delivery Route

▸ Front sun gear locked and rear carrier and rear sun gears in rotation

▸ Activation of the overdrive clutch (OD/C) synchronizes the rear planetary gear's carrier and sun gears. The 1:1 rotation ratio passes through the rear and front annulus gears and reaches the front planetary gear's front carrier, to which the sun gear is attached.

▸ Here, the middle planetary gear's middle sun gear rotates at a faster rate in the normal direction and at zero load due to the actions of the reduced annulus gear and the carrier having a 1:1 rotation ratio.

D5	UD/B	LR/B	26/B	35R/C	OD/C	OWC
				●	●	



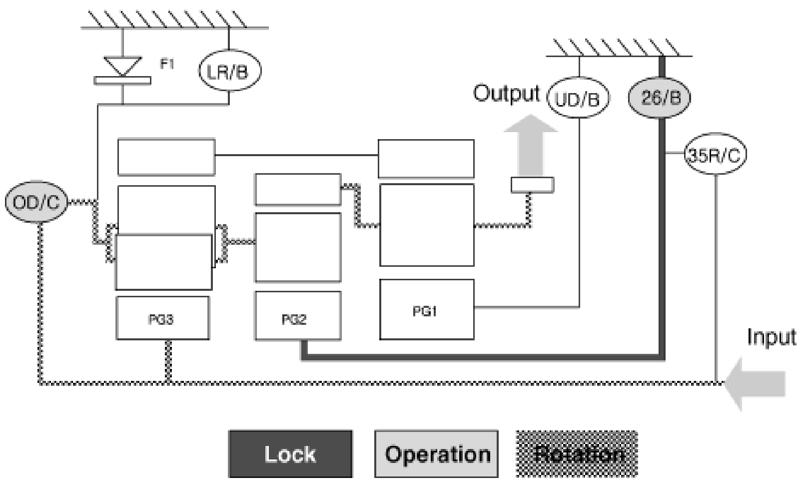
◘ Power Delivery Route

▸ Middle and rear carriers, middle sun gear, and rear sun gear in rotation

▸ The middle planetary gear's middle carrier and sun gear rotate simultaneously, resulting in the 1:1 rotation ratio being transferred to the middle annulus gear (front carrier).

▸ Here, the rear planetary gear rotates in a 1:1 rotation ratio, as it would when the 4th gear is engaged; however, the front planetary gear remains unrestrained and the front sun gear rotates in the normal direction, at a zero load, and at a rotation ratio of 1:1.

D6	UD/B	LR/B	26/B	35R/C	OD/C	OWC
			●		●	



◘ Power Delivery Route

▸ Middle carrier in rotation and middle sun gear locked

▸ When the middle planetary gear's sun gear is locked in place and the train's carrier's allowed to rotate, the middle annulus gear increases its rate of rotation and transfers power to the front carrier.

▸ Here, the rear planetary gear maintains a 1:1 rotation ratio as it would when 4th or 5th gear is engaged; however, the front planetary gear remains unrestrained and the front sun gear rotates at a faster rate in the normal direction and at zero load.

Automatic Transaxle Control System

Repair procedures

Adjustment

Transaxle Control Module (TCM) Learning

When shift shock is occurred or parts related with the transaxle are replaced, TCM learning should be performed.

In the following case, TCM learning is required.

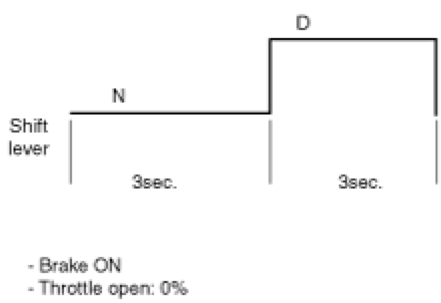
- Transaxle assembly replacement
- TCM replacement
- TCM upgrading

TCM learning procedure

Automatic Transaxle Fluid (ATF) temperature: 40 ~ 100°C (104 ~ 212°F)

Static learning

Repeat the below shift pattern four times or more with stepping on the brake.



Driving learning

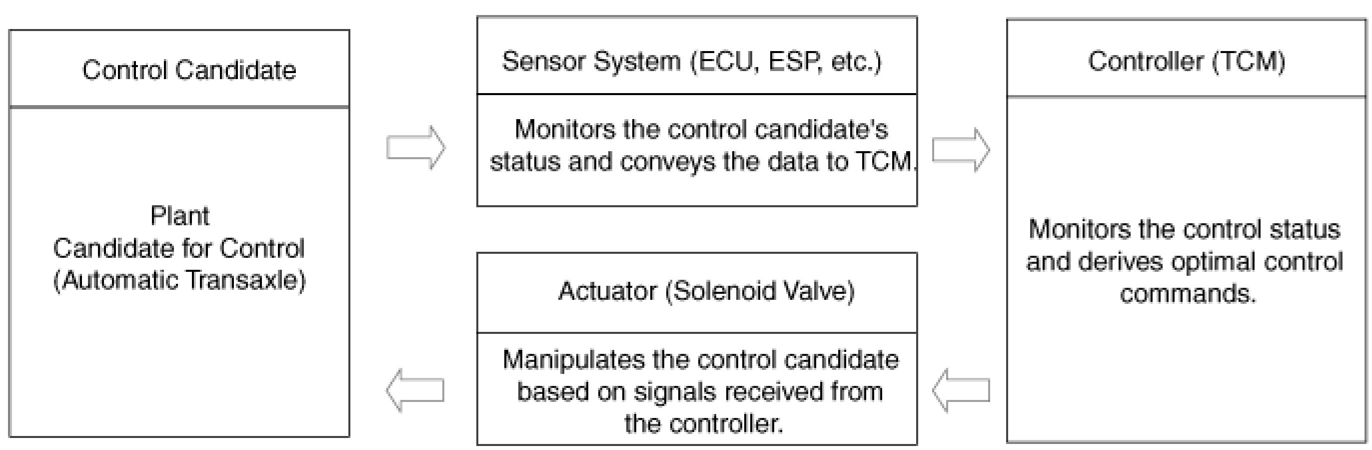
Drive the vehicle from a stop in D through all gears 1st, 2nd, 3rd, 4th, 5th and 6th gear while holding the throttle steady at the specified Throttle Position Sensor (TPS) value (15~25%).

Description and Operation

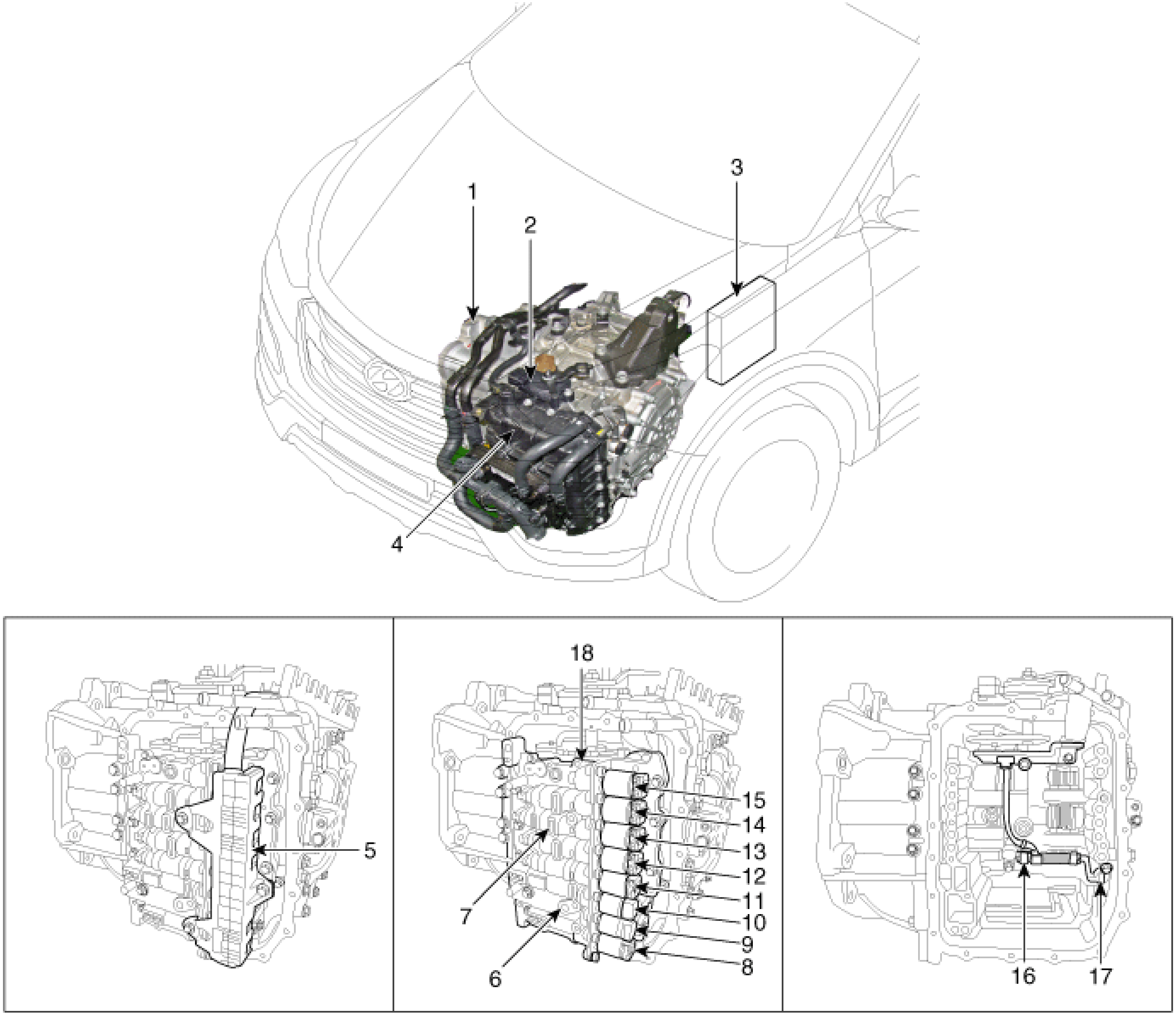
Description

Automatic transaxle system relies on various measurement data to determine the current control status and extrapolate the necessary compensation values. These values are used to control the actuators and achieve the desired control output. If a problem with the drivetrain, including the transaxle, has been identified, perform self-diagnosis and basic transaxle inspection (oil and fluid inspection) and then check the control system's components using the diagnosis tool.

Control System Composition



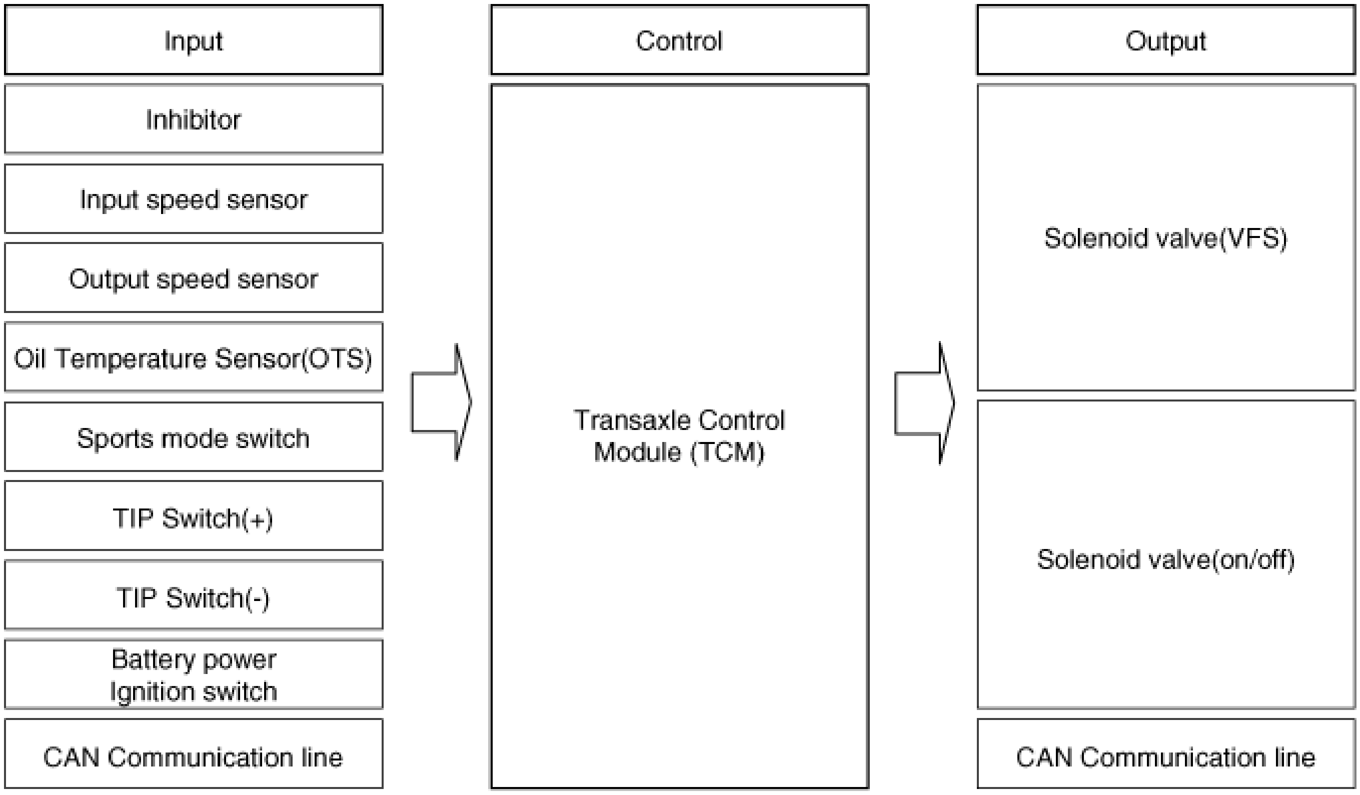
Component Location



1. Automatic transaxle 2. Inhibitor switch 3. Transaxle Control Module (TCM) 4. Valve body cover 5. Solenoid valve connect 6. Oil temperature sensor 7. Valve body assembly 8. Line Pressure Control Solenoid Valve 9. SS-A Solenoid Valve(ON/OFF)	10. SS-B Solenoid Valve (ON/OFF) 11. Overdrive Clutch Control Solenoid Valve (OD/C) 12. Underdrive Brake Control Solenoid Valve (UD/B) 13. 26 Brake Control Solenoid Valve (26/B) 14. 35R Clutch Control Solenoid Valve (35R/C) 15. Torque Converter Control Solenoid Valve (T/CON) 16. Output speed sensor 17. Input speed sensor

1. Shift lever 2. Data Link Connector (DLC)

Circuit Diagram



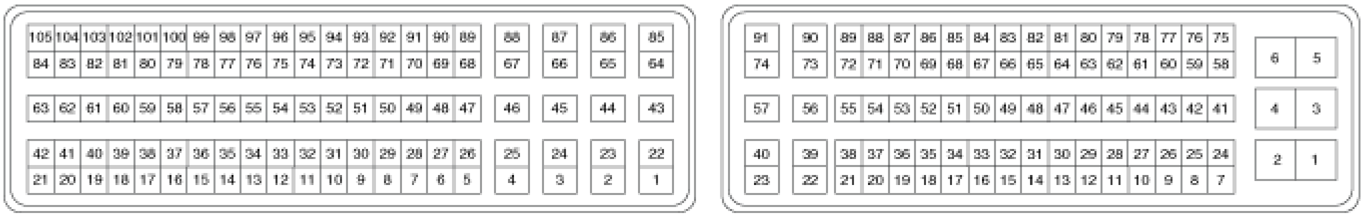
Description

Transaxle Control Module (TCM) is the automatic transaxle's brain. The module receives and processes signals from various sensors and implements a wide range of transaxle controls to ensure optimal driving conditions for the driver. TCM is programmed for optimal response to any on-road situation. In the event of a transaxle failure or malfunction, TCM stores the fault information in memory so that the technician may reference the code and quickly repair the transaxle.

Functions

- Monitors the vehicle's operating conditions to determine the optimal gear setting.
- Performs a gear change if the current gear setting differs from the identified optimal gear setting.
- Determines the need for damper clutch (D/C) activation and engages the clutch accordingly.
- Calculates the optimal line pressure level by constantly monitoring the torque level and adjusts the pressure accordingly.
- Diagnoses the automatic transaxle for faults and failures.

1. TCM connector and terminal function



Connector [A] Connector [B]

2. TCM Terminal Function

Connector [A]

Pin	Description	Pin	Description
1	—	54	—
2	Line pressure control solenoid valve (LINE_VFS)	55	—
3	Torque converter control solenoid valve (T/CON_VFS)	56	—
4	35R clutch control solenoid valve (35R/C_VFS)	57	—
5	—	58	—
6	—	59	—
7	Inhibitor switch signal "S1"	60	—
8	Inhibitor switch signal "S2"	61	—
9	Inhibitor switch signal "S3"	62	—
10	Inhibitor switch signal "S4"	63	—
11	—	64	—
12	—	65	SS-B Solenoid valve (ON/OFF)
13	—	66	SS-A Solenoid valve (ON/OFF)
14	—	67	Battery (B+)
15	—	68	—
16	—	69	Oil temperature sensor (+)
17	—	70	—
18	—	71	—
19	—	72	—
20	—	73	Output speed sensor signal
21	—	74	Sports mode up switch
22	—	75	—
23	Underdrive brake control solenoid valve (UD/B_VFS)	76	—
24	26 Brake control solenoid valve (26/B_VFS)	77	—

25	Overdrive clutch control solenoid valve (OD/C_VFS)	78	—
26	—	79	—
27	—	80	—
28	—	81	—
29	—	82	—
30	—	83	—
31	—	84	—
32	—	85	—
33	—	86	Solenoid supply power 1
34	—	87	Solenoid supply power 2
35	—	88	Battery (B+)
36	—	89	—
37	—	90	Output speed sensor power
38	—	91	Input speed sensor power
39	—	92	—
40	—	93	—
41	—	94	Input speed sensor signal
42	—	95	Sports mode down switch
43	—	96	—
44	Ground (Power 1)	97	—
45	Ground (Power 2)	98	—
46	Shift lock solenoid	99	—
47	—	100	—
48	Oil temperature sensor (-)	101	—
49	—	102	—
50	—	103	—
51	—	104	—
52	Sports mode select switch	105	—
53	—		

3. TCM Terminal Input/ Output Signal

Connector [A]

Pin	Description	Condition	Input/output value	
			Type	Level
1	-			
2	Line pressure control solenoid valve		Output	0V/Battery voltage level
	(LINE_VFS)			9V < Battery voltage level < 16V
3	Torque converter control solenoid valve		Output	0V/Battery voltage level
	(T/CON_VFS)			9V < Battery voltage level < 16V
4	35R clutch control solenoid valve		Output	0V/Battery voltage level
	(35R/C_VFS)			9V < Battery voltage level < 16V
5	-			
6	-			
7	Inhibitor switch signal "S1"	High	Input	0V/Battery voltage level
		Low		9V < Battery voltage level < 16V
8	Inhibitor switch signal "S2"	High	Input	0V/Battery voltage level
		Low		9V < Battery voltage level < 16V
9	Inhibitor switch signal "S3"	High	Input	0V/Battery voltage level
		Low		9V < Battery voltage level < 16V
10	Inhibitor switch signal "S4"	High	Input	0V/Battery voltage level
		Low		9V < Battery voltage level < 16V
11	-			
12	-			
13	-			
14	-			
15	-			
16	-			
17	-			
18	-			
19	-			
20	-			
21	-			
22	-			
23	Underdrive brake control solenoid valve		Output	0V/Battery voltage level
	(UD/B_VFS)			9V < Battery voltage level < 16V
				Power supply : V_SOL2
24	26 Brake control solenoid valve		Output	0V/Battery voltage level
	(26/B_VFS)			9V < Battery voltage level < 16V
				Power supply : V_SOL2
25	Overdrive clutch control solenoid valve		Output	0V/Battery voltage level

	(OD/C_VFS)			9V < Battery voltage level < 16V
				Power supply : V_SOL1
26	-			
27	-			
28	-			
29	-			
30	-			
31	-			
32	-			
33	-			
34	-			
35	-			
36	-			

Removal

CAUTION

When replacing the TCM, the vehicle equipped with the immobilizer must be performed procedure as below.

[In the case of installing used TCM]

Perform "TCM Neutral mode" procedure with GDS.

After finishing "TCM Neutral mode", perform "Key teaching" procedure with GDS.

[In the case of installing new TCM]

Perform "Key teaching" procedure with GDS.

CAUTION

When replacing the TCM, the vehicle equipped with the smart key system (Button start) must be performed procedure as below.

[In the case of installing used TCM]

Perform "TCM Neutral mode" procedure with GDS.

After finishing "TCM Neutral mode", insert the key (or press the start button) and turn it to the IGN ON and OFF position. Then the TCM learns the smart key information automatically.

[In the case of installing new TCM]

Insert the key (or press the start button) and turn it to the IGN ON and OFF position. Then the TCM learns the smart key information automatically.

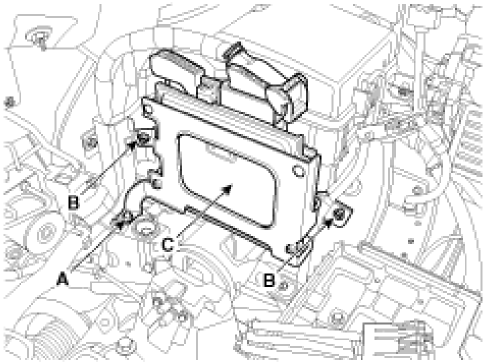
Turn ignition switch OFF and disconnect the negative (-) battery cable.

Disconnect the TCM Connector (A).

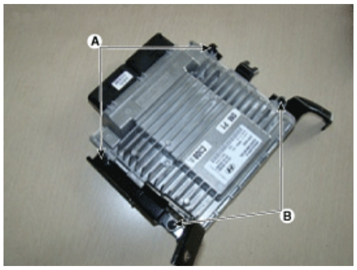
Remove the battery.

Remove the air cleaner assembly.

Remove the mounting bolts (A) and nut (B), and then remove the TCM (C).



After removing the installation nuts (A) and screws (B), remove the TCM (C) from the bracket.



Installation

CAUTION

When replacing the TCM, the vehicle equipped with the immobilizer must be performed procedure as below.
[In the case of installing used TCM]

Perform "TCM Neutral mode" procedure with GDS.

After finishing "TCM Neutral mode", perform "Key teaching" procedure with GDS.

[In the case of installing new TCM]
Perform "Key teaching" procedure with GDS.

CAUTION

When replacing the TCM, the vehicle equipped with the smart key system (Button start) must be performed procedure as below.
[In the case of installing used TCM]

Perform "TCM Neutral mode" procedure with GDS.

After finishing "TCM Neutral mode", insert the key (or press the start button) and turn it to the IGN ON and OFF position. Then the TCM learns the smart key information automatically.

[In the case of installing new TCM]
Insert the key (or press the start button) and turn it to the IGN ON and OFF position. Then the TCM learns the smart key information automatically.

Install in the reverse order of removal.

TCM installation bolt:
9.8 ~ 11.8 NM (1.0 ~ 1.2 kgf.m,7.2 ~ 8.7 lb-ft)
TCM bracket installation bolt/nut:
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m,7.2 ~ 8.7 lb-ft)

CAUTION

- Perform TCM learning after replacing the transaxle to prevent slow transaxle response, jerky acceleration and jerky startup.

TCM Problem Inspection Procedure

TEST TCM GROUND CIRCUIT: Measure resistance between TCM and chassis ground using the backside of TCM harness connector as TCM side check point. If the problem is found, repair it.

Specification: Below 1Ω

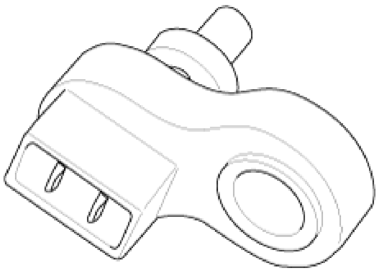
TEST TCM CONNECTOR: Disconnect the TCM connector and visually check the ground terminals on TCM side and harness side for bent pins or poor contact pressure. If the problem is found, repair it.

If problem is not found in Step 1 and 2, the TCM could be faulty. If so, make sure there were no DTC's before swapping the TCM with a new one, and then check the vehicle again. If DTC's were found, examine this first before swapping TCM.

RE-TEST THE ORIGINAL TCM: Install the original TCM (may be broken) into a known-good vehicle and check the vehicle. If the problem occurs again, replace the original TCM with a new one. If problem does not occur, this is intermittent problem (Refer to “Intermittent Problem Inspection Procedure” in Basic Inspection Procedure).

Description

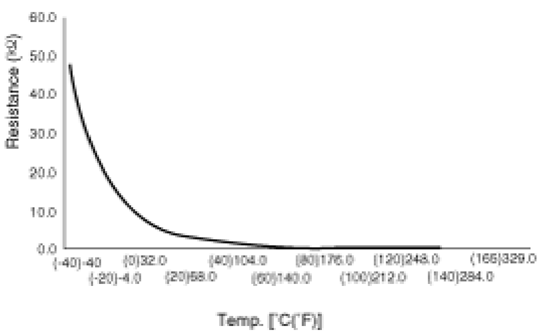
Transaxle Oil Temperature Sensor (OTS) monitors the automatic transaxle fluid's temperature and conveys the readings to TCM. It is an Negative Thermal Coefficient (NTC) sensor whose resistance has an inversely proportional relationship with the temperature level. Data produced by this sensor is used to identify damper clutch activation and deactivation zones within the low temperature and high temperature range and to compensate hydraulic pressure levels during gear changes.



Specifications

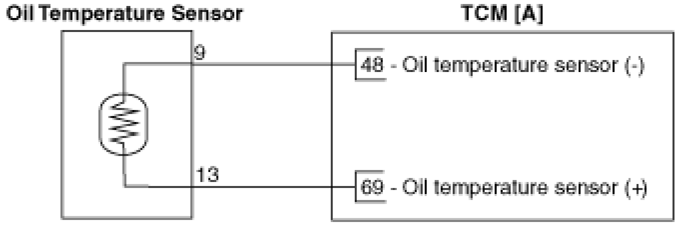
▷ Type: Negative Thermal Coefficient Type (NTC)

Temp.(°C)°F	Resistance (kΩ)
(-40)-40	48.1
(-20)-4.0	15.6
(0)32.0	5.88
(20)68.0	2.51
(40)104.0	1.11
(60)140.0	0.61
(80)176.0	0.32
(100)212.0	0.18
(120)248.0	0.10
(140)284.0	0.06
(165)329.0	0.03



Circuit Diagram

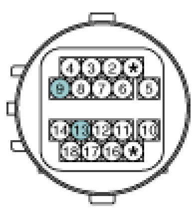
[Circuit Diagram]



[Connection Information]

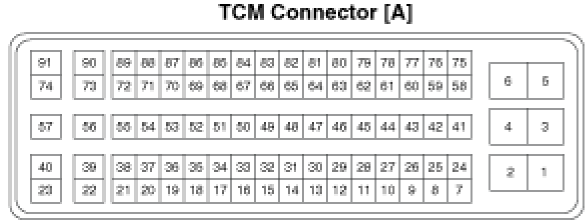
Terminal	Connected to	Function
9	TCM (48)	Oil temperature sensor (-)
13	TCM (69)	Oil temperature sensor (+)

[Harness Connector]



Solenoid Valve Connector

TCM Connector [A]



TCM Connector [B]

Inspection

Turn ignition switch OFF.

Remove the air duct.

Disconnect the solenoid valve connector (A).

Measure resistance between sensor signal terminal and sensor ground terminal.

Check that the resistance is within the specification.

Removal

Remove the battery and the battery tray.

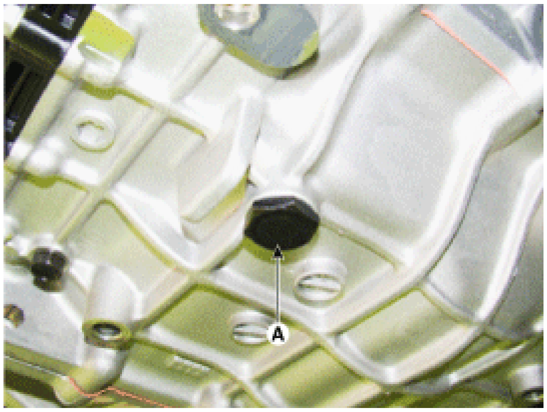
Remove the under cover (A).

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

Drain the coolant.

Remove the drain plug (A) and reinstall the drain plug after draining ATF totally.

Drain plug tightening torque:
38.2 ~ 48.1 N.m (3.9 ~ 4.9 kgf.m, 28.2 ~ 35.4 lb-ft)



CAUTION

Replace the gasket before reinstalling the drain plug.

Remove the wiring bracket installation bolt (A).

Remove the ATF Injection hole (eyebolt) (A).

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

CAUTION

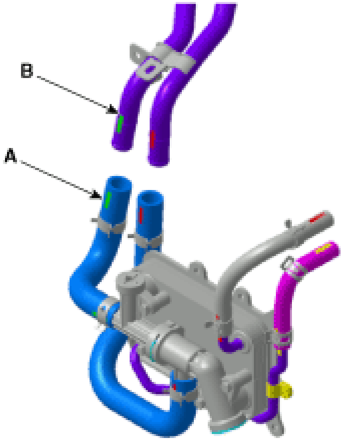
Replace the O-Ring (A) before reinstalling the eyebolt.

Disconnect the coolant hose (B) after removing the coolant hose clamp (A).

Disconnect the hose (B) after removing the automatic transaxle fluid cooler hose clamp (A).

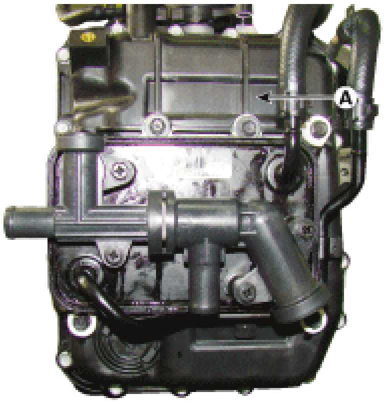
CAUTION

When hose & pipe assembly
Align marking of pipe (B), marking of hose (A), and matching color each other.



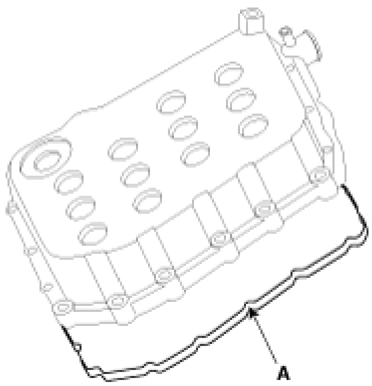
Remove the valve body cover (A).

Tightening torque:
(A) 13.7~ 15.7N.m (1.4 ~ 1.6 kgf.m, 10.1 ~ 11.6lb-ft)

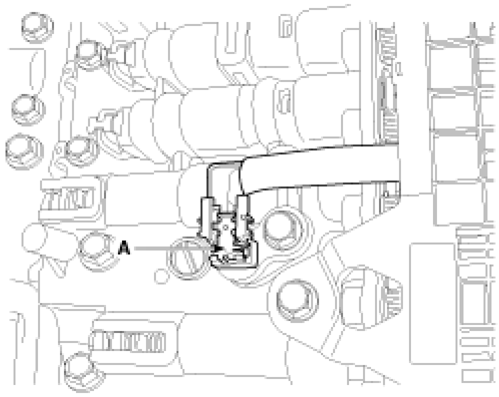


CAUTION

- Replace the gasket (A) before reinstalling the valve body cover.



Disconnect the oil temperature sensor connector (A).

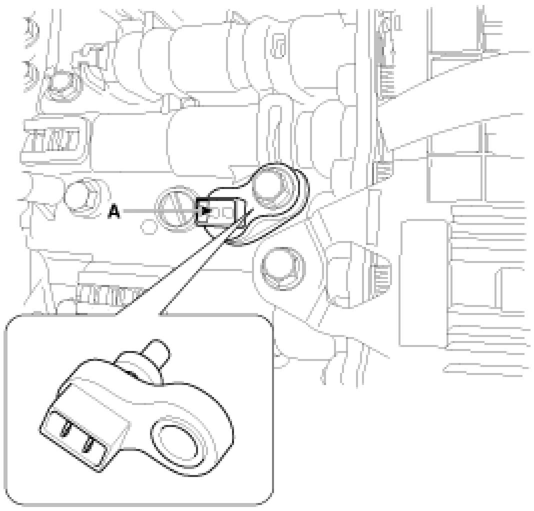


Remove the oil temperature sensor (A) after removing a bolt.

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

CAUTION

Be careful not to damage the harness lock connector.



Installation

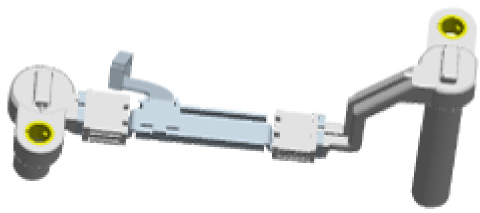
Install in the reverse order of removal.

NOTE

- Adding coolant.
- Adding Automatic Transaxle Fluid (ATF).

Description

Input speed sensor (A) is a vital unit that measures the rate of rotation of the input shaft inside the transaxle and delivers the readings to the Transaxle Control Module (TCM). The sensor provides critical input data that's used in feedback control, damper clutch control, gear setting control, line pressure control, clutch activation pressure control, and sensor fault analysis.



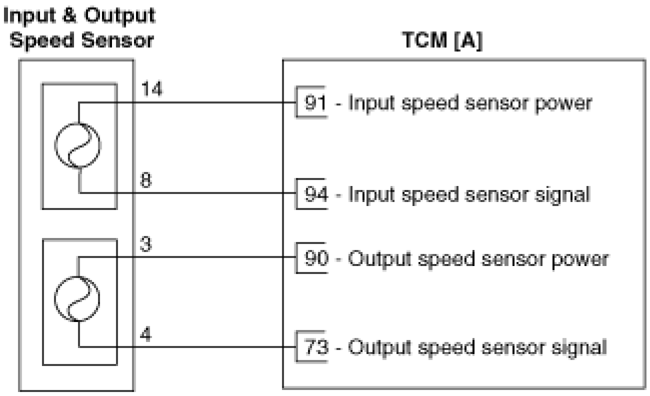
Specifications

▷ Type: Hall effect sensor

Operation condition (°C)°F		((-)40~150)) -40~302
Air gap(mm)in.		(0.95~1.65) 0.0374~0.0649
Output voltage(V)	High	1.18~1.68
	Low	0.59~0.84

Circuit Diagram

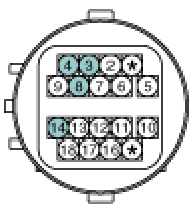
[Circuit Diagram]



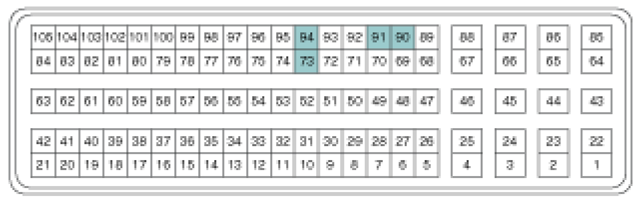
[Connection Information]

Terminal	Connected to	Function
14	TCM (91)	Input speed sensor power
8	TCM (94)	Input speed sensor signal
3	TCM (90)	Output speed sensor power
4	TCM (73)	Output speed sensor signal

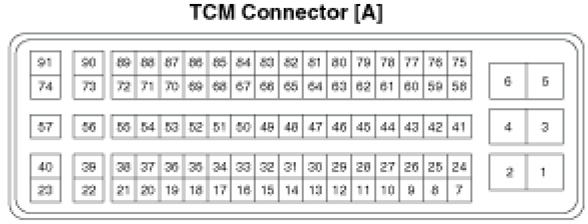
[Harness Connector]



Solenoid Valve Connector



TCM Connector [A]



TCM Connector [B]

Signal Waveform

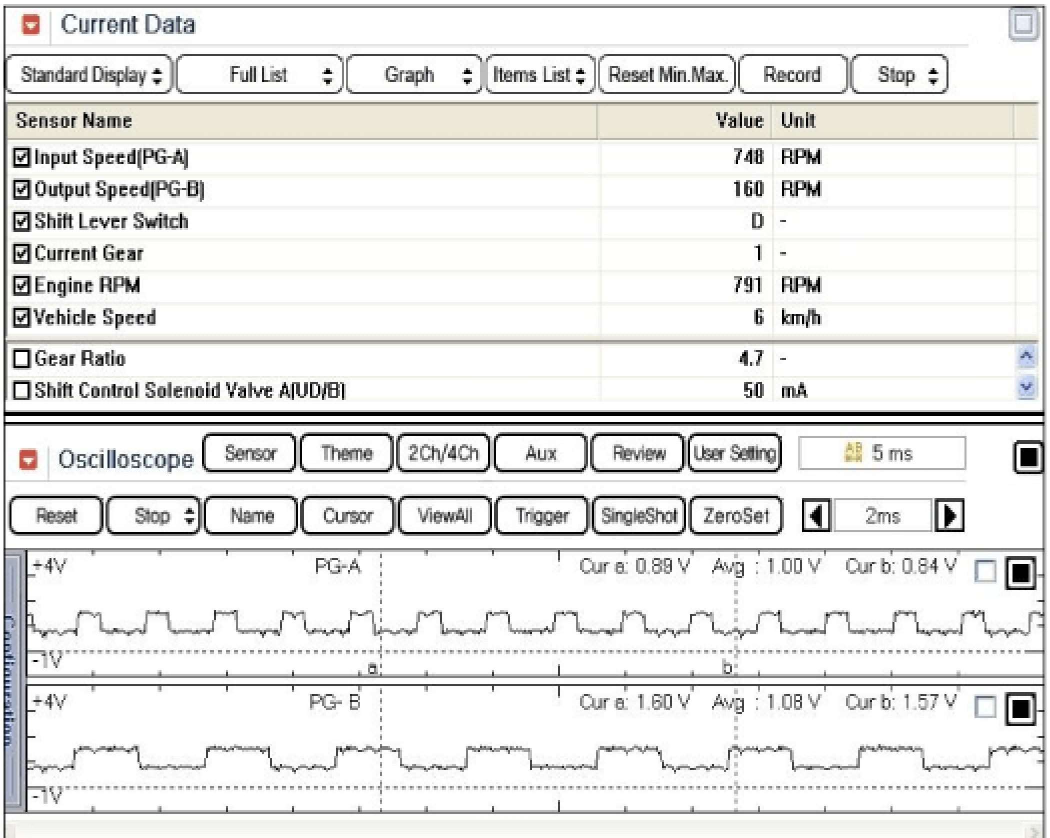


Fig.1

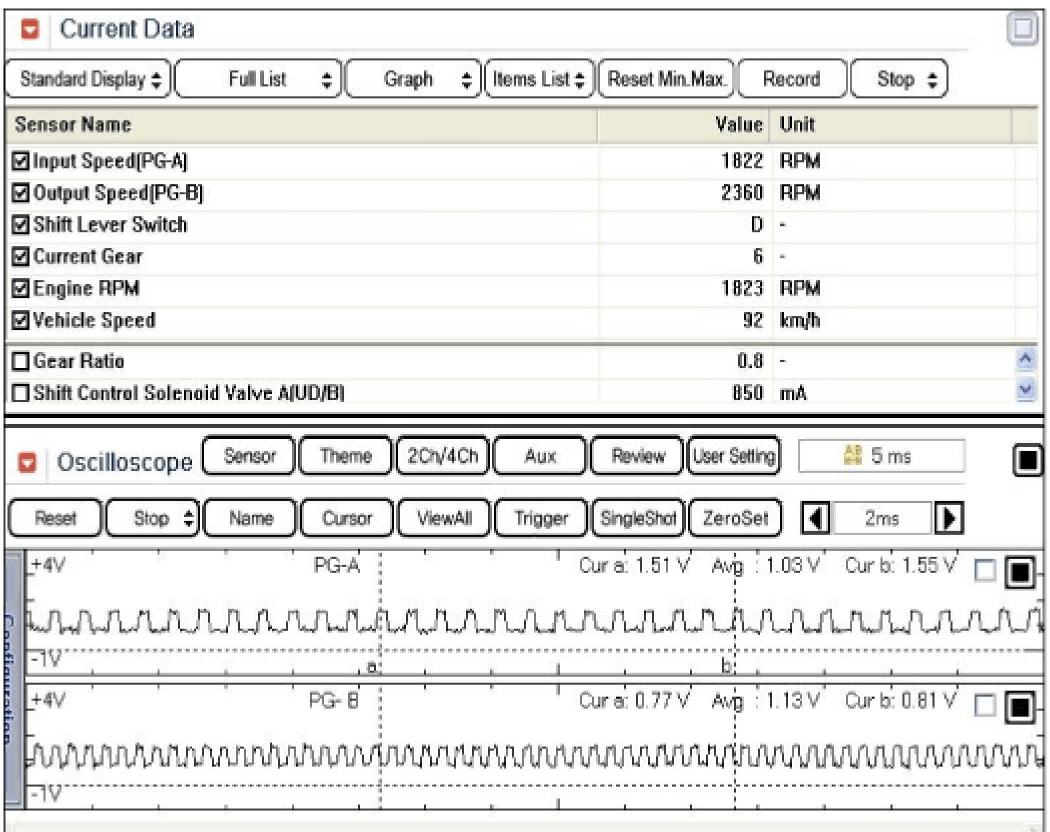
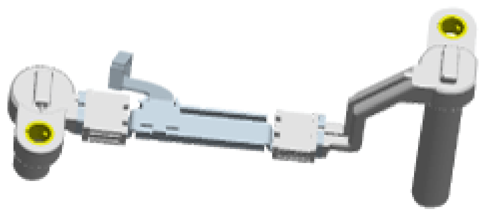


Fig.2

Description

The output speed sensor (A) is a vital unit that measures the rate of rotation of the transaxle's turbine shaft and output shaft, and delivers the readings to the Transaxle Control Module (TCM). The sensor provides critical input data that's used in feedback control, damper clutch control, gear setting control, line pressure control, clutch activation pressure control, and sensor fault analysis.



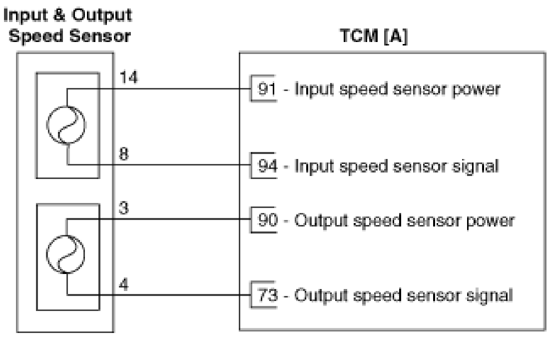
Specifications

▷ Type: Hall effect sensor

Operation condition (°C)°F		((-)40~150)) -40~302
Air gap(mm)in.		(0.25~0.70) 0.0098~0.0276
Output voltage (V)	High	1.18~1.68
	Low	0.59~0.84

Circuit Diagram

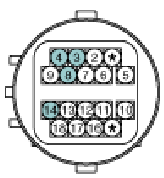
[Circuit Diagram]



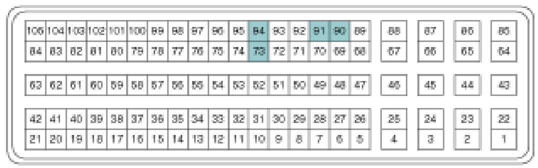
[Connection Information]

Terminal	Connected to	Function
14	TCM (91)	Input speed sensor power
8	TCM (94)	Input speed sensor signal
3	TCM (90)	Output speed sensor power
4	TCM (73)	Output speed sensor signal

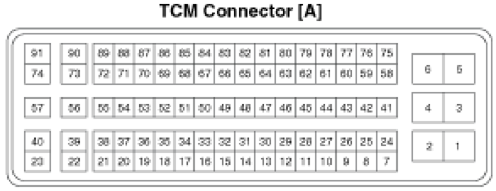
[Harness Connector]



Solenoid Valve Connector



TCM Connector [A]



TCM Connector [B]

Inspection

Check signal waveform of Input & output speed sensor using the GDS.

Specification: Refer to "Signal Wave Form" section.

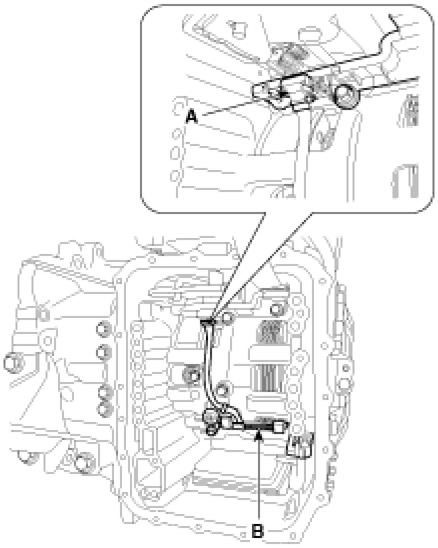
Removal

Remove the valve body assembly.

Disconnect the input & output speed sensor connector (A).

Remove the input & output speed sensor (B) after removing the bolts (2ea).

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



Installation

Install in the reverse order of removal.

NOTE

- Adding coolant.
- Adding Automatic Transaxle Fluid (ATF).

Description

Torque converter control solenoid valve (T/CON) is attached to the valve body. This variable force solenoid valve directly controls the hydraulic pressure inside the torque converter.

Specifications

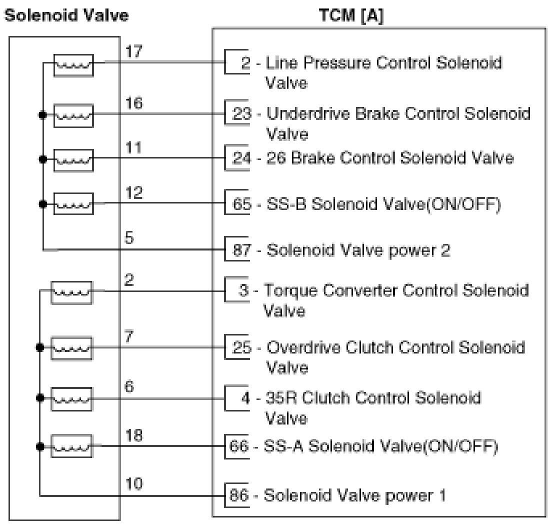
Direct control VFS [T/CON]

▷ Control type : Normal low type

Control Pressure kpa (kgf/cm², psi)	9.81~500.14 (0.1~5.1,1.42~72.54)
Current value(mA)	50~850
Internal resistance(Ω)	5.1

Circuit Diagram

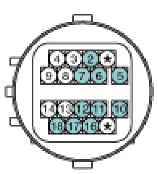
[Circuit Diagram]



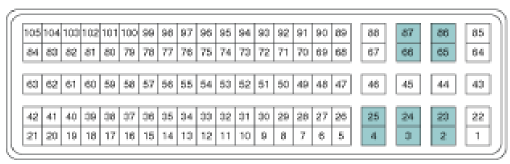
[Connection Information]

Terminal	Connected to	Function
17	TCM (2)	Line Pressure Control Solenoid Valve
16	TCM (23)	Underdrive Brake Control Solenoid Valve
11	TCM (24)	26 Brake Control Solenoid Valve
12	TCM (65)	SS-B Solenoid Valve(ON/OFF)
5	TCM (87)	Solenoid Valve power 2
2	TCM (3)	Torque Converter Control Solenoid Valve
7	TCM (25)	Overdrive Clutch Control Solenoid Valve
6	TCM (4)	35R Clutch Control Solenoid Valve
18	TCM (66)	SS-A Solenoid Valve(ON/OFF)
10	TCM (86)	Solenoid Valve power 1

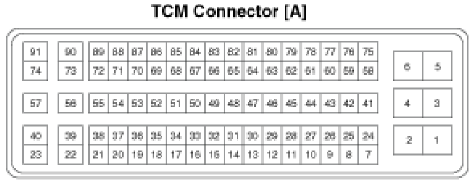
[Harness Connector]



Solenoid Valve Connector



TCM Connector [A]



TCM Connector [B]

Inspection

Turn ignition switch OFF.

Remove the air duct.

Disconnect the solenoid valve connector (A).

Measure resistance between sensor signal terminal and sensor ground terminal.

Check that the resistance is within the specification.

Removal

Remove the air duct.

Remove the battery and the battery tray.

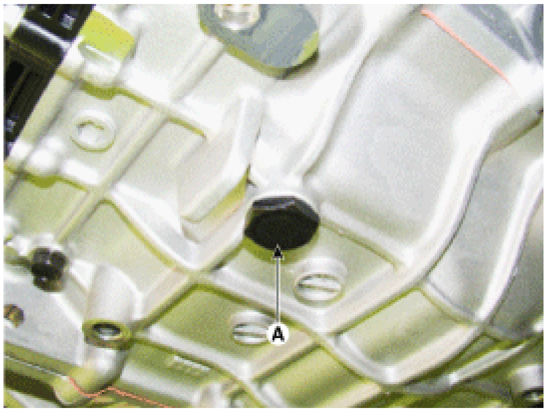
Remove the undercover (A).

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

Drain the coolant.

Remove the drain plug (A) and reinstall the drain plug after draining ATF totally.

Drain plug tightening torque:
38.2 ~ 48.1 N.m (3.9 ~ 4.9 kgf.m, 28.2 ~ 35.4 lb-ft)



CAUTION

Replace the gasket before reinstalling the drain plug.

Remove the wiring bracket installation bolt (A).

Remove the ATF Injection hole (eyebolt) (A).

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

CAUTION

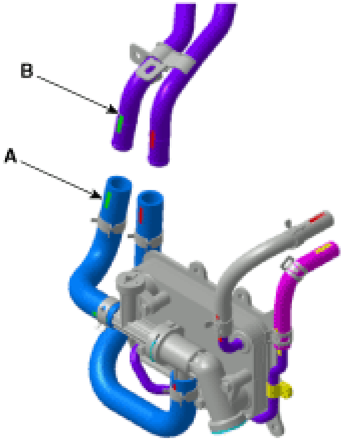
Replace the O-Ring (A) before reinstalling the eyebolt.

Disconnect the coolant hose (B) after removing the coolant hose clamp (A).

Disconnect the hose (B) after removing the automatic transaxle fluid cooler hose clamp (A).

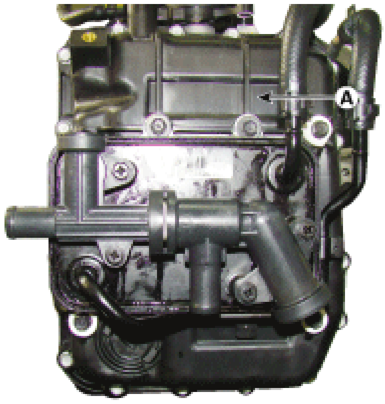
CAUTION

When hose & pipe assembly
Align marking of pipe (B), marking of hose (A), and matching color each other.



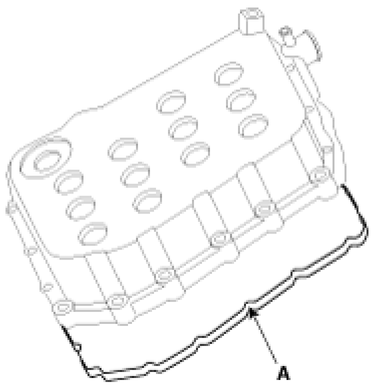
Remove the valve body cover (A).

Tightening torque:
(A) 13.7~ 15.7N.m (1.4 ~ 1.6 kgf.m, 10.1 ~ 11.6lb-ft)



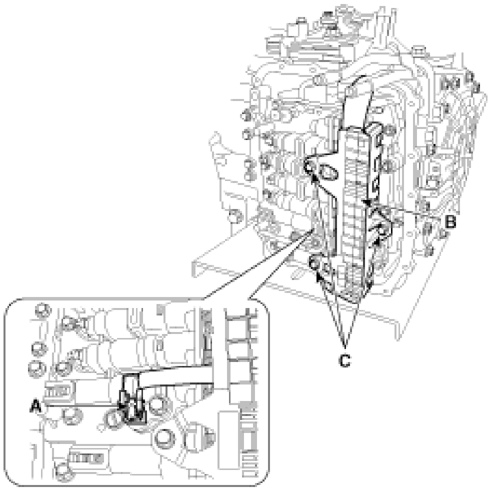
CAUTION

- Replace the gasket (A) before reinstalling the valve body cover.



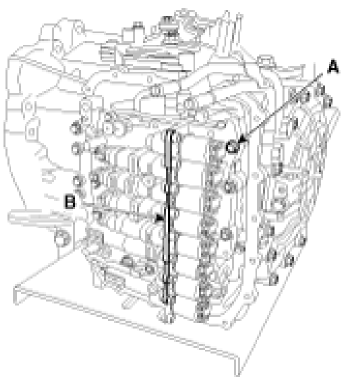
Remove the bolts (C) after disconnecting the solenoid valve connector (B) and the oil temperature sensor connector (A).

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

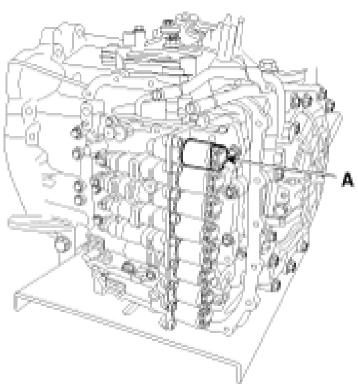


Remove the solenoid valve support bracket (B) and the valve body mounting bolt (A-1ea).

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



Remove the torque converter control solenoid valve (A).



Installation

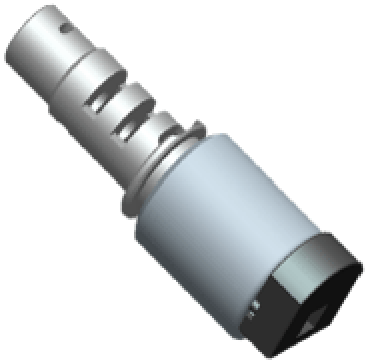
Install in the reverse order of removal.

NOTE

- Adding coolant.
- Adding Automatic Transaxle Fluid (ATF).
- Perform Transaxle Control Module (TCM) learning after replacing the valve body to prevent slow transaxle response, jerky acceleration and jerky startup.

Description

26Brake control solenoid valve (26/B) is attached to the valve body. This variable force solenoid valve directly controls the hydraulic pressure inside the 26Brake.



Specifications

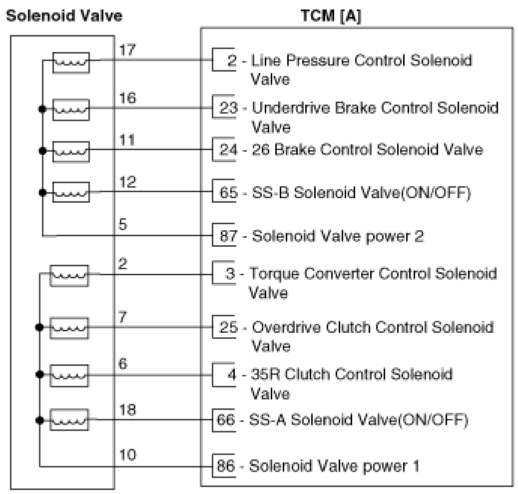
Direct control VFS [26/B]

▷ Control type : Normal low type

Control Pressure kpa (kgf/cm², psi)	9.81~500.14 (0.1~5.1, 1.42~72.54)
Current value(mA)	50~850
Internal resistance(Ω)	5.1

Circuit Diagram

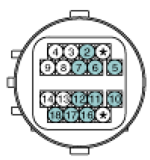
[Circuit Diagram]



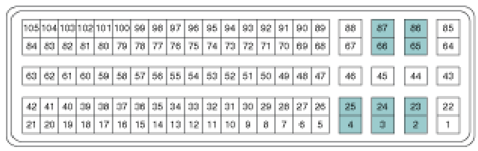
[Connection Information]

Terminal	Connected to	Function
17	TCM (2)	Line Pressure Control Solenoid Valve
16	TCM (23)	Underdrive Brake Control Solenoid Valve
11	TCM (24)	26 Brake Control Solenoid Valve
12	TCM (65)	SS-B Solenoid Valve(ON/OFF)
5	TCM (87)	Solenoid Valve power 2
2	TCM (3)	Torque Converter Control Solenoid Valve
7	TCM (25)	Overdrive Clutch Control Solenoid Valve
6	TCM (4)	35R Clutch Control Solenoid Valve
18	TCM (66)	SS-A Solenoid Valve(ON/OFF)
10	TCM (86)	Solenoid Valve power 1

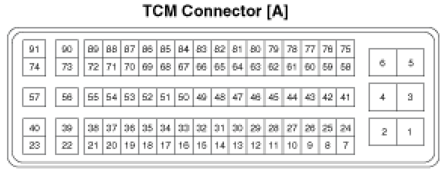
[Harness Connector]



Solenoid Valve Connector



TCM Connector [A]



TCM Connector [B]

Inspection

Turn ignition switch OFF.

Remove the air duct.

Disconnect the solenoid valve connector (A).

Measure resistance between sensor signal terminal and sensor ground terminal.

Check that the resistance is within the specification.

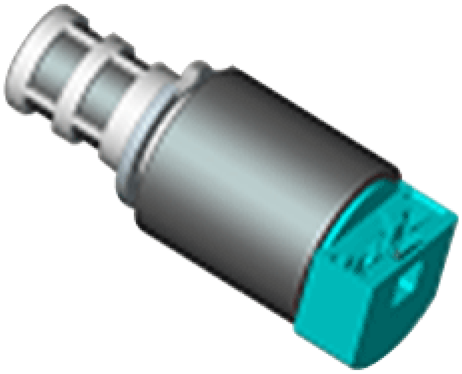
Removal

NOTE

Replacing an on/off solenoid valve (SS-A, SS-B) does not require additional hydraulic pressure adjustment; however, the hydraulic pressure will need to be adjusted after replacing the VFS solenoid valve. If replacing the VFS solenoid valve; also replace the valve body assembly.

Description

Line pressure control solenoid valve is attached to the valve body. This variable force solenoid valve directly controls the hydraulic pressure inside the line pressure.



Specifications

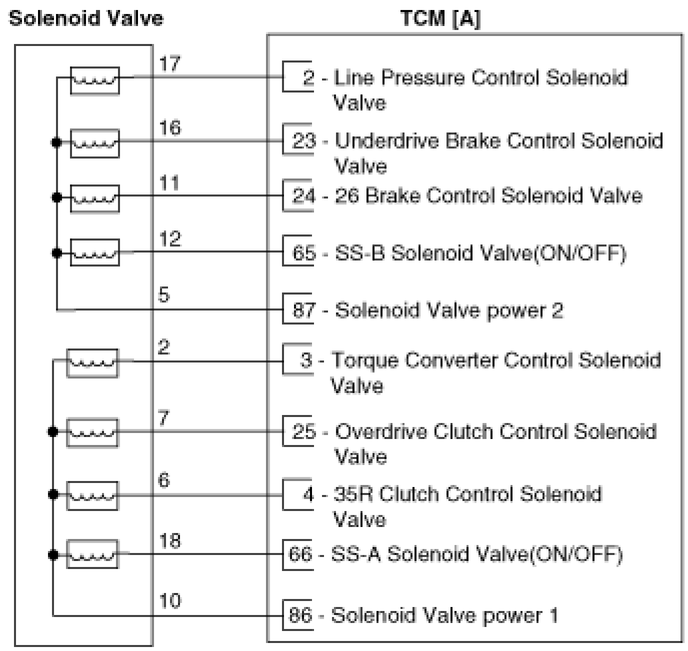
Direct control VFS [LINE Pressure]

▷ Control type : Normal high type

Control Pressure kpa (kgf/cm², psi)	500.14~9.81 (5.1~0.1,72.54~1.42)
Current value(mA)	50~850
Internal resistance(Ω)	5.1

Circuit Diagram

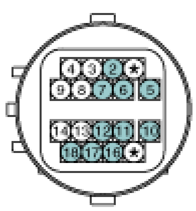
[Circuit Diagram]



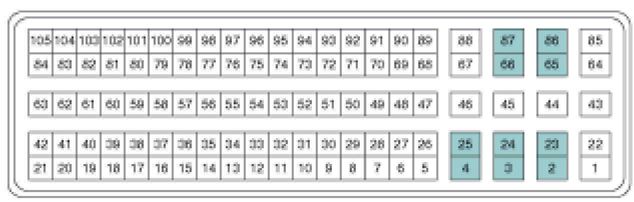
[Connection Information]

Terminal	Connected to	Function
17	TCM (2)	Line Pressure Control Solenoid Valve
16	TCM (23)	Underdrive Brake Control Solenoid Valve
11	TCM (24)	26 Brake Control Solenoid Valve
12	TCM (65)	SS-B Solenoid Valve(ON/OFF)
5	TCM (87)	Solenoid Valve power 2
2	TCM (3)	Torque Converter Control Solenoid Valve
7	TCM (25)	Overdrive Clutch Control Solenoid Valve
6	TCM (4)	35R Clutch Control Solenoid Valve
18	TCM (66)	SS-A Solenoid Valve(ON/OFF)
10	TCM (86)	Solenoid Valve power 1

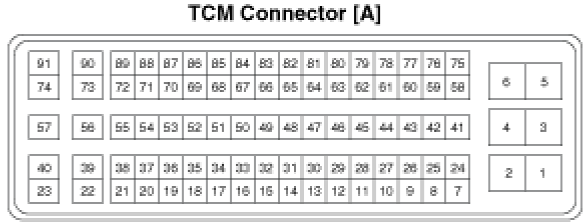
[Harness Connector]



Solenoid Valve Connector



TCM Connector [A]



TCM Connector [B]

Inspection

Turn ignition switch OFF.

Remove the air duct.

Disconnect the solenoid valve connector (A).

Measure resistance between sensor signal terminal and sensor ground terminal.

Check that the resistance is within the specification.

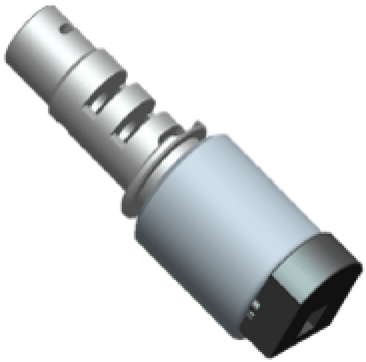
Removal

NOTE

Replacing an on/off solenoid valve (SS-A, SS-B) does not require additional hydraulic pressure adjustment; however, the hydraulic pressure will need to be adjusted after replacing the VFS solenoid valve. If replacing the VFS solenoid valve; also replace the valve body assembly.

Description

35R Clutch control solenoid valve (35R/C) is attached to the valve body. This variable force solenoid valve directly controls the hydraulic pressure inside the 35R Clutch.



Specifications

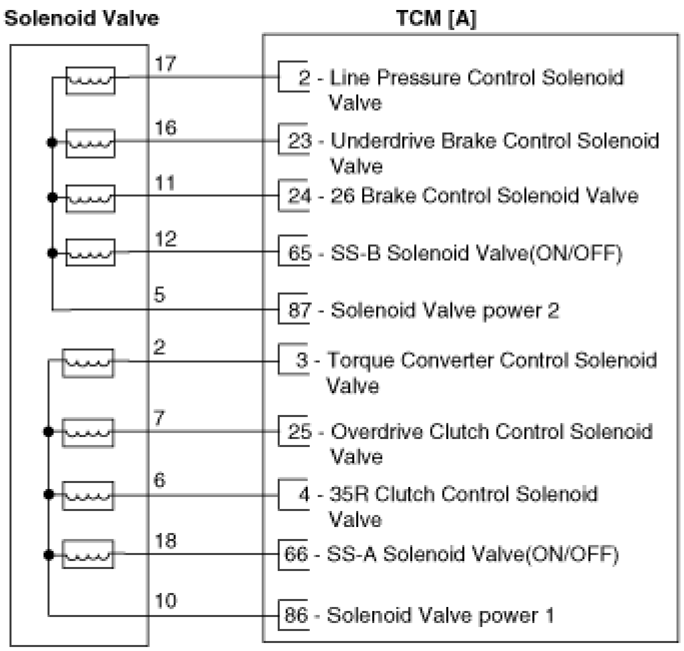
Direct control VFS [35R/C]

▷ Control type : Normal high type

Control Pressure kpa (kgf/cm², psi)	500.14~9.81 (5.1~0.1,72.54~1.42)
Current value(mA)	50~850
Internal resistance(Ω)	5.1

Circuit Diagram

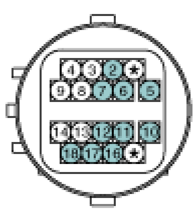
[Circuit Diagram]



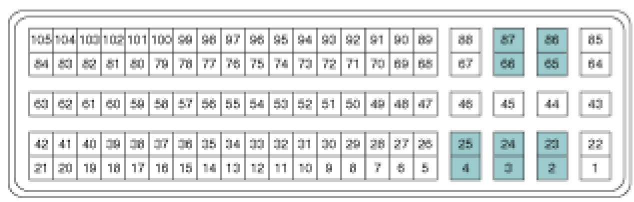
[Connection Information]

Terminal	Connected to	Function
17	TCM (2)	Line Pressure Control Solenoid Valve
16	TCM (23)	Underdrive Brake Control Solenoid Valve
11	TCM (24)	26 Brake Control Solenoid Valve
12	TCM (65)	SS-B Solenoid Valve(ON/OFF)
5	TCM (87)	Solenoid Valve power 2
2	TCM (3)	Torque Converter Control Solenoid Valve
7	TCM (25)	Overdrive Clutch Control Solenoid Valve
6	TCM (4)	35R Clutch Control Solenoid Valve
18	TCM (66)	SS-A Solenoid Valve(ON/OFF)
10	TCM (86)	Solenoid Valve power 1

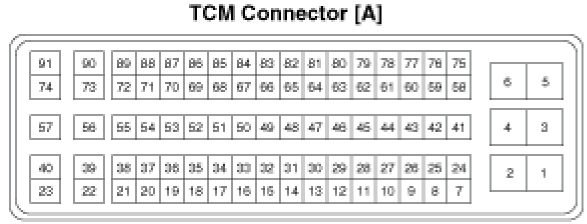
[Harness Connector]



Solenoid Valve Connector



TCM Connector [A]



TCM Connector [B]

Inspection

Turn ignition switch OFF.

Remove the air duct.

Disconnect the solenoid valve connector (A).

Measure resistance between sensor signal terminal and sensor ground terminal.

Check that the resistance is within the specification.

Removal

NOTE

Replacing an on/off solenoid valve (SS-A, SS-B) does not require additional hydraulic pressure adjustment; however, the hydraulic pressure will need to be adjusted after replacing the VFS solenoid valve. If replacing the VFS solenoid valve; also replace the valve body assembly.

Description

Underdrive brake control solenoid valve (UD/B) is attached to the valve body. This variable force solenoid valve directly controls the hydraulic pressure inside the underdrive brake.

Specifications

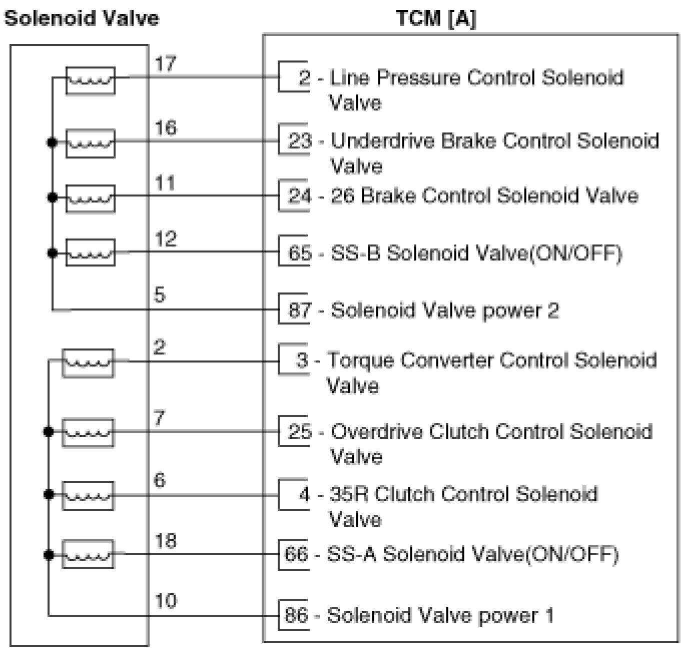
Direct control VFS [UD/B]

▷ Control type : Normal high type

Control Pressure kpa (kgf/cm², psi)	500.14~9.81 (5.1~0.1,72.54~1.42)
Current value(mA)	50~850
Internal resistance(Ω)	5.1

Circuit Diagram

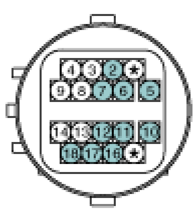
[Circuit Diagram]



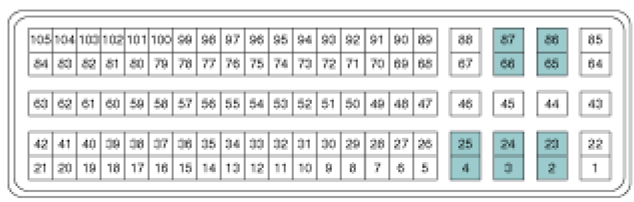
[Connection Information]

Terminal	Connected to	Function
17	TCM (2)	Line Pressure Control Solenoid Valve
16	TCM (23)	Underdrive Brake Control Solenoid Valve
11	TCM (24)	26 Brake Control Solenoid Valve
12	TCM (65)	SS-B Solenoid Valve(ON/OFF)
5	TCM (87)	Solenoid Valve power 2
2	TCM (3)	Torque Converter Control Solenoid Valve
7	TCM (25)	Overdrive Clutch Control Solenoid Valve
6	TCM (4)	35R Clutch Control Solenoid Valve
18	TCM (66)	SS-A Solenoid Valve(ON/OFF)
10	TCM (86)	Solenoid Valve power 1

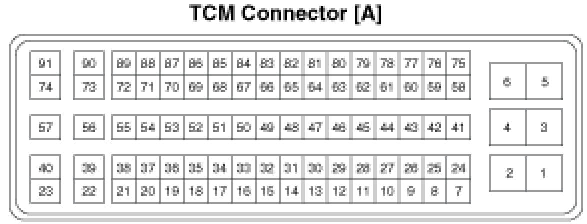
[Harness Connector]



Solenoid Valve Connector



TCM Connector [A]



TCM Connector [B]

Inspection

Turn ignition switch OFF.

Remove the air duct.

Disconnect the solenoid valve connector (A).

Measure resistance between sensor signal terminal and sensor ground terminal.

Check that the resistance is within the specification.

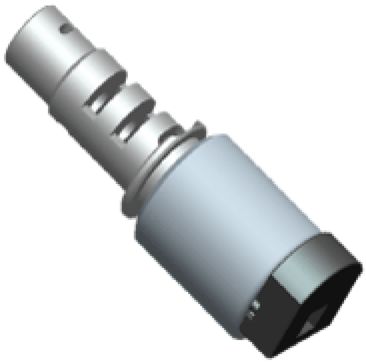
Removal

NOTE

Replacing an on/off solenoid valve (SS-A, SS-B) does not require additional hydraulic pressure adjustment; however, the hydraulic pressure will need to be adjusted after replacing the VFS solenoid valve. If replacing the VFS solenoid valve; also replace the valve body assembly.

Description

Overdrive clutch control solenoid valve (OD/C) is attached to the valve body. This variable force solenoid valve directly controls the hydraulic pressure inside the overdrive clutch.



Specifications

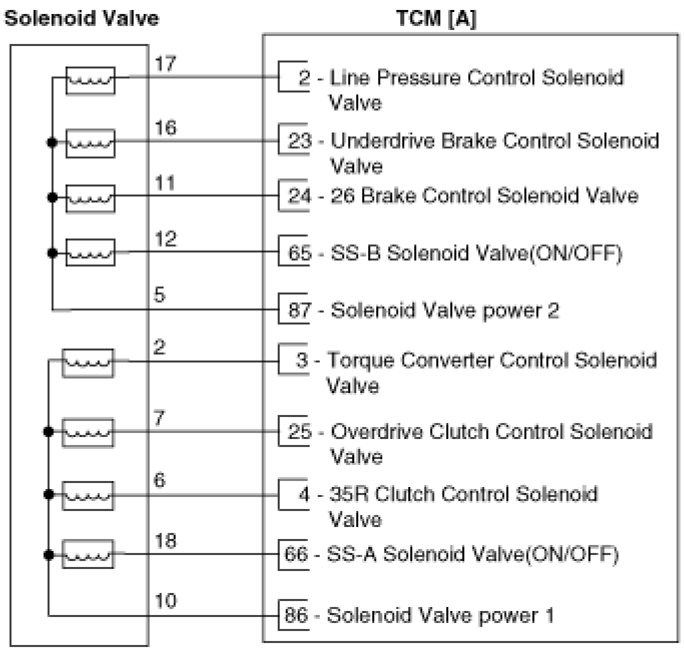
Direct control VFS [OD/C]

▹ Control type: Normal high type

Control Pressure kpa (kgf/cm², psi)	500.14~9.81 (5.1~0.1,72.54~1.42)
Current value(mA)	50~850
Internal resistance(Ω)	5.1

Circuit Diagram

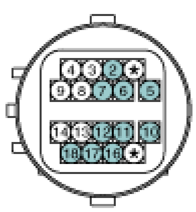
[Circuit Diagram]



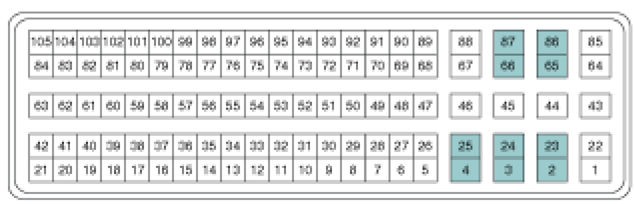
[Connection Information]

Terminal	Connected to	Function
17	TCM (2)	Line Pressure Control Solenoid Valve
16	TCM (23)	Underdrive Brake Control Solenoid Valve
11	TCM (24)	26 Brake Control Solenoid Valve
12	TCM (65)	SS-B Solenoid Valve(ON/OFF)
5	TCM (87)	Solenoid Valve power 2
2	TCM (3)	Torque Converter Control Solenoid Valve
7	TCM (25)	Overdrive Clutch Control Solenoid Valve
6	TCM (4)	35R Clutch Control Solenoid Valve
18	TCM (66)	SS-A Solenoid Valve(ON/OFF)
10	TCM (86)	Solenoid Valve power 1

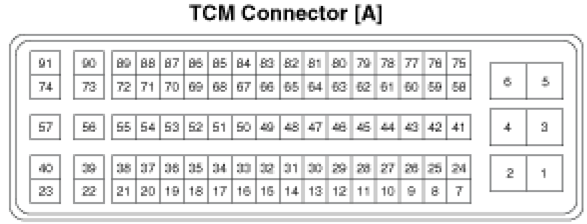
[Harness Connector]



Solenoid Valve Connector



TCM Connector [A]



TCM Connector [B]

Inspection

Turn ignition switch OFF.

Remove the air duct.

Disconnect the solenoid valve connector (A).

Measure resistance between sensor signal terminal and sensor ground terminal.

Check that the resistance is within the specification.

Removal

NOTE

Replacing an on/off solenoid valve (SS-A, SS-B) does not require additional hydraulic pressure adjustment; however, the hydraulic pressure will need to be adjusted after replacing the VFS solenoid valve. If replacing the VFS solenoid valve; also replace the valve body assembly.

Description

SS-A solenoid valve is attached to the valve body and is an on/off solenoid valve that is used to change gears.

SS-A Solenoid valve (ON/OFF) is installed at valve body.

Specifications

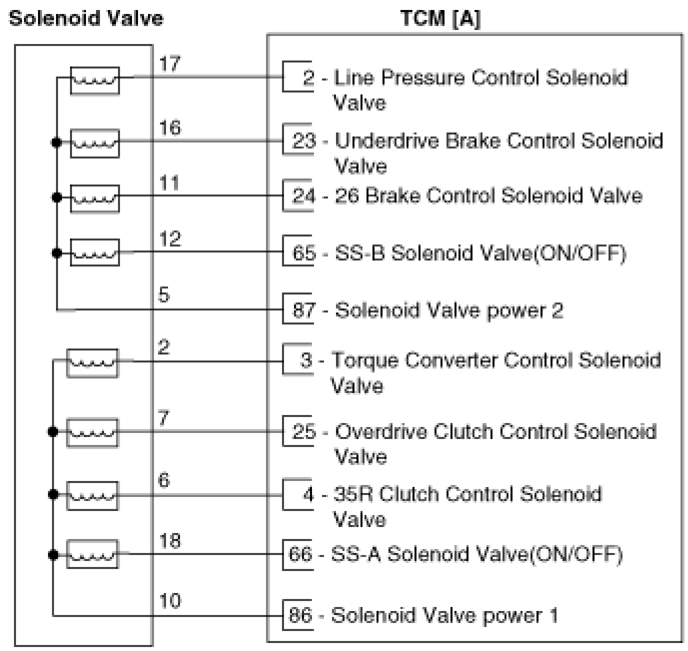
ON/OFF Solenoid Valve (SS-A)

▹ Control type : Normal low type

Control pressure kpa (kgf/cm^2, psi)	490.33(5.0, 71.12)
Internal resistance(Ω)	10~11

Circuit Diagram

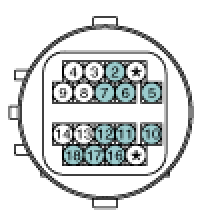
[Circuit Diagram]



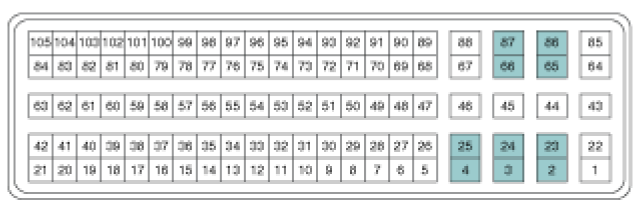
[Connection Information]

Terminal	Connected to	Function
17	TCM (2)	Line Pressure Control Solenoid Valve
16	TCM (23)	Underdrive Brake Control Solenoid Valve
11	TCM (24)	26 Brake Control Solenoid Valve
12	TCM (65)	SS-B Solenoid Valve(ON/OFF)
5	TCM (87)	Solenoid Valve power 2
2	TCM (3)	Torque Converter Control Solenoid Valve
7	TCM (25)	Overdrive Clutch Control Solenoid Valve
6	TCM (4)	35R Clutch Control Solenoid Valve
18	TCM (66)	SS-A Solenoid Valve(ON/OFF)
10	TCM (86)	Solenoid Valve power 1

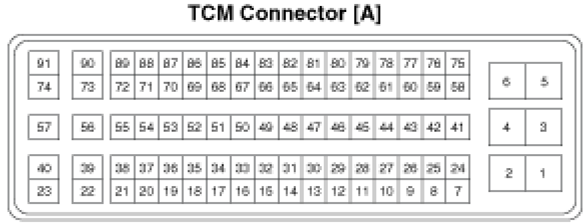
[Harness Connector]



Solenoid Valve Connector



TCM Connector [A]



TCM Connector [B]

Inspection

Turn ignition switch OFF.

Remove the air duct.

Disconnect the solenoid valve connector (A).

Measure resistance between sensor signal terminal and sensor ground terminal.

Check that the resistance is within the specification.

Removal

Remove the air duct.

Remove the battery and the battery tray.

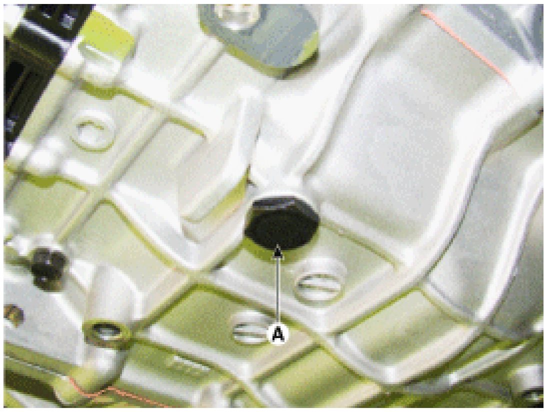
Remove the under cover (A).

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

Drain the coolant.

Remove the drain plug (A) and reinstall the drain plug after draining ATF totally.

Drain plug tightening torque:
38.2 ~ 48.1 N.m (3.9 ~ 4.9 kgf.m, 28.2 ~ 35.4 lb-ft)



CAUTION

Replace the gasket before reinstalling the drain plug.

Remove the wiring bracket installation bolt (A).

Remove the ATF Injection hole (eyebolt) (A).

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

CAUTION

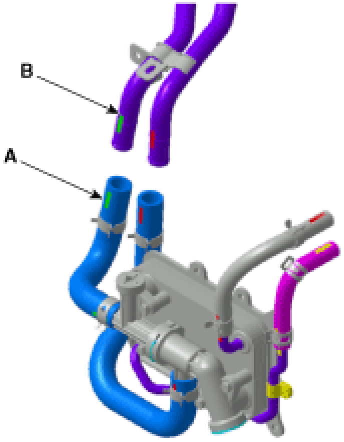
Replace the O-Ring (A) before reinstalling the eyebolt.

Disconnect the coolant hose (B) after removing the coolant hose clamp (A).

Disconnect the hose (B) after removing the automatic transaxle fluid cooler hose clamp (A).

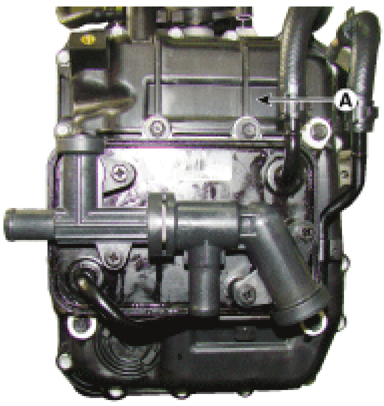
CAUTION

When hose & pipe assembly
Align marking of pipe (B), marking of hose (A), and matching color each other.



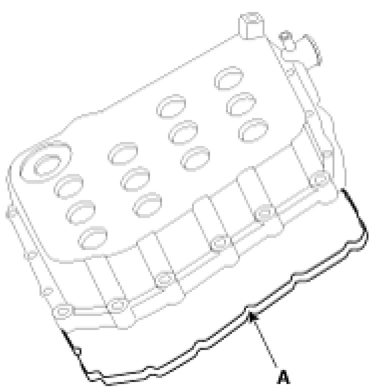
Remove the valve body cover (A).

Tightening torque:
(A) 13.7~ 15.7N.m (1.4 ~ 1.6 kgf.m, 10.1 ~ 11.6lb-ft)



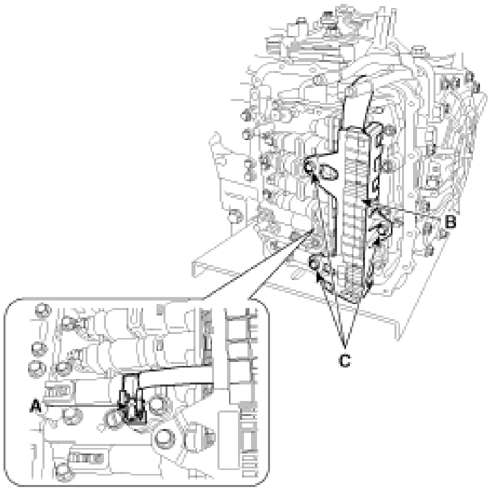
CAUTION

- Replace the gasket (A) before reinstalling the valve body cover.



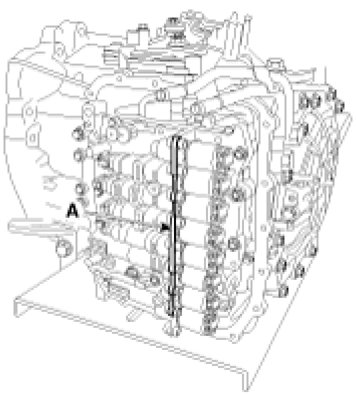
Remove the bolts (C) after disconnecting the solenoid valve connector (B) and the oil temperature sensor connector (A).

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

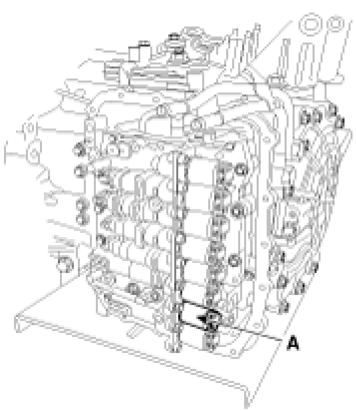


Remove the solenoid valve support bracket (A).

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

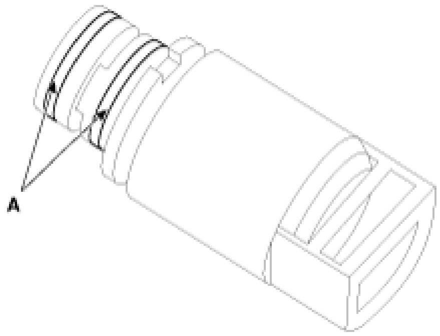


Remove the solenoid valve (A).



CAUTION

- When installing, apply the ATF oil or white Vaseline to the O-ring (A) not to be damaged.



Installation

Install in the reverse order of removal.

NOTE

- Adding coolant.
- Adding Automatic Transaxle Fluid (ATF).
- Perform Transaxle Control Module (TCM) learning after replacing the valve body to prevent slow transaxle response, jerky acceleration and jerky startup.

Description

SS-B solenoid valve is attached to the valve body and is an on/off solenoid valve that is used to change gears.
SS-B Solenoid valve (ON/OFF) is installed at valve body.

Specifications

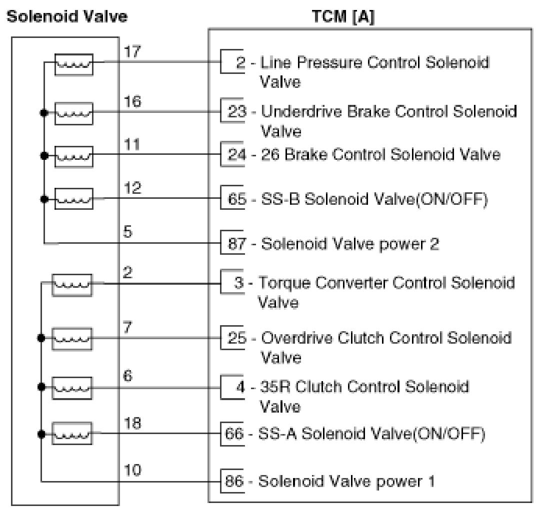
ON/OFF Solenoid Valve (SS-B)

▷ Control type : Normal low type

Control pressure kpa (kgf/cm², psi)	490.33(5.0, 71.12)
Internal resistance(Ω)	10~11

Circuit Diagram

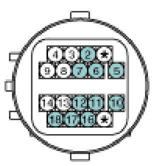
[Circuit Diagram]



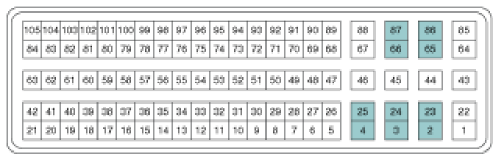
[Connection Information]

Terminal	Connected to	Function
17	TCM (2)	Line Pressure Control Solenoid Valve
16	TCM (23)	Underdrive Brake Control Solenoid Valve
11	TCM (24)	26 Brake Control Solenoid Valve
12	TCM (65)	SS-B Solenoid Valve(ON/OFF)
5	TCM (87)	Solenoid Valve power 2
2	TCM (3)	Torque Converter Control Solenoid Valve
7	TCM (25)	Overdrive Clutch Control Solenoid Valve
6	TCM (4)	35R Clutch Control Solenoid Valve
18	TCM (66)	SS-A Solenoid Valve(ON/OFF)
10	TCM (86)	Solenoid Valve power 1

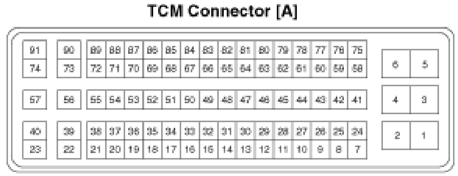
[Harness Connector]



Solenoid Valve Connector



TCM Connector [A]



TCM Connector [B]

Inspection

Turn ignition switch OFF.

Remove the air duct.

Disconnect the solenoid valve connector (A).

Measure resistance between sensor signal terminal and sensor ground terminal.

Check that the resistance is within the specification.

Removal

Remove the air duct.

Remove the battery and the battery tray.

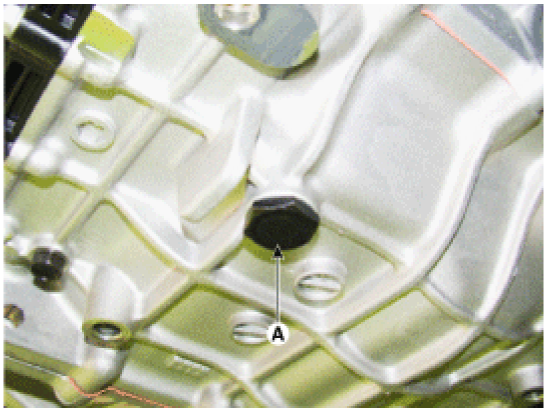
Remove the under cover (A).

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

Drain the coolant.

Remove the drain plug (A) and reinstall the drain plug after draining ATF totally.

Drain plug tightening torque:
38.2 ~ 48.1 N.m (3.9 ~ 4.9 kgf.m, 28.2 ~ 35.4 lb-ft)



CAUTION

Replace the gasket before reinstalling the drain plug.

Remove the wiring bracket installation bolt (A).

Remove the ATF Injection hole (eyebolt) (A).

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

CAUTION

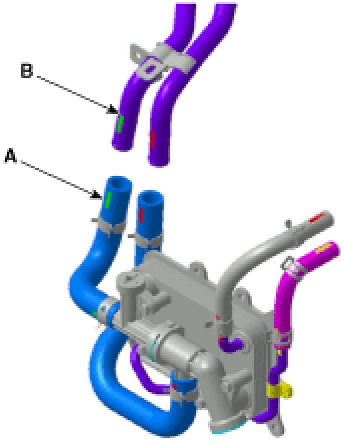
Replace the O-Ring (A) before reinstalling the eyebolt.

Disconnect the coolant hose (B) after removing the coolant hose clamp (A).

Disconnect the hose (B) after removing the automatic transaxle fluid cooler hose clamp (A).

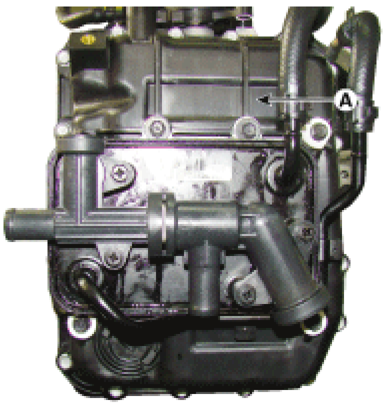
CAUTION

When hose & pipe assembly
Align marking of pipe (B), marking of hose (A), and matching color each other.



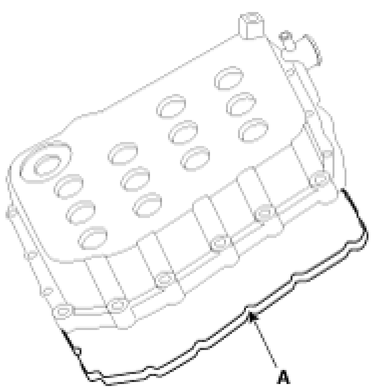
Remove the valve body cover (A).

Tightening torque:
(A) 13.7~ 15.7N.m (1.4 ~ 1.6 kgf.m, 10.1 ~ 11.6lb-ft)



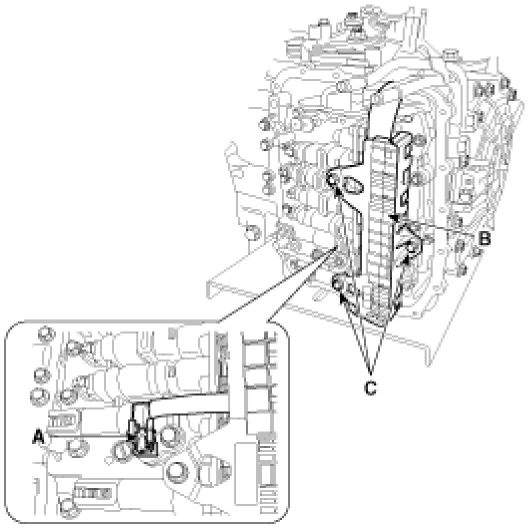
CAUTION

- Replace the gasket (A) before reinstalling the valve body cover.



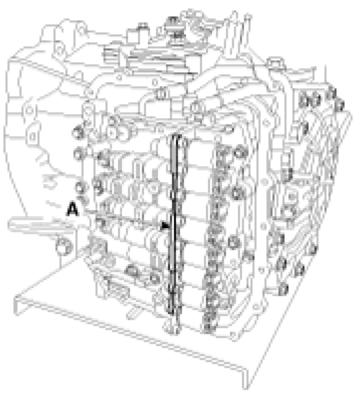
Remove the bolts (C) after disconnecting the solenoid valve connector (B) and the oil temperature sensor connector (A).

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

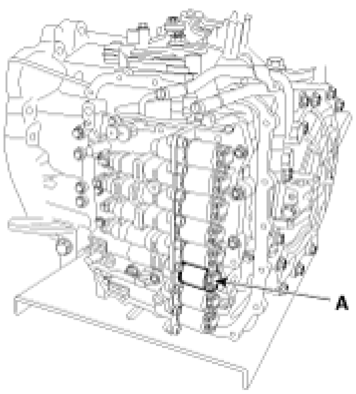


Remove the solenoid valve support bracket (A).

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

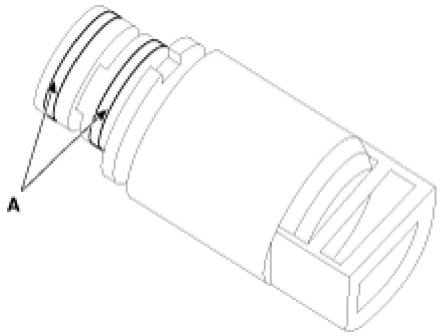


Remove the solenoid valve (A).



CAUTION

- When installing, apply the ATF oil or white Vaseline to the O-ring (A) not to be damaged.



Installation

Install in the reverse order of removal.

NOTE

- Adding coolant.
- Adding Automatic Transaxle Fluid (ATF).
- Perform Transaxle Control Module (TCM) learning after replacing the valve body to prevent slow transaxle response, jerky acceleration and jerky startup.

Description

Inhibitor Switch monitors the lever's position (P, R, N, D) and is used to control gear setting signals.

Specifications

▷ Type: Combination of output signals from 4 terminals

▷ Specifications

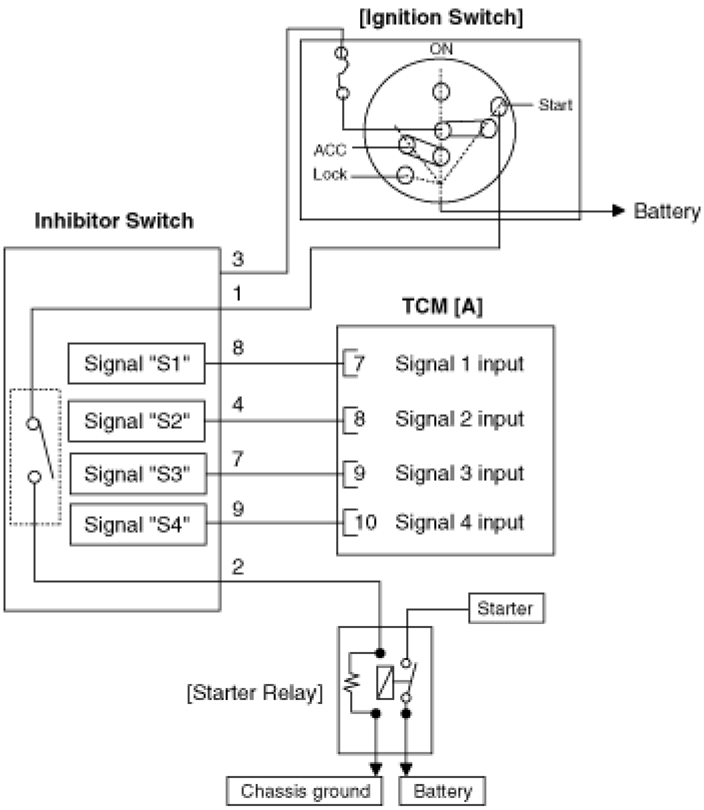
Power supply (V)	12
Output type	Pin to Pin

▷ Signal Code Table

	P	P-R	R	R-N	N	N-D	D
S1	12V	12V	0	0	0	0	0
S2	0	12V	12V	12V	0	0	0
S3	0	0	0	12V	12V	12V	0
S4	0	0	0	0	0	12V	12V

Circuit Diagram

[Circuit Diagram]

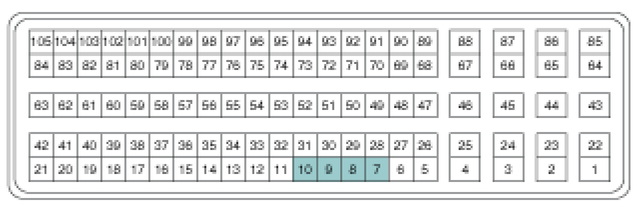


[Connection Information]

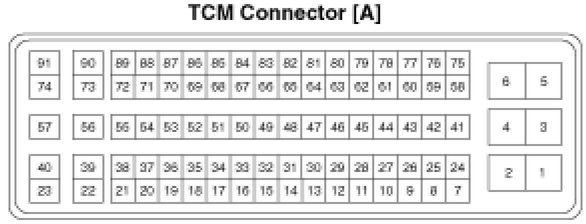
Terminal	Connected to	Function
8	TCM (7)	Signal 1 input
4	TCM (8)	Signal 2 input
7	TCM (9)	Signal 3 input
9	TCM (10)	Signal 4 input
3	Ignition switch	Ignition ON
1	Ignition switch	Starter power(ON)
2	Starter relay	Starter relay

[Harness Connector]

Inhibitor Switch Connector



TCM Connector [A]



TCM Connector [B]

Inspection

NOTE

- Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.

Power Circuit Inspection

Disconnect the Inhibitor switch connector.

Ignition KEY "ON"" & Engine "OFF".

Measure voltage between supplied power and ground at inhibitor circuit.

Specification : Approx. 12V

Signal Circuit Inspection

Connect the Inhibitor switch connector.

Ignition KEY "ON" & Engine "OFF".

Measure voltages between each terminal and chassis ground during shift lever changed "P, R, N, D".

Specification : See below "Signal Code Table"

Signal Code Table

	P	P-R	R	R-N	N	N-D	D
Signal "1"	12V	12V	0	0	0	0	0
Signal "2"	0	12V	12V	12V	0	0	0
Signal "3"	0	0	0	12V	12V	12V	0
Signal "4"	0	0	0	0	0	12V	12V

Removal

Set shift lever to "N" position.

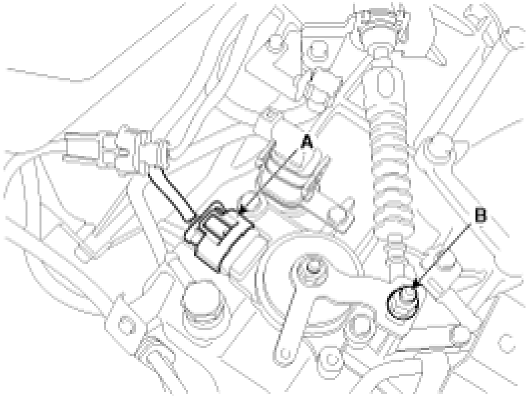
Remove the air duct.

Remove the battery and the battery tray.

Disconnect the inhibitor switch connector (A).

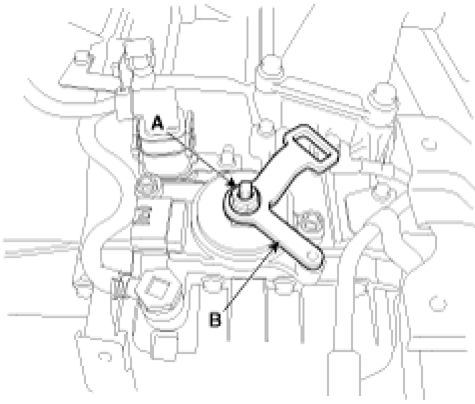
Remove the shift cable mounting nut (B).

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



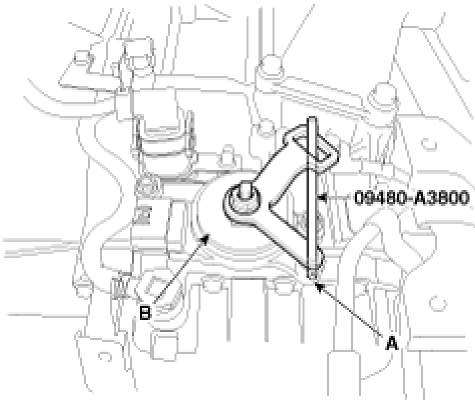
Remove the manual control lever (B) and the washer after removing a nut (A).

Tightening torque: 17.7~24.5 N.m (1.8~ 2.5 kgf.m, 13.0 ~ 18.1 lb-ft)



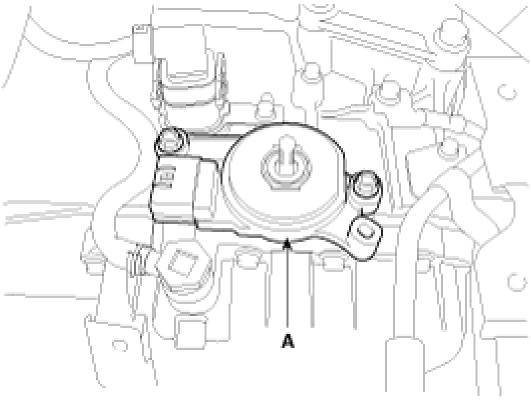
CAUTION

Use a SST (09480-A3800) or 0.1969in.(5mm) bolt, fix the inhibitor manual control lever in the N jig hole (A) when you assemble the inhibitor (B).



Remove the inhibitor assembly (A) after removing the bolts (2ea).

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



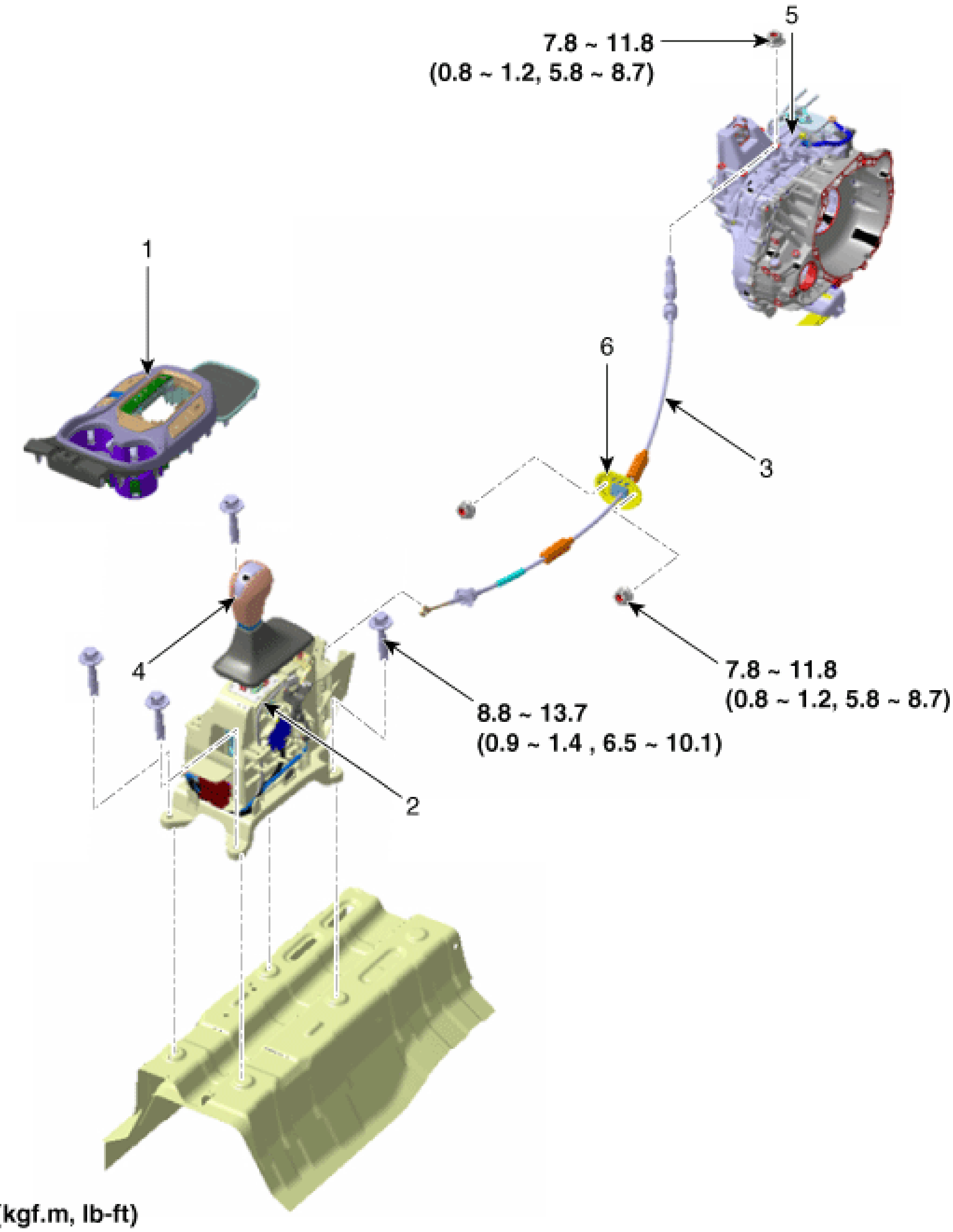
CAUTION

When installing, tighten the inhibitor assembly mounting bolt to the specification shown above.

Installation

Install in the reverse order of removal.

Components



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

1. Console upper cover 2. Shift lever assembly 3. Shift cable assembly	4. Shift lever knob & boots assembly 5. Manual control lever 6. Retainer

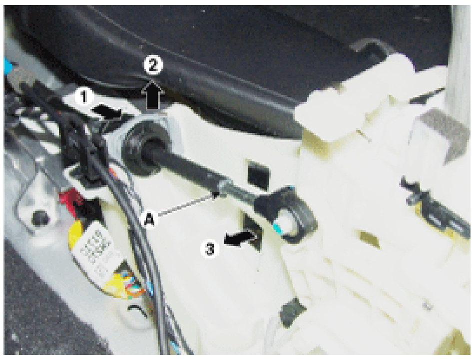
Removal

Remove the floor console.

Remove the air duct.

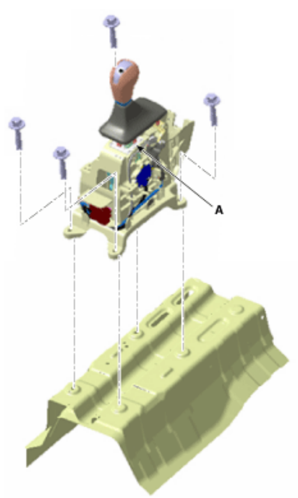
Disconnect sports mode connector (A).

Disconnect the shift cable (A).



Remove the shift lever assembly (A) by removing the bolts (C-4ea).

Tightening torque :
8.8 ~ 13.7 N.m (0.9 ~ 1.4 kgf.m, 6.5 ~ 10.1 lb-ft)



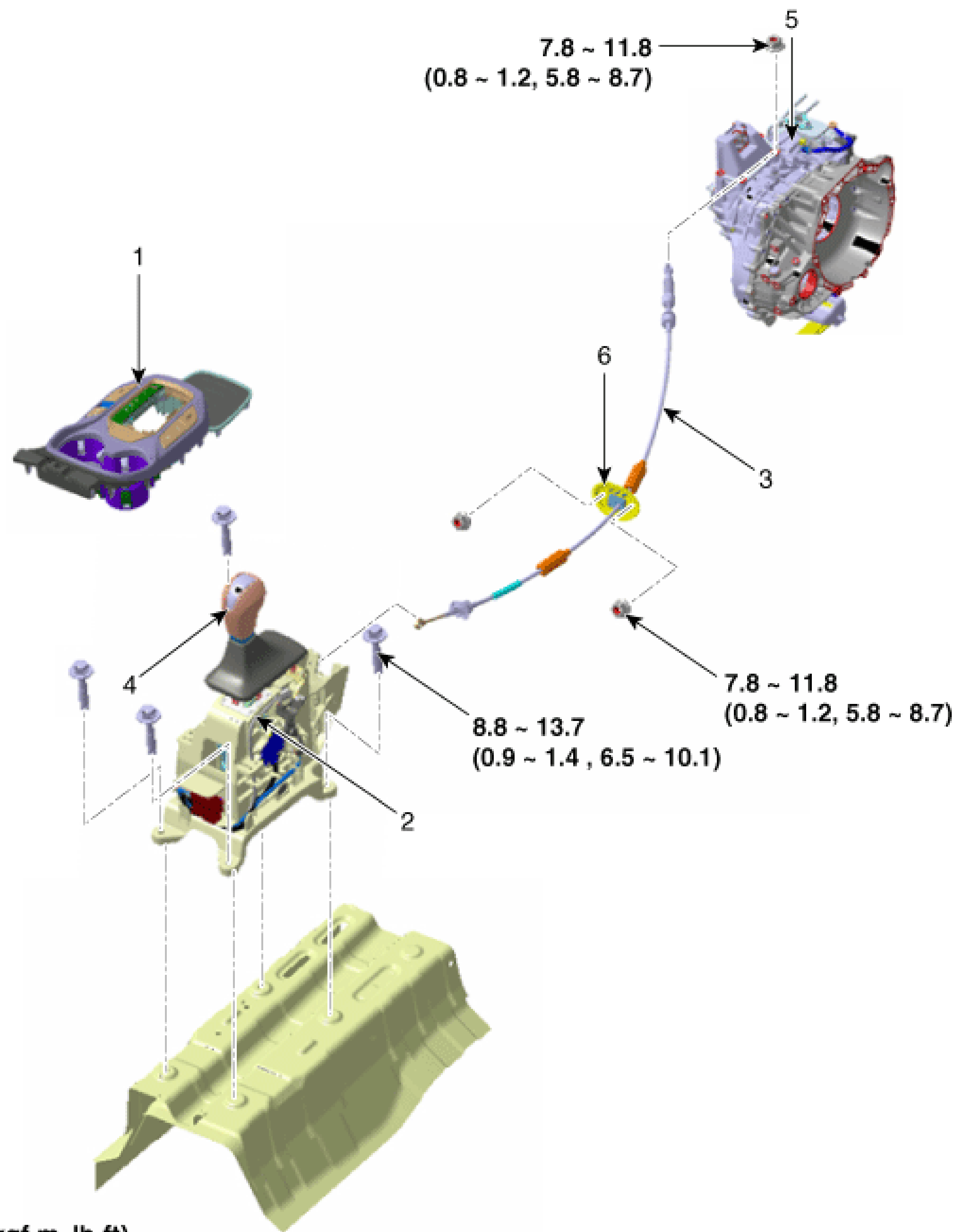
Installation

Install in the reverse order of removal.

CAUTION

Set shift lever and inhibitor switch manual control lever to "N" position.

Components



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

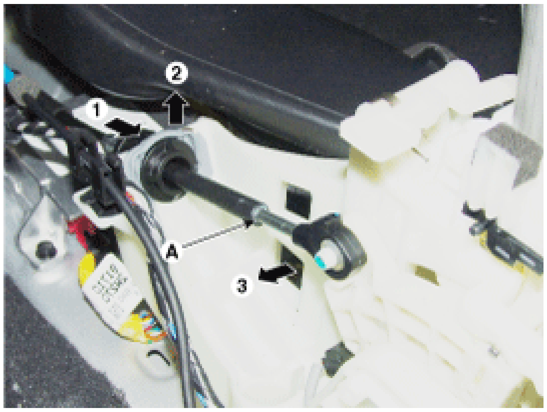
1. Console upper cover 2. Shift lever assembly 3. Shift cable assembly	4. Shift lever knob & boots assembly 5. Manual control lever 6. Retainer

Removal

Remove the floor console.

Remove the air duct.

Disconnect the shift cable (A).



Remove the retainer (A) and nut (B).

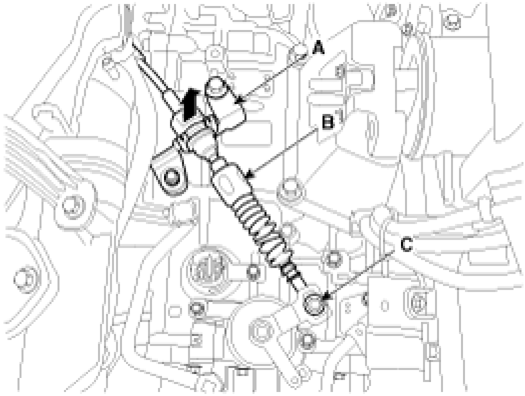
Tightening torque :
7.8 ~ 11.8 N.m (0.8 ~ 1.2 kgf.m, 5.8~8.7 lb-ft)

Remove the nut (C) from the manual control lever.

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

Remove the cable (B) from the bracket (A) at transaxle assembly side.

Remove the shift cable by pulling it toward the interior.



Installation

Install in the reverse order of removal.

CAUTION

Set shift lever and inhibitor switch manual control lever to "N" position.

Adjustment

Adjusting method for T/M control cable

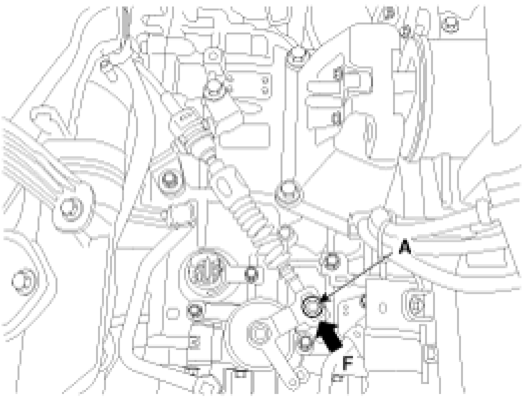
Set room side shift lever and T/M side manual control lever to "N" position.

Connect room side shift lever and shift cable.

Push cable to "F" direction shown to eliminate FREE PLAY.

Tighten adjusting nut (A).

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



After adjusting according check to be sure that this part operates surely at each range of T/M side corresponding to each position of shift lever.