

EC-2

Emission Control System

General Information

Description

Emissions control system consists of the three major systems.

- Crankcase Emission Control System prevents blow-by gas from going into the atmosphere. This system burns these gases after moving them to the intake manifold (Closed Crankcase Ventilation Type).
- Evaporative Emission Control System prevents evaporative gas going into the atmosphere. This system burns the gases 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)]

Tightening Torques

Item	kgf.m	N.m	lb-ft
Positive Crankcase Ventilation (PCV) Valve installation	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7
Canister band installation nut	0.4 ~ 0.6	3.9 ~ 5.9	2.9 ~ 4.3
Canister cover installation bolt	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7
Ventilation hose connector assembly installation bolt	0.4 ~ 0.6	3.9 ~ 5.9	2.9 ~ 4.3
Canister protector installation bolt	2.0 ~ 3.0	19.6 ~ 29.4	14.5 ~ 21.7

Troubleshooting

Symptom	Suspect area
Engine will not start or hard to start	Vapor hose damaged or disconnected
Engine hard to start	Malfunction of the purge control solenoid valve
Rough idle or engine stalls	Vapor hose damaged or disconnected
	Malfunction of the PCV valve
Rough idle	Malfunction of the evaporative emission control system
Excessive oil consumption	Positive crankcase ventilation line clogged

General Information

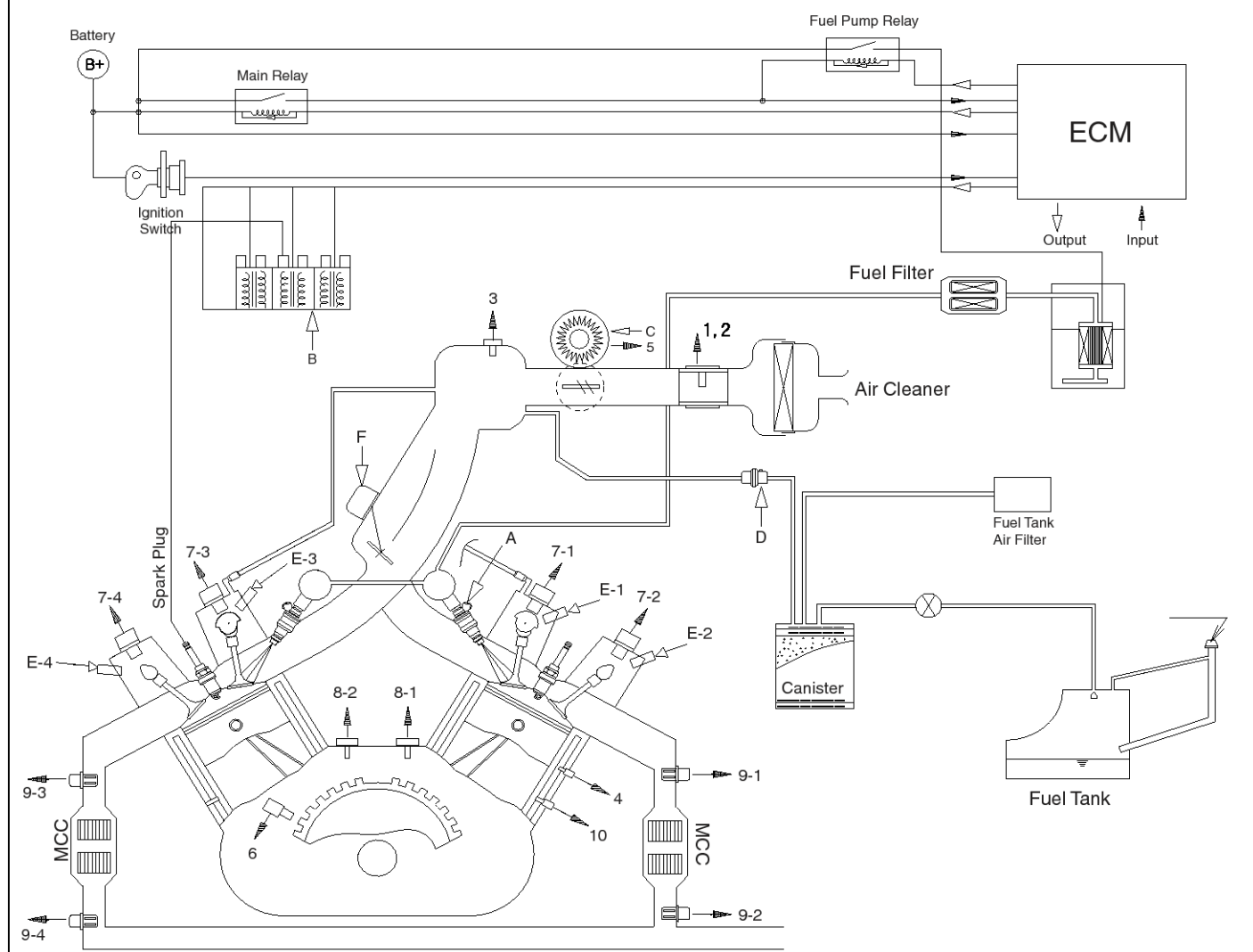
EC-3

Schematic Diagram

1. Mass Air Flow Sensor (MAFS)
2. Intake Air Temperature Sensor (IATS)
3. Manifold Absolute Pressure Sensor (MAPS)
4. Engine Coolant Temperature Sensor (ECTS)
5. Throttle Position Sensor (TPS) [integrated into ETC Module]
6. Crankshaft Position Sensor (CKPS)
- 7-1. Camshaft Position Sensor (CMPS) [Bank 1 / Intake]
- 7-2. Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust]
- 7-3. Camshaft Position Sensor (CMPS) [Bank 2 / Intake]
- 7-4. Camshaft Position Sensor (CMPS) [Bank 2 / Exhaust]
- 8-1. Knock Sensor (KS) [Bank 1]
- 8-2. Knock Sensor (KS) [Bank 2]
- 9-1. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 1]
- 9-2. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 2]
- 9-3. Heated Oxygen Sensor (HO2S) [Bank 2 / Sensor 1]
- 9-4. Heated Oxygen Sensor (HO2S) [Bank 2 / Sensor 2]
10. CVVT Oil Temperature Sensor (OTS)
- Accelerator Position Sensor (APS)
- A/C Pressure Transducer (APT)
- Power Steering Pressure Sensor (PSPS)



- A. Injector
- B. Ignition Coil
- C. ETC Motor [integrated into ETC Module]
- D. Purge Control Solenoid Valve (PCSV)
- E-1. CVVT Oil Control Valve (OCV) [Bank 1 / Intake]
- E-2. CVVT Oil Control Valve (OCV) [Bank 1 / Exhaust]
- E-3. CVVT Oil Control Valve (OCV) [Bank 2 / Intake]
- E-4. CVVT Oil Control Valve (OCV) [Bank 2 / Exhaust]
- F. Variable Intake Solenoid (VIS) Valve
- Main Relay
- Fuel Pump Relay
- A/C Control Signal
- Diagnosis

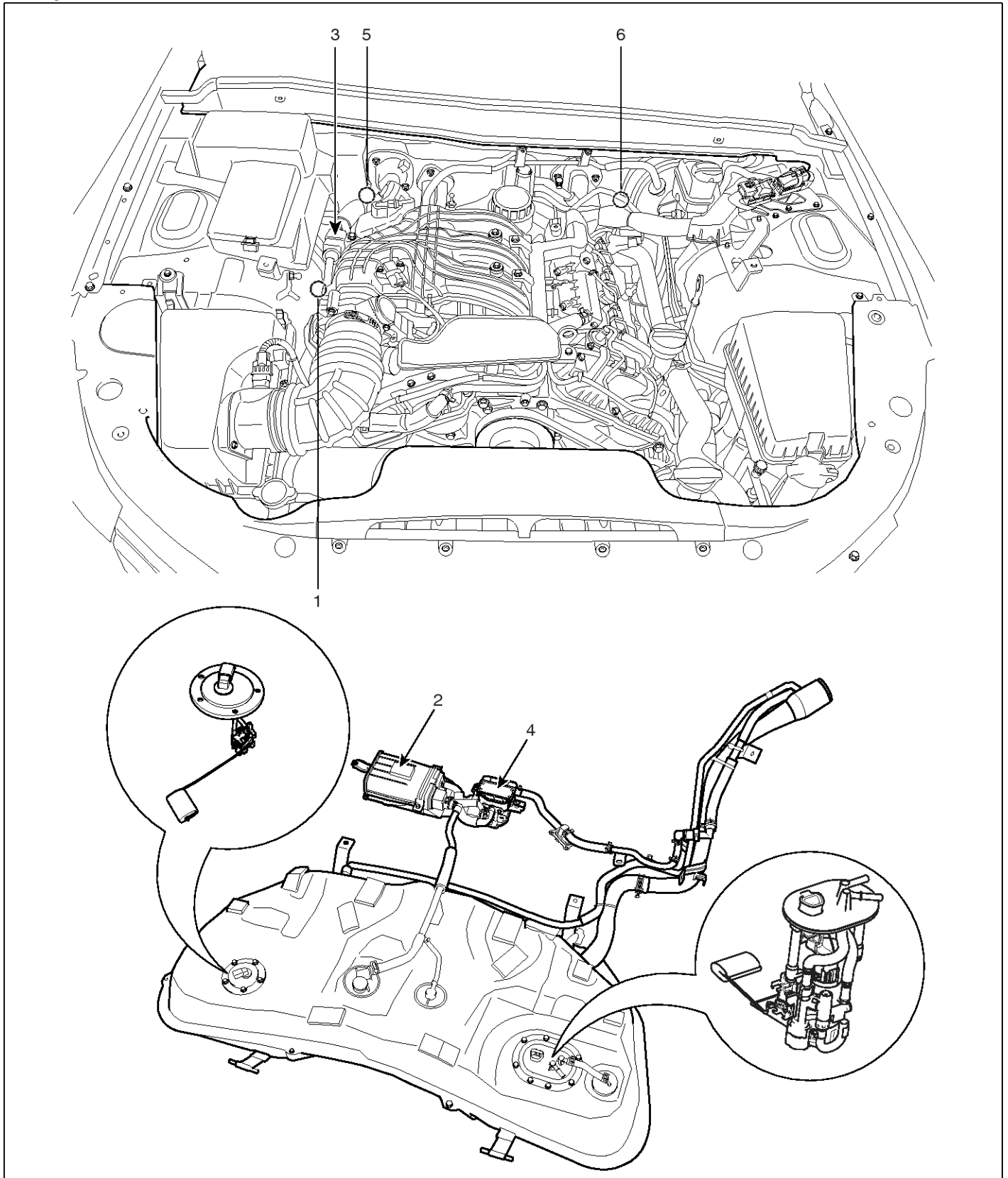


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Emission Control System

Components Location



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General Information

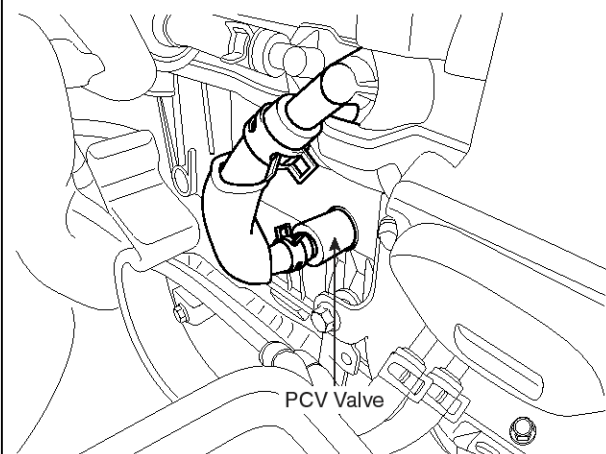
EC-5

- | | |
|--|--------------------------------------|
| 1. PCV Valve | 4. Fuel Tank Air Filter |
| 2. Canister | 5. Catalytic Converter (MCC, Bank 1) |
| 3. Purge Control Solenoid Valve (PCSV) | 6. Catalytic Converter (MCC, Bank 2) |

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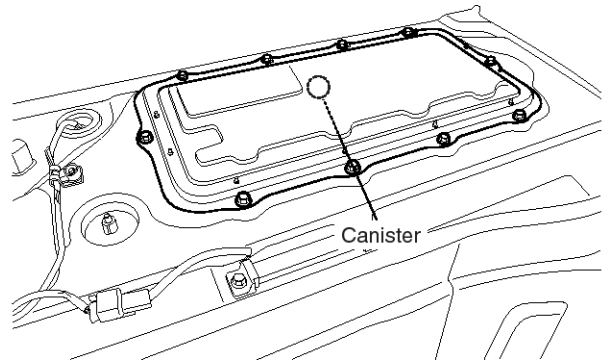
Emission Control System

1. PCV Valve



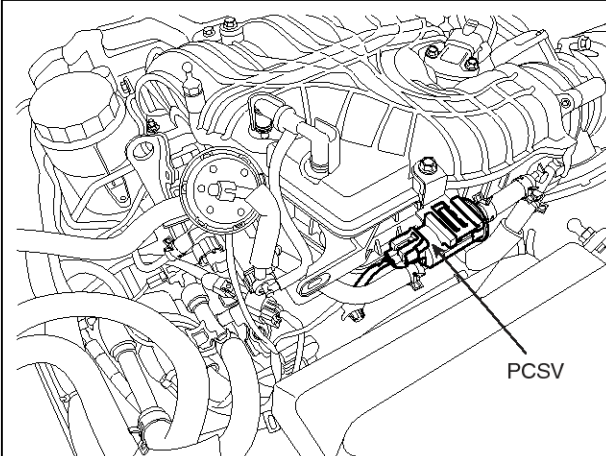
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2. Canister



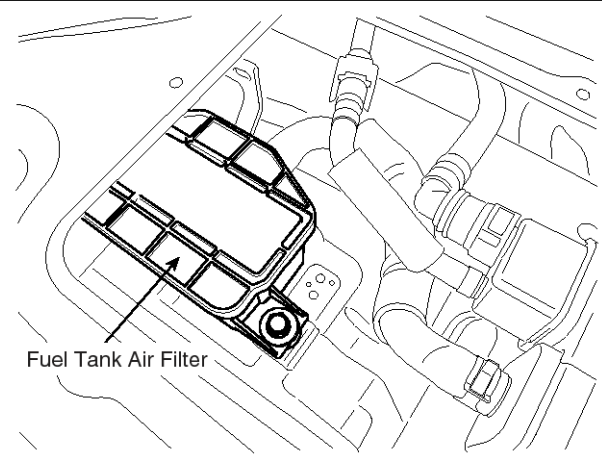
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3. Purge Control Solenoid Valve (PCSV)



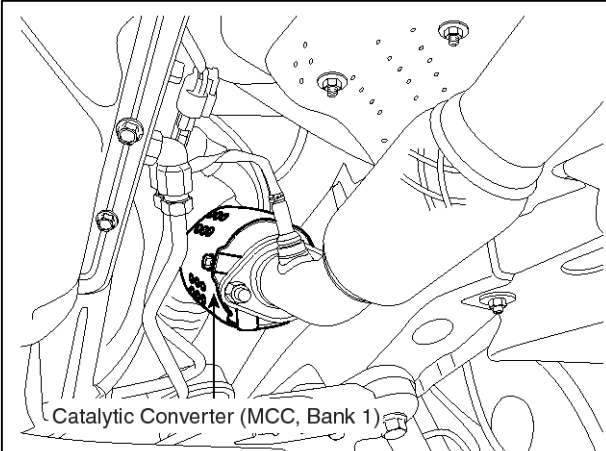
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4. Fuel Tank Air Filter



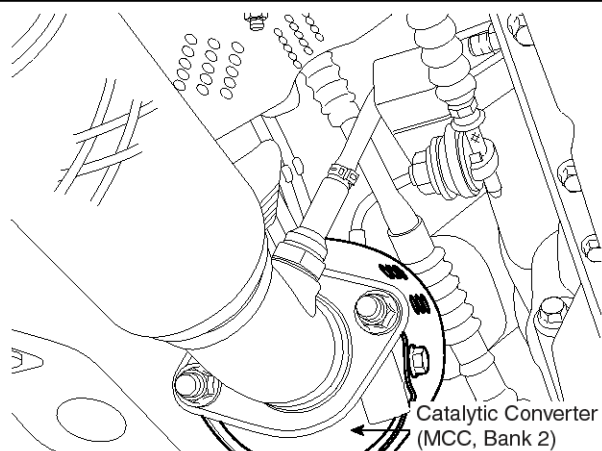
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5. Catalytic Converter (MCC, Bank 1)



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6. Catalytic Converter (MCC, Bank 2)



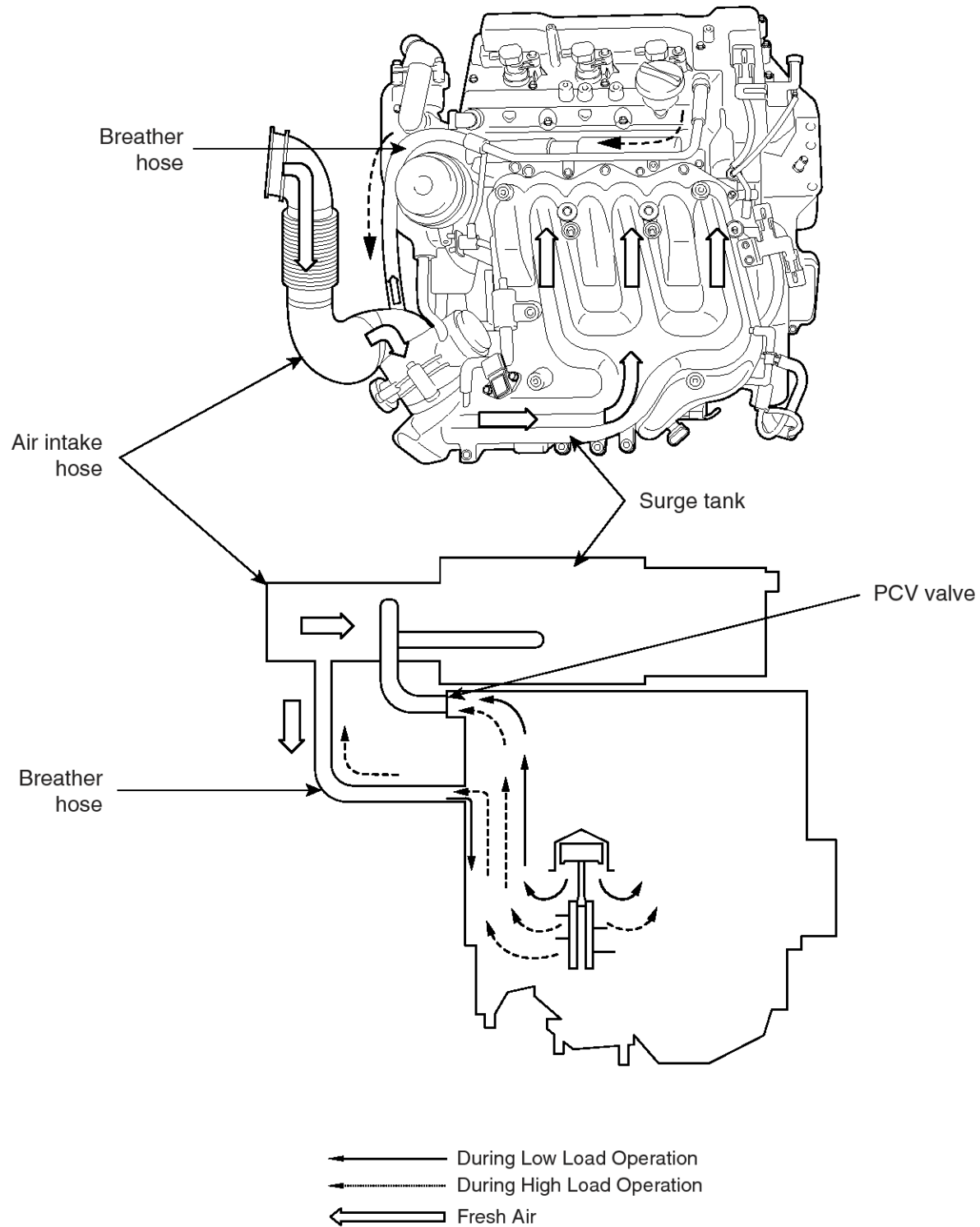
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Crankcase Emission Control System

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Crankcase Emission Control System

Schematic Diagram



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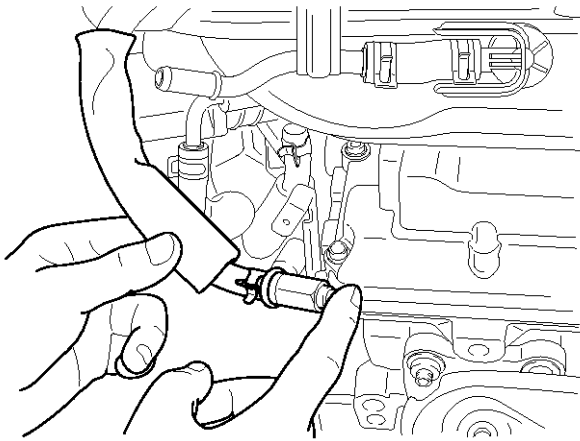
Emission Control System

Inspection

1. After disconnecting the vapor hose from the PCV valve, remove the PCV valve.
2. Reconnect the PCV valve to the vapor hose.
3. Run the engine at idle, and put a finger on the open end of the PCV valve and make sure that intake manifold vacuum can be felt.

NOTICE

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



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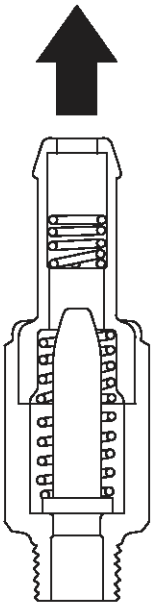
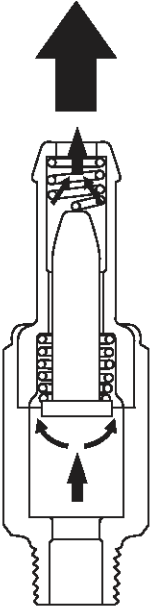
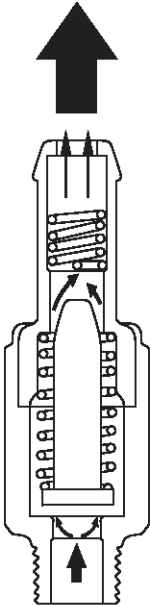
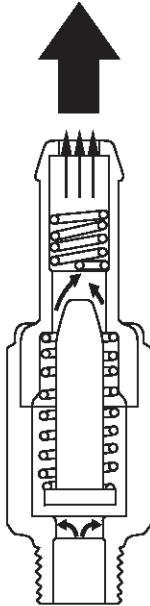
4. If the vacuum is not felt, clean or replace the vapor hose.

Crankcase Emission Control System

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Positive Crankcase Ventilation (PCV) Valve

Operation Principle

Engine Condition	Not Running	Idling or Decelerating	Normal Operation	Accelerating and High Load
Vacuum in Intake Manifold	0	High	Moderate	Low
PCV Valve	Close	Slightly Open	Properly Open	Fully Open
Blow-by Gas Flow	0	Small	Medium	Large
Schematic Diagram	Intake Manifold 	Intake Manifold 	Intake Manifold 	Intake Manifold 

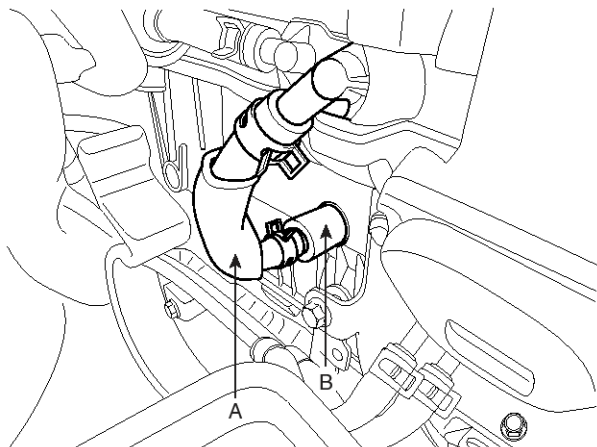
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EC-10

Emission Control System

Removal

1. Disconnect the vapor hose (A).

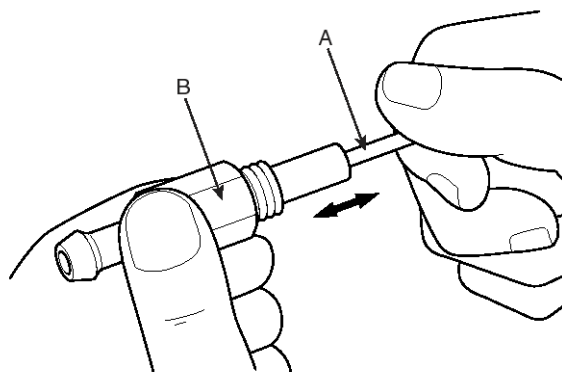


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2. Remove the rubber pad (B), and then remove the PCV valve.

Inspection

1. Insert a thin stick (A) into the PCV valve (B) from the threaded side to check that the plunger moves.



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NOTICE

If the plunger does not move (PCV valve is clogged), clean or replace the valve.

Installation

1. Installation is reverse of removal.

PCV Valve installation:

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

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Emission Control System

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, which would seal the fuel filler. After the gasket on the fuel filler cap and the fill neck flange contact each other, the ratchet produces a loud clicking noise indicating the seal has been set.

Evaporative Emission Control System

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Inspection

[System Inspection]

1. Disconnect the vapor hose from the throttle body and connect a vacuum pump to the nipple on the throttle body.
2. Check the following points with applying vacuum using the vacuum pump.
 - At Cold Engine [Engine Coolant Temperature < 60°C (140°F)]

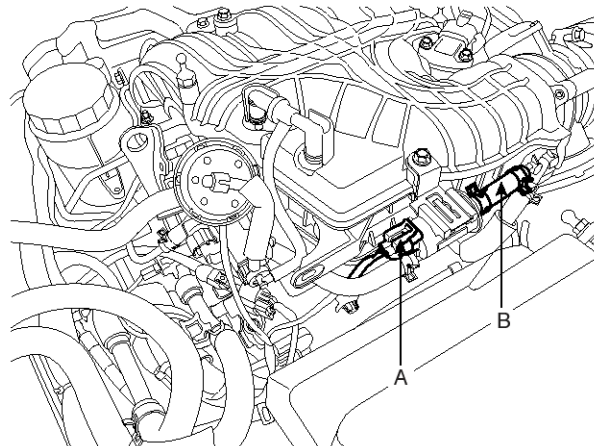
Engine Operating Condition	Applied Vacuum	Result
Idle	0.5kgf/cm ² (50kPa, 7.3psi)	Vacuum is held
3,000rpm		

- At Warmed Engine [Engine Coolant Temperature > 80°C (176°F)]

Engine Operating Condition	Applied Vacuum	Result
Idle	0.5kgf/cm ² (50kPa, 7.3psi)	Vacuum is held
Within 3 minutes after engine start at 3,000 rpm	Try to apply vacuum	Vacuum is released
In 3 minutes after engine start at 3,000 rpm	0.5kgf/cm ² (50kPa, 7.3psi)	Vacuum will be held momentarily, after which, it will be released

[PCSV Inspection]

1. Turn ignition switch OFF and disconnect the negative (-) battery cable.
2. Disconnect the PCSV connector (A).



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3. Disconnect the vapor hose (B) which is connected with the intake manifold from the PCSV.
4. After connecting a vacuum pump to the nipple, apply vacuum.
5. With the PCSV control line grounded, check valve operation when applying battery voltage to the PCSV or not.

Battery Voltage	Valve	Vacuum
Connected	Open	Released
Disconnected	Close	Maintained

6. Measure the coil resistance of the PCSV.

Specification: 19.0 ~ 22.0Ω [20°C (68°F)]

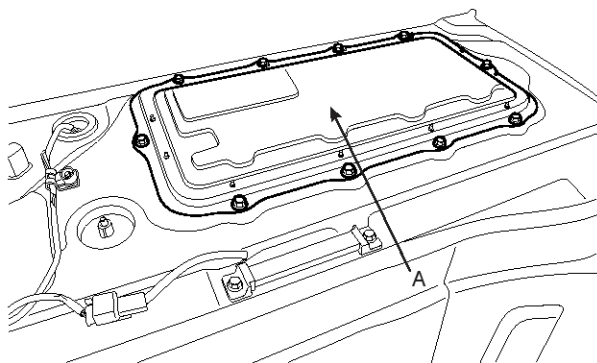
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Emission Control System

Canister

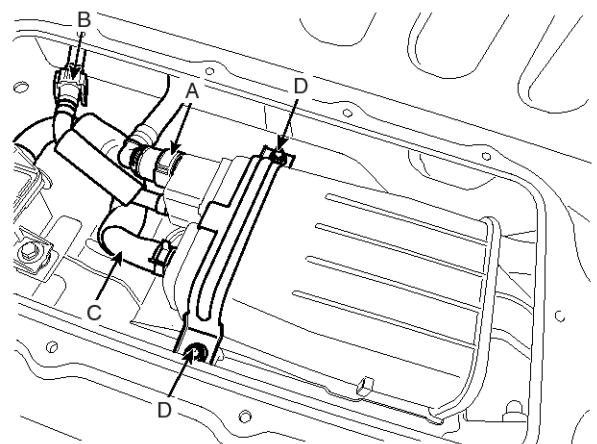
Removal

1. Turn the ignition switch OFF and disconnect the negative (-) battery cable.
2. Remove the service cover (A).



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3. Disconnect the vapor tube quick-connector (A), the vapor hose quick-connector (B), and the vapor hose (C) from the canister.

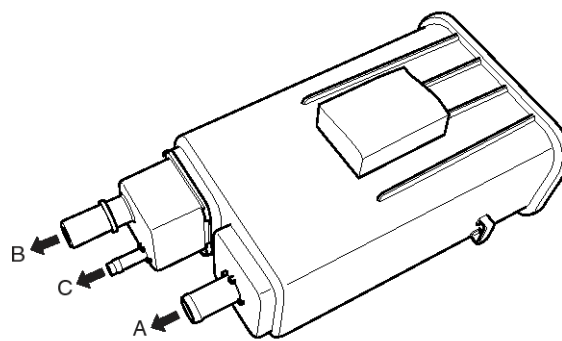


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4. Remove the canister after removing the band installation nuts (D).

Inspection

1. Check for the following items visually.
 - Cracks or leakage of the canister
 - Loose connection, distortion, or damage of the vapor hose/tube



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A: Canister ↔ Atmosphere (via Fuel Tank Air Filter)

B: Canister ↔ Fuel Tank

C: Canister ↔ Intake Manifold

Installation

Installation is reverse of removal.

Canister band installation nut :

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

Canister cover installation bolt :

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

Canister protector installation bolt :

19.6 ~ 29.4 N.m (2.0 ~ 3.0 kgf.m, 14.5 ~ 21.7 lb-ft)

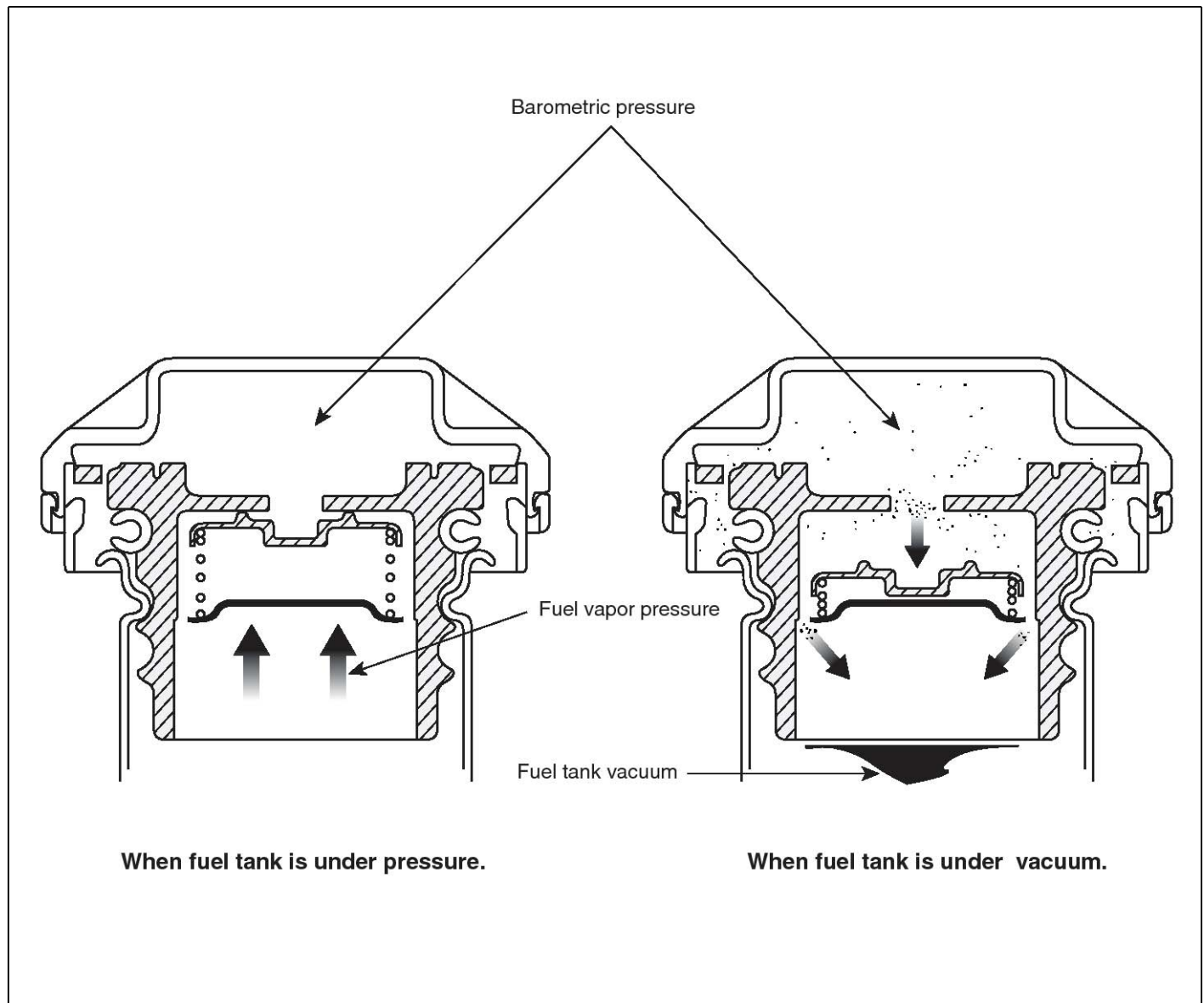
Evaporative Emission Control System

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Fuel Filler Cap

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.



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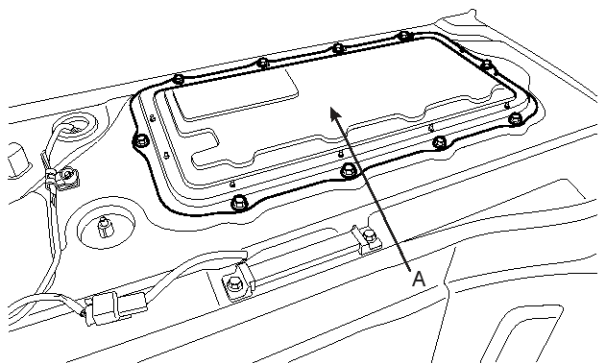
EC-16

Emission Control System

Fuel Tank Air Filter

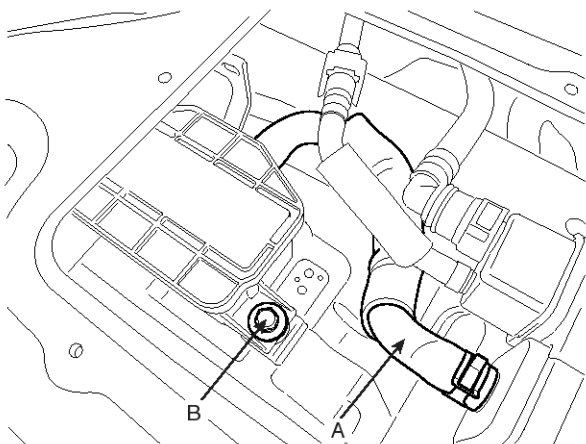
Replacement

1. Turn the ignition switch OFF and disconnect the negative (-) battery cable.
2. Remove the service cover (A).



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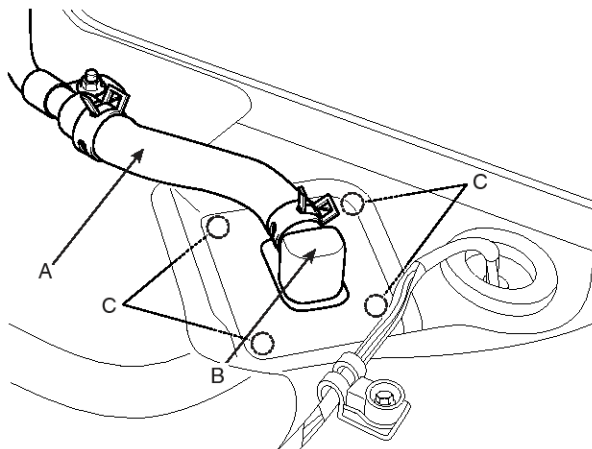
3. Disconnect the vapor hose (A) from the canister.



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4. Remove the installation bolt (B).

5. Disconnect the vapor hose (A) from the connector assembly (B).



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6. Remove the fuel tank air filter after removing the connector assembly installation bolts (C).
7. Install a new fuel tank assembly.

Ventilation hose connector assembly installation :
3.9 ~ 5.9 N.m (0.4 ~ 0.6 kgf.m, 2.9 ~ 4.3 lb-ft)

Exhaust Emission Control System

Description

Exhaust emissions (CO, HC, NOx) are controlled by a combination of engine modifications and the addition of special control components.

Modifications to the combustion chamber, intake manifold, camshaft and ignition system form the basic control system.

These items have been integrated into a highly effective system which controls exhaust emissions while maintaining good drivability and fuel economy.

Air/Fuel Mixture Control System [Multiport Fuel Injection (MFI) System]

The MFI system is a system which uses the 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 gases of the proper composition to permit the use of a three way catalyst. The three way catalyst is designed to convert the three pollutants (1) hydrocarbons (HC), (2) carbon monoxide (CO), and (3) oxides of nitrogen (NOx) into harmless substances. There are two operating modes in the MFI system.

1. Open Loop air/fuel ratio is controlled by information programmed into the ECM.
2. Closed Loop air/fuel ratio is adjusted by the ECM based on information supplied by the oxygen sensor.

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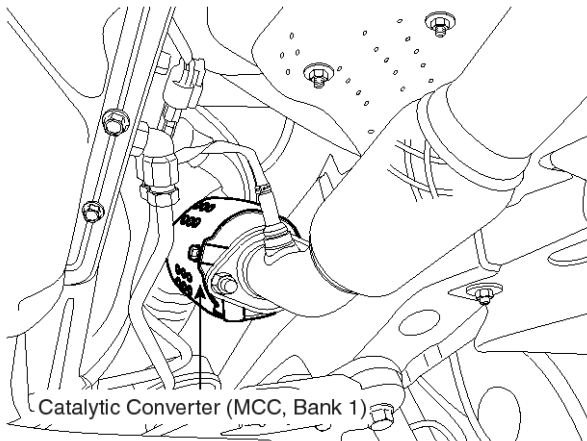
Emission Control System

Catalytic Converter

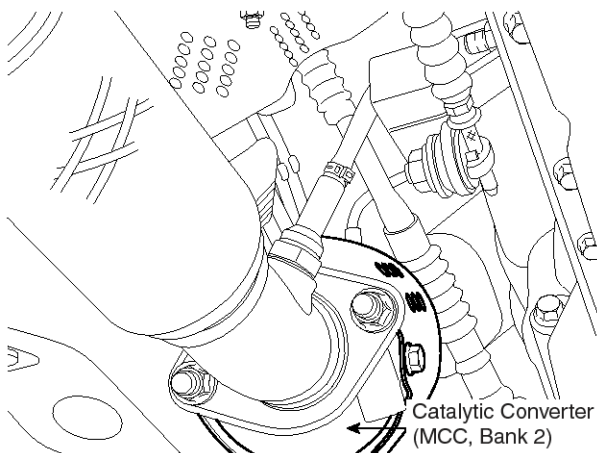
Description

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).

There are two types of three-way catalyst; Palette type and Monolith type.



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Exhaust Emission Control System

EC-19

CVVT (Continuously Variable Valve Timing) System

Description

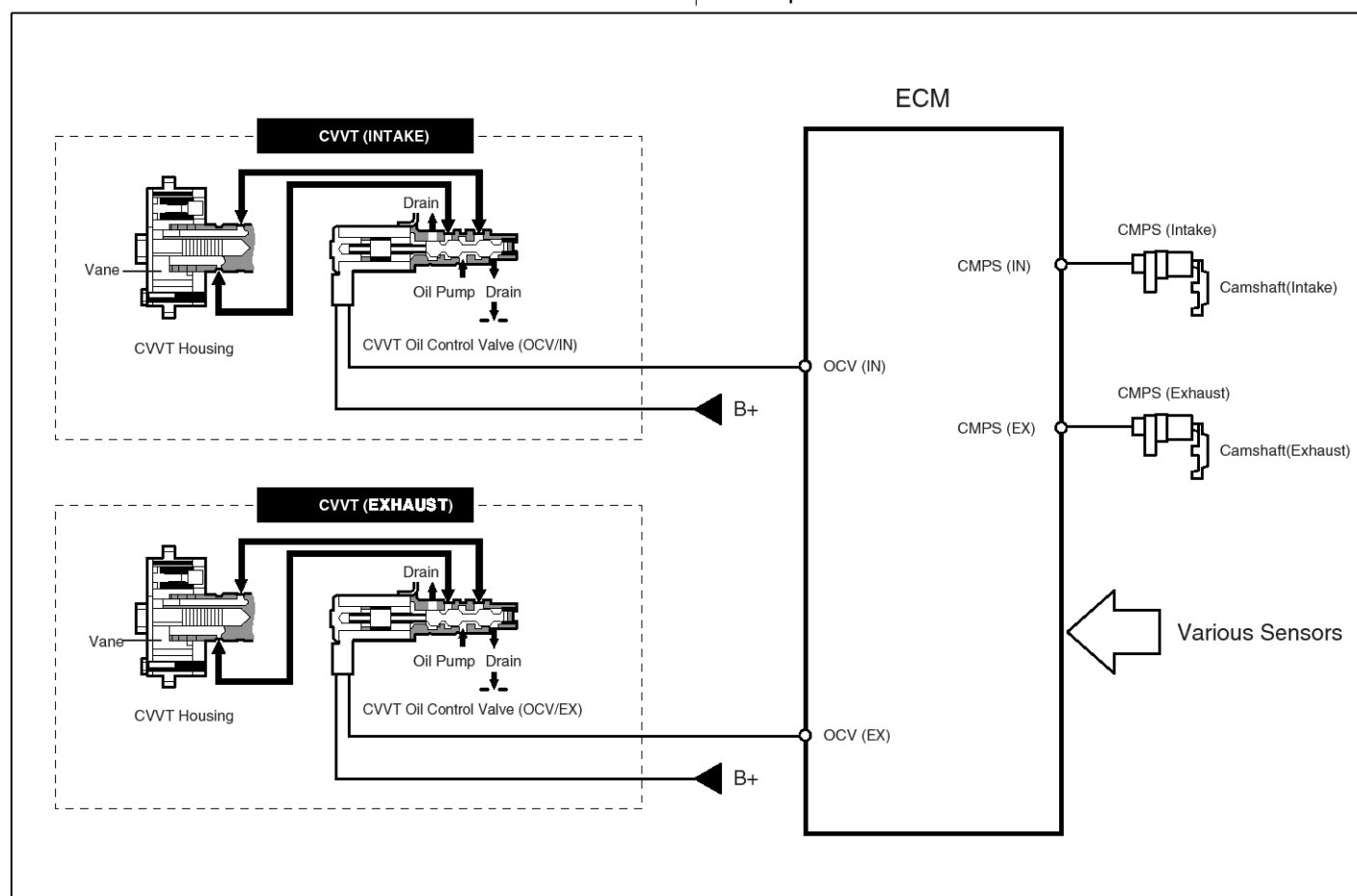
Continuous Variable Valve Timing (CVVT) system advances or retards the valve timing of the intake and exhaust valve in accordance with the ECM control signal which is calculated by the engine speed and load.

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

This system consist of

- the CVVT Oil Control Valve (OCV) which supplies the engine oil to the cam phaser or 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.



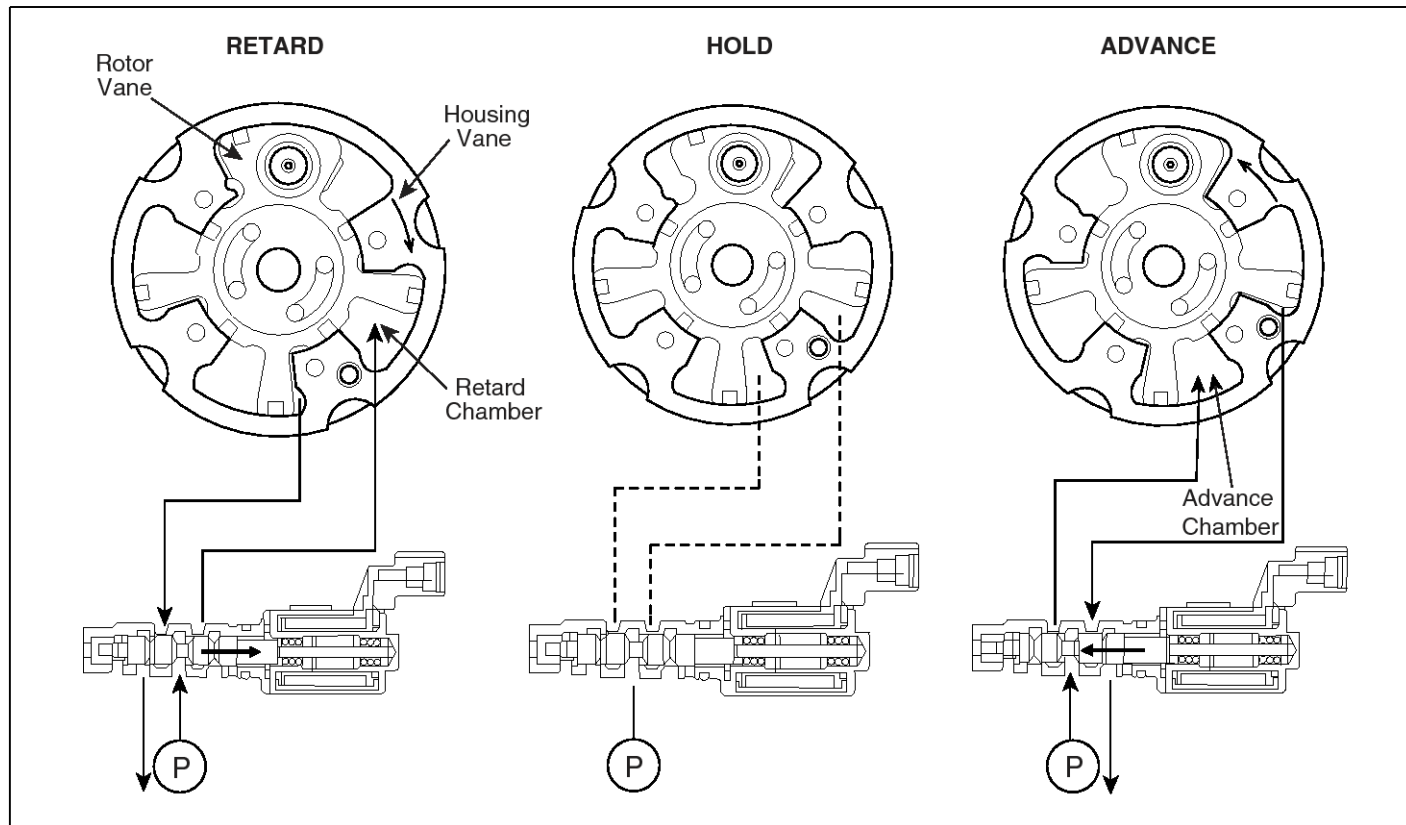
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EC-20

Emission Control System

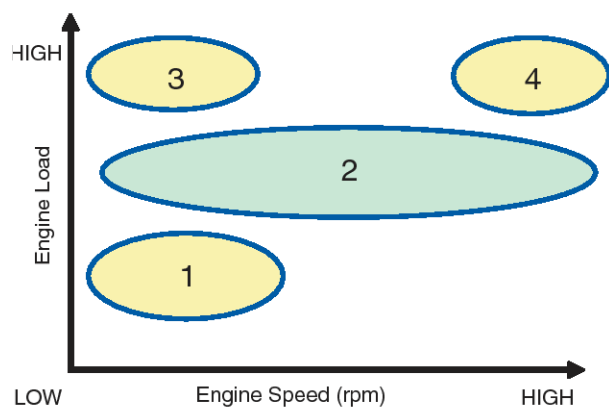
Operation Principle

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.



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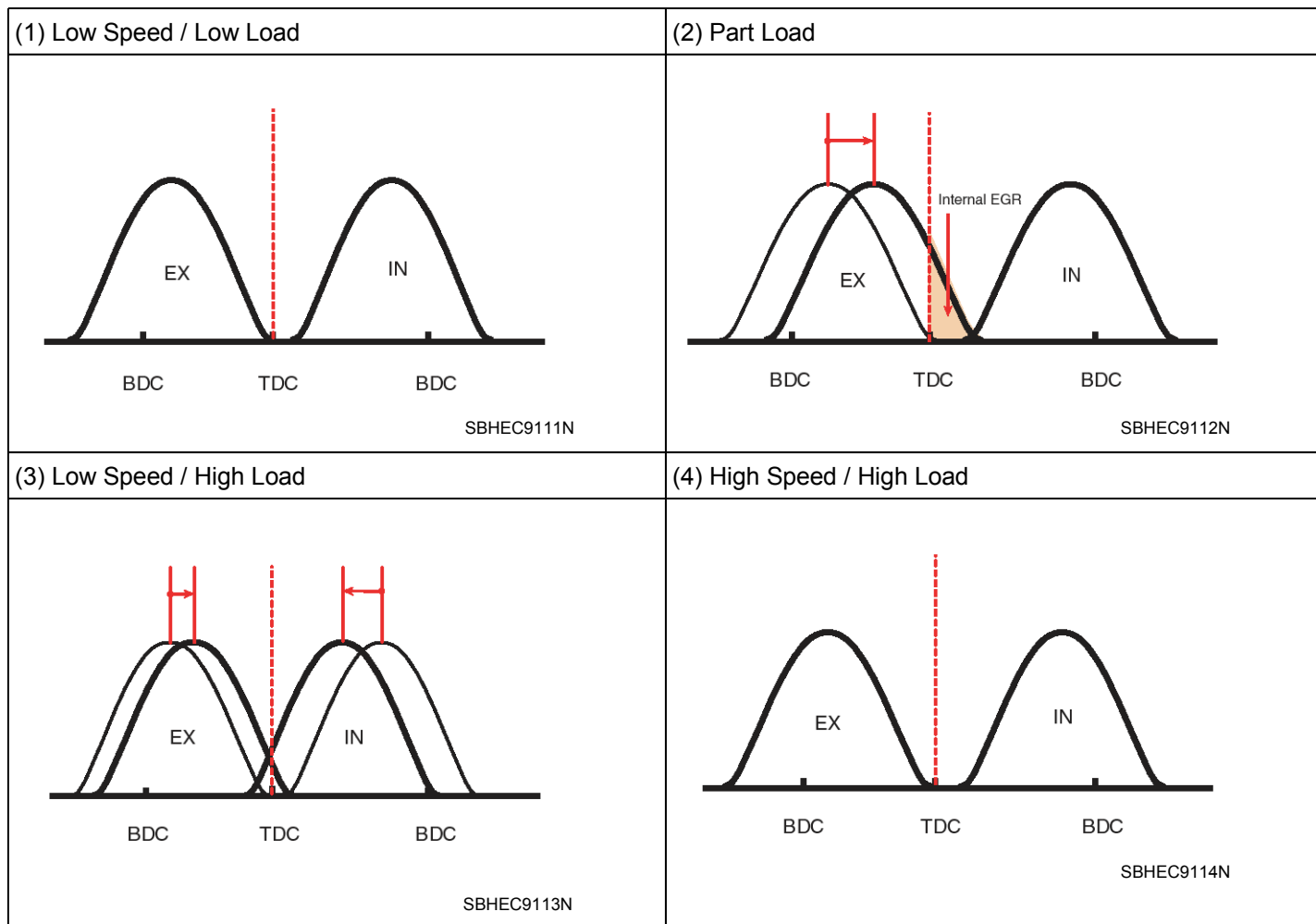
[CVVT System Mode]



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Exhaust Emission Control System

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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