

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

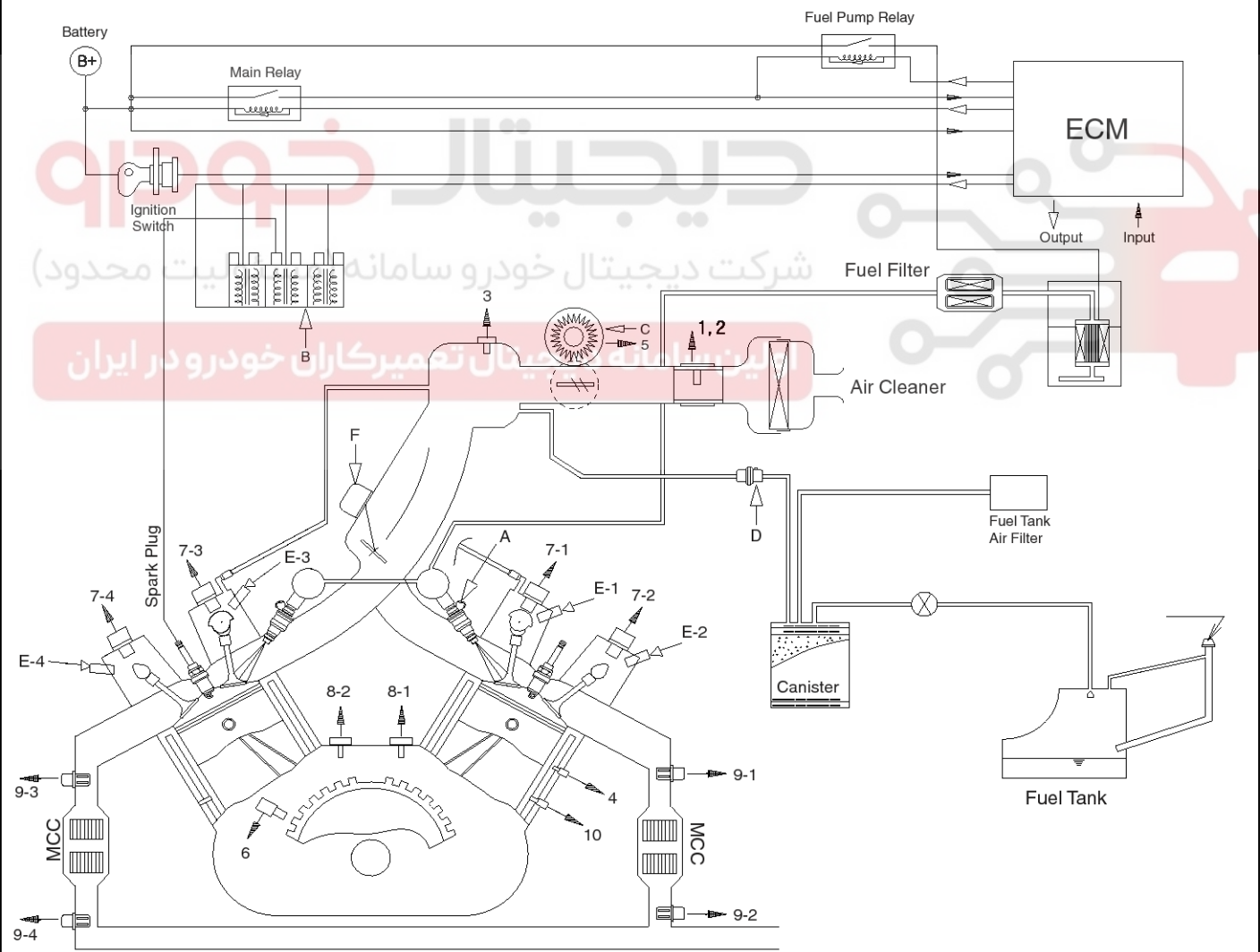
EC-3

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

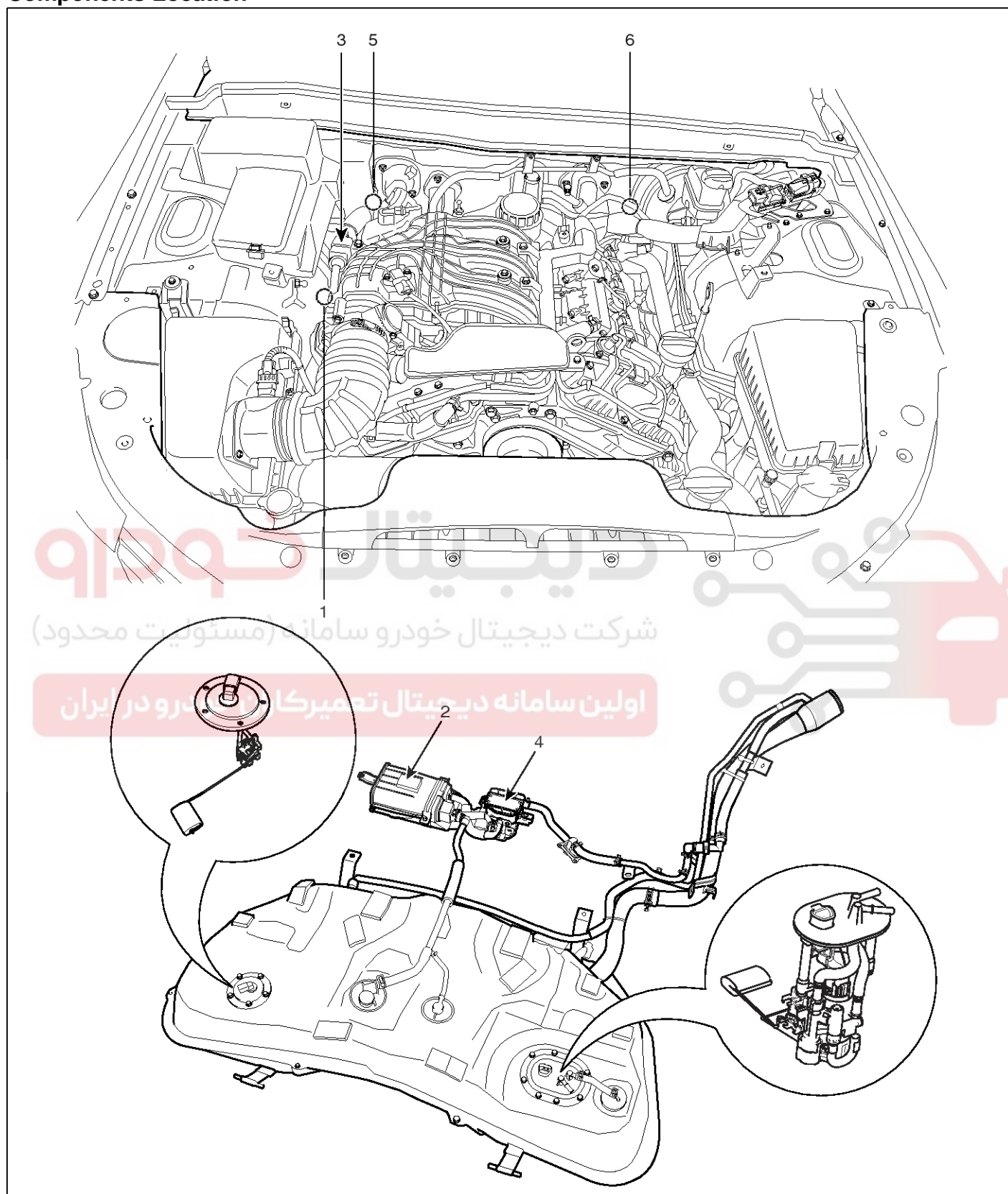


SBHEC9100L

EC-4

Emission Control System

Components Location



SBHEC9101L

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) |

دیجیتال خودرو

شرکت دیجیتال خودرو سامانه (مسئولیت محدود)

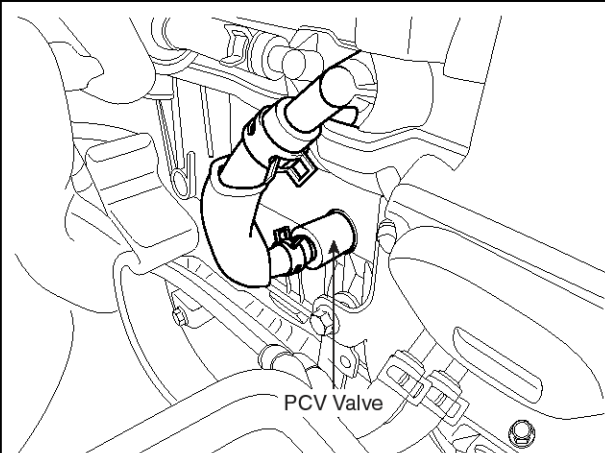
اولین سامانه دیجیتال تعمیرکاران خودرو در ایران



EC-6

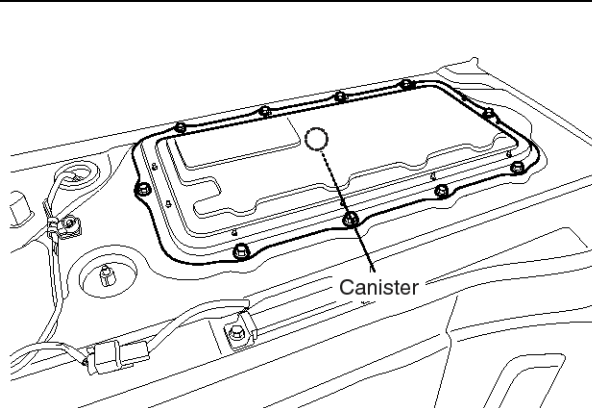
Emission Control System

1. PCV Valve



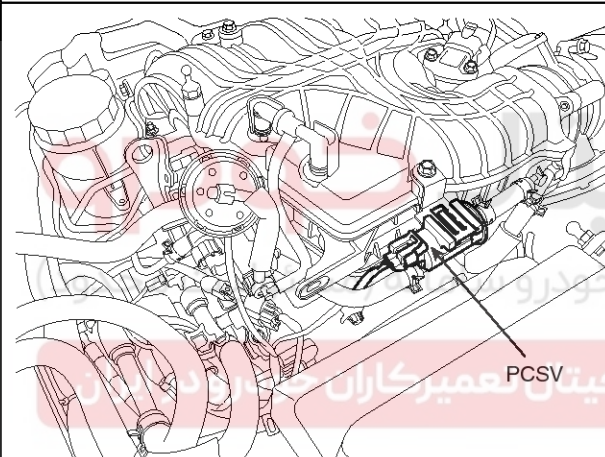
SBHEC9101N

2. Canister



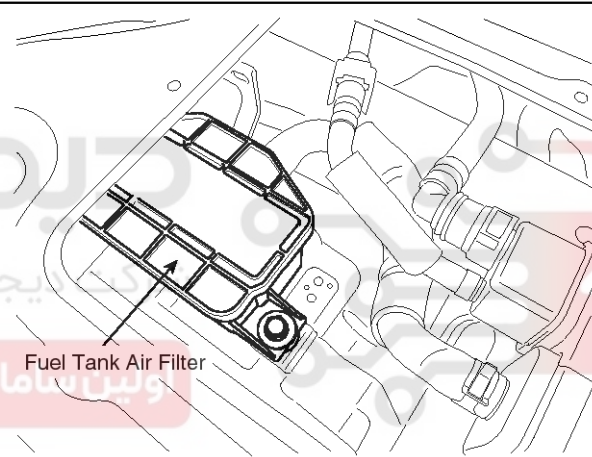
SBHEC9102N

3. Purge Control Solenoid Valve (PCSV)



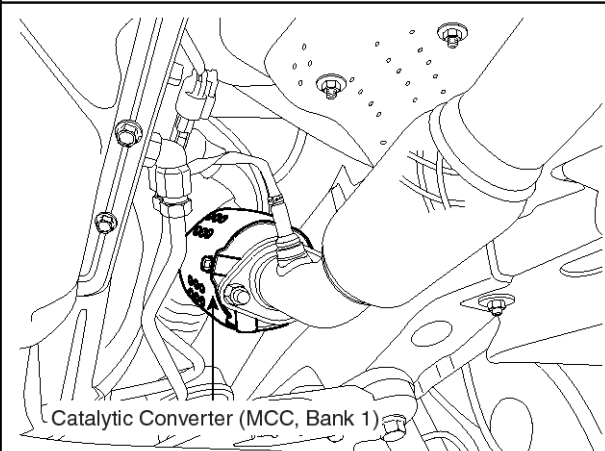
SBHEC8103D

4. Fuel Tank Air Filter



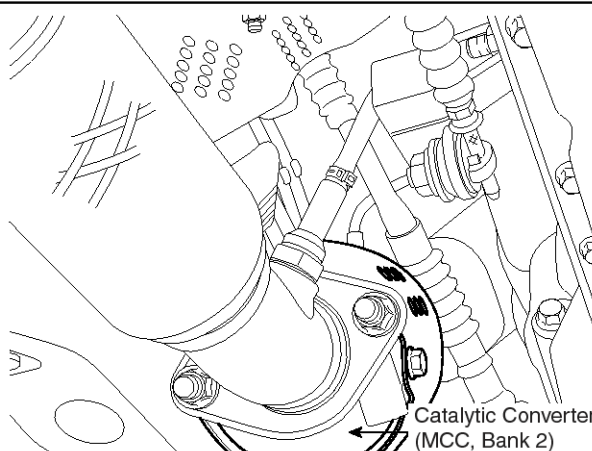
SBHEC9102L

5. Catalytic Converter (MCC, Bank 1)



SBHEC9106N

6. Catalytic Converter (MCC, Bank 2)



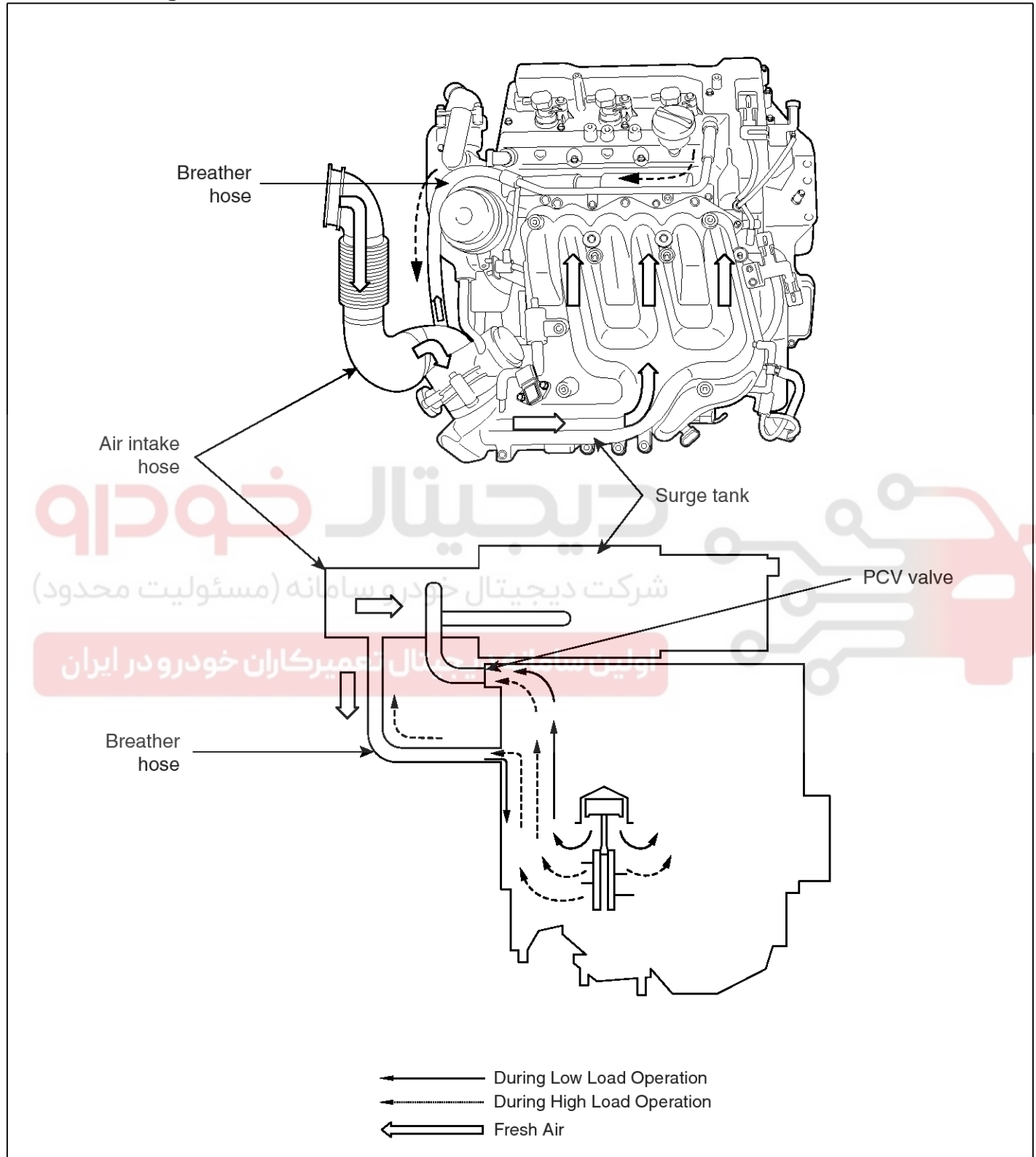
SBHEC9107N

Crankcase Emission Control System

EC-7

Crankcase Emission Control System

Schematic Diagram



EERF086B

EC-8

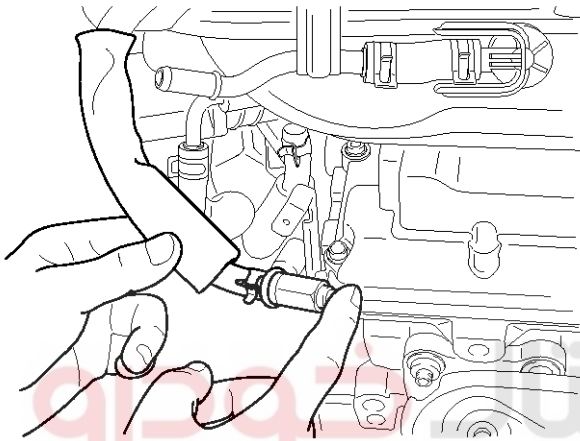
Emission Control System

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.



KECF108C

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



Crankcase Emission Control System

EC-9

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 | <p>Intake Manifold</p> | <p>Intake Manifold</p> | <p>Intake Manifold</p> | <p>Intake Manifold</p> |

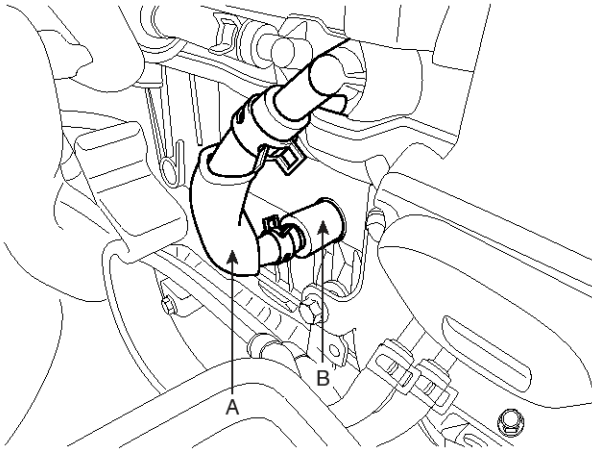
SHDEC8109C

EC-10

Emission Control System

Removal

1. Disconnect the vapor hose (A).

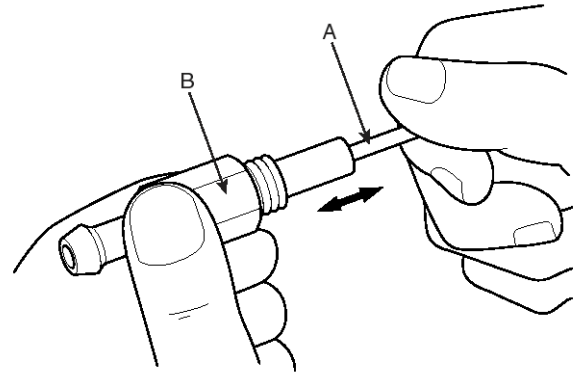


SBHEC8110D

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.



EEDA010B

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)

Evaporative Emission Control System

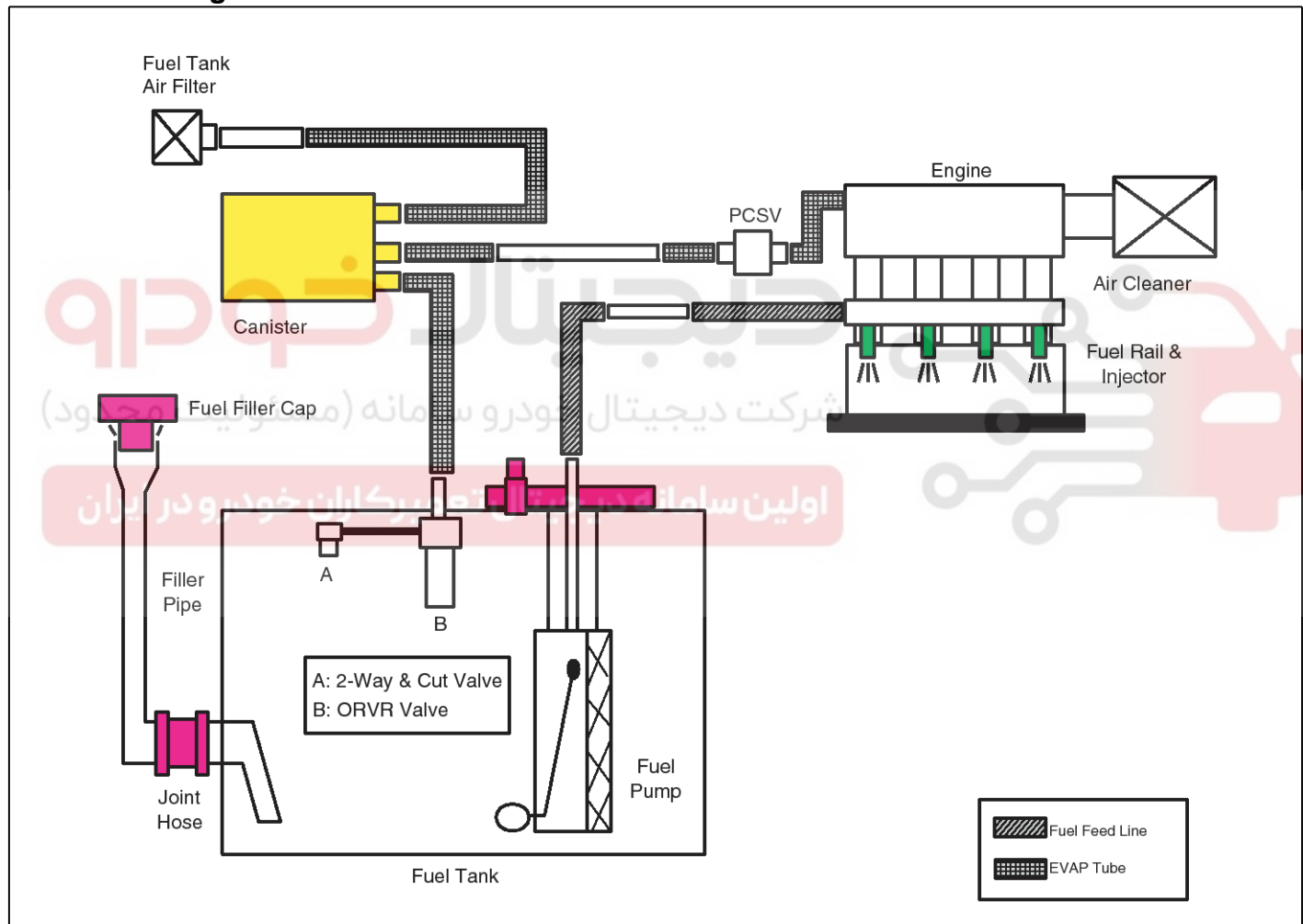
EC-11

Evaporative Emission Control System

Description

Evaporative Emission Control System prevents fuel vapor stored in fuel tank from vaporizing into the atmosphere. When the fuel evaporates in the fuel tank, the vapor passes through vent hoses or tubes to the canister filled with charcoal and 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 use vacuum in intake manifold to move it.

Schematic Diagram



LEKG033A

EC-12

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.



شرکت دیجیتال خودرو (مسئولیت محدود)

اولین سامانه دیجیتال تعمیرکاران خودرو در ایران

Evaporative Emission Control System

EC-13

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)]

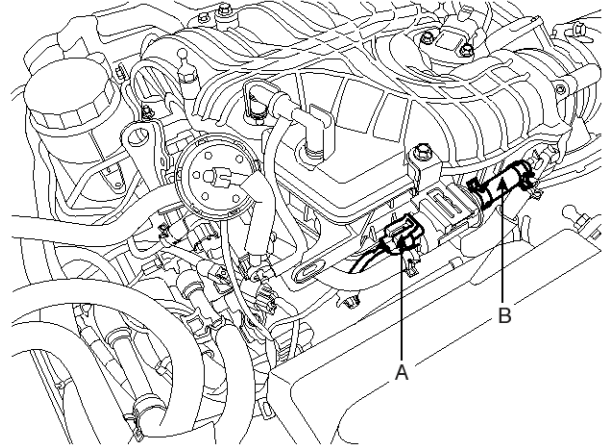
| Engine Operating Condition | Applied Vacuum | Result |
|----------------------------|---|----------------|
| Idle | 0.5kgf/cm ² (50kPa, 7.3psi) | Vacuum is held |
| 3,000rpm | | |

- 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).



SBHEC8112D

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)]

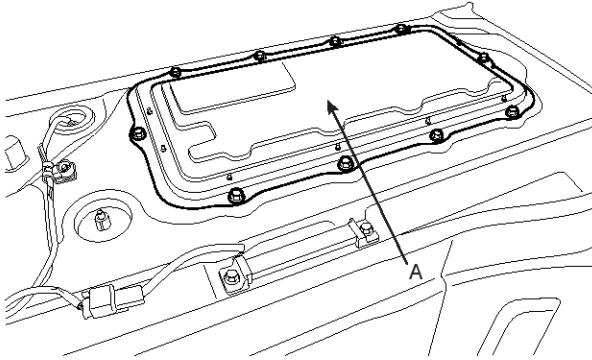
EC-14

Emission Control System

Canister

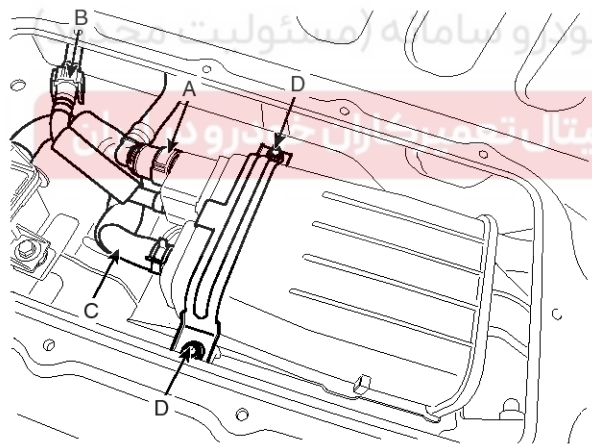
Removal

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



SBHEC8113D

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

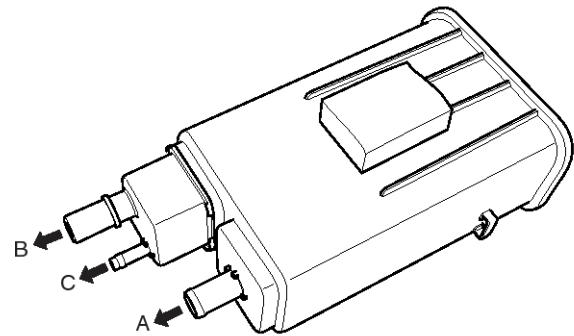


SBHEC9103L

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



SBHEC9104L

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)

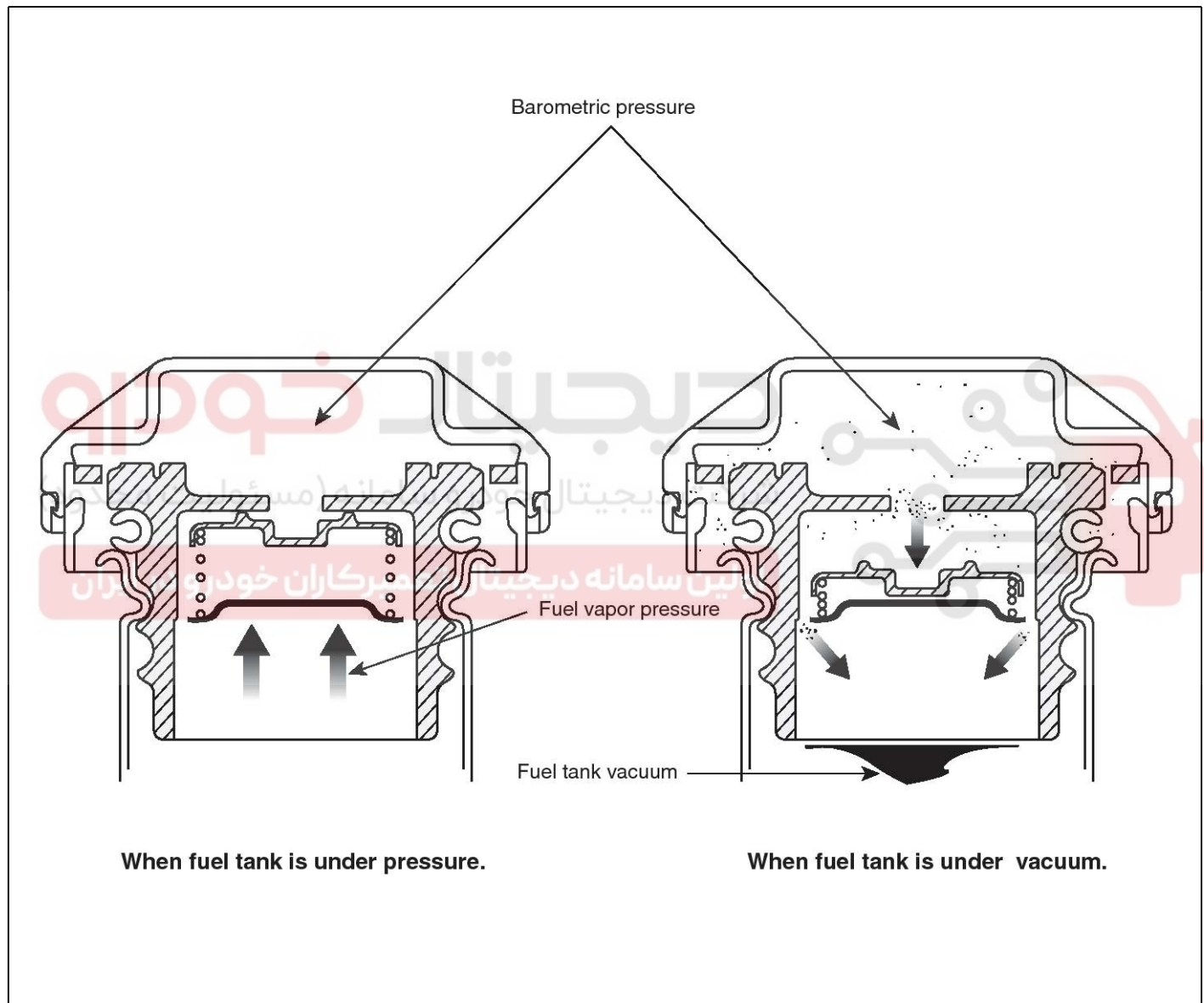
Evaporative Emission Control System

EC-15

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.



LEGE015A

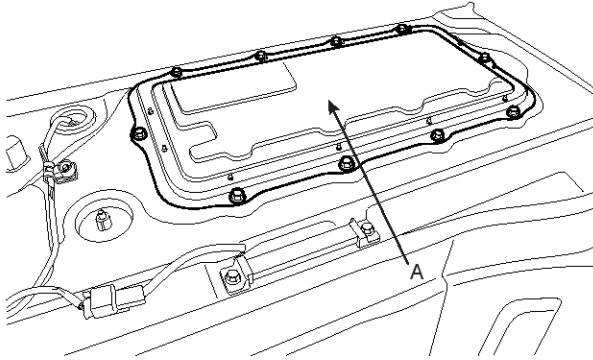
EC-16

Emission Control System

Fuel Tank Air Filter

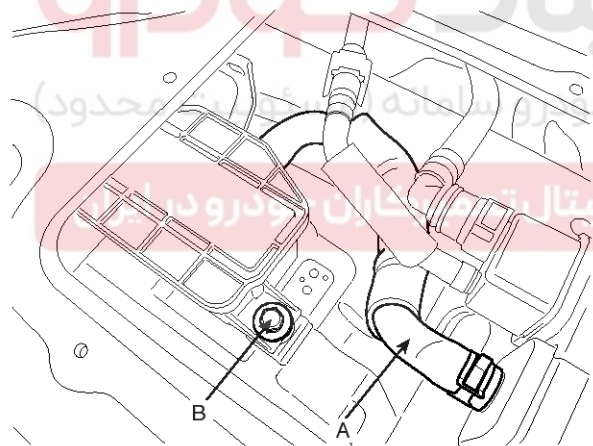
Replacement

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



SBHEC8113D

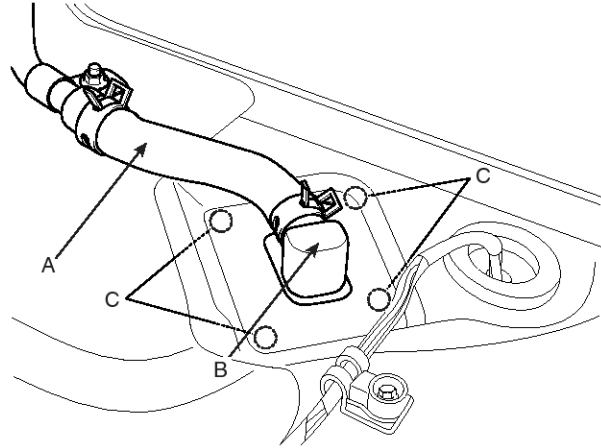
3. Disconnect the vapor hose (A) from the canister.



SBHEC9105L

4. Remove the installation bolt (B).

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



SBHEC9115N

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

EC-17

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.



EC-18

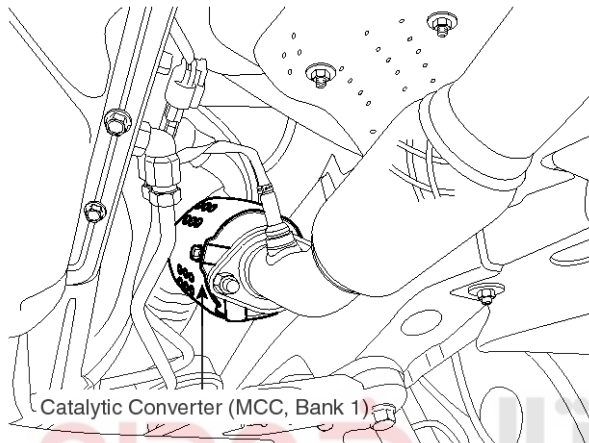
Emission Control System

Catalytic Converter

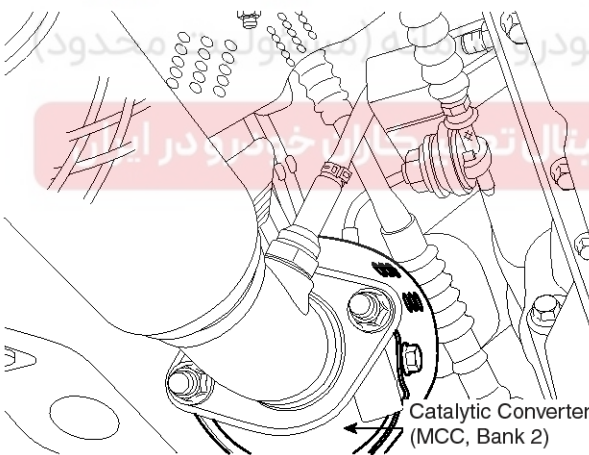
Description

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.



SBHEC9106N



SBHEC9107N

Exhaust Emission Control System

EC-19

CVVT (Continuously Variable Valve Timing) System

Description

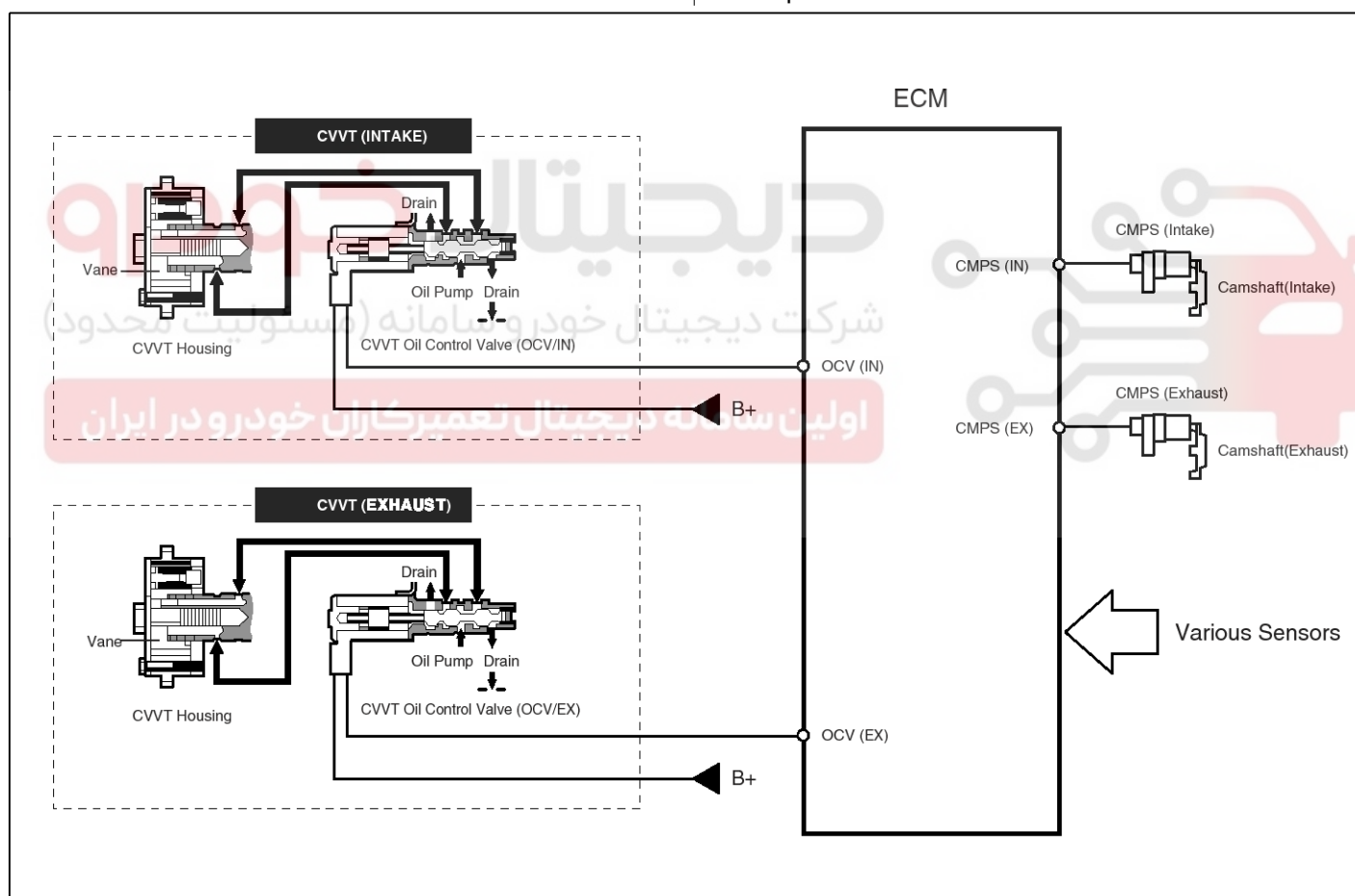
Continuous Variable Valve Timing (CVVT) system advances or retards the valve timing of the intake and exhaust valve in accordance with the ECM control signal which is calculated by the engine speed and load.

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.



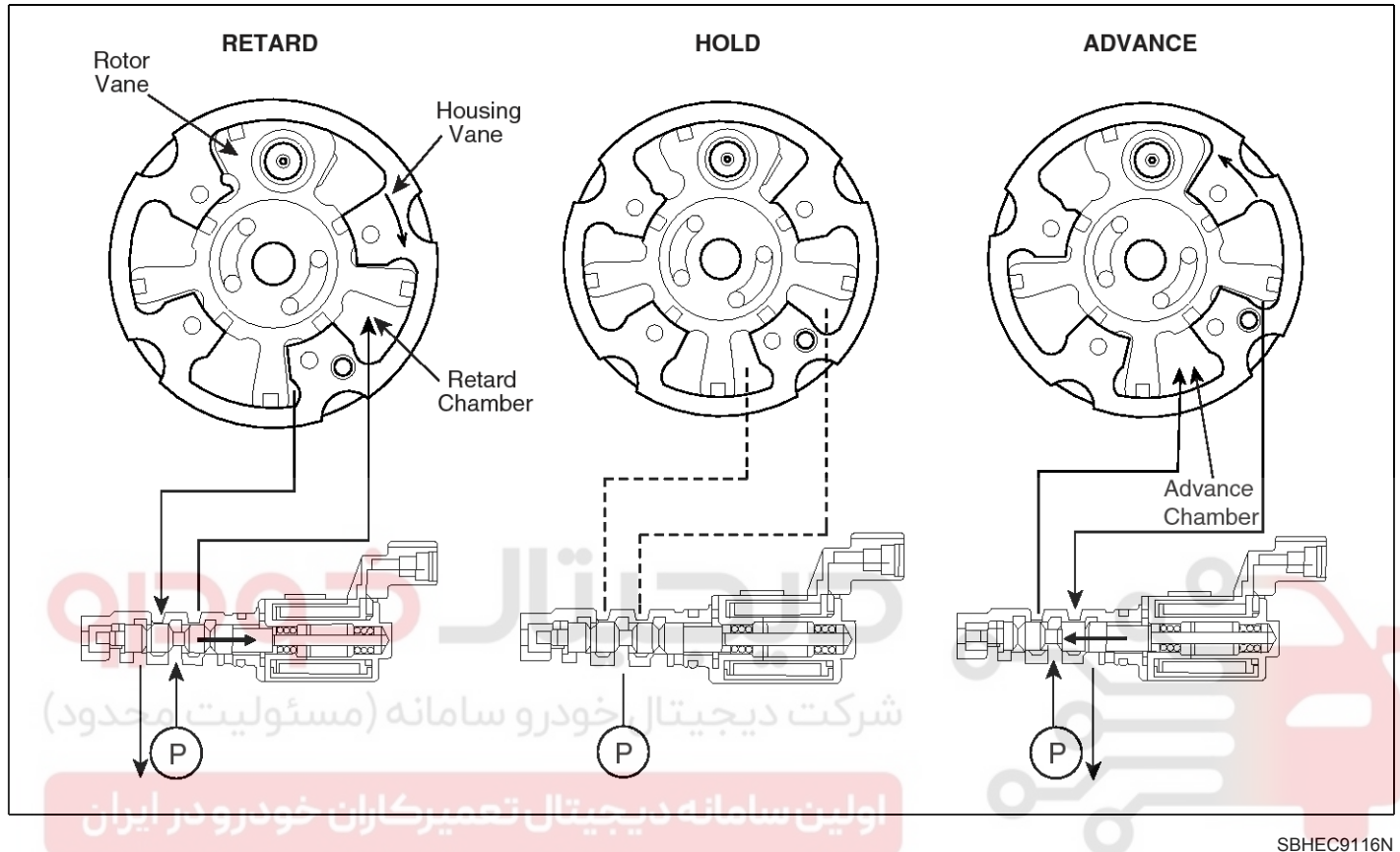
SBHEC9119N

EC-20

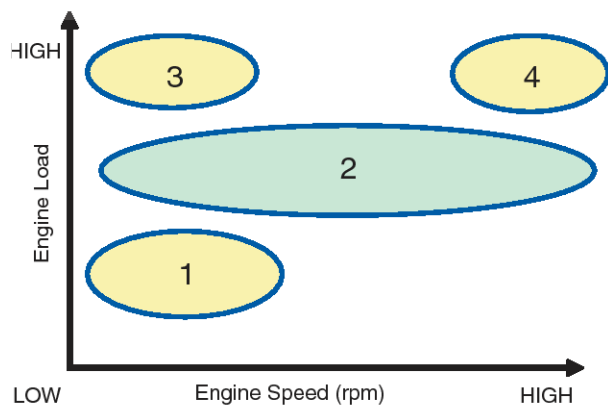
Emission Control System

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.

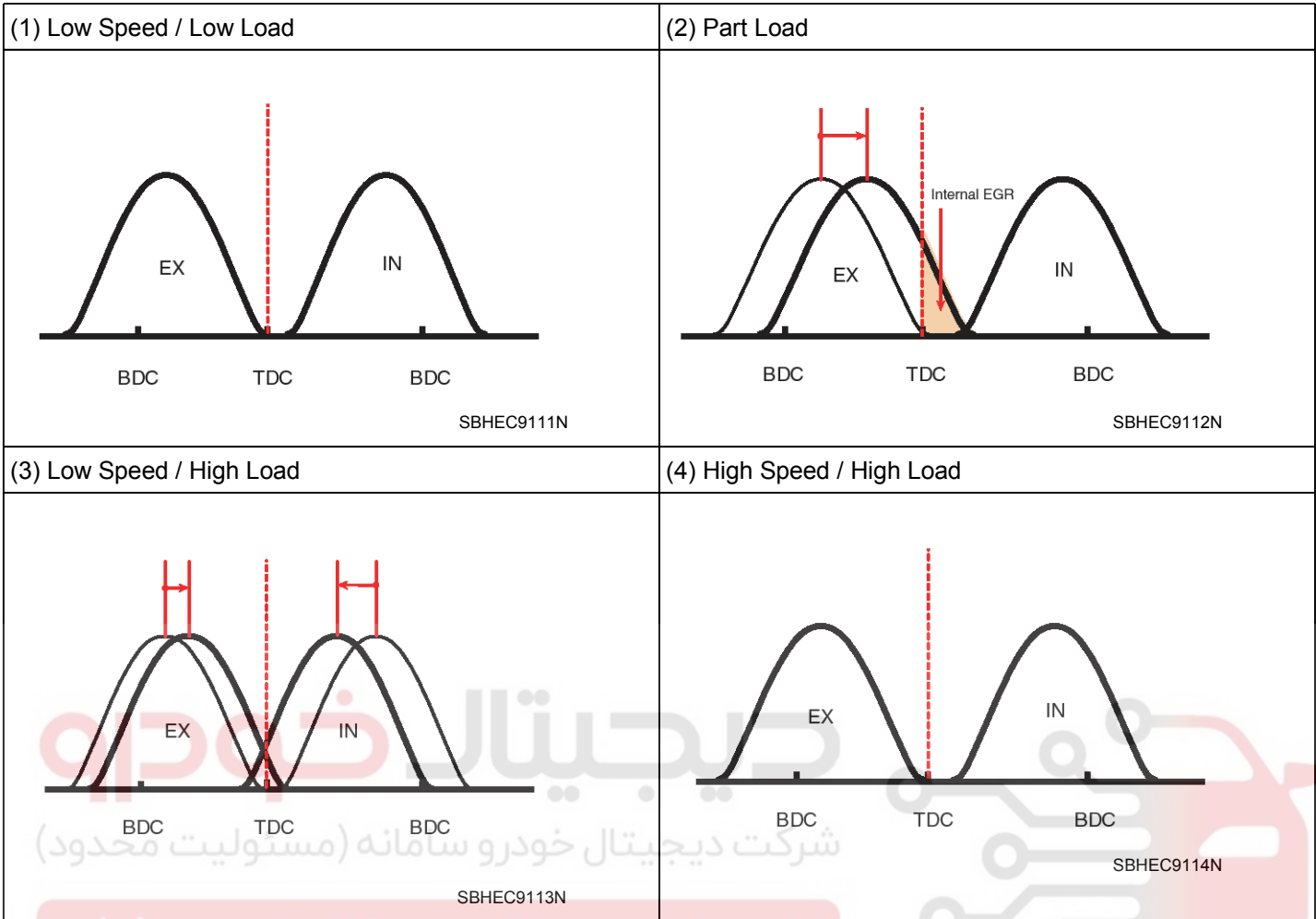


[CVVT System Mode]



Exhaust Emission Control System

EC-21



| 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 |