VELOSTER(FS) > 2012 > G 1.6 GDI > Fuel System

Fuel System > General Information > Specifications

Specifications

Fuel Delivery System

Items	Specification	
Fuel Tank	Capacity	50 lit. (13.2 U.S.gal., 52.8 U.S.qt., 43.9 Imp.qt.)
Fuel Filter	Type	Paper type
Fuel Pressure	Low Pressure Fuel Line	480 ~ 500 kPa (4.9 ~ 5.1 kgf/cm², 69.6 ~ 72.5 psi)
	High Pressure Fuel Line	5.0 ~ 12.0 MPa (51.0 ~ 122.4 kgf/cm², 725.2 ~ 1740.5 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
50	122	1.56 ~ 1.74
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: Hall IC Non-contact sensor type
▷ Specification

Throttle angle(°)	Output Voltage (V)	
	TPS1	TPS2
0	0.5	4.5
10	0.96	4.05
20	1.41	3.59
30	1.87	3.14
40	2.32	2.68
50	2.78	2.23
60	3.23	1.77
70	3.69	1.32
80	4.14	0.86
90	4.6	0.41
98	4.65	0.35
C.T (0)	0.5	4.5
W.O.T (86)	4.41	0.59

Crankshaft Position Sensor (CKPS)
▷ Type: Magnetic field sensitive Type
▷ Specification

Item	Specification
Coil Resistance (Ω)	774 ~ 946 [20°C (68°F)]

Camshaft Position Sensor (CMPS)
▷ Type: Hall effect type
Knock Sensor (KS)
▷ Type: Piezo-electricity type
▷ Specification

Item	Specification

Capacitance (pF)	950 ~ 1,350
Resistance(MΩ)	4.87

Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 1]
▷ Type: Zirconia (ZrO2) [Linear] Type
▷ Specification

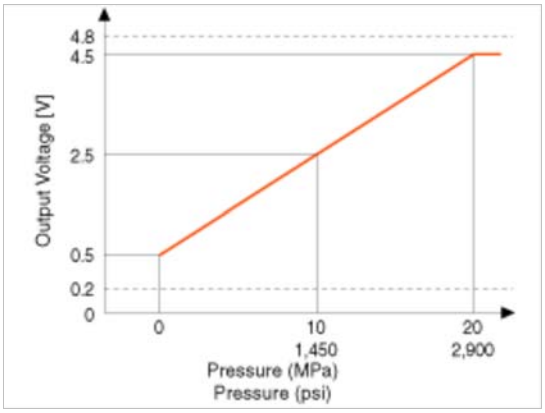
Item	Specification
Heater Resistance (Ω)	2.4 ~ 4.0 [20°C(69.8°F)]

Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2]
▷ Type: Zirconia (ZrO2) [Binary] Type
▷ Specification

A/F Ratio (λ)	Output Voltage(V)
RICH	0.6 ~ 1.0
LEAN	0 ~ 0.4

Item	Specification
Heater Resistance (Ω)	Approx. 9.0 [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	0.29 ~ 0.46
W.O.T	3.85 ~ 4.35	1.93 ~ 2.18

Fuel Tank Pressure Sensor (FTPS)
▷ Type: Piezo - Resistivity type
▷ Specification

Pressure [kPa (kgf/cm², in H2O)	Output Voltage (V)

-6.67 (-0.068, -26.8)	0.5
0	2.5
+6.67 (0.068, 26.8)	4.5

Actuators

Injector

▷ Specification

Item	Specification
Coil Resistance (Ω)	1.5 [20°C(68°F)]

ETC Motor [integrated into ETC Module]

▷ Specification

Item	Specification
Coil Resistance (Ω)	0.3 ~ 100 [20°C(68°F)]

Purge Control Solenoid Valve (PCSV)

▷ Specification

Item	Specification
Coil Resistance (Ω)	22.0 ~ 26.0 [20°C(68°F)]

CVVT Oil Control Valve (OCV)

▷ Specification

Item	Specification
Coil Resistance (Ω)	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 Regulator 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)	0.75 ± 15%[20°C(68°F)]
Secendary Coil Resistance (kΩ)	5.9 [20°C(68°F)]

Canister Close Valve (CCV)

▷ Specification

Item	Specification
Coil Resistance (Ω)	19.5 ~ 22.5 [20°C(68°F)]

Service Standard

Item		Specification	
Ignition Timing (°)		BTDC 5 ± 10	
Idle Speed (rpm)	A/C OFF	Neutral, N, P-range	630 ± 100
		D-range	630 ± 100
	A/C ON	Neutral, N, P-range	700 ± 100
		D-range	700 ± 100

Tightening Torques

Engine Control System

Item	kgf.m	N.m	lb-ft
ECM installation nut	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.
Manifold absolute pressure sensor installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Engine Coolant Temperature Sensor installation	3.0 ~ 4.0	29.4 ~ 39.2	21.7 ~ 28.9
Crankshaft position sensor installation bolt	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7
Camshaft position sensor (Bank 1 / Intake) installation bolt	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7
Camshaft position sensor (Bank 1 / Exhaust) installation bolt	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7
Knock sensor installation bolt	1.9 ~ 2.5	18.6 ~ 24.5	13.7 ~ 18.1
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	3.0 ~ 3.5	29.4 ~ 34.3	21.7 ~ 25.3
Electronic throttle body installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Purge control solenoid valve bracket installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
CVVT oil control valve (Bank 1 / Intake) installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
CVVT oil control valve (Bank 1 / Exhaust) installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Ignition coil installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7

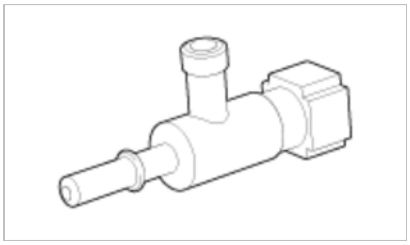
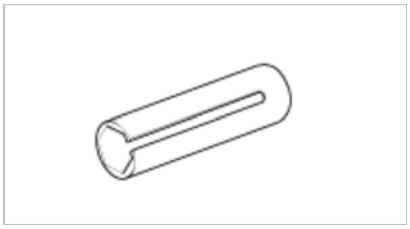
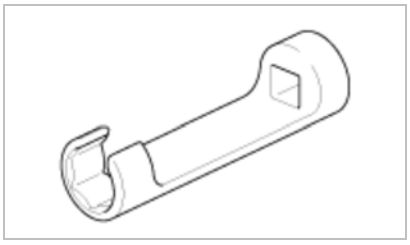
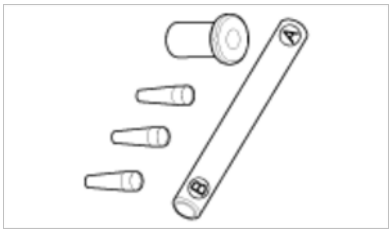
Fuel Delivery System

Item	kgf.m	N.m	lb-ft
Fuel tank installation nut	4.0 ~ 5.5	39.2 ~ 54.0	28.9 ~ 39.8
Fuel pump plate cover installation bolt	0.2 ~ 0.3	2.0 ~ 2.9	1.4 ~ 2.2
Filler-neck assembly bracket installation bolt	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7
Filler-neck assembly installation bolt	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7

Accelerator pedal module installation nut	1.0 ~ 1.5	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	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7

Fuel System > General Information > Special Service Tools

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
Torque Wrench Socket (09314-3Q100) or (09314-27130) (19mm)		Removal and installation of the high pressure fuel pipe
Injector Combustion Seal Guide & Sizing tool (09353-2B000)		Installation of the injector combustion seal

Fuel System > General Information > Troubleshooting

Basic Troubleshooting

Basic Troubleshooting Guide

1	**Bring Vehicle to Workshop**
2	**Analyze Customer's Problem**
	• Ask the customer about the conditions and environment relative to the issue. (Use CUSTOMER PROBLEM ANALYSIS SHEET).
3	**Verify Symptom, and then Check DTC and Freeze Frame Data**
	• Connect the GDS to Diagnostic Link Connector (DLC). • Record the DTC and Freeze Frame Data. ***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**

Customer Problem Analysis Sheet

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.

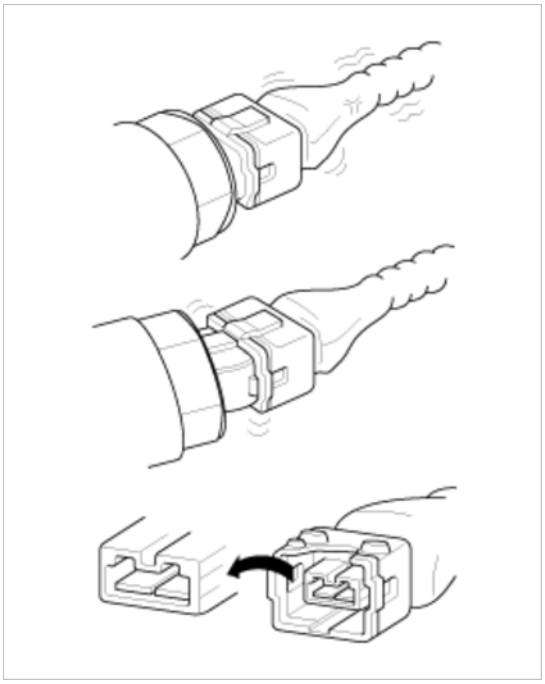
NOTE

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.

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



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

● Simulating Vibration

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

WARNING

Strong vibration may break sensors, actuators or relays

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

● Simulating Heat

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

WARNING

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

● Simulating Water Sprinkling

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

WARNING

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

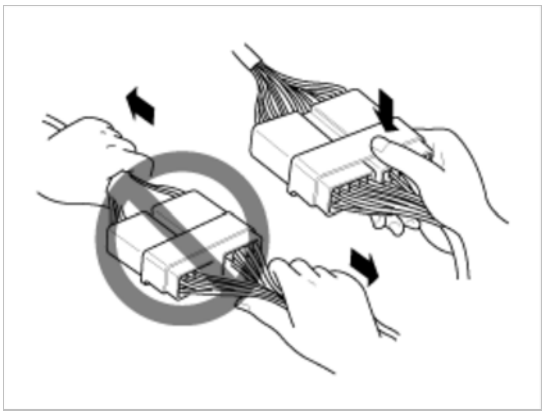
● Simulating Electrical Load

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

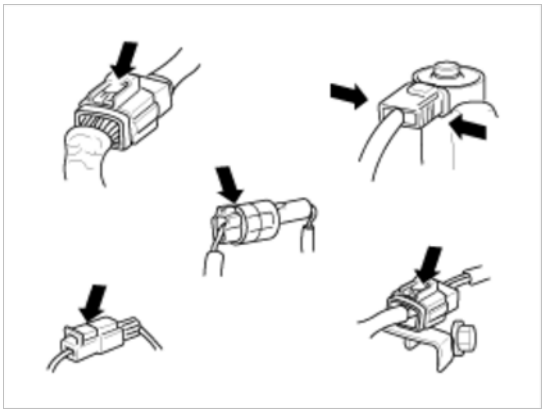
Connector Inspection Procedure

1. Handling of Connector

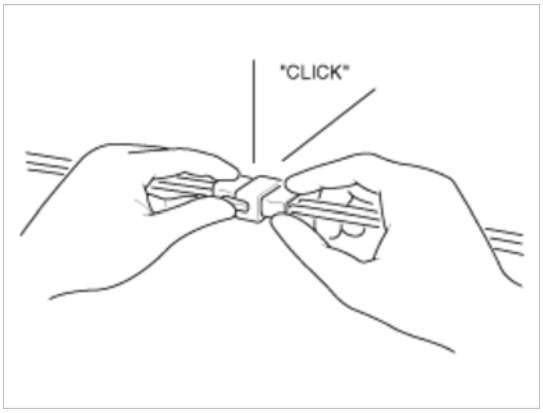
A. Never pull on the wiring harness when disconnecting connectors.



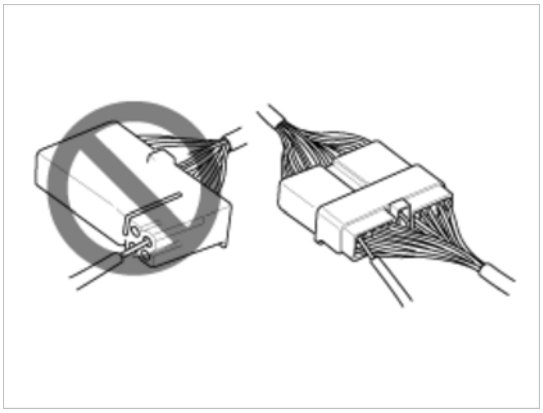
B. When removing the connector with a lock, press or pull locking lever.



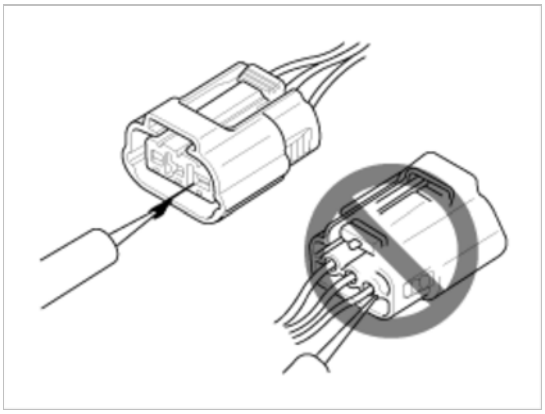
C. Listen for a click when locking connectors. This sound indicates that they are securely locked.



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



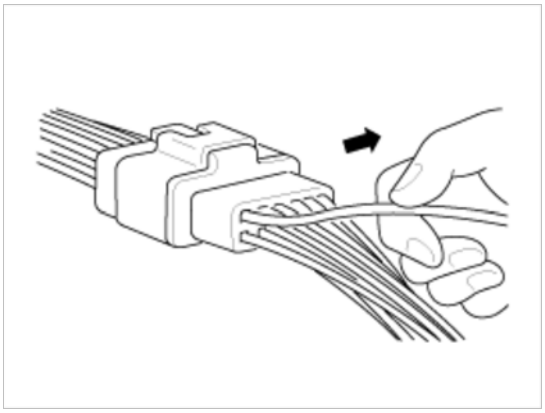
E. Check waterproof connector terminals from the connector side. Waterproof connectors cannot be accessed from harness side.



NOTE

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

2. Checking Point for Connector
   A. While the connector is connected:
      Hold the connector, check connecting condition and locking efficiency.
   B. When the connector is disconnected:
      Check missed terminal, crimped terminal or broken core wire by slightly pulling the wire harness.
      Visually check for rust, contamination, deformation and bend.
   C. Check terminal tightening condition:
      Insert a spare male terminal into a female terminal, and then check terminal tightening conditions.
   D. Pull lightly on individual wires to ensure that each wire is secured in the terminal.



3. Repair Method of Connector Terminal

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

NOTE

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

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

Wire Harness Inspection Procedure

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

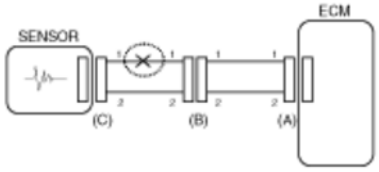
Electrical Circuit Inspection Procedure

● Check Open Circuit

1. Procedures for Open Circuit
   A. Continuity Check
   B. Voltage Check

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

FIG 1



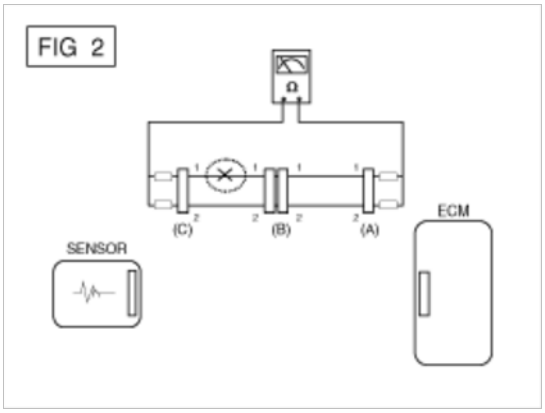
2. Continuity Check Method

NOTE

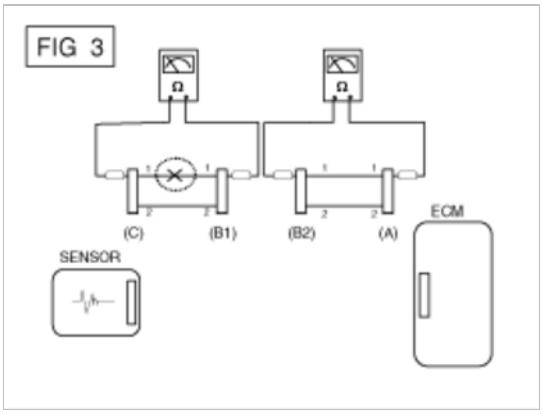
When measuring for resistance, lightly shake the wire harness above and below or from side to side.

Specification (Resistance)
1Ω or less → Normal Circuit
1MΩ or Higher → Open Circuit

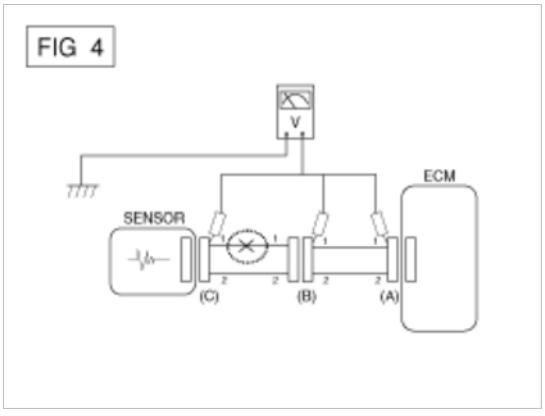
A. Disconnect connectors (A), (C) and measure resistance between connector (A) and (C) as shown in [FIG. 2].
   In [FIG.2.] the measured resistance of line 1 and 2 is higher than 1MΩ and below 1 Ω respectively. Specifically the open circuit is line 1 (Line 2 is normal). To find exact break point, check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



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



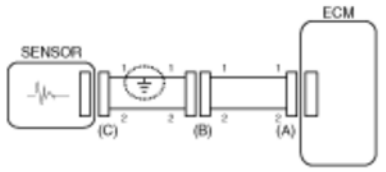
3. Voltage Check Method
   A. With each connector still connected, measure the voltage between the chassis ground and terminal 1 of each connectors (A), (B) and (C) as shown in [FIG. 4].
   The measured voltage of each connector is 5V, 5V and 0V respectively. So the open circuit is between connector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



● Check Short Circuit

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

FIG 5



2. Continuity Check Method (with Chassis Ground)

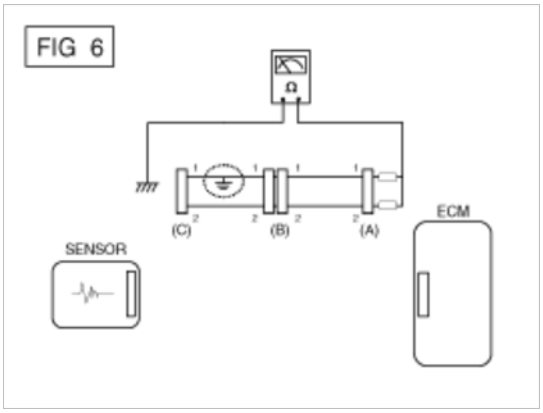
NOTE

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

Specification (Resistance)
1Ω or less → Short to Ground Circuit
1MΩ or Higher → Normal Circuit

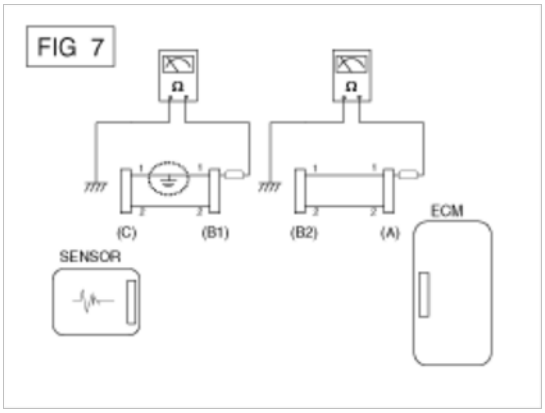
A. Disconnect connectors (A), (C) and measure for resistance between connector (A) and Chassis Ground as shown in [FIG. 6].
The measured resistance of line 1 and 2 in this example is below 1 Ω and higher than 1MΩ respectively. Specifically the short to ground circuit is line 1 (Line 2 is normal). To find exact broken point, check the sub line of line 1 as described in the following step.

FIG 6



B. Disconnect connector (B), and measure the resistance between connector (A) and chassis ground, and between (B1) and chassis ground as shown in [FIG. 7].
The measured resistance between connector (B1) and chassis ground is 1Ω or less. The short to ground circuit is between terminal 1 of connector (C) and terminal 1 of connector (B1).

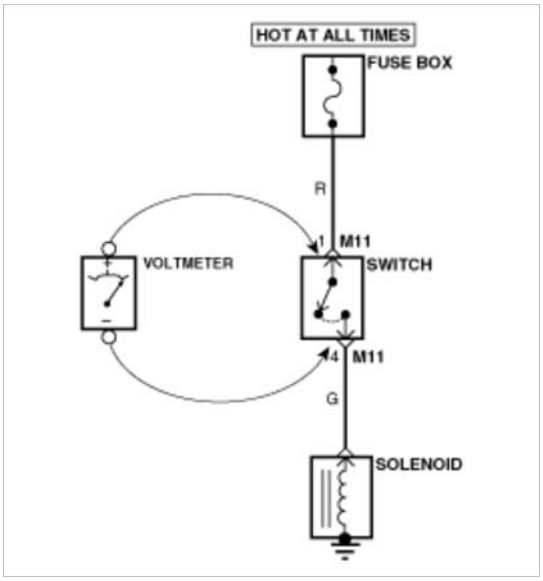
FIG 7



● Testing For Voltage Drop

This test checks for voltage drop along a wire, or through a connection orswitch.

1) 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.
2) Connect the negative lead to the other end of the wire. (or the other side of the connector or switch)
3) Operate the circuit.
4) The voltmeter will show the difference in voltage between the two points. A difference, or drop of more than 0.1 volts (50mV in 5V circuits), may indicate a problem. Check the circuit for loose or dirty connections.



Symptom Troubleshooting Guide Chart

Main symptom	Diagnostic procedure	Also check for
Unable to start (Engine does not turn over)	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 habitsIs · 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)

Fuel System > Engine Control System > Description and Operation

OBD-II review

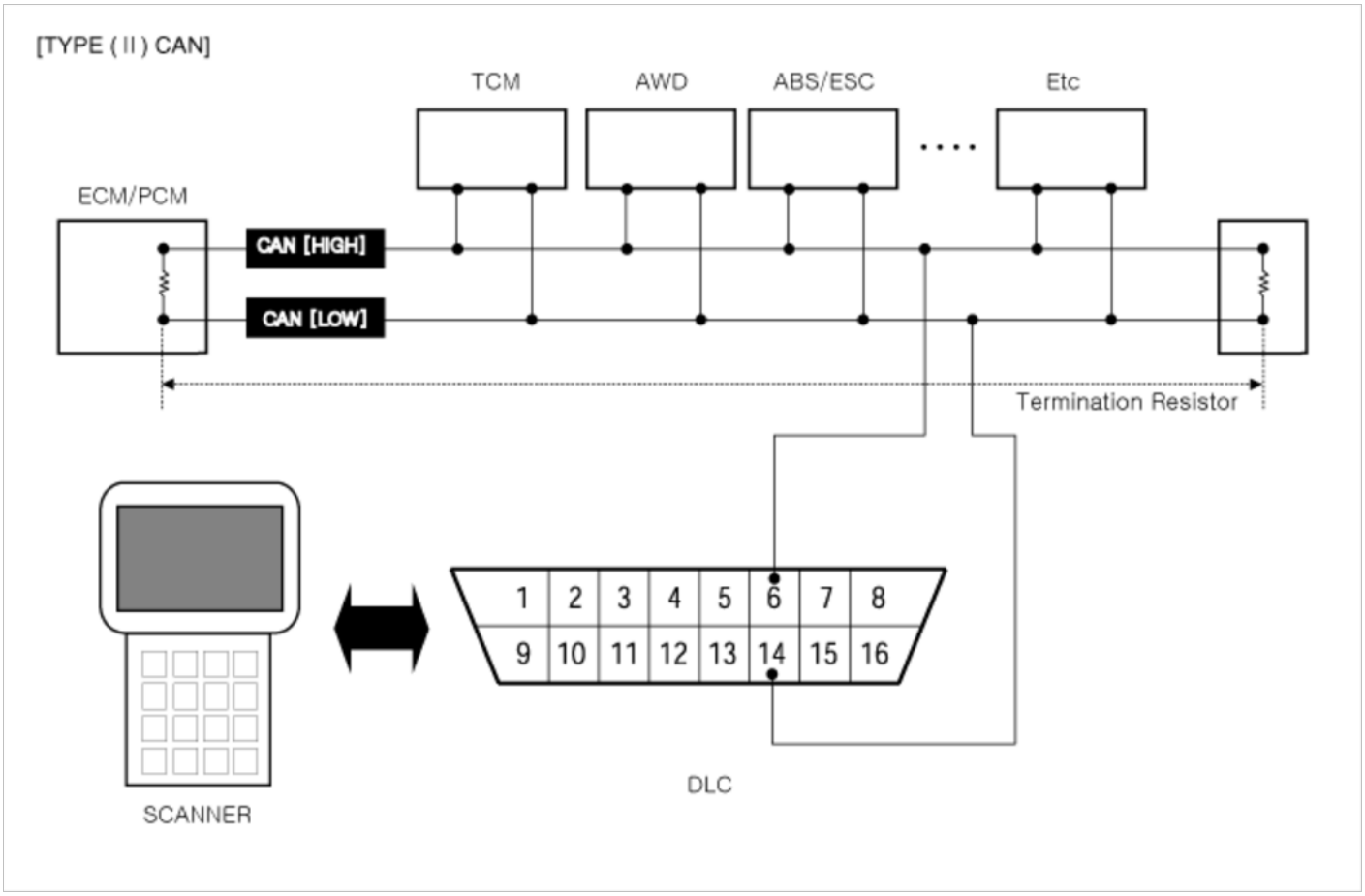
1. Overview

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) idenfying 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

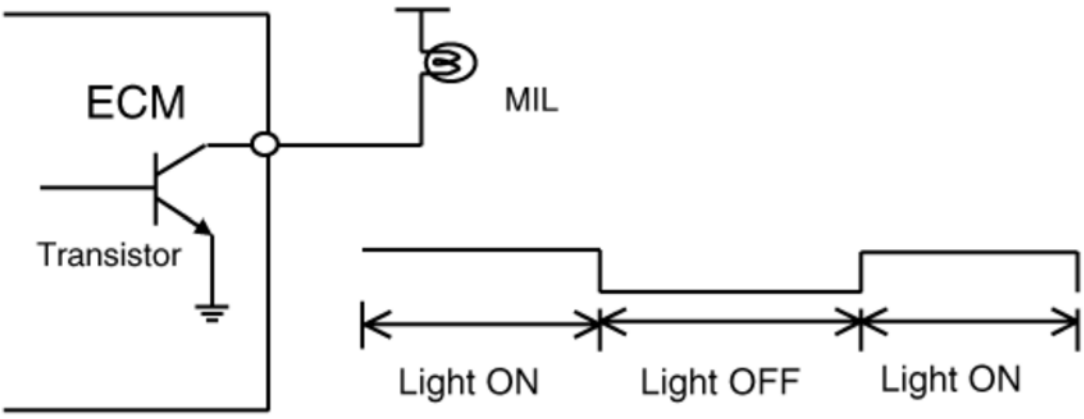
illuminated.
The diagnostic executive is a computer program in the Engine Control Module (ECM) or PowertrainControl Module (PCM) that coordinates the OBD-II self-monitoring system. This program controls all the monitors and interactions, DTC and MIL operation, freeze frame data and scan tool interface.
Freeze frame data describes stored engine conditions, such as state of the engine, state of fuel control, spark, RPM, load and warm status at the point the first fault is detected. Previously stored conditions will be replaced only if a fuel or misfire fault is detected. This data is accessible with the scan tool to assist in repairing the vehicle.
The center of the OBD-II system is a microprocessor called the Engine Control Module (ECM) or Powertrain Control Module(PCM).
The ECM or PCM receives input from sensors and other electronic components (switches, relays, and others) based on information received and programmed into its memory (keep alive random access memory, and others), the ECM or PCM generates output signals to control various relays, solenoids and actuators.

2. Configuration of hardware and related terms

1) GST (Generic scan tool)



2) MIL (Malfunction indication lamp) - MIL activity by transistor



The Malfunction Indicator Lamp (MIL) is connected between ECM or PCM-terminal Malfunction Indicator Lamp and battery supply (open collector amplifier).
In most cars, the MIL will be installed in the instrument panel. The lamp amplifier can not be damaged by a short circuit. Lamps with a power dissipation much greater than total dissipation of the MIL and lamp in the tester may cause a fault indication.
▷ At ignition ON and engine revolution (RPM)< MIN. RPM, the MIL is switched ON for an optical check by the driver.
3) MIL illumination

When the ECM or PCM detects a malfunction related emission during the first driving cycle, the DTC and engine data are stored in the freeze frame memory. The MIL is illuminated only when the ECM or PCM detects the same malfunction related to the DTC in two consecutive driving cycles.
4) MIL elimination

● Misfire and Fuel System Malfunctions:
For misfire or fuel system malfunctions, the MIL may be eliminated if the same fault does not reoccur during monitoring in three subsequent sequential driving cycles in which conditions are similar to those under which the malfunction was first detected.
● All Other Malfunctions:
For all other faults, the MIL may be extinguished after three subsequent sequential driving cycles during which the monitoring system responsible for illuminating the MIL functions without detecting the malfunction and if no other malfunction has been identified that would independently illuminate the MIL according to the requirements outlined above.
5) Erasing a fault code

The diagnostic system may erase a fault code if the same fault is not re-registered in at least 40 engine warm-up cycles, and the MIL is not illuminated for that fault code.
6) Communication Line (CAN)

- Bus Topology : Line (bus) structure
- Wiring : Twisted pair wire
- Off Board DLC Cable Length : Max. 5m
- Data Transfer Rate
- Diagnostic : 500 kbps
- Service Mode (Upgrade, Writing VIN) : 500 or 1Mbps)

7) Driving cycle

A driving cycle consists of engine start up, and engine shut off.
8) Warm-up cycle

A warm-up cycle means sufficient vehicle operation such that the engine coolant temperature has risen by at least 40 degrees Fahrenheit from engine starting and reaches a minimum temperature of at least 160 degrees Fahrenheit.
9) Trip cycle

A trip means vehicle operation (following an engine-off period) of duration and driving mode such that all components and

systems are monitored at least once by the diagnostic system except catalyst efficiency or evaporative system monitoring when a steady-speed check is used, subject to the limitation that the manufacturer-defined trip monitoring conditions shall all be encountered at least once during the first engine start portion of the applicable FTP cycle.
10) DTC format

- Diagnostic Trouble Code (SAE J2012)
- DTCs used in OBD-II vehicles will begin with a letter and are followed by four numbers.

The letter of the beginning of the DTC identifies the function of the monitored device that has failed. A "P" indicates a powertrain device, "C" indicates a chassis device. "B" is for body device and "U" indicates a network or data link code. The first number indicates if the code is generic (common to all manufacturers) or if it is manufacturer specific. A "0" & "2" indicates generic, "1" indicates manufacturer-specific. The second number indicates the system that is affected with a number between 1 and 7.
The following is a list showing what numbers are assigned to each system.

1. Fuel and air metering
2. Fuel and air metering(injector circuit malfunction only)
3. Ignition system or misfire
4. Auxiliary emission controls
5. Vehicle speed controls and idle control system
6. Computer output circuits
7. Transmission

The last two numbers of the DTC indicates the component or section of the system where the fault is located.
11) Freeze frame data

When a freeze frame event is triggered by an emission related DTC, the ECM or PCM stores various vehicle information as it existed the moment the fault ocurred. 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 ocurrence is stored in the freeze frame memory, it will remain there even when the fault ocurrs 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

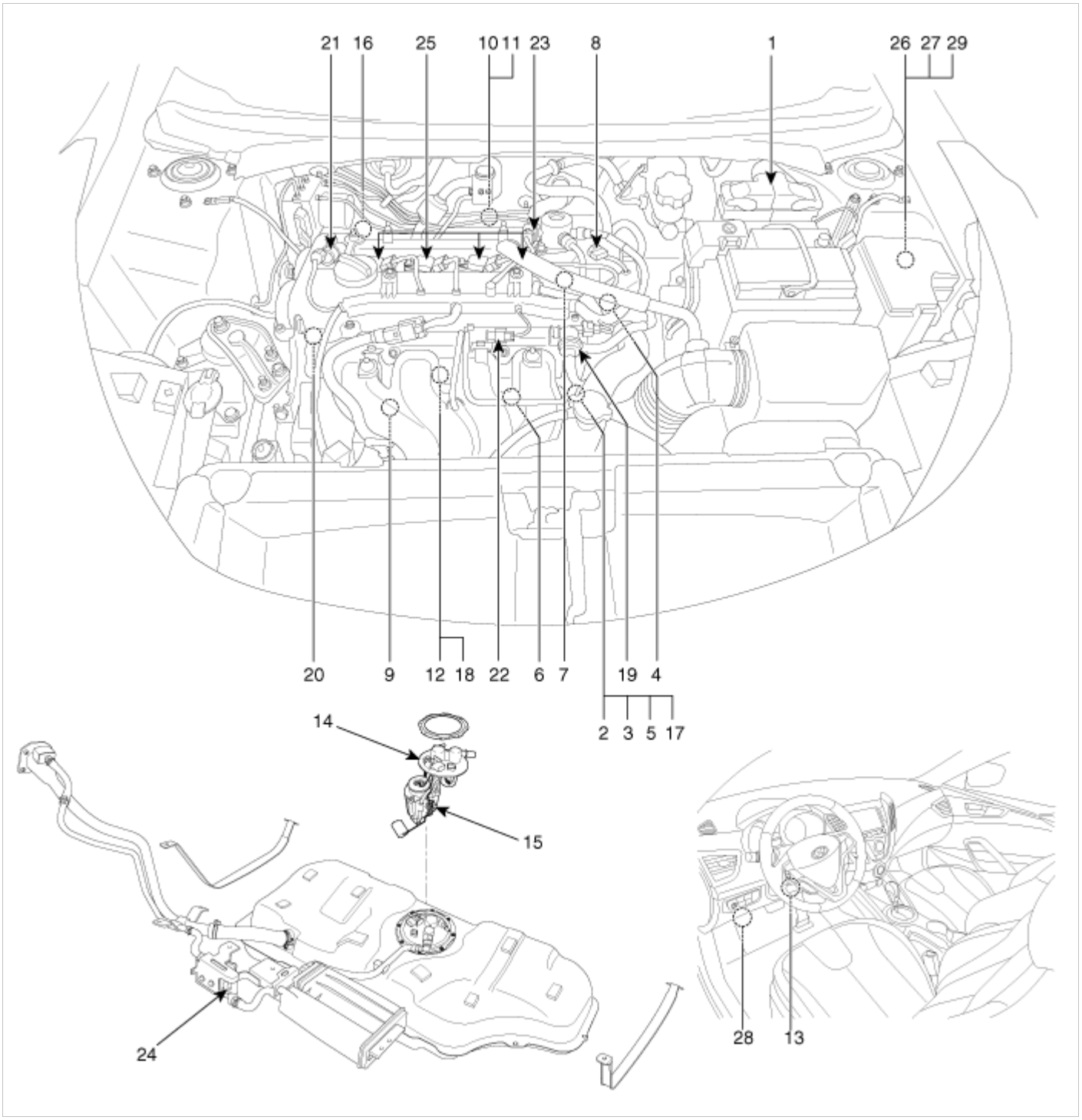
The A/C system monitoring is a self-test strategy within the ECM or PCM that monitors malfunction of all A/C system components at A/C ON.
8) Comprehensive components monitoring

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 offidle fuel and/or spark control when A/C system is on. Malfuction of A/C system components is not used as a part of the diagnostic strategy for other monitored system or component.

Fuel System > Engine Control System > Components and Components Location

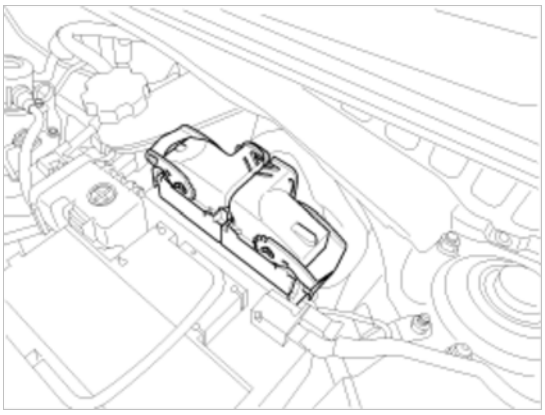
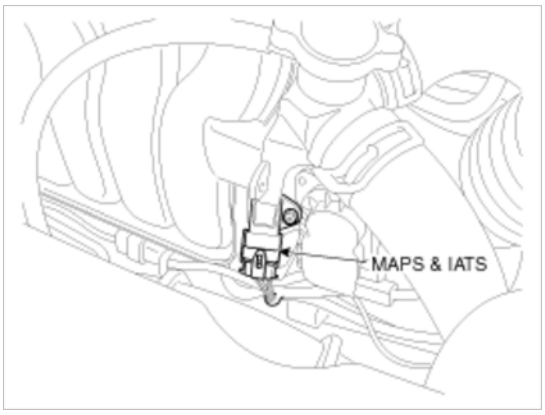
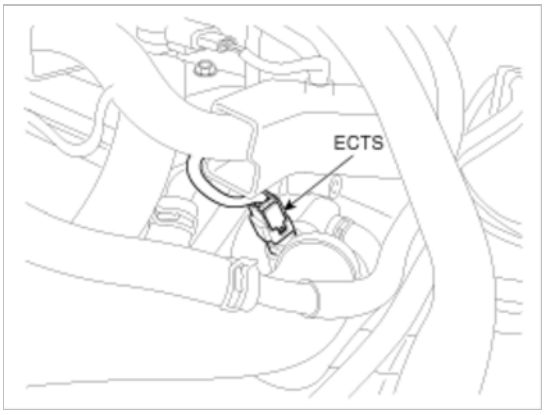
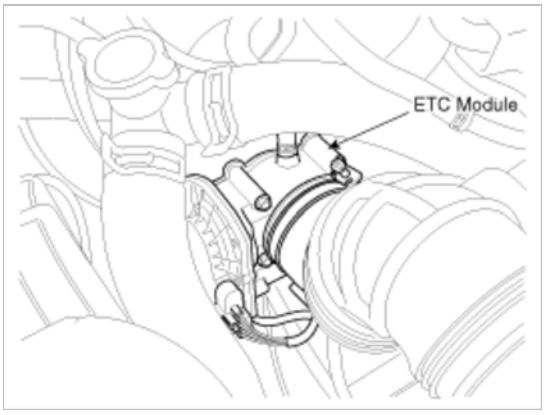
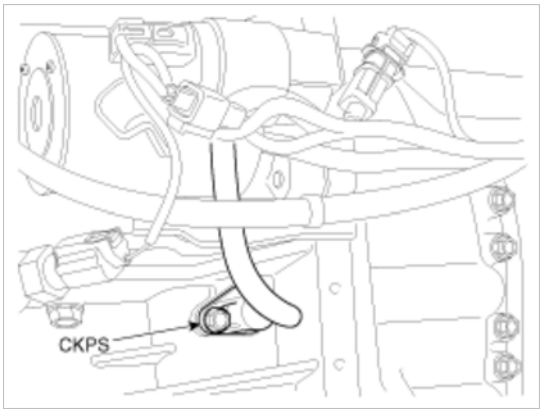
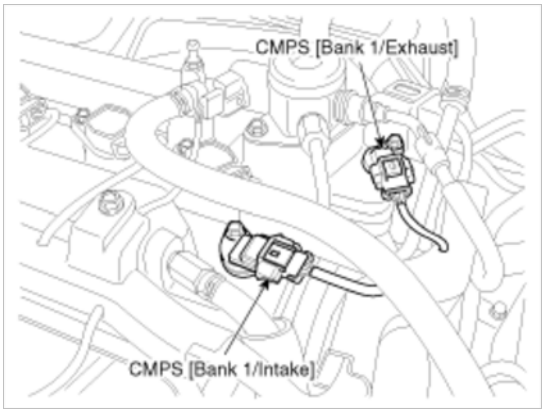
Components Location

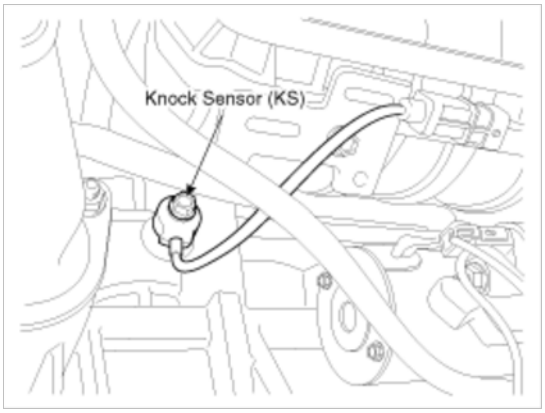


1. Engine Control Module (ECM)	16. A/C Pressure Transducer (APT)
2. Manifold Absolute Pressure Sensor (MAPS)	17. ETC Motor [integrated into ETC Module]
3. Intake Air Temperature Sensor (IATS)	18. Injector
4. Engine Coolant Temperature Sensor (ECTS)	19. Purge Control Solenoid Valve (PCSV)
5. Throttle 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]	22. Variable Intake Solenoid (VIS) Valve
8. Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust]	23. Fuel Pressure Control Valve (FPCV)
9. Knock Sensor (KS)	24. Canister Close Valve (CCV)
10. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 1]	25. Ignition Coil
11. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 2]	26. Main Relay
12. Rail Pressure Sensor (RPS)	27. Fuel Pump Relay
13. Accelerator Position Sensor (APS)	28. Data Link Connector (DLC) [16-Pin]

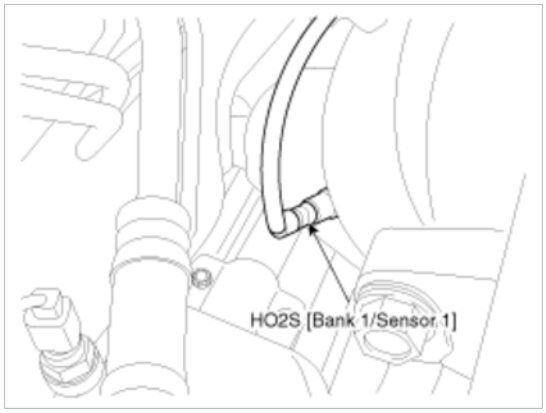
14. Fuel Tank Pressure Sensor (FTPS)
15. Fuel Level Sender (FLS)

29. Multi-Purpose Check Connector [20-Pin]

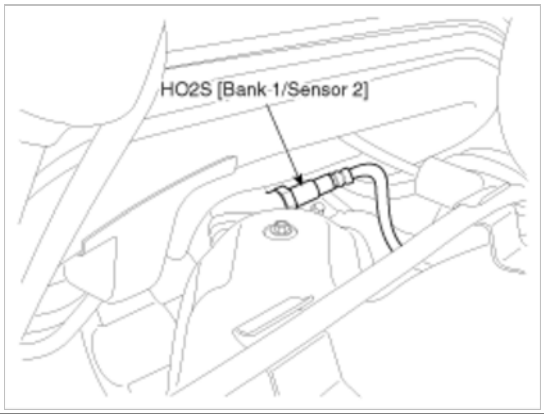
1. Engine Control Module (ECM)	2. Manifold Absolute Pressure Sensor (MAPS) 3. Intake Air Temperature Sensor (IATS)
	
4. Engine Coolant Temperature Sensor (ECTS)	5. Throttle Position Sensor (TPS) 17. ETC Motor
	
6. Crankshaft Position Sensor (CKPS)	7. Camshaft Position Sensor (CMPS) [Bank 1 / Intake] 8. Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust]
	
9. Knock Sensor (KS)	10. Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 1]



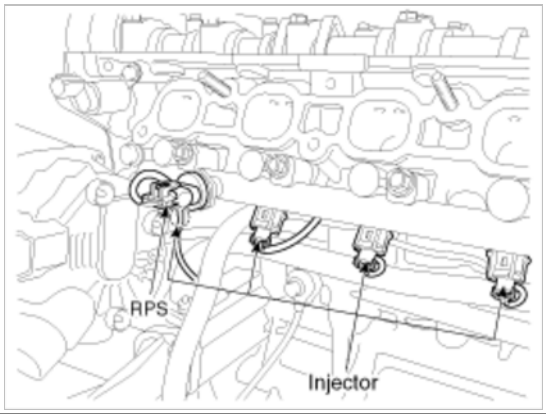
11. Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2]



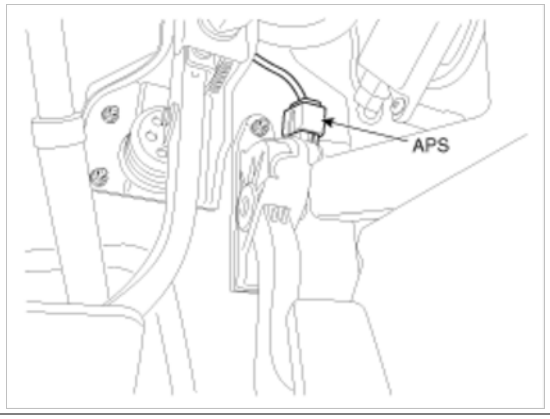
12. Rail Pressure Sensor (RPS)
18. Injector



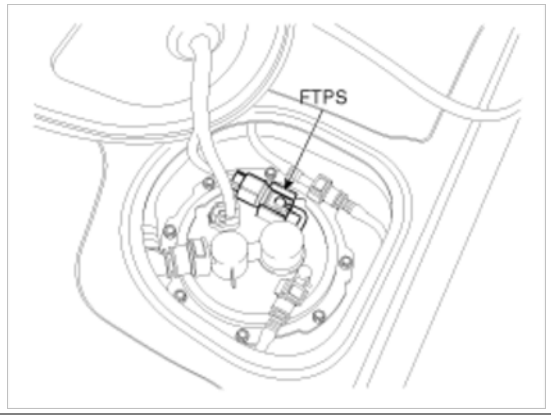
13. Accelerator Position Sensor (APS)



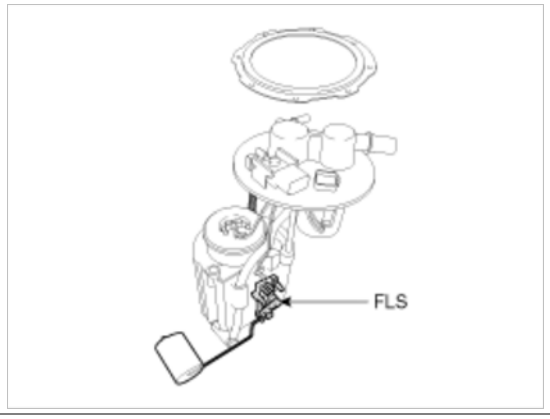
14. Fuel Tank Pressure Sensor (FTPS)

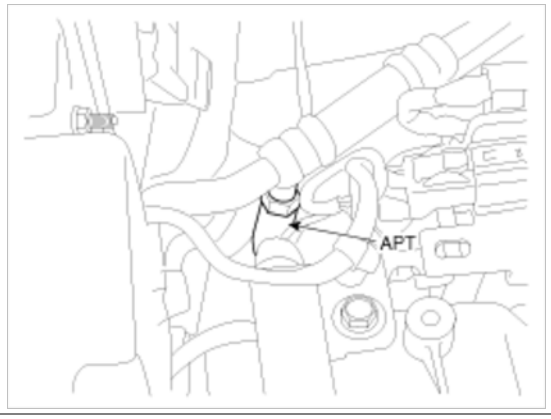


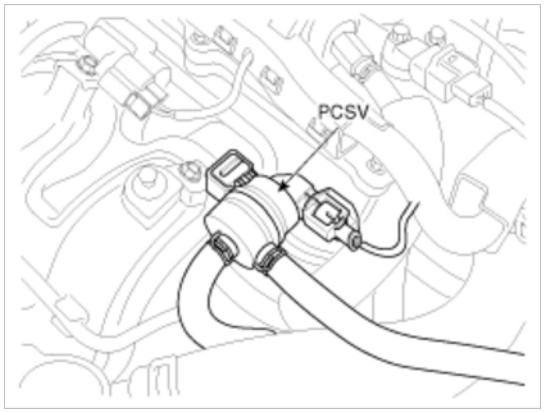
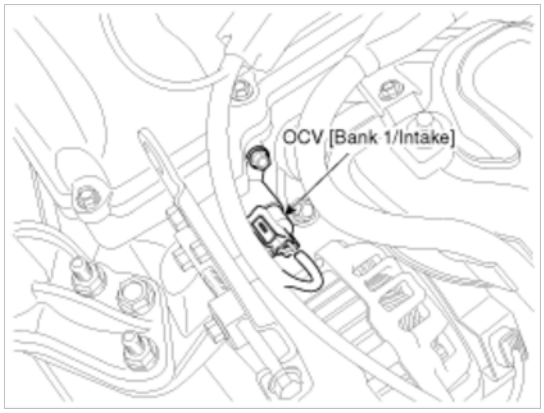
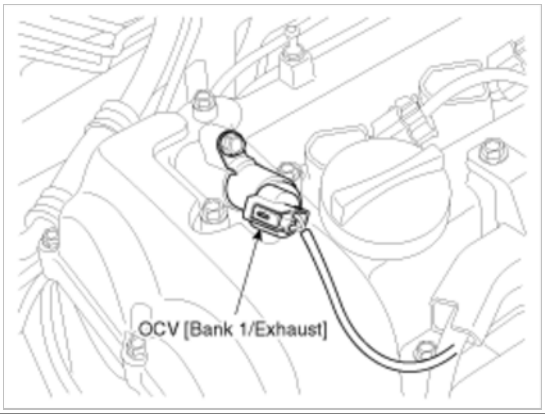
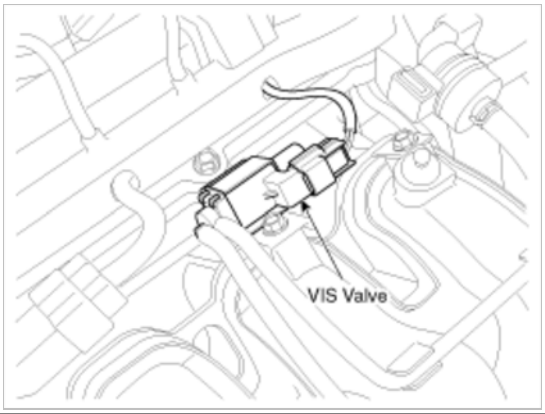
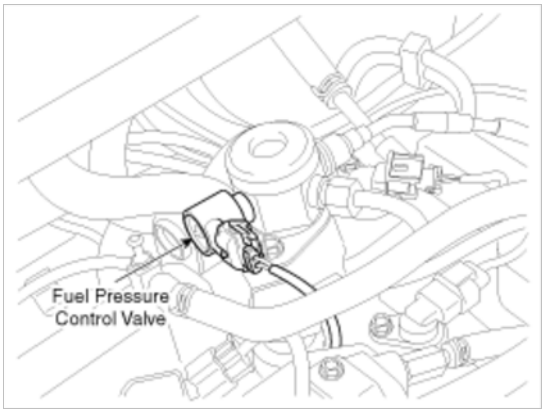
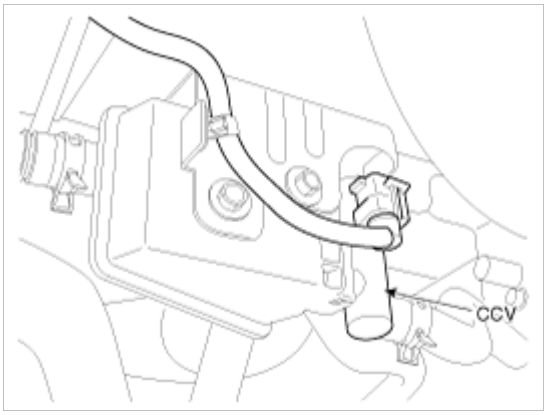
15. Fuel Level Sender (FLS)

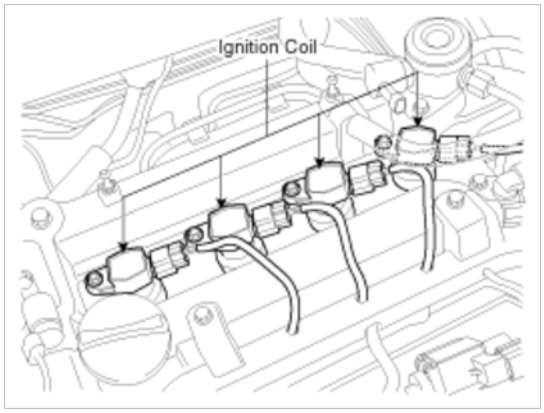


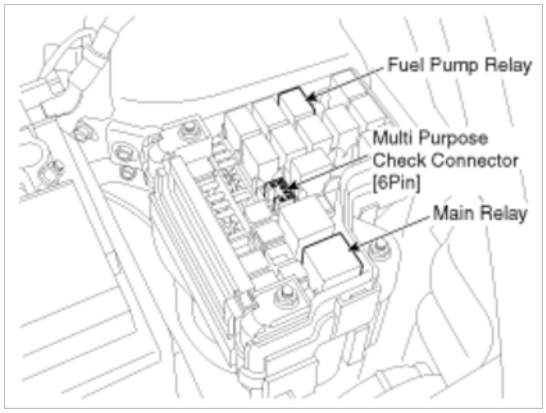
16. A/C Pressure Transducer (APT)



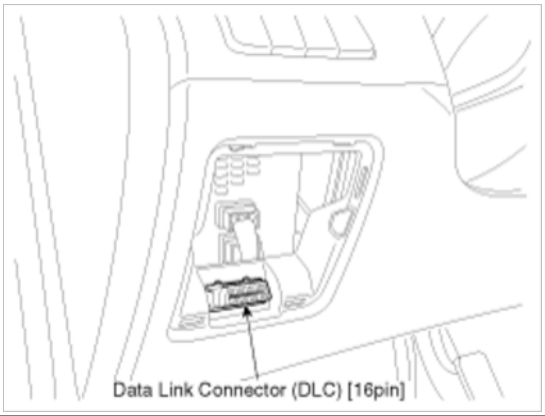


19. Purge Control Solenoid Valve (PCSV)	20. CVVT Oil Control Valve (OCV) [Bank 1 / Intake]
	
21. CVVT Oil Control Valve (OCV) [Bank 1 / Exhaust]	22. Variable Intake Solenoid (VIS) Valve
	
23. Fuel Pressure Control Valve (FPCV)	24. Canister Close Valve (CCV)
	
25. Ignition Coil	26. Main Relay 27. Fuel Pump Relay 29. Multi-Purpose Check Connector [20-Pin]



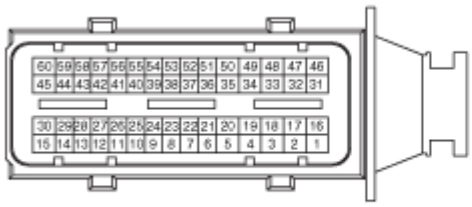


28. Data Link Connector (DLC) [16-Pin]



Fuel System > Engine Control System > Engine Control Module (ECM) > Schematic Diagrams

Harness Connector



Connector [EGGM-A]

Connector [EGGM-K]

ECM Terminal Function

Connector [EGGM-A]

Pin No.	Description	Connected to
1	Injector (Cylinder #3) [High] control output	Injector (Cylinder #3)
2	Injector (Cylinder #4) [High] control output	Injector (Cylinder #4)
3	Injector (Cylinder #2) [Low] control output	Injector (Cylinder #2)
4	-	
5	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 1] heater control output	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 1]

6	-	
7	-	
8	-	
9	-	
10	-	
11	-	
12	Immobilizer indication lamp control output	Cluster
13	-	
14	Cooling fan relay [High] control output	Cooling fan relay [High]
15	CVVT Oil Control Valve (OCV) [Bank 1/Exhaust] control output	CVVT Oil Control Valve (OCV) [Bank 1/Exhaust]
16	Injector (Cylinder #2) [High] control output	Injector (Cylinder #2)
17	Injector (Cylinder #1) [High] control output	Injector (Cylinder #1)
18	Injector (Cylinder #3) [Low] control output	Injector (Cylinder #3)
19	-	
20	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor2] heater control output	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2]
21	-	
22	-	
23	Engine Coolant Temperature Sensor (ECTS) signal input	Engine Coolant Temperature Sensor (ECTS)
24	Sensor ground	Engine Coolant Temperature Sensor (ECTS)
25	-	
26	Fuel Tank Pressure Sensor (FTPS) signal input	Fuel Tank Pressure Sensor (FTPS)
27	Fuel pump relay control output (Without Immobilizer)	Fuel pump relay
	Canister Close Valve (CCV) control output (With Immobilizer)	Canister Close Valve (CCV)
28	-	
29	A/C compressor relay control output	A/C compressor relay
30	-	
31	Ignition coil (Cylinder #3) control output	Ignition coil (Cylinder #3)
32	Ignition coil (Cylinder #1) control output	Ignition coil (Cylinder #1)
33	Injector (Cylinder #1) [Low] control output	Injector (Cylinder #1)
34	Fuel Pressure Control Valve (FPCV) [High] control output	Fuel Pressure Control Valve (FPCV)
35	ETC motor [-] control output	ETC motor
36	-	
37	Knock Sensor (KS) signal input	Knock Sensor (KS)
38	Sensor ground	Knock Sensor (KS)
39	Blower switch Max. siganl input	Heater control module
40	Brake Light switch signal input	Brake switch

41	-	
42	-	
43	-	
44	-	
45	CVVT Oil Control Valve (OCV) [Bank 1/Intake] control output	CVVT Oil Control Valve (OCV) [Bank 1/Intake]
46	Ignition coil (Cylinder #4) control output	Ignition coil (Cylinder #4)
47	Ignition coil (Cylinder #2) control output	Ignition coil (Cylinder #2)
48	Injector (Cylinder #4) [Low] control output	Injector (Cylinder #4)
49	Fuel Pressure Control Valve (FPCV) [Low] control output	Fuel Pressure Control Valve (FPCV)
50	ETC motor [+] control output	ETC motor
51	-	
52	-	
53	Brake Test switch signal input	Brake switch
54	-	
55	Clutch switch signal input	Clutch switch
56	Electric load signal input [Defrost]	Alternator
57	Alternator COM signal output	Alternator
58	Engine speed signal output	Cluster
59	Cooling fan relay [Low] control output	Cooling fan relay
60	Variable Intake Solenoid (VIS) valve control output	Variable Intake Solenoid (VIS) valve

Connector [EGGM-K]

Pin No.	Description	Connected to
1	ECM ground	Chassis ground
2	ECM ground	Chassis ground
3	ECM ground	Chassis ground
4	Battery power (B+)	Main relay
5	Battery power (B+)	Battery
6	Battery power (B+)	Battery
7	Battery power (B+)	Main relay
8	Sensor ground	Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 2]
9	Accelerator Position Sensor (APS) 1 signal input	Accelerator Position Sensor (APS) 1
10	Sensor ground	Accelerator Position Sensor (APS) 2
11	-	
12	Sensor ground	Fuel Tank Pressure Sensor (FTPS)
13	-	
14	Throttle Position Sensor (TPS) 1 signal input	Throttle Position Sensor (TPS) 1
15	-	

16	-	
17	Fuel Level signal input	Fuel Level Sender (FLS)
18	Sensor power (+5V)	Accelerator Position Sensor (APS) 2
19	-	
20	Sensor power (+5V)	Rail Pressure Sensor (RPS)
		A/C Pressure Transducer (APT)
21	-	
22	Wiper switch signal input	Wiper switch
23	-	
24	Alternator PWM signal output	Alternator
25	-	
26	-	
27	-	
28	-	
29	Ignition switch signal input	
30	Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 2] signal input	Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 2]
31	Accelerator Position Sensor (APS) 2 signal input	Accelerator Position Sensor (APS) 2
32	Sensor ground	Accelerator Position Sensor (APS) 1
33	-	
34	-	
35	Sensor ground	Throttle Position Sensor (TPS)
36	Throttle Position Sensor (TPS) 2 signal input	Throttle Position Sensor (TPS) 2
37	-	
38	-	
39	Sensor power (+5V)	Throttle Position Sensor (TPS) 1,2
40	Sensor power (+5V)	Accelerator Position Sensor (APS) 1
41	Sensor power (+5V)	Manifold Absolute Pressure Sensor (MAPS)
		Fuel Tank Pressure Sensor (FTPS)
42	Sensor power (+5V)	Camshaft Position Sensor (CMPS) [Bank 1 / Intake]
		Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust]
43	A/C switch input	Heater & A/C control module
44	A/C pressure switch	Heater & A/C control module
45	A/C Pressure Transducer (APT) signal input	A/C Pressure Transducer (APT)
46	Vehicle speed signal input	Vehicle Speed Sensor
47	Start relay (High) control output	Start relay
48	-	
49	-	
50	-	
51	-	

52	VS-/IP- (Common Ground for VS, IP)	Heated Oxygen Sensor [Bank 1/Sensor 1]
53	Rc/Rp (Pump Cell Voltage)	Heated Oxygen Sensor [Bank 1/Sensor 1]
54	-	
55	-	
56	-	
57	-	
58	Rail Pressure Sensor (RPS) signal input	Rail Pressure Sensor (RPS)
59	-	
60	Start signal input	PDM module
61	LIN communication signal input	Battery sensor
62	-	
63	CAN [Low]	Other control module, Data Link Connector (DLC), Multi-Purpose Check Connector
64	Sensor ground	Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust]
65	Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust] signal input	Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust]
66	-	
67	Crankshaft Position Sensor (CKPS) [B] signal input	Crankshaft Position Sensor (CKPS)
68	-	
69	-	
70	-	
71	-	
72	Purge Control Solenoid Valve (PCSV) control output	Purge Control Solenoid Valve (PCSV)
73	-	
74	VS+ (NERNST Cell Voltage)	Heated Oxygen Sensor [Bank 1/Sensor 1]
75	Rc (Compensative Resistance)	Heated Oxygen Sensor [Bank 1/Sensor 1]
76	Sensor ground	Rail Pressure Sensor (RPS)
77	Sensor ground	A/C Pressure Transducer (APT)
78	Sensor ground	Manifold Absolute Pressure Sensor (MAPS)
79	Intake Temperature Sensor (IATS) signal input	Intake Temperature Sensor (IATS)
80	Manifold Absolute Pressure Sensor (MAPS) signal input	Manifold Absolute Pressure Sensor (MAPS)
81	-	
82	-	
83	Immobilizer communication line	Smart Key Control Module [With Button Engine Start System]
		Immobilizer Control Module [Without Button Engine Start System]
84	-	
85	CAN [High]	Other control module, Data Link Connector (DLC), Multi-Purpose Check Connector
86	Sensor ground	Camshaft Position Sensor (CMPS) [Bank 1 / Intake]

87	Camshaft Position Sensor (CMPS) [Bank 1 / Intake] signal input	Camshaft Position Sensor (CMPS) [Bank 1 / Intake]
88	Head lamp switch input	Multi-function switch
89	Crankshaft Position Sensor (CKPS) [A] signal input	Crankshaft Position Sensor (CKPS)
90	Canister Close Valve (CCV) control output (Without Immobilizer)	Canister Close Valve (CCV)
	Fuel pump relay control output (With Immobilizer)	Fuel pump relay
91	-	
92	-	
93	Main relay control output	Main relay
94	Start relay (Low) control output	Start relay

ECM Terminal Input/Output Signal

Connector [EGGM-A]

Pin No.	Description	Condition	Type	Level
1	Injector (Cylinder #3) [High] control output	Relay ON/OFF	DC voltage	71V
2	Injector (Cylinder #4) [High] control output	Relay ON/OFF	DC voltage	71V
3	Injector (Cylinder #2) [Low] control output	Relay OFF	DC voltage	71V
		Relay ON		Max. 1.0V
4	-			
5	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 1] heater control output	Relay OFF	DC voltage	Battery voltage
		Relay ON		Max. 1.65V
6	-			
7	-			
8	-			
9	-			
10	-			
11	-			
12	Immobilizer indication lamp control output			
13	-			
14	Cooling fan relay [High] control output	Relay OFF	DC voltage	Battery voltage
		Relay ON		Max. 1.76V
15	CVVT Oil Control Valve (OCV) [Bank 1/Exhaust] control output	Idle	Pulse	High: Battery voltage
				Low: Max. 1.65V
16	Injector (Cylinder #2) [High] control output	Relay ON/OFF	DC voltage	71V
17	Injector (Cylinder #1) [High] control output	Relay ON/OFF	DC voltage	71V
18	Injector (Cylinder #3) [Low] control output	Relay OFF	DC voltage	71V
		Relay ON		Max. 1.0V
19	-			

20	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor2] heater control output	Relay OFF	DC voltage	Battery voltage
		Relay ON		Max. 1.65V
21	-			
22	-			
23	Engine Coolant Temperature Sensor (ECTS) signal input	Idle	Analog	0.270 ~ 4.77V
24	Sensor ground	Idle	DC voltage	Max. 50mV
25	-			
26	Fuel Tank Pressure Sensor (FTPS) signal input	Idle	Analog	0.3343 ~ 0.4667V
27	Canister Close Valve (CCV) control output (With Immobilizer)	Active	DC voltage	Battery voltage
		Inactive		Max. 1.76V
	Fuel pump relay control output (Without Immobilizer)	Relay OFF	DC voltage	Battery voltage
		Relay ON		Max. 1.44V
28	-			
29	A/C compressor relay control output	Relay OFF	DC voltage	Battery voltage
		Relay ON		Max. 1.0V
30	-			
31	Ignition coil (Cylinder #3) control output	Idle	Pulse	1st voltage: 370 ~ 430V
				ON voltage: Max. 2.2V
32	Ignition coil (Cylinder #1) control output	Idle	Pulse	1st voltage: 370 ~ 430V
				ON voltage: Max. 2.2V
33	Injector (Cylinder #1) [Low] control output	Relay OFF	DC voltage	71V
		Relay ON		Max. 1.0V
34	Fuel Pressure Control Valve (FPCV) [High] control output	Relay ON/OFF	DC voltage	16V
35	ETC motor [-] control output	Idle	Pulse	High: Battery voltage
				Low: Max. 1.0V
36	-			
37	Knock Sensor (KS) signal input	Knocking	Variable	
		Normal	Frequency	
38	Sensor ground	Knocking	Variable	
		Normal	Frequency	
39	Blower switch Max. siganl input			
40	Brake Light switch signal input	ON	DC voltage	Battery voltage
		OFF		Max. 2.25V
41	-			
42	-			
43	-			
44	-			
45	CVVT Oil Control Valve (OCV) [Bank 1/Intake] control	Idle	Pulse	High: Battery voltage

	output			Low: Max. 1.65V
46	Ignition coil (Cylinder #4) control output	Idle	Pulse	1st voltage: 370 ~ 430V
				ON voltage: Max. 2.2V
47	Ignition coil (Cylinder #2) control output	Idle	Pulse	1st voltage: 370 ~ 430V
				ON voltage: Max. 2.2V
48	Injector (Cylinder #4) [Low] control output	Relay OFF	DC voltage	71V
		Relay ON		Max. 1.0V
49	Fuel Pressure Control Valve (FPCV) [Low] control output	Relay OFF	DC voltage	16V
		Relay ON		Max. 1.0V
50	ETC motor [+] control output	Idle	Pulse	High: Battery voltage
				Low: Max. 1.0V
51	-			
52	-			
53	Brake Test switch signal input	ON	DC voltage	Battery voltage
		OFF		Max. 2.25V
54	-			
55	Clutch switch signal input			
56	Electric load signal input [Defrost]	ON	DC voltage	Battery voltage
		OFF		Max. 2.25V
57	Alternator COM signal output	Idle	Pulse	High: Battery voltage
				Low: Max. 0.6V
58	Engine speed signal output	Idle	Pulse	High: Battery voltage
				Low: Max. 0.6V
59	Cooling fan relay [Low] control output	Relay OFF	DC voltage	Battery voltage
		Relay ON		Max. 1.76V
60	Variable Intake Solenoid (VIS) valve control output	Relay OFF	DC voltage	Battery voltage
		Relay ON		Max. 1.65V

Connector [EGGM-K]

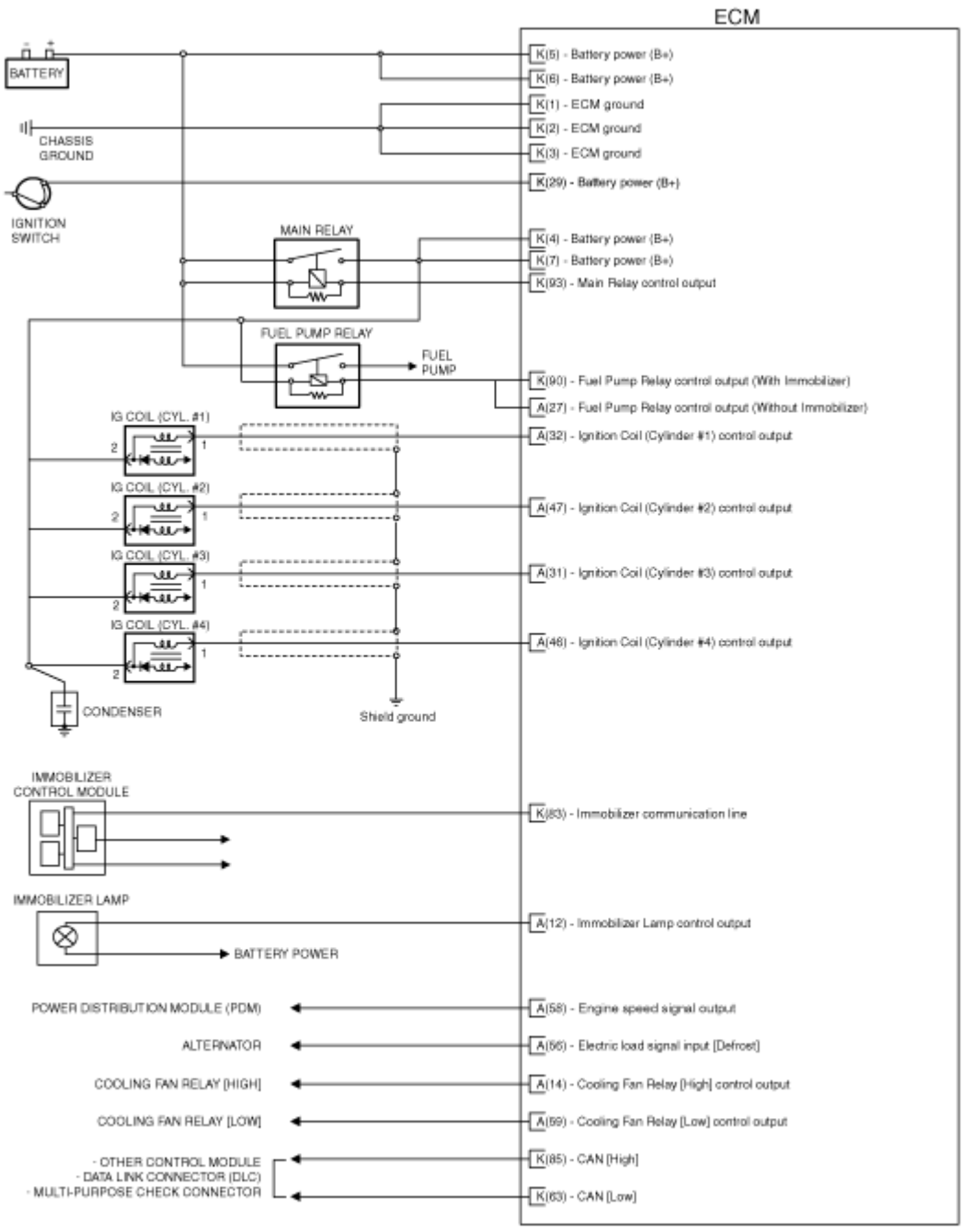
Pin No.	Description	Condition	Type	Level
1	ECM ground	Idle	DC voltage	Max. 50mV
2	ECM ground	Idle	DC voltage	Max. 50mV
3	ECM ground	Idle	DC voltage	Max. 50mV
4	Battery power (B+)	IG OFF	DC voltage	Max. 1.0V
		IG ON		Battery voltage
5	Battery power (B+)	IG OFF	DC voltage	Max. 1.0V
		IG ON		Battery voltage
6	Battery power (B+)	IG OFF	DC voltage	Max. 1.0V
		IG ON		Battery voltage

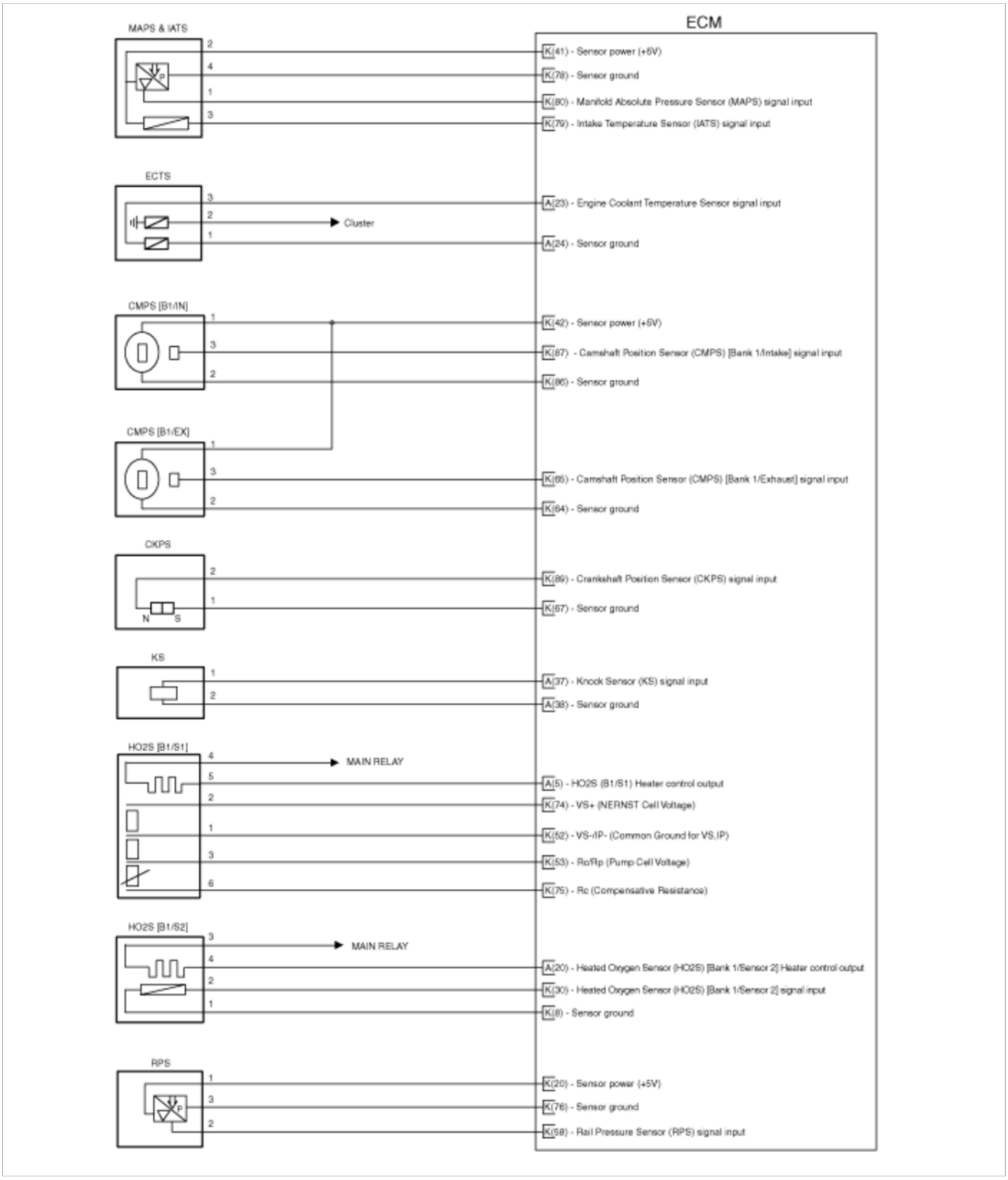
7	Battery power (B+)	IG OFF	DC voltage	Max. 1.0V
		IG ON		Battery voltage
8	Sensor ground	Idle	DC voltage	Max. 50mV
9	Accelerator Position Sensor (APS) 1 signal input	Idle	Analog	0.674 ~ 4.379 V
10	Sensor ground	Idle	DC voltage	Max. 50mV
11	-			
12	Sensor ground	Idle	DC voltage	Max. 50mV
13	-			
14	Throttle Position Sensor (TPS) 1 signal input	Idle	Analog	0.33 ~ 4.72 V
15	-			
16	-			
17	Fuel Level signal input	Idle	Analog	0.193 ~ 4.0V
18	Sensor power (+5V)	IG OFF	DC voltage	Max. 0.5V
		IG ON		4.9 ~ 5.1V
19	-			
20	Sensor power (+5V)	IG OFF	DC voltage	Max. 0.5V
		IG ON		4.9 ~ 5.1V
21	-			
22	Wiper switch signal input	ON	DC voltage	Battery voltage
		OFF		Max. 2V
23	-			
24	Alternator PWM signal output	Idle	Pulse	High: Battery voltage
				Low: Max. 1.5V
25	-			
26	-			
27	Auto Stop Lamp output			
28	-			
29	Ignition switch signal input	IG OFF	DC voltage	Max. 1.0V
		IG ON		Battery voltage
30	Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 2] signal input	Engine	Analog	Rich: 0.6 ~ 1.0V
		Running		Lean: Max. 0.4V
31	Accelerator Position Sensor (APS) 2 signal input	Idle	Analog	0.261 ~ 2.204 V
32	Sensor ground	Idle	DC voltage	Max. 50mV
33	-			
34	-			
35	Sensor ground	Idle	DC voltage	Max. 50mV
36	Throttle Position Sensor (TPS) 2 signal input	Idle	Analog	0.55 ~ 4.37 V
37	-			
38				

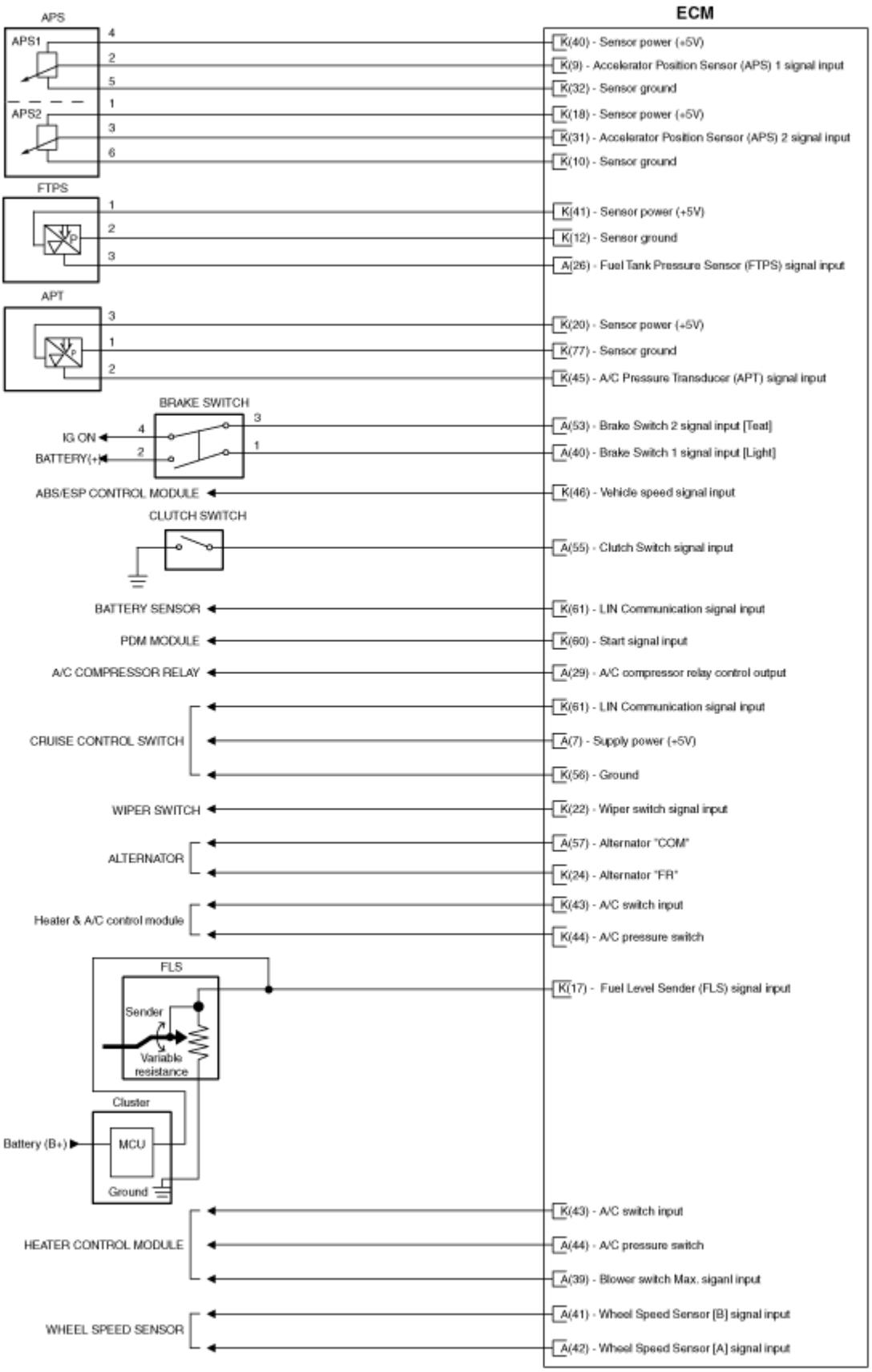
39	Sensor power (+5V)	IG OFF	DC voltage	Max. 0.5V
		IG ON		4.9 ~ 5.1V
40	Sensor power (+5V)	IG OFF	DC voltage	Max. 0.5V
		IG ON		4.9 ~ 5.1V
41	Sensor power (+5V)	IG OFF	DC voltage	Max. 0.5V
		IG ON		4.9 ~ 5.1V
42	Sensor power (+5V)	IG OFF	DC voltage	Max. 0.5V
		IG ON		4.9 ~ 5.1V
43	A/C switch input			
44	A/C pressure switch			
45	A/C Pressure Transducer (APT) signal input	A/C ON	Analog	0.348 ~ 4.63 V
46	Vehicle speed signal input	Idle	Pulse	High: Min. 5.4V
				Low: Max. 2.25V
47	Start relay (High) control output			
48	-			
49	-			
50	Malfunction Indicator Lamp (MIL) control output			
51	-			
52	VS-/IP- (Common Ground for VS, IP)	Idle	DC voltage	Max. 50mV
53	Rc/Rp (Pump Cell Voltage)	Idle	Analog	0 ~ 5.1V
54	-			
55	-			
56	-			
57	-			
58	Rail Pressure Sensor (RPS) signal input	Idle	Analog	0.43 ~ 3.46V
59	-			
60	Start signal input	ON	DC voltage	Battery voltage
		OFF		Max. 2V
61	LIN communication signal input	RECESSIVE	Pulse	max 5.6V (at 14V)
		DOMINANT		min 8.4V (at 14V)
62	-			
63	CAN [Low]	RECESSIVE	Pulse	2.0 ~ 3.0V
		DOMINANT		0.5 ~ 2.25V
64	Sensor ground	Idle	DC voltage	Max. 50mV
65	Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust] signal input	Idle	Pulse	High: min. 4.8V
				Low: Max. 0.6V
66	-			
67	Crankshaft Position Sensor (CKPS) [B] signal input	Idle	Pulse	Vp_p: Min. 1.0V
68	-			

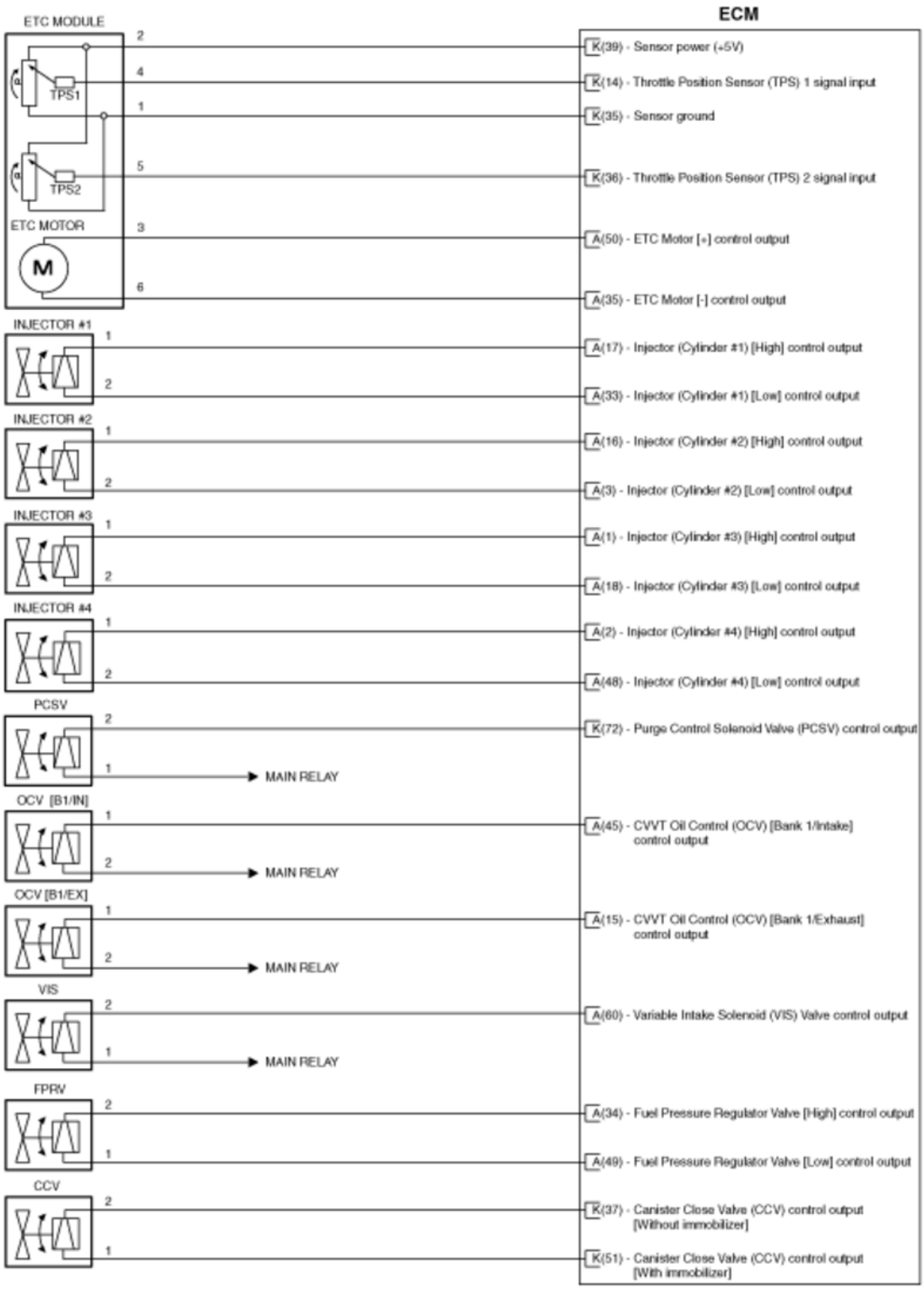
69	-			
70	-			
71	-			
72	Purge Control Solenoid Valve (PCSV) control output	Relay OFF	DC voltage	Battery voltage
		Relay ON		Max. 1.76V
73	-			
74	VS+ (NERNST Cell Voltage)	Idle	Analog	0 ~ 5.1V
75	Rc (Compensative Resistance)	Idle	Analog	0 ~ 5.1V
76	Sensor ground	Idle	DC voltage	-
77	Sensor ground	Idle	DC voltage	Max. 50mV
78	Sensor ground	Idle	DC voltage	Max. 50mV
79	Intake Temperature Sensor (IATS) signal input	Idle	Analog	0.209 ~ 4.756V
80	Manifold Absolute Pressure Sensor (MAPS) signal input	Idle	Analog	0.6683 ~ 4.346V
81	-			
82	-			
83	Immobilizer communication line	When transmitting	Pulse	High: Min. 8.4V(at 14V)
				Low: Max. 6.44V(at 14V)
84	-			
85	CAN [High]	RECESSIVE	Pulse	2.0 ~ 3.0V
		DOMINANT		2.75 ~ 4.5V
86	Sensor ground	Idle	DC voltage	Max. 50mV
87	Camshaft Position Sensor (CMPS) [Bank 1 / Intake] signal input	Idle	Pulse	High: min. 4.8V
				Low: Max. 0.6V
88	Head lamp switch input			
89	Crankshaft Position Sensor (CKPS) [A] signal input	Idle	Pulse	Vp_p: Min. 1.0V
90	Canister Close Valve (CCV) control output (Without Immobilizer)	Active	DC voltage	Battery voltage
		Inactive		Max. 1.76V
	Fuel pump relay control output (With Immobilizer)	Relay OFF	DC voltage	Battery voltage
		Relay ON		Max. 1.44V
91	-			
92	-			
93	Main relay control output	Relay OFF	DC voltage	Battery voltage
		Relay ON		Max. 1.7V
94	Start relay control output	Relay OFF	DC voltage	Battery voltage
		Relay ON		Max. 2.64V

Circuit Diagram


ECM
BATTERY
CHASSIS GROUND
IGNITION SWITCH
MAIN RELAY
FUEL PUMP RELAY
FUEL PUMP
IG COIL (CYL. #1)
IG COIL (CYL. #2)
IG COIL (CYL. #3)
IG COIL (CYL. #4)
CONDENSER
Shield ground
IMMOBILIZER CONTROL MODULE
IMMOBILIZER LAMP
BATTERY POWER
POWER DISTRIBUTION MODULE (PDM)
ALTERNATOR
COOLING FAN RELAY [HIGH]
COOLING FAN RELAY [LOW]
- OTHER CONTROL MODULE
- DATA LINK CONNECTOR (DLC)
- MULTI-PURPOSE CHECK CONNECTOR
K(5) - Battery power (B+)
K(6) - Battery power (B+)
K(1) - ECM ground
K(2) - ECM ground
K(3) - ECM ground
K(29) - Battery power (B+)
K(4) - Battery power (B+)
K(7) - Battery power (B+)
K(93) - Main Relay control output
K(90) - Fuel Pump Relay control output (With Immobilizer)
A(27) - Fuel Pump Relay control output (Without Immobilizer)
A(32) - Ignition Coil (Cylinder #1) control output
A(47) - Ignition Coil (Cylinder #2) control output
A(31) - Ignition Coil (Cylinder #3) control output
A(48) - Ignition Coil (Cylinder #4) control output
K(83) - Immobilizer communication line
A(12) - Immobilizer Lamp control output
A(58) - Engine speed signal output
A(56) - Electric load signal input [Defrost]
A(14) - Cooling Fan Relay [High] control output
A(59) - Cooling Fan Relay [Low] control output
K(85) - CAN [High]
K(63) - CAN [Low]


ECM
MAPS & IATS
2
4
1
3
K(41) - Sensor power (+5V)
K(78) - Sensor ground
K(80) - Manifold Absolute Pressure Sensor (MAPS) signal input
K(79) - Intake Temperature Sensor (IATS) signal input
ECTS
3
2
1
Cluster
A(23) - Engine Coolant Temperature Sensor signal input
A(24) - Sensor ground
CMPS [B1/IN]
1
3
2
K(42) - Sensor power (+5V)
K(87) - Camshaft Position Sensor (CMPS) [Bank 1/Intake] signal input
K(86) - Sensor ground
CMPS [B1/EX]
1
3
2
K(65) - Camshaft Position Sensor (CMPS) [Bank 1/Exhaust] signal input
K(64) - Sensor ground
CKPS
2
1
N
S
K(89) - Crankshaft Position Sensor (CKPS) signal input
K(67) - Sensor ground
KS
1
2
A(37) - Knock Sensor (KS) signal input
A(38) - Sensor ground
HO2S [B1/S1]
4
5
2
1
3
6
MAIN RELAY
A(5) - HO2S (B1/S1) Heater control output
K(74) - VS+ (NERNST Cell Voltage)
K(52) - VS-/IP- (Common Ground for VS,IP)
K(53) - Rc/Rp (Pump Cell Voltage)
K(75) - Rc (Compensative Resistance)
HO2S [B1/S2]
3
4
2
1
MAIN RELAY
A(20) - Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2] Heater control output
K(30) - Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2] signal input
K(8) - Sensor ground
RPS
1
3
2
K(20) - Sensor power (+5V)
K(76) - Sensor ground
K(58) - Rail Pressure Sensor (RPS) signal input


ECM
APS
APS1
APS2
4
2
5
1
3
6
K(40) - Sensor power (+5V)
K(9) - Accelerator Position Sensor (APS) 1 signal input
K(32) - Sensor ground
K(18) - Sensor power (+5V)
K(31) - Accelerator Position Sensor (APS) 2 signal input
K(10) - Sensor ground
FTPS
1
2
3
K(41) - Sensor power (+5V)
K(12) - Sensor ground
A(26) - Fuel Tank Pressure Sensor (FTPS) signal input
APT
3
1
2
K(20) - Sensor power (+5V)
K(77) - Sensor ground
K(45) - A/C Pressure Transducer (APT) signal input
BRAKE SWITCH
IG ON
BATTERY(+)
4
2
3
1
A(53) - Brake Switch 2 signal input [Teat]
A(40) - Brake Switch 1 signal input [Light]
ABS/ESP CONTROL MODULE
K(46) - Vehicle speed signal input
CLUTCH SWITCH
A(55) - Clutch Switch signal input
BATTERY SENSOR
K(61) - LIN Communication signal input
PDM MODULE
K(60) - Start signal input
A/C COMPRESSOR RELAY
A(29) - A/C compressor relay control output
CRUISE CONTROL SWITCH
K(61) - LIN Communication signal input
A(7) - Supply power (+5V)
K(56) - Ground
WIPER SWITCH
K(22) - Wiper switch signal input
ALTERNATOR
A(57) - Alternator "COM"
K(24) - Alternator "FR"
Heater & A/C control module
K(43) - A/C switch input
K(44) - A/C pressure switch
FLS
Sender
Variable resistance
K(17) - Fuel Level Sender (FLS) signal input
Cluster
Battery (B+)
MCU
Ground
HEATER CONTROL MODULE
K(43) - A/C switch input
A(44) - A/C pressure switch
A(39) - Blower switch Max. sigan input
WHEEL SPEED SENSOR
A(41) - Wheel Speed Sensor [B] signal input
A(42) - Wheel Speed Sensor [A] signal input



Fuel System > Engine Control System > Engine Control Module (ECM) > Repair procedures

Removal

NOTE

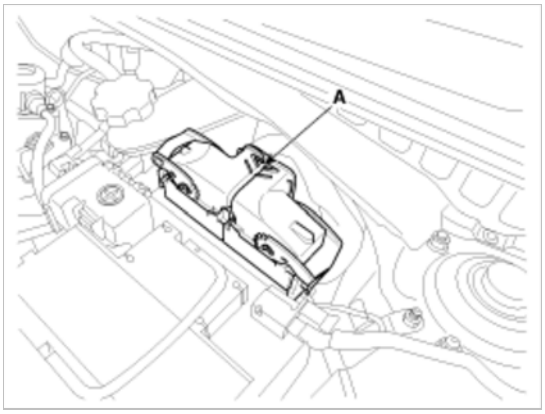
When replacing the ECM, the vehicle equipped with immobilizer must be performed the procedure as below.
[In the case of installing used ECM]

1. Perform "Neutral mode" procedure with GDS. (Refer to "Immobilizer" in BE group)
2. Insert the key and turn it to the IGN ON and OFF position.

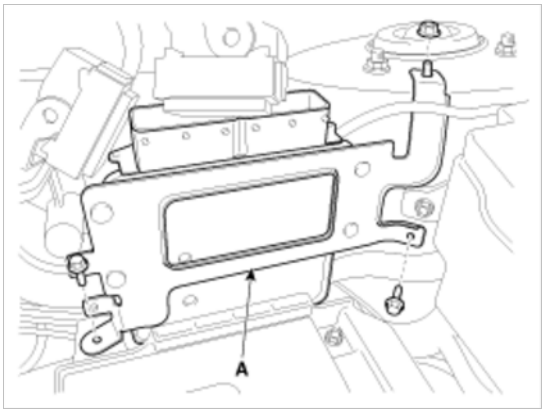
Then the ECM key register process is completed automatically.
[In the case of installing new ECM]
- Insert the key and turn it to the IGN ON and OFF position.

Then the ECM key register process is completed automatically.

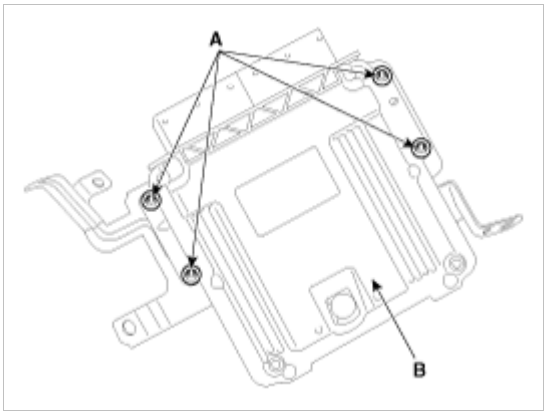
1. Turn ignition switch OFF and disconnect the negative (-) battery cable.
2. Disconnect the ECM Connector (A).



3. Remove the battery (Refer to "Charging System" in EM group).
4. Remove the mounting bolts and nut, and then remove the ECM bracket assembly (A).



5. Remove the ECM (B) after removing 4 nuts (A) from the bracket.



Installation

NOTE

When replacing the ECM, the vehicle equipped with immobilizer must be performed the procedure as below.
[In the case of installing used ECM]
1. Perform "Neutral mode" procedure with GDS. (Refer to "Immobilizer" in BE group)
2. Insert the key and turn it to the IGN ON and OFF position.

Then the ECM key register process is completed automatically.
[In the case of installing new ECM]
- Insert the key and turn it to the IGN ON and OFF position.

Then the ECM key register process is completed automatically.

1. Installation is reverse of removal.

ECM installation nut:
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 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

1. TEST ECM GROUND CIRCUIT: Measure resistance between ECM and chassis ground using the backside of ECM harness connector as ECM side check point. If the problem is found, repair it.

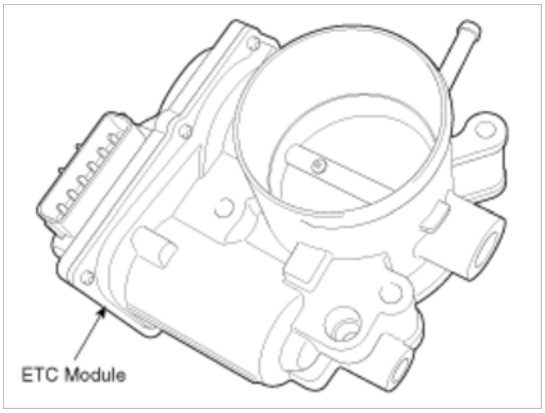
Specification: Below 1Ω

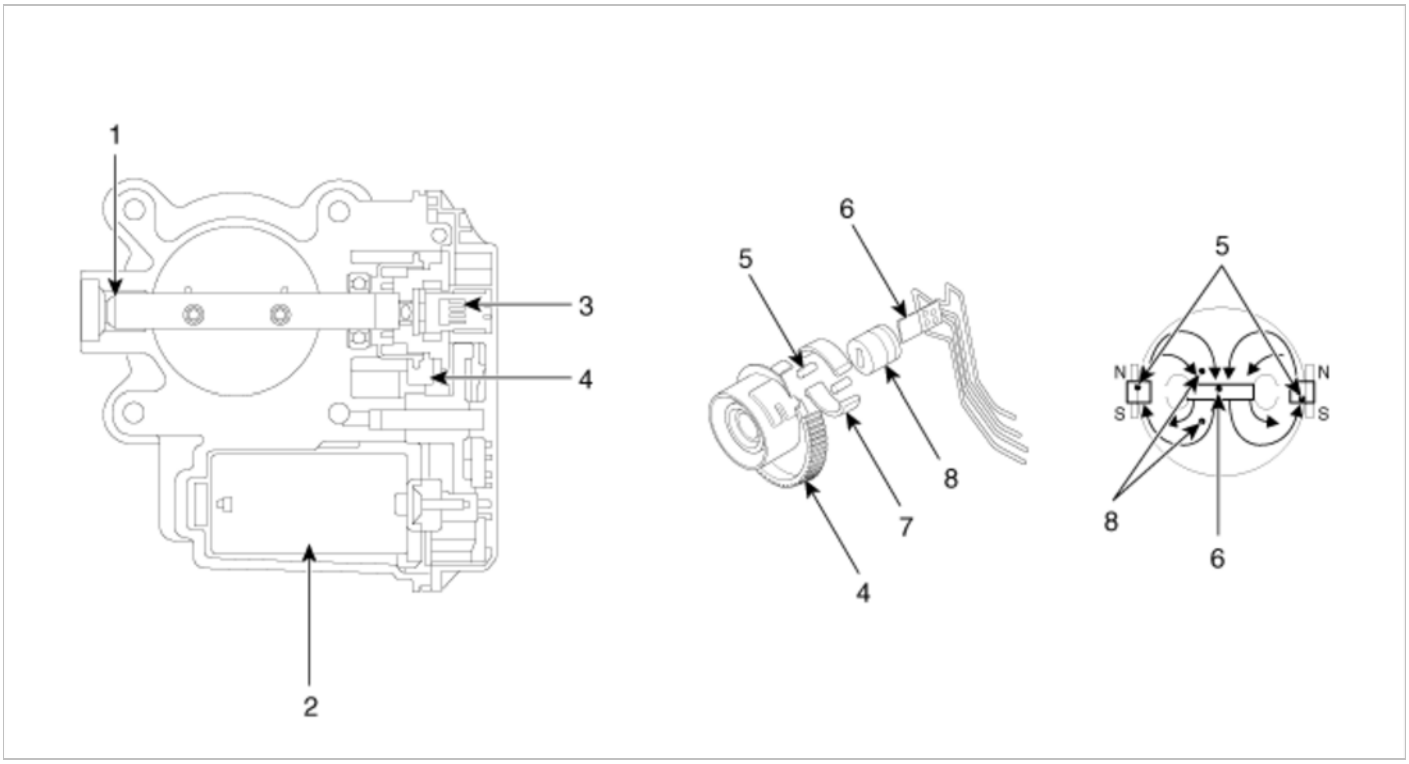
2. TEST ECM CONNECTOR: Disconnect the ECM connector and visually check the ground terminals on ECM side and harness side for bent pins or poor contact pressure. If the problem is found, repair it.
3. If problem is not found in Step 1 and 2, the ECM could be faulty. If so, make sure there were no DTC's 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.
4. RE-TEST THE ORIGINAL ECM: Install the original ECM (may be broken) into a known-good vehicle and check the vehicle. If the problem occurs again, replace the original ECM with a new one. If problem does not occur, this is intermittent problem (Refer to “Intermittent Problem Inspection Procedure” in Basic Inspection Procedure).

Fuel System > Engine Control System > ETC (Electronic Throttle Control) System > Description and Operation

Description

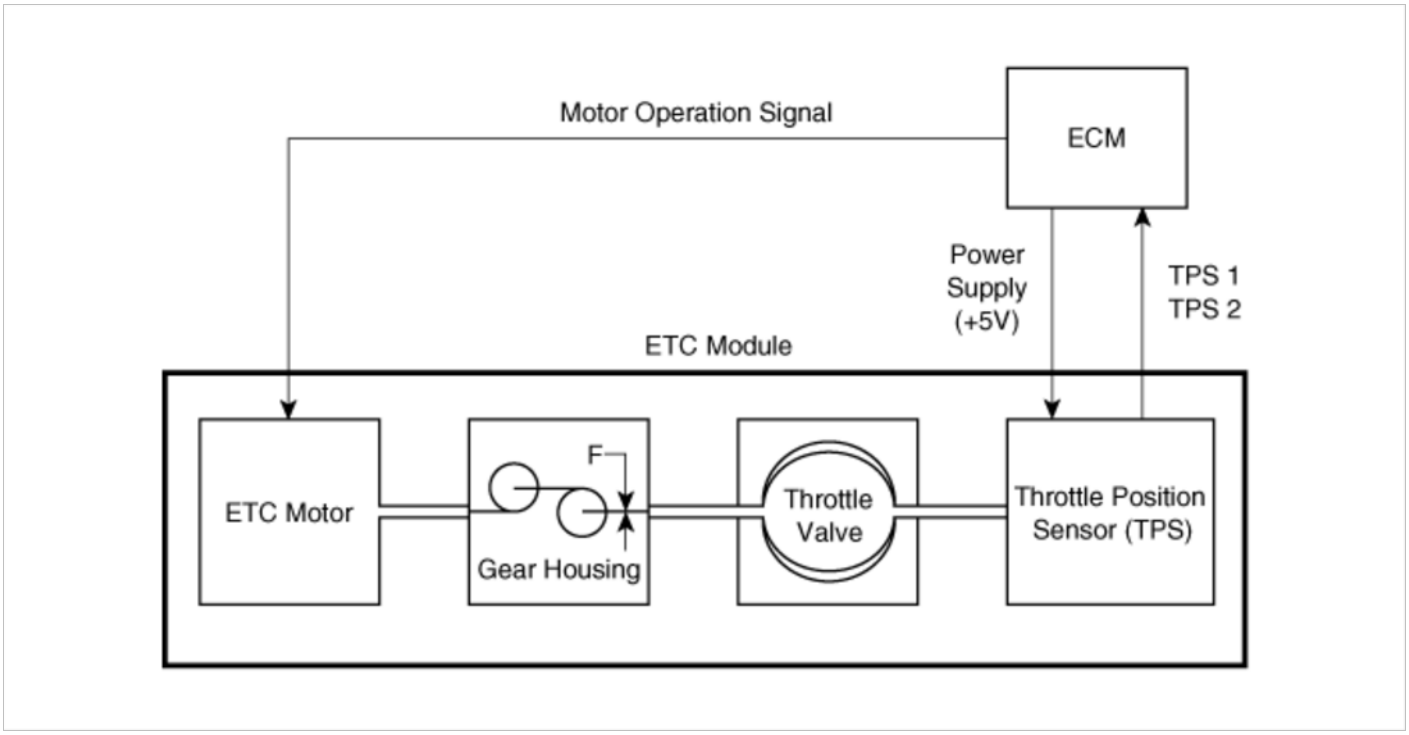
The Electronic Throttle Control (ETC) System consists of a throttle body with an integrated control motor and throttle position sensor (TPS). Instead of the traditional throttle cable, an Accelerator Position Sensor (APS) is used to receive driver input. The ECM uses the APS signal to calculate the target throttle angle; the position of the throttle is then adjusted via ECM control of the ETC motor. The TPS signal is used to provide feedback regarding throttle position to the ECM. Using ETC, precise control over throttle position is possible; the need for external cruise control modules/cables is eliminated.





1. Dry bearing	5. Magnet
2. DC motor	6. Hall IC
3. Non-contact hall sensor	7. Yoke
4. Gear	8. Stator

Schematic Diagram



Fuel System > Engine Control System > ETC (Electronic Throttle Control) System > Troubleshooting

Fail-Safe Mode

Item	Fail-Safe	
ETC Motor	Throttle valve stuck at 7°	
TPS	TPS 1 fault	ECM looks at TPS2
	TPS 2 fault	ECM looks at TPS1
	TPS 1,2 fault	Throttle valve stuck at 7°
APS	APS 1 fault	ECM looks at APS 2
	APS 2 fault	ECM looks at APS 1
	APS 1,2 fault	Engine idle state

NOTE

When throttle value is stuck at 7°, engine speed is limited at below 1,500rpm and vehicle speed at maximum 40 ~ 50 km/h (25 ~ 31 mph)

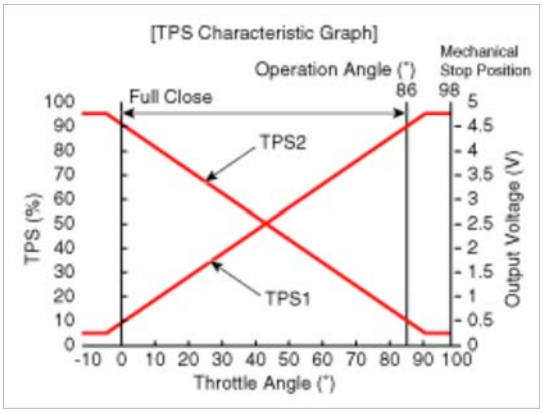
Fuel System > Engine Control System > ETC (Electronic Throttle Control) System > Specifications

Specification

[Throttle Position Sensor (TPS)]

Throttle angle(°)	Output Voltage (V)	
	TPS1	TPS2

0	0.5	4.5
10	0.96	4.05
20	1.41	3.59
30	1.87	3.14
40	2.32	2.68
50	2.78	2.23
60	3.23	1.77
70	3.69	1.32
80	4.14	0.86
90	4.6	0.41
98	4.65	0.35
C.T (0)	0.5	4.5
W.O.T (86)	4.41	0.59



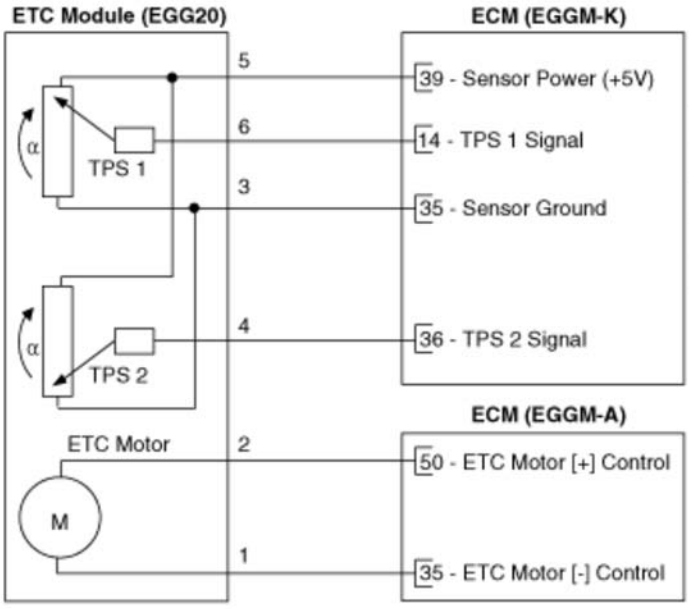
[ETC Motor]

Item	Specification
Coil Resistance (Ω)	0.3 ~100 [20°C(68°F)]

Fuel System > Engine Control System > ETC (Electronic Throttle Control) System > Schematic Diagrams

Circuit Diagram

[Circuit Diagram]

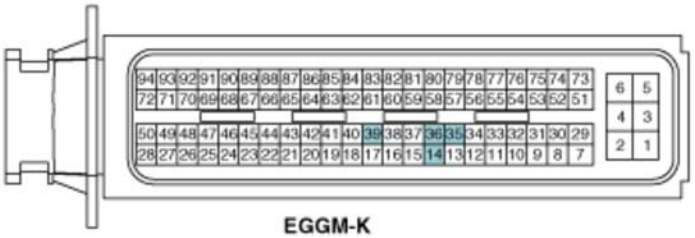


[Connection Information]

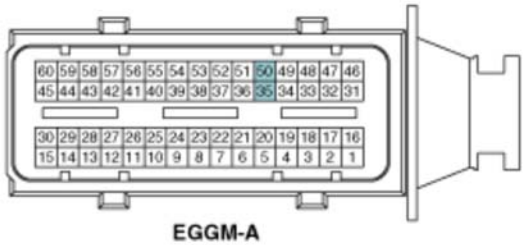
Terminal	Connected to	Function
1	ECM EGGM-A (35)	ETC Motor [-] Control
2	ECM EGGM-A (50)	ETC Motor [+] Control
3	ECM EGGM-K (35)	Sensor Ground
4	ECM EGGM-K (36)	TPS 2 Signal
5	ECM EGGM-K (39)	Sensor Power (+5V)
6	ECM EGGM-K (14)	TPS 1 Signal

[Harness Connector]

EGG20
ETC Module



EGGM-K



EGGM-A
ECM

Fuel System > Engine Control System > ETC (Electronic Throttle Control) System > Repair procedures

Inspection

Throttle Position Sensor (TPS)

1. Connect the GDS on the Data Link Connector (DLC).
2. Start the engine and measure the output voltage of TPS 1 and 2 at C.T. and W.O.T.

Throttle angle(°)	Output Voltage (V)	
	TPS1	TPS2
C.T	0.5	4.5
W.O.T	4.41	0.59

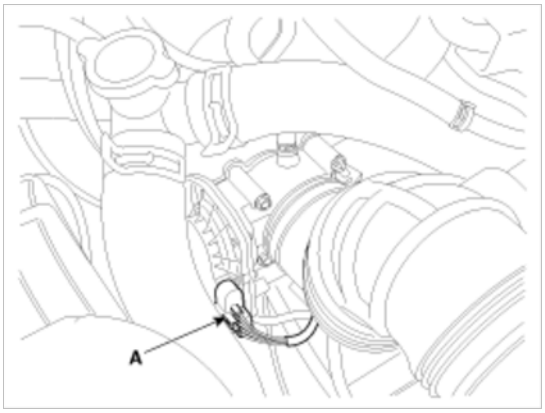
ETC Motor

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

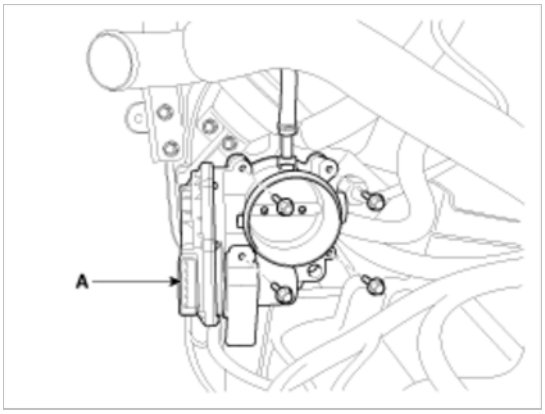
Specification: Refer to “Specification”

Removal

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Remove the resonator and the air intake hose (Refer to “Intake And Exhaust System” in EM group).
3. Disconnect the ETC module connector (A).



4. Remove the installation bolts, and then remove the ETC module (A) from the engine.



Installation

CAUTION

- Install the component with the specified torques.
- Note that internal damage may occur when the component is dropped. If the component has been dropped, inspect before installing.

1. Installation is reverse of removal.

Electronic throttle body Installation bolt:
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)

Adjustment

ETC module learning procedure

When installing new ETC module or re-installing it, ETC module learning procedure must be performed.

1. Hold the ignition key or the start button at th IG ON position during 5 seconds.
2. Turn ignition swich OFF and then start the engine.

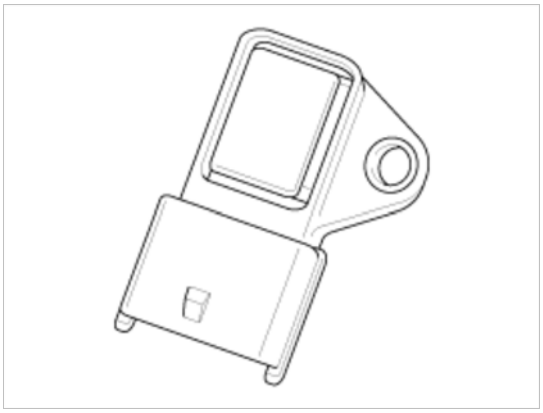
CAUTION

DTC codes (P0638, P2110) might be displayed if ETC module learning procedure does not performed after replacing ETC module.

Fuel System > Engine Control System > Manifold Absolute Pressure Sensor (MAPS) > Description and Operation

Description

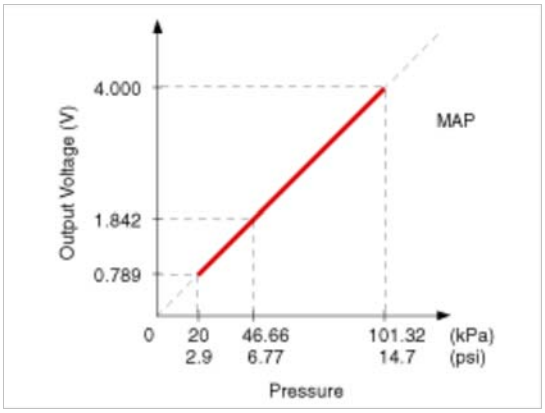
Manifold Absolute Pressure Sensor (MAPS) is a speed-density type sensor and is installed on the surge tank. It senses absolute pressure of the surge tank and transfers the analog signal proportional to the pressure to the ECM. By using this signal, the ECM calculates the intake air quantity and engine 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.



Fuel System > Engine Control System > Manifold Absolute Pressure Sensor (MAPS) > Specifications

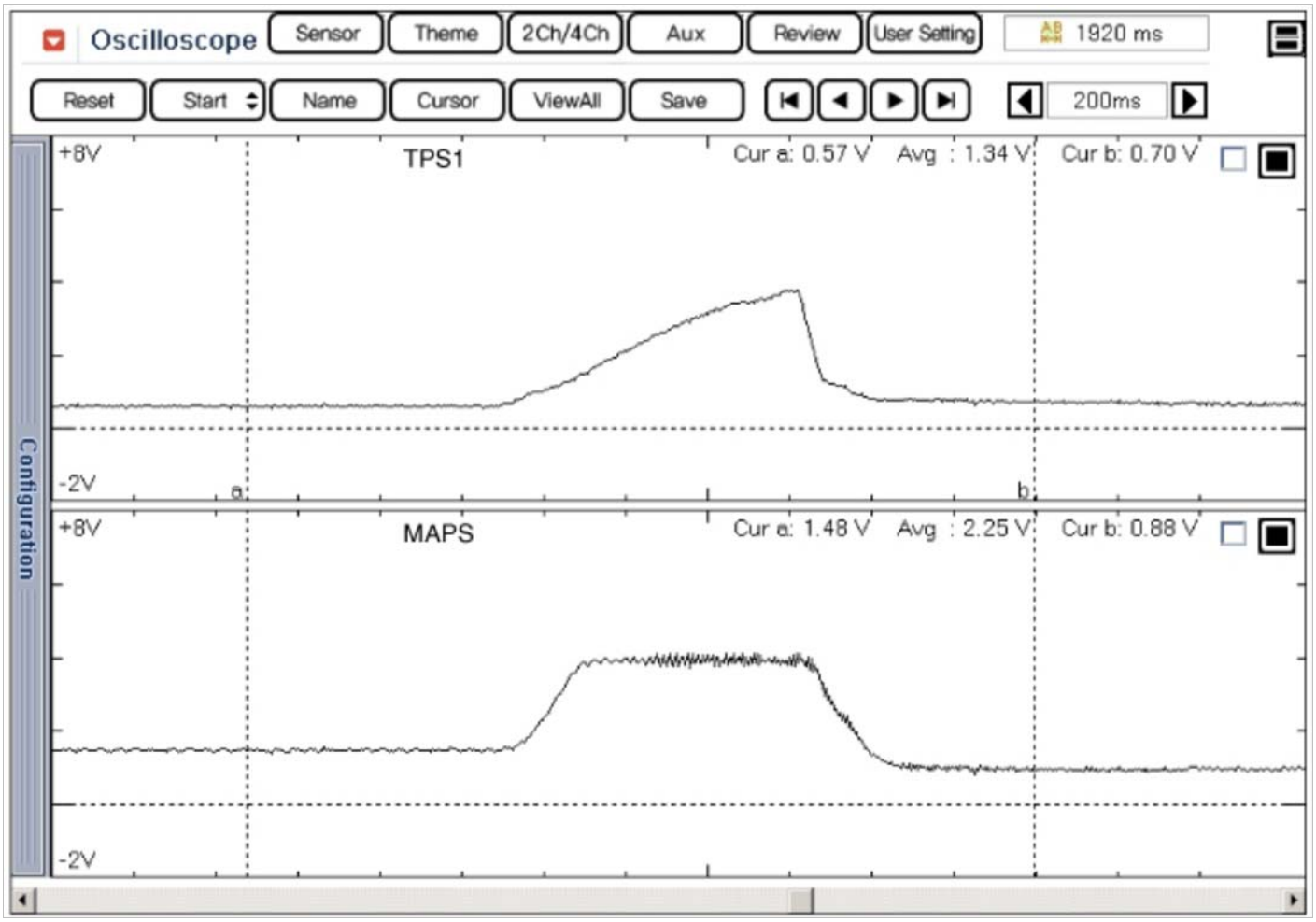
Specification

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



Fuel System > Engine Control System > Manifold Absolute Pressure Sensor (MAPS) > Troubleshooting

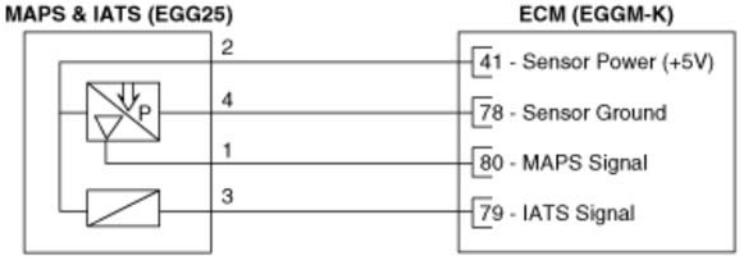
Signal Waveform



Fuel System > Engine Control System > Manifold Absolute Pressure Sensor (MAPS) > Schematic Diagrams

Circuit Diagram

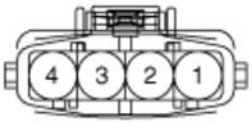
[Circuit Diagram]



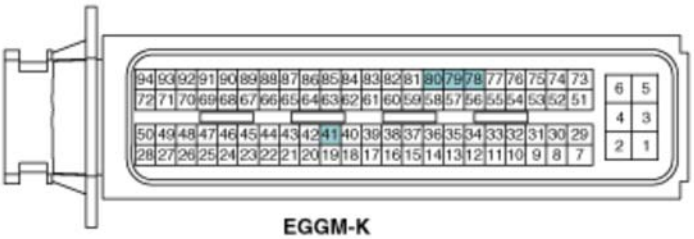
[Connection Information]

Terminal	Connected to	Function
1	ECM EGGM-K (80)	MAPS Signal
2	ECM EGGM-K (41)	Sensor Power (+5V)
3	ECM EGGM-K (79)	IATS Signal
4	ECM EGGM-K (78)	Sensor Ground

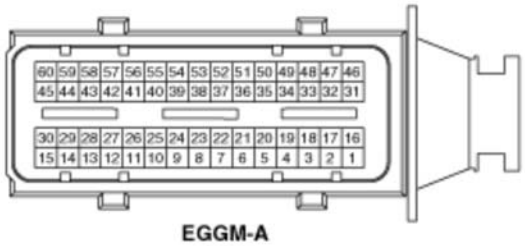
[Harness Connector]



EGG25
MAPS & IATS



EGGM-K



EGGM-A
ECM

Fuel System > Engine Control System > Manifold Absolute Pressure Sensor (MAPS) > Repair procedures

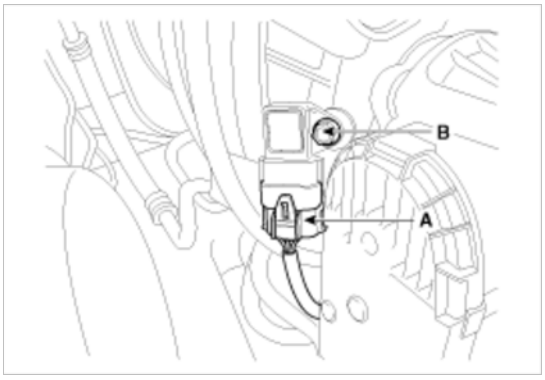
Inspection

1. Connect the GDS on the Data Link Connector (DLC).
2. Measure the output voltage of the MAPS at idle and IG ON.

Specification: Refer to "Specification"

Removal

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Disconnect the manifold absolute pressure sensor connector (A).
3. 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.

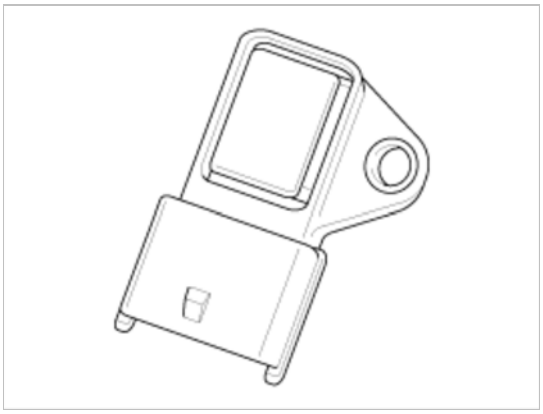
1. Installation is reverse of removal.

Manifold absolute pressure sensor installation bolt:
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)

Fuel System > Engine Control System > Intake Air Temperature Sensor (IATS) > Description and Operation

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) Thermister and it's resistance changes in reverse proportion to the temperature.



Fuel System > Engine Control System > Intake Air Temperature Sensor (IATS) >

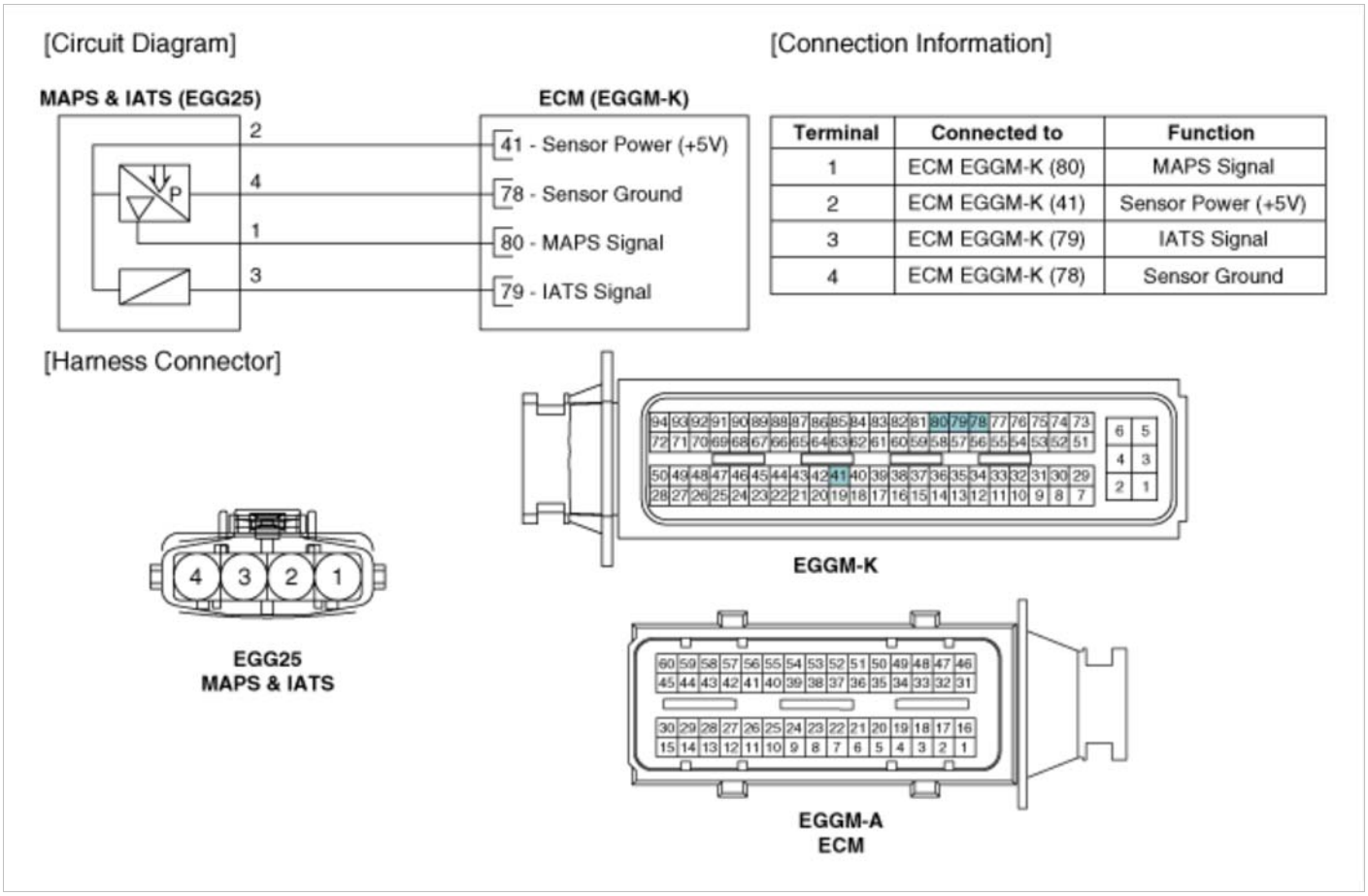
Specifications

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
50	122	1.56 ~ 1.74
60	140	0.54 ~ 0.62
80	176	0.29 ~ 0.34

Fuel System > Engine Control System > Intake Air Temperature Sensor (IATS) > Schematic Diagrams

Circuit Diagram



Fuel System > Engine Control System > Intake Air Temperature Sensor (IATS) > Repair procedures

Inspection

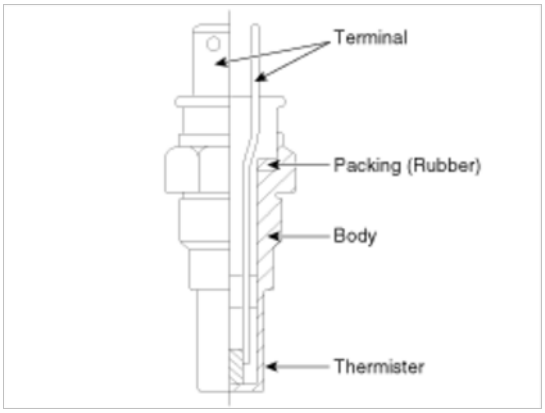
1. Turn the ignition switch OFF.
2. Disconnect the IATS connector.
3. Measure resistance between the IATS terminals 3 and 4.
4. Check that the resistance is within the specification.

Specification: Refer to “Specification”

Fuel System > Engine Control System > Engine Coolant Temperature Sensor (ECTS) > Description and Operation

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.



Fuel System > Engine Control System > Engine Coolant Temperature Sensor (ECTS) > Specifications

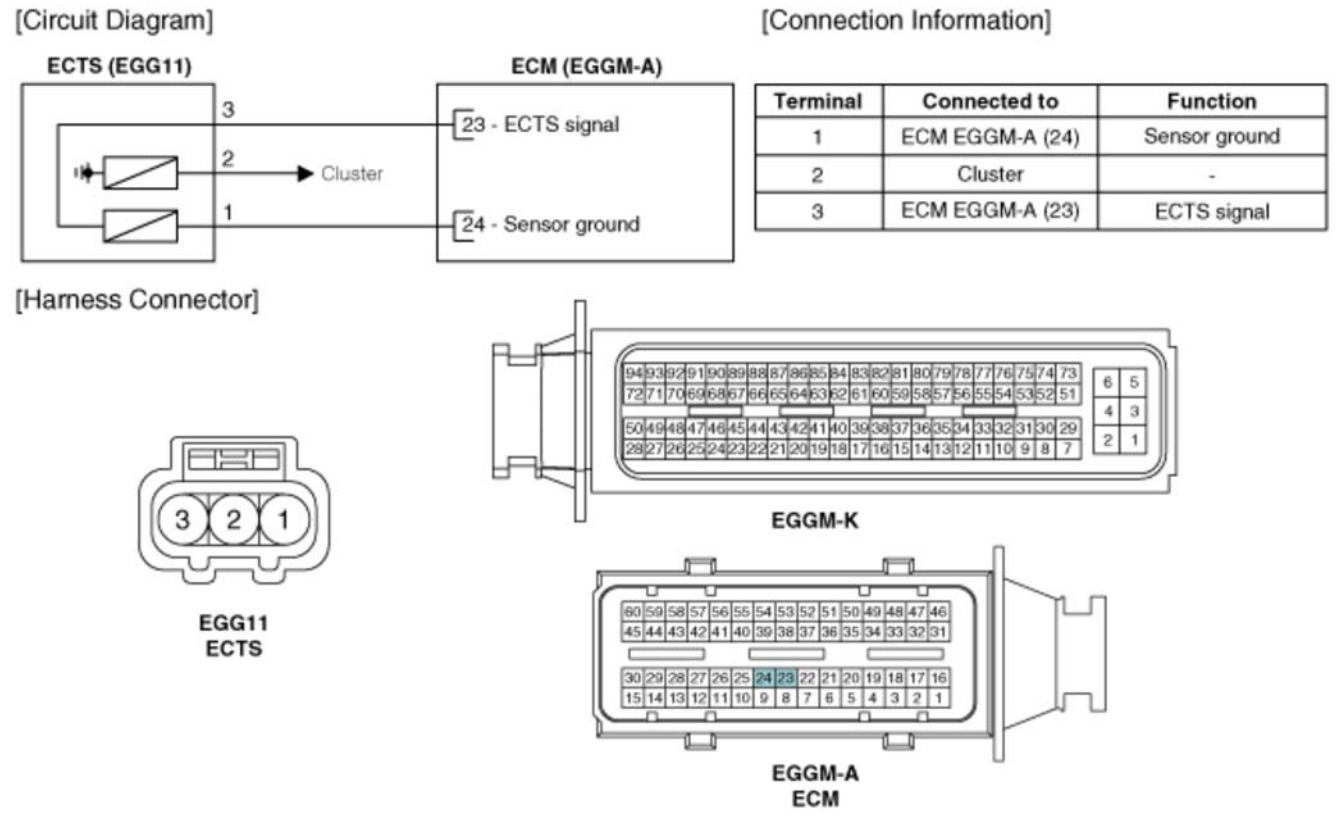
Specification

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

Fuel System > Engine Control System > Engine Coolant Temperature Sensor (ECTS) > Schematic Diagrams

Circuit Diagram



Fuel System > Engine Control System > Engine Coolant Temperature Sensor (ECTS) > Repair procedures

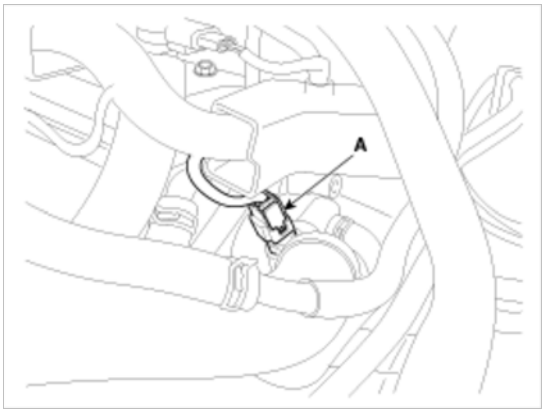
Inspection

1. Turn the ignition switch OFF.
2. Remove the ECTS (Refer to "Removal").
3. After immersing the thermistor of the sensor into engine coolant, measure resistance between the ECTS terminals 3 and 4.
4. Check that the resistance is within the specification.

Specification: Refer to “Specification”

Removal

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Disconnect the engine coolant temperature sensor connector (A).



3. Supplement the engine coolant (Refer to “Cooling System” in EM group).

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.

1. Installation is reverse of removal.

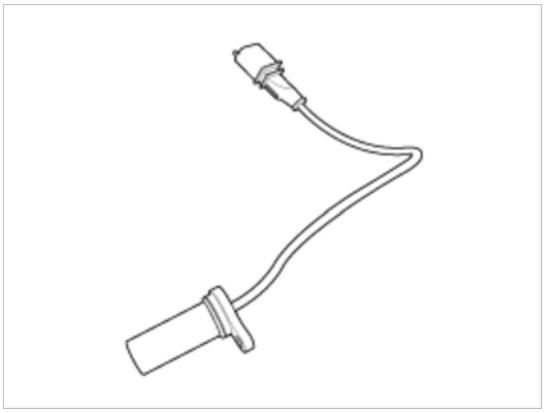
Engine Coolant Temperature Sensor installation :
19.6 ~ 39.2 N.m (2.0 ~ 4.0 kgf.m, 14.4 ~ 28.9 lb-ft)

Fuel System > Engine Control System > Crankshaft Position Sensor (CKPS) > Description and Operation

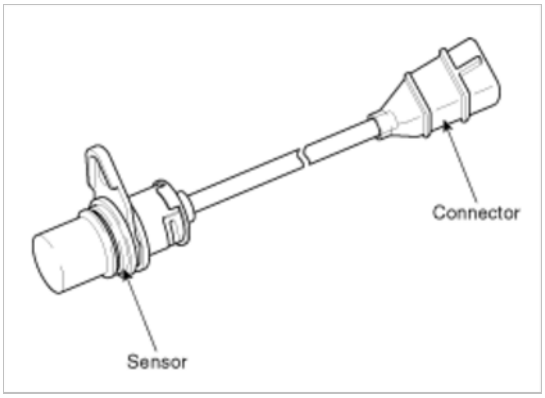
Description

Crankshaft Position Sensor (CKPS) detects the crankshaft position and is one of the most important sensors of the engine control system. If there is no CKPS signal input, the engine may stop because of CKPS signal missing.
This sensor is installed in ladder frame and generates alternating current by magnetic flux field which is made by the sensor and the target wheel when the engine rotates. The target wheel consists of 58 slots and 2 missing slots on 360 CA (Crank Angle). In case of ISG, the ISG function get reliable information about crank shaft position during all modes of operation. The CKPS in ISG function ensures short restarting time for engine and efficient combustion.

[ISG]



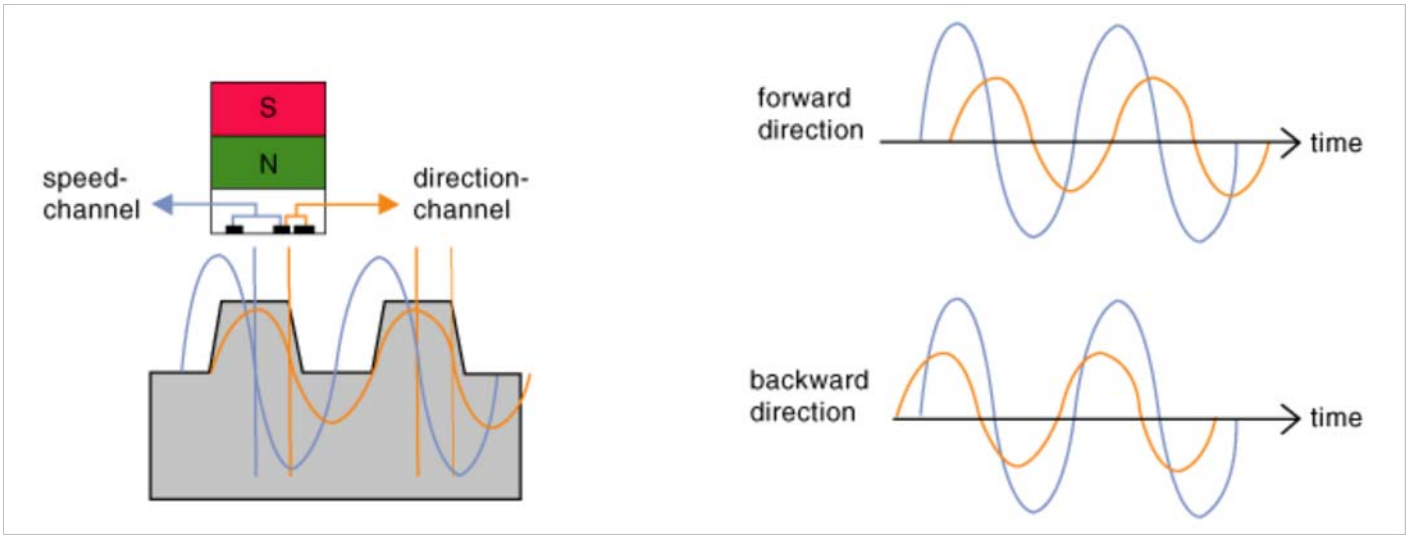
[NON - ISG]



Operation

[ISG]

Two separate differential channels for speed and direction information respectively.
Phase separation of the 2 channels delivers information on rotation direction.



Fuel System > Engine Control System > Crankshaft Position Sensor (CKPS) > Specifications

Specification

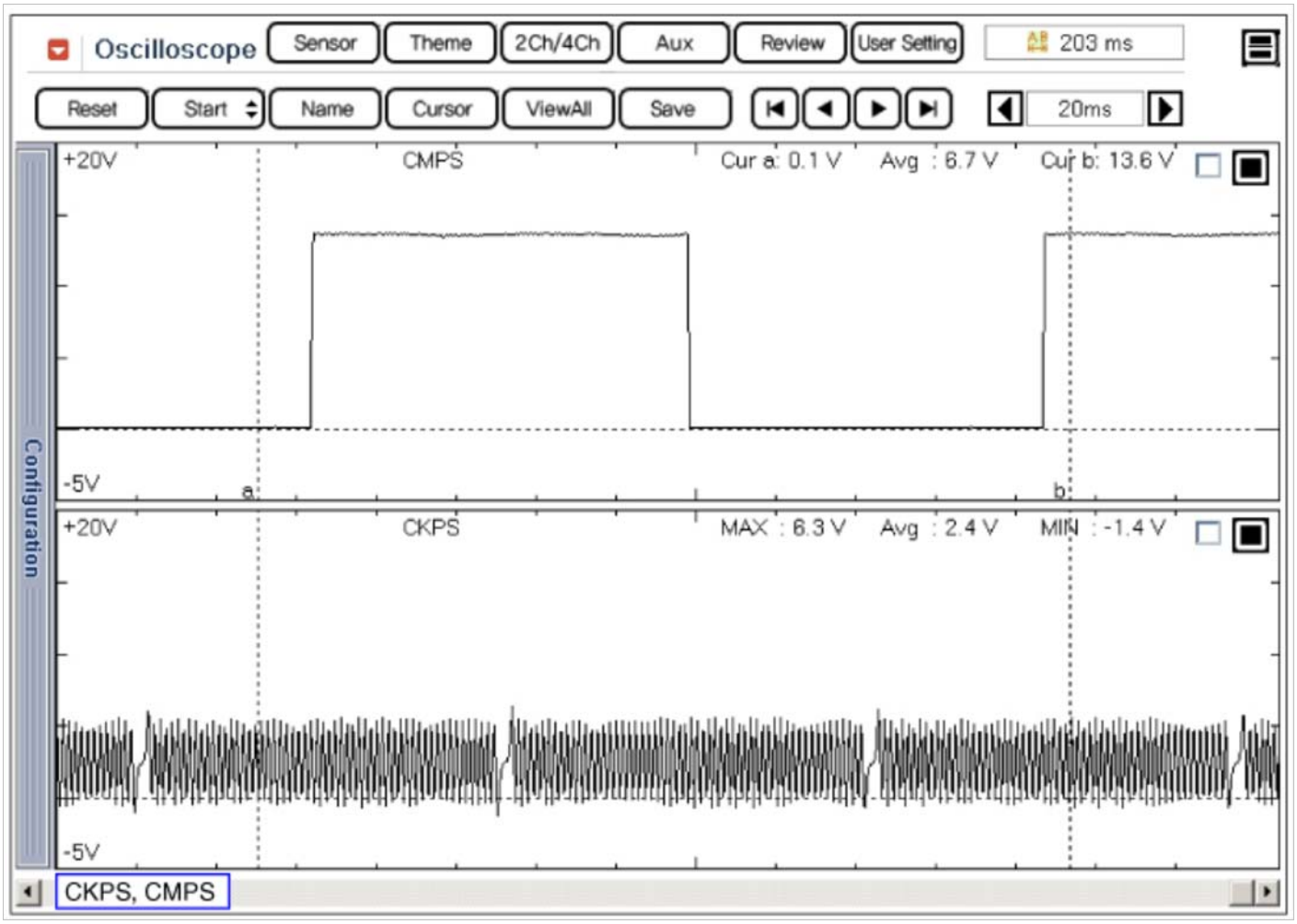
[ISG]

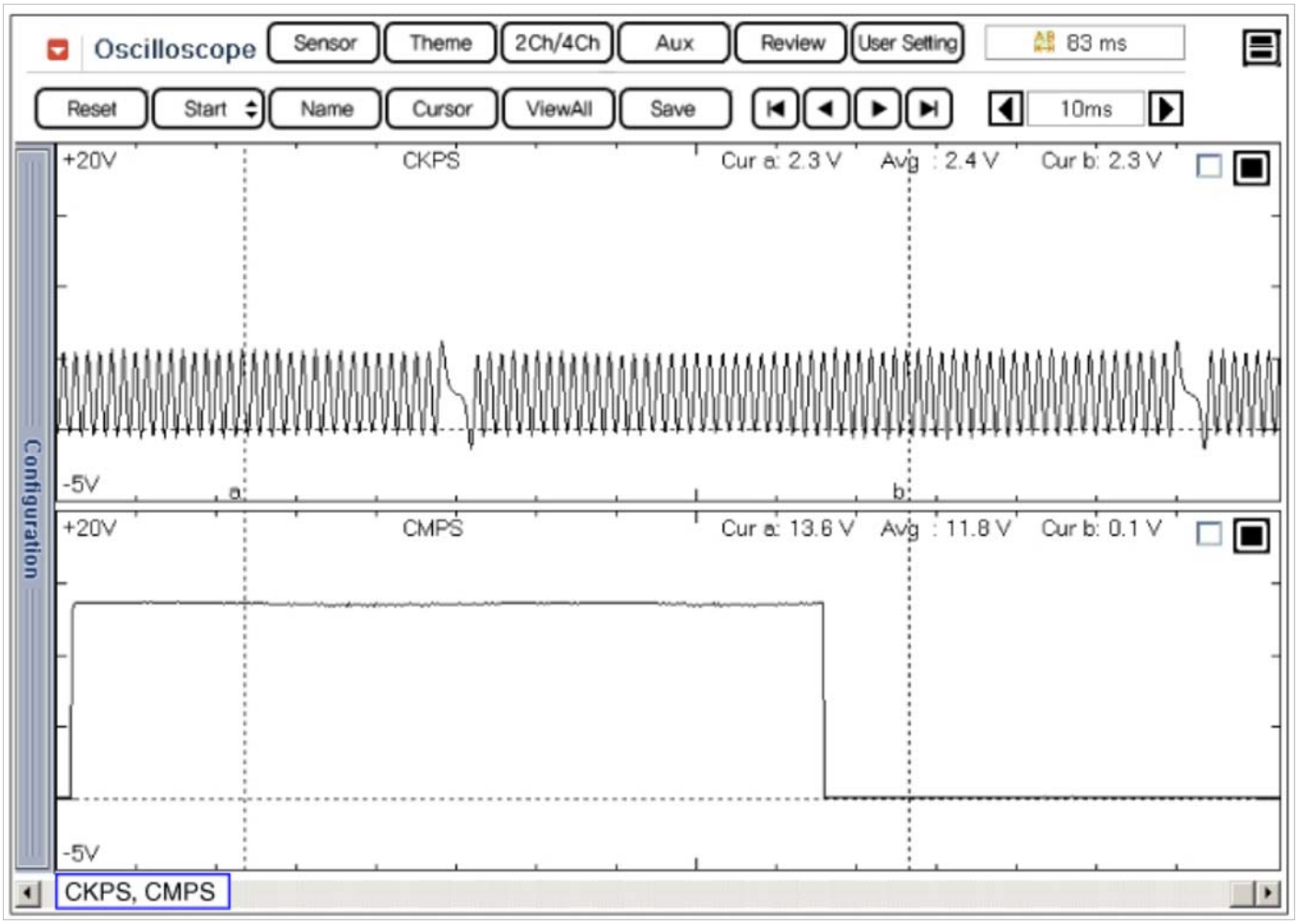
Item	Specification
Coil Resistance (Ω)	774 ~ 946 [20°C (68°F)]

Fuel System > Engine Control System > Crankshaft Position Sensor (CKPS) > Troubleshooting

Waveform

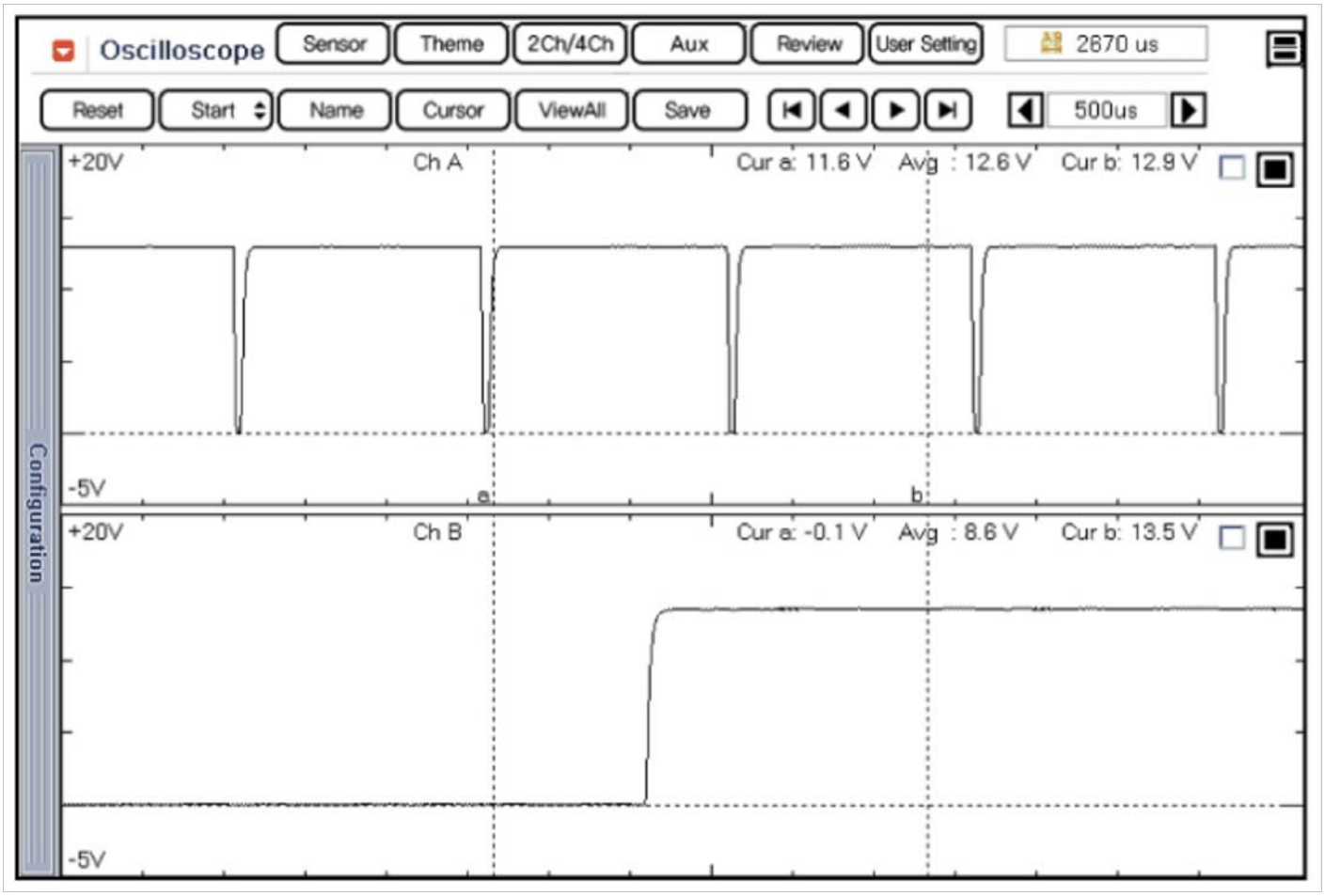
[NON-ISG]





This example shows a typical Crankshaft Position Sensor(CkPS) and Camshaft Position Sensor(CMPS) waveform at idle.The PCM controls the injection and ignition timing by using these signals.
Generally CkPS signal is used to detect the piston's position and CMPS signal is used to detect the Top Dead Center of each cylinder.

[ISG]



This example shows a typical Crankshaft Position Sensor (CKPS) and Camshaft Position Sensor (CMPS) waveform at idle.

Fuel System > Engine Control System > Crankshaft Position Sensor (CKPS) > Schematic Diagrams

Circuit Diagram

[NON - ISG]

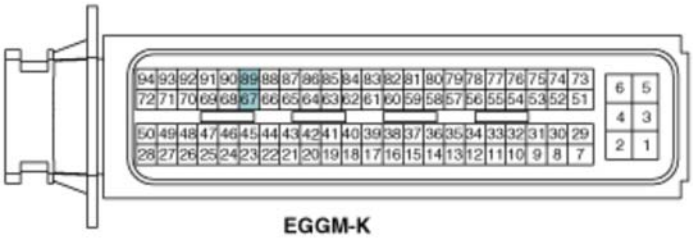
[Circuit Diagram]

[Conection Information]

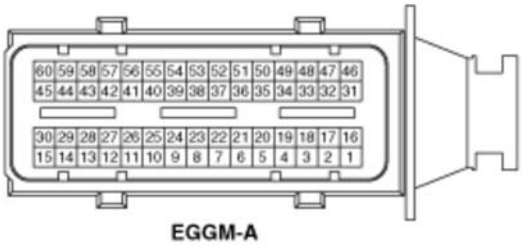
Terminal	Conected to	Function
1	ECM EGGM-K (67)	Sensor ground
2	ECM EGGM-K (89)	CKPS Signal

[Harness Connector]

EGG14-1
CKPS



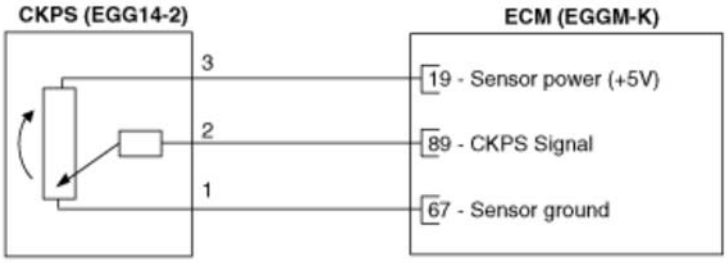
EGGM-K



EGGM-A
ECM

[ISG]

[Circuit Diagram]

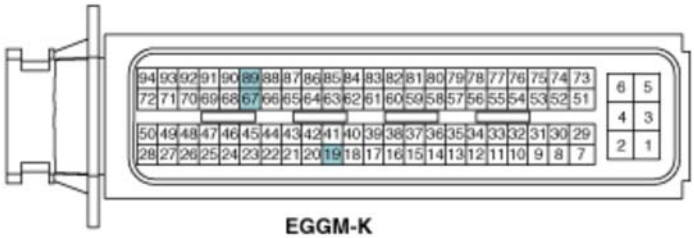


[Connection Information]

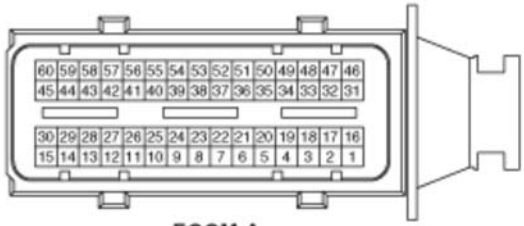
Terminal	Connected to	Function
1	ECM EGGM-K (67)	Sensor Ground
2	ECM EGGM-K (89)	CKPS Signal
3	ECM EGGM-K (19)	Sensor power (+5V)

[Harness Connector]

EGG14-2
CKPS



EGGM-K



EGGM-A
ECM

Fuel System > Engine Control System > Crankshaft Position Sensor (CKPS) > Repair procedures

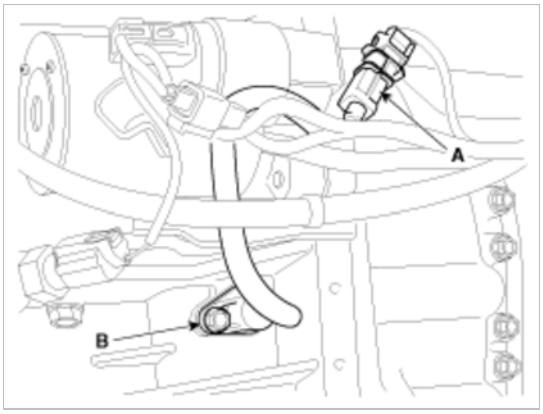
Inspection

1. Check signal waveform of CKPS and CMPS using a GDS.

Specification: Refer to “Waveform”

Removal

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Disconnect the crankshaft position sensor connector (A) and remove the sensor (B) after removing the installation bolt.



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.

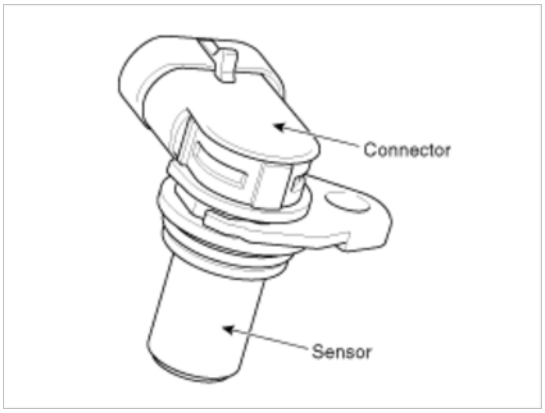
1. Installation is reverse of removal.

Crankshaft position sensor installation bolt:
7.8 ~ 11.8 N.m (0.8 ~ 1.2 kgf.m, 5.8 ~ 8.7 lb-ft)

Fuel System > Engine Control System > Camshaft Position Sensor (CMPS) > Description and Operation

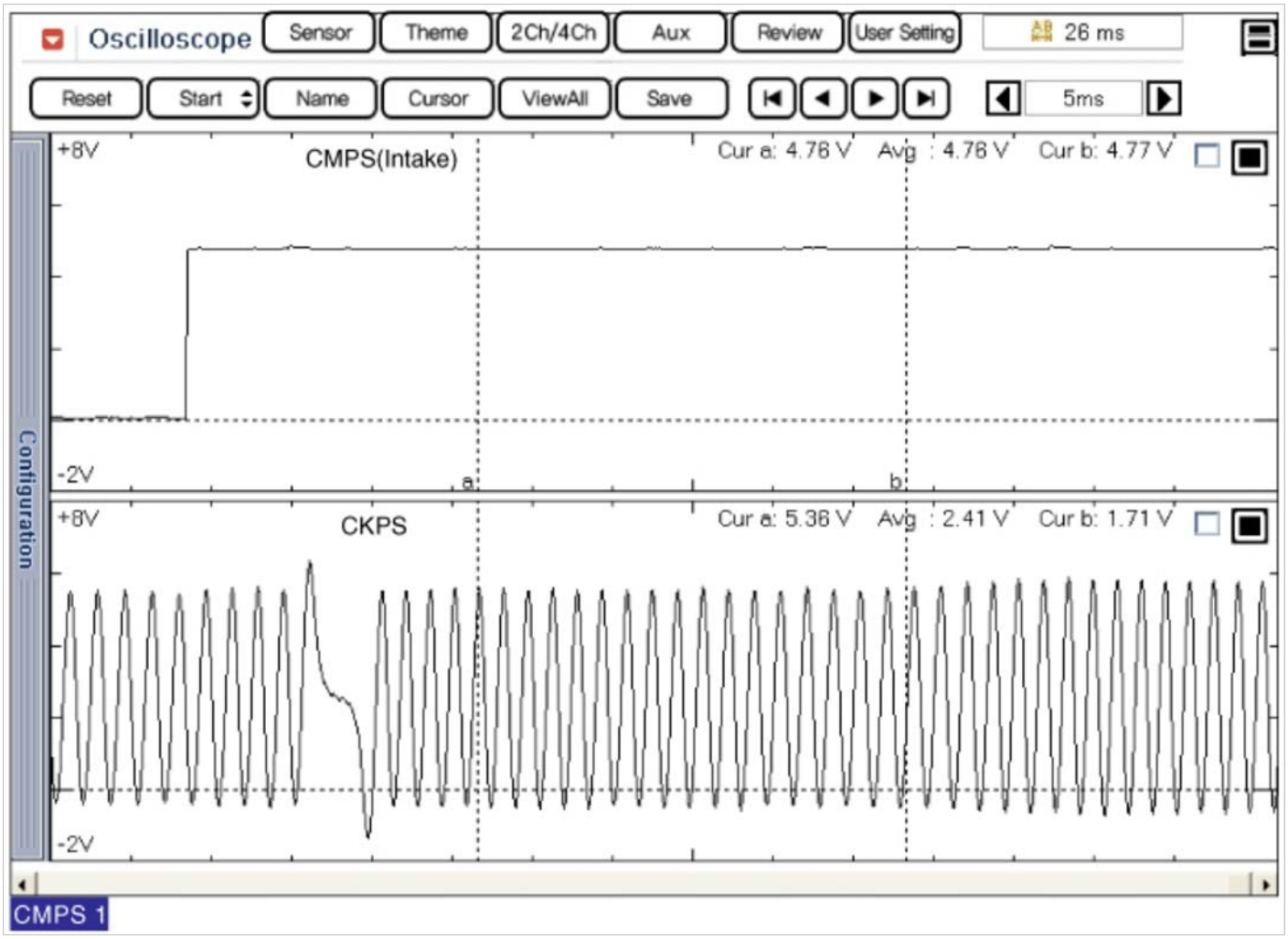
Description

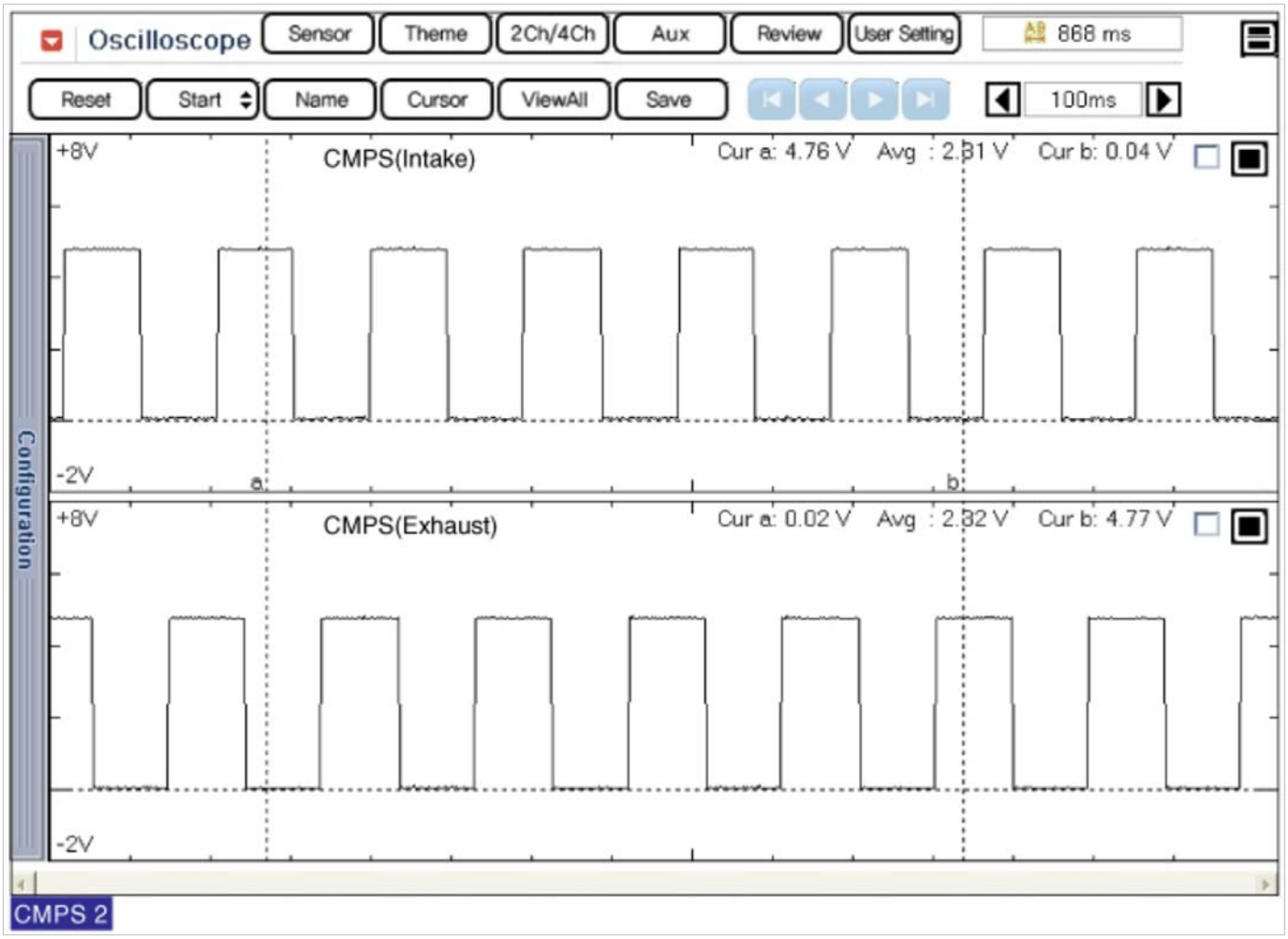
Camshaft Position Sensor (CMPS) is a hall sensor and detects the camshaft position by using a hall element.
It is related with Crankshaft Position Sensor (CKPS) and detects the piston position of each cylinder which the CKPS can't detect.
The CMPS is installed on engine head cover and uses a target wheel 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.



Fuel System > Engine Control System > Camshaft Position Sensor (CMPS) > Troubleshooting

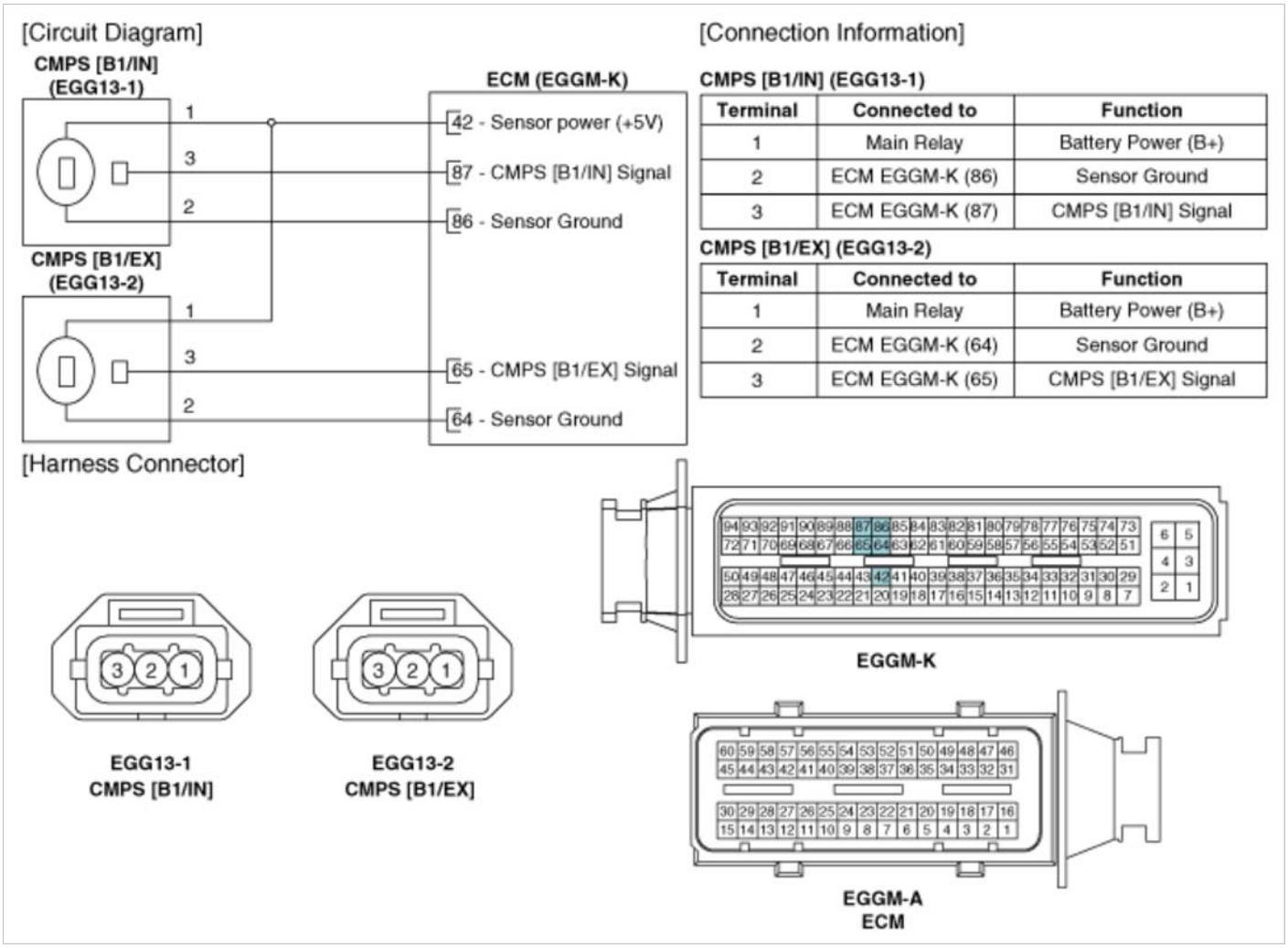
Wave Form





Fuel System > Engine Control System > Camshaft Position Sensor (CMPS) > Schematic Diagrams

Circuit Diagram



[Connection Information]

CMPS [B1/IN] (EGG13-1)

Terminal	Connected to	Function
1	Main Relay	Battery Power (B+)
2	ECM EGGM-K (86)	Sensor Ground
3	ECM EGGM-K (87)	CMPS [B1/IN] Signal

CMPS [B1/EX] (EGG13-2)

Terminal	Connected to	Function
1	Main Relay	Battery Power (B+)
2	ECM EGGM-K (64)	Sensor Ground
3	ECM EGGM-K (65)	CMPS [B1/EX] Signal

Fuel System > Engine Control System > Camshaft Position Sensor (CMPS) > Repair procedures

Inspection

1. Check the signal waveform of the CMPS and CKPS using the GDS.

Specification: Refer to “Wave Form”

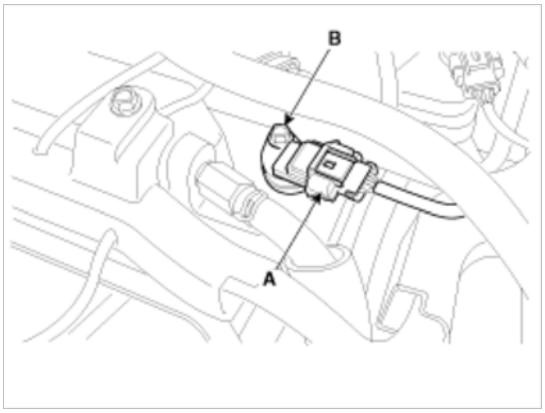
Removal

WARNING

- DON’T remove the camshaft position sensor while the engine is running or right after engine is turned off. The part and engine oil is hot and can cause burns.

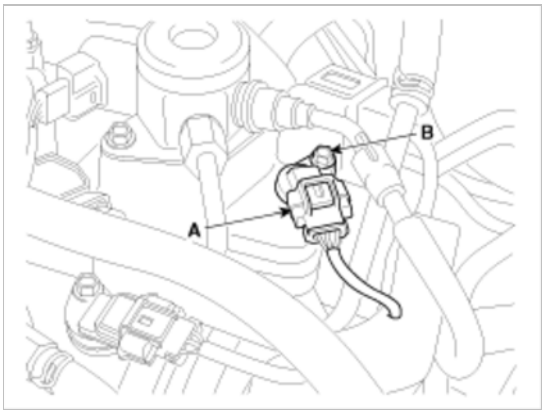
[Bank 1 / Intake]

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Disconnect the camshaft position sensor connector (A).
3. Remove the installation bolt (B), and then remove the sensor.



[Bank 1 / Exhaust]

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Disconnect the camshaft position sensor connector (A).
3. Remove the hanger and the protector.
4. 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.

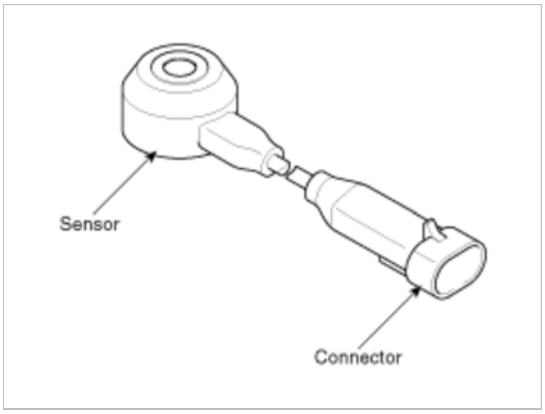
1. Installation is reverse of removal.

Camshaft position sensor installation bolt:
7.8 ~ 11.8 N.m (0.8 ~ 1.2 kgf.m, 5.8 ~ 8.7 lb-ft)

Fuel System > Engine Control System > Knock Sensor (KS) > Description and Operation

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.



Fuel System > Engine Control System > Knock Sensor (KS) > Specifications

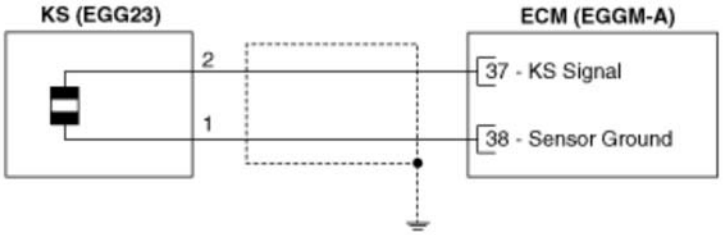
Specification

Item	Specification
Capacitance (pF)	950 ~ 1,350
Resistance (MΩ)	4.87

Fuel System > Engine Control System > Knock Sensor (KS) > Schematic Diagrams

Circuit Diagram

[Circuit Diagram]

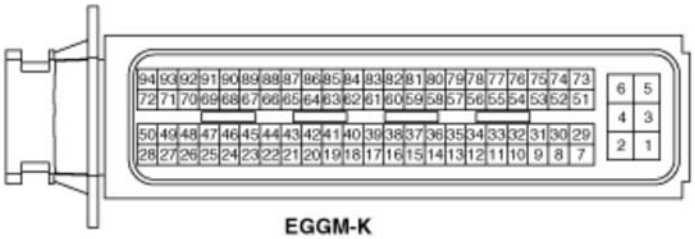


[Connection Information]

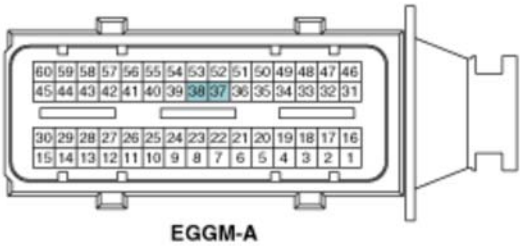
Terminal	Connected to	Function
1	ECM EGGM-A (38)	Sensor Ground
2	ECM EGGM-A (37)	KS Signal

[Harness Connector]

EGG23
Knock Sensor



EGGM-K

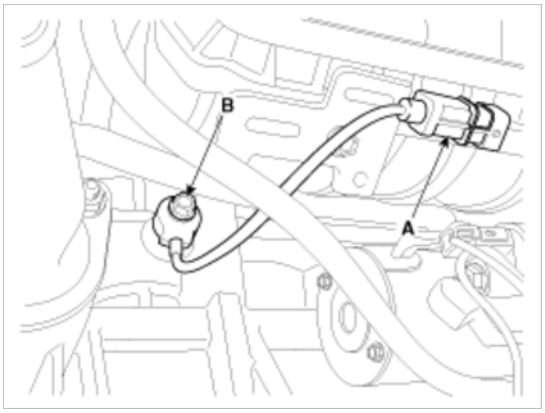


EGGM-A
ECM

Fuel System > Engine Control System > Knock Sensor (KS) > Repair procedures

Removal

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Remove the intake manifold (Refer to “Intake And Exhaust System” in EM group).
3. Disconnect the injector connector (A).
4. 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.

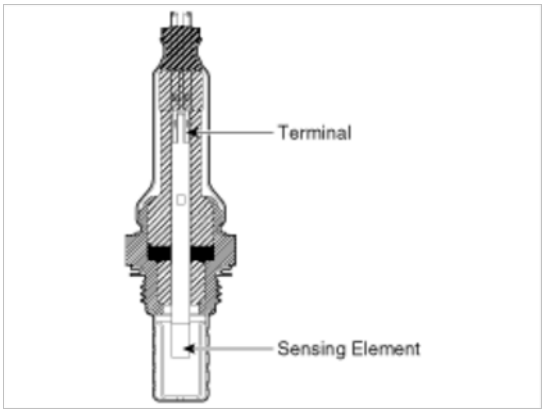
1. Installation is reverse of removal.

Knock sensor installation bolt:
18.6 ~ 24.5 N.m (1.9 ~ 2.5 kgf.m, 13.7 ~ 18.1 lb-ft)

Fuel System > Engine Control System > Heated Oxygen Sensor (HO2S) > Description and Operation

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.



Fuel System > Engine Control System > Heated Oxygen Sensor (HO2S) > Specifications

Specification

HO2S [Bank 1/Sensor 1]

Item	Specification
Heater Resistance (Ω)	2.4 ~ 4.0 [20°C(68°F)]

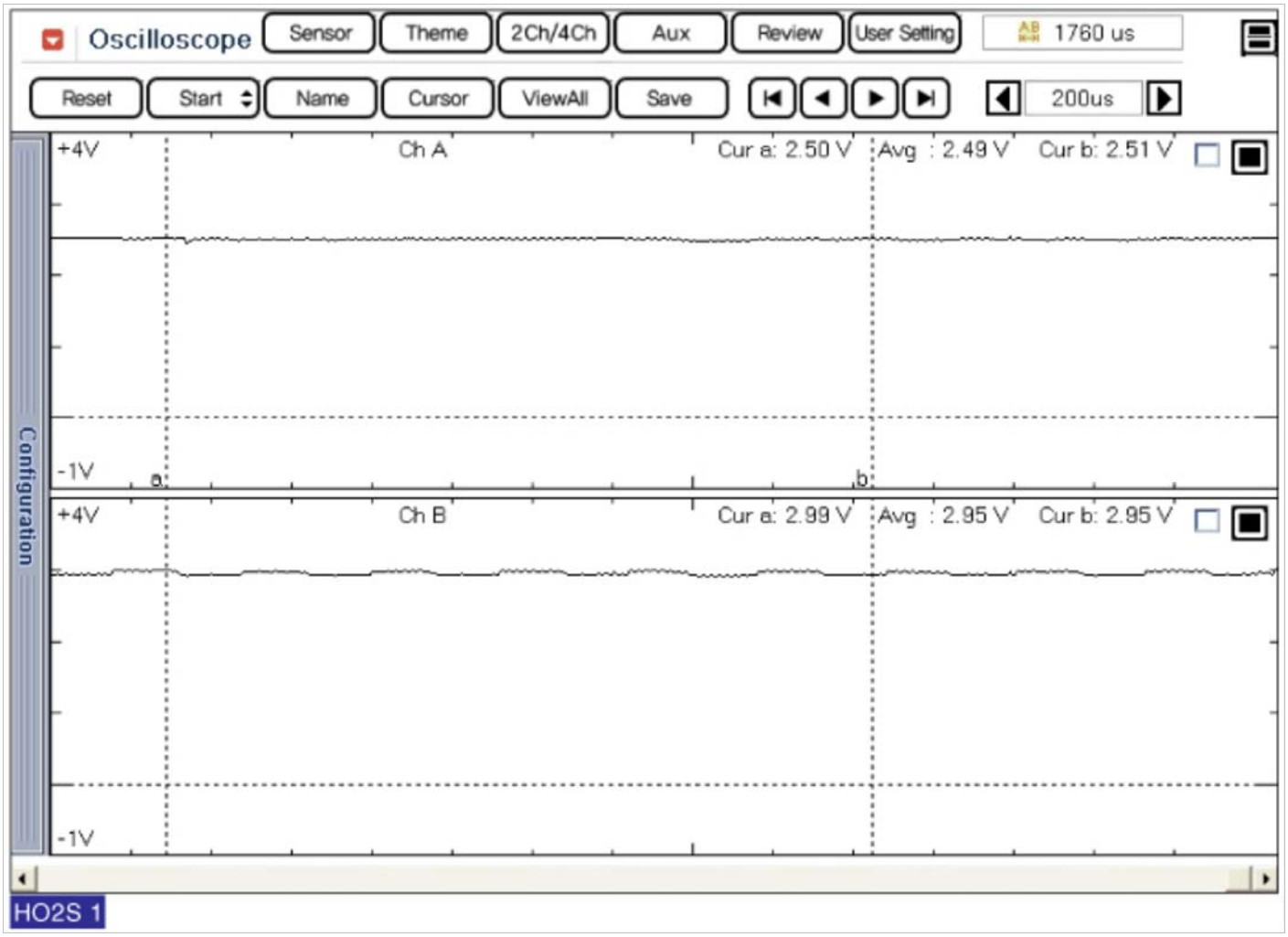
HO2S [Bank 1/Sensor 2]

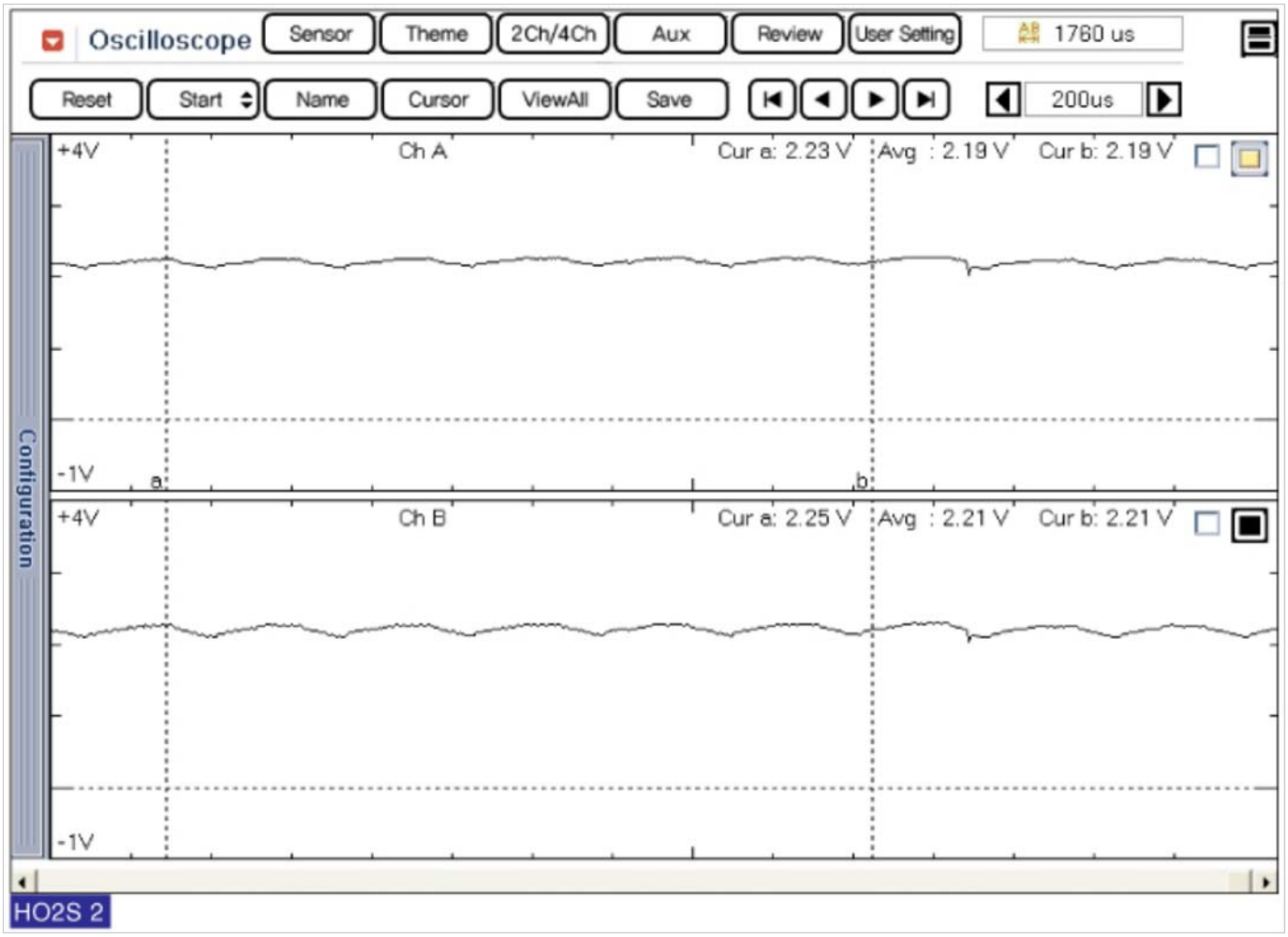
A/F Ratio (λ)	Output Voltage(V)
RICH	0.6 ~ 1.0
LEAN	0 ~ 0.4

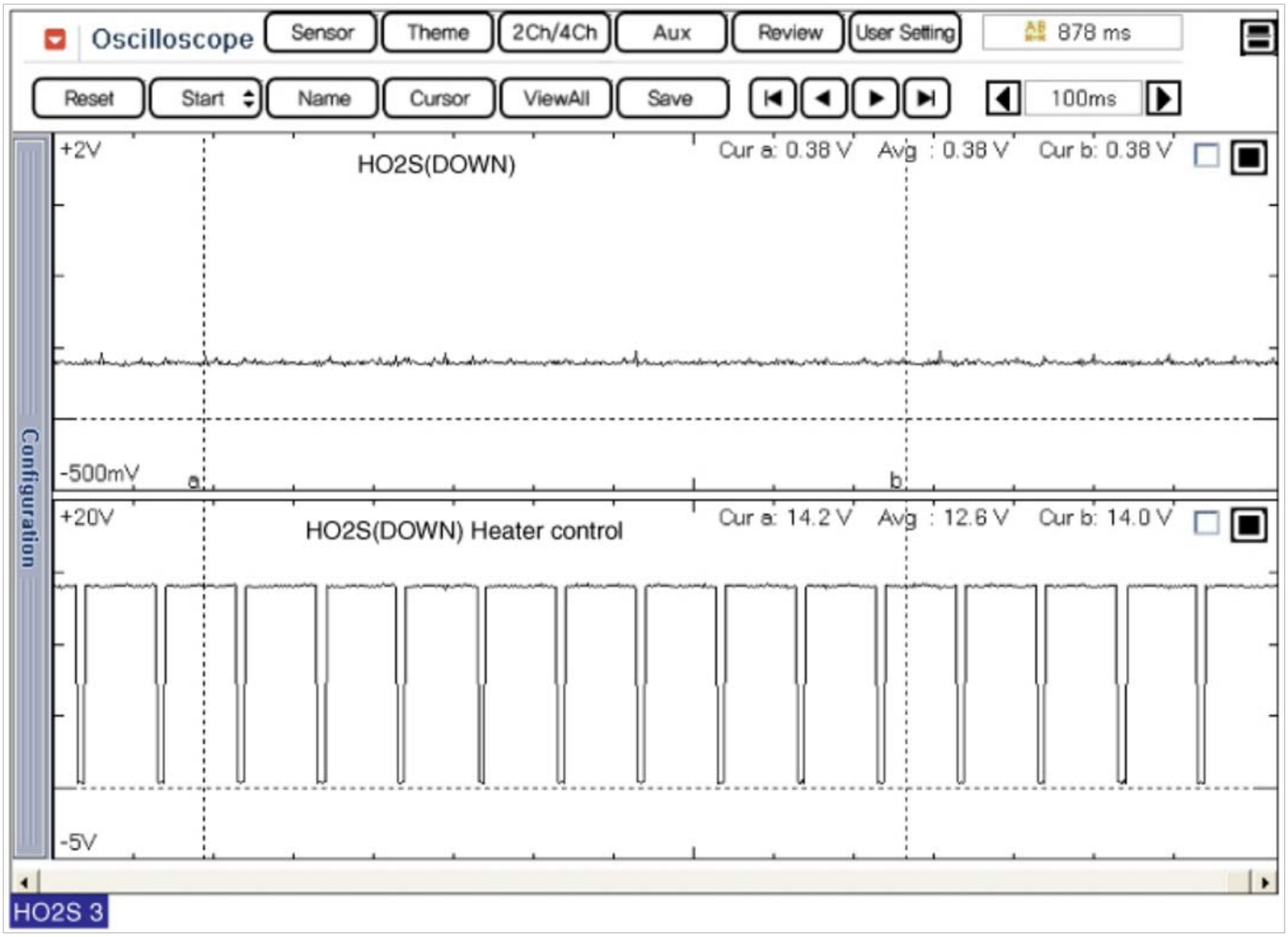
Item	Specification
Heater Resistance (Ω)	Approx. 9.0 [21°C(69.8°F)]

Fuel System > Engine Control System > Heated Oxygen Sensor (HO2S) > Troubleshooting

Signal Waveform



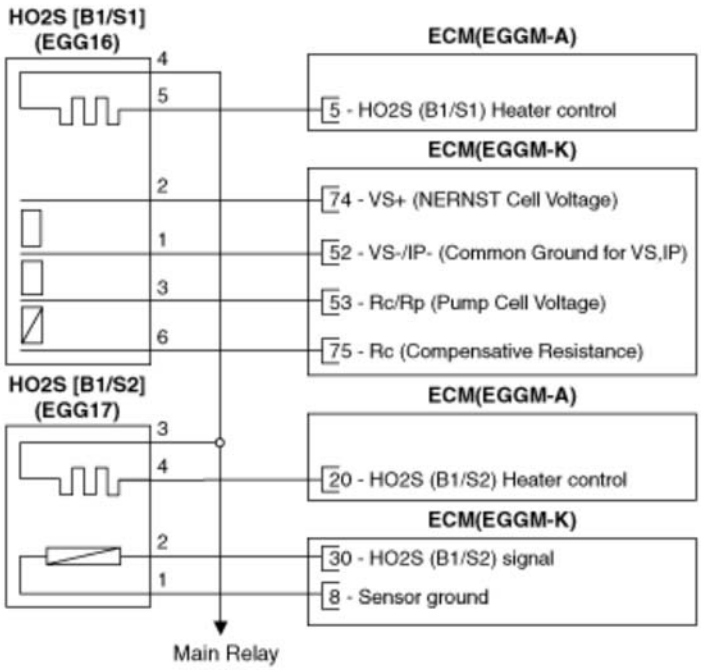

Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
1760 us
Reset
Start
Name
Cursor
ViewAll
Save
200us
Configuration
+4V
Ch A
Cur a: 2.23 V
Avg : 2.19 V
Cur b: 2.19 V
-1V
a
b
+4V
Ch B
Cur a: 2.25 V
Avg : 2.21 V
Cur b: 2.21 V
-1V
HO2S 2



Fuel System > Engine Control System > Heated Oxygen Sensor (HO2S) > Schematic Diagrams

Circuit Diagram

[Circuit Diagram]



[Connection Information]

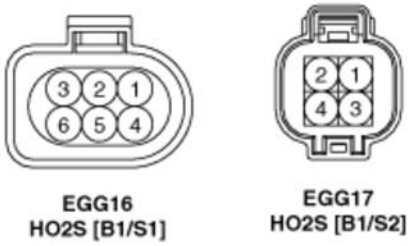
HO2S [B1/S1] (EGG16)

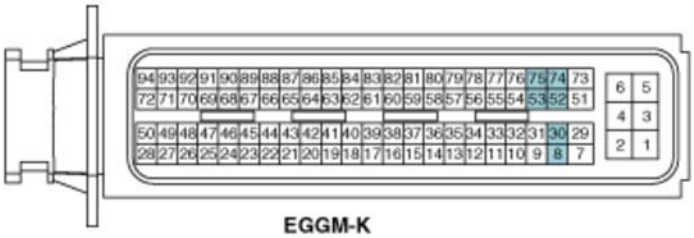
Terminal	Connected to	Function
1	ECM EGGM-K (52)	VS-/IP- (Common Ground for VS,IP)
2	ECM EGGM-K (74)	VS+ (NERNST Cell Voltage)
3	ECM EGGM-K (53)	Rc/Rp (Pump Cell Voltage)
4	Main Relay	Power Supply (B+)
5	ECM EGGM-A (5)	Heater control
6	ECM EGGM-K (75)	Rc (Compensative Resistance)

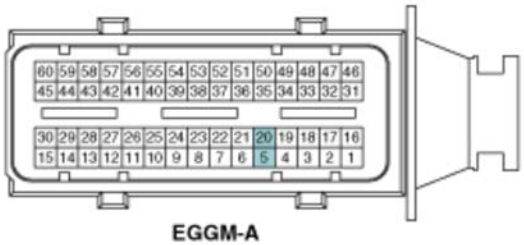
HO2S [B1/S2] (EGG17)

Terminal	Connected to	Function
1	ECM EGGM-K (8)	Sensor Ground
2	ECM EGGM-K (30)	HO2S (B1/S2) Signal
3	Main Relay	Power Supply (B+)
4	ECM EGGM-A (20)	Heater control

[Harness Connector]







Fuel System > Engine Control System > Heated Oxygen Sensor (HO2S) > Repair procedures

Inspection

1. Turn the ignition switch OFF.
2. Disconnect the HO2S connector.
3. Measure resistance between the HO2S terminals 4 and 5 [B1/S1].
4. Measure resistance between the HO2S terminals 3 and 4 [B1/S2].
5. Check that the resistance is within the specification.

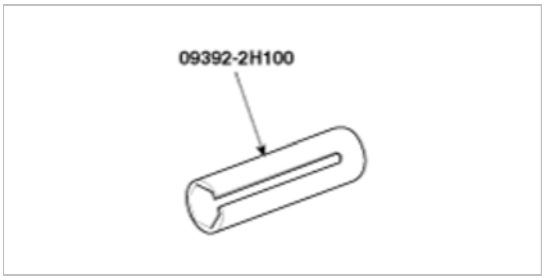
Specification: Refer to “Specification”

Removal

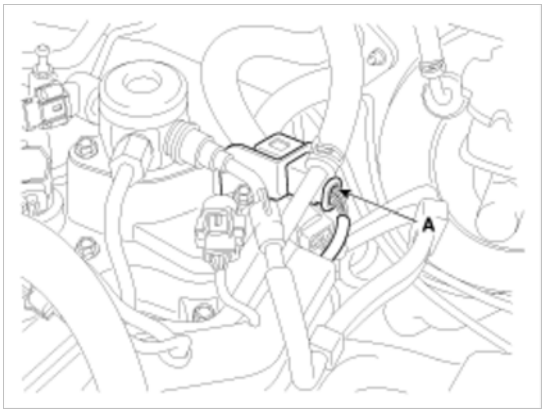
1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Disconnect the connector (A), and then remove the sensor (B).

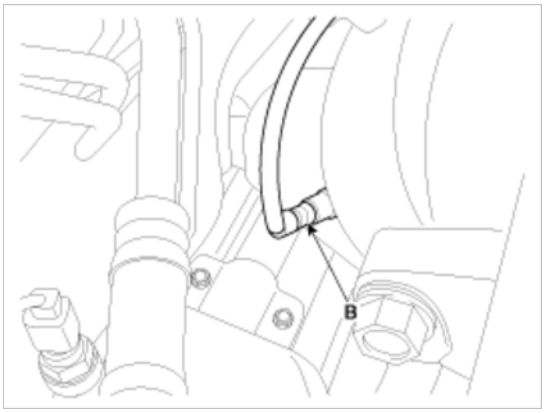
NOTE

Note that the SST (Part No.: 09392-2H100) is useful when removing the heated oxygen sensor.

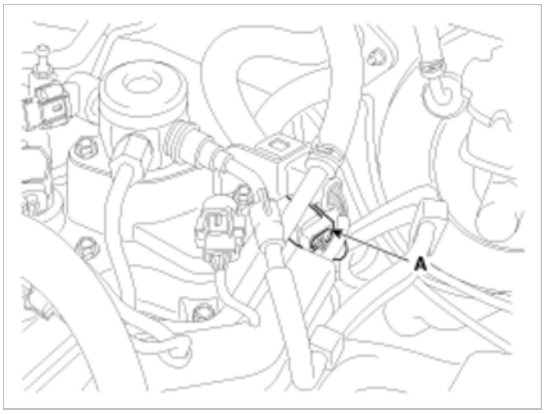


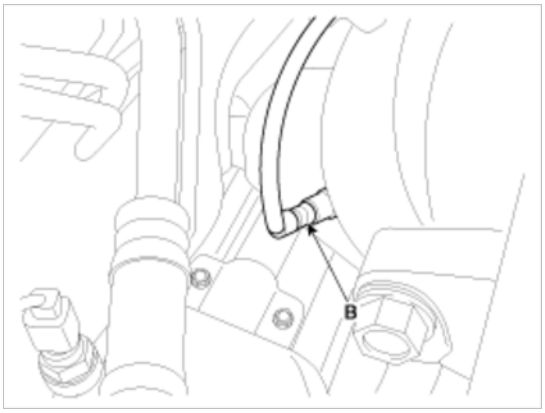
[Bank 1 / Sensor 1]





[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).

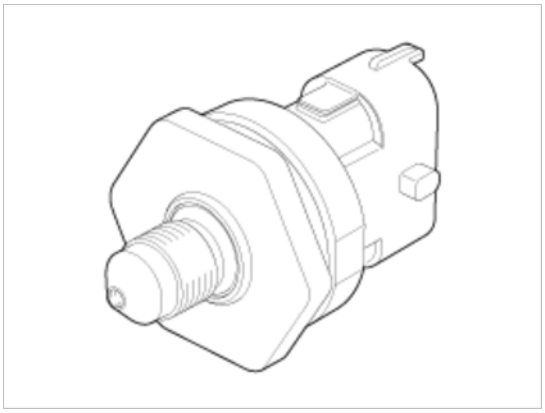
1. Installation is reverse of removal.

Heated oxygen sensor installation:
39.2 ~ 49.1 N.m (4.0 ~ 5.0 kgf.m, 28.9 ~ 36.2 lb-ft)

Fuel System > Engine Control System > Rail Pressure Sensor (RPS) > Description and Operation

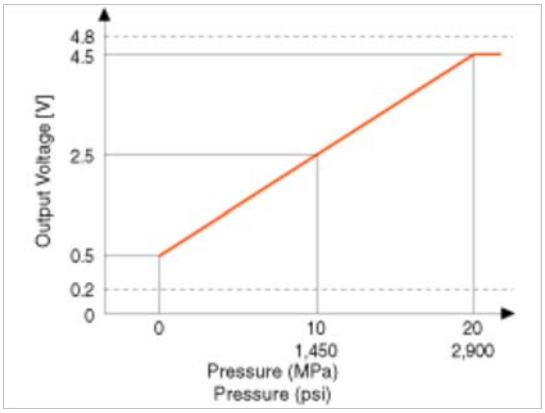
Description

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.



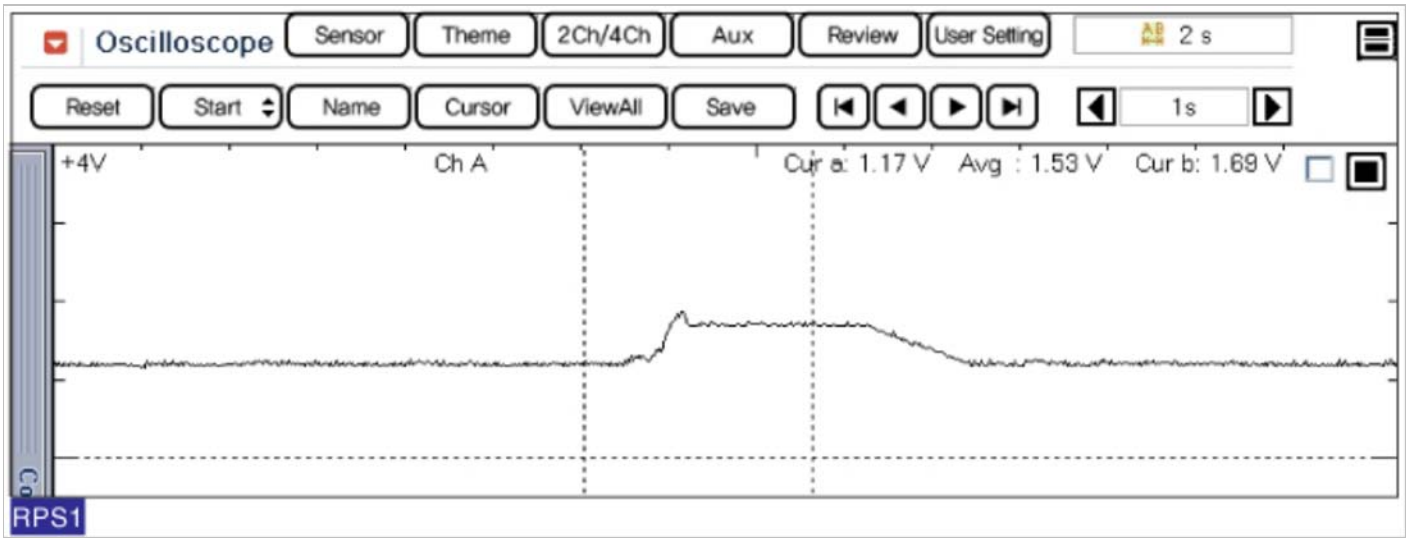
Fuel System > Engine Control System > Rail Pressure Sensor (RPS) > Specifications

Specification



Fuel System > Engine Control System > Rail Pressure Sensor (RPS) > Troubleshooting

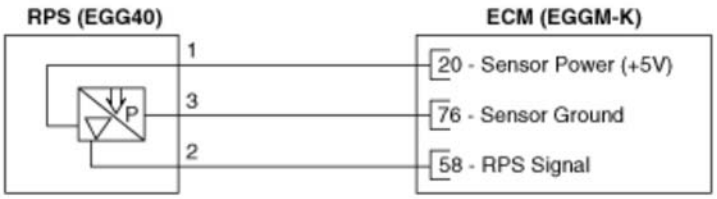
Signal Waveform



Fuel System > Engine Control System > Rail Pressure Sensor (RPS) > Schematic Diagrams

Circuit Diagram

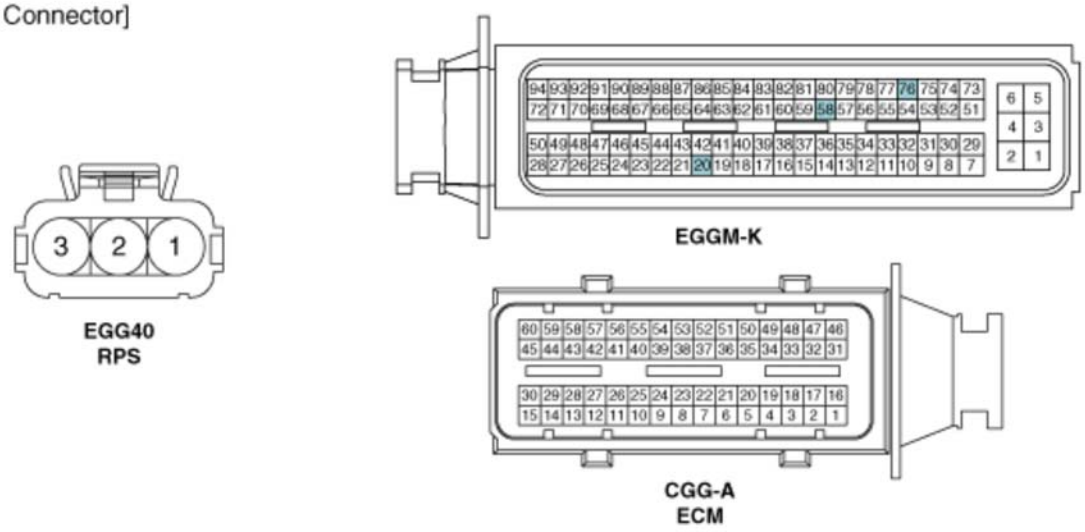
[Circuit Diagram]



[Connection Information]

Terminal	Connected to	Function
1	ECM EGGM-K (20)	Sensor Power (+5V)
2	ECM EGGM-K (58)	RPS Signal
3	ECM EGGM-K (76)	Sensor Ground

[Harness Connector]



Fuel System > Engine Control System > Rail Pressure Sensor (RPS) > Repair procedures

Inspection

1. Connect the GDS on the Data Link Connector (DLC).
2. Measure the output voltage of the RPS at idle and various engine speed.

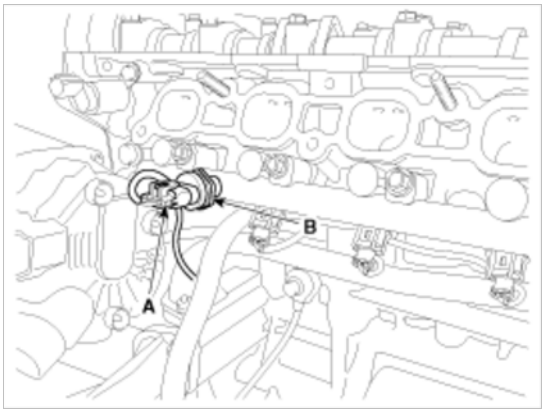
Condition	Output Voltage (V)
Idle	Approx. 1.2
1,500 rpm	2.2 ~ 2.5
6,300 rpm	Approx. 3.0

Removal

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Release the residual pressure in fuel line (Refer to “Release Residual Pressure in Fuel Line” in this group).

> CAUTION
>
> When removing the fuel pump relay, a Diagnostic Trouble Code (DTC) may occur. Delete the code with the GDS after completion of “Release Residual Pressure in Fuel Line” work.

3. Remove the intake manifold (Refer to “Intake And Exhaust System” in EM group).
4. 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.

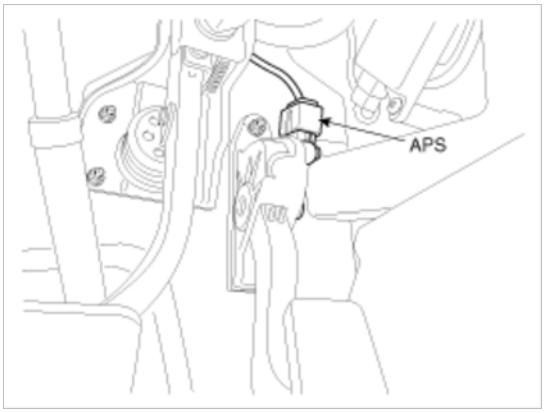
1. Installation is reverse of removal.

Rail Pressure Sensor Installation:
29.4 ~ 34.3 N.m (3.0 ~ 3.5 kgf.m, 21.7 ~ 25.3 lb-ft)

Fuel System > Engine Control System > Accelerator Position Sensor (APS) > Description and Operation

Description

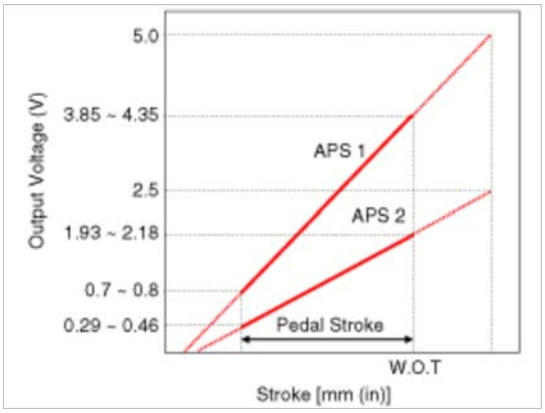
Accelerator Position Sensor (APS) is installed on the accelerator pedal module and detects the rotation angle of the accelerator pedal. The APS is one of the most important sensors in engine control system, so it consists of the two sensors which adapt individual sensor power and ground line. The second 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.



Fuel System > Engine Control System > Accelerator Position Sensor (APS) > Specifications

Specification

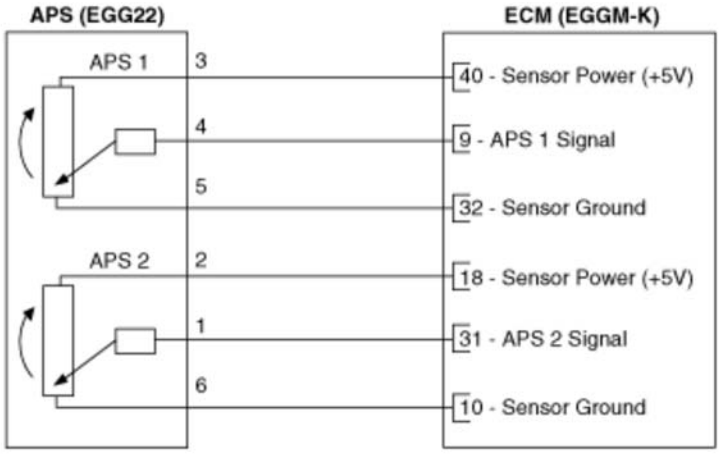
Accelerator Position	Output Voltage (V)	
	APS1	APS2
C.T	0.7 ~ 0.8	0.29 ~ 0.46
W.O.T	3.85 ~ 4.35	1.93 ~ 2.18



Fuel System > Engine Control System > Accelerator Position Sensor (APS) > Schematic Diagrams

Circuit Diagram

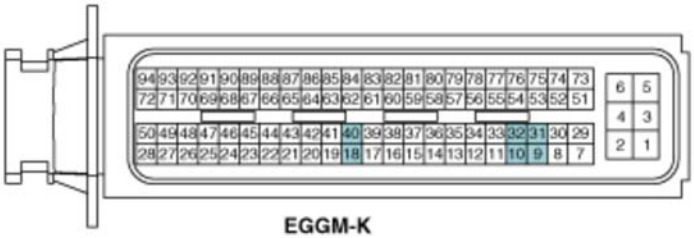
[Circuit Diagram]



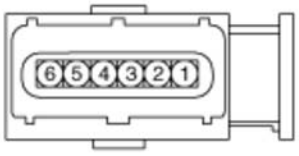
[Connection Information]

Terminal	Connected to	Function
1	ECM EGGM-K (18)	APS 2 Sensor Power (+5V)
2	ECM EGGM-K (9)	APS 1 Signal
3	ECM EGGM-K (31)	APS 2 Signal
4	ECM EGGM-K (40)	APS 1 Sensor Power (+5V)
5	ECM EGGM-K (32)	APS 1 Sensor Ground
6	ECM EGGM-K (10)	APS 2 Sensor Ground

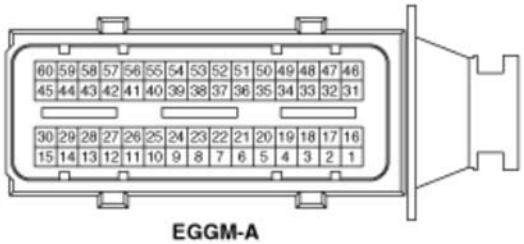
[Harness Connector]



EGGM-K



EGG22
APS



EGGM-A
ECM

Fuel System > Engine Control System > Accelerator Position Sensor (APS) > Repair procedures

Inspection

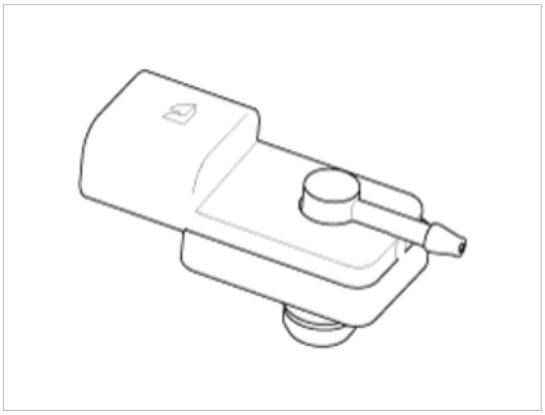
1. Connect the GDS on the Data Link Connector (DLC).
2. Turn the ignition switch ON.
3. Measure the output voltage of the APS 1 and 2 at C.T and W.O.T.

Specification: Refer to “Specification”

Fuel System > Engine Control System > Fuel Tank Pressure Sensor (FTPS) > Description and Operation

Description

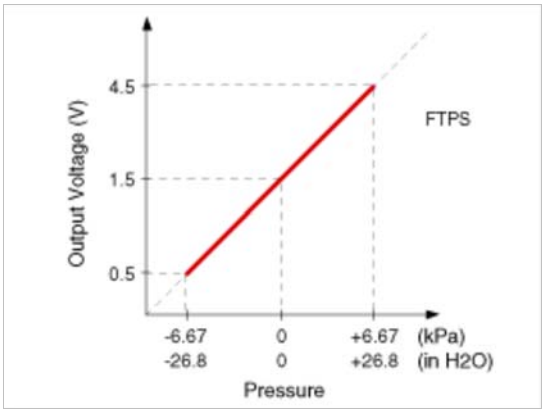
Fuel Tank Pressure Sensor (FTPS) is a component of the evaporative emission control system and is installed on the fuel tank, the fuel pump, or the canister. It checks the purge control solenoid valve operation and detects a leakage of the system.



Fuel System > Engine Control System > Fuel Tank Pressure Sensor (FTPS) > Specifications

Specification

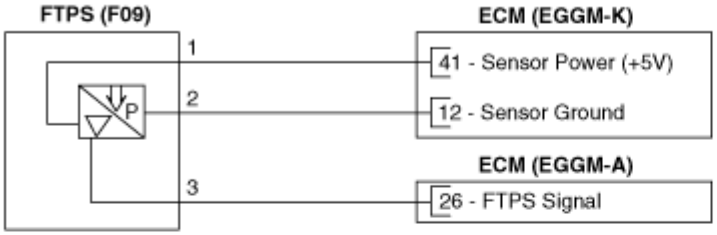
Pressure [kPa (kgf/cm², in H2O)	Output Voltage (V)
-6.67 (-0.068, -26.8)	0.5
0	2.5
+6.67 (0.068, 26.8)	4.5



Fuel System > Engine Control System > Fuel Tank Pressure Sensor (FTPS) > Schematic Diagrams

Circuit Diagram

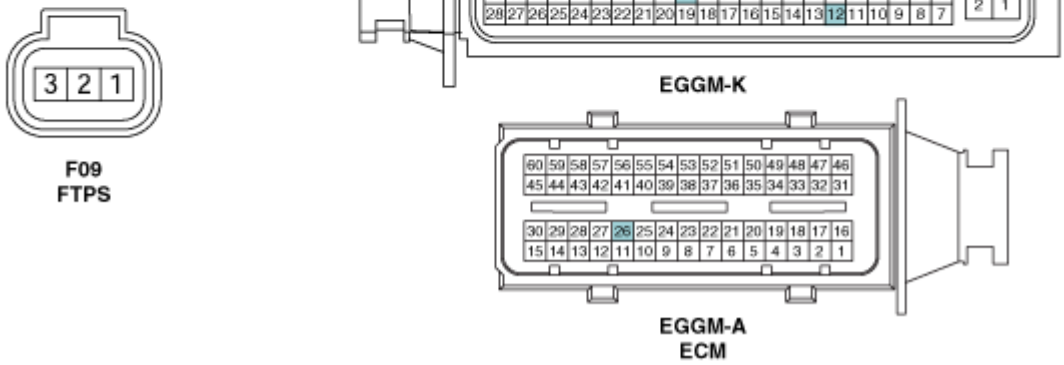
[Circuit Diagram]



[Connection Information]

Terminal	Connected to	Function
1	ECM EGGM-K (41)	Sensor Power (+5V)
2	ECM EGGM-K (12)	Sensor Ground
3	ECM EGGM-A (26)	FTPS Signal

[Harness Connector]



Fuel System > Engine Control System > Fuel Tank Pressure Sensor (FTPS) > Repair procedures

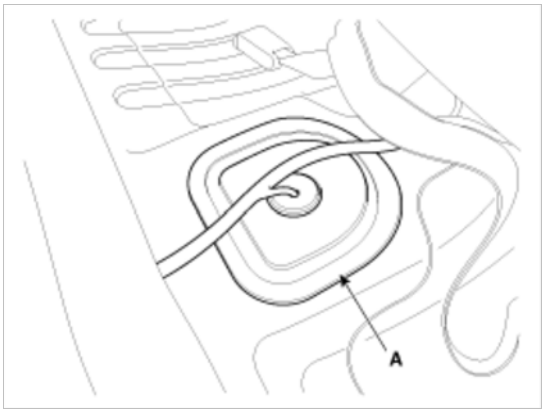
Inspection

1. Connect the GDS on the Data Link Connector (DLC).
2. Measure the output voltage of the FTPS.

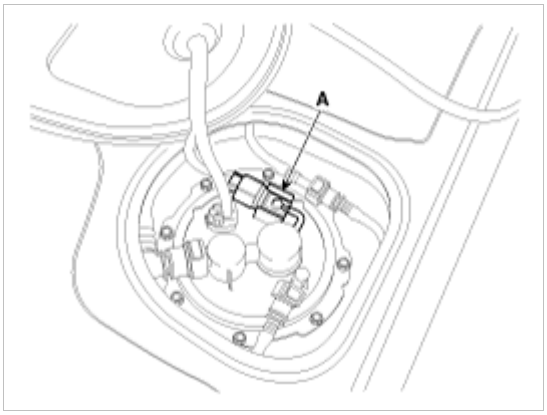
Specification: Refer to "Specification"

Removal

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Remove the rear seat (Refer to "Seat" in BD group).
3. Remove the fuel pump service cover (A).



4. Disconnect the fuel tank pressure sensor connector.
5. Remove the fuel tank pressure sensor (A) after releasing the hooks vertically.



Installation

CAUTION

- Install the component with the specified torques.
- Note that internal damage may occur when the component is dropped. In this case, use it after inspecting.

CAUTION

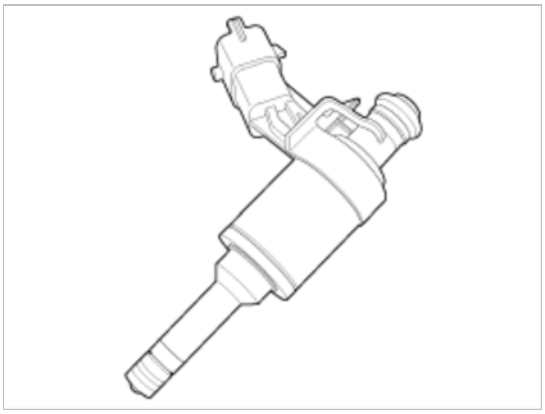
- Insert the sensor in the installation hole and be careful not to damage when installation.

1. Installation is reverse of removal.

Fuel System > Engine Control System > 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.



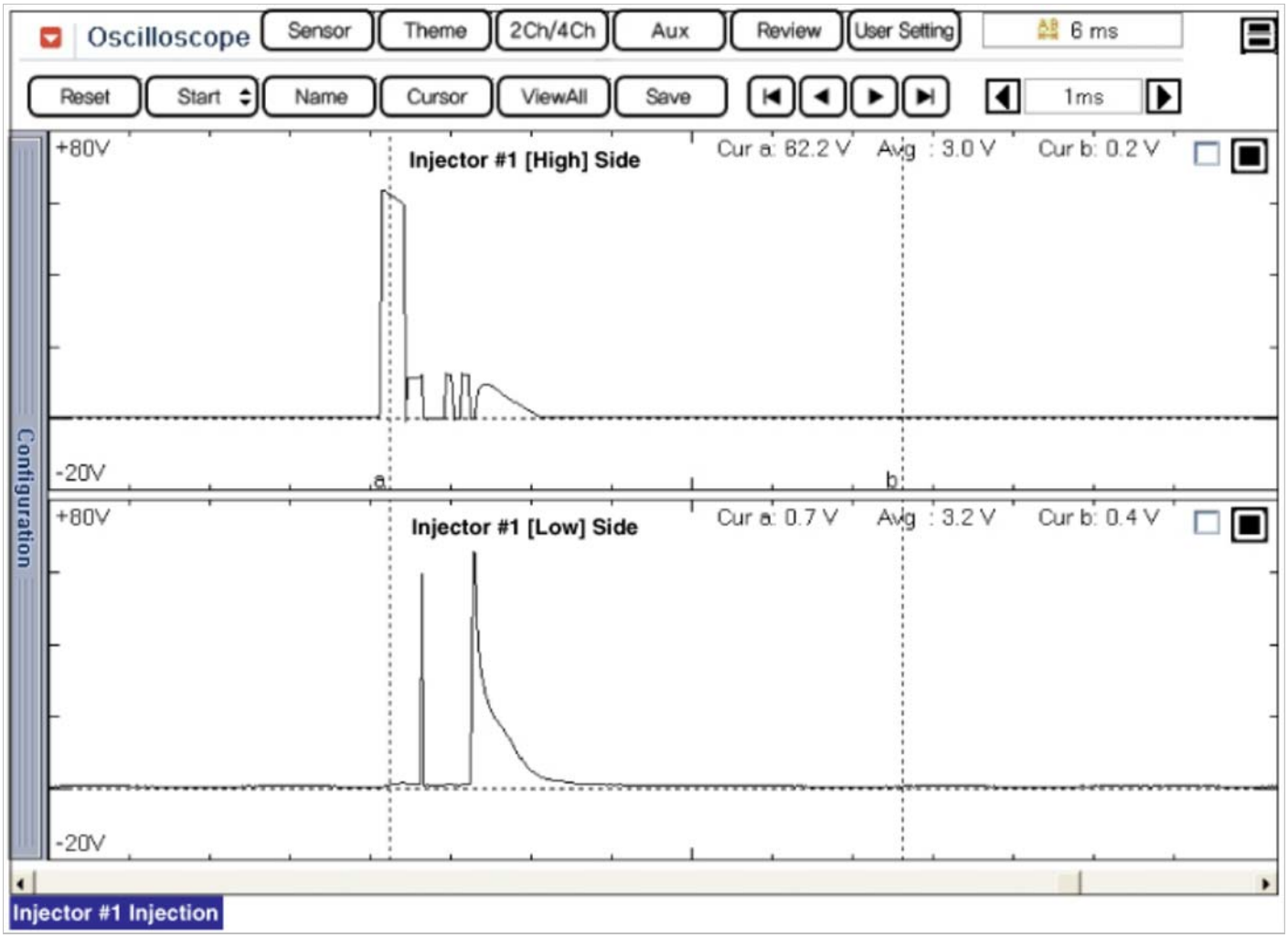
Fuel System > Engine Control System > Injector > Specifications

Specification

Item	Specification
Coil Resistance (Ω)	1.5 [20°C(68°F)]

Fuel System > Engine Control System > Injector > Troubleshooting

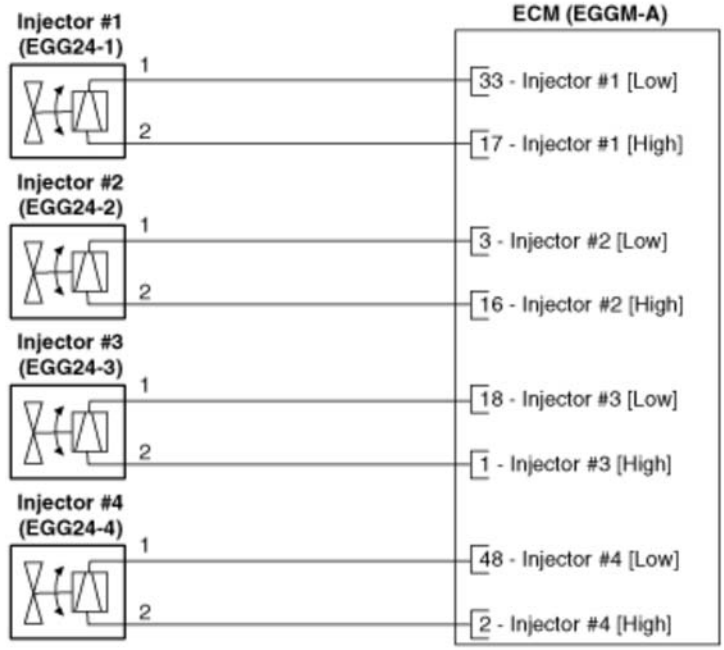
Signal Waveform



Fuel System > Engine Control System > Injector > Schematic Diagrams

Circuit Diagram

[Circuit Diagram]



[Connection Information]

Injector #1 (EGG24-1)

Terminal	Connected to	Function
1	ECM EGGM-A (33)	Injector #1 [Low] Control
2	ECM EGGM-A (17)	Injector #1 [High] Control

Injector #2 (EGG24-2)

Terminal	Connected to	Function
1	ECM EGGM-A (3)	Injector #2 [Low] Control
2	ECM EGGM-A (16)	Injector #2 [High] Control

Injector #3 (EGG24-3)

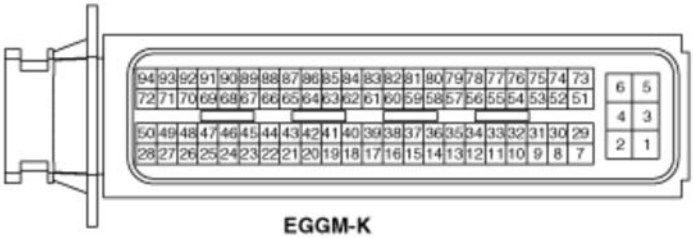
Terminal	Connected to	Function
1	ECM EGGM-A (18)	Injector #3 [Low] Control
2	ECM EGGM-A (1)	Injector #3 [High] Control

Injector #4 (EGG24-4)

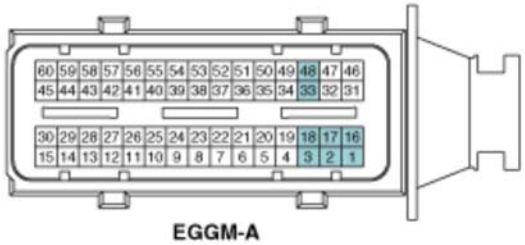
Terminal	Connected to	Function
1	ECM EGGM-A (48)	Injector #4 [Low] Control
2	ECM EGGM-A (2)	Injector #4 [High] Control

[Harness Connector]

EGG24-1,2,3,4
Injector #1,2,3,4



EGGM-K



EGGM-A
ECM

Fuel System > Engine Control System > Injector > Repair procedures

Inspection

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

Specification: Refer to “Specification”

Removal

WARNING

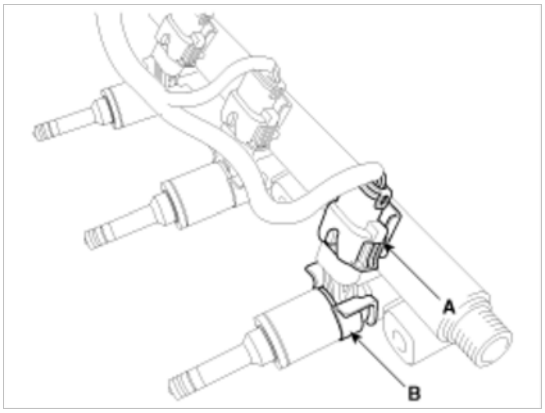
In case of removing the high pressure fuel pump, high pressure fuel pipe, delivery pipe, and injector, there may be injury caused by leakage of the high pressure fuel. So don't do any repair work right after engine stops.

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Release the residual pressure in fuel line (Refer to "Release Residual Pressure in Fuel Line" in this group).

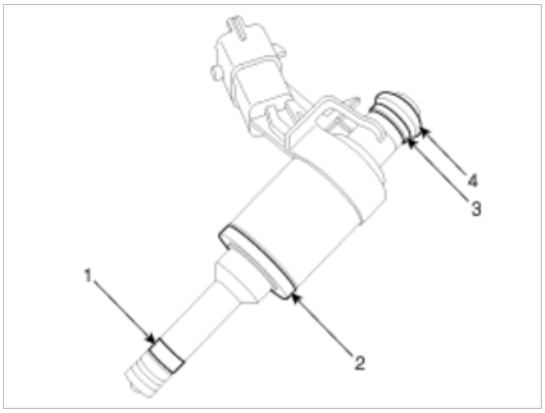
CAUTION

When removing the fuel pump relay, a Diagnostic Trouble Code (DTC) may occur. Delete the code with the GDS after completion of "Release Residual Pressure in Fuel Line" work.

3. Remove the delivery pipe & injector assembly (Refer to "Delivery Pipe" in this group).
4. Remove the connector (A) and the fixing clip (B), and then separate the injector from the delivery pipe.



Installation



1. Combustion seal
2. Rubber washer
3. Support disc
4. O-ring

CAUTION

- Do not reuse the used injector fixing clip.

CAUTION

- Install the component with the specified torques.

- Note that internal damage may occur when the component is dropped. If the component has been dropped, inspect before installing.

CAUTION

- Apply engine oil to the injector O-ring.
- Do not reuse the used injector O-ring.

CAUTION

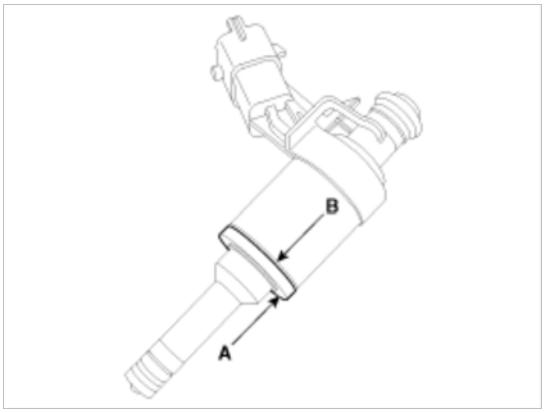
- Do not reuse the used bolt.

CAUTION

- When inserting the injector, be careful not to damage the injector tip.

CAUTION

- Do not reuse the support disc.
- Do not reuse the injector rubber washer.
- When replacing the rubber washer, the steal plate (A) part should be faced the cylinder installation part and the rubber plate (B) part should be faced the injector body part.



CAUTION

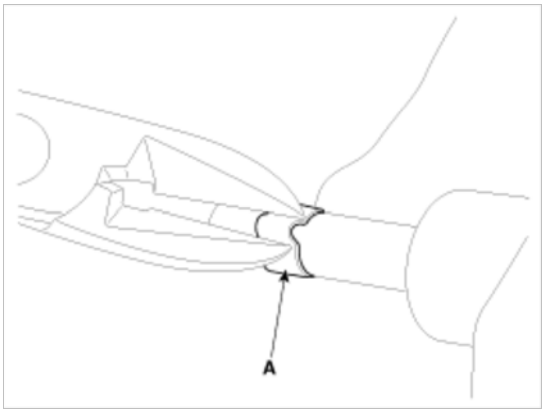
- Do not reuse the combustion seal.

1. Installation is reverse of removal.

Replacement

The injector combustion seal should be replaced new one to prevent leakage after removing the injector.

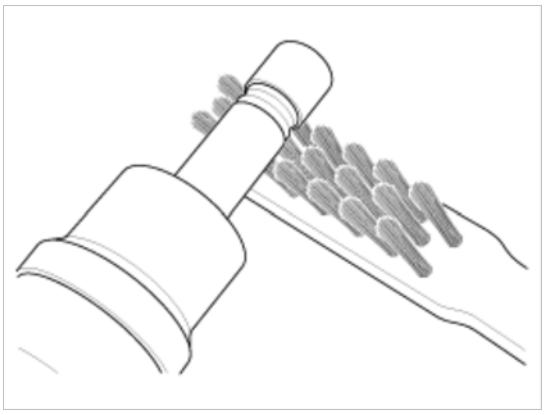
1. Remove the combustion seal (A) with a wire cutter.



CAUTION

Grip the sealing ring carefully, pull it to form a small loop and then cut it.
Be careful not to damage the surface of the valve sleeve with the wire cutter.

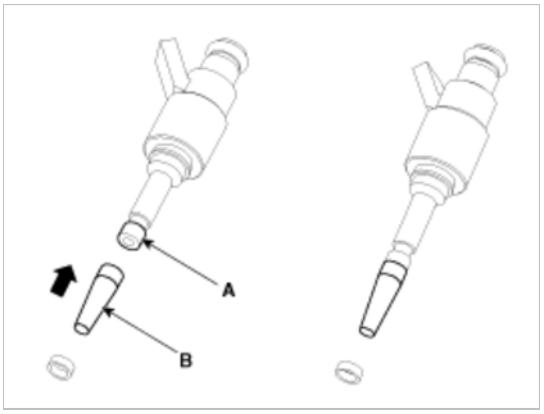
2. Before the assembly of the sealing ring the groove must be cleaned using a clean cloth.
   Any coking of the injector sealing surface must be carefully removed with a brass-wire brush.

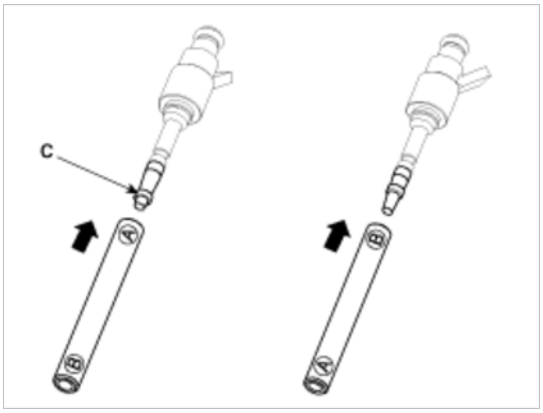


CAUTION

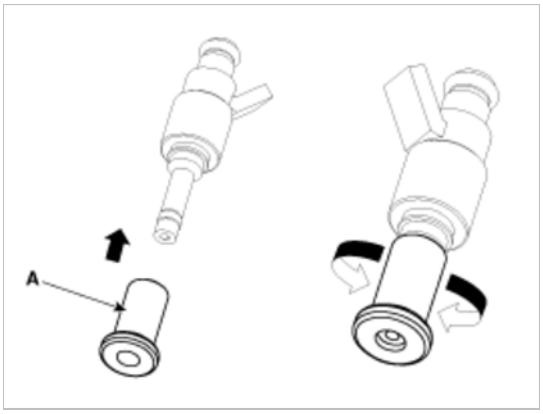
The surfaces of the new sealing ring must be clean and free of grease.

3. Place the seal installing guide (B) (SST No.: 09353-2B000) on the tip of the injector not to damage the injector tip (A).
   Push the sealing ring (C) with thumb and index finger over the conical assembly tool until it snaps into the groove.
   The complete assembly must not take longer than 2 to 3 seconds.





4. To size the sealing ring the injector is first introduced into the sizing tool (A) (SST No.: 09353-2B000) and then pressed and at the same time rotated 180° into the sizing tool.

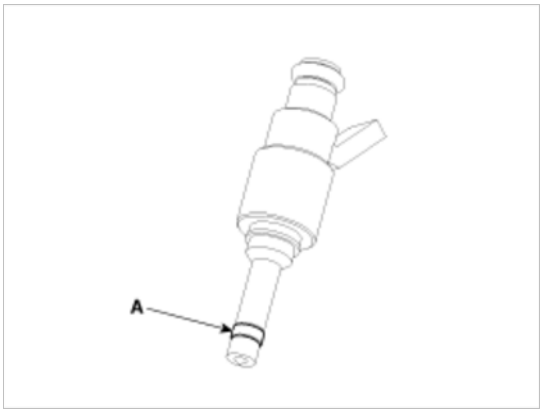


5. Pull the injector out of the sizing tool by turning it in the reverse direction to that used for the press-in process.

CAUTION

Check that the seal ring has not been damaged during assembly to the injector and that no circumferential scratches are present.
Do not reuse the combustion seal.
The seal must be completely free of grease and oil.

6. Check the combustion seal (A) installation.

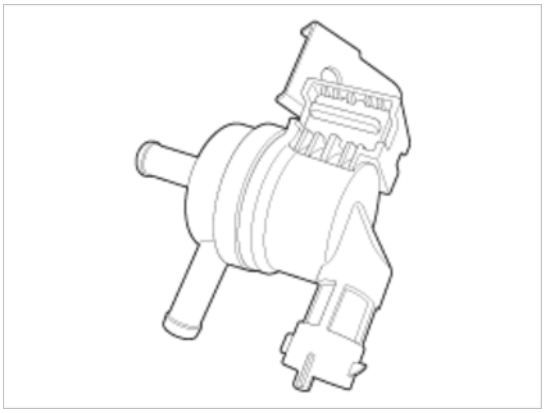


Fuel System > Engine Control System > Purge Control Solenoid Valve (PCSV) > Description and Operation

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.



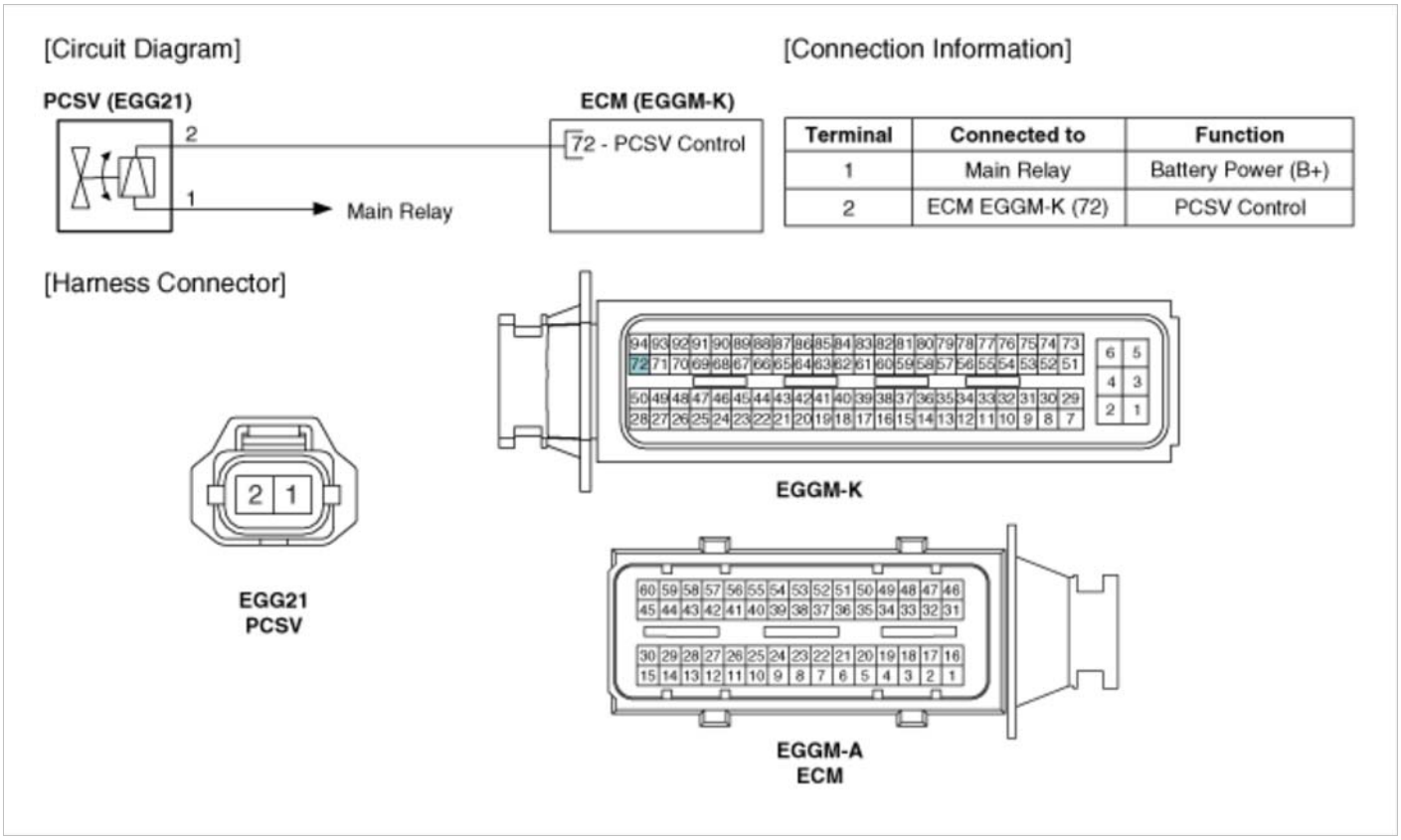
Fuel System > Engine Control System > Purge Control Solenoid Valve (PCSV) > Specifications

Specification

Item	Specification
Coil Resistance (Ω)	22.0 ~ 26.0 [20°C(68°F)]

Fuel System > Engine Control System > Purge Control Solenoid Valve (PCSV) > Schematic Diagrams

Circuit Diagram



Fuel System > Engine Control System > Purge Control Solenoid Valve (PCSV) > Repair procedures

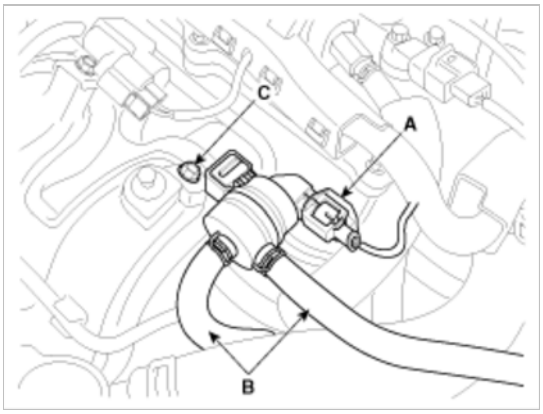
Inspection

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

Specification: Refer to “Specification”

Removal

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Disconnect the purge control solenoid valve connector (A).
3. Disconnect the vapor hoses (B) from the purge control solenoid valve.
4. Remove the valve after removing the bolt (C).



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.

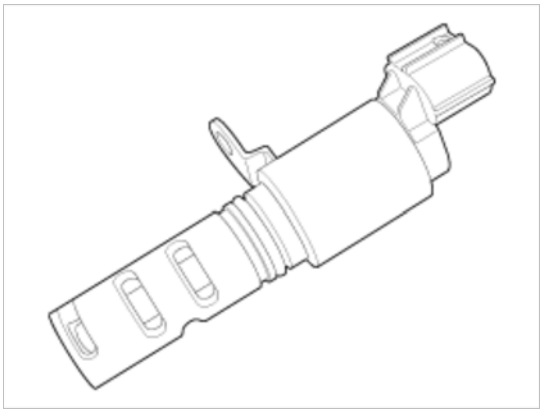
1. Installation is reverse of removal.

Purge control solenoid valve bracket installation bolt: 9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)

Fuel System > Engine Control System > CVVT Oil Control Valve (OCV) > Description and Operation

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.



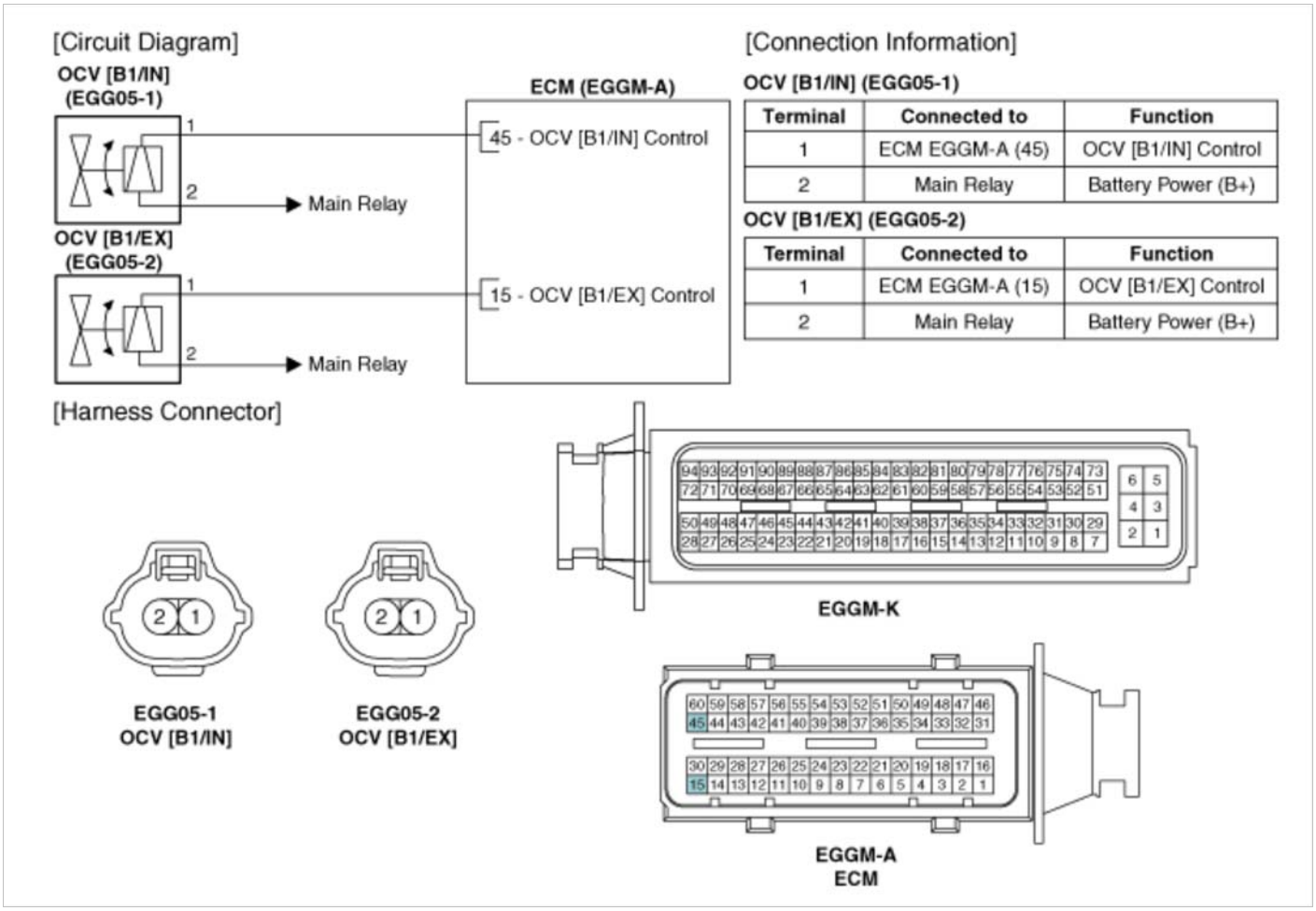
Fuel System > Engine Control System > CVVT Oil Control Valve (OCV) > Specifications

Specification

Item	Specification
Coil Resistance (Ω)	6.9 ~ 7.9 [20°C(68°F)]

Fuel System > Engine Control System > CVVT Oil Control Valve (OCV) > Schematic Diagrams

Circuit Diagram



Fuel System > Engine Control System > CVVT Oil Control Valve (OCV) > Repair procedures

Inspection

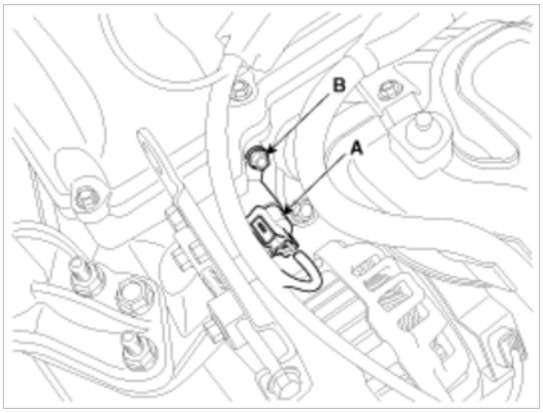
1. Turn the ignition switch OFF.
2. Disconnect the OCV connector.
3. Measure resistance between the OCV terminals 1 and 2.
4. Check that the resistance is within the specification.

Specification: Refer to “Specification”

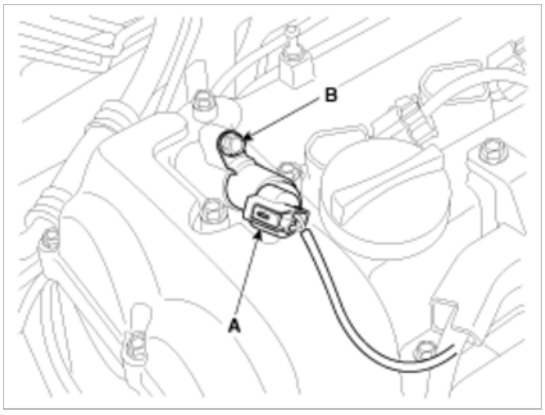
Removal

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Disconnect the CVVT oil control valve connector (A).
3. 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.

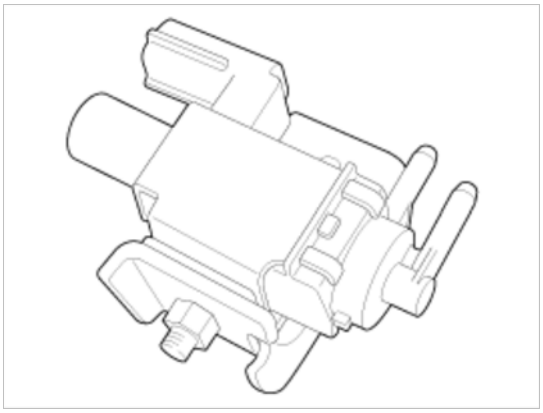
1. Installation is reverse of removal.

CVVT oil control valve installation bolt:
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)

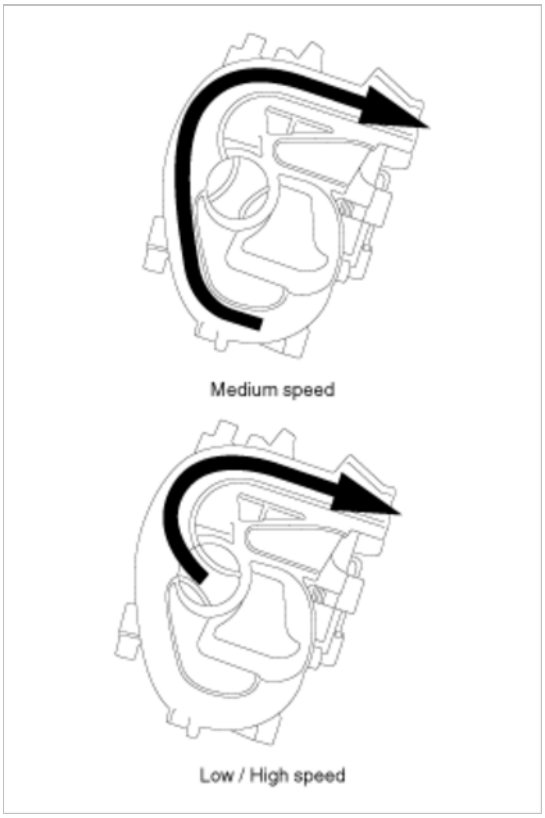
Fuel System > Engine Control System > Variable Intake Solenoid (VIS) Valve > Description and Operation

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



Fuel System > Engine Control System > Variable Intake Solenoid (VIS) Valve > Specifications

Specification

Item	Specification
Coil resistance (Ω)	30.0 ~ 35.0 [20°C(68°F)]

Fuel System > Engine Control System > Variable Intake Solenoid (VIS) Valve > Schematic Diagrams

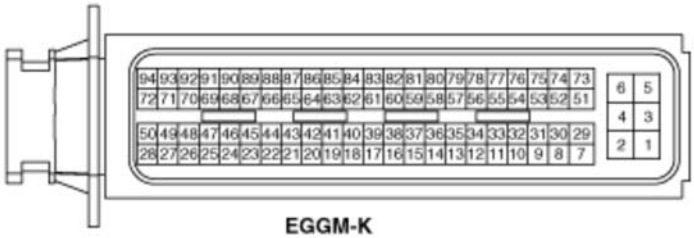
Circuit Diagram

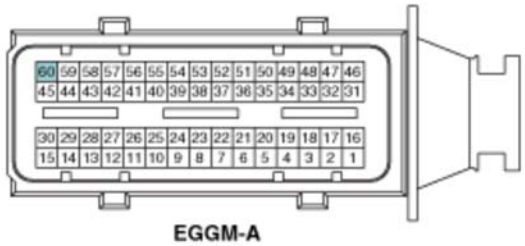
[Circuit Diagram]

[Connection Information]

Terminal	Connected to	Function
1	Main relay	Power supply (B+)
2	ECM EGGM-A (60)	VIS valve control

[Harness Connector]





Fuel System > Engine Control System > Variable Intake Solenoid (VIS) Valve > Repair procedures

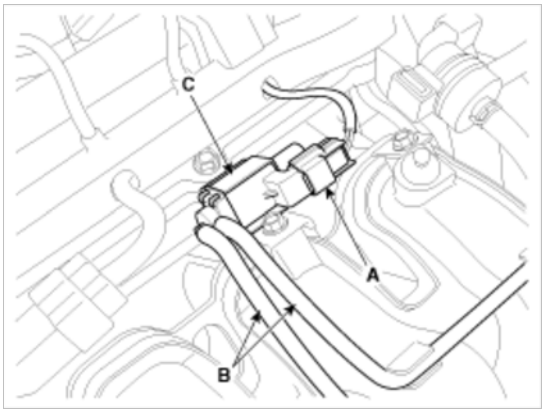
Inspection

1. Turn the ignition switch OFF.
2. Disconnect the VIS valve connector.
3. Measure resistance between VIS valve terminals 1 and 2.

Specification: Refer to "Specification"

Removal

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Disconnect the variable intake solenoid valve connector (A).
3. Disconnect the vacuum hoses (B) from the valve.
4. Remove the installation bolt, and then remove the valve (C) 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

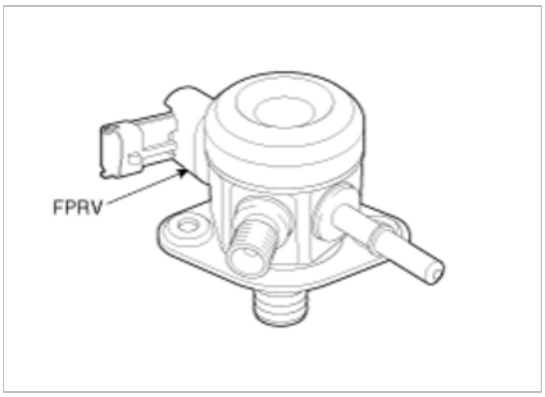
- Use care to keep foreign material out of the valve.

1. Installation is reverse of removal.

Fuel System > Engine Control System > Fuel Pressure Control Valve > Description and Operation

Description

Fuel Pressure Regulator Valve is installed on the high pressure fuel pump and controls fuel flow flowing into the injectors in accordance with the ECM signal calculated based on various engine condition.



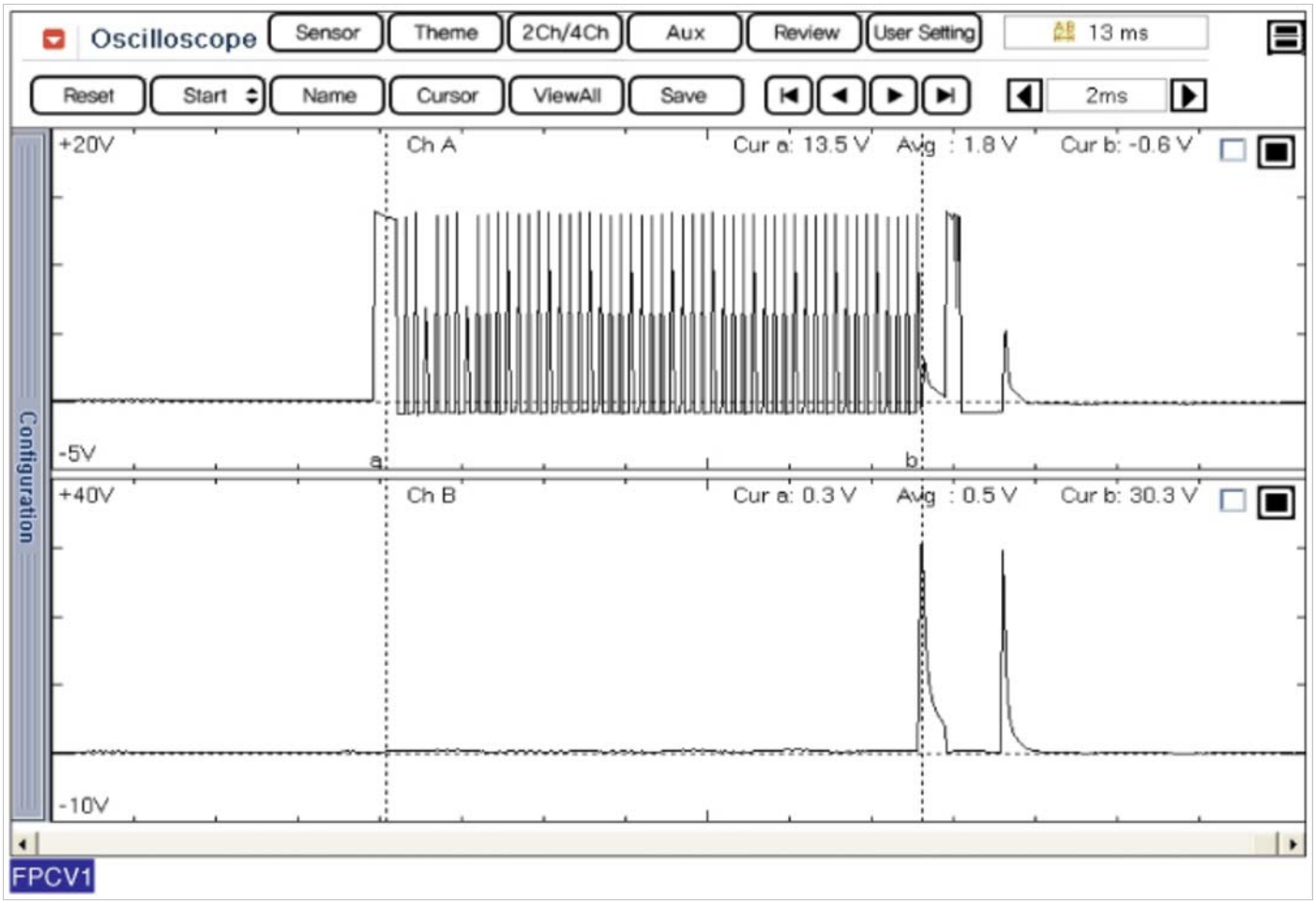
Fuel System > Engine Control System > Fuel Pressure Control Valve > Specifications

Specification

Item	Specification
Coil Resistance (Ω)	0.5 [20°C(68°F)

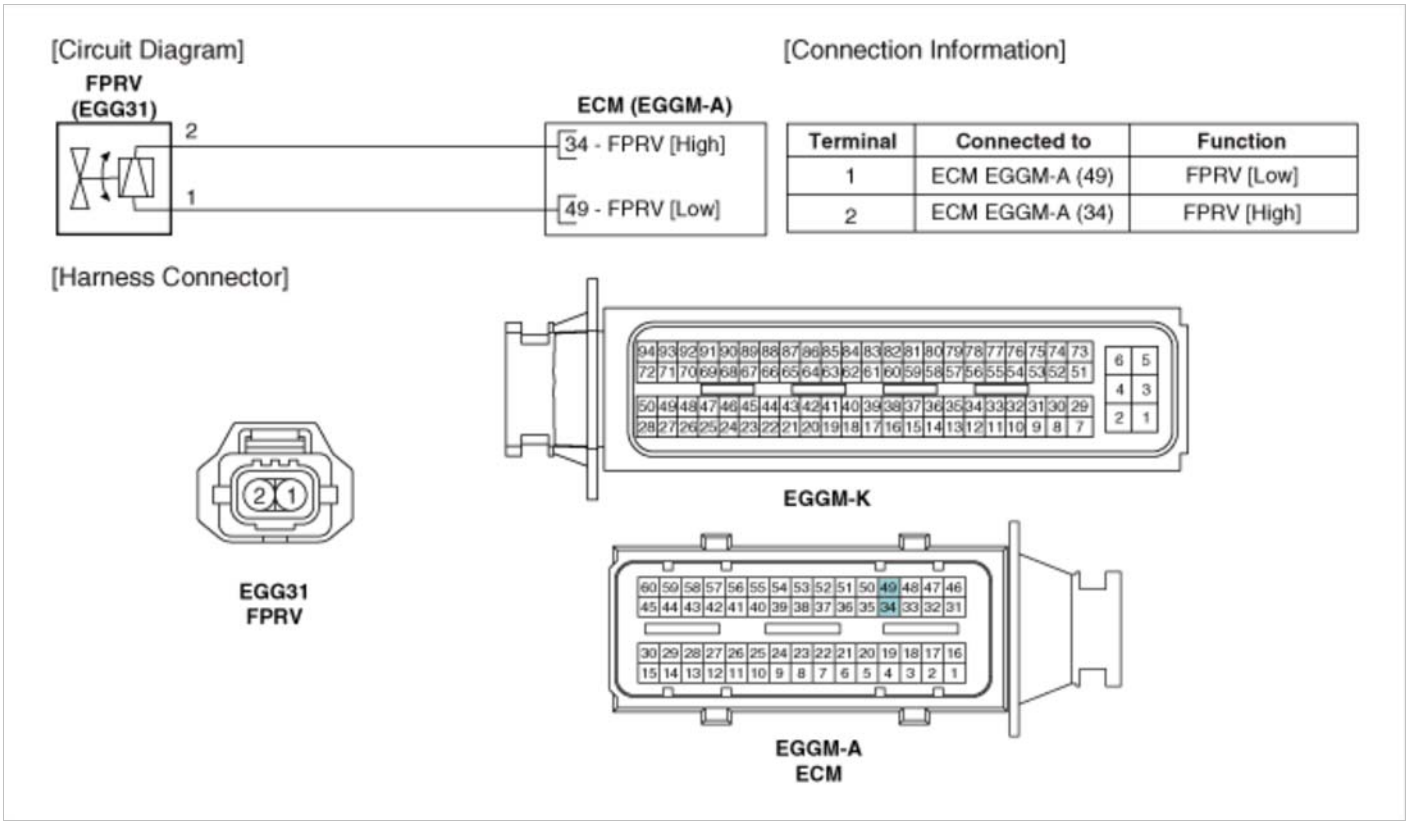
Fuel System > Engine Control System > Fuel Pressure Control Valve > Troubleshooting

Signal Waveform



Fuel System > Engine Control System > Fuel Pressure Control Valve > Schematic Diagrams

Circuit Diagram



Fuel System > Engine Control System > Fuel Pressure Control Valve > Repair procedures

Inspection

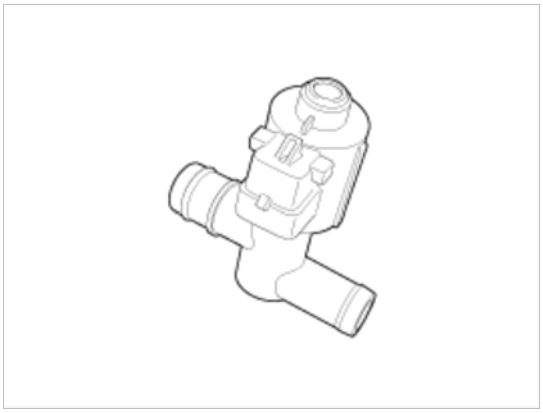
1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Disconnect the fuel pressure regulator valve connector.
3. Measure resistance between the fuel pressure regulator valve terminals 1 and 2.
4. Check that the resistance is within the specification.

Specification: Refer to “Specification”

Fuel System > Engine Control System > Canister Close Valve (CCV) > Description and Operation

Description

Canister Close Valve (CCV) is normally open and is installed on the canister ventilation line. It seals evaporative emission control system by shutting the canister from the atmosphere during EVAP leak detection process.



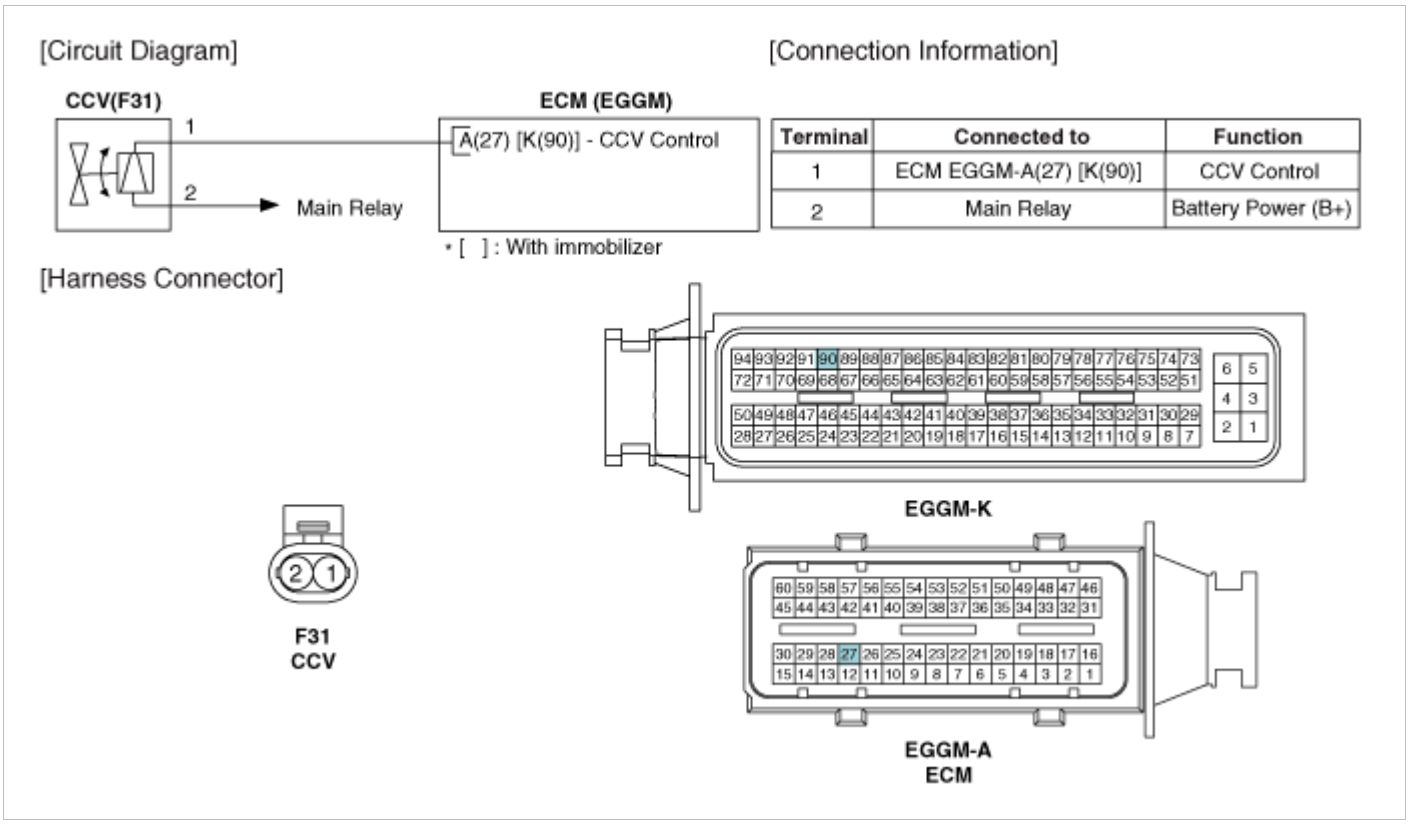
Fuel System > Engine Control System > Canister Close Valve (CCV) > Specifications

Specification

Item	Specification
Coil Resistance (Ω)	19.5 ~ 22.5 [20°C(68°F)]

Fuel System > Engine Control System > Canister Close Valve (CCV) > Schematic Diagrams

Circuit Diagram



Fuel System > Engine Control System > Canister Close Valve (CCV) > Repair procedures

Inspection

1. Turn the ignition switch OFF.

2. Disconnect the CCV connector.
3. Measure resistance between the CCV terminal 1 and 2.
4. Check that the resistance is within the specification.

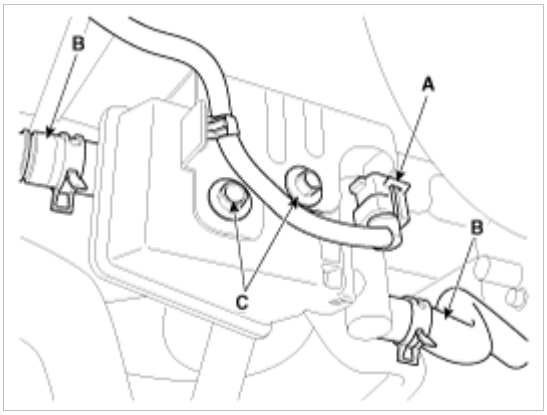
Specification: Refer to "Specification"

5. Disconnect the vapor hose connected with the canister from the CCV.
6. Connect a vacuum pump to the nipple.
7. Ground the CCV control line and apply battery voltage to the CCV power supply line.
8. Apply vacuum and check the valve operation.

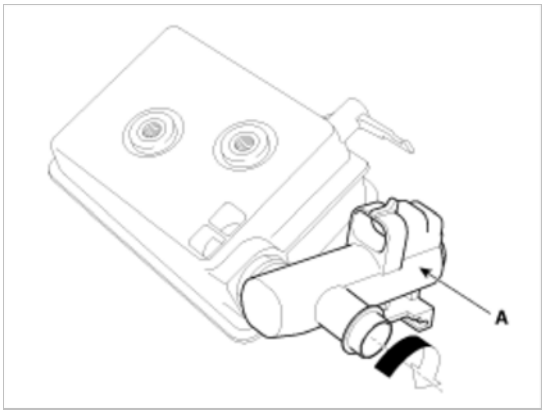
Specification: Vacuum maintained

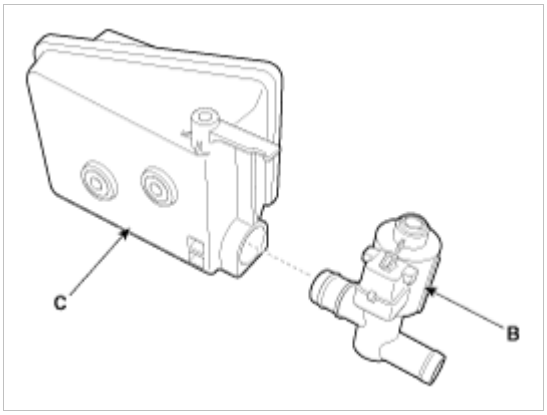
Removal

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Lift the vehicle.
3. Disconnect the canister close valve connector (A).
4. Disconnect the ventilation hose (B) from the fuel tank air filter and canister close valve.
5. Remove the fuel tank air filter assembly after removing bolts (C).



6. 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

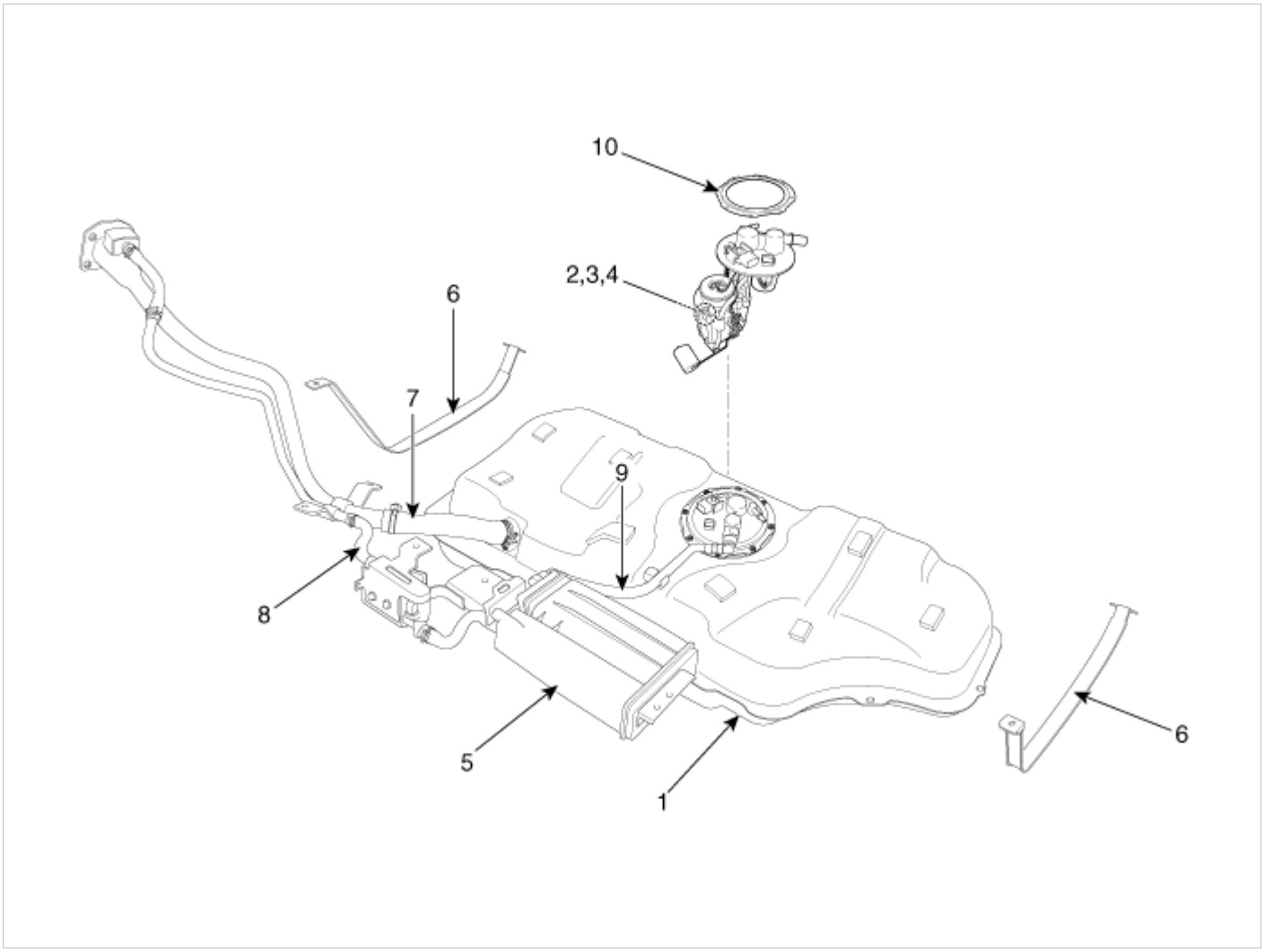
CAUTION

- Install the component with the specified torques.
- Note that internal damage may occur when the component is dropped. In this case, use it after inspecting.

1. Installation is reverse of removal.

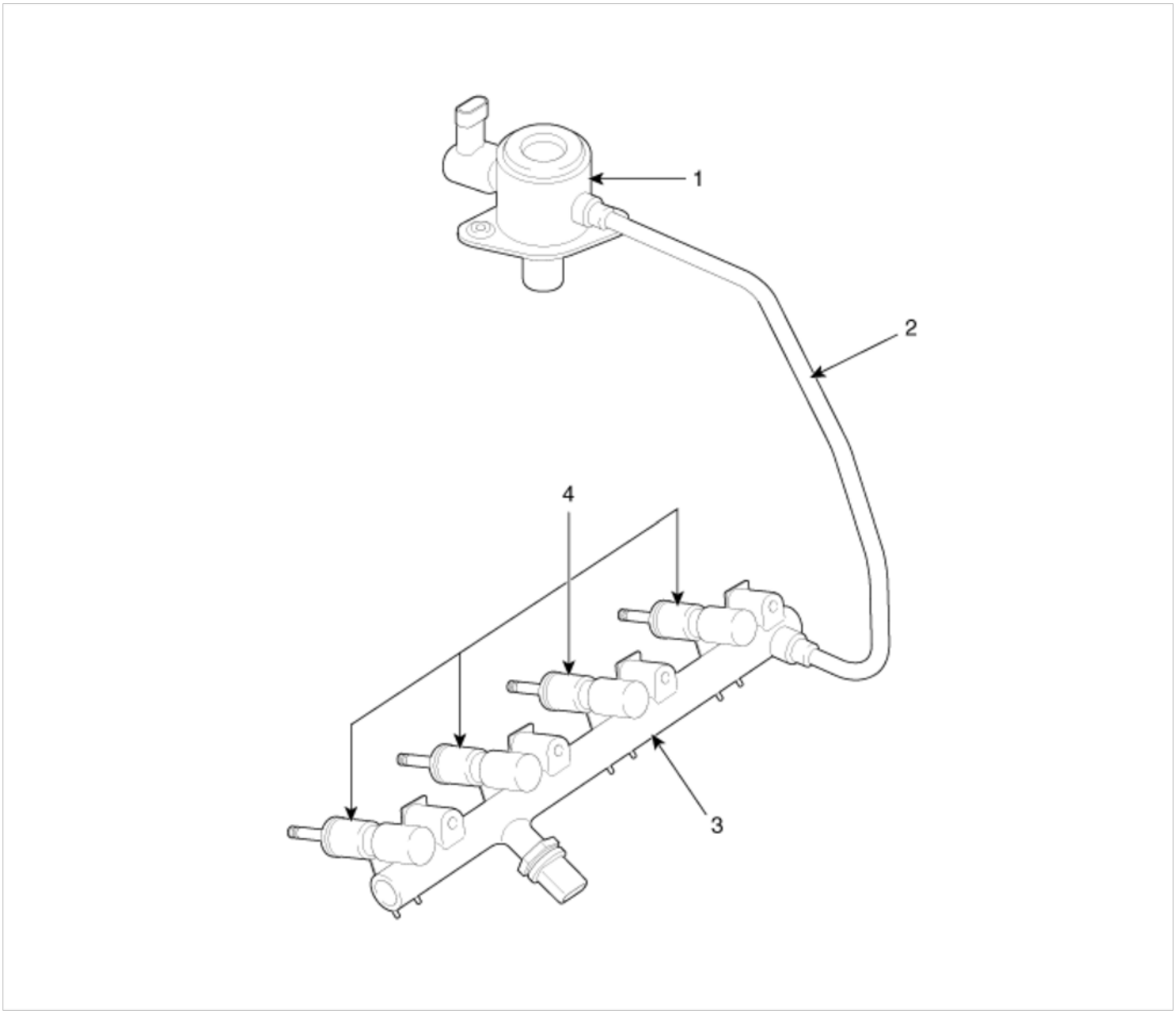
Fuel System > Fuel Delivery System > Components and Components Location

Components Location



1. Fuel Tank	6. Fuel Tank Band
2. Fuel Pump	7. Fuel Filler Hose
3. Fuel Filter	8. Ventilation Hose
4. Fuel Pressure Regulator	9. Vapor Tube
5. Canister	10. Fuel Pump Plate Cover

[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.

Fuel System > Fuel Delivery System > Repair procedures

Fuel Pressure Test

1. Release the residual pressure in fuel line (Refer to "Release Residual Pressure in Fuel Line" in this group).

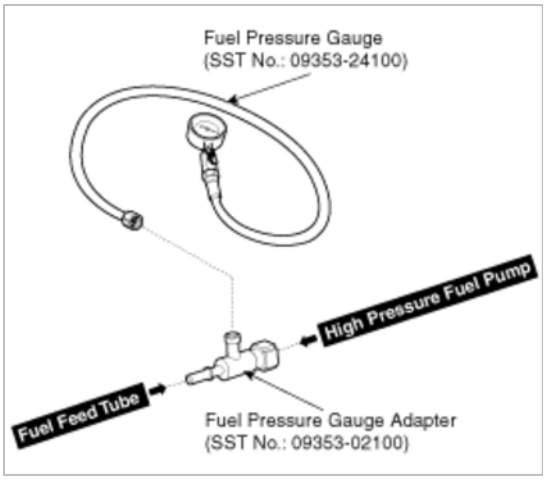
CAUTION

When removing the fuel pump relay, a Diagnostic Trouble Code (DTC) may occur. Delete the code with the GDS after completion of "Release Residual Pressure in Fuel Line" work.

2. Install the Special Service Tool (SST).
   (1) Disconnect the fuel feed tube from the delivery pipe.

> **CAUTION**
>
> There may be some residual pressure even after “Release Residual Pressure in Fuel Line” work, so cover the hose connection with a shop towel to prevent residual fuel from spilling out before disconnecting any fuel connection.

   (2) Install the special service tool for measuring the fuel pressure in between the fuel feed tube and the fuel delivery pipe (Refer to the figure below).



3. Inspect fuel leakage on connections among the fuel feed tube, the delivery pipe, and the SST components with IG ON.
4. Measure Fuel Pressure.
   (1) Start the engine and measure the fuel pressure at idle.

Fuel Pressure:
480 ~ 500 kPa (4.9 ~ 5.1 kgf/cm², 69.6 ~ 72.5 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 valve stuck	Fuel Pressure Regulator

   (2) Stop the engine, and then check for the change in the fuel pressure gauge reading.

Standard Value: The gauge reading should hold for about 5 minutes after the engine stops

> **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

(3) Turn the ignition switch OFF.

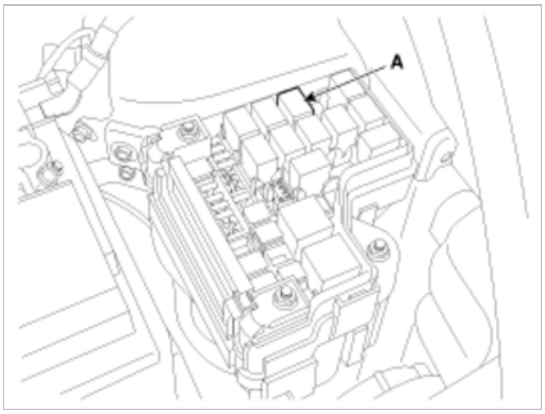
5. Release the residual pressure in fuel line (Refer to “Release Residual Pressure in Fuel Line”).
6. Test End
   (1) Remove the Special Service Tool (SST) from the fuel feed tube and the delivery pipe.
   (2) Connect the fuel feed tube and the delivery pipe.

Release Residual Pressure in Fuel Line

CAUTION

There may be some residual high pressure even after "Release Residual Pressure in Fuel Line" work, so must cover the high pressure line connection part with a shop towel or a cloth to prevent residual fuel from spilling out before removing any high pressure fuel part.
Then release pressure by carefully removing connection part.
If not, it may result in the injury by high temperature and pressure fuel.

1. Turn the ignition switch OFF and disconnect the battery (-) cable.
2. Remove the fuel pump relay (A).



CAUTION

When removing the fuel pump relay, a Diagnostic Trouble Code (DTC) may occur. Delete the code with the GDS after completion of “Release Residual Pressure in Fuel Line” work.

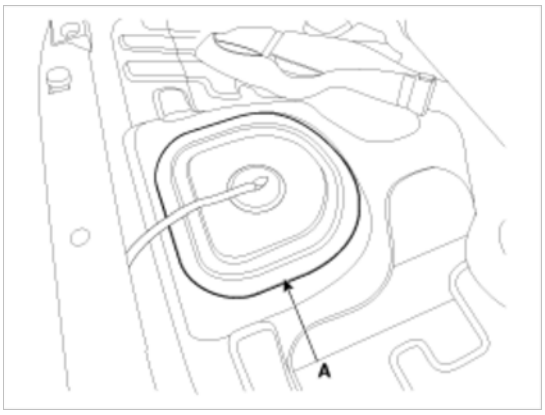
3. Connect the battery (-) cable.
4. Start the engine and let idle, and then turn the ignition switch OFF after the engine has stopped on its own.
5. Disconnect the battery (-) cable, and then install the fuel pump relay (A).
6. Connect the battery (-) cable.
7. Delete the Diagnostic Trouble Code (DTC) related the fuel pump relay with the GDS.

Fuel System > Fuel Delivery System > Fuel Tank > Repair procedures

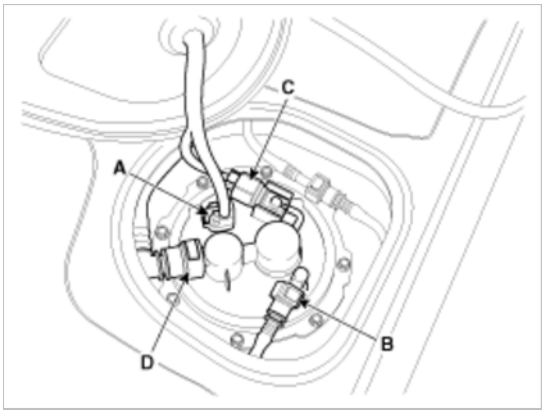
Removal

1. Release the residual pressure in fuel line (Refer to “Release Residual Pressure in Fuel Line” in this group).

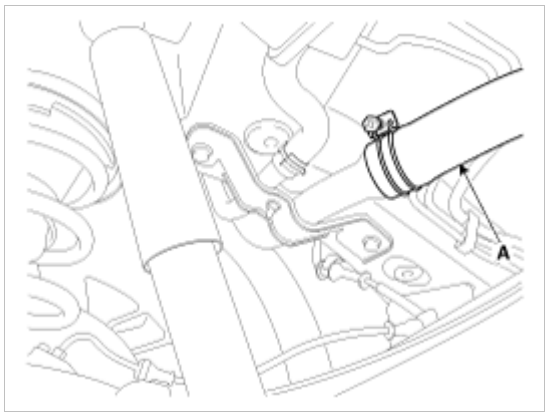
2. Remove the rear seat [LH] (Refer to “Seat” in BD group).
3. Remove the fuel pump service cover (A).



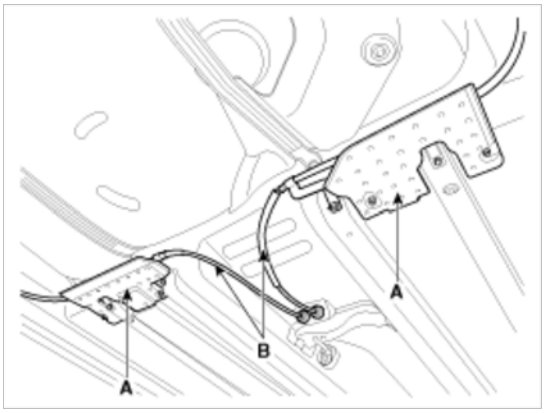
4. Disconnect the fuel pump connector (A).
5. Disconnect the fuel feed tube quick connector (B).
6. Disconnect the fuel tank pressure sensor connector (C).
7. Disconnect the vapor tube (D).



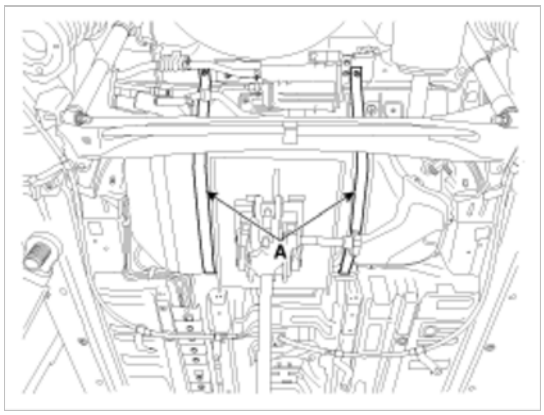
8. Lift the vehicle and support the fuel tank with a jack.
9. Remove the center muffler assembly (Refer to “Intake And Exhaust System” in EM group).
10. Disconnect the fuel filler hose (A).



11. Remove the under cover (A) and the parking brake line installation bolt (B).



12. Remove the fuel tank from the vehicle after removing the fuel tank band (A).



Installation

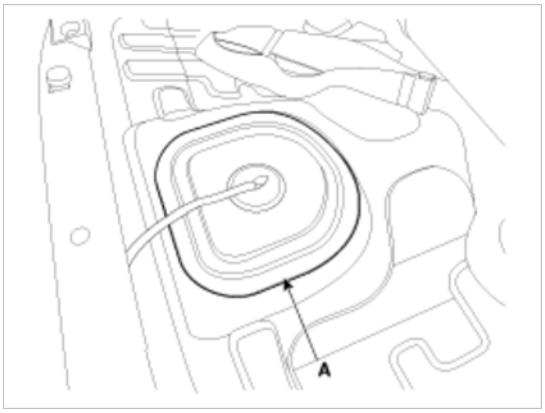
1. Installation is reverse of removal.

Fuel tank band installation nut:
39.2 ~ 54.0 N.m (4.0 ~ 5.5 kgf.m, 28.9 ~ 39.8 lb-ft)

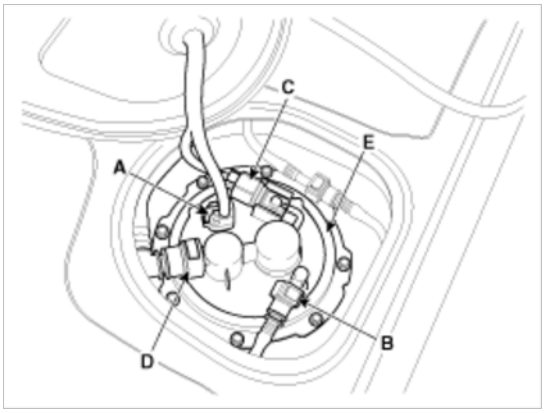
Fuel System > Fuel Delivery System > Fuel Pump > Repair procedures

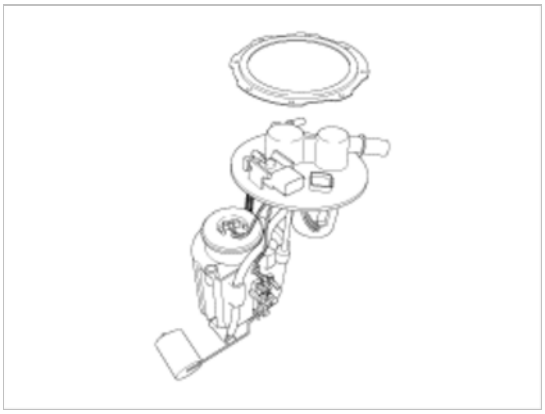
Removal

1. Release the residual pressure in fuel line (Refer to “Release Residual Pressure in Fuel Line” in this group).
2. Remove the rear seat [LH] (Refer to “Seat” in BD group).
3. Remove the fuel pump service cover (A).



4. Disconnect the fuel pump connector (A).
5. Disconnect the fuel feed tube quick connector (B).
6. Disconnect the fuel tank pressure sensor connector (C).
7. Disconnect the vapor tube quick-connector (D).
8. Remove the plate cover (E) after removing the installation bolts, and then remove the fuel pump from the fuel tank.





Installation

1. Installation is reverse of removal.

Fuel pump plate cover installation bolt :
1.96 ~ 2.94 N.m (0.2 ~ 0.3 kgf.m, 1.44 ~ 2.17 lb-ft)

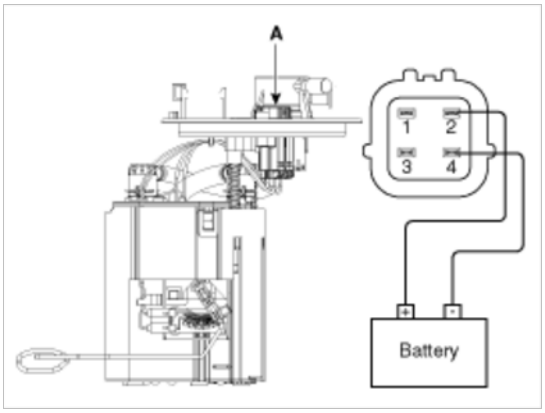
CAUTION

Be careful of fuel pump direction when installing.

Inspection

[Fuel pump]

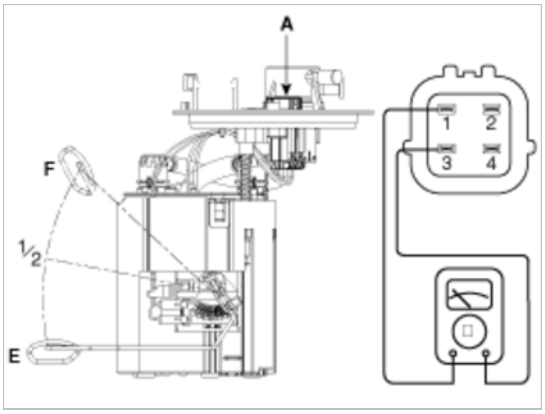
1. Turn ignition switch OFF and disconnect the negative (-)battery cable.
2. Remove the fuel pump assembly.
3. Check motor operation by fuel pump connector (A) connecting power(No.2) and ground(No.4)



Pin No.	discription
1	Fuel sender signal
2	Fuel pump (+)
3	Fuel sender ground
4	Fuel pump (-)

[Fuel sender]

1. Using an ohmmeter, measure the resistance between terminals 1 and 3 of sender connector (A) at each float level.



Pin No.	discription
1	Fuel sender signal
2	Fuel pump (+)
3	Fuel sender ground
4	Fuel pump (-)

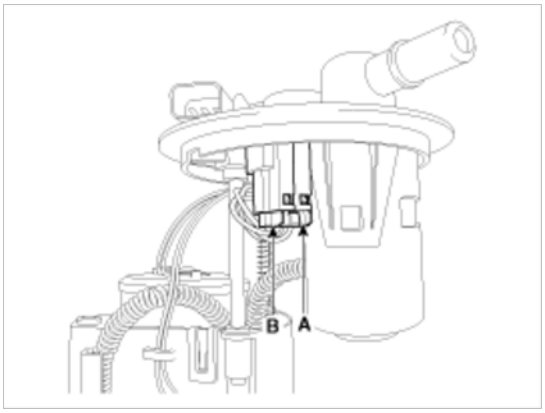
2. Also check that the resistance changes smoothly when the float is moved from "E" to "F".

Position	Resistance (Ω)	Capacity (ℓ)
E	197 ~ 203	3.0
1/2	64.2 ~ 68.2	24.6
F	6 ~ 10	49

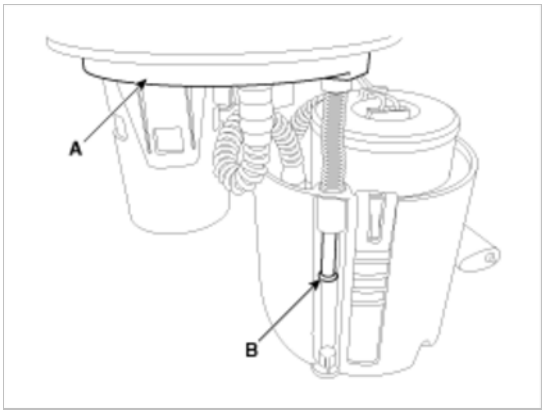
Fuel System > Fuel Delivery System > Fuel Filter > Repair procedures

Replacement

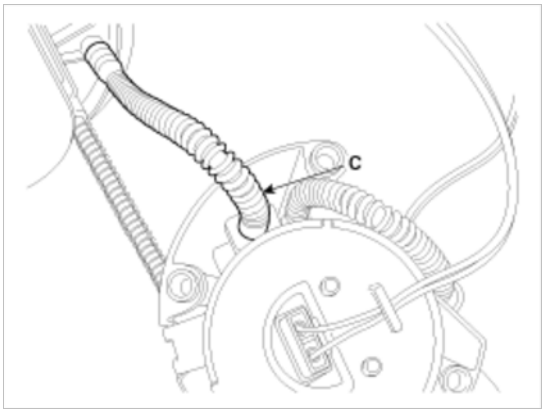
1. Remove the fuel pump (Refer to “Fuel Pump” in this group).
2. Disconnect the electric pump wiring connector (A) and the fuel sender connector (B).



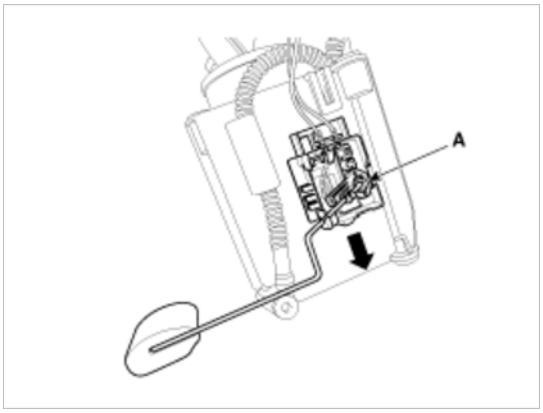
3. Remove the head assembly (A) after releasing the cushion fixing clip (B).



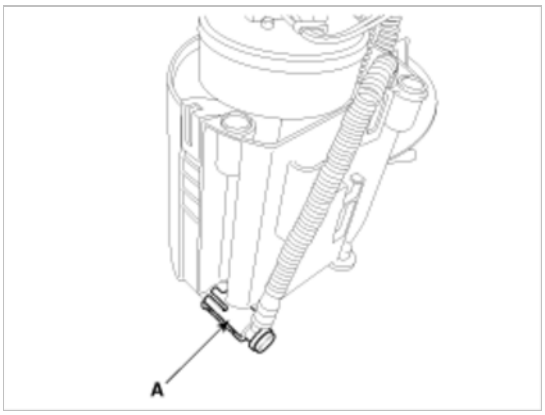
4. Disconnect the fuel tube quick-connectors (C).



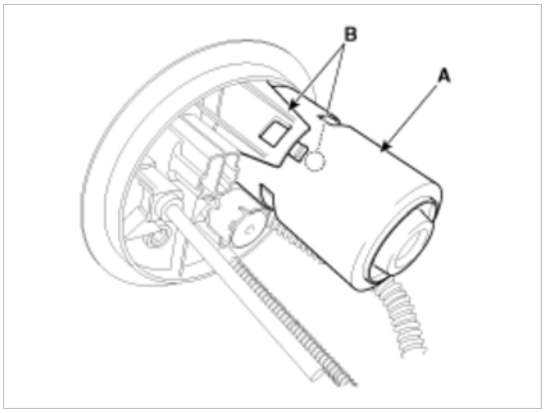
5. Remove the fuel sender (A) in the direction of an arrow.



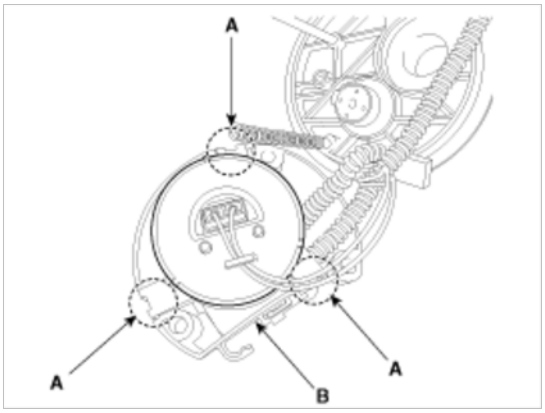
6. Disconnect the fuel tube connector (A).



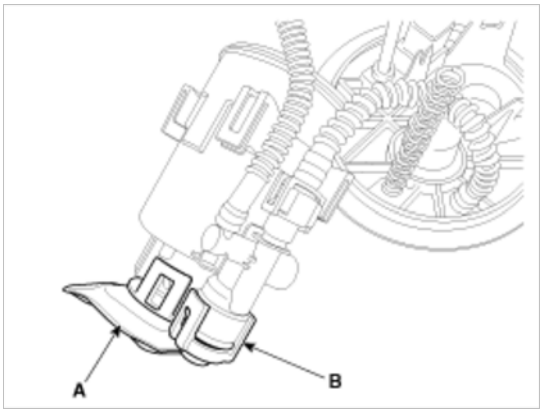
7. Remove the ORVR valve (A) after releasing hooks (B).



8. Remove the reservior-cup (B) after releasing the fixing hooks (A).



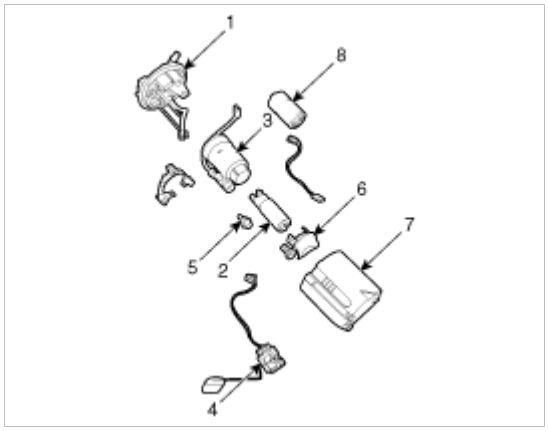
9. Release the fixing hooks, and then remove the pre-filter (A) and the fuel pressure regulator (B).



CAUTION

Be careful of O-ring.

10. Replace new fuel filter.

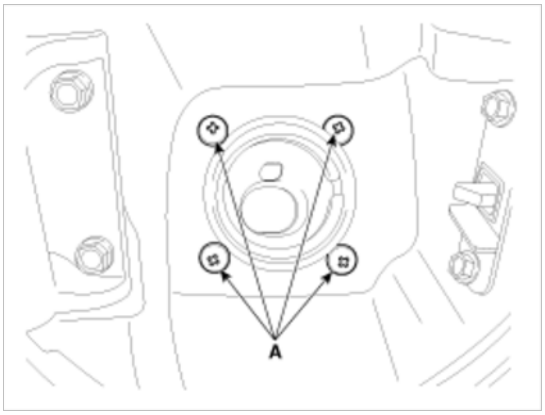


1. Head assembly
2. Electric pump motor
3. Fuel filter
4. Fuel sender
5. Fuel pressure regulator
6. Pre-filter
7. Reservoir cup
8. ORVR valve

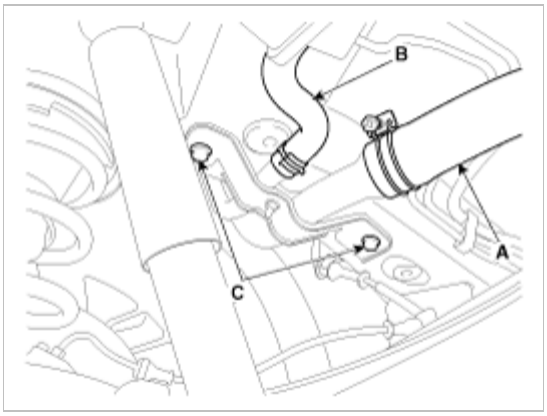
Fuel System > Fuel Delivery System > Filler-Neck Assembly > Repair procedures

Removal

1. Open the fuel filler door, and then remove the filler-neck assembly mounting screws (A).



2. Disconnect the fuel filler hose (A) and the ventilation hose (B).
3. Remove the filler-neck assembly from the vehicle after removing the bracket mounting bolt (C).



Installation

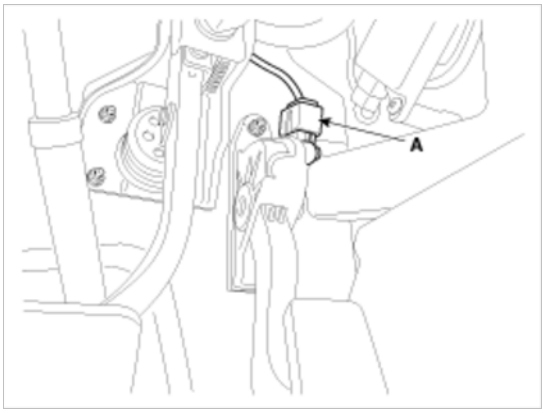
1. Installation is reverse of removal.

Filler-neck assembly bracket installation nut :
7.8 ~ 11.8 N.m (0.8 ~ 1.2 kgf.m, 5.8 ~ 8.7 lb-ft)
Filler-neck assembly installation screw :
7.8 ~ 11.8 N.m (0.8 ~ 1.2 kgf.m, 5.8 ~ 8.7 lb-ft)

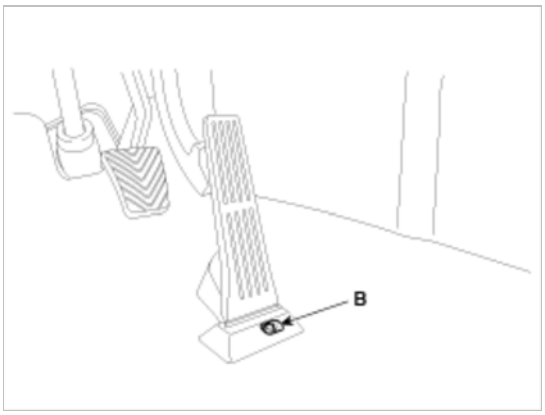
Fuel System > Fuel Delivery System > Accelerator Pedal > Repair procedures

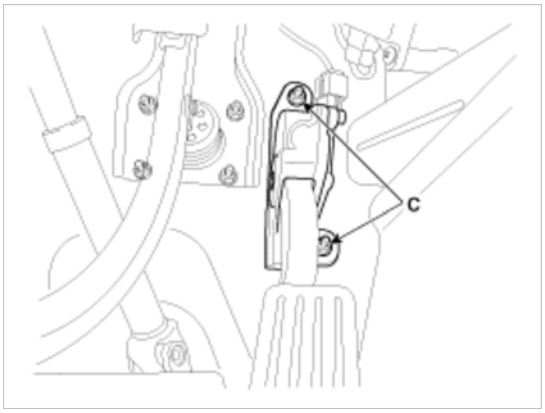
Removal

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



3. Remove the installation bolt (B) and nuts (C), and then remove the accelerator pedal module.





Installation

1. Installation is reverse of removal.

Accelerator pedal module installation nut:
9.8 ~ 14.7 N.m (1.0 ~ 1.5 kgf.m, 7.2 ~ 10.8 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)

Fuel System > Fuel Delivery System > Delivery Pipe > Repair procedures

Removal

WARNING

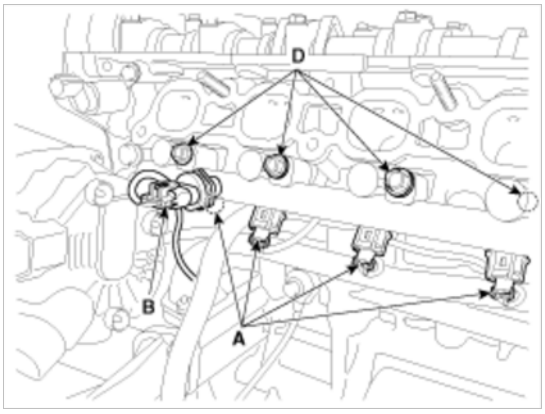
In case of removing the high pressure fuel pump, high pressure fuel pipe, delivery pipe, and injector, there may be injury caused by leakage of the high pressure fuel. So don't do any repair work right after engine stops.

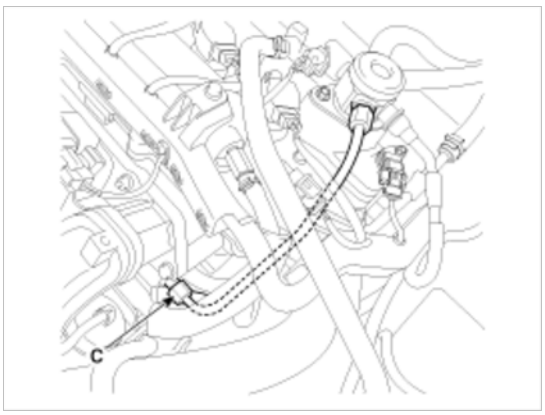
1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Release the residual pressure in fuel line (Refer to "Release Residual Pressure in Fuel Line" in this group).

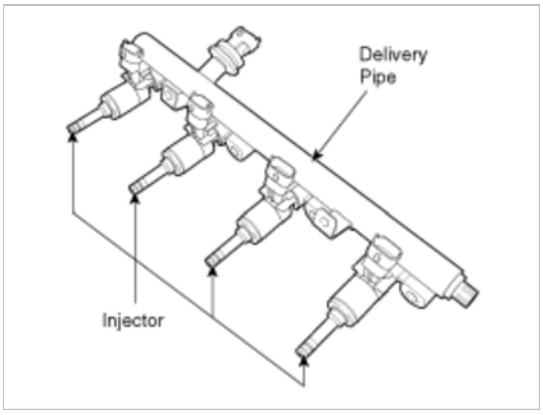
CAUTION

When removing the fuel pump relay, a Diagnostic Trouble Code (DTC) may occur. Delete the code with the GDS after completion of "Release Residual Pressure in Fuel Line" work.

3. Remove the intake manifold (Refer to "Intake And Exhaust System" in EM group).
4. Disconnect the injector connectors (A) and the rail pressure sensor connector (B).
5. Remove the high pressure fuel pipe (C).
6. Remove the engine oil gauge.
7. Remove the installation bolt (D), and then remove the delivery pipe and injector assembly from the engine.







Installation

CAUTION

- Do not use already used injector fixing clip again.

CAUTION

Do not reuse the support disc.
Do not reuse the injector rubber washer.
Do not reuse the combustion seal.

CAUTION

- Install the component with the specified torques.
- Note that internal damage may occur when the component is dropped. In this case, use it after inspecting.

CAUTION

- Apply engine oil to the injector O-ring.
- Do not use already used injector O-ring again.

CAUTION

- Do not use already used bolt again.

CAUTION

- When insert the injector, be careful not to damage the injector tip.

1. Installation is reverse of removal.

Delivery pipe installation bolt:
18.6 ~ 23.5 N.m (1.9 ~ 2.4 kgf.m, 13.7 ~ 17.4 lb-ft)
High pressure fuel pipe installation nut:
26.5 ~ 32.4 N.m (2.7 ~ 3.3 kgf.m, 19.5 ~ 23.9 lb-ft)

Fuel System > Fuel Delivery System > High Pressure Fuel Pump > Repair procedures

Removal

WARNING

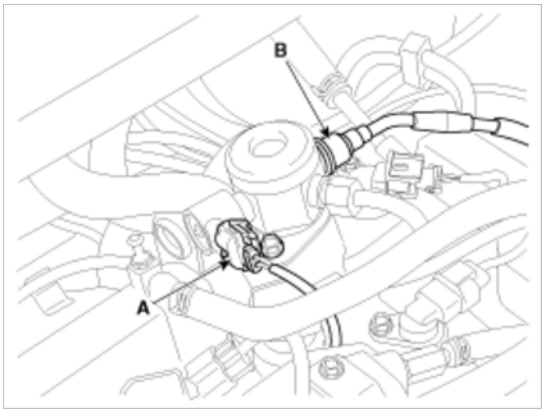
In case of removing the high pressure fuel pump, high pressure fuel pipe, delivery pipe, and injector, there may be injury caused by leakage of the high pressure fuel. So don't do any repair work right after engine stops.

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Release the residual pressure in fuel line (Refer to "Release Residual Pressure in Fuel Line" in this group).

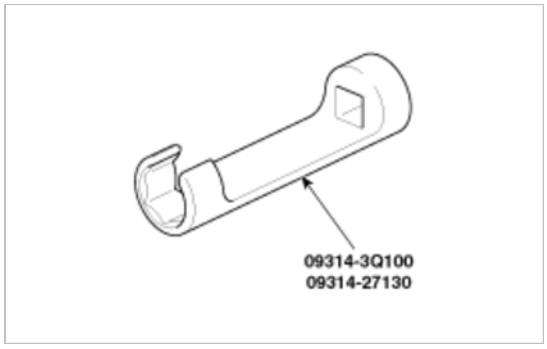
CAUTION

When removing the fuel pump relay, a Diagnostic Trouble Code (DTC) may occur.
Delete the code with the GDS after completion of "Release Residual Pressure in Fuel Line" work.

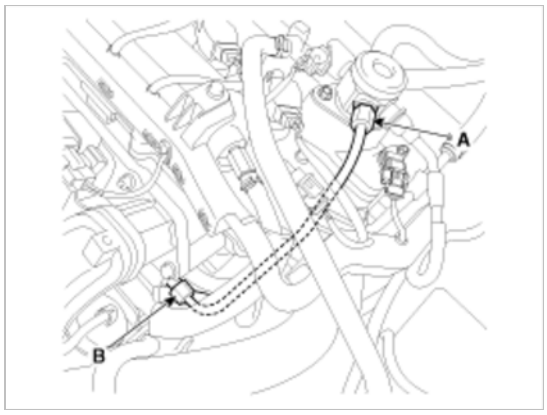
3. Remove the air cleaner and the air intake hose (Refer to “Intake And Exhaust System” in EM group).
4. Disconnect the fuel pressure regulator valve connector (A).
5. Disconnect the fuel feed tube quick-connector (B).



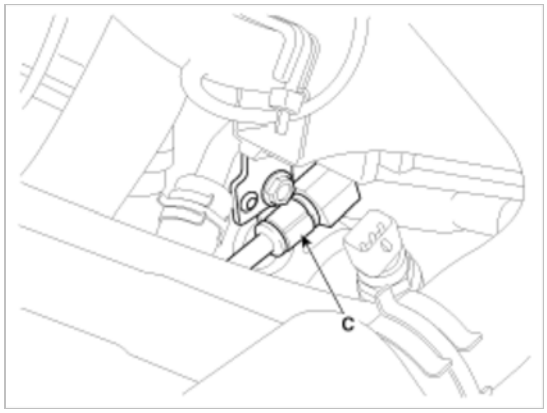
6. Remove the high pressure fuel pipe.
   (1) Remove the installation nut (A) from the high pressure fuel pump with the special service tool [SST No.: 09314-3Q100 or 09314-27130]



   (2) Remove the installation nut (B) from the delivery pipe with the special service tool [SST No.: 09314-3Q100 or 09314-27130]



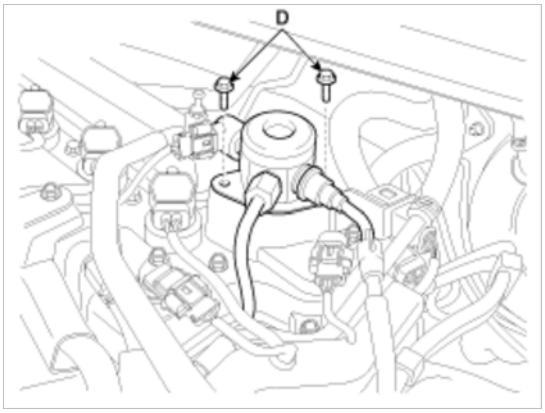
   (3) Disconnect the engine coolant temperature sensor connector.
   (4) Remove the function block (C), and then remove the high pressure fuel pipe.



7. Remove the installation bolts (D), and then remove the high pressure fuel pump from the cylinder head assembly.

CAUTION

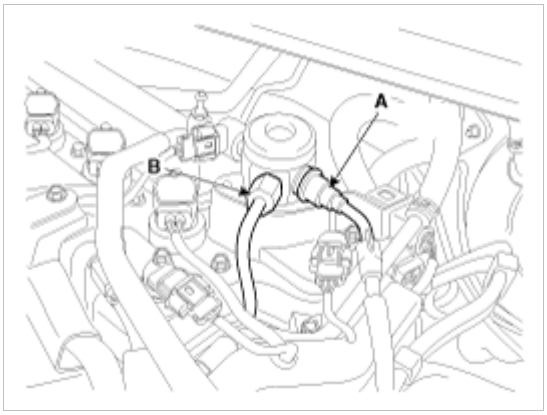
Unscrew in turn the two bolts in small step (0.5 turns). In case of fully unscrewing one of the two bolts with the other bolt installed, the housing surface of the cylinder head may be broken because of tension of the pump spring.



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

- Be careful to be free from foreign materials when assembling.

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

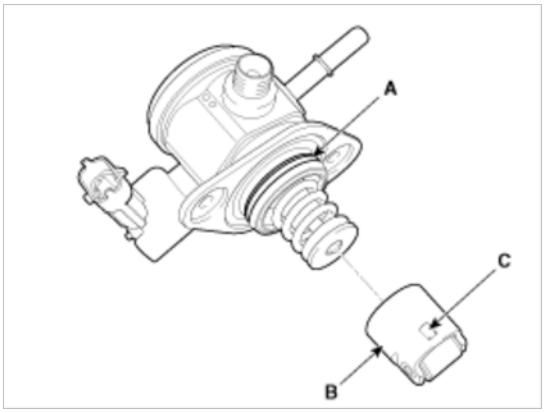
- Install the component with the specified torques.
- First hand-tighten the fasteners fully until they are not fastened any more in orderto have them inserted in place and then completely tighten to the specified torque using a torque wrench.
  If not tightening the bolts or nuts in a straight line with the mating bolt holes or fittings, it may cause a fuelleak due to broken threads.

CAUTION

- Note that internal damage may occur when the component is dropped. In this case, use it after inspecting.

CAUTION

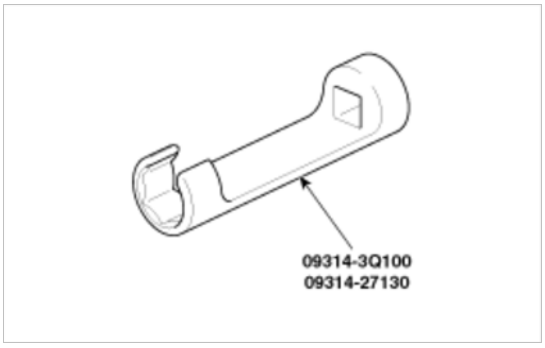
- Apply engine oil to the O-ring (A) of the high pressure fuel pump, the roller tappet (B), and the protrusion (C). Also apply engine oil to the groove on the location where the protrusion (C) is installed.



1. Installation is reverse of removal.

NOTE

Use the special service tool [SST No.: 09314-3Q100 or 09314-27130] 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)