General Information

Specifications[~2010.10.03]

Fuel Delivery System

Items	Specification	
Fuel Tank	Capacity	70 lit. (18.5 U.S.gal., 74.0 U.S.qt., 61.6 Imp.qt.)
Fuel Filter	Type	Paper type
Fuel Pressure	Low Pressure Fuel Line	430 ~ 470 kPa (4.3 ~ 4.7 kgf/㎠, 62.3 ~ 68.2 psi)
	High Pressure Fuel Line	5.0 ~ 12.0 MPa (51.0 ~ 122.4 kgf/㎠, 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)
℃	˚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)
℃	˚F	
-40	-40	48.14
-20	-4	14.13 ~ 16.83
0	32	5.79
20	68	2.31 ~ 2.59
40	104	1.15
60	140	0.59
80	176	0.32

Throttle Position Sensor (TPS) [integrated into ETC Module]

▷ Type: Variable resistor type

▷ Specification

Throttle Angle(˚)	Output Voltage (V)	
	TPS1	TPS2
0	0	5.0
10	0.48	4.52
20	0.95	4.05
30	1.43	3.57
40	1.90	3.10
50	2.38	2.62
60	2.86	2.14
70	3.33	1.67
80	3.81	1.19
90	4.29	0.71
100	4.76	0.24
105	5.0	0
C.T (6~15˚)	0.29 ~ 0.71	4.29 ~ 4.71
W.O.T (93~102˚)	4.43 ~ 4.86	0.14 ~ 0.57

Item	Resistance (kΩ)
TPS1	0.875 ~ 1.625 [20℃(68˚F)]
TPS2	0.875 ~ 1.625 [20℃(68˚F)]

Crankshaft Position Sensor (CKPS)

▷ Type: Hall effect type

Camshaft Position Sensor (CMPS)

▷ Type: Hall effect type

Knock Sensor (KS)

▷ Type: Piezo-electricity type

▷ Specification

Item	Specification
Capacitance (pF)	850 ~ 1,150

Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 1]

▷ Type: Zirconia (ZrO2) [Linear] Type

▷ Specification

Item	Specification
Heater Resistance (Ω)	2.5 ~ 4.0 [20℃(69.8˚F)]

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

▷ Type: Zirconia (ZrO2) [Binary] Type

▷ Specification

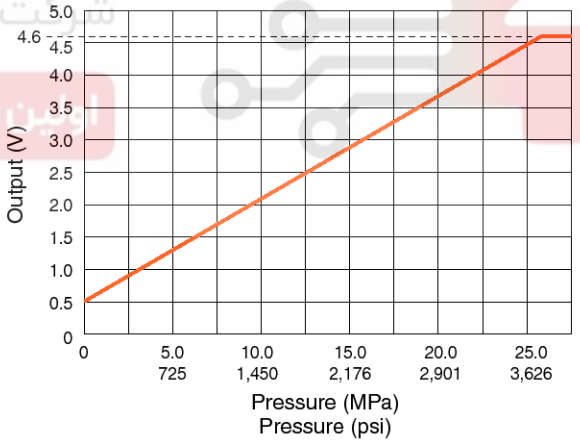
A/F Ratio (λ)	Output Voltage(V)
RICH	Approx. 0.9
LEAN	Approx. 0.04

Item	Specification
Heater Resistance (Ω)	3.3 ~ 4.1 [21℃(69.8˚F)]

Rail Pressure Sensor (RPS)

▷ Type: Piezo-electricity type

▷ Specification



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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

Actuators

Injector

▷ Specification

Item	Specification
Coil Resistance (Ω)	1.18 ~ 1.31 [20℃(68˚F)]

ETC Motor [integrated into ETC Module]

▷ Specification

Item	Specification
Coil Resistance (Ω)	1.2 ~ 1.8 [20℃(68˚F)]

Purge Control Solenoid Valve (PCSV)

▷ Specification

Item	Specification
Coil Resistance (Ω)	19.0 ~ 22.0 [20℃(68˚F)]

CVVT Oil Control Valve (OCV)

▷ Specification

Item	Specification
Coil Resistance (Ω)	6.9 ~ 7.9 [20℃(68˚F)]

Variable Intake Solenoid (VIS) Valve

▷ Specification

Item	Specification
Coil Resistance (Ω)	30.0 ~ 35.0 [20℃(68˚F)]

Fuel Pressure Regulator Valve

▷ Specification

Item	Specification
Coil Resistance (Ω)	0.5 [20℃(68˚F)]

Ignition Coil

▷ Type: Stick type

▷ Specification

Item	Specification
Primary Coil Resistance (Ω)	0.62 ± 10%[20℃(68˚F)]
Secendary Coil Resistance (kΩ)	7.0 ± 15%[20℃(68˚F)]

Specifications[2010.10.04~]

Fuel Delivery System

Items	Specification	
Fuel Tank	Capacity	70 lit. (18.5 U.S.gal., 74.0 U.S.qt., 61.6 Imp.qt.)
Fuel Filter	Type	Paper type
Fuel Pressure	Low Pressure Fuel Line	480 ~ 520 kPa (4.9 ~ 5.3 kgf/㎠, 69.6 ~ 75.4 psi)
	High Pressure Fuel Line	5.0 ~ 12.0 MPa (51.0 ~ 122.4 kgf/㎠, 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)
℃	°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)
℃	°F	
-40	-40	48.14
-20	-4	14.13 ~ 16.83
0	32	5.79
20	68	2.31 ~ 2.59
40	104	1.15
60	140	0.59
80	176	0.32

Throttle Position Sensor (TPS) [integrated into ETC Module]

▷ Type: Variable resistor type

▷ Specification

Throttle Angle(˚)	Output Voltage (V)	
	TPS1	TPS2
0	0	5.0
10	0.48	4.52
20	0.95	4.05
30	1.43	3.57
40	1.90	3.10
50	2.38	2.62
60	2.86	2.14
70	3.33	1.67
80	3.81	1.19
90	4.29	0.71
100	4.76	0.24
105	5.0	0
C.T (6~15˚)	0.29 ~ 0.71	4.29 ~ 4.71
W.O.T (93~102˚)	4.43 ~ 4.86	0.14 ~ 0.57

Item	Resistance (kΩ)
TPS1	0.875 ~ 1.625 [20℃(68˚F)]
TPS2	0.875 ~ 1.625 [20℃(68˚F)]

Crankshaft Position Sensor (CKPS)

▷ Type: Hall effect type

Camshaft Position Sensor (CMPS)

▷ Type: Hall effect type

Knock Sensor (KS)

▷ Type: Piezo-electricity type

▷ Specification

Item	Specification
Capacitance (pF)	850 ~ 1,150

Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 1]

▷ Type: Zirconia (ZrO2) [Linear] Type

▷ Specification

Item	Specification
Heater Resistance (Ω)	2.5 ~ 4.0 [20℃(69.8˚F)]

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

▷ Type: Zirconia (ZrO2) [Binary] Type

▷ Specification

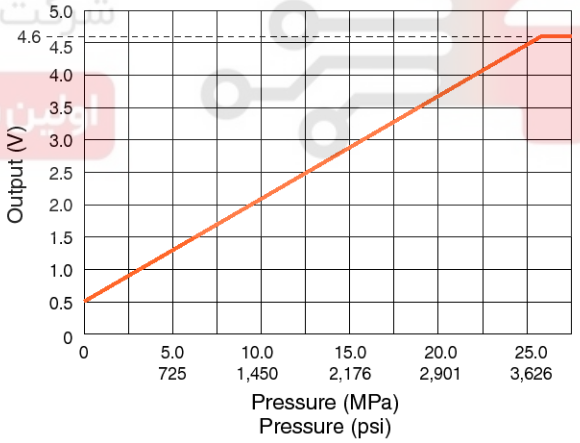
A/F Ratio (λ)	Output Voltage(V)
RICH	Approx. 0.9
LEAN	Approx. 0.04

Item	Specification
Heater Resistance (Ω)	3.3 ~ 4.1 [21℃(69.8˚F)]

Rail Pressure Sensor (RPS)

▷ Type: Piezo-electricity type

▷ Specification



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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

Actuators

Injector

▷ Specification

Item	Specification
Coil Resistance (Ω)	1.18 ~ 1.31 [20℃(68˚F)]

ETC Motor [integrated into ETC Module]

▷ Specification

Item	Specification
Coil Resistance (Ω)	1.2 ~ 1.8 [20℃(68˚F)]

Purge Control Solenoid Valve (PCSV)

▷ Specification

Item	Specification
Coil Resistance (Ω)	19.0 ~ 22.0 [20℃(68˚F)]

CVVT Oil Control Valve (OCV)

▷ Specification

Item	Specification
Coil Resistance (Ω)	6.9 ~ 7.9 [20℃(68˚F)]

Variable Intake Solenoid (VIS) Valve

▷ Specification

Item	Specification
Coil Resistance (Ω)	30.0 ~ 35.0 [20℃(68˚F)]

Fuel Pressure Regulator Valve

▷ Specification

Item	Specification
Coil Resistance (Ω)	0.5 [20℃(68˚F)]

Ignition Coil

▷ Type: Stick type

▷ Specification

Item	Specification
Primary Coil Resistance (Ω)	0.62 ± 10%[20℃(68˚F)]
Secendary Coil Resistance (kΩ)	7.0 ± 15%[20℃(68˚F)]

Service Standard

Item		Specification	
Ignition Timing (˚)		BTDC 6 ± 10	
Idle Speed (rpm)	A/C OFF	Neutral, N, P-range	600 ± 100
		D-range	600 ± 100
	A/C ON	Neutral, N, P-range	600 ± 100
		D-range	600 ± 100

Tightening Torques

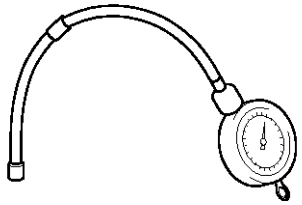
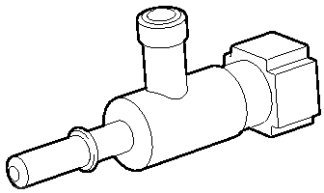
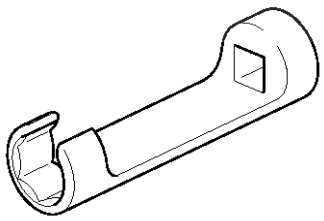
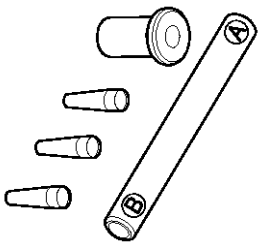
Engine Control System

Item	kgf.m	N.m	lb-ft
ECM installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
ECM bracket installation bolt/nut	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Manifold absolute pressure sensor installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Crankshaft position sensor installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Crankshaft position sensor cover installation bolt (M6)	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Crankshaft position sensor cover installation bolt (M8)	1.9 ~ 2.4	18.6 ~ 23.5	13.7 ~ 17.4
Camshaft position sensor (Bank 1 / Intake) installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Camshaft position sensor (Bank 1 / Exhaust) installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Knock sensor installation bolt	1.9 ~ 2.4	18.6 ~ 23.5	13.7 ~ 17.4
Heated oxygen sensor (Bank 1 / sensor 1) installation	4.0 ~ 5.0	39.2 ~ 49.1	28.9 ~ 36.2
Heated oxygen sensor (Bank 1 / sensor 2) installation	4.0 ~ 5.0	39.2 ~ 49.1	28.9 ~ 36.2
Rail pressure sensor installation	1.8 ~ 2.2	18.0 ~ 22.0	13.3 ~ 16.2
Electronic throttle body installation bolt	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	0.4 ~ 0.6	3.9 ~ 5.9	2.9 ~ 4.3
Filler-neck assembly installation screw	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	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7

Special Service Tools

Item	Illustration	Application
Fuel Pressure Gauge (09353-24100)	 EFDA003A	Measuring the fuel line pressure
Fuel Pressure Gauge Adapter (09353-02100)	 SYFFL0270N	Connection between the high pressure fuel pump and the fuel feed line
Heated Oxygen Sensor Socket Wrench (09392-2H100)	 SFDEM8050L	Removal and installation of the heated oxygen sensor
Torque Wrench Socket (09314-3Q100)	 AFAF201B	Removal and installation of the high pressure fuel pipe
Injector Combustion Seal Guide & Sizing tool (09353-2B000)	 SRBF11000D	Installation of the injector combustion seal

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	**Confirm test**

14	**END**

STDFL0001N

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	

SCMF10001L

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℃, 68˚F), unless stated otherwise.

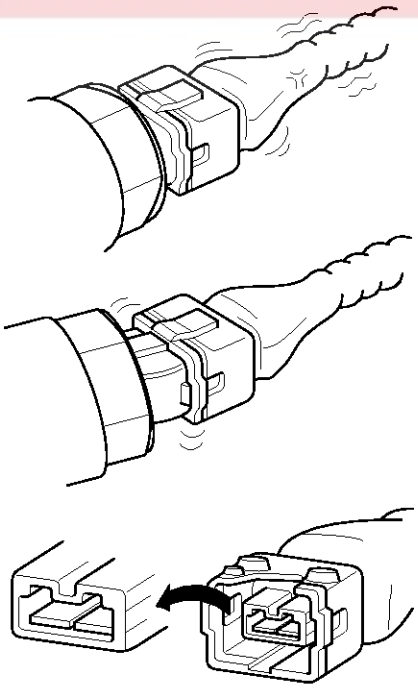
NOTICE

The measured resistance in except for ambient temperature (20℃, 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.



BFGE321A

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

● Simulating Vibration

a. Sensors and Actuators

: Slightly vibrate sensors, actuators or relays with finger.

WARNING

Strong vibration may break sensors, actuators or relays

b. Connectors and Harness

: Lightly shake the connector and wiring harness vertically and then horizontally.

● Simulating Heat

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

WARNING

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

● Simulating Water Sprinkling

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

WARNING

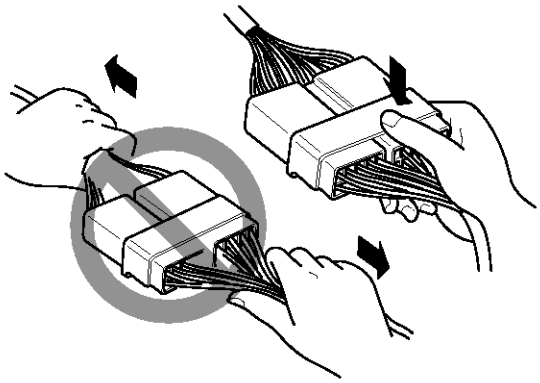
DO NOT sprinkle water directly into the engine compartment or electronic components.

● Simulating Electrical Load

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

Connector Inspection Procedure

1. Handling of Connector
   a. Never pull on the wiring harness when disconnecting connectors.



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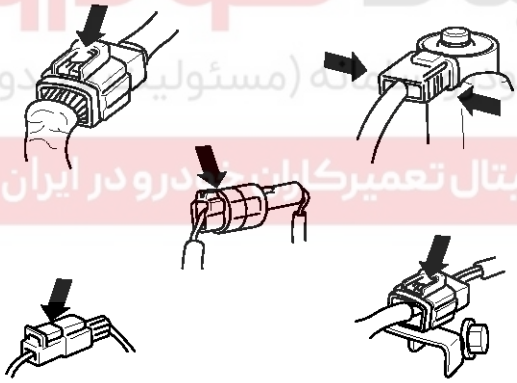
   b. When removing the connector with a lock, press or pull locking lever.



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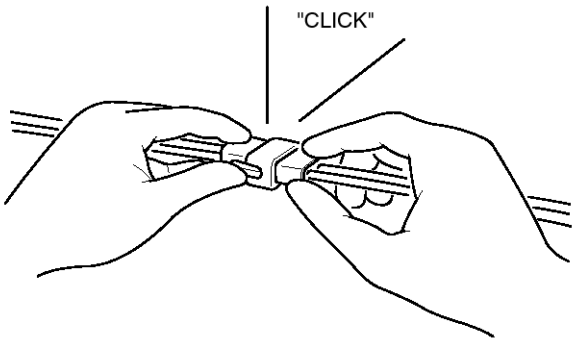
   c. Listen for a click when locking connectors. This sound indicates that they are securely locked.



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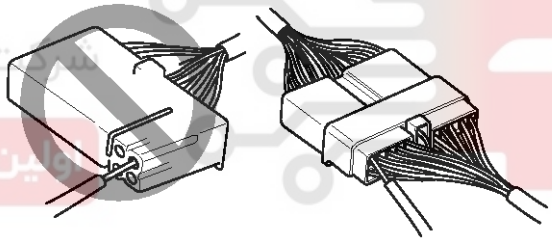
   d. When a tester is used to check for continuity, or to measure voltage, always insert tester probe from wire harness side.



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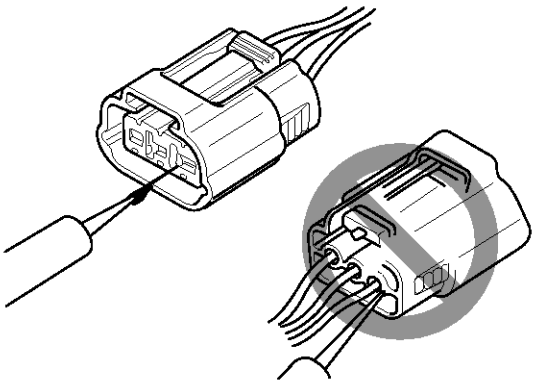
e. Check waterproof connector terminals from the connector side. Waterproof connectors cannot be accessed from harness side.



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NOTICE

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

2. Checking Point for Connector

a. While the connector is connected:

Hold the connector, check connecting condition and locking efficiency.

b. When the connector is disconnected:

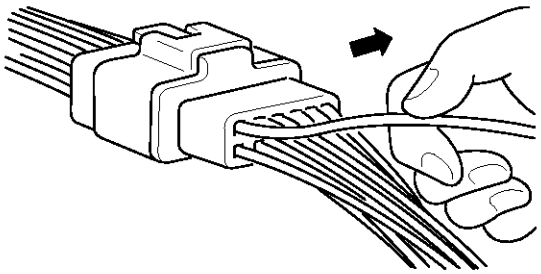
Check missed terminal, crimped terminal or broken core wire by slightly pulling the wire harness.

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.



BFGE015K

3. Repair Method of Connector Terminal

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

NOTICE

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

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.

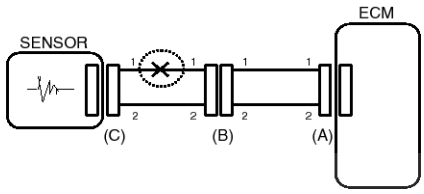
Electrical Circuit Inspection Procedure

● Check Open Circuit

1. Procedures for Open Circuit
   - Continuity Check
   - Voltage Check

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

FIG 1



BFGE501A

2. Continuity Check Method

NOTICE

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

Specification (Resistance)

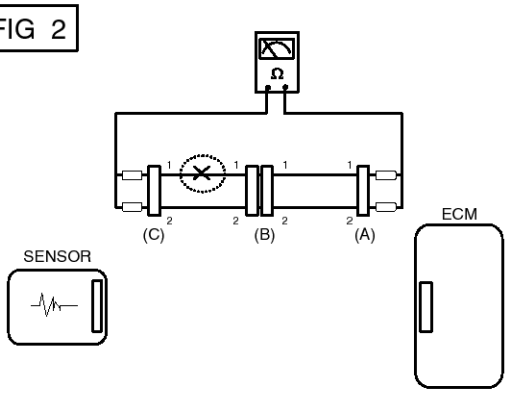
1Ω or less → Normal Circuit

1㏁ 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 1㏁ and below 1 Ω respectively. Specifically the open circuit is line 1 (Line 2 is normal). To find exact break point, check sub line of line 1 as described in next step.

FIG 2

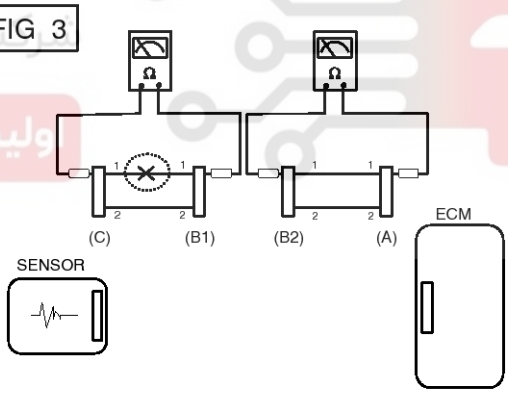


BFGE501B

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 1㏁ and the open circuit is between terminal 1 of connector (C) and terminal 1 of connector (B1).

FIG 3

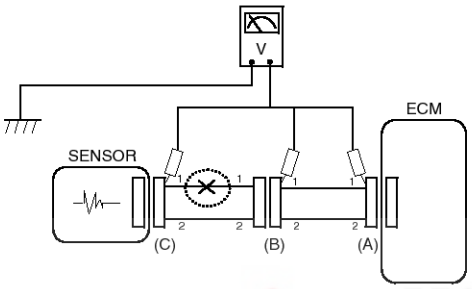


BFGE501C

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).

FIG 4



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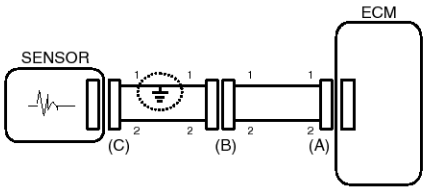
● Check Short Circuit

1. Test Method for Short to Ground Circuit
   • Continuity Check with Chassis Ground

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

FIG 5



BFGE501E

2. Continuity Check Method (with Chassis Ground)

NOTICE

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

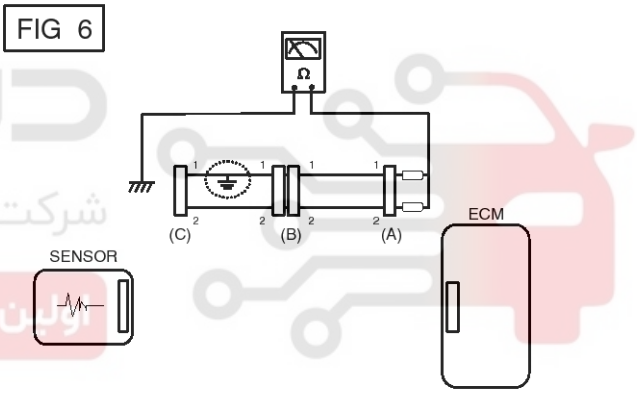
Specification (Resistance)

1Ω or less → Short to Ground Circuit
1MΩ or Higher → Normal Circuit

   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



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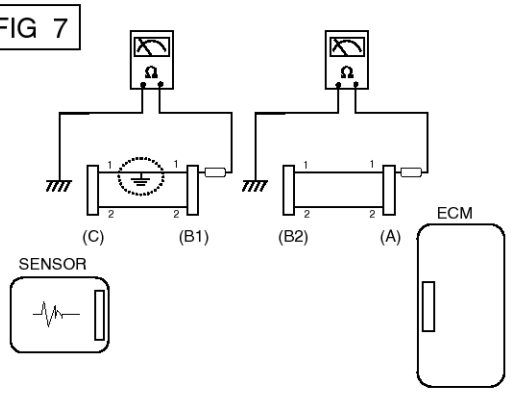
   b. Disconnect connector (B), and measure the resistance between connector (A) and chassis ground, and between (B1) and chassis ground as shown in [FIG. 7].

      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



BFGE501G

● Testing For Voltage Drop

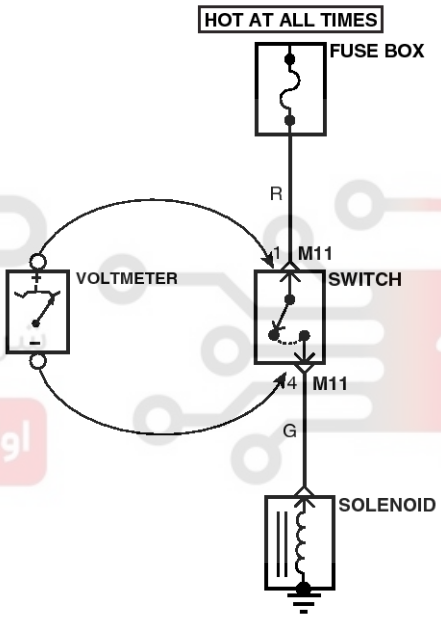
This test checks for voltage drop along a wire, or through a connection orswitch.

A. 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.

B. Connect the negative lead to the other end of the wire. (or the other side of the connector or switch)

C. Operate the circuit.

D. 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.



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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

Main symptom	Diagnostic procedure	Also check for
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)

Engine Control System

Description

If the Gasoline Engine Control system components (sensors, ECM, injector, etc.) fail, interruption to the fuel supply or failure to supply the proper amount of fuel for various engine operating conditions will result. The following situations may be encountered.

1. Engine is hard to start or does not start at all.
2. Unstable idle.
3. Poor driveability

If any of the above conditions are noted, first perform a routine diagnosis that includes basic engine checks (ignition system malfunction, incorrect engine adjustment, etc.). Then, inspect the Gasoline Engine Control system components with the GDS.

NOTICE

- *Before removing or installing any part, read the diagnostic trouble codes and then disconnect the battery negative (-) terminal.*
- *Before disconnecting the cable from battery terminal, turn the ignition switch to OFF. Removal or connection of the battery cable during engine operation or while the ignition switch is ON could cause damage to the ECM.*
- *The control harnesses between the ECM and heated oxygen sensor are shielded with the shielded ground wires to the body in order to prevent the influence of ignition noises and radio interference. When the shielded wire is faulty, the control harness must be replaced.*
- *When checking the generator for the charging state, do not disconnect the battery '+' terminal to prevent the ECM from damage due to the voltage.*
- *When charging the battery with the external charger, disconnect the vehicle side battery terminals to prevent damage to the ECM.*

Malfunction Indicator Lamp (MIL) [EOBD]

A malfunction indicator lamp illuminates to notify the driver that there is a problem with the vehicle. However, the MIL will go off automatically after 3 subsequent sequential driving cycles without the same malfunction. Immediately after the ignition switch is turned on (ON position - do not start), the MIL will illuminate continuously to indicate that the MIL operates normally.

Faults with the following items will illuminate the MIL.

- Catalyst
- Fuel system
- Air Flow Sensor
- Intake Air Temperature Sensor
- Engine Coolant Temperature Sensor
- ETC module (TPS & ETC motor)
- Heated Oxygen Sensor (Upstream)
- Heated Oxygen Sensor Heater (Upstream)
- Heated Oxygen Sensor (Downstream)
- Heated Oxygen Sensor Heater (Downstream)
- Injector
- Misfire
- Crankshaft Position Sensor
- Camshaft Position Sensor
- Evaporative Emission Control System
- Vehicle Speed Sensor
- Power Supply
- ECM/ PCM
- MT/AT Encoding
- Acceleration Sensor
- MIL-ON Request Signal
- Power Stage

NOTICE

Refer to "Inspection Chart For Diagnostic Trouble Codes (DTC)" for more information.

[NON-EOBD]

A malfunction indicator lamp illuminates to notify the driver that there is a problem with the vehicle. However, the MIL will go off automatically after 3 subsequent sequential driving cycles without the same malfunction. Immediately after the ignition switch is turned on (ON position - do not start), the MIL will illuminate continuously to indicate that the MIL operates normally.

Faults with the following items will illuminate the MIL

- Heated oxygen sensor (HO2S)
- Mass Air Flow sensor (MAFS)
- Engine coolant temperature sensor (ECTS)
- ETC module (TPS & ETC motor)
- Injectors
- ECM

NOTICE

Refer to "Inspection Chart For Diagnostic Trouble Codes (DTC)" for more information.

[INSPECTION]

1. After turning ON the ignition key, ensure that the light illuminates for about 5 seconds and then goes out.
2. If the light does not illuminate, check for an open circuit in the harness, a blown fuse or a blown bulb.

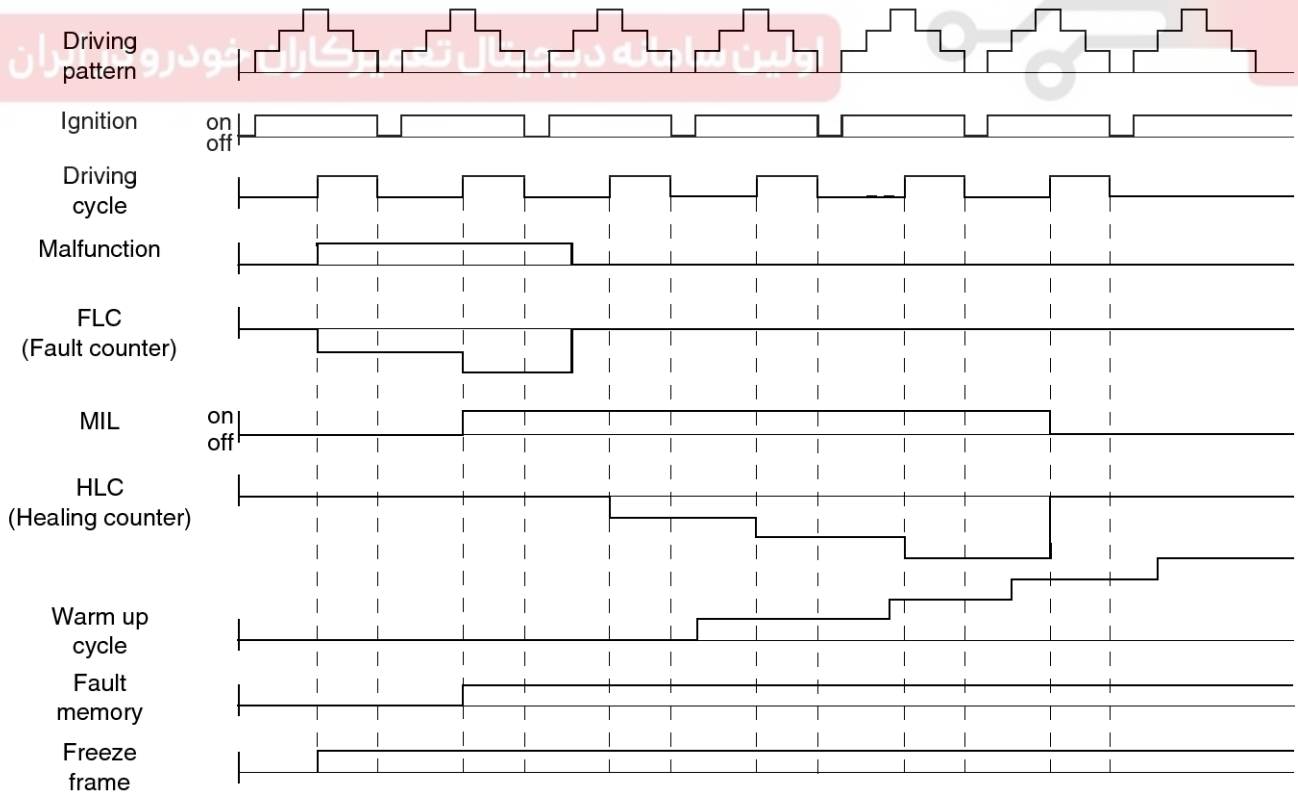
Self-Diagnosis

The ECM monitors the input/output signals (some signals at all times and the others under specified conditions). When the ECM detects an irregularity, it records the diagnostic trouble code, and outputs the signal to the Data Link connector. The diagnosis results can be read with the MIL or the GDS. Diagnostic Trouble Codes (DTC) will remain in the ECM as long as battery power is maintained. The diagnostic trouble codes will, however, be erased when the battery terminal or ECM connector is disconnected, or by the GDS.

NOTICE

If a sensor connector is disconnected with the ignition switch turned on, the diagnostic trouble code (DTC) is recorded. In this case, disconnect the battery negative terminal (-) for 15 seconds or more, and the diagnosis memory will be erased.

The relation between DTC and driving pattern in EOBD system



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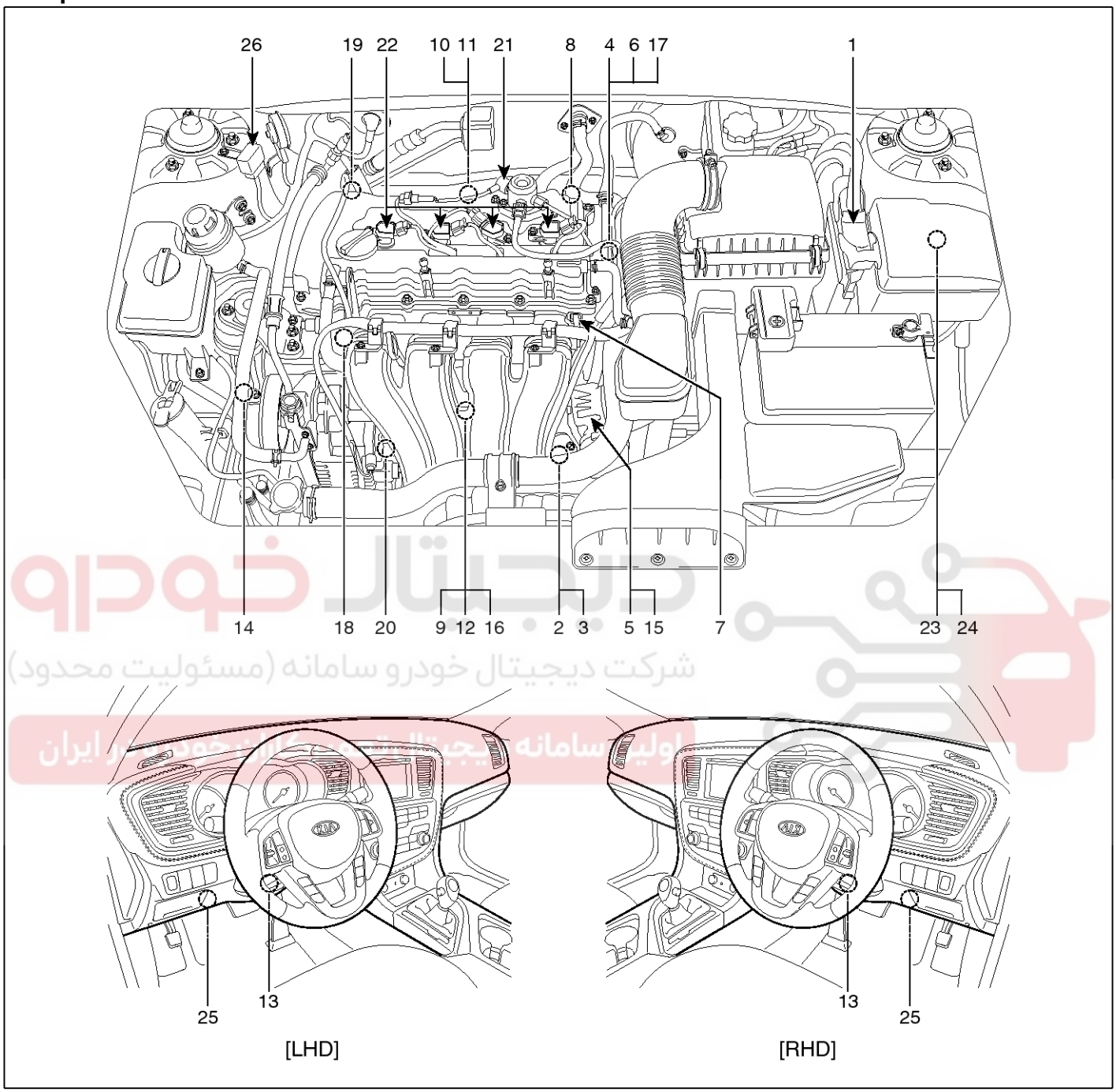
1. When the same malfunction is detected and maintained during two sequential driving cycles, the MIL will automatically illuminate.
2. The MIL will go off automatically if no fault is detected after 3 sequential driving cycles.
3. A Diagnostic Trouble Code(DTC) is recorded in ECM memory when a malfunction is detected after two sequential driving cycles. The MIL will illuminate when the malfunction is detected on the second driving cycle.

   If a misfire is detected, a DTC will be recorded, and the MIL will illuminate, immediately after a fault is first detected.
4. A Diagnostic Trouble Code(DTC) will automatically erase from ECM memory if the same malfunction is not detected for 40 driving cycles.

NOTICE

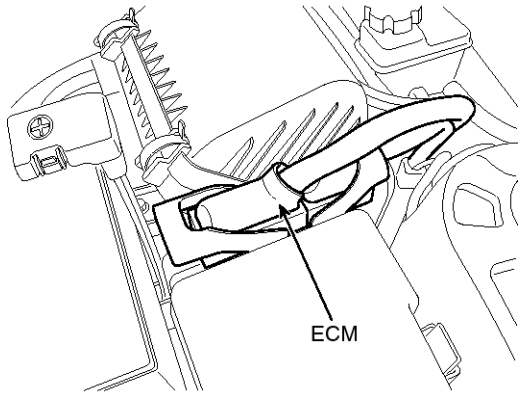
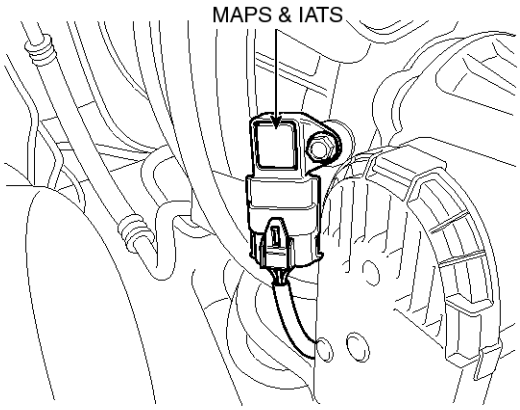
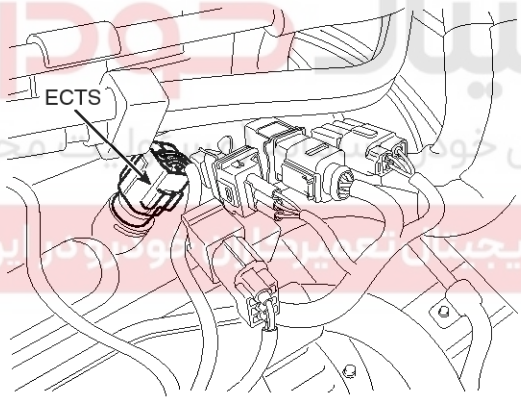
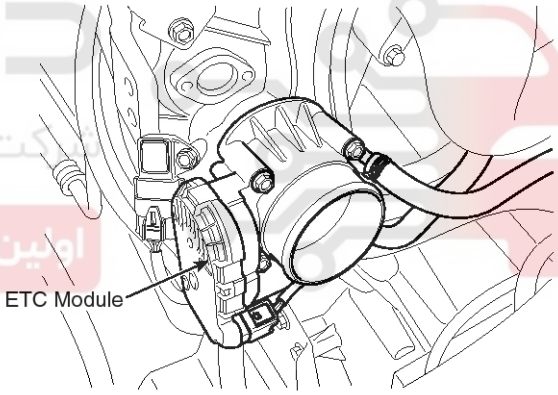
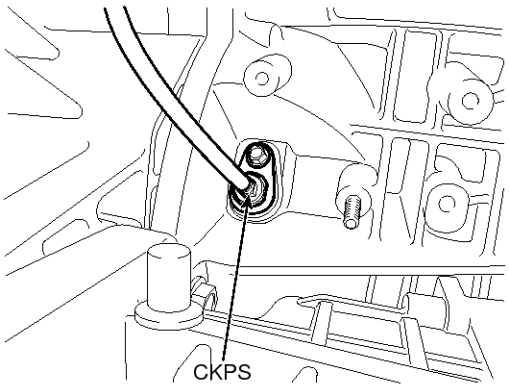
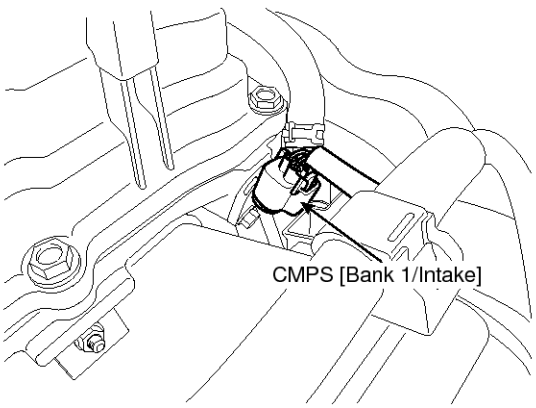
- *A "warm-up cycle" means sufficient vehicle operation such that the coolant temperature has risen by at least 40 degrees Fahrenheit from engine starting and reaches a minimum temperature of 160 degress Fahrenheit.*
- *A "driving cycle" consists of engine startup, vehicle operation beyond the beginning of closed loop operation.*

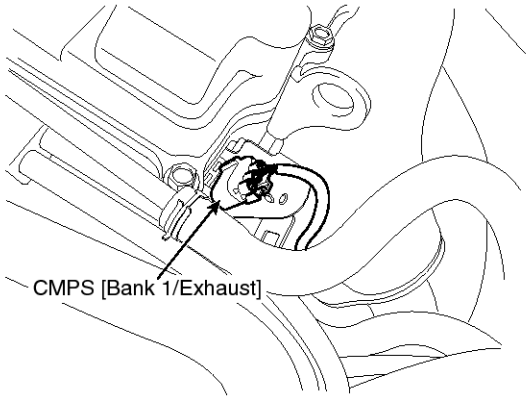
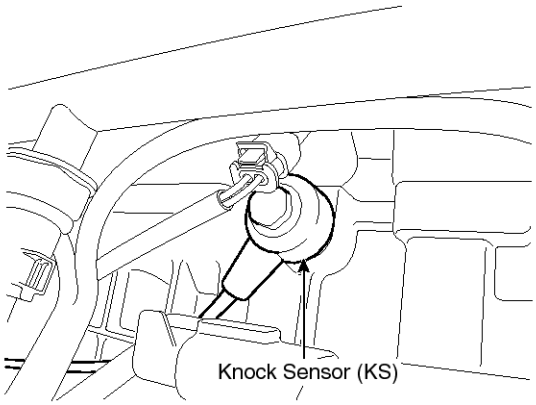
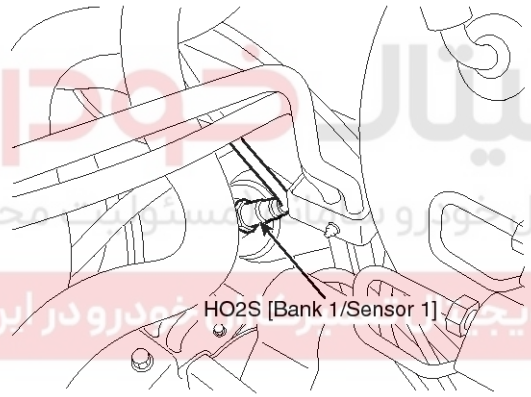
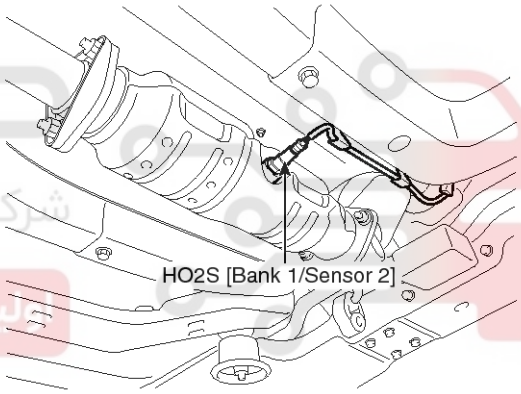
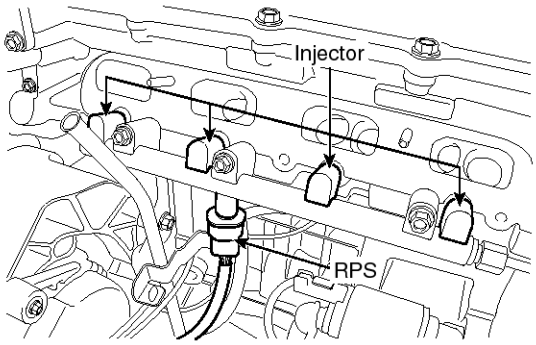
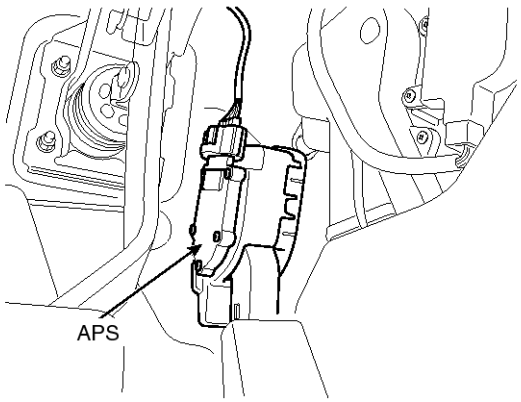
Components Location

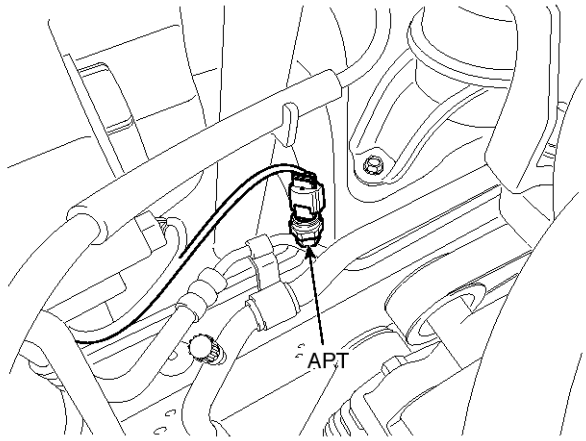
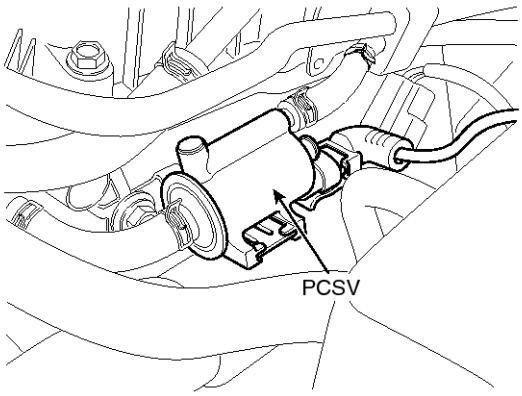
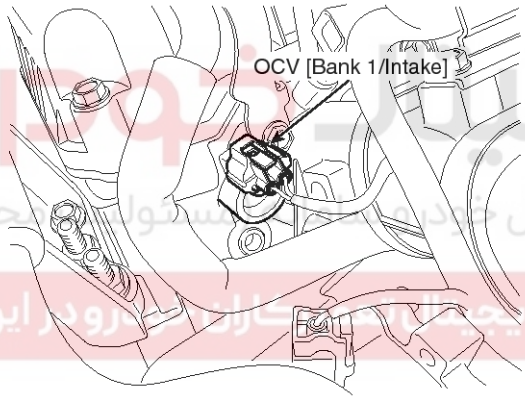
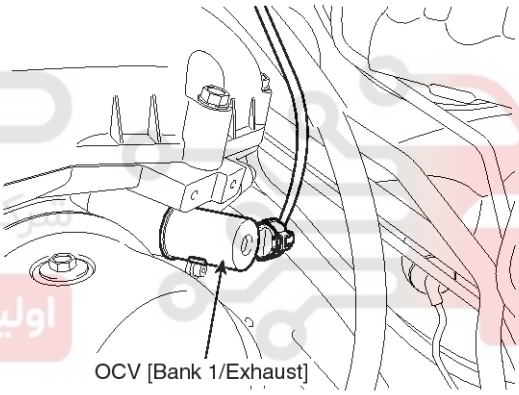
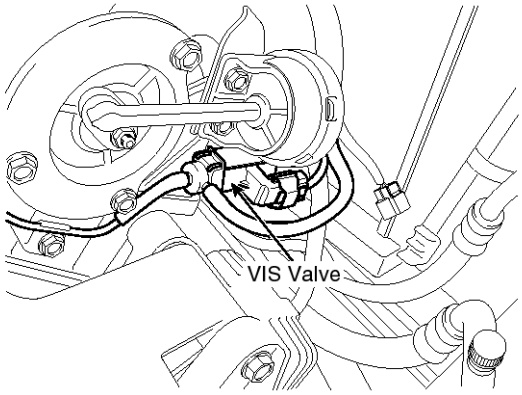
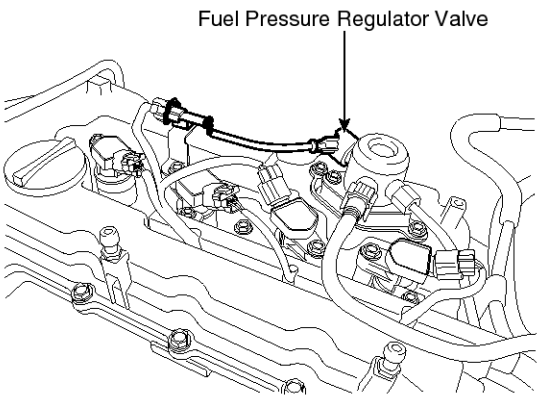


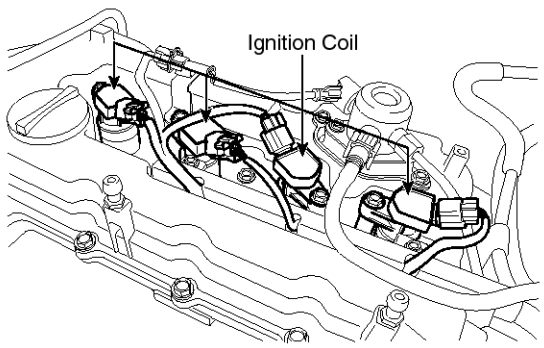
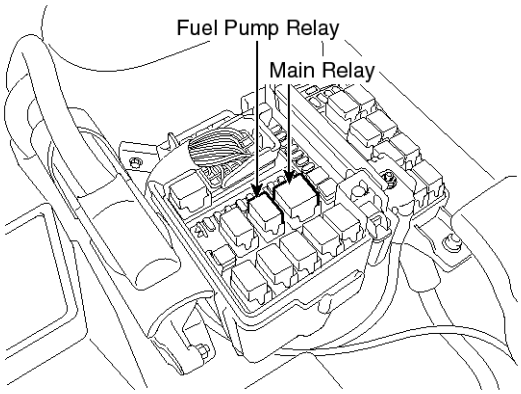
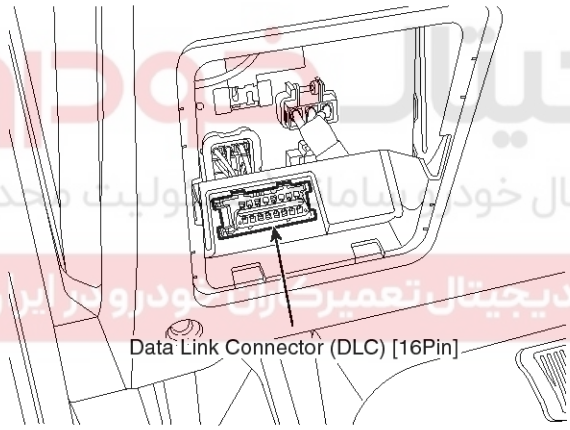
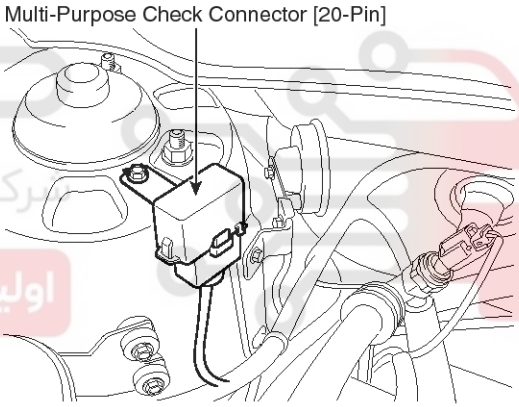
STFF11001L

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) [integrated into ETC Module]
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)
13. Accelerator Position Sensor (APS)
14. A/C Pressure Transducer (APT)
15. ETC Motor [integrated into ETC Module]
16. Injector
17. Purge Control Solenoid Valve (PCSV)
18. CVVT Oil Control Valve (OCV) [Bank 1 / Intake]
19. CVVT Oil Control Valve (OCV) [Bank 1 / Exhaust]
20. Variable Intake Solenoid (VIS) Valve
21. Fuel Pressure Regulator Valve
22. Ignition Coil
23. Main Relay
24. Fuel Pump Relay
25. Data Link Connector (DLC) [16-Pin]
26. Multi-Purpose Check Connector [20-Pin]

1. Engine Control Module (ECM)	2. Manifold Absolute Pressure Sensor (MAPS) 3. Intake Air Temperature Sensor (IATS)
 SYFF10020D	 SXMF19103D
4. Engine Coolant Temperature Sensor (ECTS)	5. Throttle Position Sensor (TPS) 15. ETC Motor
 SXMF19104D	 SXMF10105L
6. Crankshaft Position Sensor (CKPS)	7. Camshaft Position Sensor (CMPS) [Bank 1 / Intake]
 STDFL0105N	 SYFFL0020N

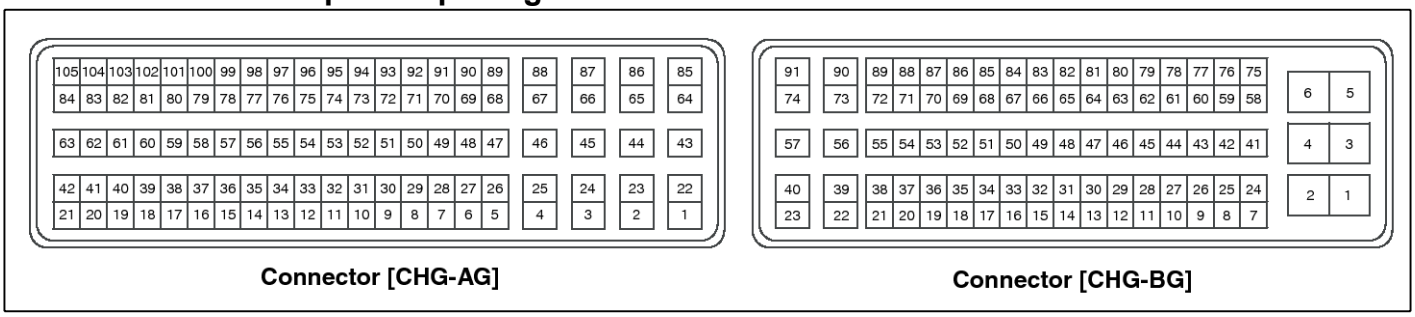
8. Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust]	9. Knock Sensor (KS)
 SYFFL0030N	 SYFFL0040N
10. Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 1]	11. Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2]
 SYFFL0139N	 SYFFL0149N
12. Rail Pressure Sensor (RPS) 16. Injector	13. Accelerator Position Sensor (APS)
 SYFFL0090N	 SYFFL0300N

14. A/C Pressure Transducer (APT)	17. Purge Control Solenoid Valve (PCSV)
 STFF11110D	 SXMF19115D
18. CVVT Oil Control Valve (OCV) [Bank 1 / Intake]	19. CVVT Oil Control Valve (OCV) [Bank 1 / Exhaust]
 SXMF10117L	 SXMF10118L
20. Variable Intake Solenoid (VIS) Valve	21. Fuel Pressure Regulator Valve
 SYFFL0100N	 SYFFL0051L

22. Ignition Coil	23. Main Relay 24. Fuel Pump Relay
 SYFFL0050N	 SYFFL0189N
25. Data Link Connector (DLC) [16-Pin]	26. Multi-Purpose Check Connector [20-Pin]
 STFF11006L	 SYFFL0209N

Engine Control Module (ECM)

ECM Terminal And Input/Output signal



SYFFL0400N

ECM Terminal Function

Connector [CHG-AG]

Pin No.	Description	Connected to
1	Ignition Coil (Cylinder #2) control output [Without Immobilizer]	Ignition Coil (Cylinder #2) [Without Immobilizer]
	Ignition Coil (Cylinder #3) control output [With Immobilizer]	Ignition Coil (Cylinder #3) [With Immobilizer]
2	-	
3	-	
4	-	
5	ETC Motor [+] control output	ETC Motor
6	ETC Motor [-] control output	ETC Motor
7	-	
8	-	
9	-	
10	-	
11	-	
12	Sensor power (+5V)	Rail Pressure Sensor (RPS)
		A/C Pressure Transducer (APT)
		Power Steering Pressure Sensor (PSPS)
13	-	
14	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2] signal input	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2]
15	-	
16	-	
17	-	
18	-	

Pin No.	Description	Connected to
19	-	
20	-	
21	-	
22	Ignition Coil (Cylinder #4) control output [Without Immobilizer]	Ignition Coil (Cylinder #4) [Without Immobilizer]
	Ignition Coil (Cylinder #1) control output [With Immobilizer]	Ignition Coil (Cylinder #1) [With Immobilizer]
23	-	
24	-	
25	-	
26	-	
27	-	
28	-	
29	-	
30	-	
31	-	
32	-	
33	Sensor power (+5V)	Throttle Position Sensor (TPS) 1,2
34	-	
35	Sensor ground	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2]
36	-	
37	-	
38	-	
39	Rail Pressure Sensor (RPS) signal input	Rail Pressure Sensor (RPS)
40	-	
41	-	
42	-	
43	Shield	Ignition Coil (Cylinder #1,2,3,4)
44	-	
45	-	
46	-	
47	-	
48	-	
49	-	
50	-	

Pin No.	Description	Connected to
51	-	
52	-	
53	-	
54	Sensor ground	Throttle Position Sensor (TPS) 1,2
55	Sensor ground	Accelerator Position Sensor (APS) 2
56	Sensor ground	Accelerator Position Sensor (APS) 1
57	Immobilizer communication line	Smart Key Control Module [With Button Engine Start System]
		Immobilizer Control Module [Without Button Engine Start System]
58	-	
59	Intake Air Temperature Sensor (IATS) signal input	Intake Air Temperature Sensor (IATS)
60	Sensor ground	Rail Pressure Sensor (RPS)
61	Sensor ground	Manifold Absolute Pressure Sensor (MAPS)
		Intake Air Temperature Sensor (IATS)
62	Sensor ground	Engine Coolant Temperature Sensor (ECTS)
63	Engine Coolant Temperature Sensor (ECTS) signal input	Engine Coolant Temperature Sensor (ECTS)
64	Ignition Coil (Cylinder #3) control output [Without Immobilizer]	Ignition Coil (Cylinder #3) [Without Immobilizer]
	Ignition Coil (Cylinder #2) control output [With Immobilizer]	Ignition Coil (Cylinder #2) [With Immobilizer]
65	-	
66	-	
67	-	
68	-	
69	-	
70	-	
71	-	
72	-	
73	-	
74	-	
75	Throttle Position Sensor (TPS) 2 signal input	Throttle Position Sensor (TPS) 2
76	Accelerator Position Sensor (APS) 2 signal input	Accelerator Position Sensor (APS) 2
77	Accelerator Position Sensor (APS) 1 signal input	Accelerator Position Sensor (APS) 1
78	Power Steering Pressure Sensor (PSPS) signal input	Power Steering Pressure Sensor (PSPS)

Pin No.	Description	Connected to
79	-	
80	Sensor ground	A/C Pressure Transducer (APT)
81	-	
82	Manifold Absolute Pressure Sensor (MAPS) signal input	Manifold Absolute Pressure Sensor (MAPS)
83	Rc/Rp (Pump Cell Voltage)	Heated Oxygen Sensor [Bank 1/Sensor 1]
84	VS-/IP- (Common Ground for VS, IP)	Heated Oxygen Sensor [Bank 1/Sensor 1]
85	Ignition Coil (Cylinder #1) control output [Without Immobilizer]	Ignition Coil (Cylinder #1) [Without Immobilizer]
	Ignition Coil (Cylinder #4) control output [With Immobilizer]	Ignition Coil (Cylinder #4) [With Immobilizer]
86	-	
87	-	
88	-	
89	-	
90	-	
91	-	
92	-	
93	-	
94	-	
95	-	
96	Throttle Position Sensor (TPS) 1 signal input	Throttle Position Sensor (TPS) 1
97	Sensor power (+5V)	Accelerator Position Sensor (APS) 2
98	Sensor power (+5V)	Accelerator Position Sensor (APS) 1
99	Sensor ground	Power Steering Pressure Sensor (PSPS)
100	-	
101	A/C Pressure Transducer (APT) signal input	A/C Pressure Transducer (APT)
102	-	
103	Sensor power (+5V)	Manifold Absolute Pressure Sensor (MAPS)
104	Rc (Compensative Resistance)	Heated Oxygen Sensor [Bank 1/Sensor 1]
105	VS+ (NERNST Cell Voltage)	Heated Oxygen Sensor [Bank 1/Sensor 1]

Connector [CHG-BG]

Pin No.	Description	Connected to
1	ECM ground	Chassis ground
2	ECM ground	Chassis ground
3	Battery power (B+)	Main Relay
4	ECM ground	Chassis ground
5	Battery power (B+)	Main Relay
6	Battery power (B+)	Main Relay
7	Wheel Speed Sensor (WSS) [A] signal input	Wheel Speed Sensor (WSS) [Without ABS/ESC]
8	Crankshaft Position Sensor (CKPS) signal input	Crankshaft Position Sensor (CKPS)
9	-	
10	Brake Switch 2 signal input	Brake Switch
11	-	
12	-	
13	-	
14	Wiper signal input	Multi-function switch
15	Electrical load signal input	Alternator
16	Alternator PWM signal output	Alternator
17	-	
18	Cooling Fan Relay [High] control output	Cooling Fan Relay [High]
19	Immobilizer Lamp control output	Immobilizer Lamp [Without Button Engine Start System]
20	-	
21	-	
22	Injector (Cylinder #2) [High] control output	Injector (Cylinder #2)
23	Injector (Cylinder #2) [Low] control output	Injector (Cylinder #2)
24	Wheel Speed Sensor (WSS) [B] signal input	Wheel Speed Sensor (WSS) [Without ABS/ESC]
25	Sensor ground	Crankshaft Position Sensor (CKPS)
26	-	
27	Brake Switch 1 signal input	Brake Switch
28	-	
29	Camshaft Position Sensor (CMPS) [Bank 1/Intake] signal input	Camshaft Position Sensor (CMPS) [Bank 1/Intake]
30	Camshaft Position Sensor (CMPS) [Bank 1/Exhaust] signal input	Camshaft Position Sensor (CMPS) [Bank 1/Exhaust]
31	-	
32	LIN communication signal input	Battery Sensor

Pin No.	Description	Connected to
33	Cooling Fan Relay [Low] control output	Cooling Fan Relay [Low]
34	-	
35	-	
36	-	
37	-	
38	-	
39	Injector (Cylinder #3) [High] control output	Injector (Cylinder #3)
40	Injector (Cylinder #3) [Low] control output	Injector (Cylinder #3)
41	Battery power (B+)	Ignition Switch
42	-	
43	-	
44	Sensor shield	Knock Sensor (KS)
45	Sensor ground	Knock Sensor (KS)
46	Sensor ground	Camshaft Position Sensor (CMPS) [Bank 1/Intake]
47	Sensor ground	Camshaft Position Sensor (CMPS) [Bank 1/Exhaust]
48	-	
49	-	
50	-	
51	-	
52	-	
53	Main Relay control output	Main Relay
54	-	
55	-	
56	Injector (Cylinder #4) [High] control output	Injector (Cylinder #4)
57	Injector (Cylinder #4) [Low] control output	Injector (Cylinder #4)
58	Battery power (B+)	Battery
59	-	
60	CAN [Low]	Other control module, Data Link Connector (DLC), Multi -Purpose Check Connector
61	-	
62	Knock Sensor (KS) signal input	Knock Sensor (KS)
63	Clutch Switch signal input	Clutch Switch [M/T]
64	-	
65	-	
66	-	

Pin No.	Description	Connected to
67	-	
68	Variable Intake Solenoid (VIS) Valve control output	Variable Intake Solenoid (VIS) Valve
69	Starter Relay control output	Starter Relay [With Button Engine Start System]
70	Fuel Pump Relay control output	Fuel Pump Relay
71	Engine speed signal output	Power Distribution Module (PDM)
72	-	
73	Injector (Cylinder #1) [High] control output	Injector (Cylinder #1)
74	Injector (Cylinder #1) [Low] control output	Injector (Cylinder #1)
75	Battery power (B+)	Battery
76	-	
77	CAN [High]	Other control module, Data Link Connector (DLC), Multi -Purpose Check Connector
78	Vehicle speed signal input	ABS/ESC Control Unit [With ABS/ESC]
79	-	
80	-	
81	-	
82	Starter Control Switch signal input	Starter Control Switch [With Button Engine Start Syste- m]
83	-	
84	CVVT Oil Control Valve (OCV) [Bank 1/Exhaust] control output	CVVT Oil Control Valve (OCV) [Bank 1/Exhaust]
85	CVVT Oil Control Valve (OCV) [Bank 1/Intake] control output	CVVT Oil Control Valve (OCV) [Bank 1/Intake]
86	Purge Control Solenoid Valve (PCSV) control output	Purge Control Solenoid Valve (PCSV)
87	-	
88	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 1] Heater control output	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 1]
89	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2] Heater control output	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2]
90	Fuel Pressure Regulator Valve [High] control output	Fuel Pressure Regulator Valve
91	Fuel Pressure Regulator Valve [Low] control output	Fuel Pressure Regulator Valve

ECM Terminal Input/ Output signal

Connector [CHG-AG]

Pin No.	Description	Condition	Type	Level
1	Ignition Coil (Cylinder #2) control output [Without Immobilizer]	Engine Running	Pulse	Vpeak = 360 ~ 440V
	Ignition Coil (Cylinder #3) control output [With Immobilizer]			125<Frequency<1,000Hz (333Hz at idle)
2	-			
3	-			
4	-			
5	ETC Motor [+] control output	Engine Running	Pulse	High: Battery Voltage
				Low: Max.1.0V
6	ETC Motor [-] control output	Engine Running	Pulse	High: Battery Voltage
				Low: Max.1.0V
7	-			
8	-			
9	-			
10	-			
11	-			
12	Sensor power (+5V)	IG OFF	DC	Max. 0.5V
		IG ON		4.75 ~ 5.25V
13	-			
14	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2] signal input	Idle	DC	Rich : 0.6 ~ 1.0V
				Lean : Max 0.4V
15	-			
16	-			
17	-			
18	-			
19	-			
20	Fuel Tank Pressure Sensor (FTPS) signal input	Idle	Analog	-0.3 ~ 5.2V
21	-			
22	Ignition Coil (Cylinder #4) control output [Without Immobilizer]	Engine Running	Pulse	Vpeak = 360 ~ 440V
	Ignition Coil (Cylinder #1) control output [With Immobilizer]			125<Frequency<1,000Hz (333Hz at idle)
23	-			
24	-			

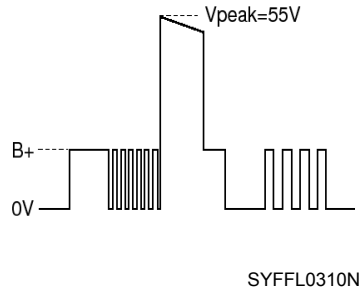
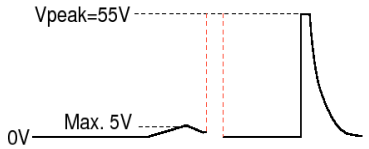
Pin No.	Description	Condition	Type	Level
25	-			
26	-			
27	-			
28	-			
29	-			
30	-			
31	-			
32	-			
33	Sensor power (+5V)	IG OFF	DC	Max. 0.5V
		IG ON		4.75 ~ 5.25V
34	-			
35	Sensor ground	Idle	DC	-0.3 ~ 0.5V
36	-			
37	-			
38	-			
39	Rail Pressure Sensor (RPS) signal input	Idle	Analog	-0.3 ~ 5.2V
40	-			
41	Sensor ground	Idle	DC	-0.3 ~ 0.5V
42	-			
43	Shield	Idle	DC	-0.3 ~ 0.5V
44	-			
45	-			
46	-			
47	-			
48	-			
49	-			
50	-			
51	-			
52	-			
53	-			
54	Sensor ground	Idle	DC	-0.3 ~ 0.5V
55	Sensor ground	Idle	DC	-0.3 ~ 0.5V
56	Sensor ground	Idle	DC	-0.3 ~ 0.5V
57	Immobilizer communication line			

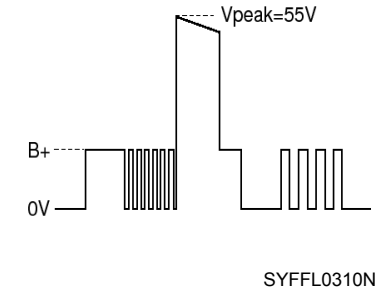
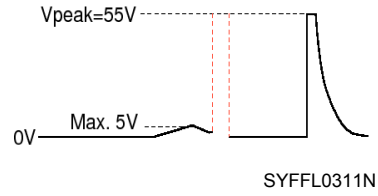
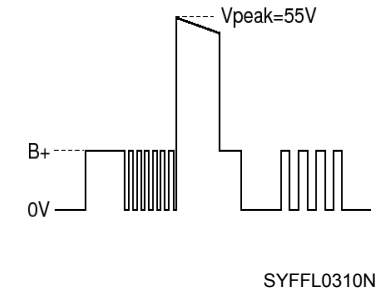
Pin No.	Description	Condition	Type	Level
58	-			
59	Intake Air Temperature Sensor (IATS) signal input	Idle	Analog	0 ~ 5.0V (2.55V at Idle)
60	Sensor ground	Idle	DC	-0.3 ~ 0.5V
61	Sensor ground	Idle	DC	-0.3 ~ 0.5V
62	Sensor ground	Idle	DC	-0.3 ~ 0.5V
63	Engine Coolant Temperature Sensor (ECTS) signal input	Idle	Analog	0.5 ~ 4.5V (1.02V at Idle)
64	Ignition Coil (Cylinder #3) control output [Without Immobilizer]	Engine Running	Pulse	Vpeak = 360 ~ 440V
	Ignition Coil (Cylinder #2) control output [With Immobilizer]			125<Frequency<1,000Hz (333Hz at idle)
65	-			
66	-			
67	-			
68	-			
69	-			
70	-			
71	-			
72	-			
73	-			
74	-			
75	Throttle Position Sensor (TPS) 2 signal input	C.T	Analog	4.2 ~ 5.0V
		W.O.T		3.3 ~ 3.8V
76	Accelerator Position Sensor (APS) 2 signal input	C.T	Analog	Max. 1.0V
		W.O.T		1.5 ~ 3.0V
77	Accelerator Position Sensor (APS) 1 signal input	C.T	Analog	Max. 1.0V
		W.O.T		Min. 4.0V
78	-			
79	-			
80	Sensor ground	Idle	DC	-0.3 ~ 0.5V
81	-			
82	Manifold Absolute Pressure Sensor (MAPS) signal input	Idle	Analog	0.8 ~ 1.6V (1.37V at Idle)

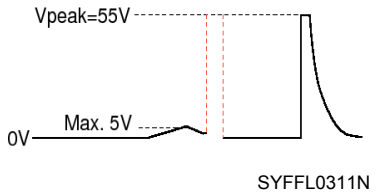
Pin No.	Description	Condition	Type	Level
83	Rc/Rp (Pump Cell Voltage)	Idle	Analog	Normal: 450±50 mV Rich: Max. Normal+150 mV Lean: Min. Normal-150 mV
84	VS-/IP- (Common Ground for VS, IP)	Idle	Analog	Reference for V_IP, V_N
85	Ignition Coil (Cylinder #1) control output [Without Immobilizer]	Engine Running	Pulse	Vpeak = 360 ~ 440V
	Ignition Coil (Cylinder #4) control output [With Immobilizer]			125<Frequency<1,000Hz (333Hz at idle)
86	-			
87	-			
88	-			
89	-			
90	-			
91	-			
92	-			
93	-			
94	-			
95	-			
96	Throttle Position Sensor (TPS) 1 signal input	C.T	Analog	0.3 ~ 0.9V
		W.O.T		1.5 ~ 3.0V
97	Sensor power (+5V)	IG OFF	DC	Max. 0.5V
		IG ON		4.75 ~ 5.25V
98	Sensor power (+5V)	IG OFF	DC	Max. 0.5V
		IG ON		4.75 ~ 5.25V
99	-			
100	-			
101	A/C Pressure Transducer (APT) signal input			
102	-			
103	Sensor power (+5V)	IG OFF	DC	Max. 0.5V
		IG ON		4.75 ~ 5.25V
104	Rc (Compensative Resistance)	Idle	Analog	| Rc-Rc/Rp | < ±0.1V
105	VS+ (NERNST Cell Voltage)	Idle	Analog	Normal: 450±50 mV Rich: Max. Normal+150 mV Lean: Min. Normal-150 mV

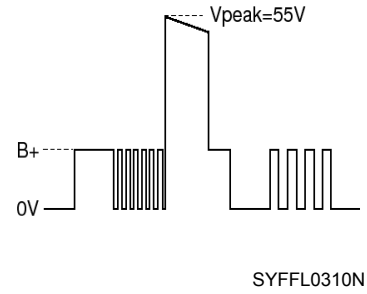
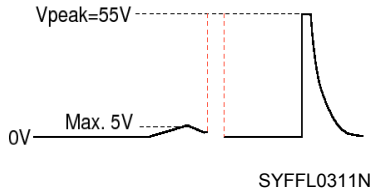
Connector [CHG-BG]

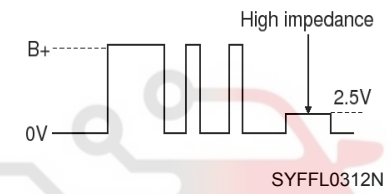
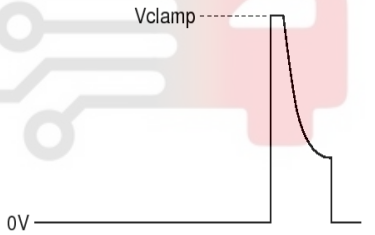
Pin No.	Description	Condition	Type	Level
1	ECM ground	Idle	DC	-0.3 ~ 0.5V
2	ECM ground	Idle	DC	-0.3 ~ 0.5V
3	Battery power (B+)	IG OFF	DC	Max. 1.0V
		IG ON		Battery Voltage
4	ECM ground	Idle	DC	-0.3 ~ 0.5V
5	Battery power (B+)	IG OFF	DC	Max. 1.0V
		IG ON		Battery Voltage
6	Battery power (B+)	IG OFF	DC	Max. 1.0V
		IG ON		Battery Voltage
7	Wheel Speed Sensor (WSS) [A] signal input			
8	Crankshaft Position Sensor (CKPS) signal input	Engine Running	Pulse	High : 4.5 ~ 5.5V Low : -0.3 ~ 0.5V Frequency: 850Hz (Idle), 3,000Hz (3,000rpm)
9	-			
10	Brake Switch 2 signal input	Brake OFF	DC	Battery Voltage
		Brake ON		Max. 0.5V
11	-			
12	-			
13	-			
14	Wiper signal input			
15	Electrical load signal input	Lamp OFF	DC	Battery Voltage
		Lamp ON		-0.3 ~ 0.5V
16	Alternator PWM signal output	Idle	Pulse	High: Battery Voltage Low: Max. 1.5V Frequency: 125Hz
17	-			
18	Cooling Fan Relay [High] control output	Relay OFF	DC	Battery Voltage
		Relay ON		Max. 1.0V
19	Immobilizer Lamp control output	Lamp OFF	DC	Battery Voltage
		Lamp ON		-0.3 ~ 1.2V
20	-			
21	-			

Pin No.	Description	Condition	Type	Level
22	Injector (Cylinder #2) [High] control output	Engine Running	PWM	 SYFFL0310N
23	Injector (Cylinder #2) [Low] control output	Engine Running	Pulse	 SYFFL0311N
24	Wheel Speed Sensor (WSS) [B] signal input			
25	Sensor ground	Idle	DC	-0.3 ~ 0.5V
26	-			
27	Brake Switch 1 signal input	Brake OFF	DC	Max. 0.5V
		Brake ON		Battery Voltage
28	-			
29	Camshaft Position Sensor (CMPS) [Bank 1/Intake] signal input	Engine Running	Pulse	High: 4.5 ~ 5.5V Low: -0.3 ~ 0.5V Frequency: 7Hz (Idle), 25Hz (3,000rpm)
30	Camshaft Position Sensor (CMPS) [Bank 1/Exhaust] signal input	Engine Running	Pulse	High: 4.5 ~ 5.5V Low: -0.3 ~ 0.5V Frequency: 7Hz (Idle), 25Hz (3,000rpm)
31	-			
32	LIN communication signal input			
33	Cooling Fan Relay [Low] control output	Relay OFF	DC	Battery Voltage
		Relay ON		-0.3 ~ 1.2V
34	-			
35	-			
36	-			
37	Malfunction Indicator Lamp (MIL) control output	Lamp OFF	DC	Battery Voltage
		Lamp ON		-0.3 ~ 1.2V
38	-			

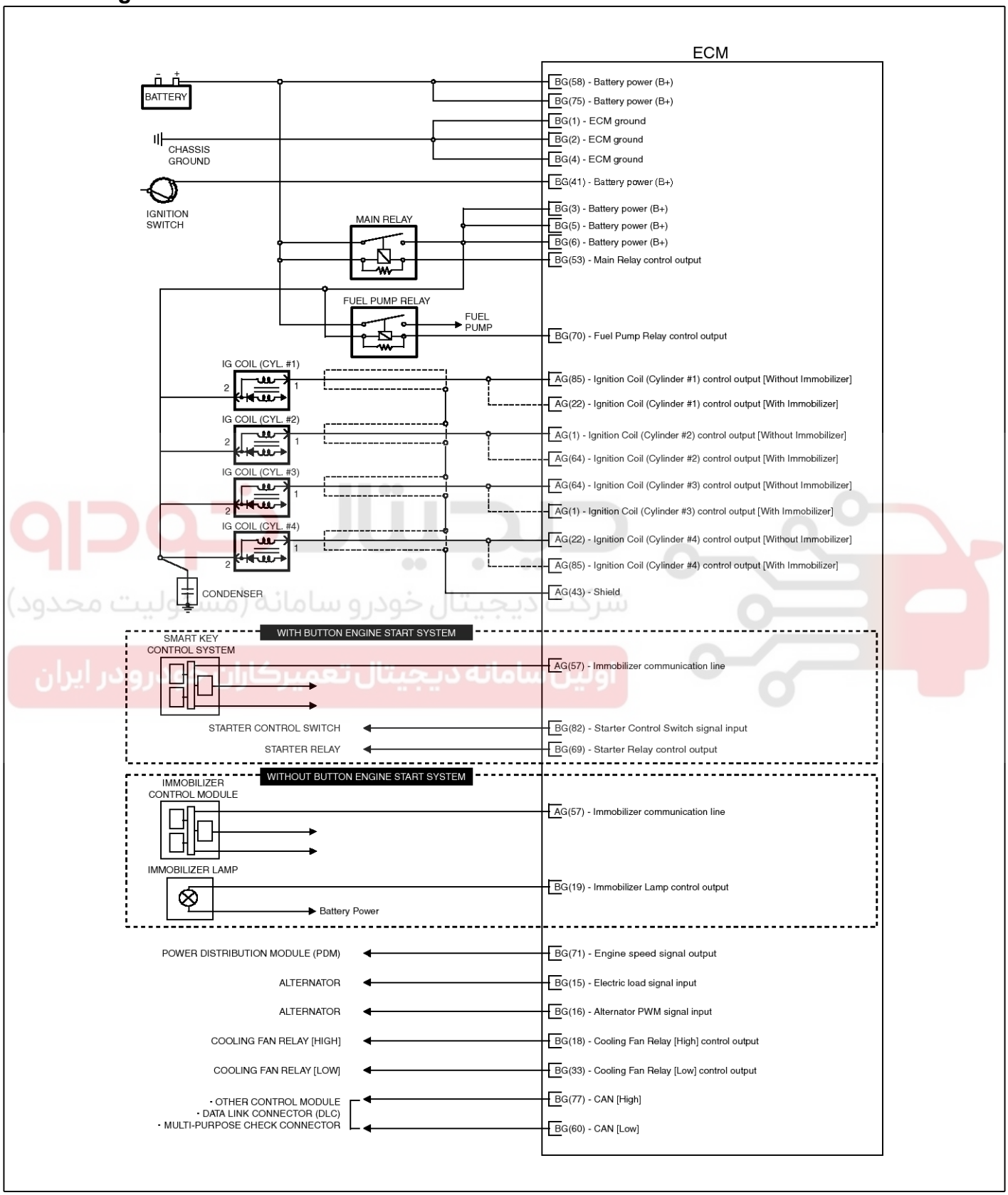
Pin No.	Description	Condition	Type	Level
39	Injector (Cylinder #3) [High] control output	Engine Running	PWM	
40	Injector (Cylinder #3) [Low] control output	Engine Running	Pulse	
41	Battery power (B+)	IG OFF	DC	Max. 1.0V
		IG ON		Battery Voltage
42	-			
43	-			
44	Sensor shield	Idle	DC	-0.3 ~ 0.5V
45	Sensor ground	Idle	DC	-0.3 ~ 0.5V
46	Sensor ground	Idle	DC	-0.3 ~ 0.5V
47	Sensor ground	Idle	DC	-0.3 ~ 0.5V
48	-			
49	-			
50	-			
51	-			
52	-			
53	Main Relay control output	Relay OFF	DC	Battery Voltage
		Relay ON		-0.3 ~ 1.2V
54	-			
55	-			
56	Injector (Cylinder #4) [High] control output	Engine Running	PWM	

Pin No.	Description	Condition	Type	Level
57	Injector (Cylinder #4) [Low] control output	Engine Running	Pulse	
58	Battery power (B^+)	IG OFF	DC	Max. 1.0V
		IG ON		Battery Voltage
59	-			
60	CAN [Low]	Recessive	Pulse	2.0 ~ 3.0V
		Dominant		2.75 ~ 4.5V
61	-			
62	Knock Sensor (KS) signal input	Knocking	Variable Frequency	-0.3 ~ 0.3V
		Normal		0V
63	Clutch Switch signal input	S/W OFF	DC	Battery Voltage
		S/W ON		-0.3 ~ 0.5V
64	-			
65	-			
66	-			
67	-			
68	Variable Intake Solenoid (VIS) Valve control output	Active	DC	Max. 1.0V
		Inactive		Battery Voltage
69	Starter Relay control output	Relay OFF	DC	Battery Voltage
		Relay ON		-0.3 ~ 1.2V
70	Fuel Pump Relay control output	Relay OFF	DC	Battery Voltage
		Relay ON		-0.3 ~ 1.2V
71	Engine speed signal output	Engine Running	Frequency	High: Battery Voltage
				Low: -0.3 ~ 1.0V
				Frequency: 21Hz (Idle), 100Hz (3,000rpm)
72	-			

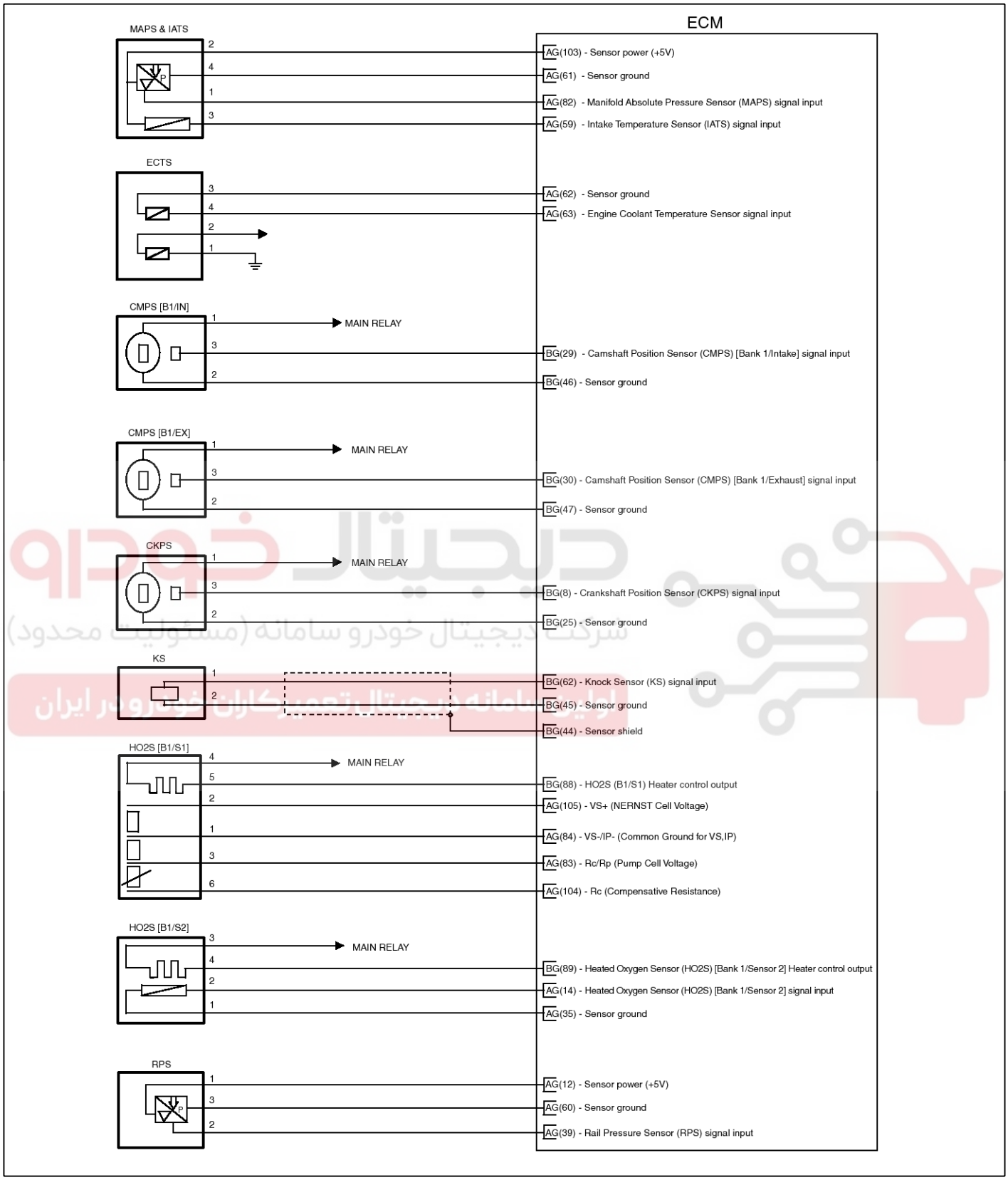
Pin No.	Description	Condition	Type	Level
73	Injector (Cylinder #1) [High] control output	Engine Running	PWM	
74	Injector (Cylinder #1) [Low] control output	Engine Running	Pulse	
75	Battery power (B+)	IG OFF	DC	Max. 1.0V
		IG ON		Battery Voltage
76	-			
77	CAN [High]	Recessive	Pulse	2.0 ~ 3.0V
		Dominant		2.75 ~ 4.5V
78	Vehicle speed signal input			
79	-			
80	-			
81	-			
82	Starter Control Switch signal input	S/W OFF	DC	-0.3 ~ 0.5V
		S/W ON		Battery Voltage
83	-			
84	CVVT Oil Control Valve (OCV) [Bank 1/Exhaust] control output	Idle	Pulse	High: Battery Voltage Low: -0.3 ~ 1.0V Frequency: 300Hz
85	CVVT Oil Control Valve (OCV) [Bank 1/Intake] control output	Idle	Pulse	High: Battery Voltage Low: -0.3 ~ 1.0V Frequency: 300Hz
86	Purge Control Solenoid Valve (PCSV) control output	Inactive Active	Pulse	High: Battery Voltage Low: Max. 1.0V Vpeak: 42.0 ~ 60.0V Frequency: 20Hz

Pin No.	Description	Condition	Type	Level
87	Canister Close Valve (CCV) control output	Active Inactive	Pulse	High: Battery Voltage Low: Max. 1.0V Vpeak: 42.0 ~ 60.0V
88	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 1] Heater control output	Engine Running	Pulse	High: Battery Voltage Low: -0.3 ~ 1.0V Frequency: 8 ~ 10Hz Duty: 0 ~ 100%
89	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2] Heater control output	Engine Running	Pulse	High: Battery Voltage Low: -0.3 ~ 1.0V Frequency: 8 ~ 10Hz Duty: 0 ~ 100%
90	Fuel Pressure Regulator Valve [High] control output	Engine Running	PWM	 SYFFL0312N
91	Fuel Pressure Regulator Valve [Low] control output	Engine Running	Pulse	 SYFFL0313N

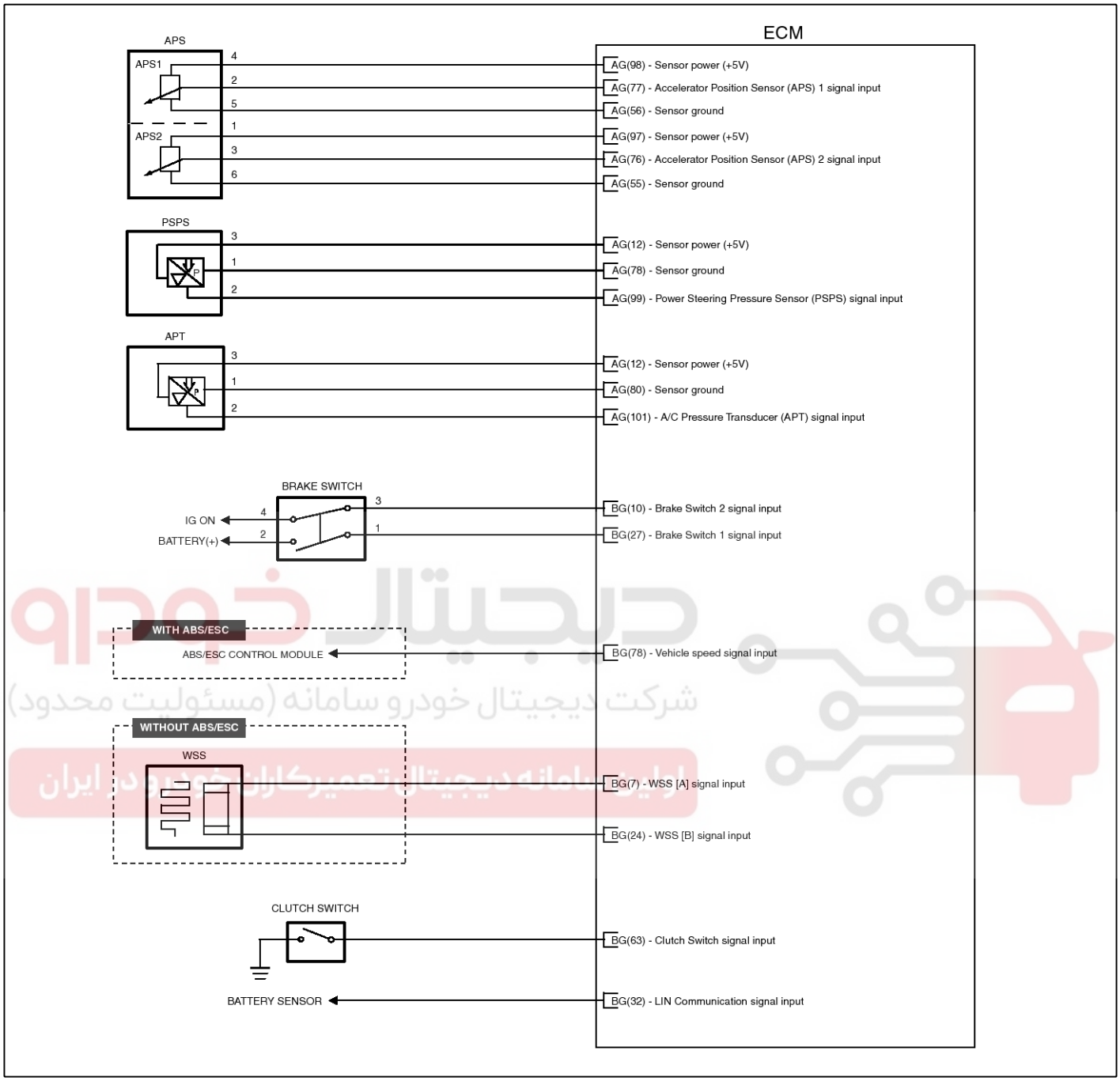
Circuit Diagram



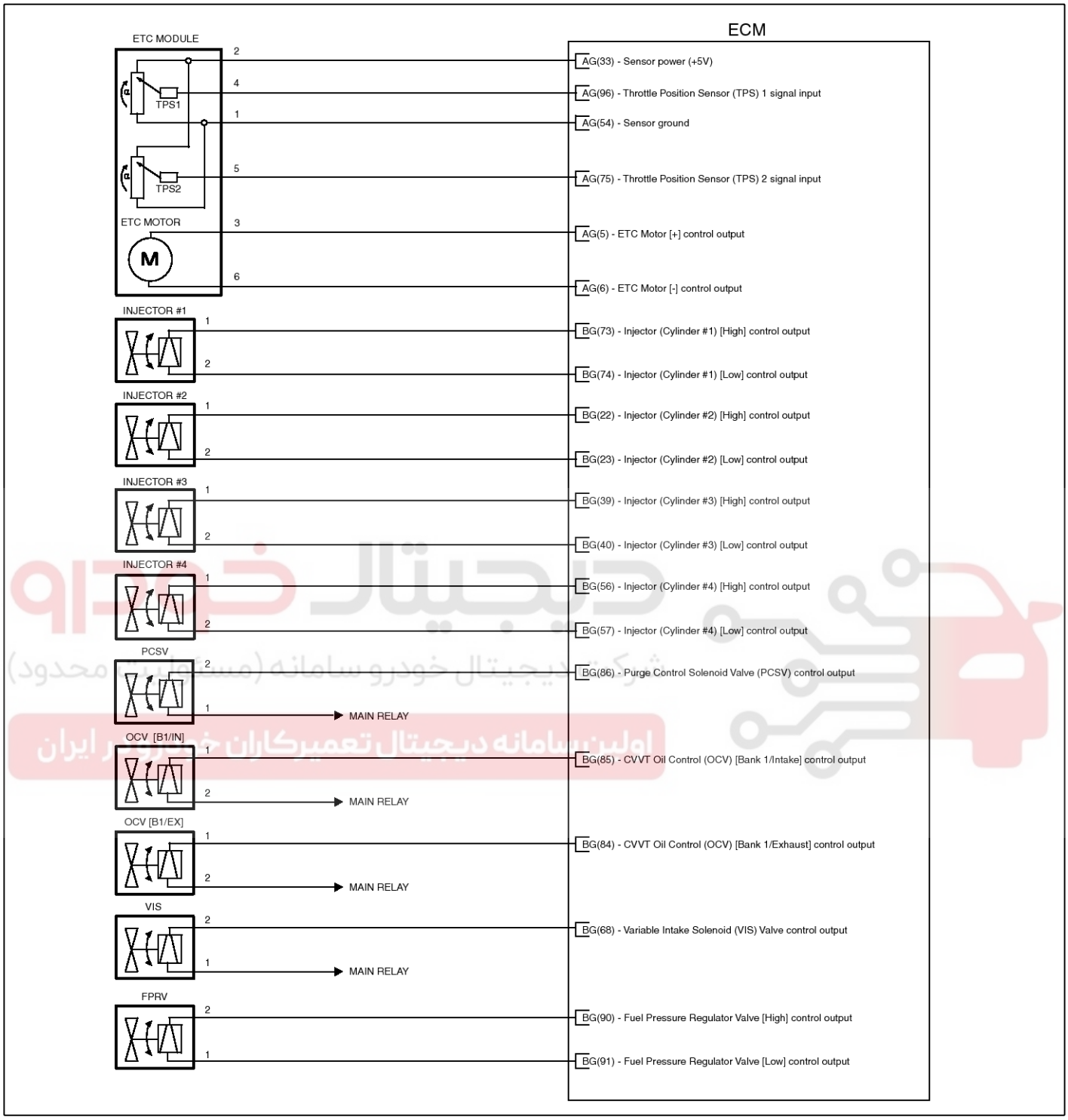
STFF11002L



SYFFL1402L



STFF11003L



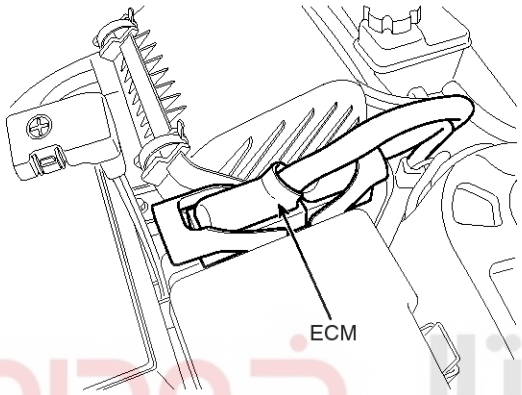
SYFFL1404L

Removal

NOTICE

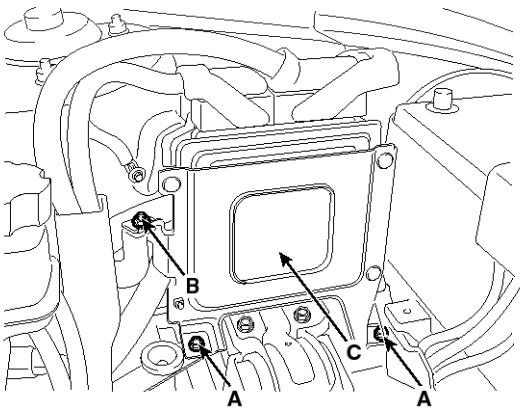
In the case of the vehicle equipped with immobilizer or button engine start system, perform "Key Teaching" procedure together (Refer to "Immobilizer" or "Button Engine Start System in BE group).

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



SYFF10020D

3. Remove the air cleaner assembly (Refer to "Intake And Exhaust System" in EM group).
4. Remove the mounting bolts (A) and nut (B), and then remove the ECM (C).



SYFF10030D

Installation

NOTICE

In the case of the vehicle equipped with immobilizer or button engine start system, perform "Key Teaching" procedure together (Refer to "Immobilizer" or "Button Engine Start System in BE group).

1. Installation is reverse of removal.

ECM installation bolt:
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m,7.2 ~ 8.7 lb-ft)
ECM bracket installation bolt/nut:
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m,7.2 ~ 8.7 lb-ft)

ECM Problem Inspection Procedure

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.

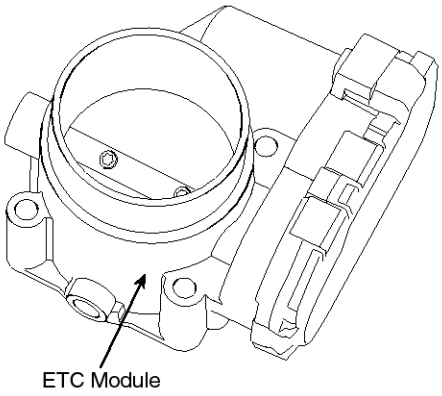
Specification: Below 1Ω

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).

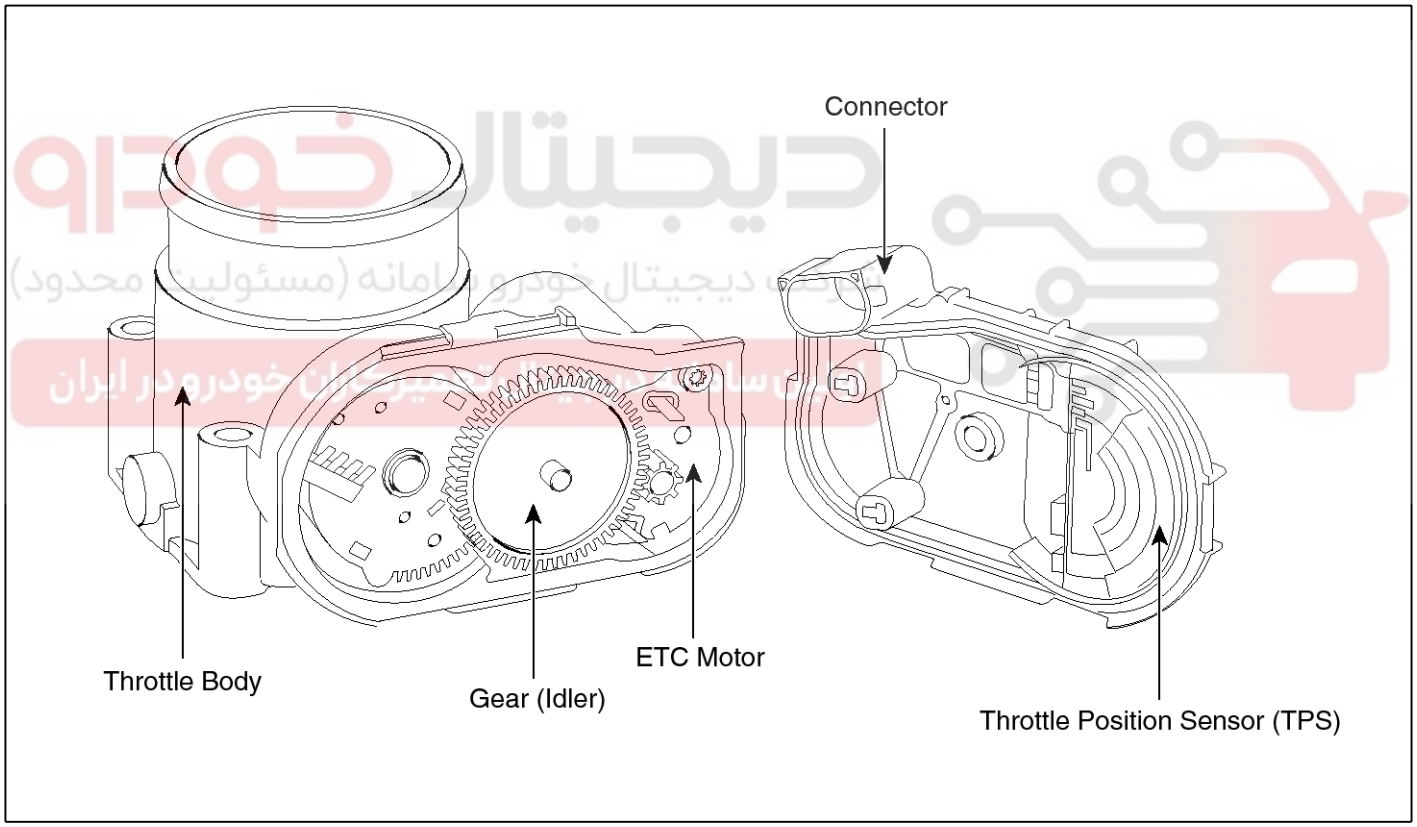
ETC (Electronic Throttle Control) System

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.

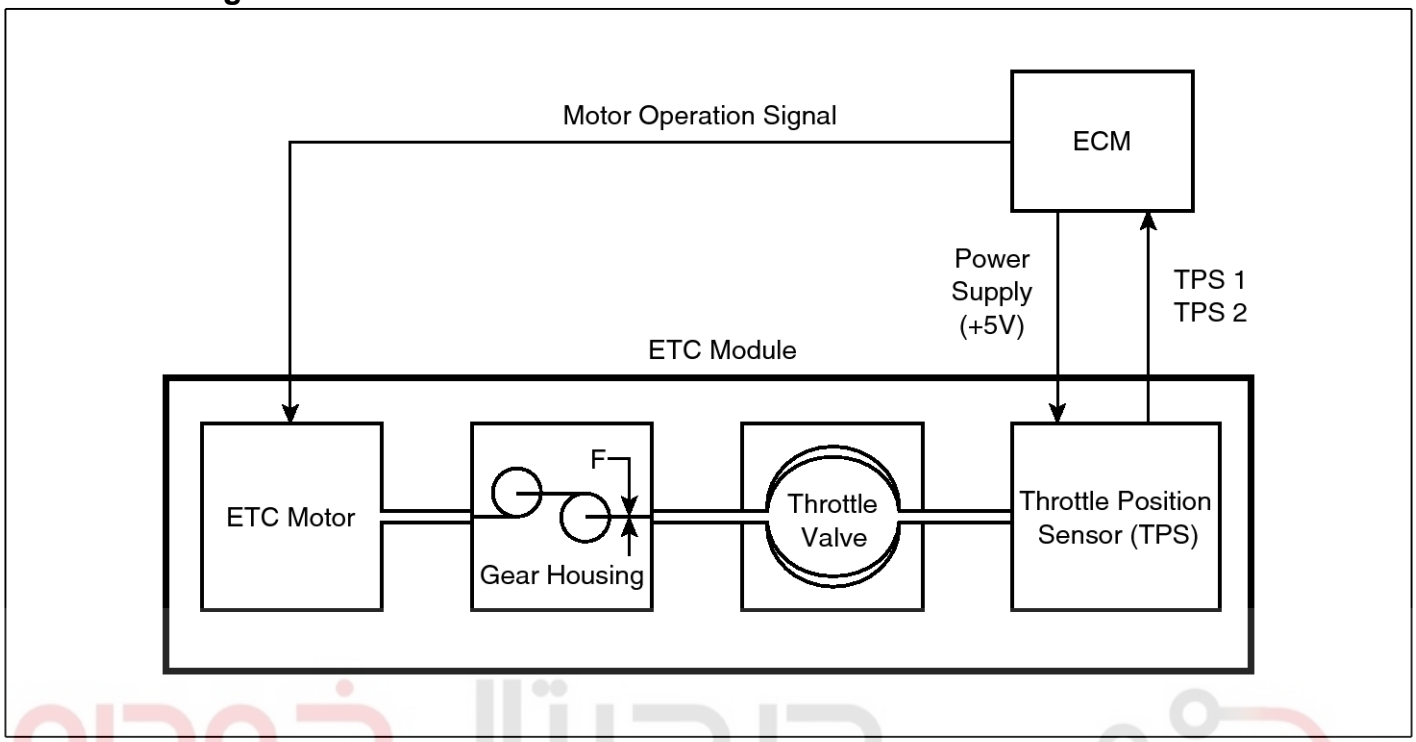


SBKFL9129L



SBKFL9130L

Schematic Diagram



SBKFL9134N

Fail-Safe Mode

Item	Fail-Safe	
ETC Motor	Throttle valve stuck at 5°	
TPS	TPS 1 fault	ECM looks at TPS2
	TPS 2 fault	ECM looks at TPS1
	TPS 1,2 fault	Throttle valve stuck at 5°
APS	APS 1 fault	ECM looks at APS 2
	APS 2 fault	ECM looks at APS 1
	APS 1,2 fault	Throttle valve stuck at 5°

NOTICE

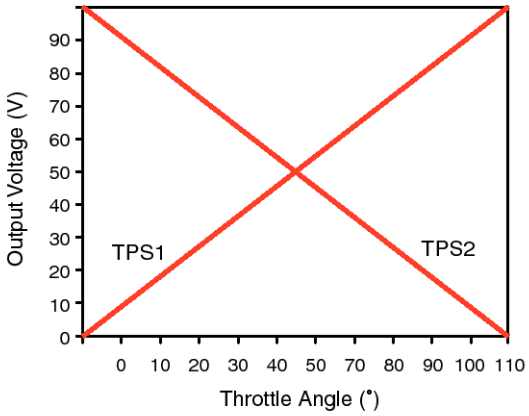
When throttle value is stuck at 5°, engine speed is limited at below 1,500rpm and vehicle speed at maximum 40 ~ 50 km/h (25 ~ 31 mph)

Specification

[Throttle Position Sensor (TPS)]

Throttle Angle(˚)	Output Voltage(V)	
	TPS1	TPS2
0	0.0	5.0
10	0.48	4.52
20	0.95	4.05
30	1.43	3.57
40	1.90	3.10
50	2.38	2.62
60	2.86	2.14
70	3.33	1.67
80	3.81	1.19
90	4.29	0.71
100	4.76	0.24
105	5.0	0
C.T (6 ~ 15˚)	0.29 ~ 0.71	4.29 ~ 4.71
W.O.T (93 ~ 102˚)	4.43 ~ 4.86	0.14 ~ 0.57

[TPS CHARACTERISTIC GRAPH]



EGRF235A

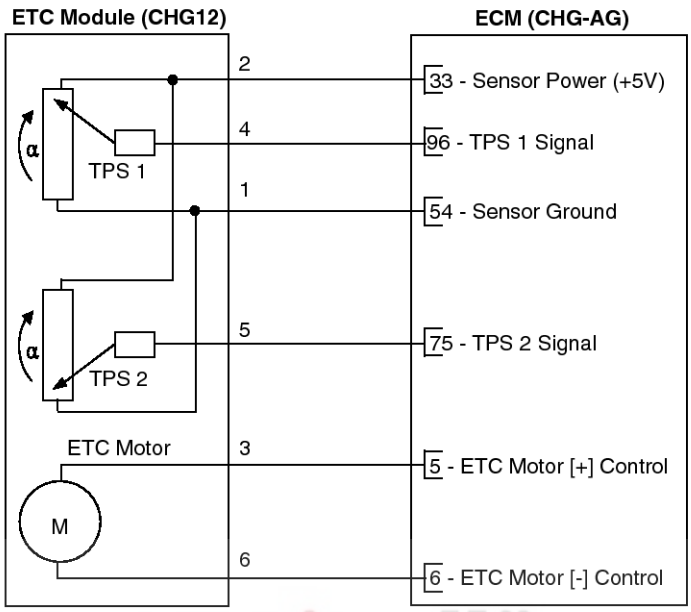
Item	Sensor Resistance(kΩ)
TPS1	0.875 ~ 1.625 [20℃(68˚F)]
TPS2	0.875 ~ 1.625 [20℃(68˚F)]

[ETC Motor]

Item	Specification
Coil Resistance (Ω)	1.2 ~ 1.8 [20℃(68˚F)]

Circuit Diagram

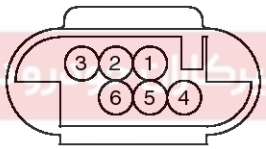
[Circuit Diagram]



[Connection Information]

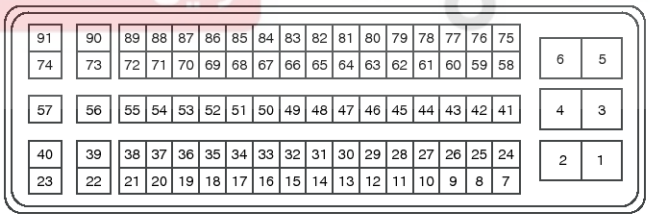
Terminal	Connected to	Function
1	ECM CHG-AG (54)	Sensor Ground
2	ECM CHG-AG (33)	Sensor Power (+5V)
3	ECM CHG-AG (5)	ETC Motor [+] Control
4	ECM CHG-AG (96)	TPS 1 Signal
5	ECM CHG-AG (75)	TPS 2 Signal
6	ECM CHG-AG (6)	ETC Motor [-] Control

[Harness Connector]



CHG12
ETC Module

CHG-AG



CHG-BG
ECM

SYFFL0405N

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.

Specification: Refer to “Specification”

3. Turn the ignition switch OFF and disconnect the scantool from the DLC.
4. Disconnect the ETC module connector and measure the resistance between the ETC module terminals 1 and 2.

Specification: Refer to “Specification”

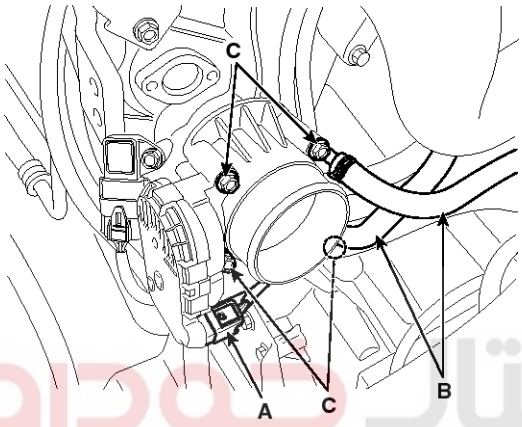
ETC Motor

1. Turn the ignition switch OFF.
2. Disconnect the ETC module connector.
3. Measure resistance between the ETC module terminals 3 and 6.
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. Disconnect the coolant hoses (B).
5. Remove the installation bolts (C), and then remove the ETC module from the engine.



SXMF19131D

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.

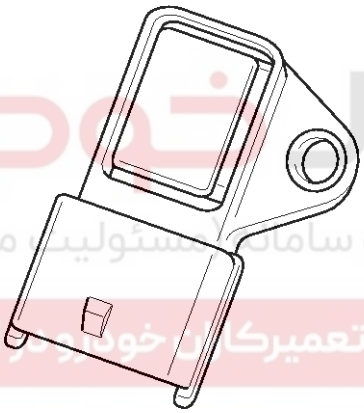
Electronic throttle body Installation bolt:
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)

Manifold Absolute Pressure Sensor (MAPS)

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.

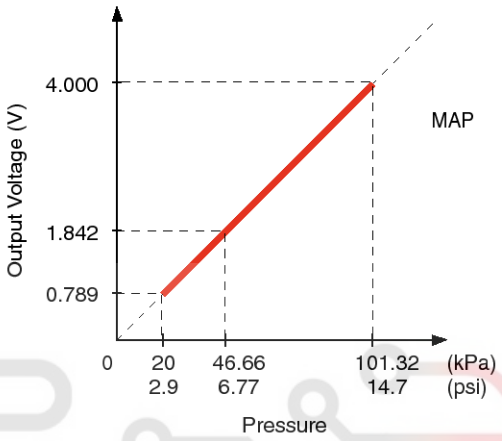
The MAPS consists of a piezo-electric element and a hybrid IC amplifying the element output signal. The element is silicon diaphragm type and adapts pressure sensitive variable resistor effect of semi-conductor. Because 100% vacuum and the manifold pressure apply to both sides of the sensor respectively, this sensor can output analog signal by using the silicon variation proportional to pressure change.



SMGF19111L

Specification

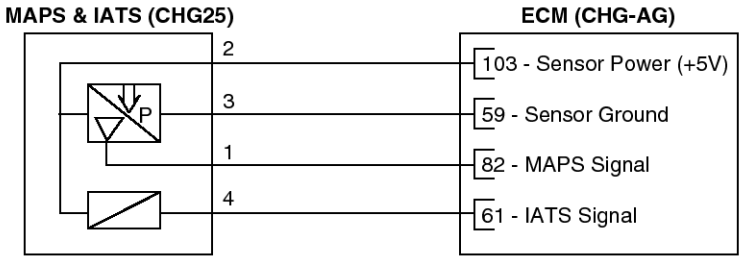
Pressure [kPa (kgf/cm², psi)]	Output Voltage (V)
20.0 (0.20, 2.9)	0.79
46.7 (0.47, 6.77)	1.84
101.3 (1.03, 14.7)	4.0



SLMFL0322N

Circuit Diagram

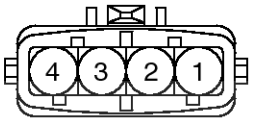
[Circuit Diagram]



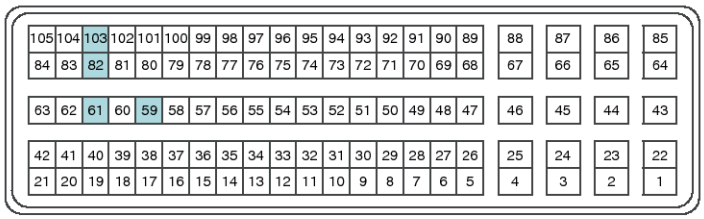
[Connection Information]

Terminal	Connected to	Function
1	ECM CHG-AG (82)	MAPS Signal
2	ECM CHG-AG (103)	Sensor Power (+5V)
3	ECM CHG-AG (59)	Sensor Ground
4	ECM CHG-AG (61)	IATS Signal

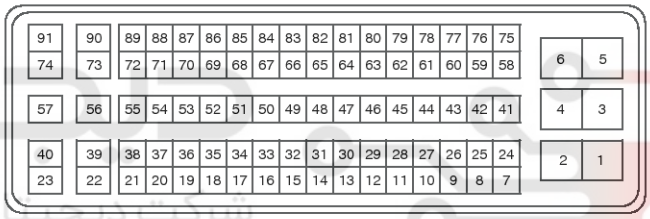
[Harness Connector]



CHG25
MAPS & IATS



CHG-AG



CHG-BG
ECM

SYFFL0406N

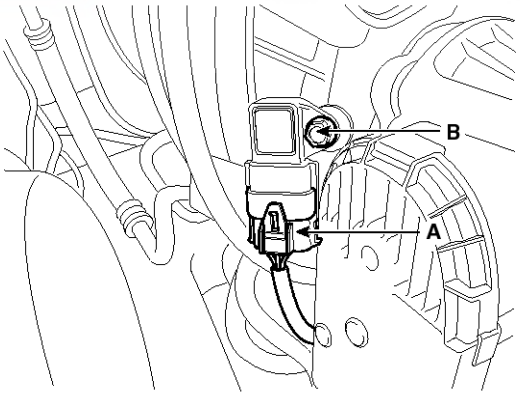
Inspection

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.



SXMF19133D

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.

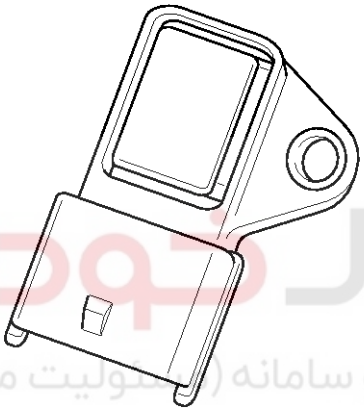
Manifold absolute pressure sensor installation bolt:
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)

Intake Air Temperature Sensor (IATS)

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.



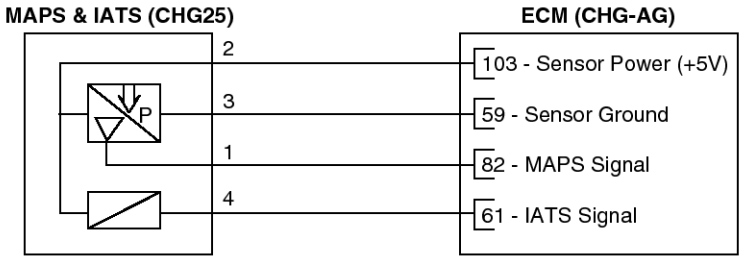
SAMF19005N

Specification

Temperature		Resistance (kΩ)
℃	°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

Circuit Diagram

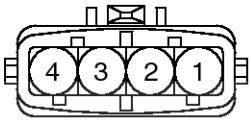
[Circuit Diagram]



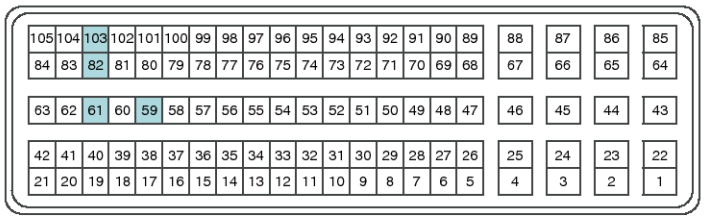
[Connection Information]

Terminal	Connected to	Function
1	ECM CHG-AG (82)	MAPS Signal
2	ECM CHG-AG (103)	Sensor Power (+5V)
3	ECM CHG-AG (59)	Sensor Ground
4	ECM CHG-AG (61)	IATS Signal

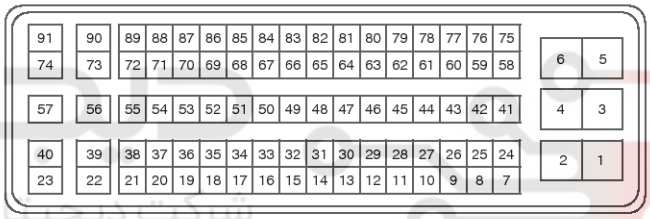
[Harness Connector]



CHG25
MAPS & IATS



CHG-AG



CHG-BG
ECM

SYFFL0406N

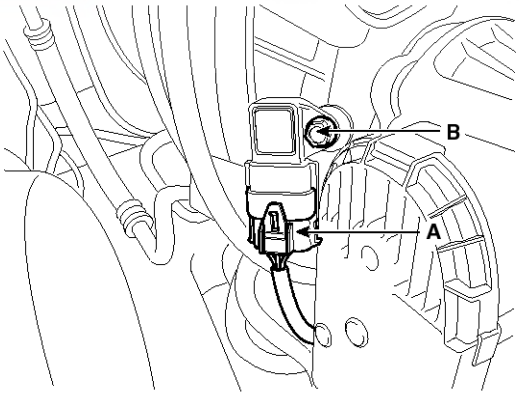
Inspection

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

Specification: Refer to “Specification”

Removal

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Disconnect the manifold absolute pressure sensor connector (A).
3. Remove the installation bolt (B), and then remove the sensor from the surge tank.



SXMF19133D

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)

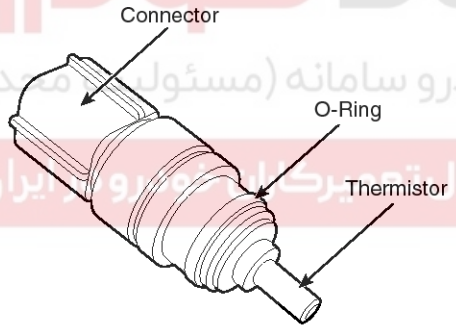
Engine Coolant Temperature Sensor (ECTS)

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.



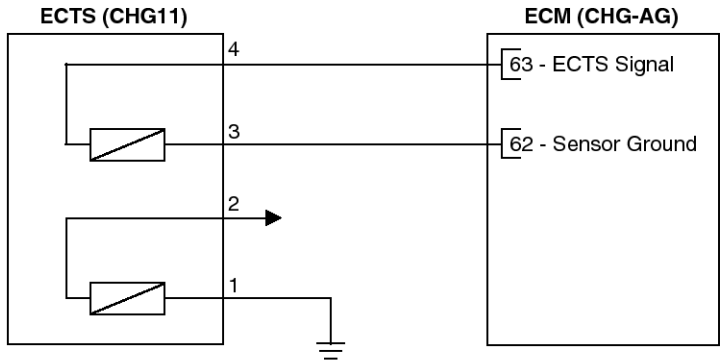
STDFL0127N

Specification

Temperature		Resistance (kΩ)
℃	°F	
-40	-40	48.14
-20	-4	14.13 ~ 16.83
0	32	5.79
20	68	2.31 ~ 2.59
40	104	1.15
60	140	0.59
80	176	0.32

Circuit Diagram

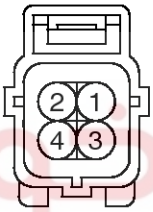
[Circuit Diagram]



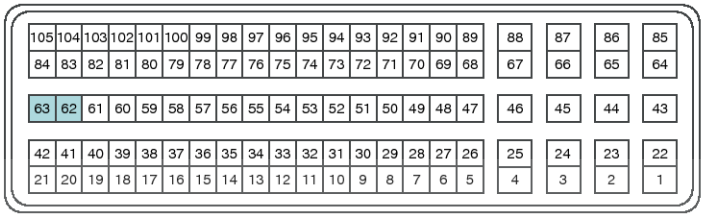
[Connection Information]

Terminal	Connected to	Function
1	Chassis Ground	Sensor Ground
2	-	-
3	ECM CHG-AG (62)	Sensor Ground
4	ECM CHG-AG (63)	ECTS Signal

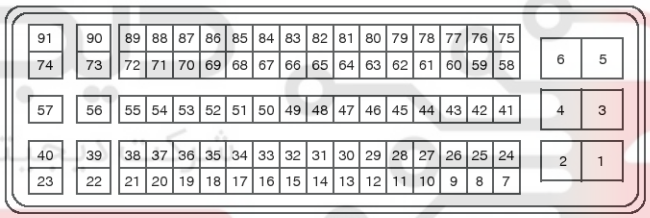
[Harness Connector]



CHG11
ECTS



CHG-AG



CHG-BG
ECM

SYFFL0407N

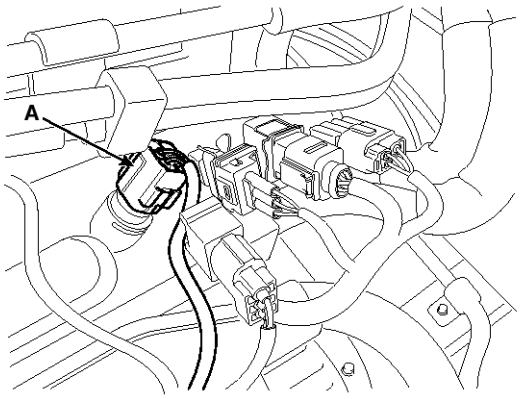
Inspection

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”

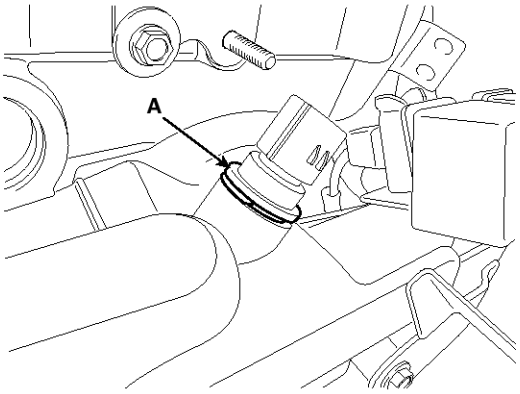
Removal

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



SXMF19198D

3. Remove the spring clip (A), and then pull the sensor from the water temperature control assembly.



SXMF19135D

⚠CAUTION
Note that engine coolant may be flowed out from the water temperature control assembly when removing the sensor.

4. 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.**

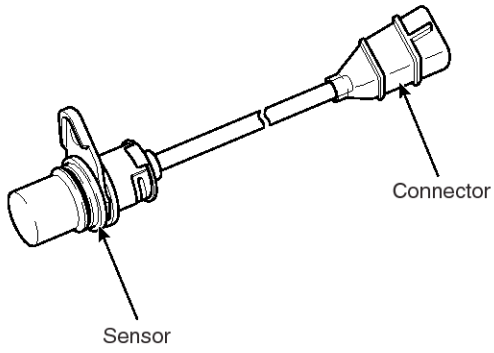
1. Installation is reverse of removal.

Crankshaft Position Sensor (CKPS)

Description

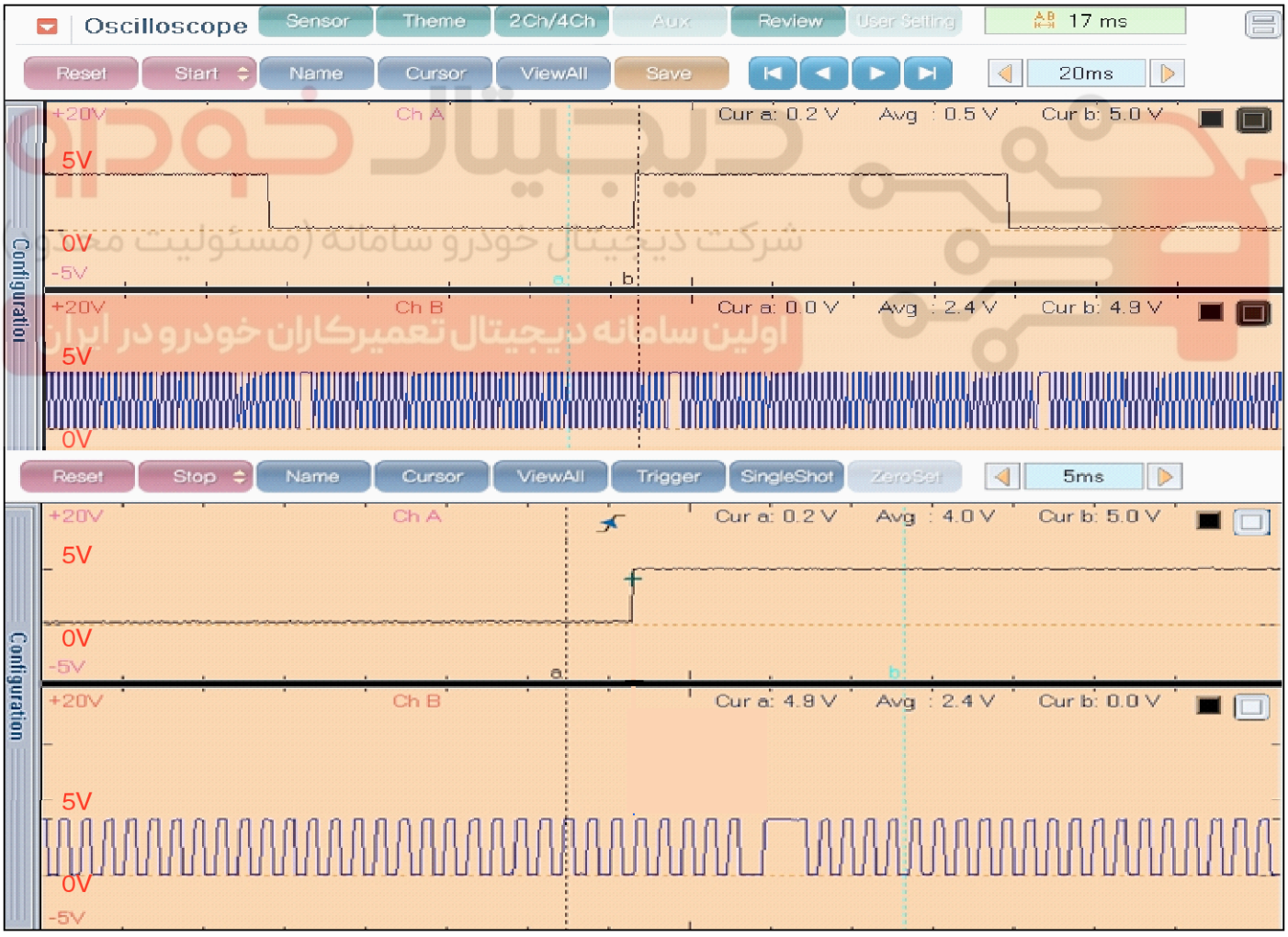
Crankshaft Position Sensor (CKPS) detects the crankshaft position and is one of the most important sensors of the engine control system. If there is no CKPS signal input, the engine may stop because of CKPS signal missing. This sensor is installed on the cylinder block or the transaxle housing and generates alternating current by magnetic flux field which is made by the sensor and the target wheel when engine runs.

The target wheel consists of 58 slots and 2 missing slots on 360 degrees CA (Crank Angle).



EGRF245A

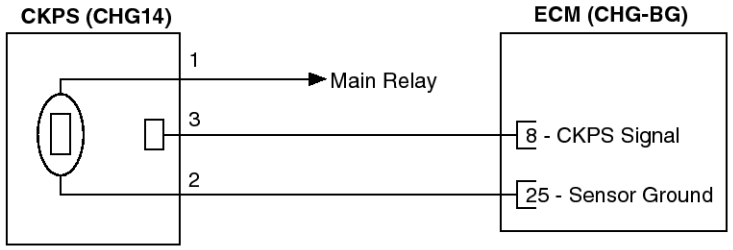
Wave Form



SBKFL9136L

Circuit Diagram

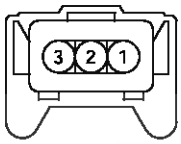
[Circuit Diagram]



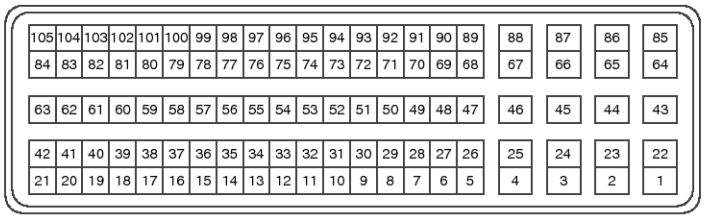
[Connection Information]

Terminal	Connected to	Function
1	Main Relay	Battery Power (B+)
2	ECM CHG-BG (25)	CKPS Signal
3	ECM CHG-BG (8)	Sensor Ground

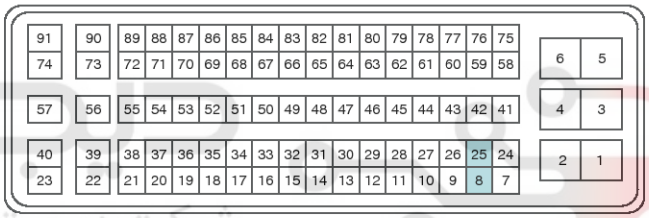
[Harness Connector]



CHG14
CKPS



CHG-AG



CHG-BG
ECM

SYFFL0408N

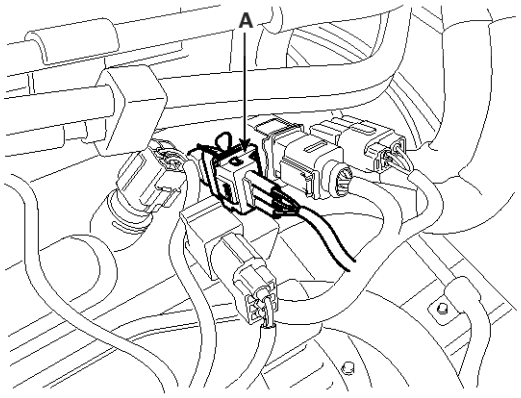
Inspection

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

Specification: Refer to “Wave Form”

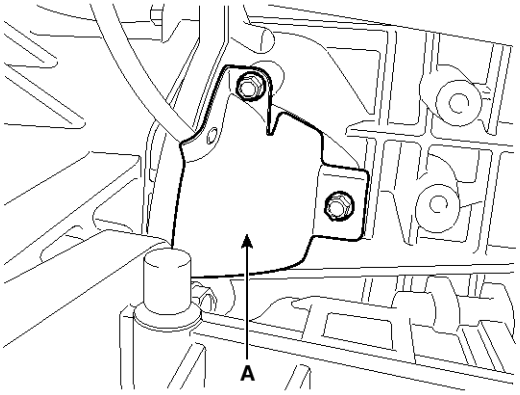
Removal

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



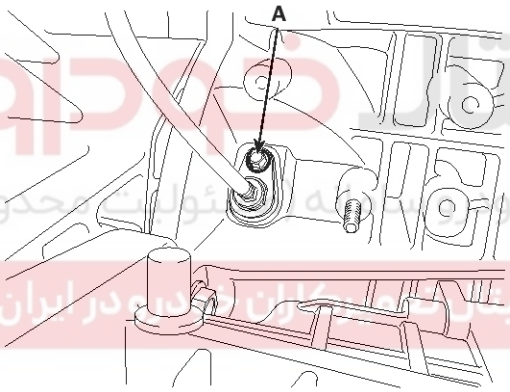
SXMF19139D

3. Remove the protector (A).



SYFFL0307N

4. Remove the installation bolt (A), and then remove the crankshaft position sensor.



SXMF19141D

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: 9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)
Crankshaft position sensor protector installation bolt (M6): 9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)
Crankshaft position sensor protector installation bolt (M8): 18.6 ~ 23.5 N.m (1.9 ~ 2.4 kgf.m, 13.7 ~ 17.4 lb-ft)

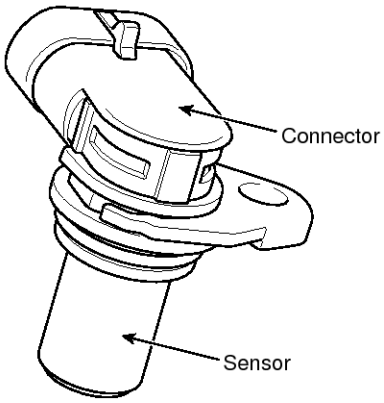
Camshaft Position Sensor (CMPS)

Description

Camshaft Position Sensor (CMPS) is a hall sensor and detects the camshaft position by using a hall element.

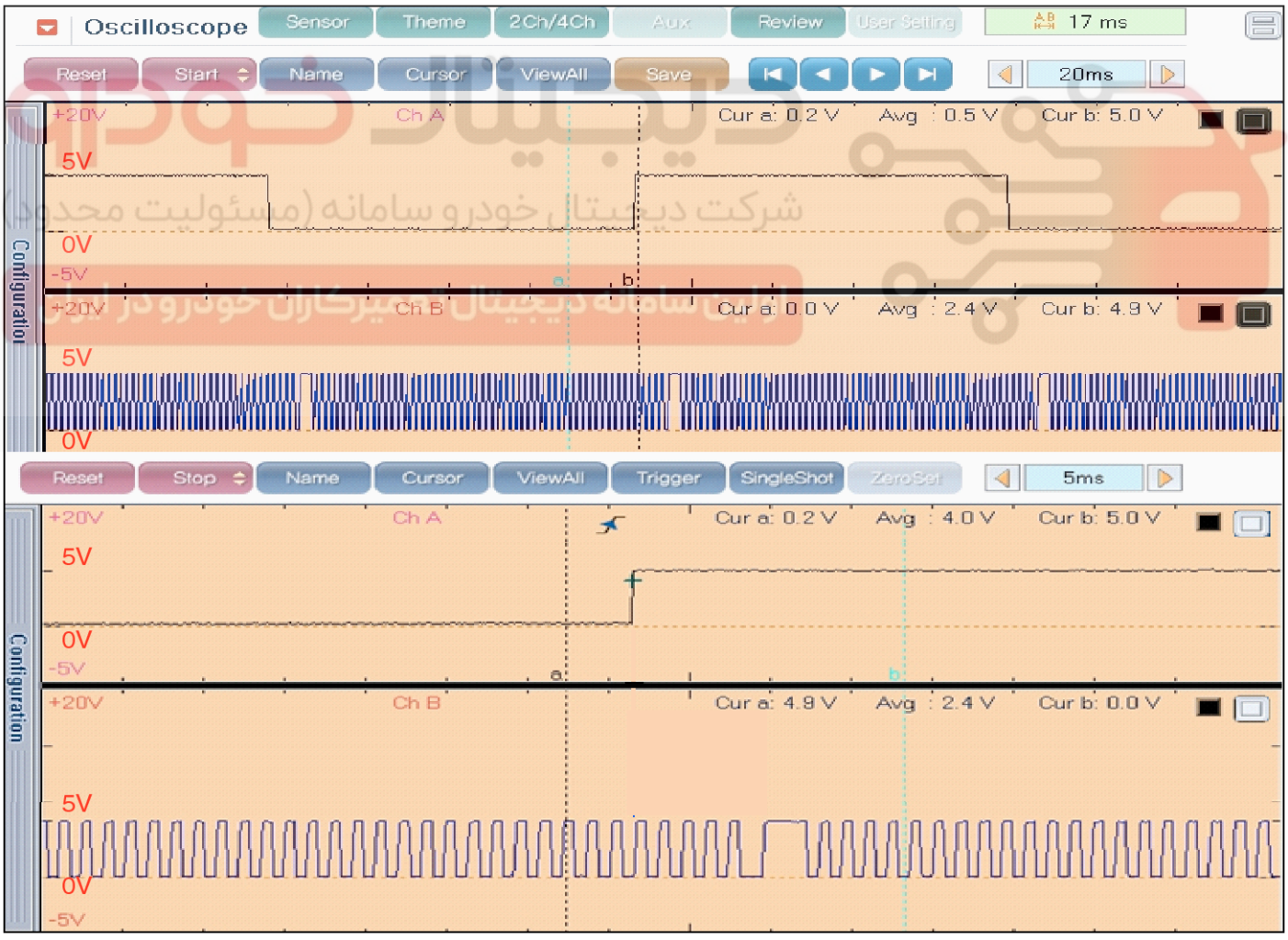
It is related with Crankshaft Position Sensor (CKPS) and detects the piston position of each cylinder which the CKPS can't detect.

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.



SBHFL9138L

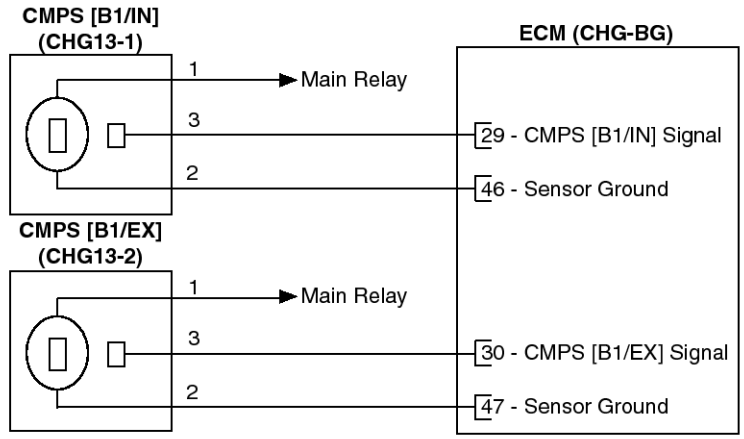
Wave Form



SBKFL9136L

Circuit Diagram

[Circuit Diagram]



[Connection Information]

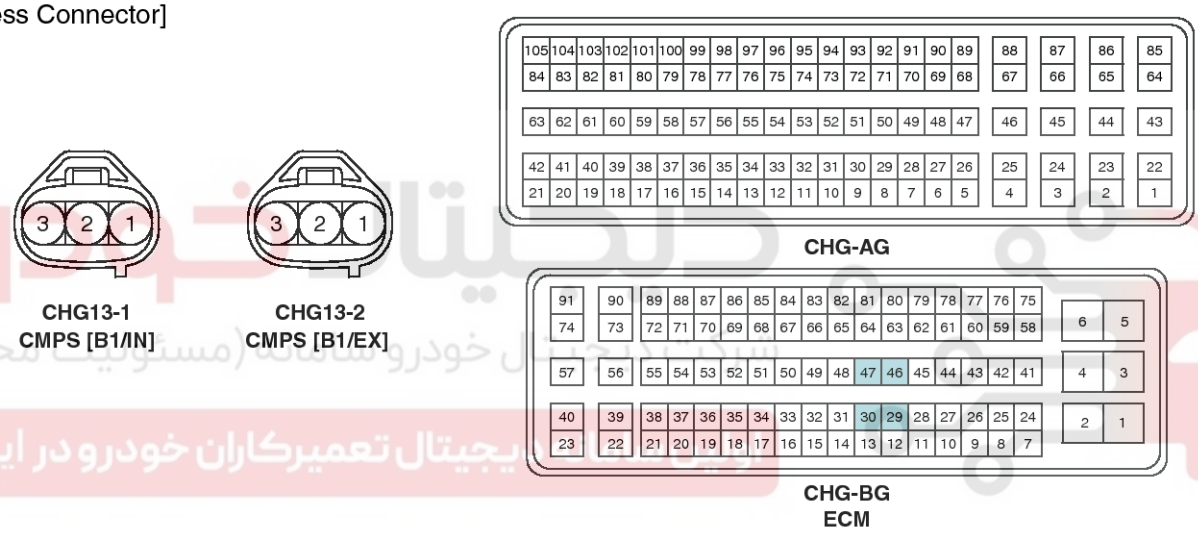
CMPS [B1/IN] (CHG13-1)

Terminal	Connected to	Function
1	Main Relay	Battery Power (B+)
2	ECM CHG-BG (46)	Sensor Ground
3	ECM CHG-BG (29)	CMPS [B1/IN] Signal

CMPS [B1/EX] (CHG13-2)

Terminal	Connected to	Function
1	Main Relay	Battery Power (B+)
2	ECM CHG-BG (47)	Sensor Ground
3	ECM CHG-BG (30)	CMPS [B1/EX] Signal

[Harness Connector]



SYFFL0409N

Inspection

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

Specification: Refer to “Wave Form”

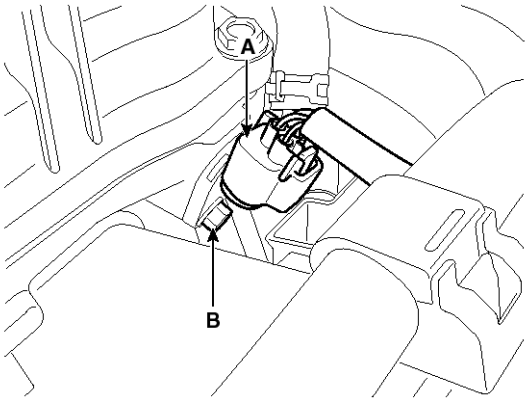
Removal

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]

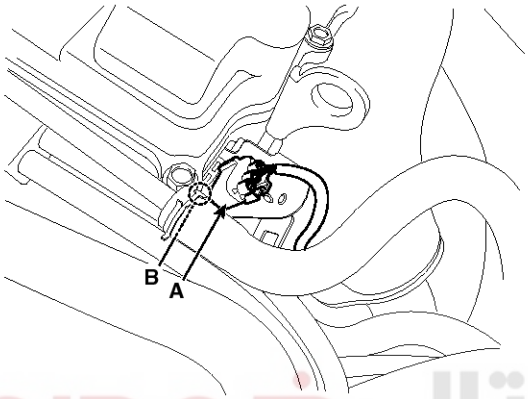
1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Disconnect the camshaft position sensor connector (A).
3. Remove the installation bolt (B), and then remove the sensor.



SYFFL0021N

[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.



SYFFL0031N

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.

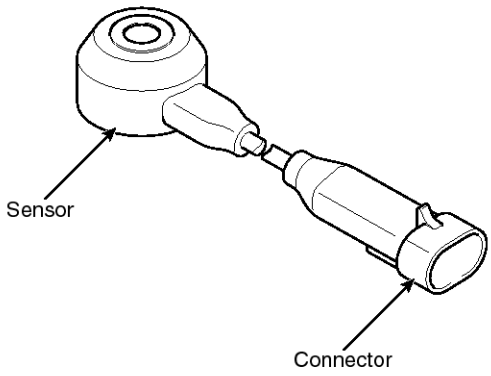
Camshaft position sensor installation bolt:
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)

Knock Sensor (KS)

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.



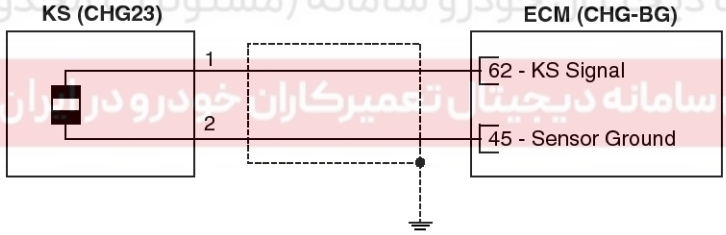
EGRF251A

Specification

Item	Specification
Capacitance (pF)	850 ~ 1,150

Circuit Diagram

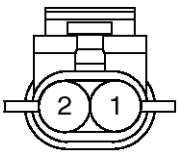
[Circuit Diagram]



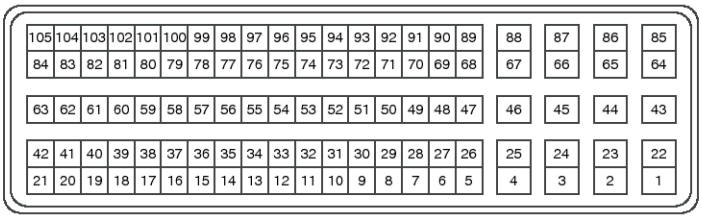
[Connection Information]

Terminal	Connected to	Function
1	ECM CHG-BG (62)	KS Signal
2	ECM CHG-BG (45)	Sensor Ground

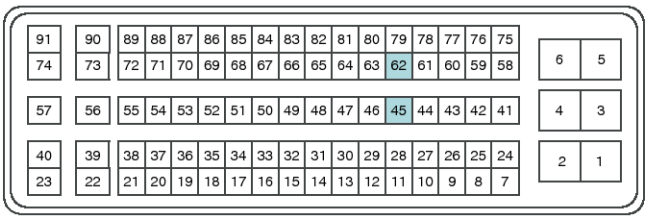
[Harness Connector]



CHG23
Knock Sensor



CHG-AG

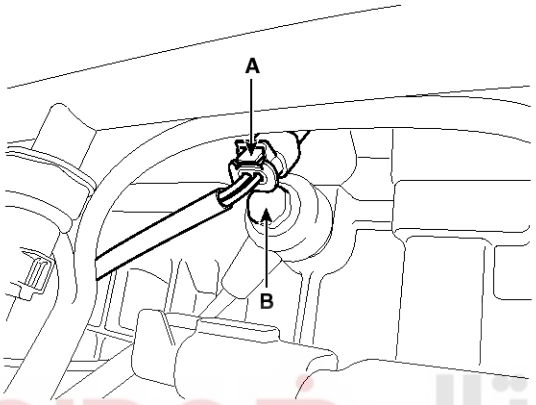


CHG-BG
ECM

SYFFL0410N

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.



SYFFL0041N

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.

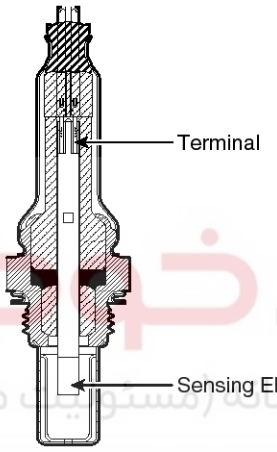
Knock sensor installation bolt:
18.6 ~ 23.5 N.m (1.9 ~ 2.4 kgf.m, 13.7 ~ 17.4 lb-ft)

Heated Oxygen Sensor (HO2S)

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.



SHDFL8147C

Specification

HO2S [Bank 1/Sensor 1]

Item	Specification
Heater Resistance (Ω)	2.5 ~ 4.0 [20℃(68°F)]

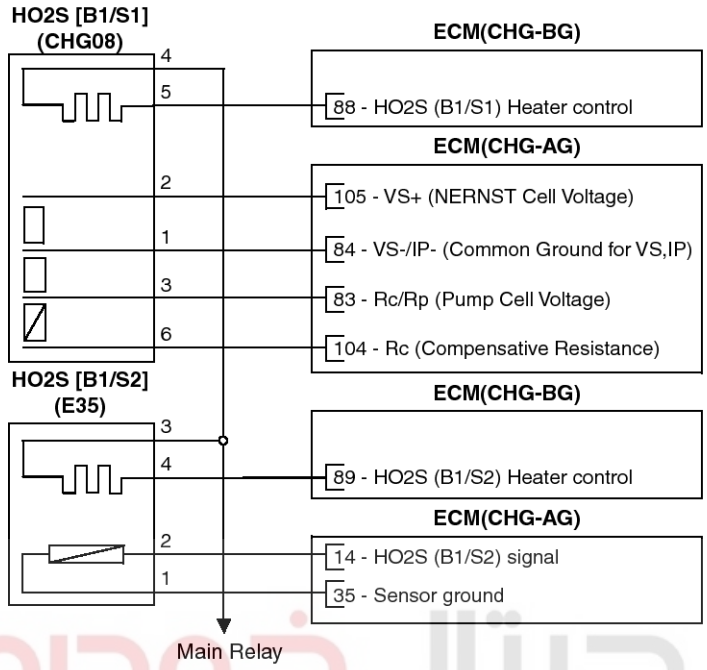
HO2S [Bank 1/Sensor 2]

A/F Ratio (λ)	Output Voltage(V)
RICH	Approx. 0.9
LEAN	Approx. 0.04

Item	Specification
Heater Resistance (Ω)	3.3 ~ 4.1Ω[21℃(69.8°F)]

Circuit Diagram

[Circuit Diagram]



[Connection Information]

HO2S [B1/S1] (CHG08)

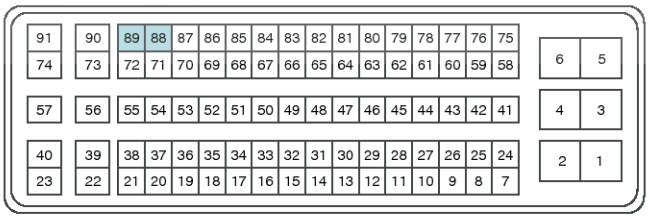
Terminal	Connected to	Function
1	ECM CHG-AG (84)	VS-/IP- (Common Ground for VS,IP)
2	ECM CHG-AG (105)	VS+ (NERNST Cell Voltage)
3	ECM CHG-AG (83)	Rc/Rp (Pump Cell Voltage)
4	Main Relay	Power Supply (B+)
5	ECM CHG-BG (88)	Heater control
6	ECM CHG-AG (104)	Rc (Compensative Resistance)

HO2S [B1/S2] (E35)

Terminal	Connected to	Function
1	ECM CHG-AG (35)	Sensor Ground
2	ECM CHG-AG (14)	HO2S (B1/S2) Signal
3	Main Relay	Power Supply (B+)
4	ECM CHG-BG (89)	Heater control

[Harness Connector]

CHG-AG



CHG-BG
ECM

CHG08
HO2S [B1/S1]

E35
HO2S [B1/S2]

SYFFL1411L

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.

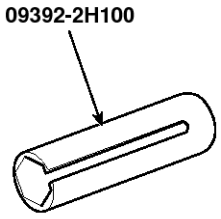
Specification: Refer to “Specification”

Removal

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

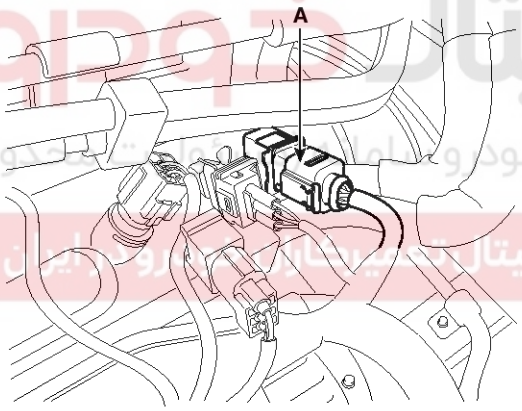
NOTICE

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

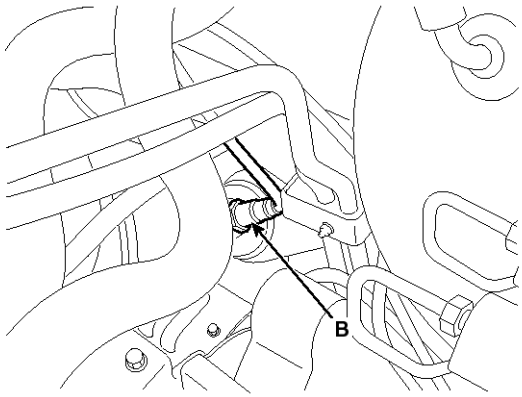


SYFFL0308N

[Bank 1 / Sensor 1]

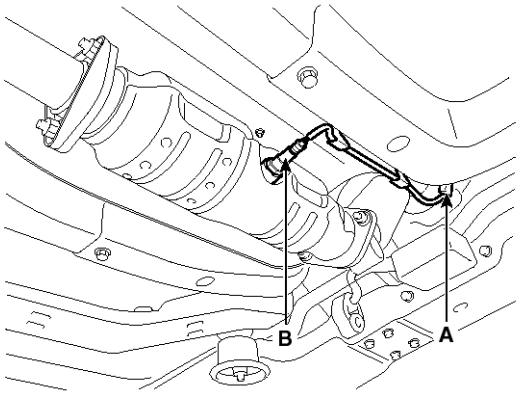


SYFFL0301N



SYFFL0131D

[Bank 1 / Sensor 2]



SYFFL0141D

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).**

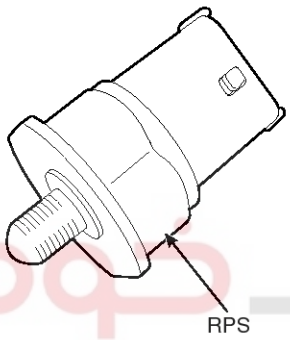
1. Installation is reverse of removal.

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

Rail Pressure Sensor (RPS)

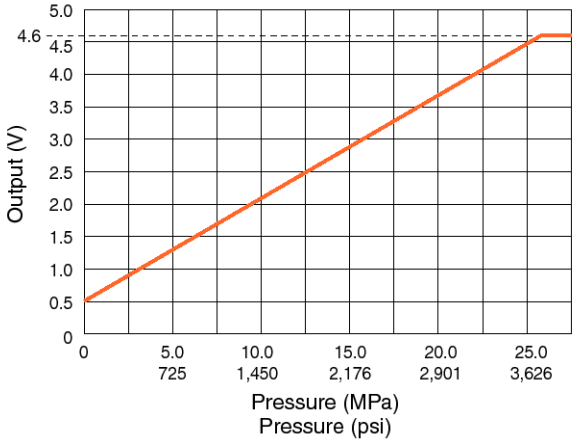
Description

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.



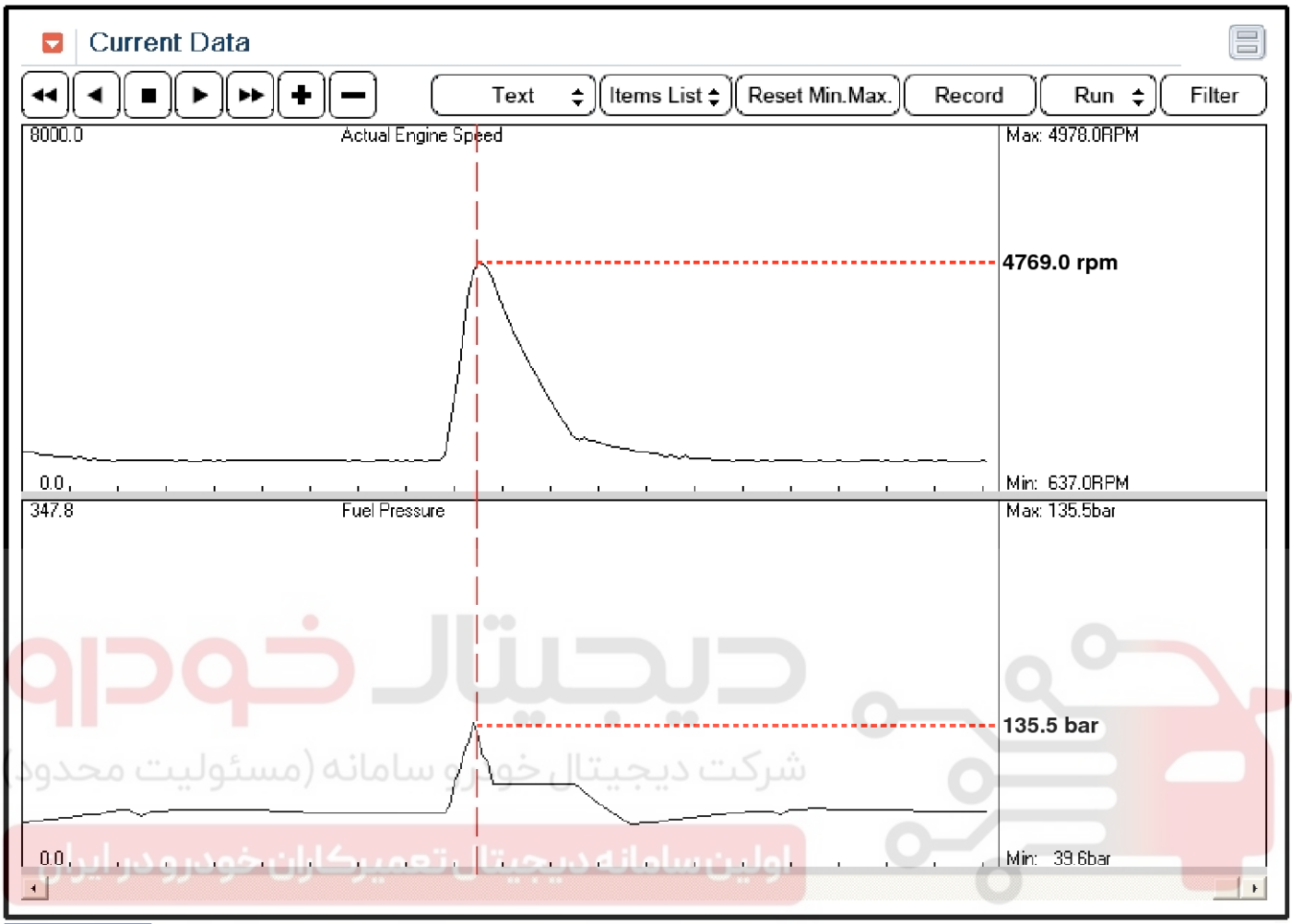
SYFFL0060N

Specification



SYFF11001L

Signal Waveform

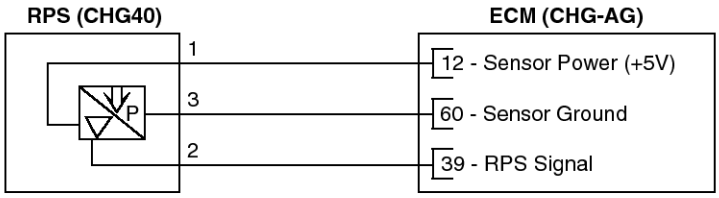


Acceleration

SYFFL0412N

Circuit Diagram

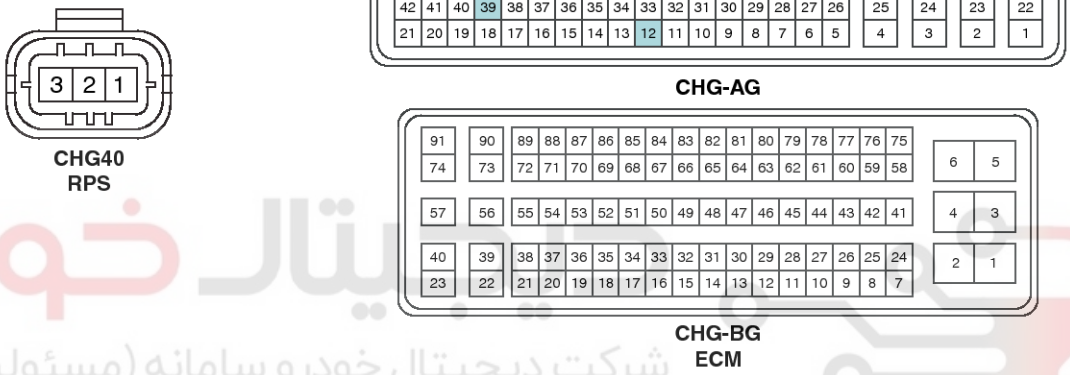
[Circuit Diagram]



[Connection Information]

Terminal	Connected to	Function
1	ECM CHG-AG (12)	Sensor Power (+5V)
2	ECM CHG-AG (39)	RPS Signal
3	ECM CHG-AG (60)	Sensor Ground

[Harness Connector]



SYFFL0413N

Inspection

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

Condition	Output Voltage (V)
Idle	Approx. 1.2
1,500 rpm	2.0 ~ 2.2
6,300 rpm	Approx. 2.8

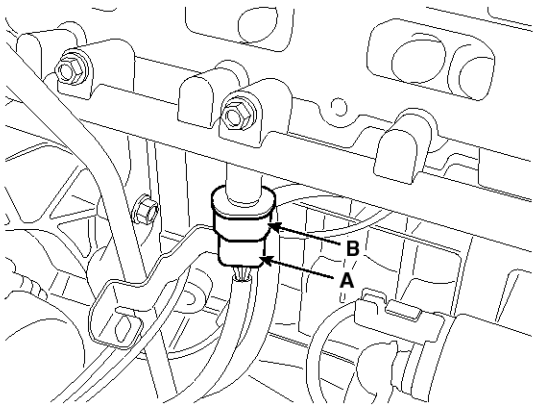
Removal

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Release the residual pressure in fuel line (Refer to “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.



SYFFL0091N

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.**

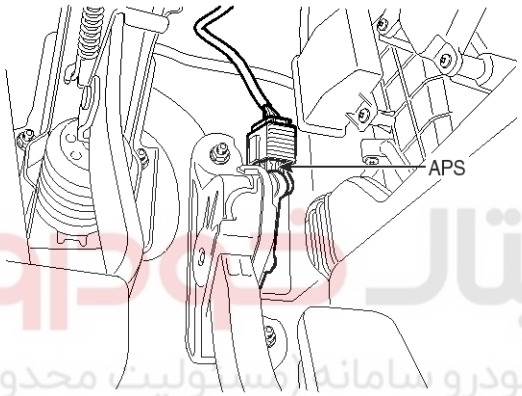
1. Installation is reverse of removal.

Rail Pressure Sensor Installation: 18.0 ~ 22.0 N.m (1.8 ~ 2.2 kgf.m, 13.3 ~ 16.2 lb-ft)

Accelerator Position Sensor (APS)

Description

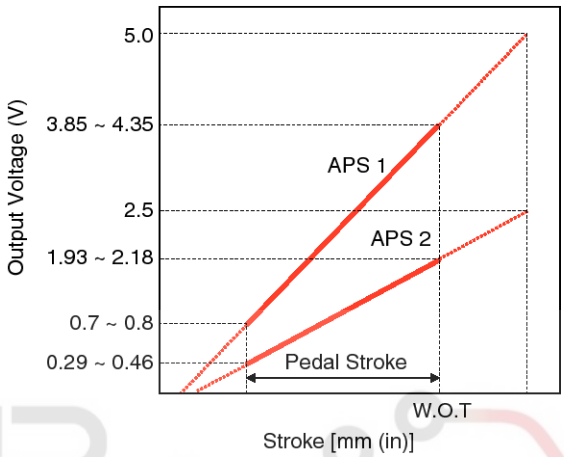
Accelerator Position Sensor (APS) is installed on the accelerator pedal module and detects the rotation angle of the accelerator pedal. The APS is one of the most important sensors in engine control system, so it consists of the two sensors which adapt individual sensor power and ground line. The second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



SXMF19110D

Specification

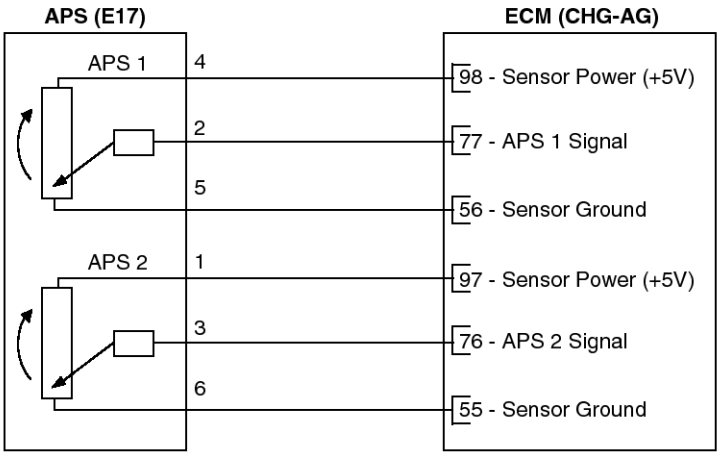
Accelerator Position	Output Voltage (V)	
	APS1	APS2
C.T	0.7 ~ 0.8	0.29 ~ 0.46
W.O.T	3.85 ~ 4.35	1.93 ~ 2.18



SXMF10143L

Circuit Diagram

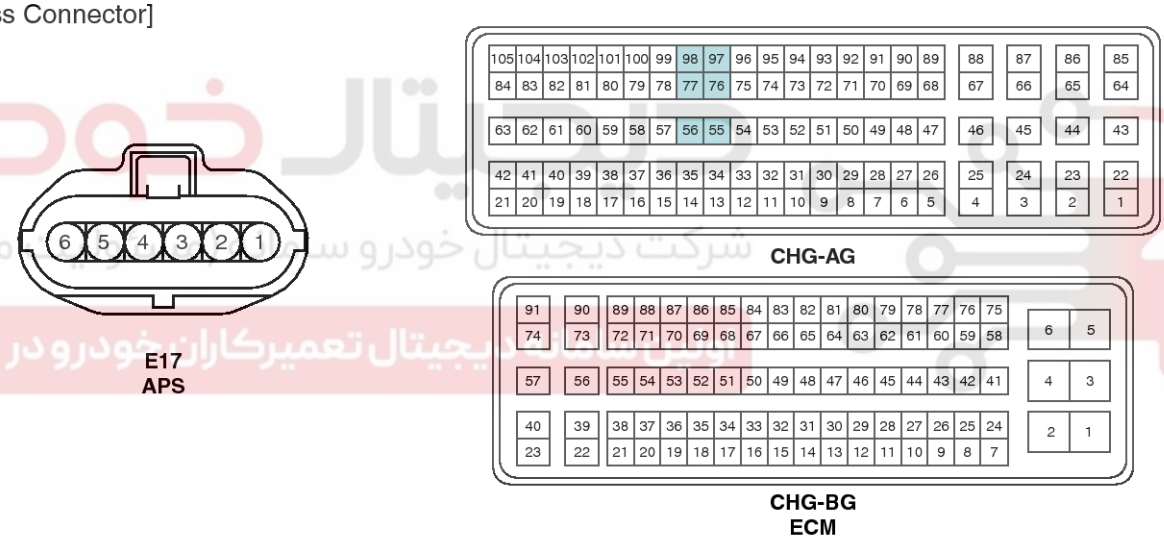
[Circuit Diagram]



[Connection Information]

Terminal	Connected to	Function
1	ECM CHG-AG (97)	APS 2 Sensor Power (+5V)
2	ECM CHG-AG (77)	APS 1 Signal
3	ECM CHG-AG (76)	APS 2 Signal
4	ECM CHG-AG (98)	APS 1 Sensor Power (+5V)
5	ECM CHG-AG (56)	APS 1 Sensor Ground
6	ECM CHG-AG (55)	APS 2 Sensor Ground

[Harness Connector]



STFF11004L

Inspection

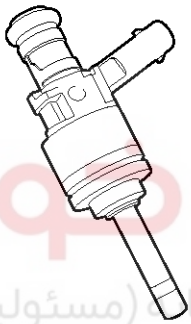
1. Connect the GDS on the Data Link Connector (DLC).
2. Turn the ignition switch ON.
3. Measure the output voltage of the APS 1 and 2 at C.T and W.O.T.

Specification: Refer to “Specification”

Injector

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.

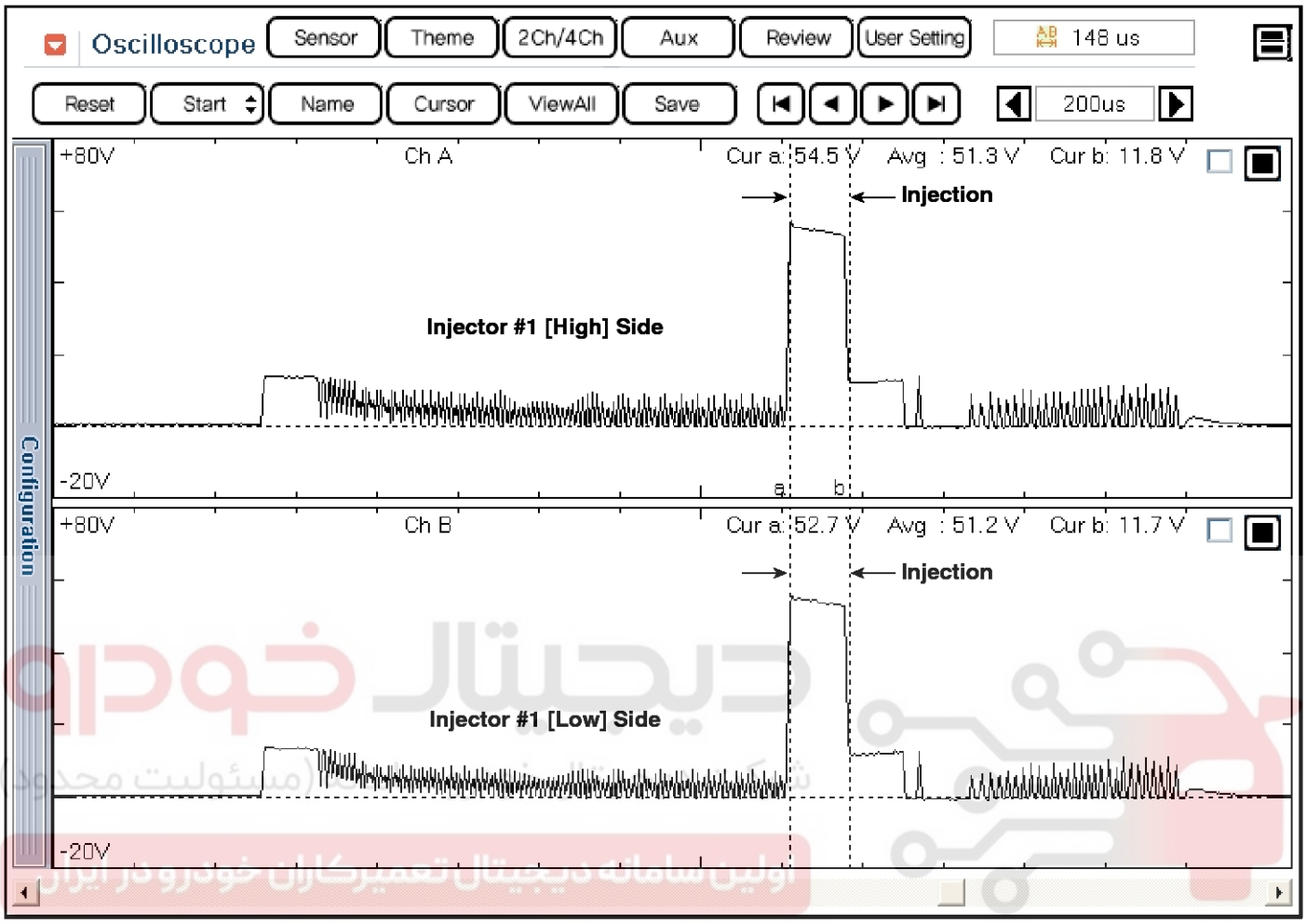


SYFFL0070N

Specification

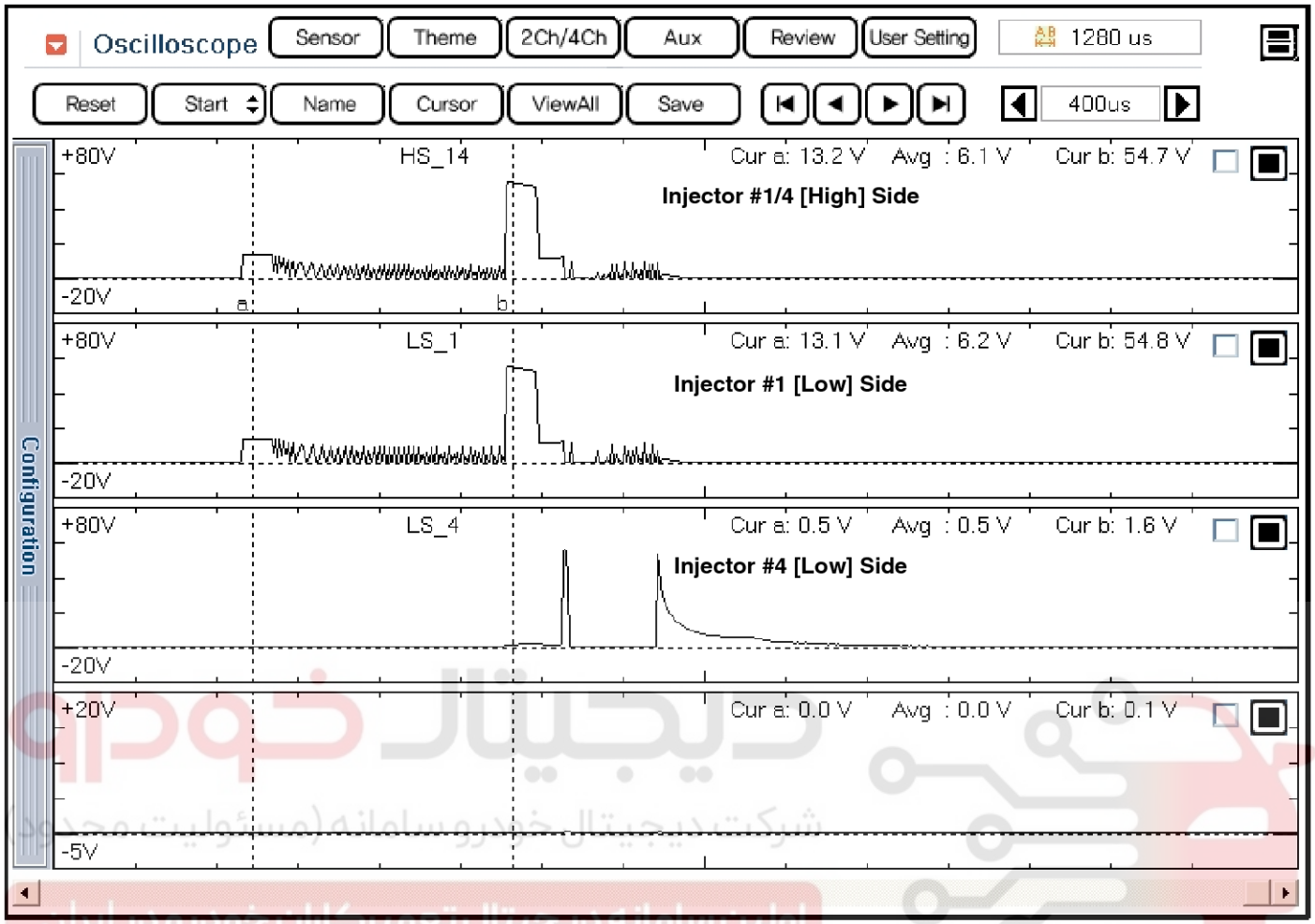
Item	Specification
Coil Resistance (Ω)	1.18 ~ 1.31 [20℃(68°F)]

Signal Waveform



Injector #1 Injection

SYFFL0416N

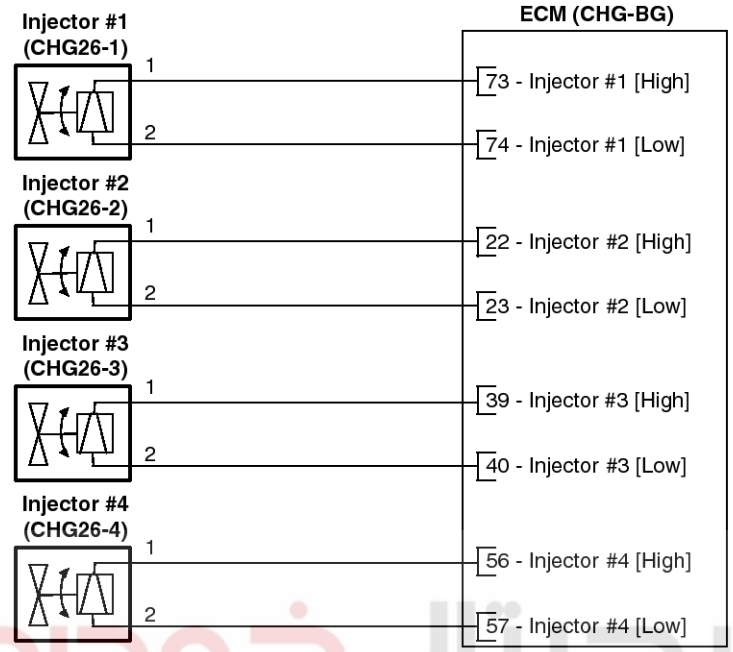


Injector #1 Injection

SYFFL0417N

Circuit Diagram

[Circuit Diagram]



[Connection Information]

Injector #1 (CHG26-1)

Terminal	Connected to	Function
1	ECM CHG-BG (73)	Injector #1 [High] Control
2	ECM CHG-BG (74)	Injector #1 [Low] Control

Injector #2 (CHG26-2)

Terminal	Connected to	Function
1	ECM CHG-BG (22)	Injector #2 [High] Control
2	ECM CHG-BG (23)	Injector #2 [Low] Control

Injector #3 (CHG26-3)

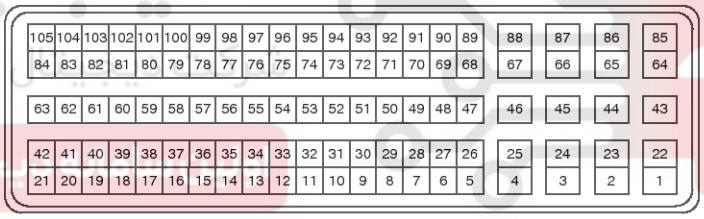
Terminal	Connected to	Function
1	ECM CHG-BG (39)	Injector #3 [High] Control
2	ECM CHG-BG (40)	Injector #3 [Low] Control

Injector #4 (CHG26-4)

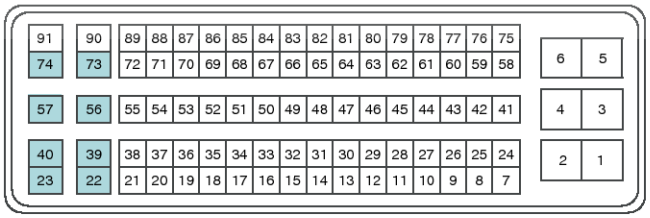
Terminal	Connected to	Function
1	ECM CHG-BG (56)	Injector #4 [High] Control
2	ECM CHG-BG (57)	Injector #4 [Low] Control

[Harness Connector]

CHG26-1,2,3,4
Injector #1,2,3,4



CHG-AG



CHG-BG
ECM

SYFFL0418N

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

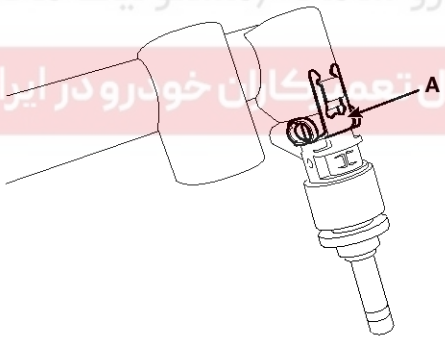
WARNING

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).

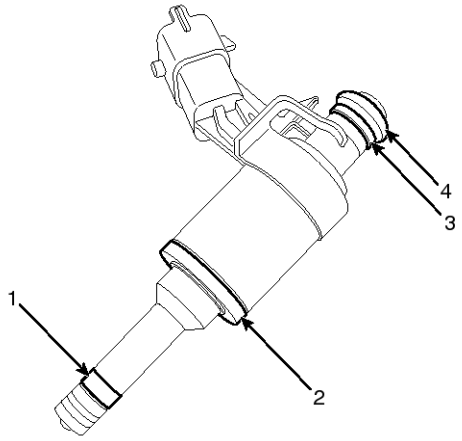
   CAUTION

   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 fixing clip (A), and then separate the injector from the delivery pipe.



SYFFL0080N

Installation



SELF11042L

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

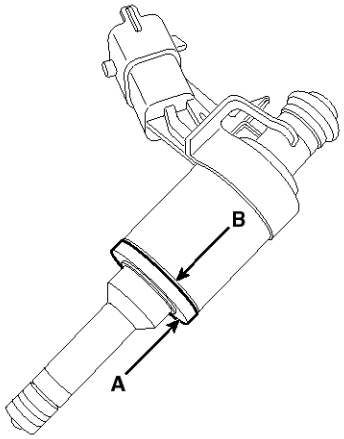
- **Do not reuse the used bolt.**

CAUTION

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

CAUTION

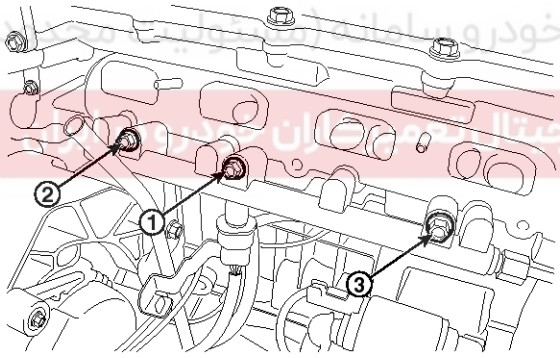
- **Do not reuse the support disc.**
- **Do not reuse the injector rubber washer.**
- **When replacing the rubber washer, the steal plate (A) part should be faced the cylinder installation part and the rubber plate (B) part should be faced the injector body part.**



SELF11060L

CAUTION
- **Do not reuse the combustion seal.**

CAUTION
- **When tightening the delivery pipe installation bolts, tighten them in accordance with the order (① → ② → ③) after tightening with hand-screwed torque.**



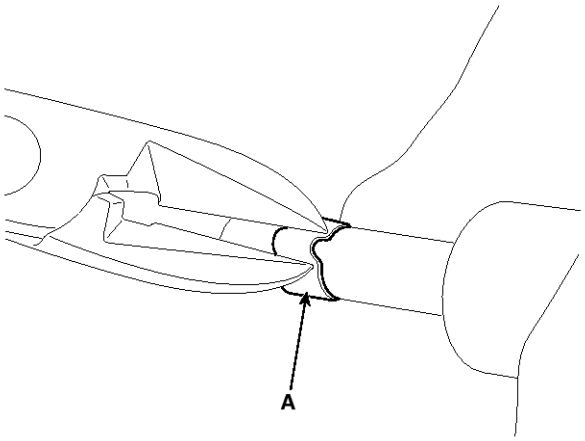
SYFFL0093N

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.



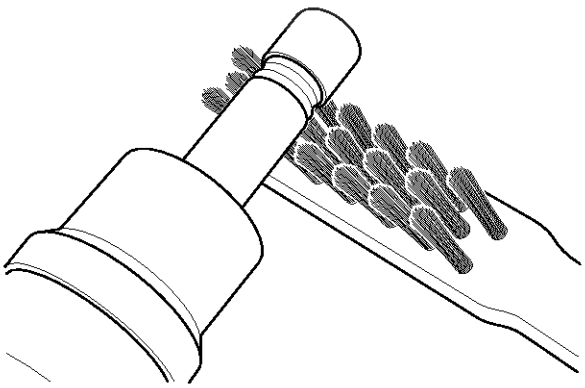
SMDFL1087D

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.



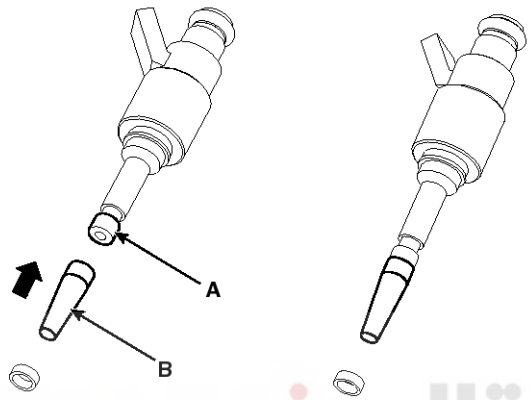
SMDFL1088D

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

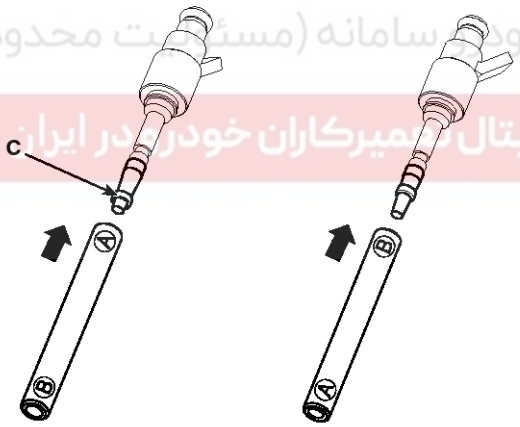
3. Place the seal installing guide (B) (SST No.: 09353-2B000) on the tip of the injector not to damage the injector tip (A).

   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.

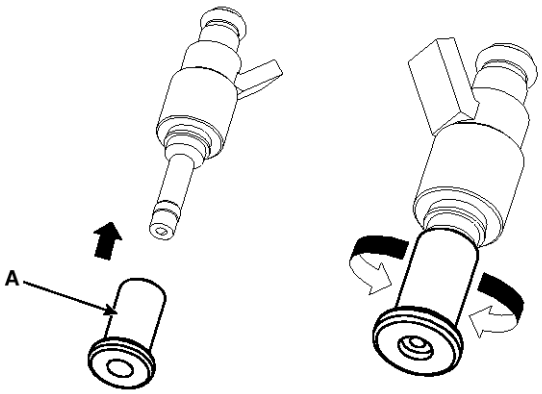


SRBF11007D



SRBF11008D

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.



SRBF11009D

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

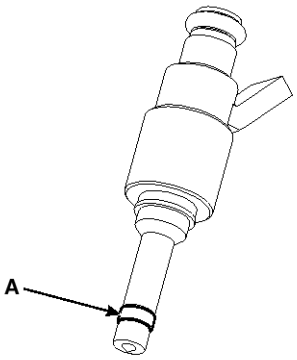
   ⚠CAUTION

   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.

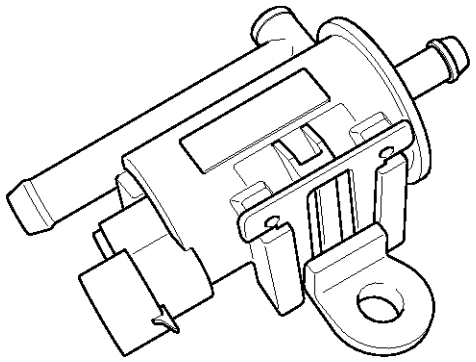


SRBF11010D

Purge Control Solenoid Valve (PCSV)

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.



KFCF1028

Specification

Item	Specification
Coil Resistance (Ω)	19.0 ~ 22.0 [20℃(68°F)]

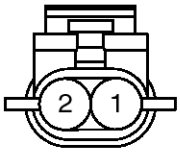
Circuit Diagram

[Circuit Diagram]

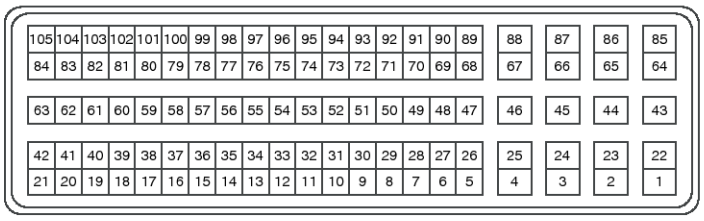
[Connection Information]

Terminal	Connected to	Function
1	Main Relay	Battery Power (B+)
2	ECM CHG-BG (86)	PCSV Control

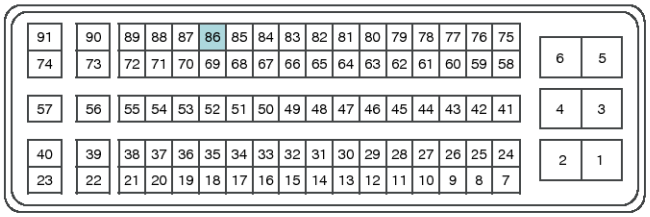
[Harness Connector]



CHG21
PCSV



CHG-AG



CHG-BG
ECM

SYFFL0419N

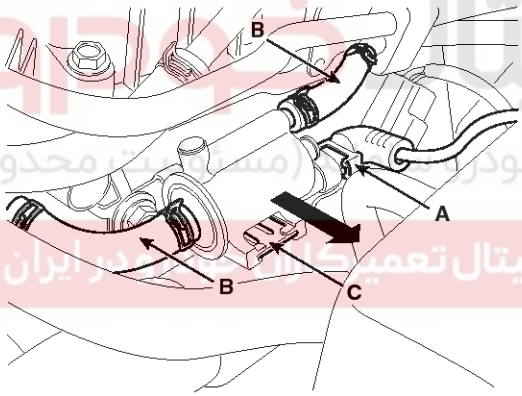
Inspection

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

Specification: Refer to “Specification”

Removal

1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Disconnect the purge control solenoid valve connector (A).
3. Disconnect the vapor hoses (B) from the purge control solenoid valve.
4. Remove the valve from the bracket (C) in the direction of the arrow.



SYFFL0302N

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)

CVVT Oil Control Valve (OCV)

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.

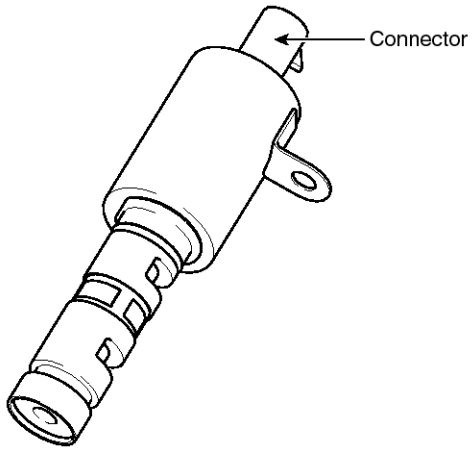
This system consist of

-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.



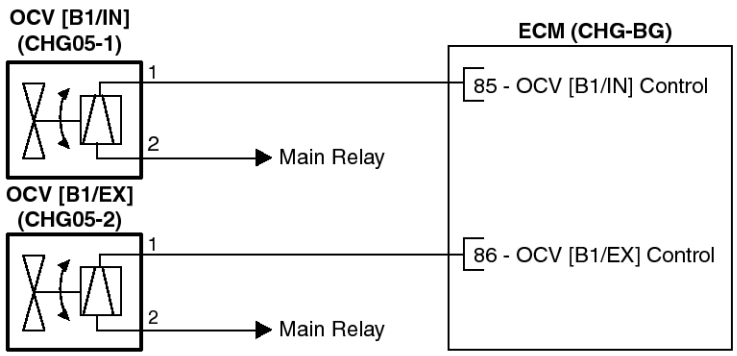
SBKFL9183L

Specification

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

Circuit Diagram

[Circuit Diagram]



[Connection Information]

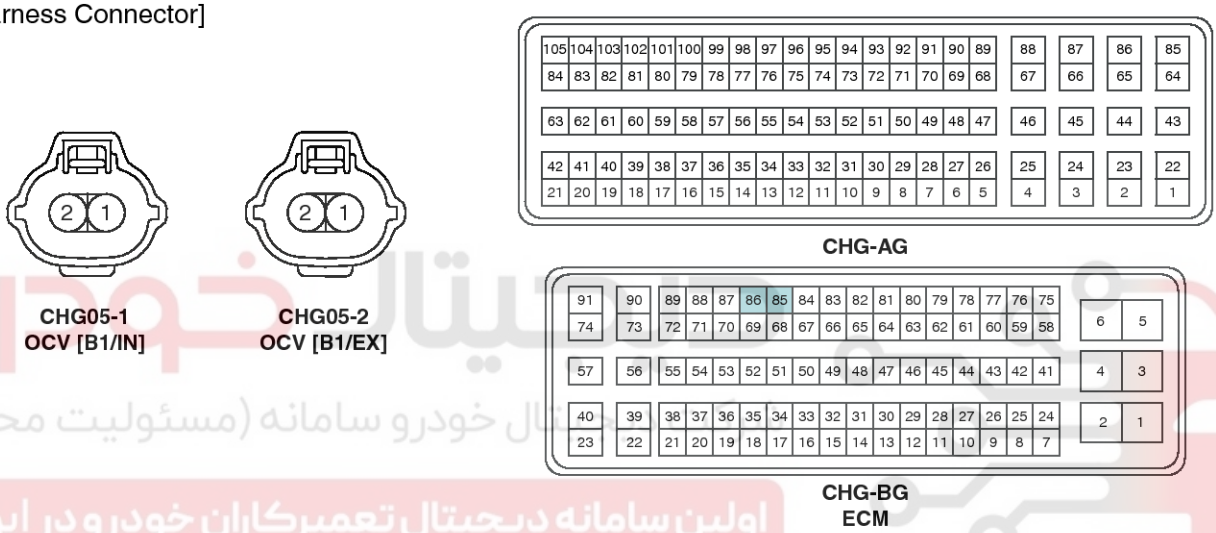
OCV [B1/IN] (CHG05-1)

Terminal	Connected to	Function
1	ECM CHG-BG (85)	OCV [B1/IN] Control
2	Main Relay	Battery Power (B+)

OCV [B1/EX] (CHG05-2)

Terminal	Connected to	Function
1	ECM CHG-BG (86)	OCV [B1/EX] Control
2	Main Relay	Battery Power (B+)

[Harness Connector]



STFF11005L

Inspection

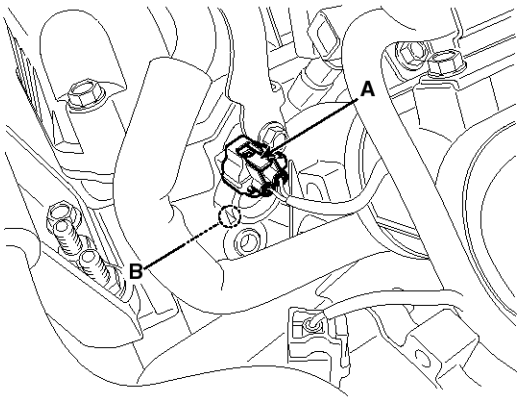
1. Turn the ignition switch OFF.
2. Disconnect the OCV connector.
3. Measure resistance between the OCV terminals 1 and 2.
4. Check that the resistance is within the specification.

Specification: Refer to “Specification”

Removal

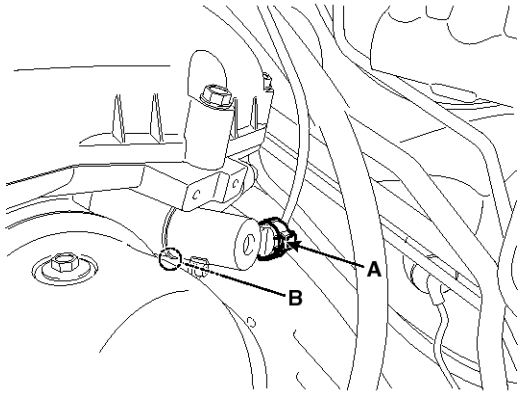
1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Disconnect the CVVT oil control valve connector (A).
3. Remove the installation bolt (B), and then remove the valve from the engine.

[Bank 1 / Intake]



SXMF19161D

[Bank 1 / Exhaust]



SXMF19162D

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.**

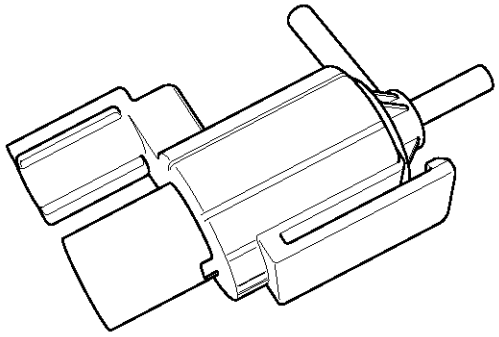
1. Installation is reverse of removal.

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

Variable Intake Solenoid (VIS) Valve

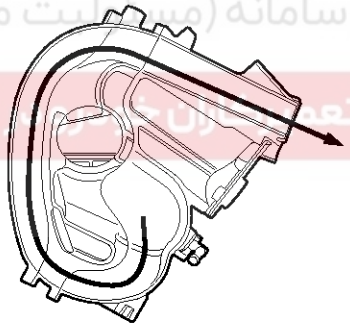
Description

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).

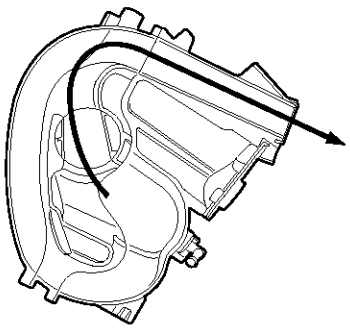


KFCF1029

Engine condition	VIS valve	Operation
Medium speed	Closed	Increasing engine performance in low engine speed by reducing intake interference among cylinders
Low / High speed	Open	Minimizing intake resistance by shortening intake manifold length and increasing area of air entrance



Medium speed



Low / High speed

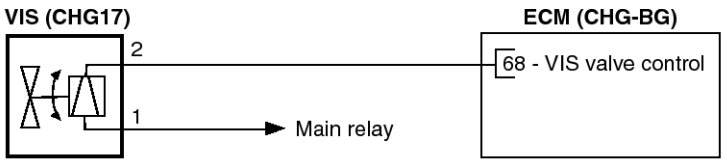
SNFFL9036N

Specification

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

Circuit Diagram

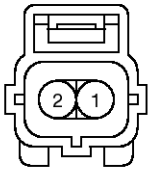
[Circuit Diagram]



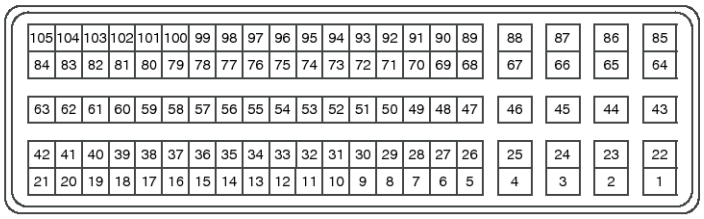
[Connection Information]

Terminal	Connected to	Function
1	Main relay	Power supply (B+)
2	ECM CHG-BG (68)	VIS valve control

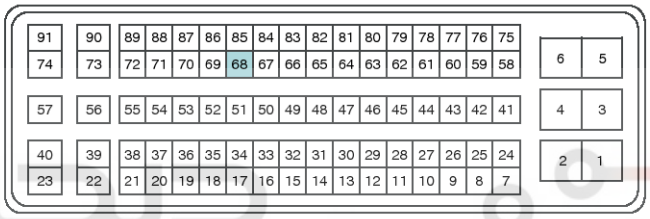
[Harness Connector]



CHG17
VIS Valve



CHG-AG



CHG-BG
ECM

SYFFL0421N

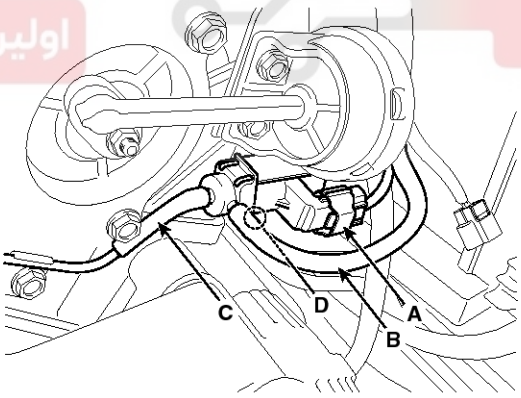
Inspection

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,C) from the valve.
4. Remove the installation bolt (D), and then remove the valve from the surge tank.



SYFFL0101N

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

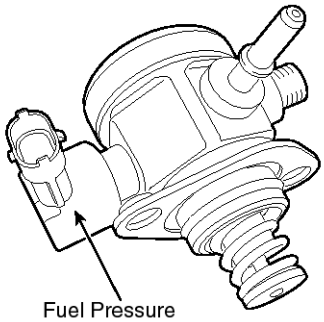
- **Use care to keep foreign material out of the valve.**

1. Installation is reverse of removal.

Fuel Pressure Control Valve

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.

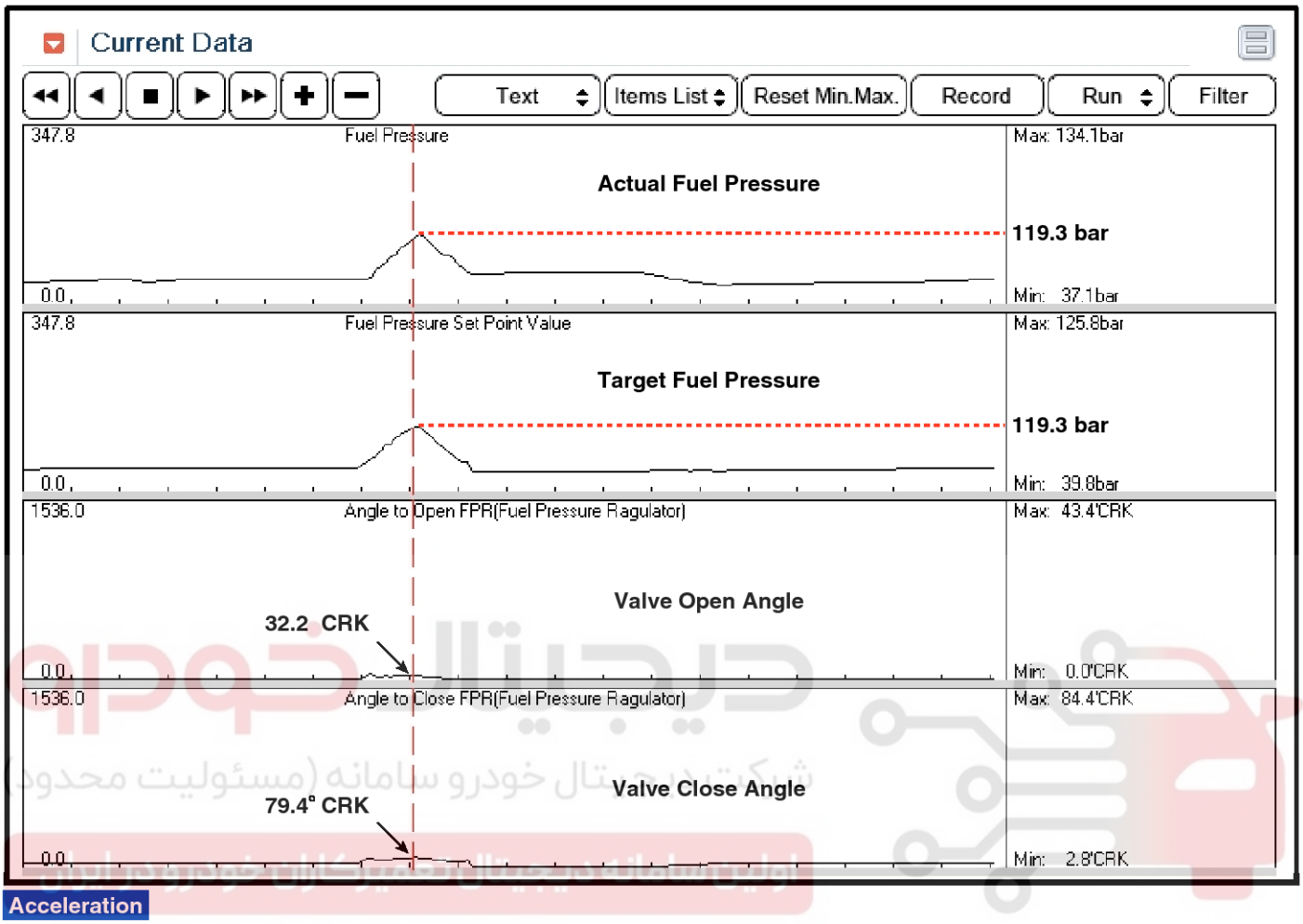


SYFFL0230N

Specification

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

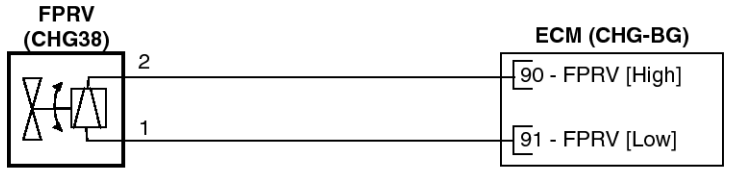
Signal Waveform



SYFFL0422N

Circuit Diagram

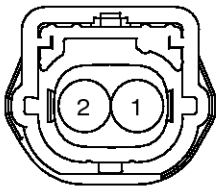
[Circuit Diagram]



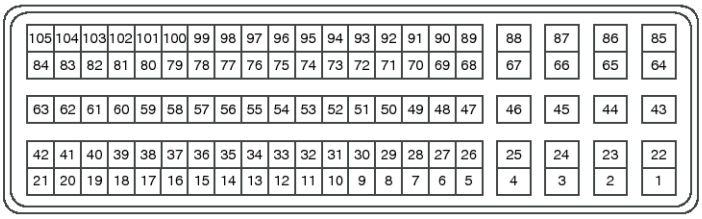
[Connection Information]

Terminal	Connected to	Function
1	ECM CHG-BG (91)	FPRV [Low]
2	ECM CHG-BG (90)	FPRV [High]

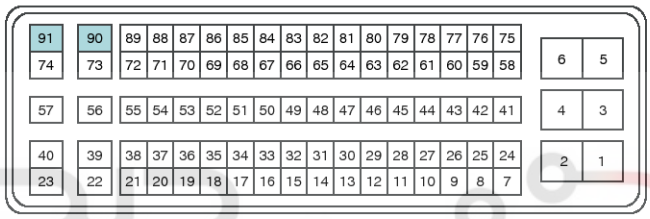
[Harness Connector]



CHG38
FPRV



CHG-AG



CHG-BG
ECM

SYFFL0423N

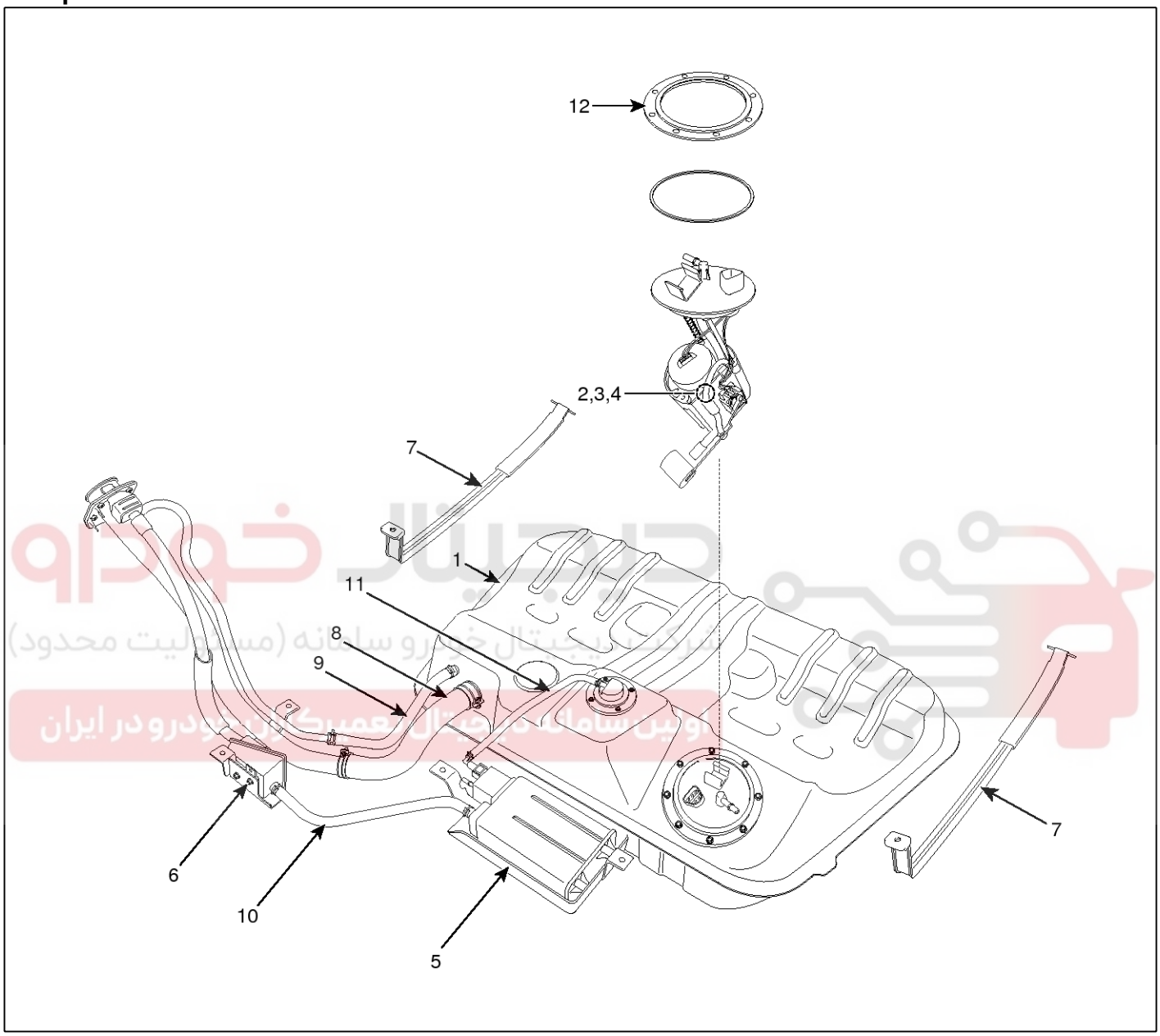
Inspection

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 Delivery System

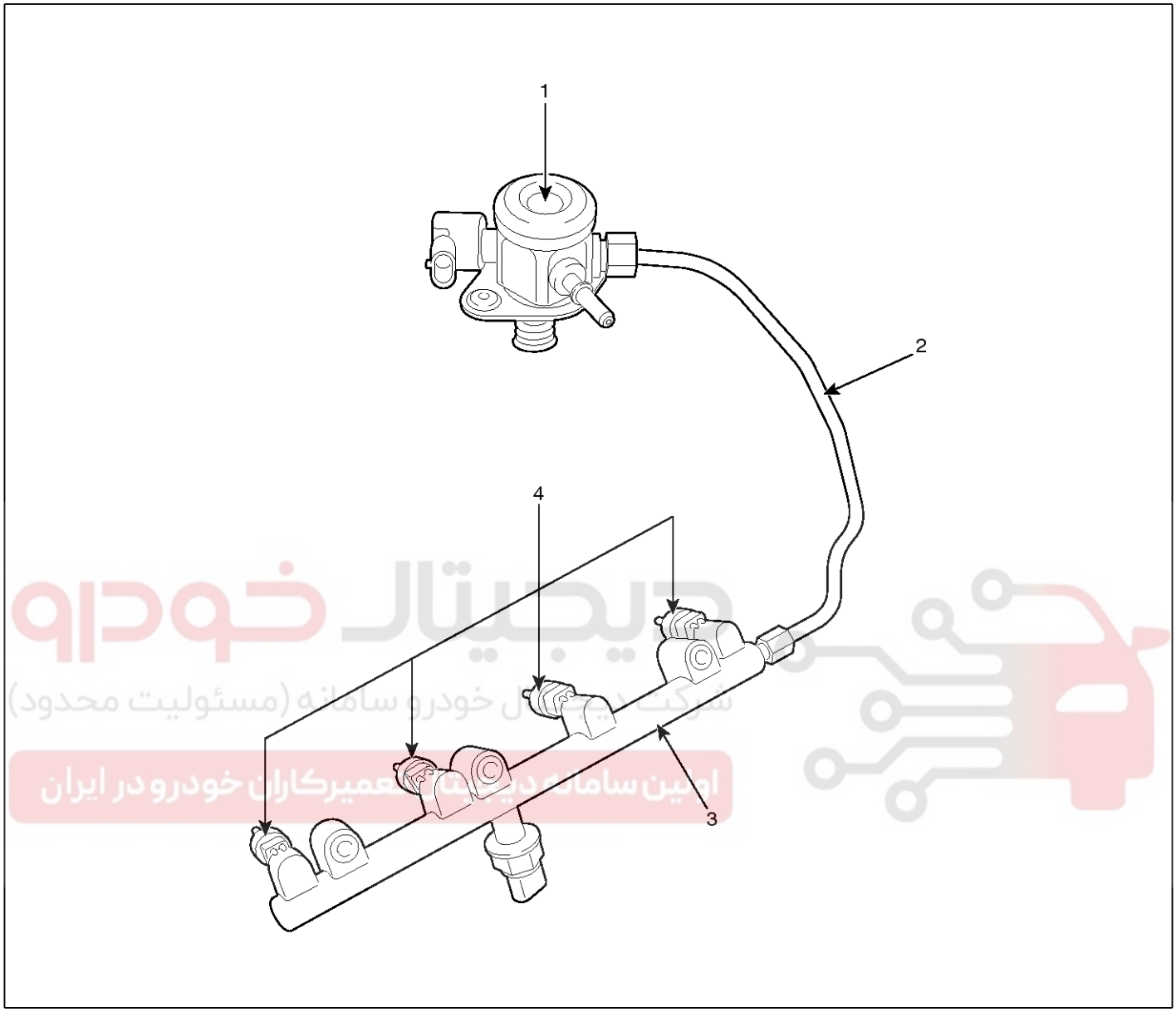
Components Location



SYFFL0122L

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

[High Pressure Fuel Line]



SYFFL0220N

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 Pressure Test[~2010.10.03]

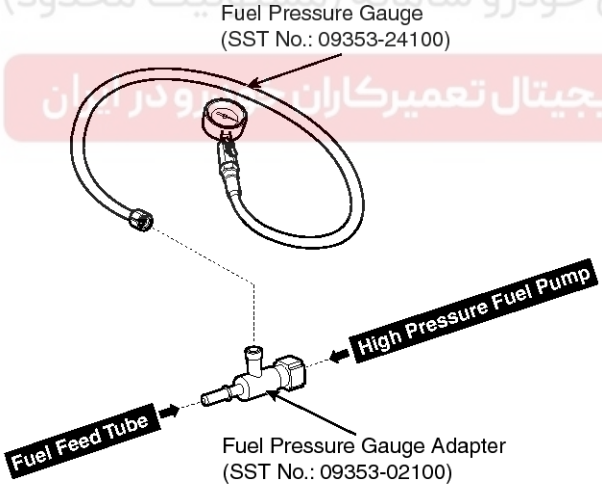
1. Release the residual pressure in fuel line (Refer to "Release Residual Pressure in Fuel Line" in this group).

   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 high pressure fuel pump.

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

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



SYFFL0144N

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

Fuel Pressure:
430 ~ 470 kPa (4.3 ~ 4.7 kgf/㎠, 62.3 ~ 68.2 psi)

NOTICE
If the fuel pressure differs from the standard value, repair or replace the related part (Refer to the table below).

Fuel Pressure	Cause	Related Part
Too Low	Fuel filter clogged	Fuel Filter
	Fuel leakage	Fuel Pressure Regulator
Too High	Fuel pressure regulator stuck	Fuel Pressure Regulator

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

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

NOTICE
If the gauge reading should not be held, repair or replace the related part (Refer to the table below).

Fuel Pressure (After Engine Stops)	Cause	Related Part
Fuel Pressure Drops Slowly	Leakage on injector	Injector
Fuel Pressure Drops Immediately	Check valve of fuel pump stuck open	Fuel Pump

   3) Turn the ignition switch OFF.
5. Release the residual pressure in fuel line (Refer to "Release Residual Pressure in Fuel Line").

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

6. Test End
   1) Remove the Special Service Tool (SST) from the fuel feed tube and the high pressure fuel pump.
   2) Connect the fuel feed tube and the high pressure fuel pump.

Fuel Pressure Test[2010.10.04~]

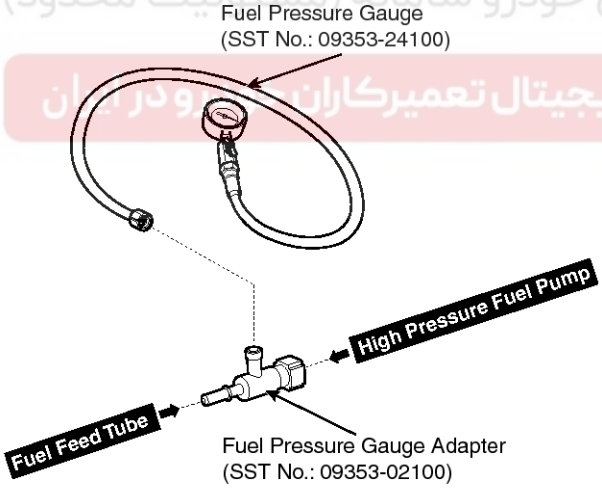
1. Release the residual pressure in fuel line (Refer to "Release Residual Pressure in Fuel Line" in this group).

   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 high pressure fuel pump.

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

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



SYFFL0144N

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

Fuel Pressure:
480 ~ 520 kPa (4.9 ~ 5.3 kgf/㎠, 69.6 ~ 75.4 psi)

NOTICE
If the fuel pressure differs from the standard value, repair or replace the related part (Refer to the table below).

Fuel Pressure	Cause	Related Part
Too Low	Fuel filter clogged	Fuel Filter
	Fuel leakage	Fuel Pressure Regulator
Too High	Fuel pressure regulator stuck	Fuel Pressure Regulator

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

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

NOTICE
If the gauge reading should not be held, repair or replace the related part (Refer to the table below).

Fuel Pressure (After Engine Stops)	Cause	Related Part
Fuel Pressure Drops Slowly	Leakage on injector	Injector
Fuel Pressure Drops Immediately	Check valve of fuel pump stuck open	Fuel Pump

   3) Turn the ignition switch OFF.
5. Release the residual pressure in fuel line (Refer to "Release Residual Pressure in Fuel Line").

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

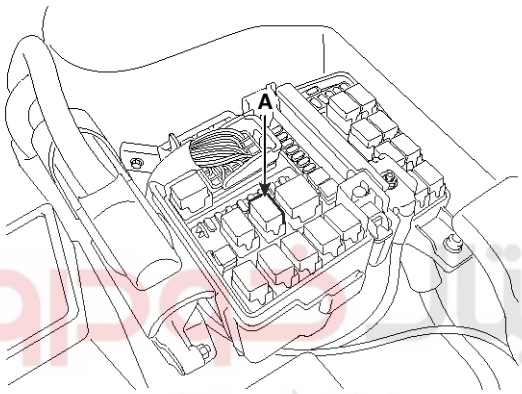
6. Test End
   1) Remove the Special Service Tool (SST) from the fuel feed tube and the high pressure fuel pump.
   2) Connect the fuel feed tube and the high pressure fuel pump.

Release Residual Pressure in Fuel Line

⚠CAUTION

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.

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



SYFFL0181D

⚠CAUTION

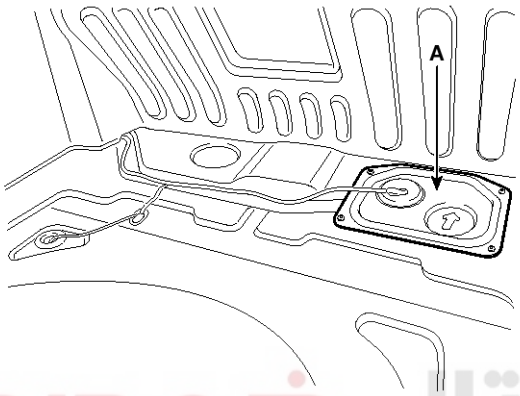
When removing the fuel pump relay, a Diagnostic Trouble Code (DTC) may occur. Delete the code with the GDS after completion of "Release Residual Pressure in Fuel Line" work.

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 Tank

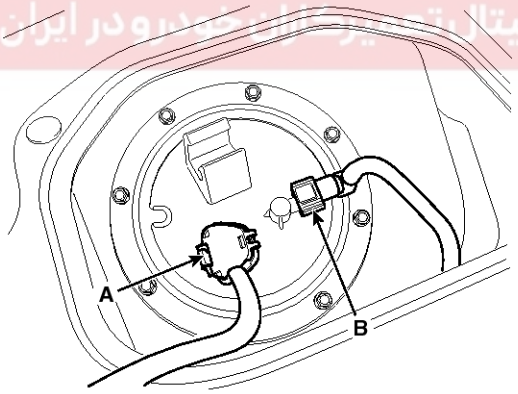
Removal

1. Release the residual pressure in fuel line (Refer to “Release Residual Pressure in Fuel Line” in this group).
2. Open the trunk and remove the floor mat.
3. Remove the fuel pump service cover (A).



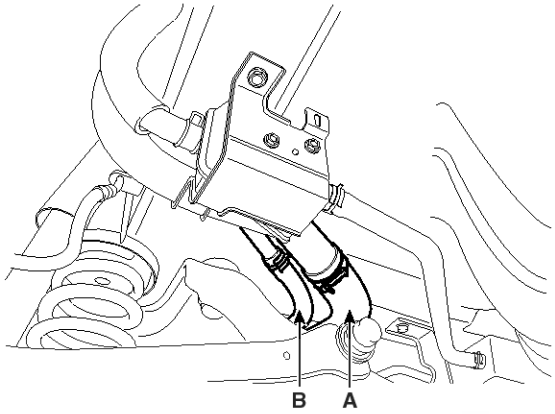
SYFFL0220D

4. Disconnect the fuel pump connector (A).
5. Disconnect the fuel feed tube quick connector (B).



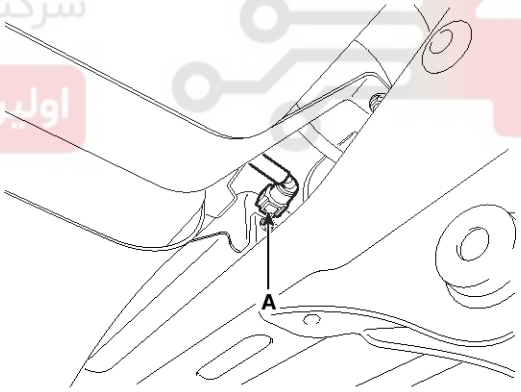
SYFFL0100L

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



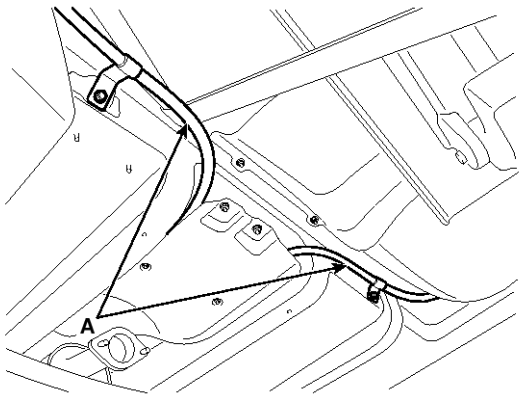
SYFFL0142L

9. Disconnect the vapor hose quick-connector (A).



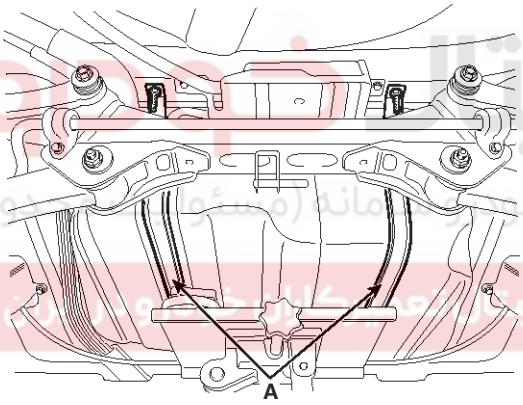
SYFFL0110L

10. Remove the brake line bracket (A).



SYFFL0120L

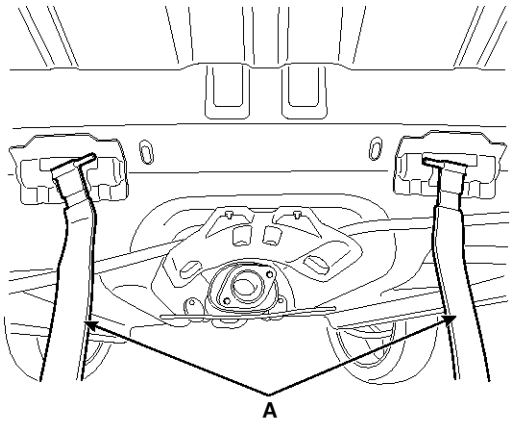
11. Remove the fuel tank from the vehicle after removing the fuel tank band (A).



SYFFL0130L

NOTICE

Remove the fuel tank band as below.



SYFFL0260D

Installation

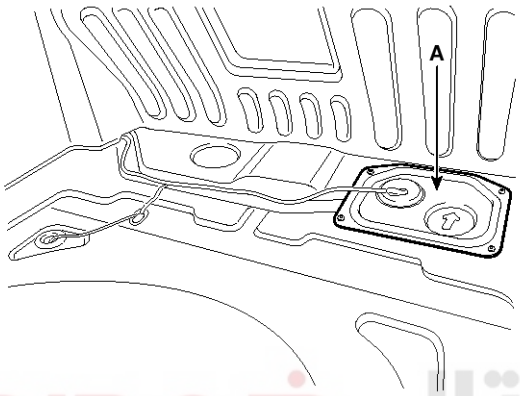
1. Installation is reverse of removal.

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

Fuel Pump

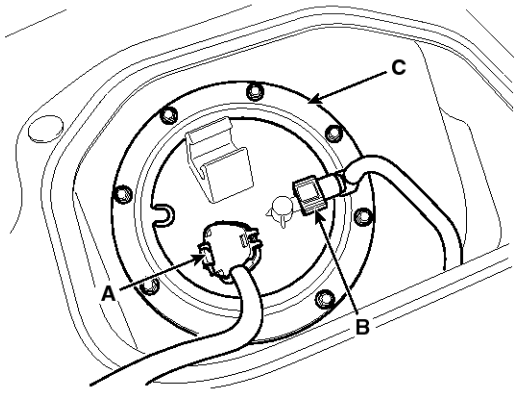
Removal

1. Release the residual pressure in fuel line (Refer to “Release Residual Pressure in Fuel Line” in this group).
2. Open the trunk and remove the floor mat.
3. Remove the fuel pump service cover (A).

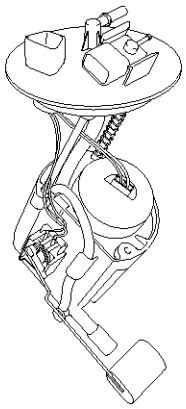


SYFFL0220D

4. Disconnect the fuel pump connector (A).
5. Disconnect the fuel feed tube quick connector (B).
6. Remove the plate cover (C) after removing the installation bolt, and then remove the fuel pump from the fuel tank.



SYFFL0101L



SYFFL0123D

Installation

1. Installation is reverse of removal.

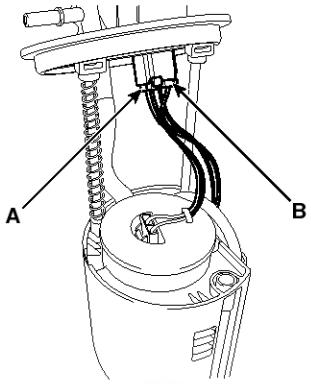
Fuel pump plate cover installation bolt:
2.0 ~ 2.9 N.m (0.2 ~ 0.3 kgf.m, 1.4 ~ 2.2 lb-ft)

⚠CAUTION
Be careful of fuel pump direction when installing (Refer to the groove in the fuel tank).

Fuel Filter

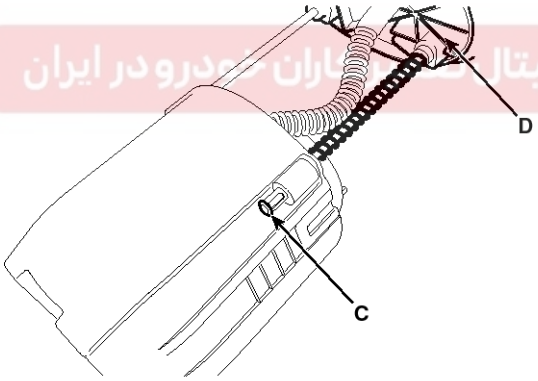
Replacement

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).



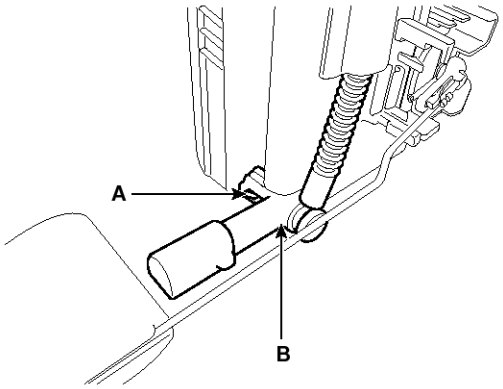
SYFFL0280D

3. Remove the cushion pipe fixing clip (C), and then separate the head assembly (D).



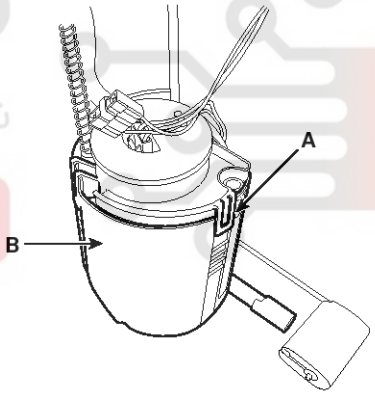
SYFFL0290D

4. Remove the return nozzle (B) after releasing the fixing hook (A).



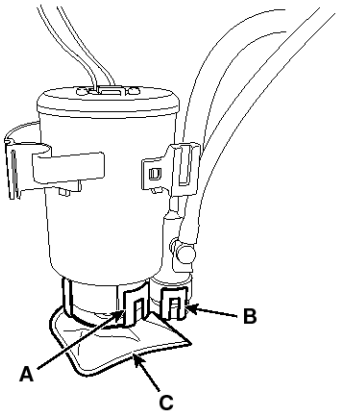
SYFFL0310D

5. Remove the reservoir-cup (B) after releasing the fixing hooks (A).



SYFFL0300D

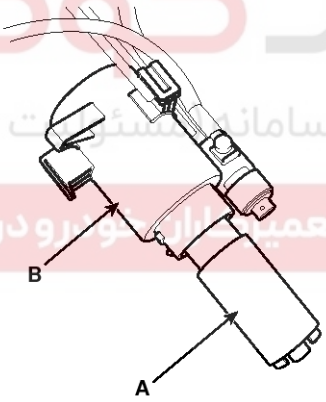
6. Remove the pre-filter (C) after releasing the fixing hooks (A,B).



SYFFL0320D

⚠CAUTION
Be careful of O-ring.

7. Separate the electric pump motor (A) from the fuel filter (B).



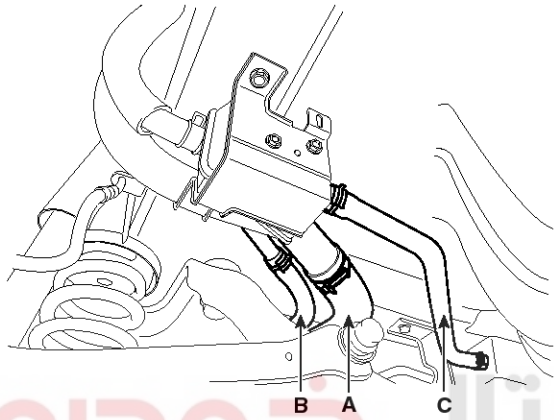
SYFFL0330D

8. Replace new fuel filter.

Filler-Neck Assembly

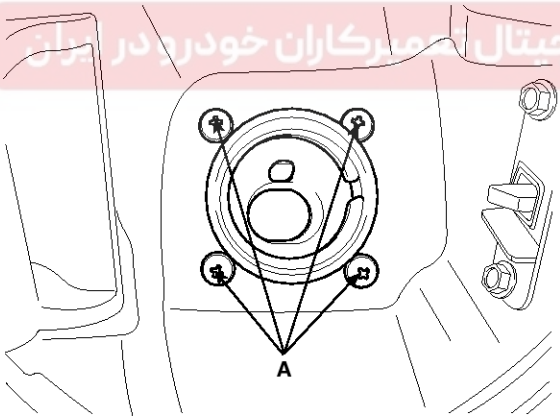
Removal

1. Lift the vehicle.
2. Disconnect the fuel filler hose (A) and the leveling hose (B).
3. Disconnect the ventilation hose (C) from the fuel tank air filter.



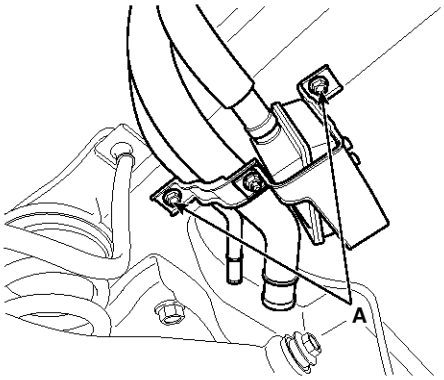
SYFFL0141L

4. Open the fuel filler door and then remove the filler-neck installation screw (A).



SYFFL0024D

5. Remove the rear-LH wheel, tire, and the inner wheel house.
6. Remove the filler-neck assembly from the vehicle after removing the bracket installation bolt (A).



SYFFL0270D

Installation

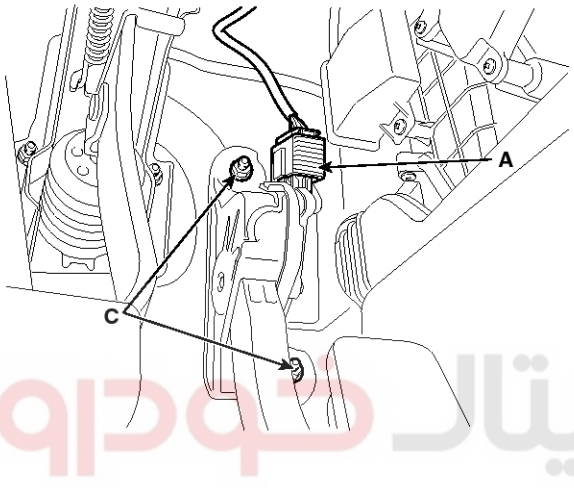
1. Installation is reverse of removal.

Filler-neck assembly bracket installation bolt :
3.9 ~ 5.9 N.m (0.4 ~ 0.6 kgf.m, 2.9 ~ 4.3 lb-ft)

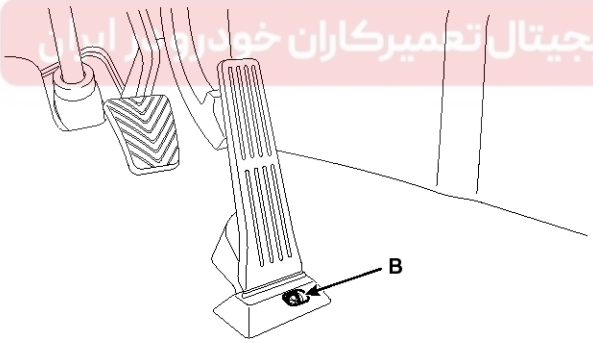
Accelerator Pedal

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.



SXMF19191D



SXMF19192D

Installation

1. Installation is reverse of removal.

Accelerator pedal module installation bolt:
8.8 ~ 13.7 N.m (0.9 ~ 1.4 kgf.m, 6.5 ~ 10.1 lb-ft)
Accelerator pedal module installation nut:
9.8 ~ 14.7 N.m (1.0 ~ 1.5 kgf.m, 7.2 ~ 10.9 lb-ft)

Delivery Pipe

Removal

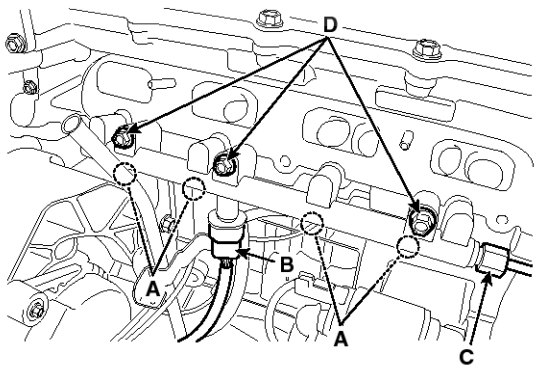
WARNING

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.

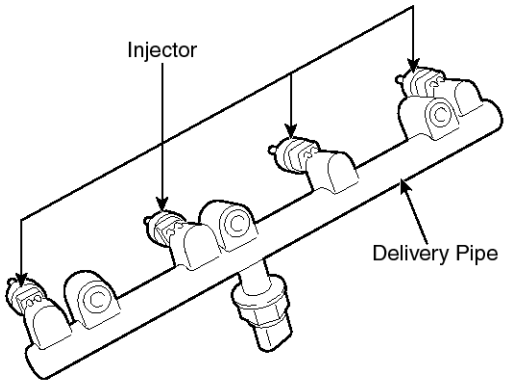
1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Release the residual pressure in fuel line (Refer to "Release Residual Pressure in Fuel Line" in this group).

   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 installation bolt (D), and then remove the delivery pipe and injector assembly from the engine.



SYFFL0092N



SYFFL0221N

Installation

CAUTION

- **Do not use already used injector fixing clip again.**

CAUTION

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

CAUTION

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

CAUTION

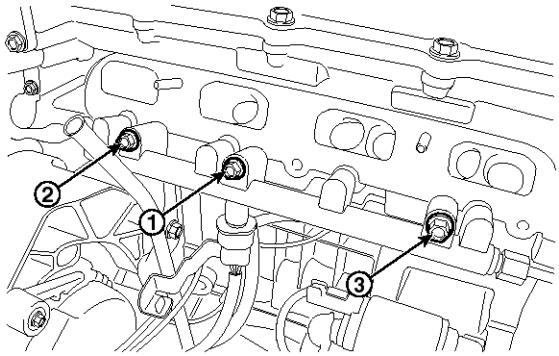
- **Do not use already used bolt again.**

CAUTION

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

CAUTION

- **When tightening the delivery pipe installation bolts, tighten them in accordance with the order (① → ② → ③) after tightening with hand-screwed torque.**



SYFFL0093N

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)

High Pressure Fuel Pump

Removal

WARNING

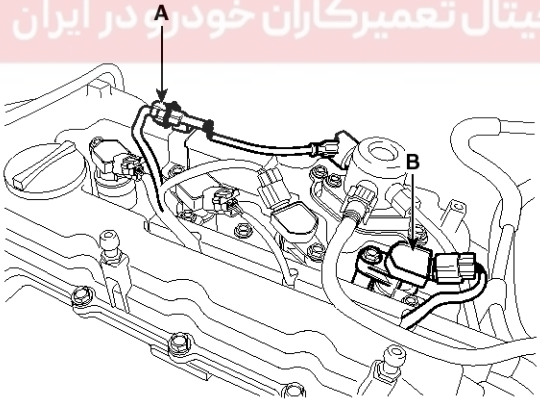
In case of removing the high pressure fuel pump, high pressure fuel pipe, delivery pipe, and injector, there may be injury caused by leakage of the high pressure fuel. So don't do any repair work right after engine stops.

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

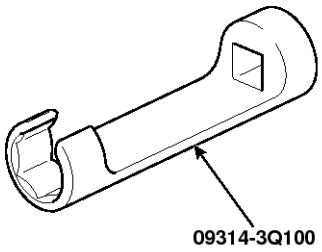
   When removing the fuel pump relay, a Diagnostic Trouble Code (DTC) may occur.

   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. Remove the ignition coil (B).



SYFFL0051N

6. Disconnect the fuel feed tube quick-connector (A).
7. Remove the high pressure fuel pipe.
   1) Remove the installation nut (B) from the high pressure fuel pump with the special service tool [SST No.: 09314-3Q100]

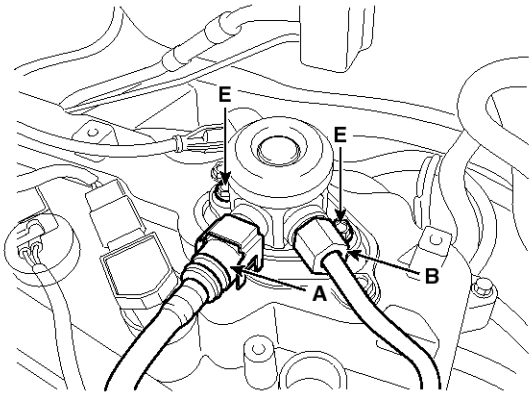


SYFFL0309N

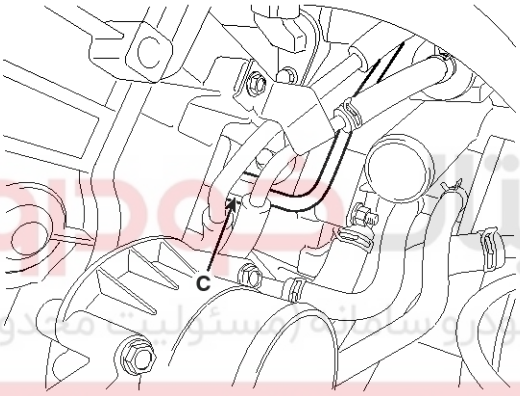
   2) Remove the installation nut (C) from the delivery pipe with the special service tool [SST No.: 09314-3Q100]
   3) Remove the purge control solenoid valve (Refer to "Purge Control Solenoid Valve" in this group).
   4) Remove the function block (D), and then remove the high pressure fuel pipe.
8. Remove the installation bolts (E), and then remove the high pressure fuel pump from the cylinder head assembly.

   CAUTION

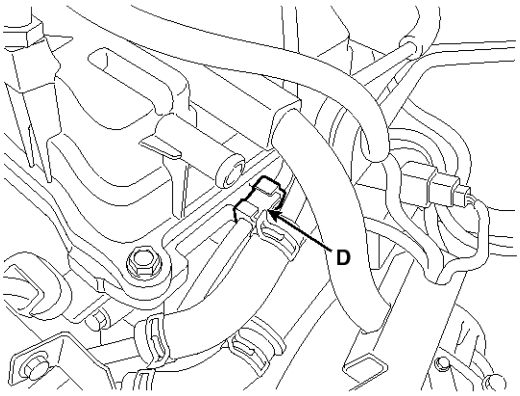
   Unscrew in turn the two bolts in small step (0.5 turns). In case of fully unscrewing one of the two bolts with the other bolt installed, the housing surface of the cylinder head may be broken because of tension of the pump spring.



SYFFL0240N



SYFFL0250N



SYFFL0260N

Installation

CAUTION
- **Before installing the high pressure fuel pump, position the roller tappet in the lowest position by rotating the crankshaft. Otherwise the installation bolts may be broken because of tension of the pump spring.**

CAUTION
- **Do not reuse the used bolt.**

CAUTION
- **Do not reuse the used high pressure fuel pipe.**

CAUTION
- **When tightening the installation bolts of the high pressure fuel pump, tighten in turn the bolts in small step (0.5 turns) after tightening them with hand-screwed torque.**

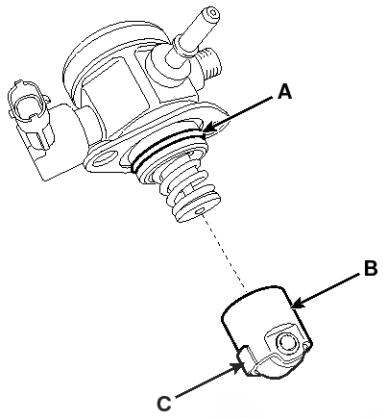
CAUTION
- **Install the component with the specified torques.**
- **First hand-tighten the fasteners fully until they are not fastened any more in order to have them inserted in place and then completely tighten to the specified torque using a torque wrench.**

  If not tightening the bolts or nuts in a straight line with the mating bolt holes or fittings, it may cause a fuel leak due to broken threads.

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

CAUTION

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

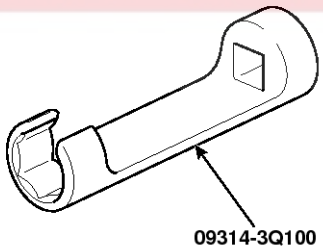


SYFFL0231N

1. Installation is reverse of removal.

NOTICE

Use the special service tool [SST No.: 09314-3Q100] to install the high pressure fuel pipe.



SYFFL0309N

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