General Information

Specification

Fuel Delivery Systemsensor circuits

Items	Specification	
Fuel Injection System	Type	Common Rail Direct Injection (CRDI)
Fuel Return System	Type	Return type
Fuel Pressure	Max. Pressure	1,600 bar
Fuel Tank	Capacity	78 lit. (20.6 U.S.gal., 17.2 Imp.gal.)
Fuel Filter	Type	High pressure type (Built in engine room)
High Pressure Fuel Pump	Type	Mechanical, Plunger Pumping Type
	Driven by	Timing chain
Low Pressure Fuel Pump	Type	Electrical, in-tank type
	Driven by	Electric motor

Sensors

Mass Air Flow Sensor (MAFS)

▷ Type: Hot-Film Type

▷ Specification

* At intake air temperature = 20℃(68˚F)

Air Flow (kg/h)	Frequency (kHz)
8.0	1.94 ~ 1.96
10.0	1.98 ~ 1.99
15.0	2.06 ~ 2.07
75.0	2.72 ~ 2.75
160.0	3.36 ~ 3.41
310.0	4.44 ~ 4.53
640.0	7.66 ~ 8.01
800.0	10.13 ~ 11.17

* At intake air temperature = -15℃(5˚F) or 80℃(176˚F)

Air Flow (kg/h)	Frequency (kHz)
10.0	1.97 ~ 1.99
75.0	2.71 ~ 2.76
160.0	3.34 ~ 3.43
310.0	4.39 ~ 4.58

Intake Air Temperature Sensor (IATS) #1 [Built In MAFS]

▷ Type: Thermistor type

▷ Specification

Temperature [℃(˚F)]	Resistance(kΩ)
-40(-40)	35.14 ~ 43.76
-20(-4)	12.66 ~ 15.12
0(32)	5.12 ~ 5.89
20(68)	2.29 ~ 2.55
40(104)	1.10 ~ 1.24
60(140)	0.57 ~ 0.65
80(176)	0.31 ~ 0.37

Boost Pressure Sensor (BPS)

▷ Type: Piezo-resistive pressure sensor type

▷ Specification

Pressure (kPa)	Output Voltage (V)
32.5	0.5
70.0	1.02 ~ 1.17
140.0	2.13 ~ 2.28
210.0	3.25 ~ 3.40
270.0	4.20 ~ 4.35
284.0	4.5

Intake Air Temperature Sensor (IATS) #2 [Built In BPS]

▷ Type: Thermistor type

▷ Specification

Temperature [℃(˚F)]	Resistance(kΩ)
-40(-40)	40.93 ~ 48.35
-20(-4)	13.89 ~ 16.03
0(32)	5.38 ~ 6.09
20(68)	2.31 ~ 2.57
40(104)	1.08 ~ 1.21
60(140)	0.54 ~ 0.62
80(176)	0.29 ~ 0.34

Engine Coolant Temperature Sensor (ECTS)

▷ Type: Thermistor type

▷ Specification

Temperature [℃(˚F)]	Resistance(kΩ)
-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

Camshaft Position Sensor (CMPS)

▷ Type: Hall effect type

▷ Specification

Level	Output Pulse (V)
High	5
Low	0

Item	Specification
Air Gap (mm)	0.5 ~ 1.5

Crankshaft Position Sensor (CKPS)

▷ Type: Magnetic field sensitive type

▷ Specification

Items	Specification
Coil Resistance (Ω)	774 ~ 946 [20℃(68˚F)]
Air Gap (mm)	0.5 ~ 1.5

Rail Pressure Sensor (RPS)

▷ Type: Piezo-resistive pressure sensor type

▷ Specification

Condition	Rail pressure (bar)	Output Voltage (V)
Idle	200 ~ 300	0.9 ~ 1.2
3,000 rpm	450 ~ 650	1.5 ~ 1.9

Fuel Temperature Sensor (FTS)

▷ Type: Thermistor type

▷ Specification

Temperature [℃(˚F)]	Resistance(kΩ)
-10(14)	8.64 ~ 10.15
20(68)	2.35 ~ 2.65
80(176)	0.31 ~ 0.33
120(248)	0.11 ~ 0.12

Lambda Sensor

▷ Type: Zirconia (ZrO2) Type

▷ Specification

[Pumping Current]

λ Value (A/F Ratio)	Pumping Current (A)
0.65	-2.2
0.7	-1.8
0.8	-1.1
0.9	-0.5
1.01	0
1.18	0.33
1.43	0.67
1.7	0.94
2.42	1.38
Air (Atmosphere)	2.54

[Heater Resistance]

Temperature [℃(˚F)]	Heater Resistance (Ω)
20(68)	2.4 ~ 4.0

Accelerator Position Sensor (APS)

▷ Type: Potentiometer type

▷ Specification

Pedal Position	Output Voltage(V) [Vref = 5.0V]	
	APS1	APS2
Released	0.7 ~ 0.8	0.275 ~ 0.475
Fully depressed	3.8 ~ 4.4	1.75 ~ 2.35

Exhaust Gas Temperature Sensor (EGTS) #1 For VGT [With CPF]

▷ Type: Thermistor type

▷ Specification

Temperature [℃(˚F)]	Resistance(kΩ)
100(212)	289.0 ~ 481.0
300(572)	5.30 ~ 6.61
600(1,112)	0.35 ~ 0.38
900(1,652)	0.08 ~ 0.09

Exhaust Gas Temperature Sensor (EGTS) #2 For CPF [With CPF]

▷ Type: Thermistor type

▷ Specification

Temperature [℃(˚F)]	Resistance(kΩ)
100(212)	289.0 ~ 481.0
300(572)	5.30 ~ 6.61
600(1,112)	0.35 ~ 0.38
900(1,652)	0.08 ~ 0.09

Differential Pressure Sensor (DPS) [With CPF]

▷ Type: Piezo-electricity type

▷ Specification: Vout = (4.5 - 1.0) / 100 * △P + 1.0 (V)

Differential Pressure [△P] (kPa)	Output Voltage (V)
0	1
10	1.35
20	1.7
30	2.05
40	2.4
50	2.75
60	3.1
70	3.45
80	3.8
90	4.15
100	4.5

Water Sensor

▷ Specification

Item	Specification
Warning Level (cc)	53 ~ 63

Actuators

Injector

▷ Number: 6

▷ Type: Piezo injector

▷ Specification

Items	Specification
Component Resistance(kΩ)	150 ~ 250 [20℃(68˚F)]
Operating Voltage (V)	100 ~ 200

Fuel Pressure Regulator Valve

▷ Specification

Item	Specification
Coil Resistance (Ω)	2.9 ~ 3.15Ω [20℃(68˚F)]

Rail Pressure Regulator Valve

▷ Specification

Items	Specification
Coil Resistance (Ω)	3.42 ~ 3.78Ω [20℃(68˚F)]
Operating Current (A)	0 ~ 1.7

Electric EGR Control Valve

▷ Type: Linear solenoid type

▷ Specification

Item	Specification
Coil Resistance (Ω)	7.3 ~ 8.3Ω [20℃(68˚F)]

Throttle Control Actuator [With CPF]

▷ Type: Duty control motor type

▷ Specification

Duty (%)	Throttel Valve Position
5	Open
5 ~ 94	Normal operation (Partialy open in proportion to duty value)
94	Closed
94 ~ 95	Maintaining the last valid position
95 ~ 97	Fully closed

Variable Swirl Control Actuator

▷ Type: Motor driven (including Position Sensor)

▷ Specification

[Motor]

Item	Specification
Coil Resistance (Ω)	3.4 ~ 4.4Ω [20℃(68˚F)]

[Position Sensor]

Item	Specification
Coil Resistance (Ω)	3.44 ~ 5.16kΩ [20℃(68˚F)]

Electric VGT Control Actuator

▷ Type: DC motor driven

Service Standard

Items	Specification		
Basic Idle rpm (After warm up)	A/CON OFF	Neutral,N,P-range	720 ± 100rpm
		D-range	720 ± 100rpm
	A/CON ON	Neutral,N,P-range	720 ± 100rpm
		D-range	720 ± 100rpm

Tightening Torques

Engine Control System

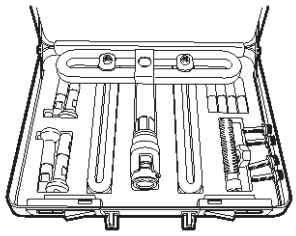
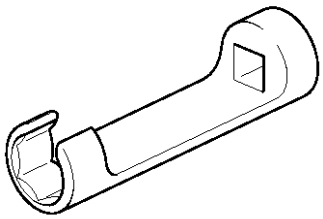
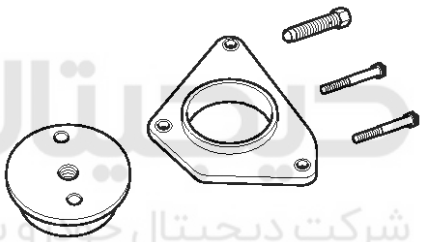
Item	Kgf.m	N.m	lb-ft
ECM installation bolts	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7
ECM bracket installation bolts/nuts	0.4 ~ 0.6	3.9 ~ 5.9	2.9 ~ 4.3
Mass air flow sensor clamp installation screw	0.3 ~ 0.5	2.9 ~ 4.9	2.2 ~ 3.6
Mass air flow sensor installation bolts	0.4 ~ 0.6	3.9 ~ 5.9	2.9 ~ 4.3
Boost pressure sensor installation bolts	0.7 ~ 1.1	6.9 ~ 10.8	5.1 ~ 8.0
Engine coolant temperature sensor installation	4.0 ~ 5.5	39.2 ~ 54.0	28.9 ~ 39.8
Camshaft position 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
Lambda sensor installation	4.0 ~ 6.0	39.2 ~ 58.9	28.9 ~ 43.4
Exhaust gas temperature sensor (For CPF) installation	4.0 ~ 5.0	39.2 ~ 49.1	28.9 ~ 36.2
Exhaust gas temperature sensor (For VGT) installation	4.0 ~ 5.0	39.2 ~ 49.1	28.9 ~ 36.2
Differential pressure sensor bracket installation bolt	0.4 ~ 0.6	3.9 ~ 5.9	2.9 ~ 4.3
Throttle control actuator [With CPF] installation nuts	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Electric EGR control valve installation bolts (Valve ↔ EGR Cooler)	2.0 ~ 2.7	19.6 ~ 26.5	14.5 ~ 19.5
Electric EGR control valve installation nuts (Valve ↔ EGR Pipe)	3.0 ~ 3.5	29.4 ~ 34.3	21.7 ~ 25.3
Variable swirl control actuator installation bolts	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Variable swirl control actuator bracket installation bolts	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Glow control module installation bolts	0.7 ~ 1.1	6.9 ~ 10.8	5.1 ~ 8.0
Glow plug installation	0.8 ~ 1.1	7.8 ~ 10.8	5.8 ~ 8.0

Fuel Delivery System

Item	Kgf.m	N.m	lb-ft
Fuel tank band installation nuts	4.0 ~ 5.5	39.2 ~ 54.0	28.9 ~ 39.8
Accelerator pedal module installation nuts	0.9 ~ 1.4	8.8 ~ 13.7	6.5 ~ 10.1
Fuel pump installation bolts	0.2 ~ 0.3	2.0 ~ 2.9	1.4 ~ 2.2
Sub fuel sender installation bolts	0.2 ~ 0.3	2.0 ~ 2.9	1.4 ~ 2.2
Injector clamp installation bolt	2.5 ~ 2.7	24.5 ~ 26.5	18.1 ~ 19.5

Item	Kgf.m	N.m	lb-ft
High pressure fuel pump installation bolts	2.5 ~ 3.5	24.5 ~ 34.3	18.1 ~ 25.3
Common rail [Bank 1] installation bolts	2.0 ~ 2.7	19.6 ~ 26.5	14.5 ~ 19.5
Common rail [Bank 2] installation bolts	2.0 ~ 2.7	19.6 ~ 26.5	14.5 ~ 19.5
High pressure fuel pipe installation nut (High pressure fuel pump ↔ Common Rail)	2.5 ~ 2.9	24.5 ~ 28.4	18.1 ~ 21.0
High pressure fuel pipe installation nut (Common Rail ↔ Injector)	2.5 ~ 2.9	24.5 ~ 28.4	18.1 ~ 21.0
High pressure fuel pipe installation nut (Common Rail [Bank 1] ↔ Common Rail [Bank 2])	2.5 ~ 2.9	24.5 ~ 28.4	18.1 ~ 21.0
High pressure fuel pipe clamp installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7

Special Service Tools

Tool (Number and name)	Illustration	Application
09351-4A300 Injector Remover		Removing the injector
09314-3A000 Torque Wrench Socket (17mm)		Installing the high pressure fuel pipe
09331-3A000 High Pressure Fuel Pump Remover		Removing the high pressure fuel pump

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 Hi-Scan (Pro) 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**

LW8F1001

Customer Problem Analysis Sheet

1. VEHICLEINFORMAITON

VIN No.		Transmission	☐ M/T ☐ A/T ☐CVT ☐ etc.
Production date		Driving type	☐ 2WD (FF) ☐ 2WD (FR) ☐ 4WD
Odometer Reading	_____km/mile		

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	

SCMFL6150L

Basic Inspection Procedure

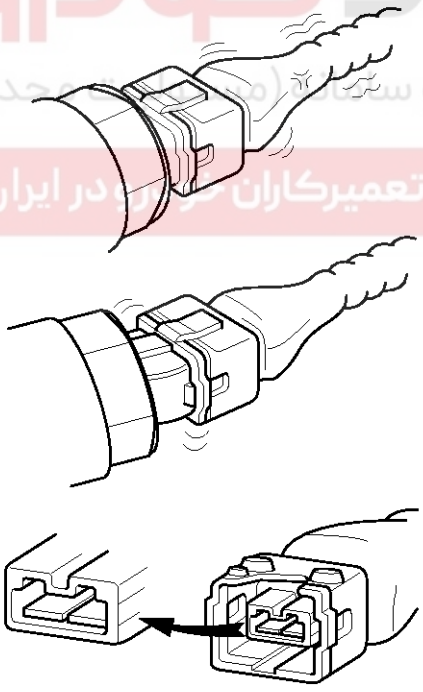
The measured resistance at high temperature after vehicle running may be high or low. So all resistance must be measured at ambient temperature (20℃, 68°F), unless stated otherwise.

NOTICE

The measured resistance in except for ambient temperature (20℃, 68°F) is reference value.

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.



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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

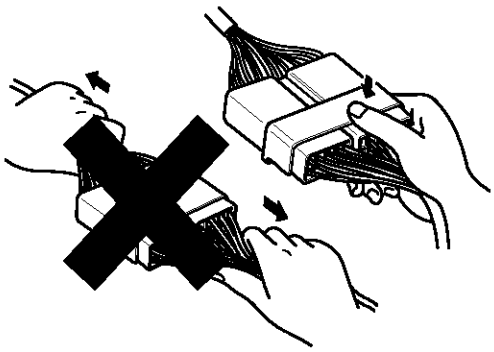
DO NOT sprinkle water directly into the engine compartment or electronic components.

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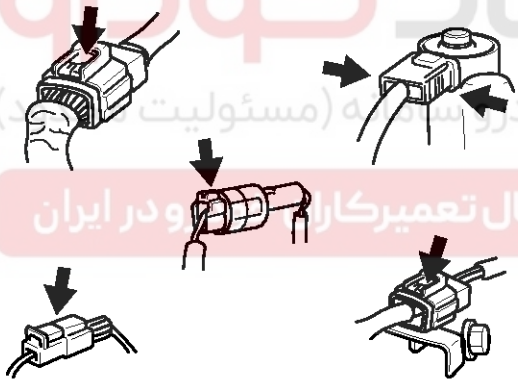
   b. When removing the connector with a lock, press or pull locking lever.



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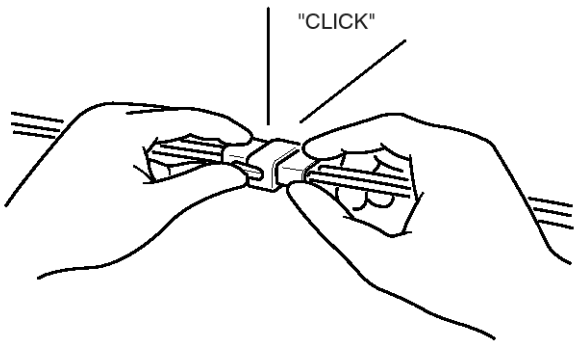
   c. Listen for a click when locking connectors. This sound indicates that they are securely locked.



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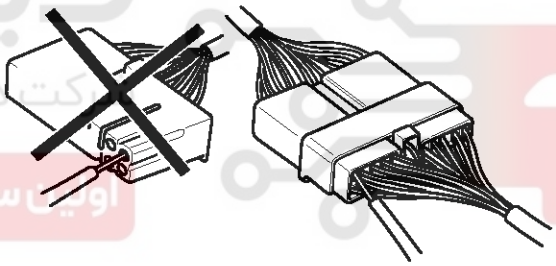
   d. When a tester is used to check for continuity, or to measure voltage, always insert tester probe from wire harness side.



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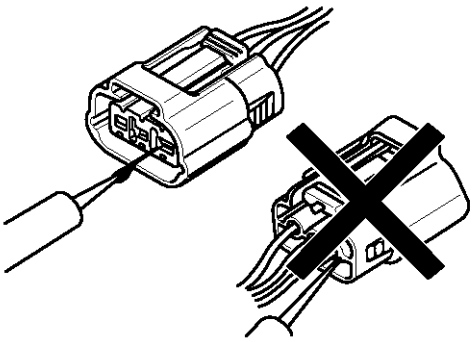
e. Check waterproof connector terminals from the connector side. Waterproof connectors cannot be accessed from harness side.



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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

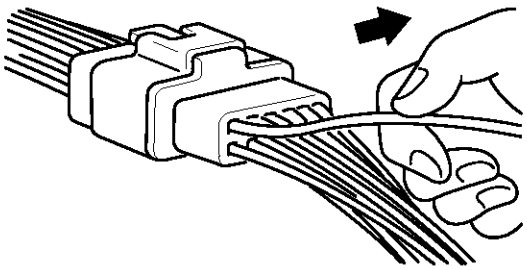
a. While the connector is connected:
Hold the connector, check connecting condition and locking efficiency.

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.



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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

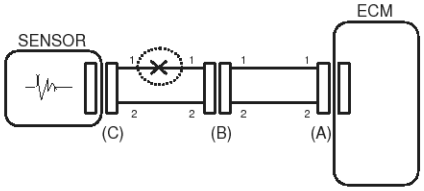
1. Before removing the wire harness, check the wire harness position and crimping in order to restore it correctly.
2. Check whether the wire harness is twisted, pulled or loosened.
3. Check whether the temperature of the wire harness is abnormally high.
4. Check whether the wire harness is rotating, 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

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



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2. Continuity Check Method

   NOTICE

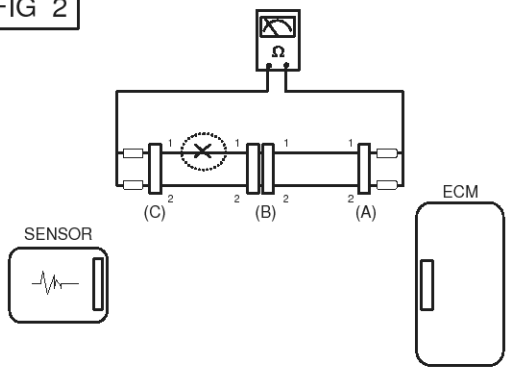
   When measuring for resistance, lightly shake the wire harness above and below or from side to side.

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

   a. Disconnect connectors (A), (C) and measure resistance between connector (A) and (C) as shown in [FIG. 2].

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

FIG 2



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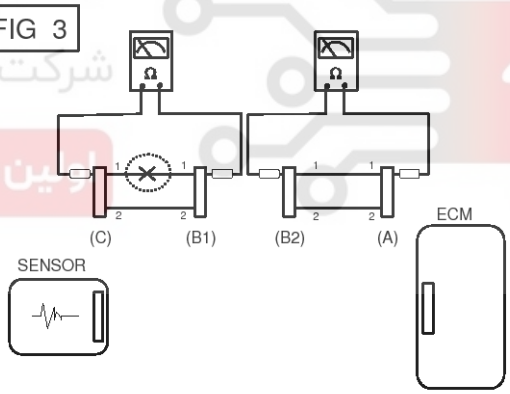
   b. Disconnect connector (B), and measure for resistance between connector (C) and (B1) and between (B2) and (A) as shown in [FIG. 3].

      In this case the measured resistance between connector (C) and (B1) is higher than 1MΩ and the open circuit is between terminal 1 of connector (C) and terminal 1 of connector (B1).

FIG 3



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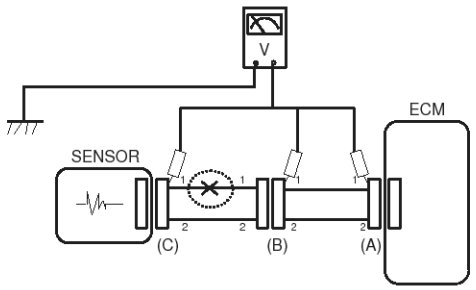
3. Voltage Check Method

   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



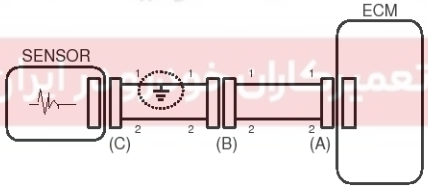
BFGE501D

● 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

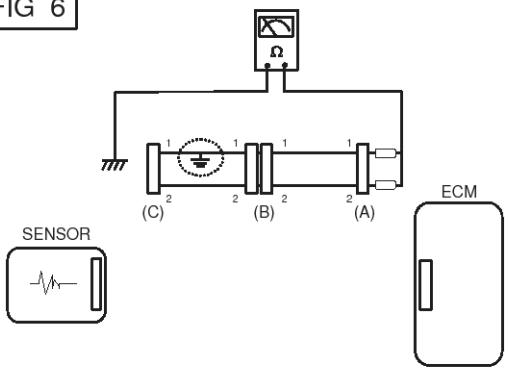
   Lightly shake the wire harness above and below, or from side to side when measuring the resistance.

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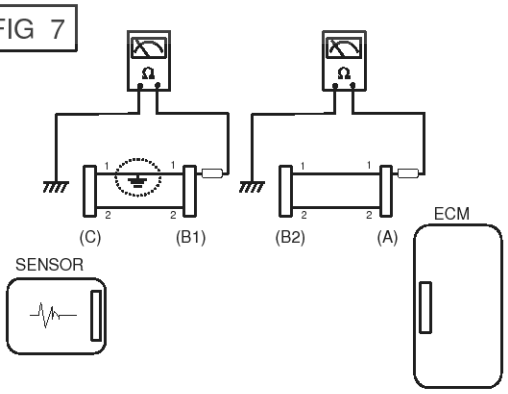
b. Disconnect connector (B), and measure the resistance between connector (A) and chassis ground, and between (B1) and chassis ground as shown in [FIG. 7].

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

Symptom Troubleshooting Guide Table

(Symptom 1) Engine Does Not Start

Possible Cause	
• Run out of fuel • Faulty starter • Not connected fuel feed line • Leakage in high pressure fuel circuit • Fuse out of order • Drift of the rail pressure sensor • Cam and crank signals missing simultaneously • Low battery voltage • Faulty immobilizer • Fuel pressure regulator valve contaminated, stuck, jammed • Rail pressure regulator valve contaminated, stuck, jammed • Bad fuel quality or water ingress in fuel	• Inversion of fuel connections (feed & return) • Faulty fuel filter • Clogged low pressure fuel circuit • Clogged fuel filter • Intermittent faulty fuel line connection • Air ingress in the low pressure fuel circuit • Clogged return line of high pressure fuel pump • Low compression pressure • Leakage at the injector • Faulty low pressure fuel pump • Faulty high pressure fuel pump • Injector jammed open • ECM program error or hardware fault • Faulty glow system

(Symptom 2) Engine Starts With Difficulty Or Starts And Stalls

Possible Cause	
• Not connected fuel return line at injector • Leakage in high pressure fuel circuit • Fuse out of order • Clogged air filter • Faulty alternator or voltage regulator • Compensation of individual injector not adapted • No engine coolant temperature sensor signal • No rail pressure sensor signal • Low battery voltage • Electric EGR control valve blocked open • Fuel pressure regulator valve contaminated, stuck, jammed • Rail pressure regulator valve contaminated, stuck, jammed • Bad fuel quality or water ingress in fuel • Inversion of fuel connections (feed & return)	• Clogged low pressure fuel circuit • Clogged fuel filter • Oil level too high or too low • Sealed or damaged catalytic converter • Intermittent faulty fuel line connection • Air ingress in the low pressure fuel circuit • Clogged return line of high pressure fuel pump • Faulty glow system • Low compression pressure • Clogged injector return line • Carbon deposit on the injector (sealed holes) • Injector needle stuck (injection possible over a certain pressure) • Gasoline in fuel • ECM program error or hardware fault

(Symptom 3) Poor Starting When Hot

Possible Cause	
• Compensation of individual injector not adapted • No rail pressure sensor signal • Electric EGR control valve blocked open • Fuel pressure regulator valve contaminated, stuck, jammed • Rail pressure regulator valve contaminated, stuck, jammed • Clogged air filter • Air ingress in the low pressure fuel circuit • Bad fuel quality or water ingress in fuel	• Clogged return line of high pressure fuel pump • Clogged fuel filter • Low compression pressure • Intermittent faulty fuel line connection • Carbon deposit on the injector (sealed holes) • Injector needle stuck (injection possible over a certain pressure) • Gasoline in fuel • ECM program error or hardware fault

(Symptom 4) Unstable Idling

Possible Cause	
• Not connected fuel return line at injector • Compensation of individual injector not adapted • No rail pressure sensor signal • Wiring harness open or poor connection • Air ingress in the low pressure fuel circuit • Bad fuel quality or water ingress in fuel • Clogged fuel filter • Clogged air filter • Clogged injector return line • Leakage in high pressure fuel circuit	• Faulty glow system • Low compression pressure • Poor tightening of injector clamp • Faulty high pressure fuel pump • Injector not adapted • Carbon deposit on the injector (sealed holes) • Injector needle stuck (injection possible over a certain pressure) • Injector jammed open • Electric EGR control valve blocked open

(Symptom 5) Idle Speed Too High Or Too Low

Possible Cause	
• No engine coolant temperature sensor signal • Incorrect state of the electrical pack devices • Faulty alternator or voltage regulator • ECM program error or hardware fault	• Electric EGR control valve blocked open • Faulty accelerator pedal (At this time, engine speed has been fixed at 1,250rpm)

(Symptom 6) Blue, White, Or Black Smokes

Possible Cause	
• Compensation of individual injector not adapted • No engine coolant temperature sensor signal • No rail pressure sensor signal • Electric EGR control valve blocked open • Fuel pressure regulator valve contaminated, stuck, jammed • Rail pressure regulator valve contaminated, stuck, jammed • Oil level too high or too low • Bad fuel quality or water ingress in fuel • Sealed or damaged catalytic converter	• Clogged air filter • Oil suction (engine racing) • Faulty glow system • Low compression pressure • Poor tightening of injector clamp • Poor injector O-ring, no O-ring or two O-ring installed • Injector not adapted • Carbon deposit on the injector (sealed holes) • Injector jammed open • Gasoline in fuel

(Symptom 7) Engine Rattling, Noisy Engine

Possible Cause	
• Compensation of individual injector not adapted • Electric EGR control valve blocked open • Electric EGR control valve blocked open • No engine coolant temperature sensor signal • Faulty glow system • Low compression pressure • Clogged injector return line • No rail pressure sensor signal	• Poor injector O-ring, no O-ring or two O-ring installed • Injector not adapted • Carbon deposit on the injector (sealed holes) • Injector needle stuck (injection possible over a certain pressure) • Injector jammed open • No engine coolant temperature sensor signal

(Symptom 8) Nurst Noise

Possible Cause	
• Compensation of individual injector not adapted • Intermittent faulty fuel line connection • Clogged exhaust system • No rail pressure sensor signal	• Fuel pressure regulator valve contaminated, stuck, jammed • Rail pressure regulator valve contaminated, stuck, jammed • ECM program error or hardware fault

(Symptom 9) Untimely Acceleration/deceleration And Engine Racing

Possible Cause	
• Blocked accelerator pedal position sensor • Electric EGR control valve blocked open • Intermittent faulty fuel line connection	• Oil suction (engine racing) • No rail pressure sensor signal • ECM program error or hardware fault

(Symptom 10) Gap When Accelerating And At Re-coupling (Response Time)

Possible Cause	
• Leakage in intake system • Incorrect state of the electrical pack devices • Blocked accelerator pedal position sensor • Electric EGR control valve blocked open • Damaged turbocharger or leakage in vacuum line • Clogged fuel filter • Low compression pressure • Leakage in high pressure fuel circuit	• Fuel pressure regulator valve contaminated, stuck, jammed • Rail pressure regulator valve contaminated, stuck, jammed • Injector needle stuck (injection possible over a certain pressure) • ECM program error or hardware fault

(Symptom 11) Engine Stop

Possible Cause	
• Run out of fuel • Not connected fuel feed line • Leakage in high pressure fuel circuit • Fuse out of order • Bad fuel quality or water ingress in fuel • Clogged low pressure fuel circuit • Clogged fuel filter • Crank signals missing • Electric EGR control valve blocked open • Fuel pressure regulator valve contaminated, stuck, jammed	• Rail pressure regulator valve contaminated, stuck, jammed • Faulty alternator or voltage regulator • Intermittent faulty fuel line connection • Sealed or damaged catalytic converter • Faulty low pressure fuel pump • Faulty high pressure fuel pump • Gasoline in fuel • ECM program error or hardware fault

(Symptom 12) Engine Judder

Possible Cause	
• Run out of fuel • Not connected fuel return line at injector • Incorrect state of the electrical pack devices • Compensation of individual injector not adapted • Electric EGR control valve blocked open • Faulty fuel filter • Air ingress in the low pressure fuel circuit • Bad fuel quality or water ingress in fuel • Clogged fuel filter • Intermittent faulty fuel line connection • Wiring harness open or poor connection • Faulty glow system	• Low compression pressure • Clogged injector return line • Poor valve clearance • Faulty low pressure fuel pump • Poor injector O-ring, no O-ring or two O-ring installed • Carbon deposit on the injector (sealed holes) • Injector needle stuck (injection possible over a certain pressure) • Injector jammed open • Gasoline in fuel • ECM program error or hardware fault

(Symptom 13) Lack Of Power

Possible Cause	
• Compensation of individual injector not adapted • Blocked accelerator pedal position sensor • Incorrect state of the electrical pack devices • Electric EGR control valve blocked open • Leakage in intake system • Clogged air filter • Oil level too high or too low • Sealed or damaged catalytic converter • Damaged turbocharger or leakage in vacuum line • Damaged turbocharger	• Clogged fuel filter • Leakage at the injector • Clogged return line of high pressure fuel pump • Clogged injector return line • Low compression pressure • Injector not adapted • Carbon deposit on the injector (sealed holes) • Poor valve clearance • Engine coolant temperature too high • Fuel temperature too high

(Symptom 14) Too Much Power

Possible Cause	
• Compensation of individual injector not adapted • Oil suction (engine racing)	• ECM program error or hardware fault

(Symptom 15) Excessive Fuel Consumption

Possible Cause	
• Not connected fuel return line at injector • Leakage at the Fuel pressure regulator valve • Leakage at fuel temperature sensor • Leakage in high pressure fuel circuit • Leakage in intake system • Clogged air filter • Compensation of individual injector not adapted • Electric EGR control valve blocked open	• Incorrect state of the electrical pack devices • Oil level too high or too low • Bad fuel quality or water ingress in fuel • Sealed or damaged catalytic converter • Damaged turbocharger • Low compression pressure • Injector not adapted • ECM program error or hardware fault

(Symptom 16) Over Speed Engine When Changing The Gear Box Ratio

Possible Cause	
• Blocked accelerator pedal position sensor • Compensation of individual injector not adapted • Intermittent faulty fuel line connection • Clutch not well set (optional)	• Oil suction (engine racing) • Damaged turbocharger • Injector not adapted • ECM program error or hardware fault

(Symptom 17) Exhaust Smells

Possible Cause	
• Leakage at electric EGR control valve • Oil suction (engine racing) • Damaged turbocharger • Oil level too high or too low • Compensation of individual injector not adapted • Sealed or damaged catalytic converter • Poor tightening of injector clamp	• Poor injector O-ring, no O-ring or two O-ring installed • Injector not adapted • Carbon deposit on the injector (sealed holes) • Injector needle stuck (injection possible over a certain pressure) • Injector jammed open • ECM program error or hardware fault

(Symptom 18) Smokes (Black, White, Blue) When Accelerating

Possible Cause	
• Compensation of individual injector not adapted • Electric EGR control valve blocked open • Clogged air filter • Bad fuel quality or water ingress in fuel • Oil level too high or too low • Damaged turbocharger • Sealed or damaged catalytic converter • Oil suction (engine racing) • Faulty air heater • Low compression pressure • Leakage in high pressure fuel circuit	• Intermittent faulty fuel line connection • Poor tightening of injector clamp • Poor injector O-ring, no O-ring or two O-ring installed • Injector not adapted • Carbon deposit on the injector (sealed holes) • Injector needle stuck (injection possible over a certain pressure) • Injector jammed open • Gasoline in fuel • ECM program error or hardware fault

(Symptom 19) Fuel Smells

Possible Cause	
• Not connected fuel feed line • Not connected fuel return line at injector • Leakage at the Fuel pressure regulator valve	• Leakage at fuel temperature sensor • Leakage in high pressure fuel circuit

(Symptom 20) The Engine Collapses At Take Off

Possible Cause	
• Blocked accelerator pedal position sensor • Incorrect state of the electrical pack devices • Clogged air filter • Inversion of fuel connections (feed & return) • Faulty fuel filter • Bad fuel quality or water ingress in fuel • Air ingress in the low pressure fuel circuit • Clogged fuel filter • Sealed or damaged catalytic converter	• Intermittent faulty fuel line connection • No rail pressure sensor signal • Fuel pressure regulator valve contaminated, stuck, jammed • Rail pressure regulator valve contaminated, stuck, jammed • Gasoline in fuel • ECM program error or hardware fault • Faulty accelerator pedal position sensor

(Symptom 21) Engine Does Not Stop

Possible Cause	
• Stuck or worn lubrication circuit of turbocharger • Too much engine oil	• Leakage at vacuum hose • ECM program error or hardware fault

(Symptom 22) Different Mechanical Noises

Possible Cause	
• Buzzer noise (discharge by the injectors) • Broken clip (vibrations, resonance, noises) • Incorrect state of the electrical pack devices • Sealed or damaged catalytic converter	• Leakage in intake system • Poor tightening of injector clamp • Damaged turbocharger • Poor valve clearance

Actuation Test

Items	Test Condition
A/C COMPRESSOR RELAY	ACTUATION TEST/IG ON/ENGINE RUN
MIL (ENGINE CHECK)	ACTUATION TEST/IG ON/ENGINE RUN
AUXILIARY HEATER RELAY	ACTUATION TEST/IG ON/ENGINE RUN
FUEL PUMP RELAY	ACTUATION TEST/IG ON/ENGINE STOP
FAN-HIGH SPEED	ACTUATION TEST/IG ON/ENGINE STOP
FAN-LOW SPEED	ACTUATION TEST/IG ON/ENGINE STOP
GLOW LAMP	ACTUATION TEST/IG ON/ENGINE RUN
IMMOBILIZER LAMP	ACTUATION TEST/IG ON/ENGINE RUN
ELECTRIC VGT CONTROL ACTUATOR	ACTUATION TEST/IG ON/ENGINE STOP
ELECTRIC EGR CONTROL VALVE	ACTUATION TEST/IG ON/ENGINE STOP
FUEL PRESSURE REGULATOR VALVE(HP PUMP SIDE)	ACTUATION TEST/IG ON/ENGINE STOP
RAIL PRESSURE REGULATOR VALVE(COMMON RAIL SIDE)	ACTUATION TEST/IG ON/ENGINE STOP

Engine Control System

Description

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

NOTICE

- *Before removing or installing any part, read the diagnostic trouble codesand 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 operationor while the ignition switch is ON could cause damage to the ECM.*
- *Wchecking the generator for the charging state, do not disconnect the battery '+' terminal to prevent the ECM from damage due to the voltage.*
- *Wcharging the battery with the external charger, disconnect the vehicleside battery terminals to prevent damage to the ECM.*

Self-diagnosis

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.

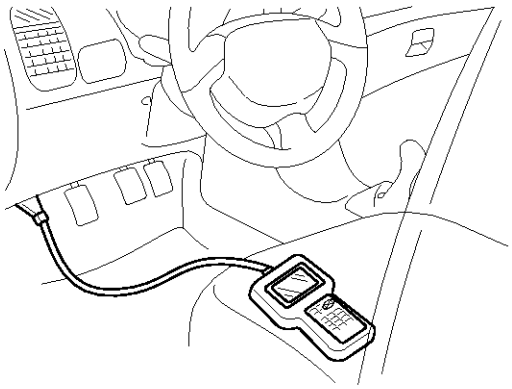
Checking Procedure (Self-diagnosis)

NOTICE

- *When attery voltage is excessively low, diagnostic trouble codes can not be read. Be sure to check the battery for voltage and the charging system before starting the test*
- *Diagnosis memory is erased if the battery or the ECM connector is disconnected. Do not disconnect the battery before the diagnostic trouble codes are completely read and recorded.*

Inspection Procedure (Using Generic Scan Tool)

1. Turn OFF the ignition switch.
2. Connect the scan tool to the data link connector on the lower crash pad.



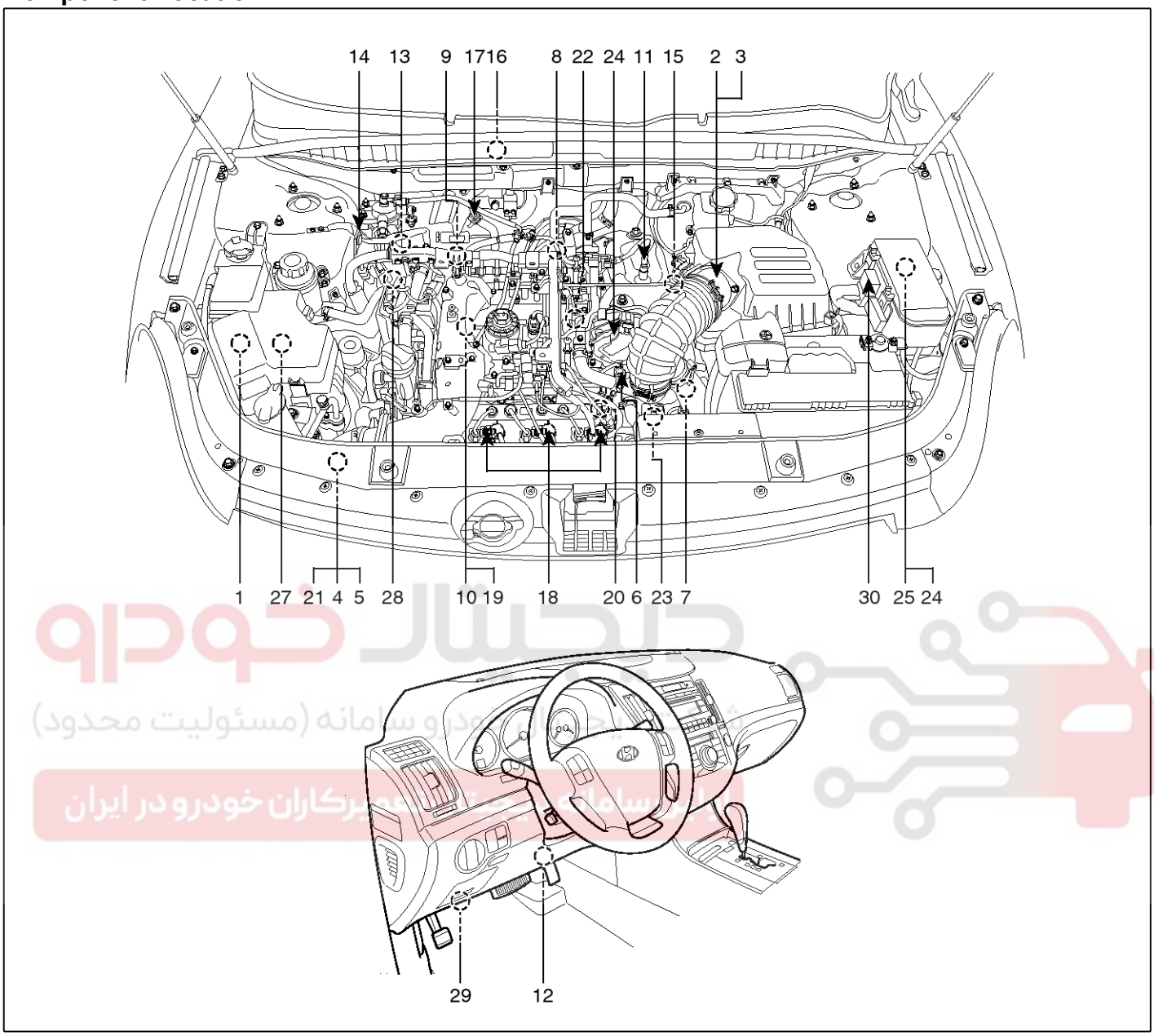
AWJF300D

3. Turn ON the ignition switch.
4. Use the scan tool to check the diagnostic trouble code.
5. Repair the faulty part from the diagnosis chart.
6. Erase the diagnostic trouble code.
7. Disconnect the GST.

NOTICE

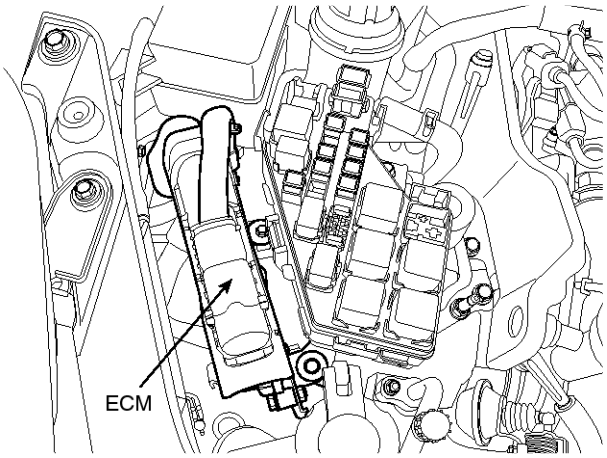
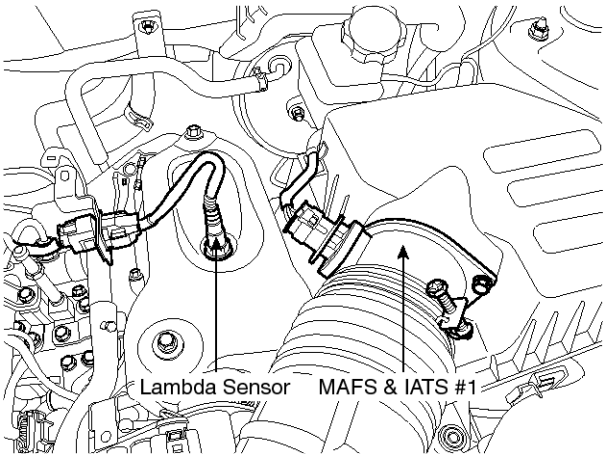
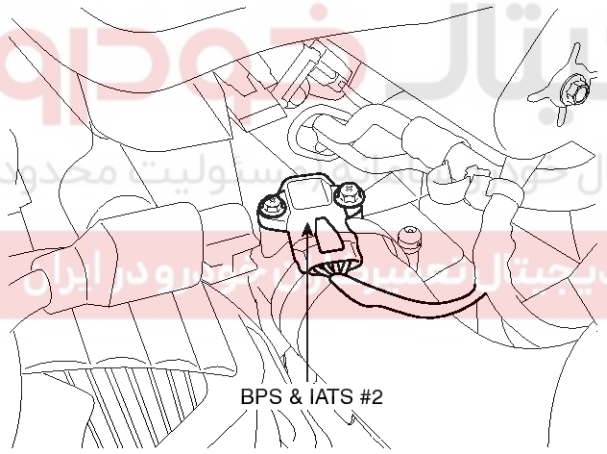
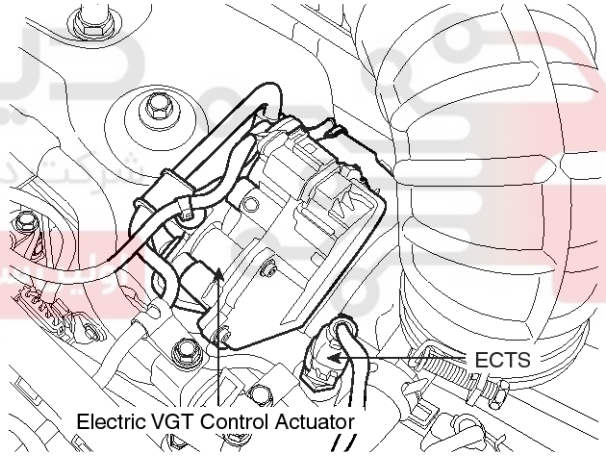
When deleting diagnostic trouble code, use scan tool as possible.

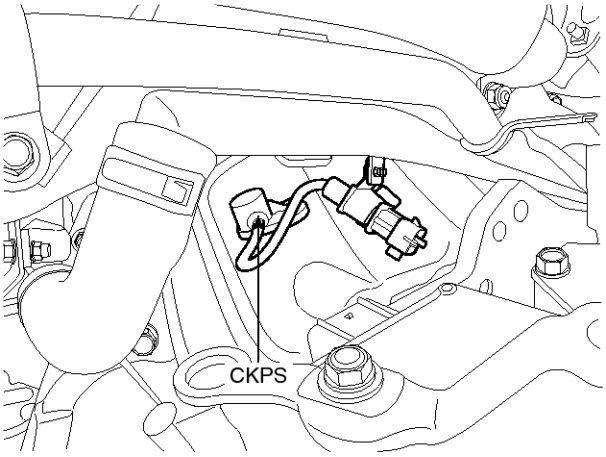
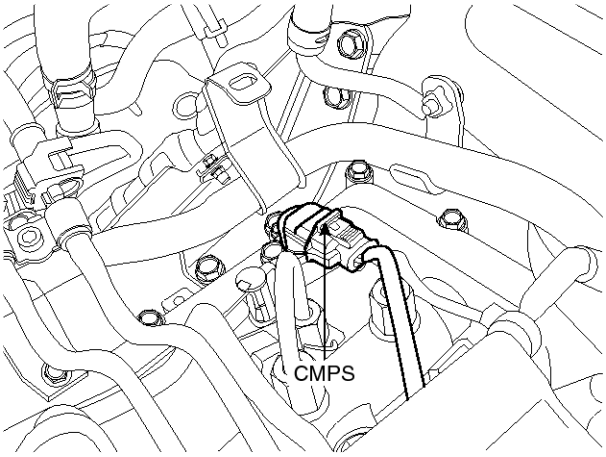
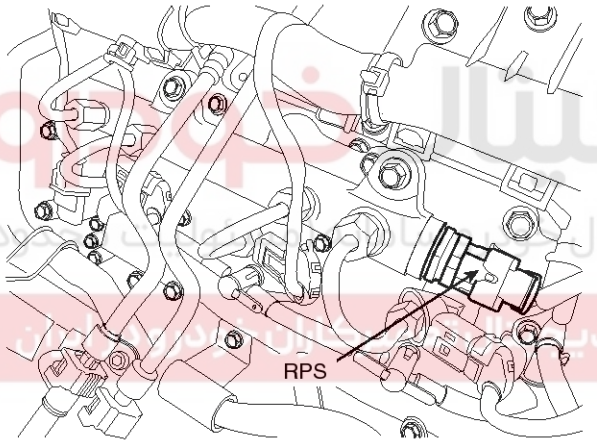
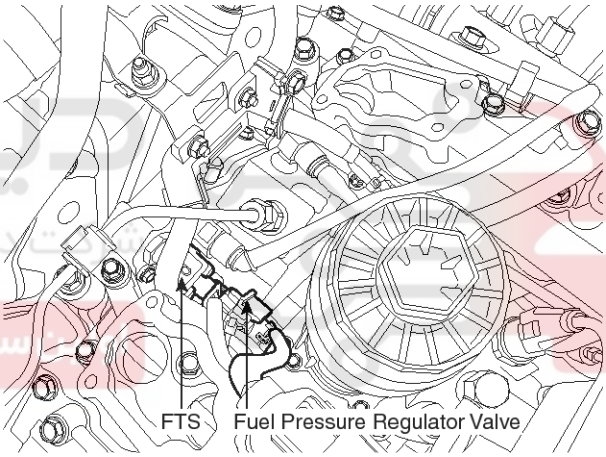
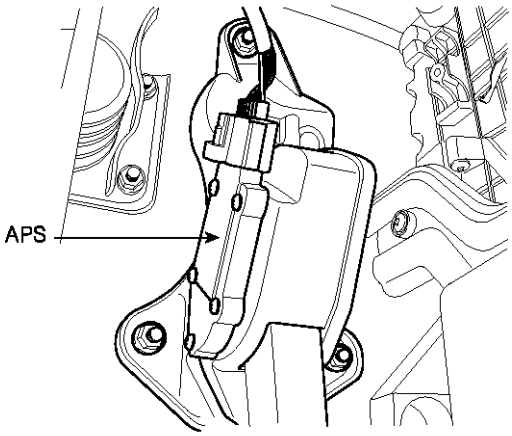
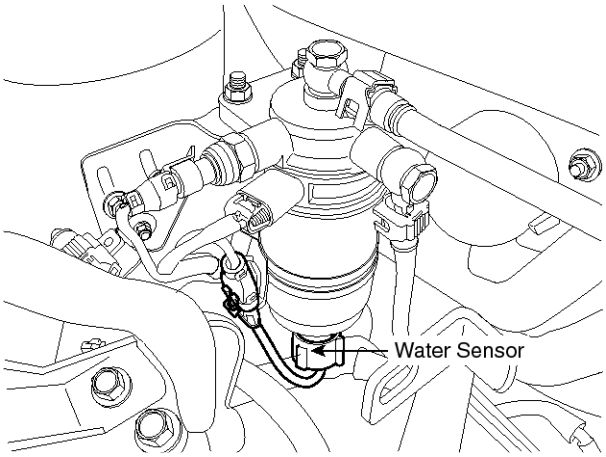
Component Location

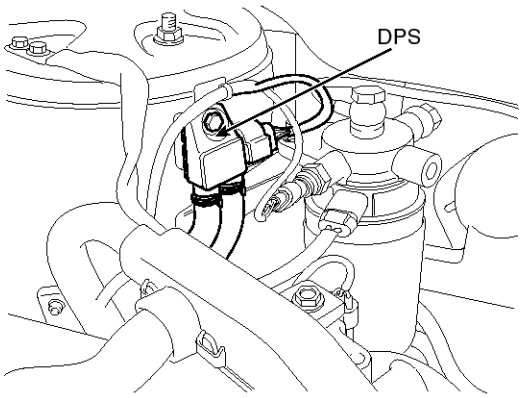
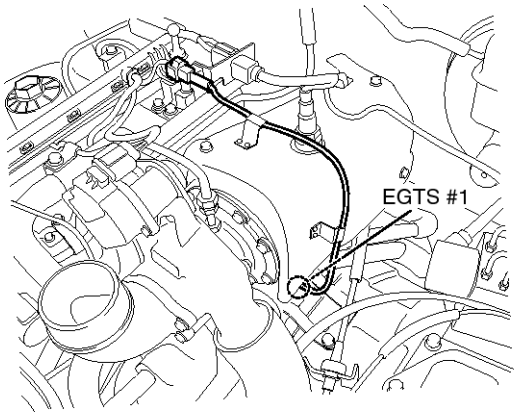
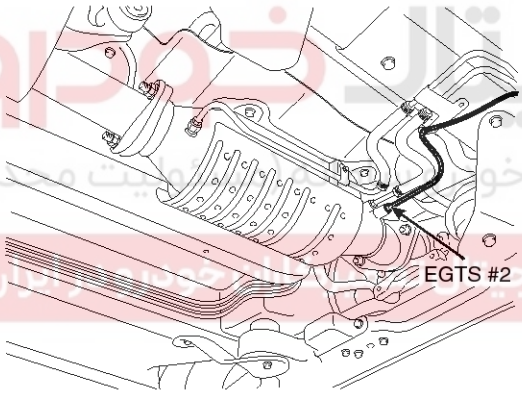
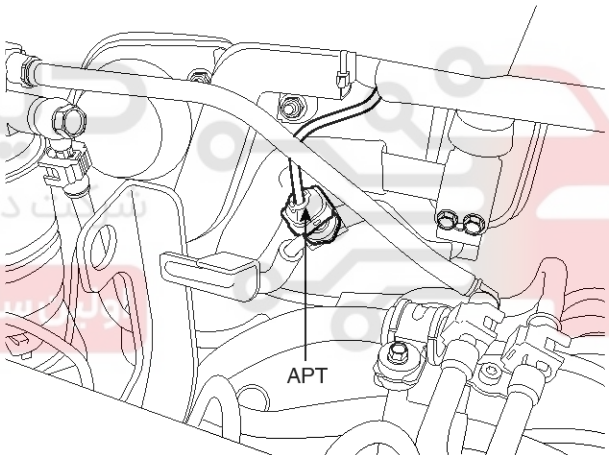


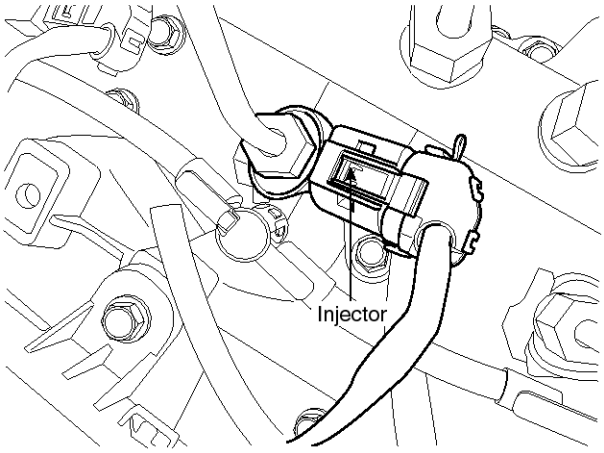
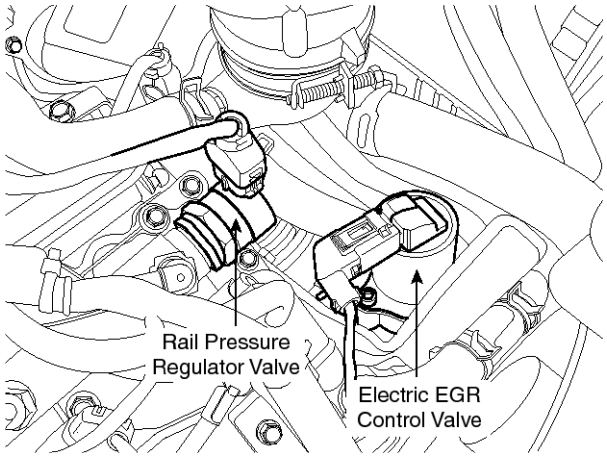
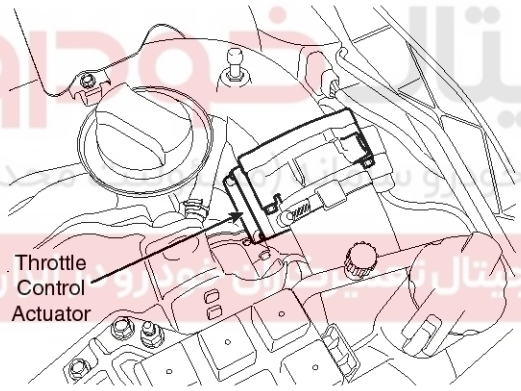
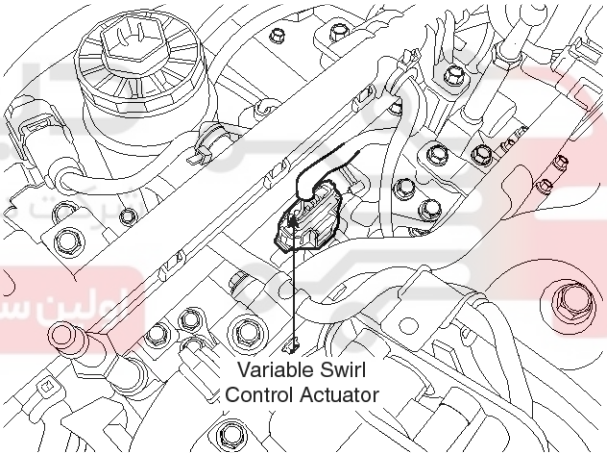
SENFL0100L

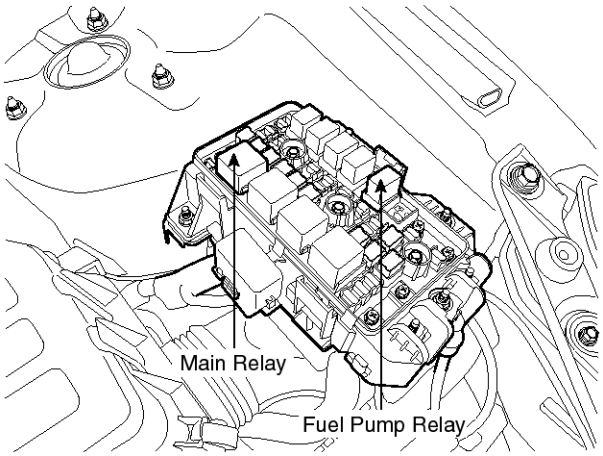
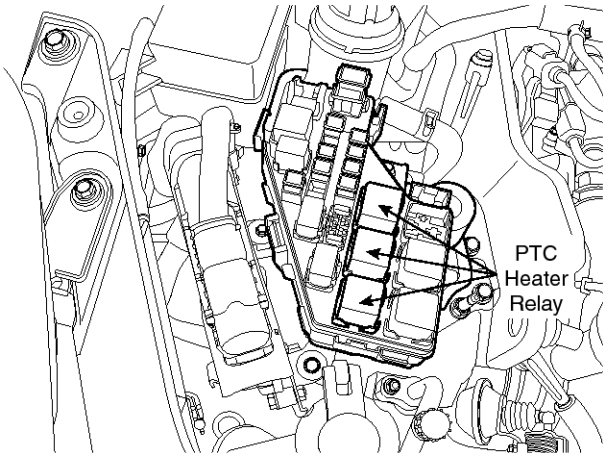
1. ECM (Engine Control Module)
2. Mass Air Flow Sensor (MAFS)
3. Intake Air Temperature Sensor (IATS) #1
4. Boost Pressure Sensor (BPS)
5. Intake Air Temperature Sensor (IATS) #2
6. Engine Coolant Temperature Sensor (ECTS)
7. Crankshaft Position Sensor (CKPS)
8. Camshaft Position Sensor (CMPS)
9. Rail Pressure Sensor (RPS)
10. Fuel Temperature Sensor (FTS)
11. Lambda Sensor
12. Accelerator Pedal Position Sensor (APS)
13. Water Sensor
14. CPF Differential Pressure Sensor (DPS)
15. Exhaust Gas Temperature Sensor (EGTS) #1 [For VGT]
16. Exhaust Gas Temperature Sensor (EGTS) #2 [For CPF]
17. A/C Pressure Transducer (APT)
18. Injector
19. Fuel Pressure Regulator Valve
20. Rail Pressure Regulator Valve
21. Throttle Control Actuator
22. Variable Swirl Control Actuator
23. Electric EGR Control Valve
24. Electric VGT Control Actuator
25. Main Relay
26. Fuel Pump Relay
27. PTC Heater Relay
28. Glow Control Module
29. Data Link Connector (DLC)
30. Multi-Purpose Check Connector

1. ECM (Engine Control Module)	2. Mass Air Flow Sensor (MAFS) 3. Intake Air Temperature Sensor (IATS) #1 11. Lambda Senosr
 SENFL7102D	 SENFL7101L
4. Boost Pressure Sensor (BPS) 5. Intake Air Temperature Sensor (IATS) #2	6. Engine Coolant Temperature Senosr (ECTS) 24. Electric VGT Control Actuator
 SENFL7104D	 SENFL7102L

7. Crankshaft Position Senosr (CKPS)	8. Camshaft Position Senosr (CMPS)
 SENFL7106D	 SENFL7107D
9. Rail Pressure Senosr (RPS)	10. Fuel Temperature Senosr (FTS) 19. Fuel Pressure Regulator Valve
 SENFL7108D	 SENFL7103L
12. Accelerator Pedal Position Senosr (APS)	13. Water Senosr
 SCMFL6005D	 SENFL7104L

14. Differential Pressure Sensor (DPS) [With CPF]	15. Exhaust Gas Temperature Sensor (EGTS) #1 For VGT [With CPF]
 SENFL0101L	 SENFL0102L
16. Exhaust Gas Temperature Sensor (EGTS) #2 For CPF [With CPF]	17. A/C Pressure Transducer (APT)
 SENFL0103L	 SENFL7111D

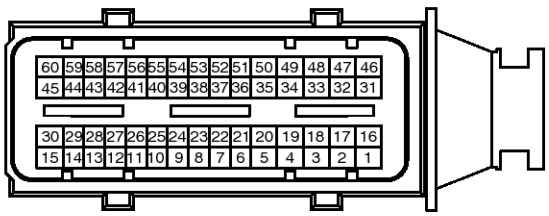
18. Injector	20. Rail Pressure Regulator Valve 23. Electric EGR Control Valve
 SENFL7105L	 SENFL7106L
21. Throttle Control Actuator [With CPF]	22. Variable Swirl Control Actuator
 SENFL0106L	 SENFL7107L

25. Main Relay 26. Fuel Pump Relay	27. PTC Heater Relay
 SENFL7108L	 SENFL7109L

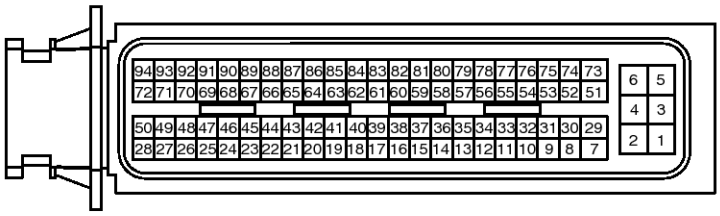
Engine Control Module (ECM)

Engine Control Module (ECM)

1. ECM Harness Connector



CONNECTOR [CSD-A]



CONNECTOR [CSD-K]

SENFL7160L

2. ECM Terminal Function

Connector [CSD-A]

Pin	Description	Connected to
1	Injector (Cylinder #2) [Low] control output	Injector (Cylinder #2)
2	Injector (Cylinder #4) [Low] control output	Injector (Cylinder #4)
3	Injector (Cylinder #6) [Low] control output	Injector (Cylinder #6)
4	Fuel Pressure Regulator Valve control output	Fuel Pressure Regulator Valve
5	Rail Pressure Regulator Valve control output	Fuel Pressure Regulator Valve
6	-	
7	Intake Air Temperature Sensor (IATS) #2 signal input	Boost Pressure Sensor (BPS)
8	-	
9	-	
10	Fuel Temperature Sensor (FTS) signal input	Fuel Temperature Sensor(FTS)
11	-	
12	-	
13	-	
14	-	
15	-	
16	Injector (Cylinder #2) [High] control output	Injector (Cylinder #2)
17	Injector (Cylinder #4) [High] control output	Injector (Cylinder #4)
18	Injector (Cylinder #6) [High] control output	Injector (Cylinder #6)
19	-	
20	Electric VGT Control Actuator control output	Electric VGT Control Actuator
21	Sensor ground	Engine Coolant Temperature Sensor (ECTS)
22	Engine Coolant Temperature Sensor(ECTS) signal input	Engine Coolant Temperature Sensor (ECTS)

Pin	Description	Connected to
23	Sensor ground	Position Sensor (Variable Swirl Control Actuator)
24	-	
25	-	
26	Sensor power (+5V)	Boost Pressure Sensor (BPS)
27	Sensor power (+5V)	Rail Pressure Sensor (RPS)
28	Camshaft Position Sensor(CMPS) signal input	Camshaft Position Sensor (CMPS)
29	Sensor ground	Camshaft Position Sensor (CMPS)
30	-	
31	Injector (Cylinder #1) [High] control output	Injector (Cylinder #1)
32	Injector (Cylinder #3) [High] control output	Injector (Cylinder #3)
33	Injector (Cylinder #5) [High] control output	Injector (Cylinder #5)
34	-	
35	-	
36	-	
37	-	
38	-	
39	Sensor ground	Fuel Temperature Sensor(FTS)
40	Rail Pressure Sensor(RPS) signal input	Rail Pressure Sensor (RPS)
41	Boost Pressure Sensor(BPS) signal input	Boost Pressure Sensor (BPS)
42	-	
43	Crankshaft Position Sensor (CKPS) [-] signal input	Crankshaft Position Sensor (CKPS)
44	-	
45	-	
46	Injector (Cylinder #1) [Low] control output	Injector (Cylinder #1)
47	Injector (Cylinder #3) [Low] control output	Injector (Cylinder #3)
48	Injector (Cylinder #5) [Low] control output	Injector (Cylinder #5)
49	Motor [+] control output	Variable Swirl Control Actuator
50	Motor [-] control output	Variable Swirl Control Actuator
51	Sensor power (+5V)	Position Sensor (Variable Swirl Control Actuator)
52	Position Sensor signal input	Position Sensor (Variable Swirl Control Actuator)
53	-	
54	Sensor power (+5V)	Camshaft Position Sensor (CMPS)
55	Sensor ground	Rail Pressure Sensor (RPS)
56	Sensor ground	Boost Pressure Sensor (BPS)
57	Sensor shield	Crankshaft Position Sensor (CKPS)

Pin	Description	Connected to
58	Crankshaft Position Sensor (CKPS) [+] signal input	Crankshaft Position Sensor (CKPS)
59	-	
60	Electric EGR Control Valve control output	Electric EGR Control Valve

Connector [CSD-K]

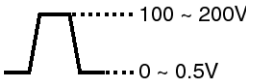
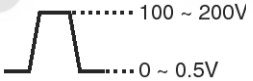
Pin	Description	Connected to
1	Power ground	Chassis ground
2	Power ground	Chassis ground
3	Battery power	Main Relay
4	Power ground	Chassis ground
5	Battery power	Main Relay
6	Battery power	Main Relay
7	Throttle Control Actuator control output [With CPF]	Throttle Control Actuator
8	ESP/ABS Auto Recognition signal input	ESP: Ground, ABS: Open
9	-	
10	VS-/IP- (Virtual Ground)	Lambda Sensor
11	VS+ (NERNST Cell Voltage)	Lambda Sensor
12	-	
13	-	
14	-	
15	Sensor power (+5V)	A/C Pressure Transducer (APT)
16	-	
17	-	
18	Battery power	Ignition Switch
19	Sensor power (+5V) [With CPF]	CPF Differential Pressure Sensor (DPS)
20	CPF Differential Pressure Sensor (DPS) signal input [With CPF]	CPF Differential Pressure Sensor (DPS)
21	Sensor ground [With CPF]	CPF Differential Pressure Sensor (DPS)
22	-	
23	-	
24	-	
25	Cooling Fan Relay [High] control output	Cooling Fan Relay [High]
26	-	
27	-	
28	-	
29	PTC Heater Relay control output	PTC Heater Relay

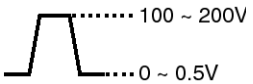
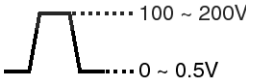
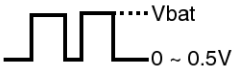
Pin	Description	Connected to
30	-	
31	Feedback signal input [With CPF]	Throttle Control Actuator
32	Rc/Rp (Pumping Cell Voltage)	Lambda Sensor
33	Immobilizer Communication Line	Immobilizer Control Module
34	-	
35	CAN [Low]	Other Control Modules
36	CAN [High]	Other Control Modules
37	-	
38	Intake Air Temperature Sensor (IATS) #1 signal input	Mass Air Flow Sensor(MAFS)
39	-	
40	Sensor Power (+5V)	Cruise Control Switch
41	-	
42	Water Sensor signal input	Water Sensor (in Fuel Filter)
43	Brake Switch 2 signal input	Brake Switch
44	Brake Switch 1 signal input	Brake Switch
45	Ground	Immobilizer Control Module
46	-	
47	Engine speed signal output	Tachometer (Cluster)
48	A/C Compressor Relay control output	A/C Compressor Relay
49	Main Relay control output	Main Relay
50	Cooling Fan Relay [Low] control output	Cooling Fan Relay [Low]
51	Lambda Sensor Heater control output	Lambda Sensor
52	-	
53	-	
54	Rc (Compensative Resistance)	Lambda Sensor
55	Exhaust Gas Temperature Sensor (EGTS) #2 signal input [With CPF]	Exhaust Gas Temperature Sensor (EGTS) #2
56	Exhaust Gas Temperature Sensor (EGTS) #1 signal input [With CPF]	Exhaust Gas Temperature Sensor (EGTS) #1
57	Accelerator Position Sensor (APS) #1 signal input	Accelerator Position Sensor (APS) #1
58	Accelerator Position Sensor (APS) #2 signal input	Accelerator Position Sensor (APS) #2
59	A/C Pressure Transducer (APT) signal input	A/C Pressure Transducer (APT)
60	Sensor power (+5V)	Accelerator Position Sensor (APS) #2
61	-	
62	-	
63	-	

Pin	Description	Connected to
64	A/C Switch "ON" signal input	A/C Switch
65	A/C Pressure Switch signal input	A/C Pressure Switch
66	-	
67	-	
68	Fuel Pump Relay control output	Fuel Pump Relay
69	Immobilizer Lamp control output	Immobilizer Lamp (Cluster)
70	-	
71	Glow Time Lamp control output	Glow Time Lamp (Cluster)
72	Diagnosis Data Line (K-Line)	Data Link Connector (DLC), Multi-Purpose Connector
73	Accelerator Position Sensor signal output	EPS Control Module
74	Mass Air Flow Sensor(MAFS) signal input	Mass Air Flow Sensor(MAFS)
75	Reference Frequency	Mass Air Flow Sensor(MAFS)
76	-	
77	-	
78	Sensor ground [With CPF]	Exhaust Gas Temperature Sensor (EGTS) #1,#2
79	Sensor ground	Accelerator Position Sensor (APS) #1
80	Sensor ground	Accelerator Position Sensor (APS) #2
81	Sensor ground	Mass Air Flow Sensor(MAFS)
82	Sensor power (+5V)	Accelerator Position Sensor (APS) #1
83	-	
84	Sensor ground	A/C Pressure Transducer (APT)
85	Thermo Switch signal input	A/C Switch
86	-	
87	-	
88	-	
89	-	
90	Feedback signal input	Electric VGT Control Actuator
91	Malfunction Indicator Lamp (MIL) control output	Malfunction Indicator Lamp (MIL)
92	-	
93	Cruise Control "ACTIVATOR" signal input	Cruise Control Switch
94	Ground	Cruise Control Switch

3. ECM Terminal Input/output Signal

Connector [CSD-A]

Pin	Description	Condition	Type	Level
1	Injector (Cylinder #2) [Low] control output	Engine Run	DC	
2	Injector (Cylinder #4) [Low] control output			
3	Injector (Cylinder #6) [Low] control output			
4	Fuel Pressure Regulator Valve control output	Engine Run	PWM (120~200 Hz)	
5	Rail Pressure Regulator Valve control output	Engine Run	PWM (1kHz)	
6	-			
7	Intake Air Temperature Sensor (IATS) #2 signal input	Idle	Analog	0.5 ~ 4.5V
8	-			
9	-			
10	Fuel Temperature Sensor (FTS) signal input	IG ON	Analog	0.5 ~ 4.5V
11	-			
12	-			
13	-			
14	-			
15	-			
16	Injector (Cylinder #2) [High] control output	Engine Run	DC	
17	Injector (Cylinder #4) [High] control output			
18	Injector (Cylinder #6) [High] control output			
19	-			
20	Electric VGT Control Actuator control output	IG ON	PWM (250Hz)	 · Engine running duty: 20~80% · Idle duty: 80% · W.O.T duty: 50%
21	Sensor ground	Always	DC	0 ~ 0.5V
22	Engine Coolant Temperature Sensor(ECTS) signal input	Idle	Analog	0.5 ~ 4.5V
23	Sensor ground	Always	DC	0 ~ 0.5V
24	-			
25	-			
26	Sensor power (+5V)	IG ON	DC	4.9 ~ 5.1V

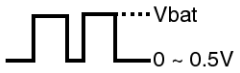
Pin	Description	Condition	Type	Level
27	Sensor power (+5V)	IG ON	DC	4.9 ~ 5.1V
28	Camshaft Position Sensor(CMPS) signal input	Engine Run	Pulse	High: 4.8 ~ 5.2V Low: Max. 1.0V
29	Sensor ground	Always	DC	0 ~ 0.5V
30	-			
31	Injector (Cylinder #1) [High] control output	Engine Run	DC	
32	Injector (Cylinder #3) [High] control output			
33	Injector (Cylinder #5) [High] control output			
34	-			
35	-			
36	-			
37	-			
38	-			
39	Sensor ground	Always	DC	0 ~ 0.5V
40	Rail Pressure Sensor(RPS) signal input	Engine Run	Analog	0.5 ~ 4.5V
41	Boost Pressure Sensor(BPS) signal input	Engine Run	Analog	1.0 ~ 4.4V
42	-			
43	Crankshaft Position Sensor (CKPS) [-] signal input	Engine Run	SINE Wave	Vp_p: Min. 1.0V
44	-			
45	-			
46	Injector (Cylinder #1) [Low] control output	Engine Run	DC	
47	Injector (Cylinder #3) [Low] control output			
48	Injector (Cylinder #5) [Low] control output			
49	Motor [+] control output	Engine Run	PWM	 · Engine running duty: below 50% · Offset learning duty: 0~100 %
50	Motor [-] control output	Engine Run	PWM	
51	Sensor power (+5V)	IG ON	DC	4.9 ~ 5.1V
52	Position Sensor signal input	Idle	DC	0.5 ~ 4.5V
53	-			
54	Sensor power (+5V)	IG ON	DC	4.9 ~ 5.1V
55	Sensor ground	Always	DC	0 ~ 0.5V
56	Sensor ground	Always	DC	0 ~ 0.5V

Pin	Description	Condition	Type	Level
57	Sensor shield			
58	Crankshaft Position Sensor (CKPS) [+] signal input	Engine Run	SINE Wave	Vp_p: Min.1.0V
59	-			
60	Electric EGR Control Valve control output	Engine Run	PWM	 · Engine running duty: 5~80 % · Valve closing: 5% · Valve opening: 80%

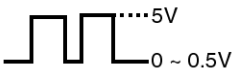
Connector [CSD-K]

Pin	Description	Condition	Type	Level
1	Power ground	Always	DC	0 ~ 0.5V
2	Power ground	Always	DC	0 ~ 0.5V
3	Battery power	IG ON	DC	Battery Voltage
4	Power ground	Always	DC	0 ~ 0.5V
5	Battery power	IG ON	DC	Battery Voltage
6	Battery power	IG ON	DC	Battery Voltage
7	Throttle Control Actuator control output	Key On/Key Off	Pulse	Hi: Vbatt Lo: Max. 1V
8	ESP/ABS Auto Recognition signal input			
9	-			
10	VS-/IP- (Virtual Ground)	Engine Run & Heater ON	DC	~ 3.0V
11	VS+ (NERNST Cell Voltage)	Engine Run & Heater ON	DC	~ 3.0V
12	-			
13	-			
14	-			
15	Sensor power (+5V)	IG ON	DC	4.9 ~ 5.1V
16	-			
17	-			
18	Battery power	IG ON	DC	Battery Voltage
19	Sensor power (+5V)	IG OFF	DC	Max. 0.5V
		IG ON		4.9 ~ 5.1V
20	CPF Differential Pressure Sensor (DPS) signal input	Idle	Analog	0.5 ~ 4.5V
21	Sensor ground	Idle	DC	Max. 50mV

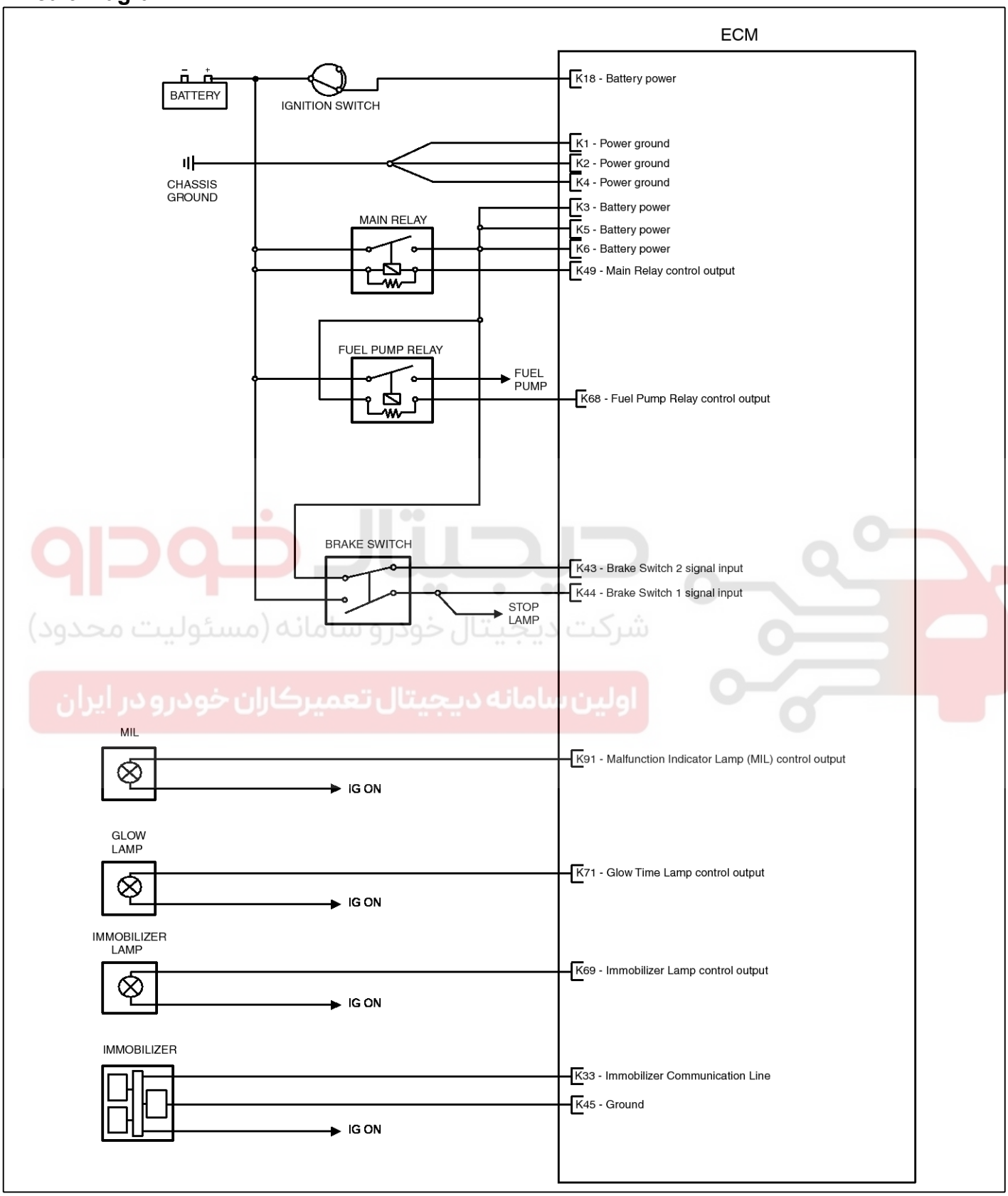
Pin	Description	Condition	Type	Level
22	-			
23	-			
24	-			
25	Cooling Fan Relay [High] control output	Relay OFF	DC	Battery Voltage
		Relay ON		Max. 1.0V
26	-			
27	-			
28	-			
29	PTC Heater Relay control output	Relay OFF	DC	Battery Voltage
		Relay ON		Max. 1.0V
30	-			
31	Feedback signal input	Normal	DC	Vbatt
		Abnormal		Max. 0.5V
32	Rc/Rp (Pumping Cell Voltage)	Engine Run & Heater ON	DC	
33	Immobilizer Communication Line			
34	-			
35	CAN [Low]	RECESSIVE	DC	2.0 ~ 3.0V
		DOMINANT		0.5 ~ 2.25V
36	CAN [High]	RECESSIVE	DC	2.0 ~ 3.0V
		DOMINANT		2.75 ~ 4.5V
37	-			
38	Intake Air Temperature Sensor (IATS) #1 signal input	Idle	Analog	0.5 ~ 4.5V
39	-			
40	Sensor Power (+5V)	IG ON	DC	4.9 ~ 5.1V
41	-			
42	Water Sensor signal input	IG ON	DC	
43	Brake Switch 2 signal input	Release	DC	Battery Voltage
		Push		Max. 0.5V
44	Brake Switch 1 signal input	Release	DC	Max. 0.5V
		Push		Battery Voltage
45	Ground	Always	DC	0 ~ 0.5V
46	-			

Pin	Description	Condition	Type	Level
47	Engine speed signal output	Engine Run	Pulse (4P-ulse/rev)	
48	A/C Compressor Relay control output	A/C OFF	DC	Battery Voltage
		A/C ON		Max. 1.0V
49	Main Relay control output	Relay OFF	DC	Battery Voltage
		Relay ON		Max. 1.0V
50	Cooling Fan Relay [Low] control output	Relay OFF	DC	Battery Voltage
		Relay ON		Max. 1.0V
51	Lambda Sensor Heater control output	Engine Run & Heater ON	PWM (100 Hz)	
52	-			
53	-			
54	Rc (Compensative Resistance)	Engine Run & Heater ON	DC	
55	Exhaust Gas Temperature Sensor (EGTS) #2 signal input	Idle	Analog	0.5 ~ 4.5V
56	Exhaust Gas Temperature Sensor (EGTS) #1 signal input	Idle	Analog	0.5 ~ 4.5V
57	Accelerator Position Sensor (APS) #1 signal input	Released	DC	0.7 ~ 0.8V
		Fully depressed		3.8 ~ 4.4V
58	Accelerator Position Sensor (APS) #2 signal input	Released	DC	0.275 ~ 0.475V
		Fully depressed		1.75 ~ 2.35V
59	A/C Pressure Transducer (APT) signal input	A/C ON	DC	Max. 4.8V
60	Sensor power (+5V)	IG ON	DC	4.9 ~ 5.1V
61	-			
62	-			
63	-			
64	A/C Switch "ON" signal input	A/C S/W OFF	DC	Max. 1.0V
		A/C S/W ON		Battery Voltage
65	A/C Pressure Switch signal input	S/W OFF	DC	Max. 1.0V
		S/W ON		Battery Voltage
66	-			
67	-			

Pin	Description	Condition	Type	Level
68	Fuel Pump Relay control output	Relay OFF	DC	Battery Voltage
		Relay ON		Max. 1.0V
69	Immobilizer Lamp control output	Lamp OFF	DC	Battery Voltage
		Lamp ON		Max. 1.0V
70	-			
71	Glow Time Lamp control output	Lamp OFF	DC	Battery Voltage
		Lamp ON		Max. 1.0V
72	Diagnosis Data Line (K-Line)	When transmitting	Pulse	High: Min. Vbatt×80%
				Low: Max. Vbatt×20%
		When receiving		High: Min. Vbatt×70%
				Low: Max. Vbatt×30%
73	Accelerator Position Sensor signal output			
74	Mass Air Flow Sensor(MAFS) signal input	Engine Run & Warmed-up	Pulse	
75	Reference Frequency	Idle	Pulse	High: Vcc or Vbat Low: Max. 1.0V
76	-			
77	-			
78	Sensor ground	Idle	DC	Max. 50mV
79	Sensor ground	Always	DC	0 ~ 0.5V
80	Sensor ground	Always	DC	0 ~ 0.5V
81	Sensor ground	Always	DC	0 ~ 0.5V
82	Sensor power (+5V)	IG ON	DC	4.9 ~ 5.1V
83	-			
84	Sensor ground	Always	DC	0 ~ 0.5V
85	Thermo Switch signal input	A/C OFF	DC	Max. 0.5V
		A/C ON		Battery Voltage
86	-			
87	-			
88	-			
89	-			

Pin	Description	Condition	Type	Level
90	Feedback signal input	IG ON	PWM	 · Engine running duty: 20~80% · Idle duty: 80% · W.O.T duty: 50
91	Malfunction Indicator Lamp (MIL) Control output	Lamp OFF	DC	Battery Voltage
		Lamp ON		Max. 1.0V
92	-			
93	Cruise Control "ACTIVATOR" signal input	IG ON	DC	4.9 ~ 5.1V
94	Ground	Always	DC	0 ~ 0.5V

Circuit Diagram



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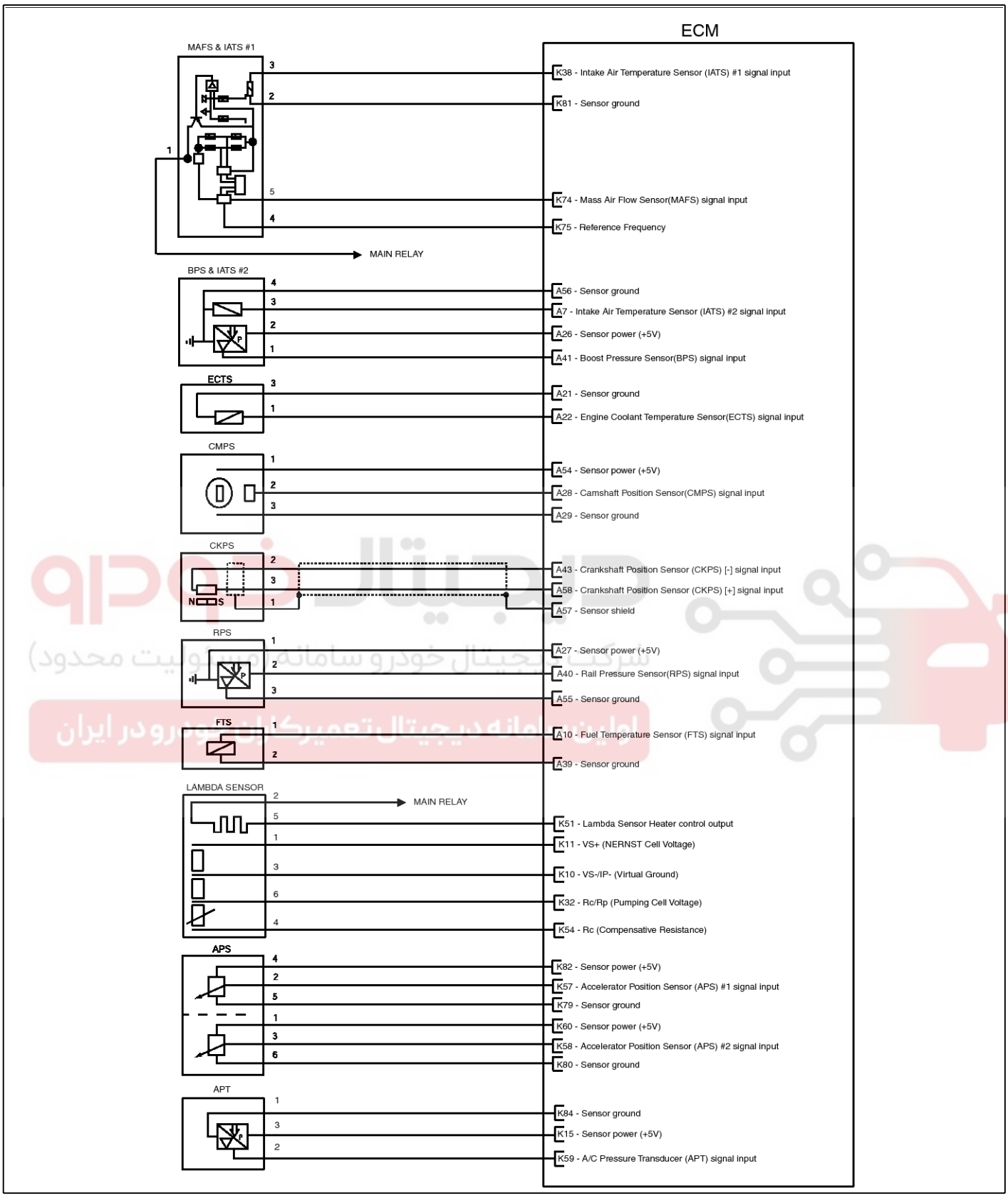

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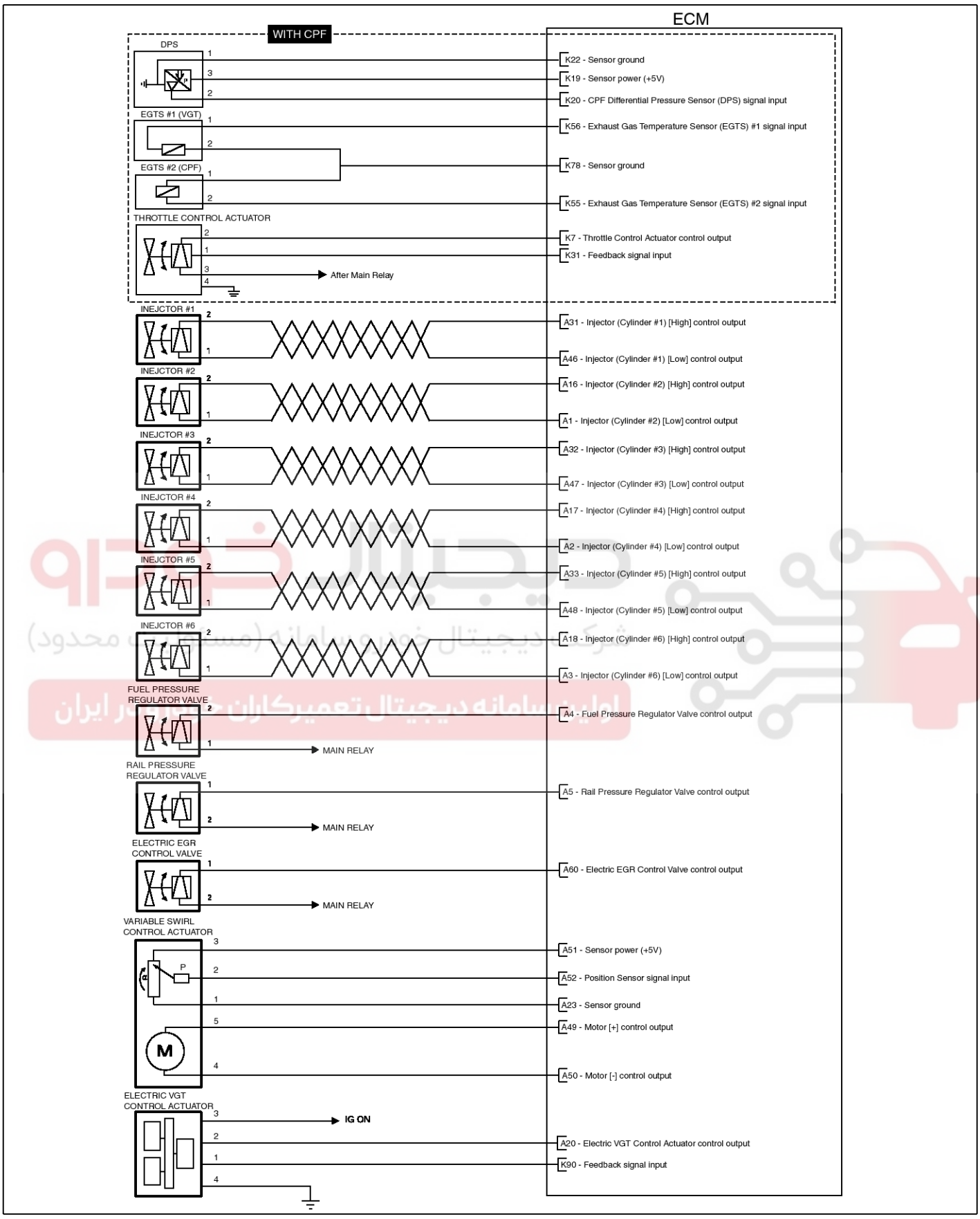

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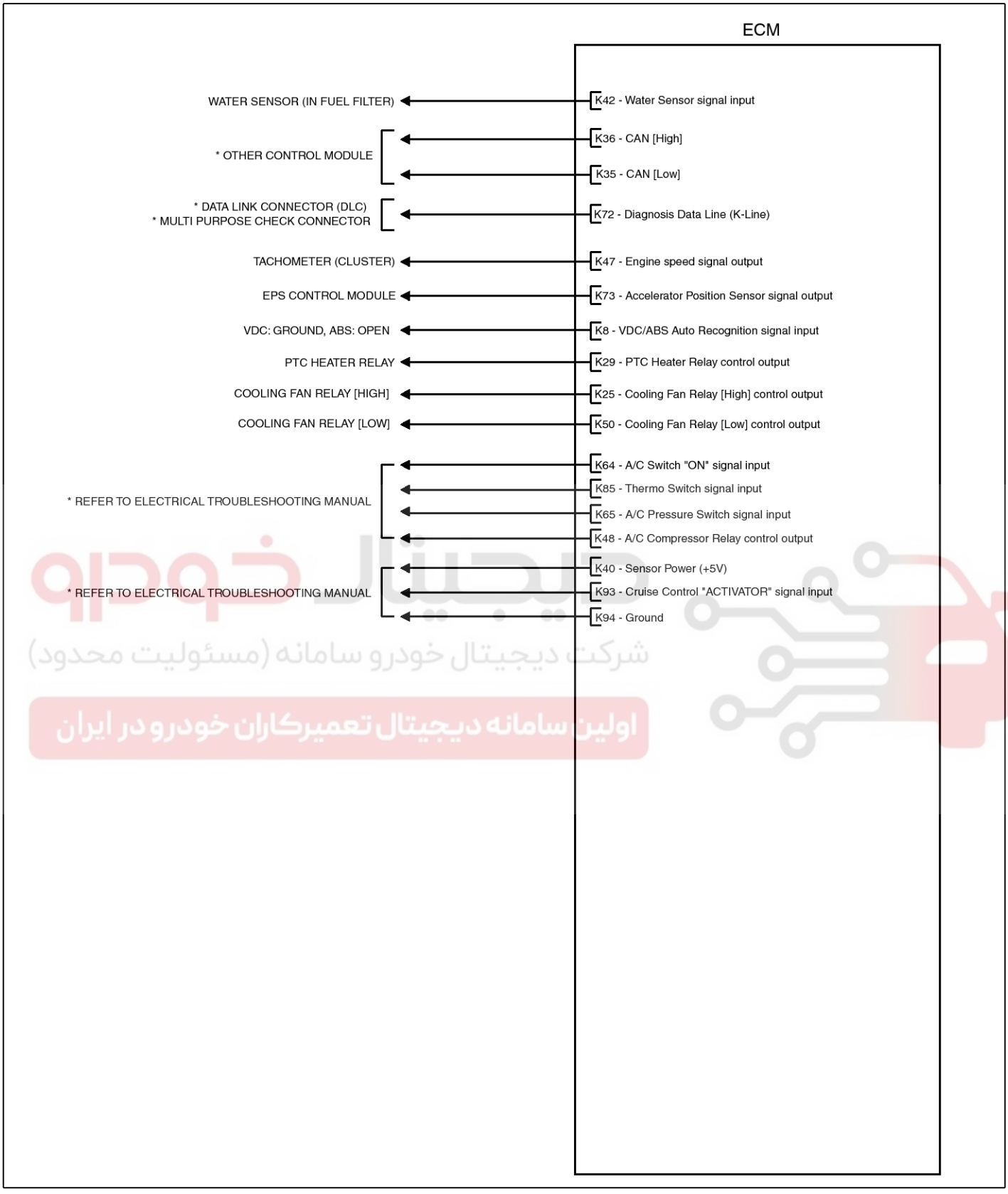


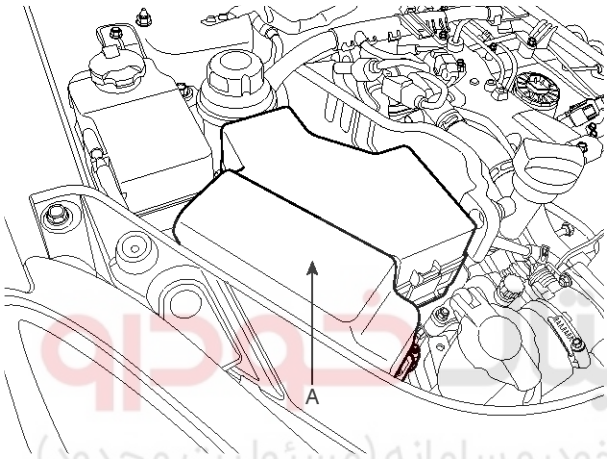
SENFL7113L

Replacement

⚠CAUTION

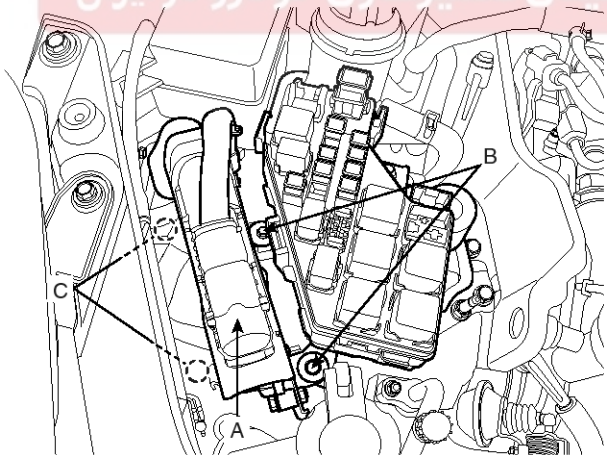
- **After replacing ECM, MUST input the injector specific data (7 digits) of each cylinder into a new ECM with scan tool.**
- **In the case of the vehicle equipped with immobilizer, perform "KEY TEACHING" procedure together (Refer to "IMMOBILIZER" in BE group).**

1. Turn ignition switch OFF and disconnect the negative (-) battery cable.
2. Remove the cover of the ECM & relay box (A).



SENFL7123D

3. Disconnect the ECM connector (A).



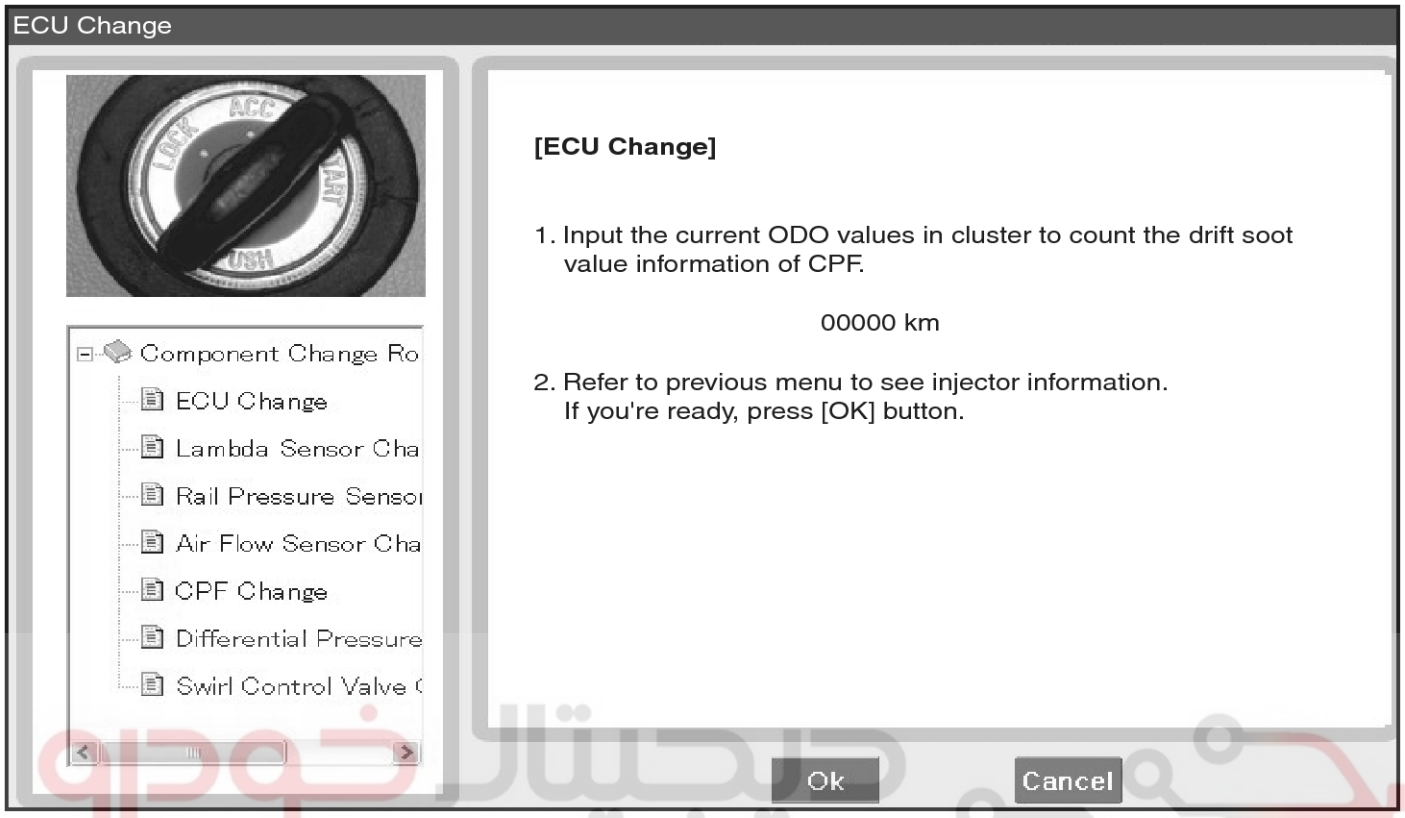
SENFL7122D

4. Unscrew the ECM bracket mounting bolts (B) and the nuts (C), and then remove the ECM.
5. Install a new ECM.

ECM installation bolts (on bracket):
7.8 ~ 11.8 N.m (0.8 ~ 1.2 kgf.m, 5.8 ~ 8.7 lb-ft)
ECM bracket installation bolts/nuts:
3.9 ~ 5.9 N.m (0.4 ~ 0.6 kgf.m, 2.9 ~ 4.3 lb-ft)

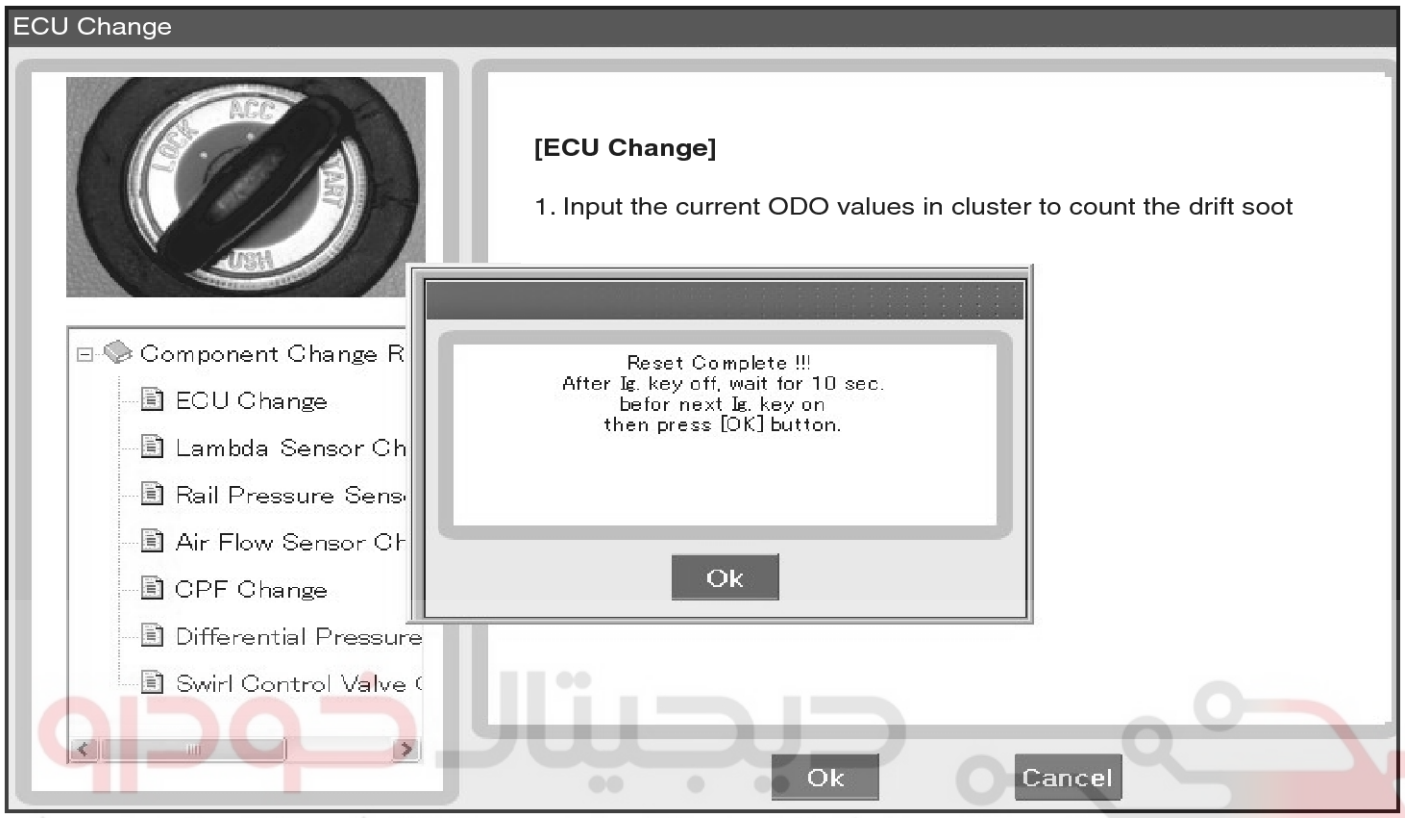
6. Connect the negative(-) battery cable.
7. Perform "ECM Change" procedure [With CPF].
   1) Turn ignition switch OFF.
   2) Connect a GDS Data Link Connector (DLC).
   3) Turn ignition switch ON.
   4) Select "Vehicle, Model year, Engine, System".
   5) Select "Vehicle S/W Management".
   6) Select "Component Change Routine".
   7) Select "ECU Change".

8) Input the mileage in odometer.



SFDF29207E

9) Confirm the "Complete" message and then turn ignition switch OFF.



SFDF29208E

10) Wait for more than 10 seconds, and then turn ignition switch ON.

8. Perform "Injector Specific Data Input" procedure (Refer to "INJECTOR" in this group).
9. Perform "Key Teaching" procedure (Refer to "IMMOBILIZER" in BE group).

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.
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 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, replace the ECM with a new one, and then check the vehicle again. If the vehicle operates normally then the problem was likely with the 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 PROCEDURE in BASIC INSPECTION PROCEDURE)

Injector

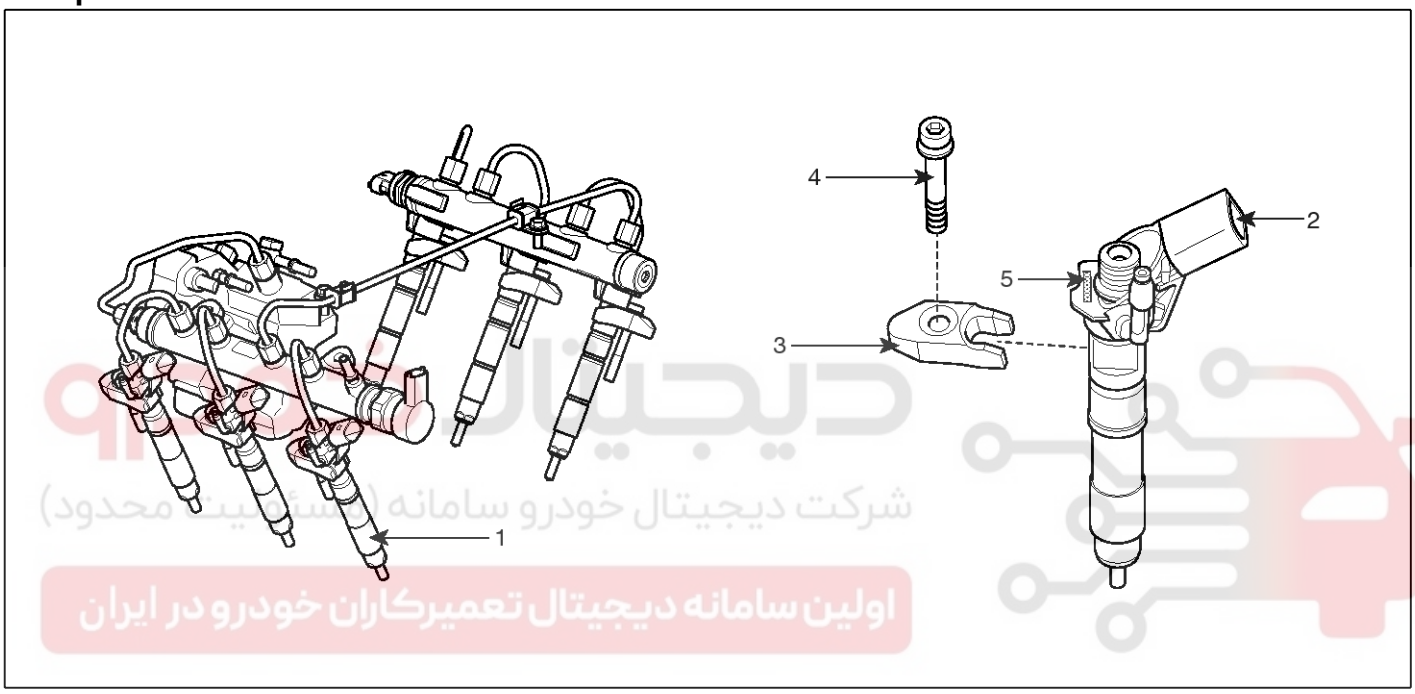
Description

WARNING

As the Piezo-Injector operates under maximum DC 200V, there may be a risk of an electric shock caused by shorted control line etc. So when repairing the injector or its wiring, disconnect the battery negative (-) terminal from the battery and wait for about 30 seconds.

The injectors are installed on the cylinder head and inject the compressed fuel stored in common rail into each cylinder by ECM control signal. This consists of the piezo actuator, the hydraulic coupler which amplifies output of the piezo actuator, the pressure control valve which moves the needle, the needle which opens or closes the injection hole of the injector, the fuel inlet nipple, and the fuel return nipple.

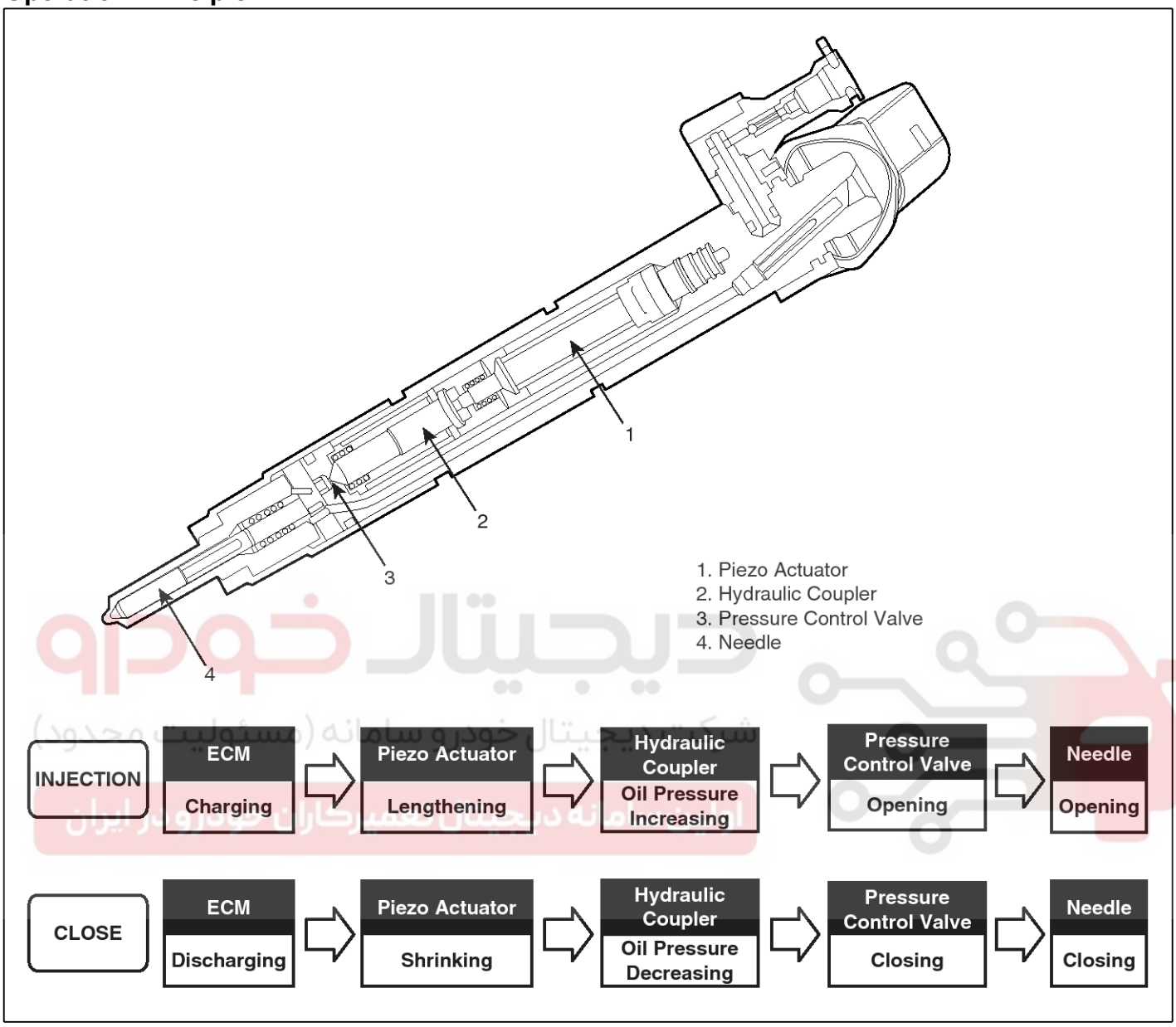
Components



SENFL9159L

1. Injector
2. Connector
3. Clamp
4. Clamp Mounting Bolt
5. Injector Specific Data (7 digits)

Operation Principle



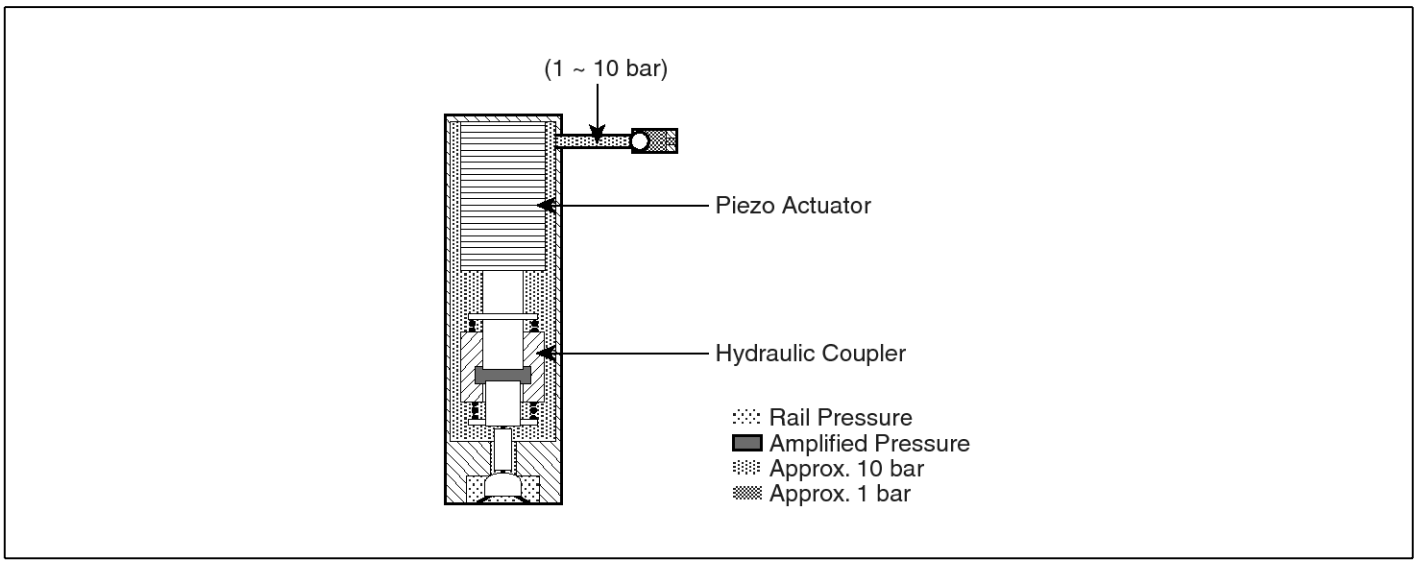
SENFL7114L

● Piezo Actuator

The Piezo Actuator is made up of several floors of cylindrical piezo-ceramic (height: approximately 90㎛). This lengthens by from 1.5% through 2.0% of its length if voltage is applied (Piezoelectric Converse Effect) and this length is “Stroke”. The number and the cross section of the ceramic are proportional to the actuator’s stroke and output respectively.

● Hydraulic Coupler

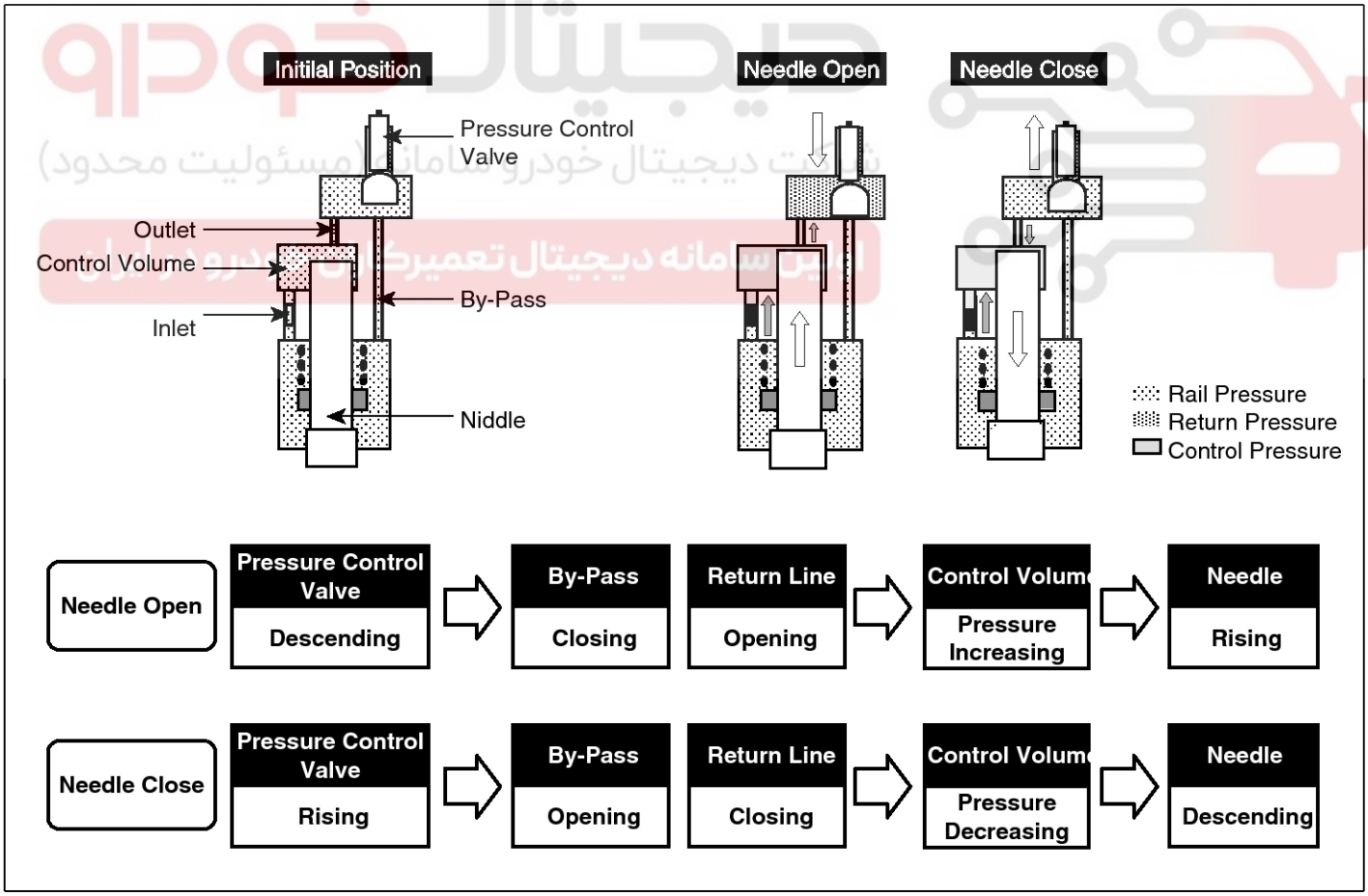
The hydraulic coupler is located under the piezo actuator and amplifies the actuator’s output by the cross section ratio of the upper and the lower pistons. At this time, the actuator’s stroke is lengthened. The hydraulic oil is the fuel and the oil pressure to operate the hydraulic coupler normally is from 1 through 10 bar.



SENFL7115L

● Pressure Control Valve

The Pressure Control Valve is located under the hydraulic coupler and controls the needle by amplified actuator's output.



SENFL7116L

● Needle

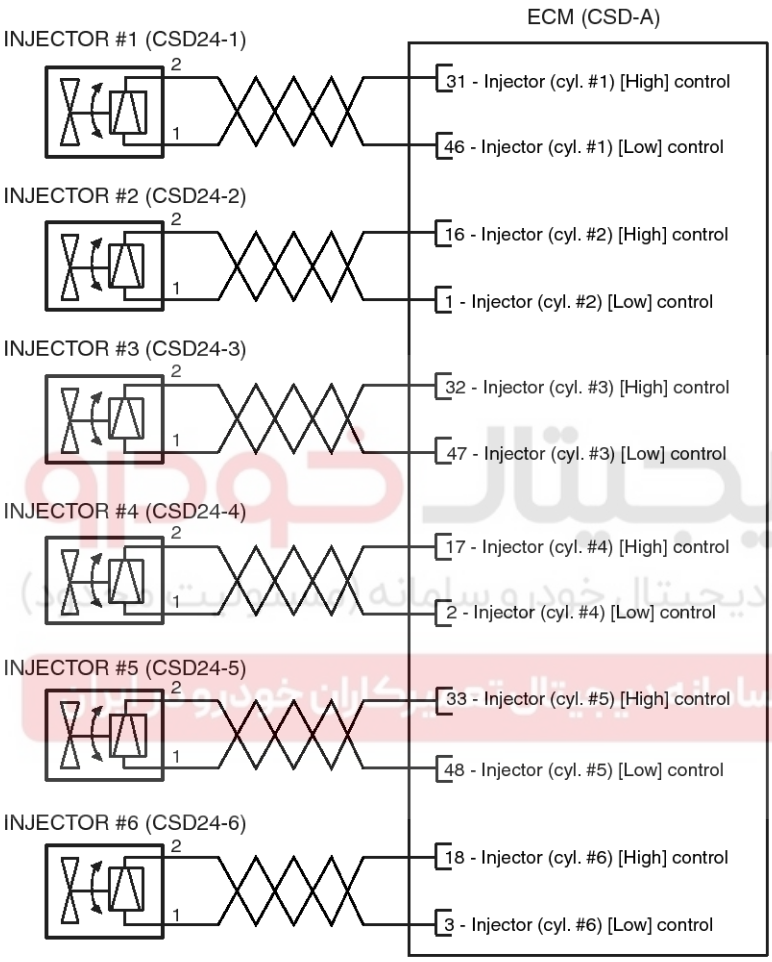
The needle is located under the pressure control valve and finally opens or closes the injection hole.

Specification

Items	Specification
Component Resistance (kΩ)	150 ~ 250 [20℃(68°F)]
Operation Voltage (V)	100 ~ 200

Circuit Diagram

[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

INJECTOR #1 (CSD24-1)

Terminal	Connected to	Function
1	ECM CSD-A (46)	Injector (cyl. #1) [LOW]
2	ECM CSD-A (31)	Injector (cyl. #1) [HIGH]

INJECTOR #2 (CSD24-2)

Terminal	Connected to	Function
1	ECM CSD-A (1)	Injector (cyl. #2) [LOW]
2	ECM CSD-A (16)	Injector (cyl. #2) [HIGH]

INJECTOR #3 (CSD24-3)

Terminal	Connected to	Function
1	ECM CSD-A (47)	Injector (cyl. #3) [LOW]
2	ECM CSD-A (32)	Injector (cyl. #3) [HIGH]

INJECTOR #4 (CSD24-4)

Terminal	Connected to	Function
1	ECM CSD-A (2)	Injector (cyl. #4) [LOW]
2	ECM CSD-A (17)	Injector (cyl. #4) [HIGH]

INJECTOR #5 (CSD24-5)

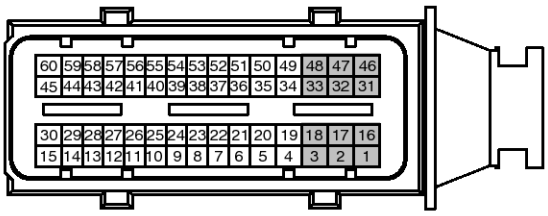
Terminal	Connected to	Function
1	ECM CSD-A (48)	Injector (cyl. #5) [LOW]
2	ECM CSD-A (33)	Injector (cyl. #5) [HIGH]

INJECTOR #6 (CSD24-6)

Terminal	Connected to	Function
1	ECM CSD-A (3)	Injector (cyl. #6) [LOW]
2	ECM CSD-A (18)	Injector (cyl. #6) [HIGH]

[HARNESS CONNECTOR]

CSD24-1,2,3,4,5,6
INJECTOR #1,2,3,4,5,6



CSD-A
ECM

SENFL7117L

Removal

WARNING

As the Piezo-Injector operates under maximum DC 200V, there may be a risk of an electric shock caused by shorted control line etc. So when repairing the injector or its wiring, disconnect the battery negative (-) terminal from the battery and wait for about 30 seconds.

CAUTION

- **Common Rail Fuel Injection System operates with extremely high pressure (approximately 1,600bar), so never perform any work on injection system with engine running or within 30 seconds after the engine stops.**
- **Keep cleanly the parts and the working area.**
- **Pay attention to a foreign substance.**
- **Just before installing injector, tube or hose, remove the protect-cap attached on them.**
- **Do not remove injector except for special case.**
- **When installing Injector**

  - Wash the contact area of the injector and replace the O-ring with a new one.

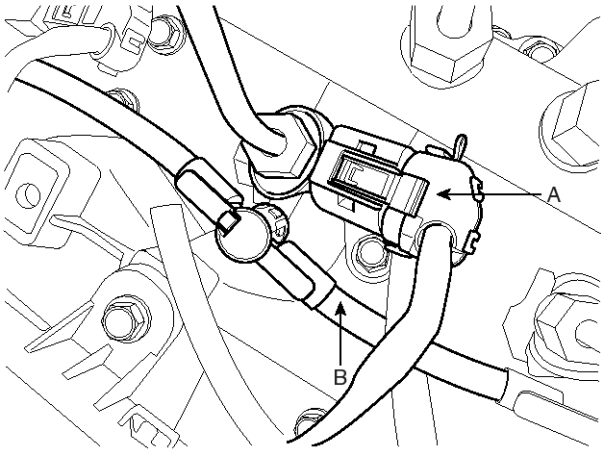
  - Spread oil on the injector O-ring.

  - To protect damage caused by shock, vertically insert the injector into the cylinder head.
- **When installing High Pressure Fuel Pipe**

  - Do not use again the used high pressure fuel pipe.

  - Install the flange nut correctly.

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

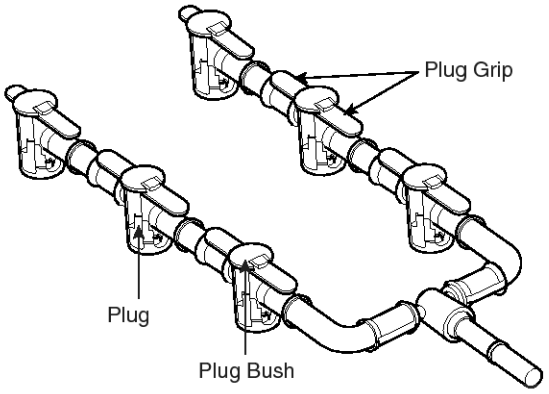


SENFL7129D

3. Disconnect the injector return line (B).

NOTICE

Before connecting the injector return line or after disconnecting the injector return line, check that the plug bush was completely raised from the plug. Otherwise fuel will leak around the injector's nipple because of broken plug.

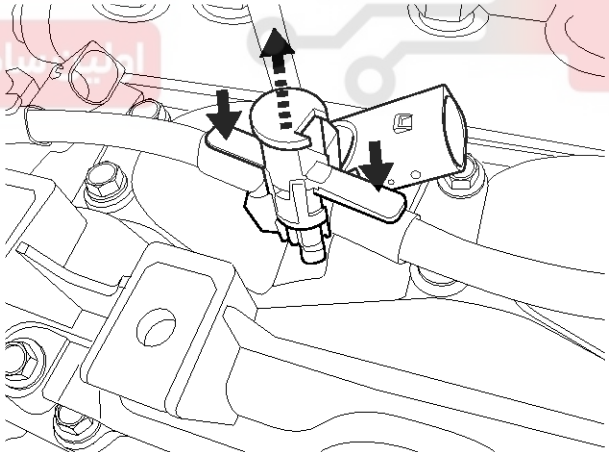


SENFL7118L

NOTICE

[DISCONNECTION-INJECTOR RETURN LINE]

1. *Pull the plug bush upward with the plug grip pressed.*

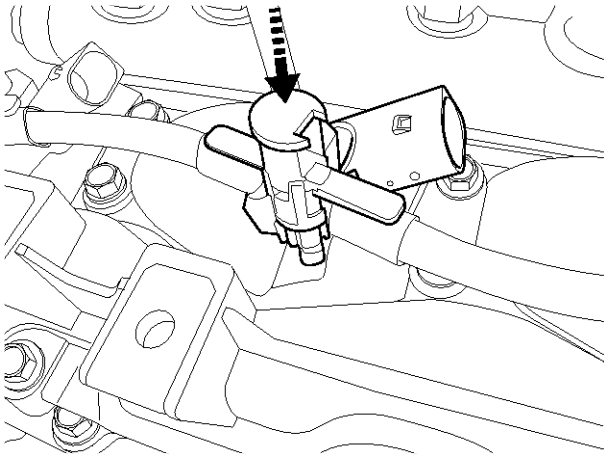


SENFL7131D

2. *Seize the return line on both sides of the plug, and then disconnect the plug upward from the injector nipple.*

[CONNECTION-INJECTOR RETURN LINE]

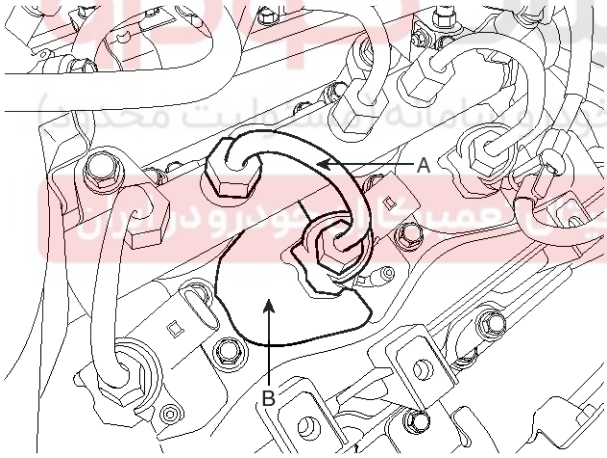
1. *With the plug bush fully raised, vertically install the plug to the injector nipple until "Click" sound generates.*



SENFL7132D

2. *Press the plug bush downward until "Click" sound generates.*

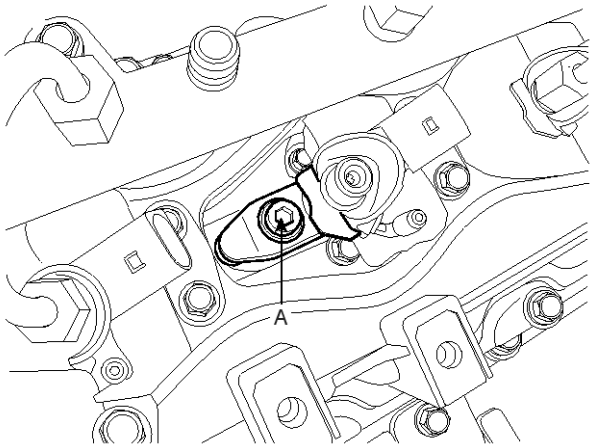
4. Disconnect the high pressure fuel pipe (A).



SENFL7133D

5. Remove the injector pad (B).

6. Unscrew the injector clamp bolt (A), and then remove the injector.



SENFL7134D

NOTICE

If the injector adheres to the cylinder head, use the Special Service Tool (SST No.: 09351-4A300).

Installation

1. Installation is reverse of removal.

NOTICE

1. When installing the high pressure fuel pipe, apply the specified tightening torques with the special service tool [SST No.: 09314-3A000].

2. When installing the high pressure fuel pipe connecting the common rail and injector, follow the below procedure.

1. Temporarily install the nuts on common rail and injector

2. Install the injector side and common rail side sequentially

---

Injector clamp installation bolt: 24.5 ~ 26.5 N·m (2.5 ~ 2.7 kgf·m, 18.1 ~ 19.5 lbf·ft)

High pressure fuel pipe installation nut: 24.5 ~ 28.4 N·m (2.5 ~ 2.9 kgf·m, 18.1 ~ 21.0 lbf·ft)

Replacement

WARNING

As the Piezo-Injector operates under maximum DC 200V, there may be a risk of an electric shock caused by shorted control line etc. So when repairing the injector or its wiring, disconnect the battery negative (-) terminal from the battery and wait for about 30 seconds.

CAUTION

- **Common Rail Fuel Injection System operates with extremely high pressure (approximately 1,600bar), so never perform any work on injection system with engine running or within 30 seconds after the engine stops.**
- **Keep cleanly the parts and the working area.**
- **Pay attention to a foreign substance.**
- **Just before installing injector, tube or hose, remove the protect-cap attached on them.**
- **Do not remove injector except for special case.**
- **When installing Injector**

  - Wash the contact area of the injector and replace the O-ring with a new one.

  - Spread oil on the injector O-ring.

  - To protect damage caused by shock, vertically insert the injector into the cylinder head.
- **When installing High Pressure Fuel Pipe**

  - Do not use again the used high pressure fuel pipe.

  - Install the flange nut correctly.

CAUTION

After replacing injector, MUST input the injector specific data (7 digits) of each cylinder into ECM with scan tool.

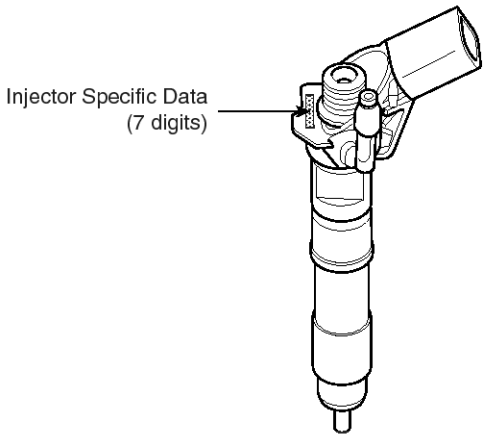
1. Remove the injector (Refer to "REMOVAL" procedure).
2. Install the injector (Refer to "INSTALLATION" procedure).
3. Perform "Injector Specific Data Input" procedure (Refer to "INJECTOR SPECIFIC DATA INPUT" procedure).

Injector Specific Data Input

⚠CAUTION

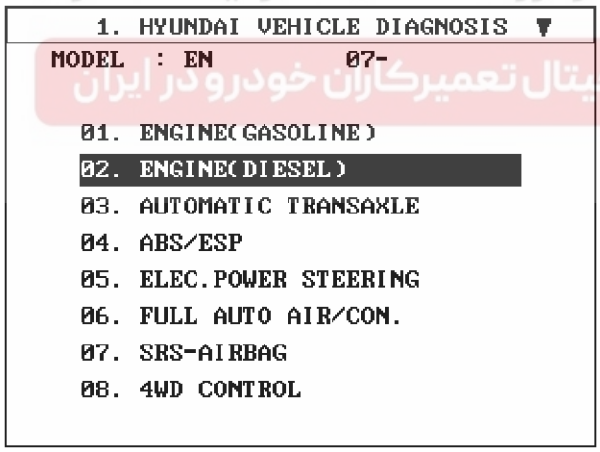
After replacing injector, MUST input the injector specific data (7 digits) of each cylinder into ECM with scan tool.

NOTICE



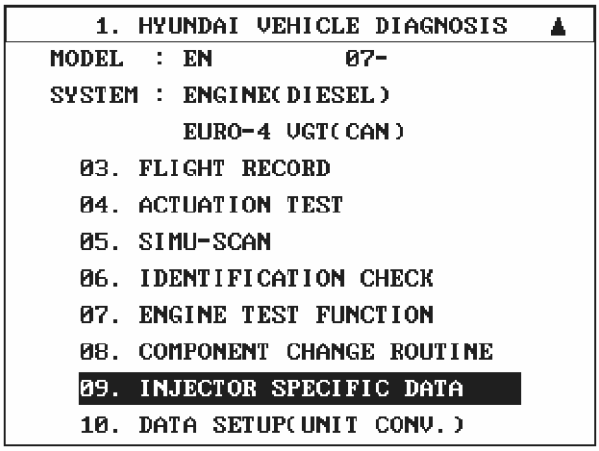
SENFL7119L

1. Turn ignition switch OFF.
2. Connect a scan tool to Data Link Connector (DLC).
3. Turn ignition switch ON.
4. Select "ENGINE (DIESEL)".



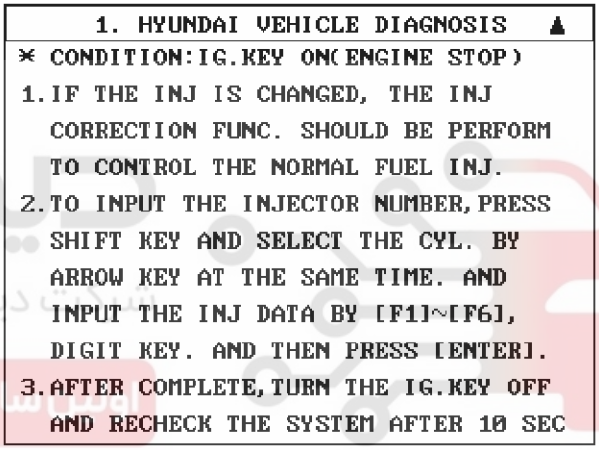
SENFL7162L

5. Select "INJECTOR SPECIFIC DATA".



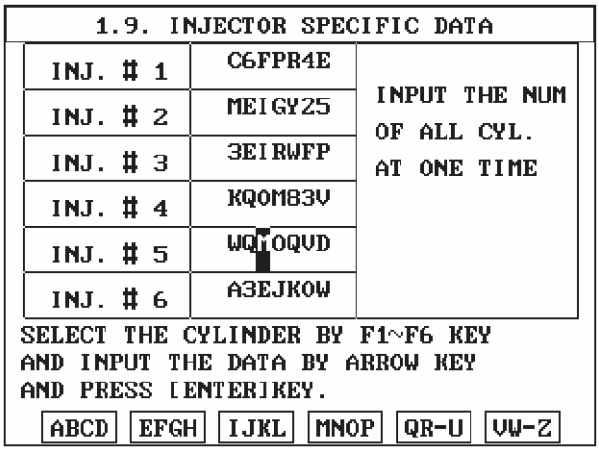
SENFL7163L

6. Confirm the message, and then press "ENTER" key.



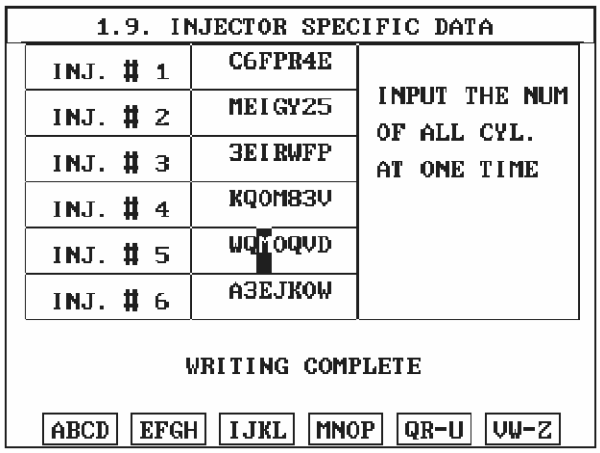
SENFL7164L

7. Input the injector data (7 digit), and then press "ENTER" key.



SENFL7165L

8. After comfirming the "Complete" message, turn ignition switch OFF.

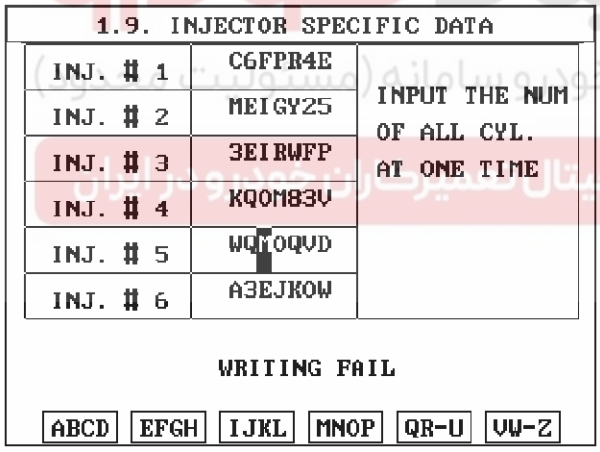


SENFL7166L

9. In about 10 seconds, turn ignition switch ON and check the injector specific data memorized in the ECM.

NOTICE

In case of failure, input the injector specific data (7 digits) into the ECM again.

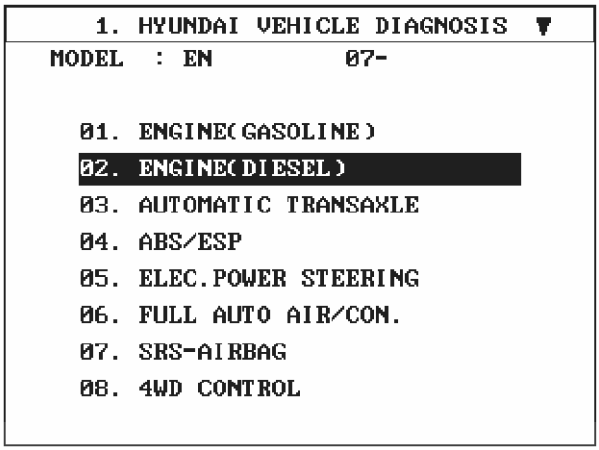


SENFL7167L

Inspection

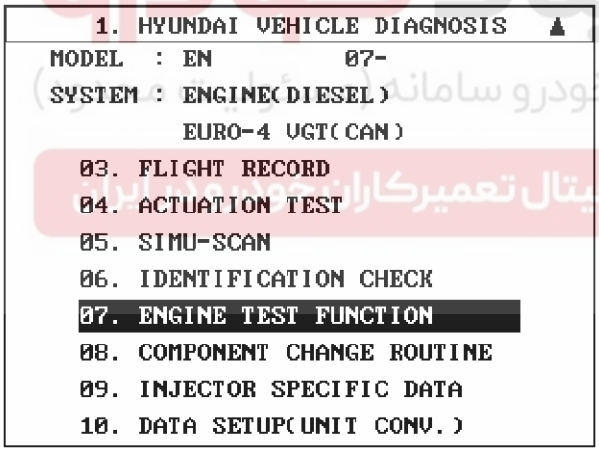
[COMPRESSION TEST]

1. Turn ignition switch OFF.
2. Connect a scan tool to Data Link Connector (DLC).
3. Turn ignition switch ON.
4. Select "ENGINE (DIESEL)".



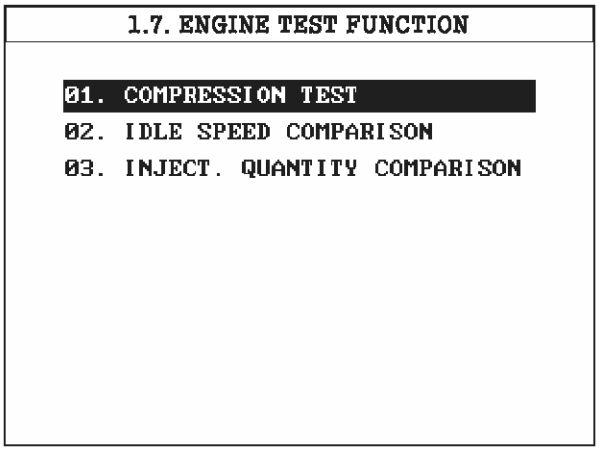
SENFL7168L

5. Select "ENGINE TEST FUNCTION".



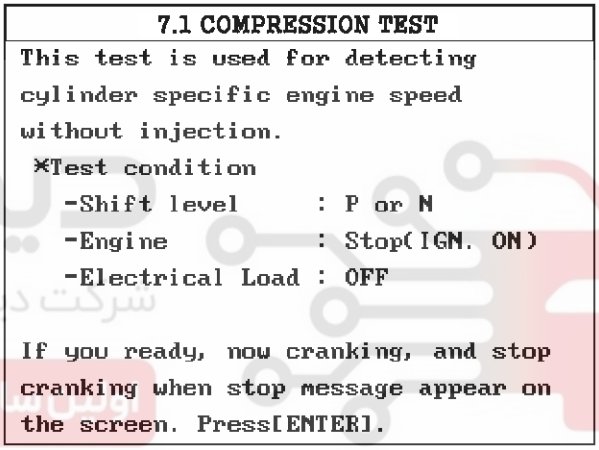
SENFL7169L

6. Select "COMPRESSION TEST".

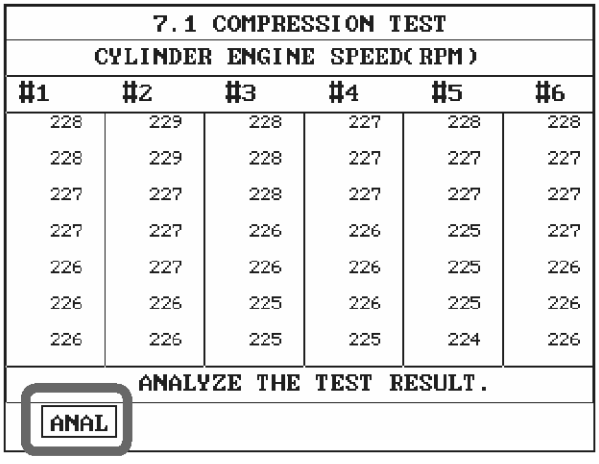


SENFL7170L

7. Perform the test in accordance with the message.



SENFL7171L



SENFL7172L

7.1 COMPRESSION TEST

CYLINDER ENGINE SPEED(RPM)

#1	#2	#3	#4	#5	#6
228	229	228	227	228	228
228	229	228	227	227	227
227	227	228	227	227	227
227	227	226	226	225	227
226	227	226	226	225	226
226	226	225	226	225	226
226	226	225	225	224	226

ANALYZE THE TEST RESULT.

<< >> AVG HELP

SENFL7173L

CYLINDER ENGINE SPEED(RPM)

SPEED(RPM)	200	250	300	350	AVG.
#1 CYL.					227
#2 CYL.					226
#3 CYL.					226
#4 CYL.					227
#5 CYL.					226
#6 CYL.					227

PREV HELP

SENFL7174L

*The higher cylinder engine speed:
->The low compression pressure.
*It can help to identify the
mechanical defects.

PREV

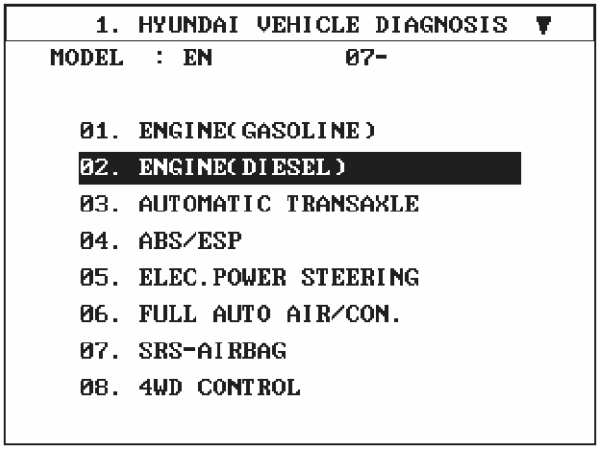
SENFL7175L

NOTICE

If a cylinder's engine speed is higher than the other cylinders, the cylinder's compression pressure is low.

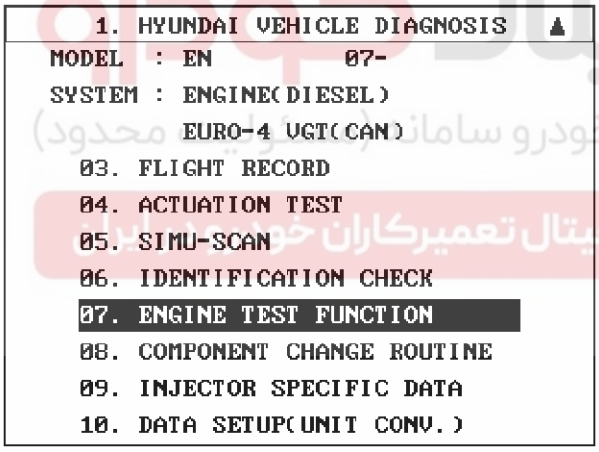
[IDLE SPEED COMPARISON]

1. Turn ignition switch OFF.
2. Connect a scan tool to Data Link Connector (DLC).
3. Turn ignition switch ON.
4. Select "ENGINE (DIESEL)".



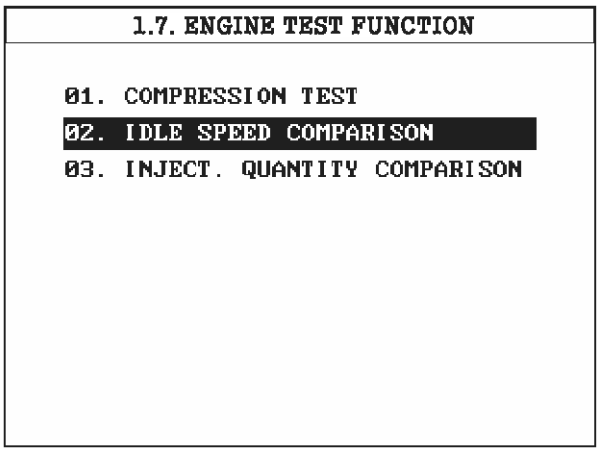
SENFL7168L

5. Select "ENGINE TEST FUNCTION".



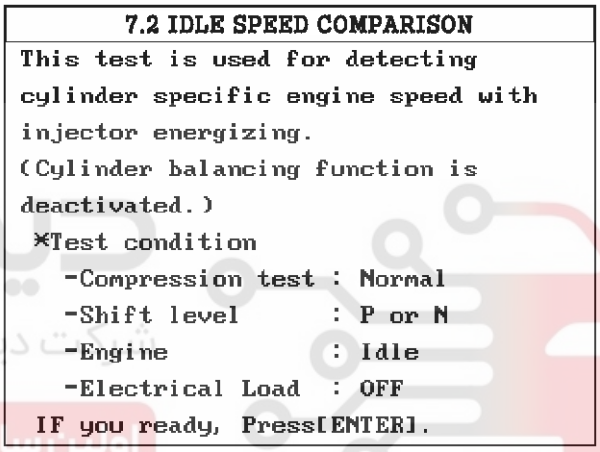
SENFL7169L

6. Select "IDLE SPEED COMPARISON".

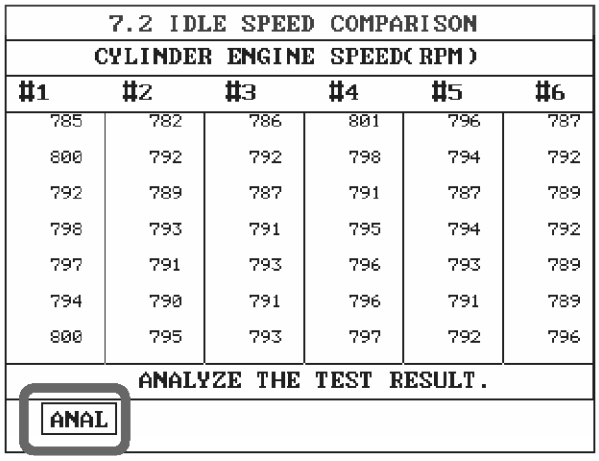


SENFL7176L

7. Perform the test in accordance with the message.



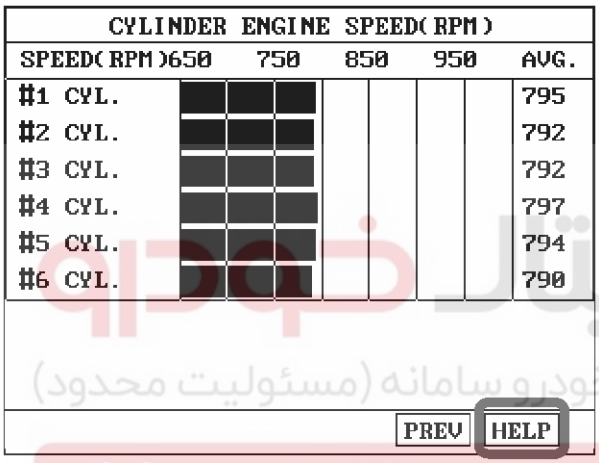
SENFL7177L



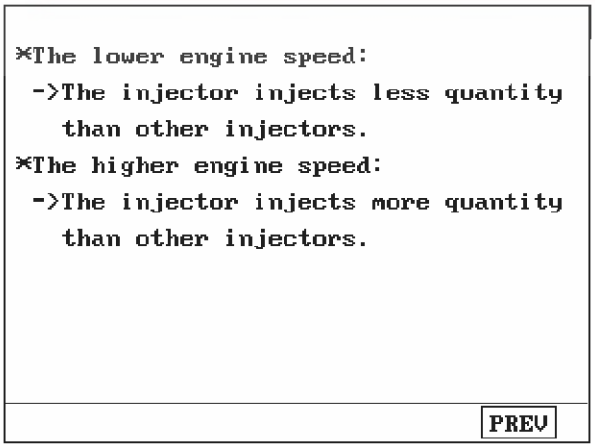
SENFL7178L

7.2 IDLE SPEED COMPARISON					
CYLINDER ENGINE SPEED(RPM)					
#1	#2	#3	#4	#5	#6
785	782	786	801	796	787
800	792	792	798	794	792
792	789	787	791	787	789
798	793	791	795	794	792
797	791	793	796	793	789
794	790	791	796	791	789
800	795	793	797	792	796
ANALYZE THE TEST RESULT.					
<<	>>	AVG		HELP	

SENFL7179L



SENFL7180L



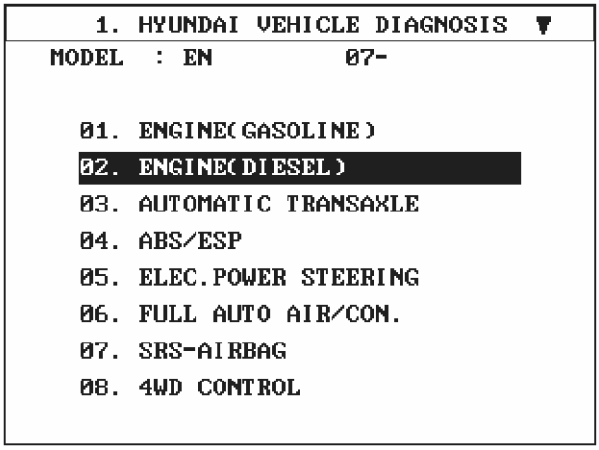
SENFL7181L

NOTICE

The injector in cylinder with significantly high (low) idle speed injects more (less) quantity than the other injectors.

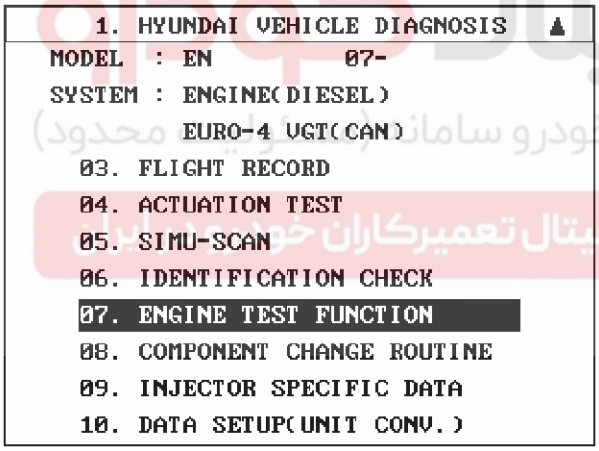
[INJECTION QUANTITY COMPARISON]

1. Turn ignition switch OFF.
2. Connect a scan tool to Data Link Connector (DLC).
3. Turn ignition switch ON.
4. Select "ENGINE (DIESEL)".



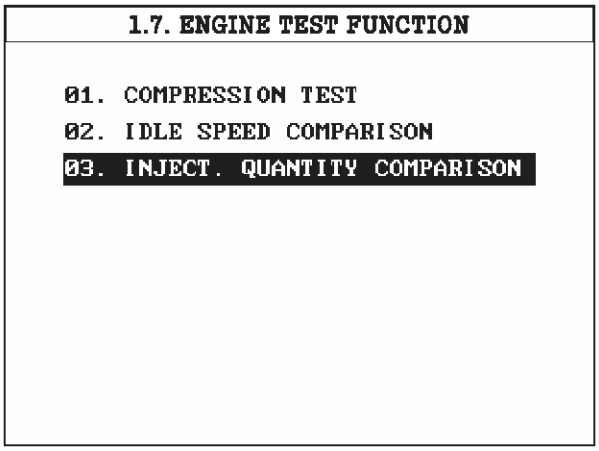
SENFL7168L

5. Select "ENGINE TEST FUNCTION".



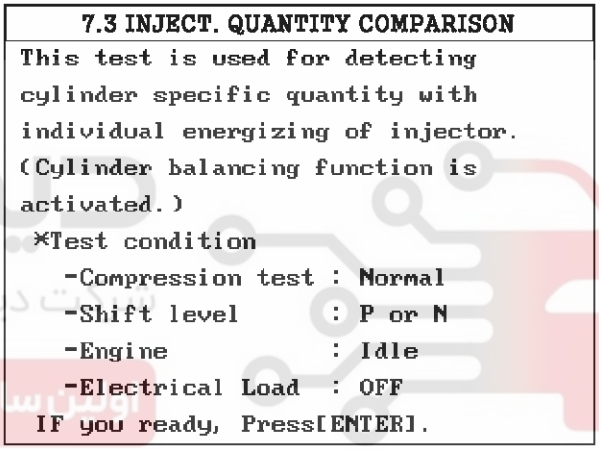
SENFL7169L

6. Select "INJECTION QUANTITY COMPARISON".

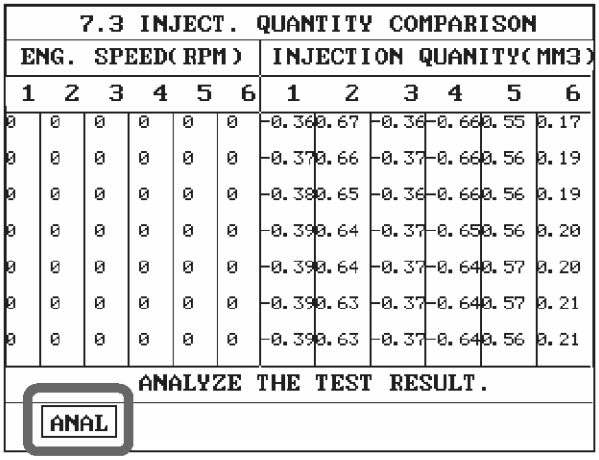


SENFL7182L

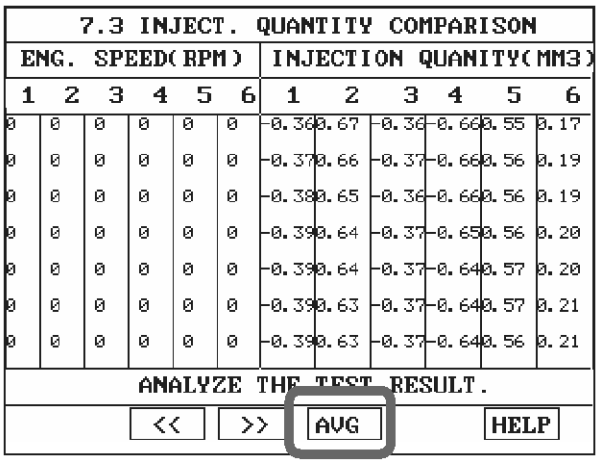
7. Perform the test in accordance with the message.



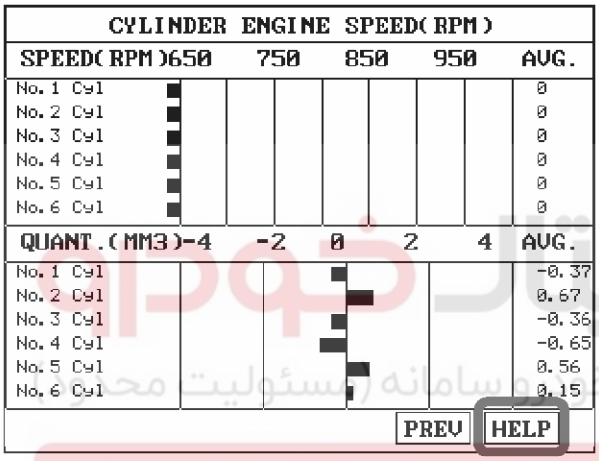
SENFL7183L



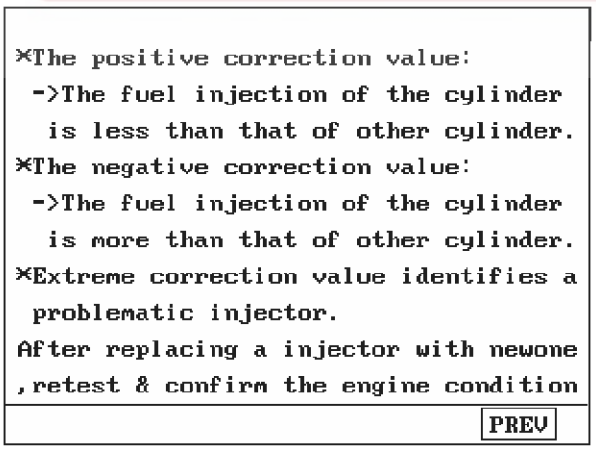
SENFL7184L



SENFL7185L



SENFL7186L



SENFL7187L

NOTICE

** (+) correction value: Injection quantity is less than the others.*

** (-) correction value: Injection quantity is more than the others.*

** Very high correction value: The injector may have any fault. At this time, replace the injector with a new one and perform these tests again.*

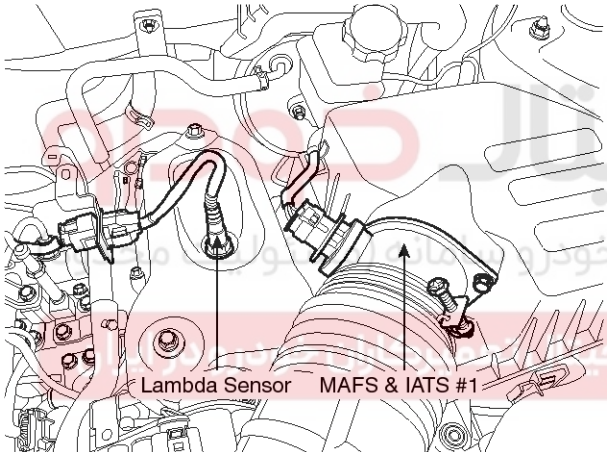
Mass Air Flow Sensor (MAFS)

Function And Operation Principle

The Mass Air Flow Sensor (MAFS) is installed in air intake line and is a hot-film type sensor. This sensor detects mass of air flow and sends the amount to the ECM by frequency signal. A large amount of intake air represents acceleration or high load conditions while a small amount of intake air represents deceleration or idle. By using this signal, the ECM can control EGR amount and fuel injection amount more correctly.

⚠CAUTION

After replacing the Mass Air Flow Sensor (MAFS), MUST perform the "COMPONENT CHANGE ROUTINE" procedure (Refer to "REPLACEMENT" procedure). Otherwise trouble related with engine performance or emission control may occur until ECM learning about the component is over.



SENFL7101L

Specification

At intake air temperature = 20℃(68°F)

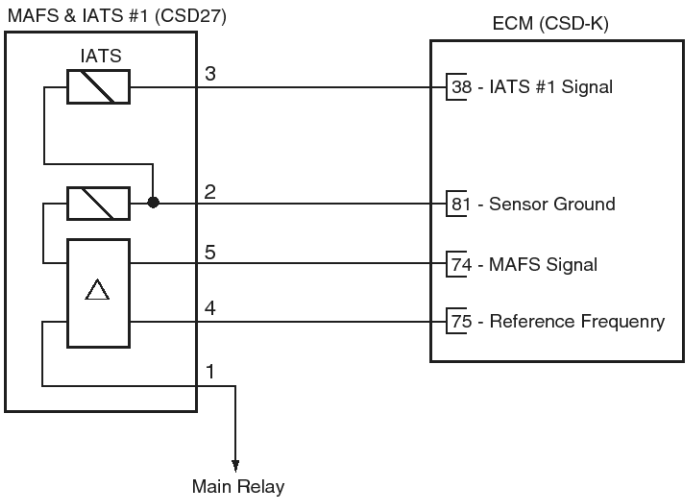
Air Flow (kg/h)	Frequency (kHz)
8	1.94 ~ 1.96
10	1.98 ~ 1.99
15	2.06 ~ 2.07
75	2.72 ~ 2.75
160	3.36 ~ 3.41
310	4.44 ~ 4.53
640	7.66 ~ 8.01
800	10.13 ~ 11.17

At intake air temperature = -15℃(5°F)

Air Flow (kg/h)	Frequency (kHz)
10	1.97 ~ 1.99
75	2.71 ~ 2.76
160	3.34 ~ 3.43
310	4.39 ~ 4.58

Circuit Diagram

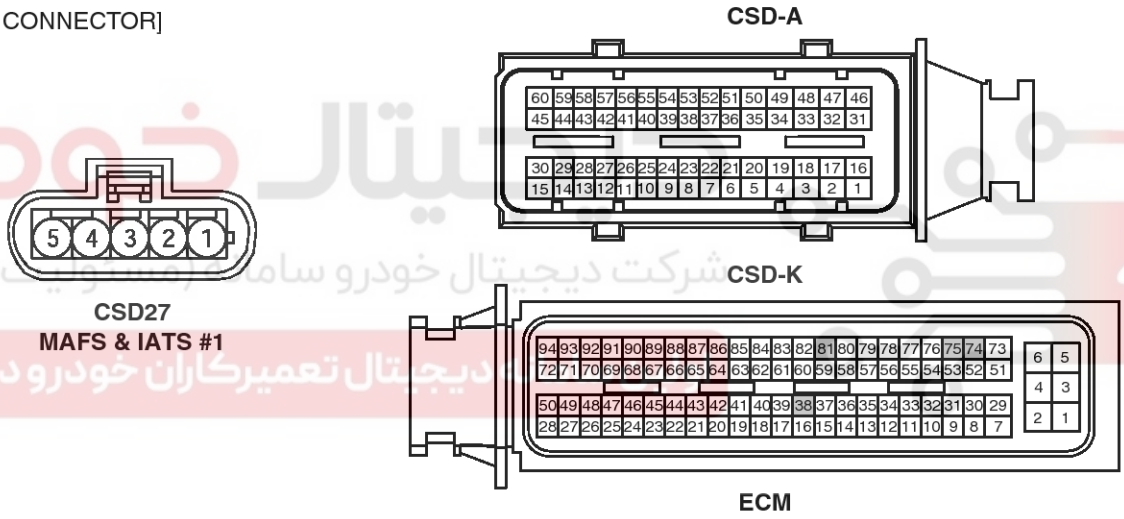
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

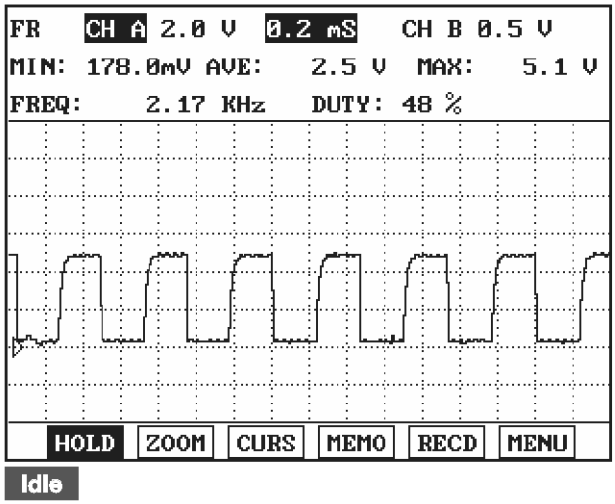
Terminal	Connected to	Function
1	Main Relay	Power Supply (B+)
2	ECM CSD-K (81)	Sensor Ground
3	ECM CSD-K (38)	IATS #1 Signal
4	ECM CSD-K (75)	Reference Frequenry
5	ECM CSD-K (74)	MAFS Signal

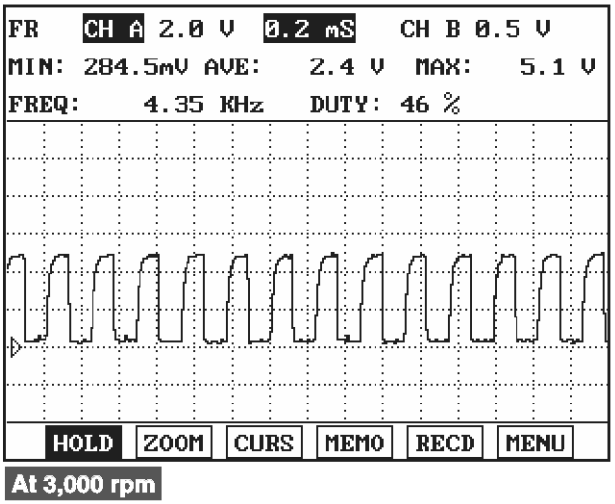
[HARNESS CONNECTOR]



SENFL7120L

Signal Waveform





SENFL7121L

Component Inspection

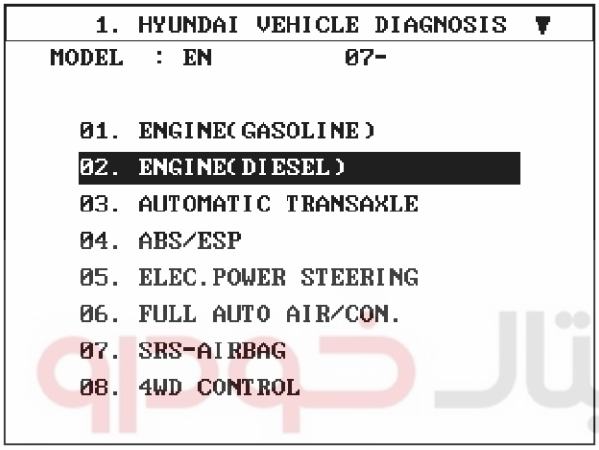
1. Check the MAFS visually.
   - Mounting direction
   - Any contamination, corrosion or damage on connector
   - Clogged or wet air cleaner
   - Deformed or blocked by any foreign material on MAFS' cylinder
2. Check any leakage on intake system and intercooler system.

Replacement

⚠CAUTION

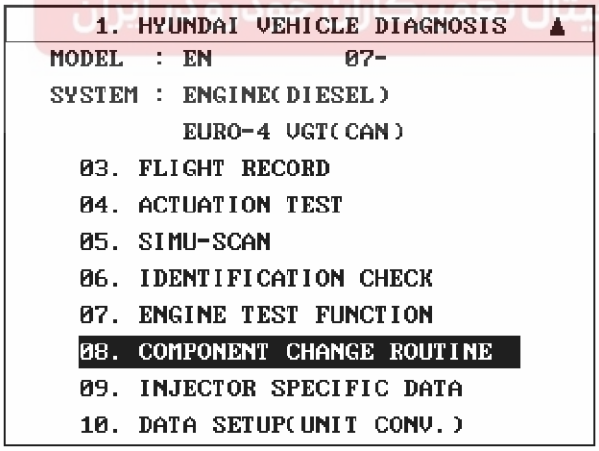
After replacing the Mass Air Flow Sensor (MAFS), MUST perform the "COMPONENT CHANGE ROUTINE" procedure. Otherwise trouble related with engine performance or emission control may occur until ECM learning about the component is over.

1. Turn ignition switch OFF.
2. Connect a scan tool to Data Link Connector (DLC).
3. Turn ignition switch ON.
4. Select "ENGINE (DIESEL)".



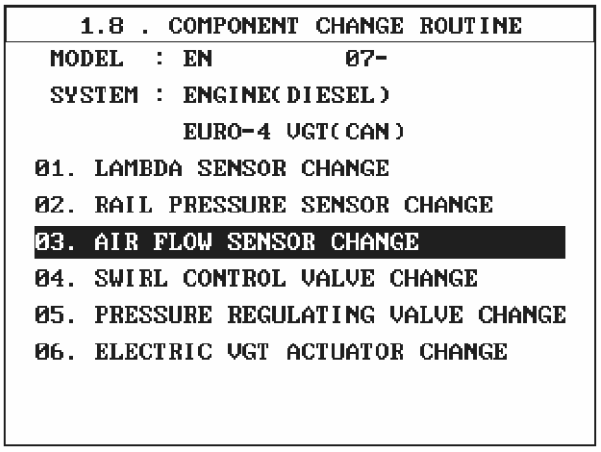
SENFL7188L

5. Select "COMPONET CHANGE ROUTINE".



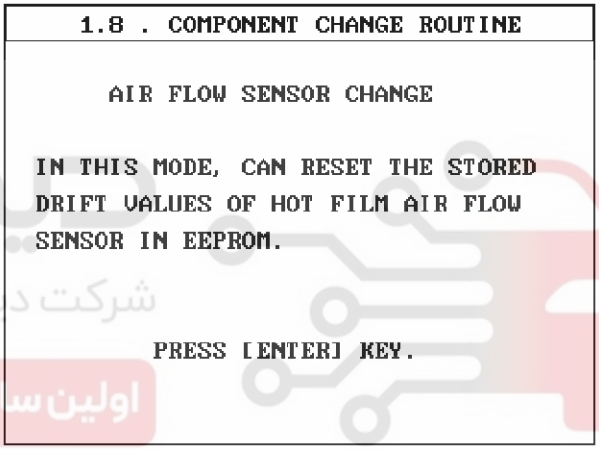
SENFL7189L

6. Select "AIR FLOW SENSOR CHANGE".



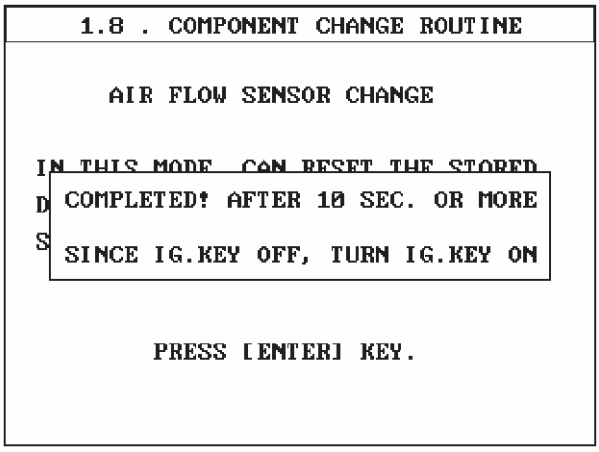
SENFL7190L

7. Confirm the message, and then press "ENTER" key.



SENFL7191L

8. Confirm the "Complete" message, and then turn ignition switch OFF.



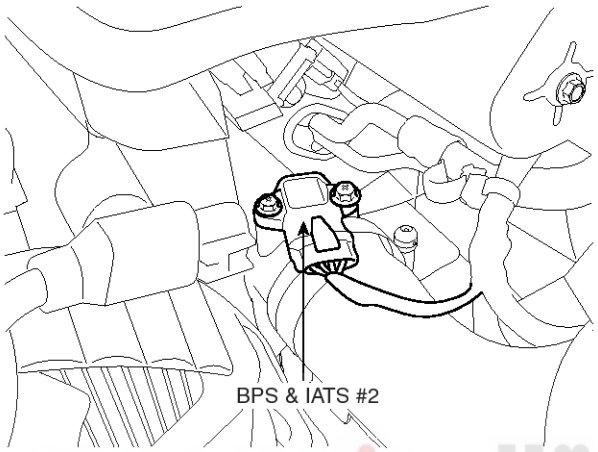
SENFL7192L

9. Wait for more than 10 seconds, and then turn ignition switch ON.

Boost Pressure Sensor (BPS)

Function And Operation Principle

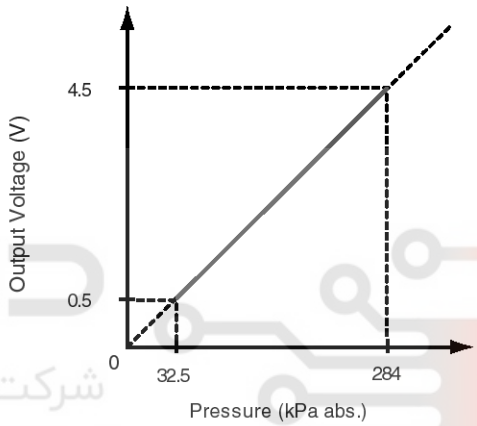
The Boost Pressure Sensor (BPS) is installed on the intercooler assembly and measures the pressure of the compressed air in turbocharger. By using this signal, the ECM controls the Variable Geometry Turbocharger (VGT).



SENFL7104D

Specification

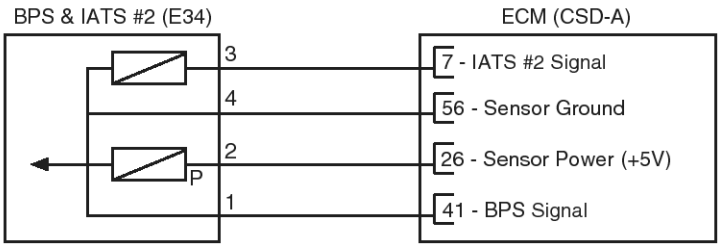
Pressure (Kpa)	Output Voltage (V)
32.5	0.5
70	1.02 ~ 1.17
140	2.13 ~ 2.28
210	3.25 ~ 3.40
270	4.20 ~ 4.35
284	4.5



EFQG038A

Circuit Diagram

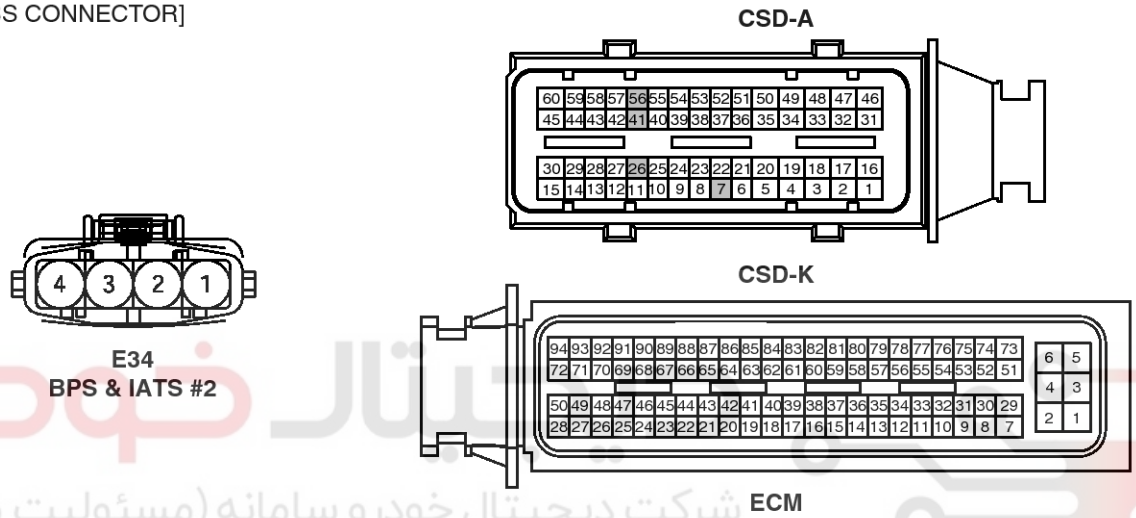
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

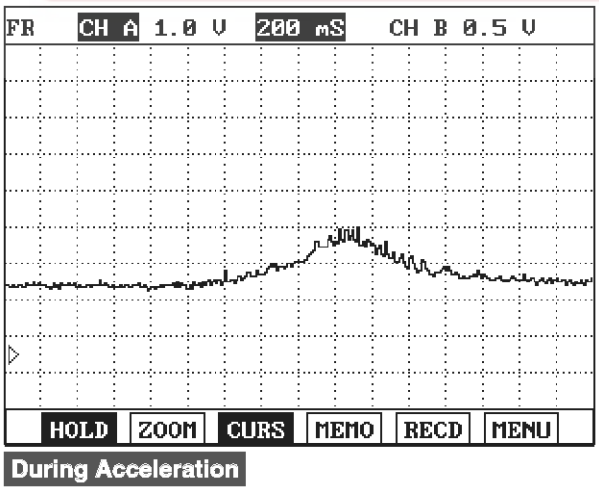
Terminal	Connected to	Function
1	ECM CSD-A (41)	BPS Signal
2	ECM CSD-A (26)	Sensor Power (+5V)
3	ECM CSD-A (7)	IATS #2 Signal
4	ECM CSD-A (56)	Sensor Ground

[HARNESS CONNECTOR]



SENFL7122L

Signal Waveform



During Acceleration

SENFL7123L

Intake Air Temperature Sensor (IATS)

Function And Operation Principle

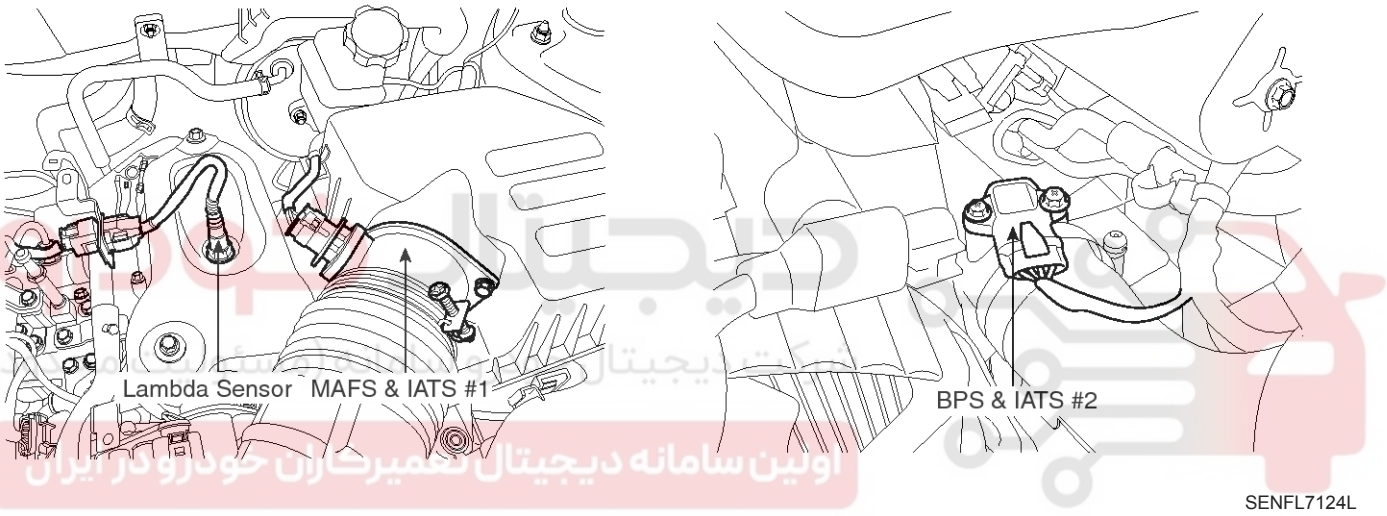
Intake Air Temperature Sensor (IATS) uses a Negative Temperature Characteristics (NTC) thermistor and senses intake air temperature. Two intake air temperature sensors are installed in this engine.

IATS #1 in Mass Air Flow Sensor (MAFS) and IATS #2 in Boost Pressure Sensor (BPS) are located in front of and behind turbo-charger respectively. IATS #1 senses air temperature entering turbo-charger and the other (IATS #2) does air temperature coming out from the turbo-charger.

Comparing these air temperature values from both sensors, more accurate sensing of intake air temperature is possible. ECM uses these air temperature signals to perform EGR control correction and fuel injection quantity correction.

⚠CAUTION

After replacing the Intake Air Temperature Sensor (IATS) #1, MUST perform the "COMPONENT CHANGE ROUTINE" procedure (Refer to "REPLACEMENT" procedure). Otherwise trouble related with engine performance or emission control may occur until ECM learning about the component is over.



SENFL7124L

Specification

IATS #1 (MAFS)

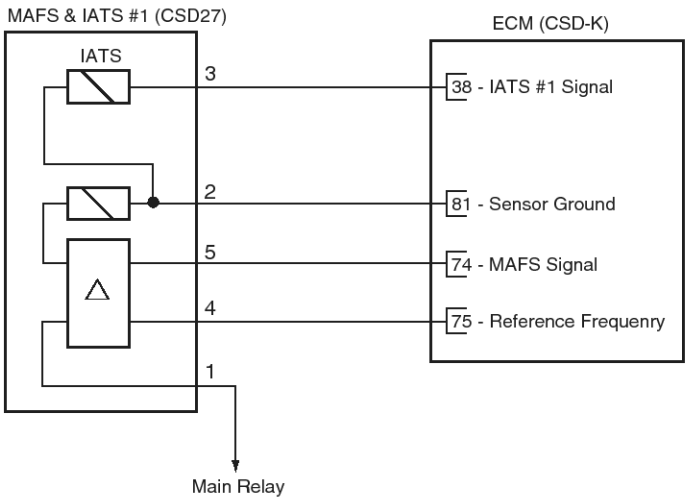
Temperature [℃(˚F)]	Resistance (kΩ)
-40(-40)	35.14 ~ 43.76
-20(-4)	12.66 ~ 15.12
0(32)	5.12 ~ 5.89
20(68)	2.29 ~ 2.55
40(104)	1.10 ~ 1.24
60(140)	0.57 ~ 0.65
80(176)	0.31 ~ 0.37

IATS #2 (BPS)

Temperature [℃(˚F)]	Resistance (kΩ)
-40(-40)	40.93 ~ 48.35
-20(-4)	13.89 ~ 16.03
0(32)	5.38 ~ 6.09
20(68)	2.31 ~ 2.57
40(104)	1.08 ~ 1.21
60(140)	0.54 ~ 0.62
80(176)	0.29 ~ 0.34

Circuit Diagram

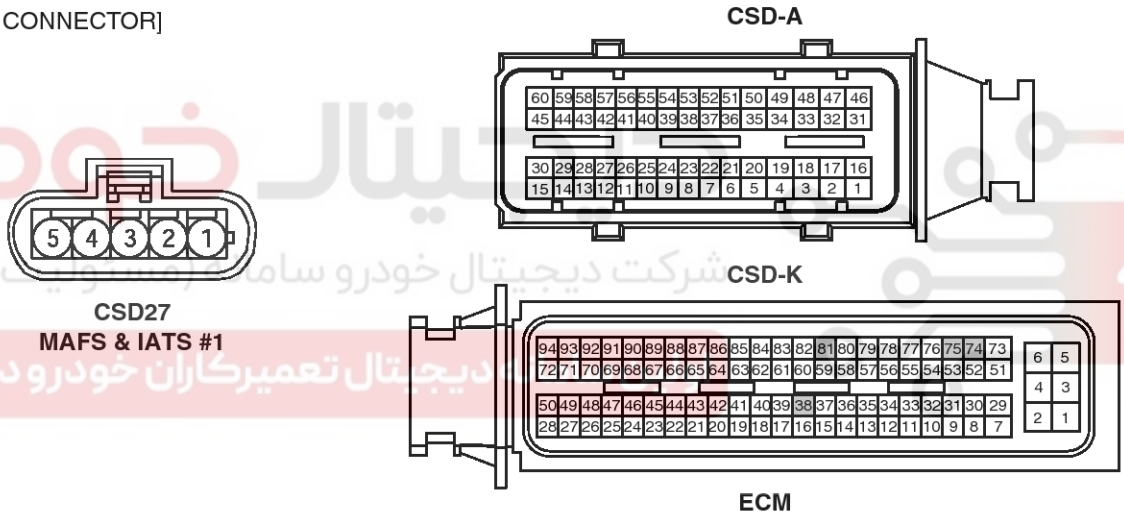
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

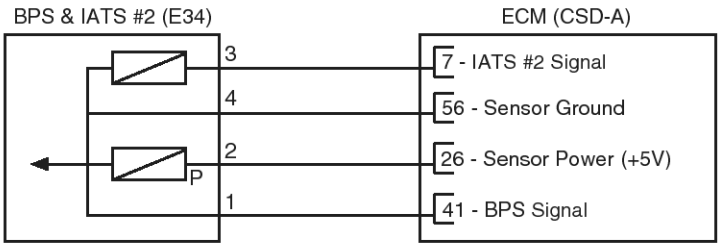
Terminal	Connected to	Function
1	Main Relay	Power Supply (B+)
2	ECM CSD-K (81)	Sensor Ground
3	ECM CSD-K (38)	IATS #1 Signal
4	ECM CSD-K (75)	Reference Frequenry
5	ECM CSD-K (74)	MAFS Signal

[HARNESS CONNECTOR]



SENFL7120L

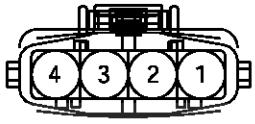
[CIRCUIT DIAGRAM]



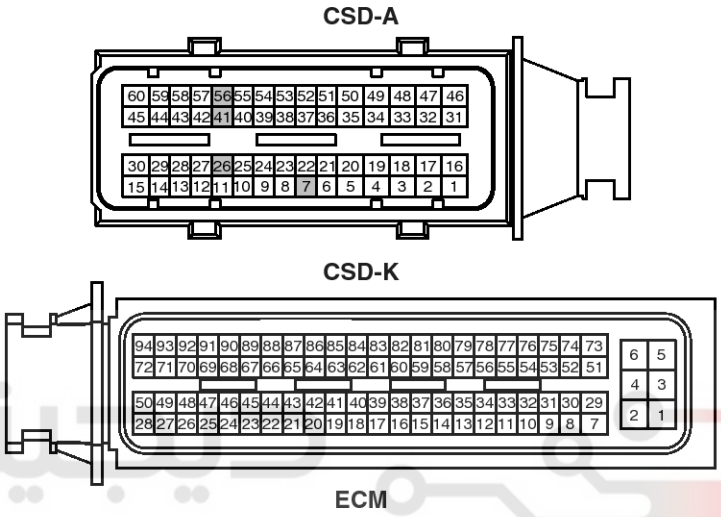
[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM CSD-A (41)	BPS Signal
2	ECM CSD-A (26)	Sensor Power (+5V)
3	ECM CSD-A (7)	IATS #2 Signal
4	ECM CSD-A (56)	Sensor Ground

[HARNESS CONNECTOR]

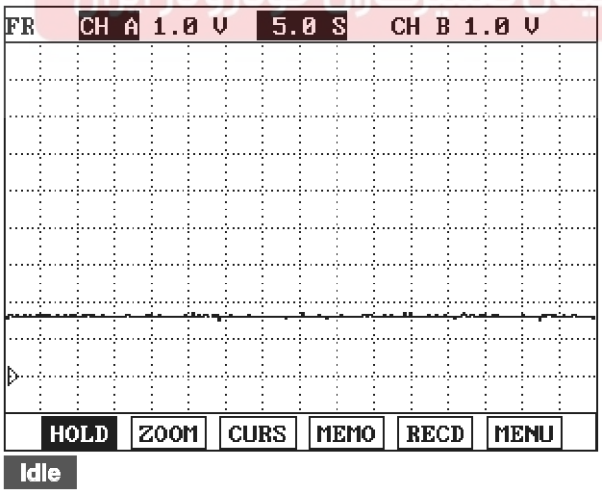


E34
BPS & IATS #2



SENFL7122L

Signal Waveform



SENFL7125L

Component Inspection

1. Turn ignition switch OFF.
2. Disconnect the MAFS (for IATS #1) or BPS (for IATS #2) connector.
3. Measure resistance between IATS signal terminal and sensor ground terminal.
4. Check that the resistance is within the specification.

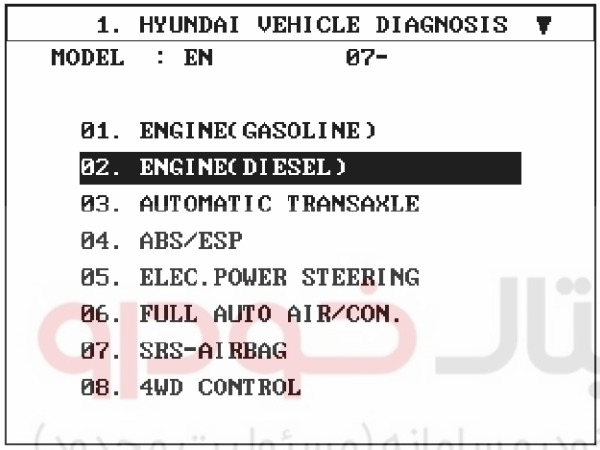
Specification: Refer to "SPECIFICATION"

Replacement

⚠CAUTION

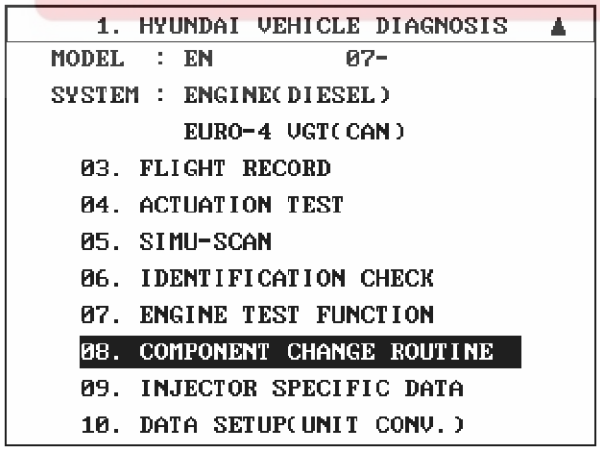
After replacing the Intake Air Temperature Sensor (IATS) #1, MUST perform the "COMPONENT CHANGE ROUTINE" procedure. Otherwise trouble related with engine performance or emission control may occur until ECM learning about the component is over.

1. Turn ignition switch OFF.
2. Connect a scan tool to Data Link Connector (DLC).
3. Turn ignition switch ON.
4. Select "ENGINE (DIESEL)".



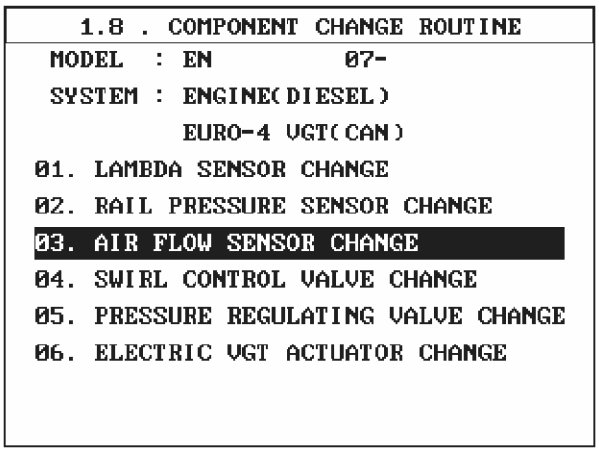
SENFL7193L

5. Select "COMPONET CHANGE ROUTINE".



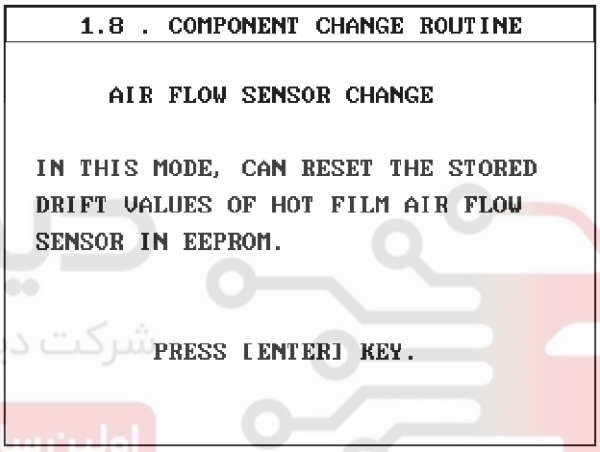
SENFL7194L

6. Select "AIR FLOW SENSOR CHANGE".



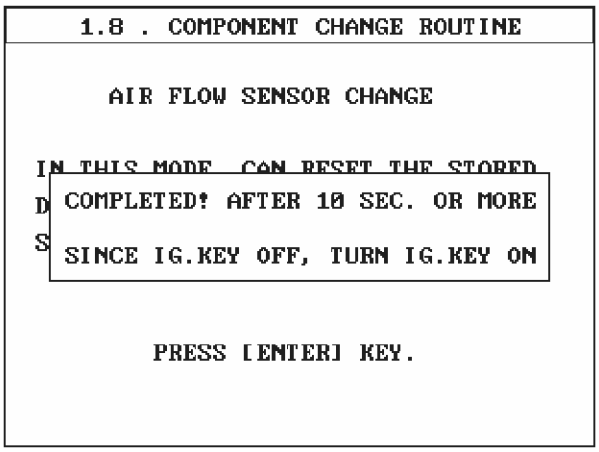
SENFL7195L

7. Confirm the message, and then press "ENTER" key.



SENFL7196L

8. Confirm the "Complete" message, and then turn ignition switch OFF.



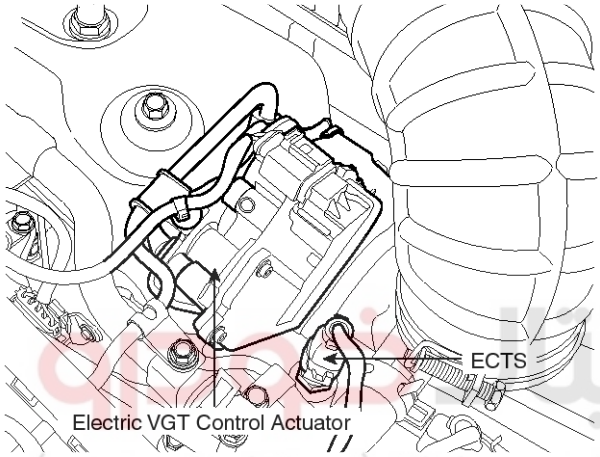
SENFL7197L

9. Wait for more than 10 seconds, and then turn ignition switch ON.

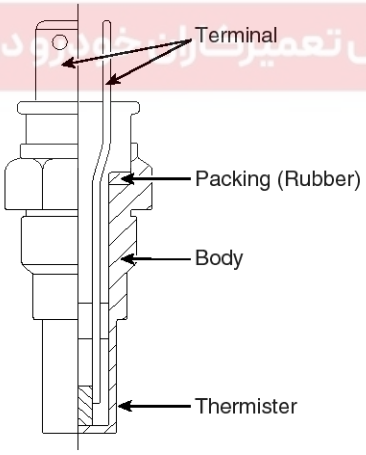
Engine Coolant Temperature Sensor (ECTS)

Function And Operation Principle

The Engine Coolant Temperature Sensor (ECTS) is located in the engine coolant passage of the cylinder for detecting the engine coolant temperature. The ECTS uses a thermistor which resistance is in inverse proportion to the temperature (NTC: Negative Temperature Coefficient). During cold engine operation, the ECM adjusts the injection amount and the timing by using this ECTS output signal to avoid engine stalling and improve drivability.



SENFL7102L



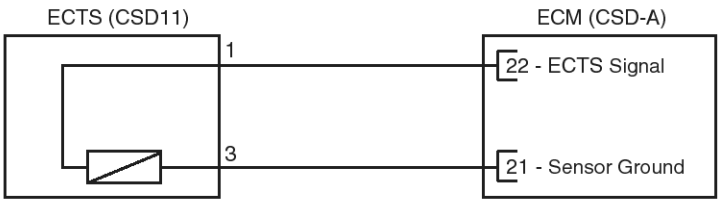
EGRF241A

Specification

Temperature [℃(˚F)]	Resistance (kΩ)
-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

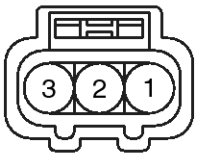
[CIRCUIT DIAGRAM]



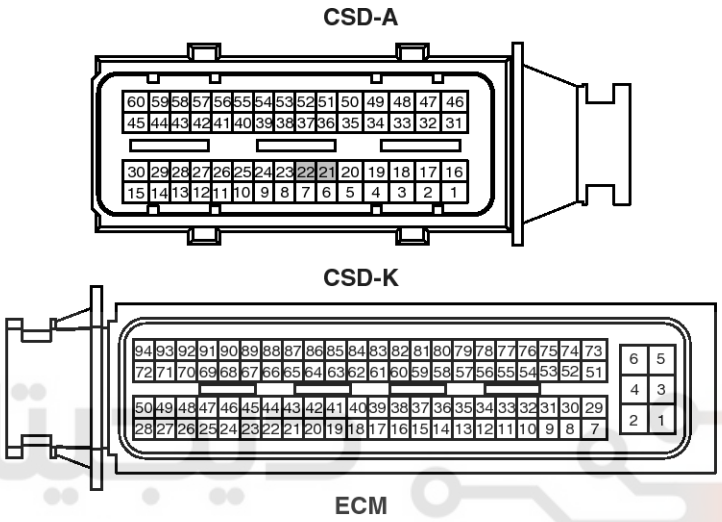
[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM CSD-A (22)	ECTS Signal
2	-	-
3	ECM CSD-A (21)	Sensor Ground

[HARNESS CONNECTOR]



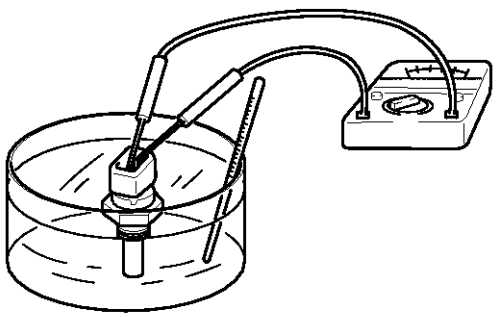
CSD11
ECTS



SENFL7126L

Component Inspection

1. Turn ignition switch OFF.
2. Disconnect the engine coolant temperature sensor connector.
3. Remove the sensor.
4. After immersing the thermistor of the sensor into engine coolant, measure resistance between ECTS signal terminal and ground terminal.



EFNF541A

5. Check that the resistance is within the specification.

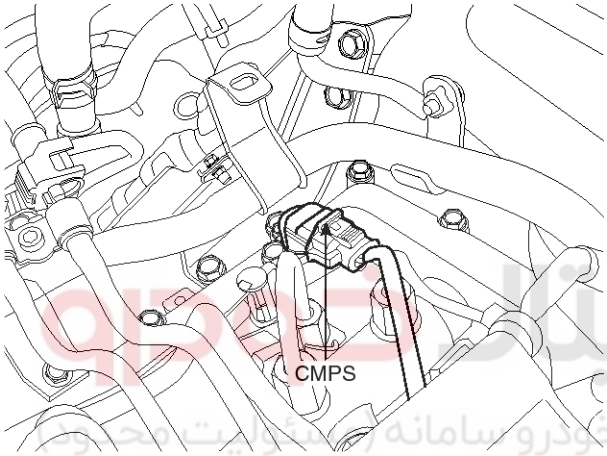
Specification: Refer to "SPECIFICATION"

Camshaft Position Sensor (CMPS)

Function And Operation Principle

The Camshaft Position Sensor (CMPS) is installed on the cylinder head cover and detects the camshaft position. This is a hall sensor and has a hall-effect IC which output voltage changes when magnetic field is made on the IC with current flow.

It is related with Crankshaft Position Sensor (CKPS) and detects the piston position of the each cylinder which the CKPS can't detect. By using this signal, the ECM perceives the position of each cylinder and controls sequential injection.



SENFL7107D

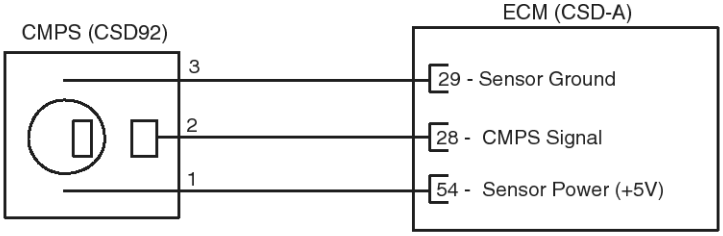
Specification

Level	Output Voltage (V)
High	5
Low	0

Item	Specification
Air gap (mm)	0.5 ~ 1.5

Circuit Diagram

[CIRCUIT DIAGRAM]

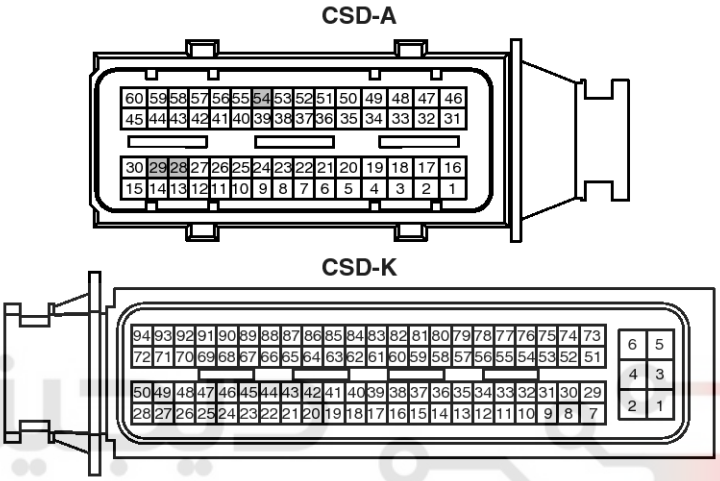


[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM CSD-A (54)	Sensor Power (+5V)
2	ECM CSD-A (28)	CMPS Signal
3	ECM CSD-A (29)	Sensor Ground

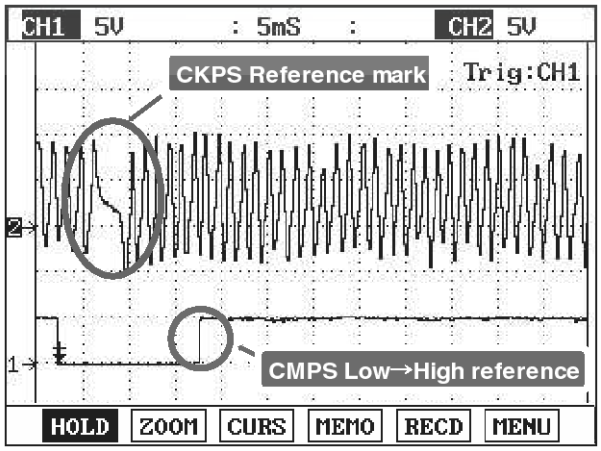
[HARNESS CONNECTOR]

CSD92
CMPS



SENFL7127L

Signal Waveform



SENFL7128L

Component Inspection

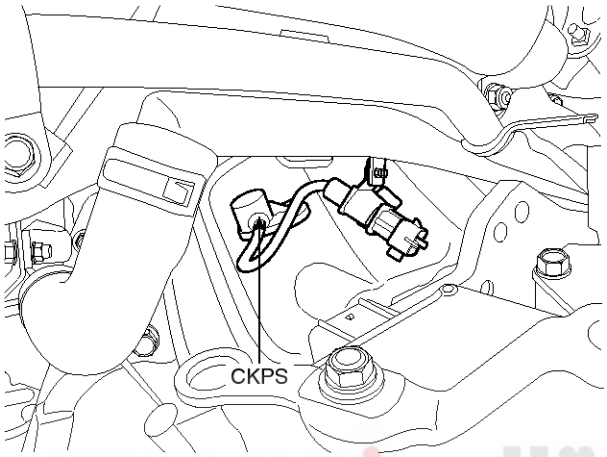
1. Check signal waveform of CMPS and CKPS using a scan tool.

Specification: Refer to "SIGNAL WAVE FORM"

Crankshaft Position Sensor (CKPS)

Function And Operation Principle

The Crankshaft Position Sensor (CKPS) is installed on the transaxle housing and detects the crankshaft position. By using this signal, the ECM can calculate the piston position of each cylinder and the engine speed for sequential injection.



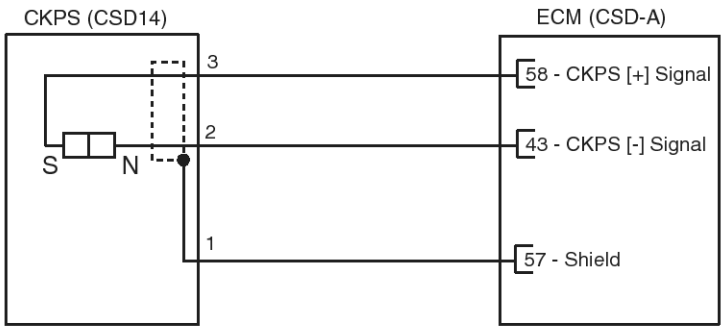
SENFL7106D

Specification

Items	Specification
Coil Resistance (Ω)	774 ~ 946Ω [20℃(68˚F)]
Air Gap (mm)	0.5 ~ 1.5

Circuit Diagram

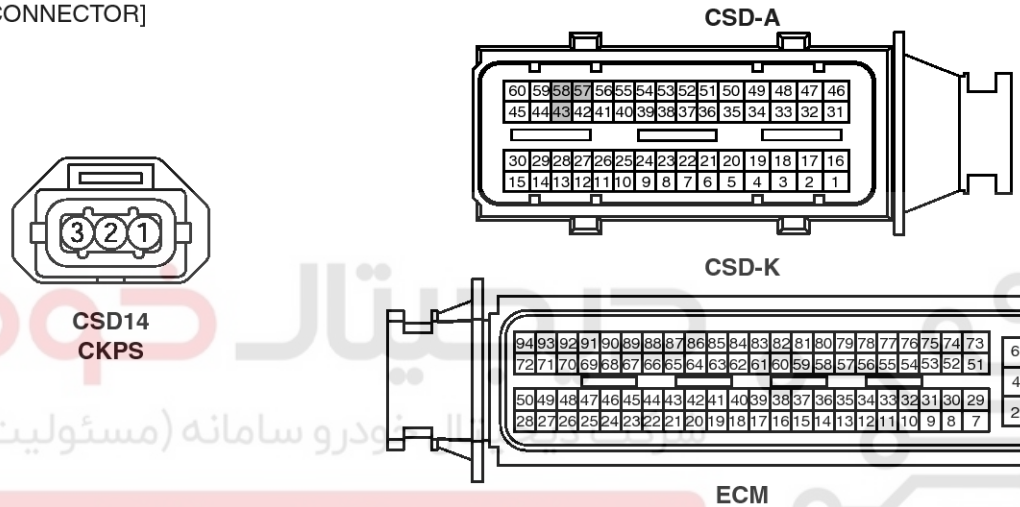
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

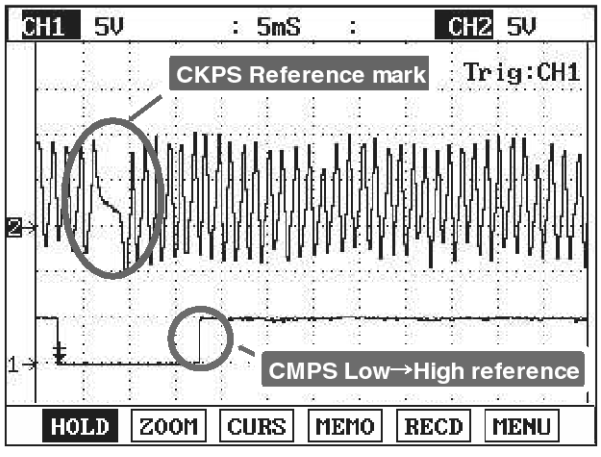
Terminal	Connected to	Function
1	ECM CSD-A (57)	Sensor Shield
2	ECM CSD-A (43)	CKPS [-] Signal
3	ECM CSD-A (58)	CKPS [+] Signal

[HARNESS CONNECTOR]



SENFL7129L

Signal Waveform



SENFL7128L

Component Inspection

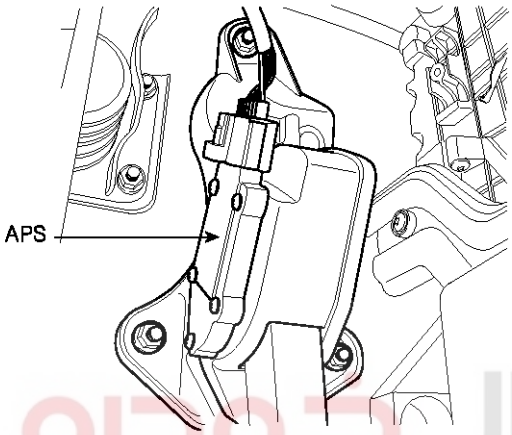
1. Check signal waveform of CMPS and CKPS using a scan tool.

Specification: Refer to "SIGNAL WAVE FORM"

Accelerator Position Sensor (APS)

Function And Operation Principle

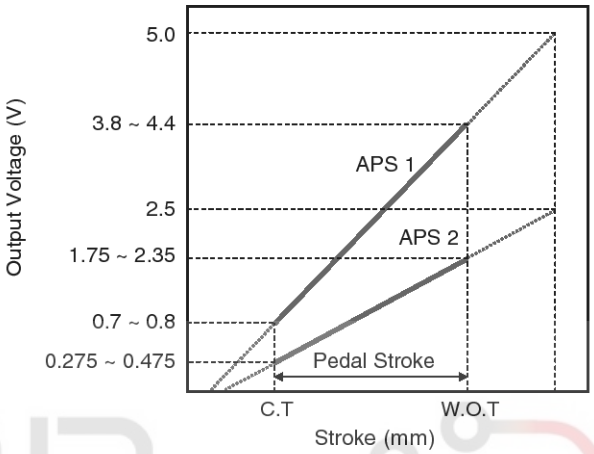
The Accelerator Pedal Position Sensor (APS) is installed on the accelerator pedal assembly and consists of the two potentiometers which have independent circuit (power, signal output, and ground) individually. This system makes the ECM recognize the driver's intention even if one sensor is broken. Also the ECM can diagnose the sensor by comparing the two sensor's signal.



SCMFL6005D

Specification

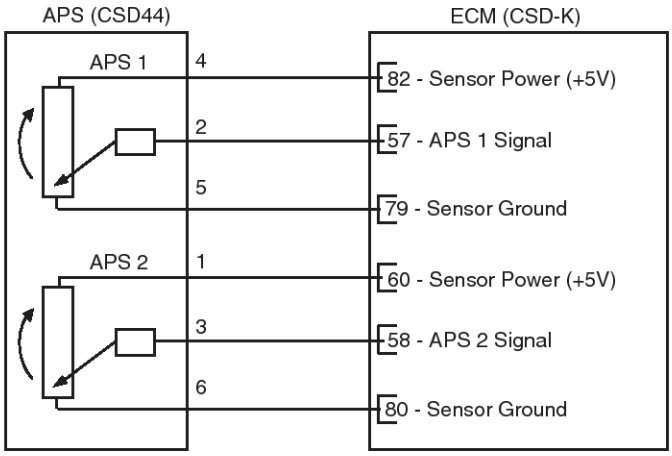
Pedal Position	Output Voltage(V) [Vref = 5.0V]	
	APS1	APS2
Released	0.7 ~ 0.8	0.275 ~ 0.475
Fully depressed	3.8 ~ 4.4	1.75 ~ 2.35



SENFL7130L

Circuit Diagram

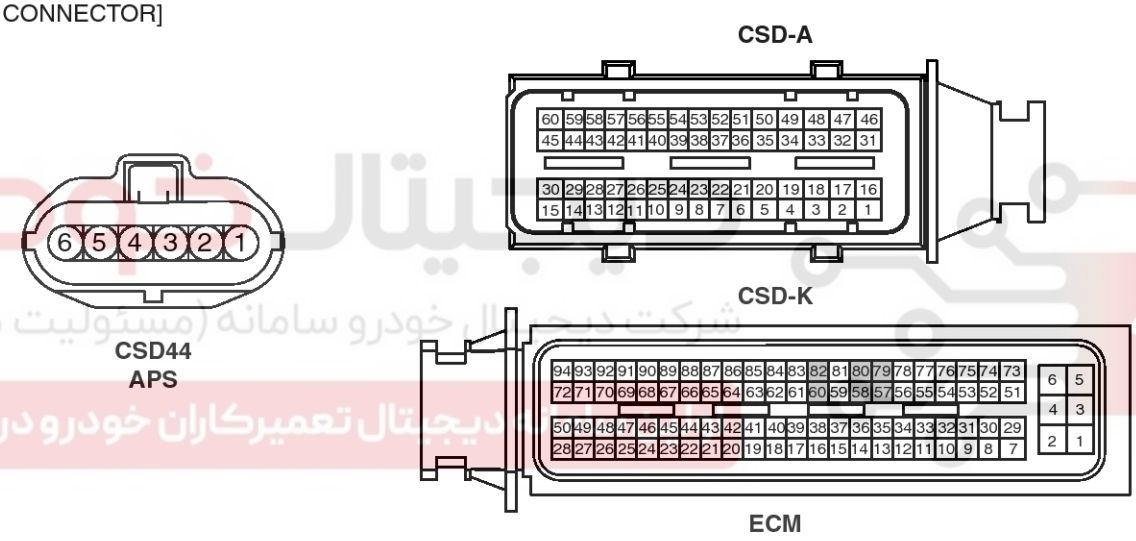
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

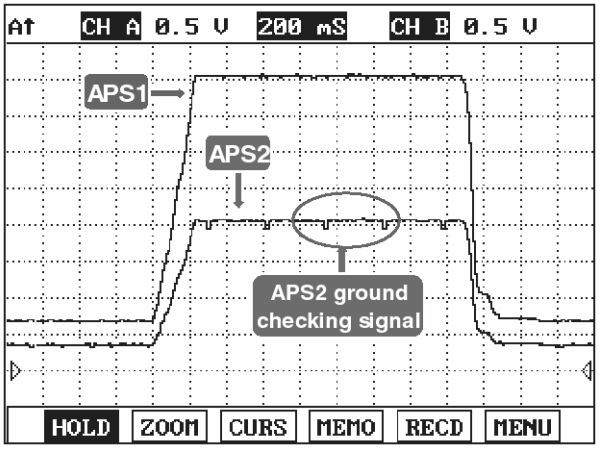
Terminal	Connected to	Function
1	ECM CSD-K (60)	APS 2 Sensor Power (+5V)
2	ECM CSD-K (57)	APS 1 Signal
3	ECM CSD-K (58)	APS 2 Signal
4	ECM CSD-K (82)	APS 1 Sensor Power (+5V)
5	ECM CSD-K (79)	APS 1 Sensor Ground
6	ECM CSD-K (80)	APS 2 Sensor Ground

[HARNESS CONNECTOR]



SENFL7131L

Signal Waveform



SENFL7132L

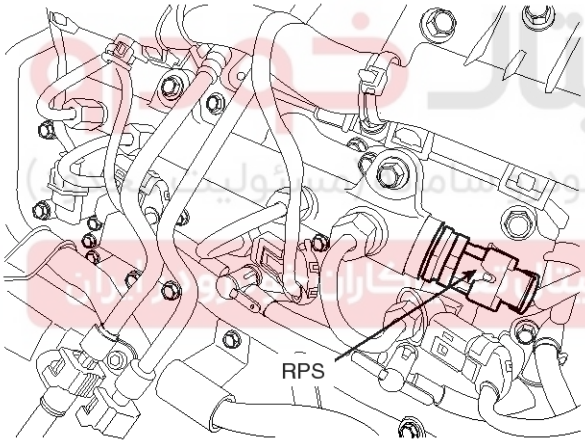
Rail Pressure Sensor (RPS)

Function And Operation Principle

The Rail Pressure Sensor (RPS) is installed at the end of the common rail (bank 1) and measures the instantaneous fuel pressure in the common rail. The sensing element (semiconductor device) built in the sensor converts the pressure to voltage signal. By using this signal, the ECM can control correct injection amount and timing. And it adjusts the rail pressure with the rail pressure regulator valve if the target pressure and the actual pressure calculated by the RPS output signal are different.

⚠CAUTION

After replacing the Rail Pressure Sensor (RPS), MUST perform the "COMPONENT CHANGE ROUTINE" procedure (Refer to "REPLACEMENT" procedure). Otherwise trouble related with engine performance or emission control may occur until ECM learning about the component is over.



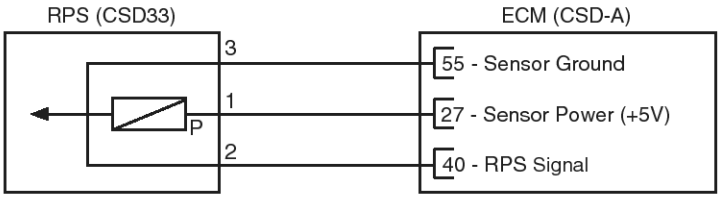
SENFL7108D

Specification

Condition	Rail pressure (bar)	Output Voltage (V)
Idle	200 ~ 300	0.9 ~ 1.2
3,000 rpm	450 ~ 650	1.5 ~ 1.9

Circuit Diagram

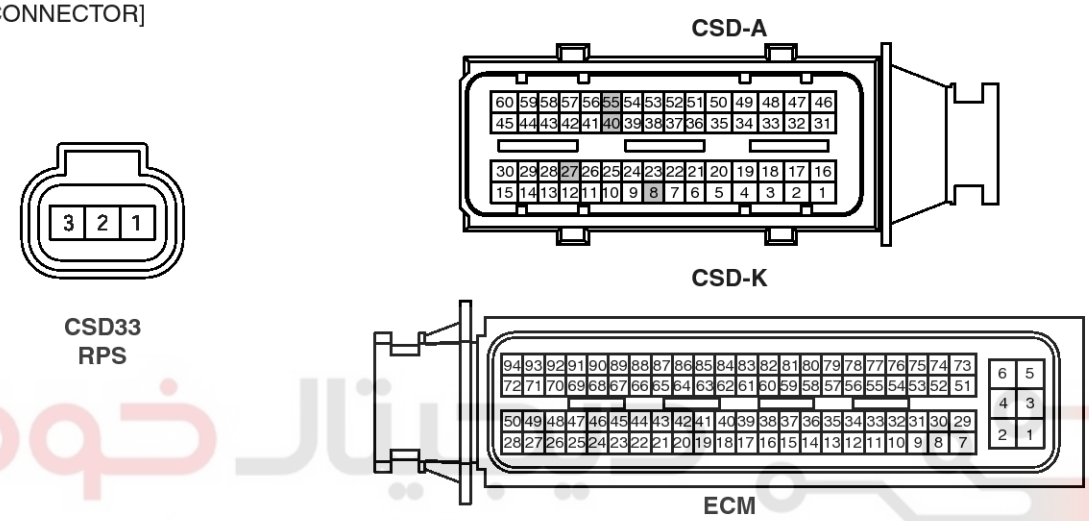
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

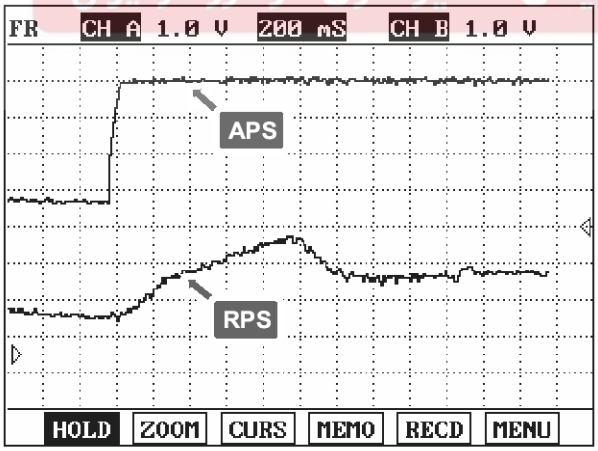
Terminal	Connected to	Function
1	ECM CSD-A (27)	Sensor Power (+5V)
2	ECM CSD-A (40)	RPS Signal
3	ECM CSD-A (55)	Sensor Ground

[HARNESS CONNECTOR]



SENFL7133L

Signal Waveform



During Acceleration

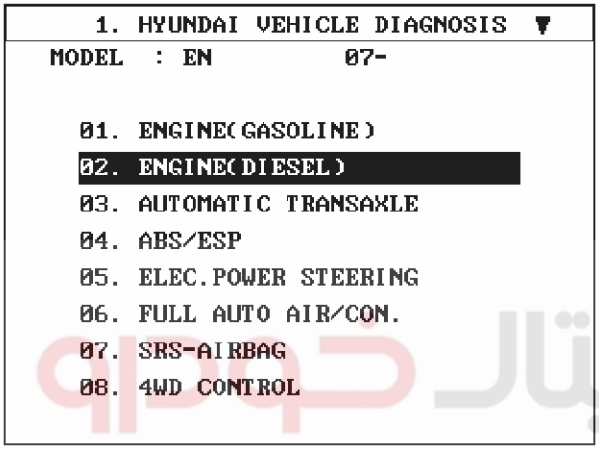
SENFL7134L

Replacement

⚠CAUTION

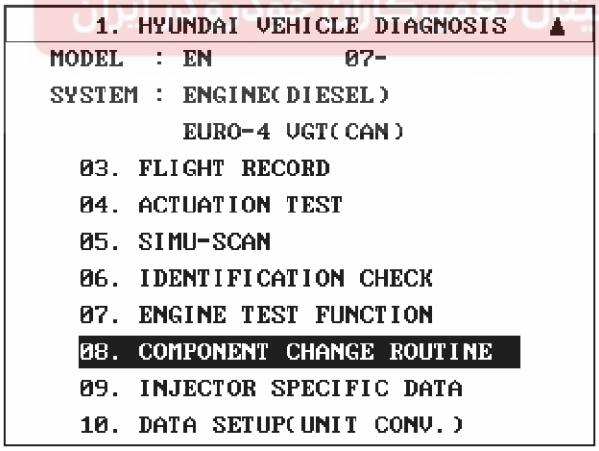
After replacing the Rail Pressure Sensor (RPS), MUST perform the "COMPONENT CHANGE ROUTINE" procedure. Otherwise trouble related with engine performance or emission control may occur until ECM learning about the component is over.

1. Turn ignition switch OFF.
2. Connect a scan tool to Data Link Connector (DLC).
3. Turn ignition switch ON.
4. Select "ENGINE (DIESEL)".



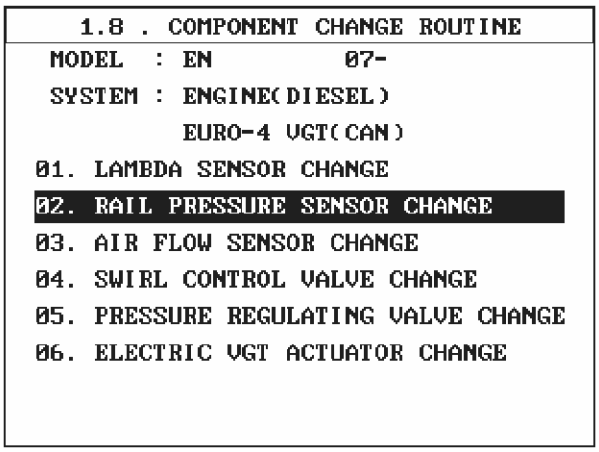
SENFL7198L

5. Select "COMPONET CHANGE ROUTINE".



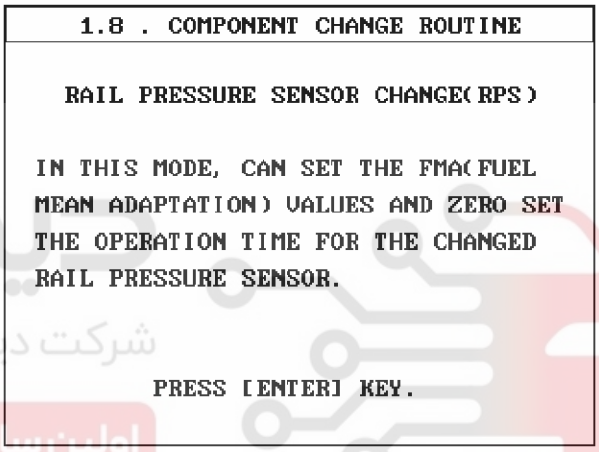
SENFL7199L

6. Select "RAIL PRESSURE SENSOR CHANGE".



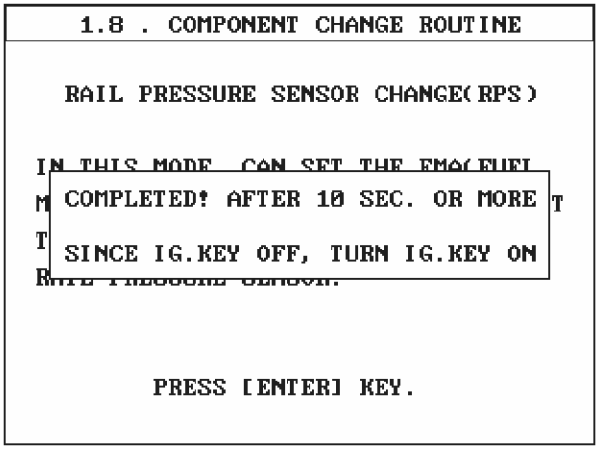
SENFL7600L

7. Confirm the message, and then press "ENTER" key.



SENFL7601L

8. Confirm the "Complete" message, and then turn ignition switch OFF.



SENFL7602L

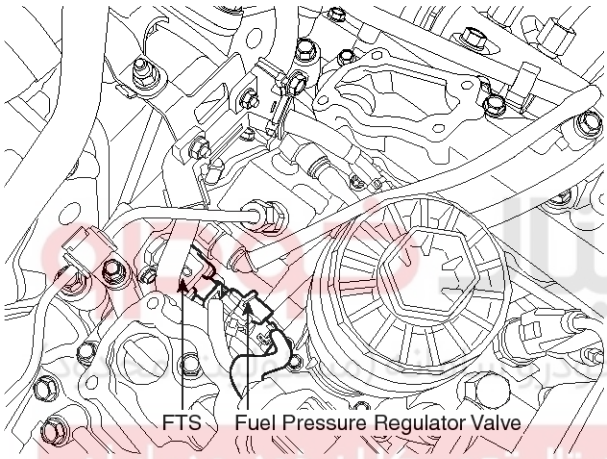
9. Wait for more than 10 seconds, and then turn ignition switch ON.

Fuel Temperature Sensor (FTS)

Function And Operation Principle

The Fuel Temperature Sensor (FTS) is installed on the high pressure fuel pump and measures the temperature of the fuel supplied from the fuel tank (via fuel filter). The FTS uses a thermistor which resistance is in inverse proportion to the temperature (NTC: Negative Temperature Coefficient). With this signal, the ECM can adjust the injection amount.

At high temperature, vapor-lock in fuel line or oil membrane destruction may appear. Especially oil membrane destruction deteriorates fuel's lubrication performance and it may damage the high pressure fuel pump and the injector.



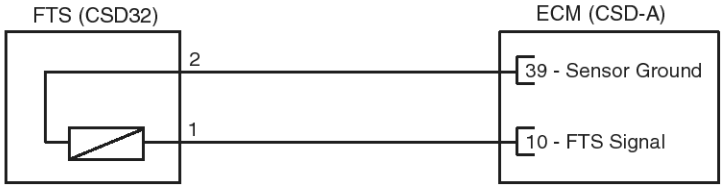
SENFL7103L

Specification

Temperature [℃(˚F)]	Resistance(kΩ)
-10(14)	8.64 ~ 10.15
20(68)	2.35 ~ 2.65
80(176)	0.31 ~ 0.33
120(248)	0.11 ~ 0.12

Circuit Diagram

[CIRCUIT DIAGRAM]

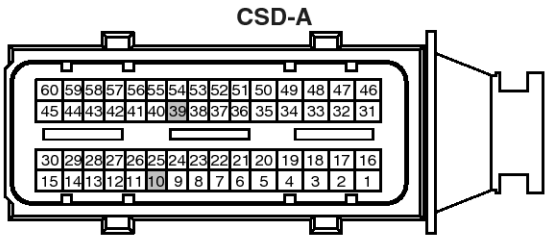


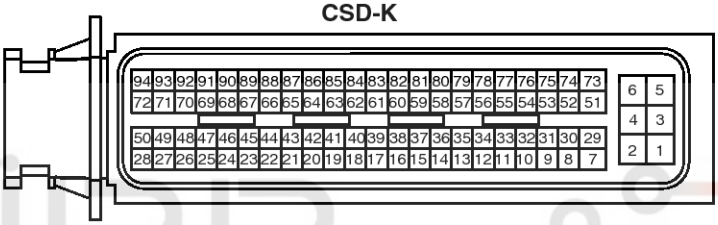
[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM CSD-A (10)	FTS Signal
2	ECM CSD-A (39)	Sensor Ground

[HARNESS CONNECTOR]

CSD32
FTS

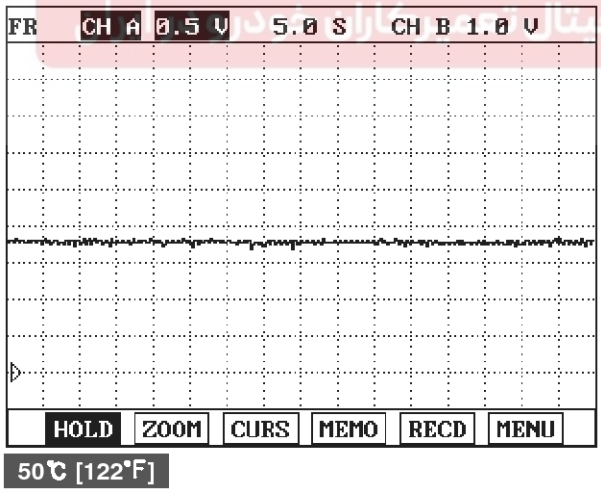




ECM

SENFL7135L

Signal Waveform



SENFL7136L

Component Inspection

1. Turn ignition switch OFF.
2. Disconnect the fuel temperature sensor connector.
3. Measure resistance between sensor signal terminal and ground terminal.
4. Check that the resistance is within the specification.

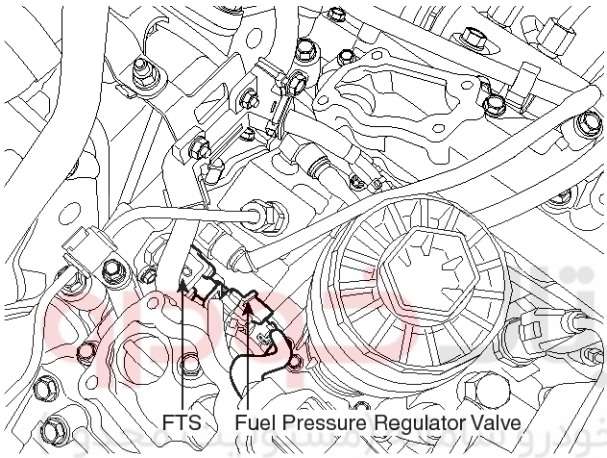
Specification: Refer to "SPECIFICATION"

Fuel Pressure Control Valve

Function And Operation Principle

The Fuel Pressure Regulator Valve and the Rail Pressure Regulator Valve are installed on high pressure pump and common rail (bank 2) respectively. These valves control fuel inlet (feed) from fuel tank via fuel filter and outlet (return) to fuel tank of high pressure fuel circuit.

This system is called "Dual Fuel Pressure Control System" and can precisely and quickly control the fuel pressure in accordance with various engine conditions by controlling the fuel inlet and outlet simultaneously.



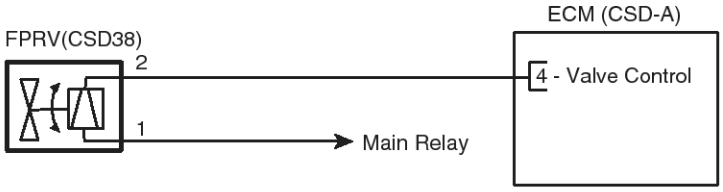
SENFL7103L

Specification

Item	Specification
Coil Resistance (Ω)	2.9 ~ 3.15Ω [20℃(68˚F)]

Circuit Diagram

[CIRCUIT DIAGRAM]

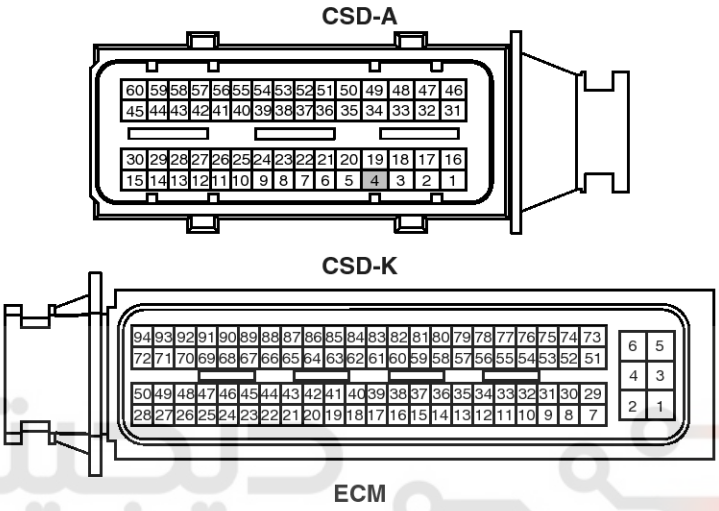


[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	Main Relay	Power Supply (B+)
2	ECM CSD-A (4)	Valve Control

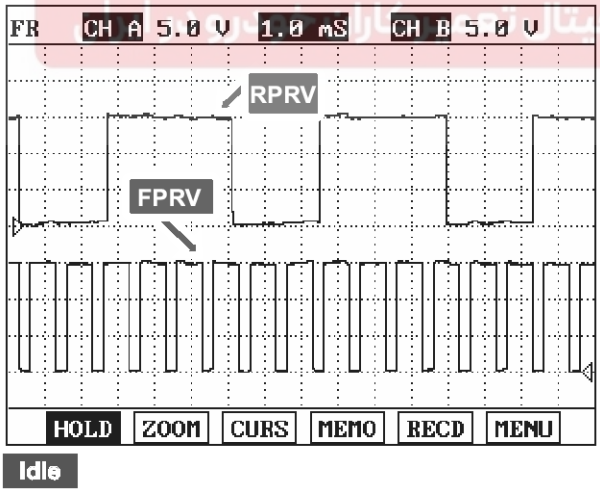
[HARNESS CONNECTOR]

CSD38
FUEL PRESSURE
REGULATOR VALVE



SENFL7137L

Signal Waveform



SENFL7138L

Component Inspection

1. Turn ignition switch OFF.
2. Disconnect the fuel pressure regulator valve connector.
3. Measure resistance between terminal 1 and 2 of the valve.
4. Check that the resistance is within the specification.

Specification: Refer to "SPECIFICATION"

Rail Pressure Regulator Valve

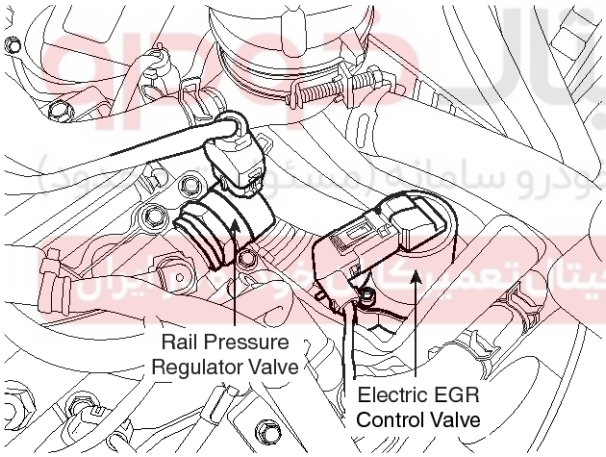
Function And Operation Principle

The Fuel Pressure Regulator Valve and the Rail Pressure Regulator Valve are installed on high pressure pump and common rail (bank 2) respectively. These valves control fuel inlet (feed) from fuel tank via fuel filter and outlet (return) to fuel tank of high pressure fuel circuit.

This system is called "Dual Fuel Pressure Control System" and can precisely and quickly control the fuel pressure in accordance with various engine conditions by controlling the fuel inlet and outlet simultaneously.

⚠CAUTION

After replacing the Rail Pressure Regulator Valve, MUST perform the "COMPONENT CHANGE ROUTINE" procedure (Refer to "REPLACEMENT" procedure). Otherwise trouble related with engine performance or emission control may occur until ECM learning about the component is over.



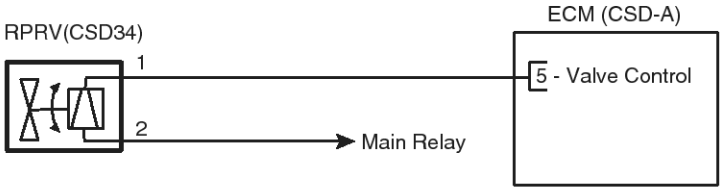
SENFL7106L

Specification

Items	Specification
Coil Resistance (Ω)	3.42 ~ 3.78Ω [20℃(68˚F)]
Operating Current (A)	0 ~ 1.7

Circuit Diagram

[CIRCUIT DIAGRAM]

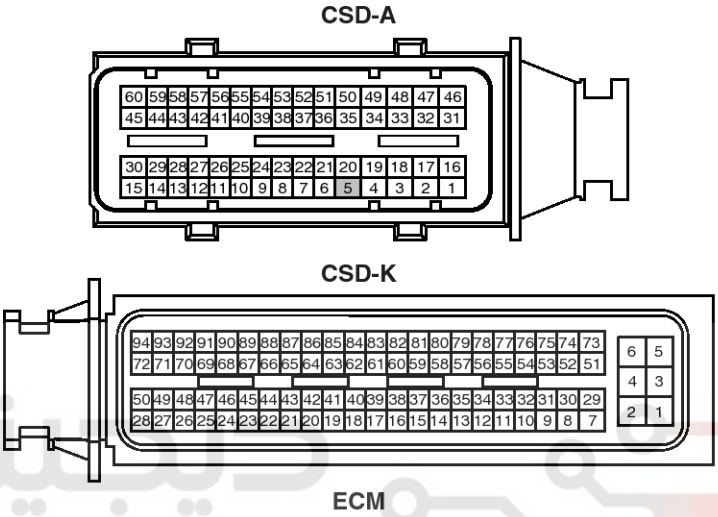


[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM CSD-A (5)	Valve Control
2	Main Relay	Power Supply (B+)

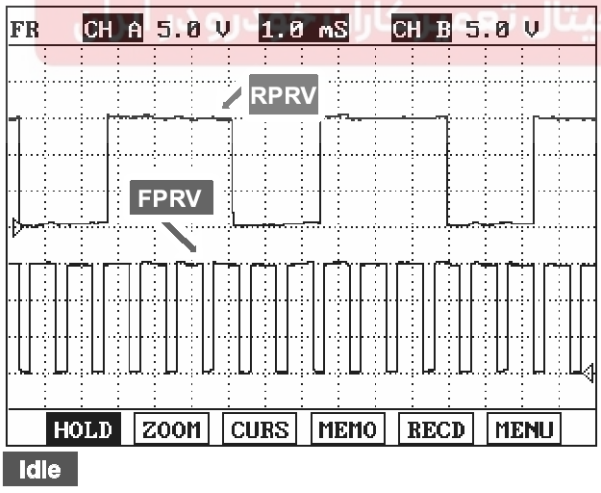
[HARNESS CONNECTOR]

CSD34
RAIL PRESSURE
REGULATOR VALVE



SENFL7139L

Signal Waveform



SENFL7140L

Component Inspection

1. Turn ignition switch OFF.
2. Disconnect the rail pressure regulator valve connector.
3. Measure resistance between terminal 1 and 2 of the valve.
4. Check that the resistance is within the specification.

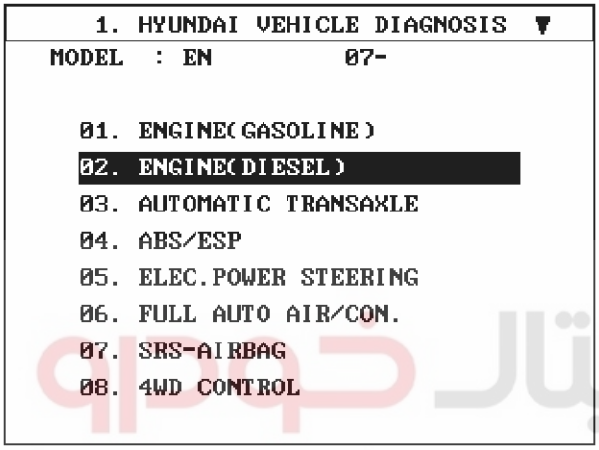
Specification: Refer to "SPECIFICATION"

Replacement

⚠CAUTION

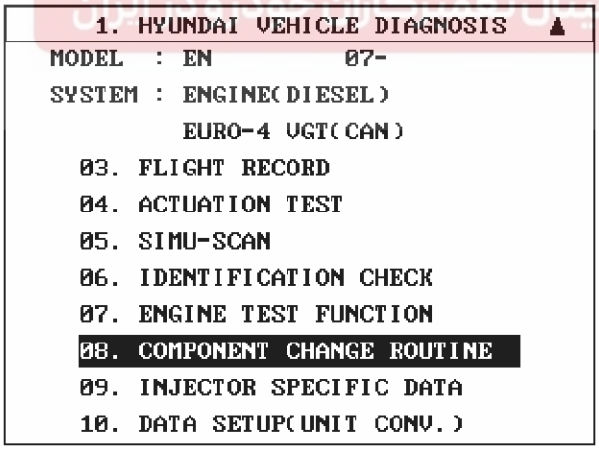
After replacing the Rail Pressure Regulator Valve, MUST perform the "COMPONENT CHANGE ROUTINE" procedure. Otherwise trouble related with engine performance or emission control may occur until ECM learning about the component is over.

1. Turn ignition switch OFF.
2. Connect a scan tool to Data Link Connector (DLC).
3. Turn ignition switch ON.
4. Select "ENGINE (DIESEL)".



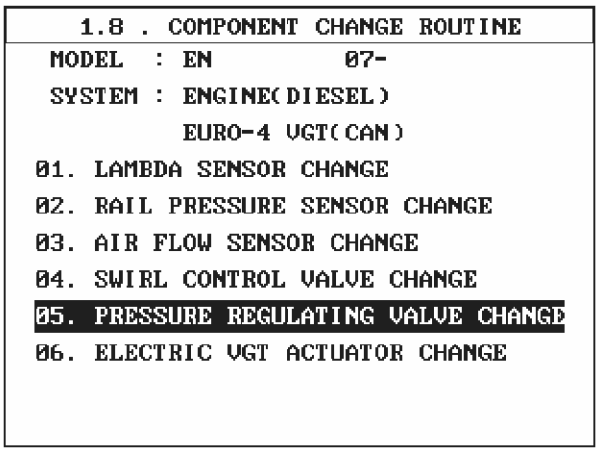
SENFL7603L

5. Select "COMPONET CHANGE ROUTINE".



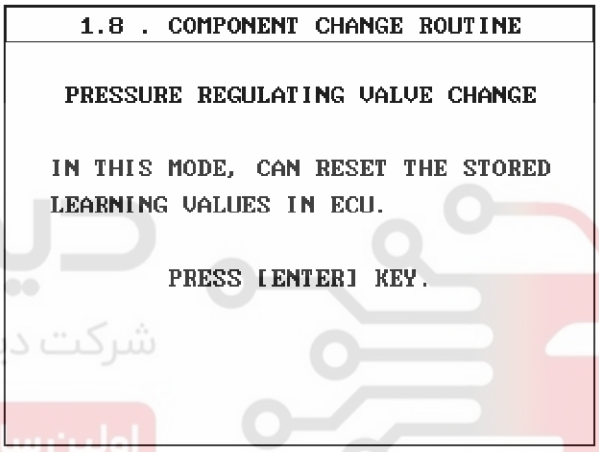
SENFL7604L

6. Select "PRESSURE REGULATING VALVE CHANGE".



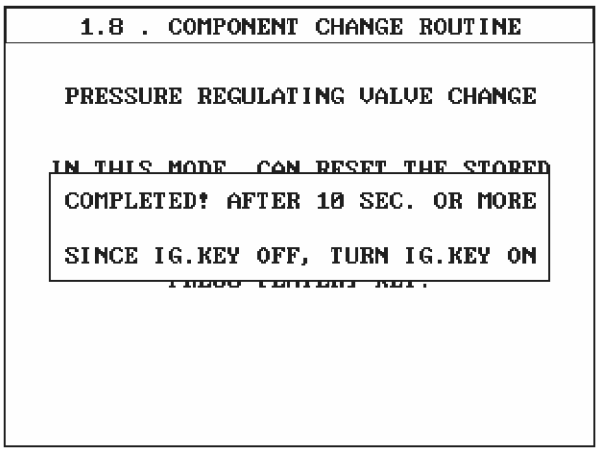
SENFL7605L

7. Confirm the message, and then press "ENTER" key.



SENFL7606L

8. Confirm the "Complete" message, and then turn ignition switch OFF.



SENFL7607L

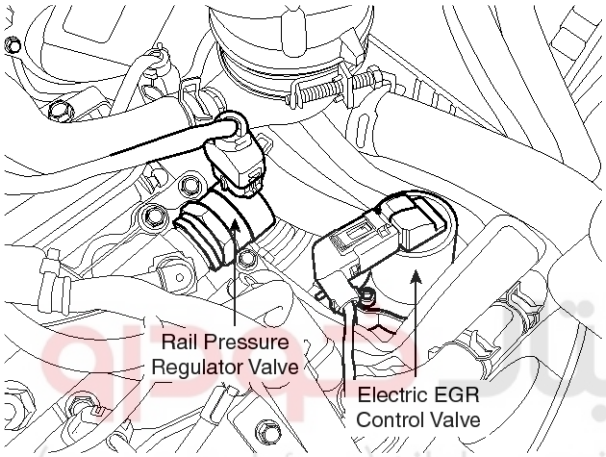
9. Wait for more than 10 seconds, and then turn ignition switch ON.

Electric EGR Control Valve

Function And Operation Principle

The Electric EGR Control Valve is installed in between the EGR cooler and the exhaust line and is a solenoid valve. This valve controls EGR (Exhaust Gas Recirculation) amount by the ECM's duty control signal depending on engine load and the need of intake air.

The Exhaust Gas Recirculation (EGR) system is used to add the exhaust gas to intake air in order to reduce an excess of air and the temperature in the combustion chamber.

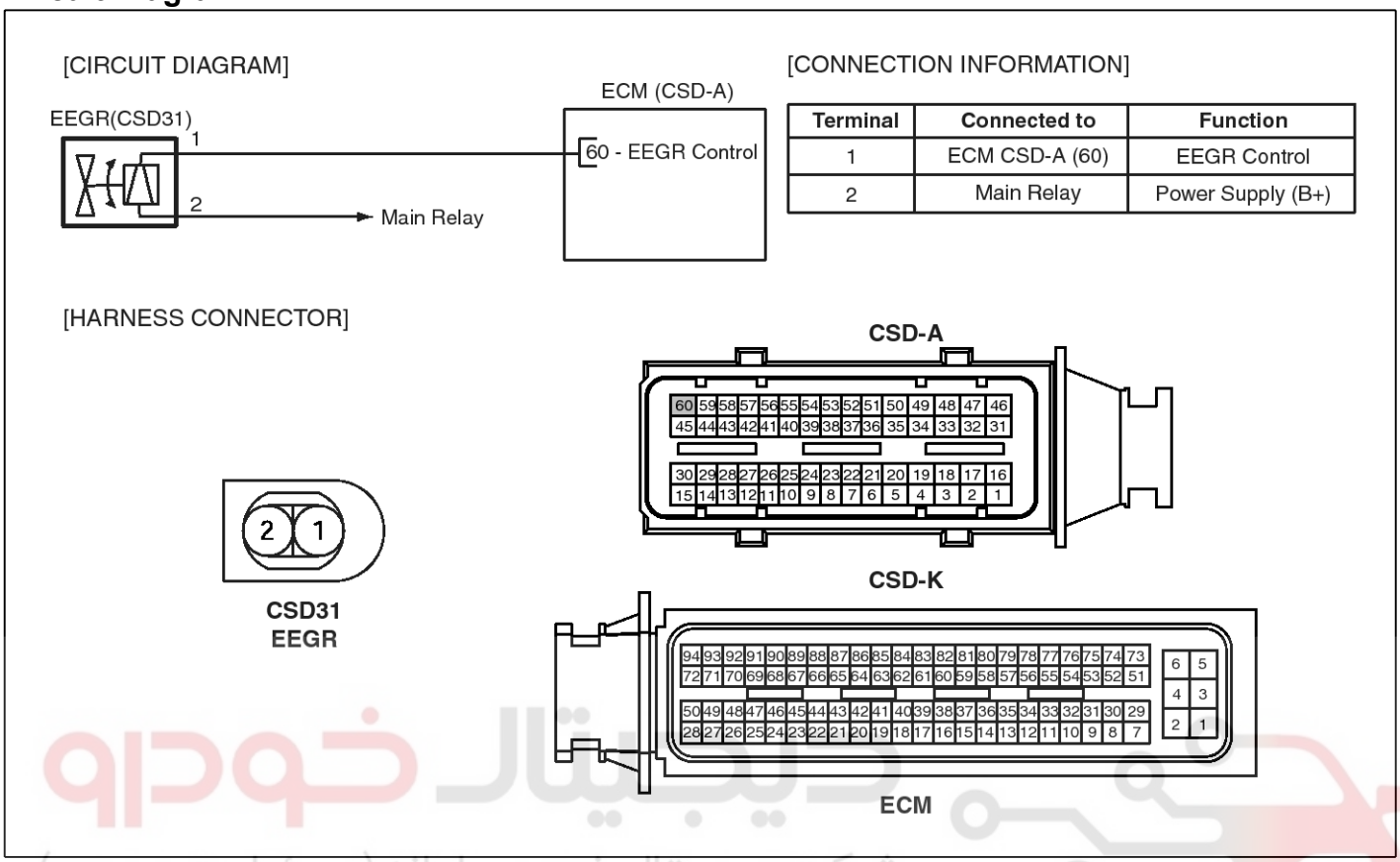


SENFL7106L

Specification

Item	Specification
Coil Resistance (Ω)	7.3 ~ 8.3Ω [20℃(68˚F)]

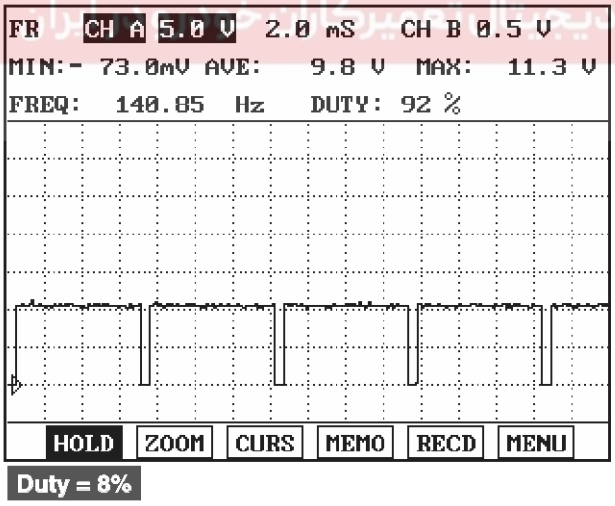
Circuit Diagram

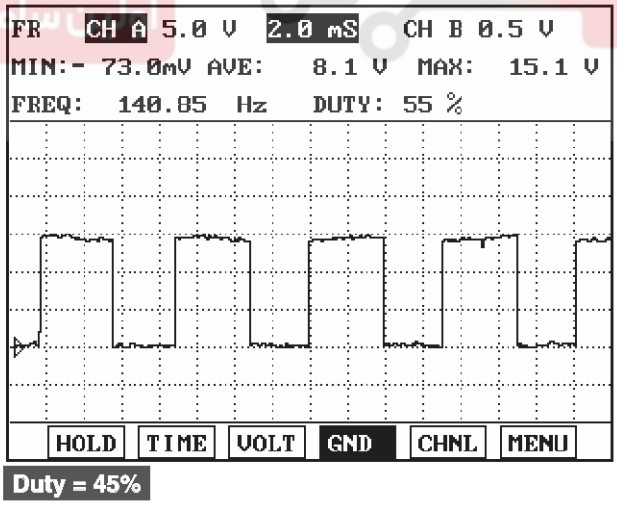


Terminal	Connected to	Function
1	ECM CSD-A (60)	EEGR Control
2	Main Relay	Power Supply (B+)

SENFL7141L

Signal Waveform





SENFL7142L

Component Inspection

1. Turn ignition switch OFF.
2. Disconnect the electric EGR control valve connector.
3. Measure resistance between terminal 1 and 2 of the valve.
4. Check that the resistance is within the specification.

Specification: Refer to "SPECIFICATION"

Variable Swirl Control Actuator

Function And Operation Principle

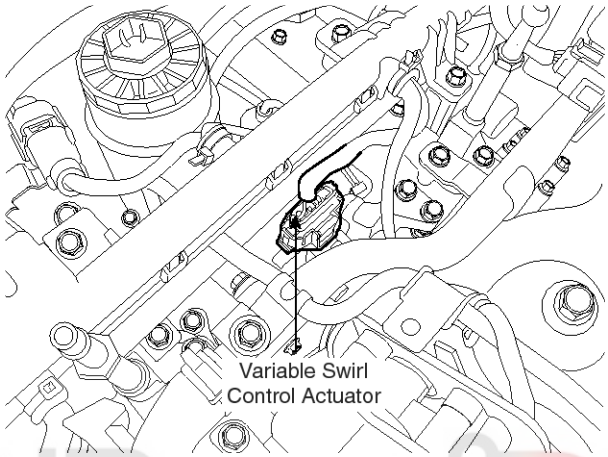
The Variable Swirl Control Actuator is installed in between the two intake manifolds (bank 1 and 2) and consists of a DC motor which actuates the swirl valve and a position sensor which detects the position of the swirl valve. This swirl system optimizes air flow entering into combustion chamber of each cylinder in accordance with the various engine conditions.

[At High Speed or High Load] Swirl valve opening → Swirl amount decreasing → Swirl effect increasing → Pumping loss decreasing → Engine power increasing

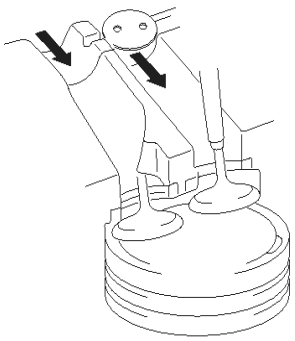
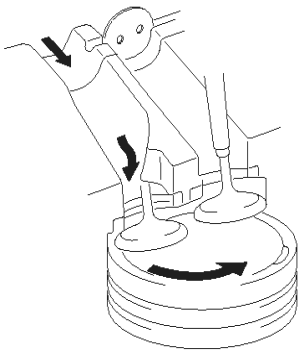
[At Low/Middle Speed or Low Load] Swirl valve closing → Swirl amount increasing → Air/fuel mixture increasing → EGR amount enlarging → Emission reducing

CAUTION

After replacing the Variable Swirl Control Actuator, MUST perform the "COMPONENT CHANGE ROUTINE" procedure (Refer to "REPLACEMENT" procedure). Otherwise trouble related with engine performance or emission control may occur until ECM learning about the component is over.



SENFL7107L

Items	High Speed or High Load	Low/Middle Speed or Low Load
Engine Speed	More than 3,000rpm	Less than 3,000rpm
Swirl Valve	Opening	Closing
Swirl Quantity	Little	Much
Effect	Swirl effect increasing → Pumping loss decreasing → Engine power increasing	Air/Fuel mixture increasing → EGR amount enlarging → Emission reducing
Description illustration		
Fail-safe	Fully opened	

NOTICE

To prevent the swirl valve and its shaft from being stuck by foreign material and to learn maximum opening and closing position of the valve, the ECM fully opens and closes the valve twice when engine is being stopped.

Specification

Motor

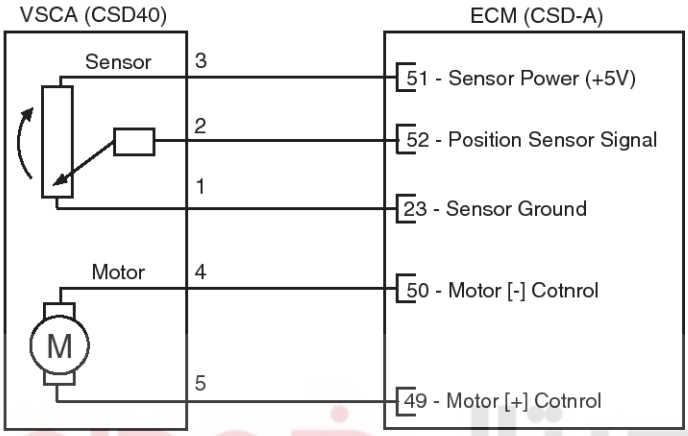
Item	Specification
Coil Resistance (Ω)	3.4 ~ 4.4Ω [20℃(68°F)]

Position Sensor

Item	Specification
Coil Resistance (Ω)	3.44 ~ 5.16kΩ [20℃(68°F)]

Circuit Diagram

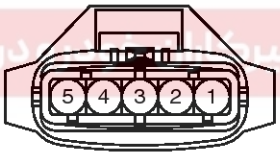
[CIRCUIT DIAGRAM]



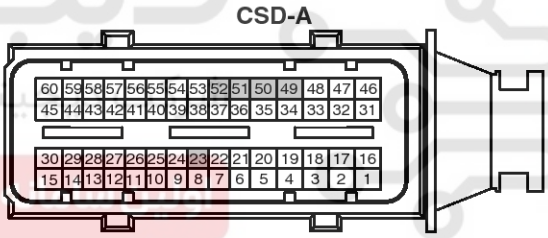
[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM CSD-A (23)	Sensor Ground
2	ECM CSD-A (52)	Position Sensor Signal
3	ECM CSD-A (51)	Sensor Power (+5V)
4	ECM CSD-A (50)	Motor [-] Cotnrol
5	ECM CSD-A (49)	Motor [+] Cotnrol

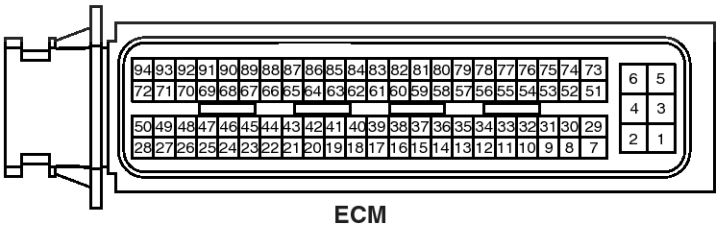
[HARNESS CONNECTOR]



CSD40
VARIABLE SWIRL
CONTROL ACTUATOR



CSD-A

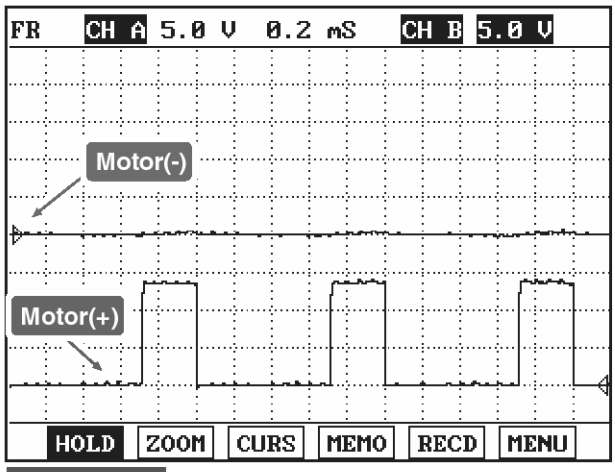


CSD-K

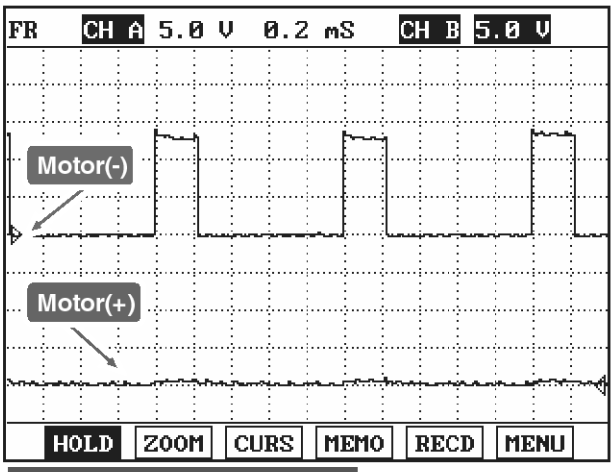
ECM

SENFL7143L

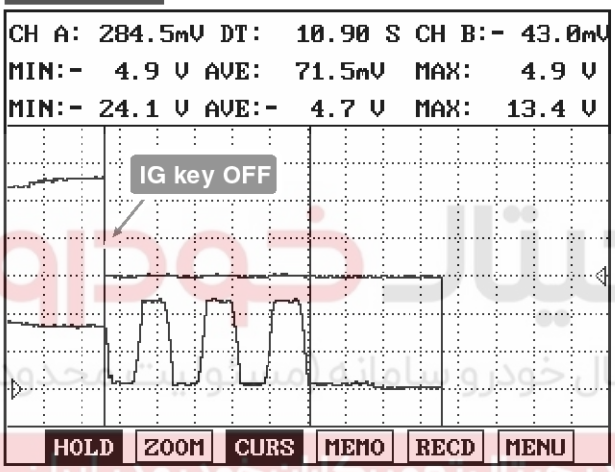
Signal Waveform



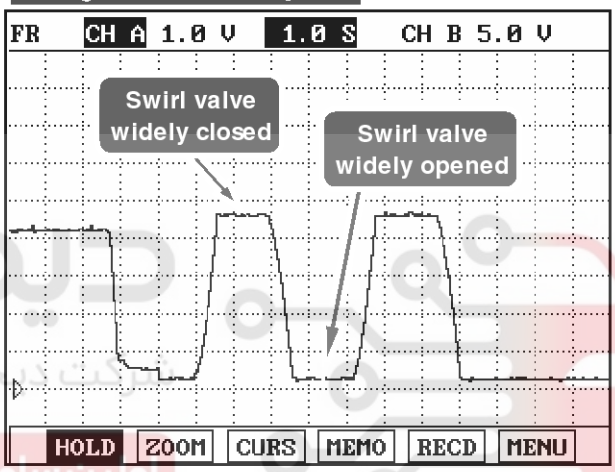
Idle - Closed



During Acceleration - Opened



Position sensor signal at IG OFF



During learning of valve position

SENFL7144L

Component Inspection

1. Turn ignition switch OFF.
2. Disconnect the electric variable swirl control actuator connector.
3. Check that swirl valve is stuck by foreign material.
4. Measure resistance between motor (+) and (-) control terminals of the motor.
5. Check that the resistance is within the specification.

Specification: Refer to "SPECIFICATION"

6. Measure resistance between voltage supply terminal and ground terminal of the position sensor.
7. Check that the resistance is within the specification.

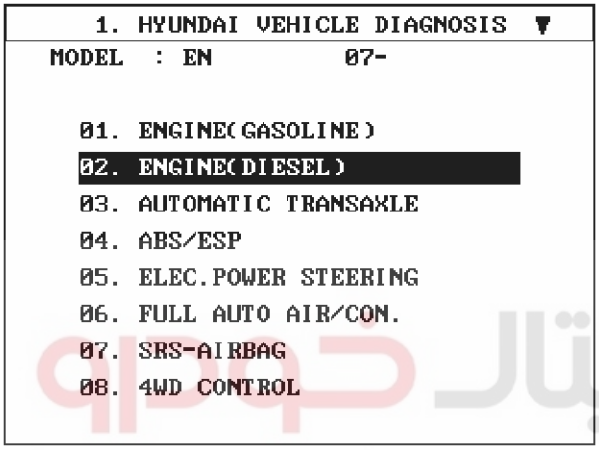
Specification: Refer to "SPECIFICATION"

Replacement

⚠CAUTION

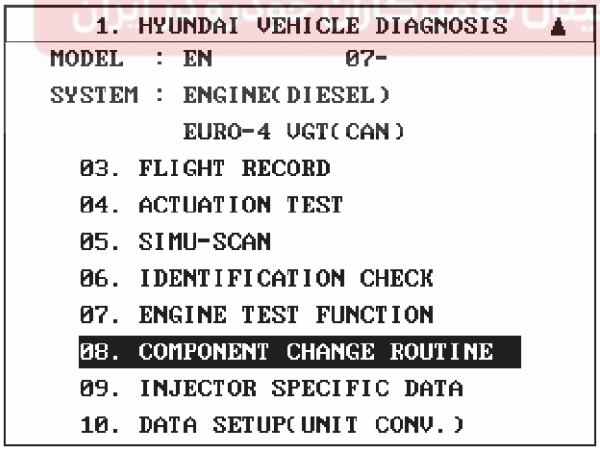
After replacing the Variable Swirl Control Actuator, MUST perform the "COMPONENT CHANGE ROUTINE" procedure. Otherwise trouble related with engine performance or emission control may occur until ECM learning about the component is over.

1. Turn ignition switch OFF.
2. Connect a scan tool to Data Link Connector (DLC).
3. Turn ignition switch ON.
4. Select "ENGINE (DIESEL)".



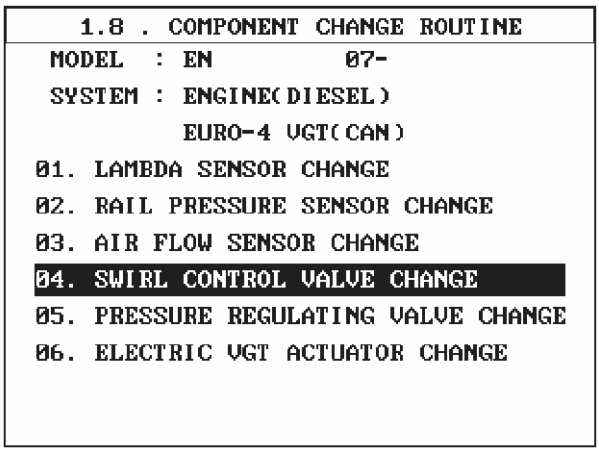
SENFL7608L

5. Select "COMPONET CHANGE ROUTINE".



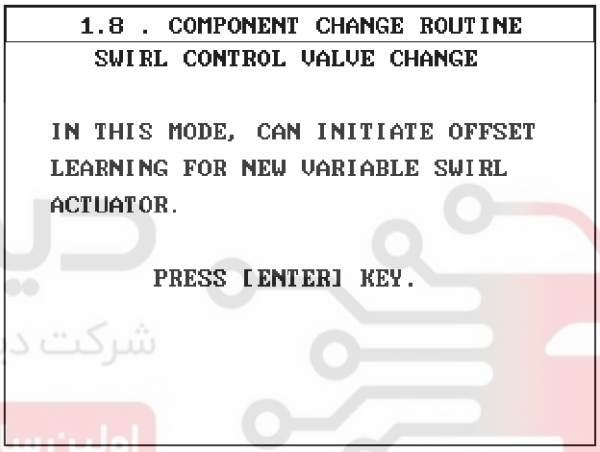
SENFL7609L

6. Select "SWIRL CONTROL VALVE CHANGE".



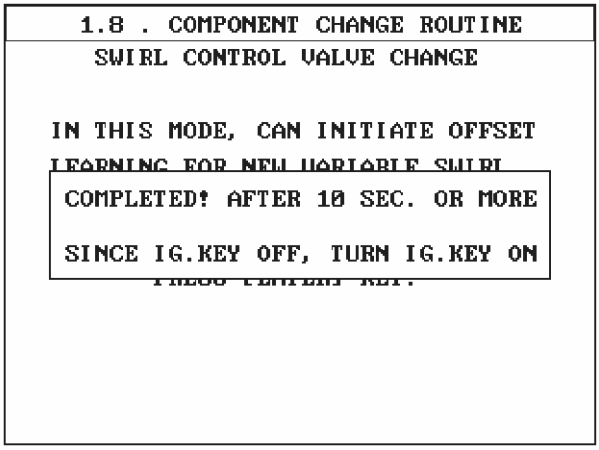
SENFL7610L

7. Confirm the message, and then press "ENTER" key.



SENFL7611L

8. Confirm the "Complete" message, and then turn ignition switch OFF.



SENFL7612L

9. Wait for more than 10 seconds, and then turn ignition switch ON.

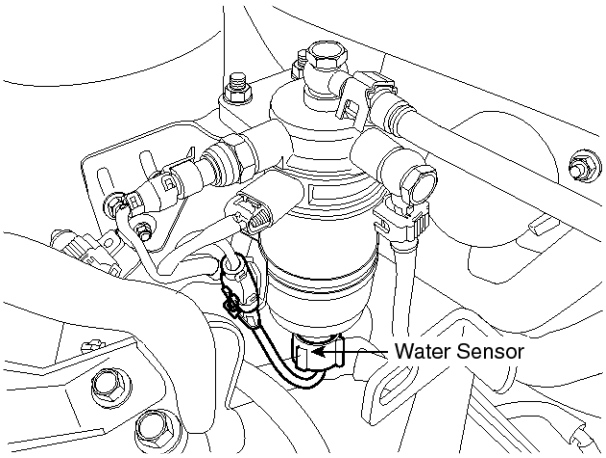
Water Sensor

Function And Operation Principle

The Water Sensor is installed on bottom end of fuel filter and detects presence of water in fuel. When the water amount reaches the predetermined level, the sensor sends the warning signal to the ECM.

NOTICE

Without presence of water, the lamp should flash for 2 seconds and turn off afterward in order that this system has normal condition.



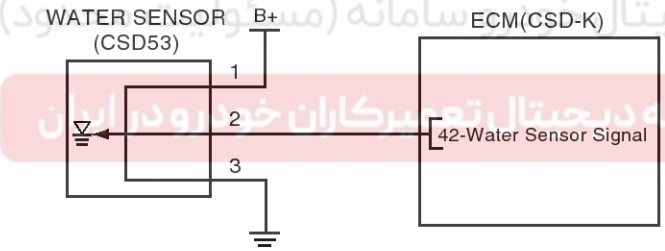
SENFL7104L

Specification

Item	Specification
Warning Level (cc)	53 ~ 63

Circuit Diagram

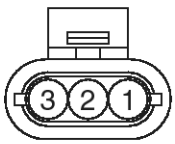
[CIRCUIT DIAGRAM]



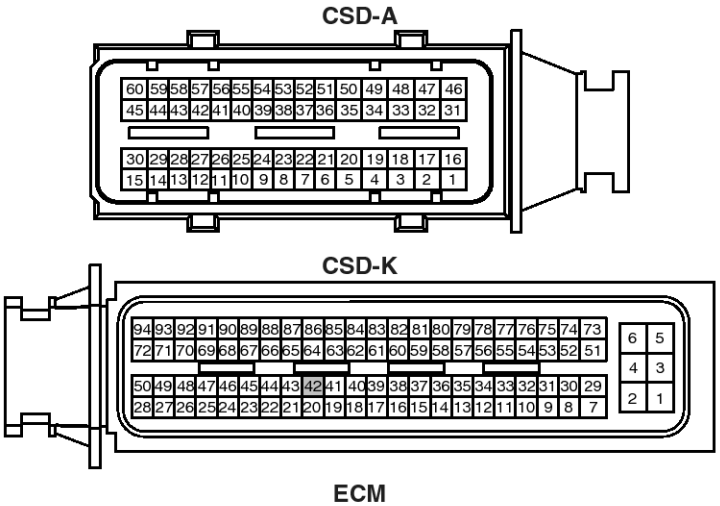
[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	Main Relay	Power Supply (B+)
2	ECM CSD-K (42)	Sensor Signal
3	Chassis Ground	Sensor Ground

[HARNESS CONNECTOR]



CSD53
WATER SENSOR



ECM

SENFL7145L

Lambda Sensor

Function And Operation Principle

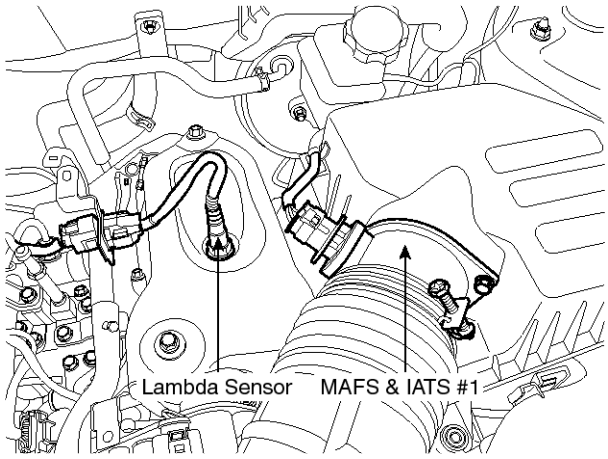
Lambda Sensor is installed on exhaust manifold and is a linear oxygen sensor. It senses oxygen density of exhaust gas in order to control EGR accurately through fuel correction and also limits smoke which is generated by reach air-fuel mixture at high engine load condition. ECM controls pumping current in order to fit λ-value from linear lambda sensor to 1.0.

- Lean air-fuel mixture(1.0 < λ < 1.1): ECM supplies pumping current to lambda sensor (+pumping current) and activates it for lambda sensor to have the characteristic at λ =1.0 (0.0 pumping current). With the value of pumping current supplied to lambda sensor, ECM detects lambda density of exhaust gas.
- Rich air-fuel mixture(0.9 < λ < 1.0): ECM takes away pumping current from lambda sensor (-pumping current) and deactivates it for lambda sensor to have the characteristic at λ =1.0 (0.0 pumping current). With the value of pumping current taken away from lambda sensor, ECM detects lambda density of exhaust gas.

This performance is the most active and fast at normal operating temperature (450℃ ~ 600℃) thus, in order to reach normal operating temp. and last at that temperature, a heater (heating coil) is integrated with lambda sensor. The heater coil is controlled by ECM as Pulse With Modulator (PWM). The resistance of heater coil is low when coil is cold thus, current through it increases while resistance is high when coil is hot thus, current decreases. With this principle, temperature of lambda sensor is measured and lambda sensor heater operation varies based on the data.

⚠CAUTION

After replacing the Lambda Sensor, MUST perform the "COMPONENT CHANGE ROUTINE" procedure (Refer to "REPLACEMENT" procedure). Otherwise trouble related with engine performance or emission control may occur until ECM learning about the component is over.



SENFL7101L

Specification

Sensor

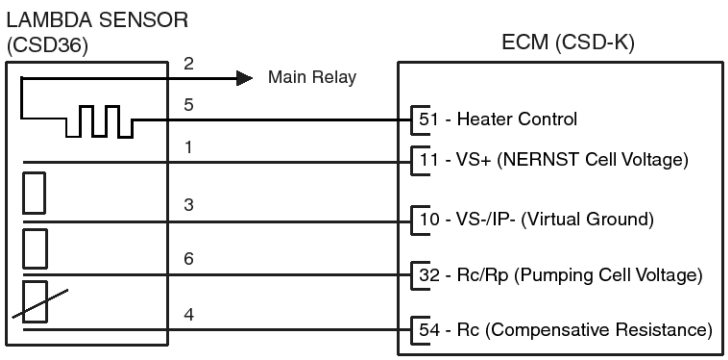
λ Value (A/F Ratio)	Pumping Current (A)
0.65	-2.2
0.7	-1.8
0.8	-1.1
0.9	-0.5
1.01	0
1.18	0.33
1.43	0.67
1.7	0.94
2.42	1.38
Air (Atmosphere)	2.54

Heater

Temperature [℃(°F)]	Heater Resistance (Ω)
20(68)	2.4 ~ 4.0

Circuit Diagram

[CIRCUIT DIAGRAM]

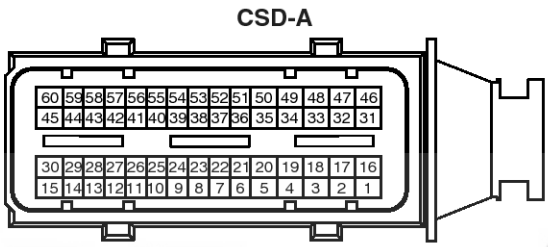


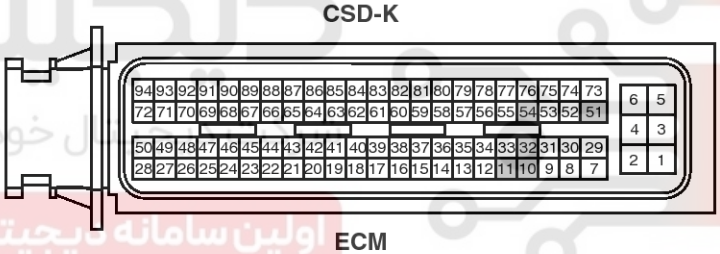
[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM CSD-K (11)	VS+ (NERNST Cell Voltage)
2	Main Relay	Power Supply (B+)
3	ECM CSD-K (10)	VS-/IP- (Virtual Ground)
4	ECM CSD-K (54)	Rc (Compensative Resistance)
5	ECM CSD-K (51)	Heater Control
6	ECM CSD-K (32)	Rc/Rp (Pumping Cell Voltage)

[HARNESS CONNECTOR]

CSD36
LAMBDA SENSOR





ECM

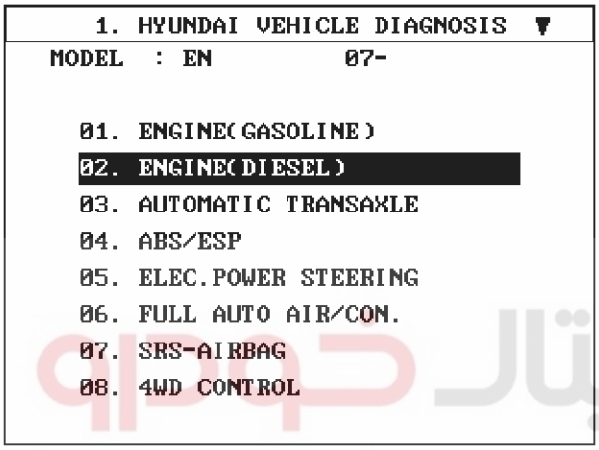
SENFL7146L

Replacement

⚠CAUTION

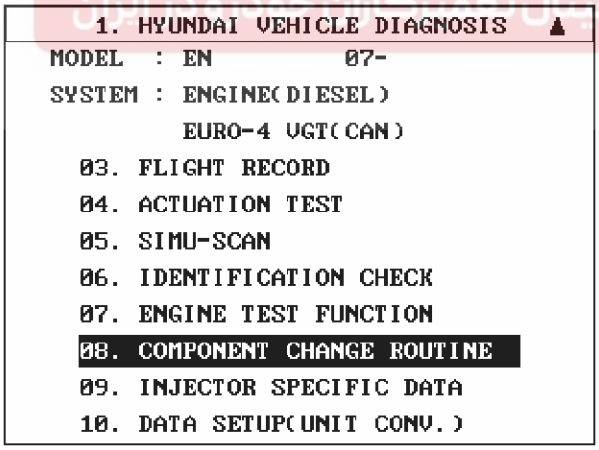
After replacing the Lambda Sensor, MUST perform the "COMPONENT CHANGE ROUTINE" procedure. Otherwise trouble related with engine performance or emission control may occur until ECM learning about the component is over.

1. Turn ignition switch OFF.
2. Connect a scan tool to Data Link Connector (DLC).
3. Turn ignition switch ON.
4. Select "ENGINE (DIESEL)".



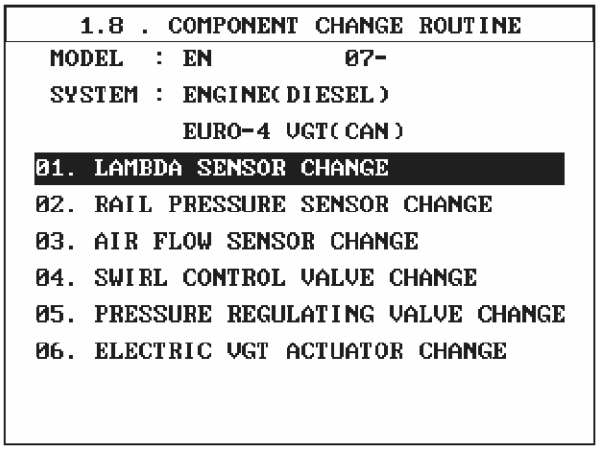
SENFL7613L

5. Select "COMPONET CHANGE ROUTINE".



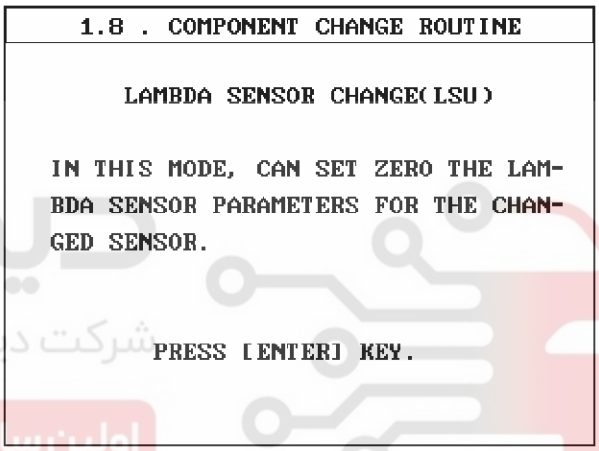
SENFL7614L

6. Select "LAMBDA SENSOR CHANGE".



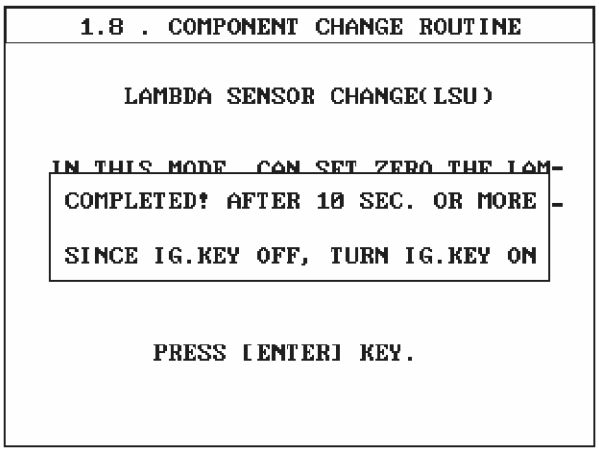
SENFL7615L

7. Confirm the message, and then press "ENTER" key.



SENFL7616L

8. Confirm the "Complete" message, and then turn ignition switch OFF.



SENFL7617L

9. Wait for more than 10 seconds, and then turn ignition switch ON.

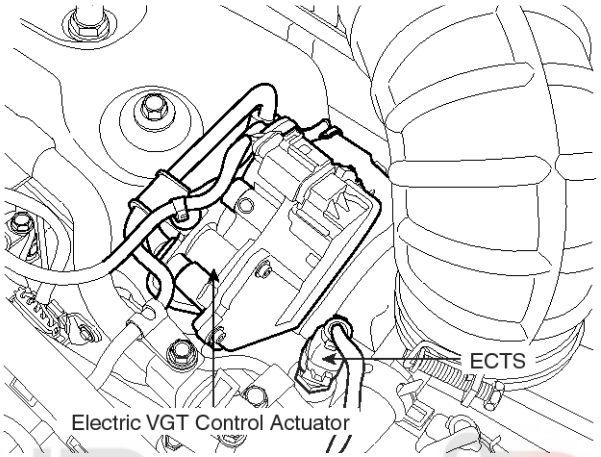
Electric VGT Control Actuator

Function And Operation Principle

The Electric VGT Control Actuator is installed on the turbocharger. It operates the vain in the Variable Geometry Turbocharger (VGT) and regulates the compressed air amount by the ECM's PWM signal. This valve consists of a DC motor which actuates the vane, a 2-step gear which increases torque of the DC motor, a position sensor which detects status of the vane, an electric control unit which drives the DC motor, and a reset spring which resets the de-energized vane to its open position.

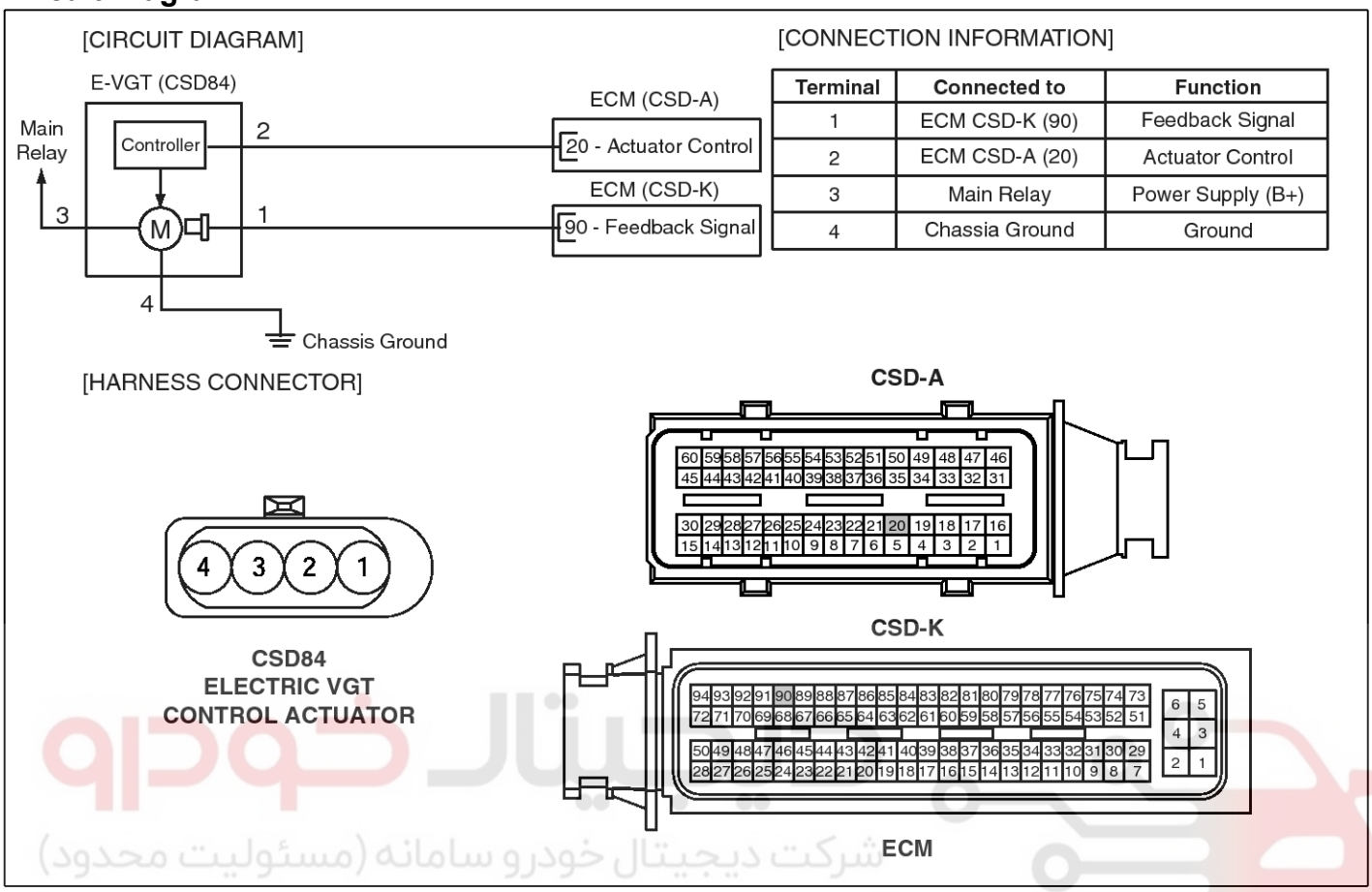
⚠CAUTION

After replacing the Electric VGT Control Actuator, MUST perform the "COMPONENT CHANGE ROUTINE" procedure (Refer to "REPLACEMENT" procedure). Otherwise trouble related with engine performance or emission control may occur until ECM learning about the component is over.



SENFL7102L

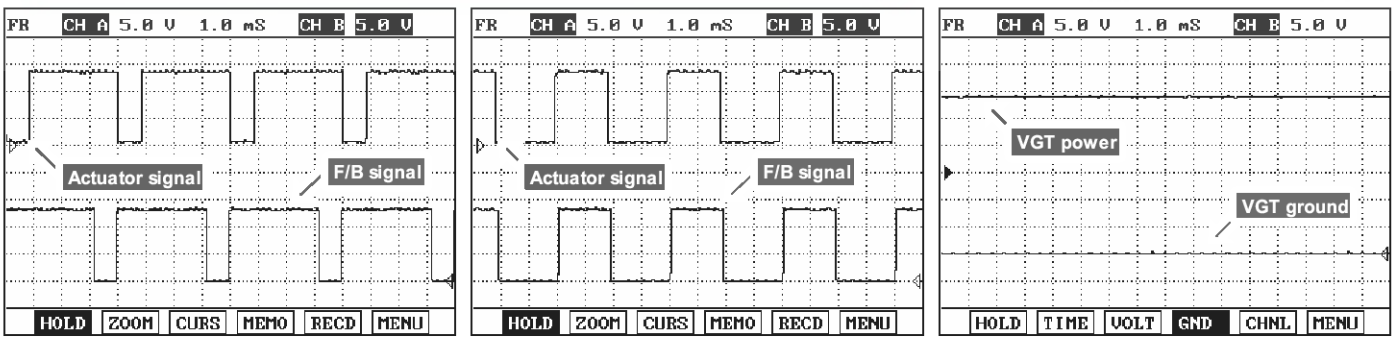
Circuit Diagram



Terminal	Connected to	Function
1	ECM CSD-K (90)	Feedback Signal
2	ECM CSD-A (20)	Actuator Control
3	Main Relay	Power Supply (B+)
4	Chassia Ground	Ground

SENFL7148L

Signal Waveform



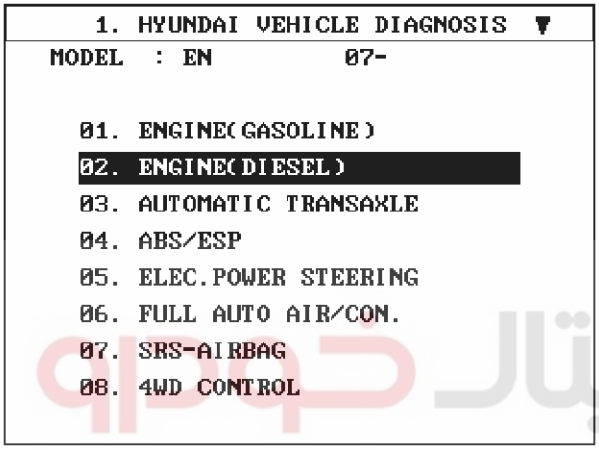
SENFL7149L

Replacement

⚠CAUTION

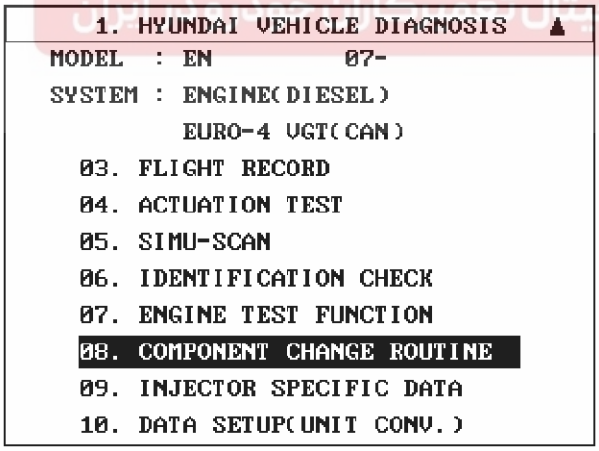
After replacing the Electric VGT Control Actuator, MUST perform the "COMPONENT CHANGE ROUTINE" procedure. Otherwise trouble related with engine performance or emission control may occur until ECM learning about the component is over.

1. Turn ignition switch OFF.
2. Connect a scan tool to Data Link Connector (DLC).
3. Turn ignition switch ON.
4. Select "ENGINE (DIESEL)".



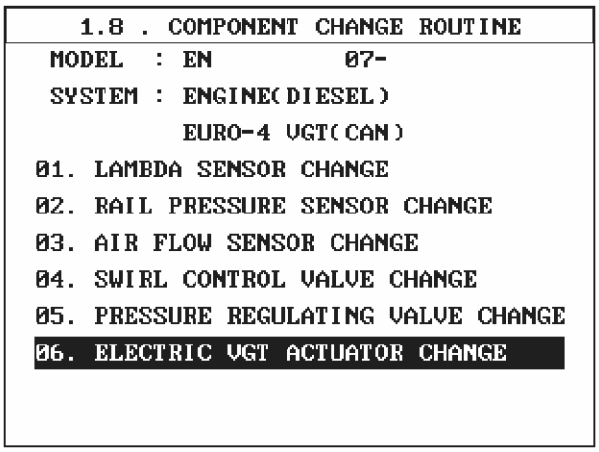
SENFL7618L

5. Select "COMPONET CHANGE ROUTINE".



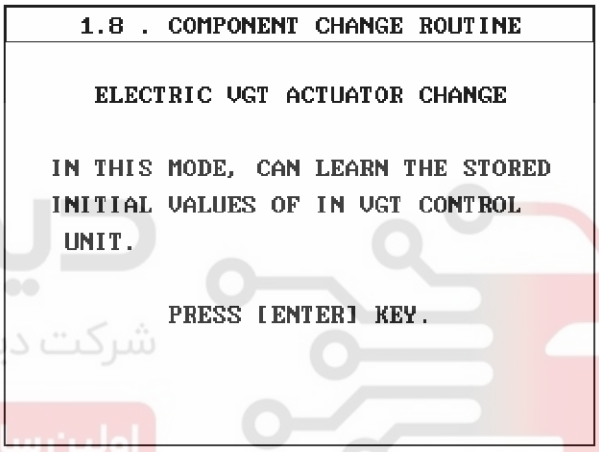
SENFL7619L

6. Select "ELECTRIC VGT ACTUATOR CHANGE".



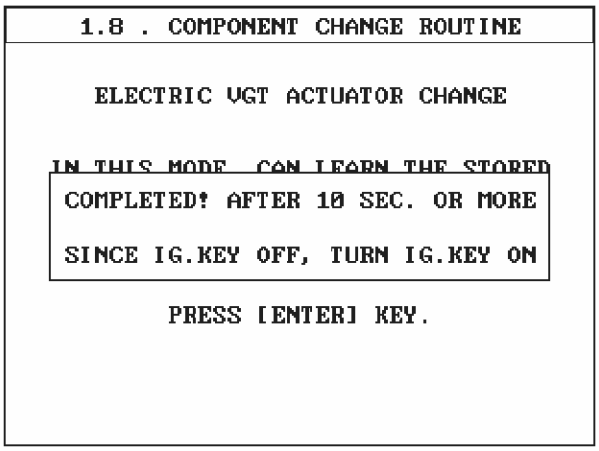
SENFL7620L

7. Confirm the message, and then press "ENTER" key.



SENFL7621L

8. Confirm the "Complete" message, and then turn ignition switch OFF.



SENFL7622L

9. Wait for more than 10 seconds, and then turn ignition switch ON.

Exhaust Gas Temperature Sensor

Description

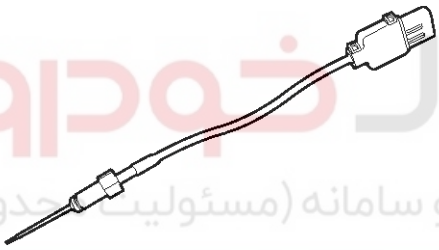
[VGT]

Exhaust Gas Temperature Sensor (EGTS) #1 for VGT is installed on exhaust manifold and senses the termperature of exhaust gas flowing into the VGT.

[CPF]

Exhaust Gas Temperature Sensor (EGTS) #2 for CPF is installed on Catalyzed Particulate Filter (CPF) assembly and senses the temperature of exhaust gas flowing into the CPF.

When pre-determined engine condition is set, ECM burns soot gathered in CPF with exhaust gas. At this time, the exhaust gas temperature is an important factor of engine condition.



SENFL0121L

Specification

EGTS #1 [VGT]

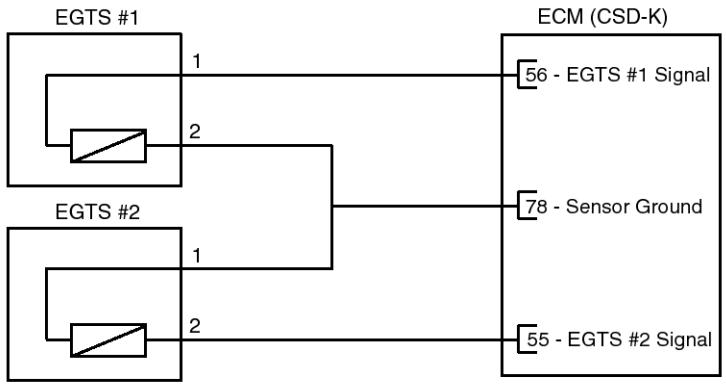
Temperature [℃(˚F)]	Resistance(kΩ)
100(212)	289.0 ~ 481.0
300(572)	5.30 ~ 6.61
600(1,112)	0.35 ~ 0.38
900(1,652)	0.08 ~ 0.09

EGTS #2 [CPF]

Temperature [℃(˚F)]	Resistance(kΩ)
100(212)	289.0 ~ 481.0
300(572)	5.30 ~ 6.61
600(1,112)	0.35 ~ 0.38
900(1,652)	0.08 ~ 0.09

Circuit Diagram

[Circuit Diagram]



[Connection Information]

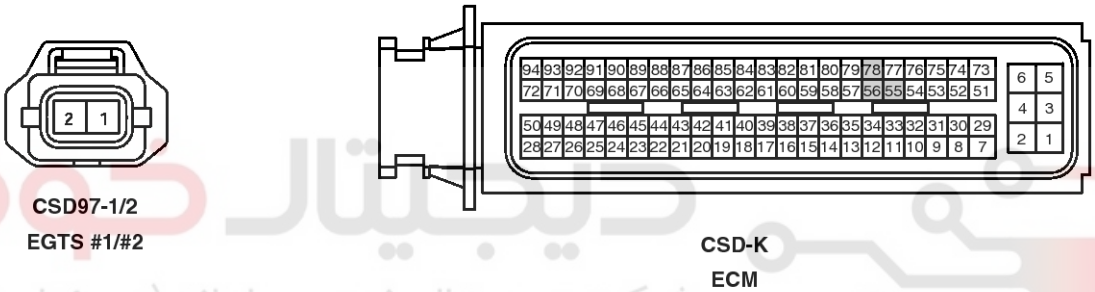
EGTS #1

Terminal	Connected to	Function
1	ECM CSD-K (56)	EGTS #1 Signal
2	ECM CSD-K (78)	Sensor Ground

EGTS #2

Terminal	Connected to	Function
1	ECM CSD-K (55)	EGTS #2 Signal
2	ECM CSD-K (78)	Sensor Ground

[Harness Connector]



SENFL0122L

Signal Waveform

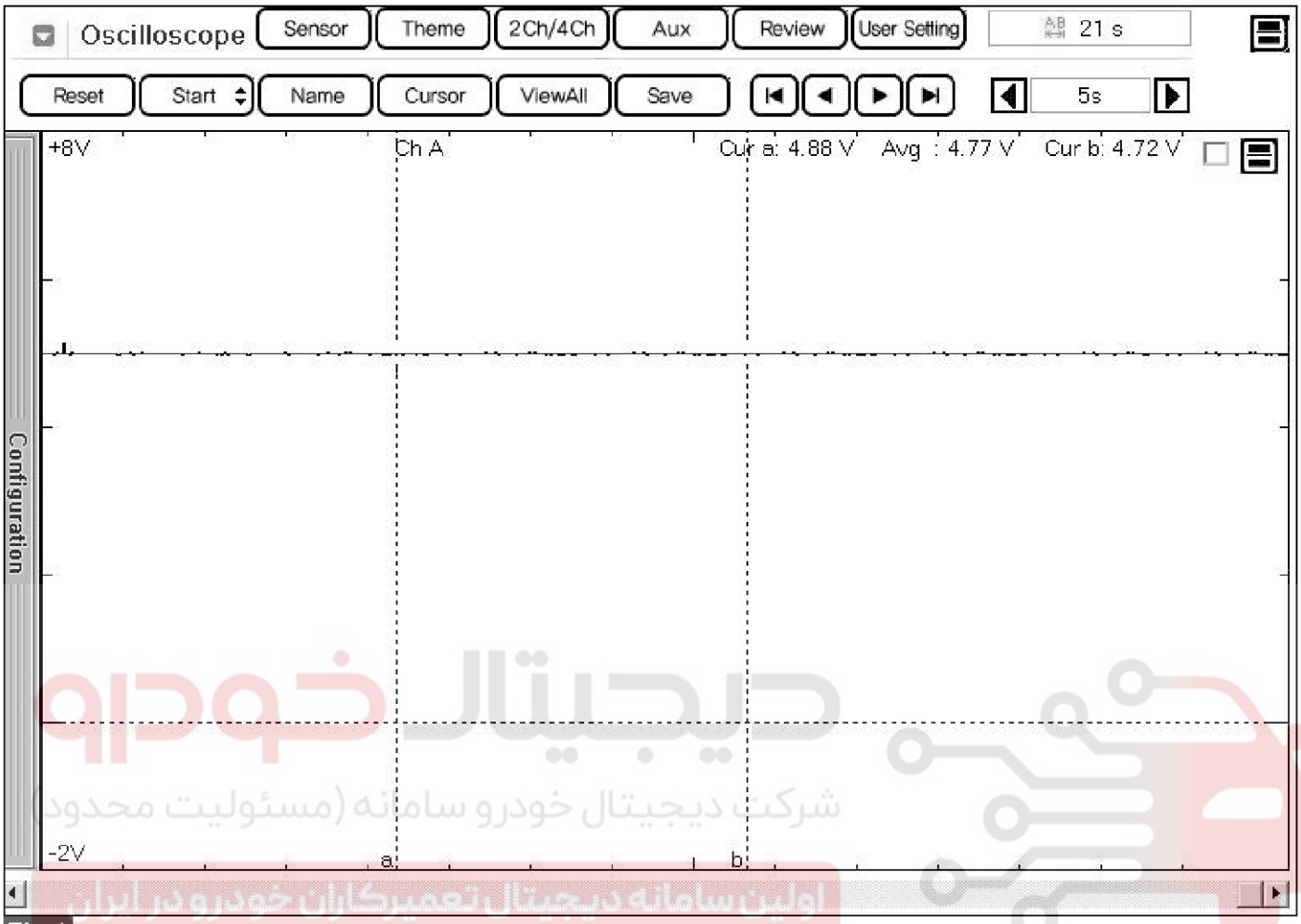


Fig.1

SPBF29851L

Fig.1) 4.8V is outputted at EGTS output signal circuit, when exhaust gas temp. is approx.150℃.

when exhaust gas temp. is 550~600℃ at CPF regeneration, output voltage drops to 0.3~0.4V.

Inspection

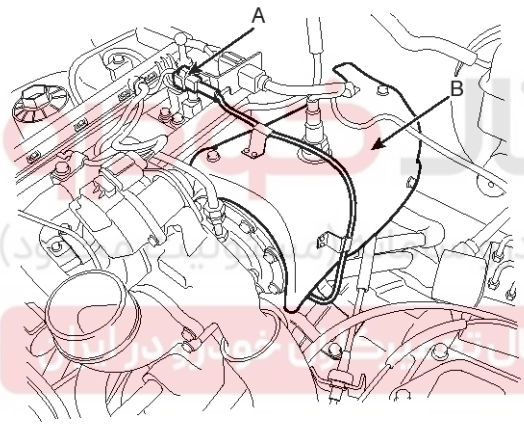
1. Turn ignition switch OFF.
2. Disconnect the exhaust gas temperature sensor #1/#2 connector.
3. Measure resistance between sensor signal terminal and ground terminal.
4. Check that the resistance is within the specification.

Specification: Refer to Specification section.

Removal

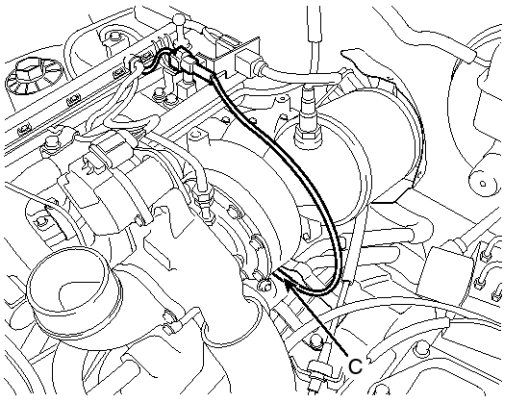
Exhaust Gas Temperature Sensor (EGTS) #1

1. Turn ignition switch OFF and disconnect the negative (-) battery cable.
2. Disconnect the exhaust gas temperature sensor #1 connector (A).
3. Remove the heat protector (B).



SENFL0112L

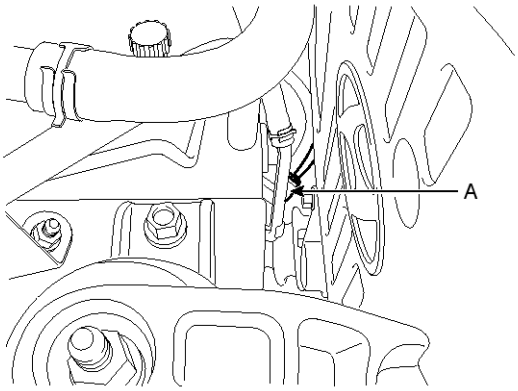
4. Remove the exhaust gas temperature sensor #1 (C).



SENFL0104L

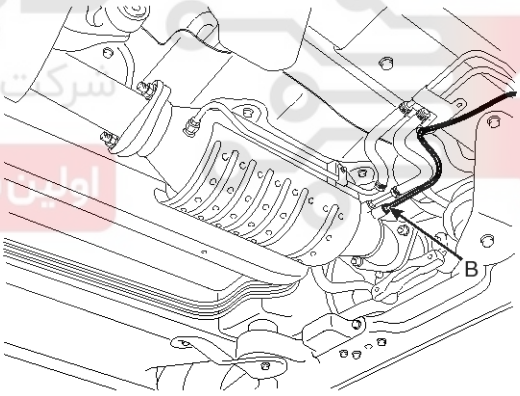
Exhaust Gas Temperature Sensor (EGTS) #2

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



SENFL0105L

3. Lift the vehicle and remove the exhaust gas temperature sensor #2 (B).



SENFL0113L

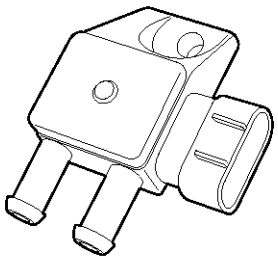
Installation

1. Installation is reverse of removal.

CPF Differential Pressure Sensor

Description

Differential Pressure Sensor (DPS) measures difference pressure between upstream and downstream exhaust gas of CPF. The ECM can calculate quantity of soot deposited in CPF with value from this sensor.



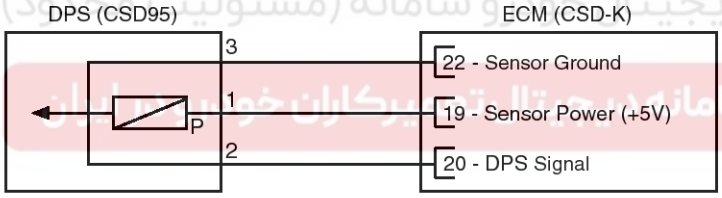
SENFL0123L

Specification

Differential Pressure [△P] (kPa)	Output Voltage (V)
0	1
10	1.35
20	1.7
30	2.05
40	2.4
50	2.75
60	3.1
70	3.45
80	3.8
90	4.15
100	4.5

Circuit Diagram

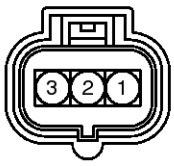
[Circuit Diagram]



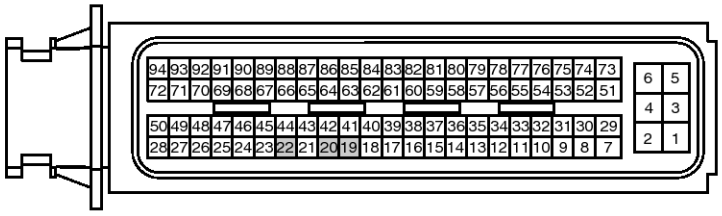
[Connection Information]

Terminal	Connected to	Function
1	ECM CSD-K (19)	Sensor Power (+5V)
2	ECM CSD-K (20)	DPS Signal
3	ECM CSD-K (22)	Sensor Ground

[Harness Connector]



CSD95
DPS



CSD-K
ECM

SENFL0124L

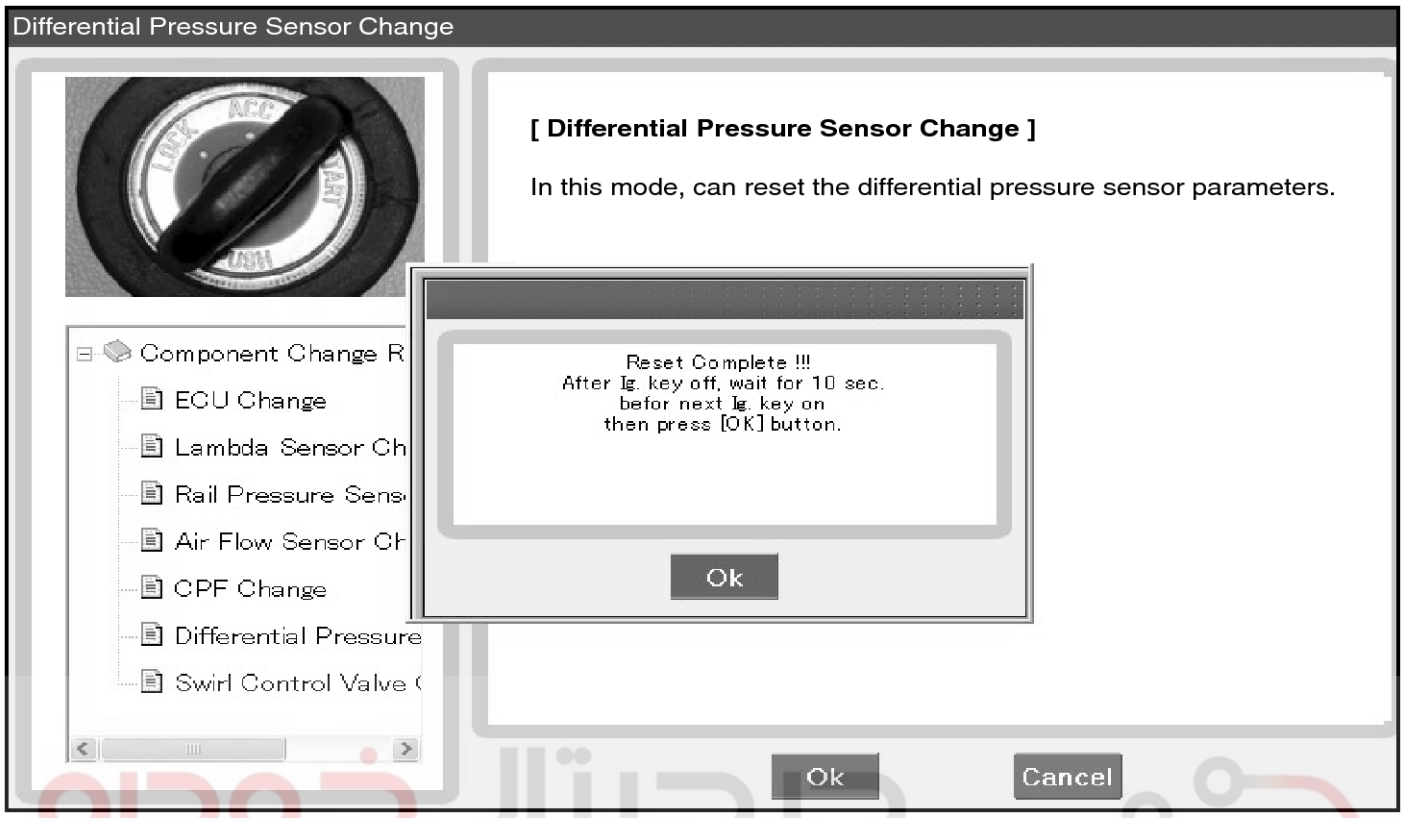
Replacement

⚠CAUTION

After replacing the Differential Pressure Sensor (DPS), MUST perform the "Component Change Routine" procedure. Otherwise trouble related with engine performance or emission control may occur until ECM learning about the component is over.

1. Turn ignition switch OFF.
2. Connect a scan tool to Data Link Connector (DLC).
3. Turn ignition switch ON.
4. Select "Vehicle, Model year, Engine, System".
5. Select "Vehicle S/W Management".
6. Select "Component Change Routine".
7. Select "Differential Pressure Sensor Change".
8. Perform the procedure in accordance with the message.

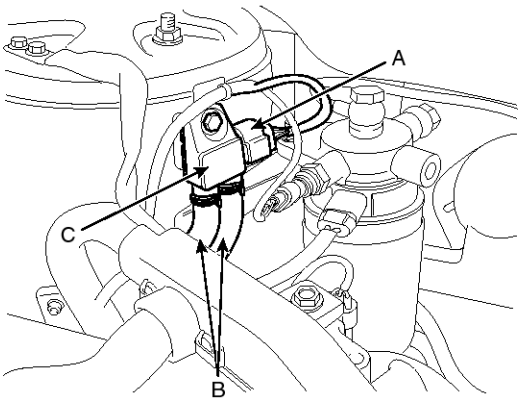
SFDF29245E



SFDF29246E

Removal

1. Turn ignition switch OFF and disconnect the negative (-) battery cable.
2. Disconnect the CPF differential pressure sensor connector (A) and the hose (B).
3. Remove the CPF differential pressure sensor (C).



SENFL0111L

Installation

1. Installation is reverse of removal.

Throttle Control Actuator

Description

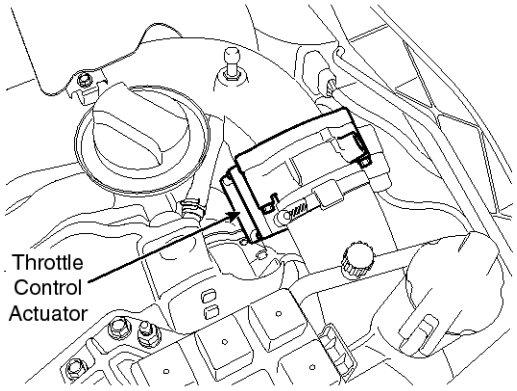
The Throttle Control Actuator is mounted on throttle body of diesel engine and controls throttle valve according to PWM (Pulse With Modulation) signal from ECM.

It consists of;

- a DC motor which actuates the throttle valve,
- a 2-step gear (transmission ratio = 1:40) which is located in between the DC motor and the throttle valve and increases torque of the DC motor,
- a position sensor which is a hall-effect sensor and detects status of the throttle valve,
- an electric control unit which is a micro-controller and drives the DC motor by the PWM (Pulse With Modulation) signal from the ECM,
- and a reset spring which resets the de-energized throttle valve to its open position.

Its function is described below:

1. Anti-judder function: When engine is shut off, the ECM can prevent intake air from entering to intake manifold by fully closing the throttle valve for 1.5 seconds (95% < Duty < 97%) to reduce engine vibration.
2. Intake air control for EGR: When exhaust gas pressure is equal to or lower than intake air pressure (for example, when low engine speed), the exhaust gas would not enter to the intake manifold. At this time, the ECM partially closes the throttle valve (5% < Duty < 94%) to reduce the intake air quantity. The intake air pressure thus is lower than the exhaust gas pressure.
3. Exhaust gas temperature control for CPF regeneration (Vehicle equipped with CPF System) : When the Catalyzed Particulate Filter (CPF) is need to regenerate, the ECM partially closes the throttle valve (5% < Duty < 94%) to reduce the intake air quantity. At this time, the air-fuel ratio would become rich and the exhaust gas temperature would be high enough to burn the soot inside the CPF.



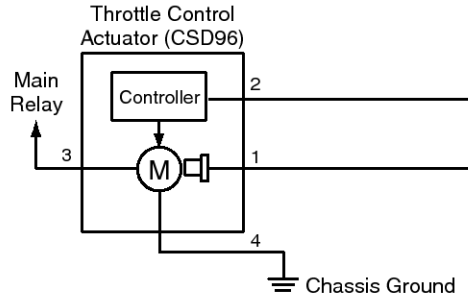
SENFL0106L

Specification

Duty (%)	Throttle Valve Position
5	Open
5 ~ 94	Normal operation (Partially open in proportion to duty value)
94	Closed
94 ~ 95	Maintaining the last valid position
95 ~ 97	Fully closed

Circuit Diagram

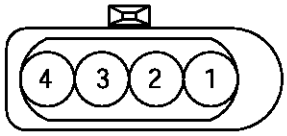
[Circuit Diagram]



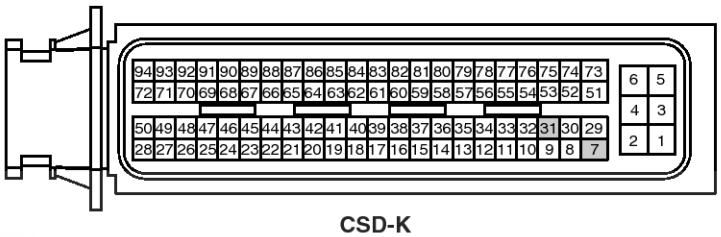
[Connection Information]

Terminal	Connected to	Function
1	ECM CSD-K (31)	Feedback Signal
2	ECM CSD-K (7)	Actuator Control
3	Main Relay	Battery Voltage
4	Chassis Ground	Ground

[Harness Connector]



Throttle Control Actuator
CSD96



CSD-K
ECM

SENFL0125L

CPF (Catalyzed Particulate Filter)

Description

The Catalyzed Particulate Filter (CPF) system prevents Particulate Matter (PM) from being discharged to the atmosphere and consists of a filter assembly, two Exhaust Gas Temperature Sensor (EGTS) and a Differential Pressure Sensor (DPS).The filter is integrated in the catalytic converter assembly and has honeycomb cell structure which can filter the PM in the exhaust gas. While the exhaust gas passes the CPF, the PM is gathered in the CPF and the others (CO2, NO, etc.) are discharged to the atmosphere via muffler. This gathered PM in CPF is called "soot".

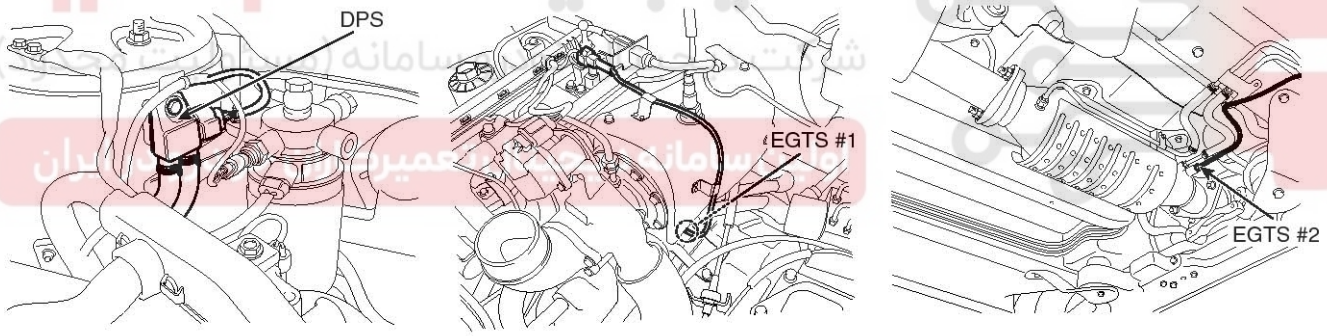
[CPF Regeneration]

If there are much soot in the CPF, the CPF must be regenerated. ECM can calculate amount of the soot by using the DPS signal, vehicle mileage or simulation data. If the ECM determines the CPF is need to regenerate, it will perform "Regeneration Procedure" when the vehicle condition is corresponded with the predetermined one (Regeneration Mode).

To burn the soot, the ECM injects additional fuel in the cylinders during exhaust stroke (two Post Injection) and increases the exhaust gas temperature to burning temperature of the soot (above 600℃). At this time, the soot are burn and its ash remains in the CPF as a result of the combustion.

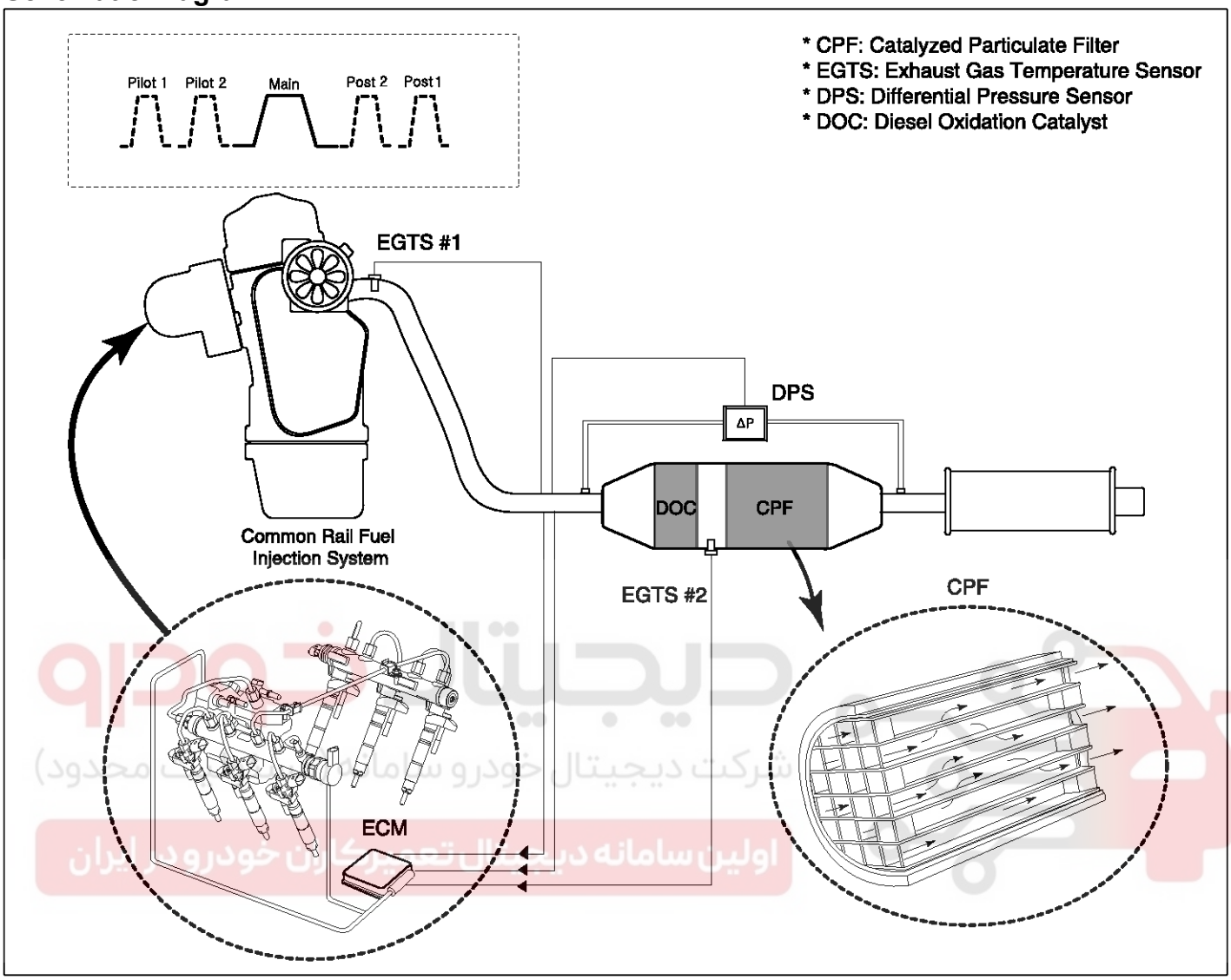
[Regeneration Mode]

1. Mileage > 1,000km
2. Engine Speed: 1,000 ~ 4,000rpm
3. Engine Load = About 0.7bar [8mg/st]
4. Vehicle Speed > 5km/h
5. Engine Coolant Temperature > 40℃

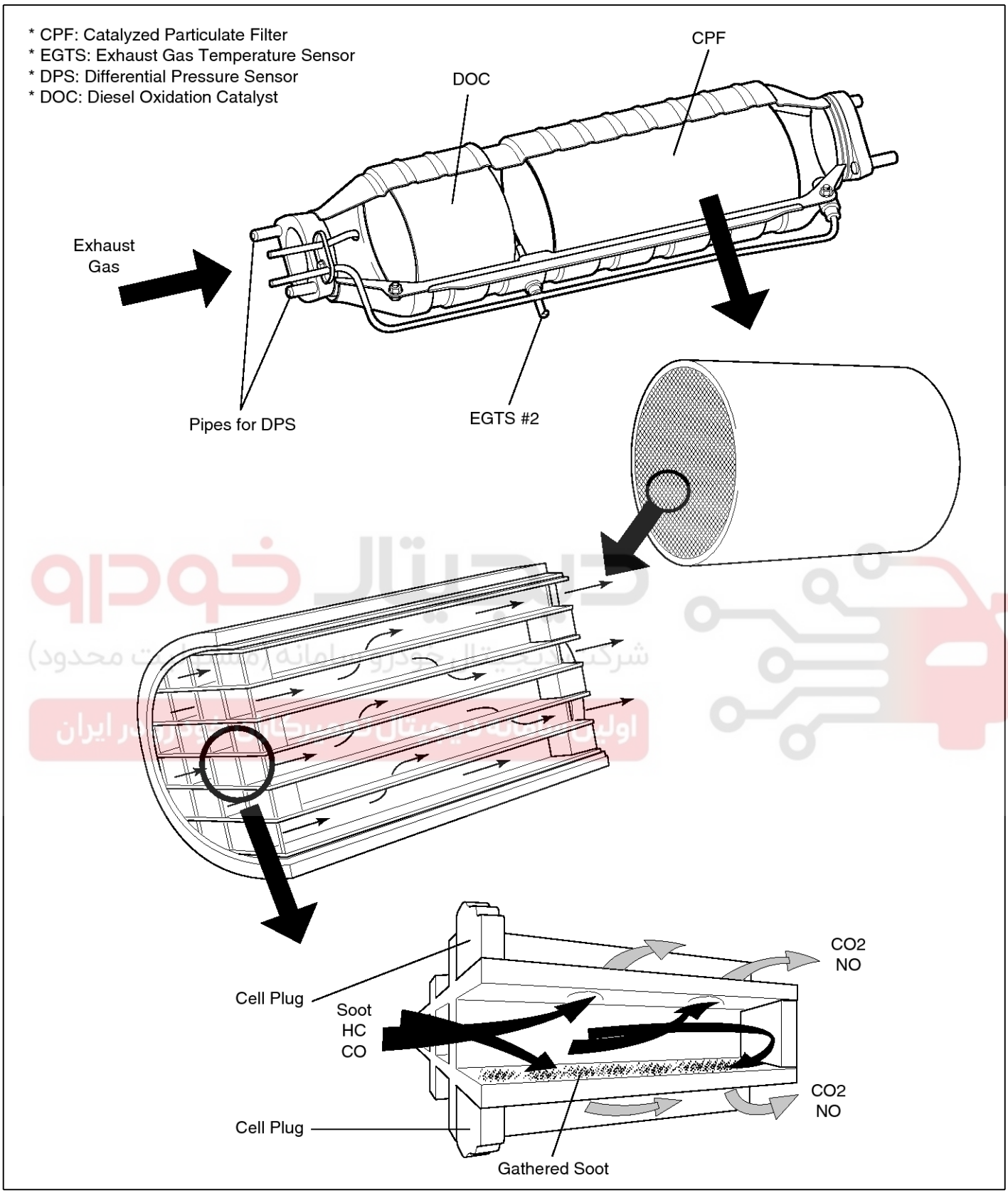


SENFL0116L

Schematic Diagram



SENFL0117L



LFIG117A

CPF Regeneration

This procedures is to forcibly regenerate the CPF with scan tool when the CPF doesn't have been regenerated during driving. For example, if the vehicle has repeated "Low speed driving" or "Short distance driving", the CPF regeneration procedure cannot be proceeded because "Regeneration Mode" doesn't made.

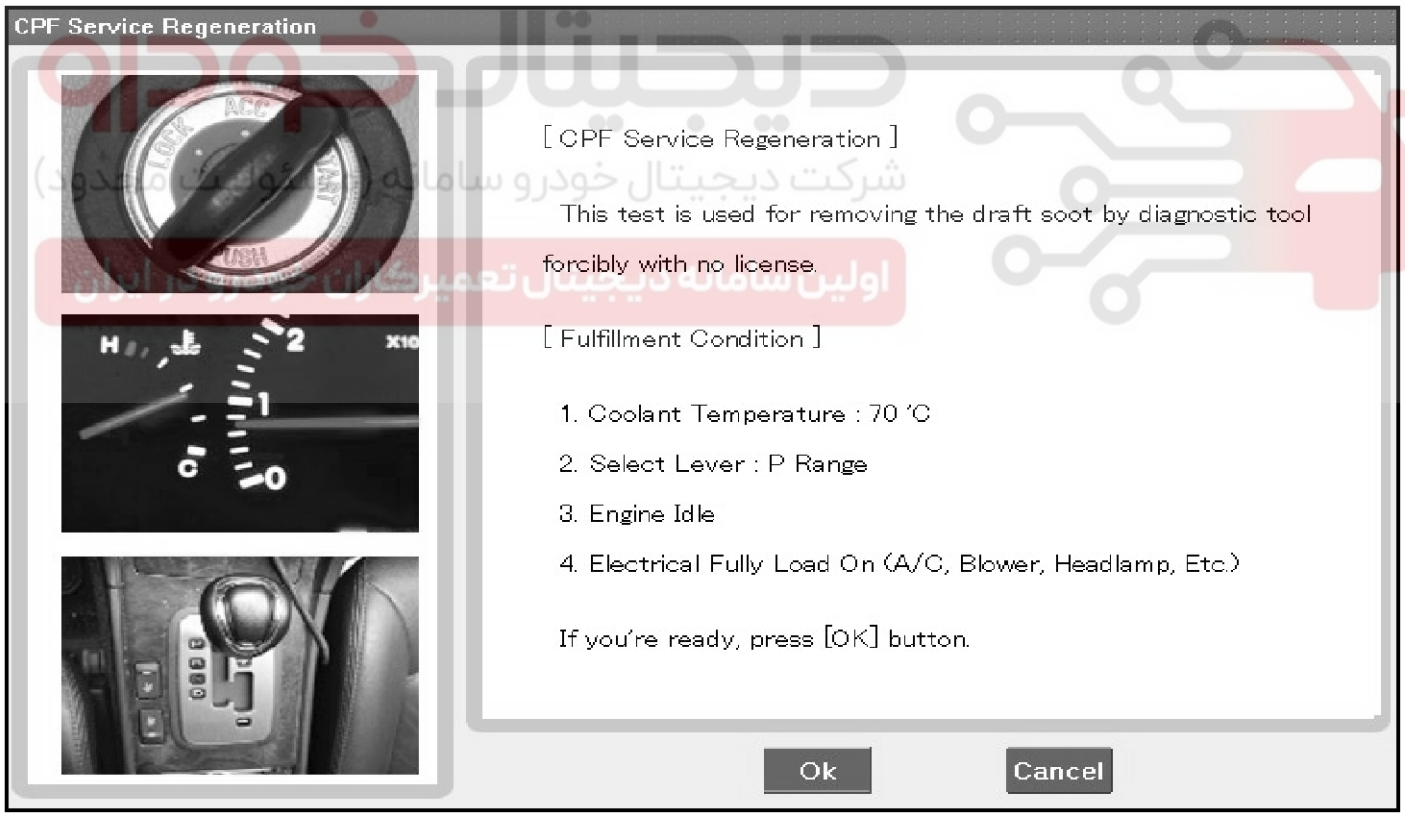
Forcibly Regeneration Condition

- Engine coolant temperature: about 70℃
- Engine at idle
- P-range (A/T) or Neutral (M/T)
- Normal battery voltage
- Electrical fully load ON (A/C ON if equipped, Blower ON with maximum speed, Head Lamp ON, Wiper ON, Other Lamps ON, etc.)

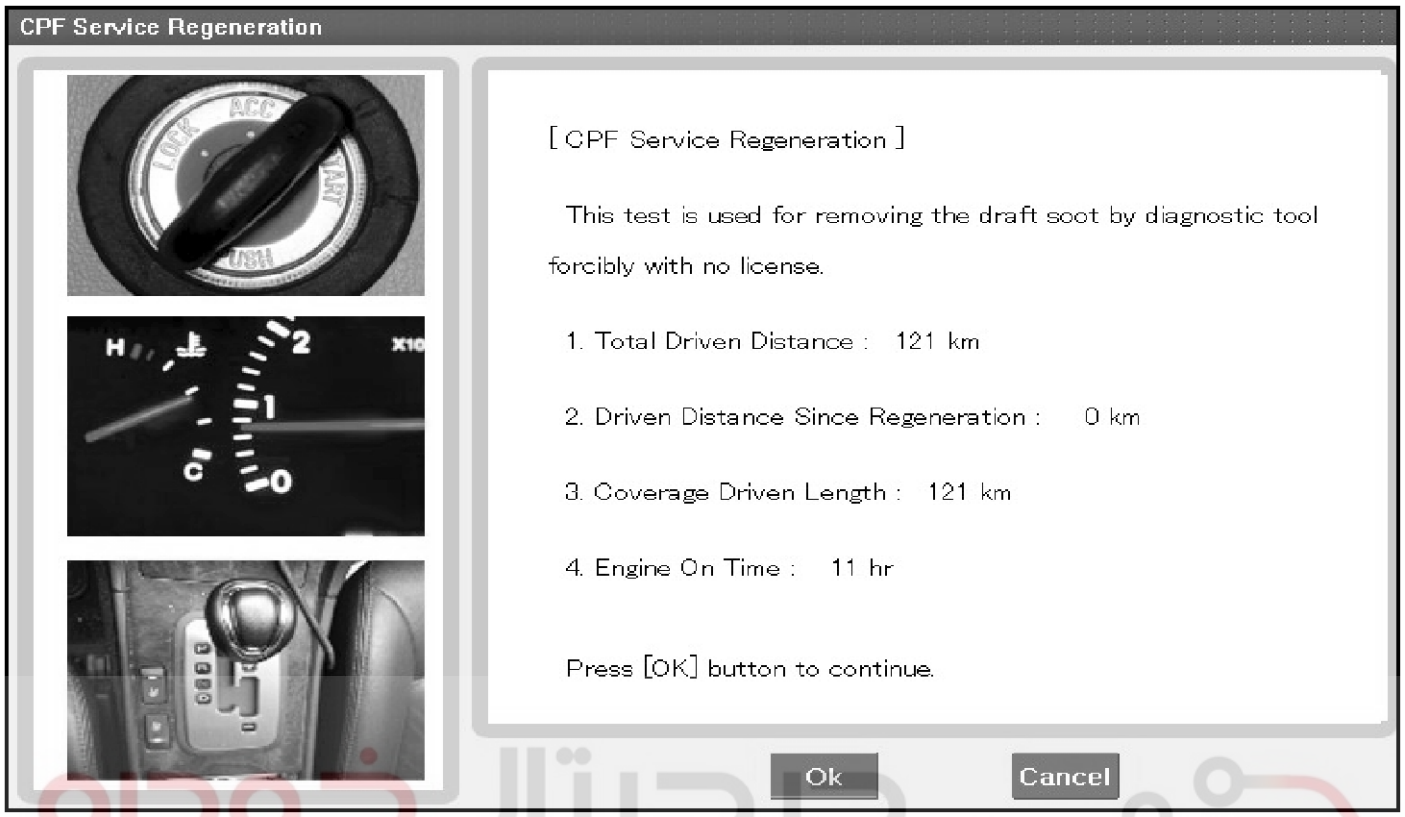
NOTICE

The air conditioner's electrical load is very high. Accordingly, to make regeneration mode more quickly, turn it ON (If eqquipped).

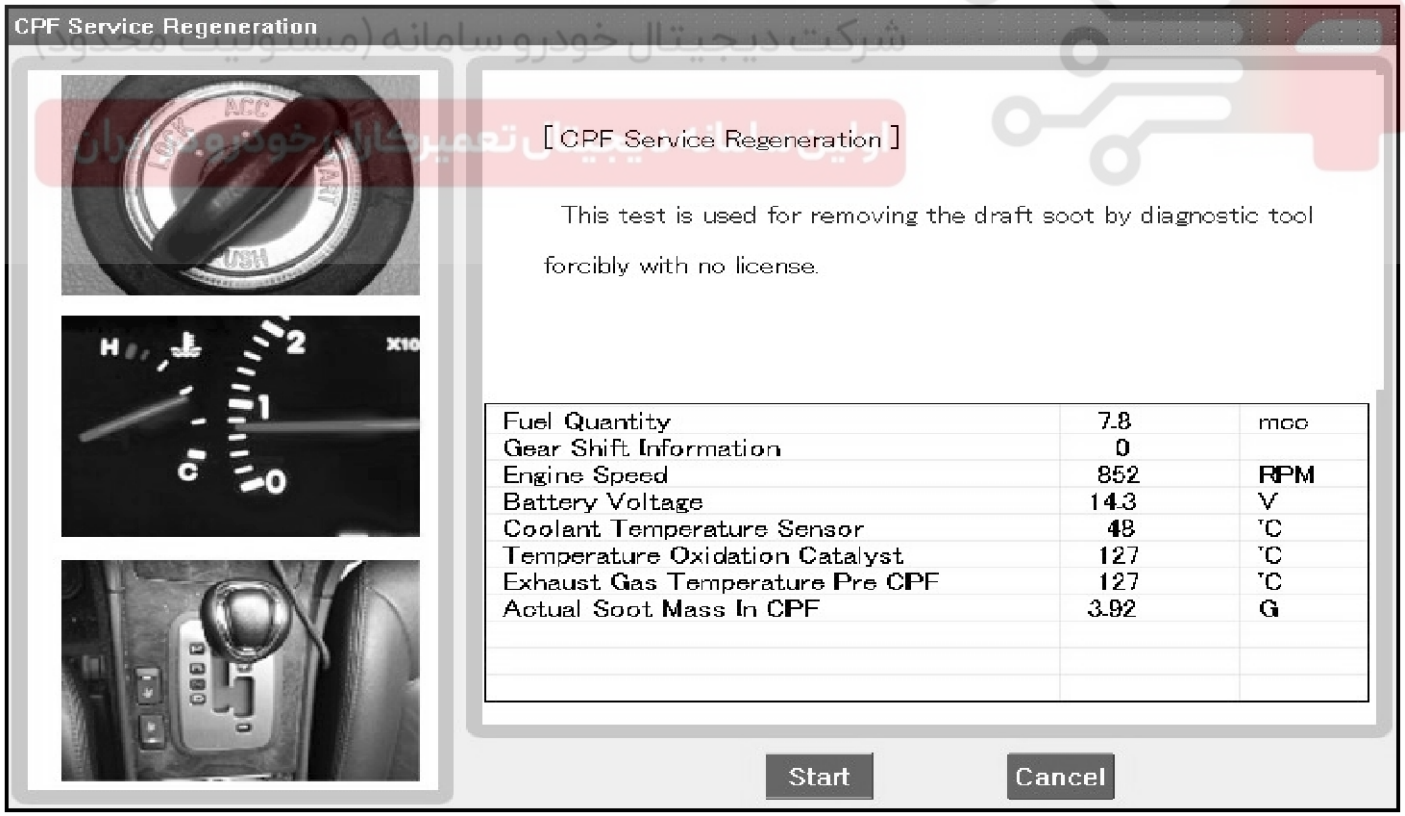
1. Turn ignition switch OFF.
2. Connect a GDS to Data Link Connector (DLC).
3. Start engine at idle and P-range (A/T) or neutral (M/T).
4. Apply electrical fully load to the vehicle (A/C ON, Blower ON with maximum speed, Head Lamp ON, Wiper ON, and Other Lamps ON, etc.)
5. Select "Vehicle, Model year, Engine, System".
6. Select "Vehicle S/W Management".
7. Select "CPF Service Regeneration".
8. Perform the test in accordance with the message.



SFDF29247E



SFDF29248E



SFDF29249E

CPF Service Regeneration

[CPF Service Regeneration]

This test is used for removing the draft soot by diagnostic tool forcibly with no license.

[[Heating Stage !!!]]

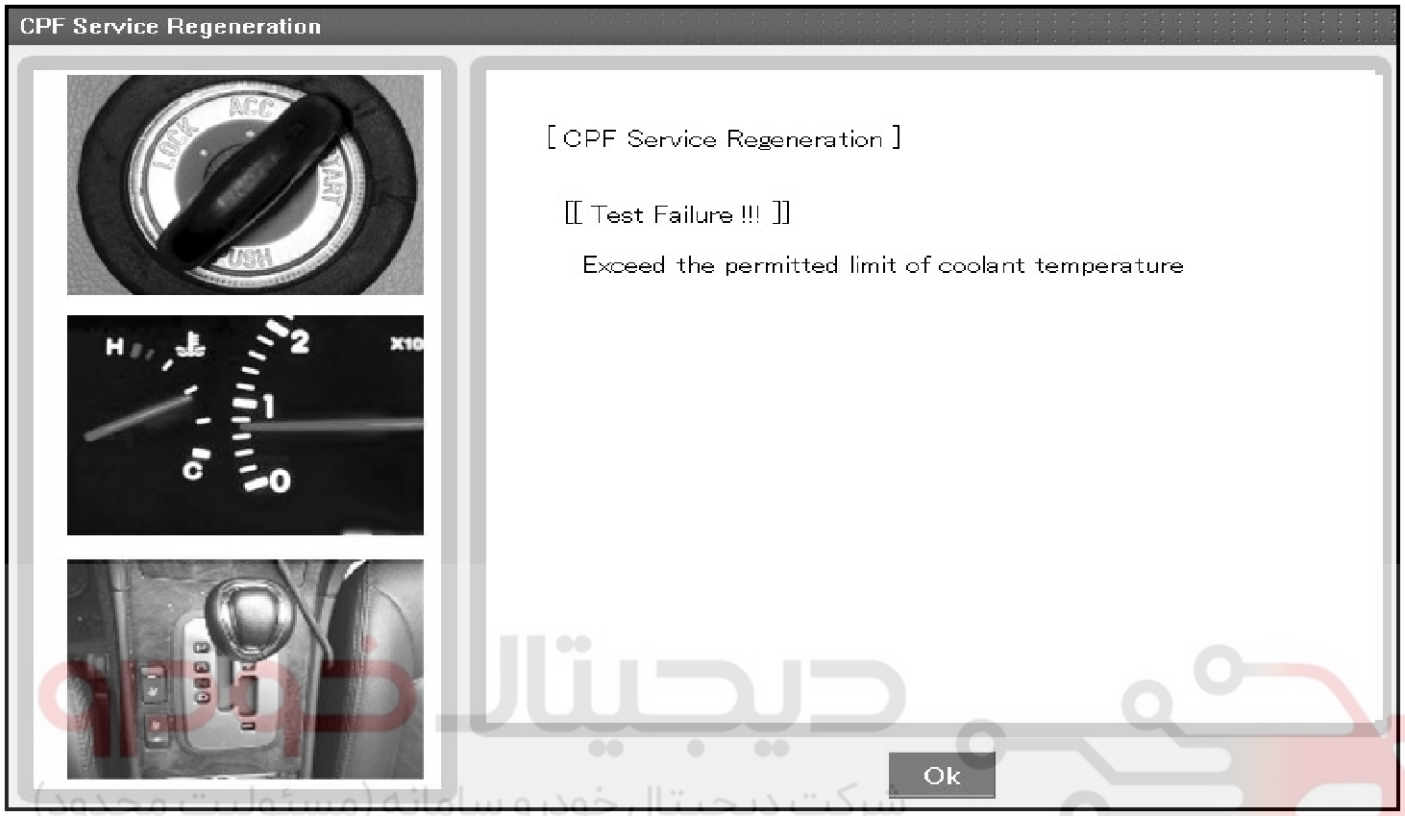
Fuel Quantity	4.7	mcc
Gear Shift Information	0	
Engine Speed	1176	RPM
Battery Voltage	14.3	V
Coolant Temperature Sensor	62	°C
Temperature Oxidation Catalyst	127	°C
Exhaust Gas Temperature Pre CPF	127	°C
Actual Soot Mass In CPF	3.92	G

Stop Cancel

SFDF29250E

NOTICE

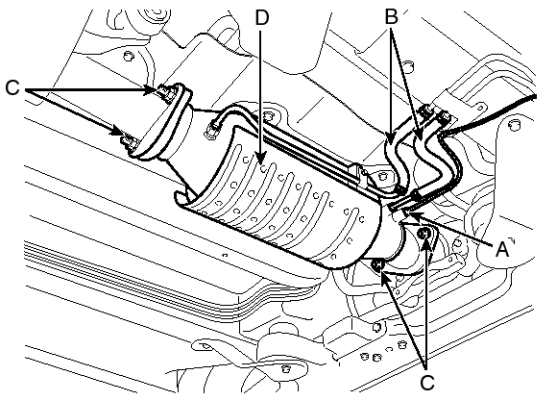
If the fulfillment condition is not satisfied, CPF regeneration test will fail.



SFDF29251E

Removal

1. Turn ignition switch OFF and disconnect the negative (-) battery cable.
2. Lift the vehicle and support the CPF assembly with a jack.
3. Remove the exhaust gas temperature sensor #2 (A).
4. Disconnect the hoses (B) connected with Differential Pressure Sensor (DPS) from the CPF assembly.



SENFL0114L

5. Remove the mounting nuts (C) and remove the CPF (D) from the vehicle.

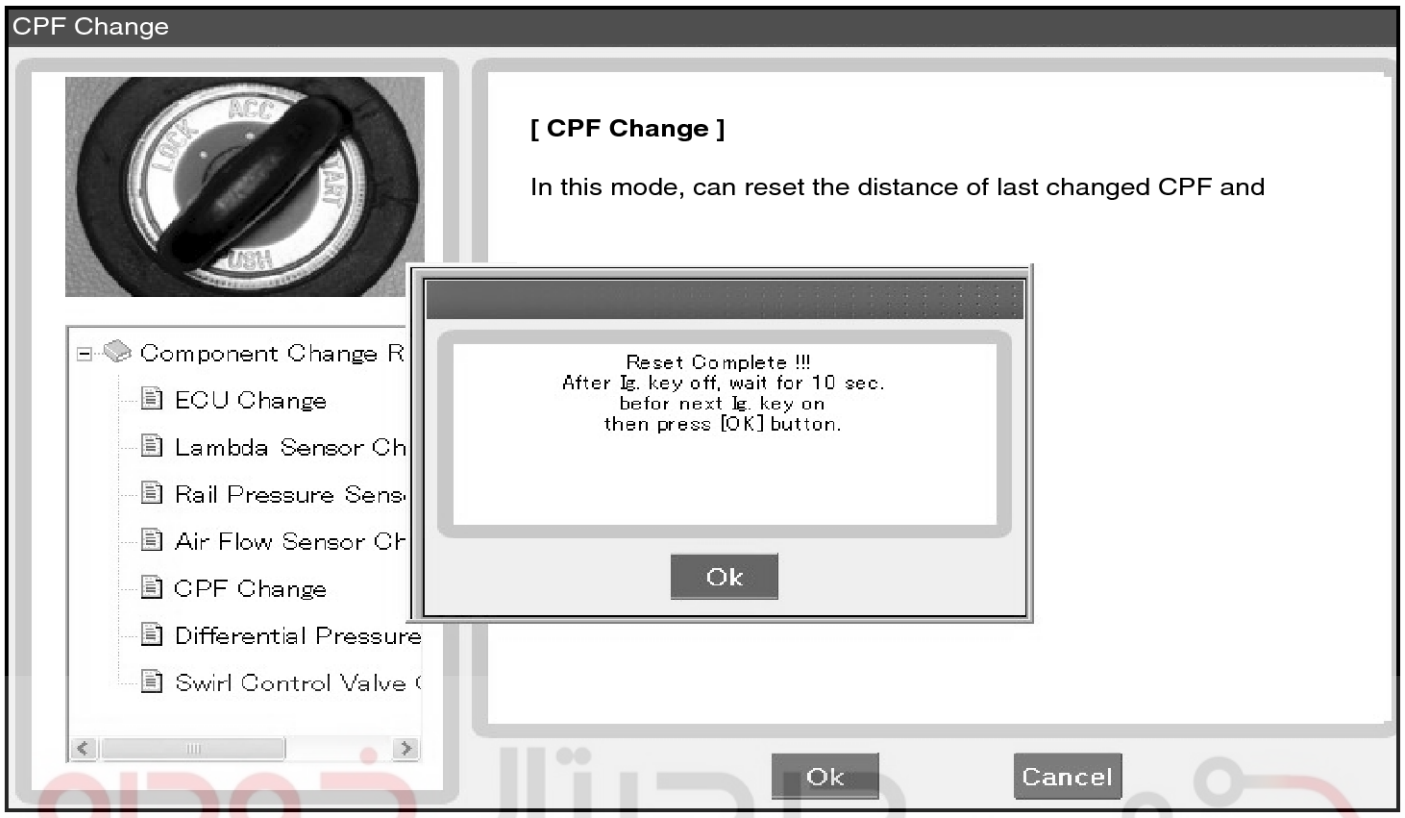
Replacement

NOTICE

After replacing the CPF assembly, MUST perform the "Component Change Routine" procedure. Otherwise trouble related with engine performance or emission control may occur until ECM learning about the component is over.

1. Turn ignition switch OFF.
2. Connect a scan tool to Data Link Connector (DLC).
3. Turn ignition switch ON.
4. Select "Vehicle, Model year, Engine, System".
5. Select "Vehicle S/W Management".
6. Select "Component Change Routine".
7. Select "CPF Change".
8. Perform the procedure in accordance with the message.

SFDF29252E



SFDF29253E

Installation

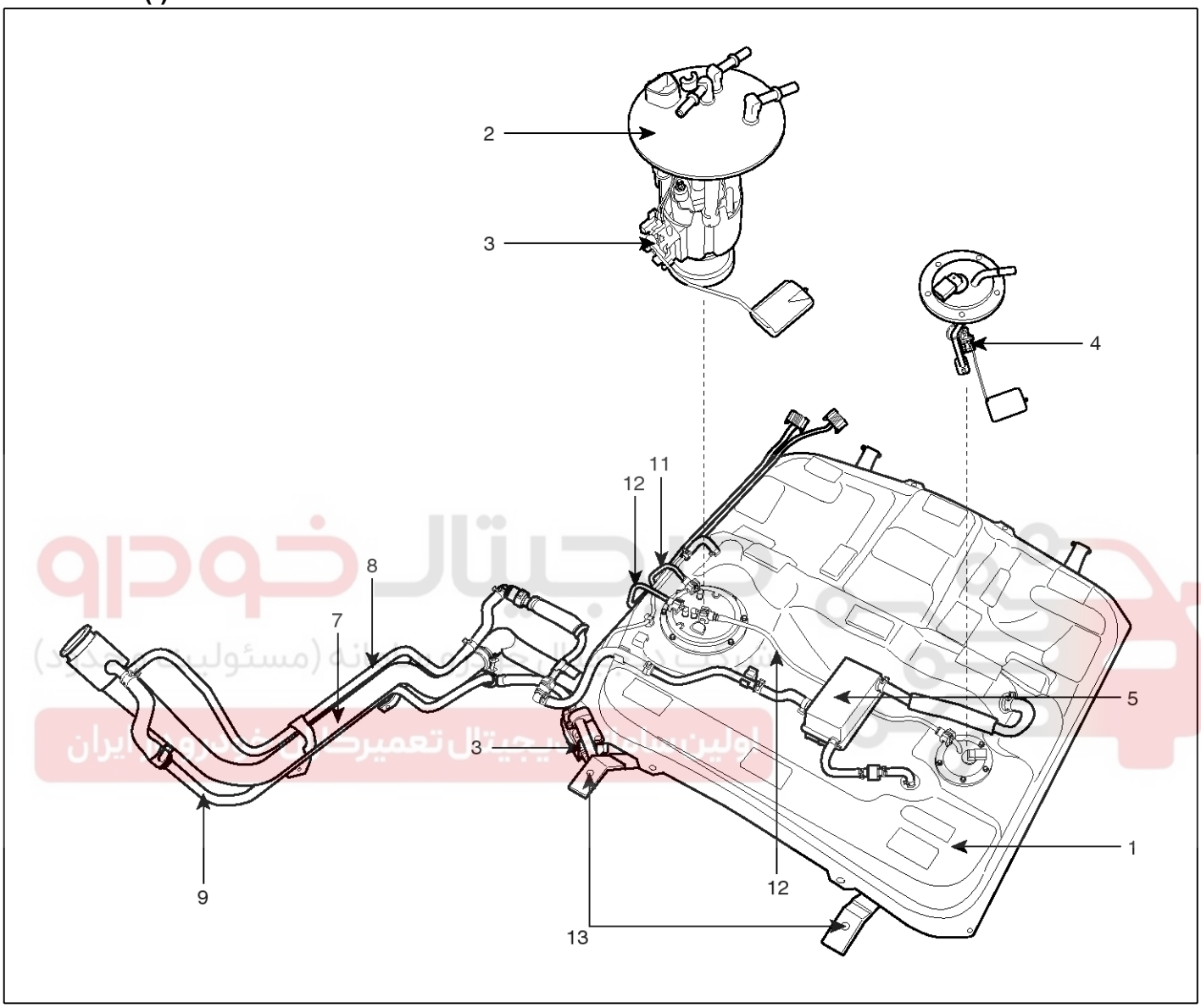
1. Installation is reverse of removal.

CPF Mounting Nuts:
39.2 ~ 58.9 N.m (4.0 ~ 6.0 kgf.m, 28.9 ~ 43.4 lb-ft)

Fuel Delivery System

Component Location

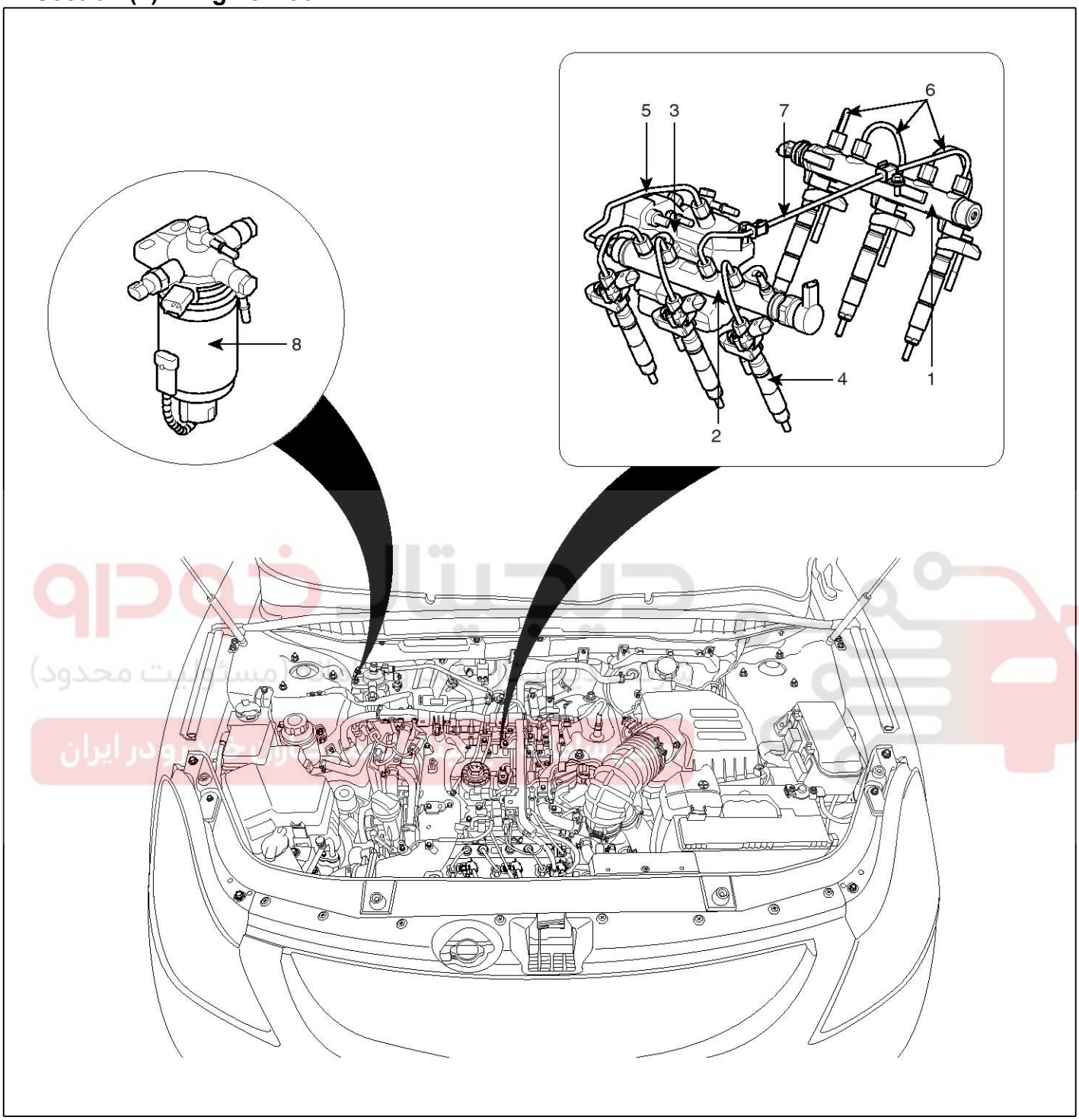
● **Section (I) - Fuel Tank**



SENFL9150L

1. Fuel Tank
2. Fuel Pump (Low Pressure)
3. Fuel Sender
4. Sub Fuel Sender
5. Separator
6. Fuel Tank Air Filter
7. Fuel Filler Pipe
8. Leveling Pipe
9. Ventilation Pipe
10. Fuel Feed Tube
11. Fuel Return Tube
12. Suction Tube
13. Fuel Tank Band

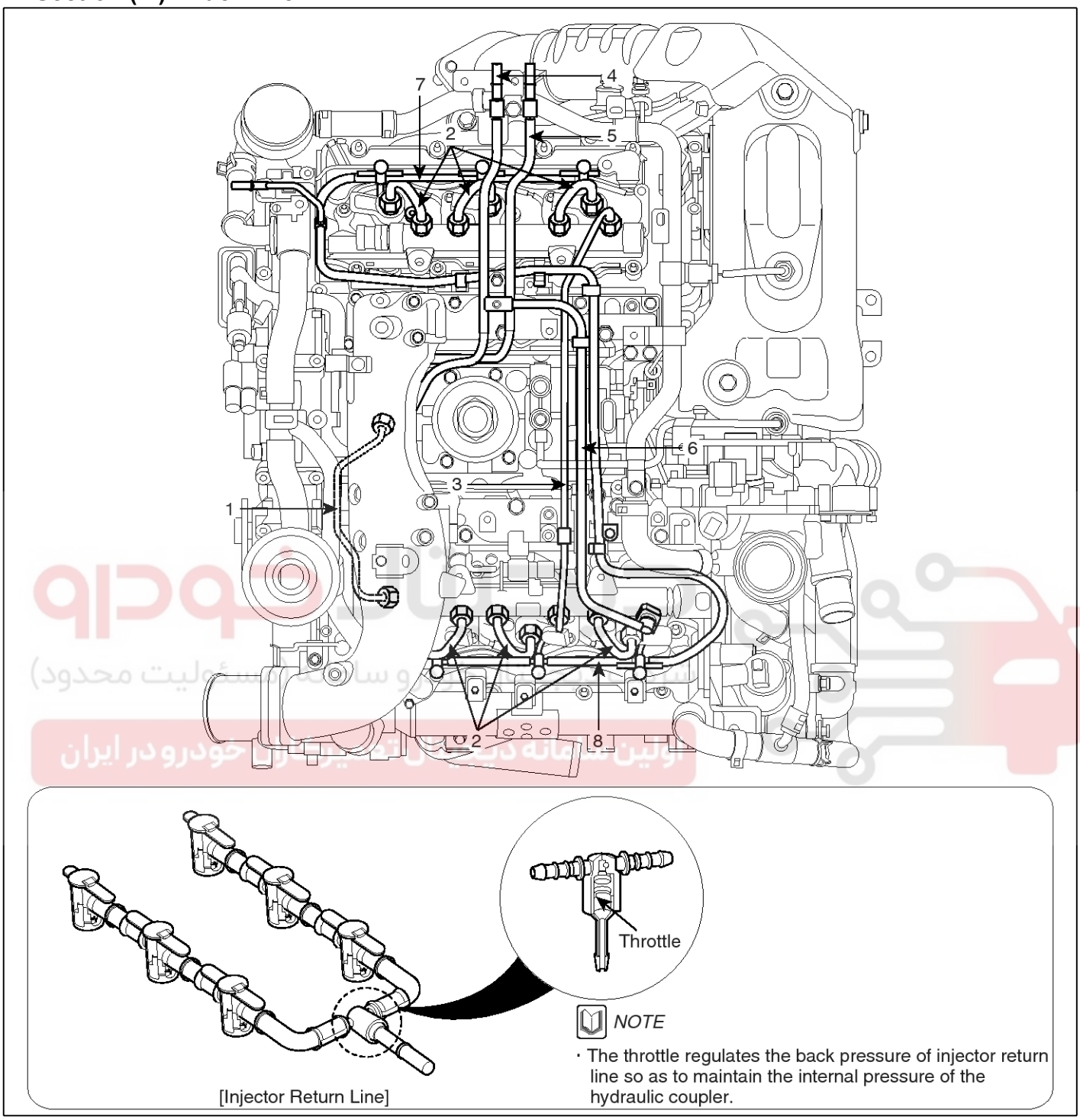
● **Section (II) - Engine Room**



SENFL0151L

1. Common Rail (Bank 1)
2. Common Rail (Bank 2)
3. High Pressure Fuel Pump
4. Injector
5. High Pressure Fuel Pipe (High Pressure Fuel Pump ↔ Common Rail)
6. High Pressure Fuel Pipe (Common Rail ↔ Injector)
7. High Pressure Fuel Pipe (Common Rail ↔ Common Rail)
8. Fuel Filter

● Section (III) - Fuel Line



SENFL9152L

1. High Pressure Fuel Pipe
   (High Pressure Fuel Pump ↔ Common Rail)
2. High Pressure Fuel Pipe
   (Common Rail ↔ Injector)
3. High Pressure Fuel Pipe
   (Common Rail ↔ Common Rail)
4. Fuel Feed Tube
   (Fuel Filter ↔ High Pressure Fuel Pump)
5. Fuel Return Tube
   (High Pressure Fuel Pump ↔ Fuel Tank)
6. Fuel Return Tube
   (Common Rail ↔ Fuel Tank)
7. Fuel Return Tube
   (Injector [Bank 1] ↔ Fuel Filter)
8. Fuel Return Tube
   (Injector [Bank 2] ↔ Fuel Filter)

WARNING

As the Piezo-Injector operates under maximum DC 200V, there may be a risk of an electric shock caused by shorted control line etc. So when repairing the injector or its wiring, disconnect the battery negative (-) terminal from the battery and wait for about 30 seconds.

CAUTION

- **Common Rail Fuel Injection System operates with extremely high pressure (approximately 1,600bar), so never perform any work on injection system with engine running or within 30 seconds after the engine stops.**
- **Keep cleanly the parts and the working area.**
- **Pay attention to a foreign substance.**
- **Just before installing injector, tube or hose, remove the protect-cap attached on them.**
- **Do not remove injector except for special case.**
- **When installing Injector**

  - Wash the contact area of the injector and replace the O-ring with a new one.

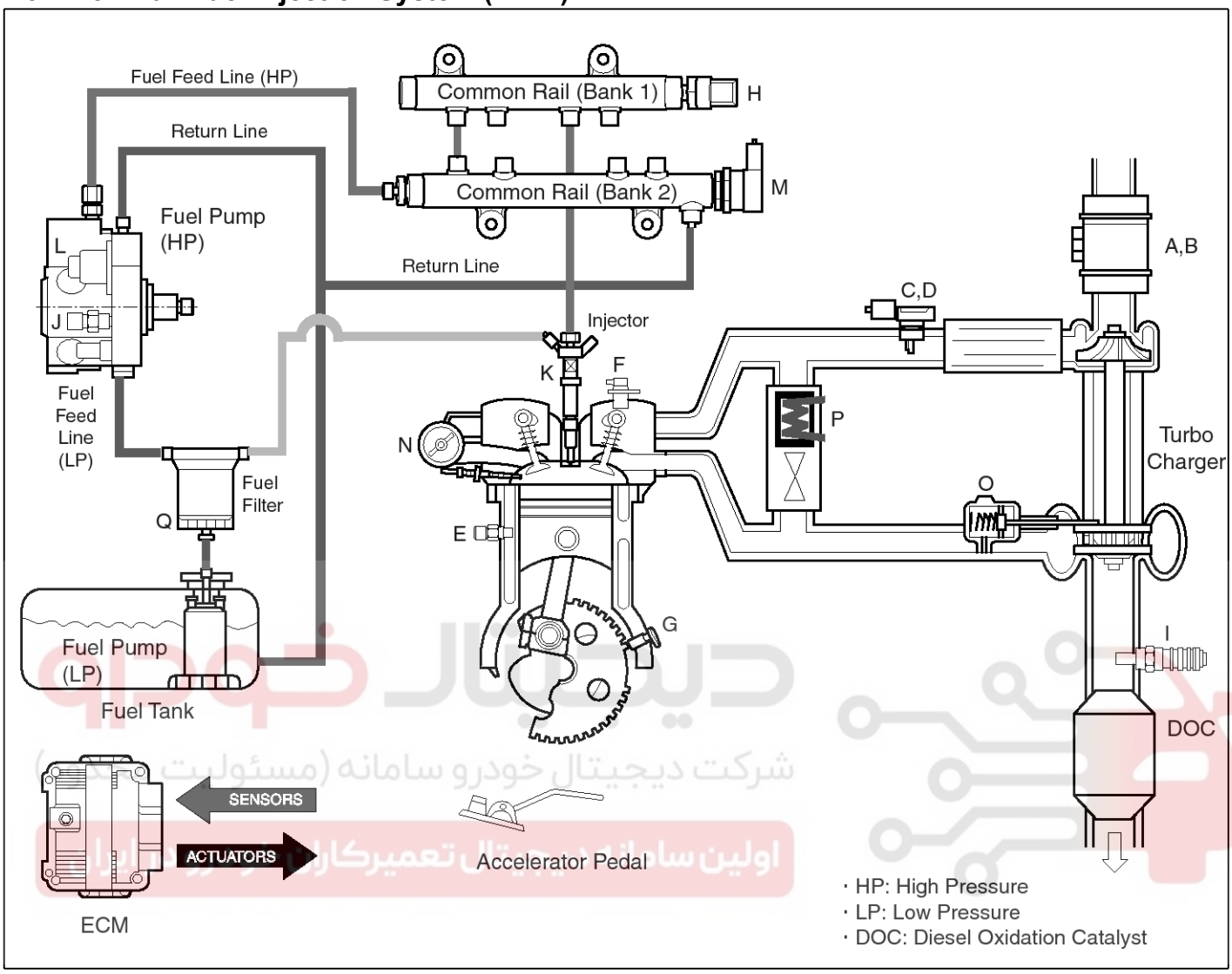
  - Spread oil on the injector O-ring.

  - To protect damage caused by shock, vertically insert the injector into the cylinder head.
- **When installing High Pressure Fuel Pipe**

  - Do not use again the used high pressure fuel pipe.

  - Install the flange nut correctly.

Common Rail Fuel Injection System (CRDI)



SENFL9153L

A. Mass Air Flow Sensor (MAFS)
B. Intake Air Temperature Sensor (IATS) #1
C. Boost Pressure Sensor (BPS)
D. Intake Air Temperature Sensor (IATS) #2
E. Engine Coolant Temperature Sensor (ECTS)
F. Camshaft Position Sensor (CMPS)
G. Crankshaft Position Sensor (CKPS)
H. Rail Pressure Sensor (RPS)
I. Lambda Sensor
J. Fuel Temperature Sensor (FTS)
K. InjectorL. Fuel Pressure Regulator Valve
M. Rail Pressure Regulator Valve
N. Variable Swirl Control Actuator
O. Electric VGT Control Actuator
P. Electric EGR Control Valve
Q. Water Sensor

● Low Pressure Fuel Circuit

Low Pressure Fuel Pump

The low pressure fuel pump is either an electric fuel pump with pre-filter, or a gear-type fuel pump. The pump draws the fuel from the fuel tank and continually delivers the required quantity of fuel in the direction of the high pressure fuel pump (via fuel filter).

Sub Fuel Sender

The sub fuel sender is installed on the fuel tank which has separated fuel storeroom (LH & RH) and detects the fuel quantity of RH's one.

The fuel stored in RH is flown into the LH by the assist pump involved in the fuel pump in LH (The sub fuel sender doesn't have an independent pump).

Fuel Filter

The fuel filter is located in between the low pressure fuel pump and the high pressure fuel pump and filters the fuel delivered from the fuel tank.

● High Pressure Fuel Circuit

High Pressure Fuel Pump

The high pressure fuel pump compresses fuel up to 1,600 bar and delivers the compressed fuel to the common rail.

Common Rail

The two common rails are installed on bank 1 and 2 and are connected with the high pressure fuel pump and the injectors by the high pressure fuel pipes. This rail stores the fuel compressed in the high pressure fuel pump. So that the two rails have same fuel pressure, the high pressure fuel pipe connects the two rails.The ECM controls the fuel pressure of the common rail by using the rail pressure sensor and the rail pressure regulator valve installed on the common rail (Bank 1) and (Bank 2) respectively.

Injector

The injector injects the high pressure fuel stored in the common rail into the cylinder by the ECM control signal.

High Pressure Fuel Pump

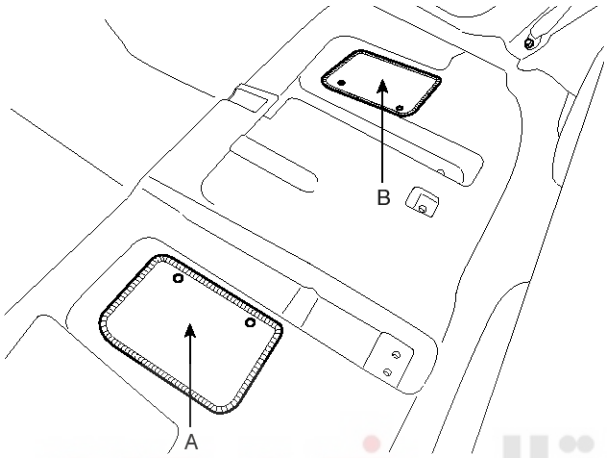
The high pressure fuel pipe is a channel in high pressure fuel circuit consisting of the high pressure fuel pump, common rails, and injectors. It is a steel tube which can withstand high frequency generated when the fuel pressure reaches the maximum pressure or fuel injection stops.

The differences in length between the common rail and the individual injectors are compensated for by using slight or pronounced bends in the individual lengths of tubing. Nevertheless, the injection lines should be kept as short as possible.

Fuel Tank

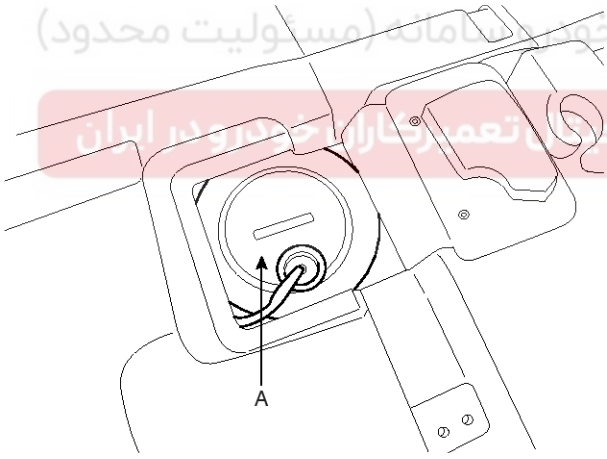
Removal

1. Turn ignition switch OFF and disconnect the negative (-) battery cable.
2. Remove the 2nd seat (Refer to "SEAT" in BD group).
3. Open the carpet (A) for the fuel pump and the carpet (B) for the sub fuel sender.



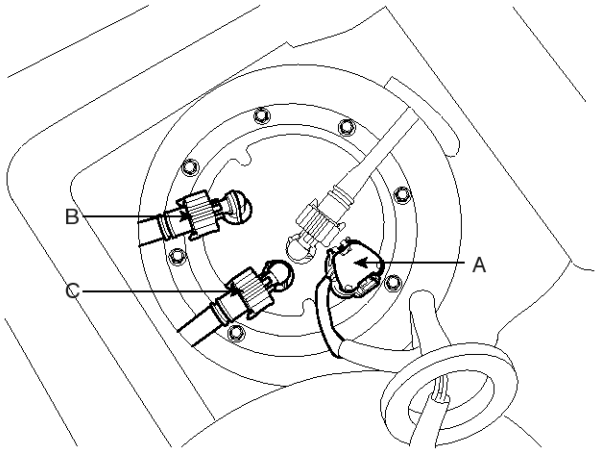
SENFL7176D

4. Remove the fuel pump service cover (A).



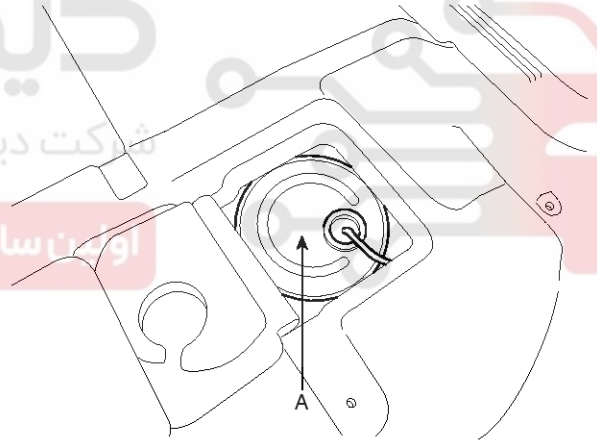
SENFL7177D

5. Disconnect the fuel pump connector (A).



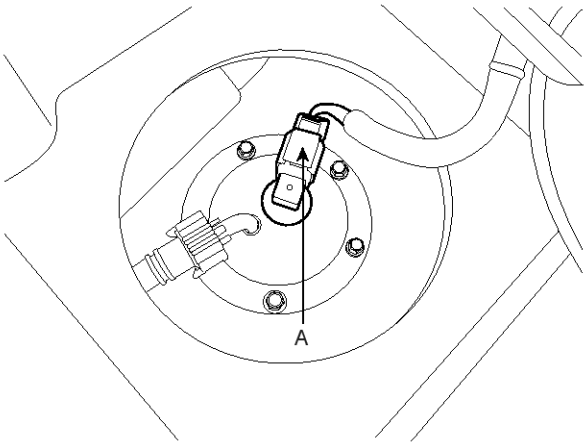
SENFL7178D

6. Disconnect the fuel feed tube quick-connector (B) and the fuel return tube quick-connector (C).
7. Remove the sub fuel sender service cover (A).



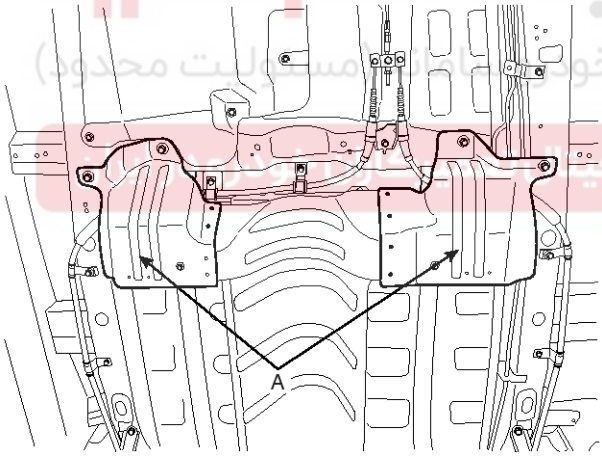
SENFL7179D

8. Disconnect the sub fuel sender connector (A).



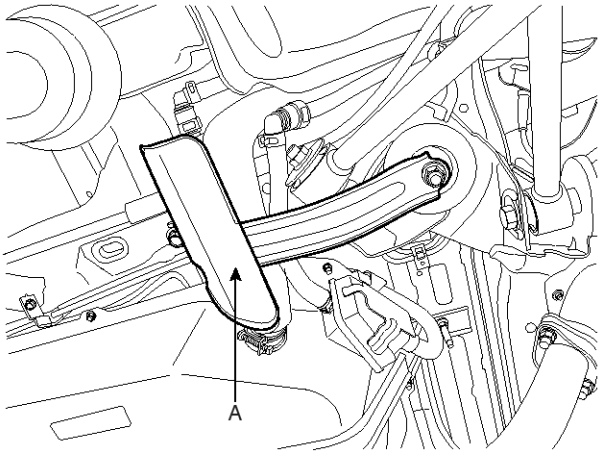
SENFL7180D

9. Lift the vehicle.
10. Remove the muffler assembly (Refer to "INTAKE AND EXHAUST SYSTEM" in EM group).
11. Remove the propeller shaft [4WD only] (Refer to "PROPELLAR SHAFT" in DS group).
12. Support the fuel tank with a jack.
13. Remove the fuel tank cover (A).



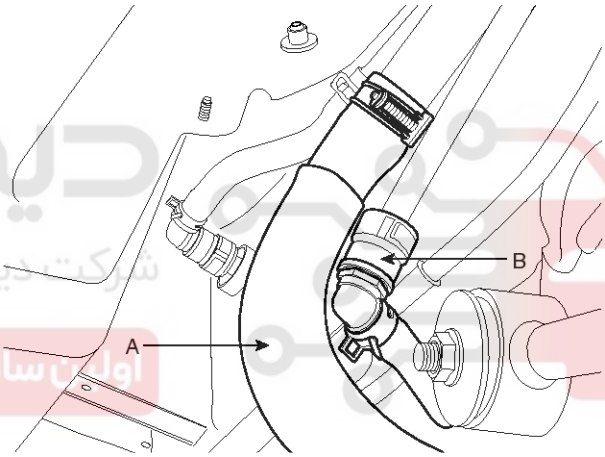
SENFL7181D

14. Remove the bracket (A).



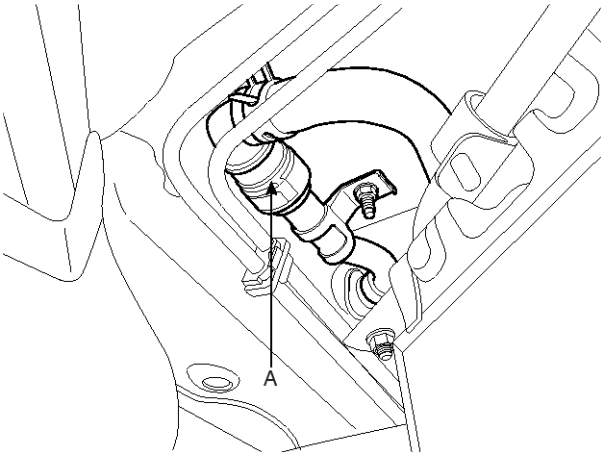
SENFL7182D

15. Disconnect the fuel filler hose (A) and the leveling tube quick-connector (B).



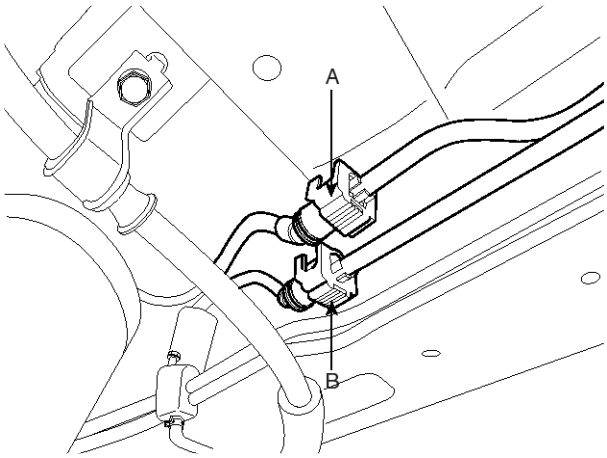
SENFL7183D

16. Disconnect the ventilation hose quick-connector (A).



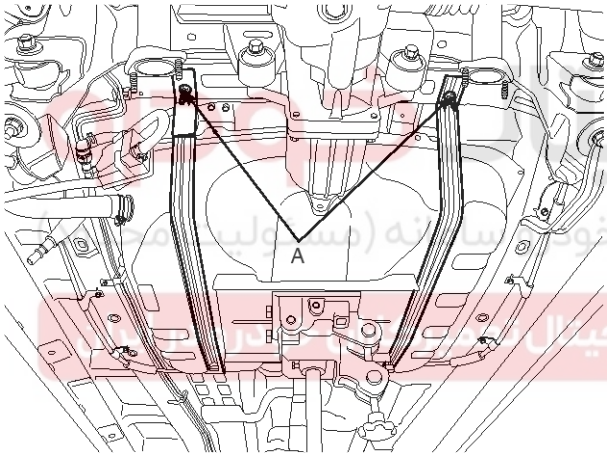
SENFL7184D

17. Disconnect the fuel feed tube quick-connector (A) and the fuel return tube quick-connector (B).



SENFL7185D

18. Unscrew the fuel tank bank installation nuts (A), and then remove the fuel tank from the vehicle.



SENFL7186D

Installation

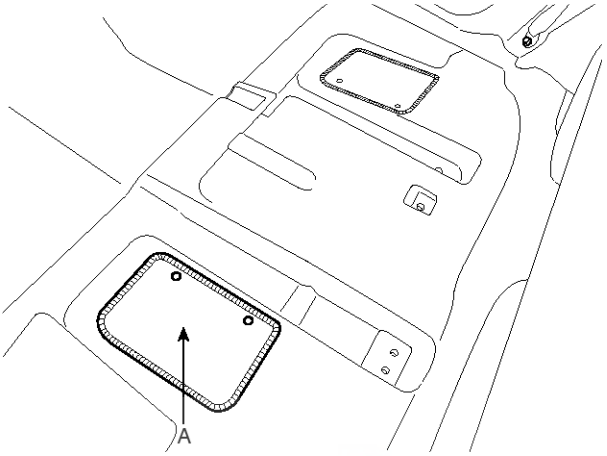
1. Installation is reverse of removal.

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

Fuel Pump

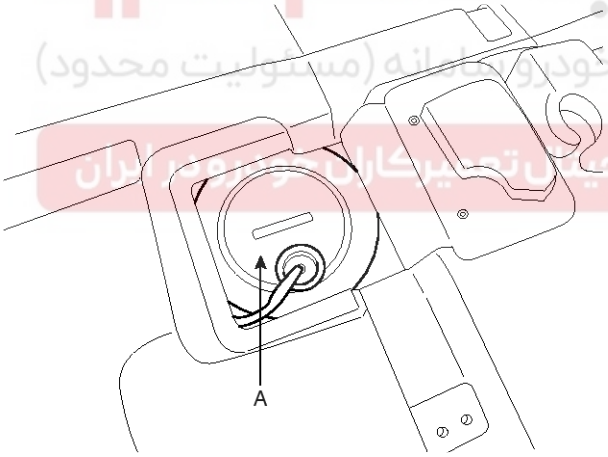
Removal

1. Turn ignition switch OFF and disconnect the negative (-) battery cable.
2. Remove the 2nd seat (Refer to "SEAT" in BD group).
3. Open the carpet (A) for the fuel pump.



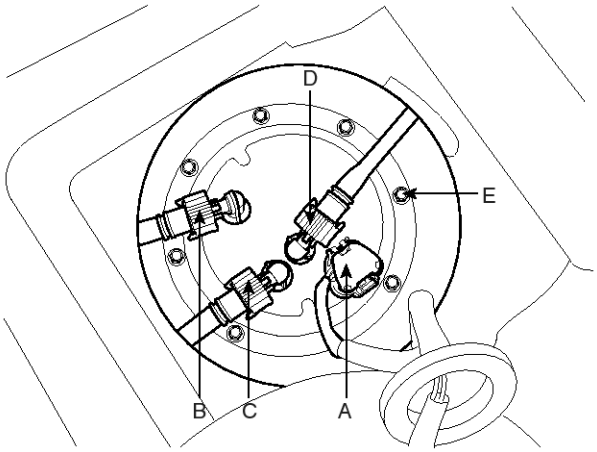
SENFL7187D

4. Remove the fuel pump service cover (A).



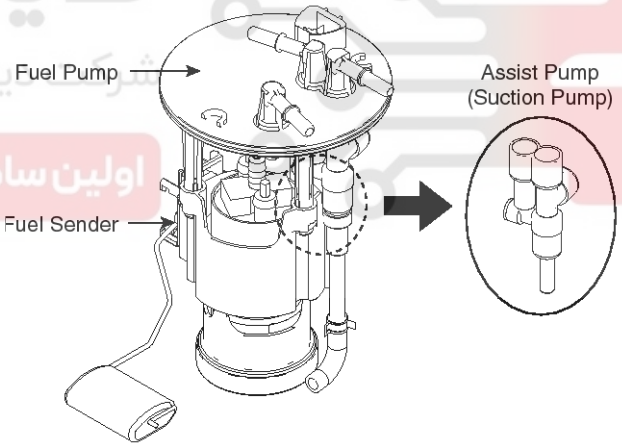
SENFL7177D

5. Disconnect the fuel pump connector (A).



SENFL7188D

6. Disconnect the fuel feed tube quick-connector (B), the fuel return tube quick-connector (C), and the suction tube quick-connector (D).
7. Unscrew the fuel pump installation bolts (E), and then remove the fuel pump from the fuel tank.



SENFL7154L

Installation

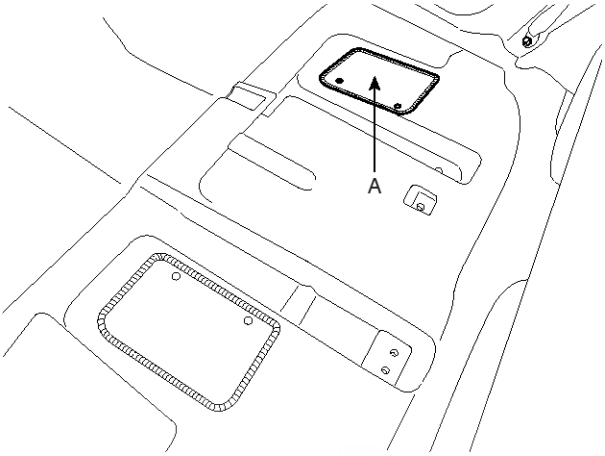
1. Installation is reverse of removal.

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

Sub Fuel Sender

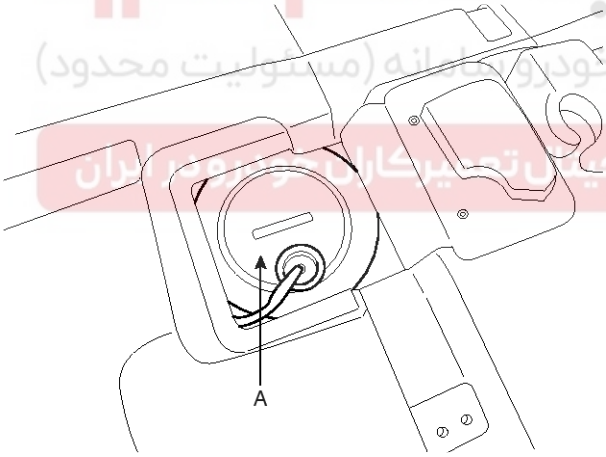
Removal

1. Turn ignition switch OFF and disconnect the negative (-) battery cable.
2. Remove the 2nd seat (Refer to "SEAT" in BD group).
3. Open the carpet (A) for the sub fuel sender.



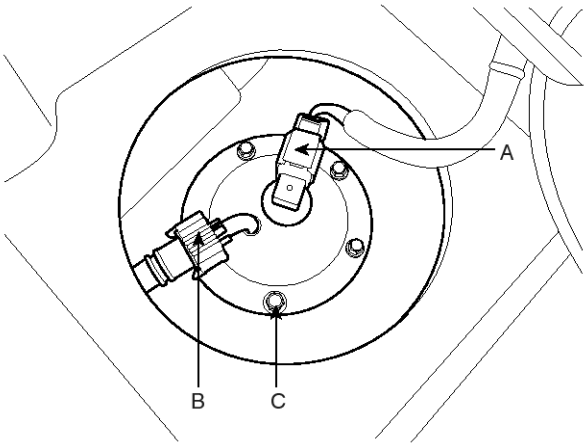
SENFL7190D

4. Remove the sub fuel sender service cover (A).



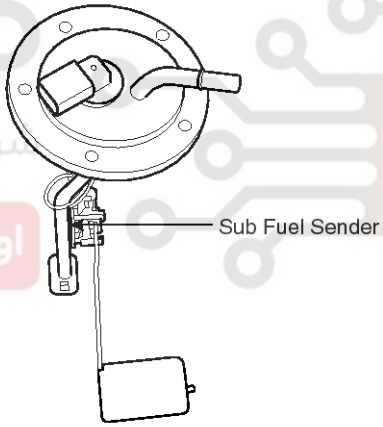
SENFL7177D

5. Disconnect the sub fuel sender connector (A).



SENFL7191D

6. Disconnect the suction tube quick-connector (B).
7. Unscrew the sub fuel sender installation bolts (C), and then remove the sub fuel sender from the fuel tank.



SENFL7155L

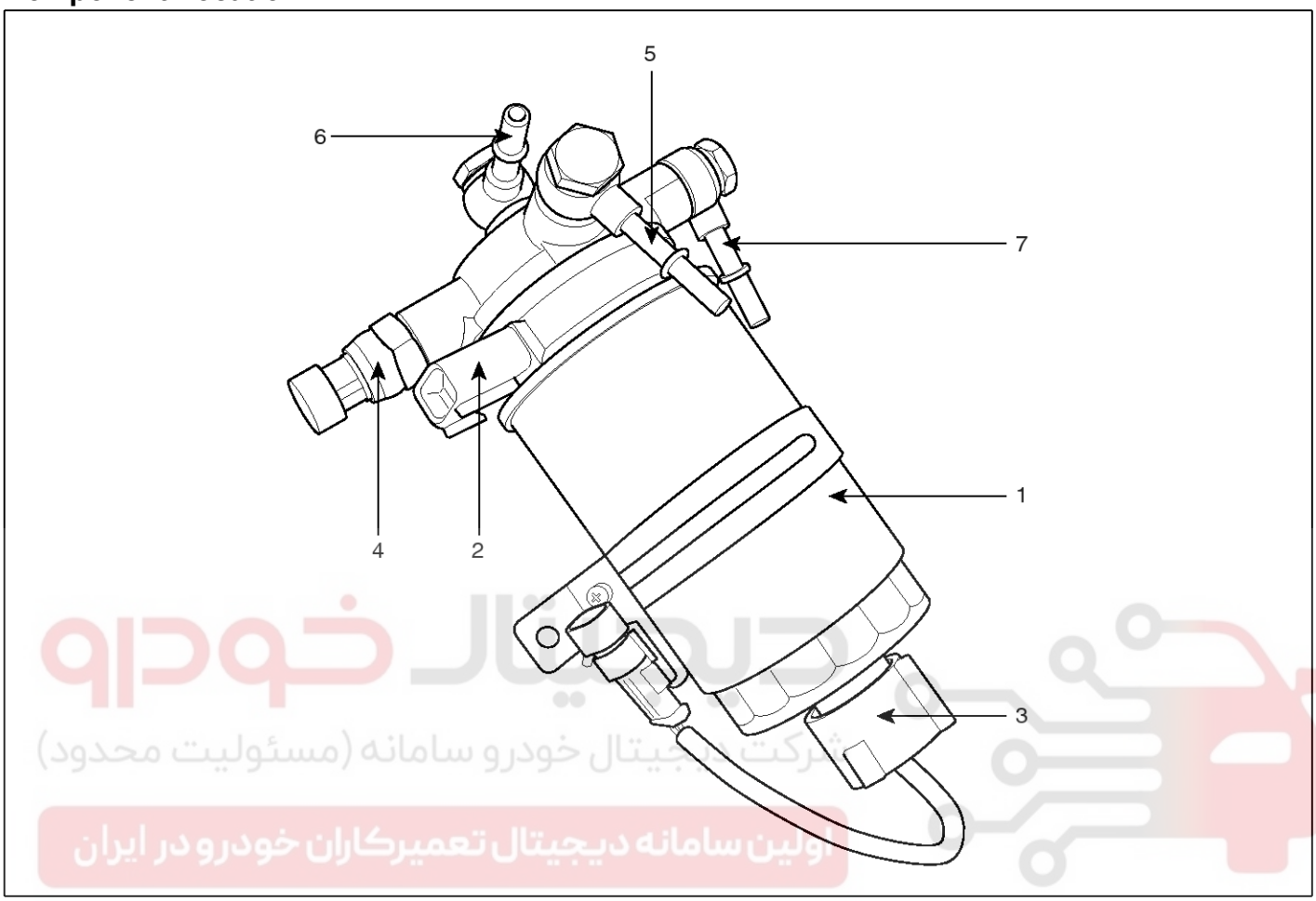
Installation

1. Installation is reverse of removal.

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

Fuel Filter

Component Location

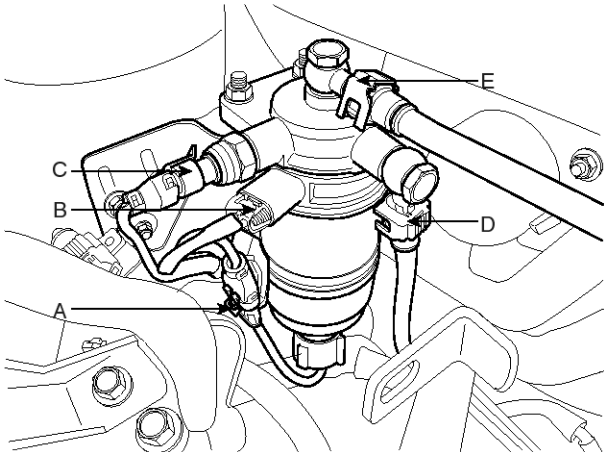


SENFL9156L

1. Fuel Filter
2. Heater
3. Water Sensor
4. Thermostat
5. Nipple (↔ Fuel Tank)
6. Nipple (↔ High Pressure Fuel Pump)
7. Nipple (↔ Injector Return Line)

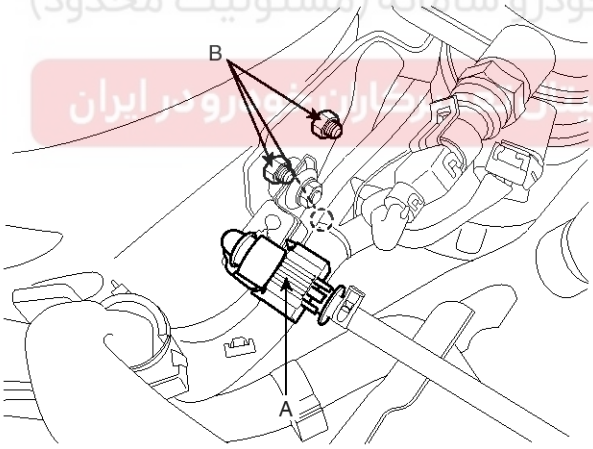
Removal

1. Turn ignition switch OFF and disconnect the negative (-) battery cable.
2. Disconnect the water sensor connector (A), the heater connector (B), and the thermostat connector (C).



SENFL7194D

3. Disconnect the fuel inlet tube quick-connector (D) and the fuel outlet tube quick-connector (E).
4. Disconnect the injector return tube quick-connector (A).



SENFL7195D

5. Unscrew the fuel filter bracket installation nuts (B), and then remove the fuel filter from the vehicle.

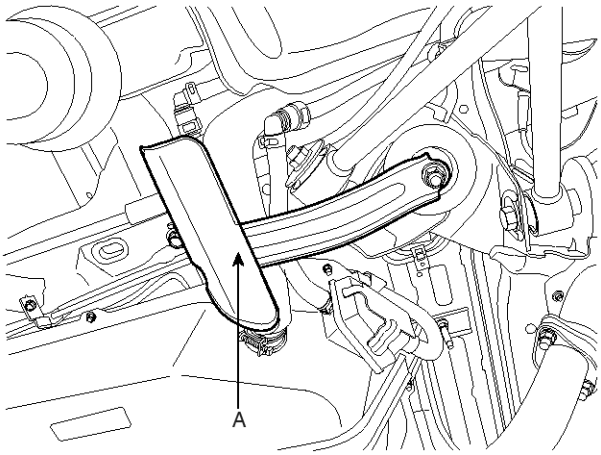
Installation

1. Installation is reverse of removal.

Filler-Neck Assembly

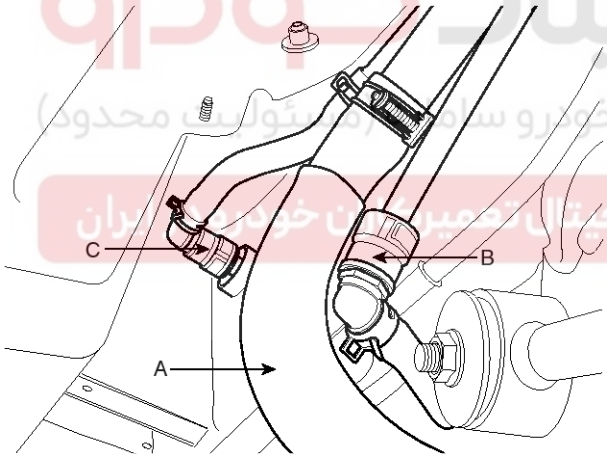
Removal

1. Remove the bracket (A).



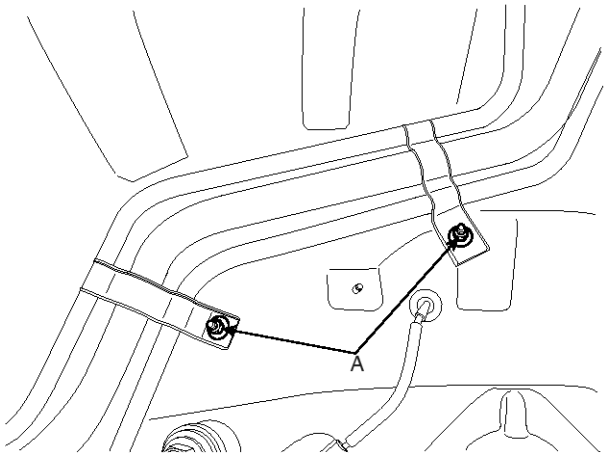
SENFL7196D

2. Disconnect the fuel filler hose (A), the leveling tube quick-connector (B), and the ventilation hose quick-connector (C).



SENFL7197D

3. Remove the left - rear wheel & tire and the wheel house.
4. Remove the filler-neck assembly after unscrewing the bracket mounting nuts (A).



SENFL7198D

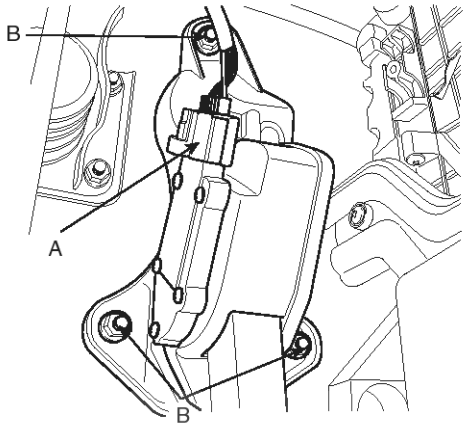
Installation

1. Installation is reverse of removal.

Accelerator Pedal and Cable

Removal

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



SCMFL6656D

3. Remove the accelerator pedal assembly from the vehicle after unscrewing the accelerator mounting nuts (B).

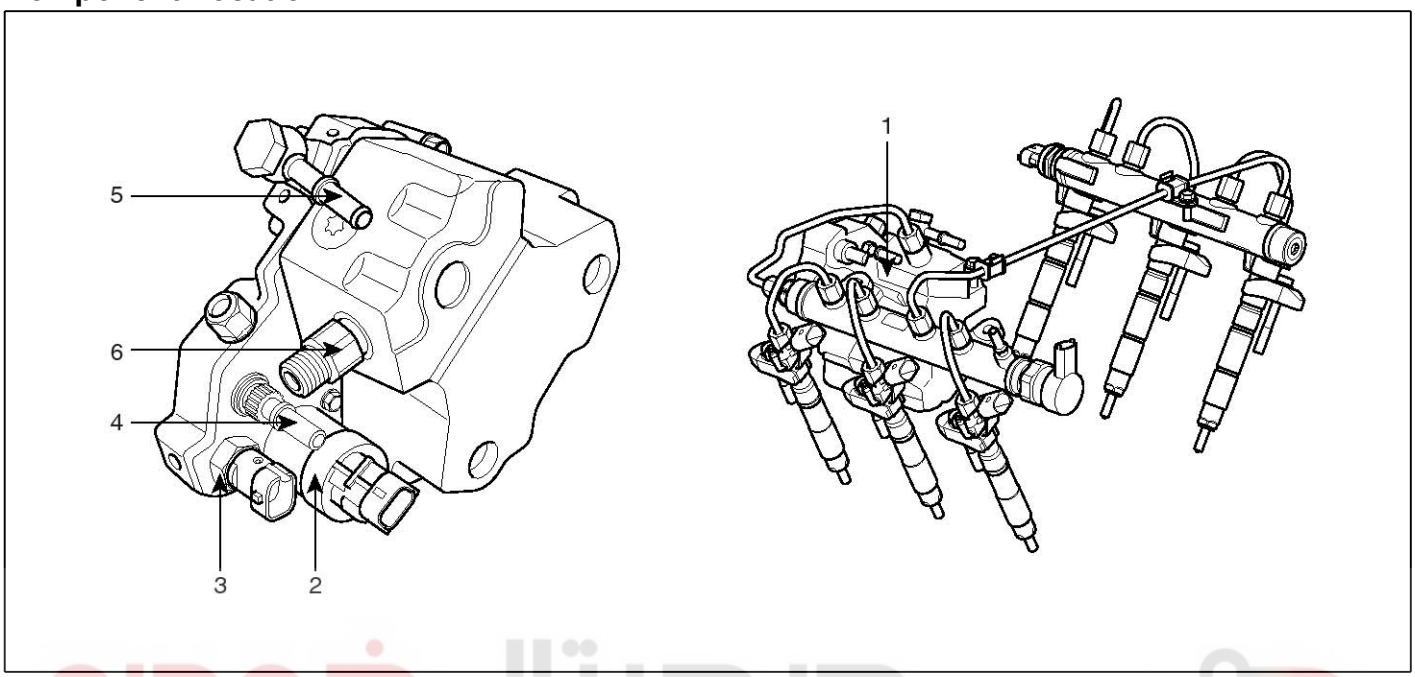
Installation

1. Installation is reverse of removal.

Fuel pump installation bolts:
8.8 ~ 13.7 N.m (0.9 ~ 1.4 kgf.m, 6.5 ~ 10.1 lb-ft)

High Pressure Pump

Component Location



SENFL9157L

1. High Pressure Fuel Pump
2. Fuel Pressure Regulator Valve
3. Fuel Temperature Sensor (FTS)
4. Nipple - Fuel Inlet (↔ Fuel Filter)
5. Nipple - Fuel Return (↔ Fuel Tank)
6. Nipple - Fuel Outlet (↔ Common Rail)

Removal

WARNING

As the Piezo-Injector operates under maximum DC 200V, there may be a risk of an electric shock caused by shorted control line etc. So when repairing the injector or its wiring, disconnect the battery negative (-) terminal from the battery and wait for about 30 seconds.

CAUTION

- **Common Rail Fuel Injection System operates with extremely high pressure (approximately 1,600bar), so never perform any work on injection system with engine running or within 30 seconds after the engine stops.**
- **Keep cleanly the parts and the working area.**
- **Pay attention to a foreign substance.**
- **Just before installing injector, tube or hose, remove the protect-cap attached on them.**
- **Do not remove injector except for special case.**
- **When installing Injector**

  - Wash the contact area of the injector and replace the O-ring with a new one.

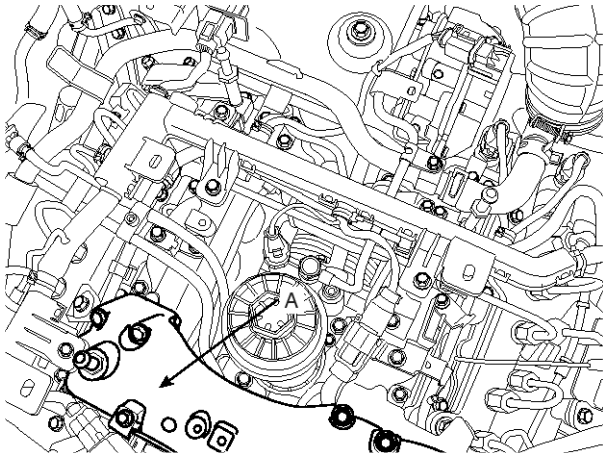
  - Spread oil on the injector O-ring.

  - To protect damage caused by shock, vertically insert the injector into the cylinder head.
- **When installing High Pressure Fuel Pipe**

  - Do not use again the used high pressure fuel pipe.

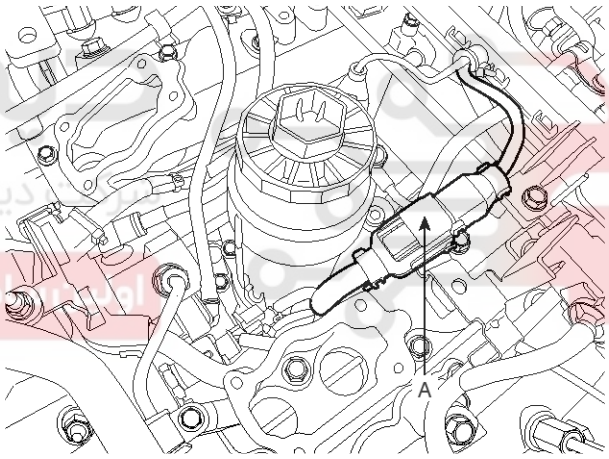
  - Install the flange nut correctly.

1. Turn ignition switch OFF and disconnect the negative (-) battery cable.
2. Remove the inlet upper manifold assembly (A).



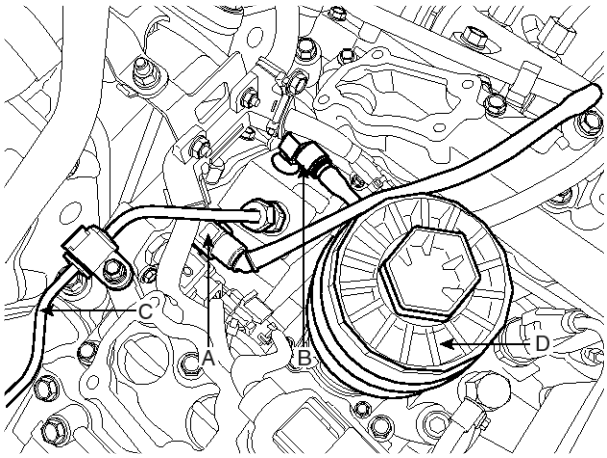
SENFL7200D

3. Disconnect the fuel pressure regulator valve & fuel temperature sensor connector (A).



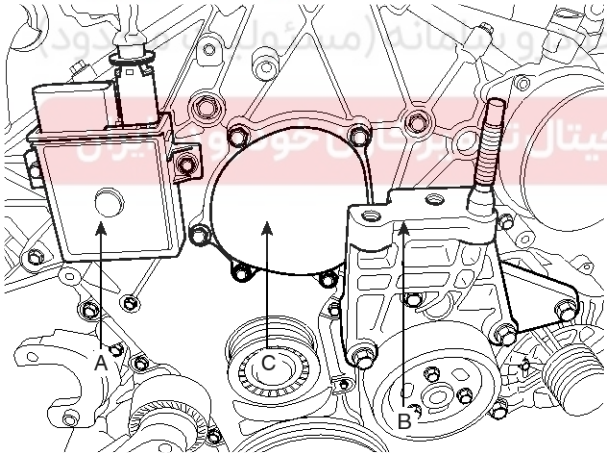
SENFL7201D

4. Disconnect the fuel inlet tube quick-connector (A) and the fuel return tube quick-connector (B).



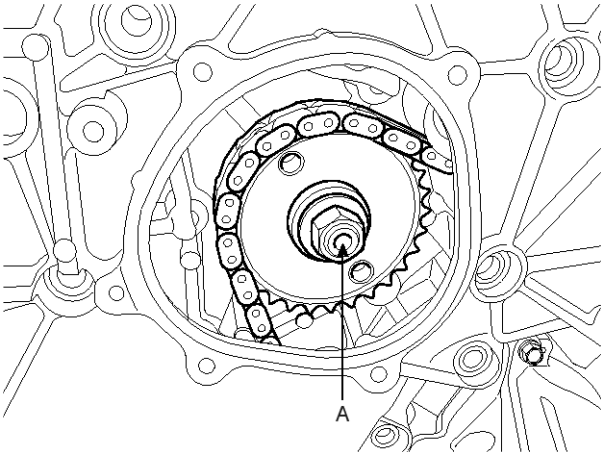
SENFL7202D

5. Remove the high pressure fuel pipe (C).
6. Remove the engine oil filter (D) (Refer to "LUBRICATION SYSTEM" in EM group).
7. Unscrew the three high pressure fuel pump mounting bolts.
8. Remove the glow control module (A) and the engine support bracket (B).



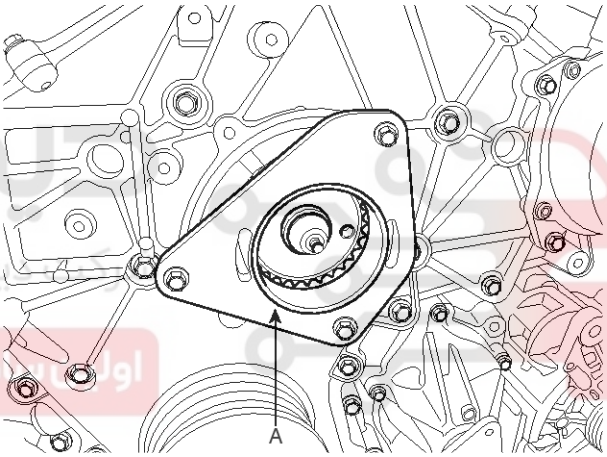
SENFL7203D

9. Remove the service cover (C).
10. Remove the sprocket tightening nut (A).



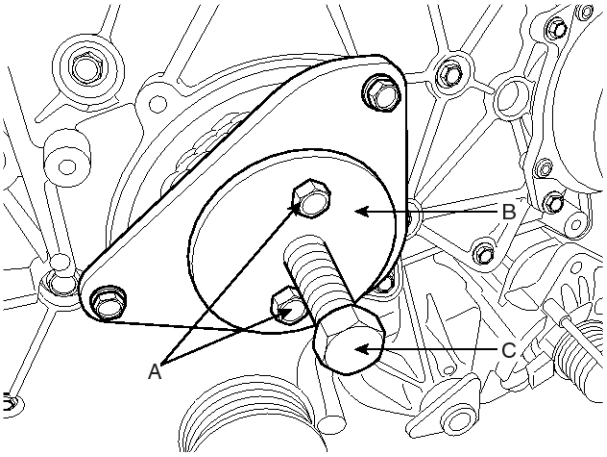
SENFL7204D

11. Install the fixing plate (A) [SST No.: 09331-3A000] on the timing case.



SENFL7205D

12. Install the supporter (B) [SST No.: 09331-3A000] on the sprocket with the bolts (A) [SST No.: 09331-3A000].



SENFL7206D

13. Push the pump shaft from the sprocket with rotating the main bolt (C) [SST No.: 09331-3A000] clockwise, and then remove the high pressure fuel pump from the engine.

Installation

1. Installation is reverse of removal.

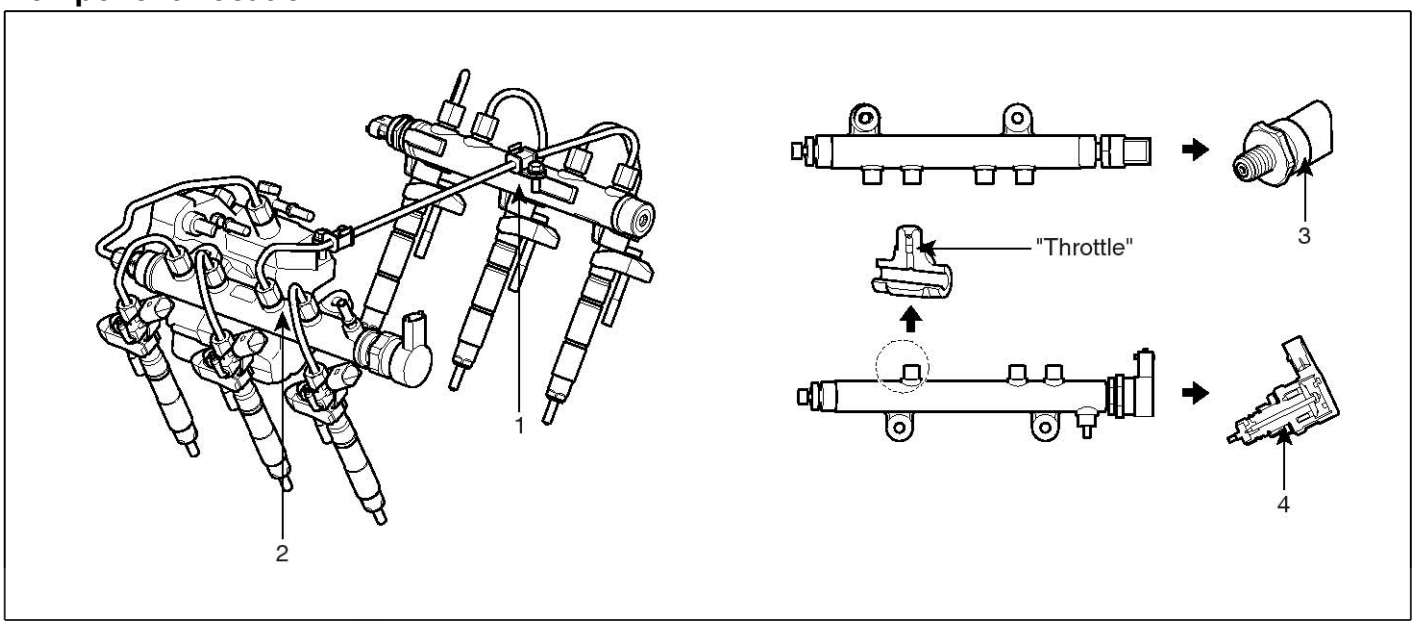
NOTICE

When installing the high pressure fuel pipe, apply the specified tightening torques with the special service tool [SST No.: 09314-3A000].

High pressure fuel pump installation bolts:
19.6 ~ 26.5 N.m (2.0 ~ 2.7 kgf.m, 14.5 ~ 19.5 lb-ft)
High pressure fuel pipe installation nut:
24.5 ~ 28.4 N.m (2.5 ~ 2.9 kgf.m, 18.1 ~ 21.0 lb-ft)

Common Rail

Component Location



SENFL7158L

1. Common Rail (Bank 1)
2. Common Rail (Bank 2)
3. Rail Pressure Sensor (RPS)
4. Rail Pressure Regulator Valve

Removal

WARNING

As the Piezo-Injector operates under maximum DC 200V, there may be a risk of an electric shock caused by shorted control line etc. So when repairing the injector or its wiring, disconnect the battery negative (-) terminal from the battery and wait for about 30 seconds.

CAUTION

- **Common Rail Fuel Injection System operates with extremely high pressure (approximately 1,600bar), so never perform any work on injection system with engine running or within 30 seconds after the engine stops.**
- **Keep cleanly the parts and the working area.**
- **Pay attention to a foreign substance.**
- **Just before installing injector, tube or hose, remove the protect-cap attached on them.**
- **Do not remove injector except for special case.**
- **When installing Injector**

  - Wash the contact area of the injector and replace the O-ring with a new one.

  - Spread oil on the injector O-ring.

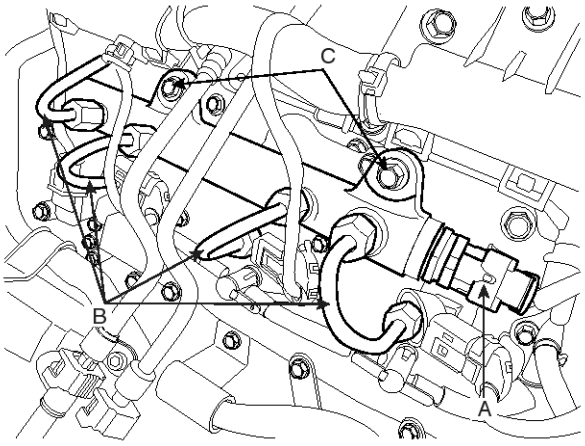
  - To protect damage caused by shock, vertically insert the injector into the cylinder head.
- **When installing High Pressure Fuel Pipe**

  - Do not use again the used high pressure fuel pipe.

  - Install the flange nut correctly.

[Common Rail (Bank 1)]

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

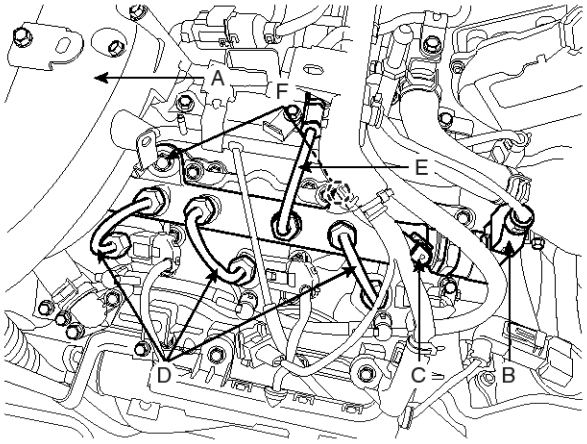


SENFL7208D

3. Remove the high pressure fuel pipes (B).
4. Unscrew the mounting bolts (C), and then remove the common rail from the engine.

[Common Rail (Bank 2)]

1. Turn ignition switch OFF and disconnect the negative (-) battery cable.
2. Remove the inlet upper manifold assembly (A).



SENFL7209D

3. Disconnect the rail pressure regulator valve connector (B).
4. Disconnect the fuel return tube quick-connector (C).
5. Remove the high pressure fuel pipes (D,E).
6. Unscrew the mounting bolts (F), and then remove the common rail from the engine.

Installation

1. Installation is reverse of removal.

NOTICE

1. When installing the high pressure fuel pipe, apply the specified tightening torques with the special service tool [SST No.: 09314-3A000].

2. When installing the high pressure fuel pipe connecting the common rail and injector, follow the below procedure.

1. *Temporarily install the nut on common rail.*
2. *Temporarily install the nut on injector.*
3. *Install the injector side nut.*
4. *Install the common rail side nut.*

Common rail installation bolts:
19.6 ~ 26.5 N.m (2.0 ~ 2.7 kgf.m, 14.5 ~ 19.5 lb-ft)
High pressure fuel pipe installation nut:
24.5 ~ 28.4 N.m (2.5 ~ 2.9 kgf.m, 18.1 ~ 21.0 lb-ft)