FL-3

### **General Information**

### **Specification**

#### **Fuel Delivery System**

Items	Specification	
Fuel Injection System	Туре	Common Rail Direct Injection (CRDI)
Fuel Return System	Туре	Return type
Fuel Pressure	Max. Pressure	1,800 bar
Fuel Tank	Capacity	55 lit. (14.5 U.S.gal., 58.1 U.S.qt., 48.3 Imp.qt.)
Fuel Filter	Туре	High pressure type (Built in engine room)
High Pressure Fuel Pump Type Mechanical, Plur		Mechanical, Plunger Pumping Type
	Driven by	Timing chain
Low Pressure Fuel Pump	Туре	Electrical, in-tank type
	Driven by	Electric motor

#### Sensors

Mass Air Flow Sensor (MAFS)

- Specification
- \* At intake air temperature = 20°C(68°F)

Air Flow (kg/h)	Frequency (kHz)
15	2.00 ~ 2.01
20	2.06 ~ 2.07
90	2.67 ~ 2.69
220	3.43 ~ 3.47
440	4.65 ~ 4.76
850	7.87 ~ 8.25
1000	9.60 ~ 10.52
	•

\* At intake air temperature =  $-15^{\circ}C(5^{\circ}F)$  or  $80^{\circ}C(176^{\circ}F)$ 

Air Flow (kg/h)	Frequency (kHz)
20	2.06 ~ 2.07
90	2.65 ~ 2.70
220	3.40 ~ 3.49
440	4.60 ~ 4.81

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

- ▷ Specification

	Temperature [°C(°F)]	Resistance( <sup>kΩ</sup> )
	-40(-40)	36.59 ~ <mark>42.71</mark>
>	-20(-4)	12.95 ~ <mark>14.7</mark> 4
	0(32)	5.19 ~ <mark>5.79</mark>
L	20(68)	2.31 ~ 2.53
	40(104)	1.12 ~ 1.21
	60(140)	0.58 ~ 0.62
	80(176)	0.33 ~ 0.34

Boost Pressure Sensor (BPS)

- ▷ Specification

Pressure (kPa)	Output Voltage (V)
50	0.5
100	1.002 ~ 1.142
300	3.288 ~ 3.428
400	4.11 ~ 4.59

## **Fuel System**

Intake Air Temperature Sensor (IATS) #2 [Built at the intercooler]

▷ Specification

Temperature [°C(°F)]	Resistance( <sup>kΩ</sup> )
-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)

▷ Specification

Temperature [°C(°F)]	Resistance( <sup>kΩ</sup> )
-40(-40)	48.14
-20(-4)	14.13 ~ 16.83
سئوليا (32)	ال خودر 5.79مانه (م
20(68)	2.31 ~ 2.59
40(104)	ديجيتال <del>1:</del> 15ميركاران
60(140)	0.59
80(176)	0.32
100(212)	0.19
110(230)	0.15
120(248)	0.12

Camshaft Position Sensor (CMPS)

▷ Specification

Level	Output Pulse (V)
High	5
Low	0
Item	Specification
Air Gap (mm)	0.5 ~ 1.5

Crankshaft Position Sensor (CKPS)

▷ Specification

Item	Specification
Air Gap (mm)	0.3 ~ 1.3

Rail Pressure Sensor (RPS)

▷ Specification

W	Condition	Rail pressure (bar)	Output Voltage (V)
	Idle	200 ~ 300	Below 1.1
	Accelerator pedal fully depressed	1,600 ~ 1,800	About 4.5

Fuel Temperature Sensor (FTS)

▷ Specification

Temperature [°C(°F)]	Resistance( <sup>kΩ</sup> )
-10(14)	9.45
20(68)	2.27 ~ 2.73
80(176)	0.30 ~ 0.32
120(248)	0.11

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Lambda Sensor

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

Accelerator Position Sensor (APS)

▷ Specification

Pedal Position	Output Voltage	e(V) [Vref = 5.0V]
Pedal Position	APS1	APS2
Released	0.7 ~ 0.8	0.287 ~ 0.462
Fully depressed	3.85 ~ 4.35	1.925 ~ 2.175

Water Sensor

▷ Specification

Item	Specification
Warning Level (cc)	40 ~ 60

Exhuast Gas Temperature Sensor (EGTS)

▷ Specification

Temperature [°C(°F)]	Resistance( <sup>kΩ</sup> )
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

Differental Pressure Sensor (DPS)

 $\triangleright$  Specification: Vout = (4.5 - 1.0) / 100 \*  $\triangle$ 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 شرکت دیا	2.75
60	3.1
70 اولین سا	3.45
80	3.8
90	4.15
100	4.5

## **Fuel System**

#### **Actuators**

Injector

Number: 4

▷ Specification

Items	Specification
Component Resistance(kΩ)	150 ~ 210 (20°C)
Operating Voltage (V)	110 ~ 156

Fuel Pressure Regulator Valve (High Pressure Fuel Pump)

▷ Specification

Item	Specification
Coil Resistance (Ω)	2.6 ~ 3.15 (20°C)
Current (A) [Min. fuel injection]	1.8

#### Rail Pressure Regulator Valve

Specification

Items	Specification
Coil Resistance (Ω)	3.42 ~3.78 (20°C)
Operating Current (A)	0.15 ~ 1.8

#### EGR Cooler Bypass Solenoid Valve

▷ Specification

Items	Specification
Coil Resistance (Ω)	28.3 ~ 31.1 (20°C)

#### Electric EGR Control Valve

▷ Specification

[Motor]

Item	Specification
Coil Resistance (Ω)	2.3 ~ 2.7 (20°C)

#### [Position Sensor]

Item	Specification
Voltage (V) [Open-6mm]	0.6 ~ 1.3
Voltage (V) [Close]	3.6 ~ 4.3

Air Control Valve (ACV)

□ Type: Duty control motor

▷ Specification

Output Voltage (V)	Valve Position
0.5	Full open
0.54 ~ 0.89	Motor power is not supplied
0.925 ~ 4.425	Normal operation position
4.5	Full close

Variable Swirl Control Actuator

□ Type: Motor driven (including Position Sensor)

▷ Specification

#### [Motor]

Item	Specification
Coil Resistance (Ω)	3.4 ~ 4.4 (20°C)

#### [Position Sensor]

Item	Specification
Coil Resistance (kΩ)	3.44 ~ 5.16 (20°C)
Output Voltage (V)	0.17 ~ <mark>4.83</mark>

**Electric VGT Control Actuator** 

Type: DC motor driven

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#### **Service Standard**

Items	Specification		
	A/CON OFF	Neutral,N,P-range	790 $\pm$ 100rpm
Basic Idle rpm	AVCON OFF	D-range	790 $\pm$ 100rpm
(After warm up)	A/CONLON	Neutral,N,P-range	790 ± 100rpm
	A/CON ON	D-range	790 ± 100rpm

# **Tightening Torques Engine Control System**

Items	kgf.m	N.m	lb-ft
ECM installation bolts	0.4 ~ 0.6	3.9 ~ 5.9	2.9 ~ 4.3
ECM bracket installation bolt	2.2 ~ 3.3	21.6 ~ 32.4	15.9 ~ 23.9
ECM bracket installation nut	1.0 ~ 1.5	9.8 ~ 14.7	7.2 ~ 8.7
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	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Intake Air Temperature Sensor (IATS) #2 installation	2.0 ~ 3.0	19.6 ~ 29.4	14.5 ~ 21.7
Engine coolant temperature sensor installation	2.0 ~ 4.0	19.6 ~ 39.2	14.5 ~ 28.9
Camshaft position sensor installation bolt	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7
Lambda sensor installation	4.1 ~ 6.1	40.2 ~ 59.8	29.7 ~ 44.1
DPF Differential Pressure Sensor installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
DPF Differential Pressure Sensor bracket installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Exhuast Gas Temperature Sensor (EGTS) installation	4.0 ~ 5.0	39.2 ~ 49.1	28.9 ~ 36.2
Electric EGR control valve installation bolt	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7
Variable swirl actuator installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Air control valve installation bolt	0.9 ~ 1.1	8.8 ~ 10.8	6.5 ~ 8.0
EGR Cooler Bypass Solenoid Valve installation bolt	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7
Glow control module installation bolt	0.7 ~ 1.1	6.9 ~ 10.8	5.1 ~ 8.0
Glow plug installation	1.5 ~ 2.0	14.7 ~ 19.6	10.9 ~ 14.5
DPF assembly installation bolt	4.5 ~ 5.5	44.1 ~ 54.0	32.6 ~ 39.8
DPF assembly installation nut	5.0 ~ 7.0	49.1 ~ 68.7	36.2 ~ 50.6
DPF assembly stay installation bolt	4.5 ~ 5.5	44.1 ~ 54.0	32.6 ~ 39.8

# **Fuel System**

### **Fuel Delivery System**

Items	kgf.m	N.m	lb-ft
Fuel tank band installation nut	4.0 ~ 5.5	39.2 ~ 54.0	28.9 ~ 39.8
Accelerator pedal module installation nut	1.7 ~ 2.6	16.7 ~ 25.5	12.3 ~ 18.8
Accelerator pedal installation bolt	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7
Fuel pump plate cover installation	6.0 ~ 7.0	58.9 ~ 68.7	43.4 ~ 50.6
Fuel filter installation nut (on the bracket)	1.0 ~ 1.3	9.8 ~ 12.8	7.2 ~ 9.4
Fuel filter bracket installation nut (on the vehicle)	0.4 ~ 0.6	3.9 ~ 5.9	2.9 ~ 4.3
Injector clamp installation bolt	3.0 ~ 3.4	29.4 ~ 33.4	21.7 ~ 24.6
High pressure fuel pump installation bolt	2.5 ~ 3.1	24.5 ~ 30.4	18.1 ~ 22.4
Service plug washer installation	7.5 ~ 9.0	73.6 ~ 88.3	54.3 ~ 65.1
Common rail installation bolt	2.0 ~ 2.7	19.6 ~ 26.5	14.5 ~ 19.5
Common rail banjo installation bolt	1.8 ~ 2.8	17.7 ~ 27.5	13.0 ~ 20.3
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
Hig <mark>h</mark> pressure fuel pipe clamp installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Filler - neck assembly installation nut	0.4 ~ 0.6	3.9 ~ 5.9	2.9 ~ 4.3
Filler - neck assembly installation screw	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7

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**Special Service Tools** 

Tool (Number and name)	Illustration	Application
09351-4A300 Injector Remover		Removing the injector
	SVQFL6499D	
09314-27120 Torque Wrench Socket (17mm)		Installing the high pressure fuel pipe
	AFAF201B	
09331-1M100 High Pressure Fuel Pump Remover		Removing the high pressure fuel pump
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09310-2S100 Fuel Pump Plate Cover Remover		Removing the low pressure fuel pump plate cover
	SSLF11000L	
09392-2H100 Lambda sensor socket wrench		Removing the lambda sensor
	SFDEM8050L	

## **Fuel System**

#### **Basic Troubleshooting**

#### **Basic Troubleshooting Guide**

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



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



NEVER erase DTC and Freeze Frame Data before completing Step 2 : MIL/DTC in CUSTOMER PROBLEM ANALYSIS SHEET.

- 6 Inspect Vehicle Visually
- Go to Step 11, if you recognize the problem.
- 7 Recreate (Simulate) Symptoms of the DTC
- Try to recreate or simulate the symptoms and conditions of the malfunction as described by customer.
- If DTC(s) is/are displayed, simulate the condition according to troubleshooting procedure for the DTC.
- 8 Confirm Symptoms of Problem
- If DTC(s) is/are not displayed, go to Step 9.
- If DTC(s) is/are displayed, go to Step 11.
- 9 Recreate (Simulate) Symptom
- Try to recreate or simulate the condition of the malfunction as described by the customer.
- 10 Check the DTC
- If DTC(s) does(do) not occur, refer to INTERMITTENT PROBLEM PROCEDURE in BASIC INSPECTION PROCEDURE.
- If DTC(s) occur(s), go to Step 11.
- 11 Perform Troubleshooting Procedure for DTC
- 12 Adjust or repair the vehicle
- 13 Confirmation test
- 14 END

STDFL0001N

**FL-11** 

### **Customer Problem Analysis Sheet**

1. VEHICL	E INFORMAIT	NC		
VIN No.			Transmission	☐ M/T ☐ A/T ☐ CVT ☐ etc.
Production date		Driving type	☐ 2WD (FF) ☐ 2WD (FR) ☐ 4WD	
Odometer Reading		km/mile	DPF (Diesel Engine)	☐ With DPF ☐ Without DPF
2. SYMPT	OMS			
☐ Unable to	o start	☐ Engine does not to ☐ Initial combustion		plete combustion
☐ Difficult t	o start	☐ Engine turns over	slowly ☐ Other_	
☐ Poor idlin	ng	☐ Rough idling ☐ Ir☐ Unstable idling (Hi☐ Other		Low:rpm)
☐ Engine s	stall	□ Soon after starting □ After accelerator pedal depressed □ After accelerator pedal released □ During A/C ON □ Shifting from N to D-range □ Other		
☐ Others	0-	☐ Poor driving (Surg☐ Back fire ☐ After t	fire 🗌 Other	
3. ENVIRO	ONMENT		ŢŲ.	
Problem fre	Problem frequency			Once only
Weather	Weather ☐ Fine ☐ Cloudy ☐ Rainy ☐ Snowy ☐ Other			Other
Outdoor ten	Outdoor temperature Approx °C/°F			اوليا
Place	Place			
Engine tem	Engine temperature ☐ Cold ☐ Warming up ☐ After warming up ☐ Any temperature			g up   Any temperature
Engine oper	☐ Starting ☐ Just after starting (min) ☐ Idling ☐ Racing ☐ Driving ☐ Constant speed ☐ Acceleration ☐ Deceleration ☐ A/C switch ON/OFF ☐ Other			
4. MIL/DTC				
MIL (Malfun Lamp)	MIL (Malfunction Indicator Lamp) ☐ Remains ON ☐ Sometimes lights up ☐ Does not light		Does not light	
DTC	Normal check (Pre-check)	□ Normal □ DTC () □ Freeze Frame Data		
<b>D10</b>	Check mode	eck mode Normal DTC ()  Freeze Frame Data		
5. ECM/PC	M INFORMATI	ON		
ECM/PCM	Part No.			
ROM ID	ROM ID			

SCMF10001L

## **Fuel System**

#### **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°C, 68°F), unless stated otherwise.

#### MNOTICE

The measured resistance in except for ambient temperature ( $20^{\circ}C$ ,  $68^{\circ}F$ ) 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.



BFGE321A

- 3. Slightly shake the connector and wiring harness vertically and horizontally.
- 4. Repair or replace the component that has a problem.
- 5. Verify that the problem has disappeared with the road test.
- Simulating Vibration
- a. Sensors and Actuators
  - : Slightly vibrate sensors, actuators or relays with finger.

#### **⊗**WARNING

Strong vibration may break sensors, actuators or relays

- b. Connectors and Harness
  - : Lightly shake the connector and wiring harness vertically and then horizontally.
- Simulating Heat
- 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**

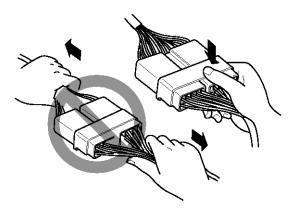
DO NOT sprinkle water directly into the engine compartment or electronic components.

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

### **FL-13**

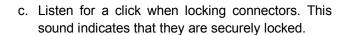
#### **Connector Inspection Procedure**

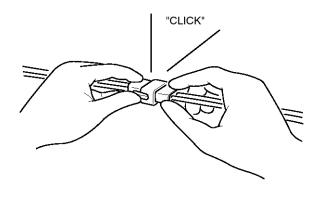
- 1. Handling of Connector
  - a. Never pull on the wiring harness when disconnecting connectors.



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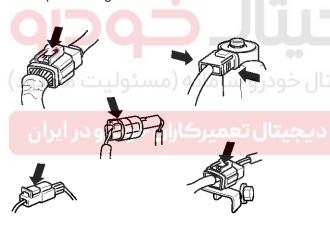
b. When removing the connector with a lock, press or pull locking lever.



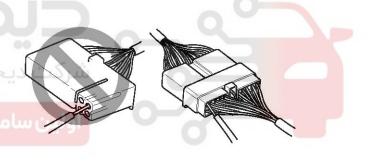


BFGE015H

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



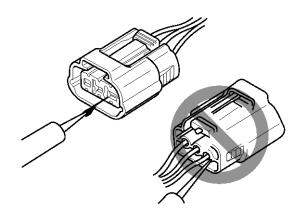
BFGE015G



BFGE015I

## **Fuel System**

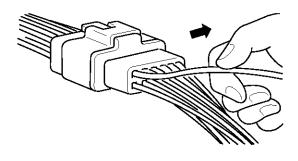
 e. Check waterproof connector terminals from the connector side. Waterproof connectors cannot be accessed from harness side.



BFGE015J

#### MNOTICE

- 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.
  - When the connector is disconnected:
     Check missed terminal, crimped terminal or broken core wire by slightly pulling the wire harness.
    - Visually check for rust, contamination, deformation and bend.
  - c. Check terminal tightening condition:
    - Insert a spare male terminal into a female terminal, and then check terminal tightening conditions.
  - d. Pull lightly on individual wires to ensure that each wire is secured in the terminal.



BFGE015K

- 3. Repair Method of Connector Terminal
  - a. Clean the contact points using air gun and/or shop rag.

#### MOTICE

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

 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.
- 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.

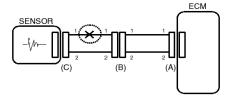
### **FL-15**

#### **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





BFGE501A

2. Continuity Check Method

### خودرو سامانه (مسئولیت NOTICE)

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

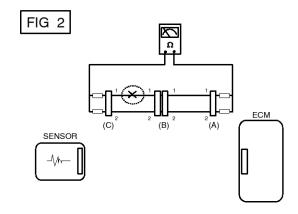
Specification (Resistance)

1Ω or less → Normal Circuit

1<sup>MΩ</sup> or Higher  $\rightarrow$  Open Circuit

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

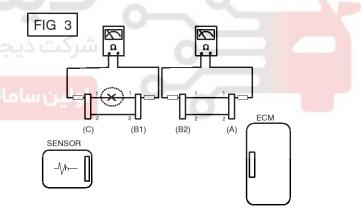
In [FIG.2.] the measured resistance of line 1 and 2 is higher than  $1^{M\Omega}$  and below 1  $\Omega$  respectively. Specifically the open circuit is line 1 (Line 2 is normal). To find exact break point, check sub line of line 1 as described in next step.



BFGE501B

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

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

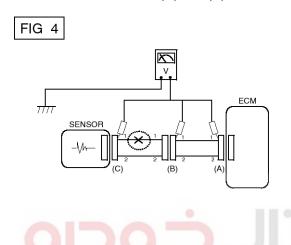


BFGE501C

### **Fuel System**

- 3. Voltage Check Method
  - a. With each connector still connected, measure the voltage between the chassis ground and terminal 1 of each connectors (A), (B) and (C) as shown in [FIG. 4].

The measured voltage of each connector is 5V, 5V and 0V respectively. So the open circuit is between connector (C) and (B).

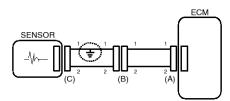


#### Check Short Circuit

- 1. Test Method for Short to Ground Circuit
  - · 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

BFGE501D

2. Continuity Check Method (with Chassis Ground)

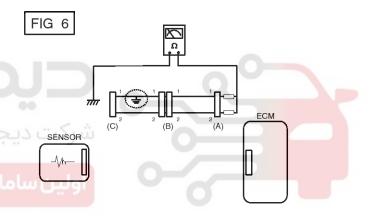
#### MOTICE

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

Specification (Resistance)  $1\Omega$  or less  $\rightarrow$  Short to Ground Circuit  $1M\Omega$  or Higher  $\rightarrow$  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  $\Omega$  and higher than  $1M\Omega$  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.



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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].

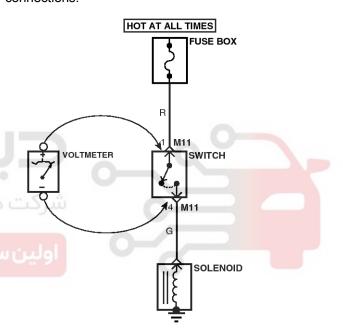
The measured resistance between connector (B1) and chassis ground is  $1\Omega$  or less. The short to ground circuit is between terminal 1 of connector (C) and terminal 1 of connector (B1).



#### Testing For Voltage Drop

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

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



SHMFL9331N

## **Fuel System**

# 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 & amp; amp; 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

- 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 & amp; amp; 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

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#### (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

- 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)

## **Fuel System**

#### (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

- 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

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#### (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

- 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

# Fuel System

### (Symptom 13) Lack Of Power

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

#### (Symptom 14) Too Much Power

Possible Cause	
<ul><li>Compensation of individual injector not adapted</li><li>Oil suction (engine racing)</li></ul>	ECM program error or hardware fault

#### (Symptom 15) Excessive Fuel Consumption

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

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

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

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#### (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

- Blocked accelerator pedal position sensor
- Incorrect state of the electrical pack devices
- Clogged air filter
- Inversion of fuel connections (feed & amp; amp; 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

## **Fuel System**

### (Symptom 21) Engine Does Not Stop

Possible Cause		
<ul><li>Stuck or worn lubrication circuit of turbocharger</li><li>Too much engine oil</li></ul>	<ul><li>Leakage at vacuum hose</li><li>ECM program error or hardware fault</li></ul>	

#### (Symptom 22) Different Mechanical Noises

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





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#### **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





## **Fuel System**

### **Engine Control System**

#### **Description**

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

#### MOTICE

- 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

#### MNOTICE

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.

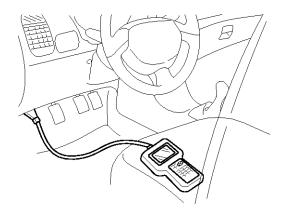
#### **Checking Procedure (Self-diagnosis)**

#### MOTICE

- 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 the GDS)

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



AWJF300D

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

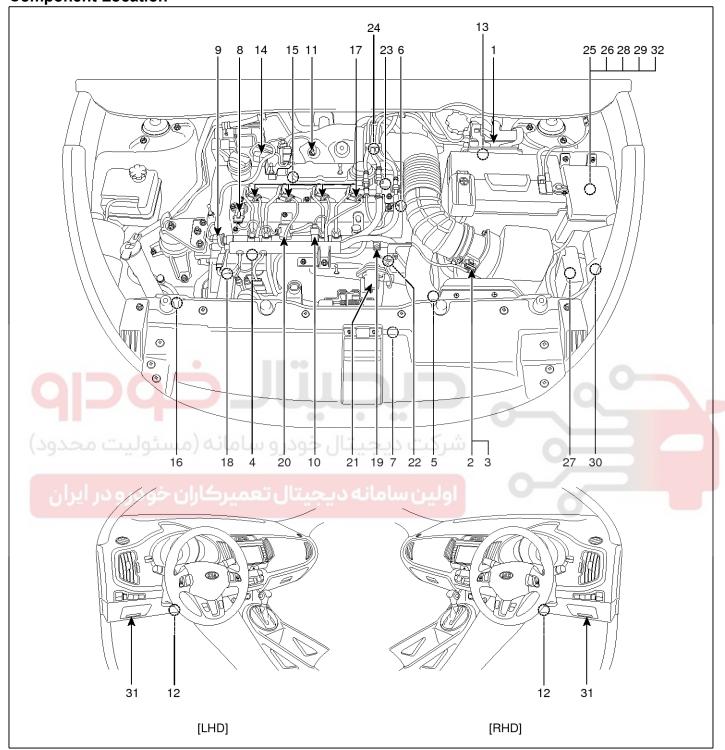
#### MNOTICE

When deleting diagnostic trouble code, use the GDS as possible.

# **Engine Control System**

**FL-27** 

**Component Location** 



SSLFL1001L

## **Fuel System**

- 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. DPF Differential Pressure Sensor (DPS)
- 15. Exhaust Gas Temperature Sensor (EGTS)
- 16. A/C Pressure Transducer (APT)

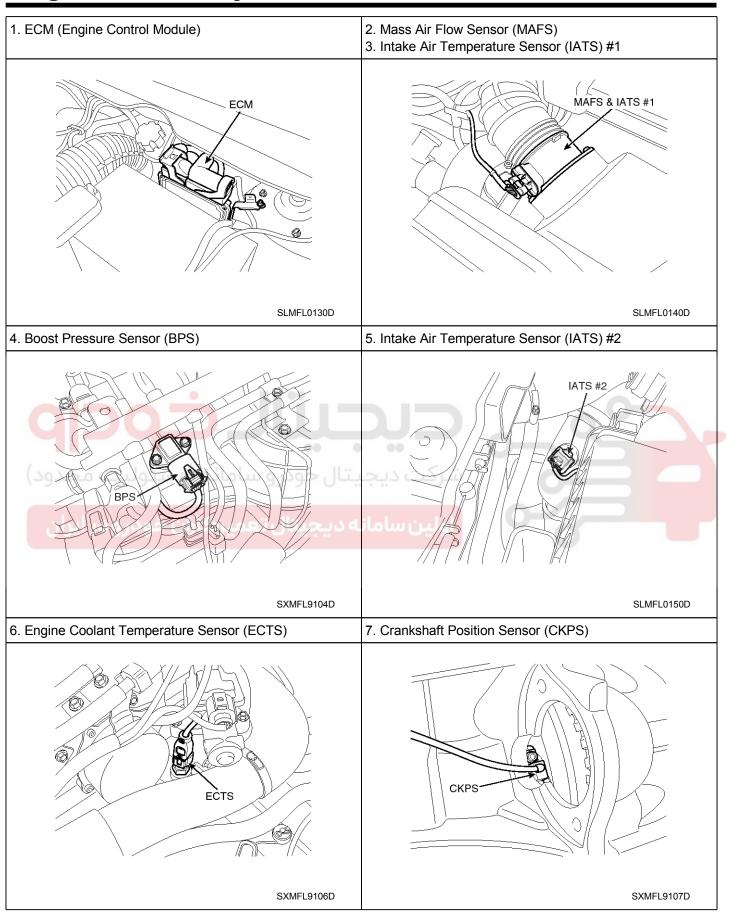
- 17. Injector
- 18. Fuel Pressure Regulator Valve (FPRV)
- 19. Rail Pressure Regulator Valve (RPRV)
- 20. EGR Cooler Bypass Solenoid Valve
- 21. Air Control Valve (ACV)
- 22. Variable Swirl Actuator (VSA)
- 23. Electric EGR Control Valve (EEGR)
- 24. Electric VGT Control Actuator
- 25. Main Relay
- 26. Fuel Pump Relay
- 27. PTC Heater Relay
- 28. Cooling Fan Relay [High]
- 29. Cooling Fan Relay [Low]
- 30. Glow Control Module
- 31. Data Link Connector (DLC)
- 32. Multi-Purpose Check Connector



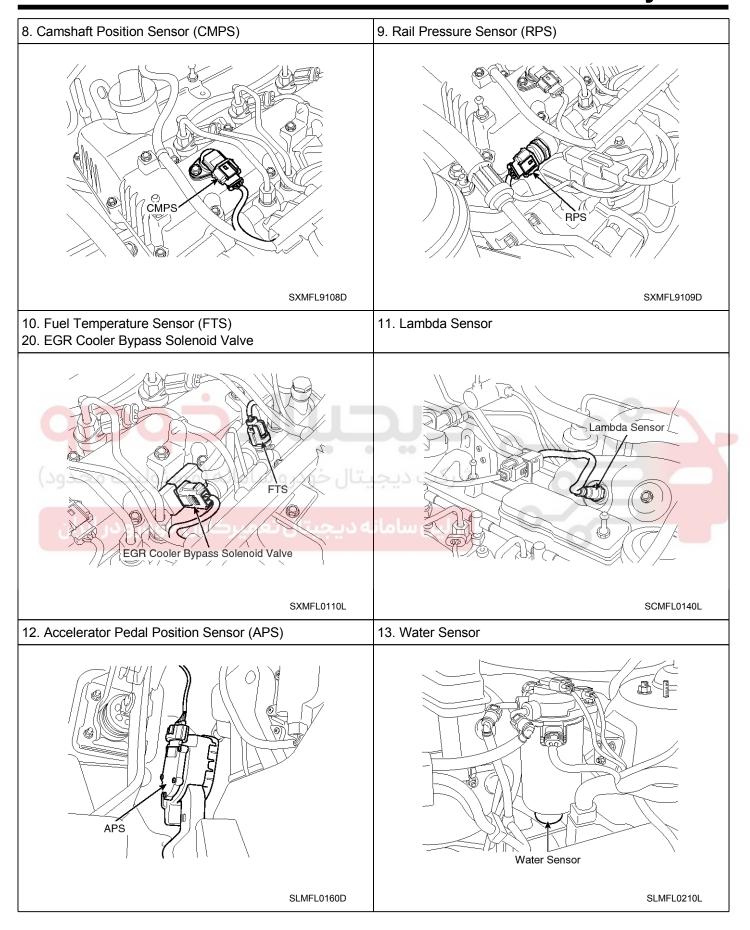


## **Engine Control System**

**FL-29** 

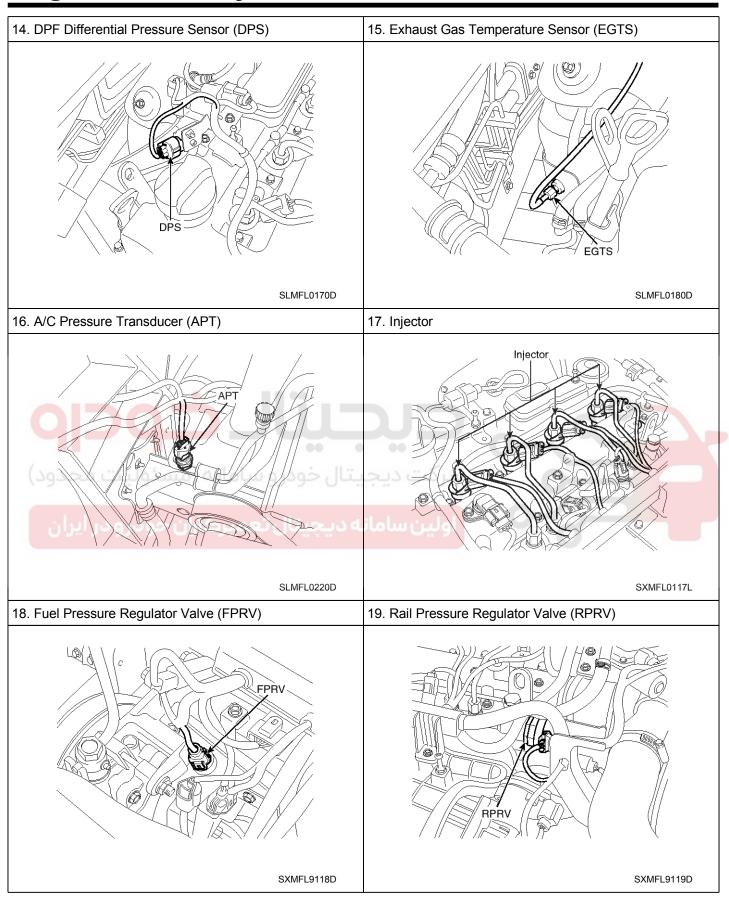


## **Fuel System**

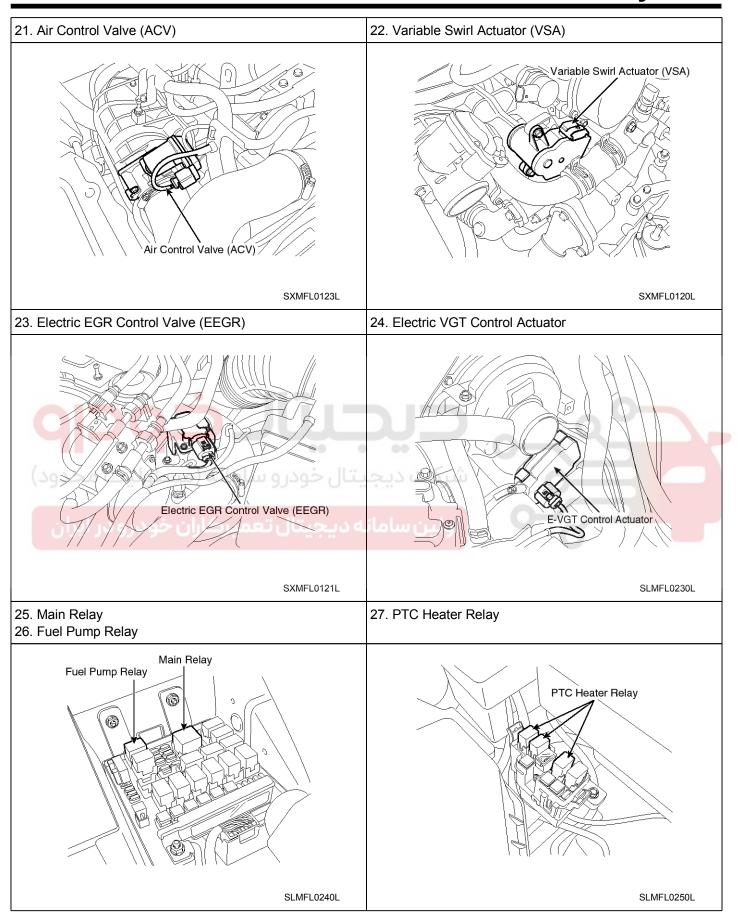


## **Engine Control System**

**FL-31** 

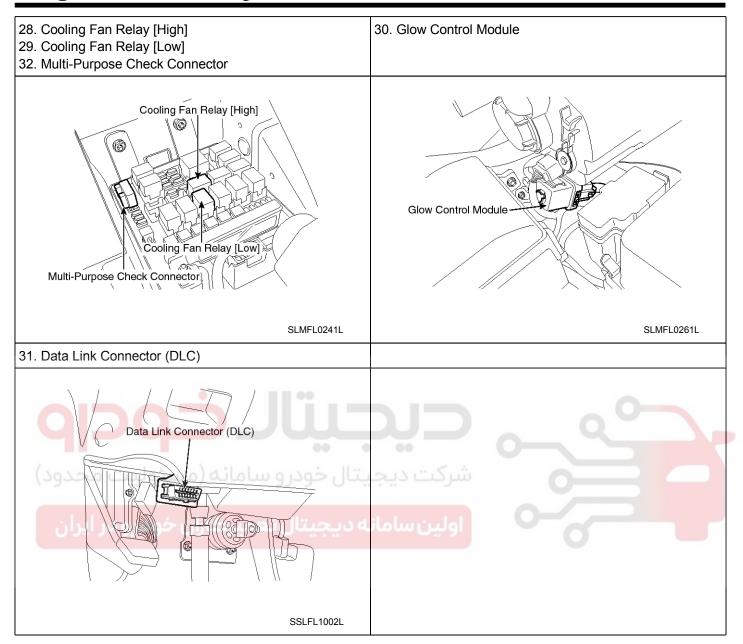


## **Fuel System**



## **Engine Control System**

**FL-33** 

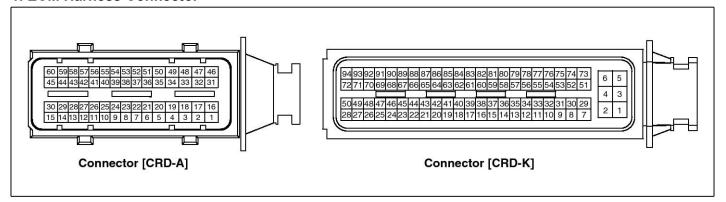


# **Fuel System**

### **Engine Control Module (ECM)**

### **Engine Control Module (ECM)**

#### 1. ECM Harness Connector



SLMFL0440L

### 2. ECM Terminal Function

#### Connector [CRD-A]

Pin.	Description	Connected to
	Injector (Cylinder #3) [Low] control output [Immobilizer]	Injector (Cylinder #3)
1	Injector (Cylinder #2) [Low] control output [Non-Immobilizer]	Injector (Cylinder #2)
/	Injector (Cylinder #2) [Low] control output [Immobilizer]	Injector (Cylinder #2)
2	Injector (Cylinder #3) [Low] control output [Non-Immobilizer]	Injector (Cylinder #3)
3	مانه دیجیتال تعمیرکاران خودرو در ایران	اولین سا
4	Motor [-] control output	Air Control Valve (ACV)
5	-	
6	-	
7	-	
8	-	
9	-	
		Variable Swirl Control Actuator
10	Feedback sensor power (+5V)	Electric EGR Control Valve (EEGR)
		Air Control Valve (ACV)
11	-	
12	Sensor ground	Rail Pressure Sensor (RPS)
13	-	
14	EGR Cooler Bypass Solenoid Valve control output	EGR Cooler Bypass Solenoid Valve
15	-	

# **Engine Control System**

**FL-35** 

Pin.	Description	Connected to
	Injector (Cylinder #3) [High] control output [Immobilizer]	Injector (Cylinder #3)
16	Injector (Cylinder #2) [High] control output [Non-Immobilizer]	Injector (Cylinder #2)
	Injector (Cylinder #2) [High] control output [Immobilizer]	Injector (Cylinder #2)
17	Injector (Cylinder #3) [High] control output [Non-Immobilizer]	Injector (Cylinder #3)
18	-	
19	Motor [+] control output	Air Control Valve (ACV)
20	Electric VGT Control Actuator PWM signal input	Electric VGT Control Actuator
21	-	
22	-	
23	-	
24	-	
		Boost Pressure Sensor (BPS)
0.5	(15)	Rail Pressure Sensor (RPS)
25	Sensor power (+5V)	DPF Differential Pressure Sensor (DPS)
		Camshaft Position Sensor (CMPS)
26	Feedback signal input	Variable Swirl Control Actuator
27	Feedback signal input	Electric EGR Control Valve (EEGR)
28	وانه درج عال تحمد كالبادخ و درود الراد	
29	المحدد والمتعدد والمت والمتعد والمتعدد والمتعدد والمتعدد والمتعدد والمتعدد والمتعدد	
30	-	
	Injector (Cylinder #1) [High] control output [Immobilizer]	Injector (Cylinder #1)
31	Injector (Cylinder #4) [High] control output [Non-Immobilizer]	Injector (Cylinder #4)
	Injector (Cylinder #4) [High] control output [Immobilizer]	Injector (Cylinder #4)
32	Injector (Cylinder #1) [High] control output [Non-Immobilizer]	Injector (Cylinder #1)
33	-	
34	Motor [-] control output	Electric EGR Control Valve (EEGR)
35	Motor [-] control output	Variable Swirl Control Actuator
36	-	
37	-	
38	Sensor ground	Camshaft Position Sensor (CMPS)
39	-	
40	Rail Pressure Sensor (RPS) signal input	Rail Pressure Sensor (RPS)

# **Fuel System**

Pin.	Description	Connected to
41	Feedback signal input	Air Control Valve (ACV)
42	Fuel Temperature Sensor (FTS) signal input	Fuel Temperature Sensor (FTS)
43	Engine Coolant Temperature Sensor (ECTS) signal input	Engine Coolant Temperature Sensor (ECTS)
44	Camshaft Position Sensor (CMPS) signal input	Camshaft Position Sensor (CMPS)
45	Rail Pressure Regulator Valve (RPRV) control output	Rail Pressure Regulator Valve (RPRV)
	Injector (Cylinder #1) [Low] control output [Immobilizer]	Injector (Cylinder #1)
46	Injector (Cylinder #4) [Low] control output [Non-Immobilizer]	Injector (Cylinder #4)
	Injector (Cylinder #4) [Low] control output [Immobilizer]	Injector (Cylinder #4)
47	Injector (Cylinder #1) [Low] control output [Non-Immobilizer]	Injector (Cylinder #1)
48	<del>-</del>	
49	Motor [+] control output	Electric EGR Control Valve (EEGR)
50	Motor [+] control output	Variable Swirl Control Actuator
	حىتال خودرو	Intake Temperature Sensor (IATS) #2
		Boost Pressure Sensor (BPS)
,	No. 11 and 11 an	Crankshaft Position Sensor (CKPS)
51	Sensor ground	Engine Coolant Temperature Sensor (ECTS)
	مانه دیجیتال تعمیرکاران خودرو در ایران	Fuel Temperature Sensor (FTS)
		Exhaust Gas Temperature Sensor (EGTS)
		Mass Air Flow Sensor(MAFS)
52	-	
53	Sensor ground	DPF Differential Pressure Sensor (DPS)
33	Sensor ground	A/C Pressure Transducer (APT)
		Variable Swirl Control Actuator
54	Feedback sensor ground	Exhaust Gas Temperature Sensor (EGTS)  Mass Air Flow Sensor(MAFS)  DPF Differential Pressure Sensor (DPS)  A/C Pressure Transducer (APT)
		Air Control Valve (ACV)
55	-	
56	-	
57	A/C Pressure Transducer (APT) signal input	A/C Pressure Transducer (APT)
58	-	
59	Auto recognition signal input [ESP/ FTCS]	Chassis ground
60	Fuel Pressure Regulator Valve (FPRV) control output	Fuel Pressure Regulator Valve (FPRV)

# **Engine Control System**

**FL-37** 

### Connector [CRD-K]

Pin.	Description	Connected to
1	Power ground	Chassis ground
2	Power ground	Chassis ground
3	Battery power (B+)	Main Relay
4	Power ground	Chassis ground
5	Battery power (B+)	Main Relay
6	Battery power (B+)	Main Relay
7	-	
8	Sensor ground	Accelerator Pedal Position Sensor (APS) #2
9	Exhaust Gas Temperature Sensor (EGTS) signal input	Exhaust Gas Temperature Sensor (EGTS)
10	-	
11	Boost Pressure Sensor (BPS) signal input	Boost Pressure Sensor (BPS)
12	-	
13	Sensor power (+5V)	Accelerator Pedal Position Sensor (APS) #1
14	Sensor power (+5V)	Cruise control switch
15	Sensor power (+5V)	Accelerator Pedal Position Sensor (APS) #2
16		0
17	حيتال خودر و سامانه (مدر+5V)	A/C Pressure Transducer (APT)
18	Mass Air Flow Sensor(MAFS) signal input	Mass Air Flow Sensor(MAFS)
19	Glow time Feedback signal input	Glow relay unit
20	Auto recognition signal input [AT/MT]	Chassis ground
21	Brake [Redundant] switch signal input	Brake switch
22	Feed-back signal input	Electric VGT Control Actuator
23	Reference Frequency	Mass Air Flow Sensor(MAFS)
24	-	
25	-	
26	-	
27	PTC Heater Relay control output	PTC Heater Relay
28	-	
29	-	
30	-	
31	-	
32	-	
33	-	
34	DPF Differential Pressure Sensor (DPS) signal input	DPF Differential Pressure Sensor (DPS)

# Fuel System

Pin.	Description	Connected to
35	-	
36	-	
37	-	
38	Immobilizer ground	Immobilizer control module
39	-	
40	Crankshaft Position Sensor (CKPS) signal input	Crankshaft Position Sensor (CKPS)
41	Vehicle Speed Sensor (VSS) signal input	Vehicle Speed Sensor (VSS)
42	<del>-</del>	
43	DPF auto recognition	Chassis ground
44	Clutch switch signal input	Clutch switch
45	Brake main switch signal input	Brake switch
46	-	
47	Immobilizer warning lamp control output	Immobilizer warning lamp (Cluster)
48		
49	A/C relay control output	A/C relay
50	Malfunction Indicator Lamp (MIL) control output	Malfunction Indicator Lamp (MIL)
51		
52	Cruise control switch signal	Cruise control switch
53	Accelerator Pedal Position Sensor (APS) #1 signal input	Accelerator Pedal Position Sensor (APS) #1
54	Accelerator Pedal Position Sensor (APS) #2 signal input	Accelerator Pedal Position Sensor (APS) #2
55	Adjust current	Lambda Sensor
56	Virtual ground	Lambda Sensor
57	<del>-</del>	
58	-	
59	-	
60	Engine speed signal output	Power Distribution Module (PDM)
61	Glow plug PWM signal output	Glow relay unit
62	<del>-</del>	
63	<del>-</del>	
64	-	
65	A/T auto recognition [2WD/4WD]	Chassis ground
66	<u>-</u>	
67	C-CAN [Low]	Other control module
68	C-CAN [High]	Other control module
69	Main Relay control output	Main Relay

**FL-39** 

Pin.	Description	Connected to
70	Cooling Fan Relay #1 control output	Cooling Fan Relay #1
71	Fuel Pump Relay control output	Fuel Pump Relay
72	-	
73	Lambda Sensor heater control output	Lambda Sensor
74	Sensor ground	Accelerator Pedal Position Sensor (APS) #1
75	Intake Temperature Sensor (IATS) #2 signal input	Intake Temperature Sensor (IATS) #2
76	Intake Temperature Sensor (IATS) #1 signal input	Intake Temperature Sensor (IATS) #1
77	Pumping current	Lambda Sensor
78	NERNST cell voltage	Lambda Sensor
79	-	
80	-	
81	-	
82	Immobilizer communication line	Immobilizer control module
83	Neutral switch signal input	Neutral switch
84		
85	Wiper motor autorecognition signal input	Wiper motor
86	LIN communication	Battery sensor
87	ON/ START power	Engine room Relay box
88	Water Sensor signal input	Water Sensor
89	مانه دیجیتال تعمیرکاران خودرو در ایران	اولین سا
90	Cooling Fan Relay #2 control output	Cooling Fan Relay #2
91	-	
92	-	
93	-	
94	-	

# Fuel System

# 3. ECM Terminal Input/output Signal Connetor [CRD-A]

Pin	Description	Condition	Туре	Level	
	Injector (Cylinder #3) [Low] control output [Immobilizer]				Operating voltage Prail ≤200bar : 110V Prail=1200bar : 118~133V Prail=1800bar : 127~156V
1	Injector (Cylinder #2) [Low] control output [Non-Immobilizer]	Idle	Pulse	Charging current(1800bar) - Max : 17A - Peak : 19A	
	•			Charging/Discharging time average 100us	
	Injector (Cylinder #2) [Low] control output [Immobilizer]			Operating voltage Prail ≤200bar : 110V Prail=1200bar : 118~133V Prail=1800bar : 127~156V	
2	Injector (Cylinder #3) [Low] control output [Non-Imm-	Idle	Idle Pulse	Pulse	Charging current - Max : 17A - Peak : 19A
/.	obilizer]		0	Charging/Discharging time average 100us	
3	يعال حودرو ساماته رمستونيت محدو	سرحت دیج			
4	ه د یحیتال تعمیرکارا Motor [-] control output	When ACV cont- rolling	Pulse	HI : Battery voltage  LO : Max. 1.0V	
5	-				
6	-				
7	-				
8	<del>-</del>				
9	-				
10	Feedback sensor power (+5V)	IG Off	DC voltage	Max. 0.5V	
	- consumer ( con)	IG On	On Do vollage	5±0.1V	
11	<del>-</del>				
12	Sensor ground	Idle	DC voltage	Max. 50 mV	
13	-				
14	EGR Cooler Bypass Solenoid Valve control output	Idle	Pulse	Battery voltage	
				Max. 1.0V	
15	-				

FL-41

Pin	Description	Condition	Туре	Level	
	Injector (Cylinder #3) [High] control output [Immobilizer]	-			Operating voltage Prail ≤200bar : 110V Prail=1200bar : 118~133V Prail=1800bar : 127~156V
16	Injector (Cylinder #2) [High] control output [Non-Immobilizer]	Idle	Pulse	Charging current - Max : 17A - Peak : 19A	
	ODIIIZEI]			Charging/Discharging time average 100us	
	Injector (Cylinder #2) [High] control output [Immobilizer]	ldle		Operating voltage Prail ≤200bar : 110V Prail=1200bar : 118~133V Prail=1800bar : 127~156V	
17	Injector (Cylinder #3) [High] control output [Non-Immobilizer]		Pulse	Charging current - Max : 17A - Peak : 19A	
				Charging/Discharging time average 100us	
18		••			
19	Motor [+] control output	When ACV cont-	nt- Pulse	HI : Batte <mark>ry vo</mark> ltage	
19	Wiotor [1] control output	rolling		LO : Max. 1.0V	
20	Electric VGT Control Actuator PWM signal input	اوليامان	Pulse	HI : Battery voltage	
20	Electric VGT Control Actuator P VVIVI Signal Input	lule	Fuise	LO : Max. 0.5V	
21	-				
22	-				
23	-				
24	-				
25	Sensor power (+5V)	IG Off	DC voltage	Max. 0.5V	
20	ecisor power (*ev)	IG On		5±0.1V	
26	Feedback signal input	IG On (EGR Off)	DC voltage	3.6~4.3V	
27	Feedback signal input	Idle	DC voltage	0.17~4.83V	
28	-				
29	-				
30	-				

# **Fuel System**

Pin	Description	Condition	Туре	Level	
	Injector (Cylinder #1) [High] control output [Immobilizer]			Operating voltage Prail ≤200bar : 110V Prail=1200bar : 118~133V Prail=1800bar : 127~156V	
31	Injector (Cylinder #4) [High] control output [Non-Imm-obilizer]	Idle	Pulse	Charging current - Max : 17A - Peak : 19A	
				Charging/Discharging time average 100us	
	Injector (Cylinder #4) [High] control output [Immobilizer]	Idle		Operating voltage Prail ≤200bar : 110V Prail=1200bar : 118~133V Prai=1800bar : 127~156V	
32	Injector (Cylinder #1) [High] control output [Non-Immobilizer]		Idle Pulse	Pulse	Charging current - Max : 17A - Peak : 19A
				Charging/Discharging time average 100us	
33		00			
34	Motor [-] control output	When EEGR co-	Pulse	HI: Battery voltage	
04		ntrolling	1 disc	LO : Max. 1.0V	
35	Motor [-] control output	When VSA cont- rolling	Pulse	HI : Battery voltage  LO : Max. 1.0V	
36	_				
37	<u>-</u>				
38	Sensor ground	Idle	DC voltage	Max. 50 mV	
39	-				
		IG ON		Max. 1.0V	
40	Rail Pressure Sensor (RPS) signal input	Idle	Analog	1.0 ~ 1.5 V	
		3000 RPM		1.5 ~ 3.0 V	
41	Feedback signal input	Idle	DC voltage	0.17~4.83V	
42	Fuel Temperature Sensor (FTS) signal input	Idle	Analog	0.5V ~ 4.5V	
43	Engine Coolant Temperature Sensor (ECTS) signal input	Idle	Analog	0.74V	
44	Camshaft Position Sensor (CMPS) signal input	Idle	Pulse	HI: Vcc or Battery voltage	
	, , , <del>,</del> ,			LO : Max. 1.0V	

**FL-43** 

Pin	Description	Condition	Туре	Level
				HI : Battery voltage
45	Rail Pressure Regulator Valve (FPRV) control output	Idle	Pulse	LO : Max. 1.0V
				Frequency =0.7~1.1kHz
	Injector (Cylinder #1) [Low] control output [Immobilizer]			Operating voltage Prail ≤200bar : 110V Prail=1200bar : 118~133V Prail=1800bar : 127~156V
46	Injector (Cylinder #4) [Low] control output [Non-Immobilizer]	Idle	Pulse	Charging current - Max : 17A - Peak : 19A
				Charging/Discharging time average 100us
	Injector (Cylinder #4) [Low] control output [Immobilizer]			Operating voltage Prail ≤200bar : 110V Prail=1200bar : 118~133V Prail=1800bar : 127~156V
47		Idle	Pulse	Charging current
	njector (Cylinder #1) [Low] control output [Non-Immo-	7	0-	- Max : 17A
(2	فالناد (مسئوليت معادة) فالمانة (مسئوليت معادة) bilizer]	شرکت دیج		- Peak : 19A  Charging/Discharging time average 100us
48	ه دیجیتال تعمیرگاران خودرو در ایران	اولین سامان	0-	
49	Motor [+] control output	When VSA cont-	Pulse	HI: Battery voltage
49	Motor [1] control output	rolling	Puise	LO : Max. 1.0V
50	Motor [+] control output	When VSA cont-	Pulse	HI : Battery voltage
30	Motor [+] control output	rolling	ruise	LO : Max. 1.0V
51	Sensor ground	Idle	DC voltage	Max. 50 mV
52	-			
53	Sensor ground	Idle	DC voltage	Max. 50 mV
54	Feedback sensor ground	Idle	DC voltage	Max. 50 mV
55	-			
56	-			
57	A/C Pressure Transducer (APT) signal input	A/C On	Analog	Max. 4.8V
58	-			
59	Auto recognition signal input [ESP/ FTCS]	ESP/TCS	DC voltage	Max. 0.5V
	- tate 1000g. mao. o.g.nar mpac [E0771 100]	ABS		Battery voltage

# Fuel System

Pin	Description	Condition	Туре	Level
60	Fuel Pressure Regulator Valve (FRRV) central output	1410	Dulas	HI : Battery voltage
60	Fuel Pressure Regulator Valve (FPRV) control output	Idle	Pulse	LO : Max. 1.0V

### Connetor [CRD-K]

Pin	Description	Condition	Туре	Level
1	Power ground	Idle	DC voltage	Max. 50 mV
2	Battery power (B+)	Idle	DC voltage	Max. 50 mV
	D-H(D-)	IG Off	DO	Max. 1.0 V
3	Battery power (B+)	IG On	DC voltage	Battery voltage
4	Power ground	Idle	DC voltage	Max. 50 mV
	Detter in power (DL)	IG Off	DC voltage	Max. 1.0 V
5	Battery power (B+)	IG On	DC voltage	Battery voltage
•	Detter a second (DL)	IG Off	DO well-	Max. 1.0 V
6	Battery power (B+)	IG On	DC voltage	Battery voltage
7				
8	Sensor ground	Idle	DC voltage	Max. 50 mV
9	Exhaust Gas Temperature Sensor (EGTS) signal input	ldle	Analog	3.3V
10	بتال خودر و سامانه (مسئولیت محدو	شرکت دیج		
11	Boost Pressure Sensor (BPS) signal input	IG ON	Analog	0.5V ~ 4.5V
12	ه دیجیتال تعمیرکاران خودرو در ایران	اولین سامان	0-	
40	Consequence (15)	IG Off	DO "	Max. 0.5V
13	Sensor power (+5V)	IG On	DC voltage	5±0.1V
4.4	Company (15)()	IG Off	DO well-	Max. 0.5V
14	Sensor power (+5V)	IG On	DC voltage	5±0.1V
45	Company (15)()	IG Off	DO well-	Max. 0.5V
15	Sensor power (+5V)	IG On	DC voltage	5±0.1V
16	-			
17	Sanger power (±5)/)	IG Off	DC voltage	Max. 0.5V
17	Sensor power (+5V)	IG On	DC voitage	5±0.1V
18	Maca Air Flow Sangar/MAES) signal input	Idle	Pulse	HI: Vcc or Battery voltage
10	Mass Air Flow Sensor(MAFS) signal input	idle	Puise	LO : Max. 1.0V
10	Clow time Ecodhook signal input	Normal	DC voltage	Battery voltage
19	Glow time Feedback signal input	Error	DC voltage	Max. 2.0V
20	Auto recognition signal input [AT/MT]	MT	DC voltage	Battery voltage
20	Auto recognition signal input [AT/MT]	AT	DC voltage	Max. 0.5V

FL-45

Pin	Description	Condition	Туре	Level
04	Dunius ID advandanti avvitah sisuad isasut	Release	DO well-	Battery voltage
21	Brake [Redundant] switch signal input	Push	DC voltage	Max. 0.5V
00	For all pools of any all in pasts	l all a	Dulaa	HI: Vcc or Battery voltage
22	Feedback signal input	Idle	Pulse	LO : Max. 1.0V
22	Deference Frequency upper	Idlo	Dulas	HI: Vcc or Battery voltage
23	Reference Frequencyuency	Idle	Pulse	LO : Max. 1.0V
24	<del>-</del>			
25	-			
26	<del>-</del>			
27	PTC Heater Relay control output	Relay Off	DC voltage	Battery voltage
21	PTC Realer Relay control output	Relay On	DC voltage	Max. 1.0V
28	-			
29	-			
30	<del>-</del>			
31				- 0-
32				Q \
33		••		
34	DPF Differential Pressure Sensor (DPS) signal input	شرکidie دیج	Analog	0.5V ~ 4.5V
35	CAN 2 II owl	Recessive	D. (1)	2.0 ~ 3.0 V
33	ه دیجیتال تعمیرکاران خودر [CAN 2 [Low]	Dominant	Pulse	0.5 ∼ 2.25 V
36	CAN 2 [High]	Recessive	Pulse	2.0 ~ 3.0 V
30	CAN 2 [High]	Dominant	Puise	2.75 ~ 4.5 V
37	<del>-</del>			
38	Immobilizer ground	Idle	DC voltage	Max. 50 mV
39	<del>-</del>			
40	Crankshaft Desition Songer (CKDS) signal input	Idle	Pulse	HI: Vcc or Battery voltage
40	Crankshaft Position Sensor (CKPS) signal input	idle	Puise	LO : Max. 0.5V
41	Vehicle Speed Sensor (VSS) signal input			
42	-			
42	DDF cute recognition	Non-DPF	DC voltage	Battery voltage
43	DPF auto recognition	DPF	DC voltage	Max. 0.5V
44	Clutch switch signal input			
45	Deales main quitab aisselliment	Release	DC	Max. 0.5V
45	Brake main switch signal input	Push	DC voltage	Battery voltage
46	-			

# **Fuel System**

Pin	Description	Condition	Туре	Level
47	Immobilizer warning lamp central output	Lamp Off	DC voltage	Battery voltage
47	Immobilizer warning lamp control output	Lamp On	DC voltage	Max. 1.0V
48	-			
49	A/C relay control autout	A/Con Off	DC voltage	Battery voltage
49	A/C relay control output	A/Con On	DC voltage	Max. 1.0V
50	Malfunction Indicator Lamp (MIL) control output	Lamp Off	DC voltage	Battery voltage
50	IMAII UI CITOTI ITICATOL LATTIP (MIL) COTTO OULPUT	Lamp On	DC voltage	Max. 1.0V
51	-			
		All Release		5.0 $\pm$ 0.1 V
		Main SW		5.0 ± 0.1 V
52	Cruise control switch signal	Set SW	DC voltage	$0.5\pm0.2\mathrm{V}$
		Resume SW		1.5 ± 0.2 V
		Cancel SW		0 ± 0.2 V
	Accelerator Pedal Position Sensor (APS) #1 signal	C.T	A I	0.3 ~ 0.9V
53	input	W.O.T	Analog	4.0 ~ 4.8V
5.1	Accelerator Pedal Position Sensor (APS) #2 signal input	C.T	Analog	0.3 ~ 0.9V
54		W.O.T		1.5 ~ 3.0V
55	Adjust current (	ENG Run	Analog	I Rc-Rp I <0.2V
56	Virtual ground	ENG Run	Analog	2.5±0.1V
57	ه دیجیتال تعمیرکاران خودرو در ایران	اولین سامان		C
58	-			
59	-			
60	Engine speed signal output			
64	Clausius DMM signal autaut	Claur On	Delle	HI : Battery voltage
61	Glow plug PWM signal output	Glow On	Pulse	LO : Max. 1.0V
62	-			
63	-			
64	-			
65	A/T guto recognition [SM/D/AM/D]	2WD	DC voltage	Battery voltage
00	A/T auto recognition [2WD/4WD]	4WD	DC voltage	Max. 0.5V
66	-			
67	C CAN II owl	Recessive	Dulas	2.0 ~ 3.0 V
67	C-CAN [Low]	Dominant	Pulse	0.5 ~ 2.25 V
60	C CAN [Ligh]	Recessive	Dulaa	2.0 ~ 3.0 V
68	C-CAN [High]	Dominant	Pulse	2.75 ~ 4.5 V

FL-47

73 Lambda Sensor heater control output  74 Sensor ground  75 Intake Temperature Sensor (IATS) #2 signal input  76 Intake Temperature Sensor (IATS) #1 signal input  77 Pumping current  78 Vehicle Run  Pulse  DC voltage  Idle  Analog  No.  Rich	Battery voltage  Max. 1.0V  Battery voltage  Max. 1.0V  Battery voltage  Max. 1.0V
Relay On  Relay Off Relay	Battery voltage  Max. 1.0V  Battery voltage
70 Cooling Fan Relay #1 control output  Relay On  Relay Off Relay On  71 Fuel Pump Relay control output  72	Max. 1.0V  Battery voltage
Relay On  Relay Off Relay Off Relay Off Relay On  72  -  73 Lambda Sensor heater control output  74 Sensor ground  Total Intake Temperature Sensor (IATS) #2 signal input  Total Intake Temperature Sensor (IATS) #1 signal input  Total Intake Temperature Se	Battery voltage
Fuel Pump Relay control output  Relay On  Coultage	, ,
Relay On  72 -	Max. 1.0V
Table 1	
73 Lambda Sensor heater control output  74 Sensor ground  75 Intake Temperature Sensor (IATS) #2 signal input  76 Intake Temperature Sensor (IATS) #1 signal input  77 Pumping current  78 Vehicle Run  Pulse  DC voltage  Idle  Analog  No.  Rich	
74 Sensor ground Idle DC voltage  75 Intake Temperature Sensor (IATS) #2 signal input Idle Analog  76 Intake Temperature Sensor (IATS) #1 signal input Idle Analog  77 Pumping current ENG Run Analog Rich	HI : Battery voltage
75 Intake Temperature Sensor (IATS) #2 signal input Idle Analog  76 Intake Temperature Sensor (IATS) #1 signal input Idle Analog  77 Pumping current ENG Run Analog Rich	LO : Max. 1.0V
76 Intake Temperature Sensor (IATS) #1 signal input Idle Analog  77 Pumping current ENG Run Analog Rich	Max. 50 mV
77 Pumping current ENG Run Analog Rich	1.9V
77 Pumping current ENG Run Analog Rich	0.5V ~ 4.5V
	formal : 0 $\pm$ 500 mV
	n : Min. Normal - 1.5V
Lear	n : Max. Normal + 1.5V
No.	ormal : 450 $\pm$ 50 mV
78 NERNST cell voltage ENG Run Analog	h : Max. Normal + 150 mV
	an : Min. Normal - 150 mV
79	
80 -	
81 -	
82 Immobilizer signal input  Communicating Pulse	HI : Min. 8.5V
82 Immobilizer signal input after IG ON Pulse	LO : Max. 3.5V
83 Neutral switch signal input	
- 84	
85 -	
86 LIN communication When co Pulse	HIGH : Min. Vb*0.8
oo Eliv Communication vinen co Fuise	LOW : Max Vb*0.2
IG Off DC voltage	Max. 1.0 V
87 ON/ START power IG On	
Full of Water	Battery voltage
88 Water Sensor signal input No Water Analog	Battery voltage Battery voltage
89 -	, ,

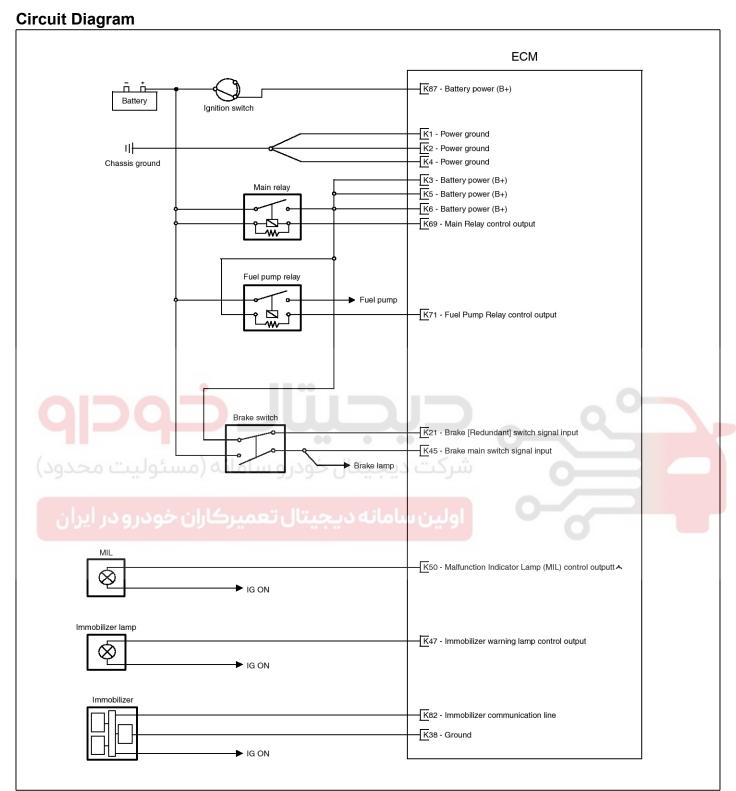
# **Fuel System**

Pin	Description	Condition	Туре	Level
00	Casting For Dalay #0 control output	Relay Off	DC voltage	Battery voltage
90	Cooling Fan Relay #2 control output	Relay On	DC voltage	Max. 1.0V
91	-			
92	-			
93	-			
94	-			



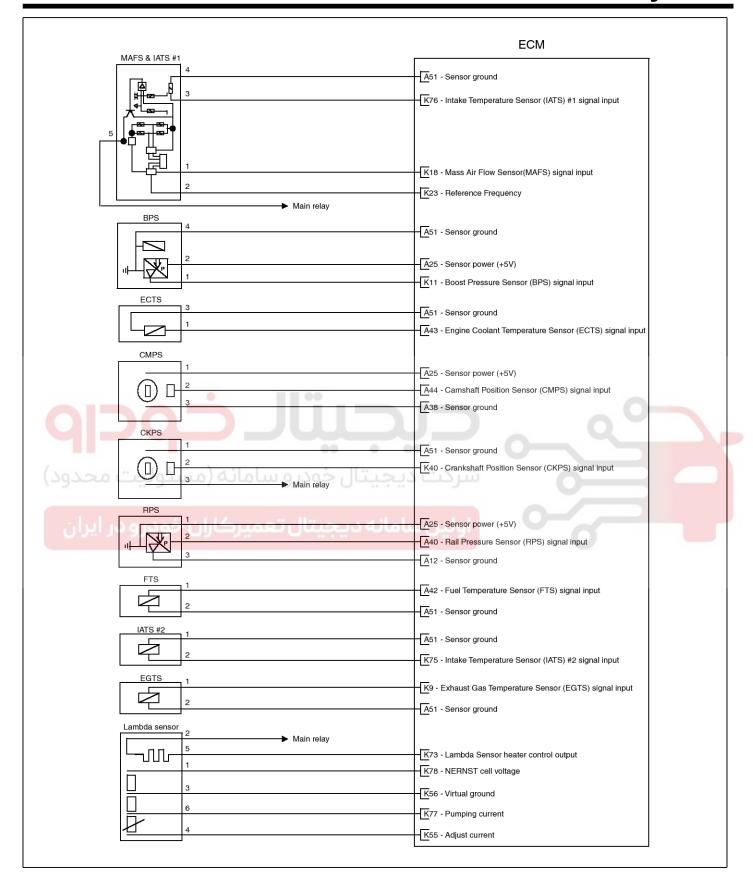


**FL-49** 



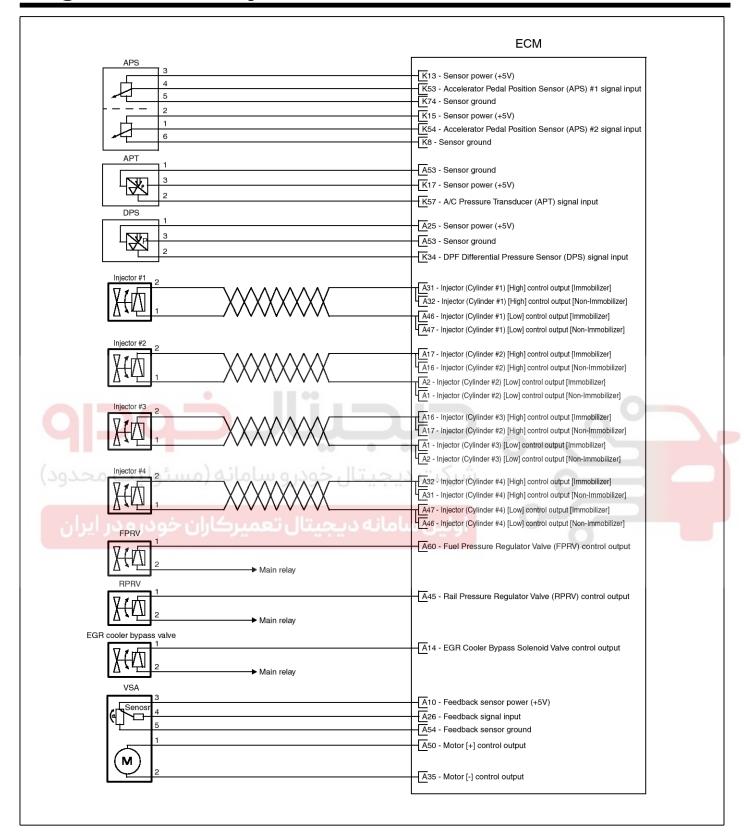
SXMFL0130L

## **Fuel System**



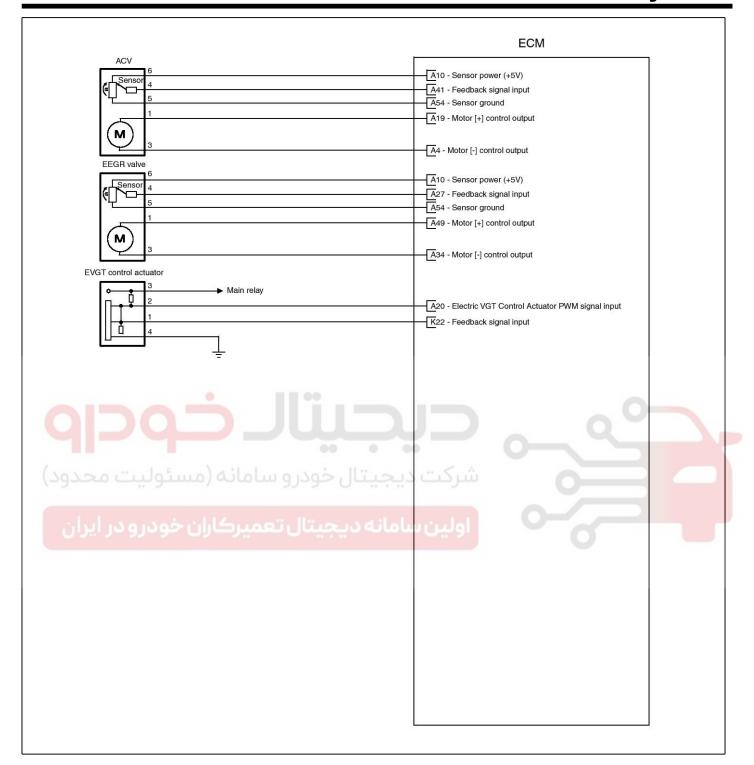
SXMFL0131L

**FL-51** 



SXMFL0132L

# **Fuel System**



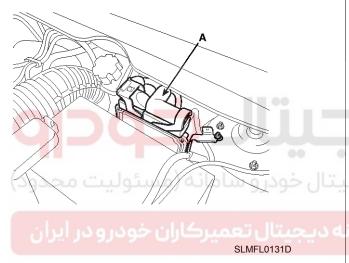
SLMFL0441L

**FL-53** 

### Replacement

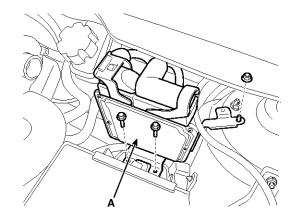
#### **ACAUTION**

- After replacing ECM, MUST input the injector specific data (7 digits) of each cylinder into a new ECM with the GDS.
- In the case of the vehicle equipped with immobilizer or smart key, perform "KEY TEACHING" procedure together (Refer to "Immobilizer" or "Smart key system" in BE group).
- 1. Turn ignition switch OFF.
- 2. Disconnect the negative (-) battery cable.
- 3. Disconnect the ECM connector (A).

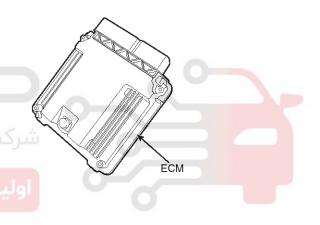


4. Remove the battery. (Refer to "intake manifold" in EM group.)

5. Unscrew the ECM bracket mounting bolts/nut and then remove the ECM (A).



SLMFL0190D



SXMFL9137D

6. Install a new ECM.

ECM installation bolts (on bracket):

 $3.9 \sim 5.9 \text{ N.m}$  (0.4  $\sim 0.6 \text{ kgf.m}$ ,  $2.9 \sim 4.3 \text{ lb-ft}$ )

**ECM** bracket installation nuts:

 $9.8 \sim 14.7 \text{ N.m} (1.0 \sim 1.5 \text{ kgf.m}, 7.2 \sim 8.7 \text{ lb-ft})$ 

**ECM** bracket installation bolt:

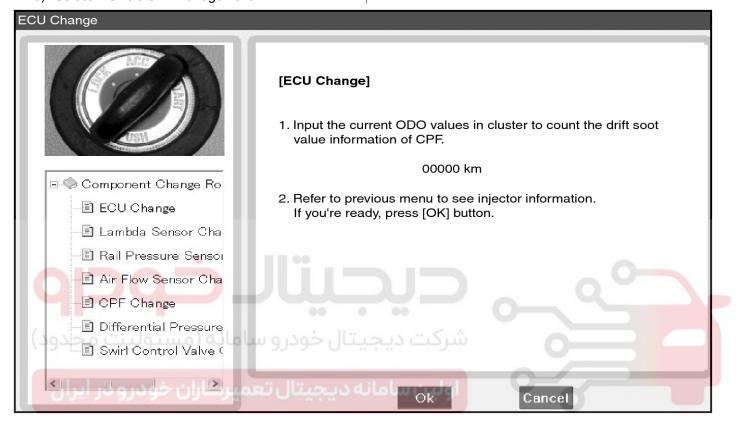
21.6  $\sim$  32.4 N.m (2.2  $\sim$  3.3 kgf.m, 15.9  $\sim$  23.9 lb-ft)

7. Connect the negative(-) battery cable.

## **Fuel System**

- 8. Perform "ECM Change" procedure [With CPF].
  - 1) Turn ignition switch OFF.
  - 2) Connect the GDS to Data Link Connector (DLC).
  - 3) Turn ignition switch ON.
  - 4) Select "Vehicle, Model year, Engine, System".
  - 5) Select "Vehicle S/W Management".

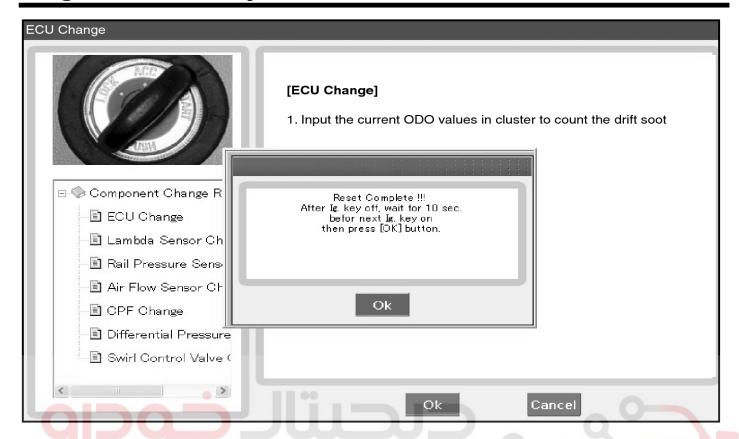
- 6) Select "Component Change Routine".
- 7) Select "ECU Change".
- 8) Input the mileage in odometer.
- 9) Confirm the "Complete" message and then turn ignition switch OFF.



SFDF29207E

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

**FL-55** 



SFDF29208E

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

### **ECM Problem Inspection Procedure**

- 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.
- 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.
- 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)

## **Fuel System**

### Injector

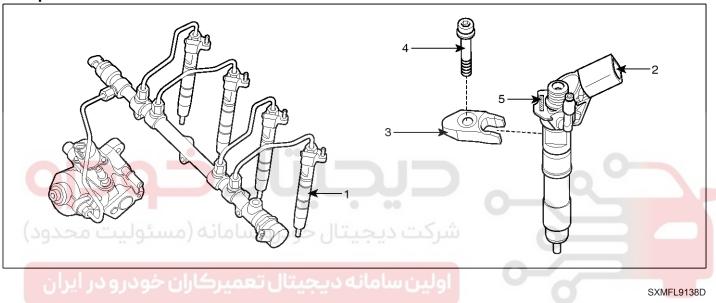
### **Description**

**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

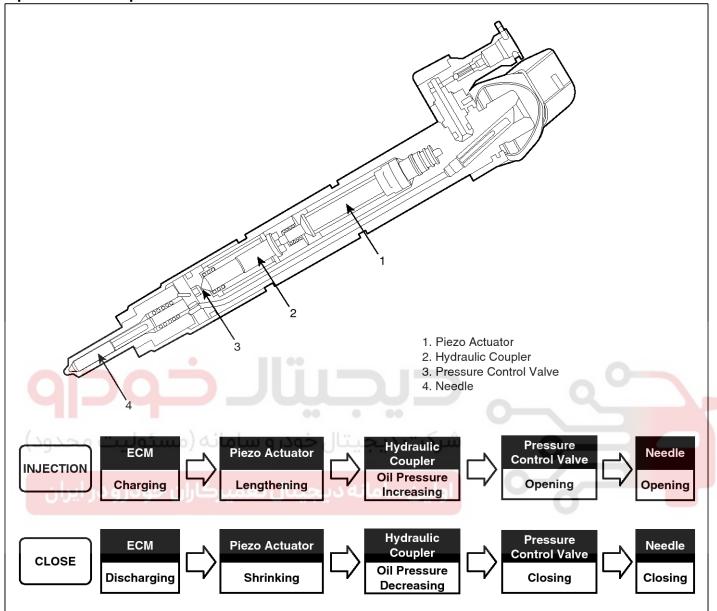


- 1. Injector
- 2. Connector
- 3. Clamp

- 4. Clamp Mounting Bolt
- 5. Injector Specific Data (7 digits)

**FL-57** 

**Operation Principle** 



SENFL7114L

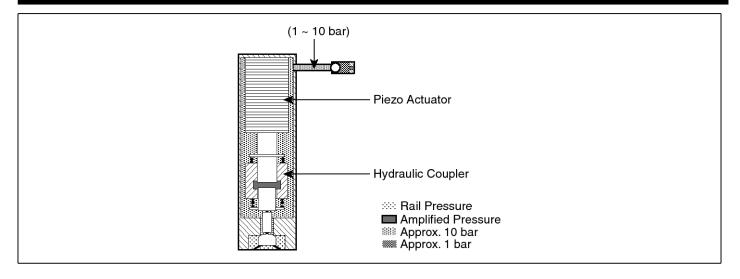
#### Piezo Actuator

The Piezo Actuator is made up of several floors of cylindrical piezo-ceramic (height: approximately  $90^{\mu\text{m}}$ ). 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.

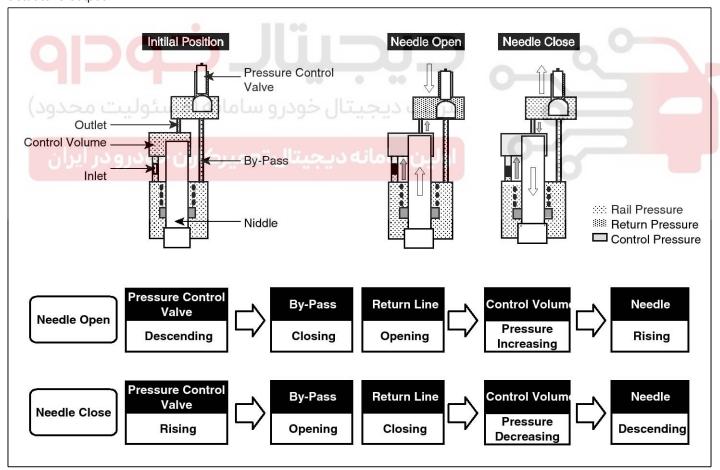
### **Fuel System**



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

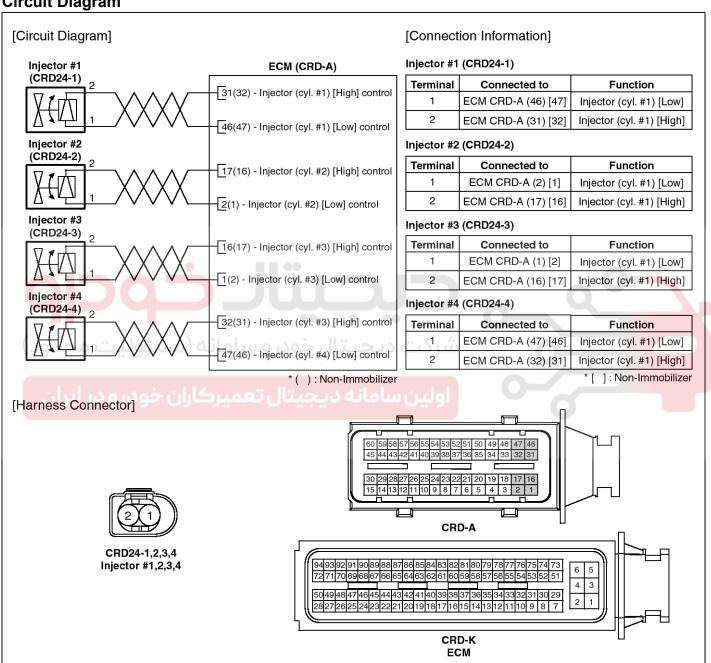
The needle is located under the pressure control valve and finally opens or closes the injection hole.

**FL-59** 

### Specification

Items	Specification
Component Resistance ( <sup>kΩ</sup> )	150 ~ 210 [20˚C(68˚F)]
Operation Voltage (V)	110 ~ 156

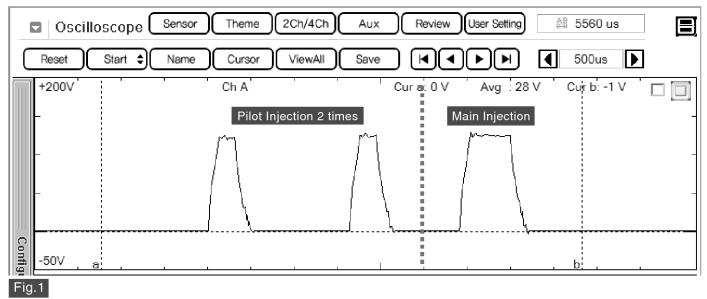
### Circuit Diagram



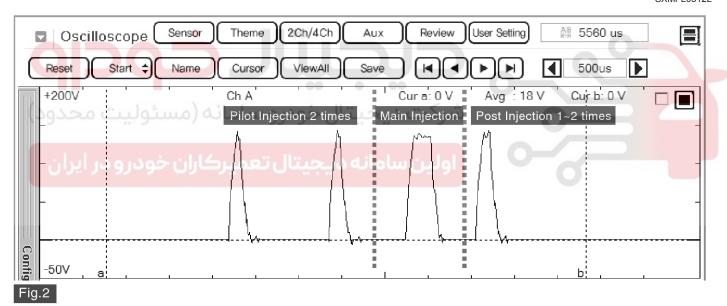
SLMFL0401L

## **Fuel System**

### **Signal Waveform**

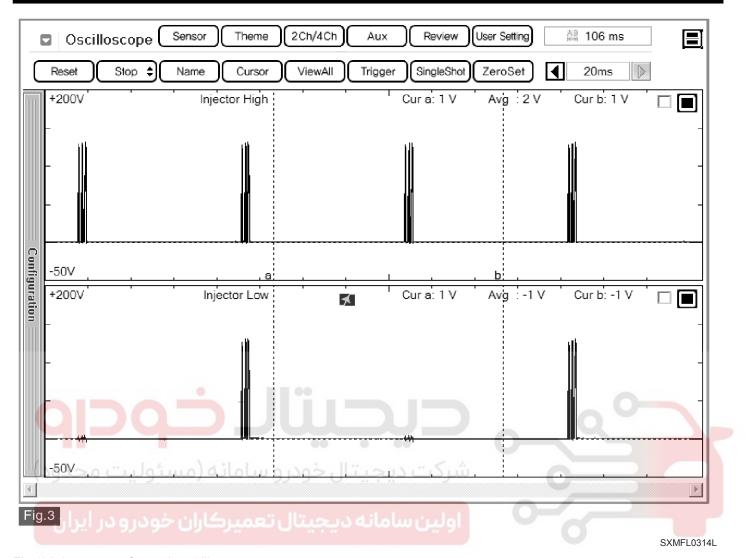


SXMFL0312L



SXMFL0313L

**FL-61** 



- Fig.1) Injector waveform when idling
- Fig.2) Injector waveform when accelerating
- Fig.3) Injector High/Low waveform when idling

### **Fuel System**

#### Removal

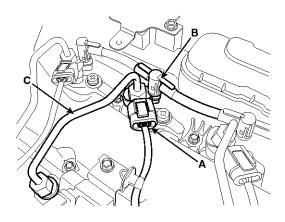
#### **WARNING**

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 1,800bar), 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 gasket with a new one.
  - To protect damage caused by shock, vertically insert the injector into the cylinder head.
  - Clean the connecting surface of the injector gasket on the cylinder head before installing the injector.
- When installing High Pressure Fuel Pipe
  - Do not use again the used high pressure fuel pipe.
  - Install the flange nut correctly.

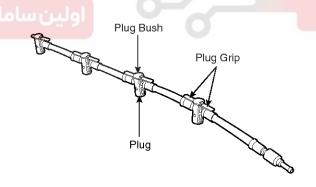
- Turn ignition switch OFF and disconnect the negative (-) battery cable.
- 2. Disconnect the injector connector (A) and the injector return line (B).
- 3. Remove the high pressure fuel pipe (C).



SXMFL9141D

#### MOTICE

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.



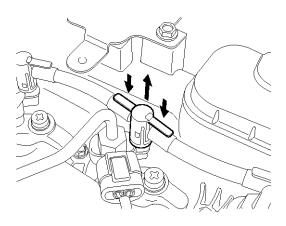
SXMFL0142L

**FL-63** 

#### **MNOTICE**

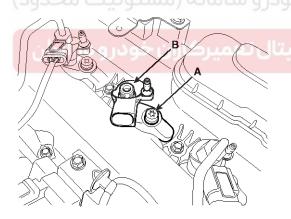
### [DISCONNECTION-INJECTOR RETURN LINE]

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



SXMFL9143D

- 2. Seize the return line on both sides of the plug, and then disconnect the plug upward from the injector nipple.
- 4. Unscrew the injector clamp bolt (A), and then remove the injector (B).



SXMFL9145D

#### MOTICE

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

#### Installation

1. Installation is reverse of removal.

#### MOTICE

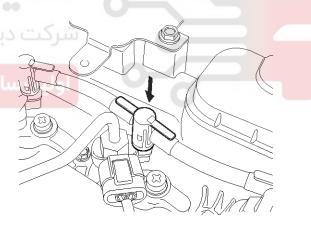
- When installing the high pressure fuel pipe, apply the specified tightening torques with the special service tool [SST No.: 09314-27110].
- When installing the high pressure fuel pipe connecting the common rail and injector, follow the below procedure.
  - Temporarily install the nuts on common rail and injector
  - Install the injector side and common rail side sequentially

Injector clamp installation bolt:  $29.4 \sim 33.4$  N.m (3.0  $\sim 3.4$  kgf.m,  $27.1 \sim 24.6$  lb-ft)

High pressure fuel pipe installation nut:  $24.5 \sim 28.4$  N.m ( $2.5 \sim 2.9$  kgf.m,  $18.1 \sim 21.0$  lb-ft)

# **WNOTICE**[CONNECTION-INJECTOR RETURN LINE]

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



SXMFL9144D

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

## **Fuel System**

### 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.

### **A**CAUTION

- Common Rail Fuel Injection System operates with extremely high pressure (approximately 1,800bar), 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 gasket with a new one.
  - To protect damage caused by shock, vertically insert the injector into the cylinder head.
  - Clean the connecting surface of the injector gasket on the cylinder head before installing the injector.
- 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 the GDS.

- 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).



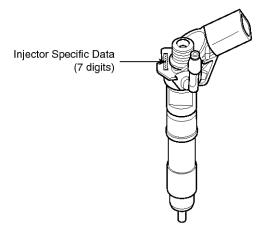
**FL-65** 

### **Injector Specific Data Input**

#### **ACAUTION**

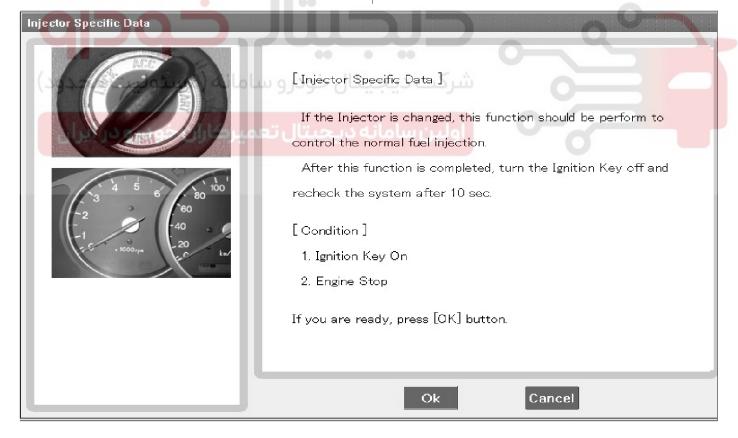
After replacing injector, MUST input the injector specific data (7 digit) of each cylinder into ECM with the GDS.

#### MOTICE



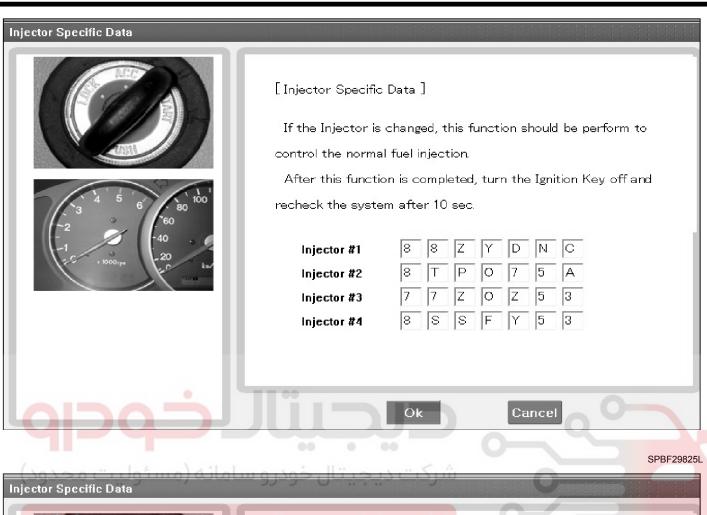
- 1. Turn ignition switch OFF.
- 2. Connect the GDS to Data Link Connector (DLC).
- 3. Turn ignition switch ON.
- 4. Select "Vehicle, Model year, Engine, System".
- 5. Select "Vehicle S/W Management".
- 6. Select "injector Specific Data".
- 7. Perform the procedure in accordance with the message.

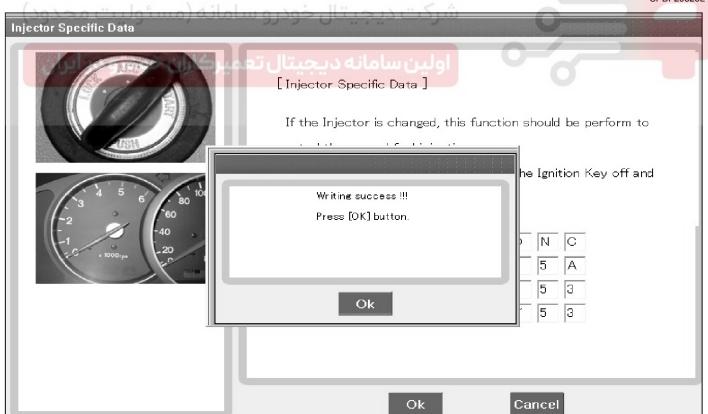
SENFL7119L



SPBF29823L

# **Fuel System**





SPBF29824L

**FL-67** 

- 8. After selecting "OK" on the "Writing success" message, turn ignition switch OFF.
- In about 10 seconds, turn ignition switch ON and recheck the injector specific data memorized in the ECM.

#### MOTICE

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





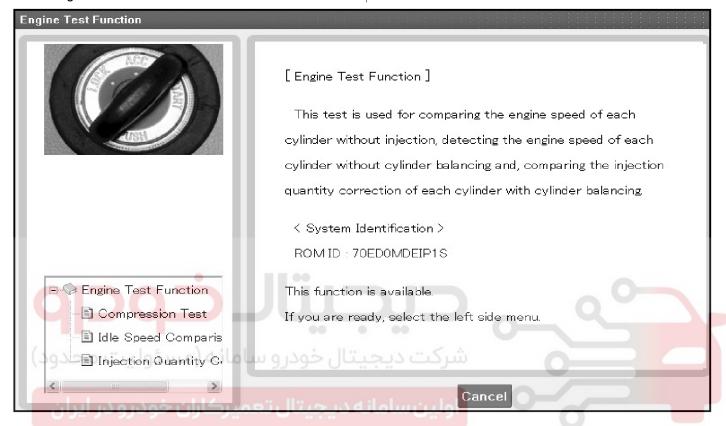
## **Fuel System**

### Inspection

### [Compression Test]

- 1. Turn ignition switch OFF.
- 2. Connect the GDS to Data Link Connector (DLC).
- 3. Turn ignition switch ON.

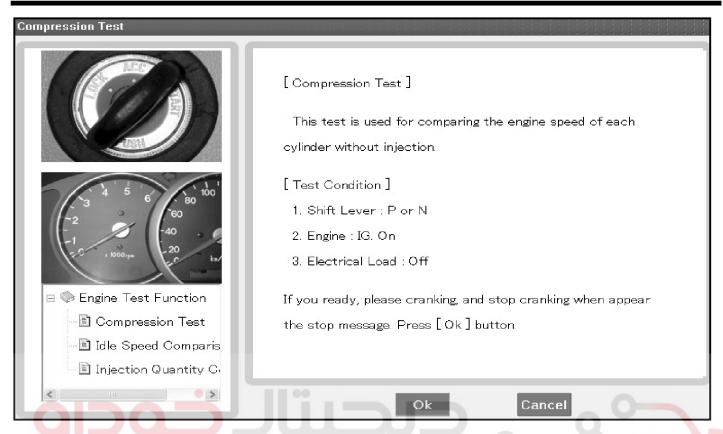
- 4. Select "Vehicle, Model year, Engine, System".
- 5. Select "Vehicle S/W Management".
- 6. Select "Engine Test Function".



SFDF29210E

- 7. Select "Compression Test".
- 8. Perform the test in accordance with the message.

**FL-69** 



Compression Test

[Compression Test]

This test is used for comparing the engine speed of each cylinder without injection.

[Test Condition]

1. Shift Lever: P or N

2. Engine: IG. On

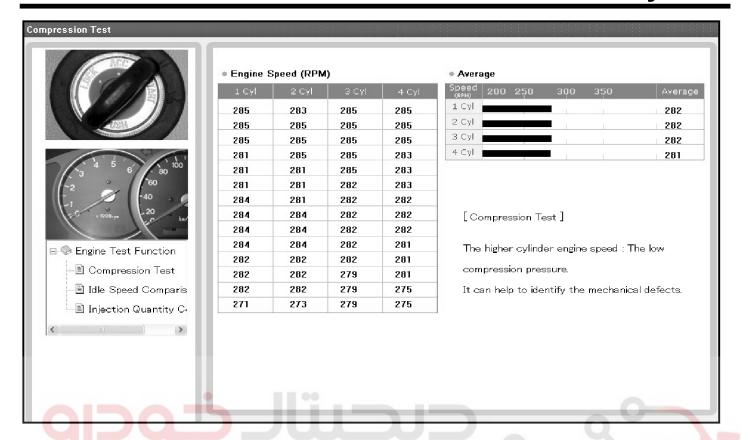
3. Electrical Load: Off

Start cranking!!!

Cancel

SFDF29212E

## **Fuel System**



### MOTICE

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

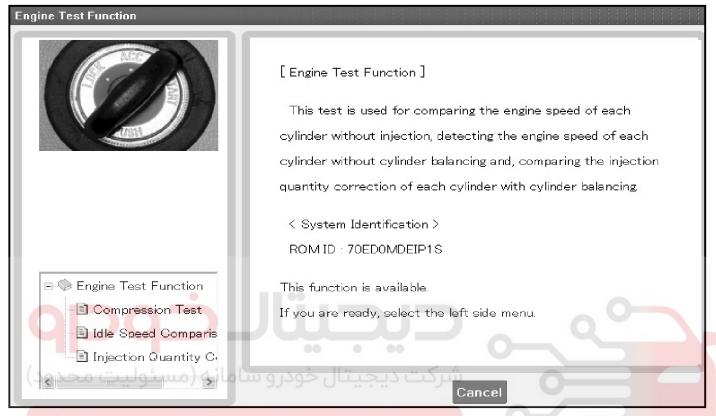
SFDF29213E

**FL-71** 

#### [Idle Speed Comparison]

- 1. Turn ignition switch OFF.
- 2. Connect the GDS 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 "Engine Test Function".

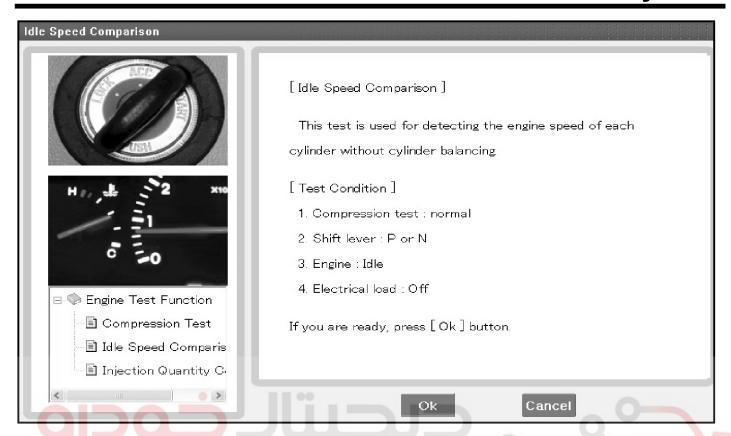


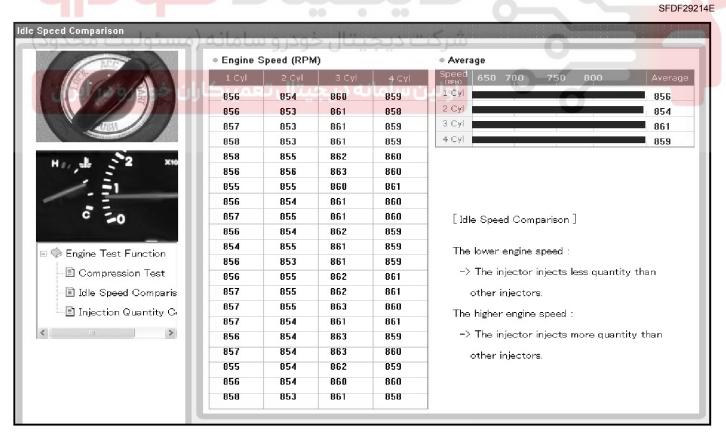
### ولین سامانه دیجیتال تعمیرکاران خودرو در ایران

SFDF29210E

- 7. Select "Idle Speed Comparision".
- 8. Perform the test in accordance with the message.

### **Fuel System**





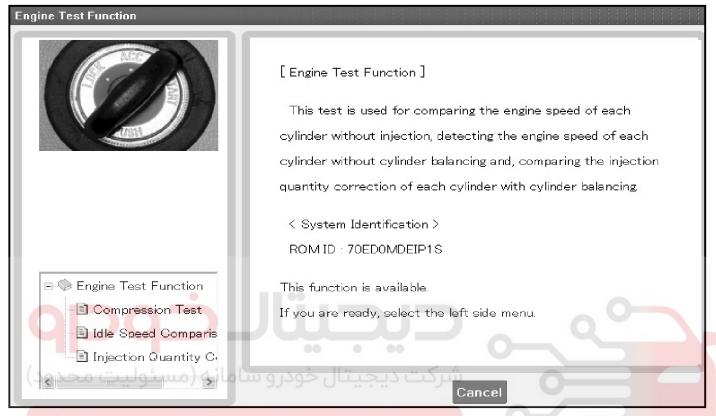
SFDF29215E

**FL-73** 

#### [Injection Quantity Comparison]

- 1. Turn ignition switch OFF.
- 2. Connect the GDS 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 "Engine Test Function".

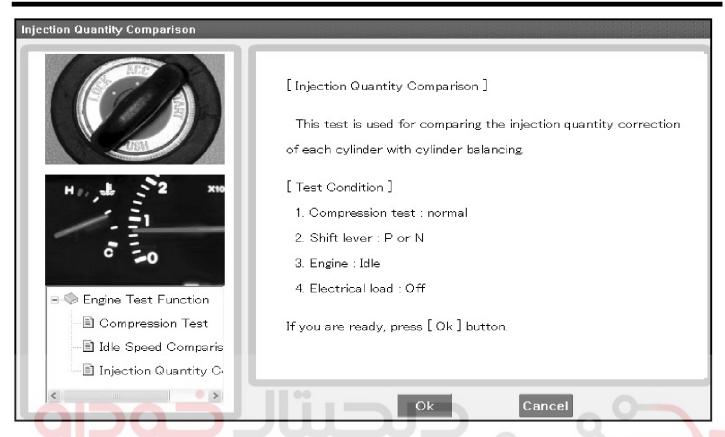


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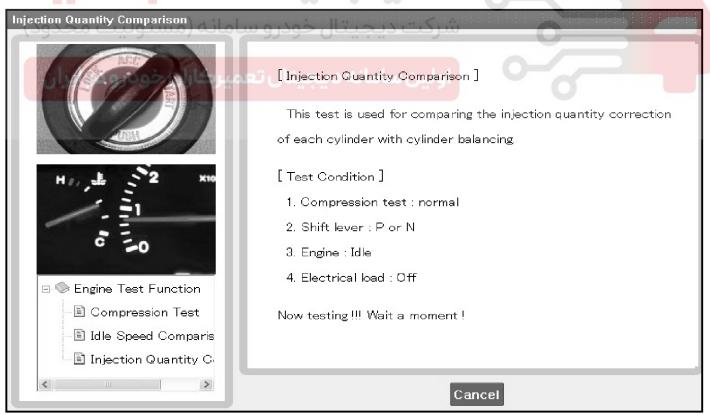
SFDF29210E

- 7. Select "Injection Quantity Comparison"
- 8. Perform the test in accordance with the message.

## **Fuel System**



SFDF29216E



SFDF29217E

**FL-75** 

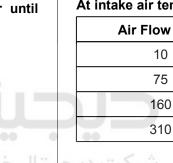
## Mass Air Flow Sensor (MAFS)

### **Description**

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.



SXMFL9146D

### **Specification**

At intake air temperature = 20°C (68°F)

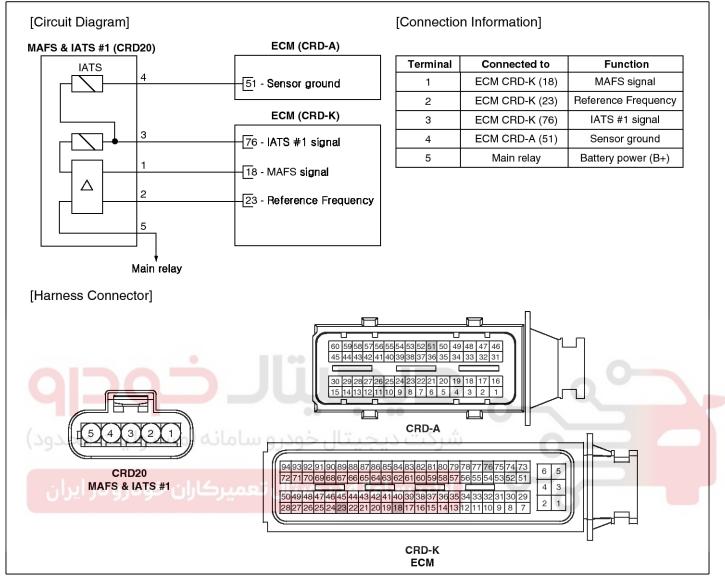
Air Flow (kg/h)	Frequency (kHz)
15	2.00 ~ 2.01
20	2.06 ~ 2.07
90	2.67 ~ 2.69
220	3.43 ~ 3.47
440	4.65 ~ 4.76
850	7.87 ~ 8.25
1000	9.60 ~ 10.52

### At intake air temperature = $-15^{\circ}C(5^{\circ}F)$

Air Flow (kg/h)	Frequency (kHz)
10	2.06 ~ 2.07
75	2.65 ~ 2.70
160	3.40 ~ 3.49
310	4.60 ~ 4.81

# **Fuel System**

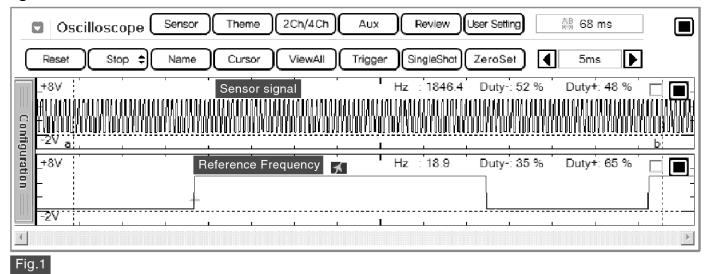




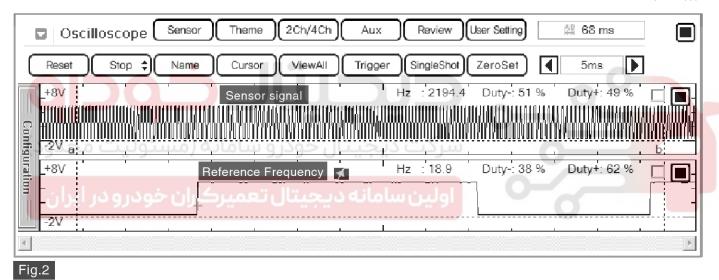
SLMFL0402L

**FL-77** 

## **Signal Waveform**



SXMFL0307L



SXMFL0308L

Fig.1) Waveform at Key ON state

Fig.2) Waveform at idle state

# **Fuel System**

### 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.

#### Removal

- 1. Turn the ignition switch OFF and disconnect the battery (-) cable.
- 2. Disconnect the mass air flow sensor connector (A) and the installation clamp (B).

#### Installation

#### CAUTION

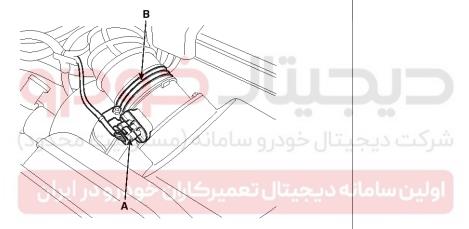
- Install the component with the specified torques.
- Note that internal damage may occur when the component is dropped. In this case, use it after inspecting.

### **ACAUTION**

- Be careful not to damage the sensing element and the honey cell.
- 1. Installation is reverse of removal.

Mass air flow sensor installation bolt:  $3.9 \sim 5.9$  N.m ( $0.4 \sim 0.6$  kgf.m,  $2.9 \sim 4.3$  lb-ft)

Mass air flow sensor clamp installation screw:  $2.9 \sim 4.9$  N.m ( $0.3 \sim 0.5$  kgf.m,  $2.2 \sim 3.6$  lb-ft)





3. Remove the mass air flow sensor after removing the installation bolts.

**FL-79** 

### Replacement

#### **ACAUTION**

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 the GDS 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 "Air Flow Sensor Change".
- 8. Perform the procedure in accordance with the message.



SFDF29219E

## **Fuel System**

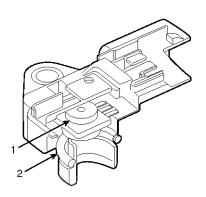


**FL-81** 

## **Boost Pressure Sensor (BPS)**

### **Description**

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).



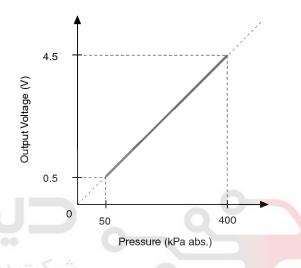
SXMFL9150D

1. Pressure sensor cell

2. O-ring

### **Specification**

Pressure (kPa)	Output Voltage (V)
50	0.5
100	1.002 ~ 1.142
300	3.288 ~ 3.428
400	4.11 ~ 4.59

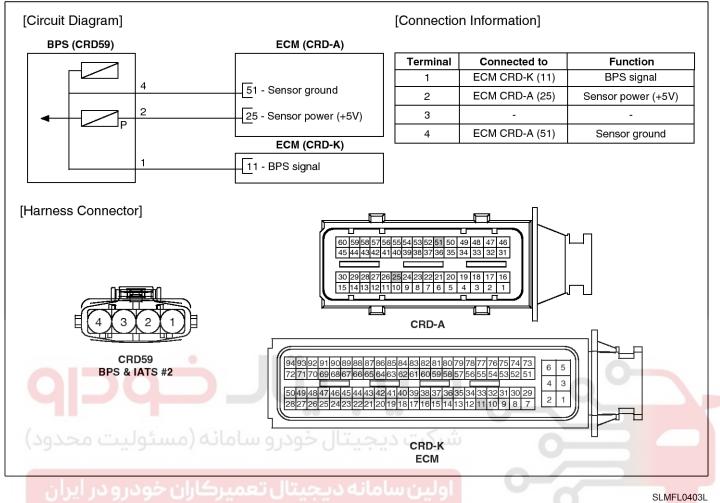


SXMFL0152L

اولین سامان<mark>ه دیجیتال تعمیرکاران خودرو در ایرا</mark>ن

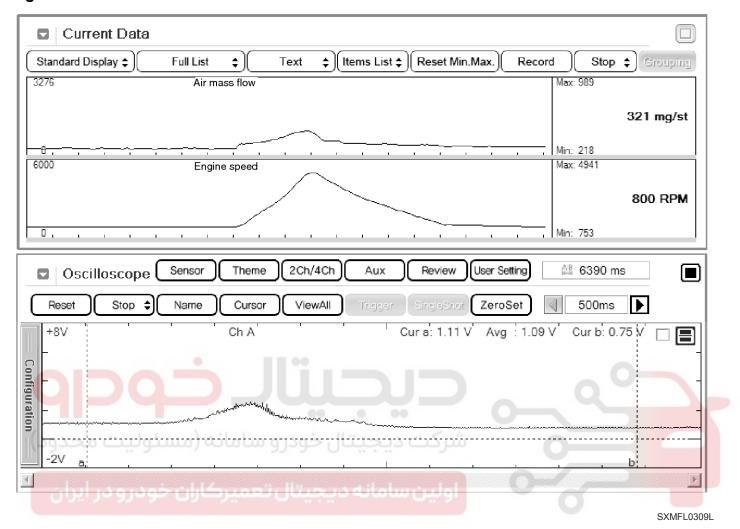
# **Fuel System**





**FL-83** 

## **Signal Waveform**



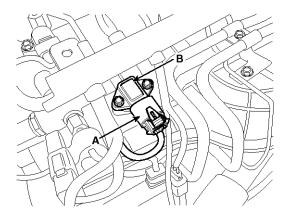
This is the waveform of BPS as accelerating at idle.

Signal voltage rises as accelerating.

## **Fuel System**

#### Removal

- 1. Turn the ignition switch OFF and disconnect the battery (-) cable.
- 2. Disconnect the boost pressure sensor connector (A).
- 3. Removal the boost pressure sensor (B) after removing the installation bolts.



SXMFL9153D

### Installation

### **ACAUTION**

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

Boost pressure sensor installation bolt: 9.8  $\sim$  11.8 N.m (1.0  $\sim$  1.2 kgf.m, 7.2  $\sim$  8.7 lb-ft)



**FL-85** 

## **Intake Air Temperature Sensor (IATS)**

### **Description**

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 installed at intercooler pipe 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.

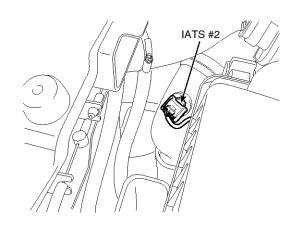
Comparing these air temperature values from both sensors, more accurate sensing of intake air temperature is possible. ECM uses these air temperature signals to perform EGR control correction and fuel injection quantity correction.

#### **⚠**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.



SLMFL0422D



SLMFL0150D

# **Specification IATS #1 (MAFS) [Built in MAFS]**

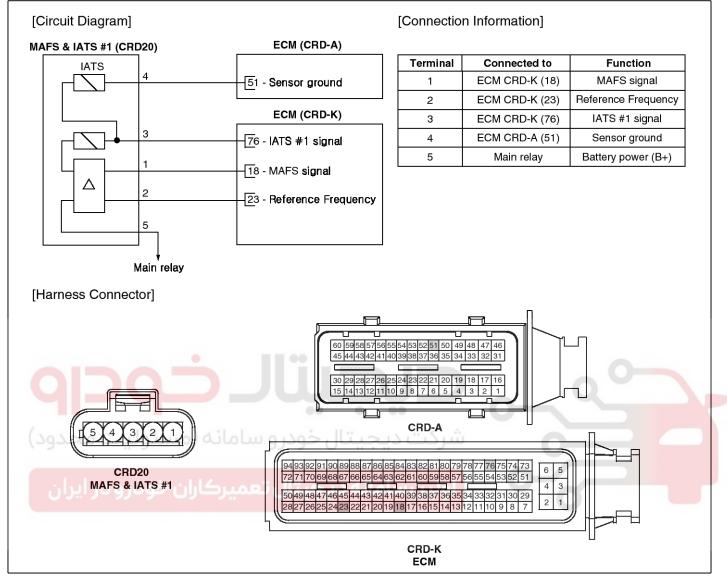
Temperature [°C(°F)]	Resistance( <sup>kΩ</sup> )
-40(-40)	36.59 ~ 42.71
-20(-4)	12.95 ~ 14.74
0(32)	5.19 ~ 5.79
20(68)	2.31 ~ 2.53
40(104)	1.12 ~ 1.21
60(140)	0.58 ~ 0.62
80(176)	0.33 ~ 0.34

### IATS #2 (BPS) [Built at the intercooler]

Temperature [°C(°F)]	Resistance( <sup>kΩ</sup> )
-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

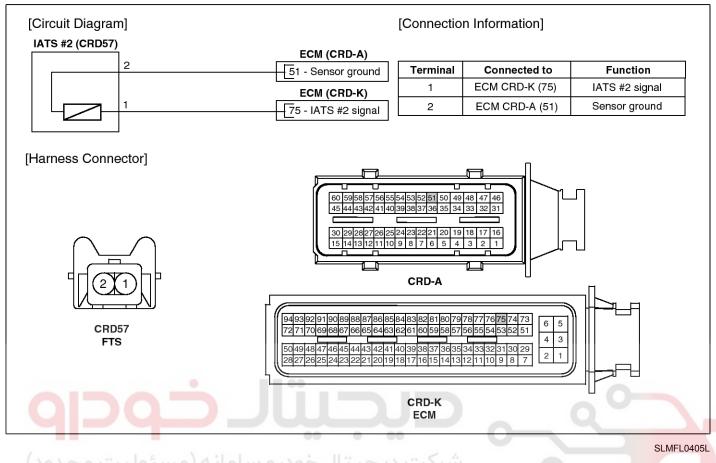
# **Fuel System**

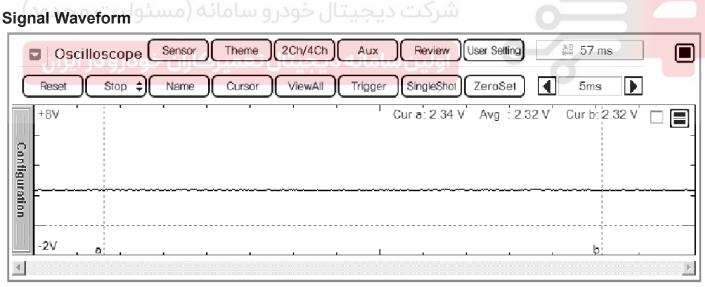
### **Circuit Diagram**



SLMFL0402L

**FL-87** 





Signal waveform at IATS at idle

SXMFL0306L

## **Fuel System**

### Inspection

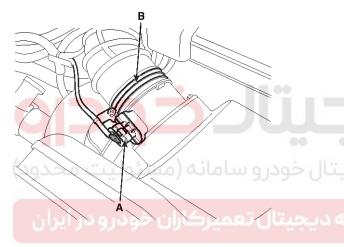
- 1. Turn ignition switch OFF.
- 2. Disconnect the IATS #1 or IATS #2 connector.
- 3. Measure resistance between IATS signal terminal and sensor ground terminal.
- 4. Check that the resistance is within the specification.

Specification: Refer to "Specification" section.

#### Removal

#### [Intake air temperature sensor (IATS) #1]

- 1. Turn the ignition switch OFF and disconnect the battery (-) cable.
- 2. Remove the intake air temperature sensor #1 connector (A) and the installation clamp (B).

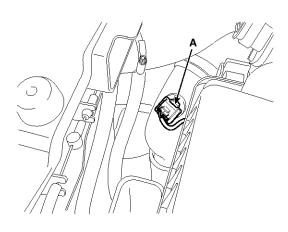


SLMFL0141D

3. Remove the intake air temperature sensor #1 after removing the installation bolt.

#### [Intake air temperature sensor (IATS) #2]

- 1. Turn the ignition switch OFF and disconnect the battery (-) cable.
- 2. Remove the intake air temperature sensor #2 (A) after disconnecting the connector.



SLMFL0151D

#### Installation

### **A**CAUTION

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

Intake air temperature sensor (IATS) #1 installation bolt:

 $3.9 \sim 5.9 \text{ N.m}$  (0.4  $\sim$  0.6 kgf.m, 2.9  $\sim$  4.3 lb-ft)

Intake air temperature sensor (IATS) #1 clamp installation screw:

 $2.9 \sim 4.9 \text{ N.m}$  (0.3  $\sim$  0.5 kgf.m, 2.2  $\sim$  3.6 lb-ft)

Intake air temperature sensor (IATS) #2 installation:

 $19.6 \sim 29.4 \text{ N.m} (2.0 \sim 3.0 \text{ kgf.m}, 14.5 \sim 21.7 \text{lb-ft})$ 

**FL-89** 

### Replacement

#### **ACAUTION**

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 the GDS 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 "Air Flow Sensor Change".
- 8. Perform the procedure in accordance with the message.



SFDF29219E

## **Fuel System**



**FL-91** 

## **Engine Coolant Temperature Sensor (ECTS)**

### **Description**

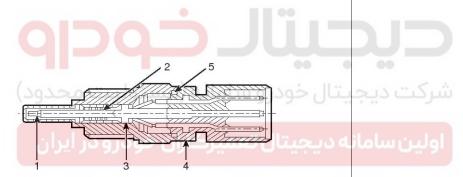
Engine Coolant Temperature Sensor (ECTS) is located in the engine coolant passage of the cylinder head for detecting the engine coolant temperature. The ECTS uses a thermistor whose resistance changes with the temperature.

The electrical resistance of the ECTS decreases as the temperature increases, and increases as the temperature decreases. The reference +5V is supplied to the ECTS via a resistor in the ECM. That is, the resistor in the ECM and the thermistor in the ECTS are connected in series. When the resistance value of the thermistor in the ECTS changes according to the engine coolant temperature, the output voltage also changes.

During cold engine operation, the ECM increases the fuel injection duration and controls the ignition timing using the information of engine coolant temperature to avoid engine stalling and improve drivability.

### **Specification**

Temperature [°C(°F)]	Resistance( <sup>k</sup> Ω)
-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
100(212)	0.19
110(230)	0.15
120(248)	0.12



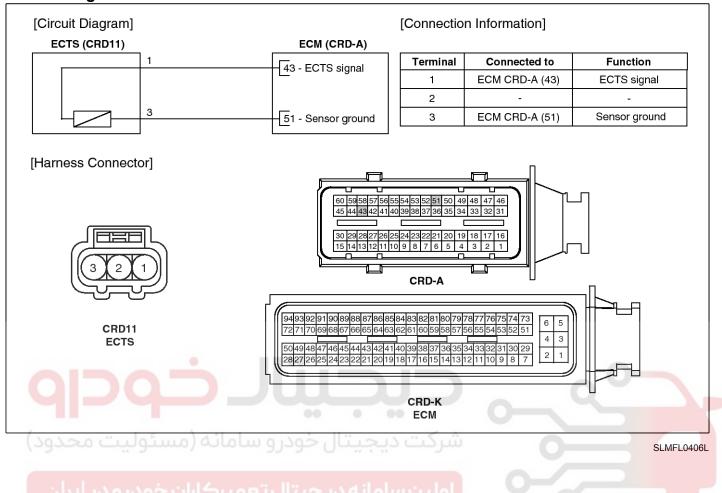


SXMFL9158D

- 1. Thermistor
- 2. Spring
- 3. Insulator
- 4. Body
- 5. O-ring

# **Fuel System**





ويین شمانه دیجیتان تعمیرهاران خودرو در ایران

**FL-93** 

### 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.
- 5. Check that the resistance is within the specification.

Specification: Refer to "Specification" section.

#### Removal

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

#### Installation

### **ACAUTION**

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

### **⚠**CAUTION

- Note that engine coolant may be flowed out from the water temperature control assembly when removing the sensor.
- 1. Installation is reverse of removal.

Engine coolant temperature sensor installation:  $19.6 \sim 39.2$  N.m ( $2.0 \sim 4.0$  kgf.m,  $14.5 \sim 28.9$  lb-ft)





SXMFL9266D

3. Remove the engine coolant temperature sensor.

## **Fuel System**

## **Camshaft Position Sensor (CMPS)**

### **Description**

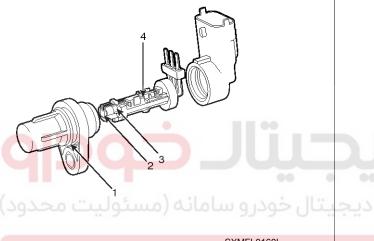
The Camshaft Position Sensor (CMPS) is installed on the cylinder head cover and detects the camshaft position. This is a hall sensor and has a hall-effect IC which output voltage changes when magnetic field is made on the IC with current flow.

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.

### **Specification**

Level	Output Voltage (V)
High	5
Low	0

Item	Specification
Air gap (mm)	0.5 ~ 1.5

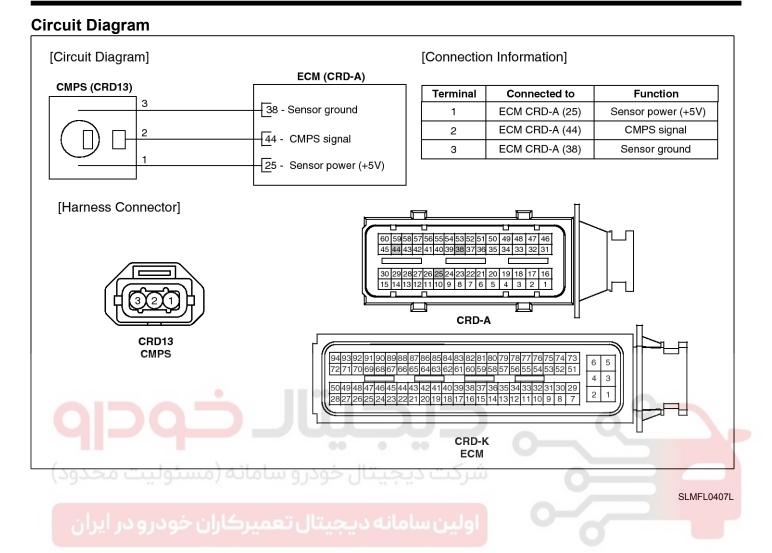




- اولین سامانه دیجیتال تعمیرکاران خودرو در ایر O-ring
- 2. Hall IC
- 3. Magnet
- 4. Resister

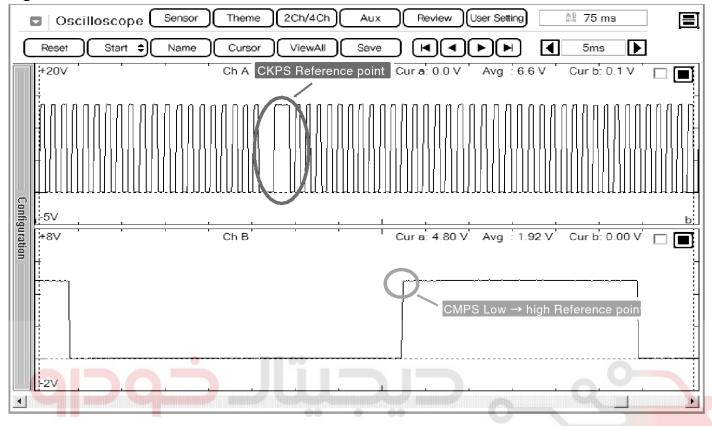


**FL-95** 



## **Fuel System**

### **Signal Waveform**



Crank Shaft Position Sensor and Camshaft Position Sensor signal are measured simultaneously.

Cam Shaft Position Sensor signal is outputted once when Crank Shaft Position sensor signal is outputted twice.

LOW and HIGH output of Cam Shaft Position sensor reference point is detected at Crankshaft Position sensor reference point.

#### MOTICE

Injection sequence is determined based on LOW and HIGH signal of Cam Shaft Position Sensor reference point as detecting cylinder position.

SXMFL0317L

**FL-97** 

### Inspection

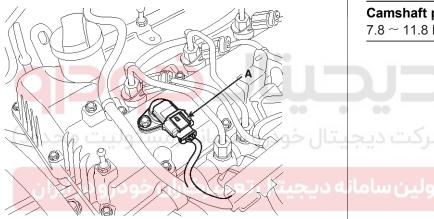
1. Check signal waveform of CMPS and CKPS using the GDS.

Specification: Refer to "Signal Wave Form" section.

#### Removal

#### **WARNING**

- DON'T remove the camshaft position sensor during engine running or right after engine stops, or a scald by the flowed out engine oil may occur.
- 1. Turn the ignition switch OFF and disconnect the battery (-) cable.
- 2. Disconnect the camshaft position sensor connector (A).



SXMFL9163D

3. Remove the camshaft position sensor.

#### Insatallation

### **ACAUTION**

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

### **ACAUTION**

- · Apply the engine coolant to the O-ring.
- · Be careful not to damage the O-ring.

### **ACAUTION**

- Insert the sensor in the installation hole and be careful not to damage when installation.
- Be careful not to damage the sensor housing and the connector.
- 1. Installation is reverse of removal.

Camshaft position sensor installation bolt:

 $7.8 \sim 11.8 \text{ N.m} (0.8 \sim 1.2 \text{kgf.m}, 5.8 \sim 8.7 \text{ lb-ft})$ 

# **Fuel System**

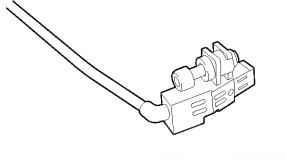
## **Crankshaft Position Sensor (CKPS)**

## **Description**

The Crankshaft Position Sensor (CKPS) is installed on the rear oil seal assembly and detects the crankshaft position by the signal of the magnetic encoder. By using this signal, the ECM can calculate the piston position of each cylinder and the engine speed for sequential injection.

### **Specification**

Items	Specification
Air Gap (mm)	0.3 ~ 1.3

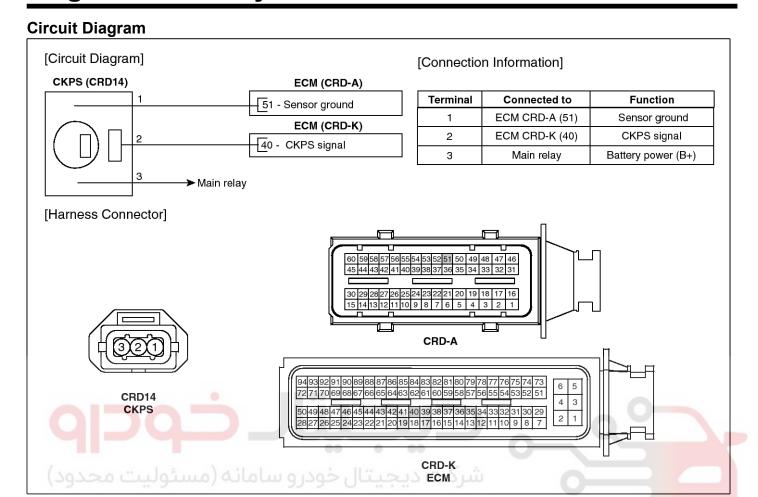




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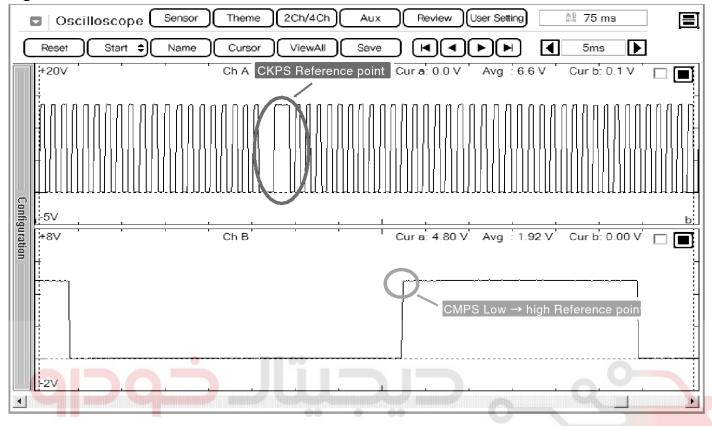
**FL-99** 



SLMFL0432L

## **Fuel System**

### **Signal Waveform**



Crank Shaft Position Sensor and Camshaft Position Sensor signal are measured simultaneously.

Cam Shaft Position Sensor signal is outputted once when Crank Shaft Position sensor signal is outputted twice.

LOW and HIGH output of Cam Shaft Position sensor reference point is detected at Crankshaft Position sensor reference point.

#### MOTICE

Injection sequence is determined based on LOW and HIGH signal of Cam Shaft Position Sensor reference point as detecting cylinder position.

SXMFL0317L

**FL-101** 

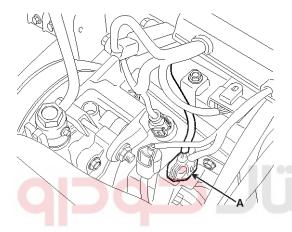
### Inspection

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

**Specification:** Refer to "Signal Wave Form" section.

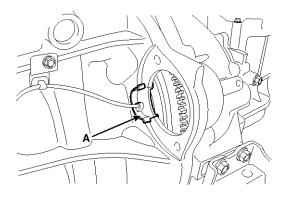
### Removal

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



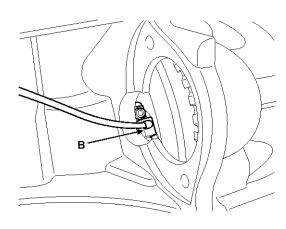
SXMFL9267D

- 3. Remove the start motor (Refer to "Start System" in EE group.)
- 4. Remove the dust cover (A).



SXMFL9166D

5. Remove the crankshaft position sensor (B) after removing the installation screw.



SXMFI 9268D

#### Installation

### **ACAUTION**

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

### CAUTION

 When you install the dust cover, stick it to the block. And then must check the sensor cable whether seperating.

#### اەلىد رىسام

1. Installation is reverse of removal.

# **Fuel System**

## **Accelerator Position Sensor (APS)**

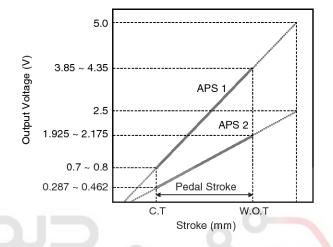
### **Description**

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.



### **Specification**

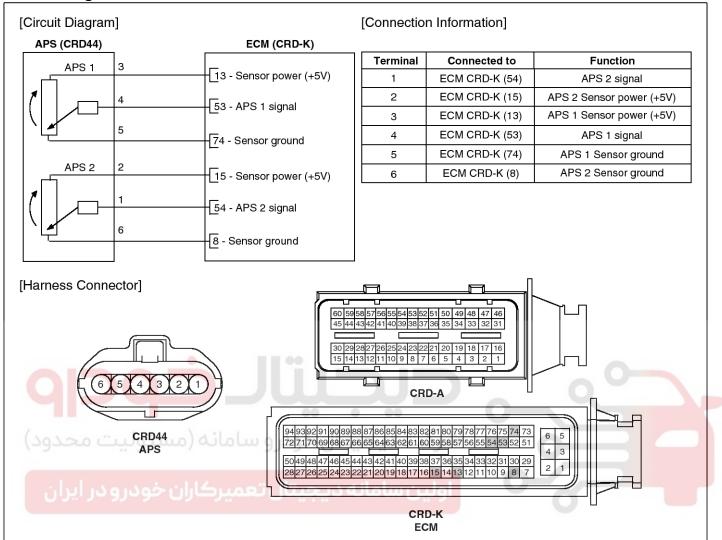
Pedal Position	Output Voltage	e(V) [Vref = 5.0V]
Pedai Position	APS1	APS2
Released	0.7 ~ 0.8	0287 ~ 0.462
Fully depressed	3.85 ~ 4.35	1.925 ~ 2.175



SCMFL0168L

**FL-103** 

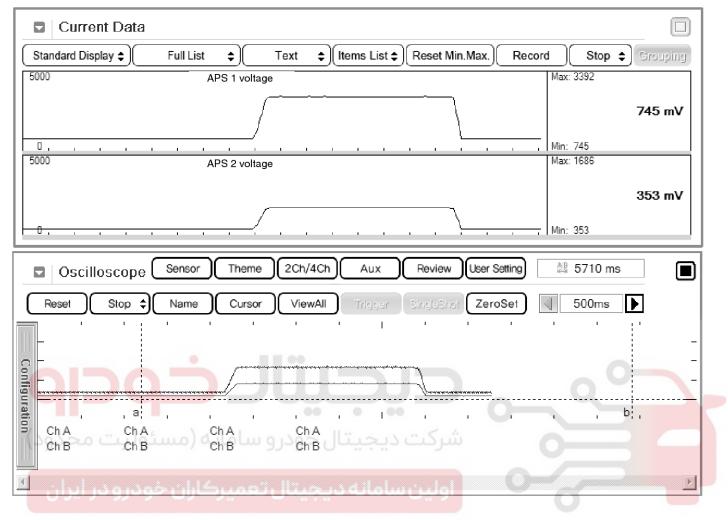
### **Circuit Diagram**



SLMFL0408L

## **Fuel System**

### Signal Waveform



SXMFL0310L

APS 1 and APS 2 signals are measured simultaneously, Check if output value is rising and APS 2 is 1/2 of APS 1 signal.

**FL-105** 

## **Rail Pressure Sensor (RPS)**

### **Description**

The Rail Pressure Sensor (RPS) is installed at the end of the common rail 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.

### **ACAUTION**

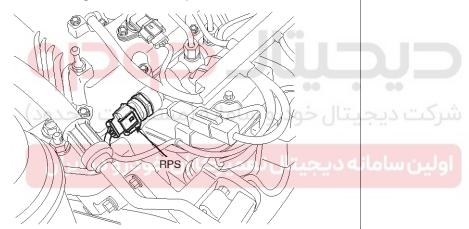
After replacing the Rail Pressure Sensor (RPS), MUST perform the "COMPONENT CHANGE ROUTINE" procedure (Refer to "REPLACEMENT" procedure). Otherwise trouble related with engine performance or emission control may occur until ECM learning about the component is over.

### **Specification**

Condition	Rail pressure (bar)	Output Voltage (V)
Idle	200 ~ 300	Below 1.1
Accelerator pedal fully depressed	1,600 ~ 1,800	About 4.5

#### MOTICE

Rail pressure keeps  $400 \sim 500$  bar steadly if you fully depress accelerator pedal during 5 seconds.

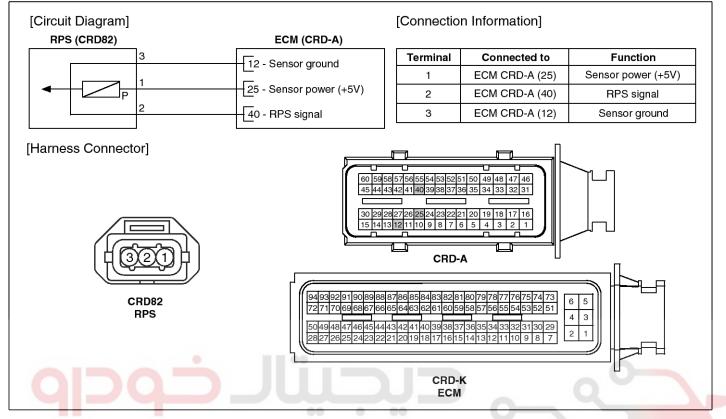




SXMFI 9171D

## **Fuel System**





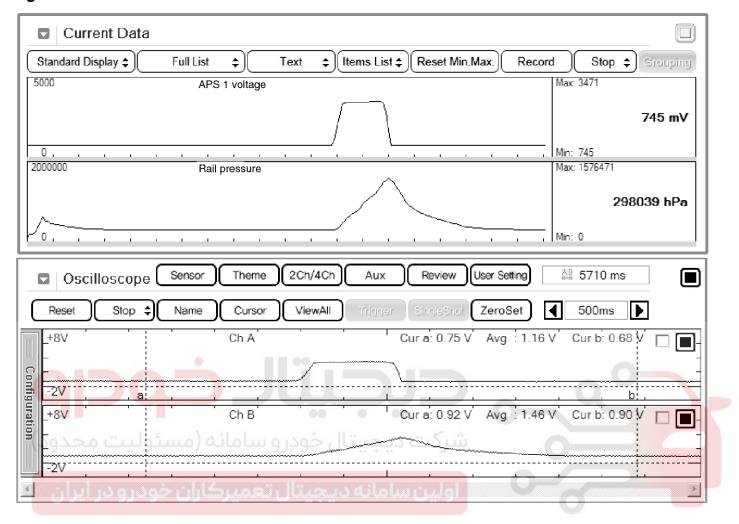
شرکت دیجیتال خودرو سامانه (مسئولیت محدود)

ولین سامانه دیجیتال تعمیرکاران خودرو در ایران

SLMFL0409L

**FL-107** 

## **Signal Waveform**



SXMFL0311L

This waveform shows the rise of RPS output voltage at rapid acceleration.

## **Fuel System**

### Replacement

#### **ACAUTION**

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 the GDS 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 "Rail Pressure Sensor Change".
- 8. Perform the procedure in accordance with the message.



SFDF29228E

**FL-109** 



## **Fuel System**

## **Fuel Temperature Sensor (FTS)**

### **Description**

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.

### **Specification**

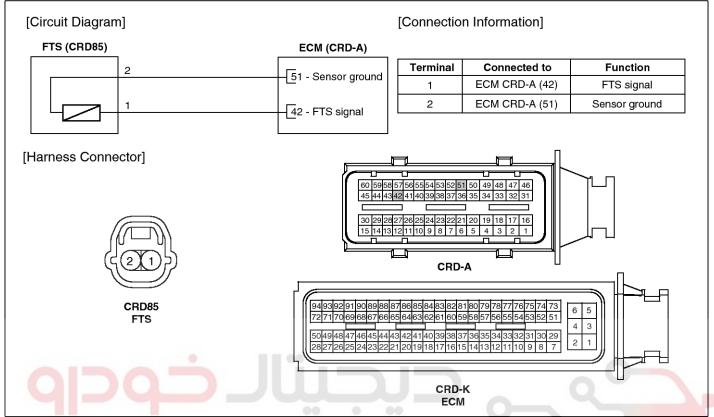
Temperature [°C(°F)]	Resistance( <sup>kΩ</sup> )
-10(14)	9.45
20(68)	2.27 ~ 2.73
80(176)	0.30 ~ 0.32
120(248)	0.11





FL-111

### **Circuit Diagram**



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" section.

SLMFL0410L

# **Fuel System**

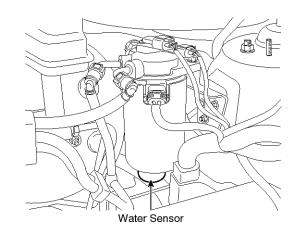
### **Water Sensor**

### **Description**

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.

#### **MNOTICE**

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



SLMFL0210L

### **Specification**

CRD-K ECM

Item	Specification
Warning Level (cc)	40 ~ 60

**Circuit Diagram** [Circuit Diagram] [Connection Information] Water Sensor ECM(CRD-K) (CRD78) Terminal Connected to **Function** Main Relay Power Supply (B+) Sensor Signal ECM CRD-K (88) 88 - Water Sensor Signal Sensor Ground Chassis Ground [Harness Connector] CRD-A CRD78 Water Senosr

SLMFL0411L

**FL-113** 

#### Lambda Sensor

### **Description**

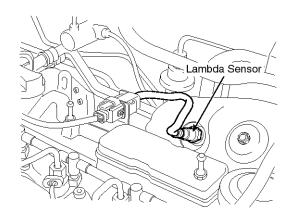
Lambda Sensor is installed on exhaust manifold and is a linear oxygen sensor. It senses oxygen density of exhaust gas in order to control EGR accurately through fuel correction and also limits smoke which is generated by reach air-fuel mixture at high engine load condition. ECM controls pumping current in order to fit  $\lambda$ -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.</li>
- Rich air-fuel mixture( $0.9 < \lambda < 1.0$ ): ECM takes away pumping current from lambda sensor (-pumping current) and deactivates it for lambda sensor to have the characteristic at  $\lambda$  =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 ( $450\,^{\circ}\mathrm{C} \sim 600\,^{\circ}\mathrm{C}$ ) 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.

#### **A**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.



SCMFL0140L

# Specification [Pumping Current]

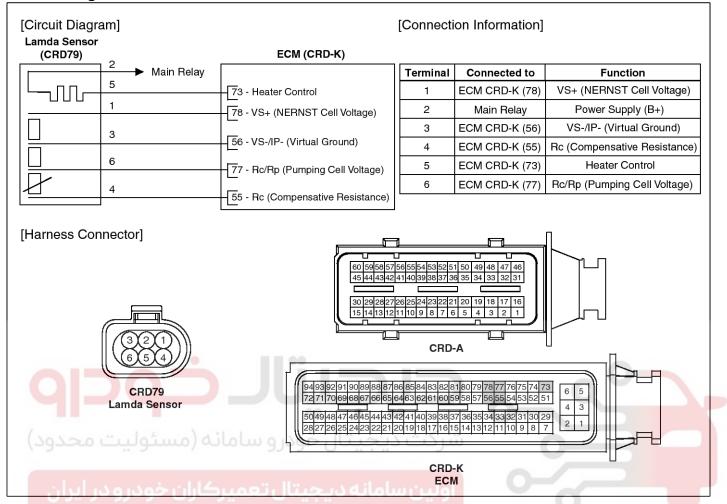
λ Value (A/F Ratio)	Pumping Current (A)
0.65	-2.22
0.7	-1.82
0.8	-1.11
0.9 مرکت دیا	-0.50
1.01	0
<mark>1.18 ولين سا</mark>	0.33
1.43	0.67
1.7	0.94
2.42	1.38
Air (Atmosphere)	2.54

#### [Heater Resistance]

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

# **Fuel System**

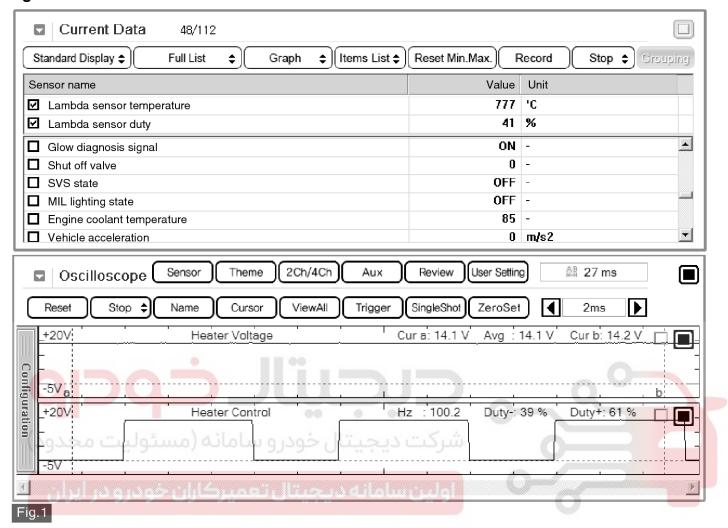
### **Circuit Diagram**



SLMFL0412L

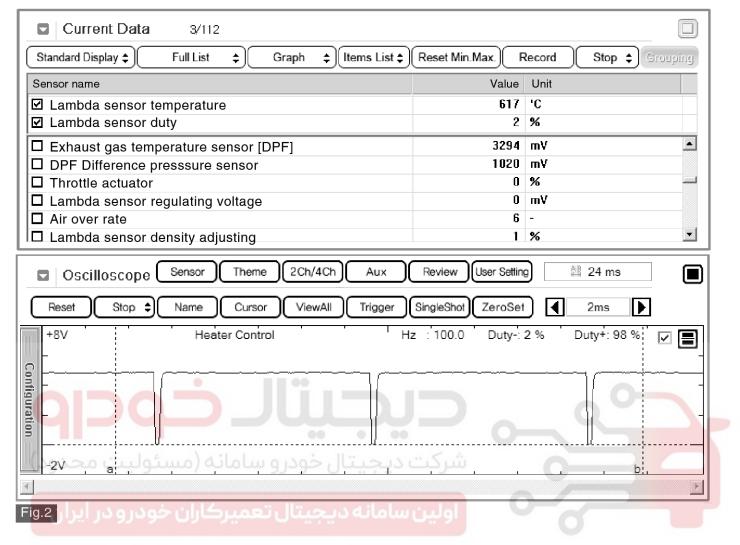
**FL-115** 

### **Signal Waveform**



SXMFL0300L

# **Fuel System**



SXMFL0301L

Fig.1) Waveform of Lambda sensor heater power.

It is battery voltage and Lambda sensor heater control at idle

Fig.2) Error waveform when disconnecting the Key ON connector.

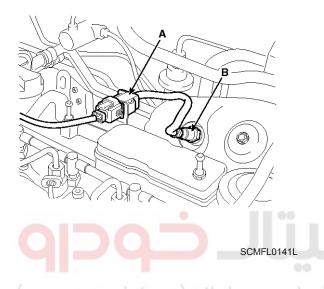
**FL-117** 

#### Removal

- 1. Turn the ignition switch OFF and disconnect the battery (-) cable.
- 2. Disconnect the lambda sensor connector (A).
- 3. Remove the lambda sensor (B).

#### MNOTICE

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



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#### Installation

#### **ACAUTION**

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

### **ACAUTION**

- DON'T use a cleaner, spray, or grease to sensing element and connector of the sensor because oil component in them may malfunction the sensor performance.
- Sensor and its wiring may be damaged in case of contacting with the exhaust system (Exhaust Manifold, Catalytic Converter, and so on).
- 1. Installation is reverse of removal.

#### Lambda sensor installation:

 $40.2 \sim 59.8 \text{ N.m} (4.1 \sim 6.1 \text{ kgf.m}, 29.7 \sim 44.1 \text{ lb-ft})$ 

# **Fuel System**

### Replacement

#### **ACAUTION**

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 the GDS 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 "Lambda Sensor Change".
- 8. Perform the procedure in accordance with the message.



SFDF29240E

FL-119



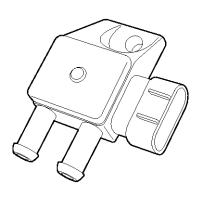
# **Fuel System**

### **DPF 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.

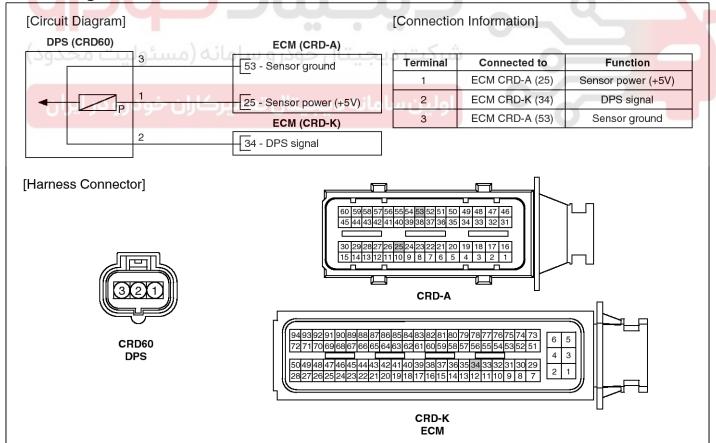


SXMFL9182D

### **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



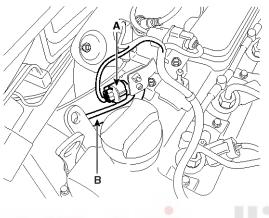


SLMFL0433L

FL-121

#### Removal

- 1. Turn the ignition switch OFF and disconnect the battery (-) cable.
- 2. Disconnect the DPF differential pressure sensor connector (A).
- 3. Disconnect the DPF hoses (B).
- 4. Remove the DPF differential pressure sensor after removing the installation bolts.



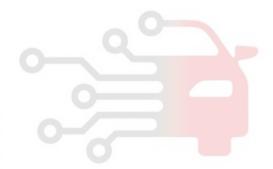
#### Installation

#### CAUTION

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

DPF differential pressure sensor installation bolt: 9.8  $\sim$  11.8 N.m (1.0  $\sim$  1.2 kgf.m, 7.2  $\sim$  8.7 lb-ft)





# **Fuel System**

### Replacement

#### **ACAUTION**

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 the GDS 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

**FL-123** 



# **Fuel System**

### **Exhaust Gas Temperature Sensor**

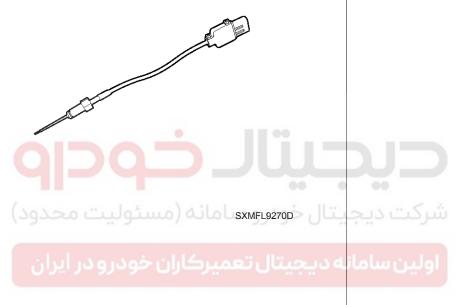
### **Description**

Exhaust Gas Temperature Sensor (EGTS) is installed on Diesel Particulate Filter (DPF) assembly and senses the temperature of exhaust gas flowing into the DPF and VGT turbocharger.

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

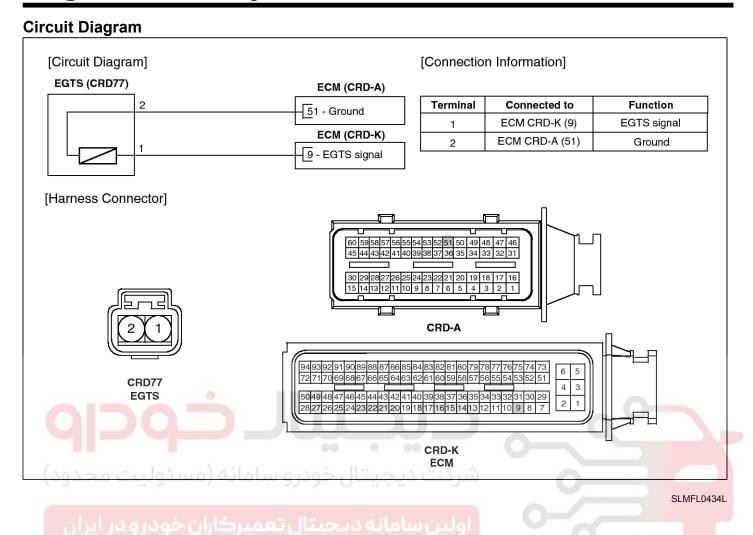
### **Specification**

Temperature [°C(°F)]	Resistance( <sup>kΩ</sup> )
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





FL-125



# **Fuel System**

### 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

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

### Installation

#### **ACAUTION**

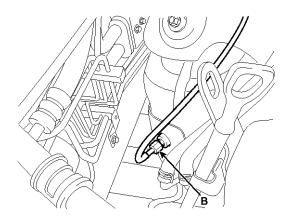
- · Install the component with the specified torques.
- Note that internal damage may occur when the component is dropped. In this case, use it after inspecting.
- 1. Installation is reverse of removal.

Exhaust gas temperature sensor installation:  $39.2 \sim 49.1$  N.m  $(4.0 \sim 5.0$  kgf.m,  $28.9 \sim 36.2$  lb-ft)





3. Remove the exhaust gas temperature sensor (B).



SLMFL0181D

**FL-127** 

### **Fuel Pressure Regulator Valve**

### **Description**

The Fuel Pressure Regulator Valve and the Rail Pressure Regulator Valve are installed on high pressure pump and common rail 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.

### **Specification**

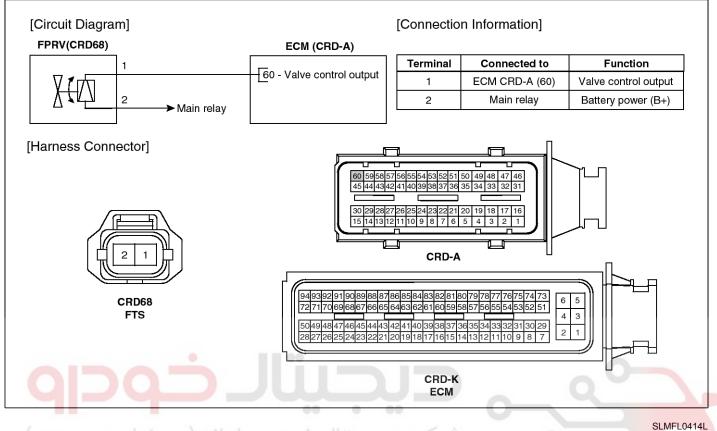
Item	Specification
Coil Resistance (Ω)	2.6 ~ 3.15 (20°C)
Current (A) [Min. fuel injection]	1.8





# **Fuel System**



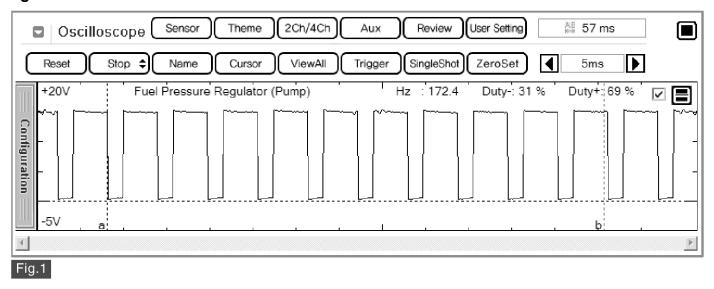


شرکت دیجیتال خودرو سامانه (مسئولیت محدود)

ولین سامانه دیجیتال تعمیرکاران خودرو در ایران

FL-129

### **Signal Waveform**



SXMFL0302L 2Ch/4Ch User Setting Sensor Theme Aux Review 
 3
 57 ms
 Oscilloscope Reset Stop \$ Name Cursor ViewAll Trigger SingleShot ZeroSet 5ms Duty-: 38 % +20V Fuel Pressure Regulator (Pump) Duty+: 62 % Hz V Configuration -5V 4 Fig.2

Fig.1) Waveform of Fuel pressure regulator valve at idle.

Fig.2) Waveform of Fuel pressure regulator valve at acceleration.

#### 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" section.

SXMFL0303L

# **Fuel System**

### **Rail Pressure Regulator Valve**

### **Description**

The Fuel Pressure Regulator Valve and the Rail Pressure Regulator Valve are installed on high pressure pump and common rail 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.

### **Specification**

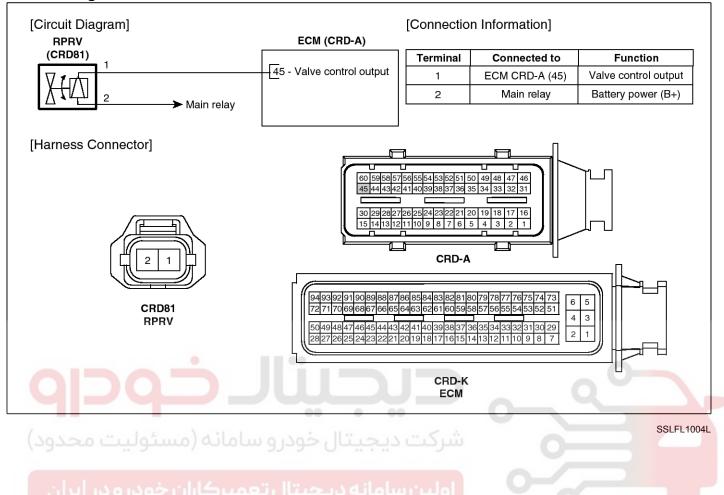
Items	Specification
Coil Resistance (Ω)	3.42 ~ 3.78 (20°C)
Operating Current (A)	0.15 ~ 1.8





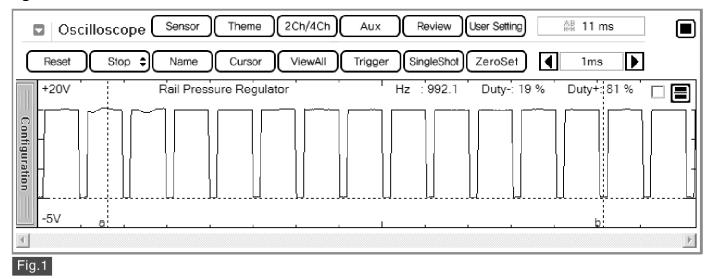
**FL-131** 



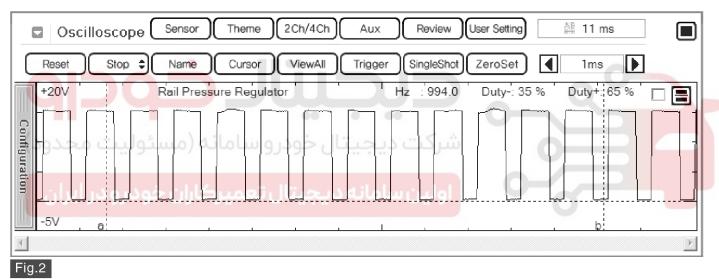


# **Fuel System**

### **Signal Waveform**



SXMFL0304L



SXMFL0305L

Fig.1) Waveform of rail pressure regulator valve at idle. Fig.2) Waveform of rail pressure regulator valve at acceleration.

#### Inspection

- 1. Turn ignition switch OFF.
- 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" section.

**FL-133** 

### **EGR Cooler Bypass Solenoid Valve**

### **Description**

EGR cooler bypass vacuum valve is installed at low side of EGR cooler assembly.

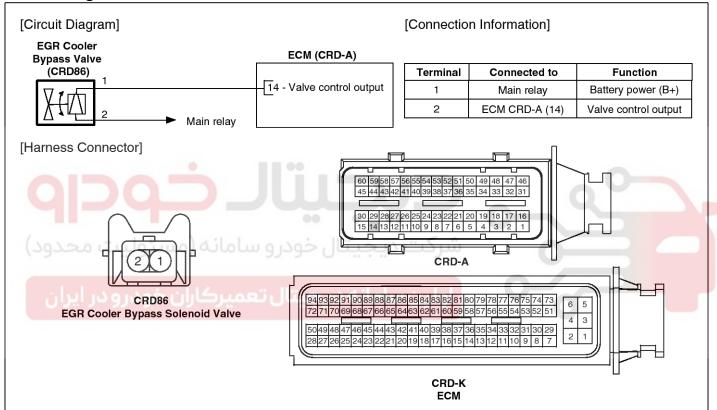
EGR cooler bypass solenoid valve controls the path to provide EGR gas to intake manifold directly in case of cold starting that engine coolant temperature is low.

This system improves engine starting performance and exhaust gas reduction.

### **Specification**

Items	Specification
Coil Resistance (Ω)	28.3 ~ 31.1 (20°C)

### **Circuit Diagram**



SSLFL1005L

# **Fuel System**

### Inspection

- 1. Turn the ignition switch OFF.
- 2. Disconnect the EGR cooler bypass solenoid valve connector.
- 3. Measure resistance between the valve terminals 1 and 2.
- 4. Check that the resistance is within the specification.

Specification: Refer to "Specification" section.

#### Removal

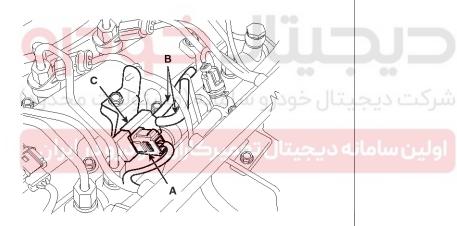
- 1. Turn the ignition switch OFF and disconnect the battery (-) cable.
- 2. Disconnect the EGR cooler bypass solenoid valve connector (A).
- 3. Disconnect the vacuum hose (B) from the EGR cooler bypass solenoid valve.
- 4. Remove the valve (C) after removing the installation bolt.

#### Installation

#### CAUTION

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

EGR cooler bypass solenoid valve installation bolt:  $7.8 \sim 11.8 \text{ N.m} \ (0.8 \sim 1.2 \text{kgf.m}, 5.8 \sim 8.7 \text{ lb-ft})$ 





**FL-135** 

### **Air Control Valve (ACV)**

#### **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 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:

- 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 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 to reduce the intake air quantity. The intake air pressure thus is lower than the exhaust gas pressure.
- 3. Exhaust gas temperature control for DPF regeneration: When the Diesel Particulate Filter (DPF) is need to regenerate, the ECM partially closes the throttle valve 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 DPF.

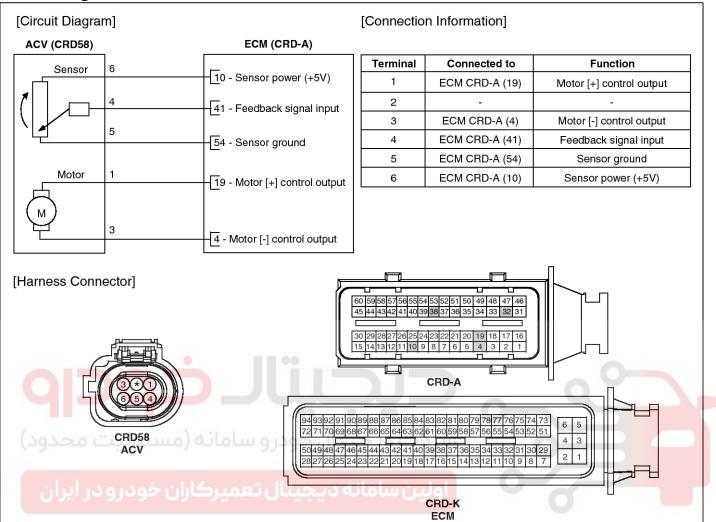
### Specification

4	Output Voltage (V)	Valve Position
	0.5	Full open
2	0.54 ~ 0.89	Motor power is not supplied
	0.925 ~ 4.425	Normal operation position
6	4.5	Full close



# **Fuel System**

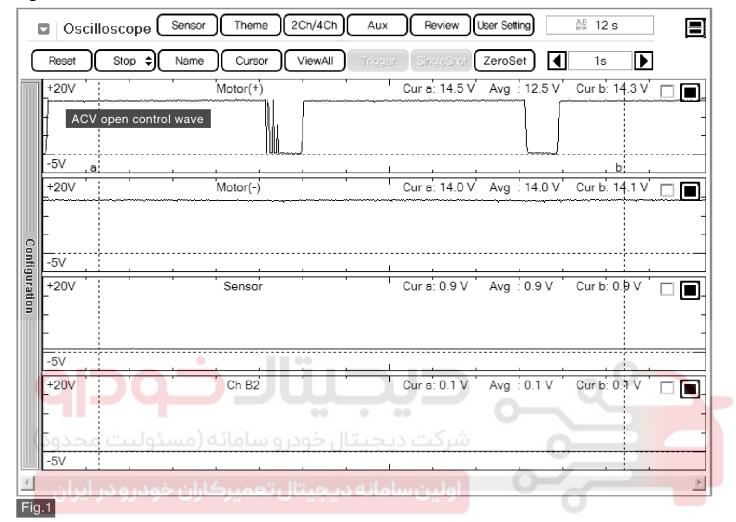
### **Circuit Diagram**



SLMFL0417L

**FL-137** 

### **Signal Waveform**



SXMFL0320L

# **Fuel System**

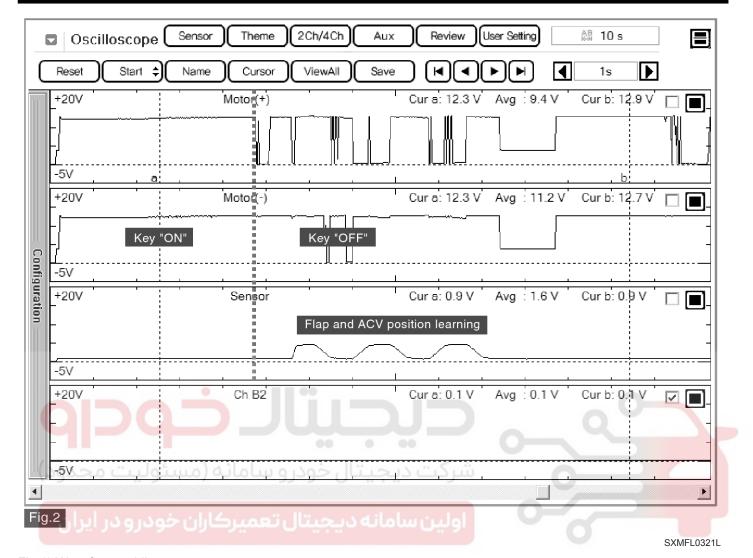


Fig.1) Waveform at idle

Fig.2) Waveform at Key 'ON'→'OFF'

**FL-139** 

#### Inspection

- 1. Turn ignition switch OFF.
- 2. Disconnect the air control valve connector.
- 3. Check that the air control 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.

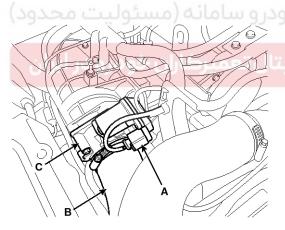
**Specification:** Refer to "Specification" section.

- 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" section.

#### Removal

- 1. Turn the ignition switch OFF and disconnect the battery (-) cable.
- 2. Disconnect the air control valve connector (A).
- 3. Disconnect the air intake hose (B) after removing the clamp from the air control valve.
- 4. Remove the valve (C) after removing the installation 3 bolt/1 nut.



SXMFL9222D

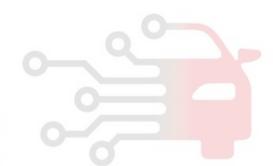
#### Installation

#### **ACAUTION**

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

Air control valve installation bolt:

 $8.8 \sim 10.8 \text{ N.m} (0.9 \sim 1.1 \text{kgf.m}, 6.5 \sim 8.0 \text{ lb-ft})$ 



# **Fuel System**

### Replacement

#### **ACAUTION**

After replacing the Air Contorol 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 the GDS 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 "Throttle Valve (ACV) Change".
- 8. Perform the procedure in accordance with the message.



SCMFL0251L

## FL-141



# **Fuel System**

### **Electric EGR Control Valve**

### **Description**

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.

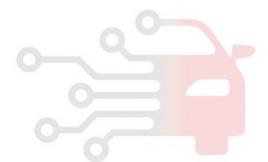
# Specification [Motor]

Item	Specification
Coil Resistance (Ω)	2.3 ~ 2.7 (20°C)

#### [Position Sensor]

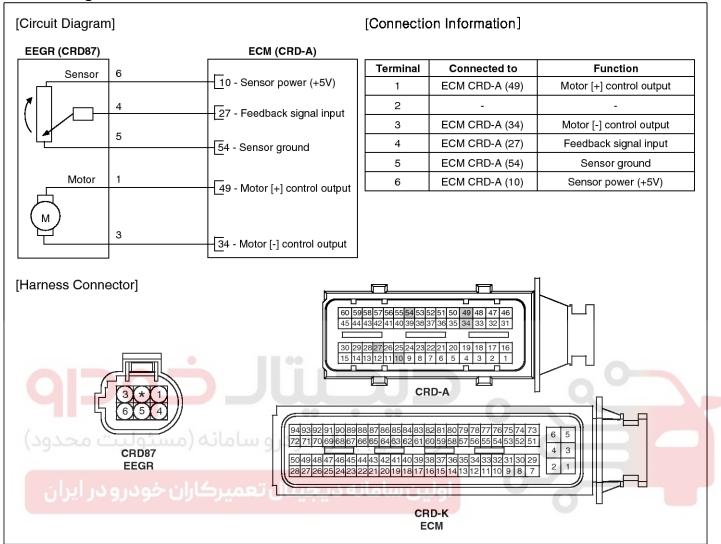
Item	Specification
Voltage (V) [Open-6mm]	0.6 ~ 1.3
Voltage (V) [Close]	3.6 ~ 4.3





FL-143

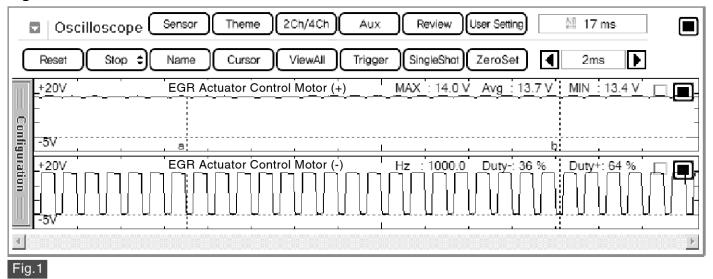
### **Circuit Diagram**



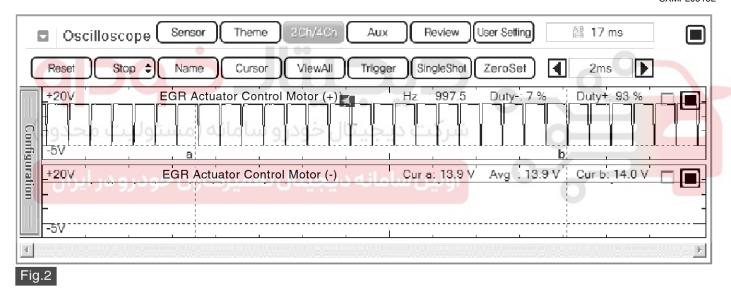
SLMFL0418L

# **Fuel System**

### Signal Waveform



SXMFL0318L



SXMFL0319L

Fig.1) Duty control [EEGR Motor (-)] at deceleration or idle

Fig.2) Duty control [EEGR Motor (+)] at acceleration

FL-145

#### Inspection

- 1. Turn ignition switch OFF.
- 2. Disconnect the EEGR valve connector.
- 3. Check that the EEGR 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.

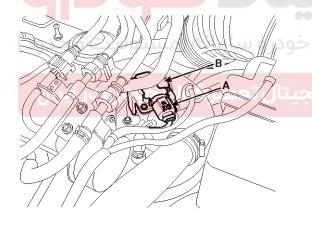
**Specification:** Refer to "Specification" section.

- 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" section.

#### Removal

- 1. Turn the ignition switch OFF and disconnect the battery (-) cable.
- 2. Disconnect the EEGR valve connector (A).
- 3. Remove the EEGR valve (B) after removing the installation bolts.



SXMFL9223D

#### Installation

#### **ACAUTION**

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

**Electric EGR control valve installation bolt:** 

 $7.8 \sim 11.8 \text{ N.m} (0.8 \sim 1.2 \text{kgf.m}, 5.8 \sim 8.7 \text{ lb-ft})$ 





# **Fuel System**

### Replacement

#### **ACAUTION**

After replacing the Electric EGR control 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 the GDS 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 " EGR Valve Change".
- 8. Perform the procedure in accordance with the message.



SCMFL0253L

# FL-147



# **Fuel System**

## Variable Swirl Actuator

## **Description**

The Variable Swirl Actuator is installed in between the two intake manifolds 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.

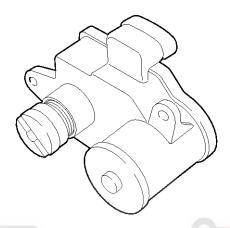
[At High Speed or High Load] Swirl valve opening  $\rightarrow$  Swirl amount decreasing  $\rightarrow$  Swirl effect increasing  $\rightarrow$  Pumping loss decreasing  $\rightarrow$  Engine power increasing

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

→ EGR amount enlarging → Emission reducing

## **ACAUTION**

After replacing the Variable Swirl 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.



SXMFL9211D

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	ین ساماله دیده <sub>Little</sub>	Much
Effect	Swirl effect increasing → Pumping loss decreasing → Engine power increasing	Air/Fuel mixture increasing → EGR amount enlarging → Emission reducing
Description illustration	KGNF302B	KGNF302A
Fail-safe	Fully opened	

### MOTICE

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.

FL-149

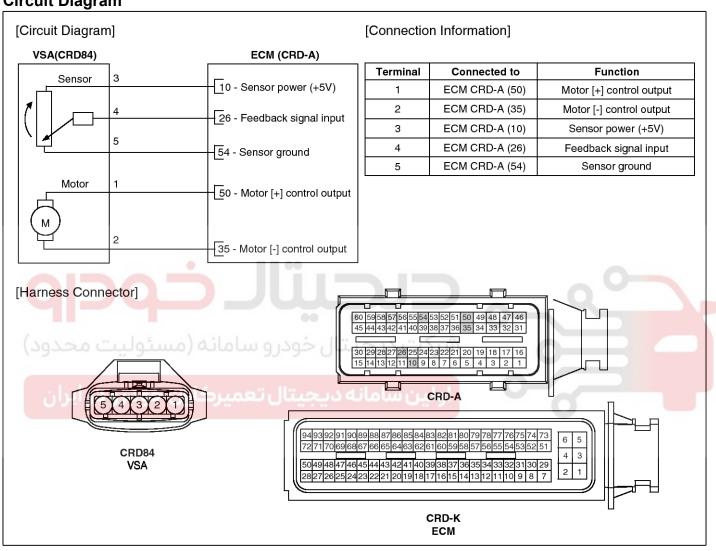
## **Specification** [Motor]

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

## [Position Sensor]

Item	Specification
Coil Resistance ( <sup>kΩ</sup> )	3.44 ~ 5.16 [20°C(68°F)]
Output Voltage (V)	0.17 ~ 4.83

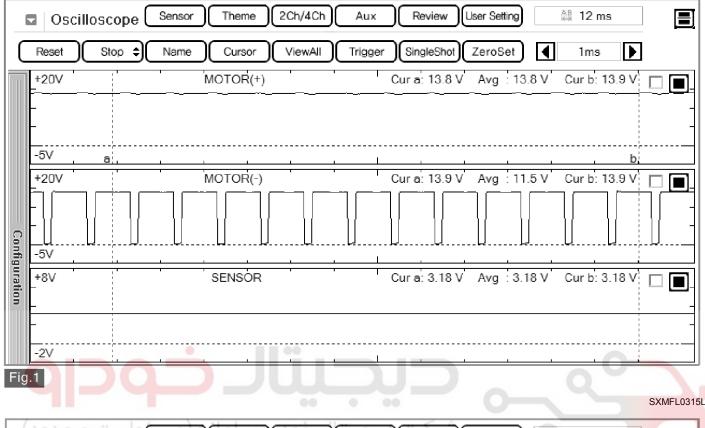
# Circuit Diagram

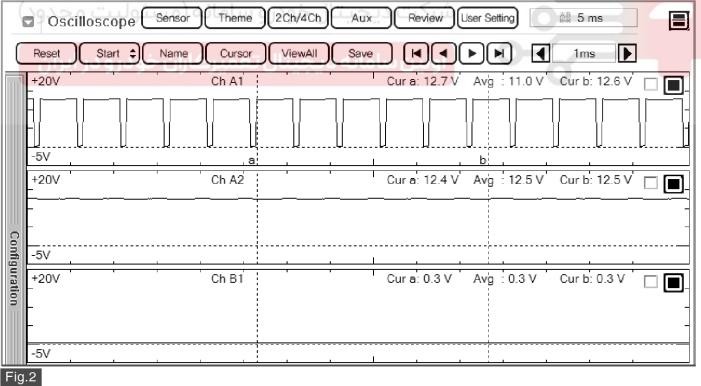


SLMFL0419L

# **Fuel System**

## **Signal Waveform**





SXMFL0316L

Fig.1)Variable swirl actuator close control waveform

Fig.2) Variable swirl actuator open control waveform

FL-151

## Inspection

- 1. Turn ignition switch OFF.
- 2. Disconnect the variable swirl actuator connector.
- 3. Check that the variable swirl actuator 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.

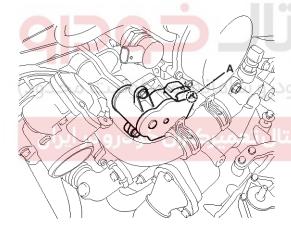
**Specification:** Refer to "Specification" section.

- 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" section.

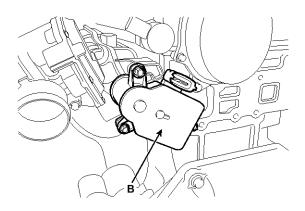
#### Removal

- 1. Turn the ignition switch OFF and disconnect the battery (-) cable.
- 2. Disconnect the variable swirl actuator connector (A).



SXMFL9220D

3. Remove the variable swirl actuator (B) after removing the installation bolts.



SXMFI 9221D

### Installation

## **ACAUTION**

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

Variable swirl actuator installation bolt:  $9.8 \sim 11.8 \text{ N.m}$  (1.0  $\sim$  1.2 kgf.m, 7.2  $\sim$  8.7 lb-ft)

# **Fuel System**

## Replacement

### **ACAUTION**

After replacing the Variable Swirl 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 the GDS 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 "Swirl Control Valve Change".
- 8. Perform the procedure in accordance with the message.



SFDF29235E

FL-153



# **Fuel System**

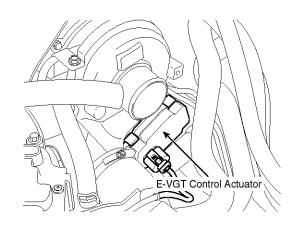
## **Electric VGT Control Actuator**

## Description

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.

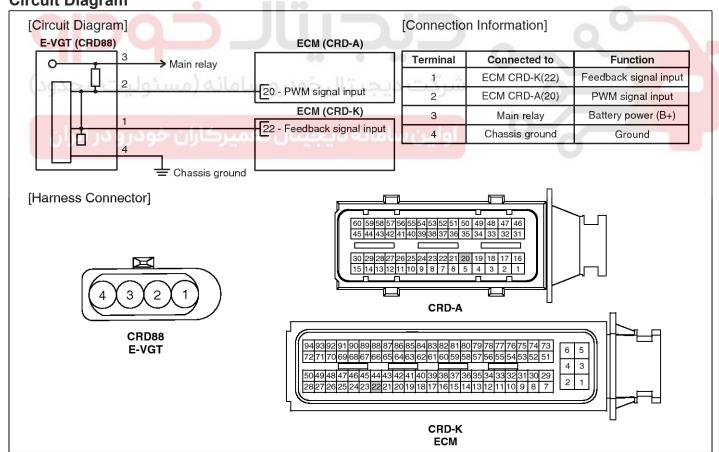
## **A**CAUTION

Electric VGT control actuator is not replacing part. It must be replaced with the turbocharger assembly.



SLMFL0230L

**Circuit Diagram** 

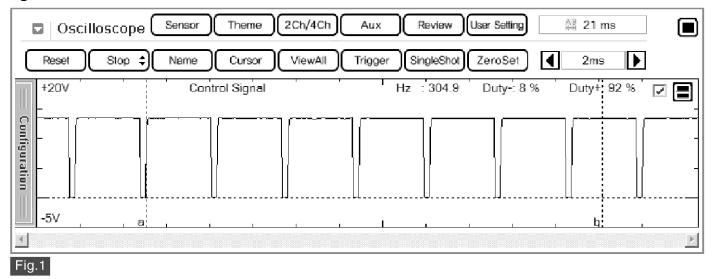


SLMFL0420L

**FL-155** 

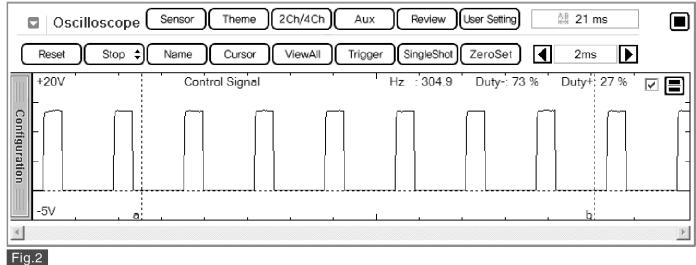
SXMFL0322L

## Signal Waveform



Current Data

Standard Display \$ Reset Min.Max. Record VSS Full List Text Stop Max: 44 VGT actuator 27 % 0 Min: 26 Max: 3224 6000 Engine speed 3200 RPM Min: 753



SXMFL0323L

Fig.1) Operation duty of the E-VGT actuator at idle

Fig.2) Operation duty of the E-VGT actuator at 3,200 rpm

# **Fuel System**

## **DPF** (Diesel Particulate Filter)

## **Description**

The Diesel Particulate Filter (DPF) 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 DPF, the PM is gathered in the DPF and the others (CO2, NO, etc.) are discharged to the atmosphere via muffler. This gathered PM in DPF is called "soot".

## [DPF Regeneration]

If there are much soot in the DPF, the DPF 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 DPF 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  $600\,^{\circ}$ C). At this time, the soot are burn and its ash remains in the DPF as a result of the combustion.

### [Regeneration Mode]

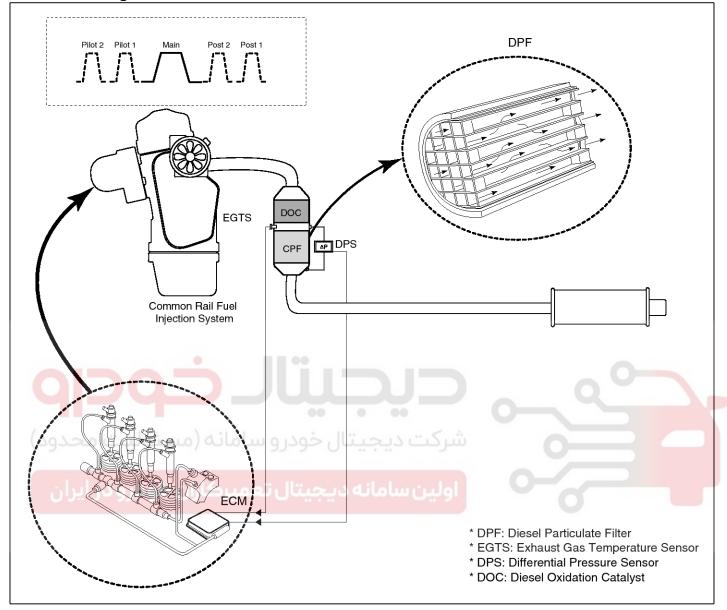
- 1. Mileage > 1,000km
- 2. Engine Speed: 1,000 ~ 4,000rpm
- 3. Engine Load = About 0.7bar [8mg/st]
- 4. Vehicle Speed > 5km/h
- 5. Engine Coolant Temperature > 40 °C



SXMFL9217D

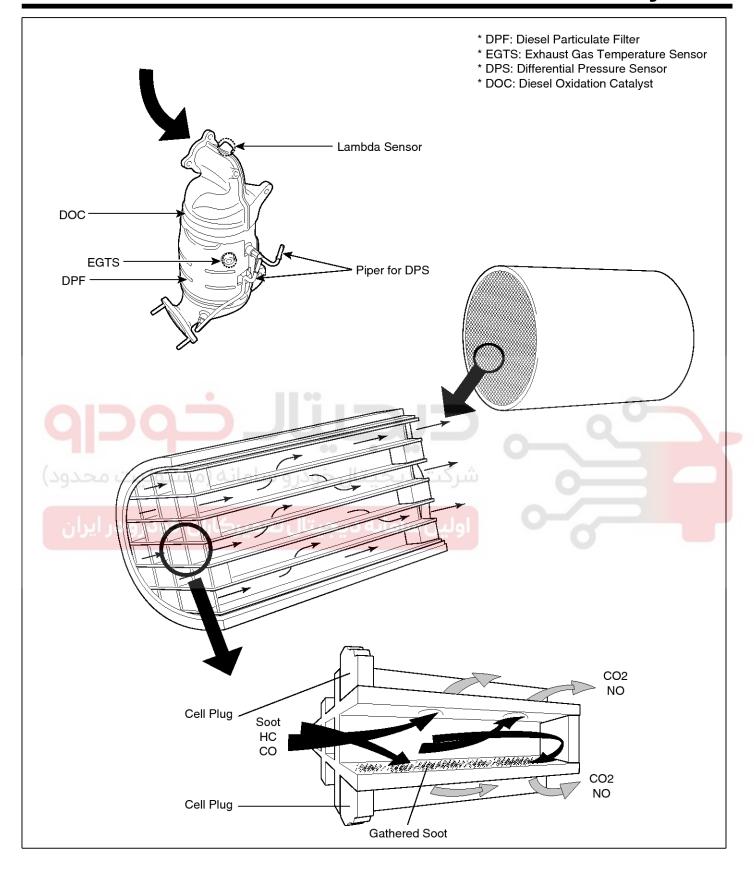
FL-157

## **Schematic Diagram**



SXMFL0218L

# Fuel System



SXMFL0219L

**FL-159** 

## **DPF Regeneration**

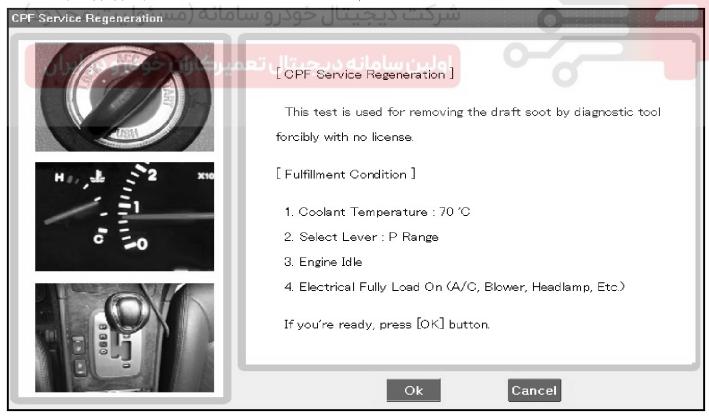
This procedures is to forcibly regenerate the DPF with the GDS when the DPF doesn't have been regenerated during driving. For example, if the vehicle has repeated "Low speed driving" or "Short distance driving", "Frequent idle driving", the DPF regeneration procedure cannot be proceeded because "Regeneration 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.)
- · Engine hood open
- Quantity of soot is 25g below. (ECU indicated)
- MOTICE

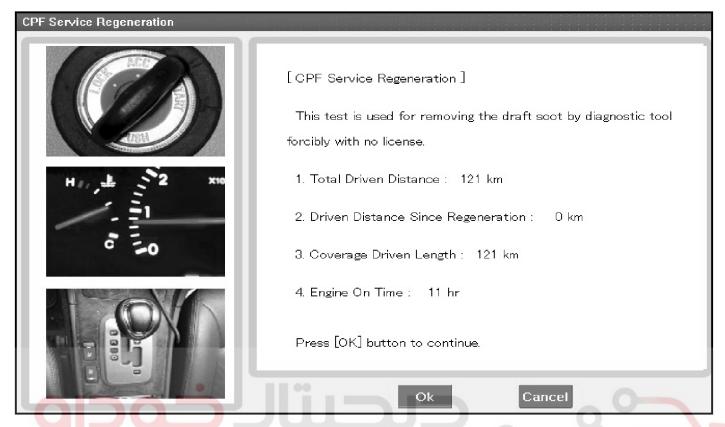
The air conditioner's electrical load is very high. Accordingly, to make regeneration mode more quickly, turn it ON (If eqquipped).

- 1. Turn ignition switch OFF.
- 2. Connect the GDS to Data Link Connector (DLC).
- 3. Start engine at idle and P-range (A/T) or neutral (M/T).
- 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 "DPF Service Regeneration".
- 8. Perform the test in accordance with the message.

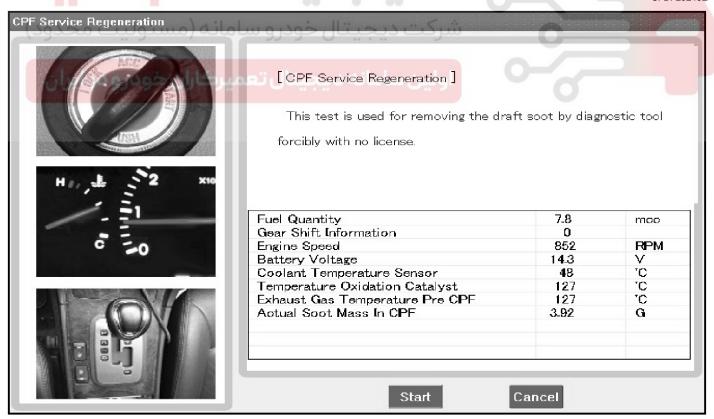


SEDE29247E

# **Fuel System**

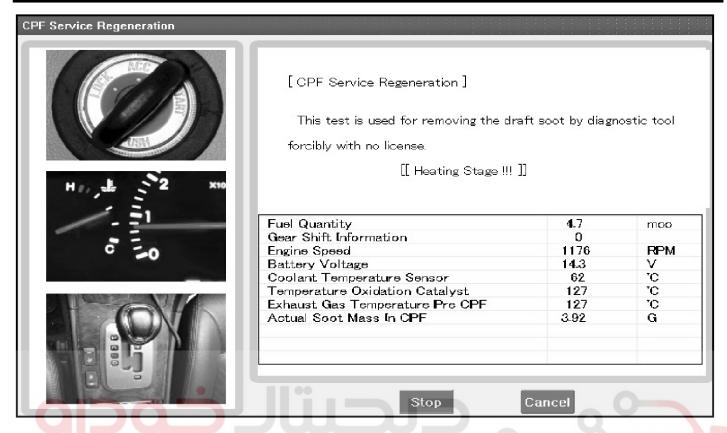


SFDF29248E



SFDF29249E

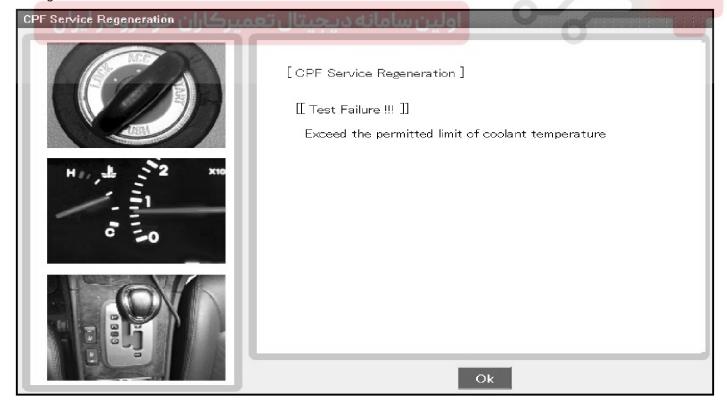
**FL-161** 



SFDF29250E

### MOTICE

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



# **Fuel System**

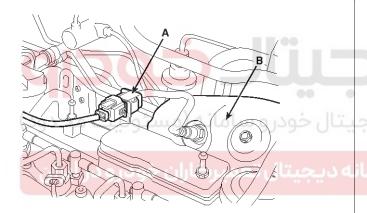
SFDF29251E

### Removal

## **ACAUTION**

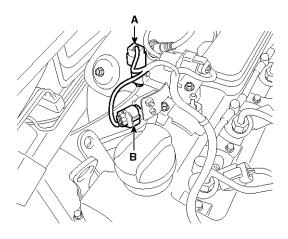
Must check damage of the DPF assembly before removing the DPF assembly.

- Remove the exhaust pipe of the DPF end side.
   Check damage or decoloration(white) of the rear section of the DPF.
- Check existence of the soot of the rear section of the DPF.
  - DPS assembly has some trouble if you find black soot.
- Turn ignition switch OFF and disconnect the negative (-) battery cable.
- 2. Remove the heater protector (B) after disconnecting the Lambda sensor connector (A).



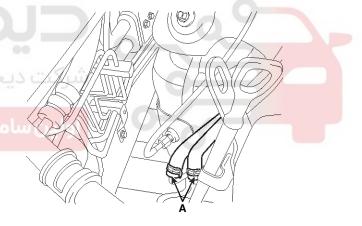
SCMFL0142L

3. Disconnect the exhaust gas temperature sensor connector (A) and the DPF differential pressure sensor connector (B).



SLMFL0173D

4. Disconnect the hoses (A) connected with the differential pressure sensor from the DPF assembly.



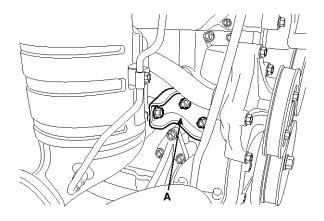
SLMFL0182D

## **ACAUTION**

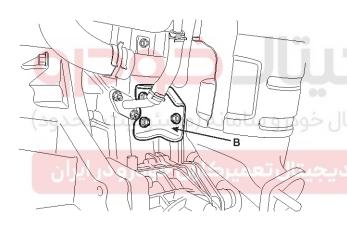
Be careful not to change front and rear of the hoses when removing and installing.

# **FL-163**

- 5. Remove the front muffler assembly installation nut after lifting the vehicle. (Refer to "Muffler" in EM group.)
- 6. Remove the DPF assembly stay (A,B).



SXMFL9188D



SXMFL9189D

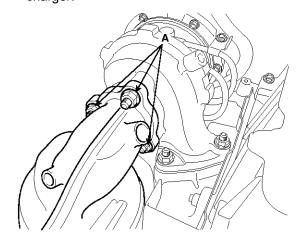
DPF assembly stay installation bolt:

44.1  $\sim$  54.0 N.m (4.5  $\sim$  5.5 kgf.m, 32.6  $\sim$  39.8 lb-ft)

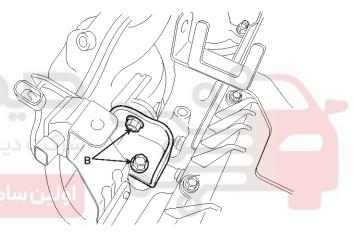
Front muffler assembly installation nut:

 $39.2 \sim 58.8 \text{ N.m} (4.0 \sim 6.4 \text{kgf.m}, 28.9 \sim 43.4 \text{ lb-ft})$ 

7. Remove the DPF assembly after removing the installation nuts (A) and bolts (B) from the turbo charger.



SXMFL9190D



SXMFL9191D

**DPF** assembly installation bolt:

44.1  $\sim$  54.0 N.m (4.5  $\sim$  5.5 kgf.m, 32.6  $\sim$  39.8 lb-ft)

DPF assembly installation nut:

49.1  $^{\sim}$  68.7 N.m (5.0  $^{\sim}$  7.0 kgf.m, 36.2  $^{\sim}$  50.6 lb-ft)

### Installation

1. Installation is reverse of removal.

### CAUTION

- Be careful not to insert foreign substances to the pipes and the DPF assembly.
- DPF assembly may be damaged or permanent/excessive regeneration is occurred if foreign substances are inserted to the DPF assembly or the pipes.
- Install the component with the specified torques.

# **Fuel System**

## Replacement

### MOTICE

After replacing the DPF 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 the GDS 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 "DPF Change".
- 8. Perform the procedure in accordance with the message.



SFDF29252E

FL-165

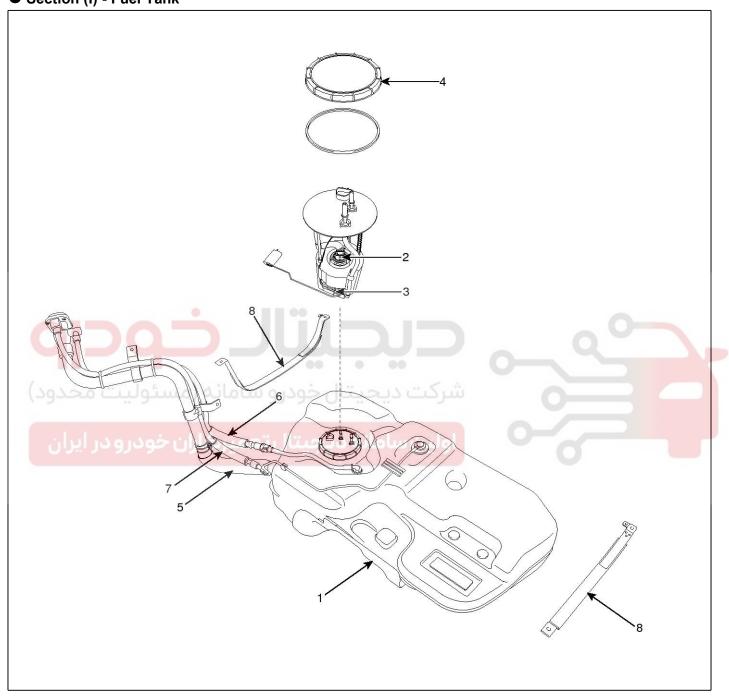


# **Fuel System**

# **Fuel Delivery System**

## **Component Location**

● Section (I) - Fuel Tank



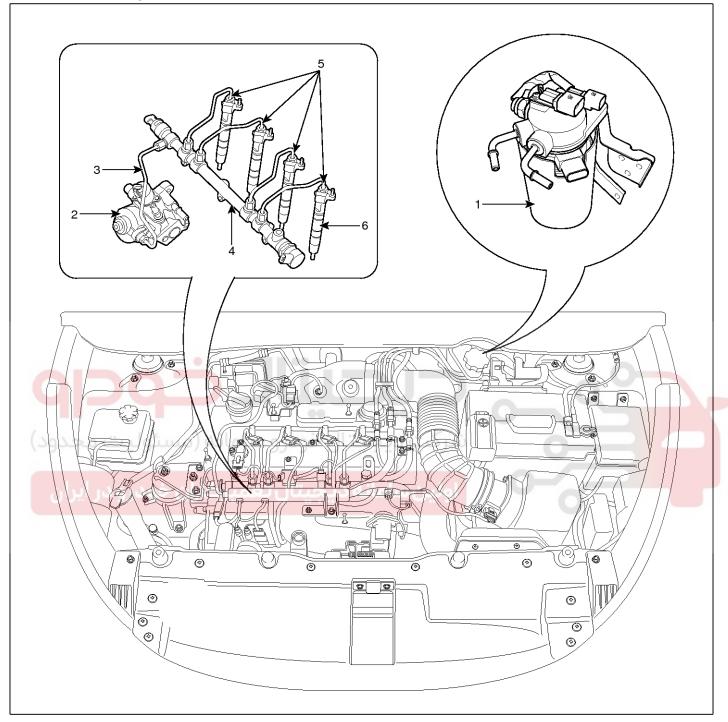
SLMFL0120D

- 1. Fuel Tank
- 2. Fuel Pump (Low Pressure)
- 3. Fuel Sender
- 4. Fuel Pump Plate Cover

- 5. Fuel Filler Pipe
- 6. Leveling hose
- 7. Ventilation hose
- 8. Fuel Tank Band

**FL-167** 

## Section (II) - Engine Room

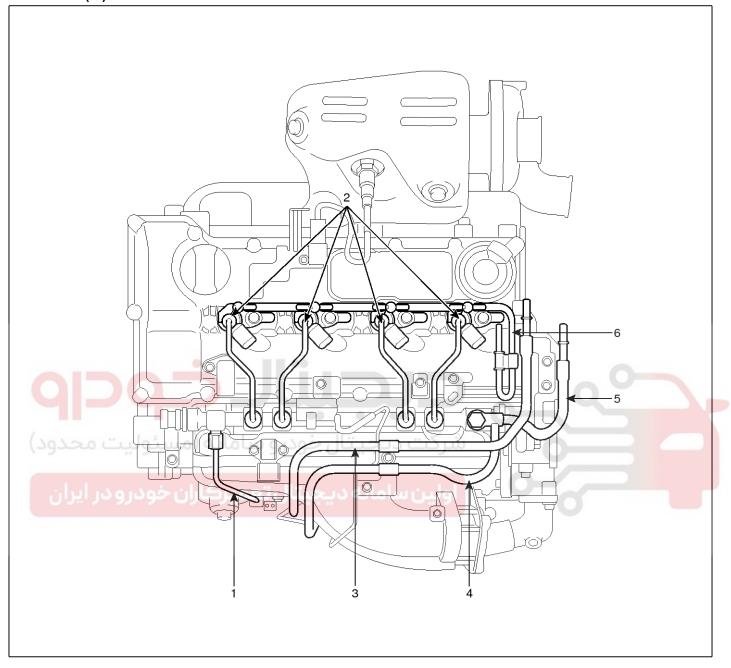


SLMFL0431D

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

# **Fuel System**

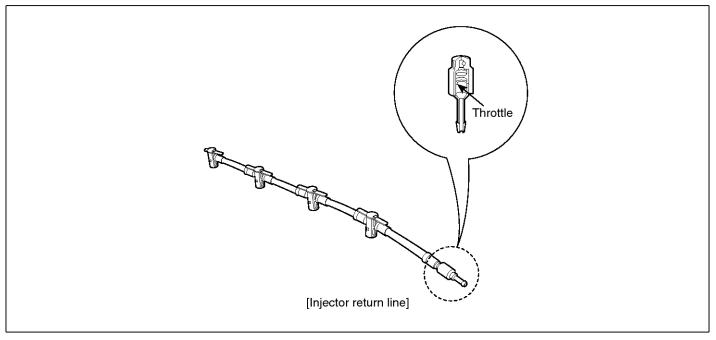
## Section (III) - Fuel Line



SXMFL9227D

- 1. High Pressure Fuel Pipe (High Pressure Fuel Pump  $\leftrightarrow$  Common Rail)
- 2. High Pressure Fuel Pipe (Common Rail ↔ Injector)
- 3. Fuel Feed Tube (Fuel Filter ↔ High Pressure Fuel Pump)
- 4. Fuel Return Tube (High Pressure Fuel Pump ↔ Fuel Tank)
- 5. Fuel Return Tube (Common Rail ↔ Fuel Tank)
- 6. Fuel Return Tube (Injector ↔ Fuel Filter)

## **FL-169**



SXMFL0228L

#### MOTICE

The throttle regulates the back pressure of injector return line so as to maintain the internal pressure of the hydraulic coupler.

#### **WARNING**

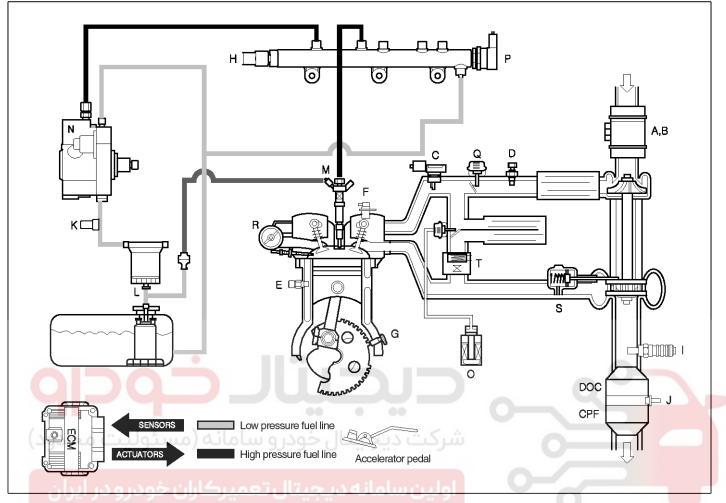
As the Piezo-Injector operates under maximum DC 200V, there may be a risk of an electric shock caused by shorted control line etc. So when repairing the injector or its wiring, disconnect the battery negative (-) terminal from the battery and wait for about 30 seconds.

### **ACAUTION**

- Common Rail Fuel Injection System operates with extremely high pressure (approximately 1,800bar), 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 gasket with a new one.
  - To protect damage caused by shock, vertically insert the injector into the cylinder head.
  - Clean the connecting surface of the injector gasket on the cylinder head before installing the injector.
- When installing High Pressure Fuel Pipe
  - Do not use again the used high pressure fuel pipe.
  - Install the flange nut correctly.

# **Fuel System**

## **Common Rail Fuel Injection System (CRDI)**



SXMFL0229L

- 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. Exhaust Gas Temperature Sensor (EGTS)

- K. Fuel Temperature Sensor (FTS)
- L. Water Sensor
- M. Injector
- N. Fuel Pressure Regulator Valve
- O. EGR cooler bypss solenoid valve
- P. Rail Pressure Regulator Valve
- Q. Air Control Valve
- R. Variable Swirl Actuator
- S. Electric VGT Control Actuator
- T. Electric EGR Control Valve

FL-171

#### 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 1,800 bar and delivers the compressed fuel to the common rail.

#### **Common Rail**

The common rail is 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. 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.

#### 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.

# Bleeding air procedure in low pressure fuel circuit

After removing or replacing the part below, bleed air in low pressure fuel circuit.

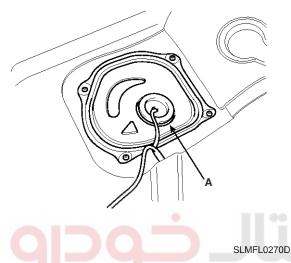
- Fuel Tank
- Fuel Sender
- Fuel Filter
- High Pressure Fuel Pump
- Low Pressure Fuel Lines
- 1. Turn ignition switch OFF.
- 2. Connect the GDS to Data Link Connector (DLC).
- 3. Turn ignition switch ON.
- 4. Select "Vehicle, Model year, Engine, System".
- 5. Select "Vehicle S/W Management".
- 6. Select "Fuel line Air removal".
- 7. Perform the procedure in accordance with the message.

# **Fuel System**

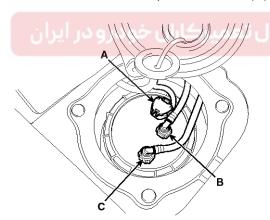
## **Fuel Tank**

### Removal

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

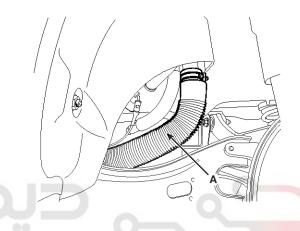


- 4. Disconnect the fuel pump connector (A).
- 5. Disconnect the fuel feed tube quick-connector (B) and the fuel return tube quick-connector (C).



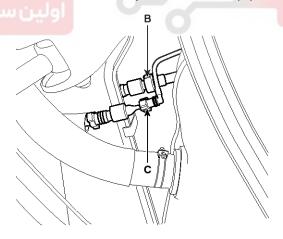
SLMFL0280D

- 6. Lift the vehicle.
- 7. Remove the rear LH wheel & tire.
- 8. Remove the muffler assembly (Refer to "Intake and exhaust system" in EM group).
- 9. Remove the propeller shaft [4WD only] (Refer to "Propeller shaft" in DS group).
- 10. Support the fuel tank with a jack.
- 11. Disconnect the fuel filler hose (A).



SLMFL0330D

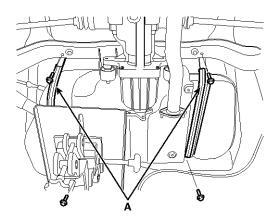
12. Disconnect the leveling tube quick-connector (B) and the ventilation hose quick - connector (C).



SLMFL0290D

**FL-173** 

13. Remove the installation 4bolts and band (A), and then remove the fuel tank from the vehicle.



SLMFL0310D

### Installation

1. Installation is reverse of removal.

Fuel tank band installation nuts:

 $39.2 \sim 54.0$  N.m (4.0  $\sim 5.5$  kgf.m,  $28.9 \sim 39.8$  lb-ft)



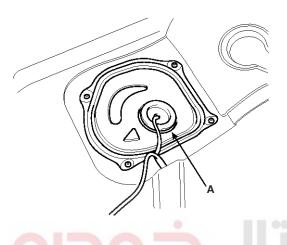


# **Fuel System**

# **Fuel Pump**

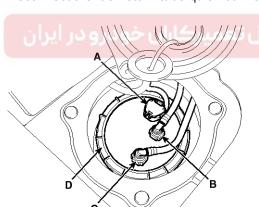
### Removal

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



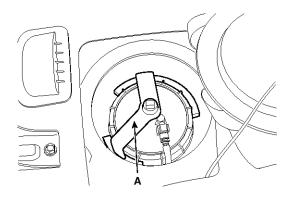
SLMFL0270D

- 4. Disconnect the fuel pump connector (A) and the fuel feed tube quick-connector (B).
- 5. Disconnect the fuel return tube quick-connector (C).

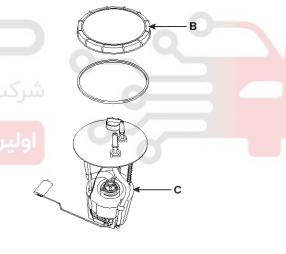


SLMFL0281D

6. Remove the fuel pump (C) after removing the plate cover (B) with SST (A) [SST No.: 09310-2S100] from the fuel tank.



SSLFL1000L



SLMFL0121L

FL-175

### Installation

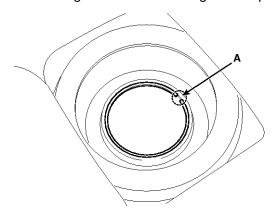
1. Installation is reverse of removal.

### Fuel pump plate cover installation:

58.9  $\sim$  68.7 N.m (6.0  $\sim$  7.0 kgf.m, 43.4  $\sim$  50.6 lb-ft)

### **WNOTICE**

Check the groove when installing the fuel pump.



SXMFL9241D



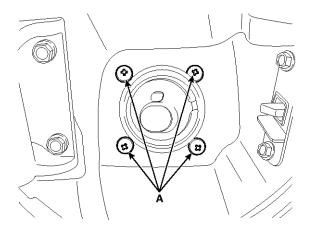


# **Fuel System**

## Filler-Neck Assembly

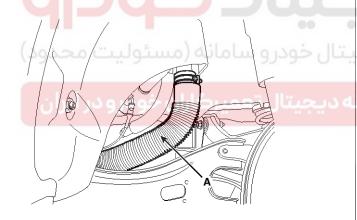
### Removal

1. Remove the filler-neck installation screw (A) after opening the fuel filler door.



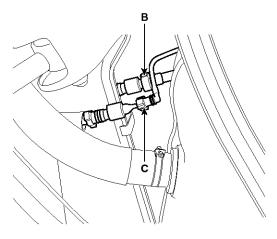
SCMFL6655D

- 2. Remove the rear LH wheel & tire.
- 3. Disconnect the fuel filler hose (A).



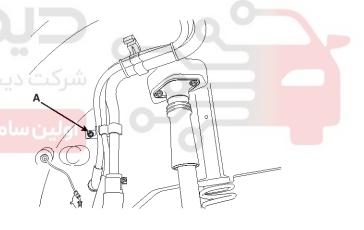
SLMFL0330D

4. Disconnect the leveling tube quick-connector (B) and the ventilation hose quick-connector (C).



SLMFL0290D

5. Remove the filler-neck assembly after removing the bracket installation nuts (A).



SLMFL0300D

## Installation

1. Installation is reverse of removal.

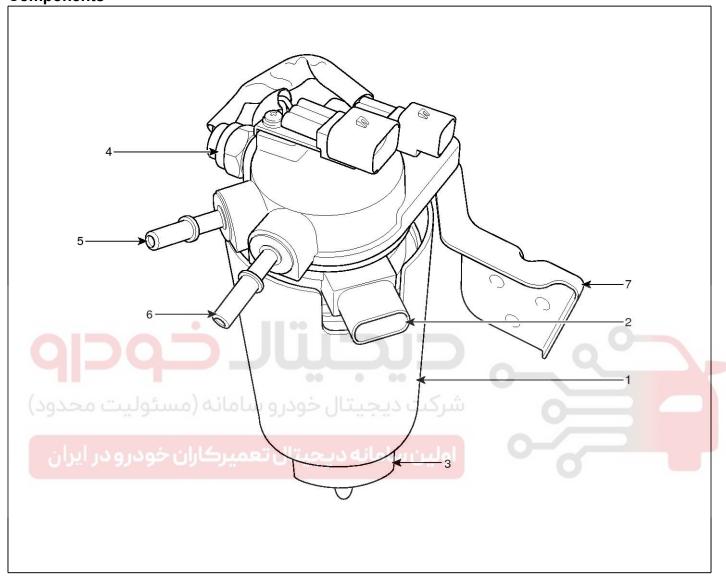
Filler-neck assembly bracket installation nut:

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

FL-177

## **Fuel Filter**

Components



SLMFL0340L

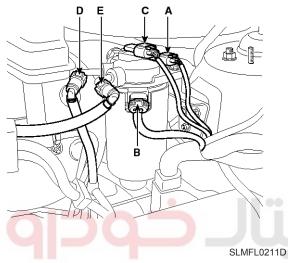
- 1. Fuel Filter
- 2. Heater
- 3. Water Sensor
- 4. Thermo switch

- 5. Inlet nipple (↔ Fuel Tank)
- 6. Outlet nipple (↔ High Pressure Fuel Pump)
- 7. Fuel filter installation bracket

# **Fuel System**

## Replacement

- Turn ignition switch OFF and disconnect the negative (-) battery cable.
- 2. Remove the ECM. (Refer to ECM in this group.)
- 3. Disconnect the water sensor connector (C), the heater connector (B) and the thermo switch connector (A).
- 4. Disconnect the fuel inlet tube quick-connector (D) and the fuel outlet tube quick-connector (E).

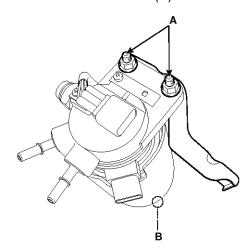


5. Remove the fuel filter installation nuts, and then remove the fuel filter(A) from the vehicle.



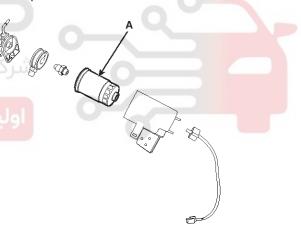
SLMFL0200D

- 6. Remove the fuel filter assembly from the bracket after removing the bracket nuts (A).
- 7. Remove the water sensor (B).



SLMFL0350E

 After removing the fuel filter (A) from the fuel filter assembly, replace it with a new one, and then install the fuel filter assembly in accordance with reverse of above steps.



SLMFL0360D

#### **⚠**CAUTION

When replacing the fuel filter, must replace the O-ring.

9. Start the engine and check that there is any leak on the low pressure fuel circuit including the fuel filter.

Fuel filter bracket installation nut:

9.8 ~12.8 N.m (1.0 ~ 1.3 kgf.m, 7.2 ~9.4 lb-ft)

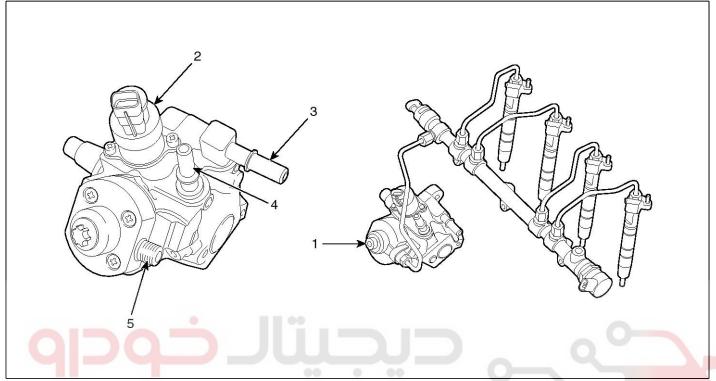
Fuel filter installation nut:

 $9.8 \sim 12.8 \text{ N.m} (1.0 \sim 1.3 \text{ kgf.m}, 7.2 \sim 9.4 \text{ lb-ft})$ 

FL-179

# **High Pressure Pump**

## Components



SXMFL9252D

- 1. High Pressure Fuel Pump
- 2. Fuel Pressure Regulator Valve
- 3. Nipple Fuel Inlet (

  Fuel Filter)
- 4. Nipple Fuel Return (→ Fuel Tank)
  5. Nipple Fuel Outlet (→ Common Rail)

# **Fuel System**

#### Removal

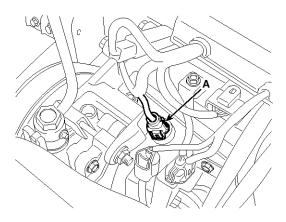
#### WARNING

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.

### **A**CAUTION

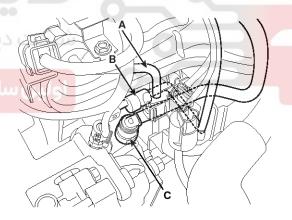
- Common Rail Fuel Injection System operates with extremely high pressure (approximately 1,800bar), so never perform any work on injection system with engine running or within 30 seconds after the engine stops.
- Keep cleanly the parts and the working area.
- · Pay attention to a foreign substance.
- 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 gasket with a new one.
  - To protect damage caused by shock, vertically insert the injector into the cylinder head.
  - Clean the connecting surface of the injector gasket on the cylinder head before installing the injector.
- When installing High Pressure Fuel Pipe
  - Do not use again the used high pressure fuel pipe.
  - Install the flange nut correctly.

- Turn ignition switch OFF and disconnect the negative
   battery cable.
- 2. Disconnect the fuel pressure regulator valve connector (A).



SXMFL9253D

- 3. Remove the high pressure fuel pipe (A) connecting the high pressure fuel pump with the common rail.
- 4. Disconnect the fuel feed tube quick-connector (B) and the fuel return tube quick-connector (C).

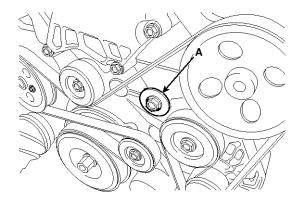


SXMFL9254D

5. Remove the drive belt (Refer to "TIMING SYSTEM" in "EM" group).

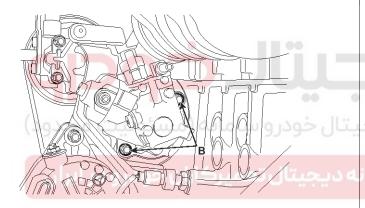
**FL-181** 

6. Remove the front cover service plug (A).



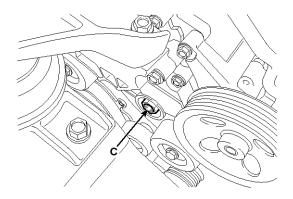
SXMFL9255D

7. Remove the high pressure fuel pump installation bolt (B).



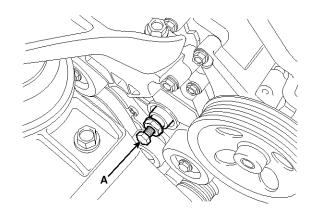
SXMFL9256D

8. Remove the high pressure fuel pump sprocket nut (C) after fixing the crankshaft.



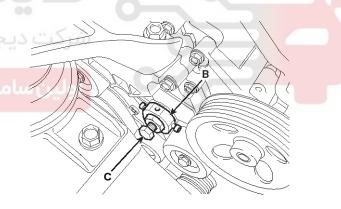
SXMFL9257D

9. Install the sprocket stopper (A) of the high pressure fuel pump remover [SST No.: 09331-1M100].



SXMFL9258D

- 10.Install the sprocket stopper support (B) of the high pressure fuel pump remover [SST No.: 09331-1M100].
- 11. Remove the high pressure fuel pump by rotating the bolt (C) of the high pressure fuel pump remover [SST No.: 09331-1M100] clockwise.



SXMFL9259D

### Installation

1. Installation is reverse of removal.

## MNOTICE

When installing the high pressure fuel pipe, apply the specified tightening torques with the special service tool [SST No.: 09314-27110]

High pressure fuel pump installation bolt:

 $24.5 \sim 30.4 \text{ N.m}$  ( $2.5 \sim 3.1 \text{ kgf.m}$ ,  $18.1 \sim 22.4 \text{ lb-ft}$ )

High pressure fuel pipe installation nut:

 $24.5 \sim 28.4 \text{ N.m} (2.5 \sim 2.9 \text{ kgf.m}, 18.1 \sim 20.1 \text{ lb-ft})$ 

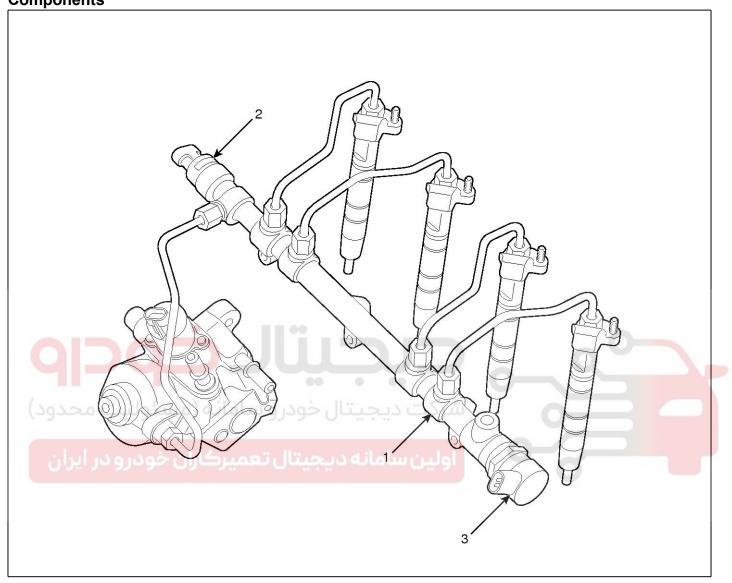
Service plug washer installation:

 $73.6 \sim 88.3 \text{ N.m} (7.5 \sim 9.0 \text{ kgf.m}, 54.3 \sim 65.1 \text{ lb-ft})$ 

# **Fuel System**

## **Common Rail**

Components



SXMFL9260D

- 1. Common rail
- 2. Rail Pressure Sensor (RPS)

3. Rail Pressure Regulator Valve (RPRV)

## **FL-183**

#### Removal

#### WARNING

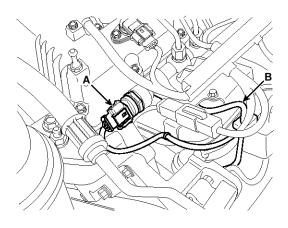
As the Piezo-Injector operates under maximum DC 200V, there may be a risk of an electric shock caused by shorted control line etc. So when repairing the injector or its wiring, disconnect the battery negative (-) terminal from the battery and wait for about 30 seconds.

### **A**CAUTION

- Common Rail Fuel Injection System operates with extremely high pressure (approximately 1,800bar), 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 gasket with a new one.
  - To protect damage caused by shock, vertically insert the injector into the cylinder head.
  - Clean the connecting surface of the injector gasket on the cylinder head before installing the injector.
- · When installing High Pressure Fuel Pipe
  - Do not use again the used high pressure fuel pipe.
  - Install the flange nut correctly.

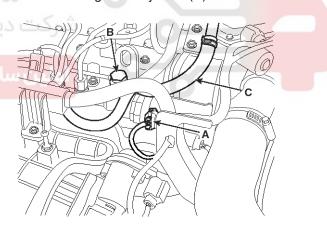
- Turn ignition switch OFF and disconnect the regative

   battery cable.
- 2. Disconnect the rail pressure sensor connector (A).
- 3. Remove the high pressure fuel pipe (B) connecting the common rail with the high pressure fuel pump.



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- 4. Disconnect the rail pressure regulator valve connector (A).
- 5. Disconnect the return hose (C) from the common rail after removing the banjo bolt (B).

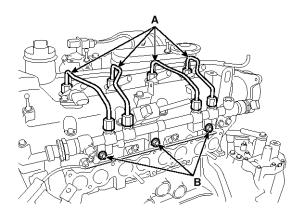


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6. Remove the intake manifold (Refer to "Intake And Exhaust Manifold" in EM group).

# **Fuel System**

- 7. Remove the high pressure fuel pipe (A) connecting the injectors with the common rail.
- 8. Remove the common rail after removing the mounting bolts (B).



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### Installation

1. Installation is reverse of removal.

#### MOTICE

When installing the high pressure fuel pipe, apply the specified tightening torques with the special service tool [SST No.: 09314-27110]

## Common rail installation bolt:

19.6  $\sim$  26.5 N.m (2.0  $\sim$  2.7 kgf.m, 14.5  $\sim$  19.5 lb-ft) High pressure fuel pipe installation nut:

24.5  $\sim$  28.4 N.m (2.5  $\sim$  2.9 kgf.m, 18.1  $\sim$  20.1 lb-ft)

Common rail banjo installation bolt:

 $17.7 \sim 27.5 \text{ N.m} (1.8 \sim 2.8 \text{ kgf.m}, 13.0 \sim 20.3 \text{ lb-ft})$ 



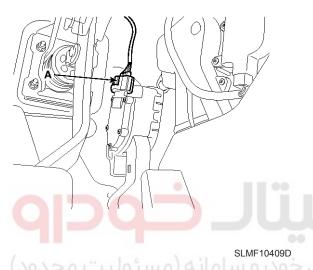


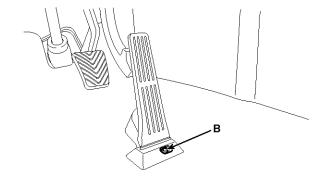
# **FL-185**

## **Accelerator Pedal**

### Removal

- Turn ignition switch OFF and disconnect the negative (-) battery cable.
- 2. Disconnect the accelerator pedal position sensor connector (A).
- 3. Remove the accelerator pedal assembly from the vehicle after unscrewing the mounting bolt (B) and nuts (C).



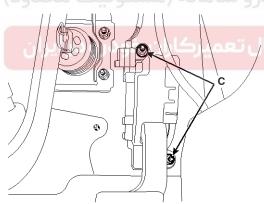


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### Installation

1. Installation is reverse of removal.

Accelerator pedal installation bolt:  $7.8 \sim 11.8 \text{ N.m} (0.8 \sim 1.2 \text{kgf.m}, 5.8 \sim 8.7 \text{ lb-ft})$  Accelerator pedal module installation nut:  $16.7 \sim 25.5 \text{ N.m} (1.7 \sim 2.6 \text{ kgf.m}, 12.3 \sim 18.8 \text{ lb-ft})$ 



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