General Information

SPECIFICATIONS

FUEL DELIVERY SYSTEM

Items	Specification	
Fuel Injection System	Type	Common Rail Direct Injection (CRDI)
Fuel Return System	Type	Return type
Fuel Pressure	Max. Pressure	1,600 bar
Fuel Tank	Capacity	53 lit. (56.0 U.S qt., 46.6 Imp qt.)
Fuel Filter	Type	High pressure type (Built in engine room)
High Pressure Fuel Pump	Type	Mechanical, Plunger Pumping Type
	Driven by	Camshaft
Low Pressure Fuel Pump	Type	Electrical, in-tank type
	Driven by	Electric motor

SENSORS

MASS AIR FLOW SENSOR (MAFS)

▷ Type: Hot-Film Type

▷ Specification

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

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

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

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

INTAKE AIR TEMPERATURE SENSOR (IATS) #1 [BUILT IN MAFS]

▷ Type: Thermistor type

▷ Specification

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

BOOST PRESSURE SENSOR (BPS)

▷ Type: Piezo-resistive pressure sensor type

▷ Specification

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

INTAKE AIR TEMPERATURE SENSOR (IATS) #2 [BUILT IN BPS]

▷ Type: Thermistor type

▷ Specification

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

ENGINE COOLANT TEMPERATURE SENSOR (ECTS)

▷ Type: Thermistor type

▷ Specification

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

CAMSHAFT POSITION SENSOR (CMPS)

▷ Type: Hall effect type

▷ Specification

Level	Output Pulse (V)
High	12V
Low	0V

Items	Specification
Air Gap	1.0 ± 0.5 mm

CRANKSHAFT POSITION SENSOR (CKPS)

▷ Type: Variable reluctance type

▷ Output Voltage (V): 0 ~ 5V

Items	Specification
Coil Resistance (Ω))	774 ~ 946Ω [20℃(68˚F)]

ACCELERATOR POSITION SENSOR (APS)

▷ Type: Potentiometer type

▷ Specification

Test Condition	Output Voltage(V)	
	APS 1	APS 2
Idle	0.7 ~ 0.8	0.275 ~ 0.475
Fully depressed	3.8 ~ 4.4	1.75 ~ 2.35

Items	Specification	
	APS 1	APS 2
Potentiometer Resistance (kΩ)	0.7 ~ 1.3	1.4 ~ 2.6

FUEL TEMPERATURE SENSOR (FTS)

▷ Type: Thermistor type

▷ Specification

Temperature [℃(˚F)]	Resistance(kΩ)
-30(-22)	27.00
-20(-4)	15.00
-10(14)	9.45
0(32)	5.89
20(68)	2.27 ~ 2.73
40(104)	1.17
50(122)	0.83
60(140)	0.60
70(158)	0.43
80(176)	0.30 ~ 0.32

RAIL PRESSURE SENSOR (RPS)

▷ Type: Piezo-electricity type

▷ Specification

Test Condition	Rail pressure (bar)	Output Voltage(V)
Idle	220 ~ 320	Below 1.7
Fully depressed	1,800	Approx. 4.5

LAMBDA SENSOR

▷ Type: Zirconia (ZrO2) Type

▷ Specification

λ Value (A/F Ratio)	Pumping Current(A)
0.65	-2.22
0.70	-1.82
0.80	-1.11
0.90	-0.50
1.01	0.00
1.18	0.33
1.43	0.67
1.70	0.94
2.42	1.38
Air (Atmosphere)	2.54

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

EXHAUST GAS TEMPERATURE SENSOR (EGTS) #1 FOR VGT

▷ Type: Thermistor type

▷ Specification

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

EXHAUST GAS TEMPERATURE SENSOR (EGTS) #2 FOR CPF

▷ Type: Thermistor type

▷ Specification

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

DIFFERENTIAL PRESSURE SENSOR (DPS)

▷ Type: Piezo-electricity type

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

Differential Pressure [△P] (kPa)	Output Voltage (V)
0	1.00
10	1.35
20	1.70
30	2.05
40	2.40
50	2.75
60	3.10
70	3.45
80	3.80
90	4.15
100	4.50

WATER SENSOR

▷ Specification

Item	Specification
Warning Level (cc)	40 ~ 60

VEHICLE SPEED SENSOR (VSS)

▷ Type: Inductive type

ACTUATORS

INJECTOR

▷ Number: 4

▷ Specification

Items	Specification
Coil Resistance (Ω)	0.33Ω [20℃(68˚F)]

FUEL PRESSURE REGULATOR VALVE

▷ Specification

Items	Specification
Coil Resistance (Ω)	2.6 ~ 3.15Ω [20℃(68˚F)]

RAIL PRESSURE REGULATOR VALVE

▷ Specification

Items	Specification
Coil Resistance (Ω)	3.42 ~ 3.78Ω [20℃(68˚F)]

THROTTLE CONTROL ACTUATOR

▷ Type : Duty control motor type

▷ Specification

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

ELECTRIC EGR CONTROL VALVE

▷ Type: Linear solenoid type

▷ Specification

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

VGT CONTROL SOLENOID VALVE

▷ Specification

Items	Specification
Coil Resistance (Ω)	14.7 ~ 16.1Ω [20℃(68˚F)]

VARIABLE SWIRL CONTROL ACTUATOR

▷ Type: Motor Driven (including Position Sensor)

▷ Specification

Motor

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

Position Sensor

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

SERVICE STANDARD

Basic Idle rpm(After warm up)	A/C OFF	Neutral,N,P-range	850 ± 100 rpm
		D-range	850 ± 100 rpm
	A/C ON	Neutral,N,P-range	850 ± 100 rpm
		D-range	850 ± 100 rpm

TIGHTENING TORQUES

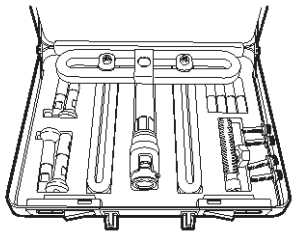
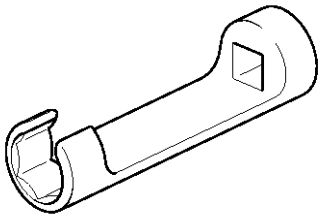
ENGINE CONTROL SYSTEM

Item	Kgf·m	N·m	lbf·ft
ECM installation bolts	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7
Mass air flow sensor clamp installation bolts	0.3 ~ 0.5	2.9 ~ 4.9	2.2 ~ 3.6
Boost pressure sensor installation bolts	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Engine coolant temperature sensor installation	2.0 ~ 4.0	19.6 ~ 39.2	14.5 ~ 28.9
Crankshaft position sensor installation bolt	0.4 ~ 0.6	3.9 ~ 5.9	2.9 ~ 4.3
Camshaft position sensor installation bolt	0.4 ~ 0.6	3.9 ~ 5.9	2.9 ~ 4.3
Lambda sensor installation	4.1 ~ 6.1	40.2 ~ 59.8	29.7 ~ 44.1
Electric EGR control valve installation bolts	2.0 ~ 2.7	19.6 ~ 26.5	14.5 ~ 19.5
Variable swirl control actuator installation bolts	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Exhaust gas temperature sensor (For CPF) installation	4.0 ~ 5.0	39.2 ~ 49.1	28.9 ~ 36.2
Exhaust gas temperature sensor (For VGT) installation	4.0 ~ 5.0	39.2 ~ 49.1	28.9 ~ 36.2
DPS & VGT control solenoid valve bracket installation bolts	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Differential pressure sensor installation bolt/nuts	1.0 ~ 1.2	9.8 ~ 11.8	7.8 ~ 8.7
Throttle body installation bolt/nuts	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Oil pressure switch installation	1.5 ~ 2.2	14.7 ~ 21.6	10.9 ~ 15.9
Glow plug installation	1.0 ~ 1.4	9.8 ~ 13.7	7.2 ~ 10.1
Pipe (DPS ↔ CPF) installation (CPF side)	3.5 ~ 5.1	34.3 ~ 50.0	25.3 ~ 36.9

FUEL DELIVERY SYSTEM

Item	Kgf·m	N·m	lbf·ft
Injector clamp installation bolt	2.5 ~ 2.9	24.5 ~ 28.4	18.1 ~ 21.0
Common rail installation bolts	2.0 ~ 2.7	19.6 ~ 26.5	14.5 ~ 19.5
High pressure fuel pump installation bolts	2.5 ~ 3.5	24.5 ~ 34.3	18.1 ~ 25.3
High pressure fuel pipe (Injector ↔ Common Rail) installation nuts	2.5 ~ 2.9	24.5 ~ 28.4	18.1 ~ 21.0
High pressure fuel pipe (Common Rail ↔ High Pressure Fuel Pump) installation nuts	2.5 ~ 2.9	24.5 ~ 28.4	18.1 ~ 21.0
Fuel tank band installation bolts	4.0 ~ 5.5	39.2 ~ 54.0	28.9 ~ 39.8
Fuel pump (Low Pressure) installation bolts	0.2 ~ 0.3	2.0 ~ 2.9	1.4 ~ 2.2
Accelerator pedal module installation bolts	1.3 ~ 1.6	12.8 ~ 15.7	9.4 ~ 11.6

SPECIAL SERVICE TOOLS

Tool (Number and name)	Illustration	Application
09351-4A300 Injector Remover		Removing the injector
09314-27110(14mm) 09314-27120(17mm) Torque Wrench Socket		Installing the high pressure fuel pipe

BASIC TROUBLESHOOTING

BASIC TROUBLESHOOTING GUIDE

1	**Bring Vehicle to Workshop**

2	**Analyze Customer's Problem**

Ask the customer about the conditions and environment relative to the issue (Use CUSTOMER PROBLEM ANALYSIS SHEET).

3	**Verify Symptom, and then Check DTC and Freeze Frame Data**

Connect Hi-Scan (Pro) to Diagnostic Link Connector (DLC).
Record the DTC and freeze frame data.

NOTE

To erase DTC and freeze frame data, refer to Step 5.

4	**Confirm the Inspection Procedure for the System or Part**

Using the SYMPTOM TROUBLESHOOTING GUIDE CHART, choose the correct inspection procedure for the system or part to be checked.

5	**Erase the DTC and Freeze Frame Data**

WARNING

NEVER erase DTC and freeze frame data before completing Step 2 MIL/DTC in "CUSTOMER PROBLEM ANALYSIS SHEET".

6	**Inspect Vehicle Visually**

Go to Step 11, if you recognize the problem.

7	**Recreate (Simulate) Symptoms of the DTC**

Try to recreate or simulate the symptoms and conditions of the malfunction as described by customer.
If DTC(s) is/are displayed, simulate the condition according to troubleshooting procedure for the DTC.

8	**Confirm Symptoms of Problem**

If DTC(s) is/are not displayed, go to Step 9.
If DTC(s) is/are displayed, go to Step 11.

9	**Recreate (Simulate) Symptom**

Try to recreate or simulate the condition of the malfunction as described by the customer.

10	**Check the DTC**

If DTC(s) does(do) not occur, refer to INTERMITTENT PROBLEM PROCEDURE in BASIC INSPECTION PROCEDURE.
If DTC(s) occur(s), go to Step 11.

11	**Perform troubleshooting procedure for DTC**

12	**Adjust or repair the vehicle**

13	**Confirm test**

14	**END**

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CUSTOMER PROBLEM ANALYSIS SHEET

1. VEHICLEINFORMAITON

VIN No.		Transmission	☐ M/T ☐ A/T ☐CVT ☐ etc.
Production date		Driving type	☐ 2WD (FF) ☐ 2WD (FR) ☐ 4WD
Odometer Reading	_____km/mile	CPF (Diesel Engine)	☐ With CPF ☐ Without CPF

2. SYMPTOMS

☐ Unable to start	☐ Engine does not turn over ☐ Incomplete combustion ☐ Initial combustion does not occur
☐ Difficult to start	☐ Engine turns over slowly ☐ Other_____
☐ Poor idling	☐ Rough idling ☐ Incorrect idling ☐ Unstable idling (High:_____ rpm, Low:_____rpm) ☐ Other
☐ Engine stall	☐ Soon after starting ☐ After accelerator pedal depressed ☐ After accelerator pedal released ☐ During A/C ON ☐ Shifting from N to D-range ☐ Other_____
☐ Others	☐ Poor driving (Surge) ☐ Knocking ☐ Poor fuel economy ☐ Back fire ☐ After fire ☐ Other_____

3. ENVIRONMENT

Problem frequency	☐ Constant ☐ Sometimes (_____) ☐ Once only ☐ Other_____
Weather	☐ Fine ☐ Cloudy ☐ Rainy ☐ Snowy ☐ Other_____
Outdoor temperature	Approx. _____ °C/°F
Place	☐ Highway ☐ Suburbs ☐ Inner City ☐ Uphill ☐ Downhill ☐ Rough road ☐ Other_____
Engine temperature	☐ Cold ☐ Warming up ☐ After warming up ☐ Any temperature
Engine operation	☐ Starting ☐ Just after starting (_____min) ☐ Idling ☐ Racing ☐ Driving ☐ Constant speed ☐ Acceleration ☐ Deceleration ☐ A/C switch ON/OFF ☐ Other_____

4. MIL/DTC

MIL (Malfunction Indicator Lamp)		☐ Remains ON ☐ Sometimes lights up ☐ Does not light
DTC	Normal check (Pre-check)	☐ Normal ☐ DTC (_____) ☐ Freeze Frame Data
	Check mode	☐ Normal ☐ DTC (_____) ☐ Freeze Frame Data

5. ECM/PCM INFORMATION

ECM/PCM Part No.	
ROM ID	

SFDF28233L

BASIC INSPECTION PROCEDURE

MEASURING CONDITION OF ELECTRONIC PARTS' RESISTANCE

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

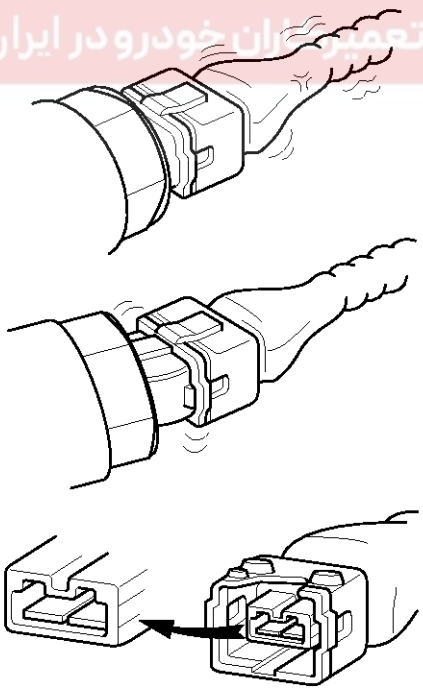
NOTICE

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

INTERMITTENT PROBLEM INSPECTION PROCEDURE

Sometimes the most difficult case in troubleshooting is when a problem symptom occurs but does not occur again during testing. An example would be if a problem appears only when the vehicle is cold but has not appeared when warm. In this case, the technician should thoroughly make out a "CUSTOMER PROBLEM ANALYSIS SHEET" and recreate (simulate) the environment and condition which occurred when the vehicle was having the issue.

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



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

● SIMULATING VIBRATION

a. Sensors and Actuators

: Slightly vibrate sensors, actuators or relays with finger.

WARNING

Strong vibration may break sensors, actuators or relays

b. Connectors and Harness

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

● SIMULATING HEAT

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

WARNING

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

● SIMULATING WATER SPRINKLING

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

WARNING

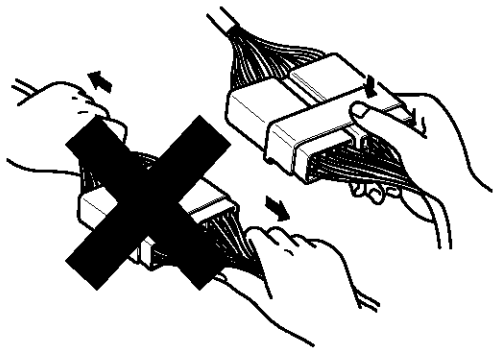
DO NOT sprinkle water directly into the engine compartment or electronic components.

● SIMULATING ELECTRICAL LOAD

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

CONNECTOR INSPECTION PROCEDURE

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



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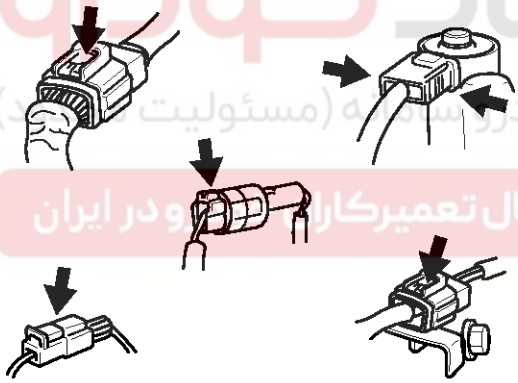
   b. When removing the connector with a lock, press or pull locking lever.



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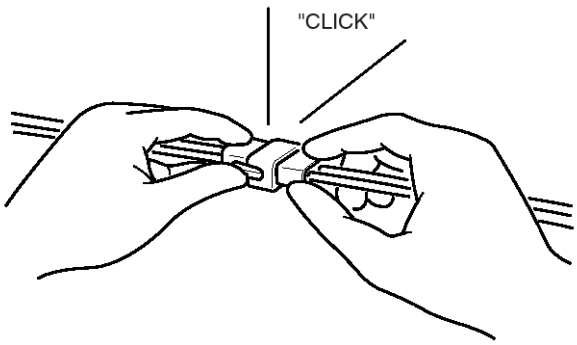
   c. Listen for a click when locking connectors. This sound indicates that they are securely locked.



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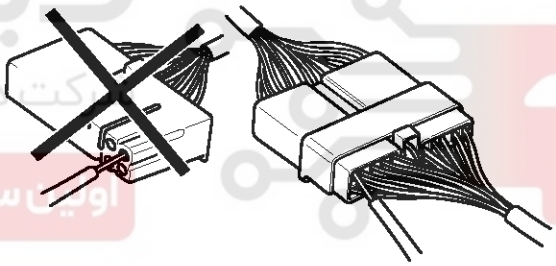
   d. When a tester is used to check for continuity, or to measure voltage, always insert tester probe from wire harness side.



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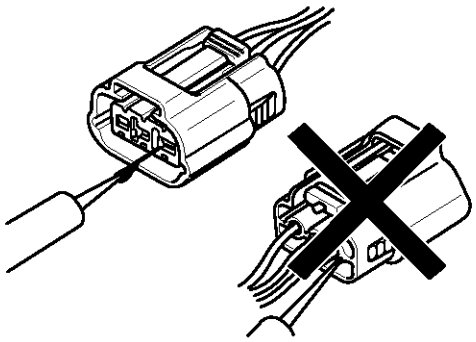
e. Check waterproof connector terminals from the connector side. Waterproof connectors cannot be accessed from harness side.



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NOTICE

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

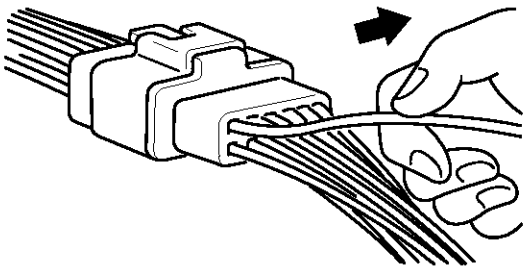
2. Checking Point for Connector

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

b. When the connector is disconnected:
Check missed terminal, crimped terminal or broken core wire by slightly pulling the wire harness.
Visually check for rust, contamination, deformation and bend.

c. Check terminal tightening condition:
Insert a spare male terminal into a female terminal, and then check terminal tightening conditions.

d. Pull lightly on individual wires to ensure that each wire is secured in the terminal.



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3. Repair Method of Connector Terminal

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

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

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

WIRE HARNESS INSPECTION PROCEDURE

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

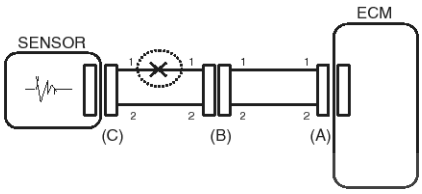
ELECTRICAL CIRCUIT INSPECTION PROCEDURE

● CHECK OPEN CIRCUIT

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

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

FIG 1



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2. Continuity Check Method

NOTICE

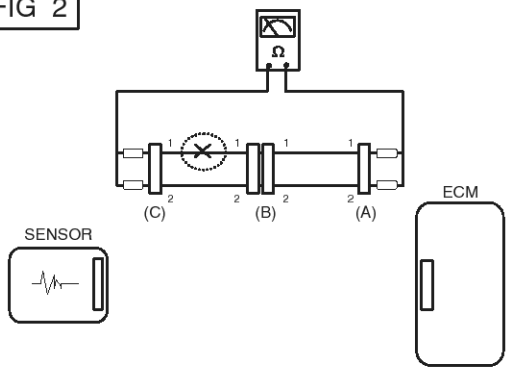
When measuring for resistance, lightly shake the wire harness above and below or from side to side.

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

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

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

FIG 2



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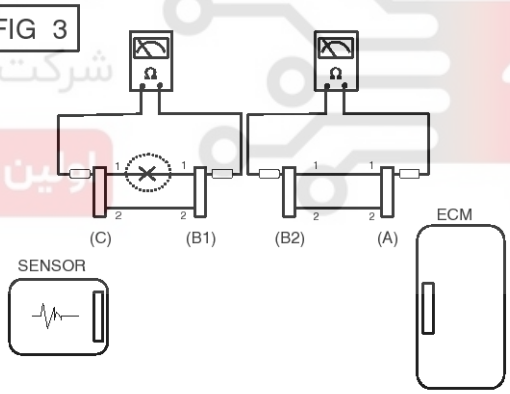
b. Disconnect connector (B), and measure for resistance between connector (C) and (B1) and between (B2) and (A) as shown in [FIG. 3].

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

FIG 3



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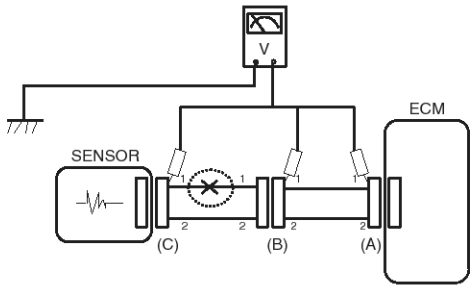
3. Voltage Check Method

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

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

FIG 4



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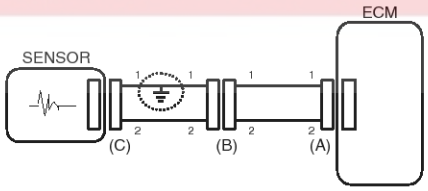
● CHECK SHORT CIRCUIT

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

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

FIG 5



BFGE501E

2. Continuity Check Method (with Chassis Ground)

   NOTICE

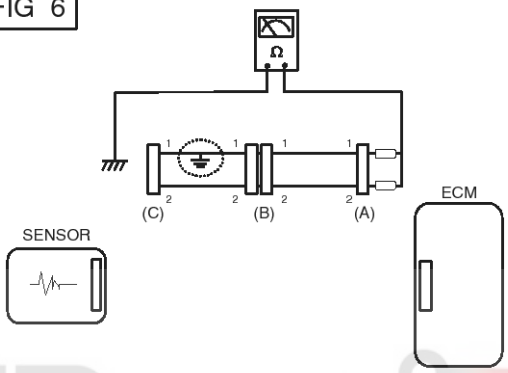
   Lightly shake the wire harness above and below, or from side to side when measuring the resistance.

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

a. Disconnect connectors (A), (C) and measure for resistance between connector (A) and Chassis Ground as shown in [FIG. 6].

   The measured resistance of line 1 and 2 in this example is below 1 Ω and higher than 1MΩ respectively. Specifically the short to ground circuit is line 1 (Line 2 is normal). To find exact broken point, check the sub line of line 1 as described in the following step.

FIG 6

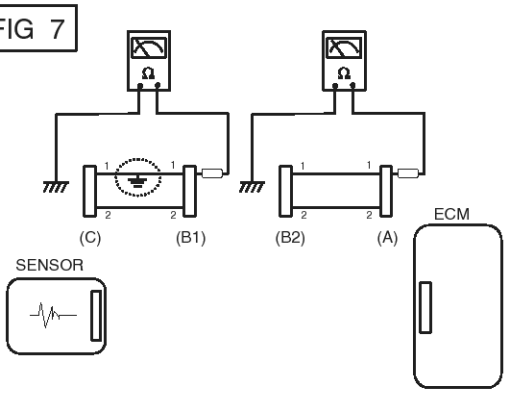


BFGE501F

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

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

FIG 7



BFGE501G

SYMPTOM TROUBLESHOOTING GUIDE TABLE

(SYMPTOM 1) ENGINE DOES NOT START

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

(SYMPTOM 2) ENGINE STARTS WITH DIFFICULTY OR STARTS AND STALLS

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

(SYMPTOM 3) POOR STARTING WHEN HOT

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

(SYMPTOM 4) UNSTABLE IDLING

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

(SYMPTOM 5) IDLE SPEED TOO HIGH OR TOO LOW

Possible Cause	
• No engine coolant temperature sensor signal • Incorrect state of the electrical pack devices • Faulty alternator or voltage regulator • ECM program error or hardware fault	• Electric EGR control valve blocked open • Faulty accelerator pedal

(SYMPTOM 6) BLUE, WHITE, OR BLACK SMOKES

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

(SYMPTOM 7) ENGINE RATTLING, NOISY ENGINE

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

(SYMPTOM 8) NURST NOISE

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

(SYMPTOM 9) UNTIMELY ACCELERATION/DECELERATION AND ENGINE RACING

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

(SYMPTOM 10) GAP WHEN ACCELERATING AND AT RE-COUPLING (RESPONSE TIME)

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

(SYMPTOM 11) ENGINE STOP

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

(SYMPTOM 12) ENGINE JUDDER

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

(SYMPTOM 13) LACK OF POWER

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

(SYMPTOM 14) TOO MUCH POWER

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

(SYMPTOM 15) EXCESSIVE FUEL CONSUMPTION

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

(SYMPTOM 16) OVER SPEED ENGINE WHEN CHANGING THE GEAR BOX RATIO

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

(SYMPTOM 17) EXHAUST SMELLS

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

(SYMPTOM 18) SMOKES (BLACK, WHITE, BLUE) WHEN ACCELERATING

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

(SYMPTOM 19) FUEL SMELLS

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

(SYMPTOM 20) THE ENGINE COLLAPSES AT TAKE OFF

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

(SYMPTOM 21) ENGINE DOES NOT STOP

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

(SYMPTOM 22) DIFFERENT MECHANICAL NOISES

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

Engine Control System

DESCRIPTION

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

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

If any of the above conditions are noted, first perform a routine diagnosis that includes basic engine checks (ignition system malfunction, incorrectengine adjustment, etc.). Then, inspect the disel contorl system components with a scan tool.

NOTICE

- *Before removing or installing any part, read the diagnostic trouble codesand then disconnect the battery negative (-) terminal.*
- *Before disconnecting the cable from battery terminal, turn the ignition switch to OFF. Removal or connection of the battery cable during engine operationor while the ignition switch is ON could cause damage to the ECM.*
- *Wchecking the generator for the charging state, do not disconnect the battery '+' terminal to prevent the ECM from damage due to the voltage.*
- *Wcharging the battery with the external charger, disconnect the vehicleside battery terminals to prevent damage to the ECM.*

SELF-DIAGNOSIS

The ECM monitors the input/output signals (some signals at all times and theothers under specified conditions). When the ECM detects an irregularity, it records the diagnostic trouble code, and outputs the signal to the Data Link connector. The diagnosis results can be read with the MIL or scan tool. Diagnostic Trouble Code(DTC) will remain in the ECM and may be deleted by the scan tool.

NOTICE

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

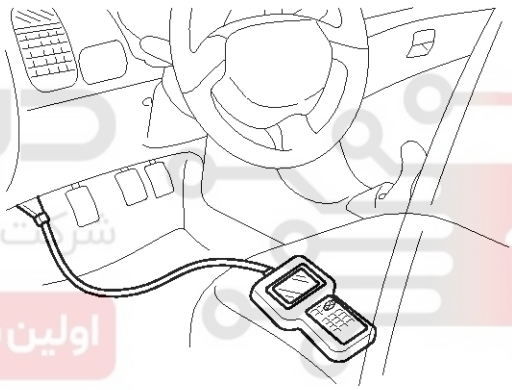
CHECKING PROCEDURE (SELF-DIAGNOSIS)

NOTICE

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

INSPECTION PROCEDURE (USING GENERIC SCAN TOOL)

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



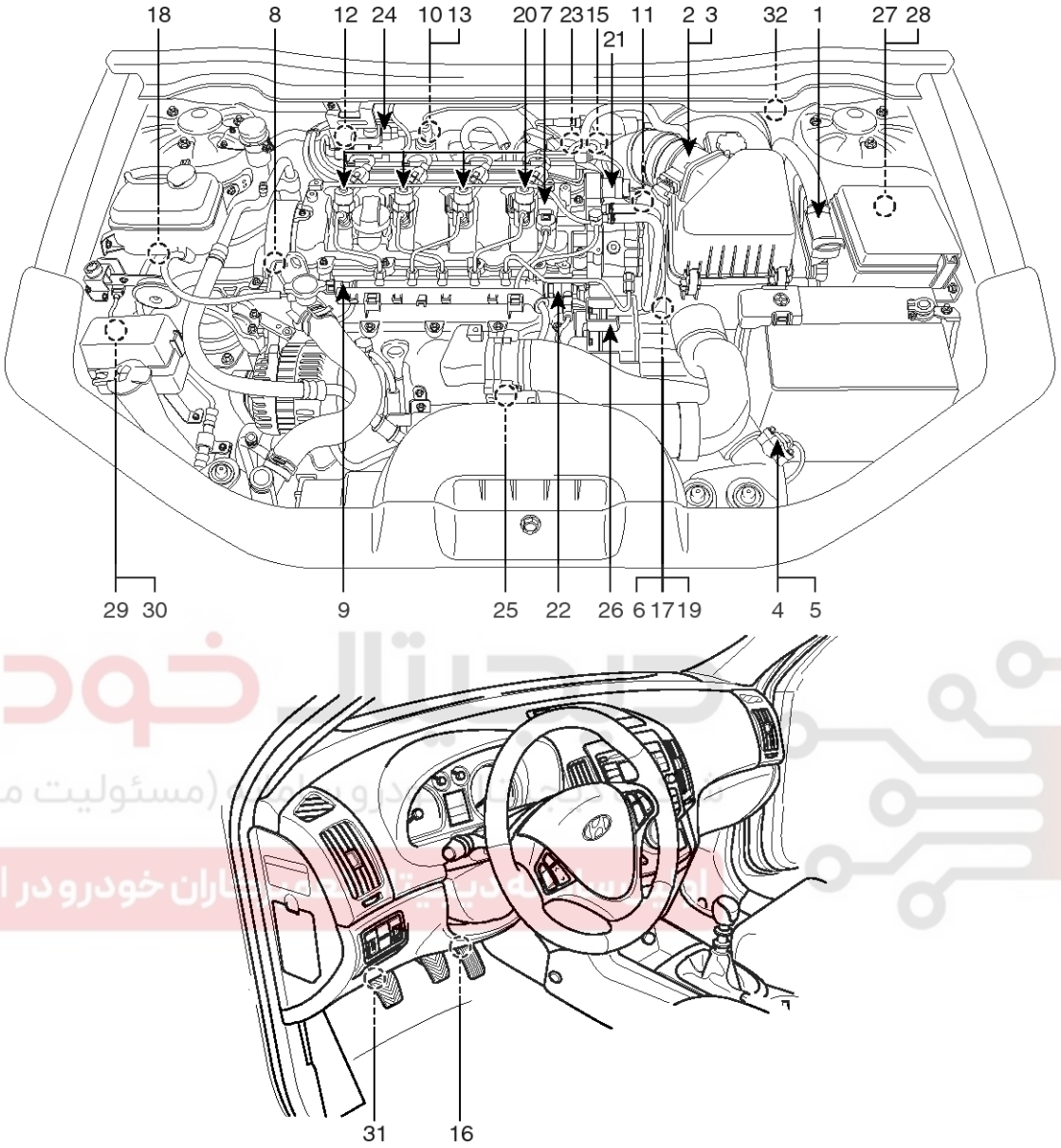
AWJF300D

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

NOTICE

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

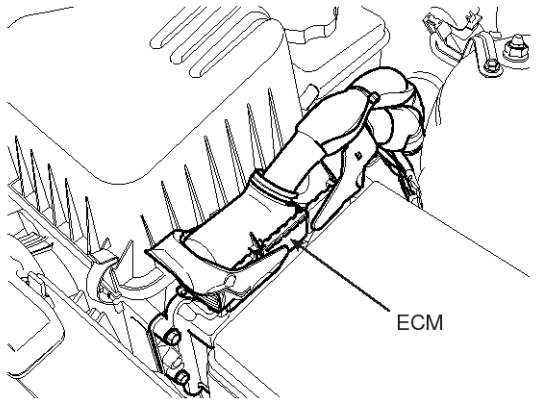
COMPONENT LOCATION



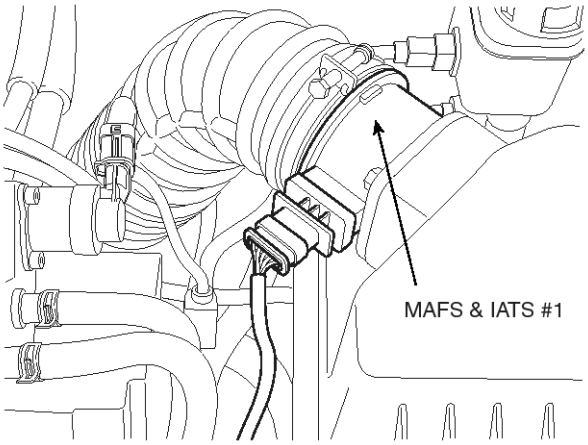
1. ECM (Engine Control Module)
2. Mass Air Flow Sensor (MAFS)
3. Intake Air Temperature Sensor (IATS) #1 built in MAFS
4. Boost Pressure Sensor (BPS)
5. Intake Air Temperature Sensor (IATS) #2 built in BPS
6. Crankshaft Position Sensor (CKPS)
7. Camshaft Position Sensor (CMPS)
8. Engine Coolant Temperature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

SFDF38200L

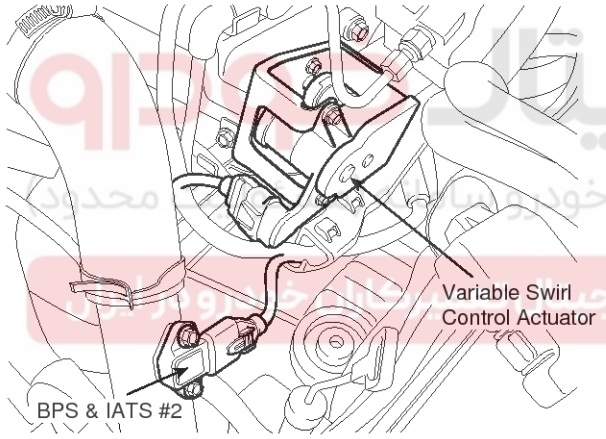
1. ECM (Engine Control Module)



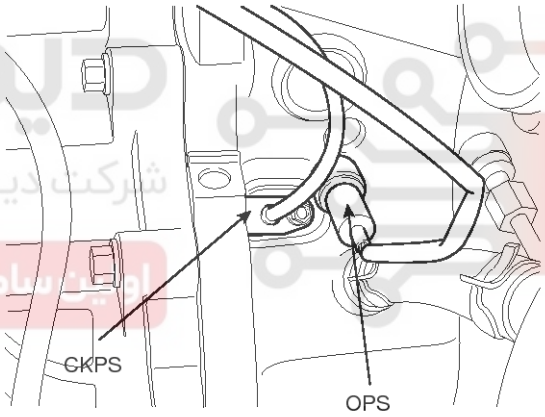
2. Mass Air Flow Sensor (MAFS)
3. Intake Air Temperature Sensor (IATS) #1 built in MAFS



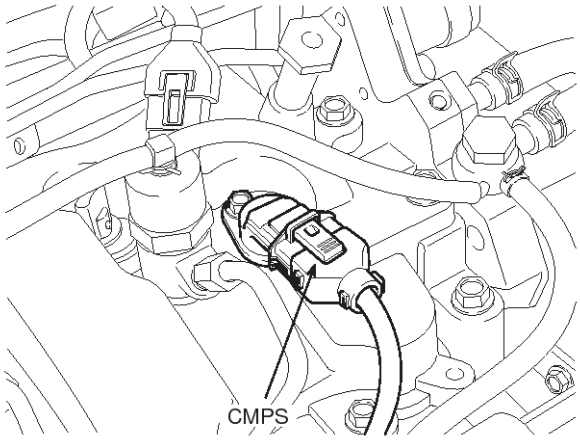
4. Boost Pressure Sensor (BPS)
5. Intake Air Temperature Sensor (IATS) #2 built in BPS
26. Variable Swirl Control Actuator



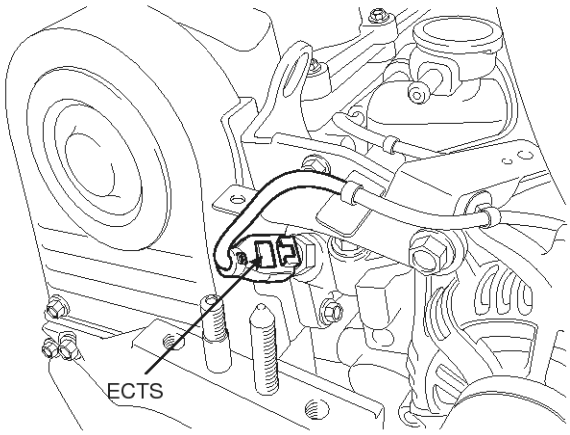
6. Crankshaft Position Sensor (CKPS)
19. Oil Pressure Switch (OPS)

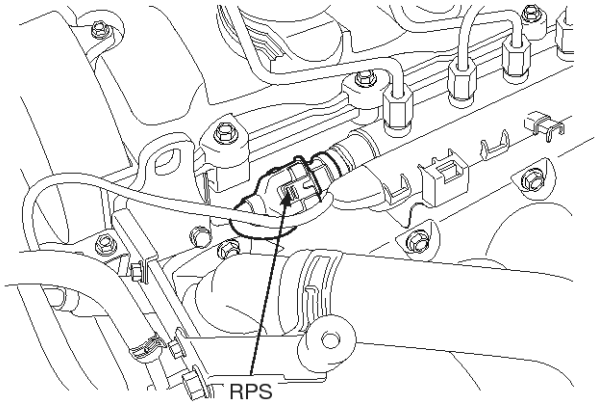
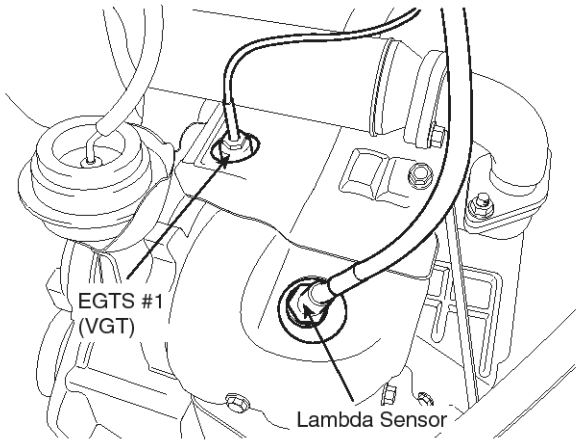
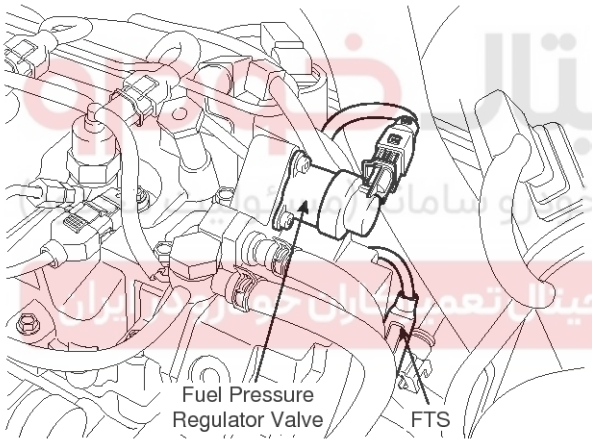
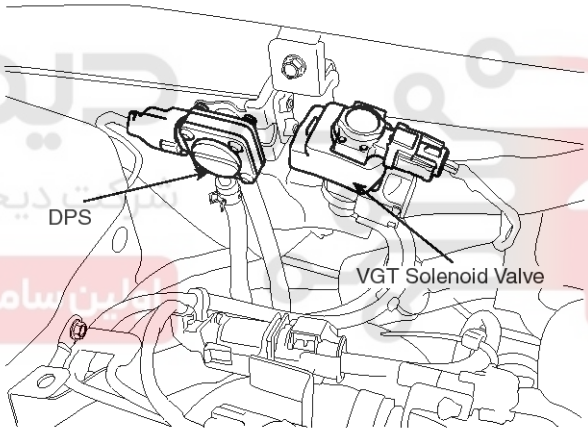
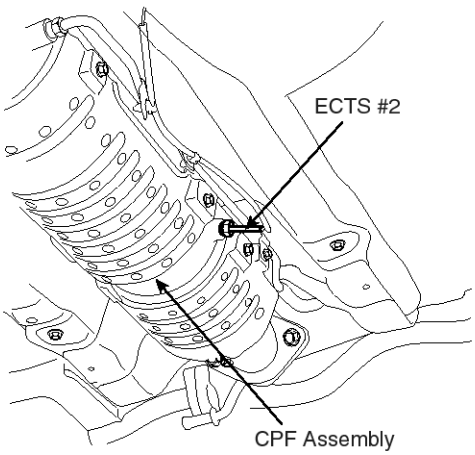
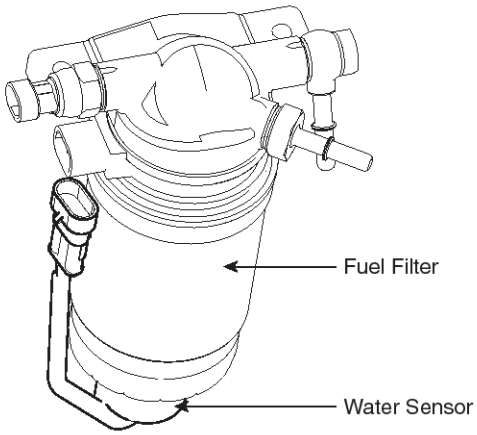


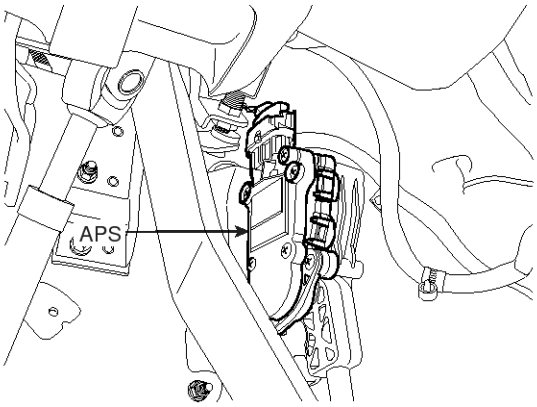
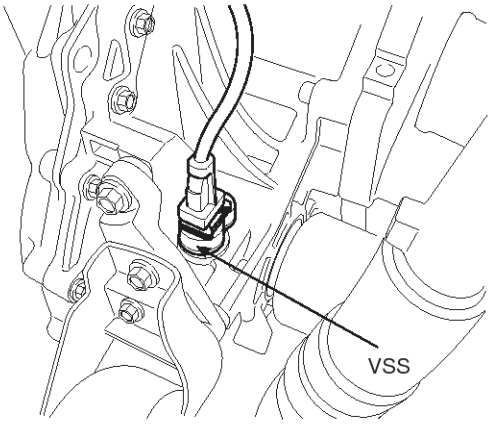
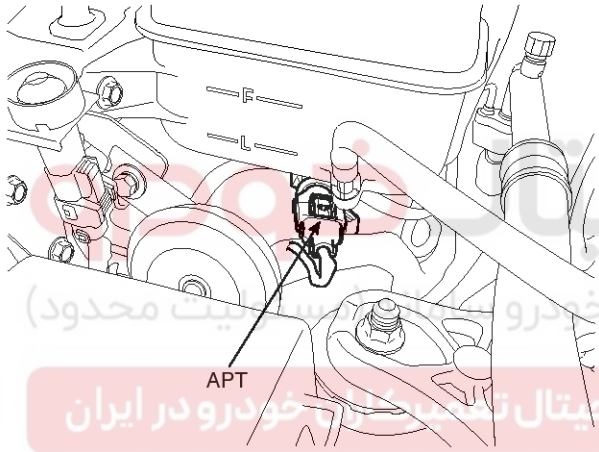
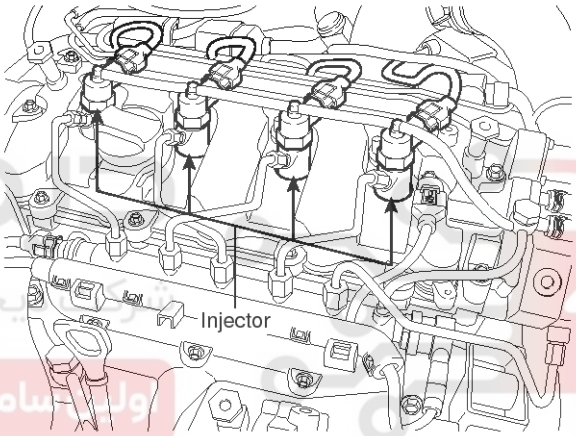
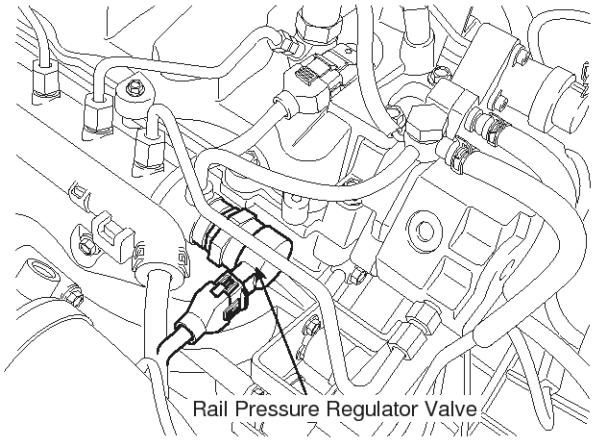
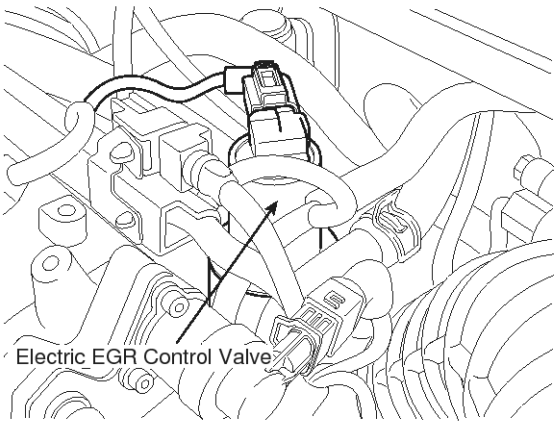
7. Camshaft Position Sensor (CMPS)

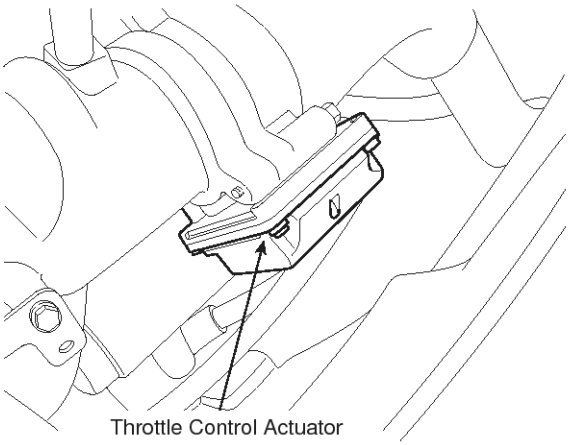
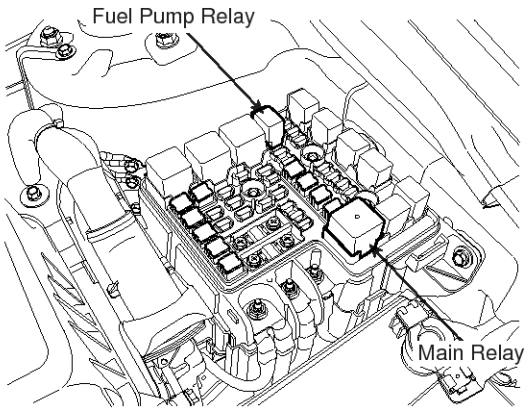
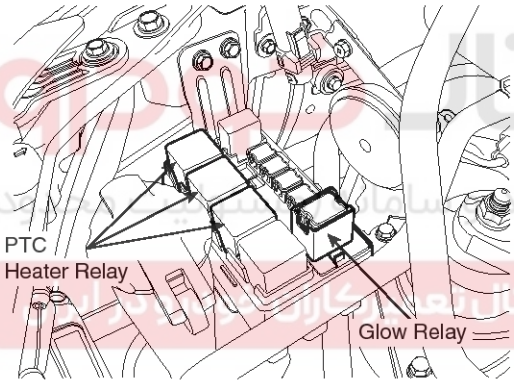


8. Engine Coolant Temperature Sensor (ECTS)



9. Rail Pressure Sensor (RPS)	10. Lambda Sensor 13. Exhaust Gas Temperature Sensor (EGTS) #1 for VGT [With CPF]
	
11. Fuel Temperature Sensor (FTS) 21. Fuel Pressure Regulator Valve	12. Differential Pressure Sensor (DPS) [With CPF] 24. VGT Control Solenoid Valve
	
14. Exhaust Gas Temperature Sensor (EGTS) #2 for CPF [With CPF]	15. Water Sensor (included in Fuel Filter)
	

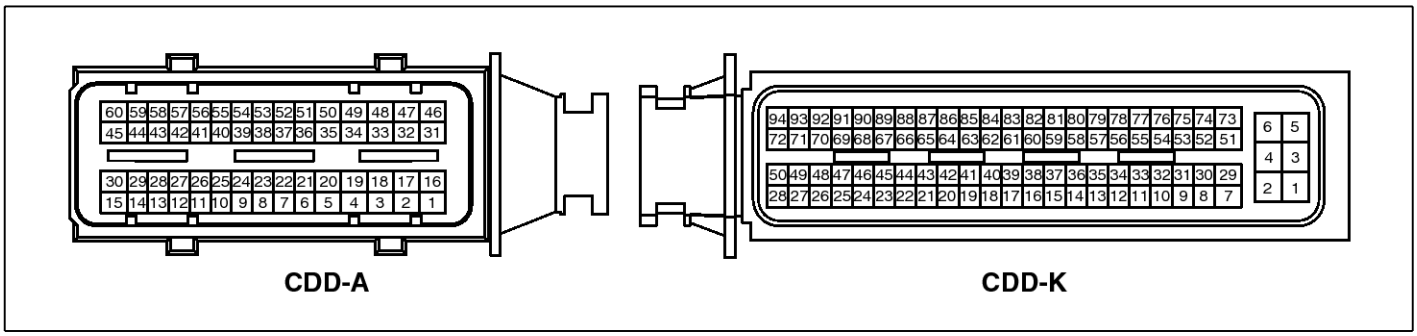
16. Accelerator Pedal Position Sensor (APS)	17. Vehicle Speed Sensor (VSS)
	
18. A/C Pressure Transducer (APT)	20. Injector
	
22. Rail Pressure Regulator Valve	23. Electric EGR Control Valve
	

25. Throttle Control Actuator	27. Main Relay 28. Fuel Pump Relay
	
29. Glow Relay 30. PTC Heater Relay (Optional)	
	

Engine Control Module (ECM)

ECM (ENGINE CONTROL MODULE)

1. ECM HARNESS CONNECTOR



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2. ECM TERMINAL FUNCTION

CONNECTOR [CDD-A]

Pin	Description	Connected to
1	Injector (Cylinder #3) [HIGH] control output	Injector (Cylinder #3)
2	Injector (Cylinder #2) [HIGH] control output	Injector (Cylinder #2)
3	-	
4	Battery power	Rail Pressure Regulator Valve
5	-	
6	Sensor ground	Position Sensor in Variable Swirl Control Actuator
7	Sensor shield	Crankshaft Position Sensor (CKPS)
8	Sensor ground	Rail Pressure Sensor (RPS)
9	-	
10	-	
11	-	
12	Crankshaft Position Sensor (CKPS) [-] signal input	Crankshaft Position Sensor (CKPS)
13	Sensor power (+5V)	Boost Pressure Sensor (BPS)
14	-	
15	-	
16	Injector (Cylinder #1) [HIGH] control output	Injector (Cylinder #1)
17	Injector (Cylinder #4) [HIGH] control output	Injector (Cylinder #4)
18	-	
19	Battery power	Fuel Pressure Regulator Valve
20	Sensor ground	Camshaft Position Sensor (CMPS)
21	-	
22	-	

Pin	Description	Connected to
23	Sensor ground	Boost Pressure Sensor (BPS)
24	-	
25	-	
26	Sensor power (+5V)	Position Sensor in Variable Swirl Control Actuator
27	Crankshaft Position Sensor (CKPS) [+] signal input	Crankshaft Position Sensor (CKPS)
28	Sensor power (+5V)	Rail Pressure Sensor (RPS)
29	-	
30	Motor [-] control output	Variable Swirl Control Actuator
31	Injector (Cylinder #2) [LOW] control output	Injector (Cylinder #2)
32	-	
33	Injector (Cylinder #4) [LOW] control output	Injector (Cylinder #4)
34	Rail Pressure Regulator Valve control output	Rail Pressure Regulator Valve
35	-	
36	-	
37	Reference frequency	Mass Air Flow Sensor (MAFS)
38	-	
39	-	
40	Boost Pressure Sensor (BPS) signal input	Boost Pressure Sensor (BPS)
41	Sensor ground	Engine Coolant Temperature Sensor (ECTS)
42	Mass Air Flow Sensor (MAFS) signal input	Mass Air Flow Sensor (MAFS)
43	Rail Pressure Sensor (RPS) signal input	Rail Pressure Sensor (RPS)
44	Sensor ground	MAFS & IATS #1
45	Fuel Pump Relay control output	Fuel Pump Relay
46	Injector (Cylinder #3) [LOW] control output	Injector (Cylinder #3)
47	Injector (Cylinder #1) [LOW] control output	Injector (Cylinder #1)
48	-	
49	Fuel Pressure Regulator Valve control output	Fuel Pressure Regulator Valve
50	Camshaft Position Sensor (CMPS) signal input	Camshaft Position Sensor (CMPS)
51	-	
52	-	
53	Intake Air Temperature Sensor (IATS) #2 signal input	Intake Air Temperature Sensor (IATS) #2 built in BPS
54	-	
55	-	
56	Position Sensor signal input	Position Sensor in Variable Swirl Control Actuator

Pin	Description	Connected to
57	-	
58	Engine Coolant Temperature Sensor (ECTS) signal input	Engine Coolant Temperature Sensor (ECTS)
59	Electric EGR Control Valve control output	Electric EGR Control Valve
60	Motor [+] control output	Variable Swirl Control Actuator

CONNECTOR [CDD-K]

Pin	Description	Connected to
1	Battery power	Main Relay
2	Power ground	Chassis Ground
3	Battery power	Main Relay
4	Power ground	Chassis Ground
5	Battery power	Main Relay
6	Power ground	Chassis Ground
7	Cooling Fan Relay [HIGH] control output	Cooling Fan Relay [HIGH]
8	Sensor ground	Accelerator Position Sensor (APS) #2
9	Accelerator Position Sensor (APS) #1 signal input	Accelerator Position Sensor (APS) #1
10	Sensor ground	Fuel Temperature Sensor (FTS)
11	Fuel Temperature Sensor (FTS) signal input	Fuel Temperature Sensor (FTS)
12	Sensor ground	A/C Pressure Transducer
13	A/C Pressure Transducer signal input	A/C Pressure Transducer
14	Ground	Cruise Control Switch
15	Cruise Control "ACTIVATOR" signal input	Cruise Control Switch
16	Ground	Immobilizer Control Module
17	-	
18	-	
19	ESP auto recognition signal input	With ESP: Ground, Without ESP: Open
20	-	
21	-	
22	Sensor power (+5V)	A/C Pressure Transducer (APT)
23	-	
24	Sensor power (+5V)	Cruise Control Switch
25	Diagnosis Data Line (K-Line)	Data Link Connector (DLC)
26	-	
27	Fuel consumption signal output	Trip computer

Pin	Description	Connected to
28	Battery power	Ignition Switch
29	VGT Control Solenoid Valve control output	VGT Control Solenoid Valve
30	Sensor ground	Accelerator Position Sensor (APS) #1
31	Accelerator Position Sensor (APS) #2 signal i-nput	Accelerator Position Sensor (APS) #2
32	Exhaust Gas Temperature Sensor (EGTS) #2 signal input	Exhaust Gas Temperature Sensor (EGTS) #2 for CPF [Wit-h CPF]
33	Sensor ground	Exhaust Gas Temperature Sensor (EGTS) #2 for CPF [Wit-h CPF]
34	Exhaust Gas Temperature Sensor (EGTS) #1 signal input	Exhaust Gas Temperature Sensor (EGTS) #1 [for VGT] [With CPF]
35	Sensor ground	Exhaust Gas Temperature Sensor (EGTS) #1 [for VGT] [With CPF]
36	Differential Pressure Sensor (DPS) signal input	Differential Pressure Sensor (DPS) [With CPF]
37	Sensor ground	Differential Pressure Sensor (DPS) [With CPF]
38	Brake Switch "1" signal input	Brake Switch
39	-	
40	Water Sensor siganl input	Water Sensor in Fuel Filter
41	-	
42	A/C Pressure Switch Signal input	Blower Switch
43	-	
44	Sensor power (+5V)	Differential Pressure Sensor (DPS) [With CPF]
45	Sensor power (+5V)	Accelerator Position Sensor (APS) #1
46	Sensor power (+5V)	Accelerator Position Sensor (APS) #2
47	Immobilizer Communication Line	Immobilizer Control Module
48	Engine speed signal output	Tachometer (Cluster)
49	Cruise Control "SET" Lamp control output	Cruise Control "SET" Lamp (Cluster)
50	-	
51	Lambda Sensor Heater control output	Lambed Sesnor
52	-	-
53	-	
54	A/C Switch "ON" signal input	A/C Switch
55	-	
56	Thermo Switch signal input	A/C Switch
57	Neutral Switch signal input (M/T Only)	Neutral Switch
58	-	
59	-	

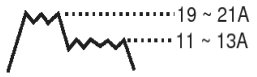
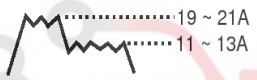
Pin	Description	Connected to
60	-	
61	-	
62	-	
63	-	
64	VS+ (NERNST Cell Voltage)	Lambda Sensor
65	Rc/Rp (Pumping Cell Voltage)	Lambda Sensor
66	-	
67	-	
68	Malfunction Indicator Lamp (MIL) control output	Malfunction Indicator Lamp (MIL)
69	Glow Time Lamp contorl output	Glow Time Indicator Lamp (Cluster)
70	A/C Compressor Relay control output	A/C Compressor Relay
71	Cooling Fan Relay [LOW] control output	Cooling Fan Relay
72	Main Relay control output	Main Relay
73	-	
74	-	
75	Vehicle speed signal input	Vehicle Speed Sensor (VSS)
76	-	
77	Feedback signal input	Throttle Control Actuator
78	-	
79	Clutch Switch signal input (M/T Only)	Clutch Switch
80	Brake Switch "2" signal input	Brake Switch
81	MT/AT auto recognition signal input	M/T: Open, A/T: Ground
82	-	
83	CAN [LOW]	Other Control Modules
84	CAN [HIGH]	Other Control Modules
85	-	
86	VS-/IP- (Virtual Ground)	Lambda Sensor
87	Rc (Compensative Resistance)	Lambda Sensor
88	-	
89	Intake Air Temperature Sensor (IATS) #1 signal input	Intake Air Temperature Sensor (IATS) #1 in MAFS
90	Throttle Control Actuator control output	Throttle Control Actuator
91	Cruise Control "MAIN" Lamp control output	Cruise Control "MAIN" Lamp (Cluster)
92	Immobilizer Lamp control output	Immobilizer Lamp (Cluster)
93	Glow Relay control output	Glow Relay

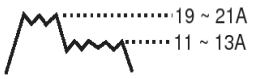
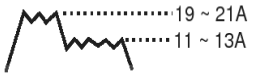
Pin	Description	Connected to
94	PTC Heater Relay control output	PTC Heater Relay

3. ECM TERMINAL INPUT/OUTPUT SIGNAL

CONNECTOR [CDD-A]

Pin	Description	Condition	Type	Level
1	Injector (Cylinder #3) [HIGH] control output	Idle	Pulse	Battery Voltage ~ 80V
2	Injector (Cylinder #2) [HIGH] control output	Idle	Pulse	Battery Voltage ~ 80V
3	-	-	-	-
4	Battery power	Idle	DC	Battery Voltage
5	-	-	-	-
6	Sensor ground	Idle	DC	Max. 50mV
7	Sensor shield	Idle	DC	Max. 50mV
8	Sensor ground	Idle	DC	Max. 50mV
9	-	-	-	-
10	-	-	-	-
11	-	-	-	-
12	Crankshaft Position Sensor (CKPS) [-] signal input	Idle	Sine Wav-e	Vpeak_to_peak: Min.1 .0V
13	Sensor power (+5V)	IG OFF	DC	Max. 0.5V
		IG ON		4.9 ~ 5.1V
14	-	-	-	-
15	-	-	-	-
16	Injector (Cylinder #1) [HIGH] control output	Idle	Pulse	Battery Voltage ~ 80V
17	Injector (Cylinder #4) [HIGH] control output	Idle	Pulse	Battery Voltage ~ 80V
18	-	-	-	-
19	Battery power	IG OFF	DC	Max. 0.5V
		IG ON		Battery Voltage
20	Sensor ground	Idle	DC	Max. 50mV
21	-	-	-	-
22	-	-	-	-
23	Sensor ground	Idle	DC	Max. 50mV
24	-	-	-	-
25	-	-	-	-
26	Sensor power (+5V)	IG OFF	DC	Max. 0.5V
		IG ON		4.9 ~ 5.1V
27	Crankshaft Position Sensor (CKPS) [+] signal input	Idle	Sine Wav-e	Vpeak_to_peak: Min.1 .0V

Pin	Description	Condition	Type	Level
28	Sensor power (+5V)	IG OFF	DC	Max. 0.5V
		IG ON		4.9 ~ 5.1V
29	-	-	-	-
30	Motor [-] control output	Active	DC	Max.0.5V
31	Injector (Cylinder #2) [LOW] control output	Idle	Pulse	Peak Current: 19 ~ 21 A Hold Current: 11 ~ 13 A 
32	-	-	-	-
33	Injector (Cylinder #4) [LOW] control output	Idle	Pulse	Peak Current: 19 ~ 21 A Hold Current: 11 ~ 13 A 
34	Rail Pressure Regulator Valve control output	Idle	Pulse	Hi: Battery Voltage Lo: Max. 1.0V Frequency = 1kHz ± 2%
35	-	-	-	-
36	-	-	-	-
37	Reference frequency	Idle	Pulse	Hi: Vcc or Battery Voltage
				Lo: Max. 1.0V
38	-	-	-	-
39	-	-	-	-
40	Boost Pressure Sensor (BPS) signal input	IG ON	Analog	0.5 ~ 4.5V
41	Sensor ground	Idle	DC	Max. 50mV
42	Mass Air Flow Sensor (MAFS) signal input	Idle	Pulse	Hi: Vcc or Battery Voltage
				Lo: Max. 1.0V
43	Rail Pressure Sensor (RPS) signal input	IG ON	Analog	Max. 1.0V
		Idle		1.0 ~ 1.5V
		3000 RPM		1.5 ~ 3.0V
44	Sensor ground	Idle	DC	Max. 50mV

Pin	Description	Condition	Type	Level
45	Fuel Pump Relay control output	Relay OFF	DC	Battery Voltage
		Relay ON		Max. 1.0V
46	Injector (Cylinder #3) [LOW] control output	Idle	Pulse	Peak Current: 19 ~ 21 A Hold Current: 11 ~ 13 A 
47	Injector (Cylinder #1) [LOW] control output	Idle	Pulse	Peak Current: 19 ~ 21 A Hold Current: 11 ~ 13 A 
48	-	-	-	-
49	Fuel Pressure Regulator Valve control output	Idle	Pulse	Hi: Battery Voltage
				Lo: Max. 1.0V
50	Camshaft Position Sensor (CMPS) signal input	Idle	Pulse	Hi: Vcc or Battery Voltage
				Lo: Max. 1.0V
51	-	-	-	-
52	-	-	-	-
53	Intake Air Temperature Sensor (IATS) #2 signal input	Idle	Analog	0.5 ~ 4.5V
54	-	-	-	-
55	-	-	-	-
56	Position Sensor signal input	Idle	DC	0.5 ~ 4.5V
57	-	-	-	-
58	Engine Coolant Temperature Sensor (ECTS) signal input	Idle	Analog	0.5 ~ 4.5V
59	Electric EGR Control Valve control output	Idle	Pulse	Hi: Battery Voltage
				Lo: Max. 1.0V
60	Motor [+] control output	Active	Pulse	Hi: Battery Voltage
				Lo: Max. 1.0V

CONNECTOR [CDD-K]

Pin	Description	Condition	Type	Level
1	Battery power	IG OFF	DC	Max. 1.0V
		IG ON		Battery Voltage
2	Power ground	Idle	DC	Max. 50mV
3	Battery power	IG OFF	DC	Max. 1.0V
		IG ON		Battery Voltage
4	Power ground	Idle	DC	Max. 50mV
5	Battery power	IG OFF	DC	Max. 1.0V
		IG ON		Battery Voltage
6	Power ground	Idle	DC	Max. 50mV
7	Cooling Fan Relay [HIGH] control output	Relay OFF	DC	Battery Voltage
		Relay ON		Max. 1.0V
8	Sensor ground	Idle	DC	Max. 50mV
9	Accelerator Position Sensor (APS) #1 signal input	C.T	Analog	0.3 ~ 0.9V
		W.O.T		4.0 ~ 4.8V
10	Sensor ground	Idle	DC	Max. 50mV
11	Fuel Temperature Sensor (FTS) signal input	IG ON	Analog	0.5 ~ 4.5V
12	Sensor ground	Idle	DC	Max. 50mV
13	A/C Pressure Transducer signal input	A/C On	Analog	Max. 4.8V
14	Ground	Idle	DC	Max. 50mV
15	Cruise Control "ACTIVATOR" signal input	-	-	-
16	Ground	Idle	DC	Max. 50mV
17	-	-	-	-
18	-	-	-	-
19	ESP auto recognition signal input	Idle	DC	Max. 50mV (With ESP)
20	-	-	-	-
21	-	-	-	-
22	Sensor power (+5V)	IG OFF	DC	Max. 0.5V
		IG ON		4.9 ~ 5.1V
23	-	-	-	-
24	Sensor power (+5V)	IG OFF	DC	Max. 0.5V
		IG ON		4.9 ~ 5.1V

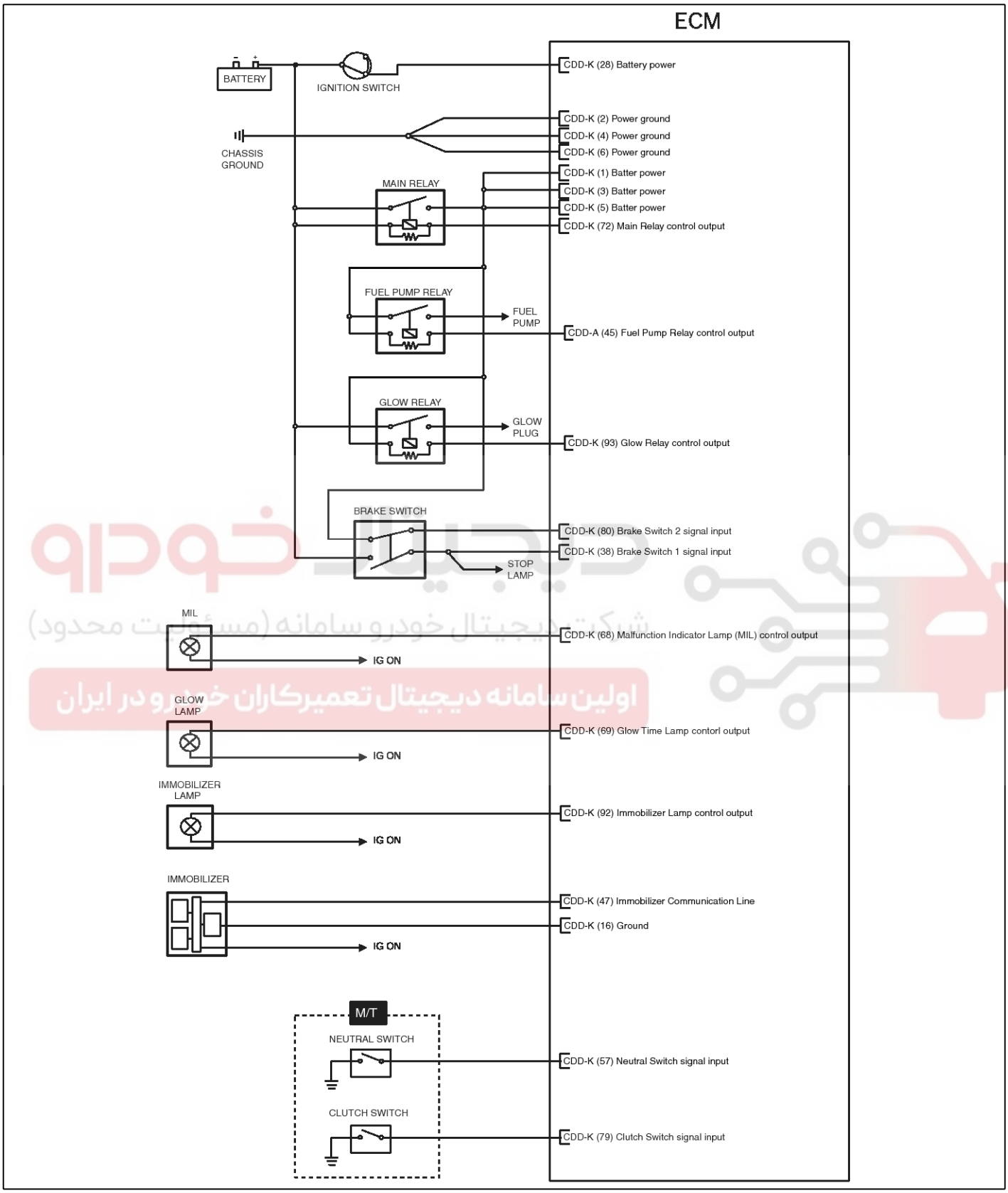
Pin	Description	Condition	Type	Level
25	Diagnosis K-Line	When transmitti-ng	Pulse	Hi: Min. VbattX80%
				Lo: Max. VbattX20%
		When receiving		Hi: Min. VbattX70%
				Lo: Max. VbattX30%
26	-	-	-	-
27	Fuel consumption signal output	Idle	Pulse	Hi: Battery Voltage or Vcc
				Lo: Max. 0.5V
28	Battery power	IG OFF	DC	Max. 1.0V
		IG ON		Battery Voltage
29	VGT Control Solenoid Valve control output	Idle	Pulse	Hi: Battery Voltage
				Lo: Max. 0.5V
30	Sensor ground	Idle	DC	Max. 50mV
31	Accelerator Position Sensor (APS) #2 signal input	C.T	Analog	0.3 ~ 0.9V
		W.O.T		1.5 ~ 3.0V
32	Exhaust Gas Temperature Sensor (EGTS) #2 signal input	Idle	Analog	0.5 ~ 4.5V
33	Sensor ground	Idle	DC	Max. 50mV
34	Exhaust Gas Temperature Sensor (EGTS) #1 signal input	Idle	Analog	0.5 ~ 4.5V
35	Sensor ground	Idle	DC	Max. 50mV
36	Differential Pressure Sensor (DPS) signal input	Idle	Analog	0.5 ~ 4.5V
37	Sensor ground	Idle	DC	Max. 50mV
38	Brake Switch "1" signal input	Release	DC	Max. 0.5V
		Push		Battery Voltage
39	-	-	-	-
40	Water Sensor siganl input	Full of Water	Analog	Battery Voltage
		No Water		Max. 1.0V
41	-	-	-	-
42	A/C Pressure Switch Signal input	Blower Off	DC	Battery Voltage
		Blower On		Max. 2.0V
43	-	-	-	-
44	Sensor power (+5V)	IG OFF	DC	Max. 0.5V
		IG ON		4.9 ~ 5.1V
45	Sensor power (+5V)	IG OFF	DC	Max. 0.5V
		IG ON		4.9 ~ 5.1V

Pin	Description	Condition	Type	Level
46	Sensor power (+5V)	IG OFF	DC	Max. 0.5V
		IG ON		4.9 ~ 5.1V
47	Immobilizer Communication Line	After IG ON wh-en communicati-ng	Pulse	Hi: Min. 8.5V
				Lo: Max. 3.5V
48	Engine speed signal output	Idle	Pulse	Hi: Battery Voltage
				Lo: Max. 5.0V
				Frequency: 50 ~ 60Hz
49	Cruise Control "SET" Lamp control output	-	-	-
50	-	-	-	-
51	Lambda Sensor Heater control output	Vehicle Run	Pulse	Hi: Battery Voltage
				Lo: Max. 1.0V
52	-	-	-	-
53	-	-	-	-
54	A/C Switch "ON" signal input	A/C SW OFF	DC	Max. 1.0V
		A/C SW ON		Battery Voltage
55	-	-	-	-
56	Thermo Switch signal input	A/C OFF	DC	Max. 0.5V
		A/C ON		Battery Voltage
57	Neutral Switch signal input (M/T Only)	SW OFF (Neutr-al)	DC	Battery Voltage
		SW ON (1st)		Max. 0.5V
58	-	-	-	-
59	-	-	-	-
60	-	-	-	-
61	-	-	-	-
62	-	-	-	-
63	-	-	-	-
64	VS+ (NERNST Cell Voltage)	Engine Run	Analog	Normal: 450 ± 50mV Rich: Max. Normal + 1 50mV Lean: Min. Normal - 1 50mV
65	Rc/Rp (Pumping Cell Voltage)	Engine Run	Analog	Normal: 0 ± 500mV Rich: Min. Normal - 1. 5V Lean: Max. Normal + 1.5V

Pin	Description	Condition	Type	Level
66	-	-	-	-
67	-	-	-	-
68	Malfunction Indicator Lamp (MIL) control output	Lamp OFF	DC	Battery Voltage
		Lamp ON		Max. 1.0V
69	Glow Time Lamp control output	Glow OFF	DC	Battery Voltage
		Glow ON		Max. 1.0V
70	A/C Compressor Relay control output	A/C OFF	DC	Battery Voltage
		A/C ON		Max. 1.0V
71	Cooling Fan Relay [LOW] control output	Relay OFF	DC	Battery Voltage
		Relay ON		Max. 1.0V
72	Main Relay control output	Relay OFF	DC	Battery Voltage
		Relay ON		Max. 1.0V
73	-	-	-	-
74	-	-	-	-
75	Vehicle speed signal input	Vehicle Run	Pulse	Hi: Min. 5.0V
				Lo: Max. 1.0V
76	-	-	-	-
77	Feedback signal input	Normal	DC	Battery Voltage
		Abnormal		Max. 0.5V
78	-	-	-	-
79	Clutch Switch signal input (M/T Only)	Release	DC	Max. 0.5V
		Push		Battery Voltage
80	Brake Switch "2" signal input	Release	DC	Battery Voltage
		Push		Max. 0.5V
81	MT/AT auto reconition signal input	MT	DC	Battery Voltage
		AT		Max. 0.5V
82	-	-	-	-
83	CAN [LOW]	RECESSIVE	Pulse	2.0 ~ 3.0V
		DOMINANT		0.5 ~ 2.25V
84	CAN [HIGH]	RECESSIVE	Pulse	2.0 ~ 3.0V
		DOMINANT		2.75 ~ 4.5V
85	-	-	-	-
86	VS-/IP- (Virtual Ground)	Engine Run	Analog	2.4 ~ 2.6V
87	Rc (Compensative Resistance)	Engine Run	Analog	|Current Pump - Current Adjust| < 0.2V

Pin	Description	Condition	Type	Level
88	-	-	-	-
89	Intake Air Temperature Sensor (IATS) #1 signal input	Idle	Analog	0.5 ~ 4.5V
90	Throttle Control Actuator control output	Key ON /Key O-FF	Pulse	Hi: Battery Voltage
				Lo: Max. 1.0V
91	Cruise Control "MAIN" Lamp control output	-	-	-
92	Immobilizer Lamp control output	Lamp OFF	DC	Battery Voltage
		Lamp ON		Max. 1.0V
93	Glow Relay control output	Relay OFF	DC	Battery Voltage
		Relay ON		Max. 1.0V
94	PTC Heater Relay control output	Relay OFF	DC	Battery Voltage
		Relay ON		Max. 1.0V

CIRCUIT DIAGRAM



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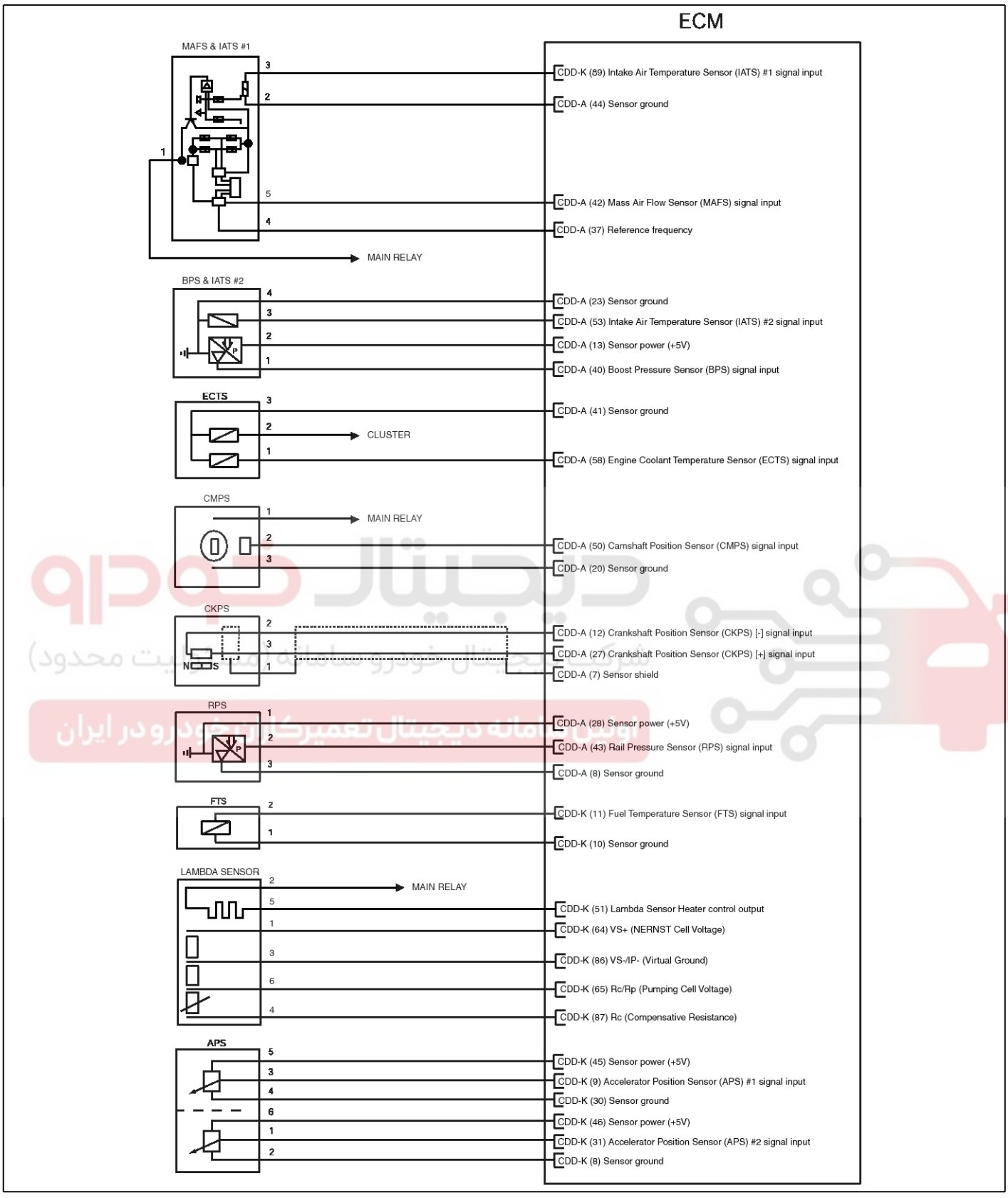

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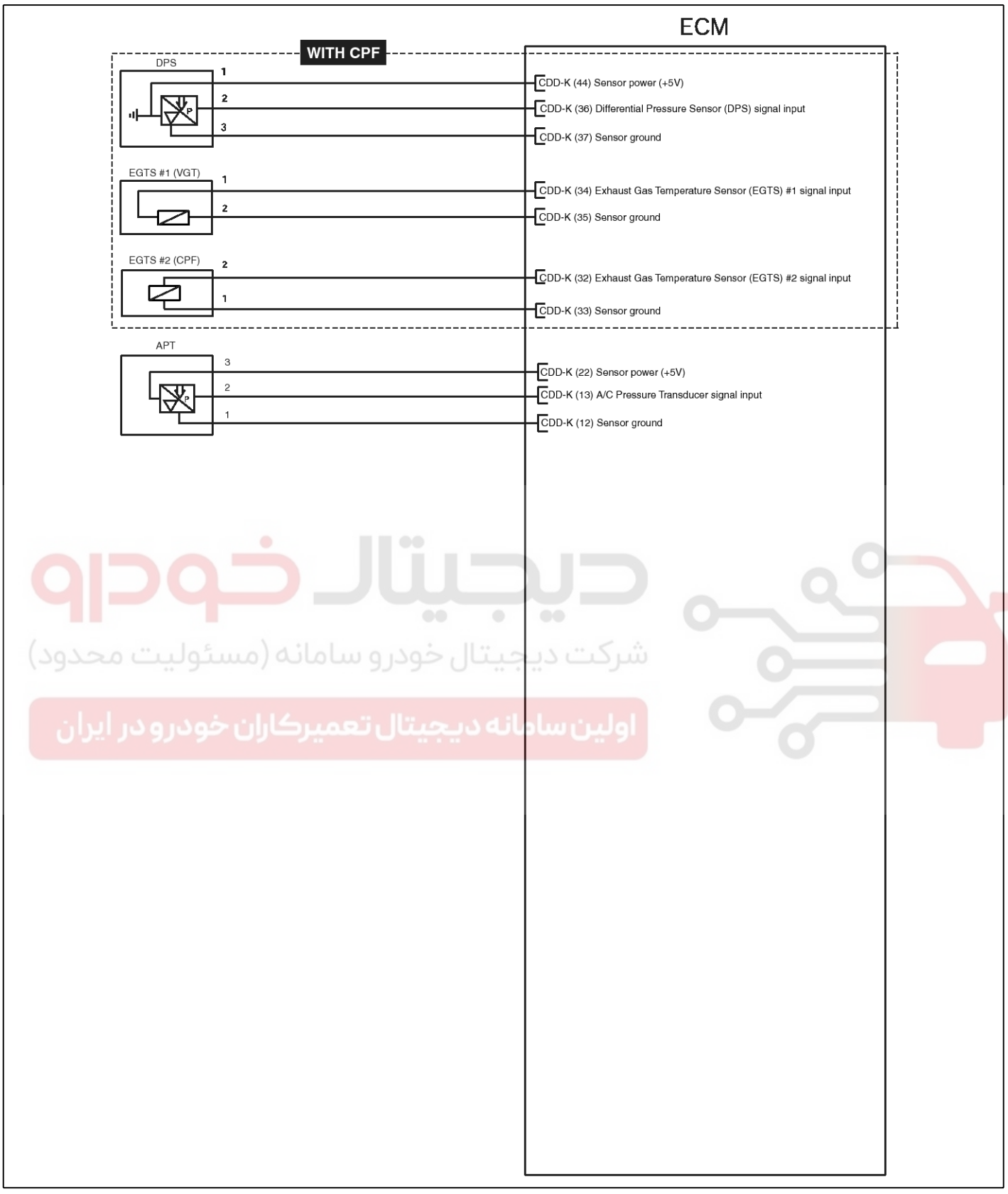

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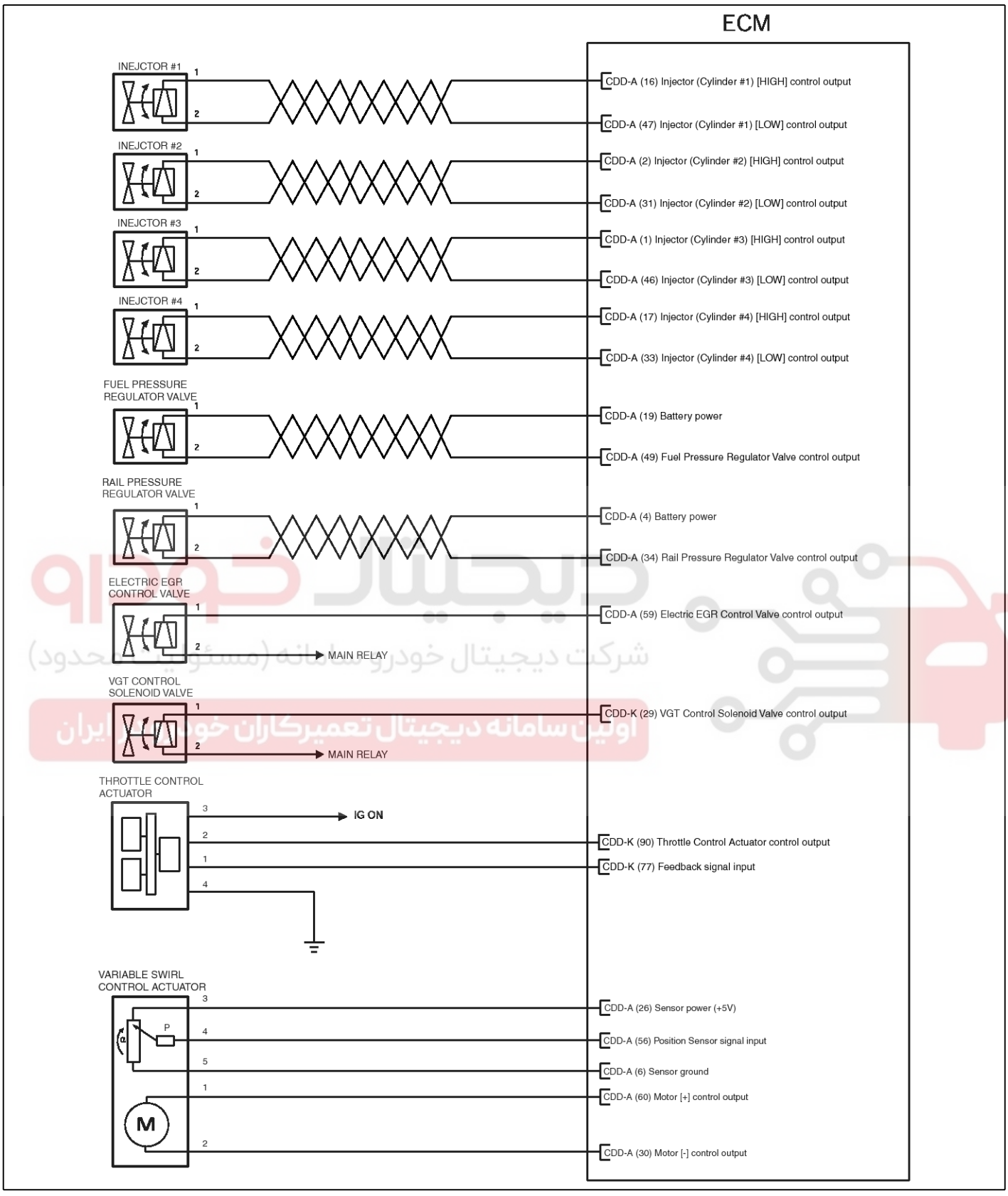
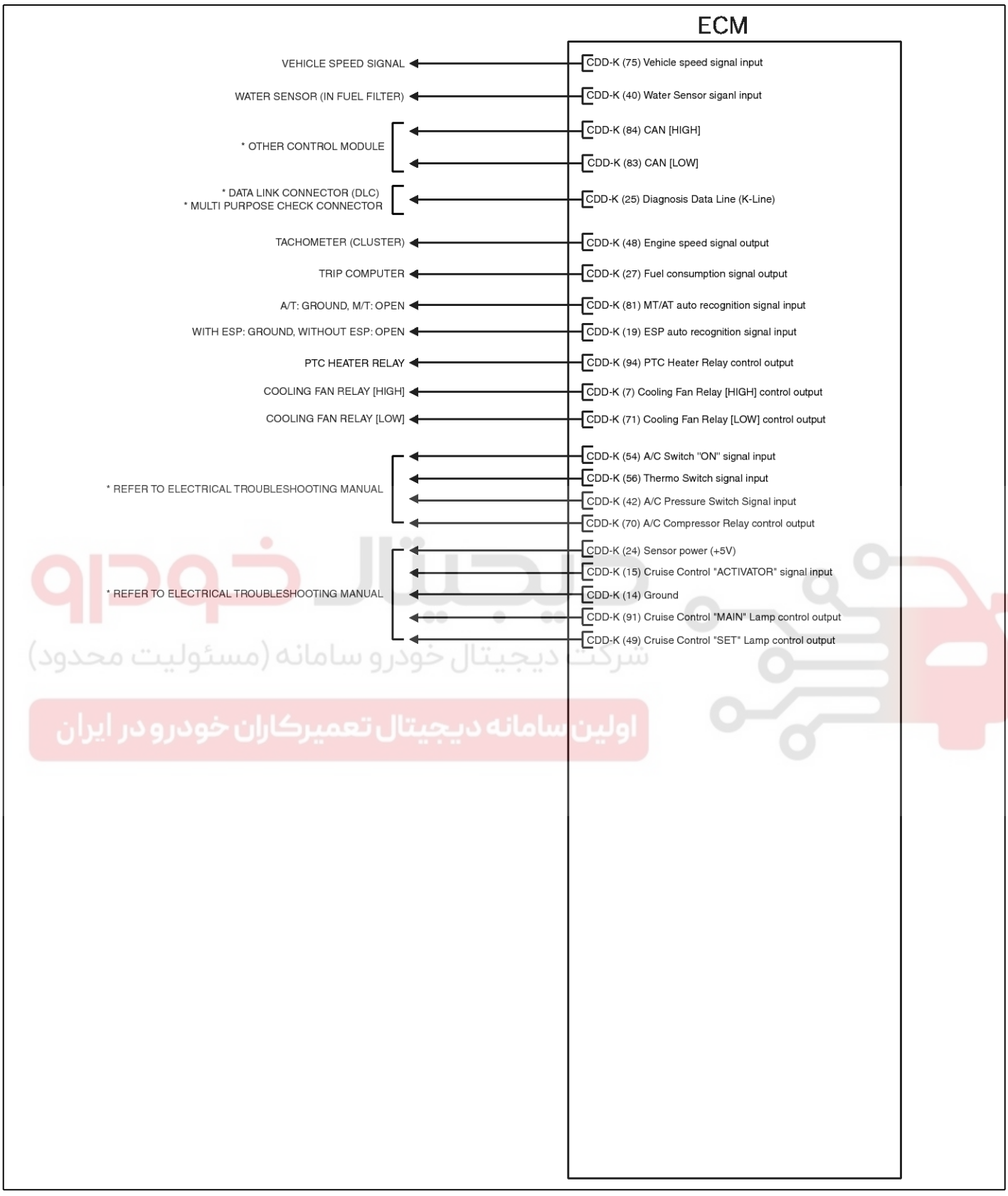


SFDF38207L



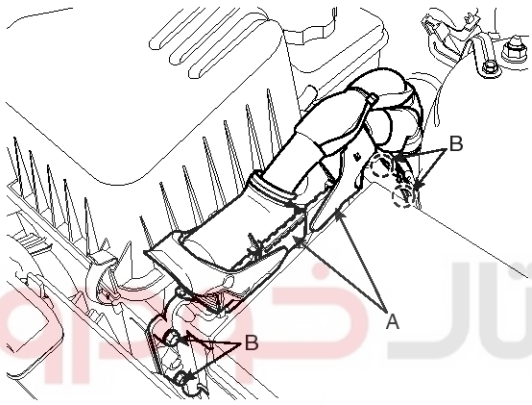
SFDF38266L

REPLACEMENT

⚠CAUTION

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

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



SFDF38208L

3. Unscrew the ECM mounting bolts (B) and remove the ECM.
4. Install a new ECM.

ECM installation bolts: 7.8 ~ 11.8 N·m (0.8 ~ 1.2 kgf·m, 5.8 ~ 8.7 lbf·ft)

5. Connect the negative(-) battery cable.
6. Perform "ECM Change" procedure [With CPF].
   1) Turn ignition switch OFF.
   2) Connect a scan tool to Data Link Connector (DLC).
   3) Turn ignition switch ON.
   4) Select "COMPONENT CHANGE ROUTINE".

```
MODEL  : VEHICLE NAME
SYSTEM : ENGINE(DIESEL)

  04. ACTUATION TEST
  05. SIMU-SCAN
  06. IDENTIFICATION CHECK
  07. ENGINE TEST FUNCTION
  08. CPF SERVICE REGENERATION
  09. COMPONENT CHANGE ROUTINE
  10. INJECTOR SPECIFIC DATA
  11. DATA SETUP(UNIT CONV.)
```

SFDF28235L

   5) Select "ECU CHANGE".

```
MODEL  : VEHICLE NAME
SYSTEM : ENGINE(DIESEL)

01. ECU CHANGE
02. LAMBDA SENSOR CHANGE
03. RAIL PRESSURE SENSOR CHANGE
04. AIR FLOW SENSOR CHANGE
05. CPF CHANGE
06. D/PRESSURE SENSOR CHANGE
07. SWIRL CONTROL VALVE CHANGE
```

SFDF28236L

   6) Input the mileage in odometer.

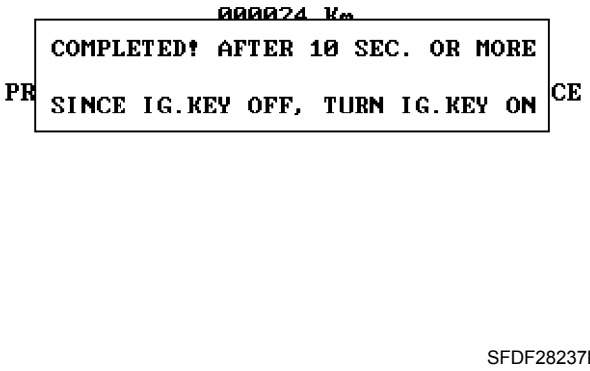
```
                <ECU CHANGE>

1.IN PUT THE CURRENT ODO VALUES IN
 CLUSTER TO COUNT THE DRIFT SOOT
 VALUE INFORMATION OF CPF.
              000000 Km
2.REFER TO PREVIOUS MENU TO SEE
  INJECTOR INFORMATION.


        PRESS [ENTER] KEY.
```

LFIG108A

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



SFDF28237L

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

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

ECM PROBLEM INSPECTION PROCEDURE

1. TEST ECM GROUND CIRCUIT: Measure resistance between ECM and chassis ground using the backside of ECM harness connector as ECM side check point. If the problem is found, repair it.
2. TEST ECM CONNECTOR: Disconnect the ECM connector and visually check the ground terminals on ECM side and harness side for bent pins or poor contact contact pressure. If the problem is found, repair it.
3. If problem is not found in Step 1 and 2, the ECM could be faulty. If so, replace the ECM with a new one, and then check the vehicle again. If the vehicle operates normally then the problem was likely with the ECM.
4. RE-TEST THE ORIGINAL ECM : Install the original ECM (may be broken) into a known-good vehicle and check the vehicle. If the problem occurs again, replace the original ECM with a new one. If problem does not occur, this is intermittent problem (Refer to INTERMITTENT PROBLEM PROCEDURE in BASIC INSPECTION PROCEDURE)

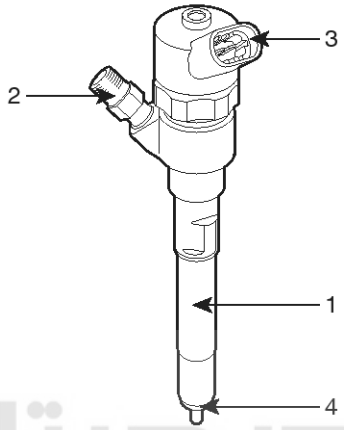
Injector

DESCRIPTION

The start of injection and the injected fuel quantity are adjusted by electrically triggered injectors. These injectors supersede the nozzle-and-holder assembly (nozzle and nozzle-holder).

Similar to the already existing nozzle-holder assemblies in direct-injection (DI) diesel engines, clamps are preferably used for installing the injectors in the cylinder head. This means that the Common Rail injectors can be installed in already existing DI diesel engines without major modifications to the cylinder head.

COMPONENTS



1. Injector
2. Fuel Inlet
3. Connector
4. O-ring

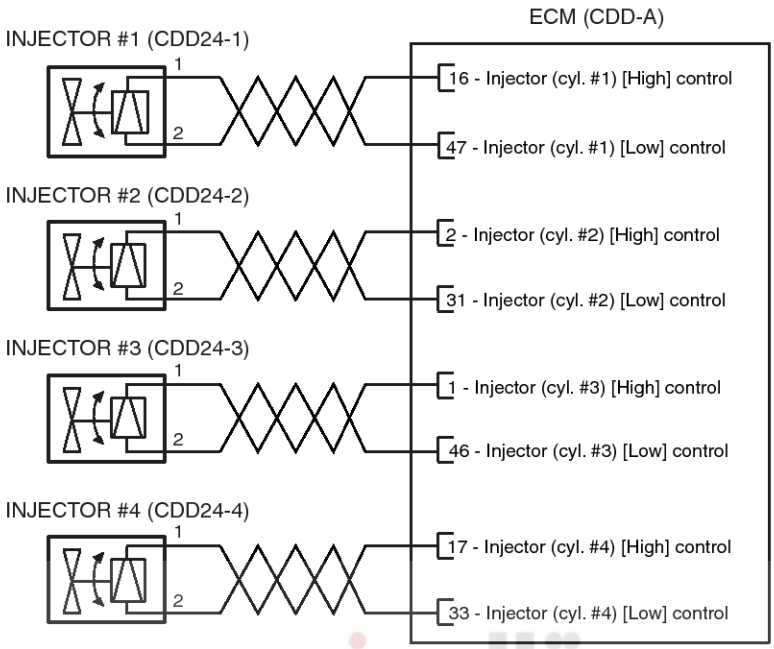
SFDF38209L

SPECIFICATION

Items	Specification
Coil Resistance (Ω)	0.33Ω [20℃(68˚F)]

CIRCUIT DIAGRAM

[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

INJECTOR #1 (CDD24-1)

Terminal	Connected to	Function
1	ECM CDD-A (16)	Injector (cyl. #1) [HIGH]
2	ECM CDD-A (47)	Injector (cyl. #1) [LOW]

INJECTOR #2 (CDD24-2)

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

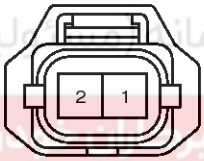
INJECTOR #3 (CDD24-3)

Terminal	Connected to	Function
1	ECM CDD-A (1)	Injector (cyl. #3) [HIGH]
2	ECM CDD-A (46)	Injector (cyl. #3) [LOW]

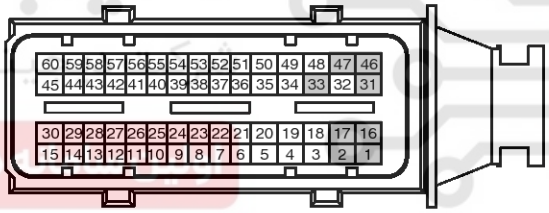
INJECTOR #4 (CDD24-4)

Terminal	Connected to	Function
1	ECM CDD-A (17)	Injector (cyl. #4) [HIGH]
2	ECM CDD-A (33)	Injector (cyl. #4) [LOW]

[HARNESS CONNECTOR]



CDD24-1,2,3,4
INJECTOR #1,2,3,4



CDD-A
ECM

SFDF38210L

REMOVAL

⚠CAUTION

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

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

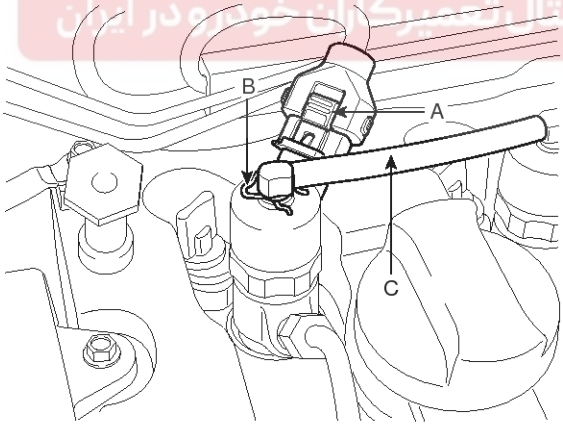
  - Spread oil on the injector O-ring.

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

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

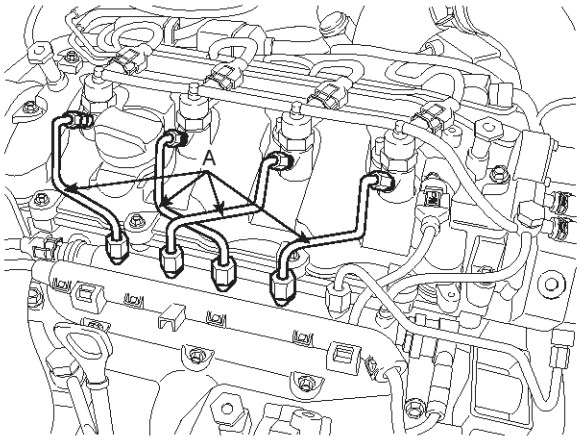
  - Install the flange nut correctly.

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



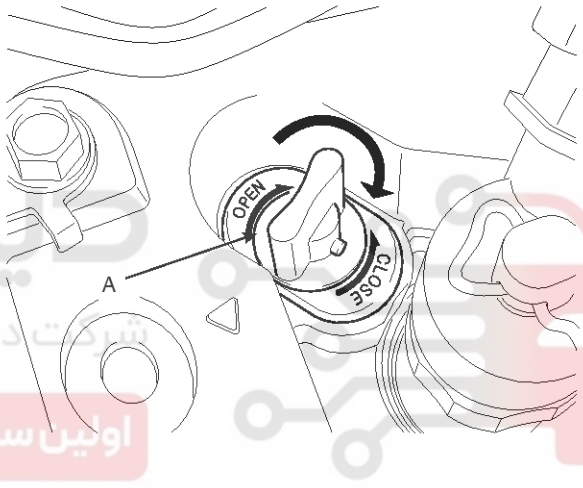
LFIG084A

3. After removing the clip (B), disconnect the retun hose (C) from the injectors.
4. Disconnect the high pressure fuel pipe (A) connecting the injectors with the common rail.



SFDF38211L

5. Rotate the lever (A) clockwise and pull it upward.

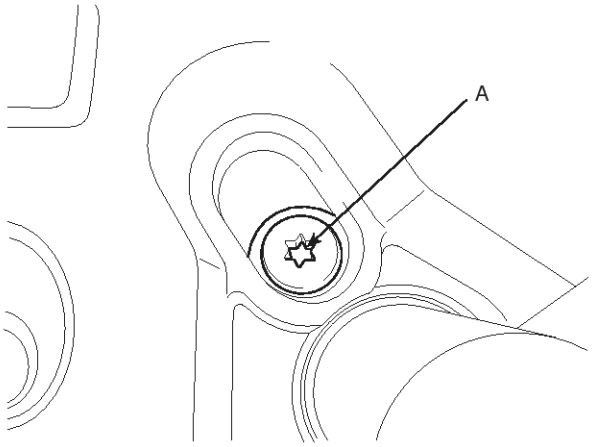


SMGFL6142L

6. Unscrew the clamp tightening bolt (A) and pull the injector upward.

NOTICE

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



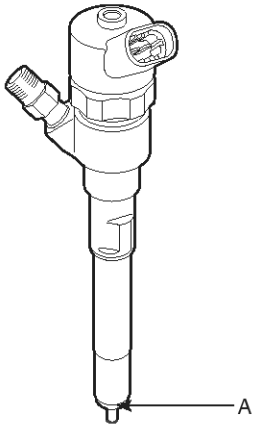
LFIG087A

INSTALLATION

1. Installation is reverse of removal.

NOTICE

When installing the injector, MUST REPLACE the O-ring (A) and apply a grease to that.



LFIG089A

NOTICE

When installing the high pressure fuel pipe, apply the specified tightening torques with the special service tool (Refer to below table).

Item	Dimension	SST No.
Flange Nut (Injector Side)	14 mm (0.551 in)	09314-27110
Flange Nut (Common Rail Side)	17 mm (0.669 in)	09314-27120

· Injector clamp installation bolt: 24.5 ~ 28.4 N·m (2.5 ~ 2.9 kgf·m, 18.1 ~ 20.1 lbf·ft)
· High pressure fuel pipe installation nut: 24.5 ~ 28.4 N·m (2.5 ~ 2.9 kgf·m, 18.1 ~ 20.1 lbf·ft)

REPLACEMENT

CAUTION

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

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

  - Spread oil on the injector O-ring.

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

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

  - Install the flange nut correctly.

CAUTION

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

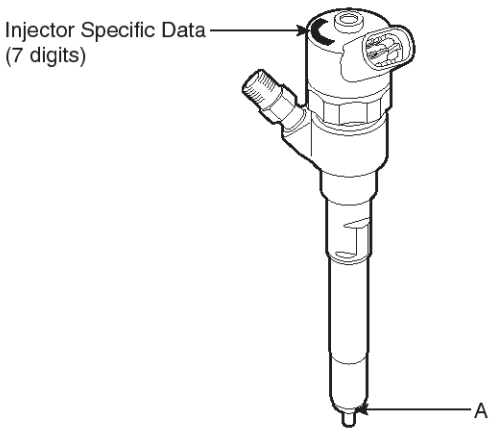
1. Remove the injector (Refer to "REMOVAL" procedure).
2. Install the injector (Refer to "INSTALLATION" procedure).
3. Perform "Injector Specific Data Input" procedure (Refer to "INJECTOR SPECIFIC DATA INPUT" procedure).

INJECTOR SPECIFIC DATA INPUT

⚠CAUTION

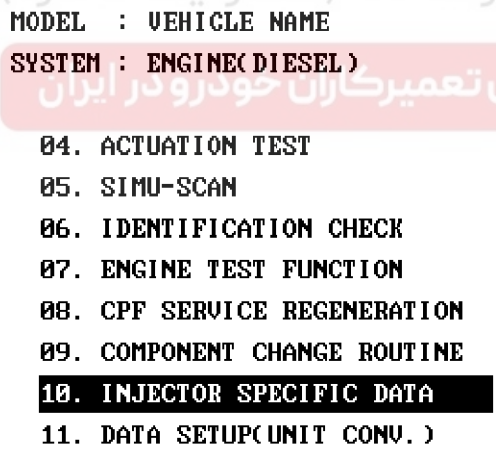
After replacing injector, MUST input the injector specific data (7 digit) of each cylinder into ECM with scan tool.

NOTICE



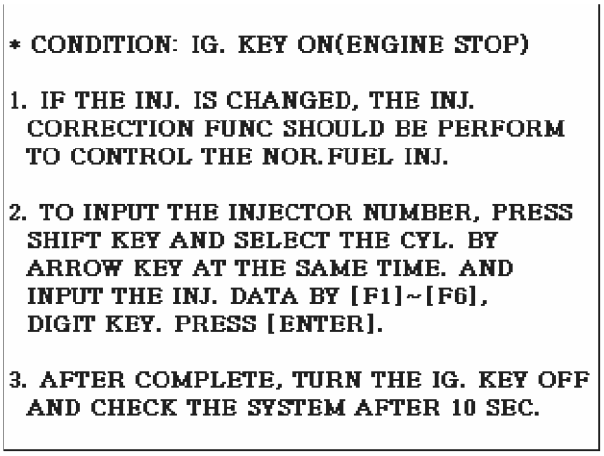
SFDF38212L

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



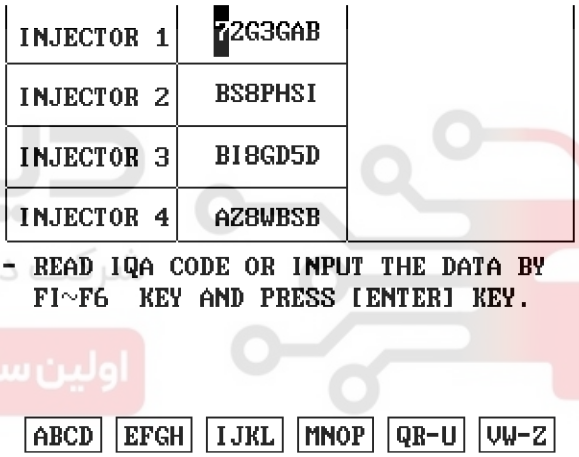
SFDF28239L

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



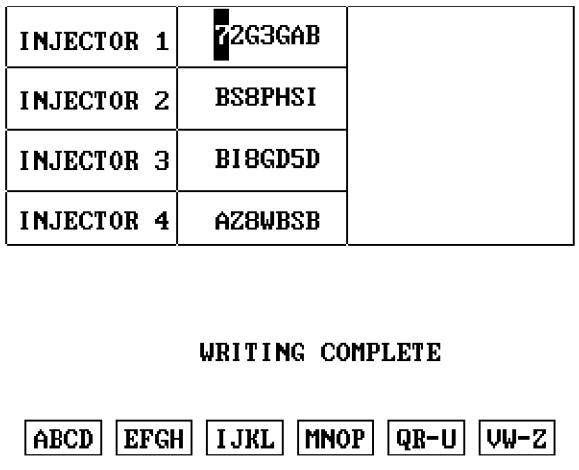
LFIG111A

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



SFDF28240L

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



SFDF28241L

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

NOTICE

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

INJECTOR 1	72G3GAB	
INJECTOR 2	BS8PHSI	
INJECTOR 3	BI8GD5D	
INJECTOR 4	AZ8WBSB	

WRITING FAIL

ABCD EFGH IJKL MNOP QR-U VW-Z

SFDF28242L

INSPECTION

[COMPRESSION TEST]

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

```
MODEL  : VEHICLE NAME
SYSTEM : ENGINE(DIESEL)

  01. DIAGNOSTIC TROUBLE CODES
  02. CURRENT DATA
  03. FLIGHT RECORD
  04. ACTUATION TEST
  05. SIMU-SCAN
  06. IDENTIFICATION CHECK
  07. ENGINE TEST FUNCTION
  08. CPF SERVICE REGENERATION
```

SFDF28243L

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

```
      System Information

  ECU H/W: 00000-00000
  ROM ID : 0000000000000


  THIS FUNCTION IS AVAILABE.

  If you ready, Press[ENTER].
```

SFDF28244L

6. Select "COMPRESSION TEST".

```
  01. COMPRESSION TEST
  02. IDLE SPEED COMPARISON
  03. INJECT. QUANTITY COMPARISON
```

SFDF28245L

7. Perform the test in accordance with the message.

```
This test is used for detecting
cylinder specific engine speed
without injection.
 *Test condition
   -Shift level     : P or N
   -Engine          : Stop(IGN. ON)
   -Electrical Load : OFF

If you ready, now cranking, and stop
cranking when stop message appear on
the screen. Press[ENTER].
```

SFDF28246L

CYLINDER ENGINE SPEED(RPM)			
#1	#2	#3	#4
257	259	259	258
263	259	259	258
263	259	263	258
263	260	263	261
256	260	263	261
256	260	258	256
256	259	258	256

ANALYZE THE TEST RESULT.

ANAL

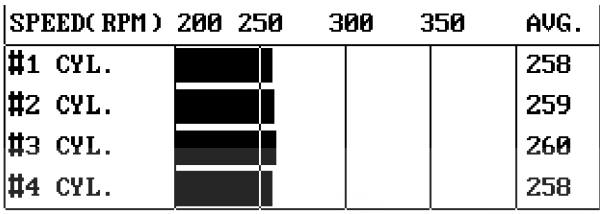
SFDF28247L

CYLINDER ENGINE SPEED(RPM)

#1	#2	#3	#4
259	261	266	260
259	261	259	257
259	257	259	257
258	257	259	257
258	257	260	260
258	259	260	260
257	259	259	260

<< >> AVG HELP

SFDF28248L



PREV HELP

SFDF28249L

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

PREV

SFDF28250L

NOTICE

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

[IDLE SPEED COMPARISON]

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

```
MODEL  : VEHICLE NAME
SYSTEM : ENGINE(DIESEL)

  01. DIAGNOSTIC TROUBLE CODES
  02. CURRENT DATA
  03. FLIGHT RECORD
  04. ACTUATION TEST
  05. SIMU-SCAN
  06. IDENTIFICATION CHECK
  07. ENGINE TEST FUNCTION
  08. CPF SERVICE REGENERATION
```

SFDF28243L

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

```
System Information

ECU H/W: 00000-00000
ROM ID : 000000000000

THIS FUNCTION IS AVAILABE.

If you ready, Press[ENTER].
```

SFDF28244L

6. Select "IDLE SPEED COMPARISON".

```
01. COMPRESSION TEST
02. IDLE SPEED COMPARISON
03. INJECT. QUANTITY COMPARISON
```

SFDF28251L

7. Perform the test in accordance with the message.

```
This test is used for detecting
cylinder specific engine speed with
injector energizing.
(Cylinder balancing function is
deactivated.)
 *Test condition
   -Compression test : Normal
   -Shift level      : P or N
   -Engine           : Idle
   -Electrical Load  : OFF
 IF you ready, Press[ENTER].
```

SFDF28252L

CYLINDER ENGINE SPEED(RPM)

#1	#2	#3	#4
909	904	909	900
911	904	913	899
911	906	911	901
913	905	911	903
909	903	910	900
908	905	906	900
913	904	911	902

ANALYZE THE TEST RESULT.

ANAL

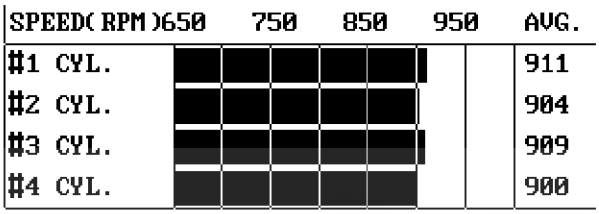
SFDF28253L

CYLINDER ENGINE SPEED(RPM)

#1	#2	#3	#4
909	904	909	900
911	904	913	899
911	906	911	901
913	905	911	903
909	903	910	900
908	905	906	900
913	904	911	902

<< >> AVG HELP

SFDF28254L



PREV HELP

SFDF28255L

*The lower engine speed:
->The injector injects less quantity than other injectors.
*The higher engine speed:
->The injector injects more quantity than other injectors.

PREV

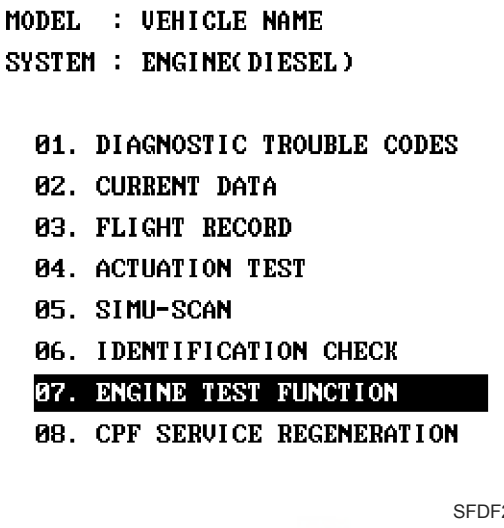
SFDF28256L

NOTICE

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

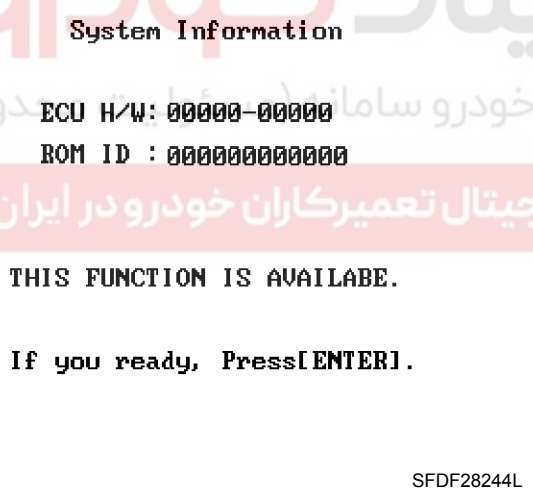
[INJECTION QUANTITY COMPARISON]

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



SFDF28243L

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

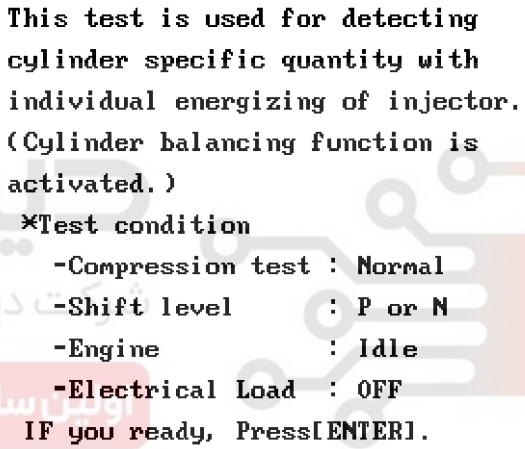


SFDF28244L

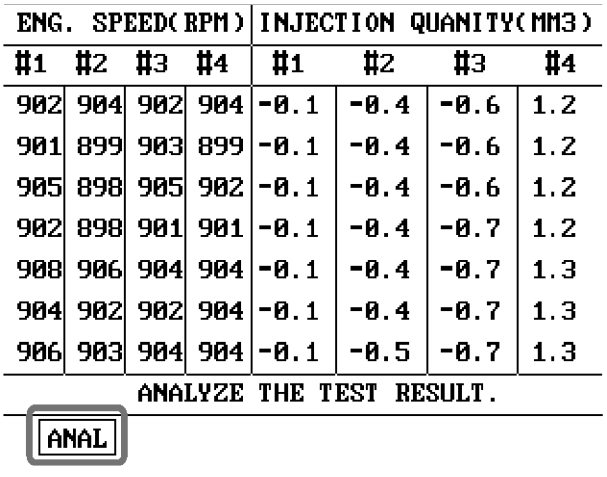
6. Select "INJECTION QUANTITY COMPARISON".

SFDF28257L

7. Perform the test in accordance with the message.



SFDF28258L



ENG. SPEED(RPM)				INJECTION QUANITY(MM3)			
#1	#2	#3	#4	#1	#2	#3	#4
902	904	902	904	-0.1	-0.4	-0.6	1.2
901	899	903	899	-0.1	-0.4	-0.6	1.2
905	898	905	902	-0.1	-0.4	-0.6	1.2
902	898	901	901	-0.1	-0.4	-0.7	1.2
908	906	904	904	-0.1	-0.4	-0.7	1.3
904	902	902	904	-0.1	-0.4	-0.7	1.3
906	903	904	904	-0.1	-0.5	-0.7	1.3

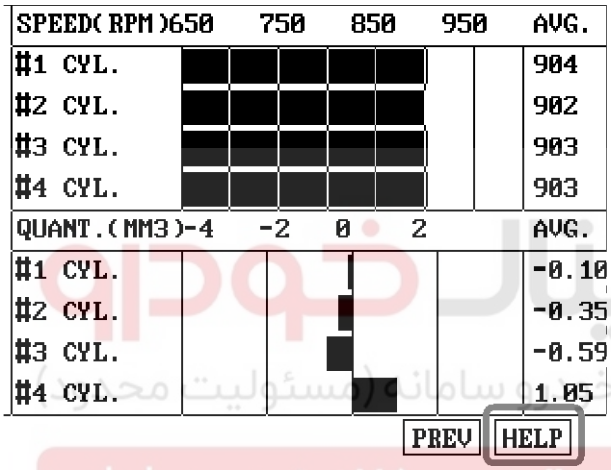
SFDF28259L

ENG. SPEED(RPM)				INJECTION QUANITY(MM3)			
#1	#2	#3	#4	#1	#2	#3	#4
902	904	902	904	-0.1	-0.4	-0.6	1.2
901	899	903	899	-0.1	-0.4	-0.6	1.2
905	898	905	902	-0.1	-0.4	-0.6	1.2
902	898	901	901	-0.1	-0.4	-0.7	1.2
908	906	904	904	-0.1	-0.4	-0.7	1.3
904	902	902	904	-0.1	-0.4	-0.7	1.3
906	903	904	904	-0.1	-0.5	-0.7	1.3

ANALYZE THE TEST RESULT.

<< >> AVG HELP

SFDF28260L



SFDF28261L

*The positive correction value:
->The fuel injection of the cylinder is less than that of other cylinder.
*The negative correction value:
->The fuel injection of the cylinder is more than that of other cylinder.
*Extreme correction value identifies a problematic injector.
After replacing a injector with newone ,retest & confirm the engine condition

PREV

SFDF28262L

NOTICE

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

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

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

Mass Air Flow Sensor (MAFS)

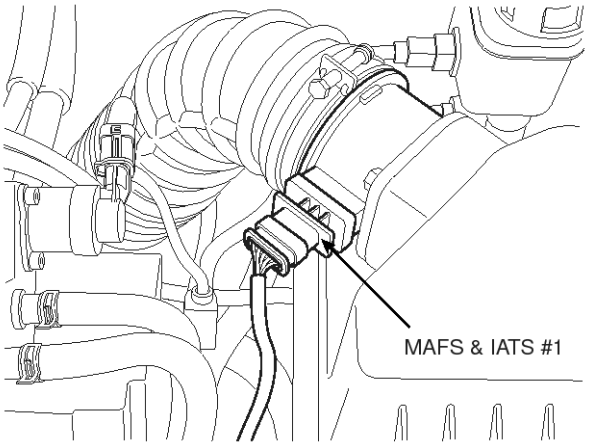
INSPECTION

FUNCTION AND OPERATION PRINCIPLE

MAFS uses a hot-film type sensing element to measure the mass of intake air entering the engine, and send the signal to ECM.

A large amount of intake air represents acceleration or high load conditions while a small amount of intake air represents deceleration or idle.

The ECM uses this information to control the EGR solenoid valve and correct the fuel amount.



SMGFL6701A

SPECIFICATION

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

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

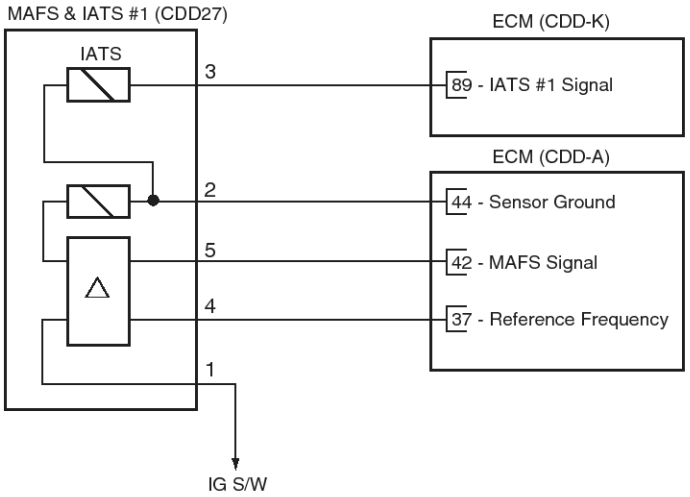
*At intake air temperature = -15℃(5˚F) or 80℃(176˚F)

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

LFIG034A

CIRCUIT DIAGRAM

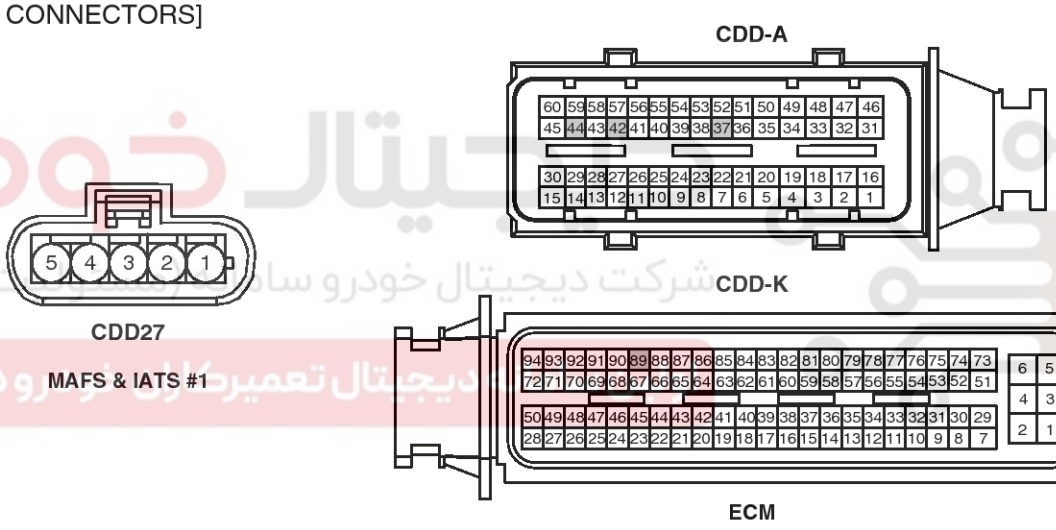
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	IG S/W	Power Supply (B+)
2	ECM CDD-A (44)	Sensor Ground
3	ECM CDD-K (89)	IATS #1 Signal
4	ECM CDD-A (37)	Reference Frequency
5	ECM CDD-A (42)	MAFS Signal

[HARNESS CONNECTORS]



SFDF38268L

SIGNAL WAVEFORM

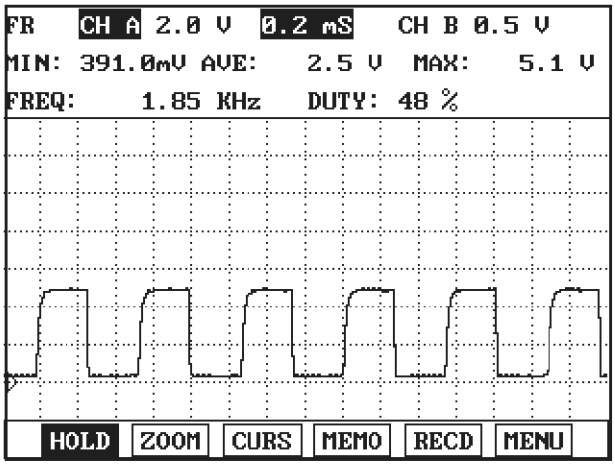


Fig.1

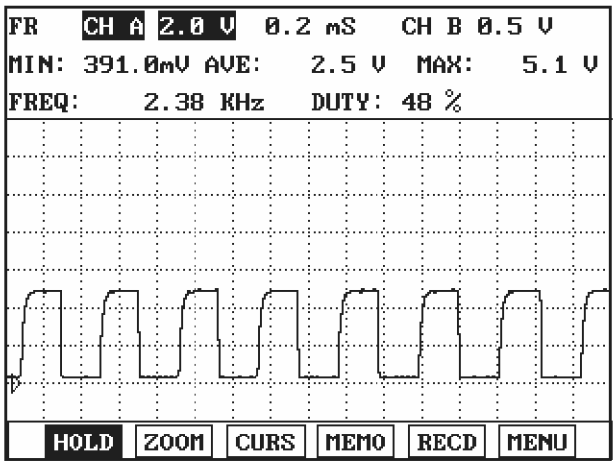


Fig.2

Fig.1) AFS signal waveform at IG KEY "ON". It shows digital signal of 50% duty, 1.8KHz.
Fig.2) AFS signal waveform at idle(790RPM, EGR actuator duty 5%, air flow for each cylinder 410mg/st).
It shows digital signal of 50% duty, 2.2~2.7KHz.

LFIG222A

COMPONENT INSPECTION

1. Check the MAFS visually.
   - Mounting direction correct.
   - Any contamination, corrosion or damage on connector.
   - Air cleaner's clogging or wet.
   - MAFS cylinder's deforming or blocking by any foreign material.
2. Check any leakage on intake system and intercooler system.

REPLACEMENT

⚠CAUTION

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

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

```
MODEL  : VEHICLE NAME
SYSTEM : ENGINE(DIESEL)

  04. ACTUATION TEST
  05. SIMU-SCAN
  06. IDENTIFICATION CHECK
  07. ENGINE TEST FUNCTION
  08. CPF SERVICE REGENERATION
  09. COMPONENT CHANGE ROUTINE
  10. INJECTOR SPECIFIC DATA
  11. DATA SETUP(UNIT CONV.)
```

SFDF28235L

5. Select "AIR FLOW SENSOR CHANGE".

```
MODEL : VEHICLE NAME
SYSTEM : ENGINE(DIESEL)

 01. ECU CHANGE
 02. LAMBDA SENSOR CHANGE
 03. RAIL PRESSURE SENSOR CHANGE
 04. AIR FLOW SENSOR CHANGE
 05. CPF CHANGE
 06. D/PRESSURE SENSOR CHANGE
 07. SWIRL CONTROL VALVE CHANGE
```

SFDF28265L

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

```
      AIR FLOW SENSOR CHANGE

 IN THIS MODE, CAN RESET THE STORED
 DRIFT VALUES OF HOT FILM AIR FLOW
 SENSOR IN EEPROM.


         PRESS [ENTER] KEY.
```

SFDF28266L

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

```
      AIR FLOW SENSOR CHANGE

 IN THIS MODE, CAN RESET THE STORED
 D COMPLETED! AFTER 10 SEC. OR MORE
 S SINCE IG.KEY OFF, TURN IG.KEY ON

         PRESS [ENTER] KEY.
```

SFDF28267L

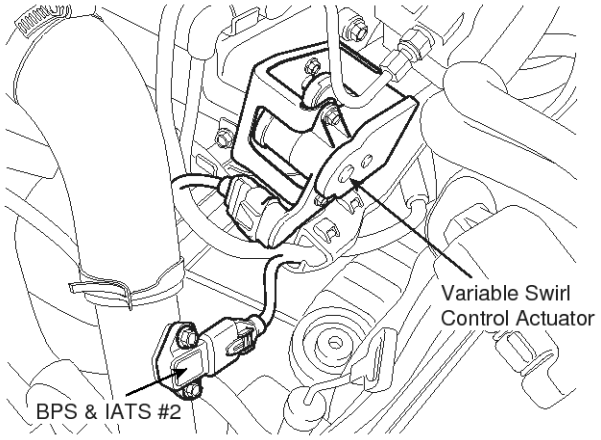
8. Wait for more than 10 seconds, and then turn ignition switch ON.

Boost Pressure Sensor (BPS)

INSPECTION

FUNCTION AND OPERATION PRINCIPLE

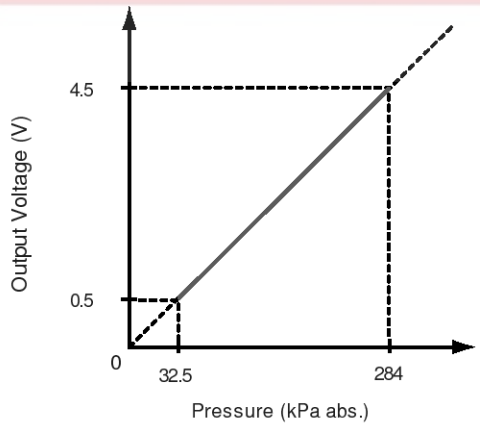
Boost pressure sensor (BPS) is installed on surge tank to measure the absolute intake manifold pressure. BPS input voltage is changed in proportion with absolute pressure in manifold. This information is used to control Variable Geometery Turbocharger (VGT) by ECM.



SUNFL6002L

SPECIFICATION

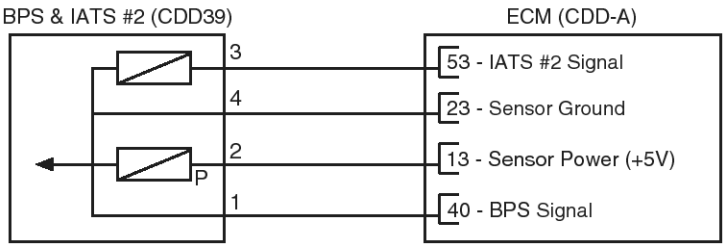
Pressure (kPa)	Output Voltage (V)
32.5	0.5
70	1.02 ~ 1.17
140	2.13 ~ 2.28
210	3.25 ~ 3.40
270	4.20 ~ 4.35
284	4.5



LFIG038A

CIRCUIT DIAGRAM

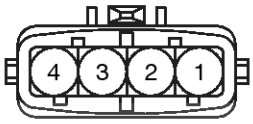
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

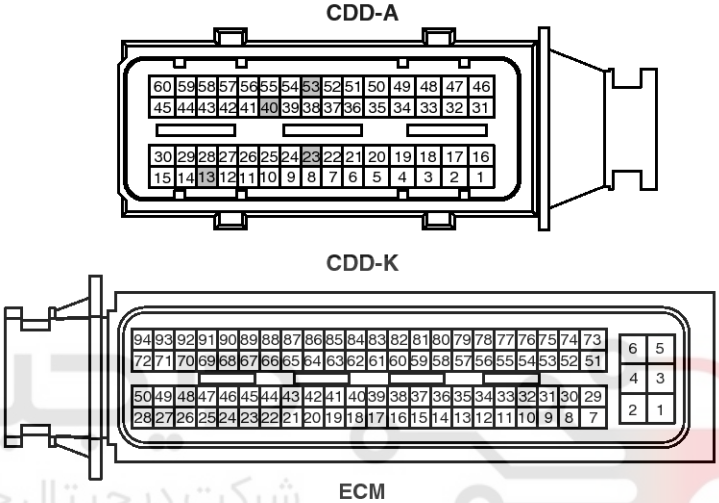
Terminal	Connected to	Function
1	ECM CDD-A (40)	BPS Signal
2	ECM CDD-A (13)	Sensor Power (+5V)
3	ECM CDD-A (53)	IATS #2 Signal
4	ECM CDD-A (23)	Sensor ground

[HARNESS CONNECTORS]



CDD39

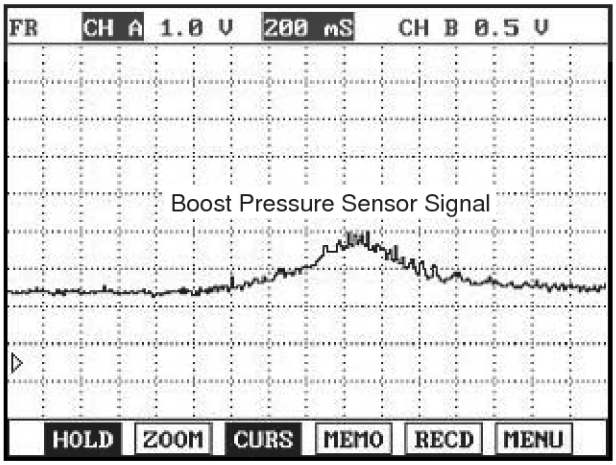
BPS & IATS #2



ECM

SFDF38269L

SIGNAL WAVEFORAM



This illustration represents waveform of BPS when accelerating and decelerating.

LFIG040A

Intake Air Temperature Sensor (IATS)

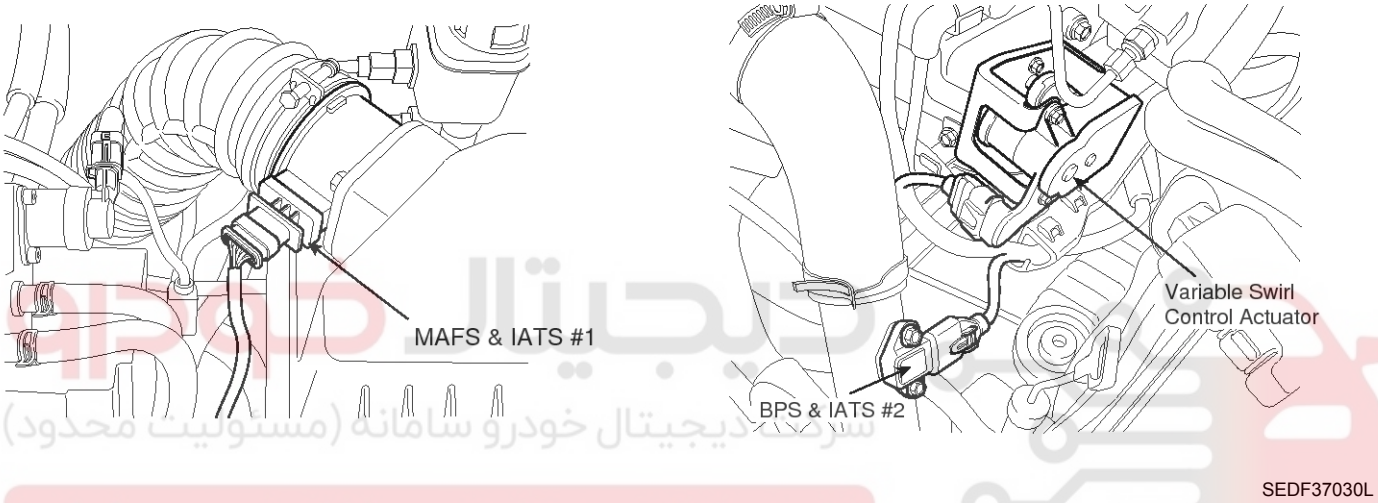
INSPECTION

FUNCTION AND OPERATION PRINCIPLE

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

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

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



SEDF37030L

SPECIFICATION

IATS #1 in MAFS

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

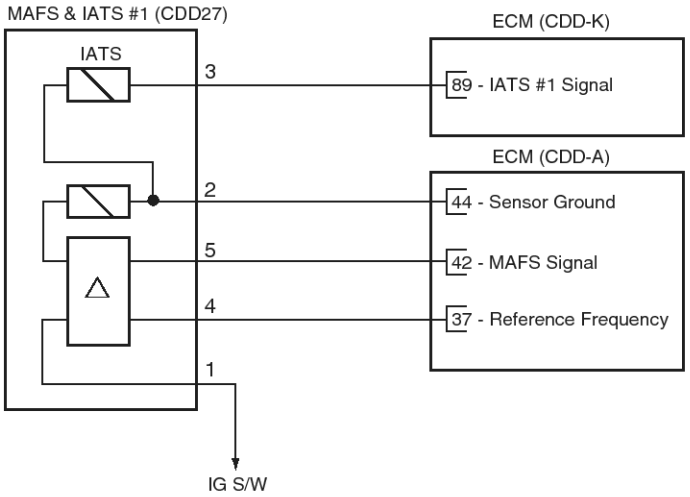
IATS #2 in BPS

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

LFIG042A

CIRCUIT DIAGRAM

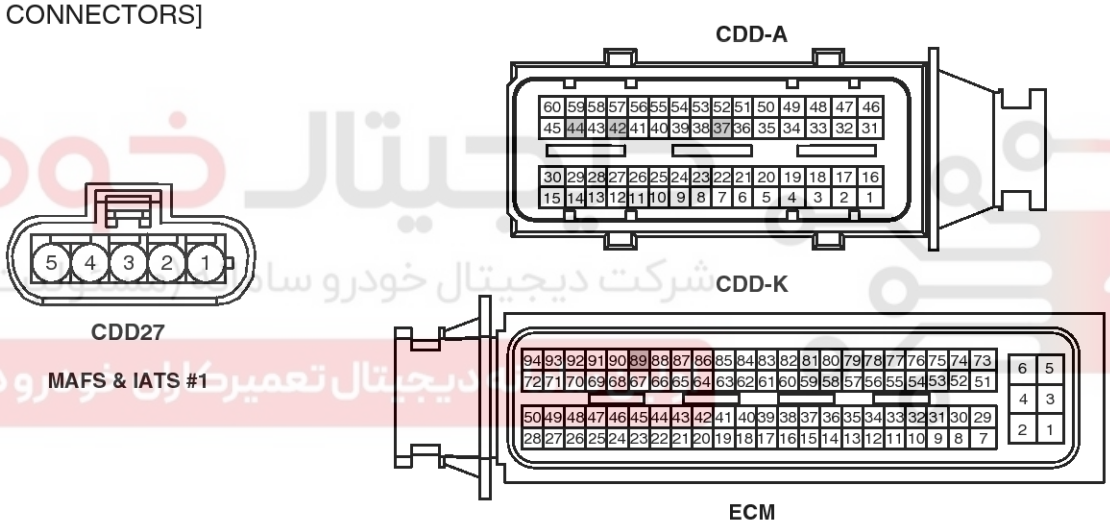
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

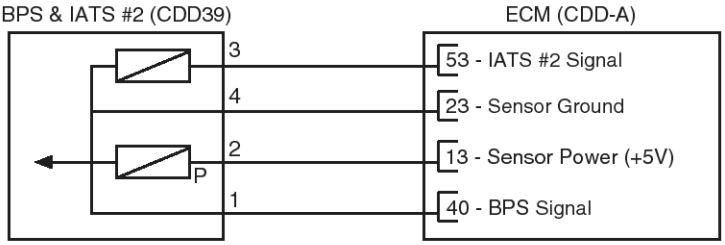
Terminal	Connected to	Function
1	IG S/W	Power Supply (B+)
2	ECM CDD-A (44)	Sensor Ground
3	ECM CDD-K (89)	IATS #1 Signal
4	ECM CDD-A (37)	Reference Frequency
5	ECM CDD-A (42)	MAFS Signal

[HARNESS CONNECTORS]



SFDF38268L

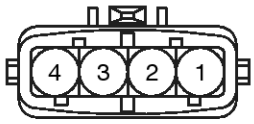
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

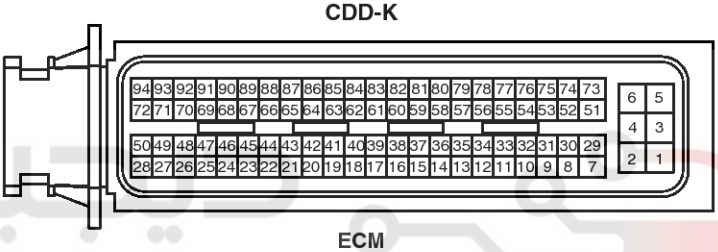
Terminal	Connected to	Function
1	ECM CDD-A (40)	BPS Signal
2	ECM CDD-A (13)	Sensor Power (+5V)
3	ECM CDD-A (53)	IATS #2 Signal
4	ECM CDD-A (23)	Sensor ground

[HARNESS CONNECTORS]



CDD39

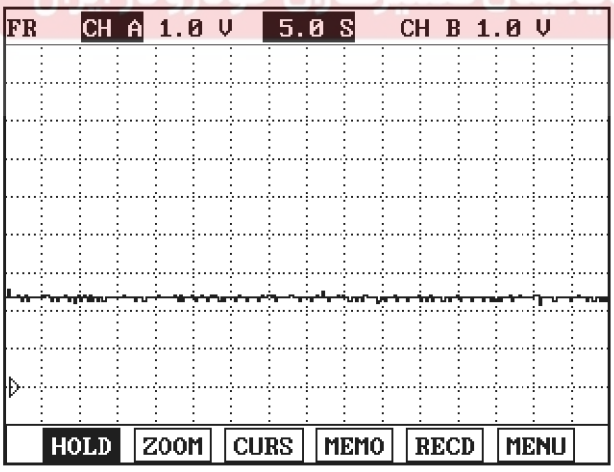
BPS & IATS #2



ECM

SFDF38269L

SIGNAL WAVEFORM



IATS signal should be smooth and continuous without any sudden changes.
After warmed-up, the IATS signal should not change significantly while ECTS signal drops.

LFIG043A

COMPONENT INSPECTION

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

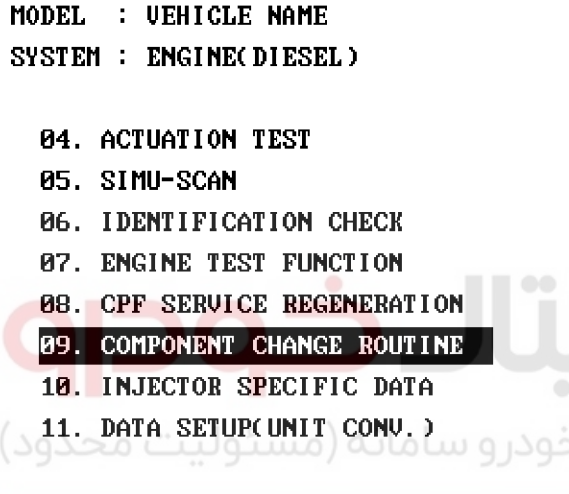
Specification: Refer to "SPECIFICATION".

REPLACEMENT

⚠CAUTION

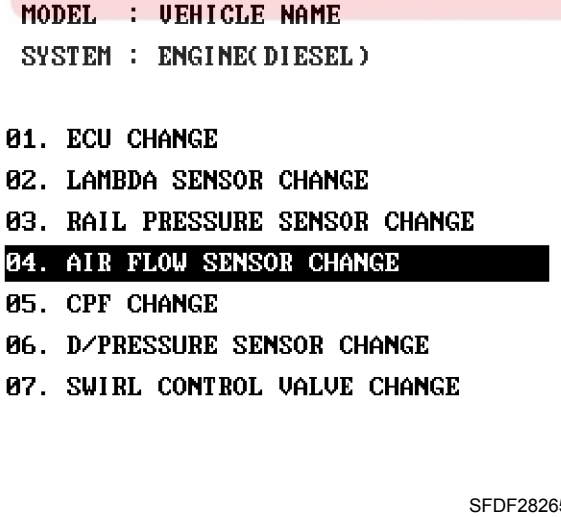
After replacing the Intake Air Temperature Sensor (IATS) #1, MUST perform the "COMPONENT CHANGE ROUTINE" procedure. Otherwise trouble related with engine performance or emission control may occur until ECM learning about the component is over.

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



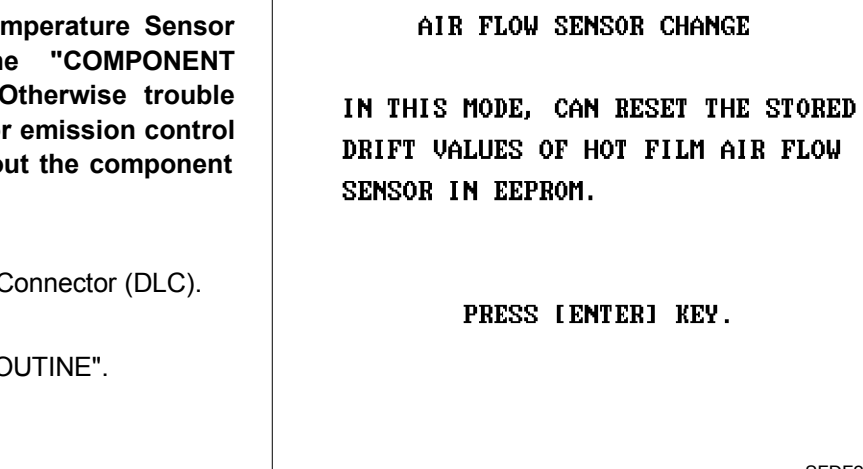
SFDF28235L

5. Select "AIR FLOW SENSOR CHANGE".



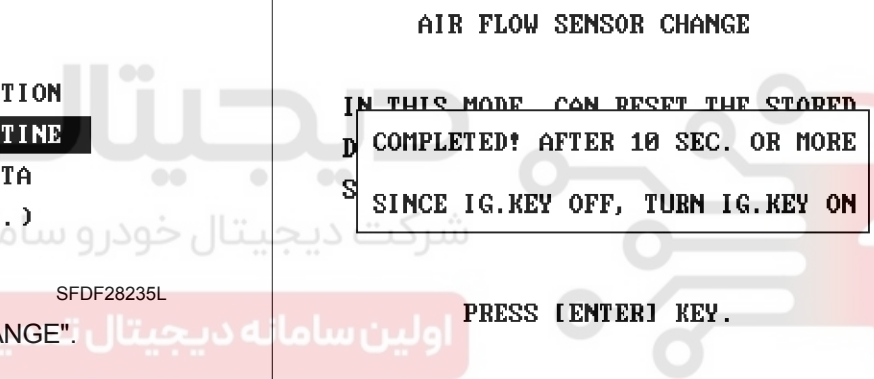
SFDF28265L

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



SFDF28266L

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



SFDF28267L

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

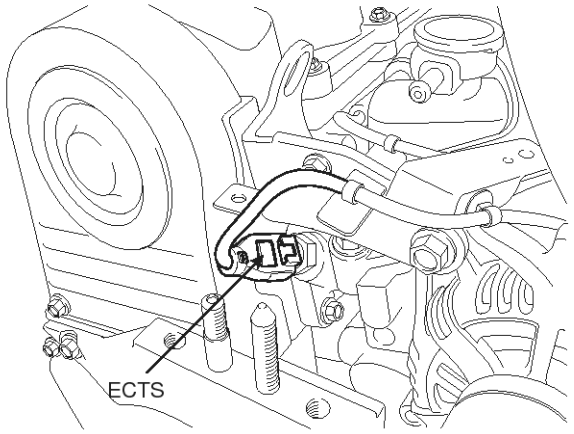
Engine Coolant Temperature Sensor (ECTS)

INSPECTION

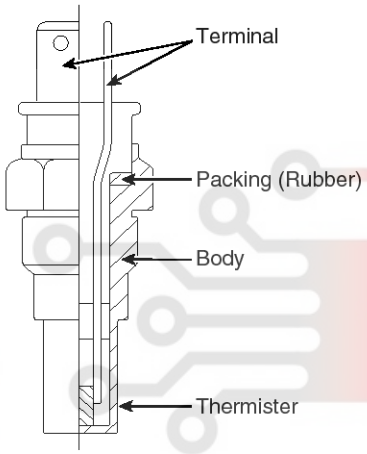
FUNCTION AND OPERATION PRINCIPLE

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 in the ECM 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.



SUNFL6003D



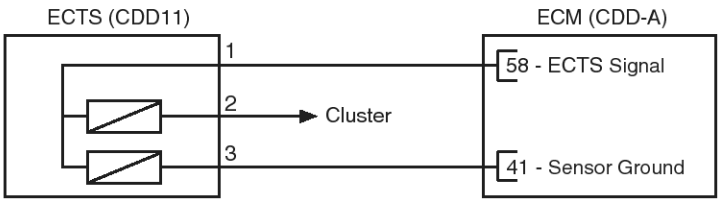
EGRF241A

SPECIFICATION

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

CIRCUIT DIAGRAM

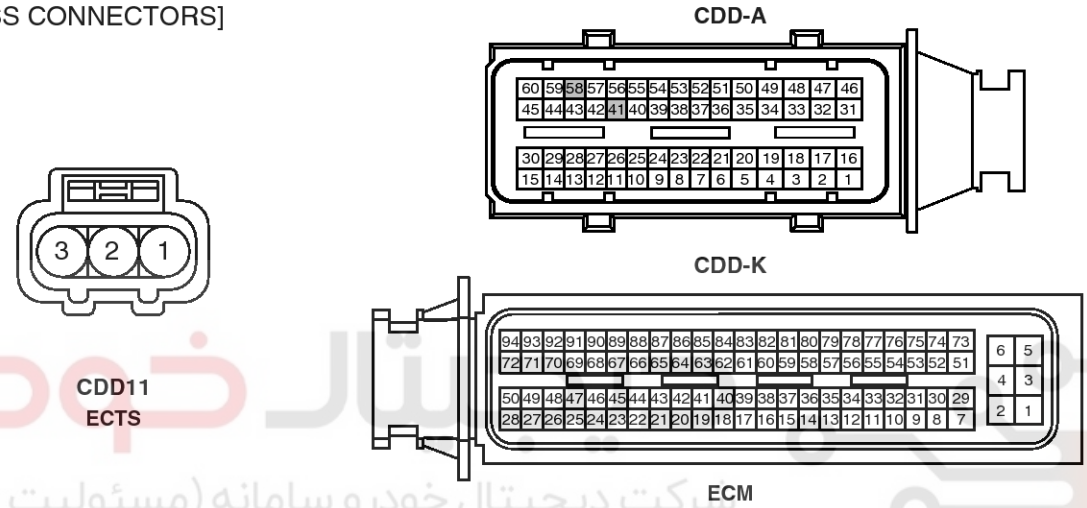
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM CDD-A (58)	ECTS Signal
2	Cluster	-
3	ECM CDD-A (41)	Sensor ground

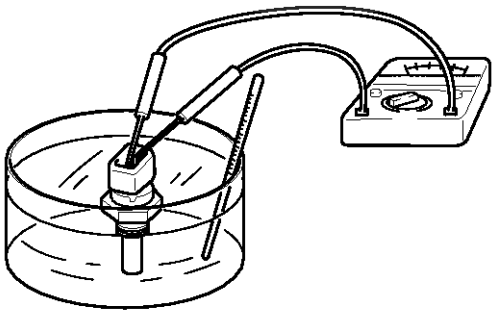
[HARNESS CONNECTORS]



SFDF38270L

COMPONENT INSPECTION

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



EFNF541A

5. Check that the resistance is within the specification.

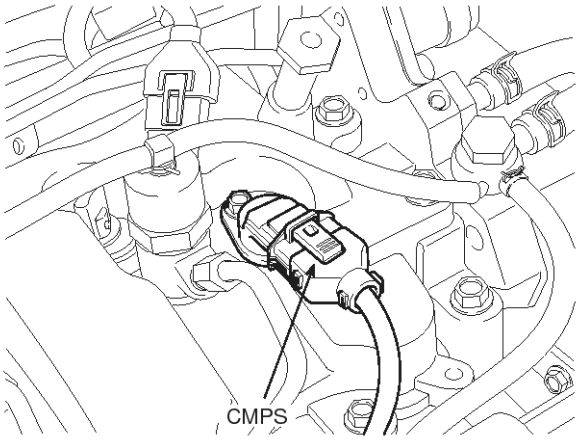
Specification: Refer to "SPECIFICATION".

Camshaft Position Sensor (CMPS)

INSPECTION

FUNCTION AND OPERATION PRINCIPLE

Camshaft Position Sensor (CMPS) is a hall sensor and detects the camshaft position by using a hall element. It is related with Crankshaft Position Sensor (CKPS) and detects the piston position of the each cylinder which the CKPS can't detect. The CMPS are installed on engine head cover and uses a target wheel installed on the camshaft. This sensor has a hall-effect IC which output voltage changes when magnetic field is made on the IC with current flow. So the sequential injection of the 4 cylinders is impossible without CMPS signal.



LFIG010A

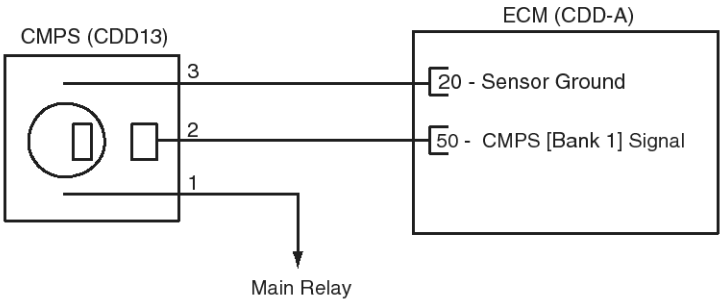
SPECIFICATION

Level	Output Pulse (V)
High	12V
Low	0V

Items	Specification
Air Gap	1.5 ± 0.1 mm

CIRCUIT DIAGRAM

[CIRCUIT DIAGRAM]



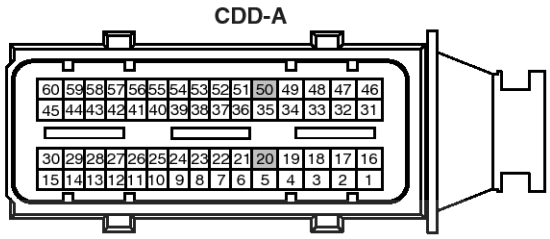
[CONNECTION INFORMATION]

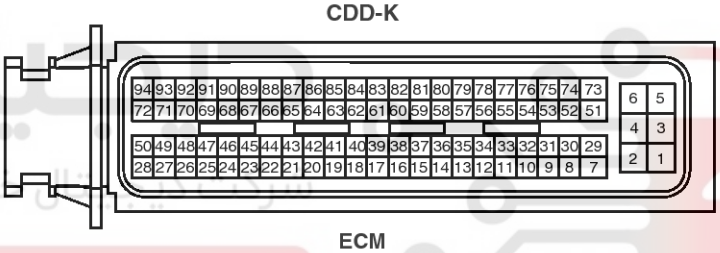
Terminal	Connected to	Function
1	Main Relay	Power Supply (B+)
2	ECM CDD-A (50)	CMPS Signal
3	ECM CDD-A (20)	Sensor Ground

[HARNESS CONNECTORS]

CDD13

CMPS





ECM

SFDF38271L

SIGNAL WAVEFORM

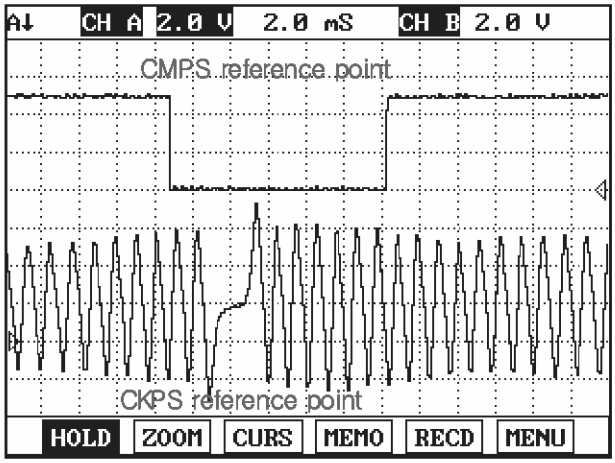


Fig.1

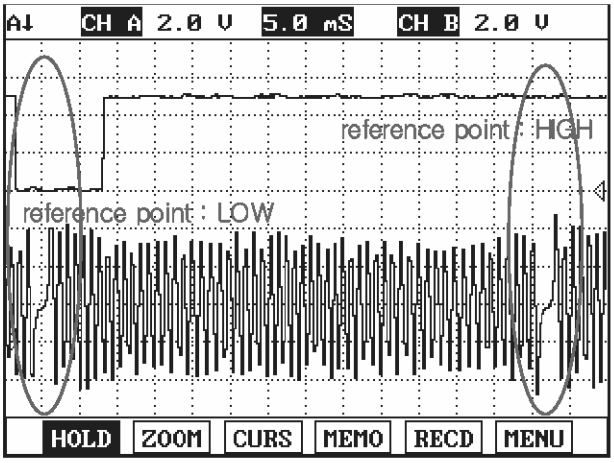


Fig.2

Fig.1) This shows waveform of Crank Shaft Position Sensor and Cam Shaft Position Sensor simulatneously. The middle area indicates reference points of Crank Shaft Position Sensor and Cam Shaft Position Sensor.

Fig.2) Crank Shaft Position Sensor and Cam Shaft 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 Crank Shaft Position sensor reference point.
(Injection sequence is determined based on LOW and HIGH signal of Cam Shaft Position Sensor reference point as detecting cylinder position.)

LFIG299A

COMPONENT INSPECTION

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

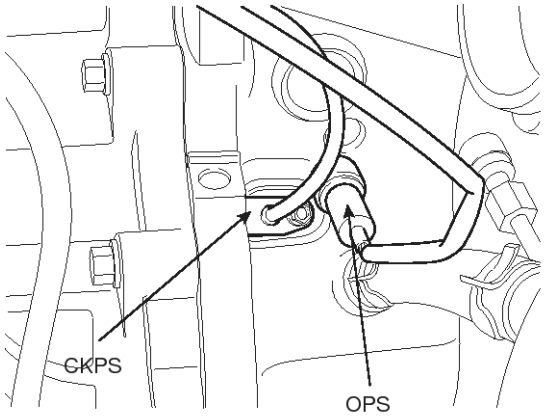
Specification: Refer ro "SIGNAL WAVEFORM"

Crankshaft Position Sensor (CKPS)

INSPECTION

FUNCTION AND OPERATION PRINCIPLE

Piston position on combustion chamber is the substantial to define the starting of injection timing. All engine pistons are connected to crankshaft by connecting rod. Sensor on crankshaft can supply the informations concerning all piston positions, revolution speed is defined by revolution perminute of crankshaft. Prior input variable is determined at ECM by using signal induced from crankshaft position sensor.



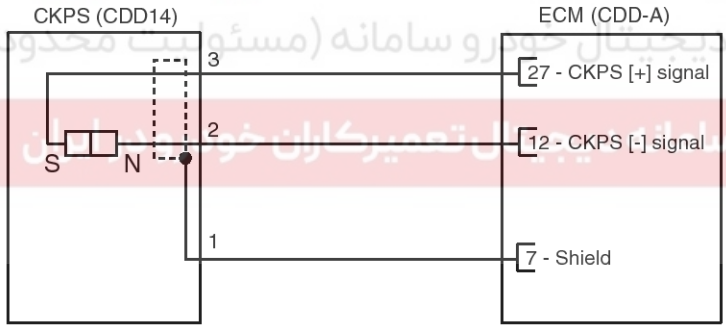
SUNFL6004D

SPECIFICATION

Items	Specification
Coil Resistance (Ω)	774 ~ 946Ω [20℃(68˚F)]

CIRCUIT DIAGRAM

[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

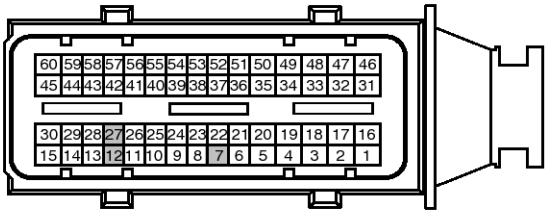
Terminal	Connected to	Function
1	ECM CDD-A (7)	Sensor Shield
2	ECM CDD-A (12)	CKPS [-] Signal
3	ECM CDD-A (27)	CKPS [+] Signal

[HARNESS CONNECTORS]

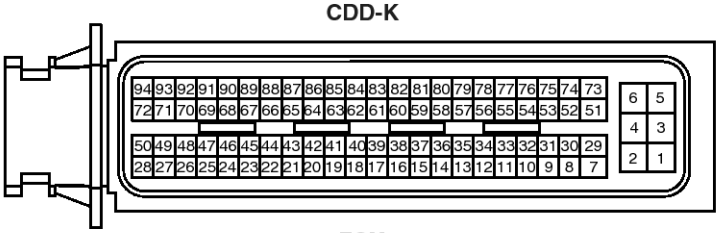
CDD14

CKPS

CDD-A



CDD-K



ECM

SFDF38272L

SIGNAL WAVEFORM

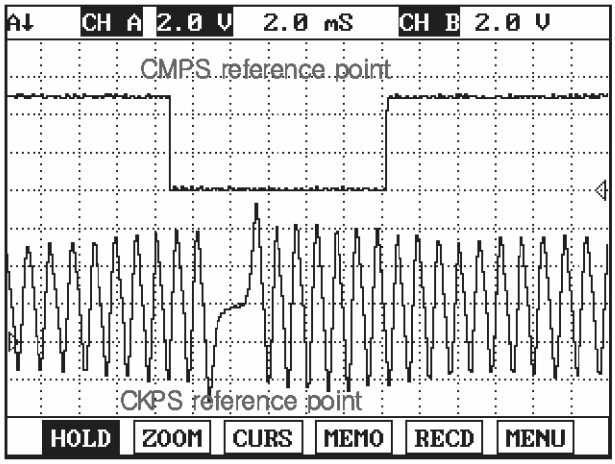


Fig.1

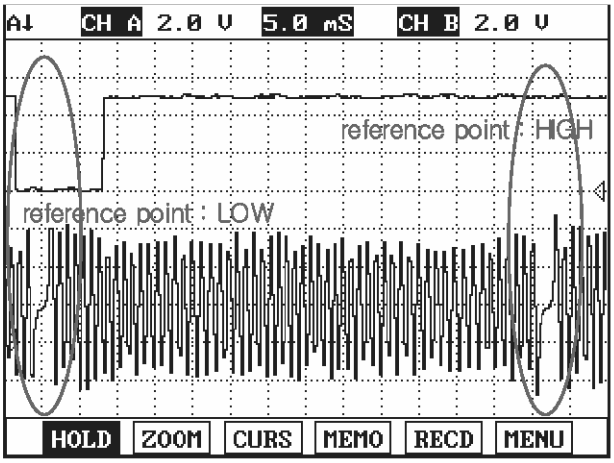


Fig.2

Fig.1) This shows waveform of Crank Shaft Position Sensor and Cam Shaft Position Sensor simulatneously. The middle area indicates reference points of Crank Shaft Position Sensor and Cam Shaft Position Sensor.

Fig.2) Crank Shaft Position Sensor and Cam Shaft 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 Crank Shaft Position sensor reference point.
(Injection sequence is determined based on LOW and HIGH signal of Cam Shaft Position Sensor reference point as detecting cylinder position.)

LFIG299A

COMPONENT INSPECTION

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

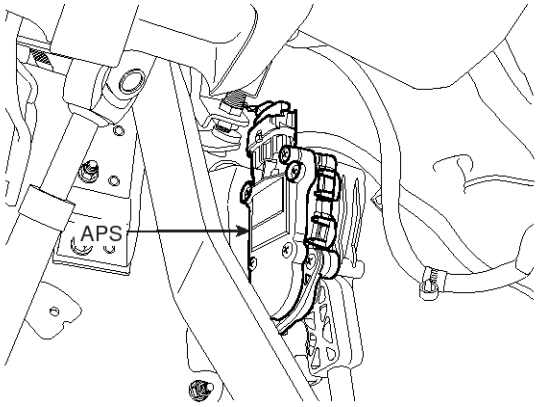
Specification: Refer ro "SIGNAL WAVEFORM"

Accelerator Position Sensor (APS)

INSPECTION

FUNCTION AND OPERATION PRINCIPLE

On electronic injection systems, there is no longer a load lever that mechanically controls the fuelling. The flow is caculated by the ECM depending on a number of parameters, including pedal position, which is measured using a potentiometer. The pedal sensor has two potentio-meters whoses slides are mechanically solid. The two potentiometers are supplied from distinct and different power sources so there is built in redundancy of information giving reliable driver's request information. A voltage is generated across the potentiometer in the acceleration position sensor as a function of the accelerator-pedal setting. Using a peogrammed characteristic curve, the pedal's position is then calculated from this voltage.

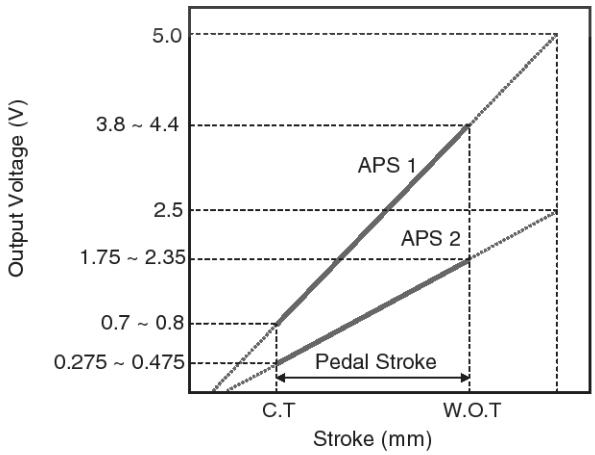


SHDF26007D

SPECIFICATION

Test Condition	Output Voltage(V)	
	APS 1	APS 2
Idle	0.7 ~ 0.8	0.275 ~ 0.475
Fully depressed	3.8 ~ 4.4	1.75 ~ 2.35

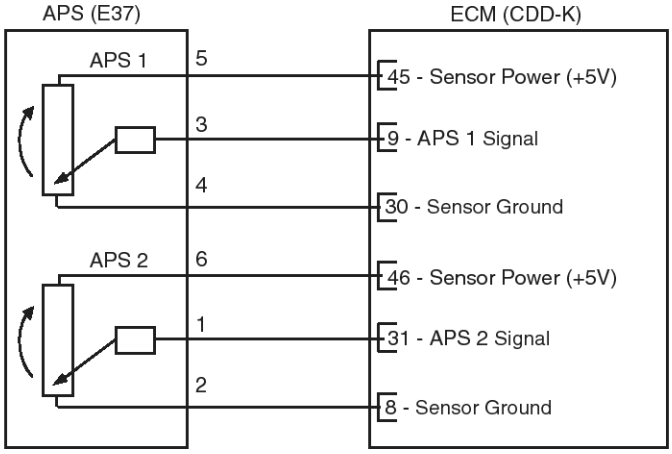
Items	Specification	
	APS 1	APS 2
Potentiometer Resistance (kΩ)	0.7 ~ 1.3	1.4 ~ 2.6



LFIG092A

CIRCUIT DIAGRAM

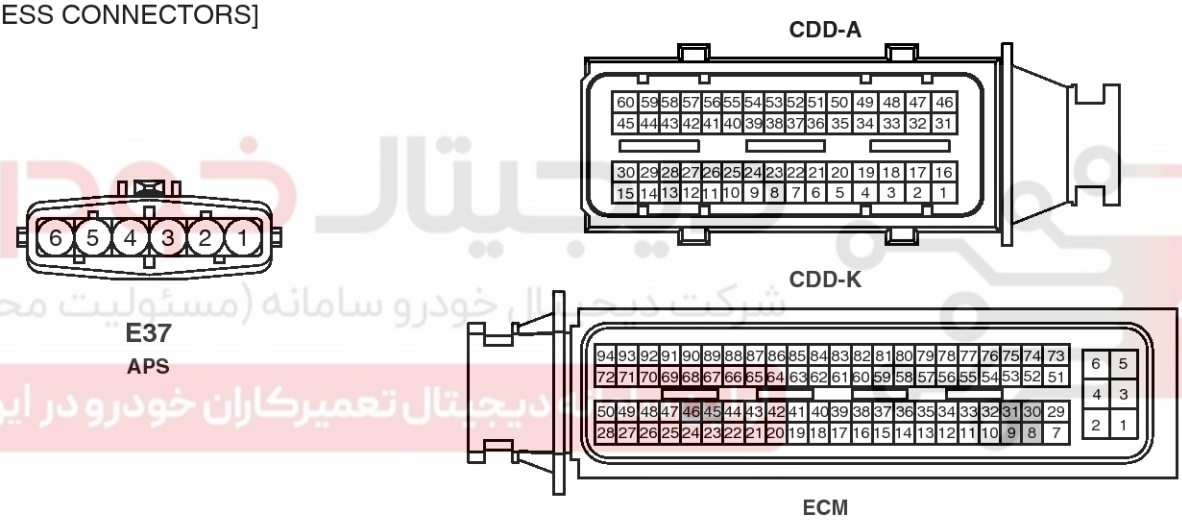
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM CDD-K (31)	APS 2 Signal
2	ECM CDD-K (8)	APS 2 Ground
3	ECM CDD-K (9)	APS 1 Signal
4	ECM CDD-K (30)	APS 1 Ground
5	ECM CDD-K (45)	APS 1 Sensor Power (+5V)
6	ECM CDD-K (46)	APS 2 Sensor Power (+5V)

[HARNESS CONNECTORS]



SFDF38273L

SIGNAL WAVEFORM

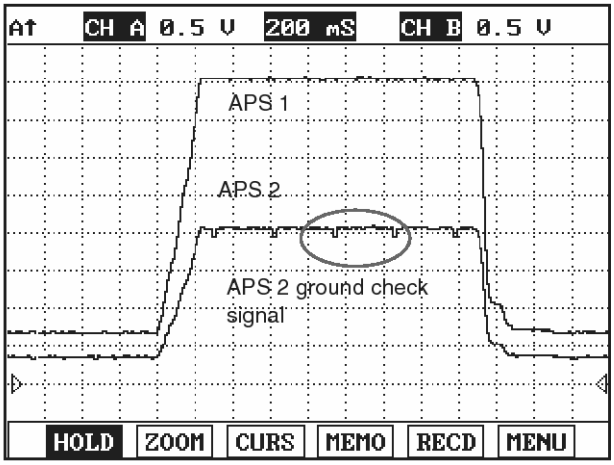


Fig.1

Fig.1) 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.

LFIG541A

COMPONENT INSPECTION

1. Turn ignition switch OFF.
2. Disconnect the accelerator position sensor connector.
3. Measure resistance between voltage supply terminal and ground terminal of APS1.
4. Measure resistance between voltage supply terminal and ground terminal of APS2.
5. Check that the resistance is within the specification.

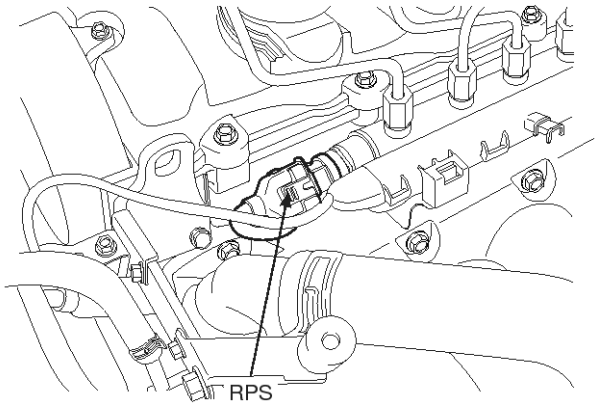
Specification: Refer to "SPECIFICATION".

Rail Pressure Sensor (RPS)

INSPECTION

FUNCTION AND OPERATION PRINCIPLE

Rail Pressure Sensor (RPS) is installed at the end of the common rail and measures the instantaneous fuel pressure in the common rail by using its diaphragm. Its sensing element (semiconductor device) mounted on the diaphragm converts the fuel pressure to an electric signal.



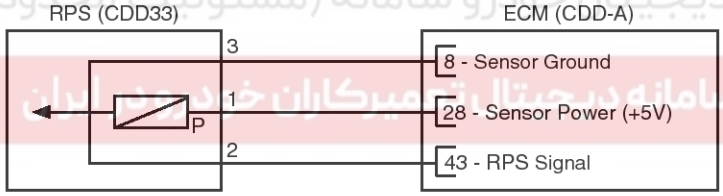
LFIG017A

SPECIFICATION

Test Condition	Rail pressure (bar)	Output Voltage (V)
Idle	220 ~ 320	Below 1.7
Fully depressed	1,800	Approx. 4.5

CIRCUIT DIAGRAM

[CIRCUIT DIAGRAM]



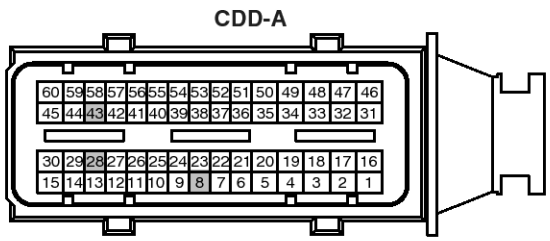
[CONNECTION INFORMATION]

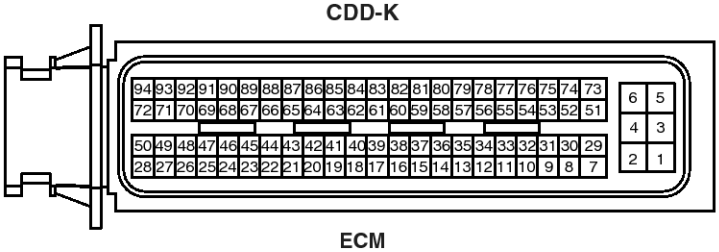
Terminal	Connected to	Function
1	ECM CDD-A (28)	Sensor Power (+5V)
2	ECM CDD-A (43)	RPS Signal
3	ECM CDD-A (8)	Sensor Signal

[HARNESS CONNECTORS]

CDD33

RPS

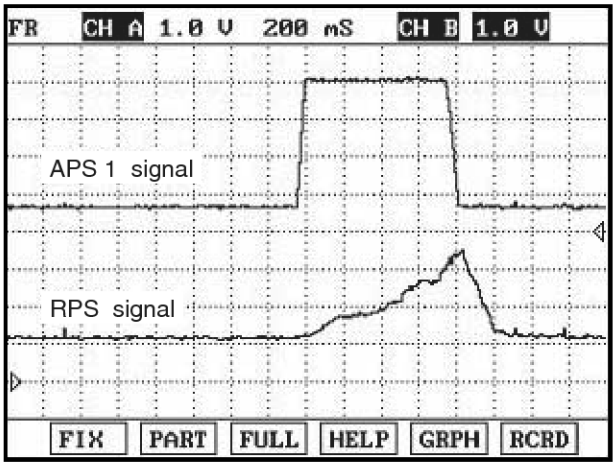




ECM

SFDF38274L

SIGNAL WAVEFORM



Rail Pressure Sensor (RPS) is to provide to the ECM the voltage signal corresponding to rail pressure.
The change in resistance is preportional to the rail pressure acting upon the diaphragm and rail pressure increases as load increases.

EFNF550A

REPLACEMENT

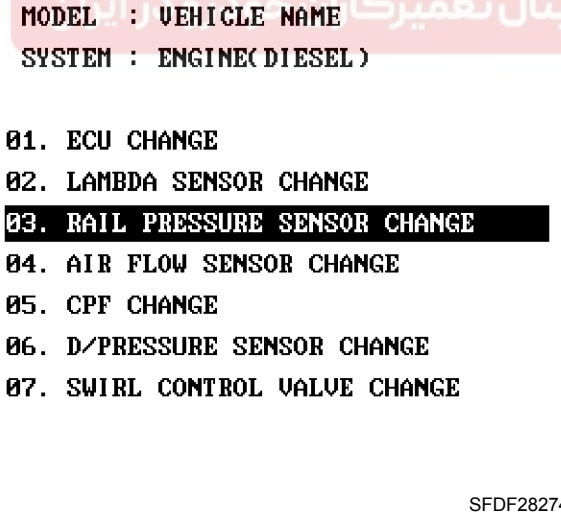
⚠CAUTION

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

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

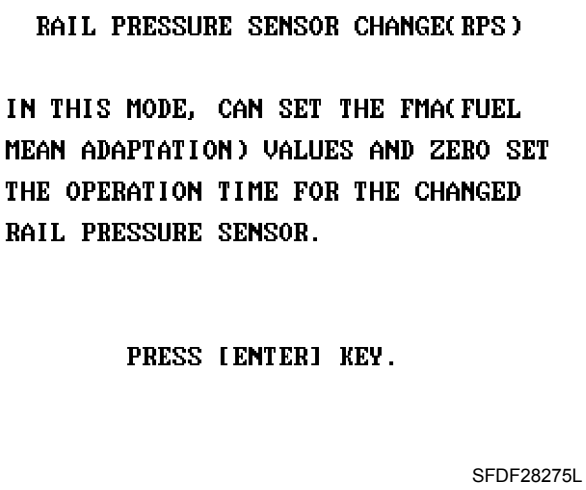
SFDF28235L

5. Select "RAIL PRESSURE SENSOR CHANGE".



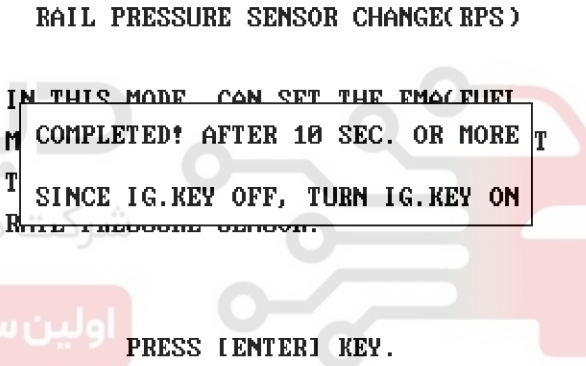
SFDF28274L

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



SFDF28275L

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



SFDF28276L

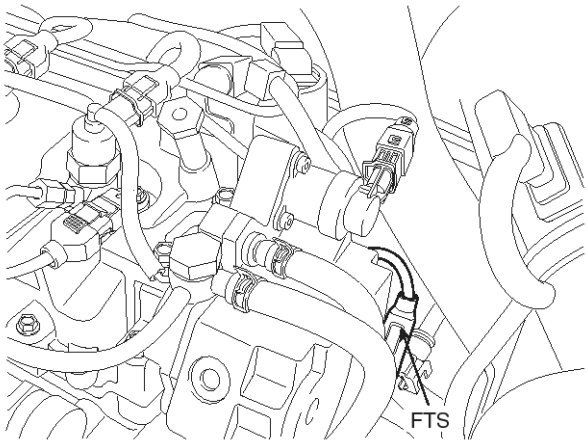
8. Wait for more than 10 seconds, and then turn ignition switch ON.

Fuel Temperature Sensor (FTS)

INSPECTION

FUNCTION AND OPERATION PRINCIPLE

Fuel Temperature Sensor(FTS) is installed in fuel supplying line and senses the termperature of fuel supplied to high pressure pump. Fuel temperature is limmited to protect fuel such as high pressure pump and injectors from damages due to rapid deterioration by vapor-lock which can occur at high temperature or destruction of oil membrance.



LFIG051A

SPECIFICATION

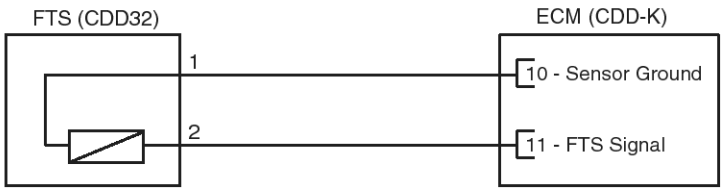
Temperature [℃(°F)]	Resistance (kΩ)
-30 (-22)	27.00
-20 (-4)	15.67
-10 (14)	9.45
0 (32)	5.89
20 (68)	2.27 ~ 2.73

Temperature [℃(°F)]	Resistance (kΩ)
40 (104)	1.17
50 (122)	0.83
60 (140)	0.60
70 (158)	0.43
80 (176)	0.30 ~ 0.32

LFIG052A

CIRCUIT DIAGRAM

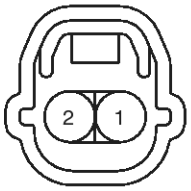
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

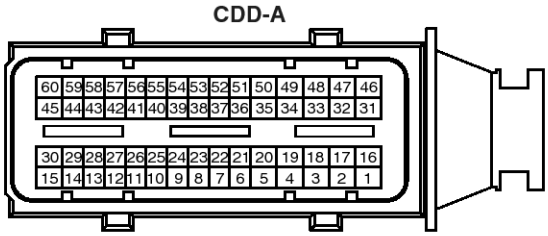
Terminal	Connected to	Function
1	ECM CDD-K (10)	Sensor Ground
2	ECM CDD-K (11)	FTS Signal

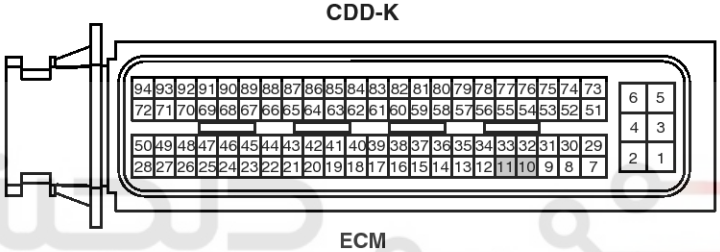
[HARNESS CONNECTORS]



CDD32

FTS

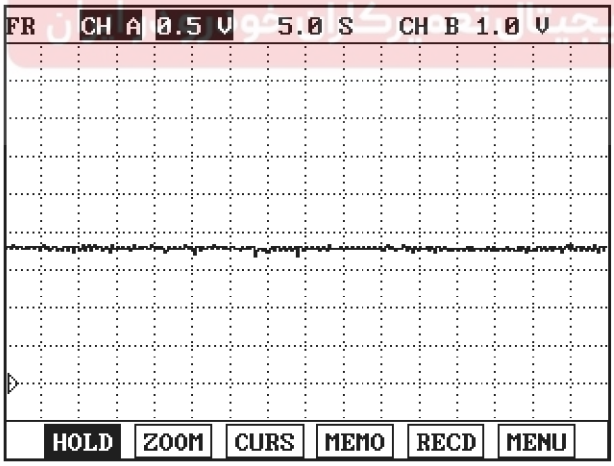




ECM

SFDF38275L

SIGNAL WAVEFORM



This illustration shows the waveform of fuel temperature sensor at 50℃.
The higher fuel temperature rises, the lower signal voltage becomes.

LGJF502I

COMPONENT INSPECTION

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

Specification: Refer to "SPECIFICATION".

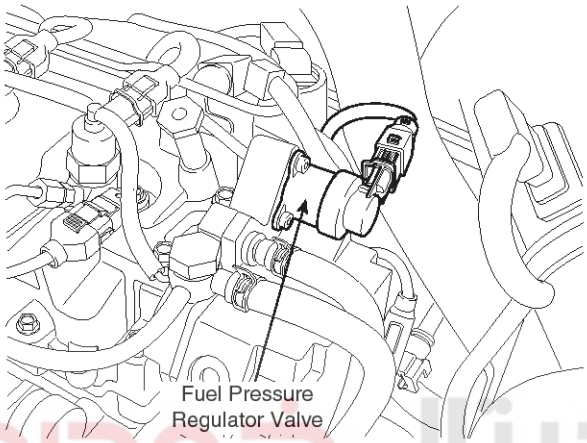
Fuel Pressure Control Valve

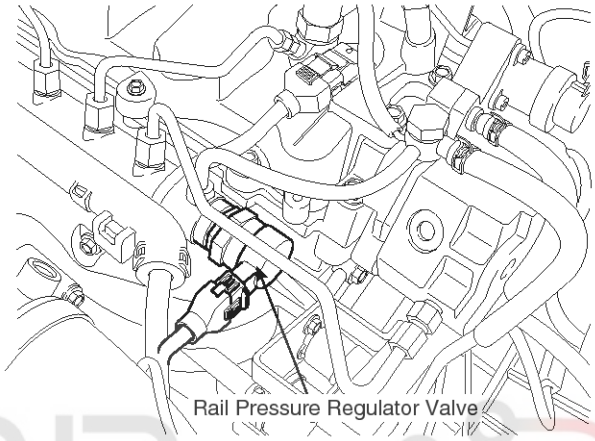
INSPECTION

FUNCTION AND OPERATION PRINCIPLE

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.





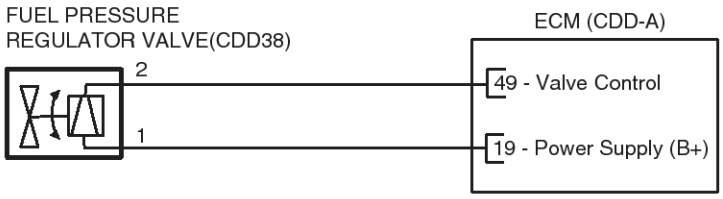
LFIG114A

SPECIFICATION

Items	Specification
Coil Resistance (Ω)	2.6 ~ 3.15Ω [20℃(68°F)]

CIRCUIT DIAGRAM

[CIRCUIT DIAGRAM]



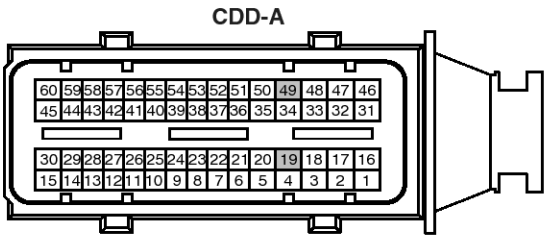
[CONNECTION INFORMATION]

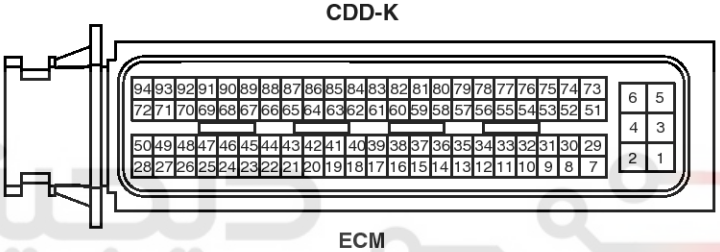
Terminal	Connected to	Function
1	ECM CDD-A (19)	Power Supply (B+)
2	ECM CDD-A (49)	Valve Control

[HARNESS CONNECTORS]

CDD38

FUEL PRESSURE REGULATOR VALVE





SFDF38276L

SIGNAL WAVEFORM

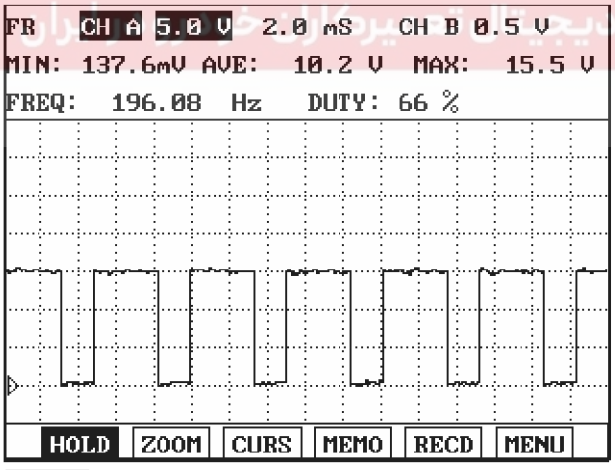


Fig.1

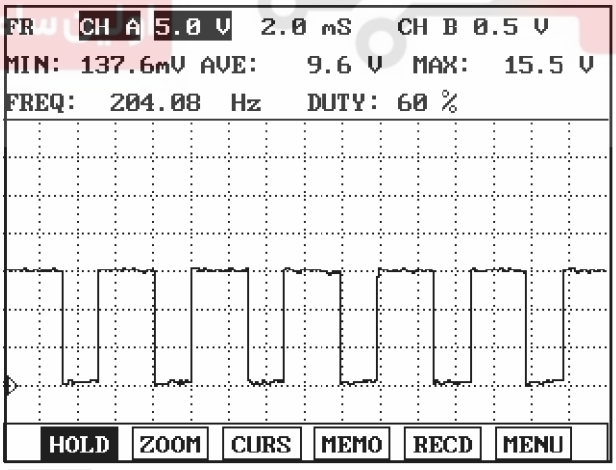


Fig.2

Fig.1) Waveform of fuel pressure regulator valve at idle. It shows approx. 34% duty((-)duty).
Fig.2) Waveform of fuel pressure regulator valve as accelerating. approx. 38% duty((-)duty) is outputted as engine load increases.

LFIG396A

COMPONENT INSPECTION

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

Specification: Refer to "SPECIFICATION".

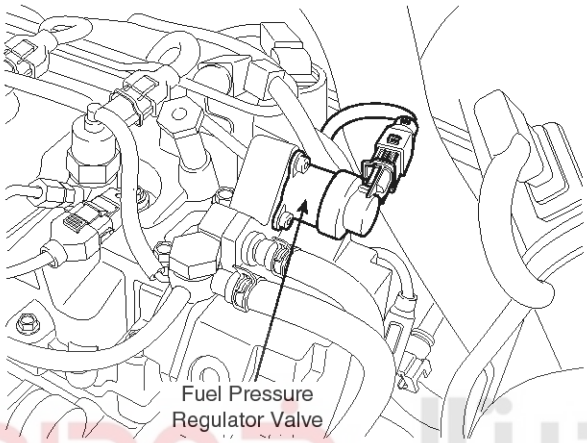
Rail Pressure Regulator Valve

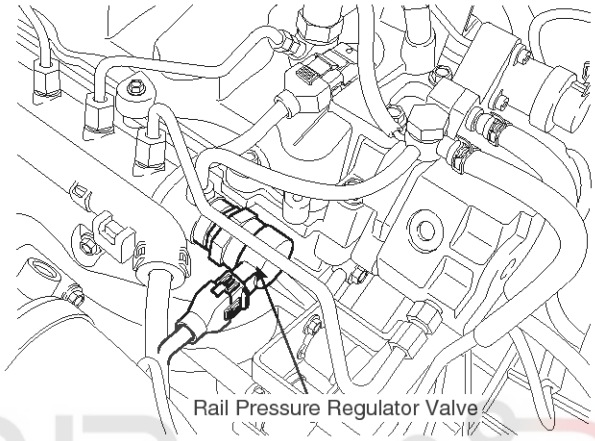
INSPECTION

FUNCTION AND OPERATION PRINCIPLE

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.



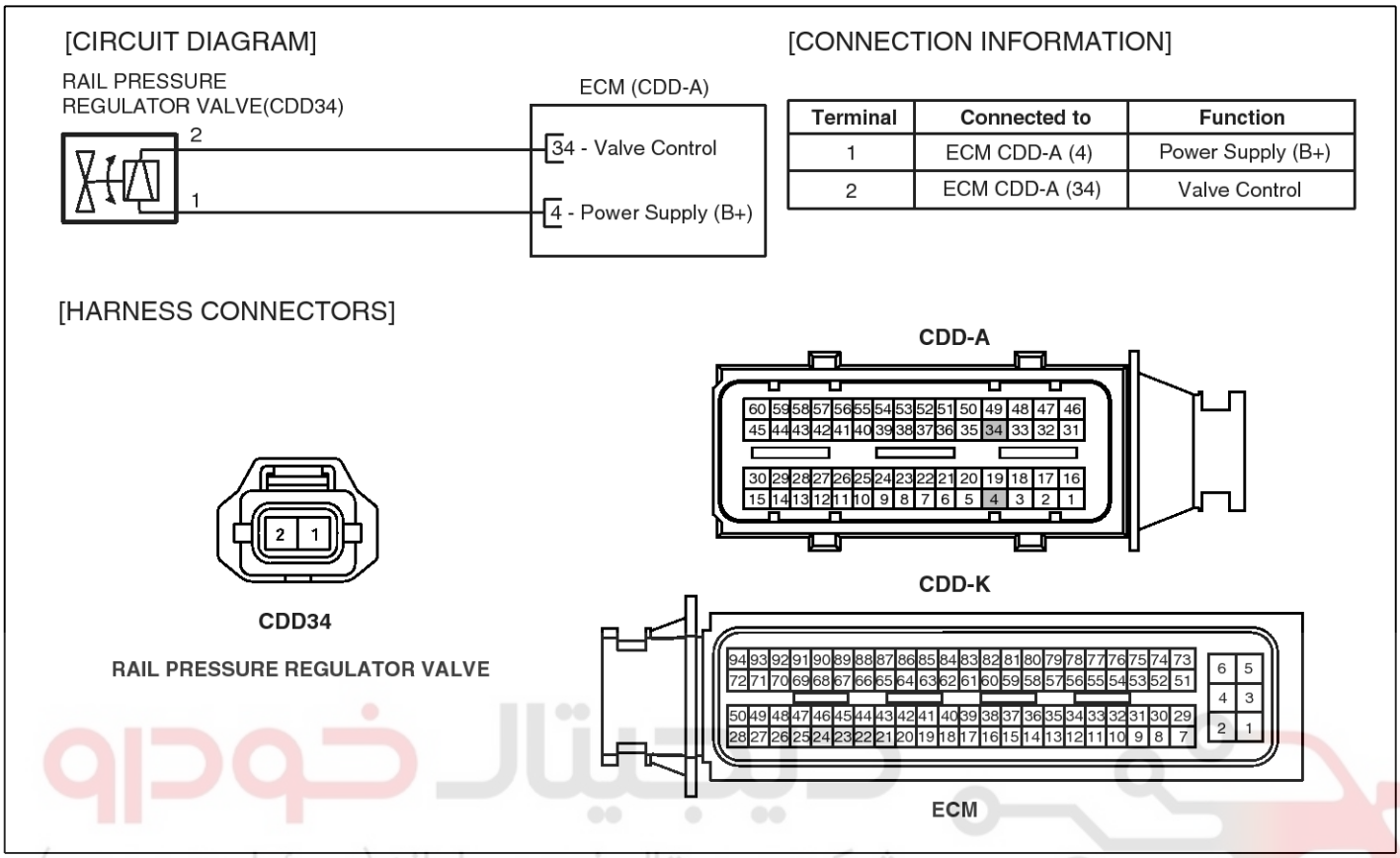


LFIG114A

SPECIFICATION

Items	Specification
Coil Resistance (Ω)	3.42 ~ 3.78Ω [20℃(68°F)]

CIRCUIT DIAGRAM



Terminal	Connected to	Function
1	ECM CDD-A (4)	Power Supply (B+)
2	ECM CDD-A (34)	Valve Control

SFDF38277L

SIGNAL WAVEFORM

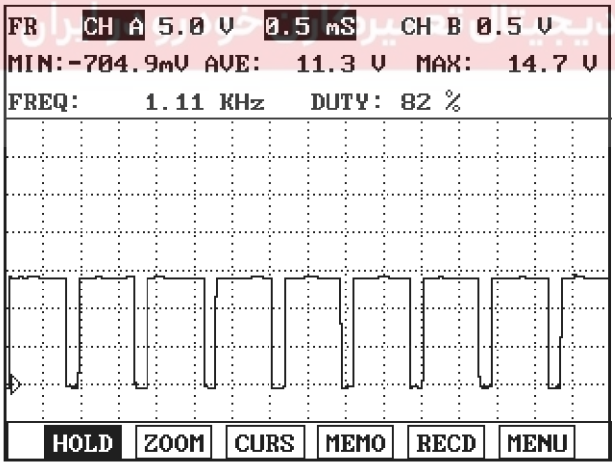


Fig.1

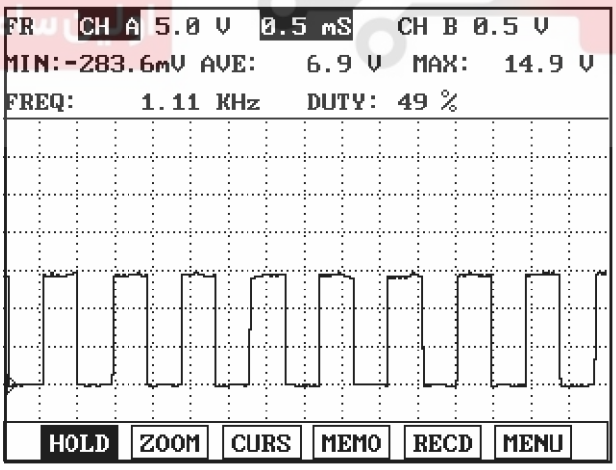


Fig.2

Fig.1) Waveform of rail pressure regulator valve at idle. It shows approx. 17% duty((-) duty.
Fig.2) Waveform of rail pressure regulator valve as accelerating. Approx. 50% duty is outputted as engine load increases.
(When rail pressure increases as accelerating, rail pressure regulator valve duty(current) rises.)

LFIG377A

COMPONENT INSPECTION

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

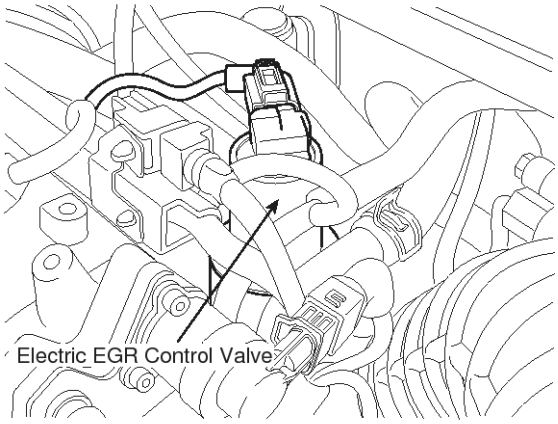
Specification: Refer to "SPECIFICATION".

EGR (Exhaust Gas Recirculation) Valve

INSPECTION

FUNCTION AND OPERATION PRINCIPLE

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. The Electric EGR valve is controlled by ECM's duty control signal depending on engine load and the need of intake air and is operated by solenoid valve not vacuum valve.



SUNFL6010L

SPECIFICATION

Items	Specification
Coil Resistance (Ω)	7.3 ~ 8.3Ω [20℃(68°F)]

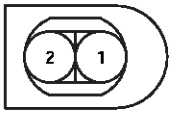
CIRCUIT DIAGRAM

[CIRCUIT DIAGRAM]

[CONNECTION INFORMATION]

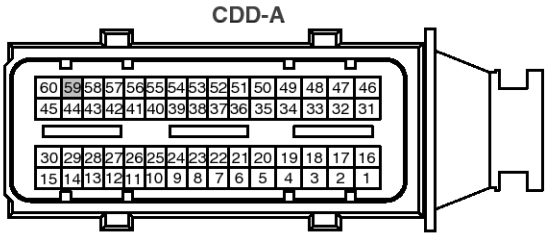
Terminal	Connected to	Function
1	ECM CDD-A (59)	EEGR Control
2	Main Relay	Power Supply (B+)

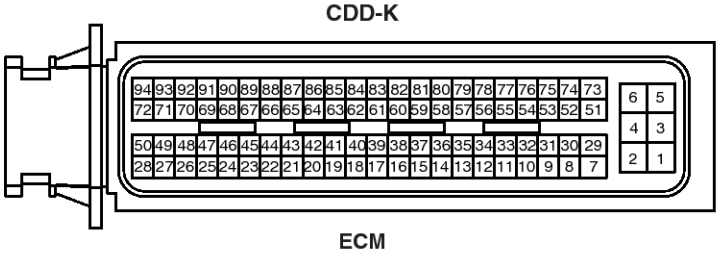
[HARNESS CONNECTORS]



CDD31

EEGR





ECM

SFDF38278L

SIGNAL WAVEFORM

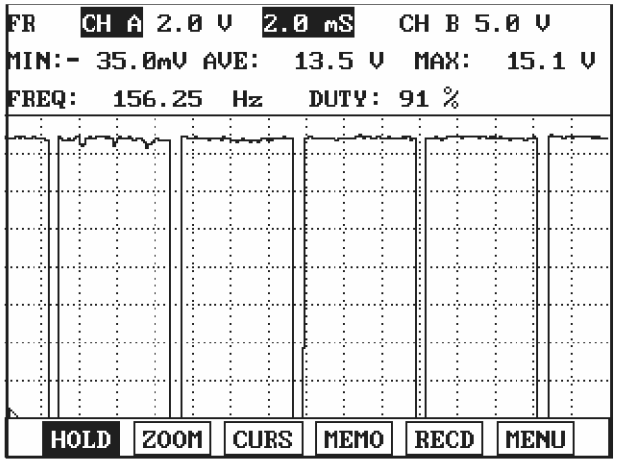


Fig.1

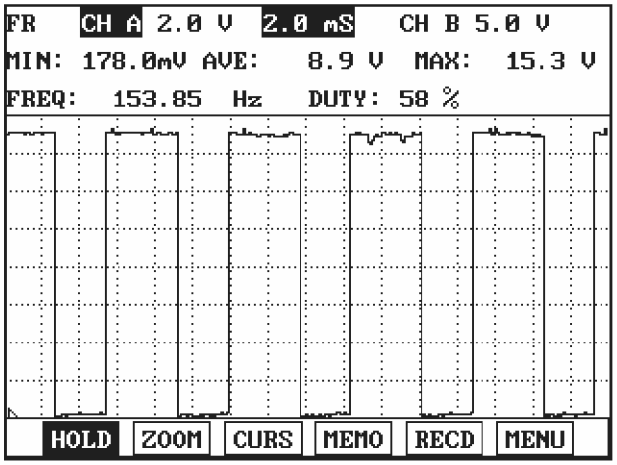


Fig.2

Fig.1) Approx. 10% duty((-)duty) signal waveform of EEGR actuator (with EEGR valve closed)
Fig.2) Approx. 40% duty((-)duty) signal waveform of EEGR actuator(with EEGR valve opened)

LFIG414A

COMPONENT INSPECTION

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

Specification: Refer to "SPECIFICATION".

Throttle Flap Control Solenoid Valve

INSPECTION

FUNCTION AND OPERATION PRINCIPLE

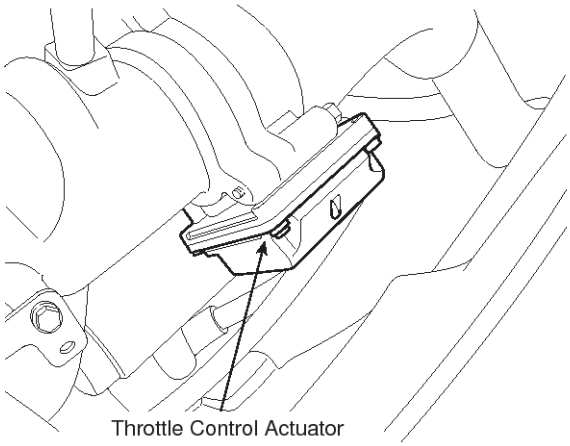
The Throttle Control Actuator is mounted on throttle body of diesel engine and controls throttle valve according to PWM (Pulse With Modulation) signal from ECM.

It consists of;

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

Its function is described below:

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



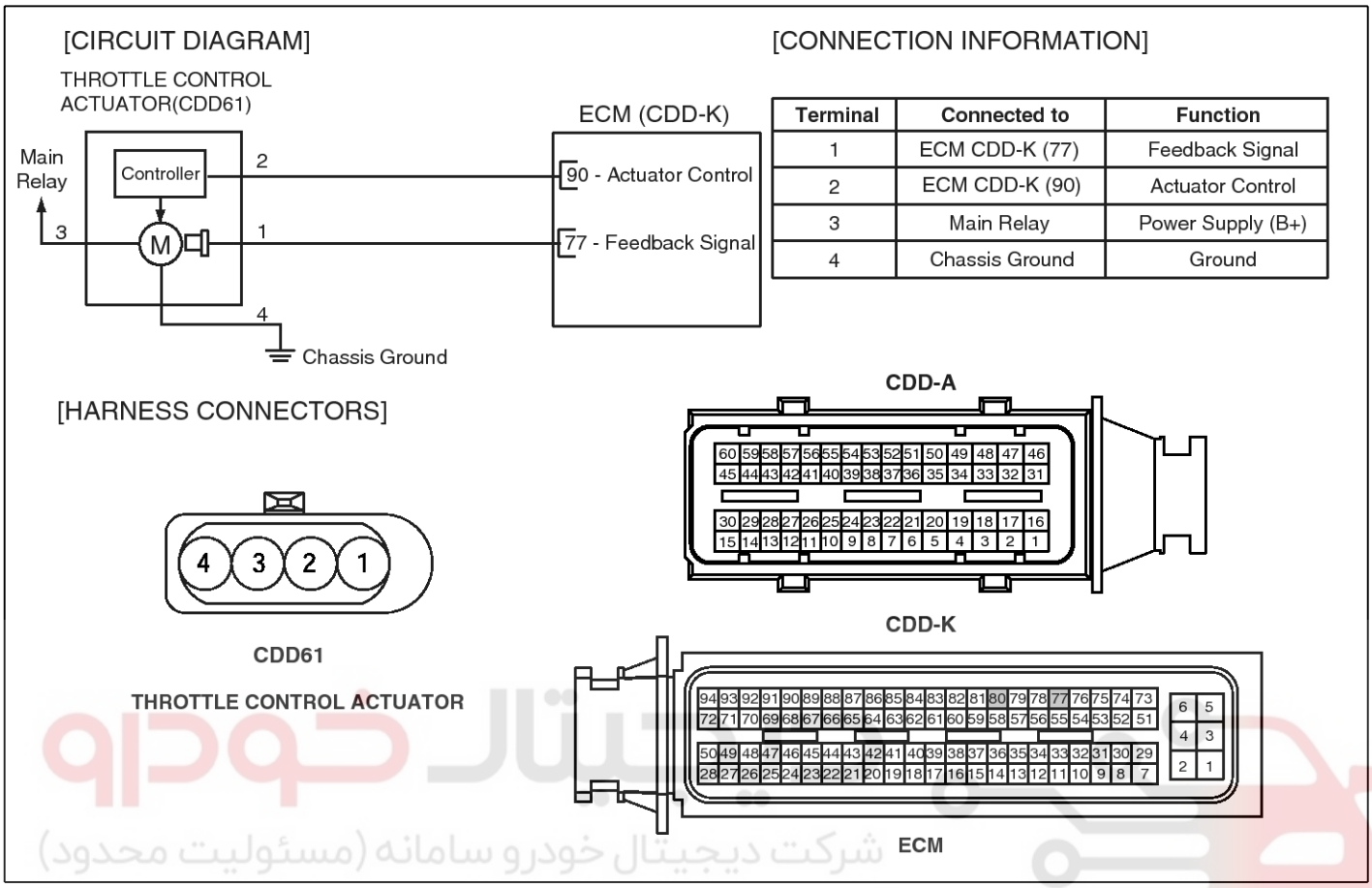
Throttle Control Actuator

LFIG021A

SPECIFICATION

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

CIRCUIT DIAGRAM



Terminal	Connected to	Function
1	ECM CDD-K (77)	Feedback Signal
2	ECM CDD-K (90)	Actuator Control
3	Main Relay	Power Supply (B+)
4	Chassis Ground	Ground

SFDF38279L

SIGNAL WAVEFORM

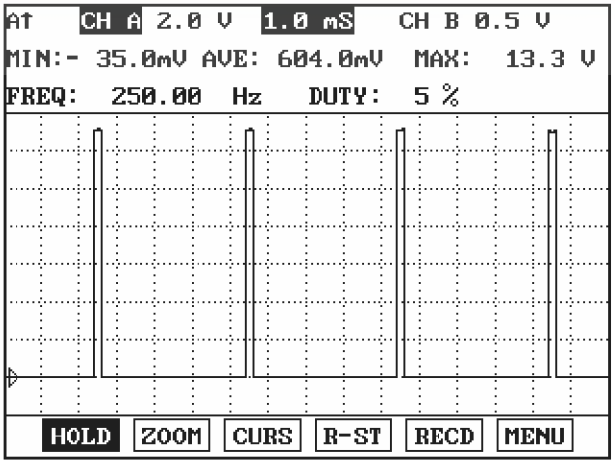


Fig.1

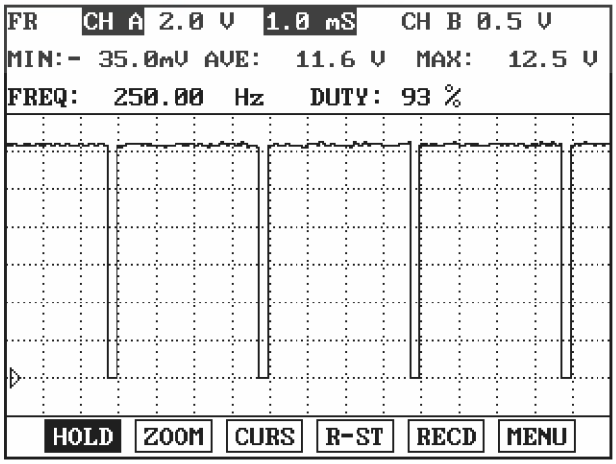


Fig.2

Fig.1) Waveform of Throttle control actuator at wide open(at idle) : At IG KEY "ON", ENGINE "ON", 5% duty is outputted continuously.
Fig.2) Waveform of Throttle control actuator at closed position : At IG KEY "OFF", 93% duty is outputted for about 1 sec.

LFIG529A

COMPONENT INSPECTION

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

Specification: Refer to "SPECIFICATION".

Variable Swirl Actuator

DESCRIPTION

Variable Swirl Control Actuator consists of DC motor and position sensor which detects the position of the swirl valve.

At idle or below 3,000rpm, the swirl valve is closed. This swirl effect increases air flow rate.

SZZF19100D

	Low and Middle Load	High Load
Engine speed	Below 3000rpm	Above 3000rpm
Valve operation	CLOSE	OPEN
Description illustration		
Fail-safe	Fully opened	

NOTICE

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

SPECIFICATION

Motor

Items	Specification
Coil Resistance (Ω)	3.4 ~ 4.4Ω [20℃(68℉)]

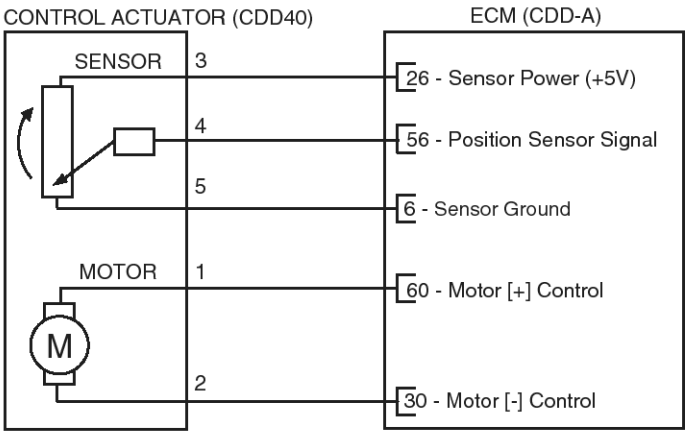
Position Sensor

Items	Specification
Coil Resistance (Ω)	3.44 ~ 5.16Ω [20℃(68℉)]

LFIG058A

CIRCUIT DIAGRAM

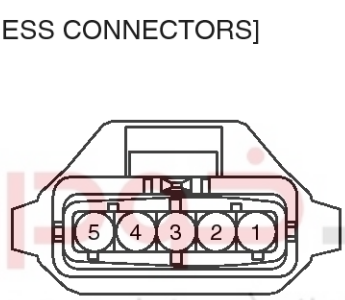
[CIRCUIT DIAGRAM]



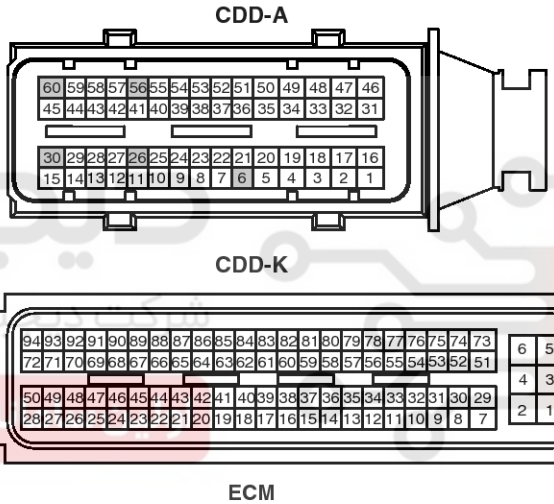
[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM CDD-A (60)	Motor [+] Control
2	ECM CDD-A (30)	Motor [-] Control
3	ECM CDD-A (26)	Sensor Power (+5V)
4	ECM CDD-A (56)	Position Signal
5	ECM CDD-A (6)	Sensor Ground

[HARNESS CONNECTORS]



CDD40
VARIABLE SWIRL CONTROL ACTUATOR



SFDF38280L

SIGNAL WAVEFORM

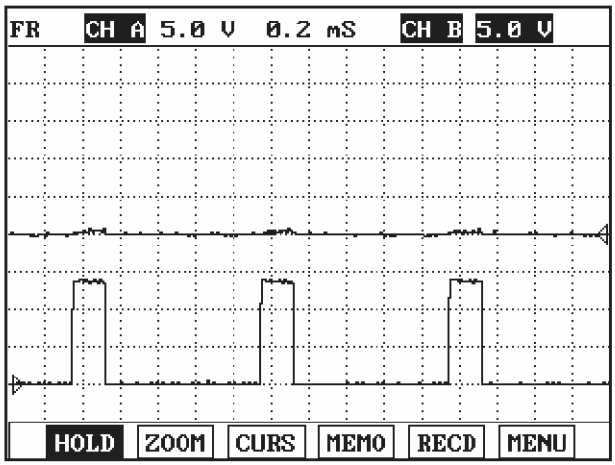


Fig.1

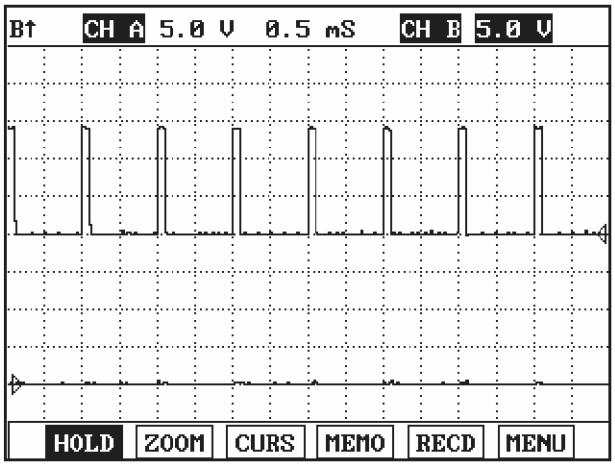


Fig.2

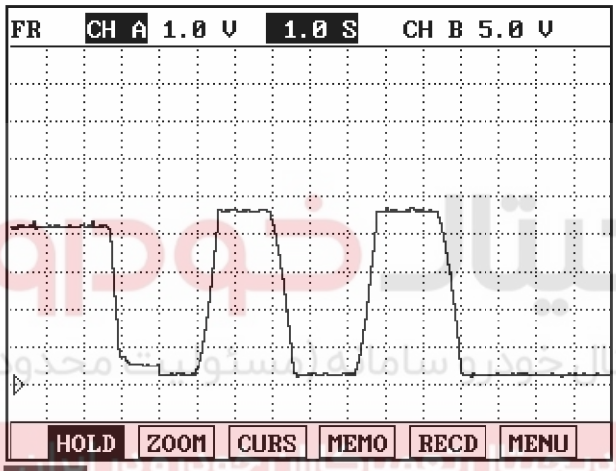


Fig.3

Fig.1) Waveform when variable swirl valve closed at idle. Terminal 1 is (+) and 2 is (-).
Fig. 2) Waveform when variable swirl valve opened at above 3000RPM. Terminal 1 is (-) and 2 is (+).
Fig. 3) Waveform of variable swirl control actuator motor position sensor at the point of turning engine OFF.
4.3V at swirl valve closed and 0.3V at swirl valve opened. Swirl valve is opened and closed twice at engine "OFF".

LFIG512A

COMPONENT INSPECTION

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

Specification: Refer to "SPECIFICATION".

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

Specification: Refer to "SPECIFICATION".

REPLACEMENT

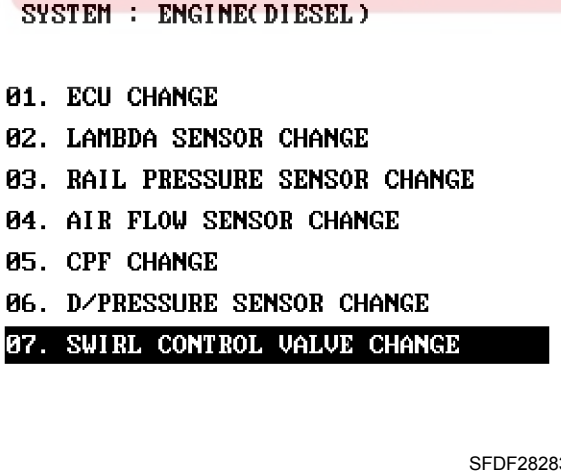
⚠CAUTION

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

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

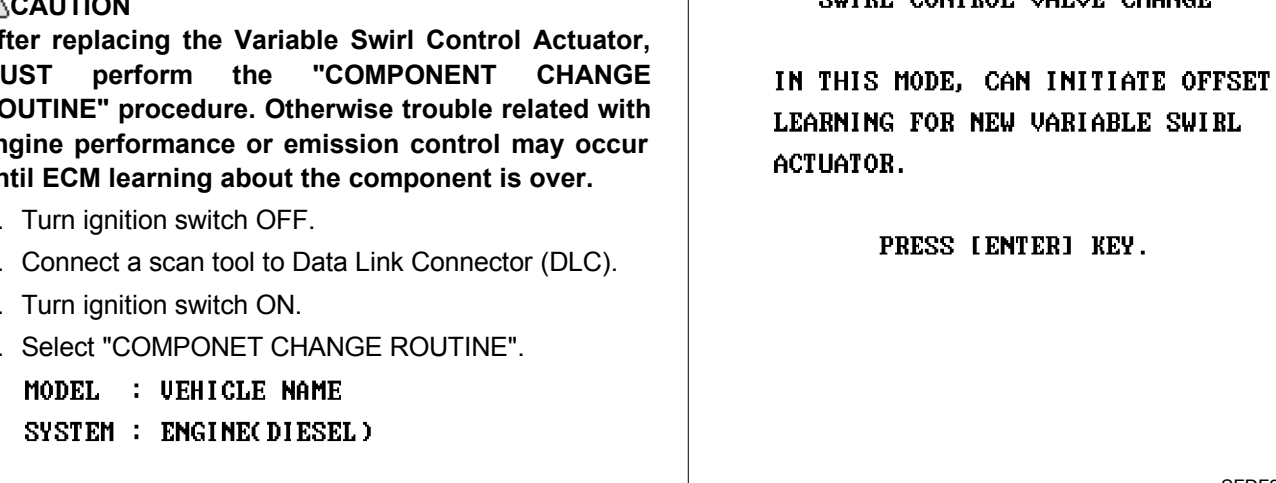
SFDF28235L

5. Select "SWIRL CONTROL VALVE CHANGE".



SFDF28283L

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



SFDF28284L

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

SFDF28285L

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

REMOVAL

1. Disconnect the battery (-) terminal.
2. Mark painting on the top (A) of the variable swirl actuator coupling of the intake manifold side.

SZZF19101D

3. Disconnect the variable swirl actuator connector (A).
4. Remove the variable swirl actuator (C) after removing the installation bolt (B).

SZZF19102D

INSTALLATION

1. Installation is the reverse order of removal.

Variable swirl actuator installation bolt:
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)

⚠CAUTION

If the coupling of the intake manifold side is rotated a 180-degree turn, a real gap between the port and the flap in the intake manifold may be different from measuring it.

Install the actuator after confirming the mark on the top of the coupling.

2. Confirm normal operation of the actuator more than 3 times when the ignition switch OFF after full warm up (Engine Coolant Temperature > 70 ˚C).

Water Sensor

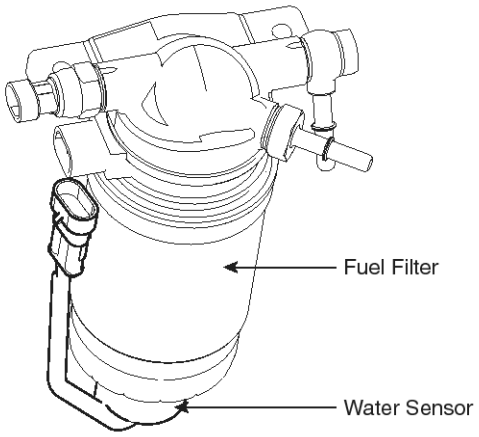
INSPECTION

FUNCTION AND OPERATION PRINCIPLE

Water Sensor is installed on bottom end of fuel filter and detects presence of water in fuel. When the water level reaches the lower level of the upper electrode, the "WATER" lamp in cluster should flash. If the water level decreases below the lower electrode, the lamp should turn off.

NOTICE

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



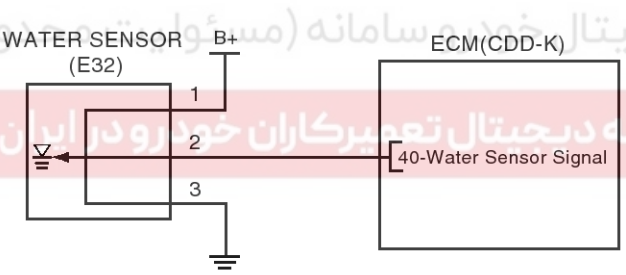
SFDF38264L

SPECIFICATION

Item	Specification
Warning Level (cc)	40 ~ 60

CIRCUIT DIAGRAM

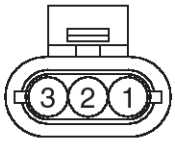
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

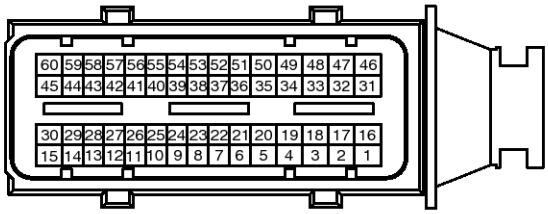
Terminal	Connected to	Function
1	Main Relay	Power Supply (B+)
2	ECM CDD-K (40)	Sensor Signal
3	Chassis ground	Sensor ground

[HARNESS CONNECTOR]

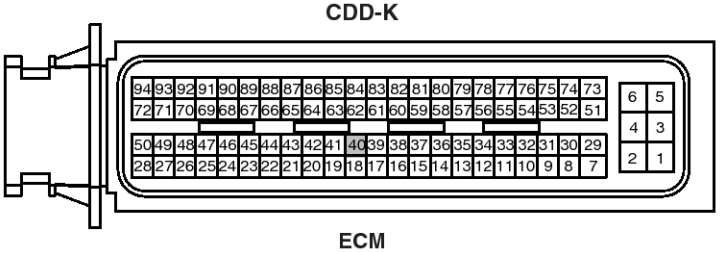


E32
WATER SENSOR

CDD-A



CDD-K



ECM

SFDF38281L

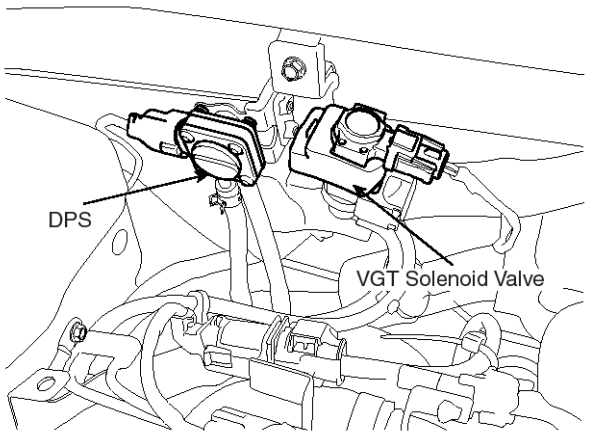
VGT Control Solenoid Valve

INSPECTION

FUNCTION AND OPERATION PRINCIPLE

Variable Geometry Turbo-charger (VGT) is used to charge additional air into combustion chamber for improvement of combustion efficiency.

ECM controls the VGT with controlling duty of the VGT control solenoid valve according to engine load.



SMGFL6144L

SPECIFICATION

Items	Specification
Coil Resistance (Ω)	14.7 ~ 16.1Ω [20℃(68°F)]

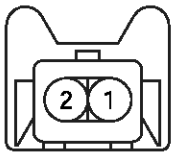
CIRCUIT DIAGRAM

[CIRCUIT DIAGRAM]

[CONNECTION INFORMATION]

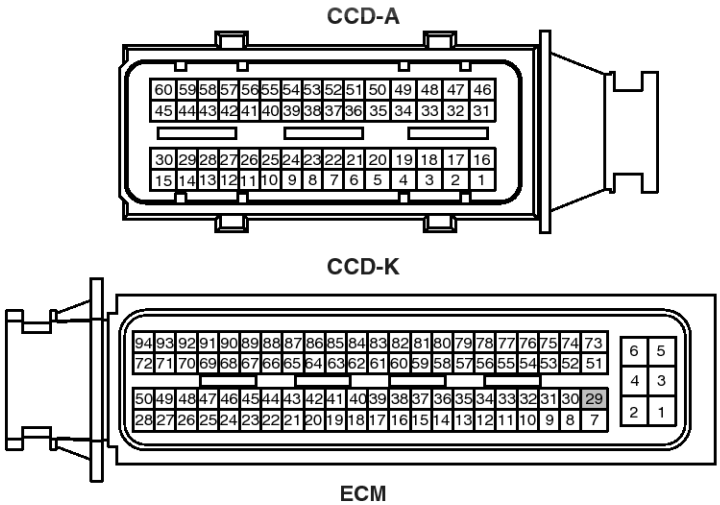
Terminal	Connected to	Function
1	ECM CCD-K (29)	Valve Control
2	Main Relay	Power Supply (B+)

[HARNESS CONNECTORS]



E53

VGT CONTROL SOLENOID VALVE



SFDF38282L

SIGNAL WAVEFORM

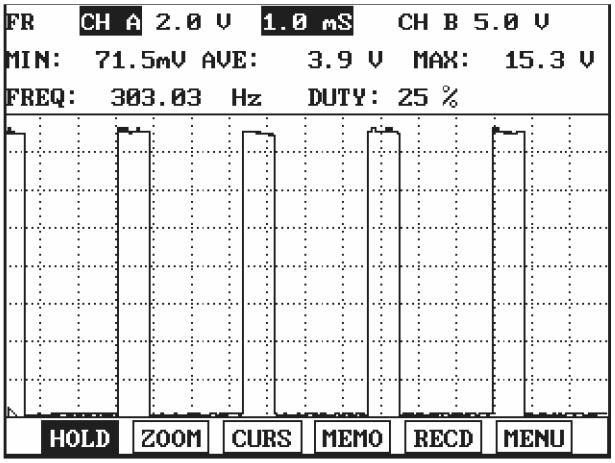


Fig.1

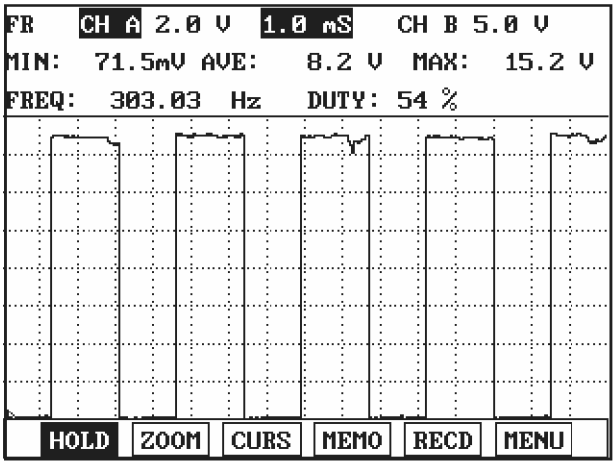


Fig.2

Fig.1) VGT actuator output waveform at 76% duty((-)duty. Duty decreases as boost pressure increases.
Fig.2) VGT actuator duty((-)duty) decreases as accelerating.

LFIG369A

COMPONENT INSPECTION

1. Turn ignition switch OFF.
2. Disconnect the VGT control solenoid 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".

Heated Oxygen Sensor (HO2S)

INSPECTION

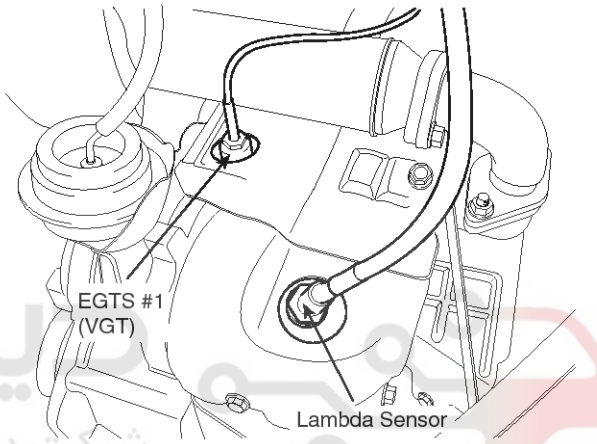
FUNCTION AND OPERATION PRINCIPLE

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

Lean air-fuel mixture($1.0 < \lambda < 1.1$): ECM supplies pumping current to lambda sensor (+pumping current) and activates it for lambda sensor to have the characteristic at $\lambda = 1.0$ (0.0 pumping current). With the value of pumping current supplied to lambda sensor, ECM detects lambda density of exhaust gas.

Rich air-fuel mixture($0.9 < \lambda < 1.0$): 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℃ ~ 600℃) thus, in order to reach normal operating temp. and last at that temperature, a heater (heating coil) is integrated with lambda sensor. The heater coil is controlled by ECM as Pulse With Modulator (PWM). The resistance of heater coil is low when coil is cold thus, current through it increases while resistance is high when coil is hot thus, current decreases. With this principle, temperature of lambda sensor is measured and lambda sensor heater operation varies based on the data.



SMGFL6129L

SPECIFICATION

Sensor

λ Value (A/F Ratio)	Pumping Current (A)
0.65	-2.22
0.70	-1.82
0.80	-1.11
0.90	-0.50
1.01	0.00
1.18	0.33
1.43	0.67
1.70	0.94
2.42	1.38
Air (Atmosphere)	2.54

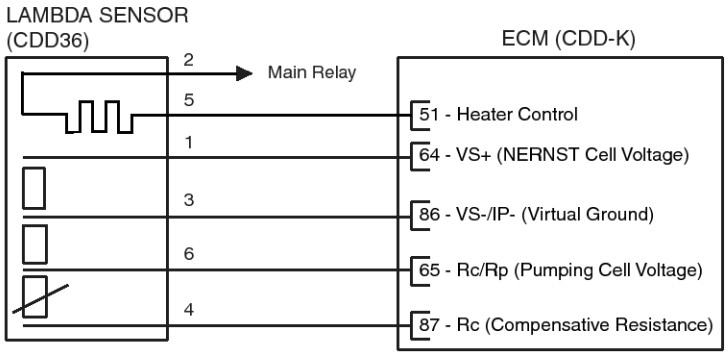
Heater

Temperature [℃(°F)]	Heater Resistance(Ω)
20 (68)	9.2
100 (212)	10.7
200 (392)	13.1
300 (572)	14.6
400 (752)	17.7
500 (932)	19.2
600 (1,112)	20.7
700 (1,292)	22.5

LFIG062A

CIRCUIT DIAGRAM

[CIRCUIT DIAGRAM]



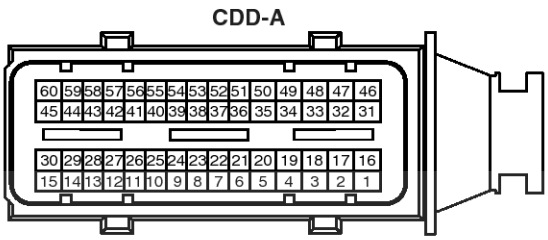
[CONNECTION INFORMATION]

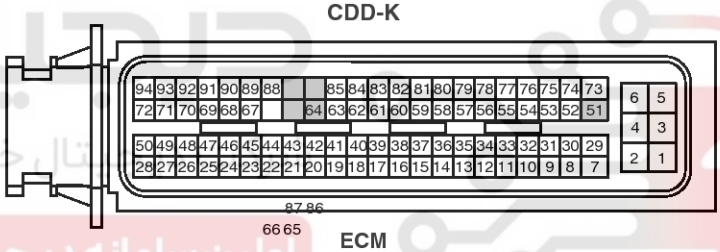
Terminal	Connected to	Function
1	ECM CDD-K (64)	VS+ (NERNST Cell Voltage)
2	Main Relay	Power Supply (B+)
3	ECM CDD-K (86)	VS-/IP- (Virtual Ground)
4	ECM CDD-K (87)	Rc (Compensative Resistance)
5	ECM CDD-K (51)	Heater Control
6	ECM CDD-K (65)	Rc/Rp (Pumping Cell Voltage)

[HARNESS CONNECTORS]

CDD36

LAMBDA SENSOR





SFDF38267L

SIGNAL WAVEFORM

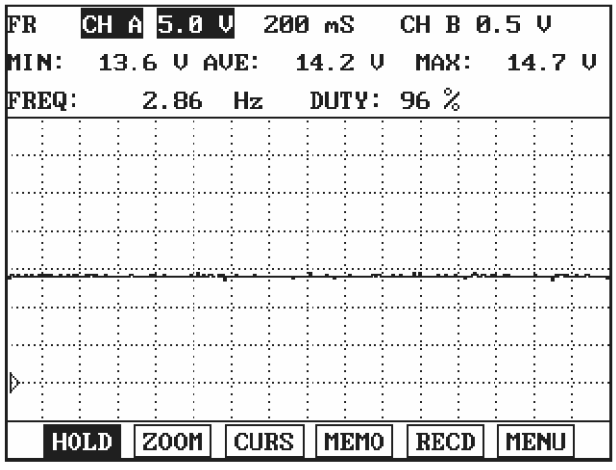


Fig.1

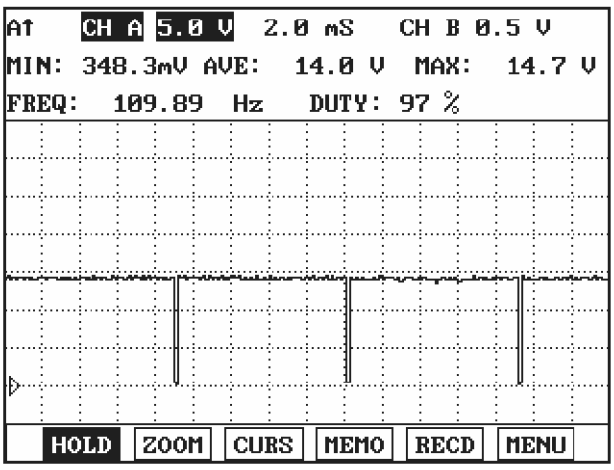


Fig.2

Fig.1) Waveform of Lambda sensor heater power. It is battery voltage.
Fig.2) Waveform of Lambda sensor heater control at cold idle.(duty increases to approx. 40% at heater operation.)

LFIG200A

REPLACEMENT

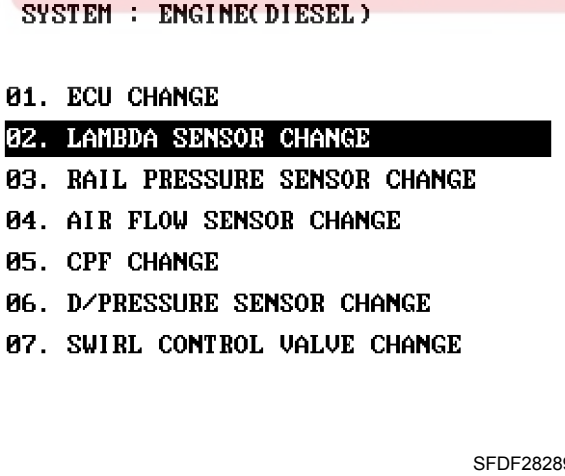
⚠CAUTION

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

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

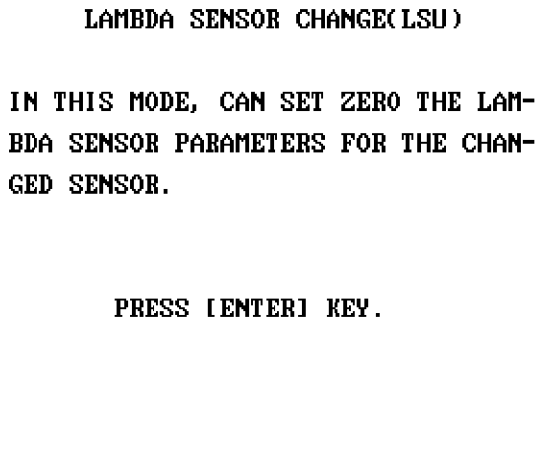
SFDF28235L

5. Select "LAMBDA SENSOR CHANGE".



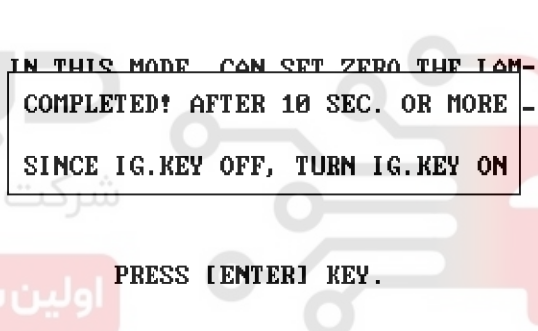
SFDF28289L

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



SFDF28290L

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



SFDF28291L

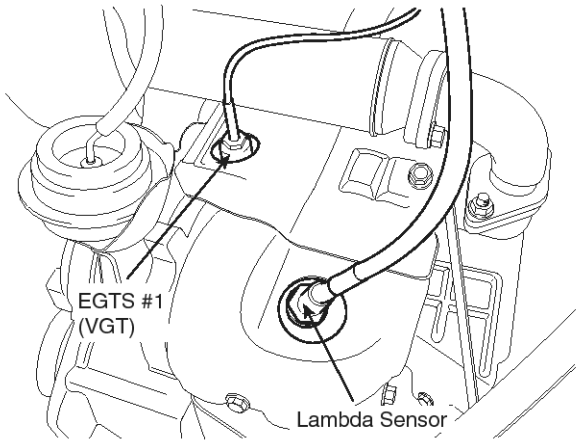
8. Wait for more than 10 seconds, and then turn ignition switch ON.

Exhaust Gas Temperature Sensor for VGT

INSPECTION

FUNCTION AND OPERATION PRINCIPLE

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



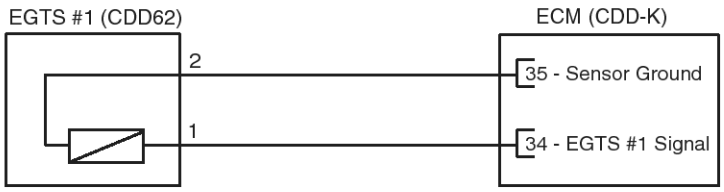
SMGFL6129L

SPECIFICATION

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

CIRCUIT DIAGRAM

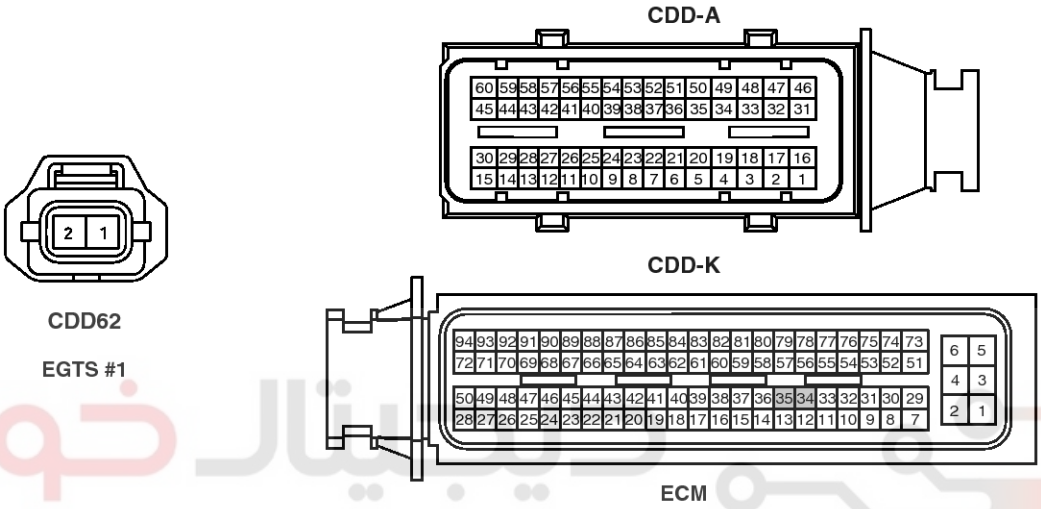
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM CDD-K (34)	EGTS #1 Signal
2	ECM CDD-K (35)	Sensor Ground

[HARNESS CONNECTORS]



SFDF38283L

SIGNAL WAVEFORM

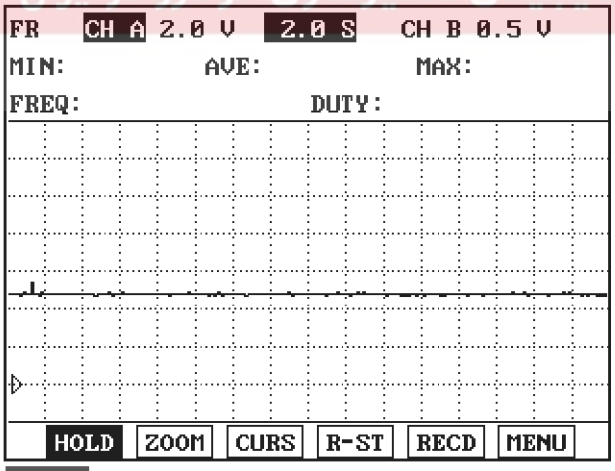


Fig.1

Fig.1) 4.8V is outputted at EGTS output signal circuit, when exhaust gas temp. is approx.150℃.
when exhaust gas temp. is 550~600℃ at CPF regeneration, output voltage drops to 0.3~0.4V.

LFIG448A

COMPONENT INSPECTION

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

Specification: Refer to "SPECIFICATION".

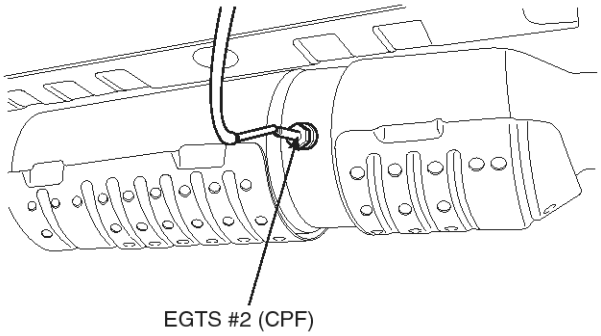
Exhaust Gas Temperature Sensor for CPF

INSPECTION

FUNCTION AND OPERATION PRINCIPLE

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

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



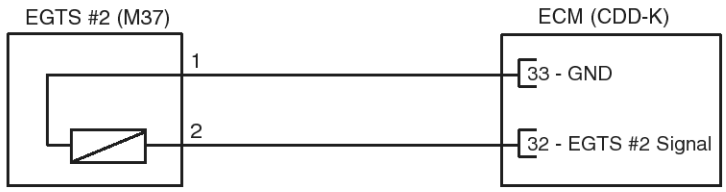
SMGFL6133L

SPECIFICATION

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

CIRCUIT DIAGRAM

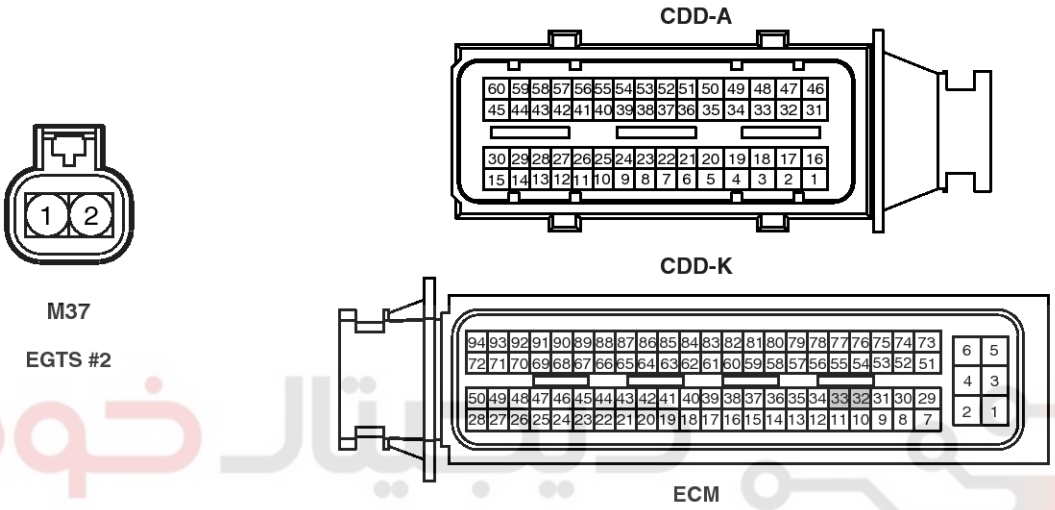
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM CDD-K (33)	Sensor ground
2	ECM CDD-K (32)	EGTS #2 Signal

[HARNESS CONNECTORS]



SFDF38284L

SIGNAL WAVEFORM

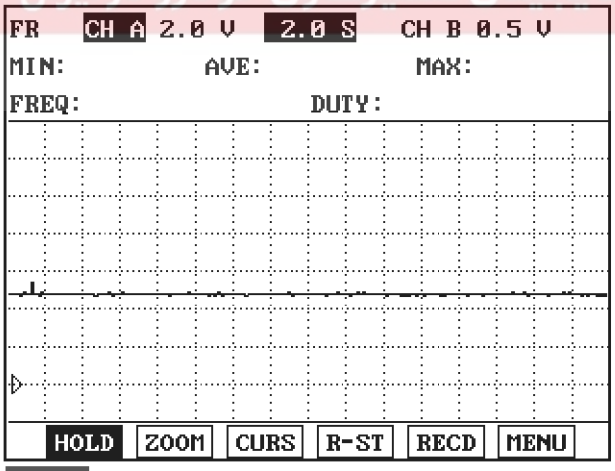


Fig.1

Fig.1) 4.8V is outputted at EGTS output signal circuit, when exhaust gas temp. is approx.150℃.
when exhaust gas temp. is 550~600℃ at CPF regeneration, output voltage drops to 0.3~0.4V.

LFIG448A

COMPONENT INSPECTION

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

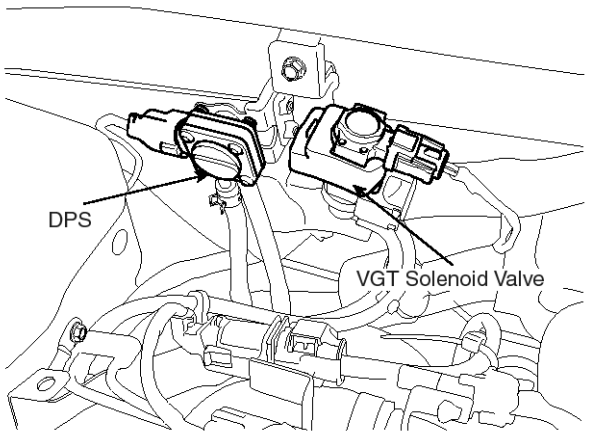
Specification: Refer to "SPECIFICATION".

CPF Differential Pressure Sensor

INSPECTION

FUNCTION AND OPERATION PRINCIPLE

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.



SMGFL6144L

SPECIFICATION

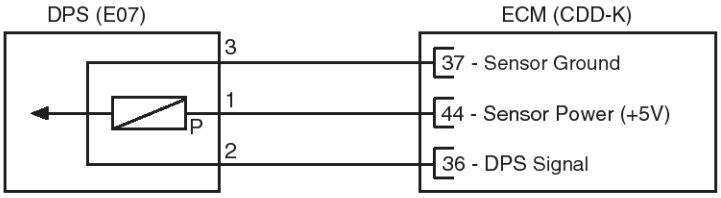
Differential Pressure[ΔP] (kPa)	Output Voltage (V)
0	1.00
10	1.35
20	1.70
30	2.05
40	2.40
50	2.75

Differential Pressure[ΔP] (kPa)	Output Voltage (V)
60	3.10
70	3.45
80	3.80
90	4.15
100	4.50

LFIG068A

CIRCUIT DIAGRAM

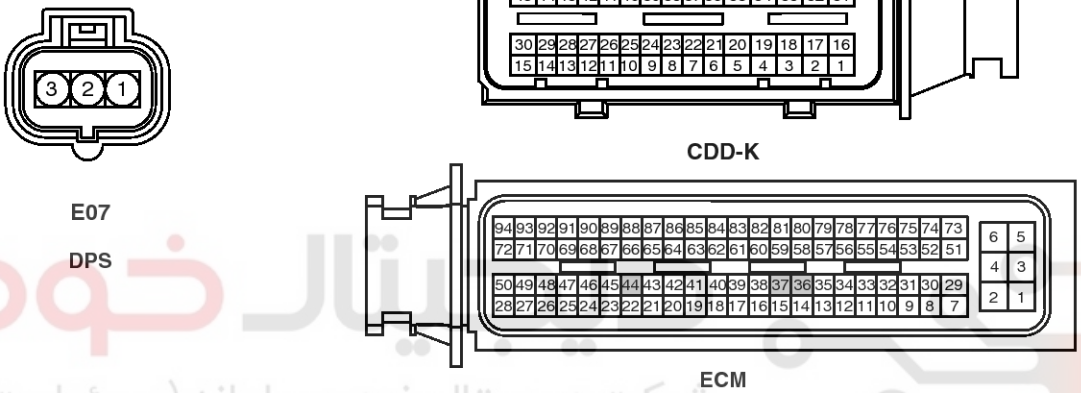
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM CDD-K (44)	Sensor Power (+5V)
2	ECM CDD-K (36)	DPS Signal
3	ECM CDD-K (37)	Sensor ground

[HARNESS CONNECTORS]



SFDF38285L

SIGNAL WAVEFORM

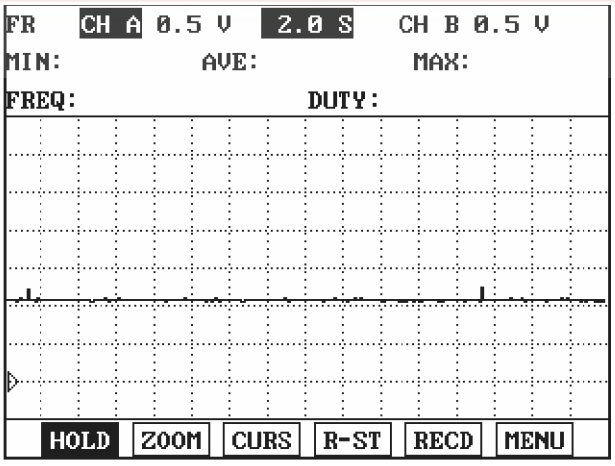


Fig.1

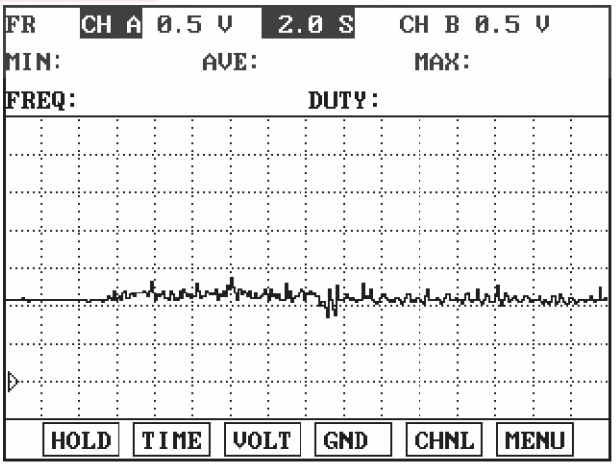


Fig.2

Fig1). This is the signal waveform of DPS at idle state. When CPF is new, 1.0~1.2V is outputted normally.
Fig2). This is the waveform of DPS as accelerating.

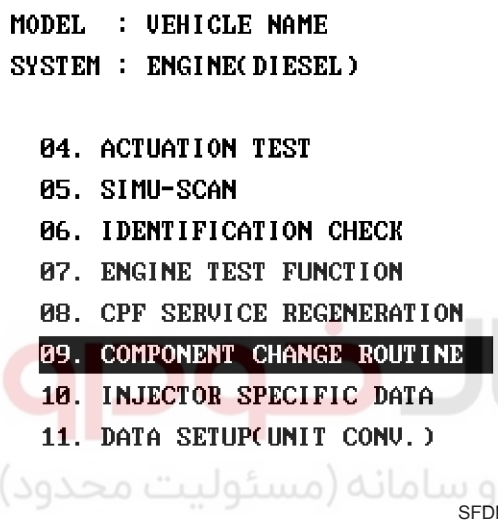
LFIG423A

REPLACEMENT

⚠CAUTION

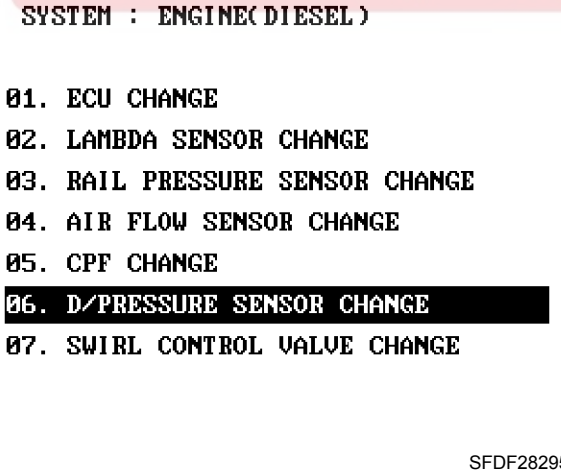
After replacing the Differential Pressure Sensor (DPS), MUST perform the "COMPONENT CHANGE ROUTINE" procedure. Otherwise trouble related with engine performance or emission control may occur until ECM learning about the component is over.

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



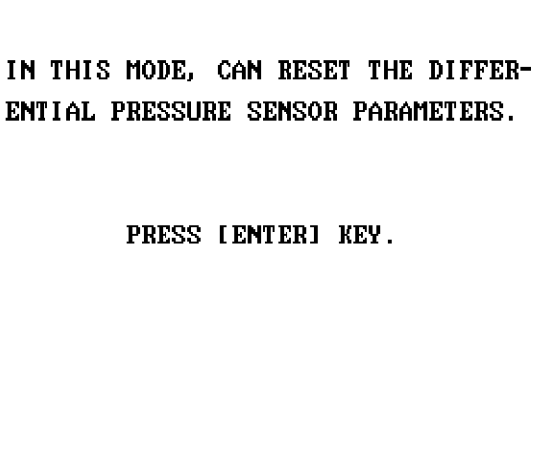
SFDF28235L

5. Select "D/PRESSURE SENSOR CHANGE".



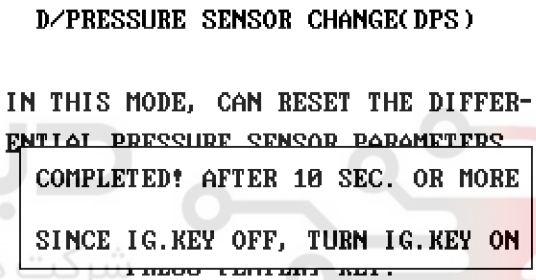
SFDF28295L

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



SFDF28296L

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



SFDF28297L

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

CPF (Catalyzed Particulate Filter)

DESCRIPTION

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

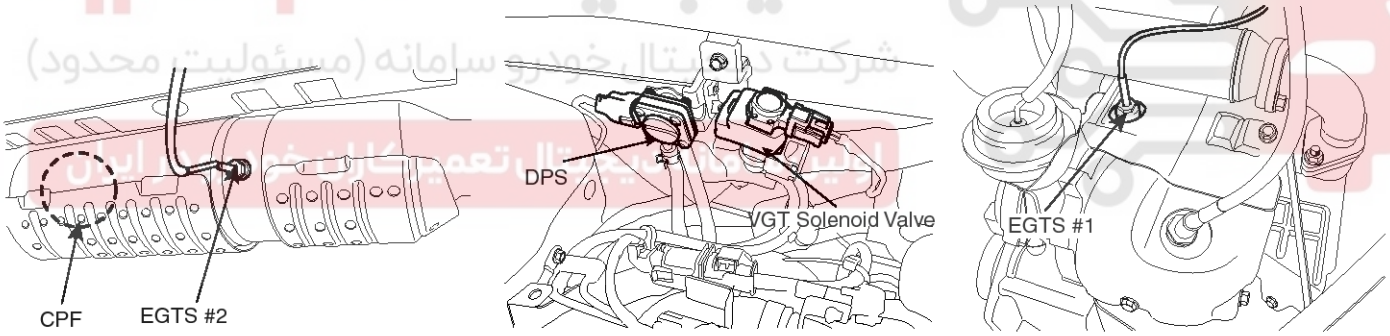
[CPF Regeneration]

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

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

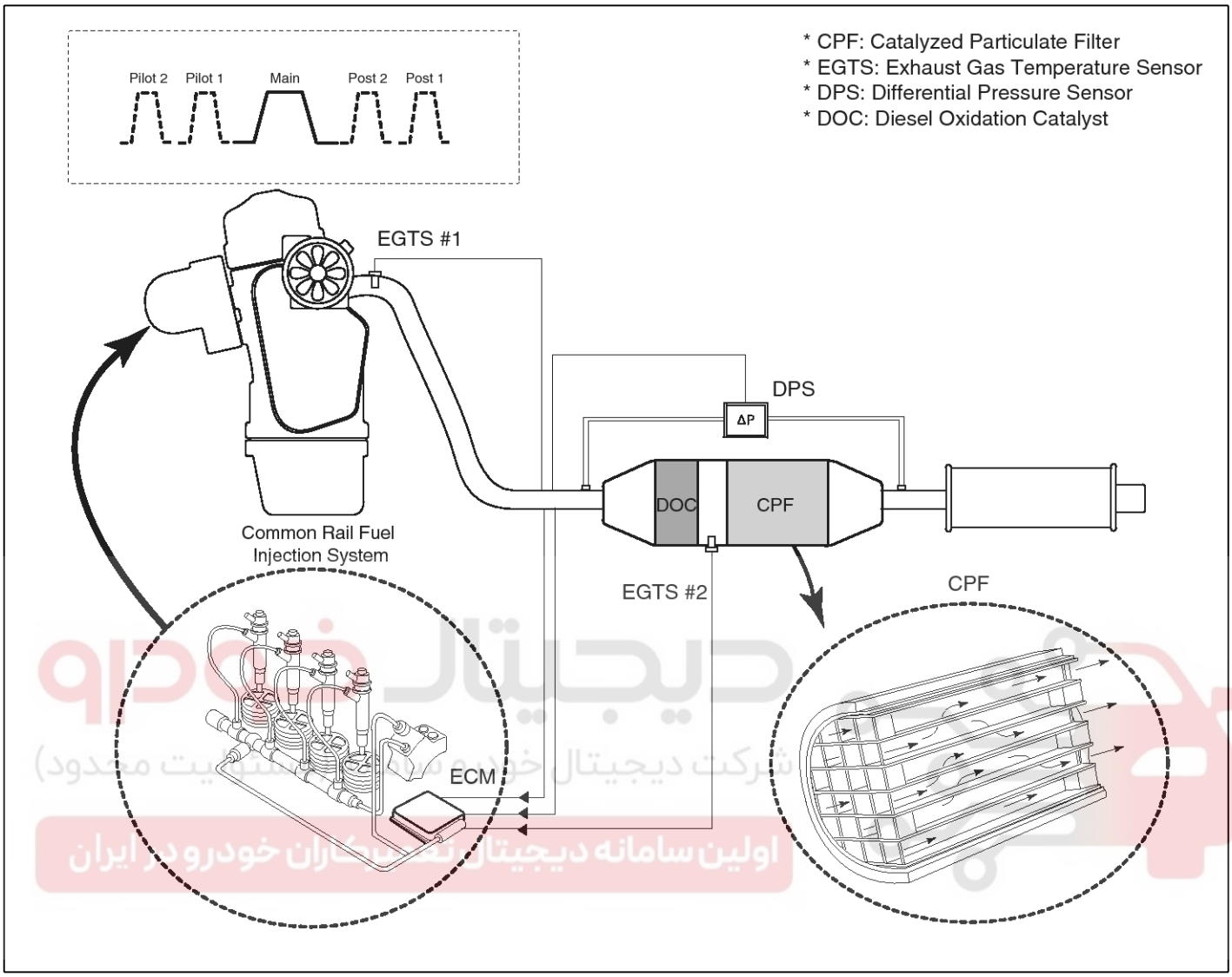
[Regeneration Mode]

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

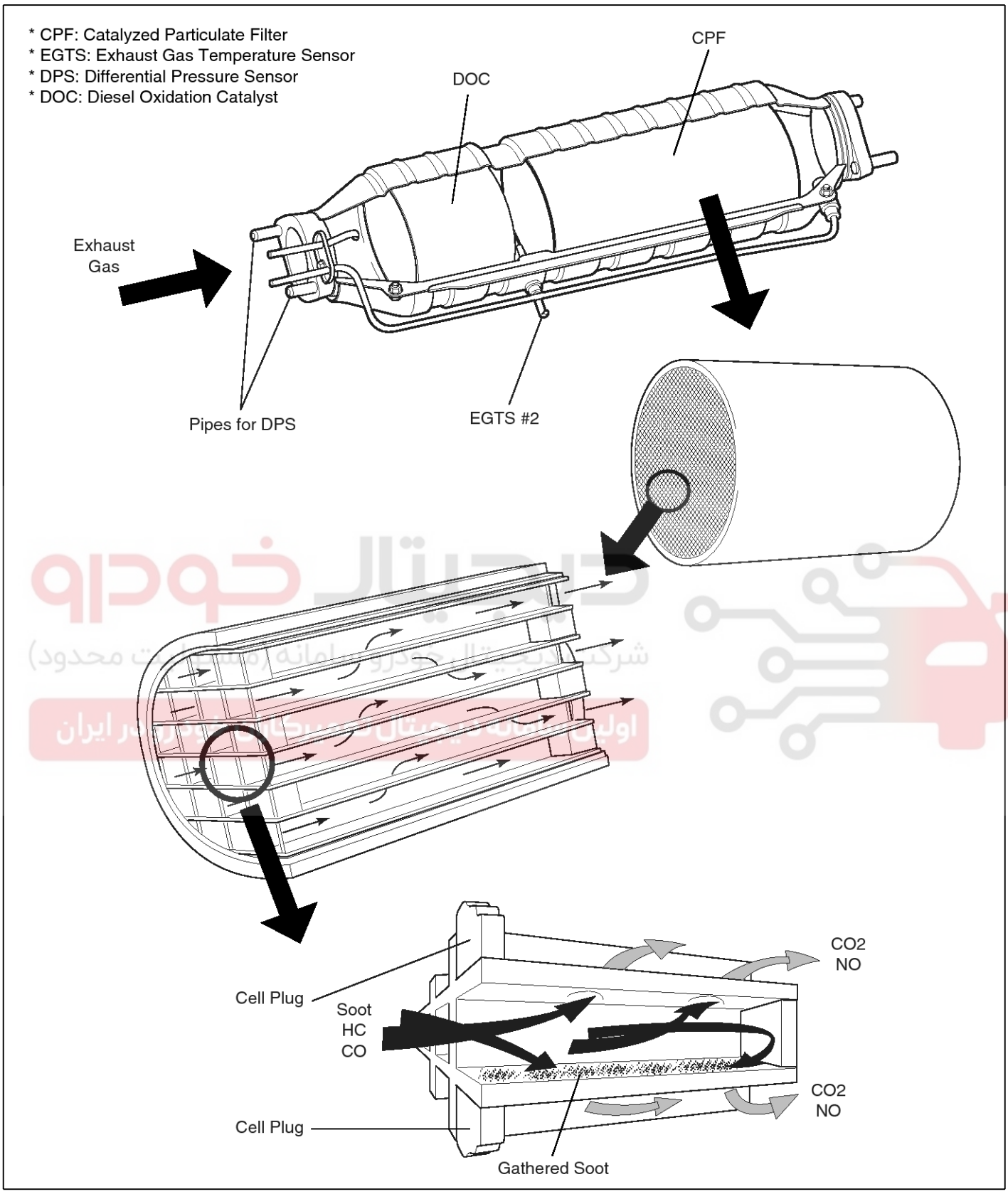


SMGFL6137L

SCHEMATIC DIAGRAM



SFDF28298L



LFIG117A

CPF REGENERATION

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

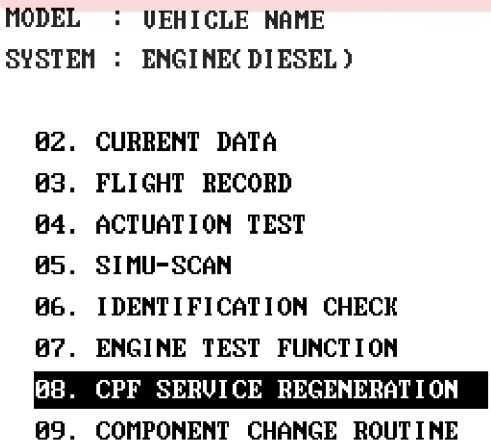
FORCIBLY REGENERATION CONDITION

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

NOTICE

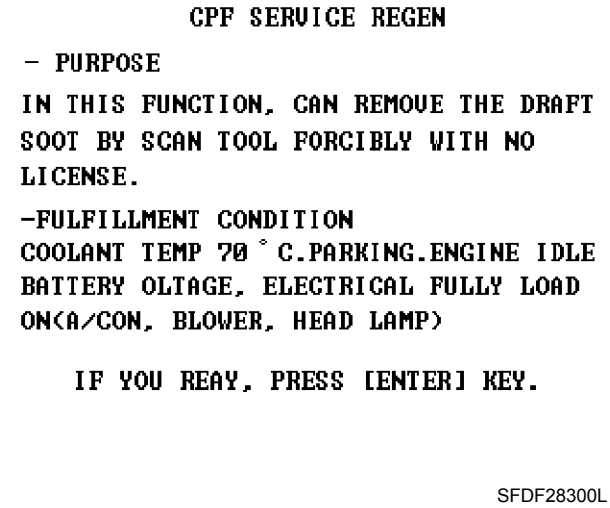
The air conditioner's electrical load is very high. Accordingly, to make regeneration mode more quickly, turn it ON (If eqquipped).

1. Turn ignition switch OFF.
2. Connect a scan tool to Data Link Connector (DLC).
3. Start engine at idle and P-range (A/T) or neutral (M/T).
4. Apply electrical fully load to the vehicle (A/C ON, Blower ON with maximum speed, Head Lamp ON, Wiper ON, and Other Lamps ON, etc.)
5. Select "CPF SERVICE REGENERATION".



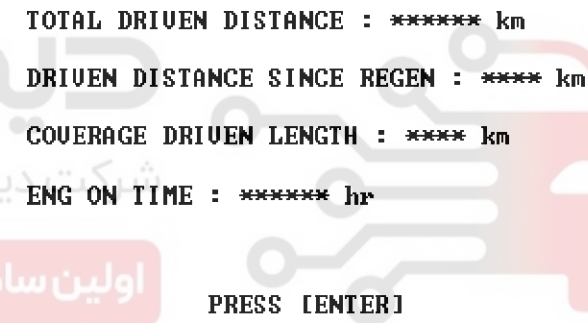
SFDF28299L

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



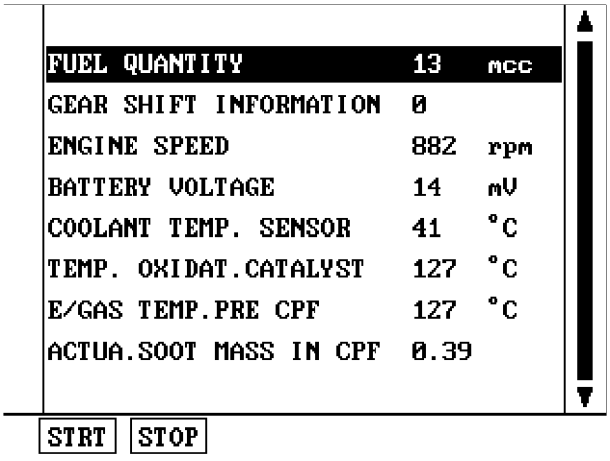
SFDF28300L

7. Confirm the data memorized in ECM, and then "ENTER" key.



SFDF28301L

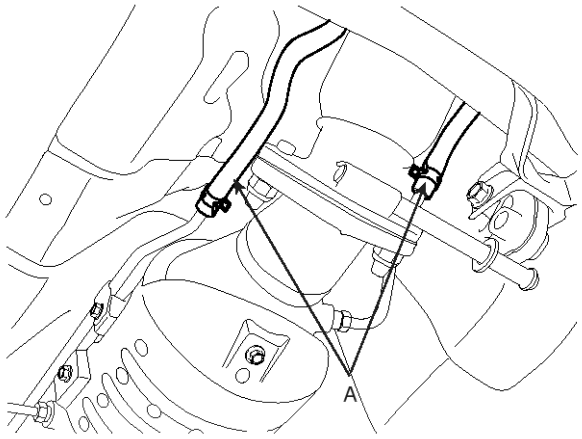
8. Perform CPF regeneration (Press "STRT" key).



SFDF28302L

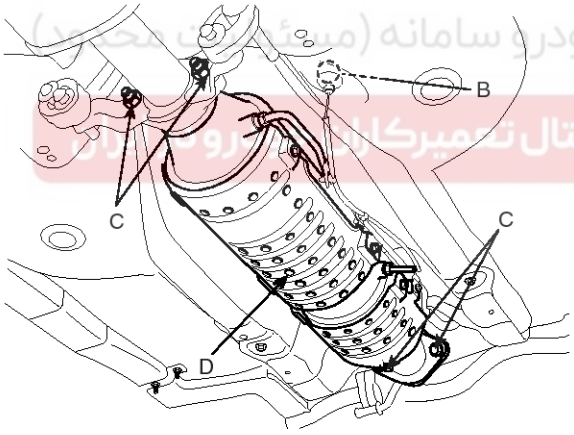
REMOVAL

1. Turn ignition switch OFF and disconnect the negative (-) battery cable.
2. Lift the vehicle and support the CPF assembly with a jack.
3. Disconnect the hoses (A) connected with the differential pressure sensor from the CPF assembly.



SMGFL6735A

4. Disconnect the exhaust gas temperature sensor #2 connector (B).



SFDF38243L

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

INSTALLATION

1. Installation is reverse of removal.

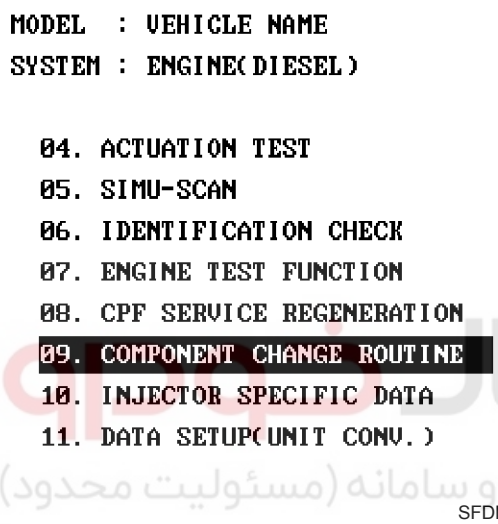
CPF mounting nuts: 39.2 ~ 58.9N·m (4.0 ~ 6.0 kgf·m, 28.9 ~ 43.4lbf·ft)

REPLACEMENT

NOTICE

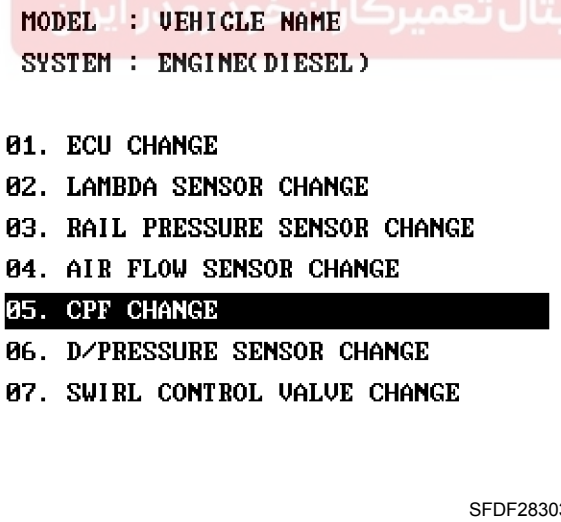
After replacing the CPF assembly, MUST perform the "COMPONENT CHANGE ROUTINE" procedure. Otherwise trouble related with engine performance or emission control may occur until ECM learning about the component is over.

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



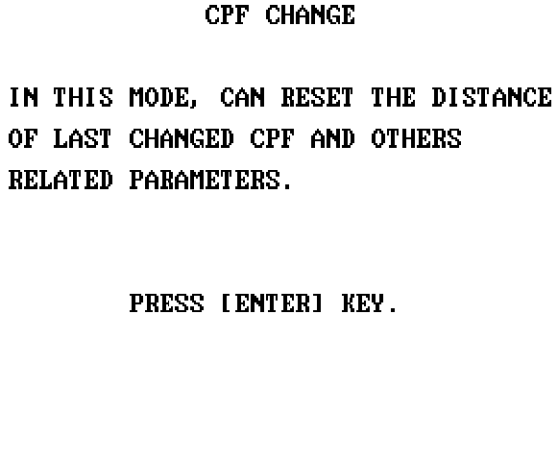
SFDF28235L

5. Select "CPF CHANGE".



SFDF28303L

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



SFDF28304L

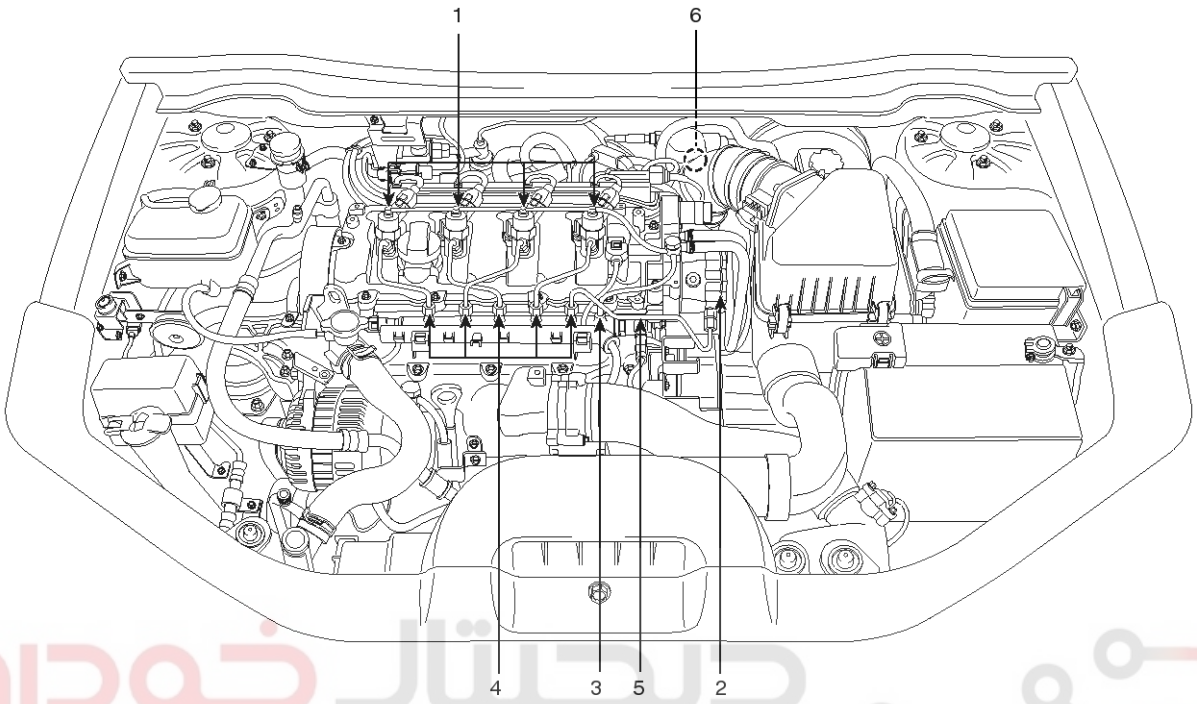
7. Confirm the "Complete" message, and then turn ignition switch OFF.

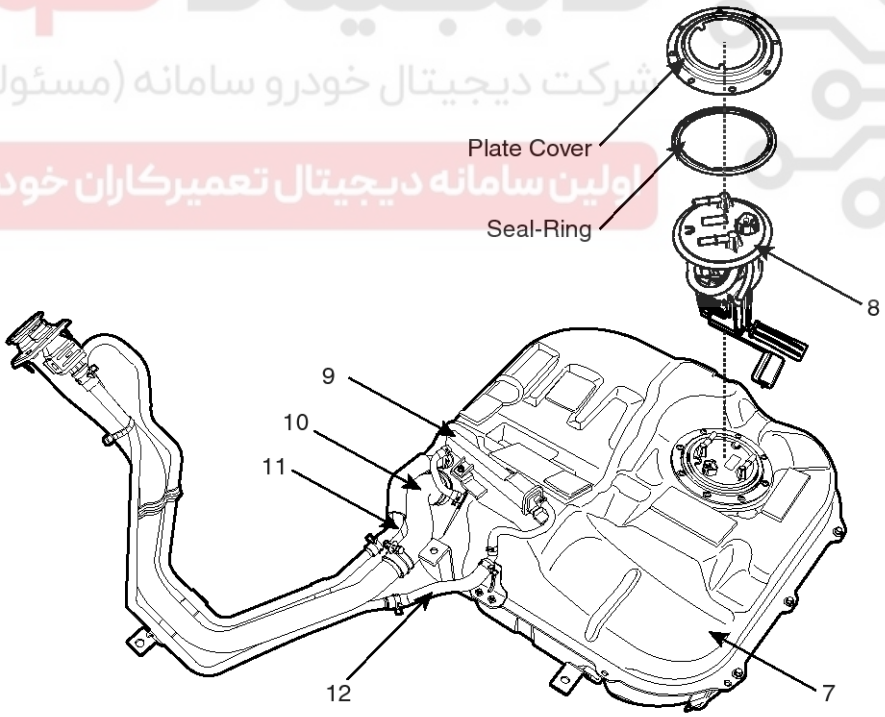
SFDF28305L

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

Fuel Delivery System

COMPONENT LOCATION





1. Injector
2. High Pressure Fuel Pump
3. Common Rail
4. High Pressure Fuel Pipe (Injector → Common Rail)
5. High Pressure Fuel Pipe (Common Rail → High Pressure Fuel Pump)
6. Fuel Filter
7. Fuel Tank
8. Fuel Fump
9. Separator
10. Fuel Filler Hose
11. Leveling Hose
12. Ventilation Hose

SFDF38246L

⚠CAUTION

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

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

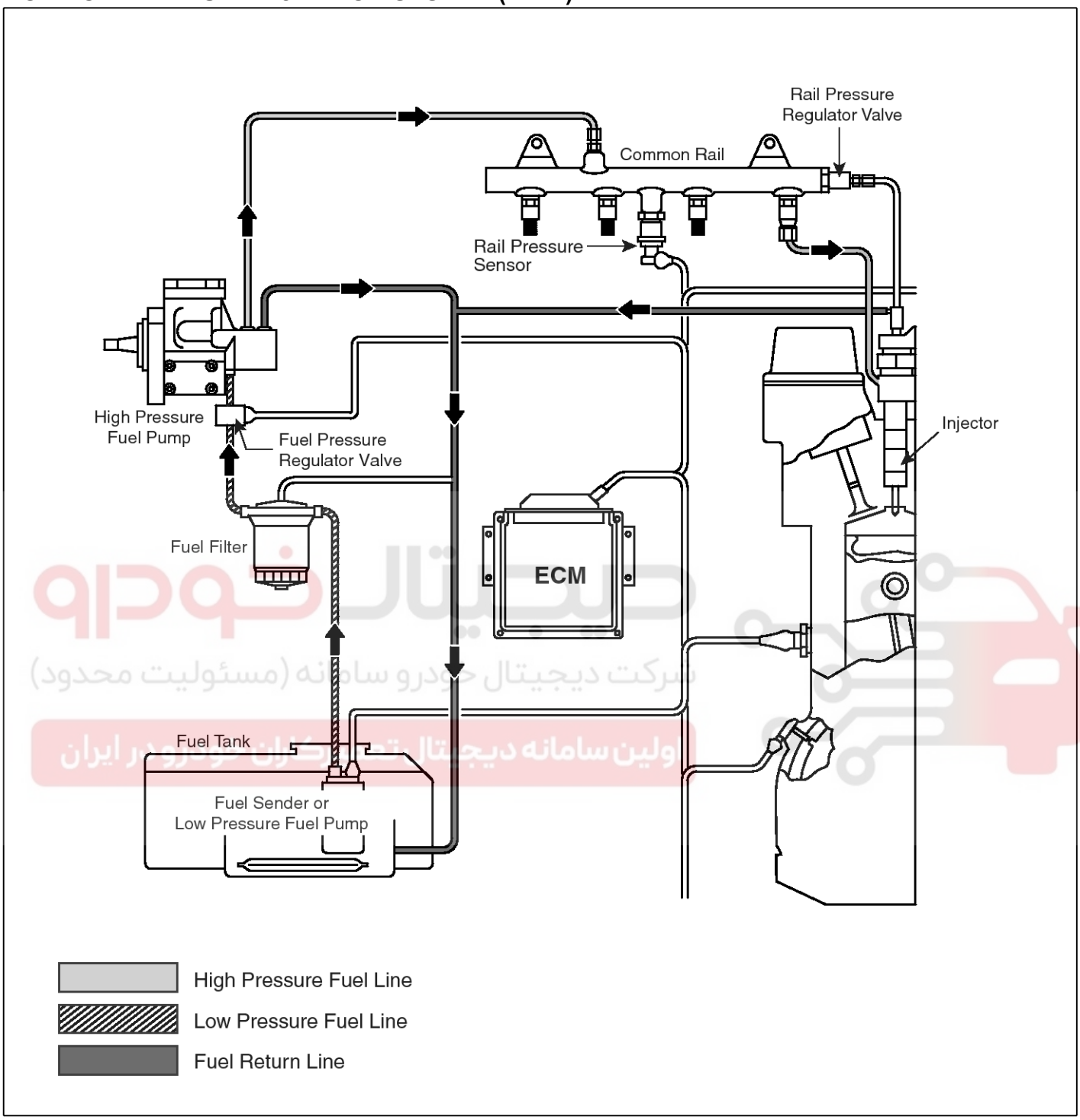
  - Spread oil on the injector O-ring.

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

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

  - Install the flange nut correctly.

COMMON RAIL FUEL INJECTION SYSTEM (CRDI)



SFDF38247L

● 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).

FUEL SENDER

The fuel sender is located into the fuel tank and measures amount of fuel contained in fuel tank.

FUEL FILTER

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

● HIGH PRESSURE FUEL CIRCUIT

HIGH PRESSURE FUEL PUMP

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

COMMON RAIL

The 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 PIPE

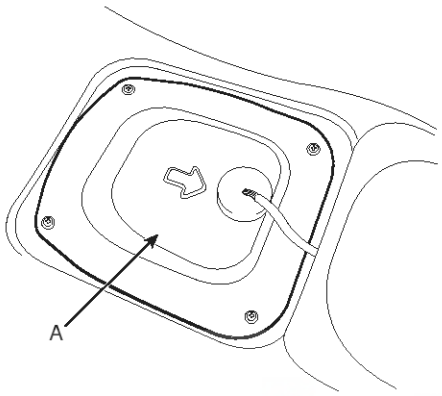
The high pressure fuel pipe is a channel in high pressure fuel circuit consisting of the high pressure fuel pump, common rails, and injectors. It is a steel tube which can withstand high frequency generated when the fuel pressure reaches the maximum pressure or fuel injection stops.

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

Fuel Tank

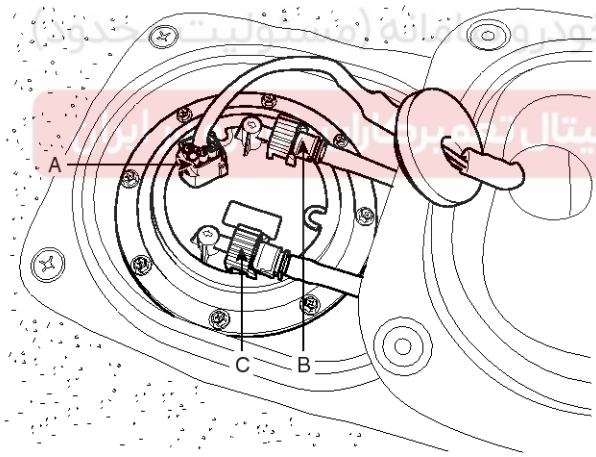
REMOVAL

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



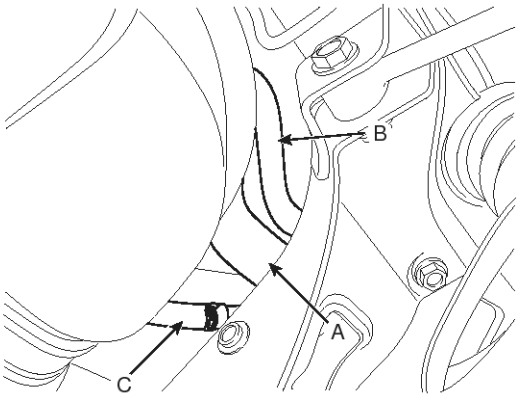
SEDF37004L

4. Disconnect the fuel pump connector (A).



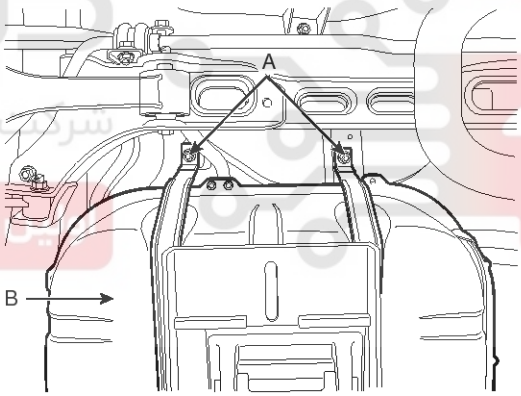
SFDF38248L

5. Disconnect the fuel feed tube quick-connector (B) and the fuel return tube quick-connector (C).
6. Lift the vehicle.
7. Support the fuel tank with a jack.
8. Disconnect the fuel filler hose (A), the leveling hose (B), and the ventilation hose (C).



SEDF37007L

9. Unscrew the fuel tank band installation nuts (A), and then remove the fuel tank (B) from the vehicle.



SEDF37009L

INSTALLATION

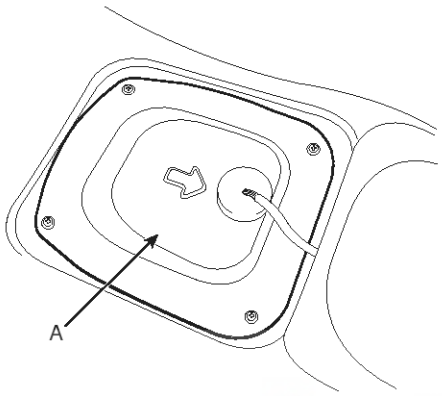
1. Installation is reverse of removal.

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

Fuel Pump

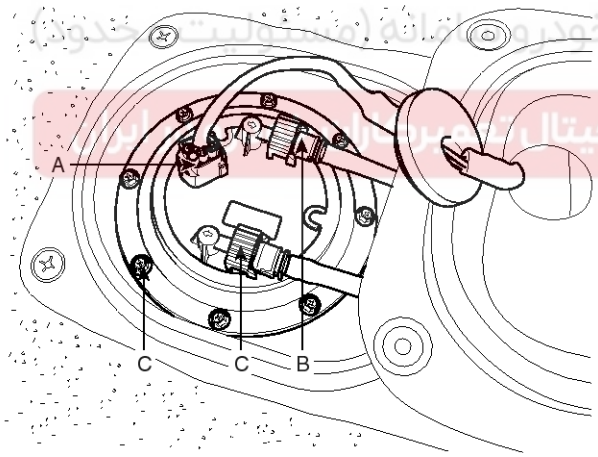
REMOVAL

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



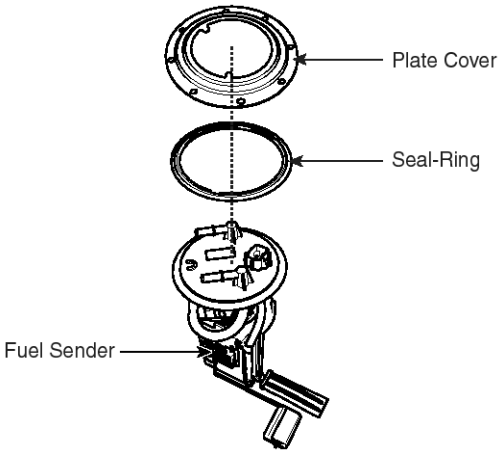
SEDF37004L

4. Disconnect the fuel pump connector (A).



SFDF38249L

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



SFDF38250L

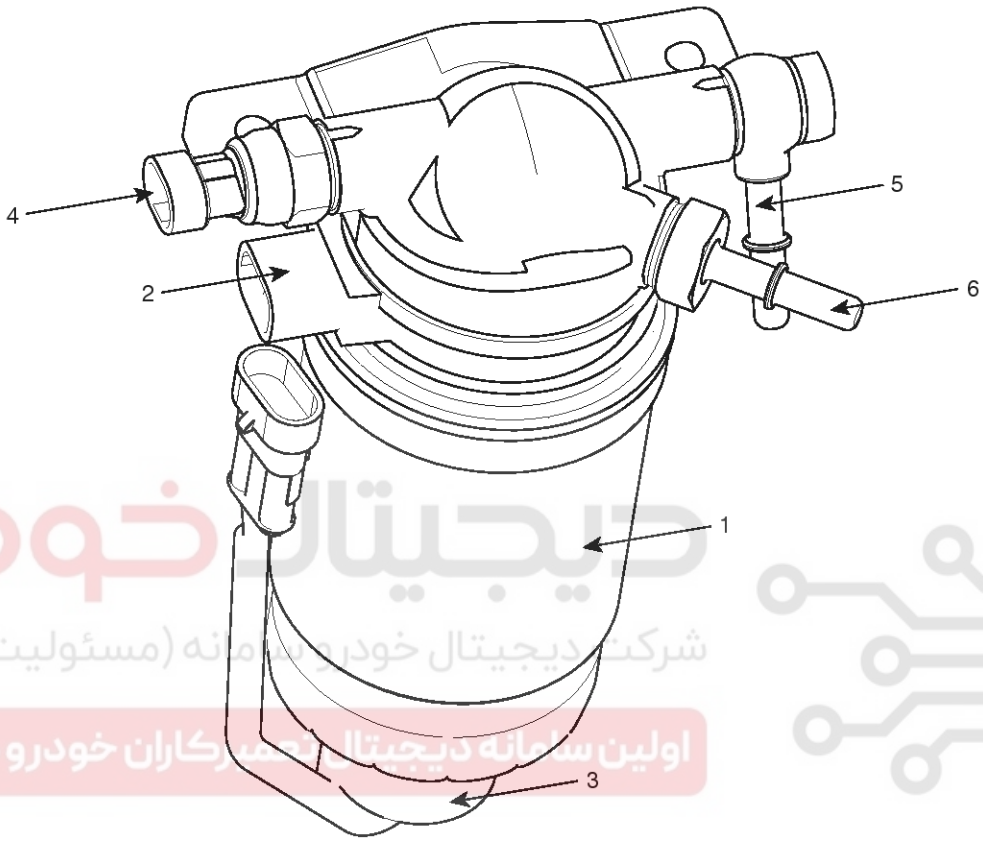
INSTALLATION

1. Installation is reverse of removal.

Fuel pump installation bolts: 2.0 ~ 2.9 N·m (0.2 ~ 0.3 kgf·m, 1.4 ~ 2.2 lbf·ft)

Fuel Filter

COMPONENTS

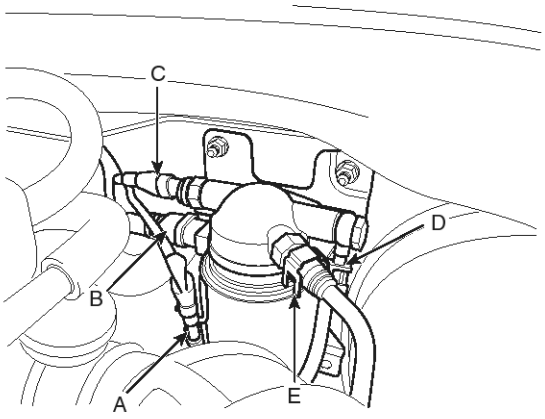


1. Fuel Filter
2. Heater
3. Water Sensor
4. Thermostat
5. Nipple (↔ Fuel Tank)
6. Nipple (↔ High Pressure Fuel Pump)

SFDF38251L

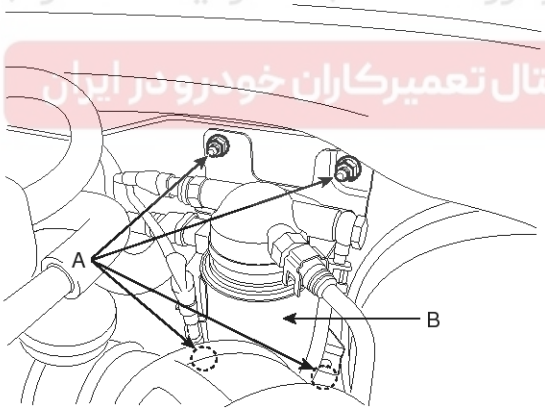
REPLACEMENT

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



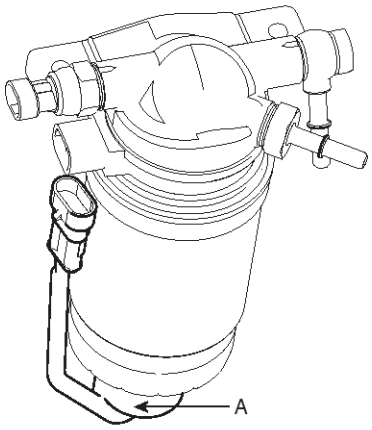
SFDF38252L

3. Disconnect the fuel inlet tube quick-connector (D) and the fuel outlet tube quick-connector (E).
4. Unscrew the fuel filter installation nuts (A), and then remove the fuel filter (B) from the vehicle.



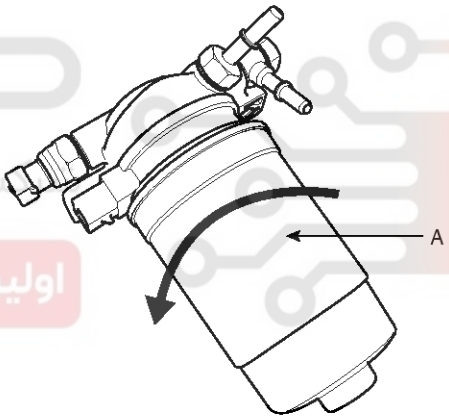
SEDF37012L

5. Remove the water sensor (A).

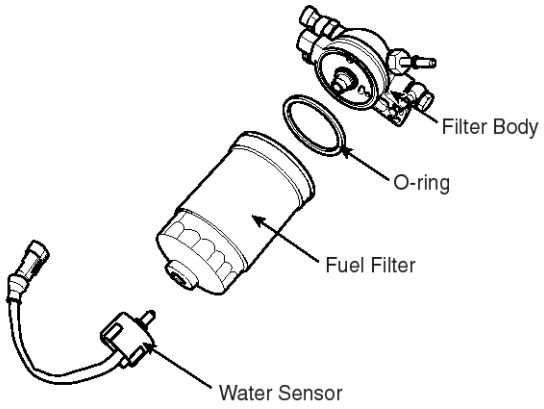


SFDF38253L

6. 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.



SFDF38254L



SFDF38255L

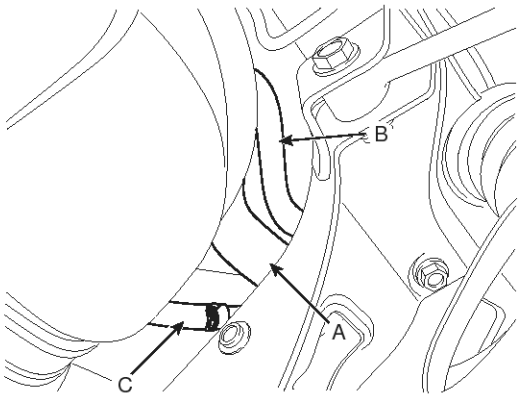
⚠CAUTION
When replacing the fuel filter, must replace the O-ring.

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

Filler-Neck Assembly

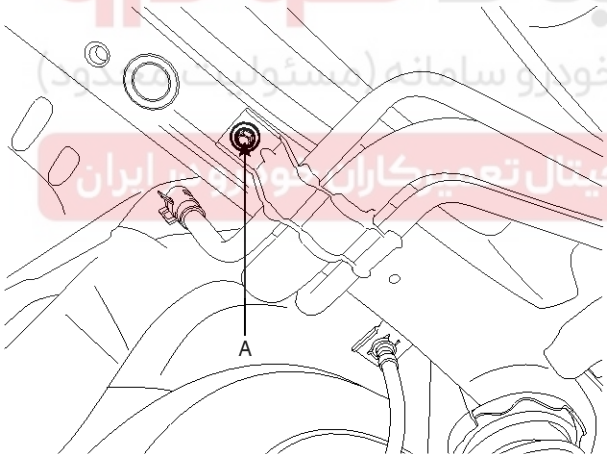
REMOVAL

1. Disconnect the fuel filler hose (A), the leveling hose (B), and the ventilation hose (C).



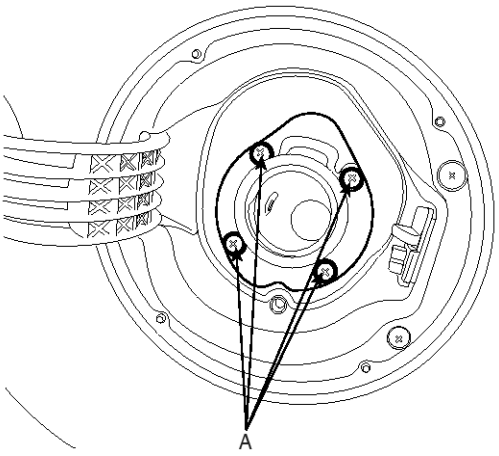
SEDF37007L

2. Remove the left - rear wheel & tire and the wheel house.
3. Unscrew the mounting bolt (A).



SFDF38256L

4. Remove the fuel filler neck assembly after unscrewing the mounting screws (A).



SFDF38257L

NOTICE

If the filler neck assembly can't be removed easily, remove it again after loosening the rear cross member mounting bolt partly (Refer ro "REAR LOW ARM" in SS group).

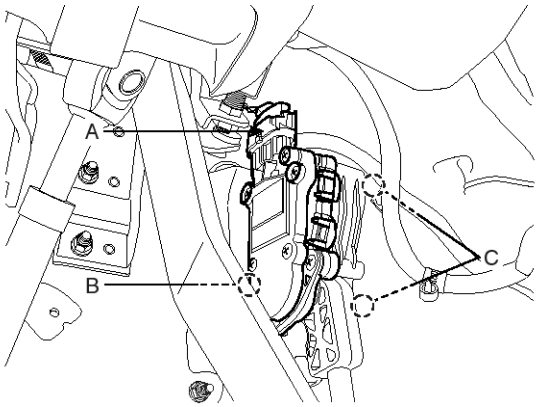
INSTALLATION

1. Installation is reverse of removal.

Accelerator Pedal

REMOVAL

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



SFDF38258L

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

INSTALLATION

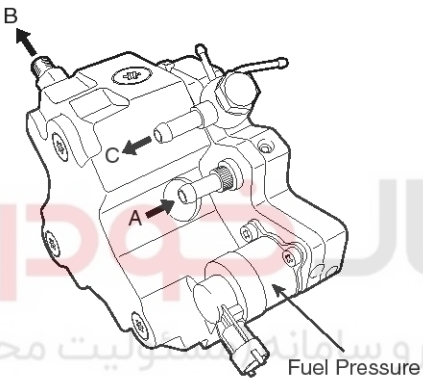
1. Installation is reverse of removal.

Fuel pump installation bolts: 12.8 ~ 15.7 N·m (1.3 ~ 1.6 kgf·m, 9.4 ~ 11.6 lbf·ft)

High Pressure Pump

DESCRIPTION

The high pressure fuel pump is the interface between the low pressure and the high pressure stages. Under all operating conditions, it is responsible for providing adequate high pressure fuel through out the vehicle's complete service life. This also includes the provision of extra as needed for rapid starting and for rapid build-up of pressure in the rail. The high pressure pump continually generates the system pressure as needed in the high-pressure accumulator (common rail). This means therefore, that in contrast to conventional systems, the fuel does not have to be specially compressed for each individual injection process.



A : Fuel Inlet
(From Fuel Tank via Fuel Filter)
B : Fuel Outlet (To Common Rail)
C : Fuel Return (To Fuel Tank)

SFDF38261L

REMOVAL

CAUTION

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

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

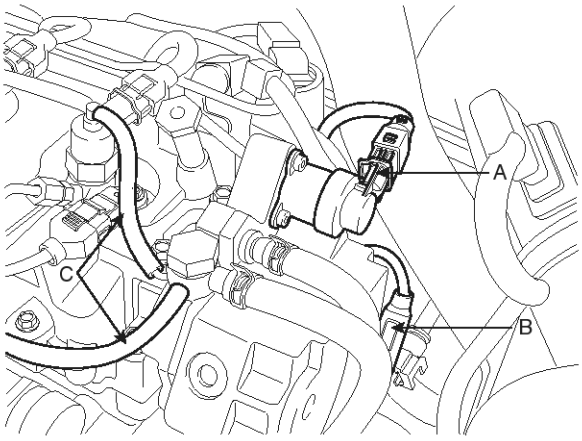
  - Spread oil on the injector O-ring.

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

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

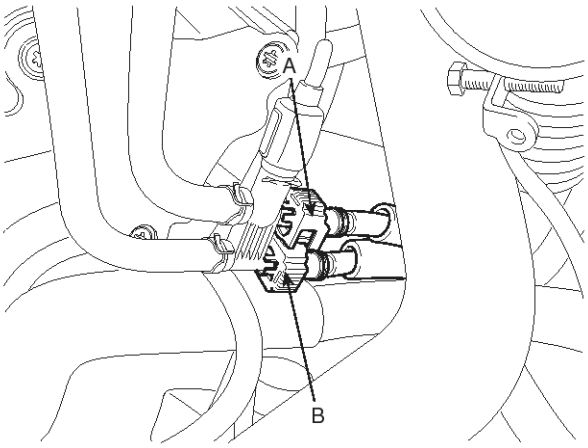
  - Install the flange nut correctly.

1. Turn ignition switch OFF and disconnect the negative (-) battery cable.
2. Remove the air cleaner assembly (Refer to group "EM" in this Shop Manual).
3. Disconnect the fuel pressure regulator valve connector (A) and the fuel temperature sensor connector (B).



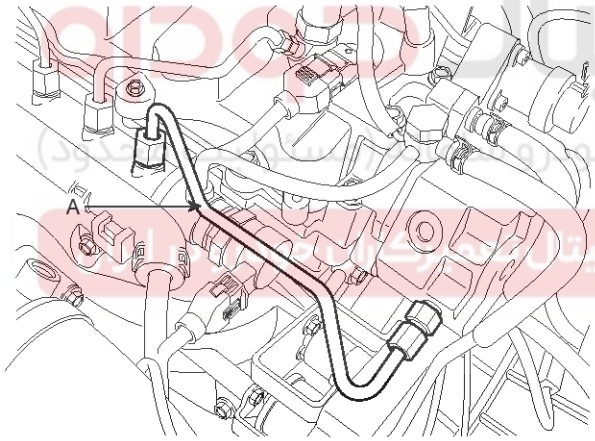
SFDF38259L

4. Disconnect the return hoses (C) connected with the injectors and the common rail.
5. Disconnet the fuel feed tube quick-connector (A) and the return tube quick-connector (B).



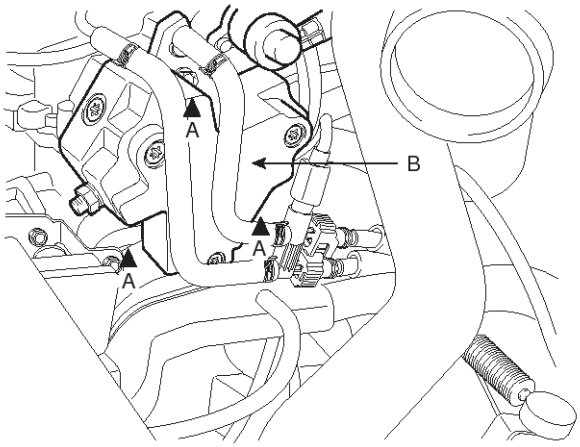
LFIG077A

6. Remove the high pressure fuel pipe (A) connecting the high pressure fuel pump with the common rail.



SFDF38260L

7. Unscrew the mounting bolts (A) and remove the high pressure fuel pump (B) from the engine.



LFIG080A

INSTALLATION

1. Installation is reverse of removal.

NOTICE

When installing the high pressure fuel pipe, apply the specified tightening torques with the special service tool (Refer to below table).

Item	Dimension	SST No.
Flange Nut (HP Pump Side)	14 mm (0.551 in)	09314-27110
Flange Nut (Common Rail Side)	17 mm (0.669 in)	09314-27120

High pressure fuel pump installation bolts: 24.5 ~ 34.3 N·m (2.5 ~ 3.5 kgf·m, 12.1 ~ 25.3 lbf·ft)
High pressure fuel pipe installation nut: 24.5 ~ 28.4 N·m (2.5 ~ 2.9 kgf·m, 18.1 ~ 20.1 lbf·ft)

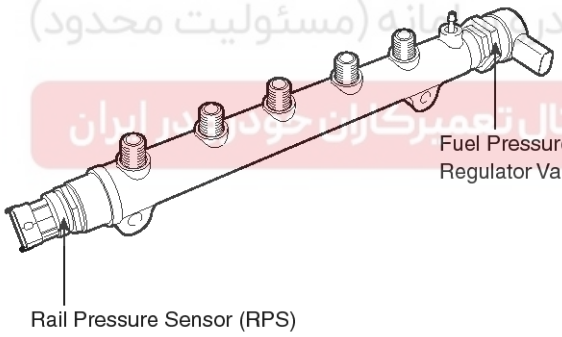
Common Rail

DESCRIPTION

The common rail stores the fuel at high pressure. At the same time, the pressure oscillations which are generated due to the high-pressure pump delivery and the injection of fuel are damped by the rail volume. This common rail is common to all cylinders, hence its name "common rail". Even when large quantities of fuel are extracted, the common rail maintains its inner pressure practically constant from the moment the injector opens.

In order to comply with the wide variety of engine installation conditions, the common rail with its flow limiters and the provistions for attaching rail pressure sensor, fuel pressure control valve, and pressure limiter valve is available in a number of different designs.

The available common rail volume is permanently filled with pressurized fuel. The compressibility of the fuel resulting from the high pressure is utilized to achieve the accumulator effect. When fuel leaves the rail for injection, the pressure variations resulting from the pulsating fuel supply from the high-pressure pump are compensated for.



SFDF38262L

REMOVAL

⚠CAUTION

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

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

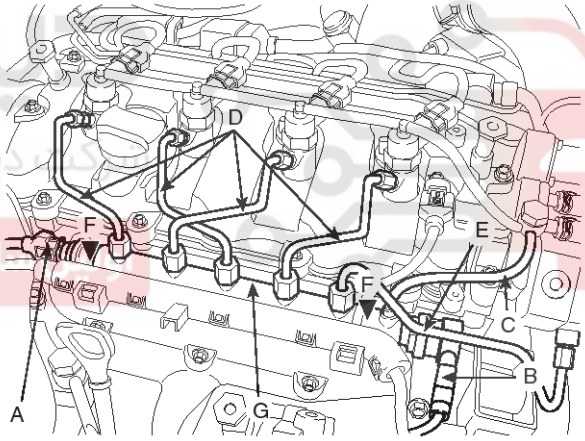
  - Spread oil on the injector O-ring.

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

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

  - Install the flange nut correctly.

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



SFDF38286L

3. Disconnect the return hose (C) from the common rail.
4. Remove the high pressure fuel pipe (D) connecting the injectors with the common rail.
5. Remove the high pressure fuel pipe (E) connecting the common rail with the high pressure fuel pump.
6. Unscrew the two mounting bolts (F) and remove the common rail (G).

INSTALLATION

1. Installation is reverse of removal.

NOTICE

When installing the high pressure fuel pipe, apply the specified tightening torques with the special service tool (Refer to below table).

Item	Dimension	SST No.
Flange Nut (Injector Side)	14 mm (0.551 in)	09314-27110
Flange Nut (HP Pump Side)		
Flange Nut (Common Rail Side)	17 mm (0.669 in)	09314-27120

· Common rail installation bolts: 19.6 ~ 26.5 N·m (2.0 ~ 2.7 kgf·m, 14.5 ~ 19.5 lbf·ft)
· High pressure fuel pipe installation nut: 24.5 ~ 28.4 N·m (2.5 ~ 2.9 kgf·m, 18.1 ~ 20.1 lbf·ft)