Fuel System

GENERAL

DIESEL CONTROL SYSTEM

- ENGINE CONTROL MODULE (ECM)
- MASS AIR FLOW SENSOR (MAFS)
- BOOST PRESSURE SENSOR (BPS)
- INTAKE AIR TEMPERATURE SENSOR (IATS)
- ENGINE COOLANT TEMPERATURE SENSOR (ECTS)
- CAMSHAFT POSITION SENSOR (CMPS)
- CRANKSHAFT POSITION SENSOR (CKPS)
- ACCELERATOR POSITION SENSOR (APS)
- RAIL PRESSURE SENSOR (RPS)
- FUEL TEMPERATURE SENSOR (FTS)
- FUEL PRESSURE REGULATOR VALVE
- RAIL PRESSURE REGULATOR VALVE
- ELECTRIC EGR CONTROL VALVE
- VARIABLE SWIRL CONTROL ACTUATOR
- WATER SENSOR
- VGT CONTROL SOLENOID VALVE
- LAMBDA SENSOR

DTC TROUBLESHOOTING PROCEDURES

FUEL DELIVERY SYSTEM-DIESEL

- FUEL TANK
- FUEL SENDER
- FUEL FILTER
- HIGH PRESSURE FUEL PUMP
- COMMON RAIL
- INJECTOR

GENERAL

SPECIFICATION E6C0851C

FUEL DELIVERY SYSTEM

Items	Specification	
Fuel Tank	Capacity	55 lit. (14.5 Imp.gal., 12.1 U.S.gal.)
Fuel Return System	Type	Return Type
Fuel Filter	Type	High pressure type (Built in engine room)
High Pressure Fuel Pump	Type	Mechanical, Plunger Pumping Type
	Driven by	Drive Belt
Fuel Pressure (Maximum)	Pressure	1,600 bar (160 MPa, 23,206 psi)

INPUT SENSORS

MASS AIR FLOW SENSOR (MAFS)
▷ Type: Hot-Film Type
▷ Specification

*** AT INTAKE AIR TEMPERATURE = 20℃(68℉)**

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℉) OR 80℃(176℉)**

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

BOOST PRESSURE SENSOR (BPS)
▷ Type: Piezo-resistive pressure sensor type
▷ Specification

Pressure (kPa)	Output Voltage (V)
32.5	0.5
70.0	1.02 ~ 1.17
100.0	1.53 ~ 1.68
150.0	2.33 ~ 2.48
200.0	3.12 ~ 3.27
250.0	3.92 ~ 4.07
270.0	4.20 ~ 4.35
284.0	4.5

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

▷ Type: Thermistor type

▷ Specification

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

ENGINE COOLANT TEMPERATURE SENSOR (ECTS)

▷ Type: Thermistor type

▷ Specification

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

CAMSHAFT POSITION SENSOR (CMPS)

▷ Type: Hall effect type

▷ Specification

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

CRANKSHAFT POSITION SENSOR (CKPS)

▷ Type: Variable reluctance type

▷ Output Voltage (V): 0 ~ 5V

Items	Specification
Coil Resistance(Ω)	774 ~ 946Ω [℃(°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)	27.0
-20(-4)	15.67
-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	1800	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

Temperature [℃(℉)]	Heater Resistance(Ω)
20(68)	9.2
100(212)	10.7
200(392)	13.0
300(572)	14.6
400(752)	17.7
500(932)	19.2
600(1,112)	20.7
700(1,292)	22.5

VEHICLE SPEED SENSOR (VSS)
▷ Type: Inductive type

OUTPUT ACTUATORS

INJECTOR
▷ Number: 4
▷ Specification

Items	Specification
Coil Resistance (Ω)	0.215 ~ 0.295Ω [20~70℃(68~158℉)]

FUEL PRESSURE REGULATOR VALVE
▷ Type: Duty control type
▷ Specification

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

RAIL PRESSURE REGULATOR VALVE
▷ Type: Duty control type
▷ Specification

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

ELECTRIC EGR CONTROL VALVE
▷ Type: Linear solenoid type
▷ Specification

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

VGT CONTROL SOLENOID VALVE
▷ Type: Duty control type
▷ Specification

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

VARIALBE SWIRL CONTROL ACTUATOR
▷ Type : Motor driven (including Position Sensor)
▷ Specification
Motor

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

Position Sensor

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

SERVICE STANDARD E03CD241

Basic Idle rpm(After warm up)	A/C OFF	Neutral,N,P-range	830 ± 100 rpm
		D-range	830 ± 100 rpm
	A/C ON	Neutral,N,P-range	830 ± 100 rpm
		D-range	830 ± 100 rpm

TIGHTENING TORQUES EAD0A383

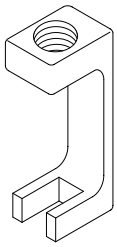
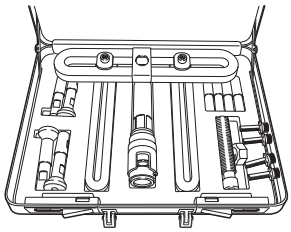
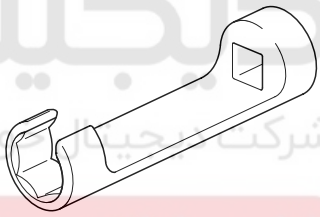
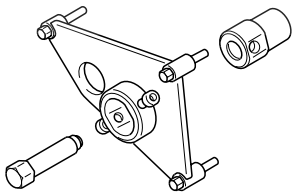
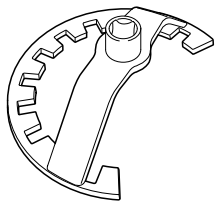
ENGINE CONTROL SYSTEM

Item	N·m	Kgf·m	lbf·ft
ECM installation bolts/nuts (on bracket)	8.8 ~ 13.7	0.9 ~ 1.4	6.5 ~ 10.1
ECM bracket installation bolts/nuts	3.9 ~ 5.9	0.4 ~ 0.6	2.9 ~ 4.3
Mass air flow sensor clamp tightening	2.9 ~ 4.9	0.3 ~ 0.5	2.2 ~ 3.6
Mass air flow sensor mounting bolts (on air cleaner assembly)	2.9 ~ 4.9	0.3 ~ 0.5	2.2 ~ 3.6
Boost pressure sensor installation bolts	6.9 ~ 10.8	0.7 ~ 1.1	5.1 ~ 8
Engine coolant temperature sensor installation	24.5 ~ 34.3	2.5 ~ 3.5	18.1 ~ 25.3
Crankshaft position sensor installation bolt	5.9 ~ 9.8	0.6 ~ 1.0	4.3 ~ 7.2
Camshaft position sensor installation bolt	6.9 ~ 9.8	0.7 ~ 1.0	5.1 ~ 7.2
Lambda sensor installation	39.2 ~ 58.9	4.0 ~ 6.0	28.9 ~ 43.4
Electric EGR control valve installation bolts	21.6 ~ 27.5	2.2 ~ 2.8	15.9 ~ 20.0
VGT control solenoid valve bracket installation nuts	6.9 ~ 10.8	0.7 ~ 1.1	5.1 ~ 8
Throttle body installation nuts	6.9 ~ 10.8	0.7 ~ 1.1	5.1 ~ 8
Glow plug installation	14.7 ~ 19.6	1.5 ~ 2.0	10.9 ~ 14.5
Glow plug plate installation nuts	0.8 ~ 1.5	0.08 ~ 0.15	0.6 ~ 1.1

FUEL DELIVERY SYSTEM

Item	N·m	Kgf·m	lbf·ft
Injector clamp installation bolt	28.4 ~ 30.4	2.9 ~ 3.1	21 ~ 22.4
Common rail installation bolts	14.7 ~ 21.6	1.5 ~ 2.2	10.9 ~ 15.9
High pressure fuel pump installation bolts	14.7 ~ 19.6	1.5 ~ 2.0	10.9 ~ 14.5
High pressure pipe (Injector ↔ Common Rail) installation nuts	24.5 ~ 28.4	2.5 ~ 2.9	18.1 ~ 21
High pressure pipe (Common Rail ↔ High Pressure Fuel Pump) installation nuts	24.5 ~ 28.4	2.5 ~ 2.9	18.1 ~ 21
Fuel sender plate cover tightening	60.0 ~ 70.0	6.1 ~ 7.1	44.3 ~ 51.6
Accelerator pedal installation bolts	7.8 ~ 11.8	0.8 ~ 1.2	5.8 ~ 8.7

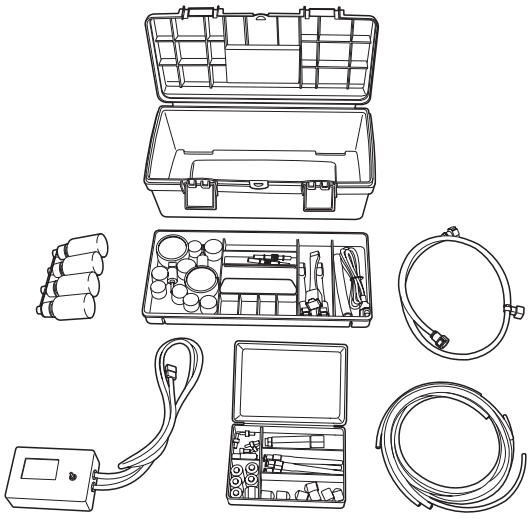
SPECIAL SERVICE TOOLS E5232CF6

Tool (Number and name)	Illustration	Application
09351-2A100 Injector Remover Adapter	 LCGF062A	Removing the injector
09351-4A300 Injector Remover	 SVQFL6499D	Removing the injector
09314-27110(14mm) 09314-27120(17mm) Torque Wrench Socket	 AFAF201B	Installing the high pressure pipe
09331-2A000 High Pressure Pump Sprocket Remover	 LXGF021A	Removing the high pressure fuel pump
09310-2B100 Fuel Pump Plate Cover Wrench	 SCMFL6666D	Removing and installing the fuel sender plate cover

REFERENCE SERVICE TOOL - COMMON RAIL TESTER

Tool Number	Tool Name
CRT-1000	Common Rail Tester (Standard Kit)
CRT-1010	Tool Case
CRT-1020	Regulator Valve
CRT-1021	Plug (for Delphi) M14mm
CRT-1022	Plug (for Bosch) M12mm
CRT-1023	Adapter (for Bosch)
CRT-1030	Flask & Holder
CRT-1031	Visible Tube
CRT-1032	Injector Return Hose Adapter
CRT-1033	Injector Return Hose Plug
CRT-1034	Flushing Tube
CRT-1035	Dust Cap
CRT-1040	High Pressure Meter
CRT-1041	Adapter Connector (for Delphi Old)
CRT-1042	Adapter Connector (for Delphi New)
CRT-1043	Adapter Connector (for Bosch)
CRT-1044	IMV Control Valve
CRT-1050	Vacuum Gauge
CRT-1051	Pressure Gauge
CRT-1052	Gauge Connection Tube
CRT-1053	Connection Adapter
CRT-1054	Connection Adapter with Hose
CRT-1055	Hose Clamp
CRT-1060	User's Guide

* To use this Common Rail Tester, refer to the user's guide included in this kit.



SCMFL6900L

BASIC TROUBLESHOOTING ECE46520

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		

2. SYMPTOMS

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

3. ENVIRONMENT

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

4. MIL/DTC

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

5. ECM/PCM INFORMATION

ECM/PCM Part No.	
ROM ID	

SCMFL6150L

BASIC INSPECTION PROCEDURE

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.

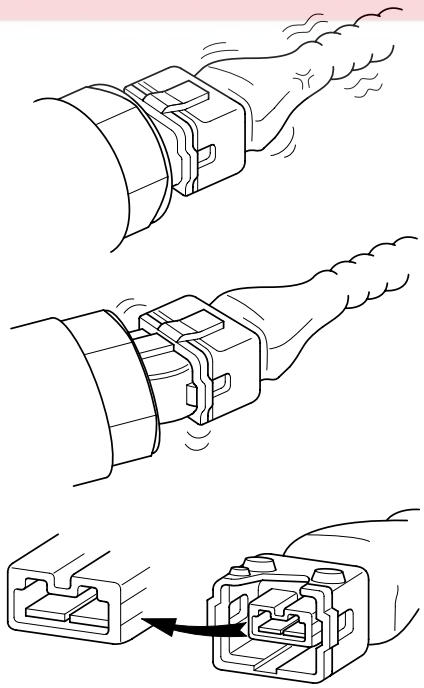
NOTE

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

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

WARNING

Strong vibration may break sensors, actuators or relays

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

● SIMULATING HEAT

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

WARNING

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

● SIMULATING WATER SPRINKLING

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

WARNING

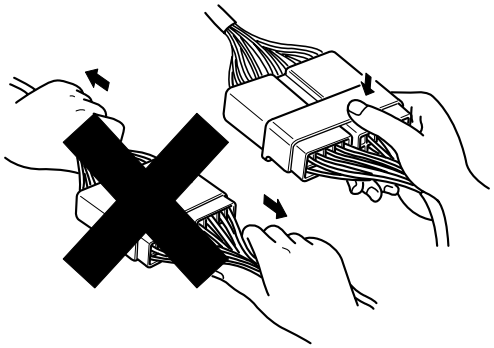
DO NOT sprinkle water directly into the engine compartment or electronic components.

● SIMULATING ELECTRICAL LOAD

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

CONNECTOR INSPECTION PROCEDURE

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



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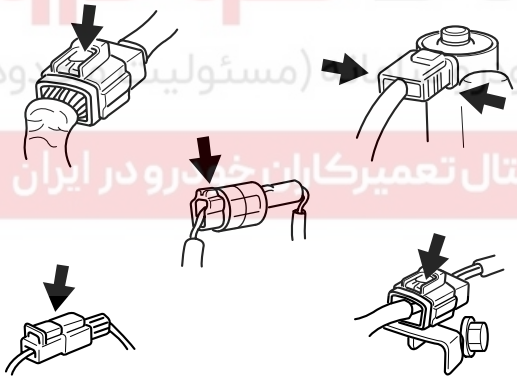
   b. When removing the connector with a lock, press or pull locking lever.



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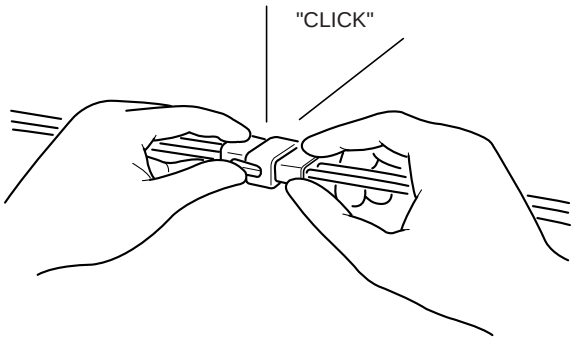
   c. Listen for a click when locking connectors. This sound indicates that they are securely locked.



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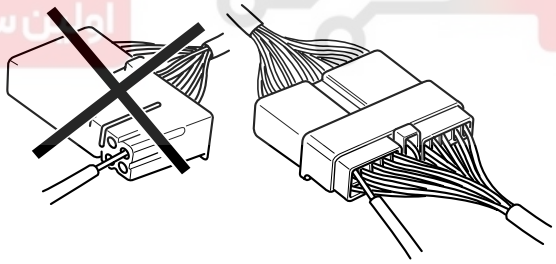
   d. When a tester is used to check for continuity, or to measure voltage, always insert tester probe from wire harness side.



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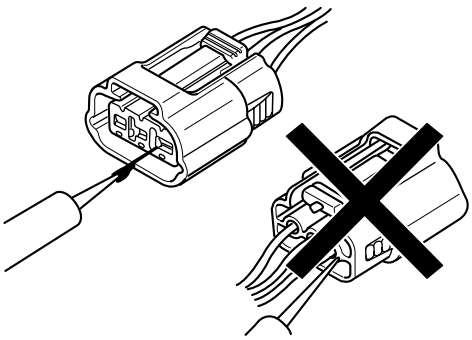
e. Check waterproof connector terminals from the connector side. Waterproof connectors cannot be accessed from harness side.



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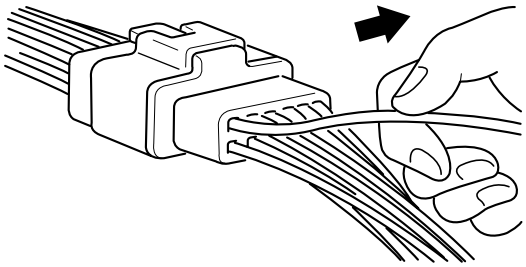
NOTE

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

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



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

NOTE

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

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

WIRE HARNESS INSPECTION PROCEDURE

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

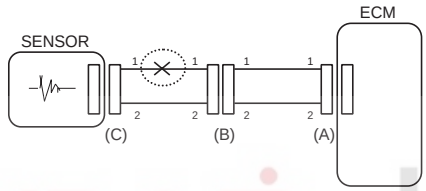
ELECTRICAL CIRCUIT INSPECTION PROCEDURE

● CHECK OPEN CIRCUIT

1. Procedures for Open Circuit
   - 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

   NOTE

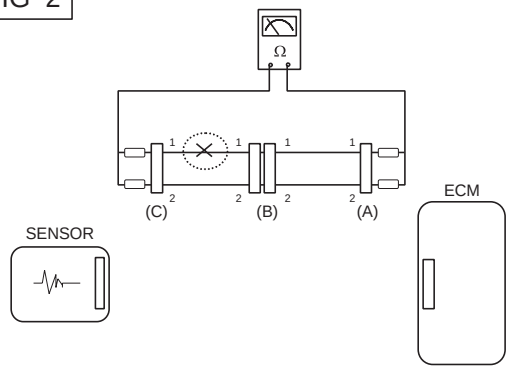
   When measuring for resistance, lightly shake the wire harness above and below or from side to side.

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

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

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

FIG 2

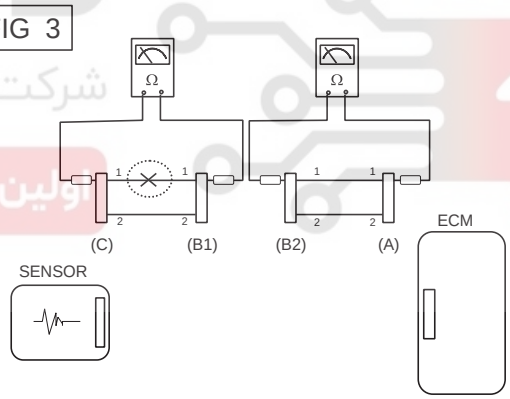


BFGE501B

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

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

FIG 3



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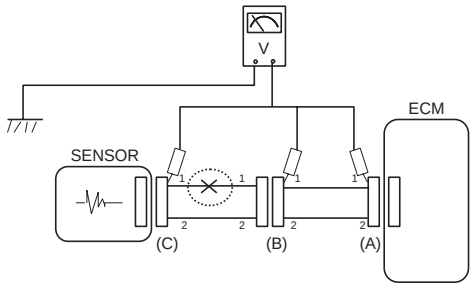
3. Voltage Check Method
   a. With each connector still connected, measure the voltage between the chassis ground and terminal 1 of each connectors (A), (B) and (C) as shown in [FIG. 4].

      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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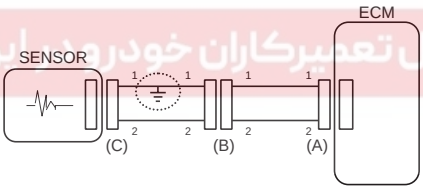
● CHECK SHORT CIRCUIT

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



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2. Continuity Check Method (with Chassis Ground)

   NOTE

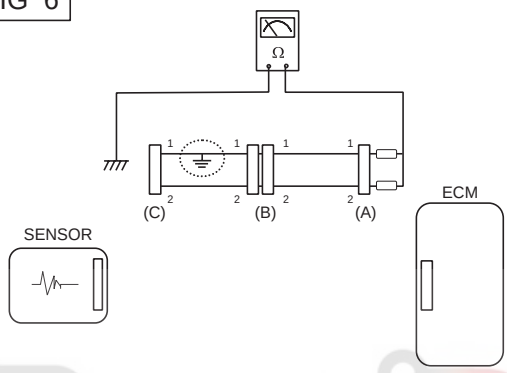
   Lightly shake the wire harness above and below, or from side to side when measuring the resistance.

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

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

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

FIG 6



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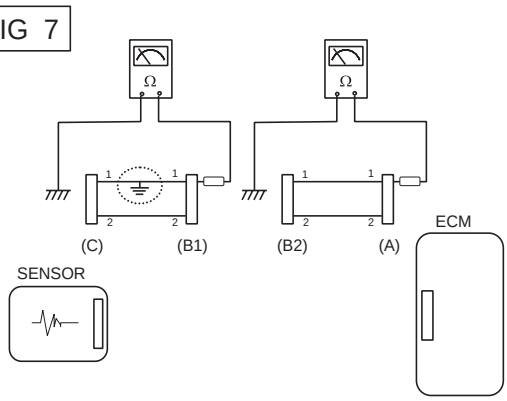
b. Disconnect connector (B), and measure the resistance between connector (A) and chassis ground, and between (B1) and chassis ground as shown in [FIG. 7].

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

FIG 7



BFGE501G

SYMPTOM TROUBLESHOOTING GUIDE TABLE

(SYMPTOM 1) ENGINE DOES NOT START

Possible Cause	
• Run out of fuel • Starter faulty • Fuel pump hose supply cut • High pressure leakage • Fuse out of order • Drift of the rail pressure sensor not detected • Cam and Crank signals missing simultaneously • Battery voltage too low • Faulty immobilizer • Electric EGR control valve blocked open • Fuel pressure regulator valve contaminated, stuck, jammed • Rail pressure regulator valve contaminated, stuck, jammed • Fuel quality / presence of water	• Inversion of low pressure fuel connections • Fuel filter not adapted • Low pressure fuel circuit sealed • Sealed fuel filter • Intermittent fault connection • Air ingress in the low pressure fuel circuit • Fuel return circuit of the pump sealed • Engine compression too low • Leakage at the injector • Low pressure fuel pump faulty • High pressure fuel pump faulty • Injector jammed open • Bug software or hardware fault not detected • Glow system faulty

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

Possible Cause	
• Run out of fuel • Fuel return hose of injector cut • High pressure leakage • Fuse faulty • Air filter sealed • Alternator or voltage regulator faulty • The compensation of individual injector not adapted • Drift of the engine coolant temperature sensor not detected • Drift of the rail pressure sensor not detected • Battery voltage too low • Electric EGR control valve blocked open • Fuel pressure regulator valve contaminated, stuck, jammed • Rail pressure regulator valve contaminated, stuck, jammed • Fuel quality / presence of water	• Inversion of low pressure fuel connections • Low pressure fuel circuit sealed • Sealed fuel filter • Oil level too high/too low • Catalytic converter sealed or damaged • Intermittent fault connection • Air ingress in the low pressure fuel circuit • Fuel return circuit of the pump sealed • Glow system faulty • Engine compression too low • Fuel return hose of injector sealed • Carbon deposit on the injector (sealed holes) • Needle stuck (injection possible over a certain pressure) • Gasoline in fuel • Bug software or hardware fault not detected

(SYMPTOM 3) POOR STARTING WHEN HOT

Possible Cause	
• The compensation of individual injector not adapted • Drift of the rail pressure sensor not detected • Electric EGR control valve blocked open • Fuel pressure regulator valve contaminated, stuck, jammed • Rail pressure regulator valve contaminated, stuck, jammed • Air filter sealed • Air ingress in the low pressure fuel circuit • Fuel quality / presence of water	• Fuel return circuit of the pump sealed • Sealed fuel filter • Engine compression too low • Intermittent fault connection • Carbon deposit on the injector (sealed holes) • Needle stuck (injection possible over a certain pressure) • Gasoline in fuel • Bug software or hardware fault not detected

(SYMPTOM 4) UNSTABLE IDLING

Possible Cause	
• Fuel return hose of injector cut • The compensation of individual injector not adapted • Drift of the rail pressure sensor not detected • Harness resistance increased • Air ingress in the low pressure fuel circuit • Fuel quality / presence of water • Sealed fuel filter • Air filter sealed • Fuel return hose of injector sealed • High pressure leakage	• Glow system faulty • Engine compression too low • Bad flanging of the injector • High pressure pump out of order • Injector not adapted • Carbon deposit on the injector (sealed holes) • 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	
• Drift of the engine coolant temperature sensor not detected • Incorrect state of the electrical pack devices • Alternator or voltage regulator faulty	• Clutch not well set • Bug software or hardware fault not detected • Electric EGR control valve blocked open • Throttle control actuator faulty

(SYMPTOM 6) BLUE, WHITE, OR BLACK SMOKES

Possible Cause	
• The compensation of individual injector not adapted • Drift of the engine coolant temperature sensor not detected • Drift of the rail pressure sensor not detected • Electric EGR control valve blocked open • Fuel pressure regulator valve contaminated, stuck, jammed • Rail pressure regulator valve contaminated, stuck, jammed • Oil level too high/too low • Fuel quality / presence of water	• Catalytic converter sealed or damaged • Air filter sealed • Oil suction (engine racing) • Glow system faulty • Engine compression too low • Bad flanging of the injector • Injector washer not adapted, forgotten, doubled • Injector not adapted • Carbon deposit on the injector (sealed holes) • Injector jammed open • Gasoline in fuel

(SYMPTOM 7) ENGINE RATTLING, NOISY ENGINE

Possible Cause	
• The compensation of individual injector not adapted • Electric EGR control valve blocked closed (noisy engine) • Electric EGR control valve blocked open • Drift of the engine coolant temperature sensor not detected • Glow system faulty • Engine compression too low • Fuel return hose of injector sealed	• Drift of the rail pressure sensor not detected • Injector washer not adapted, forgotten, doubled • Injector not adapted • Carbon deposit on the injector (sealed holes) • Needle stuck (injection possible over a certain pressure) • Injector jammed open • Drift of engine coolant temperature sensor not detected

(SYMPTOM 8) BURST NOISE

Possible Cause	
• The compensation of individual injector not adapted • Intermittent fault connection • Exhaust system sealed • Drift of the rail pressure sensor not detected	• Fuel pressure regulator valve contaminated, stuck, jammed • Rail pressure regulator valve contaminated, stuck, jammed • Bug software or hardware fault not detected

(SYMPTOM 9) UNTIMELY ACCELERATION/DECELERATION AND ENGINE RACING

Possible Cause	
• Accelerator position sensor blocked • Electric EGR valve blocked open • Intermittent fault connection	• Oil suction (engine racing) • Drift of the rail pressure sensor not detected • Bug software or hardware fault not detected

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

Possible Cause	
• Air inlet circuit open • Incorrect state of the electrical pack devices • Accelerator position sensor blocked • Electric EGR valve blocked open • Turbo charger damaged, vacuum hose line leakage • Sealed fuel filter	• Engine compression too low • High pressure leakage • Fuel pressure regulator valve contaminated, stuck, jammed • Rail pressure regulator valve contaminated, stuck, jammed • Needle stuck (injection possible over a certain pressure) • Bug software or hardware fault not detected

(SYMPTOM 11) ENGINE STOP OR STALLING

Possible Cause	
• Run out of fuel • Fuel pump hose supply cut • High pressure leakage • Fuse faulty • Fuel quality / presence of water • Low pressure fuel circuit sealed • Sealed fuel filter • Crank signals missing simultaneously • Electric EGR valve blocked open • Fuel pressure regulator valve contaminated, stuck, jammed	• Rail pressure regulator valve contaminated, stuck, jammed • Alternator or voltage regulator faulty • Intermittent fault connection • Catalytic converter sealed or damaged • Oil suction (engine racing) • Low pressure fuel pump faulty • High pressure pump faulty • Faulty ignition key • Gasoline in fuel • Bug software or hardware fault not detected

(SYMPTOM 12) ENGINE JUDDER

Possible Cause	
• Run out of fuel • Fuel return hose of injector cut • Incorrect state of the electrical pack devices • The compensation of individual injector not adapted • Electric EGR valve blocked open • Fuel filter not adapted • Air ingress in the low pressure fuel circuit • Fuel quality / presence of water • Sealed fuel filter • Intermittent fault connection • Harness resistance increased	• Glow system faulty • Engine compression too low • Fuel return hose of injector sealed • Valve clearance • Low pressure fuel pump faulty • Injector washer not adapted, forgotten, doubled • Carbon deposit on the injector (sealed holes) • Needle stuck (injection possible over a certain pressure) • Injector jammed open • Gasoline in fuel • Bug software or hardware fault not detected

(SYMPTOM 13) LACK OF POWER

Possible Cause	
• The compensation of individual injector not adapted • Accelerator position sensor blocked • Incorrect state of the electrical pack devices • Electric EGR valve blocked open • Air inlet circuit open • Air filter sealed • Oil level too high/too low • Catalytic converter sealed or damaged • Turbo charger damaged, vacuum hose line leakage	• Sealed fuel filter • Leakage at the injector • Fuel return circuit of the pump sealed • Fuel return hose of injector sealed • Engine compression too low • Injector not adapted • Carbon deposit on the injector (sealed holes) • Valve clearance

(SYMPTOM 14) TOO MUCH POWER

Possible Cause	
• The compensation of individual injector not adapted • Oil suction (engine racing)	• Bug software or hardware fault not detected

(SYMPTOM 15) EXCESSIVE FUEL CONSUMPTION

Possible Cause	
• Fuel return hose of injector cut • Leakage at the Fuel pressure regulator valve • Leakage at fuel temperature sensor • Leakage at the spacers • High pressure leakage • Air inlet circuit open • Air filter sealed • The compensation of individual injector not adapted • Electric EGR valve blocked open	• Incorrect state of the electrical pack devices • Oil level too high/too low • Fuel quality / presence of water • Catalytic converter sealed or damaged • Turbo charger damaged • Engine compression too low • Injector not adapted • Bug software or hardware fault not detected

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

Possible Cause	
• Accelerator position sensor blocked • The compensation of individual injector not adapted • Intermittent fault connection • Clutch not well set	• Oil suction (engine racing) • Turbo charger damaged • Injector not adapted • Bug software or hardware fault not detected

(SYMPTOM 17) EXHAUST SMELLS

Possible Cause	
• Electric EGR control valve leakage • Oil suction (engine racing) • Turbo charger damaged • Oil level too high/too low • The compensation of individual injector not adapted • Catalytic converter sealed or damaged • Bad flanging of the injector	• Injector washer not adapted, forgotten, doubled • Injector not adapted • Carbon deposit on the injector (sealed holes) • Needle stuck (injection possible over a certain pressure) • Injector jammed open • Bug software or hardware fault not detected

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

Possible Cause	
• The compensation of individual injector not adapted • Electric EGR valve blocked open • Air filter sealed • Fuel quality / presence of water • Oil level too high/too low • Turbo charger damaged • Catalytic converter sealed or damaged • Oil suction (engine racing) • Air heaters out of order • Engine compression too low • High pressure leakage	• Intermittent fault connection • Bad flanging of the injector • Injector washer not adapted, forgotten, doubled • Injector not adapted • Carbon deposit on the injector (sealed holes) • Needle stuck (injection possible over a certain pressure) • Injector jammed open • Gasoline in fuel • Bug software or hardware fault not detected • Catalyzed Particulate Filter (CPF) fail

(SYMPTOM 19) FUEL SMELLS

Possible Cause	
• Fuel pump hose supply cut • Fuel return hose of injector cut • Leakage at the Fuel pressure regulator valve	• Leakage at fuel temperature sensor • Leakage at the spacers • High pressure leakage

(SYMPTOM 20) THE ENGINE COLLAPSES AT TAKE OFF

Possible Cause	
• Accelerator position sensor blocked • Incorrect state of the electrical pack devices • Air filter sealed • Inversion of low pressure fuel connections • Fuel filter not adapted • Fuel quality/presence of water • Air ingress in the low pressure fuel circuit • Sealed fuel filter	• Catalytic converter sealed or damaged • Clutch not well set • Intermittent fault connection • Drift of the rail pressure sensor not detected • Fuel pressure regulator valve contaminated, stuck, jammed • Rail pressure regulator valve contaminated, stuck, jammed • Gasoline in fuel • Bug software or hardware fault not detected

(SYMPTOM 21) THE ENGINE DOES NOT STOP

Possible Cause
• Faulty ignition key • Oil suction (engine racing) • Bug software or hardware fault not detected

(SYMPTOM 22) DIFFERENT MECHANICAL NOISES

Possible Cause	
• Buzzer noise (discharge by the injectors) • Clip broken (vibrations, resonance, noises) • Incorrect state of the electrical pack devices • Catalytic converter sealed or damaged • Air inlet circuit open	• Bad flanging of the injector • Clutch not well set • Turbo charger damagedValve clearance • Valve clearance

DIESEL CONTROL SYSTEM

DESCRIPTION E13A928B

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 the HI-SCAN (Pro).

NOTE

- *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 HI-SCAN(Pro). Diagnostic Trouble Codes(DTC) will remain in the ECM as long as battery power is maintained. The diagnostic trouble codes will, however, be erased when the battery terminal or the engine control module(ECM) connector isdisconnected, or by the HI-SCAN (Pro).

NOTE

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)

NOTE

- *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.*

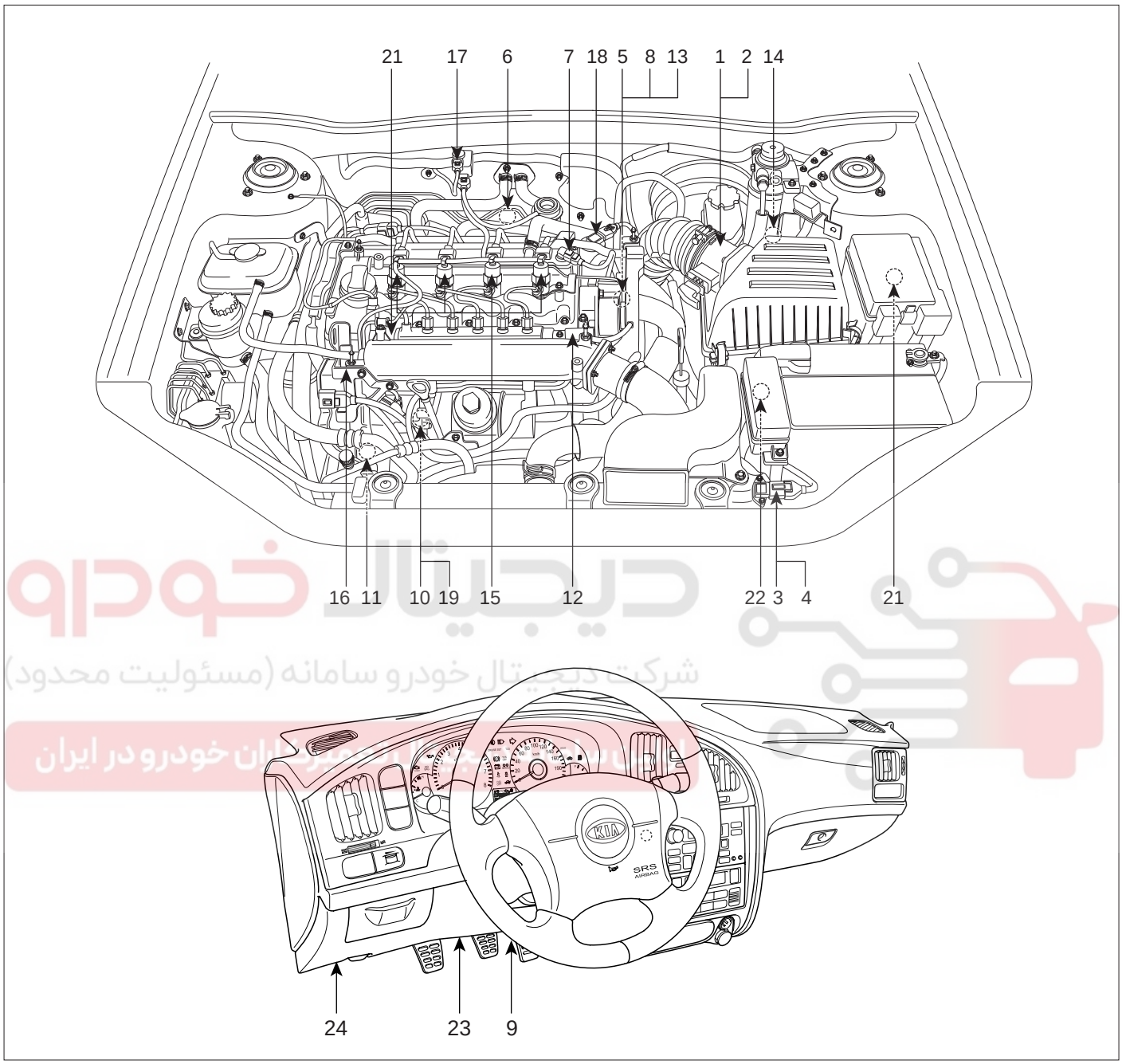
INSPECTION PROCEDURE (USING GENERIC SCAN TOOL)

1. Turn OFF the ignition switch.
2. Connect the scan tool to the data link connector on the lower crash pad.
3. Turn ON the ignition switch.
4. Use the scan tool to check the diagnostic trouble code.
5. Repair the faulty part from the diagnosis chart.
6. Erase the diagnostic trouble code.
7. Disconnect the GST.

NOTE

When deleting diagnostic trouble code, use scan tool as possible. When deleting diagnostic trouble code by disconnecting battery terminal(-), data for ECM control may delete simultaneously.

COMPONENT LOCATION EB38101A



1. Mass Air Flow Sensor (MAFS)
2. Intake Air Temperature Sensor (IATS) #1 (built in MAFS)
3. Boost Pressure Sensor (BPS)
4. Intake Air Temperature Sensor (IATS) #2 (built in BPS)
5. Engine Coolant Temperature Sensor (ECTS)
6. Lambda Sensor
7. Camshaft Position Sensor (CMPS)
8. Crankshaft Position Sensor (CKPS)
9. Accelerator Position Sensor (APS)
10. Fuel Temperature Sensor (FTS)
11. A/C Pressure Transducer (APT)
12. Rail Pressure Sensor (RPS)
13. Vehicle Speed Sensor (VSS)
14. Water Sensor (included in Fuel Filter)
15. Injector
16. Variable Swirl Control Actuator
17. VGT Control Solenoid Valve
18. Electric EGR Control Valve
19. Fuel Pressure Regulator Valve
20. Rail Pressure Regulator Valve
21. Main Relay
22. Glow Relay
23. Data Link Connector (DLC)
24. ECM (Engine Control Module)

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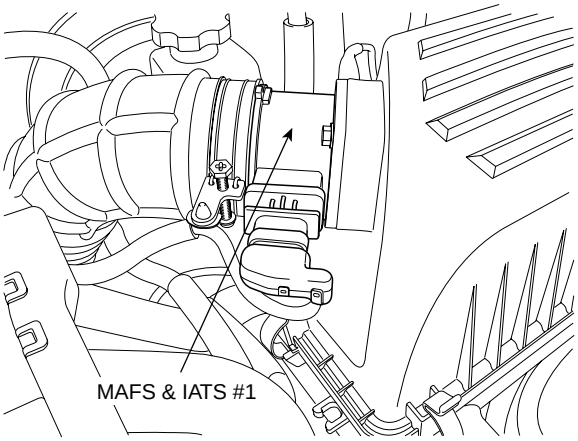
1. Mass Air Flow Sensor (MAFS)
2. Intake Air Temperature Sensor (IATS) #1 built in MAFS



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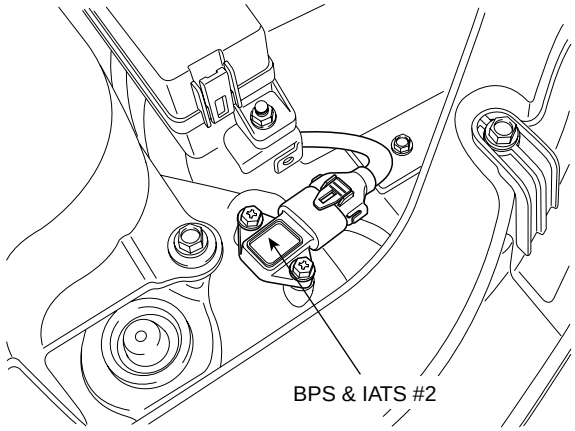
3. Boost Pressure Sensor (BPS)
4. Intake Air Temperature Sensor (IATS) #2 built in BPS



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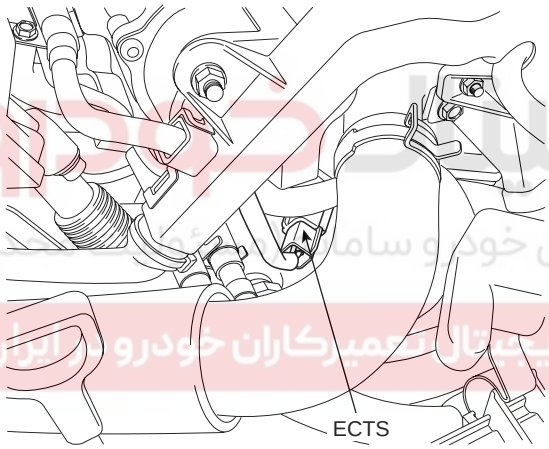
5. Engine Coolant Temperature Sensor (ECTS)



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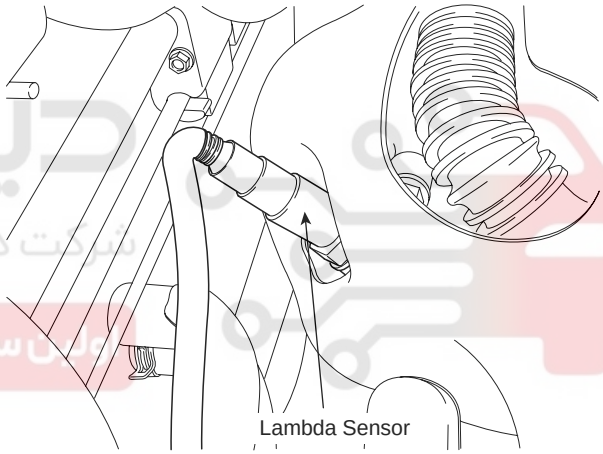
6. Lambda Sensor



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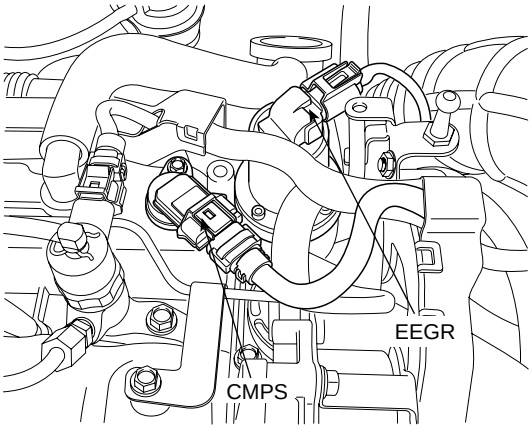
7. Camshaft Position Sensor (CMPS)
18. Electric EGR Control Valve



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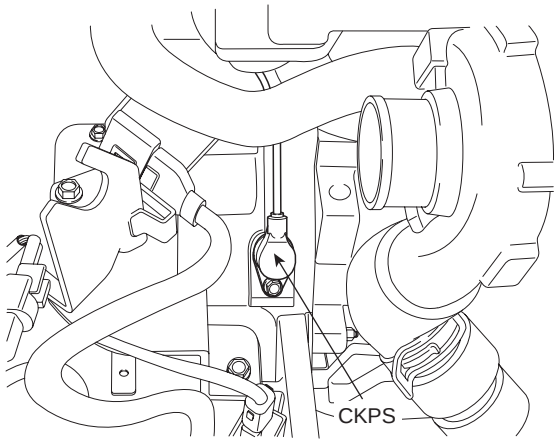
8. Crankshaft Position Sensor (CKPS)



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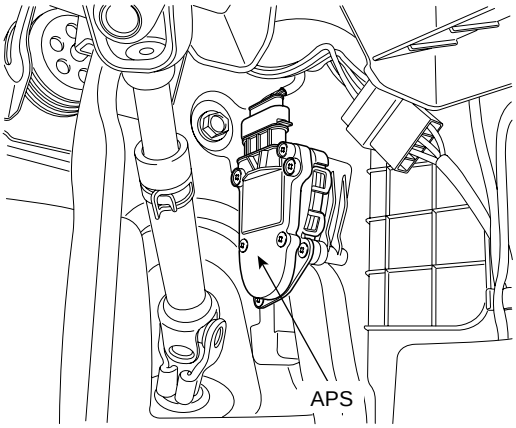
9. Accelerator Pedal Position Sensor (APS)



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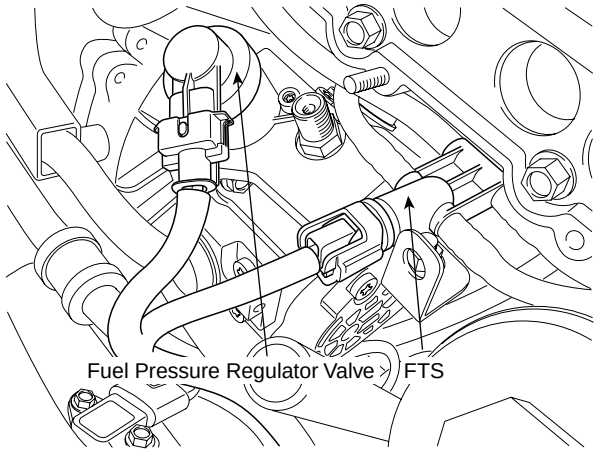
10. Fuel Temperature Sensor (FTS)
19. Fuel Pressure Regulator Valve



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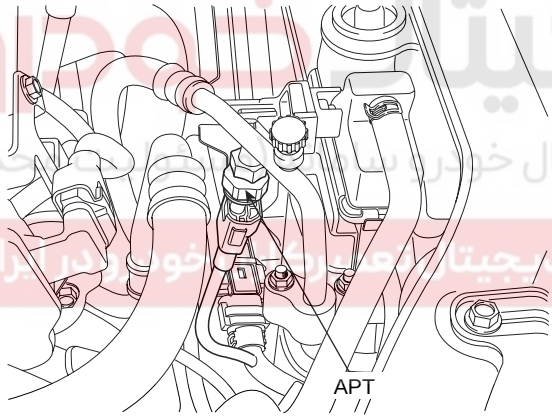
11.A/C Pressure Transducer (APT)



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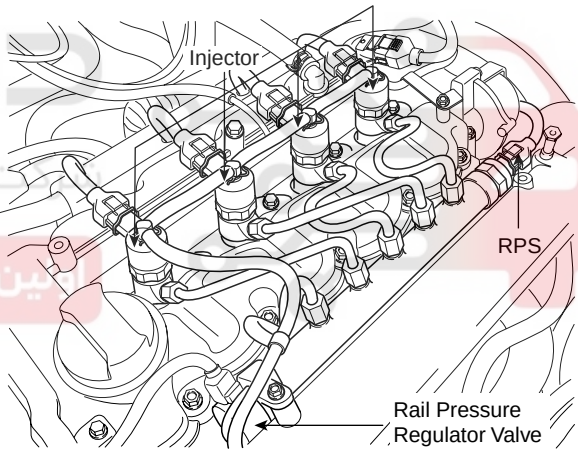
12. Rail Pressure Sensor (RPS)
15. Injector
20. Rail Pressure Regulator Valve



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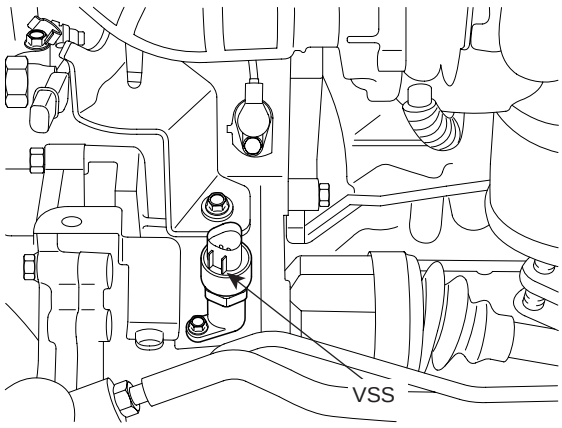
13. Vehicle Speed Sensor (VSS)



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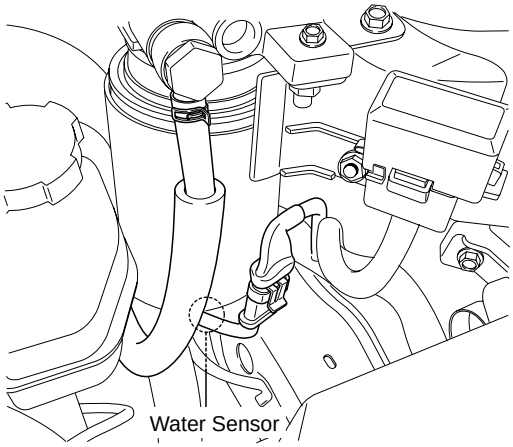
14. Water Sensor (included in Fuel Filter)



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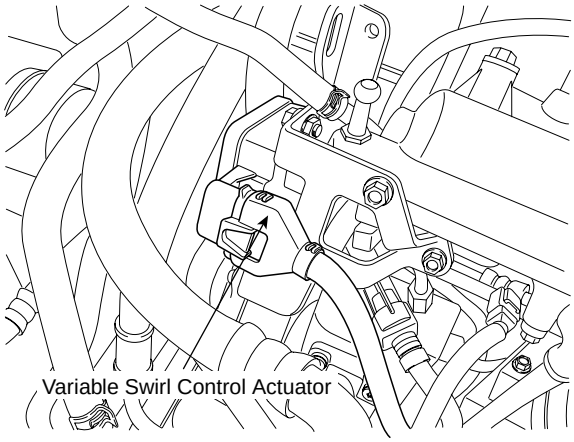
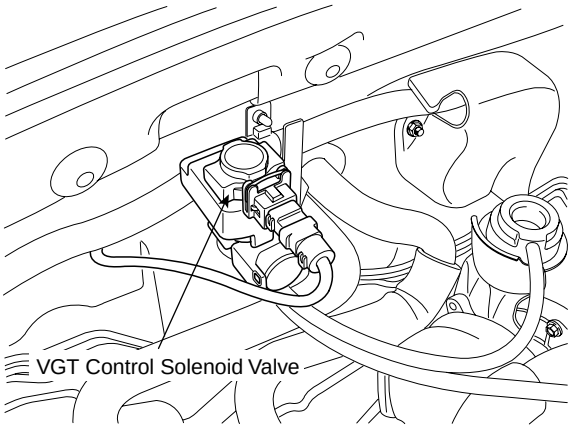
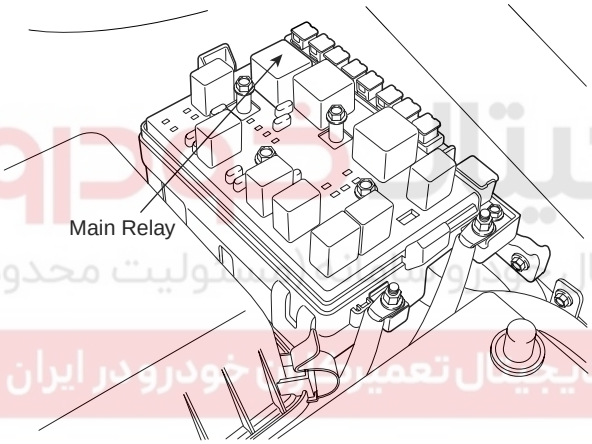
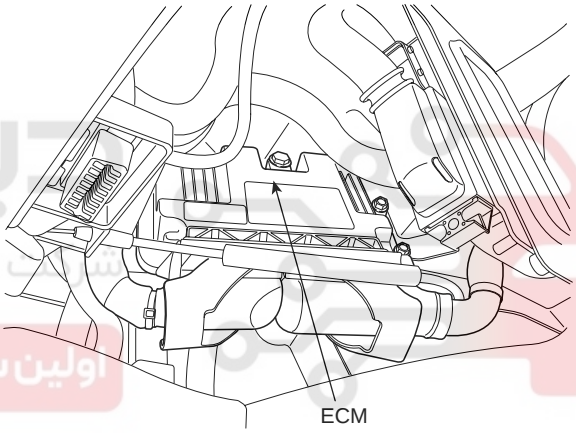
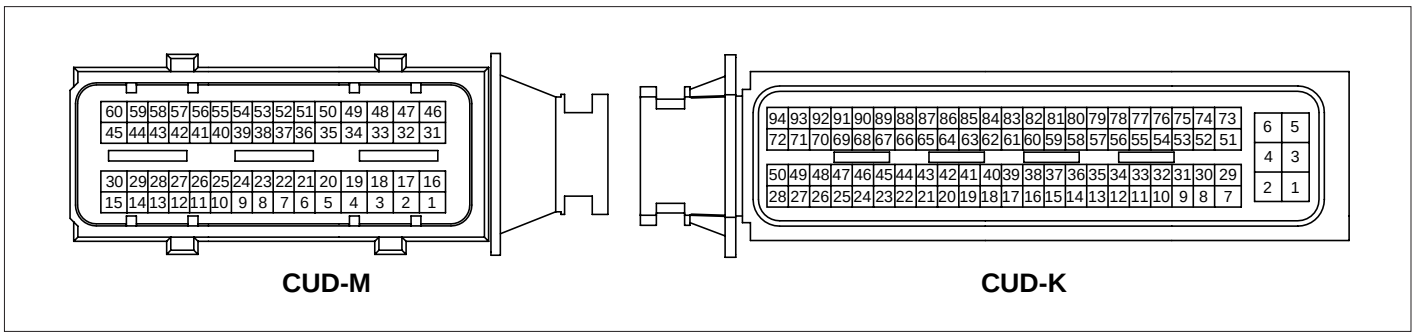
16. Variable Swirl Control Actuator	17. VGT Control Solenoid Valve
 SLDFL6114L	 SLDFL6111L
21. Main Relay	**24. ECM (Engine Control Module)**
 SLDFL6112L	 SLDFL6113L

ENGINE CONTROL MODULE (ECM)

ECM (ENGINE CONTROL MODULE) E2087BCC

1. ECM HARNESS CONNECTOR



SLDF27115L

2. ECM TERMINAL FUNCTION

CONNECTOR [CUD-M]

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	-	
23	Sensor ground	Boost Pressure Sensor (BPS)

Pin	Description	Connected to
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	Variable Swirl Control Actuator [-] 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	-	
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)
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	Variable Swirl Control Actuator [+] control output	Variable Swirl Control Actuator

CONNECTOR [CUD-K]

Pin	Description	Connected to
1	Battery voltage supply after main relay	Main Relay
2	Power ground	Chassis Ground
3	Battery voltage supply after main relay	Main Relay
4	Power ground	Chassis Ground
5	Battery voltage supply after main relay	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 "ACTUATOR" signal input	Cruise Control Switch
16	Ground	Immobilizer Control Module
17	-	
18	-	
19	-	
20	-	
21	-	
22	Sensor Power (+5V)	A/C Pressure Transducer
23	-	
24	Power Supply	Cruise Control Switch
25	Diagnostic K-Line	Data Link Connector (DLC)
26	-	
27	Fuel consumption signal output	Trip computer
28	Ignition switch signal input	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 input	Accelerator Position Sensor (APS) #2
32	-	
33	-	
34	-	
35	-	
36	-	
37	-	
38	Brake Switch "Lamp" signal input	Brake Switch

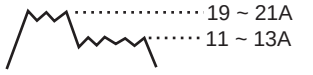
Pin	Description	Connected to
39	-	
40	Water Sensor siganl input	Water Sensor in Fuel Filter
41	-	
42	Blower Switch Signal input	Blower Switch
43	-	
44	-	
45	Sensor Power (+5V)	Accelerator Position Sensor (APS) #1
46	Sensor Power (+5V)	Accelerator Position Sensor (APS) #2
47	Immobilizer Communication 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	Lambda Sensor
52	"Idle Up" signal input	EPS control module
53	-	
54	A/C Switch "ON" signal input	A/C Switch
55	-	
56	Thermo Switch signal input	A/C Switch
57	Gear Neutral Switch signal input (MT Only)	Gear Neutral Switch
58	-	
59	-	
60	-	
61	-	
62	-	
63	-	
64	Lambda Sensor Voltage "NERNST"	Lambda Sensor
65	Lambda Sensor Current Pump	Lambda Sensor
66	-	
67	-	
68	Malfunction Indicator Lamp (MIL) control output	Malfunction Indicator Lamp (MIL)
69	Glow Time Indicator Lamp control 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	-	

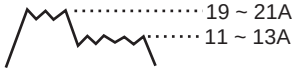
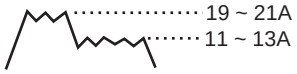
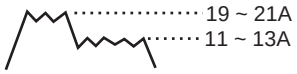
Pin	Description	Connected to
78	-	
79	Clutch Switch signal input	Clutch Switch
80	Brake Switch "Redundant" signal input	Brake Switch
81	MT/AT Auto recognition signal input	M/T : Open, A/T : Ground
82	-	
83	CAN [LOW]	Other Control Modules
84	CAN [HIGH]	Other Control Modules
85	-	
86	Lambda Sensor Virtual Ground	Lambda Sensor
87	Lambda Sensor Current Adjust	Lambda Sensor
88	-	
89	Intake Air Temperature Sensor (IATS) #1 signal input	Intake Air Temperature Sensor (IATS) #1 in MAFS
90	-	
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
94	PTC Heater Relay control output	PTC Heater Relay

3. ECM TERMINAL INPUT/OUTPUT SIGNAL

CONNECTOR [CUD-M]

Pin	Description	Vehicle State	Type	Level	Test Result
1	Injector (Cylinder #3) [HIGH] control output	Idle	Pulse	Battery Voltage ~ 80V	46.4V
					7.418Hz
2	Injector (Cylinder #2) [HIGH] control output	Idle	Pulse	Battery Voltage ~ 80V	46.4V
					7.418Hz
3	-				
4	Battery power	Idle	DC	Battery Voltage	13.96V
5	-				
6	Sensor ground	Idle	DC	Max. 50mV	-1.7mV
7	Sensor shield	Idle	DC	Max. 50mV	-2.858mV
8	Sensor ground	Idle	DC	Max. 50mV	-2.702mV
9	-				
10	-				
11	-				
12	Crankshaft Position Sensor (CKPS) [+] signal input	Idle	Sine Wave	Vpeak_to_peak: Min.1.0V	52.8V

Pin	Description	Vehicle State	Type	Level	Test Result
13	Sensor Power (+5V)	IG OFF	DC	Max. 0.5V	-50mV
		IG ON		4.9 ~ 5.1V	4.95V
14	-				
15	-				
16	Injector (Cylinder #1) [HIGH] control output	Idle	Pulse	Battery Voltage ~ 80V	46.6V
					7.44Hz
17	Injector (Cylinder #4) [HIGH] control output	Idle	Pulse	Battery Voltage ~ 80V	46.2V
					7.44Hz
18	-				
19	Battery power	IG OFF	DC	Max. 0.5 V	175mV
		IG ON		Battery Voltage	12.57V
20	Sensor ground	Idle	DC	Max. 50mV	-3.031mV
21	-				
22	-				
23	Sensor ground	Idle	DC	Max. 50mV	-2.857mV
24	-				
25	-				
26	Sensor Power (+5V)	IG OFF	DC	Max. 0.5V	-50mV
		IG ON		4.9 ~ 5.1V	4.91V
27	Crankshaft Position Sensor (CKPS) [-] signal input	Idle	Sine Wave	Vpeak_to_peak: Min.1.0V	52.8V
28	Sensor Power (+5V)	IG OFF	DC	Max. 0.5V	-50mV
		IG ON		4.9 ~ 5.1V	4.91V
29	-				
30	Variable Swirl Control Actuator [-] control output	Active	Pulse	Hi: Battery Voltage	
				Low: Max. 1.0V	
				Frequency: 1,000Hz	
31	Injector (Cylinder #2) [LOW] control output	Idle	Pulse	Peak Current: 19 ~ 21 A Hold Current: 11~ 13 A  EFQG102A	Peak Current: 19.7 A Hold Current: 13.4 A
32	-				

Pin	Description	Vehicle State	Type	Level	Test Result
33	Injector (Cylinder #4) [LOW] control output	Idle	Pulse	Peak Current: 19 ~ 21 A Hold Current: 11~ 13 A  EFQG102A	Peak Current: 19.7 A Hold Current: 13.4 A
34	Rail Pressure Regulator Valve control output	Idle	Pulse	Hi: Battery Voltage	14.78V
				Lo: Max. 1.0V	60mV
				Frequency: 1kHz±2%	1.098KHz
					Duty (+): 74.37%
35	-				
36	-				
37	Reference frequency	Idle	Pulse	Hi: Vcc	4.94V
				Lo: Max. 1.0V	340mV
38	-				
39	-				
40	Boost Pressure Sensor (BPS) signal input	IG ON	Analog	0.5 ~ 4.5V	1.602mV
41	Sensor ground	Idle	DC	Max. 50mV	-3.301mV
42	Mass Air Flow Sensor (MAFS) signal input	Idle	Pulse	Hi: Vcc	4.95V
				Lo: Max. 1.0V	350mV
43	Rail Pressure Sensor (RPS) signal input	IG ON	Analog	Max. 1.0V	512mV
		Idle		1.0 ~ 1.5 V	1.089V
		3000 RPM		1.5 ~ 3.0 V	1.886V
44	Sensor ground	Idle	DC	Max. 50mV	-1.845mV
45	-				
46	Injector (Cylinder #3) [LOW] control output	Idle	Pulse	Peak Current: 19 ~ 21 A Hold Current: 11~ 13 A  EFQG102A	Peak Current: 19.8A Hold Current: 13.5A
47	Injector (Cylinder #1) [LOW] control output	Idle	Pulse	Peak Current: 19 ~ 21 A Hold Current: 11~ 13 A  EFQG102A	Peak Current: 19.6A Hold Current: 13.4A
48	-				

Pin	Description	Vehicle State	Type	Level	Test Result
49	Fuel Pressure Regulator Valve control output	Idle	Pulse	Hi: Battery Voltage	15.02V
				Lo: Max. 1.0V	540mV
					203Hz
50	Camshaft Position Sensor (CMPS) signal input	Idle	Pulse	Hi: Vcc or Battery Voltage	4.95V
				Lo: Max. 1.0V	-10mV
					17.44Hz
		3000rpm		Hi: Vcc or Battery Voltage	4.95V
				Lo: Max. 1.0V	-10mV
					52.33Hz
51	-				
52	-				
53	Intake Air Temperature Sensor (IATS) #2 signal input	Idle	Analog	0.5 ~ 4.5V	1.954V
54	-				
55	-				
56	Position Sensor signal input	IG ON	Analog	0.5 ~ 4.5V	
57	-				
58	Engine Coolant Temperature Sensor (ECTS) signal input	Idle	Analog	0.5 ~ 4.5V	804.6mV
59	Electric EGR Control Valve control output	Idle	Pulse	Hi: Battery Voltage	14.7V
				Lo: Max. 1.0V	-20mV
					154.7Hz
					Duty(+): 91.79%
60	Variable Swirl Control Actuator [+] control output	Active	Pulse	Hi: Battery Voltage	
				Low: Max. 1.0V	
				Frequency: 1,000Hz	

CONNECTOR [CUD-K]

Pin	Description	Vehicle State	Type	Level	Test Result
1	Battery voltage supply after main relay	IG OFF	DC	Max. 1.0 V	175mV
		IG ON		Battery Voltage	12.77V
2	Power ground	Idle	DC	Max. 50mV	
3	Battery voltage supply after main relay	IG OFF	DC	Max. 1.0 V	-25mV
		IG ON		Battery Voltage	12.57V
4	Power ground	Idle	DC	Max. 50mV	
5	Battery voltage supply after main relay	IG OFF	DC	Max. 1.0 V	-25mV
		IG ON		Battery Voltage	12.57V
6	Power ground	Idle	DC	Max. 50mV	

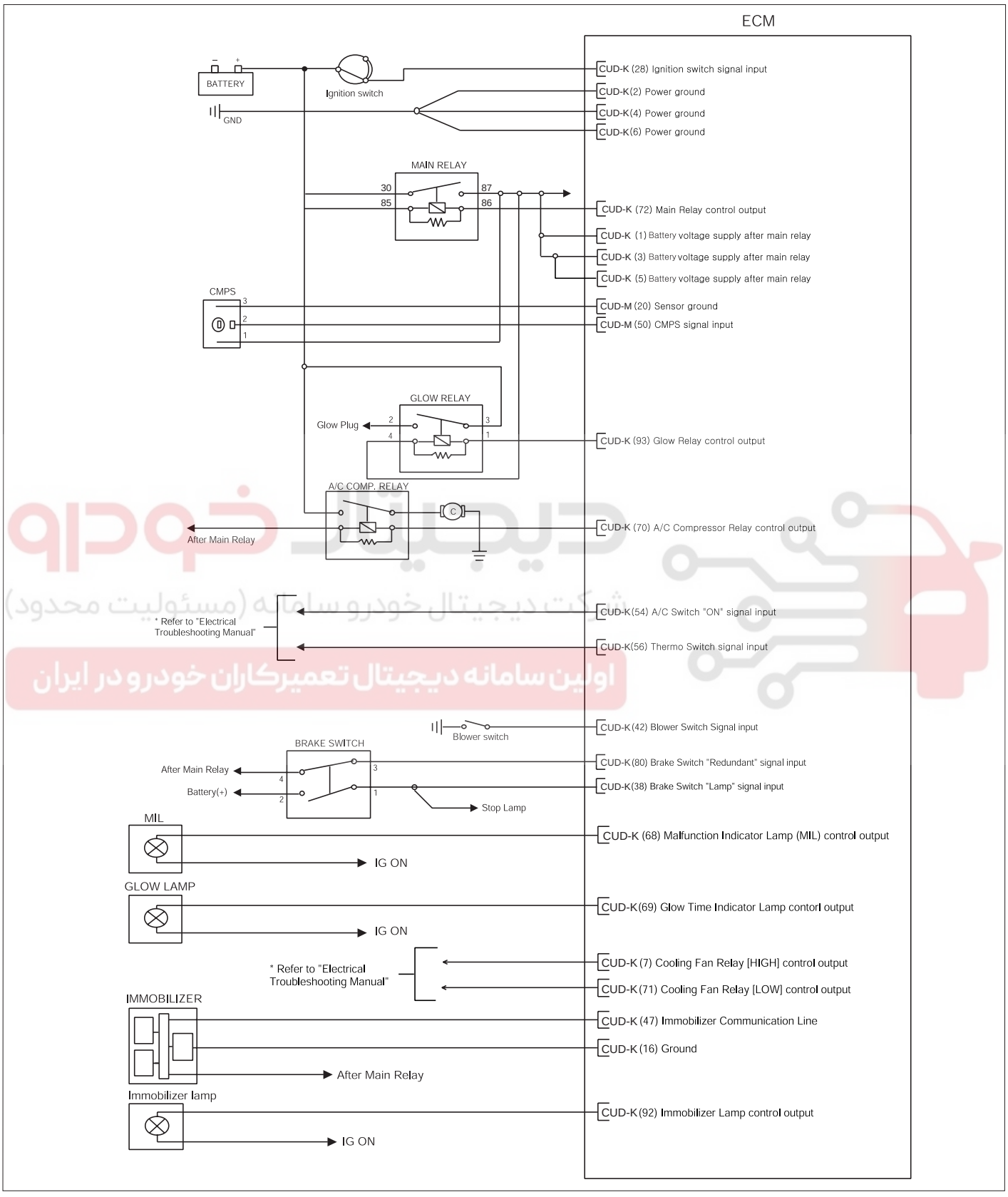
Pin	Description	Vehicle State	Type	Level	Test Result
7	Cooling Fan Relay [HIGH] control output	Relay OFF	DC	Battery Voltage	13.98V
		Relay ON		Max. 1.0V	-25mV
8	Sensor ground	Idle	DC	Max. 50mV	-3.145mV
9	Accelerator Position Sensor (APS) #1 signal input	C.T	Analog	0.3 ~ 0.9V	682.8mV
		W.O.T		4.0 ~ 4.8V	4.029V
10	Sensor ground	Idle	DC	Max. 50mV	-3.586mV
11	Fuel Temperature Sensor (FTS) signal input	IG ON	Analog	0.5 ~ 4.5V	2.311V
12	Sensor ground	Idle	DC	Max. 50mV	-3.38mV
13	A/C Pressure Transducer signal input	A/C OFF	Analog	Max. 4.8V	1.327V
		A/C ON			2.426V
14	Ground	Idle	DC	Max. 50mV	-1.7mV
15	Cruise Control "ACTIVATOR" signal input				
16	Ground	Idle	DC	Max. 50mV	-3.801mV
17	-				
18	-				
19	-				
20	-				
21	-				
22	Sensor Power (+5V)	IG OFF	DC	Max. 0.5V	-50mV
		IG ON		4.9 ~ 5.1V	4.91V
23	-				
24	Power Supply	IG OFF	DC	Max. 0.5V	
		IG ON		4.9 ~ 5.1V	
25	Diagnostic K-Line	When transmitting	Pulse	Hi: Min. Battery Voltage×80%	12.78V
				Lo: Max. Battery Voltage×20%	140mV
		When receiving		Hi: Min. Battery Voltage×70%	12.78V
				Lo: Max. Battery Voltage×30%	700mV
26	-				
27	Fuel consumption signal output	Idle	Pulse	Hi: Battery Voltage or Vcc	3.435V
				Lo: Max. 0.5V	-5mV
					1.25Hz
28	Ignition switch signal input	IG OFF	DC	Max. 1.0 V	-25mV
		IG ON		Battery Voltage	12.57V

Pin	Description	Vehicle State	Type	Level	Test Result
29	VGT Control Solenoid Valve control output	Idle	Pulse	Hi: Battery Voltage	14.97V
				Lo: Max. 0.5V	175mV
					Duty (+): 19.87%
		3000rpm		Hi: Battery Voltage	14.97V
				Lo: Max. 0.5V	175mV
					Duty(+): 53.48%
30	Sensor ground	Idle	DC	Max. 50mV	-3.201mV
31	Accelerator Position Sensor (APS) #2 signal input	C.T	Analog	0.3 ~ 0.9V	333.8mV
		W.O.T		1.5 ~ 3.0V	1.989V
32	-				
33	-				
34	-				
35	-				
36	-				
37	-				
38	Brake Switch "Lamp" signal input	Release	DC	Max. 0.5V	-20mV
		Push		Battery Voltage	12.06V
39	-				
40	Water Sensor siganl input	Full of Water	Analog	Battery Voltage	11.26V
		No Water		Max. 1V	-20mV
41	-				
42	Blower Switch Signal input	Blower OFF	DC	Battery Voltage	12.17V
		Blower ON		Max. 2V	175mV
43	-				
44	-				
45	Sensor Power (+5V)	IG OFF	DC	Max. 0.5V	-10mV
		IG ON		4.9 ~ 5.1V	4.99V
46	Sensor Power (+5V)	IG OFF	DC	Max. 0.5V	-10mV
		IG ON		4.9 ~ 5.1V	4.99V
47	Immobilizer Communication Line	When communicating after IG ON	Pulse	Hi: Min. 8.5V	12.54V
				Lo: Max. 3.5V	1.1V
48	Engine speed signal output	Idle	Pulse	Hi: Battery Voltage	13.18V
				Lo: Max. 0.5V	140mV
				Frequency: 50~60Hz	59.53Hz
49	Cruise Control "SET" Lamp control output				
50	-				

Pin	Description	Vehicle State	Type	Level	Test Result
51	Lambda Sensor Heater control output	Vehicle Run	Pulse	Hi: Battery Voltage	14.3V
				Lo: Max. 1.0V	220mV
					109.8Hz
52	Idle Up signal input	SW OFF	DC	Hi: Vcc	4.99V
		SW ON		Lo: Max. 1.0V	70mV
53	-				
54	A/C Switch "ON" signal input	A/C SW OFF	DC	Max. 1.0V	140mV
		A/C SW ON		Battery Voltage	14.06V
55	-				
56	Thermo Switch signal input	A/C OFF	DC	Max. 0.5V	-20mV
		A/C ON		Battery Voltage	13.1V
57	Gear Neutral Switch signal input (MT ONly)	SW OFF (1st)	DC	Battery Voltage	12.54V
		SW ON (neutral)		Max. 0.5V	-20mV
58	-				
59	-				
60	-				
61	-				
62	-				
63	-				
64	Lambda Sensor Voltage "NERNST"	Engine Running	Analog	Normal: 450 ± 50mV	452mV
				Rich: Max. Normal + 150mV	452.9V
				Lean: Min. Normal - 150mV	351mV
65	Lambda Sensor Current Pump	Engine Running	Analog	Normal: 0 ± 500mV	608mV
				Rich: Min. Normal - 1.5V	447.7mV
				Lean: Max. Normal + 1.5V	816.4mV
66	-				
67	-				
68	Malfunction Indicator Lamp (MIL) control output	Lamp OFF	DC	Battery Voltage	12.3V
		Lamp ON		Max. 1.0V	-20mV
69	Glow Time Indicator Lamp control output	Glow OFF	DC	Battery Voltage	12.06V
		Glow ON		Max. 1.0V	-20mV
70	A/C Compressor Relay control output	A/Con OFF	DC	Battery Voltage	13.9V
		A/Con ON		Max. 1.0V	60mV
71	Cooling Fan Relay [LOW] control output	Relay OFF	DC	Battery Voltage	13.97V
		Relay ON		Max. 1.0V	175mV

Pin	Description	Vehicle State	Type	Level	Test Result
72	Main Relay control output	Relay OFF	DC	Battery Voltage	12.94V
		Relay ON		Max. 1.0V	940mV
73	-				
74	-				
75	Vehicle speed signal input	Vehicle Run	Pulse	Hi: Min. 5.0V	13.18V
				Lo: Max. 1.0V	60mV
					12.52Hz at 20kph
76	-				
77	-				
78	-				
79	Clutch Switch signal input	Release	DC	Max. 0.5V	-20mV
		Push		Battery Voltage	13.74V
80	Brake Switch "Redundant" signal input	Release	DC	Battery Voltage	14.14V
		Push		Max. 0.5V	-20mV
81	MT/AT Auto recognition signal input	M/T	DC	Battery Vaoltage	
		A/T		Max. 0.5V	
82	-				
83	CAN [LOW]	Recessive	Pulse	2.0 ~ 3.0 V	
		Dominant		0.5 2.25 V	
84	CAN [HIGH]	Recessive	Pulse	2.0 ~ 3.0 V	
		Dominant		2.75 4.5 V	
85	-				
86	Lambda Sensor Virtual Ground	Engine Running	Analog	2.4 ~ 2.6V	2.462V
87	Lambda Sensor Current Adjust	Engine Running	Analog	|Current Pump - Current Adjust| < 0.2V	86.86mV
88	-				
89	Intake Air Temperature Sensor (IATS) #1 signal input	Idle	Analog	0.5 ~ 4.5V	2.129V
90	-				
91	Cruise Control "MAIN" Lamp control output				
92	Immobilizer Lamp control output	Lamp OFF	DC	Battery Voltage	12.54V
		Lamp ON		Max. 1.0V	65mV
93	Glow Relay control output	Relay OFF	DC	Battery Voltage	12.46V
		Relay ON		Max. 1.0V	60mV
94	PTC Heater Relay control output	Relay OFF	DC	Battery Voltage	13.18V
		Relay ON		Max. 1.0V	-20mV

CIRCUIT DIAGRAM E2B85863



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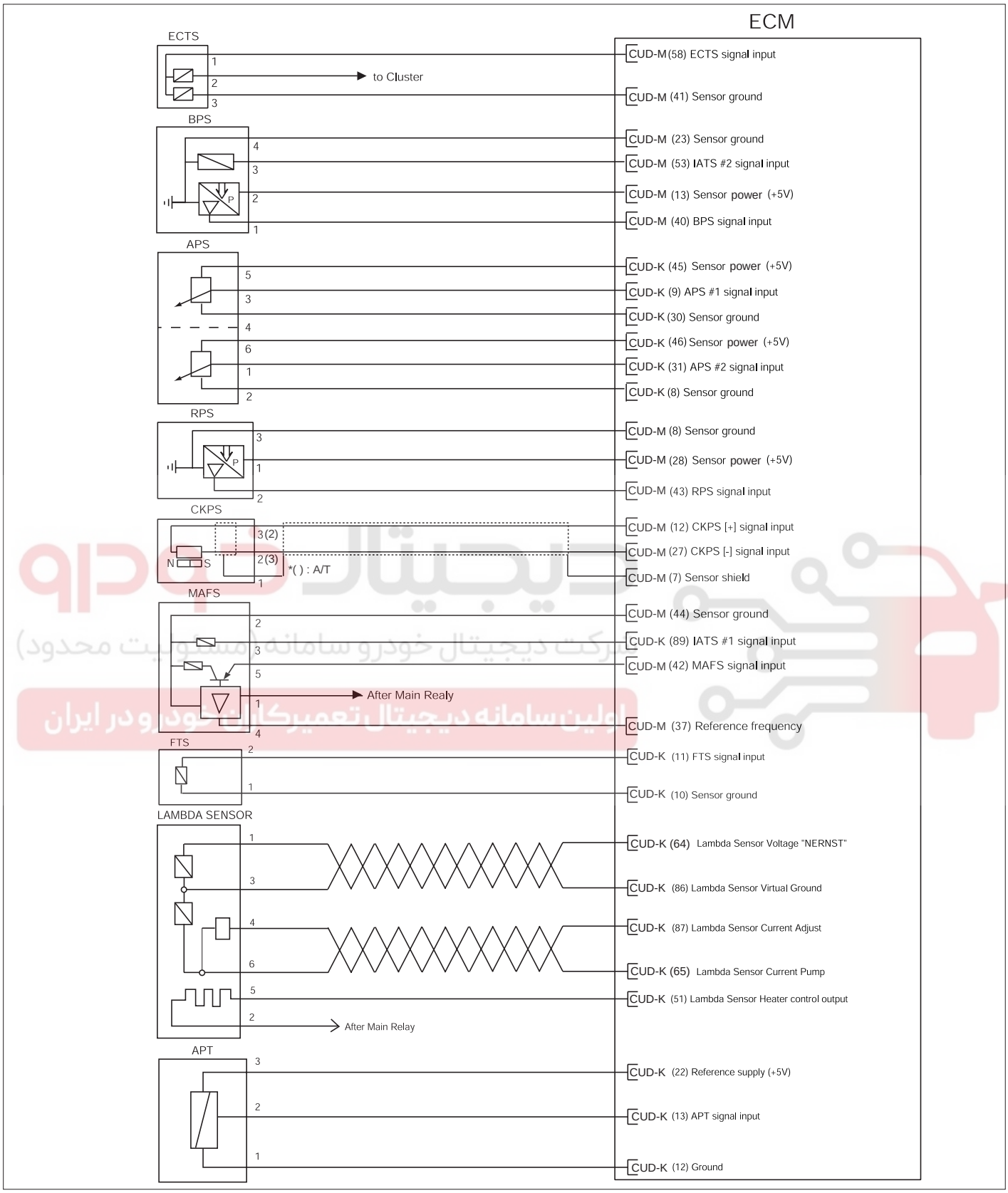

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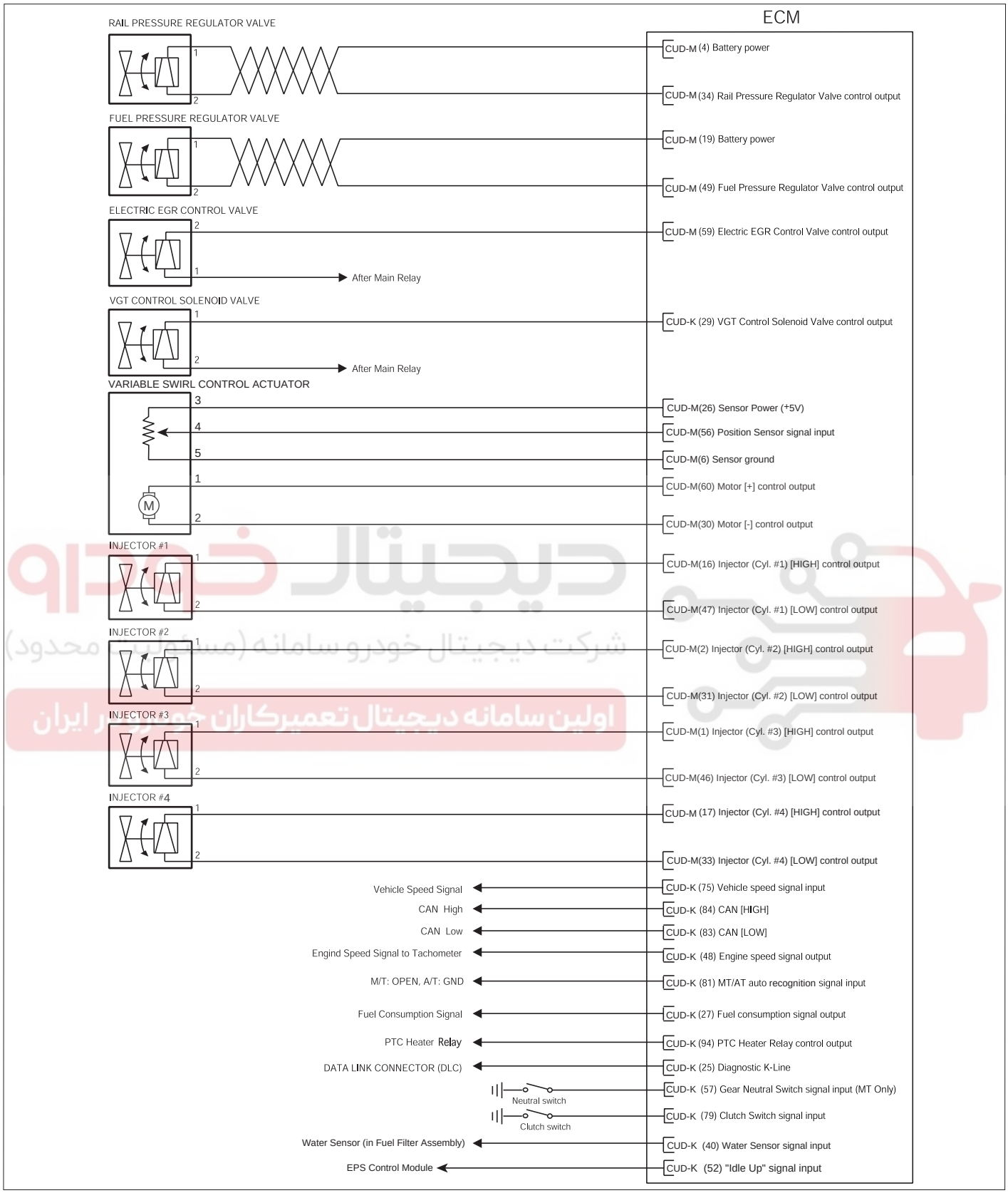

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ECM PROBLEM INSPECTION PROCEDURE E101D777

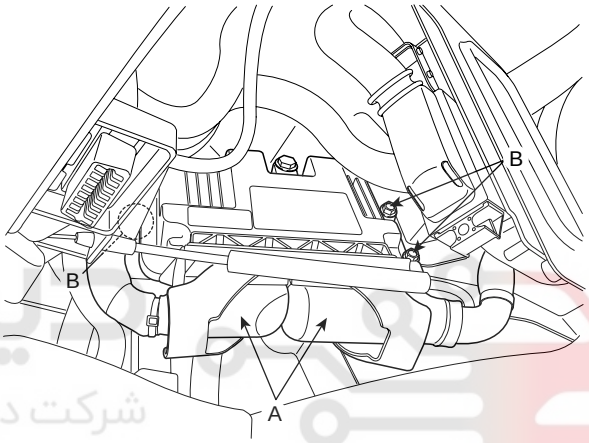
1. TEST ECM GROUND CIRCUIT: Measure resistance between ECM and chassis ground using the backside of ECM harness connector as ECM side check point. If the problem is found, repair it.
2. TEST ECM CONNECTOR: Disconnect the ECM connector and visually check the ground terminals on ECM side and harness side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

REPLACEMENT E1FC79DA

CAUTION

After replacing an ECM, MUST input the injector data (7 digit) of each cylinder into a new ECM.

1. Turn ignition switch OFF.
2. Disconnect the battery negative (-) cable from the battery.
3. Disconnect the ECM connector (A) and unfasten the mounting bolts (B) under the instrument panel (RH side).



SLDFL6119L

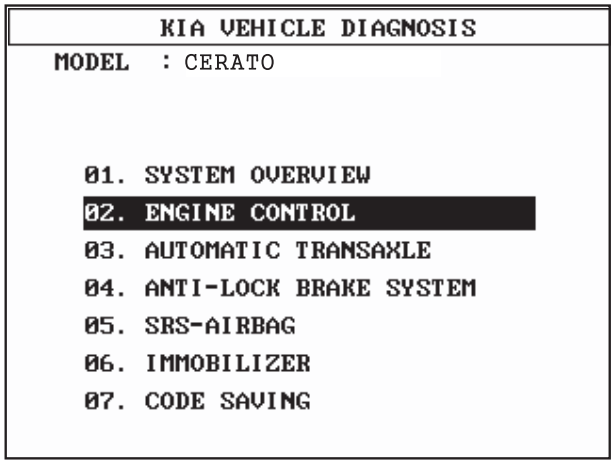
4. Install a new ECM according to the reverse order of steps 1, 2, and 3.

ECM mounting bolts/nuts : 0.4 ~ 0.6kgf·m (3.9 ~ 5.9 N·m, 2.9 ~ 4.3lbf·ft)

5. Connect a scan tool to Data Link Connector (DLC) and turn ignition switch on.

6. Proceed "INJECTOR CORRECTION" procedure.

1) Select "ENGINE CONTROL".



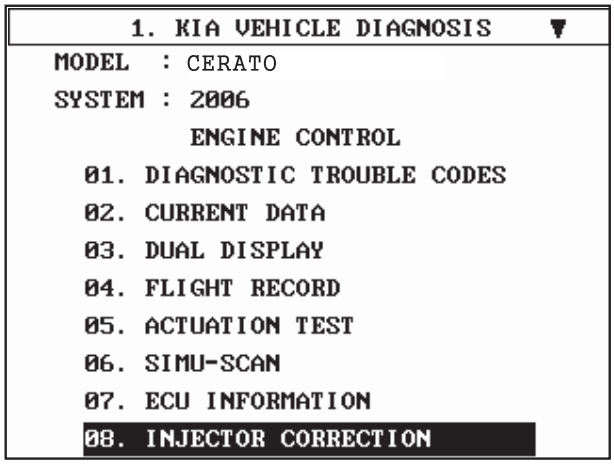
SLDFL6120L

2) Select "AUTO SELECTION MODE" or "MANUAL SELECTION MODE".

SLDFL6121L

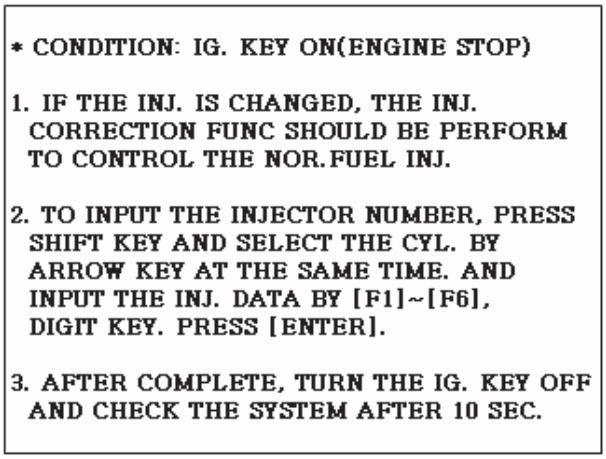
3) Select "1.6L VGT DIESEL" in case of "MANUAL SELECTION MODE".

4) Select "INJECTOR CORRECTION".



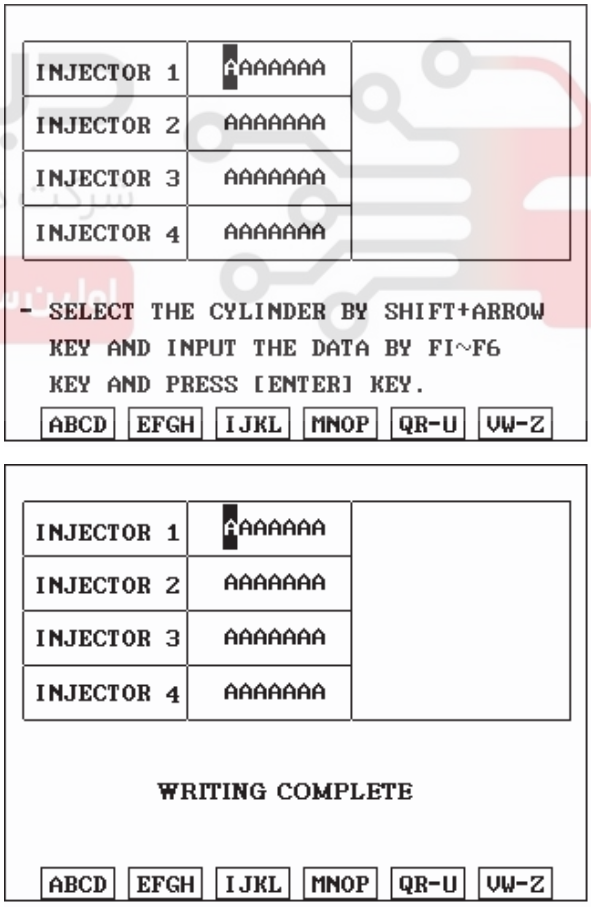
SLDFL6122L

5) Press "ENTER" key.



SSAFL6127L

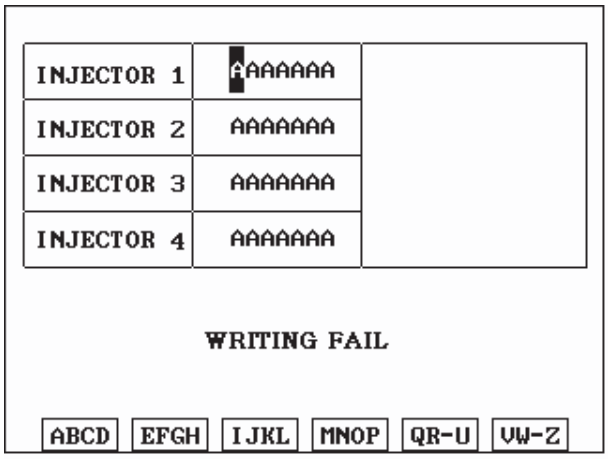
6) Input the injector data (7 digit) written on the top of each inejctor with function keys ([F1] ~ [F6]) and number keys.



EFQG112A

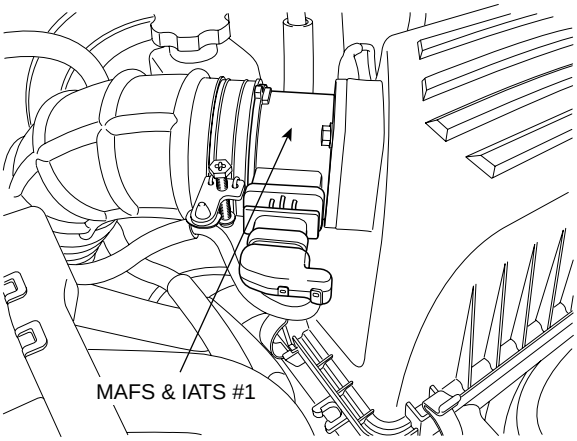
NOTE

When "WRITING FAIL" is displayed on the scan tool, input injector data (7 digits) of each cylinder into a new ECM again as prior procedure.



EFQG113A

MASS AIR FLOW SENSOR (MAFS)



SLDFL6102L

INSPECTION E9DB985F

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.

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

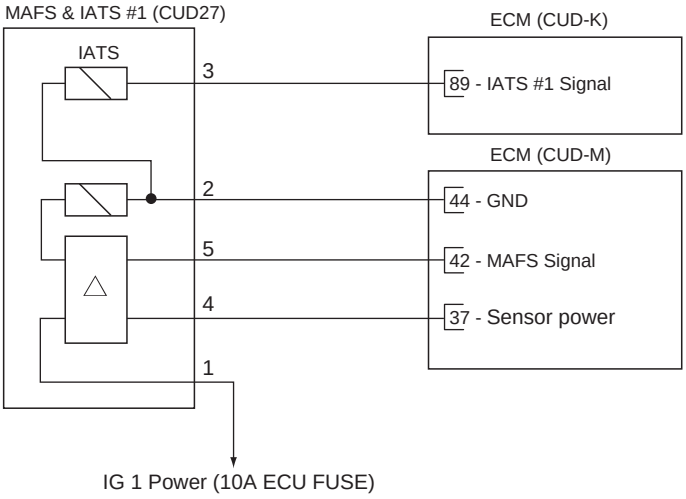
*At intake air temperature = -15℃(5˚F) or 80℃(176˚F)

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

EFQG034A

CIRCUIT DIAGRAM

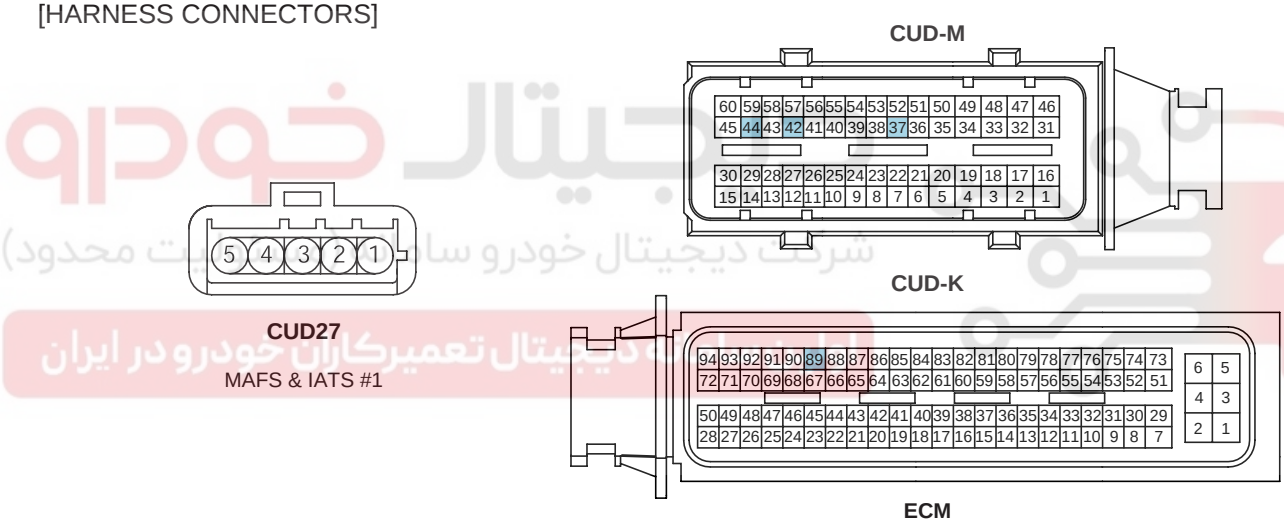
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	IG 1 Power (10A ECU FUSE)	Battery Voltage (B+)
2	ECM CUD-M (44)	Sensor Ground
3	ECM CUD-K (89)	IATS #1 Signal
4	ECM CUD-M (37)	Sensor power
5	ECM CUD-M (42)	MAFS Signal

[HARNESS CONNECTORS]



SLDF27123L

SIGNAL WAVEFORM

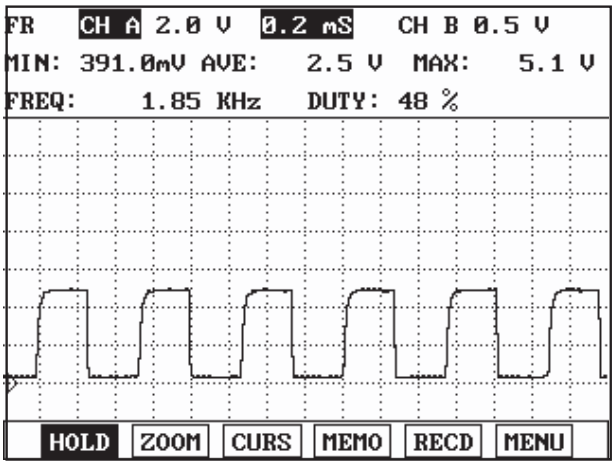


Fig.1

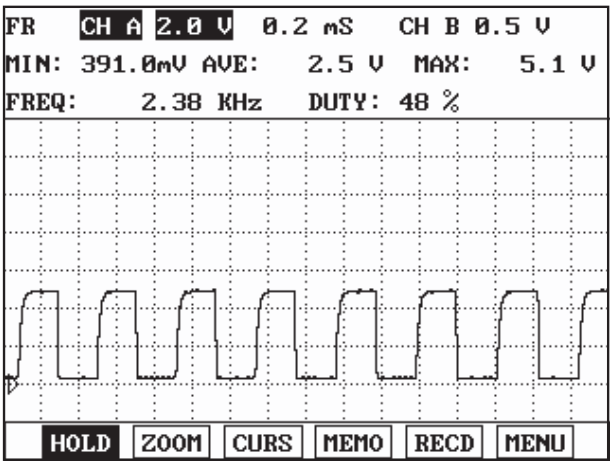


Fig.2

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

SLDFL6159L

COMPONENT INSPECTION

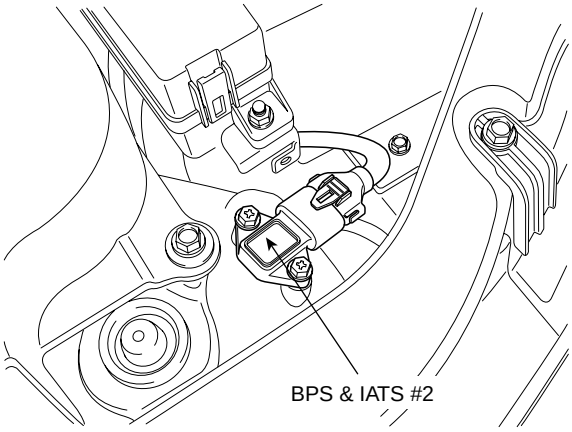
1. Check the MAFS visually.
   - Mounting direction correct.
   - Any contamination, corrosion or damage on connector.
   - Air cleaner's clogging or wet.
   - MAFS cylinder's deforming or blocking by any foreign material.
2. Check any leakage on intake system and intercooler system.

BOOST PRESSURE SENSOR (BPS)

INSPECTION E4C4881B

FUNCTION AND OPERATION PRINCIPLE

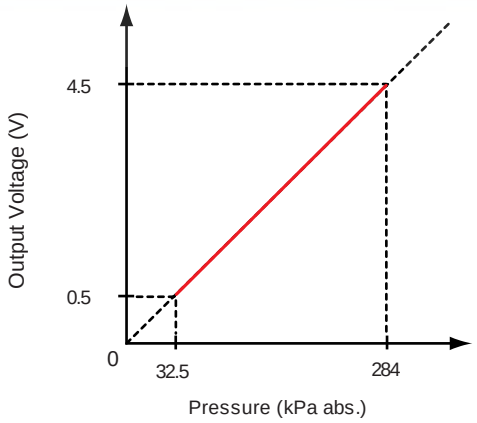
Boost pressure sensor (BPS) is installed on surge tank to measure the absolute intake manifold pressure. BPS input voltage is changed in proportion with absolute pressure in manifold. This information is used to control Variable Geometery Turbocharger (VGT) by ECM.



SLDFL6103L

SPECIFICATION

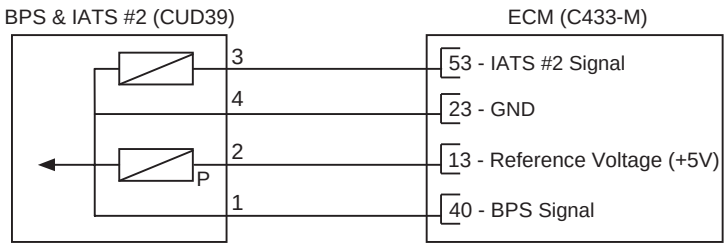
Pressure (kPa)	Output Voltage (V)
32.5	0.5
70.0	1.02 ~ 1.17
100.0	1.53 ~ 1.68
150.0	2.33 ~ 2.48
200.0	3.12 ~ 3.27
250.0	3.92 ~ 4.07
270.0	4.20 ~ 4.35
284.0	4.5



EFQG038A

CIRCUIT DIAGRAM

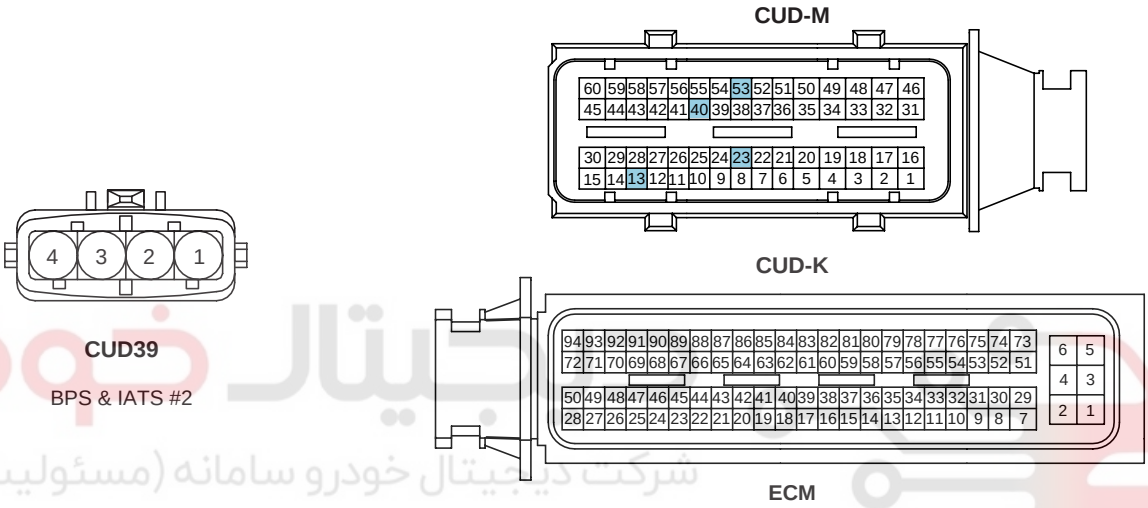
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

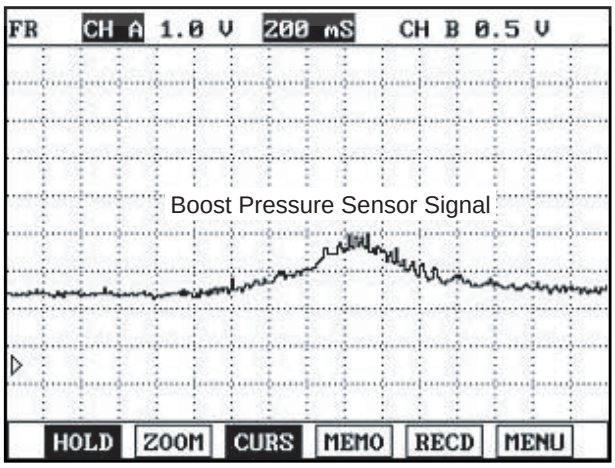
Terminal	Connected to	Function
1	ECM CUD-M (40)	BPS Signal
2	ECM CUD-M (13)	Reference Voltage (+5V)
3	ECM CUD-M (53)	IATS #2 Signal
4	ECM CUD-M (23)	Sensor ground

[HARNESS CONNECTORS]



SLDF27124L

SIGNAL WAVEFORM



This illustration represents waveform of BPS when accelerating and decelerating.

EFQG040A

INTAKE AIR TEMPERATURE SENSOR (IATS)

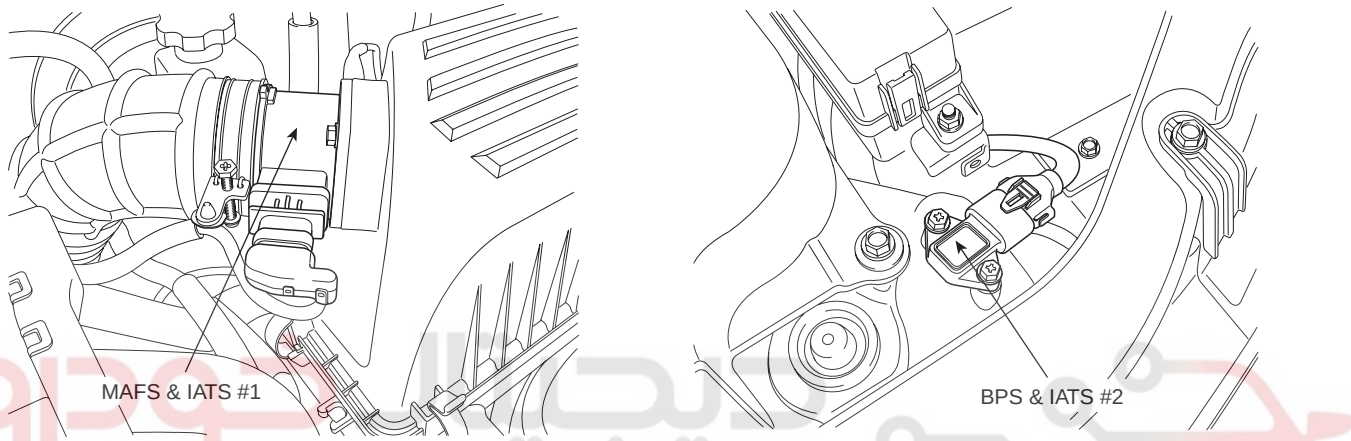
INSPECTION E2EC03B1

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.



SLDFL6125L

SPECIFICATION

IATS #1 in MAFS

Temperature [℃(℉)]	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

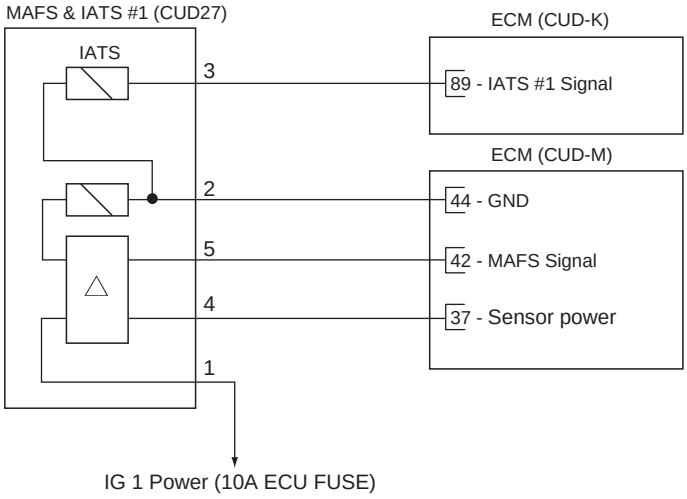
IATS #2 in BPS

Temperature [℃(℉)]	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

EFQG042A

CIRCUIT DIAGRAM

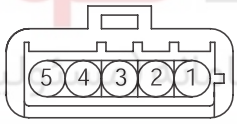
[CIRCUIT DIAGRAM]



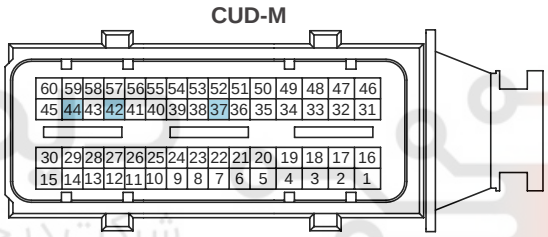
[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	IG 1 Power (10A ECU FUSE)	Battery Voltage (B+)
2	ECM CUD-M (44)	Sensor Ground
3	ECM CUD-K (89)	IATS #1 Signal
4	ECM CUD-M (37)	Sensor power
5	ECM CUD-M (42)	MAFS Signal

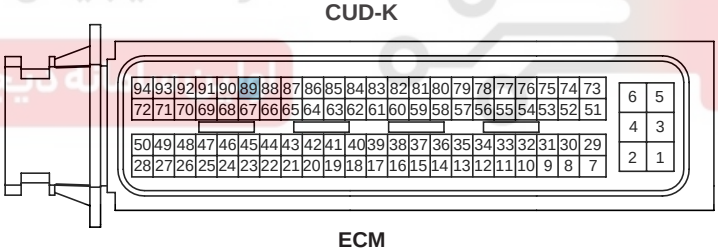
[HARNESS CONNECTORS]



CUD27
MAFS & IATS #1



CUD-M

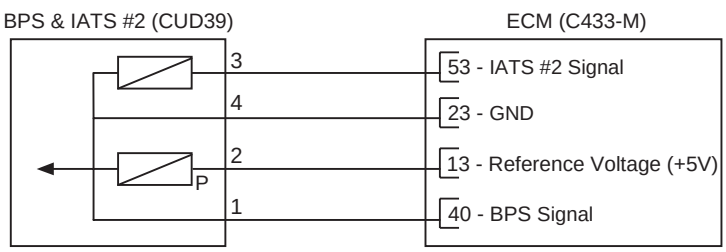


CUD-K

ECM

SLDF27123L

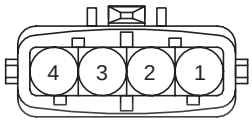
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

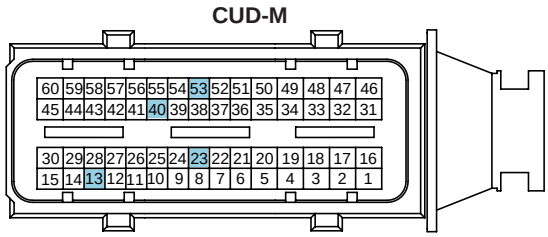
Terminal	Connected to	Function
1	ECM CUD-M (40)	BPS Signal
2	ECM CUD-M (13)	Reference Voltage (+5V)
3	ECM CUD-M (53)	IATS #2 Signal
4	ECM CUD-M (23)	Sensor ground

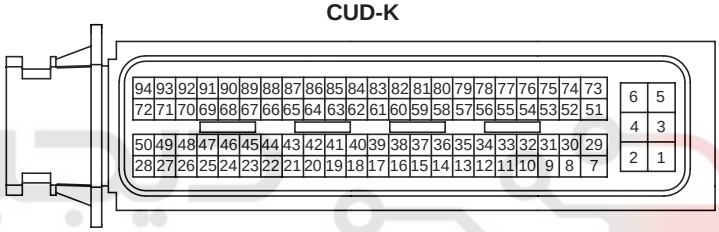
[HARNESS CONNECTORS]



CUD39

BPS & IATS #2

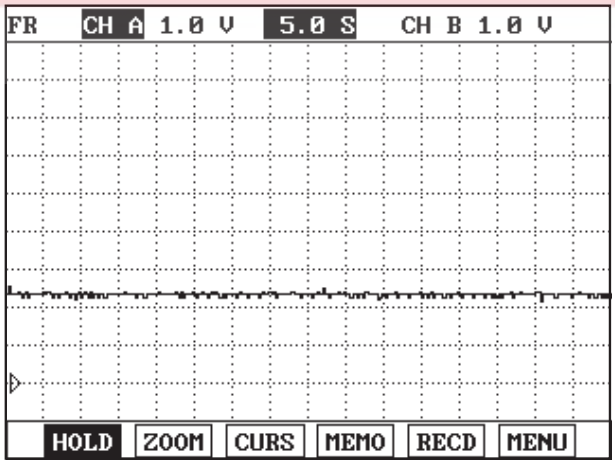




ECM

SLDF27124L

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.

EFQG043A

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.

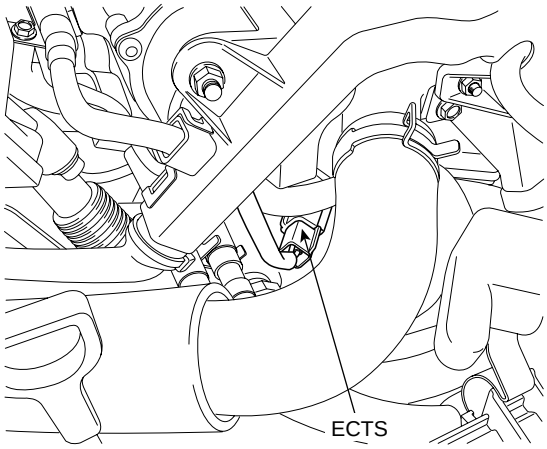
Specification: Refer to "SPECIFICATION".

ENGINE COOLANT TEMPERATURE SENSOR (ECTS)

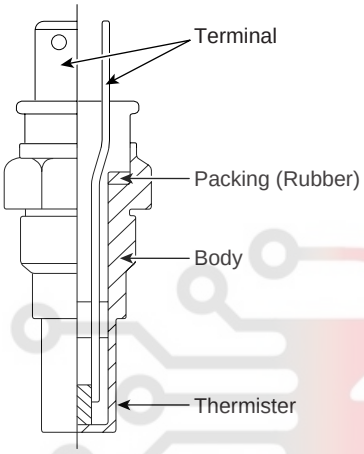
INSPECTION EE2BEC57

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.



SLDFL6104L



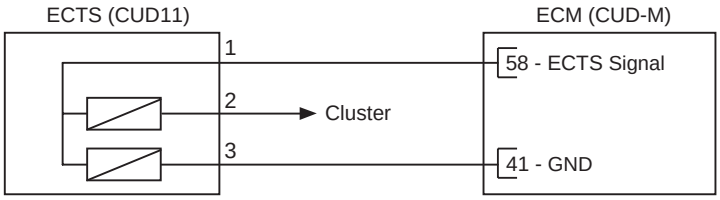
EGRF241A

SPECIFICATION

Temperature [℃(℉)]	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

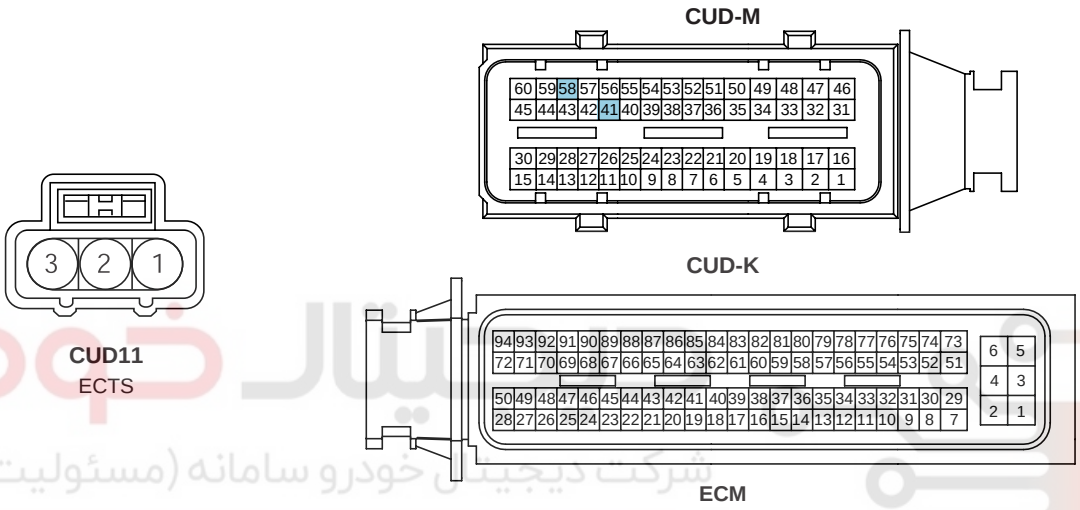
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

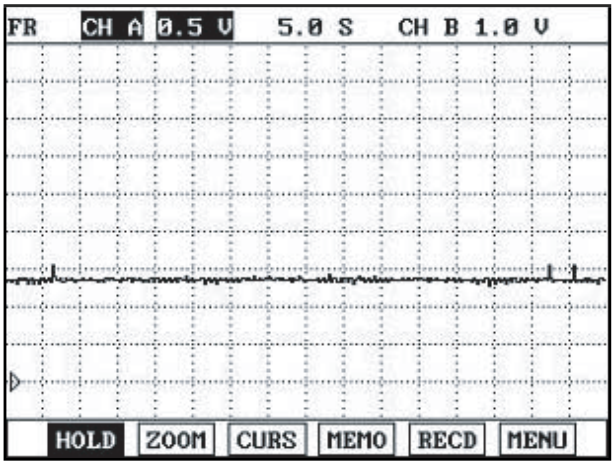
Terminal	Connected to	Function
1	ECM CUD-M (58)	Sensor ground
2	Cluster	-
3	ECM CUD-M (41)	ECTS Signal

[HARNESS CONNECTORS]



SLDF27126L

SIGNAL WAVEFORM

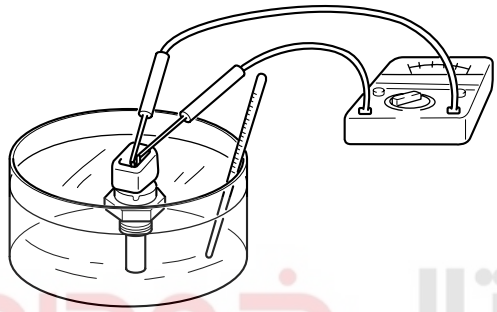


ECTS signal should be smooth and continuous without any sudden changes.
As the engine warms up, ECTS signal will drop.

EFNF539A

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.

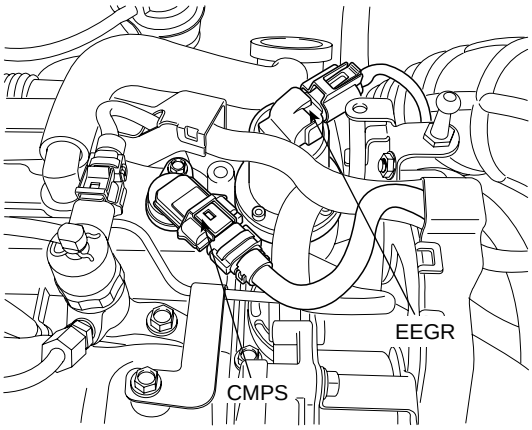


EFNF541A

5. Check that the resistance is within the specification.

Specification: Refer to "SPECIFICATION".

CAMSHAFT POSITION SENSOR (CMPS)



SLDFL6105L

INSPECTION EBD71A6A

FUNCTION AND OPERATION PRINCIPLE

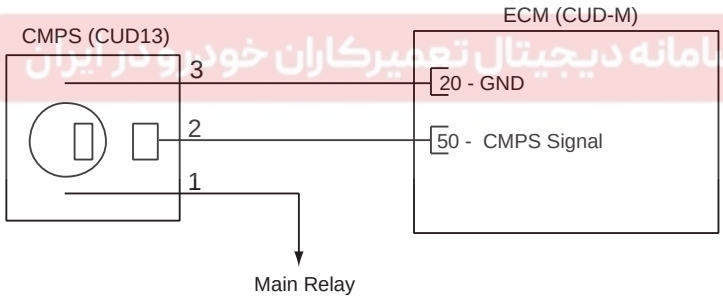
Camshaft Position Sensor (CMPS) is a hall sensor and detects the camshaft position by using a hall element. It is related with Crankshaft Position Sensor (CKPS) and detects the piston position of the each cylinder which the CKPS can't detect. This sensor is installed on engine head cover and uses a target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

SPECIFICATION

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

CIRCUIT DIAGRAM

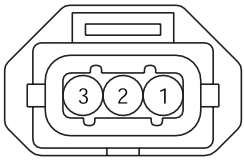
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	Main Relay	Battery Voltage
2	ECM CUD-M (50)	CMPS Signal
3	ECM CUD-M (20)	GND

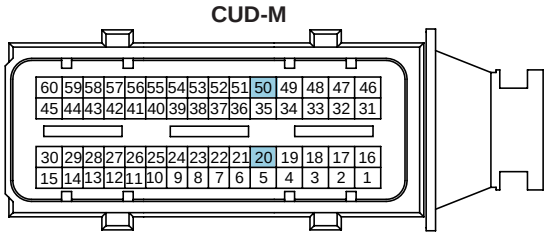
[HARNESS CONNECTORS]



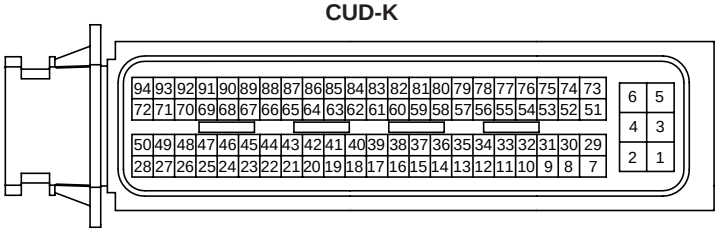
CUD13

CMPS

CUD-M



CUD-K



ECM

SLDF27127L

SIGNAL WAVEFORM

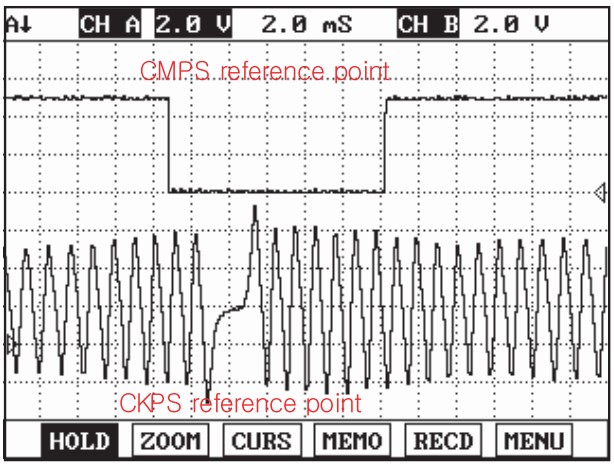


Fig.1

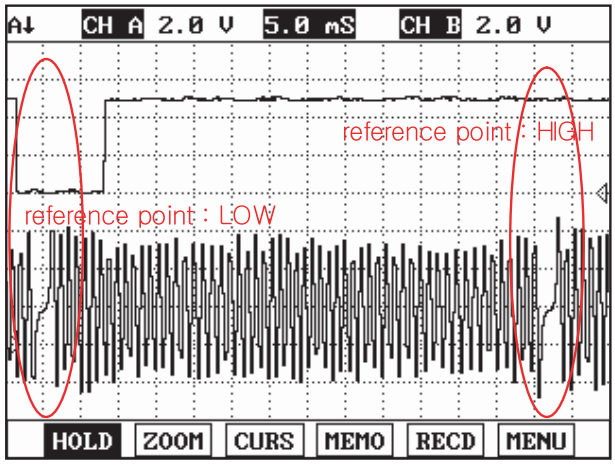


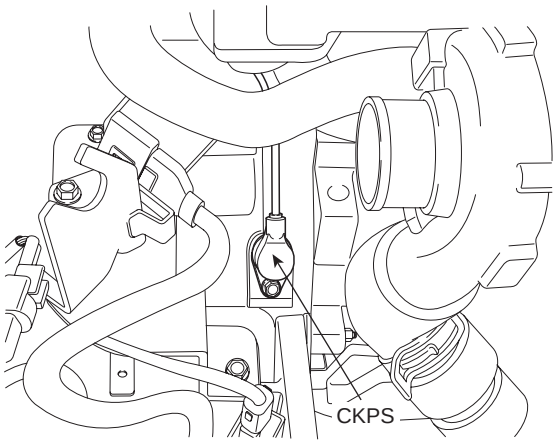
Fig.2

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.)

EFQG299A

CRANKSHAFT POSITION SENSOR (CKPS)



SSAFL6107L

INSPECTION E50B0018

FUNCTION AND OPERATION PRINCIPLE

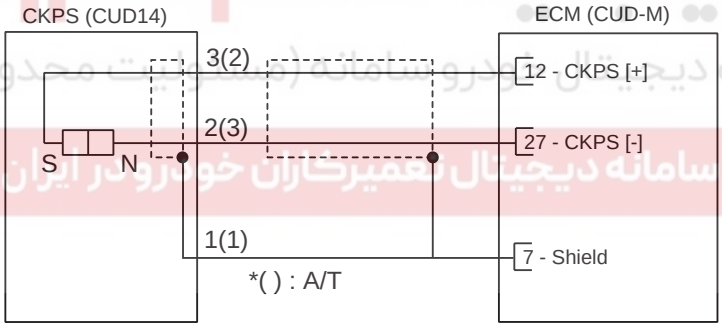
Piston position on combustion chamber is the substantial to define the starting of injection timing. All engine pistons are connected to crankshaft by connecting rod. Sensor on crankshaft can supply the informations concerning all piston positions, revolution speed is defined by revolution perminute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

SPECIFICATION

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

CIRCUIT DIAGRAM

[CIRCUIT DIAGRAM]

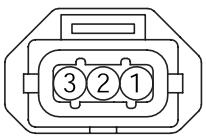


[CONNECTION INFORMATION]

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

*( ) : A/T

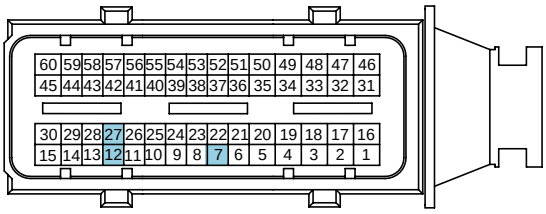
[HARNESS CONNECTORS]



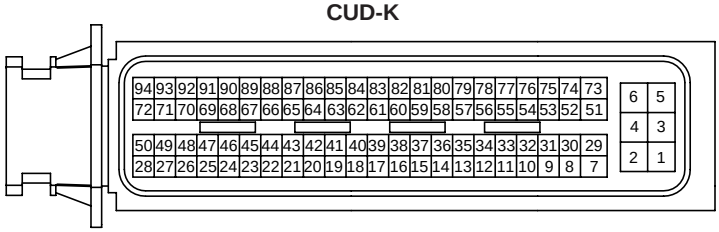
CUD14

CKPS

CUD-M



CUD-K



ECM

SLDF27128L

SIGNAL WAVEFORM

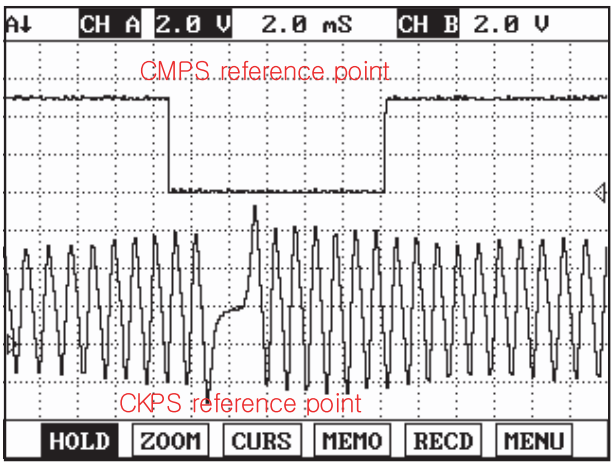


Fig.1

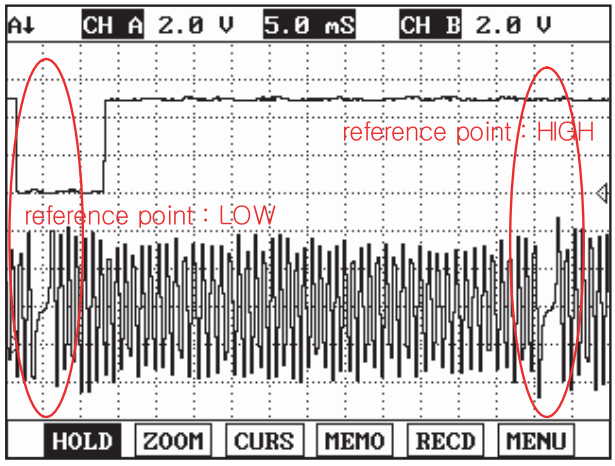


Fig.2

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.)

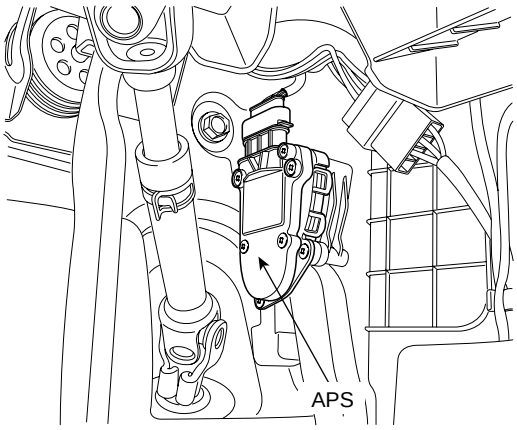
EFQG299A

ACCELERATOR POSITION SENSOR (APS)

INSPECTION E658F4FC

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.

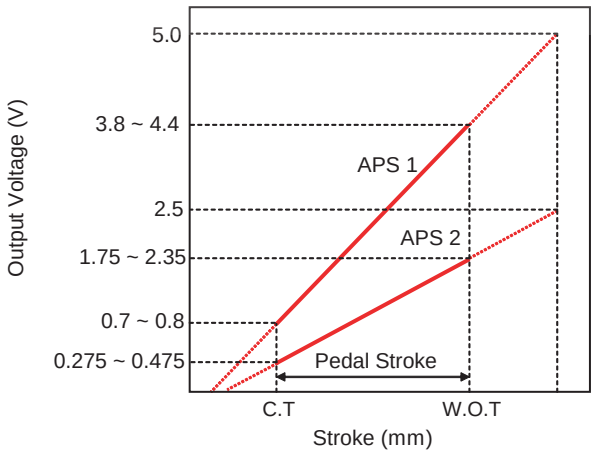


SLDFL6106L

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

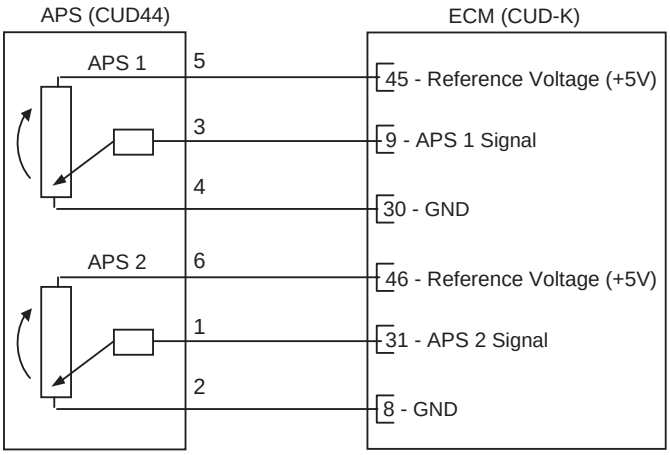
Items	Specification	
	APS 1	APS 2
Potentiometer Resistance (kΩ)	0.7 ~ 1.3	1.4 ~ 2.6



EFQG092A

CIRCUIT DIAGRAM

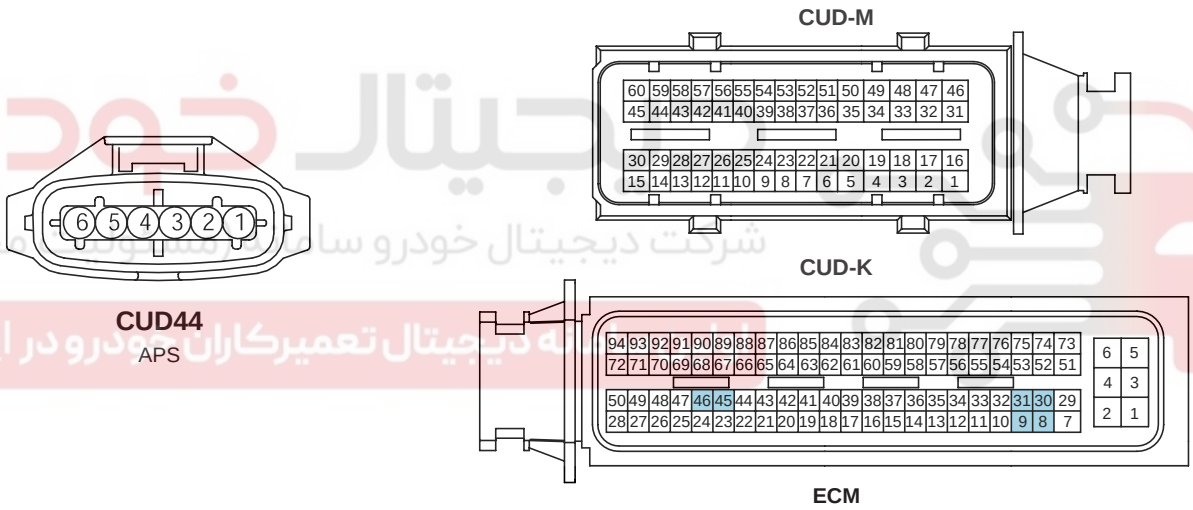
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

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

[HARNESS CONNECTORS]



SLDF27129L

SIGNAL WAVEFORM

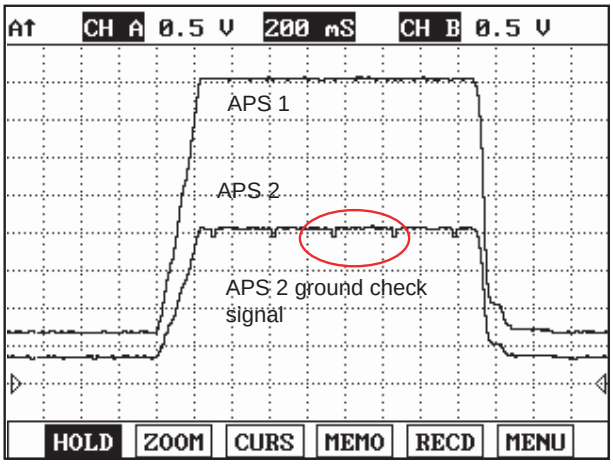


Fig.1

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.

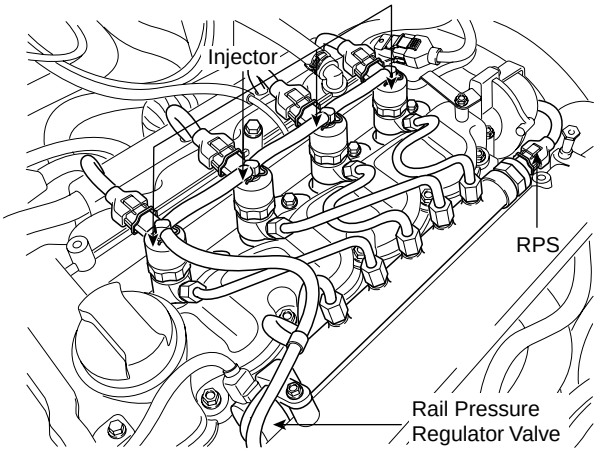
EFQG541A

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.

Specification: Refer to "SPECIFICATION".

RAIL PRESSURE SENSOR (RPS)



SLDFL6108L

INSPECTION E20575CF

FUNCTION AND OPERATION PRINCIPLE

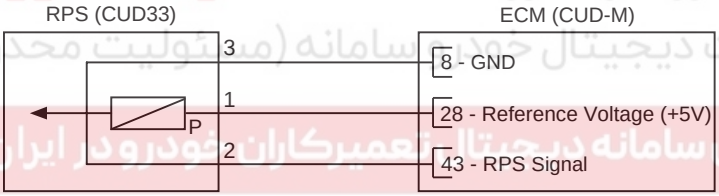
Rail Pressure Sensor (RPS) is installed at the end of the common rail and measures the instantaneous fuel pressure in the common rail by using its diaphragm. Its sensing element (semiconductor device) mounted on the diaphragm converts the fuel pressure to an electric signal.

SPECIFICATION

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

CIRCUIT DIAGRAM

[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

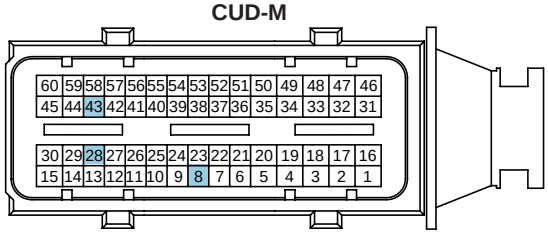
Terminal	Connected to	Function
1	ECM CUD-M (28)	Reference Voltage (+5V)
2	ECM CUD-M (43)	RPS Signal
3	ECM CUD-M (8)	Sensor Signal

[HARNESS CONNECTORS]

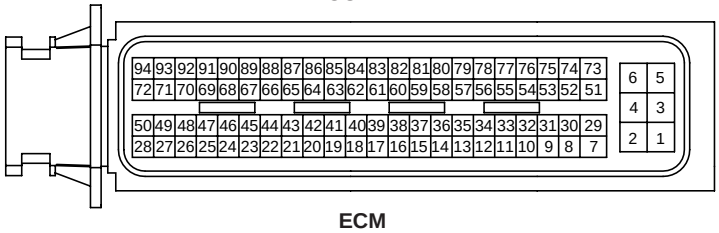
CUD33

RPS

CUD-M



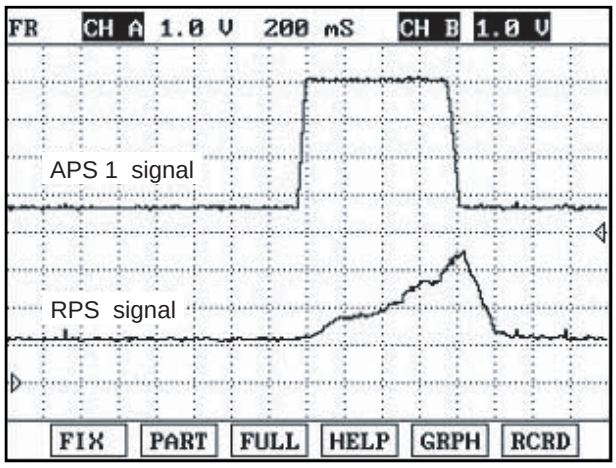
CUD-K



ECM

SLDF27130L

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.

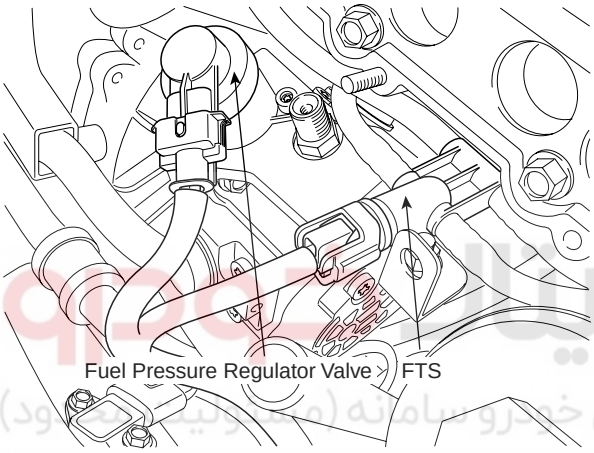
EFNF550A

FUEL TEMPERATURE SENSOR (FTS)

INSPECTION EB4209ED

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.



SSAFL6108L

SPECIFICATION

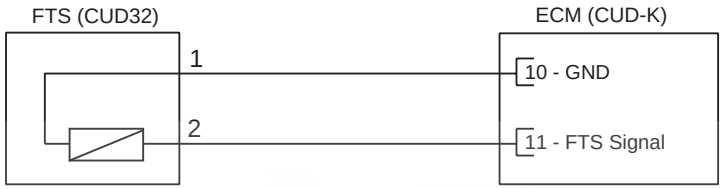
Temperature [℃(°F)]	Resistance (kΩ)
-30 (-22)	27.00
-20 (-4)	15.67
-10 (14)	9.45
0 (32)	5.89
20 (68)	2.27 ~ 2.73

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

EFQG052A

CIRCUIT DIAGRAM

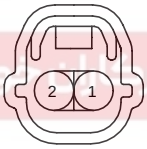
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

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

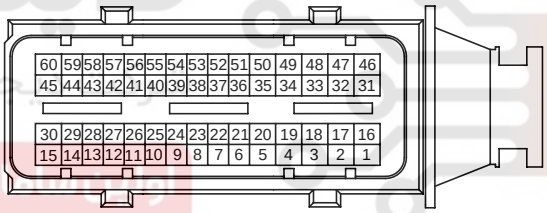
[HARNESS CONNECTORS]



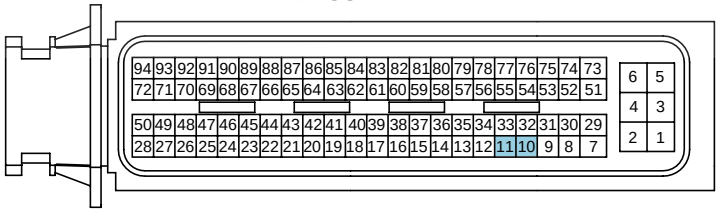
CUD32

FTS

CUD-M



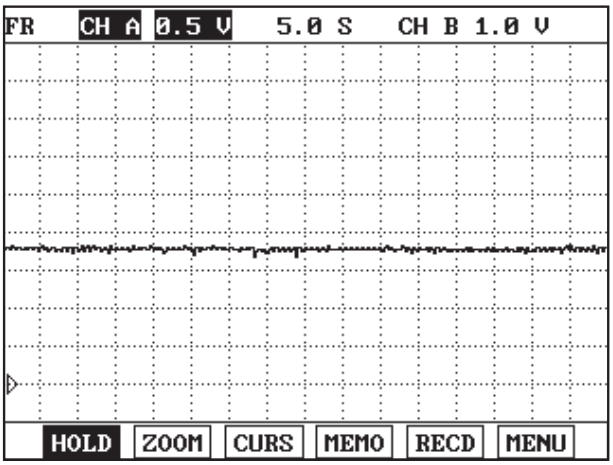
CUD-K



ECM

SLDF27131L

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.

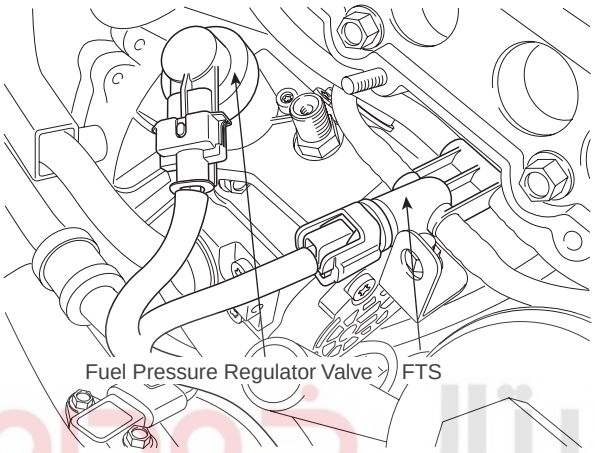
Specification: Refer to "SPECIFICATION".

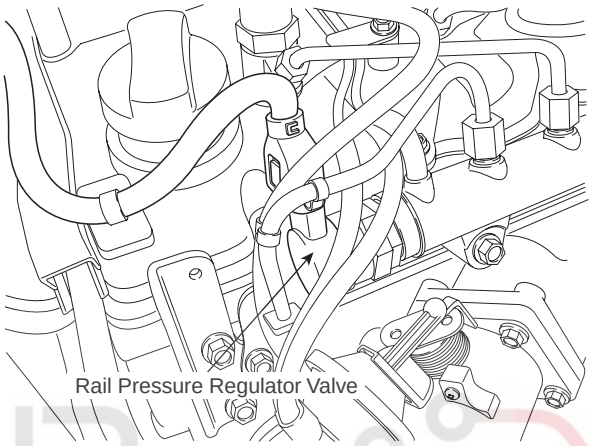
FUEL PRESSURE REGULATOR VALVE

INSPECTION ED55B05E

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.



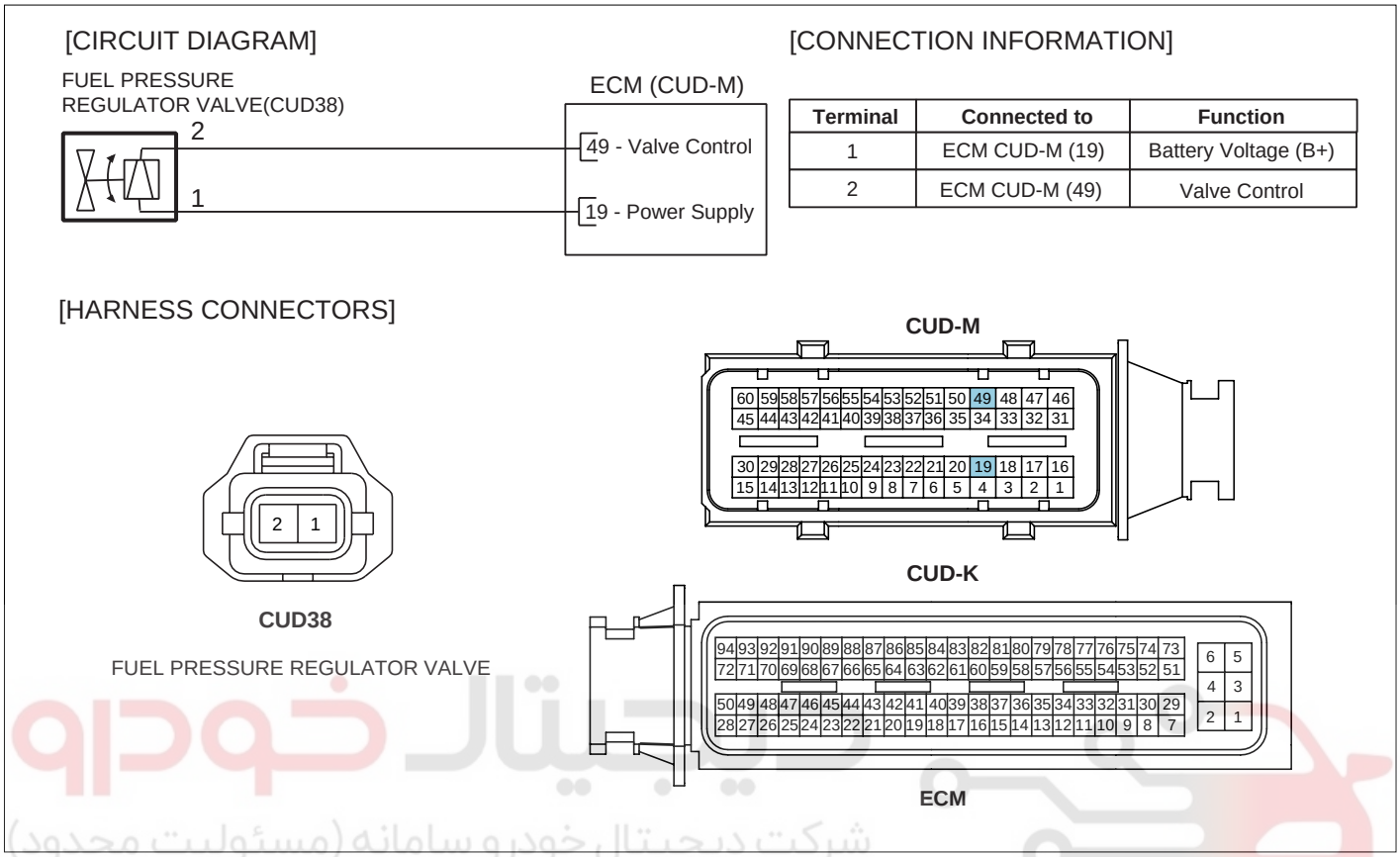


SSAFL6139L

SPECIFICATION

Items	Specification
Coil Resistance (Ω)	2.9 ~ 3.15Ω [20℃(68°F)]

CIRCUIT DIAGRAM



SLDF27132L

SIGNAL WAVEFORM

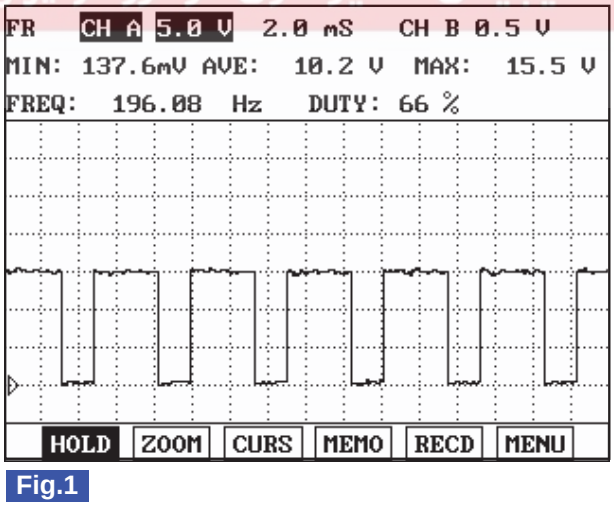


Fig.1

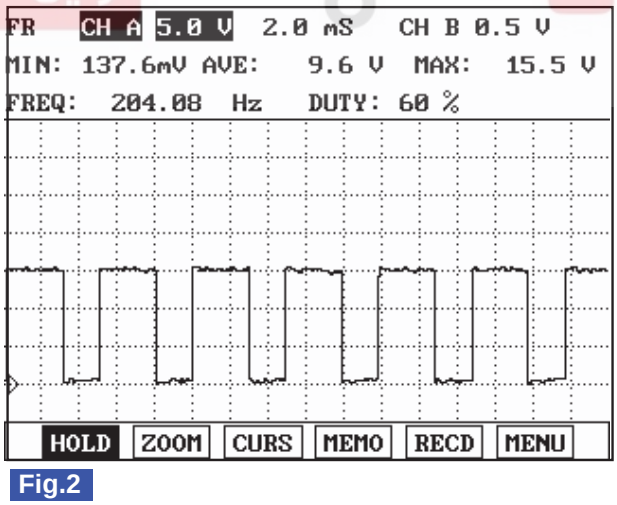


Fig.2

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.

EFQG396A

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.

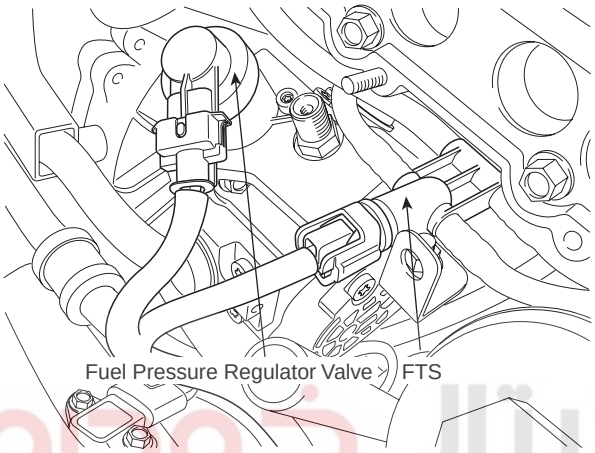
Specification: Refer to "SPECIFICATION".

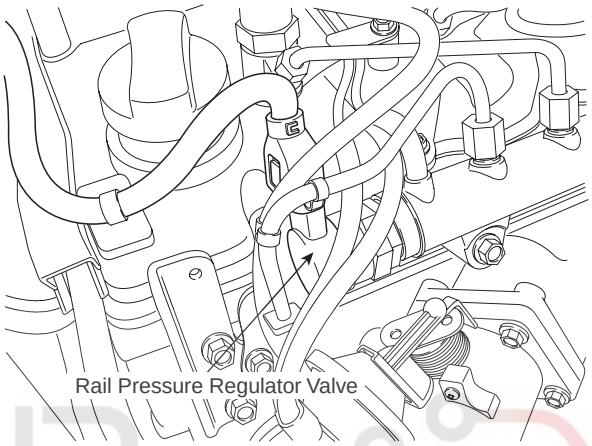
RAIL PRESSURE REGULATOR VALVE

INSPECTION E376D46E

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.



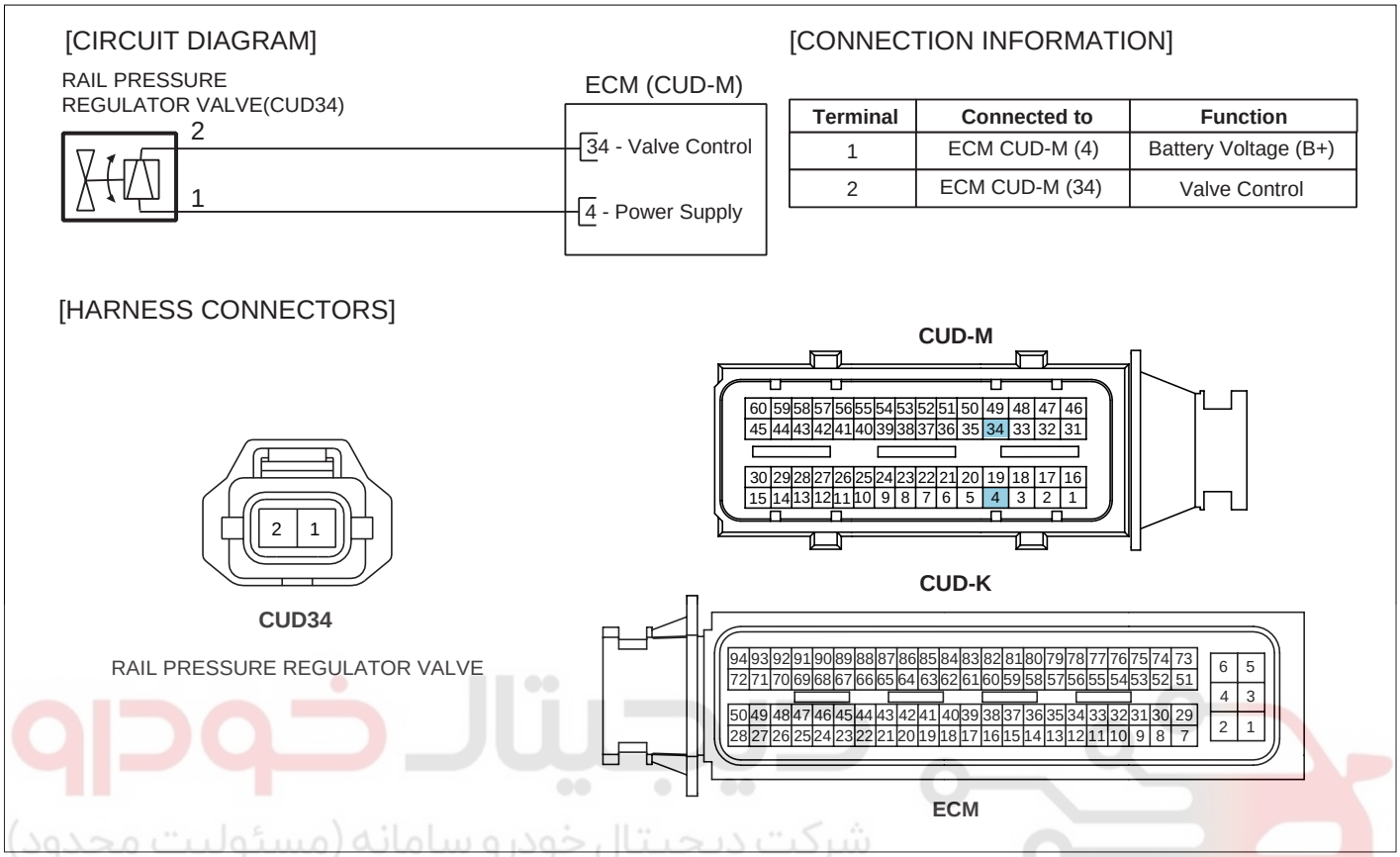


SSAFL6139L

SPECIFICATION

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

CIRCUIT DIAGRAM



SLDF27133L

SIGNAL WAVEFORM

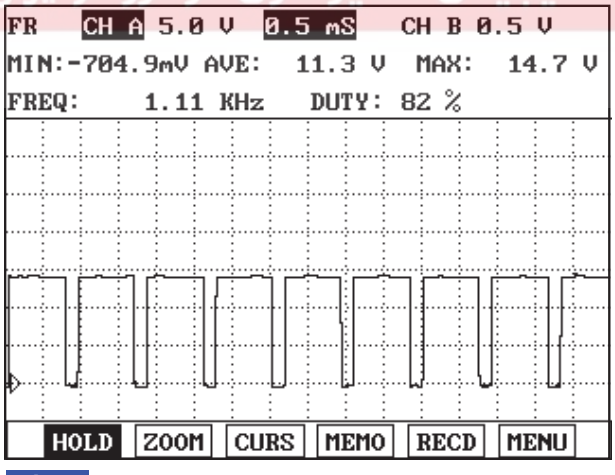


Fig.1

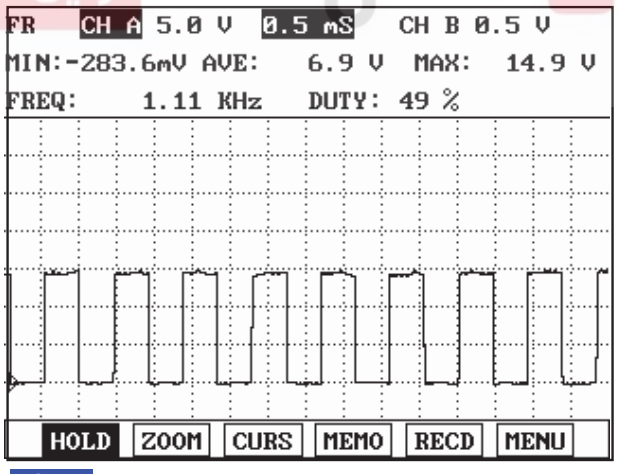


Fig.2

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.)

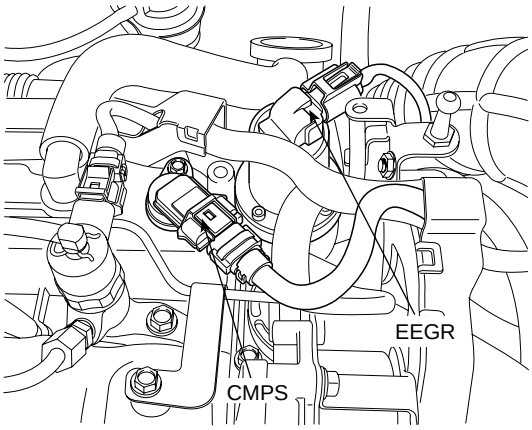
EFQG377A

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.

Specification: Refer to "SPECIFICATION".

ELECTRIC EGR CONTROL VALVE



SLDFL6105L

INSPECTION E5E34FB7

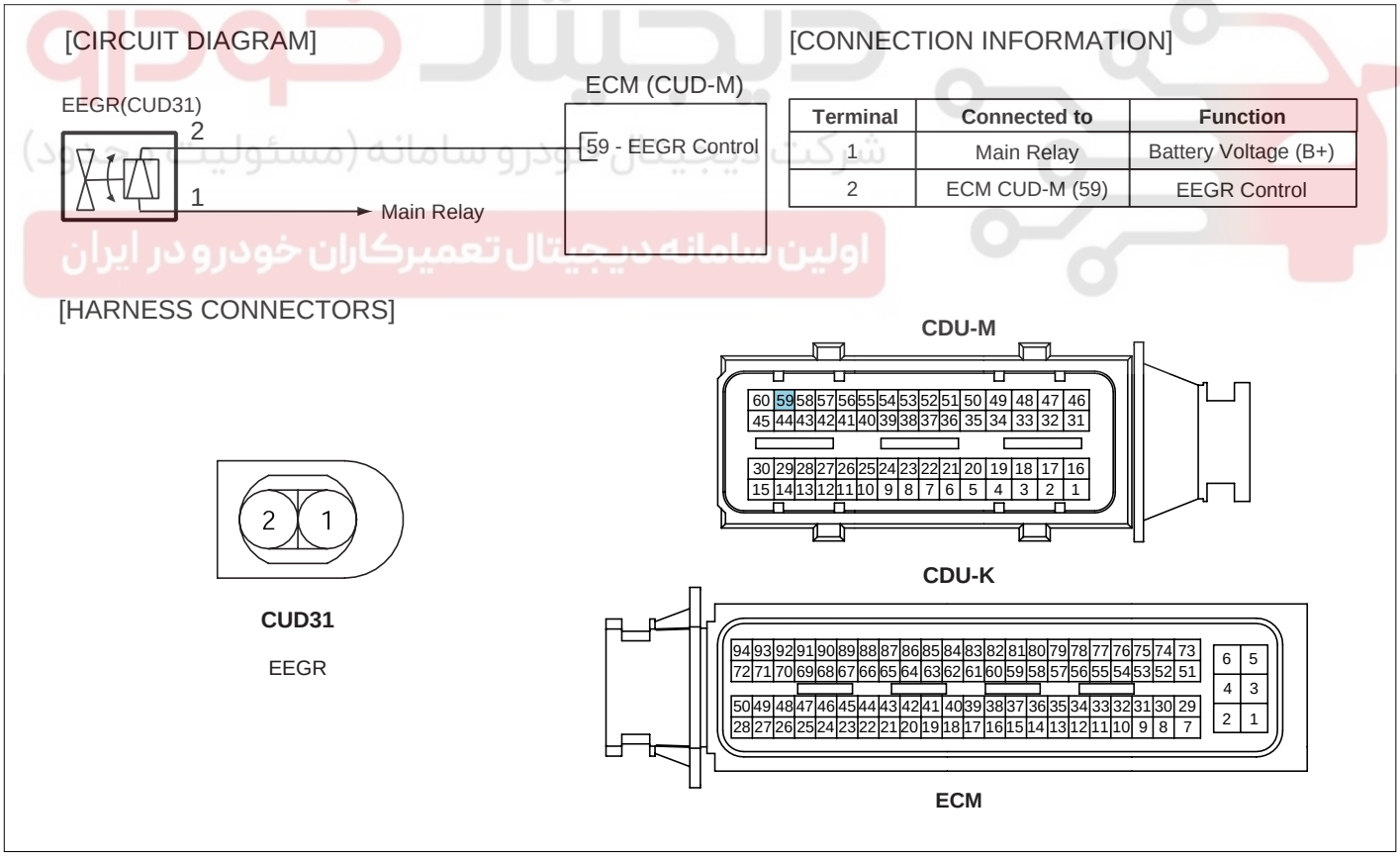
FUNCTION AND OPERATION PRINCIPLE

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.

SPECIFICATION

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

CIRCUIT DIAGRAM



SLDF27134L

SIGNAL WAVEFORM

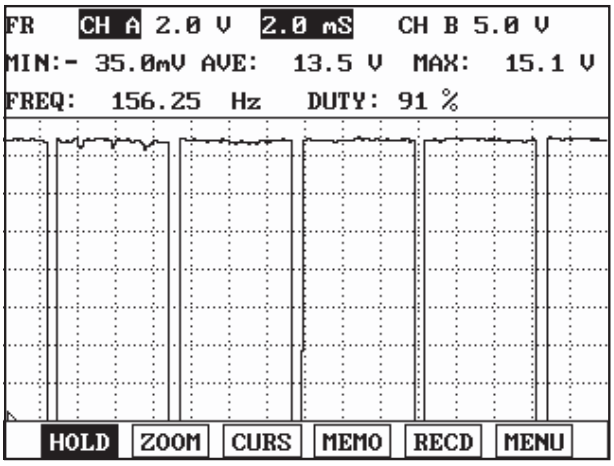


Fig.1

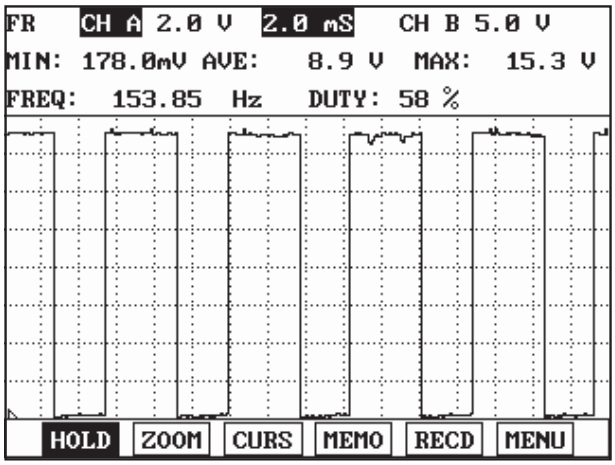


Fig.2

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)

EFQG414A

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.

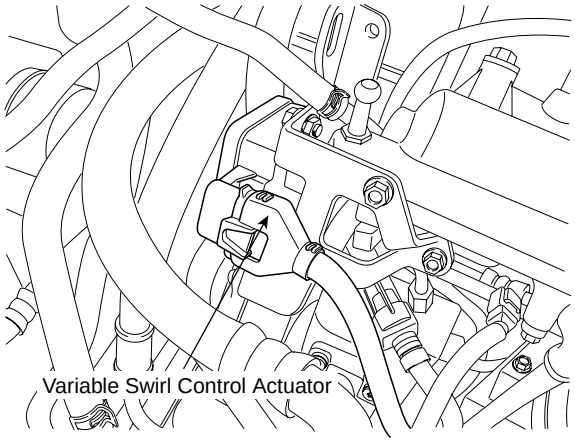
Specification: Refer to "SPECIFICATION".

VARIABLE SWIRL CONTROL ACTUATOR

INSPECTION E67A5BAC

FUNCTION AND OPERATION PRINCIPLE

Variable Swirl Control Actuator consists of DC motor and position sensor which detects the position of the swirl valve.
At idle or below 3000rpm, the swirl valve is closed. This swirl effect increases air flow rate.



SLDFL6114L

	Low and Middle Load	High Load
Engine speed	Below 3000rpm	Above 3000rpm
Valve operation	CLOSE	OPEN
Description illustration	 KGNF302A	 KGNF302B
Fail-safe	Fully opened	

NOTE

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˚F)]

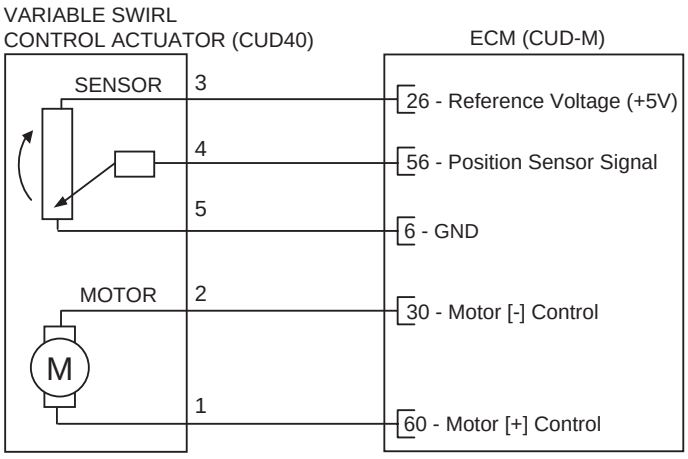
Position Sensor

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

EFQG058A

CIRCUIT DIAGRAM

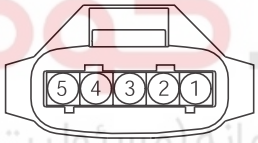
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

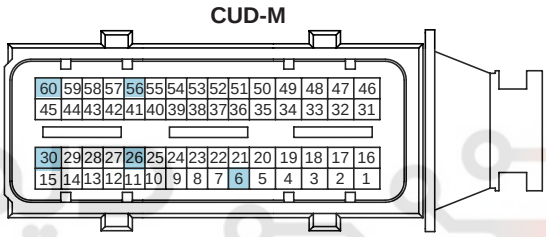
Terminal	Connected to	Function
1	ECM CUD-M (60)	Motor [+] Control
2	ECM CUD-M (30)	Motor [-] Control
3	ECM CUD-M (26)	Reference Voltage (+5V)
4	ECM CUD-M (56)	Position Signal
5	ECM CUD-M (6)	Sensor Ground

[HARNESS CONNECTORS]

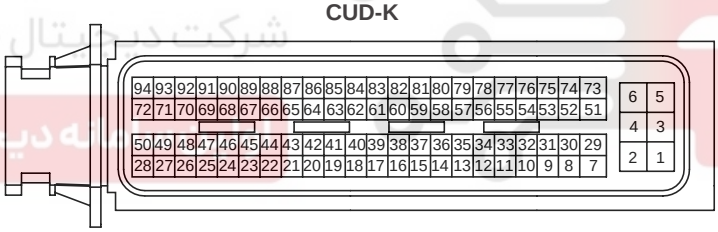


CUD40

VARIABLE SWIRL CONTROL ACTUATOR



CUD-M



CUD-K

ECM

SLDF27135L

SIGNAL WAVEFORM

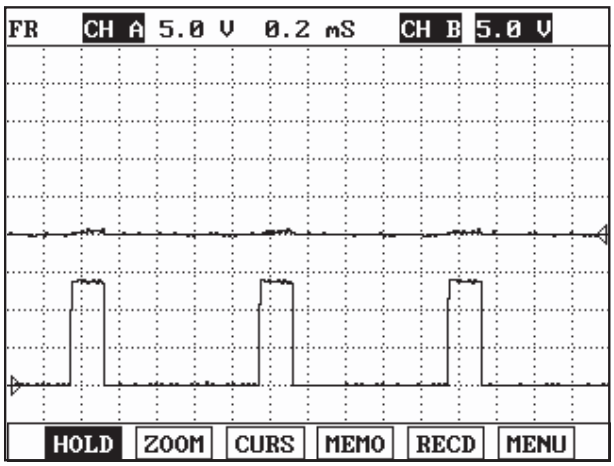


Fig.1

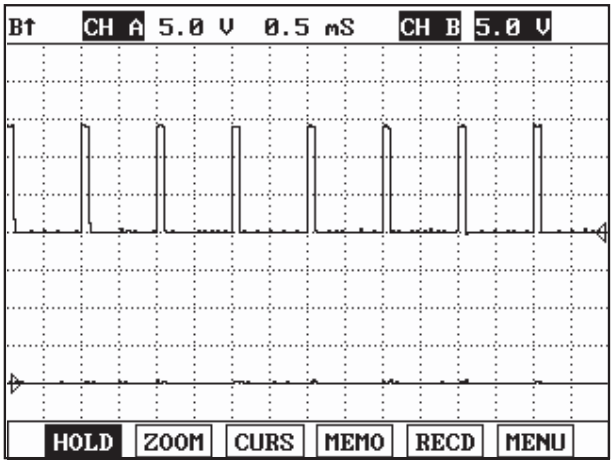


Fig.2

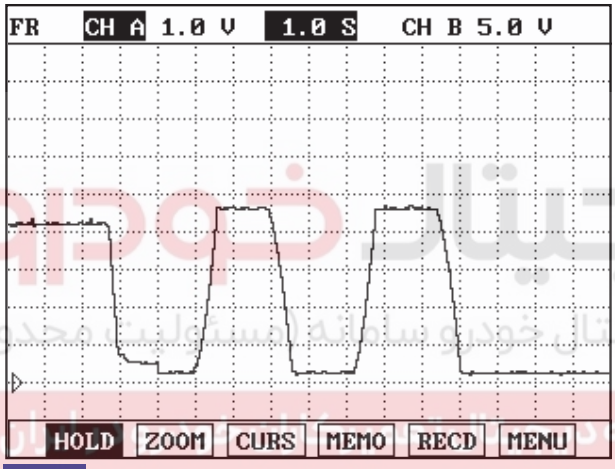


Fig.3

Fig.1) Waveform when variable swirl valve closed at idle. Terminal 5 is (+) and 4 is (-).
Fig. 2) Waveform when variable swirl valve opened at above 3000RPM. Terminal 5 is (-) and 4 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".

EFQG512A

COMPONENT INSPECTION

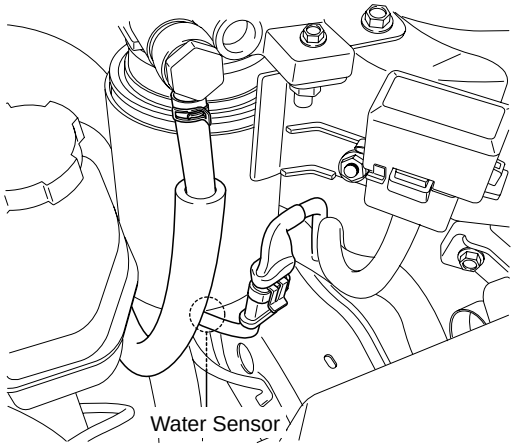
1. Turn ignition switch OFF.
2. Disconnect the variable swirl control actuator connector.
3. Check that swirl valve is stuck by foreign material.
4. Measure resistance between motor (+) and (-) control terminals.

Specification: Refer to "SPECIFICATION".

5. Measure resistance between voltage supply terminal and ground terminal of position sensor.

Specification: Refer to "SPECIFICATION".

WATER SENSOR



SLDFL6110L

INSPECTION E65D7ECA

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.

NOTE

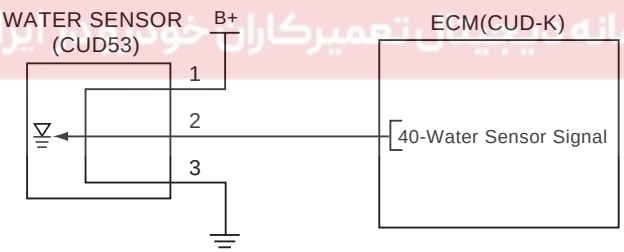
Without presence of water, the lamp should flash for 2 seconds and turn off afterward in order that this system has normal condition.

SPECIFICATION

Items	Specification
Warning Level of Water Presence (cc)	40 ~ 60

CIRCUIT DIAGRAM

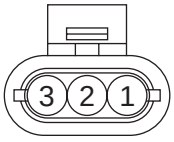
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

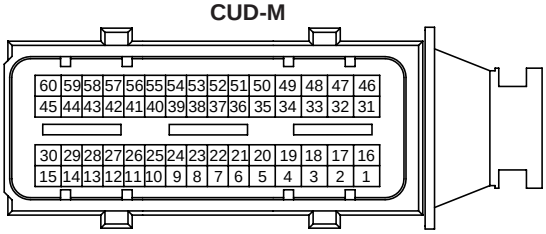
Terminal	Connected to	Function
1	Main Relay	Battery voltage(B+)
2	ECM CUD-K (40)	Sensor Signal
3	Chassis ground	Sensor ground

[HARNESS CONNECTOR]

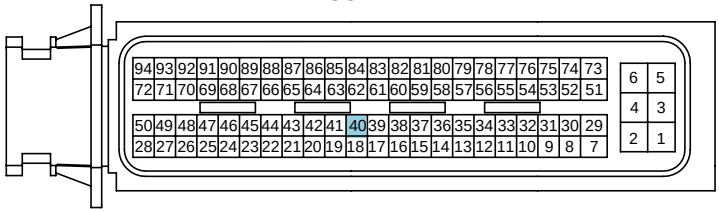


CUD53
WATER SENSOR

CUD-M



CUD-K



ECM

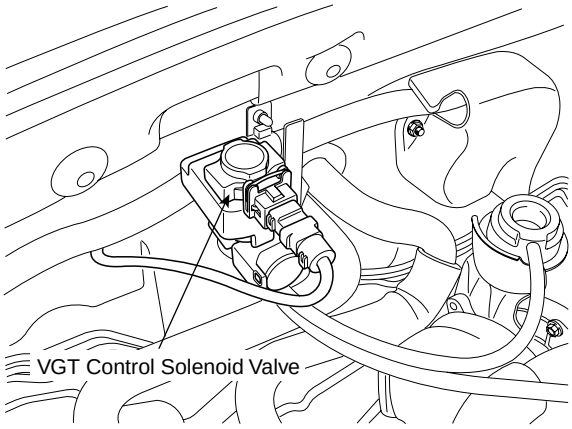
SLDF27136L

VGT CONTROL SOLENOID VALVE

INSPECTION EF3075E1

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.

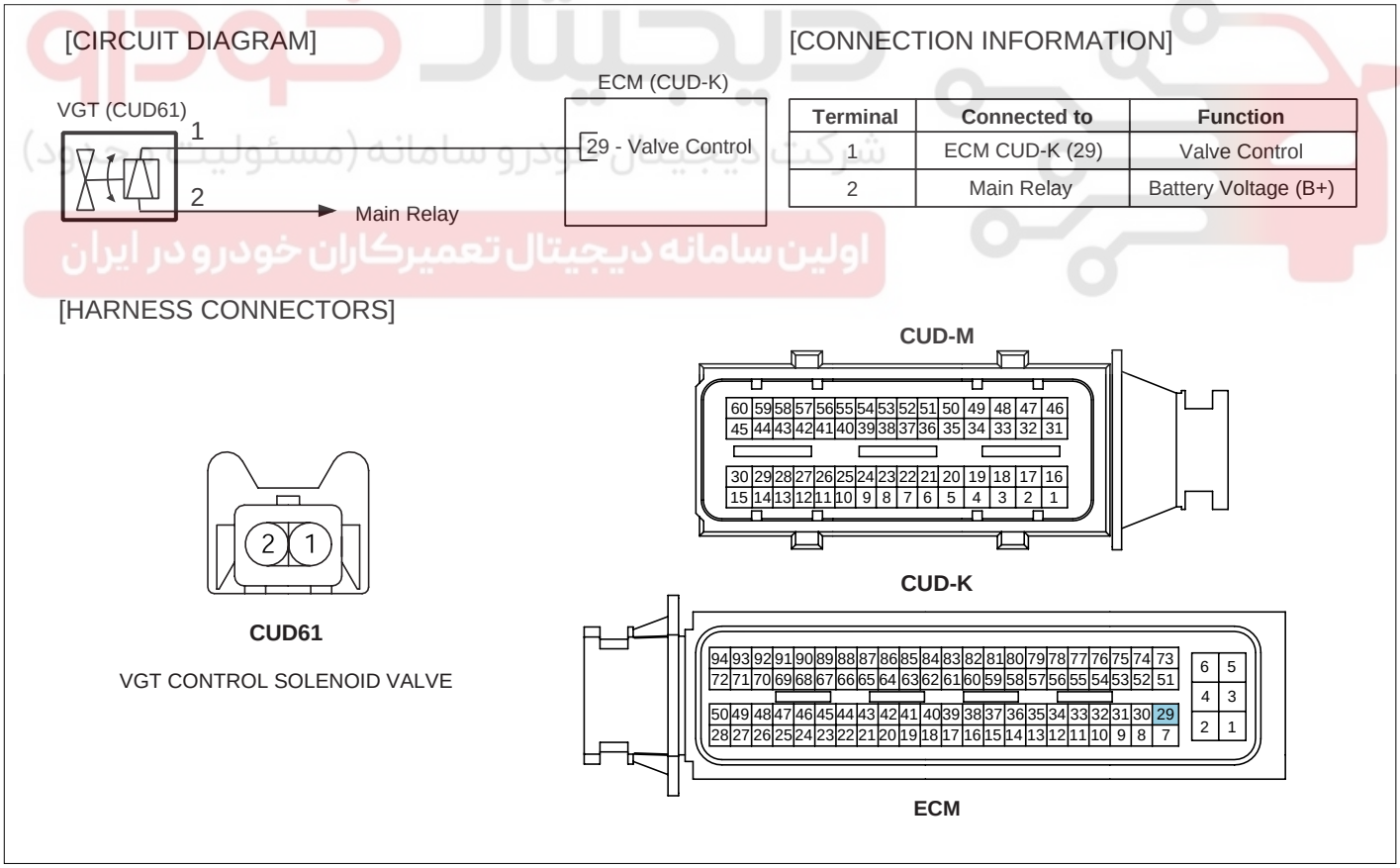


SLDFL6111L

SPECIFICATION

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

CIRCUIT DIAGRAM



SLDF27137L

SIGNAL WAVEFORM

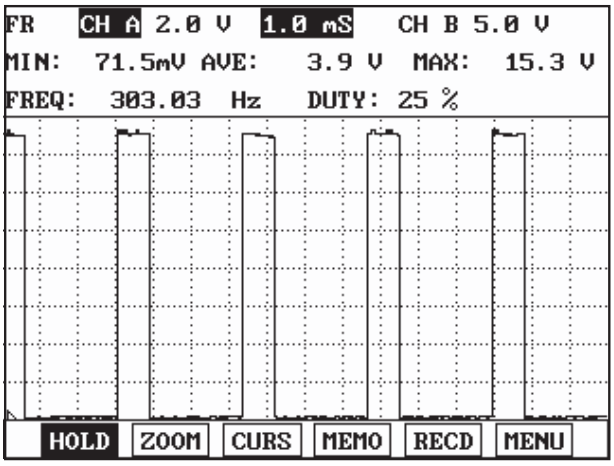


Fig.1

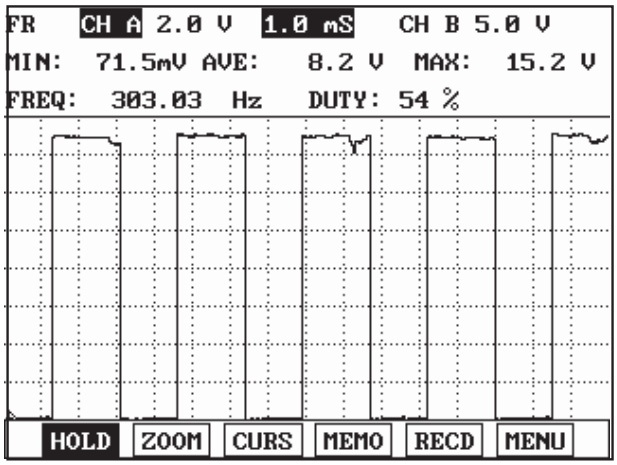


Fig.2

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.

EFQG369A

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.

Specification: Refer to "SPECIFICATION".

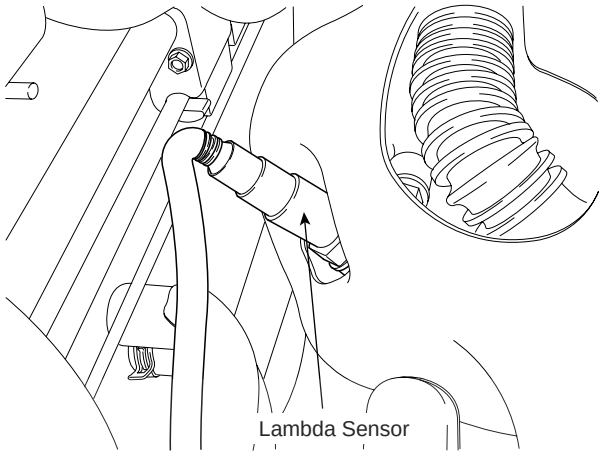
LAMBDA SENSOR

INSPECTION EBAD39D1

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 rich 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°C ~ 600°C) thus, in order to reach normal operating temp. and last at that temperature, a heater (heating coil) is integrated with lambda sensor. The heater coil is controlled by ECM as Pulse Width Modulation (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.



SSAFL6105L

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

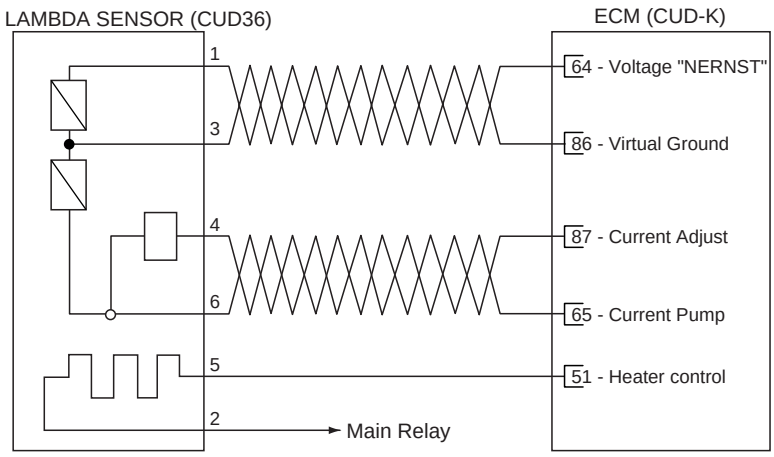
Heater

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

EFQG062A

CIRCUIT DIAGRAM

[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

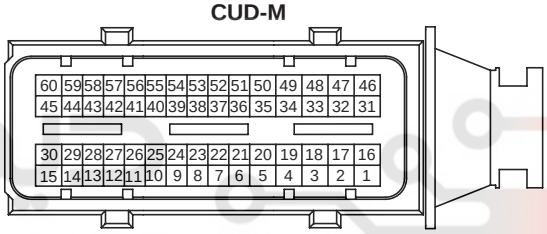
Terminal	Connected to	Function
1	ECM CUD-K (64)	Voltage "NERNST"
2	Main Relay	Battery Voltage (B+)
3	ECM CUD-K (86)	Virtual Ground
4	ECM CUD-K (87)	Current Adjust
5	ECM CUD-K (51)	Heater control
6	ECM CUD-K (65)	Current Pump

[HARNESS CONNECTORS]

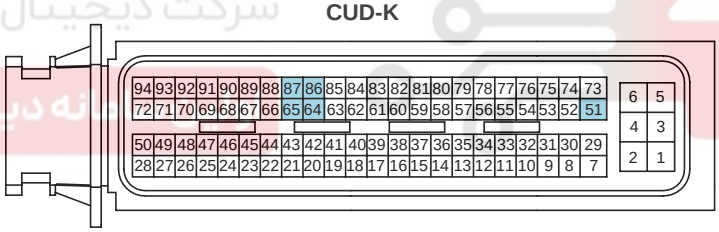
CUD36

LAMBDA SENSOR

CUD-M



CUD-K



ECM

SLDF27138L

SIGNAL WAVEFORM

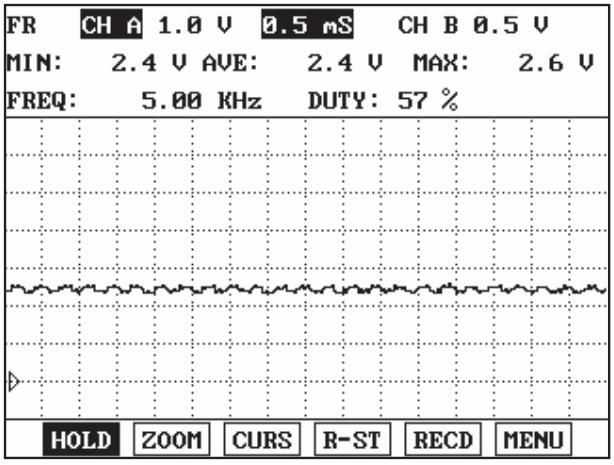


Fig.1

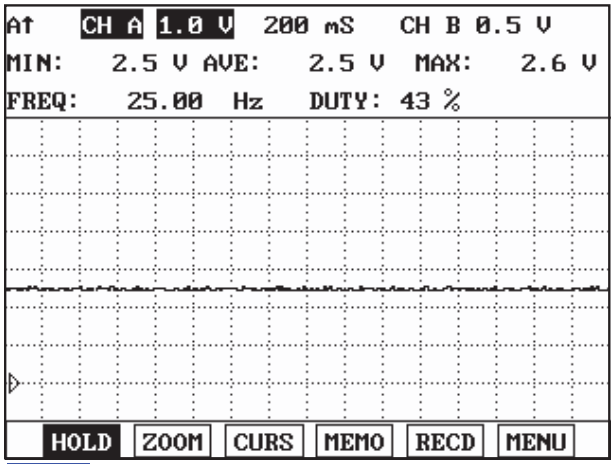


Fig.2

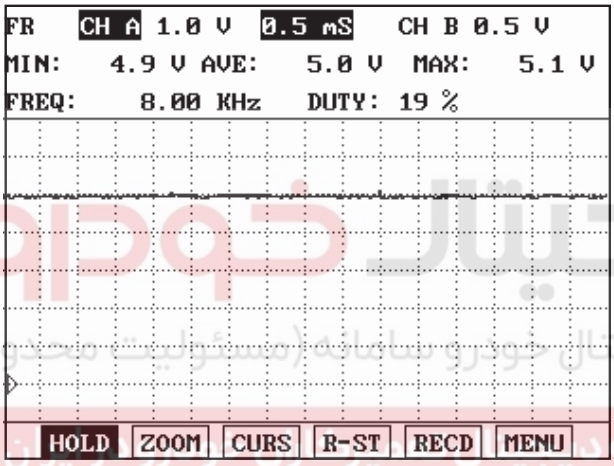


Fig.3

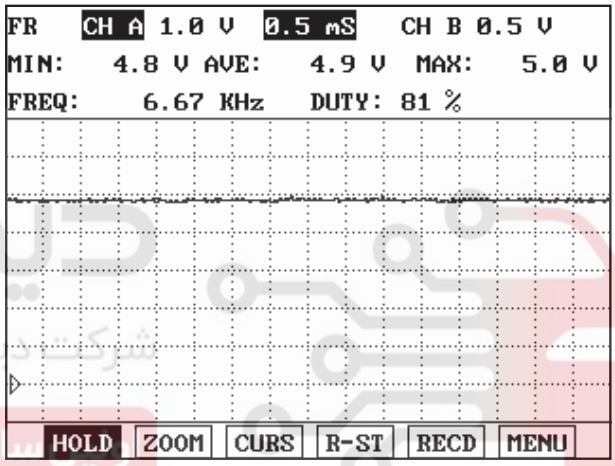


Fig.4

Fig.1) Waveform of Lambda sensor power(terminal 1) at IG KEY "ON" and Engine running. It fluctuates between 2V and 3V periodically.
Fig.2) Waveform of Lambda sensor ground(terminal 3) at IG KEY "ON" and Engine running. 2.5V is displayed.
Fig.3) Waveform of Lambda sensor signal(terminal 4) at IG KEY "ON" and Engine running. 5V is displayed.
Fig.4) Waveform of Lambda sensor pump(terminal 6) at IG KEY "ON" and Engine running. 5V is displayed.

SLDFL6481L

DTC TROUBLESHOOTING PROCEDURES

INSPECTION CHART FOR DIAGNOSTIC TROUBLE CODES (DTC) EAD39CB6

DTC	DESCRIPTION	MIL	PAGE
P0031	Lambda Sensor Heater Circuit Low (Bank 1 / Sensor 1)	▲	FLB-87
P0032	Lambda Sensor Heater Circuit High (Bank 1 / Sensor 1)	▲	FLB-94
P0047	VGT Vaccum Modulator Circuit Low	▲	FLB-97
P0048	VGT Vaccum Modulator Circuit High	▲	FLB-104
P0069	Boost Pressure Sensor Circuit Malfunction	▲	FLB-108
P0087	Rail Pressure Monitoring-Minimum Pressure at Engine Speed Too Low	●	FLB-115
P0088	Rail Pressure Monitoring-Maximum Pressure Exceeded	●	FLB-119
P0089	Rail Pressure Regulator Valve Circuit Over Current	●	FLB-120
P0091	Rail Pressure Regulator Valve Circuit Low	●	FLB-127
P0092	Rail Pressure Regulator Valve Circuit High	●	FLB-130
P0097	Intake Air Temperature Sensor 2 Circuit Low Input	▲	FLB-133
P0098	Intake Air Temperature Sensor 2 Circuit High Input	▲	FLB-139
P0101	Mass or Volume Air Flow Circuit Range/Performance	●/▲	FLB-143
P0102	Mass or Volume Air Flow Circuit Low Input	▲	FLB-151
P0103	Mass or Volume Air Flow Circuit High Input	▲	FLB-155
P0107	Atmospheric Pressure Circuit Low Input	▲	FLB-159
P0108	Atmospheric Pressure Circuit High Input	▲	FLB-162
P0112	Intake Air Temperature Sensor 1 Circuit Low Input	▲	FLB-164
P0113	Intake Air Temperature Sensor 1 Circuit High Input	▲	FLB-170
P0117	Engine Coolant Temperature Circuit Low Input	▲	FLB-174
P0118	Engine Coolant Temperature Circuit High Input	▲	FLB-180
P0182	Fuel Temperature Sensor A Circuit Low Input	▲	FLB-184
P0183	Fuel Temperature Sensor A Circuit High Input	▲	FLB-190
P0192	Fuel Rail Pressure Sensor-Low input	●	FLB-194
P0193	Fuel Rail Pressure Sensor-High Input	●	FLB-201
P0201	Cylinder 1-Injector Circuit/Open	●	FLB-206
P0202	Cylinder 2-Injector Circuit/Open	●	FLB-206
P0203	Cylinder 3-Injector Circuit/Open	●	FLB-206
P0204	Cylinder 4-Injector Circuit/Open	●	FLB-206

DTC	DESCRIPTION	MIL	PAGE
P0237	Boost Pressure Sensor Circuit Low Input	▲	FLB-212
P0238	Boost Pressure Sensor Circuit High Input	▲	FLB-219
P0252	Fuel Pressure Regulator Valve Circuit Over Current	●	FLB-224
P0253	Fuel Pressure Regulator Valve Circuit Low	●	FLB-230
P0254	Fuel Pressure Regulator Valve Circuit High	●	FLB-233
P0262	Cylinder 1-Injector Circuit High	●	FLB-236
P0265	Cylinder 2-Injector Circuit High	●	FLB-236
P0268	Cylinder 3-Injector Circuit High	●	FLB-236
P0271	Cylinder 4-Injector Circuit High	●	FLB-236
P0335	Crankshaft Position Sensor "A" Circuit	●	FLB-243
P0336	Crankshaft Position Sensor "A" Circuit Range/Performance	●	FLB-252
P0340	Camshaft Position Sensor "A" Circuit Malfunction (Bank 1 or Single Sensor)	●	FLB-257
P0341	Camshaft Position Sensor "A" Circuit Range/Performance (Bank 1 or Single Sensor)	●	FLB-265
P0381	Glow Indicator Lamp - Circuit Malfunction	▲	FLB-269
P0401	Exhaust Gas Recirculation Flow Insufficient Detected	●	FLB-274
P0402	Exhaust Gas Recirculation Flow Excessive Detected	●	FLB-281
P0489	Exhaust Gas Recirculation Control Circuit Low Voltage	▲	FLB-284
P0490	Exhaust Gas Recirculation Control Circuit High Voltage	▲	FLB-287
P0501	Vehicle Speed Sensor A Range/Performance	▲	FLB-290
P0504	Brake Switch "A"/"B" Correlation	▲	FLB-297
P0532	A/C Refrigerant Pressure Sensor "A" Circuit Low Input	▲	FLB-303
P0533	A/C Refrigerant Pressure Sensor "A" Circuit High Input	▲	FLB-310
P0562	System Voltage Low	▲	FLB-314
P0563	System Voltage High	▲	FLB-320
P0602	EEPROM-Programing Error	▲	FLB-323
P0605	Internal Control Module Read Only Memory(ROM) Error	▲	FLB-325
P0606	ECM/PCM Processor(ECM-SELF TEST Failed)	●	FLB-326
P0611	Injector Circuit Malfunction (More than two injectors)	●	FLB-328
P062D	Voltage regulator #1 for injector Malfunction	●	FLB-332
P062E	Voltage regulator #2 for injector Malfunction	●	FLB-336
P0642	Sensor Reference Voltage "A" Circuit Low	▲	FLB-338
P0643	Sensor Reference Voltage "A" Circuit High	▲	FLB-343
P0646	A/C Clutch Relay Control Circuit Low	▲	FLB-346

DTC	DESCRIPTION	MIL	PAGE
P0647	A/C Clutch Relay Control Circuit High	▲	FLB-352
P0650	Malfunction Indicator Lamp(MIL) Control Circuit	▲	FLB-356
P0652	Sensor Reference Voltage "B" Circuit Low	▲	FLB-360
P0653	Sensor Reference Voltage "B" Circuit High	▲	FLB-366
P0670	Glow Relay Circuit Malfunction	▲	FLB-369
P0685	ECM/PCM Power Relay Control Circuit /Open	▲	FLB-376
P0698	Sensor Reference Voltage "C" Circuit Low	▲	FLB-384
P0699	Sensor Reference Voltage "C" Circuit High	▲	FLB-389
P0700	TCU Request for MIL ON	▲	FLB-392
P0701	TCM Status Error	▲	FLB-393
P0820	Neutral S/W Malfunction	▲	FLB-394
P0830	Clutch Pedal Switch "A" Circuit	▲	FLB-399
P1145	Overrun monitoring error	▲	FLB-405
P1185	Fuel Pressure Monitoring-Maximum Pressure Exceeded	●	FLB-407
P1186	Fuel Pressure Monitoring-Minimum Pressure at Engine Speed Too Low	●	FLB-411
P1586	MT/AT Encoding	◆	FLB-414
P1587	CAN communication error (MT/AT recognition error)	◆	FLB-417
P1588	Signal Change through MT/AT line (during engine running)	◆	FLB-423
P1634	AUX. Heater Malfunction	▲	FLB-426
P1652	Ignition Switch Circuit Malfunction	▲	FLB-433
P1670	Injector Classification Error (Diesel 1) / Injector Specific Data Error (Diesel 2)	◆	FLB-437
P1671	Check-sum error	◆	FLB-439
P1692	Immobilizer Lamp error	▲	FLB-441
P2009	Intake Manifold Runner Control Circuit Low(Bank 1)	▲	FLB-444
P2010	Intake Manifold Runner Control Circuit High(Bank 1)	▲	FLB-450
P2015	Intake Manifold Runner Position Sensor/Switch Circuit Range/Performance (Bank 1)	▲	FLB-454
P2016	Intake Manifold Runner Position Sensor/Switch Circuit Low (Bank 1)	▲	FLB-459
P2017	Intake Manifold Runner Position Sensor/Switch Circuit High (Bank 1)	▲	FLB-464
P2123	Throttle/Pedal Position Sensor/Switch "D" Circuit High Input	●	FLB-469
P2128	Throttle/Pedal Position Sensor/Switch "E" Circuit High Input	●	FLB-476
P2138	Throttle/Pedal Position Sensor/Switch "D" / "E" Voltage Correlation	●	FLB-480
P2238	Lambda Sensor Pumping Current Circuit Low (Bank 1 / Sensor 1)	▲	FLB-485
P2239	Lambda Sensor Pumping Current Circuit High (Bank 1 / Sensor 1)	▲	FLB-494

DTC	DESCRIPTION	MIL	PAGE
P2251	Lambda Sensor Reference Ground Circuit/Open (Bank 1 / Sensor 1)	▲	FLB-500
P2264	Detection of Water in fuel	▲	FLB-506
P2299	Brake Pedal Position / Accelerator Pedal Position Incompatible	▲	FLB-511
U0001	Lost Communication with ECM/PCM "A"	▲	FLB-520
U0100	CAN-Time Out ECU	▲	FLB-526
U0101	Serial Communication Problem with TCU (Timeout)	▲	FLB-530
U0122	ECM-TCS CAN Error	▲	FLB-534
U0416	Abnormal Torque rise request from TCS	▲	FLB-540

NOTE

●*: MIL ON & Memory*
▲*: MIL OFF & Memory*
◆*: Glow Lamp Blanking & MEMORY*

DTC P0031 LAMBDA SENSOR HEATER CIRCUIT LOW (BANK 1 / SENSOR 1)

COMPONENT LOCATION EA42E9F3

SLDFL6201L

GENERAL DESCRIPTION E74C89EB

Lambda sensor installed at exhaust manifold is linear Lambda sensor and it senses Lambda density of exhaust gas for accurate EGR control through fuel correction. It also limits smoke which is generated by reach air-fuel mixture at engine maximum loading condition. ECM controls pumping current in order to fit λ -value from linear Lambda sensor to 1.0.

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

This performance is the most active and fast at normal operating temp.(450°C~600°C) thus, in order to reach normal operating temp. and last at that temp., heater(heating coil) is integrated with Lambda sensor.Heater coil is controlled by ECM as 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, Lambda sensor temp. is measured and Lambda sensor heater operation varies based on the data.

DTC DESCRIPTION E87DDD03

P0031 is set when open or short to ground in Lambda sensor control circuit is detected for more than 2.0 sec. at Lambda sensor heater control condition. This code is due to 1)open or short to ground in heater control circuit or 2)Lambda sensor heater internal short.

DTC DETECTING CONDITION E415D7F8

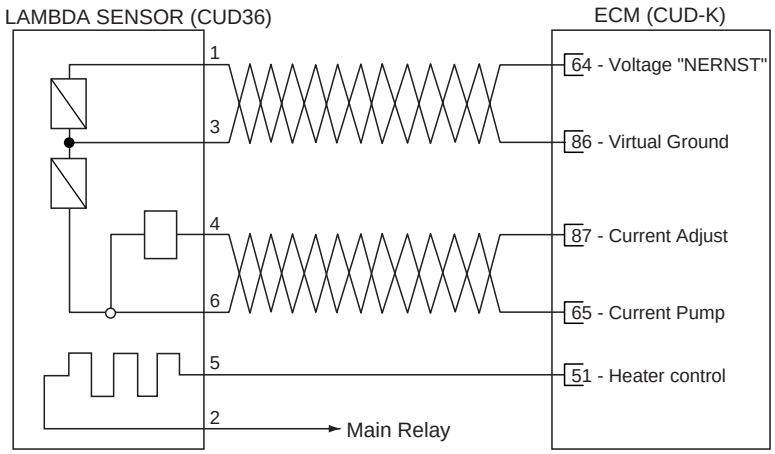
Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Lambda sensor heater circuit • Lambda sensor component
Enable Conditions	• Engine running			
ThresholdValue	• Short to GND in Lambda sensor heater control circuit • Open in Lambda sensor heater control circuit			
DiagnosticTime	• 5 sec.			
Fail Safe	Fuel Cut	NO		
	EGR Off	NO		
	Fuel Limit	NO		
	MIL	OFF		

SPECIFICATION E90804A5

Temperature (℃)	Lambda sensor heater resistance(Ω)	Temperature (℃)	Lambda sensor heater resistance(Ω)	Lambda sensor heater control Hz
20	9.2	400	17.7	100 Hz
100	10.7	500	19.2	
200	13.1	600	20.7	
300	14.6	700	22.5	

SCHEMATIC DIAGRAM EEB41D48

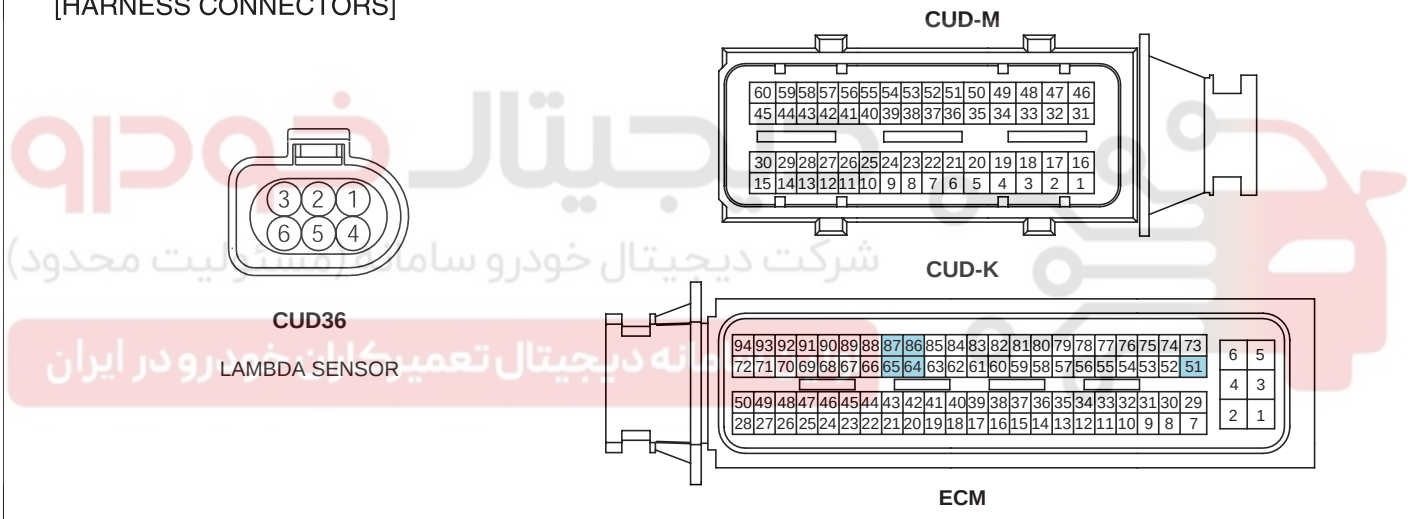
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM CUD-K (64)	Voltage "NERNST"
2	Main Relay	Battery Voltage (B+)
3	ECM CUD-K (86)	Virtual Ground
4	ECM CUD-K (87)	Current Adjust
5	ECM CUD-K (51)	Heater control
6	ECM CUD-K (65)	Current Pump

[HARNESS CONNECTORS]



SLDF27138L

SIGNAL WAVEFORM AND DATA E06B59D6

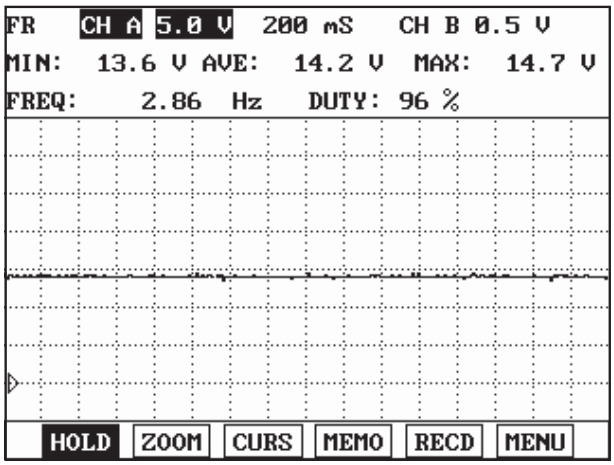


Fig.1

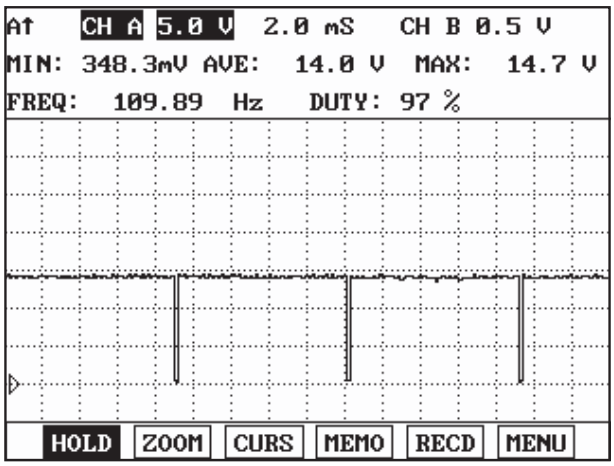


Fig.2

Fig.1) Waveform of Lambda sensor heater power. It is battery voltage.
Fig.2) Waveform of Lambda sensor heater control at idle.

SLDFL6200L

TERMINAL AND CONNECTOR INSPECTION E10B550A

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.
2. Perform checking procedure as follows.
   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.
   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

   NOTE

   Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position.)
3. Is the problem found?

   YES

   ▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

   NO

   ▶ Go to "Power Circuit Inspection".

POWER CIRCUIT INSPECTION EFF71F21

1. IG Key "OFF", Engine "OFF".
2. Disconnect Lambda sensor connector.
3. IG Key "ON".
4. Measure the voltage of Lambda sensor connector terminal 2.

Specification : 11.0V~13.0V (Main relay ON power)

5. Is the measured voltage within the specification?

YES

▶ Go to "Control Circuit Inspection".

NO

▶ Repair open in Main relay power circuit and E/R JUNCTION BOX 15A SNSR3 FUSE and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION EC01DDBF

1. Check Lambda sensor heater control circuit voltage

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect Lambda sensor connector.

   3) IG Key "ON".

   4) Measure the voltage of Lambda sensor connector terminal 5.

Specification : 2.0V~2.5V

   5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ No voltage is detected : Go to "2. Check open in Lambda sensor heater control circuit" as follows.
▶ High voltage is detected : Repair short to battery in control circuit and go to "Verification of Vehicle Repair".

2. Check open in Lambda sensor heater control circuit

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect Lambda sensor connector and ECM connector.

   3) Check continuity between Lambda sensor connector terminal 5 and ECM connector (CUD-K) terminal 51.

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification?

YES

▶ Repair short to ground in control circuit and go to "Verification of Vehicle Repair".

NO

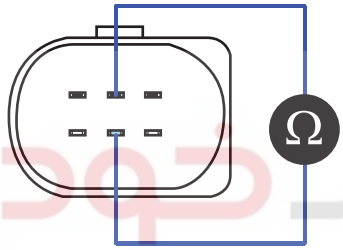
▶ Repair open in Lambda sensor heater control circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E2C30DED

1. IG Key "OFF", Engine "OFF".
2. Disconnect Lambda sensor connector.
3. Check continuity between Lambda sensor component connector terminal 2 and terminal 5.

SPECIFICATION :

Temperature (°C)	Heater resistance (Ω)	Temperature (°C)	Heater resistance (Ω)	Heater OperationFre-quency
20	9.2	400	17.7	100 Hz
100	10.7	500	19.2	
200	13.1	600	20.7	
300	14.6	700	22.5	



SLDFL6205L

4. Is the measured resistance within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace Lambda sensor and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E8FAAD60

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0032 LAMBDA SENSOR HEATER CIRCUIT HIGH (BANK 1 / SENSOR 1)

COMPONENT LOCATION E206432D

Refer to DTC P0031.

GENERAL DESCRIPTION EA0F9F75

Refer to DTC P0031.

DTC DESCRIPTION ED3E86CA

P0032 is set when short to battery in Lambda sensor control circuit is detected for more than 5 sec. at Lambdasensor heater control condition. This code is due to 1)short to battery in heater control circuit or 2)Lambda sensor heater internal open.

DTC DETECTING CONDITION EFFAD6E9

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• Lambda sensor heater circuit
• Lambda sensor component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• Short to battery in Lambda sensor heater control circuit</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 5 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4"></td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SPECIFICATION EDC41F54

Temperature (℃)	Lambda sensor heater resistance(Ω)	Temperature (℃)	Lambda sensor heater resistance(Ω)	Lambda sensor heater control Hz
20	9.2	400	17.7	100 Hz
100	10.7	500	19.2	
200	13.1	600	20.7	
300	14.6	700	22.5	

SCHEMATIC DIAGRAM EA75C906

Refer to DTC P0031.

SIGNAL WAVEFORM AND DATA E8D03955

Refer to DTC P0031.

TERMINAL AND CONNECTOR INSPECTION E935B0FE

Refer to DTC P0031.

POWER CIRCUIT INSPECTION E98DC023

1. IG Key "OFF", Engine "OFF".
2. Disconnect Lambda sensor connector.
3. IG Key "ON".
4. Measure the voltage of Lambda sensor connector terminal 2.

Specification : 11.0V~13.0V (Main relay ON power)

5. Is the measured voltage within the specification?

YES

▶ Go to "Control Circuit Inspection".

NO

▶ Repair open in Main relay power circuit and E/R JUNCTION BOX 15A SNSR3 FUSE and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION E946B9F3

1. Check Lambda sensor heater control circuit voltage
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect Lambda sensor connector.
   3) IG Key "ON".
   4) Measure the voltage of Lambda sensor connector terminal 5.

Specification : 2.0V~2.5V

   5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ No voltage is detected : Go to "2. Check open in Lambda sensor heater control circuit" as follows.
▶ High voltage is detected : Repair short to battery in control circuit and go to "Verification of Vehicle Repair".

2. Check open in Lambda sensor heater control circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect Lambda sensor connector and ECM connector.

3) Check continuity between Lambda sensor connector terminal 5 and ECM connector (CUD-K) terminal 51.

Specification : Continuity (below 1.0Ω)

4) Is the measured resistance within the specification?

YES

▶ Repair short to ground in control circuit and go to "Verification of Vehicle Repair".

NO

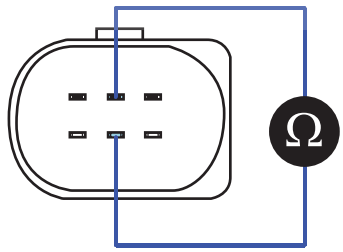
▶ Repair open in Lambda sensor heater control circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION EE308E98

1. IG Key "OFF", Engine "OFF".
2. Disconnect Lambda sensor connector.
3. Check continuity between Lambda sensor component connector terminal 2 and terminal 5.

SPECIFICATION :

Temperature (°C)	Heater resistance (Ω)	Temperature (°C)	Heater resistance (Ω)	Heater OperationFre-quency
20	9.2	400	17.7	100 Hz
100	10.7	500	19.2	
200	13.1	600	20.7	
300	14.6	700	22.5	



SLDFL6205L

4. Is the measured resistance within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

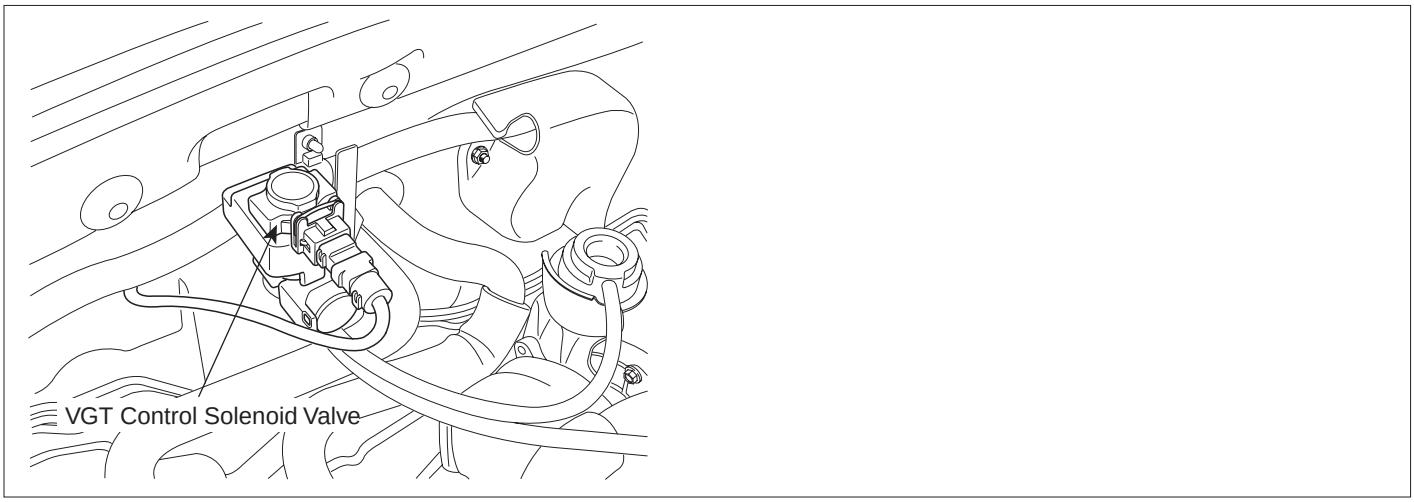
▶ Replace Lambda sensor and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E363AB98

Refer to DTC P0031.

DTC P0047 VGT VACUUM MODULATOR CIRCUIT LOW

COMPONENT LOCATION E2E0401C



SLDFL6206L

GENERAL DESCRIPTION E69A2D61

VGT(Variable Geometric Turbocharger) is the device which increases the efficiency of turbocharger at low rpm and lasts optimum turbo efficiency at high rpm as varying the cross sectional area through which exhaust gas passes turbocharger impeller. It relieves turbo lag at low speed and increse engine power generation. Engine speed, APS signal, MAFS and Boost pressure sensor data are inputted to ECM. ECM actuates vacuum diafragm which controls exhaust gas line as controlling VGT actuator duty to maintain optimum state of air compression.

DTC DESCRIPTION ECBE899D

P0047 is set when "0"A is detected in VGT actuator control circuit for more than 1.0 sec. This code is due to open or short to ground in VGT actuator circuit, or open in VGT actuator component.

DTC DETECTING CONDITION E73D063D

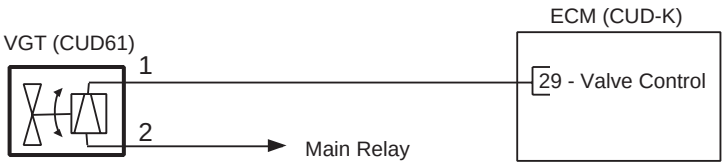
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Signal monitoring</td><td rowspan="6">• VGT actuator circuit
• VGT actuator component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• Short to GND
• Wiring open</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 1 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4"></td></tr>
<tr><td>EGR Off</td><td>YES</td></tr>
<tr><td>Fuel Limit</td><td>YES</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SPECIFICATION E95DF07D

VGT actuator component resistance	VGT actuator operating Hz	VGT actuator operating duty
14.7 ~ 16.1Ω (20℃)	300Hz	75% at idle, decreases as accelerating

SCHEMATIC DIAGRAM E2DE36F9

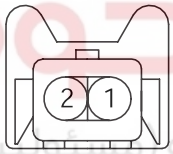
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

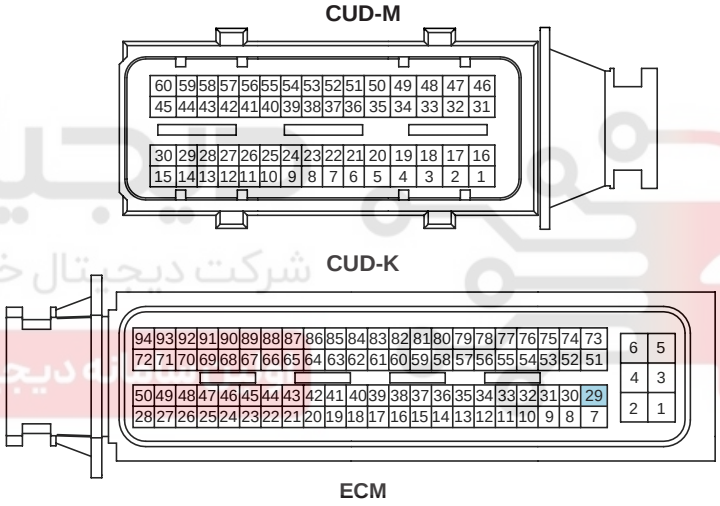
Terminal	Connected to	Function
1	ECM CUD-K (29)	Valve Control
2	Main Relay	Battery Voltage (B+)

[HARNESS CONNECTORS]



CUD61

VGT CONTROL SOLENOID VALVE



SLDF27137L

SIGNAL WAVEFORM AND DATA E797C5EA

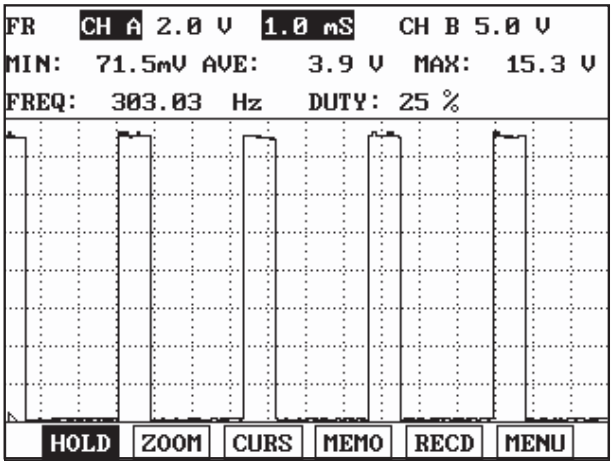


Fig.1

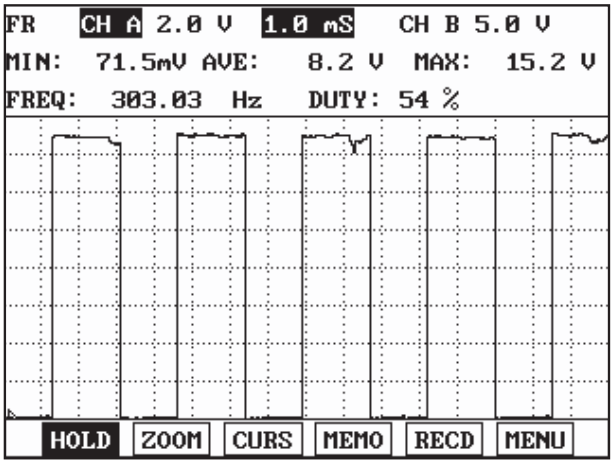


Fig.2

Fig.1) VGT actuator output waveform at 75% duty. Duty decreases as boost pressure increases.
Fig.2) VGT actuator duty decreased at acceleration.

SLDFL6208L

MONITOR SCANTOOL DATA E09825E6

1. Connect scantool to Data Link Cable. (DLC)
2. Warm engine up to normal operating temperature.
3. Turn "OFF" electrical devices and A/C.
4. Monitor "BOOST PRESS. SENSOR" parameter on the Scantool.

Specification : 1028hpa ± 100hpa(VGT actuator : 75%) at idle

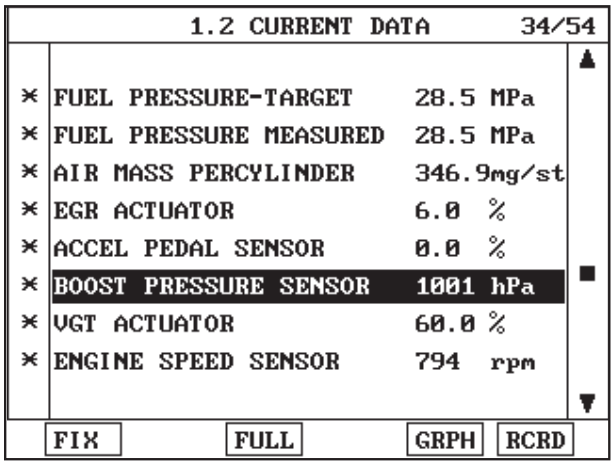


Fig.1

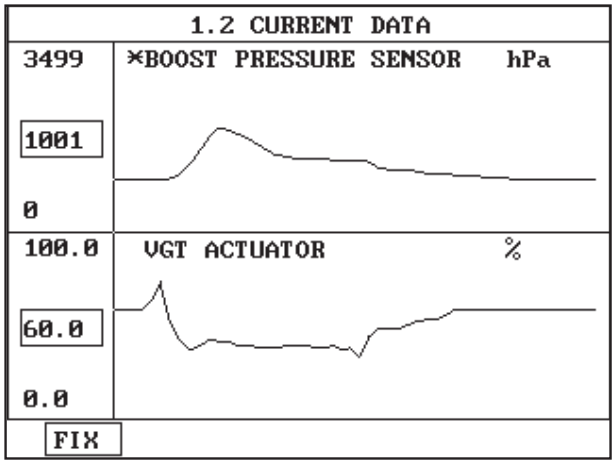


Fig.2

Fig1) Monitor "BOOST PRESSURE SENSOR" parameter on the Scantool at idle after warming engine up. 1000±100hpa(approx. 1 atm) is correct value.
Fig.2) VGT Control Solenoid Valve duty decreases and boost pressure increases as accelerating. If boost pressure rises and reaches certain value, VGT Control Solenoid Valve duty stops to drop and keeps steady. Releasing accelerator pedal at this moment, VGT Control Solenoid Valve duty drops to 9.8%, then if RPM drops to idle range, duty returns to 75%.

SLDFL6283L

TERMINAL AND CONNECTOR INSPECTION E9F161CB

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.
2. Perform checking procedure as follows.
   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.
   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

NOTE

Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector or checking connecting condition. (after checking, reconnect the pin at correct position.)

3. Is the problem found?

YES

▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

NO

▶ Go to "Power Circuit Inspection".

POWER CIRCUIT INSPECTION E22F8E2C

1. IG Key "OFF", Engine "OFF".
2. Disconnect VGT actuator connector.
3. IG Key "ON".
4. Measure the voltage of VGT actuator terminal 2 .

Specification : 11.5V~13.0V

5. Is the measured voltage within the specification?

YES

▶ Go to "Control Circuit Inspection".

NO

▶ Repair E/R JUNCTION BOX 15A SNSR3 FUSE and related circuit and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION E1F5634E

1. Check monitoring voltage in control circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect VGT actuator connector.
   3) IG Key "ON".

4) Measure the voltage of VGT actuator terminal 1 .

Specification : 3.2V~3.7V

5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ When voltage is not detected : Go to "2. Check open in control circuit" as follows.
▶ When high voltage is detected : Repair short to battery and go to "Verification of Vehicle Repair".

2. Check open in control circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect VGT actuator connector and ECM connector.

3) Check continuity between VGT actuator connector terminal 1and ECM connector (CUD-K) terminal 29.

Specification : Continuity (below 1.0Ω)

4) Is the measured resistance within the specification?

YES

▶ Repair short to ground and go to "Verification of Vehicle Repair".

NO

▶ Repair open in control circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E75B28D0

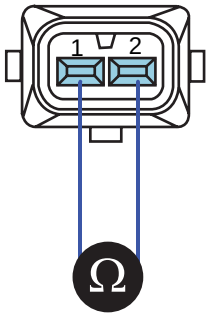
1. Check VGT actuator component resistance

1) IG Key "OFF", Engine "OFF".

2) Disconnect VGT actuator connector.

3) Measure the resistance between VGT actuator component terminal 1 and terminal 2.

Specification : 14.7 ~ 16.1Ω (20℃)



SLDFL6212L

4) Is VGT actuator component resistance within the specification?

YES

▶ Go to "2.Check VGT actuator operation" as follows.

NO

▶ Replace VGT actuator and go to "Verification of Vehicle Repair".

2. Check VGT actuator operation

1) IG Key "ON", Engine "ON".

2) Check that VGT actuator operating duty is 75% after warming engine up.

3) Check if vacuum generates after disconnecting VGT valve vacuum hose.

4) Check if vacuum generates when decelerating after rapid acceleration (VGT actuator operating duty 45%).

Specification :
VGT actuator duty 76% : vacuum generates
VGT actuator duty 45% : vacuum does not generate

5) Does vacuum state changes correctly depending on the change of VGT actuator operating duty?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace VGT actuator and go to "Verification of Vehicle Repair".

※ Repeat this process 2~3 times.

VERIFICATION OF VEHICLE REPAIR E75D7186

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.

2. Clear recorded DTC using Scantool.

3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0048 VGT VACUUM MODULATOR CIRCUIT HIGH

COMPONENT LOCATION EEDAC5EE

Refer to DTC P0047.

GENERAL DESCRIPTION EC7109DD

Refer to DTC P0047.

DTC DESCRIPTION ED4AC25E

P0048 is set when excessive current is detected in VGT actuator control circuit for more than 1 sec. This code is due to short to battery in control circuit or internal short of VGT actuator component.

DTC DETECTING CONDITION E3E5939C

Item	Detecting Condition		Possible Cause
DTC Strategy	• Signal monitoring		• VGT actuator circuit • VGT actuator component
Enable Conditions	• IG Key "ON"		
ThresholdValue	• Short to battery		
DiagnosticTime	• 1 sec.		
Fail Safe	Fuel Cut	NO	
	EGR Off	YES	
	Fuel Limit	YES	
	MIL	OFF	

SPECIFICATION E1CE4686

VGT actuator component resistance	VGT actuator operating Hz	VGT actuator operating duty
14.7 ~ 16.1Ω (20℃)	300Hz	75% at idle, decreases as accelerating

SCHEMATIC DIAGRAM EEC22B47

Refer to DTC P0047.

SIGNAL WAVEFORM AND DATA E4E6ED28

Refer to DTC P0047.

MONITOR SCANTOOL DATA E01B805B

Refer to DTC P0047.

TERMINAL AND CONNECTOR INSPECTION E7DE5625

Refer to DTC P0047.

POWER CIRCUIT INSPECTION E057AED0

1. IG Key "OFF", Engine "OFF".
2. Disconnect VGT actuator connector.
3. IG Key "ON".
4. Measure the voltage of VGT actuator terminal 2 .

Specification : 11.5V~13.0V

5. Is the measured voltage within the specification?

YES

▶ Go to "Control Circuit Inspection".

NO

▶ Repair E/R JUNCTION BOX 15A SNSR3 FUSE and related circuit and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION E96493C9

1. Check monitoring voltage in control circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect VGT actuator connector.
   3) IG Key "ON".
   4) Measure the voltage of VGT actuator terminal 1 .

Specification : 3.2V~3.7V

   5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ When voltage is not detected : Go to "2. Check open in control circuit" as follows.
▶ When high voltage is detected : Repair short to battery and go to "Verification of Vehicle Repair".

2. Check open in control circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect VGT actuator connector and ECM connector.
   3) Check continuity between VGT actuator connector terminal 1and ECM connector (CUD-K) terminal 29.

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification?

YES

▶ Repair short to ground and go to "Verification of Vehicle Repair".

NO

▶ Repair open in control circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E5941139

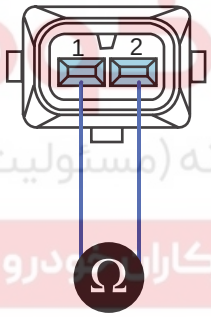
1. Check VGT actuator component resistance

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect VGT actuator connector.

   3) Measure the resistance between VGT actuator component terminal 1 and terminal 2.

Specification : 14.7 ~ 16.1Ω (20℃)



SLDFL6212L

   4) Is VGT actuator component resistance within the specification?

YES

▶ Go to "2.Check VGT actuator operation" as follows.

NO

▶ Replace VGT actuator and go to "Verification of Vehicle Repair".

2. Check VGT actuator operation

   1) IG Key "ON", Engine "ON".

   2) Check that VGT actuator operating duty is 75% after warming engine up.

   3) Check if vacuum generates after disconnecting VGT valve vacuum hose.

   4) Check if vacuum generates when decelerating after rapid acceleration (VGT actuator operating duty 45%).

Specification :
VGT actuator duty 76% : vacuum generates
VGT actuator duty 45% : vacuum does not generate

5) Does vacuum state changes correctly depending on the change of VGT actuator operating duty?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace VGT actuator and go to "Verification of Vehicle Repair".

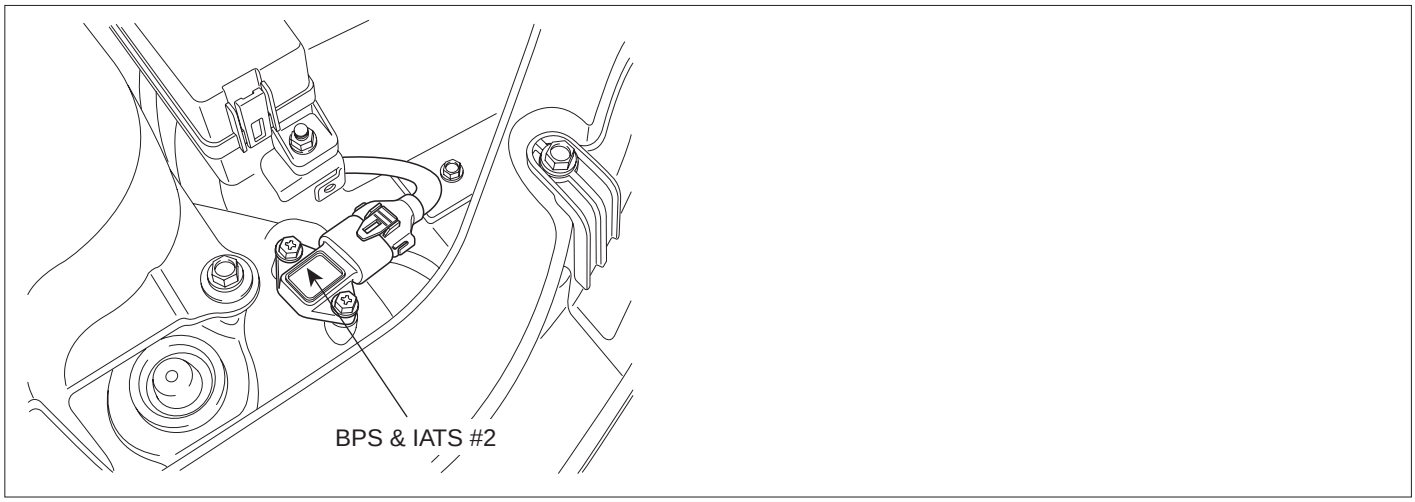
※ Repeat this process 2~3 times.

VERIFICATION OF VEHICLE REPAIR EC75A3A1

Refer to DTC P0047.

DTC P0069 BOOST PRESSURE SENSOR CIRCUIT MALFUNCTION

COMPONENT LOCATION E892EAB4



SLDFL6213L

GENERAL DESCRIPTION EF5AA1CE

Boost Pressure Sensor(BPS) is installed in intake manifold and senses the pressure of air inside of intake manifold which is compressed by turbo charager.Measuring mass air flow accurately with the information of intake mainfold pressure, mass air flow and intake air temperature, ECM performs actuating correction of EGR and VGT.When excessive intake manifold pressure is detected, engine power generation is limited to protect engine because too highly compressed pressure due to turbo charger may harm engine.

DTC DESCRIPTION E3716033

P0069 is set when the difference between Boost pressure and atmospheric pressure sensor is above 100hpa at below 100RPM(in other word, IG Key ON condition) for more than 3 sec. This code is due to abnormal output characteristic of BPS component.

DTC DETECTING CONDITION E6F80CB5

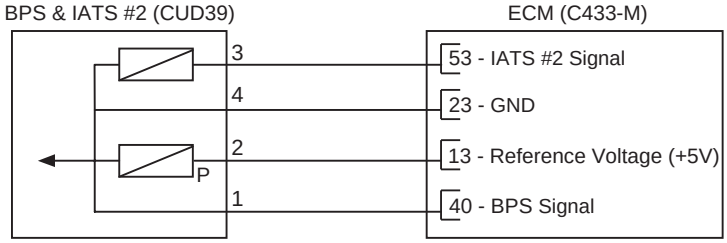
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• BPS circuit
• BPS component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"/Afterrun (below 100RPM)</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• |Boost pressure - Atmospheric pressure| is above 300hpa.</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 3 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• Boost pressure is fixed at 900 hpa.</td></tr>
<tr><td>EGR Off</td><td>YES</td></tr>
<tr><td>Fuel Limit</td><td>YES</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SPECIFICATION E2D9B4D6

Pressure [Kpa]	20	100	190	250
Outpur voltage [V]	0.4±0.077	1.878±0.063	3.541±0.063	4.650±0.077

SCHEMATIC DIAGRAM E70C6A49

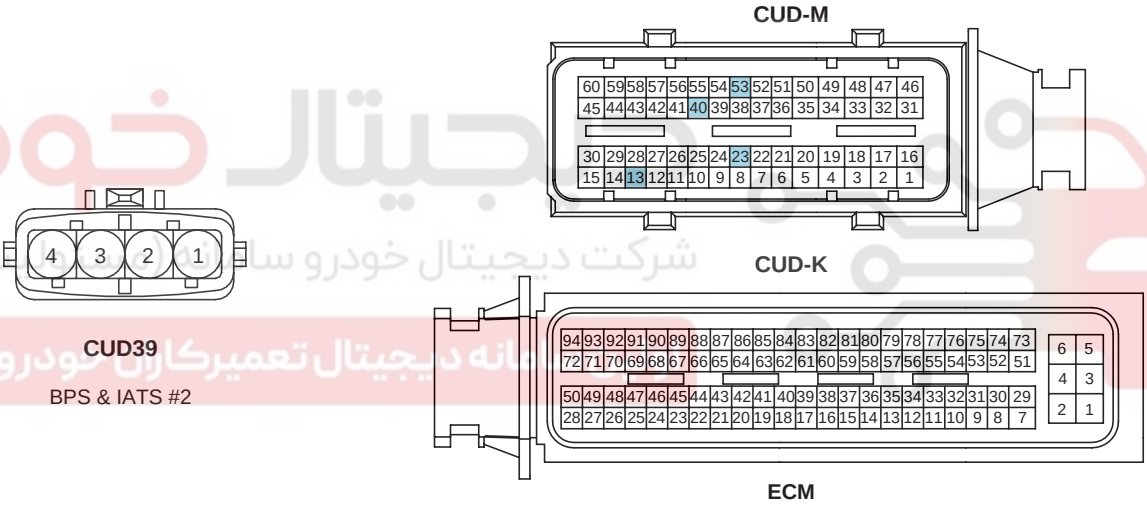
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM CUD-M (40)	BPS Signal
2	ECM CUD-M (13)	Reference Voltage (+5V)
3	ECM CUD-M (53)	IATS #2 Signal
4	ECM CUD-M (23)	Sensor ground

[HARNESS CONNECTORS]



SLDF27124L

SIGNAL WAVEFORM AND DATA E315145B

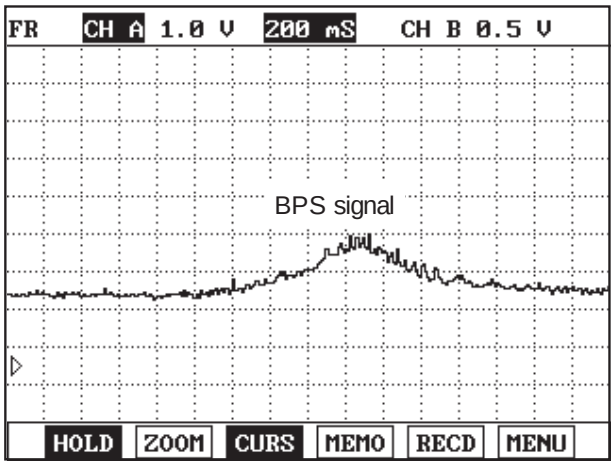


Fig.1

Fig1) This is the waveform of BPS as accelerating from idle state. Signal voltage rises as accelerating.

SLDFL6282L

MONITOR SCANTOOL DATA E47FB1F8

1. Connect Scantool to Data Link Connector (DLC).
2. Warm engine up to normal operating temperature.
3. Turn "OFF" electrical devices and A/C.
4. Monitor "BOOST PRESS. SENSOR" parameter on the Scantool.

Specification : 1000hpa ± 100hpa(VGT actuator : 75%) at idle

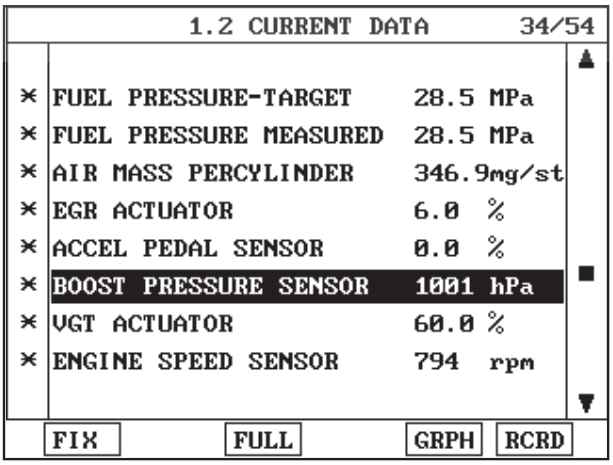


Fig.1

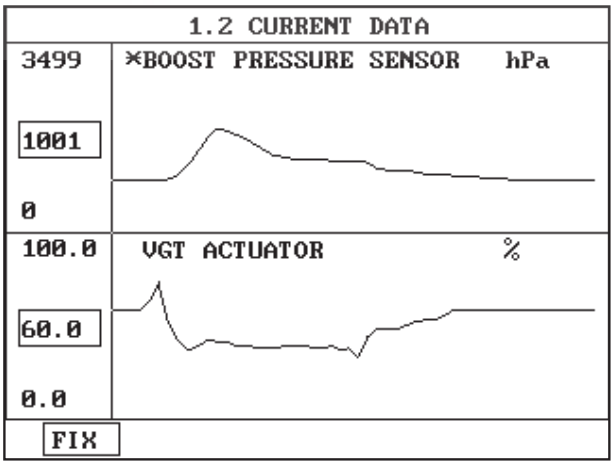


Fig.2

Fig1) Monitor "BOOST PRESSURE SENSOR" parameter on the Scantool at idle after warming engine up. 1000±100hpa(approx. 1 atm) is correct value.

Fig.2) VGT Control Solenoid Valve duty decreases and boost pressure increases as accelerating. If boost pressure rises and reaches certain value, VGT Control Solenoid Valve duty stops to drop and keeps steady. Releasing accelerator pedal at this moment, VGT Control Solenoid Valve duty drops to 9.8%, then if RPM drops to idle range, duty returns to 75%.

SLDFL6283L

TERMINAL AND CONNECTOR INSPECTION EF1E97E7

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.
2. Perform checking procedure as follows.
   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.
   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

NOTE

Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position.)

3. Is the problem found?

YES

▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

NO

▶ Go to "Component Inspection ".

POWER CIRCUIT INSPECTION E15A76E6

1. IG Key "OFF", Engine "OFF".
2. Disconnect BPS connector.
3. IG Key "ON".
4. Measure the voltage of BPS connector terminal 2.

Specification : 4.8V~5.1V

5. Is the measured voltage within the specification?

YES

▶ Go to "Signal Circuit Inspection".

NO

▶ Repair open in power circuit and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION ED3E5DAB

1. Check signal circuit voltage
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect BPS connector.
   3) IG Key "ON".

4) Measure the voltage of BPS connector terminal 1.

Specification : 4.8V~5.1V

5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ Go to "2. Check short to ground in signal circuit" as follows.

2. Check short to ground in signal circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect BPS connector and ECM connector.

3) Check continuity between BPS connector terminal 1 and chassis ground.

Specification : Discontinuity (Infinite Ω)

4) Is the measured resistance within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ Repair short to ground in signal circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E42A32F0

1. BPS visual inspection

1) IG Key "OFF", Engine "OFF".

2) Disconnect BPS connector.

3) Check if corrosion and damage in BPS terminal is detected.

4) Check BPS mounting state, leakage at O'ring, clogged carbon at pressure detecting hall.

5) Are the problems relevant to BPS found?

YES

▶ Replace BPS if necessary and go to "Verification of Vehicle Repair".

NO

▶ Go to "2. Check BPS output voltage at IG KEY ON" as follows.

2. Check BPS output voltage at IG KEY ON

1) IG Key "OFF", Engine "OFF".

2) Connect Scantool to Data Link Connector (DLC).

3) IG Key "ON".

4) Monitor "ATMOSPHERIC PRESSURE" and "BOOST PRESSURE SENSOR" parameters on scantool.

5) Check if both "ATMOSPHERIC PRESSURE" and "BOOST PRESSURE SENSOR" indicates similar value at IG Key "ON".

Specification : 1013hpa ± 100hpa(VGT actuator : approx. 76%) at idle

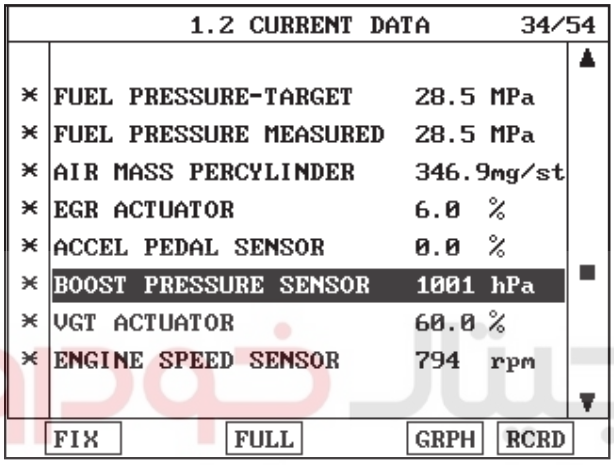


Fig.1

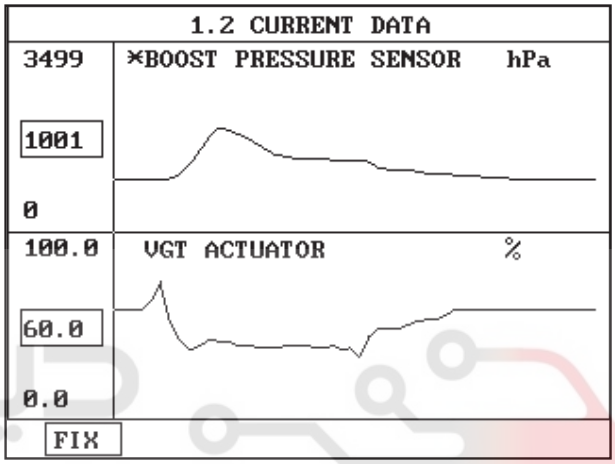


Fig.2

Fig1) Monitor "BOOST PRESSURE SENSOR" parameter on the Scantool at idle after warming engine up. 1013±100hpa(approx. 1 atm) is correct value.

Fig.2) VGT Control Solenoid Valve duty decreases and boost pressure increases as accelerating. If boost pressure rises and reaches certain value, VGT Control Solenoid Valve duty stops to drop and keeps steady. Releasing accelerator pedal at this moment, VGT Control Solenoid Valve duty drops to 9.8%, then if RPM drops to idle range, duty returns to 75%.

SLDF27506L

6) Is any BPS related problem is detected?

YES

▶ Replace BPS and go to "Verification of Vehicle Repair".

NO

▶ Go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E2B014F0

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

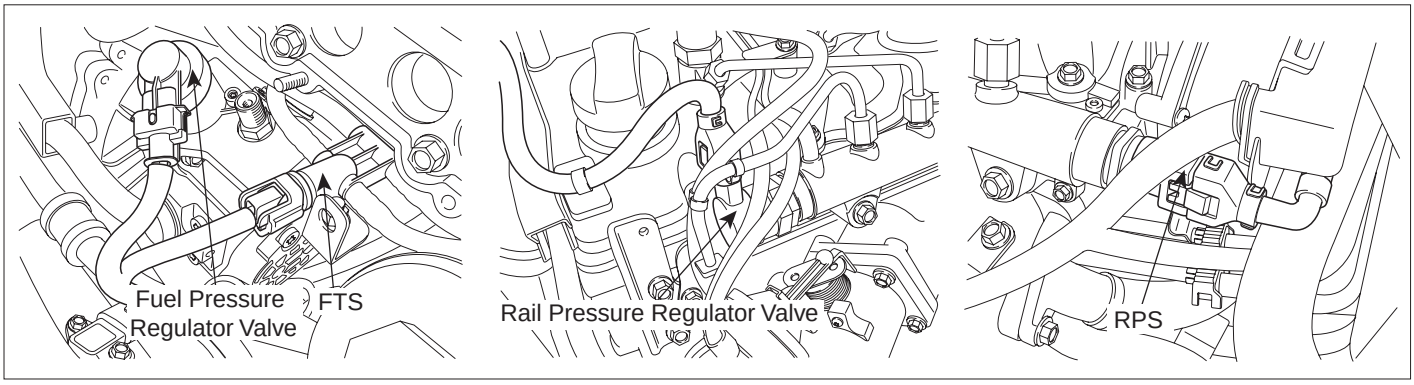
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0087 RAIL PRESSURE MONITORING-MINIMUM PRESSURE AT ENGINE SPEED TOO LOW

COMPONENT LOCATION EDC4B8DC



SLDFL6214L

GENERAL DESCRIPTION ECAF3701

As inputted rail pressure sensor signal, ECM of Commom rail diesel engine controls fuel press. regulator valve(FPR-intergrated with high press. pump) and rail pressure regulator valve(RPR-integrated with common rail) in order to maintain optimum rail pressure according to current engine rpm and load. However when the problem that leads rail pressure to out of target value intended by ECM occurs due to mechanical or electronical reason, ECM shuts engine down and sets DTC by limiting fuel (stops injector operation) in order to prevent engine from being controlled abnormally. "rail pressure monitoring error" is the DTC which diagnose 1).supplying state of low pressure fuel and 2).mechanical operating conditions of high pressure pump and 3). RPRV indirectly based on RPS output voltage and RPS duty. thus, repair relavant to this DTC requires mechanics the total understand of fuel system.

DTC DESCRIPTION EDC3D6F4

P0087 is set when 1) rail pressure is below target rail pressure by more than 200~150at RPRV operating condition OR 2) RPRV current value increases more than 80mA comparing with the target value at RPRV operating condition OR 3) Rail pressure is below minimum limiting value(50~280bar) at RPRV operating condition. - 0.3 sec.. This code is due to 1)fuel less than target value supplied to common rail or 2)excessive return of fuel supplied to common rail or 3)short to low voltage line in rail pressure sensor.

DTC DETECTING CONDITION E7EEF12F

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Fuel press. regulator valve (close stuck) • Rail pressure regulator valve (open stuck) • Rail pressure sensor (Output fixed at low voltage line)
Enable Conditions	• Engine running			
ThresholdValue	• Rail pressure is below target rail pressure by more than 200~150at RPRV operating condition. - 0.8 sec. • RPRV current value increases more than 80mA comparing with the target value at RPRV operating condition. - 0.8 sec. • Rail pressure is below minimum limiting value(50~280bar) at RPRV operating condition. - 0.3 sec.			
DiagnosticTime	• Refer to threshold Value.			
Fail Safe	Fuel Cut	NO		
	EGR Off	NO		
	Fuel Limit	YES		
	MIL	ON		

MONITOR SCANTOOL DATA EDBC7215

1. Monitoring rail pressure data

   1) Connect Scantool to Data Link Connector (DLC).

   2) Warm engine up to normal operating temperature.

   3) Turn "OFF" electrical devices and A/C.

   4) Monitor "FUEL PRESSURE MEASURED", "FUEL PRESSURE-TARGET", "RAIL PRESS. REGULATOR1", "INJ. PUMP REGULATOR" parameter on the Scantool.

Specification :
FUEL PRESSURE MEASURED : similar to "FUEL PRESSURE-TARGET"
FUEL PRESSURE-TARGET : 28 ± 5 Mpa
RAIL PRESS. REGULATOR1 : 17 ± 5%
INJ. PUMP REGULATOR : 35 ± 5%

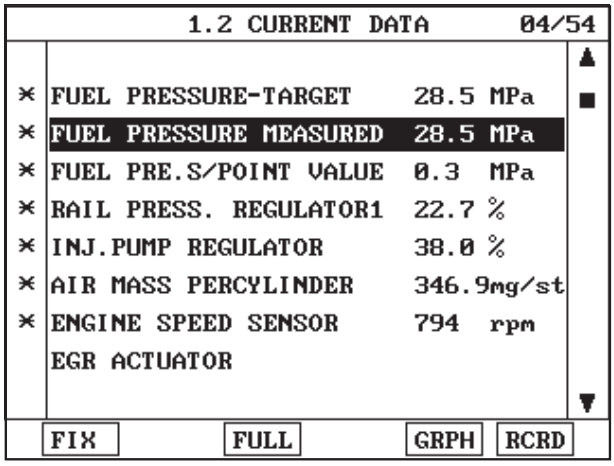


Fig.1

Fig.1) Monitor "FUEL PRESSURE MEASURED" at idle after warming engine up.

SLDFL6438L

Check if "FUEL PRESSURE MEASURED"data is similar to "FUEL PRESSURE-TARGET". Not only former two data but also "RAIL PRESS. REGULATOR1" and "INJ. PUMP REGULATOR"should be monitored carefully. Although "FUEL PRESSURE MEASURED" is similar to "FUEL PRESSURE-TARGET", if "RAIL PRESS. REGULATOR1" and "INJ. PUMP REGULATOR" is out of specification, it means wear, leakage, stuck of fuel system.

2. Monitoring rail pressure data at acceleration(loading condition).

   1) Connect Scantool to Data Link Connector (DLC).

   2) Warm engine up to normal operating temperature.

   3) Turn "OFF" electrical devices and A/C.

   4) Monitor "FUEL PRESSURE MEASURED", "RAIL PRESS. REGULATOR1", "INJ. PUMP REGULATOR" parameter on the Scantool.

SPECIFICATION :

	Idle(without load)	Accelerating(stall test)	Diagnosis
INJ. PUMP REGULATOR	35 ± 5%	38 ± 5%	duty decreases
FUEL PRESSURE MEASURED	28 ± 5 Mpa	above 75 Mpa	press. increases
RAIL PRESS. REGULATOR1	17 ± 5%	45 ± 5%	duty increases

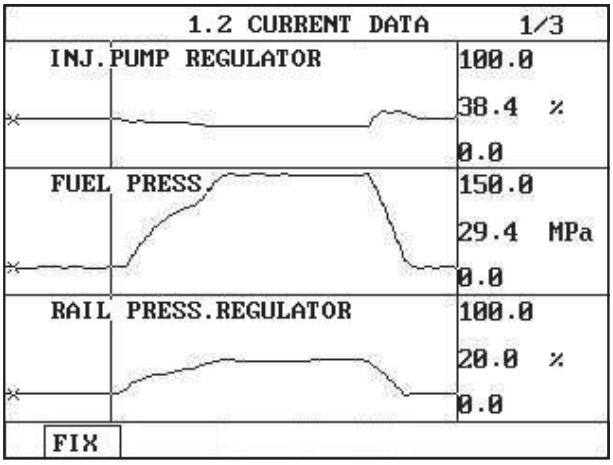


Fig.1

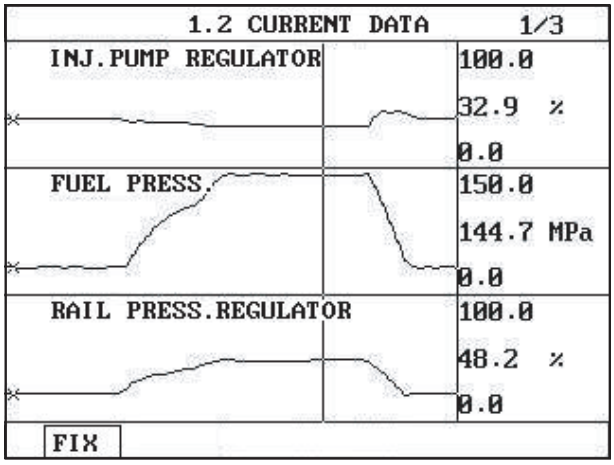


Fig.2

Fig.1) The position of curser on the graph represents idle data.
Fig.2) Data during acceleration(stall test).

SLDFL6439L

NOTE

The waveform of fuel metering unit installed at high pressure pump(fuel detecting MPROP) shows 38% duty at idle, duty drops to approx. 32% at acceleration to raise rail pressure. Duty drop means the decrease of current.
→ Fuel delivered to common rail increases as current drops.

The waveform of rail pressure control valve installed at common rail shows 19% duty at idle, duty rises to approx. 48% at acceleration to raise rail pressure. Duty rise means the increase of current.
→ If current rises, the returning quantity of fuel deliverd to common rail decreases and common rail pressure rises.

VERIFICATION OF VEHICLE REPAIR E04FBA80

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0088 RAIL PRESSURE MONITORING-MAXIMUM PRESSURE EXCEEDED

COMPONENT LOCATION EC84A0DB

Refer to DTC P0087.

GENERAL DESCRIPTION EFA7FE1C

Refer to DTC P0087.

DTC DESCRIPTION EB803953

P0088 is set if measured rail pressure is higher than target rail pressure by more than 200bar when rail pressure is regulated by rail pressure regulator valve(RPR) or rail pressure is above the max limiting value. This code is due to 1)fuel more than target value supplied to common rail or 2)poor return of fuel supplied to common rail or 3)short to high voltage line in fuel press. sensor.

DTC DETECTING CONDITION E800E6CF

Item	Detecting Condition		Possible Cause
DTC Strategy	• Voltage monitoring		• Fuel press.regulator valve (open stuck) • Rail pressure regulator valve (close stuck) • Rail pressure sensor (Output fixed at low voltage line)
Enable Conditions	• Engine running		
ThresholdValue	• Rail pressure is above target rail pressure by more than 250bar at PPRV operating condition.- 2 sec. • RPRV current value arrives at lower limit (330mA) at RPRV operating condition. - 2 sec. • Rail pressure is above upper limit value(1750bar) at PPRV operating condition. - 0.24 sec.		
DiagnosticTime	• Refer to threshold Value.		
Fail Safe	Fuel Cut	NO	
	EGR Off	NO	
	Fuel Limit	YES	
	MIL	ON	

MONITOR SCANTOOL DATA E63EB6DF

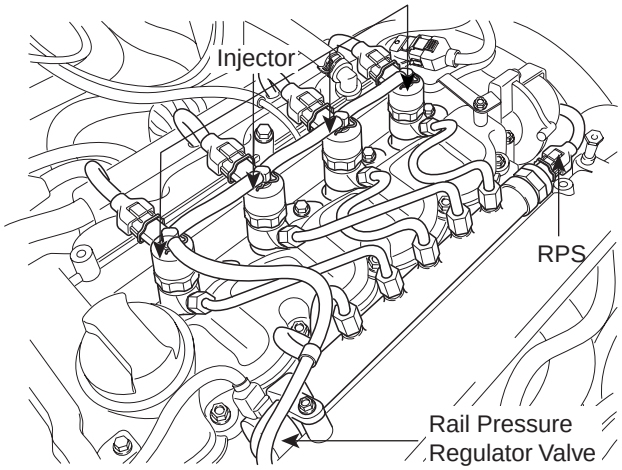
Refer to DTC P0087.

VERIFICATION OF VEHICLE REPAIR E46D22B7

Refer to DTC P0087.

DTC P0089 RAIL PRESSURE REGULATOR VALVE CIRCUIT OVER CURRENT

COMPONENT LOCATION E07AAA39



SLDFL6215L

GENERAL DESCRIPTION E8C70C4F

Rail press. regulator valve(RPR) is installed in common rail and controls common rail pressure fast as regulating returning quantity of fuel which is delivered to common rail when fast rise of rail pressure is required like the moment of turning engine ON or when fast relief of pressure is required like at the point of deceleration.The lower RPRV current is, the more fuel is supplied to common rail. Thus it leads rail pressure to be high. On the contrary, the higher RPRV current is, the less fuel is supplied to common rail.

DTC DESCRIPTION E0D19ECA

P0089 is set when excessive current in control circuit of Rail Pressure regulator valve(integrated with common rail) is detected for more than 0.22 sec.. This code is due to short to battery in control circuit or Rail Pressure Regulator valve internal short.

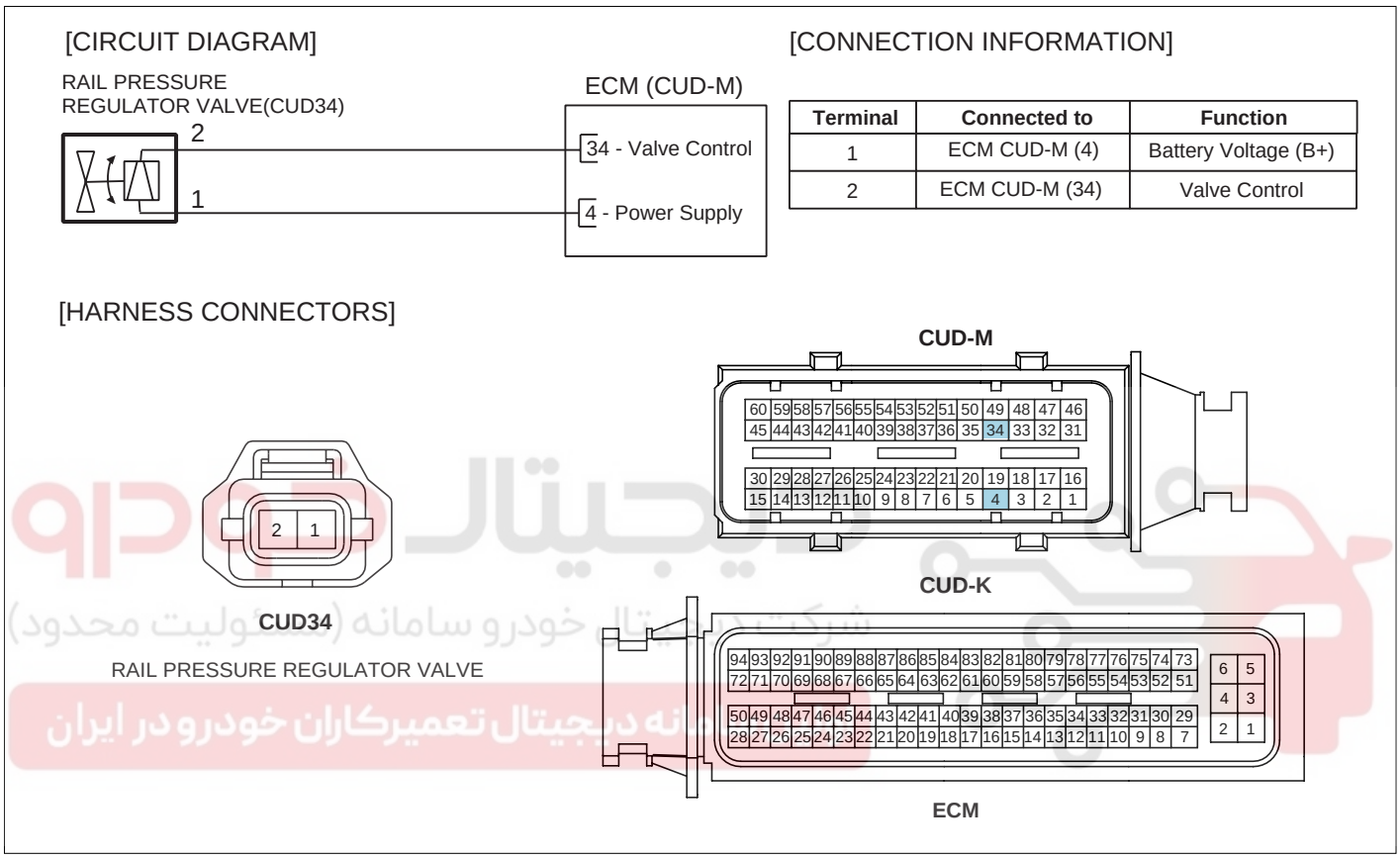
DTC DETECTING CONDITION EE16BBEA

Item	Detecting Condition		Possible Cause
DTC Strategy	• Voltage monitoring		• RPRV circuit • RPRV component
Enable Conditions	• IG Key "ON"		
ThresholdValue	• Short to battery (control circuit of rail pressure control valve)		
DiagnosticTime	• 0.22 sec.		
Fail Safe	Fuel Cut	YES	
	EGR Off	NO	
	Fuel Limit	NO	
	MIL	ON	

SPECIFICATION E3D83DF8

rail pressure control valve resistance	Operating frequancy
3.42 ~ 3.78Ω (20℃)	1000Hz(1KHz)

SCHEMATIC DIAGRAM EAD6318F



SLDF27133L

SIGNAL WAVEFORM AND DATA EA323A81

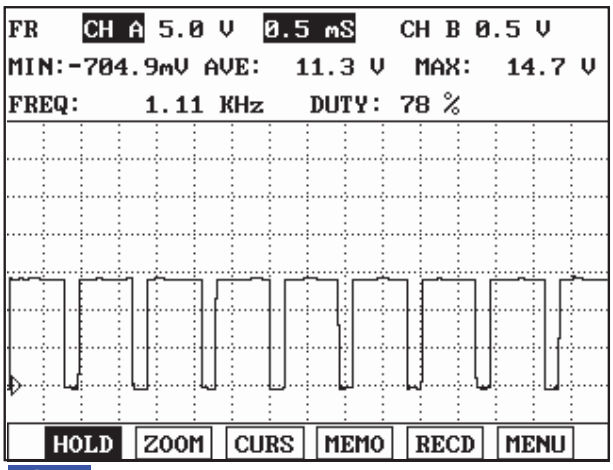


Fig.1

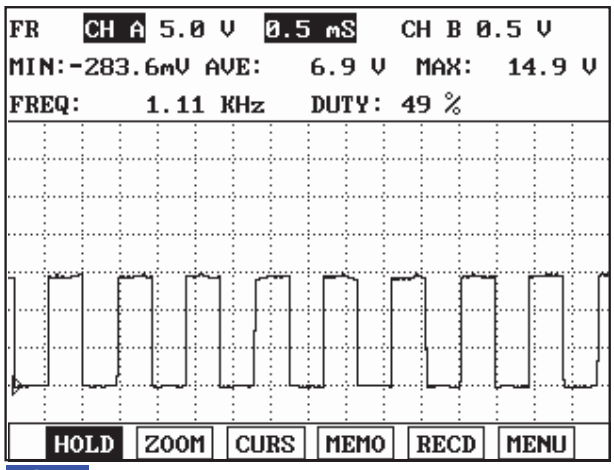


Fig.2

Fig.1) Waveform of rail pressure control valve at idle. It shows approx. 20% duty.
Fig.2) Waveform of rail pressure control valve as accelerating. Approx. 50% duty is outputted as engine load increases.
(When rail pressure increases as accelerating, rail pressure control valve duty(current) rises.)

SLDFL6216L

MONITOR SCANTOOL DATA E744806E

1. Connect Scantool to Data Link Connector (DLC).
2. Warm engine up to normal operating temperature.
3. Turn "OFF" electrical devices and A/C.
4. Monitor "FUEL PRESSURE MEASURED", "RAIL PRESS. REGULATOR1", "INJ. PUMP REGULATOR" parameter on the Scantool.

SPECIFICATION :

	Idle(without load)	Accelerating(stall test)	Diagnosis
INJ. PUMP REGULATOR	38 ± 5%	32 ± 5%	duty decreases
FUEL PRESSURE MEASURED	28.5 ± 5 Mpa	145 ± 10 Mpa	press. increases
RAIL PRESS. REGULATOR1	19 ± 5%	48 ± 5%	duty increases

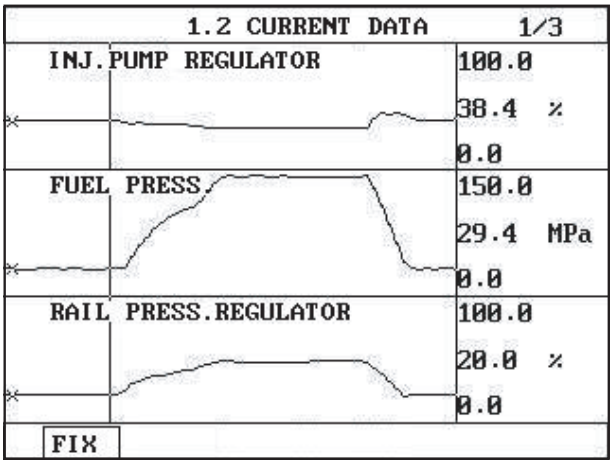


Fig.1

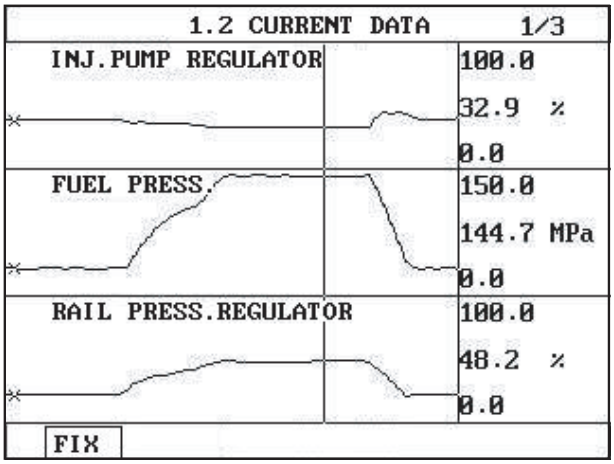


Fig.2

Fig.1) The position of curser on the graph represents idle data.
Fig.2) Data during acceleration(stall test).

SLDFL6291L

NOTE

The waveform of fuel metering unit installed at high pressure pump(fuel detecting MPROP) shows 38% duty at idle, duty drops to approx. 32% at acceleration to raise rail pressure. Duty drop means the decrease of current.
→ Fuel delivered to common rail increases as current drops.

The waveform of rail pressure control valve installed at common rail shows 19% duty at idle, duty rises to approx. 48% at acceleration to raise rail pressure. Duty rise means the increase of current.
→ If current rises, the returning quantity of fuel deliverd to common rail decreases and common rail pressure rises.

TERMINAL AND CONNECTOR INSPECTION E3589ED1

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.

2. Perform checking procedure as follows.

   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.

   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

NOTE

Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position.)

3. Is the problem found?

YES

▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

NO

▶ Go to "Power Circuit Inspection".

POWER CIRCUIT INSPECTION E4517AFA

1. IG Key "OFF", Engine "OFF".
2. Disconnect RPRV connector.
3. IG Key "ON".
4. Measure the voltage of RPRV connector terminal 1.

Specification : 11.5V~13.0V

5. Is the measured voltage within the specification?

YES

▶ Go to "Control Circuit Inspection".

NO

▶ Repair open between RPRV connector terminal 1 and ECM connector (CUD-M) terminal 4 and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION E0CC11E0

1. Check monitoring voltage in control circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect RPRV connector.
   3) IG Key "ON".
   4) Measure the voltage of RPRV connector terminal 2.

Specification : 3.2V~3.7V

   5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ When voltage is not detected : Go to "2. Check open in control circuit" as follows.
▶ When high voltage is detected : Repair short to battery and go to "Verification of Vehicle Repair".

2. Check open in control circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect RPRV connector and ECM connector.
   3) Check continuity between RPRV connector terminal 2 and ECM connector(CUD-M) terminal 34.

Specification : Continuity (below 1.0Ω)

4) Is the measured resistance within the specification?

YES

▶ Repair short to ground in RPRV control circuit and go to "Verification of Vehicle Repair".

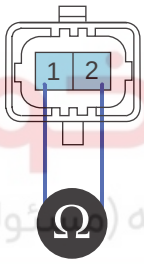
NO

▶ Repair open in RPRV control circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION EF23C5C2

1. IG Key "OFF", Engine "OFF".
2. Disconnect RPRV connector.
3. Measure resistance between RPRV component terminal 1 and terminal 2.

Specification : 3.42 ~ 3.78Ω (20℃)



SLDFL6220L

4. Is the measured resistance within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace common rail assy' and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E9860B4B

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0091 RAIL PRESSURE REGULATOR VALVE CIRCUIT LOW

COMPONENT LOCATION EBA34735

Refer to DTC P0089.

GENERAL DESCRIPTION EE66C150

Refer to DTC P0089.

DTC DESCRIPTION E56D1254

P0091 is set when "0"A in control circuit of Rail Pressure regulator valve(integrated with common rail) is detected for more than specified duration. This code is due to open or short to ground in control circuit or Rail Pressure regulator valve internal open.

DTC DETECTING CONDITION E63B2F70

Item	Detecting Condition		Possible Cause
DTC Strategy	• Voltage monitoring		• RPRV circuit • RPRV component
Enable Conditions	• IG Key "ON"		
ThresholdValue	• Short to GND - 0.22 sec. • Wiring open - 0.28 sec.		
DiagnosticTime	• Refer to threshold Value.		
Fail Safe	Fuel Cut	YES	
	EGR Off	NO	
	Fuel Limit	NO	
	MIL	ON	

SPECIFICATION E7D2D77E

rail pressure control valve resistance	Operating frequancy
3.42 ~ 3.78Ω (20℃)	1000Hz(1KHz)

SCHEMATIC DIAGRAM ED9334E9

Refer to DTC P0089.

SIGNAL WAVEFORM AND DATA EEED6665

Refer to DTC P0089.

MONITOR SCANTOOL DATA E582CA5B

Refer to DTC P0089.

TERMINAL AND CONNECTOR INSPECTION E4B8F0AD

Refer to DTC P0089.

POWER CIRCUIT INSPECTION E0BC51A2

1. IG Key "OFF", Engine "OFF".
2. Disconnect RPRV connector.
3. IG Key "ON".
4. Measure the voltage of RPRV connector terminal 1.

Specification : 11.5V~13.0V

5. Is the measured voltage within the specification?

YES

▶ Go to "Control Circuit Inspection".

NO

▶ Repair open between RPRV connector terminal 1 and ECM connector (CUD-M) terminal 4 and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION E807CEDC

1. Check monitoring voltage in control circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect RPRV connector.
   3) IG Key "ON".
   4) Measure the voltage of RPRV connector terminal 2.

Specification : 3.2V~3.7V

   5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ When voltage is not detected : Go to "2. Check open in control circuit" as follows.
▶ When high voltage is detected : Repair short to battery and go to "Verification of Vehicle Repair".

2. Check open in control circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect RPRV connector and ECM connector.

3) Check continuity between RPRV connector terminal 2 and ECM connector(CUD-M) terminal 34.

Specification : Continuity (below 1.0Ω)

4) Is the measured resistance within the specification?

YES

▶ Repair short to ground in RPRV control circuit and go to "Verification of Vehicle Repair".

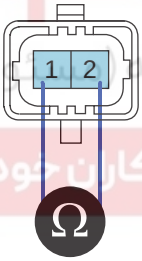
NO

▶ Repair open in RPRV control circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E03D70C6

1. IG Key "OFF", Engine "OFF".
2. Disconnect RPRV connector.
3. Measure resistance between RPRV component terminal 1 and terminal 2.

Specification : 3.42 ~ 3.78Ω (20℃)



SLDFL6220L

4. Is the measured resistance within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace common rail assy' and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E0288586

Refer to DTC P0089.

DTC P0092 RAIL PRESSURE REGULATOR VALVE CIRCUIT HIGH

COMPONENT LOCATION E10D80AC

Refer to DTC P0089.

GENERAL DESCRIPTION E325AA52

Refer to DTC P0089.

DTC DESCRIPTION E6BA32E8

P0092 is set when excessive current in power circuit of Rail Pressure regulator valve(integrated with common rail) is detected for more than 0.28 sec.. This code is due to short to battery in power circuit or Rail pressure regulator valve internal short.

DTC DETECTING CONDITION E6E3E432

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• RPRV circuit
• RPRV component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• Short to battery (power circuit in rail pressure regulator valve)</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 0.28 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>YES</td><td rowspan="4"></td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>ON</td></tr>
</table>

SPECIFICATION E359D832

rail pressure control valve resistance	Operating frequancy
3.42 ~ 3.78Ω (20°C)	1000Hz(1KHz)

SCHEMATIC DIAGRAM EC81536A

Refer to DTC P0089.

SIGNAL WAVEFORM AND DATA E433F60C

Refer to DTC P0089.

MONITOR SCANTOOL DATA E0445586

Refer to DTC P0089.

TERMINAL AND CONNECTOR INSPECTION E45A58BA

Refer to DTC P0089.

POWER CIRCUIT INSPECTION E3B23E52

1. IG Key "OFF", Engine "OFF".
2. Disconnect RPRV connector.
3. IG Key "ON".
4. Measure the voltage of RPRV connector terminal 1.

Specification : 11.5V~13.0V

5. Is the measured voltage within the specification?

YES

▶ Go to "Control Circuit Inspection".

NO

▶ Repair open between RPRV connector terminal 1 and ECM connector (CUD-M) terminal 4 and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION E317ADA3

1. Check monitoring voltage in control circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect RPRV connector.
   3) IG Key "ON".
   4) Measure the voltage of RPRV connector terminal 2.

Specification : 3.2V~3.7V

   5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ When voltage is not detected : Go to "2. Check open in control circuit" as follows.
▶ When high voltage is detected : Repair short to battery and go to "Verification of Vehicle Repair".

2. Check open in control circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect RPRV connector and ECM connector.

3) Check continuity between RPRV connector terminal 2 and ECM connector(CUD-M) terminal 34.

Specification : Continuity (below 1.0Ω)

4) Is the measured resistance within the specification?

YES

▶ Repair short to ground in RPRV control circuit and go to "Verification of Vehicle Repair".

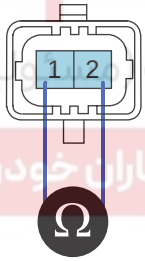
NO

▶ Repair open in RPRV control circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E2FA7469

1. IG Key "OFF", Engine "OFF".
2. Disconnect RPRV connector.
3. Measure resistance between RPRV component terminal 1 and terminal 2.

Specification : 3.42 ~ 3.78Ω (20℃)



SLDFL6220L

4. Is the measured resistance within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

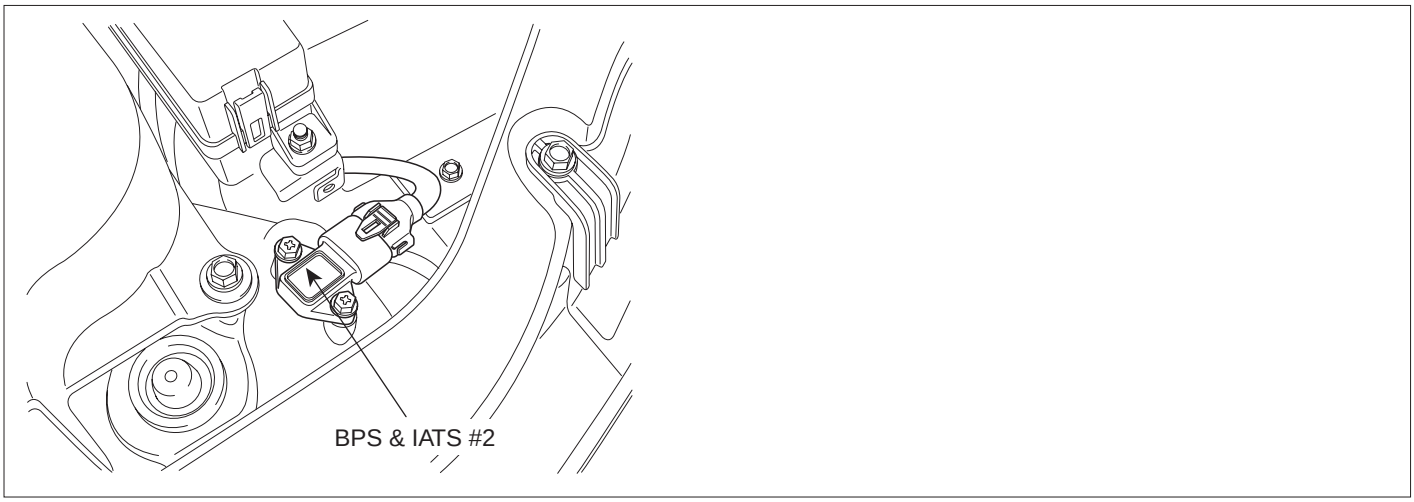
▶ Replace common rail assy' and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E4F3015E

Refer to DTC P0089.

DTC P0097 INTAKE AIR TEMPERATURE SENSOR 2 CIRCUIT LOW INPUT

COMPONENT LOCATION E76377B0



SLDFL6213L

GENERAL DESCRIPTION E2863030

Intake Air Temperature Sensor(IATS) is NTC thermistor. Installed inside of both MAFS and BPS, it senses intake air temperature. In case of EURO-4 diesel engine, IATS is installed in front of turbocharger(inside of MAFS) and behind it(inside of BPS). Comparing air temperature from both sensors(one is intake air temperature, the other is air temperature passing through turbo charger), more accurate sensing of intake air temperature is possible. With intake air temperature signal, ECM performs EGR control correction and fuel injection quantity correction.(MAFS is needed for EGR FEED BACK control in electronically controlled diesel engine. The calculation of air density at certain temperture is required to perform EGR FEED BACK control correctly.)

DTC DESCRIPTION E4FDEF47

P0097 is set when the voltage below 73mV - minimum output voltage of IATS(inside of BPS) - is detected for more than 2.0 sec. This code is due to short to ground in IATS signal circuit.

DTC DETECTING CONDITION E5BA69BB

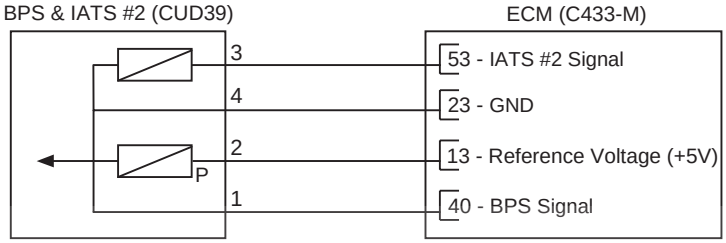
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• IATS circuit
• IATS component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• Output signal below minimum value(below 73mV)</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 2.0 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• Air temp. fixed at 28 ℃</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SPECIFICATION EADFF2B9

Temp.	-40℃	-20℃	0℃	20℃
Resistance	35.14 ~ 43.76KΩ	12.66 ~ 15.12KΩ	5.12 ~ 5.89KΩ	2.29 ~ 2.55KΩ
Temp.	40℃	60℃	80℃	
Resistance	1.10 ~ 1.24KΩ	0.57 ~ 0.65KΩ	0.31 ~ 0.37KΩ	

SCHEMATIC DIAGRAM E5922BEE

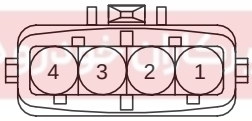
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

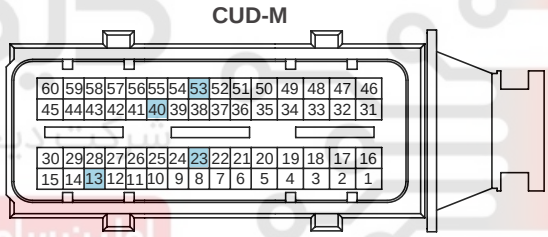
Terminal	Connected to	Function
1	ECM CUD-M (40)	BPS Signal
2	ECM CUD-M (13)	Reference Voltage (+5V)
3	ECM CUD-M (53)	IATS #2 Signal
4	ECM CUD-M (23)	Sensor ground

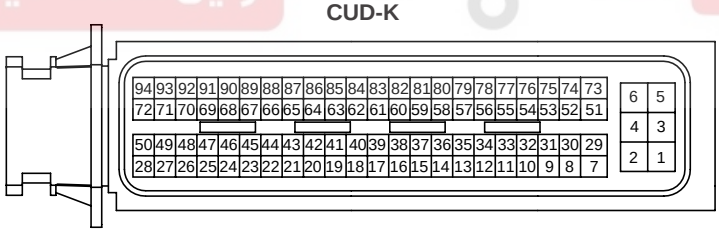
[HARNESS CONNECTORS]



CUD39

BPS & IATS #2





ECM

SLDF27124L

SIGNAL WAVEFORM AND DATA E3BAE705

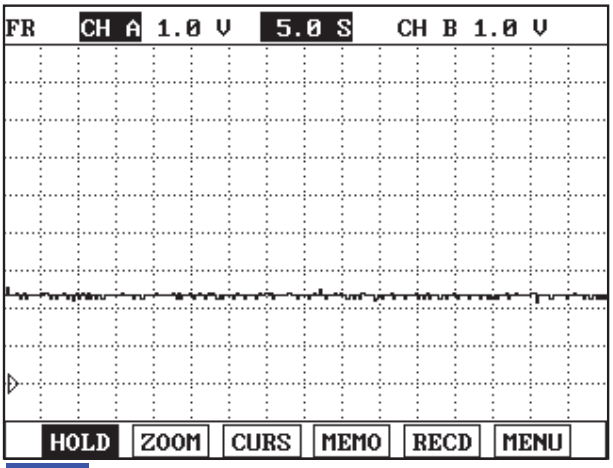


Fig.1

Fig.1) IATS output waveform at 25℃. The higher temperature is, the lower voltage becomes.

SLDFL6221L

MONITOR SCANTOOL DATA EA7301EC

1. Connect Scantool to Data Link Connector (DLC).
2. Warm engine up to normal operating temperature.
3. Turn "OFF" electrical devices and A/C.
4. Monitor "AIR TEMPERATURE SENSOR" parameter on the Scantool.

specification : current intake air temperture is displayed.

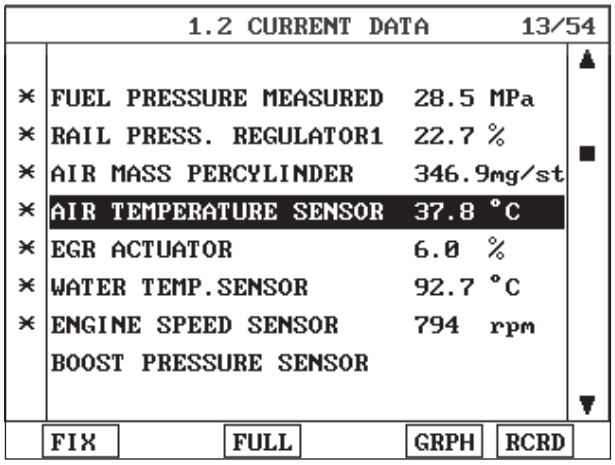


Fig.1

Fig.1) Check if current temperature is same as the value displayed on the Scantool.

SLDFL6222L

TERMINAL AND CONNECTOR INSPECTION EAF908CD

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.
2. Perform checking procedure as follows.

1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.

2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

NOTE

Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position.)

3. Is the problem found?

YES

▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

NO

▶ Go to "Signal Circuit Inspection".

SIGNAL CIRCUIT INSPECTION EF594E20

1. Check signal circuit voltage

1) IG Key "OFF", Engine "OFF".

2) Disconnect BPS connector.

3) IG Key "ON".

4) Check the voltage of BPS connector terminal 3.

Specification : 4.8V~5.1V

5) Is the measured voltage within the specificaiton?

YES

▶ Go to "Component Inspection".

NO

▶ Repair "2. Check short to ground in signal circuit" as follows.

2. Check short to ground in signal circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect BPS connector and ECM connector.

3) Check continuity between BPS connector terminal 3 and chassis ground.

Specification : Discontinuity (Infinite Ω)

4) Is the measured resistance within the specification?

YES

▶ Go to"Component Inspection".

NO

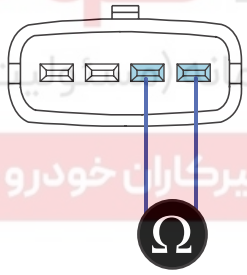
▶ Repair short to ground in signal circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION EB5EEE3B

1. IG Key "OFF", Engine "OFF".
2. Disconnect BPS connector.
3. Measure resistance between BPS component terminal 3 and terminal 4.

SPECIFICATION :

Temp.	-40℃	-20℃	0℃	20℃
Resistance	35.14 ~ 43.76KΩ	12.66 ~ 15.12KΩ	5.12 ~ 5.89KΩ	2.29 ~ 2.55KΩ
Temp.	40℃	60℃	80℃	
Resistance	1.10 ~ 1.24KΩ	0.57 ~ 0.65KΩ	0.31 ~ 0.37KΩ	



SLDFL6225L

4. Is the measured resistance at certain temperature within the specified resisance range at the temperature?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace BPS assy' and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E9DBC7FF

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.

5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0098 INTAKE AIR TEMPERATURE SENSOR 2 CIRCUIT HIGH INPUT

COMPONENT LOCATION E7163056

Refer to DTC P0097.

GENERAL DESCRIPTION E4223DD6

Refer to DTC P0097.

DTC DESCRIPTION EE7FA02E

P0098 is set when the voltage above 4965mV - maximum output voltage of IATS(integrated with BPS) - is detected for more than 2.0 sec.. This code is due to 1) open or 2)short to battery in IATS signal circuit.

DTC DETECTING CONDITION EB4527EB

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="5">• IATS circuit
• IATS component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• Output signal above maximum value(above 4965mV)</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 2.0 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• Air temp. fixed at 28 °C</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SPECIFICATION EE979233

Temp.	-40℃	-20℃	0℃	20℃
Resistance	35.14 ~ 43.76KΩ	12.66 ~ 15.12KΩ	5.12 ~ 5.89KΩ	2.29 ~ 2.55KΩ
Temp.	40℃	60℃	80℃	
Resistance	1.10 ~ 1.24KΩ	0.57 ~ 0.65KΩ	0.31 ~ 0.37KΩ	

SCHEMATIC DIAGRAM E6A4445A

Refer to DTC P0097.

SIGNAL WAVEFORM AND DATA E0AA4288

Refer to DTC P0097.

MONITOR SCANTOOL DATA E5A162FF

Refer to DTC P0097.

TERMINAL AND CONNECTOR INSPECTION E86B0252

Refer to DTC P0097.

SIGNAL CIRCUIT INSPECTION EBB944AB

1. Check signal circuit voltage
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect BPS connector.
   3) IG Key "ON".
   4) Check the voltage of BPS connector terminal 3.

Specification : 4.8V~5.1V

   5) Is the measured voltage within the specificaiton?

YES

▶ Go to "Ground Circuit Inspection".

NO

▶ Go to "2.Check open in signal circuit" as follows.

2. Check open in signal circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect BPS connector and ECM connector.
   3) Check continuity between BPS connector terminal 3 and ECM connector (CUD-M) terminal 53.

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification?

YES

▶ Go to "3. Check short to battery in signal circuit" as follows.

NO

▶ Repair open in signal circuit and go to "Verification of Vehicle Repair".

3. Check short to battery in signal circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect BPS connector and ECM connector.
   3) IG Key "ON".
   4) Check the voltage of BPS connector terminal 3.

Specification : 0.0V~0.1V

5) Is the measured voltage within the specification?(with both connector disconnected)

YES

▶ Repair short to battery in signal circuit and go to "Verification of Vehicle Repair".

NO

▶ Go to "Ground Circuit Inspection".

GROUND CIRCUIT INSPECTION ED2418A1

1. IG Key "OFF", Engine "OFF".
2. Disconnect BPS connector.
3. IG Key "ON".
4. Measure the voltage of BPS connector terminal 3. [TEST "A"]
5. Measure the voltage between BPS connector terminal 3 and terminal 4. [TEST "B"]
(terminal 3 : Check + prove , terminal 4 : Check - prove)

Specification : [TEST "A"] Voltage - [TEST "B"] Voltage = below 200mV

6. Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

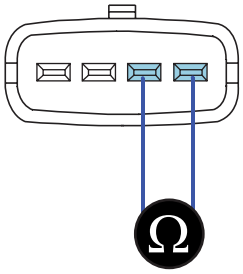
▶ When "B" voltage is not detected : Repair open in ground circuit and go to "Verification of Vehicle Repair".
▶ When the voltage difference between "A" and "B" is above 200mV : Eliminate the causes of excessive resistance and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E707F6FC

1. IG Key "OFF", Engine "OFF".
2. Disconnect BPS connector.
3. Measure resistance between BPS component terminal 3 and terminal 4.

SPECIFICATION :

Temp.	**-40**℃	**-20**℃	**0**℃	**20**℃
Resistance	35.14 ~ 43.76KΩ	12.66 ~ 15.12KΩ	5.12 ~ 5.89KΩ	2.29 ~ 2.55KΩ
Temp.	**40**℃	**60**℃	**80**℃	
Resistance	1.10 ~ 1.24KΩ	0.57 ~ 0.65KΩ	0.31 ~ 0.37KΩ	



SLDFL6225L

4. Is the measured resistance at certain temperature within the specified resisance range at the temperature?

YES

▶ Go to "Verification of Vehicle Repair".

NO

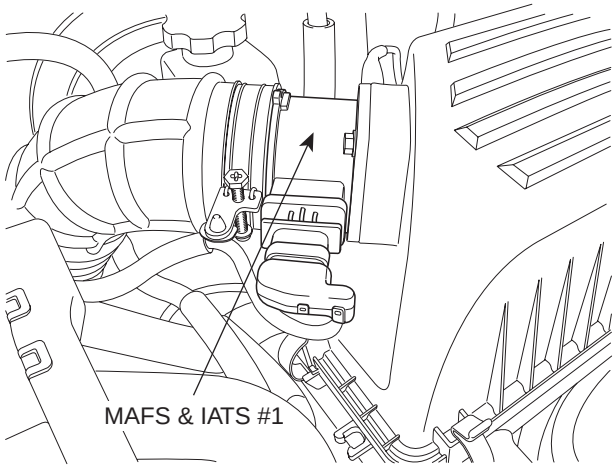
▶ Replace BPS assy' and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E569D12E

Refer to DTC P0097.

DTC P0101 MASS OR VOLUME AIR FLOW CIRCUIT RANGE/PERFORMANCE

COMPONENT LOCATION EF9A6566



SLDFL6228L

GENERAL DESCRIPTION E023C8DC

Mass Air Flow Sensor (MAFS) is digital sensor. Measuring mass of air flow, signal is outputted as frequency(Hz). ECM performs EGR system feed back control with the information of measured mass air flow. (The role of MAFS in diesel engine is different from gasoline engine. Fuel injection quantity is decided by MAFS signal in gasoline engine.) When the amount of EGR gas(contains no oxygen) flowing into combustion chamber increases, the air passing through MAFS(contains oxygen) decreases. Thus, with the output signal change of MAFS accompanied by EGR actuator actuation, ECM determines the amount of recirculated EGR gas quantity.

NOTE

NOx is produced in the reaction of nitrogen and oxygen. If least intake air required for complete combustion flows into combustion chamber by controlling EGR gas(contains no oxygen) which is recirculated to combustion chamber, NOx decreases because there is no supplementary oxygen to react with nitrogen.

DTC DESCRIPTION E5217D7E

P0101 is set when Air mass ratio(real/threshold) above 1.36 or below 0.78 is detected for more than 7 sec..

DTC DETECTING CONDITION E3743974

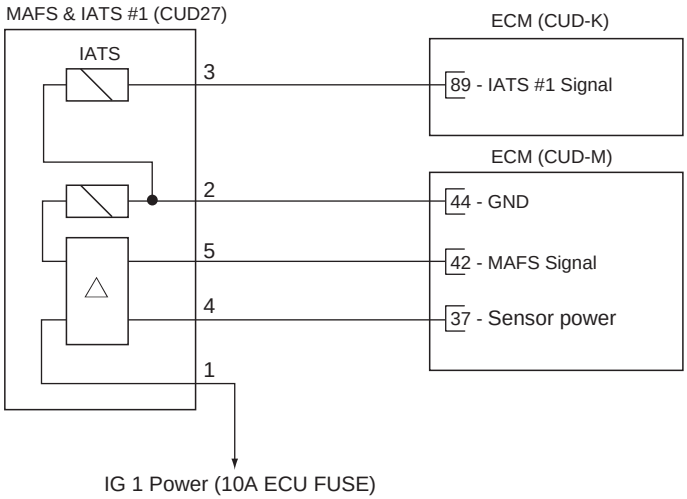
Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• MAFS circuit • MAFS component
Enable Conditions	• Engine running			
ThresholdValue	• Air mass ratio(real/threshold) is above 1.36 or below 0.78			
DiagnosticTime	• 7 sec.			
Fail Safe	Fuel Cut	NO		
	EGR Off	YES		
	Fuel Limit	YES		
	MIL	ON		

SPECIFICATION E29A3233

Intake air quantity (Kg/h)	Output frequency (KHz)		deviation [%]
	20℃	80℃	
8	1.97		±3
10	2.01	2.01	±2
40	2.50	2.50	±2
105	3.20	3.20	±2
220	4.30		±2
480	7.80	7.80	±2
560	9.50		±3

SCHEMATIC DIAGRAM EFCA12BA

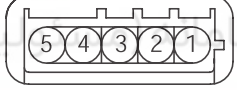
[CIRCUIT DIAGRAM]



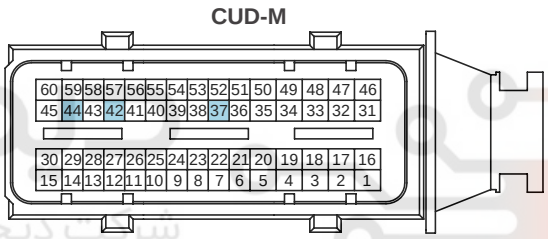
[CONNECTION INFORMATION]

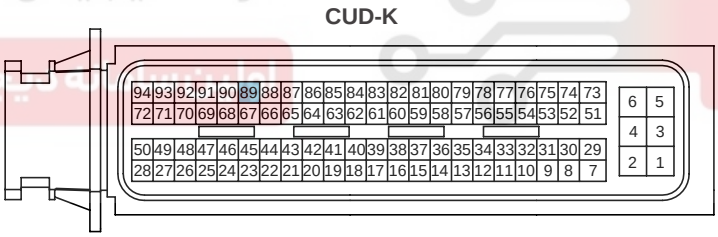
Terminal	Connected to	Function
1	IG 1 Power (10A ECU FUSE)	Battery Voltage (B+)
2	ECM CUD-M (44)	Sensor Ground
3	ECM CUD-K (89)	IATS #1 Signal
4	ECM CUD-M (37)	Sensor power
5	ECM CUD-M (42)	MAFS Signal

[HARNESS CONNECTORS]



CUD27
MAFS & IATS #1





SLDF27123L

SIGNAL WAVEFORM AND DATA EBE2FCB4

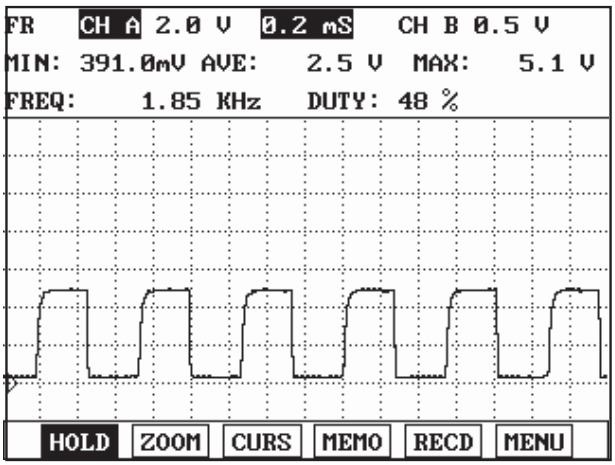


Fig.1

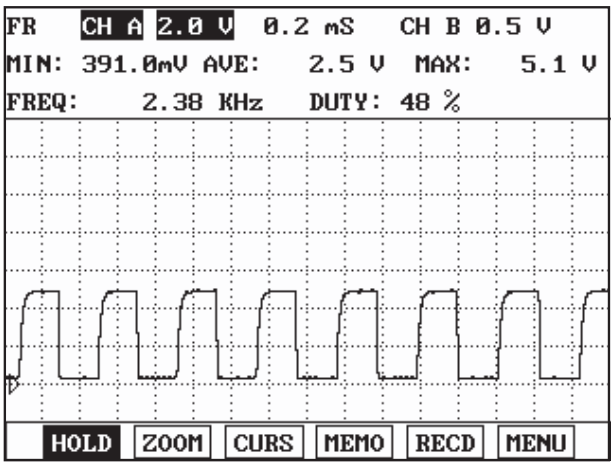


Fig.2

Fig.1) MAFS signal waveform at IG KEY "ON". It shows digital signal of 50% duty, 1.8KHz.
Fig.2) MAFS signal waveform at idle(830RPM, EGR actuator duty 9.4%, air flow for each cylinder 340mg/st).
It shows digital signal of 50% duty, 2.0~2.5KHz.

SLDFL6229L

NOTE

Signal frequency increases as RPM rises.

MONITOR SCANTOOL DATA EDB1B030

1. Connect Scantool to Data Link Connector (DLC).
2. Warm engine up to normal operating temperature.
3. Turn "OFF" electrical devices and A/C.
4. Monitor "AIR MASS PERCYLINDER" parameter on the Scantool.

Specification :
When EEGR actuator does not operate (6% duty) at idle : 340mg/st ± 50 mg/st
When EEGR actuator operates(50% duty) at idle : 200ms/st ± 50 mg/st

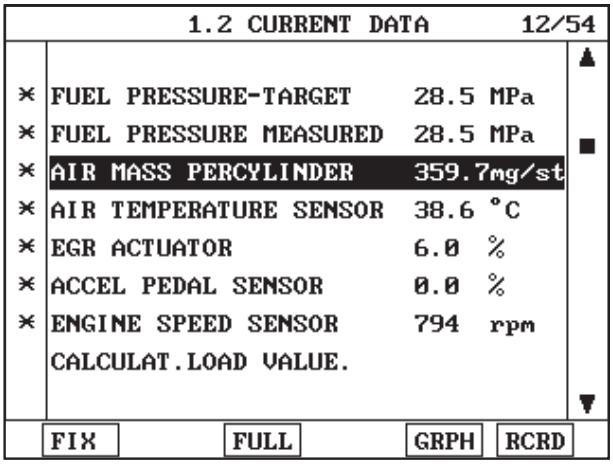


Fig.1

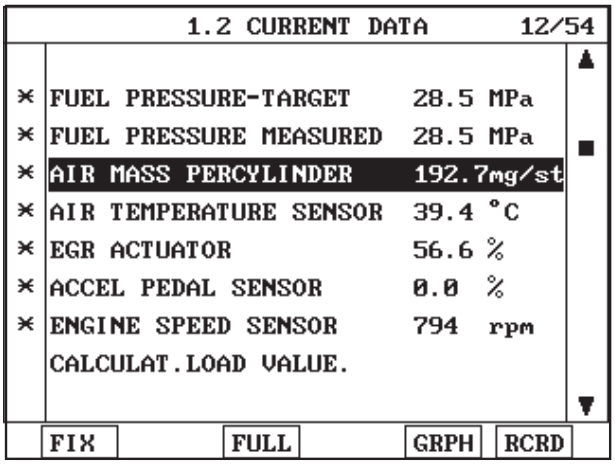


Fig.2

Fig.1) Check if "AIR MASS PER CYLINDER" output signal is 340mg/st ± 50mg/st without EEGR operation at warm idle (EEGR actuator 6% duty)
Fig.2) Check if "AIR MASS PER CYLINDER" output signal is 200mg/st ± 50mg/st with EEGR operation at warm idle (EEGR actuator 50% duty)

※EEGR actuator operates as decelerating after rapid acceleration when idle EEGR does not operate, EEGR actuator operating duty decreases as time goes by. This controlling process lasts for about 3 min. and EEGR actuator turns "OFF" (duty 6%) after 3 min.

SLDFL6230L

TERMINAL AND CONNECTOR INSPECTION E09A4258

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.
2. Perform checking procedure as follows.
   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.
   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

   NOTE

   Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position.)
3. Is the problem found?

   YES

   ▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

   NO

   ▶ Go to "Power Circuit Inspection".

POWER CIRCUIT INSPECTION EC165BD9

1. IG Key "OFF", Engine "OFF".
2. Disconnect MAFS connector.

3. IG Key "ON".

4. Measure the voltage of MAFS connector terminal 1 and terminal 4.

Specification :
Terminal 1 (IG Power) : 11.5V~13.0V
Terminal 4 (Sensor power) : 4.8V~5.1V

5. Is the measured voltage within the specification?

YES

▶ Go to "Signal Circuit Inspection".

NO

▶ When output voltage is not detected at terminal 1 :
☞ Repair open in I/P junction box 10A ECU FUSE and related circuit and go to "Verification of Vehicle Repair".
▶ When output voltage is not detected at terminal 4 :
☞ Repair open between MAFS connector terminal 4 and ECM connector (CUD-M) terminal 37, and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION EBF07393

1. IG Key "OFF", Engine "OFF".

2. Disconnect MAFS connector and ECM connector.

3. IG Key "ON".

4. Measure the voltage of MAFS connector terminal 3 and terminal 5.

Specification :
Terminal 3 (IATS signal) : 4.8V~5.1V
Terminal 5 (MAFS signal) : 4.8V~5.1V

5. Is the measured voltage within the specification?

YES

▶ Go to "Ground Circuit Inspection".

NO

▶ Repair short to battery in signal circuit and go to "Verification of Vehicle Repair".

GROUND CIRCUIT INSPECTION EEA1FDD7

1. IG Key "OFF", Engine "OFF".

2. Disconnect MAFS connector.

3. IG Key "ON".

4. Measure the voltage of MAFS connector terminal 4. [TEST "A"]

5. Measure the voltage between MAFS connector terminal 4 and terminal 2. [TEST "B"]

(terminal 4 : Check + prove , terminal 2 : Check - prove)

Specification : [TEST "A"] Voltage - [TEST "B"] Voltage = below 200mV

6. Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ When "B" voltage is not detected : Repair open in ground circuit and go to "Verification of Vehicle Repair".
▶ When the voltage difference between "A" and "B" is above 200mV : Eliminate the causes of excessive resistance and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E3450010

1. IG Key "OFF", Engine "OFF".
2. Check that MAFS is installed in correctly according to the direction of arrow on MAFS assy'.
3. Check contamination of air cleaner filter.
4. IG Key "ON", Engine "ON".
5. Let idle RPM last after warming engine up.
6. Check the leakage of intake system(the leakage or damage of intercooler).
7. Check that VGT operates correctly.(Check if vacuum operating state of VGT actuator is appropriate, if VGT diaphragm and unison ring are stuck.)
8. Check that EEGR actuator does not operate.
   (EEGR actuator turns "OFF" and 4.4% duty is outputted 3 min. after rapid acceleration.)
9. Monitor signal voltage of MAFS when engine speed lasts at approx. 800RPM using Scantool.
10. Check MAFS output signal at idle after rapid acceleration.(EEGR actuator duty 45%)

Specification :
When EEGR actuator does not operate (5%) at idle : 410mg/st ± 50 mg/st
EEGR When EEGR actuator operates(45%) at idle : 360mg/st ± 50 mg/st

11. Is output signal within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace MAFS assy' and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E619D82E

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0102 MASS OR VOLUME AIR FLOW CIRCUIT LOW INPUT

COMPONENT LOCATION E6E9F9A1

Refer to DTC P0101.

GENERAL DESCRIPTION E898E806

Refer to DTC P0101.

DTC DESCRIPTION E10D1764

P0102 is set when MAFS output voltage below 0.2V(below 1200Hz) is detected for more than 0.6 sec. This code is due to 1)open in power circuit 2) open or short to ground in signal circuit.

DTC DETECTING CONDITION E6B6EC99

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="5">• MAFS circuit
• MAFS component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• Abnormal minimum output signal(below 1200Hz)</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 0.6 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4"></td></tr>
<tr><td>EGR Off</td><td>YES</td></tr>
<tr><td>Fuel Limit</td><td>YES</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SPECIFICATION E6C7C985

Intake air quantity (Kg/h)	Output frequency (KHz)		deviation [%]
	20℃	80℃	
8	1.97		±3
10	2.01	2.01	±2
40	2.50	2.50	±2
105	3.20	3.20	±2
220	4.30		±2
480	7.80	7.80	±2
560	9.50		±3

SCHEMATIC DIAGRAM E026D170

Refer to DTC P0101.

SIGNAL WAVEFORM AND DATA E254A68D

Refer to DTC P0101.

MONITOR SCANTOOL DATA E26088A9

Refer to DTC P0101.

TERMINAL AND CONNECTOR INSPECTION EC7E4384

Refer to DTC P0101.

POWER CIRCUIT INSPECTION EFEFC895

1. IG Key "OFF", Engine "OFF".
2. Disconnect MAFS connector.
3. IG Key "ON".
4. Measure the voltage of MAFS connector terminal 1 and terminal 4.

Specification :
Terminal 1 (IG Power) : 11.5V~13.0V
Terminal 4 (Sensor power) : 4.8V~5.1V

5. Is the measured voltage within the specification?

YES

▶ Go to "Signal Circuit Inspection".

NO

▶ When output voltage is not detected at terminal 1 :
☞ Repair open in I/P junction box 10A ECU FUSE and related circuit and go to "Verification of Vehicle Repair".
▶ When output voltage is not detected at terminal 4 :
☞ Repair open between MAFS connector terminal 4 and ECM connector (CUD-M) terminal 37, and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION E1BB9B7B

1. Check signal circuit voltage
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect MAFS connector and ECM connector.
   3) IG Key "ON".
   4) Measure the voltage of MAFS connector terminal 5.

Specification : 4.8 ~ 5.1V

   5) Is the measured voltage within the specification?

YES

▶ Go to "Ground Circuit Inspection".

NO

▶ Go to "2. Check open in signal circuit" as follows.

2. Check open in signal circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect MAFS sensor connector and ECM connector.

3) Check continuity between MAFS connector terminal 5 and ECM connector (CUD-M) terminal 42.

Specification : Continuity (below 1.0Ω)

4) Is the measured resistance within the specification?

YES

▶ Go to "3. Check short to ground in signal circuit" as follows.

NO

▶ Repair open in signal circuit and go to "Verification of Vehicle Repair".

3. Check short to ground in signal circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect MAFS sensor connector and ECM connector.

3) Check continuity between MAFS connector terminal 5 and chassis ground.

Specification : Discontinuity(Infinite Ω)

4) Is the measured resistance within the specification?

YES

▶ Go to "Ground Circuit Inspection".

NO

▶ Repair short to ground in signal circuit and go to "Verification of Vehicle Repair".

GROUND CIRCUIT INSPECTION E0A590D6

1. IG Key "OFF", Engine "OFF".
2. Disconnect MAFS connector.
3. IG Key "ON".
4. Measure the voltage of MAFS connector terminal 4. [TEST "A"]
5. Measure the voltage between MAFS connector terminal 4 and terminal 2. [TEST "B"]
(terminal 4 : Check + prove , terminal 2 : Check - prove)

Specification : [TEST "A"] Voltage - [TEST "B"] Voltage = below 200mV

6. Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ When "B" voltage is not detected : Repair open in ground circuit and go to "Verification of Vehicle Repair".
▶ When the voltage difference between "A" and "B" is above 200mV : Eliminate the causes of excessive resistance and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E215ED87

1. IG Key "OFF", Engine "OFF".
2. Check that MAFS is installed in correctly according to the direction of arrow on MAFS assy'.
3. Check contamination of air cleaner filter.
4. IG Key "ON", Engine "ON".
5. Let idle RPM last after warming engine up.
6. Check the leakage of intake system(the leakage or damage of intercooler).
7. Check that VGT operates correctly.(Check if vacuum operating state of VGT actuator is appropriate, if VGT diaphragm and unison ring are stuck.)
8. Check that EEGR actuator does not operate.
(EEGR actuator turns "OFF" and 4.4% duty is outputted 3 min. after rapid acceleration.)
9. Monitor signal voltage of MAFS when engine speed lasts at approx. 800RPM using Scantool.
10. Check MAFS output signal at idle after rapid acceleration.(EEGR actuator duty 45%)

Specification :
When EEGR actuator does not operate (5%) at idle : 410mg/st ± 50 mg/st
EEGR When EEGR actuator operates(45%) at idle : 360mg/st ± 50 mg/st

11. Is output signal within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace MAFS assy' and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E7F1A4D3

Refer to DTC P0101.

DTC P0103 MASS OR VOLUME AIR FLOW CIRCUIT HIGH INPUT

COMPONENT LOCATION EA04BF92

Refer to DTC P0101.

GENERAL DESCRIPTION E2873F5C

Refer to DTC P0101.

DTC DESCRIPTION E1B4745A

P0103 is set when MAFS output voltage above 14100Hz is detected for more than 0.6 sec.. This code is due to excessive output voltage from sensor component or poor connection in sensor circuit.

DTC DETECTING CONDITION E871FD4A

Item	Detecting Condition		Possible Cause
DTC Strategy	• Voltage monitoring		• MAFS circuit • MAFS component
Enable Conditions	• Engine running		
ThresholdValue	• Abnormal maximum output signal(above 14100Hz)		
DiagnosticTime	• 0.6 sec.		
Fail Safe	Fuel Cut	NO	
	EGR Off	YES	
	Fuel Limit	YES	
	MIL	OFF	

SPECIFICATION E1920BA0

Intake air quantity (Kg/h)	Output frequency (KHz)		deviation [%]
	20℃	80℃	
8	1.97		±3
10	2.01	2.01	±2
40	2.50	2.50	±2
105	3.20	3.20	±2
220	4.30		±2
480	7.80	7.80	±2
560	9.50		±3

SCHEMATIC DIAGRAM EFA5F5B5

Refer to DTC P0101.

SIGNAL WAVEFORM AND DATA E46A9C1F

Refer to DTC P0101.

MONITOR SCANTOOL DATA EA436093

Refer to DTC P0101.

TERMINAL AND CONNECTOR INSPECTION E6C08A75

Refer to DTC P0101.

POWER CIRCUIT INSPECTION EF37CF18

1. IG Key "OFF", Engine "OFF".
2. Disconnect MAFS connector.
3. IG Key "ON".
4. Measure the voltage of MAFS connector terminal 1 and terminal 4.

Specification :
Terminal 1 (IG Power) : 11.5V~13.0V
Terminal 4 (Sensor power) : 4.8V~5.1V

5. Is the measured voltage within the specification?

YES

▶ Go to "Signal Circuit Inspection".

NO

▶ When output voltage is not detected at terminal 1 :
☞ Repair open in I/P junction box 10A ECU FUSE and related circuit and go to "Verification of Vehicle Repair".
▶ When output voltage is not detected at terminal 4 :
☞ Repair open between MAFS connector terminal 4 and ECM connector (CUD-M) terminal 37, and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION E59BB9A6

1. Check signal circuit voltage
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect MAFS connector and ECM connector.
   3) IG Key "ON".
   4) Measure the voltage of MAFS connector terminal 5.

Specification : 4.8 ~ 5.1V

   5) Is the measured voltage within the specification?

YES

▶ Go to "Ground Circuit Inspection".

NO

▶ Go to "2. Check open in signal circuit" as follows.

2. Check open in signal circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect MAFS sensor connector and ECM connector.

3) Check continuity between MAFS connector terminal 5 and ECM connector (CUD-M) terminal 42.

Specification : Continuity (below 1.0Ω)

4) Is the measured resistance within the specification?

YES

▶ Go to "3. Check short to ground in signal circuit" as follows.

NO

▶ Repair open in signal circuit and go to "Verification of Vehicle Repair".

3. Check short to ground in signal circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect MAFS sensor connector and ECM connector.

3) Check continuity between MAFS connector terminal 5 and chassis ground.

Specification : Discontinuity(Infinite Ω)

4) Is the measured resistance within the specification?

YES

▶ Go to "Ground Circuit Inspection".

NO

▶ Repair short to ground in signal circuit and go to "Verification of Vehicle Repair".

GROUND CIRCUIT INSPECTION EB5962D4

1. IG Key "OFF", Engine "OFF".
2. Disconnect MAFS connector.
3. IG Key "ON".
4. Measure the voltage of MAFS connector terminal 4. [TEST "A"]
5. Measure the voltage between MAFS connector terminal 4 and terminal 2. [TEST "B"]
(terminal 4 : Check + prove , terminal 2 : Check - prove)

Specification : [TEST "A"] Voltage - [TEST "B"] Voltage = below 200mV

6. Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ When "B" voltage is not detected : Repair open in ground circuit and go to "Verification of Vehicle Repair".
▶ When the voltage difference between "A" and "B" is above 200mV : Eliminate the causes of excessive resistance and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E491BE97

1. IG Key "OFF", Engine "OFF".
2. Check that MAFS is installed in correctly according to the direction of arrow on MAFS assy'.
3. Check contamination of air cleaner filter.
4. IG Key "ON", Engine "ON".
5. Let idle RPM last after warming engine up.
6. Check the leakage of intake system(the leakage or damage of intercooler).
7. Check that VGT operates correctly.(Check if vacuum operating state of VGT actuator is appropriate, if VGT diaphragm and unison ring are stuck.)
8. Check that EEGR actuator does not operate.
(EEGR actuator turns "OFF" and 4.4% duty is outputted 3 min. after rapid acceleration.)
9. Monitor signal voltage of MAFS when engine speed lasts at approx. 800RPM using Scantool.
10. Check MAFS output signal at idle after rapid acceleration.(EEGR actuator duty 45%)

Specification :
When EEGR actuator does not operate (5%) at idle : 410mg/st ± 50 mg/st
EEGR When EEGR actuator operates(45%) at idle : 360mg/st ± 50 mg/st

11. Is output signal within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

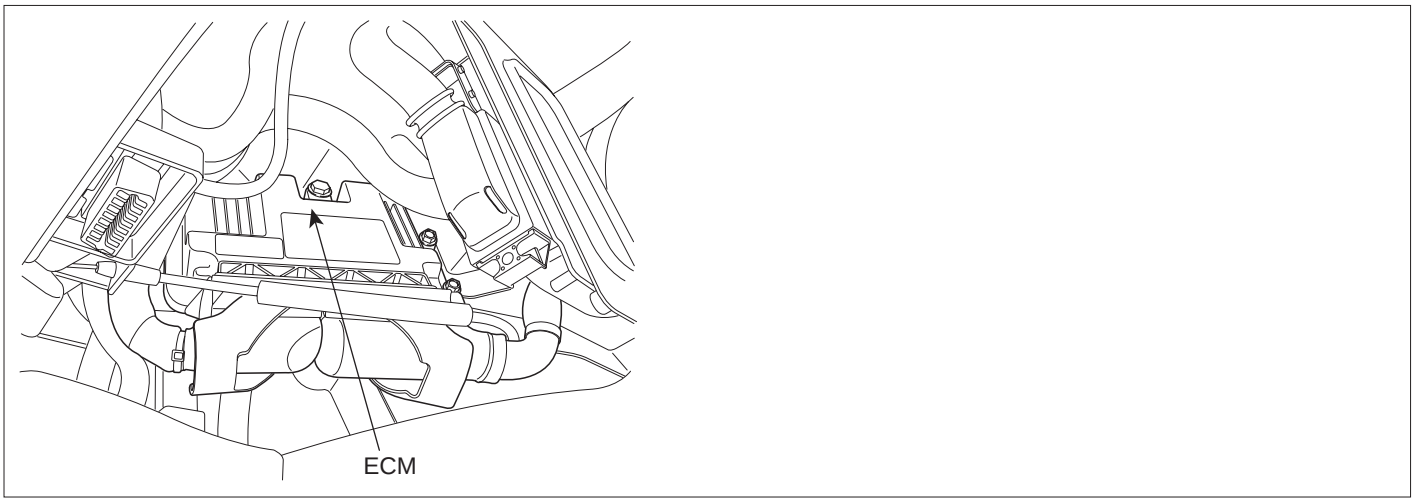
▶ Replace MAFS assy' and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E98C91F5

Refer to DTC P0101.

DTC P0107 ATMOSPHERIC PRESSURE CIRCUIT LOW INPUT

COMPONENT LOCATION EAA6E795



SLDFL6237L

GENERAL DESCRIPTION E17DA33D

Atmospheric sensor is installed in ECM and senses atmospheric pressure where the vehicle is. Based on singal of atmospheric sensor, air density is calculated. And atmospheric sensor is used to detect mass air flow with MAFS, IATS. This sensor is required to perform 1) fuel injection quantity correction in high altitude and 2) EGR control. Atmospheric pressure is fixed at 1,000hpa when atmospheric sensor fails.

DTC DESCRIPTION E57CDF84

P0107 is set when the voltage below 0.25V - minimum output voltage of Atmospheric pressure sensor - is detected for more than 5 sec. This code is due to fhe failure of the sensor inside of ECM.

DTC DETECTING CONDITION E137C09B

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• Atmospheric pressure sensor (ECM component)</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• When output voltage is below the minimum value.(below 0.25V)</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 5 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• Atmospheric pressure is fixed at 1,000hpa.</td></tr>
<tr><td>EGR Off</td><td>YES</td></tr>
<tr><td>Fuel Limit</td><td>YES</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SPECIFICATION E1A03479

1ATM IS SAME AS

hpa (hecto pascal)	mb	mmHg
1013	1013	760

MONITOR SCANTOOL DATA EC2D853B

1. Connect scantool to Data Link Cable. (DLC)
2. Warm engine up to normal operating temperature.
3. Turn "OFF" electrical devices and A/C.
4. Monitor "ATMOSPHERIC PRESS. SNSR" parameter on the scantool.

Specification : Approx. 1 atm is displayed

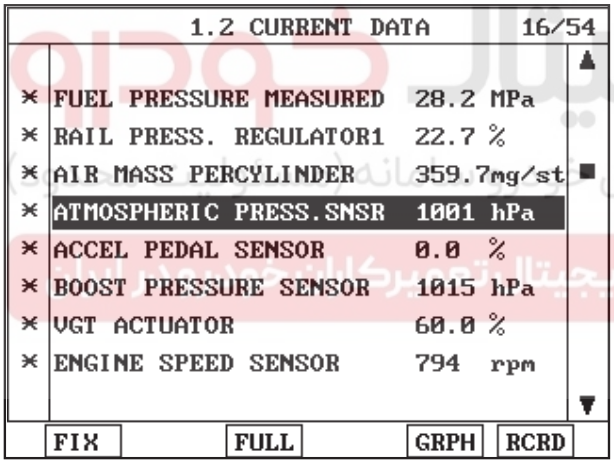


Fig.1

Fig 1) The atmospheric pressure where the vehicle is displayed. Atmospheric pressure decreases as vehicle going up to higher altitude. The pressure at average level of sea surface is regarded as 1atm and, check if the pressure different from 1 atm is displayed. (1 atm is correct pressure)

SLDFL6238L

COMPONENT INSPECTION E809D7DE

1. IG Key "OFF", Engine "OFF".
2. Disconnect ECM.
3. Replace ECM, check if abnormal operations disappear.
4. If problems are corrected, replace ECM.

NOTE

Input injector IQA data(7 letters) using scantool at replacing ECM.
For immobilizer applied vehicle, input pin code.

VERIFICATION OF VEHICLE REPAIR E6AE8935

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0108 ATMOSPHERIC PRESSURE CIRCUIT HIGH INPUT

COMPONENT LOCATION E361EE23

Refer to DTC P0107.

GENERAL DESCRIPTION E3E2804A

Refer to DTC P0107.

DTC DESCRIPTION EFE6B0AB

P0108 is set when the voltage above 4.85V - maximum output voltage of Barometric pressure sensor - is detected for more than 5 sec. This code is due to fhe failure of the sensor inside of ECM.

DTC DETECTING CONDITION EC4F09B8

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• Atmospheric pressure sensor (ECM component)</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• When output voltage is above the maximum value. (above 4.85V)</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 5 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• Atmospheric pressure is fixed at 1,000hpa.</td></tr>
<tr><td>EGR Off</td><td>YES</td></tr>
<tr><td>Fuel Limit</td><td>YES</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SPECIFICATION E7577B35

1ATM IS SAME AS

hpa (hecto pascal)	mb	mmHg
1013	1013	760

MONITOR SCANTOOL DATA EE5B2FED

Refer to DTC P0107.

COMPONENT INSPECTION EDAE30A5

1. IG Key "OFF", Engine "OFF".
2. Disconnect ECM.
3. Replace ECM, check if abnormal operations disappear.
4. If problems are corrected, replace ECM.

NOTE

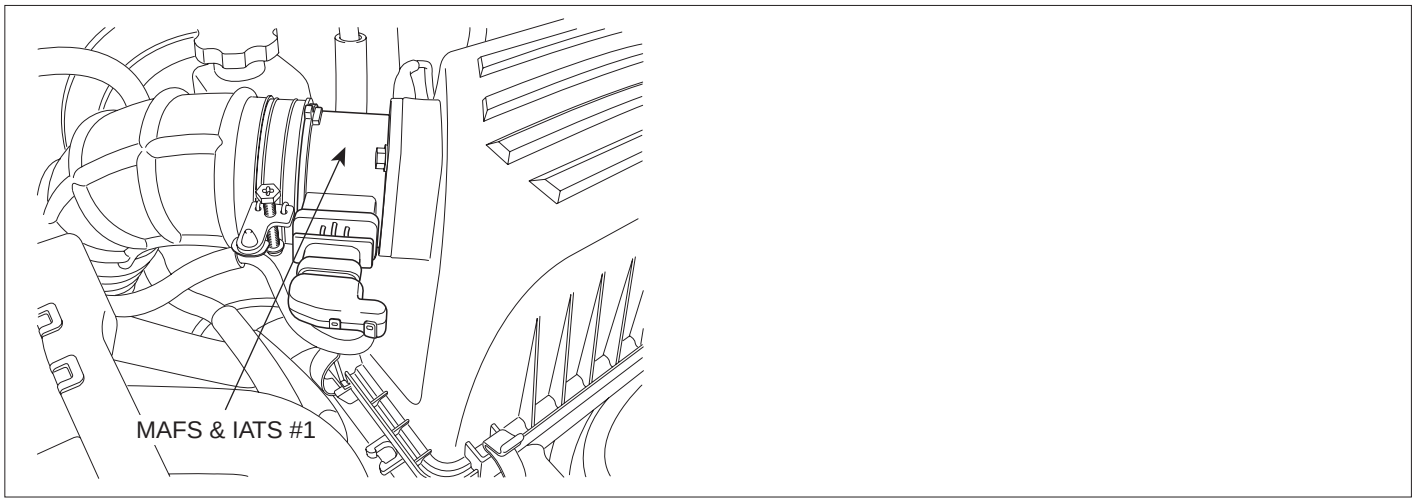
Input injector IQA data(7 letters) using scantool at replacing ECM.
For immobilizer applied vehicle, input pin code.

VERIFICATION OF VEHICLE REPAIR EA942CE9

Refer to DTC P0107.

DTC P0112 INTAKE AIR TEMPERATURE SENSOR1 CIRCUIT LOW INPUT

COMPONENT LOCATION E2FEDA1A



SLDFL6228L

GENERAL DESCRIPTION E13AF5AC

Intake Air Temperature Sensor(IATS) is NTC thermistor. Installed inside of both MAFS and BPS, it senses intake air temperature. In case of EURO-4 diesel engine, IATS is installed in front of turbocharger(inside of MAFS) and behind it(inside of BPS). Comparing air temperature from both sensors(one is intake air temperature, the other is air temperature passing through turbo charger), more accurate sensing of intake air temperature is possible. With intake air temperature signal, ECM performs EGR control correction and fuel injection quantity correction.(MAFS is needed for EGR FEED BACK control in electronically controlled diesel engine. The calculation of air density at certain temperture is required to perform EGR FEED BACK control correctly.)

DTC DESCRIPTION E733B97F

P0112 is set when the voltage below 73mV - minimum output voltage of IATS(inside of MAFS) - is detected for more than 1 sec. This code is due to short to ground in IATS signal circuit.

DTC DETECTING CONDITION ECBAF915

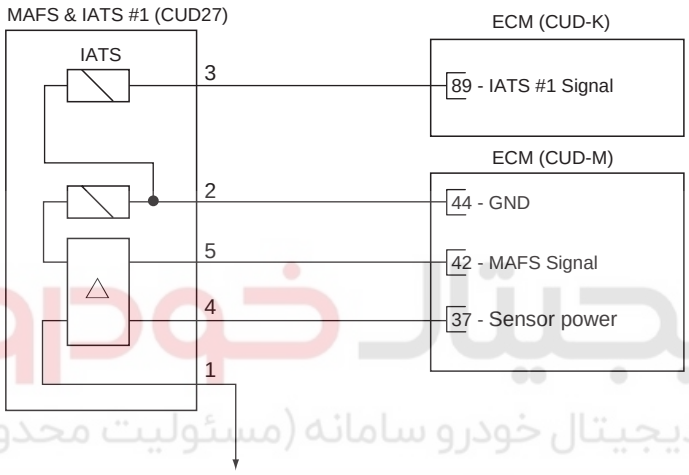
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage Monitoring</td><td rowspan="7">• IATS circuit
• IATS component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• When output signal is below the minimum value (below 73mV)</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 1.0 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• Intake air temperature is considered as 50°C</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SPECIFICATION E0DA9093

Temp.	-40℃	-20℃	0℃	20℃
Resistance	35.14 ~ 43.76KΩ	12.66 ~ 15.12KΩ	5.12 ~ 5.89KΩ	2.29 ~ 2.55KΩ
Temp.	40℃	60℃	80℃	
Resistance	1.10 ~ 1.24KΩ	0.57 ~ 0.65KΩ	0.31 ~ 0.37KΩ	

SCHEMATIC DIAGRAM EC1B880B

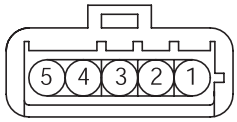
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

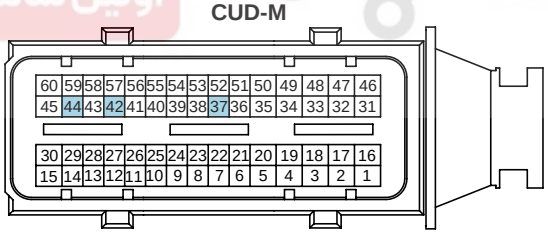
Terminal	Connected to	Function
1	IG 1 Power (10A ECU FUSE)	Battery Voltage (B+)
2	ECM CUD-M (44)	Sensor Ground
3	ECM CUD-K (89)	IATS #1 Signal
4	ECM CUD-M (37)	Sensor power
5	ECM CUD-M (42)	MAFS Signal

[HARNESS CONNECTORS]

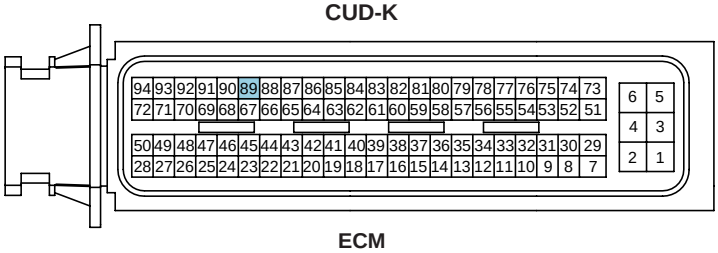


CUD27

MAFS & IATS #1



CUD-M



CUD-K

ECM

SLDF27123L

SIGNAL WAVEFORM AND DATA E5A3E571

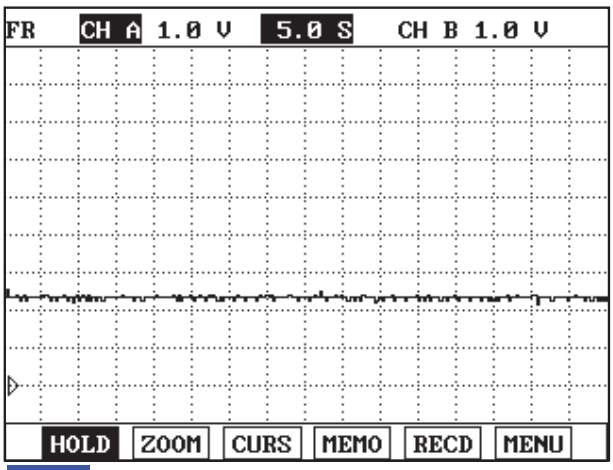


Fig.1

Fig.1) IATS output waveform at 25℃. The higher temperature is, the lower voltage becomes.

SLDFL6221L

MONITOR SCANTOOL DATA EE0ED572

1. Connect scantool to Data Link Cable. (DLC)
2. Warm engine up to normal operating temperature.
3. Turn "OFF" electrical devices and A/C.
4. Monitor "AIR TEMPERATURE SENSOR" parameter on the scantool.

Specification : Intake air temperature is displayed

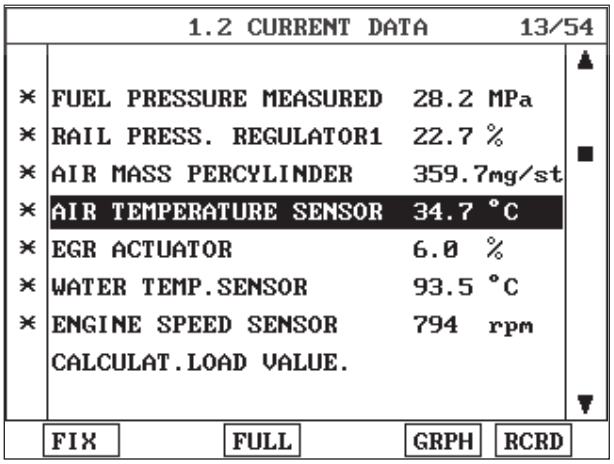


Fig.1

Fig.1) "AIR TEMPERATURE SENSOR" value should not change according to engine state.

SLDFL6240L

TERMINAL AND CONNECTOR INSPECTION ED710171

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.
2. Perform checking procedure as follows.

1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.

2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

NOTE

Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector or checking connecting condition. (after checking, reconnect the pin at correct position.)

3. Is the problem found?

YES

▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

NO

▶ Go to "Signal Circuit Inspection".

SIGNAL CIRCUIT INSPECTION E24DC326

1. Check signal circuit voltage

1) IG Key "OFF", Engine "OFF".

2) Disconnect MAFS connector

3) IG Key "ON".

4) Measure the voltage of MAFS connector terminal 3.

Specification : 4.8V~5.1V

5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ Go to "2.Check short to ground in signal circuit" as follows.

2. Check short to ground in signal circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect MAFS connector and ECM connector

3) Check continuity between MAFS connector terminal 3 and chassis ground.

Specification : Discontinuity (Infinite Ω)

4) Is the measured resistance within the specification?

YES

▶ Go to "Component Inspection".

NO

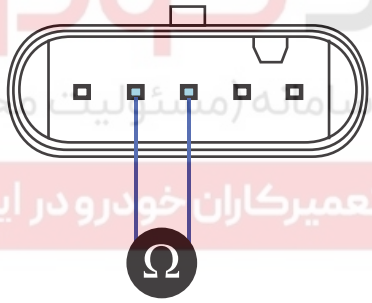
▶ Repair short to ground in signal circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION EA8455B4

1. IG Key "OFF", Engine "OFF".
2. Disconnect MAFS connector.
3. Measure resistance of MAFS component terminal 3 and terminal 2.

SPECIFICATION :

Temp.	-40℃	-20℃	0℃	20℃
Resistance	35.14 ~ 43.76KΩ	12.66 ~ 15.12KΩ	5.12 ~ 5.89KΩ	2.29 ~ 2.55KΩ
Temp.	40℃	60℃	80℃	
Resistance	1.10 ~ 1.24KΩ	0.57 ~ 0.65KΩ	0.31 ~ 0.37KΩ	



SLDFL6243L

4. Is the measured resistance at certain temperature within the specified resisance range at the temperature?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace MAFS ASSY' and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR EB3BD9D2

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.

5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0113 INTAKE AIR TEMPERATURE SENSOR1 CIRCUIT HIGH INPUT

COMPONENT LOCATION E0303ACA

Refer to DTC P0112.

GENERAL DESCRIPTION E38CF51F

Refer to DTC P0112.

DTC DESCRIPTION E0BD37D0

P0113 is set when the voltage above 4.886 V - maximum output voltage of IATS - is detected for more than 1 sec. This code is due to 1) open or 2) short to battery in IATS signal circuit.

DTC DETECTING CONDITION ED30EFFE

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage Monitoring</td><td rowspan="6">• IATS circuit
• IATS component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• When output signal is above the maximum value (above 4.886 V)</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 1.0 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• Intake air temperature is considered as 50°C</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SPECIFICATION E78AAAD6

Temp.	-40°C	-20°C	0°C	20°C
Resistance	35.14 ~ 43.76KΩ	12.66 ~ 15.12KΩ	5.12 ~ 5.89KΩ	2.29 ~ 2.55KΩ
Temp.	40°C	60°C	80°C	
Resistance	1.10 ~ 1.24KΩ	0.57 ~ 0.65KΩ	0.31 ~ 0.37KΩ	

SCHEMATIC DIAGRAM E715824D

Refer to DTC P0112.

SIGNAL WAVEFORM AND DATA E972F84A

Refer to DTC P0112.

MONITOR SCANTOOL DATA EC53796E

Refer to DTC P0112.

TERMINAL AND CONNECTOR INSPECTION E04B98E6

Refer to DTC P0112.

SIGNAL CIRCUIT INSPECTION E1AD8B33

1. Check signal circuit voltage

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect MAFS connector

   3) IG Key "ON".

   4) Measure the voltage of MAFS connector terminal 3.

Specification : 4.8V~5.1V

   5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection"

NO

▶ Go to "2.Check open in signal circuit" as follows.

2. Check open in signal circuit

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect MAFS connector and ECM connector

   3) Check continuity between MAFS connector terminal 3 and ECM connector (CUD-K) terminal 89.

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification?

YES

▶ Go to "3.Check short to battery in signal circuit " as follows

NO

▶ Repair open spots in signal circuit and go to "Verification of Vehicle Repair".

3. Check short to battery in signal circuit

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect MAFS connector and ECM connector

   3) IG Key "ON".

   4) Measure the voltage of MAFS connector terminal 3.

Specification : 0.0V~0.1V

5) Is abnormal voltage detected in the circuit with both connector disconnected?

YES

▶ Repair short to battery and go to "Verification of Vehicle Repair".

NO

▶ Go to "Ground Circuit Inspection".

GROUND CIRCUIT INSPECTION E2D3A32D

1. IG Key "OFF", Engine "OFF".
2. Disconnect MAFS connector and ECM connector
3. IG Key "ON".
4. Measure the voltage of MAFS connector terminal 3. [TEST "A"]
5. Measure the voltage of MAFS connector terminal 3 and terminal 2. [TEST "B"]
(terminal 3 : Check + prove , terminal 2 : Check - prove)

Specification : the voltage difference between TEST "A" and TEST "B" is within 200mV

6. Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

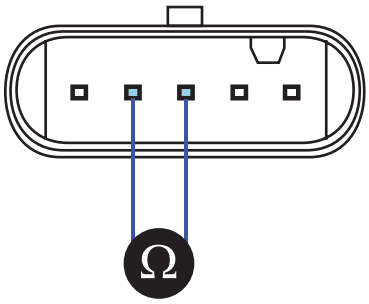
▶ When "B" voltage is not detected : Repair open in ground circuit and go to "Verification of Vehicle Repair".
▶ When the voltage difference between "A" and "B" is above 200mV : Eliminate the causes of excessive resistance and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E888CB6F

1. IG Key "OFF", Engine "OFF".
2. Disconnect MAFS connector.
3. Measure resistance of MAFS component terminal 3 and terminal 2.

SPECIFICATION :

Temp.	-40℃	-20℃	0℃	20℃
Resistance	35.14 ~ 43.76KΩ	12.66 ~ 15.12KΩ	5.12 ~ 5.89KΩ	2.29 ~ 2.55KΩ
Temp.	40℃	60℃	80℃	
Resistance	1.10 ~ 1.24KΩ	0.57 ~ 0.65KΩ	0.31 ~ 0.37KΩ	



SLDFL6243L

4. Is the measured resistance at certain temperature within the specified resisance range at the temperature?

YES

▶ Go to "Verification of Vehicle Repair".

NO

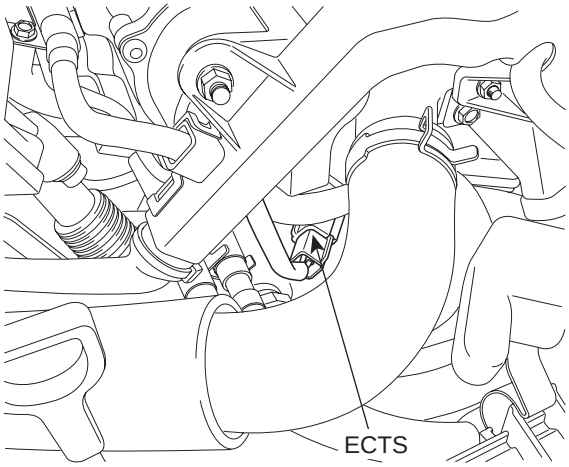
▶ Replace MAFS ASSY' and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR EEB82833

Refer to DTC P0112.

DTC P0117 ENGINE COOLANT TEMPERATURE CIRCUIT LOW INPUT

COMPONENT LOCATION E5554E86



SLDFL6246L

GENERAL DESCRIPTION E64AB719

Engine Coolant Temperature Sensor(ECTS), installed in coolant line, senses engine coolant temperature. With the information about engine coolant temperature, ECM performs fuel injection quantity correction, cooling fan control and glow relay operating duration control.
Especially, because ECTS signal is main variable of fuel injection quantity correction when engine is cold, sensor trouble makes starting engine difficult when engine is cold. If engine is running when ECTS is out of order, ECM considers engine coolant temperature as 80℃. And during cranking, ECM considers engine coolant temperature as -10℃. Besides, cooling fan, which is controlled based on ECTS signal, operates at HIGH-MODE to prevent engine from being overheated and supplementary heater is deactivated.

DTC DESCRIPTION E2A73AD8

P0117 is set when the voltage below 0.225 V - minimum output voltage of ECTS - is detected for more than 2.0 sec. This code is due to short to ground in signal circuit.

DTC DETECTING CONDITION E7111C3D

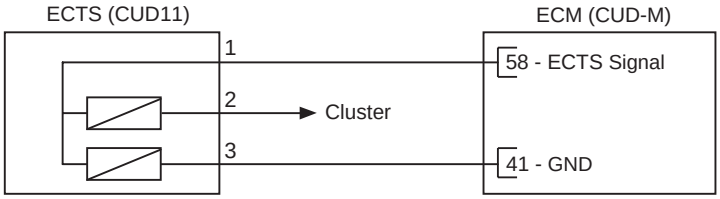
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="8">• ECTS circuit
• ECTS component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• Output signal below the minimum value.(below 0.225 V)</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 2.0 sec.</td></tr>
<tr><td rowspan="5">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="5">• A/C condensor fan control operation based on engine coolant temperature inhibited.
• PTC heater inhibited.
• Cooling fan is fixed at HIGH-MODE.
• During engine operation : temperature is fixed at 80℃
• At cold and cranking : temperature is fixed at -10℃</td></tr>
<tr><td>EGR Off</td><td>YES</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td rowspan="2">MIL</td><td rowspan="2">OFF</td></tr>
<tr></tr>
</table>

SPECIFICATION E46E9930

Temperature	-40℃	-20℃	0℃	20℃	40℃
Resistance	48.14kΩ	15.48±1.35kΩ	5.790kΩ	2.45±0.14kΩ	1.148kΩ
Temperature	60℃	80℃	100℃	110℃	120℃
Resistance	0.586kΩ	0.322kΩ	0.188kΩ	0.147±0.002kΩ	0.116kΩ

SCHEMATIC DIAGRAM E9CD6369

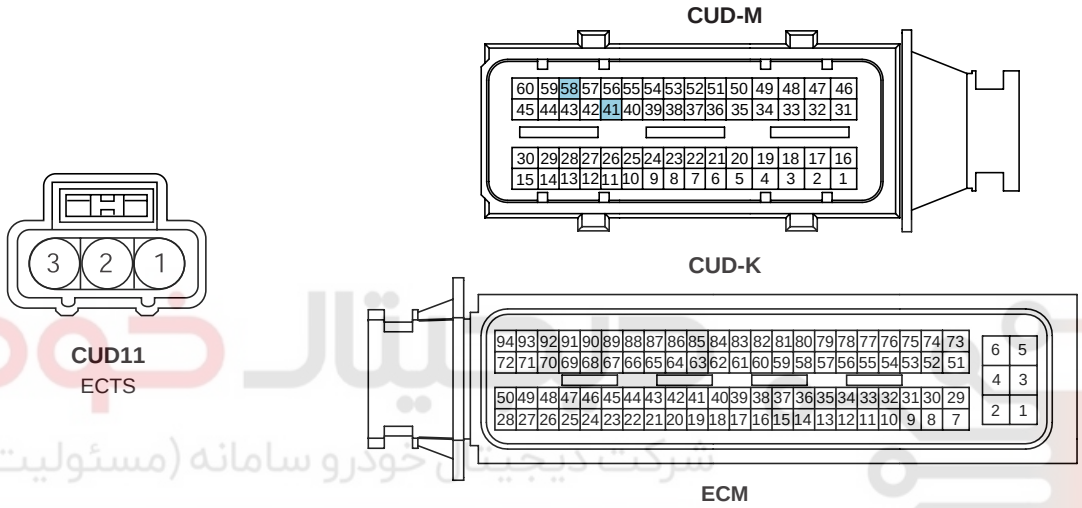
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

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

[HARNESS CONNECTORS]



SLDF27126L

SIGNAL WAVEFORM AND DATA E0606DE8

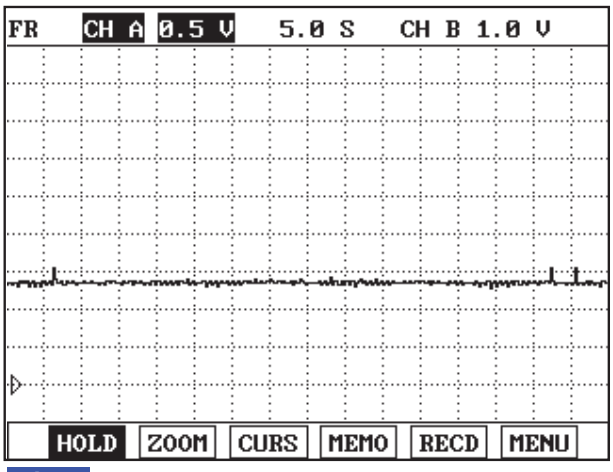


Fig.1

Fig.1) ECTS output signal at 80℃.The higher temperature rises, the lower signal voltage becomes.

SLDFL6247L

MONITOR SCANTOOL DATA ECEA7FE0

1. Connect Scantool to Data Link Connector (DLC).

2. Warm engine up to normal operating temperature.

3. Turn "OFF" electrical devices and A/C.

4. Monitor "ECTS" parameter on the Scantool.

Specification : Current enigne coolant temperature is displayed.

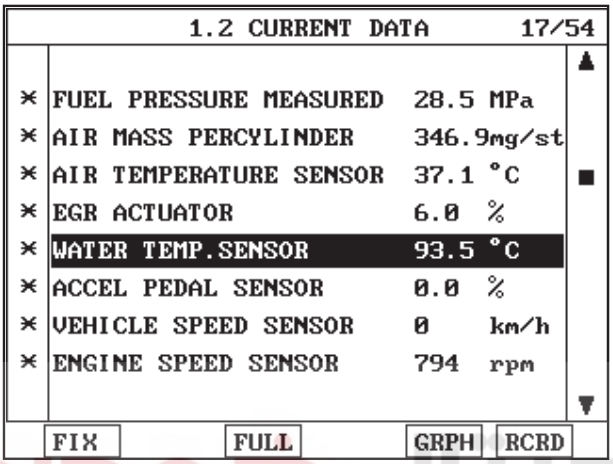


Fig.1

Fig.1) Check if 1) incorrect value is displayed 2) coolant temperature is fixed at 80℃ suddenly during driving 3)coolant temperature is fixed at -10℃ when turning IG KEY "ON". That coolant temperature is fixed at -10℃ or 80℃ means failure of ECTS. To prevent overheat of engine due to ECTS , if ECTS fails, cooling fan operates continuously.

SLDFL6248L

TERMINAL AND CONNECTOR INSPECTION E4E133DB

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.

2. Perform checking procedure as follows.

   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.

   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

NOTE

Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position.)

3. Is the problem found?

YES

▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

NO

▶ Go to "Signal Circuit Inspection ".

SIGNAL CIRCUIT INSPECTION E34DDDED

1. Check signal circuit voltage
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect ECTS connector.
   3) IG Key "ON".
   4) Measure the voltage of ECTS connector terminal 1.

Specification : 4.8V~5.1V

   5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ Go to "2.Check short to ground in signal circuit" as follows.

2. Check short to ground in signal circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect ECTS connector and ECM connector.
   3) Check continuity between ECTS connector terminal 1 and chassis ground.

Specification : Discontinuity (Infinite Ω)

   4) Is the measured resistance within the specification?

YES

▶ Go to "Component Inspection".

NO

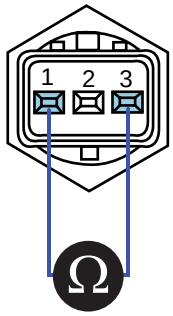
▶ Repair short to ground in signal circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION ECD328C5

1. IG Key "OFF", Engine "OFF".
2. Disconnect ECTS connector.
3. Measure resistance between ECTS terminal 1 and terminal 3.

SPECIFICATION :

Temperature	-40℃	-20℃	0℃	20℃	40℃
Resistance	48.14kΩ	15.48±1.35kΩ	5.790kΩ	2.45±0.14kΩ	1.148kΩ
Temperature	60℃	80℃	100℃	110℃	120℃
Resistance	0.586kΩ	0.322kΩ	0.188kΩ	0.147±0.002kΩ	0.116kΩ



SLDFL6251L

4. Is the measured resistance at certain temperature within the specified resisance range at the temperature?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace ECTS and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E9F24BF6

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0118 ENGINE COOLANT TEMPERATURE CIRCUIT HIGH INPUT

COMPONENT LOCATION E531AA06

Refer to DTC P0117.

GENERAL DESCRIPTION ED51E229

Refer to DTC P0117.

DTC DESCRIPTION E5819CE8

P0118 is set when the voltage above 4.965V - maximum output voltage of ECTS - is detected for more than 2.0 sec. This code is due to open or short to battery in signal circuit or open in ground circuit.

DTC DETECTING CONDITION EAB1FE4B

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="5">• ECTS circuit
• ECTS component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• Output signal above the maximum value(above 4965mV)</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 2.0 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• A/C condensor fan control operation based on engine coolant temperature inhibited.
• PTC heater inhibited.
• Cooling fan is fixed at HIGH-MODE.
• During engine operation : temperature is fixed at 80°C
• At cold and cranking : temperature is fixed at -10°C</td></tr>
<tr><td>EGR Off</td><td>YES</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SPECIFICATION E581BDEC

Temperature	-40°C	-20°C	0°C	20°C	40°C
Resistance	48.14kΩ	15.48±1.35kΩ	5.790kΩ	2.45±0.14kΩ	1.148kΩ
Temperature	60°C	80°C	100°C	110°C	120°C
Resistance	0.586kΩ	0.322kΩ	0.188kΩ	0.147±0.002kΩ	0.116kΩ

SCHEMATIC DIAGRAM E4460DF4

Refer to DTC P0117.

SIGNAL WAVEFORM AND DATA E7CFA4EA

Refer to DTC P0117.

MONITOR SCANTOOL DATA EEF922B7

Refer to DTC P0117.

TERMINAL AND CONNECTOR INSPECTION E58239DB

Refer to DTC P0117.

SIGNAL CIRCUIT INSPECTION EFAA8272

1. Check signal circuit voltage
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect ECTS connector.
   3) IG Key "ON".
   4) Measure the voltage of ECTS connector terminal 1.

Specification : 4.8V~5.1V

   5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ Go to "2.Check open in signal circuit" as follows.

2. Check open in signal circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect ECTS connector and ECM connector.
   3) Check continuity between ECTS connector terminal 1 and ECM connector (CUD-M) terminal 58.

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification?

YES

▶ Go to "3.Check short to battery in signal circuit" as follows.

NO

▶ Repair open in signal circuit and go to "Verification of Vehicle Repair".

3. Check short to battery in signal circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect ECTS connector and ECM connector.

3) IG Key "ON".

4) Measure the voltage of ECTS connector terminal 1.

Specification : 0.0V~0.1V

5) Is the measured voltage within the specification?

YES

▶ Go to "Ground Circuit Inspection".

NO

▶ Repair short to battery in signal circuit and go to "Verification of Vehicle Repair".

GROUND CIRCUIT INSPECTION EE715543

1. IG Key "OFF", Engine "OFF".
2. Disconnect ECTS connector.
3. IG Key "ON".
4. Measure the voltage of ECTS connector terminal 1. [TEST "A"]
5. Measure the voltage between ECTS connector terminal 1 and terminal 3. [TEST "B"]
   (terminal 1 : Check + prove , terminal 3 : Check - prove)

Specification : [TEST "A"] Voltage - [TEST "B"] Voltage = below 200mV

6. Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

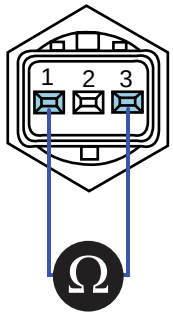
▶ When "B" voltage is not detected : Repair open in ground circuit and go to "Verification of Vehicle Repair".
▶ When the voltage difference between "A" and "B" is above 200mV : Eliminate the causes of excessive resistance and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E2B12AA5

1. IG Key "OFF", Engine "OFF".
2. Disconnect ECTS connector.
3. Measure resistance between ECTS terminal 1 and terminal 3.

SPECIFICATION :

Temperature	-40°C	-20°C	0°C	20°C	40°C
Resistance	48.14kΩ	15.48±1.35kΩ	5.790kΩ	2.45±0.14kΩ	1.148kΩ
Temperature	60°C	80°C	100°C	110°C	120°C
Resistance	0.586kΩ	0.322kΩ	0.188kΩ	0.147±0.002kΩ	0.116kΩ



SLDFL6251L

4. Is the measured resistance at certain temperature within the specified resisance range at the temperature?

YES

▶ Go to "Verification of Vehicle Repair".

NO

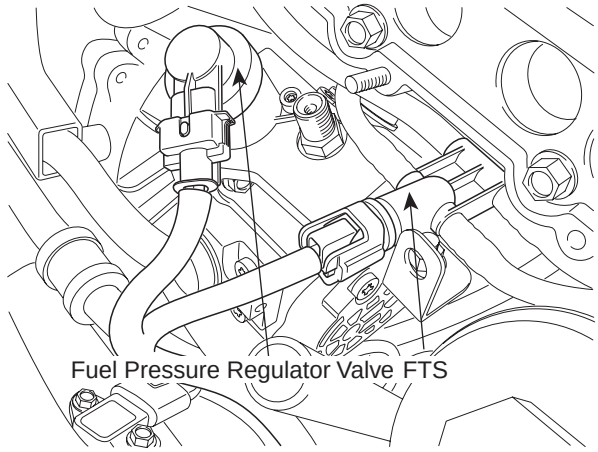
▶ Replace ECTS and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR EC0D6AAC

Refer to DTC P0117.

DTC P0182 FUEL TEMP SENSOR A CIRCUIT LOW INPUT

COMPONENT LOCATION E6F29BB7



SLDFL6254L

GENERAL DESCRIPTION EA7C9CFA

Fuel Temperature Sensor is NTC thermistor installed in fuel supplying line. It senses the temperature of fuel supplied to high pressure pump. Fuel temperature is limited (engine power is limited) to keep fuel temperature from reaching at 120°C. This limit is to protect fuel line such as high pressure pump and injectors from damages due to rapid deterioration by vapor-lock phenomenon which can occur at high temperature or destruction of oil membrane.

DTC DESCRIPTION EFD9D62D

P0182 is set when the voltage below 0.053V - minimum voltage of FTS output - is detected for more than 2.0 sec.. This code is due to short to ground in FTS signal circuit.

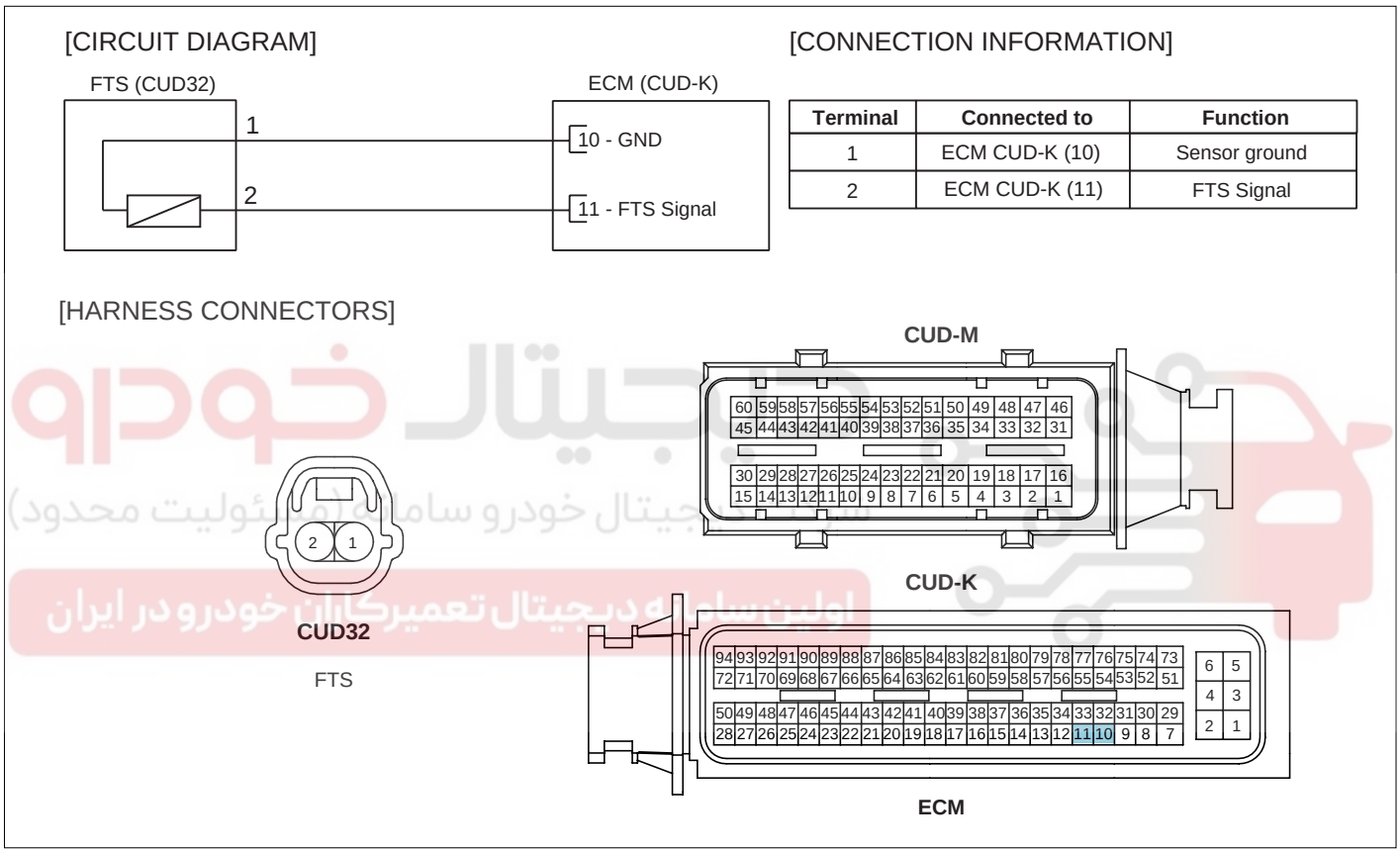
DTC DETECTING CONDITION E4DAD3A0

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage Monitoring</td><td rowspan="6">• FTS circuit
• FTS component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• When output signal is below the minimum value.(below 53mV)</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 2.0sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• Fuel temp. fixed at 40°C</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SPECIFICATION E343D0D0

Temperature	-30℃	-20℃	-10℃	0℃	20℃
Resistance	22.22~31.78kΩ	13.24~18.10kΩ	8.16~10.74kΩ	5.18~6.60kΩ	2.27~2.73kΩ
Temperature	40℃	50℃	60℃	70℃	
Resistance	1.059~1.281kΩ	0.748~0.904kΩ	0.538~0.650kΩ	0.392~0.476kΩ	

SCHEMATIC DIAGRAM EF460A38



SLDF27131L

SIGNAL WAVEFORM AND DATA ED80B756

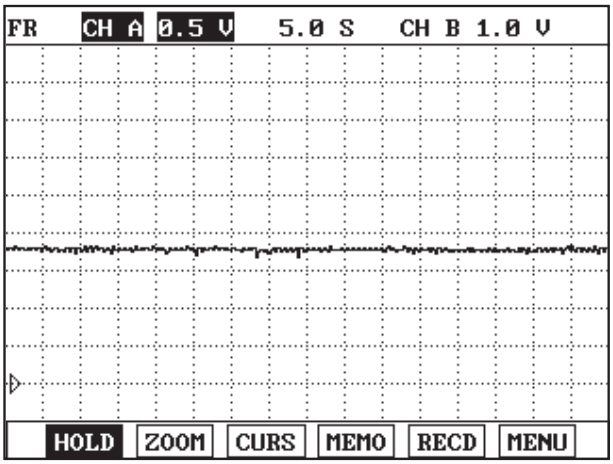


Fig.1

Fig.1) FTS output signal at 50℃.The higher temperature rises, the lower signal voltage becomes.

SLDFL6255L

MONITOR SCANTOOL DATA E1F332C0

1. Connect Scantool to Data Link Connector (DLC).
2. Warm engine up to normal operating temperature.
3. Turn "OFF" electrical devices and A/C.
4. Monitor "FUEL TEMPERATURE" parameter on the scantool.

Specification :Fuel temperature is displayed

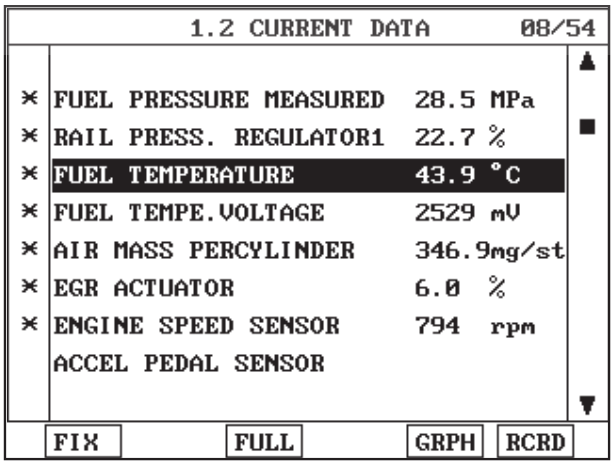


Fig.1

Fig.1) Check if too high or low temperature is displayed.(too high or low temperature is abnormal value.)

SLDFL6256L

TERMINAL AND CONNECTOR INSPECTION E1FB19AD

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.
2. Perform checking procedure as follows.

1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.

2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

NOTE

Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector or checking connecting condition. (after checking, reconnect the pin at correct position.)

3. Is the problem found?

YES

▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

NO

▶ Go to "Signal Circuit Inspection ".

SIGNAL CIRCUIT INSPECTION ECA426B0

1. Check signal circuit voltage

1) IG Key "OFF", Engine "OFF".

2) Disconnect FTS connector.

3) IG Key "ON".

4) Measure the voltage of FTS connector terminal 2 .

Specification : 4.8V~5.1V

5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ Go to "2.Check short to ground in signal circuit" as follows.

2. Check short to ground in signal circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect FTS connector and ECM connector.

3) Check continuity between FTS connector terminal 2 and chassis ground.

Specification : Discontinuity (Infinite Ω)

4) Is the measured resistance within the specification?

YES

▶ Go to "Component Inspection".

NO

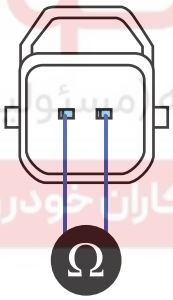
▶ Repair short to ground in signal circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E506078E

1. IG Key "OFF", Engine "OFF".
2. Disconnect FTS connector.
3. Measure resistance of FTS component terminal 1 and terminal 2.

SPECIFICATION :

Temperature	-30℃	-20℃	-10℃	0℃	20℃
Resistance	22.22~31.78kΩ	13.24~18.10kΩ	8.16~10.74kΩ	5.18~6.60kΩ	2.27~2.73kΩ
Temperature	40℃	50℃	60℃	70℃	
Resistance	1.059~1.281kΩ	0.748~0.904kΩ	0.538~0.650kΩ	0.392~0.476kΩ	



SLDFL6259L

4. Is the measured resistance at certain temperature within the specified resisance range at the temperature?

YES

▶ Go to "Verification of Vehicle Rapair".

NO

▶ Replace FTS and go to "Verification of Vehicle Rapair".

VERIFICATION OF VEHICLE REPAIR E3D87573

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.

5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0183 FUEL TEMP SENSOR A CIRCUIT HIGH INPUT

COMPONENT LOCATION E5DFFA83

Refer to DTC P0182.

GENERAL DESCRIPTION EC9A86AD

Refer to DTC P0182.

DTC DESCRIPTION E9F8563F

P0183 is set when the voltage above 4.912V - maximum voltage of FTS output - is detected for more than 2.0 sec.. This code is due to 1)open or short to battery in FTS signal circuit or 2)open in ground circuit.

DTC DETECTING CONDITION E91A32F1

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage Monitoring</td><td rowspan="6">• FTS circuit
• FTS component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• When output signal is above the maximum value.(above 4912mV)</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 2.0sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• Fuel temp. fixed at 40°C</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SPECIFICATION E744592D

Temperature	-30°C	-20°C	-10°C	0°C	20°C
Resistance	22.22~31.78kΩ	13.24~18.10kΩ	8.16~10.74kΩ	5.18~6.60kΩ	2.27~2.73kΩ
Temperature	40°C	50°C	60°C	70°C	
Resistance	1.059~1.281kΩ	0.748~0.904kΩ	0.538~0.650kΩ	0.392~0.476kΩ	

SCHEMATIC DIAGRAM EA47C3DD

Refer to DTC P0182.

SIGNAL WAVEFORM AND DATA E0B5445A

Refer to DTC P0182.

MONITOR SCANTOOL DATA E3A4FD1A

Refer to DTC P0182.

TERMINAL AND CONNECTOR INSPECTION E7619A3E

Refer to DTC P0182.

SIGNAL CIRCUIT INSPECTION E951CAC7

1. Check signal circuit voltage

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect FTS connector.

   3) IG Key "ON".

   4) Measure the voltage of FTS connector terminal 2 .

Specification : 4.8V~5.1V

   5) Is the measured voltage within the specification?

   YES

   ▶ Go to "Ground Circuit Inspection".

   NO

   ▶ Go to "2.Check open in signal circuit" as follows.

2. Check open in signal circuit

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect FTS connector and ECM connector.

   3) Check continuity between FTS connector terminal 2 and ECM connector(CUD-K) terminal 11.

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification?

   YES

   ▶ Go to "3. Check short to battery in signal circuit" as follows.

   NO

   ▶ Repair open in signal circuit and go to "Verification of Vehicle Repair".

3. Check short to battery in signal circuit

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect FTS connector and ECM connector.

   3) IG Key "ON".

   4) Measure the voltage of FTS connector terminal 2.

Specification : 0.0V~0.1V

5) Is the measured voltage within the specification?

YES

▶ Go to "Ground Circuit Inspection".

NO

▶ Repair short to battery and go to "Verification of Vehicle Repair".

GROUND CIRCUIT INSPECTION E7D25B13

1. IG Key "OFF", Engine "OFF".
2. Disconnect FTS connector and ECM connector.
3. IG Key "ON".
4. Measure the voltage of FTS connector terminal 2.[TEST "A"]
5. Measure the voltage between FTS connector terminal 2 and terminal 1. [TEST "B"]
(terminal 2 : Check + prove , terminal 1 : Check - prove)

Specification : [TEST "A"] Voltage - [TEST "B"] Voltage = below 200mV

6. Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

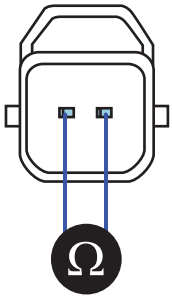
▶ When "B" voltage is not detected : Repair open in ground circuit and go to "Verification of Vehicle Repair".
▶ When the voltage difference between "A" and "B" is above 200mV : Eliminate the causes of excessive resistance and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION ED298289

1. IG Key "OFF", Engine "OFF".
2. Disconnect FTS connector.
3. Measure resistance of FTS component terminal 1 and terminal 2.

SPECIFICATION :

Temperature	-30℃	-20℃	-10℃	0℃	20℃
Resistance	22.22~31.78kΩ	13.24~18.10kΩ	8.16~10.74kΩ	5.18~6.60kΩ	2.27~2.73kΩ
Temperature	40℃	50℃	60℃	70℃	
Resistance	1.059~1.281kΩ	0.748~0.904kΩ	0.538~0.650kΩ	0.392~0.476kΩ	



SLDFL6259L

4. Is the measured resistance at certain temperature within the specified resisance range at the temperature?

YES

▶ Go to "Verification of Vehicle Rapair".

NO

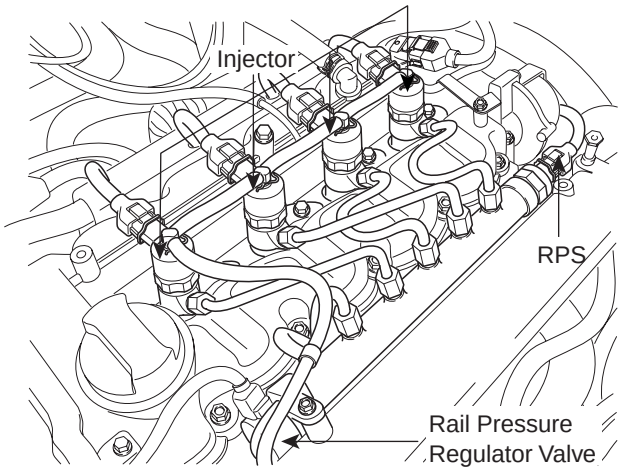
▶ Replace FTS and go to "Verification of Vehicle Rapair".

VERIFICATION OF VEHICLE REPAIR E6BFAA28

Refer to DTC P0182.

DTC P0192 FUEL RAIL PRESS. SENSOR-LOW INPUT

COMPONENT LOCATION EC1C3976



SLDFL6262L

GENERAL DESCRIPTION E5539489

RPS(Rail Pressure Sensor), consists of piezzo electric element, measures rail pressure inside of common rail. ECM determines optimum fuel injection quantity at specific engine condition based on RPS signal. RPS signal is also used as rail pressure regualtor feed back signal in order to achieve optimum rail pressure at certain engine condition.

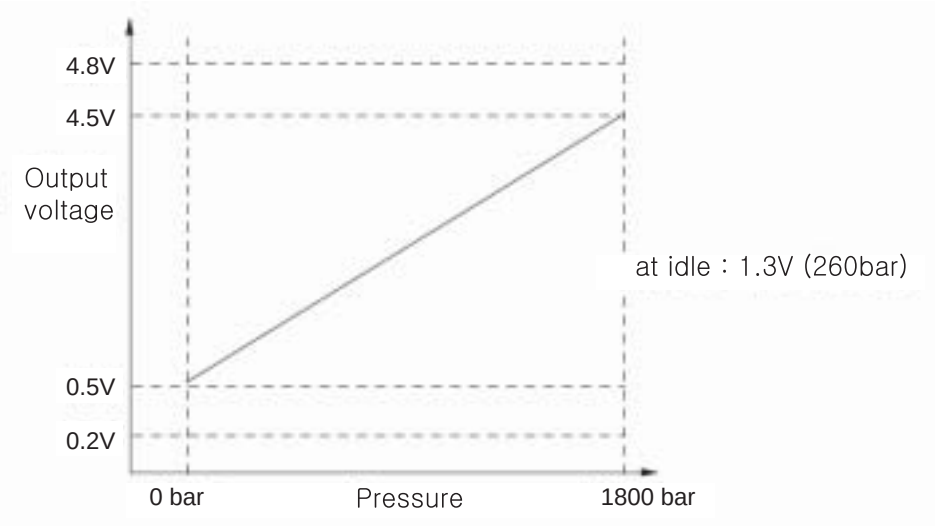
DTC DESCRIPTION E9991C98

P0192 is set when RPS output voltage is below the minimum value of 0.254V for more than 0.2 sec.. This code is due to the open in power circuit or the short to ground in signal circuit.

DTC DETECTING CONDITION EBB6AB41

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• RPS circuit
• RPS component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• Output sinal below minimum value (below 254mV)</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 200ms</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• Rail press. Sensor value fixed at 330bar</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>YES</td></tr>
<tr><td>MIL</td><td>ON</td></tr>
</table>

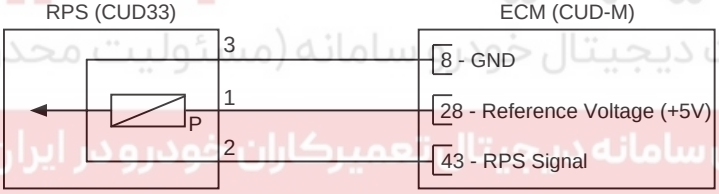
SPECIFICATION E0D5DCB4



SLDFL6264L

SCHEMATIC DIAGRAM EF845CFD

[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

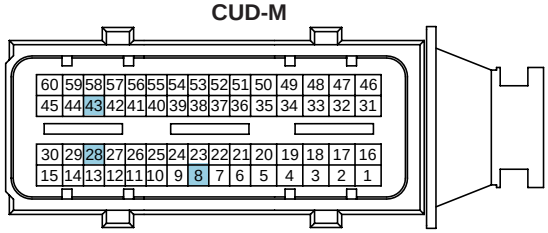
Terminal	Connected to	Function
1	ECM CUD-M (28)	Reference Voltage (+5V)
2	ECM CUD-M (43)	RPS Signal
3	ECM CUD-M (8)	Sensor Signal

[HARNESS CONNECTORS]

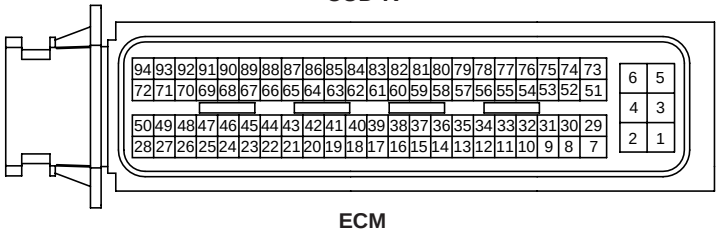
CUD33

RPS

CUD-M



CUD-K



ECM

SLDF27130L

SIGNAL WAVEFORM AND DATA E3BC3F22

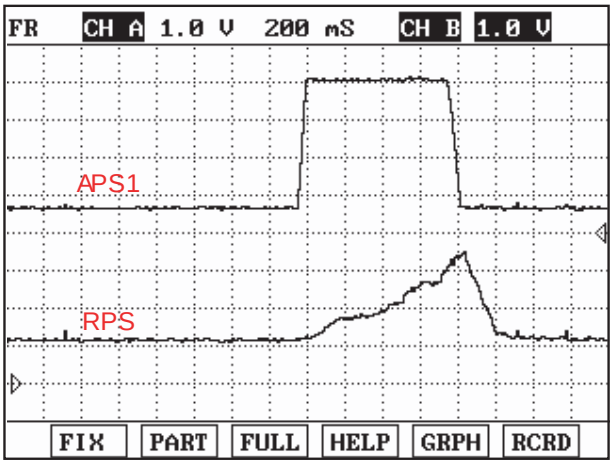


Fig.1

Fig.1) APS 1 and RPS signals are measured simultaneously.
This waveform shows the rise of RPS output voltage at rapid acceleration.

SLDFL6265L

MONITOR SCANTOOL DATA E1EE8810

1. Connect Scantool to Data Link Connector (DLC).
2. Warm engine up to normal operating temperature.
3. Turn "OFF" electrical devices and A/C.
4. Monitor "FUEL PRESSURE MEASURED", "RAIL PRESS. REGULATOR1", "INJ. PUMP REGULATOR" parameter on the Scantool.

SPECIFICATION :

	Idle(without load)	Accelerating(stall test)	Diagnosis
INJ. PUMP REGULATOR	38 ± 5%	32 ± 5%	duty decreases
FUEL PRESSURE MEASURED	28.5 ± 5 Mpa	145 ± 10 Mpa	press. increases
RAIL PRESS. REGULATOR1	19 ± 5%	48 ± 5%	duty increases

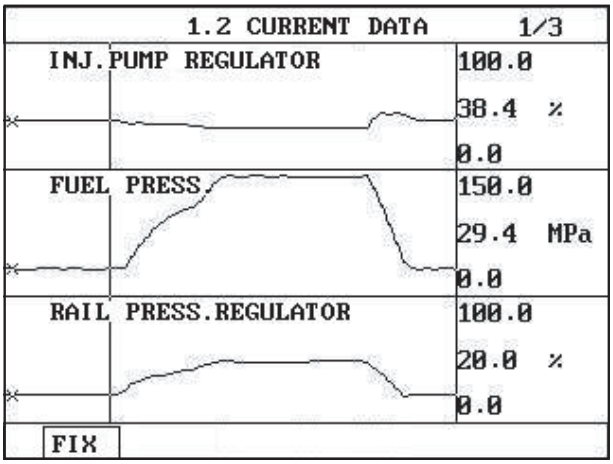


Fig.1

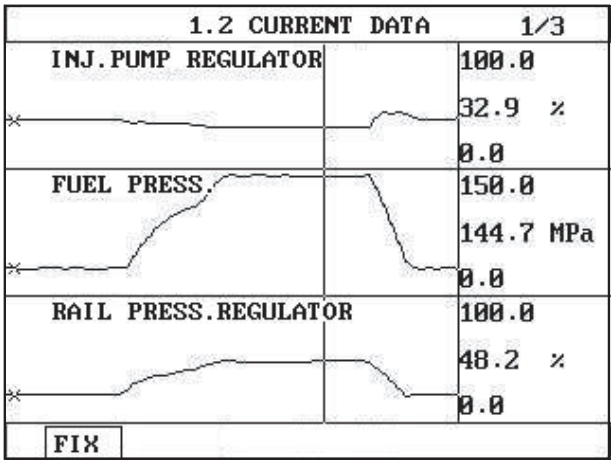


Fig.2

Fig.1) The position of curser on the graph represents idle data.
Fig.2) Data during acceleration(stall test).

SLDFL6291L

NOTE

The waveform of fuel metering unit installed at high pressure pump(fuel detecting MPROP) shows 38% duty at idle, duty drops to approx. 32% at acceleration to raise rail pressure. Duty drop means the decrease of current.
→ Fuel delivered to common rail increases as current drops.

The waveform of rail pressure control valve installed at common rail shows 19% duty at idle, duty rises to approx. 48% at acceleration to raise rail pressure. Duty rise means the increase of current.
→ If current rises, the returning quantity of fuel deliverd to common rail decreases and common rail pressure rises.

TERMINAL AND CONNECTOR INSPECTION EDE53199

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.

2. Perform checking procedure as follows.

   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.

   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

NOTE

Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position.)

3. Is the problem found?

YES

▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

NO

▶ Go to "Power Circuit Inspection".

POWER CIRCUIT INSPECTION E0B356F9

1. IG Key "OFF", Engine "OFF".
2. Disconnect RPS connector.
3. IG Key "ON".
4. Measure the voltage of RPS connector terminal "1".

Specification : 4.8V~5.1V

5. Is the measured voltage within the specification?

YES

▶ Go to "Signal Circuit Inspection".

NO

▶ Repair open in RPS power circuit and go to "Verification of Vehicle Repair".
[Check the circuit between RPS connector terminal 1 and ECM connector(CUD-M) terminal 28.]

SIGNAL CIRCUIT INSPECTION E869351B

1. Check signal circuit voltage
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect RPS connector.
   3) IG Key "ON".
   4) Measure the voltage of RPS connector terminal 2.

Specification : 4.8V~5.1V

   5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ Go to "2.Check short to ground in signal circuit" as follows.

2. Check short to ground in signal circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect RPS connector and ECM connector.
   3) Check continuity between RPS connector terminal 2 and chassis ground.

Specification : Discontinuity (Infinite Ω)

   4) Is the measured resistance within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ Repair short to ground in signal circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E28F7BC8

1. Visual Inspection of RPS
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect RPS connector.
   3) Check if corrosion and damage in RPS terminal is detected.
   4) Check RPS mounting torque and oil leakage.
   5) Are the problems relevant to RPS found?

YES

▶ Replace RPS if necessary and go to "Verification of Vehicle Repair".

NO

▶ Go to "RPS waveform Inspection".

2. RPS Waveform Inspection
   1) IG Key "OFF", Engine "OFF".
   2) Connect RPS connector.
   3) Connect an Oscilloscope to RPS connector terminal 2.
   4) After turning engine "ON", Check waveform at idle and during acceleration.

SPECIFICATION :

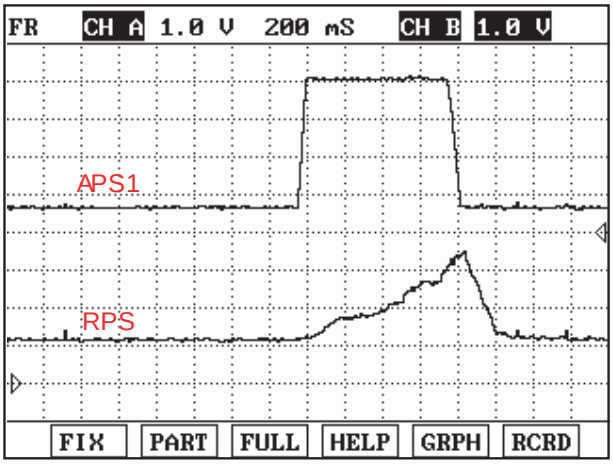


Fig.1

Fig.1) APS 1 and RPS signals are measured simultaneously.
This waveform shows the rise of RPS output voltage at rapid acceleration.

SLDFL6265L

5) Does RPS waveform look similar to standard "Signal Waveform & Data"?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace RPS and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR EB3D3E10

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0193 FUEL RAIL PRESS. SENSOR-HIGH INPUT

COMPONENT LOCATION EB31D7BD

Refer to DTC P0192.

GENERAL DESCRIPTION E5686219

Refer to DTC P0192.

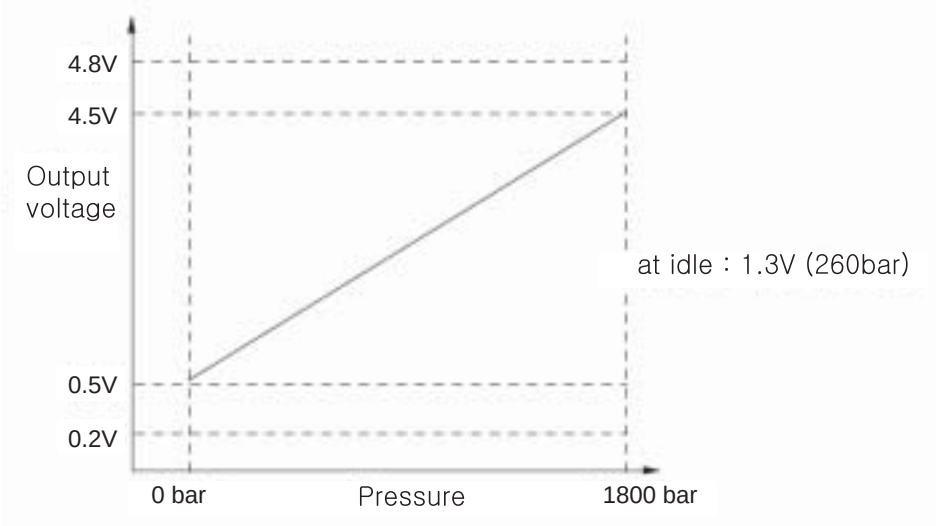
DTC DESCRIPTION E85D58A5

P0193 is set when RPS output voltage is above the maximum value of 4.75V for more than 0.2 sec.. This code is due to 1) short to battery in signal circuit 2) open in signal circuit or 3) open in ground circuit.

DTC DETECTING CONDITION E5F37B2F

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="5">• RPS circuit
• RPS component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• Output signal above the maximum value(above 4750mV)</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 200ms</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• Rail press. Sensor value fixed at 330bar</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>YES</td></tr>
<tr><td>MIL</td><td>ON</td></tr>
</table>

SPECIFICATION E0057016



SLDFL6264L

SCHEMATIC DIAGRAM E00E5508

Refer to DTC P0192.

SIGNAL WAVEFORM AND DATA E9C2CA70

Refer to DTC P0192.

MONITOR SCANTOOL DATA E44D1E99

Refer to DTC P0192.

TERMINAL AND CONNECTOR INSPECTION E73F9BC7

Refer to DTC P0192.

POWER CIRCUIT INSPECTION ED4A0149

1. IG Key "OFF", Engine "OFF".
2. Disconnect RPS connector.
3. IG Key "ON".
4. Measure the voltage of RPS connector terminal "1".

Specification : 4.8V~5.1V

5. Is the measured voltage within the specification?

YES

▶ Go to "Signal Circuit Inspection".

NO

▶ Repair open in RPS power circuit and go to "Verification of Vehicle Repair".
[Check open between RPS connector terminal 1 and ECM connector(CUD-M) terminal 28.]

SIGNAL CIRCUIT INSPECTION E16F2454

1. Check signal circuit voltage
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect RPS connector.
   3) IG Key "ON".
   4) Measure the voltage of RPS connector terminal 2.

Specification : 4.8V~5.1V

   5) Is the measured voltage within the specification?

YES

▶ Go to "Ground Circuit Inspection".

NO

▶ Go to "2. Check open in signal circuit" as follows.

2. Check open in signal circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect RPS connector and ECM connector.

3) Check continuity between RPS connector terminal 2 and ECM connector(CUD-M) terminal 43.

Specification : Continuity (below 1.0Ω)

4) Is the measured resistance within the specification?

YES

▶ Go to "3. Check short to battery in signal circuit" as follows.

NO

▶ Repair open in RPS signal circuit and go to "Verification of Vehicle Repair".
[Check the circuit between RPS connector terminal 2 and ECM connector (CUD-M) terminal 43.]

3. Check short to battery in signal circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect RPS connector and ECM connector.

3) IG Key "ON".

4) Measure the voltage of RPS connector terminal 2.

Specification : 0.0V~0.1V

5) Is abnormal voltage measured in signal circuit(with both connectors disconnected)?

YES

▶ Repair short to battery in signal circuit and go to "Verification of Vehicle Repair".

NO

▶ Go to "Component Inspection".

GROUND CIRCUIT INSPECTION EDFFFE1C

1. IG Key "OFF", Engine "OFF".
2. Disconnect RPS connector.
3. IG Key "ON".

4. Measure the voltage of RPS connector terminal 2. [TEST "A"]

5. Measure the voltage between RPS connector terminal 2 and terminal 3. [TEST "B"]
(terminal 2 : Check + prove , terminal 3 : Check - prove)

Specification : [TEST "A"] Voltage - [TEST "B"] Voltage = below 200mV

6. Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ When "B" voltage is not detected : Repair open in ground circuit and go to "Verification of Vehicle Repair".
▶ When the voltage difference between "A" and "B" is above 200mV : Eliminate the causes of excessive resistance and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E85756B1

1. Visual Inspection of RPS
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect RPS connector.
   3) Check if corrosion and damage in RPS terminal is detected.
   4) Check RPS mounting torque and oil leakage.
   5) Are the problems relevant to RPS found?

YES

▶ Replace RPS if necessary and go to "Verification of Vehicle Repair".

NO

▶ Go to "RPS waveform Inspection".

2. RPS Waveform Inspection
   1) IG Key "OFF", Engine "OFF".
   2) Connect RPS connector.
   3) Connect an Oscilloscope to RPS connector terminal 2.
   4) After turning engine "ON", Check waveform at idle and during acceleration.

SPECIFICATION :

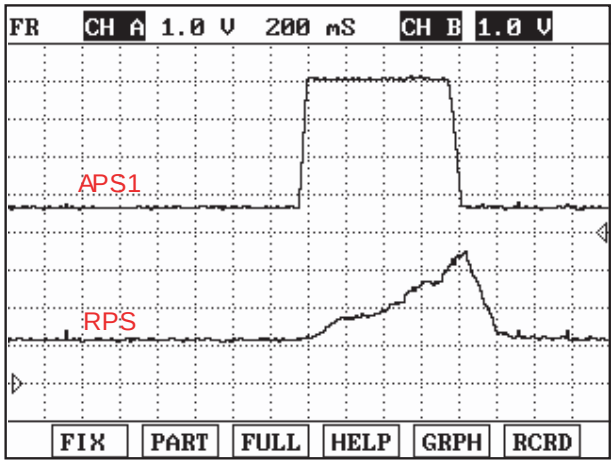


Fig.1

Fig.1) APS 1 and RPS signals are measured simultaneously.
This waveform shows the rise of RPS output voltage at rapid acceleration.

SLDFL6265L

5) Does RPS waveform look similar to standard "Signal Waveform & Data"?

YES

▶ Go to "Verification of Vehicle Repair".

NO

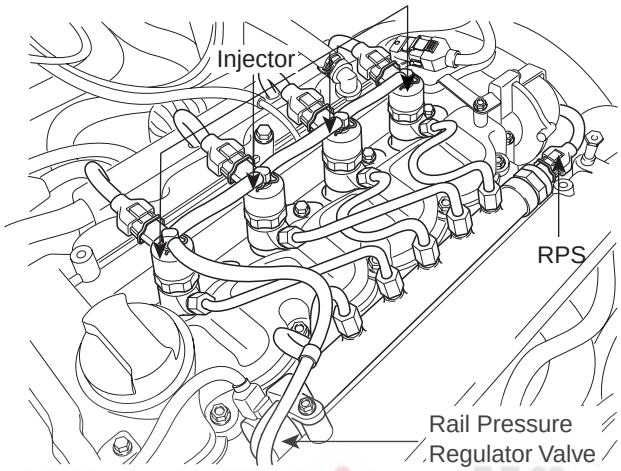
▶ Replace RPS and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E9D68C76

Refer to DTC P0192.

DTC P0201 CYLINDER 1-INJECTOR CIRCUIT/OPEN
DTC P0202 CYLINDER 2-INJECTOR CIRCUIT/OPEN
DTC P0203 CYLINDER 3-INJECTOR CIRCUIT/OPEN
DTC P0204 CYLINDER 4-INJECTOR CIRCUIT/OPEN

COMPONENT LOCATION E53F4FC5



SLDFL6270L

GENERAL DESCRIPTION EBDDA4BE

Injectors spray fuel in the highly compressed combustion chamber, and power generates through combustion process. Fuel pressure is raised to 1600bar in common rail diesel engine for the purpose of making fuel into minute particles. And fuel devided into minute particles leads smoke reduction, high power generation, and improved fuel efficiency. To control pressure of 1600bar with solenoid, oil pressure servo is applied. And injector solenoids is actuated by solenoid operating voltage raised to 80V with the method of current control. Needle valve inside of injector is located between A and B chamber. If applied pressure to B chamber is relived by injector solenoid, niddle valve is raised by the pressure of A chamber then, fuel is injected. If same pressure is applied to A and B chamber, niddle valve closes by the elasticity then, fuel injection stops. As electronically controlled injector is applied instead of mechanical injector, pilot and post injection, injeciton duration and quantity control are achieved. And engine performance is improved by these control.

DTC DESCRIPTION E7B301CB

P0201/P0202/P0203/P0204 is set when no current is detected in injector power and control circuit at injector #1 /#2/#3/#4 operating condition. This code is due to open in injector circuit or open in injector component coil.

DTC DETECTING CONDITION E0C86295

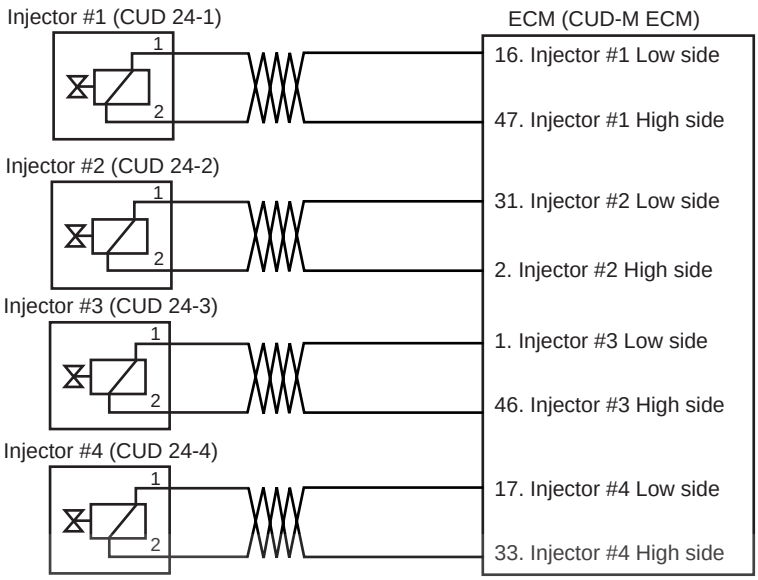
Item	Detecting Condition			Possible Cause
DTC Strategy	• Current monitoring			• Open in injector circuit • Injector component
Enable Conditions	• IG Key "ON"			
ThresholdValue	• Open in injector circuit			
DiagnosticTime	• Immediately			
Fail Safe	Fuel Cut	NO		
	EGR Off	NO		
	Fuel Limit	YES		
	MIL	ON		

SPECIFICATION E387FD6D

Injector Component Resistance	Injector Operating Voltage	Injector Operating Current	Injector Control Type
0.255 ±0.04Ω (20°C)	80V	Peak current : 18±0.5A Hold in current : 12±0.5A	Current control

SCHEMATIC DIAGRAM E6829E0F

[CIRCUIT DIAGRAM]



[CONNECTOR INFORMATION]

[Injector #1 (CUD 24-1)]

Terminal	Connected to	Function
1	CUD-M terminal 16	Injector #1
2	CUD-M terminal 47	Injector #1

[Injector #2 (CUD 24-2)]

Terminal	Connected to	Function
1	CUD-M terminal 2	Injector #2
2	CUD-M terminal 31	Injector #2

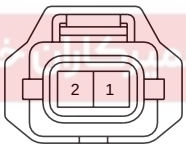
[Injector #3 (CUD 24-3)]

Terminal	Connected to	Function
1	CUD-M terminal1	Injector #3
2	CUD-M terminal 46	Injector #3

[Injector #4(CUD 24-4)]

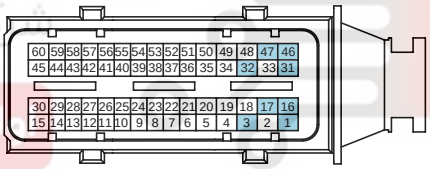
Terminal	Connected to	Function
1	CUD-M terminal 17	Injector #4
2	CUD-M terminal 33	Injector #4

[HARNESS CONNECTOR]

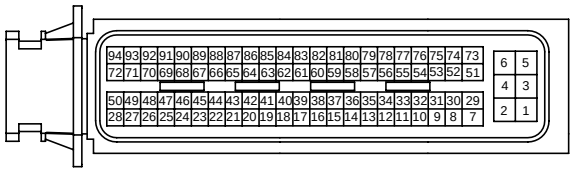


CUD 24-1,2,3,4
INJECTOR #1,2,3,4

CUD-M



CUD-K



ECM

SLDF27679L

SIGNAL WAVEFORM AND DATA E5D6629A

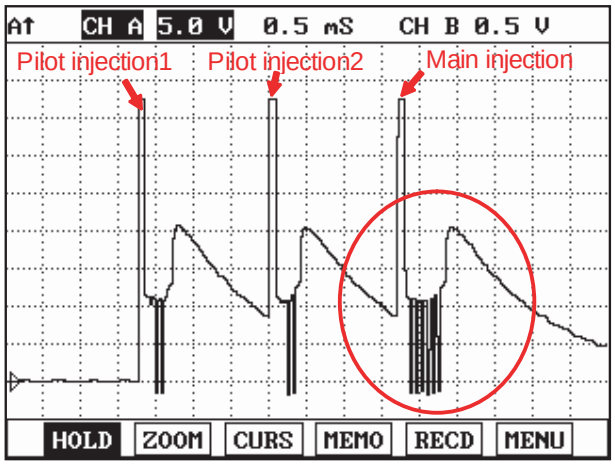


Fig.1

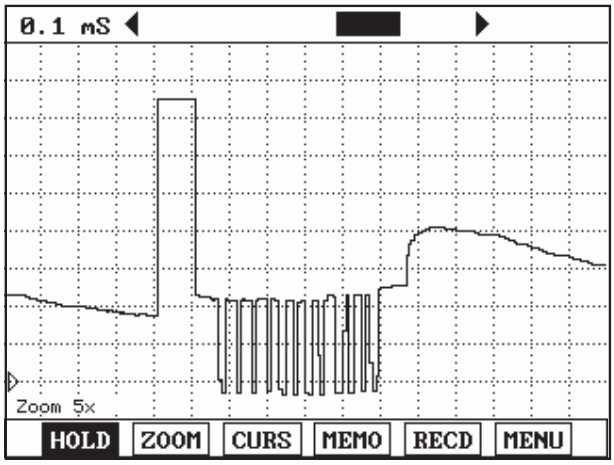


Fig.2

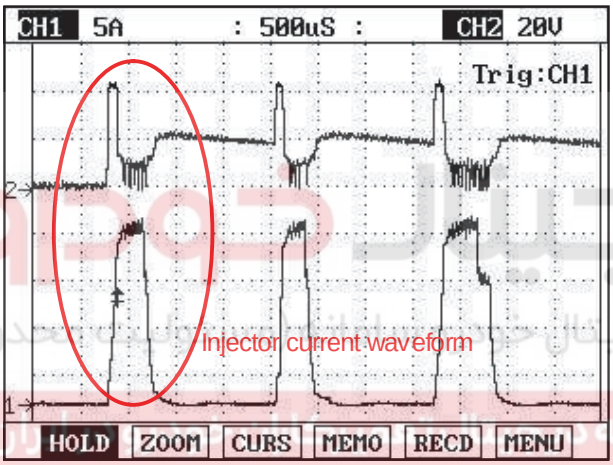


Fig.3

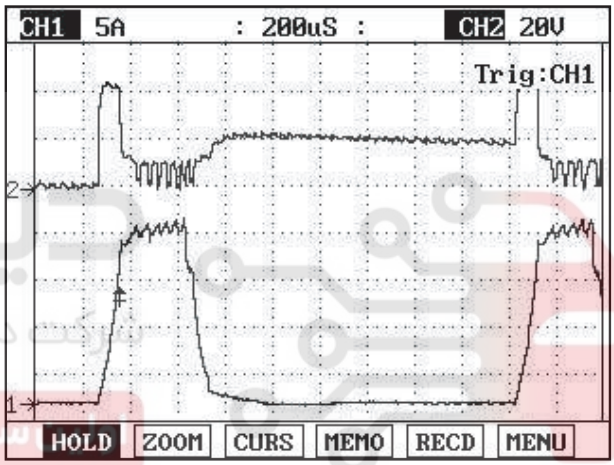


Fig.4

Fig.1) Injector operating waveform at Low side, It shows 2 pilot and 1 main injection.
Fig.2) Magnified waveform of main injection at Fig.1)
Fig.3) Injector voltage and current waveforms are measured at the same time using current prove of scope meter.
Fig.4) Magnified waveform of pilot injection at Fig.3)

SLDFL6273L

TERMINAL AND CONNECTOR INSPECTION E094B509

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.

2. Perform checking procedure as follows.

   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.

   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

   NOTE

   Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position.)

3. Is the problem found?

YES

▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

NO

▶ Go to "Power Circuit Inspection".

POWER CIRCUIT INSPECTION E02C21B3

1. IG Key "OFF", Engine "OFF".
2. Disconnect injector connector and ECM connector.
3. p0201) Check continuity between injector #1 connector terminal 2 and ECM connector(CUD-M) terminal 47.
   p0202) Check continuity between injector #2 connector terminal 2 and ECM connector(CUD-M) terminal 2.
   p0203) Check continuity between injector #3 connector terminal 2 and ECM connector(CUD-M) terminal 46.
   p0204) Check continuity between injector #4 connector terminal 2 and ECM connector(CUD-M) terminal 33.

Specification : Continuity (below 1.0Ω)

4. Is the measured resistance within the specification?

YES

▶ Go to "Control Circuit Inspection".

NO

▶ Repair open in injector power circuit and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION E0035CB4

1. IG Key "OFF", Engine "OFF".
2. Disconnect injector connector and ECM connector.
3. P0201) Check continuity between injector #1 connector terminal 1 and ECM connector(CUD-M) terminal 16.
   P0202) Check continuity between injector #2 connector terminal 1 and ECM connector(CUD-M) terminal 31.
   P0203) Check continuity between injector #3 connector terminal 1 and ECM connector(CUD-M) terminal 1.
   P0204) Check continuity between injector #4 connector terminal 1 and ECM connector(CUD-M) terminal 33.

Specification : Continuity (below 1.0Ω)

4. Is the measured resistance within the specification?

YES

▶ Go to "Component Inspection".

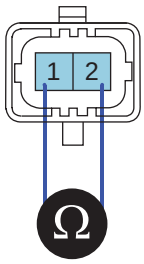
NO

▶ Repair open in injector control circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E19D896F

1. IG Key "OFF", Engine "OFF".
2. Disconnect injector connector.
3. Measure the resistance between injector component terminal 1 and terminal 2.

Specification : 0.255Ω ±0.04 (20°C).



SLDFL6276L

4. Is the measured resistance(of injector solenoid) within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace injector and go to "Verification of Vehicle Repair".

NOTE

Replacing injectors, peculiar IQA code of each injector should be inputted to ECM
Perform this process using "Injector data input" function on scantool, Refer to P1670, P1671 for more detailed information.

VERIFICATION OF VEHICLE REPAIR EEF095C3

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

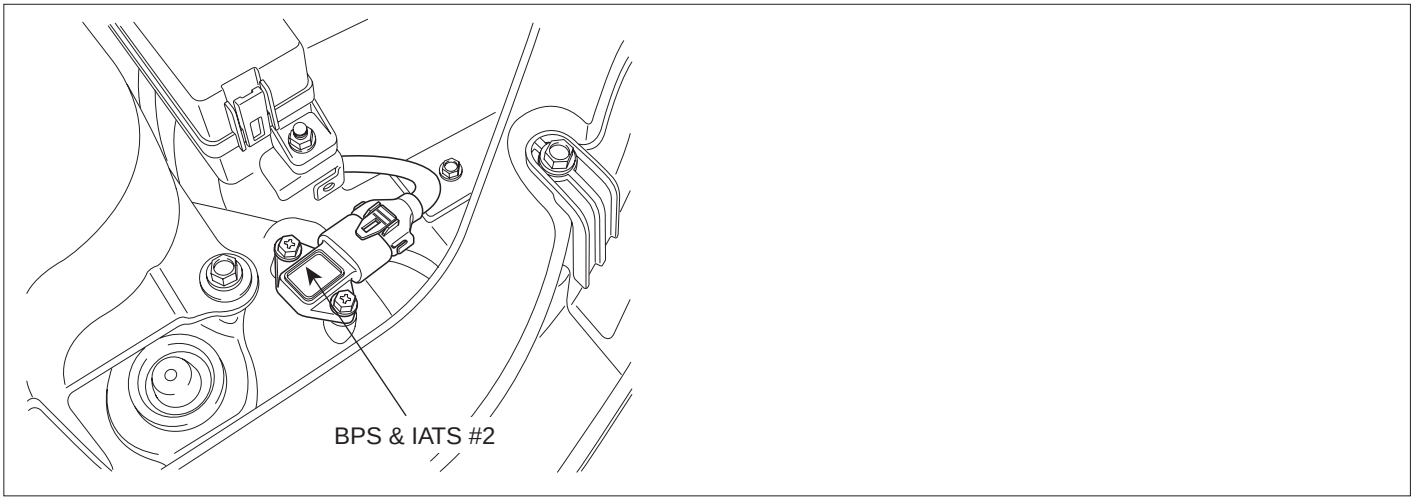
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0237 BOOST PRESSURE SENSOR CIRCUIT LOW INPUT

COMPONENT LOCATION EC2F6135



SLDFL6213L

GENERAL DESCRIPTION E2FA6A1A

Boost Pressure Sensor(BPS) is installed in intake manifold and senses the pressure of air inside of intake manifold which is compressed by turbo charager.Measuring mass air flow accurately with the information of intake mainfold pressure, mass air flow and intake air temperature, ECM performs actuating correction of EGR and VGT.When excessive intake manifold pressure is detected, engine power generation is limited to protect engine because too highly compressed pressure due to turbo charger may harm engine.

DTC DESCRIPTION E07B3F0C

P0237 is set when the voltage below 200mV - mimimum output voltage of BPS - is detected for more than 2.0 sec. This code is due to short to ground in signal circuit.

DTC DETECTING CONDITION E72EC464

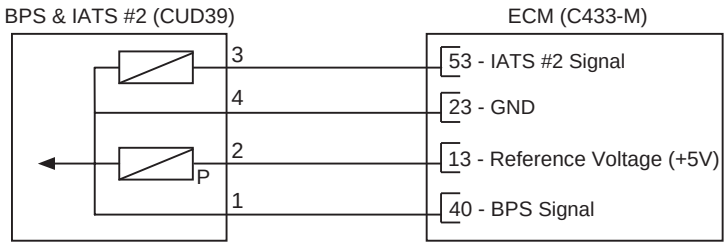
Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• BPS circuit • BPS component
Enable Conditions	• IG Key "ON"			
ThresholdValue	• Output signal below minimum value(below 200mV)			
DiagnosticTime	• 2.0 sec.			
Fail Safe	Fuel Cut	NO	• Boost pressure is fixed at 1000 hpa.	
	EGR Off	YES		
	Fuel Limit	YES		
	MIL	OFF		

SPECIFICATION EC08421A

Pressure [Kpa]	20	100	190	250
Outpur voltage [V]	0.4±0.077	1.878±0.063	3.541±0.063	4.650±0.077

SCHEMATIC DIAGRAM EFEEBD65

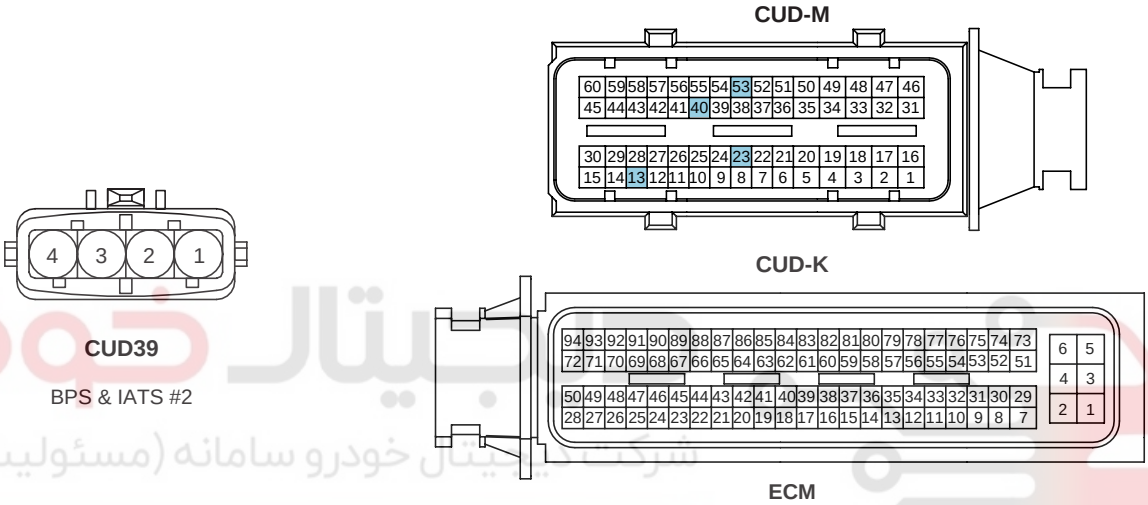
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM CUD-M (40)	BPS Signal
2	ECM CUD-M (13)	Reference Voltage (+5V)
3	ECM CUD-M (53)	IATS #2 Signal
4	ECM CUD-M (23)	Sensor ground

[HARNESS CONNECTORS]



SLDF27124L

SIGNAL WAVEFORM AND DATA EF929E3C

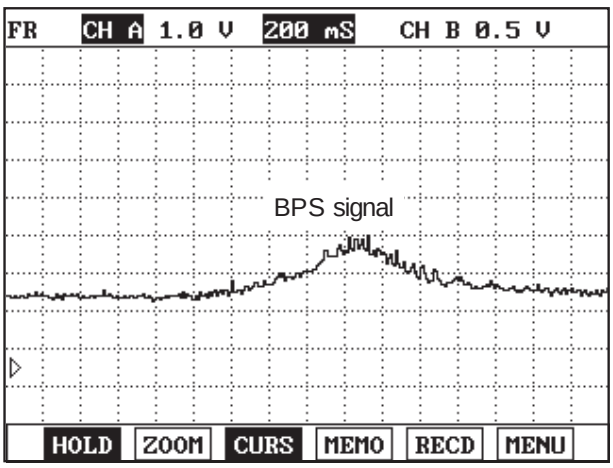


Fig.1

Fig1) This is the waveform of BPS as accelerating from idle state. Signal voltage rises as accelerating.

SLDFL6282L

MONITOR SCANTOOL DATA E6841383

1. Connect Scantool to Data Link Connector (DLC).

2. Warm engine up to normal operating temperature.
3. Turn "OFF" electrical devices and A/C.
4. Monitor "BOOST PRESSURE SENSOR" parameter on the Scantool.

Specification : 1000hpa ± 100hpa(VGT actuator : 75%) at idle

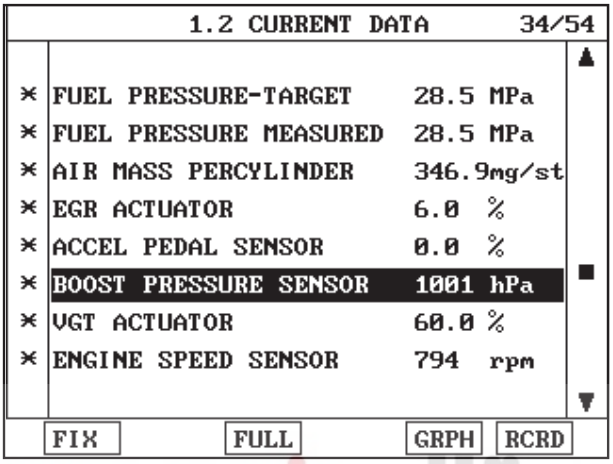


Fig.1

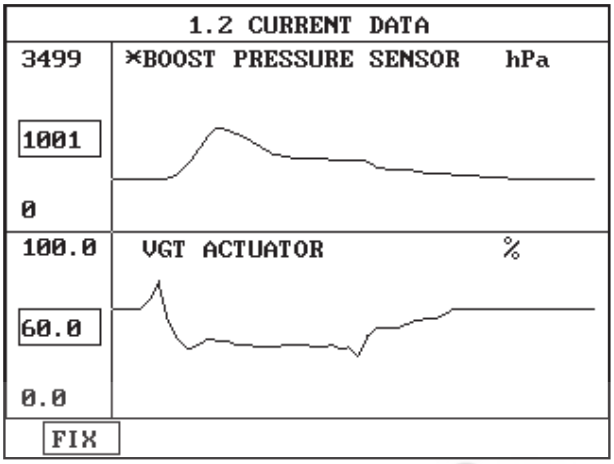


Fig.2

Fig1) Monitor "BOOST PRESSURE SENSOR" parameter on the Scantool at idle after warming engine up. 1000±100hpa(approx. 1 atm) is correct value.
Fig.2) VGT Control Solenoid Valve duty decreases and boost pressure increases as accelerating. If boost pressure rises and reaches certain value, VGT Control Solenoid Valve duty stops to drop and keeps steady. Releasing accelerator pedal at this moment, VGT Control Solenoid Valve duty drops to 9.8%, then if RPM drops to idle range, duty returns to 75%.

SLDFL6283L

TERMINAL AND CONNECTOR INSPECTION E6A44402

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.
2. Perform checking procedure as follows.
   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.
   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

NOTE

Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position.)

3. Is the problem found?

YES

▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

NO

▶ Go to "Power Circuit Inspection".

POWER CIRCUIT INSPECTION EFF16115

1. IG Key "OFF", Engine "OFF".
2. Disconnect BPS connector.
3. IG Key "ON".
4. Measure the voltage of BPS connector terminal 2.

Specification : 4.8V~5.1V

5. Is the measured voltage within the specification?

YES

▶ Go to "Signal Circuit Inspection".

NO

▶ Repair open in power circuit and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION E7EE9E08

1. Check signal circuit voltage
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect BPS connector.
   3) IG Key "ON".
   4) Measure the voltage of BPS connector terminal 1.

Specification : 4.8V~5.1V

   5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ Go to "2. Check short to ground in signal circuit" as follows.

2. Check short to ground in signal circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect BPS connector and ECM connector.
   3) Check continuity between BPS connector terminal 1 and chassis ground.

Specification : Discontinuity (Infinite Ω)

   4) Is the measured resistance within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ Repair short to ground in signal circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION EA665755

1. BPS visual inspection

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect BPS connector.

   3) Check if corrosion and damage in BPS terminal is detected.

   4) Check BPS mounting state, leakage at O'ring, clogged carbon at pressure detecting hall.

   5) Are the problems relevant to BPS found?

   YES

   ▶ Replace BPS if necessary and go to "Verification of Vehicle Repair".

   NO

   ▶ Go to "2. Check VGT Turbo charger and leakage in intake system" as follows.

2. Check VGT turbo charger and leakage in intake system

   1) IG Key "OFF", Engine "OFF".

   2) Check if VGT actuating rod which is connected to diaphragm of VGT turbo charger assy' is at the bottom position.

   3) IG Key "ON", Engine "ON".

   4) Check if VGT actuating rod is pulled upward Approx. 10mm when engine is about to start.

   5) As accelerating and decelerating, Check if VGT actuating rod moves upward and downward.

   6) Check if intake air leak is detected at intake hose at acceleration.
   (Check if intake hose inflates properly.)

   7) Are the problems relevant to VGT turbo charger and intake hose found?

   YES

   ▶ VGT actuating rod does not work.
   ☞ If any problem is not detected after checking connecting condition of VGT actuator vacuum hose and VGT actuator operating states(refer to "Component Inspection" of P0048), VGT actuator variable controlling part is considered as stuck. Replace VGT turbo charger in this case.

   ▶ Intake air leak is detected.
   ☞ Checking intake hose is not damaged and band clamp is fastened well, repair trouble causing parts.

   If trouble causing parts are repaired, go to "Verification of Vehicle Repair".

NO

▶ Go to "3. BPS Waveform inspection" as follows.

3. BPS Waveform inspection

1) IG Key "OFF", Engine "OFF".

2) Connect BPS.

3) Connect Oscilloscope to BPS connector terminal 1.

4) Monitor the waveform at idle and acceleration after ENGINE "ON".

SPECIFICATION :

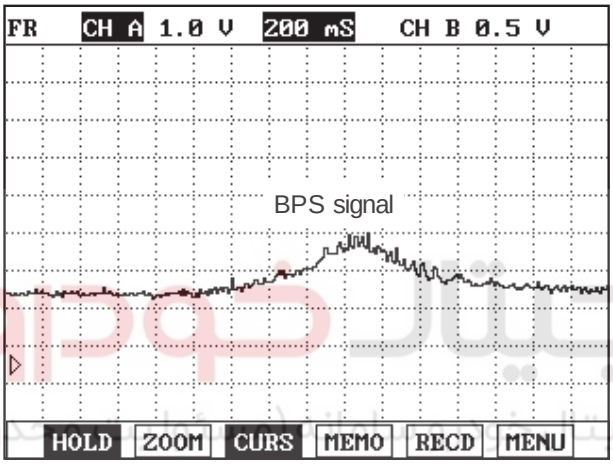


Fig.1

Fig1) This is the waveform of BPS as accelerating from idle state. Signal voltage rises as accelerating.

SLDFL6282L

5) Is BPS waveform displayed correctly?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace BPS and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR EFD71AD3

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0238 BOOST PRESSURE SENSOR CIRCUIT HIGH INPUT

COMPONENT LOCATION EDD53A61

Refer to DTC P0237.

GENERAL DESCRIPTION E1CDBAC9

Refer to DTC P0237.

DTC DESCRIPTION E7598FA3

P0238 is set when the voltage above 4.9V - maximum output voltage of BPS - is detected for more than 2 sec.. This code is due to 1) short to battery or open in signal circuit or 3) open in ground circuit.

DTC DETECTING CONDITION E87A8FE6

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="5">• BPS circuit
• BPS component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• Output signal above maximum value(above 4900mV)</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 2.0 sec</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• Boost pressure is fixed at 1000 hpa.</td></tr>
<tr><td>EGR Off</td><td>YES</td></tr>
<tr><td>Fuel Limit</td><td>YES</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SPECIFICATION E6323453

Pressure [Kpa]	20	100	190	250
Outpur voltage [V]	0.4±0.077	1.878±0.063	3.541±0.063	4.650±0.077

SCHEMATIC DIAGRAM EA5FB139

Refer to DTC P0237.

SIGNAL WAVEFORM AND DATA EB396C99

Refer to DTC P0237.

MONITOR SCANTOOL DATA EBCF5DE1

Refer to DTC P0237.

TERMINAL AND CONNECTOR INSPECTION E788BC8E

Refer to DTC P0237.

POWER CIRCUIT INSPECTION E2D3BC23

1. IG Key "OFF", Engine "OFF".
2. Disconnect BPS connector.
3. IG Key "ON".
4. Measure the voltage of BPS connector terminal 2.

Specification : 4.8V~5.1V

5. Is the measured voltage within the specification?

YES

▶ Go to "Signal Circuit Inspection".

NO

▶ Sensor power too high : Refer to circuit inspection of P0653.

SIGNAL CIRCUIT INSPECTION ED2479EA

1. Check signal circuit voltage
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect BPS connector.
   3) IG Key "ON".
   4) Measure the voltage of BPS connector terminal 1.

Specification : 4.8V~5.1V

   5) Is the measured voltage within the specification?

YES

▶ Go to "Ground Circuit Inspection".

NO

▶ Go to "2. Check open in signal circuit" as follows.

2. Check open in signal circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect BPS connector and ECM connector.
   3) Check continuity between BPS connector terminal 1 and ECM connector(CUD-M) terminal 40.

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification?

YES

▶ Repair short to battery in signal circuit and go to "Verification of Vehicle Repair".

NO

▶ Repair open in BPS signal circuit and go to "Verification of Vehicle Repair".

GROUND CIRCUIT INSPECTION EC0A2A15

1. IG Key "OFF", Engine "OFF".
2. Disconnect BPS connector.
3. IG Key "ON".
4. Measure the voltage of BPS connector terminal 2. [TEST "A"]
5. Measure the voltage between BPS connector terminal 2 and terminal 4. [TEST "B"]
   (terminal 2 : Check + prove , terminal 4 : Check - prove)

Specification : [TEST "A"] Voltage - [TEST "B"] Voltage = below 200mV

6. Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ When "B" voltage is not detected : Repair open in ground circuit and go to "Verification of Vehicle Repair".
▶ When the voltage difference between "A" and "B" is above 200mV : Eliminate the causes of excessive resistance and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION EB03C490

1. BPS visual inspection
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect BPS connector.
   3) Check if corrosion and damage in BPS terminal is detected.
   4) Check BPS mounting state, leakage at O'ring, clogged carbon at pressure detecting hall.
   5) Are the problems relevant to BPS found?

YES

▶ Replace BPS if necessary and go to "Verification of Vehicle Repair".

NO

▶ Go to "2. Check VGT Turbo charger and leakage in intake system" as follows.

2. Check VGT turbo charger and leakage in intake system

1) IG Key "OFF", Engine "OFF".

2) Check if VGT actuating rod which is connected to diaphragm of VGT turbo charger assy' is at the bottom position.

3) IG Key "ON", Engine "ON".

4) Check if VGT actuating rod is pulled upward Approx. 10mm when engine is about to start.

5) As accelerating and decelerating, Check if VGT actuating rod moves upward and downward.

6) Check if intake air leak is detected at intake hose at acceleration.
(Check if intake hose inflates properly.)

7) Are the problems relevant to VGT turbo charger and intake hose found?

YES

▶ VGT actuating rod does not work.
☞ If any problem is not detected after checking connecting condition of VGT actuator vacuum hose and VGT actuator operating states(refer to "Component Inspection" of P0048), VGT actuator variable controlling part is considered as stuck. Replace VGT turbo charger in this case.

▶ Intake air leak is detected.
☞ Checking intake hose is not damaged and band clamp is fastened well, repair trouble causing parts.

If trouble causing parts are repaired, go to "Verification of Vehicle Repair".

NO

▶ Go to "3. BPS Waveform inspection" as follows.

3. BPS Waveform inspection

1) IG Key "OFF", Engine "OFF".

2) Connect BPS.

3) Connect Oscilloscope to BPS connector terminal 1.

4) Monitor the waveform at idle and acceleration after ENGINE "ON".

SPECIFICATION :

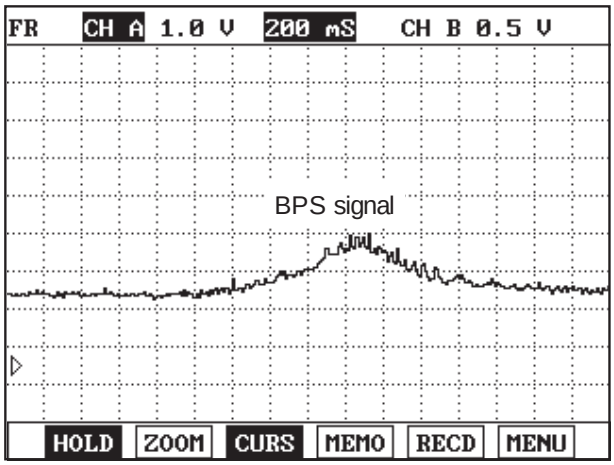


Fig.1

Fig1) This is the waveform of BPS as accelerating from idle state. Signal voltage rises as accelerating.

SLDFL6282L

5) Is BPS waveform displayed correctly?

YES

▶ Go to "Verification of Vehicle Repair".

NO

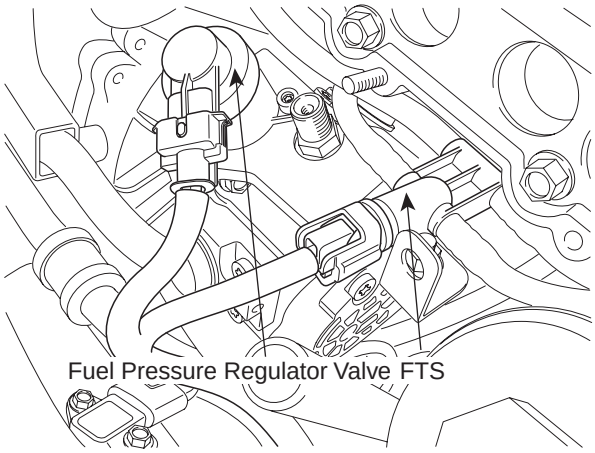
▶ Replace BPS and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E9E29917

Refer to DTC P0237.

DTC P0252 FUEL PRESSURE REGULATOR VALVE CIRCUIT OVER CURRENT

COMPONENT LOCATION EEC9002C



SLDFL6289L

GENERAL DESCRIPTION E078BA7C

Fuel Pressure Regulator Valve(FPRV) is integrated with high pressure pump and controls common rail pressure as regulating the quantity of fuel which is delivered to common rail. In order to control rail pressure to be optimum to current driving condition, ECM controls fuel pressure regulator valve operating current(with the method of duty-control) using RPCV signal, RPM and APS signal. The lower Fuel pressure regulator valve current is, the more fuel is supplied to common rail.

DTC DESCRIPTION E68A4127

P0252 is set when excessive current in control circuit of Fuel metering unit(integrated with high pressure pump) is detected for more than 0.22 sec.. This code is due to short to battery in control circuit or Fuel metering unit internal short.

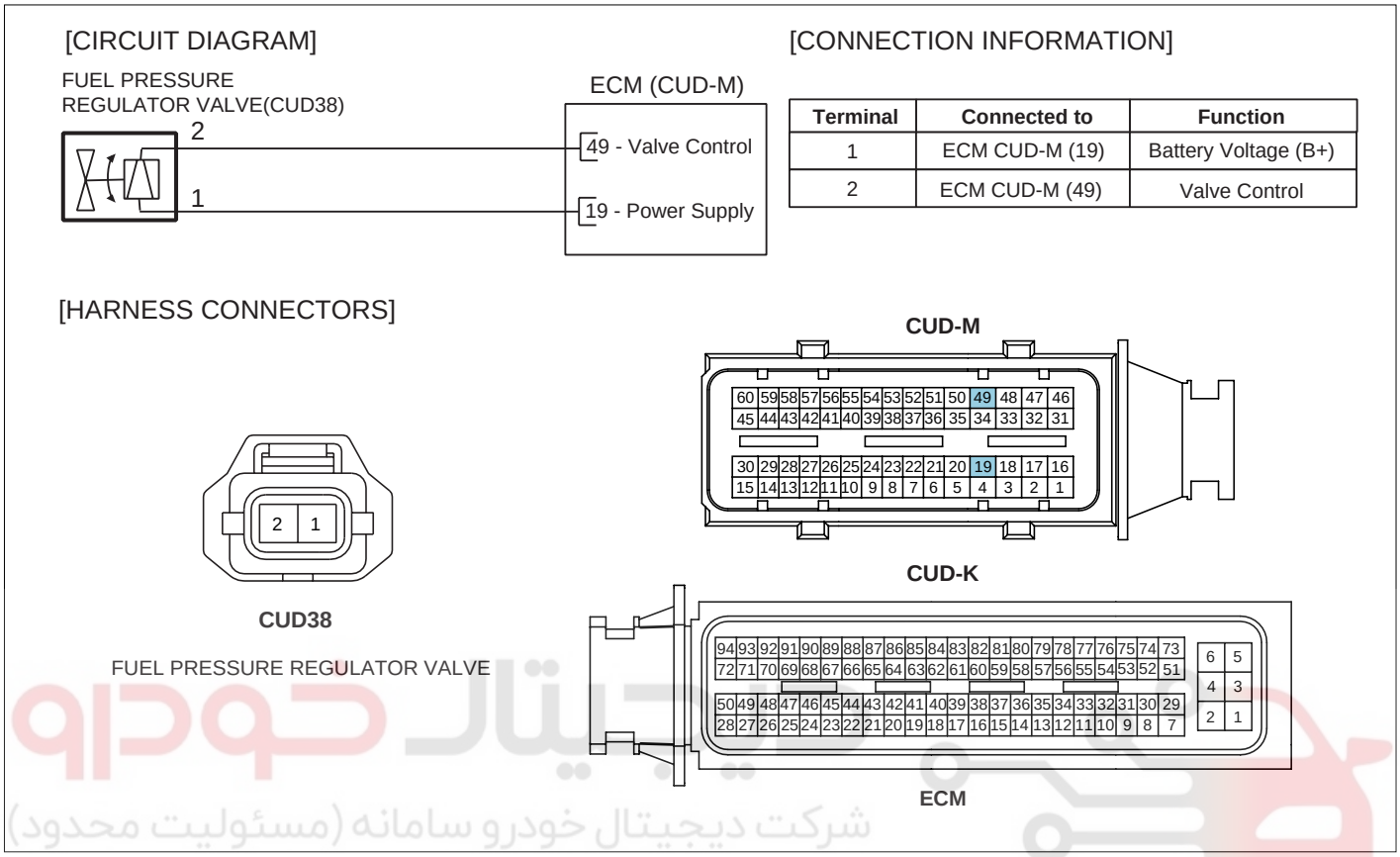
DTC DETECTING CONDITION EC1EBBDC

Item	Detecting Condition		Possible Cause
DTC Strategy	• Voltage monitoring		• FPRV circuit • FPRV component
Enable Conditions	• IG Key "ON"		
ThresholdValue	• Short to battery (control circuit in FPRV)		
DiagnosticTime	• 220ms		
Fail Safe	Fuel Cut	YES	
	EGR Off	NO	
	Fuel Limit	NO	
	MIL	ON	

SPECIFICATION E32DD507

rail pressure control valve resistance	Operating frequancy
2.6 ~ 3.15Ω (20℃)	185 Hz

SCHEMATIC DIAGRAM E303347C



SLDF27132L

SIGNAL WAVEFORM AND DATA E19ED82A

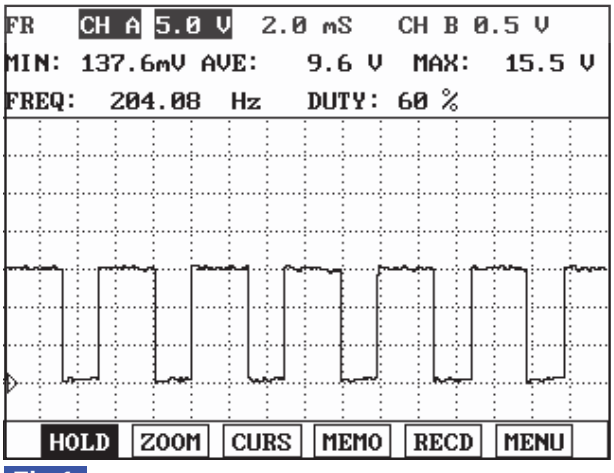


Fig.1

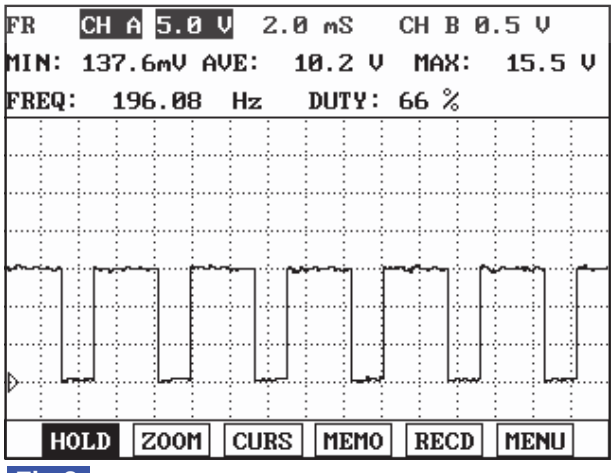


Fig.2

Fig.1) Waveform of fuel metering unit at idle. It shows approx. 38% duty.
Fig.2) Waveform of fuel metering unit as accelerating. Approx. 32% duty is outputted as engine load increases.
(When rail pressure increases as accelerating, rail pressure control valve duty(current) drops.)

SLDFL6290L

MONITOR SCANTOOL DATA E8DBAB13

1. Connect Scantool to Data Link Connector (DLC).

2. Warm engine up to normal operating temperature.

3. Turn "OFF" electrical devices and A/C.

4. Monitor "FUEL PRESSURE MEASURED", "RAIL PRESS. REGULATOR1", "INJ. PUMP REGULATOR" parameter on the Scantool.

SPECIFICATION :

	Idle(without load)	Accelerating(stall test)	Diagnosis
INJ. PUMP REGULATOR	38 ± 5%	32 ± 5%	duty decreases
FUEL PRESSURE MEASURED	28.5 ± 5 Mpa	145 ± 10 Mpa	press. increases
RAIL PRESS. REGULATOR1	19 ± 5%	48 ± 5%	duty increases

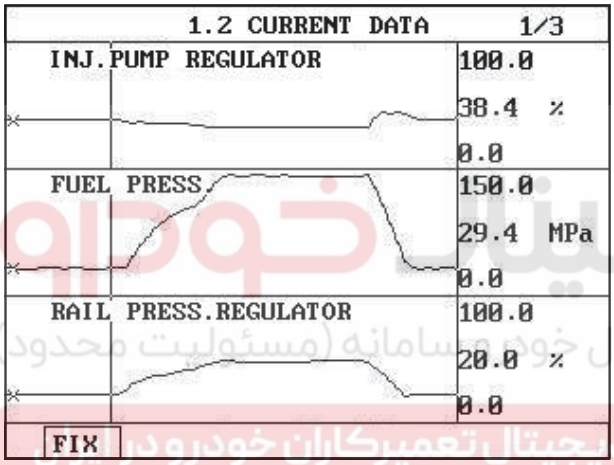


Fig.1

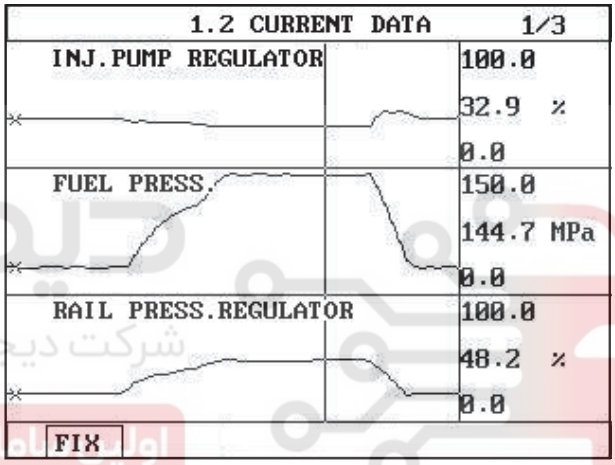


Fig.2

Fig.1) The position of curser on the graph represents idle data.
Fig.2) Data during acceleration(stall test).

SLDFL6291L

NOTE

The waveform of fuel metering unit installed at high pressure pump(fuel detecting MPROP) shows 38% duty at idle, duty drops to approx. 32% at acceleration to raise rail pressure. Duty drop means the decrease of current.
→ Fuel delivered to common rail increases as current drops.

The waveform of rail pressure control valve installed at common rail shows 19% duty at idle, duty rises to approx. 48% at acceleration to raise rail pressure. Duty rise means the increase of current.
→ If current rises, the returning quantity of fuel deliverd to common rail decreases and common rail pressure rises.

TERMINAL AND CONNECTOR INSPECTION E5513913

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.

2. Perform checking procedure as follows.

   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.

   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

NOTE

Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position.)

3. Is the problem found?

YES

▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

NO

▶ Go to "Power Circuit Inspection".

POWER CIRCUIT INSPECTION E049ED5D

1. IG Key "OFF", Engine "OFF".
2. Disconnect FPRV connector.
3. IG Key "ON".
4. Measure the voltage of FPRV connector terminal 1.

Specification : 11.5V~13.0V

5. Is the measured voltage within the specification?

YES

▶ Go to "Control Circuit Inspection".

NO

▶ Repair open between FPRV connector terminal 1 and ECM connector(CUD-M) terminal 19 and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION E742E0C1

1. Check monitoring voltage in control circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect FPRV connector.
   3) IG Key "ON".
   4) Measure the voltage of FPRV connector terminal 2.

Specification : 3.2V~3.7V

   5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection"

NO

▶ When voltage is not detected : Go to "2. Check open in control circuit" as follows.
▶ When high voltage is detected : Repair short to battery and go to "Verification of Vehicle Repair".

2. Check open in control circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect FPRV and ECM connector.

3) Check continuity between FPRV connector terminal 2 and ECM connector(CUD-M) terminal 49.

Specification : Continuity (below 1.0Ω)

4) Is the measured resistance within the specification?

YES

▶ Repair short to ground in FPRV control circuit and go to "Verification of Vehicle Repair".

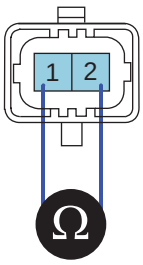
NO

▶ Repair open in FPRV control circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E1530E73

1. IG Key "OFF", Engine "OFF".
2. Disconnect Fuel pressure regulator valve connector.
3. Measure the resistance between FPRV component terminal 1 and terminal 2.

Specification : 2.6 ~ 3.15Ω (20℃)



SLDFL6295L

4. Is FPRV component resistance within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace High pressure pump ass'y and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E9C337D3

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0253 FUEL PRESSURE REGULATOR VALVE CIRCUIT LOW

COMPONENT LOCATION EEEB6702

Refer to DTC P0252.

GENERAL DESCRIPTION EF037314

Refer to DTC P0252.

DTC DESCRIPTION E533F36B

P0253 is set when "0"A in control circuit of Fuel metering unit(integrated with high pressure pump) is detected for more than specified duration. This code is due to open or short to ground in control circuit or Fuel metering unit internal open.

DTC DETECTING CONDITION E1270AAF

<table>
<tr><th colspan="2">Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td colspan="2">DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="11">• FPRV circuit
• FPRV component</td></tr>
<tr><td colspan="2">Enable Conditions</td><td colspan="3">• IG Key "ON"</td></tr>
<tr><td rowspan="6">Case 1</td><td>Thresh-old Value</td><td colspan="3">• Short to GND</td></tr>
<tr><td>Diagnos-tic Time</td><td colspan="3">• 0.28 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>YES</td><td rowspan="4"></td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>ON</td></tr>
<tr><td rowspan="6">Case 2</td><td>Thresh-old Value</td><td colspan="3">• Wiring open</td></tr>
<tr><td>Diagnos-tic Time</td><td colspan="3">• 0.22 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4"></td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>YES</td></tr>
<tr><td>MIL</td><td>ON</td></tr>
</table>

SPECIFICATION E2182214

rail pressure control valve resistance	Operating frequancy
2.6 ~ 3.15Ω (20℃)	185 Hz

SCHEMATIC DIAGRAM EB41D376

Refer to DTC P0252.

SIGNAL WAVEFORM AND DATA EBE3816F

Refer to DTC P0252.

MONITOR SCANTOOL DATA EB362A26

Refer to DTC P0252.

TERMINAL AND CONNECTOR INSPECTION E61DF98B

Refer to DTC P0252.

POWER CIRCUIT INSPECTION EFCECA46

1. IG Key "OFF", Engine "OFF".
2. Disconnect FPRV connector.
3. IG Key "ON".
4. Measure the voltage of FPRV connector terminal 1.

Specification : 11.5V~13.0V

5. Is the measured voltage within the specification?

YES

▶ Go to "Control Circuit Inspection".

NO

▶ Repair open between FPRV connector terminal 1 and ECM connector(CUD-M) terminal 19 and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION E6BC289E

1. Check monitoring voltage in control circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect FPRV connector.
   3) IG Key "ON".
   4) Measure the voltage of FPRV connector terminal 2.

Specification : 3.2V~3.7V

   5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection"

NO

▶ When voltage is not detected : Go to "2. Check open in control circuit" as follows.
▶ When high voltage is detected : Repair short to battery and go to "Verification of Vehicle Repair".

2. Check open in control circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect FPRV and ECM connector.

3) Check continuity between FPRV connector terminal 2 and ECM connector(CUD-M) terminal 49.

Specification : Continuity (below 1.0Ω)

4) Is the measured resistance within the specification?

YES

▶ Repair short to ground in FPRV control circuit and go to "Verification of Vehicle Repair".

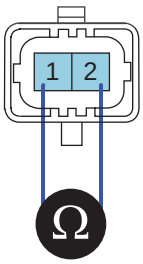
NO

▶ Repair open in FPRV control circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E4B3F3DE

1. IG Key "OFF", Engine "OFF".
2. Disconnect Fuel pressure regulator valve connector.
3. Measure the resistance between FPRV component terminal 1 and terminal 2.

Specification : 2.6 ~ 3.15Ω (20℃)



SLDFL6295L

4. Is FPRV component resistance within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace High pressure pump ass'y and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E4BC0317

Refer to DTC P0252.

DTC P0254 FUEL PRESSURE REGULATOR VALVE CIRCUIT HIGH

COMPONENT LOCATION E7EEA31C

Refer to DTC P0252.

GENERAL DESCRIPTION E20356AA

Refer to DTC P0252.

DTC DESCRIPTION E6ECF246

P0254 is set when excessive current in power circuit of Fuel metering unit(integrated with high pressure pump) is detected for more than 0.22 sec.. This code is due to short to battery in power circuit or Fuel metering unit internal short.

DTC DETECTING CONDITION E86A578F

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• FPRV circuit
• FPRV component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• Short to battery (power circuit in Fuel Press. Control Valve)</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 220ms</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4"></td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>YES</td></tr>
<tr><td>MIL</td><td>ON</td></tr>
</table>

SPECIFICATION E27366B2

rail pressure control valve resistance	Operating frequancy
2.6 ~ 3.15Ω (20°C)	185 Hz

SCHEMATIC DIAGRAM ECAC93E6

Refer to DTC P0252.

SIGNAL WAVEFORM AND DATA E275846C

Refer to DTC P0252.

MONITOR SCANTOOL DATA E2648EBD

Refer to DTC P0252.

TERMINAL AND CONNECTOR INSPECTION EB495DB8

Refer to DTC P0252.

POWER CIRCUIT INSPECTION EB395DB7

1. IG Key "OFF", Engine "OFF".
2. Disconnect FPRV connector.
3. IG Key "ON".
4. Measure the voltage of FPRV connector terminal 1.

Specification : 11.5V~13.0V

5. Is the measured voltage within the specification?

YES

▶ Go to "Control Circuit Inspection".

NO

▶ Repair open between FPRV connector terminal 1 and ECM connector(CUD-M) terminal 19 and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION E99FF2B0

1. Check monitoring voltage in control circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect FPRV connector.
   3) IG Key "ON".
   4) Measure the voltage of FPRV connector terminal 2.

Specification : 3.2V~3.7V

   5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection"

NO

▶ When voltage is not detected : Go to "2. Check open in control circuit" as follows.
▶ When high voltage is detected : Repair short to battery and go to "Verification of Vehicle Repair".

2. Check open in control circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect FPRV and ECM connector.
   3) Check continuity between FPRV connector terminal 2 and ECM connector(CUD-M) terminal 49.

Specification : Continuity (below 1.0Ω)

4) Is the measured resistance within the specification?

YES

▶ Repair short to ground in FPRV control circuit and go to "Verification of Vehicle Repair".

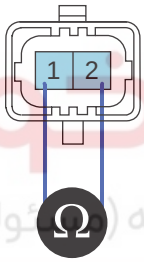
NO

▶ Repair open in FPRV control circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E1D433CC

1. IG Key "OFF", Engine "OFF".
2. Disconnect Fuel pressure regulator valve connector.
3. Measure the resistance between FPRV component terminal 1 and terminal 2.

Specification : 2.6 ~ 3.15Ω (20℃)



SLDFL6295L

4. Is FPRV component resistance within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

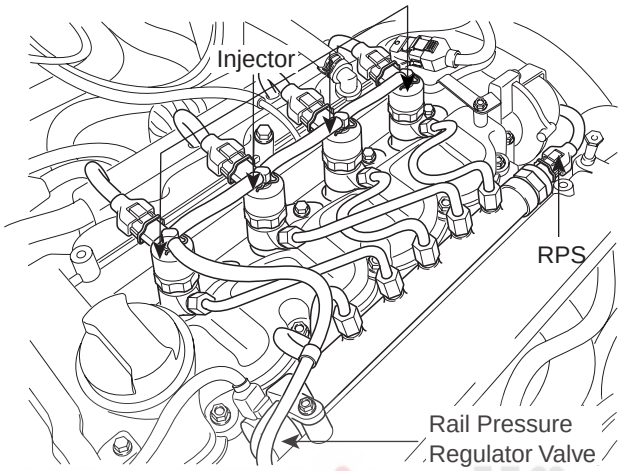
▶ Replace High pressure pump ass'y and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E9C26A58

Refer to DTC P0252.

DTC P0262 CYLINDER 1-INJECTOR CIRCUIT HIGH
DTC P0265 CYLINDER 2-INJECTOR CIRCUIT HIGH
DTC P0268 CYLINDER 3-INJECTOR CIRCUIT HIGH
DTC P0271 CYLINDER 4-INJECTOR CIRCUIT HIGH

COMPONENT LOCATION E85857D7



SLDFL6270L

GENERAL DESCRIPTION E95EEB4B

Injectors spray fuel in the highly compressed combustion chamber, and power generates through combustion process. Fuel pressure is raised to 1600bar in common rail diesel engine for the purpose of making fuel into minute particles. And fuel devided into minute particles leads smoke reduction, high power generation, and improved fuel efficiency. To control pressure of 1600bar with solenoid, oil pressure servo is applied. And injector solenoids is actuated by solenoid operating voltage raised to 80V with the method of current control. Needle valve inside of injector is located between A and B chamber. If applied pressure to B chamber is relived by injector solenoid, niddle valve is raised by the pressure of A chamber then, fuel is injected. If same pressure is applied to A and B chamber, niddle valve closes by the elasticity then, fuel injection stops. As electronically controlled injector is applied instead of mechanical injector, pilot and post injection, injeciton duration and quantity control are achieved. And engine performance is improved by these control.

DTC DESCRIPTION EB014504

P0262/P0265/P0268/P0271 is set when 1)short between injector power circuit(High side) and control circuit(Low side) or 2)short between control circuit(Low side) and battery occurs at injector #1/#2/#3/#4 operating condition.

DTC DETECTING CONDITION ECEBBD6A

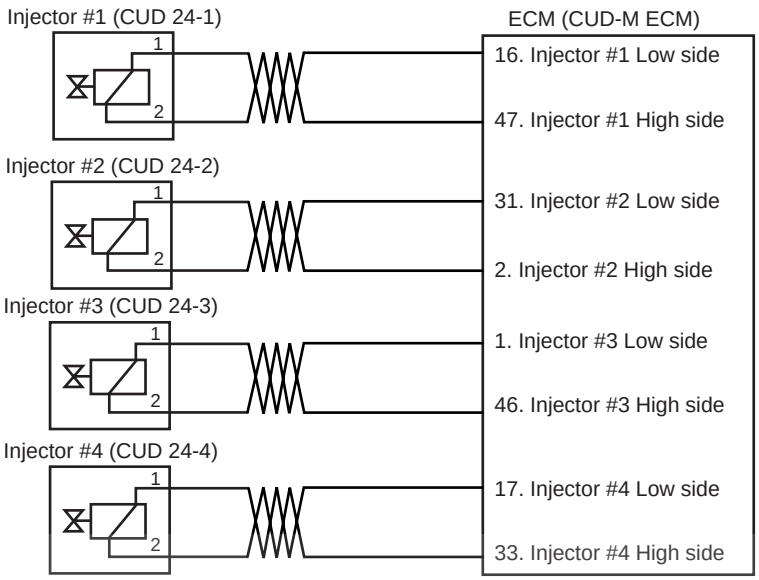
Item	Detecting Condition			Possible Cause
DTC Strategy	• Current monitoring			• Short in injector circuit • Injector component
Enable Conditions	• IG Key "ON"			
ThresholdValue	• Highside short to Lowside • Lowside short to battery			
DiagnosticTime	• Immediately			
Fail Safe	Fuel Cut	YES		
	EGR Off	NO		
	Fuel Limit	NO		
	MIL	ON		

SPECIFICATION ED46BFF0

Injector Component Resistance	Injector Operating Voltage	Injector Operating Current	Injector Control Type
0.255 ±0.04Ω (20°C)	80V	Peak current : 18±0.5A Hold in current : 12±0.5A	Current control

SCHEMATIC DIAGRAM E95183EB

[CIRCUIT DIAGRAM]



[CONNECTOR INFORMATION]

[Injector #1 (CUD 24-1)]

Terminal	Connected to	Function
1	CUD-M terminal 16	Injector #1
2	CUD-M terminal 47	Injector #1

[Injector #2 (CUD 24-2)]

Terminal	Connected to	Function
1	CUD-M terminal 2	Injector #2
2	CUD-M terminal 31	Injector #2

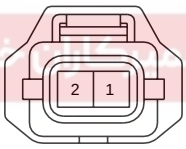
[Injector #3 (CUD 24-3)]

Terminal	Connected to	Function
1	CUD-M terminal1	Injector #3
2	CUD-M terminal 46	Injector #3

[Injector #4(CUD 24-4)]

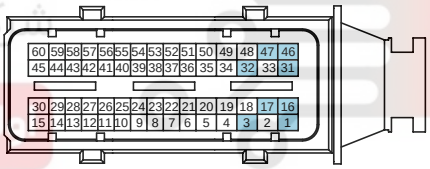
Terminal	Connected to	Function
1	CUD-M terminal 17	Injector #4
2	CUD-M terminal 33	Injector #4

[HARNESS CONNECTOR]

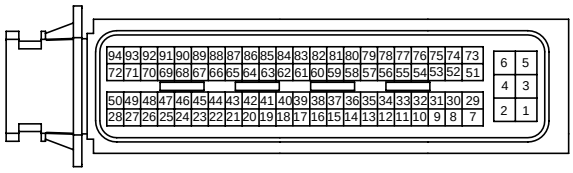


CUD 24-1,2,3,4
INJECTOR #1,2,3,4

CUD-M



CUD-K



ECM

SLDF27679L

SIGNAL WAVEFORM AND DATA EB5C0B83

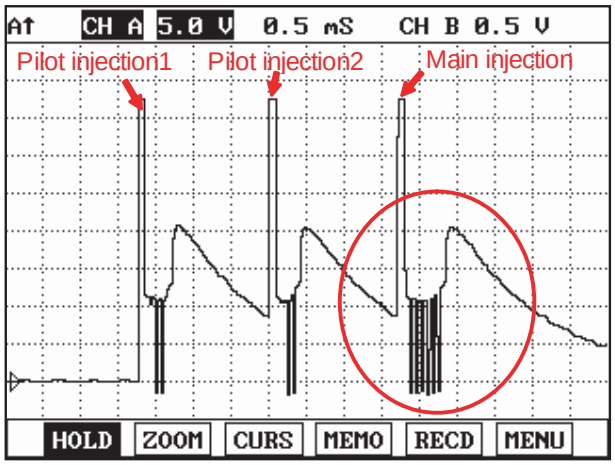


Fig.1

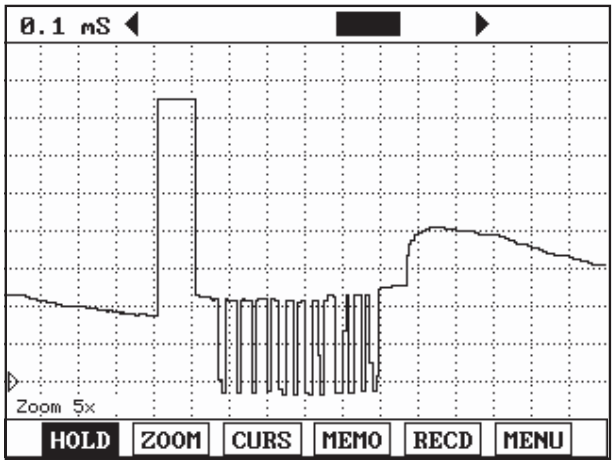


Fig.2

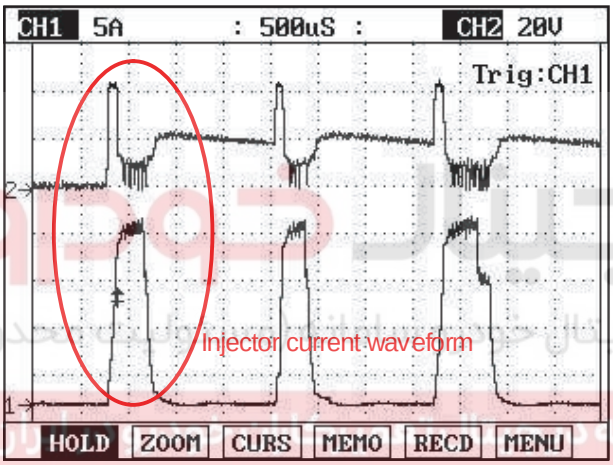


Fig.3

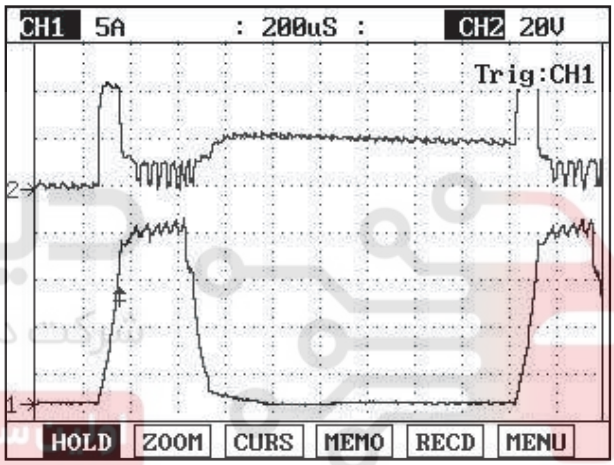


Fig.4

Fig.1) Injector operating waveform at Low side, It shows 2 pilot and 1 main injection.
Fig.2) Magnified waveform of main injection at Fig.1)
Fig.3) Injector voltage and current waveforms are measured at the same time using current prove of scope meter.
Fig.4) Magnified waveform of pilot injection at Fig.3)

SLDFL6273L

TERMINAL AND CONNECTOR INSPECTION EC8782C3

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.

2. Perform checking procedure as follows.

   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.

   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

   NOTE

   Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position.)

3. Is the problem found?

YES

▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

NO

▶ Go to "Power Circuit Inspection".

POWER CIRCUIT INSPECTION E6AA2A41

1. Check short to ground in power circuit(High side)
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect injector connector and ECM connector.
   3) Check continuity between injector connector terminal 2 and chassis ground.

Specification : Discontinuity (Infinite Ω)

   4) Is the measured resistance within the specification?

YES

▶ Go to "2. Check short between power circuit and control circuit" as follows.

NO

▶ Repair short to ground in injector power circuit and go to "Verification of Vehicle Repair".

2. Check short between power circuit and control circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect injector connector and ECM connector.
   3) Check continuity between injector connector terminal 1 and terminal 2.

Specification : Discontinuity (Infinite Ω)

   4) Is the measured resistance within the specification?

YES

▶ Go to "Control Circuit Inspection".

NO

▶ Repair short between injector power circuit and control circuit and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION E67D74EA

1. IG Key "OFF", Engine "OFF".
2. Disconnect injector connector.
3. IG Key "ON".

4. Measure the voltage of injector connector terminal 1.

Specification : 0.3~0.5V

5. Is the measured voltage within the specification?

YES

▶ Go to "Component Inspectiont".

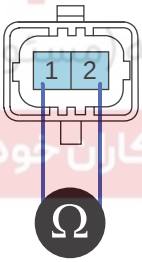
NO

▶ Repair short to battery in injector control circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E49769C8

1. IG Key "OFF", Engine "OFF".
2. Disconnect injector connector.
3. Measure the resistance between injector component terminal 1 and terminal 2.

Specification : 0.255Ω ±0.04 (20°C).



SLDFL6276L

4. Is the measured resistance(of injector solenoid) within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace injector and go to "Verification of Vehicle Repair".

NOTE

Replacing injectors, peculiar IQA code of each injector should be inputted to ECM
Perform this process using "Injector data input" function on scantool, Refer to P1670, P1671 for more detailed information.

VERIFICATION OF VEHICLE REPAIR EE1B01A3

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.

2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

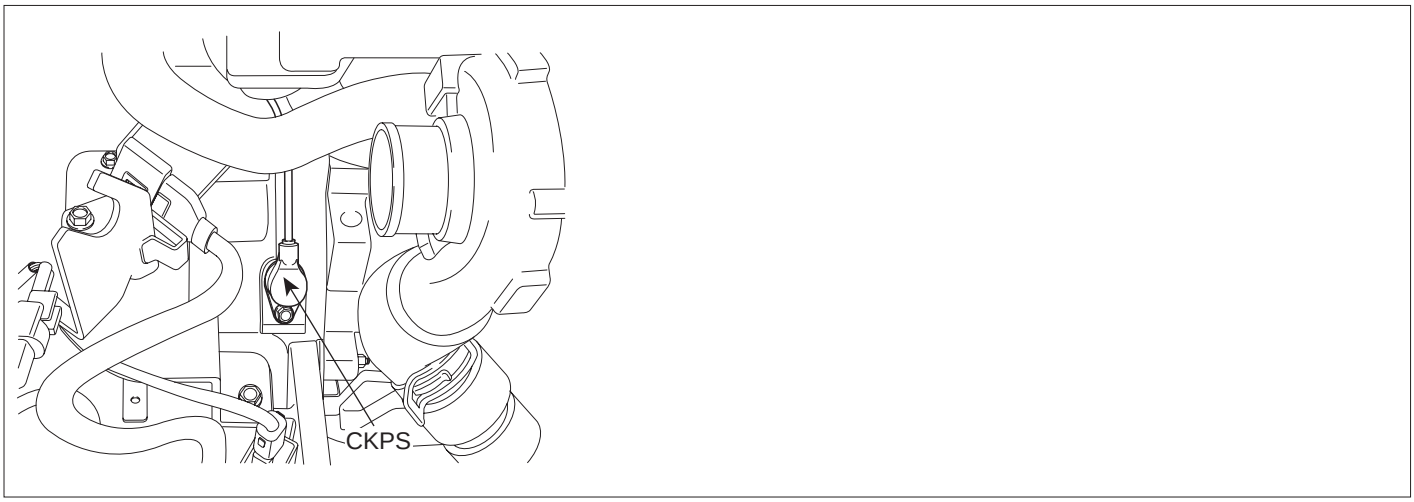
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0335 CRANKSHAFT POSITION SENSOR A CIRCUIT

COMPONENT LOCATION EBF41BF7



SLDFL6305L

GENERAL DESCRIPTION E7247965

Crank Shaft Position Sensor(CKPS) is magnetic inductive type. Mounted on cylinder block, it senses tone wheel position of crank shaft. As tone wheel is devided with 58 teeth and 2 missing teeth (referrence point), 1 tooth corresponds to 6 degree. CKPS which calculates RPM and crank angle is important to determine fuel injection quantity and injection timing with APS. Crank shaft position is closely related to engine starting.

DTC DESCRIPTION ED1BA3CF

P0335 is set when CKPS signal does not generate for more than 0.7 sec. while CMPS signal is outputted. This code is due to CKPS circuit or component failure. If CKPS signal is not inputted during driving, RPM is calculated based on CMPS signal.

DTC DETECTING CONDITION E41BA0EF

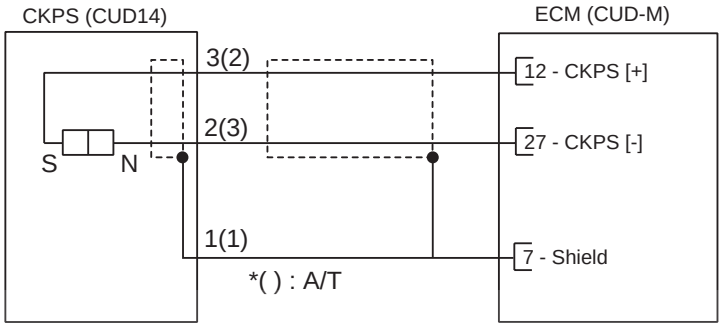
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Signal monitoring</td><td rowspan="7">• CKPS circuit
• CKPS component
• Abnormal deformation of Crank Shaft tone wheel</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• During accelerating and turning engine "ON"</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• CMPS signal is outputted while CKPS signal does not generate.</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• Tone wheel rotates 4 times</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>YES</td><td rowspan="4">• RPM is considered as double speed of CMPS signal.</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>ON</td></tr>
</table>

SPECIFICATION EA677503

Sensor Type	Output Signal Characteristic	Air Gab	Low RPM Minimum Detecting Voltage	High RPM Minimum Detecting Voltage
Magnetic inductive	A/C waveform	1.8mm	230mV	2769 mV

SCHEMATIC DIAGRAM E9AEF0A9

[CIRCUIT DIAGRAM]

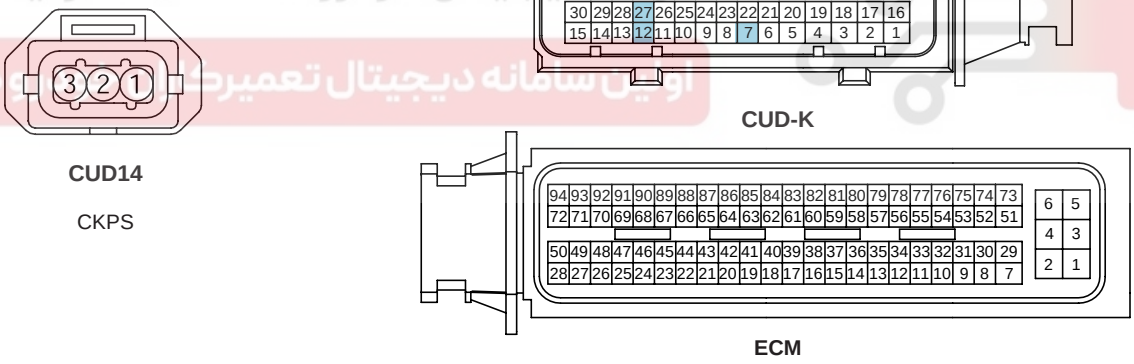


[CONNECTION INFORMATION]

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

*( ) : A/T

[HARNESS CONNECTORS]



SLDF27128L

SIGNAL WAVEFORM AND DATA E62B7C0B

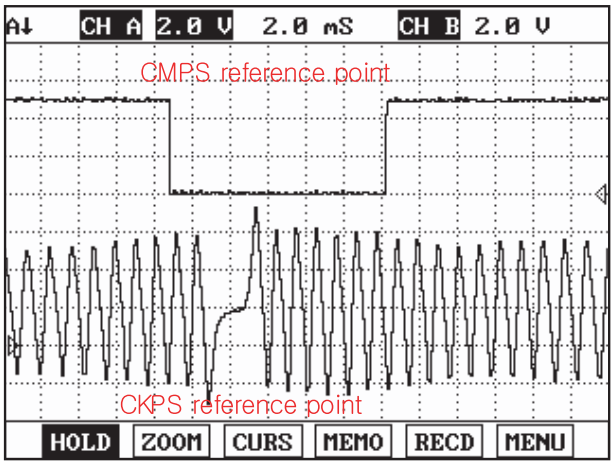


Fig.1

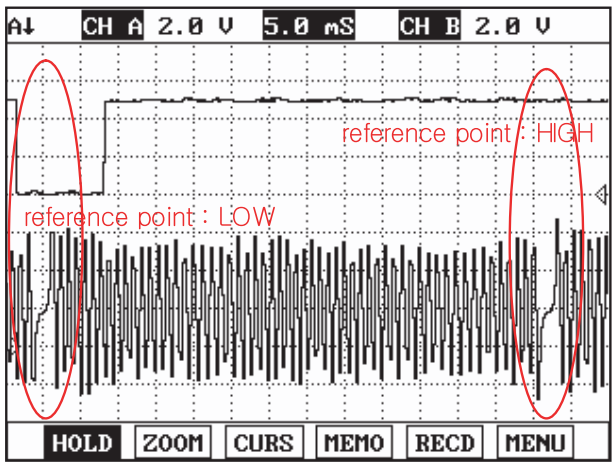


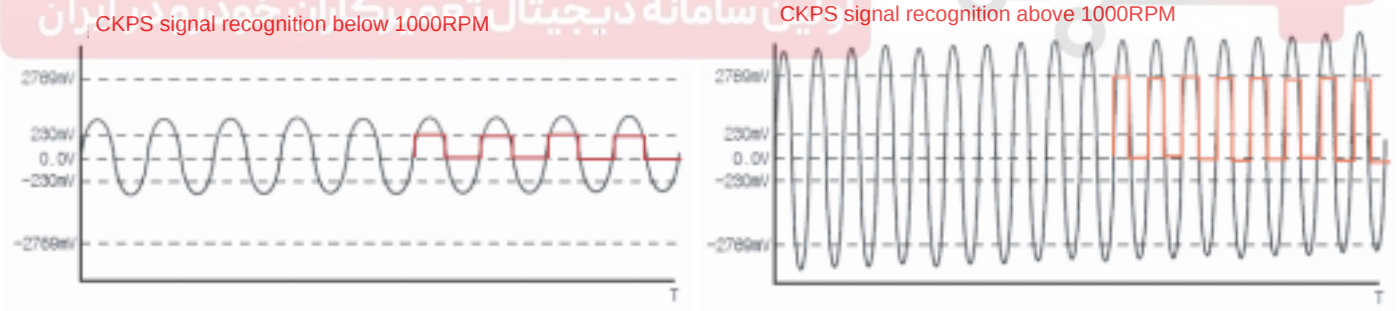
Fig.2

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.)

SLDFL6306L

※ SIGNAL ANALYSIS



SLDFL6307L

1. The output voltage of CKPS signal varies according to rpm(the speed of tone wheel passing by sensor)
(low voltage is inducted for low speed and high voltage is inducted for high speed.)

2. CKPS should detect from low rpm at cranking to above 5000rpm. If minimum detecting voltage is set low for the ease of signal detection at low rpm, 1) the abnormal signal at high rpm from which high voltage generates or 2) electrical NOise through circuit can be recognized as Crank signal. Thus minimum detecting voltages at low rpm and high rpm are set differently.

3. ECM convert analog signal like the waveform illustrated above into digital signal with A/D converter.The voltage above minimum detecting voltage of crank signal and "-"voltage below 0.0V is meaningless at converting process. RPM is detected as Hz.(signal detecting period)

MONITOR SCANTOOL DATA E8B4CD18

1. Connect Scantool to Data Link Connector (DLC).

2. Warm engine up to normal operating temperature.
3. Turn "OFF" electrical devices and A/C.
4. Monitor "ENGINE SPEED SENSOR" parameter on the Scantool.

Specification : 800±50RPM at idle

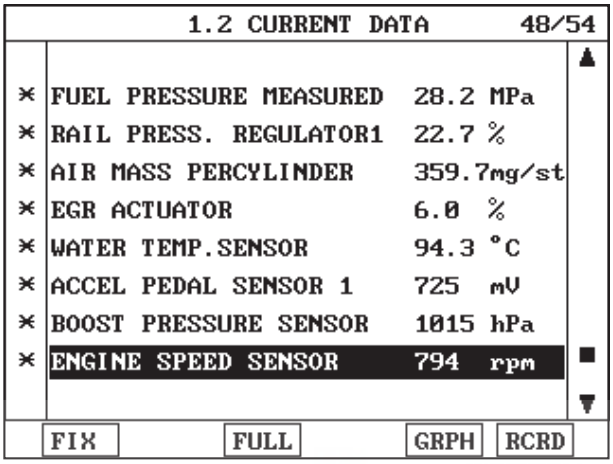


Fig.1

Fig.1) Check "ENGINE SPEED SENSOR" parameter carefully after warming engine up, also check engine stall and rpm instability or engine shut down.

SLDFL6318L

TERMINAL AND CONNECTOR INSPECTION E0AE94C2

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.
2. Perform checking procedure as follows.
   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.
   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

NOTE

Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector or checking connecting condition. (after checking, reconnect the pin at correct position.)

3. Is the problem found?

YES

▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

NO

▶ Go to "Signal Circuit Inspection ".

SIGNAL CIRCUIT INSPECTION E9854E30

1. Check signal circuit voltage

1) IG Key "OFF", Engine "OFF".
2) Disconnect CKPS connector.
3) IG Key "ON".
4) Measure the voltage of CKPS connector terminal 2.
5) Measure the voltage of CKPS connector terminal 3.

Specification : 0.6V~1.0V

6) Is the measured voltage within the specification?

YES

▶ Go to "3.Check short between signal circuits" as follows.

NO

▶ Go to "2.Check open in signal circuit" as follows.

2. Check open in signal circuit

1) IG Key "OFF", Engine "OFF".
2) Disconnect CKPS connector and ECM connector.
3) Check continuity between CKPS connector terminal 2 and ECM connector(CUD-M) terminal 12.
4) Check continuity between CKPS connector terminal 3 and ECM connector(CUD-M) terminal 27.

Specification : Continuity (below 1.0Ω)

5) Is the measured resistance within the specification?

YES

▶ Go to "3.Check short between signal circuits" as follows.

NO

▶ Repair open in signal circuit and go to "Verification of Vehicle Repair".

3. Check short between signal circuits

1) IG Key "OFF", Engine "OFF".
2) Disconnect CKPS connector and ECM connector.
3) Check continuity between CKPS connector terminal 2 and terminal 3.

Specification : Discontinuity (Infinite Ω)

4) Is the measured resistance within the specification?

YES

▶ Go to "4. Check short to ground in signal circuit" as follows.

NO

▶ Repair short between signal circuits and go to "Verification of Vehicle Repair".

4. Check short to ground in signal circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect CKPS connector and ECM connector.

3) Check continuity between CKPS connector terminal 1(shield ground) and terminal 2.(crank signal)

4) Check continuity between CKPS connector terminal 1(shield ground) and terminal 3.(crank signal)

Specification : Discontinuity (Infinite Ω)

5) Is the measured resistance within the specification?

YES

▶ Go to "Ground Circuit Inspection".

NO

▶ Repair the short between signal circuit and shield ground and go to "Verification of Vehicle Repair".

GROUND CIRCUIT INSPECTION E696286D

1. IG Key "OFF", Engine "OFF".
2. Disconnect CKPS connector.
3. Check continuity between CKPS connector terminal 1(shield ground) and chassis ground.

Specification : Continuity (below 1.0Ω)

4. Is the measured resistance within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ Repair open or poor connection in ground circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E01F14F2

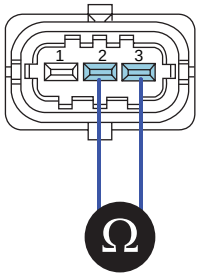
1. Check Resistance of CKPS component

1) IG Key "OFF", Engine "OFF".

2) Disconnect CKPS connector.

3) Check resistance between CKPS connector terminal 2 and terminal 3 at component side.

Specification : 860Ω ±10% (20℃)



SLDFL6313L

4) Is the measured resistance within the specification?

YES

▶ Go to "2. Check short to ground in CKPS component" as follows.

NO

▶ Replace CKPS and go to "Verification of Vehicle Repair".

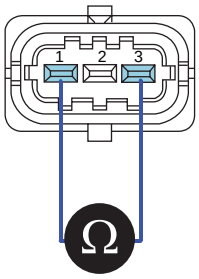
2. Check short to ground in CKPS component

1) IG Key "OFF", Engine "OFF".

2) Disconnect CKPS connector.

3) Check resistance between CKPS connector terminal 1 and terminal 3 at component side.

Specification : Discontinuity (Infinite Ω)



SLDFL6314L

4) Is the measured resistance within the specification? (Is the inside of component insulated correctly?)

YES

▶ Go to "3. Check CKPS waveform" as follows.

NO

▶ Replace CKPS and go to "Verification of Vehicle Repair".

3. Check CKPS waveform

1) IG Key "OFF", Engine "OFF".

2) Connect CKPS connector.

3) Connect Oscilloscope to CKPS connector terminal 2, terminal 3.

4) Check if CKPS waveform is outputted correctly as cranking or turning engine on.

SPECIFICATION :

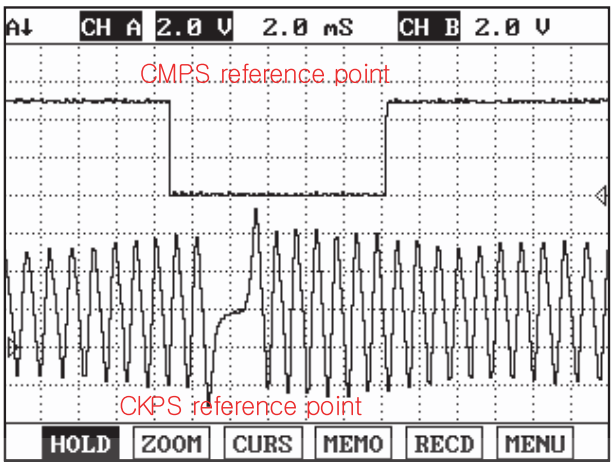


Fig.1

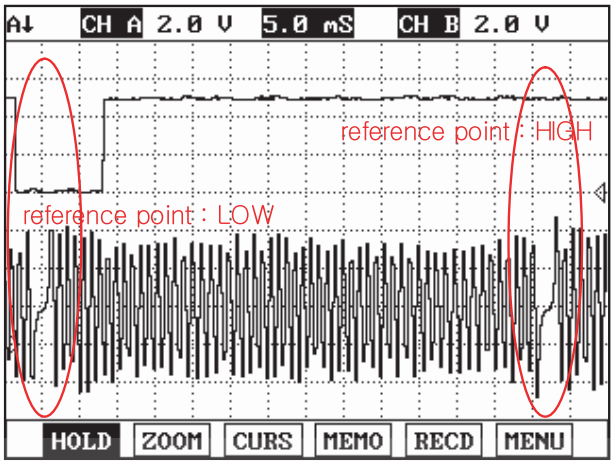


Fig.2

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.)

SLDFL6306L

5) Is CKPS waveform outputted correctly?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace CKPS and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR EE5A0993

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0336 CRANKSHAFT POSITION SENSOR A CIRCUIT RANGE/PERFORMANCE

COMPONENT LOCATION EAC61B14

Refer to DTC P0335.

GENERAL DESCRIPTION EE04BF01

Refer to DTC P0335.

DTC DESCRIPTION E1FFB524

P0336 is set when 1). engine speed detected by CKPS is above 6000RPM, or 2). CKPS signal pulse is abnormal. For repair, check temporary poor connection in CKPS circuit, component failure or deformation of tone wheel.

DTC DETECTING CONDITION ECA0B76A

Item	Detecting Condition			Possible Cause
DTC Strategy	• Signal monitoring			• CKPS circuit • CKPS component • Abnormal deformation of Crank Shaft tone wheel
Enable Conditions	• During accelerating and turning engine "ON"			
ThresholdValue	• Engine speed sensed at CKPS above 6000RPM • Abnormal crank signal pulse			
DiagnosticTime	• Immediately			
Fail Safe	Fuel Cut	YES		
	EGR Off	NO		
	Fuel Limit	NO		
	MIL	ON		

SPECIFICATION EDF5D6B7

Sensor Type	Output Signal Characteristic	Air Gab	Low RPM Minimum Detecting Voltage	High RPM Minimum Detecting Voltage
Magnetic inductive	A/C waveform	1.8mm	230mV	2769 mV

SCHEMATIC DIAGRAM EB5E75C1

Refer to DTC P0335.

SIGNAL WAVEFORM AND DATA EC361340

Refer to DTC P0335.

MONITOR SCANTOOL DATA E42769DB

Refer to DTC P0335.

TERMINAL AND CONNECTOR INSPECTION E9355726

Refer to DTC P0335.

SIGNAL CIRCUIT INSPECTION E8180D00

1. Check signal circuit voltage

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect CKPS connector.

   3) IG Key "ON".

   4) Measure the voltage of CKPS connector terminal 2.

   5) Measure the voltage of CKPS connector terminal 3.

Specification : 0.6V~1.0V

   6) Is the measured voltage within the specification?

YES

▶ Go to "3.Check short between signal circuits" as follows.

NO

▶ Go to "2.Check open in signal circuit" as follows.

2. Check open in signal circuit

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect CKPS connector and ECM connector.

   3) Check continuity between CKPS connector terminal 2 and ECM connector(CUD-M) terminal 12.

   4) Check continuity between CKPS connector terminal 3 and ECM connector(CUD-M) terminal 27.

Specification : Continuity (below 1.0Ω)

   5) Is the measured resistance within the specification?

YES

▶ Go to "3.Check short between signal circuits" as follows.

NO

▶ Repair open in signal circuit and go to "Verification of Vehicle Repair".

3. Check short between signal circuits

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect CKPS connector and ECM connector.

   3) Check continuity between CKPS connector terminal 2 and terminal 3.

Specification : Discontinuity (Infinite Ω)

4) Is the measured resistance within the specification?

YES

▶ Go to "4. Check short to ground in signal circuit" as follows.

NO

▶ Repair short between signal circuits and go to "Verification of Vehicle Repair".

4. Check short to ground in signal circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect CKPS connector and ECM connector.

3) Check continuity between CKPS connector terminal 1(shield ground) and terminal 2.(crank signal)

4) Check continuity between CKPS connector terminal 1(shield ground) and terminal 3.(crank signal)

Specification : Discontinuity (Infinite Ω)

5) Is the measured resistance within the specification?

YES

▶ Go to "Ground Circuit Inspection".

NO

▶ Repair the short between signal circuit and shield ground and go to "Verification of Vehicle Repair".

GROUND CIRCUIT INSPECTION E9D83D9E

1. IG Key "OFF", Engine "OFF".
2. Disconnect CKPS connector.
3. Check continuity between CKPS connector terminal 1(shield ground) and chassis ground.

Specification : Continuity (below 1.0Ω)

4. Is the measured resistance within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ Repair open or poor connection in ground circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E981A532

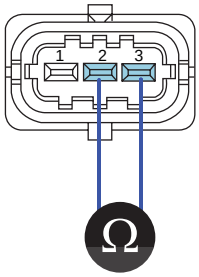
1. Check Resistance of CKPS component

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect CKPS connector.

   3) Check resistance between CKPS connector terminal 2 and terminal 3 at component side.

Specification : 860Ω ±10% (20℃)



SLDFL6313L

   4) Is the measured resistance within the specification?

YES

▶ Go to "2. Check short to ground in CKPS component" as follows.

NO

▶ Replace CKPS and go to "Verification of Vehicle Repair".

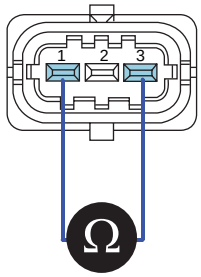
2. Check short to ground in CKPS component

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect CKPS connector.

   3) Check resistance between CKPS connector terminal 1 and terminal 3 at component side.

Specification : Discontinuity (Infinite Ω)



SLDFL6314L

   4) Is the measured resistance within the specification? (Is the inside of component insulated correctly?)

YES

▶ Go to "3. Check CKPS waveform" as follows.

NO

▶ Replace CKPS and go to "Verification of Vehicle Repair".

3. Check CKPS waveform

1) IG Key "OFF", Engine "OFF".

2) Connect CKPS connector.

3) Connect Oscilloscope to CKPS connector terminal 2, terminal 3.

4) Check if CKPS waveform is outputted correctly as cranking or turning engine on.

SPECIFICATION :

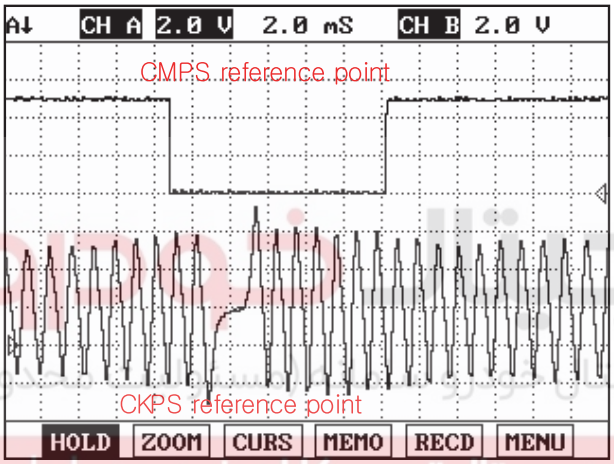


Fig.1

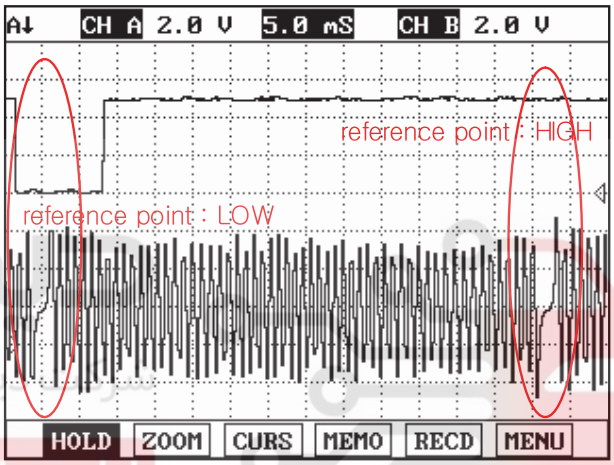


Fig.2

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.)

SLDFL6306L

5) Is CKPS waveform outputted correctly?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace CKPS and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E11907DF

Refer to DTC P0335.

DTC P0340 CAMSHAFT POSITION SENSOR A CIRCUIT MALFUNCTION (BANK 1 OR SINGLE SENSOR)

COMPONENT LOCATION EF51E1E6

SLDFL6315L

GENERAL DESCRIPTION E60BDC5C

Cam Shaft Position Sensor (CMPS) is hall sensor type. Sensing the teeth attatch at the end of cam shaft, CMPS detects rotation of Cam shaft. (1 signal per 1 lotation) As Cam shaft rotates once while Crank shaft does twice, CMPS referrence point generates once while CKPS' do twice. As this signal inputted to ECM, it distinguishes crank angle and the cylinder which requires fuel injection in order to determine injection sequence and duration.

DTC DESCRIPTION ECBAE9D7

P0340 is set when CMPS signal does not generate while CKPS signal is outputted for the duration that crank shaft rotates 4 times. This code is due to the failure relevant to CMPS related circuit and sensor component.

DTC DETECTING CONDITION E21BBE49

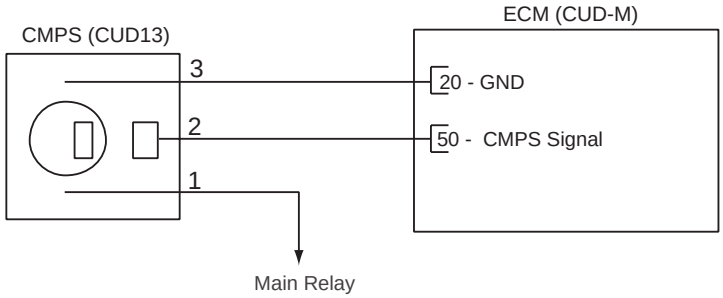
Item	Detecting Condition			Possible Cause
DTC Strategy	• Signal monitoring			• CMPS circuit • CMPS component
Enable Conditions	• During accelerating and turning engine "ON"			
ThresholdValue	• CKPS signal is outputted while CMPS signal does not generate.			
DiagnosticTime	• Crank Shaft rotates 4 times			
Fail Safe	Fuel Cut	NO		
	EGR Off	NO		
	Fuel Limit	YES		
	MIL	ON		

SPECIFICATION EAE8045B

Sensor Type	Output Signal Characteristic	Air Gab	LOW Signal Detecting Voltage	HIGH Signal Detecting Voltage
Hall effect type	0V~5V Digital signal output	1.25mm	below 2.0V	above 3.8V

SCHEMATIC DIAGRAM ECFC3C82

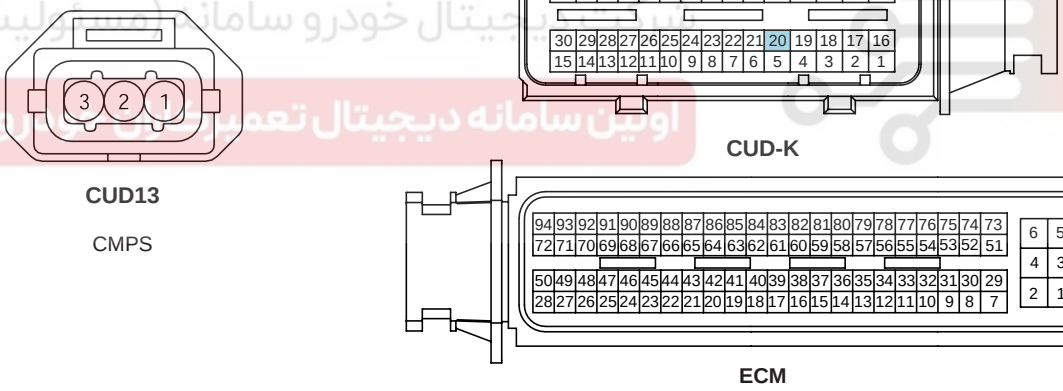
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	Main Relay	Battery Voltage
2	ECM CUD-M (50)	CMPS Signal
3	ECM CUD-M (20)	GND

[HARNESS CONNECTORS]



SLDF27127L

SIGNAL WAVEFORM AND DATA EB487EC2

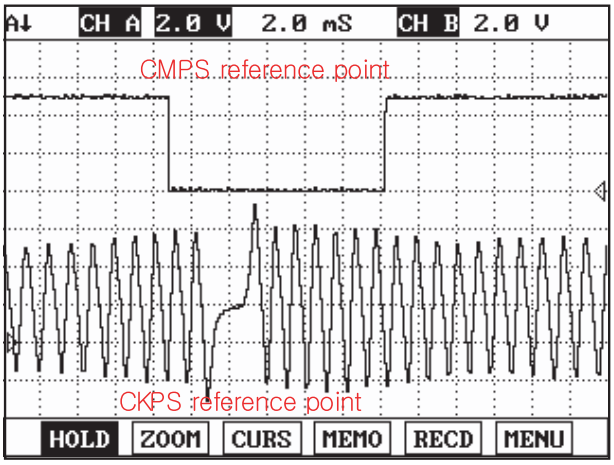


Fig.1

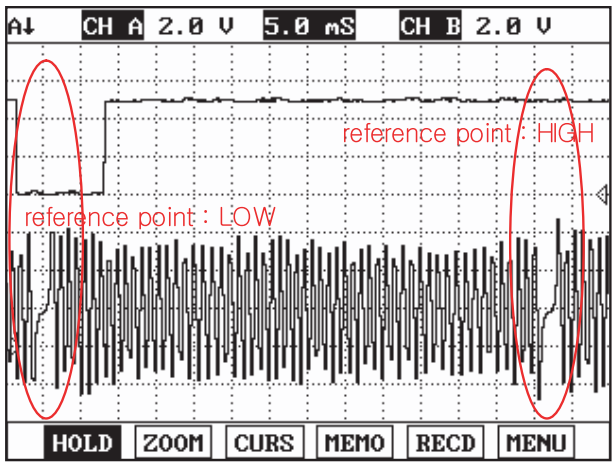


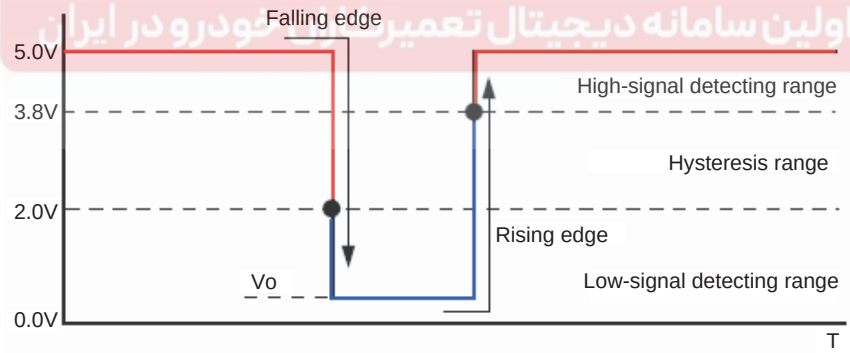
Fig.2

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.)

SLDFL6316L

※ SIGNAL ANALYSIS



SLDFL6317L

1. ECM recognizes HIGH signal as LOW signal when CMPS signal drops below 2.0V and LOW signal as HIGH signal when CMPS signal rises above 3.8V.

2. V0 - the Minimum voltage of LOW signal does not drop below 0.0V due to the hall sensor inside resistance. When the Minimum voltage of LOW signal is above 0.6V during signal waveform inspection, check excessive resistance inside of CMPS component or in ground circuit.

MONITOR SCANTOOL DATA E41F8D36

1. Connect Scantool to Data Link Connector (DLC).

2. Warm engine up to normal operating temperature.

3. Turn "OFF" electrical devices and A/C.

4. Monitor "ENGINE SPEED SENSOR" parameter on the Scantool.

Specification : 800±50RPM at idle

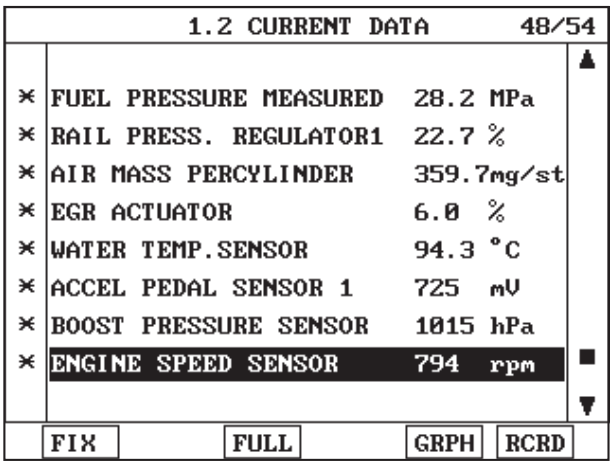


Fig.1

Fig.1) Check "ENGINE SPEED SENSOR" parameter carefully after warming engine up, also check engine stall and rpm instability or engine shut down.

SLDFL6318L

TERMINAL AND CONNECTOR INSPECTION E0B85874

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.

2. Perform checking procedure as follows.
   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.
   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

NOTE

Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector or checking connecting condition. (after checking, reconnect the pin at correct position.)

3. Is the problem found?

YES

▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

NO

▶ Go to "Power Circuit Inspection".

POWER CIRCUIT INSPECTION E4DB24EB

1. IG Key "OFF", Engine "OFF".
2. Disconnect CMPS connector.
3. IG Key "ON".

4. Measure the voltage of CMPS connector terminal 1.

Specification : 11.0V~13.0V (Main relay "ON" power)

5. Is the measured voltage within the specification?

YES

▶ Go to "Signal Circuit Inspection".

NO

▶ Repair open in Main relay power circuit and fuse, and go to "Verification of Vehicle Repair".
[Check open in E/R JUNCTION BOX 15A INJ FUSE and related circuit.]
※ If the fuse is damaged again after replacing the damaged fuse, repair short to ground in Main relay power circuit.

SIGNAL CIRCUIT INSPECTION EF6E36F6

1. Check CMPS signal voltage

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect CMPS connector.

   3) IG Key "ON".

   4) Measure the voltage of CMPS connector terminal 2.

Specification : 4.8V~5.1V

   5) Is the measured voltage within the specification?

   YES

   ▶ Go to "Ground Circuit Inspection".

   NO

   ▶ Go to "2. Check open in signal circuit" as follows.

2. Check open in signal circuit

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect CMPS connector and ECM connector.

   3) Check continuity between CMPS connector terminal 2 and ECM connector(CUD-M) terminal 50.

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification? (Is continuity confirmed?)

   YES

   ▶ Repair short to ground in signal circuit and go to "Verification of Vehicle Repair".

   NO

▶ Repair open in the circuit between CMPS connector terminal 2 and ECM connector(CUD-M) terminal 50 and go to "Verification of Vehicle Repair".

GROUND CIRCUIT INSPECTION E6EEFB13

1. IG Key "OFF", Engine "OFF".
2. Disconnect CMPS connector.
3. IG Key "ON".
4. Check the voltage of CMPS connetor terminal 2. [TEST "A"]
5. Check the voltage between CMPS connetor terminal 2 and terminal 3. [TEST "B"]
   (terminal 2 : Check + prove , terminal 3 : Check - prove)

Specification : [TEST "A"] Voltage - [TEST "B"] Voltage = below 200mV

6. Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ When "B" voltage is not detected : Repair open in ground circuit and go to "Verification of Vehicle Repair".
▶ When the voltage difference between "A" and "B" is above 200mV : Eliminate the causes of excessive resistance and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E33FF282

1. Cam shaft detecting teeth inspection
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect CMPS connector.
   3) Disconnect CMPS.
   4) Check the condition of Cam shaft detecting teeth through CMPS mounting hall.
   5) Is abnormal deformation of Cam shaft detecting teeth found?

YES

▶ Replace Cam shaft assy' or Cylinder head assy' and go to "Verification of Vehicle Repair".

NO

▶ Go to "2. CMPS waveform Inspection" as follows.

2. CMPS waveform inspection
   1) IG Key "OFF", Engine "OFF".
   2) Connect CMPS connector.
   3) Connect Oscilloscope to CMPS connector terminal 2.

4) Monitor if CMPS waveform is outputted normally as cranking or turning engine "ON".

SPECIFICATION :

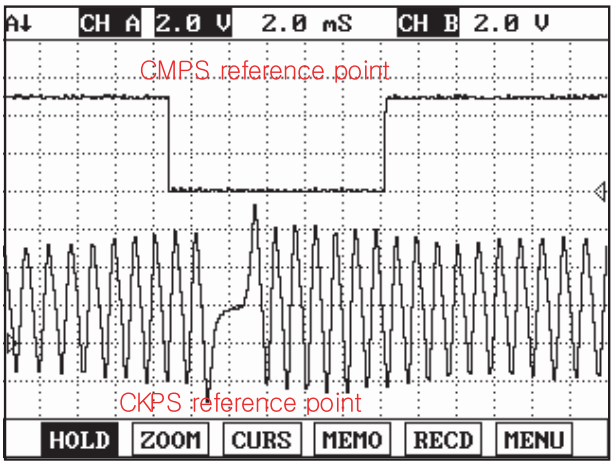


Fig.1

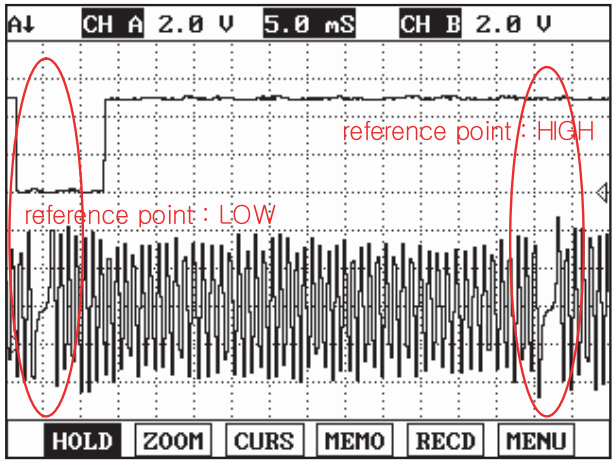


Fig.2

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.)

SLDFL6316L

5) Is CMPS waveform displayed correctly?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace CMPS and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR EF8113A6

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0341 CAMSHAFT POSITION SENSOR A CIRCUIT RANGE/PERFORMANCE (BANK 1 OR SINGLE SENSOR)

COMPONENT LOCATION E7755DDB

Refer to DTC P0340.

GENERAL DESCRIPTION E6957AA0

Refer to DTC P0340.

DTC DESCRIPTION EE5DD951

P0341 is set when CMPS reference point is detected more or less than twice while CKPS reference point is recognized 4 times. This code is due to temporary poor connection or short to ground in CMPS circuit, CMPS component failure.

DTC DETECTING CONDITION EF79C347

Item	Detecting Condition		Possible Cause
DTC Strategy	• Signal monitoring		• CMPS circuit • CMPS component
Enable Conditions	• During accelerating and turning engine "ON"		
ThresholdValue	• When RPM from CMPS correlates with RPM from CKPS abnormally.		
DiagnosticTime	• Crank Shaft rotates 4 times		
Fail Safe	Fuel Cut	NO	
	EGR Off	NO	
	Fuel Limit	YES	
	MIL	ON	

SPECIFICATION E92B9857

Sensor Type	Output Signal Characteristic	Air Gab	LOW Signal Detecting Voltage	HIGH Signal Detecting Voltage
Hall effect type	0V~5V Digital signal output	1.25mm	below 2.0V	above 3.8V

SCHEMATIC DIAGRAM EDA59572

Refer to DTC P0340.

SIGNAL WAVEFORM AND DATA EADFCF5A

Refer to DTC P0340.

MONITOR SCANTOOL DATA ED27ABEC

Refer to DTC P0340.

TERMINAL AND CONNECTOR INSPECTION EBAC99B5

Refer to DTC P0340.

POWER CIRCUIT INSPECTION EC104127

1. IG Key "OFF", Engine "OFF".
2. Disconnect CMPS connector.
3. IG Key "ON".
4. Measure the voltage of CMPS connector terminal 1.

Specification : 11.0V~13.0V (Main relay "ON" power)

5. Is the measured voltage within the specification?

YES

▶ Go to "Signal Circuit Inspection".

NO

▶ Repair open in Main relay power circuit and fuse, and go to "Verification of Vehicle Repair".
[Check open in E/R JUNCTION BOX 15A INJ FUSE and related circuit.]
※ If the fuse is damaged again after replacing the damaged fuse, repair short to ground in Main relay power circuit.

SIGNAL CIRCUIT INSPECTION EC0D1200

1. Check CMPS signal voltage
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect CMPS connector.
   3) IG Key "ON".
   4) Measure the voltage of CMPS connector terminal 2.

Specification : 4.8V~5.1V

   5) Is the measured voltage within the specification?

YES

▶ Go to "Ground Circuit Inspection".

NO

▶ Go to "2. Check open in signal circuit" as follows.

2. Check open in signal circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect CMPS connector and ECM connector.

3) Check continuity between CMPS connector terminal 2 and ECM connector(CUD-M) terminal 50.

Specification : Continuity (below 1.0Ω)

4) Is the measured resistance within the specification? (Is continuity confirmed?)

YES

▶ Repair short to ground in signal circuit and go to "Verification of Vehicle Repair".

NO

▶ Repair open in the circuit between CMPS connector terminal 2 and ECM connector(CUD-M) terminal 50 and go to "Verification of Vehicle Repair".

GROUND CIRCUIT INSPECTION ED12E06A

1. IG Key "OFF", Engine "OFF".
2. Disconnect CMPS connector.
3. IG Key "ON".
4. Check the voltage of CMPS connetor terminal 2. [TEST "A"]
5. Check the voltage between CMPS connetor terminal 2 and terminal 3. [TEST "B"]
   (terminal 2 : Check + prove , terminal 3 : Check - prove)

Specification : [TEST "A"] Voltage - [TEST "B"] Voltage = below 200mV

6. Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ When "B" voltage is not detected : Repair open in ground circuit and go to "Verification of Vehicle Repair".
▶ When the voltage difference between "A" and "B" is above 200mV : Eliminate the causes of excessive resistance and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION ED4285B7

1. Cam shaft detecting teeth inspection
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect CMPS connector.
   3) Disconnect CMPS.
   4) Check the condition of Cam shaft detecting teeth through CMPS mounting hall.
   5) Is abnormal deformation of Cam shaft detecting teeth found?

YES

▶ Replace Cam shaft assy' or Cylinder head assy' and go to "Verification of Vehicle Repair".

NO

▶ Go to "2. CMPS waveform Inspection" as follows.

2. CMPS waveform inspection

1) IG Key "OFF", Engine "OFF".

2) Connect CMPS connector.

3) Connect Oscilloscope to CMPS connector terminal 2.

4) Monitor if CMPS waveform is outputted normally as cranking or turning engine "ON".

SPECIFICATION :

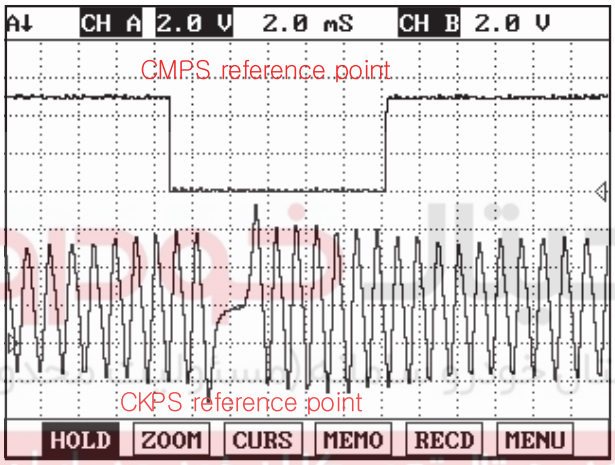


Fig.1

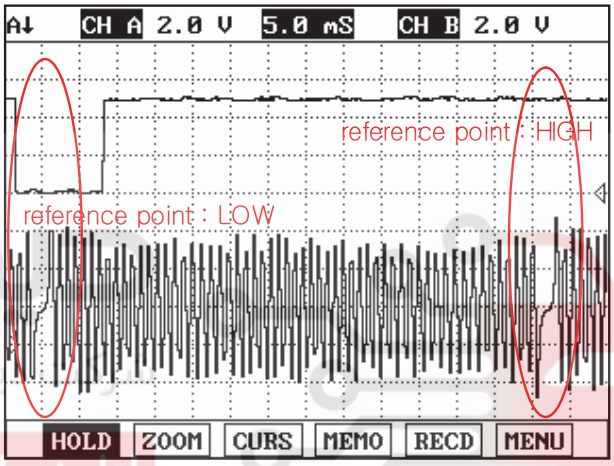


Fig.2

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.)

SLDFL6316L

5) Is CMPS waveform displayed correctly?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace CMPS and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E4F08619

Refer to DTC P0340.

DTC P0381 GLOW INDICATOR LAMP - CIRCUIT MALFUNCTION

GENERAL DESCRIPTION EA0F10B8

Heating combustion chamber, glow plug increases fuel ignitibility and makes fuel in the foggy state easily when engine is cold. Thus, glow plug makes engine starting easily and decreases exhaust gas produced just after turning engine on when engine is cold. ECM controls operation and operating duration of glow plug relay which supplies power to glow plug with ECTS signal, battery voltage and IG KEY ON signal. Through glow lamp in cluster, ECM let drivers know if glow plug is ON.

DTC DESCRIPTION E1C9BE0E

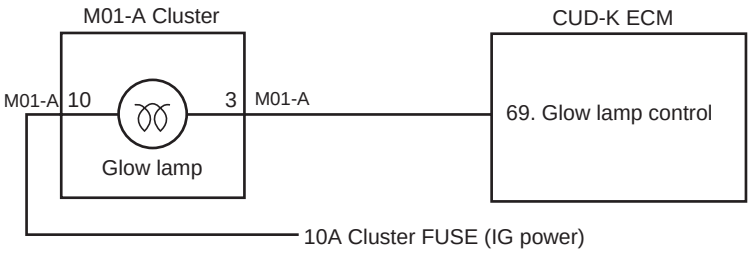
P0381 is set when 1)excessive voltage is detected or 2)no current is detected like open or short to ground in glow lamp control circuit for more than 1 sec. at glow lamp ON condition. This code is due to open in glow lamp control circuit or internal open in filament of glow lamp component.

DTC DETECTING CONDITION E4D354F9

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• Open in glow lamp
• Glow lamp circuit</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON" (monitoring only performed within lamp operating condition)</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• Short to battery
• Short to GND
• Wiring open</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 1.0 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4"></td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SCHEMATIC DIAGRAM E870AC45

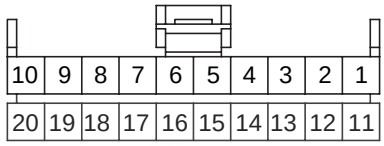
[CIRCUIT DIAGRAM]



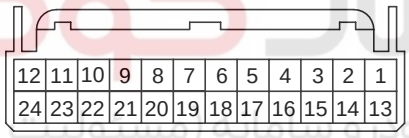
[CONNECTOR INFORMATION]

Terminal	Connected to	Function
M01-A terminal 10	10A Cluster FUSE	IG power
M01-A terminal 3	CUD-K terminal 69	Glow lamp control

[HARNESS CONNECTOR]

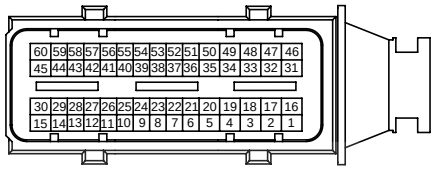


M01-A

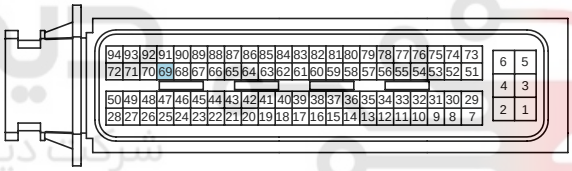


M01-B

CUD-M



CUD-K



ECM

SLDF27680L

MONITOR SCANTOOL DATA E394F4BB

1. Connect Scantool to Data Link Connector (DLC).
2. Warm engine up to normal operating temperature.
3. Turn "OFF" electrical devices and A/C.
4. Select "ACTUATION TEST" parameter on the scantool.

specification : Lamp turns ON at ACTUATION TEST of Glow lamp.

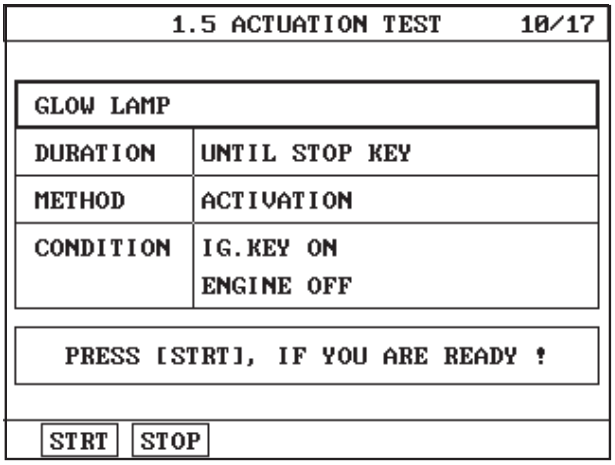


Fig.1

Fig.1) Diagnosing problem is convenient through ACTUATION TEST of glow lamp.

SLDFL6326L

TERMINAL AND CONNECTOR INSPECTION EDAD55D4

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.
2. Perform checking procedure as follows.
   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.
   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

   NOTE

   Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position.)
3. Is the problem found?

   YES

   ▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

   NO

   ▶ Go to "Control Circuit Inspection".

CONTROL CIRCUIT INSPECTION E5FEF78E

1. Check voltage in control circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect ECM connector.
   3) IG Key "ON".
   4) Measure the voltage of ECM connector(CUD-K) terminal 69.

Specification : 10.8V~13.0V

5) Is the measured voltage within the specification?

YES

▶ Go to "2. Grounding test of glow lamp control circuit" as follows.

NO

▶ Check filament of glow lamp. (Refer to Component Inspection)

2. Grounding test of glow lamp control circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect ECM connector.

3) IG Key "ON".

4) Ground ECM connector(CUD-K) terminal 69 to chassis ground.

Specification : Glow lamp turns ON.

5) Does glow lamp turn ON?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Repair short to battery in glow lamp control circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E1D7CE23

1. IG Key "OFF", Engine "OFF".
2. Dismount cluster and disconnect glow lamp.
3. Check filament of glow lamp.
4. Supply 12V to glow lamp to turn lamp ON.

Specification : Lamp turns ON when 12V is supplied.

5. Does glow lamp turn ON?

1)

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace glow lamp and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E875A75E

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

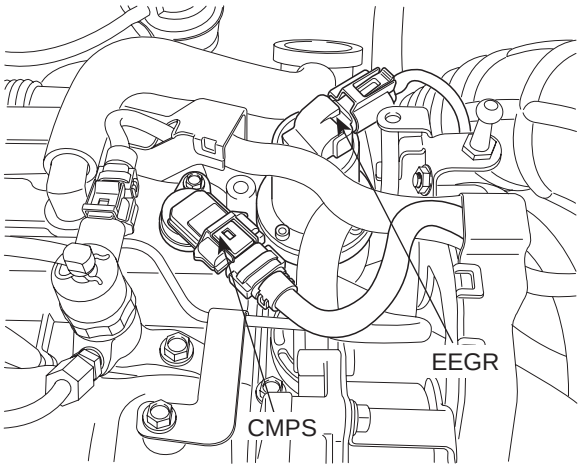
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0401 EXHAUST GAS RECIRCULATION FLOW INSUFFICIENT DETECTED

COMPONENT LOCATION EFA7BB56



SLDFL6332L

GENERAL DESCRIPTION E401B83E

Receiving ECM signal, linear solenoid type electronic EGR actuator operates EEGR valve directly. ECM performs EGR system feed back control with the information of measured mass air flow. (The role of MAFS in diesel engine is different from gasoline engine. Fuel injection quantity is decided by MAFS signal in gasoline engine.) When EGR gas(contains no oxygen) flowing into combustion chamber increases, the air passing through MAFS(contains oxygen) decreases. Thus, with the output signal change of MAFS accompanied by EEGR actuator actuation, ECM determine the amount of recirculated EGR gas quantity.

NOTE

NOx is produced from the reaction of nitrogen and oxygen. Controlling EGR gas(contains no oxyger) which is recirculated to combustion chamber, if least intake air required for complete combustion flows into combustion chamber, NOx decreases because there is no supplementary oxygen to react with nitrogen.

DTC DESCRIPTION EE9C450B

P401 is set when ECM/PCM detects that duty amount of EEGR actuator contol valve, ENG speed or amount of EGR is exceeded to minimum set point last to more than 15 sec. In this case, check that stuck of EEGR actuator, air leakage of intake line.

DTC DETECTING CONDITION E338D652

Item	Detecting Condition			Possible Cause
DTC Strategy	• Signal monitoring			• EGR actuator stuck • EGR actuator component • Air leakage of intake line
Enable Conditions	• Engine running			
ThresholdValue	• EGR is exceeded to minimum set point			
DiagnosticTime	• 15 sec.			
Fail Safe	Fuel Cut	NO		
	EGR Off	YES		
	Fuel Limit	NO		
	MIL	ON		

SPECIFICATION E4487699

EGR actuator component resistance	EGR actuator operating Hz	EGR actuator operating duty
7.3 ~ 8.8Ω (20°C)	142Hz	10%(closed) ~ 40%(opened)

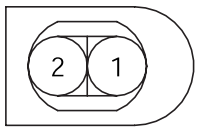
SCHEMATIC DIAGRAM EEFA4A00

[CIRCUIT DIAGRAM]

[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	Main Relay	Battery Voltage (B+)
2	ECM CUD-M (59)	EEGR Control

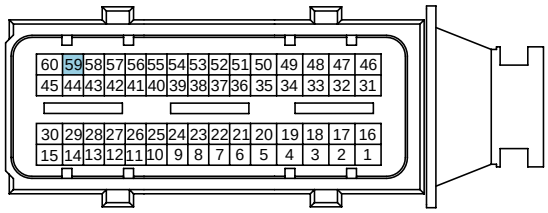
[HARNESS CONNECTORS]



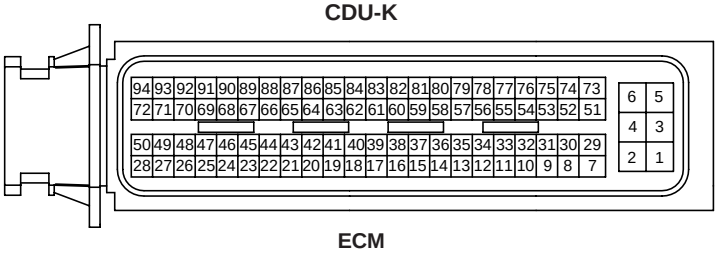
CUD31

EEGR

CDU-M



CDU-K



ECM

SLDF27134L

SIGNAL WAVEFORM AND DATA E1F8E193

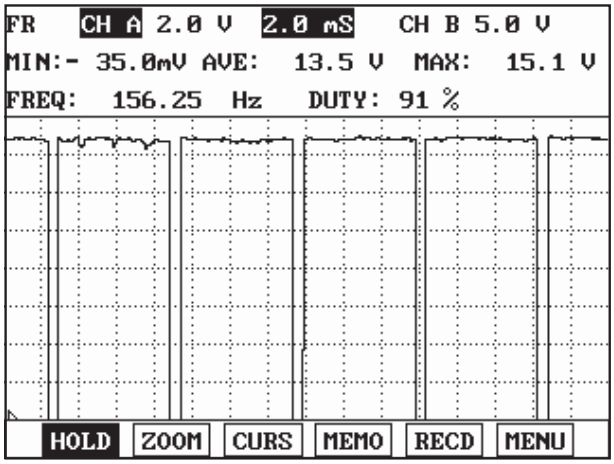


Fig.1

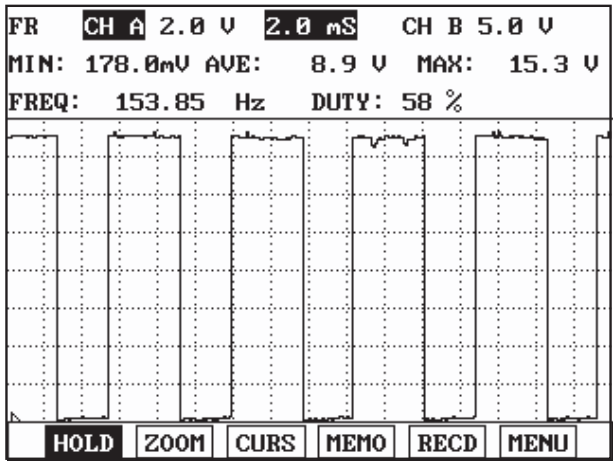


Fig.2

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

SLDF27699L

NOTE

The output of approx. 10% duty is mainly for the diagnosis of EEGR actuator circuit than actuating EEGR.

MONITOR SCANTOOL DATA E2B173D2

1. Connect scantool to Data Link Cable. (DLC)
2. Warm engine up to normal operating temperature.
3. Turn "OFF" electrical devices and A/C.
4. Monitor "AIR MASS PERCYLINDER" parameter on the Scantool.

Specification :
When EEGR actuator does not operate (6% duty) at idle : 340mg/st ± 50 mg/st
When EEGR actuator operates(50% duty) at idle : 200ms/st ± 50 mg/st

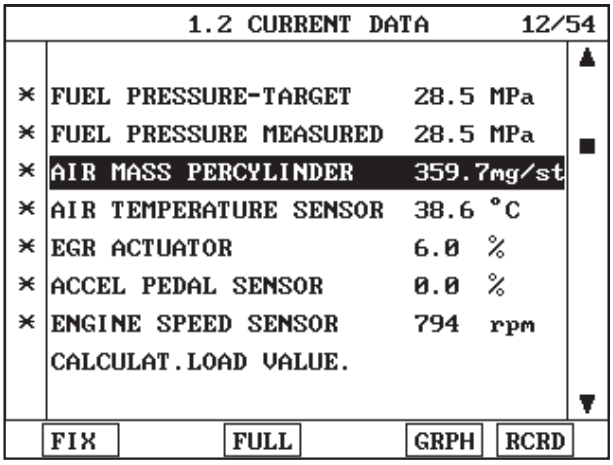


Fig.1

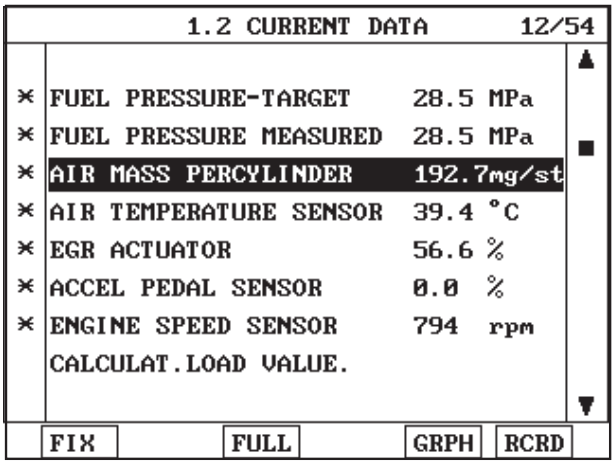


Fig.2

Fig.1) Check if "AIR MASS PER CYLINDER" output signal is 340mg/st ± 50mg/st without EEGR operation at warm idle (EEGR actuator 6% duty)
Fig.2) Check if "AIR MASS PER CYLINDER" output signal is 200mg/st ± 50mg/st with EEGR operation at warm idle (EEGR actuator 50% duty)

※EEGR actuator operates as decelerating after rapid acceleration when idle EEGR does not operate, EEGR actuator operating duty decreases as time goes by. This controlling process lasts for about 3 min. and EEGR actuator turns "OFF" (duty 6%) after 3 min.

SLDFL6230L

TERMINAL AND CONNECTOR INSPECTION E9701E45

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.
2. Perform checking procedure as follows.
   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.
   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

NOTE

Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector or checking connecting condition. (after checking, reconnect the pin at correct position.)

3. Is the problem found?

YES

▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

NO

▶ Go to "Power Circuit Inspection".

POWER CIRCUIT INSPECTION EC1D2E26

1. IG Key "OFF", Engine "OFF".
2. Disconnect EGR actuator connector

3. IG Key "ON".

4. Measure the voltage of EGR actuator connector terminal 2.

Specification : 11.5V~13.0V

5. Is the measured voltage within the specification?

YES

▶ Go to "Control Circuit Inspection".

NO

▶ Repair E/R FUSE & RELAY BOX 15A SNSR 2 FUSE and related circuit and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION EB53CFB1

1. Check control circuit monitoring voltage

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect EGR actuator connector.

   3) IG Key "ON".

   4) Measure the voltage of EGR actuator connector terminal 1.

Specification : 3.2V~3.7V

   5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ When voltage is not detected : Go to "2. Check open in control circuit" as follows.
▶ When high voltage is detected : Repair short to battery and go to "Verification of Vehicle Repair".

2. Check open in control circuit

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect EGR actuator connector and ECM connector.

   3) Check continuity between EGR actuator terminal 1 and ECM connector (CUD-M) terminal 59.

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification?

YES

▶ Repair short to ground and go to "Verification of Vehicle Repair".

NO

▶ Repair open in control circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION EDCE01BA

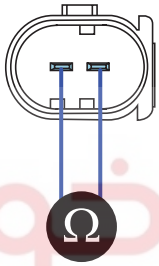
1. Check EGR actuator component resistance

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect EGR actuator.

   3) Measure the resistance between EGR actuator component terminal 1 and terminal 2.

Specification : 7.3~ 8.8Ω (20℃)



SLDFL6331L

   4) Is EEGR actuator component resistance within the specification?

YES

▶ Go to "2. Check EEGR actuator operation condition"as follows.

NO

▶ Replace EEGR actuator and go to "Verification of Vehicle Repair".

2. EEGR operation check

   1) IG Key "OFF", Engine "OFF".

   2) Check that MAFS is installed in correctly according to the direction of arrow on MAFS assy'.

   3) Check contamination of air cleaner filter.

   4) IG Key "ON", Engine "ON".

   5) Let IDLE RPM last after warming engine up.

   6) Check the leakage of intake system(the leakage or damage of intercooler).

   7) Check that VGT operates correctly.(Check if vacuum operating state of VGT actuator is appropriate, if VGT diaphragm and unison ring are stuck.)

   8) Check that EEGR actuator does not operate.
   (EEGR actuator turns "OFF" and 4.4% duty is outputted 3 min after rapid acceleration.)

   9) Monitor signal voltage of MAFS when engine speed lasts at approx. 800RPM using Scantool.

10) Check MAFS output signal at idle after rapid acceleration.(EEGR actuator duty 45%)

Specification :
When EEGR actuator does not operate (5%) at idle : 410mg/st ± 50 mg/st
When EEGR actuator operates(45%) at idle : 360mg/st ± 50 mg/st

11) Is output signal within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ After checking that carbon is clogged inside of EGR pipe and EEGR actuator or EGR valve is stuck, if any troble is not detected, repair EEGR actuator assy' and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E7D21AB7

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0402 EXHAUST GAS RECIRCULATION FLOW EXCESSIVE DETECTED

COMPONENT LOCATION EB18487F

Refer to DTC P0401.

GENERAL DESCRIPTION ECE974F6

Refer to DTC P0401.

DTC DESCRIPTION E24AEA88

P0402 is set when EGR governer deviaton is above the upper limit value for more than 5 sec.. This code is due to open or short to battery in EEGR actuator circuit or internal open in EEGR component.

DTC DETECTING CONDITION EA645FCF

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Signal monitoring</td><td rowspan="6">• EGR actuator circuit
• EGR actuator component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• Short to battery
• Wiring open</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 5 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4"></td></tr>
<tr><td>EGR Off</td><td>YES</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>ON</td></tr>
</table>

SPECIFICATION EF5B2E45

EGR actuator component resistance	EGR actuator operating Hz	EGR actuator operating duty
7.3 ~ 8.8Ω (20℃)	142Hz	10%(closed) ~ 40%(opened)

SCHEMATIC DIAGRAM E174F9E5

Refer to DTC P0401.

SIGNAL WAVEFORM AND DATA E9EC14B5

Refer to DTC P0401.

MONITOR SCANTOOL DATA E5193A29

Refer to DTC P0401.

TERMINAL AND CONNECTOR INSPECTION E2399A05

Refer to DTC P0401.

POWER CIRCUIT INSPECTION E6F409A8

1. IG Key "OFF", Engine "OFF".
2. Disconnect EGR actuator connector
3. IG Key "ON".
4. Measure the voltage of EGR actuator connector terminal 2.

Specification : 11.5V~13.0V

5. Is the measured voltage within the specification?

YES

▶ Go to "Control Circuit Inspection".

NO

▶ Repair E/R FUSE & RELAY BOX 15A SNSR 2 FUSE and related circuit and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION E4C8EEFD

1. Check control circuit monitoring voltage
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect EGR actuator connector.
   3) IG Key "ON".
   4) Measure the voltage of EGR actuator connector terminal 1.

Specification : 3.2V~3.7V

   5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ When voltage is not detected : Go to "2. Check open in control circuit" as follows.
▶ When high voltage is detected : Repair short to battery and go to "Verification of Vehicle Repair".

2. Check open in control circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect EGR actuator connector and ECM connector.
   3) Check continuity between EGR actuator terminal 1 and ECM connector (CUD-M) terminal 59.

Specification : Continuity (below 1.0Ω)

4) Is the measured resistance within the specification?

YES

▶ Go to "Component Inspection".

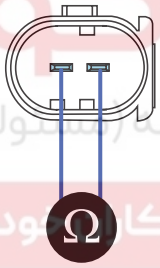
NO

▶ Repair open in control circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E95E286A

1. IG Key "OFF", Engine "OFF".
2. Disconnect EGR actuator.
3. Measure the resistance between EGR actuator component terminal 1 and terminal 2.

Specification : 7.3~ 8.8Ω (30℃)



SLDFL6331L

4. Is EEGR actuator component resistance within the specification?

YES

▶ Go to "2. EEGR operation check".

NO

▶ Replace EEGR actuator and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E2926E3E

Refer to DTC P0401.

DTC P0489 EXHAUST GAS RECIRCULATION CONTROL CIRCUIT LOW VOLTAGE

COMPONENT LOCATION E8AEBD5B

Refer to DTC P0401.

GENERAL DESCRIPTION EE0F71BB

Refer to DTC P0401.

DTC DESCRIPTION EF104923

P0489 is set when '0'A is detected in EEGR actuator circuit for more than 0.5 sec.. This code is due to open or short to ground in EEGR actuator circuit or internal open in EEGR component.

DTC DETECTING CONDITION E7A3A80A

Item	Detecting Condition		Possible Cause
DTC Strategy	• Signal monitoring		• EEGR actuator circuit • EEGR actuator component
Enable Conditions	• Engine run		
ThresholdValue	• Short to GND • Wiring open		
DiagnosticTime	• 0.5 sec.		
Fail Safe	Fuel Cut	NO	
	EGR Off	YES	
	Fuel Limit	NO	
	MIL	OFF	

SPECIFICATION E311F9A1

EGR actuator component resistance	EGR actuator operating Hz	EGR actuator operating duty
7.3 ~ 8.8Ω (20℃)	142Hz	10%(closed) ~ 40%(opened)

SCHEMATIC DIAGRAM EE6D1C94

Refer to DTC P0401.

SIGNAL WAVEFORM AND DATA E102B230

Refer to DTC P0401.

MONITOR SCANTOOL DATA EB8C31F1

Refer to DTC P0401.

TERMINAL AND CONNECTOR INSPECTION E885D331

Refer to DTC P0401.

POWER CIRCUIT INSPECTION E54AB53A

1. IG Key "OFF", Engine "OFF".
2. Disconnect EGR actuator connector
3. IG Key "ON".
4. Measure the voltage of EGR actuator connector terminal 2.

Specification : 11.5V~13.0V

5. Is the measured voltage within the specification?

YES

▶ Go to "Control Circuit Inspection".

NO

▶ Repair E/R FUSE & RELAY BOX 15A SNSR 2 FUSE and related circuit and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION EDEF3F10

1. Check control circuit monitoring voltage
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect EGR actuator connector.
   3) IG Key "ON".
   4) Measure the voltage of EGR actuator connector terminal 1.

Specification : 3.2V~3.7V

   5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ When voltage is not detected : Go to "2. Check open in control circuit" as follows.
▶ When high voltage is detected : Repair short to battery and go to "Verification of Vehicle Repair".

2. Check open in control circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect EGR actuator connector and ECM connector.
   3) Check continuity between EGR actuator terminal 1 and ECM connector (CUD-M) terminal 59.

Specification : Continuity (below 1.0Ω)

4) Is the measured resistance within the specification?

YES

▶ Repair short to ground and go to "Verification of Vehicle Repair".

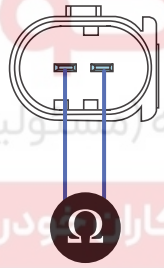
NO

▶ Repair open in control circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E0593ED3

1. IG Key "OFF", Engine "OFF".
2. Disconnect EGR actuator.
3. Measure the resistance between EGR actuator component terminal 1 and terminal 2.

Specification : 7.3~ 8.8Ω (20℃)



SLDFL6331L

4. Is EEGR actuator component resistance within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace EEGR actuator and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E82C0F09

Refer to DTC P0401.

DTC P0490 EXHAUST GAS RECIRCULATION CONTROL CIRCUIT HIGH VOLTAGE

COMPONENT LOCATION E9BB3D2F

Refer to DTC P0401.

GENERAL DESCRIPTION EF7373B7

Refer to DTC P0401.

DTC DESCRIPTION EDA16E79

P0490 is set when excessive current is detected in EEGR actuator circuit for more than 0.5 sec.. This code is due to short to battery in EEGR actuator control circuit or internal short in EEGR component.

DTC DETECTING CONDITION E446232E

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Signal monitoring</td><td rowspan="6">• EEGR actuator circuit
• EEGR actuator component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• Short to battery</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 0.5 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4"></td></tr>
<tr><td>EGR Off</td><td>YES</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SPECIFICATION E7AE5E9B

EGR actuator component resistance	EGR actuator operating Hz	EGR actuator operating duty
7.3 ~ 8.8Ω (20℃)	142Hz	10%(closed) ~ 40%(opened)

SCHEMATIC DIAGRAM E94D735B

Refer to DTC P0401.

SIGNAL WAVEFORM AND DATA ED08DE18

Refer to DTC P0401.

MONITOR SCANTOOL DATA E8AB6B9F

Refer to DTC P0401.

TERMINAL AND CONNECTOR INSPECTION E878DF73

Refer to DTC P0401.

POWER CIRCUIT INSPECTION E7C69247

1. IG Key "OFF", Engine "OFF".
2. Disconnect EGR actuator connector
3. IG Key "ON".
4. Measure the voltage of EGR actuator connector terminal 2.

Specification : 11.5V~13.0V

5. Is the measured voltage within the specification?

YES

▶ Go to "Control Circuit Inspection".

NO

▶ Repair E/R FUSE & RELAY BOX 15A SNSR 2 FUSE and related circuit and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION EC4B80D5

1. Check control circuit monitoring voltage
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect EGR actuator connector.
   3) IG Key "ON".
   4) Measure the voltage of EGR actuator connector terminal 1.

Specification : 3.2V~3.7V

   5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ When voltage is not detected : Go to "2. Check open in control circuit" as follows.
▶ When high voltage is detected : Repair short to battery and go to "Verification of Vehicle Repair".

2. Check open in control circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect EGR actuator connector and ECM connector.
   3) Check continuity between EGR actuator terminal 1 and ECM connector (CUD-M) terminal 59.

Specification : Continuity (below 1.0Ω)

4) Is the measured resistance within the specification?

YES

▶ Repair short to ground and go to "Verification of Vehicle Repair".

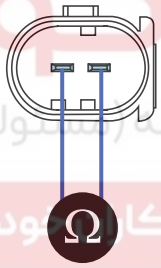
NO

▶ Repair open in control circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E24E0EB3

1. IG Key "OFF", Engine "OFF".
2. Disconnect EGR actuator.
3. Measure the resistance between EGR actuator component terminal 1 and terminal 2.

Specification : 7.3~ 8.8Ω (20℃)



SLDFL6331L

4. Is EEGR actuator component resistance within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

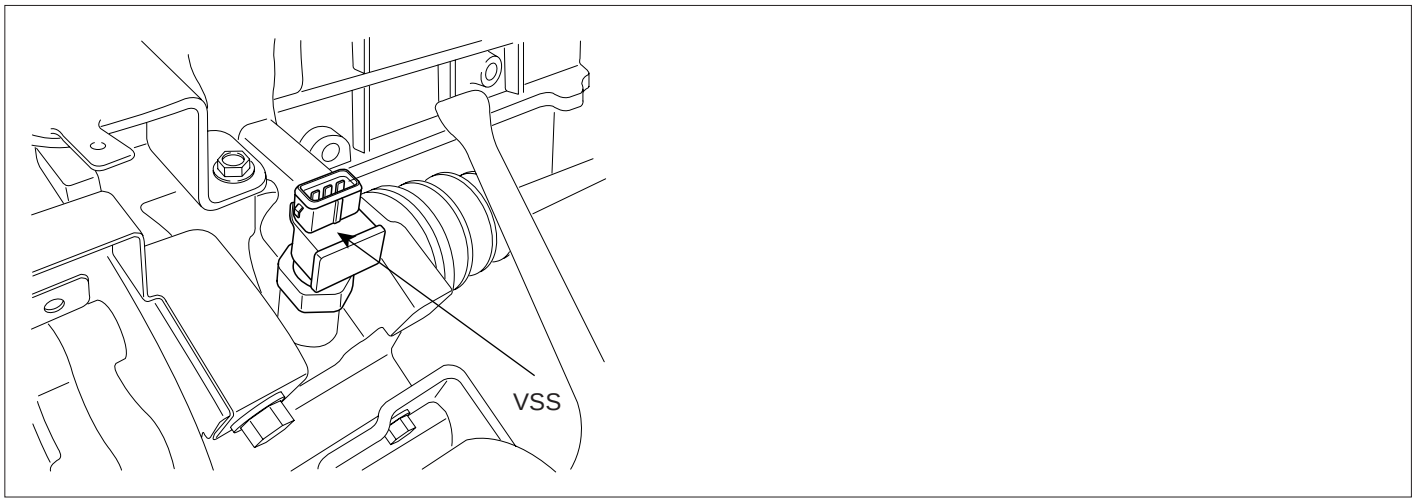
▶ Replace EEGR actuator and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR ECE59EEA

Refer to DTC P0401.

DTC P0501 VEHICLE SPEED SENSOR A RANGE/PERFORMANCE

COMPONENT LOCATION E2DB9813



SLDFL6337L

GENERAL DESCRIPTION E0DF6C9E

Vehicle Speed Sensor(VSS) is hall sensor type and senses the rotating speed of differential gear mounted on transaxle. Comparing engine speed with vehicle speed calculated based on vehicle speed sensor signal, ECM recognizes engaged gear. And based on the information about engaged gear, ECM performs optimum fuel injection quantity correction. VSS signal is also used in speed meter of cluster, ETACS(or BCM), aircon control module, navigation system, etc.

DTC DESCRIPTION E548BF74

P0501 is set when vehicle speed below 13.8 kph is detected for more than 4 sec. at above 4,000RPM and above 38.5 cc of fuel injection quantity. This code is due to open/short in VSS circuit, poor connection/damaged harness or VSS component failure.

DTC DETECTING CONDITION E6423A44

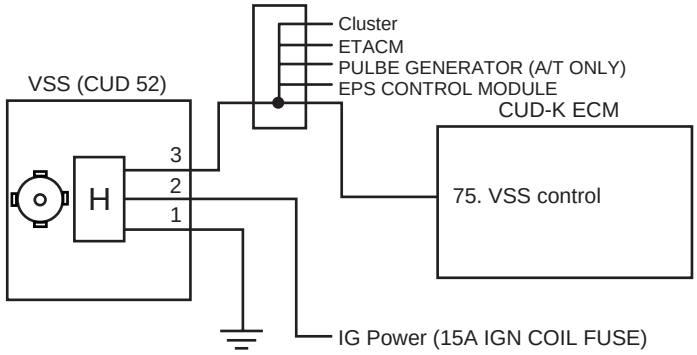
Item		Detecting Condition		Possible Cause
DTC Strategy		• Signal monitoring		• Vehicle speed sensor circuit • Vehicle speed sensor component
Enable Conditions		• Vehicle driving		
Case 1	Threshold Value	• When vehicle speed below 13.8 kph is detected. at above 4,000RPM and above 38.5 cc of fuel injection quantity.		
	Diagnostic Time	• 4 sec		
Case 2	Threshold Value	• When vehicle speed is calculated more than 240kph by ECM.		
	Diagnostic Time	• 0.5 sec		
Case 3	Threshold Value	• When VSS signal is not valid.		
	Diagnostic Time	• 1 sec		
Fail Safe		Fuel Cut	NO	
		EGR Off	NO	
		Fuel Limit	NO	
		MIL	OFF	

SPECIFICATION E5C9DA7C

Sensing Type	LOW Signal Voltage	HIGH Signal Voltage	Signal Duty
Hall sensor type	below 1.5V	above 3.5V	50±5%

SCHEMATIC DIAGRAM E19A01C7

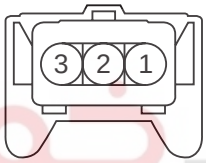
[CIRCUIT DIAGRAM]



[CONNECTOR INFORMATION]

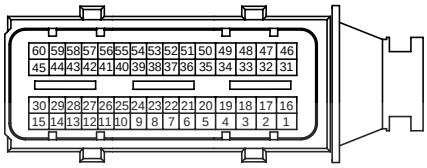
Terminal	Connected to	Function
1	I/P-F terminal 27	Chassis Ground
2	GUD 08 J/C terminal 5	IG Power
3	ECM CUD-K (75)	VSS signal

[HARNESS CONNECTOR]

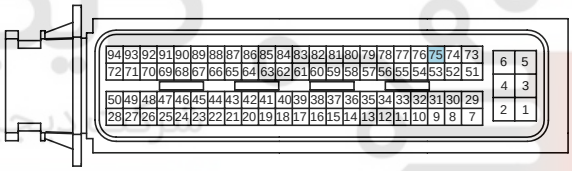


CUD 52
VSS

CUD-M



CUD-K



ECM

SLDF27681L

SIGNAL WAVEFORM AND DATA E1DABA6A

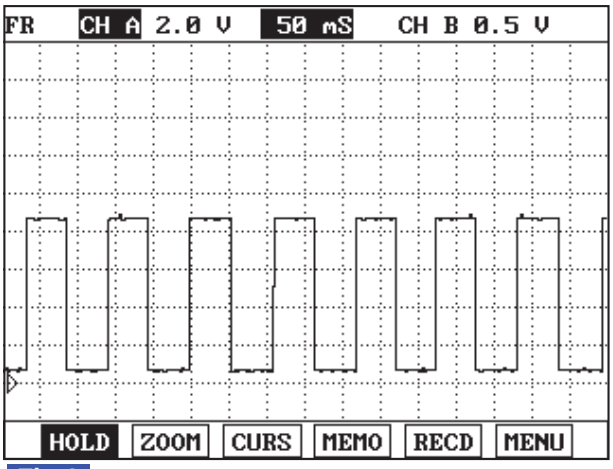


Fig.1

Fig.1) This is the signal waveform of vehicle speed sensor. Digital waveform, LOW 0.8V, HIGH : 10V with 50% duty is outputted. ECM detects vehicle speed, sensing this ON-OFF period (Hz).

SLDFL6339L

MONITOR SCANTOOL DATA EC572A95

1. Connect Scantool to Data Link Connector (DLC).
2. Warm engine up to normal operating temperature.
3. Turn "OFF" electrical devices and A/C.
4. Monitor "VEHICLE SPEED SENSOR " parameter on the Scantool.

Specification : Current vehicle speed is displayed.

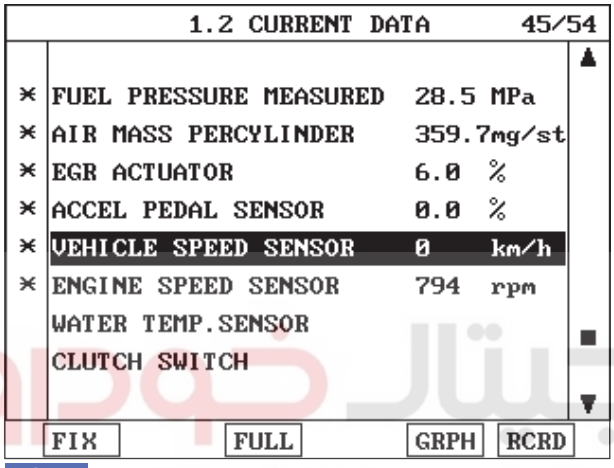


Fig.1

Fig.1) Check if current vehicle speed is same as vehicle speed displayed on the Scantool.

SLDFL6340L

TERMINAL AND CONNECTOR INSPECTION E8E2D8F3

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.
2. Perform checking procedure as follows.
   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.
   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

NOTE

Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position.)

3. Is the problem found?

YES

▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

NO

▶ with go to "Power Circuit Inspection".

POWER CIRCUIT INSPECTION E38DF34A

1. IG Key "OFF", Engine "OFF".
2. Disconnect Vehicle Speed Sensor connector.
3. IG Key "ON".
4. Measure the voltage of VSS connector terminal 2.

Specification : 11.5V~13.0V

5. Is the measured voltage within the specification?

YES

▶ Go to "Signal Circuit Inspection".

NO

▶ Repair I/P JUNCTION BOX 10A ECU FUSE and related circuit, and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION E8455324

1. Check signal circuit voltage (sensor side)
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect VSS connector.
   3) IG Key "ON".
   4) Measure the voltage of VSS connector termianl 3.

Specification : 8.0V~11.5V

   5) Is the measured voltage within the specification?

YES

▶ Go to "2. Check signal circuit voltage (ECM side)"as follows.

NO

▶ Repair poor connection or open in signal circuit and go to "Verification of Vehicle Repair".

2. Check signal circuit voltage (ECM side)
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect Vehicle Speed Sensor connector and ECM connector.
   3) IG Key "ON".
   4) Measure the voltage of ECM connector (CUD-K) terminal 75.

Specification : 8.0V~11.5V

5) Is the measured voltage within the specification?

YES

▶ Go to "Ground Circuit Inspection".

NO

▶ Repair poor connection or open in ECM connector (CUD-K) terminal 75 related circuit and go to "Verification of Vehicle Repair".

GROUND CIRCUIT INSPECTION EB6117A4

1. IG Key "OFF", Engine "OFF".
2. Disconnect VSS connector.
3. IG Key "ON".
4. Measure the voltage of VSS connector terminal 2. [TEST "A"]
5. Measure the voltage between VSS connector terminal 2 and terminal 1. [TEST "B"]
(terminal 2 : Check + prove , terminal 1 : Check - prove)

Specification : [TEST "A"] Voltage - [TEST "B"] Voltage = below 200mV

6. Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ When "B" voltage is not detected : Repair open in ground circuit and go to "Verification of Vehicle Repair".
▶ When the voltage difference between "A" and "B" is above 200mV : Eliminate the causes of excessive resistance and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E252A9C6

1. IG Key "OFF", Engine "OFF".
2. Disconnect VSS connector.
3. Disconnect VSS and Driven gear assy'.
4. Check rotating state of VSS driven gear.
5. Connect VSS connector and IG Key "ON".
6. Rotate Driven gear with hand.

SPECIFICATION :

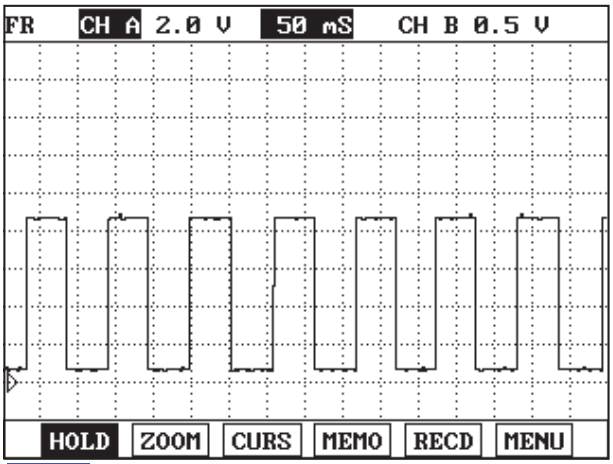


Fig.1

Fig.1) This is the signal waveform of vehicle speed sensor. Digital waveform, LOW 0.8V, HIGH : 10V with 50% duty is outputted. ECM detects vehicle speed, sensing this ON-OFF period (Hz).

SLDFL6339L

7. Does vehicle speed signal generate?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace vehicle speed sensor and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E0945387

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0504 BRAKE SWITCH "A"/"B" CORRELATION

GENERAL DESCRIPTION E62BECDA

Brake switch is connected to brake pedal and transmits brake operating state to ECM. When the output signal of APS is higher than what driver intended during driving (e.g. short to high voltage line in APS circuit, false signal), driver depresses brake pedal. Like this, if driver's decelerating intension is transmitted to ECM (break pedal depressed)when APS output voltage is high, ECM recognizes APS trouble and Limp Home mode is activated. At Limp Home mode, engine speed is fixed at approx. 1000RPM and engine power generation is limitted. Even at Limp home mode, if correct APS signal is detected, Limp Home mode is deactivated. Brake switch, which monitors proper operation of APS, is devided 1 and 2 for the fidelity of brake switch.

DTC DESCRIPTION E4186436

When brake switch operates correctly, switch 1 is OFF and switch 2 is ON when releasing brake pedal, while switch 1 is ON and switch 2 is OFF when depressing brake pedal. thus when the signal from a switch is different from the other's, brake switch is in good condition. When the signal from a switch is same as the other's, brake switch is fault.

DTC DETECTING CONDITION E87916E5

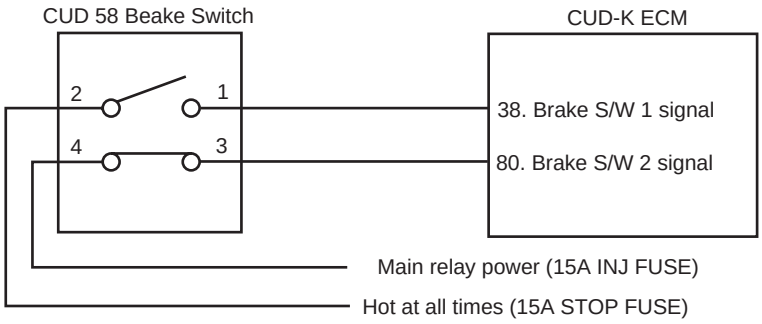
Item	Detecting Condition		Possible Cause
DTC Strategy	• Signal monitoring		• Brake switch component • Abnormal brake pedal height • Brake switch circuit
Enable Conditions	• IG Key "ON"		
ThresholdValue	• Wiring open		
DiagnosticTime	• 100 sec.		
Fail Safe	Fuel Cut	NO	
	EGR Off	NO	
	Fuel Limit	NO	
	MIL	OFF	

SPECIFICATION E1EE2658

Condition	Brake Pedal Released		Brake Pedal Depressed	
Switch state	Switch 1	Switch 2	Switch 1	Switch 2
	Opened	Closed	Closed	Opened

SCHEMATIC DIAGRAM EC969870

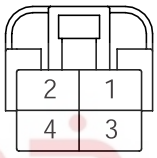
[CIRCUIT DIAGRAM]



[CONNECTOR INFORMATION]

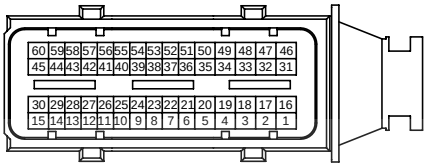
Terminal	Connected to	Function
1	CUD-K terminal 38	Brake S/W 1 signal
2	E/R CUD terminal 56	Hot at all times
3	CUD-K terminal 80	Brake S/W 2 signal
4	E/R-CUD terminal 61	Main relay power

[HARNESS CONNECTOR]

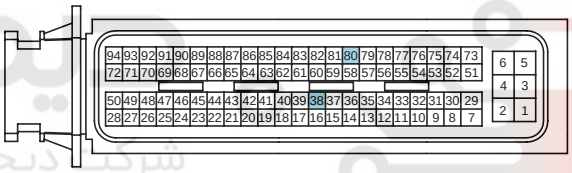


CUD 58
Beake Switch

CUD-M



CUD-K



ECM

SLDF27682L

SIGNAL WAVEFORM AND DATA E7E0F628

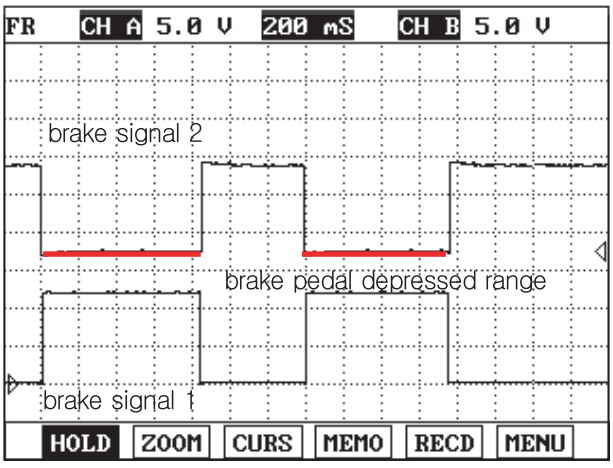


Fig.1

Fig.1) The waveform of brake signal 1 and 2 are measured simultaneously. Both waveforms are symmetrical.

SLDFL6347L

MONITOR SCANTOOL DATA ECDED228

1. Connect scantool to Data Link Cable. (DLC)

2. Warm engine up to normal operating temperature.

3. Turn "OFF" electrical devices and A/C.

4. Monitor "BRAKE SWITCH" and "REDUNDANT BRAKE SWITCH" parameter on the Scantool.

Specification :
When brake pedal is released : "BRAKE SWITCH" and "REDUNDANT BRAKE SWITCH" : OFF
When brake pedal is depressed : "BRAKE SWITCH" and "REDUNDANT BRAKE SWITCH" : ON

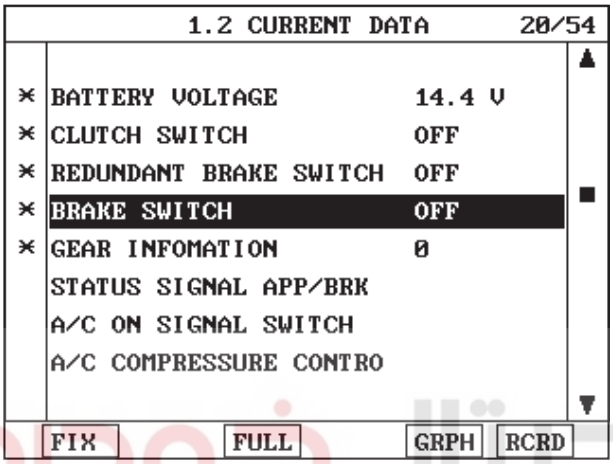


Fig.1

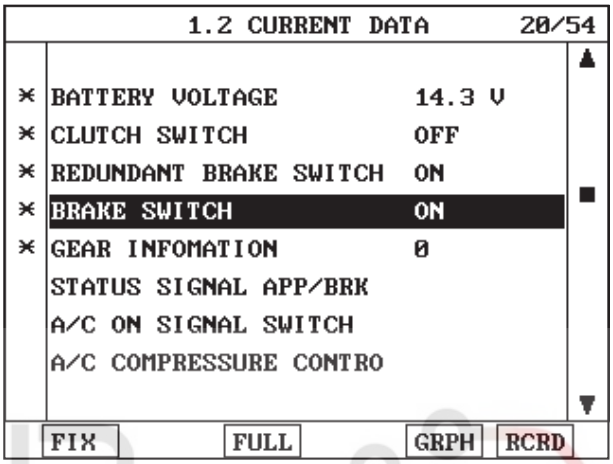


Fig.2

Fig.1) Data when brake switch(brake pedal) is deactivated(released) :
"BRAKE SWITCH" and "REDUNDANT BRAKE SWITCH" : OFF
Fig.2) Data when brake switch(brake pedal) is activated(depressed) :
"BRAKE SWITCH" and "REDUNDANT BRAKE SWITCH" : ON

SLDFL6348L

TERMINAL AND CONNECTOR INSPECTION E767FD04

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.

2. Perform checking procedure as follows.

   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.

   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

   NOTE

   Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector or checking connecting condition. (after checking, reconnect the pin at correct position.)

3. Is the problem found?

   YES

   ▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

   NO

   ▶ Go to "Power Circuit Inspection".

POWER CIRCUIT INSPECTION EDE31C35

1. Check brake switch 1 "HOT AT ALL TIMES"

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect brake switch connector.

   3) Measure the voltage of brake switch connector terminal 2.

Specification : 11.5V~13.0V

   4) Is the measured voltage within the specification?

   YES

   ▶ Go to "2.Check brake switch 2 main relay power" as follows.

   NO

   ▶ Repair E/R-CUD JUNCTION BOX 15A STOP FUSE and related circuit and go to "Verification of Vehicle Repair".

2. Check brake switch 2 main relay power

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect brake switch connector.

   3) IG Key "ON".

   4) Measure the voltage of brake switch connector terminal 4.

Specification : 11.5V~13.0V

   5) Is the measured voltage within the specification?

   YES

   ▶ Go to "Signal Circuit Inspection".

   NO

   ▶ Repair E/R JUNCTION BOX 15A SNSR3 FUSE and related circuit and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION E5242CFD

1. Check brake switch signal circuit voltage

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect ECM connector with brake switch connector connected.

   3) Disconnect E/R JUNCTION BOX main relay, connect main relay terminal 30, 87 and 87a using jump wire.

   4) Measure the voltage of ECM connector(CUD-K) terminal 38 as depressing brake pedal.

   5) Measure the voltage of ECM connector(CUD-K) terminal 80 as depressing brake pedal.

SPECIFICATION :

	Brake Pedal Released	Brake Pedal Depressed
Brake switch 1 (terminal 38)	0.0V~0.1V	11.5V~13.0V
Brake switch 2 (terminal 80)	11.5V~13.0V	0.0V~0.1V

6) Is the measured voltage within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ If there is any problem on component after checking "Component Inspection" procedure, go to "2. Check open in signal circuit "as follows.

2. Check open in signal circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect brake switch connector and ECM connector.

3) Check continuity between brake switch connector terminal 1 and ECM connector (CUD-K) terminal 38. (brake switch 1 circuit)

4) Check continuity between brake switch connector terminal 3 and ECM connector (CUD-K) terminal 80. (brake switch 2 circuit)

Specification : Continuity (below 1.0Ω)

5) Is the measured resistance within the specification?

YES

▶ Repair short in signal circuit and go to "Verification of Vehicle Repair".

NO

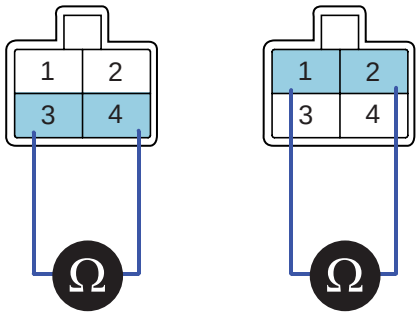
▶ Repair open in signal circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION EAE98052

1. IG Key "OFF", Engine "OFF".
2. Disconnect brake switch connector.
3. Check continuity between brake switch component terminal 1and terminal 2 as depressing brake pedal. (brake switch 1)
4. Check continuity between brake switch component terminal 3and terminal 4 as depressing brake pedal. (brake switch 2)

SPECIFICATION :

Condition	Brake Pedal Released		Brake Pedal Depressed	
Switch state	1 ↔ 2	3 ↔ 4	1 ↔ 2	3 ↔ 4
	Discontinuity	Continuity	Continuity	Discontinuity



SLDFL6353L

5. Does brake switch operate correctly?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Unless any problem is detected after checking height of brake pedal, replace brake switch component and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E8030CCA

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

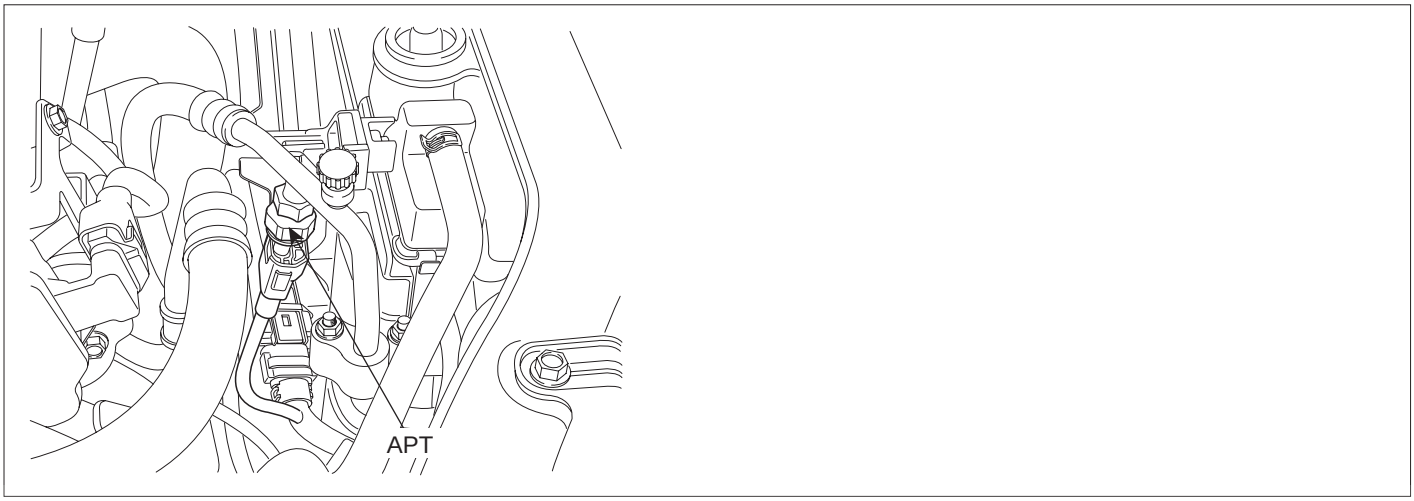
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0532 A/C REFRIGERANT PRESSURE SENSOR "A" CIRCUIT LOW INPUT

COMPONENT LOCATION E7230D29



SLDFL6354L

GENERAL DESCRIPTION EDD5F373

A/C pressure transducer consists of piezoelectric element and it detects A/C refrigerant pressure. Piezoeletric type is more advantageous to obtain linear data of pressure than existing switch type. Thus, optimum control of A/C compressor and fan is realized and improved fuel efficiency follows with it.

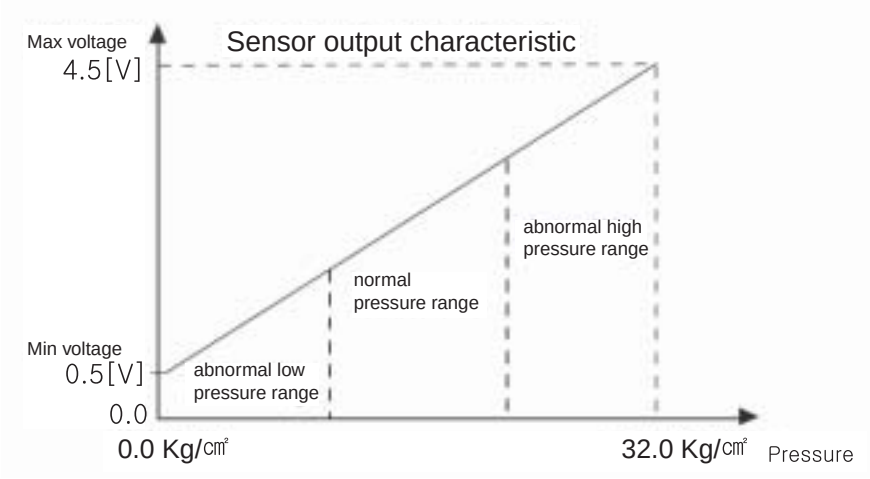
DTC DESCRIPTION ED3D4FDD

P0532 is set when the voltage below 0.3V - minimum voltage of A/C pressure transducer signal - is detected for more than 0.6 sec.. This code is due to open in power circuit or short to ground in signal circuit of A/C pressure transducer.

DTC DETECTING CONDITION E911D3CC

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="8">• A/C pressure transducer circuit
• A/C pressure transducer component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• When output voltage is below the minimum value (below 0.3V)</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 600ms</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• A/C pressure fixed at 4,000 hPa</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SPECIFICATION EA6EC836



SLDFL6355L

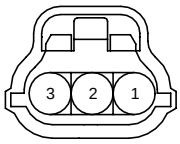
SCHEMATIC DIAGRAM E2F0C9C4

[CIRCUIT DIAGRAM]

[CONNECTOR INFORMATION]

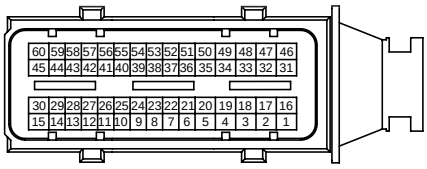
Terminal	Connected to	Function
1	CUD-K terminal 12	Sensor ground
2	CUD-K terminal 13	Sensor signal
3	CUD-K terminal 22	Sensor power

[HARNESS CONNECTOR]

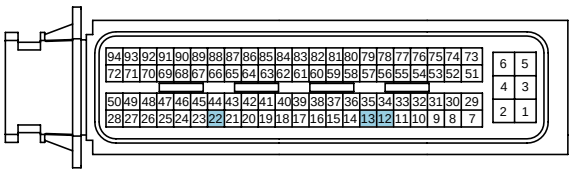


E 24
APT

CUD-M



CUD-K



ECM

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SIGNAL WAVEFORM AND DATA EFCCD463

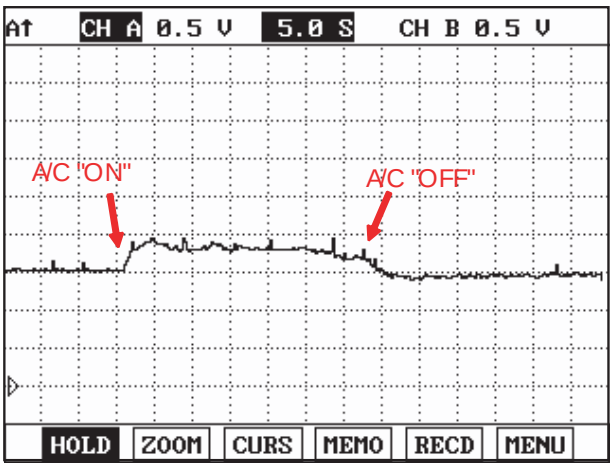


Fig.1

Fig.1) Waveform of A/C pressure transducer in accordance with A/C operation.(A/C compressor operation)

SLDFL6357L

NOTE

Output signal(voltage) changes in accordance with the amount of refrigerant and the change of weather.occurs Check if normal pressure change in accordance with A/C compressor operation at normal pressure range shown in "Specification".

MONITOR SCANTOOL DATA E1B2ACE5

1. Connect scantool to Data Link Cable (DLC).
2. Warm engine up to normal operating temperature.
3. Turn "OFF" electrical devices and A/C.
4. Monitor "A/C PRESSURE SENSOR" parameter on the scantool.

Specification :
A/C "OFF" : 1200mV~1500mV
A/C " ON" : 1500mV~ 2400mV

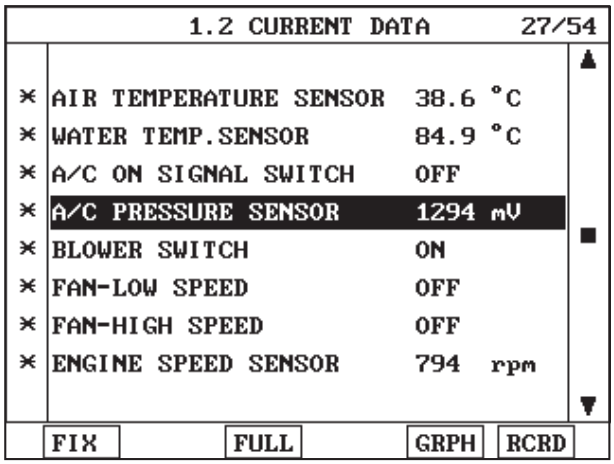


Fig.1

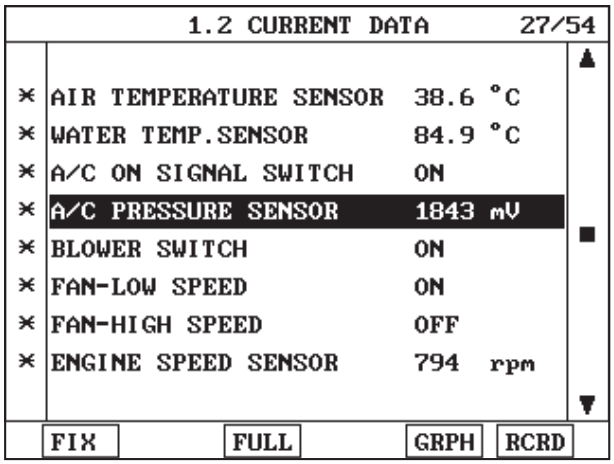


Fig.2

Fig.1) Data at idle and A/C "OFF", A/C pressure transducer output voltage is 2058mV.
Fig.2) Data at idle and A/C "ON". A/C pressure transducer output voltage increases as A/C compressor operates.

SLDFL6358L

TERMINAL AND CONNECTOR INSPECTION E8634D06

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damage of component.
2. Perform checking procedure as follows.
   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.
   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

   NOTE

   Disconnect the pin which requires checking at mail connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position)
3. Is the problem found?

   YES

   ▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

   NO

   ▶ Go to "Power Circuit Inspection".

POWER CIRCUIT INSPECTION E1B7FF8A

1. IG Key "OFF", Engine "OFF".
2. Disconnect A/C pressure transducer connector.
3. IG Key "ON".
4. Measure the voltage of A/C pressure transducer terminal 3.

Specification : 4.8V~5.1V

5. Is the measured voltage within the specification ?

YES

▶ Go to "Signal Circuit Inspection".

NO

▶ Repair open in A/C pressure transducer power circuit and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION E11BE0C8

1. Check open in signal circuit

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect A/C pressure transducer connector and ECM connector.

   3) Check continuity between A/C pressure transducer connector terminal 2 and ECM connector (CUD-K) terminal 13.

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification?

YES

▶ Go to "2. Check short to ground in signal circuit" as follows.

NO

▶ Repair open in signal circuit and go to "Verification of Vehicle Repair".

2. Check short to ground in signal circuit

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect A/C pressure transducer connector and ECM connector.

   3) Check continuity between A/C pressure transducer connector terminal 2 and chassis ground.

Specification : Discontinuity (Infinite Ω)

   4) Is the measured resistance within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ Repair short to ground in signal circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E38538AA

1. A/C pressure transducer visual inspection

1) IG Key "OFF", Engine "OFF".
2) Disconnect A/C pressure transducer connector.
3) Check if corrosion and contamination at A/C pressure transducer terminal is detected.
4) Check A/C pressure transducer connecting torque and A/C refrigerant leakage.
5) Does any problem is detected at A/C pressure transducer?

YES

▶ Replace A/C pressure transducer and go to "Verification of Vehicle Repair".

NO

▶ Go to "2. Check A/C pressure transducer waveform " as follows.

2. Check A/C pressure transducer waveform

1) IG Key "OFF", Engine "OFF".
2) Connect A/C pressure transducer connector.
3) Connect oscilloscope to A/C pressure transducer connector terminal 2.
4) Monitor A/C pressure transducer waveform at idle as turning A/C "ON".

SPECIFICATION :

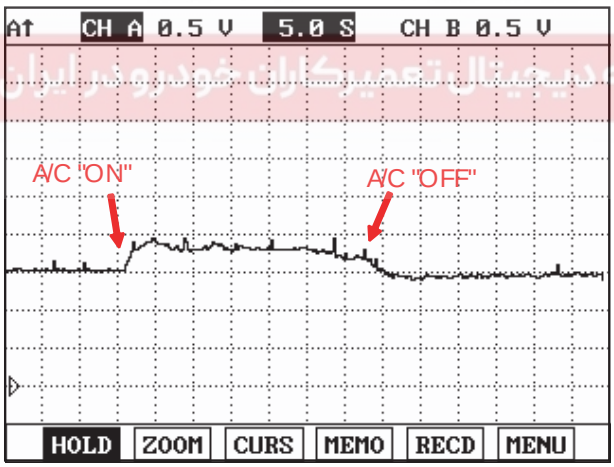


Fig.1

Fig.1) Waveform of A/C pressure transducer in accordance with A/C operation.(A/C compressor operation)

SLDFL6357L

NOTE

Output signal(voltage) changes in accordance with the amount of refrigerant and the change of weather.occurs Check if normal pressure change in accordance with A/C compressor operation at normal pressure range shown in "Specification".

5) Is A/C pressure transducer waveform outputted correctly?

YES

▶ Go to "Verification of Vehicle Rapair".

NO

▶ Replace A/C pressure transducer and go to "Verification of Vehicle Rapair".

VERIFICATION OF VEHICLE REPAIR E36E7C53

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0533 A/C REFRIGERANT PRESSURE SENSOR "A" CIRCUIT HIGH INPUT

COMPONENT LOCATION E3399899

Refer to DTC P0532.

GENERAL DESCRIPTION E40D2E3A

Refer to DTC P0532.

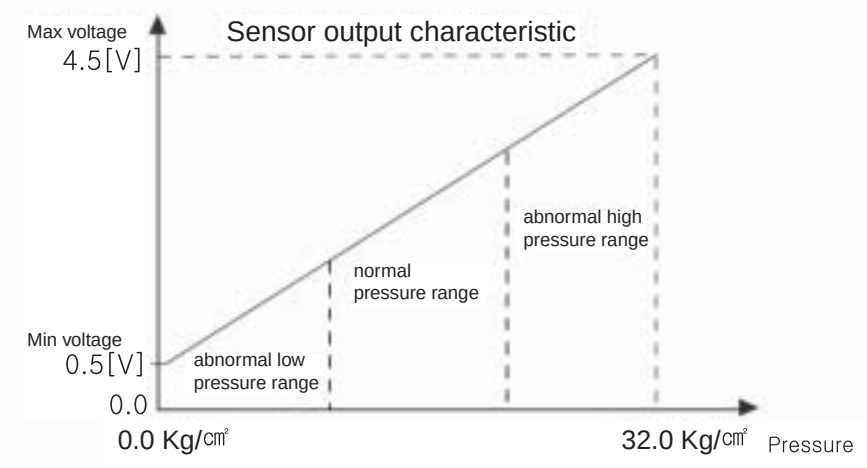
DTC DESCRIPTION E5A46581

P0533 is set when the voltage above 4.87V - maximum voltage of A/C pressure transducer signal - is detected for more than 0.6 sec.. This code is due to open or short in signal or ground circuit of A/C pressure transducer.

DTC DETECTING CONDITION EF14951C

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• A/C pressure transducer circuit • A/C pressure transducer component
Enable Conditions	• IG Key "ON"			
ThresholdValue	• When output signal is above the maximum value (above 4.87V)			
DiagnosticTime	• 0.6 sec.			
Fail Safe	Fuel Cut	NO	• A/C pressure fixed at 4,000 hPa	
	EGR Off	NO		
	Fuel Limit	NO		
	MIL	OFF		

SPECIFICATION EE4B0CFF



SLDFL6355L

SCHEMATIC DIAGRAM E9E6021B

Refer to DTC P0532.

SIGNAL WAVEFORM AND DATA E3E7010A

Refer to DTC P0532.

MONITOR SCANTOOL DATA E227819D

Refer to DTC P0532.

TERMINAL AND CONNECTOR INSPECTION EF7FF2E4

Refer to DTC P0532.

POWER CIRCUIT INSPECTION EC19D674

1. IG Key "OFF", Engine "OFF".
2. Disconnect A/C pressure transducer connector.
3. IG Key "ON".
4. Measure the voltage of A/C pressure transducer terminal 3.

Specification : 4.8V~5.1V

5. Is the measured voltage within the specification ?

YES

▶ Go to "Signal Circuit Inspection".

NO

▶ Repair open in A/C pressure transducer power circuit and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION E0DBD1C0

1. IG Key "OFF", Engine "OFF".
2. Disconnect A/C pressure transducer connector and ECM connector.
3. IG Key "ON".
4. Measure the voltage of A/C pressure transducer terminal 2.

Specification : 0.0V~0.1V

5. Is the measured voltage within the specification ?

YES

▶ Go to "Ground Circuit Inspection".

NO

▶ Repair short to battery and go to "Verification of Vehicle Repair".

GROUND CIRCUIT INSPECTION EB7BDA79

1. IG Key "OFF", Engine "OFF".
2. Disconnect A/C pressure transducer connector.
3. IG Key "ON".
4. Measure the voltage of A/C pressure transducer terminal 3. [TEST "A"]
5. Measure the voltage of A/C pressure transducer terminal 3 and terminal 1. [TEST "B"]
   (terminal 3: Check + prove , terminal 1 : Check - prove)

Specification :The voltage difference between TEST "A" and TEST "B" is within 200mV

6. Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ When "B" voltage is not detected : Repair open in ground circuit and go to "Verification of Vehicle Repair".
▶ When the voltage difference between "A" and "B" is above 200mV : Eliminate the causes of excessive resistance and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION EC4F7E89

1. A/C pressure transducer visual inspection
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect A/C pressure transducer connector.
   3) Check if corrosion and contamination at A/C pressure transducer terminal is detected.
   4) Check A/C pressure transducer connecting torque and A/C refrigerant leakage.
   5) Does any problem is detected at A/C pressure transducer?

      YES

      ▶ Replace A/C pressure transducer and go to "Verification of Vehicle Repair".

      NO

      ▶ Go to "2. Check A/C pressure transducer waveform " as follows.
2. Check A/C pressure transducer waveform
   1) IG Key "OFF", Engine "OFF".
   2) Connect A/C pressure transducer connector.

3) Connect oscilloscope to A/C pressure transducer connector terminal 2.

4) Monitor A/C pressure transducer waveform at idle as turning A/C "ON".

SPECIFICATION :

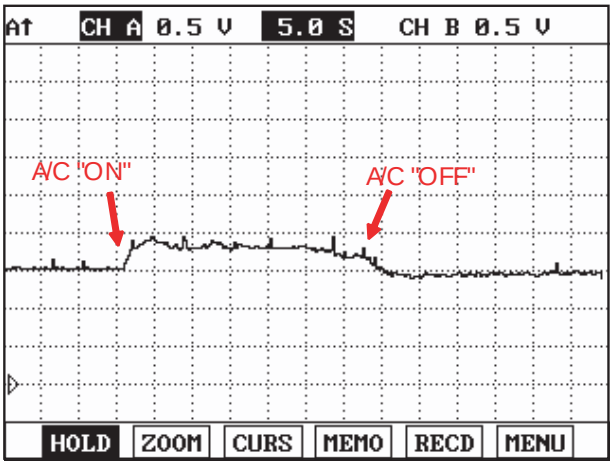


Fig.1

Fig.1) Waveform of A/C pressure transducer in accordance with A/C operation.(A/C compressor operation)

SLDFL6357L

NOTE

Output signal(voltage) changes in accordance with the amount of refrigerant and the change of weather.occurs Check if normal pressure change in accordance with A/C compressor operation at normal pressure range shown in "Specification".

5) Is A/C pressure transducer waveform outputted correctly?

YES

▶ Go to "Verification of Vehicle Rapair".

NO

▶ Replace A/C pressure transducer and go to "Verification of Vehicle Rapair".

VERIFICATION OF VEHICLE REPAIR E6BEBE93

Refer to DTC P0532.

DTC P0562 SYSTEM VOLTAGE LOW

GENERAL DESCRIPTION E6A6DC7C

Normally, battery voltage fluctuates from 11.5V to 14.5V. Especially at cranking, voltage can drop to 9.8V. Therefore, actuators which require 12V power supply meet fluctuation of power by 5V. A little change of voltage supply can shift controlling characteristic of actuators, such as injectors, RPCV and EGR actuator, which should be controlled delicately. To correct controlling characteristic change arrised from voltage fluctuation, ECM performs actuator operating correction according to voltage change as detecting battery voltage change.

DTC DESCRIPTION EB6F5502

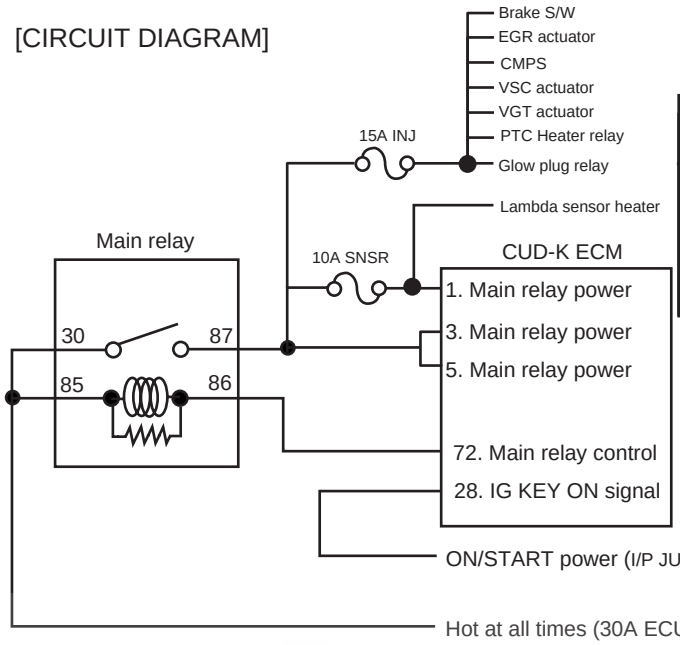
P0562 is set when battery voltage below 6V is detected for more than 5 sec. Check charging system.(charging circuit, alternator component)
▶ ECM senses battery voltage as monitoring the voltages in ECM(CUD-K) connector terminal 1,3,5 which are transmitted from main relay.

DTC DETECTING CONDITION E6B9A0DA

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• Charging circuit
• Alternator component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• When battery voltage is below 6V</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 5 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• Battery voltage is considered as 7.9V.</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

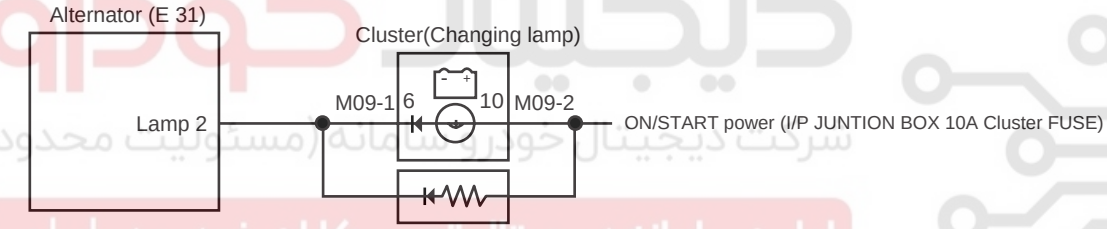
SCHEMATIC DIAGRAM E515FFB5

[CIRCUIT DIAGRAM]

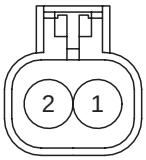


[CONNECTOR INFORMATION]

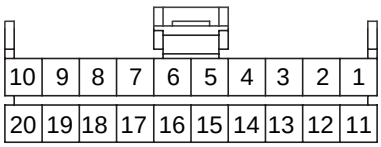
Terminal	Connected to	Function
30	30A ECU FUSIBLE LINK	Hot at all times
85	30A ECU FUSIBLE LINK	Main relay coil power
86	CUD-K terminal 72	Main relay control
87	CUD-K terminal 1,3,5 etc	Power supply to ECM, Sensor, Actuator



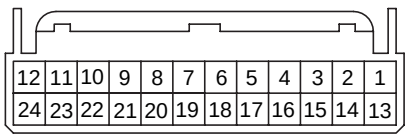
[HARNESS CONNECTOR]



E 31
Alternator

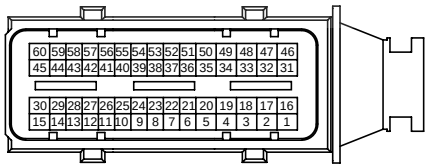


M01-A

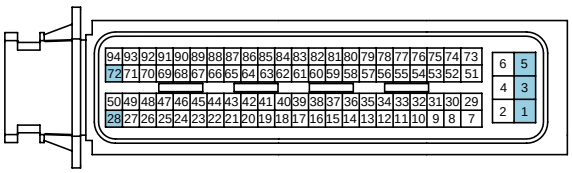


M01-B

CUD-M



CUD-K



ECM

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SIGNAL WAVEFORM AND DATA E01C7B85

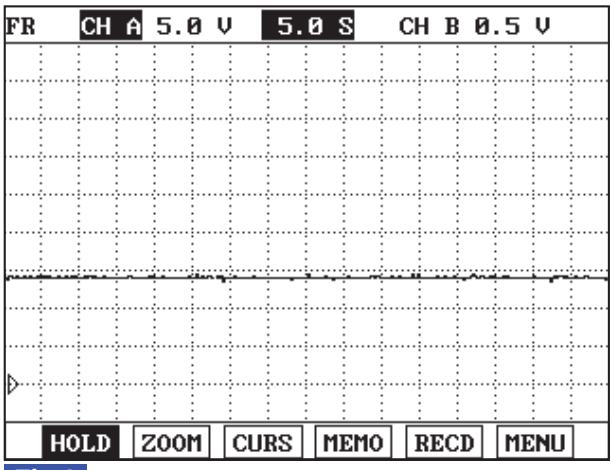


Fig.1

Fig.1) This is alternator charging waveform during engine running. Check if battery voltage drops dramatically as turning on the electrical device such as head lamp, defogger and A/C.

SLDFL6366L

MONITOR SCANTOOL DATA E0097F37

1. Connect scantool to Data Link Cable. (DLC)
2. Warm engine up to normal operating temperature.
3. Turn "OFF" electrical devices and A/C.
4. Monitor "BATTERY VOLTAGE" parameter on the Scantool.

specification :12.5V~14.5V at idle without any load(800RPM)

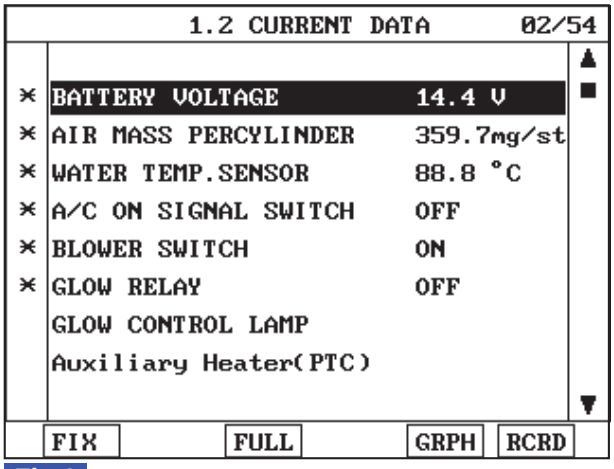


Fig.1

Fig 1) "BATTERY VOLTAGE" data at idle after warming engine up.
Check if the symptoms listed below occur as checking if battery voltage drops dramatically when turning on the electrical devices.

SLDFL6367L

※ The vehicles with the alternator of poor charging efficiency
1. Lamps are dim at idle, while lamps are bright at acceleration.
2. Intermitently RPM drops excessively or engine shut down at low RPM close to idle state at times.

3. Smooth cranking happens rarely. (Warning lamps in cluster turn dimmer excessively at cranking and poor cranking happen.)
4. Charging lamp turns on during driving.

TERMINAL AND CONNECTOR INSPECTION E248CE13

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.

2. Perform checking procedure as follows.

   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.

   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

   NOTE

   Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector or checking connecting condition. (after checking, reconnect the pin at correct position.)

3. Is the problem found?

YES

▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

NO

▶ Go to "Power Circuit Inspection".

POWER CIRCUIT INSPECTION E62AA664

1. Check power supply in alternator connector (Sensing)

   1) IG Key "ON", Turn engine "OFF".

   2) Disconnect alternator connector.

   3) Measure the voltage of alternator connector terminal 2.

Specification : 10.5V~12.0V

   4) Is the measured voltage within the specification?

   YES

   ▶ Go to "2. Check charging lamp operation"as follows.

   NO

   ▶ Repair E/R JUNCTION BOX 10A ECU FUSE and related circuit and go to "Verification of Vehicle Repair".

2. Check charging lamp operation

   1) IG Key "ON", Engine "OFF".

2) Disconnect alternator connector.

3) Ground alternator connector terminal 2 to chassis ground using jump wire.

Specification : Charging lamp "ON" when grounded to chassis ground.

4) Does charging lamp turn ON?

YES

▶ Go to "3.Check voltage drop of aternator B+ cable"as follows.

NO

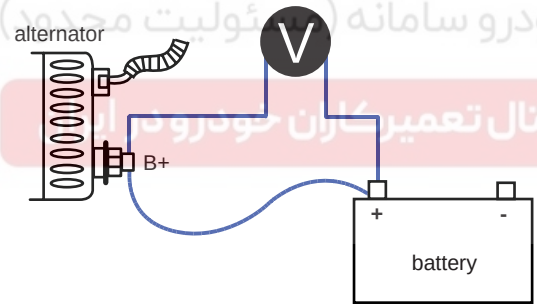
▶ Replace lamp and go to "Verification of Vehicle Repair".

3. Check voltage drop of aternator B+ cable

1) IG Key "ON", Turn engine "ON".

2) Measure the voltage difference between alternator B+ terminal and battery + terminal.
(Connect + terminal of multimeter to alternator B+ and connect - terminal of multimeter to battery +terminal.)

Specification : Below 0.2V (below 200mV)



SLDFL6371L

3) Is the measured voltage within the specification? (Is the voltage drop in alternator B+ cable normal?)

YES

▶ Go to "Component Inspection".

NO

▶ After checking corrosion and deformation of alternator B+ cable and replace it if needed and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION EE6C8B21

1. IG Key "OFF", Engine "OFF".
2. Check belt tension which operates alternator .
3. Check battery terminal and fusible link, poor connection or corrosion of alternator B+ terminal.

4. Turn engine "ON".
5. Operate the electrical device such as head lamp,defroster and blower motor.
6. Check battery voltage at above 2000 RPM.

Specification : 12.5V~14.5V

7. Is the measured voltage within the specification?

YES

▶ Alternator is performing within the specification.

NO

▶ Replace alternator and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR ECAC045D

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0563 SYSTEM VOLTAGE HIGH

GENERAL DESCRIPTION E8D05AB7

Refer to DTC P0562.

DTC DESCRIPTION E3065970

P0563 is set when battery voltage above 17.5V is detected for more than 5 sec.. Check alternator component. (over-charging of alternator)
▶ ECM senses battery voltage as monitoring the voltages in ECM(CUD-K)connector terminal 1,3,5 which are transmitted from main relay.

DTC DETECTING CONDITION E8166FB6

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="5">• Charging circuit
• Alternator component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• When battery voltage is above 17.5V</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 5 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• Battery voltage is considered as 7.9V.</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SCHEMATIC DIAGRAM EF82D9F7

Refer to DTC P0562.

SIGNAL WAVEFORM AND DATA EB9D268D

Refer to DTC P0562.

MONITOR SCANTOOL DATA EBEE296E

Refer to DTC P0562.

TERMINAL AND CONNECTOR INSPECTION E8764DE3

Refer to DTC P0562.

POWER CIRCUIT INSPECTION EB374F86

1. Check power supply in alternator connector (Sensing)
   1) IG Key "ON", Turn engine "OFF".
   2) Disconnect alternator connector.
   3) Measure the voltage of alternator connector terminal 2.

Specification : 10.5V~12.0V

4) Is the measured voltage within the specification?

YES

▶ Go to "2. Check charging lamp operation"as follows.

NO

▶ Repair E/R JUNCTION BOX 10A ECU FUSE and related circuit and go to "Verification of Vehicle Repair".

2. Check charging lamp operation

1) IG Key "ON", Engine "OFF".

2) Disconnect alternator connector.

3) Ground alternator connector terminal 2 to chassis ground using jump wire.

Specification : Charging lamp "ON" when grounded to chassis ground.

4) Does charging lamp turn ON?

YES

▶ Go to "3.Check voltage drop of aternator B+ cable"as follows.

NO

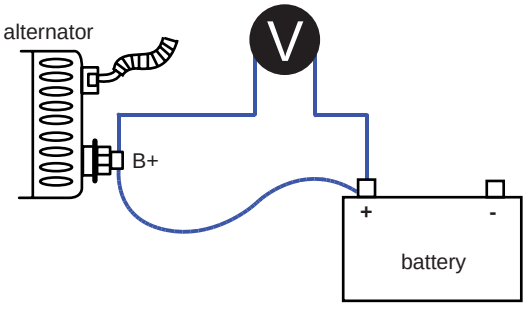
▶ Replace lamp and go to "Verification of Vehicle Repair".

3. Check voltage drop of aternator B+ cable

1) IG Key "ON", Turn engine "ON".

2) Measure the voltage difference between alternator B+ terminal and battery + terminal.
(Connect + terminal of multimeter to alternator B+ and connect - terminal of multimeter to battery +terminal.)

Specification : Below 0.2V (below 200mV)



SLDFL6371L

3) Is the measured voltage within the specification? (Is the voltage drop in alternator B+ cable normal?)

YES

▶ Go to "Component Inspection".

NO

▶ After checking corrosion and deformation of alternator B+ cable and replace it if needed and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E346A972

1. IG Key "OFF", Engine "OFF".
2. Check belt tension which operates alternator .
3. Check battery terminal and fusible link, poor connection or corrosion of alternator B+ terminal.
4. Turn engine "ON".
5. Operate the electrical device such as head lamp,defroster and blower motor.
6. Check battery voltage at above 2000 RPM.

Specification : 12.5V~14.5V

7. Is the measured voltage within the specification?

YES

▶ Alternator is performing within the specification.

NO

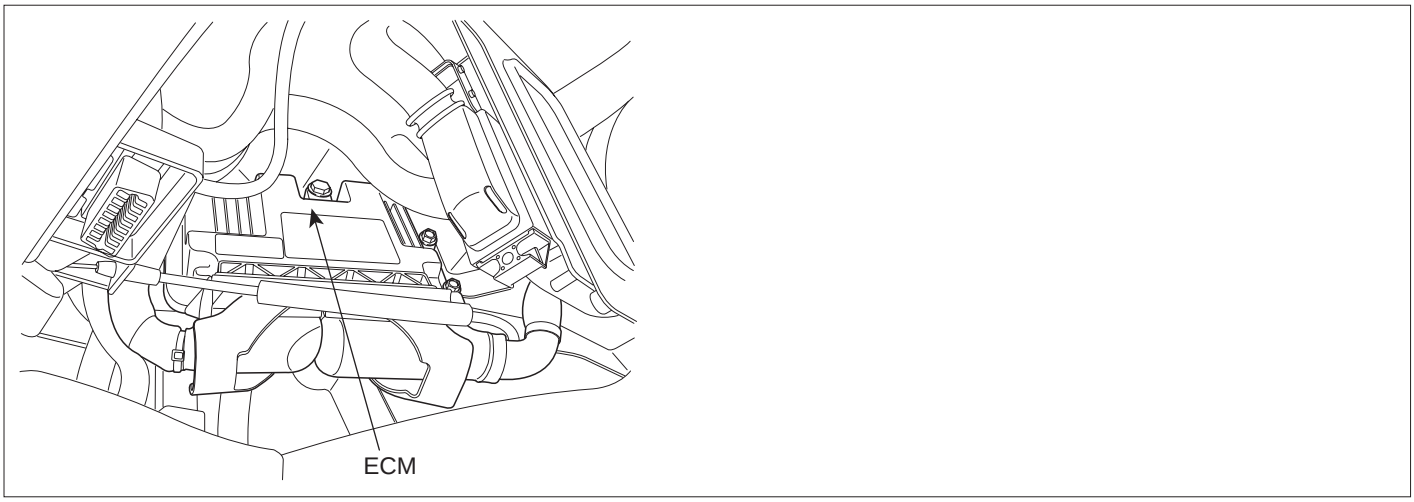
▶ Replace alternator and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E79CF321

Refer to DTC P0562.

DTC P0602 EEPROM-PROGRAMING ERROR

COMPONENT LOCATION E28FD30D



SLDFL6237L

GENERAL DESCRIPTION EF999DD0

ECM is activated by power supply. Signals from several sensors, such as CKPS and APS, is inputted to ECM. Comparing inputted siganals with control LOGIC saved at micro controller and EEPROM, ECM controlls engine as actuating injectors, solenoids and relays. To guarantee accurate control, ECM performs SELF TEST, DIAGNOSIS of several sensors and actuators. And if serious trouble which affects vehicle performance occurrs, ECM sets DTCs.At certain cases, ECM shuts down whole systems in order to prevent dangerous situation due to incorrect control.

DTC DESCRIPTION E174D499

P0602 is set when data writing on EEPROM inside of ECM is impossible.This code is due to the failure of ECM(ECM hardware failure).

DTC DETECTING CONDITION EA972D76

Item	Detecting Condition			Possible Cause
DTC Strategy	• EEPROM monitorting			• ECM component failure
Enable Conditions	• Engine running			
ThresholdValue	• When data writing on EEPROM inside of ECM is impossible			
DiagnosticTime	• Immediately			
Fail Safe	Fuel Cut	YES		
	EGR Off	NO		
	Fuel Limit	NO		
	MIL	OFF		

COMPONENT INSPECTION E513630D

1. IG Key "OFF", Engine "OFF".

2. Disconnect ECM.
3. Replace ECM, check if abnormal operations disappear.
4. If problems are corrected, replace ECM.

NOTE

Input injector IQA data(7 letters) using scantool at replacing ECM. Enter the driving distance - how many km the CPF is used- into New ECM with scanner. For immobilizer applied vehicle, input pin code.

VERIFICATION OF VEHICLE REPAIR E0C0620C

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0605 INTERNAL CONTROL MODULE READ ONLY MEMORY(ROM) ERROR

COMPONENT LOCATION EB79D5D2

Refer to DTC P0602.

GENERAL DESCRIPTION EDE1170D

Refer to DTC P0602.

DTC DESCRIPTION EBC1AB18

P0605 is set when 1)communication error between micro controller inside of ECM and EEP ROM is detected or 2)a different vesion of ECM is installed.

DTC DETECTING CONDITION EF7641C7

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• EEPROM monitorting</td><td rowspan="6">• Version difference between ECM and ECMcommunication module
• ECM component failure</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• EEPROM communication error : Communication failure between micro controller inside of ECM and EEPROM.
• Each data range is activated abnormally.
• Self test about optional devices(A/C, immobilizer, cruise control)</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• Immediately</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>YES</td><td rowspan="4"></td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

COMPONENT INSPECTION EB1E052D

1. IG Key "OFF", Engine "OFF".
2. Disconnect ECM.
3. Replace ECM, check if abnormal operations disappear.
4. If problems are corrected, replace ECM.

NOTE

Input injector IQA data(7 letters) using scantool at replacing ECM. Enter the driving distance - how many km the CPF is used- into New ECM with scanner. For immobilizer applied vehicle, input pin code.

VERIFICATION OF VEHICLE REPAIR E801C1EB

Refer to DTC P0602.

DTC P0606 ECM/PCM PROCESSOR(ECM-SELF TEST FAILED)

COMPONENT LOCATION E2231626

Refer to DTC P0602.

GENERAL DESCRIPTION EC6A904F

Refer to DTC P0602.

DTC DESCRIPTION EC63494E

P0606 is set when the voltage of sensor power supply 1 and 2 (the standard voltage of A/D converter) are below 4.7V or above 5.1V. This code is due to ECM internal failure.

DTC DETECTING CONDITION E66D6BE9

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Signal monitoring</td><td rowspan="5">• ECM component failure</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• A/D converter failure inside of ECM</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• Immediately</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>YES</td><td rowspan="4"></td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>ON</td></tr>
</table>

SIGNAL WAVEFORM AND DATA EA6B9316

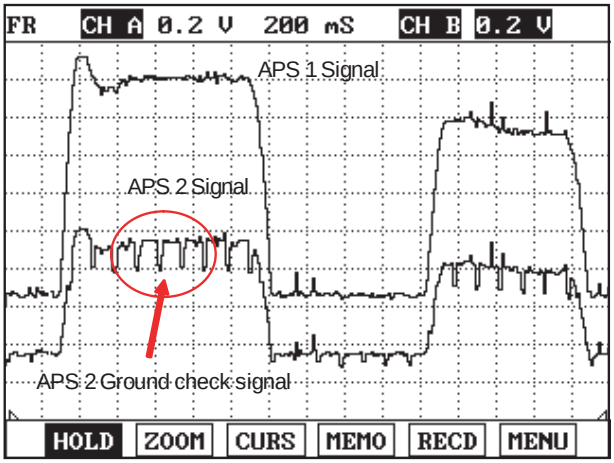


Fig.1

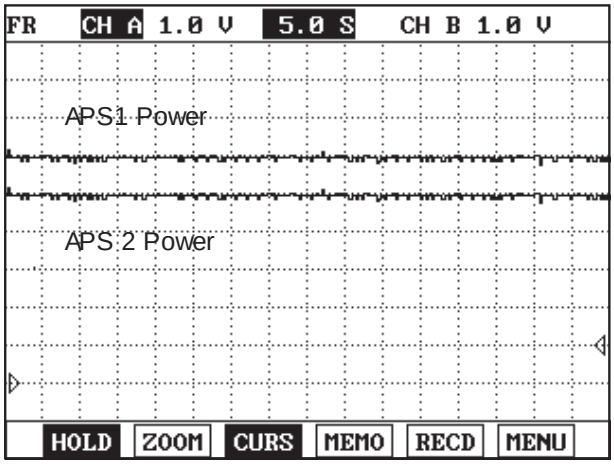


Fig.2

Fig.1) Ground checking signal of APS 2 signal is for ECM to monitor APS 2. This signal drops APS 2 output voltage to below 200.39mV every 200msec. If APS 2 output voltage does not drop to below 200.39mV, ECM sets DTC as recognizing ground circuit error of APS 2 .

※ The waveform below 200.39mV is not detectable in ground checking signal waveform of APS 2 signal. Instead, the waveform which drops a little is detected. If APS 2 data of "SERVICE DATA" on the Scantool varies from 350mV to 0mV periodically, it means it works normally.

Fig.2) APS 1 and APS 2 signals are measured simultaneously, Check if 5V sensor voltage(the standard voltage of A/D converter inside of ECM) is from 4.8V to 5.16V.

SLDFL6375L

COMPONENT INSPECTION E4643116

1. IG Key "OFF", Engine "OFF".
2. Disconnect ECM.
3. Replace ECM, check if abnormal operations disappear.
4. If problems are corrected, replace ECM.

NOTE

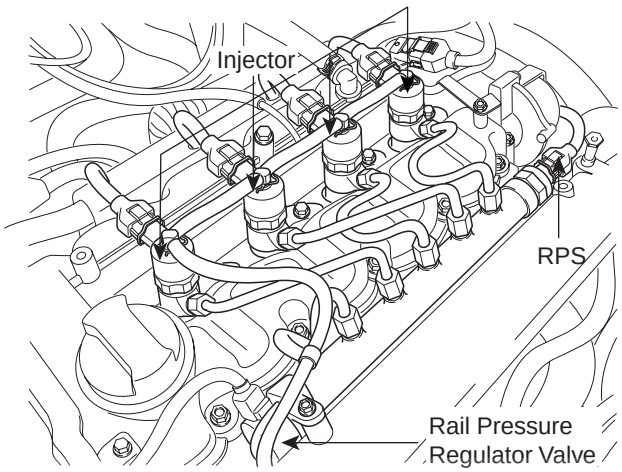
Input injector IQA data(7 letters) using scantool at replacing ECM. Enter the driving distance - how many km the CPF is used- into New ECM with scanner. For immobilizer applied vehicle, input pin code.

VERIFICATION OF VEHICLE REPAIR E79F8325

Refer to DTC P0602.

DTC P0611 INJECTOR CIRCUIT MALFUNCTION (MORE THAN TWO INJECTORS)

COMPONENT LOCATION EFF616C9



SLDFL6270L

GENERAL DESCRIPTION E446EC88

Injectors spray fuel in the highly compressed combustion chamber, and power generates through combustion process. Fuel pressure is raised to 1600bar in common rail diesel engine for the purpose of making fuel into minute particles. And fuel devided into minute particles leads smoke reduction, high power generation, and improved fuel efficiency. To control pressure of 1600bar with solenoid, oil pressure servo is applied. And injector solenoids is actuated by solenoid operating voltage raised to 80V with the method of current control. Needle valve inside of injector is located between A and B chamber. If applied pressure to B chamber is relived by injector solenoid, niddle valve is raised by the pressure of A chamber then, fuel is injected. If same pressure is applied to A and B chamber, niddle valve closes by the elasticity then, fuel injection stops. As electronically controlled injector is applied instead of mechanical injector, pilot and post injection, injeciton duration and quantity control are achieved. And engine performance is improved by these control.

DTC DESCRIPTION E1418592

P0611 is set when the problems of more than 2 injector circuits are detected thus, it is difficult to find abnormal injector. Check "Circuit Inspection" of all injectors

DTC DETECTING CONDITION EE70DAF6

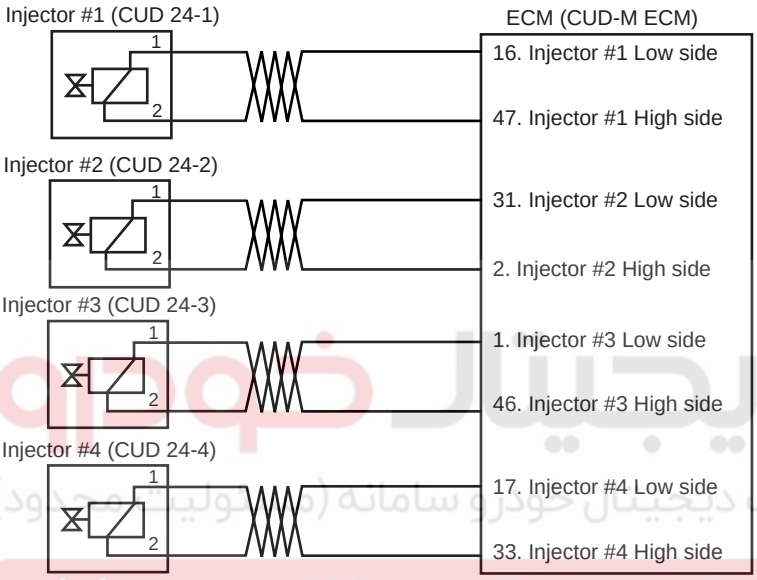
Item	Detecting Condition			Possible Cause
DTC Strategy	• Current monitoring			• Short in injector circuit • Injector component
Enable Conditions	• IG Key "ON"			
ThresholdValue	• Cylinder recognition is impossible due to the failure more than 2 injectors.			
DiagnosticTime	• Immediately			
Fail Safe	Fuel Cut	YES		
	EGR Off	NO		
	Fuel Limit	NO		
	MIL	ON		

SPECIFICATION ECE0FC2C

Injector Component Resistance	Injector Operating Voltage	Injector Operating Current	Injector Control Type
0.255 ±0.04Ω (20℃)	80V	Peak current : 18±0.5A Hold in current : 12±0.5A	Current control

SCHEMATIC DIAGRAM ECD73597

[CIRCUIT DIAGRAM]



[CONNECTOR INFORMATION]

[Injector #1 (CUD 24-1)]

Terminal	Connected to	Function
1	CUD-M terminal 16	Injector #1
2	CUD-M terminal 47	Injector #1

[Injector #2 (CUD 24-2)]

Terminal	Connected to	Function
1	CUD-M terminal 2	Injector #2
2	CUD-M terminal 31	Injector #2

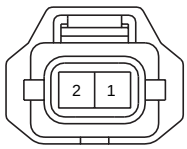
[Injector #3 (CUD 24-3)]

Terminal	Connected to	Function
1	CUD-M terminal1	Injector #3
2	CUD-M terminal 46	Injector #3

[Injector #4(CUD 24-4)]

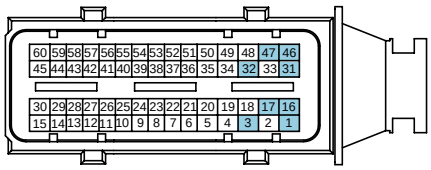
Terminal	Connected to	Function
1	CUD-M terminal 17	Injector #4
2	CUD-M terminal 33	Injector #4

[HARNESS CONNECTOR]

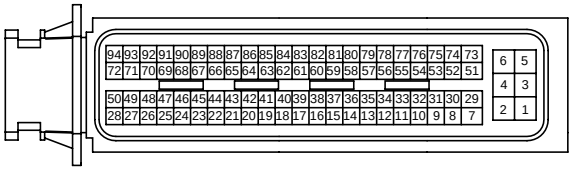


CUD 24-1,2,3,4
INJECTOR #1,2,3,4

CUD-M



CUD-K



ECM

SLDF27679L

SIGNAL WAVEFORM AND DATA EFA0E968

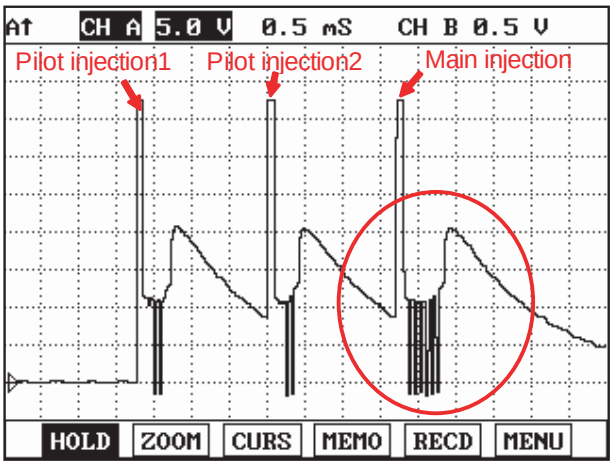


Fig.1

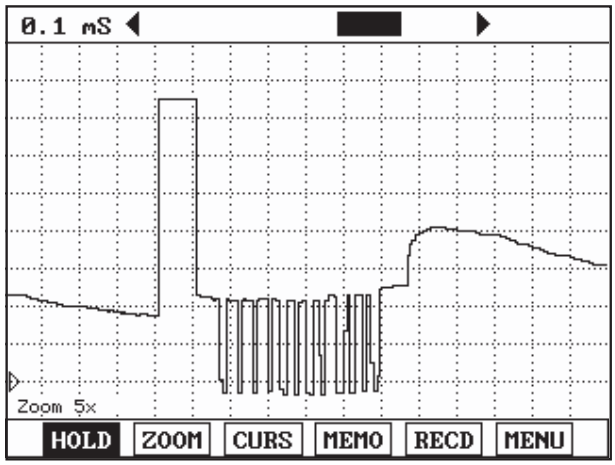


Fig.2

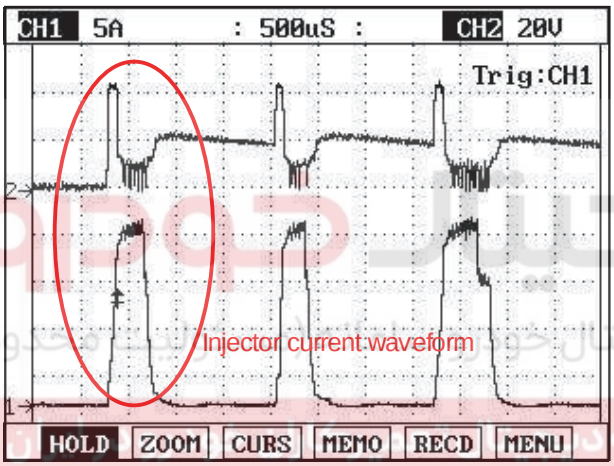


Fig.3

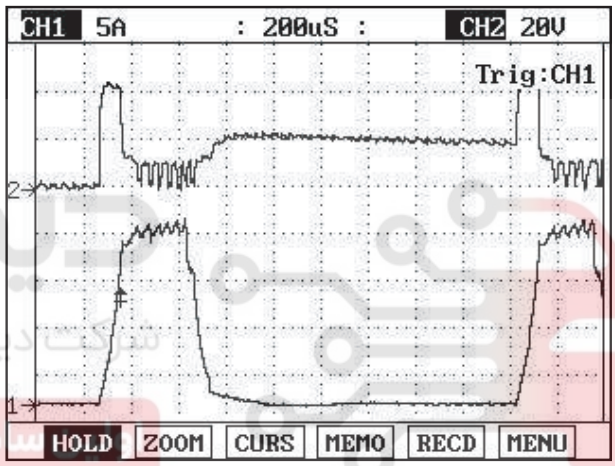


Fig.4

Fig.1) Injector operating waveform at Low side, It shows 2 pilot and 1 main injection.
Fig.2) Magnified waveform of main injection at Fig.1)
Fig.3) Injector voltage and current waveforms are measured at the same time using current prove of scope meter.
Fig.4) Magnified waveform of pilot injection at Fig.3)

SLDFL6273L

MONITOR SCANTOOL DATA ED5B7BDD

1. Connect scantool to Data Link Connector (DLC).
2. IG Key "ON".
3. Check the DTC on the engine system with scantool.
4. Check the DTC related injectors on ECM.

Specification : DTC related injectors should not be set.

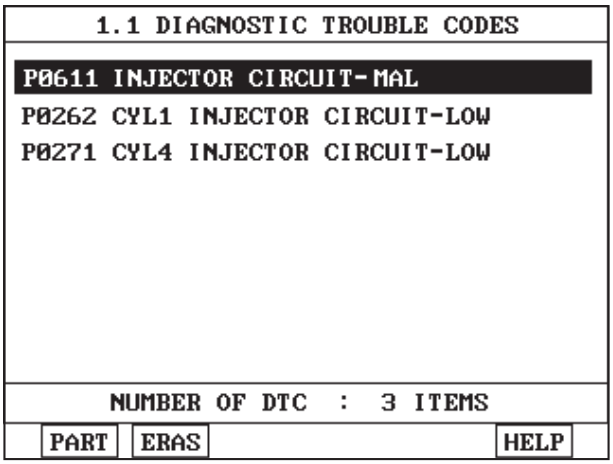


Fig.1

Fig.1) The example of DTC related DTC.

SLDF27600L

5. Is there any DTC related injectors ?

YES

▶ Refer to "DTC" guide corresponding to each problem occurred injector.
☞ Injector #1 circuit related problem : Refer to P0201 for open / P0262 for short.
☞ Injector #2 circuit related problem : Refer to P0202 for open / P0265 for short.
☞ Injector #3 circuit related problem : Refer to P0203 for open / P0268 for short.
☞ Injector #4 circuit related problem : Refer to P0204 for open / P0271 for short.

NO

▶ Go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E276317F

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

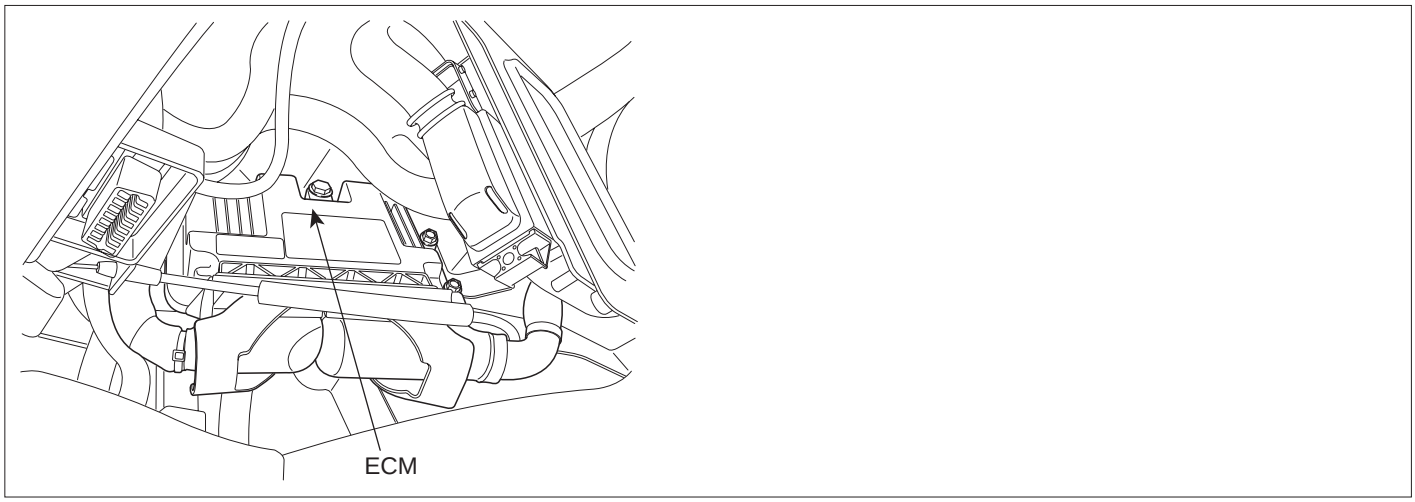
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P062D VOLTAGE REGULATOR #1 FOR INJECTOR MALFUNCTION

COMPONENT LOCATION EBE83F5C



SLDFL6237L

GENERAL DESCRIPTION E7D5500A

There are two transformer for injector operation in side of ECM. 1 pilot and 1 main injection are operated by ECM in EURO 3 diesel engine therefore one transformer device is sufficient to control injector however, 2 pilot and if CPF is applied, 2 post injection are performed additionally by ECM in EURO 4 diesel engine thus, two transformer is required.

DTC DESCRIPTION EEA8385C

P062D is set when the problem of transforming system 1 for injector contol occurs. This code is due to the failure of transforming system inside of ECM.
※ If battery voltage is low, this code can be set. Therefore, beforehand, check DTC code relevant to battery voltage and charging system.

DTC DETECTING CONDITION EE703410

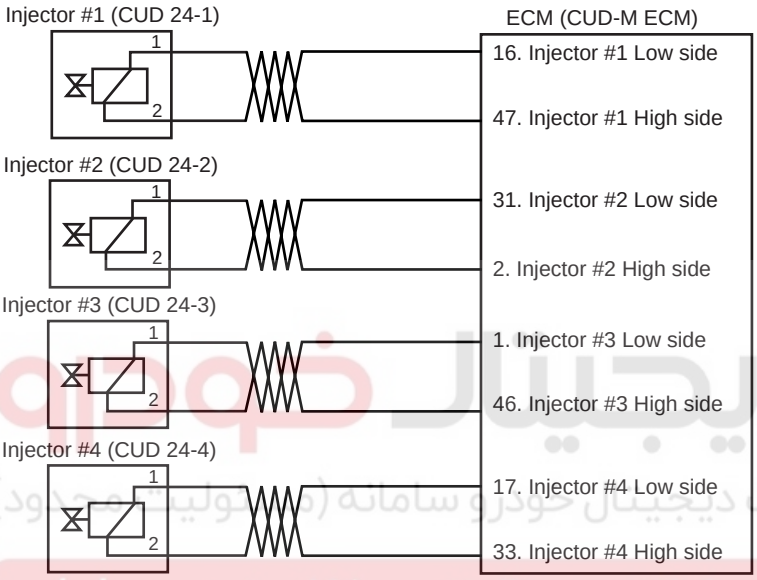
Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Injector circuit • ECM internal error
Enable Conditions	• Engine running			
ThresholdValue	• Power stage error for injector voltage control, CPU circuit failure • Disable to distingish which cylinder is failed by resulting of multiple of random injectors failure.			
DiagnosticTime	• Immediately			
Fail Safe	Fuel Cut	YES		
	EGR Off	NO		
	Fuel Limit	NO		
	MIL	ON		

SPECIFICATION EC7A508B

Injector Component Resistance	Injector Operating Voltage	Injector Operating Current	Injector Control Type
0.255 ±0.04Ω (20℃)	80V	Peak current : 18±0.5A Hold in current : 12±0.5A	Current control

SCHEMATIC DIAGRAM EC771FE1

[CIRCUIT DIAGRAM]



[CONNECTOR INFORMATION]

[Injector #1 (CUD 24-1)]

Terminal	Connected to	Function
1	CUD-M terminal 16	Injector #1
2	CUD-M terminal 47	Injector #1

[Injector #2 (CUD 24-2)]

Terminal	Connected to	Function
1	CUD-M terminal 2	Injector #2
2	CUD-M terminal 31	Injector #2

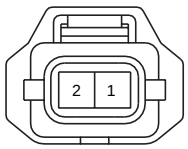
[Injector #3 (CUD 24-3)]

Terminal	Connected to	Function
1	CUD-M terminal1	Injector #3
2	CUD-M terminal 46	Injector #3

[Injector #4(CUD 24-4)]

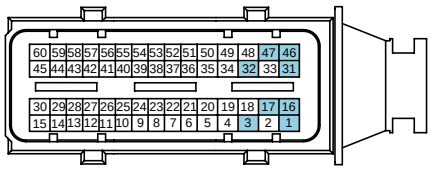
Terminal	Connected to	Function
1	CUD-M terminal 17	Injector #4
2	CUD-M terminal 33	Injector #4

[HARNESS CONNECTOR]

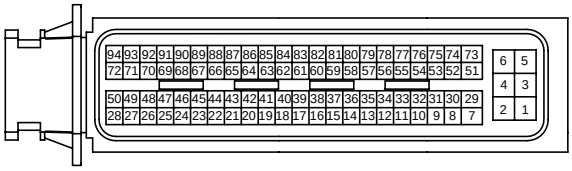


CUD 24-1,2,3,4
INJECTOR #1,2,3,4

CUD-M



CUD-K



ECM

SLDF27679L

SIGNAL WAVEFORM AND DATA EFF59381

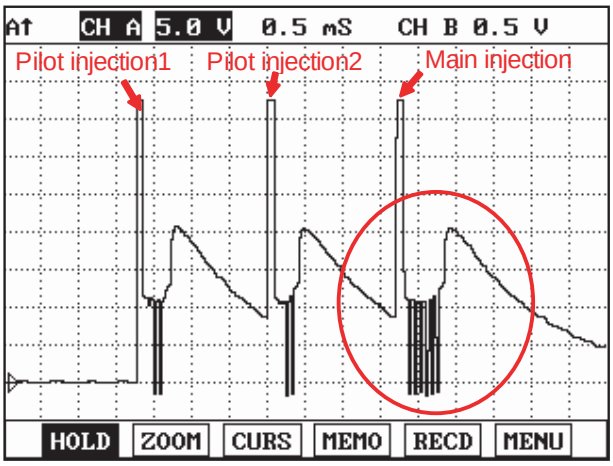


Fig.1

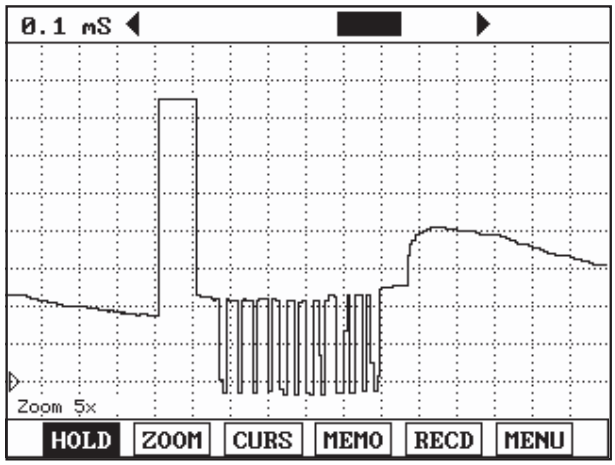


Fig.2

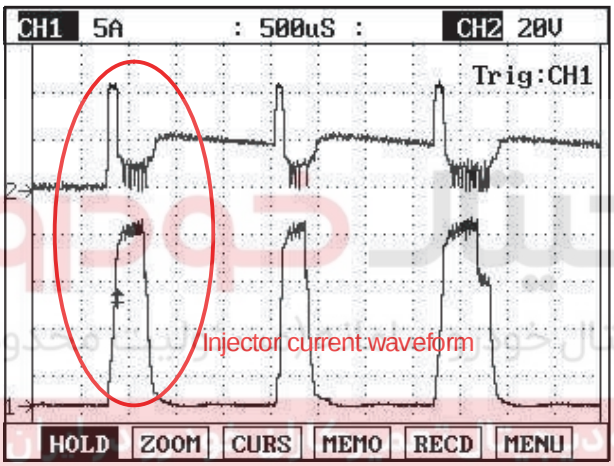


Fig.3

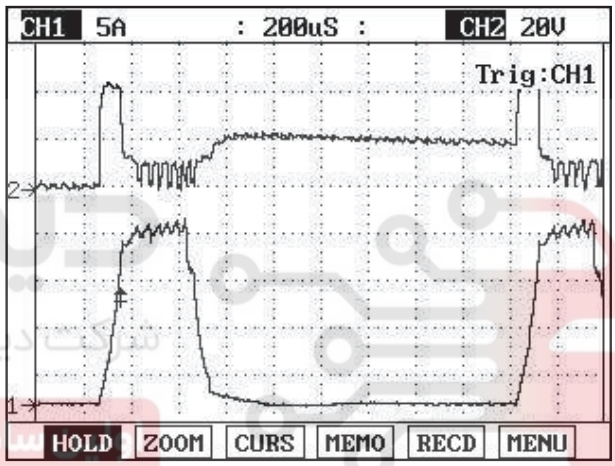


Fig.4

Fig.1) Injector operating waveform at Low side, It shows 2 pilot and 1 main injection.
Fig.2) Magnified waveform of main injection at Fig.1)
Fig.3) Injector voltage and current waveforms are measured at the same time using current prove of scope meter.
Fig.4) Magnified waveform of pilot injection at Fig.3)

SLDFL6273L

MONITOR SCANTOOL DATA EC84B11B

1. Connect scantool to Data Link Connector (DLC).
2. IG Key "ON".
3. Check the DTC on the engine system with scantool.
4. Check the DTC related injectors on ECM.

Specification : DTC related injectors should not be set.

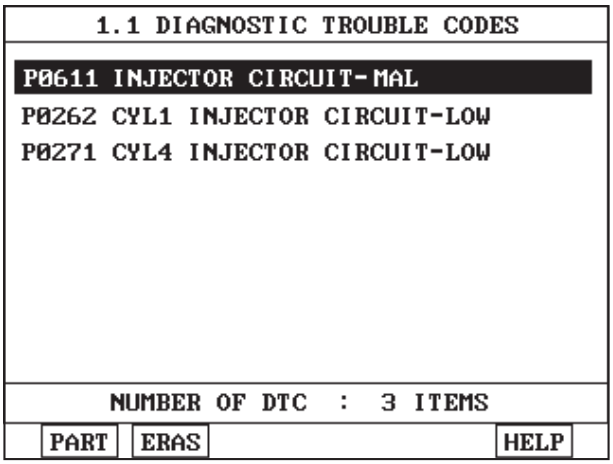


Fig.1

Fig.1) The example of DTC related DTC.

SLDF27600L

5. Is there any DTC related injectors ?

YES

▶ Refer to "DTC" guide corresponding to each problem occurred injector.
☞ Injector #1 circuit related problem : Refer to P0201 for open / P0262 for short.
☞ Injector #2 circuit related problem : Refer to P0202 for open / P0265 for short.
☞ Injector #3 circuit related problem : Refer to P0203 for open / P0268 for short.
☞ Injector #4 circuit related problem : Refer to P0204 for open / P0271 for short.

NO

▶ Go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E4E3B378

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P062E VOLTAGE REGULATOR #2 FOR INJECTOR MALFUNCTION

COMPONENT LOCATION E38ED4AF

Refer to DTC P062D.

GENERAL DESCRIPTION E4D7CF8E

Refer to DTC P062D.

DTC DESCRIPTION E37549E8

P062E is set when the problem of transforming system 2 for injector contol occurs. This code is due to the failure of transforming system inside of ECM.
※ If battery voltage is low, this code can be set. Therefore, beforehand, check DTC code relevant to battery voltage and charging system.

DTC DETECTING CONDITION E9BDBC88

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• Injector circuit
• ECM internal error</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• Power stage error for injector voltage control, CPU circuit failure
• Disable to distingish which cylinder is failed by resulting of multiple of random injectors failure.</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• Immediately</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>YES</td><td rowspan="4"></td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>ON</td></tr>
</table>

SPECIFICATION EAF1D956

Injector Component Resistance	Injector Operating Voltage	Injector Operating Current	Injector Control Type
0.255 ±0.04Ω (20℃)	80V	Peak current : 18±0.5A Hold in current : 12±0.5A	Current control

SCHEMATIC DIAGRAM E6E1FBB3

Refer to DTC P062D.

SIGNAL WAVEFORM AND DATA E3868455

Refer to DTC P062D.

MONITOR SCANTOOL DATA E4A17814

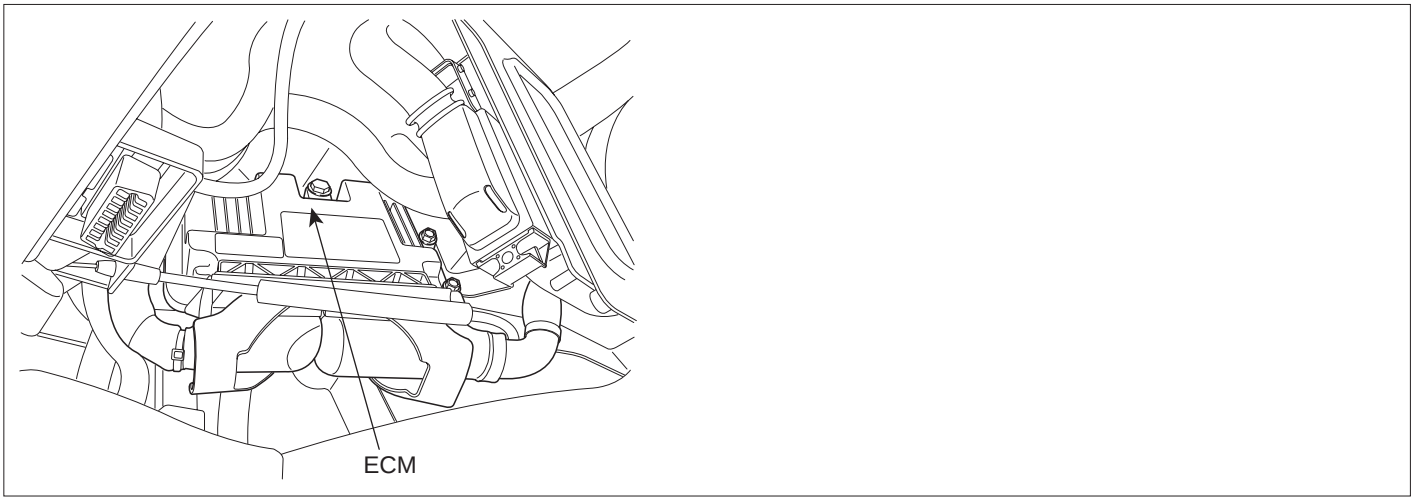
Refer to DTC P062D.

VERIFICATION OF VEHICLE REPAIR E71666A7

Refer to DTC P062D.

DTC P0642 SENSOR REFERENCE VOLTAGE "A" CIRCUIT LOW

COMPONENT LOCATION EF442780



SLDFL6237L

GENERAL DESCRIPTION EBDF7785

ECM is activated by power supply. Signals from several sensors, such as CKPS and APS, is inputted to ECM. Comparing inputted siganals with control LOGIC saved at micro controller and EEPROM, ECM controlls engine as actuating injectors, solenoids and relays. To guarantee accurate control, ECM performs SELF TEST, DIAGNOSIS of several sensors and actuators. And if serious trouble which affects vehicle performance occurrs, ECM sets DTCs.At certain cases, ECM shuts down whole systems in order to prevent dangerous situation due to incorrect control.

DTC DESCRIPTION E45C0CBA

P0642 is set when the voltage below 4700mV - minimum voltage of sensor power supply 1 generates from ECM - is detected for more than 0.1 sec. This code is due to the short to ground in sensor power circuit or the voltage problem inside of ECM.

DTC DETECTING CONDITION E9D29F9D

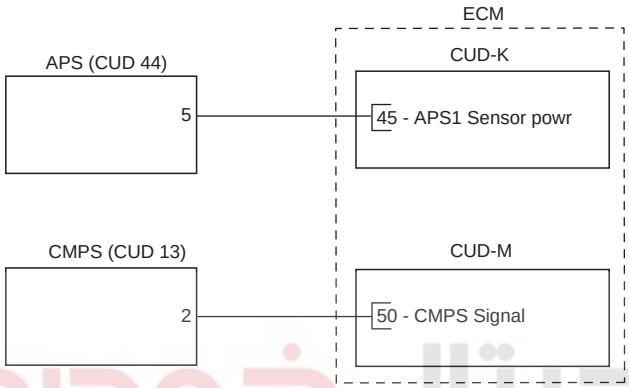
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="8">• CMPS power supply circuit
• APS 1 power supply circuit
• ECM component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"(Accelerator pedal depressed)</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• When the voltage is below the minimum voltage of sensor power supply.
(below 4700mV)</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 0.1 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• APS standard value is 0%.
• Limp home idle engine speed is fixed at 1200RPM.</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>YES</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SPECIFICATION E1085623

Sensor power 1	Sensor power 2	Sensor power 3
APS1, CMPS	RPS, APS 2, BPS, MAFS	APT, VSCA, ECTS
4830mV~5158mV	4830mV~5158mV	4830mV~5158mV

SCHEMATIC DIAGRAM E58F2B7C

[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

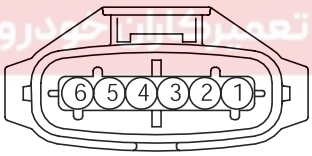
[CUD 44 Accelerator Position Sensor]

Terminal	Connected to	Function
1	CUD-K terminal 31	APS 2 sensor signal
2	CUD-K terminal 8	APS 2 sensor ground
3	CUD-K terminal 9	APS 1 sensor signal
4	CUD-K terminal 30	APS 1 sensor ground
5	CUD-K terminal 45	APS 1 sensor power
6	CUD-K terminal 46	APS 2 sensor power

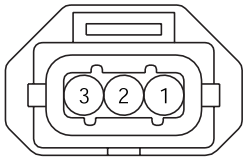
[CUD 13 CMPS]

Terminal	Connected to	Function
1	E/R-CUD terminal 61	Main relay power
2	CUD-M terminal 50	Sensor signal
3	CUD-M terminal 20	Sensor ground

[HARNESS CONNECTORS]

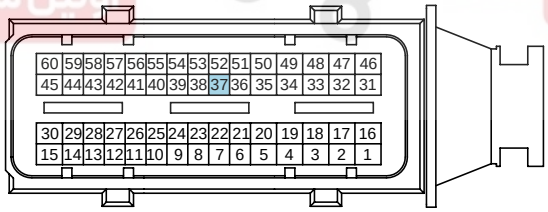


CUD 44
APS

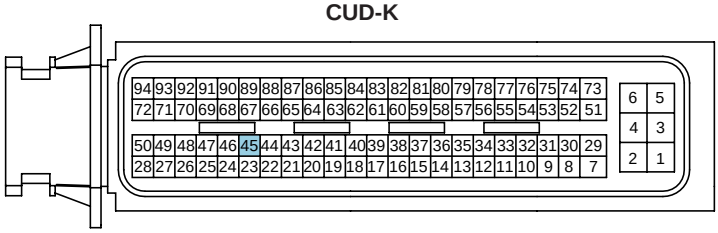


CUD 13
CMPS

CUD-M



CUD-K



ECM

SLDF27685L

SIGNAL WAVEFORM AND DATA E6DC98F5

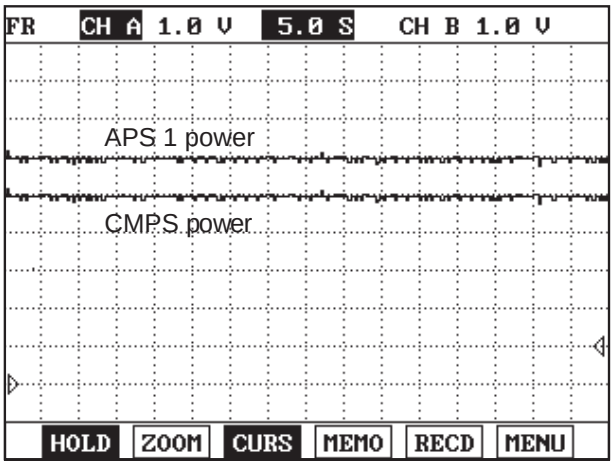


Fig.1

Fig.1) APS 1 and CMPS power supply is measured simultaneously , check if this waveform is within the specification (4.8~5.1V) when turning ignition "ON".

※ Reference voltage from CMPS will be reading approximately 0.2V according to the position of Cam shaft. Therefore, check the CMPS after disconnecting CMPS connector.

SLDF27601L

TERMINAL AND CONNECTOR INSPECTION EDEC4BAE

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damage of component.
2. Perform checking procedure as follows.
   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.
   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

NOTE

Disconnect the pin which requires checking at mail connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position)

3. Is the problem found?

YES

▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

NO

▶ Go to "Power Circuit Inspection".

POWER CIRCUIT INSPECTION E343C5C6

1. Check power circuit voltage
   1) IG Key "OFF", Engine "OFF".
   2) Disconnector CMPS connector and APS connector.

3) IG Key "ON".

4) Measure the voltage between CMPS connector terminal 2 or APS connector terminal 5 and chassis ground.

Specification : 4.8V~5.1V

5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ Go to "2. Check short to ground in power circuit" as follows.

2. Check short to ground in power circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect CMPS connector, APS connector and ECM connectors.

3) Check continuity between CMPS connector terminal 2 or APS connector terminal 5 and chassis ground.

Specification : Discontinuity (Infinite Ω)

4) Is the measured resistance within the specification?

YES

▶ If the circuit is insulated well and the sensor power supply from ECM is low, replace ECM and "Verification of Vehicle Repair".

NO

▶ Repair short to ground and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E96E9B29

1. IG Key "OFF", Engine "OFF".
2. Disconnect CMPS connector and APS connector.
3. Check that sensor connector power supply is within the specification after turning IG Key "ON".
4. Connect CMPS connector and APS connector in turn.
5. Measure the voltage of power circuit of each sensor with all connector connected.

Specification :
☞ APS : Sensor power supply should not change as connecting APS connector. (If the change of sensor power supply occur as connecting sensor connector, this means the occurrence of short inside of sensor.)
☞ CMPS : Sensor signal voltage will be droped approximately 0.2V not only when connecting cam shaft position sensor but also when locating the cam shaft in case.

6. Does change of sensor power supply occur as connecting sensor connector?

YES

▶ Replace related sensors.(CMPS/APS)

NO

▶ Go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR ED340451

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0643 SENSOR REFERENCE VOLTAGE "A" CIRCUIT HIGH

COMPONENT LOCATION E4032FE3

Refer to DTC P0642.

GENERAL DESCRIPTION EA22F37E

Refer to DTC P0642.

DTC DESCRIPTION E7A446D9

P0643 is set when the voltage above 5158mV - maximum voltage of sensor power supply 1 generates from ECM - is detected for more than 0.1 sec. This code is due to the short to battery in sensor power circuit or the voltage problem inside of ECM.

DTC DETECTING CONDITION EA90000E

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• CMPS power supply circuit
• APS 1 power supply circuit
• ECM component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"(Accelerator pedal depressed)</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• When the voltage is above the maximum voltage of sensor power supply.
(above 5158mV)</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 0.1 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• APS standard value is 0%.
• Limp home idle engine speed is fixed at 1200RPM.</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>YES</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SPECIFICATION E490ABDE

Sensor power 1	Sensor power 2	Sensor power 3
APS1, CMPS	RPS, APS 2, BPS, MAFS	APT, VSCA, ECTS
4830mV~5158mV	4830mV~5158mV	4830mV~5158mV

SCHEMATIC DIAGRAM E7ACBE22

Refer to DTC P0642.

SIGNAL WAVEFORM AND DATA EA05206D

Refer to DTC P0642.

TERMINAL AND CONNECTOR INSPECTION EE4C1B1F

Refer to DTC P0642.

POWER CIRCUIT INSPECTION E6514B8B

1. Check power circuit voltage
   1) IG Key "OFF", Engine "OFF".
   2) Disconnector CMPS connector and APS connector.
   3) IG Key "ON".
   4) Measure the voltage between CMPS connector terminal 2 or APS connector terminal 5 and chassis ground.

Specification : 4.8V~5.1V

   5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ Go to "2. Check short to battery in power circuit" as follows.

2. Check short to battery in power circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect CMPS connector, APS connector and ECM connectors.
   3) IG Key "ON".
   4) Measure the voltage between CMPS connector terminal 2 or APS connector terminal 5 and chassis ground.

Specification : 0.0V~0.1V

   5) Is abnormal voltate measured in this test?

YES

▶ Repair short to battery and go to "Verification of Vehicle Repair".

NO

▶ If the circuit is insulated well and the sensor power supply from ECM is high, replace ECM and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION ED7926EC

1. IG Key "OFF", Engine "OFF".
2. Disconnect CMPS connector and APS connector.
3. Check that sensor connector power supply is within the specification after turning IG Key "ON".
4. Connect CMPS connector and APS connector in turn.
5. Measure the voltage of power circuit of each sensor with all connector connected.

Specification :
☞ APS : Sensor power supply should not change as connecting APS connector. (If the change of sensor power supply occur as connecting sensor connector, this means the occurrence of short inside of sensor.)
☞ CMPS : Sensor signal voltage will be droped approximately 0.2V not only when connecting cam shaft position sensor but also when locating the cam shaft in case.

6. Does change of sensor power supply occur as connecting sensor connector?

YES

▶ Replace related sensors.(CMPS/APS)

NO

▶ Go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E0B8B025

Refer to DTC P0642.

DTC P0646 A/C CLUTCH RELAY CONTROL CIRCUIT LOW

GENERAL DESCRIPTION E567F59E

A/C relay which is controled by ECM supplies and cut electrical power to A/C compressor. ECM activates or deactivates A/C relay based on inputted signal such as A/C switch siganl and A/C pressure switch signal. As controlling A/C relay, ECM 1)turns OFF A/C compressor at rapid acceleration to retain suffiecient capacity for acceleration, 2)actively performs idle-up function to cope with the change of engine load which happens at A/C compressor operation.

DTC DESCRIPTION E69BDA76

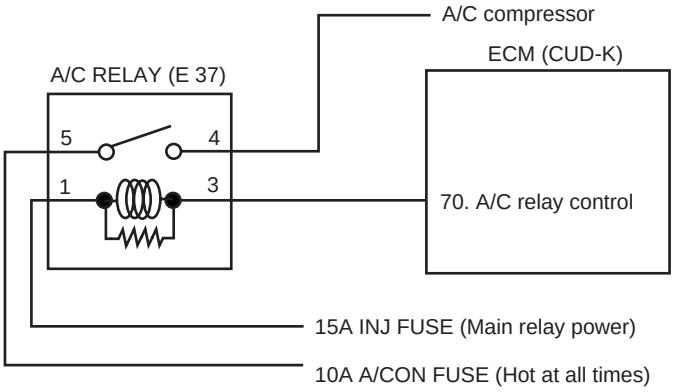
P0646 is set when '0A' is detected in A/C relay control circuit for more than 1 sec.. This code is due to open or short to ground in A/C relay control circuit or internal open in relay component.

DTC DETECTING CONDITION E3DB7B40

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="5">• A/C relay circuit
• A/C relay component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• Short to GND
• Wiring open</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 1.0 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4"></td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SCHEMATIC DIAGRAM E09535CB

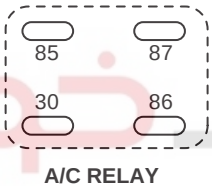
[CIRCUIT DIAGRAM]

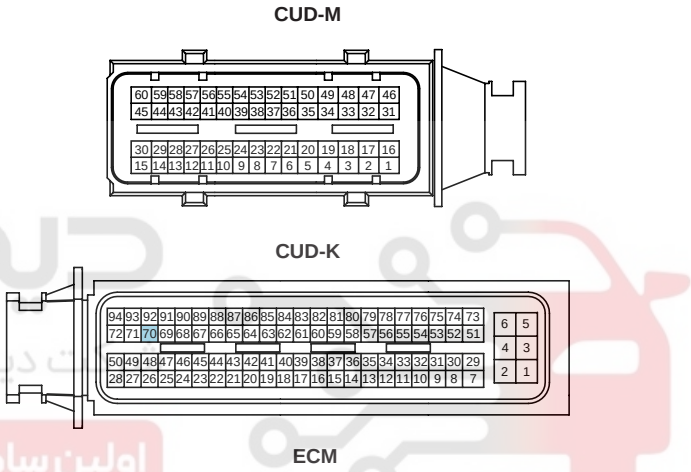


[CONNECTOR INFORMATION]

Terminal	Connected to	Function
30	10A A/CON FUSE (Hot at all times)	Relay power(INPUT)
85	Main relay power	Relay control
86	CUD-K terminal 70	Relay control power
87	E 37 terminal A/C compressor	Relay power(OUTPUT)

[HARNESS CONNECTOR]





SLDF27686L

MONITOR SCANTOOL DATA ECC75534

1. Connect scantool to Data Link Cable (DLC).
2. Warm engine up to normal operating temperature.
3. Turn "OFF" electrical devices and A/C.
4. Monitor "A/C COMPRESSOR CONTROL" parameter on the scantool.

Specification :
A/C switch "ON" : A/C RELAY "ON" (Aircon compressor turns ON and OFF periodically by Aircon pressure S/W.)
A/C switch "OFF" : A/C RELAY "OFF"

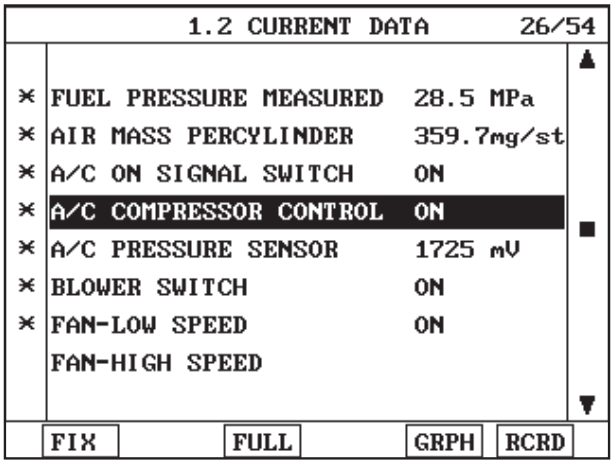


Fig.1

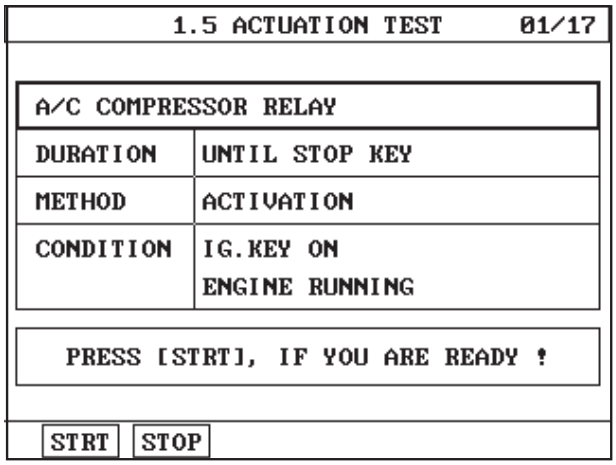


Fig.2

Fig.1) The operating condition of A/C relay is shown. Check if A/C compressor works properly when A/C switch is turning ON.
Fig.2) Diagnosing problem of "A/C RELAY" and "A/C COMPRESSOR" is convenient through ACTUATION TEST on the Scantool.

SLDFL6383L

TERMINAL AND CONNECTOR INSPECTION EEF1D515

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damage of component.
2. Perform checking procedure as follows.
   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.
   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

   NOTE

   Disconnect the pin which requires checking at mail connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position)
3. Is the problem found?

YES

▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

NO

▶ Go to "Power Circuit Inspection".

POWER CIRCUIT INSPECTION E5B65440

1. Check power circuit voltage
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect A/C relay.
   3) Measure the voltage of A/C relay terminal 30.

Specification : 11.5V~13.0V

4) Is the measured voltage within the specification?

YES

▶ Go to "2. Check IG KEY "ON" power circuit" as follows.

NO

▶ Repair problems of E/R JUNCTION BOX 10A A/C FUSE and related circuit and go to "Verification of Vehicle Repair".

2. Check IG KEY "ON" power circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect A/C relay.

3) IG Key "ON".

4) Measure the voltage of A/C relay terminal 1.

Specification : 11.5V~13.0V

5) Is the measured voltage within the specification?

YES

▶ Go to "Control Circuit Inspection".

NO

▶ Repair problems of E/R JUNCTION BOX 10A SNSR fuse and related circuit and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION ECE59953

1. Check monitoring voltage in control circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect A/C relay.

3) IG Key "ON".

4) Measure the voltage of A/C relay terminal 86.

Specification : 3.2V~3.7V

5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ When voltage is not detected : Go to "2. Check open in control circuit" as follows.
▶ When high voltage is detected : Repair short to battery and go to "Verification of Vehicle Repair".

2. Check open in control circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect A/C relay and ECM connector .

3) Check continuity between glow relay terminal 86 and ECM connector(CUD-K) terminal 70.

Specification : Continuity (below 1.0Ω)

4) Is the measured resistance within the specification?

YES

▶ Repair short to ground and go to "Verification of Vehicle Repair".

NO

▶ Repair open in control circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E1C762E3

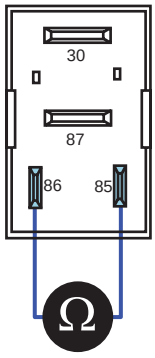
1. Check A/C relay component resistance

1) IG Key "OFF", Engine "OFF".

2) Disconnect A/C relay.

3) Measure the resistance of A/C relay coil.

Specification :80±5 Ω (20℃)



SLDFL6388L

4) Is the measured resistance within the specification?

YES

▶ Go to "2. Check A/C relay component operation" as follows..

NO

▶ Replace A/C relay and go to "Verification of Vehicle Repair".

2. Check A/C relay component operation

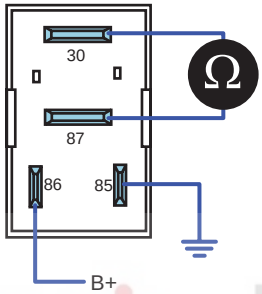
   1) IG Key "OFF", Engine "OFF".

   2) Disconnect A/C relay

   3) Supplies random B+ and ground to coil sides of A/C relay (terminal 85, terminal 86)

   4) Check continuity between A/C relay terminal 30 and terminal 87.

Specification :
When power is supplied : Continuity (below 1.0Ω)
When power is not supplied : Discontinuity (Infinite Ω)



SLDFL6389L

   5) Is the continuity test within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace A/C relay and go to "Verification of Vehicle Repair".

※ Repeat this process 2~3 times.

VERIFICATION OF VEHICLE REPAIR EB59D9B2

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0647 A/C CLUTCH RELAY CONTROL CIRCUIT HIGH

GENERAL DESCRIPTION E514D243

Refer to DTC P0646.

DTC DESCRIPTION EA89AE97

P0647 is set when excessive current is detected in A/C relay control circuit for more than 1 sec.. This code is due to short to battery in A/C relay control circuit or internal short in relay component.

DTC DETECTING CONDITION EF504BBE

Item	Detecting Condition		Possible Cause
DTC Strategy	• Voltage monitoring		• A/C relay circuit • A/C relay component
Enable Conditions	• IG Key "ON"		
ThresholdValue	• Short to battery		
DiagnosticTime	• 1.0 sec.		
Fail Safe	Fuel Cut	NO	
	EGR Off	NO	
	Fuel Limit	NO	
	MIL	OFF	

SCHEMATIC DIAGRAM E0BC18E1

Refer to DTC P0646.

MONITOR SCANTOOL DATA EC4C0FB5

Refer to DTC P0646.

TERMINAL AND CONNECTOR INSPECTION E455AE8D

Refer to DTC P0646.

POWER CIRCUIT INSPECTION ECE4D9E0

1. Check power circuit voltage
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect A/C relay.
   3) Measure the voltage of A/C relay terminal 30.

Specification : 11.5V~13.0V

   4) Is the measured voltage within the specification?

YES

▶ Go to "2. Check IG KEY "ON" power circuit" as follows.

NO

▶ Repair problems of E/R JUNCTION BOX 10A A/C FUSE and related circuit and go to "Verification of Vehicle Repair".

2. Check IG KEY "ON" power circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect A/C relay.

3) IG Key "ON".

4) Measure the voltage of A/C relay terminal 1.

Specification : 11.5V~13.0V

5) Is the measured voltage within the specification?

YES

▶ Go to "Control Circuit Inspection".

NO

▶ Repair problems of E/R JUNCTION BOX 10A SNSR fuse and related circuit and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION E5066064

1. Check monitoring voltage in control circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect A/C relay.

3) IG Key "ON".

4) Measure the voltage of A/C relay terminal 86.

Specification : 3.2V~3.7V

5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ When voltage is not detected : Go to "2. Check open in control circuit" as follows.
▶ When high voltage is detected : Repair short to battery and go to "Verification of Vehicle Repair".

2. Check open in control circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect A/C relay and ECM connector .

3) Check continuity between glow relay terminal 86 and ECM connector(CUD-K) terminal 70.

Specification : Continuity (below 1.0Ω)

4) Is the measured resistance within the specification?

YES

▶ Repair short to ground and go to "Verification of Vehicle Repair".

NO

▶ Repair open in control circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION ECF3ADE7

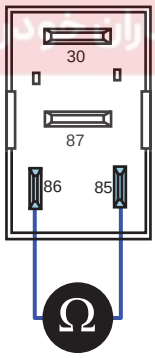
1. Check A/C relay component resistance

1) IG Key "OFF", Engine "OFF".

2) Disconnect A/C relay.

3) Measure the resistance of A/C relay coil.

Specification :80±5 Ω (20℃)



SLDFL6388L

4) Is the measured resistance within the specification?

YES

▶ Go to "2. Check A/C relay component operation" as follows..

NO

▶ Replace A/C relay and go to "Verification of Vehicle Repair".

2. Check A/C relay component operation

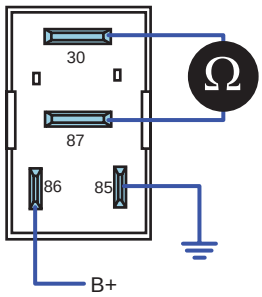
1) IG Key "OFF", Engine "OFF".

2) Disconnect A/C relay

3) Supplies random B+ and ground to coil sides of A/C relay (terminal 85, terminal 86)

4) Check continuity between A/C relay terminal 30 and terminal 87.

Specification :
When power is supplied : Continuity (below 1.0Ω)
When power is not supplied : Discontinuity (Infinite Ω)



SLDFL6389L

5) Is the continuity test within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace A/C relay and go to "Verification of Vehicle Repair".

※ Repeat this process 2~3 times.

VERIFICATION OF VEHICLE REPAIR ECDB3802

Refer to DTC P0646.

DTC P0650 MALFUNCTION INDICATOR LAMP(MIL) CONTROL CIRCUIT

GENERAL DESCRIPTION EEE39251

As monitoring the errors of several sensors and actuator circuit, TCM related problem and ECM error, if any problem occurs, ECM turns Engine Check Lamp ON at cluster to notify driver the occurence of a problem. Generally, Engine Check Lamp turns ON at Ignition ON and turns OFF within couple of seconds after turning engine ON. If engine check lamp turns on during driving, perform diagnosis of engine system and auto-transaxle system.

DTC DESCRIPTION EE6BC848

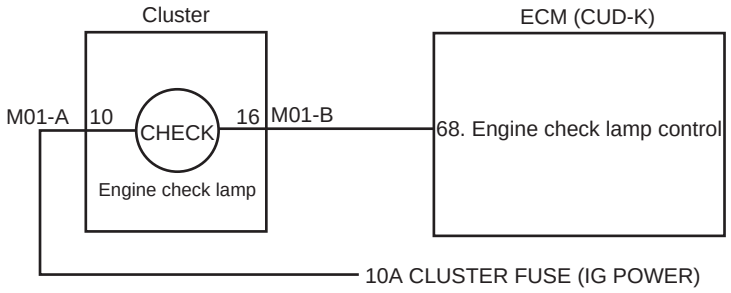
P0650 is set when 1)excessive current is detected in engine check lamp control circuit for more than 1.0 sec.. at engine check lamp ON condition or 2)like open or short to ground, no current is detected. This code is due to open in control circuit or opened filament of lamp component.

DTC DETECTING CONDITION E2C2E6CC

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="5">• Open in engine check lamp
• Engine check lamp circuit.</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON" (Monitoring only performed within lamp operating condition)</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• Short to battery
• Short to GND
• Wiring open</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 2.0 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4"></td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SCHEMATIC DIAGRAM EFB519AA

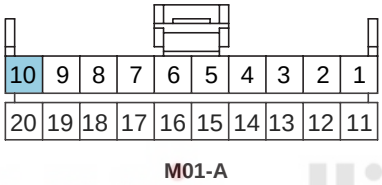
[CIRCUIT DIAGRAM]



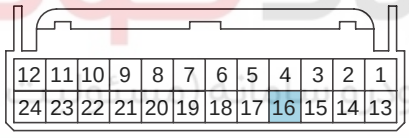
[CONNECTOR INFORMATION]

Terminal	Connected to	Function
M01-A terminal 10	10A CLUSTER FUSE	IG power
M01-B terminal 16	CUD-K terminal 68	Engine check lamp control

[HARNESS CONNECTOR]

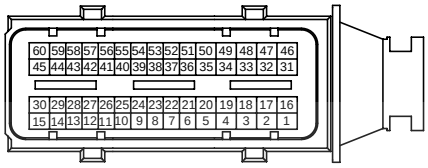


M01-A

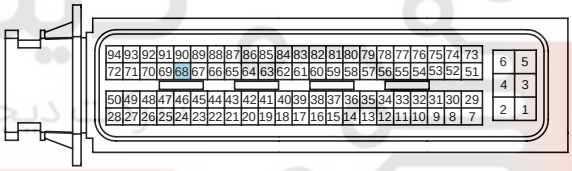


M01-B

CUD-M



CUD-K



ECM

SLDF27687L

TERMINAL AND CONNECTOR INSPECTION EA368B13

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.

2. Perform checking procedure as follows.

   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.

   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

   NOTE

   Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position.)

3. Is the problem found?

   YES

   ▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

   NO

▶ Go to "Control Circuit Inspection".

CONTROL CIRCUIT INSPECTION ECDD87F7

1. Check control circuit voltage

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect ECM connector.

   3) IG Key "ON".

   4) Measure the voltage of ECM connector(CUD-K) terminal 68.

Specification : 10.8V~13.0V

   5) Is the measured voltage within the specification?

   YES

   ▶ Go to "2. Grounding test of check lamp control circuit" as follows.

   NO

   ▶ Check open in filament of check lamp. (Refer to Component Inspection)
   ▶ Repair open between cluster connector(M01-B) terminal 16 and ECM connector(CUD-K) terminal 68 and go to "Verification of Vehicle Repair",

2. Grounding test of check lamp control circuit

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect ECM connector.

   3) IG Key "ON".

   4) Ground ECM connector(CUD-K) terminal 68 to chassis ground.

Specification : Check lamp turns ON.

   5) Does check lamp turn ON?

   YES

   ▶ Go to "Verification of Vehicle Repair".

   NO

   ▶ Repair short to battery in check lamp control circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION EF25CA57

1. IG Key "OFF", Engine "OFF".
2. Dismount cluster and disconnect check lamp.
3. Check check lamp filament.

4. Supply 12V to "check lamp" to turn lamp ON.

Specification : Lamp turns ON when 12V is supplied.

5. Does check lamp turn ON?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace check lamp and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E0285A24

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

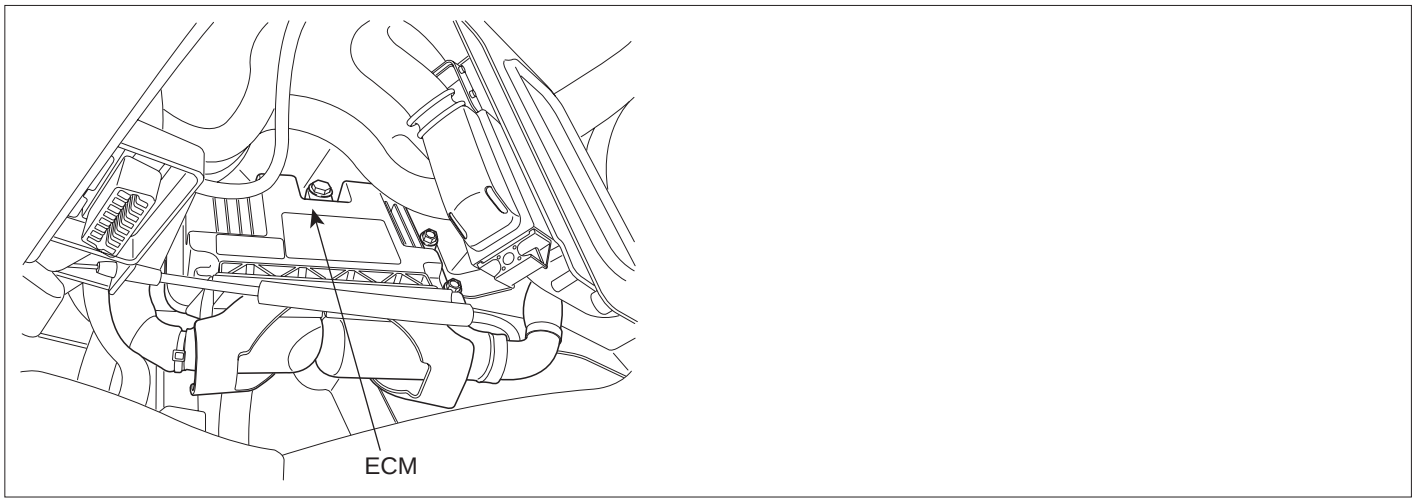
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0652 SENSOR REFERENCE VOLTAGE "B" CIRCUIT LOW

COMPONENT LOCATION E63B089E



SLDFL6237L

GENERAL DESCRIPTION EFAACA33

ECM is activated by power supply. Signals from several sensors, such as CKPS and APS, is inputted to ECM. Comparing inputted siganals with control LOGIC saved at micro controller and EEPROM, ECM controlls engine as actuating injectors, solenoids and relays. To guarantee accurate control, ECM performs SELF TEST, DIAGNOSIS of several sensors and actuators. And if serious trouble which affects vehicle performance occurrs, ECM sets DTCs.At certain cases, ECM shuts down whole systems in order to prevent dangerous situation due to incorrect control.

DTC DESCRIPTION E79315EF

P0652 is set when the voltage below 4700mV - minimum voltage of sensor power supply 2 generates from ECM - is detected for more than 0.1 sec. This code is due to the short to ground in sensor power circuit or the voltage problem inside of ECM.

DTC DETECTING CONDITION E00FA089

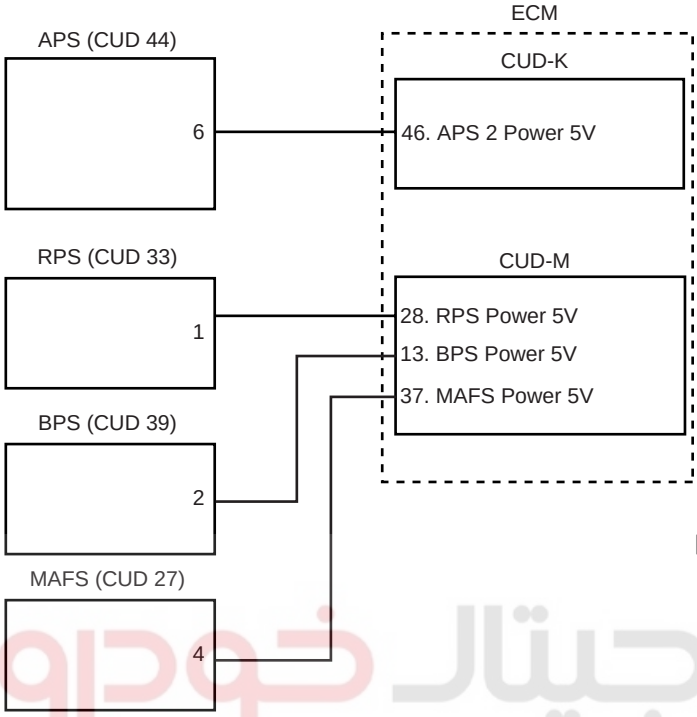
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• RPS power supply circuit
• APS 2 power supply circuit
• BPS power supply circuit
• MAFS power supply circuit
• ECM component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• When the voltage is below the minimum voltage of sensor power supply (below 4700mV)</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 0.1 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• APS standard value is 0%.
• Limp home idle engine speed is fixed at 1200RPM.</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>YES</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SPECIFICATION E81BBD5B

Sensor power 1	Sensor power 2	Sensor power 3
APS1, CMPS	RPS, APS 2, BPS, MAFS	APT, VSCA, ECTS
4830mV~5158mV	4830mV~5158mV	4830mV~5158mV

SCHEMATIC DIAGRAM E506AF52

[CIRCUIT DIAGRAM]



[CONNECTOR INFORMATION]

[CUD 44 Accelerator Position Seneor]

Terminal	Connected to	Function
1	CUD-K terminal 31	APS 2 Sensor signal
2	CUD-K terminal 8	APS 2 Sensor ground
3	CUD-K terminal 9	APS 1 Sensor signal
4	CUD-K terminal 30	APS 1 Sensor ground
5	CUD-K terminal 45	APS 1 Sensor power
6	CUD-K terminal 46	APS 2 Sensor power

[CUD 33 RPS]

Terminal	Connected to	Function
1	CUD-M terminal 28	Sensor power
2	CUD-M terminal 43	Sensor signal
3	CUD-M terminal 8	Sensor ground

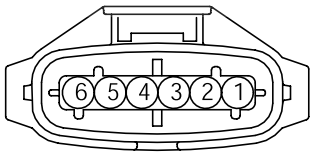
[CUD 39 Boost pressure sensor]

Terminal	Connected to	Function
1	CUD-M terminal 40	BPS signal
2	CUD-M terminal 13	BPS power
3	CUD-M terminal 53	IATS signal
4	CUD-M terminal 23	Sensor ground

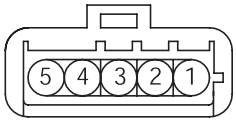
[CUD 27 Accelerator Position Seneor]

Terminal	Connected to	Function
1	I/P-F terminal 27	IG 1 power
2	CUD-M terminal 44	Sensor ground
3	CUD-K terminal 89	IATS signal
4	CUD-M terminal 37	Sensor power
5	CUD-M terminal 42	Sensor signal

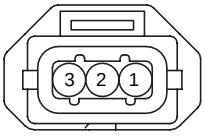
[HARNESS CONNECTOR]



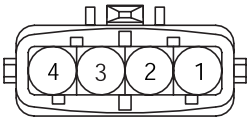
CUD 44
APS



CUD 27
MAFS

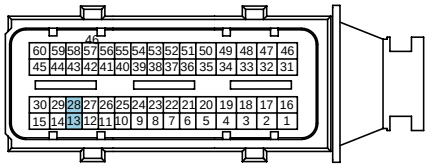


CUD 33
RPS

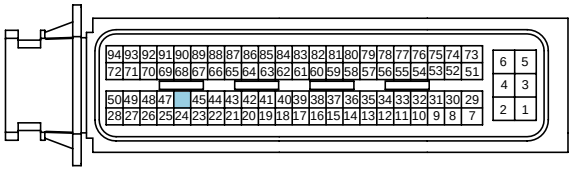


CUD 39
BPS

CUD-M



CUD-K



ECM

SLDF27688L

SIGNAL WAVEFORM AND DATA E931359A

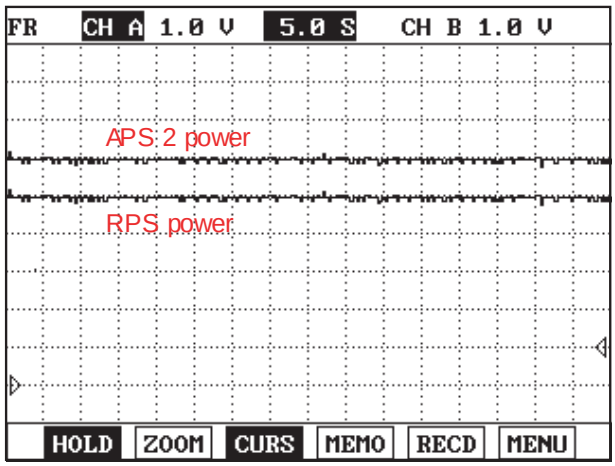


Fig.1

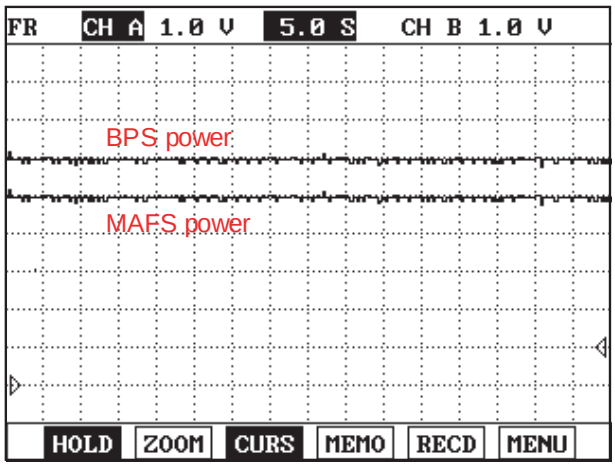


Fig.2

Fig.1) APS2 and RPS power supply signals are measured simultaneously. Check if the voltages are within the specification (4.8~5.1V) at IG Key "ON".
Fig.2) BPS and MAFS power supply signals are measured simultaneously. Check if the voltages are within the specification (4.8~5.1V) at IG Key "ON".

SLDFL6395L

TERMINAL AND CONNECTOR INSPECTION EC5D9B8A

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damage of component.

2. Perform checking procedure as follows.
   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.
   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

   NOTE

   Disconnect the pin which requires checking at mail connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position)

3. Is the problem found?

   YES

   ▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

   NO

   ▶ Go to "Power Circuit Inspection".

POWER CIRCUIT INSPECTION EE27A151

1. Check power circuit voltage
   1) IG Key "OFF", Engine "OFF".
   2) Disconnector RPS connector, APS connector, MAFS connector and BPS connector.

3) IG Key "ON".

4) Measure the voltage of RPS connector terminal 1, APS connector terminal 6, MAFS connector terminal 4 and BPS terminal 2.

Specification : 4.8V~5.1V

5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ Go to "2. Check short to ground in power circuit" as follows.

2. Check short to ground in power circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect RPS connector, APS connector, MAFS connector, BPS connector and ECM connectors.

3) Check continuity between RPS connector terminal 1, APS connector terminal 6, MAFS connector terminal 4, BPS connector terminal 2 and chassis ground.

Specification : Discontinuity (Infinite Ω)

4) Is the measured resistance within the specification?

YES

▶ If the circuit is insulated well and the sensor power supply from ECM is low, replace ECM and "Verification of Vehicle Repair".

NO

▶ Repair short to ground and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E4457B6C

1. IG Key "OFF", Engine "OFF".
2. Disconnect RPS connector, APS connector, MAFS connector, BPS connector.
3. Check that sensor connector power supply is within the specification after turning IG Key "ON".
4. Connect RPS connector and APS connector, MAFS connector, BPS connector in turn.
5. Measure the voltage of power circuit of each sensor with all connector connected.

Specification : Sensor power supply should not change as connecting RPS connector, APS connector, MAFS connector, BPS connector. (If the change of sensor power supply occur as connecting sensor connector, this means the occurrence of short inside of sensor.)

6. Does change of sensor power supply occur as connecting sensor connector?

YES

▶ Replace related sensors.(RPS/APS/MAFS/BPS)

NO

▶ Go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E810C4BD

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0653 SENSOR REFERENCE VOLTAGE "B" CIRCUIT HIGH

COMPONENT LOCATION E70105FD

Refer to DTC P0652.

GENERAL DESCRIPTION ED6B82CD

Refer to DTC P0652.

DTC DESCRIPTION E53FFC83

P0653 is set when the voltage above 5158mV - maximum voltage of sensor power supply 2 generates from ECM - is detected for more than 0.1 sec. This code is due to the short to battery in sensor power circuit or the voltage problem inside of ECM.

DTC DETECTING CONDITION ECB582CF

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="5">• RPS power supply circuit
• APS 2 power supply circuit
• BPS power supply circuit
• MAFS power supply circuit
• ECM component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• When the voltage is above the maximum voltage of sensor power supply. (above 5158mV)</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 0.1 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• APS standard value is 0%.
• Limp home idle engine speed is fixed at 1200RPM.</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>YES</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SPECIFICATION E14D56BF

Sensor power 1	Sensor power 2	Sensor power 3
APS1, CMPS	RPS, APS 2, BPS, MAFS	APT, VSCA, ECTS
4830mV~5158mV	4830mV~5158mV	4830mV~5158mV

SCHEMATIC DIAGRAM E2F2733A

Refer to DTC P0652.

SIGNAL WAVEFORM AND DATA E0E5F633

Refer to DTC P0652.

TERMINAL AND CONNECTOR INSPECTION E42434AB

Refer to DTC P0652.

POWER CIRCUIT INSPECTION E48DF654

1. Check power circuit voltage

   1) IG Key "OFF", Engine "OFF".

   2) Disconnector RPS connector, APS connector, MAFS connector and BPS connector.

   3) IG Key "ON".

   4) Measure the voltage of RPS connector terminal 1, APS connector terminal 6, MAFS connector terminal 4 and BPS terminal 2.

Specification : 4.8V~5.1V

   5) Is the measured voltage within the specification?

   YES

   ▶ Go to "Component Inspection".

   NO

   ▶ Go to "2. Check short to battery in power circuit" as follows.

2. Check short to battery in power circuit

   1) IG Key "OFF", Engine "OFF".

   2) Disconnector RPS connector, APS connector , MAFS connector, BPS connector and ECM connector

   3) IG Key "ON".

   4) Measure the voltage of RPS connector terminal 1, APS connector terminal 6, MAFS connector terminal 4 and BPS connector terminal 2.

Specification : 0.0V~0.1V

   5) Is abnormal voltate measured in this test?

   YES

   ▶ Repair short to battery and go to "Verification of Vehicle Repair".

   NO

   ▶ If the circuit is insulated well and the sensor power supply from ECM is high, replace ECM and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E5ED309E

1. IG Key "OFF", Engine "OFF".
2. Disconnect RPS connector, APS connector, MAFS connector, BPS connector.
3. Check that sensor connector power supply is within the specification after turning IG Key "ON".
4. Connect RPS connector and APS connector, MAFS connector, BPS connector in turn.

5. Measure the voltage of power circuit of each sensor with all connector connected.

Specification : Sensor power supply should not change as connecting RPS connector, APS connector, MAFS connector, BPS connector. (If the change of sensor power supply occur as connecting sensor connector, this means the occurrence of short inside of sensor.)

6. Does change of sensor power supply occur as connecting sensor connector?

YES

▶ Replace related sensors.(RPS/APS/MAFS/BPS)

NO

▶ Go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR EE8FE256

Refer to DTC P0652.

DTC P0670 GLOW RELAY CIRCUIT MALFUNCTION

GENERAL DESCRIPTION EF5E39B7

Heating combustion chamber, glow plug increases fuel ignitibility and makes fuel in the foggy state easily when engine is cold. Thus, glow plug makes engine starting easily and decreases exhaust gas produced just after turning engine on when engine is cold. ECM controls operation and operating duration of glow plug relay which supplies power to glow plug with ECTS signal, battery voltage and IG KEY ON signal. Through glow lamp in cluster, ECM let drivers know if glow plug is ON.

DTC DESCRIPTION EE57949F

P0670 is set when 1)excessive voltage is detected or 2)no current is detected like open or short to ground in glow relay control circuit for more than 1 sec. at glow relay ON condition. This code is due to open in glow relay control circuit or internal open in glow relay component.

DTC DETECTING CONDITION EDBBD34E

Item	Detecting Condition		Possible Cause
DTC Strategy	• Voltage monitoring		• Glow relay control circuit • Glow relay component
Enable Conditions	• IG Key "ON" (monitoring only performed within relay operating condition)		
ThresholdValue	• Short to battery • Short to GND • Wiring open		
DiagnosticTime	• 1.0 sec.		
Fail Safe	Fuel Cut	NO	
	EGR Off	NO	
	Fuel Limit	NO	
	MIL	OFF	

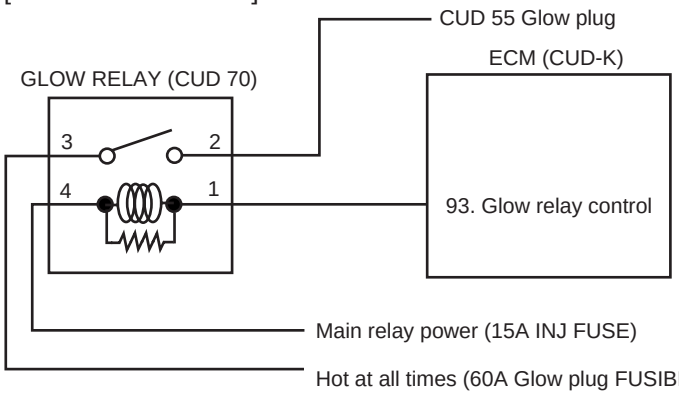
SPECIFICATION E74DBF86

※ RELAY OPERATING TIME

	-20℃	-10℃	10℃	50℃
10V	16sec	10sec	4sec	2.0sec
14.9V	16sec	10sec	4sec	2.0sec

SCHEMATIC DIAGRAM E5E0F577

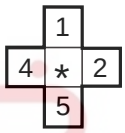
[CIRCUIT DIAGRAM]

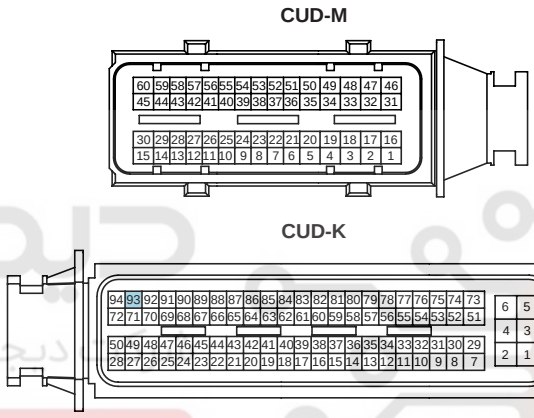


[CONNECTOR INFORMATION]

Terminal	Connected to	Function
1	60A Glow plug FUSIBLE LINK	Glow plug power(INPUT)
2	CUD-K terminal 93	Glow relay control
3	-	-
4	Main relay power	Glow relay coil power
5	CUD 70 terminal 1	Glow plug power(OUTPUT)

[HARNESS CONNECTOR]





SLDF27689L

MONITOR SCANTOOL DATA E972AB0D

1. Connect Scantool to Data Link Connector (DLC).
2. Warm engine up to normal operating temperature.
3. Turn "OFF" electrical devices and A/C.
4. Monitor "GLOW RELAY" parameter on the Scantool.

Specification : After operating according to engine coolant temperature and battery voltage, Glow relay turns "OFF".

	- 20℃	- 10℃	10℃	50℃
10V	16sec	10sec	4sec	2.0sec
14.9V	16sec	10sec	4sec	2.0sec

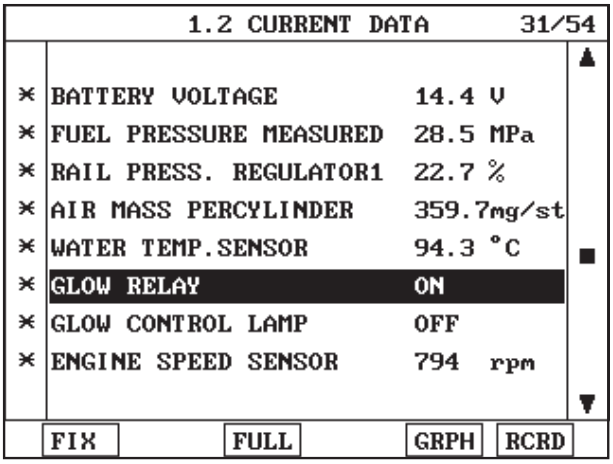


Fig.1

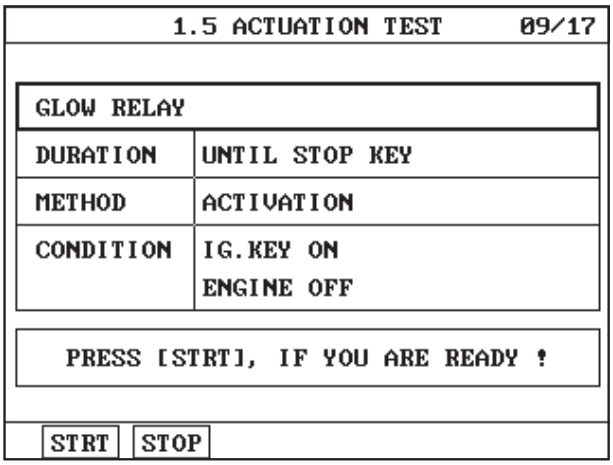


Fig.2

Fig 1) Operating state of Glow relay is shown. However, it is difficult to check operating state because Glow relay turns OFF 2~3 sec. after operation at normal temp.
Fig.2) Checking glow relay operation and power supply to glow plug using "ACTUATION TEST" on Scantool is convenient.

SLDFL6400L

TERMINAL AND CONNECTOR INSPECTION EFF28506

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.
2. Perform checking procedure as follows.
   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.
   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

   NOTE

   Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position.)
3. Is the problem found?

   YES

   ▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

   NO

   ▶ Go to "Power Circuit Inspection".

POWER CIRCUIT INSPECTION E8EC9E37

1. Check HOT AT ALL TIMES power circuit voltage
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect glow relay.
   3) Measure the voltage of glow relay connector terminal 1.

Specification : 11.5V~13.0V

4) Is the measured voltage within the specification?

YES

▶ Go to "2. Check IG Key "ON" power circuit voltage" as follows.

NO

▶ Repair E/R FUSIBLE LINK BOX 60A GLOW PLUG FUSIBLE LINK and related circuit and go to "Verification of Vehicle Repair".

2. Check IG Key "ON" power circuit voltage

1) IG Key "OFF", Engine "OFF".

2) Disconnect glow relay.

3) IG Key "ON".

4) Measure the voltage of glow relay connector terminal 4.

Specification : 11.5V~13.0V

5) Is the measured voltage within the specification?

YES

▶ Go to "Control Circuit Inspection".

NO

▶ Repair E/R JUNCTION BOX 15A INJ fuse and related circuit and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION E825162A

1. Check control circuit monitoring voltage

1) IG Key "OFF", Engine "OFF".

2) Disconnect glow relay.

3) IG Key "ON".

4) Measure the voltage of glow relay connector terminal 2.

Specification : 3.2V~3.7V

5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ When no value is detected : Go to "2. Check open in control circuit" as follows.
▶ When high voltage is detected : Repair short to battery in signal circuit and go to "Verification of Vehicle Repair".

2. Check open in control circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect glow relay and ECM connector.

3) Check continuity between glow relay connector terminal 2 and ECM connector(CUD-K) terminal 93.

Specification : Continuity (below 1.0Ω)

4) Is the measured resistance within the specification?

YES

▶ Repair short to ground and go to "Verification of Vehicle Repair".

NO

▶ Repair open in control circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION EF28BD02

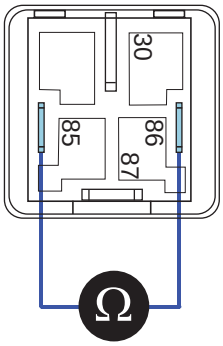
1. Check golw relay component coil resistance

1) IG Key "OFF", Engine "OFF".

2) Disconnect glow relay.

3) Measure the resistance of glow relay component component terminal 85 and terminal 86.

Specification : 55±5 Ω (20°C)



SLDFL6405L

4) Is the measured resistance within the specification?

YES

▶ Go to "2. Check glow relay component operation" as follows.

NO

▶ Replace glow relay and go to "Verification of Vehicle Repair".

2. Check glow relay component operation

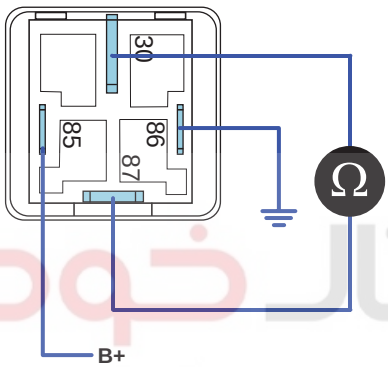
   1) IG Key "OFF", Engine "OFF".

   2) Disconnect glow relay.

   3) Supplies random B+ and ground to coil sides of glow relay (terminal 85, terminal 86).

   4) Check continuity between glow relay component terminal 30 and terminal 87.

Specification :
When power is supplied : Continuity (below 1.0Ω)
When power is not supplied : Discontinuity (Infinite Ω)



SLDFL6406L

   5) Is the measured resistance within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace glow relay and go to "Verification of Vehicle Repair".

※ Repeat this process 2~3 times.

VERIFICATION OF VEHICLE REPAIR EB28E905

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

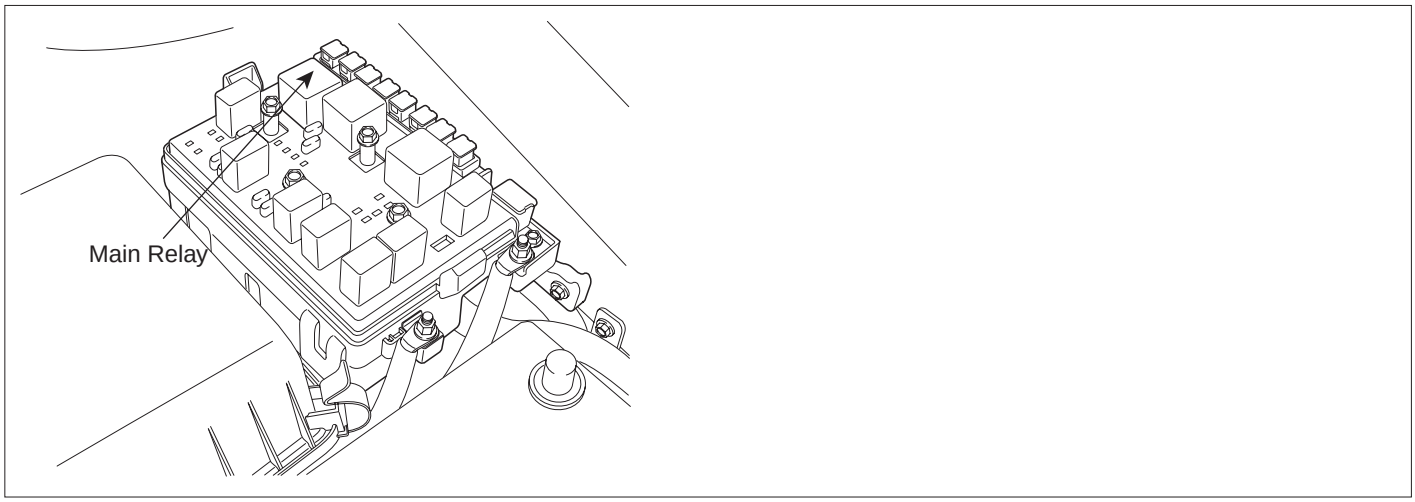
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0685 ECM/PCM POWER RELAY CONTROL CIRCUIT /OPEN

COMPONENT LOCATION E242C9D8



SLDFL6407L

GENERAL DESCRIPTION E2622E96

Main relay operates when Ignition ON signal is inputted to ECM connector(CUD-K) terminal 28 and it supplies power to ECM, fuel pump relay, CMP, EGR actuator, throttle flap actuator, PTC heater relay and brake switch, etc. Especially, the power supplied to ECM is used as a main power of injectors, rail pressure control valve and ECM operation. When IG Key ON signal is shut off during turning engine OFF, ECM stops injector operation then engine turns OFF. Approx. after 16 sec., ECM shuts OFF main relay and system turns OFF. Main relay is very important for engine operation, so careful inspection is strongly required.

DTC DESCRIPTION EAC67F30

When IG Key OFF signal is imputted to ECM. ECM stops injector operation and engine turns OFF. Then, After-run(turning off process of ECM internal system) is performed in order to shut system down. During this process, if main relay power supply is cut too late or power supply is cut too early before After-run process completes, ECM detect main relay error and P0685 is set.

DTC DETECTING CONDITION E080429E

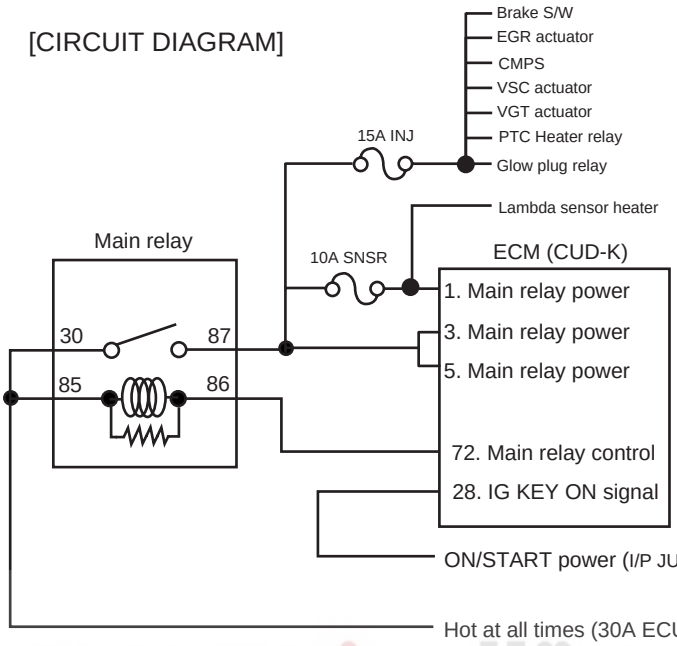
Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Main relay circuit • Main relay component
Enable Conditions	• IG KEY "ON"			
ThresholdValue	• When main relay respond to IG Key ON/OFF signal too fast or slow. - After-run finished and it requires more than 2 sec. for Main relay to be deactivated. - Main relay deactivated before After-run finished more than 3 times.			
DiagnosticTime	• Immediately			
Fail Safe	Fuel Cut	NO		
	EGR Off	NO		
	Fuel Limit	NO		
	MIL	OFF		

SPECIFICATION E5E950BC

Main Relay Coil Resistance	80±10 Ω (20°C)

SCHEMATIC DIAGRAM EDA22E08

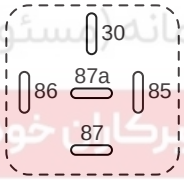
[CIRCUIT DIAGRAM]



[CONNECTOR INFORMATION]

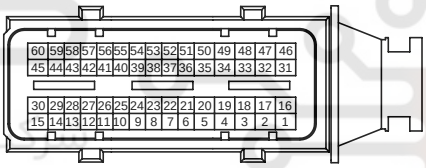
Terminal	Connected to	Function
30	30A ECU FUSIBLE LINK	Hot at all times
85	30A ECU FUSIBLE LINK	Main relay coil power
86	CUD-K terminal 72	Main relay control
87	CUD-K terminal 1,3,5 etc	Power supply to ECM, Sensor, Actuator

[HARNESS CONNECTOR]

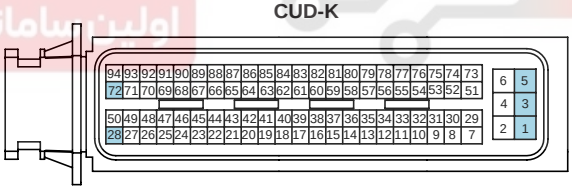


Main relay

CUD-M



CUD-K



ECM

SLDF27690L

SIGNAL WAVEFORM AND DATA E4A25F31

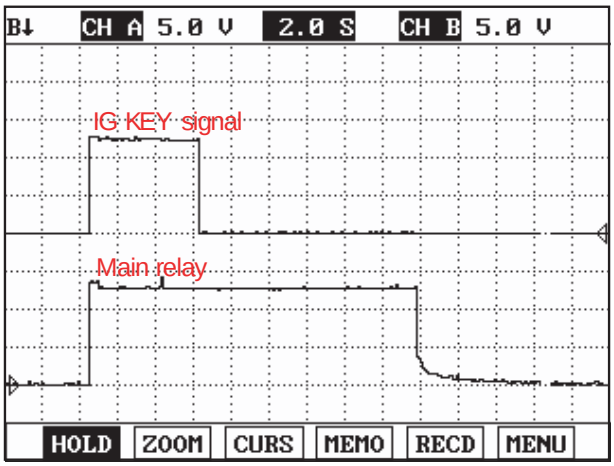


Fig.1

Fig.1) Main relay operates when IG KEY "ON" (C101-K terminal 28 ON signal), it turns "OFF" in 16 sec. after IG KEY "OFF".

SLDF27616L

TERMINAL AND CONNECTOR INSPECTION E9386C3F

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.
2. Perform checking procedure as follows.
   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.
   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

   NOTE

   Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position.)
3. Is the problem found?

   YES

   ▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

   NO

   ▶ Go to "Power Circuit Inspection".

POWER CIRCUIT INSPECTION EDF687A5

1. Check power circuit voltage
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect main relay.
   3) Measure the voltage of main relay terminal 30.
   4) Measure the voltage of main relay terminal 85.

Specification : 11.5V~13.0V

5) Is the measured voltage within the specification?

YES

▶ Go to "Check power supply line(relay→actuator)" as follows.

NO

▶ Repair E/R JUNCTION BOX 30A ECU RLY FUSIBLE LINK and related circuit and go to "Verification of Vehicle Repair".

2. Check power supply line(relay→actuator)

1) IG Key "OFF", Engine "OFF".

2) Disconnect main relay and ECM connector.

3) Connect main relay terminal 30 and terminal 87, terminal 87a using jump wire.

4) Measure the voltage of ECM connector(CUD-K) terminal 1, terminal 3 and terminal 5.

Specification : 11.5V~13.0V

5) Is the measured voltage within the specification?

YES

▶ Go to "Control Circuit Inspection".

NO

▶ Check and repair the open circuit where voltage can not be checked and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION E7F32E45

1. Check open in control circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect main relay and ECM connector.

3) Check continuity between main relay terminal 86 and ECM connector(CUD-K) terminal 72.

Specification : Continuity (below 1.0Ω)

4) Is the measured resistance within the specification?

YES

▶ Go to "2. Check short to ground in control circuit" as follows.

NO

▶ Repair open in control circuit and go to "Verification of Vehicle Repair".

2. Check short to ground in control circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect main relay and ECM connector.

3) Check continuity between main relay terminal 86 and chassis ground.

Specification : Discontinuity (Infinite Ω)

4) Is the measured resistance within the specification?

YES

▶ Go to "3.Check short to battery in control circuit" as follows.

NO

▶ Repair short to ground in control circuit and go to "Verification of Vehicle Repair".

3. Check short to battery in control circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect main relay and ECM connector.

3) IG Key "ON".

4) Measure the voltage of main relay connector terminal 86.

Specification : 0.0V~0.1V

5) Is abnormal voltage detected in the circuit with both connectors disconnected?

YES

▶ Go to "Component Inspection".

NO

▶ Repair short to battery in signal circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E1ECAA59

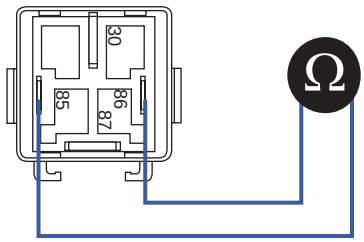
1. Check main relay component resistance

1) IG Key "OFF", Engine "OFF".

2) Disconnect main relay.

3) Measure the resistance between main relay coil component terminal 85 and terminal 86.

Specification : 80±10 Ω (20℃)



KFQG438A

4) Is the measured resistance within the specification?

YES

▶ Go to "2. Check main relay component operation" as follows.

NO

▶ Replace main relay and go to "Verification of Vehicle Repair".

2. Check main relay component operation

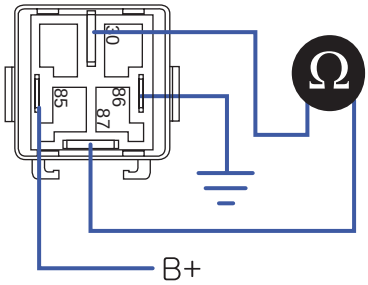
1) IG Key "OFF", Engine "OFF".

2) Disconnect main relay.

3) Supplies random B+ and ground to coil sides of main relay. (terminal 85, terminal 86)

4) Check continuity between main relay component terminal 30 and terminal 87, terminal 87a.

Specification :
When power is supplied : Continuity (below 1.0Ω)
When power is not supplied : Discontinuity (Infinite Ω)



KFQG439A

5) Is the continuity test within the specification?

YES

▶ go to "Verification of Vehicle Repair".

NO

▶ Replace main relay and go to "Verification of Vehicle Repair".

※ Repeat this process 2~3 times.

VERIFICATION OF VEHICLE REPAIR EEE40577

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

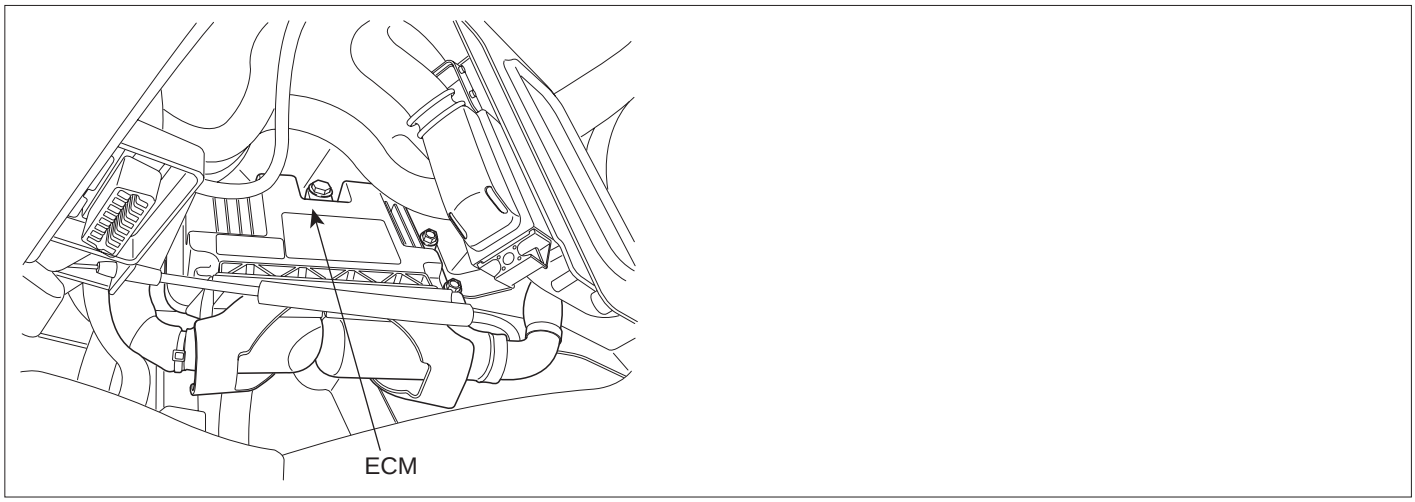
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0698 SENSOR REFERENCE VOLTAGE "C" CIRCUIT LOW

COMPONENT LOCATION EB7705DF



SLDFL6237L

GENERAL DESCRIPTION EA0FEE05

ECM is activated by power supply. Signals from several sensors, such as CKPS and APS, is inputted to ECM. Comparing inputted siganals with control LOGIC saved at micro controller and EEPROM, ECM controlls engine as actuating injectors, solenoids and relays. To guarantee accurate control, ECM performs SELF TEST, DIAGNOSIS of several sensors and actuators. And if serious trouble which affects vehicle performance occurrs, ECM sets DTCs.At certain cases, ECM shuts down whole systems in order to prevent dangerous situation due to incorrect control.

DTC DESCRIPTION EA7E4A7D

P0698 is set when the voltage below 4700mV - minimum voltage of sensor power supply 3 generates from ECM - is detected for more than 0.1 sec. This code is due to the short to ground in sensor power circuit or the voltage problem inside of ECM.

DTC DETECTING CONDITION E16859D6

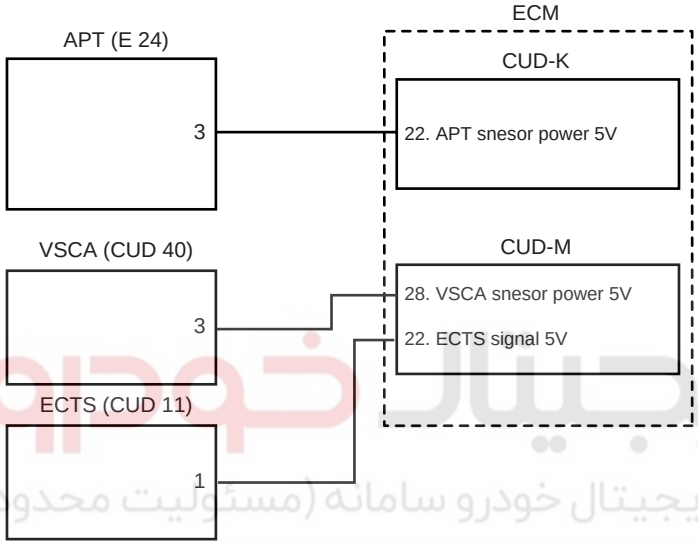
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• A/C pressure transducer power supply circuit
• VSCA power supply circuit
• ECTS signal circuit
• ECM component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• When the voltage is below the minimum voltage of sensor power supply. (below 4700mV)</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 0.1 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• Limp home idle engine speed is fixed at 1200RPM.</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>YES</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SPECIFICATION E1CAD1AE

Sensor power 1	Sensor power 2	Sensor power 3
APS1, CMPS	RPS, APS 2, BPS, MAFS	APT, VSCA, ECTS
4830mV~5158mV	4830mV~5158mV	4830mV~5158mV

SCHEMATIC DIAGRAM E6E3F9F8

[CIRCUIT DIAGRAM]



[CONNECTOR INFORMATION]

APT (E 24)

Terminal	Connected to	Function
1	CUD-K terminal 12	Sensor ground
2	CUD-K terminal 13	Sensor signal
3	CUD-K terminal 22	Sensor power

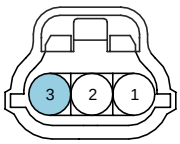
Variable Swirl Control Actuator (CUD 40)

Terminal	Connected to	Function
1	CUD-M terminal 60	Motor (+)
2	CUD-M terminal 30	Motor (-)
3	CUD-M terminal 26	Sensor power
4	CUD-M terminal 56	Sensor feed back
5	CUD-M terminal 6	Sensor ground

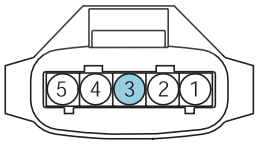
ECTS (CUD 11)

Terminal	Connected to	Function
1	CUD-M terminal 58	Sensor signal
2	M01-B terminal 3	Water temp. gauge (Cluster)
3	CUD-M terminal 41	Sensor ground

[HARNESS CONNECTOR]

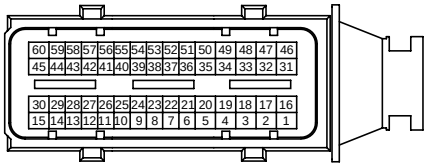


E 24
APT

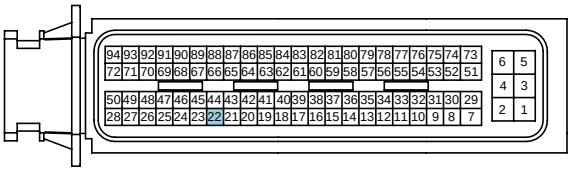


CUD 40
VARIABLE SWIRL
CONTROL ACTUATOR

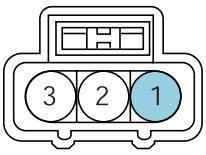
CUD-M



CUD-K



ECM



CUD 11
ECTS

SLDF27691L

SIGNAL WAVEFORM AND DATA E0905616

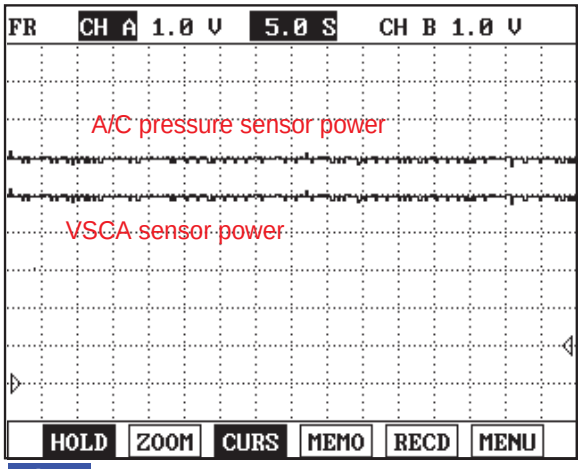


Fig.1

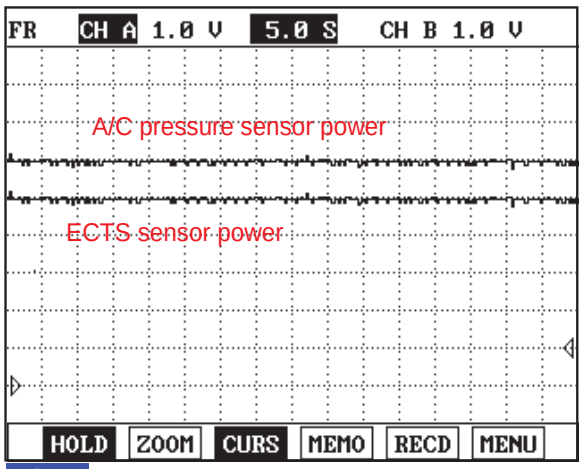


Fig.2

Fig.1) A/C pressure transducer and VSCA sensor power supply signals are measured simultaneously.
Check if the voltages are within the specification (4.8~5.1V) at IG Key "ON"
Fig.2) A/C pressure transducer and ECTS sensor power supply signals are measured simultaneously.
Check if the voltages are within the specification (4.8~5.1V) at IG Key "ON"

※ According to the engine coolant temperature, ECTS signal will vary from 0.6V to 4.5V, therefore, check the voltage after disconnecting connector.

SLDFL6418L

TERMINAL AND CONNECTOR INSPECTION E31DE6E7

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damage of component.
2. Perform checking procedure as follows.
   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.
   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

NOTE

Disconnect the pin which requires checking at mail connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position)

3. Is the problem found?

YES

▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

NO

▶ Go to "Power Circuit Inspection".

POWER CIRCUIT INSPECTION E76FD7A9

1. Check power circuit voltage

1) IG Key "OFF", Engine "OFF".

2) Disconnector APTS connector, VSCA connector and ECTS connector.

3) IG Key "ON".

4) Measure the voltage of APTS connector terminal 3, VSCA connector terminal 3 and ECTS terminal 1.

Specification : 4.8V~5.1V

5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ Go to "2. Check short to ground in power circuit" as follows.

2. Check short to ground in power circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnector APTS connector, VSCA connector and ECTS connector.

3) Check continuity between APTS connector terminal 3, VSCA connector terminal 3, ECTS connector terminal 1 and chassis ground.

Specification : Discontinuity (Infinite Ω)

4) Is the measured resistance within the specification?

YES

▶ If the circuit is insulated well and the sensor power supply from ECM is low, replace ECM and go to "Verification of Vehicle Repair".

NO

▶ Repair short to ground and go to go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E23CB9EB

1. IG Key "OFF", Engine "OFF".

2. Disconnect APTS connector, VSCA connector and ECTS connector.

3. Check that sensor connector power supply is within the specification after turning IG Key "ON".

4. Connect APTS connector and VSCA connector and ECTS connector in turn.

5. Measure the voltage of power circuit of each sensor with all connector connected.

Specification :
APTS, VSCA: Sensor power supply should not change as connecting APTS connector, VSCA connector.(If the change of sensor power supply occur as connecting sensor connector, this means the occurrence of short inside of sensor.)

ECTS : Connecting ECTS connector terminal, signal voltage is outputted from 0.6V to 4.5V depending on ECTS tempt. (While connector is being connected, if output voltage rises or no DTC is outputted, the sensor component is considered as normal one.)

6. Does change of sensor power supply occur as connecting sensor connector?

YES

▶ Replace related sensors.(APTS/VSCA/ECTS)

NO

▶ Go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E25A61C9

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0699 SENSOR REFERENCE VOLTAGE "C" CIRCUIT HIGH

COMPONENT LOCATION EB15F999

Refer to DTC P0698.

GENERAL DESCRIPTION EAD176BB

Refer to DTC P0698.

DTC DESCRIPTION EBA900F1

P0699 is set when the voltage above 5158mV - maximum voltage of sensor power supply 3 generates from ECM - is detected for more than 0.1 sec. This code is due to the short to battery in sensor power circuit or the voltage problem inside of ECM.

DTC DETECTING CONDITION E3CAAC6B

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="5">• A/C pressure transducer power supply circuit
• VSCA power supply circuit
• ECTS signal circuit
• ECM component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• When the voltage is above the maximum voltage of sensor power supply. (above 5158mV)</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 0.1 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• Limp home idle engine speed is fixed at 1200RPM.</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>YES</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SPECIFICATION E4626BCC

Sensor power 1	Sensor power 2	Sensor power 3
APS1, CMPS	RPS, APS 2, BPS, MAFS	APT, VSCA, ECTS
4830mV~5158mV	4830mV~5158mV	4830mV~5158mV

SCHEMATIC DIAGRAM E5550F9E

Refer to DTC P0698.

SIGNAL WAVEFORM AND DATA EC025987

Refer to DTC P0698.

TERMINAL AND CONNECTOR INSPECTION E32C0AF1

Refer to DTC P0698.

POWER CIRCUIT INSPECTION EB94A912

1. Check power circuit voltage
   1) IG Key "OFF", Engine "OFF".
   2) Disconnector APTS connector, VSCA connector and ECTS connector.
   3) IG Key "ON".
   4) Measure the voltage of APTS connector terminal 3, VSCA connector terminal 3 and ECTS terminal 1.

Specification : 4.8V~5.1V

   5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ Go to "2. Check short to battery in power circuit" as follows

2. Check short to battery in power circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnector APTS connector, VSCA connector, ECTS connector and ECM connectors.
   3) IG Key "ON".
   4) Measure the voltage of APTS connector terminal 3, VSCA connector terminal 3 and ECTS terminal 1.

Specification : 0.0V~0.1V

   5) Is abnormal voltate measured in this test?

YES

▶ Repair short to battery and go to "Verification of Vehicle Repair".

NO

▶ If the circuit is insulated well and the sensor power supply from ECM is high, replace ECM and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E3132D7C

1. IG Key "OFF", Engine "OFF".
2. Disconnect APTS connector, VSCA connector and ECTS connector.
3. Check that sensor connector power supply is within the specification after turning IG Key "ON".
4. Connect APTS connector and VSCA connector and ECTS connector in turn.
5. Measure the voltage of power circuit of each sensor with all connector connected.

Specification :
APTS, VSCA: Sensor power supply should not change as connecting APTS connector, VSCA connector.(If the change of sensor power supply occur as connecting sensor connector, this means the occurrence of short inside of sensor.)

ECTS : Connecting ECTS connector terminal, signal voltage is outputted from 0.6V to 4.5V depending on ECTS tempt. (While connector is being connected, if output voltage rises or no DTC is outputted, the sensor component is considered as normal one.)

6. Does change of sensor power supply occur as connecting sensor connector?

YES

▶ Replace related sensors.(APTS/VSCA/ECTS)

NO

▶ Go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E08ED44B

Refer to DTC P0698.

DTC P0700 TCU REQUEST FOR MIL ON

GENERAL DESCRIPTION E0E38D79

ECM and TCM give and take various data through CAN communication each other. When the problem of TCM related sensor(input speed sensor, output speed sensor, inhibiter switch, etc.) and actuators(transaxle solenoid valve, etc.) occurs, gear is fixed at 3rd gear position. However, there is no alarming device such as "TCM warning lamp" which notifies drivers of the occurrence of TCM related problem. Therefore if power train related problem happens, Engine check lamp turns ON to let drivers recognize the occurrence of power train system(A/T system) related problem.

DTC DESCRIPTION E36A0808

P0700 is the code which notifies drivers of the occurrence of TCM related problem indirectly as illuminating engine check lamp. If this code is recorded, Do not check engine but auto transaxle.

DTC DETECTING CONDITION E37CD017

Item	Detecting Condition		Possible Cause
DTC Strategy	• Signal monitoring		• Problem of TCM system
Enable Conditions	• Engine "ON"		
ThresholdValue	• Engine check lamp ON requirement from TCM		
DiagnosticTime	• Immediately		
Fail Safe	Fuel Cut	NO	
	EGR Off	NO	
	Fuel Limit	NO	
	MIL	OFF	

VERIFICATION OF VEHICLE REPAIR EE6FC053

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0701 TCM STATUS ERROR

GENERAL DESCRIPTION E32A9691

ECM and TCM give and take various data through CAN communication each other. When the problem of TCM related sensor(input speed sensor, output speed sensor, inhibiter switch, etc.) and actuators(transaxle solenoid valve, etc.) occurs, gear is fixed at 3rd gear position. However, there is no alarming device such as "TCM warning lamp" which notifies drivers of the occurrence of TCM related problem. Therefore if power train related problem happens, Engine check lamp turns ON to let drivers recognize the occurrence of power train system(A/T system) related problem.

DTC DESCRIPTION EE64737F

P0701 is set when ECM detects TCM problem through CAN communication. Check whether TCM operatures or not.

DTC DETECTING CONDITION EE9B4185

Item	Detecting Condition		Possible Cause
DTC Strategy	• Signal monitoring		• TCM failure
Enable Conditions	• Engine "ON"		
ThresholdValue	• TCM failure		
DiagnosticTime	• Immediately		
Fail Safe	Fuel Cut	NO	
	EGR Off	NO	
	Fuel Limit	NO	
	MIL	OFF	

VERIFICATION OF VEHICLE REPAIR EE459247

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0820 NEUTRAL S/W MALFUNCTION

GENERAL DESCRIPTION E47065CC

Neutral Gear Switch is installed in M/T vehicle and senses driver's intension to shift gear(driver's intension to drive). ECM recognizes engaged gear based on vehicle speed sensor signal and engine RPM in M/T vehicle. And Black Smoke limiting fuel quantity value varies according to engaged gear.(As higher gear shift is engaged, maximum possible fuel injection quantity increases to raise power generation.) The recognition of engaged gear is available when vehicle speed reachs to 2 kph - the minimum speed for ECM to detect. When vehicle starts to move after standing for a while and vehicle speed does not reach to 2 kph , fuel quantity mapping value at neutral gear is adopted to vehicle. Moreover, this phenomenon is more serious when vehicle requires high power generation such as the situation when vehicle is on the slope. To cope with this problem, neutral gear switch which senses driver's intension of starting to move is applied. And fuel injection quantity mapping value suitable for 1st gear is adopted immediately.

NOTE

To reduce black smoke produced during rapid acceleration when no load is applied, fuel injection quantity at none load condition is 70% of that at 1st gear.

DTC DESCRIPTION E8D2961D

P0820 is set when 1) gear is engaged at engine ON, but clutch signal is not detected or 2) neutral signal is detected 'ON' continuously. This code is due to open, short to battery or ground in neutral gear switch circuit.

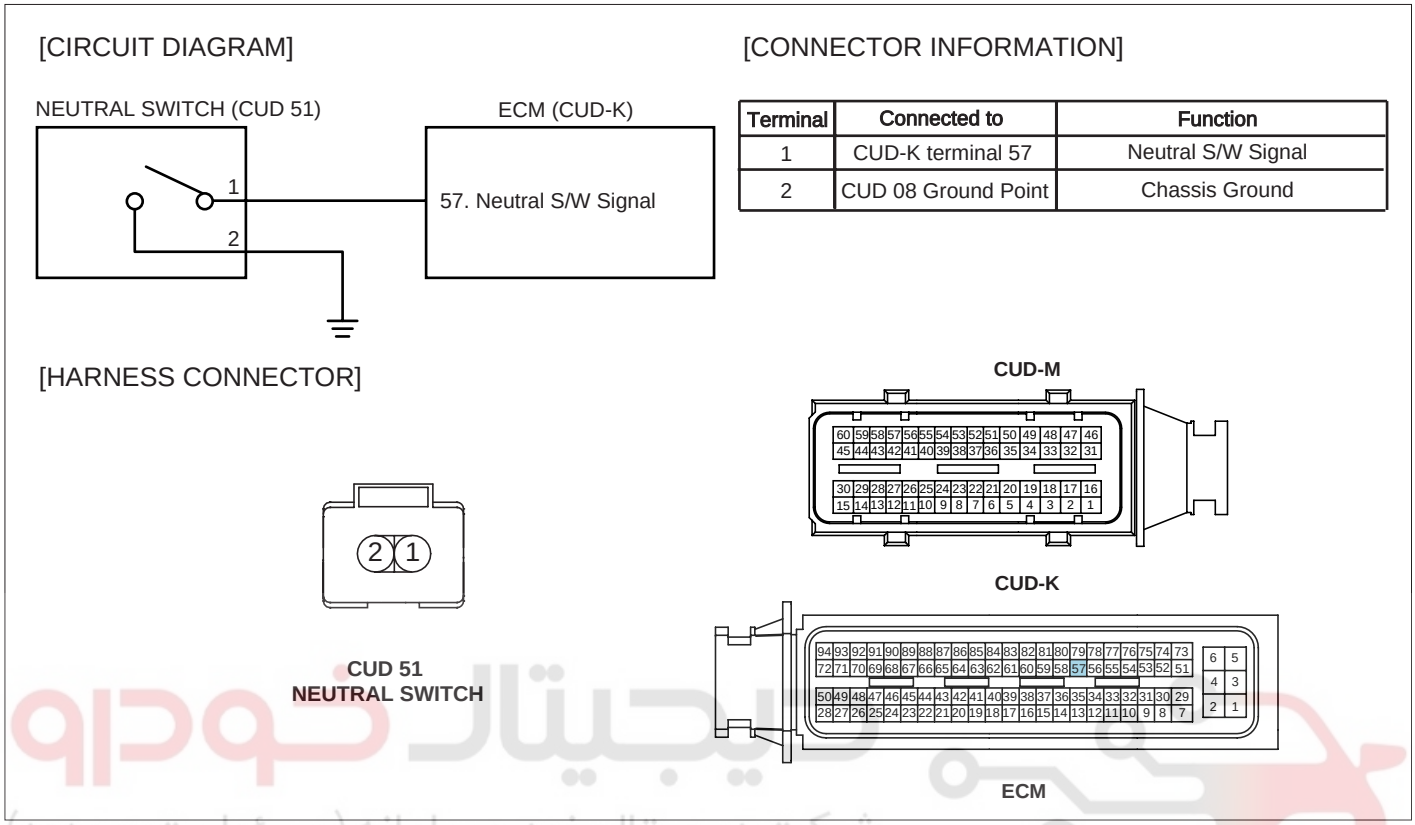
DTC DETECTING CONDITION E40A30C7

Item		Detecting Condition			Possible Cause
DTC Strategy		• Signal monitoring			• Nertral gear switch component • Nertral gear switch circuit
Case 1	Enable Conditions	• APS output signal is below 5% • Vehicle speed is below 1kph • Engine speed is above 600RPM			
	Threshold Value	• Clutch signal is not detected			
Case 2	Enable Conditions	• Vehicle speed is over 80 kph after engine starting			
	Threshold Value	• When the signal, Neutral gear switch, stays at the 'ON'.			
DiagnosticTime		• 3 sec.			
Fail Safe		Fuel Cut	NO		
		EGR Off	NO		
		Fuel Limit	NO		
		MIL	OFF		

SPECIFICATION E187CCA6

Signal Voltage	Neutral Position	Except Neutral Position
11.0V~13.5V	0.0V~0.2V(LOW)	11.0V~13.5V(HIGH)

SCHEMATIC DIAGRAM ECB4C674



Terminal	Connected to	Function
1	CUD-K terminal 57	Neutral S/W Signal
2	CUD 08 Ground Point	Chassis Ground

SLDF27692L

SIGNAL WAVEFORM AND DATA E2184B68

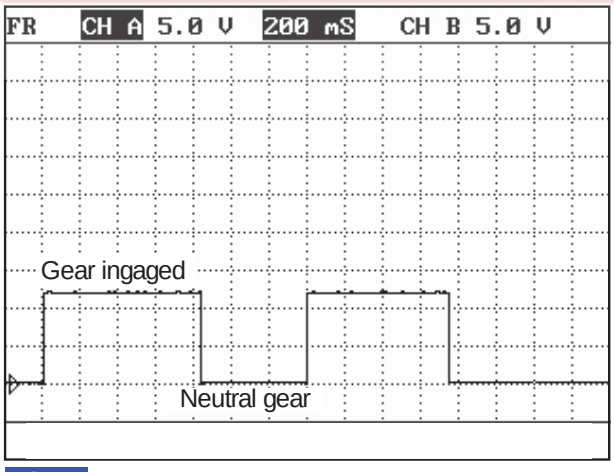


Fig.1

Fig 1) 0V at neutral gear position, 12V at any gear position except neutral position.

SLDFL6424L

TERMINAL AND CONNECTOR INSPECTION E7A71E31

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.

2. Perform checking procedure as follows.

1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.

2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

NOTE

Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector or checking connecting condition. (after checking, reconnect the pin at correct position.)

3. Is the problem found?

YES

▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

NO

▶ Go to "Signal Circuit Inspection".

SIGNAL CIRCUIT INSPECTION E3A6D5F4

1. Neutral gear switch Voltage Inspection

1) IG Key "OFF", Engine "OFF".

2) Disconnect neutral gear switch connector.

3) IG Key "ON".

4) Check the voltage of neutral gear switch connector terminal 1.

Specification : 11.5V~13.0V

5) Is the measured voltage within the specification?

YES

▶ Go to "Ground Circuit Inspection".

NO

▶ Go to "2. Check open in neutral gear switch signal cicuit" as follows.

2. Check open in neutral gear switch signal cicuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect neutral gear switch connector and ECM connector.

3) Check the continuity between neutral gear switch connector terminal 1 and ECM connector(CUD-K) terminal 57.

Specification : Continuity (below 1.0Ω)

4) Is the measured resistance within the specifications ?

YES

▶ Repair short to ground in signal circuit and go to "Verification of Vehicle Repair".

NO

▶ Repair open in signal circuit and go to "Verification of Vehicle Repair".

GROUND CIRCUIT INSPECTION E49E33F2

1. IG Key "OFF", Engine "OFF".
2. Disconnect neutral gear switch connector and ECM connector.
3. IG Key "ON".
4. Measure the voltage of neutral gear switch connector terminal 1. [TEST "A"]
5. Measure the voltage between neutral gear switch connector terminal 1 and terminal 2. [TEST "B"]
   (Terminal 1 : Check + prove , terminal 2 : Check - prove)

Specification : [TEST "A"] Voltage - [TEST "B"] Voltage = below 200mV

6. Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

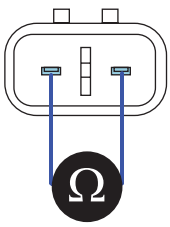
NO

▶ When "B" voltage is not detected : Repair open in ground circuit and go to "Verification of Vehicle Repair".
▶ When the voltage difference between "A" and "B" is above 200mV : Eliminate the causes of excessive resistance and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E5D16C6F

1. IG Key "OFF", Engine "OFF".
2. Disconnect neutral gear switch connector.
3. Check the contituity between neutral gear switch component terminal 1 and terminal 2 as shifting gear lever 2~3 times.

Specifications : The measured resistance varies from below 1.0Ω (Continuity) to infinite Ω (Discontinuity) in accordance with gear shifting.



SLDFL6428L

4. Is the measured resistance within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace neutral gear switch and go to Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E44E2AAD

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0830 CLUTCH PEDAL SWITCH "A" CIRCUIT

GENERAL DESCRIPTION EC8FFA8E

Clutch switch is connected to clutch pedal and transmits clutch operating state to ECM. When clutch pedal is depressed during driving, engine load changes from loaded to none loaded condition. However, ECM considers vehicle to be loaded becuase VSS signal is still inputted to it. therefore, ECM controls none loaded engine with the condition suitable for loaded engine. Accordingly, optimum fuel injection control is not performed then, RPM becomes unstable and smoke is produced. Clutch operation is detected through clutch switch signal. This signal enables ECM to cope with instant change of load condition. Besides, clutch switch signal is used to detect engaged gear with vehicle speed and engine speed.

DTC DESCRIPTION EA6B4480

P0830 is set when no clutch switch signal change is detected while gear shifts 4 times at above 1500rpm. This code is due to 1) clutch switch component failure or 2) open or short in circuit 3) improper height of clutch pedal.
※ ECM recognizes ingaged gear with rpm and vehicle speed sensor signal.

DTC DETECTING CONDITION EA8AD5AB

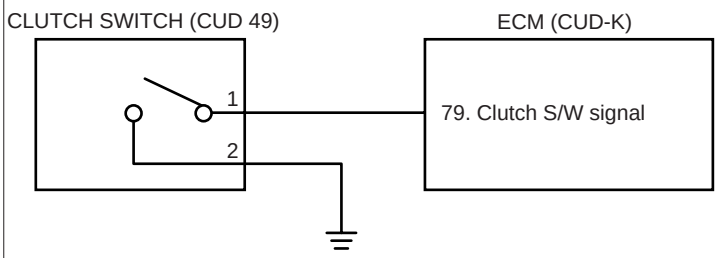
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Signal monitoring</td><td rowspan="5">• Clutch S/W circuit
• Clutch S/W component
• Clutch S/W pedal hight</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine speed is above 1500rpm.</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• Clutch switch signal change is not detected until gear shifts 4 times by Vehicle speed/engine speed</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• Immediately</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4"></td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SPECIFICATION E37D680B

Condition	Clutch Pedal Depressed	Clutch Pedal Released
Switch Operation	Switch ON	Switch OFF

SCHEMATIC DIAGRAM E17BC4E4

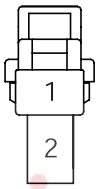
[CIRCUIT DIAGRAM]



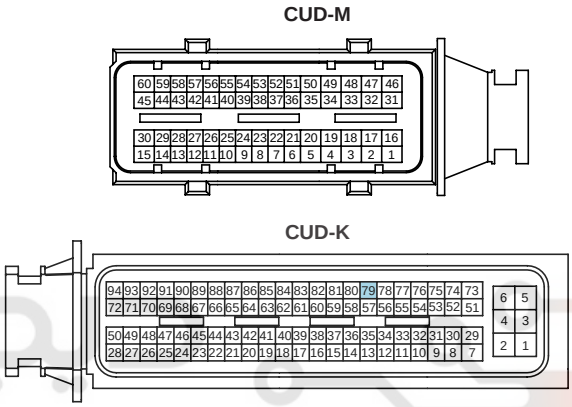
[CONNECTOR INFORMATION]

Terminal	Connected to	Function
1	CUD-K terminal 79	Clutch S/W signal
2	CUD 08 ground point	Chassis ground

[HARNESS CONNECTOR]



CUD 49
CLUTCH SWITCH



SLDF27693L

SIGNAL WAVEFORM AND DATA E407EE6F

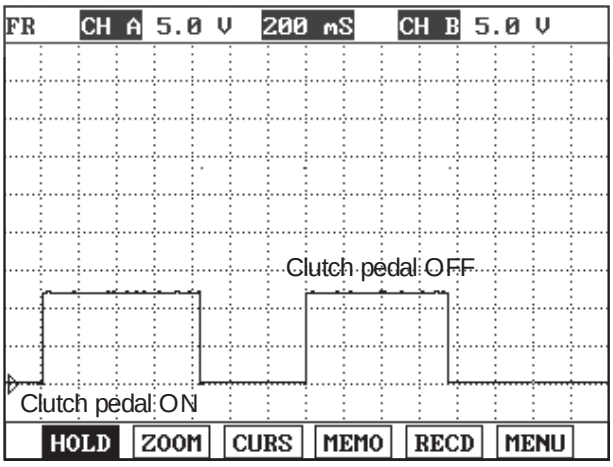


Fig.1

Fig.1) The waveform of clutch switch when clutch pedal is depressed. The output voltage of clutch pedal is 0V when clutch pedal is depressed and 12V when released.

SLDFL6431L

Even though clutch pedal is not depressed just after turning engine on, signal voltage is outputted as 0V. Therefore even ifclutch pedal is not depressed, engine can be turned on. However, if pedal is depressed once, clutch switch signal is no more 0V. In this case, turning engine on is possible only when clutch pedal is depressed.

MONITOR SCANTOOL DATA EDB6C345

1. Connect scantool to Data Link Cable. (DLC)
2. Warm engine up to normal operating temperature.
3. Turn "OFF" electrical devices and A/C.
4. Select "CLUTCH SWITCH" parameter on the Scantool.

Specification :
When clutch switch released : CLUTCH SWITCH : OFF
When clutch switch depressed : CLUTCH SWITCH : ON

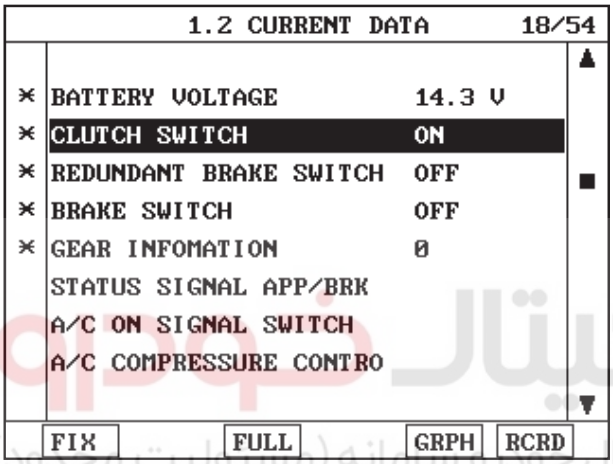


Fig.1

Fig. 1) Check if "CLUTCH SWITCH" parameter changes correctly from "ON" to "OFF" and vice versa as activating clutch pedal.

SLDFL6432L

TERMINAL AND CONNECTOR INSPECTION E5E6F413

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.
2. Perform checking procedure as follows.
   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.
   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

NOTE

Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector or checking connecting condition. (after checking, reconnect the pin at correct position.)

3. Is the problem found?

YES

▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

NO

▶ Go to "Signal Circuit Inspection".

SIGNAL CIRCUIT INSPECTION E8F53081

1. Check clutch switch pull-up voltage
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect clutch switch connector.
   3) IG Key "ON".
   4) Measure the voltage of clutch switch connector terminal 2.

Specification : 11.5V~13.0V

   5) Is the measured voltage within the specification?

YES

▶ Go to "Ground Circuit Inspection".

NO

▶ Go to "2.Check open in clutch switch signal circuit" as follows.

2. Check open in clutch switch signal circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect clutch switch connector and ECM connector.
   3) Check continuity between clutch switch connector terminal 2 and ECM connector(CUD-K) terminal 79.

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification?

YES

▶ Repair short to ground in signal circuit and go to "Verification of Vehicle Repair".

NO

▶ Repair open in signal circuit and go to "Verification of Vehicle Repair".

GROUND CIRCUIT INSPECTION ECD50588

1. IG Key "OFF", Engine "OFF".
2. Disconnect clutch switch connector.
3. IG Key "ON".
4. Measure the voltage of clutch switch connector terminal 2. [TEST "A"]
5. Measure the voltage between clutch switch connector terminal 2 and terminal 1. [TEST "B"]
   (Terminal 2 : Check + prove , terminal 1 : Check - prove)

Specification : [TEST "A"] Voltage - [TEST "B"] Voltage = below 200mV

6. Is the measured resistance within the specification?

YES

▶ Go to "Component Inspection".

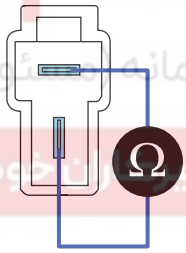
NO

▶ When "B" voltage is not detected : Repair open in ground circuit and go to "Verification of Vehicle Repair".
▶ When the voltage difference between "A" and "B" is above 200mV : Eliminate the causes of excessive resistance and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E5A08799

1. IG Key "OFF", Engine "OFF".
2. Disconnect clutch switch connector.
3. Check continuity between clutch switch component terminal 1 and terminal 2 as depressing clutch pedal.

Specification :
Clutch pedal depressed : Continuity (below 1.0Ω)
Clutch pedal released : Discontinuity (Infinite Ω)



SLDFL6436L

4. Is the measured resistance within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ After checking height of clutch pedal, if therer is no problem, replace clutch switch and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR EE567F8E

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.

5. Are any DTCs recorded ?

YES

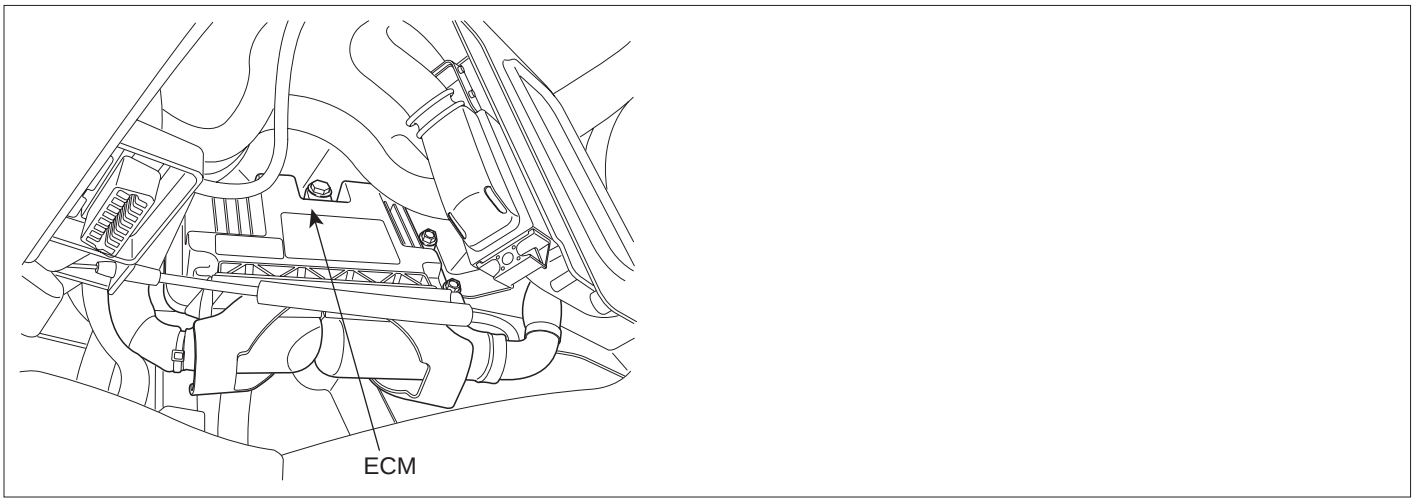
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P1145 OVERRUN MONITORING ERROR

COMPONENT LOCATION ECAFAF79



SLDFL6237L

GENERAL DESCRIPTION EC1E7A7C

ECM is activated by power supply. Signals from several sensors, such as CKPS and APS, is inputted to ECM. Comparing inputted siganals with control LOGIC saved at micro controller and EEPROM, ECM controlls engine as actuating injectors, solenoids and relays. To guarantee accurate control, ECM performs SELF TEST, DIAGNOSIS of several sensors and actuators. And if serious trouble which affects vehicle performance occurrs, ECM sets DTCs.At certain cases, ECM shuts down whole systems in order to prevent dangerous situation due to incorrect control.

DTC DESCRIPTION E424967C

P1145 will be set when Fuel Cut is not performed , that is ECM still controls fuel injection through the injector although accelerator pedal is off or actual Engine RPM is higher than 320RPM which is target RPM controlled by ECM for more than 0.8sec. In this case, Drive stage for injectors in ECM is failure to controlling the Power supply cut.

DTC DETECTING CONDITION E14CC3F9

Item	Detecting Condition			Possible Cause
DTC Strategy	• Software monitoring			• ECM internal error
Enable Conditions	• Vehicle driving			
ThresholdValue	• Overrun lasts for seconds. (Fuel injection performed regardless with driver's intension) • Actual Engine RPM is higher than 320 RPM which is target RPM controlled by ECM. - 0.8 sec			
DiagnosticTime	• Immediately			
Fail Safe	Fuel Cut	YES		
	EGR Off	NO		
	Fuel Limit	NO		
	MIL	OFF		

COMPONENT INSPECTION E6A68CD1

1. IG Key "OFF", Engine "OFF".
2. Disconnect ECM.
3. Replace ECM, check if abnormal operations disappear.
4. If problems are corrected, replace ECM.

NOTE

Input injector IQA data(7 letters) using scantool at replacing ECM. Enter the driving distance - how many km the CPF is used- into New ECM with scanner. For immobilizer applied vehicle, input pin code.

VERIFICATION OF VEHICLE REPAIR E87A02FE

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

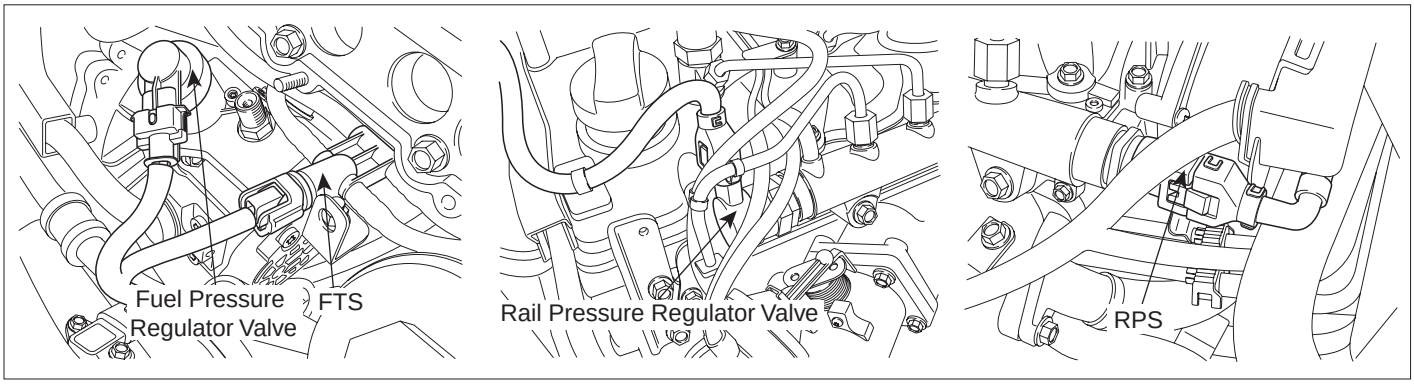
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P1185 FUEL PRESSURE MONITORING-MAXIMUM PRESSURE EXCEEDED

COMPONENT LOCATION E3E49EF7



SLDFL6437L

GENERAL DESCRIPTION ECFAA44F

As inputted rail pressure sensor signal, ECM of Commom rail diesel engine controls fuel metering unit(MPROP-intergrated with high press. pump) and rail pressure control valve(PCV-integrated with common rail) in order to maintain optimum rail pressure according to current engine rpm and load. However when the problem that leads rail pressure to out of target value intended by ECM occurs due to mechanical or electronical reason, ECM limits engine performance and sets DTC by limiting fuel (stops injector operation) in order to prevent engine from being controlled abnormally. "rail pressure monitoring error" is the DTC which diagnose 1).supplying state of low pressure fuel and 2).mechanical operating conditions of high pressure pump and 3). RPCV indirectly based on RPS output voltage and RPS duty. thus, repair relavant to this DTC requires mechanics the total understand of fuel system.

DTC DESCRIPTION EA2B0353

P1185 is set when 1)rail pressure is higher than target rail pressure by more than 350 ~ 200 bar in condition that rail pressure is controlled by fuel metering unit(MPROP) or 2)rail pressure exceeds maximum limiting value. This code is due to 1)more than intended fuel supply to common rail or 2)poor return of fuel supplied to common rail or 3)short to high voltage line in RPS.

DTC DETECTING CONDITION EED8EF4A

Item	Detecting Condition		Possible Cause
DTC Strategy	• Voltage monitoring		• Fuel metering unit (open stuck) • Rail pressure control valve (close stuck) • Rail pressure sensor (Output fixed at high voltage line)
Enable Conditions	• Engine running		
ThresholdValue	• Rail pressure is above target rail pressure by more than 350 ~ 200 bar at fuel pressure regulator valve(MPROP) operating condition.- 2 sec. • Injection pump Fuel amount is exceeded to limited minimum value. (-690 ㎣/s) - 2 sec. • Rail pressure is above maximum limiting value(1750bar) at fuel pressure regulator valve(MPROP) operating condition. - 0.24 sec.		
DiagnosticTime	• Refer to threshold Value		
Fail Safe	Fuel Cut	NO	
	EGR Off	NO	
	Fuel Limit	YES	
	MIL	ON	

MONITOR SCANTOOL DATA E631FC00

1. Monitoring rail pressure data

   1) Connect Scantool to Data Link Connector (DLC).

   2) Warm engine up to normal operating temperature.

   3) Turn "OFF" electrical devices and A/C.

   4) Monitor "FUEL PRESSURE MEASURED", "FUEL PRESSURE-TARGET", "RAIL PRESS. REGULATOR1", "INJ. PUMP REGULATOR" parameter on the Scantool.

Specification :
FUEL PRESSURE MEASURED : Similar to "FUEL PRESSURE-TARGET"
FUEL PRESSURE-TARGET : 28 ± 5 Mpa
RAIL PRESS. REGULATOR1 : 20 ± 5%
INJ. PUMP REGULATOR : 40 ± 5%

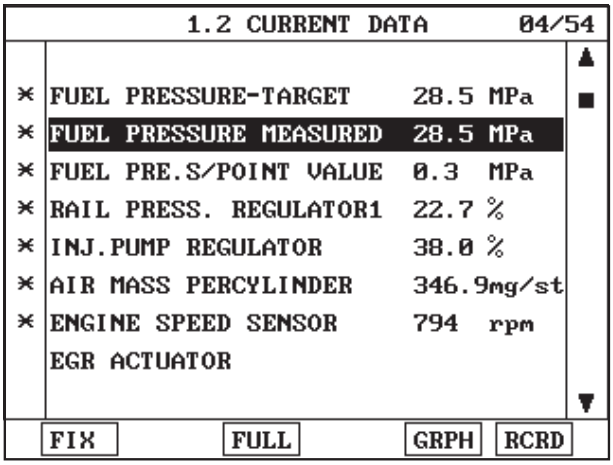


Fig.1

Fig.1) Monitor "FUEL PRESSURE MEASURED" at idle after warming engine up.

SLDFL6438L

Check if "FUEL PRESSURE MEASURED"data is similar to "FUEL PRESSURE-TARGET". Not only former two data but also "RAIL PRESS. REGULATOR1" and "INJ. PUMP REGULATOR"should be monitored carefully. Although "FUEL PRESSURE MEASURED" is similar to "FUEL PRESSURE-TARGET", if "RAIL PRESS. REGULATOR1" and "INJ. PUMP REGULATOR" is out of specification, it means wear, leakage, stuck of fuel system.

2. Monitoring rail pressure data at acceleration(loading condition).

   1) Connect Scantool to Data Link Connector (DLC).

   2) Warm engine up to normal operating temperature.

   3) Turn "OFF" electrical devices and A/C.

   4) Monitor "FUEL PRESSURE MEASURED", "RAIL PRESS. REGULATOR1", "INJ. PUMP REGULATOR" parameter on the Scantool.

SPECIFICATION :

	Idle(without load)	Accelerating(stall test)	Diagnosis
INJ. PUMP REGULATOR	38 ± 5%	32 ± 5%	duty decreases
FUEL PRESSURE MEASURED	28.5 ± 5 Mpa	145 ± 10 Mpa	press. increases
RAIL PRESS. REGULATOR1	19 ± 5%	48 ± 5%	duty increases

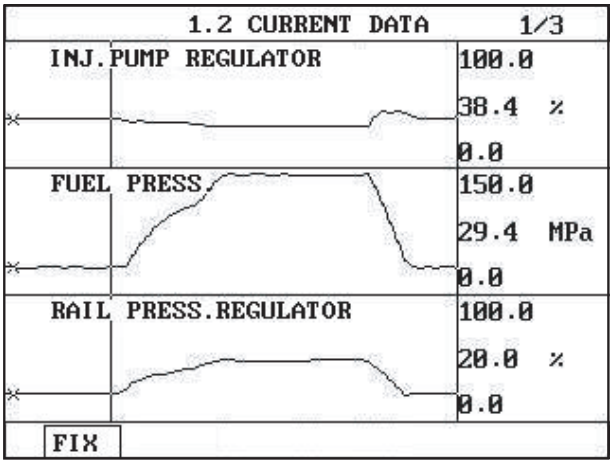


Fig.1

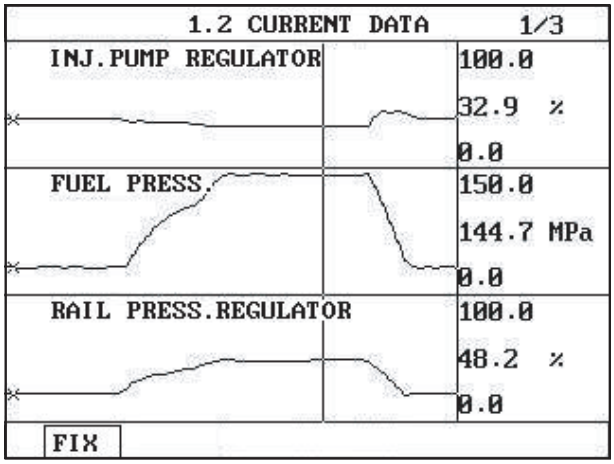


Fig.2

Fig.1) The position of curser on the graph represents idle data.
Fig.2) Data during acceleration(stall test).

SLDFL6439L

NOTE

The waveform of fuel metering unit installed at high pressure pump(fuel detecting MPROP) shows 38% duty at idle, duty drops to approx. 32% at acceleration to raise rail pressure. Duty drop means the decrease of current.
→ Fuel delivered to common rail increases as current drops.

The waveform of rail pressure control valve installed at common rail shows 19% duty at idle, duty rises to approx. 48% at acceleration to raise rail pressure. Duty rise means the increase of current.
→ If current rises, the returning quantity of fuel deliverd to common rail decreases and common rail pressure rises.

VERIFICATION OF VEHICLE REPAIR EDD835A6

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P1186 FUEL PRESSURE MONITORING-MINIMUM PRESSURE AT ENGINE SPEED TOO LOW

COMPONENT LOCATION E117BA53

Refer to DTC P1185.

GENERAL DESCRIPTION EBA9BB7B

Refer to DTC P1185.

DTC DESCRIPTION EBA14B8C

P1186 is set when measured rail pressure, within the range where rail pressure is controlled by MPROP, is lower than 500 ~ 150 bar controlled as target rail pressure or when high pump amount is lowered than limited minimum value for lasting 2.0sec. Check whether less amount of fuel is delivered than target amount of fuel controlled by ECM, too much return amount delivered to common rail or stuck resulting from low voltage of RPS.

DTC DETECTING CONDITION E5B1BCE3

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Fuel press. regulator valve(close stuck) • Rail pressure control valve(open stuck) • Rail pressure sensor(Output fixed at low voltage line)
Enable Conditions	• Engine running			
ThresholdValue	• Rail pressure is below target rail pressure by more than 500 ~ 150 bar at fuel pressure regulator(MPROP) operating condition. - 0.8 sec. • Injection pump Fuel amount is exceeded to limited minimum value. (11000 ~ 35000 ㎣/s) - 0.8 sec. • Rail pressure is above minimum limiting value(50 ~ 280 bar) at fuel pressure regulator valve(MPROP) operating condition. - 0.3 sec.			
DiagnosticTime	• Refer to threshold Value			
Fail Safe	Fuel Cut	NO		
	EGR Off	NO		
	Fuel Limit	YES		
	MIL	ON		

MONITOR SCANTOOL DATA EC698423

1. Monitoring rail pressure data

   1) Connect Scantool to Data Link Connector (DLC).

   2) Warm engine up to normal operating temperature.

   3) Turn "OFF" electrical devices and A/C.

   4) Monitor "FUEL PRESSURE MEASURED", "FUEL PRESSURE-TARGET", "RAIL PRESS. REGULATOR1", "INJ. PUMP REGULATOR" parameter on the Scantool.

Specification :
FUEL PRESSURE MEASURED : Similar to "FUEL PRESSURE-TARGET"
FUEL PRESSURE-TARGET : 28 ± 5 Mpa
RAIL PRESS. REGULATOR1 : 20 ± 5%
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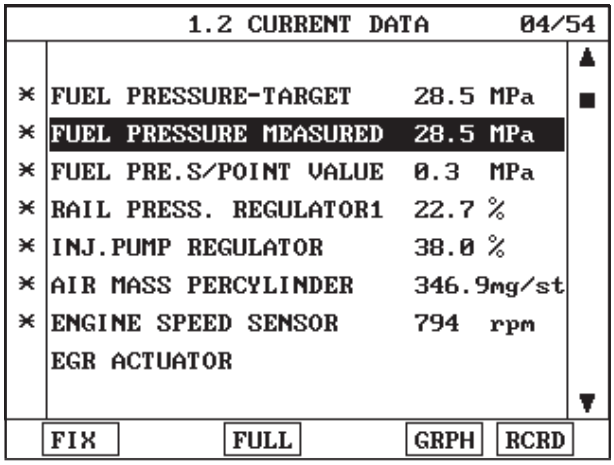


Fig.1

Fig.1) Monitor "FUEL PRESSURE MEASURED" at idle after warming engine up.

SLDFL6438L

Check if "FUEL PRESSURE MEASURED"data is similar to "FUEL PRESSURE-TARGET". Not only former two data but also "RAIL PRESS. REGULATOR1" and "INJ. PUMP REGULATOR"should be monitored carefully. Although "FUEL PRESSURE MEASURED" is similar to "FUEL PRESSURE-TARGET", if "RAIL PRESS. REGULATOR1" and "INJ. PUMP REGULATOR" is out of specification, it means wear, leakage, stuck of fuel system.

2. Monitoring rail pressure data at acceleration(loading condition).
   1) Connect Scantool to Data Link Connector (DLC).
   2) Warm engine up to normal operating temperature.
   3) Turn "OFF" electrical devices and A/C.
   4) Monitor "FUEL PRESSURE MEASURED", "RAIL PRESS. REGULATOR1", "INJ. PUMP REGULATOR" parameter on the Scantool.

SPECIFICATION :

	Idle(without load)	Accelerating(stall test)	Diagnosis
INJ. PUMP REGULATOR	38 ± 5%	32 ± 5%	duty decreases
FUEL PRESSURE MEASURED	28.5 ± 5 Mpa	145 ± 10 Mpa	press. increases
RAIL PRESS. REGULATOR1	19 ± 5%	48 ± 5%	duty increases

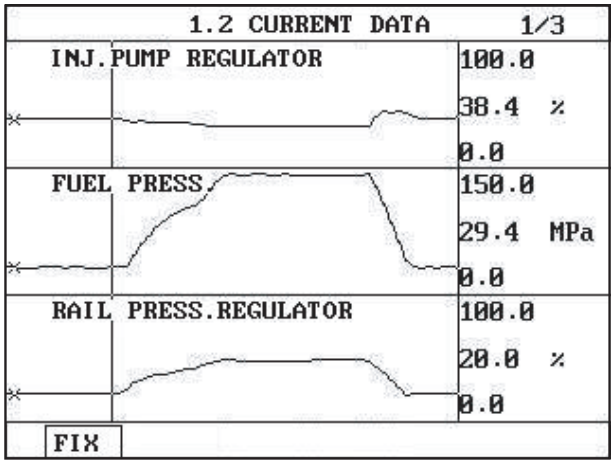


Fig.1

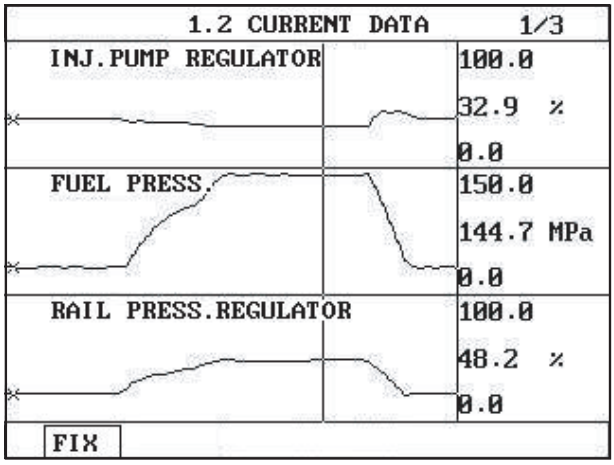


Fig.2

Fig.1) The position of curser on the graph represents idle data.
Fig.2) Data during acceleration(stall test).

SLDFL6439L

NOTE

The waveform of fuel metering unit installed at high pressure pump(fuel detecting MPROP) shows 38% duty at idle, duty drops to approx. 32% at acceleration to raise rail pressure. Duty drop means the decrease of current.
→ Fuel delivered to common rail increases as current drops.

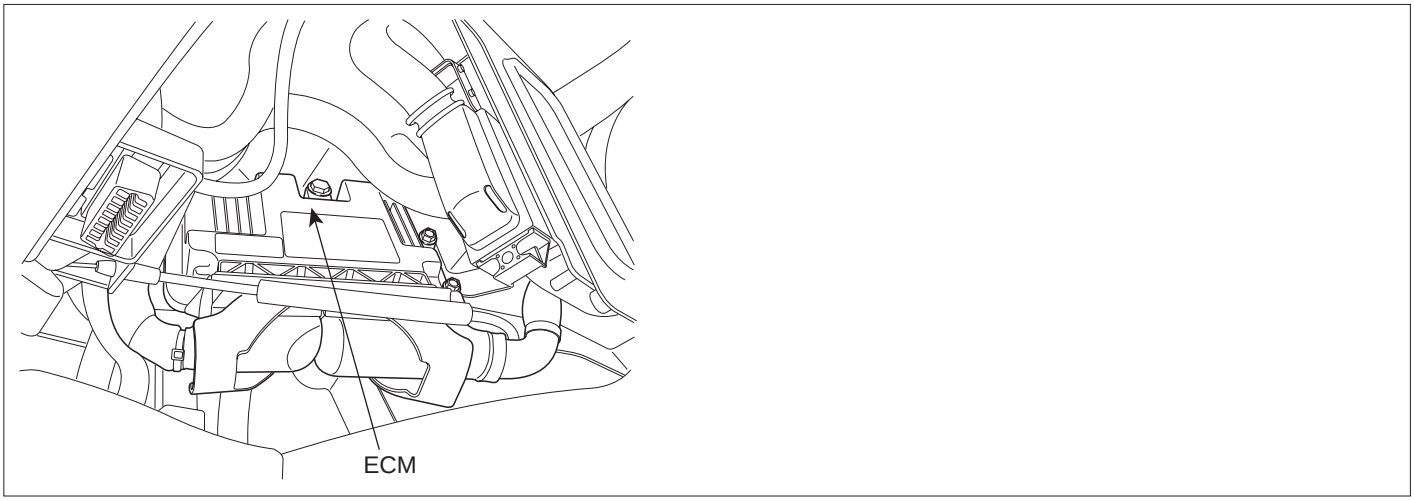
The waveform of rail pressure control valve installed at common rail shows 19% duty at idle, duty rises to approx. 48% at acceleration to raise rail pressure. Duty rise means the increase of current.
→ If current rises, the returning quantity of fuel deliverd to common rail decreases and common rail pressure rises.

VERIFICATION OF VEHICLE REPAIR E0BECFA2

Refer to DTC P1185.

DTC P1586 MT/AT ENCODING

COMPONENT LOCATION EA1B86B2



SLDFL6237L

GENERAL DESCRIPTION EA6CEA63

Because both A/T and M/T fuel control map is inputted in one type of ECM and selecting option is possible, one type is applied to both A/T and M/T option.When ECM is installed to vehicle, A/T and M/T recognition is performed by ECM automatically as checking whether ground line(ECM connector CUD-K terminal 81) is grounded or opened.(A/T and M/T recognition is performed every IG Key ON process.) If A/T, M/T recognition is not fulfilled well or any error occurs during the process, engine power generation is not sufficient and glow lamp on cluster blinks.

A/T : ECM connector CUD-K terminal 81 is grounded.
M/T : ECM connector CUD-K terminal 81 is opened.(no wiring exists)

DTC DESCRIPTION EC8FB4BD

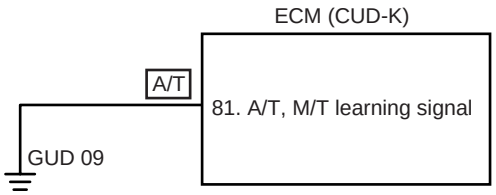
P1586 is set when recognized A/T, M/T data based on ECM connector CUD-K terminal 81 state(grounded or opened) is not readable or writable at EEP ROM. This code is due to ECM failur

DTC DETECTING CONDITION EC036C4E

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Software monitoring</td><td rowspan="6">• ECM component failure</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• A/T, M/T learning error
(When data writing on EEPROM inside of ECM is impossible)</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 4 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• Glow Lamp blinks.</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SCHEMATIC DIAGRAM E08A8707

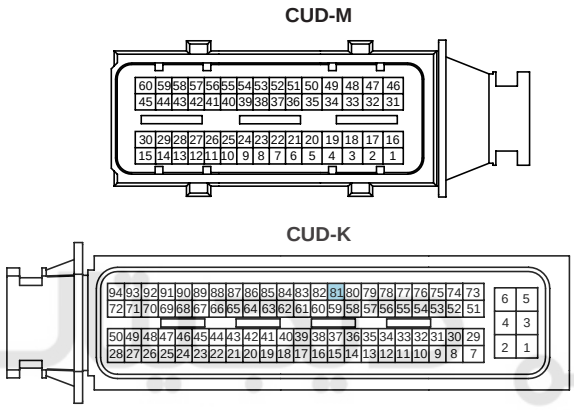
[CIRCUIT DIAGRAM]



[CONNECTOR INFORMATION]

Terminal	Connected to	Function
81	GUD 09 ground point	A/T, M/T learning

[HARNESS CONNECTOR]



SLDF27694L

COMPONENT INSPECTION E7E55168

1. IG Key "OFF", Engine "OFF".
2. Disconnect ECM.
3. Replace ECM, check if abnormal operations disappear.
4. If problems are corrected, replace ECM.

NOTE

Input injector IQA data(7 letters) using scantool at replacing ECM. Enter the driving distance - how many km the CPF is used- into New ECM with scanner. For immobilizer applied vehicle, input pin code.

VERIFICATION OF VEHICLE REPAIR E32CC5EE

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

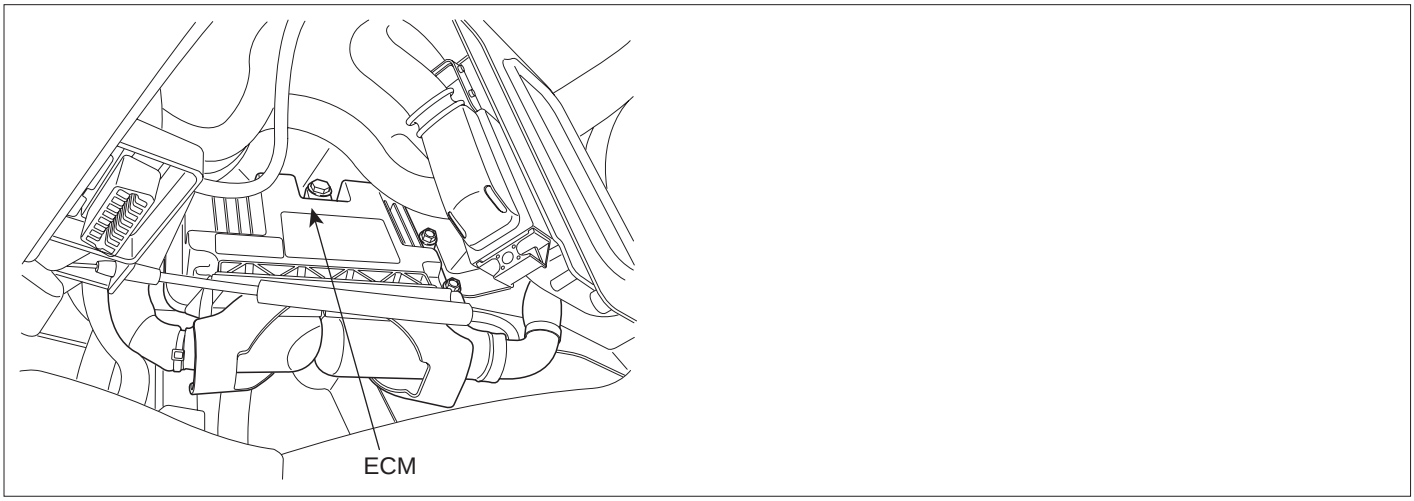
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P1587 CAN COMMUNICATION ERROR (MT/AT RECOGNITION ERROR)

COMPONENT LOCATION E528D4B9



SLDFL6237L

GENERAL DESCRIPTION EE549445

Because both A/T and M/T fuel control map is inputted in one type of ECM and selecting option is possible, one type is applied to both A/T and M/T option.When ECM is installed to vehicle, A/T and M/T recognition is performed by ECM automatically as checking whether ground line(ECM connector CUD-K terminal 81) is grounded or opened.(A/T and M/T recognition is performed every IG Key ON process.) If A/T, M/T recognition is not fulfilled well or any error occurs during the process, engine power generation is not sufficient and glow lamp on cluster blinks.

A/T : ECM connector CUD-K terminal 81 is grounded.
M/T : ECM connector CUD-K terminal 81 is opened.(no wiring exists)

DTC DESCRIPTION EBB2F872

P1587 is set when ECM is recognized as 1)A/T but CAN communication signal is not transmitted from TCM 2)M/T but CAN communication signal is transmitted from TCM. After checking if A/T, M/T auto recognition terminal is correct for each vehicle option, if no problem is detected, check poor connection in CAN communication circuit or CAN communication problem of TCM.

DTC DETECTING CONDITION E822ABDD

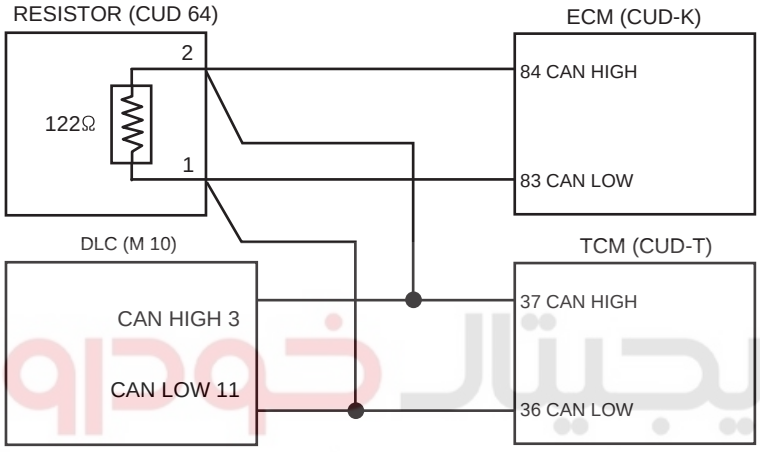
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="7">• A/T, M/T recognition terminal circuit
• CAN communication linecircuit
• TCM component failure
• ECM component failure</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine run</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• TCM signal is not detected at A/T vehicle
• TCM signal is detected at M/T vehicle</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 1.0 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• Glow Lamp blinks.</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SPECIFICATION E48AB5FA

Communication Format	DIGITAL "0"		DIGITAL "1"(BUS IDLE)		CAN Communication Line Resistance	
	HIGH	LOW	HIGH	LOW	Inside of ECM	Inside of I/P junction box
CAN 2.0B	3.5V	1.5V	2.5V	2.5V	120Ω (20°C)	120Ω (20°C)

SCHEMATIC DIAGRAM E8381AAC

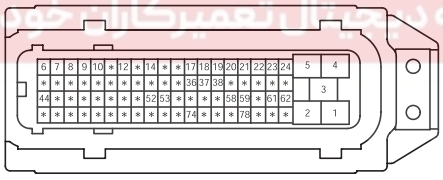
[CIRCUIT DIAGRAM]



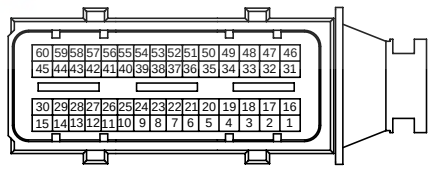
[CONNECTOR INFORMATION]

Terminal	Connected to	Function
84	CUD 64 terminal 2 CUD-T TCM terminal 37 M 10 terminal 3	CAN HIGH
83	CUD 64 terminal 1 CUD-T TCM terminal 36 M 10 terminal 11	CAN LOW

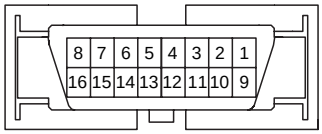
[HARNESS CONNECTOR]



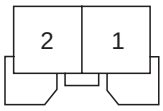
CUD-T
TCM



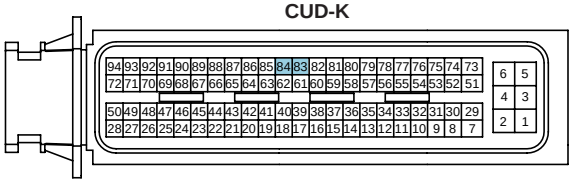
CUD-M



M 10
DATA LINK CONNECTOR



CUD 64 Resistor
RESISTOR



CUD-K
ECM

SLDF27695L

SIGNAL WAVEFORM AND DATA EDE43B84

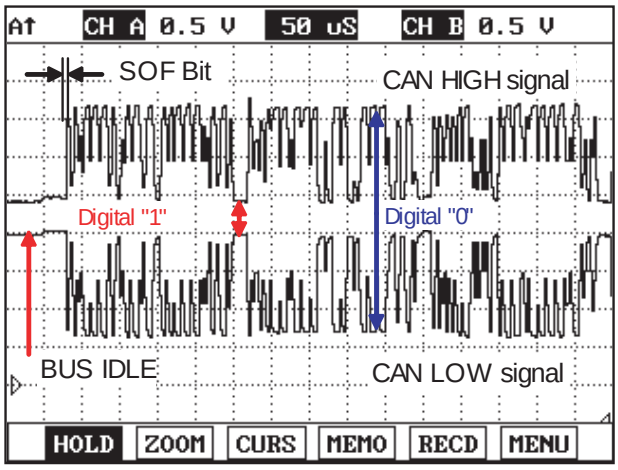


Fig.1 CAN communication waveform

Monitoring CAN HIGH and LOW simultaneously is important in monitoring CAN communication waveform. When CAN HIGH signal rise to 3.5V and LOW signal drops to 1.5V - voltage difference between HIGH and LOW signal is 2V - at BUS IDLE state(DIGITAL "1") whose reference voltage is 2.5V, "0" is recognized. Besides, comparing HIGH and LOW signal if opposite waveform is detected with the reference voltage of 2.5V, Check if current cam signal transfers correctly. Continuous "0"signal above 6BIT means the occurence of error in CAN communication. 1BIT is easily distinguished as calculating the time when "SOF"(START OF FRAME) which notifies the start of frame occurs. Check if "0"signal above 6BIT is detected continuously when monitoring CAN communication waveform.

SUNFL7718L

TERMINAL AND CONNECTOR INSPECTION ED816A69

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.
2. Perform checking procedure as follows.
   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.
   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

   NOTE

   Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position.)
3. Is the problem found?

   YES

   ▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

   NO

   ▶ Go to "Signal Circuit Inspection".

SIGNAL CIRCUIT INSPECTION EC73D179

1. Check CAN BUS resistance
   1) IG Key "OFF", Engine "OFF".
   2) Measure the resistance between DLC terminal 3 and terminal 11. (TEST 1)
   3) Disconnect ECM connector and TCM connector.
   4) Measure the resistance between DLC terminal 3 and terminal 11. (TEST 2)

Specification :
Both ECM and TCM connected : 60 ± 3Ω (Test 1)
Both ECM and TCM disconnected : 120 ± 3Ω (Test 2)

5) Is CAN BUS resistance within the specification?

YES

▶ Go to "2.Check short to ground in CAN BUS" as follows.

NO

▶ Below 10Ω for both conditions(disconnected, connected) : Repair short between CAN BUS and go to "Verification of Vehicle Repair".
▶ 120Ω for both conditions(disconnected, connected) : Go to "4. Check CAN BUS continuity" as follows.
▶ Infinite Ω for both conditions(disconnected, connected) :Repair open in CAN communication circuit between DLC terminal and joint connector.

2. Check short to ground in CAN BUS

1) IG Key "OFF", Engine "OFF".

2) Disconnect ECM connector and TCM connector.

3) Check continuity between DLC terminal 3 and chassis ground. (CAN High)

4) Check continuity between DLC terminal 11 and chassis ground. (CAN Low)

Specification : Discontinuity (Infinite Ω)

5) Is measured resistance within the specification?

YES

▶ Go to "3. Check short to battery in CAN BUS" as follows.

NO

▶ Repair short to ground in circuit and go to "Verification of Vehicle Repair".

3. Check short to battery in CAN BUS

1) IG Key "OFF", Engine "OFF".

2) Disconnect ECM connector and TCM connector.

3) IG Key "ON".

4) Measure the voltage of DLC terminal 3. (CAN High)

5) Measure the voltage of DLC terminal 11. (CAN Low)

Specification : 0.0V~0.1V

6) Is measured resistance within the specification with both connector disconnected?

YES

▶ Go to"4. Check CAN BUS continuity" as follows.

NO

▶ Repair short to battery and go to "Verification of Vehicle Repair".

4. Check CAN BUS continuity

1) IG Key "OFF", Engine "OFF".

2) Disconnect ECM connector and TCM connector.

3) Check continuity between DLC terminal 3 and CAN High terminal of each module.
(CAN High terminal : ECM connector terminal 84, TCM connector terminal 3.)

4) Check continuity between DLC terminal 11 and CAN Low terminal of each module.
(CAN Low terminal : ECM connector terminal 83, TCM connector terminal 36.)

Specification : Continuity(below 1.0Ω)

5) Is the measured resistance within the specification?

YES

▶ Go to "Component Inspection".

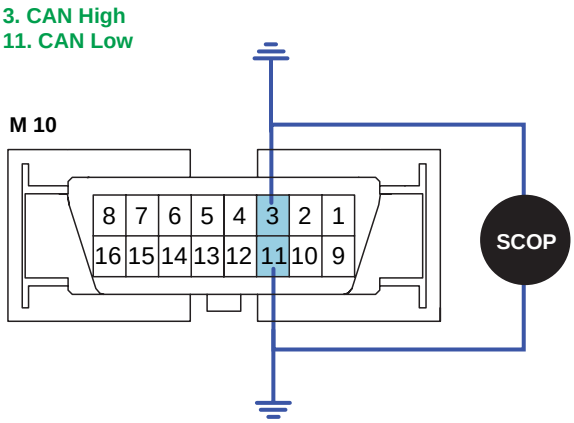
NO

▶ Repair open in CAN BUS and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION ED5F9067

1. IG Key "OFF", Engine "OFF".
2. Connect 2 channel scope to DLC terminal 3(CAN High) and terminal 11.(CAN Low)
3. IG Key "ON" after connecting only ECM to CAN BUS.
4. IG Key "ON" after connecting only TCM to CAN BUS.

Specification : At IG Key "ON".
※ Different from "Signal Waveform & Data", if 1) both CAN High and LOW signal are fixed at 2.5 V or 2) HIGH and LOW signal are fixed at 3.5 V and 1.5 V, respectively, it is due to communication error between modules.



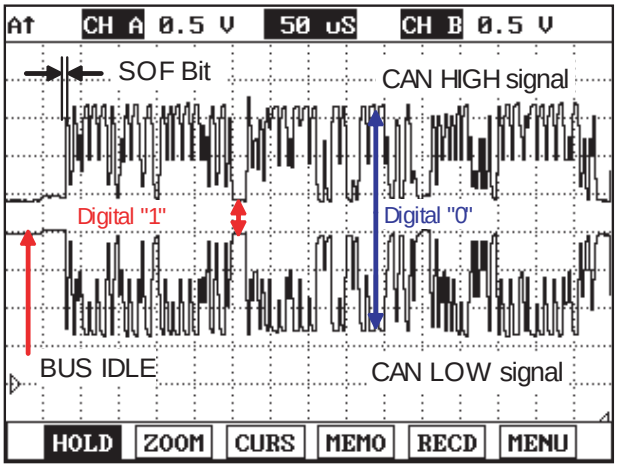


Fig.1 CAN communication waveform

SLDF27634L

5. Does correct waveform generate from each module?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace the module which generates poor communication waveform, and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E160D738

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P1588 SIGNAL CHANGE THROUGH MT/AT LINE (DURING ENGINE RUNNING)

COMPONENT LOCATION EB6E5257

Refer to DTC P1587.

GENERAL DESCRIPTION ED4E7201

Refer to DTC P1587.

DTC DESCRIPTION E4876121

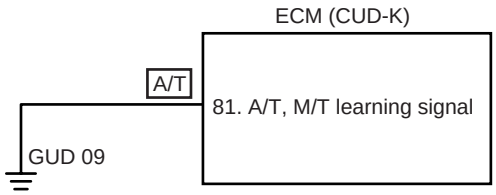
P1588 is set when the signal from A/T, M/T auto recognition terminal(ECM CUD-K terminal 81) changes during engine running. This code is due to open in terminal for A/T option, grounded condition for M/T option. This code is normally arises from A/T option vehicle. Check the grounding condition of A/T, M/T auto recognition terminal.

DTC DETECTING CONDITION E3F74109

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="5">• A/T, M/T recognition terminal circuit
• ECM component failure</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• A/T, M/T auto recognition signal changes at engine ON.</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 1.0 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• Glow Lamp blinks.</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SCHEMATIC DIAGRAM EFBEF215

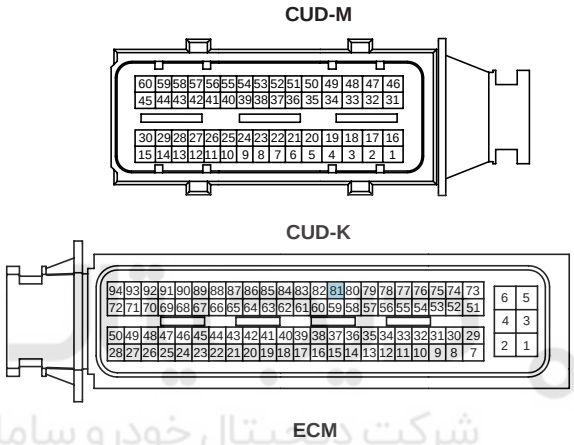
[CIRCUIT DIAGRAM]



[CONNECTOR INFORMATION]

Terminal	Connected to	Function
81	GUD 09 ground point	A/T, M/T learning

[HARNESS CONNECTOR]



SLDF27694L

TERMINAL AND CONNECTOR INSPECTION EB091E4E

Refer to DTC P1587.

GROUND CIRCUIT INSPECTION E4794D13

1. IG Key "OFF", Engine "OFF".
2. Disconnect ECM connector.
3. Check continuity between ECM connector(CUD-K) terminal 81 and chassis ground.

Specification : Continuity (below 1.0 Ω)

4. Is A/T, M/T auto recognition terminal grounded well?

YES

▶ Go to "Component Inspection".

NO

▶ Repair poor connection or open between ECM connector(CUD-K) terminal 81 and ground point GUD 09 and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E17E3D60

1. IG Key "OFF", Engine "OFF".
2. Disconnect ECM.
3. Replace ECM, check if abnormal operations disappear.
4. If problems are corrected, replace ECM.

NOTE

Input injector IQA data(7 letters) using scantool at replacing ECM. Enter the driving distance - how many km the CPF is used- into New ECM with scanner. For immobilizer applied vehicle, input pin code.

VERIFICATION OF VEHICLE REPAIR EA5683FC

Refer to DTC P1587.

DTC P1634 AUX. HEATER MALFUNCTION

GENERAL DESCRIPTION E45AEB84

Because thermal efficiency of electronically controlled diesel engine is higher than that of gasoline engine, heat loss to cylinder wall is lower. This enables electronically controlled diesel engine to generate high power and have high fuel efficiency. However in other point of view, due to low engine coolant temperature, heating efficiency lowered then, driver is unsatisfied with the heating. To cope with this situation, PTC heater is installed in coolant line and it raises heating efficiency and raise coolant temperature.

[Heater relay operating condition] When all the following condition are met.Blower ON, Engine speed below 700RPM, Battery voltage above 12.5V, Aircon OFF, Air temperature below 5℃, engine coolant temperature below 70℃ - Maximum operating duration is limited to 40 min.

DTC DESCRIPTION E33597DA

P1634 is set when excessive current or "0"A is detected in heater relay control circuit for more than 1.0 sec. at heater relay operating condition. This code is due to 1)open or 2)short to battery or ground in heater relay control circuit or 3)component problem.

DTC DETECTING CONDITION E0F2ABE7

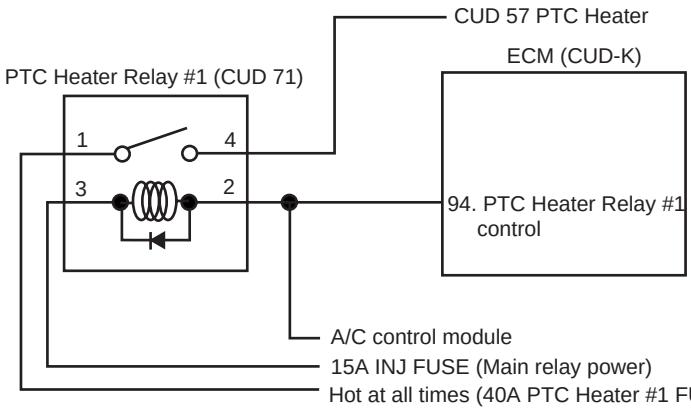
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• PTC heater relay #1control circuit
• Heater relay component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON" (monitoring only performed at relay operating condition)</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• Short to Battery
• Short to GND
• Wiring open</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 1.0 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4"></td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SPECIFICATION ED21D3CE

Heater relay coil resistance	52±5Ω (20℃)

SCHEMATIC DIAGRAM E51F3421

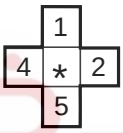
[CIRCUIT DIAGRAM]



[CONNECTOR INFORMATION]

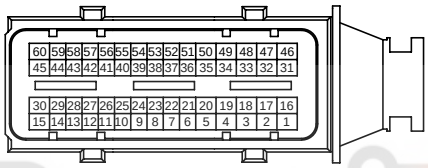
Terminal	Connected to	Function
1	40A PTC Heater #1 Fusible Link	PTC Heater Relay power(INPUT)
2	CUD-K M06-2 Terminal 8 M05-1 Terminal 23	PTC Heater control (ECM) PTC Heater Relay "ON" signal (A/C module)
3	-	-
4	Main relay power	PTC Heater Relay coil power
5	CUD 57 Terminal 3	PTC Heater Relay power(OUTPUT)

[HARNESS CONNECTOR]

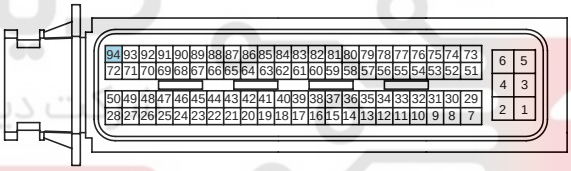


CUD 71
PTC Heater Relay #1

CUD-M



CUD-K



ECM

SLDF27696L

MONITOR SCANTOOL DATA E03FB618

1. Connect Scantool to Data Link Connector (DLC).
2. ENGINE "ON".(Engine coolant temp. below 70℃,Intake air temp. below 5℃)
3. Blower switch "ON".
4. Monitor "Auxiliary Heater(PTC)" parameter on the Scantool.
   (As soon as turning engine ON "Auxiliary Heater(PTC)" parameter turns "ON". Check if the parameter turns "OFF" after engine is warmed up.)

Specification :
Engine coolant temp. below 70℃(Intake air temp. below 5℃) : "Auxiliary Heater(PTC)" "ON"
Engine coolant temp. above 70℃ : "Auxiliary Heater(PTC)" "OFF"

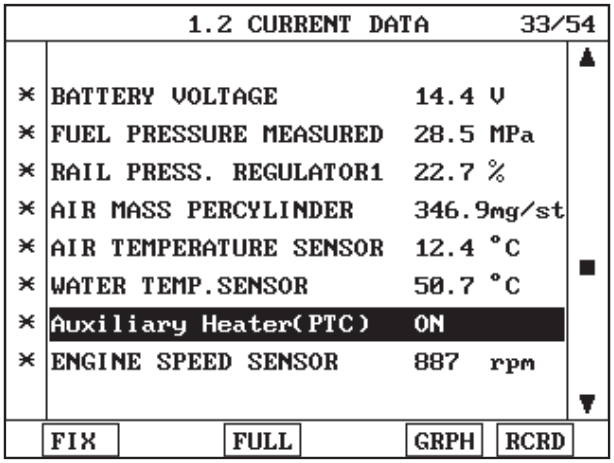


Fig.1

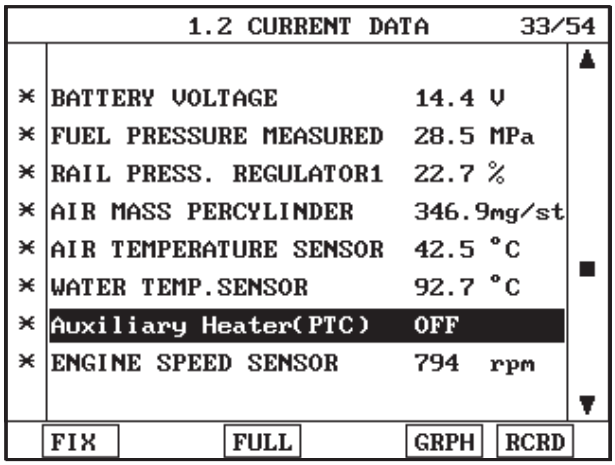


Fig.2

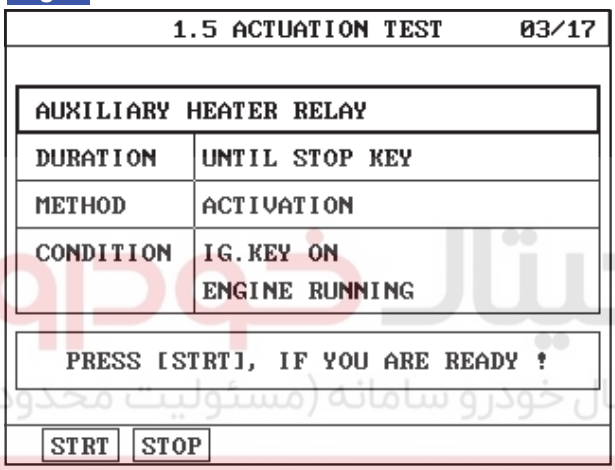


Fig.3

Fig.1) "Auxiliary Heater(PTC)" operates only when Intake air temp. is below 5℃ and Engine coolant temp. is below 70℃. "ON" state of "Auxiliary Heater(PTC)" lasts till Engine coolant temp. reaches 70℃.
Fig.2) "Auxiliary Heater(PTC)" turns "OFF" as soon as engine coolant temp. reaches 70℃.
Fig.3) If it is difficult to cool engine when current condition does not meat "Auxiliary Heater(PTC)" operating condition, check relay operation using "Auxiliary Heater(PTC)" on the Scantool.

SLDFL6443L

TERMINAL AND CONNECTOR INSPECTION E70732CD

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.

2. Perform checking procedure as follows.

   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.

   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

   NOTE

   Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position.)

3. Is the problem found?

YES

▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

NO

▶ Go to "Power Circuit Inspection".

POWER CIRCUIT INSPECTION E6B2E9D6

1. Check HOT AT ALL TIMES power circuit voltage

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect PTC heater relay #1.

   3) Measure the voltage of PTC heater relay #1 connector terminal 1.

Specification : 11.5V~13.0V

   4) Is the measured voltage within the specification?

YES

▶ Go to "2. Check IG KEY "ON" power circuit voltage" as follows.

NO

▶ Repair Fusible link box 40A PTC heater#1 fusible link and related circuit and go to "Verification of Vehicle Repair".

2. Check IG KEY "ON" power circuit voltage

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect PTC heater relay #1.

   3) IG Key "ON".

   4) Measure the voltage of PTC heater relay #1 connector terminal 4.

Specification : 11.5V~13.0V

   5) Is the measured voltage within the specification?

YES

▶ Go to "Control Circuit Inspection".

NO

▶ Repair E/R JUNCTION BOX 15A SNSR2 FUSE and related circuit and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION EC5ECDD9

1. Check control circuit monitoring voltage

1) IG Key "ON", Engine "OFF".

2) Disconnect PTC heater relay #1.

3) IG Key "ON".

4) Measure the voltage of PTC heater relay #1connector terminal 2.

Specification : 8.0V~10.0V

5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ When voltage is not detected : Go to "2. Check open in control circuit" as follows.
▶ When high voltage is detected : Repair short to battery and go to "Verification of Vehicle Repair".

2. Check open in control circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect PTC heater relay #1 and ECM connector.

3) Check continuity between PTC heater relay #1 connector terminal 2 and ECM connector (CUD-K) terminal 94.

Specification : Continuity (below 1.0Ω)

4) Is the measured resistance within the specification?

YES

▶ Repair short to ground in controll circuit and go to "Verification of Vehicle Repair".

NO

▶ Repair open in controll circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION EB98D0F3

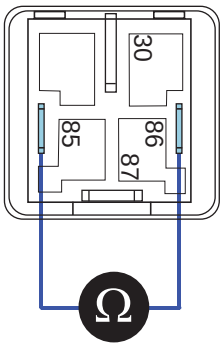
1. Check PTC heater relay #1 component coil resistance

1) IG Key "OFF", Engine "OFF".

2) Disconnect PTC heater relay #1.

3) Measure the resistance between PTC heater relay #1 component terminal 85 and terminal 86.

Specification : 52±5 Ω (20℃)



SLDFL6448L

4) Is the measured resistance within the specification?

YES

▶ Go to "2. Check PTC heater relay #1 component operation" as follows.

NO

▶ Replace PTC heater relay #1 and go to "Verification of Vehicle Repair".

2. Check PTC heater relay #1 component operation

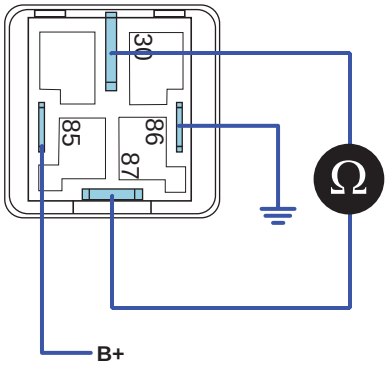
1) IG Key "OFF", Engine "OFF".

2) Disconnect PTC heater relay #1.

3) Supplies random B+ and ground to coil sides of PTC heater relay #1. (terminal 85, terminal 86)

4) Check continuity between PTC heater relay #1 component terminal 30 and terminal 87.

Specification :
When power is supplied : Continuity (below 1.0Ω)
When power is not supplied : Discontinuity (Infinite Ω)



SLDFL6449L

5) Is the continuity test within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace PTC heater relay #1 and go to "Verification of Vehicle Repair".

※ Repeat this process 2~3 times.

VERIFICATION OF VEHICLE REPAIR EB735575

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P1652 IGNITION SWITCH CIRCUIT MALFUNCTION

GENERAL DESCRIPTION EBC0F8B3

When a driver turns on IG Key, IG Key ON signal is inputted to ECM connector(CUD-K) terminal 28 through IG Key switch. This signal initializes(boots) ECM accordingly, main relay operates. Main relay supplies powers for ECM, sensors and actuators in order to enable engine to start. When IG Key ON signal is shut off during turning engine OFF, ECM stops injector operation then engine turns OFF. Approx. after 16 sec., ECM shuts OFF main relay and system turns OFF.

DTC DESCRIPTION EBCDF272

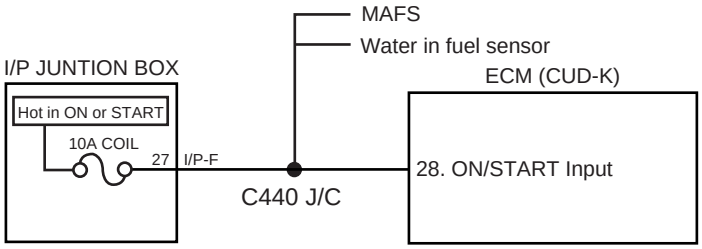
When the condition that IG Key ON signal turns OFF while ECM, to which IG signal inputted, is initialized (booting, Approx. 25ms is required), IG Key switch error is recognized and P1652 is set (monitored only once every IG Key ON initialization process). This code is due to poor connection in IG Key ON signal circuit.

DTC DETECTING CONDITION EC29ACBC

Item	Detecting Condition		Possible Cause
DTC Strategy	• Voltage monitoring		• IG Key "ON" signal circuit • IG Key switch
Enable Conditions	• IG KEY "ON"		
ThresholdValue	• No signal through IG line after IG Key "ON"		
DiagnosticTime	• Immediately		
Fail Safe	Fuel Cut	NO	
	EGR Off	NO	
	Fuel Limit	NO	
	MIL	OFF	

SCHEMATIC DIAGRAM EBDA2A37

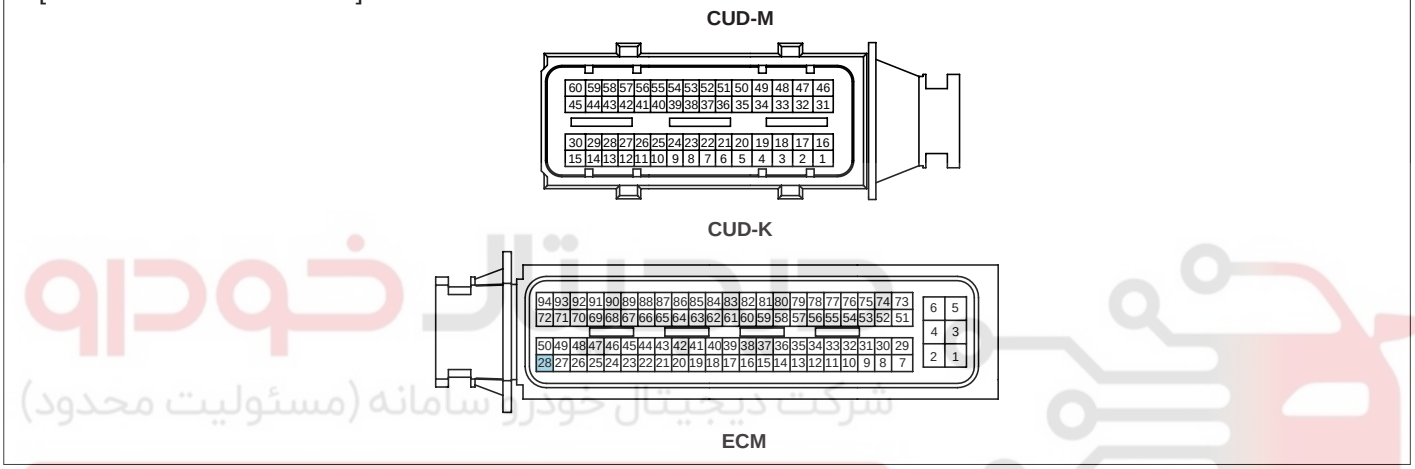
[CIRCUIT DIAGRAM]



[CONNECTOR INFORMATION]

Terminal	Connected to	Function
28	I/P-F terminal 27	ON/START Input

[HARNESS CONNECTOR]



SLDF27697L

SIGNAL WAVEFORM AND DATA EB39E874

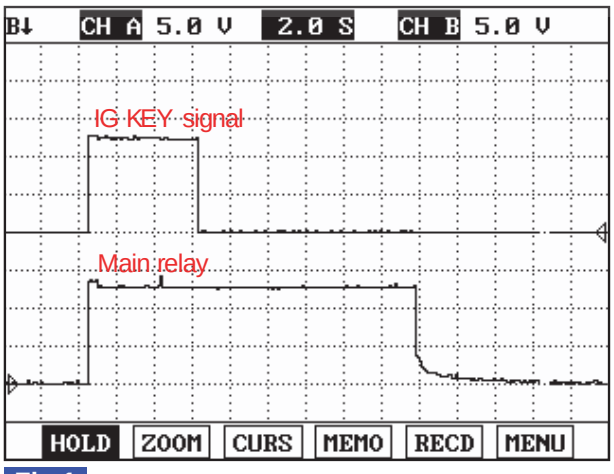


Fig.1

Fig.1) The waveforms of IG KEY "ON" signal and main relay operation are measured simultaneously. Check poor connection at the point of IG KEY "ON".

SLDFL6452L

TERMINAL AND CONNECTOR INSPECTION E4ABB434

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.

2. Perform checking procedure as follows.

   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.

   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

   NOTE

   Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position.)

3. Is the problem found?

   YES

   ▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

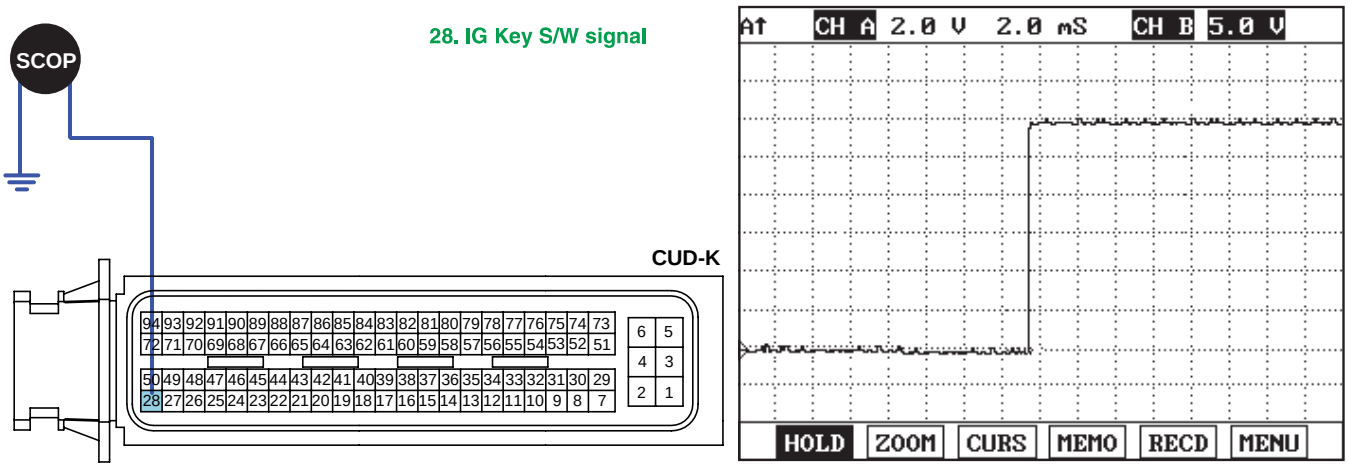
   NO

   ▶ Go to "Signal Circuit Inspection".

SIGNAL CIRCUIT INSPECTION E339C456

1. IG Key "OFF", Engine "OFF".
2. Connect Oscilloscope to ECM connector(CUD-K) terminal 28 with ECM connector being connected.
3. Check IG Key "ON" signal waveform at IG Key "ON".

Specification : The signals indicate poor connection should not exist at IG Key "ON" range.



SLDF27640L

4. Does abnormal waveform generate at IG Key "ON" range?

   YES

▶ Repair IG Key S/W and poor connection of E/R JUNCTION BOX 10A PCU FUSE, I/P-F joint connector terminal 27 and related circuit and go to "Verification of Vehicle Repair".

NO

▶ Go to "Verification of Vehicle Repair".

※ Repeat this process 2~3 times.

VERIFICATION OF VEHICLE REPAIR ED3FEBB7

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

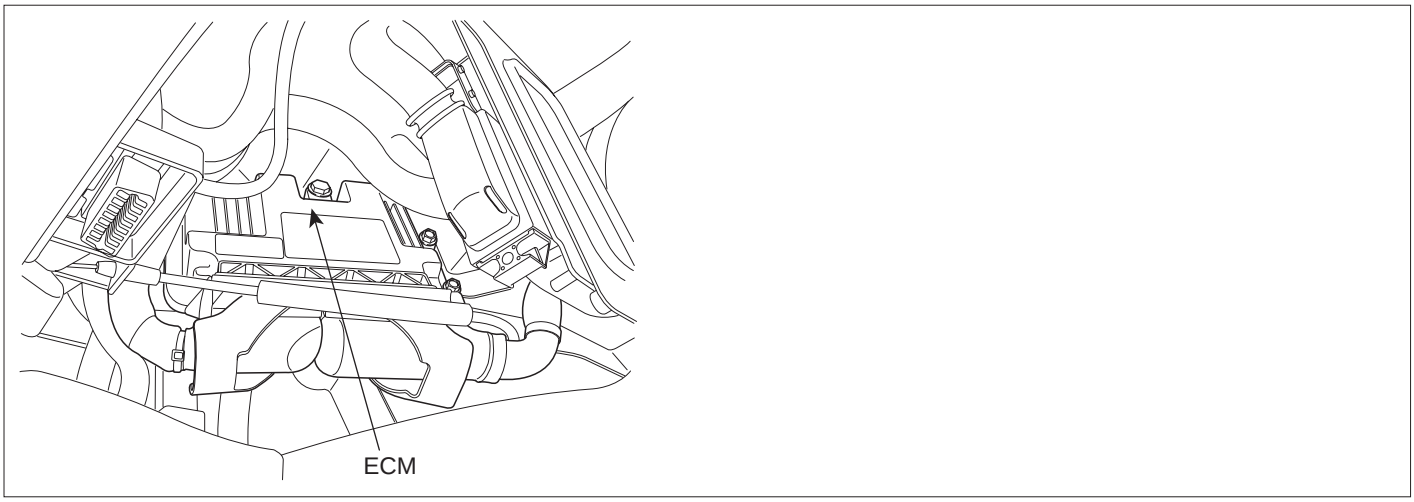
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P1670 INJECTOR SPECIFIC DATA ERROR

COMPONENT LOCATION E401842C



SLDFL6237L

GENERAL DESCRIPTION E2FEB13D

Inputting IQA code of injectors installed in each cylinder to ECM, ECM recognizes the fuel injection quantity difference between each injectors. ECM adjusts every injector to have same fuel injecting characteristic as recognizing specific fuel injection map which is different for each serial number.

[IQA(Injector Quantity Adjustment)] IQA means adjusting fuel injection quantity difference between injectors which occurs inevitably at manufacturing process as allotting serial number consists of 7 letters to each injectors.

DTC DESCRIPTION E02517F4

P1670 is set when 'IQA read or write error' occurs in EEP ROM where IQA data is saved. This code is due to incorrect input of IQA code to ECM.

DTC DETECTING CONDITION E25ED239

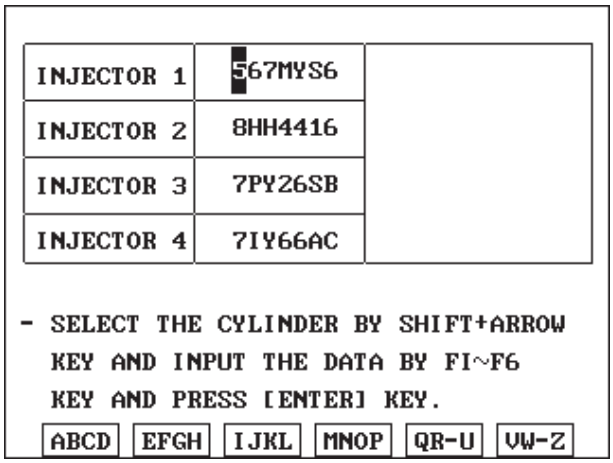
Item	Detecting Condition			Possible Cause
DTC Strategy	• EEPROM monitorting			• ECM internal error
Enable Conditions	• IG Key "ON"			
ThresholdValue	• Incorrect input of IQA code to ECM.			
DiagnosticTime	• Immediately			
Fail Safe	Fuel Cut	NO	• Engine Check Lamp blinks.	
	EGR Off	NO		
	Fuel Limit	NO		
	MIL	BLINK		

COMPONENT INSPECTION E55F03E3

1. IG Key "OFF", Engine "OFF".

2. Using Scantool, select "ENGINE CONTROL" - "INJECTOR CORRECTION".
3. Check currently inputted "injector class input state".

Specification : IQA data inputted to ECM should be identical with IQA data of injector.



SLDFL6455L

4. Are both data identical?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ If error is not corrected after reperforming "INJECTOR CORRECTION" procedure, replace ECM.

NOTE

Input IQA data of injector mounted at cylinder at replacing ECM using scantool. Enter the driving distance - how many km the CPF is used- into New ECM with scanner. For immobilizer applied vehicle, input pin code. If this process is not performed, engine check lamp on cluster blinks and normal engine power generation is impossible.

VERIFICATION OF VEHICLE REPAIR EF7C4288

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P1671 CHECK-SUM ERROR

COMPONENT LOCATION EA1A0DDA

Refer to DTC P1670.

GENERAL DESCRIPTION EFB23466

Refer to DTC P1670.

DTC DESCRIPTION E9AB02D1

P1671 is set when IQA data is not inputted to ECM during initialization of ECM.

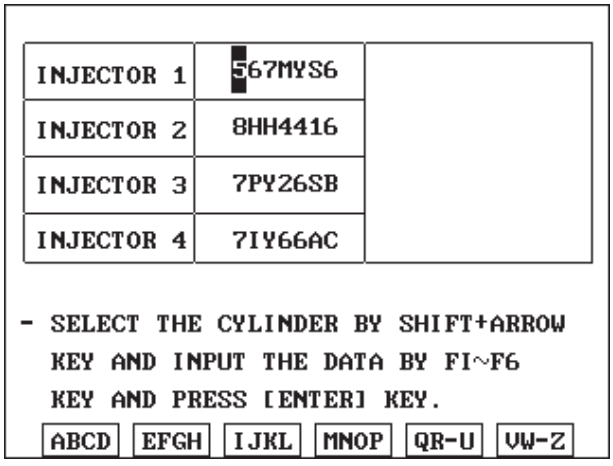
DTC DETECTING CONDITION ECDD05CA

Item	Detecting Condition			Possible Cause
DTC Strategy	• EEPROM monitorting			• IQA not inputted to ECM
Enable Conditions	• IG Key "ON"			
ThresholdValue	• IQA code is not inputted to ECM.			
DiagnosticTime	• Immediately			
Fail Safe	Fuel Cut	NO	• Engine Check Lamp blinks.	
	EGR Off	NO		
	Fuel Limit	NO		
	MIL	BLINK		

COMPONENT INSPECTION E4BD9A8D

1. IG Key "OFF", Engine "OFF".
2. Using Scantool, select "ENGINE CONTROL" - "INJECTOR CORRECTION".
3. Check currently inputted "injector class input state".

Specification : IQA data inputted to ECM should be identical with IQA data of injector.



SLDFL6455L

4. Are both data identical?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ If error is not corrected after reperforming "INJECTOR CORRECTION" procedure, replace ECM.

NOTE

Input IQA data of injector mounted at cylinder at replacing ECM using scantool. Enter the driving distance - how many km the CPF is used- into New ECM with scanner. For immobilizer applied vehicle, input pin code. If this process is not performed, engine check lamp on cluster blinks and normal engine power generation is impossible.

VERIFICATION OF VEHICLE REPAIR E386C0CB

Refer to DTC P1670.

DTC P1692 IMMOBILIZER LAMP ERROR

GENERAL DESCRIPTION EA06CF35

SMARTRA type immobilizer is an anti-theft device which allows engine to turn ON only when the key recognized in Transponder is inserted in the key hall.After checking that the inserted key is registered, immobilizer module transmits engine ON permitting signal to ECM. If engine is tried to turn ON when non-registered key is inserted in the key hall or no key signal is detected (buglary), immobilizer module transmits engine ON prohibitting order to ECM and injector operation is disabled. Driver can check if immobilizer system is verified as monitoring immobilizer lamp. Until engine turns on after successful verification, the lamp is turning "ON". After IG "ON", immobilizer lamp turns ON for 30 sec., then OFF. If any error of immobilizer system is detected or Key verification fails, lamp blink 5 times, then turns OFF.

[SMARTRA] SMARt TRansponder Antenna

DTC DESCRIPTION EF66AF5C

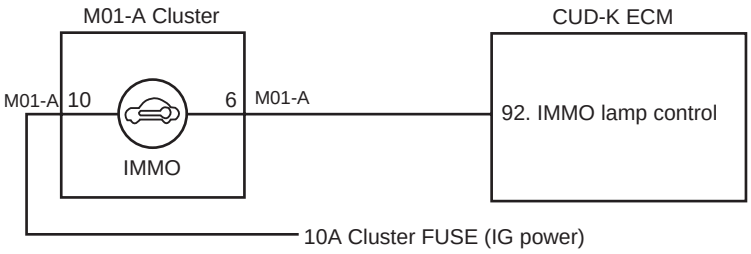
P1692 is set when excessive current is detected in immobilizer indicator lamp control circuit for more than 1.0 sec. This code is due to short to battery in immobilizer indicator lamp control circuit.

DTC DETECTING CONDITION EBB4AC90

<table>
<tr><th>Item</th><th colspan="2">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="2">• Voltage monitoring</td><td rowspan="6">• Immobilizer indicator lamp circuit</td></tr>
<tr><td>Enable Conditions</td><td colspan="2">• IG Key "ON"(monitoring only performed at lamp ON condition)</td></tr>
<tr><td>ThresholdValue</td><td colspan="2">• Short to battery</td></tr>
<tr><td>DiagnosticTime</td><td colspan="2">• 1.0 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SCHEMATIC DIAGRAM E97AFDEE

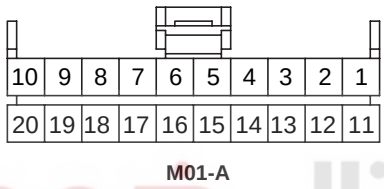
[CIRCUIT DIAGRAM]



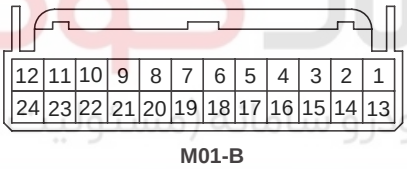
[CONNECTOR INFORMATION]

Terminal	Connected to	Function
M01-A terminal 10	10A Cluster FUSE	IG power
M01-A terminal 6	CUD-K terminal 92	IMMO lamp control

[HARNESS CONNECTOR]

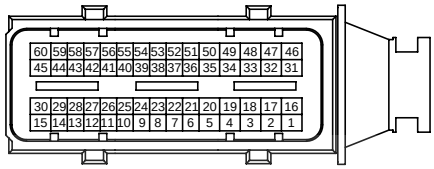


M01-A

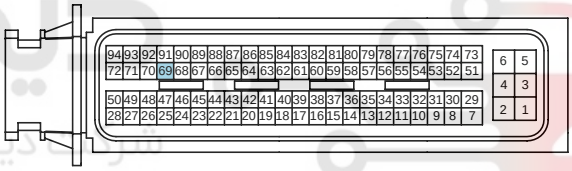


M01-B

CUD-M



CUD-K



ECM

SLDF27700L

TERMINAL AND CONNECTOR INSPECTION E700F6C0

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.

2. Perform checking procedure as follows.

   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.

   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

   NOTE

   Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position.)

3. Is the problem found?

   YES

   ▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

   NO

▶ Go to "Control Circuit Inspection".

CONTROL CIRCUIT INSPECTION ED73EDDF

1. IG Key "OFF", Engine "OFF".
2. Disconnect cluster connector and ECM connector.
3. IG Key "ON".
4. Measure the voltage of ECM connector(CUD-K) terminal 92.

Specification : 10.8V~13.0V

5. Is measured voltage within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Repair short to battery in Immobilizer indicator lamp control circuit and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E3D392DA

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

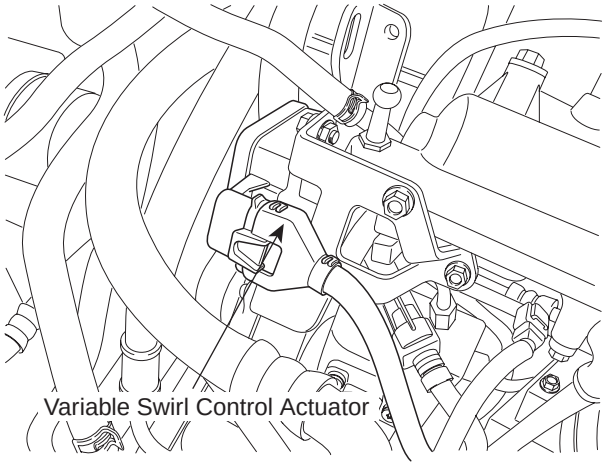
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P2009 INTAKE MANIFOLD RUNNER CONTROL CIRCUIT LOW(BANK 1)

COMPONENT LOCATION EA187D8C



SLDFL6456L

GENERAL DESCRIPTION E6BB2C9E

Variable swirl control actuator consists of DC motor and motor position sensor (potentiometer) which detects the position of swirl valve. As closing one intake port out of two at idle and below 3000RPM, swirl effect is taken on intake air. This swirl effect increases air flow rate. However, because air flow rate is too high, swirl effect is neglectable thus, swirl valve is opened for efficiency of intake air. To prevent swirl valve and shaft form being stuck by foreign metarial, and to learn max opening and closing position of swirl valve, it is fully opened and closed twice at turning engine OFF.

[Swirl] The air flow which indicates Intake air swirls with respect to the axis passing through the centre of piston with length-direction by intake port which is eccentric from the centre of combustion chamber.

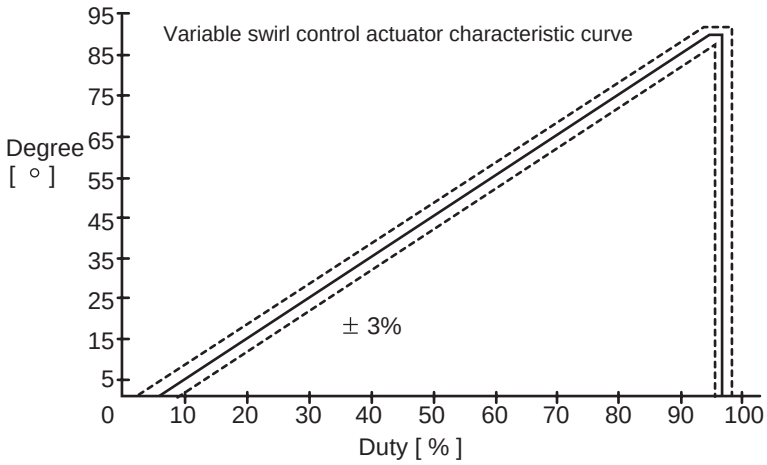
DTC DESCRIPTION EFDE186D

P2009 is set when 1) short to ground in variable swirl actuator driving motor (+) or (-) output terminal. or 2) tiny open in motor (-) output terminal for a long period occurs. The polarity of (+) and (-) lines shift each other in accordance with the condition of swirl valve(opened or closed) thus, checking both (+) and (-) circuits is required.

DTC DETECTING CONDITION ECE94B0B

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="8">• Variable swirl valvemotor circuit</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• Short to ground in motor(+) terminal
• Short to ground in motor(-) terminal
• Tiny open in motor(-) terminal for a long period</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 0.2 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• Swirl valve opened at variable swirl control actuator failure</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

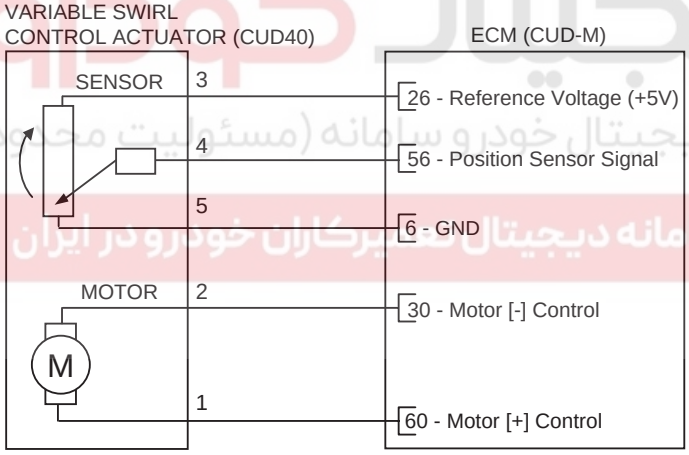
SPECIFICATION EC1B8851



SLDFL6625L

SCHEMATIC DIAGRAM E6334840

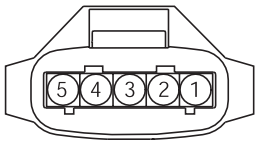
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

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

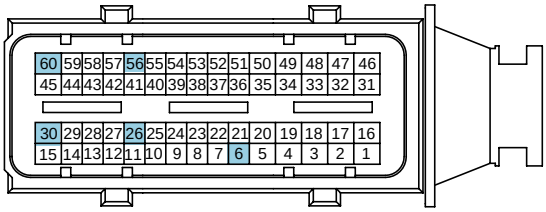
[HARNESS CONNECTORS]



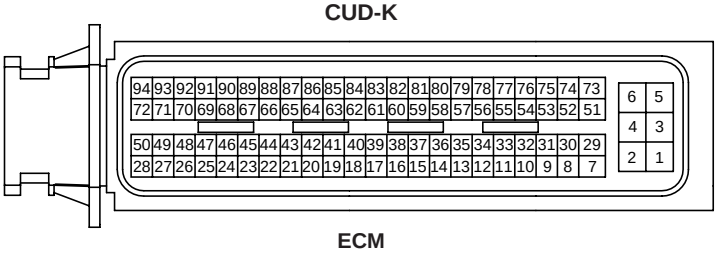
CUD40

VARIABLE SWIRL CONTROL ACTUATOR

CUD-M



CUD-K



ECM

SLDF27135L

SIGNAL WAVEFORM AND DATA EFA85A00

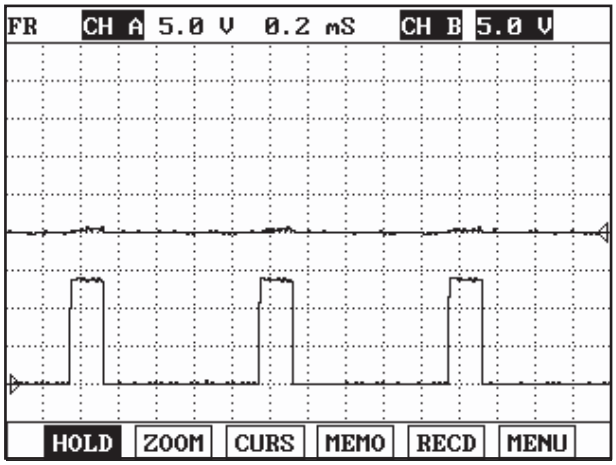


Fig.1

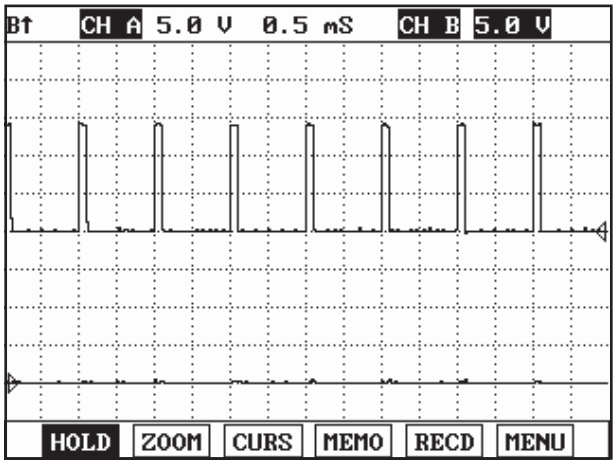


Fig.2

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 (+).

SUNFL7667L

TERMINAL AND CONNECTOR INSPECTION E21E023F

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.
2. Perform checking procedure as follows.
   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.
   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

NOTE

Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position.)

3. Is the problem found?

YES

▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

NO

▶ Go to "Control Circuit Inspection".

CONTROL CIRCUIT INSPECTION E2B382FB

1. Check short to ground in control circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect variable swirl control actuator connector and ECM connector.
   3) Check continuity between variable swirl control actuator connector terminal 1 and chassis ground.

4) Check continuity between variable swirl control actuator connector terminal 2 and chassis ground.

Specification : Discontinuity(Infinite Ω)

5) Is the measured resistance within the specification?

YES

▶ Go to "2.Check open in motor circuit" as follows.

NO

▶ Repair short to ground in variable swirl control actuator motor circuit and go to "Verification of Vehicle Repair".

2. Check open in motor circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect variable swirl control actuator connector and ECM connector.

3) Check continuity between variable swirl control actuator connector terminal 1 and ECM connecor (CUD-M) terminal 60.

4) Check continuity between variable swirl control actuator connector terminal 2 and ECM connecor (CUD-M) terminal 30.

Specification : Continuity (below 1.0Ω)

5) Is the measured resistance within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ Repair open in variable swirl control actuator motor circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E7B2D831

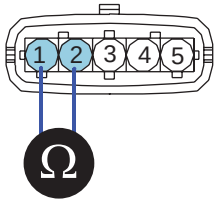
1. Check motor coil resistance

1) IG Key "OFF", Engine "OFF".

2) Disconnect variable swirl control actuator connector.

3) Measure the resistance between variable swirl control actuator component terminal 1 and terminal 2.

Specification : 15.0 ± 3 Ω (20℃)



SLDFL6611L

4) Is the measured resistance within the specification?

YES

▶ Go to "2. Check motor operation" as follows.

NO

▶ Replace variable swirl control actuator assy' and go to "Verification of Vehicle Repair".

2. Check motor operation

1) IG Key "ON", Engine "ON".

2) Keep engine at idle state.

3) Monitor the waveform of variable swirl control actuator terminal 1and terminal 2 with two channel oscilloscope.

4) Accelerating engine to above 3000RPM, let variable swirl control actuator be opened(operates).

SPECIFICATION :

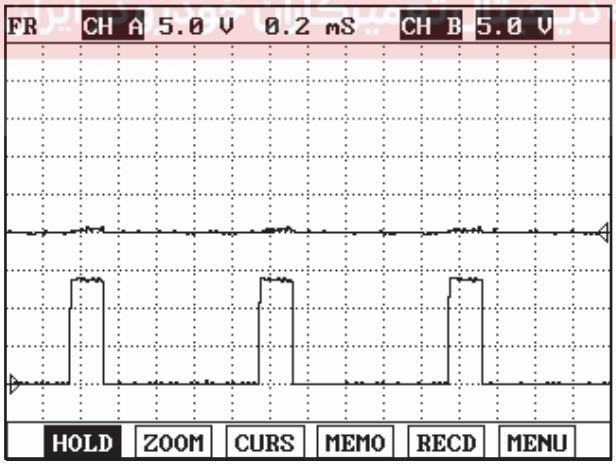


Fig.1

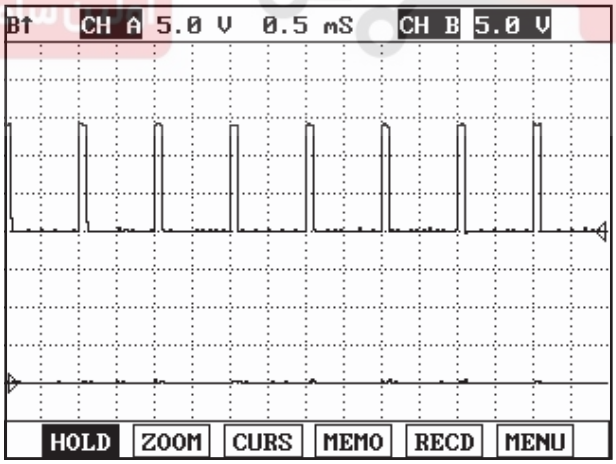


Fig.2

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 (+).

SUNFL7667L

5) Does variable swirl control actuator operate correctly?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace variable swirl control actuator assy' and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR EC2CC0C1

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P2010 INTAKE MANIFOLD RUNNER CONTROL CIRCUIT HIGH(BANK 1)

COMPONENT LOCATION E5B6F471

Refer to DTC P2009.

GENERAL DESCRIPTION E6E565CF

Refer to DTC P2009.

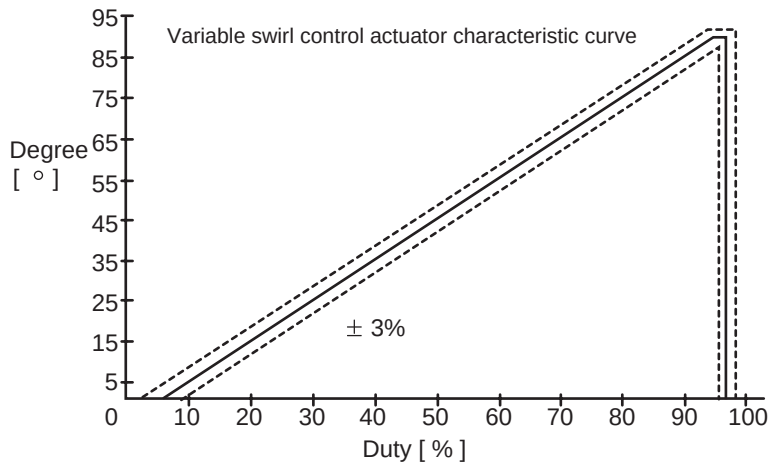
DTC DESCRIPTION EE657EB8

P2010 is set when 1) short to battery in variable swirl actuator driving motor (+) or (-) output terminal. or 2) tiny short in motor (-) output terminal for a long period occurs. The polarity of (+) and (-) lines shift each other in accordance with the condition of swirl valve(opened or closed) thus, checking both (+) and (-) circuits is required.

DTC DETECTING CONDITION E7F77982

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• Variable swirl valvemotor circuit</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• Short to battery in motor(+) terminal
• Tiny short to battery/ground in motor(+) terminal for a long period
• Short to battery in motor(-) terminal</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 0.2 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• Swirl valve opened at variable swirl control actuator failure</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SPECIFICATION E6615CFA



SLDFL6625L

SCHEMATIC DIAGRAM EE9C3589

Refer to DTC P2009.

SIGNAL WAVEFORM AND DATA EFAF8AE9

Refer to DTC P2009.

TERMINAL AND CONNECTOR INSPECTION EFA33B94

Refer to DTC P2009.

CONTROL CIRCUIT INSPECTION ECE9E25C

1. Check control circuit voltage

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect variable swirl control actuator connector.

   3) IG Key "ON".

   4) Measure the voltage of variable swirl control actuator connector terminal 1.

   5) Measure the voltage of variable swirl control actuator connector terminal 2.

Specification : 0.0V~0.1V

   6) Is the measured voltage within the specification?

YES

▶ Check "2. Check open in motor circuit" as follows.

NO

▶ Repair short to battery in variable swirl control actuator motor circuit and go to "Verification of Vehicle Repair".

2. Check open in motor circuit

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect variable swirl control actuator connector and ECM connector.

   3) Check continuity between variable swirl control actuator connector terminal 1 and ECM connecor (CUD-M) terminal 60.

   4) Check continuity between variable swirl control actuator connector terminal 2 and ECM connecor (CUD-M) terminal 30.

Specification : Continuity(Infinite Ω)

   5) Is the measured resistance within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ Repair short to ground in variable swirl control actuator motor circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION EB035DED

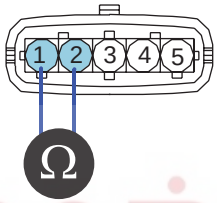
1. Check motor coil resistance

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect variable swirl control actuator connector.

   3) Measure the resistance between variable swirl control actuator component terminal 1 and terminal 2.

Specification : 15.0 ± 3 Ω (20℃)



SLDFL6611L

   4) Is the measured resistance within the specification?

YES

▶ Go to "2. Check motor operation" as follows.

NO

▶ Replace variable swirl control actuator assy' and go to "Verification of Vehicle Repair".

2. Check motor operation

   1) IG Key "ON", Engine "ON".

   2) Keep engine at idle state.

   3) Monitor the waveform of variable swirl control actuator terminal 1and terminal 2 with two channel oscilloscope.

   4) Accelerating engine to above 3000RPM, let variable swirl control actuator be opened(operates).

SPECIFICATION :

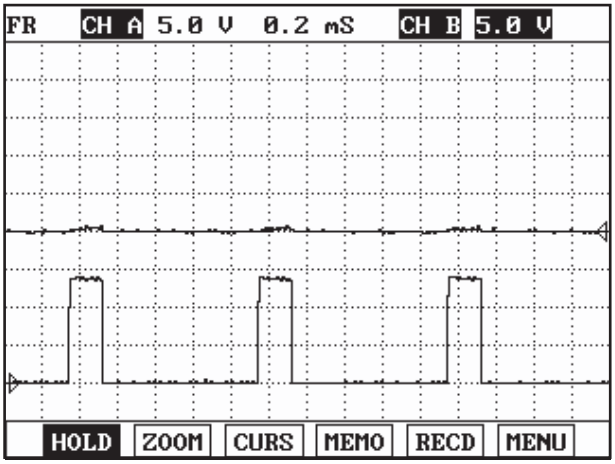


Fig.1

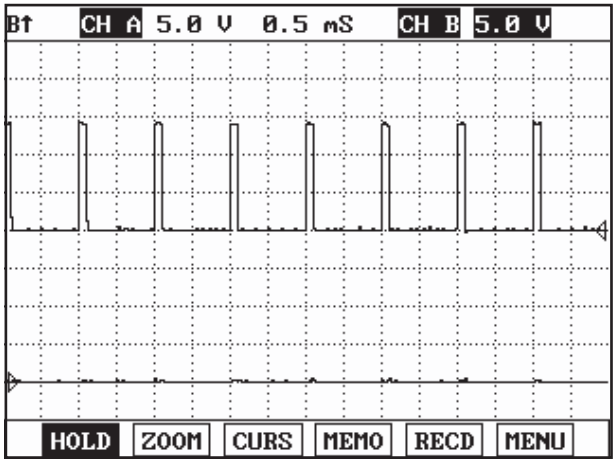


Fig.2

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 (+).

SUNFL7667L

5) Does variable swirl control actuator operate correctly?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace variable swirl control actuator assy' and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR EFC3660B

Refer to DTC P2009.

DTC P2015 INTAKE MANIFOLD RUNNER POSITION SENSOR/SWITCH CIRCUIT RANGE/PERFORMANCE(BANK 1)

COMPONENT LOCATION EE67FBAC

Refer to DTC P2009.

GENERAL DESCRIPTION E668B066

Refer to DTC P2009.

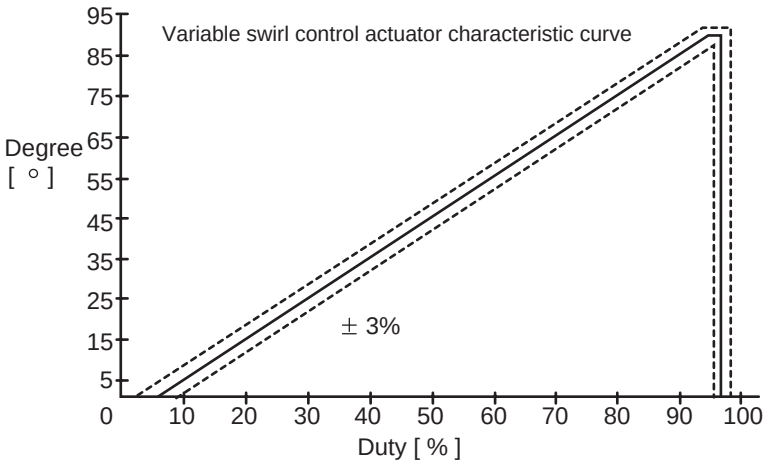
DTC DESCRIPTION E3CBEB89

P2015 is set if variable swirl valve position fails to reach target position within 3.0 sec. while ECM already outputted motor driving signal(swirl valve fully open or close signal). This code is due to 1)swirl valve shaft stuck or problem of link device or 2)variable swirl valve position sensor output value stuck.

DTC DETECTING CONDITION EEDB7020

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="5">• Variable swirl valveshaft stuck
• Variable swirl valvelink device problem
• Variable swirl valve position sensor component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• Variable swirl valve operating motor mechanically stuck at offset learning</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 3 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• Swirl valve opened at variable swirl control actuator failure</td></tr>
<tr><td>EGR Off</td><td>YES</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SPECIFICATION E7EE402F



SLDFL6625L

SCHEMATIC DIAGRAM E2E3375B

Refer to DTC P2009.

SIGNAL WAVEFORM AND DATA E11D2563

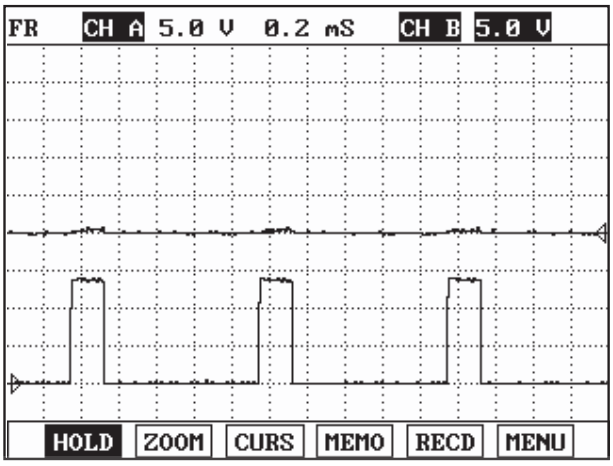


Fig.1

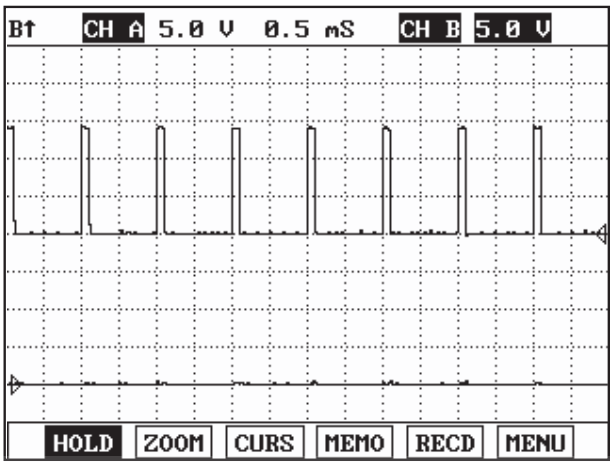


Fig.2

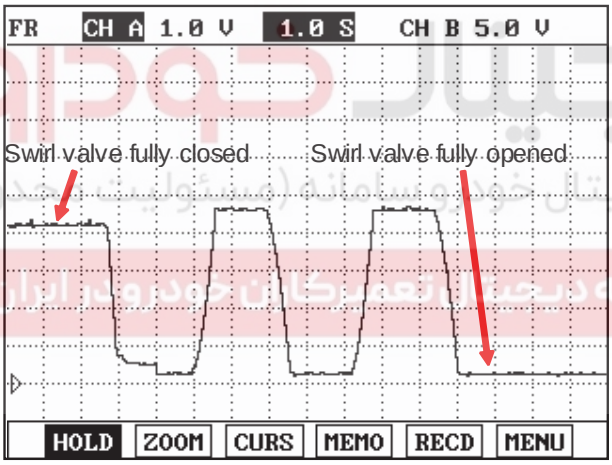


Fig.3

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".(measured at terminal 4)

SLDFL6457L

COMPONENT INSPECTION EA70FD6A

1. Check variable swirl control actuator link device operation

   1) IG Key "OFF", Engine "OFF".

   2) Wait for approx. 16 sec. and check that Main relay turns "OFF".

   3) Disconnect variable swirl control actuator connector.

   4) Pressing variable swirl control actuator link with hands, check if shaft stuck, tightness or problem of link device is detected.

Specification : VSCA link device should move smoothly.

5) Does variable swirl control actuator move slowly?

YES

▶ Go to "2. Check motor coil resistance" as follows.

NO

▶ Replace stuck or too tight parts of component(intake manifold assy' or swirl actuator) and go to "Verification of Vehicle Repair".

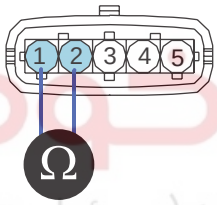
2. Check motor coil resistance

1) IG Key "OFF", Engine "OFF".

2) Disconnect variable swirl control actuator connector.

3) Measure the resistance between variable swirl control actuator component terminal 1 and terminal 2.

Specification : 15.0 ± 3 Ω (20℃)



SLDFL6611L

4) Is the measured resistance within the specification?

YES

▶ Go to "3. Check variable swirl control actuator position sensor resistance" as follows.

NO

▶ Replace variable swirl control actuator and go to "Verification of Vehicle Repair".

3. Check variable swirl control actuator position sensor resistance

1) IG Key "OFF", Engine "OFF".

2) Disconnect variable swirl control actuator.

3) Measure the resistance of variable swirl control actuator component terminal 3,4,5 referring "Terminal resistance table" as follows.

Specification : Terminal resistance table

	Detecting terminal	Resistance (KΩ 20℃)		Characteristic	Component connector shape
		valve fully opend	valve fully closed		
variable swirl control actuator position sensor	3(power)-5(ground)	4.47±0.1KΩ	4.47±0.1KΩ	stable	 SLDFL6613L
	3(power)-4(signal)	4.81±0.1KΩ	0.85±0.1KΩ	resistance drops	
	4(signal)-5(ground)	0.75±0.1KΩ	4.71±0.1KΩ	resistance rises	

4) Is the measured resistance within the specification?

YES

▶ Go to "4. Check motor operation" as follows.

NO

▶ Replace variable swirl control actuator assy' and go to "Verification of Vehicle Repair".

4. Check motor operation

1) IG Key "ON", Engine "ON".

2) Keep engine at idle state.

3) Monitor the waveform of variable swirl control actuator terminal 1and terminal 2 with two channel oscilloscope.

4) Accelerating engine to above 3000RPM, let variable swirl control actuator be opened(operates).

SPECIFICATION :

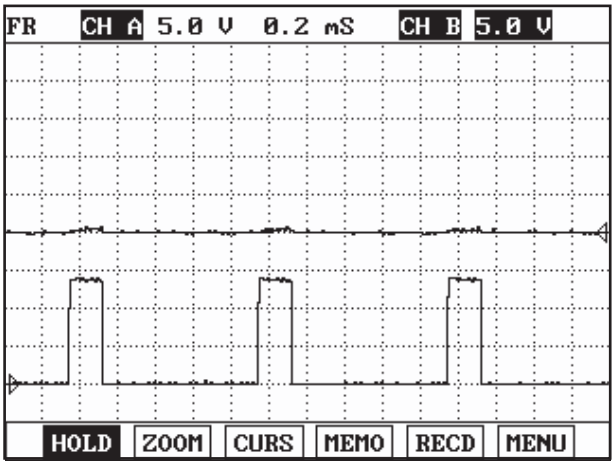


Fig.1

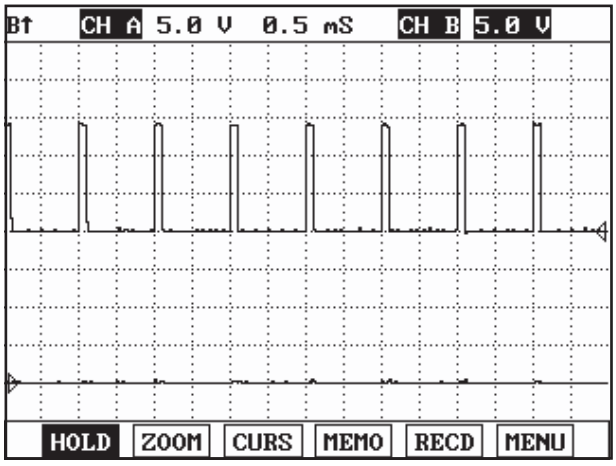


Fig.2

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 (+).

SUNFL7667L

5) Does variable swirl control actuator operate correctly?

YES

▶ Go to "5. Check variable swirl control actuator position sensor operation" as follows.

NO

▶ Replace variable swirl control actuator assy' and go to "Verification of Vehicle Repair".

5. Check variable swirl control actuator position sensor operation

1) IG Key "ON", Engine "ON".

2) Keep engine at idle state.

3) Monitor the waveform of variable swirl control actuator terminal 4 with oscilloscope.

4) Turning off engine, monitor the waveform of variable swirl control actuator at the point of operation stop.

SPECIFICATION :

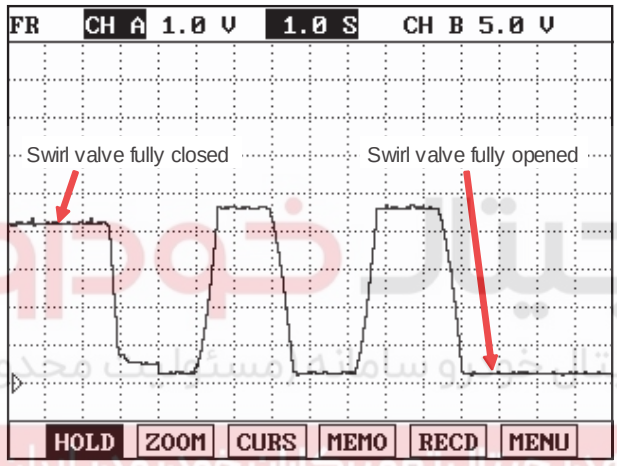


Fig.3

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".(at terminal 4)

SLDF27645L

5) Does variable swirl control actuator and position sensor operations are OK?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace variable swirl control actuator assy' and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR ECE4C2B2

Refer to DTC P2009.

DTC P2016 INTAKE MANIFOLD RUNNER POSITION SENSOR/SWITCH CIRCUIT LOW(BANK 1)

COMPONENT LOCATION EC1D0E9C

Refer to DTC P2009.

GENERAL DESCRIPTION E17EB90A

Refer to DTC P2009.

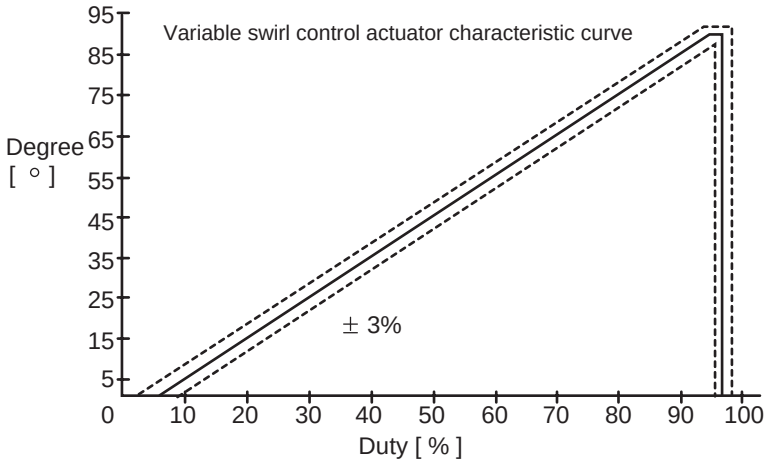
DTC DESCRIPTION ED50A8DA

P2016 is set when variable swirl valve position sensor output voltage below 0.133V is detected for more than 2.5 sec.. This code is due to open in power circuit or short to ground in signal circuit.

DTC DETECTING CONDITION E20E7EB3

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• Variable swirl valve position sensor circuit
• Variable swirl valve position sensor component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• VSVPS Output voltage is below minimum value. (below 133mV)</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 2.5 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• Swirl valve opened at variable swirl control actuator failure</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SPECIFICATION E6FE8A6F



SLDFL6625L

SCHEMATIC DIAGRAM E0215A26

Refer to DTC P2009.

SIGNAL WAVEFORM AND DATA EC94898C

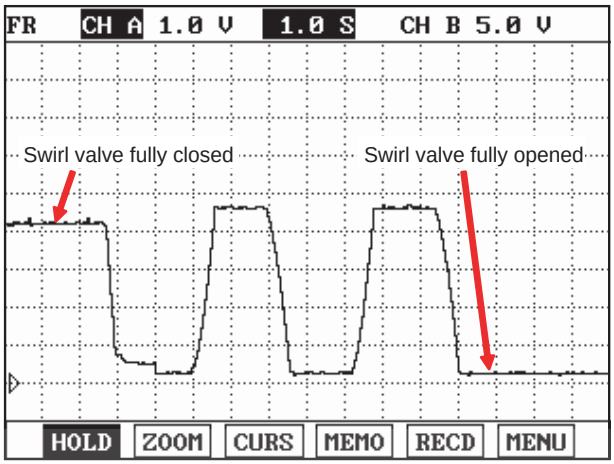


Fig.1

Fig.1) 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".(at terminal 4)

SLDF27646L

TERMINAL AND CONNECTOR INSPECTION E2554E1C

Refer to DTC P2009.

POWER CIRCUIT INSPECTION E9503B50

1. IG Key "OFF", Engine "OFF".
2. Disconnect variable swirl control actuator connector.
3. IG Key "ON".
4. Measure the voltage of variable swirl control actuator connector terminal 3.

Specification : 4.8V~5.1V

5. Is the measured voltage within the specification?

YES

▶ Go to "Signal Circuit Inspection".

NO

▶ Repair open in power circuit and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION E2DC8368

1. Check signal circuit voltage

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect variable swirl control actuator connector.

   3) IG Key "ON".

   4) Measure the voltage of variable swirl control actuator connector terminal 4.

Specification : 4.8V~5.1V

   5) Is the measured voltage within the specification?

   YES

   ▶ Go to "Component Inspection".

   NO

   ▶ Go to "2. Check short to ground in signal circuit" as follows.

2. Check short to ground in signal circuit

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect variable swirl control actuator connector and ECM connector.

   3) Check continuity between variable swirl control actuator connector terminal 4 and chassis ground.

Specification : Discontinuity(Infinite Ω)

   4) Is the measured resistance within the specificaiton?

   YES

   ▶ Go to "Component Inspection".

   NO

   ▶ Repair short to ground in signal circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E09F6650

1. Check variable swirl control actuator position sensor resistance

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect variable swirl control actuator.

   3) Measure the resistance of variable swirl control actuator component terminal 3,4,5 referring "Terminal resistance table" as follows.

Specification : Terminal resistance table

	Detecting terminal	Resistance (KΩ 20℃)		Characteristic	Component connector shape
		valve fully opend	valve fully closed		
variable swirl control actuator position sensor	3(power)-5(ground)	4.47±0.1KΩ	4.47±0.1KΩ	stable	 SLDFL6613L
	3(power)-4(signal)	4.81±0.1KΩ	0.85±0.1KΩ	resistance drops	
	4(signal)-5(ground)	0.75±0.1KΩ	4.71±0.1KΩ	resistance rises	

4) Is the measured resistance within the specification?

YES

▶ Go to "2. Check variable swirl control actuator position sensor operation" as follows.

NO

▶ Replace variable swirl control actuator assy' and go to "Verification of Vehicle Repair".

2. Check variable swirl control actuator position sensor operation

1) IG Key "ON", Engine "ON".

2) Keep engine at idle state.

3) Monitor the waveform of variable swirl control actuator terminal 4 with oscilloscope.

4) Turning off engine, monitor the waveform of variable swirl control actuator at the point of operation stop.

SPECIFICATION :

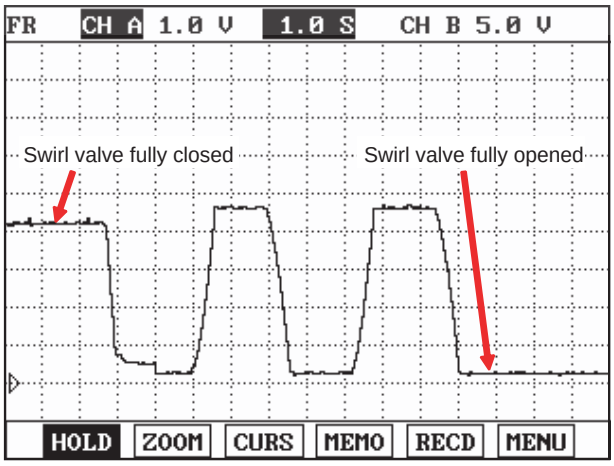


Fig.1

Fig.1) 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".(at terminal 4)

SLDF27646L

5) Does variable swirl control actuator and position sensor operations are OK?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace variable swirl control actuator assy' and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E701093C

Refer to DTC P2009.

DTC P2017 INTAKE MANIFOLD RUNNER POSITION SENSOR/SWITCH CIRCUIT HIGH(BANK 1)

COMPONENT LOCATION E91822B7

Refer to DTC P2009.

GENERAL DESCRIPTION E072A8BC

Refer to DTC P2009.

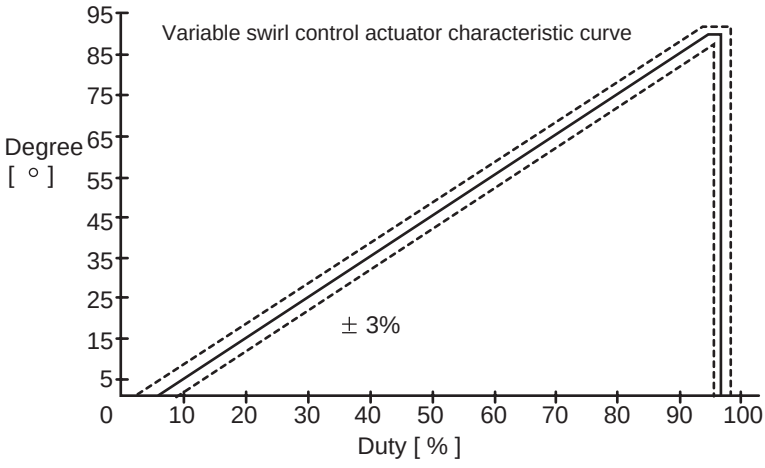
DTC DESCRIPTION E5734BFF

P2017 is set when variable swirl valve position sensor output voltage above 4.8V is detected for more than 2.5 sec.. This code is due to 1)open in signal circuit or ground circuit or 2)short to battery in power circuit or signal circuit.

DTC DETECTING CONDITION ED9E186F

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="5">• Variable swirl valve position sensor circuit
• Variable swirl valve position sensor component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• VSVPS Output voltage is above maximum value. (above 4800mV)</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 2.5 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• Swirl valve opened at variable swirl control actuator failure</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>MIL</td><td>OFF</td></tr>
</table>

SPECIFICATION EF789503



SLDFL6625L

SCHEMATIC DIAGRAM E32E30B4

Refer to DTC P2009.

SIGNAL WAVEFORM AND DATA EF9BDCA1

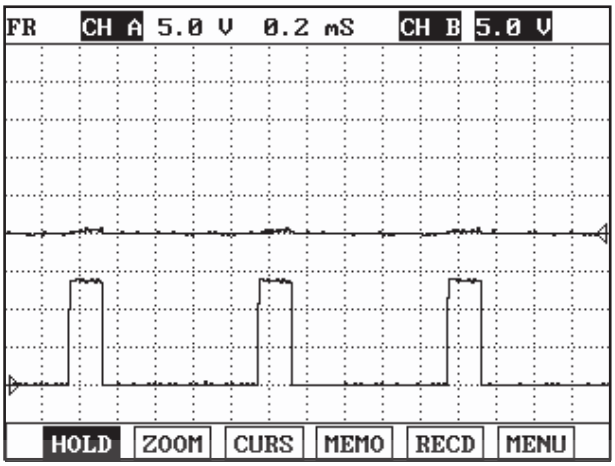


Fig.1

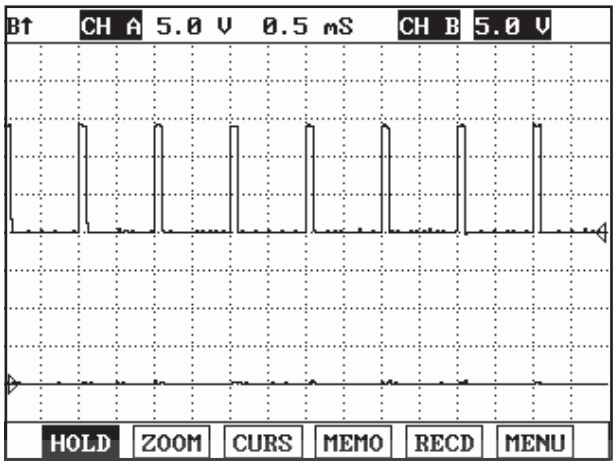


Fig.2

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 (+).

SUNFL7667L

TERMINAL AND CONNECTOR INSPECTION EF7C2A64

Refer to DTC P2009.

POWER CIRCUIT INSPECTION E1FE0CDD

1. IG Key "OFF", Engine "OFF".
2. Disconnect variable swirl control actuator connector.
3. IG Key "ON".
4. Measure the voltage of variable swirl control actuator connector terminal 3.

Specification : 4.8V~5.1V

5. Is the measured voltage within the specification?

YES

▶ Go to "Signal Circuit Inspection".

NO

▶ Repair open in power circuit and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION EEC0FE6D

1. Check signal circuit voltage

1) IG Key "OFF", Engine "OFF".
2) Disconnect variable swirl control actuator connector.
3) IG Key "ON".
4) Measure the voltage of variable swirl control actuator connector terminal 4.

Specification : 4.8V~5.1V

5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ Go to "2. Check open in signal circuit" as follows.

2. Check open in signal circuit

1) IG Key "OFF", Engine "OFF".
2) Disconnect variable swirl control actuator connector and ECM connector.
3) Check continuity between variable swirl control actuator connector terminal 4 and ECM connector (CUD-M) terminal 56.

Specification : Continuity (below 1.0Ω)

4) Is the measured resistance within the specificaiton?

YES

▶ Repair short to ground in signal circuit and go to "Verification of Vehicle Repair".

NO

▶ Repair open in signal circuit and go to "Verification of Vehicle Repair".

GROUND CIRCUIT INSPECTION E72BF3E6

1. IG Key "OFF", Engine "OFF".
2. Disconnect variable swirl control actuator connector.
3. IG Key "ON".
4. Measure the voltage of variable swirl control actuator connector terminal 3. [TEST "A"]
5. Measure the voltage between variable swirl control actuator connector terminal 3 and terminal 5. [TEST "B"]
(terminal 3 : Check + prove , terminal 5 : Check - prove)

Specification : [TEST "A"] Voltage - [TEST "B"] Voltage = below 200mV

6. Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ When "B" voltage is not detected : Repair open in ground circuit and go to "Verification of Vehicle Repair".
▶ When the voltage difference between "A" and "B" is above 200mV : Eliminate the causes of excessive resistance and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E5F4DB79

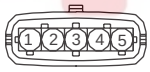
1. Check variable swirl control actuator position sensor resistance

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect variable swirl control actuator.

   3) Measure the resistance of variable swirl control actuator component terminal 3,4,5 referring "Terminal resistance table" as follows.

Specification : Terminal resistance table

	Detecting terminal	Resistance (KΩ 20℃)		Characteristic	Component connector shape
		valve fully opend	valve fully closed		
variable swirl control actuator position sensor	3(power)-5(ground)	4.47±0.1KΩ	4.47±0.1KΩ	stable	 SLDFL6613L
	3(power)-4(signal)	4.81±0.1KΩ	0.85±0.1KΩ	resistance drops	
	4(signal)-5(ground)	0.75±0.1KΩ	4.71±0.1KΩ	resistance rises	

   4) Is the measured resistance within the specification?

   YES

   ▶ Go to "2. Check variable swirl control actuator position sensor operation" as follows.

   NO

   ▶ Replace variable swirl control actuator assy' and go to "Verification of Vehicle Repair".

2. Check variable swirl control actuator position sensor operation

   1) IG Key "ON", Engine "ON".

   2) Keep engine at idle state.

   3) Monitor the waveform of variable swirl control actuator terminal 4 with oscilloscope.

   4) Turning off engine, monitor the waveform of variable swirl control actuator at the point of operation stop.

SPECIFICATION :

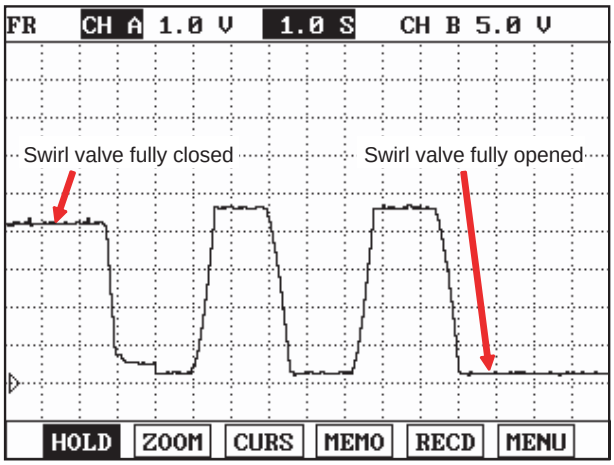


Fig.1

Fig.1) 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".(at terminal 4)

SLDF27646L

5) Does variable swirl control actuator and position sensor operations are OK?

YES

▶ Go to "Verification of Vehicle Repair".

NO

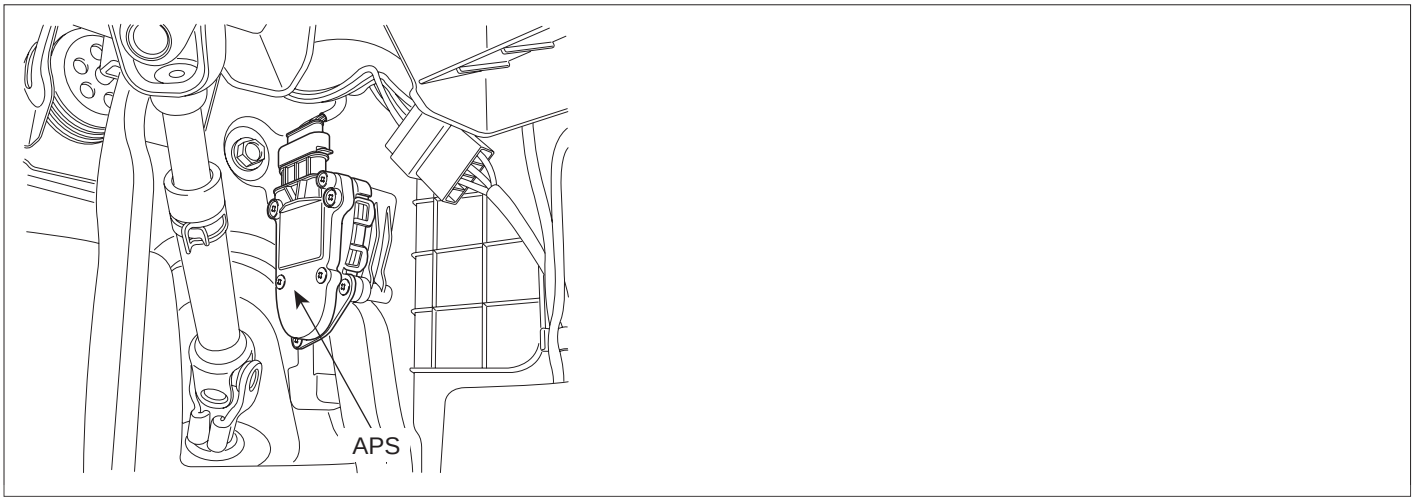
▶ Replace variable swirl control actuator assy' and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E859FCE5

Refer to DTC P2009.

DTC P2123 THROTTLE/PEDAL POSITION SENSOR/SWITCH "D" CIRCUIT HIGH INPUT

COMPONENT LOCATION E03FEED9



SLDFL6467L

GENERAL DESCRIPTION EC92F70C

Driver's intension to accelerate is transmitted to ECM through Accelerator Pedal Sensor(APS) . And APS, whose mechanism is same as TPS, is required for ECM to determine optimum fuel injection quantity. As fidelity of APS is strongly required, APS is devided into two. One is APS1, which outputs main signals and the other is APS2, which monitors APS1 performance. APS1 and 2 do not share power supply and ground. Normally, APS2 output voltage is the half of APS1 and if the ratio of two signal is out of specified value, error is recognized then, Limp Home mode is activated. When Limp Home mode is activated, engine speed is fixed at 1200RPM and driving performance is limited to prevent excessive power generation due to APS false signal.

DTC DESCRIPTION E953B69A

P2123 is set when output voltage of APS 1 is above the maximum value of 4.9V for more than 0.6 sec. This code is due to the short to battery in APS 1 power circuit and signal circuit or open in sensor ground circuit.

DTC DETECTING CONDITION E50168B9

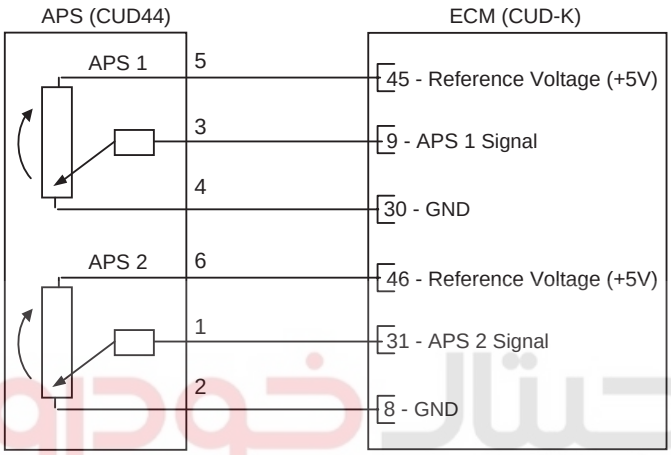
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• APS 1 Circuit
• APS component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"(Accelerator pedal depressed)</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• When output signal is above the maximum value (above 4900mV)</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 0.6 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• APS standard value is 0%.
• Limp home idle engine speed is fixed at 1200RPM.</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>YES</td></tr>
<tr><td>MIL</td><td>ON</td></tr>
</table>

SPECIFICATION EE8A425B

	Pedal released	Pedal depressed	Sensor Type
APS 1	0.7V~0.8V	3.8V~4.4V	Variable resistance type(Potentiometer)
APS 2	0.275V~0.475V	1.75V~2.35V	

SCHEMATIC DIAGRAM EB186678

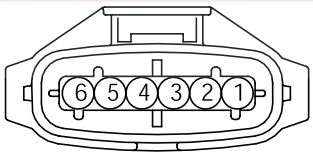
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

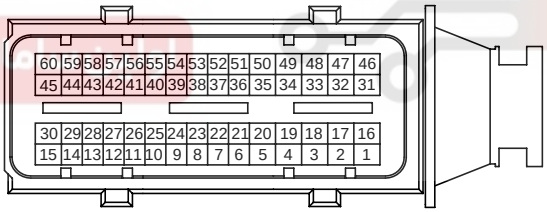
Terminal	Connected to	Function
1	ECM CUD-K (31)	APS 2 Signal
2	ECM CUD-K (8)	APS 2 Ground
3	ECM CUD-K (9)	APS 1 Signal
4	ECM CUD-K (30)	APS 1 Ground
5	ECM CUD-K (45)	APS 1 Reference Voltage (+5V)
6	ECM CUD-K (46)	APS 2 Reference Voltage (+5V)

[HARNESS CONNECTORS]

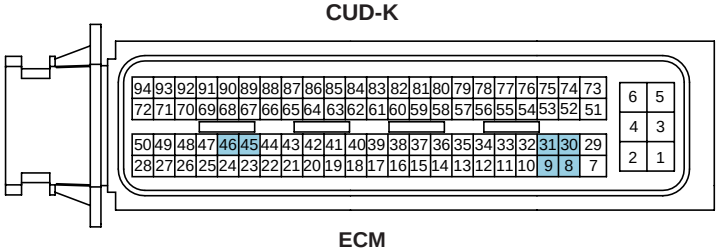


CUD44
APS

CUD-M



CUD-K



ECM

SLDF27129L

SIGNAL WAVEFORM AND DATA EB63D7CA

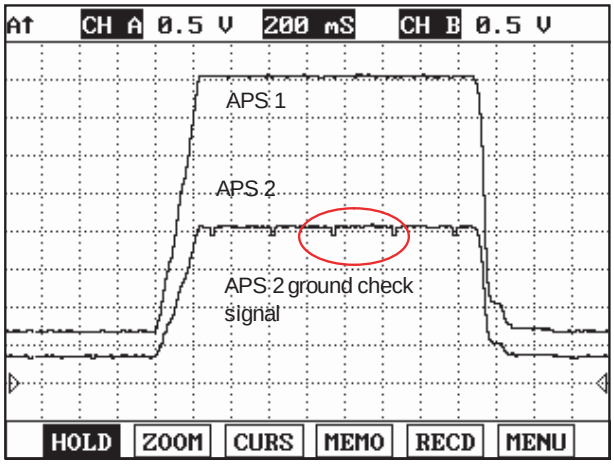


Fig.1

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.

SLDFL6468L

NOTE

APS 2 Ground checking signal is for ECM to monitor APS 2. This signal drops APS 2 output voltage to below 200.39mV per 200msec. If APS 2 output voltage does not drop to below 200.39mV, ECM sets DTC as recognizing ground circuit error of APS 2 .

※ The waveform below 200.39mV is not detectable in Ground checking signal waveform of APS 2 signal. Instead, the waveform which drops a little is detected. If APS 2 data of "SERVICE DATA" on the Scantool varies from 350mV to 0mV periodically, it means it works well.

MONITOR SCANTOOL DATA EF06E4DC

1. Connect scantool to Data Link Cable (DLC).
2. Warm engine up to normal operating temperature.
3. Turn "OFF" electrical devices and A/C.
4. Monitor "ACCEL PEDAL SENSOR", "ACCEL PEDAL SENSOR 1", "ACCEL PEDAL SENSOR 2 " parameter on the scantool.

Specification : At idle(0%)
ACCEL PEDAL SENSOR 1 : 600mV~800mV
ACCEL PEDAL SENSOR 2 : 1/2 of ACCEL PEDAL SENSOR 1

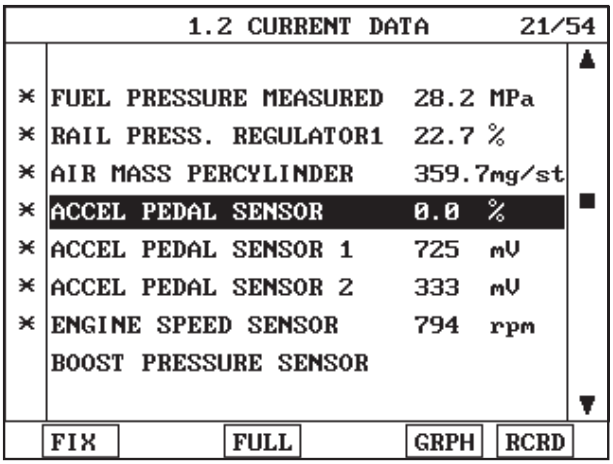


Fig.1

Fig.1) APS output data at warm idle. Check if output value is rising and "ACCEL PEDAL SENSOR 2" is 1/2 of "ACCEL PEDAL SENSOR 1" signal.

SLDFL6469L

TERMINAL AND CONNECTOR INSPECTION E8D02EBC

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damage of component.
2. Perform checking procedure as follows.
   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.
   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

   NOTE

   Disconnect the pin which requires checking at mail connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position)
3. Is the problem found?

   YES

   ▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

   NO

   ▶ Go to "Power Circuit Inspection".

POWER CIRCUIT INSPECTION ED8A4D68

1. IG Key "OFF", Engine "OFF".
2. Disconnect APS connector.
3. IG Key "ON".
4. Measure the voltage of APS connector terminal 5.

Specification : 4.8V~5.1V

5. Is the measured voltage within the specification?

YES

▶ Go to "Signal Circuit Inspection".

NO

▶ If the measured voltage is not within the specified value, find and repair short to battery in APS 1 power circuit and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION ECF17437

1. Check open in signal circuit

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect APS connector and ECM connector.

   3) Check continuity between APS connector terminal 3 and ECM connector (CUD-K) terminal 9.

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification?

YES

▶ Go to "Check short to battery in signal circuit" as follows.

NO

▶ Repair open in signal circuit and go to "Verification of Vehicle Repair".

2. Check short to battery in signal circuit

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect APS connector and ECM connector.

   3) IG Key "ON".

   4) Measure the voltage of APS connector terminal 3 .

Specification : 0.0V~0.1V

   5) Is abnormal voltage detected in signal circuit with both connector disconnected?

YES

▶ Repair short to battery and go to "Verification of Vehicle Repair".

NO

▶ Go to "Ground Circuit Inspection".

GROUND CIRCUIT INSPECTION EBF8609C

1. IG Key "OFF", Engine "OFF".
2. Disconnect APS connector.
3. IG Key "ON".
4. Measure the voltage of APS connector terminal 5. [TEST "A"]
5. Measure the voltage of APS connector terminal 5 and terminal 4. [TEST "B"]
   (terminal 5 : Check + prove , terminal 4 : Check - prove)

Specification : [TEST "A"] Voltage - [TEST "B"] Voltage = below 200mV

6. Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

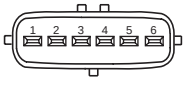
NO

▶ When "B" voltage is not detected : Repair open in ground circuit and go to "Verification of Vehicle Repair".
▶ When the voltage difference between "A" and "B" is above 200mV : Eliminate the causes of excessive resistance and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E4646FE7

1. IG Key "OFF", Engine "OFF".
2. Disconnect APS connector.
3. Check resistance for each terminal refering to Resistance characteristic table.

Specification : Resistance characteristic table for each terminal

	Checking point	Resistance(KΩ 20℃)		Characteristic	Component Connector Shape
		Pedal Depressed	Pedal released		
APS 1	5(power)-4(ground)	1.0±0.1KΩ	1.0±0.1KΩ	Unchanged	 SLDFL6474L
	5(power)-3(signal)	1.8±0.1KΩ	1.1±0.1KΩ	Resistance drops	
	3(signal)-4(ground)	1.1±0.1KΩ	1.8±0.1KΩ	Resistance rises	
APS 2	6(power)-2(ground)	2.0±0.1KΩ	2.0±0.1KΩ	Unchanged	
	6(power)-1(signal)	2.9±0.1KΩ	2.1±0.1KΩ	Resistance drops	
	1(signal)-2(ground)	1.1±0.1KΩ	1.8±0.1KΩ	Resistance rises	

4. Are resistances for each terminal measured correctly?

YES

▶ Go to "Verification of Vehicle Rapair".

NO

▶ Replace APS and go to "Verification of Vehicle Rapair".

VERIFICATION OF VEHICLE REPAIR EA616AB6

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P2128 THROTTLE/PEDAL POSITION SENSOR/SWITCH "E" CIRCUIT HIGH INPUT

COMPONENT LOCATION EEEED708

Refer to DTC P2123.

GENERAL DESCRIPTION EFCD1379

Refer to DTC P2123.

DTC DESCRIPTION E1DE9AB4

P2128 is set when output voltage of APS 2 is above the maximum value of 2.463V for more than 0.18 sec. This code is due to the short to battery in APS 2 power circuit and signal circuit or open in sensor ground circuit.

DTC DETECTING CONDITION E4C41786

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• APS 2 Circuit
• APS component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• When output signal is above the maximum value (above 2464mV)</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 180ms</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• APS standard value is 0%.
• Limp home idle engine speed is fixed at 1200RPM.</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>YES</td></tr>
<tr><td>MIL</td><td>ON</td></tr>
</table>

SPECIFICATION EB66ACFD

	Pedal released	Pedal depressed	Sensor Type
APS 1	0.7V~0.8V	3.8V~4.4V	Variable resistance type(Potentiometer)
APS 2	0.275V~0.475V	1.75V~2.35V	

SCHEMATIC DIAGRAM EFF93557

Refer to DTC P2123.

SIGNAL WAVEFORM AND DATA E16D0F8C

Refer to DTC P2123.

MONITOR SCANTOOL DATA E806A37C

Refer to DTC P2123.

TERMINAL AND CONNECTOR INSPECTION E3033303

Refer to DTC P2123.

POWER CIRCUIT INSPECTION E969C0A6

1. IG Key "OFF", Engine "OFF".
2. Disconnect APS connector.
3. IG Key "ON".
4. Measure the voltage of APS connector terminal 6.

Specification : 4.8V~5.1V

5. Is the measured voltage within the specification?

YES

▶ Go to "Signal Circuit Inspection".

NO

▶ If the measured voltage is not within the specified value, find and repair short to battery in APS 2 power circuit and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION E1661075

1. Check open in signal circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect APS connector and ECM connector.
   3) Check continuity between APS connector terminal 1 and ECM connector (CUD-K) terminal 31.

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification?

YES

▶ Go to "2. Check short to battery in signal circuit" as follows.

NO

▶ Repair open in signal circuit and go to "Verification of Vehicle Repair".

2. Check short to battery in signal circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect APS connector and ECM connector.
   3) IG Key "ON".
   4) Measure the voltage of APS connector terminal 1 .

Specification : 0.0V~0.1V

5) Is abnormal voltage detected in signal circuit with both connector disconnected?

YES

▶ Repair short to battery and go to "Verification of Vehicle Repair".

NO

▶ Go to "Ground Circuit Inspection".

GROUND CIRCUIT INSPECTION E4EE5060

1. IG Key "OFF", Engine "OFF".
2. Disconnect APS connector.
3. IG Key "ON".
4. Measure the voltage of APS connector terminal 6. [TEST "A"]
5. Measure the voltage of APS connector terminal 6 and terminal 2. [TEST "B"]
   (terminal 6 : Check + prove , terminal 2 : Check - prove)

Specification : [TEST "A"] Voltage - [TEST "B"] Voltage = below 200mV

6. Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

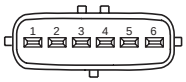
▶ When "B" voltage is not detected : Repair open in ground circuit and go to "Verification of Vehicle Repair".
▶ When the voltage difference between "A" and "B" is above 200mV : Eliminate the causes of excessive resistance and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION EC792182

1. IG Key "OFF", Engine "OFF".
2. Disconnect APS connector.
3. Check resistance for each terminal refering to Resistance characteristic table.

Specification : Resistance characteristic table for each terminal

	Checking point	Resistance(KΩ 20℃)		Characteristic	Component Connector Shape
		Pedal Depressed	Pedal released		

APS 1	5(power)-4(ground)	1.0±0.1KΩ	1.0±0.1KΩ	Unchanged	 SLDFL6474L
	5(power)-3(signal)	1.8±0.1KΩ	1.1±0.1KΩ	Resistance drops	
	3(signal)-4(ground)	1.1±0.1KΩ	1.8±0.1KΩ	Resistance rises	
APS 2	6(power)-2(ground)	2.0±0.1KΩ	2.0±0.1KΩ	Unchanged	
	6(power)-1(signal)	2.9±0.1KΩ	2.1±0.1KΩ	Resistance drops	
	1(signal)-2(ground)	1.1±0.1KΩ	1.8±0.1KΩ	Resistance rises	

4. Are resistances for each terminal measured correctly?

YES

▶ Go to "Verification of Vehicle Rapair".

NO

▶ Replace APS and go to "Verification of Vehicle Rapair".

VERIFICATION OF VEHICLE REPAIR EA674EFC

Refer to DTC P2123.

DTC P2138 THROTTLE/PEDAL POSITION SENSOR/SWITCH "D" / "E" VOLTAGE CORRELATION

COMPONENT LOCATION E7FA101C

Refer to DTC P2123.

GENERAL DESCRIPTION E24CF4E7

Refer to DTC P2123.

DTC DESCRIPTION E36B9EF5

P2138 is set when APS 2 output voltage which is not 1/2 of APS 1 output voltage is detected for more than 0.24 sec. Careful inspection of poor connection between APS 1 and APS 2, resistance characteristic of APS component is needed.

DTC DETECTING CONDITION E9E52727

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• APS 1 Circuit
• APS 2 Circuit
• APS component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG Key "ON"(Accelerator pedal depressed)</td></tr>
<tr><td>ThresholdValue</td><td colspan="3">• When APS 1, 2 signal is all above 0% and below 5%.
- The difference between APS 1and 2 is above 308mV
• When APS 1, 2 signal is all above 7%.
- The difference between APS 1 and 2 is above 405mV</td></tr>
<tr><td>DiagnosticTime</td><td colspan="3">• 0.24 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel Cut</td><td>NO</td><td rowspan="4">• APS standard value is 0%.
• Limp home idle engine speed is fixed at 1200RPM.</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>YES</td></tr>
<tr><td>MIL</td><td>ON</td></tr>
</table>

SPECIFICATION E248E9B6

	Pedal released	Pedal depressed	Sensor Type
APS 1	0.7V~0.8V	3.8V~4.4V	Variable resistance type(Potentiometer)
APS 2	0.275V~0.475V	1.75V~2.35V	

SCHEMATIC DIAGRAM E6ACA70F

Refer to DTC P2123.

SIGNAL WAVEFORM AND DATA E166867F

Refer to DTC P2123.

MONITOR SCANTOOL DATA EFBEDC82

Refer to DTC P2123.

TERMINAL AND CONNECTOR INSPECTION EAEFB97D

Refer to DTC P2123.

POWER CIRCUIT INSPECTION EC3FE7E8

1. IG Key "OFF", Engine "OFF".
2. Disconnect APS connector.
3. IG Key "ON".
4. Measure the voltage of APS connector terminal 5.
5. Measure the voltage of APS connector terminal 6.

Specification : 4.8V~5.1V

6. Is the measured voltage within the specification?

YES

▶ Go to "Signal Circuit Inspection".

NO

▶ If the measured voltage is not within the specified value, find and repair trouble causing part in circuits and go to "Verification of Vehicle Repair".
☞ When the measured voltage of APS 1 is higher than the specified value : Refer to P0643 Circuit Inspection.
☞ When the measured voltage of APS 2 is higher than the specified value : Refer to P0653 Circuit Inspection.
☞ When the measured voltage of APS 1 is lower than the specified value : Refer to P0642 Circuit Inspection.
☞ When the measured voltage of APS 2 is lower than the specified value : Refer to P0652 Circuit Inspection.

SIGNAL CIRCUIT INSPECTION EC2643F5

1. Check open in signal circuit
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect APS connector and ECM connector.
   3) Check continuity between APS connector terminal 3 and ECM connector (CUD-K) terminal 9.(APS 1)
   4) Check continuity between APS connector terminal 1 and ECM connector (CUD-K) terminal 31.(APS 2)

Specification : Continuity (below 1.0Ω)

   5) Is the measured resistance within the specification?

YES

▶ Go to "2. Check short in signal circuit (APS 1)"as follows.

NO

▶ Repair open in signal circuit and go to "Verification of Vehicle Repair".

2. Check short in signal circuit (APS 1)

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect APS connector and ECM connector.

   3) IG Key "ON".

   4) Check continuity between APS connector terminal 3 and chassis ground. (Check short to ground)

   5) Measure the voltage of APS connector terminal 3. (Check short to battery)

Specification :
Check short to ground : Discontinuity (Infinite Ω)
Check short to battery : 0.0V~0.1V

   6) Is APS 1 signal circuit insulated normally?

   YES

   ▶ Go to "3.Signal Circuit Inspection (APS 2)" as follows.

   NO

   ▶ Repair short in circuit and go to "Verification of Vehicle Repair".

3. Signal Circuit Inspection (APS 2)

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect APS connector and ECM connector.

   3) IG Key "ON".

   4) Check continuity between APS connector terminal 1 and chassis ground. (Check short to ground)

   5) Measure the voltage of APS connector terminal 1. (Check short to battery)

Specification :
Check short to ground : Discontinuity (Infinite Ω)
Check short to battery : 0.0V~0.1V

   6) Is APS 2 signal circuit insulated normally?

   YES

   ▶ Go to "Ground Circuit Inspection".

   NO

   ▶ Repair short in circuit and go to "Verification of Vehicle Repair".

GROUND CIRCUIT INSPECTION E6D436E4

1. Check ground circuit (APS1)

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect APS connector.

3) IG Key "ON".

4) Measure the voltage of APS terminal 5. [TEST "A"]

5) Measure the voltage of APS terminal 5 and terminal 4. [TEST "B"]
(terminal 5 : Check + prove , terminal 4 : Check - prove)

Specification : [TEST "A"] Voltage - [TEST "B"] Voltage = below 200mV

6) Is the measured voltage within the specification?

YES

▶ Go to "2. Check ground circuit (APS2)"as follows.

NO

▶ When "B" voltage is not detected : Repair open in ground circuit and go to "Verification of Vehicle Repair".
▶ When the voltage difference between "A" and "B" is above 200mV : Eliminate the causes of excessive resistance and go to "Verification of Vehicle Repair".

2. Check ground circuit (APS2)

1) IG Key "OFF", Engine "OFF".

2) Disconnect APS connector.

3) IG Key "ON".

4) Measure the voltage of APS terminal 6. [TEST "A"]

5) Measure the voltage of APS terminal 6 and terminal 2. [TEST "B"]
(terminal 6 : Check + prove , terminal 2 : Check - prove)

Specification : [TEST "A"] Voltage - [TEST "B"] Voltage = below 200mV

6) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ When "B" voltage is not detected : Repair open in ground circuit and go to "Verification of Vehicle Repair".
▶ When the voltage difference between "A" and "B" is above 200mV : Eliminate the causes of excessive resistance and go to "Verification of Vehicle Repair".

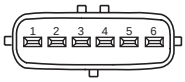
COMPONENT INSPECTION E614900E

1. IG Key "OFF", Engine "OFF".

2. Disconnect APS connector.

3. Check resistance for each terminal refering to Resistance characteristic table.

Specification : Resistance characteristic table for each terminal

	Checking point	Resistance(KΩ 20℃)		Characteristic	Component Connector Shape
		Pedal Depressed	Pedal released		
APS 1	5(power)-4(ground)	1.0±0.1KΩ	1.0±0.1KΩ	Unchanged	 SLDFL6474L
	5(power)-3(signal)	1.8±0.1KΩ	1.1±0.1KΩ	Resistance drops	
	3(signal)-4(ground)	1.1±0.1KΩ	1.8±0.1KΩ	Resistance rises	
APS 2	6(power)-2(ground)	2.0±0.1KΩ	2.0±0.1KΩ	Unchanged	
	6(power)-1(signal)	2.9±0.1KΩ	2.1±0.1KΩ	Resistance drops	
	1(signal)-2(ground)	1.1±0.1KΩ	1.8±0.1KΩ	Resistance rises	

4. Are resistances for each terminal measured correctly?

YES

▶ Go to "Verification of Vehicle Rapair".

NO

▶ Replace APS and go to "Verification of Vehicle Rapair".

VERIFICATION OF VEHICLE REPAIR E9F11AAD

Refer to DTC P2123.

DTC P2238 LAMBDA SENSOR PUMPING CURRENT CIRCUIT LOW (BANK 1 / SENSOR 1)

COMPONENT LOCATION EFFFBC80

SLDFL6479L

GENERAL DESCRIPTION E57304AF

Lambda sensor installed at exhaust manifold is planar ZrO2 dual cell type and it senses O2 density of exhaust gas for accurate EGR control through fuel correction. It also limits smoke which is generated by reach air-fuel mixture at engine maximum loading condition. ECM controls pumping current in order to fit λ -value from linear O2 sensor to 1.0.

[Lean air-fuel mixture(1.0＜λ ＜1.1)] ECM supplies pumping current to Lambda sensor (+pumping current) and activates it for Lambda sensor to have the characteristic at λ =1.0 (0.0 pumping current). With the value of pumping current supplied to Lambda sensor, ECM detects O2 density of exhaust gas.

[Rich air-fuel mixture(0.9＜λ ＜1.0)]ECM takes away pumping current from O2 sensor (-pumping current) and deactivates it for Lambda sensor to have the characteristic at λ =1.0 (0.0 pumping current). With the value of pumping current taken away from Lambda sensor, ECM detects O2 density of exhaust gas.

This performance is the most active and fast at normal operating temp.(450°C~600°C) thus, in order to reach normal operating temp. and last at that temp., heater(heating coil) is integrated with Lambda sensor.Heater coil is controlled by ECM as 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, Lambda sensor temp. is measured and Lambda sensor heater operation varies based on the data.

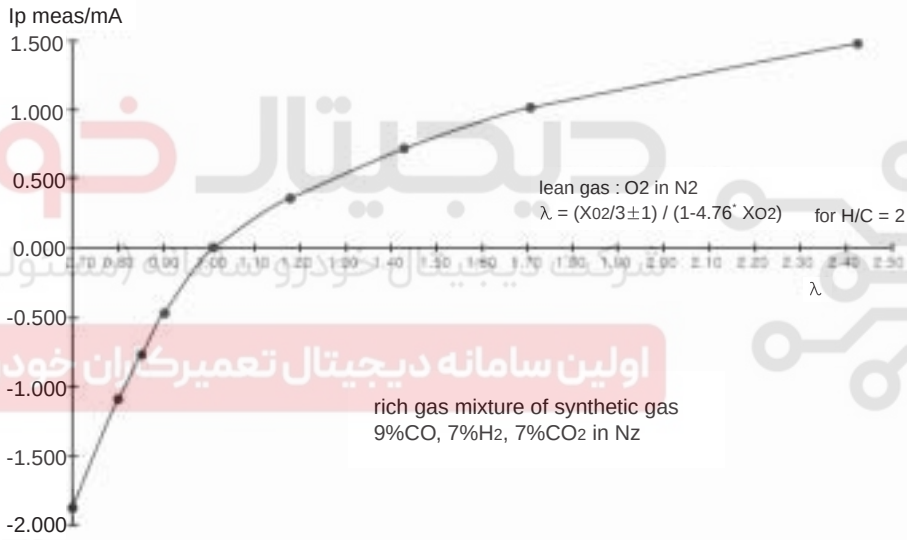
DTC DESCRIPTION E9A9CF31

P2238 is set when 1) short to ground in signal line(terminal4), ground line(terminal3), pumping current line(terminal6) or 2) open in pumping current line(terminal6), ground line(terminal3), sensor power(terminal1) is detected for more than 2 sec.. This code is due to the problem of Lambda sensor circuit.

DTC DETECTING CONDITION E1172A16

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Lambda sensor circuit • Lambda sensor component
Enable Conditions	• Engine running			
ThresholdValue	• Short to GND in Lambda sensor circuit • Open in Lambda sensor circuit			
DiagnosticTime	• 2.0 sec.			
Fail Safe	Fuel Cut	NO		
	EGR Off	NO		
	Fuel Limit	NO		
	MIL	OFF		

SPECIFICATION EAB48F65

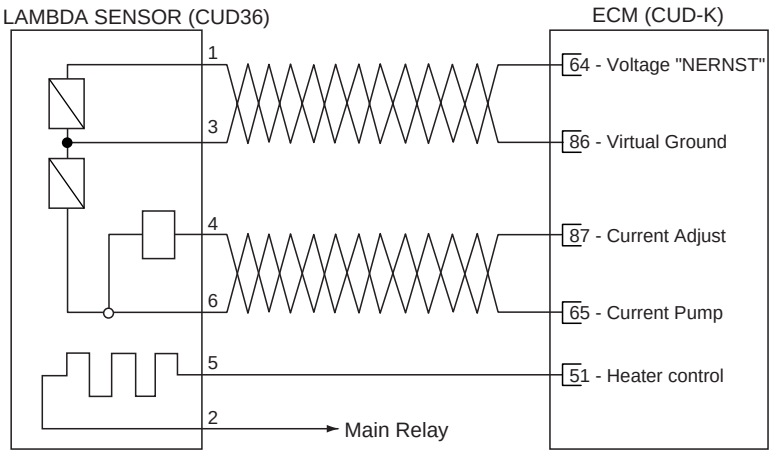


SLDFL6480L

λ value	0.65	0.70	0.80	0.90	1.01
Pumping current	-2.22	-1.82	-1.11	-0.50	0.00
λ value	1.18	1.43	1.70	2.42	Air
Pumping current	0.33	0.67	0.94	1.38	2.54

SCHEMATIC DIAGRAM E4E22CA0

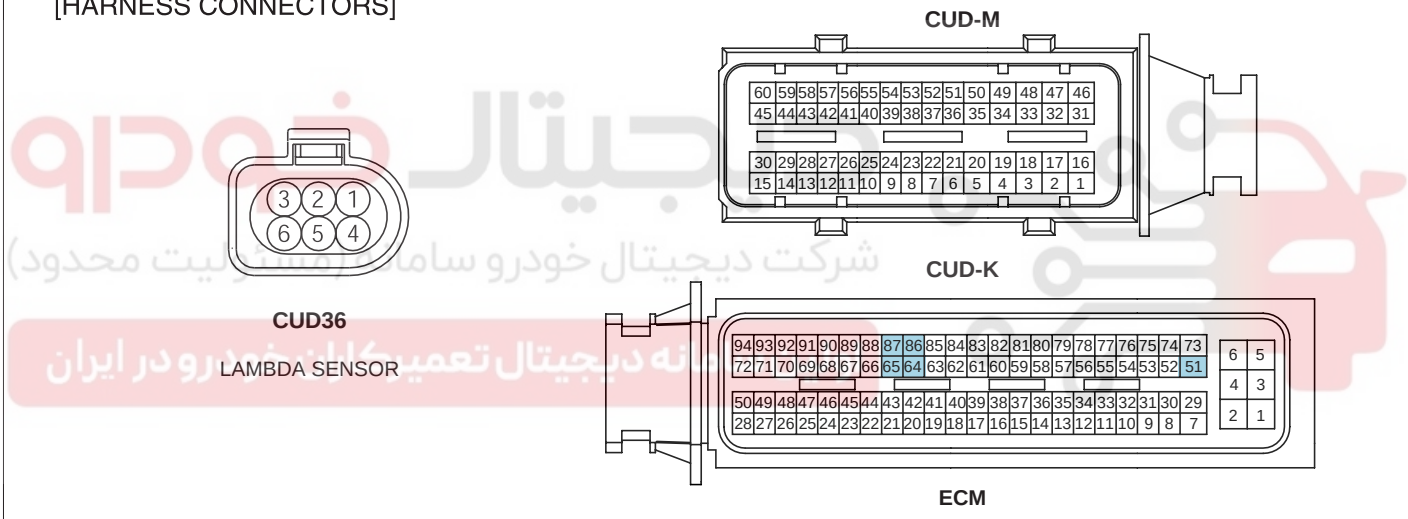
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM CUD-K (64)	Voltage "NERNST"
2	Main Relay	Battery Voltage (B+)
3	ECM CUD-K (86)	Virtual Ground
4	ECM CUD-K (87)	Current Adjust
5	ECM CUD-K (51)	Heater control
6	ECM CUD-K (65)	Current Pump

[HARNESS CONNECTORS]



SLDF27138L

SIGNAL WAVEFORM AND DATA E1D25361

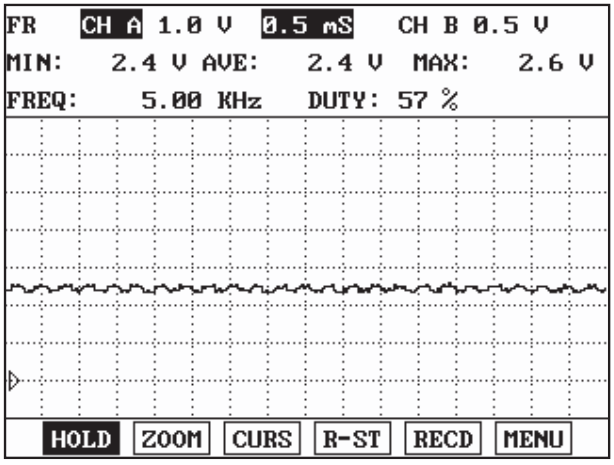


Fig.1

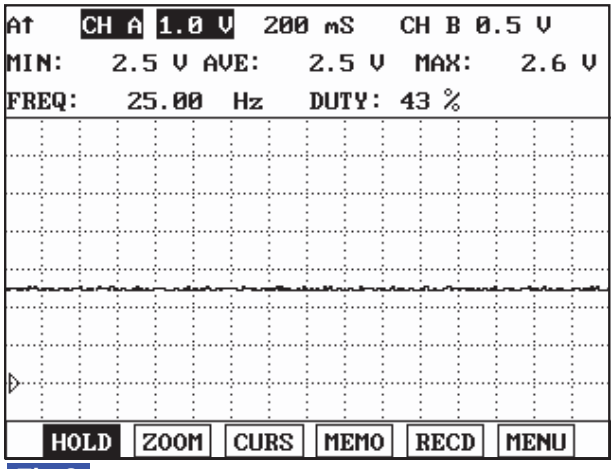


Fig.2

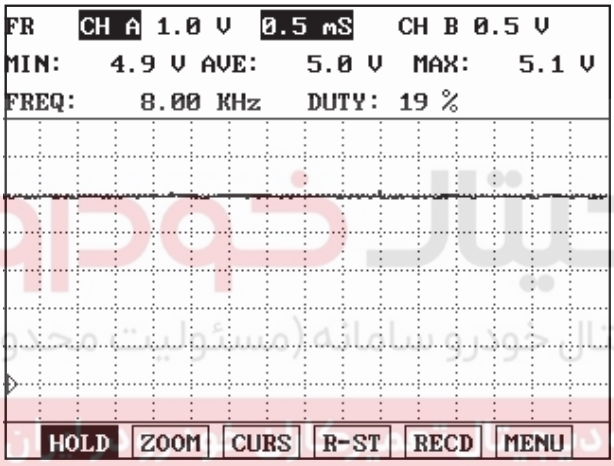


Fig.3

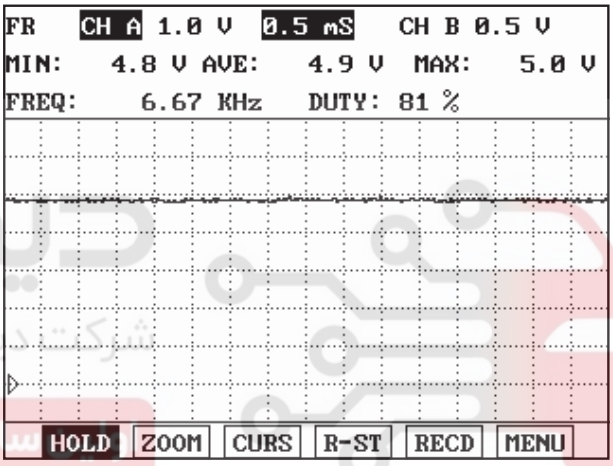


Fig.4

Fig.1) Waveform of Lambda sensor power(terminal 1) at IG KEY "ON" and Engine running. It fluctuates between 2V and 3V periodically.
Fig.2) Waveform of Lambda sensor ground(terminal 3) at IG KEY "ON" and Engine running. 2.5V is displayed.
Fig.3) Waveform of Lambda sensor signal(terminal 4) at IG KEY "ON" and Engine running. 5V is displayed.
Fig.4) Waveform of Lambda sensor pump(terminal 6) at IG KEY "ON" and Engine running. 5V is displayed.

SLDFL6481L

TERMINAL AND CONNECTOR INSPECTION E23C4B34

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.

2. Perform checking procedure as follows.

   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.

   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

NOTE

Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position.)

3. Is the problem found?

YES

▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

NO

▶ Go to "Power Circuit Inspection".

POWER CIRCUIT INSPECTION E5417BFB

1. Check voltage & waveform in sensor power circuit

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect Lambda sensor connector.

   3) IG Key "ON".

   4) Measure the voltage of Lambda sensor connector terminal 1.

Specification : Measured voltage : 2.3V~2.7V

   5) Monitor the waveform in Lambda sensor connector terminal 1.

Specification : It fluctuates between 2V and 3V periodically.

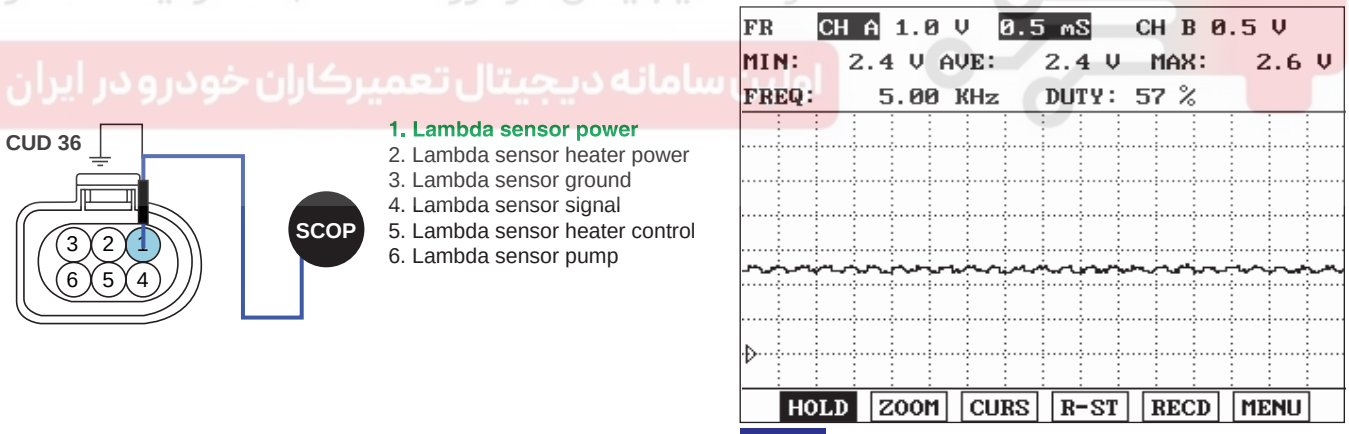


Fig. 1

SLDF27667L

   6) Is the measured voltage within the specification?

YES

▶ Go to "Signal Circuit Inspection".

NO

▶ No voltage detected in Lambda sensor power circuit : Go to "2. Check open in sensor power circuit" as follows.
▶ High voltage detected in Lambda sensor power circuit : Repair short to battery in Lambda sensor power circuit and go to "Verification of Vehicle Repair".

2. Check open in Lambda sensor power circuit

1) IG Key "OFF", Engine "OFF".
2) Disconnect Lambda sensor connector and ECM connector.
3) Check continuity between Lambda sensor connector terminal 1 and ECM connector (CUD-K) terminal 64.

Specification : Continuity(below 1.0Ω)

4) Is the measured voltage within the specification?

YES

▶ Repair short to ground in Lambda sensor power circuit and go to "Verification of Vehicle Repair".

NO

▶ Reapir open in Lambda sensor power circuit and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION EE461AD4

1. Check voltage in sensor signal circuit

1) IG Key "OFF", Engine "OFF".
2) Disconnect Lambda sensor connector.
3) IG Key "ON".
4) Measure the voltage of Lambda sensor connector terminal 4.

Specification : 4.8V~5.1V

5) Is the measured voltage within the specification?

YES

▶ Go to "3. Check sensor pump circuit" as follows.

NO

▶ No voltage detected in Lambda sensor signal circuit : Go to "2. Check open in sensor signal circuit" as follows.
▶ High voltage detected in Lambda sensor power circuit : Repair short to battery in Lambda sensor signal circuit and go to "Verification of Vehicle Repair".

2. Check open in Lambda sensor signal circuit

1) IG Key "OFF", Engine "OFF".
2) Disconnect Lambda sensor connector and ECM connector.
3) Check continuity between Lambda sensor connector terminal 4 and ECM connector (CUD-K) terminal 87.

Specification : Continuity (below 1.0Ω)

4) Is the measured resistance within the specification?

YES

▶ Repair short to ground in Lambda sensor signal circuit and go to "Verification of Vehicle Repair".

NO

▶ Repair open in Lambda sensor signal circuit and go to "Verification of Vehicle Repair".

3. Check voltage in sensor pump circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect Lambda sensor connector.

3) IG Key "ON".

4) Measure the voltage of Lambda sensor connector terminal 6.

Specification : 4.8V~5.1V

5) Is the measured voltage within the specification?

YES

▶ Go to "Ground Circuit Inspection".

NO

▶ No voltage detected in Lambda sensor pumpl circuit : Go to "4. Check open in sensor pump circuit" as follows.
▶ High voltage detected in Lambda sensor power circuit : Repair short to battery in Lambda sensor pump circuit and go to "Verification of Vehicle Repair".

4. Check open in sensor pump circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect Lambda sensor connector and ECM connector.

3) Check continuity between Lambda sensor connector terminal 6 and ECM connector (CUD-K) terminal 65.

Specification : Continuity (below 1.0Ω)

4) Is the measured resistance within the specification?

YES

▶ Repair short to ground in Lambda sensor pump circuit and go to "Verification of Vehicle Repair".

NO

▶ Repair open in Lambda sensor pump circuit and go to "Verification of Vehicle Repair".

GROUND CIRCUIT INSPECTION E2DF9C71

1. Check voltage in sensor ground circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect Lambda sensor connector.

3) IG Key "ON".

4) Measure the voltage of Lambda sensor connector terminal 3.

Specification : 2.3V~2.7V

5) Is the measured voltage within the specification?

YES

▶ Go to"Component Inspection".

NO

▶ No voltage detected in Lambda sensor ground circuit : Go to "2. Check open in sensor ground circuit" as follows.
▶ High voltage detected in Lambda sensor ground circuit : Repair short to battery in Lambda sensor ground circuit and go to "Verification of Vehicle Repair".

2. Check open in sensor ground circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect Lambda sensor connector and ECM connector.

3) Check continuity between Lambda sensor connector terminal 3 and ECM connector (CUD-K) terminal 86.

Specification : Continuity (below 1.0Ω)

4) Is the measured resistance within the specification?

YES

▶ Repair short to ground in Lambda sensor ground circuit and go to "Verification of Vehicle Repair".

NO

▶ Repair open in Lambda sensor ground circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION EBDD92E9

1. IG Key "OFF", Engine "OFF".
2. Disconnect Lambda sensor connector.
3. Perform visual inspection for each checking point as follows.
   1) Check corrosion inside of Lambda sensor terminal.
   2) Check damaged coverring and open in component wiring.
   3) Check connecting torque(poor connection) of Lambda sensor component.
   4) Disconnect Lambda sensor and check deformation, clogging, melting of Lambda detecting prove.

Specification : Everyting OK

4. Is any problem of Lambda sensor detected?

YES

▶ Replace Lambda sensor and go to "Verification of Vehicle Repair".

NO

▶ Refer to "NOTE" as follows.

NOTE

In diesel engine, ultra lean combustion generates at normal operating condition. Therefore, Lambda sensor signal change in accordance with engine acceleration and various loading condition rarely happens, unlikely to linear Lambda sensor of gasoline engine. Moreover, pumping current is not measurable with normal measuring device(ampere meter) because maximum value is 3mA. If DTC code is recorded continuously eventhough circuit inspection is correctly performed and no problem at visual inspection of component is detected, replace Lambda sensor.

VERIFICATION OF VEHICLE REPAIR E696F2B7

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P2239 LAMBDA SENSOR PUMPING CURRENT CIRCUIT HIGH (BANK 1 / SENSOR 1)

COMPONENT LOCATION E32C725E

Refer to DTC P2238.

GENERAL DESCRIPTION EC28F0FE

Refer to DTC P2238.

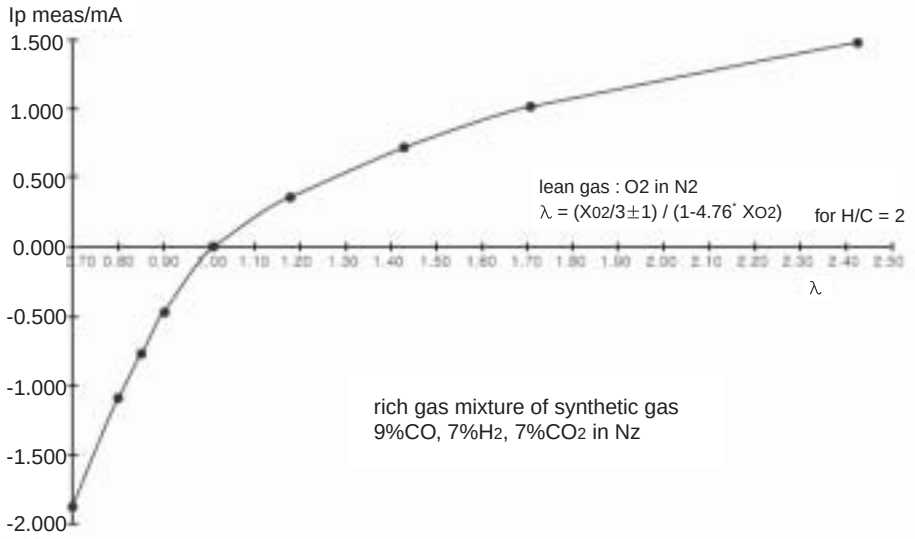
DTC DESCRIPTION EBECBB09

P2239 is set when 1) short to battery in signal line(terminal4), ground line(terminal3), power line(terminal1), pumping current line(terminal6) or 2) open in ground line(terminal 86) is detected for more than 2 sec.. This code is due to the problem of Lambda sensor circuit.

DTC DETECTING CONDITION E301FCCA

Item	Detecting Condition		Possible Cause
DTC Strategy	• Voltage monitoring		• Lambda sensor circuit • Lambda sensor component
Enable Conditions	• Engine running		
ThresholdValue	• Short to battery in Lambda sensor circuit - 2.0 sec. • Short to open in Lambda sensor ground circuit - 60 sec.		
DiagnosticTime	• 2.0 sec.		
Fail Safe	Fuel Cut	NO	
	EGR Off	NO	
	Fuel Limit	NO	
	MIL	OFF	

SPECIFICATION E73607F1



SLDFL6480L

λ value	0.65	0.70	0.80	0.90	1.01
Pumping current	-2.22	-1.82	-1.11	-0.50	0.00
λ value	1.18	1.43	1.70	2.42	Air
Pumping current	0.33	0.67	0.94	1.38	2.54

SCHEMATIC DIAGRAM EF9460E8

Refer to DTC P2238.

SIGNAL WAVEFORM AND DATA EE28F7AF

Refer to DTC P2238.

TERMINAL AND CONNECTOR INSPECTION E3A52755

Refer to DTC P2238.

POWER CIRCUIT INSPECTION E7E9A9D4

1. Check voltage & waveform in sensor power circuit

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect Lambda sensor connector.

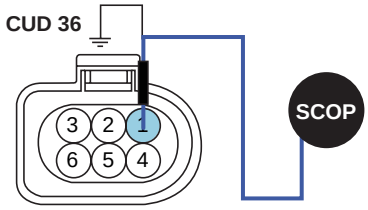
   3) IG Key "ON".

   4) Measure the voltage of Lambda sensor connector terminal 1.

Specification : Measured voltage : 2.3V~2.7V

   5) Monitor the waveform in Lambda sensor connector terminal 1.

Specification : It fluctuates between 2V and 3V periodically.



1. Lambda sensor power
2. Lambda sensor heater power
3. Lambda sensor ground
4. Lambda sensor signal
5. Lambda sensor heater control
6. Lambda sensor pump

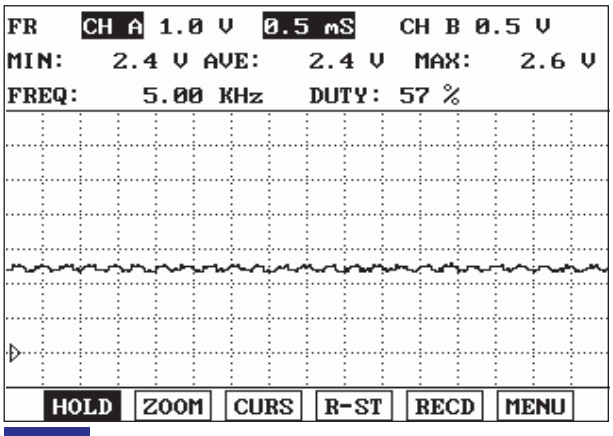


Fig. 1

SLDF27667L

6) Is the measured voltage within the specification?

YES

▶ Go to "Signal Circuit Inspection".

NO

▶ No voltage detected in Lambda sensor power circuit : Go to "2. Check open in sensor power circuit" as follows.
▶ High voltage detected in Lambda sensor power circuit : Repair short to battery in Lambda sensor power circuit and go to "Verification of Vehicle Repair".

2. Check open in Lambda sensor power circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect Lambda sensor connector and ECM connector.

3) Check continuity between Lambda sensor connector terminal 1 and ECM connector (CUD-K) terminal 64.

Specification : Continuity(below 1.0Ω)

4) Is the measured voltage within the specification?

YES

▶ Repair short to ground in Lambda sensor power circuit and go to "Verification of Vehicle Repair".

NO

▶ Reapir open in Lambda sensor power circuit and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION EE4D33B5

1. Check voltage in sensor signal circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect Lambda sensor connector.

3) IG Key "ON".

4) Measure the voltage of Lambda sensor connector terminal 4.

Specification : 4.8V~5.1V

5) Is the measured voltage within the specification?

YES

▶ Go to "3. Check sensor pump circuit" as follows.

NO

▶ No voltage detected in Lambda sensor signal circuit : Go to "2. Check open in sensor signal circuit" as follows.
▶ High voltage detected in Lambda sensor power circuit : Repair short to battery in Lambda sensor signal circuit and go to "Verification of Vehicle Repair".

2. Check open in Lambda sensor signal circuit

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect Lambda sensor connector and ECM connector.

   3) Check continuity between Lambda sensor connector terminal 4 and ECM connector (CUD-K) terminal 87.

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification?

   YES

   ▶ Repair short to ground in Lambda sensor signal circuit and go to "Verification of Vehicle Repair".

   NO

   ▶ Repair open in Lambda sensor signal circuit and go to "Verification of Vehicle Repair".

3. Check voltage in sensor pump circuit

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect Lambda sensor connector.

   3) IG Key "ON".

   4) Measure the voltage of Lambda sensor connector terminal 6.

Specification : 4.8V~5.1V

   5) Is the measured voltage within the specification?

   YES

   ▶ Go to "Ground Circuit Inspection".

   NO

   ▶ No voltage detected in Lambda sensor pumpl circuit : Go to "4. Check open in sensor pump circuit" as follows.
   ▶ High voltage detected in Lambda sensor power circuit : Repair short to battery in Lambda sensor pump circuit and go to "Verification of Vehicle Repair".

4. Check open in sensor pump circuit

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect Lambda sensor connector and ECM connector.

   3) Check continuity between Lambda sensor connector terminal 6 and ECM connector (CUD-K) terminal 65.

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification?

   YES

▶ Repair short to ground in Lambda sensor pump circuit and go to "Verification of Vehicle Repair".

NO

▶ Repair open in Lambda sensor pump circuit and go to "Verification of Vehicle Repair".

GROUND CIRCUIT INSPECTION E7198EE6

1. Check voltage in sensor ground circuit

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect Lambda sensor connector.

   3) IG Key "ON".

   4) Measure the voltage of Lambda sensor connector terminal 3.

Specification : 2.3V~2.7V

   5) Is the measured voltage within the specification?

YES

▶ Go to"Component Inspection".

NO

▶ No voltage detected in Lambda sensor ground circuit : Go to "2. Check open in sensor ground circuit" as follows.
▶ High voltage detected in Lambda sensor ground circuit : Repair short to battery in Lambda sensor ground circuit and go to "Verification of Vehicle Repair".

2. Check open in sensor ground circuit

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect Lambda sensor connector and ECM connector.

   3) Check continuity between Lambda sensor connector terminal 3 and ECM connector (CUD-K) terminal 86.

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification?

YES

▶ Repair short to ground in Lambda sensor ground circuit and go to "Verification of Vehicle Repair".

NO

▶ Repair open in Lambda sensor ground circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION EADE64E5

1. IG Key "OFF", Engine "OFF".

2. Disconnect Lambda sensor connector.
3. Perform visual inspection for each checking point as follows.
   1) Check corrosion inside of Lambda sensor terminal.
   2) Check damaged coverring and open in component wiring.
   3) Check connecting torque(poor connection) of Lambda sensor component.
   4) Disconnect Lambda sensor and check deformation, clogging, melting of Lambda detecting prove.

Specification : Everyting OK

4. Is any problem of Lambda sensor detected?

YES

▶ Replace Lambda sensor and go to "Verification of Vehicle Repair".

NO

▶ Refer to "NOTE" as follows.

NOTE

In diesel engine, ultra lean combustion generates at normal operating condition. Therefore, Lambda sensor signal change in accordance with engine acceleration and various loading condition rarely happens, unlikely to linear Lambda sensor of gasoline engine. Moreover, pumping current is not measurable with normal measuring device(ampere meter) because maximum value is 3mA. If DTC code is recorded continuously eventhough circuit inspection is correctly performed and no problem at visual inspection of component is detected, replace Lambda sensor.

VERIFICATION OF VEHICLE REPAIR E8AE9BC2

Refer to DTC P2238.

DTC P2251 LAMBDA SENSOR REFERENCE GROUND CIRCUIT/OPEN (BANK 1 / SENSOR 1)

COMPONENT LOCATION E5BEBB36

Refer to DTC P2238.

GENERAL DESCRIPTION EE1648E5

Refer to DTC P2238.

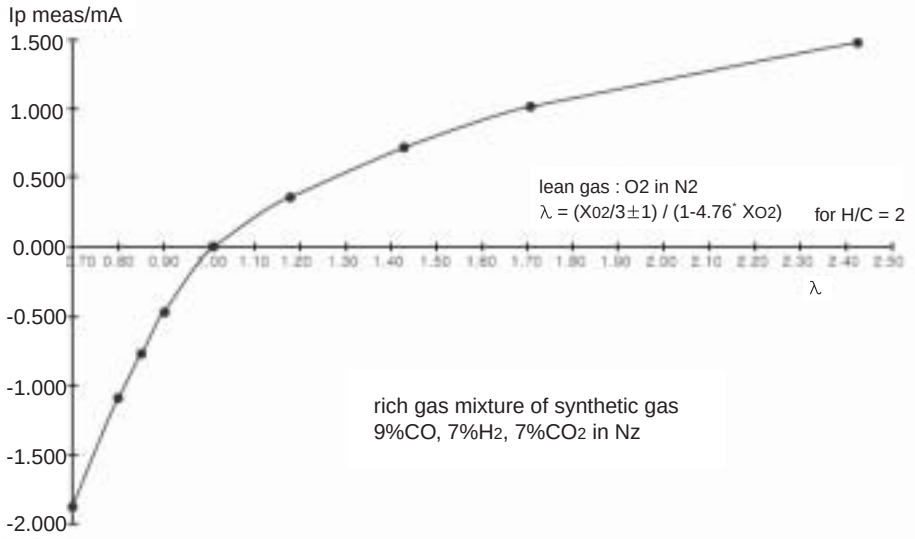
DTC DESCRIPTION E163C515

P2251 is set when short to battery or ground in signal line(terminal4), ground line(terminal3), power line(terminal1), pumping current line(terminal6) or 2) open in ground circuit is detected. This code is due to the problem of Lambda sensor circuit.

DTC DETECTING CONDITION EEFBE24A

Item	Detecting Condition		Possible Cause
DTC Strategy	• Voltage monitoring		• Lambda sensor circuit • Lambda sensor component
Enable Conditions	• Engine running		
ThresholdValue	• Short to battery/GND in Lambda sensor circuit • Open in Lambda sensor ground circuit		
DiagnosticTime	• 2.0 sec.		
Fail Safe	Fuel Cut	NO	
	EGR Off	NO	
	Fuel Limit	NO	
	MIL	OFF	

SPECIFICATION EEACFDC6



SLDFL6480L

λ value	0.65	0.70	0.80	0.90	1.01
Pumping current	-2.22	-1.82	-1.11	-0.50	0.00
λ value	1.18	1.43	1.70	2.42	Air
Pumping current	0.33	0.67	0.94	1.38	2.54

SCHEMATIC DIAGRAM E995E50D

Refer to DTC P2238.

SIGNAL WAVEFORM AND DATA EFE4AA2A

Refer to DTC P2238.

TERMINAL AND CONNECTOR INSPECTION E592555A

Refer to DTC P2238.

POWER CIRCUIT INSPECTION EE0BF4D6

1. Check voltage & waveform in sensor power circuit

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect Lambda sensor connector.

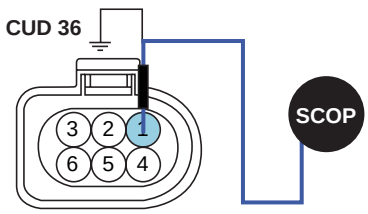
   3) IG Key "ON".

   4) Measure the voltage of Lambda sensor connector terminal 1.

Specification : Measured voltage : 2.3V~2.7V

   5) Monitor the waveform in Lambda sensor connector terminal 1.

Specification : It fluctuates between 2V and 3V periodically.



1. Lambda sensor power
2. Lambda sensor heater power
3. Lambda sensor ground
4. Lambda sensor signal
5. Lambda sensor heater control
6. Lambda sensor pump

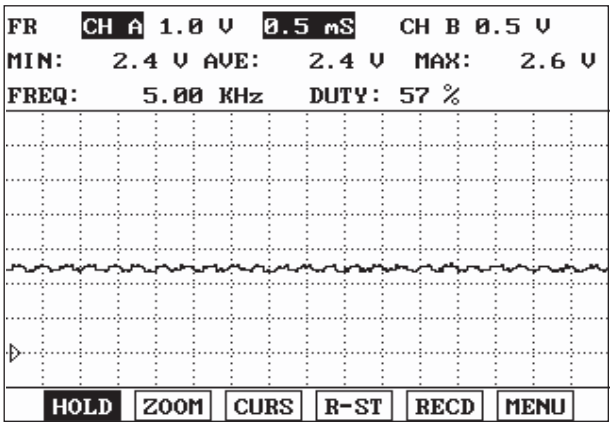


Fig. 1

SLDF27667L

6) Is the measured voltage within the specification?

YES

▶ Go to "Signal Circuit Inspection".

NO

▶ No voltage detected in Lambda sensor power circuit : Go to "2. Check open in sensor power circuit" as follows.
▶ High voltage detected in Lambda sensor power circuit : Repair short to battery in Lambda sensor power circuit and go to "Verification of Vehicle Repair".

2. Check open in Lambda sensor power circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect Lambda sensor connector and ECM connector.

3) Check continuity between Lambda sensor connector terminal 1 and ECM connector (CUD-K) terminal 64.

Specification : Continuity(below 1.0Ω)

4) Is the measured voltage within the specification?

YES

▶ Repair short to ground in Lambda sensor power circuit and go to "Verification of Vehicle Repair".

NO

▶ Reapir open in Lambda sensor power circuit and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION E7ABD440

1. Check voltage in sensor signal circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect Lambda sensor connector.

3) IG Key "ON".

4) Measure the voltage of Lambda sensor connector terminal 4.

Specification : 4.8V~5.1V

5) Is the measured voltage within the specification?

YES

▶ Go to "3. Check sensor pump circuit" as follows.

NO

▶ No voltage detected in Lambda sensor signal circuit : Go to "2. Check open in sensor signal circuit" as follows.
▶ High voltage detected in Lambda sensor power circuit : Repair short to battery in Lambda sensor signal circuit and go to "Verification of Vehicle Repair".

2. Check open in Lambda sensor signal circuit

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect Lambda sensor connector and ECM connector.

   3) Check continuity between Lambda sensor connector terminal 4 and ECM connector (CUD-K) terminal 87.

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification?

   YES

   ▶ Repair short to ground in Lambda sensor signal circuit and go to "Verification of Vehicle Repair".

   NO

   ▶ Repair open in Lambda sensor signal circuit and go to "Verification of Vehicle Repair".

3. Check voltage in sensor pump circuit

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect Lambda sensor connector.

   3) IG Key "ON".

   4) Measure the voltage of Lambda sensor connector terminal 6.

Specification : 4.8V~5.1V

   5) Is the measured voltage within the specification?

   YES

   ▶ Go to "Ground Circuit Inspection".

   NO

   ▶ No voltage detected in Lambda sensor pumpl circuit : Go to "4. Check open in sensor pump circuit" as follows.
   ▶ High voltage detected in Lambda sensor power circuit : Repair short to battery in Lambda sensor pump circuit and go to "Verification of Vehicle Repair".

4. Check open in sensor pump circuit

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect Lambda sensor connector and ECM connector.

   3) Check continuity between Lambda sensor connector terminal 6 and ECM connector (CUD-K) terminal 65.

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification?

   YES

▶ Repair short to ground in Lambda sensor pump circuit and go to "Verification of Vehicle Repair".

NO

▶ Repair open in Lambda sensor pump circuit and go to "Verification of Vehicle Repair".

GROUND CIRCUIT INSPECTION E5BA1A5E

1. Check voltage in sensor ground circuit

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect Lambda sensor connector.

   3) IG Key "ON".

   4) Measure the voltage of Lambda sensor connector terminal 3.

Specification : 2.3V~2.7V

   5) Is the measured voltage within the specification?

YES

▶ Go to"Component Inspection".

NO

▶ No voltage detected in Lambda sensor ground circuit : Go to "2. Check open in sensor ground circuit" as follows.
▶ High voltage detected in Lambda sensor ground circuit : Repair short to battery in Lambda sensor ground circuit and go to "Verification of Vehicle Repair".

2. Check open in sensor ground circuit

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect Lambda sensor connector and ECM connector.

   3) Check continuity between Lambda sensor connector terminal 3 and ECM connector (CUD-K) terminal 86.

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification?

YES

▶ Repair short to ground in Lambda sensor ground circuit and go to "Verification of Vehicle Repair".

NO

▶ Repair open in Lambda sensor ground circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION EFE7493B

1. IG Key "OFF", Engine "OFF".

2. Disconnect Lambda sensor connector.
3. Perform visual inspection for each checking point as follows.
   1) Check corrosion inside of Lambda sensor terminal.
   2) Check damaged coverring and open in component wiring.
   3) Check connecting torque(poor connection) of Lambda sensor component.
   4) Disconnect Lambda sensor and check deformation, clogging, melting of Lambda detecting prove.

Specification : Everyting OK

4. Is any problem of Lambda sensor detected?

YES

▶ Replace Lambda sensor and go to "Verification of Vehicle Repair".

NO

▶ Refer to "NOTE" as follows.

NOTE

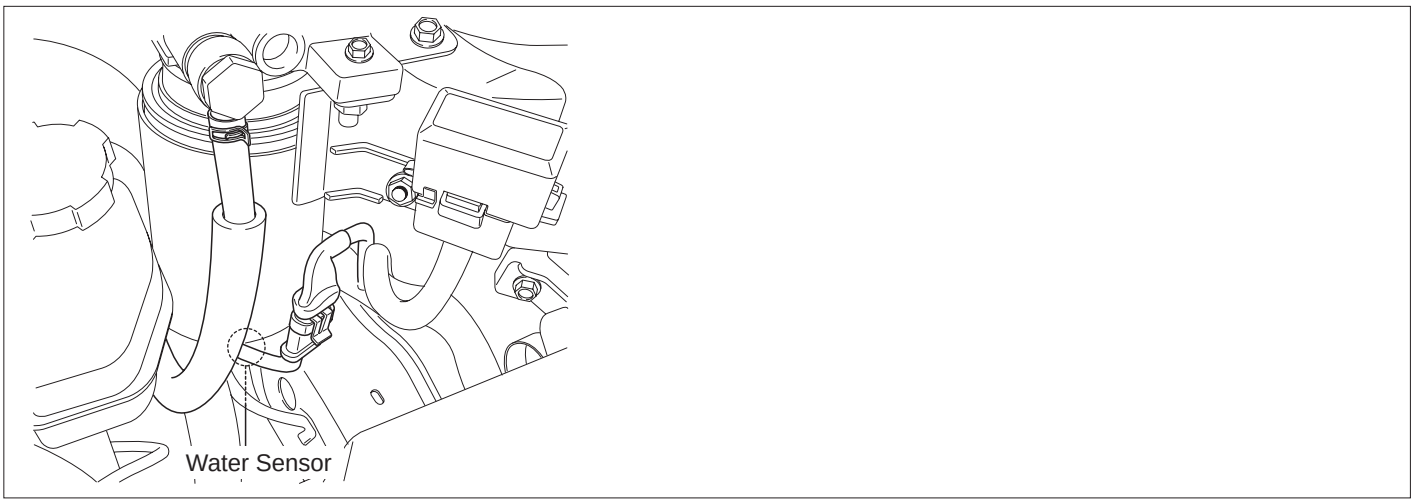
In diesel engine, ultra lean combustion generates at normal operating condition. Therefore, Lambda sensor signal change in accordance with engine acceleration and various loading condition rarely happens, unlikely to linear Lambda sensor of gasoline engine. Moreover, pumping current is not measurable with normal measuring device(ampere meter) because maximum value is 3mA. If DTC code is recorded continuously eventhough circuit inspection is correctly performed and no problem at visual inspection of component is detected, replace Lambda sensor.

VERIFICATION OF VEHICLE REPAIR EEC7096E

Refer to DTC P2238.

DTC P2264 DETECTION OF WATER IN FUEL

COMPONENT LOCATION EFCDF60E



SLDFL6490L

GENERAL DESCRIPTION E8462C39

Diesel fuel filter can seperate water from fuel. If water more than specified amount is detected by "water in fuel sensor" installed at the bottom of fuel filter, "Fuel warning lamp" on cluster turns ON. Especially for high pressure pump and injectors of common rail diesel engine water is fatal. because water causes poor lubrication and corrosion in such accurate devices, furthermore, it leads engine hesitation. In order to prevent this harsh condition to engine, "Water warning lamp" turns ON to let driver relief the gathered water from the filter and engine power generation is limited .

NOTE

If sensing prove of water in fuel sensor contacts with water, impressed voltage on prove is grounded to chassis ground, then 12V is outputted from signal line. With this method, ECM recognizes the amount of water.

DTC DESCRIPTION E31D9E27

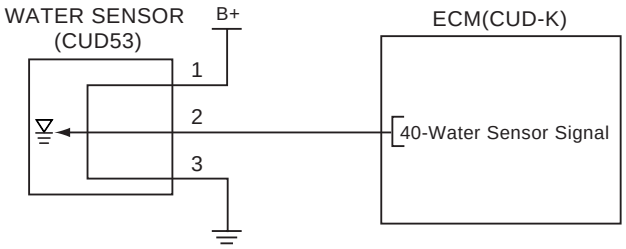
P2264 is set when water in fuel sensor operates for more than 4 sec. Water warning lamp turns on and engine power generation is limited in this condition. When this code is set, water in the filter should be removed to prevent engine from water contained fuel. If same code is set even after removing water, check short to battery in water in fuel sensor signal circuit or component failure.

DTC DETECTING CONDITION EAE61107

Item	Detecting Condition		Possible Cause
DTC Strategy	• Voltage Monitoring		• Water stored inside of fuel filter (remove water inside of filter) • Water in Fuel sensor circuit(short to battery) • Water in Fuel sensor component
Enable Conditions	• IG Key "ON"		
ThresholdValue	• Signal voltage detected at water in fuel sensor		
DiagnosticTime	• 4.0sec.		
Fail Safe	Fuel Cut	NO	
	EGR Off	NO	
	Fuel Limit	YES	
	MIL	OFF	

SCHEMATIC DIAGRAM E115E033

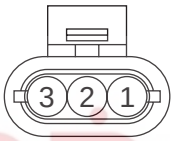
[CIRCUIT DIAGRAM]



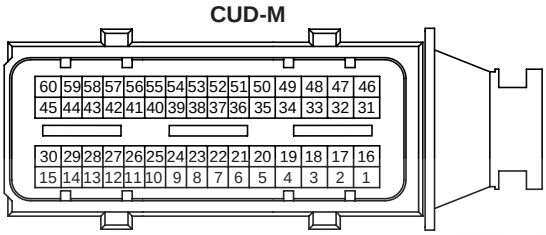
[CONNECTION INFORMATION]

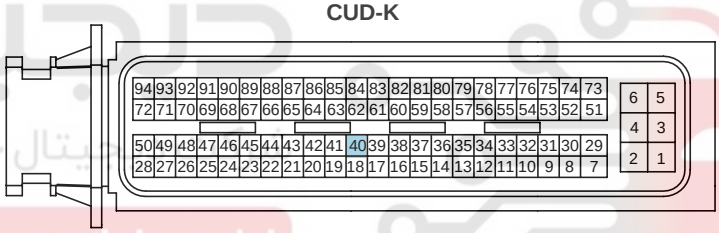
Terminal	Connected to	Function
1	Main Relay	Battery voltage(B+)
2	ECM CUD-K (40)	Sensor Signal
3	Chassis ground	Sensor ground

[HARNESS CONNECTOR]



CUD53
WATER SENSOR





SLDF27136L

TERMINAL AND CONNECTOR INSPECTION ED5520B6

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.

2. Perform checking procedure as follows.

   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.

   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

   NOTE

   Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector or checking connecting condition. (after checking, reconnect the pin at correct position.)

3. Is the problem found?

   YES

   ▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

   NO

▶ Go to "Power Circuit Inspection".

POWER CIRCUIT INSPECTION E6645B67

1. IG Key "OFF", Engine "OFF".
2. Disconnect water sensor connector.
3. IG Key "ON".
4. Measure the voltage of water sensor connector terminal 1.

Specification : 11.0V~12.5V

5. Is the measured voltage within the specification?

YES

▶ Go to "Signal Circuit Inspection".

NO

▶ Repair open in I/P JUNCTION BOX 10A ECU FUSE and related circuit and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION E8F5F01F

1. Check signal circuit voltage
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect water sensor connector.
   3) IG Key "ON".
   4) Measure the voltage of water sensor connector terminal 2.

Specification : 0.0V~0.1V

   5) Is the measured voltage within the specification?

YES

▶ Go to "2. Water warning lamp operation test" as follows.

NO

▶ Repair short to battery and go to "Verification of Vehicle Repair".

2. Water warning lamp operation test
   1) IG Key "OFF", Engine "OFF".
   2) Disconnect water sensor connector.
   3) IG Key "ON".
   4) Connect water sensor connector terminal 1 and terminal 2 using jump wire.

Specification : Water warning lamp on cluster turns ON. 12V battery voltage is detected at ECM connector (CUD-K) terminal 40.

5) Does water warning lamp turn ON? And is 12V battery voltage detected at ECM connector(CUD-K) terminal 40?

YES

▶ Go to "Ground Circuit Inspection".

NO

▶ Repair open in water warning lamp filament and related circuit and go to "Verification of Vehicle Repair".

GROUND CIRCUIT INSPECTION EEFC9169

1. IG Key "OFF", Engine "OFF".
2. Disconnect water in Fuel sensor connector.
3. Check continuity between water in Fuel sensor connector terminal 3 and chassis ground.

Specification : Continuity (below 1.0Ω)

4. Is the measured resistance within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ Repair open in signal circuit and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E59567AF

1. Check water inside of fuel filter

1) IG Key "OFF", Engine "OFF".

2) Disconnect fuel filter assy' from vehicle. (note : fuel filter should be maintained to stand up vertically at disconnecting.)

3) Set up clean vessel like beaker to collect fuel outflowed from filter.

4) Disconnect water in fuel sensor and collect fuel and water mixed to it.

Specification : Outflowed fuel must not contain much water.

5) Does fuel contains much water?

YES

▶ Checking odometer and filter used duration, replace fuel filter if needed. If too much water flowed to fuel filter, check if water flowed into fuel tank and clean up inside of fuel tank.
After replacing filter and clean up fuel tank and go to "Verification of Vehicle Repair".

NO

▶ Go to "2.Check water in fuel sensor component" as follows.

2. Check water in fuel sensor component

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect fuel filter assy' from vehicle. (note : fuel filter should be maintained to stand up vertically at disconnecting.)

   3) Set up clean vessel like beaker to collect fuel outflowed from filter.

   4) Disconnect fuel warning sensor from disconnected fuel filter.

   5) Connect water in fuel sensor to disconnected wiring connector.

   6) IG Key "ON".

   7) Touch water sensing prove of water in fuel sensor to chassis ground.

Specification : Water warning lamp turns ON when touching water sensing prove to chassis ground.

   8) Does water warning lamp operate well?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace water in fuel sensor and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR EC1AA807

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

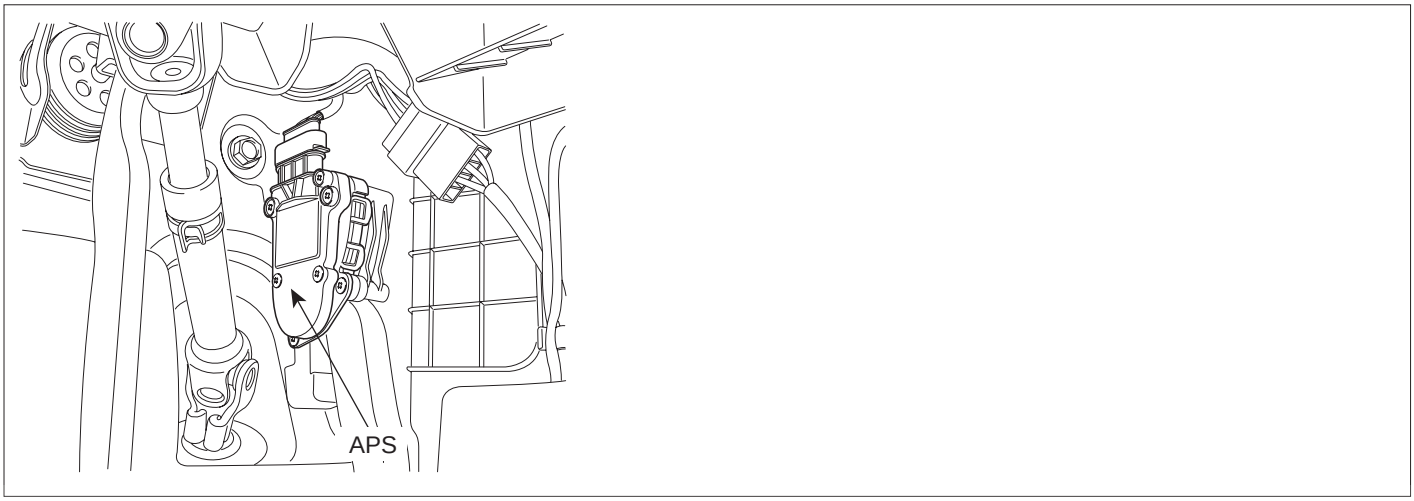
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P2299 BRAKE PEDAL POSITION / ACCELERATOR PEDAL POSITION INCOMPATIBLE

COMPONENT LOCATION E491E05E



SLDFL6496L

GENERAL DESCRIPTION EB40677E

Brake switch monitors malfunction of accel pedal sensor(APS). Drivers depress brake pedal when 1).the voltage higher than driver's intension is detected due to APS malfunction(signal circuit short to high voltage) 2).engine power generates excessively due to fault signal. Like previous example, if driver's intension to decelerate is transmitted to ECM(brake pedal depressed) when APS signal is high, ECM consider APS to be fault and Limp Home mode is activated. When Limp Home mode is activated, engine speed is fixed at 1200RPM and driving performance is limited, later, if correct APS signal is detected, Limp Home mode is deactivated immediately.

DTC DESCRIPTION EF13FC8D

P2299 is set when brake signal is inputted to ECM for more than 0.5 sec. while APS is depressed more than 5% at above 870 RPM and 2 kph. And Limp Home mode is activated with the DTC code occurence. Later, if correct APS signal is detected, Limp Home mode is deactivated immediately. This code is set when APS signal is a bit higher than the voltage at accelerator released position and driver's pedal manipulation, therefore careful inspection of APS and checking driver's pedal depressing habit is required.

DTC DETECTING CONDITION EA975FFE

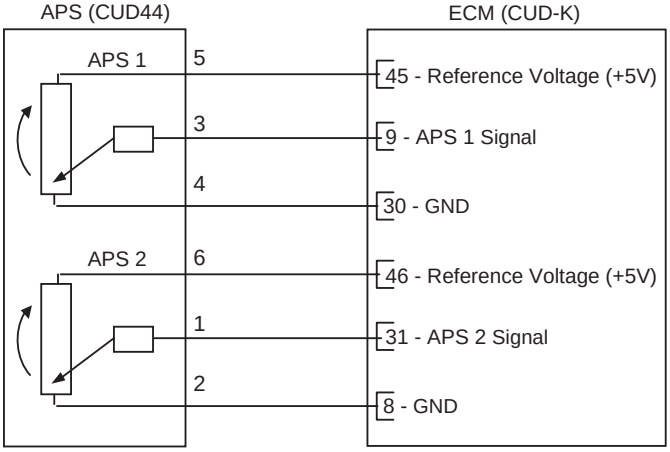
Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• APS 1 Circuit • APS 2 Circuit • APS component
Enable Conditions	• Engine speed is above 870 RPM • Vehicle speed is above 2 kph			
ThresholdValue	• Brake pedal singal inputted at APS output voltage above 5%			
DiagnosticTime	• 0.5 sec.			
Fail Safe	Fuel Cut	NO	• APS standard value is 0%. • Limp home idle engine speed is fixed at 1200RPM. • Error disappears when brake pedal released or accelerator pedal depressed 200% per sec.	
	EGR Off	NO		
	Fuel Limit	YES		
	MIL	OFF		

SPECIFICATION EC9599A0

	Pedal released	Pedal depressed	Sensor Type
APS 1	0.7V~0.8V	3.8V~4.4V	Variable resistance type(Potentiometer)
APS 2	0.275V~0.475V	1.75V~2.35V	

SCHEMATIC DIAGRAM E1815281

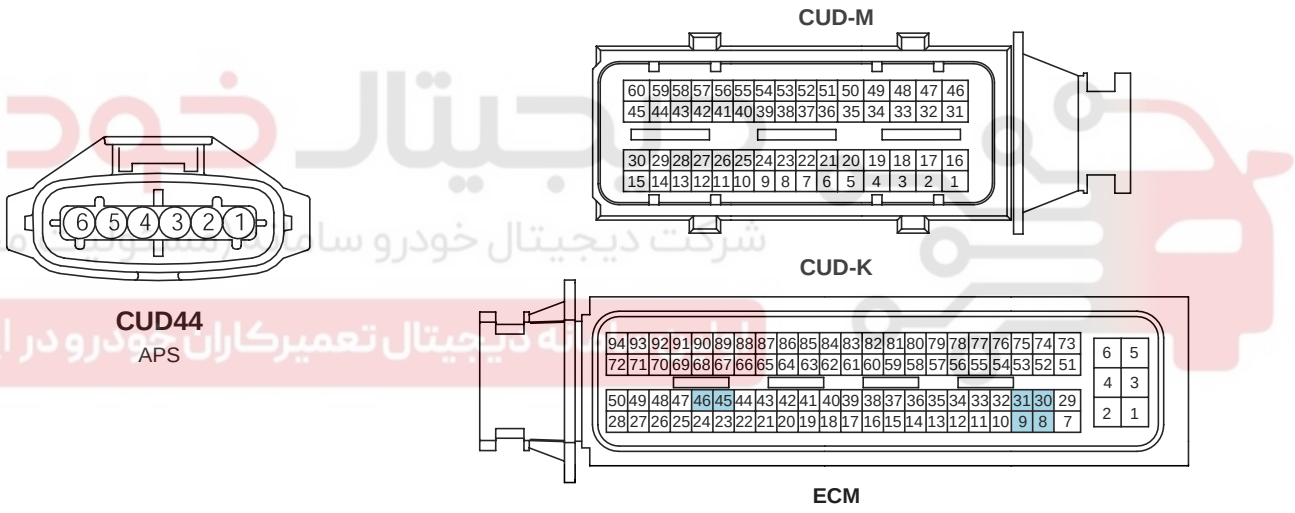
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

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

[HARNESS CONNECTORS]



SLDF27129L

SIGNAL WAVEFORM AND DATA E4B3258E

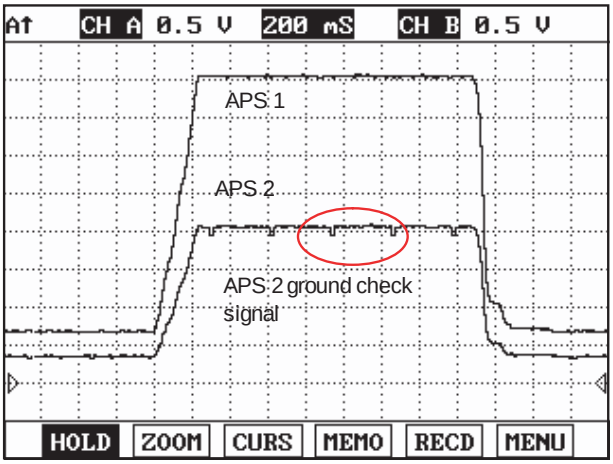


Fig.1

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.

SLDFL6468L

NOTE

APS 2 Ground checking signal is for ECM to monitor APS 2. This signal drops APS 2 output voltage to below 200.39mV per 200msec. If APS 2 output voltage does not drop to below 200.39mV, ECM sets DTC as recognizing ground circuit error of APS 2 .

※ The waveform below 200.39mV is not detectable in Ground checking signal waveform of APS 2 signal. Instead, the waveform which drops a little is detected. If APS 2 data of "SERVICE DATA" on the Scantool varies from 350mV to 0mV periodically, it means it works well.

MONITOR SCANTOOL DATA E3ADF86A

1. Connect scantool to Data Link Cable (DLC).
2. Warm engine up to normal operating temperature.
3. Turn "OFF" electrical devices and A/C.
4. Monitor "ACCEL PEDAL SENSOR", "ACCEL PEDAL SENSOR 1", "ACCEL PEDAL SENSOR 2 " parameter on the scantool.

Specification : At idle(0%)
ACCEL PEDAL SENSOR 1 : 600mV~800mV
ACCEL PEDAL SENSOR 2 : 1/2 of ACCEL PEDAL SENSOR 1

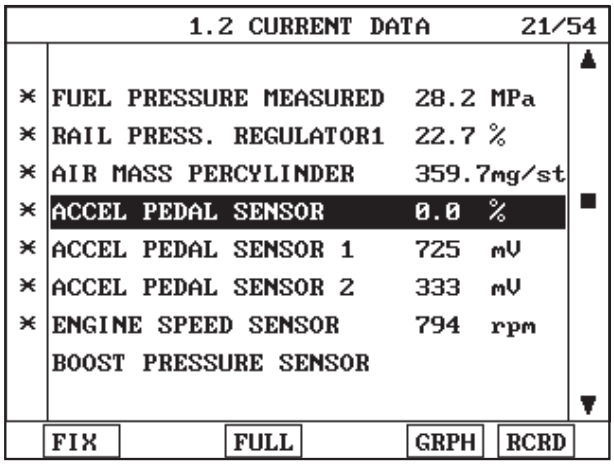


Fig.1

Fig.1) APS output data at warm idle. Check if output value is rising and "ACCEL PEDAL SENSOR 2" is 1/2 of "ACCEL PEDAL SENSOR 1" signal.

SLDFL6469L

TERMINAL AND CONNECTOR INSPECTION E995D721

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damage of component.
2. Perform checking procedure as follows.
   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.
   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

NOTE

Disconnect the pin which requires checking at mail connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position)

3. Is the problem found?

YES

▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

NO

▶ Go to "Power Circuit Inspection".

POWER CIRCUIT INSPECTION E0C010C7

1. IG Key "OFF", Engine "OFF".
2. Disconnect APS connector.
3. IG Key "ON".
4. Measure the voltage of APS connector terminal 5.
5. Measure the voltage of APS connector terminal 6.

Specification : 4.8V~5.1V

6. Is the measured voltage within the specification?

YES

▶ Go to "Signal Circuit Inspection".

NO

▶ If the measured voltage is not within the specified value, find and repair trouble causing part in circuits and go to "Verification of Vehicle Repair".
☞ When the measured voltage of APS 1 is higher than the specified value : Refer to P0643 Circuit Inspection.
☞ When the measured voltage of APS 2 is higher than the specified value : Refer to P0653 Circuit Inspection.
☞ When the measured voltage of APS 1 is lower than the specified value : Refer to P0642 Circuit Inspection.
☞ When the measured voltage of APS 2 is lower than the specified value : Refer to P0652 Circuit Inspection.

SIGNAL CIRCUIT INSPECTION E0852937

1. Check open in signal circuit

1) IG Key "OFF", Engine "OFF".

2) Disconnect APS connector and ECM connector.

3) Check continuity between APS connector terminal 3 and ECM connector (CUD-K) terminal 9.(APS 1)

4) Check continuity between APS connector terminal 1 and ECM connector (CUD-K) terminal 31.(APS 2)

Specification : Continuity (below 1.0Ω)

5) Is the measured resistance within the specification?

YES

▶ Go to "2. Check short in signal circuit (APS 1)"as follows.

NO

▶ Repair open in signal circuit and go to "Verification of Vehicle Repair".

2. Check short in signal circuit (APS 1)

1) IG Key "OFF", Engine "OFF".

2) Disconnect APS connector and ECM connector.

3) IG Key "ON".

4) Check continuity between APS connector terminal 3 and chassis ground. (Check short to ground)

5) Measure the voltage of APS connector terminal 3. (Check short to battery)

Specification :
Check short to ground : Discontinuity (Infinite Ω)
Check short to battery : 0.0V~0.1V

6) Is APS 1 signal circuit insulated normally?

YES

▶ Go to "3.Signal Circuit Inspection (APS 2)" as follows.

NO

▶ Repair short in circuit and go to "Verification of Vehicle Repair".

3. Signal Circuit Inspection (APS 2)

1) IG Key "OFF", Engine "OFF".

2) Disconnect APS connector and ECM connector.

3) IG Key "ON".

4) Check continuity between APS connector terminal 1 and chassis ground. (Check short to ground)

5) Measure the voltage of APS connector terminal 1. (Check short to battery)

Specification :
Check short to ground : Discontinuity (Infinite Ω)
Check short to battery : 0.0V~0.1V

6) Is APS 2 signal circuit insulated normally?

YES

▶ Go to "Ground Circuit Inspection".

NO

▶ Repair short in circuit and go to "Verification of Vehicle Repair".

GROUND CIRCUIT INSPECTION E1DBB70E

1. Check ground circuit (APS1)

1) IG Key "OFF", Engine "OFF".

2) Disconnect APS connector.

3) IG Key "ON".

4) Measure the voltage of APS terminal 5. [TEST "A"]

5) Measure the voltage of APS terminal 5 and terminal 4. [TEST "B"]
(terminal 5 : Check + prove , terminal 4 : Check - prove)

Specification : [TEST "A"] Voltage - [TEST "B"] Voltage = below 200mV

6) Specification : [TEST "A"] Voltage - [TEST "B"] Voltage = below 200mV

YES

▶ Go to "2. Check ground circuit (APS2)"as follows.

NO

▶ When "B" voltage is not detected : Repair open in ground circuit and go to "Verification of Vehicle Repair".
▶ When the voltage difference between "A" and "B" is above 200mV : Eliminate the causes of excessive resistance and go to "Verification of Vehicle Repair".

2. Check ground circuit (APS2)

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect APS connector.

   3) IG Key "ON".

   4) Measure the voltage of APS terminal 6. [TEST "A"]

   5) Measure the voltage of APS terminal 6 and terminal 2. [TEST "B"]
   (terminal 6 : Check + prove , terminal 2 : Check - prove)

Specification : [TEST "A"] Voltage - [TEST "B"] Voltage = below 200mV

   6) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ When "B" voltage is not detected : Repair open in ground circuit and go to "Verification of Vehicle Repair".
▶ When the voltage difference between "A" and "B" is above 200mV : Eliminate the causes of excessive resistance and go to "Verification of Vehicle Repair".

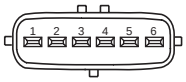
COMPONENT INSPECTION E28F275C

1. IG Key "OFF", Engine "OFF".

2. Disconnect APS connector.

3. Check resistance for each terminal refering to Resistance characteristic table.

Specification : Resistance characteristic table for each terminal

	Checking point	Resistance(KΩ 20℃)		Characteristic	Component Connector Shape
		Pedal Depressed	Pedal released		
APS 1	5(power)-4(ground)	1.0±0.1KΩ	1.0±0.1KΩ	Unchanged	 SLDFL6474L
	5(power)-3(signal)	1.8±0.1KΩ	1.1±0.1KΩ	Resistance drops	
	3(signal)-4(ground)	1.1±0.1KΩ	1.8±0.1KΩ	Resistance rises	
APS 2	6(power)-2(ground)	2.0±0.1KΩ	2.0±0.1KΩ	Unchanged	
	6(power)-1(signal)	2.9±0.1KΩ	2.1±0.1KΩ	Resistance drops	
	1(signal)-2(ground)	1.1±0.1KΩ	1.8±0.1KΩ	Resistance rises	

4. Are resistances for each terminal measured correctly?

YES

▶ Go to "Verification of Vehicle Rapair".

NO

▶ Replace APS and go to "Verification of Vehicle Rapair".

VERIFICATION OF VEHICLE REPAIR EDD9E471

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

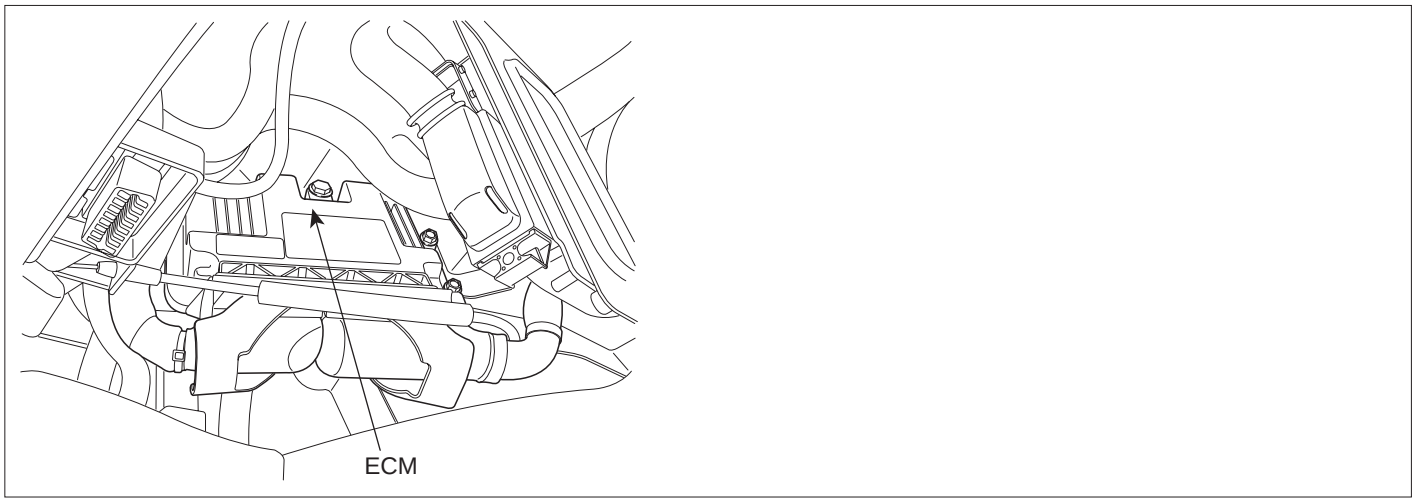
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC U0001 CAN COMMUNICATION MALFUNCTION

COMPONENT LOCATION E97ED61E



SLDFL6237L

GENERAL DESCRIPTION EFCD1A49

Several control units are applied to electronically controlled vehicles. These units perform each control with informations from various sensors. Thus, sharing signal information from sensors is needed, so CAN communication type whose communication speed is high and insensitive to electrical noise by spark generation is adopted to controlling power-train(engine, atutomatic transaxle, ABS, TCS, ECS)As sharing signals of engine speed, APS, engaged gear and torque reduction through CAN communication, ECM and TCM modules control vehicle actively.

DTC DESCRIPTION EE7E5E7C

U0001 is set when signal transmission through CAN communication line is impossible for more than 0.1 sec. because of open or short to ground in CAN communication line. Checking CAN communication BUS and signals from ECM, TCM module is required.

DTC DETECTING CONDITION EA084BF5

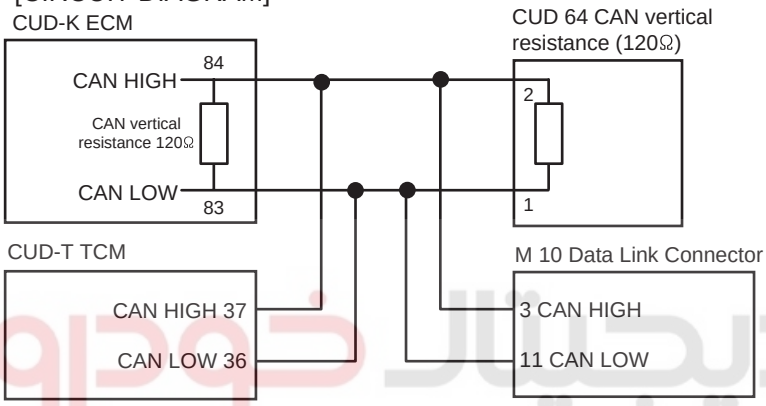
Item	Detecting Condition		Possible Cause
DTC Strategy	• Signal monitoring		• CAN BUS • CAN communication module component
Enable Conditions	• IG Key "ON"		
ThresholdValue	• CAN BUS error between ECM and TCM.		
DiagnosticTime	• 0.1 sec.		
Fail Safe	Fuel Cut	NO	
	EGR Off	NO	
	Fuel Limit	NO	
	MIL	OFF	

SPECIFICATION EA5AA235

Communication Format	DIGITAL "0"		DIGITAL "1"(BUS IDLE)		CAN Communication Line Resistance	
	HIGH	LOW	HIGH	LOW	Inside of ECM	Inside of I/P junction box
CAN 2.0B	3.5V	1.5V	2.5V	2.5V	120Ω (20°C)	120Ω (20°C)

SCHEMATIC DIAGRAM ED9C0835

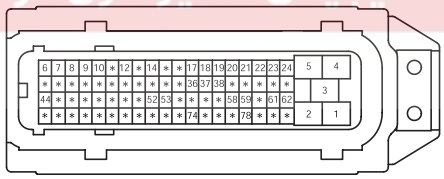
[CIRCUIT DIAGRAM]



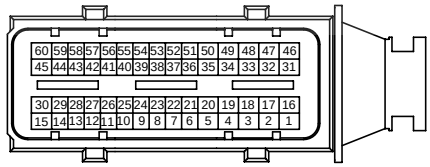
[CONNECTOR INFORMATION]

Terminal	Connected to	Function
84	CUD 64 terminal 2 CUD-T TCM terminal 37 M 10 terminal 3	CAN HIGH
83	CUD 64 terminal 1 CUD-T TCM terminal 36 M 10 terminal 11	CAN LOW

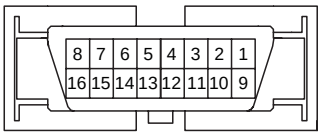
[HARNESS CONNECTOR]



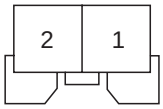
CUD-T TCM



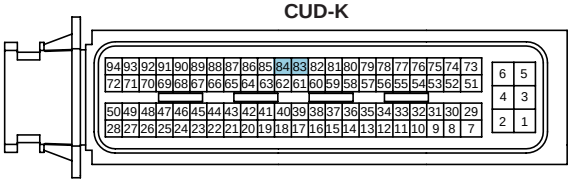
CUD-M



M10 DATA LINK CONNECTOR



CUD 64 RESISTOR



CUD-K

ECM

SLDF27698L

SIGNAL WAVEFORM AND DATA E4B98BF3

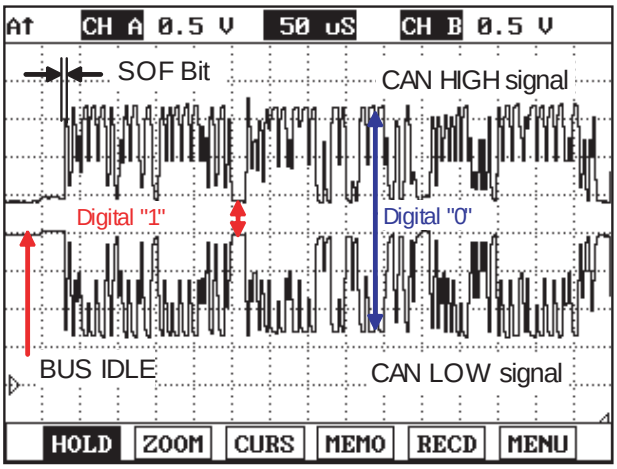


Fig.1 CAN communication waveform

Monitoring CAN HIGH and LOW simultaneously is important in monitoring CAN communication waveform. When CAN HIGH signal rise to 3.5V and LOW signal drops to 1.5V - voltage difference between HIGH and LOW signal is 2V - at BUS IDLE state(DIGITAL "1") whose reference voltage is 2.5V, "0" is recognized. Besides, comparing HIGH and LOW signal if opposite waveform is detected with the reference voltage of 2.5V, Check if current cam signal transfers correctly. Continuous "0"signal above 6BIT means the occurence of error in CAN communication. 1BIT is easily distinguished as calculating the time when "SOF"(START OF FRAME) which notifies the start of frame occurs. Check if "0"signal above 6BIT is detected continuously when monitoring CAN communication waveform.

SUNFL7718L

TERMINAL AND CONNECTOR INSPECTION E664A0F4

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.
2. Perform checking procedure as follows.
   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.
   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

   NOTE

   Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position.)
3. Is the problem found?

   YES

   ▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

   NO

   ▶ Go to "Signal Circuit Inspection".

SIGNAL CIRCUIT INSPECTION E999C993

1. Check CAN BUS resistance
   1) IG Key "OFF", Engine "OFF".
   2) Measure the resistance between DLC terminal 3 and terminal 11. (TEST 1)
   3) Disconnect ECM connector and TCM connector.
   4) Measure the resistance between DLC terminal 3 and terminal 11. (TEST 2)

Specification :
Both ECM and Resistor connected : 60 ± 3Ω (Test 1)
ECM connector disconnected : 120 ± 3Ω (Test 2)

5) Is CAN BUS resistance within the specification?

YES

▶ Go to "2.Check short to ground in CAN BUS" as follows.

NO

▶ Below 10Ω for both conditions(disconnected, connected) : Repair short between CAN BUS and go to "Verification of Vehicle Repair".
▶ 120Ω for both conditions(disconnected, connected) : Go to "4. Check CAN BUS continuity" as follows.
▶ Infinite Ω for both conditions(disconnected, connected) :Repair open in CAN communication circuit between DLC terminal and I/P junction box.

2. Check short to ground in CAN BUS

1) IG Key "OFF", Engine "OFF".

2) Disconnect ECM connector and TCM connector.

3) Check continuity between DLC terminal 3 and chassis ground. (CAN High)

4) Check continuity between DLC terminal 11 and chassis ground. (CAN Low)

Specification : Discontinuity (Infinite Ω)

5) Is measured resistance within the specification?

YES

▶ Go to "3. Check short to battery in CAN BUS" as follows.

NO

▶ Repair short to ground in circuit and go to "Verification of Vehicle Repair".

3. Check short to battery in CAN BUS

1) IG Key "OFF", Engine "OFF".

2) Disconnect ECM connector and TCM connector.

3) IG Key "ON".

4) Measure the voltage of DLC terminal 3. (CAN High)

5) Measure the voltage of DLC terminal 11. (CAN Low)

Specification : 0.0V~0.1V

6) Is measured resistance within the specification with both connector disconnected?

YES

▶ Go to"4. Check CAN BUS continuity" as follows.

NO

▶ Repair short to battery and go to "Verification of Vehicle Repair".

4. Check CAN BUS continuity

1) IG Key "OFF", Engine "OFF".

2) Disconnect ECM connector and TCM connector.

3) Check continuity between DLC terminal 3 and CAN High terminal of each module.
[CAN High terminal] ECM connector terminal 84, TCM connector terminal 3.

4) Check continuity between DLC terminal 11 and CAN Low terminal of each module.
[CAN Low terminal] ECM connector terminal 83, TCM connector terminal 36.

Specification : Continuity(below 1.0Ω)

5) Is the measured resistance within the specification?

YES

▶ Go to "Component Inspection".

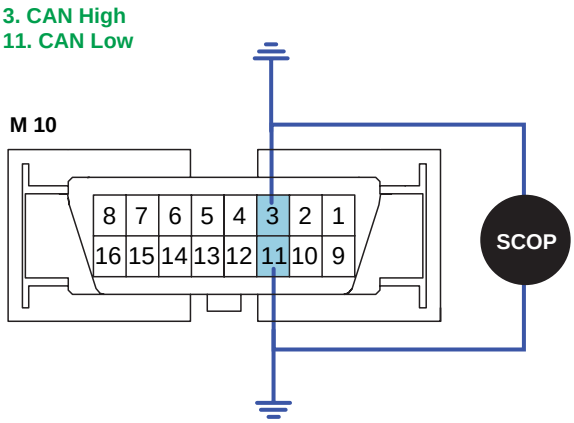
NO

▶ Repair open in CAN BUS and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E7D8EFF6

1. IG Key "OFF", Engine "OFF".
2. Connect 2 channel scope to DLC terminal 3(CAN High) and terminal 11.(CAN Low)
3. IG Key "ON" after connecting only ECM to CAN BUS.
4. IG Key "ON" after connecting only TCM to CAN BUS.

Specification : At IG Key "ON".
※ Different from "Signal Waveform & Data", if 1) both CAN High and LOW signal are fixed at 2.5 V or 2) HIGH and LOW signal are fixed at 3.5 V and 1.5 V, respectively, it is due to communication error between modules.



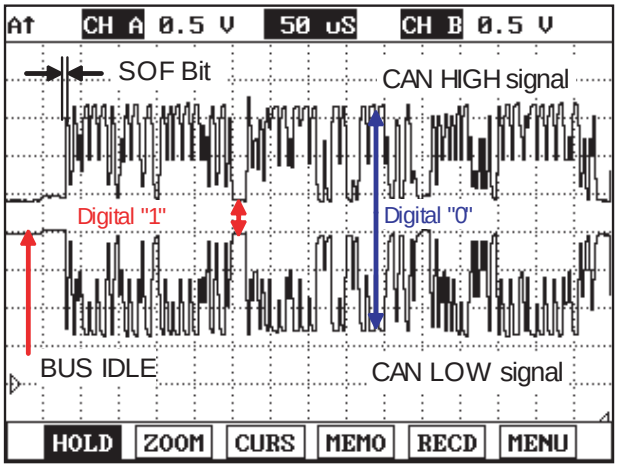


Fig.1 CAN communication waveform

SLDF27634L

5. Does correct waveform generate from each module?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace the module which generates poor communication waveform, and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E23AFB71

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC U0100 CAN MI-COM OR CIRCUIT MAL

COMPONENT LOCATION E44A8D3E

Refer to DTC U0001.

GENERAL DESCRIPTION E2926C8D

Refer to DTC U0001.

DTC DESCRIPTION E7BD53E8

U0100 is set when no signal transmission through CAN BUS occurs for more than 0.6 sec.. This code is due to CAN BUS problem or CAN communication module failure.

DTC DETECTING CONDITION E1A09AD4

Item	Detecting Condition		Possible Cause
DTC Strategy	• Signal monitoring		• CAN BUS • CAN communication module component
Enable Conditions	• IG Key "ON"		
ThresholdValue	• No signal transmission through CAN BUS.(Only AT)		
DiagnosticTime	• 0.6 sec.		
Fail Safe	Fuel Cut	NO	
	EGR Off	NO	
	Fuel Limit	NO	
	MIL	OFF	

SPECIFICATION E9AC6786

Communication Format	DIGITAL "0"		DIGITAL "1"(BUS IDLE)		CAN Communication Line Resistance	
	HIGH	LOW	HIGH	LOW	Inside of ECM	Inside of I/P junction box
CAN 2.0B	3.5V	1.5V	2.5V	2.5V	120Ω (20°C)	120Ω (20°C)

SCHEMATIC DIAGRAM E1C84E18

Refer to DTC U0001.

SIGNAL WAVEFORM AND DATA E63013B4

Refer to DTC U0001.

TERMINAL AND CONNECTOR INSPECTION EB136A87

Refer to DTC U0001.

SIGNAL CIRCUIT INSPECTION EDA3FE08

1. Check CAN BUS resistance

   1) IG Key "OFF", Engine "OFF".

   2) Measure the resistance between DLC terminal 3 and terminal 11. (TEST 1)

   3) Disconnect ECM connector and TCM connector.

   4) Measure the resistance between DLC terminal 3 and terminal 11. (TEST 2)

Specification :
Both ECM and Resistor connected : 60 ± 3Ω (Test 1)
ECM connector disconnected : 120 ± 3Ω (Test 2)

   5) Is CAN BUS resistance within the specification?

   YES

   ▶ Go to "2.Check short to ground in CAN BUS" as follows.

   NO

   ▶ Below 10Ω for both conditions(disconnected, connected) : Repair short between CAN BUS and go to "Verification of Vehicle Repair".
   ▶ 120Ω for both conditions(disconnected, connected) : Go to "4. Check CAN BUS continuity" as follows.
   ▶ Infinite Ω for both conditions(disconnected, connected) :Repair open in CAN communication circuit between DLC terminal and I/P junction box.

2. Check short to ground in CAN BUS

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect ECM connector and TCM connector.

   3) Check continuity between DLC terminal 3 and chassis ground. (CAN High)

   4) Check continuity between DLC terminal 11 and chassis ground. (CAN Low)

Specification : Discontinuity (Infinite Ω)

   5) Is measured resistance within the specification?

   YES

   ▶ Go to "3. Check short to battery in CAN BUS" as follows.

   NO

   ▶ Repair short to ground in circuit and go to "Verification of Vehicle Repair".

3. Check short to battery in CAN BUS

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect ECM connector and TCM connector.

   3) IG Key "ON".

4) Measure the voltage of DLC terminal 3. (CAN High)

5) Measure the voltage of DLC terminal 11. (CAN Low)

Specification : 0.0V~0.1V

6) Is measured resistance within the specification with both connector disconnected?

YES

▶ Go to"4. Check CAN BUS continuity" as follows.

NO

▶ Repair short to battery and go to "Verification of Vehicle Repair".

4. Check CAN BUS continuity

1) IG Key "OFF", Engine "OFF".

2) Disconnect ECM connector and TCM connector.

3) Check continuity between DLC terminal 3 and CAN High terminal of each module.
[CAN High terminal] ECM connector terminal 84, TCM connector terminal 3.

4) Check continuity between DLC terminal 11 and CAN Low terminal of each module.
[CAN Low terminal] ECM connector terminal 83, TCM connector terminal 36.

Specification : Continuity(below 1.0Ω)

5) Is the measured resistance within the specification?

YES

▶ Go to "Component Inspection".

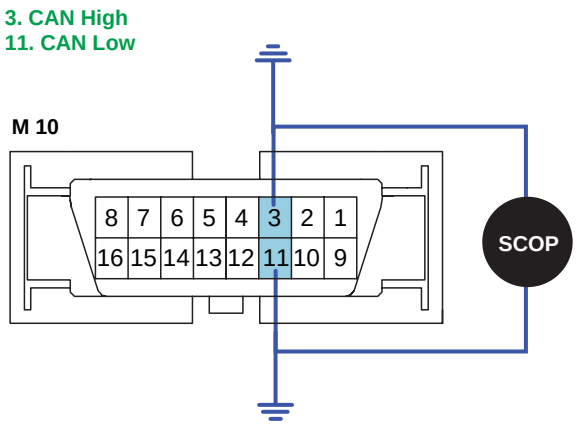
NO

▶ Repair open in CAN BUS and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION EB49F97C

1. IG Key "OFF", Engine "OFF".
2. Connect 2 channel scope to DLC terminal 3(CAN High) and terminal 11.(CAN Low)
3. IG Key "ON" after connecting only ECM to CAN BUS.
4. IG Key "ON" after connecting only TCM to CAN BUS.

Specification : At IG Key "ON".
※ Different from "Signal Waveform & Data", if 1) both CAN High and LOW signal are fixed at 2.5 V or 2) HIGH and LOW signal are fixed at 3.5 V and 1.5 V, respectively, it is due to communication error between modules.



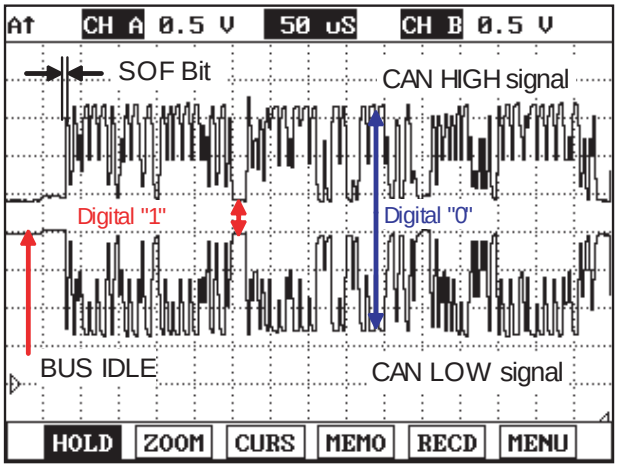


Fig.1 CAN communication waveform

SLDF27634L

5. Does correct waveform generate from each module?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace the module which generates poor communication waveform, and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR EF06E53E

Refer to DTC U0001.

DTC U0101 CAN COMMUNICATION MALFUNCTION (ECM/PCM - TCM)

COMPONENT LOCATION E7242B1B

Refer to DTC U0001.

GENERAL DESCRIPTION E9247E39

Refer to DTC U0001.

DTC DESCRIPTION E8089269

U0101 is set when ECM send data requiring signal to TCM, but no return signal is transmitted to ECM within 0.49 sec.. This code is due to TCM CAN line related problem or TCM module failure.

DTC DETECTING CONDITION EB1E3B6F

Item	Detecting Condition		Possible Cause
DTC Strategy	• Signal monitoring		• CAN BUS • CAN communication module component
Enable Conditions	• IG Key "ON"		
ThresholdValue	• CAN communication error between ECM and TCM.(Only AT)		
DiagnosticTime	• 0.49 sec.		
Fail Safe	Fuel Cut	NO	
	EGR Off	NO	
	Fuel Limit	NO	
	MIL	OFF	

SPECIFICATION E5B1DA9B

Communication Format	DIGITAL "0"		DIGITAL "1"(BUS IDLE)		CAN Communication Line Resistance	
	HIGH	LOW	HIGH	LOW	Inside of ECM	Inside of I/P junction box
CAN 2.0B	3.5V	1.5V	2.5V	2.5V	120Ω (20°C)	120Ω (20°C)

SCHEMATIC DIAGRAM EE2F7994

Refer to DTC U0001.

SIGNAL WAVEFORM AND DATA E5192673

Refer to DTC U0001.

TERMINAL AND CONNECTOR INSPECTION E537FE08

Refer to DTC U0001.

SIGNAL CIRCUIT INSPECTION E194AAD1

1. Check CAN BUS resistance

   1) IG Key "OFF", Engine "OFF".

   2) Measure the resistance between DLC terminal 3 and terminal 11. (TEST 1)

   3) Disconnect ECM connector and TCM connector.

   4) Measure the resistance between DLC terminal 3 and terminal 11. (TEST 2)

Specification :
Both ECM and Resistor connected : 60 ± 3Ω (Test 1)
ECM connector disconnected : 120 ± 3Ω (Test 2)

   5) Is CAN BUS resistance within the specification?

   YES

   ▶ Go to "2.Check short to ground in CAN BUS" as follows.

   NO

   ▶ Below 10Ω for both conditions(disconnected, connected) : Repair short between CAN BUS and go to "Verification of Vehicle Repair".
   ▶ 120Ω for both conditions(disconnected, connected) : Go to "4. Check CAN BUS continuity" as follows.
   ▶ Infinite Ω for both conditions(disconnected, connected) :Repair open in CAN communication circuit between DLC terminal and I/P junction box.

2. Check short to ground in CAN BUS

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect ECM connector and TCM connector.

   3) Check continuity between DLC terminal 3 and chassis ground. (CAN High)

   4) Check continuity between DLC terminal 11 and chassis ground. (CAN Low)

Specification : Discontinuity (Infinite Ω)

   5) Is measured resistance within the specification?

   YES

   ▶ Go to "3. Check short to battery in CAN BUS" as follows.

   NO

   ▶ Repair short to ground in circuit and go to "Verification of Vehicle Repair".

3. Check short to battery in CAN BUS

   1) IG Key "OFF", Engine "OFF".

   2) Disconnect ECM connector and TCM connector.

   3) IG Key "ON".

4) Measure the voltage of DLC terminal 3. (CAN High)

5) Measure the voltage of DLC terminal 11. (CAN Low)

Specification : 0.0V~0.1V

6) Is measured resistance within the specification with both connector disconnected?

YES

▶ Go to"4. Check CAN BUS continuity" as follows.

NO

▶ Repair short to battery and go to "Verification of Vehicle Repair".

4. Check CAN BUS continuity

1) IG Key "OFF", Engine "OFF".

2) Disconnect ECM connector and TCM connector.

3) Check continuity between DLC terminal 3 and CAN High terminal of each module.
[CAN High terminal] ECM connector terminal 84, TCM connector terminal 3.

4) Check continuity between DLC terminal 11 and CAN Low terminal of each module.
[CAN Low terminal] ECM connector terminal 83, TCM connector terminal 36.

Specification : Continuity(below 1.0Ω)

5) Is the measured resistance within the specification?

YES

▶ Go to "Component Inspection".

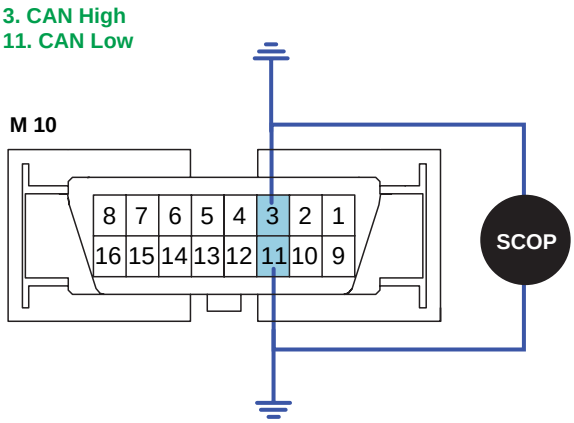
NO

▶ Repair open in CAN BUS and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E7DD2171

1. IG Key "OFF", Engine "OFF".
2. Connect 2 channel scope to DLC terminal 3(CAN High) and terminal 11.(CAN Low)
3. IG Key "ON" after connecting only ECM to CAN BUS.
4. IG Key "ON" after connecting only TCM to CAN BUS.

Specification : At IG Key "ON".
※ Different from "Signal Waveform & Data", if 1) both CAN High and LOW signal are fixed at 2.5 V or 2) HIGH and LOW signal are fixed at 3.5 V and 1.5 V, respectively, it is due to communication error between modules.



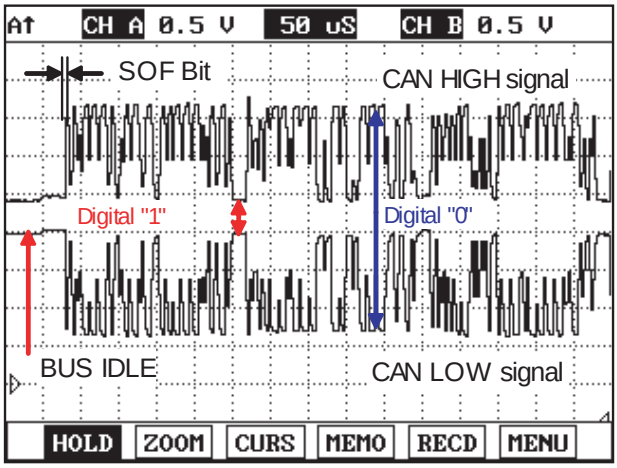


Fig.1 CAN communication waveform

SLDF27634L

5. Does correct waveform generate from each module?

YES

▶ Go to "Verification of Vehicle Repair".

NO

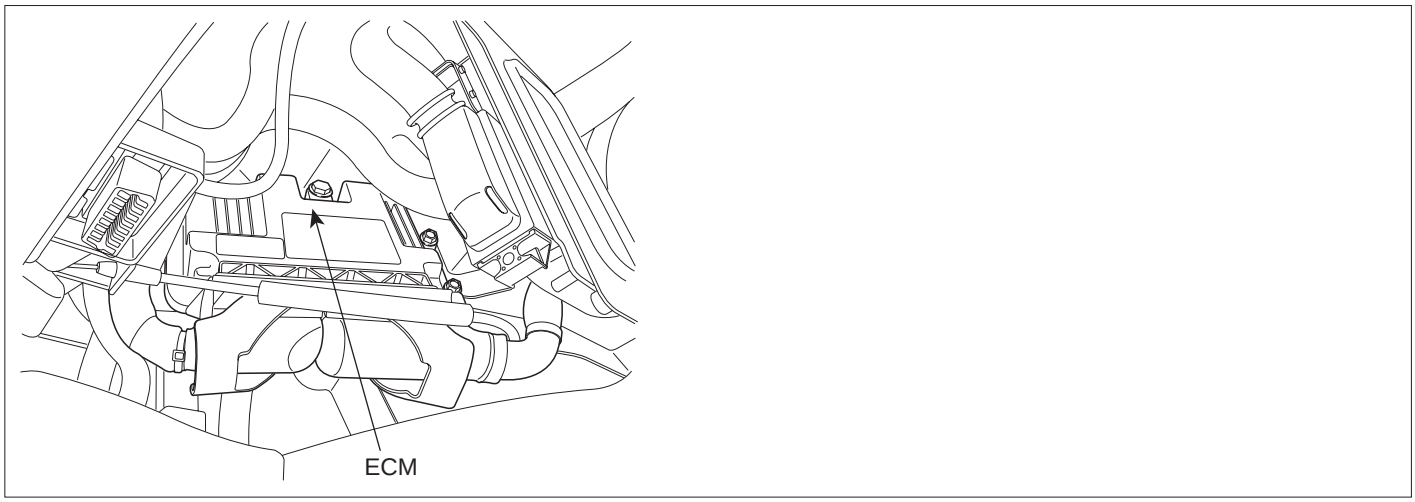
▶ Replace the module which generates poor communication waveform, and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR EDBEB5D0

Refer to DTC U0001.

DTC U0122 CAN COMMUNICATION MALFUNCTION (ECM/PCM - VDC)

COMPONENT LOCATION EAD26762



SLDFL6237L

GENERAL DESCRIPTION E251CABF

Several control units are applied to electronically controlled vehicles. These units perform each control with informations from various sensors. Thus, sharing signal information from sensors is needed, so CAN communication type whose communication speed is high and insensitive to electrical noise by spark generation is adopted to controlling power-train(engine, atutomatic transaxle, ABS, TCS, ECS)As sharing signals of engine speed, APS, engaged gear and torque reduction through CAN communication, ECM and TCM modules control vehicle actively.

DTC DESCRIPTION EF9CAA89

U0122 is set when ECM sends data requiring signal to TCS, but no return signal is transmitted to ECM by within 0.5 sec.. This code is due to TCS CAN line related problem or TCS module failure.

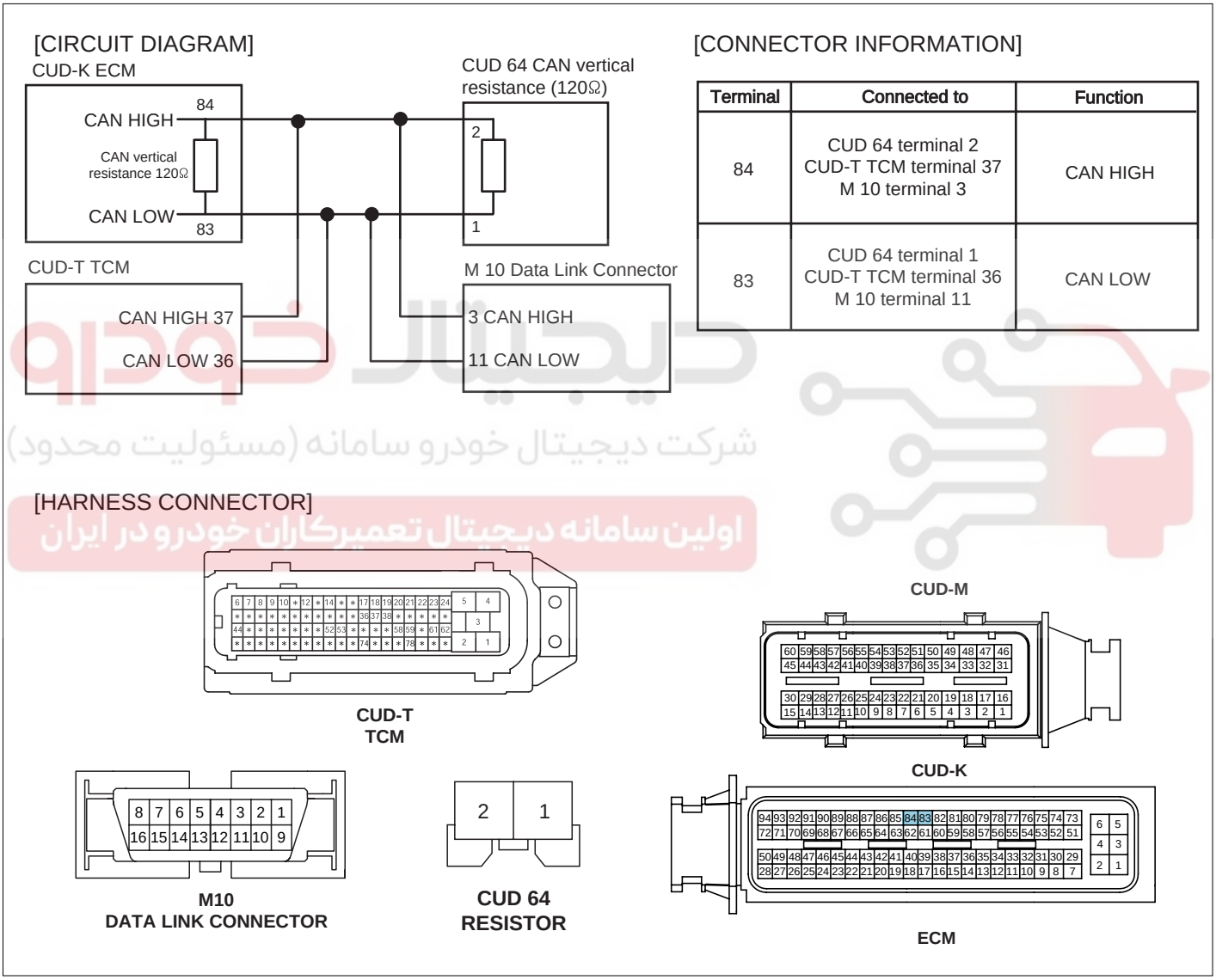
DTC DETECTING CONDITION E1647A96

Item	Detecting Condition			Possible Cause
DTC Strategy	• Signal monitoring			• CAN BUS • CAN communication module component
Enable Conditions	• IG Key "ON"			
ThresholdValue	• CAN communication error between ECM and TCS.			
DiagnosticTime	• 0.5 sec.			
Fail Safe	Fuel Cut	NO		
	EGR Off	NO		
	Fuel Limit	NO		
	MIL	OFF		

SPECIFICATION E1A611CA

Communication Format	DIGITAL "0"		DIGITAL "1"(BUS IDLE)		CAN Communication Line Resistance	
	HIGH	LOW	HIGH	LOW	Inside of ECM	Inside of I/P junction box
CAN 2.0B	3.5V	1.5V	2.5V	2.5V	120Ω (20°C)	120Ω (20°C)

SCHEMATIC DIAGRAM E26A17C4



SLDF27698L

SIGNAL WAVEFORM AND DATA E974B7C9

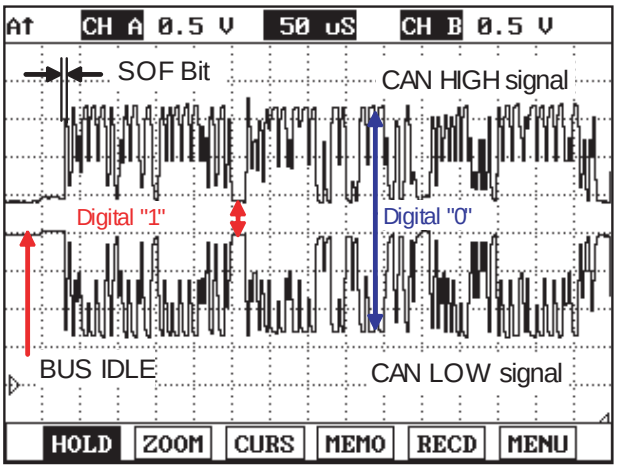


Fig.1 CAN communication waveform

Monitoring CAN HIGH and LOW simultaneously is important in monitoring CAN communication waveform. When CAN HIGH signal rise to 3.5V and LOW signal drops to 1.5V - voltage difference between HIGH and LOW signal is 2V - at BUS IDLE state(DIGITAL "1") whose reference voltage is 2.5V, "0" is recognized. Besides, comparing HIGH and LOW signal if opposite waveform is detected with the reference voltage of 2.5V, Check if current cam signal transfers correctly. Continuous "0"signal above 6BIT means the occurence of error in CAN communication. 1BIT is easily distinguished as calculating the time when "SOF"(START OF FRAME) which notifies the start of frame occurs. Check if "0"signal above 6BIT is detected continuously when monitoring CAN communication waveform.

SUNFL7718L

TERMINAL AND CONNECTOR INSPECTION E8B1DAC5

1. Electrical systems consist of a lot of harness and connectors, poor connection of terminals can cause various problems and damge of component.
2. Perform checking procedure as follows.
   1) Check damage of harness and terminals : Check terminals for contact resistance, corrosion and deformation.
   2) Check connecting condition of ECM and component connector : Check terminal seperation, damage of locking device and connecting condition between terminal and wiring.

   NOTE

   Disconnect the pin which requires checking at male connector and insert it to the terminal at female connector for checking connecting condition. (after checking, reconnect the pin at correct position.)
3. Is the problem found?

   YES

   ▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

   NO

   ▶ Go to "Signal Circuit Inspection".

SIGNAL CIRCUIT INSPECTION ED67B5C6

1. Check CAN BUS resistance
   1) IG Key "OFF", Engine "OFF".
   2) Measure the resistance between DLC terminal 3 and terminal 11. (TEST 1)
   3) Disconnect ECM connector and TCM connector.
   4) Measure the resistance between DLC terminal 3 and terminal 11. (TEST 2)

Specification :
Both ECM and Resistor connected : 60 ± 3Ω (Test 1)
ECM connector disconnected : 120 ± 3Ω (Test 2)

5) Is CAN BUS resistance within the specification?

YES

▶ Go to "2.Check short to ground in CAN BUS" as follows.

NO

▶ Below 10Ω for both conditions(disconnected, connected) : Repair short between CAN BUS and go to "Verification of Vehicle Repair".
▶ 120Ω for both conditions(disconnected, connected) : Go to "4. Check CAN BUS continuity" as follows.
▶ Infinite Ω for both conditions(disconnected, connected) :Repair open in CAN communication circuit between DLC terminal and I/P junction box.

2. Check short to ground in CAN BUS

1) IG Key "OFF", Engine "OFF".

2) Disconnect ECM connector and TCM connector.

3) Check continuity between DLC terminal 3 and chassis ground. (CAN High)

4) Check continuity between DLC terminal 11 and chassis ground. (CAN Low)

Specification : Discontinuity (Infinite Ω)

5) Is measured resistance within the specification?

YES

▶ Go to "3. Check short to battery in CAN BUS" as follows.

NO

▶ Repair short to ground in circuit and go to "Verification of Vehicle Repair".

3. Check short to battery in CAN BUS

1) IG Key "OFF", Engine "OFF".

2) Disconnect ECM connector and TCM connector.

3) IG Key "ON".

4) Measure the voltage of DLC terminal 3. (CAN High)

5) Measure the voltage of DLC terminal 11. (CAN Low)

Specification : 0.0V~0.1V

6) Is measured resistance within the specification with both connector disconnected?

YES

▶ Go to"4. Check CAN BUS continuity" as follows.

NO

▶ Repair short to battery and go to "Verification of Vehicle Repair".

4. Check CAN BUS continuity

1) IG Key "OFF", Engine "OFF".

2) Disconnect ECM connector and TCM connector.

3) Check continuity between DLC terminal 3 and CAN High terminal of each module.
[CAN High terminal] ECM connector terminal 84, TCM connector terminal 3.

4) Check continuity between DLC terminal 11 and CAN Low terminal of each module.
[CAN Low terminal] ECM connector terminal 83, TCM connector terminal 36.

Specification : Continuity(below 1.0Ω)

5) Is the measured resistance within the specification?

YES

▶ Go to "Component Inspection".

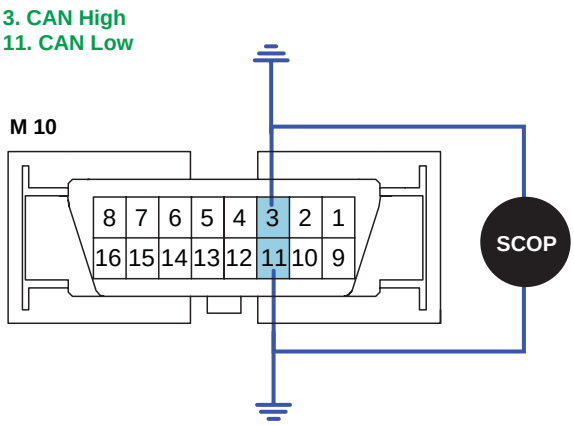
NO

▶ Repair open in CAN BUS and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E74BF6E1

1. IG Key "OFF", Engine "OFF".
2. Connect 2 channel scope to DLC terminal 3(CAN High) and terminal 11.(CAN Low)
3. IG Key "ON" after connecting only ECM to CAN BUS.
4. IG Key "ON" after connecting only TCM to CAN BUS.

Specification : At IG Key "ON".
※ Different from "Signal Waveform & Data", if 1) both CAN High and LOW signal are fixed at 2.5 V or 2) HIGH and LOW signal are fixed at 3.5 V and 1.5 V, respectively, it is due to communication error between modules.



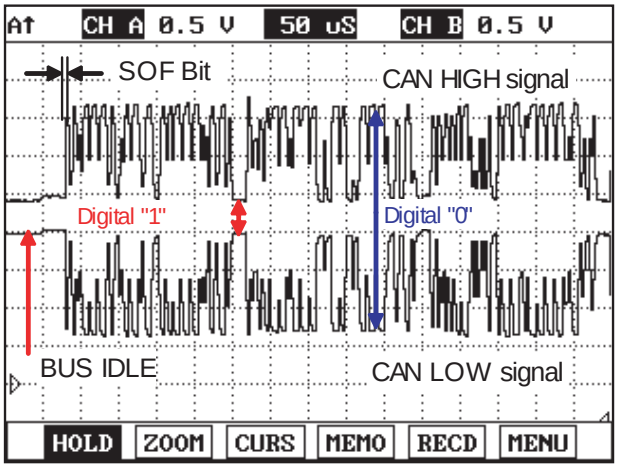


Fig.1 CAN communication waveform

SLDF27634L

5. Does correct waveform generate from each module?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace the module which generates poor communication waveform, and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR EAFD21CF

After a repair, it is essential to verify that the fault is corrected.

1. After connecting Scantool select "DIAGNOSTIC TROUBLE CODES(DTCs)" mode.
2. Clear recorded DTC using Scantool.
3. Drive the vehicle within DTC "Enable conditions" in "General information".
4. After selecting "DIAGNOSTIC TROUBLE CODES(DTCs)" mode and check if DTC is recorded again.
5. Are any DTCs recorded ?

YES

▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC U0416 ABNORMAL TORQUE RISE REQUEST FROM TCS

COMPONENT LOCATION EC562FA1

Refer to DTC U0122.

GENERAL DESCRIPTION EF4CC29E

Refer to DTC U0122.

DTC DESCRIPTION E6B522C4

U0416 is set when ECM detects the signal requires abnormal torque increase from ECM for more than 0.5 sec. Checking CAN communication line or TCS module is required.

DTC DETECTING CONDITION E2DE2098

Item	Detecting Condition		Possible Cause
DTC Strategy	• Signal monitoring		• CAN BUS • CAN communication module component
Enable Conditions	• IG Key "ON"		
ThresholdValue	• Abnormal torque increase request from TCS.		
DiagnosticTime	• 0.5 sec.		
Fail Safe	Fuel Cut	NO	
	EGR Off	NO	
	Fuel Limit	NO	
	MIL	OFF	

SPECIFICATION E4978F79

Communication Format	DIGITAL "0"		DIGITAL "1"(BUS IDLE)		CAN Communication Line Resistance	
	HIGH	LOW	HIGH	LOW	Inside of ECM	Inside of I/P junction box
CAN 2.0B	3.5V	1.5V	2.5V	2.5V	120Ω (20°C)	120Ω (20°C)

SCHEMATIC DIAGRAM ECB85758

Refer to DTC U0122.

SIGNAL WAVEFORM AND DATA E377F299

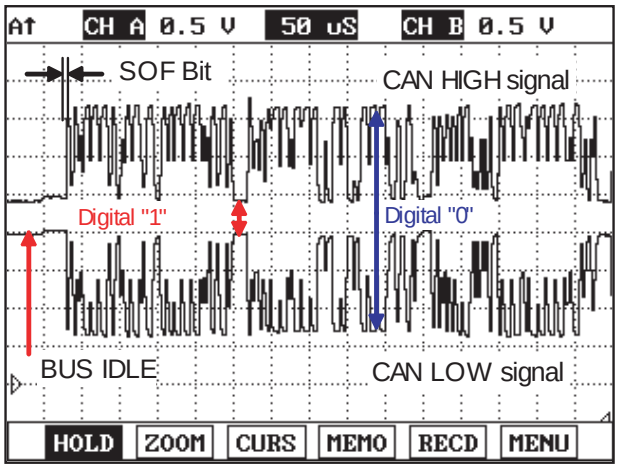


Fig.1 CAN communication waveform

Monitoring CAN HIGH and LOW simultaneously is important in monitoring CAN communication waveform. When CAN HIGH signal rise to 3.5V and LOW signal drops to 1.5V - voltage difference between HIGH and LOW signal is 2V - at BUS IDLE state(DIGITAL "1") whose reference voltage is 2.5V, "0" is recognized. Besides, comparing HIGH and LOW signal if opposite waveform is detected with the reference voltage of 2.5V, Check if current cam signal transfers correctly. Continuous "0"signal above 6BIT means the occurence of error in CAN communication. 1BIT is easily distinguished as calculating the time when "SOF"(START OF FRAME) which notifies the start of frame occurs. Check if "0"signal above 6BIT is detected continuously when monitoring CAN communication waveform.

SUNFL7718L

TERMINAL AND CONNECTOR INSPECTION E04D61E9

Refer to DTC U0122.

SIGNAL CIRCUIT INSPECTION E31E9C26

1. Check CAN BUS resistance

   1) IG Key "OFF", Engine "OFF".

   2) Measure the resistance between DLC terminal 3 and terminal 11. (TEST 1)

   3) Disconnect ECM connector and TCM connector.

   4) Measure the resistance between DLC terminal 3 and terminal 11. (TEST 2)

Specification :
Both ECM and Resistor connected : 60 ± 3Ω (Test 1)
ECM connector disconnected : 120 ± 3Ω (Test 2)

   5) Is CAN BUS resistance within the specification?

   YES

   ▶ Go to "2.Check short to ground in CAN BUS" as follows.

   NO

   ▶ Below 10Ω for both conditions(disconnected, connected) : Repair short between CAN BUS and go to "Verification of Vehicle Repair".
   ▶ 120Ω for both conditions(disconnected, connected) : Go to "4. Check CAN BUS continuity" as follows.
   ▶ Infinite Ω for both conditions(disconnected, connected) :Repair open in CAN communication circuit between DLC terminal and I/P junction box.

2. Check short to ground in CAN BUS

   1) IG Key "OFF", Engine "OFF".

2) Disconnect ECM connector and TCM connector.

3) Check continuity between DLC terminal 3 and chassis ground. (CAN High)

4) Check continuity between DLC terminal 11 and chassis ground. (CAN Low)

Specification : Discontinuity (Infinite Ω)

5) Is measured resistance within the specification?

YES

▶ Go to "3. Check short to battery in CAN BUS" as follows.

NO

▶ Repair short to ground in circuit and go to "Verification of Vehicle Repair".

3. Check short to battery in CAN BUS

1) IG Key "OFF", Engine "OFF".

2) Disconnect ECM connector and TCM connector.

3) IG Key "ON".

4) Measure the voltage of DLC terminal 3. (CAN High)

5) Measure the voltage of DLC terminal 11. (CAN Low)

Specification : 0.0V~0.1V

6) Is measured resistance within the specification with both connector disconnected?

YES

▶ Go to"4. Check CAN BUS continuity" as follows.

NO

▶ Repair short to battery and go to "Verification of Vehicle Repair".

4. Check CAN BUS continuity

1) IG Key "OFF", Engine "OFF".

2) Disconnect ECM connector and TCM connector.

3) Check continuity between DLC terminal 3 and CAN High terminal of each module.
[CAN High terminal] ECM connector terminal 84, TCM connector terminal 3.

4) Check continuity between DLC terminal 11 and CAN Low terminal of each module.
[CAN Low terminal] ECM connector terminal 83, TCM connector terminal 36.

Specification : Continuity(below 1.0Ω)

5) Is the measured resistance within the specification?

YES

▶ Go to "Component Inspection".

NO

▶ Repair open in CAN BUS and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION EFC554C1

1. IG Key "OFF", Engine "OFF".
2. Connect 2 channel scope to DLC terminal 3(CAN High) and terminal 11.(CAN Low)
3. IG Key "ON" after connecting only ECM to CAN BUS.
4. IG Key "ON" after connecting only TCM to CAN BUS.

Specification : At IG Key "ON".
※ Different from "Signal Waveform & Data", if 1) both CAN High and LOW signal are fixed at 2.5 V or 2) HIGH and LOW signal are fixed at 3.5 V and 1.5 V, respectively, it is due to communication error between modules.

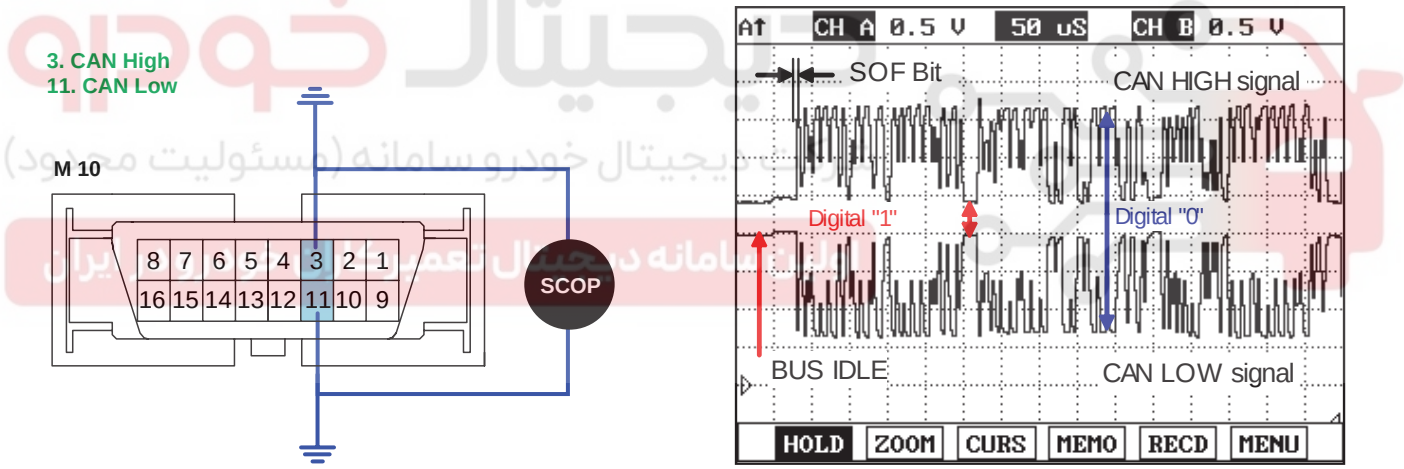


Fig.1 CAN communication waveform

SLDF27634L

5. Does correct waveform generate from each module?

YES

▶ Go to "Verification of Vehicle Repair".

NO

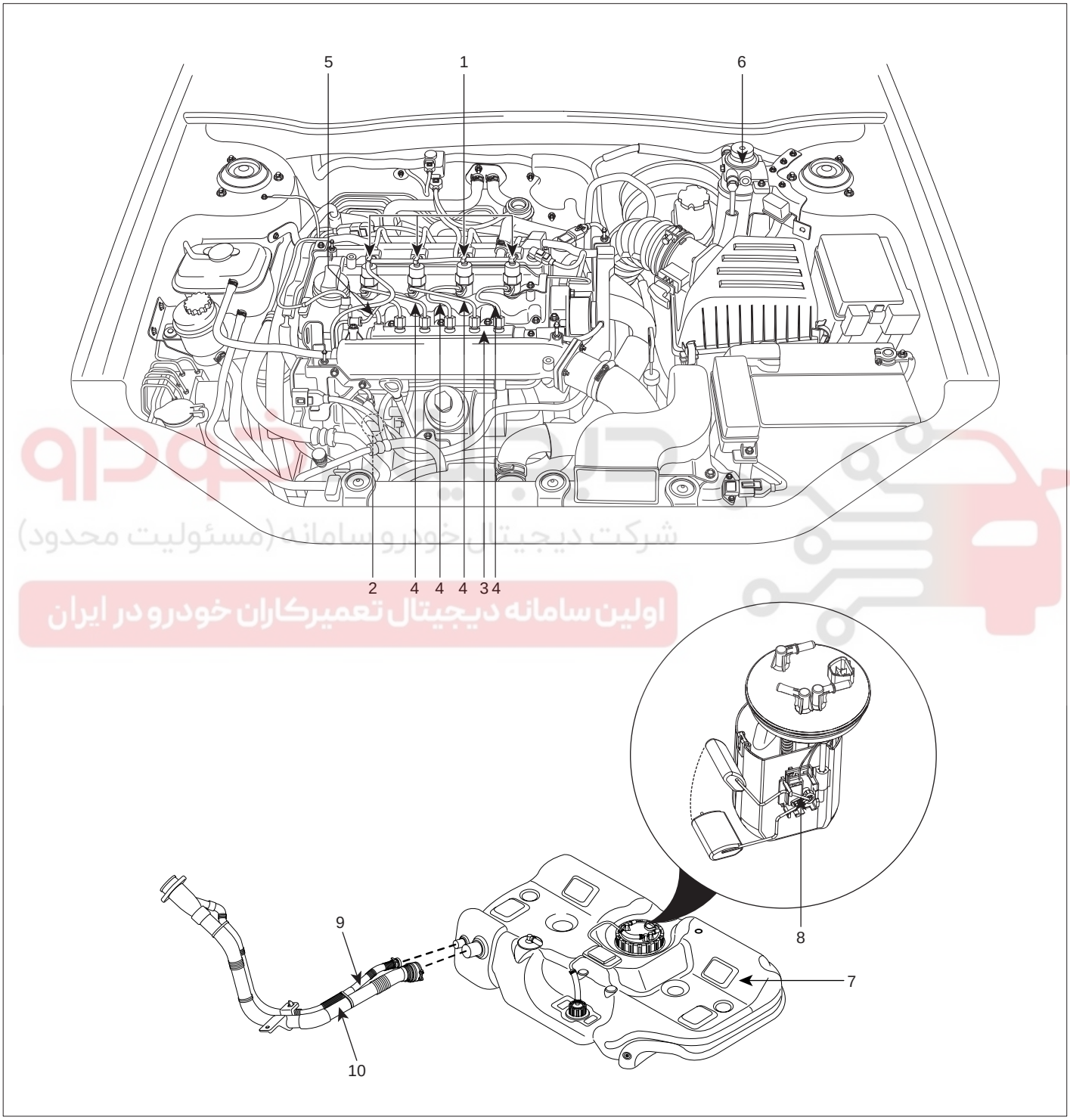
▶ Replace the module which generates poor communication waveform, and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E4981557

Refer to DTC U0122.

FUEL DELIVERY SYSTEM-DIESEL

COMPONENT LOCATION E78C8EC7



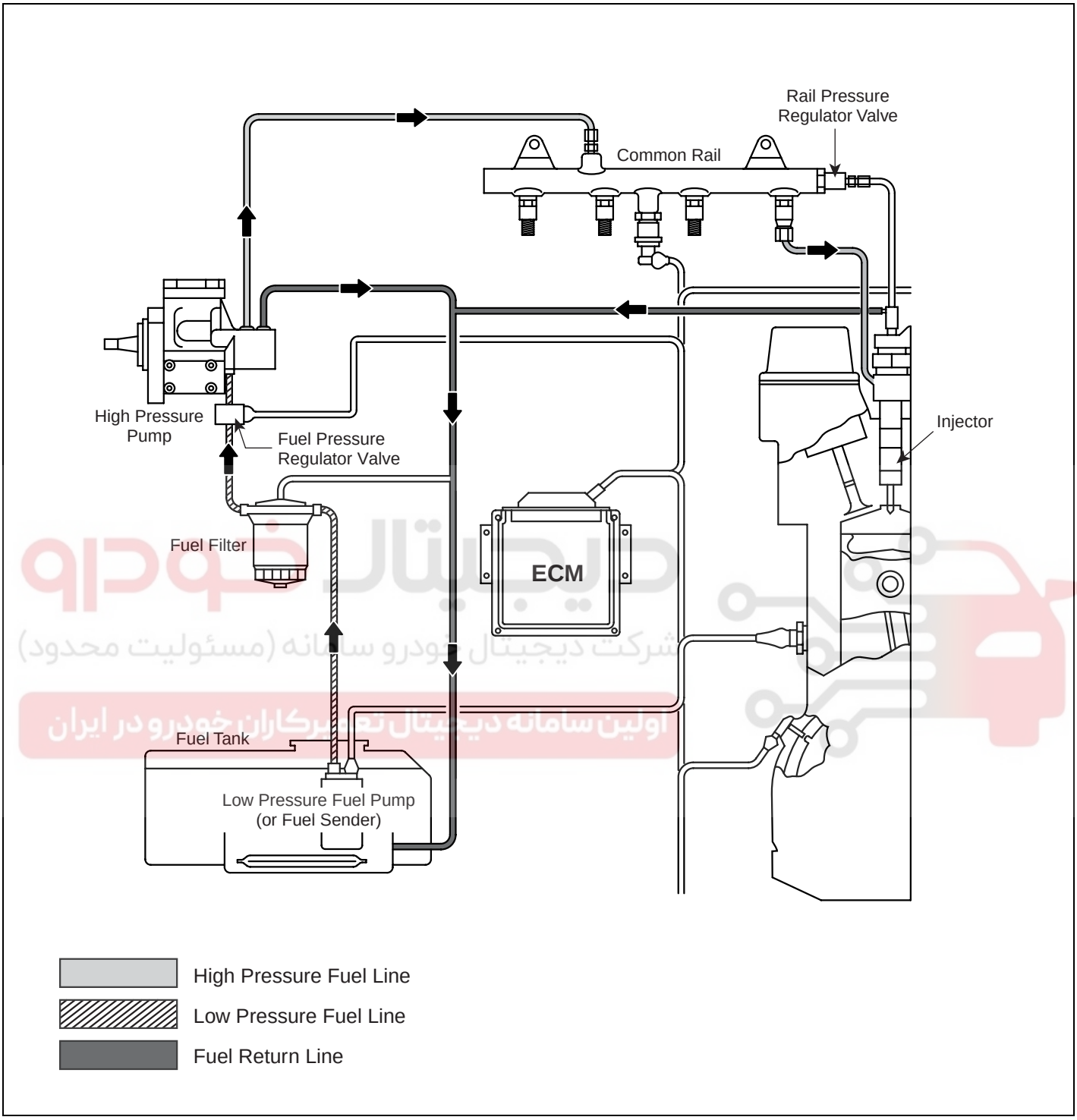
1. Injector
2. High Pressure Fuel Pump
3. Common Rail
4. High Pressure Pipe (Injector ← Common Rail)
5. High Pressure Pipe (Common Rail ← High Pressure Fuel Pump)
6. Fuel Filter
7. Fuel Tank
8. Fuel Sender
9. Fuel Filler Hose
10. Levelivg Hose

SLDFL6139L

CAUTION

- ***Common Rail Fuel Injection System is subject to extremely high pressure (Approximately 1,600 bar)***
- ***Never perform any work on injection system with engine running or within 30 seconds after the engine stops.***
- ***Always pay attention to safety precaution.***
- ***Ensure the absolute cleanliness.***
- ***It is not recommended to remove the injectors without any notice.***

SCHEMATIC DIAGRAM E3AF879B



SLDFL6140L

● LOW PRESSURE FUEL SYSTEM COMPONENTS

FUEL PUMP
The fuel pump is either an electric fuel pump(located in fuel tank) with pre-filter, or a gear-type fuel pump(involved in high pressure 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 pump.

FUEL FILTER
Inadequate filtering can lead to damage at the pump components, delivery valves, and injector nozzles. The fuel filter cleans the fuel before it reaches the high-pressure pump, and thereby prevents premature wear at the pump's sensitive components.

● HIGH PRESSURE FUEL SYSTEM COMPONENTS

HIGH PRESSURE FUEL PUMP
The high-pressure pump pressurizes the fuel to a system pressure of up to 1,600bar. This pressurized fuel then passes through a high-pressure line and into the tubular common rail.

COMMON RAIL (HIGH PRESSURE ACCUMULATOR)
Even after an injector has taken fuel from the rail in order to inject it, the fuel pressure inside the rail remains practically constant. This is due to the accumulator effect arising from the fuel's inherent elasticity. Fuel pressure is measured by the rail pressure sensor and maintained at the desired level by the pressure-control valve.

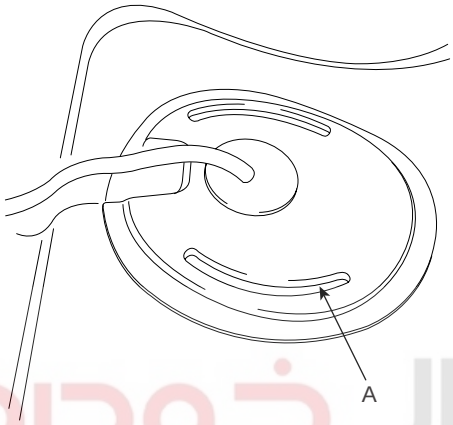
INJECTORS
The nozzles of these injectors open when the solenoid valve is triggered and permit the flow of fuel. They inject the fuel directly into the engine's combustion chamber. The excess fuel which was needed for opening the injector nozzles flows back to the tank through a collector line. The return fuel from the fuel pressure control valve and from the low-pressure stage is also led into this collector line together with the fuel used to lubricate the high-pressure pump.

HIGH PRESSURE PIPE
These High Pressure Pipes carry the high-pressure fuel. They must therefore be able to permanently withstand the maximum system pressure and, during the pauses in injection, the sometimes high-frequency pressure fluctuations which occur. They are therefore manufactured from steel tubing.
Normally, they have an outside diameter of about 6.35mm and an internal diameter of about 3.0mm. The injection lines between the common rail and the injectors must all be of the same length. 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

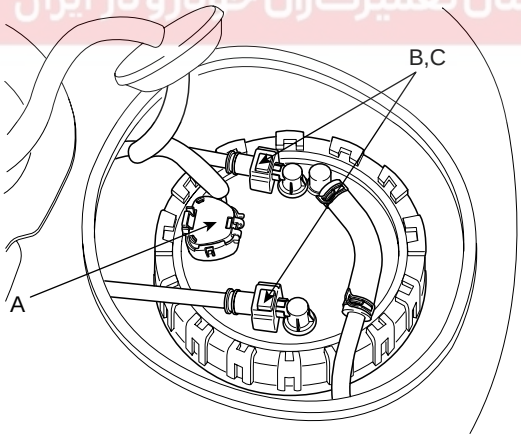
REMOVAL E88E3540

1. Turn ignition switch off.
2. Remove the second seat (Refer to "BD" group in this WORKSHOP MANUAL).
3. Open the service cover (A).



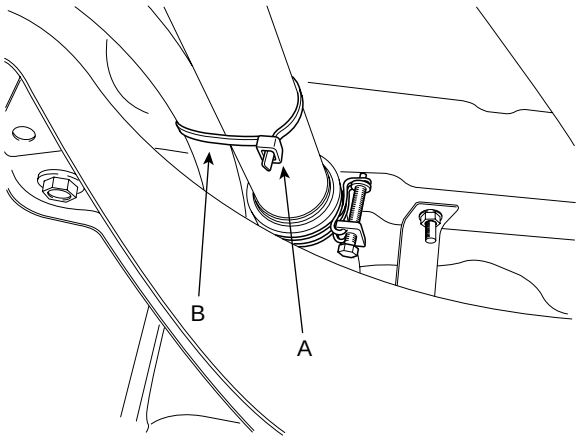
SLDFL6141L

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



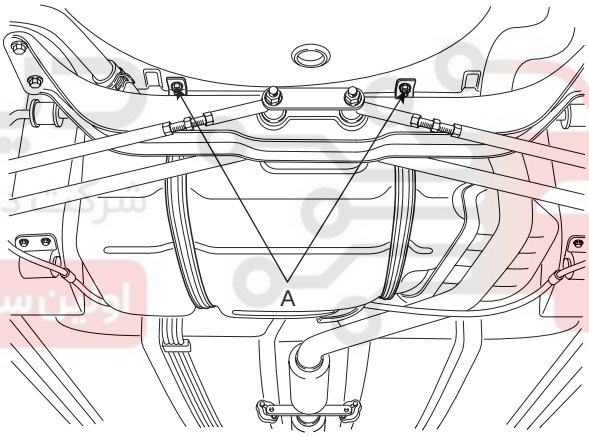
SLDFL6142L

5. Lift the vehicle and remove the mufflers passing under the fuel tank (Refer to group "EM" in this WORKSHOP MANUAL).
6. Support the fuel tank with a jack and remove the brake line mounting bolts (LH & RH).
7. Disconnect the fuel filler hose (A) and the leveling hose (B).



SLDFL6143L

8. Remove the fuel tank band mounting bolts (A) and remove the fuel tank from the vehicle.



SLDFL6144L

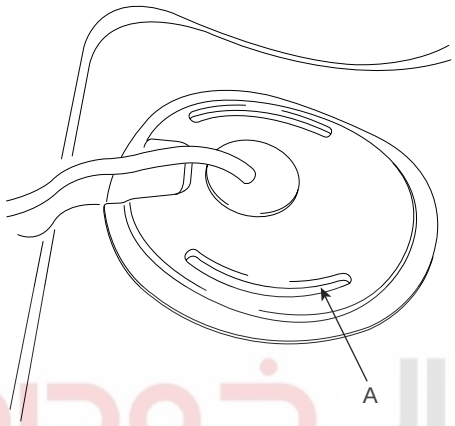
INSTALLATION E6A3F782

1. Install the fuel tank according to the reverse order of "REMOVAL" procedure.

FUEL SENDER

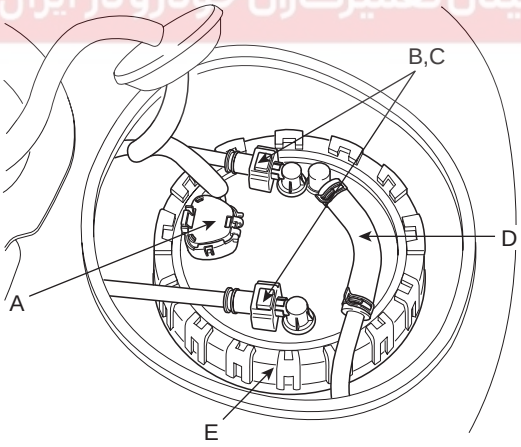
REMOVAL E224BEF3

1. Turn ignition switch off.
2. Remove the second seat (Refer to "BD" group in this WORKSHOP MANUAL).
3. Open the service cover (A).



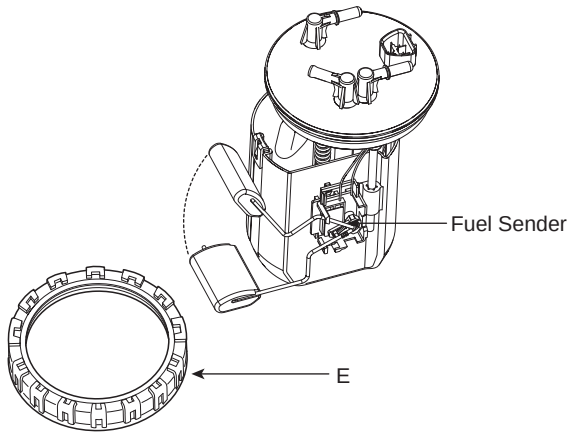
SLDFL6141L

4. Disconnect the fuel sender connector (A), the fuel feed tube quick-connector (B), the return tube quick - connector (C) and the suction hose (D).



SLDFL6145L

5. Remove the fuel sender assembly after removing the fuel sender plate cover (E) with SST (No.:09310-2B100).



SLDFL6146L

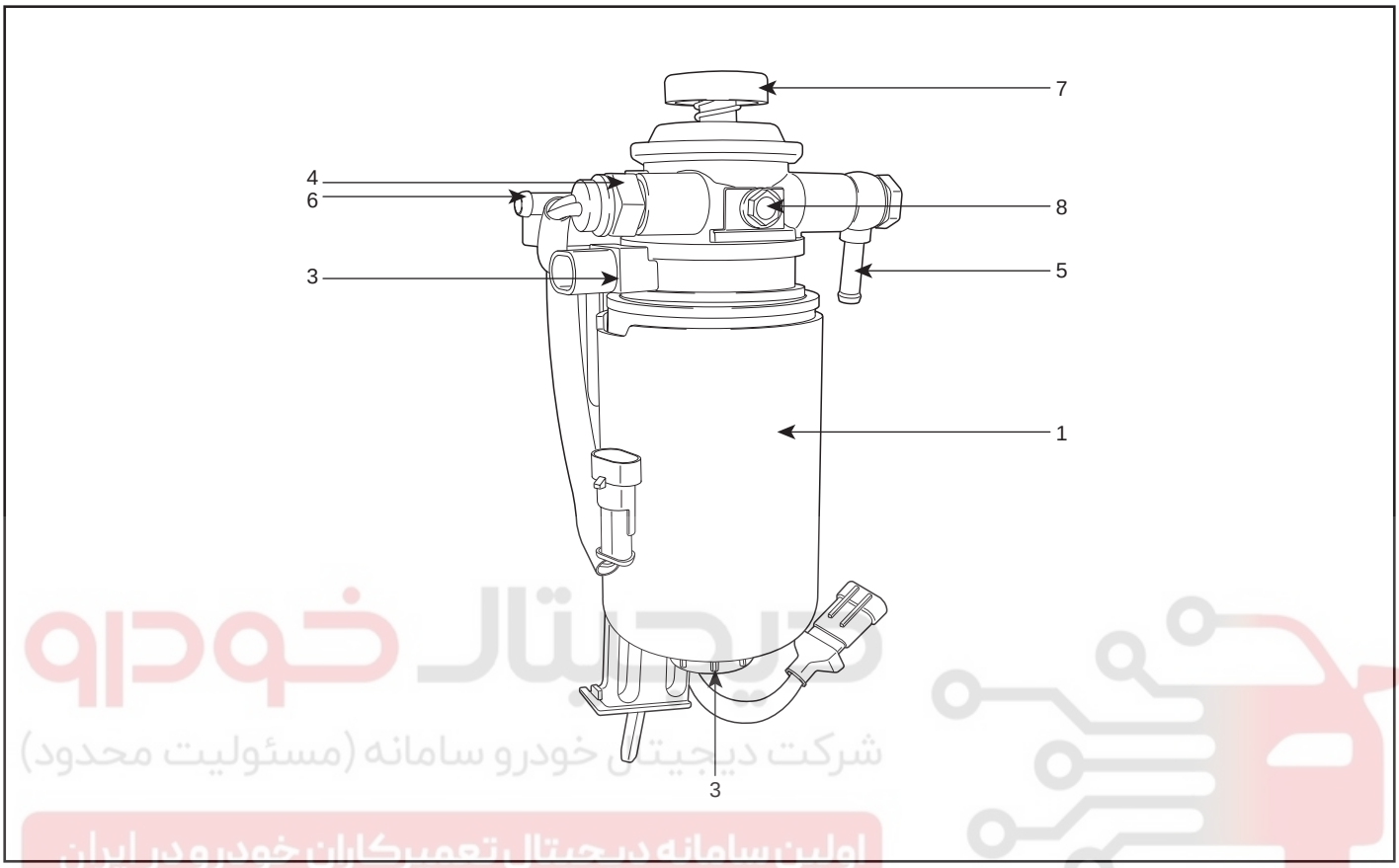
INSTALLATION E4C97271

1. Install the fuel pump assembly according to the reverse order of "Removal" procedure.

Fuel sender plate cover tightening: 60.0 ~ 70.0N·m (6.1 ~ 7.1kgf·m, 44.3 ~ 51.6lbf·ft)

FUEL FILTER

COMPONENTS E665B9DB

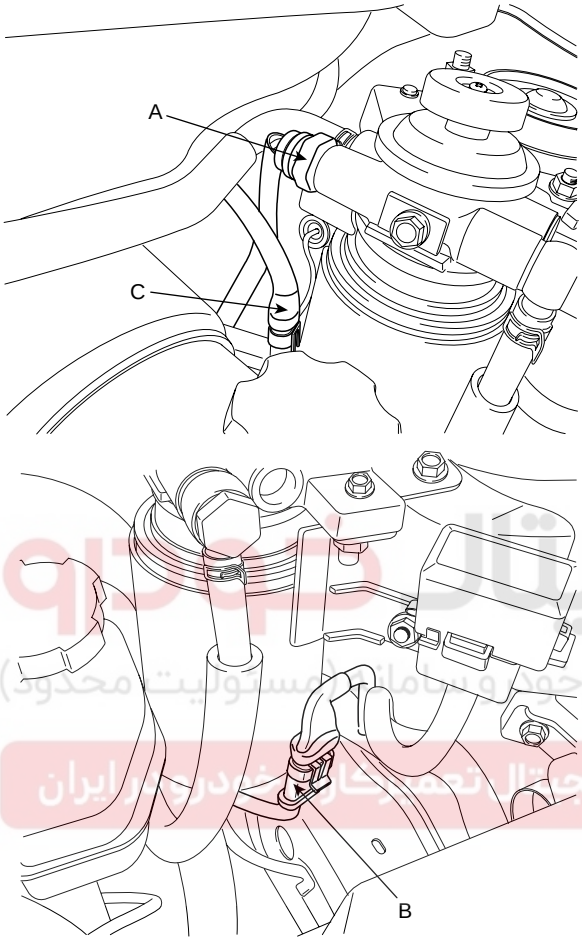


1. Fuel Filter
2. Heater
3. Water Sensor
4. Thermostat
5. Nipple (From Fuel Tank)
6. Nipple (To High Pressure Fuel Pump)
7. Priming pump
8. Air plug (for service)

SLDFL6147L

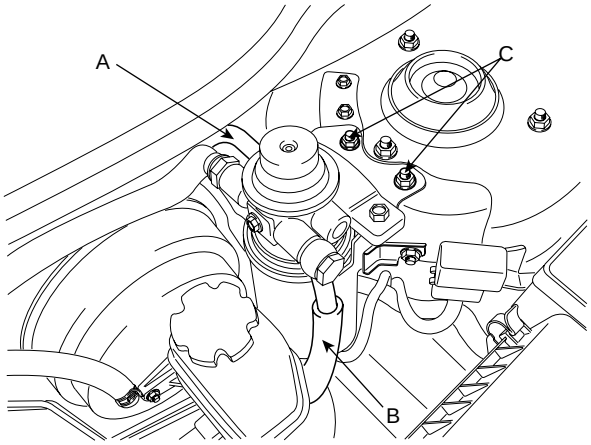
REMOVAL E1F497DB

1. Turn ignition switch off.
2. Disconnect the thermostat connector (A), the water sensor connector (B) and the heater connector (C).



SLDFL6148L

3. Disconnet the outlet hose (A) and the inlet hose (B).



SLDFL6149L

CAUTION

Cover the hose connection with the shop towel to prevent splashing of fuel caused by residual pressure in the fuel line.

4. Unscrew the two mounting nuts (C) and remove the fuel filter.

INSTALLATION EA51F75D

1. Install the fuel filter according to the reverse order of "REMOVAL" procedure.

HIGH PRESSURE FUEL PUMP

DESCRIPTION EE29F586

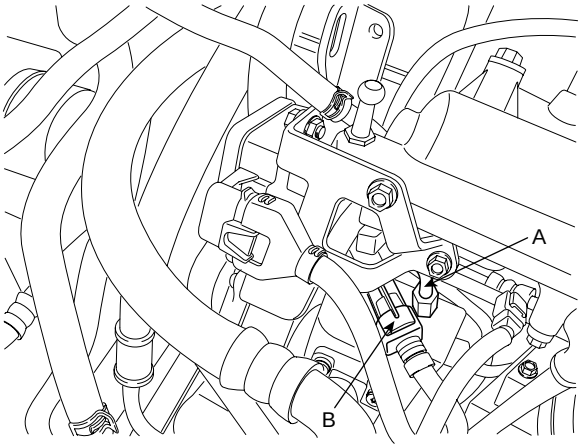
The high-pressure pump is the interface between the low pressure and the high-pressure stages. Under all operating conditions, it is responsible for providing adequate high-pressure fuel through out the vehicle's complete service life. This also includes the provision of extra as needed for rapid starting 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.

REMOVAL E6FAF7B7

WARNING

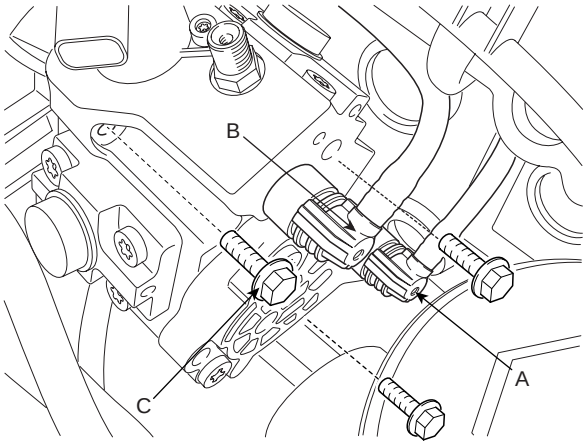
- **Common Rail Fuel Injection System is subject to extremely high pressure (Approximately 1,600 bar)**
- **Never perform any work on injection system with engine running or within 30 seconds after the engine stops.**
- **Always pay attention to safety precaution.**
- **Ensure the absolute cleanliness.**
- **It is not recommended to remove the injectors without any notice.**

1. Turn ignition switch off.
2. Disconnect the negative battery (-) terminal and wait for about 30 seconds.
3. Remove the intake manifold. (Refer to the group "EM" in this WORKSHOP MANUAL).
4. Remove the high pressure pipe (A) connecting high pressure fuel pump and common rail.



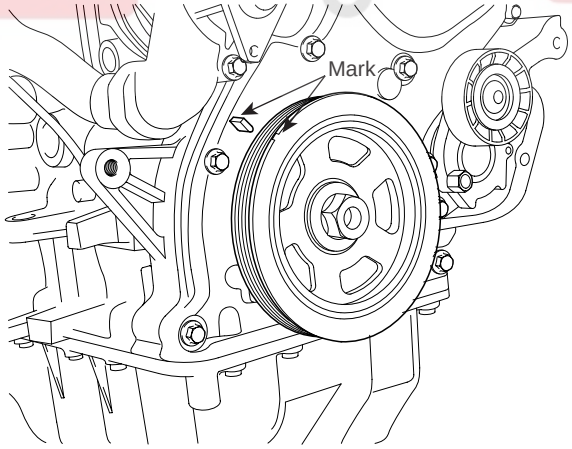
SLDFL6150L

5. Disconnect the fuel pressure regulator valve connector (B).
6. Remove the oil gage guide.
7. Disconnect the feed tube (A) and the return tube (B).



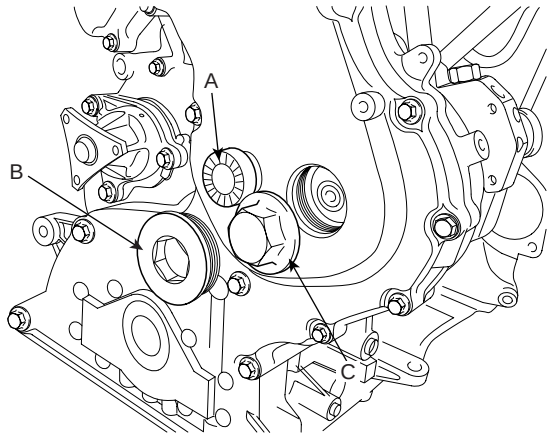
SLDFL6151L

8. Unscrew the three high pressure fuel pump mounting bolts (C).
9. Remove the drive belt (Refer to the group "EM" in this WORKSHOP MANUAL).
10. Turn the crankshaft pulley and align its groove with timing mark "T" of the timing chain cover.
(NO.1 cylinder compression TDC position.)



SLDFL6152L

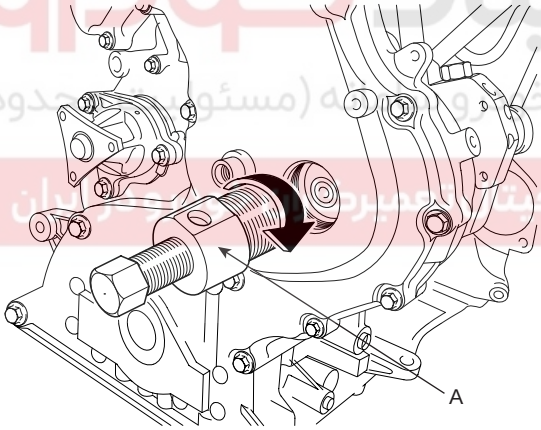
11. Remove the idler (A) and the timing chain cover plug (B).



SSAFL6162L

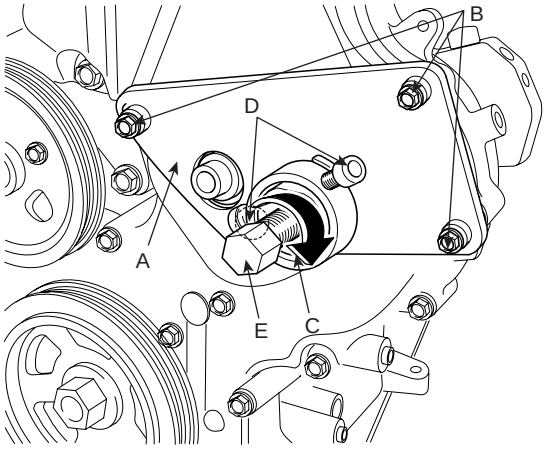
12. Remove the high pressure fuel pump sprocket nut (C) after fixing the crank shaft.

13. Install the high pressure fuel pump sprocket stopper (A) (SST No.: 09331-2A000) with rotating it clockwise.



SLDFL6157L

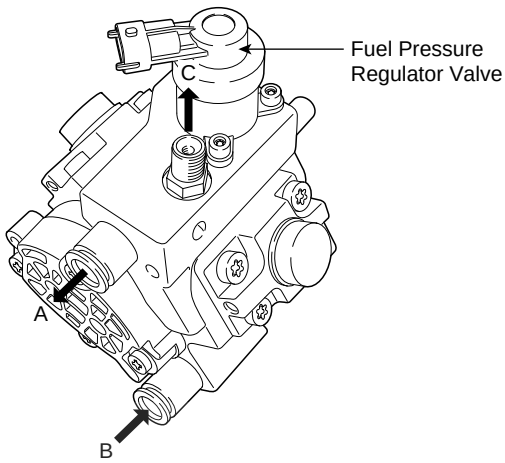
14. Install the high pressure fuel pump remover (SST No.:09331-2A000) (A) with three mounting bolts (B).



SSAFL6164L

15. Fix the high pressure fuel pump remover (SST No.:09331-2A000) (A) and sprocket stopper (C) with two fixing bolts (D).

16. Rotate the bolt (E) of the high pressure fuel pump remover (SST No.:09331-2A000) (A) clockwise till the high pressure fuel pump is pushed out.



A : To Fuel Tank (Return Line)
B : From Fuel Tank (Via fuel filter)
C : To Common Rail

SSAFL6160L

INSTALLATION E78DBF7E

1. Install the high pressure fuel pump according to the reverse order of "REMOVAL" procedure.

NOTE

When installing the high pressure pipe, apply the specified tightening torques to the flange nuts of the high pressure pipe side and the common rail side with SST (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: 14.7 ~ 19.6 N·m (1.5 ~ 2.0 kgf·m, 10.9 ~ 14.5 lbf·ft)

· High pressure pipe flange nuts (Common Rail ↔ High Pressure Fuel Pump):
24.5 ~ 28.4 N·m (2.5 ~ 2.9 kgf·m, 18.1 ~ 20.1 lbf·ft)

COMMON RAIL

DESCRIPTION E2E4FA1E

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.

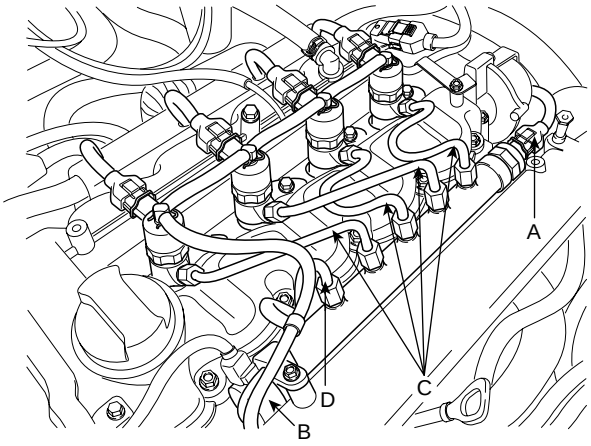
In order to comply with the wide variety of engine installation conditions, the common rail with its flow limiters and the provistions for attaching rail pressure sensor, fuel pressure control valve, and pressure limiter valve is available in a number of different designs.
The available common rail volume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

REMOVAL EB8404D3

WARNING

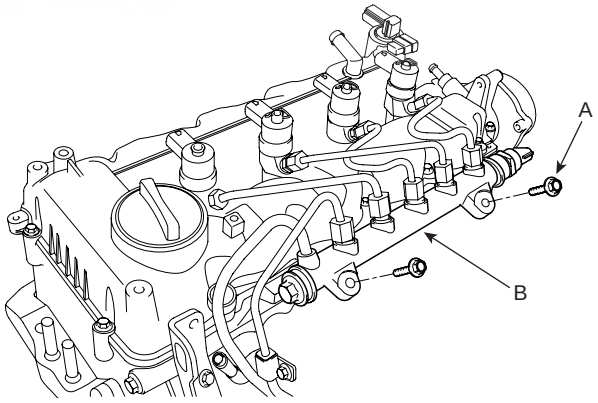
- **Common Rail Fuel Injection System is subject to extremely high pressure (Approximately 1,600 bar)**
- **Never perform any work on injection system with engine running or within 30 seconds after the engine stops.**
- **Always pay attention to safety precaution.**
- **Ensure the absolute cleanliness.**
- **It is not recommended to remove the injectors without any notice.**

1. Turn ignition switch to OFF position.
2. Disconnect the negative battery (-) terminal and wait for about 30 seconds.
3. Disconnect the rail pressure sensor connector (A).



SLDFL6153L

4. Disconnect the rail pressure regulator valve connector (B).
5. Remove the high pressure pipe (C) connecting injectors and the common rail.
6. Remove the high pressure pipe (D) connecting the high pressure fuel pump and and the common rail.
7. Remove the intake manifold (Refer to the group "EM" in this WORKSHOP MANUAL).
8. Unscrew the common rail mounting bolts (A) and the remove the common rail (B).



SLDFL6154L

INSTALLATION ECF8DB32

1. Install the common rail according to the reverse order of "REMOVAL" procedure.

NOTE

When installing the high pressure pipe, apply the specified tightening torques to the flange nuts of the injectors, the high pressure pipe, and the common rail side with SST (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: 14.7 ~ 21.6 N·m (1.5 ~ 2.2 kgf·m, 10.9 ~ 15.9 lbf·ft)

· High pressure pipe flange nuts (Injectors ↔ Common Rail):
24.5 ~ 28.4 N·m (2.5 ~ 2.9 kgf·m, 18.1 ~ 20.1 lbf·ft)

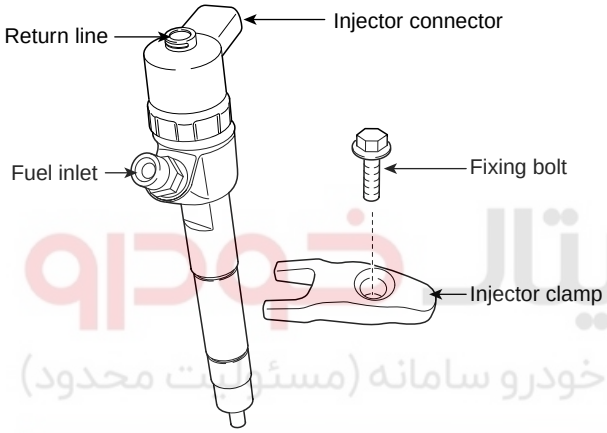
· High pressure pipe flange nuts (Common Rail ↔ HP Pump):
24.5 ~ 28.4 N·m (2.5 ~ 2.9 kgf·m, 18.1 ~ 20.1 lbf·ft)

INJECTOR

DESCRIPTION E4F0603D

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



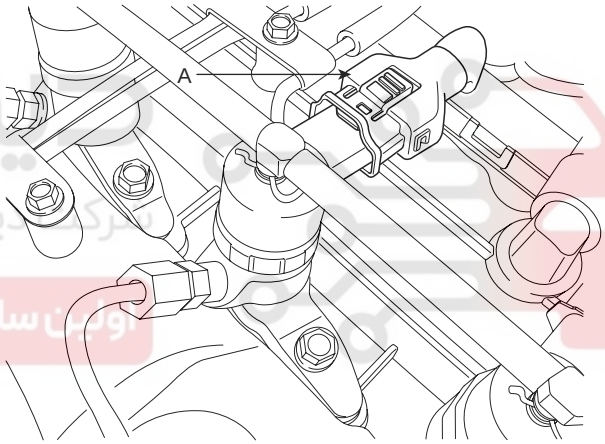
SSAFL6169L

REMOVAL EB82BA0F

WARNING

- **Common Rail Fuel Injection System is subject to extremely high pressure (Approximately 1,600 bar)**
- **Never perform any work on injection system with engine running or within 30 seconds after the engine stops.**
- **Always pay attention to safety precaution.**
- **Ensure the absolute cleanliness.**
- **It is not recommended to remove the injectors without any notice.**

1. Turn ignition switch to OFF position.
2. Disconnect the negative battery (-) terminal and wait for about 30 seconds.
3. Disconnect the injector connector (A).

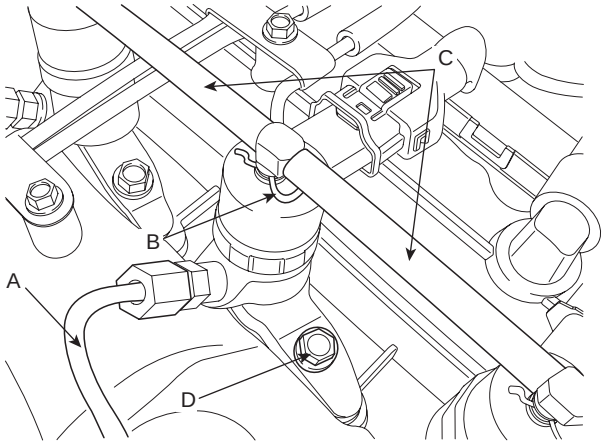


SSAFL6170L

WARNING

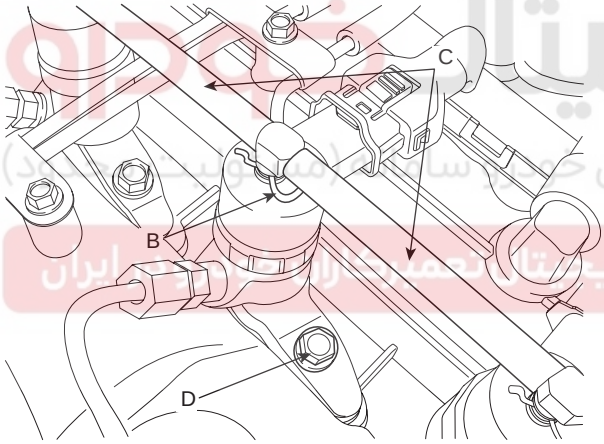
- **Plugs must be installed and/or uninstalled only with the ignition switch turned OFF.**
- **Do not extremely bend or squeeze the cable, do not bring them in contact with sharp edges, and also secure cables against vibrations.**

4. Disconnect the high pressure pipe (A) connecting the injectors with the common rail.



SLDFL6155L

5. After removing the clip (B), disconnect the retun hose (C) from the injectors and unscrew the clamp tightening bolt (D).



SSAFL6172L

6. Pull the injector assembly.

CAUTION

When pulling the injector, pull the injector upright so that the nozzle needle cannot be scratched or damaged.

NOTE

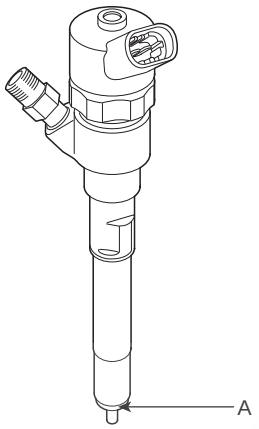
When the injector is stuck on cylinder head, pull it out with SST (SST No.: 09351-4A300).

INSTALLATION EE6BF794

1. Install the injector according to the reverse order of REMOVAL procedure.

NOTE

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



EFQG089A

NOTE

When installing the high pressure pipe, apply the specified tightening torques to the flange nuts of the injectors and the common rail side with SST (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 bolts: 28.4 ~ 30.4 N·m (2.9 ~ 3.1 kgf·m, 21 ~ 22.4 lbf·ft)

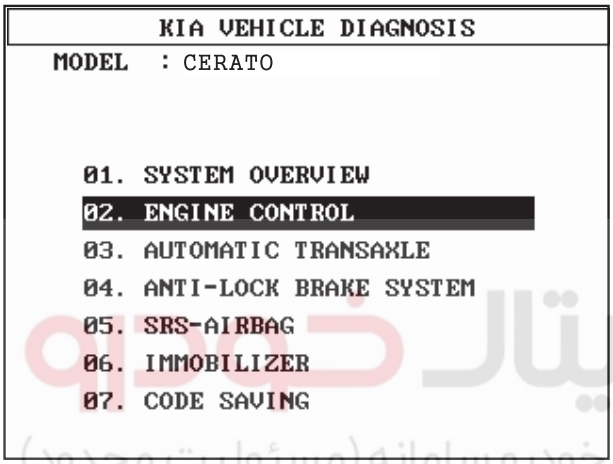
· High pressure pipe flange nuts (Injectors ↔ Common Rail): 24.5 ~ 28.4 N·m(2.5 ~ 2.9 kgf·m, 18.1 ~ 20.1 lbf·ft)

REPLACEMENT E63ECF7E

CAUTION

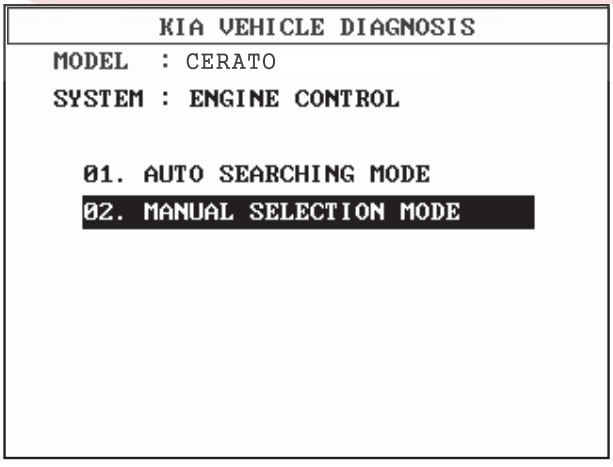
After replacing an ECM, MUST input the injector data (7 digit) of each cylinder into a new ECM.

1. Replace the injector with a new one according to the "REMOVAL" and "INSTALLATION" procedures.
2. Connect a scan tool to Data Link Connector (DLC) and turn ignition switch on.
3. Select "ENGINE CONTROL".



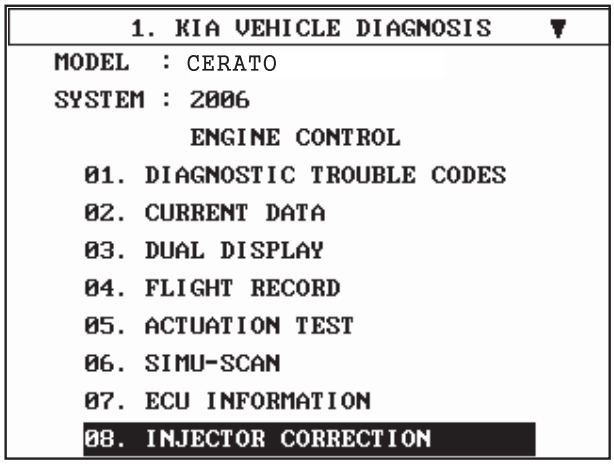
SLDFL6120L

4. Select "AUTO SELECTION MODE" or "MANUAL SELECTION MODE".



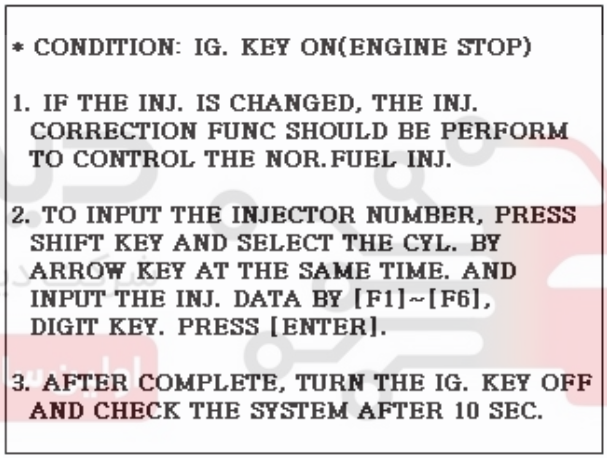
SLDFL6121L

5. Select "1.6L VGT DIESEL" in case of "MANUAL SELECTION MODE".
6. Select "INJECTOR CORRECTION".



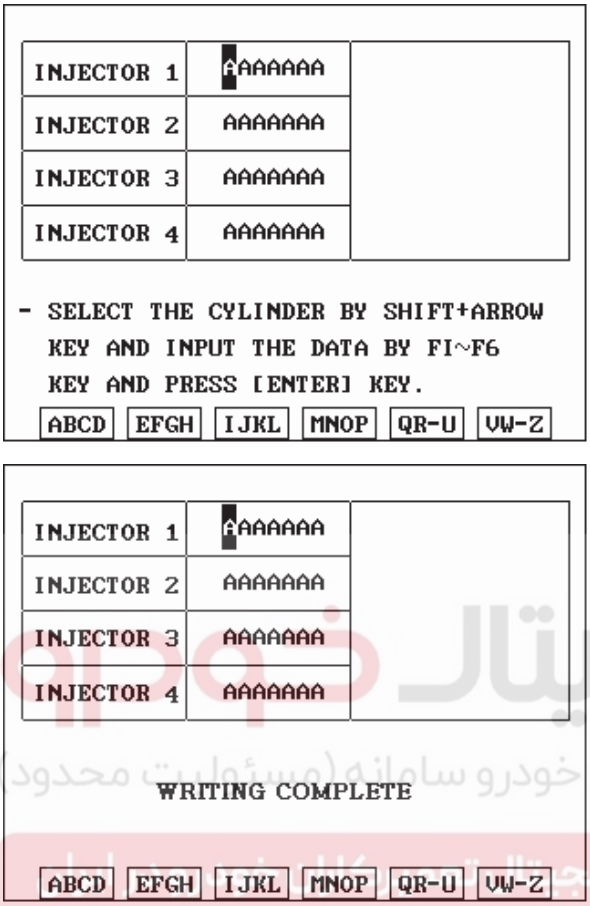
SLDFL6122L

7. Press "ENTER" key.



SSAFL6127L

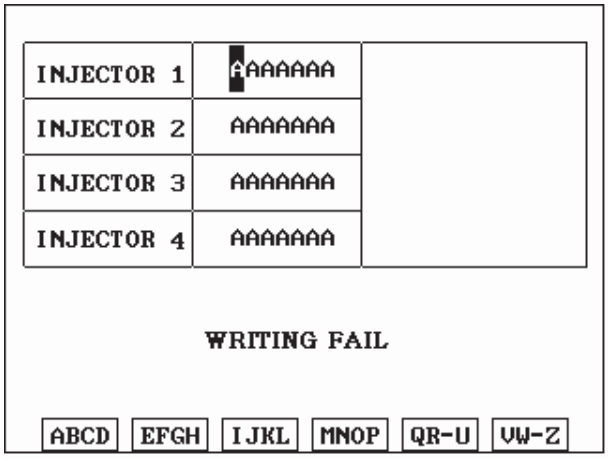
8. Input the injector data (7 digit) written on the top of each inejctor with function keys ([F1] ~ [F6]) and number keys.



EFQG112A

NOTE

When "WRITING FAIL" is displayed on the scan tool, input injector data (7 digits) of each cylinder into a new ECM again as prior procedure.



EFQG113A

INSPECTION E6605747

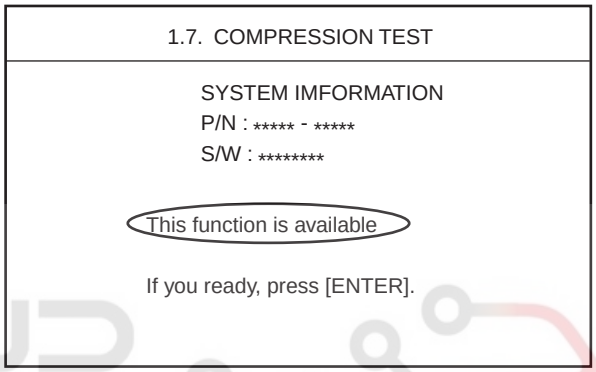
USING HI-SCAN(PRO)

- COMPRESSION TEST
- IDLE SPEED COMPARISON
- INJECT QUANTITY COMPARISON

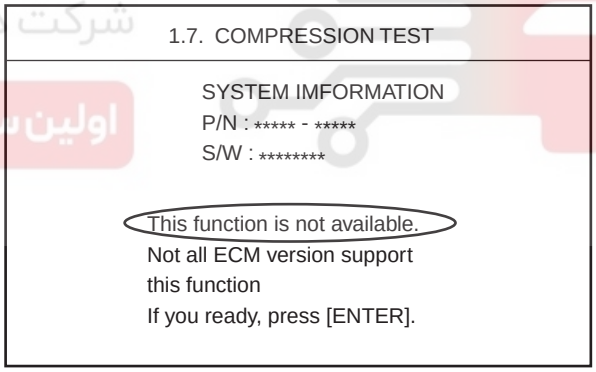
TEST PROCEDURE

1. Connect Hi-Scan(Pro) and select "Vehicle" and "Engine Test Function".

2. Information for ECM version is displayed as below.



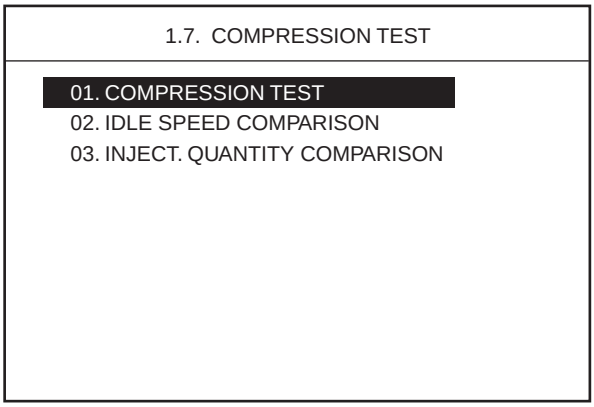
<Available system>



<Not available system>

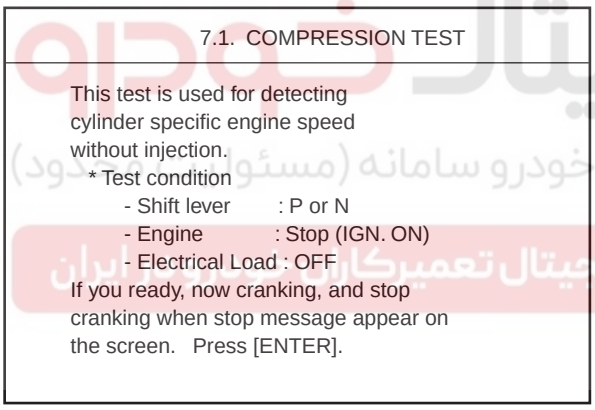
SLDFL6158L

3. After pressing "[ENTER]", select "COMPRESSION TEST" mode and press "[ENTER]".



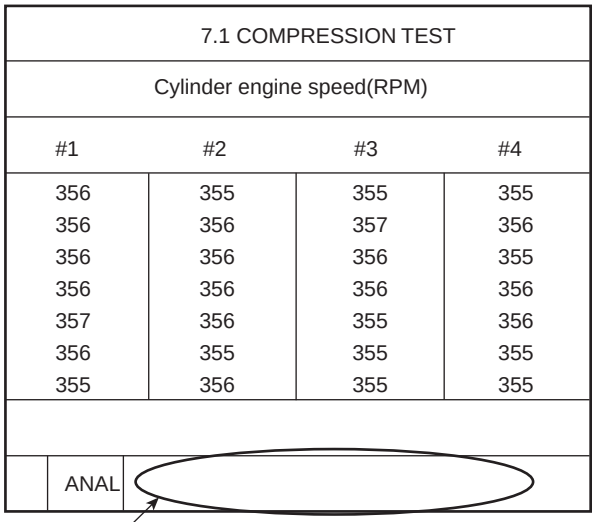
LFIF660D

4. Set the test condition described as below screen and then, crank engine. When engine stop message being appeared, stop cranking.



LFIF660E

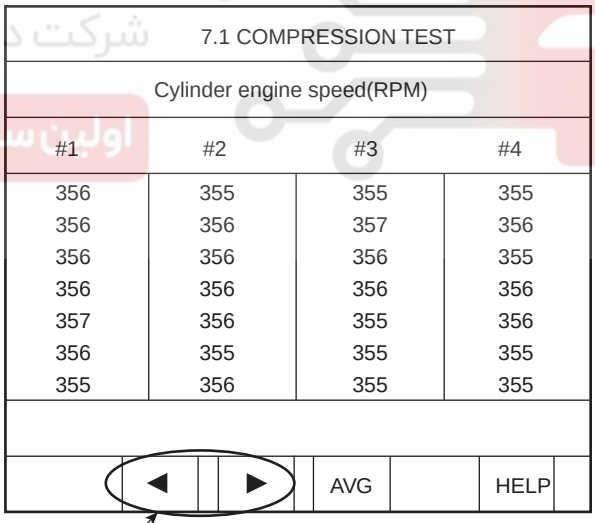
5. Press "ANAL" and the test result is appeared.



LFIF660F

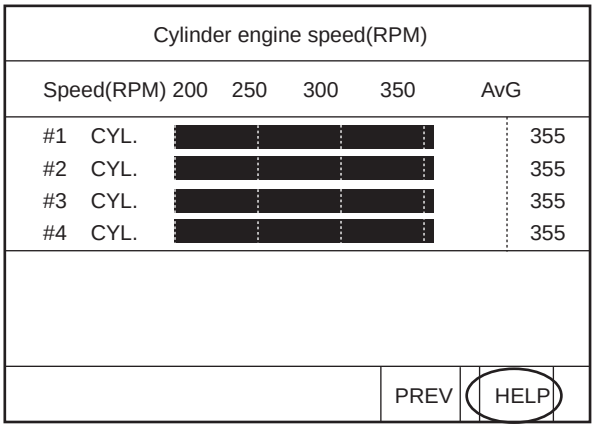
NOTE

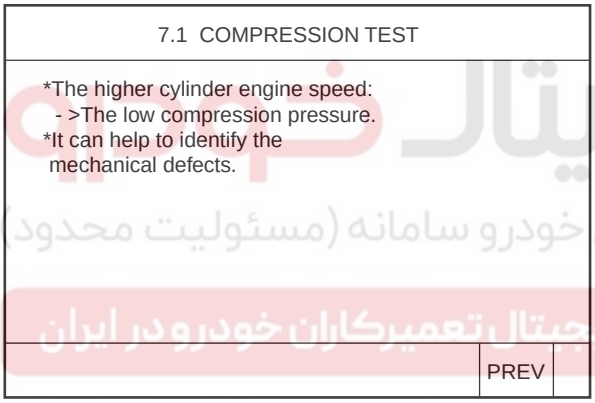
During cranking engine does not start.



LFIF660G

6. Press "AVG" and the data average of each cylinder is appeared.
   Press "HELP" and description of the data is appeared.

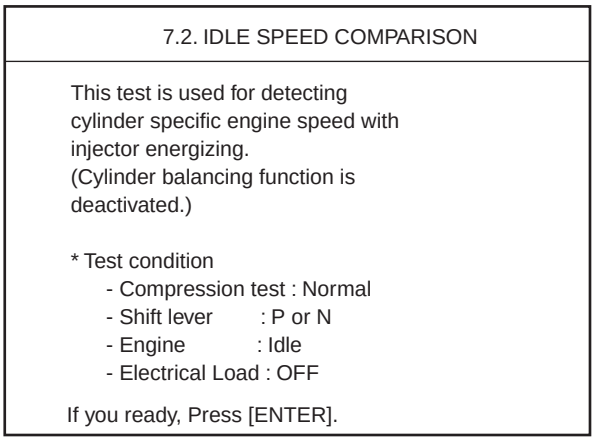




LFIF660H

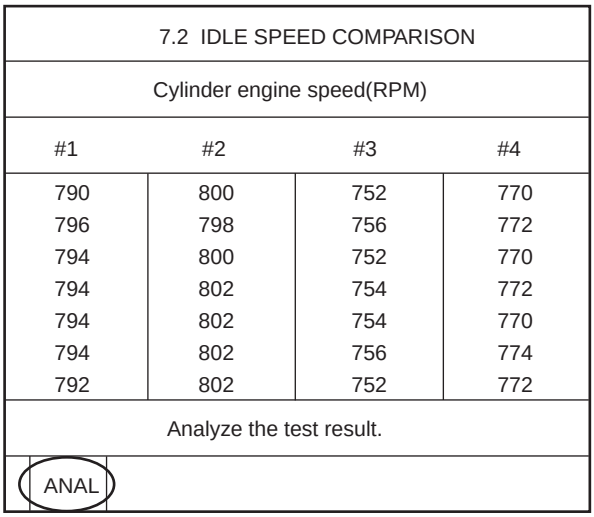
7. After pressing "ESC", select "IDLE SPEED COMPARISON" and press "[ENTER]".

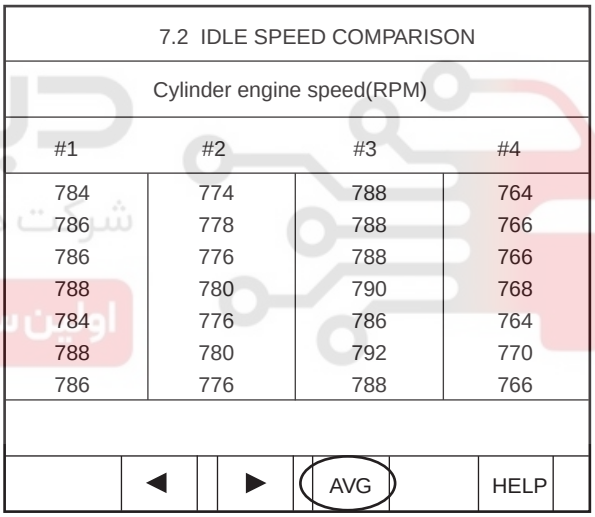
8. Set the test condition described as below screen and press "[ENTER]".



LFIF660J

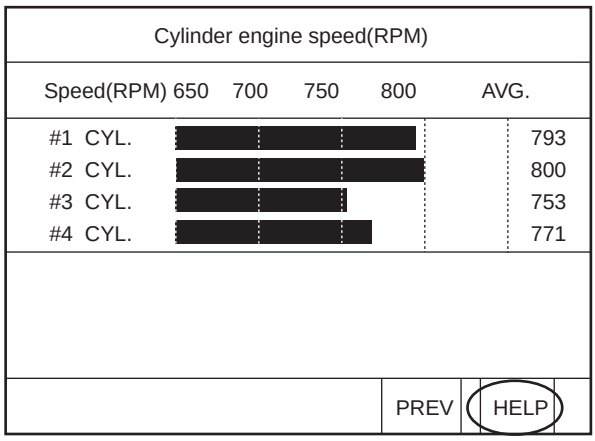
9. The rpm data of each cylinder is appeared.

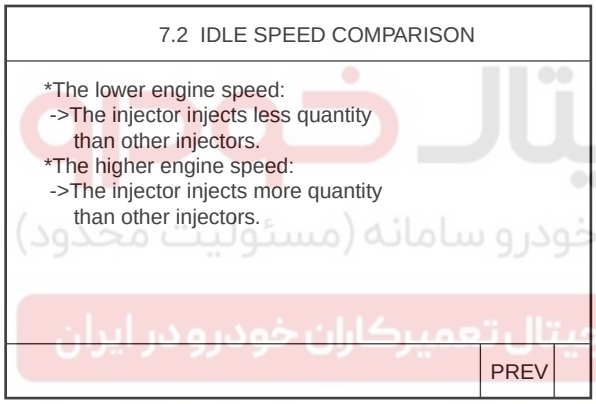




LFIF660K

10. Press "AVG" and the data average of each cylinder is appeared.
    Press "HELP" and description of the data is appeared.

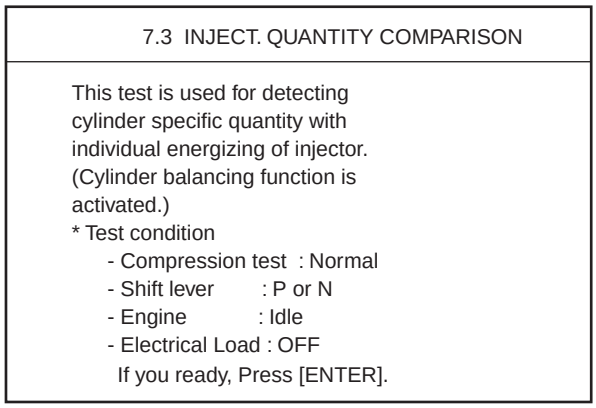




LFIF660M

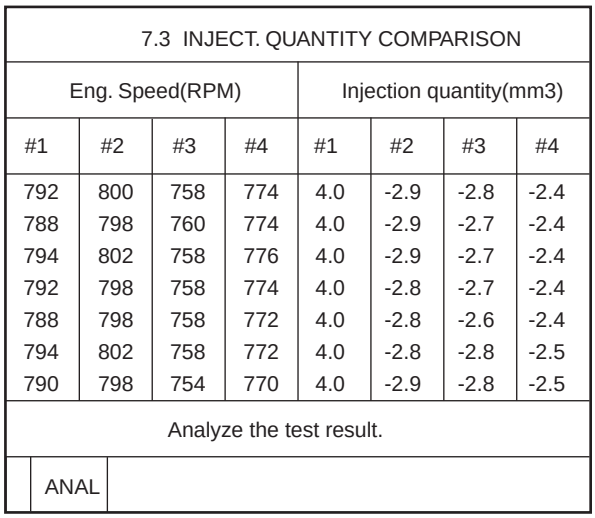
11. After pressing "ESC", select "INJECTOR QUANTITY COMPARISON" and press "[ENTER]".

12. Set the test condition described as below screen and press "[ENTER]".



LFIF660O

13. The data od each cylinder about RPM and compensating injection quantity is appeared.

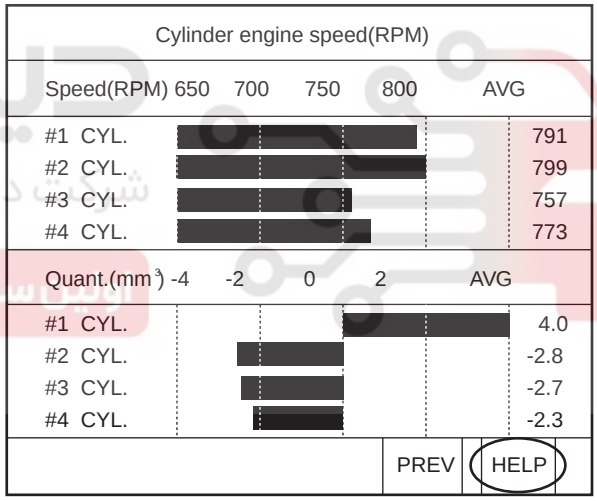


7.3 INJECT. QUANTITY COMPARISON

Eng. Speed(RPM)				Injection quantity(mm3)			
#1	#2	#3	#4	#1	#2	#3	#4
792	800	758	774	4.0	-2.9	-2.8	-2.4
788	798	760	774	4.0	-2.9	-2.7	-2.4
794	802	758	776	4.0	-2.9	-2.7	-2.4
792	798	758	774	4.0	-2.8	-2.7	-2.4
788	798	758	772	4.0	-2.8	-2.6	-2.4
794	802	758	772	4.0	-2.8	-2.8	-2.5
790	798	754	770	4.0	-2.9	-2.8	-2.5

Analyze the test result.

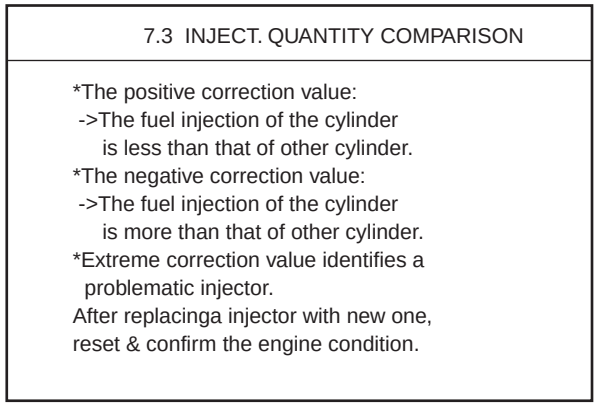
ANAL



<Abnormal state>

LFIF660P

14. Press "HELP" and description of the data is displayed as below.



LFIF660R

15. Replace the default injector, and then repeat previous test modes to check if the injector is normal.

COMPONENT INSPECTION

1. Turn ignition switch "OFF".
2. Disconnect injector connector.
3. Measure resistance between the terminals 1 and 2 of injector connector.

Resistance : 0.215 ~ 0.295Ω [20 ~ 70℃(68 ~ 158℉)]