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
- THROTTLE CONTROL ACTUATOR
- VARIABLE SWIRL CONTROL ACTUATOR
- WATER SENSOR
- VGT CONTROL SOLENOID VALVE
- LAMBDA SENSOR
- EXHAUST GAS TEMPERATURE SENSOR (EGTS) FOR VGT
- EXHAUST GAS TEMPERATURE SENSOR (EGTS) FOR CPF
- DIFFERENTIAL PRESSURE SENSOR (DPS)
- CATALYZED PARTICULATE FILTER (CPF)

DTC TROUBLESHOOTING PROCEDURES

FUEL DELIVERY SYSTEM-DIESEL

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

GENERAL

SPECIFICATIONS E670548B

FUEL DELIVERY SYSTEM

Items	Specification	
Fuel Tank	Capacity	75 lit. (16.5 Imp.gal., 19.8 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	Camshaft
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˚F)

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

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

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

INTAKE AIR TEMPERATURE SENSOR (IATS) #1 [BUILT IN MAFS]
▷ Type: Thermistor type
▷ Specification

Temperature [℃(˚F)]	Resistance(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	1.02 ~ 1.17
140	2.13 ~ 2.28
210	3.25 ~ 3.40
270	4.20 ~ 4.35
284	4.5

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

▷ Type: Thermistor type

▷ Specification

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

ENGINE COOLANT TEMPERATURE SENSOR (ECTS)

▷ Type: Thermistor type

▷ Specification

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

CAMSHAFT POSITION SENSOR (CMPS)

▷ Type: Hall effect type

▷ Specification

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

Items	Specification
Air Gap	1.5 ± 0.1 mm

CRANKSHAFT POSITION SENSOR (CKPS)

▷ Type: Variable reluctance type

▷ Output Voltage (V): 0 ~ 5V

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

ACCELERATOR POSITION SENSOR (APS)

▷ Type: Potentiometer type

▷ Specification

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

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

FUEL TEMPERATURE SENSOR (FTS)

▷ Type: Thermistor type

▷ Specification

Temperature [℃(°F)]	Resistance(kΩ)
-30(-22)	27.00
-20(-4)	15.67
-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 [℃(˚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

EXHAUST GAS TEMPERATURE SENSOR (EGTS) #1 FOR VGT
▷ Type: Thermistor type
▷ Specification

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

DIFFERENTIAL PRESSURE SENSOR (DPS)
▷ Type: Piezo-electricity type
▷ Specification: Vout = (4.5 - 1.0) / 100 * △P + 1.0 (V)

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

EXHAUST GAS TEMPERATURE SENSOR (EGTS) #2 FOR CPF
▷ Type: Thermistor type
▷ Specification

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

VEHICLE SPEED SENSOR (VSS)
▷ Type: Inductive type

OUTPUT ACTUATORS

INJECTOR
▷ Number: 4
▷ Specification

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

FUEL PRESSURE REGULATOR VALVE
▷ Specification

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

RAIL PRESSURE REGULATOR VALVE
▷ Specification

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

THROTTLE CONTROL ACTUATOR
▷ Type : Duty control motor type
▷ Specification

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

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

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

VGT CONTROL SOLENOID VALVE
▷ Specification

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

VARIABLE SWIRL CONTROL ACTUATOR
▷ Type: Motor Driven (including Position Sensor)
▷ Specification
Motor

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

Position Sensor

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

SERVICE STANDARD EA925EF7

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

TIGHTENING TORQUES E3562770

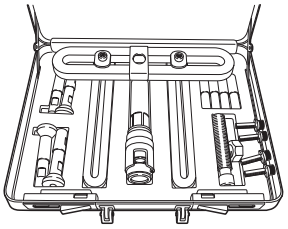
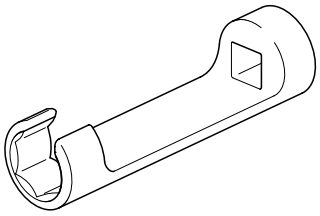
ENGINE CONTROL SYSTEM

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

FUEL DELIVERY SYSTEM

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

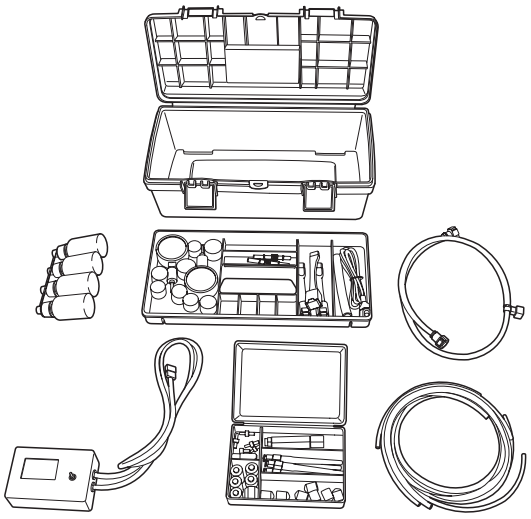
SPECIAL SERVICE TOOLS E94FDF3C

Tool (Number and name)	Illustration	Application
09351-4A300 Injector Remover	 SVQFL6499D	Removing the injector
09314-27110(14mm) 09314-27120(17mm) Torque Wrench Socket	 AFAF201B	Installing the high pressure pipe

REFERENCE SERVICE TOOL - COMMON RAIL TESTER

Tool Number	Tool Name
CTR-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 E7201775

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	Confirmation test

14	END

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.

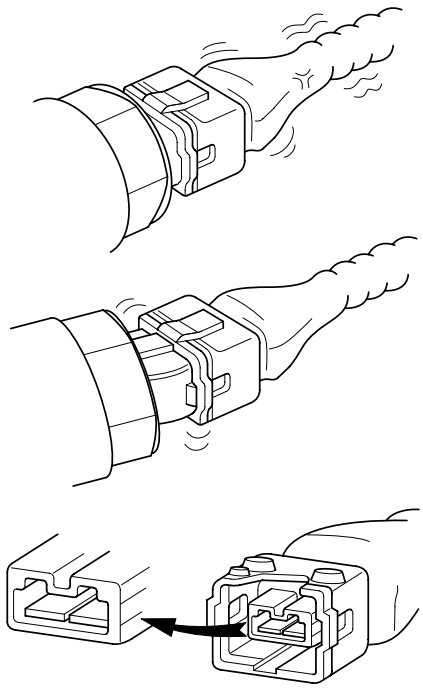
NOTE

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.



BFGE321A

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

● SIMULATING VIBRATION

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

WARNING

Strong vibration may break sensors, actuators or relays

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

● SIMULATING HEAT

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

WARNING

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

● SIMULATING WATER SPRINKLING

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

WARNING

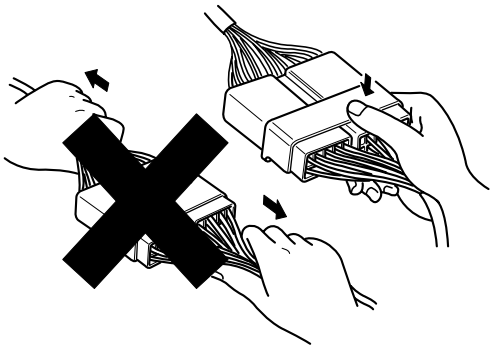
DO NOT sprinkle water directly into the engine compartment or electronic components.

● SIMULATING ELECTRICAL LOAD

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

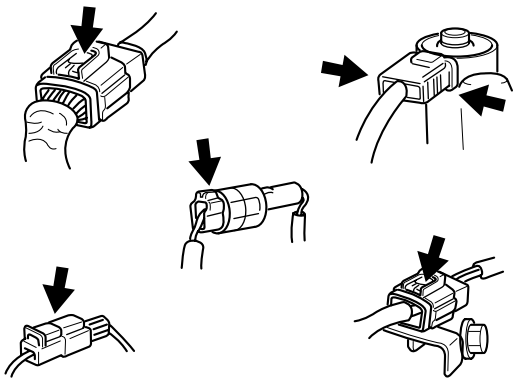
CONNECTOR INSPECTION PROCEDURE

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



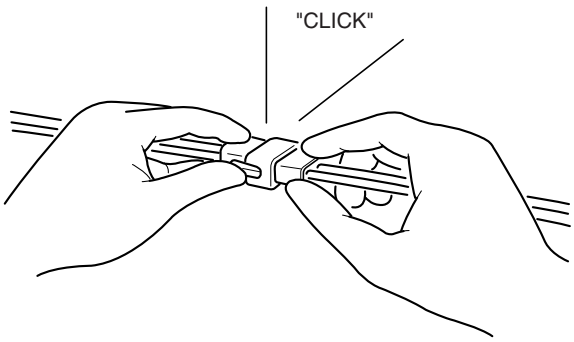
BFGE015F

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



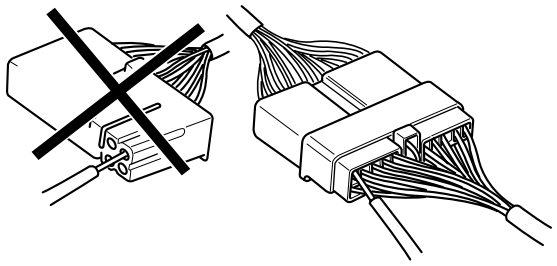
BFGE015G

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



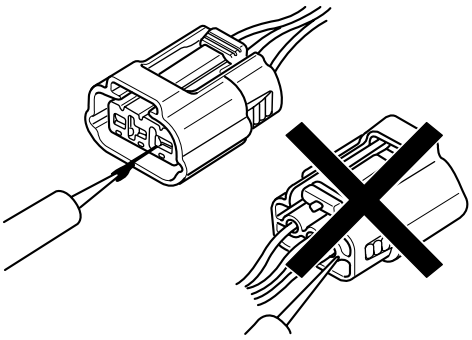
BFGE015H

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



BFGE015I

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

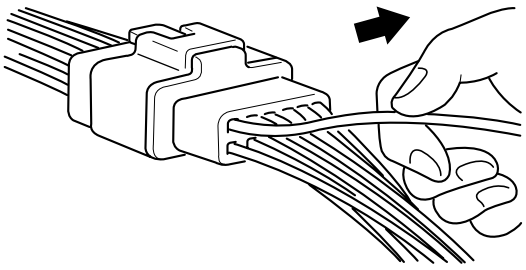


BFGE015J

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.



BFGE015K

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.

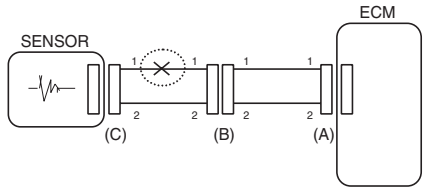
ELECTRICAL CIRCUIT INSPECTION PROCEDURE

● 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



BFGE501A

2. Continuity Check Method

   NOTE

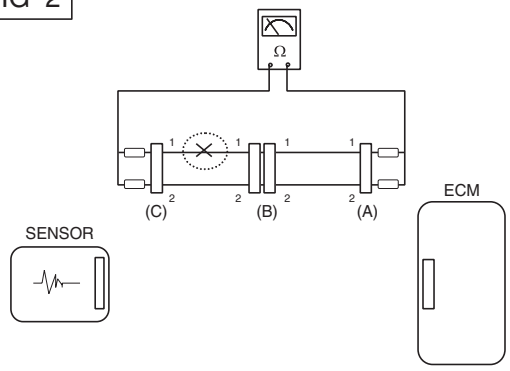
   When measuring for resistance, lightly shake the wire harness above and below or from side to side.

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

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

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

FIG 2

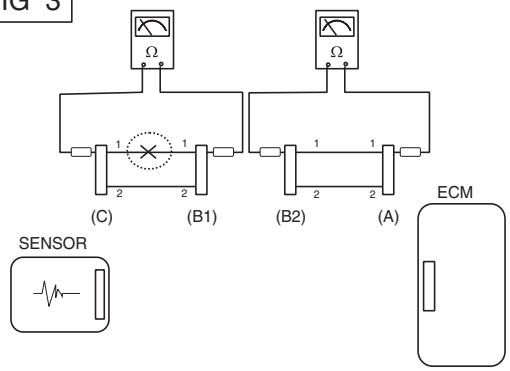


BFGE501B

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

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

FIG 3

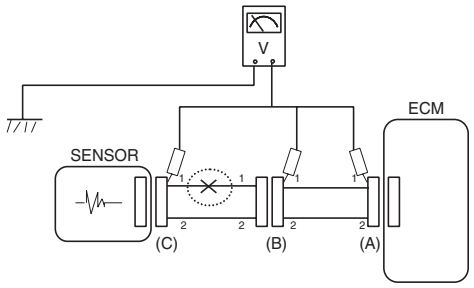


BFGE501C

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

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

FIG 4



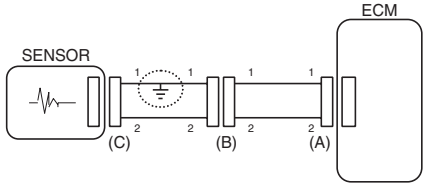
BFGE501D

● CHECK SHORT CIRCUIT

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

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

FIG 5



BFGE501E

2. Continuity Check Method (with Chassis Ground)

   NOTE

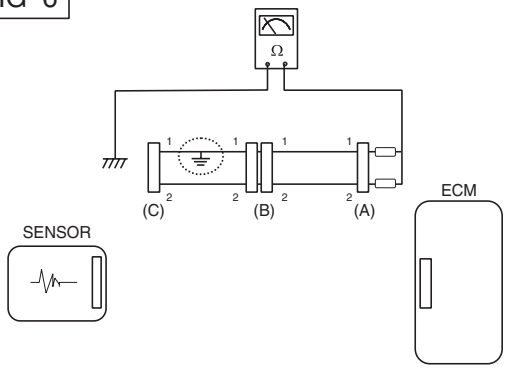
   Lightly shake the wire harness above and below, or from side to side when measuring the resistance.

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

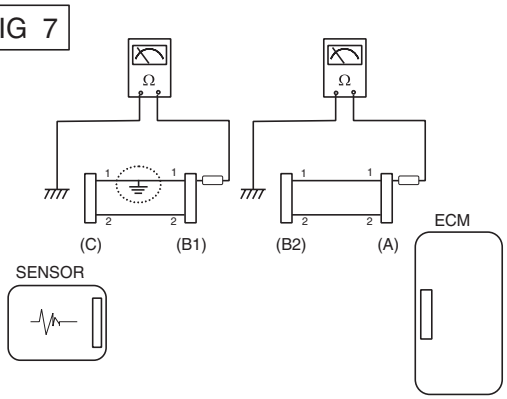


BFGE501F

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

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

FIG 7



BFGE501G

SYMPTOM TROUBLESHOOTING GUIDE TABLE

(SYMPTOM 1) ENGINE DOES NOT START

Possible Cause	
• Run out of fuel • 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 E02A4912

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.*

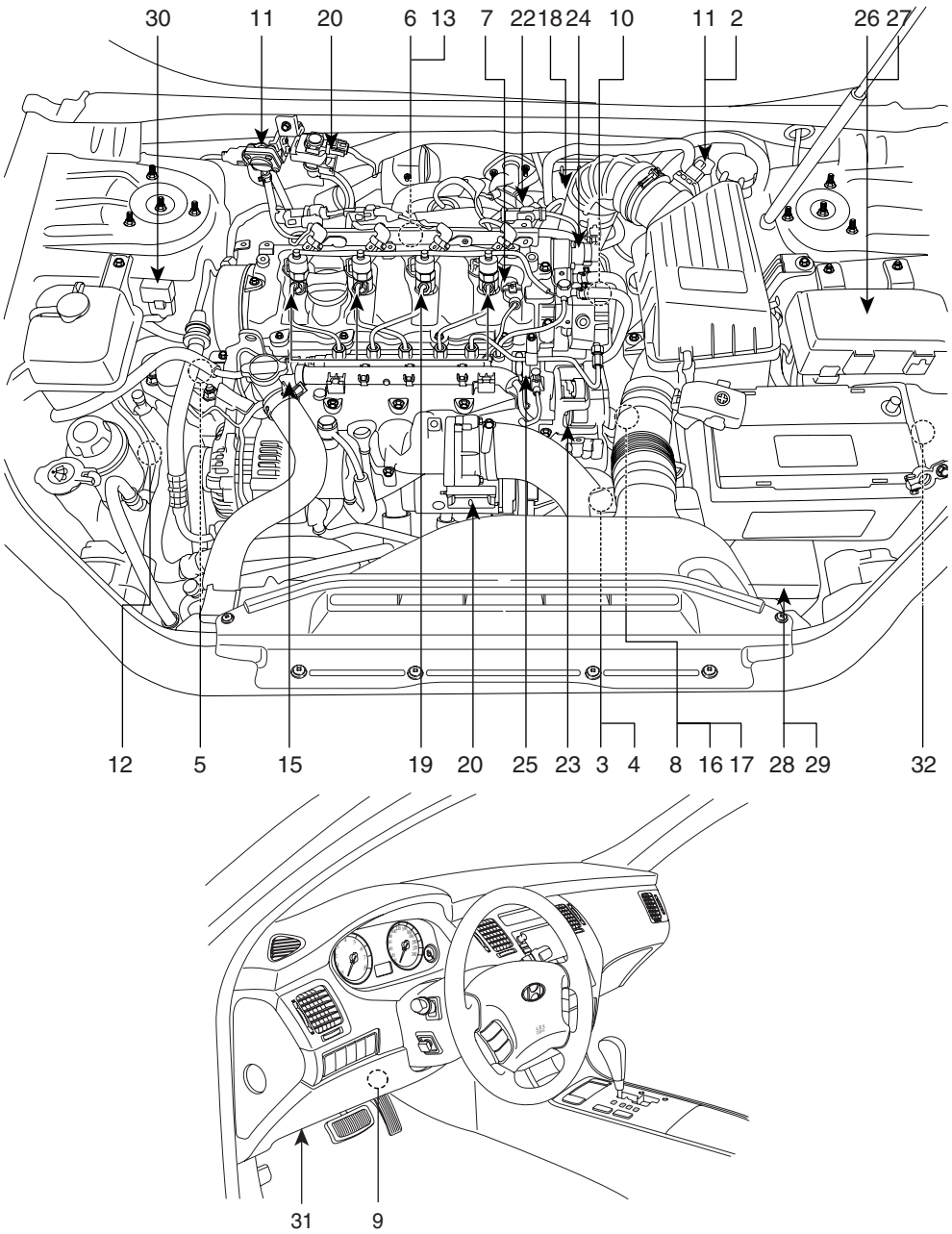
INSPECTION PROCEDURE (USING GENERIC SCAN TOOL)

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.

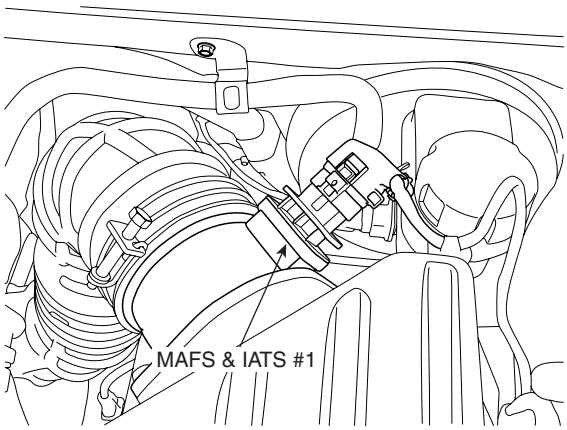
COMPONENT LOCATION E311F376



1. Mass Air 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. Differential Pressure Sensor (DPS)
12. A/C Pressure Transducer (APT)
13. Exhaust Gas Temperature Sensor (EGTS) #1 for VGT
14. Exhaust Gas Temperature Sensor (EGTS) #2 for CPF
15. Rail Pressure Sensor (RPS)
16. Vehicle Speed Sensor (VSS)
17. Oil Pressure Switch (OPS)
18. Water Sensor (included in Fuel Filter)
19. Injector
20. Throttle Control Actuator
21. VGT Control Solenoid Valve
22. Electric EGR Control Valve
23. Variable Swirl Control Actuator
24. Fuel Pressure Regulator Valve
25. Rail Pressure Regulator Valve
26. Main Relay
27. Fuel Pump Relay
28. Glow Relay
29. Auxiliary Heater Relay
30. Multi-Purpose Check Connector
31. Data Link Connector (DLC)
32. ECM (Engine Control Module)

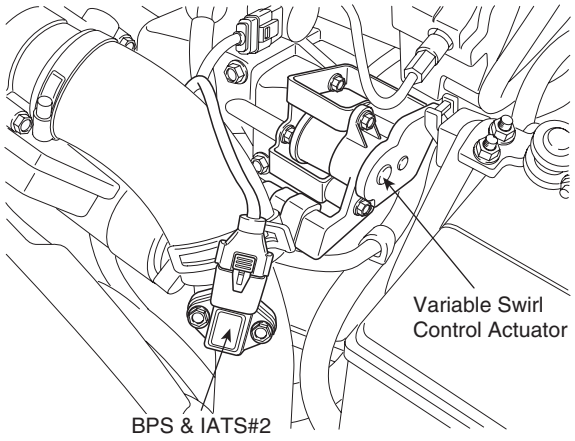
STGFL7100L

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



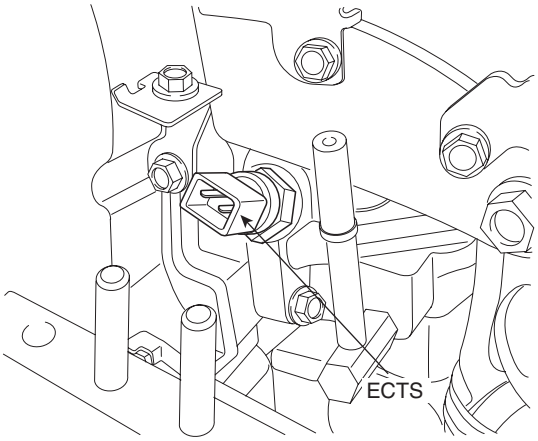
SNFFL6101D

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



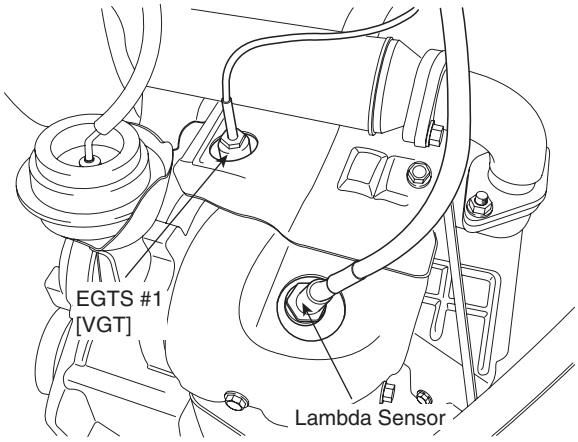
LFIG007A

5. Engine Coolant Temperature Sensor (ECTS)



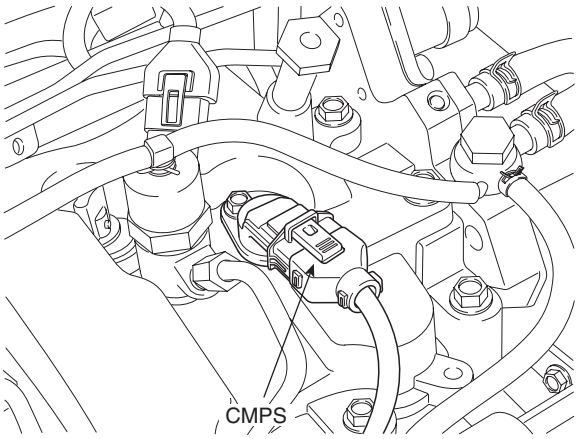
LFIG008A

6. Lambda Sensor
13. Exhaust Gas Temperature Sensor (EGTS) #1 for VGT



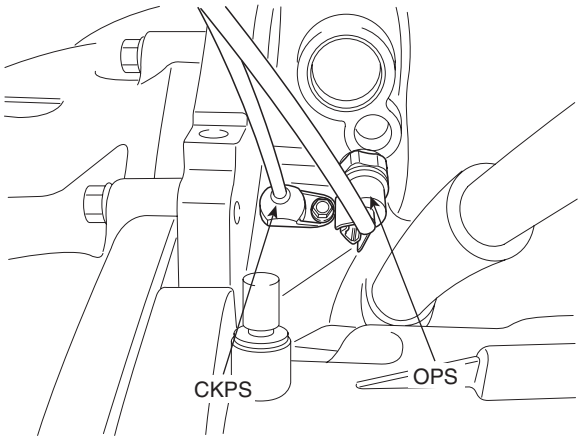
SNFFL6101L

7. Camshaft Position Sensor (CMPS)



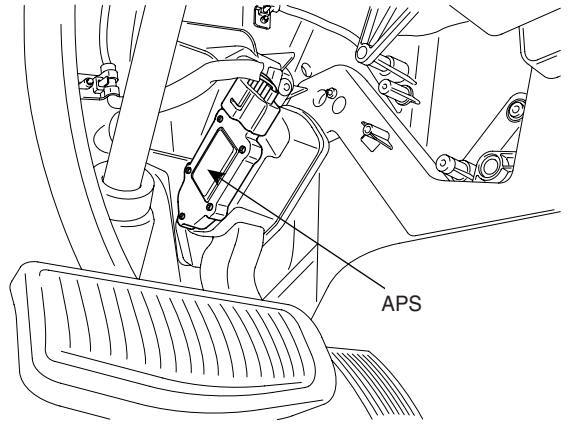
LFIG010A

8. Crankshaft Position Sensor (CKPS)
17. Oil Pressure Switch (OPS)



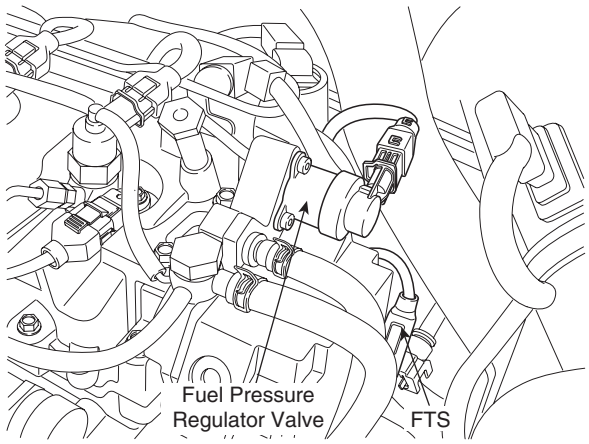
LFIG011A

9. Accelerator Pedal Position Sensor (APS)



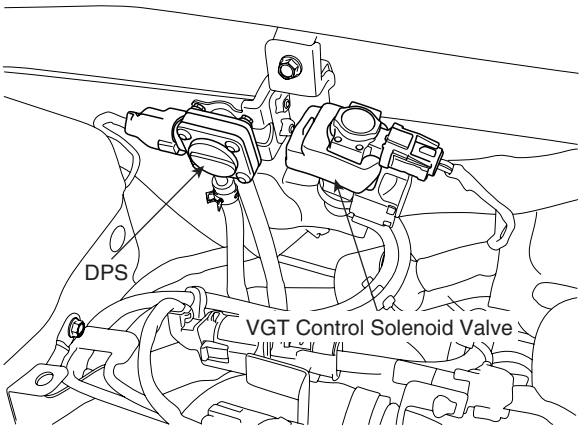
SNFFL6102D

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



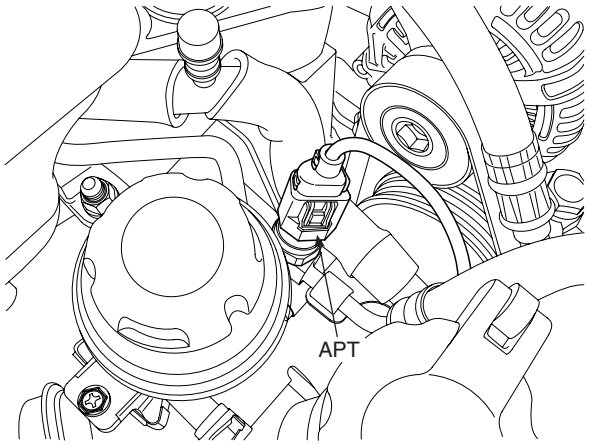
LFIG013A

11. Differential Pressure Sensor (DPS)
21. VGT Control Solenoid Valve



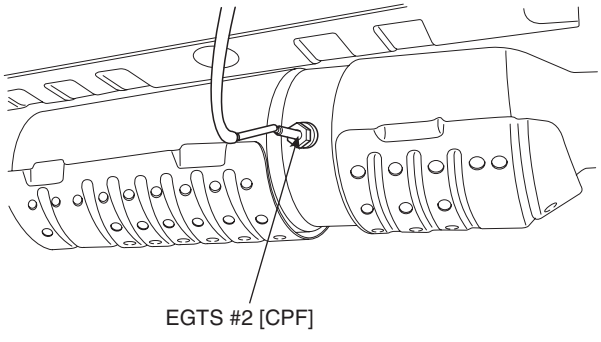
SNFFL6103L

12. A/C Pressure Transducer (APT)



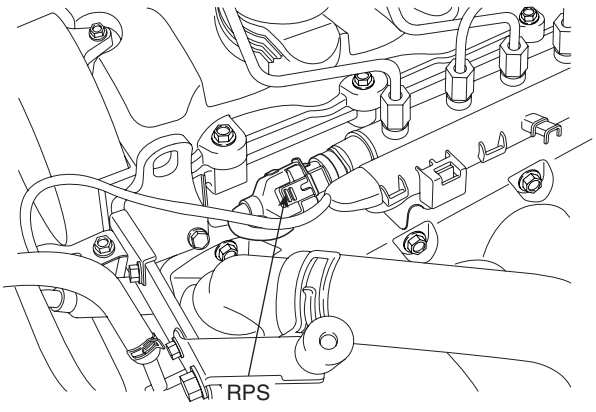
STGFL6101D

14. Exhaust Gas Temperature Sensor (EGTS) #2 for CPF



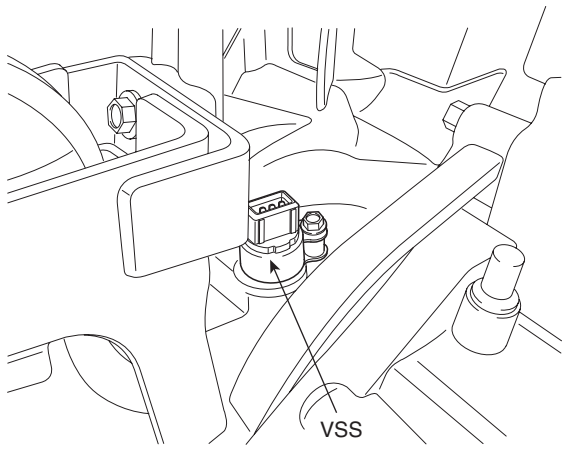
SNFFL6102L

15. Rail Pressure Sensor (RPS)



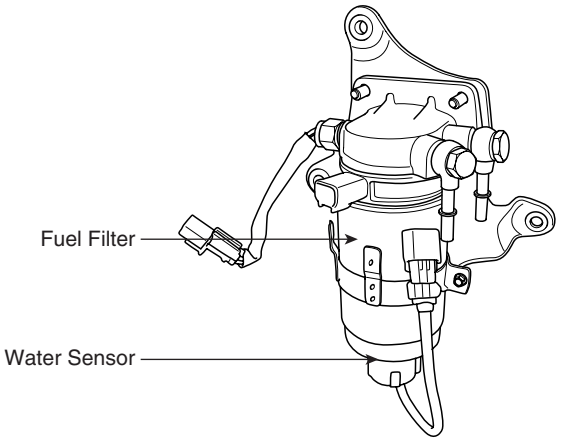
LFIG017A

16. Vehicle Speed Sensor (VSS)



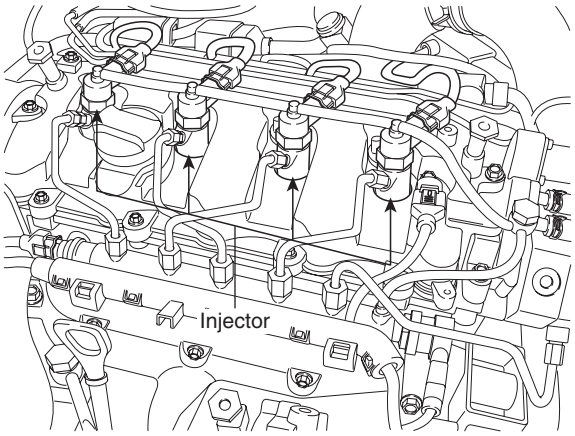
LFIG018A

18. Water Sensor (included in Fuel Filter)



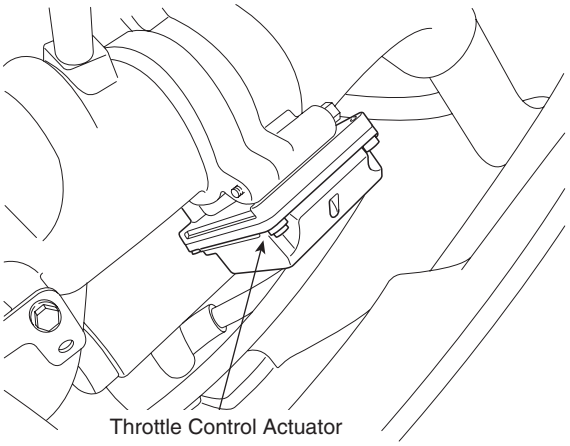
SNFFL6105L

19. Injector



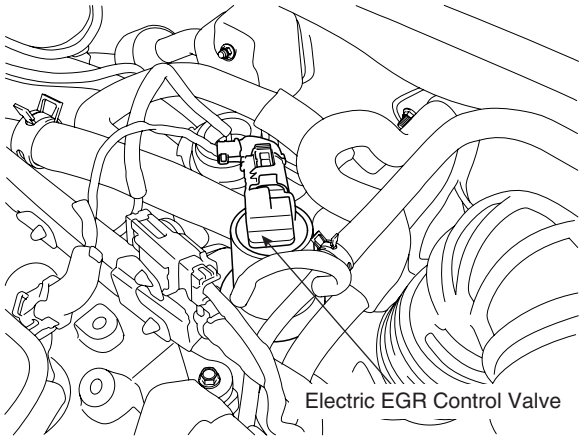
LFIG020A

20. Throttle Control Actuator



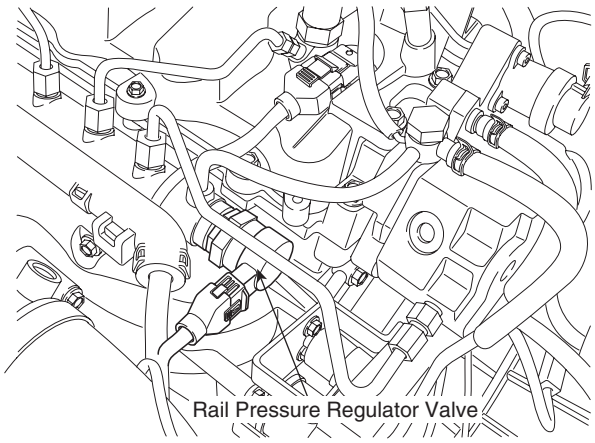
LFIG021A

22. Electric EGR Control Valve



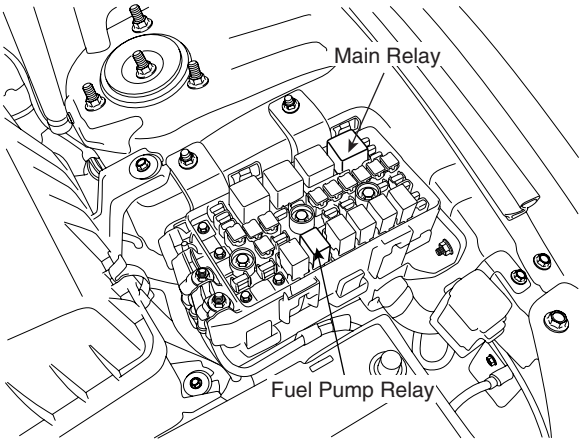
SNFFL6106L

25. Rail Pressure Regulator Valve



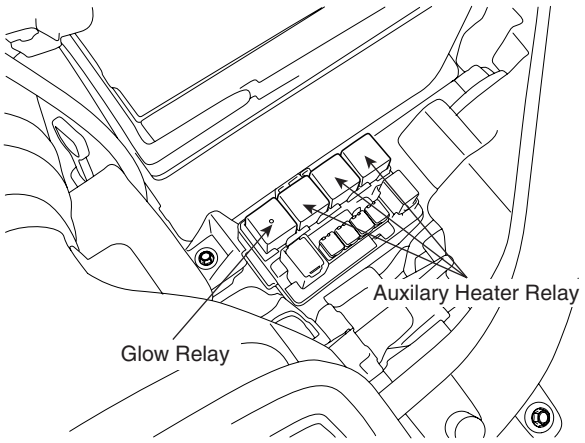
LFIG023A

26. Main Relay
27. Fuel Pump Relay



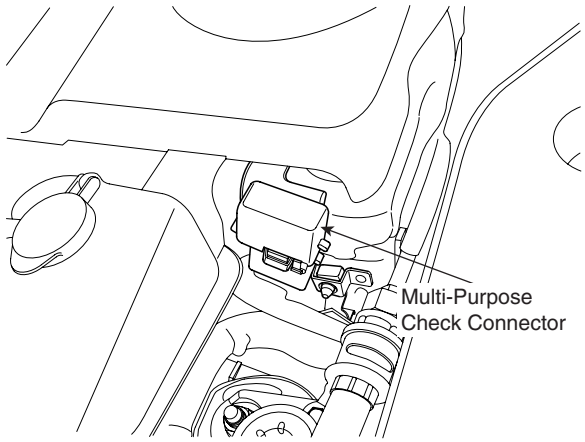
SNFFL6107L

28. Glow Relay
29. Auxiliary Heater Relay



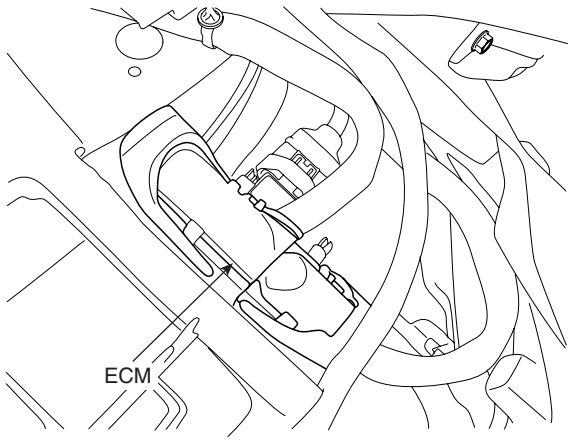
SNFFL6108L

30. Multi-Purpose Check Connector



STGFL7102L

32. ECM (Engine Control Module)

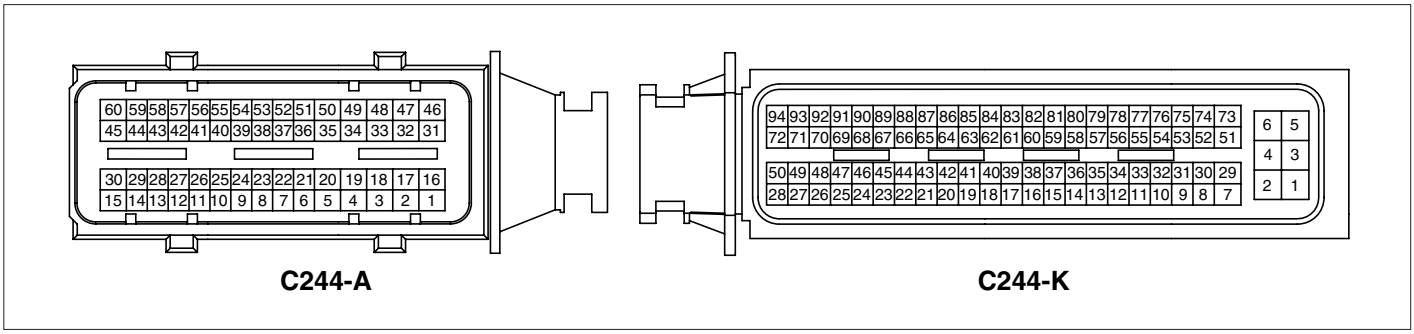


STGFL6600D

ENGINE CONTROL MODULE (ECM)

ECM (ENGINE CONTROL MODULE) E9D63F3D

1. ECM HARNESS CONNECTOR



STGFL7110L

2. ECM TERMINAL FUNCTION

CONNECTOR [C244-A]

Pin	Description	Connected to
1	Injector (Cylinder #3) [HIGH] control output	Injector (Cylinder #3)
2	Injector (Cylinder #2) [HIGH] control output	Injector (Cylinder #2)
3	-	
4	Battery power	Rail Pressure Regulator Valve
5	-	
6	Sensor ground	Position Sensor in Variable Swirl Control Actuator
7	Sensor shield	Crankshaft Position Sensor (CKPS)
8	Sensor ground	Rail Pressure Sensor (RPS)
9	-	
10	-	
11	-	
12	Crankshaft Position Sensor (CKPS) [-] signal input	Crankshaft Position Sensor (CKPS)
13	Reference voltage (+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	Reference voltage (+5V)	Position Sensor in Variable Swirl Control Actuator
27	Crankshaft Position Sensor (CKPS) [+] signal input	Crankshaft Position Sensor (CKPS)
28	Reference voltage (+5V)	Rail Pressure Sensor (RPS)
29	-	
30	Motor [-] control output	Variable Swirl Control Actuator
31	Injector (Cylinder #2) [LOW] control output	Injector (Cylinder #2)
32	-	
33	Injector (Cylinder #4) [LOW] control output	Injector (Cylinder #4)
34	Rail Pressure Regulator Valve control output	Rail Pressure Regulator Valve
35	-	
36	-	
37	Reference frequency	Mass Air Flow Sensor (MAFS)
38	-	
39	-	
40	Boost Pressure Sensor (BPS) signal input	Boost Pressure Sensor (BPS)
41	Sensor ground	Engine Coolant Temperature Sensor (ECTS)
42	Mass Air Flow Sensor (MAFS) signal input	Mass Air Flow Sensor (MAFS)
43	Rail Pressure Sensor (RPS) signal input	Rail Pressure Sensor (RPS)
44	Sensor ground	MAFS & IATS #1
45	Fuel Pump Relay output	Fuel Pump Relay
46	Injector (Cylinder #3) [LOW] control output	Injector (Cylinder #3)
47	Injector (Cylinder #1) [LOW] control output	Injector (Cylinder #1)
48	-	
49	Fuel Pressure Regulator Valve control output	Fuel Pressure Regulator Valve
50	Camshaft Position Sensor (CMPS) signal input	Camshaft Position Sensor (CMPS)
51	-	
52	-	
53	Intake Air Temperature Sensor (IATS) #2 signal input	Intake Air Temperature Sensor (IATS) #2 built in BPS
54	-	
55	-	
56	Position Sensor signal input	Position Sensor in Variable Swirl Control Actuator
57	-	
58	Engine Coolant Temperature Sensor (ECTS) signal input	Engine Coolant Temperature Sensor (ECTS)
59	Electric EGR Control Valve control output	Electric EGR Control Valve
60	Motor [+] control output	Variable Swirl Control Actuator

CONNECTOR [C244-K]

Pin	Description	Connected to
1	Batter voltage supply after main relay	Main Relay
2	Power ground	Chassis Ground
3	Batter voltage supply after main relay	Main Relay
4	Power ground	Chassis Ground
5	Batter voltage supply after main relay	Main Relay
6	Power ground	Chassis Ground
7	-	
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	Ground	A/C Pressure Transducer
13	A/C Pressure Transducer signal input	A/C Pressure Transducer
14	Ground	Cruise Control Switch
15	Cruise Control "ACTIVATOR" signal input	Cruise Control Switch
16	Ground	Immobilizer Control Module
17	-	
18	-	
19	Ground (VDC)	
20	-	
21	-	
22	Reference voltage (+5V)	A/C Pressure Transducer
23	-	
24	Reference voltage (+5V)	Cruise Control Switch
25	Diagnosis Data Line (K-Line)	Data Link Connector (DLC)
26	Throttle Position (PWM)	EPS module
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	Exhaust Gas Temperature Sensor (EGTS) #2 signal input	Exhaust Gas Temperature Sensor (EGTS) #2 for CPF
33	Sensor ground	Exhaust Gas Temperature Sensor (EGTS) #2 for CPF
34	Exhaust Gas Temperature Sensor (EGTS) #1 signal input	Exhaust Gas Temperature Sensor (EGTS) #1 for VGT
35	Sensor ground	Exhaust Gas Temperature Sensor (EGTS) #1 for VGT

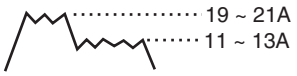
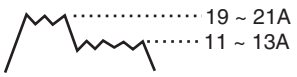
Pin	Description	Connected to
36	Differential Pressure Sensor (DPS) signal input	Differential Pressure Sensor (DPS)
37	Sensor ground	Differential Pressure Sensor (DPS)
38	Brake Switch "Lamp" signal input	Brake Switch
39	-	
40	Water Sensor siganl input	Water Sensor in Fuel Filter
41	-	
42	Blower Switch Signal input	Blower Switch
43	-	
44	Reference voltage (+5V)	Differential Pressure Sensor (DPS)
45	Reference voltage (+5V)	Accelerator Position Sensor (APS) #1
46	Reference voltage (+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	-	
53	-	
54	A/C Switch "ON" signal input	A/C Switch
55	-	
56	Thermo Switch signal input	A/C Switch
57	-	
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 contorl output	Glow Time Indicator Lamp (Cluster)
70	A/C Compressor Relay control output	A/C Compressor Relay
71	Cooling Fan Relay [LOW] control output	Cooling Fan Relay
72	Main Relay control output	Main Relay
73	-	
74	-	

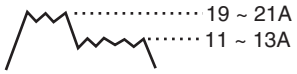
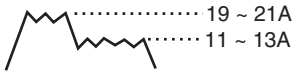
Pin	Description	Connected to
75	Vehicle speed signal input	Vehicle Speed Sensor (VSS)
76	-	
77	Feedback signal input	Throttle Control Actuator
78	-	
79	-	
80	Brake Switch "Redundant" signal input	Brake Switch
81	-	
82	-	
83	CAN [LOW]	Other Control Modules
84	CAN [HIGH]	Other Control Modules
85	-	
86	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	Throttle Control Actuator control output	Throttle Control Actuator
91	Cruise Control "MAIN" Lamp control output	Cruise Control "MAIN" Lamp (Cluster)
92	Immobilizer Lamp control output	Immobilizer Lamp (Cluster)
93	Glow Relay control output	Glow Relay
94	PTC Heater Relay control output	PTC Heater Relay

3. ECM TERMINAL INPUT/OUTPUT SIGNAL

CONNECTOR [C244-A]

Pin	Description	Type	Vehicle State	Level
1	Injector (Cylinder #3) [HIGH] control output	Idle	Pulse	B+ ~ 80V
2	Injector (Cylinder #2) [HIGH] control output	Idle	Pulse	B+ ~ 80V
3	-	-	-	-
4	Battery power	Idle	DC	Vbatt
5	-	-	-	-
6	Sensor ground	Idle	DC	Max. 50mV
7	Sensor shield	Idle	DC	Max. 50mV
8	Sensor ground	Idle	DC	Max. 50mV
9	-	-	-	-
10	-	-	-	-
11	-	-	-	-
12	Crankshaft Position Sensor (CKPS) [-] signal input	Idle	Sine Wave	Vp_p : Min.1.0V

Pin	Description	Type	Vehicle State	Level
13	Reference voltage (+5V)	IG OFF	DC	Max. 0.5V
		IG ON		4.9 ~ 5.1V
14	-	-	-	-
15	-	-	-	-
16	Injector (Cylinder #1) [HIGH] control output	Idle	Pulse	Vbatt ~ 80V
17	Injector (Cylinder #4) [HIGH] control output	Idle	Pulse	Vbatt ~ 80V
18	-	-	-	-
19	Battery power	IG OFF	DC	Max. 0.5 V
		IG ON		Vbatt
20	Sensor ground	Idle	DC	Max. 50 mV
21	-	-	-	-
22	-	-	-	-
23	Sensor ground	Idle	DC	Max. 50 mV
24	-	-	-	-
25	-	-	-	-
26	Reference voltage (+5V)	IG OFF	DC	Max. 0.5V
		IG ON		4.9 ~ 5.1V
27	Crankshaft Position Sensor (CKPS) [+] signal input	Idle	Sine Wave	Vp_p : Min.1.0V
28	Reference voltage (+5V)	IG OFF	DC	Max. 0.5V
		IG ON		4.9 ~ 5.1V
29	-	-	-	-
30	Motor [-] control output	Active	DC	Max.0.5V
31	Injector (Cylinder #2) [LOW] control output	Idle	Pulse	Peak Current : 19 ~ 21 A Hold Current : 11~ 13 A  LFIG102A
32	-	-	-	-
33	Injector (Cylinder #4) [LOW] control output	Idle	Pulse	Peak Current : 19 ~ 21 A Hold Current : 11~ 13 A  LFIG102A
34	Rail Pressure Regulator Valve control output	Idle	Pulse	Hi: Vbatt Lo: Max. 1.0V Frequency = 1kHz ± 2%
35	-	-	-	-
36	-	-	-	-

Pin	Description	Type	Vehicle State	Level
37	Reference frequency	Idle	Pulse	Hi: Vcc or Vbatt Lo: Max. 1.0V
38	-	-	-	-
39	-	-	-	-
40	Boost Pressure Sensor (BPS) signal input	IG ON	Analog	0.5 ~ 4.5V
41	Sensor ground	Idle	DC	Max. 50 mV
42	Mass Air Flow Sensor (MAFS) signal input	Idle	Pulse	Hi: Vcc or Vbatt Lo: Max. 1.0V
43	Rail Pressure Sensor (RPS) signal input	IG ON	Analog	Max. 1.0V
		Idle		1.0 ~ 1.5 V
		3000 RPM		1.5 ~ 3.0 V
44	Sensor ground	Idle	DC	Max. 50 mV
45	Fuel Pump Relay output	Relay OFF	DC	Vbatt
		Relay ON		Max. 1.0V
46	Injector (Cylinder #3) [LOW] control output	Idle	Pulse	Peak Current : 19 ~ 21 A Hold Current : 11~ 13 A  LFIG102A
47	Injector (Cylinder #1) [LOW] control output	Idle	Pulse	Peak Current : 19 ~ 21 A Hold Current : 11~ 13 A  LFIG102A
48	-	-	-	-
49	Fuel Pressure Regulator Valve control output	Idle	Pulse	Hi: Vbatt Lo: Max. 1.0V
50	Camshaft Position Sensor (CMPS) signal input	Idle	Pulse	Hi: Vcc or Vbatt Lo: Max. 1.0V
51	-	-	-	-
52	-	-	-	-
53	Intake Air Temperature Sensor (IATS) #2 signal input	Idle	Analog	0.5 ~ 4.5V
54	-	-	-	-
55	-	-	-	-
56	Position Sensor signal input	Idle	DC	0.5 ~ 4.5V
57	-	-	-	-
58	Engine Coolant Temperature Sensor (ECTS) signal input	Idle	Analog	0.5 ~ 4.5V

Pin	Description	Type	Vehicle State	Level
59	Electric EGR Control Valve control output	Idle	Pulse	Hi: Vbatt Lo: Max. 1.0V
60	Motor [+] control output	Active	Pulse	Hi: Vbatt Lo: Max. 1.0V

CONNECTOR [C244-K]

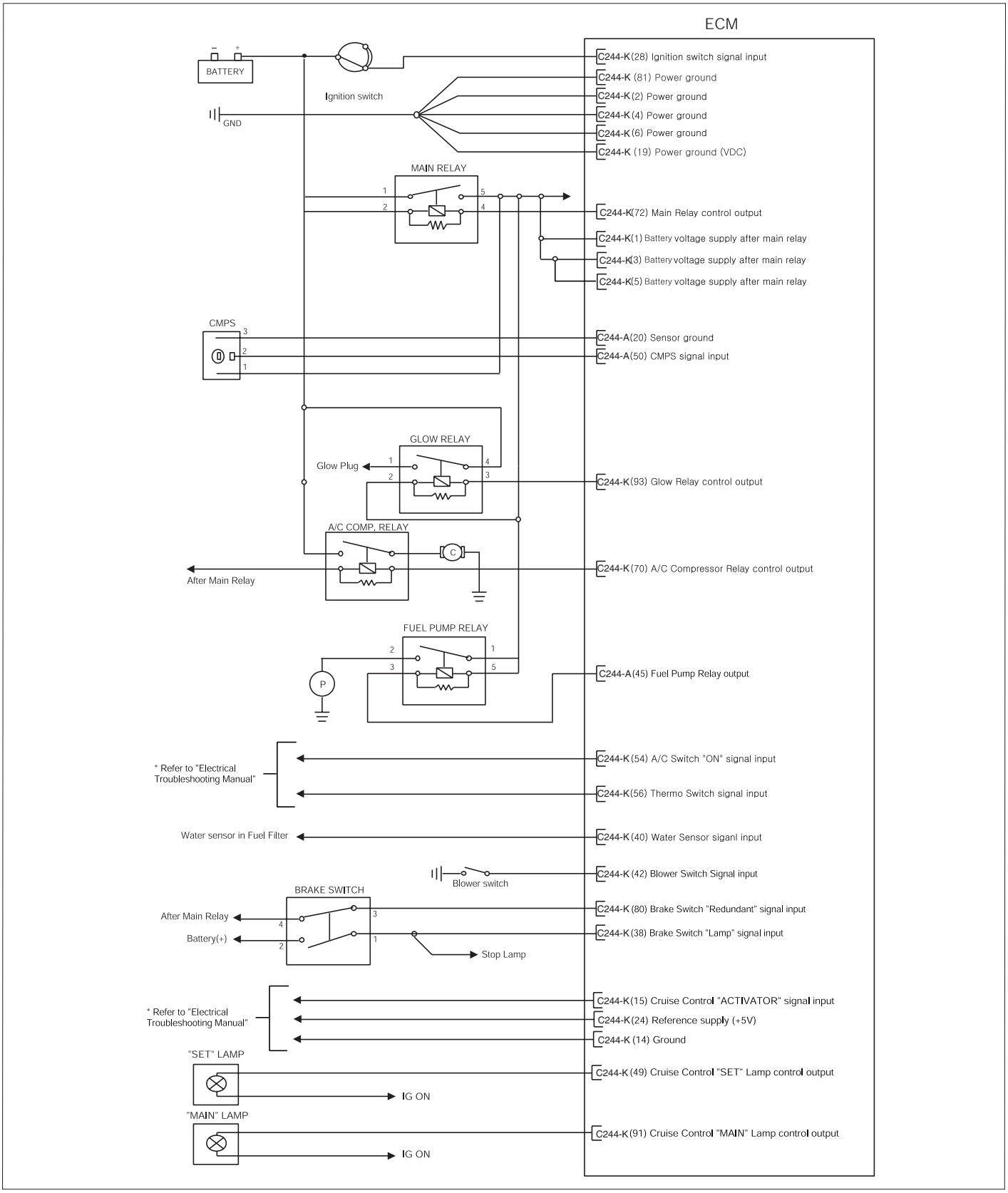
Pin	Description	Type	Vehicle State	Level
1	Battery voltage supply after main relay	IG OFF	DC	Max. 1.0 V
		IG ON		Vbatt
2	Power ground	Idle	DC	Max. 50 mV
3	Battery voltage supply after main relay	IG OFF	DC	Max. 1.0 V
		IG ON		Vbatt
4	Power ground	Idle	DC	Max. 50 mV
5	Battery voltage supply after main relay	IG OFF	DC	Max. 1.0 V
		IG ON		Vbatt
6	Power ground	Idle	DC	Max. 50 mV
7	-	-	-	-
8	Sensor ground	Idle	DC	Max. 50 mV
9	Accelerator Position Sensor (APS) #1 signal input	C.T	Analog	0.3 ~ 0.9V
		W.O.T		4.0 ~ 4.8V
10	Sensor ground	Idle	DC	Max. 50 mV
11	Fuel Temperature Sensor (FTS) signal input	IG ON	Analog	0.5 ~ 4.5V
12	Ground	Idle	DC	Max. 50 mV
13	A/C Pressure Transducer signal input	A/C On	Analog	Max. 4.8V
14	Ground	Idle	DC	Max. 50mV
15	Cruise Control "ACTIVATOR" signal input	-	-	-
16	Ground	Idle	DC	Max. 50 mV
17	-	-	-	-
18	-	-	-	-
19	Ground	Idle	DC	Max. 50 mV
20	-	-	-	-
21	-	-	-	-
22	Reference voltage (+5V)	IG OFF	DC	Max. 0.5V
		IG ON		4.9 ~ 5.1V
23	-	-	-	-
24	Reference voltage (+5V)	IG OFF	DC	Max. 0.5V
		IG ON		4.9 ~ 5.1V

Pin	Description	Type	Vehicle State	Level
25	Diagnosis K-Line	When transmitting	Pulse	Hi: Min. Vbatt×80% Lo: Max. Vbatt×20%
		When receiving		Hi: Min. Vbatt×70% Lo: Max. Vbatt×30%
26	Throttle position	-	-	-
27	Fuel consumption signal output	Idle	Pulse	Hi: Vbatt or Vcc Lo: Max. 0.5V
28	Ignition switch signal input	IG OFF	DC	Max. 1.0V
		IG ON		Vbatt
29	VGT Control Solenoid Valve control output	Idle	Pulse	Hi: Vbatt Lo: Max. 0.5V
30	Sensor ground	Idle	DC	Max. 50 mV
31	Accelerator Position Sensor (APS) #2 signal input	C.T	Analog	0.3 ~ 0.9V
		W.O.T		1.5 ~ 3.0V
32	Exhaust Gas Temperature Sensor (EGTS) #2 signal input	Idle	Analog	0.5 ~ 4.5V
33	Sensor ground	Idle	DC	Max. 50 mV
34	Exhaust Gas Temperature Sensor (EGTS) #1 signal input	Idle	Analog	0.5 ~ 4.5V
35	Sensor ground	Idle	DC	Max. 50 mV
36	Differential Pressure Sensor (DPS) signal input	Idle	Analog	0.5 ~ 4.5V
37	Sensor ground	Idle	DC	Max. 50 mV
38	Brake Switch "Lamp" signal input	Release	DC	Max. 0.5V
		Push		Vbatt
39	-	-	-	-
40	Water Sensor siganl input	Full of Water	Analog	Vbatt
		No Water		Max. 1V
41	-	-	-	-
42	Blower Switch Signal input	Blower Off	DC	Vbatt
		Blower On		Max. 2V
43	-	-	-	-
44	Reference voltage (+5V)	IG OFF	DC	Max. 0.5V
		IG ON		4.9 ~ 5.1V
45	Reference voltage (+5V)	IG OFF	DC	Max. 0.5V
		IG ON		4.9 ~ 5.1V
46	Reference voltage (+5V)	IG OFF	DC	Max. 0.5V
		IG ON		4.9 ~ 5.1V
47	Immobilizer Communication Line	After IG ON when communicating	Pulse	Hi: Min. 8.5V
				Lo: Max. 3.5V

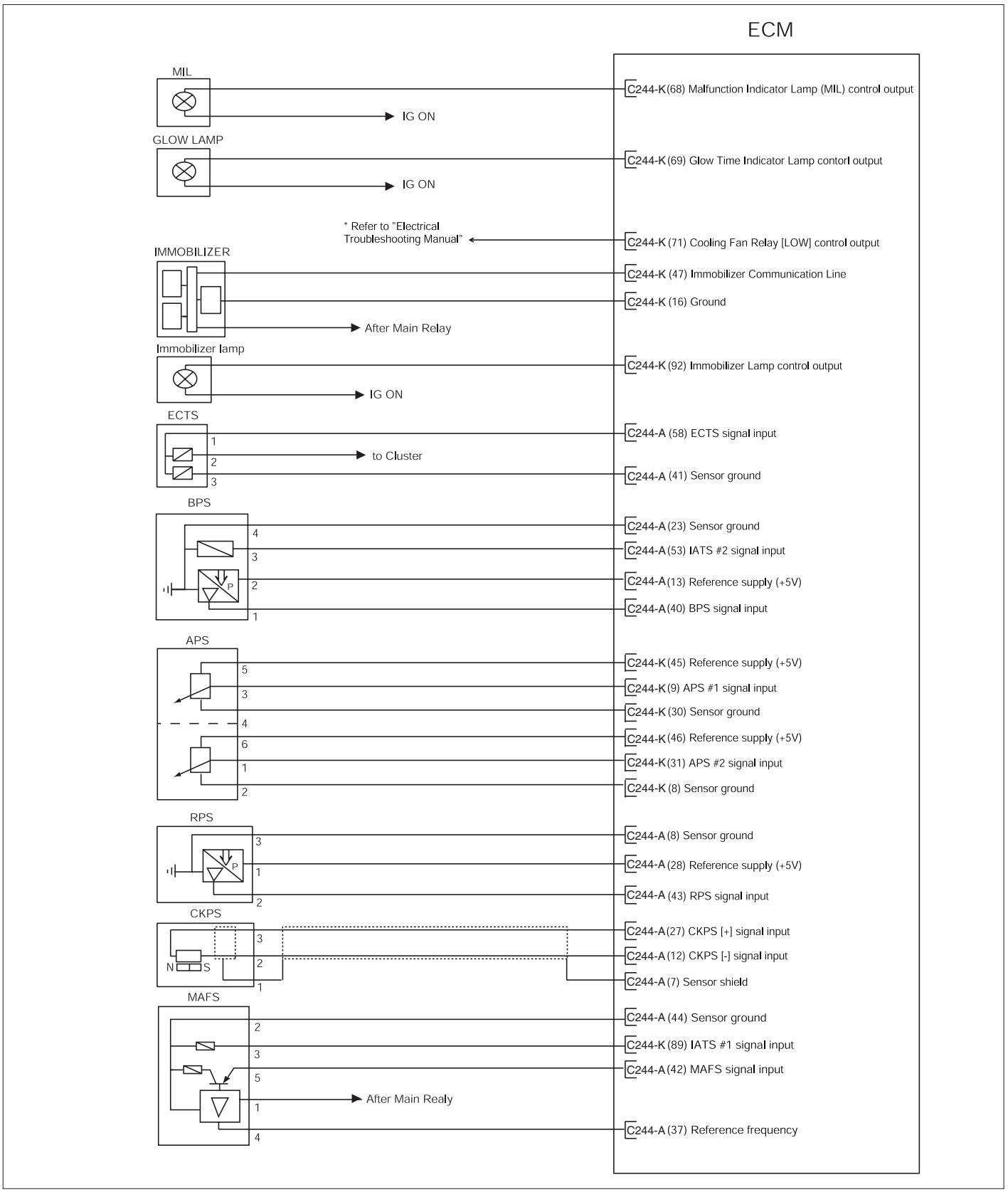
Pin	Description	Type	Vehicle State	Level
48	Engine speed signal output	Idle	Pulse	Hi: Vbatt Lo: Max. 5V Frequency : 50~60Hz
49	Cruise Control "SET" Lamp control output	-	-	-
50	-	-	-	-
51	Lambda Sensor Heater control output	Vehicle Run	Pulse	Hi: Vbatt Lo: Max. 1.0V
52	-	-	-	-
53	-	-	-	-
54	A/C Switch "ON" signal input	A/C SW OFF	DC	Max. 1.0V
		A/C SW ON		Vbatt
55	-	-	-	-
56	Thermo Switch signal input	A/C OFF	DC	Max. 0.5V
		A/C ON		Vbatt
57	-	-	-	-
58	-	-	-	-
59	-	-	-	-
60	-	-	-	-
61	-	-	-	-
62	-	-	-	-
63	-	-	-	-
64	Lambda Sensor Voltage "NERNST"	Engine Run	Analog	Normal : 450 ± 50 mV Rich : Max. Normal + 150mV Lean : Min. Normal - 150mV
65	Lambda Sensor Current Pump	Engine Run	Analog	Normal : 0 ± 500 mV Rich : Min. Normal - 1.5V Lean : Max. Normal + 1.5V
66	-	-	-	-
67	-	-	-	-
68	Malfunction Indicator Lamp (MIL) control output	Lamp OFF	DC	Vbatt
		Lamp ON		Max. 1.0V
69	Glow Time Indicator Lamp control output	Glow OFF	DC	Vbatt
		Glow ON		Max. 1.0V
70	A/C Compressor Relay control output	A/Con OFF	DC	Vbatt
		A/Con ON		Max. 1.0V
71	Cooling Fan Relay [LOW] control output	Relay OFF	DC	Vbatt
		Relay ON		Max. 1.0V
72	Main Relay control output	Relay OFF	DC	Vbatt
		Relay ON		Max. 1.0V
73	-	-	-	-

Pin	Description	Type	Vehicle State	Level
74	-	-	-	-
75	Vehicle speed signal input	Vehicle Run	Pulse	Hi: Min. 5.0V Lo: Max. 1.0V
76	-	-	-	-
77	Feedback signal input	Normal	DC	Vbatt
		Abnormal		Max. 0.5V
78	-	-	-	-
79	-	-	-	-
80	Brake Switch "Redundant" signal input	Release	DC	Vbatt
		Push		Max. 0.5V
81	-	-	-	-
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 Run	Analog	2.4 ~ 2.6V
87	Lambda Sensor Current Adjust	Engine Run	Analog	|Current Pump - Current Adjust |< 0.2V
88	-	-	-	-
89	Intake Air Temperature Sensor (IATS) #1 signal input	Idle	Analog	0.5V ~ 4.5V
90	Throttle Control Actuator control output	Key On/Key Off	Pulse	Hi: Vbatt Lo: Max. 1V
91	Cruise Control "MAIN" Lamp control output	-	-	-
92	Immobilizer Lamp control output	Lamp OFF	DC	Vbatt
		Lamp ON		Max. 1.0V
93	Glow Relay control output	Relay OFF	DC	Vbatt
		Relay ON		Max. 1.0V
94	PTC Heater Relay control output	Relay OFF	DC	Vbatt
		Relay ON		Max. 1.0V

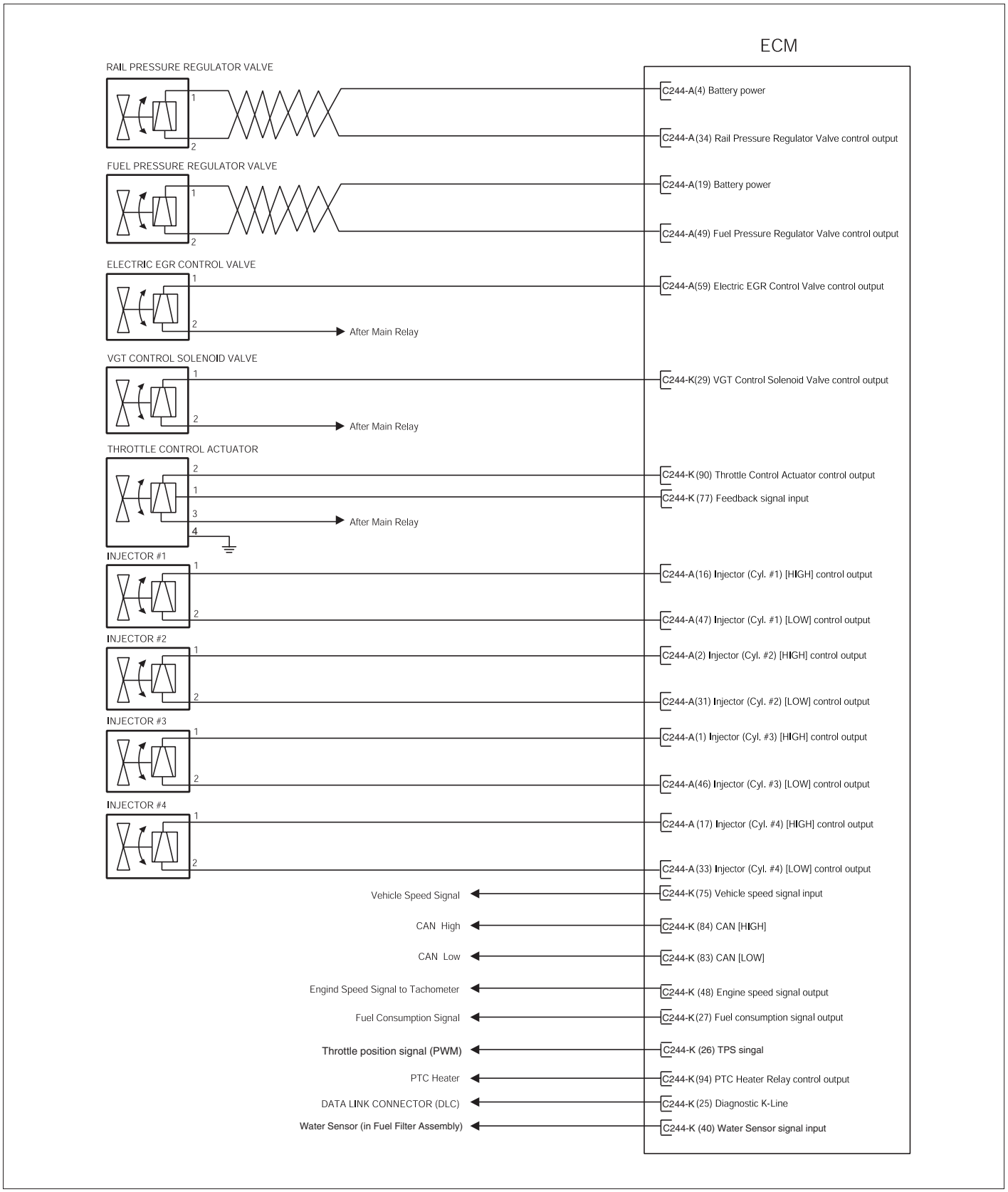
CIRCUIT DIAGRAM EAC8E626



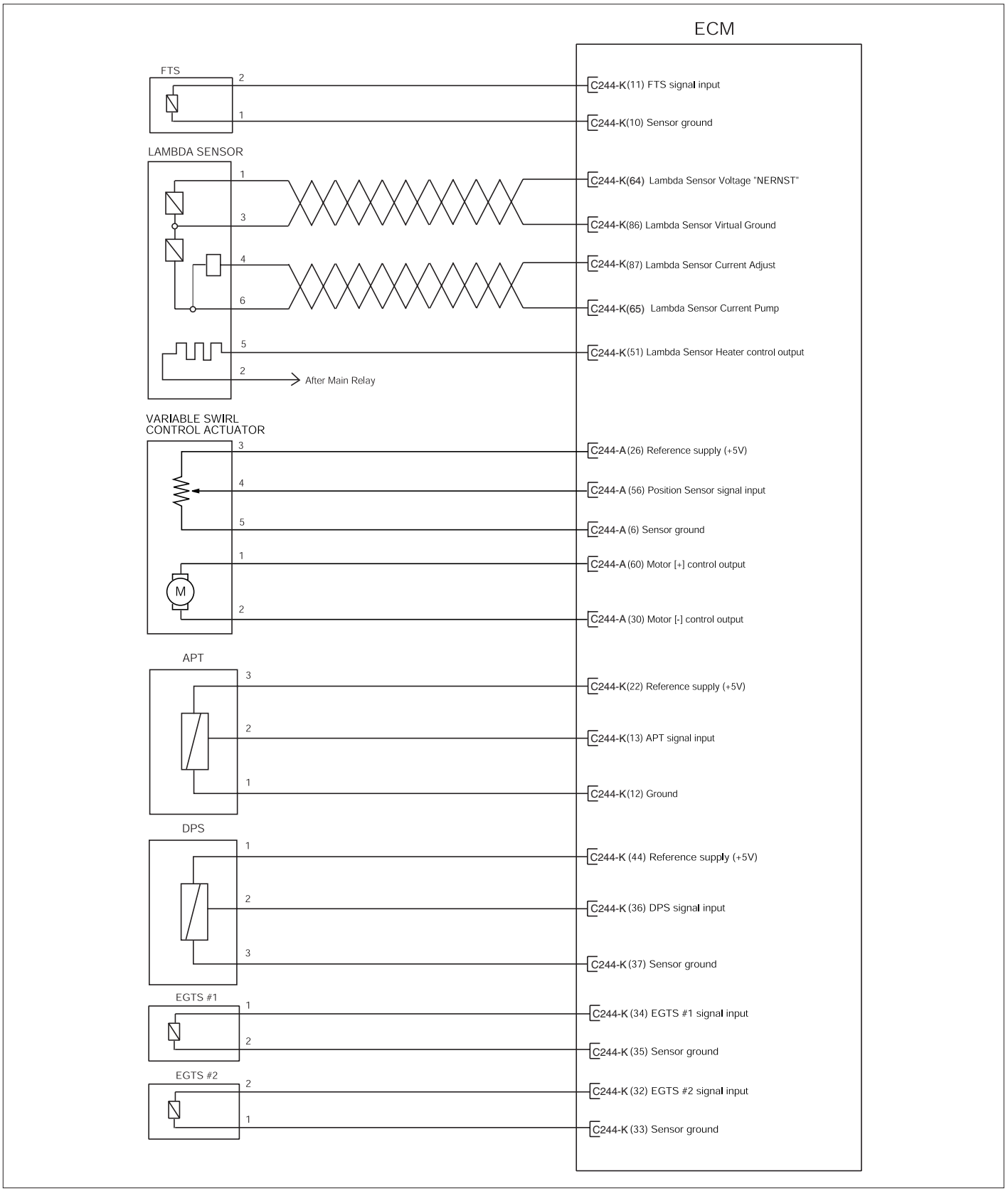
STGFL7111L


ECM
MIL
IG ON
C244-K (68) Malfunction Indicator Lamp (MIL) control output
GLOW LAMP
IG ON
C244-K (69) Glow Time Indicator Lamp contorl output
* Refer to "Electrical Troubleshooting Manual"
C244-K (71) Cooling Fan Relay [LOW] control output
IMMOBILIZER
C244-K (47) Immobilizer Communication Line
C244-K (16) Ground
After Main Relay
Immobilizer lamp
IG ON
C244-K (92) Immobilizer Lamp control output
ECTS
1
2
3
to Cluster
C244-A (58) ECTS signal input
C244-A (41) Sensor ground
BPS
4
3
2
1
P
C244-A (23) Sensor ground
C244-A (53) IATS #2 signal input
C244-A (13) Reference supply (+5V)
C244-A (40) BPS signal input
APS
5
3
4
6
1
2
C244-K (45) Reference supply (+5V)
C244-K (9) APS #1 signal input
C244-K (30) Sensor ground
C244-K (46) Reference supply (+5V)
C244-K (31) APS #2 signal input
C244-K (8) Sensor ground
RPS
3
1
2
P
C244-A (8) Sensor ground
C244-A (28) Reference supply (+5V)
C244-A (43) RPS signal input
CKPS
3
2
1
N
S
C244-A (27) CKPS [+] signal input
C244-A (12) CKPS [-] signal input
C244-A (7) Sensor shield
MAFS
2
3
5
1
4
After Main Realy
C244-A (44) Sensor ground
C244-K (89) IATS #1 signal input
C244-A (42) MAFS signal input
C244-A (37) Reference frequency

STGFL7112L


ECM
RAIL PRESSURE REGULATOR VALVE
1
2
C244-A(4) Battery power
C244-A(34) Rail Pressure Regulator Valve control output
FUEL PRESSURE REGULATOR VALVE
1
2
C244-A(19) Battery power
C244-A(49) Fuel Pressure Regulator Valve control output
ELECTRIC EGR CONTROL VALVE
1
2
C244-A(59) Electric EGR Control Valve control output
After Main Relay
VGT CONTROL SOLENOID VALVE
1
2
C244-K(29) VGT Control Solenoid Valve control output
After Main Relay
THROTTLE CONTROL ACTUATOR
2
1
3
4
C244-K (90) Throttle Control Actuator control output
C244-K (77) Feedback signal input
After Main Relay
INJECTOR #1
1
2
C244-A(16) Injector (Cyl. #1) [HIGH] control output
C244-A(47) Injector (Cyl. #1) [LOW] control output
INJECTOR #2
1
2
C244-A(2) Injector (Cyl. #2) [HIGH] control output
C244-A(31) Injector (Cyl. #2) [LOW] control output
INJECTOR #3
1
2
C244-A(1) Injector (Cyl. #3) [HIGH] control output
C244-A(46) Injector (Cyl. #3) [LOW] control output
INJECTOR #4
1
2
C244-A (17) Injector (Cyl. #4) [HIGH] control output
C244-A (33) Injector (Cyl. #4) [LOW] control output
Vehicle Speed Signal
C244-K(75) Vehicle speed signal input
CAN High
C244-K (84) CAN [HIGH]
CAN Low
C244-K (83) CAN [LOW]
Engind Speed Signal to Tachometer
C244-K (48) Engine speed signal output
Fuel Consumption Signal
C244-K(27) Fuel consumption signal output
Throttle position signal (PWM)
C244-K (26) TPS singal
PTC Heater
C244-K(94) PTC Heater Relay control output
DATA LINK CONNECTOR (DLC)
C244-K (25) Diagnostic K-Line
Water Sensor (in Fuel Filter Assembly)
C244-K (40) Water Sensor signal input

STGFL7113L


ECM
FTS
2
1
C244-K(11) FTS signal input
C244-K(10) Sensor ground
LAMBDA SENSOR
1
3
4
6
5
2
After Main Relay
C244-K(64) Lambda Sensor Voltage "NERNST"
C244-K(86) Lambda Sensor Virtual Ground
C244-K(87) Lambda Sensor Current Adjust
C244-K(65) Lambda Sensor Current Pump
C244-K(51) Lambda Sensor Heater control output
VARIABLE SWIRL
CONTROL ACTUATOR
3
4
5
1
2
M
C244-A (26) Reference supply (+5V)
C244-A (56) Position Sensor signal input
C244-A (6) Sensor ground
C244-A (60) Motor [+] control output
C244-A (30) Motor [-] control output
APT
3
2
1
C244-K(22) Reference supply (+5V)
C244-K(13) APT signal input
C244-K(12) Ground
DPS
1
2
3
C244-K (44) Reference supply (+5V)
C244-K (36) DPS signal input
C244-K (37) Sensor ground
EGTS #1
1
2
C244-K (34) EGTS #1 signal input
C244-K (35) Sensor ground
EGTS #2
2
1
C244-K (32) EGTS #2 signal input
C244-K (33) Sensor ground

STGFL7114L

ECM PROBLEM INSPECTION PROCEDURE EF6D6E39

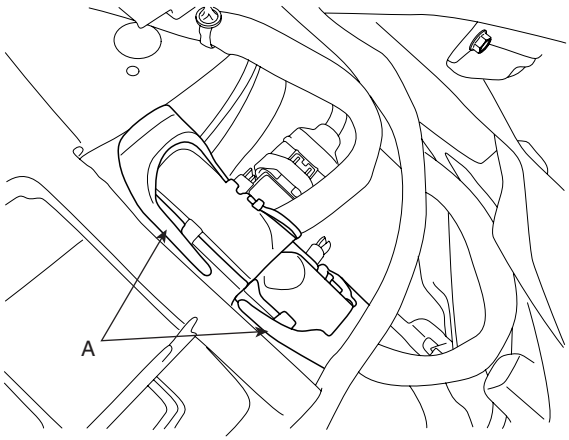
1. TEST ECM GROUND CIRCUIT: Measure resistance between ECM and chassis ground using the backside of ECM harness connector as ECM side check point. If the problem is found, repair it.
2. TEST ECM CONNECTOR: Disconnect the ECM connector and visually check the ground terminals on ECM side and harness side 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 E54D9658

CAUTION

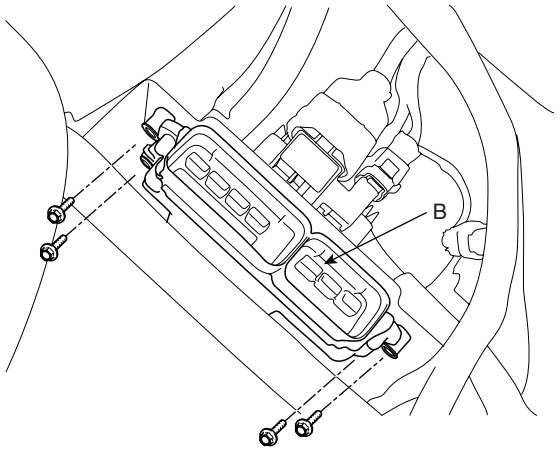
After replacing an ECM, MUST input the vehicle mileage and the injector data (7 digit) of each cylinder into a new ECM.

1. Turn ignition switch OFF.
2. Disconnect the battery negative (-) cable from the battery.
3. Remove the battery.
4. Remove the left head lamp assembly. (Refer to BE group)
5. Disconnect the ECM connectors (A).



SNFFL6111D

6. Remove the ECM (B) after unscrewing 4 bolts.



SNFFL6112D

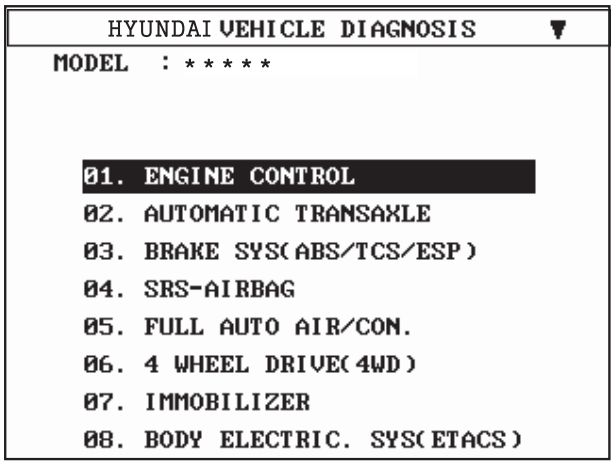
7. Install a new ECM in the reverse order of step 1 ~ 6.

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

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

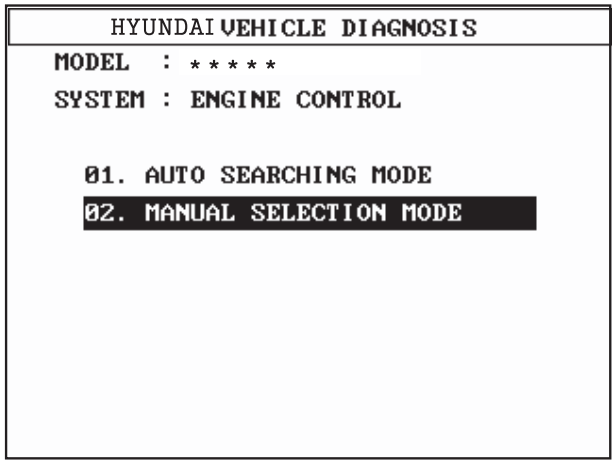
9. Proceed "ECM CHANGE" procedure.

   1) Select "ENGINE CONTROL".



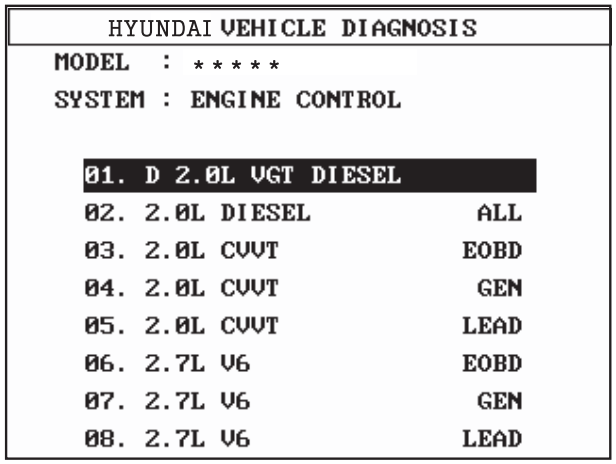
STGFL7115L

   2) Select "MANUAL SELECTION MODE".



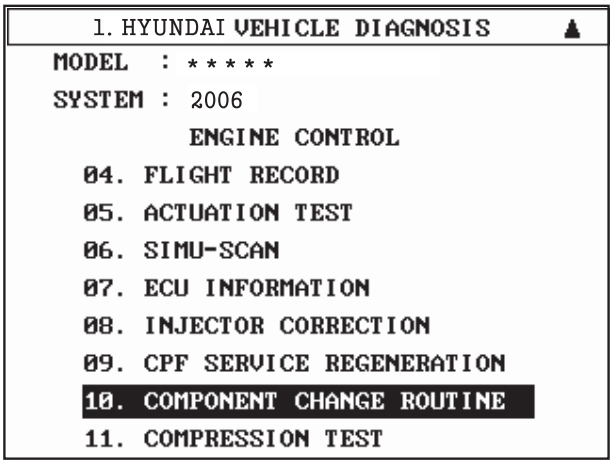
STGFL7116L

   3) Select "D 2.0L VGT DIESEL".



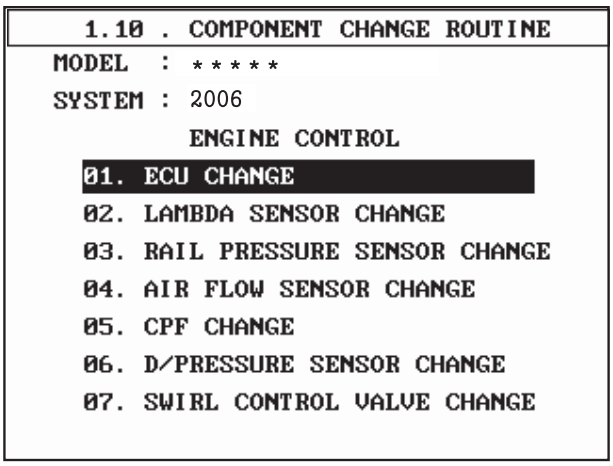
STGFL7117L

   4) Select "COMPONET CHANGE ROUTNE"



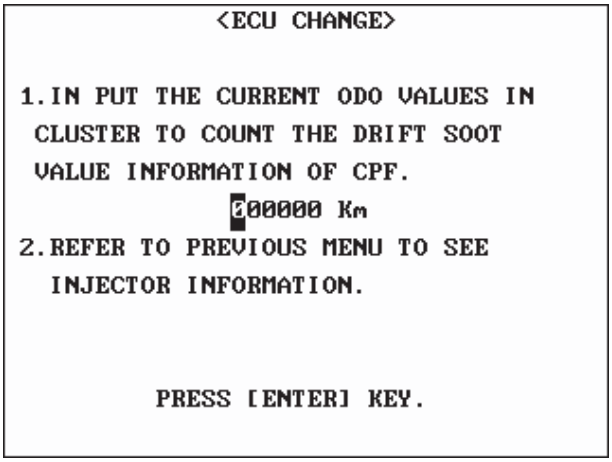
STGFL7118L

   5) Select "ECU CHANGE".



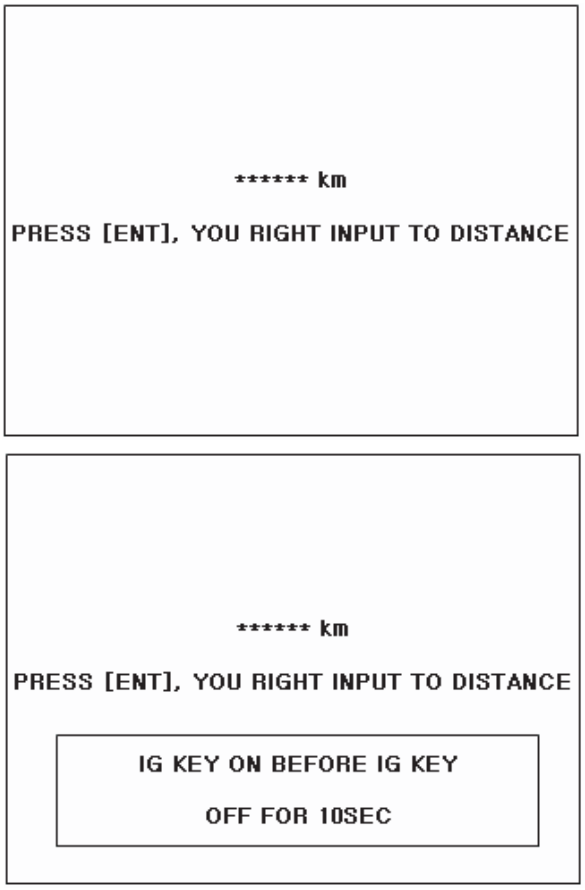
STGFL7119L

   6) Press "ENTER" key.



LFIG108A

7) Input the vehicle mileage and press "ENTER" key.



LFIG109A

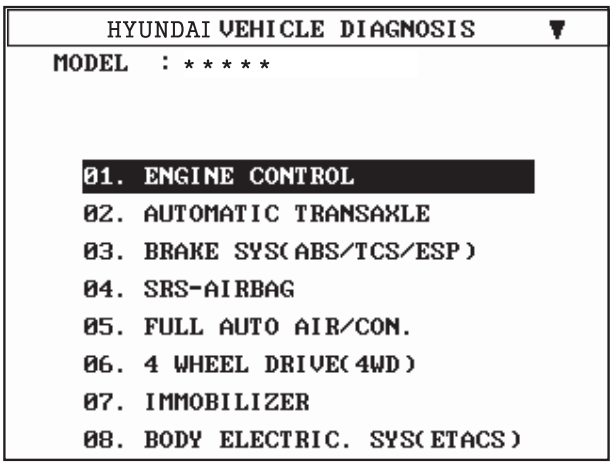
8) Wait 10 seconds with IG ON.

9) Turn ignition switch off.

10. Turn ignition switch on.

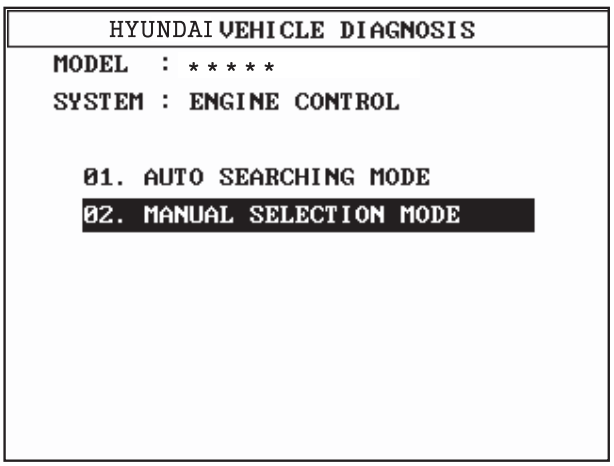
11. Proceed "INJECTOR CORRECTION" procedure.

1) Select "ENGINE CONTROL".



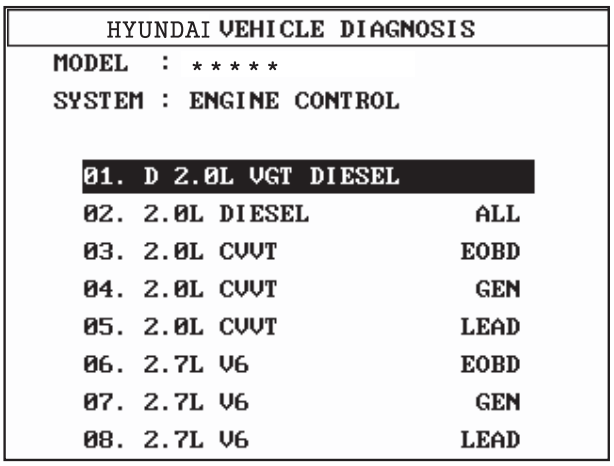
STGFL7115L

2) Select "MANUAL SELECTION MODE".



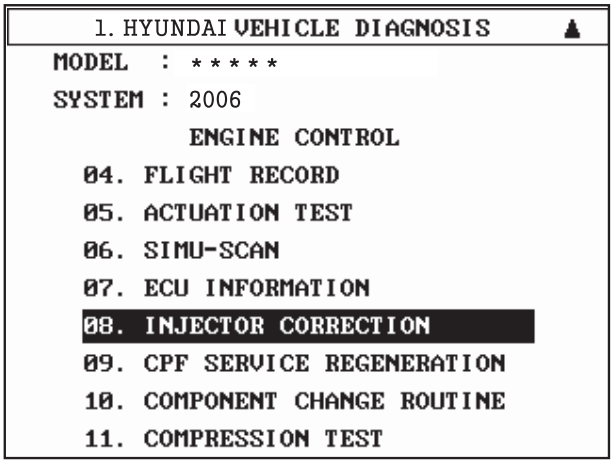
STGFL7116L

3) Select "D 2.0L VGT DIESEL".



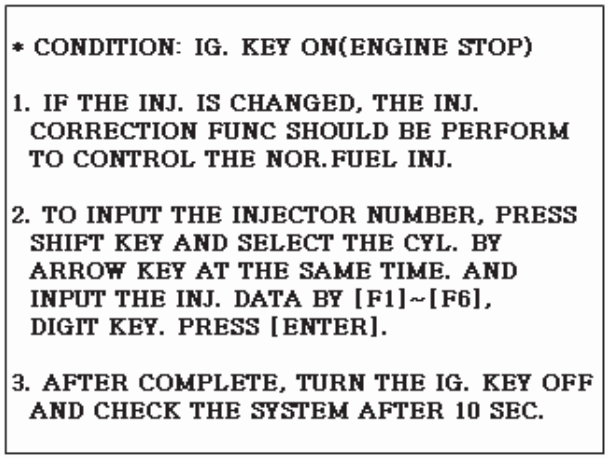
STGFL7117L

4) Select "INJECTOR CORRECTION".



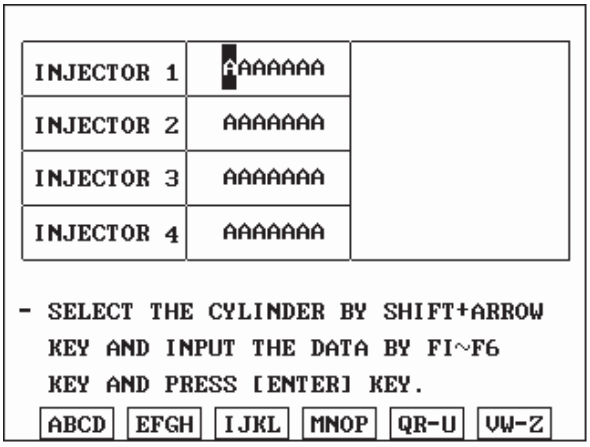
STGFL7120L

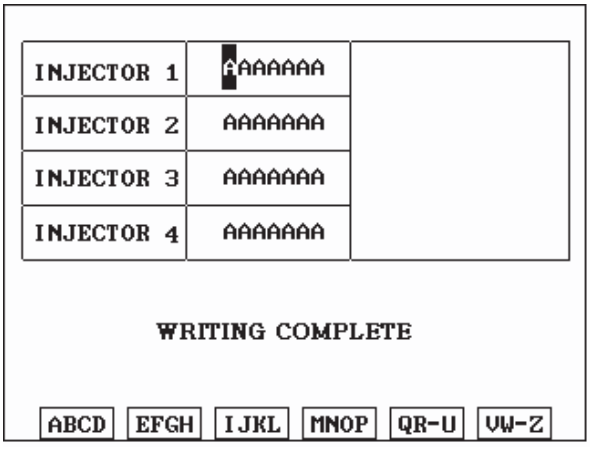
5) Press "ENTER" key.



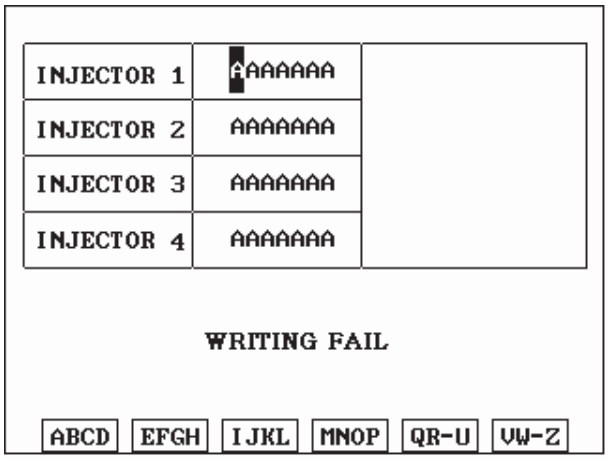
LFIG111A

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





LFIG112A



LFIG113A

NOTE

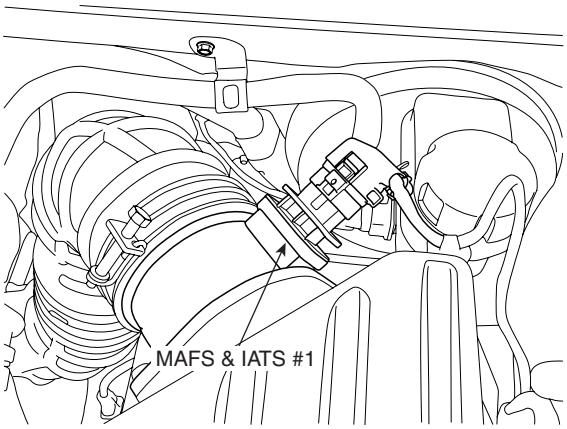
When "WRITING FAIL" is displayed on the scan tool, input injector data (7 digits) of each cylinder into a new ECM again as prior procedure.

MASS AIR FLOW SENSOR (MAFS)

INSPECTION E09E1CDA

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.



SNFFL6101D

SPECIFICATION

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

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

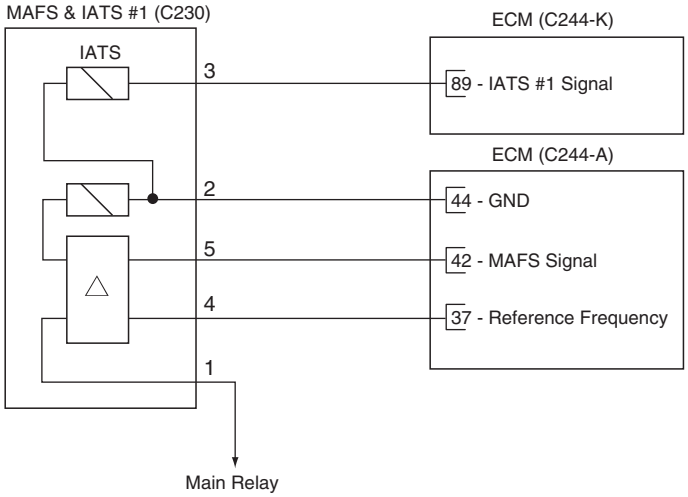
*At intake air temperature = -15℃(5˚F) or 80℃(176˚F)

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

LFIG034A

CIRCUIT DIAGRAM

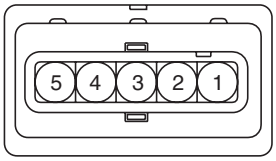
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	Main Relay	Battery Voltage (B+)
2	ECM C244-A (44)	Sensor Ground
3	ECM C244-K (89)	IATS #1 Signal
4	ECM C244-A (37)	Reference Frequency
5	ECM C244-A (42)	MAFS Signal

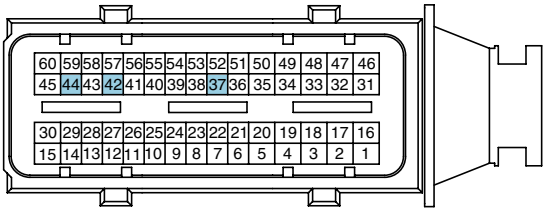
[HARNESS CONNECTORS]



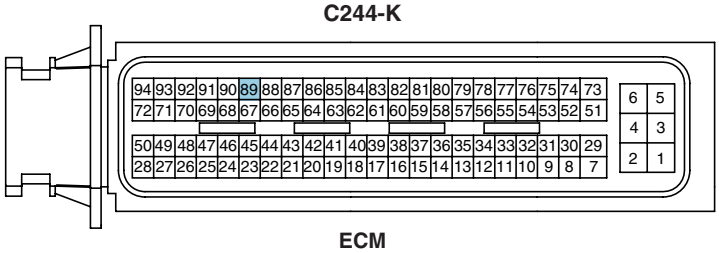
C230

MAFS & IATS #1

C244-A



C244-K



ECM

STGFL7135L

SIGNAL WAVEFORM

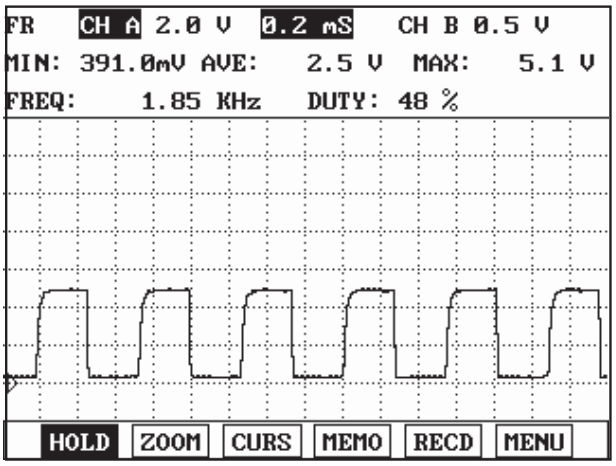


Fig.1

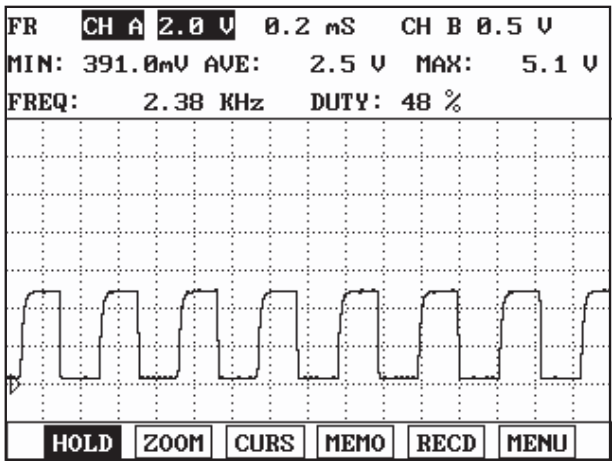


Fig.2

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

LFIG222A

COMPONENT INSPECTION

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

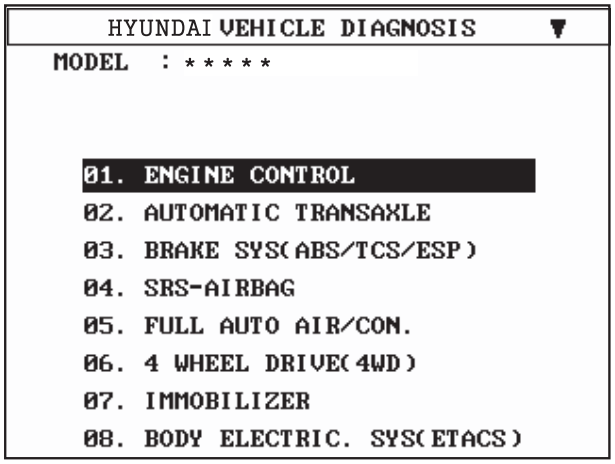
2. Check any leakage on intake system and intercooler system.

REPLACEMENT EE06EA00

NOTE

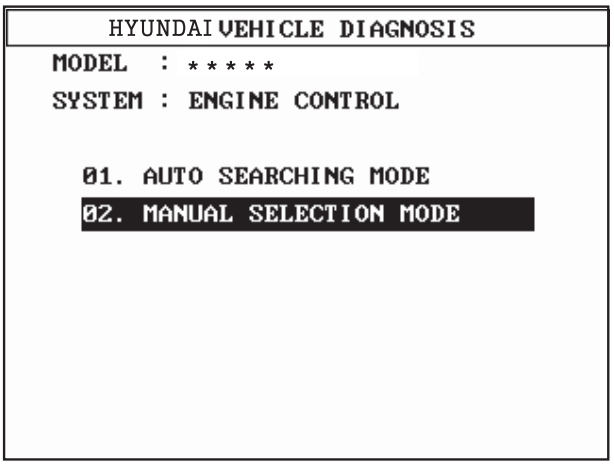
After replacing a Mass Air Flow Sensor (MAFS) or Intake Air Temperature Sensor (IATS)#1, MUST proceed below procedure.

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



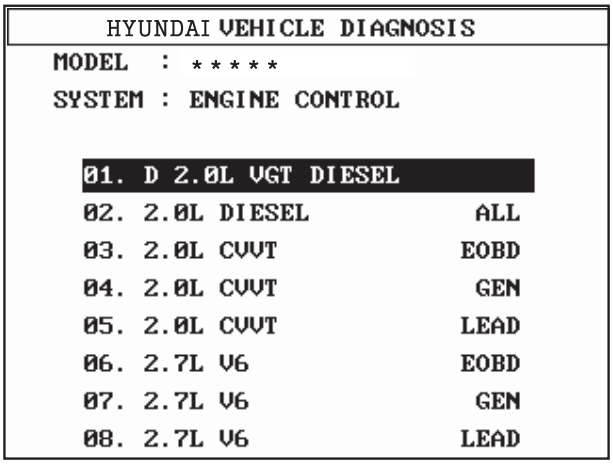
STGFL7115L

5. Select "MANUAL SELECTION MODE".



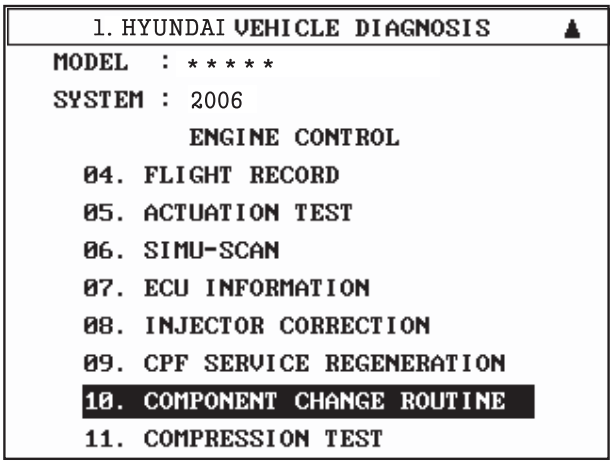
STGFL7116L

6. Select "D 2.0L VGT DIESEL".



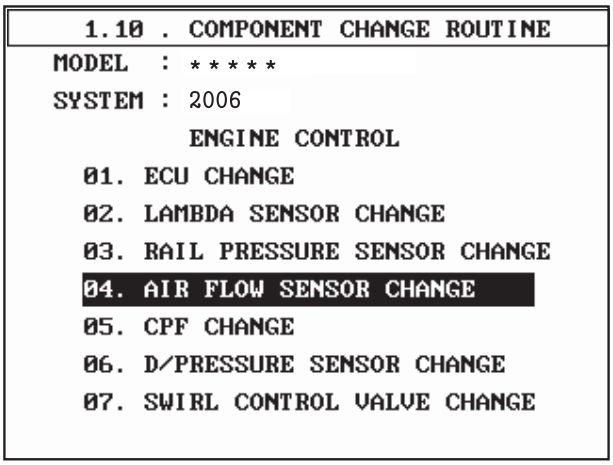
STGFL7117L

7. Select "COMPONET CHANGE ROUTNE"



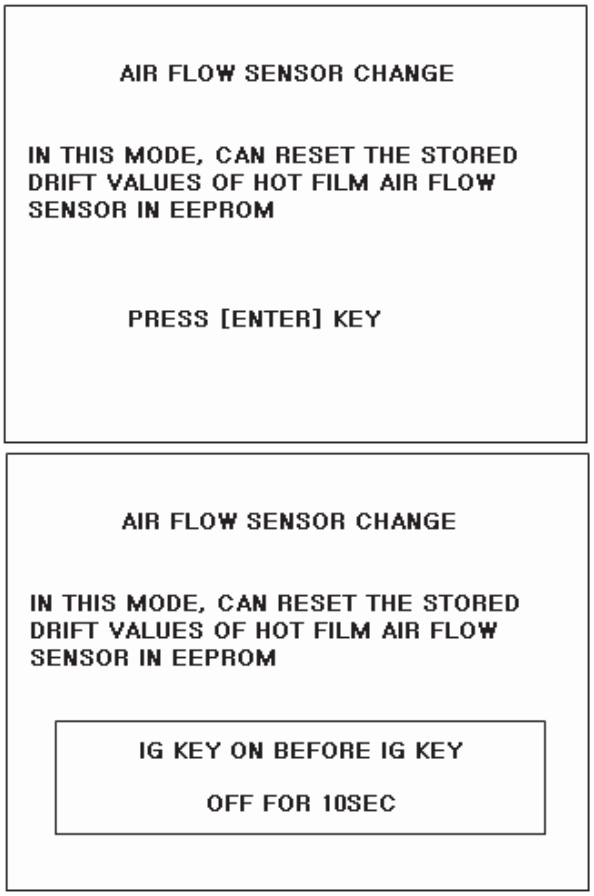
STGFL7118L

8. Select "AIR FLOW SENSOR CHANGE".



STGFL7121L

9. Press "ENTER" key.

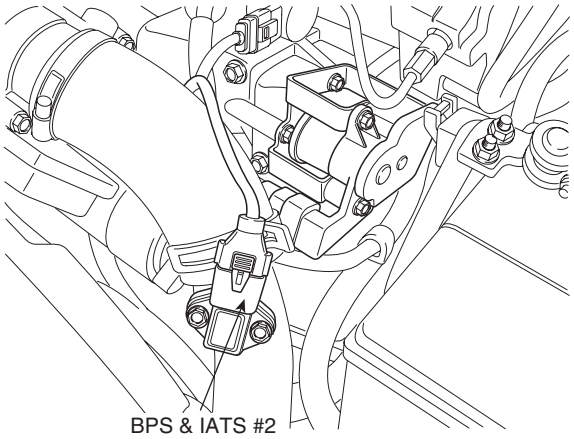


LFIG129A

10. Wait 10 seconds with IG ON.

11. Turn ignition switch off.

BOOST PRESSURE SENSOR (BPS)



LFIG044A

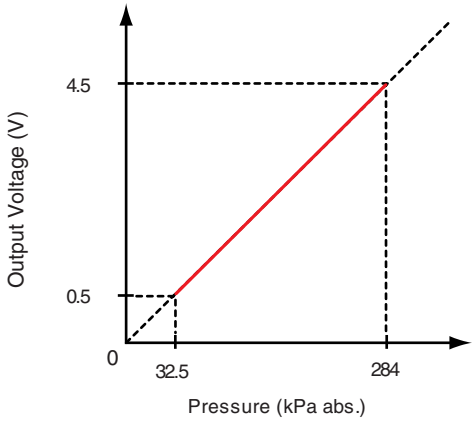
INSPECTION E497534D

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.

SPECIFICATION

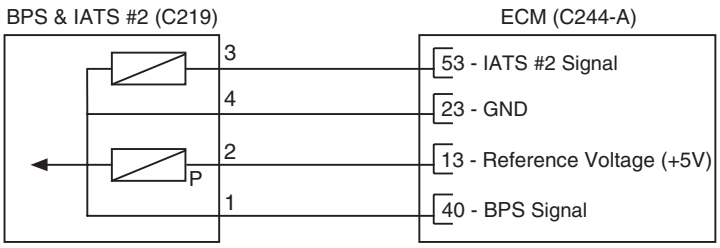
Pressure (kPa)	Output Voltage (V)
70	1.02 ~ 1.17
140	2.13 ~ 2.28
210	3.25 ~ 3.40
270	4.20 ~ 4.35



LFIG038A

CIRCUIT DIAGRAM

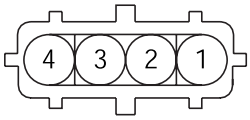
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-A (40)	BPS Signal
2	ECM C244-A (13)	Reference Voltage (+5V)
3	ECM C244-A (53)	IATS #2 Signal
4	ECM C244-A (23)	Sensor ground

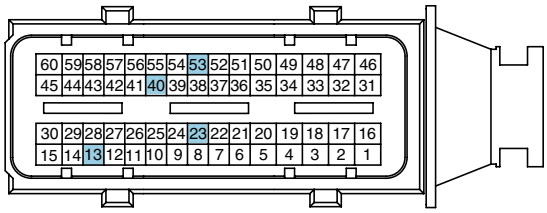
[HARNESS CONNECTORS]



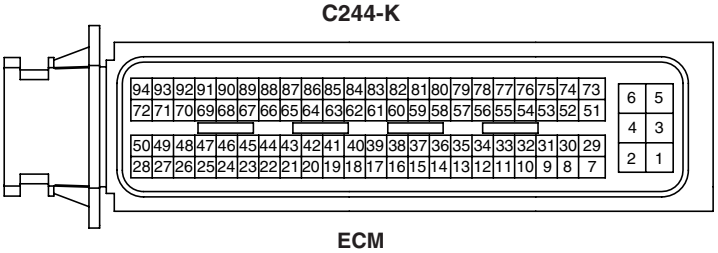
C219

BPS & IATS #2

C244-A



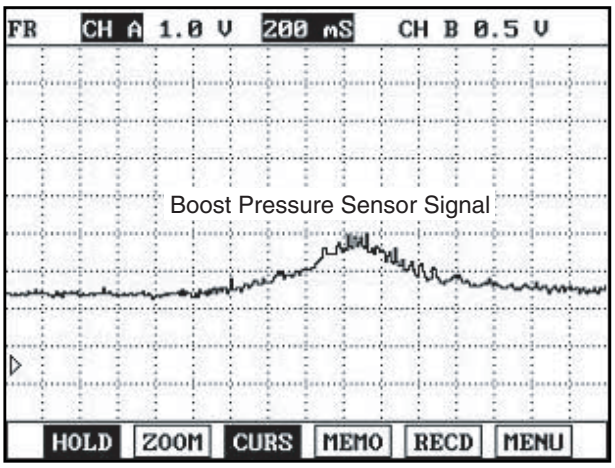
C244-K



ECM

STGFL7139L

SIGNAL WAVEFORM



This illustration represents waveform of BPS when accelerating and decelerating.

LFIG040A

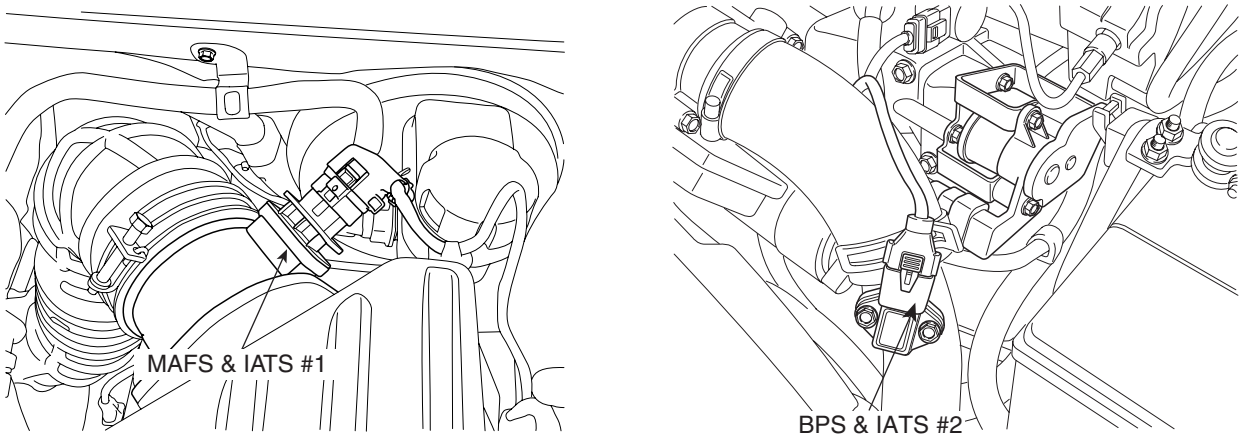
INTAKE AIR TEMPERATURE SENSOR (IATS)

INSPECTION E826298B

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.



SNFFL6122D

SPECIFICATION

IATS #1 in MAFS

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

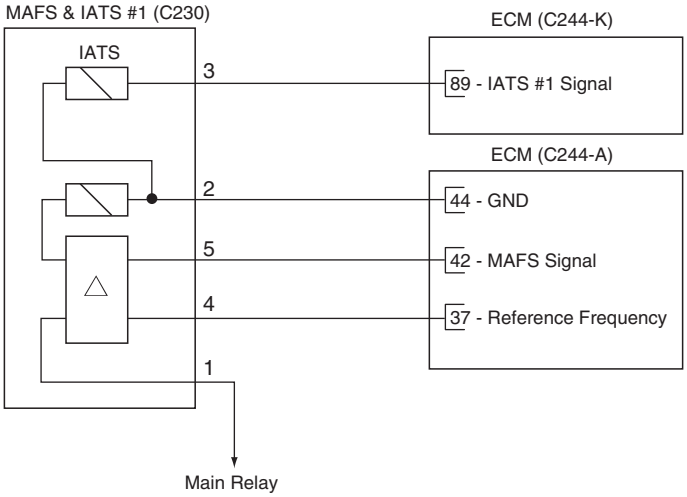
IATS #2 in BPS

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

LFIG042A

CIRCUIT DIAGRAM

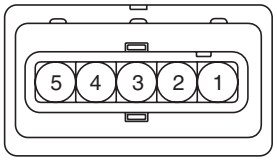
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	Main Relay	Battery Voltage (B+)
2	ECM C244-A (44)	Sensor Ground
3	ECM C244-K (89)	IATS #1 Signal
4	ECM C244-A (37)	Reference Frequency
5	ECM C244-A (42)	MAFS Signal

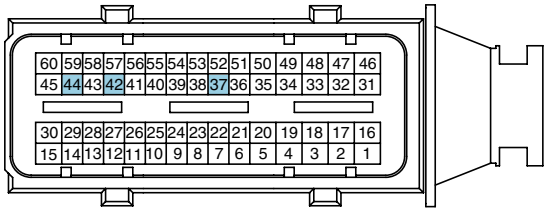
[HARNESS CONNECTORS]



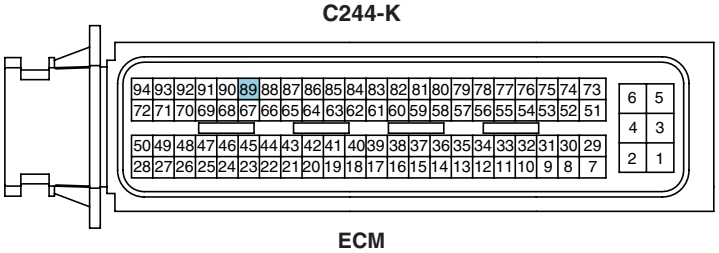
C230

MAFS & IATS #1

C244-A



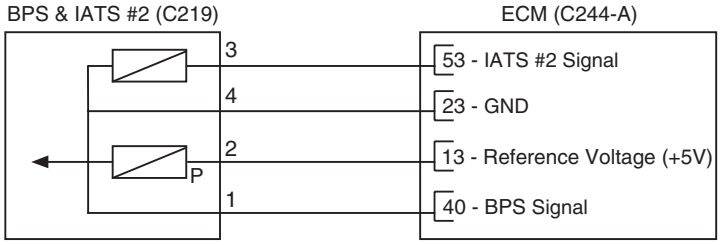
C244-K



ECM

STGFL7135L

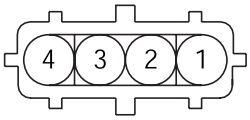
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-A (40)	BPS Signal
2	ECM C244-A (13)	Reference Voltage (+5V)
3	ECM C244-A (53)	IATS #2 Signal
4	ECM C244-A (23)	Sensor ground

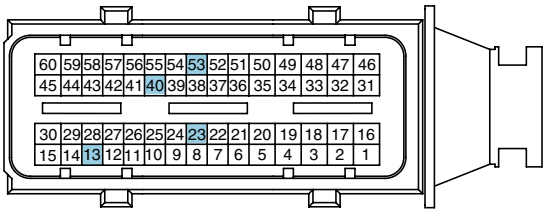
[HARNESS CONNECTORS]



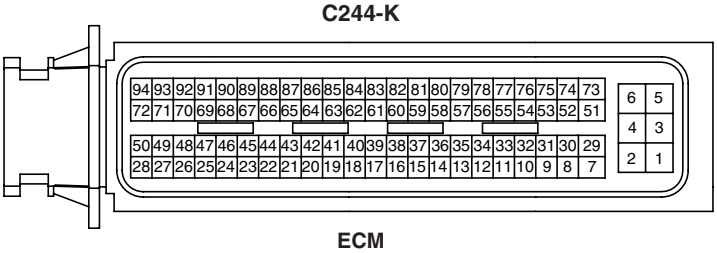
C219

BPS & IATS #2

C244-A



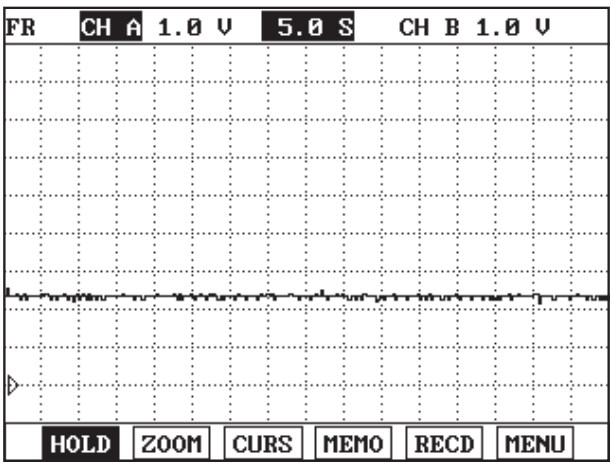
C244-K



ECM

STGFL7139L

SIGNAL WAVEFORM



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

LFIG043A

COMPONENT INSPECTION

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

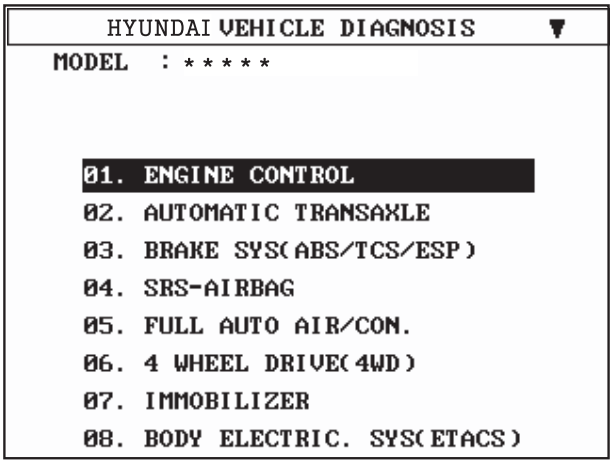
Specification: Refer to "SPECIFICATION".

REPLACEMENT EB9ACB19

NOTE

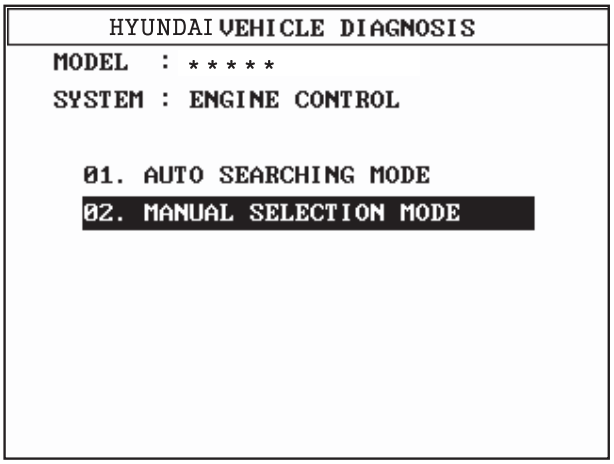
After replacing a Mass Air Flow Sensor (MAFS) or Intake Air Temperature Sensor (IATS)#1, MUST proceed below procedure.

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



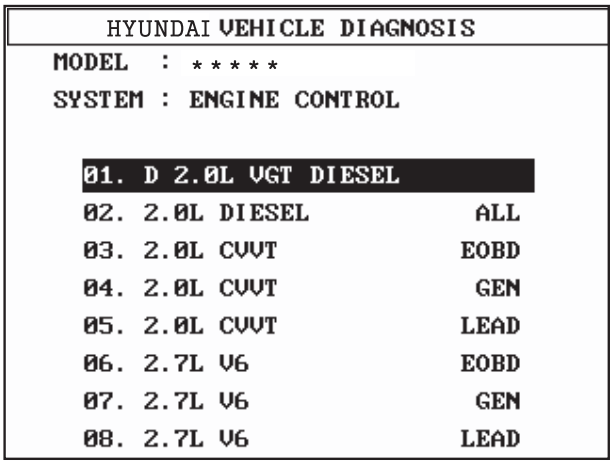
STGFL7115L

5. Select "MANUAL SELECTION MODE".



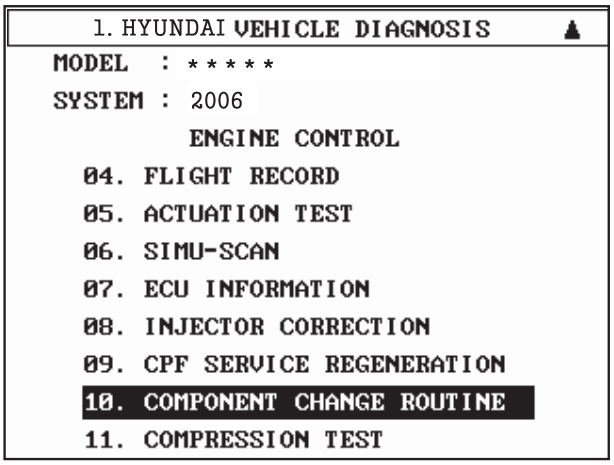
STGFL7116L

6. Select "D 2.0L VGT DIESEL".



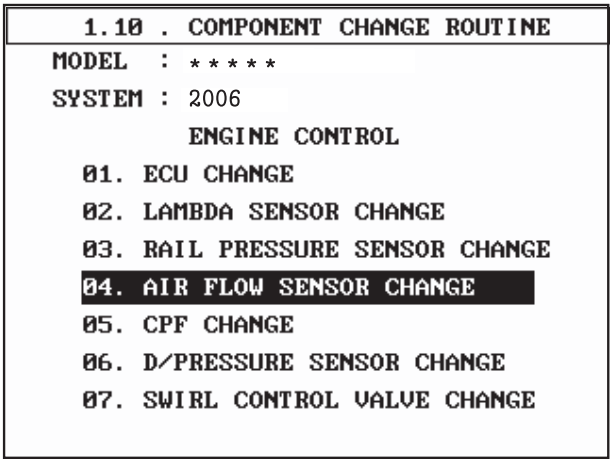
STGFL7117L

7. Select "COMPONET CHANGE ROUTNE"



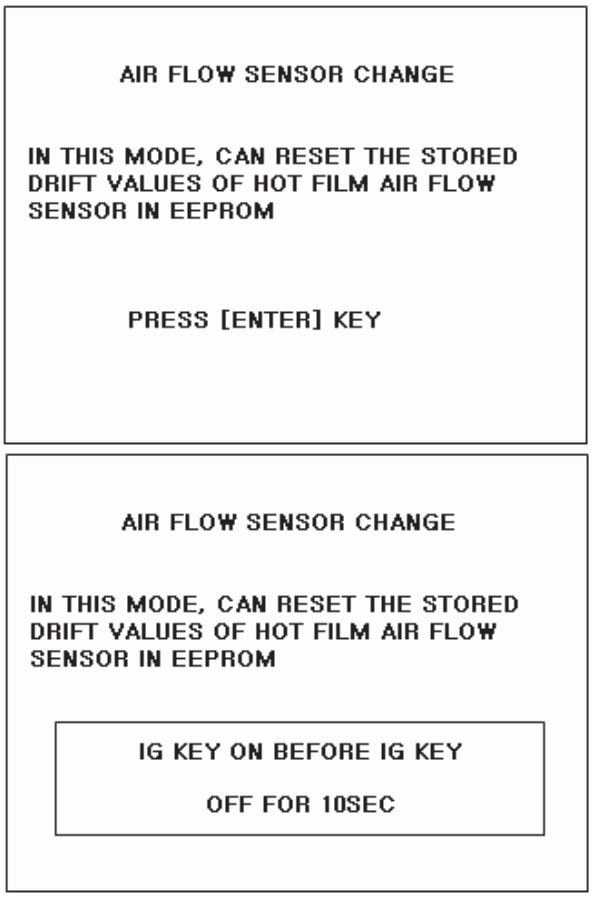
STGFL7118L

8. Select "AIR FLOW SENSOR CHANGE".



STGFL7121L

9. Press "ENTER" key.

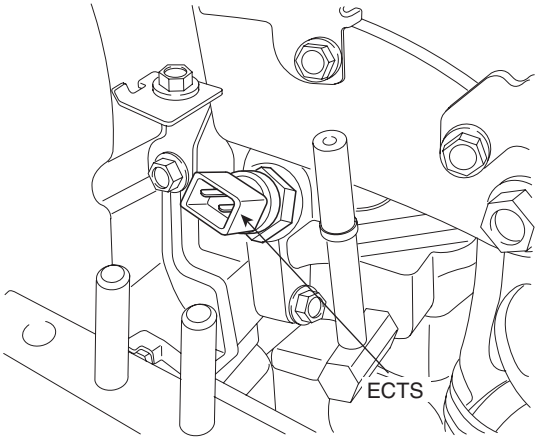


LFIG129A

10. Wait 10 seconds with IG ON.

11. Turn ignition switch off.

ENGINE COOLANT TEMPERATURE SENSOR (ECTS)

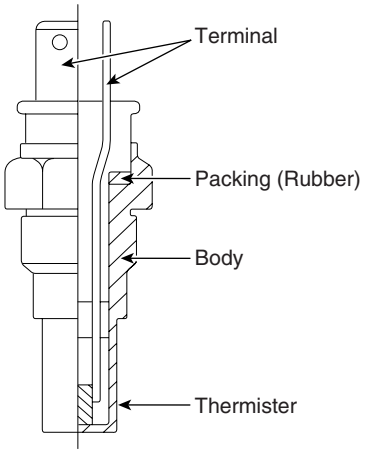


LFIG008A

INSPECTION E1C34D15

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.



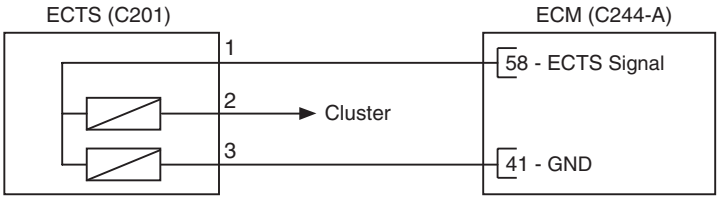
EGRF241A

SPECIFICATION

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

CIRCUIT DIAGRAM

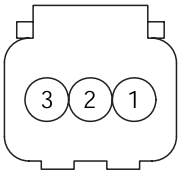
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

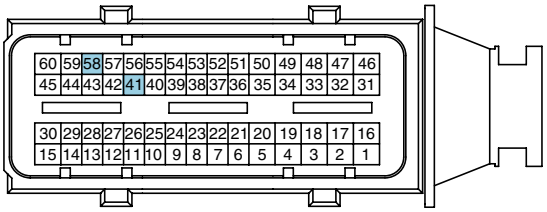
Terminal	Connected to	Function
1	ECM C244-A (58)	ECTS Signal
2	Cluster	-
3	ECM C244-A (41)	Sensor ground

[HARNESS CONNECTORS]

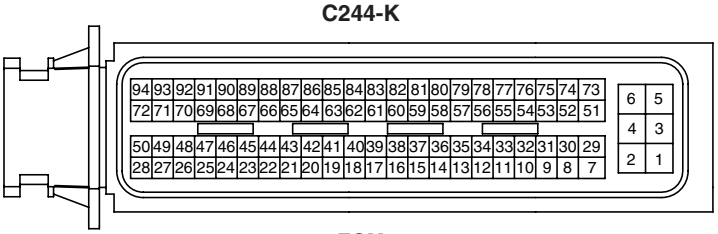


C201
ECTS

C244-A



C244-K

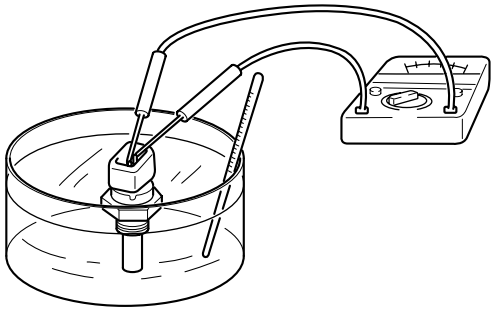


ECM

STGFL7137L

COMPONENT INSPECTION

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



EFNF541A

5. Check that the resistance is within the specification.

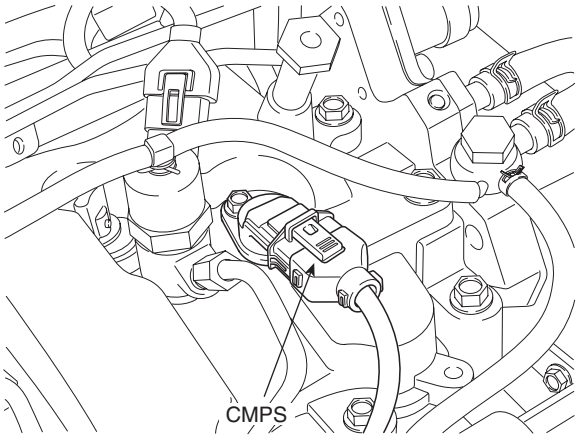
Specification: Refer to "SPECIFICATION".

CAMSHAFT POSITION SENSOR (CMPS)

INSPECTION E9909235

FUNCTION AND OPERATION PRINCIPLE

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



LFIG010A

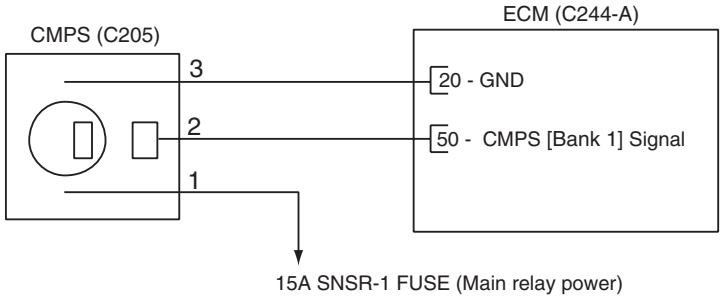
SPECIFICATION

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

Items	Specification
Air Gap	1.5 ± 0.1 mm

CIRCUIT DIAGRAM

[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

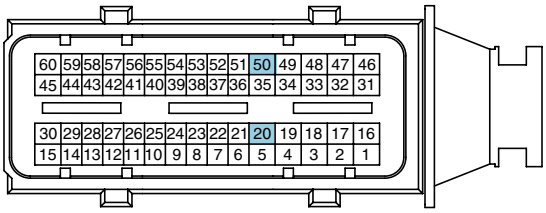
Terminal	Connected to	Function
1	JC301 (61)	Main relay power
2	ECM C244-A (50)	CMPS Signal
3	ECM C244-A (20)	GND

[HARNESS CONNECTORS]

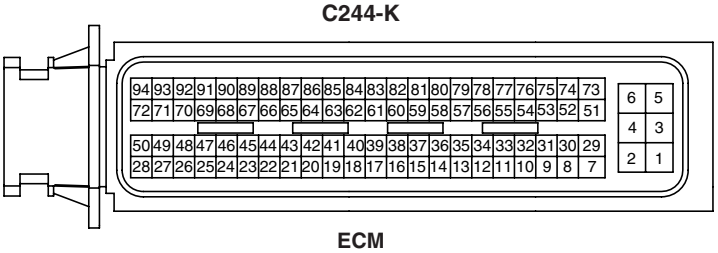
C205

CMPS

C244-A



C244-K



ECM

STGFL7145L

SIGNAL WAVEFORM

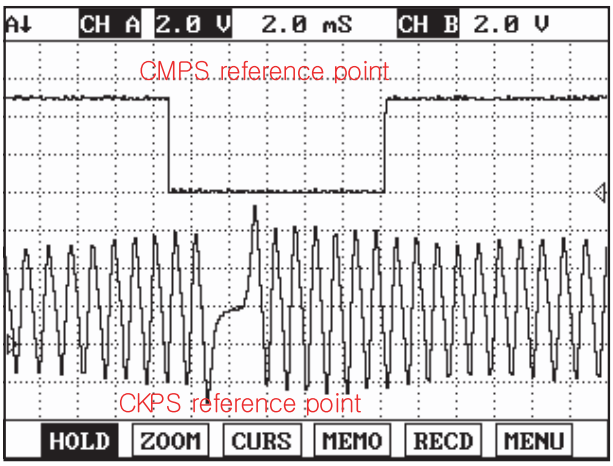


Fig.1

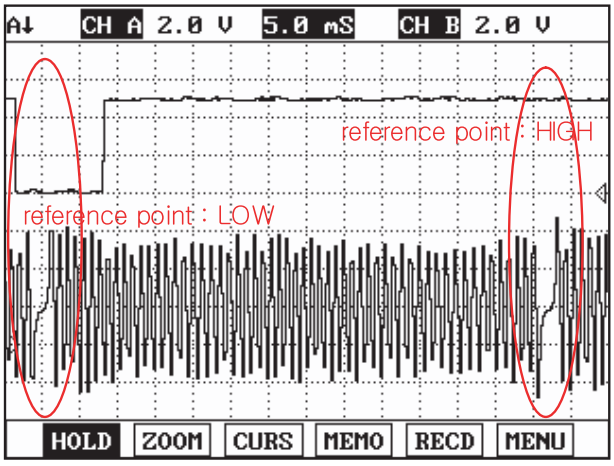


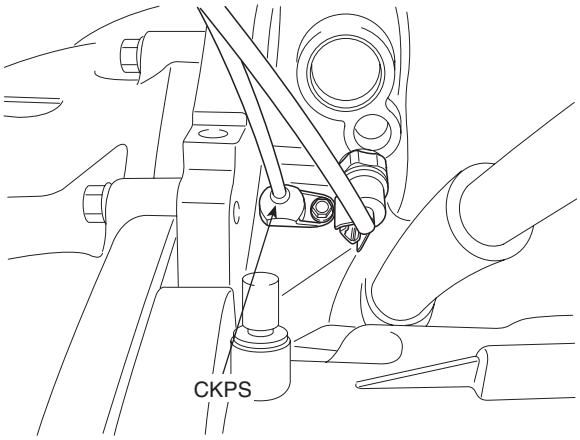
Fig.2

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

Fig.2) Crank Shaft Position Sensor and Cam Shaft Position Sensor signal are measured simultaneously.
Cam Shaft Position Sensor
signal is outputted once when Crank Shaft Position sensor signal is outputted twice. LOW and HIGH output of Cam Shaft Position sensor reference point is detected at Crank Shaft Position sensor reference point.
(Injection sequence is determined based on LOW and HIGH signal of Cam Shaft Position Sensor reference point as detecting cylinder position.)

LFIG299A

CRANKSHAFT POSITION SENSOR (CKPS)



LFIG046A

INSPECTION E39BA5C3

FUNCTION AND OPERATION PRINCIPLE

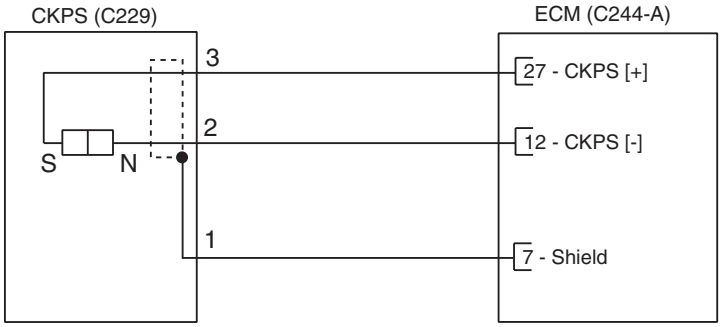
Piston position on combustion chamber is the substantial to define the starting of injection timing. All engine pistons are connected to crankshaft by connecting rod. Sensor on crankshaft can supply the informations concerning all piston positions, revolution speed is defined by revolution perminute 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]

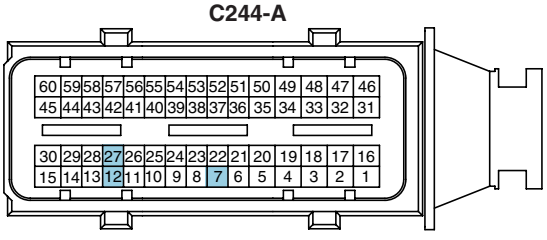
Terminal	Connected to	Function
1	ECM C244-A (7)	Sensor Shield
2	ECM C244-A (12)	CKPS [-] Signal
3	ECM C244-A (27)	CKPS [+] Signal

[HARNESS CONNECTORS]

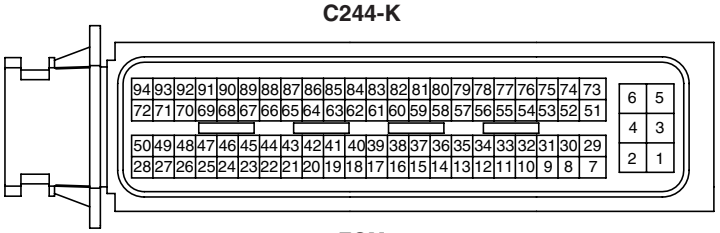
C229

CKPS

C244-A



C244-K



ECM

STGFL7147L

SIGNAL WAVEFORM

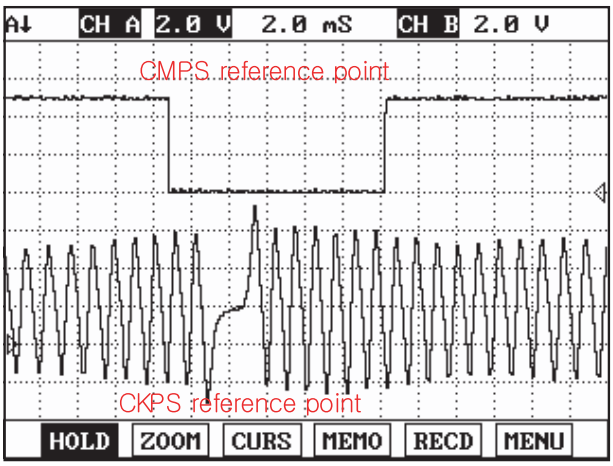


Fig.1

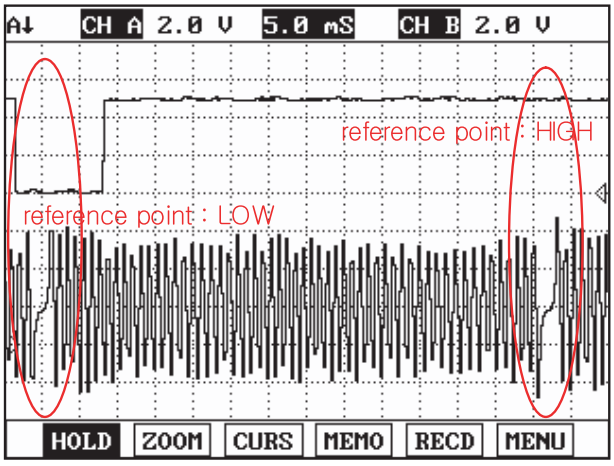


Fig.2

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

Fig.2) Crank Shaft Position Sensor and Cam Shaft Position Sensor signal are measured simultaneously.
Cam Shaft Position Sensor
signal is outputted once when Crank Shaft Position sensor signal is outputted twice. LOW and HIGH output of Cam Shaft Position sensor reference point is detected at Crank Shaft Position sensor reference point.
(Injection sequence is determined based on LOW and HIGH signal of Cam Shaft Position Sensor reference point as detecting cylinder position.)

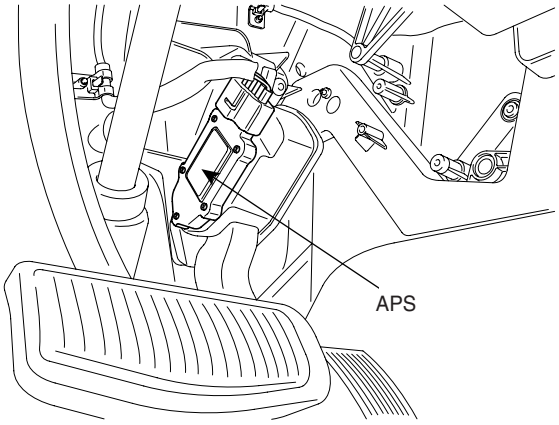
LFIG299A

ACCELERATOR POSITION SENSOR (APS)

INSPECTION E66C7390

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.

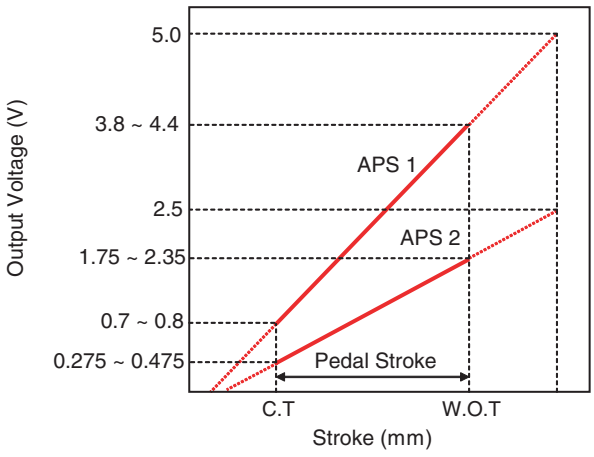


SNFFL6102D

SPECIFICATION

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

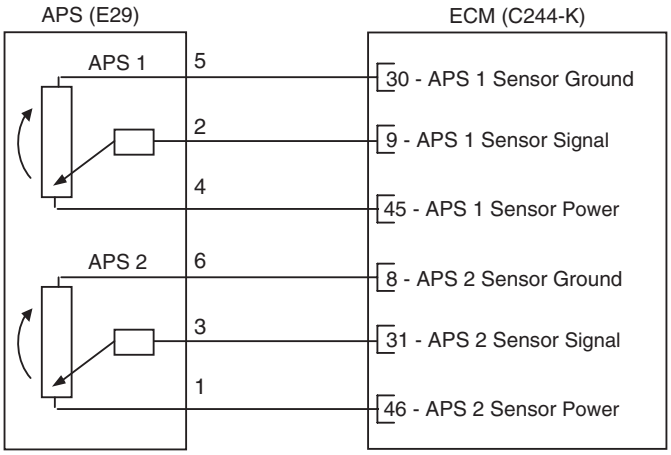
Items	Specification	
	APS 1	APS 2
Potentiometer Resistance (kΩ)	0.7 ~ 1.3	1.4 ~ 2.6



LFIG092A

CIRCUIT DIAGRAM

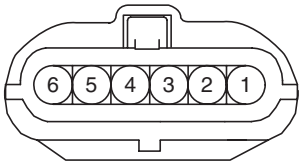
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

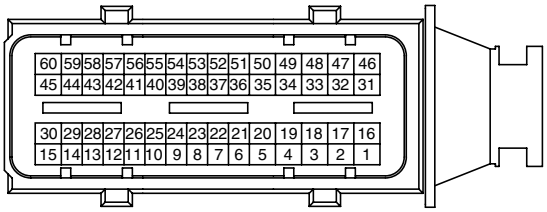
Terminal	Connected to	Function
1	ECM C244-K (46)	APS 2 Sensor Power
2	ECM C244-K (9)	APS 1 Sensor Signal
3	ECM C244-K (31)	APS 2 Sensor Signal
4	ECM C244-K (45)	APS 1 Sensor Power
5	ECM C244-K (30)	APS 1 Sensor Ground
6	ECM C244-K (8)	APS 2 Sensor Ground

[HARNESS CONNECTORS]

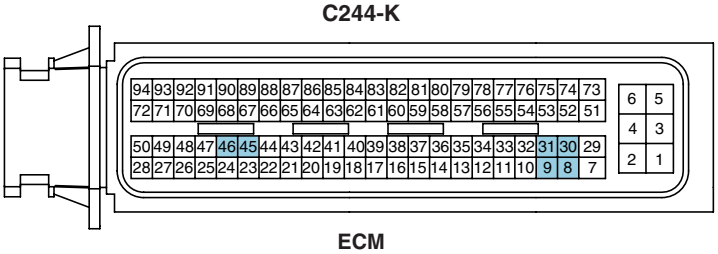


E29
APS

C244-A



C244-K



ECM

STGFL7149L

SIGNAL WAVEFORM

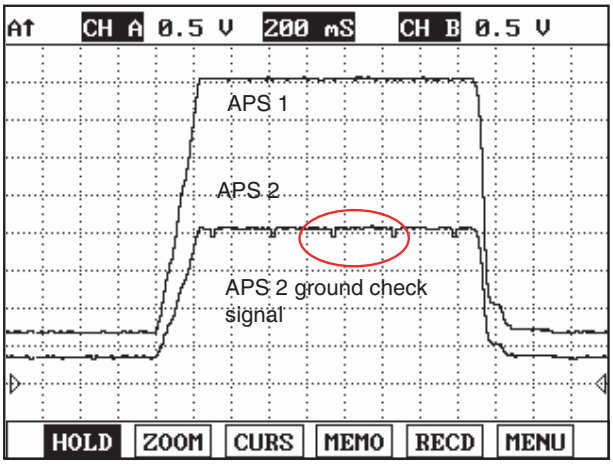


Fig.1

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

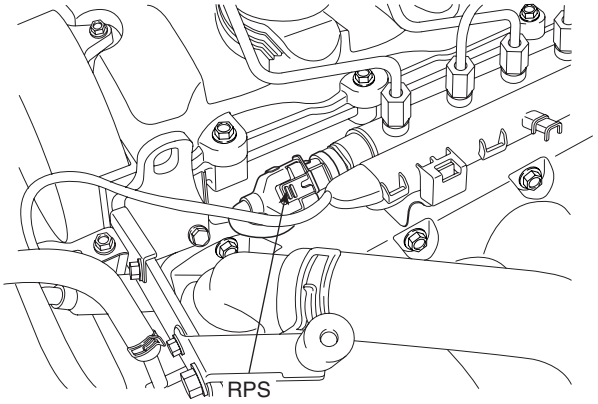
LFIG541A

COMPONENT INSPECTION

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

Specification: Refer to "SPECIFICATION".

RAIL PRESSURE SENSOR (RPS)



LFIG017A

INSPECTION E0734AD3

FUNCTION AND OPERATION PRINCIPLE

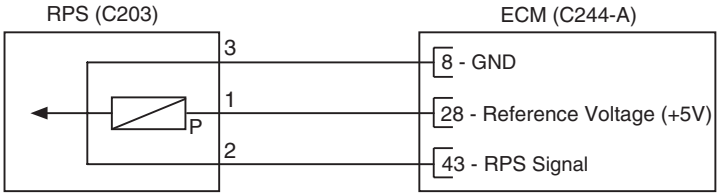
Rail Pressure Sensor (RPS) is installed at the end of the common rail and measures the instantaneous fuel pressure in the common rail by using its diaphragm. Its sensing element (semiconductor device) mounted on the diaphragm converts the fuel pressure to an electric signal.

SPECIFICATION

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

CIRCUIT DIAGRAM

[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

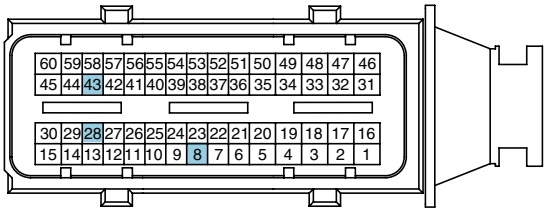
Terminal	Connected to	Function
1	ECM C244-A (28)	Reference Voltage (+5V)
2	ECM C244-A (43)	RPS Signal
3	ECM C244-A (8)	Sensor Signal

[HARNESS CONNECTORS]

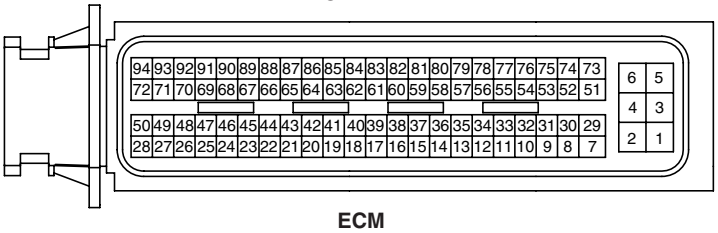
C203

RPS

C244-A



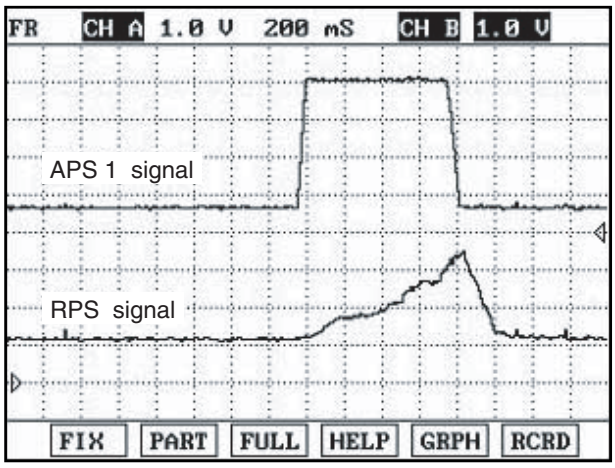
C244-K



ECM

STGFL7150L

SIGNAL WAVEFORM



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

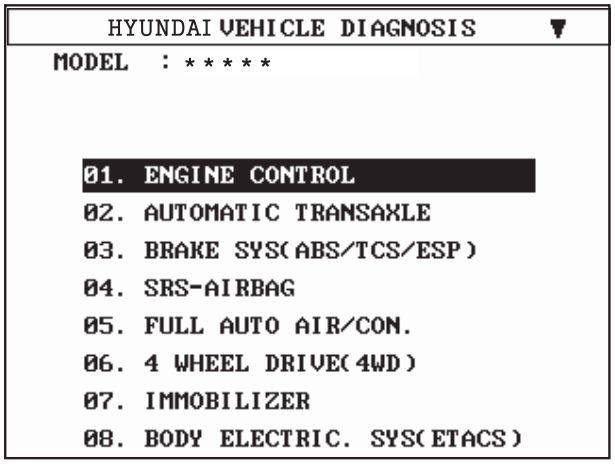
EFNF550A

REPLACEMENT E1CDDEAF

NOTE

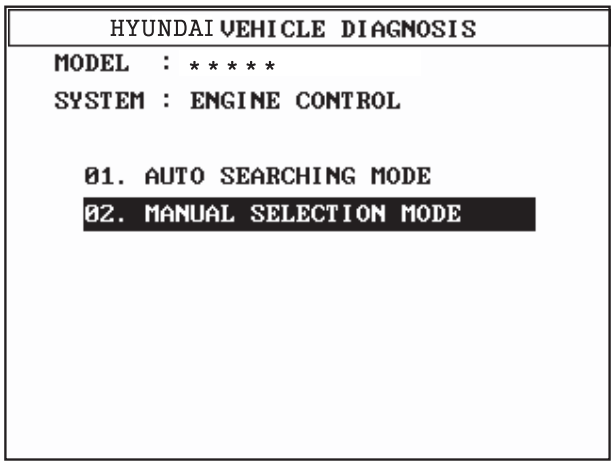
After replacing a Rail Pressure Sensor (RPS), MUST proceed below procedure.

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



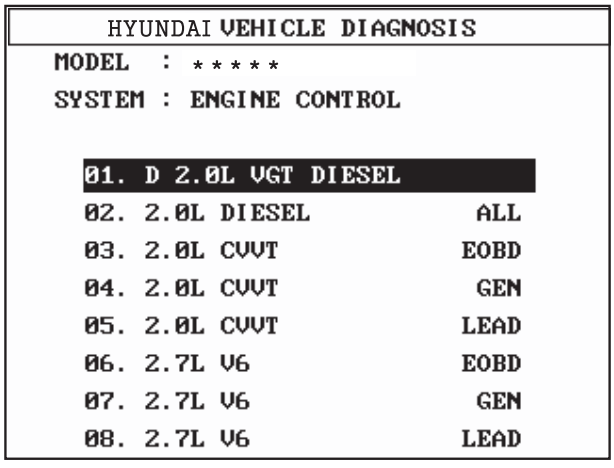
STGFL7115L

5. Select "MANUAL SELECTION MODE".



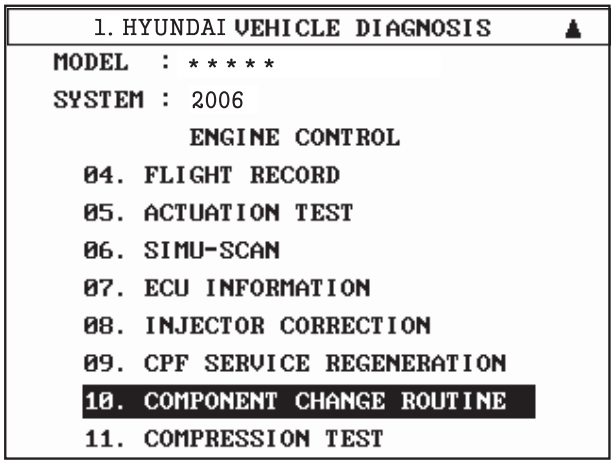
STGFL7116L

6. Select "D 2.0L VGT DIESEL".



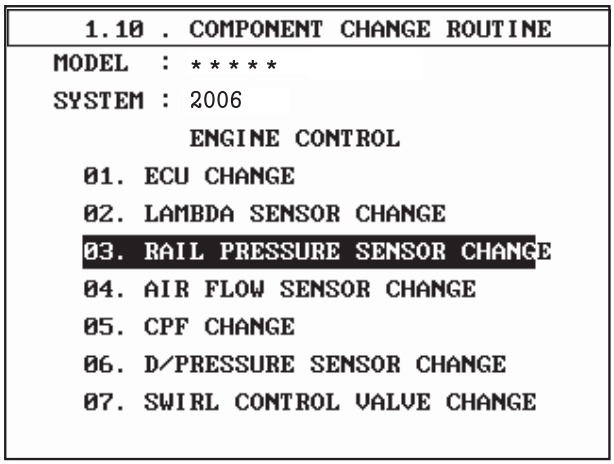
STGFL7117L

7. Select "COMPONET CHANGE ROUTNE"



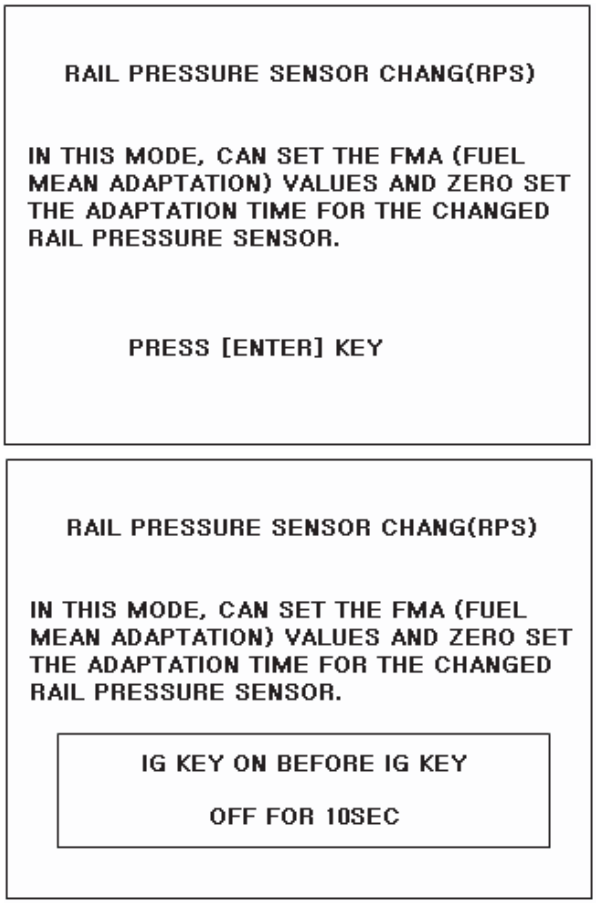
STGFL7118L

8. Select "RAIL PRESSURE SENSOR CHANGE".



STGFL7122L

9. Press "ENTER" key.



LFIG127A

10. Wait 10 seconds with IG ON.

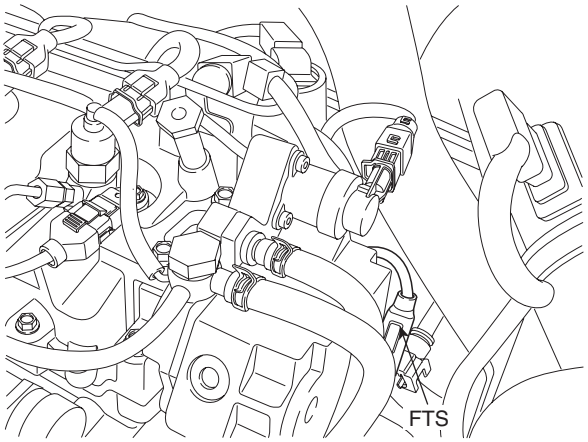
11. Turn ignition switch off.

FUEL TEMPERATURE SENSOR (FTS)

INSPECTION E2D9DBE8

FUNCTION AND OPERATION PRINCIPLE

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



LFIG051A

SPECIFICATION

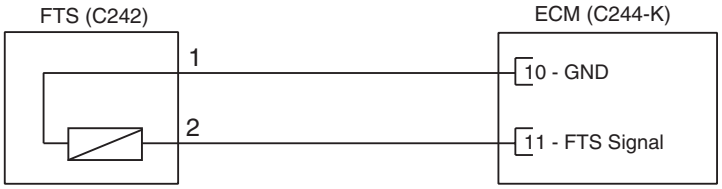
Temperature [℃(°F)]	Resistance (kΩ)
-30 (-22)	27.00
-20 (-4)	15.67
-10 (14)	9.45
0 (32)	5.89
20 (68)	2.27 ~ 2.73

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

LFIG052A

CIRCUIT DIAGRAM

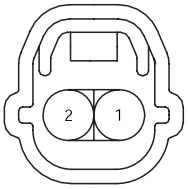
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-K (10)	Sensor ground
2	ECM C244-K (11)	FTS Signal

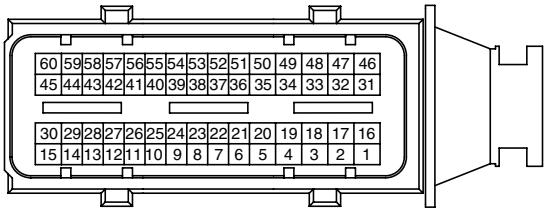
[HARNESS CONNECTORS]



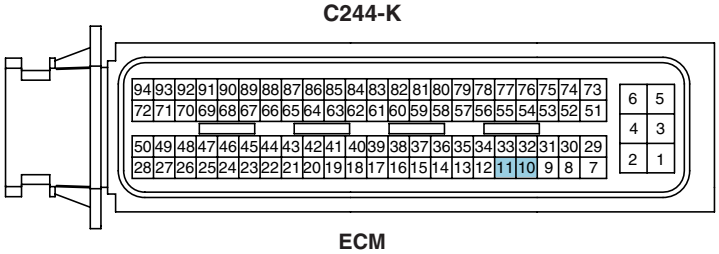
C242

FTS

C244-A



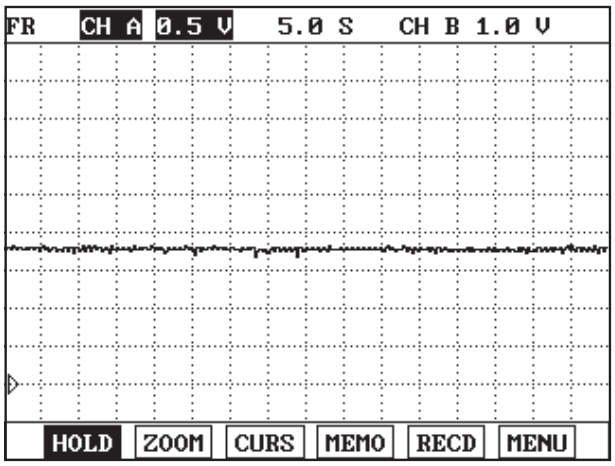
C244-K



ECM

STGFL7153L

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.

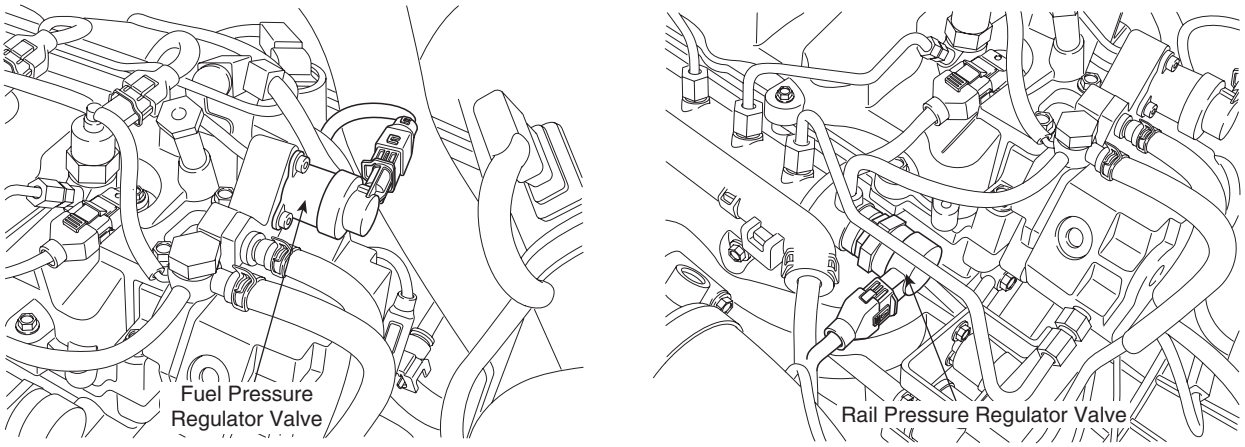
Specification: Refer to "SPECIFICATION".

FUEL PRESSURE REGULATOR VALVE

INSPECTION E58A5218

FUNCTION AND OPERATION PRINCIPLE

The Fuel Pressure Regulator Valve and the Rail Pressure Regulator Valve are installed on high pressure pump and common rail respectively. These valves control fuel inlet (feed) from fuel tank via fuel filter and outlet (return) to fuel tank of high pressure fuel circuit.
This system is called "Dual Fuel Pressure Control System" and can precisely and quickly control the fuel pressure in accordance with various engine conditions by controlling the fuel inlet and outlet simultaneously.

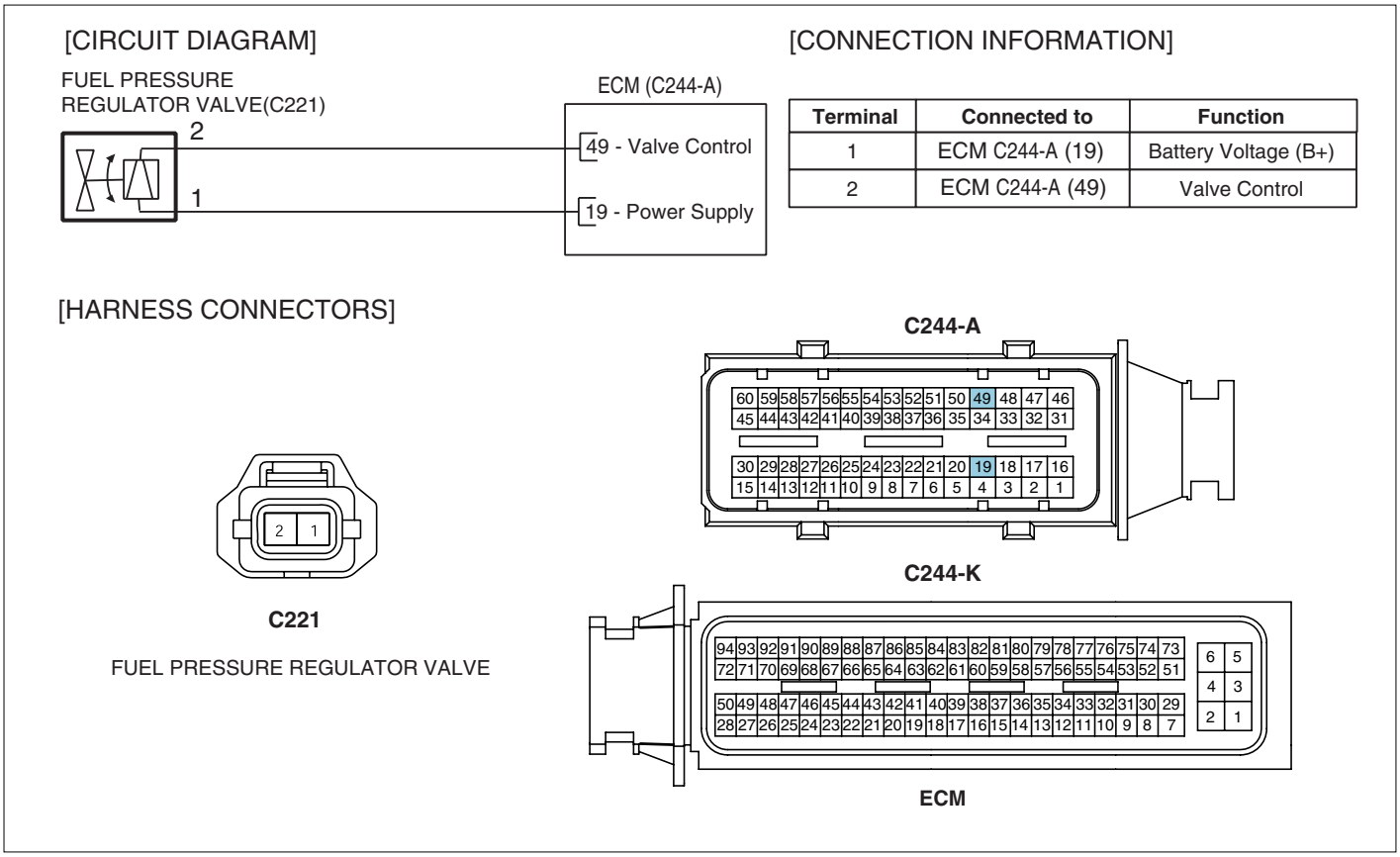


LFIG114A

SPECIFICATION

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

CIRCUIT DIAGRAM



STGFL7155L

SIGNAL WAVEFORM

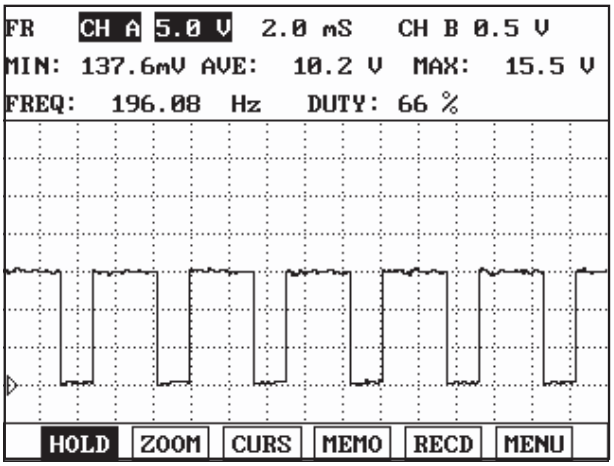


Fig.1

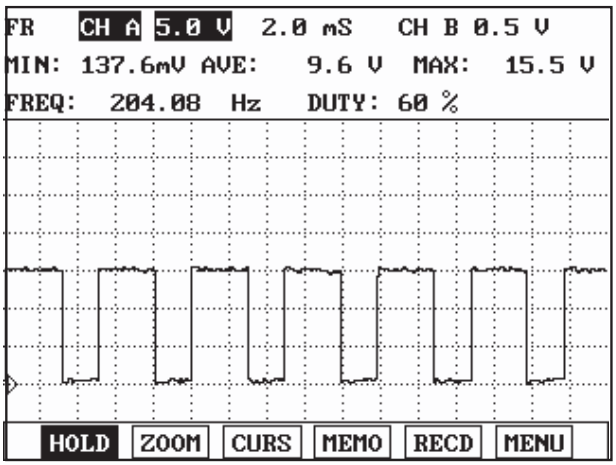


Fig.2

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

LFIG396A

COMPONENT INSPECTION

1. Turn ignition switch OFF.
2. Disconnect the fuel pressure regulator valve connector.
3. Measure resistance between terminal 1 and 2 of the valve.

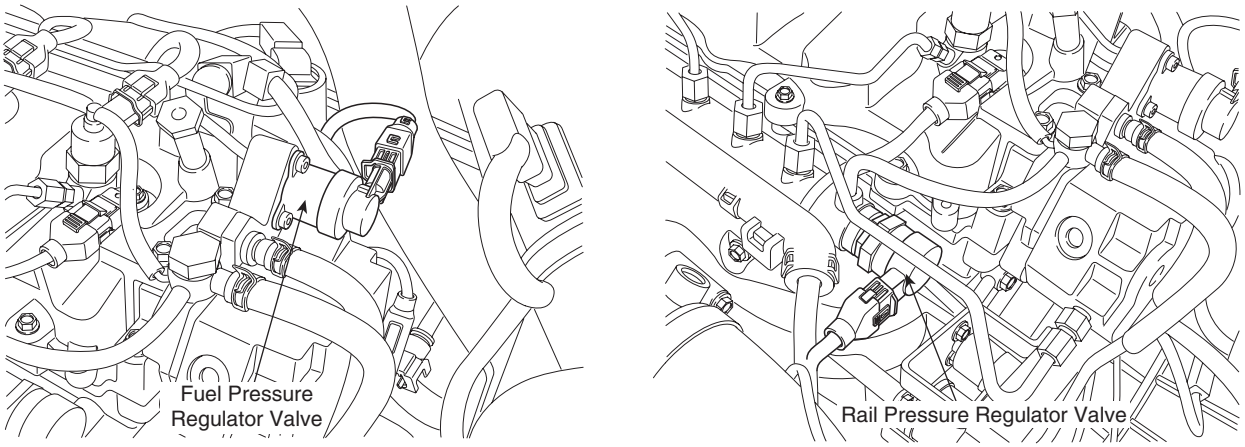
Specification: Refer to "SPECIFICATION".

RAIL PRESSURE REGULATOR VALVE

INSPECTION EE7E3738

FUNCTION AND OPERATION PRINCIPLE

The Fuel Pressure Regulator Valve and the Rail Pressure Regulator Valve are installed on high pressure pump and common rail respectively. These valves control fuel inlet (feed) from fuel tank via fuel filter and outlet (return) to fuel tank of high pressure fuel circuit.
This system is called "Dual Fuel Pressure Control System" and can precisely and quickly control the fuel pressure in accordance with various engine conditions by controlling the fuel inlet and outlet simultaneously.



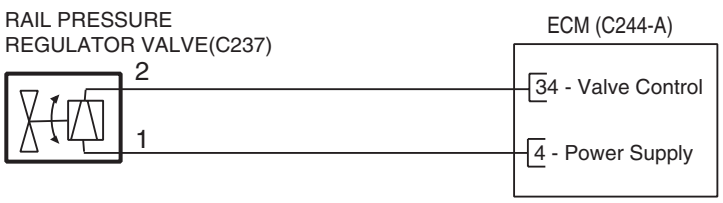
LFIG114A

SPECIFICATION

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

CIRCUIT DIAGRAM

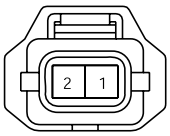
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-A (4)	Battery Voltage (B+)
2	ECM C244-A (34)	Valve Control

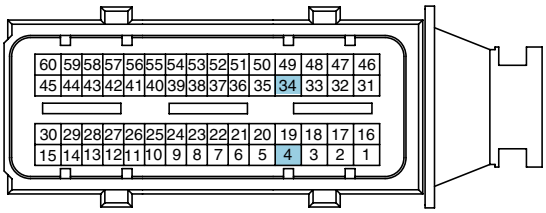
[HARNESS CONNECTORS]



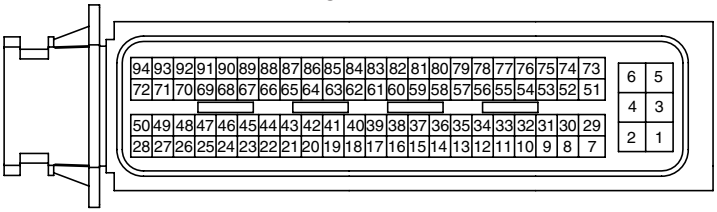
C237

RAIL PRESSURE REGULATOR VALVE

C244-A



C244-K



ECM

STGFL7194L

SIGNAL WAVEFORM

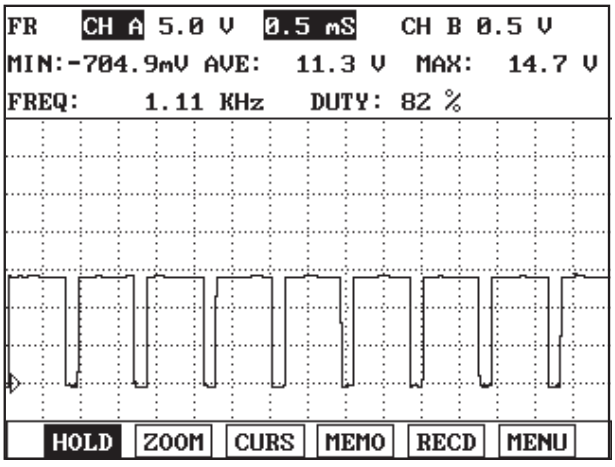


Fig.1

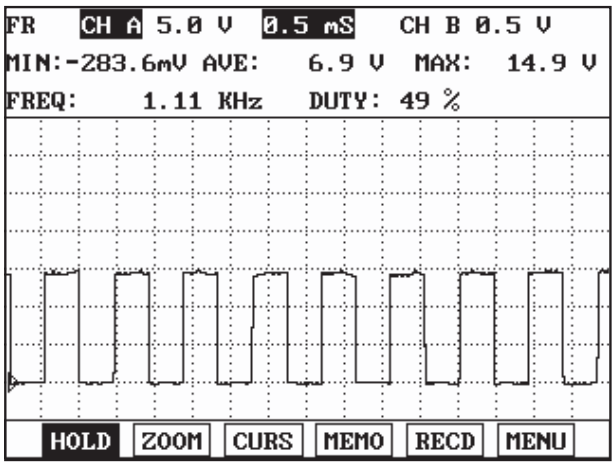


Fig.2

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

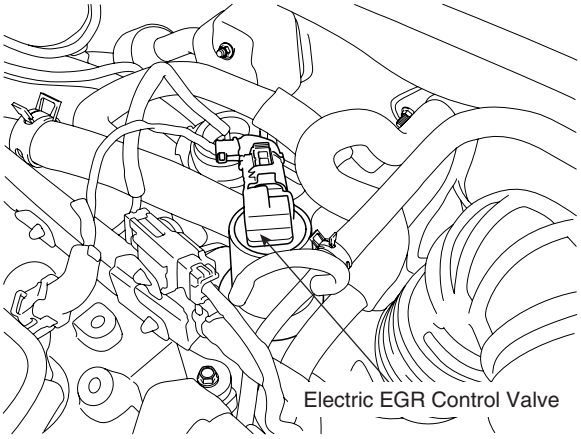
LFIG377A

COMPONENT INSPECTION

1. Turn ignition switch OFF.
2. Disconnect the rail pressure regulator valve connector.
3. Measure resistance between terminal 1 and 2 of the valve.

Specification: Refer to "SPECIFICATION".

ELECTRIC EGR CONTROL VALVE



SNFFL6106L

INSPECTION E0CD3D42

FUNCTION AND OPERATION PRINCIPLE

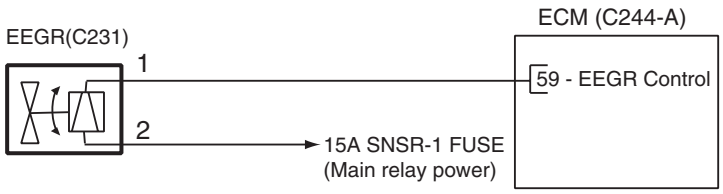
The Exhaust Gas Recirculation (EGR) system is used to add the exhaust gas to intake air in order to reduce an excess of air and the temperature in the combustion chamber. The Electric EGR valve is controlled by ECM' s duty control signal depending on engine load and the need of intake air and is operated by solenoid valve not vacuum valve.

SPECIFICATION

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

CIRCUIT DIAGRAM

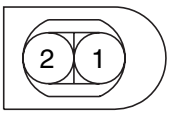
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-A (59)	EEGR Control
2	JC 01 (31)	Main Relay

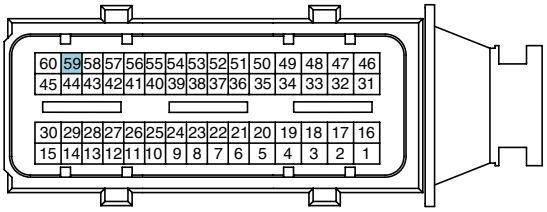
[HARNESS CONNECTORS]



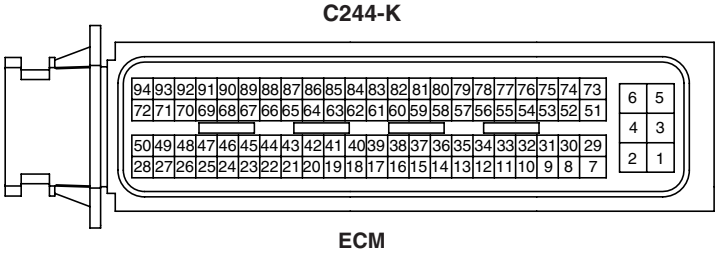
C231

EEGR

C244-A



C244-K



ECM

STGFL7195L

SIGNAL WAVEFORM

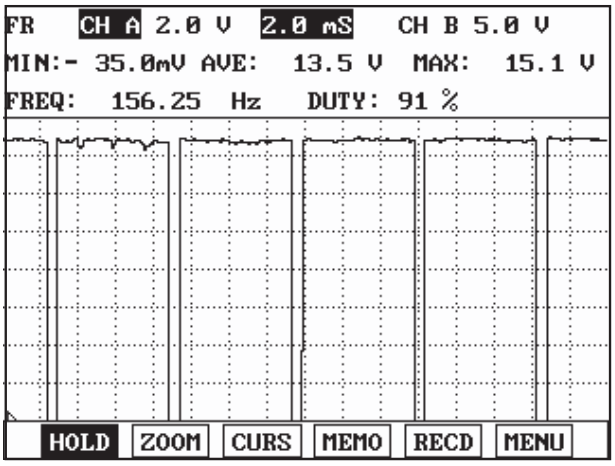


Fig.1

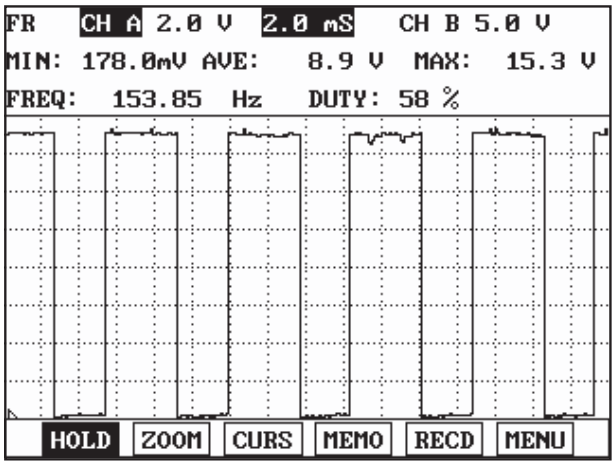


Fig.2

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

LFIG414A

COMPONENT INSPECTION

1. Turn ignition switch OFF.
2. Disconnect the electric EGR control valve connector.
3. Measure resistance between terminal 1 and 2 of the valve.

Specification: Refer to "SPECIFICATION".

THROTTLE CONTROL ACTUATOR

INSPECTION EE647E4E

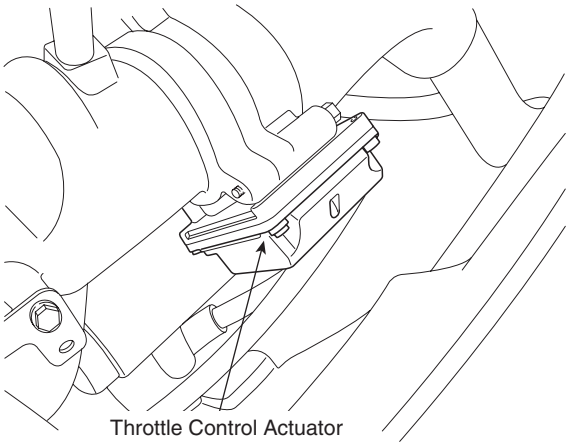
FUNCTION AND OPERATION PRINCIPLE

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

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

Its function is described below:

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

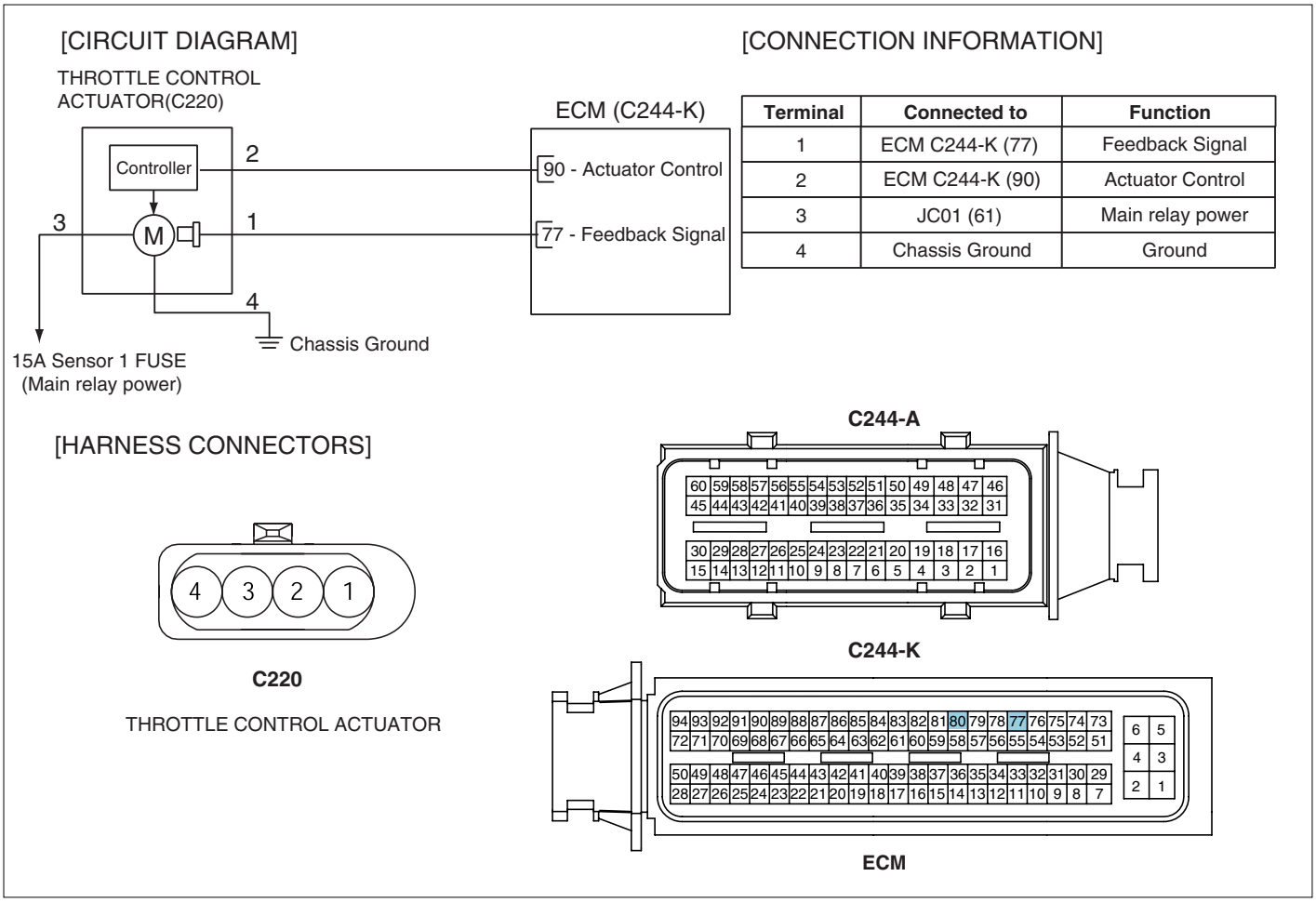


LFIG021A

SPECIFICATION

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

CIRCUIT DIAGRAM



Terminal	Connected to	Function
1	ECM C244-K (77)	Feedback Signal
2	ECM C244-K (90)	Actuator Control
3	JC01 (61)	Main relay power
4	Chassis Ground	Ground

STGFL7197L

SIGNAL WAVEFORM

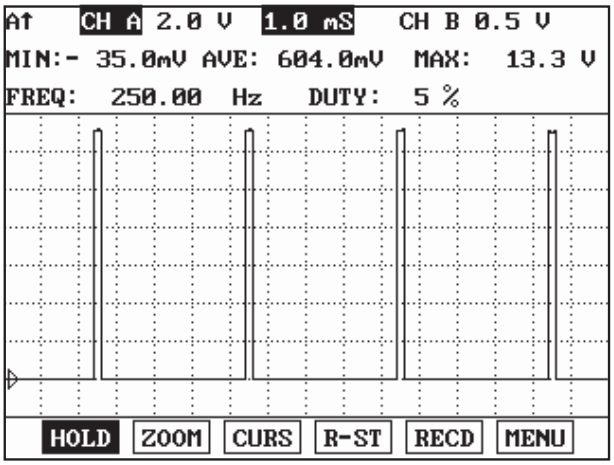


Fig.1

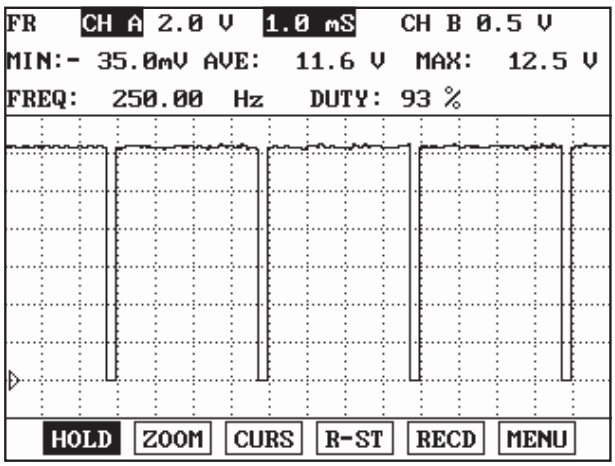


Fig.2

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

LFIG529A

COMPONENT INSPECTION

1. Turn ignition switch OFF.
2. Disconnect the electric throttle control actuator connector.
3. Measure resistance between terminal 1 and 2 of the valve.

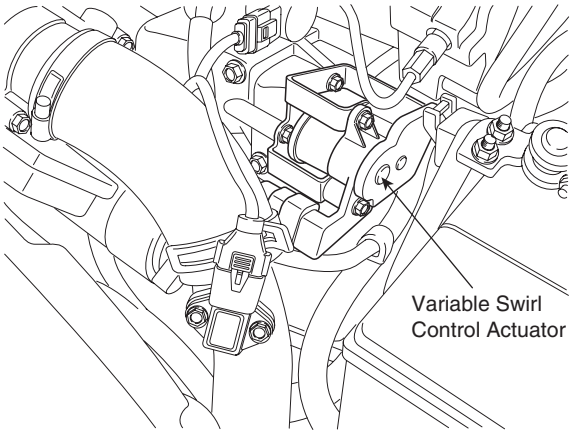
Specification: Refer to "SPECIFICATION".

VARIABLE SWIRL CONTROL ACTUATOR

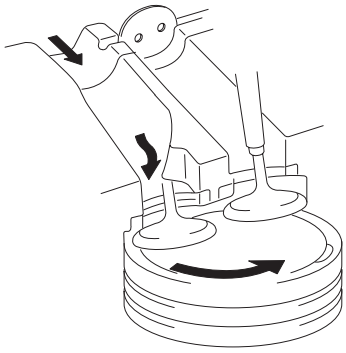
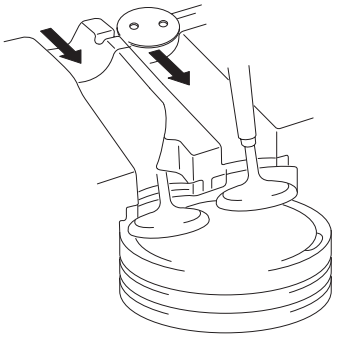
INSPECTION EF65DC23

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.



LFIG057A

	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)]

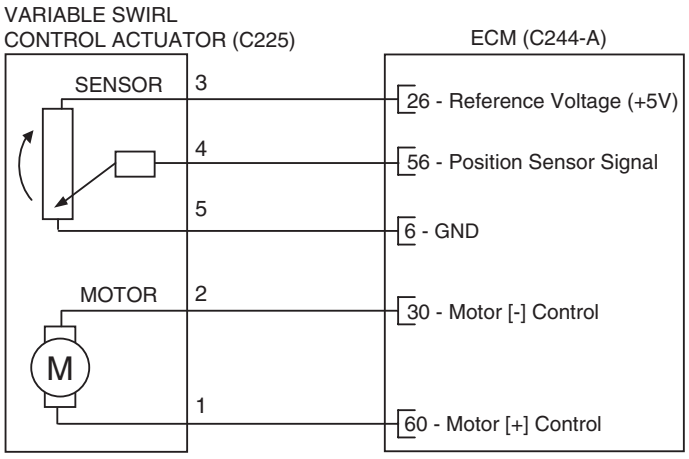
Position Sensor

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

LFIG058A

CIRCUIT DIAGRAM

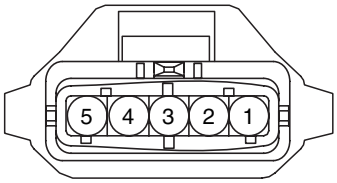
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-A (60)	Motor [+] Control
2	ECM C244-A (30)	Motor [-] Control
3	ECM C244-A (26)	Reference Voltage (+5V)
4	ECM C244-A (56)	Position Signal
5	ECM C244-A (6)	Sensor Ground

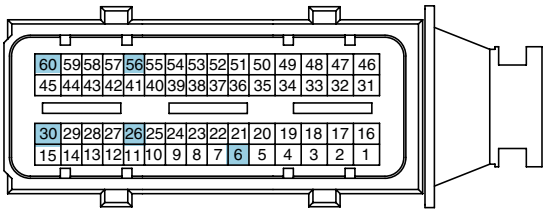
[HARNESS CONNECTORS]



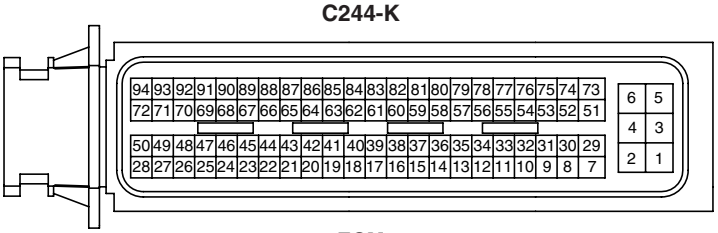
C225

VARIABLE SWIRL CONTROL ACTUATOR

C244-A



C244-K



ECM

STGFL7159L

SIGNAL WAVEFORM

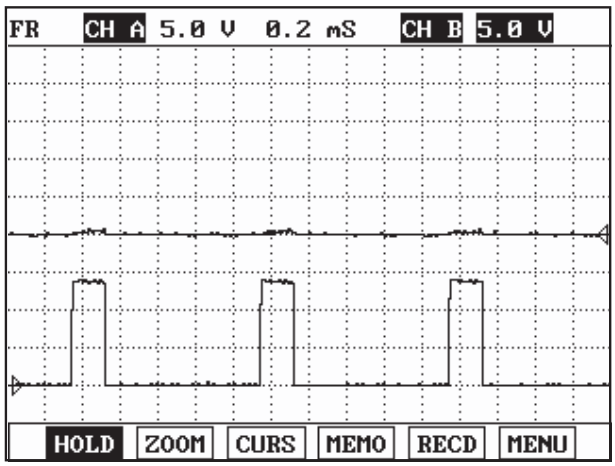


Fig.1

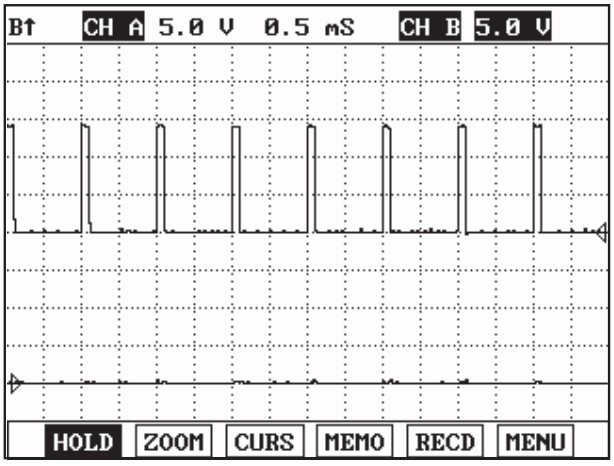


Fig.2

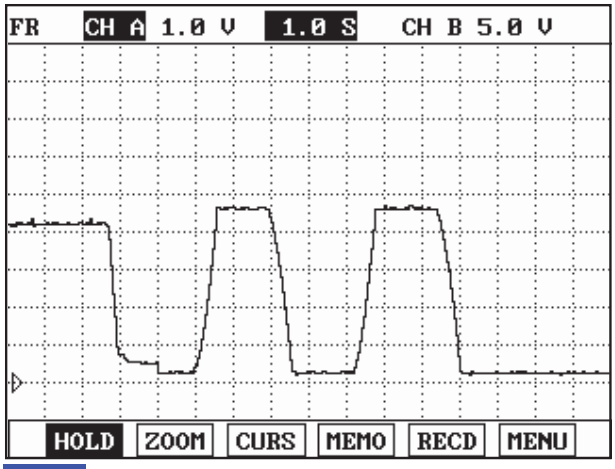


Fig.3

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

LFIG512A

COMPONENT INSPECTION

1. Turn ignition switch OFF.
2. Disconnect the electric EGR control valve 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.

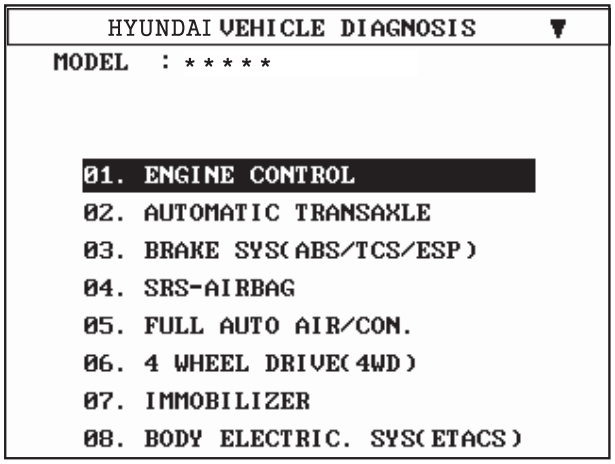
Specification: Refer to "SPECIFICATION".

REPLACEMENT EB91BC1B

NOTE

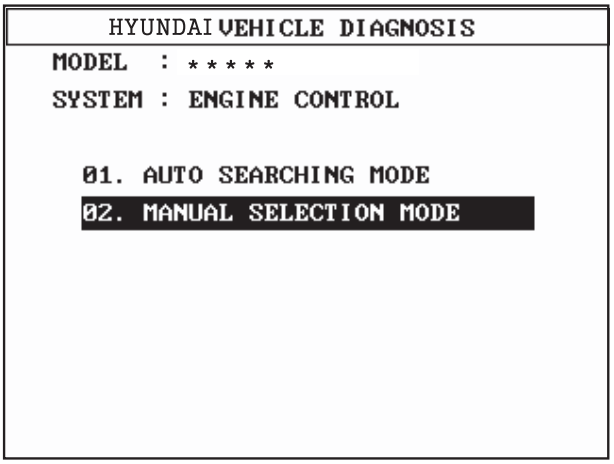
After replacing a Variable Swirl Actuator, MUST proceed below procedure.

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



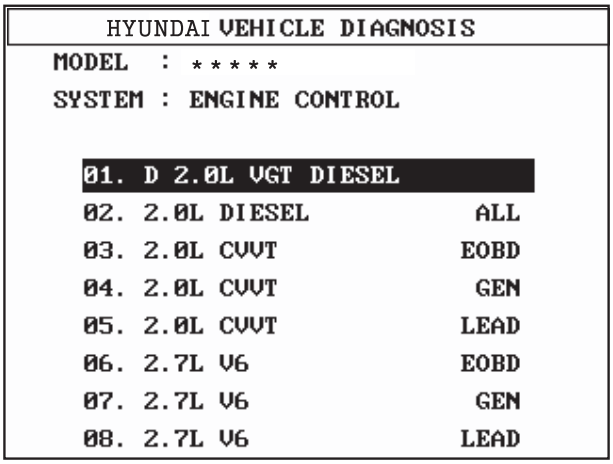
STGFL7115L

5. Select "MANUAL SELECTION MODE".



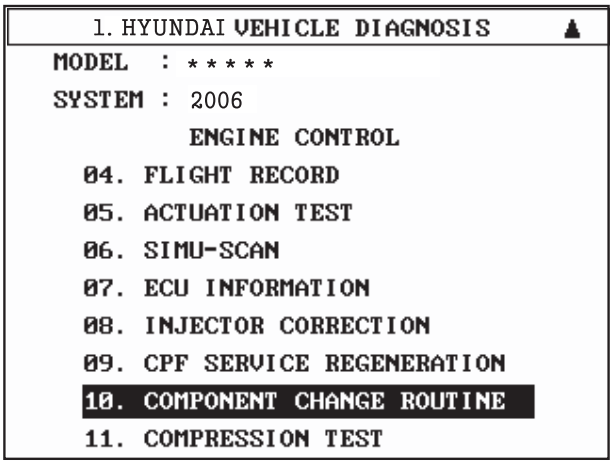
STGFL7116L

6. Select "D 2.0L VGT DIESEL".



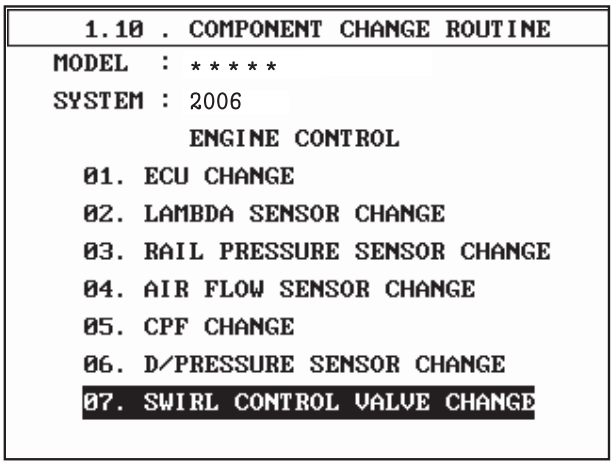
STGFL7117L

7. Select "COMPONET CHANGE ROUTNE"



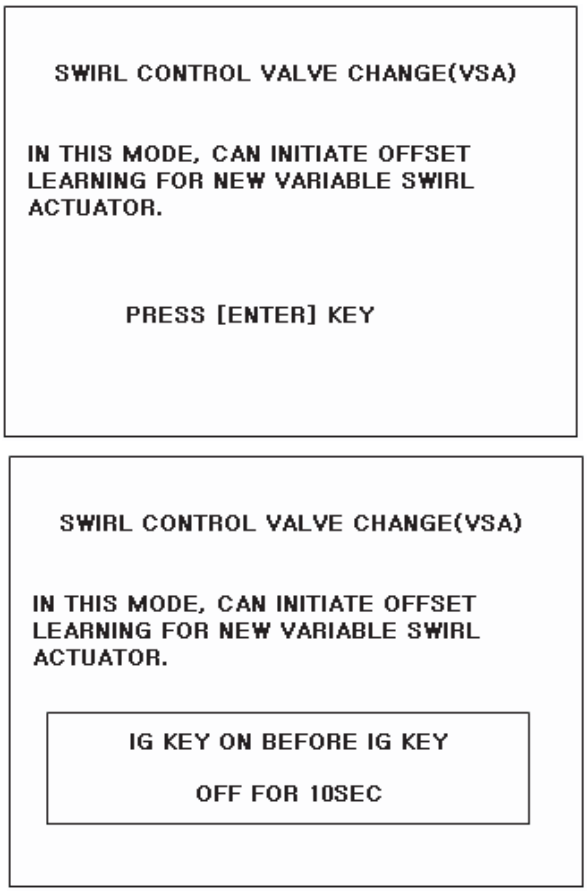
STGFL7118L

8. Select "SWIRL CONTROL VALVE CHANGE".



STGFL7123L

9. Press "ENTER" key.



LFIG133A

10. Wait 10 seconds with IG ON.

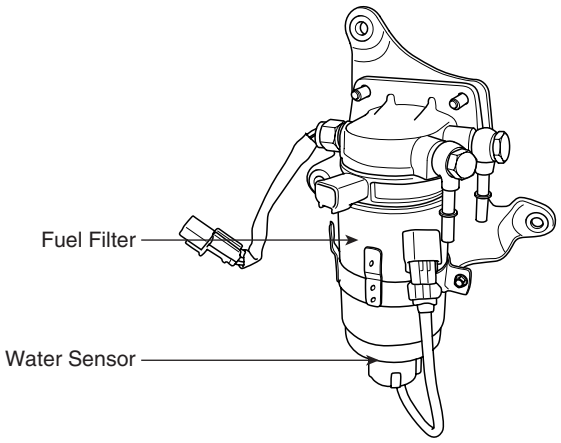
11. Turn ignition switch off.

WATER SENSOR

INSPECTION E254D4A2

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.



SNFFL6105L

NOTE

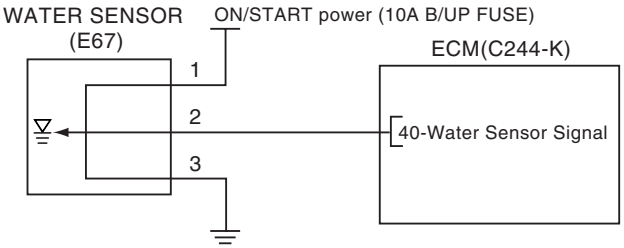
Without presence of water, the lamp should flash for 2 seconds and turn off afterward in order that this system has normal condition.

SPECIFICATION

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

CIRCUIT DIAGRAM

[CIRCUIT DIAGRAM]



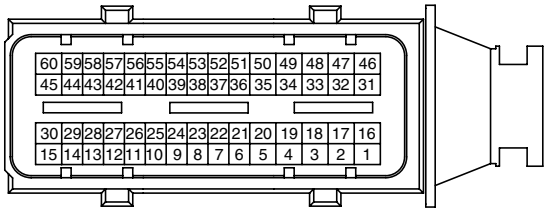
[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	JE02 terminal 42	IG power
2	ECM C244-K (40)	Sensor Signal
3	Chassis ground(G11)	Sensor ground

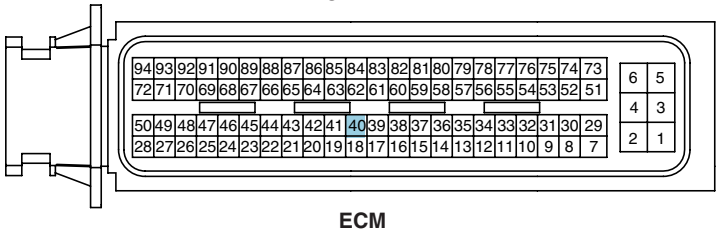
[HARNESS CONNECTOR]

E67
WATER SENSOR

C244-A



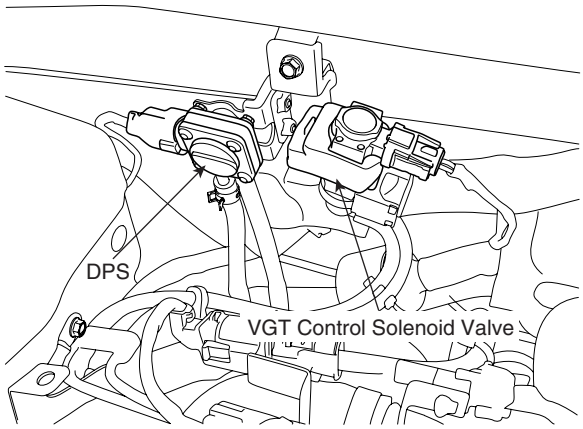
C244-K



ECM

STGFL7160L

VGT CONTROL SOLENOID VALVE



SNFFL6103L

INSPECTION E5398CFD

FUNCTION AND OPERATION PRINCIPLE

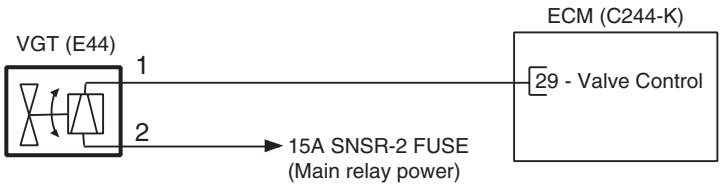
Variable Geometry Turbo-charger (VGT) is used to charge additional air into combustion chamber for improvement of combustion efficiency.
ECM controls the VGT with controlling duty of the VGT control solenoid valve according to engine load.

SPECIFICATION

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

CIRCUIT DIAGRAM

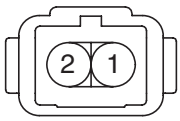
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-K (29)	Valve Control
2	JE02 (46)	Main relay power

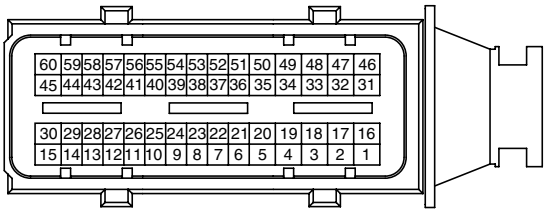
[HARNESS CONNECTORS]



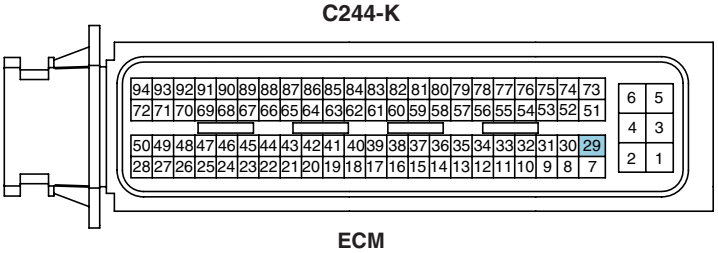
E44

VGT CONTROL SOLENOID VALVE

C244-A



C244-K



ECM

STGFL7161L

SIGNAL WAVEFORM

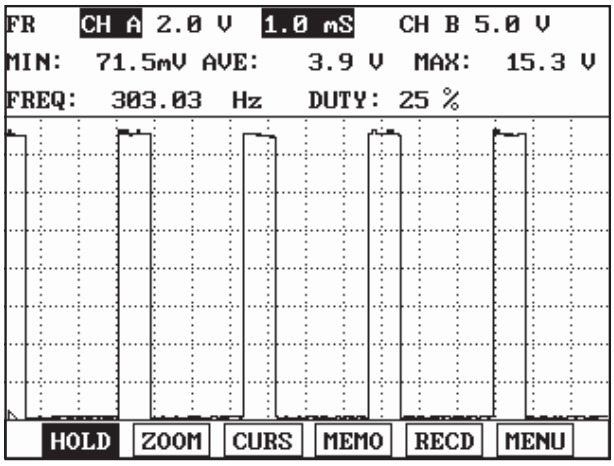


Fig.1

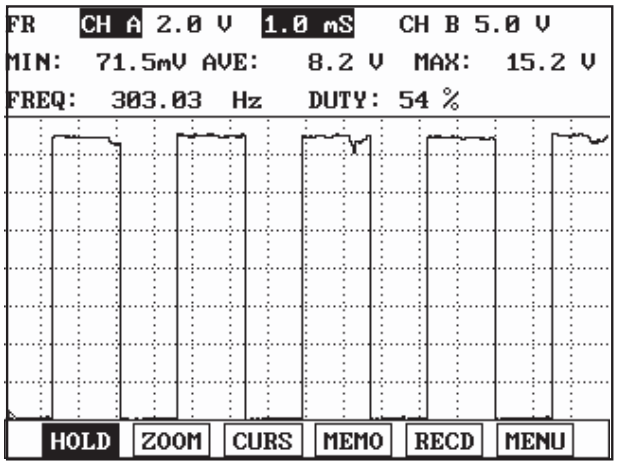


Fig.2

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

LFIG369A

COMPONENT INSPECTION

1. Turn ignition switch OFF.
2. Disconnect the VGT control solenoid valve connector.
3. Measure resistance between terminal 1 and 2 of the valve.

Specification: Refer to "SPECIFICATION".

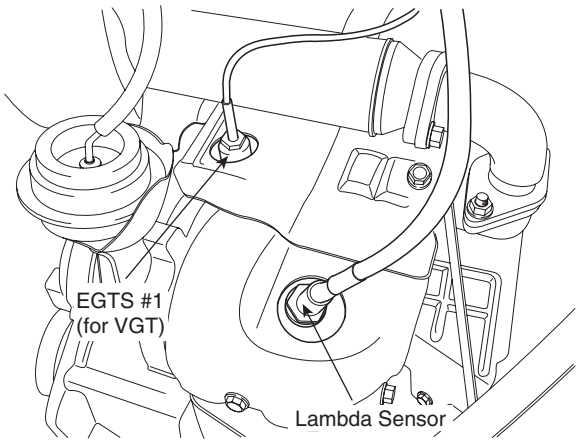
LAMBDA SENSOR

INSPECTION EFA65A59

FUNCTION AND OPERATION PRINCIPLE

Lambda Sensor is installed on exhaust manifold and is a linear oxygen sensor. It senses oxygen density of exhaust gas in order to control EGR acculately through fuel correction and also limits smoke which is generated by reach air-fuel mixture at high engine load condition. ECM controls pumping current in order to fit λ -value from linear lambda sensor to 1.0.
Lean air-fuel mixture($1.0 < \lambda < 1.1$): ECM supplies pumping current to lambda sensor (+pumping current) and activates it for lambda sensor to have the characteristic at 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($0.9 < \lambda < 1.0$): ECM takes away pumping current from lambda sensor (-pumping current) and deactivates it for lambda sensor to have the characteristic at λ =1.0 (0.0 pumping current). With the value of pumping current taken away from lambda sensor, ECM detects lambda density of exhaust gas.
This performance is the most active and fast at normal operating temperature (450℃ ~ 600℃) thus, in order to reach normal operating temp. and last at that temperature, a heater (heating coil) is integrated with lambda sensor. The heater coil is controlled by ECM as Pulse With Modulator (PWM). The resistance of heater coil is low when coil is cold thus, current through it increases while resistance is high when coil is hot thus, current decreases. With this principle, temperature of lambda sensor is measured and lambda sensor heater operation varies based on the data.



LFIG009A

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

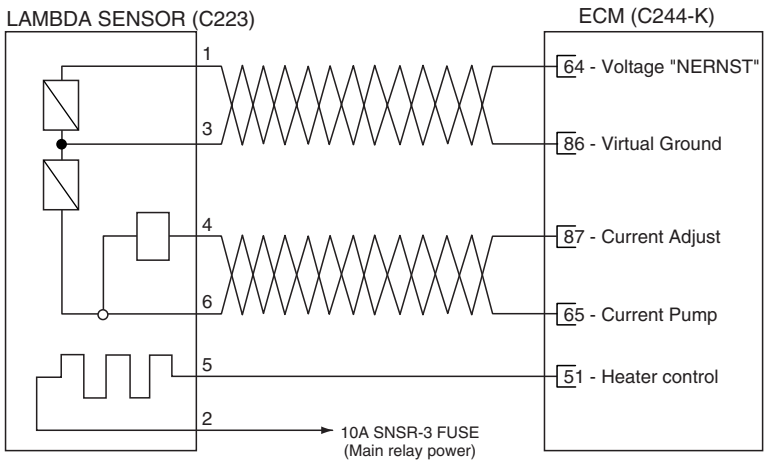
Heater

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

LFIG062A

CIRCUIT DIAGRAM

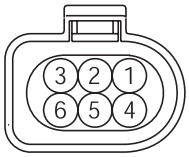
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-K (64)	Voltage "NERNST"
2	10A SNSR-3 FUSE	Main relay power
3	ECM C244-K (86)	Virtual Ground
4	ECM C244-K (87)	Current Adjust
5	ECM C244-K (51)	Heater control
6	ECM C244-K (65)	Current Pump

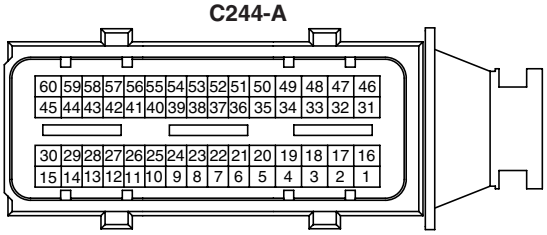
[HARNESS CONNECTORS]



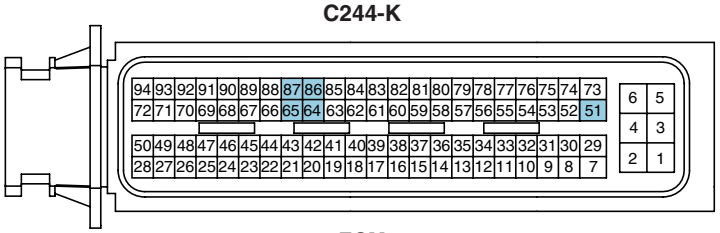
C223

LAMBDA SENSOR

C244-A



C244-K



ECM

STGFL7163L

SIGNAL WAVEFORM

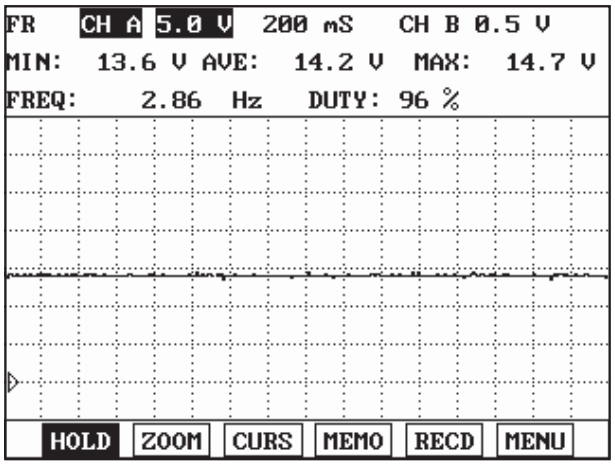


Fig.1

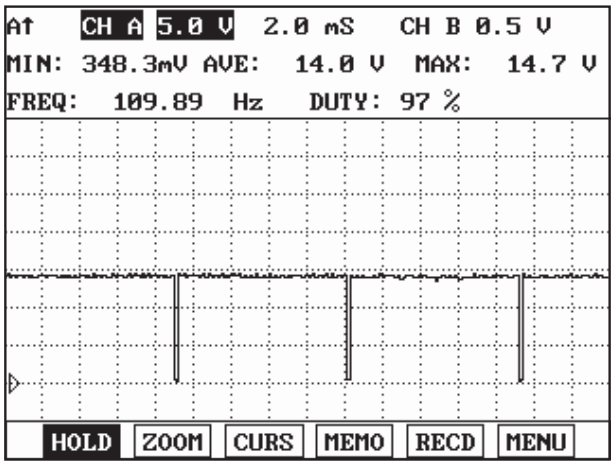


Fig.2

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

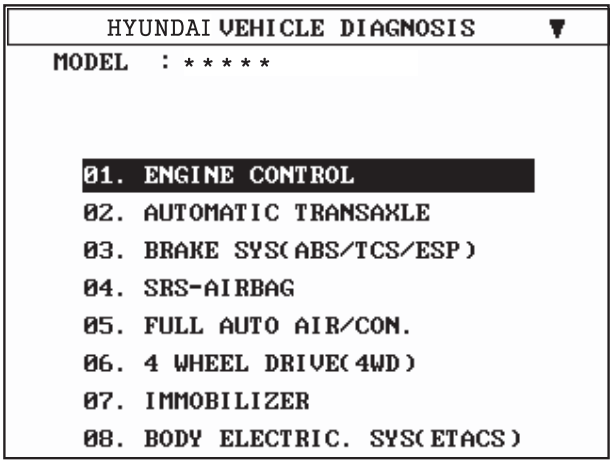
LFIG200A

REPLACEMENT E942EEFD

NOTE

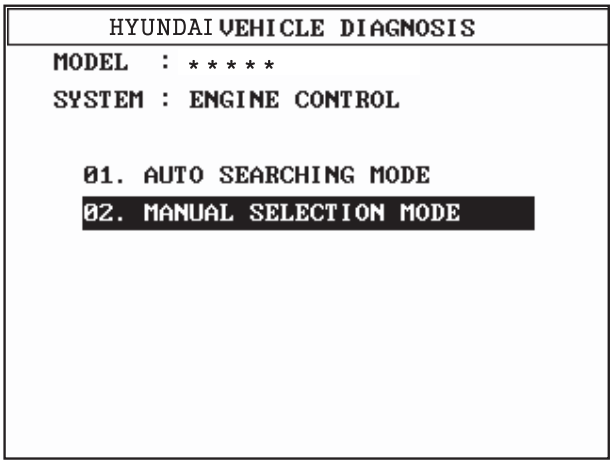
After replacing a Lambda Sensor, MUST proceed below procedure.

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



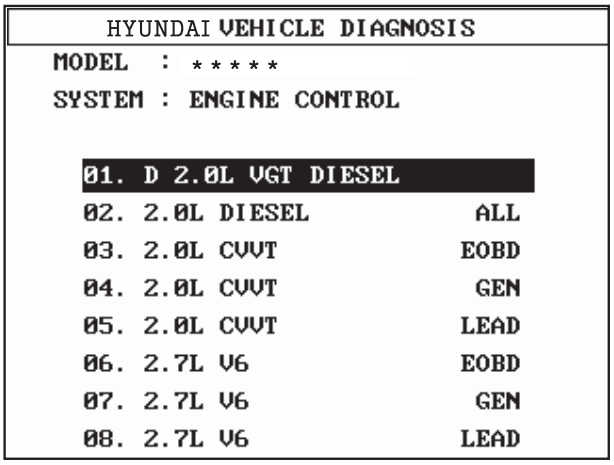
STGFL7115L

5. Select "MANUAL SELECTION MODE".



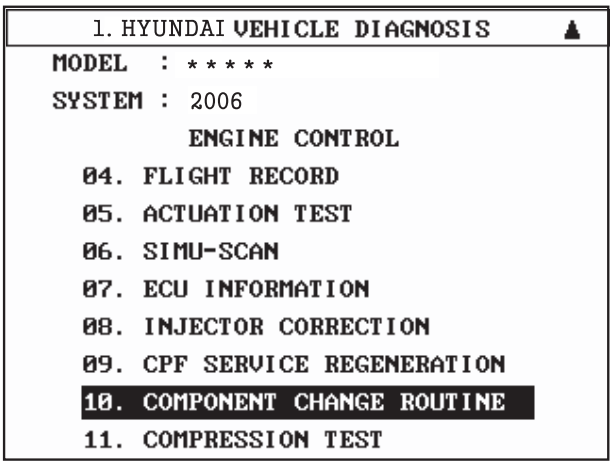
STGFL7116L

6. Select "D 2.0L VGT DIESEL".



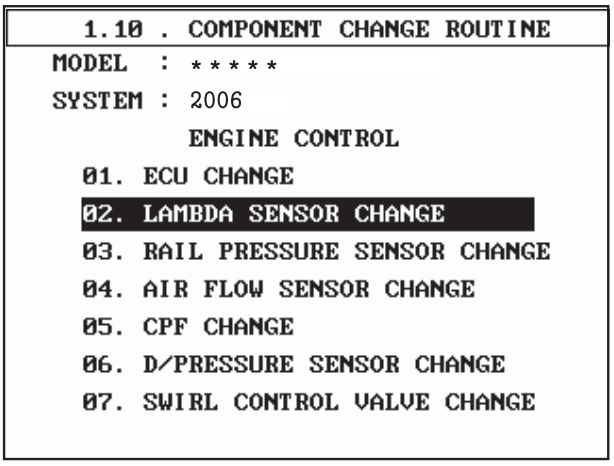
STGFL7117L

7. Select "COMPONET CHANGE ROUTNE"



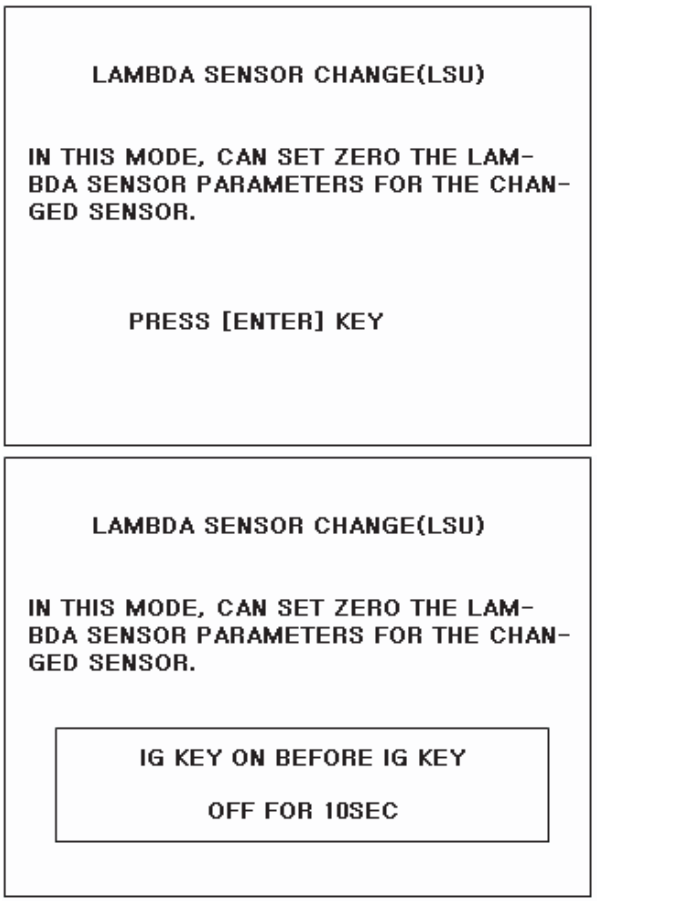
STGFL7118L

8. Select "LAMBDA SENSOR CHANGE".



STGFL7124L

9. Press "ENTER" key.



LFIG125A

10. Wait 10 seconds with IG ON.

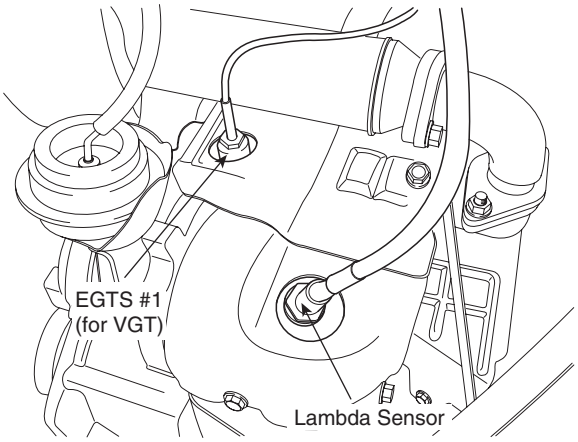
11. Turn ignition switch off.

EXHAUST GAS TEMPERATURE SENSOR (EGTS) FOR VGT

INSPECTION E534FCC0

FUNCTION AND OPERATION PRINCIPLE

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



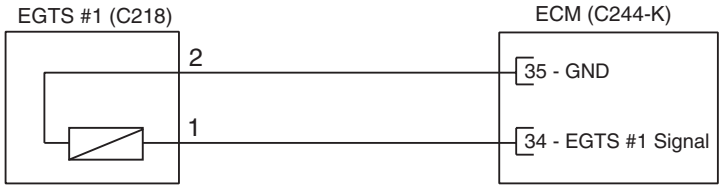
LFIG009A

SPECIFICATION

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

CIRCUIT DIAGRAM

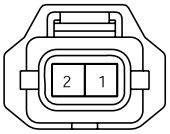
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-K (34)	EGTS #1 Signal
2	ECM C244-K (35)	Sensor ground

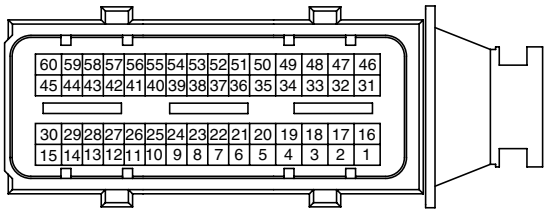
[HARNESS CONNECTORS]



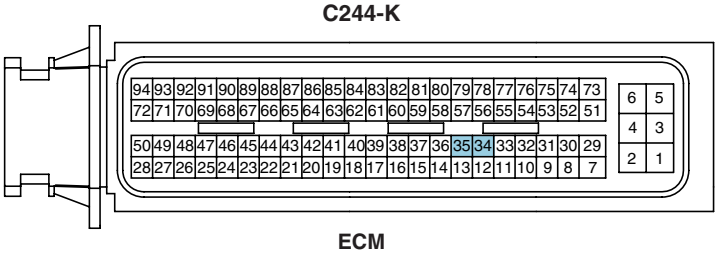
C218

EGTS #1

C244-A



C244-K



ECM

STGFL7164L

SIGNAL WAVEFORM

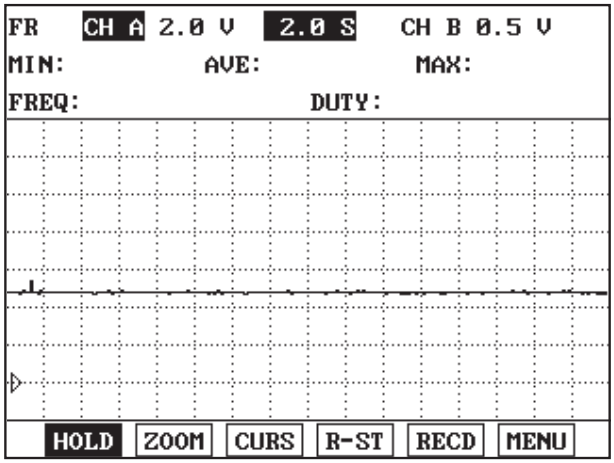


Fig.1

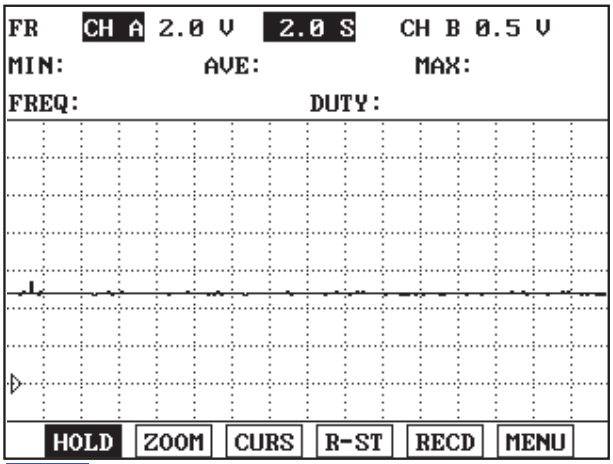


Fig.2

Fig.1) 4.8V is outputted at EGTS(T3-VGT) output signal circuit at IG KEY ON.
Fig.1) 4.8V is outputted at EGTS(T5-CPF) output signal circuit at IG KEY ON.

LFIG448A

COMPONENT INSPECTION

1. Turn ignition switch OFF.
2. Disconnect the exhaust gas temperature sensor #1 connector.
3. Measure resistance between sensor signal terminal and ground terminal.

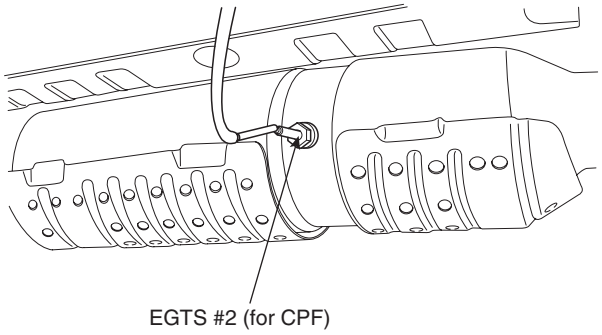
Specification: Refer to "SPECIFICATION".

EXHAUST GAS TEMPERATURE SENSOR (EGTS) FOR CPF

INSPECTION E9F3717C

FUNCTION AND OPERATION PRINCIPLE

Exhaust Gas Temperature Sensor (EGTS) #2 for CPF is installed on Catalyzed Particulate Filter (CPF) assembly and senses the temperature of exhaust gas flowing into the CPF.
When pre-determined engine condition is set, ECM burns soot gathered in CPF with exhaust gas. At this time, the exhaust gas temperature is an important factor of engine condition.



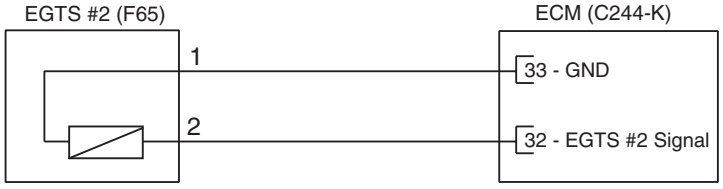
LFIG016A

SPECIFICATION

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

CIRCUIT DIAGRAM

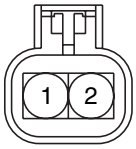
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

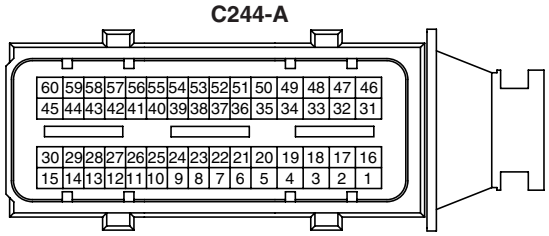
Terminal	Connected to	Function
1	ECM C244-K (33)	Sensor ground
2	ECM C244-K (32)	EGTS #2 Signal

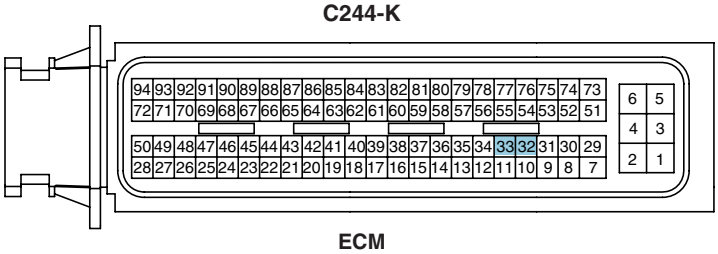
[HARNESS CONNECTORS]



F65

EGTS #2





ECM

STGFL7166L

SIGNAL WAVEFORM

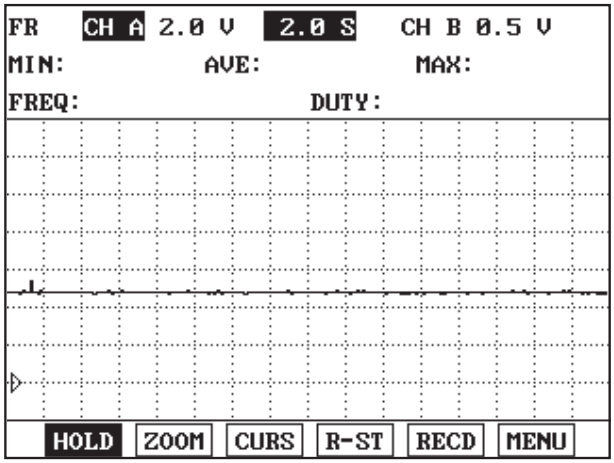


Fig.1

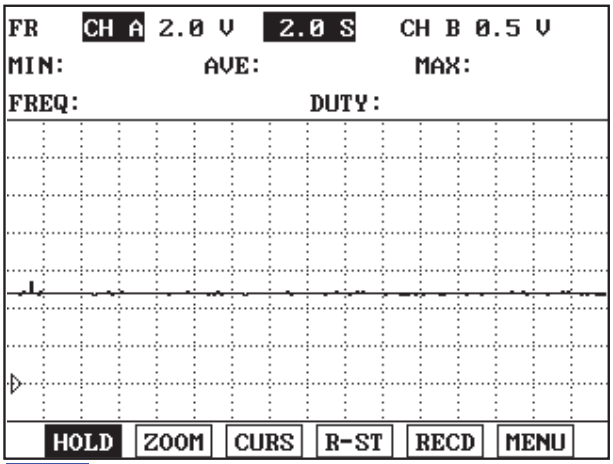


Fig.2

Fig.1) 4.8V is outputted at EGTS(T3-VGT) output signal circuit at IG KEY ON.
Fig.1) 4.8V is outputted at EGTS(T5-CPF) output signal circuit at IG KEY ON.

LFIG448A

COMPONENT INSPECTION

1. Turn ignition switch OFF.
2. Disconnect the exhaust gas temperature sensor #2 connector.
3. Measure resistance between sensor signal terminal and ground terminal.

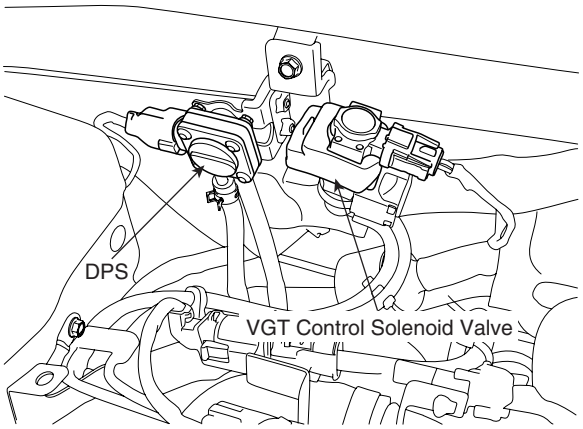
Specification: Refer to "SPECIFICATION".

DIFFERENTIAL PRESSURE SENSOR (DPS)

INSPECTION ED4351A6

FUNCTION AND OPERATION PRINCIPLE

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



SNFFL6103L

SPECIFICATION

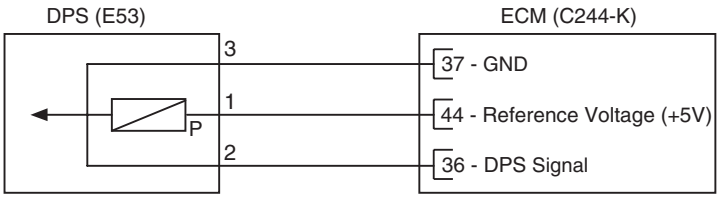
Differential Pressure[△P] (kPa)	Output Voltage (V)
0	1.00
10	1.35
20	1.70
30	2.05
40	2.40
50	2.75

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

LFIG068A

CIRCUIT DIAGRAM

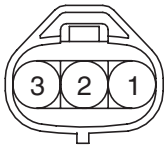
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

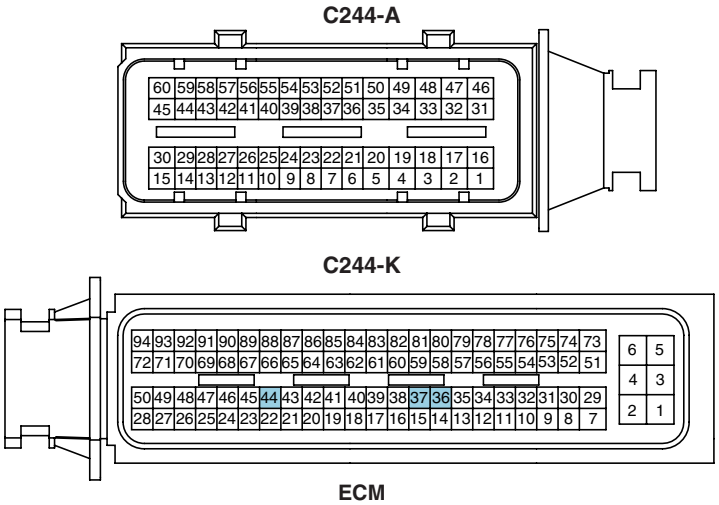
Terminal	Connected to	Function
1	ECM C244-K (44)	Reference Voltage (+5V)
2	ECM C244-K (36)	DPS Signal
3	ECM C244-K (37)	Sensor ground

[HARNESS CONNECTORS]



E53

DPS



STGFL7169L

SIGNAL WAVEFORM

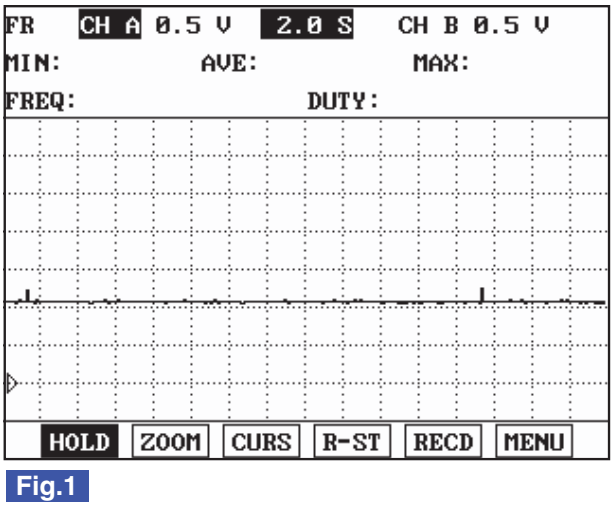


Fig.1

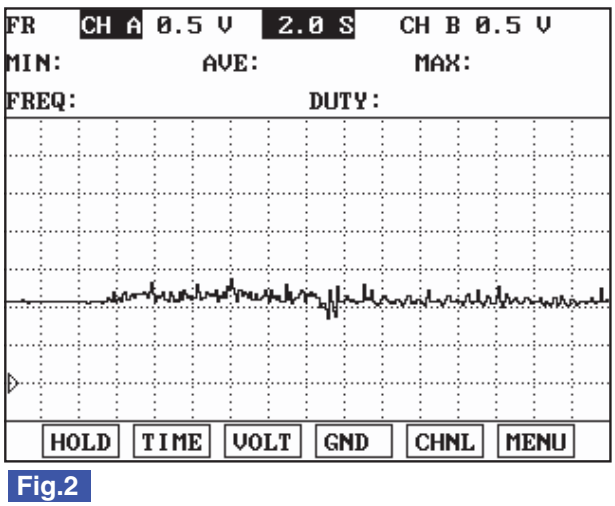


Fig.2

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

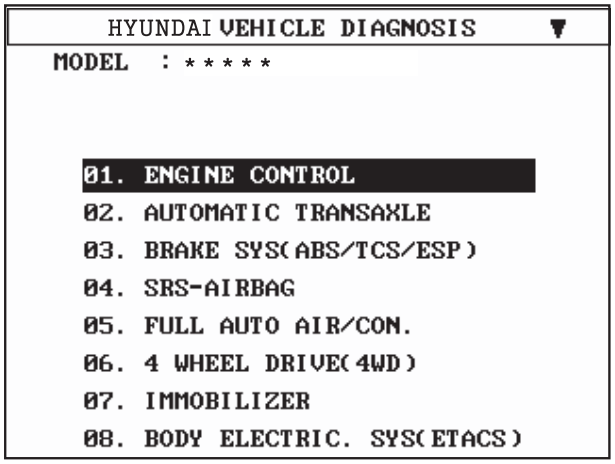
LFIG423A

REPLACEMENT EA34C2C0

NOTE

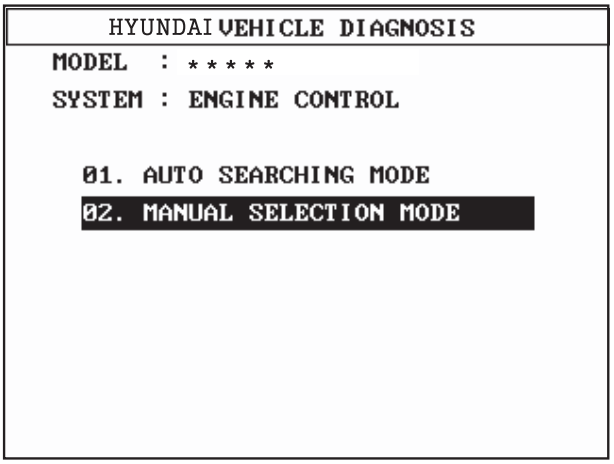
After replacing a Differential Pressure Sensor (DPS), MUST proceed below procedure.

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



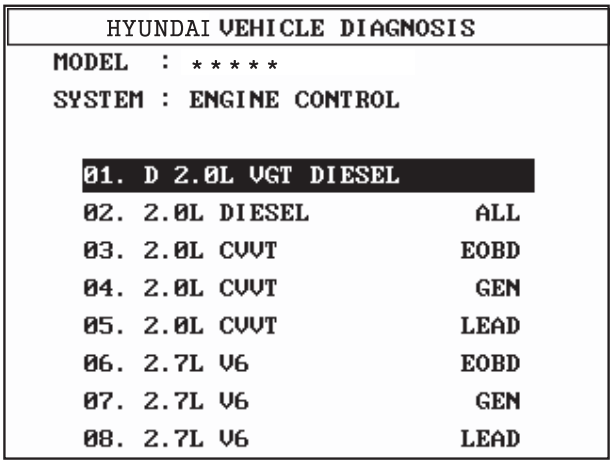
STGFL7115L

5. Select "MANUAL SELECTION MODE".



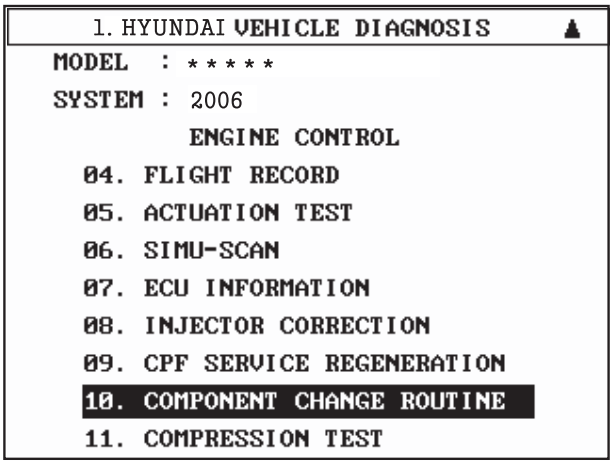
STGFL7116L

6. Select "D 2.0L VGT DIESEL".



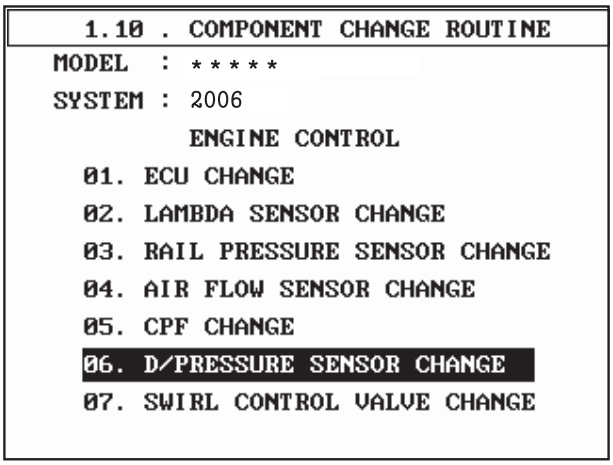
STGFL7117L

7. Select "COMPONET CHANGE ROUTNE"



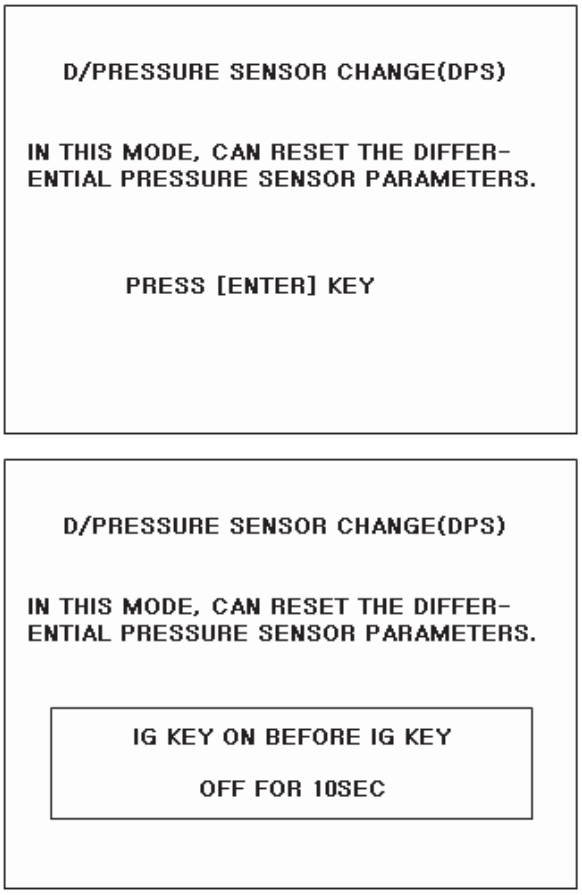
STGFL7118L

8. Select "D/PRESSURE SENSOR CHANGE".



STGFL7136L

9. Press "ENTER" key.



LFIG131A

10. Wait 10 seconds with IG ON.

11. Turn ignition switch off.

CATALYZED PARTICULATE FILTER (CPF)

DESCRIPTION EF62DCBB

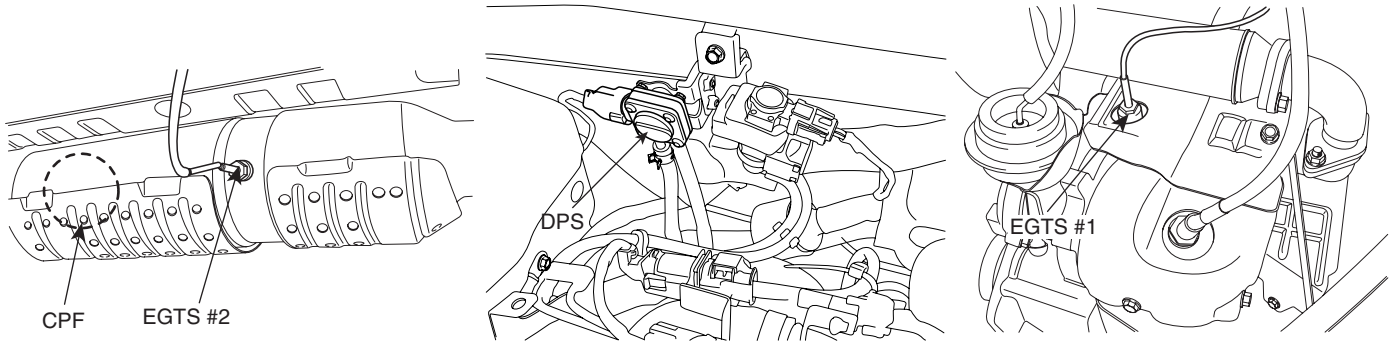
The Catalyzed Particulate Filter (CPF) system prevents Particulate Matter (PM) from being discharged to the atmosphere and consists of a filter assembly, two Exhaust Gas Temperature Sensor (EGTS) and a Differential Pressure Sensor (DPS).The filter is integrated in the catalytic converter assembly and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

[CPF REGENERATION]

If there are much soot in the CPF, the CPF must be regenerated. ECM can calculate amount of the soot by using the DPS signal, vehicle mileage or simulation data. If the ECM determines the CPF is need to regenerate, it will perform "Regeneration Procedure" when the vehicle condition is corresponded with the predetermined one (Regeneration Mode).
To burn the soot, the ECM injects additional fuel in the cylinders during exhaust stroke (two Post Injection) and increases the exhaust gas temperature to burning temperature of the soot (above 600℃). At this time, the soot are burn and its ash remains in the CPF as a result of the combustion.

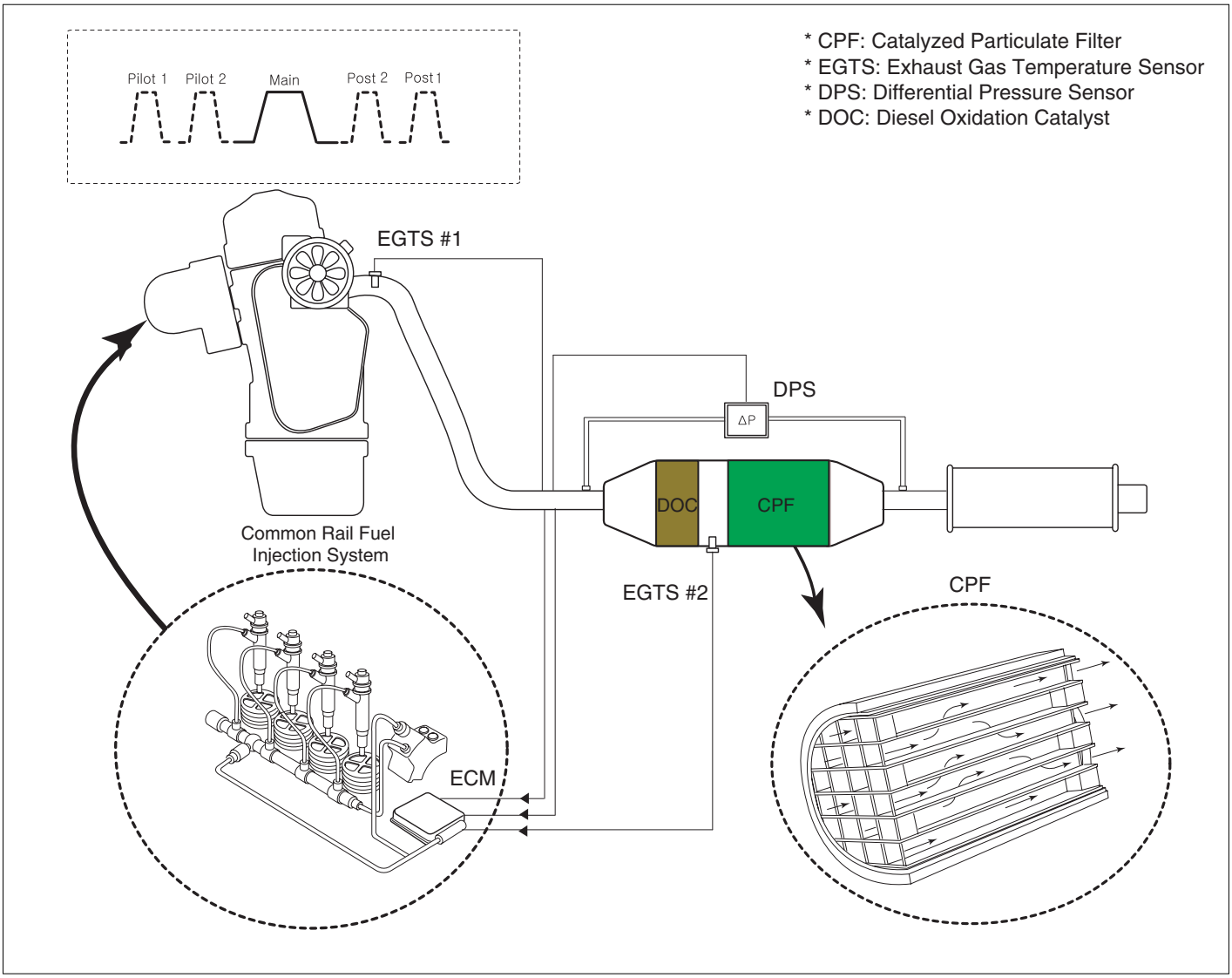
[REGENERATION MODE]

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

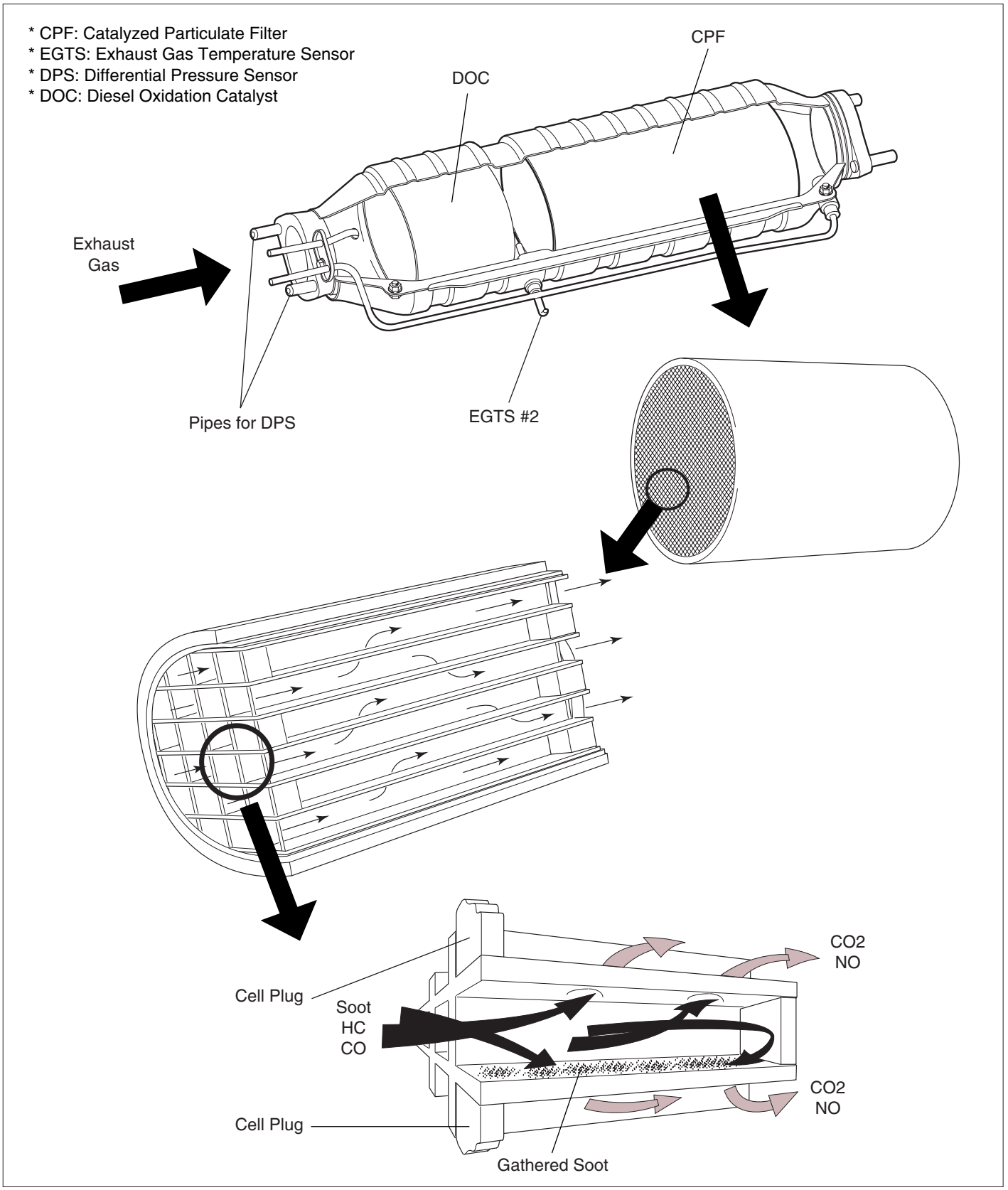


SNFFL6139D

SCHEMATIC DIAGRAM E299EBEC



LFIG116A


* CPF: Catalyzed Particulate Filter
* EGTS: Exhaust Gas Temperature Sensor
* DPS: Differential Pressure Sensor
* DOC: Diesel Oxidation Catalyst
CPF
DOC
Exhaust Gas
Pipes for DPS
EGTS #2
CO2
NO
Cell Plug
Soot
HC
CO
CO2
NO
Cell Plug
Gathered Soot

LFIG117A

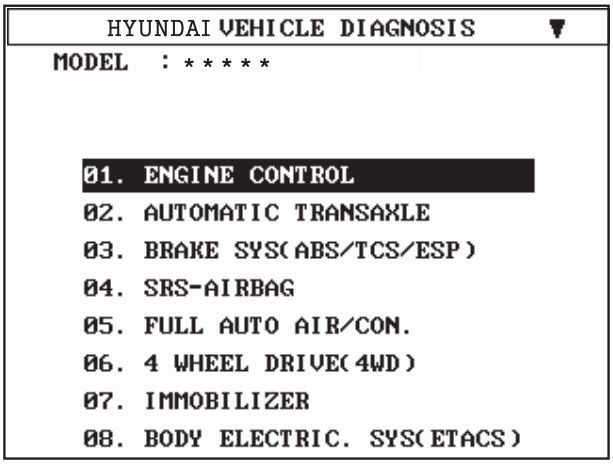
CPF REGENERATION EF0803FD

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

FORCIBLY REGENERATION CONDITION

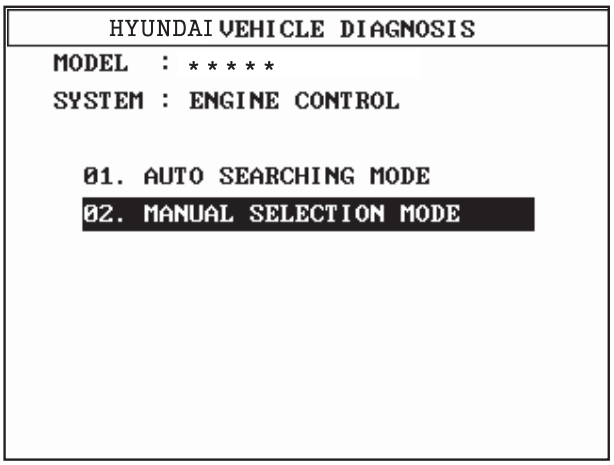
- Engine coolant temperature: about 70℃
- Engine at idle
- P-range (A/T) or Neutral (M/T)
- Normal battery voltage
- Electrical fully load (A/C ON if equipped, Blower ON with maximum speed, Head Lamp ON, Wiper ON, Other Lamps ON, etc.)

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



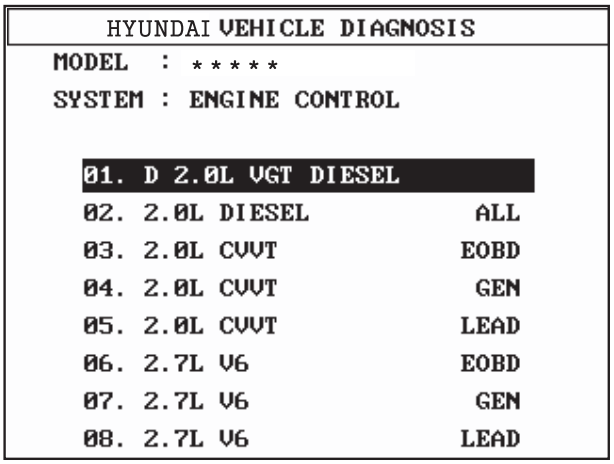
STGFL7115L

6. Select "MANUAL SELECTION MODE".



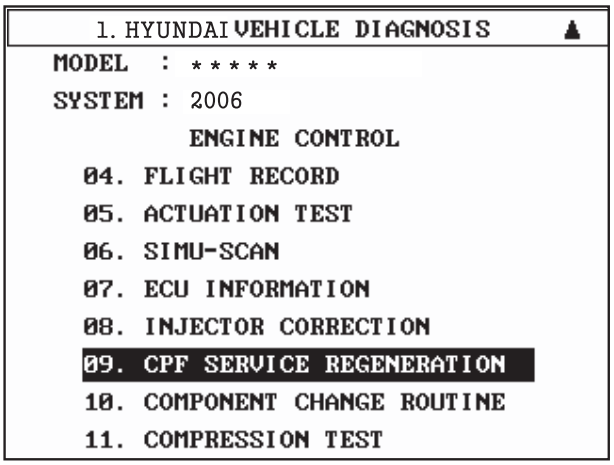
STGFL7116L

7. Select "D 2.0L VGT DIESEL".



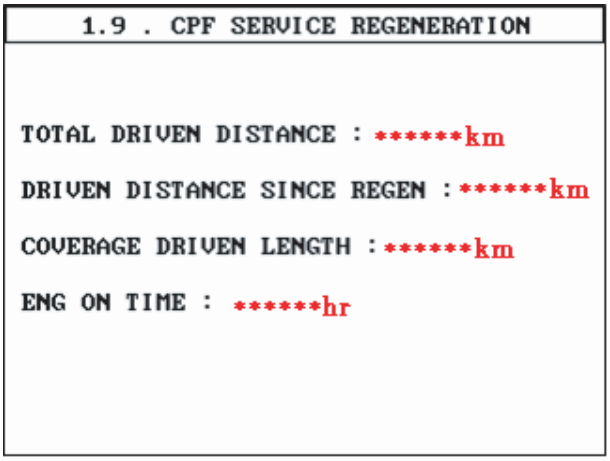
STGFL7117L

8. Select "CPF SERVICE REGENERATION".



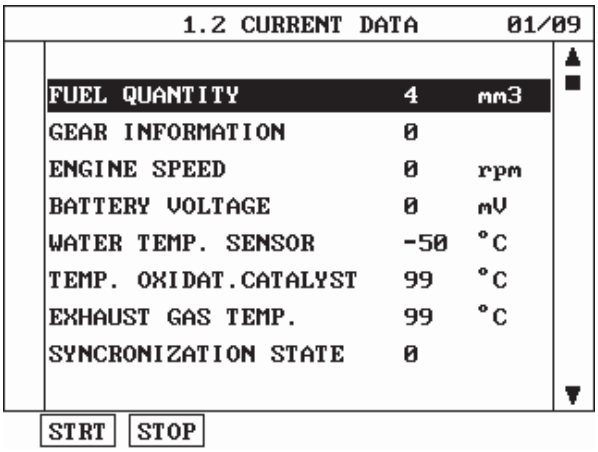
STGFL7138L

9. Press "ENTER" key after looking around data memorized in ECM.



LFIG119A

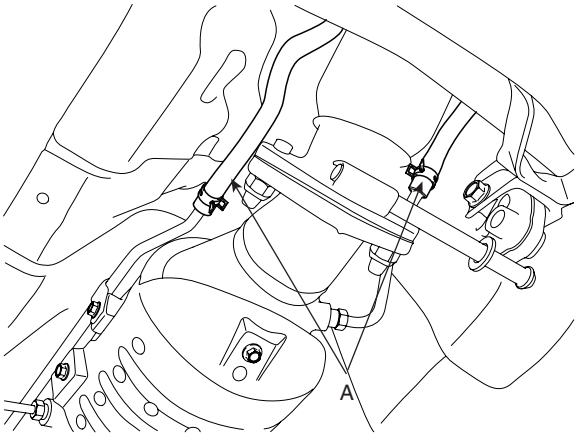
10. Press "STRT" key.



LFIG120A

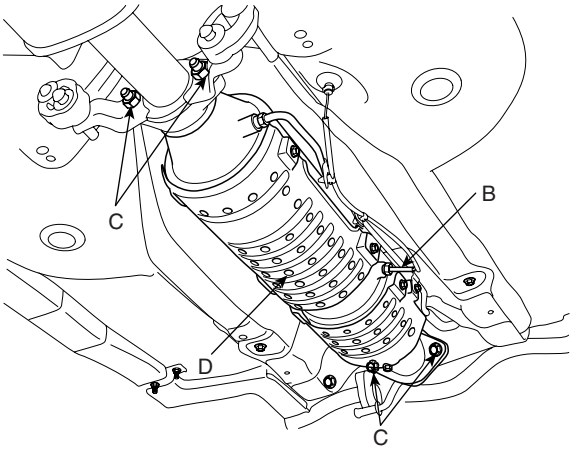
REMOVAL E1D92256

1. Turn ignition switch off.
2. Lift the vehicle and support the CPF assembly with a jack.
3. Disconnect the hoses (A) connected with Differential Pressure Sensor (DPS) from the CPF assembly.



SMGFL6735A

4. Disconnect the Exhaust Gas Temperature Sensor (EGTS) #2 connector (B).



SNFFL6141D

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

INSTALLATION E42FCB09

1. Installation is the reverse order of "REMOVAL" procedure.

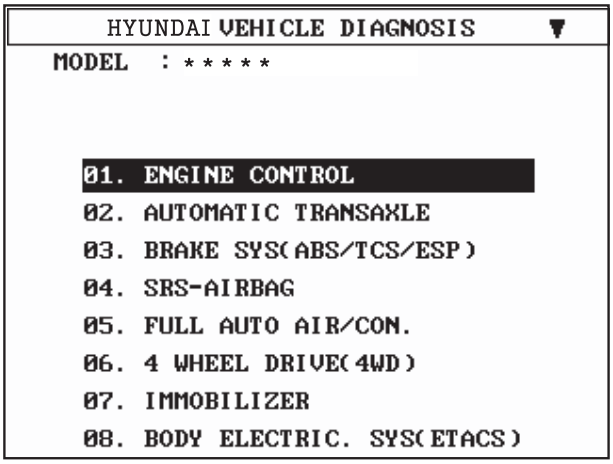
CPF Mounting Nuts: 39.2 ~ 58.9N·m (4.0 ~ 6.0 kgf·m, 28.9 ~ 43.4lbf·ft)

REPLACEMENT EA2A453A

NOTE

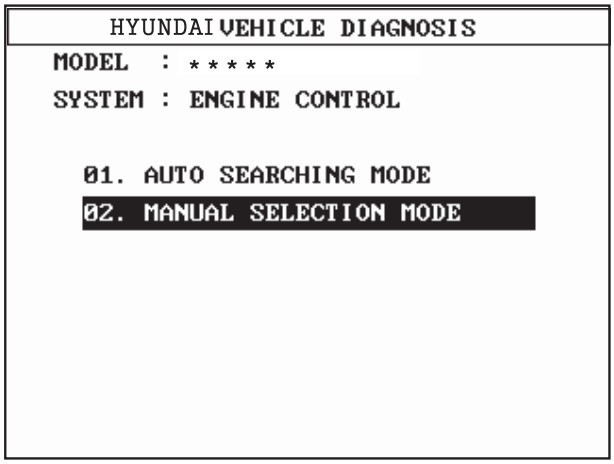
After replacing a CPF, MUST proceed below procedure.

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



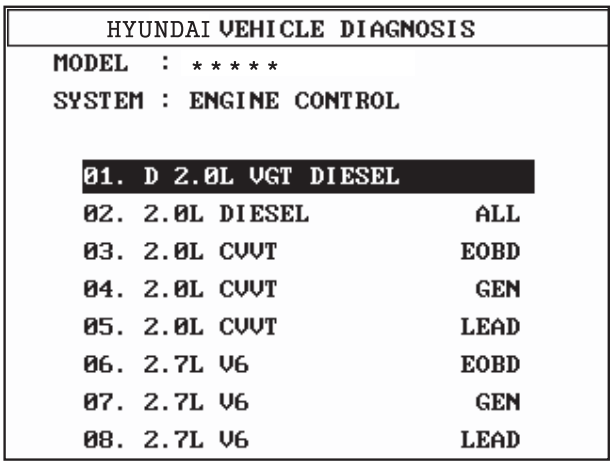
STGFL7115L

5. Select "MANUAL SELECTION MODE".



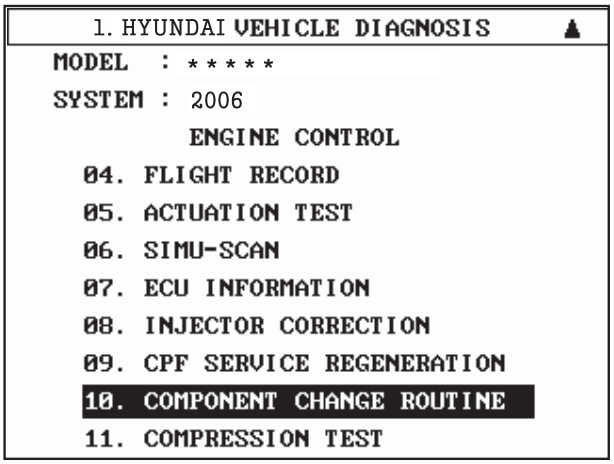
STGFL7116L

6. Select "D 2.0L VGT DIESEL".



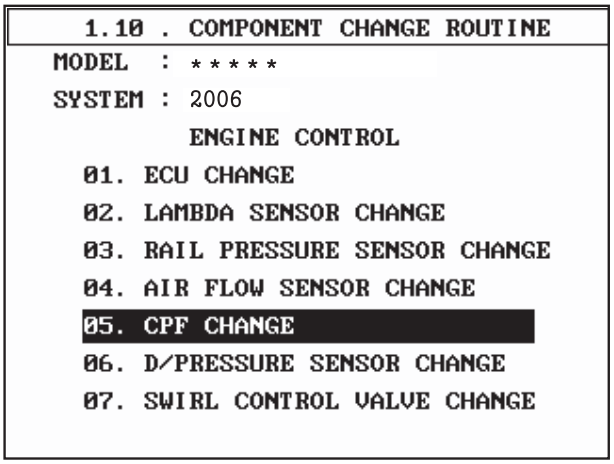
STGFL7117L

7. Select "COMPONET CHANGE ROUTNE"



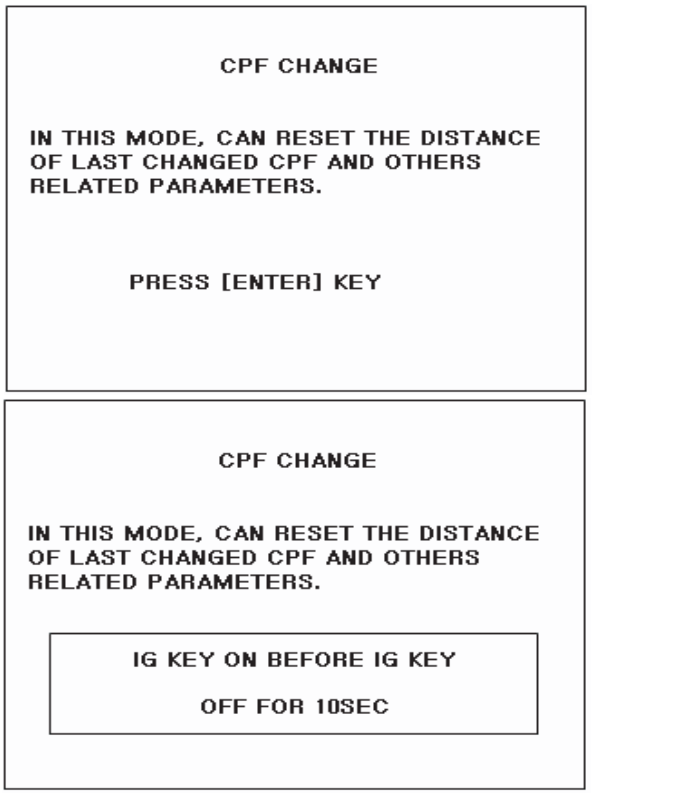
STGFL7118L

8. Select "CPF CHANGE".



STGFL7140L

9. Press "ENTER" key.



LFIG122A

10. Wait 10 seconds with IG ON.

11. Turn ignition switch off.

DTC TROUBLESHOOTING PROCEDURES

INSPECTION CHART FOR DIAGNOSTIC TROUBLE CODES (DTC) E6AE7104

DTC	DESCRIPTION	MIL	PAGE
P0031	Lambda Sensor Heater Circuit Low (Bank 1 / Sensor 1)	▲	FL-117
P0032	Lambda Sensor Heater Circuit High (Bank 1 / Sensor 1)	▲	FL-124
P0047	VGT Vacuum Modulator Circuit Low	●	FL-127
P0048	VGT Vacuum Modulator Circuit High	●	FL-134
P0069	Boost Pressure Sensor Circuit Malfunction	▲	FL-138
P0087	Rail Pressure Monitoring-Minimum Pressure at Engine Speed Too Low	●	FL-143
P0088	Rail Pressure Monitoring-Maximum Pressure Exceeded	●	FL-147
P0089	Rail Pressure Regulator Valve Circuit Over Current	●	FL-148
P0091	Rail Pressure Regulator Valve Circuit Low	●	FL-155
P0092	Rail Pressure Regulator Valve Circuit High	●	FL-159
P0097	Intake Air Temperature Sensor 2 Circuit Low Input	▲	FL-163
P0098	Intake Air Temperature Sensor 2 Circuit High Input	▲	FL-169
P0101	Mass or Volume Air Flow Circuit Range/Performance	●	FL-173
P0102	Mass or Volume Air Flow Circuit Low Input	●	FL-181
P0103	Mass or Volume Air Flow Circuit high Input	●	FL-185
P0107	Atmospheric Pressure Circuit Low Input	●	FL-189
P0108	Atmospheric Pressure Circuit High Input	●	FL-192
P0112	Intake Air Temperature Sensor 1 Circuit Low Input	▲	FL-194
P0113	Intake Air Temperature Sensor 1 Circuit High Input	▲	FL-199
P0116	Engine Coolant Temperature Circuit Range/Performance	●	FL-203
P0117	Engine Coolant Temperature Circuit Low Input	●	FL-208
P0118	Engine Coolant Temperature Circuit High Input	●	FL-211
P0182	Fuel Temperature Sensor A Circuit Low Input	▲	FL-215
P0183	Fuel Temperature Sensor A Circuit High Input	▲	FL-221
P0192	Fuel Rail Pressure Sensor Low input	●	FL-225
P0193	Fuel Rail Pressure Sensor High Input	●	FL-232
P0201	Cylinder 1-Injector Circuit/Open	●	FL-236
P0202	Cylinder 2-Injector Circuit/Open	●	FL-236
P0203	Cylinder 3-Injector Circuit/Open	●	FL-236

DTC	DESCRIPTION	MIL	PAGE
P0204	Cylinder 4-Injector Circuit/Open	●	FL-236
P0231	Electric Fuel Pump Relay-Open or Short Circuit	▲	FL-243
P0232	Electric Fuel Pump Relay-Short Circuit	▲	FL-250
P0234	Turbo/Super Charger Overboost Condition	●	FL-254
P0237	Boost Pressure Sensor Circuit Low Input	●	FL-259
P0238	Boost Pressure Sensor Circuit High Input	●	FL-266
P0252	Fuel Pressure Regulator Valve Circuit Over Current	●	FL-270
P0253	Fuel Pressure Regulator Valve Circuit Low	●	FL-276
P0254	Fuel Pressure Regulator Valve Circuit High	●	FL-280
P0262	Cylinder 1-Injector Circuit High	●	FL-284
P0265	Cylinder 2-Injector Circuit High	●	FL-284
P0268	Cylinder 3-Injector Circuit High	●	FL-284
P0271	Cylinder 4-Injector Circuit High	●	FL-284
P0299	Turbo/Super Charger Underboost Condition	●	FL-291
P0335	Crankshaft Position Sensor A Circuit	●	FL-296
P0336	Crankshaft Position Sensor A Circuit Range/Performance	●	FL-304
P0340	Camshaft Position Sensor A Circuit Malfunction (Bank 1 or Single Sensor)	●	FL-309
P0341	Camshaft Position Sensor A Circuit Range/Performance (Bank 1 or Single Sensor)	●	FL-316
P0381	Glow Indicator Lamp Circuit Malfunction	▲	FL-320
P0401	Exhaust Gas Recirculation Flow Insufficient Detected	●	FL-325
P0471	Exhaust Pressure Sensor "A" Circuit Range/Performance	●	FL-332
P0472	Exhaust Differential Pressure Sensor Circuit Malfunction - High Input	■	FL-340
P0473	Exhaust Gas Differential Pressure Sensor High	■	FL-343
P0489	Exhaust Gas Recirculation Control Circuit Low Voltage	●	FL-348
P0490	Exhaust Gas Recirculation Control Circuit High Voltage	●	FL-355
P0501	Vehicle Speed Sensor A Range/Performance	▲	FL-358
P0504	Brake Pedal Position A/B Correlation	▲	FL-364
P0532	A/C Refrigerant Pressure Sensor "A" Circuit Low Input	▲	FL-370
P0533	A/C Refrigerant Pressure Sensor "A" Circuit High Input	▲	FL-377
P0545	Exhaust Gas Temperature Sensor Circuit Low (Bank 1 / Sensor 1)	▲	FL-381
P0546	Exhaust Gas Temperature Sensor Circuit High (Bank 1 / Sensor 1)	▲	FL-388
P0562	System Voltage Low	▲	FL-392
P0563	System Voltage High	▲	FL-398

DTC	DESCRIPTION	MIL	PAGE
P0602	EEPROM-Programming Error	▲	FL-402
P0605	Internal Control Module Read Only Memory(ROM) Error	▲	FL-404
P0606	ECM/PCM Processor(ECM-SELF TEST Failed)	●	FL-406
P0611	Injector Circuit Malfunction (More than two injectors)	●	FL-409
P062D	Voltage Regulator #1 for Injector Malfunction	●	FL-415
P062E	Voltage Regulator #2 for Injector Malfunction	●	FL-420
P0642	Sensor Reference Voltage "A" Circuit Low	▲	FL-422
P0643	Sensor Reference Voltage "A" Circuit High	▲	FL-428
P0646	A/C Clutch Relay Control Circuit Low	▲	FL-431
P0647	A/C Clutch Relay Control Circuit High	▲	FL-438
P0650	Malfunction Indicator Lamp (MIL) Control Circuit	▲	FL-442
P0652	Sensor Reference Voltage "B" Circuit Low	●/▲	FL-446
P0653	Sensor Reference Voltage "B" Circuit High	●/▲	FL-454
P0670	Glow Relay Circuit Malfunction	▲	FL-457
P0685	ECM/PCM Power Relay Control Circuit /Open	▲	FL-464
P0698	Sensor Reference Voltage "C" Circuit Low	▲	FL-472
P0699	Sensor Reference Voltage "C" Circuit High	▲	FL-480
P1145	Overrun monitoring error	▲	FL-483
P1171	Minimum Rail Pressure Exceeded	▲	FL-485
P1172	Maximum Rail Pressure Exceeded	▲	FL-489
P1185	Fuel Pressure Monitoring-Maximum Pressure Exceeded	●	FL-490
P1186	Fuel Pressure Monitoring-Minimum Pressure at Engine Speed Too Low	●	FL-494
P1403	Differential Pressure not plausible (Hose Line Frozen)	▲	FL-495
P1405	CPF - Permanent Regeneration	■	FL-503
P1406	Exhaust Gas Temperature Not Plausible Between Calculated And Simulated	▲	FL-510
P1407	Plausibility Of Temperature Calculated And Simulated Upstream Of Particulate Filter	■	FL-517
P1634	Auxiliary Heater Malfunction	▲	FL-522
P1652	Ignition Switch Circuit Malfunction	▲	FL-530
P1670	Injector Specific Data Error	■	FL-534
P1671	Check-Sum Error	■	FL-536
P1815	ESP/FTCS Auto Recognition Signal Circuit Malfunction	▲	FL-538
P2002	Particulate Trap Efficiency Below Threshold	■	FL-542
P2009	Intake Manifold Runner Control Circuit Low (Bank 1)	▲	FL-549

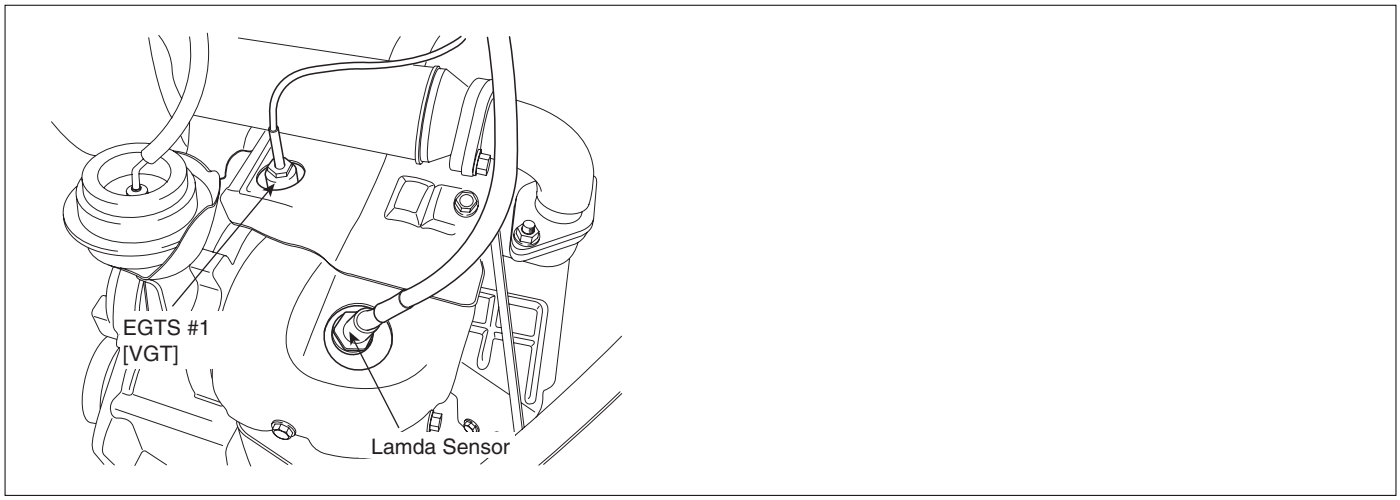
DTC	DESCRIPTION	MIL	PAGE
P2010	Intake Manifold Runner Control Circuit High (Bank 1)	▲	FL-556
P2015	Intake Manifold Runner Position Sensor/Switch Circuit Range/Performance (Bank 1)	●/▲	FL-560
P2016	Intake Manifold Runner Position Sensor/Switch Circuit Low (Bank 1)	▲	FL-567
P2017	Intake Manifold Runner Position Sensor/Switch Circuit High (Bank 1)	▲	FL-571
P2030	Exhaust Temperature Value Not Plausible With Sensor 1 And 2	▲	FL-575
P2032	Exhaust Gas Temperature Sensor Circuit Low (Bank 1 / Sensor 2)	■	FL-581
P2033	Exhaust Gas Temperature Sensor Circuit High (Bank 1 / Sensor 2)	■	FL-587
P2034	Exhaust Gas Temperature Sensor Performance (Sensor 2)-CPF	●	FL-593
P2080	Exhaust Gas Temperature Sensor Performance (Sensor 1)-VGT	▲	FL-597
P2111	Throttle Control Actuator Circuit High	●	FL-604
P2112	Throttle Control Actuator Circuit Low	●	FL-611
P2113	Throttle/Pedal Position Sensor "B" Minimum Stop Performance	▲	FL-616
P2123	Throttle/Pedal Position Sensor/Switch "D" Circuit High Input	●	FL-620
P2128	Throttle/Pedal Position Sensor/Switch "E" Circuit High Input	●	FL-627
P2138	Throttle/Pedal Position Sensor/Switch "D" / "E" Voltage Correlation	●	FL-631
P2238	Lambda Sensor Pumping Current Circuit Low (Bank 1 / Sensor 1)	▲	FL-636
P2239	Lambda Sensor Pumping Current Circuit High (Bank 1 / Sensor 1)	▲	FL-645
P2251	Lambda Sensor Reference Ground Circuit/Open (Bank 1 / Sensor 1)	▲	FL-651
P2264	Detection of Water in fuel	▲	FL-657
P2299	Brake Pedal Position / Accelerator Pedal Position Incompatible	▲	FL-663
U0001	CAN Communication Malfunction	▲	FL-672
U0100	CAN MI-COM of Circuit MAL	▲	FL-679
U0101	Serial Communication Problem ith TCU (TIME OUT)	▲	FL-683
U0122	ECM-TCS CAN error	▲	FL-687
U0416	Abnormal Torque Rise Request rom TCS	▲	FL-694

NOTE

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

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

COMPONENT LOCATION EDF66116



SNFFL6238L

GENERAL DESCRIPTION E70CBB46

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($1.0<\lambda<1.1$) : 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($0.9<\lambda<1.0$) : 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℃~600℃) 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 ED73F202

P0031 is set when open or short to ground in Lambda sensor control circuit is detected for more than 5 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 E1F36303

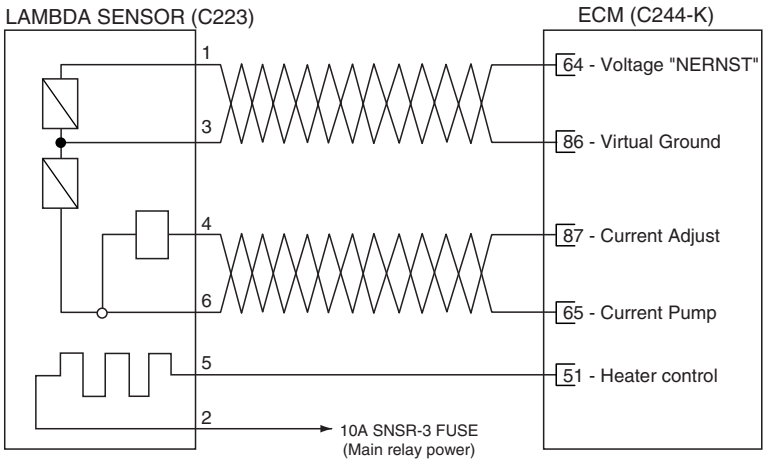
Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Lambda sensor heater circuit • Lambda sensor component
Enable Conditions	• Engine running			
Threshold Value	• Short to GND in Lambda sensor heater control circuit • Open in Lambda sensor heater control circuit			
Diagnostic Time	• 5 sec.			
Fail Safe	Fuel cut	NO		
	EGR Off	NO		
	Fuel Limit	NO		
	Check Lamp	NO		

SPECIFICATION E07043B4

Temperature (℃)	Heater resistance (Ω)	Temperature (℃)	Heater resistance (Ω)	Heater Operation Frequency
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 E9D7AEE6

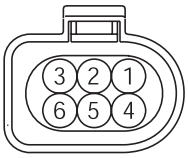
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-K (64)	Voltage "NERNST"
2	10A SNSR-3 FUSE	Main relay power
3	ECM C244-K (86)	Virtual Ground
4	ECM C244-K (87)	Current Adjust
5	ECM C244-K (51)	Heater control
6	ECM C244-K (65)	Current Pump

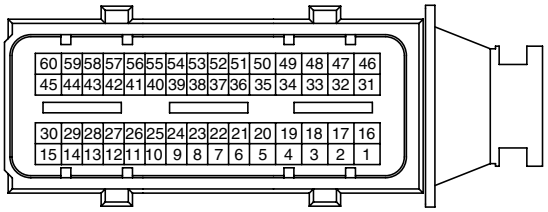
[HARNESS CONNECTORS]



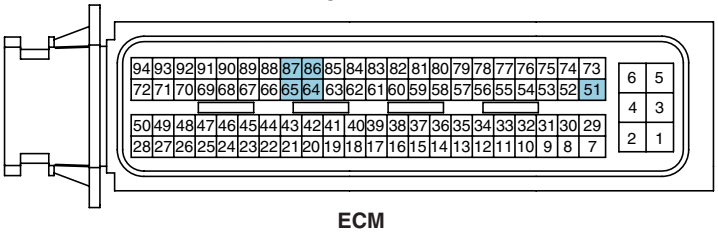
C223

LAMBDA SENSOR

C244-A



C244-K



ECM

STGFL7163L

SIGNAL WAVEFORM AND DATA EB4E9A92

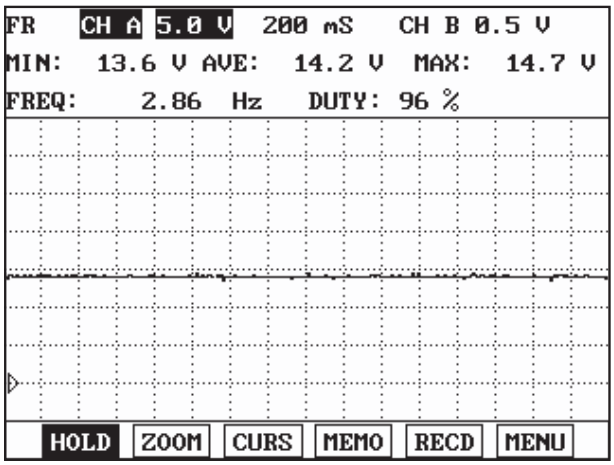


Fig.1

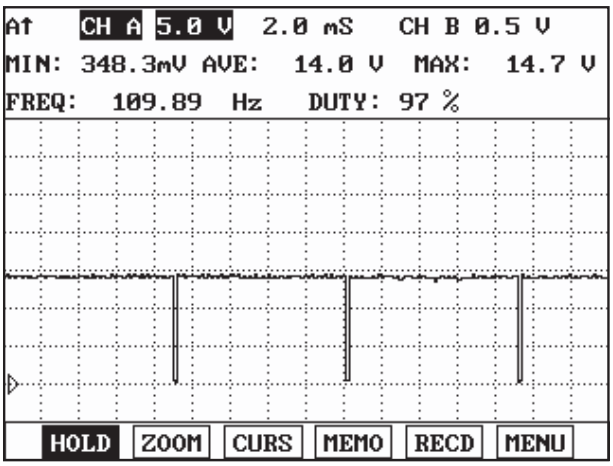


Fig.2

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

LFIG200A

TERMINAL AND CONNECTOR INSPECTION EBC44864

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 EF57A4DA

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 10A SNSR3 FUSE and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION E9663452

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 (C244-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".

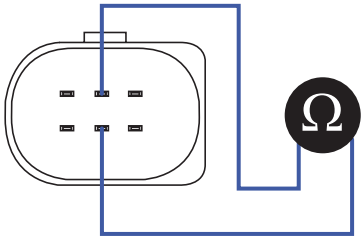
COMPONENT INSPECTION E6AD2C3E

1. Check Lambda sensor component heater coil resistance

   1) IG KEY "OFF", ENGINE "OFF".

   2) Disconnect Lambda sensor connector.

   3) Check continuity between Lambda sensor component connector 2 and 5.



KFQG304A

Specification : approx. 4.8Ω at room temperature

   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 EC9EA5C0

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 EB031684

Refer to DTC P0031.

GENERAL DESCRIPTION E2730D60

Refer to DTC P0031.

DTC DESCRIPTION EEEACA7F

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 E98F6F07

<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>Threshold Value</td><td colspan="3">• Short to battery in Lambda sensor heater control circuit</td></tr>
<tr><td>Diagnostic Time</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>Check Lamp</td><td>NO</td></tr>
</table>

SPECIFICATION EC84CE40

Temperature (℃)	Heater resistance (Ω)	Temperature (℃)	Heater resistance (Ω)	Heater Operation Frequency
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 EFFE906A

Refer to DTC P0031.

SIGNAL WAVEFORM AND DATA EEF51153

Refer to DTC P0031.

TERMINAL AND CONNECTOR INSPECTION EC7046CE

Refer to DTC P0031.

POWER CIRCUIT INSPECTION EED2D9D4

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 10A SNSR3 FUSE and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION E0869C09

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 (C244-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".

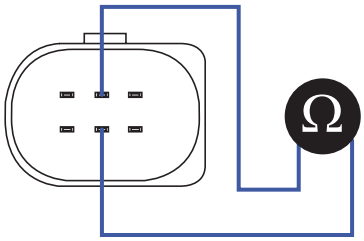
COMPONENT INSPECTION E01EFEF2

1. Check Lambda sensor component heater coil resistance

1) IG KEY "OFF", ENGINE "OFF".

2) Disconnect Lambda sensor connector.

3) Check continuity between Lambda sensor component connector 2 and 5.



KFQG304A

Specification : approx. 4.8Ω at room temperature

4) Is the measured resistance within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

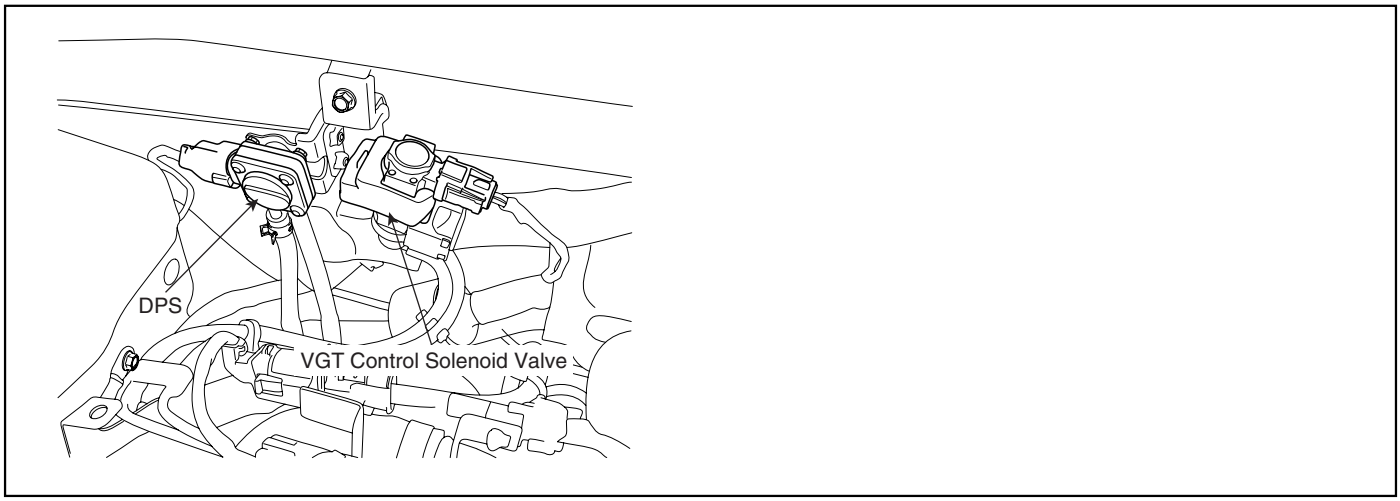
▶ Replace Lambda sensor and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E79FDA31

Refer to DTC P0031.

DTC P0047 VGT VACUUM MODULATOR CIRCUIT LOW

COMPONENT LOCATION E2D3F84E



SNFFL6200L

GENERAL DESCRIPTION E88C451B

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 information is 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 EBA784B6

P0047 is set when "0"A is detected in VGT actuator control circuit for more than 1 sec.. This code is due to open or short to ground in VGT actuator circuit, or open in VGT actuator component.

DTC DETECTING CONDITION E1B0BA6B

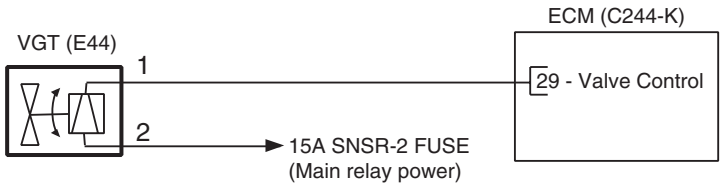
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Signal monitoring</td><td rowspan="6">• VGT actuator circuit
• VGT actuator component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• short to GND, wiring open</td></tr>
<tr><td>Diagnostic Time</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>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION E71947EC

VGT actuator component resistance	VGT actuator operating Hz	VGT actuator operating duty
14.7 ~ 16.1Ω (20℃)	300Hz	76% at idle, decreases as accelerating

SCHEMATIC DIAGRAM E4100B80

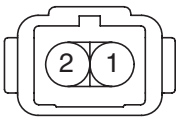
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-K (29)	Valve Control
2	JE02 (46)	Main relay power

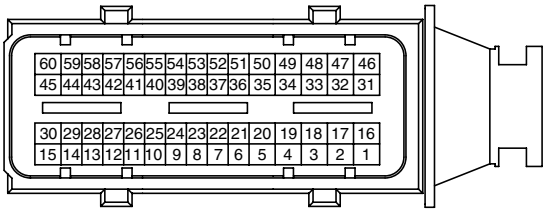
[HARNESS CONNECTORS]



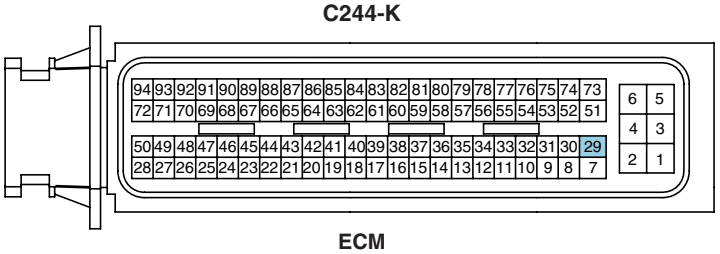
E44

VGT CONTROL SOLENOID VALVE

C244-A



C244-K



ECM

STGFL7161L

SIGNAL WAVEFORM AND DATA E7E746AD

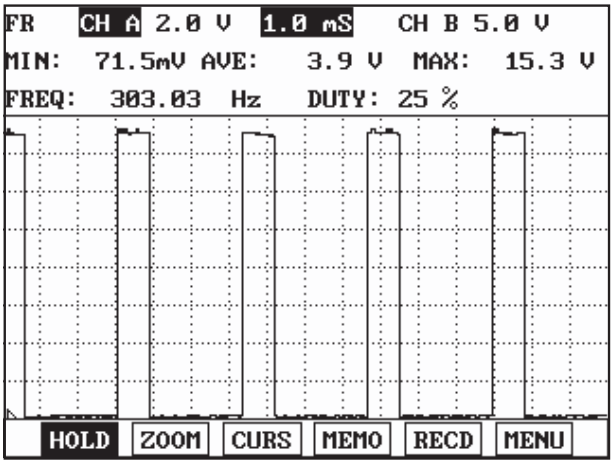


Fig.1

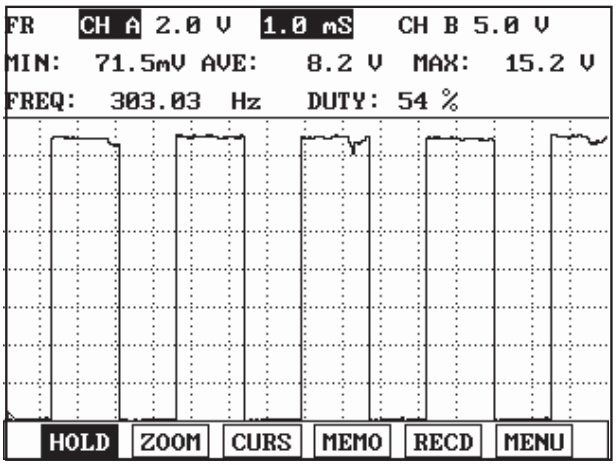


Fig.2

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

LFIG369A

MONITOR SCANTOOL DATA E215F141

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 : approx. 76%) at idle

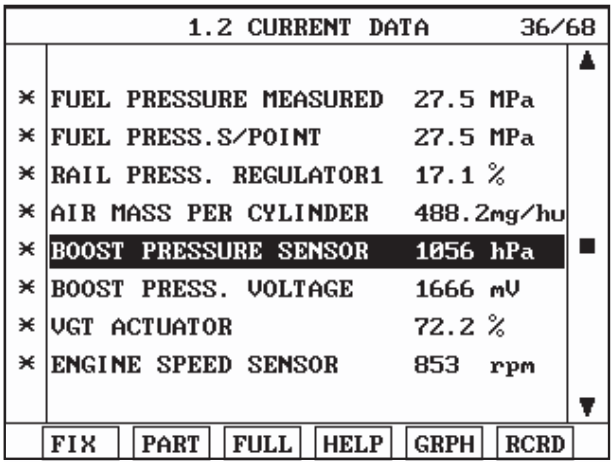


Fig.1

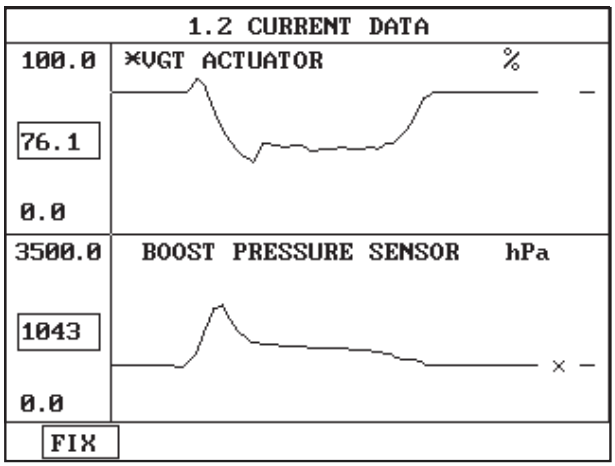


Fig.2

Fig1) Monitor "BOOST PRESSURE SENSOR" parameter on the Scantool at idle after warming engine up.
1000hpa ± 100hpa(approx. 1 atm) is correct value.
Fig.2) VGT actuator duty and boost pressure atacceleration is shown . If boost pressure rises and reaches certain value,
VGT actuator duty stops to drop and keeps steady. Releasing accelerator pedal at this moment,
VGT actuator duty drops to approx. 45%, then if RPM drops to idle range, duty returns to 76%.

STGFL7605L

TERMINAL AND CONNECTOR INSPECTION EE9A6CFC

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 EBFD3161

1. Check power circuit voltage
   1) IG KEY "OFF", ENGINE "OFF"
   2) Disconnect VGT actuator connector
   3) IG KEY "ON"
   4) Measure the voltage of terminal 2 of VGT actuator.

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 E9151062

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 terminal 1 of VGT actuator.

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 1 and ECM connector(C244-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".

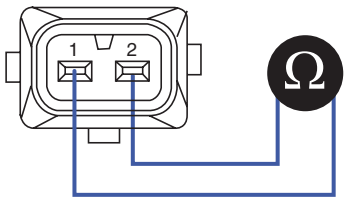
COMPONENT INSPECTION E31AC33D

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 2.



SNFFL6316D

Specification : 14.7 ~ 16.1Ω (20℃)

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 76% 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 (Vacuum must not generates, correct VGT actuator operating duty is 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 EB7E5E85

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 E31DDD68

Refer to DTC P0047.

GENERAL DESCRIPTION EA6F0477

Refer to DTC P0047.

DTC DESCRIPTION E1025927

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 EBDE4E4B

<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>Threshold Value</td><td colspan="3">• Short to battery</td></tr>
<tr><td>Diagnostic Time</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>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION E44EFFDF

VGT actuator component resistance	VGT actuator operating Hz	VGT actuator operating duty
14.7 ~ 16.1Ω (20℃)	300Hz	76% at idle, decreases as accelerating

SCHEMATIC DIAGRAM E768BDB4

Refer to DTC P0047.

SIGNAL WAVEFORM AND DATA E43FC67F

Refer to DTC P0047.

MONITOR SCANTOOL DATA E9315435

Refer to DTC P0047.

TERMINAL AND CONNECTOR INSPECTION EFCF8A29

Refer to DTC P0047.

POWER CIRCUIT INSPECTION E7D4F518

1. Check power circuit voltage
   1) IG KEY "OFF", ENGINE "OFF"
   2) Disconnect VGT actuator connector
   3) IG KEY "ON"
   4) Measure the voltage of terminal 2 of VGT actuator.

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 E604F693

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 terminal 1 of VGT actuator.

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 1 and ECM connector(C244-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".

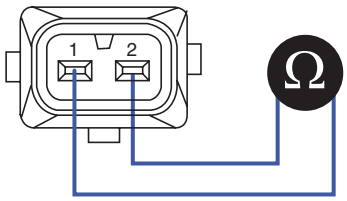
COMPONENT INSPECTION E43F790B

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 2.



SNFFL6316D

Specification : 14.7 ~ 16.1Ω (20℃)

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 76% 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 (Vacuum must not generates, correct VGT actuator operating duty is 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".

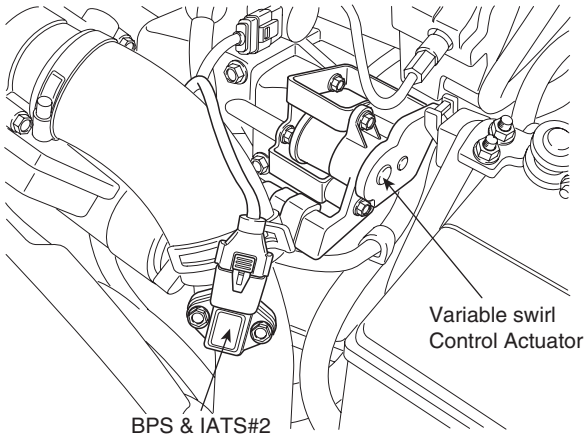
※ Repeat this process 2~3 times.

VERIFICATION OF VEHICLE REPAIR E73EDB11

Refer to DTC P0047.

DTC P0069 BOOST PRESSURE SENSOR CIRCUIT MALFUNCTION

COMPONENT LOCATION E1BE504F



SNFFL6210L

GENERAL DESCRIPTION ED281F70

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 E1A24E17

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 2 sec. This code is due to abnormal output characteristic of BPS component.

DTC DETECTING CONDITION EAA4EA2C

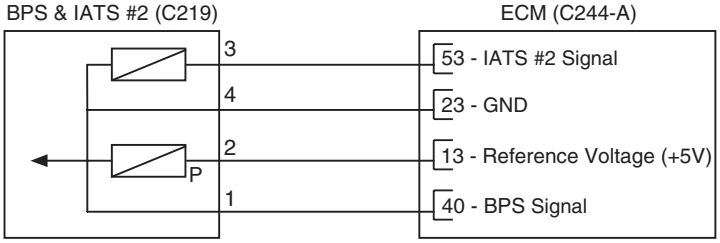
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="8">• BPS circuit
• BPS component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON" (below 100RPM)</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• |Boost pressure - Atmospheric pressure| is above 100hpa.</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• 2 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>Check Lamp</td><td>NO</td></tr>
</table>

SPECIFICATION E96F7817

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

SCHEMATIC DIAGRAM E4B4ECFC

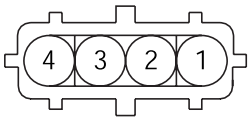
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-A (40)	BPS Signal
2	ECM C244-A (13)	Reference Voltage (+5V)
3	ECM C244-A (53)	IATS #2 Signal
4	ECM C244-A (23)	Sensor ground

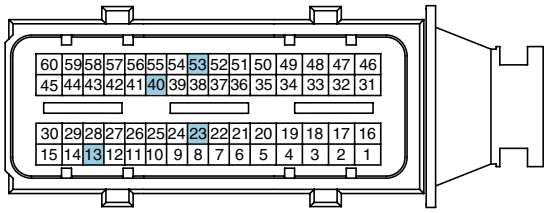
[HARNESS CONNECTORS]



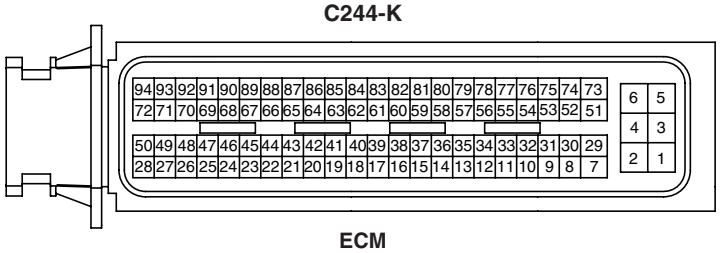
C219

BPS & IATS #2

C244-A



C244-K



ECM

STGFL7139L

SIGNAL WAVEFORM AND DATA E0883984

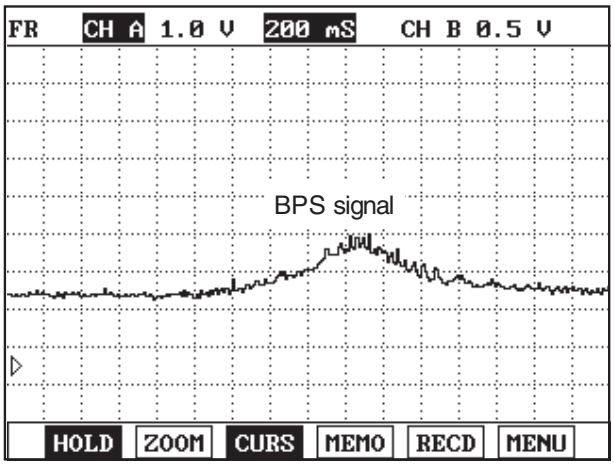


Fig.1

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

LFIG208A

MONITOR SCANTOOL DATA ED79DC4A

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 : approx. 76%) at idle

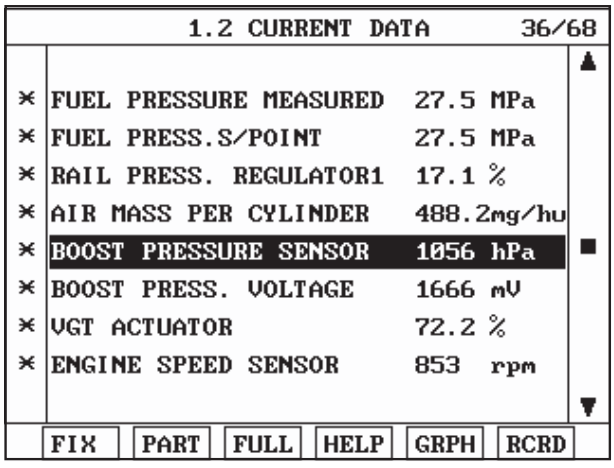


Fig.1

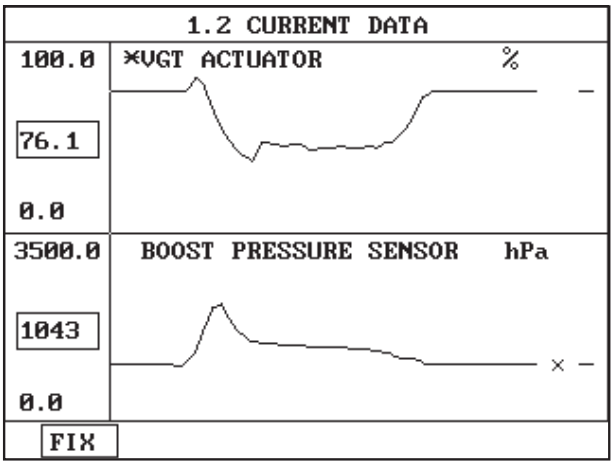


Fig.2

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

Fig.2) VGT actuator duty and boost pressure atacceleration is shown . If boost pressure rises and reaches certain value, VGT actuator duty stops to drop and keeps steady. Releasing accelerator pedal at this moment, VGT actuator duty drops to approx. 45%, then if RPM drops to idle range, duty returns to 76%.

STGFL7605L

TERMINAL AND CONNECTOR INSPECTION EE7CA11A

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 ".

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 : Refer to "Monitor Scantool Data" .

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 EE191B53

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

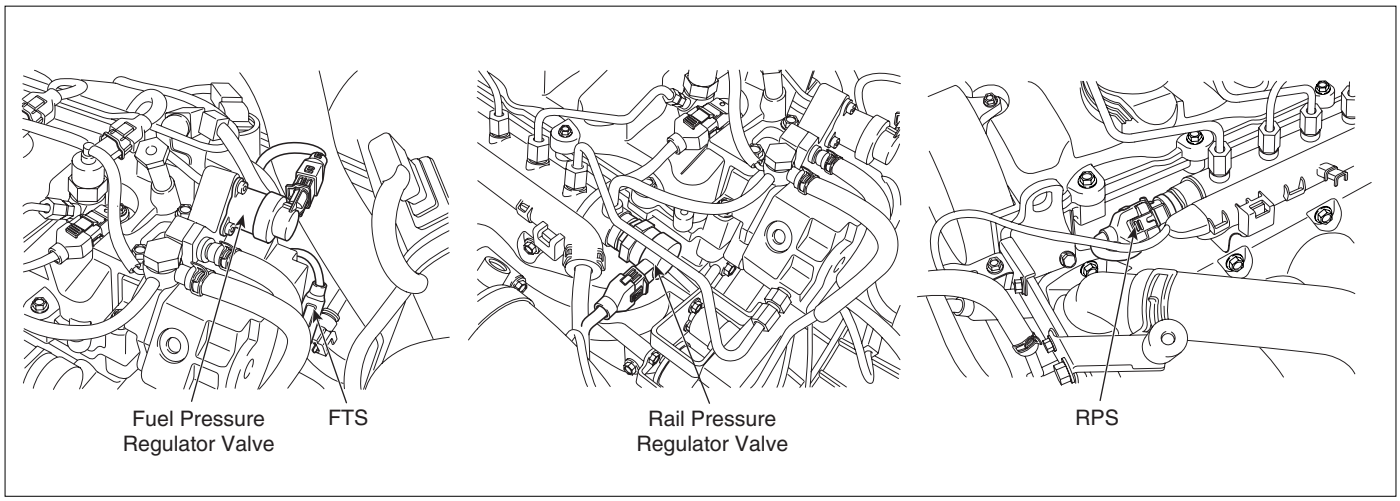
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

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

COMPONENT LOCATION E7F91708



SNFFL6517L

GENERAL DESCRIPTION E763DDF8

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 EE69C2CE

P0087 is set when rail pressure is lower than target rail pressure by more than 250bar for more than 2 sec. in condition that rail press. is controlled by rail pressure regulator valve(RPRV) or rail pressure is below the lower limit value(200bar). 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 press. sensor.

DTC DETECTING CONDITION E1AF079E

<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">• fuel pressure regulator valve (close stuck)
• rail pressure regulator valve (open stuck)
• Rail pressure sensor(Output fixed at low voltage line)</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Rail pressure is below target rail pressure by more than 250bar at rail pressure regulator valve(RPRV) operating condition.
• Rail pressure is below minimum limiting value(200bar) at rail pressure regulator valve(RPRV) operating condition.</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• 2 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>Check Lamp</td><td>YES</td></tr>
</table>

MONITOR SCANTOOL DATA ED817027

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 PRESS. S/POINT", "RAIL PRESS. REGULATOR1", "INJ. PUMP REGULATOR" parameter on the Scantool.

Specification : FUEL PRESSURE MEASURED similar to "FUEL PRESSURE-TARGET"
FUEL PRESS. S/POINT : 28.5 ± 5 Mpa
RAIL PRESS. REGULATOR1 : 17 ± 5%
INJ. PUMP REGULATOR : 35 ± 5%

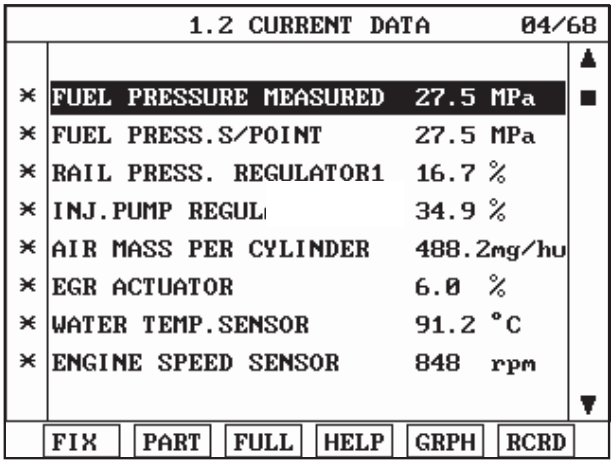


Fig.1

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

STGFL7608L

Check if "FUEL PRESSURE MEASURED"data is similar to "FUEL PRESS. S/POINT". 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 PRESS. S/POINT", 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", "INJ. PUMP REGULATOR","RAIL PRESS. REGULATOR1" parameter on the Scantool.

SPECIFICATION :

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

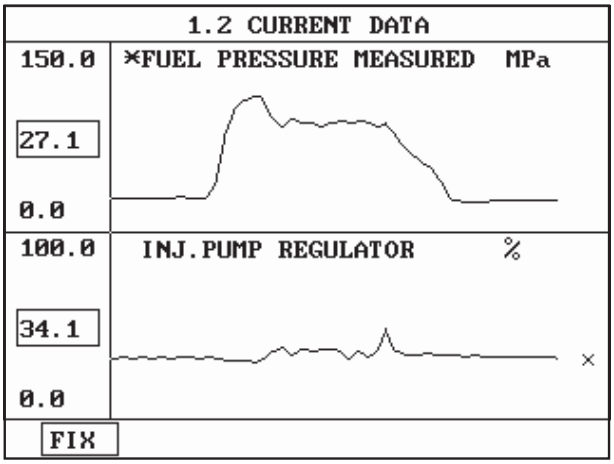


Fig.2

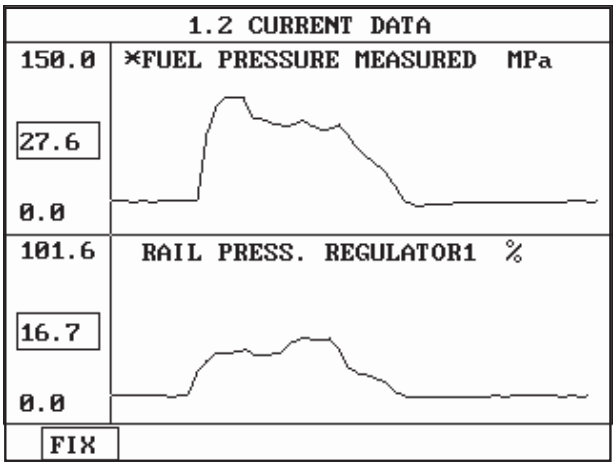


Fig.3

Fig.2) Fuel pressure and Fuel pressure regulator valve data at idle. Rail Pressure increases when the duty of "Fuel pressure regulator" increases.
Fig.3) Fuel pressure and Rail pressure regulator valve data at idle. Rail Pressure increases when the duty of "Rail pressure regulator" increases.

SNFFL6530L

NOTE

The waveform of fuel pressure regulator valve installed at high pressure pump(fuel detecting MPROP) shows 35 ± 5% duty at idle, duty rises to approx. 40% at acceleration to raise rail pressure.
▶ *Fuel amonut delivered from injection pump to rail is increases if the duty of "Fuel pressure regulator" increases*

The waveform of rail pressure regulator valve installed at common rail shows 17 ± 5% duty at idle, duty rises to approx. 45% at acceleration to raise rail pressure.
▶ *If the current increases, pressure in common rail will increase. because fuel return amount delivered to commom rail will decrease.*

VERIFICATION OF VEHICLE REPAIR EBA939A2

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 E95DA808

Refer to DTC P0087.

GENERAL DESCRIPTION E57CCD38

Refer to DTC P0087.

DTC DESCRIPTION E6A7625E

P0088 is set if rail pressure is above the upper limit 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 rail press. sensor.

DTC DETECTING CONDITION E2791FDA

<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">• fuel pressure regulator valve (open stuck)
• rail pressure regulator valve (close stuck)
• Rail pressure sensor(Output fixed at high voltage line)</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Rail pressure is above target rail pressure by more than 200bar at rail pressure regulator valve(PPRV) operating condition.- 0.8 sec.
• Rail pressure is above upper limit value(1750bar) at rail pressure regulator valve(PPRV) operating condition. - 0.24 sec.</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• Refer to threshold Value.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel cut</td><td>NO</td><td rowspan="4">• Engine shut down</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>YES</td></tr>
<tr><td>Check Lamp</td><td>YES</td></tr>
</table>

MONITOR SCANTOOL DATA EB518E8A

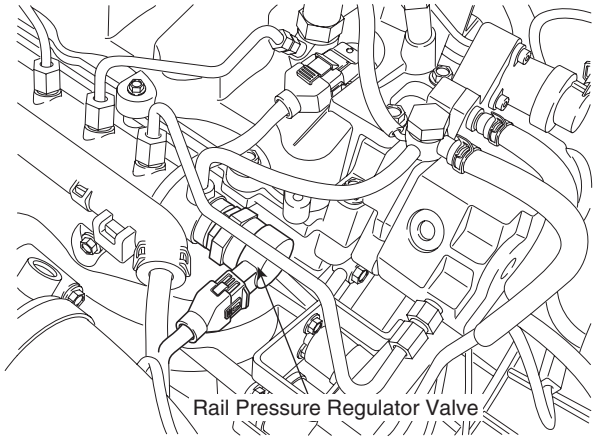
Refer to DTC P0087.

VERIFICATION OF VEHICLE REPAIR EC3D3546

Refer to DTC P0087.

DTC P0089 RAIL PRESSURE REGULATOR VALVE CIRCUIT OVER CURRENT

COMPONENT LOCATION E438AB9C



SNFFL6201L

GENERAL DESCRIPTION E4888215

Rail press. regulator valve(RPRV) 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 E78F4221

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 E60B09A8

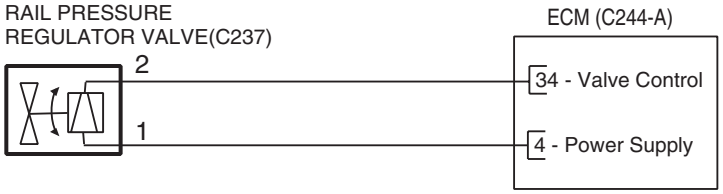
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="7">• RPRV circuit
• RPRV component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Short to battery in control circuit</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• 0.22 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>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION E418C5A6

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

SCHEMATIC DIAGRAM EB8B7CC6

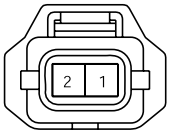
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-A (4)	Battery Voltage (B+)
2	ECM C244-A (34)	Valve Control

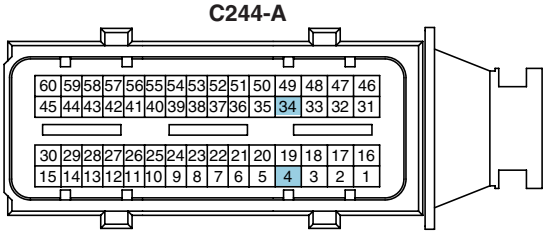
[HARNESS CONNECTORS]



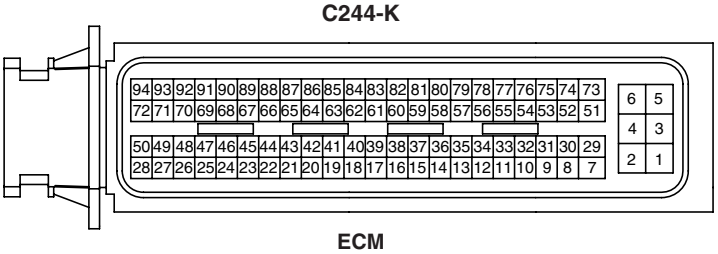
C237

RAIL PRESSURE REGULATOR VALVE

C244-A



C244-K



ECM

STGFL7194L

SIGNAL WAVEFORM AND DATA EED609B1

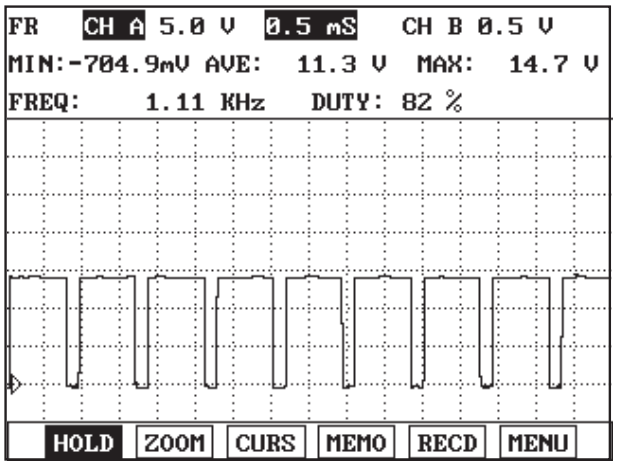


Fig.1

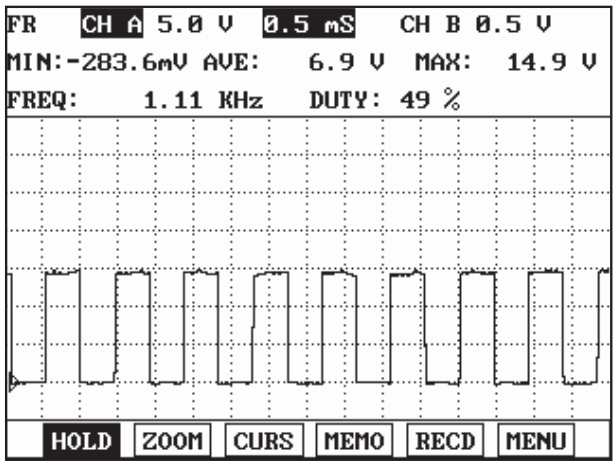


Fig.2

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

LFIG377A

MONITOR SCANTOOL DATA E36856D2

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", "INJ. PUMP REGULATOR","RAIL PRESS. REGULATOR1" parameter on the Scantool.

SPECIFICATION :

	Idle(without load)	Accelerating(stall test)	Diagnosis
FUEL PRESSURE MEASURED	27 ± 5 Mpa	above 75 Mpa	press. increases
INJ. PUMP REGULATOR	34 ± 3%	38 ± 3%	duty increases
RAIL PRESS. REGULATOR1	16 ± 3%	45 ± 3%	duty increases

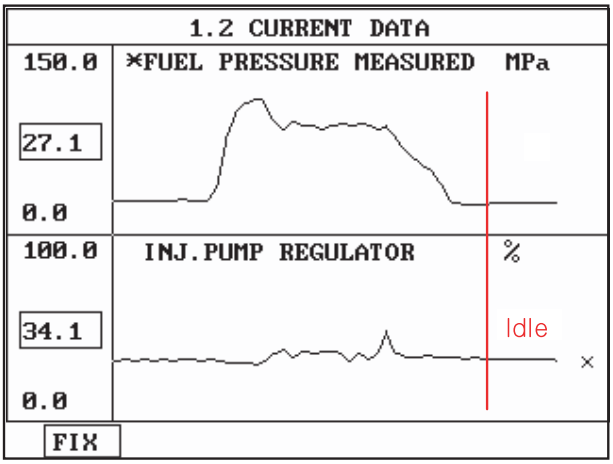


Fig.1

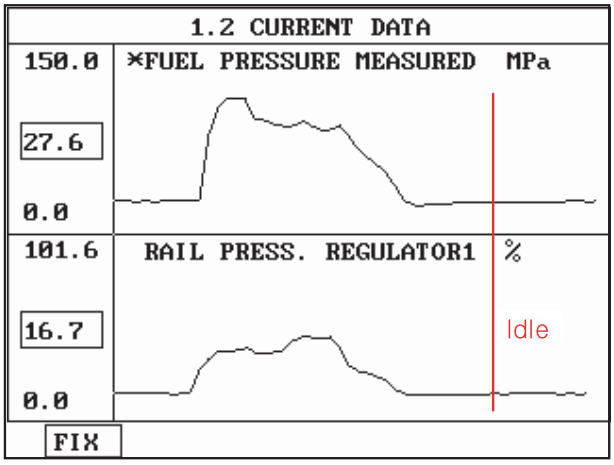


Fig.2

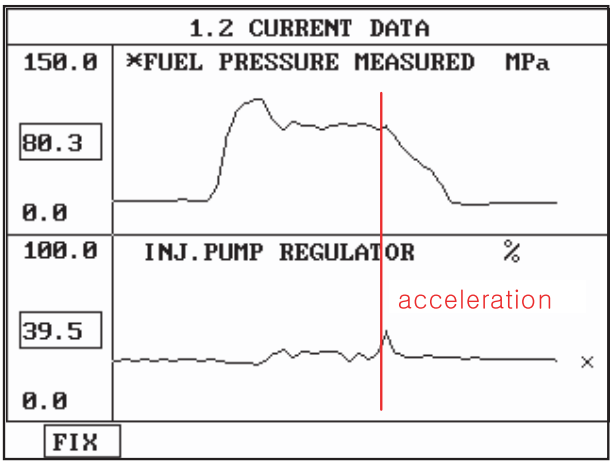


Fig.3

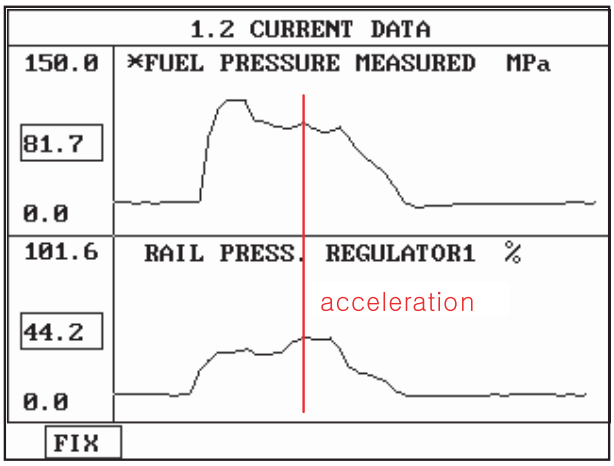


Fig.4

Fig.1) Fuel pressure and Fuel pressure regulator valve data at idle.
Fig.2) Fuel pressure and Rail pressure regulator valve data at idle.
Fig.3) Fuel pressure and Fuel pressure regulator valve data at acceleration.
Fig.4) Fuel pressure and Rail pressure regulator valve data at acceleration.

LFIG375A

NOTE

The waveform of fuel pressure regulator valve installed at high pressure pump(fuel detecting MPROP) shows 35 ± 3% duty at idle, duty rises to approx. 38% at acceleration to raise rail pressure.

The waveform of rail pressure regulator valve installed at common rail shows 17 ± 3% duty at idle, duty rises to approx. 45% at acceleration to raise rail pressure.

TERMINAL AND CONNECTOR INSPECTION E9CA1686

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

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 E872E161

1. Check power circuit voltage

   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 rail pressure regulator valve connector terminal 1 and ECM connector terminal 4 and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION E9A14AA1

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(C244-A) 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".

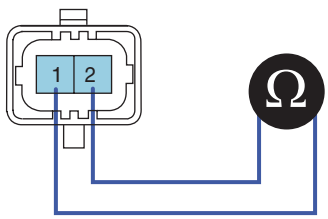
COMPONENT INSPECTION E0864B74

1. Check RPRV component resistance

1) IG KEY "OFF", ENGINE "OFF".

2) Disconnect RPRV connector.

3) Check RPRV component resistance.



KFQG320B

Specification : 3.42 ~ 3.78Ω (20℃)

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 EE7ADF3D

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 EE6F4788

Refer to DTC P0089.

GENERAL DESCRIPTION EAC4CE59

Refer to DTC P0089.

DTC DESCRIPTION E2D42A88

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 EA1128E7

<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>Threshold Value</td><td colspan="3">• Short to GND - 0.22 sec.
• Wiring open - 0.28 sec.</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• Refer to threshold Value.</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>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION EDD3F929

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

SCHEMATIC DIAGRAM E1F85C0F

Refer to DTC P0089.

SIGNAL WAVEFORM AND DATA E89F5672

Refer to DTC P0089.

MONITOR SCANTOOL DATA EC8DF0A3

Refer to DTC P0089.

TERMINAL AND CONNECTOR INSPECTION E45C2DFB

Refer to DTC P0089.

POWER CIRCUIT INSPECTION E2F918E5

1. Check power circuit voltage

   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 rail pressure regulator valve connector terminal 1 and ECM connector terminal 4 and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION E6A23B16

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(C244-A) 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".

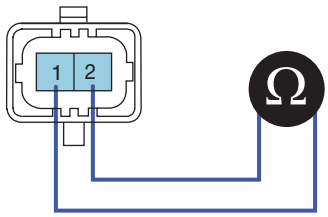
COMPONENT INSPECTION E2D5ADA2

1. Check RPRV component resistance

1) IG KEY "OFF", ENGINE "OFF".

2) Disconnect RPRV connector.

3) Check RPRV component resistance.



KFQG320B

Specification : 3.42 ~ 3.78Ω (20℃)

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 E4848332

Refer to DTC P0089.

DTC P0092 RAIL PRESSURE REGULATOR VALVE CIRCUIT HIGH

COMPONENT LOCATION EA28FE1E

Refer to DTC P0089.

GENERAL DESCRIPTION E4BDC5CA

Refer to DTC P0089.

DTC DESCRIPTION E01B3164

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 EB66B445

<table>
<tr><th>Item</th><th colspan="4">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="4">• Voltage monitoring</td><td rowspan="6">• RPRV circuit
• RPRV component</td></tr>
<tr><td>Enable Conditions</td><td colspan="4">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="4">• Short to battery (power circuit in rail pressure regulator valve)</td></tr>
<tr><td>Diagnostic Time</td><td colspan="4">• 0.28 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel cut</td><td>YES</td><td rowspan="4">• Engine shut down</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION E2BADE99

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

SCHEMATIC DIAGRAM E6CC03A1

Refer to DTC P0089.

SIGNAL WAVEFORM AND DATA EAB08ED0

Refer to DTC P0089.

MONITOR SCANTOOL DATA EDFA6C25

Refer to DTC P0089.

TERMINAL AND CONNECTOR INSPECTION ECBD4F31

Refer to DTC P0089.

POWER CIRCUIT INSPECTION ED82AADD

1. Check power circuit voltage

   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 rail pressure regulator valve connector terminal 1 and ECM connector terminal 4 and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION EAB6CD0B

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(C244-A) 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".

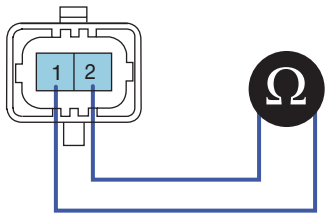
COMPONENT INSPECTION EF6FD8AE

1. Check RPRV component resistance

1) IG KEY "OFF", ENGINE "OFF".

2) Disconnect RPRV connector.

3) Check RPRV component resistance.



KFQG320B

Specification : 3.42 ~ 3.78Ω (20℃)

4) Is the measured resistance within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

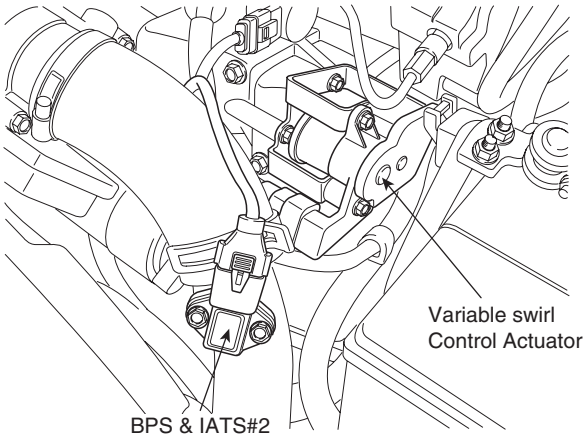
▶ Replace common rail assy' and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR EDECE00F

Refer to DTC P0089.

DTC P0097 INTAKE AIR TEMPERATURE SENSOR 2 CIRCUIT LOW INPUT

COMPONENT LOCATION E67033BC



SNFFL6210L

GENERAL DESCRIPTION E4D90703

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 E3FE6714

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

DTC DETECTING CONDITION E925684D

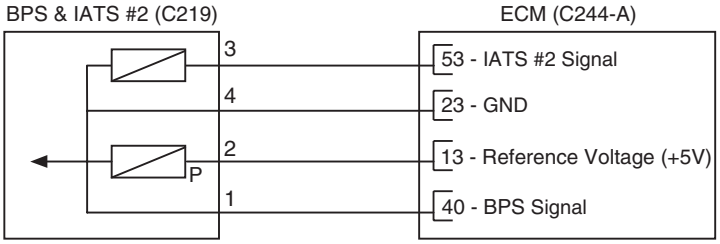
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="7">• IATS circuit
• IATS component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Output signal below minimum value(below 73mV)</td></tr>
<tr><td>Diagnostic Time</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>Check Lamp</td><td>NO</td></tr>
</table>

SPECIFICATION E8B7F239

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

SCHEMATIC DIAGRAM E18D185D

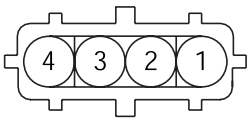
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-A (40)	BPS Signal
2	ECM C244-A (13)	Reference Voltage (+5V)
3	ECM C244-A (53)	IATS #2 Signal
4	ECM C244-A (23)	Sensor ground

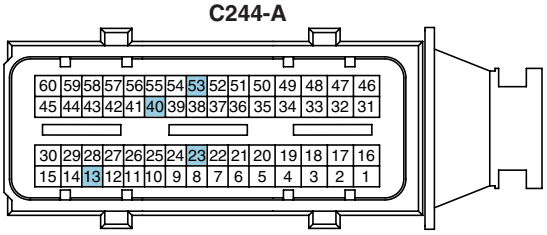
[HARNESS CONNECTORS]



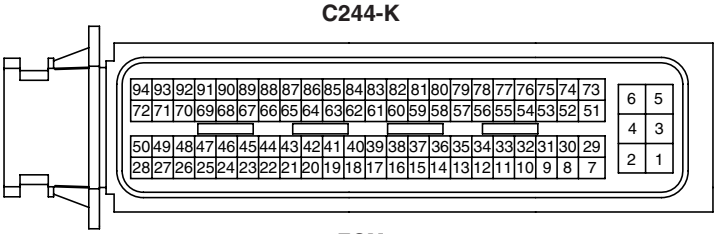
C219

BPS & IATS #2

C244-A



C244-K



ECM

STGFL7139L

SIGNAL WAVEFORM AND DATA E9EE8CEA

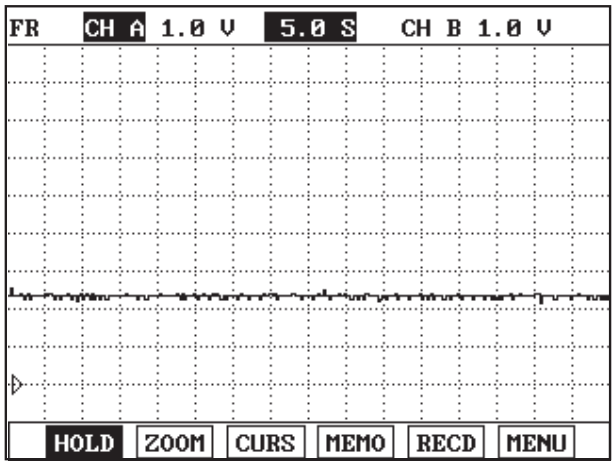


Fig.1

Fig.1) IATS output waveform at 45℃. The higher temperature is, the lower voltage becomes.

LFIG381A

MONITOR SCANTOOL DATA EB5601D3

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 TERMPERATURE SENSOR" parameter on the Scantool.

specification : current intake air temperture is displayed.

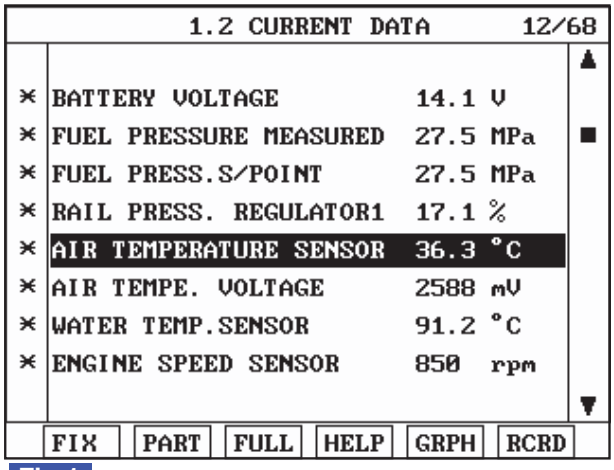


Fig.1

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

STGFL7600L

TERMINAL AND CONNECTOR INSPECTION E37C39EC

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

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 EB4A2F1F

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".

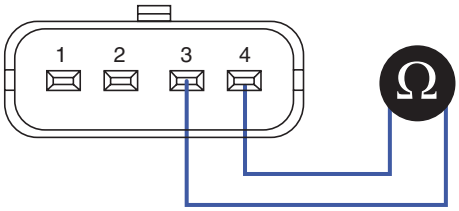
NO

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

COMPONENT INSPECTION E08990DE

1. IG KEY "OFF", ENGINE "OFF".
2. Disconnect BPS connector.
3. Measure resistance between IATS component terminal 3 and 4, referring to resistance characteristic table of specification of General information.

Specification : Refer to Specification of General Information



KFQG323A

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 E36A954E

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 E616B3FF

Refer to DTC P0097.

GENERAL DESCRIPTION E5F196CD

Refer to DTC P0097.

DTC DESCRIPTION E6DFC952

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 EA2C8C4D

<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>Threshold Value</td><td colspan="3">• Output signal above maximum value(above 4965mV)</td></tr>
<tr><td>Diagnostic Time</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>Check Lamp</td><td>NO</td></tr>
</table>

SPECIFICATION E898D2D7

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

SCHEMATIC DIAGRAM EA995407

Refer to DTC P0097.

SIGNAL WAVEFORM AND DATA EE31C990

Refer to DTC P0097.

MONITOR SCANTOOL DATA ED4B1094

Refer to DTC P0097.

TERMINAL AND CONNECTOR INSPECTION EBC05B74

Refer to DTC P0097.

SIGNAL CIRCUIT INSPECTION E5C5C92B

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(C244-A) 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

▶ Go to "Ground Circuit Inspection".

NO

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

GROUND CIRCUIT INSPECTION E61BCC4C

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 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".

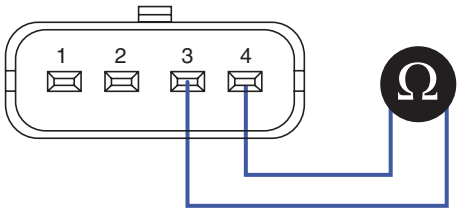
NO

▶ 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 EF39E398

1. IG KEY "OFF", ENGINE "OFF".
2. Disconnect BPS connector.
3. Measure resistance between IATS component terminal 3 and 4, referring to resistance characteristic table of specification of General information.

Specification : Refer to Specification of General Information



KFQG323A

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

YES

▶ Go to "Verification of Vehicle Repair".

NO

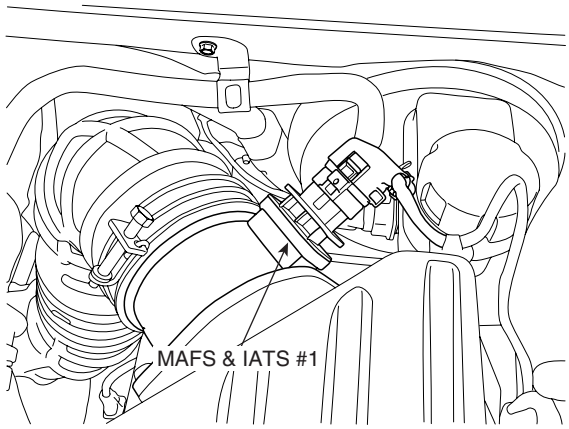
▶ Replace BPS assy' and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E7F9E9F2

Refer to DTC P0097.

DTC P0101 MASS OR VOLUME AIR FLOW CIRCUIT RANGE/PERFORMANCE

COMPONENT LOCATION EEEE17FF



SNFFL6202D

GENERAL DESCRIPTION E7671BAE

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 E049FA0D

P0101 is set 1) when Air mass ratio(real/threshold) above 1.5 or below 0.87 is detected for more than 10 sec.. or 2) short to battery or ground in AFS or IATS signal circuit is detected for more than 0.58 sec. or 3) short to low or high voltage line in IATS signal circuit is detected for more than 0.58 sec..

DTC DETECTING CONDITION E02A7933

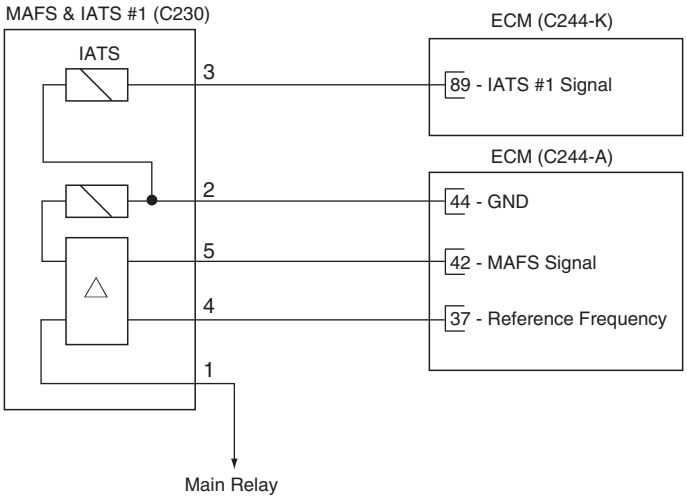
Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• MAFS circuit • MAFS component
Enable Conditions	• Engine running			
Threshold Value	• Air mass ratio(real/threshold) above 1.5 or below 0.87 - 10 sec. • Short to low or high voltage line in IATS signal circuit - 0.58 sec. • Shrot to battery or ground in MAFS or IATS circuit - 0.58 sec.			
Diagnostic Time	• Refer to threshold Value.			
Fail Safe	Fuel cut	NO		
	EGR Off	YES		
	Fuel Limit	YES		
	Check Lamp	YES		

SPECIFICATION E8013648

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 EDA71D21

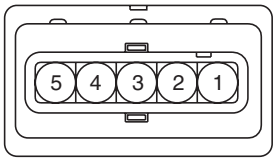
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	Main Relay	Battery Voltage (B+)
2	ECM C244-A (44)	Sensor Ground
3	ECM C244-K (89)	IATS #1 Signal
4	ECM C244-A (37)	Reference Frequency
5	ECM C244-A (42)	MAFS Signal

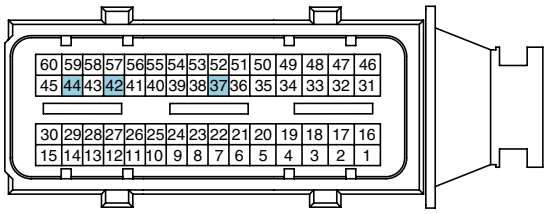
[HARNESS CONNECTORS]



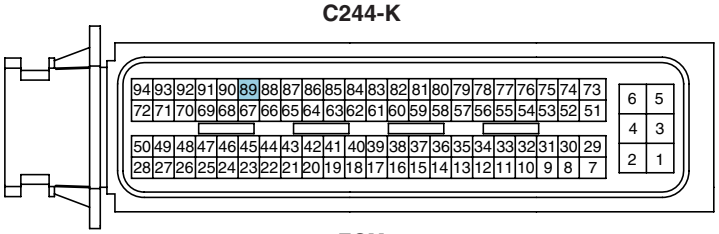
C230

MAFS & IATS #1

C244-A



C244-K



ECM

STGFL7135L

SIGNAL WAVEFORM AND DATA E7147ED8

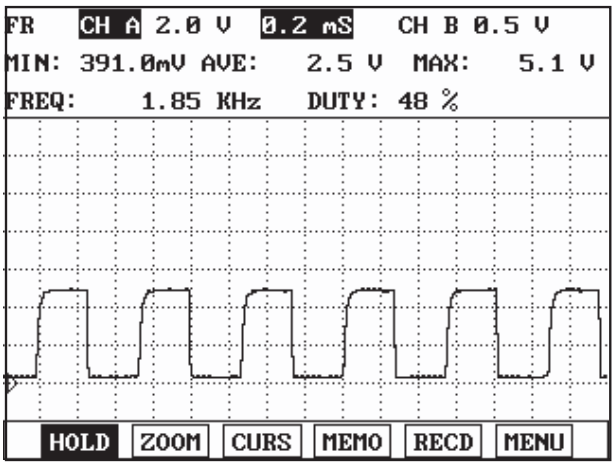


Fig.1

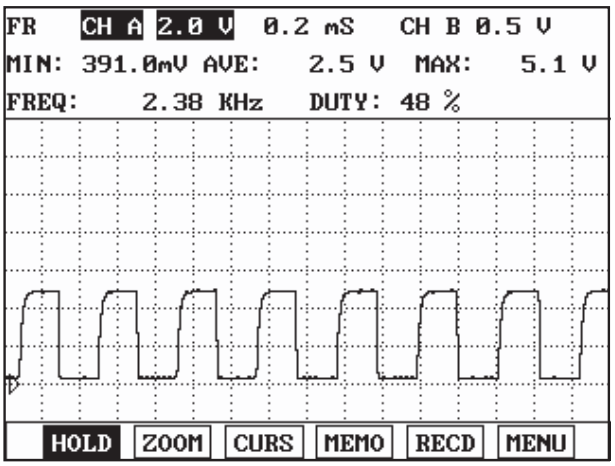


Fig.2

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(800RPM, EEGR actuator duty 4.4%, air flow for each cylinder 450mg/st).
It shows digital signal of 50% duty, 2.0~2.5KHz.

STGFL7601L

NOTE

Signal frequency increases as RPM rises.

MONITOR SCANTOOL DATA EC90964C

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 5% duty) at idle : 450mg/st ± 50 mg/st
When EEGR actuator operates(Approx. 50% duty) at idle : 300mg/st ± 50 mg/st

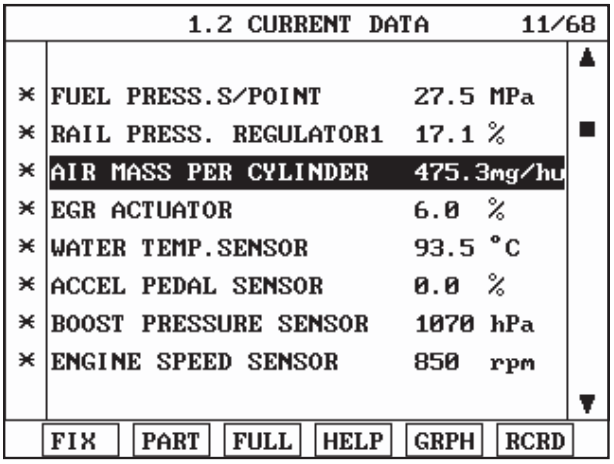


Fig.1

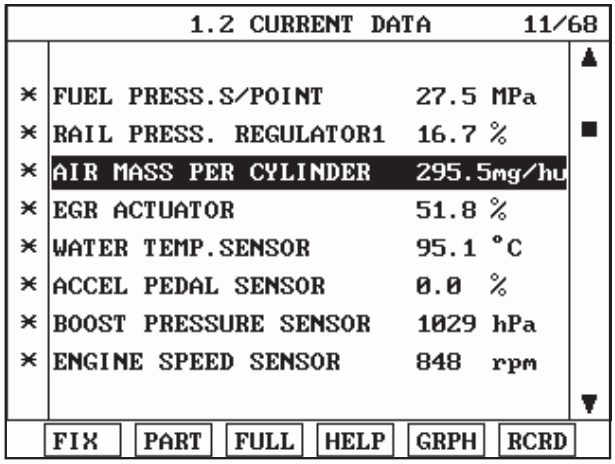


Fig.2

Fig.1) Check if "AIR MASS PERCYLINDER"l is 450mg/st ± 50mg/st without EEGR operation at warm idle (EEGR actuator 5% duty)
Fig.2) Check if "AIR MASS PERCYLINDER"l is 300mg/st ± 50mg/st with EEGR operation at warm idle (EEGR actuator approx. 50% duty)

STGFL7531L

NOTE

EEGR actuator operates as decelerating after rapid acceleration when idle EEGR does not operate, EEGR actuator duty rises to approx. 45% at operating condition. This controlling process lasts for about 56 sec. then EEGR actuator turns "OFF" (duty 5%).

TERMINAL AND CONNECTOR INSPECTION E5D4EF33

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

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 EE21F774

1. Check power circuit voltage

1) IG KEY "OFF", ENGINE "OFF".

2) Disconnect MAFS connector.

3) IG KEY "ON".

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

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

5) Is the measured voltage within the specification?

YES

▶ Go to "Signal Circuit Inspection".

NO

6) ▶ When output voltage is not detected at terminal 1 :
☞ Repair open in E/R 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 terminal 37, and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION E9EFE38E

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 3 and 5.

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

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 E02158E5

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 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 E15837EE

1. IG KEY "OFF", ENGINE "OFF".

2. Check that AFS is installed in correctly according to the direction of arrow on AFS 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 5.9% duty is outputted 1 min. after rapid acceleration.)

9. Monitor signal voltage of AFS when engine speed lasts at approx. 800RPM using Scantool.

10. Check MAFS output signal at idle after rapid acceleration.(EEGR actuator duty 50%)

Specification : When EEGR actuator does not operate 5% duty) at idle : 450mg/st ± 50 mg/st
When EEGR actuator operates(Approx. 50% duty) at idle : 300mg/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 ED479790

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 ED4B0D80

Refer to DTC P0101.

GENERAL DESCRIPTION ED0ACD9B

Refer to DTC P0101.

DTC DESCRIPTION E13C0747

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 EAF070B9

<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">• AFS circuit
• AFS component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Abnormal minimum output signal(below 1200Hz)</td></tr>
<tr><td>Diagnostic Time</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>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION E66267A6

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 ED1D3A95

Refer to DTC P0101.

SIGNAL WAVEFORM AND DATA E33158E4

Refer to DTC P0101.

MONITOR SCANTOOL DATA EB8EA9F0

Refer to DTC P0101.

TERMINAL AND CONNECTOR INSPECTION E10F61EE

Refer to DTC P0101.

POWER CIRCUIT INSPECTION E6801C71

1. Check power circuit voltage

   1) IG KEY "OFF", ENGINE "OFF".

   2) Disconnect MAFS connector.

   3) IG KEY "ON".

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

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

   5) Is the measured voltage within the specification?

YES

▶ Go to "Signal Circuit Inspection".

NO

   6) ▶ When output voltage is not detected at terminal 1 :
   ☞ Repair open in E/R 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 terminal 37, and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION EAE3EC3F

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 5.

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 MAFS sensor connector and ECM connector.

   3) Check continuity between MAFS connector terminal 5 and ECM connector(C244-A) 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 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 E479AFCE

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 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 E14139F4

1. IG KEY "OFF", ENGINE "OFF".
2. Check that AFS is installed in correctly according to the direction of arrow on AFS 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 5.9% duty is outputted 1 min. after rapid acceleration.)
9. Monitor signal voltage of AFS when engine speed lasts at approx. 800RPM using Scantool.
10. Check AFS output signal at idle after rapid acceleration.(EEGR actuator duty 50%)

Specification : When EEGR actuator does not operate (5%) at idle : 450mg/st ± 50 mg/st
EEGR When EEGR actuator operates(50%) at idle : 300ms/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 E9051915

Refer to DTC P0101.

DTC P0103 MASS OR VOLUME AIR FLOW CIRCUIT HIGH INPUT

COMPONENT LOCATION E60D2AC9

Refer to DTC P0101.

GENERAL DESCRIPTION E54291AD

Refer to DTC P0101.

DTC DESCRIPTION EF75F36A

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 EB28A7B8

<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">• MAFS circuit
• MAFS componen</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Abnormal maximum output signal(above 14100Hz)</td></tr>
<tr><td>Diagnostic Time</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>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION E5180086

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 E35F2305

Refer to DTC P0101.

SIGNAL WAVEFORM AND DATA E13D8510

Refer to DTC P0101.

MONITOR SCANTOOL DATA EA647230

Refer to DTC P0101.

TERMINAL AND CONNECTOR INSPECTION EEA31F85

Refer to DTC P0101.

POWER CIRCUIT INSPECTION E39961E4

1. Check power circuit voltage

   1) IG KEY "OFF", ENGINE "OFF".

   2) Disconnect MAFS connector.

   3) IG KEY "ON".

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

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

   5) Is the measured voltage within the specification?

YES

▶ Go to "Signal Circuit Inspection".

NO

   6) ▶ When output voltage is not detected at terminal 1 :
   ☞ Repair open in E/R 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 terminal 37, and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION E9A90BF3

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 5.

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 MAFS sensor connector and ECM connector.

   3) Check continuity between MAFS connector terminal 5 and ECM connector(C244-A) 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 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 E00A97A7

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 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 ED7C9D0D

1. IG KEY "OFF", ENGINE "OFF".
2. Check that AFS is installed in correctly according to the direction of arrow on AFS 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 5.9% duty is outputted 1 min. after rapid acceleration.)
9. Monitor signal voltage of AFS when engine speed lasts at approx. 800RPM using Scantool.
10. Check AFS output signal at idle after rapid acceleration.(EEGR actuator duty 50%)

Specification : When EEGR actuator does not operate (5%) at idle : 450mg/st ± 50 mg/st
EEGR When EEGR actuator operates(50%) at idle : 300ms/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 EBF48A1B

Refer to DTC P0101.

DTC P0107 ATMOSPHERIC PRESSURE CIRCUIT LOW INPUT

GENERAL DESCRIPTION EE288751

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 1000 hpa when atmospheric sensor fails.

DTC DESCRIPTION E60BA0C8

P0107 is set when the voltage below 1.002V - minimum output voltage of Atmospheric pressure sensor - is detected for more than 0.8 sec. This code is due to fhe failure of the sensor inside of ECM.

DTC DETECTING CONDITION E0AD6BA1

<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>Threshold Value</td><td colspan="3">• When output voltage is below the minimum value.(below 1.002V)</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• 0.8 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 900 hpa.</td></tr>
<tr><td>EGR Off</td><td>YES</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION E6D72BDC

1atm is same as		
hpa (hecto pascal)	**mb**	**mmHg**
1013	1013	760

MONITOR SCANTOOL DATA E2E727D0

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 "ATMOSPHERIC PRESS. SNSR " parameter on the scantool.

Specification : Approx. 1 atm is displayed

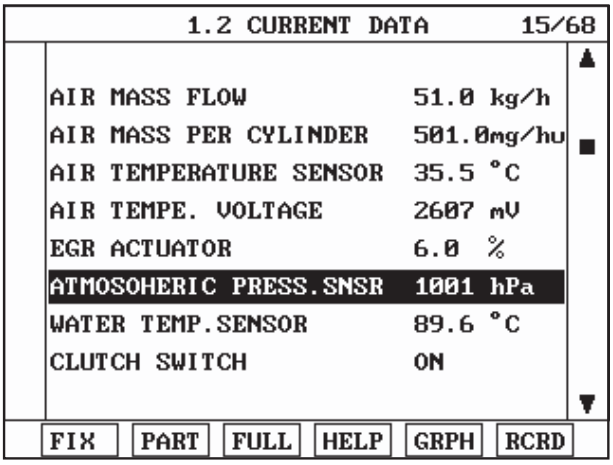


Fig.1

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 considered as 1atm and, check if the pressure different from 1 atm is displayed. (1 atm is correct pressure)

STGFL7602L

COMPONENT INSPECTION EC819D59

1. ECM Component Inspection

   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 E19D0072

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

GENERAL DESCRIPTION E8D790A9

Refer to DTC P0107.

DTC DESCRIPTION EE87F1B5

P0108 is set when the voltage above 4.902V - maximum output voltage of Barometric pressure sensor - is detected for more than 0.8 sec. This code is due to fhe failure of the sensor inside of ECM.

DTC DETECTING CONDITION EB79236E

<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>Threshold Value</td><td colspan="3">• When output voltage is above the maximum value. (above 4.902V)</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• 0.8 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 900 hpa.</td></tr>
<tr><td>EGR Off</td><td>YES</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION E3C55B11

1atm is same as		
hpa (hecto pascal)	**mb**	**mmHg**
1013	1013	760

MONITOR SCANTOOL DATA EFF60DE3

Refer to DTC P0107.

COMPONENT INSPECTION EAAB6581

1. ECM Component Inspection
   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.

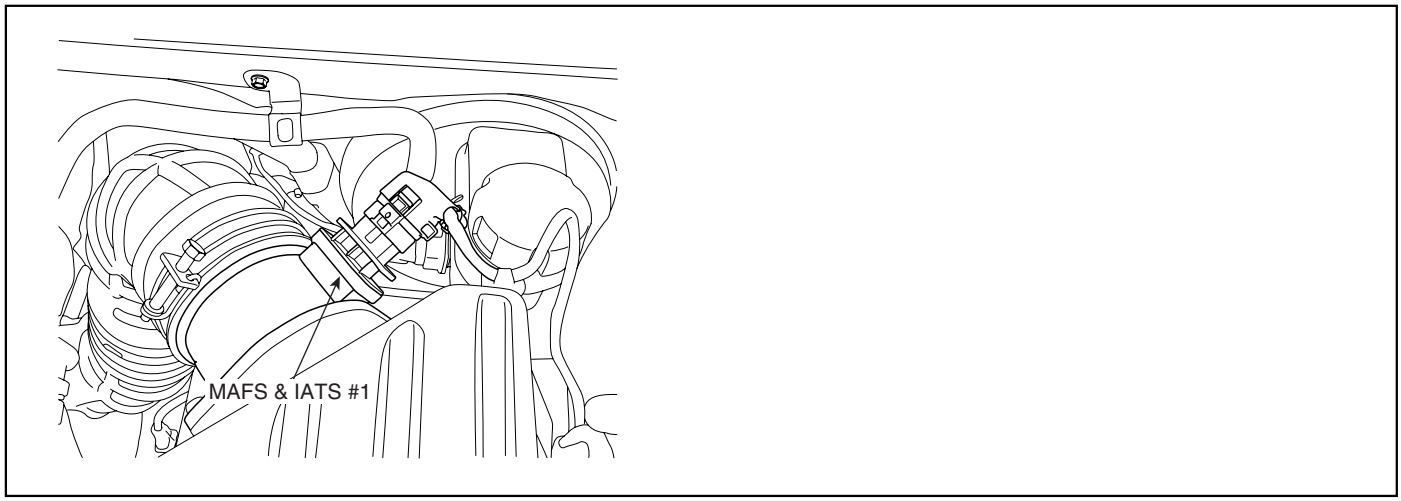
Enter the driving distance - how many km the CPF is used- into New ECM with scanner.
For immobilizer applied vehicle, input pin code.

VERIFICATION OF VEHICLE REPAIR E56D405C

Refer to DTC P0107.

DTC P0112 INTAKE AIR TEMPERATURE SENSOR1 CIRCUIT LOW INPUT

COMPONENT LOCATION E3C8B301



SNFFL6202D

GENERAL DESCRIPTION E936B290

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 E96E5888

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 EB8B6F70

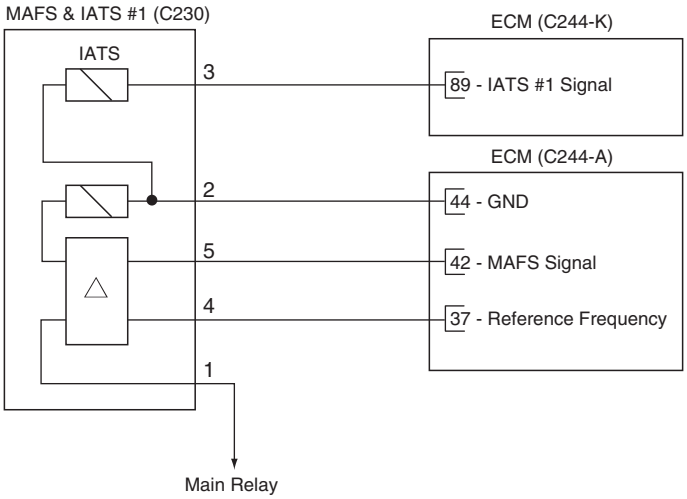
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• IATS circuit
• IATS component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• When output signal is below the minimum value (below 0.073V)</td></tr>
<tr><td>Diagnostic Time</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">• Intake air temperature is considered as 20℃</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>Check Lamp</td><td>NO</td></tr>
</table>

SPECIFICATION EA5B229B

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

SCHEMATIC DIAGRAM EFE3B9CA

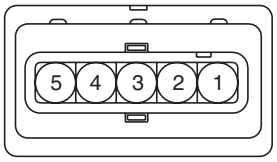
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	Main Relay	Battery Voltage (B+)
2	ECM C244-A (44)	Sensor Ground
3	ECM C244-K (89)	IATS #1 Signal
4	ECM C244-A (37)	Reference Frequency
5	ECM C244-A (42)	MAFS Signal

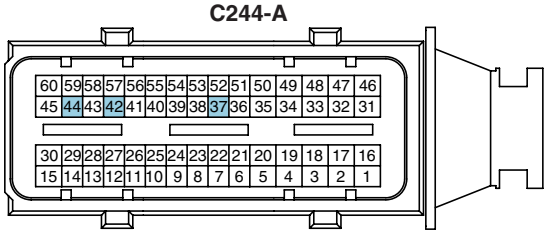
[HARNESS CONNECTORS]



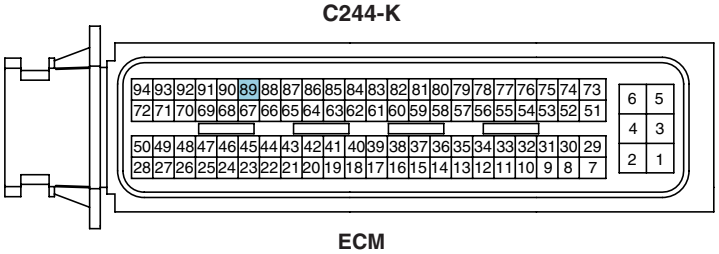
C230

MAFS & IATS #1

C244-A



C244-K



ECM

STGFL7135L

SIGNAL WAVEFORM AND DATA E14B1CB2

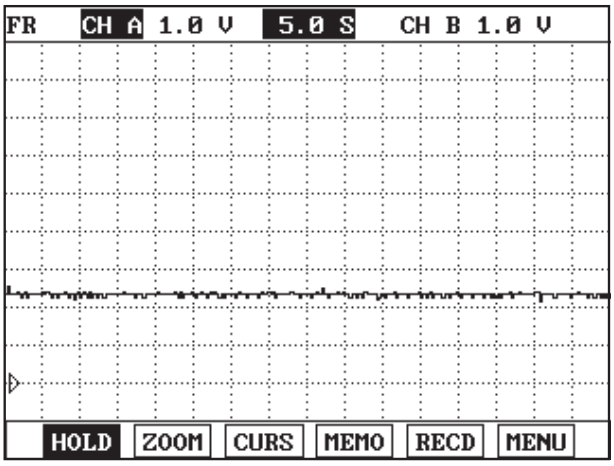


Fig.1

Fig.1) IATS output signal at warm idle.The higher temperature rises, the lower signal voltage becomes.

LFIG234A

TERMINAL AND CONNECTOR INSPECTION E8DFF227

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 EFC4C008

1. Check signal circuit voltage
   1) IG KEY "OFF", ENGINE "OFF".
   2) Disconnect IATS connector
   3) IG KEY "ON"
   4) Measure the voltage of terminal 3 of MAFS connector.

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".

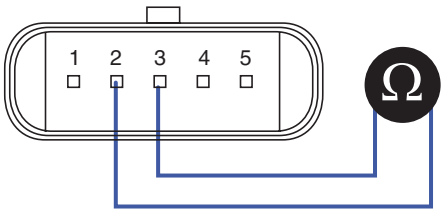
NO

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

COMPONENT INSPECTION E64161C3

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect MAFS connector.
3. Measure resistance of IATS component terminal 3 and 2, referring to resistance characteristic table of specification of General information.

Specification : Refer to Specification of General Information.



KFQG338A

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

VERIFICATION OF VEHICLE REPAIR E7F6435E

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 E3BA2FB2

Refer to DTC P0112.

GENERAL DESCRIPTION E4B35448

Refer to DTC P0112.

DTC DESCRIPTION E7039491

P0113 is set when the voltage above 4.89V - 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 E93AB657

<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>Threshold Value</td><td colspan="3">• When output signal is above the maximum value (above 4.89V)</td></tr>
<tr><td>Diagnostic Time</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">• Intake air temperature is considered as 20℃</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>Check Lamp</td><td>NO</td></tr>
</table>

SPECIFICATION E6EA3ABB

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

SCHEMATIC DIAGRAM E16C5F9E

Refer to DTC P0112.

SIGNAL WAVEFORM AND DATA E8605A3C

Refer to DTC P0112.

TERMINAL AND CONNECTOR INSPECTION E4A2FFF6

Refer to DTC P0112.

SIGNAL CIRCUIT INSPECTION EA6595CC

1. Check signal circuit voltage

   1) IG KEY "OFF", ENGINE "OFF".

   2) Disconnect MAFS connector.

   3) IG KEY "ON"

   4) Measure the voltage of terminal 3 of MAFS connector.

Specification : 4.8~5.1V

   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(C244-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 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 terminal 3 of MAFS connector.

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 EC57554A

1. IG KEY "OFF", ENGINE "OFF".
2. Disconnect MAFS connector and ECM connector
3. IG KEY "ON"
4. Measure the voltage of terminal 3 of MAFS connector. [TEST "A"]
5. Measure the voltage of MAFS 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"

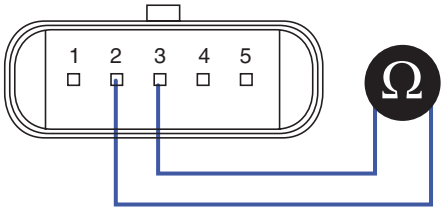
NO

▶ 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 E378C8EC

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect AFS connector.
3. Measure resistance of IATS component terminal 3 and 2, referring to resistance characteristic table of specification of General information.

Specification : Refer to Specification of General Information.



KFQG338A

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

YES

▶ Go to "Verification of Vehicle Rapair"

NO

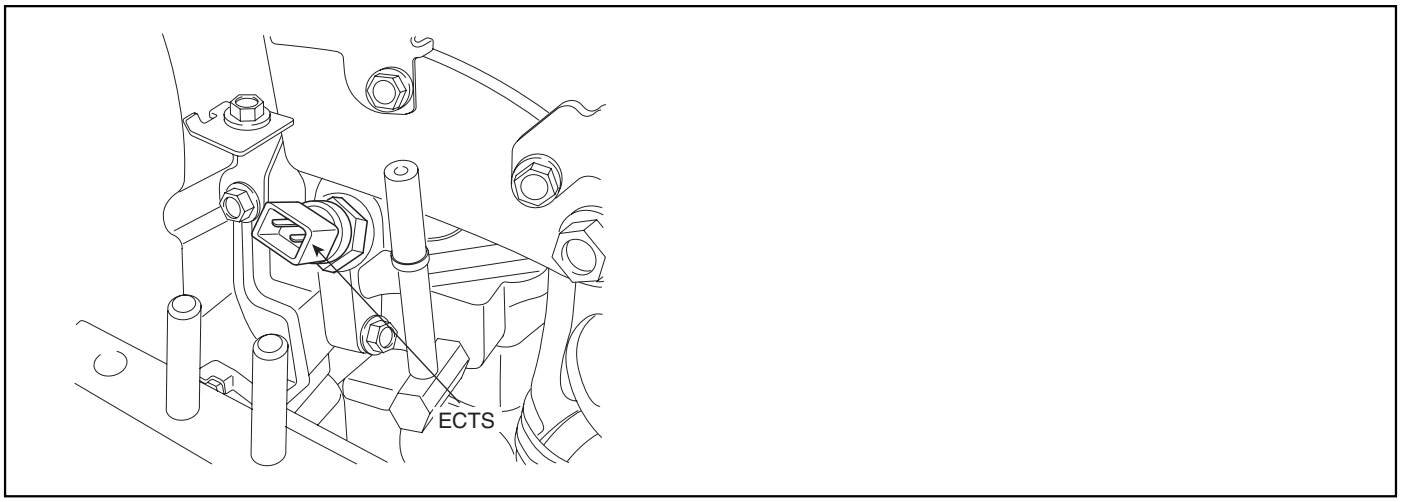
▶ Replace MAFS ASSY' and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E31D2BA8

Refer to DTC P0112.

DTC P0116 ENGINE COOLANT TEMPERATURE CIRCUIT RANGE/PERFORMANCE

COMPONENT LOCATION E862F846



SNFFL6203D

GENERAL DESCRIPTION E75BFF16

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 EB6CDABE

P0116 is set when engine coolant temp. rise is below 10℃ within certain duration after engine ON when engine coolant termp. is below 40℃ in condition of above 700RPM and 10mg/hub of fuel injection quantity. (e.g. duration at 0℃ of engine coolant temp. - 1065 sec.)

DTC DETECTING CONDITION E98D52BE

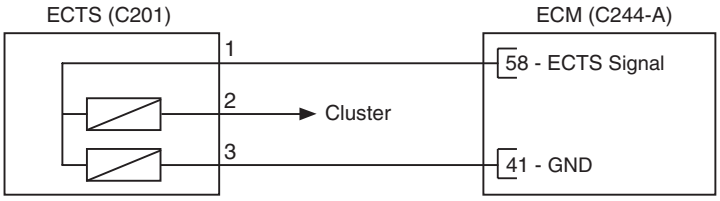
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="8">• ECTS circuit
• ECTS component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Minimum temperature or temperature raise no reached whithin time limit</td></tr>
<tr><td>Diagnostic Time</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℃
at cold and cranking : temperature is fixed at -10℃</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION E024B8A8

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

SCHEMATIC DIAGRAM E77F9EDD

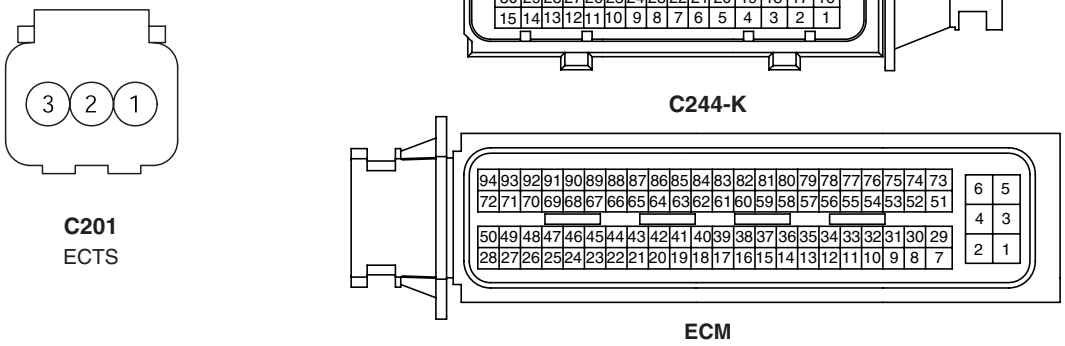
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-A (58)	ECTS Signal
2	Cluster	-
3	ECM C244-A (41)	Sensor ground

[HARNESS CONNECTORS]



STGFL7137L

SIGNAL WAVEFORM AND DATA E6BCA42F

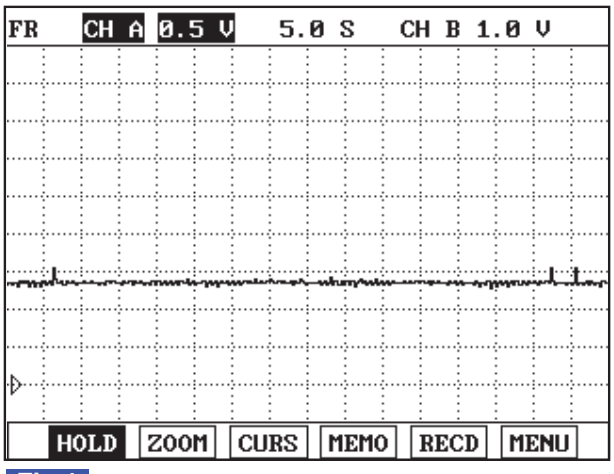


Fig.1

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

LFIG387A

MONITOR SCANTOOL DATA EEDA6DE5

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.

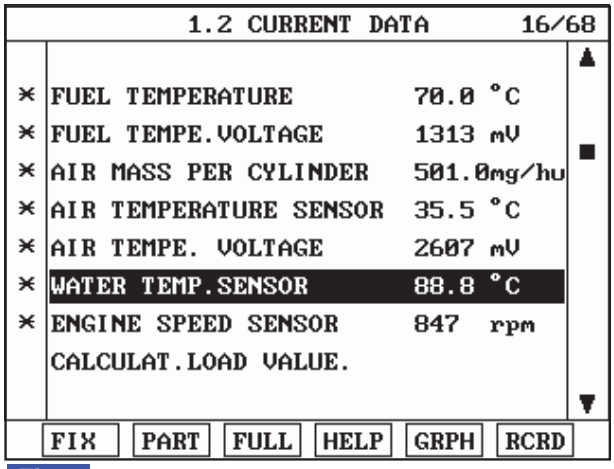


Fig.1

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

STGFL7603L

TERMINAL AND CONNECTOR INSPECTION EFBD296D

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".

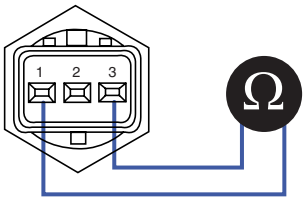
NO

▶ Go to "Component Inspection ".

COMPONENT INSPECTION E8EC657E

1. IG KEY "OFF", ENGINE "OFF".
2. Disconnect ECTS connector.
3. Measure resistance between ECTS terminal 1 and 3, referring to resistance characteristic table of specification of General information.

Specification : Refer to Specification of General Information



KFQG345A

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 E0315348

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 P0117 ENGINE COOLANT TEMPERATURE CIRCUIT LOW INPUT

COMPONENT LOCATION E356AAFA

Refer to DTC P0116.

GENERAL DESCRIPTION ED40FB54

Refer to DTC P0116.

DTC DESCRIPTION E89F57FF

P0117 is set when the voltage below 0.083V - 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 E23715EB

<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>Threshold Value</td><td colspan="3">• Output signal below the minimum value.(below 0.083 V)</td></tr>
<tr><td>Diagnostic Time</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℃
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>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION EDD59882

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

SCHEMATIC DIAGRAM EB2B9D17

Refer to DTC P0116.

SIGNAL WAVEFORM AND DATA E1DC218B

Refer to DTC P0116.

MONITOR SCANTOOL DATA E40B5BFF

Refer to DTC P0116.

TERMINAL AND CONNECTOR INSPECTION E633DB0B

Refer to DTC P0116.

SIGNAL CIRCUIT INSPECTION EA1B1C97

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".

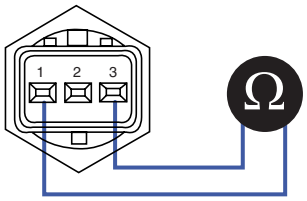
NO

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

COMPONENT INSPECTION E9CA9562

1. IG KEY "OFF", ENGINE "OFF".
2. Disconnect ECTS connector.
3. Measure resistance between ECTS terminal 1 and 3, referring to resistance characteristic table of specification of General information.

Specification : Refer to Specification of General Information



KFQG345A

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 EA8FE41C

Refer to DTC P0116.

DTC P0118 ENGINE COOLANT TEMPERATURE CIRCUIT HIGH INPUT

COMPONENT LOCATION EBBA68BC

Refer to DTC P0116.

GENERAL DESCRIPTION EC579CDE

Refer to DTC P0116.

DTC DESCRIPTION E9AFE60A

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 E5E011D3

<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>Threshold Value</td><td colspan="3">• Output signal above the maximum value(above 4.965V)</td></tr>
<tr><td>Diagnostic Time</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">Check Lamp</td><td rowspan="2">YES</td></tr>
</table>

SPECIFICATION E86F4553

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

SCHEMATIC DIAGRAM E9281AE2

Refer to DTC P0116.

SIGNAL WAVEFORM AND DATA E3E0DA72

Refer to DTC P0116.

MONITOR SCANTOOL DATA E0DE472D

Refer to DTC P0116.

TERMINAL AND CONNECTOR INSPECTION EE38B71D

Refer to DTC P0116.

SIGNAL CIRCUIT INSPECTION ECFE1A35

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(C244-A) 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 E33FEF79

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 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".

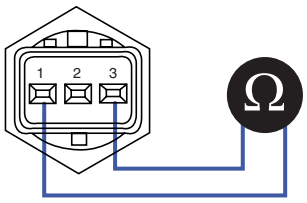
NO

▶ 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 E1B394C1

1. IG KEY "OFF", ENGINE "OFF".
2. Disconnect ECTS connector.
3. Measure resistance between ECTS terminal 1 and 3, referring to resistance characteristic table of specification of General information.

Specification : Refer to Specification of General Information



KFQG345A

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 E1DA77D4

Refer to DTC P0116.

DTC P0182 FUEL TEMP SENSOR A CIRCUIT LOW INPUT

COMPONENT LOCATION EDC6B4D4

SNFFL6204L

GENERAL DESCRIPTION EA9DBC2F

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℃.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 EAA3ACA6

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 E8AA4FEC

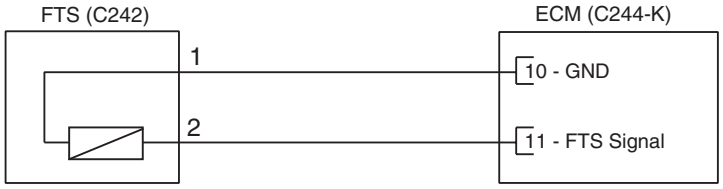
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• FTS circuit
• FTS component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• When output signal is below the minimum value.(below 0.053V)</td></tr>
<tr><td>Diagnostic Time</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">• Fuel temp. fixed at 85℃</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>Check Lamp</td><td>NO</td></tr>
</table>

SPECIFICATION E76FB9BC

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

SCHEMATIC DIAGRAM EE38CA0A

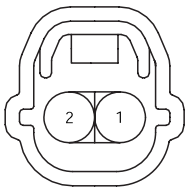
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-K (10)	Sensor ground
2	ECM C244-K (11)	FTS Signal

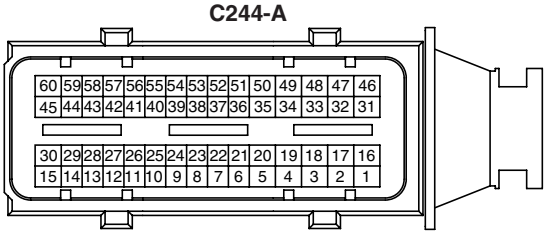
[HARNESS CONNECTORS]



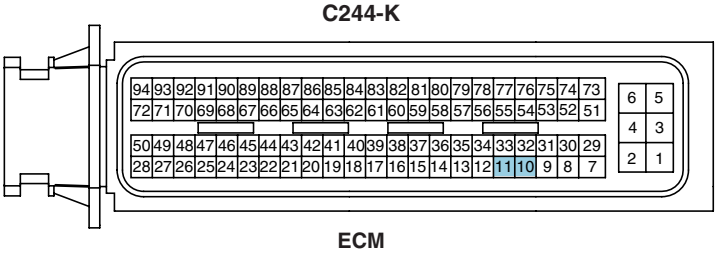
C242

FTS

C244-A



C244-K



ECM

STGFL7153L

SIGNAL WAVEFORM AND DATA E3BBF5F8

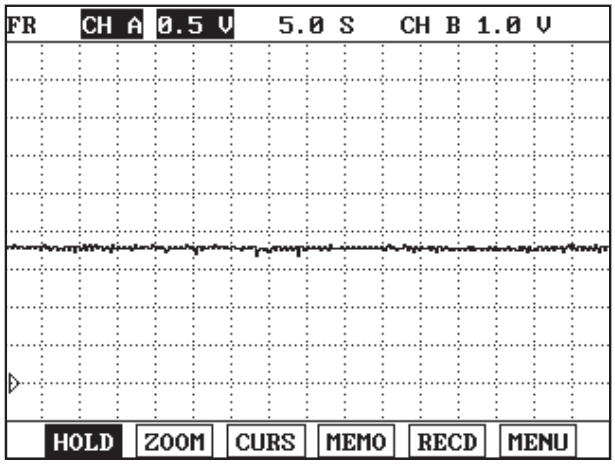


Fig.1

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

LFIG242A

MONITOR SCANTOOL DATA EA939F92

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

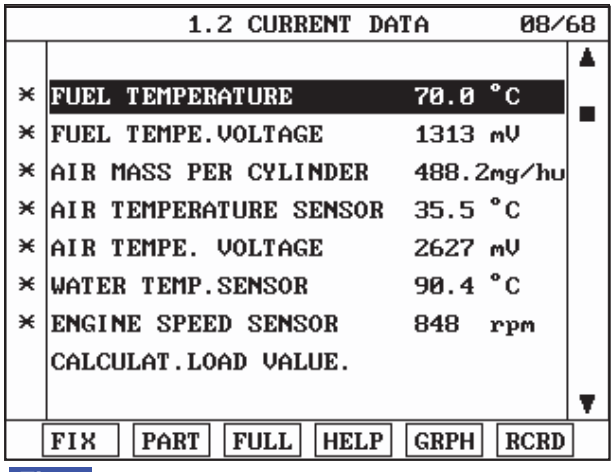


Fig.1

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

STGFL7604L

TERMINAL AND CONNECTOR INSPECTION E237490F

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 E86E55F0

1. Check signal circuit voltage

   1) IG KEY "OFF", ENGINE "OFF".

   2) Disconnect FTS connector.

   3) IG KEY "ON"

   4) Measure the voltage of terminal 2 of FTS connector.

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".

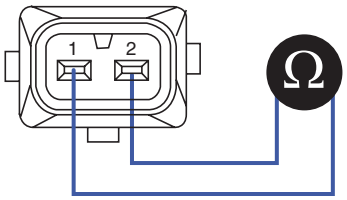
NO

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

COMPONENT INSPECTION E7426B3E

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect FTS connector.
3. Measure resistance of FTS component terminal 1 and 2, referring to resistance characteristic table of specification of General information.

Specification : Refer to Specification of General Information.



SNFFL6316D

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 E5157BAD

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 ED9FFBA8

Refer to DTC P0182.

GENERAL DESCRIPTION E2B0DE69

Refer to DTC P0182.

DTC DESCRIPTION E994022B

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 E7551B39

<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>Threshold Value</td><td colspan="3">• When output signal is above the maximum value.(above 4.912V)</td></tr>
<tr><td>Diagnostic Time</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">• Fuel temp. fixed at 85℃</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>Check Lamp</td><td>NO</td></tr>
</table>

SPECIFICATION E510A89A

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 E31A4E97

Refer to DTC P0182.

SIGNAL WAVEFORM AND DATA E2101392

Refer to DTC P0182.

MONITOR SCANTOOL DATA ED9217BD

Refer to DTC P0182.

TERMINAL AND CONNECTOR INSPECTION E63D6AEF

Refer to DTC P0182.

SIGNAL CIRCUIT INSPECTION E7084471

1. Check signal circuit voltage
   1) IG KEY "OFF", ENGINE "OFF".
   2) Disconnect FTS connector.
   3) IG KEY "ON"
   4) Measure the voltage of terminal 2 of FTS connector.

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(C244-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 terminal 2 of FTS connector.

Specification : 0.0V~0.1V

5) Is the measured resistance within the specification?

YES

▶ Go to "Ground Circuit Inspection".

NO

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

GROUND CIRCUIT INSPECTION EACA4CC7

1. IG KEY "OFF", ENGINE "OFF".
2. Disconnect FTS connector and ECM connector
3. IG KEY "ON"
4. Measure the voltage of terminal 2 of FTS connector.[TEST "A"]
5. Measure the voltage between FTS connector terminal 2 and 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".

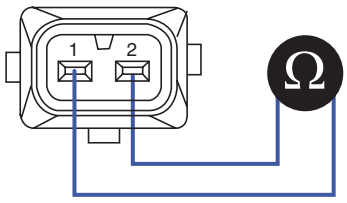
NO

▶ 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 E76F14E6

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect FTS connector.
3. Measure resistance of FTS component terminal 1 and 2, referring to resistance characteristic table of specification of General information.

Specification : Refer to Specification of General Information.



SNFFL6316D

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

YES

▶ Go to "Verification of Vehicle Rapair"

NO

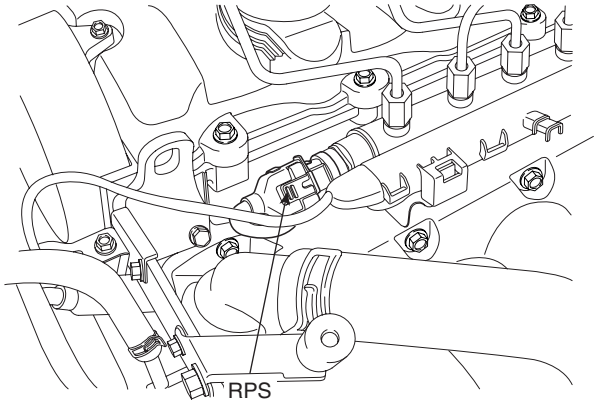
▶ Replace FTS and go to "Verification of Vehicle Rapair".

VERIFICATION OF VEHICLE REPAIR E879ADF7

Refer to DTC P0182.

DTC P0192 FUEL RAIL PRESS. SENSOR-LOW INPUT

COMPONENT LOCATION E739C00E



SNFFL6205D

GENERAL DESCRIPTION E924335A

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.

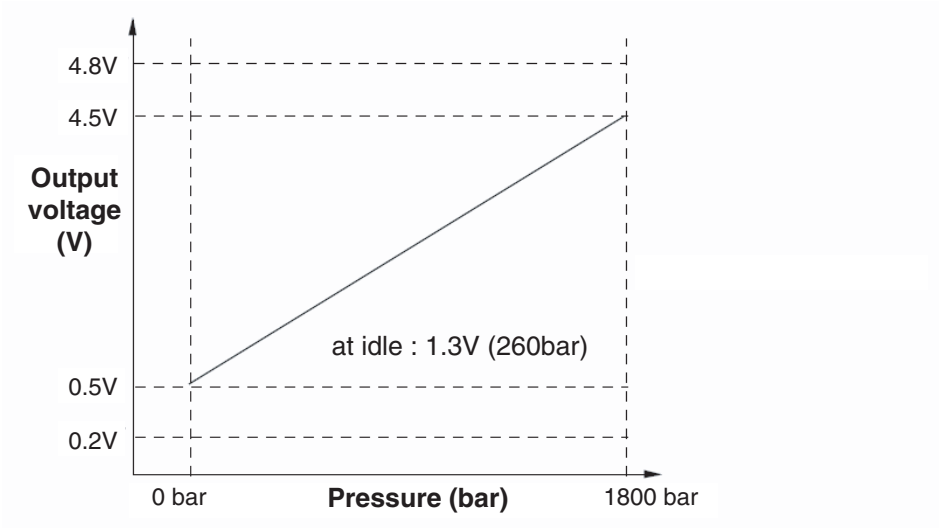
DTC DESCRIPTION E67297D6

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 EB5D921E

<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="9">• RPS circuit
• RPS component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Output sinal below minimum value (below 0.254V)</td></tr>
<tr><td>Diagnostic Time</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">• 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>Check Lamp</td><td>YES</td></tr>
</table>

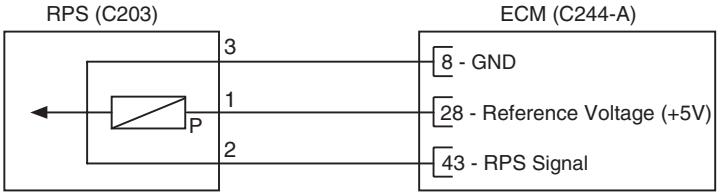
SPECIFICATION E0AA2EF8



EGNG010O

SCHEMATIC DIAGRAM E9F59A63

[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

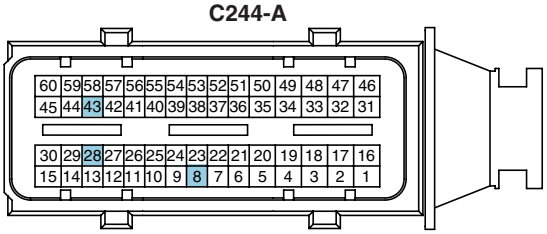
Terminal	Connected to	Function
1	ECM C244-A (28)	Reference Voltage (+5V)
2	ECM C244-A (43)	RPS Signal
3	ECM C244-A (8)	Sensor Signal

[HARNESS CONNECTORS]

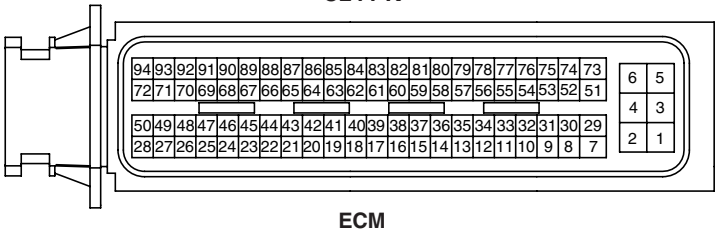
C203

RPS

C244-A



C244-K



ECM

STGFL7150L

SIGNAL WAVEFORM AND DATA E5B8454E

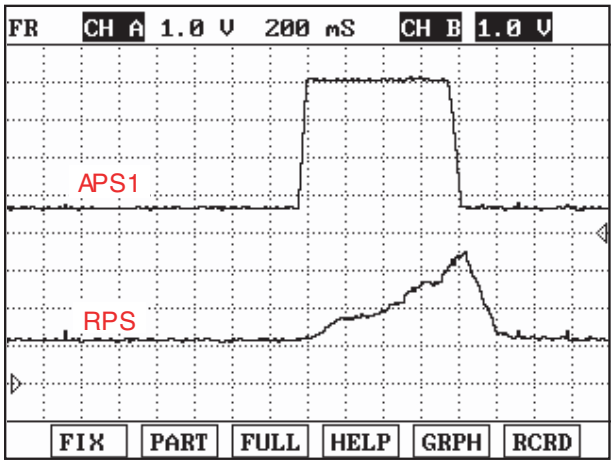


Fig.1

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

LFIG251A

MONITOR SCANTOOL DATA EE9EB2BC

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", "INJ. PUMP REGULATOR","RAIL PRESS. REGULATOR1" parameter on the Scantool.

SPECIFICATION :

	Idle(without load)	Accelerating(stall test)	Diagnosis
FUEL PRESSURE MEASURED	27 ± 5 Mpa	above 75 Mpa	press. increases
INJ. PUMP REGULATOR	34 ± 3%	38 ± 3%	duty increases
RAIL PRESS. REGULATOR1	16 ± 3%	45 ± 3%	duty increases

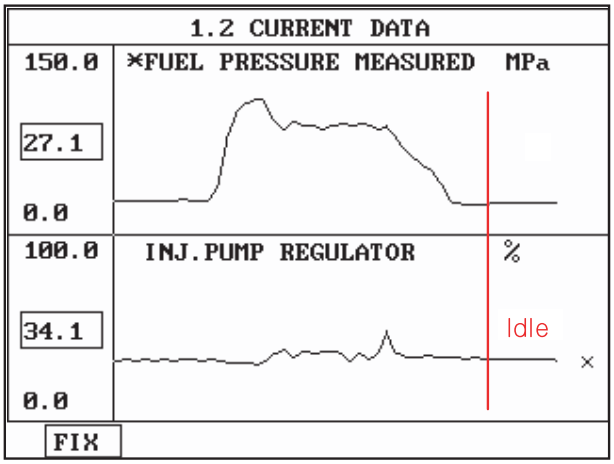


Fig.1

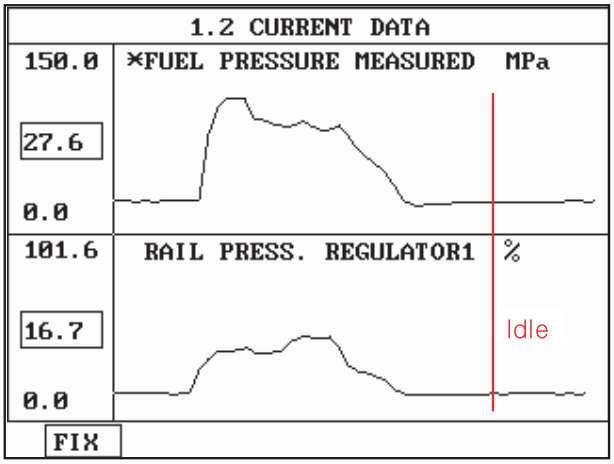


Fig.2

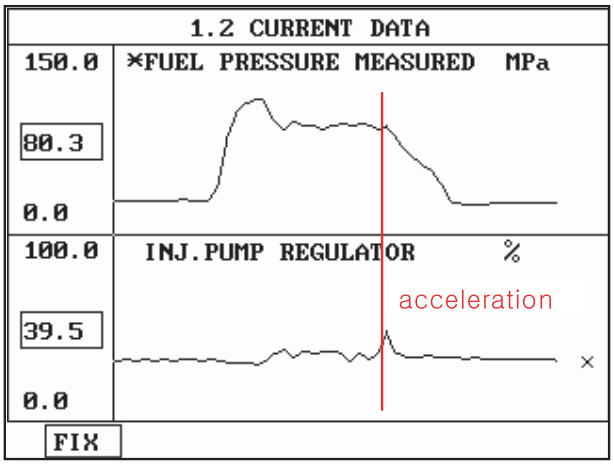


Fig.3

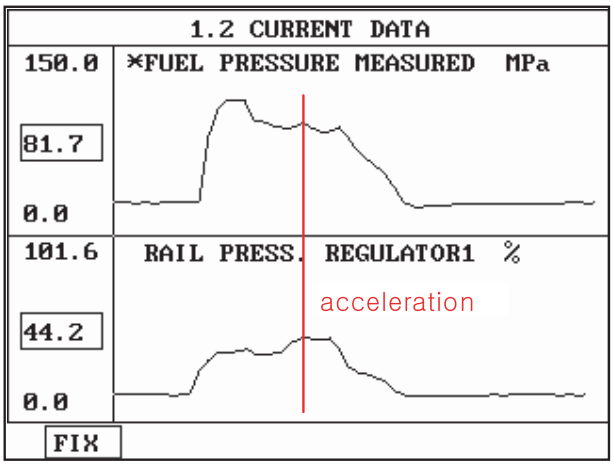


Fig.4

Fig.1) Fuel pressure and Fuel pressure regulator valve data at idle.
Fig.2) Fuel pressure and Rail pressure regulator valve data at idle.
Fig.3) Fuel pressure and Fuel pressure regulator valve data at acceleration.
Fig.4) Fuel pressure and Rail pressure regulator valve data at acceleration.

LFIG375A

NOTE

The waveform of fuel pressure regulator valve installed at high pressure pump(fuel detecting MPROP) shows 35 ± 3% duty at idle, duty rises to approx. 38% at acceleration to raise rail pressure.

The waveform of rail pressure regulator valve installed at common rail shows 17 ± 3% duty at idle, duty rises to approx. 45% at acceleration to raise rail pressure.

TERMINAL AND CONNECTOR INSPECTION E7C78F86

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 E82D2EB8

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 between RPS connector terminal 1 and ECM connector terminal 28.]

SIGNAL CIRCUIT INSPECTION E1A21937

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 EB0A9855

1. Visual Inspection of RPS

   1) IG KEY "OFF", ENGINE "OFF".

   2) Disconnect RPS connector.

   3) Check if corrosion or 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 : Refer to "Signal Waveform & Data" of "General Information".

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 EC493B21

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 E28EC543

Refer to DTC P0192.

GENERAL DESCRIPTION ED2931F8

Refer to DTC P0192.

DTC DESCRIPTION EFFF1CB2

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 EFB534E1

<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>Threshold Value</td><td colspan="3">• Output signal above the maximum value(above 4.75V)</td></tr>
<tr><td>Diagnostic Time</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">• 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>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION E876DB3D

Refer to DTC P0192.

SCHEMATIC DIAGRAM EB151563

Refer to DTC P0192.

SIGNAL WAVEFORM AND DATA E8E071BD

Refer to DTC P0192.

MONITOR SCANTOOL DATA E45B1C20

Refer to DTC P0192.

TERMINAL AND CONNECTOR INSPECTION E75ECF8B

Refer to DTC P0192.

POWER CIRCUIT INSPECTION E62DCA6E

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 between RPS connector terminal 1 and ECM connector terminal28.]

SIGNAL CIRCUIT INSPECTION EB449233

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(C244-A) 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 Rail Pressure sensor terminal 2 and ECM connector 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 the measured resistance 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 EA17760C

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 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 E70011A5

1. Visual Inspection of RPS
   1) IG KEY "OFF", ENGINE "OFF".
   2) Disconnect RPS connector.
   3) Check if corrosion or 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 : Refer to "Signal Waveform & Data" of "General Information".

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

      YES

      ▶ Go to "Verification of Vehicle Repair".

      NO

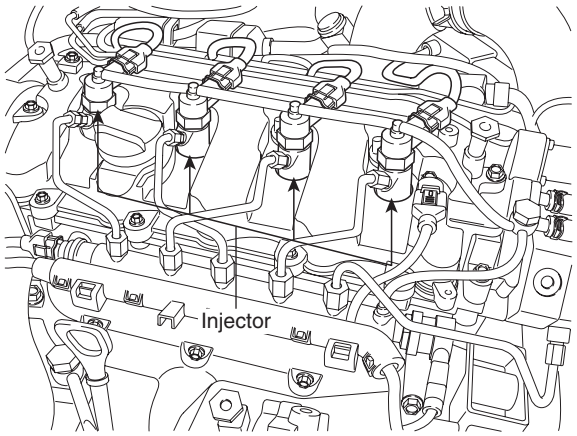
      ▶ Replace RPS and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR EA7E9B14

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 EB5A36F5



SNFFL6206L

GENERAL DESCRIPTION EC3A5B38

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 ED92DC9D

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 EB127AE5

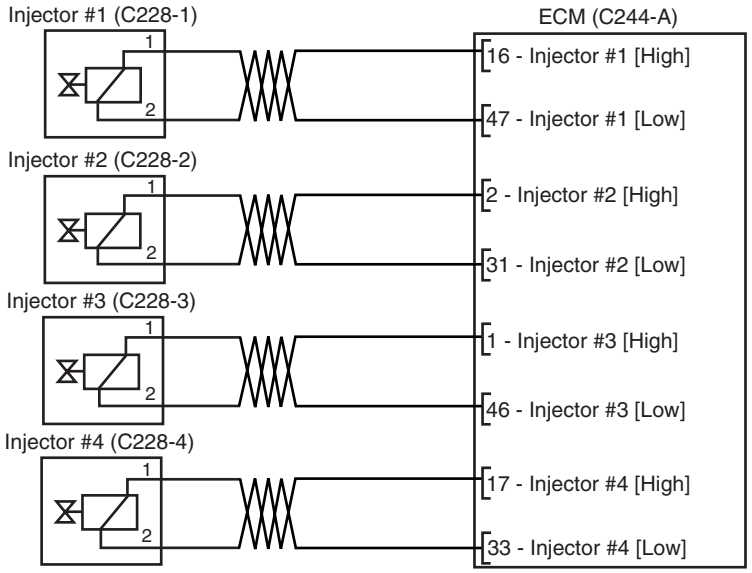
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Current monitoring</td><td rowspan="6">• Open in injector circuit
• Injector component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Open in injector circuit</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• Immediately</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel cut</td><td>NO</td><td rowspan="4">• Open circuit of More than 2 injectors : Engine OFF</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>YES</td></tr>
<tr><td>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION EB15543C

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 EC91C311

[CIRCUIT DIAGRAM]



[CONNECTOR INFORMATION]

[Injector #1]

Terminal	Connected to	Function
1	ECM C244-A (16)	Injector #1 [High] control
2	ECM C244-A (47)	Injector #1 [Low] control

[Injector #2]

Terminal	Connected to	Function
1	ECM C244-A (2)	Injector #2 [High] control
2	ECM C244-A (31)	Injector #2 [Low] control

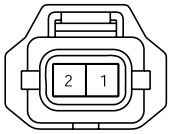
[Injector #3]

Terminal	Connected to	Function
1	ECM C244-A (1)	Injector #3 [High] control
2	ECM C244-A (46)	Injector #3 [Low] control

[Injector #4]

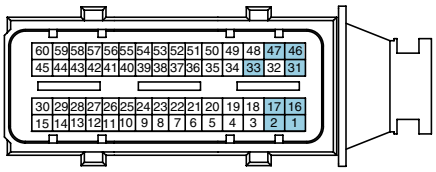
Terminal	Connected to	Function
1	ECM C244-A (17)	Injector #4 [High] control
2	ECM C244-A (33)	Injector #4 [Low] control

[HARNESS CONNECTOR]

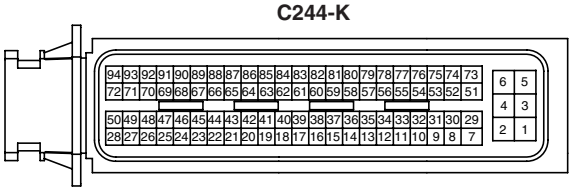


C228-1,2,3,4
Injector #1,#2,#3,#4

C244-A



C244-K



ECM

STGFL7258L

SIGNAL WAVEFORM AND DATA E78342AB

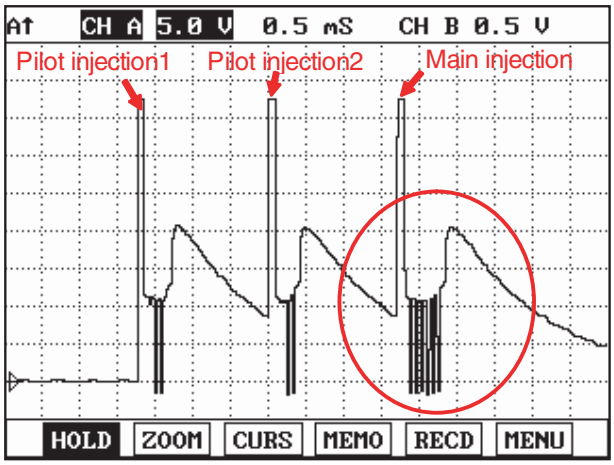


Fig.1

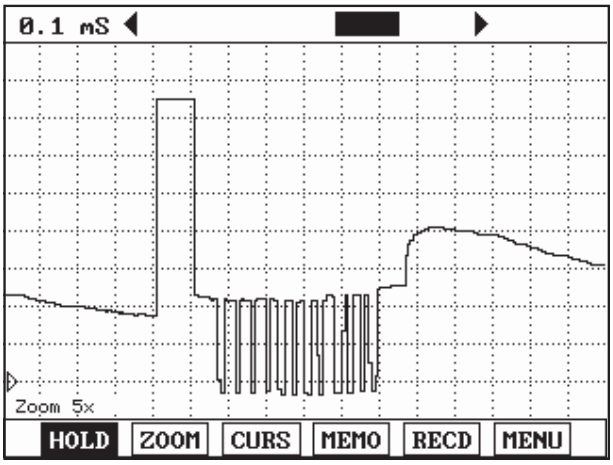


Fig.2

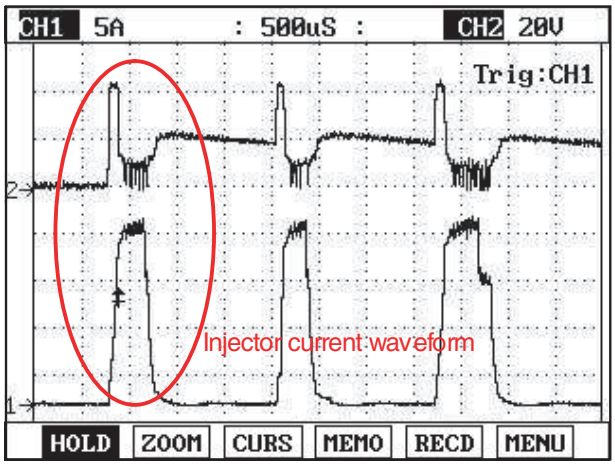


Fig.3

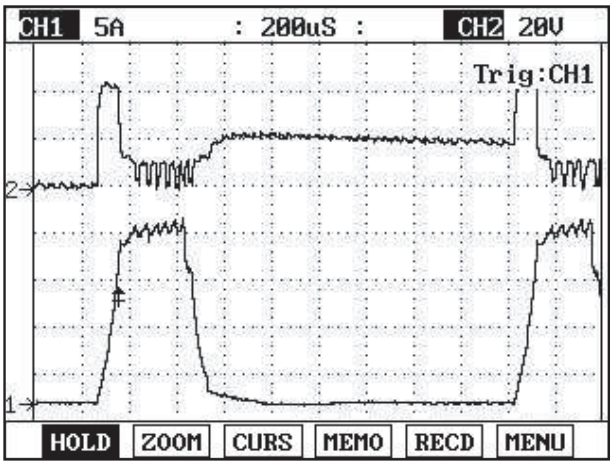


Fig.4

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)

LFIG259A

TERMINAL AND CONNECTOR INSPECTION E4982099

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 ED0A8269

1. Check open in power circuit(High side)

   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(C244-A) terminal 47.
      P0202) Check continuity between injector #2 connector terminal 2 and ECM connector(C244-A) terminal 31.
      P0203) Check continuity between injector #3 connector terminal 2 and ECM connector(C244-A) terminal 46.
      P0204) Check continuity between injector #4 connector terminal 2 and ECM connector(C244-A) 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 E6A03E03

1. Check open in control circuit(Low side)

   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(C244-A) terminal 16.
      P0202)Check continuity between injector #2 connector terminal 1 and ECM connector(C244-A) terminal 2.
      P0203)Check continuity between injector #3 connector terminal 1 and ECM connector(C244-A) terminal 1.
      P0204)Check continuity between injector #4 connector terminal 1 and ECM connector(C244-A) terminal 17.

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".

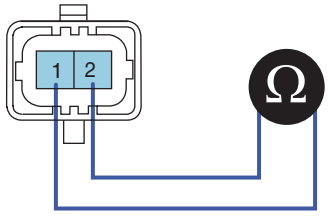
COMPONENT INSPECTION E25144D3

1. Check injector component resistance

   1) IG KEY "OFF", ENGINE "OFF".

   2) Disconnect injector connector.

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



KFQG320B

Specification : 0.255 ± 0.04Ω (20℃)

   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 CORRECTION" function on scantool, Refer to P1670, P1671 for more detailed information.

VERIFICATION OF VEHICLE REPAIR E39AD433

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

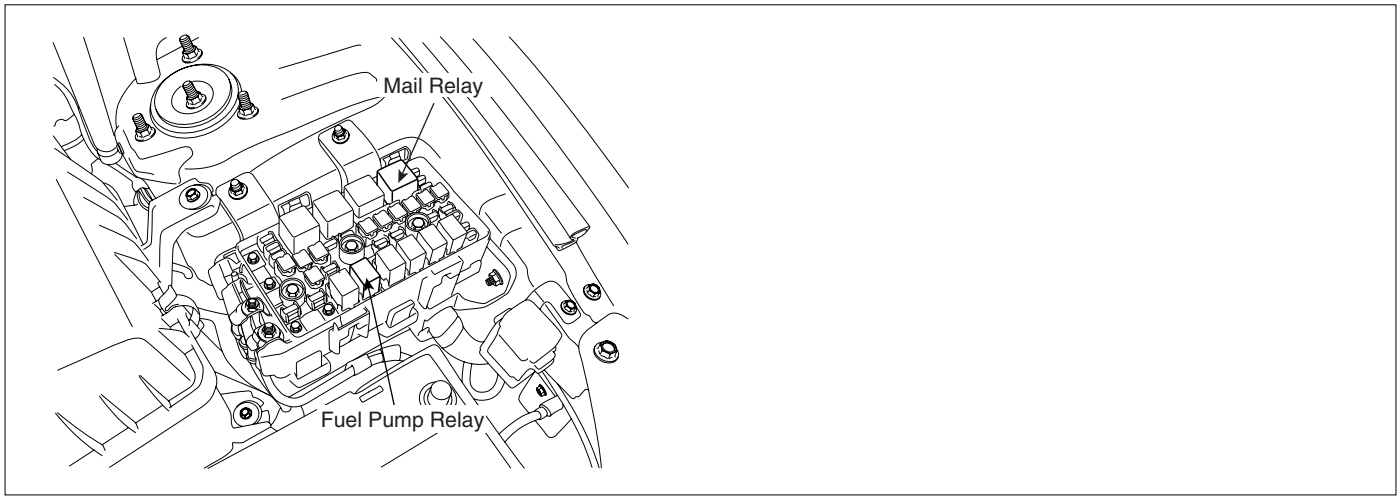
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0231 ELECTRIC FUEL PUMP RELAY-OPEN OR SHORT CIRCUIT

COMPONENT LOCATION E8E43295



SNFFL6209L

GENERAL DESCRIPTION E70481E1

Vain pump type fuel pump which is driven by electric motor is applied to this vehicle. Fuel pump which is installed inside of fuel tank supplies fuel to high pressure pump. ECM controls Fuel pump relay to supply power to low pressure fuel pump. The relay operates for 1.5 sec. for the diagnosis fuel pump relay at IG KEY ON, then if engine speed above 45rpm is detected by CKPS, relay turns ON and fuel is supplied to high pressure pump.

DTC DESCRIPTION E251BDEA

P0231 is set when no current or excessively low current is detected in fuel pump relay control circuit for more than 1 sec. at Fuel pump relay ON condition. This code is due to open or short to ground in glow relay control circuit or internal open in Fuel pump relay component.

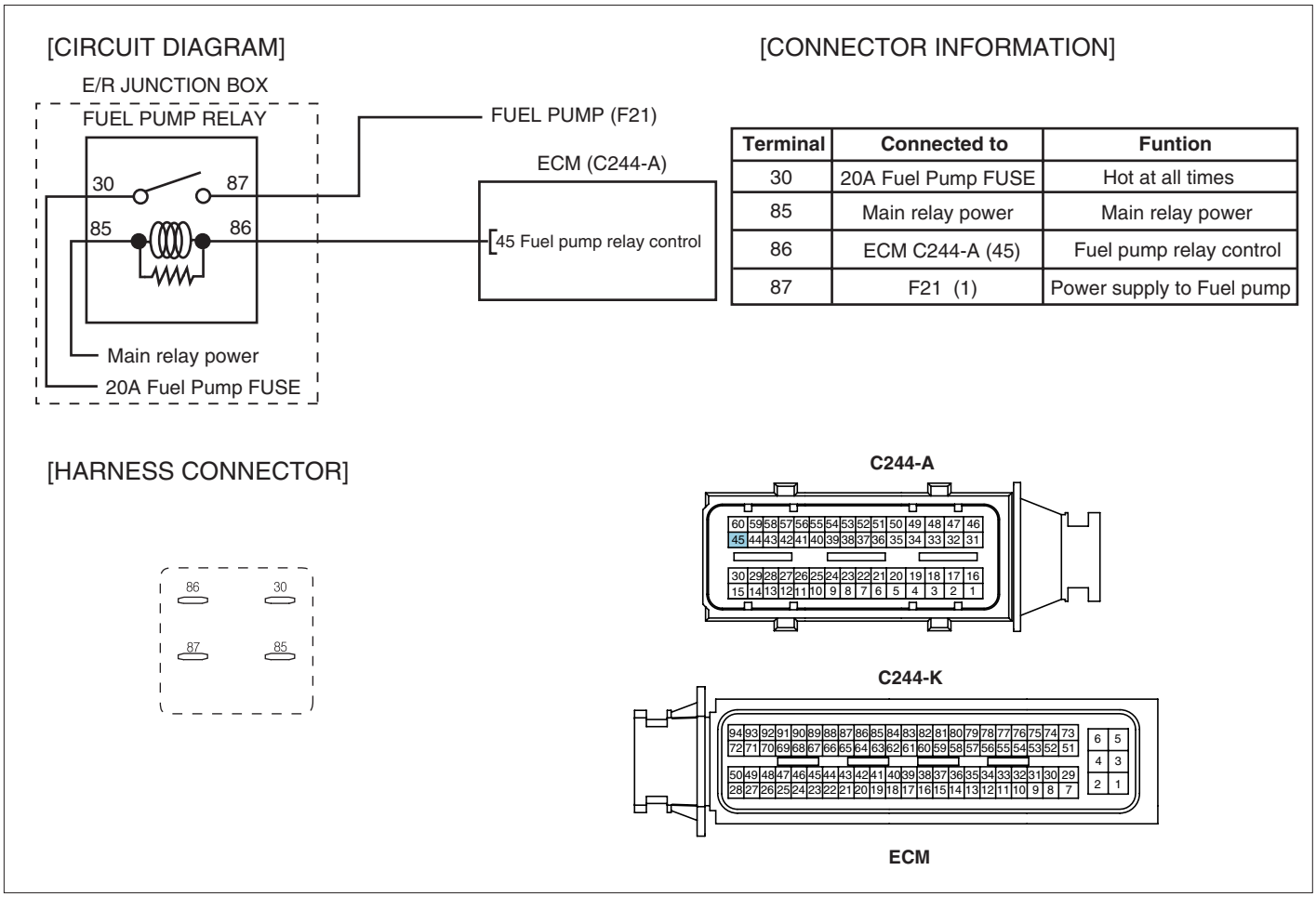
DTC DETECTING CONDITION E2A6ACE0

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Fuel pump relay control circuit • Fuel pump relay component
Enable Conditions	• IG KEY "ON" (monitoring only performed within relay operating condition)			
Threshold Value	• Short to GND, Wiring open			
Diagnostic Time	• 1.0 sec.			
Fail Safe	Fuel cut	NO		
	EGR Off	NO		
	Fuel Limit	NO		
	Check Lamp	NO		

SPECIFICATION EF3D2C62

Relay Coil Resistance	Motor Type	Pumping Pressure
75±10Ω (20℃)	Electric motor type vein pump	4 - 5 bar

SCHEMATIC DIAGRAM E97CCFE2



Terminal	Connected to	Funtion
30	20A Fuel Pump FUSE	Hot at all times
85	Main relay power	Main relay power
86	ECM C244-A (45)	Fuel pump relay control
87	F21 (1)	Power supply to Fuel pump

STGFL7549L

MONITOR SCANTOOL DATA EAFD5954

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 "ACTUATION TEST" parameter on the scantool.

specification : Fuel pump(fuel pump relay) operates at actuation test

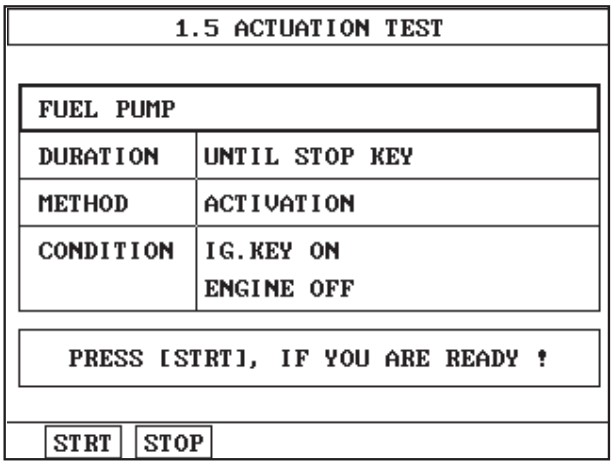


Fig.1

Fig.1) Diagnosing problem is convenient and accurate through ACTUATION TEST of fuel pump relay

LFIG270A

TERMINAL AND CONNECTOR INSPECTION E66FC9AE

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 E5EFA67E

1. Check Fuel pump motor power(Input) voltage

   1) IG KEY "OFF", ENGINE "OFF".

   2) Disconnect fuel pump relay.

   3) Measure the voltage of fuel pump relay connector terminal 30.

Specification : 11.5V~13.0V

4) Is the measured voltage within the specification?

YES

▶ Go to "2. Check Fuel pump motor power(Input) voltage" as follows.

NO

▶ Repair open in E/R JUNCTION BOX 20A F/PUMP fuse and related circuit and go to "Verification of Vehicle Repair".

2. Check Relay coil power circuit voltage

1) IG KEY "OFF", ENGINE "OFF".

2) Disconnect fuel pump relay.

3) IG KEY "ON".

4) Measure the voltage of fuel pump relay connector terminal 85.

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 E4E31AF6

1. Check short to ground in control circuit

1) IG KEY "OFF", ENGINE "OFF".

2) Disconnect fuel pump relay.

3) IG KEY "ON".

4) Measure the voltage of fuel pump relay connector terminal 86.

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".
▶ 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 fuel pump relay and ECM connector.

   3) Check continuity between fuel pump relay connector terminal 86 and ECM connector(C244-A) terminal 45.

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".

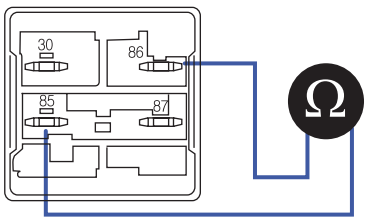
COMPONENT INSPECTION E748D1BD

1. Check fuel pump relay component coil resistance

   1) IG KEY "OFF", ENGINE "OFF".

   2) Disconnect fuel pump relay.

   3) Measure the resistance of fuel pump relay component coil.



SNFFL6367D

Specification : 75±5 Ω (20℃)

   4) Is the measured resistance within the specification?

YES

▶ Go to "2. Check fuel pump relay component operation" as follows.

NO

▶ Replace fuel pump relay and go to "Verification of Vehicle Repair".

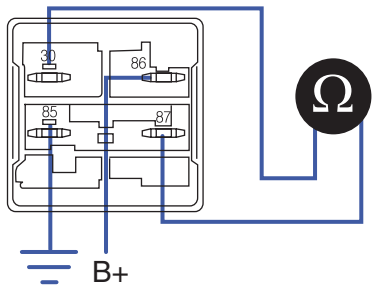
2. Check fuel pump relay component operation

   1) IG KEY "OFF", ENGINE "OFF".

   2) Disconnect fuel pump relay.

   3) Supplies random B+ and ground to coil sides of fuel pump relay (terminal 85, terminal 86).

   4) Check continuity between fuel pump relay terminal 30 and terminal 87.



SNFFL6368D

specification : When power is supplied : Continuity (below 1.0Ω)
When power is not supplied : Discontinuity (Infinite Ω)

   5) Is the measured resistance within the specification?

   YES

   ▶ Go to "Verification of Vehicle Repair".

   NO

   ▶ Replace fuel pump relay and go to "Verification of Vehicle Repair".

   ※ Repeat this process 2~3 times.

VERIFICATION OF VEHICLE REPAIR E28E9746

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 P0232 ELECTRIC FUEL PUMP RELAY-SHORT CIRCUIT

COMPONENT LOCATION ECB826BF

Refer to DTC P0231.

GENERAL DESCRIPTION E326391B

Refer to DTC P0231.

DTC DESCRIPTION ED083760

P0232 is set when excessive voltage is detected in Fuel pump relay control circuit for more than 1 sec. at Fuel pump relay ON condition. This code is due to short to battery in Fuel pump relay control circuit.

DTC DETECTING CONDITION E79A2371

<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">• Fuel pump relay control circuit
• Fuel pump relay component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON" (monitoring only performed within relay operating condition)</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• short to battery</td></tr>
<tr><td>Diagnostic Time</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>Check Lamp</td><td>NO</td></tr>
</table>

SPECIFICATION E86209F7

Relay Coil Resistance	Motor Type	Pumping Pressure
75±10Ω (20℃)	Electric motor type vein pump	4 - 5 bar

SCHEMATIC DIAGRAM ED2EBCA1

Refer to DTC P0231.

MONITOR SCANTOOL DATA E265CAB0

Refer to DTC P0231.

TERMINAL AND CONNECTOR INSPECTION E998FFCB

Refer to DTC P0231.

POWER CIRCUIT INSPECTION E1749BD3

1. Check Fuel pump motor power(Input) voltage

   1) IG KEY "OFF", ENGINE "OFF".

   2) Disconnect fuel pump relay.

   3) Measure the voltage of fuel pump relay connector terminal 30.

Specification : 11.5V~13.0V

   4) Is the measured voltage within the specification?

   YES

   ▶ Go to "2. Check Fuel pump motor power(Input) voltage" as follows.

   NO

   ▶ Repair open in E/R JUNCTION BOX 20A F/PUMP fuse and related circuit and go to "Verification of Vehicle Repair".

2. Check Relay coil power circuit voltage

   1) IG KEY "OFF", ENGINE "OFF".

   2) Disconnect fuel pump relay.

   3) IG KEY "ON".

   4) Measure the voltage of fuel pump relay connector terminal 85.

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 EACE6D1A

1. Check short to ground in control circuit

   1) IG KEY "OFF", ENGINE "OFF".

   2) Disconnect fuel pump relay.

   3) IG KEY "ON".

   4) Measure the voltage of fuel pump relay connector terminal 86.

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".
▶ 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 fuel pump relay and ECM connector.

3) Check continuity between fuel pump relay connector terminal 86 and ECM connector(C244-A) terminal 45.

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".

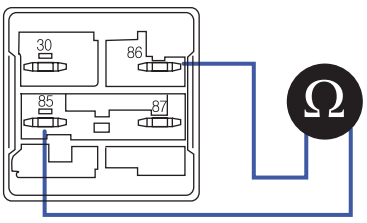
COMPONENT INSPECTION ED959BF8

1. Check fuel pump relay component coil resistance

1) IG KEY "OFF", ENGINE "OFF".

2) Disconnect fuel pump relay.

3) Measure the resistance of fuel pump relay component coil.



SNFFL6367D

Specification : 75±5 Ω (20℃)

4) Is the measured resistance within the specification?

YES

▶ Go to "2. Check fuel pump relay component operation" as follows.

NO

▶ Replace fuel pump relay and go to "Verification of Vehicle Repair".

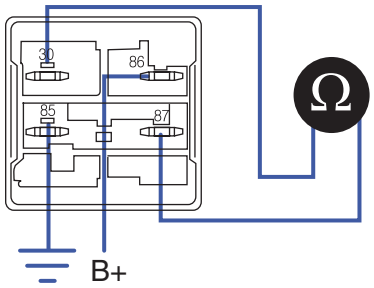
2. Check fuel pump relay component operation

1) IG KEY "OFF", ENGINE "OFF".

2) Disconnect fuel pump relay.

3) Supplies random B+ and ground to coil sides of fuel pump relay (terminal 85, terminal 86).

4) Check continuity between fuel pump relay terminal 30 and terminal 87.



SNFFL6368D

specification : When power is supplied : Continuity (below 1.0Ω)
When power is not supplied : Discontinuity (Infinite Ω)

5) Is the measured resistance within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace fuel pump relay and go to "Verification of Vehicle Repair".

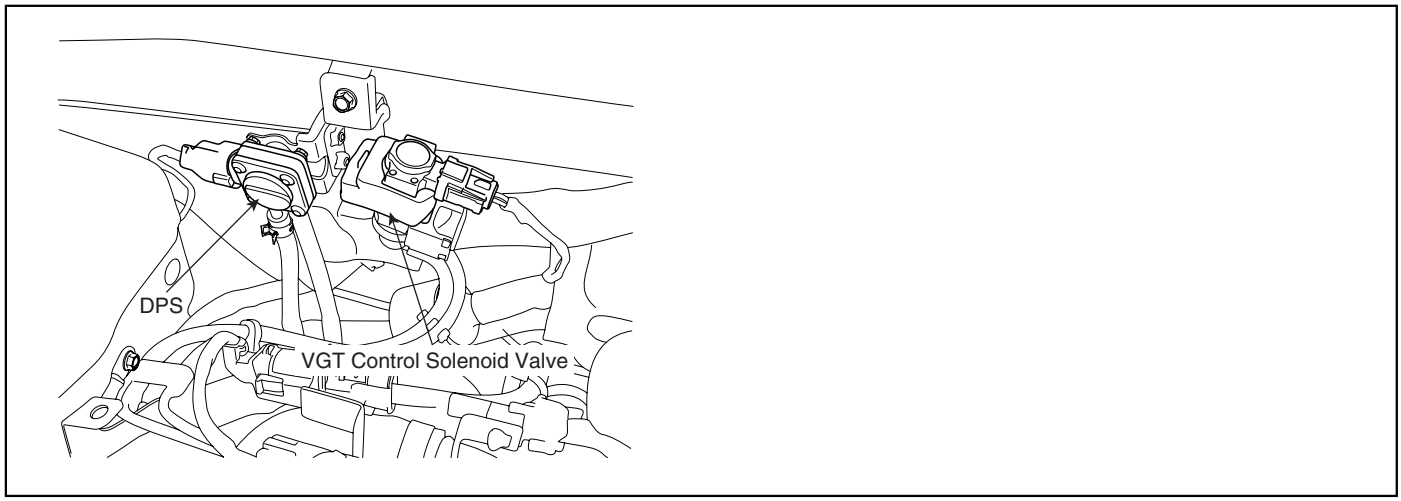
※ Repeat this process 2~3 times.

VERIFICATION OF VEHICLE REPAIR EF49A4E7

Refer to DTC P0231.

DTC P0234 TURBO/SUPER CHARGER OVERBOOST CONDITION

COMPONENT LOCATION ED0ED326



SNFFL6200L

GENERAL DESCRIPTION E1921F5B

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 information is 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 E306B38F

P0234 is set when real boost pressure is much lower than target boost pressure for more than 15 sec. at above 1750RPM and 10~22mg/hub of fuel injection quantity. This code is due to poor connection of VGT solenoid valve vacuum hose, vacuum leakage, clogging, VGT turbo charger component failure.

DTC DETECTING CONDITION E3E9A4DC

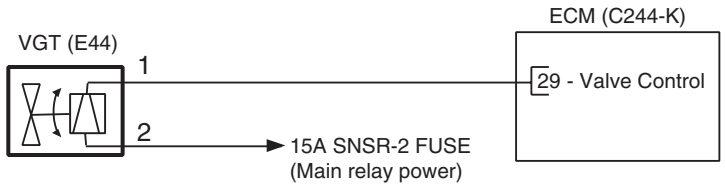
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Signal monitoring</td><td rowspan="8">• VGT solenoid component
• VGT vacuum line
• VGT turbo charger component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running(at above 1750RPM and 10 ~ 22mg/hub of fuel injection quantity)</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Real boost press. is much higher than target boost press.</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• 15 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>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION E920E0BD

VGT actuator component resistance	VGT actuator operating Hz	VGT actuator operating duty
14.7 ~ 16.1Ω (20℃)	300Hz	76% at idle, decreases as accelerating

SCHEMATIC DIAGRAM E75F1E5A

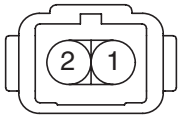
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-K (29)	Valve Control
2	JE02 (46)	Main relay power

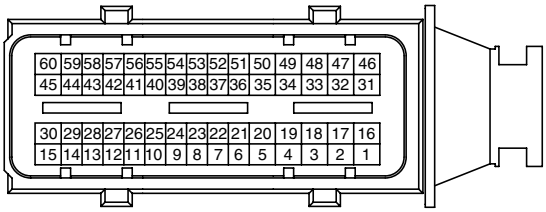
[HARNESS CONNECTORS]



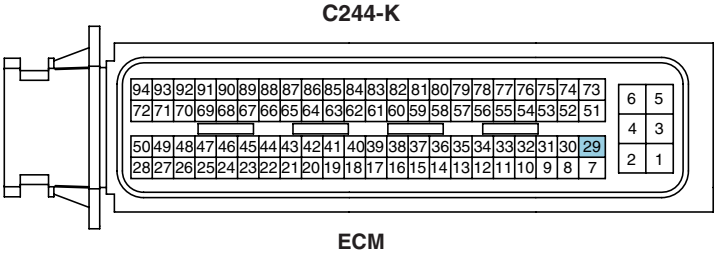
E44

VGT CONTROL SOLENOID VALVE

C244-A



C244-K



ECM

STGFL7161L

SIGNAL WAVEFORM AND DATA EDA0135A

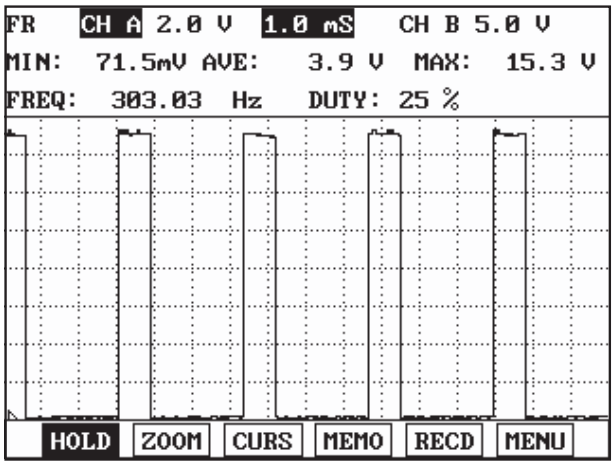


Fig.1

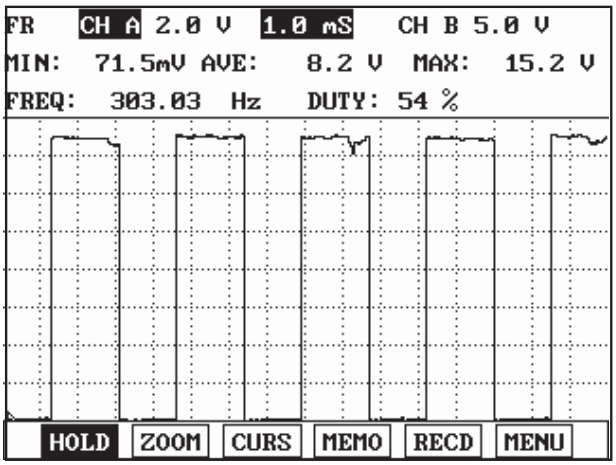


Fig.2

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

LFIG369A

MONITOR SCANTOOL DATA E6AB0D73

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 : approx. 76%) at idle

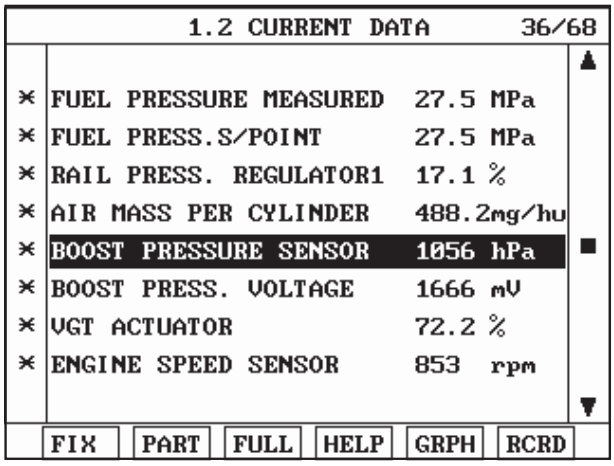


Fig.1

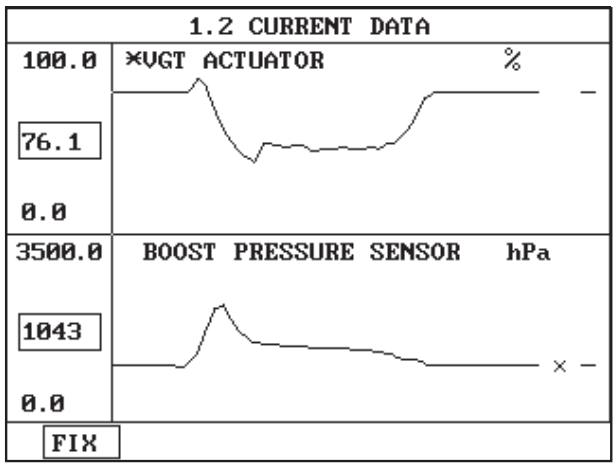


Fig.2

Fig1) Monitor "BOOST PRESSURE SENSOR" parameter on the Scantool at idle after warming engine up.
1000hpa ± 100hpa(approx. 1 atm) is correct value.
Fig.2) VGT actuator duty and boost pressure atacceleration is shown . If boost pressure rises and reaches certain value, VGT actuator duty stops to drop and keeps steady. Releasing accelerator pedal at this moment, VGT actuator duty drops to approx. 45%, then if RPM drops to idle range, duty returns to 76%.

STGFL7605L

TERMINAL AND CONNECTOR INSPECTION E2E1D5E1

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

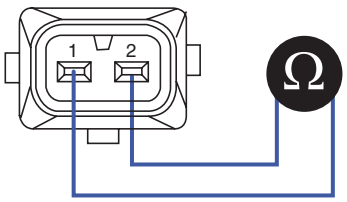
   ▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

   NO

   ▶ Go to "Component Inspection".

COMPONENT INSPECTION E8F6720A

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 2.



SNFFL6316D

Specification : 14.7 ~ 16.1Ω (20℃)

   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 76% 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 (Vacuum must not generates, correct VGT actuator operating duty is 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 E73800D6

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

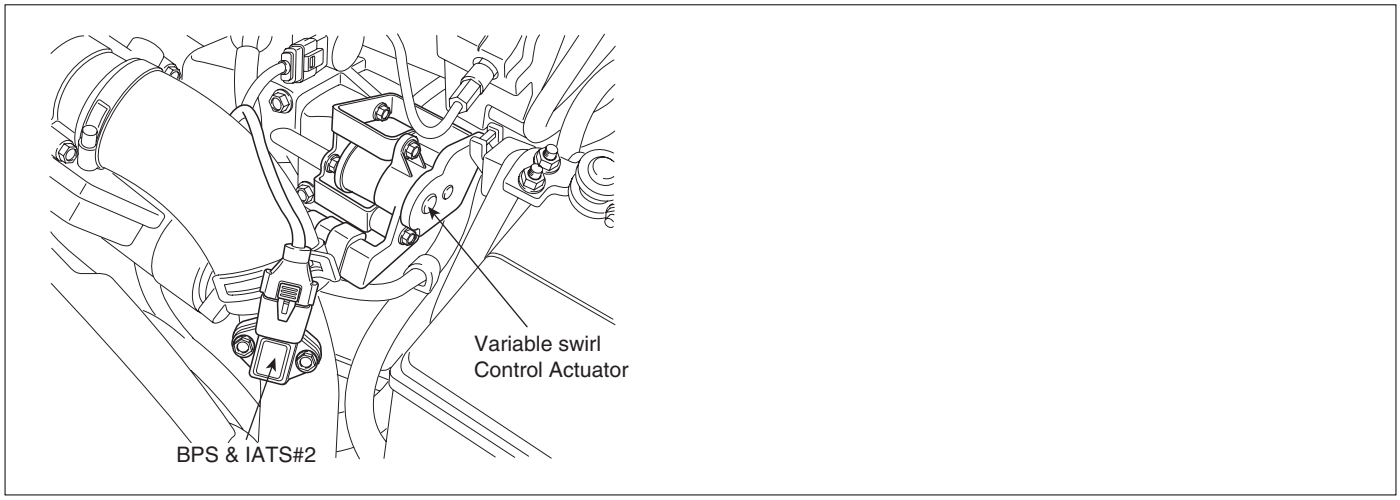
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0237 BOOST PRESSURE SENSOR CIRCUIT LOW INPUT

COMPONENT LOCATION EDAB9384



SNFFL6210L

GENERAL DESCRIPTION E24B323B

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 ECCB5E26

P0237 is set when the voltage below 0.2V - mimimum output voltage of BPS - is detected for more than 2 sec.. This code is due to open in power circuit or short to ground in signal circuit.

DTC DETECTING CONDITION EAF655CC

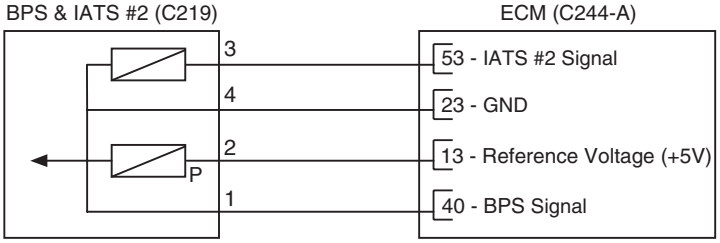
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• BPS circuit
• BPS component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Output signal below minimum value(below 200mV)</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• 2 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>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION E86C9D22

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

SCHEMATIC DIAGRAM E0142F1D

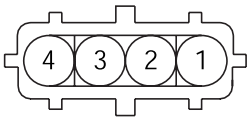
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-A (40)	BPS Signal
2	ECM C244-A (13)	Reference Voltage (+5V)
3	ECM C244-A (53)	IATS #2 Signal
4	ECM C244-A (23)	Sensor ground

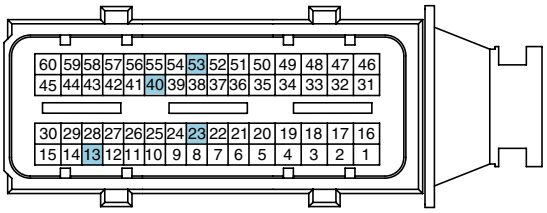
[HARNESS CONNECTORS]



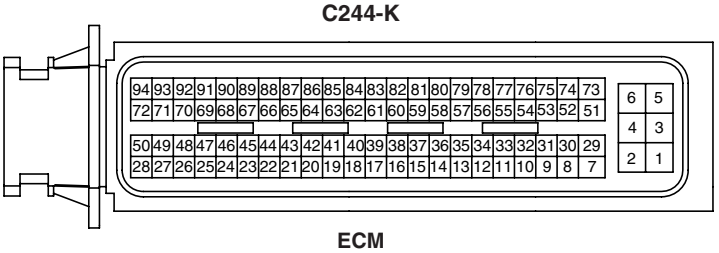
C219

BPS & IATS #2

C244-A



C244-K



ECM

STGFL7139L

SIGNAL WAVEFORM AND DATA E9686A08

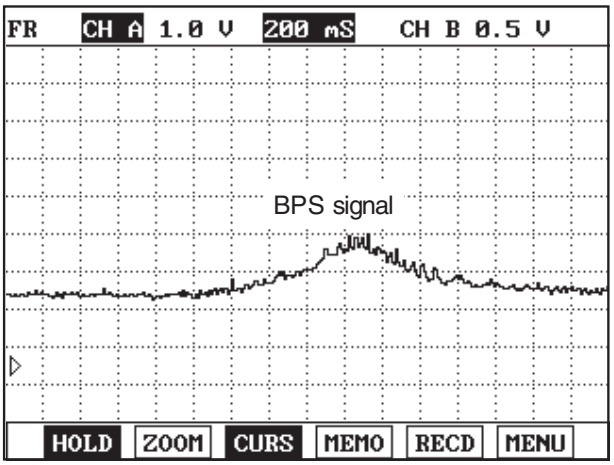


Fig.1

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

LFIG208A

MONITOR SCANTOOL DATA EA0E5911

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 : 1013hpa ± 100hpa(VGT actuator : approx. 70%) at idle

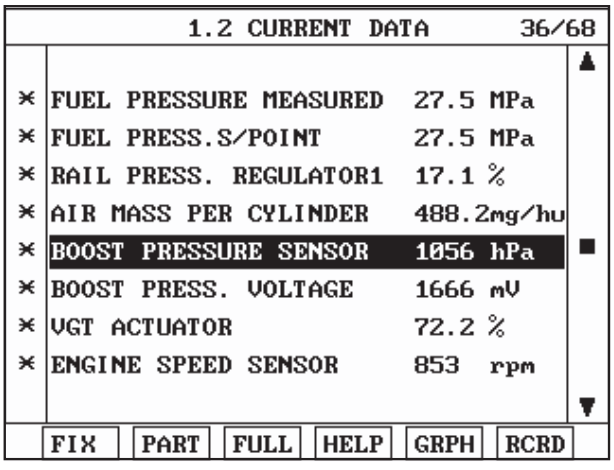


Fig.1

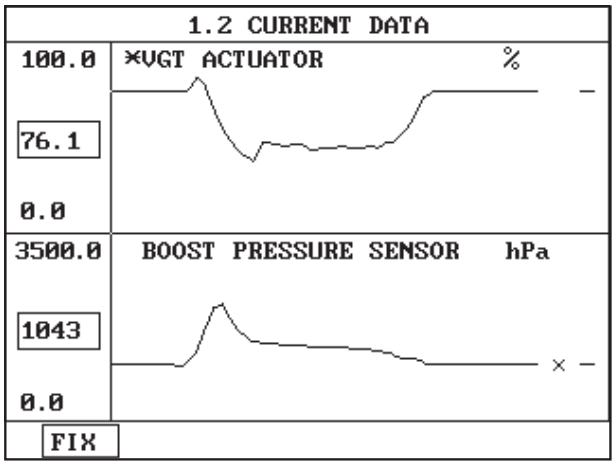


Fig.2

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

Fig.2) VGT actuator duty and boost pressure atacceleration is shown . If boost pressure rises and reaches certain value, VGT actuator duty stops to drop and keeps steady. Releasing accelerator pedal at this moment, VGT actuator duty drops to approx. 45%, then if RPM drops to idle range, duty returns to 76%.

STGFL7605L

TERMINAL AND CONNECTOR INSPECTION EE30EC4D

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 E863B4E7

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 EEE0DDF7

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 resistance 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 continutity 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 E0895801

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".

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 to be 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".

3. BPS Waveform inspection

1) IG KEY "ON", ENGINE "OFF".

2) Connect BPS.

3) Connect Oscilloscope to BPS connector terminal 1.

4) Monitor the waveform at idle and acceleration.

Specification : Refer to "Signal Waveform & Data" of "General Information".

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 E4D09EDB

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 EB67C22E

Refer to DTC P0237.

GENERAL DESCRIPTION E61F172F

Refer to DTC P0237.

DTC DESCRIPTION EE30B4C5

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 EFF0BEB4

<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"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Output signal above maximum value(above 4.9V)</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• 2 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>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION E36C5ED7

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

SCHEMATIC DIAGRAM E4E5E26E

Refer to DTC P0237.

SIGNAL WAVEFORM AND DATA EC24607B

Refer to DTC P0237.

MONITOR SCANTOOL DATA EA48F862

Refer to DTC P0237.

TERMINAL AND CONNECTOR INSPECTION EBADE34C

Refer to DTC P0237.

POWER CIRCUIT INSPECTION EE9894CE

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 E948D14B

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 : below 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".

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(C244-A) 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 E5201409

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 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 E3567416

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".

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 to be 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".

3. BPS Waveform inspection

1) IG KEY "ON", ENGINE "OFF".

2) Connect BPS.

3) Connect Oscilloscope to BPS connector terminal 1.

4) Monitor the waveform at idle and acceleration.

Specification : Refer to "Signal Waveform & Data" of "General Information".

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 EB580DF1

Refer to DTC P0237.

DTC P0252 FUEL PRESSURE REGULATOR VALVE CIRCUIT OVER CURRENT

COMPONENT LOCATION EF46378F

SNFFL6204L

GENERAL DESCRIPTION E681692E

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 ECE5431D

P0252 is set when excessive current in control circuit of Fuel metering unit(integrated with high pressure pump) is detected for more than 0.28 sec.. This code is due to short to battery in control circuit or Fuel metering unit internal short.

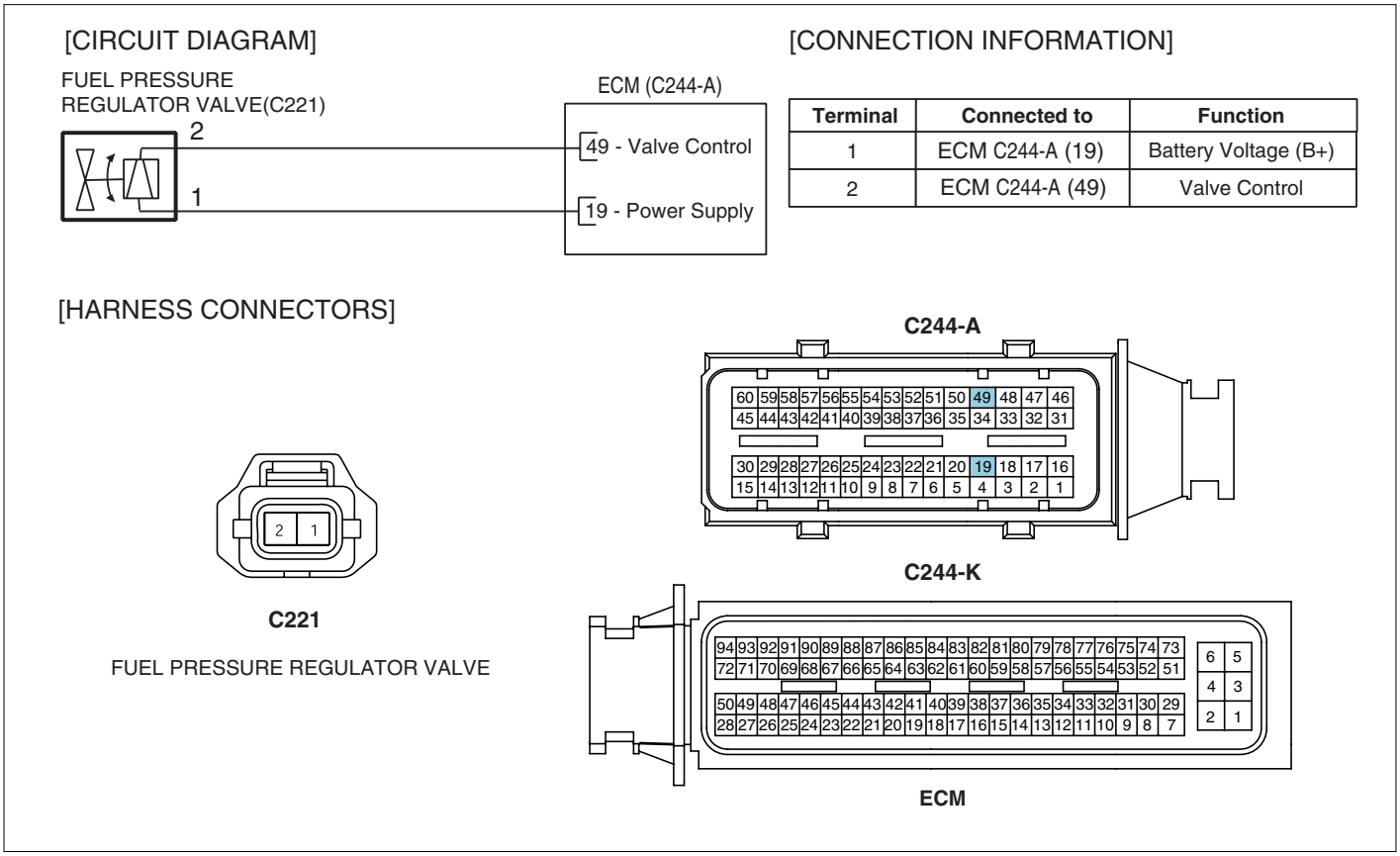
DTC DETECTING CONDITION E49F55F3

<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">• FPRV circuit
• FPRV component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Short to battery (control circuit in FPRV)</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• 0.28 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>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION E4B5298A

Rail pressure regulator valve resistance	Operating frequancy
2.9 ~ 3.15Ω (20℃)	185 Hz

SCHEMATIC DIAGRAM EADD4247



STGFL7155L

SIGNAL CIRCUIT INSPECTION E394805A

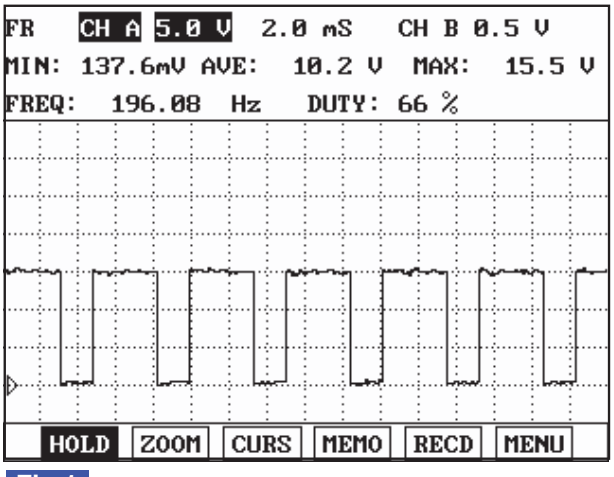


Fig.1

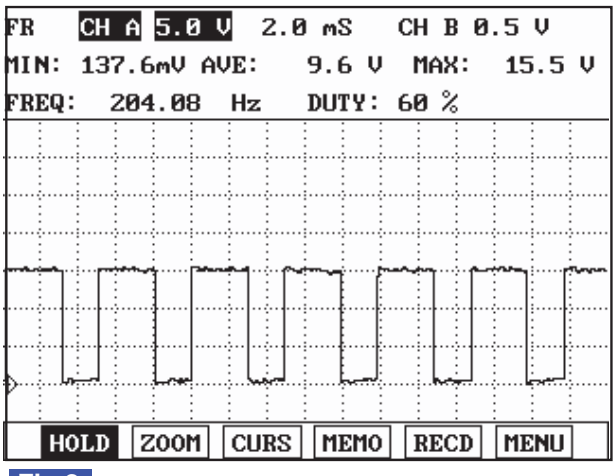


Fig.2

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

LFIG396A

MONITOR SCANTOOL DATA E563040C

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", "INJ. PUMP REGULATOR","RAIL PRESS. REGULATOR1" parameter on the Scantool.

SPECIFICATION :

	Idle(without load)	Accelerating(stall test)	Diagnosis
FUEL PRESSURE MEASURED	27 ± 5 Mpa	above 75 Mpa	press. increases
INJ. PUMP REGULATOR	34 ± 3%	38 ± 3%	duty increases
RAIL PRESS. REGULATOR1	16 ± 3%	45 ± 3%	duty increases

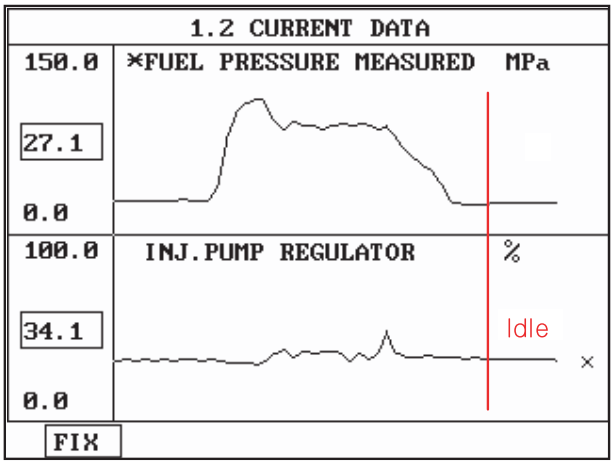


Fig.1

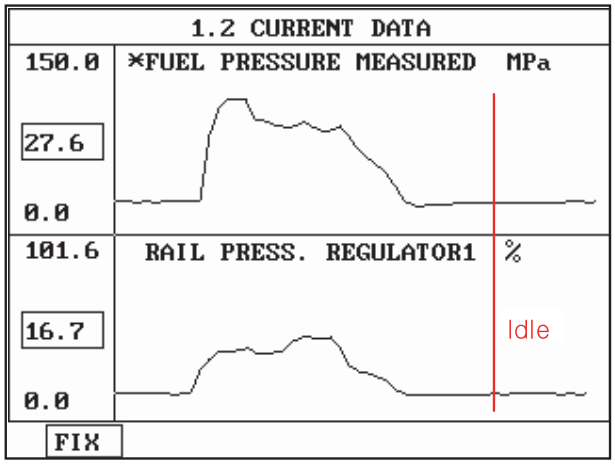


Fig.2

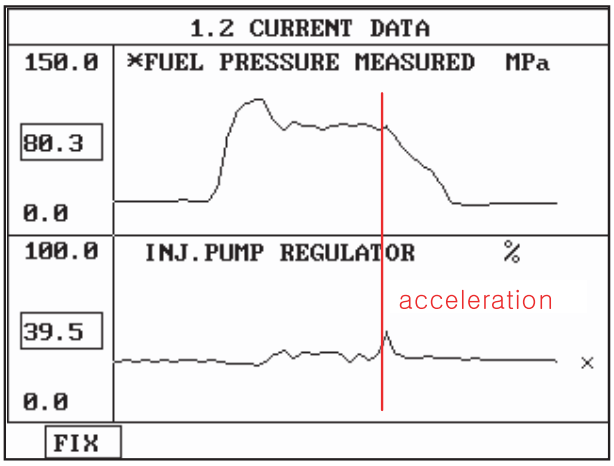


Fig.3

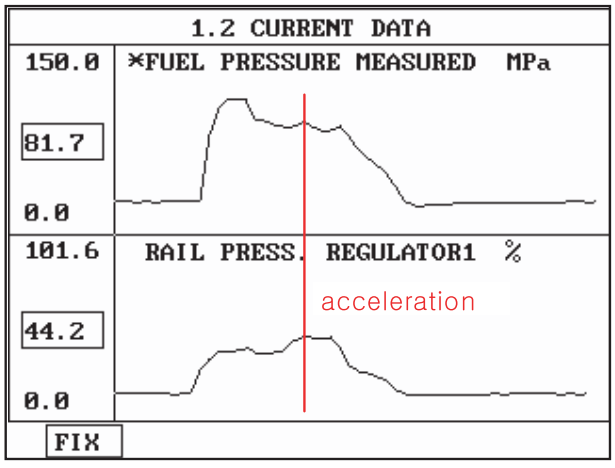


Fig.4

Fig.1) Fuel pressure and Fuel pressure regulator valve data at idle.
Fig.2) Fuel pressure and Rail pressure regulator valve data at idle.
Fig.3) Fuel pressure and Fuel pressure regulator valve data at acceleration.
Fig.4) Fuel pressure and Rail pressure regulator valve data at acceleration.

LFIG375A

NOTE

The waveform of fuel pressure regulator valve installed at high pressure pump(fuel detecting MPROP) shows 35 ± 3% duty at idle, duty rises to approx. 38% at acceleration to raise rail pressure.

The waveform of rail pressure regulator valve installed at common rail shows 17 ± 3% duty at idle, duty rises to approx. 45% at acceleration to raise rail pressure.

TERMINAL AND CONNECTOR INSPECTION E6D71921

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 E2F2B1D7

1. Check power circuit voltage
   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 terminal 19 and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION EC5CE4F6

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 (C244-A) 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".

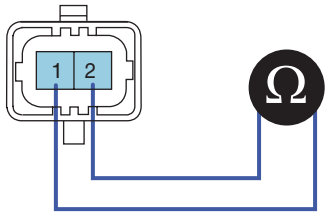
COMPONENT INSPECTION E71C26C3

1. Check FPRV component resistance

   1) IG KEY "OFF", ENGINE "OFF".

   2) Disconnect rail pressure regulator valve connector.

   3) Check FPRV component resistance.



KFQG320B

Specification : 2.9 ~ 3.15Ω (20℃)

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 E9DA2806

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 E13AC435

Refer to DTC P0252.

GENERAL DESCRIPTION EE181D0D

Refer to DTC P0252.

DTC DESCRIPTION EBDBEB6A

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 E69A2D44

<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>Threshold Value</td><td colspan="3">• Short to GND
• Wiring open</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• Refer to threshold value</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>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION E6675637

Rail pressure regulator valve resistance	Operating frequancy
2.9 ~ 3.15Ω (20℃)	185 Hz

SCHEMATIC DIAGRAM EF10FDA3

Refer to DTC P0252.

SIGNAL CIRCUIT INSPECTION E3B55AAE

Refer to DTC P0252.

MONITOR SCANTOOL DATA E77102B1

Refer to DTC P0252.

TERMINAL AND CONNECTOR INSPECTION E7C01545

Refer to DTC P0252.

POWER CIRCUIT INSPECTION E12F7850

1. Check power circuit voltage

   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 terminal 19 and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION E113E563

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 (C244-A) 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".

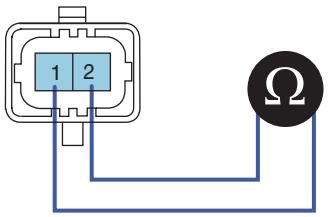
COMPONENT INSPECTION E13DD505

1. Check FPRV component resistance

1) IG KEY "OFF", ENGINE "OFF".

2) Disconnect rail pressure regulator valve connector.

3) Check FPRV component resistance.



KFQG320B

Specification : 2.9 ~ 3.15Ω (20℃)

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 E7CD8220

Refer to DTC P0252.

DTC P0254 FUEL PRESSURE REGULATOR VALVE CIRCUIT HIGH

COMPONENT LOCATION E96A7D25

Refer to DTC P0252.

GENERAL DESCRIPTION E9AA1DAE

Refer to DTC P0252.

DTC DESCRIPTION EF088AC1

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 E7B3B771

<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>Threshold Value</td><td colspan="3">• Short to battery (power circuit in fuel pressure regulator valve)</td></tr>
<tr><td>Diagnostic 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>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION E47A73AA

Rail pressure regulator valve resistance	Operating frequancy
2.9 ~ 3.15Ω (20℃)	185 Hz

SCHEMATIC DIAGRAM E4F2D5D2

Refer to DTC P0252.

SIGNAL CIRCUIT INSPECTION EDE56D74

Refer to DTC P0252.

MONITOR SCANTOOL DATA E53D7091

Refer to DTC P0252.

TERMINAL AND CONNECTOR INSPECTION EE35ED47

Refer to DTC P0252.

POWER CIRCUIT INSPECTION EF6C7AC2

1. Check power circuit voltage

   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 terminal 19 and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION E7C60142

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 (C244-A) 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".

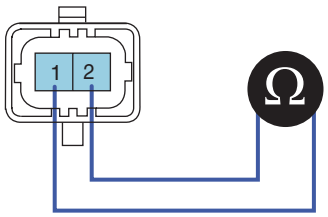
COMPONENT INSPECTION E8F8C790

1. Check FPRV component resistance

1) IG KEY "OFF", ENGINE "OFF".

2) Disconnect rail pressure regulator valve connector.

3) Check FPRV component resistance.



KFQG320B

Specification : 2.9 ~ 3.15Ω (20℃)

4) Is FPRV component resistance within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

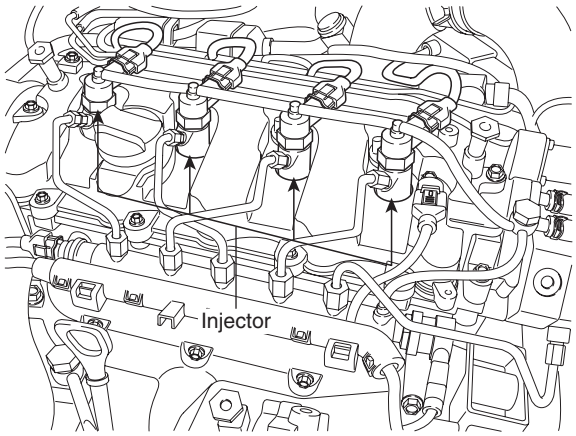
▶ Replace High pressure pump ass'y and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E686D6AF

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 EFBC7F1A



SNFFL6206L

GENERAL DESCRIPTION E960AAAB

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 E51F67F8

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 E18F5210

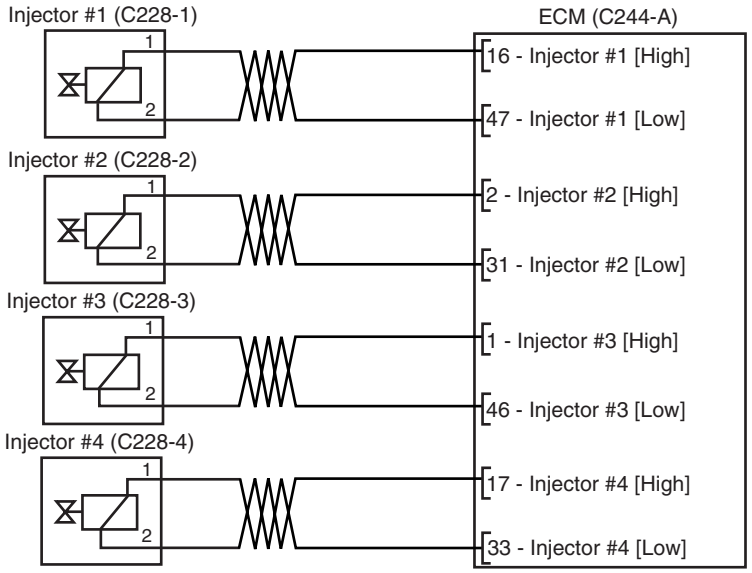
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Current monitoring</td><td rowspan="6">• Short in injector circuit
• Injector component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Highside short to Lowside, Lowside short to battery</td></tr>
<tr><td>Diagnostic Time</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>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION E2E599C4

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 E0DA7342

[CIRCUIT DIAGRAM]



[CONNECTOR INFORMATION]

[Injector #1]

Terminal	Connected to	Function
1	ECM C244-A (16)	Injector #1 [High] control
2	ECM C244-A (47)	Injector #1 [Low] control

[Injector #2]

Terminal	Connected to	Function
1	ECM C244-A (2)	Injector #2 [High] control
2	ECM C244-A (31)	Injector #2 [Low] control

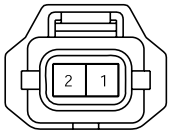
[Injector #3]

Terminal	Connected to	Function
1	ECM C244-A (1)	Injector #3 [High] control
2	ECM C244-A (46)	Injector #3 [Low] control

[Injector #4]

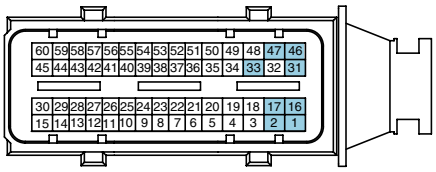
Terminal	Connected to	Function
1	ECM C244-A (17)	Injector #4 [High] control
2	ECM C244-A (33)	Injector #4 [Low] control

[HARNESS CONNECTOR]

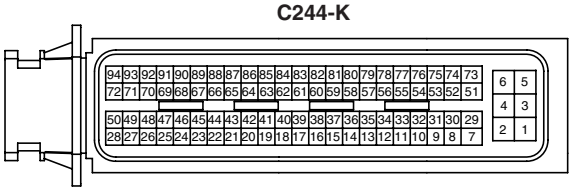


C228-1,2,3,4
Injector #1,#2,#3,#4

C244-A



C244-K



ECM

STGFL7258L

SIGNAL WAVEFORM AND DATA EE0DE7E6

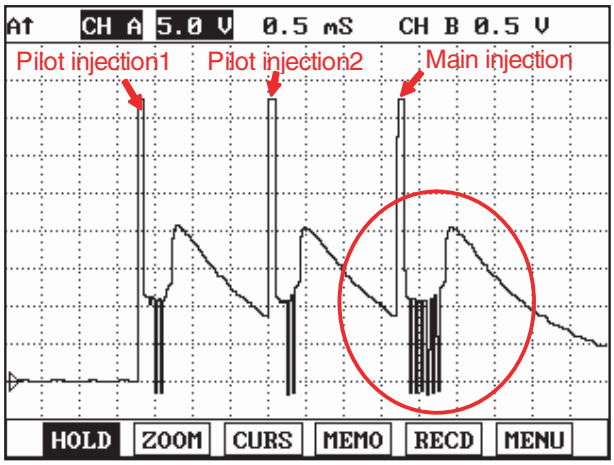


Fig.1

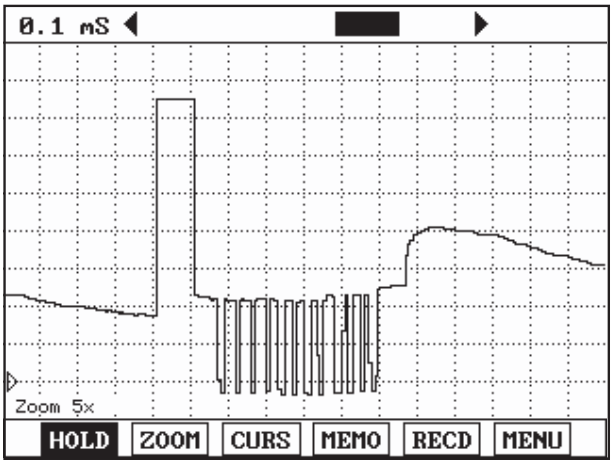


Fig.2

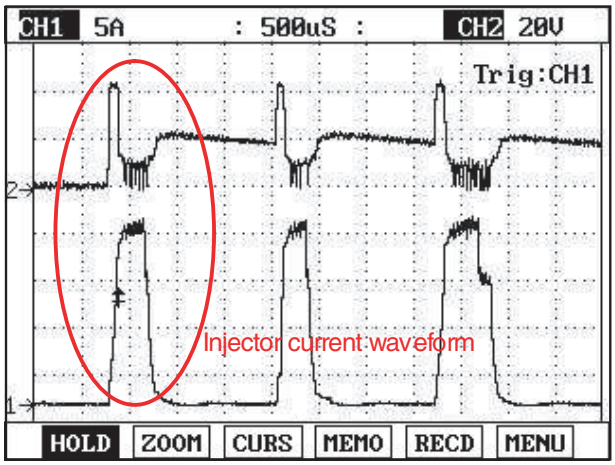


Fig.3

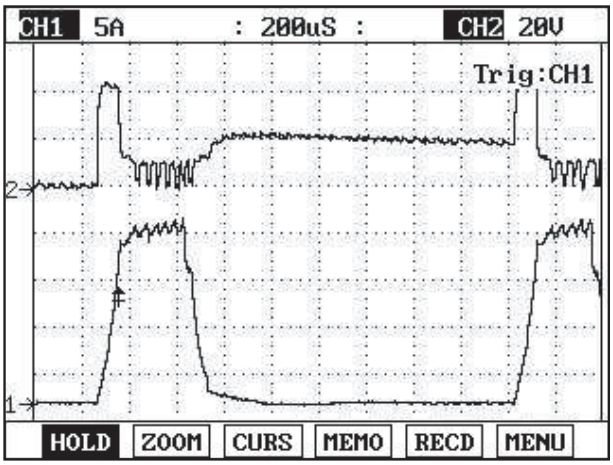


Fig.4

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)

LFIG259A

TERMINAL AND CONNECTOR INSPECTION E0F93F52

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 E87DA964

1. Check open 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 open 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 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 E3C92118

1. Check open in control circuit(Low side)
   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 resistance within the specification?

YES

▶ Go to "Component Inspectiont".

NO

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

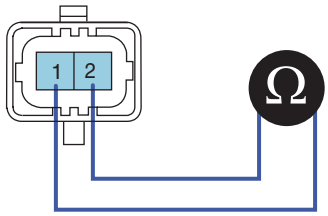
COMPONENT INSPECTION E3ECB9CF

1. Check injector component resistance

1) IG KEY "OFF", ENGINE "OFF".

2) Disconnect injector connector.

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



KFQG320B

Specification : 0.255 ± 0.04Ω (20℃)

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 CORRECTION" function on scantool, Refer to P1670, P1671 for more detailed information.

VERIFICATION OF VEHICLE REPAIR E6C81F9D

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

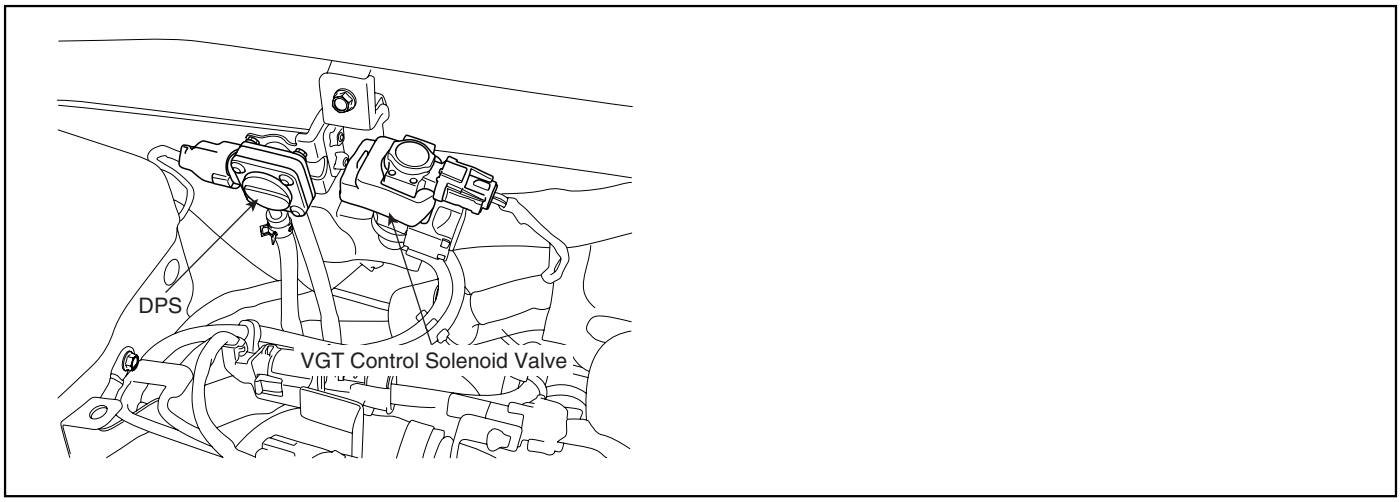
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0299 TURBO/SUPER CHARGER UNDERBOOST CONDITION

COMPONENT LOCATION E22A62B7



SNFFL6200L

GENERAL DESCRIPTION ED63D594

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 information is 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 E9634186

P0299 is set when real boost pressure is much higher than target boost pressure for more than 15 sec. at above 1750RPM and 10~22mg/hub of fuel injection quantity.This code is due to poor connection of VGT solenoid valve vacuum hose, vacuum leakage, clogging, VGT turbo charger component failure.

DTC DETECTING CONDITION E7B34F1D

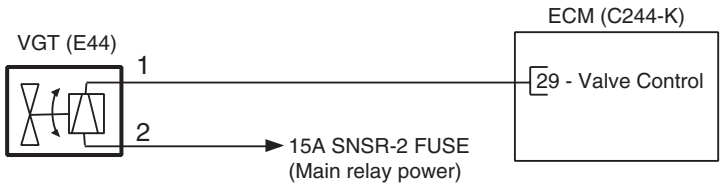
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Signal monitoring</td><td rowspan="8">• VGT solenoid component
• VGT vacuum line
• VGT turbo charger component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running
(at above 1750RPM and 10~22mg/hub of fuel injection quantity)</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Real boost press. is much lower than target boost press.</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• 15 sec.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel cut</td><td>NO</td><td rowspan="4">• Engine Check Lamp blinks.</td></tr>
<tr><td>EGR Off</td><td>YES</td></tr>
<tr><td>Fuel Limit</td><td>YES</td></tr>
<tr><td>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION E115195D

VGT actuator component resistance	VGT actuator operating Hz	VGT actuator operating duty
14.7 ~ 16.1Ω (20℃)	300Hz	76% at idle, decreases as accelerating

SCHEMATIC DIAGRAM EA5076C6

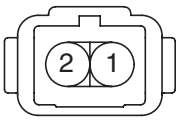
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-K (29)	Valve Control
2	JE02 (46)	Main relay power

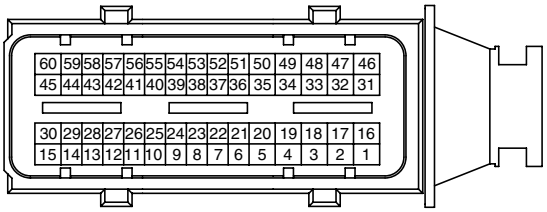
[HARNESS CONNECTORS]



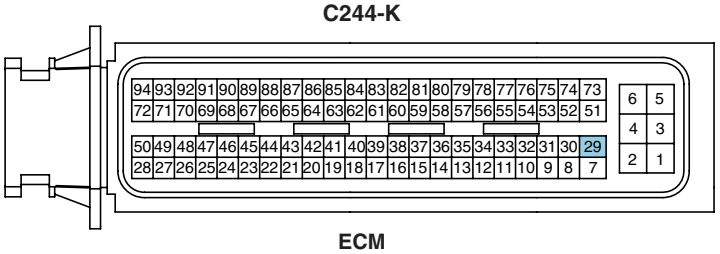
E44

VGT CONTROL SOLENOID VALVE

C244-A



C244-K



ECM

STGFL7161L

SIGNAL WAVEFORM AND DATA E7886796

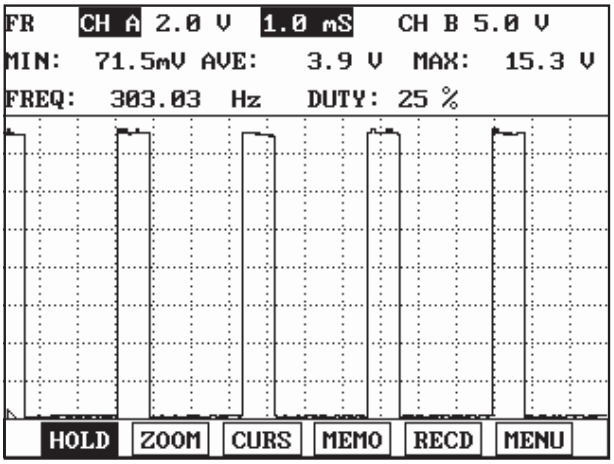


Fig.1

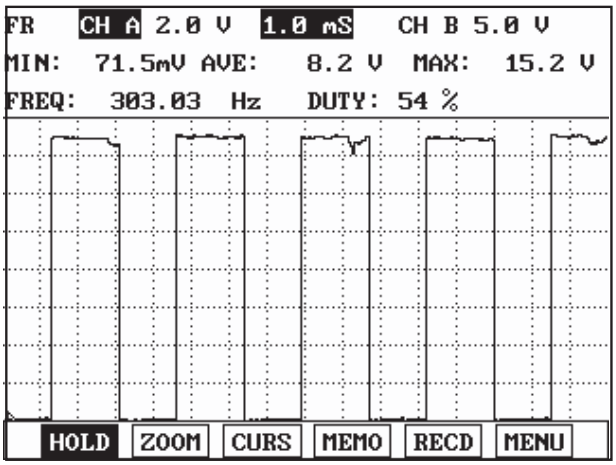


Fig.2

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

LFIG369A

MONITOR SCANTOOL DATA EACDE251

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 : 1013hpa ± 100hpa(VGT actuator : approx. 70%) at idle

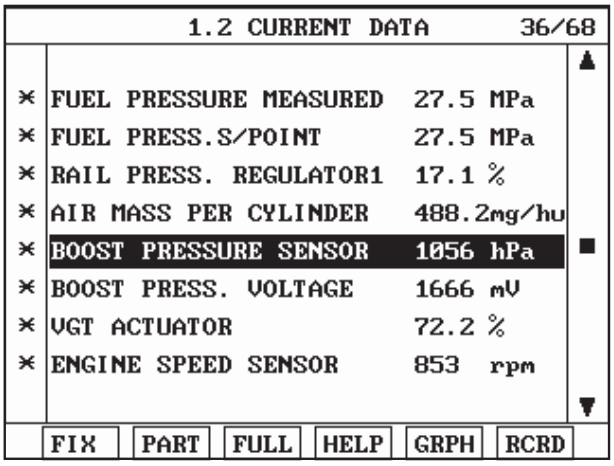


Fig.1

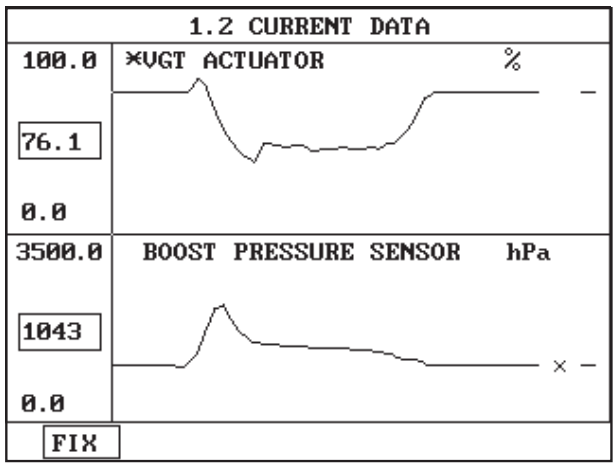


Fig.2

Fig1) Monitor "BOOST PRESSURE SENSOR" parameter on the Scantool at idle after warming engine up.
1000hpa ± 100hpa(approx. 1 atm) is correct value.
Fig.2) VGT actuator duty and boost pressure atacceleration is shown . If boost pressure rises and reaches certain value, VGT actuator duty stops to drop and keeps steady. Releasing accelerator pedal at this moment, VGT actuator duty drops to approx. 45%, then if RPM drops to idle range, duty returns to 76%.

STGFL7605L

TERMINAL AND CONNECTOR INSPECTION E015498F

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

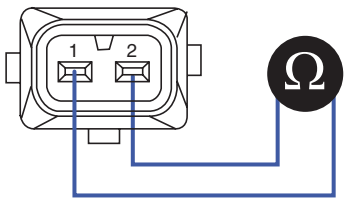
▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

NO

▶ Go to "Component Inspection".

COMPONENT INSPECTION E274811D

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 2.



SNFFL6316D

Specification : 14.7 ~ 16.1Ω (20℃)

   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 76% 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 (Vacuum must not generates, correct VGT actuator operating duty is 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 E4067EAA

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

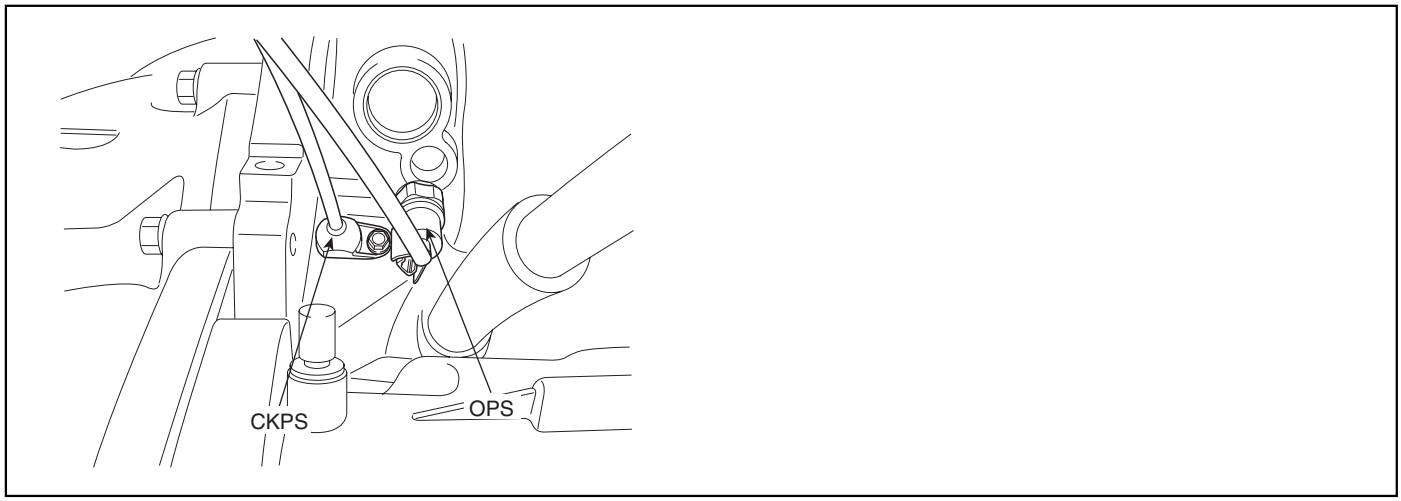
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0335 CRANKSHAFT POSITION SENSOR A CIRCUIT

COMPONENT LOCATION E5A3953F



SNFFL6212D

GENERAL DESCRIPTION EB5B7B57

Crank Shaft Position Sensor(CKPS) is magnetic inductive type. Mounted on transaxle hausing, it senses tone wheel position of fly wheel.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 E39484BC

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 E9232897

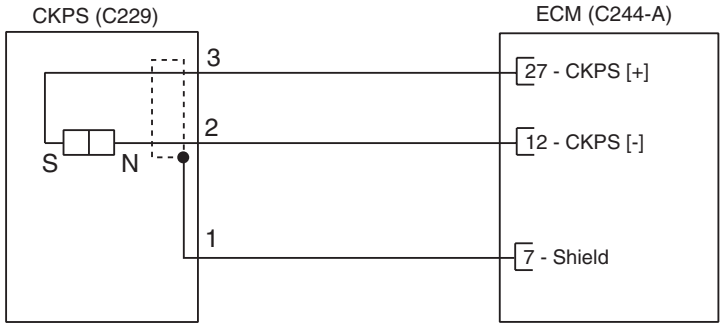
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Signal monitoring</td><td rowspan="6">• CKPS circuit
• CKPS component
• Abnormal deformation of Crank Shaft tone wheel</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• During accelerating and turning engine "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• CMPS signal is outputted while CKPS signal does not generate.</td></tr>
<tr><td>Diagnostic Time</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"></td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION EF48BD49

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 EA0086CF

[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

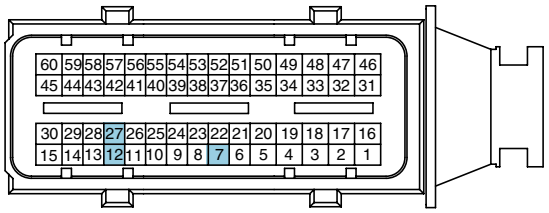
Terminal	Connected to	Function
1	ECM C244-A (7)	Sensor Shield
2	ECM C244-A (12)	CKPS [-] Signal
3	ECM C244-A (27)	CKPS [+] Signal

[HARNESS CONNECTORS]

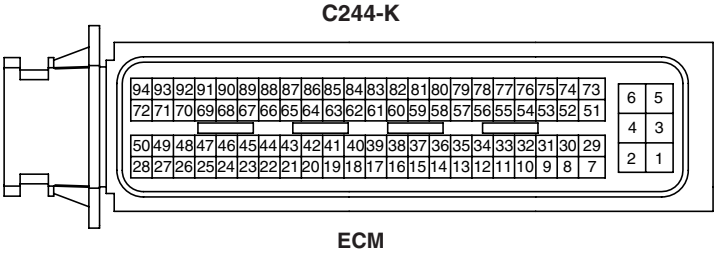
C229

CKPS

C244-A



C244-K



ECM

STGFL7147L

SIGNAL WAVEFORM AND DATA EECFC870

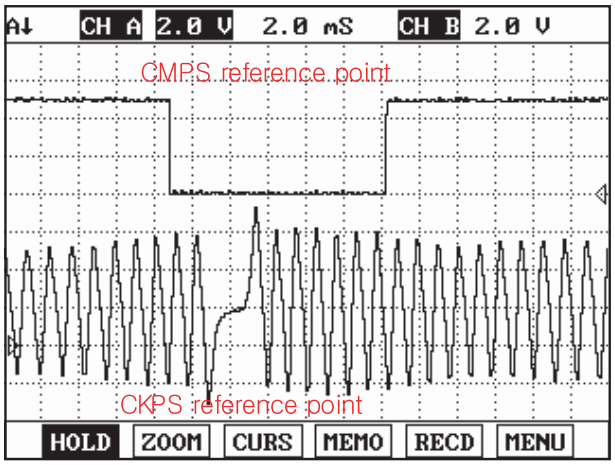


Fig.1

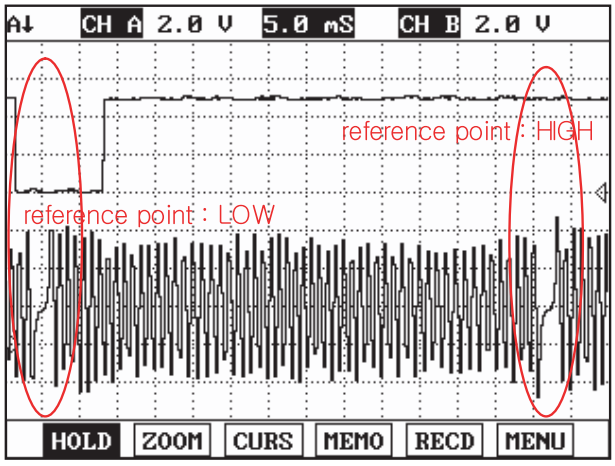


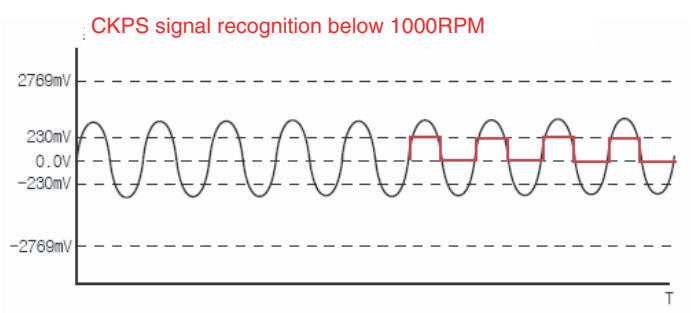
Fig.2

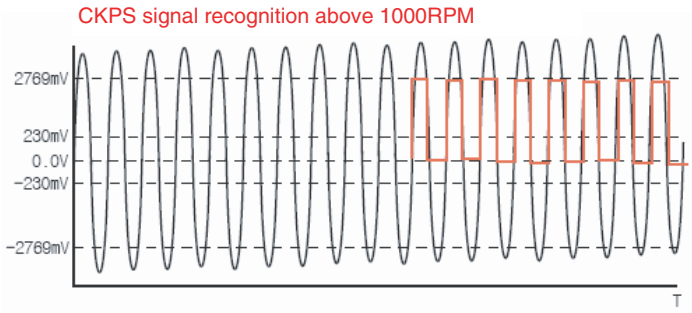
Fig.1) This shows waveform of Crank Shaft Position Sensor and Cam Shaft Position Sensor simulatneously. The middle area indicates reference points of Crank Shaft Position Sensor and Cam Shaft Position Sensor.

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.)

LFIG289A

※ SIGNAL ANALYSIS





LFIG290A

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 E994BAA5

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

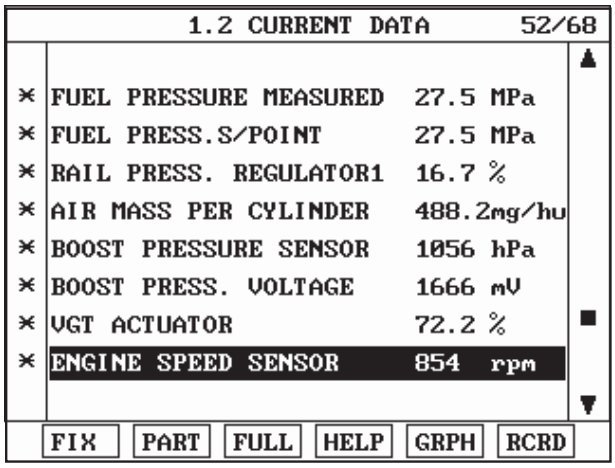


Fig.1

Fig.1) Check "ENGINE SPEED SENSOR" parameter carefully after warming engine up, also check engine stall and rpm instability or engine shut down.

STGFL7606L

TERMINAL AND CONNECTOR INSPECTION E10B825D

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 E5DB71CF

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 and 3.

Specification : 0.6V~1.0V

5) Is the measured voltage within the specification?

YES

▶ Go to "3.Check short between signal circuits."

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(C244-A) terminal 12.
4) Check continuity between CKPS connector terminal 3 and ECM connector(C244-A) terminal 27.

Specification : continuity (below 1.0Ω)

5) Is the measured resistance within the specification?

YES

▶ Go to "3. Check short between signal circuits".

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 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 2,3(crank signal)

Specification : Discontinuity (Infinite Ω)

   4) 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 EDBB1033

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".

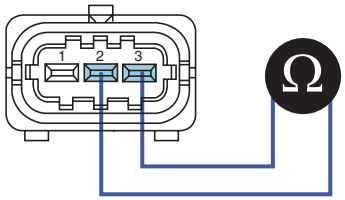
COMPONENT INSPECTION E5389AEB

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 3 at component side.



SNFFL6393L

Specification : 860Ω ±10% (20℃)

4) Is the measured resistance within the specification?

YES

▶ Go to "2. Check short to ground in CKPS component" as follows.

NO

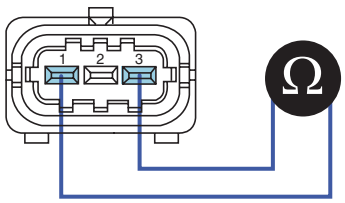
▶ Replace CKPS and go to "Verification of Vehicle Repair".

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 3 at component side.



KFQG394A

Specification : Discontinuity (Infinite Ω)

4) Is the measured resistance within the specification? (Is the inside of component insulated correctly?)

YES

▶ Go to "Check CKPS waveform".

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 and 3.

   4) Check if CKPS waveform is outputted correctly as cranking or turning engine on.

Specification : Refer to "Signal waveform & data" of "General Information".

   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 ECD0EDA5

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 E7C0CD86

Refer to DTC P0335.

GENERAL DESCRIPTION E5D1F6B3

Refer to DTC P0335.

DTC DESCRIPTION E3CE13EE

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 E259CD3D

<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">• 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>Threshold Value</td><td colspan="3">• Engine speed sensed at CKPS above 6000RPM
• Abnormal crank signal pulse</td></tr>
<tr><td>Diagnostic Time</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>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION E763E76E

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 EC488D46

Refer to DTC P0335.

SIGNAL WAVEFORM AND DATA E413F7DE

Refer to DTC P0335.

MONITOR SCANTOOL DATA E699919B

Refer to DTC P0335.

TERMINAL AND CONNECTOR INSPECTION EC699D59

Refer to DTC P0335.

SIGNAL CIRCUIT INSPECTION EF9AF39F

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 and 3.

Specification : 0.6V~1.0V

   5) Is the measured voltage within the specification?

   YES

   ▶ Go to "3.Check short between signal circuits."

   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(C244-A) terminal 12.

   4) Check continuity between CKPS connector terminal 3 and ECM connector(C244-A) terminal 27.

Specification : continuity (below 1.0Ω)

   5) Is the measured resistance within the specification?

   YES

   ▶ Go to "3. Check short between signal circuits".

   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 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 2,3(crank signal)

Specification : Discontinuity (Infinite Ω)

4) 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 EA624CD6

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".

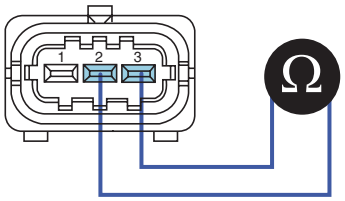
COMPONENT INSPECTION EF697ED8

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 3 at component side.



SNFFL6393L

Specification : 860Ω ±10% (20℃)

4) Is the measured resistance within the specification?

YES

▶ Go to "2. Check short to ground in CKPS component" as follows.

NO

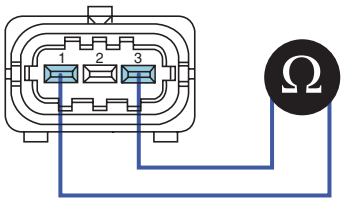
▶ Replace CKPS and go to "Verification of Vehicle Repair".

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 3 at component side.



KFQG394A

Specification : Discontinuity (Infinite Ω)

4) Is the measured resistance within the specification? (Is the inside of component insulated correctly?)

YES

▶ Go to "Check CKPS waveform".

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 and 3.

4) Check if CKPS waveform is outputted correctly as cranking or turning engine on.

Specification : Refer to "Signal waveform & data" of "General Information".

5) Is CKPS waveform outputted correctly?

YES

▶ Go to "Verification of Vehicle Repair".

NO

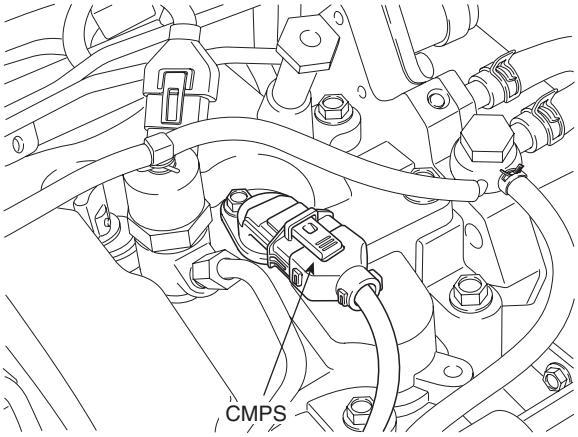
▶ Replace CKPS and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E9D635EA

Refer to DTC P0335.

DTC P0340 CAMSHAFT POSITION SENSOR A CIRCUIT MALFUNCTION (BANK 1 OR SINGLE SENSOR)

COMPONENT LOCATION E96A3409



SNFFL6213D

GENERAL DESCRIPTION E1B69506

Cam Shaft Position Sensor(CMPS) is hall sensor type. Sensing the teeth attatch at the end of exhaust 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 EC75AD9D

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 EC53A6C3

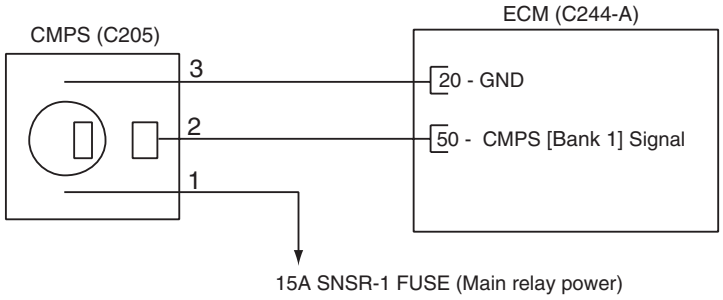
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Signal monitoring</td><td rowspan="6">• CMPS circuit
• CMPS component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• During accelerating and turning engine "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• CKPS signal is outputted while CMPS signal does not generate.</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• Crank Shaft rotates 4 times</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>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION E7EC0A4A

Sensor Type	Output Signal Characteristic	Air Gab	Low RPM Minimum Detecting Voltage	High RPM Minimum Detecting Voltage
Hall effect type	0V~5V Digital signal output	1.25mm	below 2.0V	above 3.8V

SCHEMATIC DIAGRAM EB05E2C2

[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

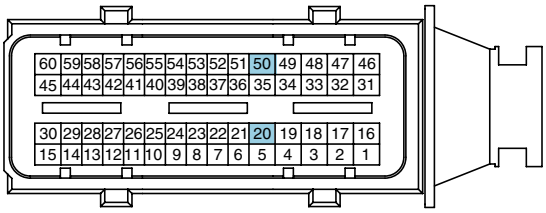
Terminal	Connected to	Function
1	JC301 (61)	Main relay power
2	ECM C244-A (50)	CMPS Signal
3	ECM C244-A (20)	GND

[HARNESS CONNECTORS]

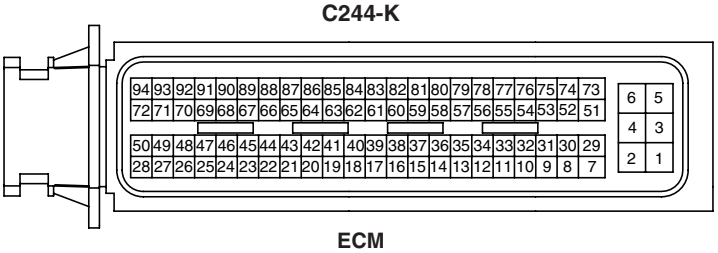
C205

CMPS

C244-A



C244-K



ECM

STGFL7145L

SIGNAL WAVEFORM AND DATA E8F887C6

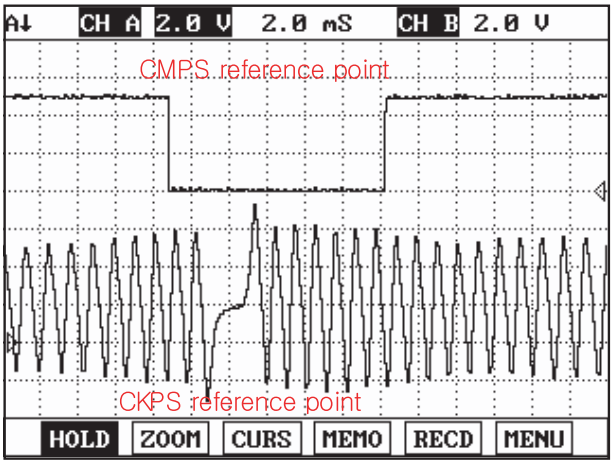


Fig.1

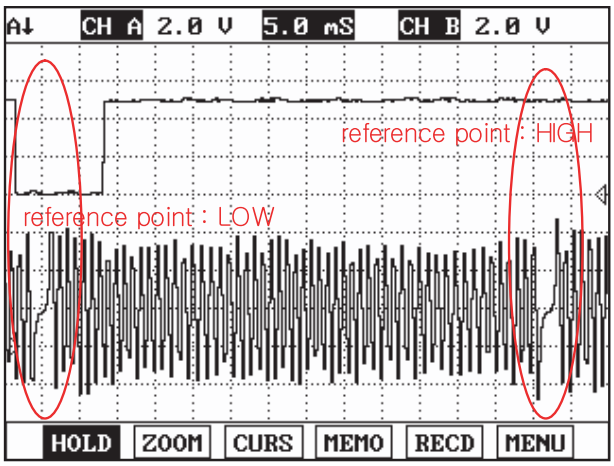


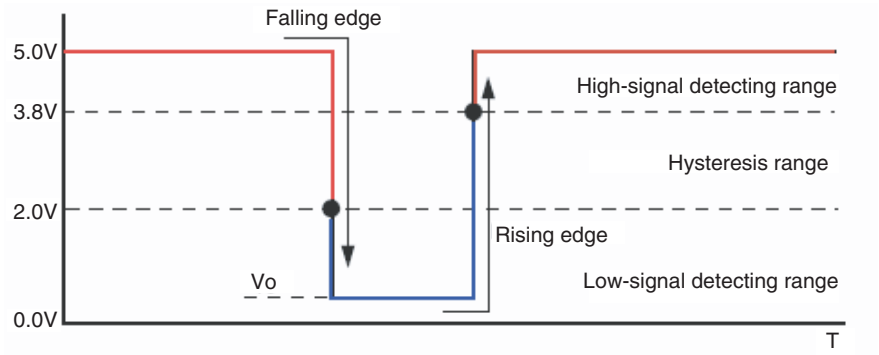
Fig.2

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

Fig.2) Crank Shaft Position Sensor and Cam Shaft Position Sensor signal are measured simultaneously.
Cam Shaft Position Sensor
signal is outputted once when Crank Shaft Position sensor signal is outputted twice. LOW and HIGH output of Cam Shaft Position sensor reference point is detected at Crank Shaft Position sensor reference point.
(Injection sequence is determined based on LOW and HIGH signal of Cam Shaft Position Sensor reference point as detecting cylinder position.)

LFIG299A

※ SIGNAL ANALYSIS



LFIG300A

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 E9480675

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

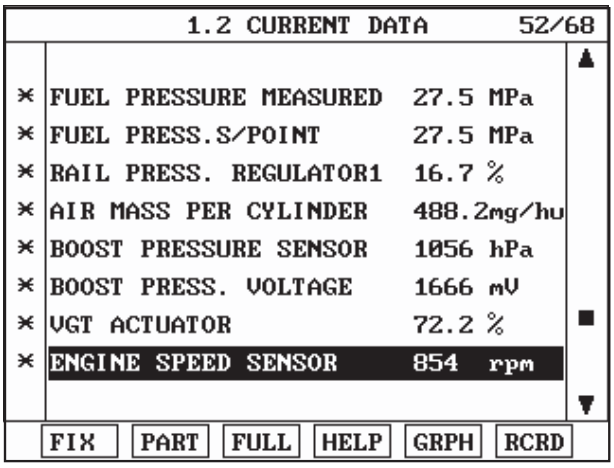


Fig.1

Fig.1) Check "ENGINE SPEED SENSOR" parameter carefully after warming engine up, also check engine stall and rpm instability or engine shut down.

STGFL7606L

TERMINAL AND CONNECTOR INSPECTION E9A94F7B

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 E81DF3F4

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 SNSR1 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 E9DE30C4

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 "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(C244-A) terminal 50.

Specification : continuity (below 1.0Ω)

   4) Is the measured resistance within the specification? (Is continuity confirmed?)

YES

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

NO

▶ Repair open in the circuit between CMPS connector terminal 2 and ECM connector terminal 50 and go to "Verification of Vehicle Repair".

GROUND CIRCUIT INSPECTION E6177CA6

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 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 EC77953B

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 "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 : Refer to "Signal waveform & Data" of "General Information".

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 E8E6B554

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 E497B9B1

Refer to DTC P0340.

GENERAL DESCRIPTION E0963EC2

Refer to DTC P0340.

DTC DESCRIPTION EF450093

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 E532D45B

<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">• CMPS circuit
• CMPS component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• During accelerating and turning engine "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• When RPM from CMPS correlates with RPM from CKPS abnormally.</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• Crank Shaft rotates 4 times</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>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION ED93DEBB

Sensor Type	Output Signal Characteristic	Air Gab	Low RPM Minimum Detecting Voltage	High RPM Minimum Detecting Voltage
Hall effect type	0V~5V Digital signal output	1.25mm	below 2.0V	above 3.8V

SCHEMATIC DIAGRAM E3971B72

Refer to DTC P0340.

SIGNAL WAVEFORM AND DATA E5B13E95

Refer to DTC P0340.

MONITOR SCANTOOL DATA EFB722A7

Refer to DTC P0340.

TERMINAL AND CONNECTOR INSPECTION E1463867

Refer to DTC P0340.

POWER CIRCUIT INSPECTION E573AA3B

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 SNSR1 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 EF25C6C9

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 "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(C244-A) terminal 50.

Specification : continuity (below 1.0Ω)

4) Is the measured resistance within the specification? (Is continuity confirmed?)

YES

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

NO

▶ Repair open in the circuit between CMPS connector terminal 2 and ECM connector terminal 50 and go to "Verification of Vehicle Repair".

GROUND CIRCUIT INSPECTION E7473936

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 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 ECA061A1

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 "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 : Refer to "Signal waveform & Data" of "General Information".

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 EEBEEBD8

Refer to DTC P0340.

DTC P0381 GLOW INDICATOR LAMP - CIRCUIT MALFUNCTION

GENERAL DESCRIPTION E7427052

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 E44CC376

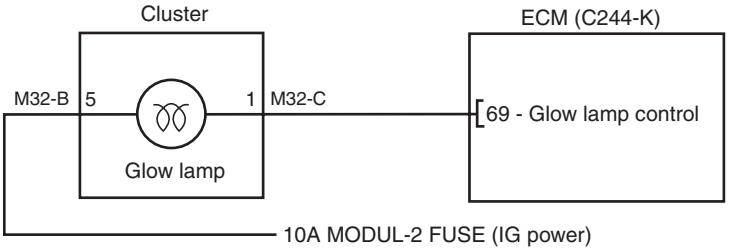
P0381 is set when 1)excessive voltage is detected or 2)no current is detected like open or short to ground in glow lamp control circuit for more than 1 sec. at glow lamp ON condition. This code is due to open in glow lamp control circuit or internal open in filament of glow lamp component.

DTC DETECTING CONDITION E76CEDE3

<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>Threshold Value</td><td colspan="3">• Short to battery
• Short to GND, Wiring open</td></tr>
<tr><td>Diagnostic Time</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>Check Lamp</td><td>NO</td></tr>
</table>

SCHEMATIC DIAGRAM E1655D21

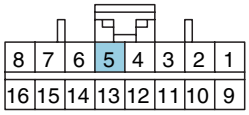
[CIRCUIT DIAGRAM]



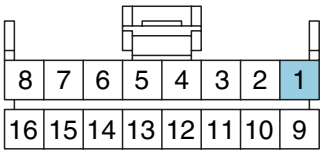
[CONNECTOR INFORMATION]

Terminal	Connected to	Function
M32-B (5)	10A MODUL-2 FUSE	IG power
M32-C (1)	ECM C244-K (69)	Glow lamp control

[HARNESS CONNECTOR]

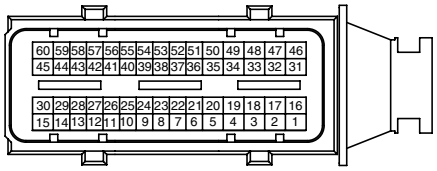


M32-B
Cluster

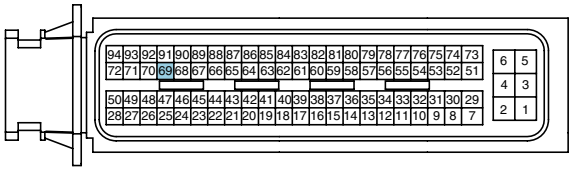


M32-C
Cluster

C244-A



C244-K



ECM

STGFL7157L

MONITOR SCANTOOL DATA E2EC6B21

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

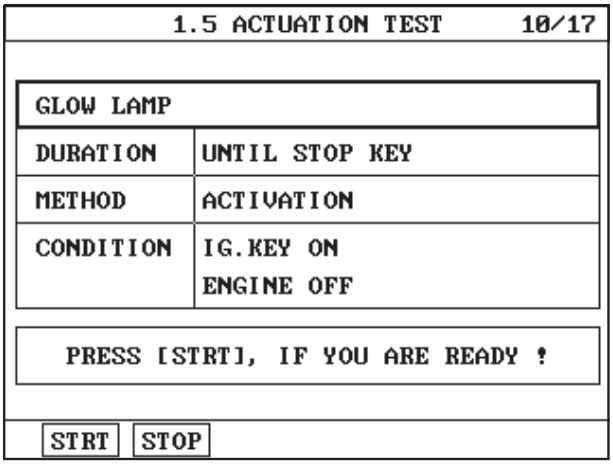


Fig.1

Fig.1) Diagnosing problem is convenient through ACTUATION TEST of glow lamp.

LFIG308A

TERMINAL AND CONNECTOR INSPECTION E8F21B48

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 E0EB1485

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 terminal 69 of ECM connector(C244-K).

Specification : 10.8V~13.0V

5) Is the measured voltage within the specification?

YES

▶ Go to "2. Grounding test of glow lamp control circuit"..

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(C244-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 E825953E

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?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace glow lamp and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR EEDF802C

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

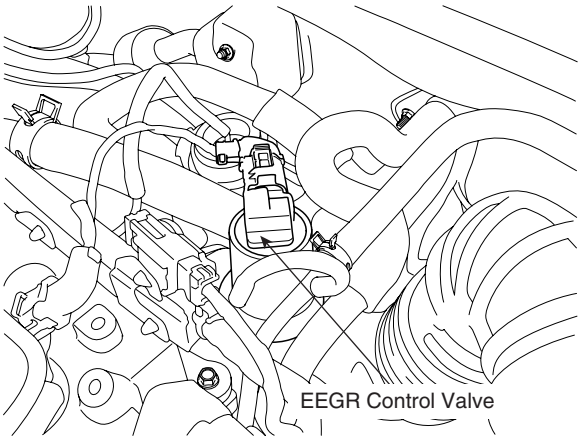
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0401 EXHAUST GAS RECIRCULATION FLOW INSUFFICIENT DETECTED

COMPONENT LOCATION EB90523C



SNFFL6216L

GENERAL DESCRIPTION ED83DCC3

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 AFS in diesel engine is different from gasoline engine. Fuel injection quantity is decided by AFS signal in gasoline engine.)When EGR gas(contains no oxygen) flowing into combustion chamber increases, the air passing through AFS(contains oxygen) decreases. Thus, with the output signal change of AFS 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 EB7F06FE

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 20sec. In this case, check that stuck of EEGR actuator, air leakage of intake line.

DTC DETECTING CONDITION E6C1308E

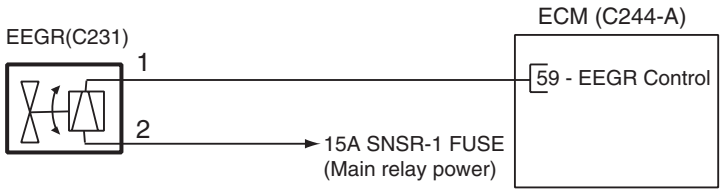
Item	Detecting Condition			Possible Cause
DTC Strategy	• Signal monitoring			• EGR actuator stuck • EGR actuator component • Air leakage of intake line
Enable Conditions	• Engine running			
Threshold Value	• EGR is exceeded to minimum set point			
Diagnostic Time	• 20 sec.			
Fail Safe	Fuel cut	NO		
	EGR Off	YES		
	Fuel Limit	NO		
	Check Lamp	YES		

SPECIFICATION E63C09D2

EGR actuatorcomponent resistance	EGR actuator operating Hz	EGR actuator operating duty
7.3~ 8.8Ω (30℃)	142Hz	approx.10%(closed)~40%(opened)

SCHEMATIC DIAGRAM E0E0DB3C

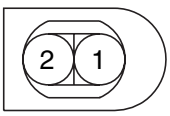
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-A (59)	EEGR Control
2	JC 01 (31)	Main Relay

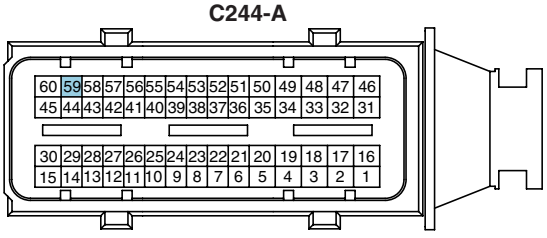
[HARNESS CONNECTORS]



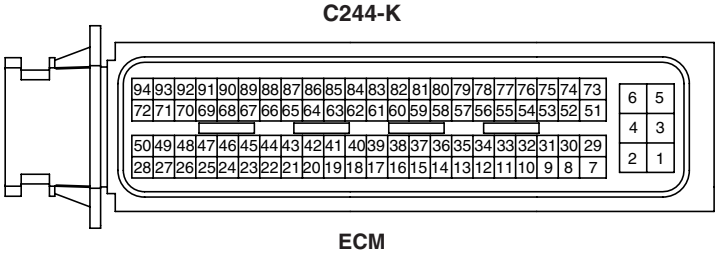
C231

EEGR

C244-A



C244-K



ECM

STGFL7195L

SIGNAL WAVEFORM AND DATA E828EC26

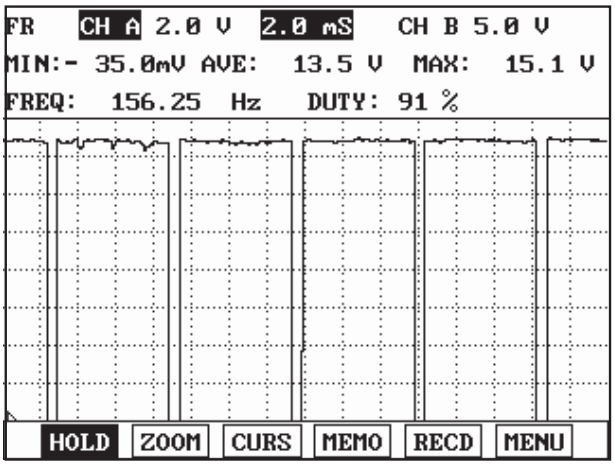


Fig.1

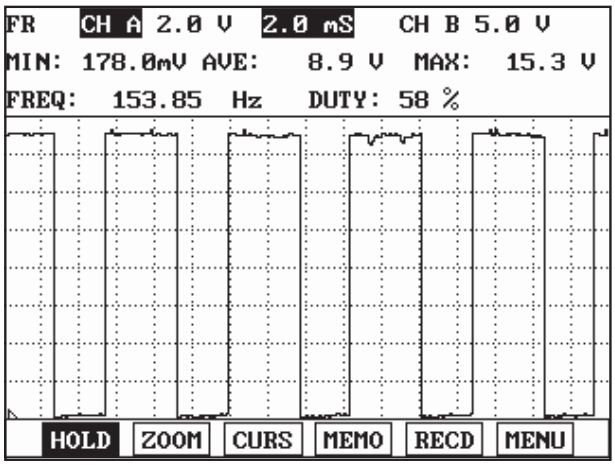


Fig.2

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

LFIG414A

NOTE

The output of approx. 10% duty is mainly for the diagnosis of EEGR actuator circuit than actuating EEGR.

MONITOR SCANTOOL DATA E069A7BE

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 5% duty) at idle : 450mg/st ± 50 mg/st
When EEGR actuator operates(Approx. 50% duty) at idle : 300mg/st ± 50 mg/st

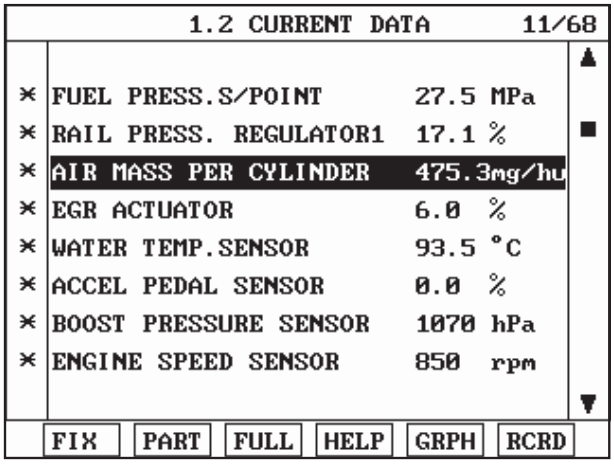


Fig.1

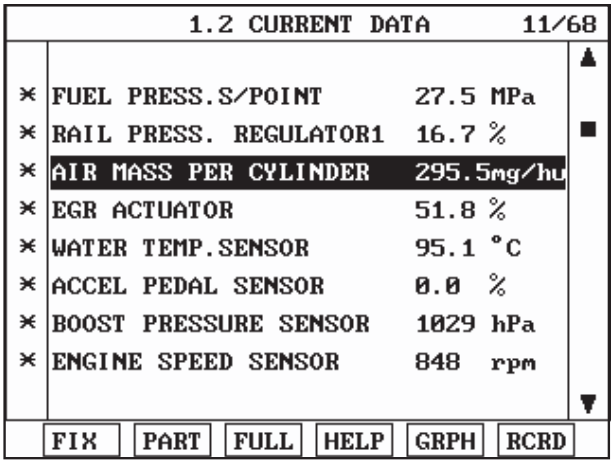


Fig.2

Fig.1) Check if "AIR MASS PERCYLINDER"I is 450mg/st ± 50mg/st without EEGR operation at warm idle (EEGR actuator 5% duty)
Fig.2) Check if "AIR MASS PERCYLINDER"I is 300mg/st ± 50mg/st with EEGR operation at warm idle (EEGR actuator approx. 50% duty)

STGFL7531L

NOTE

EEGR actuator operates as decelerating after rapid acceleration when idle EEGR does not operate, EEGR actuator duty rises to approx. 45% at operating condition. This controlling process lasts for about 56 sec. then EEGR actuator turns "OFF" (duty 5%).

TERMINAL AND CONNECTOR INSPECTION E15ADE06

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 E8F266A3

1. Check power circuit voltage

1) IG KEY "OFF", ENGINE "OFF"

2) Disconnect EEGR actuator connector

3) IG KEY "ON"

4) Measure the voltage of terminal 2 of EEGR actuator connector.

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 SNSR1 fuse and related circuit and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION E8E3B0BD

1. Check control circuit monitoring voltage

1) IG KEY "OFF", ENGINE "OFF"

2) Disconnect EEGR actuator connector.

3) IG KEY "ON"

4) Measure the voltage of terminal 1 of EEGR actuator connector.

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 EEGR actuator connector and ECM connector

3) Check continuity between EEGR actuator terminal 1 and ECM connector (C244-A) 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".

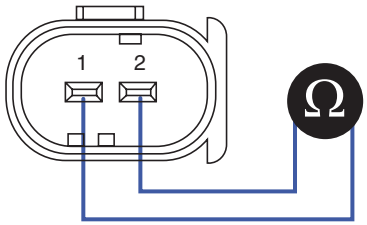
COMPONENT INSPECTION EAD3FC9B

1. Check EEGR actuator component resistance

   1) IG KEY "OFF", ENGINE "OFF".

   2) Disconnect EEGR actuator.

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



KFQG404A

Specification : 7.3~ 8.8Ω (30℃)

   4) Is EEGR actuator component resistance within the specification?

YES

▶ Go to "2. Check EEGR actuator operation condition".

NO

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

2. Check EEGR actuator operation condition

   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 5.9% duty is outputted 1 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 50%)

Specification : When EEGR actuator does not operate (5.9%) at idle : 450mg/st ± 50 mg/st
When EEGR actuator operates(50%) at idle : 300mg/st ± 50 mg/st

11) Is output signal within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Check that EEGR actuator is stuck. If it is, replace EEGR actuator assembly then, go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E775E7E0

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

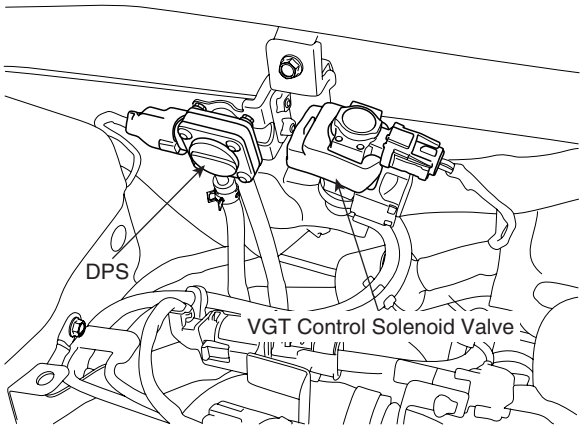
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0471 EXHAUST PRESSURE SENSOR "A" CIRCUIT RANGE/PERFORMANCE

COMPONENT LOCATION E7C80F8A



SNFFL6200L

GENERAL DESCRIPTION E0CDF8FA

Differential pressure sensor(DPS) is piezzo electric type sensor. Sensing the differential pressure between in front of CPF and in the back of CPF, DPS outputs linear signal from 0~5V. Using output signal, DPS detects the amount of soot, sulfide, SOF(soluble organic fraction) to determine if CPF regeneration is needed.

※CPF regeneration : When vehicle is in steady speed condition and above normal engine loading condition, if differential pressure between before and after CPF is above the specified pressure, ECM considers that stored soot inside of CPF is excessive. In this condition, exhaust gas tempt. is raised by post injection 1 and 2 to warm CPF up to 550℃~650℃. In this high tempt, soot inside of CPF burns up naturally and this mechanism is called as "CPF regeneration".Most of soot is burned up during regeneration process but a little amount of soot is not burned up and stored inside of CPF continuously. The stored soot decreases the efficiency of CPF slowly. DPS corrects CPF regeneration period and duration as comparing and calculating the differential pressure due to stored soot with the total distance covered.

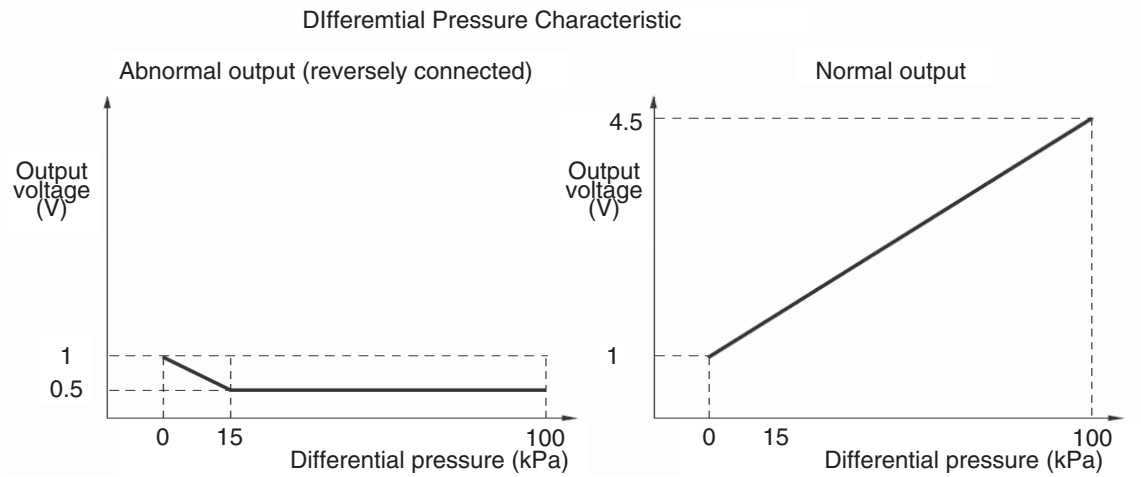
DTC DESCRIPTION E4EE7D30

P0471 is set when measured Differential pressure is above 100 hPa - the upper limiting value - for more than 1 sec..This code is due to 1) short beween power and signal circuit or 2) short to battery in signal circuit or 3) short to ground in ground circuit.

DTC DETECTING CONDITION E6113CAD

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• DPS Wiring • DPS component • Reversly connectedDPS hose line • Clogged DPS • Clogged CPF inlet section • Clogged CPF
Enable Conditions	• IG KEY "ON"			
Threshold Value	• When differential pressure is above 100 hPa			
Diagnostic Time	• 1.0 sec.			
Fail Safe	Fuel cut	NO	• Engine check lamp blinks. • Differential pressure considered as 10hPa. • Soot simulation ON mode activated • Regeneration mileage shorten	
	EGR Off	NO		
	Fuel Limit	NO		
	Check Lamp	YES		

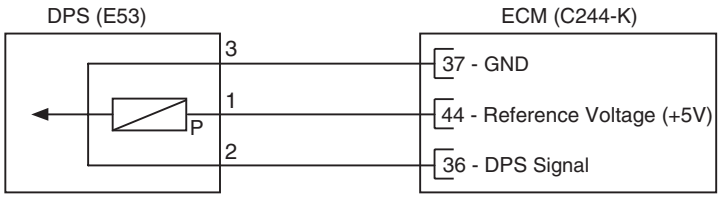
SPECIFICATION ECAABBDE



LFIG421A

SCHEMATIC DIAGRAM E7DB46AD

[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

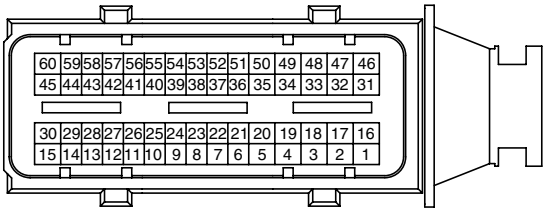
Terminal	Connected to	Function
1	ECM C244-K (44)	Reference Voltage (+5V)
2	ECM C244-K (36)	DPS Signal
3	ECM C244-K (37)	Sensor ground

[HARNESS CONNECTORS]

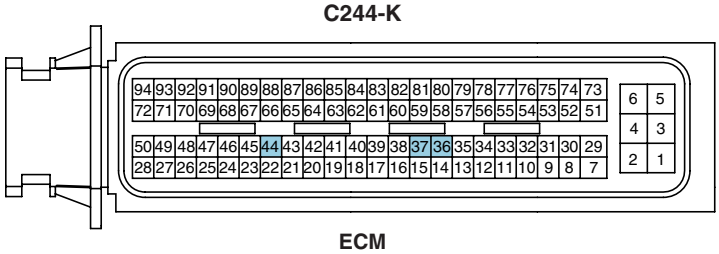
E53

DPS

C244-A



C244-K



ECM

STGFL7169L

SIGNAL WAVEFORM AND DATA E8CA0CE2

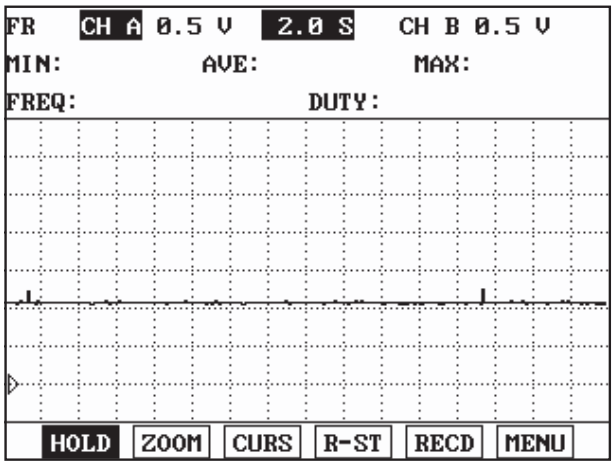


Fig.1

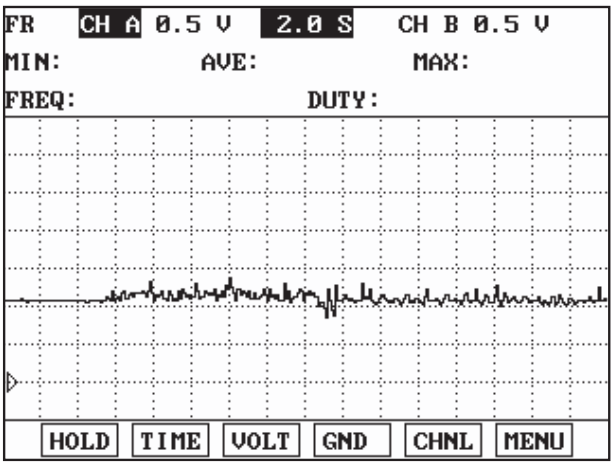


Fig.2

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

LFIG423A

NOTE

As accelerating, DPS signal output voltage does not vary too much. Even when accelerator pedal is fully depressed, the signal voltage fluctuates just a little bit like "Fig. 2". However, the more CPF is used, the more waveform fluctuates.

MONITOR SCANTOOL DATA ED56A182

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 "DIFFERENTIAL PRESSURE" and "PRESSURE PRE CPF" parameter on the scantool.

specification : "DIFFERENTIAL PRESSURE" and "PRESSURE PRE CPF" data must not be too high or low.

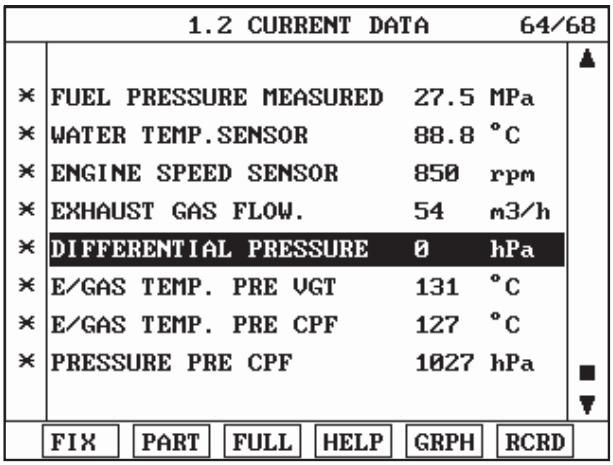


Fig.1

Fig. 1) Check if "DIFFERENTIAL PRESSURE" and "PRESSURE PRE CPF" data is abnormally too high or low.

STGFL7535L

☞ When "DIFFERENTIAL PRESSURE" is too high : Check if excessive soot is accumulated inside of CPF before inspecting DPS related problem.
If needed, perform "CPF SERVICE REGENERATION" to burn the soot inside of CPF and monitor data change.
☞ When "DIFFERENTIAL PRESSURE" is too low : "DIFFERENTIAL PRESSURE" and "PRESSURE PRE CPF" data rises depending on engine load increase and the amount of soot inside of CPF. If differential pressure is not generated or soot is emitted without the rise of "PRESSURE PRE CPF" during excceleration, check CPF component failure.

※The "Scantool Data" shown above is measured at the vehicle with new CPF component. Therfore, data varies depending on CPF used duration and total driven distance.

TERMINAL AND CONNECTOR INSPECTION E5DFEBF7

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 EDE43F3D

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect DPS connector.
3. IG KEY "ON"
4. Measure the voltage of DPS 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 power circuit and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION E5CAFEB0

1. Check signal circuit voltage
   1) IG KEY "OFF", ENGINE "OFF"
   2) Disconnect DPS connector.
   3) IG KEY "ON"
   4) Measure the voltage of DPS 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 DPS connector and ECM connector.

3) Check continuity between DPS connector terminal 2 and ECM connector (C244-K) terminal 36.

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 DPS 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 DPS connector and ECM connector.

3) IG KEY "ON"

4) Measure the voltage of DPS connector terminal 2.

Specification : 0.0V~0.1V

5) Is the measured resistance 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 EDEF0BA3

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect DPS connector.
3. IG KEY "ON"
4. Measure the voltage of DPS connector terminal 1. [TEST "A"]
5. Measure the voltage between DPS connector terminal 1 and 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

7. ▶ 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 EBBA7FB7

1. DPS visual inspection
   1) IG KEY "OFF", ENGINE "OFF"
   2) Disconnect DPS connector.
   3) Check DPS terminals for corrosion and contamination.
   4) Check (1)connecting condition of DPS and pressure sensing hose, (2)exhaust gas pressure leakate, (3)miss connection of pressure sensing hose (reverse connection) is detected.
   5) Is DPS related problem detected?

      YES

      ▶ If needed, replace DPS or pressure sensing hose and go to "Verification of Vehicle Repair".

      NO

      ▶ Go to "2. Monitor DPS signal waveform" as follows.

2. Monitor DPS signal waveform
   1) IG KEY "ON", ENGINE "OFF"
   2) Connect DPS connector.
   3) Connect oscilloscope to DPS connector terminal 2.
   4) After warming engine up, monitor the waveform at idle and during acceleration.

Specification : Refer to "Signal Waveform & Data" of "General Information".

   5) Is DPS signal waveform is similar to the waveform of "Signal Waveform & Data"?

      YES

      ▶ Go to "Verification of Vehicle Repair".

      NO

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

VERIFICATION OF VEHICLE REPAIR EEA97B9A

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 P0472 EXHAUST DIFFERENTIAL PRESSURE SENSOR CIRCUIT MALFUNCTION - LOW INPUT

COMPONENT LOCATION E6F717FE

Refer to DTC P0471.

GENERAL DESCRIPTION E5EA62EA

Refer to DTC P0471.

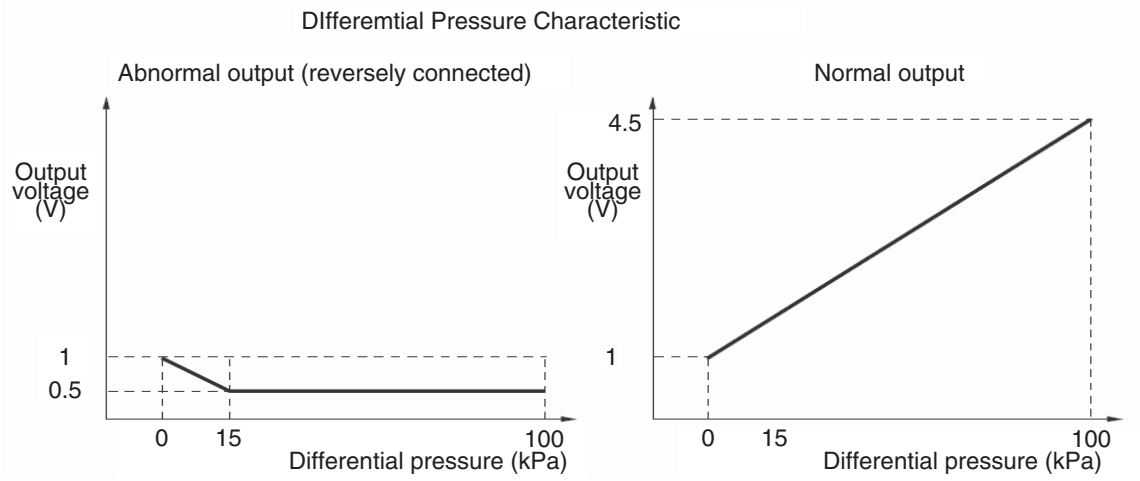
DTC DESCRIPTION EAFE4D78

P0472 is set when the voltage below 0.85V - mimimum output voltage of DPS - is detected for more than 0.6 sec.. This code is due to open in power circuit or short to ground in signal circuit.

DTC DETECTING CONDITION E3AE50F5

<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">• DPS Wiring
• DPS component
• Reversly connectedDPS hose line
• Clogged DPS
• Clogged CPF inlet section</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Open in power circuit
• Short to GND in signal circuit</td></tr>
<tr><td>Diagnostic Time</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">• Engine check lamp blinks.
• Differential pressure considered as 10hPa.
• Soot simulation ON mode activated
• Regeneration mileage shorten</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION E96F55D2



LFIG421A

SCHEMATIC DIAGRAM EB9A9ABA

Refer to DTC P0471.

SIGNAL WAVEFORM AND DATA E5EFF477

Refer to DTC P0471.

MONITOR SCANTOOL DATA EDB03645

Refer to DTC P0471.

TERMINAL AND CONNECTOR INSPECTION EDECF601

Refer to DTC P0471.

POWER CIRCUIT INSPECTION EC77031D

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect DPS connector.
3. IG KEY "ON"
4. Measure the voltage of DPS 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 power circuit and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION E520A395

1. Check signal circuit voltage
   1) IG KEY "OFF", ENGINE "OFF"
   2) Disconnect DPS connector.
   3) IG KEY "ON"
   4) Measure the voltage of DPS connector terminal 2.

Specification : 4.8V~5.1V

   5) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspectiont".

NO

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

COMPONENT INSPECTION E25A5F75

1. DPS visual inspection

   1) IG KEY "OFF", ENGINE "OFF"

   2) Disconnect DPS connector.

   3) Check DPS terminals for corrosion and contamination.

   4) Check (1)connecting condition of DPS and pressure sensing hose, (2)exhaust gas pressure leakate, (3)miss connection of pressure sensing hose (reverse connection) is detected.

   5) Is DPS related problem detected?

   YES

   ▶ If needed, replace DPS or pressure sensing hose and go to "Verification of Vehicle Repair".

   NO

   ▶ Go to "2. Monitor DPS signal waveform" as follows.

2. Monitor DPS signal waveform

   1) IG KEY "ON", ENGINE "OFF"

   2) Connect DPS connector.

   3) Connect oscilloscope to DPS connector terminal 2.

   4) After warming engine up, monitor the waveform at idle and during acceleration.

Specification : Refer to "Signal Waveform & Data" of "General Information".

   5) Is DPS signal waveform is similar to the waveform of "Signal Waveform & Data"?

   YES

   ▶ Go to "Verification of Vehicle Repair".

   NO

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

VERIFICATION OF VEHICLE REPAIR E1020B36

Refer to DTC P0471.

DTC P0473 EXHAUST DIFFERENTIAL PRESSURE SENSOR CIRCUIT MALFUNCTION - HIGH INPUT

COMPONENT LOCATION EC111E1E

Refer to DTC P0471.

GENERAL DESCRIPTION E240C6B4

Refer to DTC P0471.

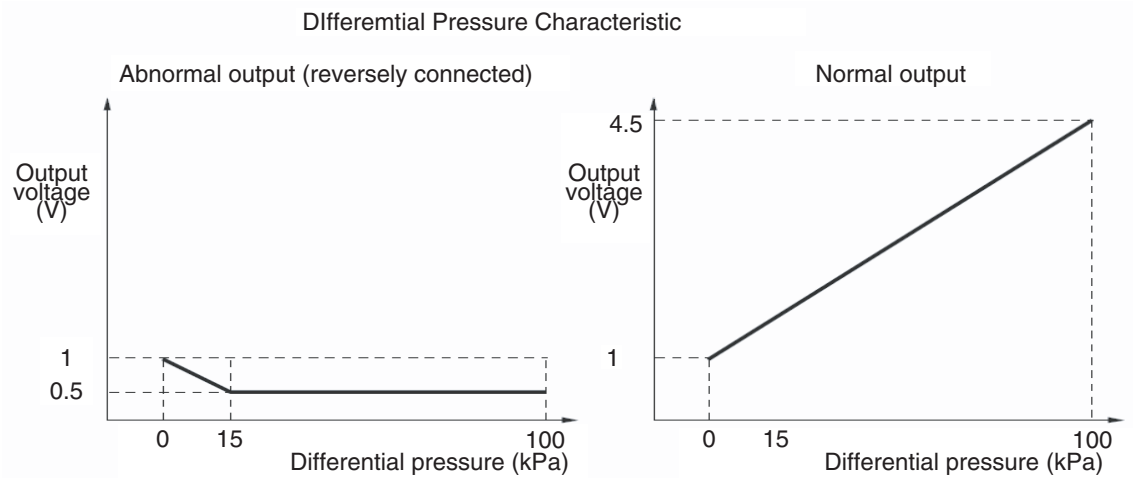
DTC DESCRIPTION E6912EE9

P0473 is set when the voltage above 4.72V - maximum output voltage of DPS - is detected for more than 0.6 sec.. or measured Differential pressure is above 500 hPa - the upper limiting value - for more than 1 sec..This code is due to 1) short beween power and signal circuit or 2) short to battery in signal circuit or 3) short to ground in ground circuit.

DTC DETECTING CONDITION E753DC0B

<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">• DPS Wiring
• DPS component
• Reversly connectedDPS hose line
• Clogged DPS
• Clogged CPF inlet section
• Clogged CPF</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• When output signal is above the maximum value(above 4.72V) - 0.6sec
• When differential pressure is above 500 hPa - 1.0 sec</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• Refer to DTC description.</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel cut</td><td>NO</td><td rowspan="4">• Engine check lamp blinks.
• Differential pressure considered as 10hPa.
• Soot simulation ON mode activated
• Regeneration mileage shorten</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION EAFB4EC6



LFIG421A

SCHEMATIC DIAGRAM ED376B9C

Refer to DTC P0471.

SIGNAL WAVEFORM AND DATA EB88999C

Refer to DTC P0471.

MONITOR SCANTOOL DATA E5556524

Refer to DTC P0471.

TERMINAL AND CONNECTOR INSPECTION E2FEFE6D

Refer to DTC P0471.

POWER CIRCUIT INSPECTION E87BB131

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect DPS connector.
3. IG KEY "ON"
4. Measure the voltage of DPS 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 power circuit and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION E27BDF1E

1. Check signal circuit voltage
   1) IG KEY "OFF", ENGINE "OFF"
   2) Disconnect DPS connector.
   3) IG KEY "ON"
   4) Measure the voltage of DPS 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 DPS connector and ECM connector.

   3) Check continuity between DPS connector terminal 2 and ECM connector (C244-K) terminal 36.

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 DPS 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 DPS connector and ECM connector.

   3) IG KEY "ON"

   4) Measure the voltage of DPS connector terminal 2.

Specification : 0.0V~0.1V

   5) Is the measured resistance 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 E4C5D5AD

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect DPS connector.
3. IG KEY "ON"
4. Measure the voltage of DPS connector terminal 1. [TEST "A"]

5. Measure the voltage between DPS connector terminal 1 and 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

7. ▶ 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 E1E4F451

1. DPS visual inspection

   1) IG KEY "OFF", ENGINE "OFF"

   2) Disconnect DPS connector.

   3) Check DPS terminals for corrosion and contamination.

   4) Check (1)connecting condition of DPS and pressure sensing hose, (2)exhaust gas pressure leakate, (3)miss connection of pressure sensing hose (reverse connection) is detected.

   5) Is DPS related problem detected?

   YES

   ▶ If needed, replace DPS or pressure sensing hose and go to "Verification of Vehicle Repair".

   NO

   ▶ Go to "2. Monitor DPS signal waveform" as follows.

2. Monitor DPS signal waveform

   1) IG KEY "ON", ENGINE "OFF"

   2) Connect DPS connector.

   3) Connect oscilloscope to DPS connector terminal 2.

   4) After warming engine up, monitor the waveform at idle and during acceleration.

Specification : Refer to "Signal Waveform & Data" of "General Information".

   5) Is DPS signal waveform is similar to the waveform of "Signal Waveform & Data"?

   YES

   ▶ Go to "Verification of Vehicle Repair".

NO

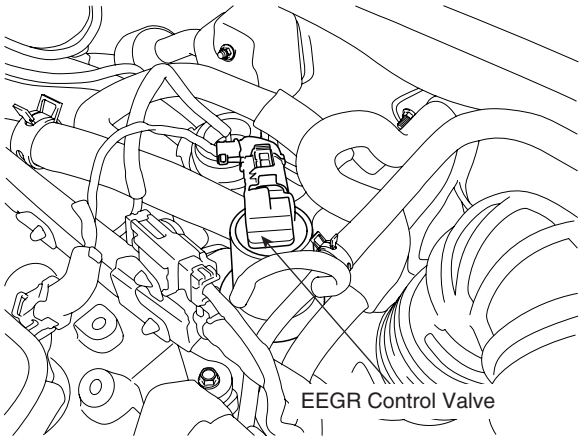
▶ Replace DPS and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR EFED6EE6

Refer to DTC P0471.

DTC P0489 EXHAUST GAS RECIRCULATION CONTROL CIRCUIT LOW VOLTAGE

COMPONENT LOCATION E3D6B455



SNFFL6216L

GENERAL DESCRIPTION EE712472

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 AFS(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 EC76B7FA

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 E252D1F2

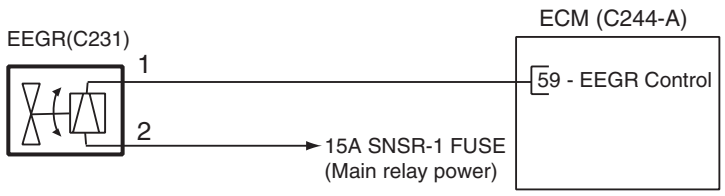
Item	Detecting Condition			Possible Cause
DTC Strategy	• Signal monitoring			• EEGR actuator circuit • EEGR actuator component
Enable Conditions	• Engine running			
Threshold Value	• short to GND, wiring open			
Diagnostic Time	• 0.5 sec.			
Fail Safe	Fuel cut	NO		
	EGR Off	YES		
	Fuel Limit	NO		
	Check Lamp	YES		

SPECIFICATION ED548F01

EGR actuatorcomponent resistance	EGR actuator operating Hz	EGR actuator operating duty
7.3~ 8.8Ω (30℃)	142Hz	approx.10%(closed)~40%(opened)

SCHEMATIC DIAGRAM EE8614DC

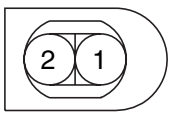
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-A (59)	EEGR Control
2	JC 01 (31)	Main Relay

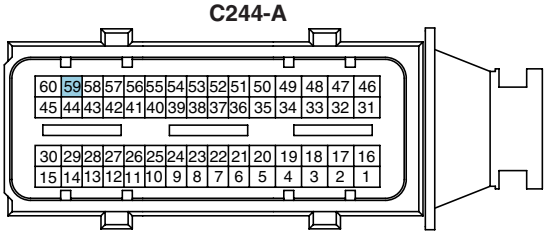
[HARNESS CONNECTORS]



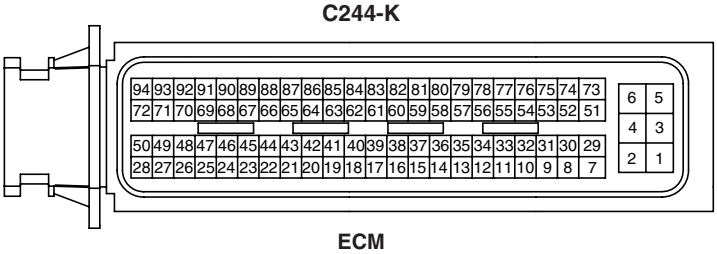
C231

EEGR

C244-A



C244-K



ECM

STGFL7195L

SIGNAL WAVEFORM AND DATA E18677BD

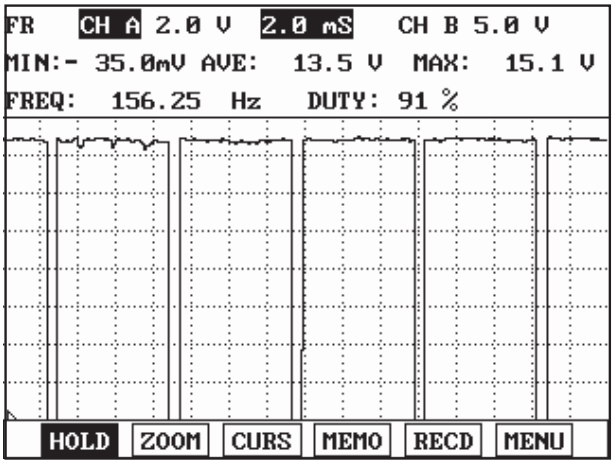


Fig.1

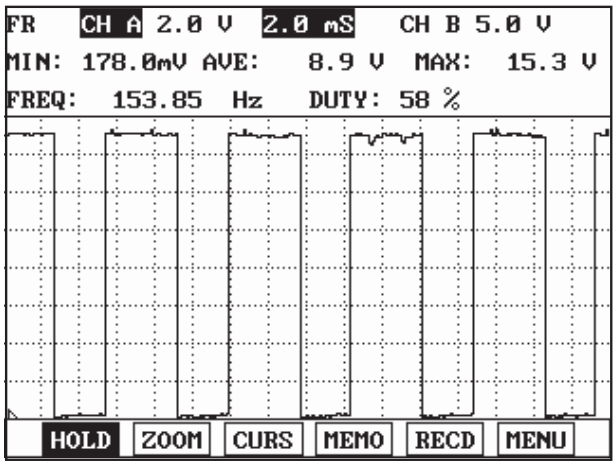


Fig.2

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

LFIG414A

NOTE

The output of approx. 10% duty is mainly for the diagnosis of EEGR actuator circuit than actuating EEGR.

MONITOR SCANTOOL DATA EBBD393F

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 5% duty) at idle : 450mg/st ± 50 mg/st
When EEGR actuator operates(Approx. 50% duty) at idle : 300mg/st ± 50 mg/st

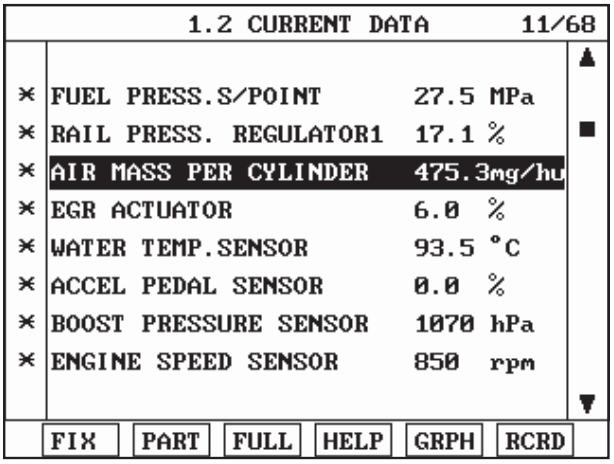


Fig.1

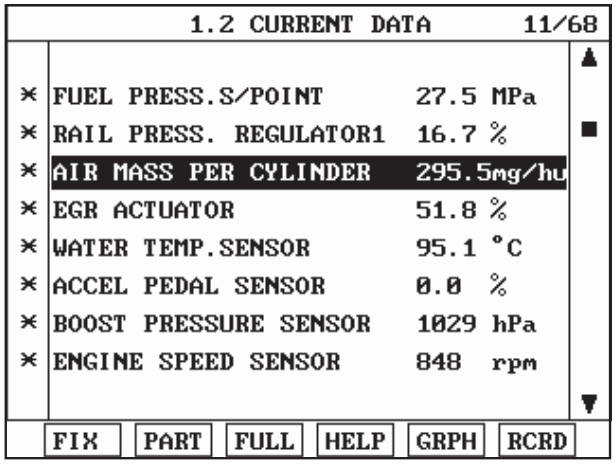


Fig.2

Fig.1) Check if "AIR MASS PERCYLINDER"l is 450mg/st ± 50mg/st without EEGR operation at warm idle (EEGR actuator 5% duty)
Fig.2) Check if "AIR MASS PERCYLINDER"l is 300mg/st ± 50mg/st with EEGR operation at warm idle (EEGR actuator approx. 50% duty)

STGFL7531L

NOTE

EEGR actuator operates as decelerating after rapid acceleration when idle EEGR does not operate, EEGR actuator duty rises to approx. 45% at operating condition. This controlling process lasts for about 56 sec. then EEGR actuator turns "OFF" (duty 5%).

TERMINAL AND CONNECTOR INSPECTION E42512D6

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 E8BFDA17

1. Check power circuit voltage

1) IG KEY "OFF", ENGINE "OFF"

2) Disconnect EEGR actuator connector

3) IG KEY "ON"

4) Measure the voltage of terminal 2 of EEGR actuator connector.

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 SNSR1 fuse and related circuit and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION EB89F8B3

1. Check control circuit monitoring voltage

1) IG KEY "OFF", ENGINE "OFF"

2) Disconnect EEGR actuator connector.

3) IG KEY "ON"

4) Measure the voltage of terminal 1 of EEGR actuator connector.

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 EEGR actuator connector and ECM connector

3) Check continuity between EEGR actuator terminal 1 and ECM connector (C244-A) terminal 59.

specification : Continuity (below 1.0Ω)

4) Is the measured resistance within the specification?

YES

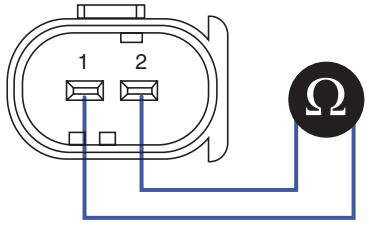
▶ Repair short to ground and go to "Verification of Vehicle Repair".

NO

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

COMPONENT INSPECTION E43A28D2

1. Check EEGR actuator component resistance
   1) IG KEY "OFF", ENGINE "OFF".
   2) Disconnect EEGR actuator connector.
   3) Measure the resistance between EEGR actuator component terminal 1 and 2.



KFQG404A

Specification : 7.3~ 8.8Ω (30℃)

   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 E353431E

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 P0490 EXHAUST GAS RECIRCULATION CONTROL CIRCUIT HIGH VOLTAGE

COMPONENT LOCATION E92CCACE

Refer to DTC P0489.

GENERAL DESCRIPTION E650A351

Refer to DTC P0489.

DTC DESCRIPTION E9FEBBF5

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 EEEBC657

<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>Threshold Value</td><td colspan="3">• Short to battery</td></tr>
<tr><td>Diagnostic Time</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>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION EE90B70B

EGR actuatorcomponent resistance	EGR actuator operating Hz	EGR actuator operating duty
7.3~ 8.8Ω (30℃)	142Hz	approx.10%(closed)~40%(opened)

SCHEMATIC DIAGRAM E9541B11

Refer to DTC P0489.

SIGNAL WAVEFORM AND DATA E2704E5D

Refer to DTC P0489.

MONITOR SCANTOOL DATA E874BC7B

Refer to DTC P0489.

TERMINAL AND CONNECTOR INSPECTION E97F6D2D

Refer to DTC P0489.

POWER CIRCUIT INSPECTION E5791A48

1. Check power circuit voltage
   1) IG KEY "OFF", ENGINE "OFF"
   2) Disconnect EEGR actuator connector
   3) IG KEY "ON"
   4) Measure the voltage of terminal 2 of EEGR actuator connector.

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 SNSR1 fuse and related circuit and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION EDC4C781

1. Check control circuit monitoring voltage
   1) IG KEY "OFF", ENGINE "OFF"
   2) Disconnect EEGR actuator connector.
   3) IG KEY "ON"
   4) Measure the voltage of terminal 1 of EEGR actuator connector.

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 EEGR actuator connector and ECM connector

3) Check continuity between EEGR actuator terminal 1 and ECM connector (C244-A) 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".

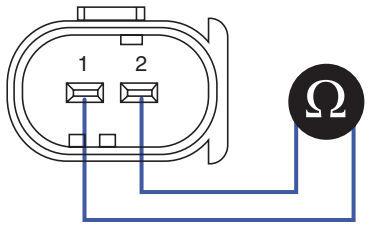
COMPONENT INSPECTION E0C9ABA6

1. Check EEGR actuator component resistance

1) IG KEY "OFF", ENGINE "OFF".

2) Disconnect EEGR actuator connector.

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



KFQG404A

Specification : 7.3~ 8.8Ω (30℃)

4) Is EEGR actuator component resistance within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

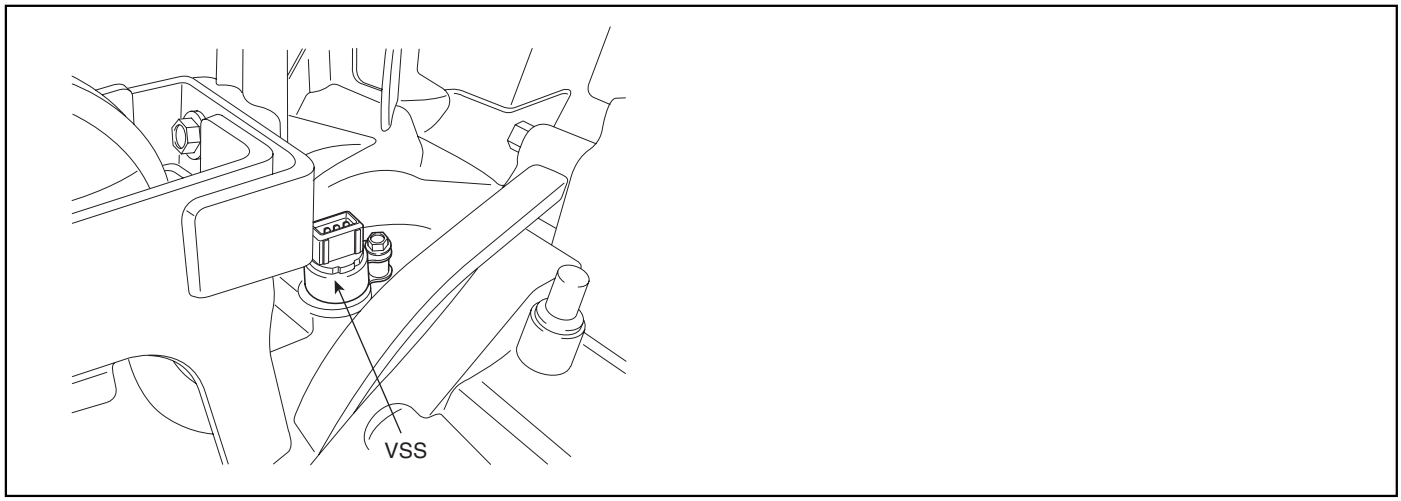
▶ Replace EEGR actuator and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E8710ED1

Refer to DTC P0489.

DTC P0501 VEHICLE SPEED SENSOR A RANGE/PERFORMANCE

COMPONENT LOCATION EF2D198E



SNFFL6217D

GENERAL DESCRIPTION E6CA14C8

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 E93D55D0

P0501 is set when vehicle speed below 15Km/h is detected for more than 1 sec. at above 3500RPM and above 38.25 mg/hub of fuel injection quantity

DTC DETECTING CONDITION EB992519

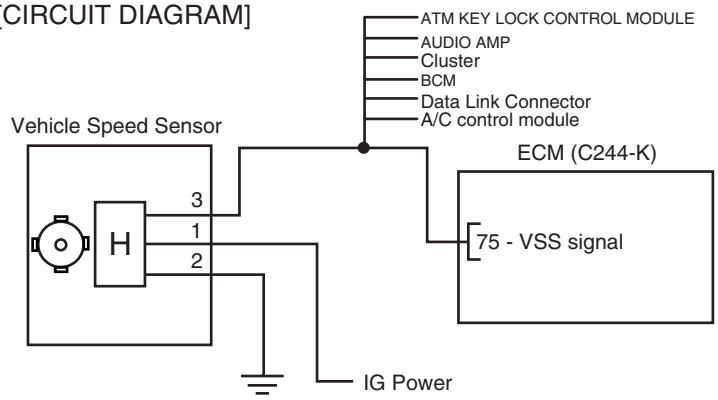
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Signal monitoring</td><td rowspan="8">• Vehicle speed sensor circuit
• Vehicle speed sensor component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• When vehicle speed below 15Km/h is detected for more than 1.0 sec. at above 3500RPM and above 38.25 mg/hub of fuel injection quantity.</td></tr>
<tr><td>Diagnostic Time</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>Check Lamp</td><td>NO</td></tr>
</table>

SPECIFICATION EDB7381D

Sensing Type	LOW Signal Voltage	HIGH Signal Voltage	Signal Duty
Hall sensor type	below 1.5V	above 3.5V	50±5%

SCHEMATIC DIAGRAM E9F53019

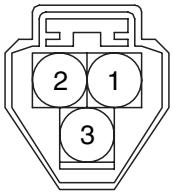
[CIRCUIT DIAGRAM]



[CONNECTOR INFORMATION]

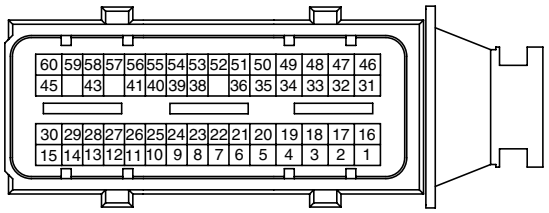
Terminal	Connected to	Function
1	JC 01 (87)	IG Power
2	G215 Ground point	Chassis Ground
3	ECM C244-K (75)	VSS signal

[HARNESS CONNECTOR]

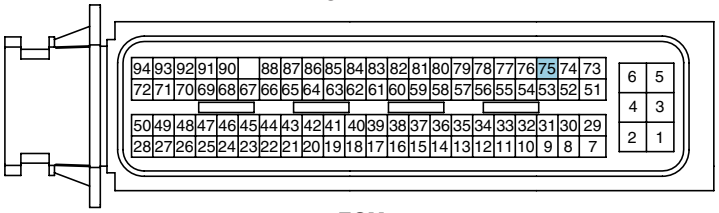


C212
VSS

C244-A



C244-K



ECM

STGFL7520L

SIGNAL WAVEFORM AND DATA ECE31503

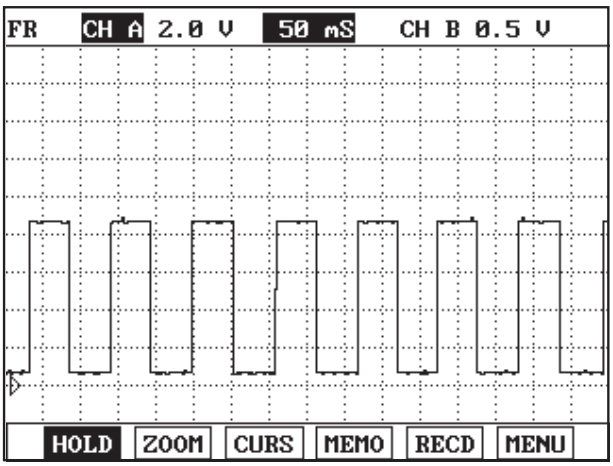


Fig.1

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).

LFIG432A

MONITOR SCANTOOL DATA EAB7AE87

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.

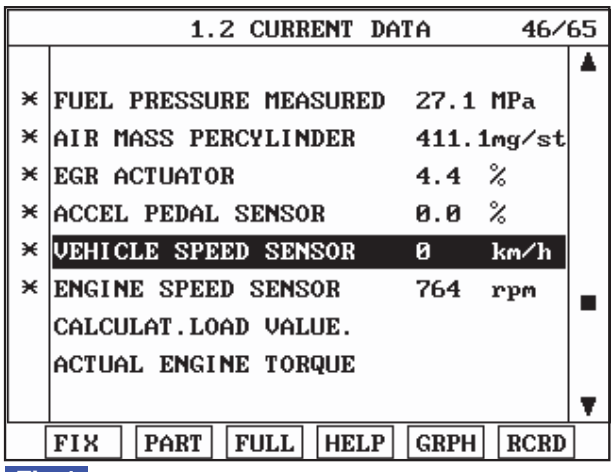


Fig.1

Fig.1) Check if current vehicle speed is same as vehicle speed displayed on the Scantool.

LFIG433A

TERMINAL AND CONNECTOR INSPECTION E3727CDC

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 E11C8A07

1. Check power circuit voltage

   1) IG KEY "OFF", ENGINE "OFF"

   2) Disconnect Vehicle Speed Sensor connector.

   3) IG KEY "ON"

   4) Measure the voltage of VSS connector terminal 1.

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 10A FUSE and related circuit, and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION E7B8598C

1. Check signal circuit voltage (sensor side)

   1) IG KEY "OFF", ENGINE "OFF"

   2) Disconnect Vehicle Speed Sensor connector.

   3) IG KEY "ON"

   4) Measure the voltage of VSS connector terminal 3.

Specification : 8.0V~11.5V

5) Is the measured voltage within the specification?

YES

▶ Go to "2. Check signal circuit voltage (ECM side)".

NO

▶ Repair poor connection or open in joint connector M-1 terminal 1 related 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(C244-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 joint connector M-1 terminal 1 related circuit and go to "Verification of Vehicle Repair".

GROUND CIRCUIT INSPECTION E8B95D68

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect VSS connector.
3. IG KEY "ON"
4. Measure the voltage of VSS connector terminal 3. [TEST "A"]
5. Measure the voltage between VSS connector terminal 3 and 2. [TEST "B"]
   (terminal 3 : 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 E9450E59

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 : Vehicle Speed Signal generates.

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 EF4A4254

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 E54A7148

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 EC47044E

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 E3E7B167

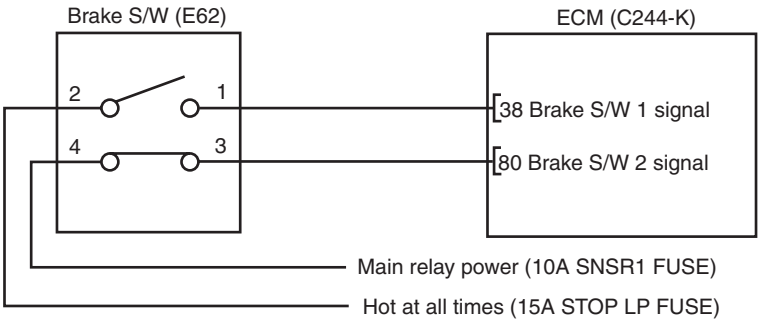
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Signal monitoring</td><td rowspan="6">• Brake switch component
• Abnormal brake pedal height
• Brake switch circuit</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Wiring open or short</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• 180 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>Check Lamp</td><td>NO</td></tr>
</table>

SPECIFICATION EB1C8246

Condition	Brake Pedal Released		Brake Pedal Depressed	
switch state	Switch 1	Switch 2	Switch 1	Switch 2
	Opened	Closed	Closed	Opened

SCHEMATIC DIAGRAM EA387AD9

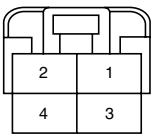
[CIRCUIT DIAGRAM]



[CONNECTOR INFORMATION]

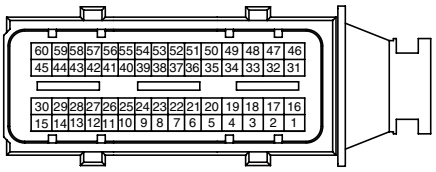
Terminal	Connected to	Function
1	ECM C244-K (38)	Brake S/W 1 signal
2	JE 02 (22)	Hot at all times
3	ECM C244-K (80)	Brake S/W 2 signal
4	JE 02 (42)	Main relay power

[HARNESS CONNECTOR]

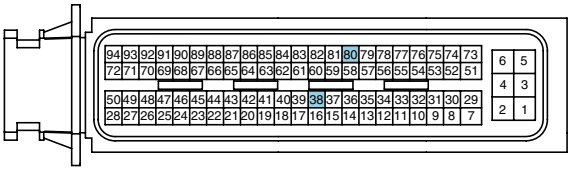


E62
Brake S/W

C244-A



C244-K



ECM

STGFL7521L

SIGNAL WAVEFORM AND DATA EF4BE3CA

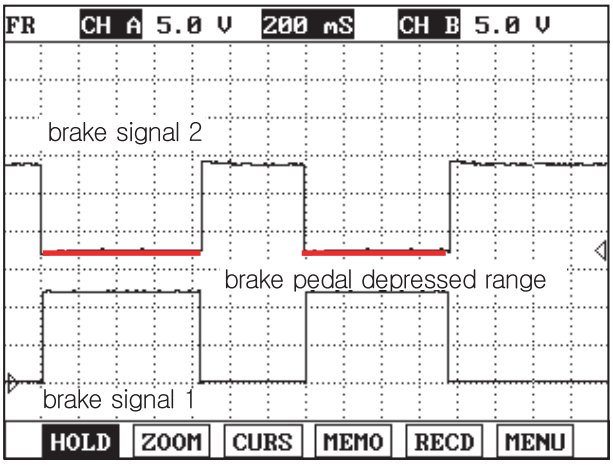


Fig.1

Fig.1) The waveform of brake signal 1 and 2 are measured simultaneously. Both waveforms are symmetrical.

LFIG313A

MONITOR SCANTOOL DATA E36704C3

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 "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

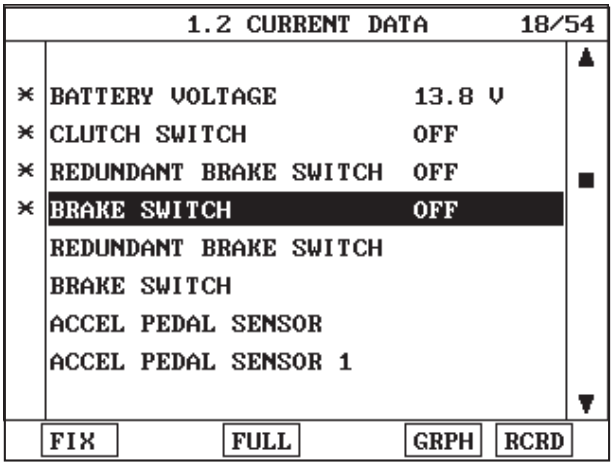


Fig.1

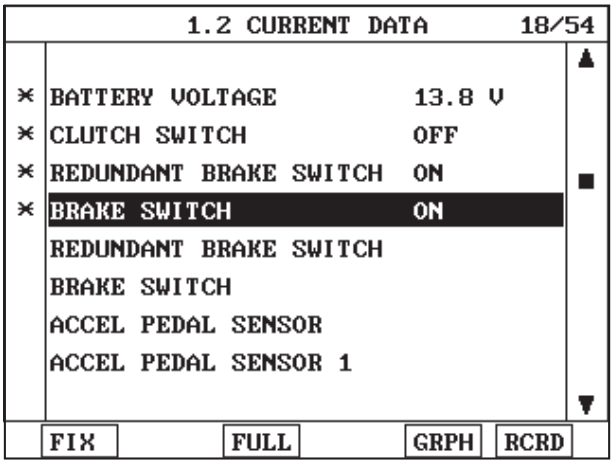


Fig.2

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

LFIG314A

TERMINAL AND CONNECTOR INSPECTION E989CFB5

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 E369C6F6

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 terminal 2 of brake switch connector.

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 I/P 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 SNSR1 FUSE and related circuit and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION EBEAD6E4

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 and 87, 87a using jump wire.
   4) Measure the voltage of ECM connector (C244-K) terminal 38 and 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

5) Is the measured voltage within the specification?

YES

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

NO

▶ If there is any problem on component after checking "Component Inspection" procedure, go to "2. Check open in signal circuit " procedure.

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(C244-K) terminal 38. (brake switch 1 circuit)

4) Check continuity between brake switch connector terminal 3 and ECM connector(C244-K) terminal 80. (brake switch 2 circuit)

specification : Continuity (below 1.0Ω)

5) Is the measured resistance within the specification?

YES

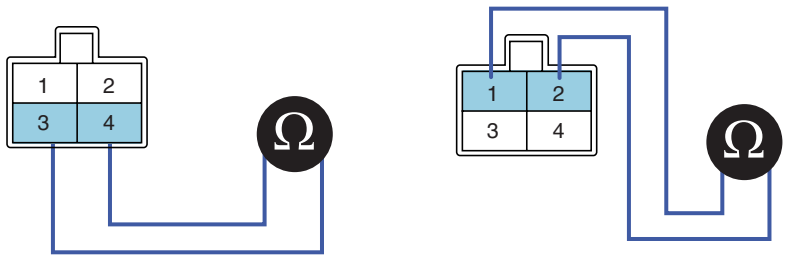
▶ Repair short in signal circuit and go to "Verification of Vehicle Repair".

NO

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

COMPONENT INSPECTION E5469650

1. IG KEY "OFF", ENGINE "OFF".
2. Disconnect brake switch connector.
3. Check continuity between brake switch component terminal 1and 2 as depressing brake pedal. (brake switch 1)
4. Check continuity between brake switch component terminal 3and 4 as depressing brake pedal. (brake switch 2)



KFQG413A

SPECIFICATION :

Brake Pedal Released		Brake Pedal Depressed	
Switch 1	**Switch 2**	**Switch 1**	**Switch 2**
Discontinuity	Continuity	Continuity	Discontinuity

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 E38D2612

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

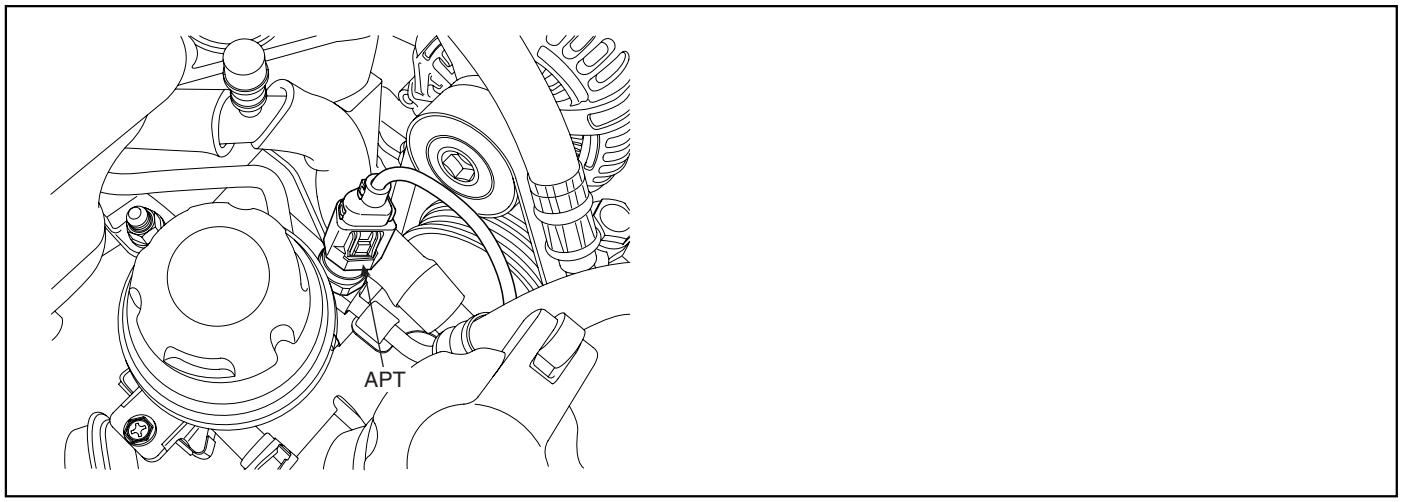
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0532 A/C REFRIGERANT PRESSURE SENSOR "A" CIRCUIT LOW INPUT

COMPONENT LOCATION E567B01B



STGFL7219L

GENERAL DESCRIPTION E46071EF

A/C pressure transducer consists of piezoelectric element and it detects aircon refrigerant pressure. Piezoeletric type is more advantageous to obtain linear data of pressure than existing switch type. Thus, optimum control of aircon compressor and fan is realized and improved fuel efficiency follows with it.

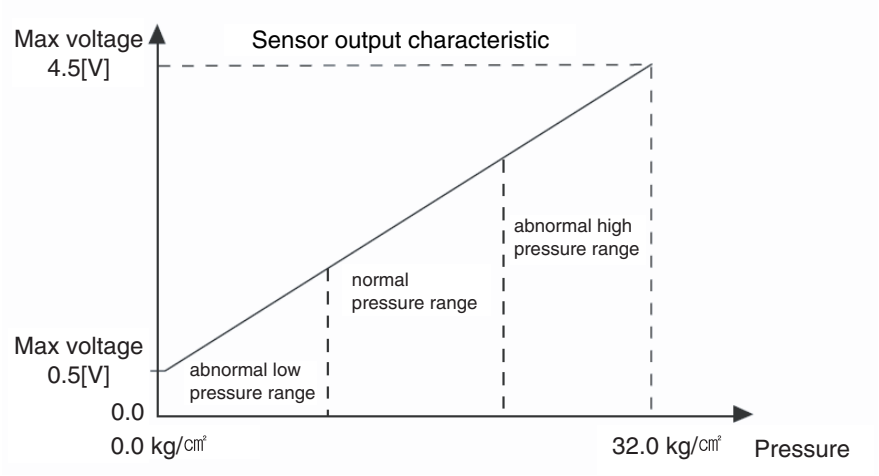
DTC DESCRIPTION E1FD20AE

P0532 is set when the voltage below 0.18V - 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 E4D0AD11

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• A/C pressure transducer circuit • A/C pressure transducer component
Enable Conditions	• IG KEY "ON"			
Threshold Value	• When output voltage is below the minimum value (below 0.18V)			
Diagnostic Time	• 0.6 sec.			
Fail Safe	Fuel cut	NO		
	EGR Off	NO		
	Fuel Limit	NO		
	Check Lamp	NO		

SPECIFICATION EF7D07B1



LFIG438A

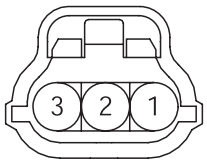
SCHEMATIC DIAGRAM EEEDF708

[CIRCUIT DIAGRAM]

[CONNECTOR INFORMATION]

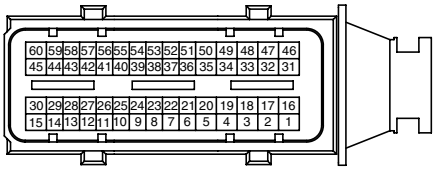
Terminal	Connected to	Function
1	ECM C244-K (12)	Sensor ground
2	ECM C244-K (13)	Sensor signal
3	ECM C244-K (22)	Sensor power

[HARNESS CONNECTOR]

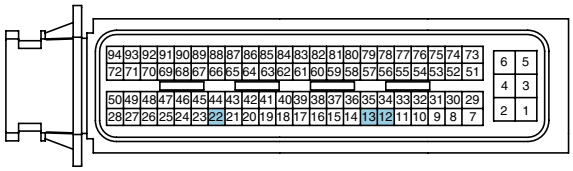


E31
A/C pressure transducer

C244-A



C244-K



ECM

STGFL7522L

SIGNAL WAVEFORM AND DATA E525E32E

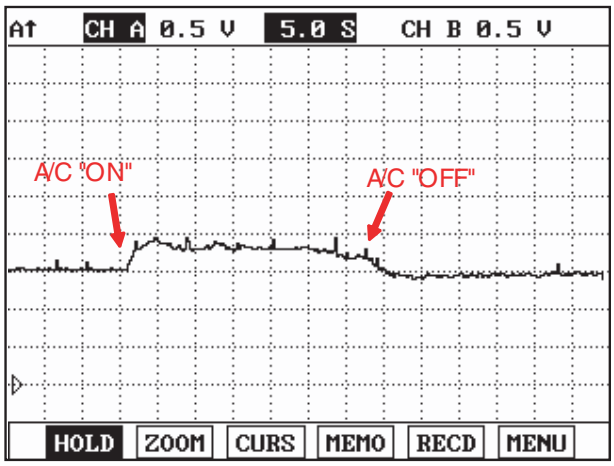


Fig.1

Fig.1) Waveform of A/C pressure transducer in accordance with aircon operation.(aircon compressor operation)

LFIG440A

NOTE

Output signal(voltage) changes in accordance with the amount of refrigerant and the change of weather. Check if normal pressure change occurs in accordance with aircon compressor operation at normal pressure range shown in "Specification".

MONITOR SCANTOOL DATA E461D1AE

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 " A/C PRESSURE SENSOR " parameter on the scantool.

Specification : A/C "OFF" : 1200mV~1800mV
A/C "ON" : higher than A/C "OFF" pressure by more than 500mV

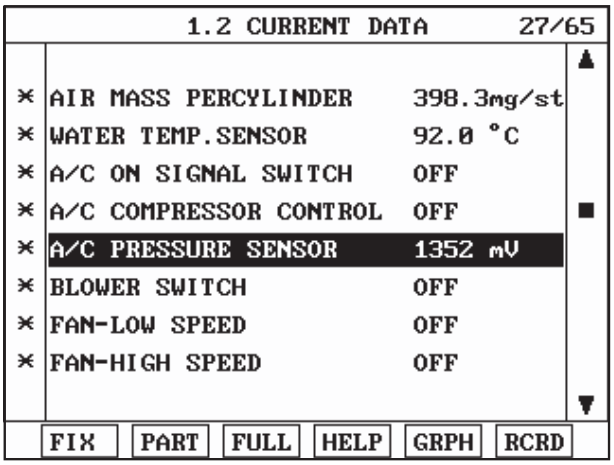


Fig.1

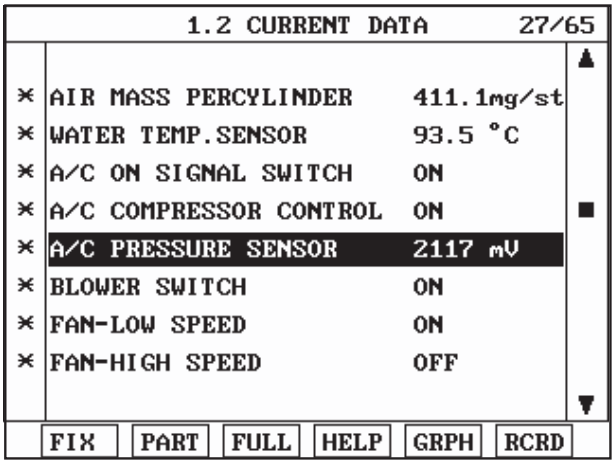


Fig.2

Fig.1) Data at idle and aircon "OFF", Aircon pressure sensor output voltage is 2058mV.
Fig.2) Data at idle and aircon "ON". Aircon pressure sensor output voltage increases as aircon compressor operates.
※ A/C Pressure sensor transducer voltage varies too much, therefore do not concern too much about the figure instead, check the rising tendancy of A/C Pressure transducer.

LFIG441A

※ A/C Pressure sensor transducer voltage varies too much, therefore do not concern too much about the figure instead, check the rising tendancy of A/C Pressure transducer.

TERMINAL AND CONNECTOR INSPECTION E93E9DD3

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 E99A2654

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 power circuit of A/C pressure transducer and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION EA07A4BE

1. Check signal circuit voltage
   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(C244-K) terminal 13.

Specification : Continuity (below 1.0Ω)

   4) Is the measured voltage 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 voltage 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 E3EB568E

1. Aircon pressure sensor visual inspection
   1) IG KEY "OFF", ENGINE "OFF"
   2) Disconnect A/C pressure transducer connector.
   3) Check if corrosion and contamination at aircon pressure sensor terminal is detected.
   4) Check aircon pressure sensor connecting torque and aircon refrigerant leakage.
   5) Does any problem is detected at aircon pressure sensor?

      YES

      ▶ Replace aircon pressure sensor 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 aircon pressure sensor waveform at idle as turning Aircon "ON".

Specification : Refer to "Siganl waveform & data"

   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 E152C1B2

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 E70CA3EA

Refer to DTC P0532.

GENERAL DESCRIPTION E34FCF9E

Refer to DTC P0532.

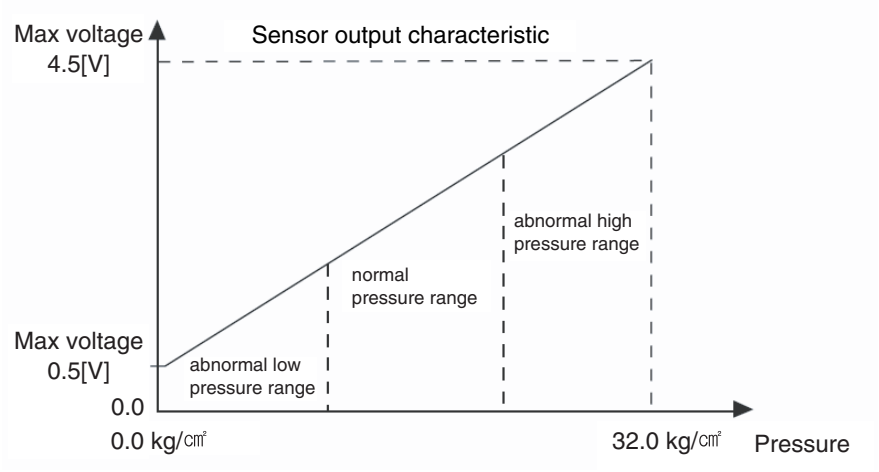
DTC DESCRIPTION E209BD48

P0533 is set when the voltage above 4.7V - 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 E0598DE6

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• A/C pressure transducer circuit • A/C pressure transducer component
Enable Conditions	• IG KEY "ON"			
Threshold Value	• When output signal is above the maximum value (above 4.7V)			
Diagnostic Time	• 0.6 sec.			
Fail Safe	Fuel cut	NO		
	EGR Off	NO		
	Fuel Limit	NO		
	Check Lamp	NO		

SPECIFICATION EC722FD3



LFIG438A

SCHEMATIC DIAGRAM E194549F

Refer to DTC P0532.

SIGNAL WAVEFORM AND DATA E88A6D2C

Refer to DTC P0532.

MONITOR SCANTOOL DATA EDF1AD55

Refer to DTC P0532.

TERMINAL AND CONNECTOR INSPECTION E317A702

Refer to DTC P0532.

POWER CIRCUIT INSPECTION E83F3A58

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 power circuit of A/C pressure transducer and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION EBEDE63B

1. Check signal circuit voltage
   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 E47E4DDF

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 EDAC38F3

1. Aircon pressure sensor visual inspection
   1) IG KEY "OFF", ENGINE "OFF"
   2) Disconnect A/C pressure transducer connector.
   3) Check if corrosion and contamination at aircon pressure sensor terminal is detected.
   4) Check aircon pressure sensor connecting torque and aircon refrigerant leakage.
   5) Does any problem is detected at aircon pressure sensor?

YES

▶ Replace aircon pressure sensor 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 aircon pressure sensor waveform at idle as turning Aircon "ON".

Specification : Refer to "Siganl waveform & data"

5) Is A/C pressure transducer waveform outputted correctly?

YES

▶ Go to "Verification of Vehicle Rapair".

NO

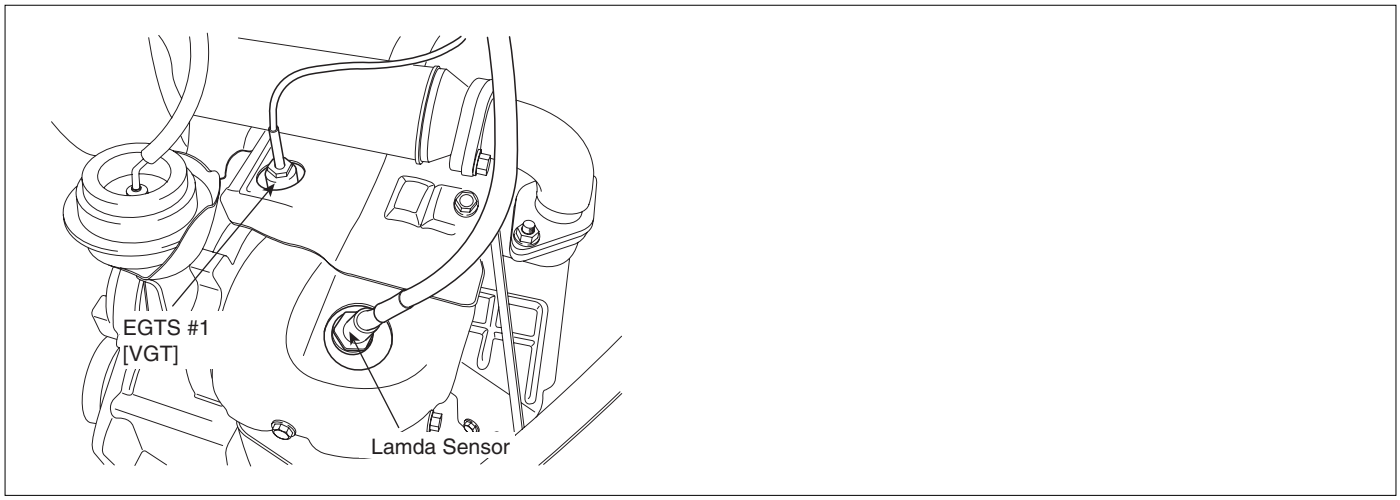
▶ Replace A/C pressure transducer and go to "Verification of Vehicle Rapair".

VERIFICATION OF VEHICLE REPAIR EDCBC152

Refer to DTC P0532.

DTC P0545 EXHAUST GAS TEMPERATURE SENSOR CIRCUIT LOW (BANK 1 / SENSOR 1)

COMPONENT LOCATION EC22649F



SNFFL6238L

GENERAL DESCRIPTION EAB8E8EB

In EURO4 diesel engine with CPF, injection is devided into 2 pilot, 1 main, 2 post injections. Among these injections, pilot and main injections are for the operation of engine, however post injections are for CPF regeneration. Only in activating condition of CPF regeneration during driving, post injection starts. 1st post injection happens at the end of combustion cycle then, injected fuel is used to raise exhaust temperature. that temp. is sensed at T3 exhaust tempt. sensor which is ahead of Turbo charger. 2nd post injection happens at exhaust cycle then, injected fuel is also used to raise exhaust temperature. that temp. is sensed T5 exhaust tempt. sensor which is between Oxydation catalyst and CPF. The reason of raising exhaust tempt. is because exhaust tempt. in diesel engine is too low for CPF regeneration. The optimum tempt. for CPF regeneration is 550~600℃ thus, the goal of post injection is raise exhaust tempt. to that range of tempt.. However if exhaust tempt. is too high, turbo charger or CPF are likely to be damaged. Therefore if tempt. measured at each sensor is out of permittable value(specification), ECM deactivates CPF regeneration.

DTC DESCRIPTION E0D34DF5

P0545 is set when front exhaust gas temp. sensor(T3-VGT) signal voltage is below 0.2V - the lower limit value - for more than 0.6 sec.

DTC DETECTING CONDITION E8B33D6C

<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">• Exhaust gas temp. sensor(T3-VGT) wiring
• Exhaust gas temp. sensor(T3-VGT) component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON" or Engine running</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Signal voltage below 0.2V(Short to ground in signal circuit)</td></tr>
<tr><td>Diagnostic Time</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">• Exhaust gas temp. fixed at 400℃</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>Check Lamp</td><td>NO</td></tr>
</table>

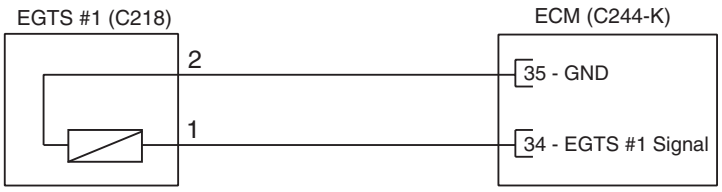
SPECIFICATION EA71F15F

RESISTANCE/TEMPERATURE CHARACTERISTICS

Temp. (℃)	Nominal (kΩ)	NEW		AGED	
		Min(kΩ)	Max(kΩ)	Min(kΩ)	Max(kΩ)
100	371	289	481	272	515
300	5.92	5.3	6.61	5.15	6.79
600	0.363	0.347	0.379	0.341	0.386
900	0.0893	0.0842	0.0949	0.0833	0.096

SCHEMATIC DIAGRAM E6532067

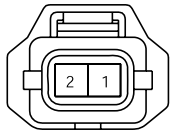
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-K (34)	EGTS #1 Signal
2	ECM C244-K (35)	Sensor ground

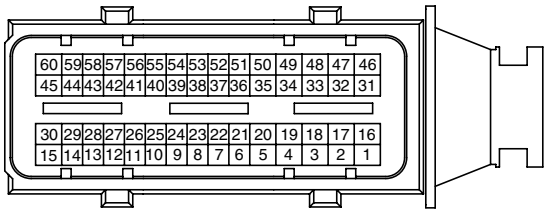
[HARNESS CONNECTORS]



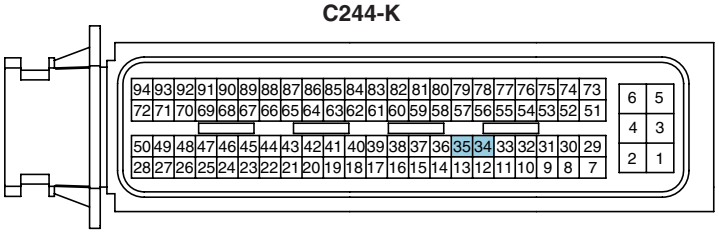
C218

EGTS #1

C244-A



C244-K



ECM

STGFL7164L

SIGNAL WAVEFORM AND DATA EE826CFD

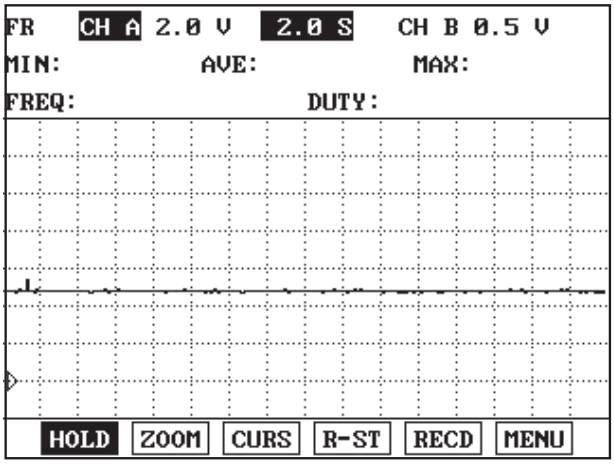


Fig.1

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

SNFFL6538L

MONITOR SCANTOOL DATA EB8FC796

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 "E/GAS TEMP. PRE VGT","E/GAS TEMP. PRE CPF" parameter on the Scantool.

Specification : Current "E/GAS TEMP." is displayed.

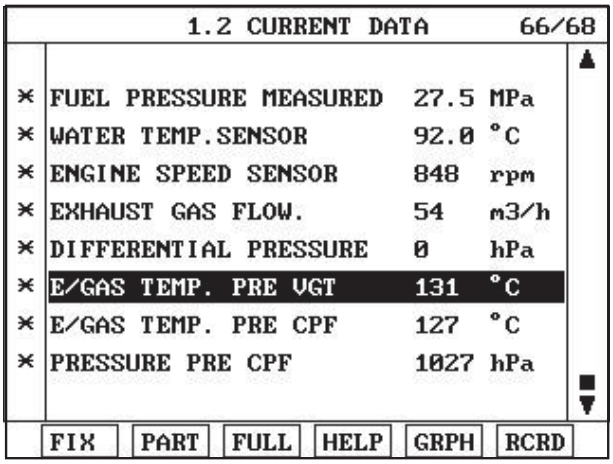


Fig.1

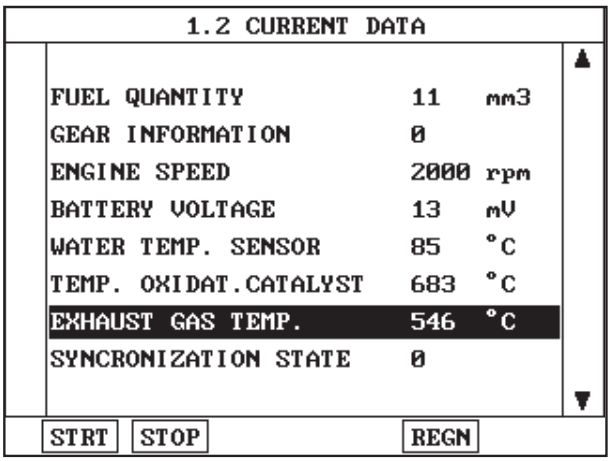


Fig.2

Fig.1) "EXHAUST GAS TEMP." at idle is shown. Monitor if abnormall difference between "Fig. 1) data" and the data from the vehicle to test.
Fig.2) The display during performing CPF regeneration after selecting "CPF SERVICE REGENERATION" mode is shown. Monitor if "EXHAUST GAS TEMP." varies correctly.

STGFL7539L

TERMINAL AND CONNECTOR INSPECTION E7A99ADA

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 E8734118

1. Check signal circuit voltage

   1) IG KEY "OFF", ENGINE "OFF"

   2) Disconnect EGTS(T3-VGT) connector.

   3) IG KEY "ON"

   4) Measure the voltage of EGTS(T3-VGT) 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 EGTS(T3-VGT) connector and ECM connector.

   3) Check continuity between EGTS(T3-VGT) connector terminal 1 and ECM connector(C244-K) terminal 34.

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification?

YES

▶ Go to "Check short to ground in signal circuit".

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 EGTS(T3-VGT) connector and ECM connector.

   3) Check continuity between EGTS(T3-VGT) connector terminal 1 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 E209FF80

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect EGTS(T3-VGT) connector.
3. IG KEY "ON"
4. Measure the voltage of EGTS(T3-VGT) connector terminal 1. [TEST "A"]
5. Measure the voltage between EGTS(T3-VGT) connector terminal 1 and 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".

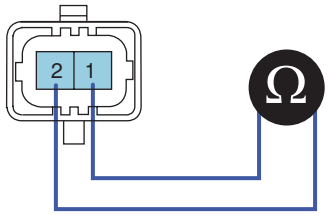
NO

▶ 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 E3675D4B

1. IG KEY "OFF", ENGINE "OFF".
2. Disconnect EGTS(T3-VGT) connector.
3. Measure resistance between EGTS(T3-VGT) terminal 1 and 2, referring to resistance characteristic table of specification of General information.

Specification : Refer to Specification of General Information



KFQG320A

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 EGTS(T3-VGT) and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E613264B

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 P0546 EXHAUST GAS TEMPERATURE SENSOR CIRCUIT HIGH (BANK 1 / SENSOR 1)

COMPONENT LOCATION E3E6B817

Refer to DTC P0545.

GENERAL DESCRIPTION EE2248A3

Refer to DTC P0545.

DTC DESCRIPTION E0D6617C

P0546 is set when the Exhaust gas temperature sensor(EGTS) - VST signal is detected over maximum set temperature(890℃),- In case that exhaust gas temperature on the front side of VGT is abnormally increased -, for more than 1sec. Therefore, check component or vehicle is driven in severe driving condition.
*. In case that real exhaust gas temperature reaches up to 890℃, engine and exhaust line(Turbo charger), CPF can be damaged.

DTC DETECTING CONDITION E2F7B044

<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">• abnormal over-load (driving) condition
• Exhaust gas temp. sensor(T3-VGT) wiring
• Exhaust gas temp. sensor(T3-VGT) component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON" or Engine running</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• exhaust gas temp. exceeds 890℃(EGTS-VGT)</td></tr>
<tr><td>Diagnostic Time</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>Check Lamp</td><td>NO</td></tr>
</table>

SPECIFICATION E262B80E

RESISTANCE/TEMPERATURE CHARACTERISTICS

Temp. (℃)	Nominal (kΩ)	NEW		AGED	
		Min(kΩ)	Max(kΩ)	Min(kΩ)	Max(kΩ)
100	371	289	481	272	515
300	5.92	5.3	6.61	5.15	6.79
600	0.363	0.347	0.379	0.341	0.386
900	0.0893	0.0842	0.0949	0.0833	0.096

SCHEMATIC DIAGRAM EECDC8F8

Refer to DTC P0545.

SIGNAL WAVEFORM AND DATA E5B79696

Refer to DTC P0545.

MONITOR SCANTOOL DATA EFB67CED

Refer to DTC P0545.

TERMINAL AND CONNECTOR INSPECTION E1D948C7

Refer to DTC P0545.

SIGNAL CIRCUIT INSPECTION E8EB30C8

1. Check signal circuit voltage
   1) IG KEY "OFF", ENGINE "OFF"
   2) Disconnect EGTS(T3-VGT) connector.
   3) IG KEY "ON"
   4) Measure the voltage of EGTS(T3-VGT) 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 EGTS(T3-VGT) connector and ECM connector.
   3) Check continuity between EGTS(T3-VGT) connector terminal 1 and ECM connector(C244-K) terminal 34.

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification?

YES

▶ Go to "Check short to ground in signal circuit".

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 EGTS(T3-VGT) connector and ECM connector.

3) Check continuity between EGTS(T3-VGT) connector terminal 1 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 E116E719

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect EGTS(T3-VGT) connector.
3. IG KEY "ON"
4. Measure the voltage of EGTS(T3-VGT) connector terminal 1. [TEST "A"]
5. Measure the voltage between EGTS(T3-VGT) connector terminal 1 and 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".

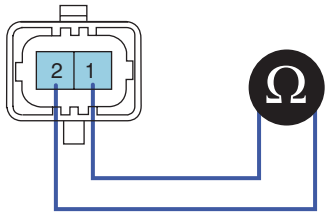
NO

▶ 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 E4586569

1. IG KEY "OFF", ENGINE "OFF".
2. Disconnect EGTS(T3-VGT) connector.
3. Measure resistance between EGTS(T3-VGT) terminal 1 and 2, referring to resistance characteristic table of specification of General information.

Specification : Refer to Specification of General Information



KFQG320A

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

YES

▶ Go to "Verification of Vehicle Repair".

NO

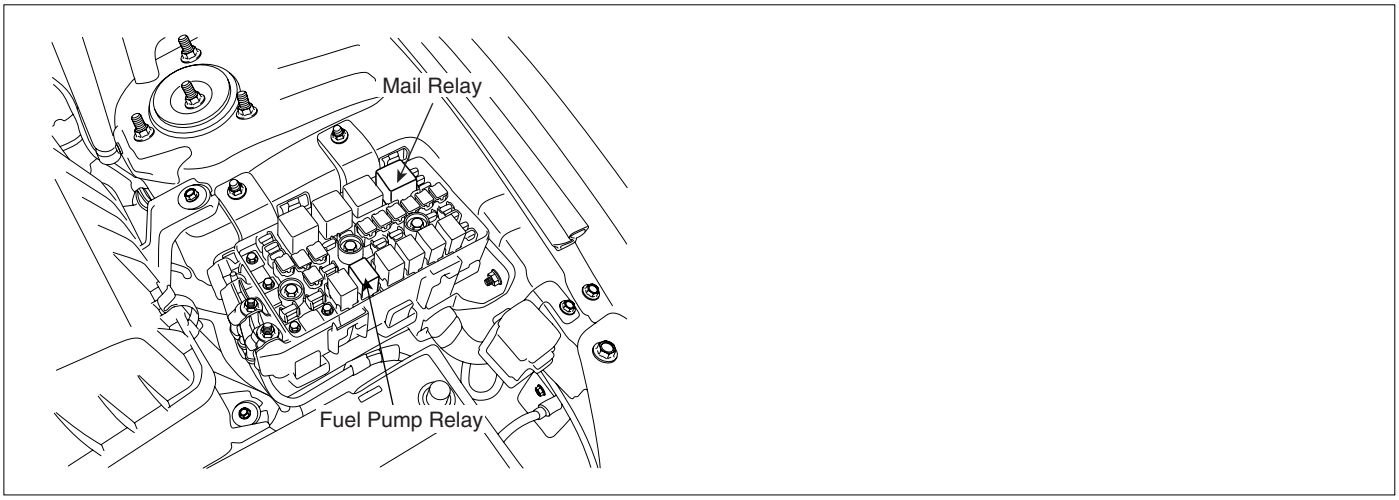
▶ Replace EGTS(T3-VGT) and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR EC4EB154

Refer to DTC P0545.

DTC P0562 SYSTEM VOLTAGE LOW

COMPONENT LOCATION EE4FD5BD



SNFFL6209L

GENERAL DESCRIPTION E58E8632

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 ED7E01EF

P0562 is set when battery voltage below 5.8V is detected for more than 5 sec. Check charging system.(charging circuit, alternator component)

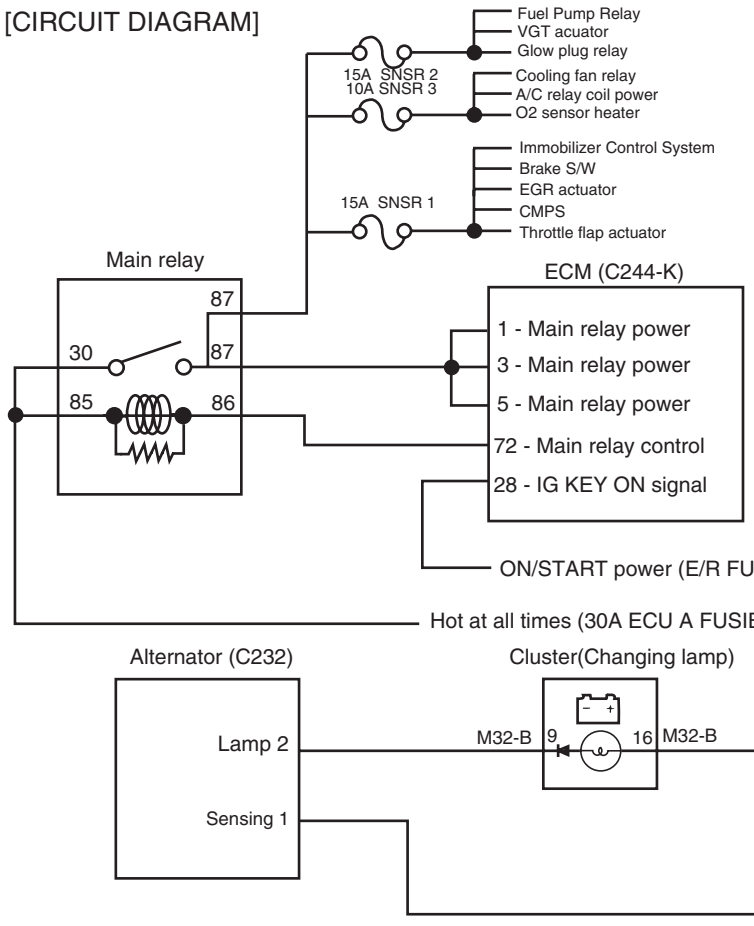
▶ ECM senses battery voltage as monitoring the voltages in ECM(C244-K) connector terminal 1,3,5 which are transmitted from main relay.

DTC DETECTING CONDITION EF9B8A2E

<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">• Charging circuit
• Alternator component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• when battery voltage is below 5.8V</td></tr>
<tr><td>Diagnostic Time</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 12V.</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>Check Lamp</td><td>NO</td></tr>
</table>

SCHEMATIC DIAGRAM E0138C7C

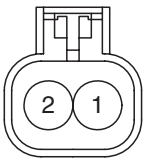
[CIRCUIT DIAGRAM]



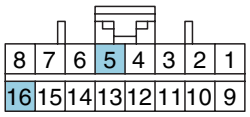
[CONNECTOR INFORMATION]

Terminal	Connected to	Function
30	30A ECU FUSIBLE LINK	Hot at all times
85	30A ECU FUSIBLE LINK	Main relay coil power
86	ECM C244-K (72)	Main relay control
87	SNSR1,3 Fuse ECM C244-K (1,3,5)	Power supply to Sensor, Actuator Power supply to ECM
87a	SNSR2 Fuse	Power supply to Sensor, Actuator

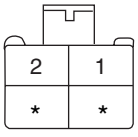
[HARNESS CONNECTOR]



C232
Alternator

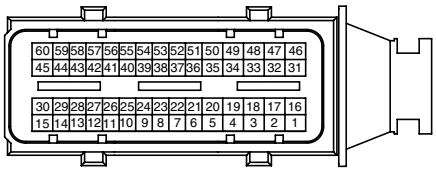


M32-B
Cluster

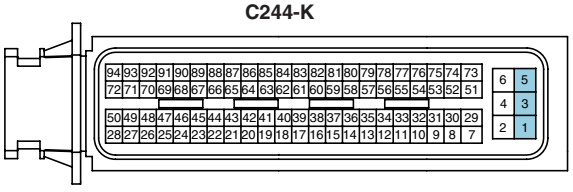


M84
Pre excitation Resistor

C244-A



C244-K



ECM

STGFL7523L

SIGNAL WAVEFORM AND DATA EA8B40D5

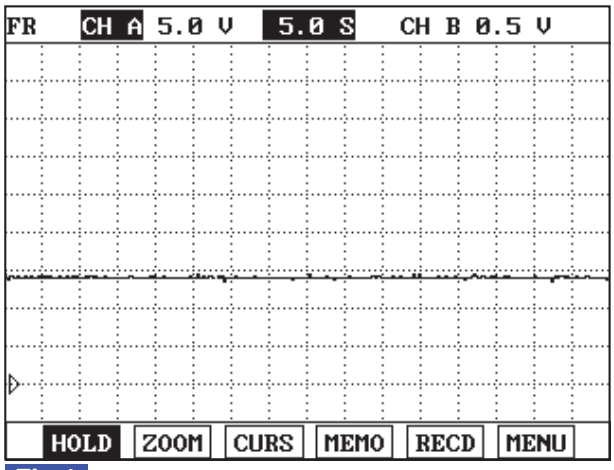


Fig.1

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.

LFIG321A

MONITOR SCANTOOL DATA EB16879A

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 "BATTERY VOLTAGE" parameter on the Scantool.

specification :12.5V~14.5V at idle without any load(800RPM)

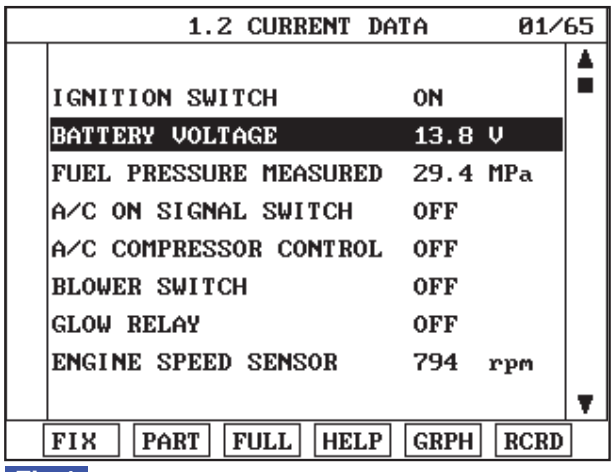


Fig.1

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.

LFIG322A

※ 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 crankinghappen.)
4. Charging lamp turns on during driving.

TERMINAL AND CONNECTOR INSPECTION EB6748B5

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 E2EE4FF1

1. Check power supply in alternator connector (Sensing)

   1) IG KEY "ON", Turn engine "OFF".

   2) Disconnect alternator connector.

   3) Measure the voltage of terminal 1 of alternator connector.

Specification : 11.5V~13.0V

   4) Is the measured voltage within the specification?

      YES

      ▶ Go to "2. Check power supply in alternator connector (Charging lamp)".

      NO

      ▶ Repair E/R JUNCTION BOX 10A ECU FUSE and related circuit and go to "Verification of Vehicle Repair".

2. Check power supply in alternator connector (Charging lamp)

   1) IG KEY "ON", Turn engine "OFF".

2) Disconnect alternator connector.

3) Measure the voltage of terminal 2 of alternator connector.

Specification : 10.5V~12.0V

4) Is the measured voltage within the specification?

YES

▶ Go to "3. Check charging lamp operation".

NO

▶ Check charging lamp on cluster, M21 charging lamp resistor and related circuit and go to "Verification of Vehicle Repair".

3. 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 "4.Check voltage drop of aternator B+ cable".

NO

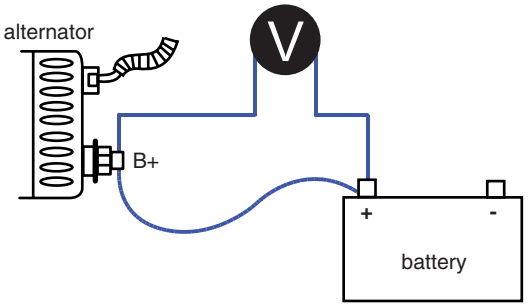
▶ Replace lamp and go to "Verification of Vehicle Repair".

4. 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)



EGNG003S

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 E85B04CE

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 Engien "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 E273EA22

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

COMPONENT LOCATION E35E17B0

Refer to DTC P0562.

GENERAL DESCRIPTION EE3BE8BA

Refer to DTC P0562.

DTC DESCRIPTION E09C125F

P0563 is set when battery voltage above 17.3V is detected for more than 5 sec.. Check alternator component. (over-charging of alternator)
▶ ECM senses battery voltage as monitoring the voltages in ECM(C244-K)connector terminal 1,3,5 which are transmitted from main relay.

DTC DETECTING CONDITION E6F65752

<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">• Charging circuit
• Alternator component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• when battery voltage is above 17.3V</td></tr>
<tr><td>Diagnostic Time</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 12V.</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>Check Lamp</td><td>NO</td></tr>
</table>

SCHEMATIC DIAGRAM E64CC9F4

Refer to DTC P0562.

SIGNAL WAVEFORM AND DATA E26DF378

Refer to DTC P0562.

MONITOR SCANTOOL DATA EEBC41B1

Refer to DTC P0562.

TERMINAL AND CONNECTOR INSPECTION E02E898A

Refer to DTC P0562.

POWER CIRCUIT INSPECTION E328A798

1. Check power supply in alternator connector (Sensing)

1) IG KEY "ON", Turn engine "OFF".

2) Disconnect alternator connector.

3) Measure the voltage of terminal 1 of alternator connector.

Specification : 11.5V~13.0V

4) Is the measured voltage within the specification?

YES

▶ Go to "2. Check power supply in alternator connector (Charging lamp)".

NO

▶ Repair E/R JUNCTION BOX 10A ECU FUSE and related circuit and go to "Verification of Vehicle Repair".

2. Check power supply in alternator connector (Charging lamp)

1) IG KEY "ON", Turn engine "OFF".

2) Disconnect alternator connector.

3) Measure the voltage of terminal 2 of alternator connector.

Specification : 10.5V~12.0V

4) Is the measured voltage within the specification?

YES

▶ Go to "3. Check charging lamp operation".

NO

▶ Check charging lamp on cluster, M21 charging lamp resistor and related circuit and go to "Verification of Vehicle Repair".

3. 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 "4.Check voltage drop of aternator B+ cable".

NO

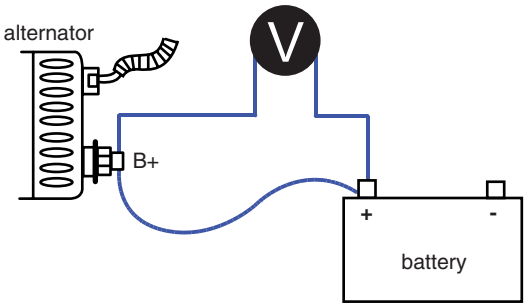
▶ Replace lamp and go to "Verification of Vehicle Repair".

4. 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)



EGNG003S

   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 EE657166

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 Engien "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 E67485D8

Refer to DTC P0562.

DTC P0602 EEPROM-PROGRAMING ERROR

GENERAL DESCRIPTION E16ACCF3

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 EF088B88

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 EC8A9145

<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">• ECM component failure</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• when data writing on EEPROM inside of ECM is impossible</td></tr>
<tr><td>Diagnostic Time</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>Check Lamp</td><td>NO</td></tr>
</table>

COMPONENT INSPECTION E64AC9F1

1. ECM Component Inspection

   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 E2C1C9FF

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

GENERAL DESCRIPTION E7A43BB4

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 EA4B51C2

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 E63BFEFD

<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>Threshold Value</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>Diagnostic Time</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>Check Lamp</td><td>NO</td></tr>
</table>

COMPONENT INSPECTION E49BD40C

1. ECM Component Inspection

   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 E7D3C8AE

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 P0606 ECM/PCM PROCESSOR(ECM-SELF TEST FAILED)

GENERAL DESCRIPTION E9A500E2

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 E9272743

P0606 is set when 1) writing/reading error inside of ECM occurs. 2) error of APS 2 ground checking which is repeated every 0.2 sec. or 3) 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 EDD416B5

<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">• ECM component failure</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• writing/reading error inside of ECM
• APS 2 ground checking error
• APS 2 ground checking error</td></tr>
<tr><td>Diagnostic Time</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>Check Lamp</td><td>YES</td></tr>
</table>

SIGNAL WAVEFORM AMD DATA E33E89E6

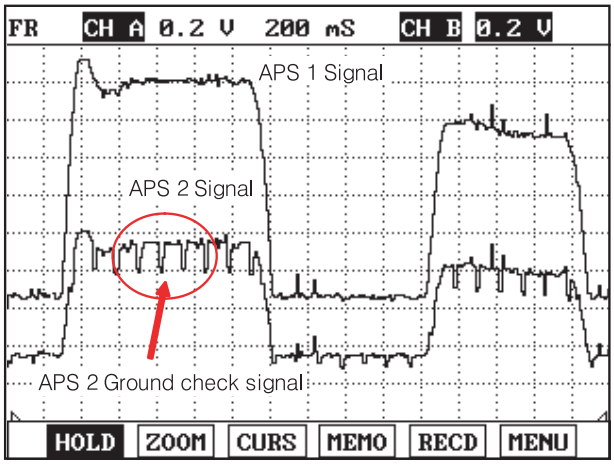


Fig.1

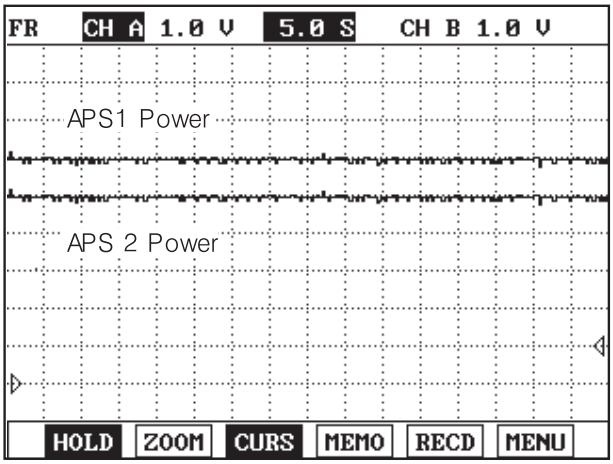


Fig.2

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.

SNFFL6550L

COMPONENT INSPECTION E44F7A10

1. ECM Component Inspection

   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 EC4492D6

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

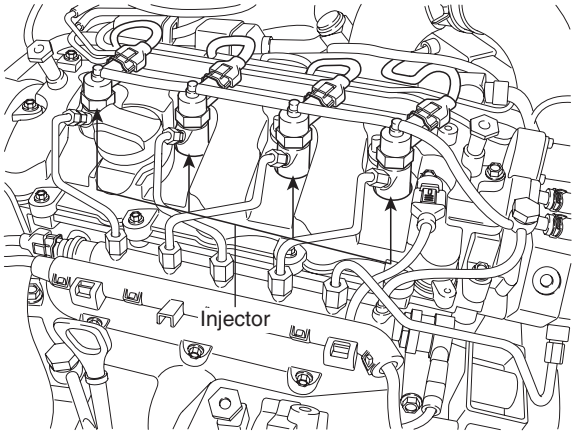
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0611 INJECTOR CIRCUIT MALFUNCTION (MORE THAN TWO INJECTORS)

COMPONENT LOCATION ECDE1443



SNFFL6206L

GENERAL DESCRIPTION E47264C9

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 E8C4E74A

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 E5839995

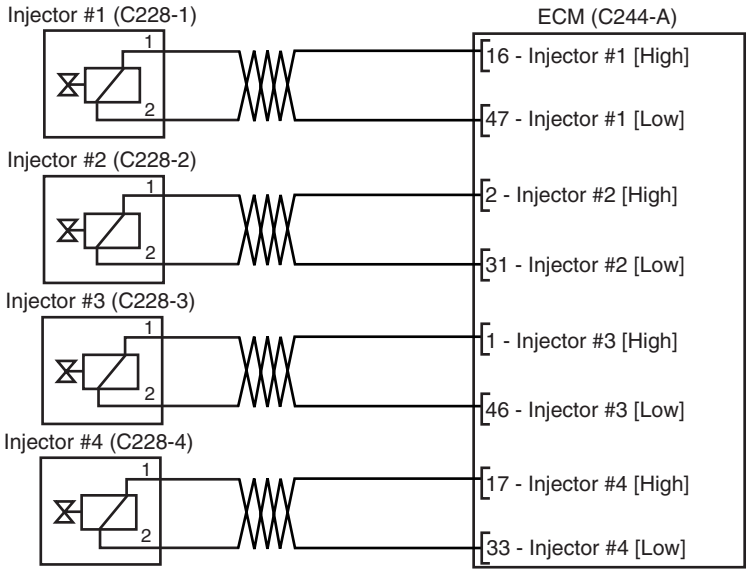
Item	Detecting Condition			Possible Cause
DTC Strategy	• Current monitoring			• Short in Injector circuit • Injector component
Enable Conditions	• IG KEY "ON"			
Threshold Value	• Failed cylinder recognition is impossible due to the failure more than 2 injectors.			
Diagnostic Time	• Immediately			
Fail Safe	Fuel cut	YES		
	EGR Off	NO		
	Fuel Limit	NO		
	Check Lamp	YES		

SPECIFICATION EBC29898

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 E1B6080D

[CIRCUIT DIAGRAM]



[CONNECTOR INFORMATION]

[Injector #1]

Terminal	Connected to	Function
1	ECM C244-A (16)	Injector #1 [High] control
2	ECM C244-A (47)	Injector #1 [Low] control

[Injector #2]

Terminal	Connected to	Function
1	ECM C244-A (2)	Injector #2 [High] control
2	ECM C244-A (31)	Injector #2 [Low] control

[Injector #3]

Terminal	Connected to	Function
1	ECM C244-A (1)	Injector #3 [High] control
2	ECM C244-A (46)	Injector #3 [Low] control

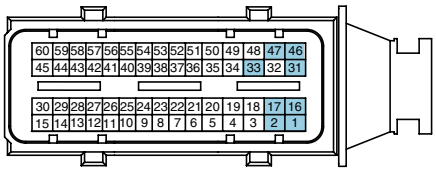
[Injector #4]

Terminal	Connected to	Function
1	ECM C244-A (17)	Injector #4 [High] control
2	ECM C244-A (33)	Injector #4 [Low] control

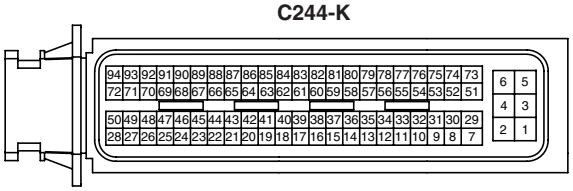
[HARNESS CONNECTOR]

C228-1,2,3,4
Injector #1,#2,#3,#4

C244-A



C244-K



ECM

STGFL7258L

SIGNAL WAVEFORM AND DATA E62A9419

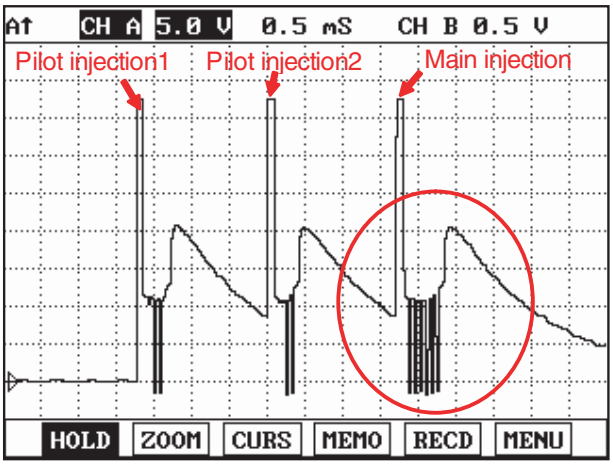


Fig.1

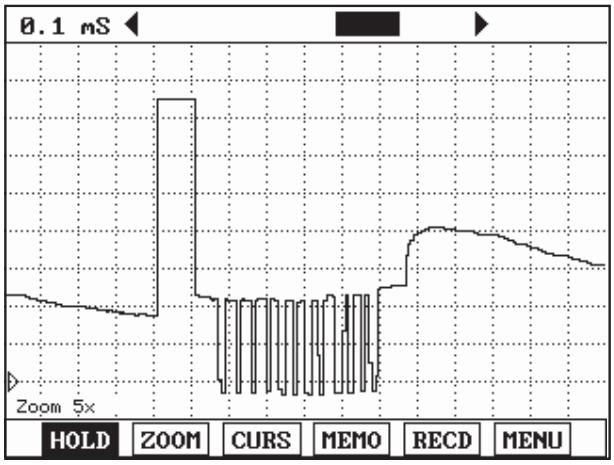


Fig.2

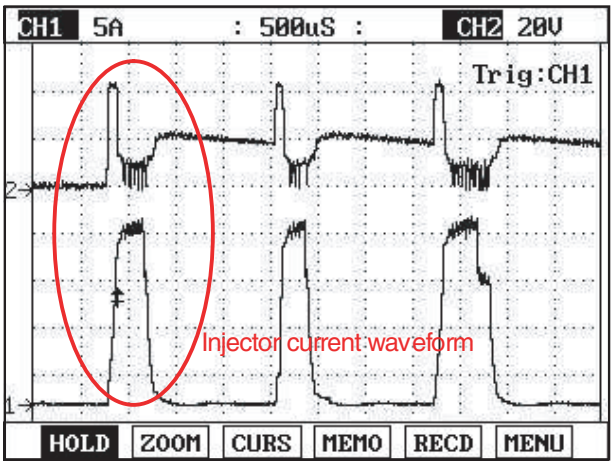


Fig.3

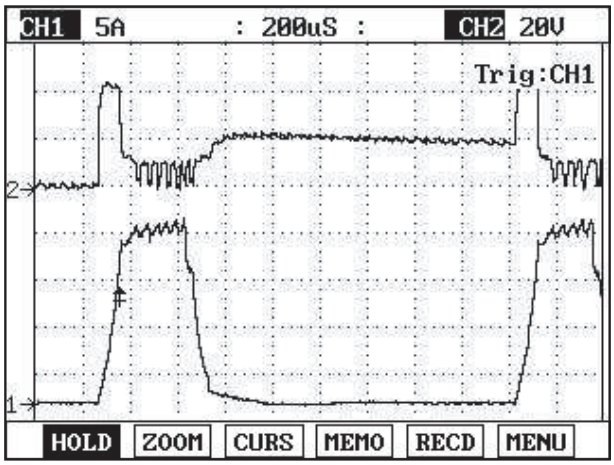


Fig.4

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)

LFIG259A

TERMINAL AND CONNECTOR INSPECTION E0323365

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".

MONITOR SCANTOOL DATA EE23FCB9

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.

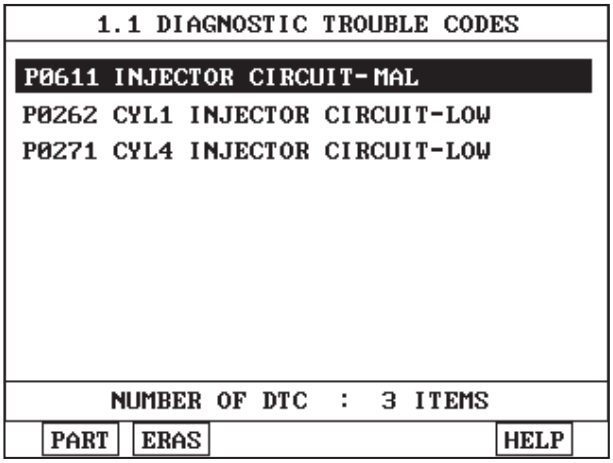


Fig.1

Fig.1) The example of DTC related DTC.

SNFFL6540L

5. Is there any DTC related injectors ?

YES

Refer to "DTC" guide corresponding to each problem occurred injector.

NO

Go to "Verification of Vehicle Repair".

Injector #1 related problem :
Refer to P0201for open in injector circuit.
Refer to P0262 for short in injectoer circuit.

Injector #2 related problem :
Refer to P0202 for open in injector circuit.
Refer to P0265 for short in injectoer circuit.

Injector #3 related problem :

Refer to P0203 for open in injector circuit.
Refer to P0268 for short in injectoer circuit.

Injector #4 related problem :
Refer to P0204 for open in injector circuit.
Refer to P0271 for short in injectoer circuit.

VERIFICATION OF VEHICLE REPAIR EB7951E4

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

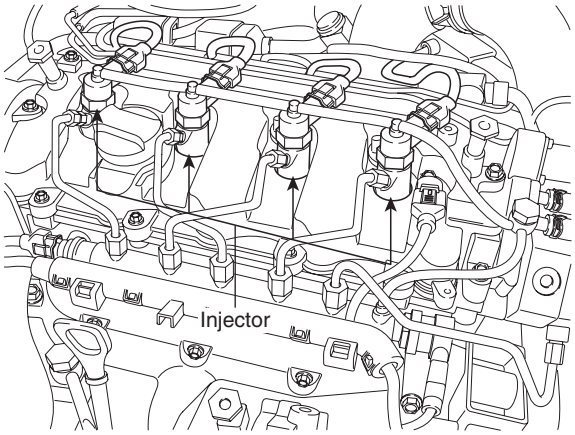
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P062D VOLTAGE REGULATOR #1 FOR INJECTOR MALFUNCTION

COMPONENT LOCATION EA28CEA2



SNFFL6206L

GENERAL DESCRIPTION EFDB2ED4

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 E6151C52

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 E4A8F960

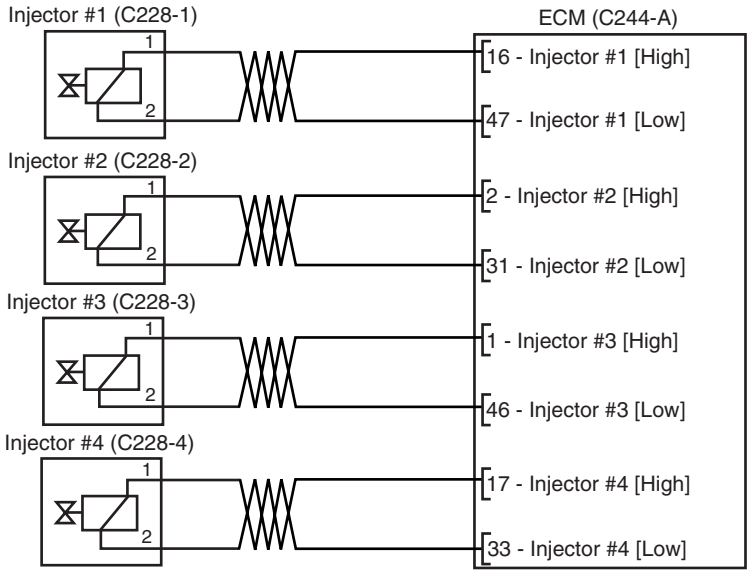
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="7">• Injector circuit
• ECM internal error</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>Threshold Value</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>Diagnostic Time</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>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION EF952355

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 E6604589

[CIRCUIT DIAGRAM]



[CONNECTOR INFORMATION]

[Injector #1]

Terminal	Connected to	Function
1	ECM C244-A (16)	Injector #1 [High] control
2	ECM C244-A (47)	Injector #1 [Low] control

[Injector #2]

Terminal	Connected to	Function
1	ECM C244-A (2)	Injector #2 [High] control
2	ECM C244-A (31)	Injector #2 [Low] control

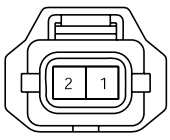
[Injector #3]

Terminal	Connected to	Function
1	ECM C244-A (1)	Injector #3 [High] control
2	ECM C244-A (46)	Injector #3 [Low] control

[Injector #4]

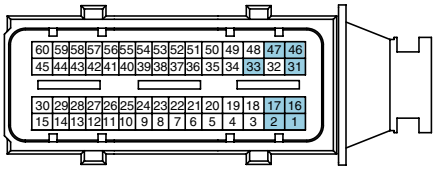
Terminal	Connected to	Function
1	ECM C244-A (17)	Injector #4 [High] control
2	ECM C244-A (33)	Injector #4 [Low] control

[HARNESS CONNECTOR]

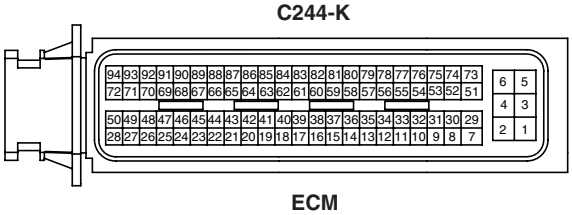


C228-1,2,3,4
Injector #1,#2,#3,#4

C244-A



C244-K



ECM

STGFL7258L

SIGNAL WAVEFORM AND DATA EBE3CAAB

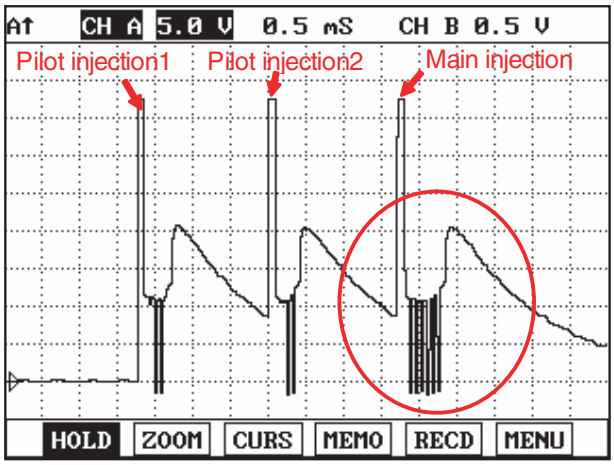


Fig.1

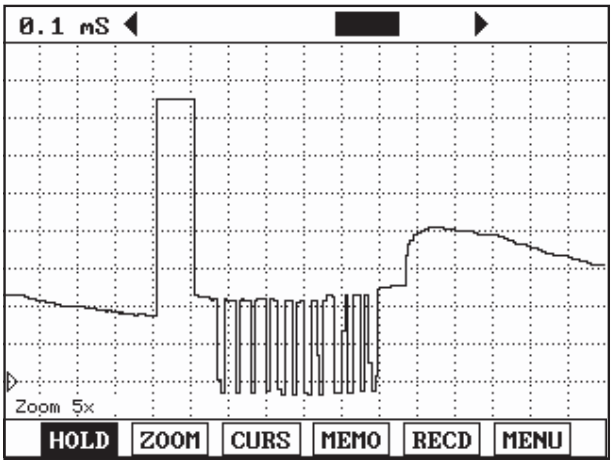


Fig.2

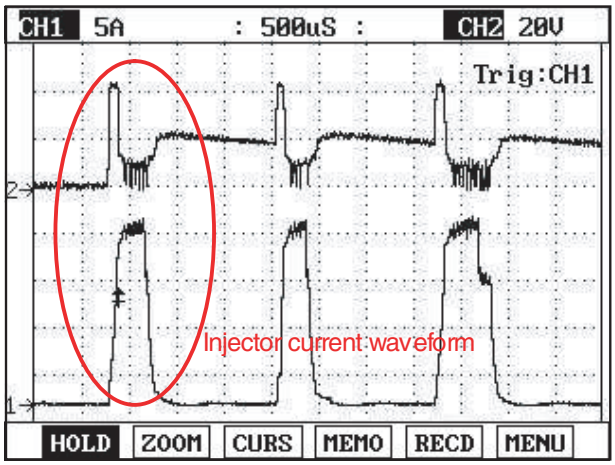


Fig.3

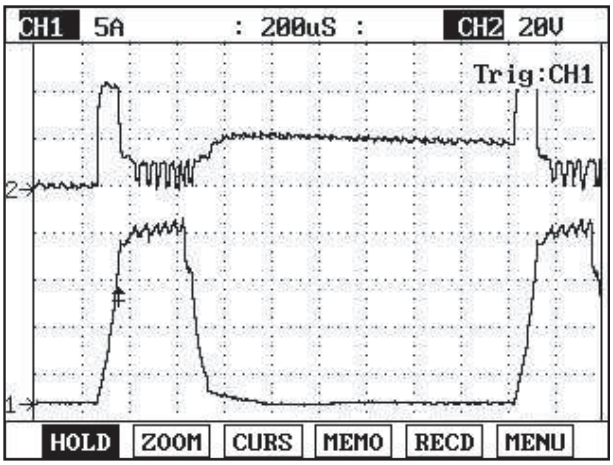


Fig.4

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)

LFIG259A

TERMINAL AND CONNECTOR INSPECTION E2BD2130

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".

MONITOR SCANTOOL DATA E6EC0D70

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.

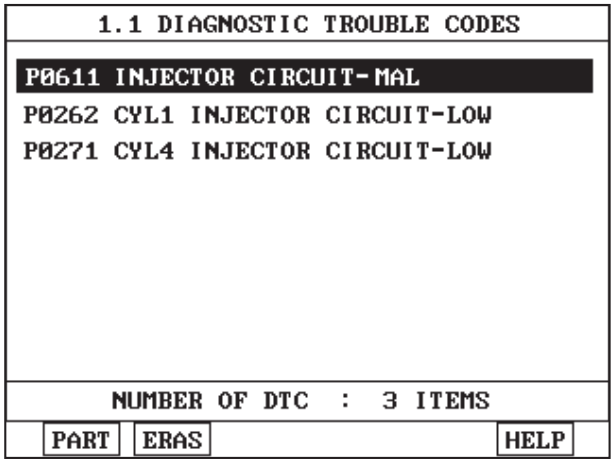


Fig.1

Fig.1) The example of DTC related DTC.

SNFFL6540L

5. Is there any DTC related injectors ?

YES

Refer to "DTC" guide corresponding to each problem occurred injector.

NO

Go to "Verification of Vehicle Repair".

Injector #1 related problem :
Refer to P0201for open in injector circuit.
Refer to P0262 for short in injectoer circuit.

Injector #2 related problem :
Refer to P0202 for open in injector circuit.
Refer to P0265 for short in injectoer circuit.

Injector #3 related problem :

Refer to P0203 for open in injector circuit.
Refer to P0268 for short in injectoer circuit.

Injector #4 related problem :
Refer to P0204 for open in injector circuit.
Refer to P0271 for short in injectoer circuit.

VERIFICATION OF VEHICLE REPAIR E019081F

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 E07EB908

Refer to DTC P062D.

GENERAL DESCRIPTION E3E85140

Refer to DTC P062D.

DTC DESCRIPTION EB57D406

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 EDD501E8

<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>Threshold Value</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>Diagnostic Time</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>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION EFA9E6BD

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 E7C8E262

Refer to DTC P062D.

SIGNAL WAVEFORM AND DATA E4CE4D77

Refer to DTC P062D.

TERMINAL AND CONNECTOR INSPECTION ED37B1AF

Refer to DTC P062D.

MONITOR SCANTOOL DATA E7CEF419

Refer to DTC P062D.

VERIFICATION OF VEHICLE REPAIR E58BA8EF

Refer to DTC P062D.

DTC P0642 SENSOR REFERENCE VOLTAGE "A" CIRCUIT LOW

GENERAL DESCRIPTION EC7DA3AD

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 E391557F

P0642 is set when the voltage below 4.7V - 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 EA9F074F

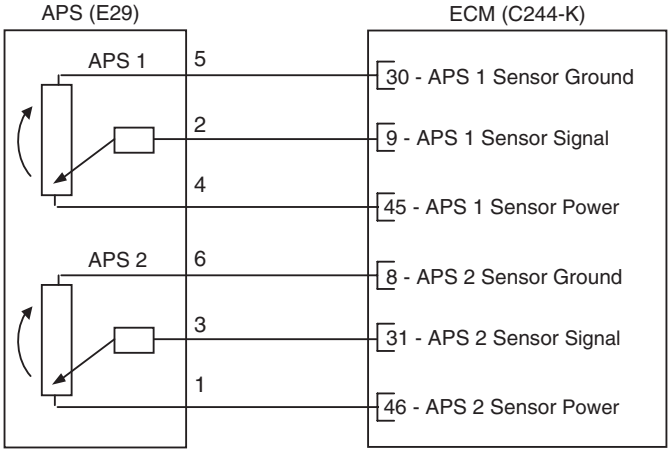
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• CMPS signal circuit
• APS 1 power supply circuit
• ECM component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• when the voltage is below the minimum voltage of sensor power supply. (below 4700mV)</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• 100ms</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel cut</td><td>NO</td><td rowspan="4">• Limp home mode is activated. (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>Check Lamp</td><td>NO</td></tr>
</table>

SPECIFICATION E3B931C6

Sensor power 1	Sensor power 2	Sensor power 3
APS1 CMPS 4830mV~5158mV	RPS, APS 2, BPS, MAFS 4830mV~5158mV	APT, VSCA DPS, ECTS 4830mV~5158mV

SCHEMATIC DIAGRAM E1479339

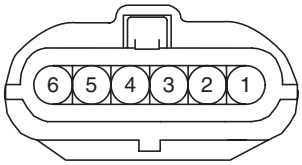
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

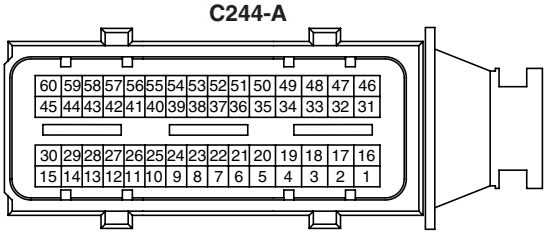
Terminal	Connected to	Function
1	ECM C244-K (46)	APS 2 Sensor Power
2	ECM C244-K (9)	APS 1 Sensor Signal
3	ECM C244-K (31)	APS 2 Sensor Signal
4	ECM C244-K (45)	APS 1 Sensor Power
5	ECM C244-K (30)	APS 1 Sensor Ground
6	ECM C244-K (8)	APS 2 Sensor Ground

[HARNESS CONNECTORS]

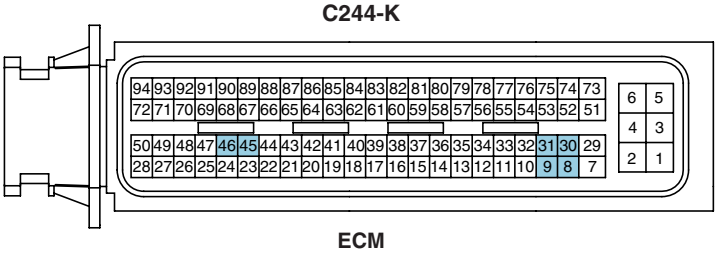


E29
APS

C244-A



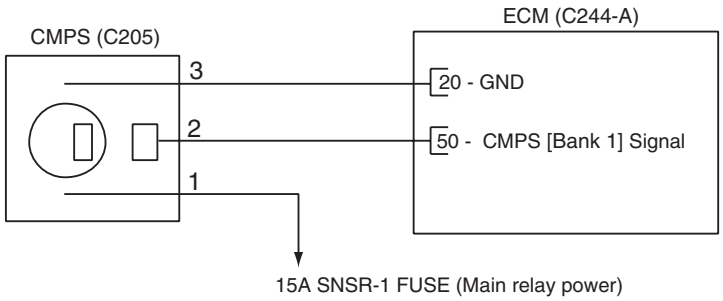
C244-K



ECM

STGFL7149L

[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

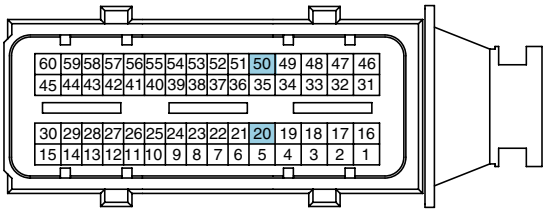
Terminal	Connected to	Function
1	JC301 (61)	Main relay power
2	ECM C244-A (50)	CMPS Signal
3	ECM C244-A (20)	GND

[HARNESS CONNECTORS]

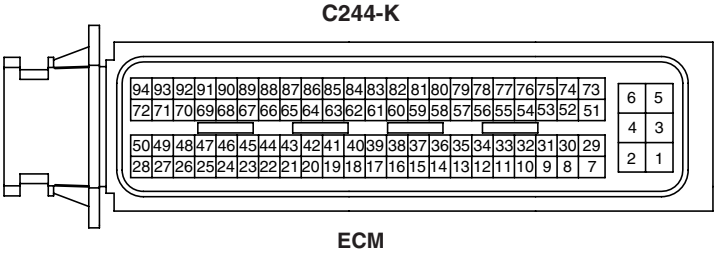
C205

CMPS

C244-A



C244-K



ECM

STGFL7145L

SIGNAL WAVEFORM AND DATA EA274F04

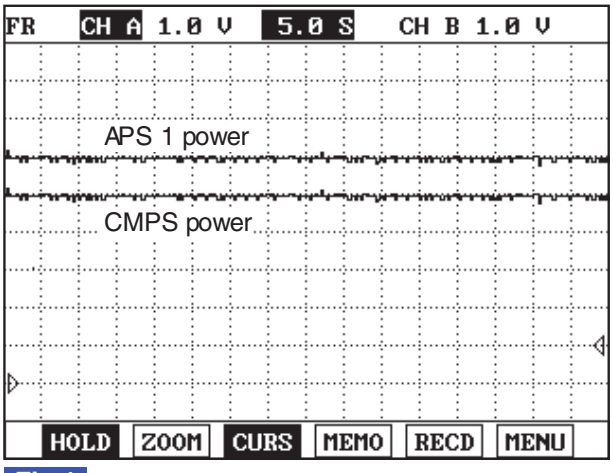


Fig.1

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".

SNFFL6541L

※ 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.

TERMINAL AND CONNECTOR INSPECTION E527D191

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 ED0B5405

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 4 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, ECM connectors.
   3) Check continuity between CMPS connector terminal 2 or APS connector terminal 4 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 "Verification of Vehicle Repair".

COMPONENT INSPECTION E64A5CBD

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 E5361879

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

GENERAL DESCRIPTION E0BACFA5

Refer to DTC P0642.

DTC DESCRIPTION EBE58970

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 EEEBD270

<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 signal circuit
• APS 1 power supply circuit
• ECM component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• when the voltage is above the maximum voltage of sensor power supply. (above 5158mV)</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• 100ms</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel cut</td><td>NO</td><td rowspan="4">• Limp home mode is activated. (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>Check Lamp</td><td>NO</td></tr>
</table>

SPECIFICATION EA1AD87A

Sensor power 1	Sensor power 2	Sensor power 3
APS1 CMPS 4830mV~5158mV	RPS, APS 2, BPS, MAFS 4830mV~5158mV	APT, VSCA DPS, ECTS 4830mV~5158mV

SCHEMATIC DIAGRAM EC3E6A29

Refer to DTC P0642.

SIGNAL WAVEFORM AND DATA E7F80B35

Refer to DTC P0642.

TERMINAL AND CONNECTOR INSPECTION E4EAEA04

Refer to DTC P0642.

POWER CIRCUIT INSPECTION E516470E

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 4 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 open in power circuit" as follows.

2. Check open in power circuit

1) IG KEY "OFF", ENGINE "OFF".

2) Disconnect CMPS connector, APS connector, ECM connectors.

3) IG KEY "ON".

4) Measure the voltage between CMPS connector terminal 2 or APS connector terminal 4 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 E87EEE95

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 E3A6F049

Refer to DTC P0642.

DTC P0646 A/C CLUTCH RELAY CONTROL CIRCUIT LOW

GENERAL DESCRIPTION E962F179

Aircon Relay which is controled by ECM supplies and cut electrical power to Aircon compressor. ECM activates or deactivates Aircon Relay based on inputted signal such as aircon switch siganl and Aircon switch signal.As controlling Aircon Relay, ECM 1)turns OFF aircon 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 aircon compressor operation.

DTC DESCRIPTION EC208B40

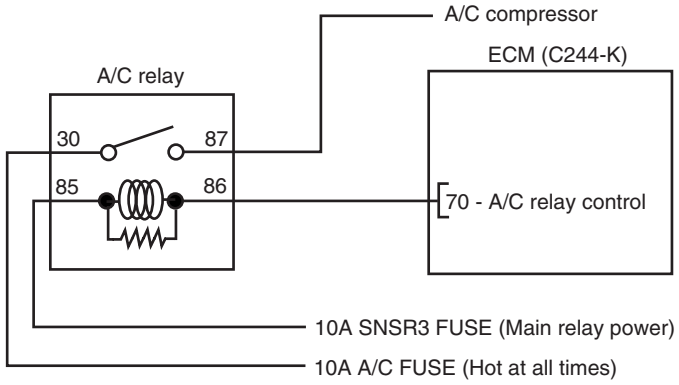
P0646 is set when '0A' is detected in Aircon relay control circuit for more than 1 sec.. This code is due to open or short to ground in Aircon relay control circuit or internal open in relay component.

DTC DETECTING CONDITION E52A59E6

<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 relay circuit
• A/C relay component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Short to GND, Wiring open</td></tr>
<tr><td>Diagnostic Time</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>Check Lamp</td><td>NO</td></tr>
</table>

SCHEMATIC DIAGRAM EA097066

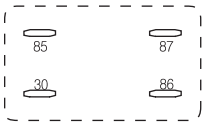
[CIRCUIT DIAGRAM]



[CONNECTOR INFORMATION]

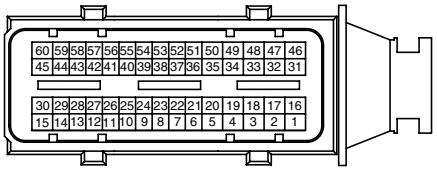
Terminal	Connected to	Function
30	10A A/C FUSE (Hot at all times)	Relay power(INPUT)
85	Main relay power	Relay coil power
86	ECM C244-K (70)	Relay control
87	A/C compressor	Relay power(OUTPUT)

[HARNESS CONNECTOR]

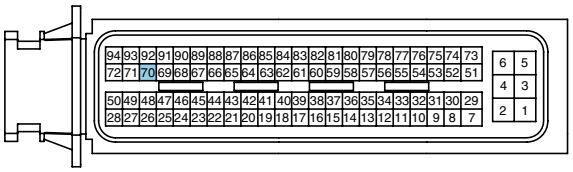


A/C relay

C244-A



C244-K



ECM

STGFL7546L

MONITOR SCANTOOL DATA E8919359

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"

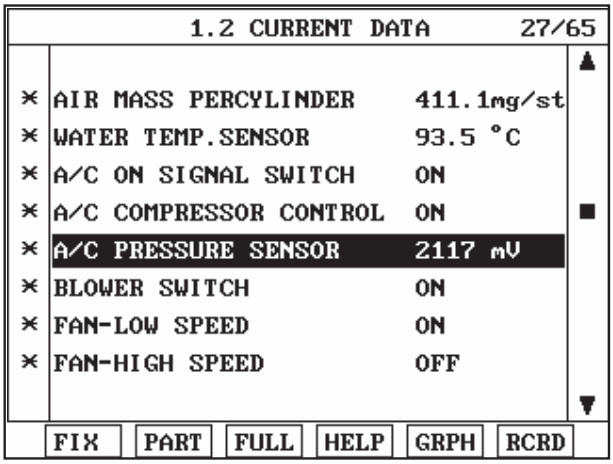


Fig.1

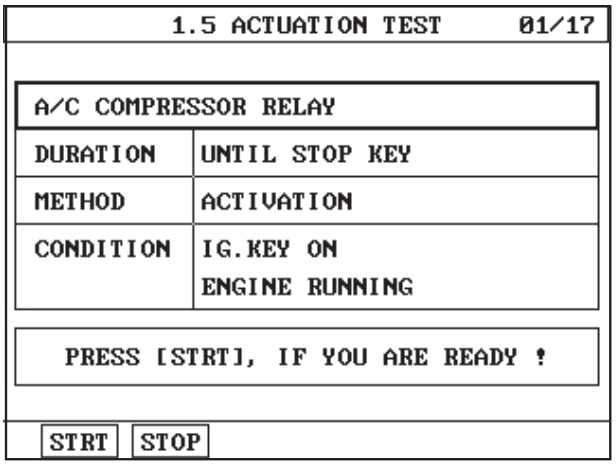


Fig.2

Fig.1) The operating condition of aircon relay is shown. Check if aircon compressor works properly when aircon switch is turning ON.
Fig.2) Diagnosing problem of "A/C RELAY" and "AIRCON COMPRESSOR" is convenient through ACTUATION TEST on the Scantool.

LFIG337A

TERMINAL AND CONNECTOR INSPECTION ECA5DD0F

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 E7FE6D95

1. Check power circuit voltage

   1) IG KEY "OFF", ENGINE "OFF".

   2) Disconnect A/CON relay.

   3) Measure the voltage of A/CON 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" .

NO

▶ Repair problems of A/CON 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/CON relay.

3) IG KEY "ON".

4) Measure the voltage of glow relay terminal 85.

specification : 11.5V~13.0V

5) Is the measured voltage within the specification?

YES

▶ Go to "Control Circuit Inspection".

NO

▶ Check the operation of Main Relay or repair open circuit as necessary and then, go to "Verification of Vehicle Repair" procedure.

CONTROL CIRCUIT INSPECTION EE8ED526

1. Check monitoring voltage in control circuit

1) IG KEY "OFF", ENGINE "OFF".

2) Disconnect A/CON relay.

3) IG KEY "ON".

4) Measure the voltage of A/CON 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/CON relay and ECM connector .

3) Check continuity between glow relay terminal 86 and ECM connector(C244-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".

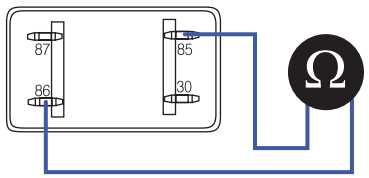
COMPONENT INSPECTION EA2E0A28

1. Check A/CON relay component resistance

1) IG KEY "OFF", ENGINE "OFF".

2) Disconnect A/CON relay.

3) Measure the coil resistance of A/CON relay.



AFIG367A

specification : 80±5 Ω (20℃)

4) Is the measured resistance within the specification?

YES

▶ Go to "2. Check A/CON relay component operation" as follows.

NO

▶ Replace A/CON relay and go to "Verification of Vehicle Repair".

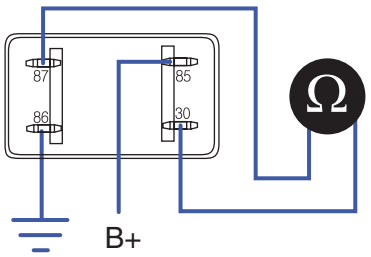
2. Check A/CON relay component operation

   1) IG KEY "OFF", ENGINE "OFF".

   2) Disconnect A/CON 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.



AFIG368B

specification : When power is supplied : Continuity (below 1.0Ω)
When power is not supplied : Discontinuity (Infinite Ω)

   5) Is the continuity test within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace A/CON relay and go to "Verification of Vehicle Repair".

※ Repeat this process 2~3 times.

VERIFICATION OF VEHICLE REPAIR EDB7A26A

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 E377A26F

Refer to DTC P0646.

DTC DESCRIPTION E71515B1

0647 is set when excessive current is detected in Aircon relay control circuit for more than 1 sec.. This code is due to short to battery in Aircon relay control circuit or internal short in relay component.

DTC DETECTING CONDITION E4F44700

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• A/C relay circuit • A/C relay component
Enable Conditions	• IG KEY "ON"			
Threshold Value	• Short to battery			
Diagnostic Time	• 1.0 sec.			
Fail Safe	Fuel cut	NO		
	EGR Off	NO		
	Fuel Limit	NO		
	Check Lamp	NO		

SCHEMATIC DIAGRAM ED516334

Refer to DTC P0646.

MONITOR SCANTOOL DATA E9F9CFA6

Refer to DTC P0646.

TERMINAL AND CONNECTOR INSPECTION E7DE28D1

Refer to DTC P0646.

POWER CIRCUIT INSPECTION E0DA793D

1. Check power circuit voltage
   1) IG KEY "OFF", ENGINE "OFF".
   2) Disconnect A/CON relay.
   3) Measure the voltage of A/CON 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" .

NO

▶ Repair problems of A/CON 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/CON relay.

3) IG KEY "ON".

4) Measure the voltage of glow relay terminal 85.

specification : 11.5V~13.0V

5) Is the measured voltage within the specification?

YES

▶ Go to "Control Circuit Inspection".

NO

▶ Check the operation of Main Relay or repair open circuit as necessary and then, go to "Verification of Vehicle Repair" procedure.

CONTROL CIRCUIT INSPECTION EB9FF0E5

1. Check monitoring voltage in control circuit

1) IG KEY "OFF", ENGINE "OFF".

2) Disconnect A/CON relay.

3) IG KEY "ON".

4) Measure the voltage of A/CON 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/CON relay and ECM connector .

3) Check continuity between glow relay terminal 86 and ECM connector(C244-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".

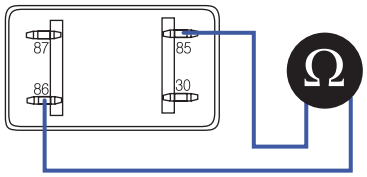
COMPONENT INSPECTION E7D39463

1. Check A/CON relay component resistance

1) IG KEY "OFF", ENGINE "OFF".

2) Disconnect A/CON relay.

3) Measure the coil resistance of A/CON relay.



AFIG367A

specification : 80±5 Ω (20℃)

4) Is the measured resistance within the specification?

YES

▶ Go to "2. Check A/CON relay component operation" as follows.

NO

▶ Replace A/CON relay and go to "Verification of Vehicle Repair".

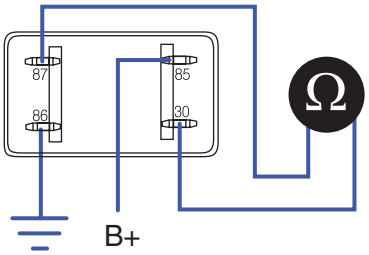
2. Check A/CON relay component operation

1) IG KEY "OFF", ENGINE "OFF".

2) Disconnect A/CON 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.



AFIG368B

specification : When power is supplied : Continuity (below 1.0Ω)
When power is not supplied : Discontinuity (Infinite Ω)

5) Is the continuity test within the specification?

YES

▶ Go to "Verification of Vehicle Repair".

NO

▶ Replace A/CON relay and go to "Verification of Vehicle Repair".

※ Repeat this process 2~3 times.

VERIFICATION OF VEHICLE REPAIR E839EB58

Refer to DTC P0646.

DTC P0650 MALFUNCTION INDICATOR LAMP(MIL) CONTROL CIRCUIT

GENERAL DESCRIPTION E3CFDE6C

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 E01ACF53

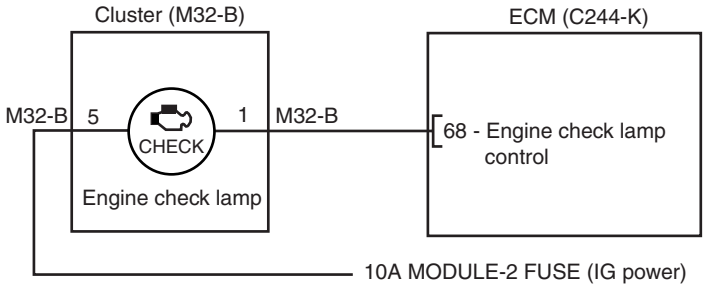
P0650 is set when 1)excessive current is detected in engine check lamp control circuit for more than 2.0 sec.. at engine check lamp ON condition or 2)like open or short to ground, no current is detected. This code is due to open in control circuit or opened filament of lamp component.

DTC DETECTING CONDITION EF1E1552

<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 engine checklamp
• 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>Threshold Value</td><td colspan="3">• Short to battery
• Short to GND, Wiring open</td></tr>
<tr><td>Diagnostic Time</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>Check Lamp</td><td>NO</td></tr>
</table>

SCHEMATIC DIAGRAM E20DEEC4

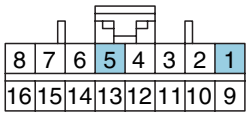
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

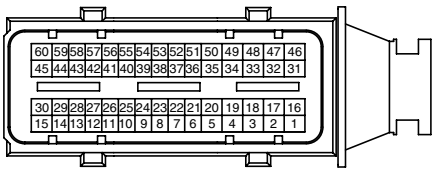
Terminal	Connected to	Function
M32-B(5)	10A MODULE-2 FUSE	IG power
M32-B(1)	ECM C244-K (68)	Engine check lamp control

[HARNESS CONNECTOR]

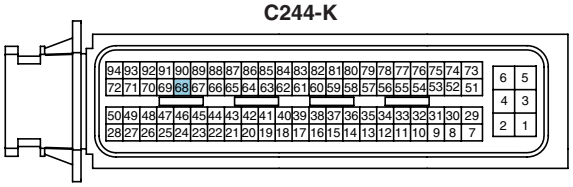


M32-B
Cluster

C244-A



C244-K



ECM

STGFL7547L

TERMINAL AND CONNECTOR INSPECTION E5CAECA4

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 E7DF2DCD

1. Check control circuit voltage

   1) IG KEY "OFF", ENGINE "OFF".

   2) Disconnect ECM connector.

   3) IG KEY "ON".

   4) Measure the voltage of terminal 68 of ECM connector(C244-K).

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(M32-B) terminal 1 and ECM connector(C244-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 connectori(C244-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 ECE5AC65

1. IG KEY "OFF", ENGINE "OFF".
2. Dismount cluster and disconnect check lamp.
3. Check filament of check lamp.

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 E779A0FA

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

GENERAL DESCRIPTION E16D8AB6

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 E77C406A

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 E422D052

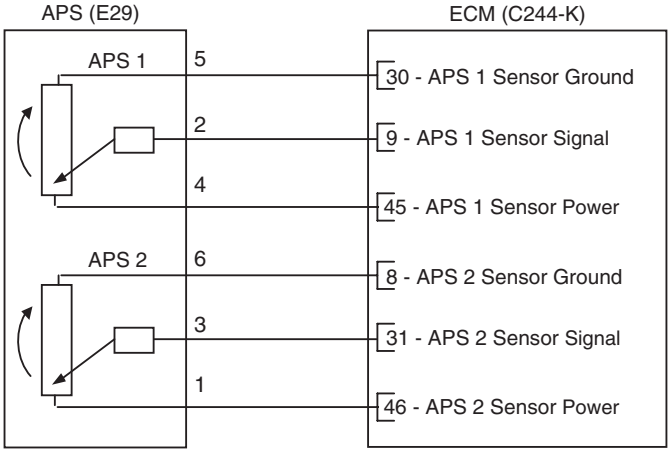
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="8">• RPS power supply circuit
• APS 2 power supply circuit
• BPS power supply circuit
• MAFS power supply circuit
• ECM component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• when the voltage is below the minimum voltage of sensor power supply (below 4700mV)</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• 100ms</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel cut</td><td>NO</td><td rowspan="4">• Limp home mode is activated.(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>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION E71043FC

Sensor power 1	Sensor power 2	Sensor power 3
APS1 CMPS 4830mV~5158mV	RPS, APS 2, BPS, MAFS 4830mV~5158mV	APT, VSCA DPS, ECTS 4830mV~5158mV

SCHEMATIC DIAGRAM EFD5718B

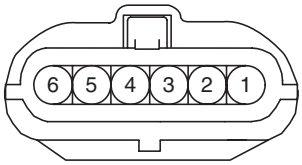
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

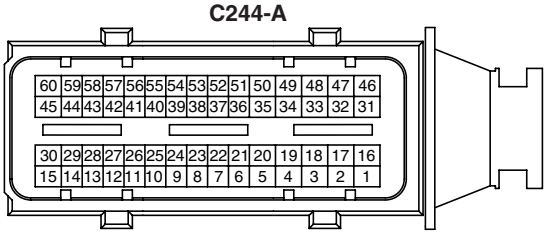
Terminal	Connected to	Function
1	ECM C244-K (46)	APS 2 Sensor Power
2	ECM C244-K (9)	APS 1 Sensor Signal
3	ECM C244-K (31)	APS 2 Sensor Signal
4	ECM C244-K (45)	APS 1 Sensor Power
5	ECM C244-K (30)	APS 1 Sensor Ground
6	ECM C244-K (8)	APS 2 Sensor Ground

[HARNESS CONNECTORS]

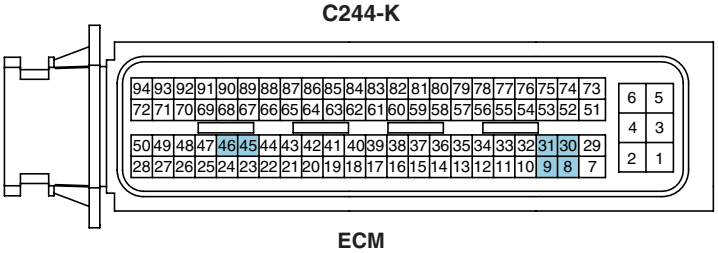


E29
APS

C244-A



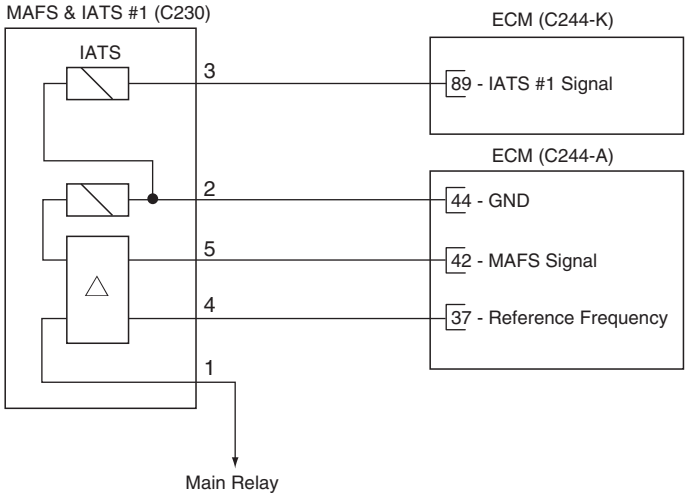
C244-K



ECM

STGFL7149L

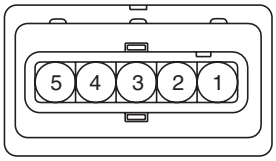
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	Main Relay	Battery Voltage (B+)
2	ECM C244-A (44)	Sensor Ground
3	ECM C244-K (89)	IATS #1 Signal
4	ECM C244-A (37)	Reference Frequency
5	ECM C244-A (42)	MAFS Signal

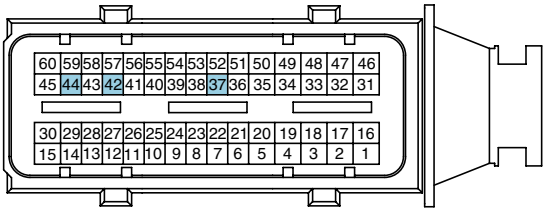
[HARNESS CONNECTORS]



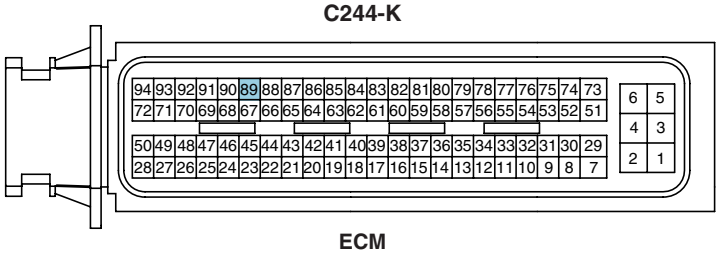
C230

MAFS & IATS #1

C244-A



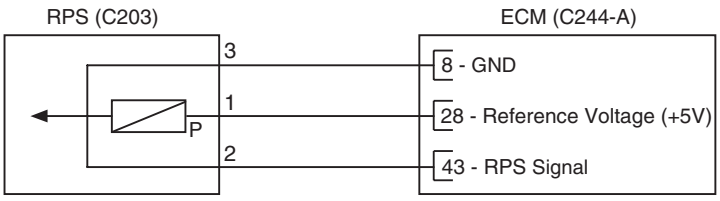
C244-K



ECM

STGFL7135L

[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

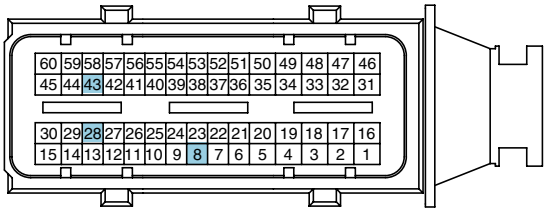
Terminal	Connected to	Function
1	ECM C244-A (28)	Reference Voltage (+5V)
2	ECM C244-A (43)	RPS Signal
3	ECM C244-A (8)	Sensor Signal

[HARNESS CONNECTORS]

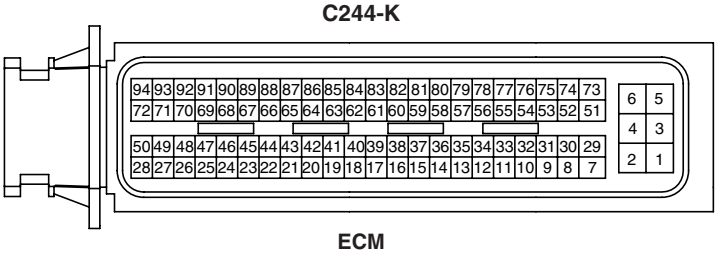
C203

RPS

C244-A



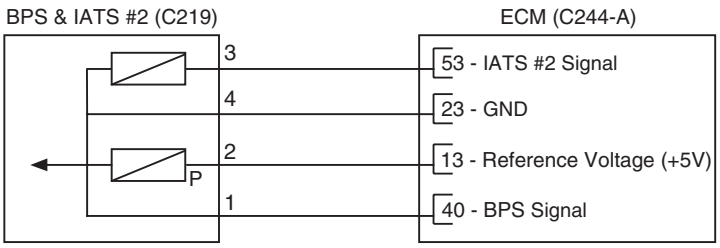
C244-K



ECM

STGFL7150L

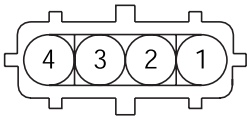
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-A (40)	BPS Signal
2	ECM C244-A (13)	Reference Voltage (+5V)
3	ECM C244-A (53)	IATS #2 Signal
4	ECM C244-A (23)	Sensor ground

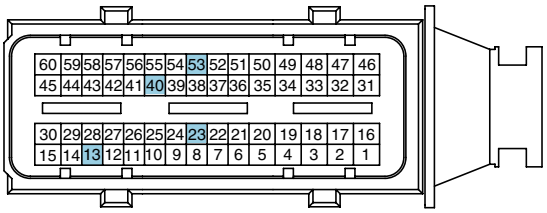
[HARNESS CONNECTORS]



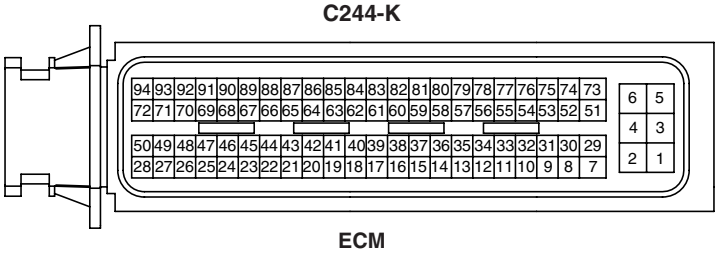
C219

BPS & IATS #2

C244-A



C244-K



ECM

STGFL7139L

SIGNAL WAVEFORM AND DATA E90CFA9C

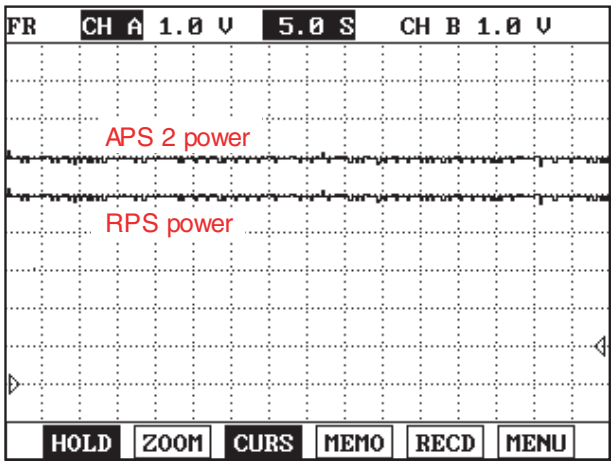


Fig.1

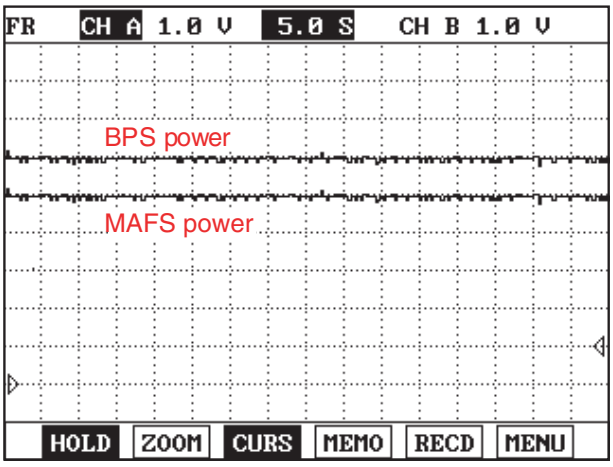


Fig.2

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".

SNFFL6548L

TERMINAL AND CONNECTOR INSPECTION EBF273D1

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 E66EC9F6

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 1, 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, ECM connectors.

3) Check continuity between RPS connector terminal 1, APS connector terminal 1, 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 go to "Verification of Vehicle Repair".

NO

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

COMPONENT INSPECTION E4D9D040

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 EB460508

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

GENERAL DESCRIPTION E6E1BFEF

Refer to DTC P0652.

DTC DESCRIPTION EBEA1843

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 E1037AE3

<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>Threshold Value</td><td colspan="3">• when the voltage is above the maximum voltage of sensor power supply.(above 5158mV)</td></tr>
<tr><td>Diagnostic Time</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 mode is activated.(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>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION E88D96CE

Sensor power 1	Sensor power 2	Sensor power 3
APS1 CMPS 4830mV~5158mV	RPS, APS 2, BPS, MAFS 4830mV~5158mV	APT, VSCA DPS, ECTS 4830mV~5158mV

SCHEMATIC DIAGRAM EA3A895E

Refer to DTC P0652.

SIGNAL WAVEFORM AND DATA E0770F9C

Refer to DTC P0652.

TERMINAL AND CONNECTOR INSPECTION E40BAF73

Refer to DTC P0652.

POWER CIRCUIT INSPECTION EF4E87F8

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 1, 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, ECM connectors.

3) Check continuity between RPS connector terminal 1, APS connector terminal 1, MAFS connector terminal 4, BPS connector terminal 2.

Specification : 0.0V~0.1V

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 "Verification of Vehicle Repair".

COMPONENT INSPECTION EAA913D1

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

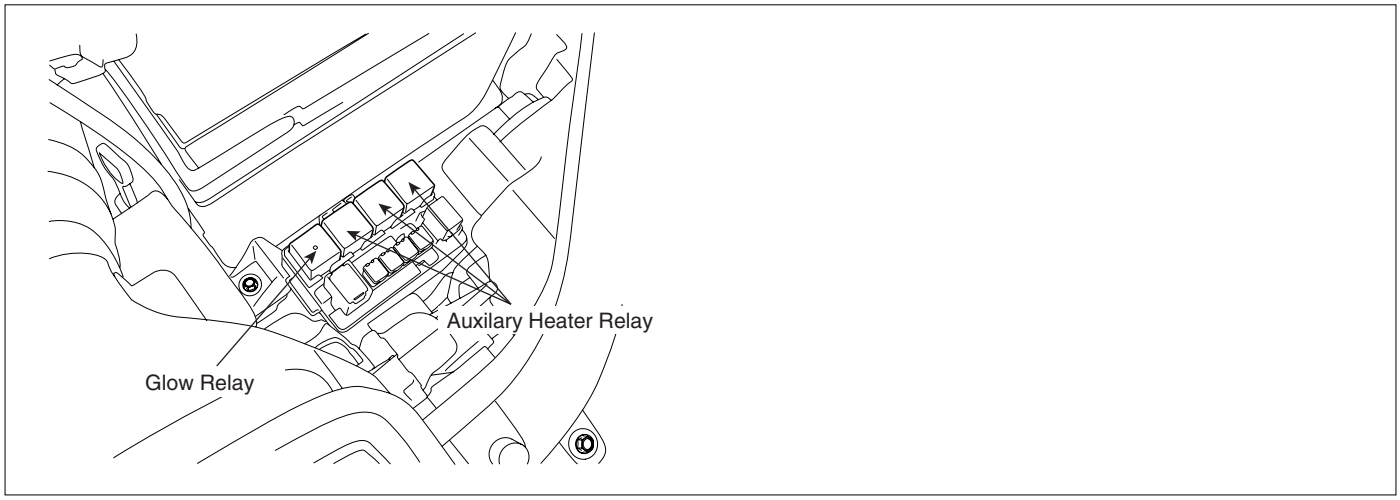
▶ Go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E4C6AA40

Refer to DTC P0652.

DTC P0670 GLOW RELAY CIRCUIT MALFUNCTION

COMPONENT LOCATION ED0542EA



SNFFL6225L

GENERAL DESCRIPTION ED2AA0E4

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 E7020BF3

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 EF4807F1

<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">• Glow relay control circuit
• Glow relay component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON" (monitoring only performed within relay operating condition)</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• short to battery
• Short to GND, Wiring open</td></tr>
<tr><td>Diagnostic Time</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>Check Lamp</td><td>NO</td></tr>
</table>

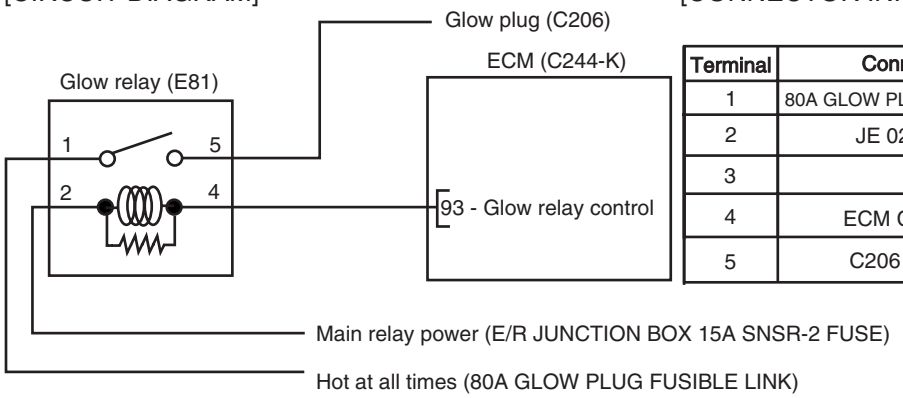
SPECIFICATION E971562A

※ RELAY OPERATING TIME

	- 20℃	-10℃	10℃	50℃
10V	16sec	10sec	4sec	2.0sec
14.9V	16sec	10sec	4sec	2.0sec

SCHEMATIC DIAGRAM E832E495

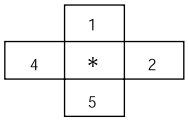
[CIRCUIT DIAGRAM]



[CONNECTOR INFORMATION]

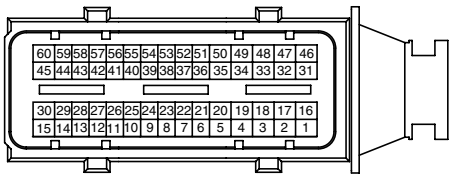
Terminal	Connected to	Function
1	80A GLOW PLUG FUSIBLE LINK	Glow plug power(INPUT)
2	JE 02 (46)	Glow relay coil power
3	-	-
4	ECM C244-K (93)	Glow relay control
5	C206 terminal 1	Glow plug power(OUTPUT)

[HARNESS CONNECTOR]

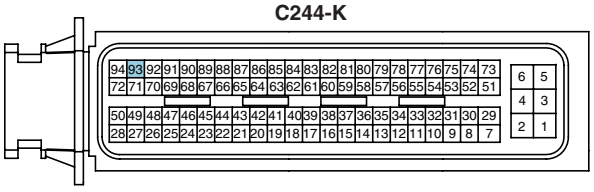


E81
Glow relay

C244-A



C244-K



ECM

STGFL7532L

MONITOR SCANTOOL DATA EFD64FA9

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". at IG KEY "ON". (Refer to Specification)

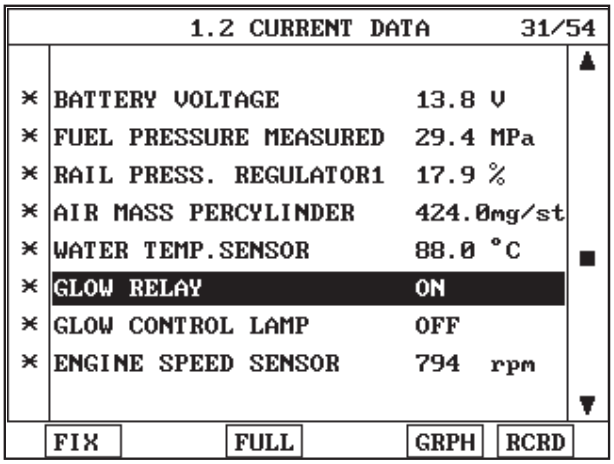


Fig.1

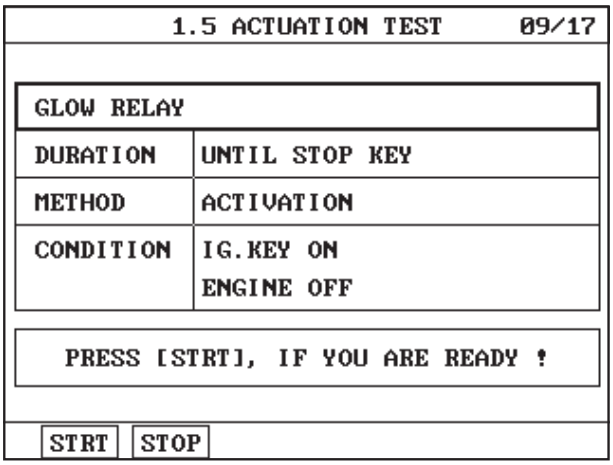


Fig.2

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.

LFIG353A

TERMINAL AND CONNECTOR INSPECTION ED7D66C4

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 E7CB40A7

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 FUSIBLE BOX 80A 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 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 SNSR2 fuse and related circuit and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION ECEF7E5F

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 4.

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".
▶ 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 4 and ECM connector(C244-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".

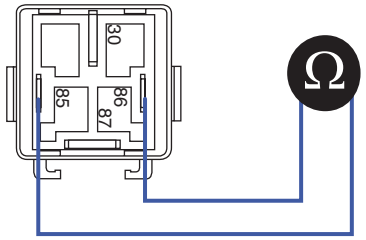
COMPONENT INSPECTION E0118EC9

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 coil.



KFQG438A

Specification : 55±5 Ω (20℃)

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".

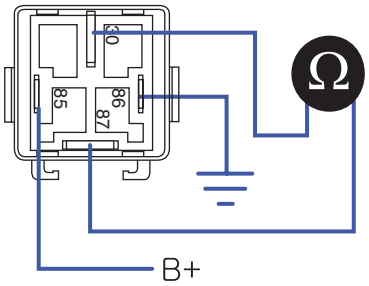
2. Check glow relay component operation

   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 terminal 30 and terminal 87.



KFQG439A

specification : When power is supplied : Continuity (below 1.0Ω)
When power is not supplied : Discontinuity (Infinite Ω)

   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 E5386DA9

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

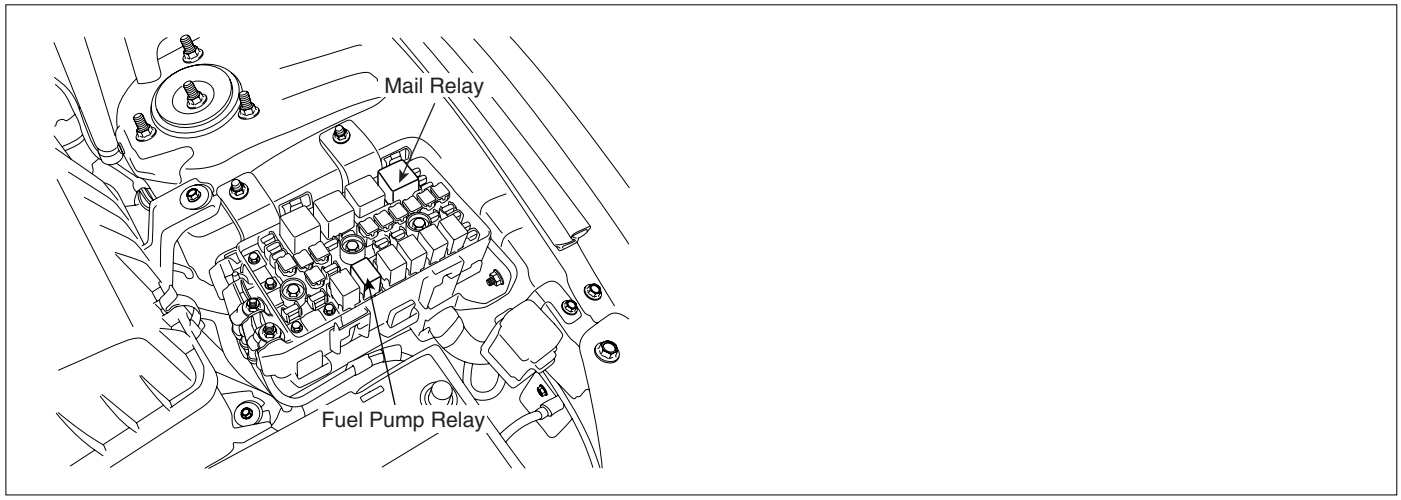
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P0685 ECM/PCM POWER RELAY CONTROL CIRCUIT /OPEN

COMPONENT LOCATION E84BCA07



SNFFL6209L

GENERAL DESCRIPTION ED9CFAB0

Main relay operates when Ignition ON signal is inputted to ECM connector(C244-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 E3790076

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 E6C9ECE0

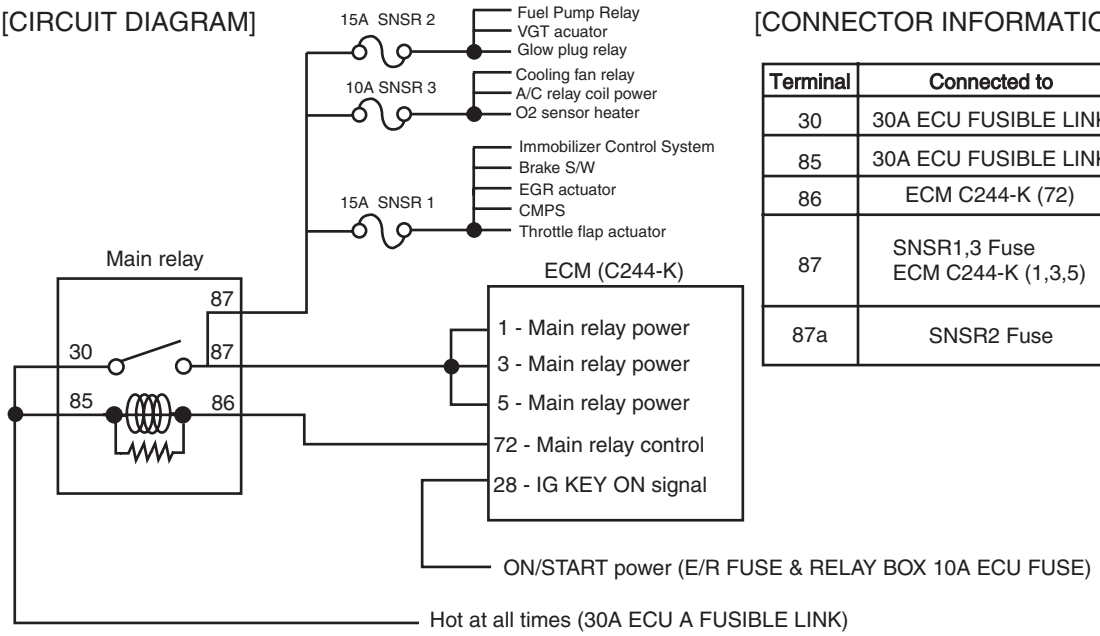
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• Main relay circuit
• Main relay component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• 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.)</td></tr>
<tr><td>Diagnostic Time</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>Check Lamp</td><td>NO</td></tr>
</table>

SPECIFICATION E402657B

Main Relay Coil Resistance	80±10 Ω (20℃)

SCHEMATIC DIAGRAM EB7ED8A6

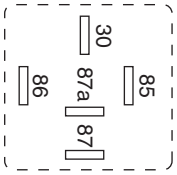
[CIRCUIT DIAGRAM]



[CONNECTOR INFORMATION]

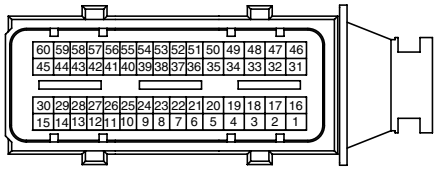
Terminal	Connected to	Function
30	30A ECU FUSIBLE LINK	Hot at all times
85	30A ECU FUSIBLE LINK	Main relay coil power
86	ECM C244-K (72)	Main relay control
87	SNSR1,3 Fuse ECM C244-K (1,3,5)	Power supply to Sensor, Actuator Power supply to ECM
87a	SNSR2 Fuse	Power supply to Sensor, Actuator

[HARNESS CONNECTOR]

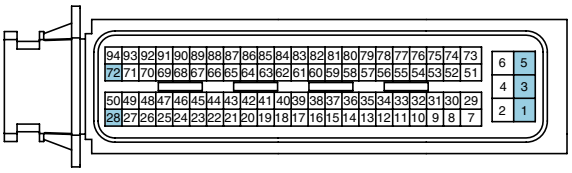


Main Relay

C244-A



C244-K



ECM

STGFL7533L

SIGNAL WAVEFORM AND DATA EE4A0870

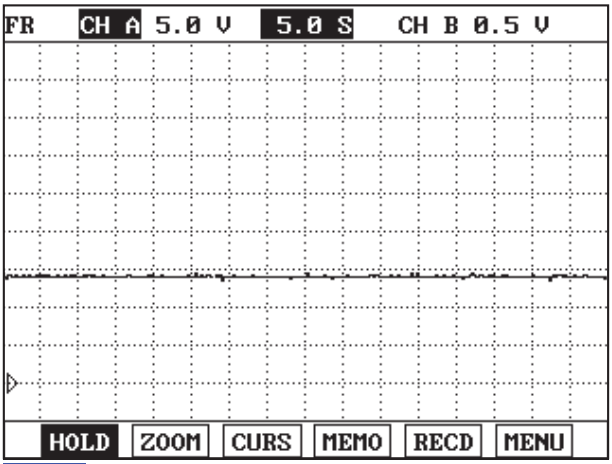


Fig.1

Fig.1) Main relay operates when IG KEY "ON" (C244-K terminal 28 ON signal), it turns "OFF" in 16 sec. after IG KEY "OFF".

STGFL7607L

TERMINAL AND CONNECTOR INSPECTION E0B082ED

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 E6CF3DDE

1. Check power circuit voltage

   1) IG KEY "OFF", ENGINE "OFF".

   2) Disconnect main relay.

   3) Measure the voltage of main relay terminal 30 and 85.

Specification : 11.5V~13.0V

4) 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 87, 87a using jump wire.

4) Measure the voltage of ECM connector(C244-K) terminal 1,3,5.

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 E02B93DD

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(C244-K) 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 the measured resistance within the specification?

   YES

   ▶ Go to "Component Inspection".

   NO

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

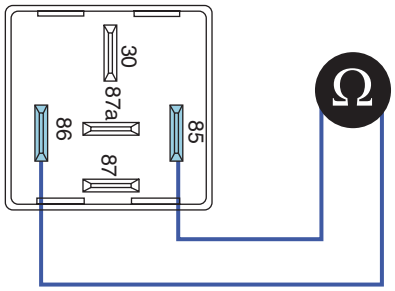
COMPONENT INSPECTION E23A6338

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 86.



SNFFL6446D

Specification : 80±10 Ω (20℃)

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 87, 87a.

specification : When power is supplied : Continuity (below 1.0Ω)
When power is not supplied : Discontinuity (Infinite Ω)

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 EFBCBCD3

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

GENERAL DESCRIPTION EDE30970

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 E9F08875

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 E2C2A9A5

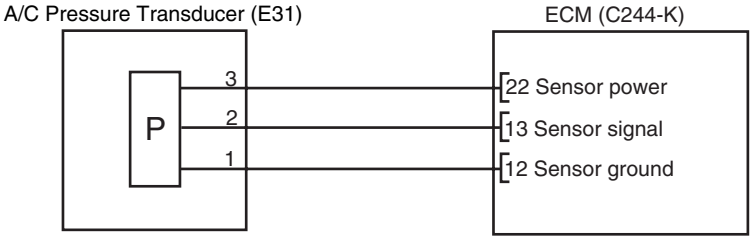
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• A/C pressure transducer power supply circuit
• DPS power supply circuit
• VSCA power supply circuit
• ECTS signal circuit
• ECM component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• when the voltage is below the minimum voltage of sensor power supply (below 4700mV)</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• 100ms</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel cut</td><td>NO</td><td rowspan="4">• Limp home mode is activated (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>Check Lamp</td><td>NO</td></tr>
</table>

SPECIFICATION EF3F308F

Sensor power 1	Sensor power 2	Sensor power 3
APS1 CMPS 4830mV~5158mV	RPS, APS 2, BPS, MAFS 4830mV~5158mV	APT, VSCA DPS, ECTS 4830mV~5158mV

SCHEMATIC DIAGRAM EF2F84F3

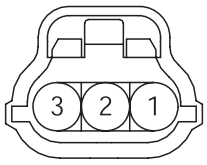
[CIRCUIT DIAGRAM]



[CONNECTOR INFORMATION]

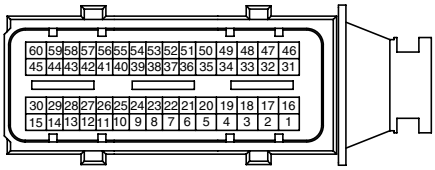
Terminal	Connected to	Function
1	ECM C244-K (12)	Sensor ground
2	ECM C244-K (13)	Sensor signal
3	ECM C244-K (22)	Sensor power

[HARNESS CONNECTOR]

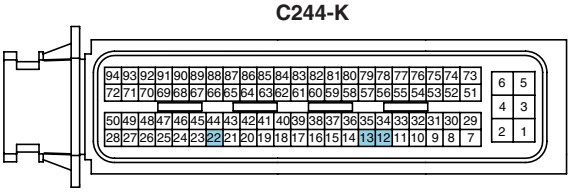


E31
A/C pressure transducer

C244-A



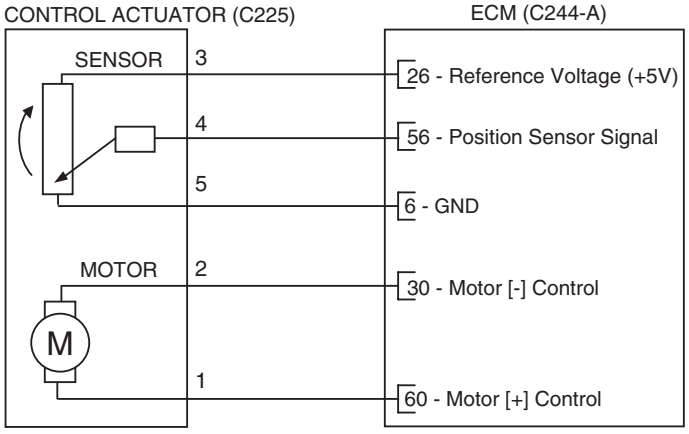
C244-K



ECM

STGFL7522L

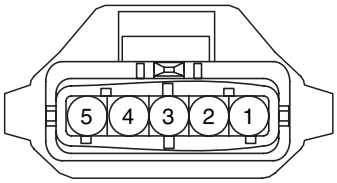
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-A (60)	Motor [+] Control
2	ECM C244-A (30)	Motor [-] Control
3	ECM C244-A (26)	Reference Voltage (+5V)
4	ECM C244-A (56)	Position Signal
5	ECM C244-A (6)	Sensor Ground

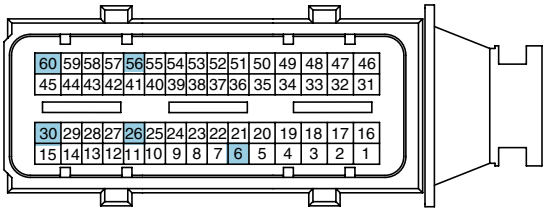
[HARNESS CONNECTORS]



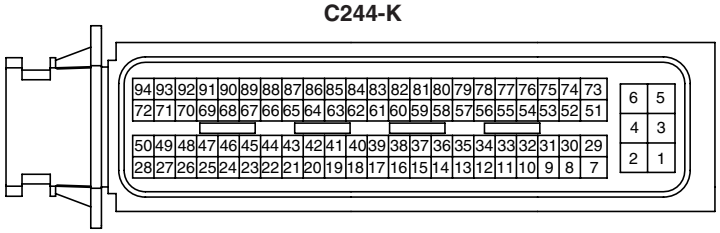
C225

VARIABLE SWIRL CONTROL ACTUATOR

C244-A



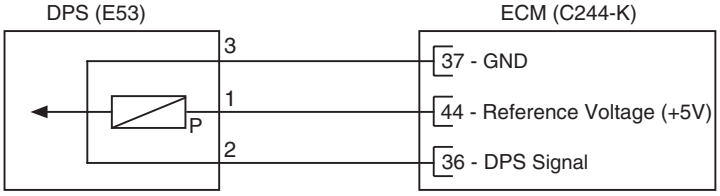
C244-K



ECM

STGFL7159L

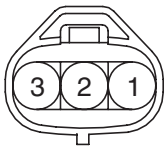
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-K (44)	Reference Voltage (+5V)
2	ECM C244-K (36)	DPS Signal
3	ECM C244-K (37)	Sensor ground

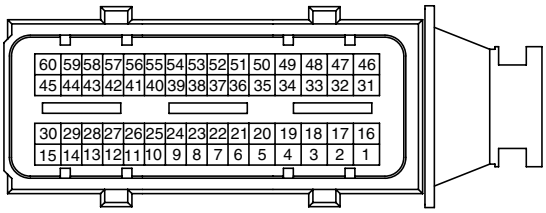
[HARNESS CONNECTORS]



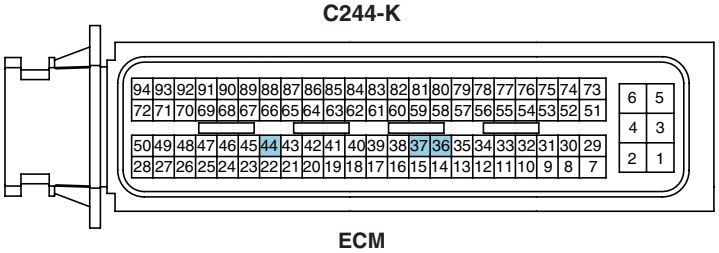
E53

DPS

C244-A



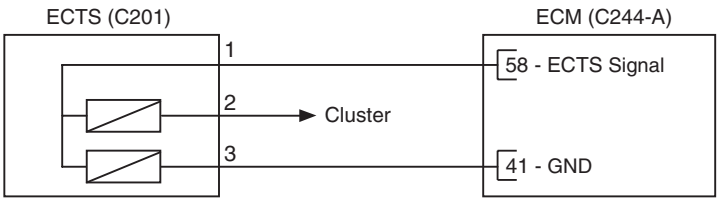
C244-K



ECM

STGFL7169L

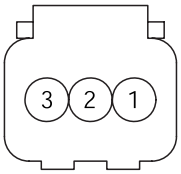
[CIRCUIT DIAGRAM]



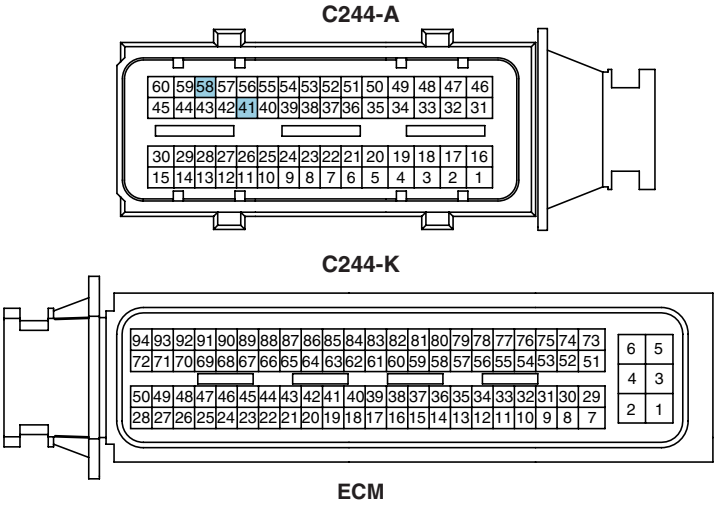
[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-A (58)	ECTS Signal
2	Cluster	-
3	ECM C244-A (41)	Sensor ground

[HARNESS CONNECTORS]



C201
ECTS



STGFL7137L

SIGNAL WAVEFORM AND DATA EA4C2F95

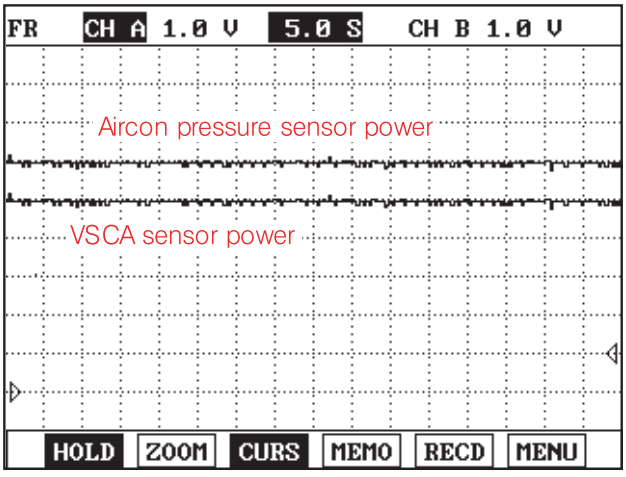


Fig.1

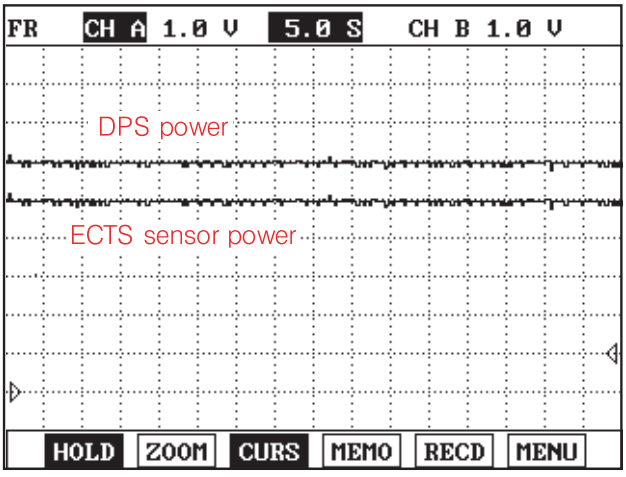


Fig.2

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) DPS 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"

SNFFL6542L

※ According to the engine coolant temperature, ECTS signal will vary from 0.6V to 4.5V, therefore, check the voltage after disconnecting connector.

TERMINAL AND CONNECTOR INSPECTION EC175D89

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 EC2CF9CF

1. Check power circuit voltage
   1) IG KEY "OFF", ENGINE "OFF"
   2) Disconnector APTS connector, VSCA connector, DPS connector, ECTS connector.
   3) IG KEY "ON"
   4) Measure the voltage of APTS connector terminal 3, VSCA connector terminal 3, DPS connector terminal 1 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, DPS connector, ECTS connector, ECM connectors.

3) Check continuity between APTS connector terminal 3, VSCA connector terminal 3, DPS connector terminal 1, ECTS connector terminal 1and 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 "Verification of Vehicle Repair".

COMPONENT INSPECTION E1B5FBA5

1. IG KEY "OFF", ENGINE "OFF".
2. Disconnect APTS connector, VSCA connector, DPS connector, 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, DPS connector, ECTS connector in turn.
5. Measure the voltage of power circuit of each sensor with all connector connected.

Specification : APTS, VSCA, DPS : sensor power supply should not change as connecting APTS connector, VSCA connector, DPS 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, DPS, ECTS)

NO

▶ Go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR EE2EADFB

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

GENERAL DESCRIPTION E6EB821A

Refer to DTC P0698.

DTC DESCRIPTION E8533693

P0699 is set when the voltage above 5.158V - 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 E7645EBA

<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
• DPS 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>Threshold Value</td><td colspan="3">• when the voltage is above the maximum voltage of sensor power supply(above 5.158V)</td></tr>
<tr><td>Diagnostic Time</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 mode is activated (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>Check Lamp</td><td>NO</td></tr>
</table>

SPECIFICATION E1291B6F

Sensor power 1	Sensor power 2	Sensor power 3
APS1 CMPS 4830mV~5158mV	RPS, APS 2, BPS, MAFS 4830mV~5158mV	APT, VSCA DPS, ECTS 4830mV~5158mV

SCHEMATIC DIAGRAM E70D6732

Refer to DTC P0698.

SIGNAL WAVEFORM AND DATA ECA68A50

Refer to DTC P0698.

TERMINAL AND CONNECTOR INSPECTION ED0D429C

Refer to DTC P0698.

POWER CIRCUIT INSPECTION E0F941F7

1. Check power circuit voltage

1) IG KEY "OFF", ENGINE "OFF"

2) Disconnector APTS connector, VSCA connector, DPS connector, ECTS connector.

3) IG KEY "ON"

4) Measure the voltage of APTS connector terminal 3, VSCA connector terminal 3, DPS connector terminal 1 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, DPS connector, ECTS connector, ECM connector.

3) IG KEY "ON"

4) Measure the voltage of APTS connector terminal 3, VSCA connector terminal 3, DPS connector terminal 1 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 EC4D41CA

1. IG KEY "OFF", ENGINE "OFF".
2. Disconnect APTS connector, VSCA connector, DPS connector, 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, DPS connector, ECTS connector in turn.
5. Measure the voltage of power circuit of each sensor with all connector connected.

Specification : APTS, VSCA, DPS : sensor power supply should not change as connecting APTS connector, VSCA connector, DPS 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, DPS, ECTS)

NO

▶ Go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E30F29AE

Refer to DTC P0698.

DTC P1145 OVERRUN MONITORING ERROR

GENERAL DESCRIPTION E5F490AB

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 EE63CE3D

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 E44DC5E9

<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="8">• ECM internal error</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• 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</td></tr>
<tr><td>Diagnostic Time</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>Check Lamp</td><td>NO</td></tr>
</table>

COMPONENT INSPECTION E9099A5F

1. ECM Component Inspection

   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 E0710F7C

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

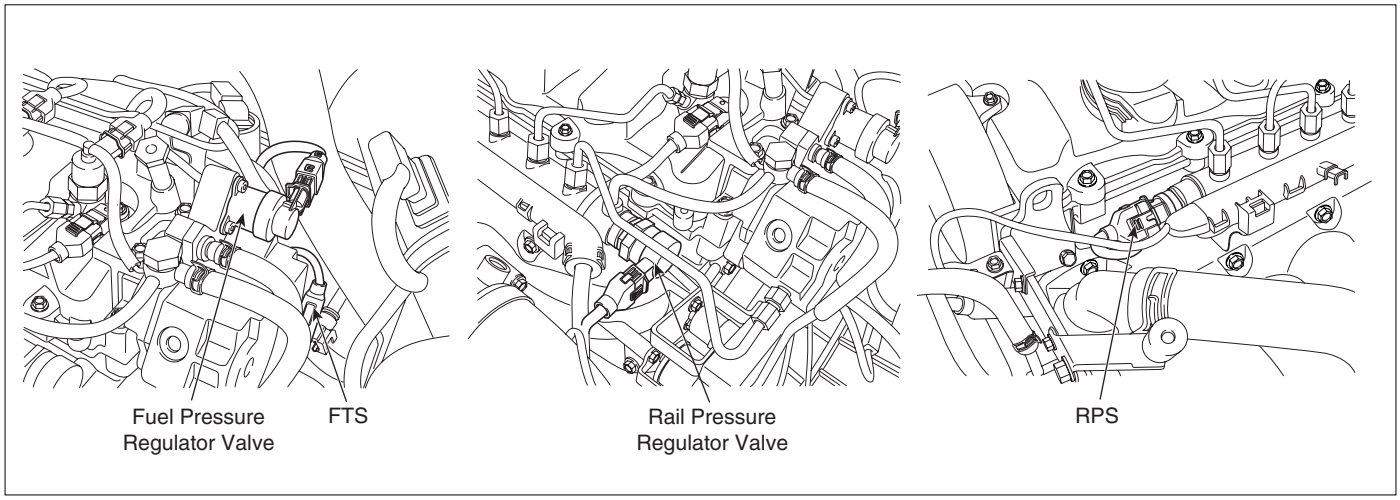
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P1171 MINIMUM RAIL PRESSURE EXCEEDED

COMPONENT LOCATION E58ECD38



SNFFL6517L

GENERAL DESCRIPTION EA9FBB7B

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 E54C6EAC

Rail pressure is controlled by 1)only RPRV or 2)both RPRV and FPRV or 3)only RPRV depending on engine condition. These three modes are called 'CPC mode'. During transition from one mode to another mode, if rail pressure is below the minimum rail pressure for each certain engine condition for more than 300ms. P1171 is set then, rail pressure is controlled by RPRV alone.

DTC DETECTING CONDITION E8E237BC

Item	Detecting Condition			Possible Cause
DTC Strategy	• Signal monitoring			• ECM internal error • RPRV component • FPRV component • RPS componet
Enable Conditions	• Engine running			
Threshold Value	• If rail pressure is below the minimum rail pressure for each certain engine condition			
Diagnostic Time	• 0.3 sec.			
Fail Safe	Fuel cut	NO		
	EGR Off	NO		
	Fuel Limit	NO		
	Check Lamp	NO		

MONITOR SCANTOOL DATA EE0FFC84

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 PRESS. S/POINT", "RAIL PRESS. REGULATOR1", "INJ. PUMP REGULATOR" parameter on the Scantool.

Specification : FUEL PRESSURE MEASURED similar to "FUEL PRESSURE-TARGET"
FUEL PRESS. S/POINT : 28.5 ± 5 Mpa
RAIL PRESS. REGULATOR1 : 17 ± 5%
INJ. PUMP REGULATOR : 35 ± 5%

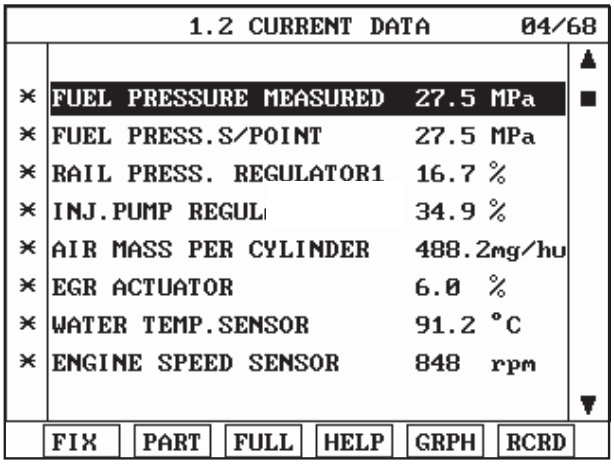


Fig.1

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

STGFL7608L

Check if "FUEL PRESSURE MEASURED"data is similar to "FUEL PRESS. S/POINT". 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 PRESS. S/POINT", 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", "INJ. PUMP REGULATOR","RAIL PRESS. REGULATOR1" parameter on the Scantool.

SPECIFICATION :

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

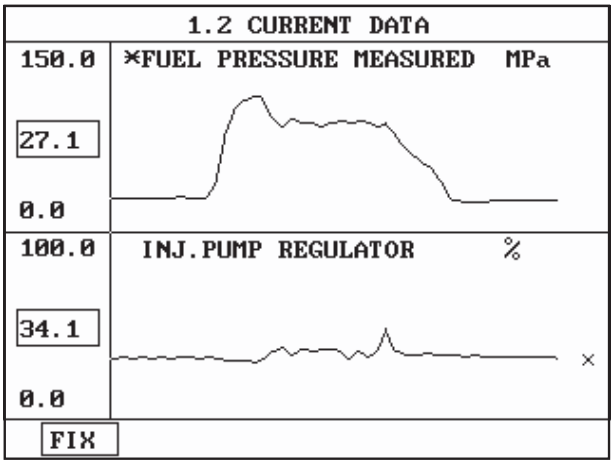


Fig.2

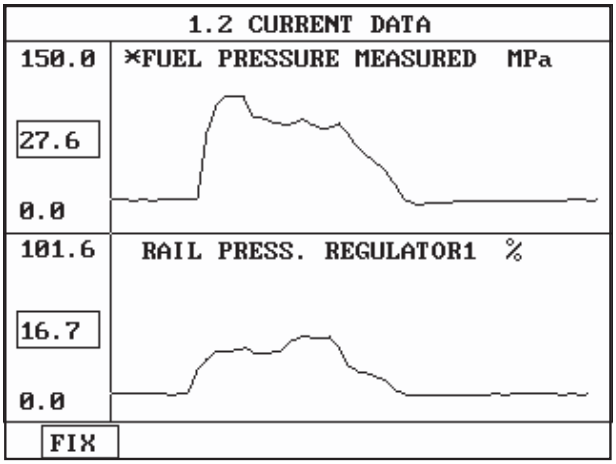


Fig.3

Fig.2) Fuel pressure and Fuel pressure regulator valve data at idle. Rail Pressure increases when the duty of "Fuel pressure regulator" increases.
Fig.3) Fuel pressure and Rail pressure regulator valve data at idle. Rail Pressure increases when the duty of "Rail pressure regulator" increases.

SNFFL6530L

NOTE

The waveform of fuel pressure regulator valve installed at high pressure pump(fuel detecting MPROP) shows 35 ± 5% duty at idle, duty rises to approx. 40% at acceleration to raise rail pressure.
▶ Fuel amonut delivered from injection pump to rail is increases if the duty of "Fuel pressure regulator" increases

The waveform of rail pressure regulator valve installed at common rail shows 17 ± 5% duty at idle, duty rises to approx. 45% at acceleration to raise rail pressure.
▶ If the current increases, pressure in common rail will increase. because fuel return amount delivered to commom rail will decrease.

VERIFICATION OF VEHICLE REPAIR E9C74079

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 P1172 MAXIMUM RAIL PRESSURE EXCEEDED

COMPONENT LOCATION EDBFC90B

Refer to DTC P1171.

GENERAL DESCRIPTION EAB4EEB3

Refer to DTC P1171.

DTC DESCRIPTION ED4E77F8

Rail pressure is controlled by 1)only RPRV or 2)both RPRV and FPRV or 3)only RPRV depending on engine condition. These three modes are called 'CPC mode'. During transition from one mode to another mode, if rail pressure is above the maximum rail pressure for each certain engine condition for more than 240ms. P1172 is set then, rail pressure is controlled by RPRV alone.

DTC DETECTING CONDITION ED2B0C07

<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="8">• ECM internal error
• RPRV component
• FPRV component
• RPS componet</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• If rail pressure is above the maximum rail pressure for each certain engine condition</td></tr>
<tr><td>Diagnostic Time</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"></td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>Check Lamp</td><td>NO</td></tr>
</table>

MONITOR SCANTOOL DATA EDEB0A0E

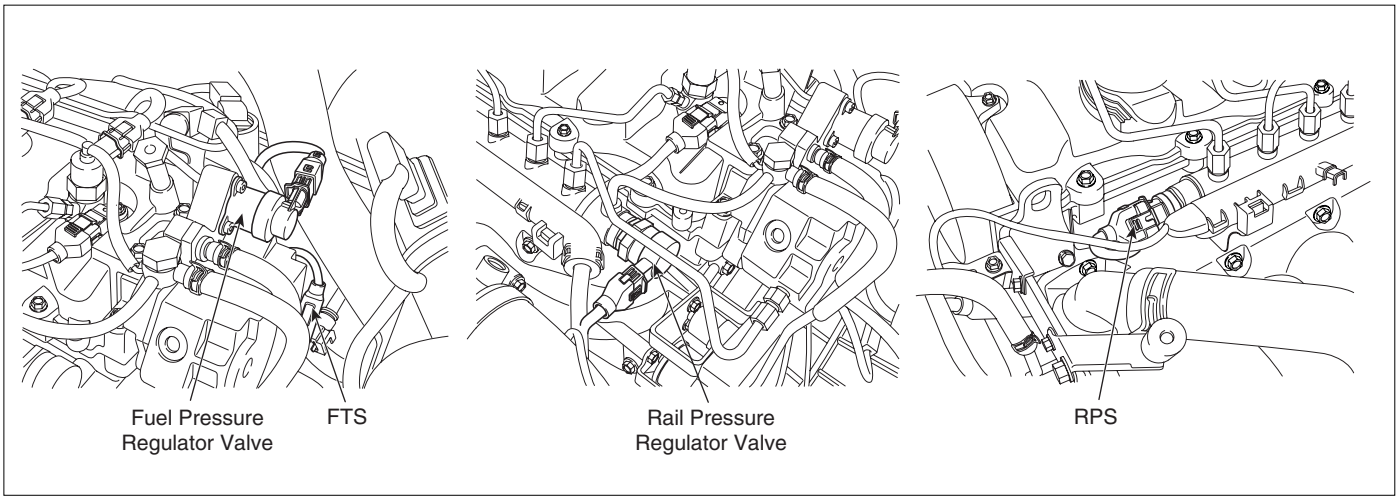
Refer to DTC P1171.

VERIFICATION OF VEHICLE REPAIR E745FE2D

Refer to DTC P1171.

DTC P1185 FUEL PRESSURE MONITORING-MAXIMUM PRESSURE EXCEEDED

COMPONENT LOCATION E4ADC0C3



SNFFL6517L

GENERAL DESCRIPTION EAF6524D

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 EF4165F7

P1185 is set when 1)rail press. is higher than target rail press. by 200bar in condition that rail press. is controlled by fuel metering unit(MPROP) or 2)rail press. 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 fuel press. sensor.

DTC DETECTING CONDITION E129418D

<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">• fuel pressure regulator valve(open stuck)
• rail pressure regulator valve(close stuck)
• Rail pressure sensor(Output fixed at high voltage line)</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Rail pressure is above target rail pressure by more than 200bar at fuel pressure regulator valve(MPROP) operating condition.- 2 sec. (Injection pump Fuel amount is exceeded to limited minimum value (-410㎣/s))
• Rail pressure is above maximum limiting value(1750bar) at fuel pressure regulator valve(MPROP) operating condition. - 0.24 sec.</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• Refer to threshold Value</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>Check Lamp</td><td>YES</td></tr>
</table>

MONITOR SCANTOOL DATA EE9D7AAD

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 PRESS. S/POINT", "RAIL PRESS. REGULATOR1", "INJ. PUMP REGULATOR" parameter on the Scantool.

Specification : FUEL PRESSURE MEASURED similar to "FUEL PRESSURE-TARGET"
FUEL PRESS. S/POINT : 28.5 ± 5 Mpa
RAIL PRESS. REGULATOR1 : 17 ± 5%
INJ. PUMP REGULATOR : 35 ± 5%

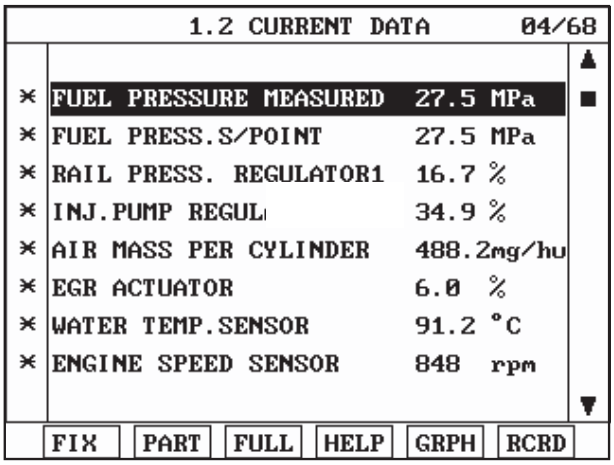


Fig.1

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

STGFL7608L

Check if "FUEL PRESSURE MEASURED"data is similar to "FUEL PRESS. S/POINT". 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 PRESS. S/POINT", 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", "INJ. PUMP REGULATOR","RAIL PRESS. REGULATOR1" parameter on the Scantool.

SPECIFICATION :

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

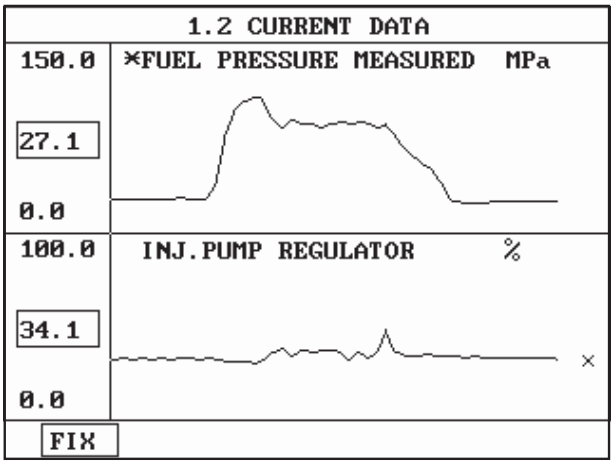


Fig.2

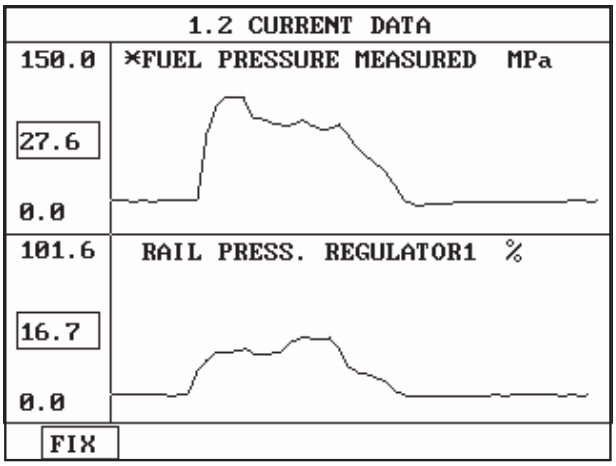


Fig.3

Fig.2) Fuel pressure and Fuel pressure regulator valve data at idle. Rail Pressure increases when the duty of "Fuel pressure regulator" increases.
Fig.3) Fuel pressure and Rail pressure regulator valve data at idle. Rail Pressure increases when the duty of "Rail pressure regulator" increases.

SNFFL6530L

NOTE

The waveform of fuel pressure regulator valve installed at high pressure pump(fuel detecting MPROP) shows 35 ± 5% duty at idle, duty rises to approx. 40% at acceleration to raise rail pressure.
▶ *Fuel amonut delivered from injection pump to rail is increases if the duty of "Fuel pressure regulator" increases*

The waveform of rail pressure regulator valve installed at common rail shows 17 ± 5% duty at idle, duty rises to approx. 45% at acceleration to raise rail pressure.
▶ *If the current increases, pressure in common rail will increase. because fuel return amount delivered to commom rail will decrease.*

VERIFICATION OF VEHICLE REPAIR EA2EA934

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 E68C7240

Refer to DTC P1185.

GENERAL DESCRIPTION EFC7CE40

Refer to DTC P1185.

DTC DESCRIPTION E9E4EDB4

P1186 is set when measured rail pressure, within the range where rail pressure is controlled by MPROP, is higher or lower than 200bar controlled as target rail pressure or when high pump amount is lowered than limited minimum value for lasting 0.8sec.. 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 rail pressure sensor.

DTC DETECTING CONDITION E0647F0A

<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">• rail pressure regulator valve(close stuck)
• rail pressure control valve(open stuck)
• Rail pressure sensor(Output fixed at high voltage line)</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Rail pressure is below target rail pressure by more than 200bar at fuel pressure regulator(MPROP) operating condition.</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• 0.8 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>Check Lamp</td><td>YES</td></tr>
</table>

MONITOR SCANTOOL DATA E9BA4B25

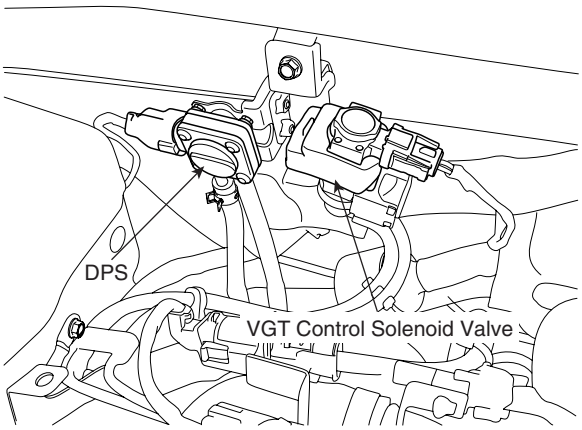
Refer to DTC P1185.

VERIFICATION OF VEHICLE REPAIR EE9206BE

Refer to DTC P1185.

DTC P1403 DIFFERENTIAL PRESSURE NOT PLAUSIBLE (HOSE LINE FROZEN)

COMPONENT LOCATION E73079C4



SNFFL6200L

GENERAL DESCRIPTION E9EBBF1F

Differential pressure sensor(DPS) is piezzo electric type sensor. Sensing the differential pressure between in front of CPF and in the back of CPF, DPS outputs linear signal from 0~5V. Using output signal, DPS detects the amount of soot, sulfide, SOF(soluble organic fraction) to determine if CPF regeneration is needed.
※CPF regeneration : When vehicle is in steady speed condition and above normal engine loading condition, if differential pressure between before and after CPF is above the specified pressure, ECM considers that stored soot inside of CPF is excessive. In this condition, exhaust gas tempt. is raised by post injection 1 and 2 to warm CPF up to 550℃~650℃. In this high tempt, soot inside of CPF burns up naturally and this mechanism is called as "CPF regeneration".Most of soot is burned up during regeneration process but a little amount of soot is not burned up and stored inside of CPF continuously. The stored soot decreases the efficiency of CPF slowly. DPS corrects CPF regeneration period and duration as comparing and calculating the differential pressure due to stored soot with the total distance covered.

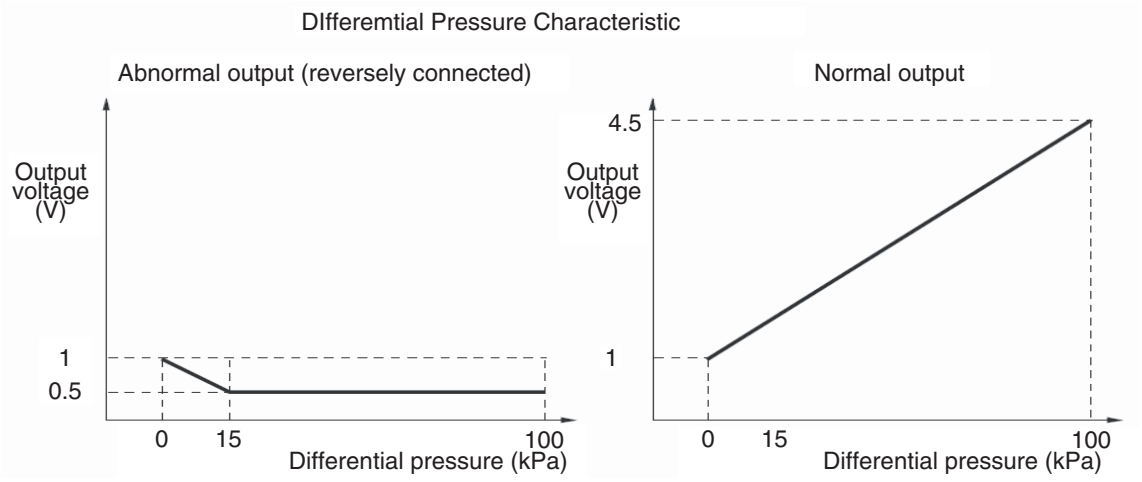
DTC DESCRIPTION E0A8C20A

P1403 is set when outdoor temp. is -5℃ and failure ID signal is outputted as 1. If differncial pressure does not change or it is extremly low, ECM recognizes hose line to be faulty. This code is likely to be set when vehicle is parked at a slope with front side of vehicle headed to downward.

DTC DETECTING CONDITION E41AD351

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Water freezing • DPS Wiring • DPS component • Reversly connectedDPS hose line • Clogged DPS hose • Clogged CPF inlet section • Clogged CPF
Enable Conditions	• Engine running			
Threshold Value	• Abnormal signal outputted at below -5℃ of outdoor temp.			
Diagnostic Time	• Immediately			
Fail Safe	Fuel cut	NO		
	EGR Off	NO		
	Fuel Limit	NO		
	Check Lamp	NO		

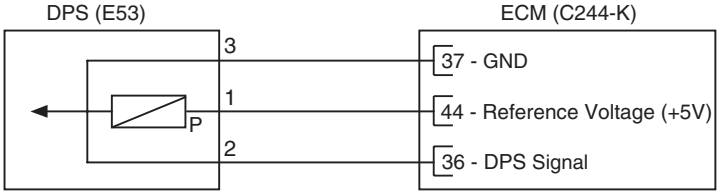
SPECIFICATION EE9ECB55



LFIG421A

SCHEMATIC DIAGRAM ED3A2AA7

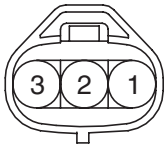
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

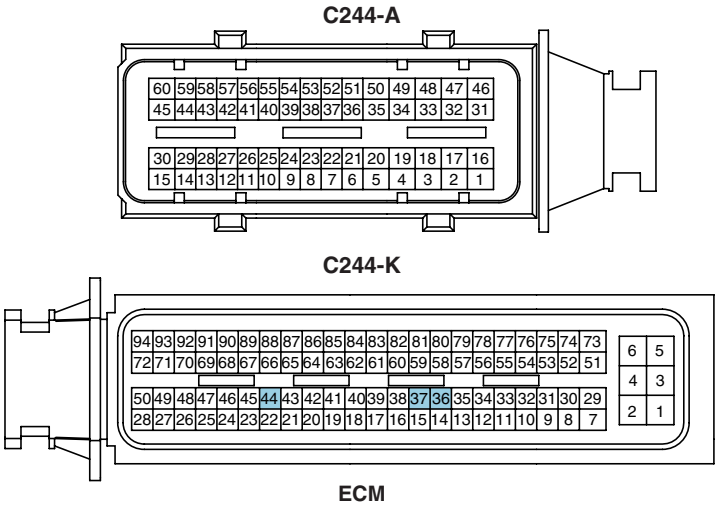
Terminal	Connected to	Function
1	ECM C244-K (44)	Reference Voltage (+5V)
2	ECM C244-K (36)	DPS Signal
3	ECM C244-K (37)	Sensor ground

[HARNESS CONNECTORS]



E53

DPS



STGFL7169L

SIGNAL WAVEFORM AND DATA EF7BF7CC

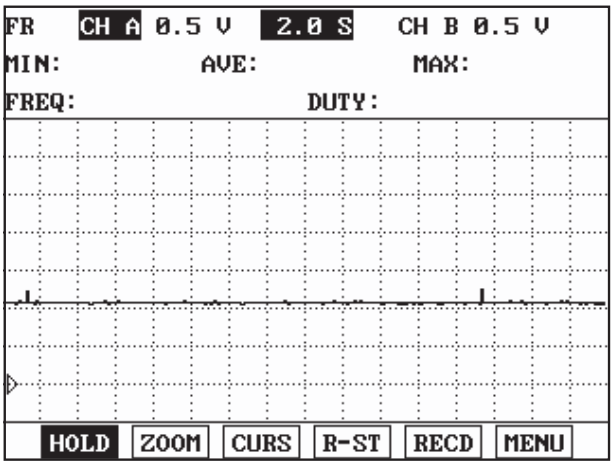


Fig.1

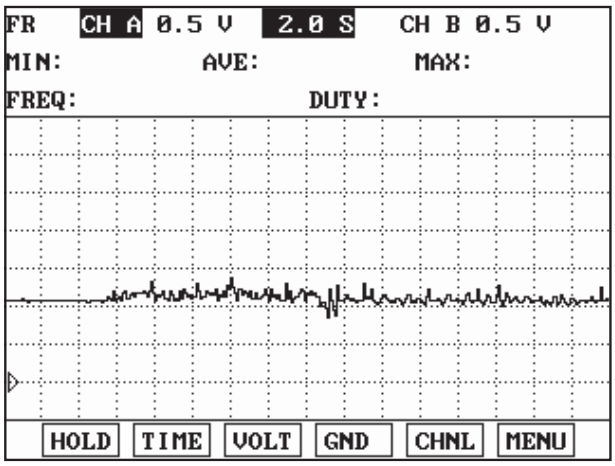


Fig.2

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

LFIG423A

NOTE

As accelerating, DPS signal output voltage does not vary too much. Even when accelerator pedal is fully depressed, the signal voltage fluctuates just a little bit like "Fig. 2". However, the more CPF is used, the more waveform fluctuates.

MONITOR SCANTOOL DATA ECCBACED

1. Connect Scantool to Data Link Connector (DLC).
2. When atmospheric temp. is below 0℃, monitor data as soon as turning engine ON.
3. Turn "OFF" electrical devices and A/C.
4. Monitor "DIFFERENTIAL PRESSURE" and "PRESSURE PRE CPF" parameter on the scantool.

specification : "DIFFERENTIAL PRESSURE" and "PRESSURE PRE CPF" data vary normally.
even at the temperature of below 0℃

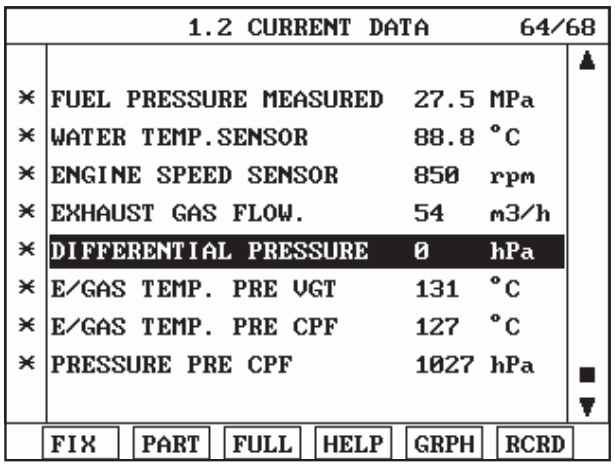


Fig.1

Fig. 1) When turning enigne ON at below 0¡ in which water freezes, monitor if "DIFFERENTIAL PRESSURE" and "PRESSURE PRE CPF" data vary normally. When a vehicle is in acceleration or driven in that cold condition, "DIFFERENTIAL PRESSURE" and "PRESSURE PRE CPF" data must vary.

STGFL7537L

※ When data do not vary
☞ Check if diconnected differential pressure sensing hose or pressure leakage is detected. Check if the deformation(which may disturb water flow) of the steel pipe connecting CPF and DIFFERENTIAL PRESSURE SENSOR as well.

TERMINAL AND CONNECTOR INSPECTION EC78781D

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 E2BD4196

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect DPS connector.
3. IG KEY "ON"
4. Measure the voltage of DPS 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 power circuit and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION ED360B0A

1. Check signal circuit voltage
   1) IG KEY "OFF", ENGINE "OFF"
   2) Disconnect DPS connector.
   3) IG KEY "ON"
   4) Measure the voltage of DPS 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".

2. Check open in signal circuit
   1) IG KEY "OFF", ENGINE "OFF"

2) Disconnect DPS connector and ECM connector.

3) Check continuity between DPS connector terminal 2 and ECM connector(C244-K) terminal 36.

Specification : Continuity (below 1.0Ω)

4) Is the measured resistance within the specification?

YES

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

NO

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

3. Check short in signal circuit

1) IG KEY "OFF", ENGINE "OFF"

2) Disconnect DPS connector and ECM connector.

3) IG KEY "ON"

4) Check continutity between DPS connector terminal 2 and chassis ground. (Test for short to ground)

5) Check voltage between DPS connector terminal 2 and chassis ground. (Test for short to battery)

Specification : Test for short to ground : Discontinuity (Infinite Ω)
Test for short to battery : below 0.1 V

6) Is the isolation of DPS signal circuit normal?

YES

▶ Go to "Ground Circuit Inspection".

NO

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

GROUND CIRCUIT INSPECTION ED2DBC3D

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect EGTS connector.
3. IG KEY "ON"
4. Measure the voltage of DPS connector terminal 2. [TEST "A"]
5. Measure the voltage between DPS connector terminal 2 and 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 E683D87B

1. DPS visual inspection

   1) IG KEY "OFF", ENGINE "OFF"

   2) Disconnect DPS connector.

   3) Check DPS terminals for corrosion and contamination.

   4) Check (1)connecting condition of DPS and pressure sensing hose, (2)exhaust gas pressure leakate, (3)miss connection of pressure sensing hose (reverse connection) is detected.

   5) Is DPS related problem detected?

      YES

      ▶ If needed, replace DPS or pressure sensing hose and go to "Verification of Vehicle Repair".

      NO

      ▶ Go to "2. Monitor DPS signal waveform" as follows.

2. Monitor DPS signal waveform

   1) IG KEY "ON", ENGINE "OFF"

   2) Connect DPS connector.

   3) Connect oscilloscope to DPS connector terminal 2.

   4) After warming engine up, monitor the waveform at idle and during acceleration.

Specification : Refer to "Signal Waveform & Data" of "General Information".

   5) Is DPS signal waveform is similar to the waveform of "Signal Waveform & Data"?

      YES

      ▶ Go to "Verification of Vehicle Repair".

      NO

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

VERIFICATION OF VEHICLE REPAIR E5915BBA

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

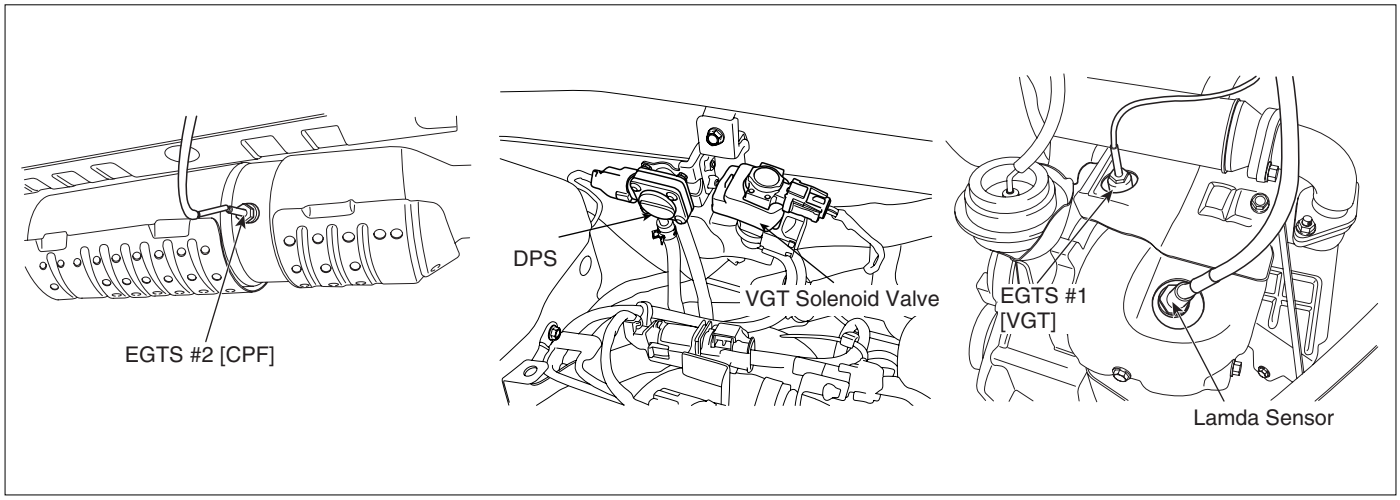
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P1405 CPF - PERMANENT REGENERATION

COMPONENT LOCATION EBE5EAED



SNFFL6232L

GENERAL DESCRIPTION E9994EDD

Comparing with gasoline engine, one of the worst point of diesel engine is that a lot of particle material(PM) are generated after combustion process. In order to decrease the amount of PM, CPF is equipped in EURO-4 diesel engine. CPF is the device which gathers PM with installed filter then burns it up as raising the tempt. inside of CPF above the ignition point of PM. The process which burns up PM is called "CPF regeneration".
※CPF regeneration : When vehicle is in steady speed condition and above normal engine loading condition, if differential pressure between before and after CPF is above the specified pressure, ECM considers that stored soot inside of CPF is excessive. In this condition, exhaust gas tempt. is raised by post injection 1 and 2 to warm CPF up to 550℃~650℃. In this high tempt, soot inside of CPF burns up naturally and this mechanism is called as "CPF regeneration".
Most of soot is burned up during regeneration process but a little amount of soot is not burned up and stored inside of CPF continuously. The stored soot decreases the efficiency of CPF slowly. DPS corrects CPF regeneration period and duration as comparing and calculating the differential pressure due to stored soot with the total distance covered.

DTC DESCRIPTION EA4591A8

P1405 is set when CPF is in generation mode to get rid of piled P.M but generation has not completed for exceeding designated time (600sec.) or temperature difference between VGT-CPF sensors signal is over set temperature (40℃) during cold condition.This DTC will be set by foreign materials in the CPF, Malfunctioning of DPS signal, Faulty EGTS - VGT or CPF or circuit malfunction.

DTC DETECTING CONDITION EA2E9A65

<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">• Dropped regeneration efficiency
• Clogged CPF
• DPS circuit
• DPS component
• EGTS circuit (VGT,CPF)
• EGTS component (VGT,CPF)</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Regenerating duration lasts more than the specified duration - 600sec
• temperature difference between VGT-CPF sensors signal is over set temperature (40℃) during cold condition. - 1.0sec</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• Refer to "Threshold Value"</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel cut</td><td>NO</td><td rowspan="4">• Engine check lamp blinks.</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>Check Lamp</td><td>BLINK</td></tr>
</table>

MONITOR SCANTOOL DATA E46D5827

1. Data analysis about CPF

   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 "DIFFERENTIAL PRESSURE" and "PRESSURE PRE CPF" parameter on the scantool.

specification : "DIFFERENTIAL PRESSURE" and "PRESSURE PRE CPF" data must not be too high or low.

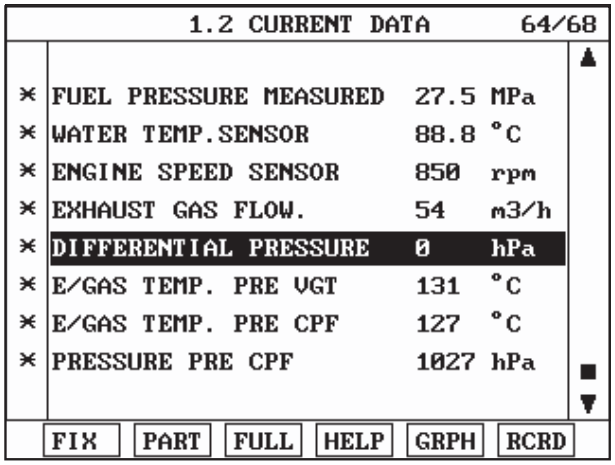


Fig.1

Fig. 1) Check if "DIFFERENTIAL PRESSURE" and "PRESSURE PRE CPF" data is abnormally too high or low.

STGFL7535L

NOTE

The "Scantool Data" shown above is measured at the vehicle with new CPF component. Therfore, data varies depending on CPF used duration and total driven distance.

☞ *When "DIFFERENTIAL PRESSURE" is too high : Check if excessive soot is accumulated inside of CPF before inspecting DPS related problem. If needed, perform "CPF SERVICE REGENERATION" to burn the soot inside of CPF and monitor data change.*

☞ *When "DIFFERENTIAL PRESSURE" is too low : "DIFFERENTIAL PRESSURE" and "PRESSURE PRE CPF" data rises depending on engine load increase and the amount of soot inside of CPF. If differential pressure is not generated or soot is emitted without the rise of "PRESSURE PRE CPF" during excceleration, check CPF component failure.*

☞ *When "DIFFERENTIAL PRESSURE" doesn't change : If the not only Black smoke is not exhausted but the pressure difference also is not measred between at the front and rear of CPF, check disconnection, clog or leakage of DPS pressure hose.*

2. CPF SERVICE REGENERATION procedure.

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

   2) Warm engine up to normal operating temperature.

   3) Turn the all the electrocity (Head lamp -HIGH, Blower motor - Max speed, Defroster)and air conditioner "ON".

   4) Perform the "CPF SERVICE REGENERATION" procedure with scantool.

■ specification : CPF regeneration should be O.K when performing CPF service mode.

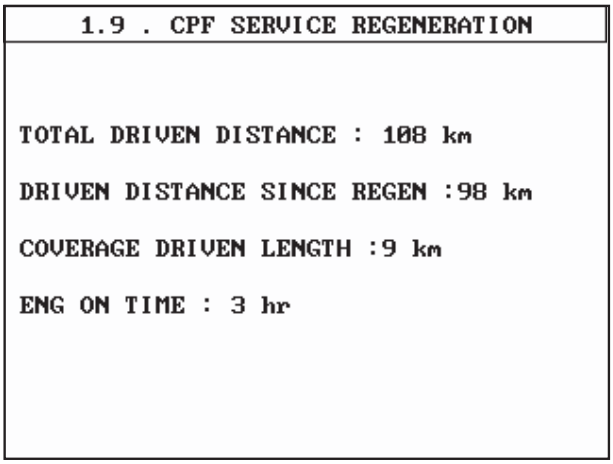


Fig.2

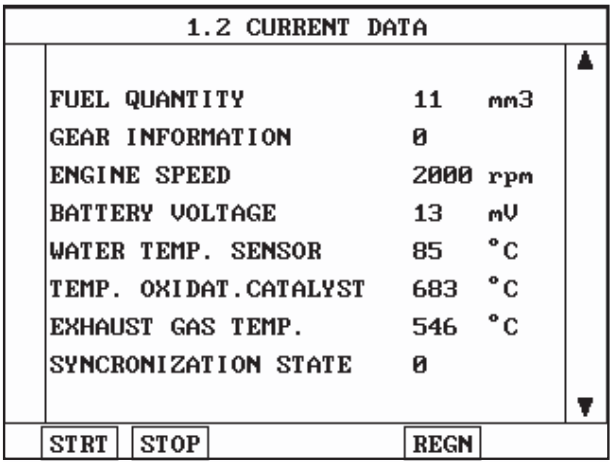


Fig.3

Fig 2) Check "COVERAGE DRIVEN LENGTH" will be change to "0"km by checking the initial display after performing the CPF Service mode.
Fig 3) Check the temperature both EGTS(CPF) and EGTS(VGT) are within 500¡ ~700¡ after performing CPF service mode with scantool displaying in the middle of procedure.

SNFFL6536L

TERMINAL AND CONNECTOR INSPECTION E89BE8E1

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 ED783F53

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect DPS connector.
3. IG KEY "ON"
4. Measure the voltage of DPS 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 power circuit and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION E04C00C4

1. Check signal circuit voltage
   1) IG KEY "OFF", ENGINE "OFF"
   2) Disconnect DPS connector.
   3) IG KEY "ON"
   4) Measure the voltage of DPS 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".

2. Check open in signal circuit

   1) IG KEY "OFF", ENGINE "OFF"

   2) Disconnect DPS connector and ECM connector.

   3) Check continuity between DPS connector terminal 2 and ECM connector(C244-K) terminal 36.

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification?

YES

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

NO

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

3. Check short in signal circuit

   1) IG KEY "OFF", ENGINE "OFF"

   2) Disconnect DPS connector and ECM connector.

   3) IG KEY "ON"

   4) Check continutity between DPS connector terminal 2 and chassis ground. (Test for short to ground)

   5) Check voltage between DPS connector terminal 2 and chassis ground. (Test for short to battery)

Specification : Test for short to ground : Discontinuity (Infinite Ω)
Test for short to battery : below 0.1 V

   6) Is the isolation of DPS signal circuit normal?

YES

▶ Go to "Ground Circuit Inspection".

NO

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

GROUND CIRCUIT INSPECTION EF83B28C

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect EGTS connector.
3. IG KEY "ON"
4. Measure the voltage of DPS connector terminal 2. [TEST "A"]

5. Measure the voltage between DPS connector terminal 2 and 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 EBB6D7CA

1. DPS visual inspection

   1) IG KEY "OFF", ENGINE "OFF"

   2) Disconnect DPS connector.

   3) Check DPS terminals for corrosion and contamination.

   4) Check (1)connecting condition of DPS and pressure sensing hose, (2)exhaust gas pressure leakate, (3)miss connection of pressure sensing hose (reverse connection) is detected.

   5) Is DPS related problem detected?

   YES

   ▶ If needed, replace DPS or pressure sensing hose and go to "Verification of Vehicle Repair".

   NO

   ▶ Go to "2. Monitor DPS signal waveform" as follows.

2. Monitor DPS signal waveform

   1) IG KEY "ON", ENGINE "OFF"

   2) Connect DPS connector.

   3) Connect oscilloscope to DPS connector terminal 2.

   4) After warming engine up, monitor the waveform at idle and during acceleration.

Specification : Refer to "Signal Waveform & Data" of "General Information".

   5) Is DPS signal waveform is similar to the waveform of "Signal Waveform & Data"?

   YES

   ▶ Go to "3. CPF component visual inspection".

NO

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

3. CPF component visual inspection

   1) IG KEY "OFF", ENGINE "OFF"

   2) Visually inspect any evidence of exhaust gas leakage on the connection of the exhaust pipe.

   3) After removing CPF assembly, check any Inside of CPF is contaminated or Catalyst converter is damaged, disengaged or melted.

Specification : Catalyst Converter and PM filter in the CPF should be normal.

   4) Is CPF related problem detected?

YES

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

NO

▶ Go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E4E8E866

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

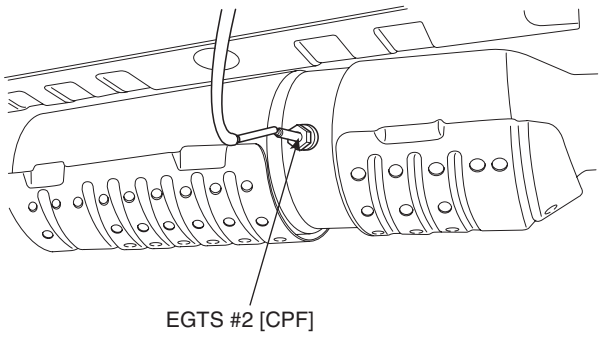
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P1406 EXHAUST GAS TEMPERATURE NOT PLAUSIBLE BETWEEN CALCULATED AND SIMULATED

COMPONENT LOCATION E9DFB5FF



KFQG122A

GENERAL DESCRIPTION E30F240E

In EURO4 diesel engine with CPF, injection is devided into 2 pilot, 1 main, 2 post injections. Among these injections, pilot and main injections are for the operation of engine, however post injections are for CPF regeneration. Only in activating condition of CPF regeneration during driving, post injection starts. 1st post injection happens at the end of combustion cycle then, injected fuel is used to raise exhaust temperature. that temp. is sensed at T3 exhaust tempt. sensor which is ahead of Turbo charger. 2nd post injection happens at exhaust cycle then, injected fuel is also used to raise exhaust temperature. that temp. is sensed T5 exhaust tempt. sensor which is between Oxydation catalyst and CPF. The reason of raising exhaust tempt. is because exhaust tempt. in diesel engine is too low for CPF regeneration. The optimum tempt. for CPF regeneration is 550~600℃ thus, the goal of post injection is raise exhaust tempt. to that range of tempt.. However if exhaust tempt. is too high, turbo charger or CPF are likely to be damaged. Therefore if tempt. measured at each sensor is out of permittable value(specification), ECM deactivates CPF regeneration.

DTC DESCRIPTION E707D351

P1406 is set when the temperature difference between catalyst converter, its temperature is measured by EGTS-CPF and model value memorized in ECM is higher than 300℃. This DTC will be set by resulting from faulty exhaust temperature sensor(EGTS - CPF) circuit malfunction, catalyst converter of CPF or Faulty post injector #2.

DTC DETECTING CONDITION E97796B3

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Exhaust gas temp. sensor circuit • Exhaust gas temp. sensor component
Enable Conditions	• IG KEY "ON"			
Threshold Value	• temperature difference between catalyst converter, its temperature is measured by EGTS-CPF and model value memorized in ECM is higher than 300℃.			
Diagnostic Time	• 10 sec.			
Fail Safe	Fuel cut	NO		
	EGR Off	NO		
	Fuel Limit	NO		
	Check Lamp	NO		

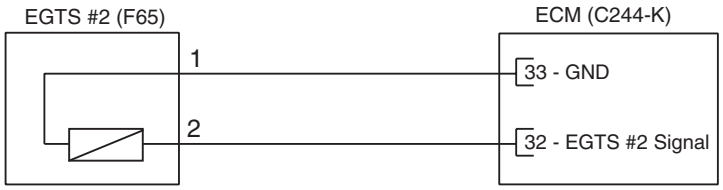
SPECIFICATION E0F68989

RESISTANCE/TEMPERATURE CHARACTERISTICS

Temp. (℃)	NEW		AGED	
	Min(kΩ)	Max(kΩ)	Min(kΩ)	Max(kΩ)
100	317	436	272	515
300	5.52	6.34	5.15	6.79
600	0.341	0.386	0.321	0.411
900	0.0862	0.0925	0.0833	0.096

SCHEMATIC DIAGRAM EB292BDD

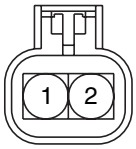
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-K (33)	Sensor ground
2	ECM C244-K (32)	EGTS #2 Signal

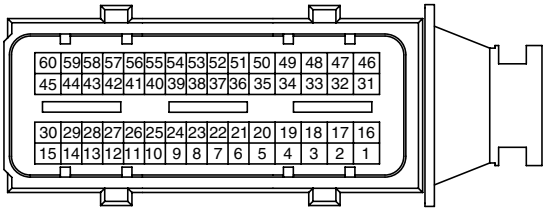
[HARNESS CONNECTORS]



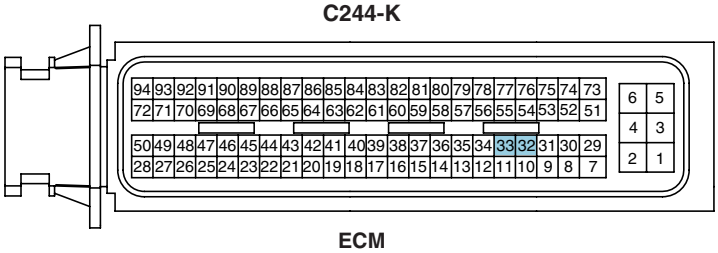
F65

EGTS #2

C244-A



C244-K



ECM

STGFL7166L

SIGNAL WAVEFORM AND DATA EEE940EE

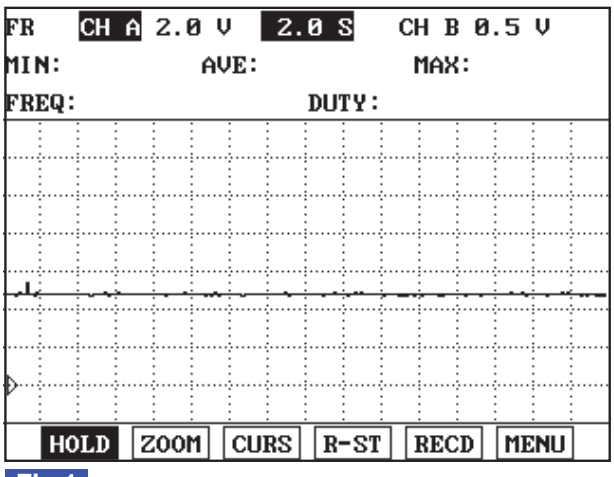


Fig.1

Fig. 1) Signal waveform when exhaust gas temperature(T5-CPF) shows the higher temperature increases, lower the voltage decreases.
If the exhaust gas temperature increases up to approx. 600℃, output voltage will decreases in 0.3~0.4V

SNFFL6543L

MONITOR SCANTOOL DATA E4333931

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 "E/GAS TEMP. PRE VGT","E/GAS TEMP. PRE CPF" parameter on the Scantool.

Specification : Current "E/GAS TEMP." is displayed.

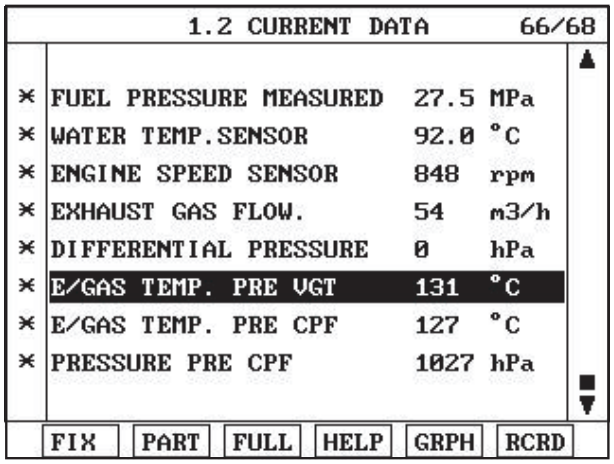


Fig.1

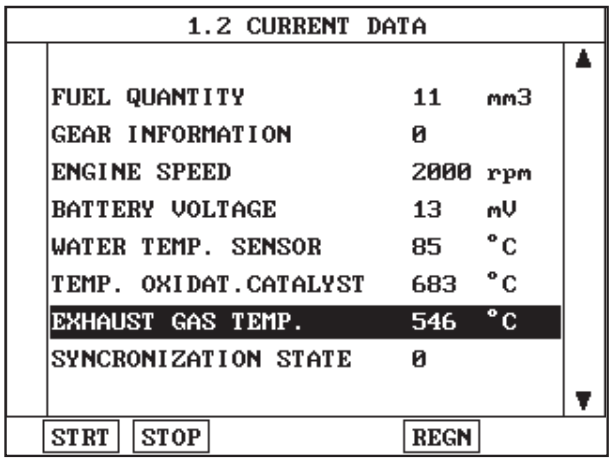


Fig.2

Fig.1) "EXHAUST GAS TEMP." at idle is shown. Monitor if abnormall difference between "Fig. 1) data" and the data from the vehicle to test.
Fig.2) The display during performing CPF regeneration after selecting "CPF SERVICE REGENERATION" mode is shown. Monitor if "EXHAUST GAS TEMP." varies correctly.

STGFL7539L

TERMINAL AND CONNECTOR INSPECTION E67626C5

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 ECAB5FCA

1. Check signal circuit voltage

   1) IG KEY "OFF", ENGINE "OFF"

   2) Disconnect EGTS(T5-CPF) connector.

   3) IG KEY "ON"

   4) Measure the voltage of EGTS(T5-CPF) 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 EGTS(T5-CPF) connector and ECM connector.

   3) Check continuity between EGTS(T5-CPF) connector terminal 2 and ECM connector(C244-K) terminal 32.

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification?

YES

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

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 EGTS(T5-CPF) connector and ECM connector.

   3) Check continuity between EGTS(T5-CPF) connector terminal 2 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 E3E5D41B

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect EGTS(T5-CPF) connector.
3. IG KEY "ON"
4. Measure the voltage of EGTS(T5-CPF) connector terminal 2. [TEST "A"]
5. Measure the voltage between EGTS(T5-CPF) connector terminal 2 and 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".

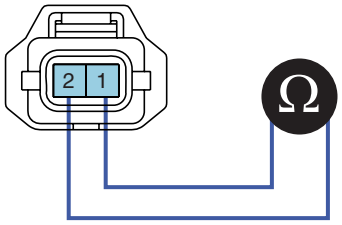
NO

▶ 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 E489F3F5

1. IG KEY "OFF", ENGINE "OFF".
2. Disconnect EGTS(T5-CPF) connector.
3. Measure resistance between EGTS(T5-CPF) terminal 1 and 2, referring to resistance characteristic table of specification of General information.

Specification : Refer to Specification of General Information



SNFFL6169D

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 EGTS(T5-CPF) and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E2790CC2

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 P1407 PLAUSIBILITY OF TEMPERATURE CALCULATED AND SIMULATED UPSTREAM OF PARTICULATE FILTER

COMPONENT LOCATION ED42CADE

Refer to DTC P1406.

GENERAL DESCRIPTION EB7D431C

Refer to DTC P1406.

DTC DESCRIPTION E9B8E148

P1407 is set when the temperature difference between exhaust gas temperature measured by exhaust gas temperature sensor at the front of turbo charger and model temperature memorized in ECM is higher than 140℃ for more than 10sec. This DTC will be turned on in case of the faulty EGTS -VGT itself, circuit malfunction or faulty post injector #1.

DTC DETECTING CONDITION E8E5BFC3

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Exhaust gas temp. sensor(T3-VGT) wiring • Exhaust gas temp. sensor(T3-VGT) component
Enable Conditions	• IG KEY "ON"			
Threshold Value	• | signal temp. - model temp. | is above 140℃.			
Diagnostic Time	• 10 sec.			
Fail Safe	Fuel cut	NO		
	EGR Off	NO		
	Fuel Limit	NO		
	Check Lamp	BLINK		

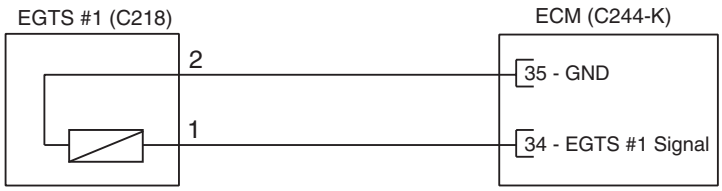
SPECIFICATION E09AC7DE

RESISTANCE/TEMPERATURE CHARACTERISTICS

Temp. (℃)	Nominal (kΩ)	NEW		AGED	
		Min(kΩ)	Max(kΩ)	Min(kΩ)	Max(kΩ)
100	371	289	481	272	515
300	5.92	5.3	6.61	5.15	6.79
600	0.363	0.347	0.379	0.341	0.386
900	0.0893	0.0842	0.0949	0.0833	0.096

SCHEMATIC DIAGRAM ED1FC465

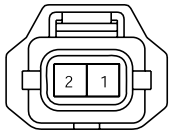
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

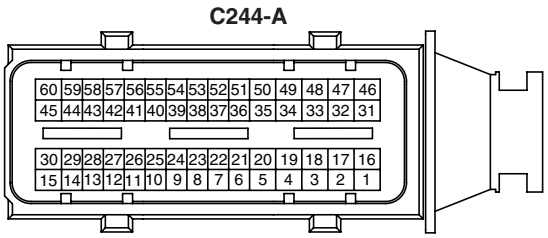
Terminal	Connected to	Function
1	ECM C244-K (34)	EGTS #1 Signal
2	ECM C244-K (35)	Sensor ground

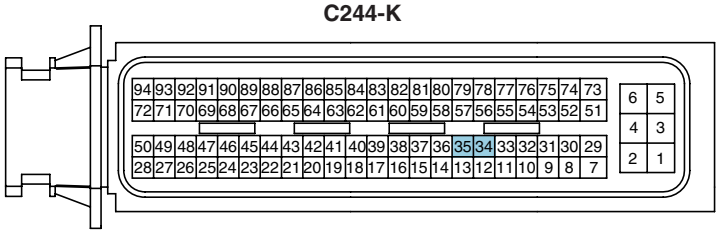
[HARNESS CONNECTORS]



C218

EGTS #1





ECM

STGFL7164L

SIGNAL WAVEFORM AND DATA E1AF9FDE

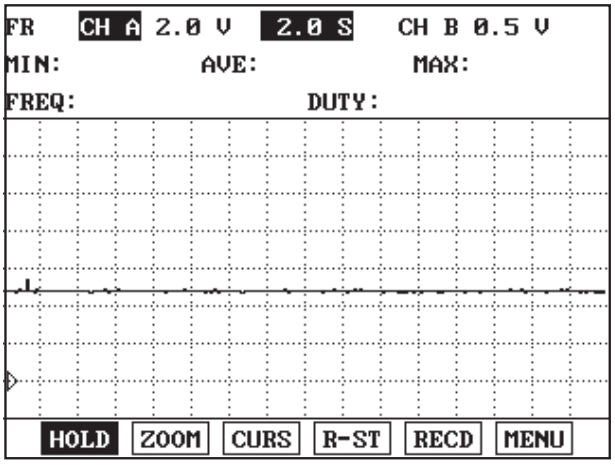


Fig.1

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

SNFFL6538L

MONITOR SCANTOOL DATA E05E8E15

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 "E/GAS TEMP. PRE VGT","E/GAS TEMP. PRE CPF" parameter on the Scantool.

Specification : Current "E/GAS TEMP." is displayed.

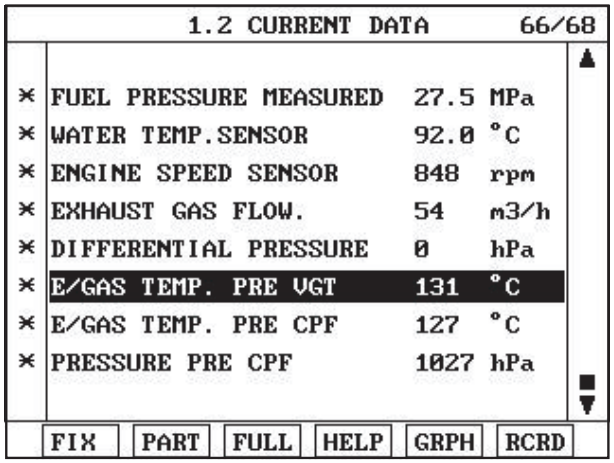


Fig.1

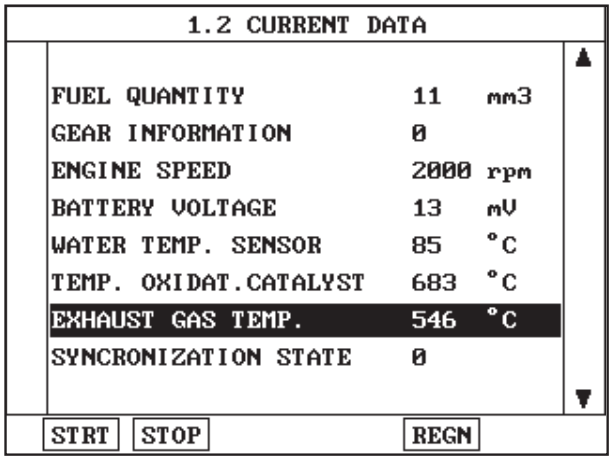


Fig.2

Fig.1) "EXHAUST GAS TEMP." at idle is shown. Monitor if abnormall difference between "Fig. 1) data" and the data from the vehicle to test.
Fig.2) The display during performing CPF regeneration after selecting "CPF SERVICE REGENERATION" mode is shown. Monitor if "EXHAUST GAS TEMP." varies correctly.

STGFL7539L

TERMINAL AND CONNECTOR INSPECTION EB5B5886

Refer to DTC P1406.

SIGNAL CIRCUIT INSPECTION EF642905

1. Check signal circuit voltage
   1) IG KEY "OFF", ENGINE "OFF"
   2) Disconnect EGTS(T3-VGT) connector.
   3) IG KEY "ON"
   4) Measure the voltage of EGTS(T3-VGT) 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 EGTS(T3-VGT) connector and ECM connector.

   3) Check continuity between EGTS(T3-VGT) connector terminal 1 and ECM connector(C244-K) terminal 34.

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification?

YES

▶ Go to "Check short to ground in signal circuit".

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 EGTS(T3-VGT) connector and ECM connector.

   3) Check continuity between EGTS(T3-VGT) connector terminal 1 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 EBA9B8DA

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect EGTS(T3-VGT) connector.
3. IG KEY "ON"
4. Measure the voltage of EGTS(T3-VGT) connector terminal 1. [TEST "A"]
5. Measure the voltage between EGTS(T3-VGT) connector terminal 1 and 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".

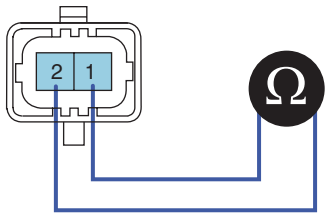
NO

▶ 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 EADC8111

1. IG KEY "OFF", ENGINE "OFF".
2. Disconnect EGTS(T3-VGT) connector.
3. Measure resistance between EGTS(T3-VGT) terminal 1 and 2, referring to resistance characteristic table of specification of General information.

Specification : Refer to Specification of General Information



KFQG320A

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

YES

▶ Go to "Verification of Vehicle Repair".

NO

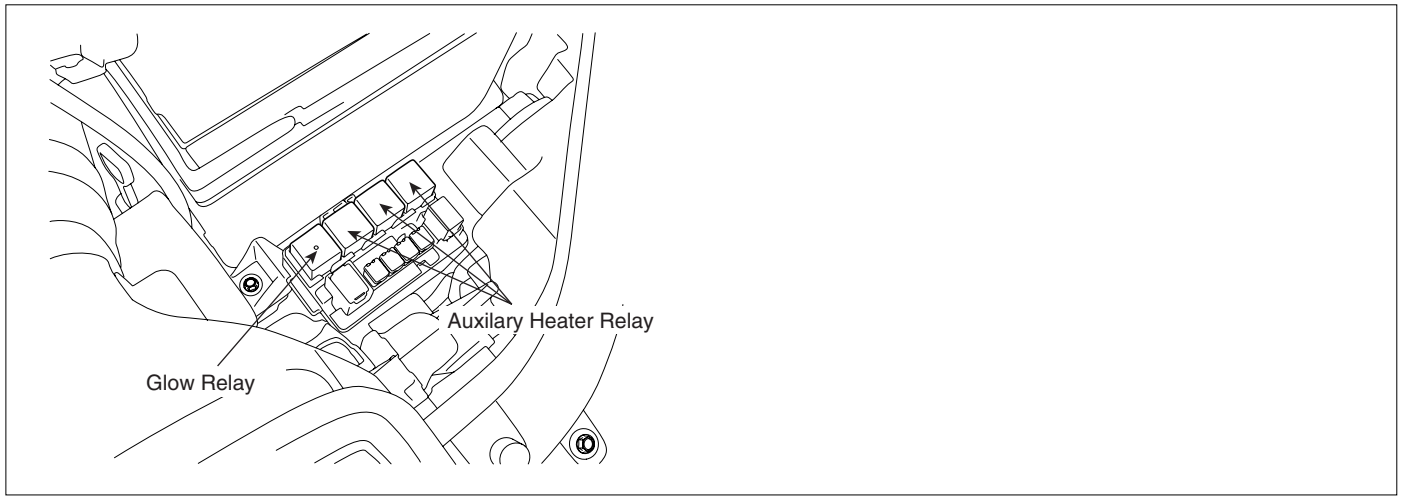
▶ Replace EGTS(T3-VGT) and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E8FBF51D

Refer to DTC P1406.

DTC P1634 AUX. HEATER MALFUNCTION

COMPONENT LOCATION EACE7ED0



SNFFL6225L

GENERAL DESCRIPTION E39F3A0D

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 EDEFAF51

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 EFEA2E97

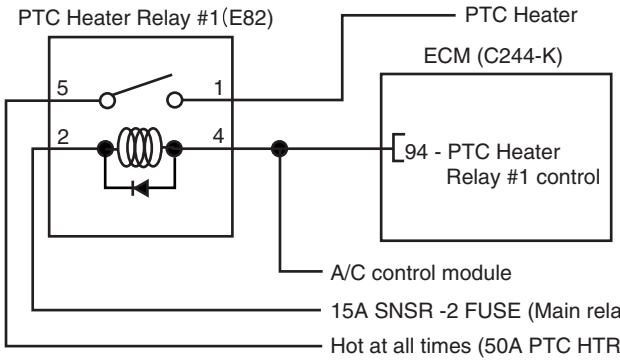
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• PTC heater relay #1control circuit
• Heater relay component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON" (monitoring only performed at relay operating condition)</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Short to Battery
• short to GND, wiring open</td></tr>
<tr><td>Diagnostic Time</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>Check Lamp</td><td>NO</td></tr>
</table>

SPECIFICATION EC5C3A00

Heater relay coil resistance	PTC heater operating temperature	PTC heater operating condition
52±5Ω (20℃)	Refer to "General Information"	Refer to "General Information"

SCHEMATIC DIAGRAM EEEEA097

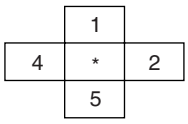
[CIRCUIT DIAGRAM]



[CONNECTOR INFORMATION]

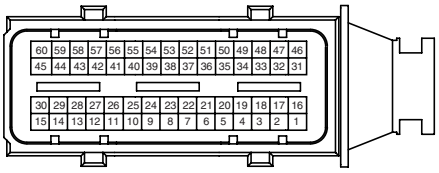
Terminal	Connected to	Function
1	M31 Terminal 3	PTC Heater Relay power (Output)
2	Main relay power	PTC Heater Relay coil power
3	*	-
4	C244-K Terminal 94 (ECM) M22-2 Terminal 25 (Maual A/CON module) M21-2 Terminal 20 (Auto A/CON module)	PTC Heater control (ECM) PTC Heater Relay "ON" signal (A/CON module)
5	50A PTC HTR #1 Fusible Link	PTC Heater Relay power (Input)

[HARNESS CONNECTOR]

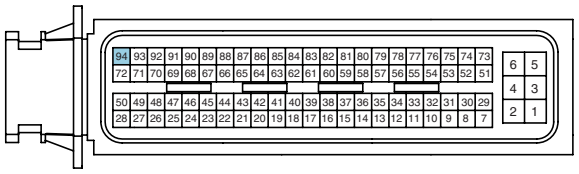


E82
PTC Heater Relay #1

C244-A



C244-K



ECM

STGFL7527L

MONITOR SCANTOOL DATA E7D014EC

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" parameter on the Scantool.
   (As soon as turning engine ON "AUXILIARY HEATER" 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" "ON"
Engine coolant temp. above 70℃ : "AUXILIARY HEATER" "OFF"

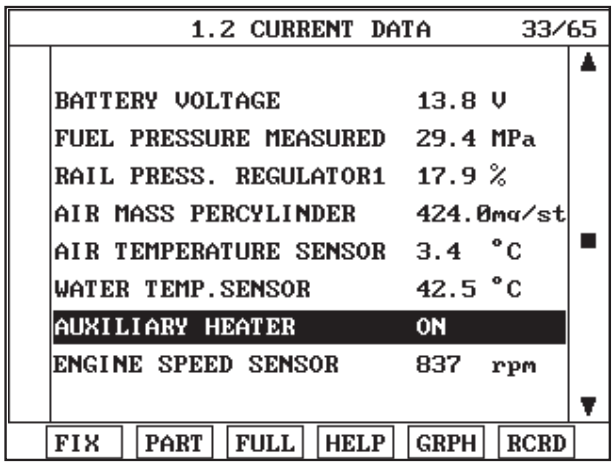


Fig.1

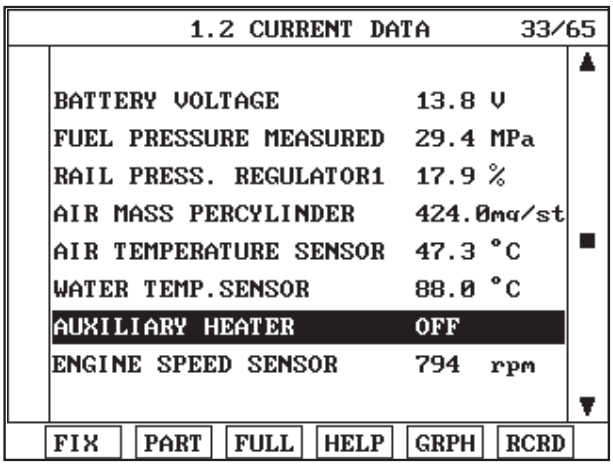


Fig.2

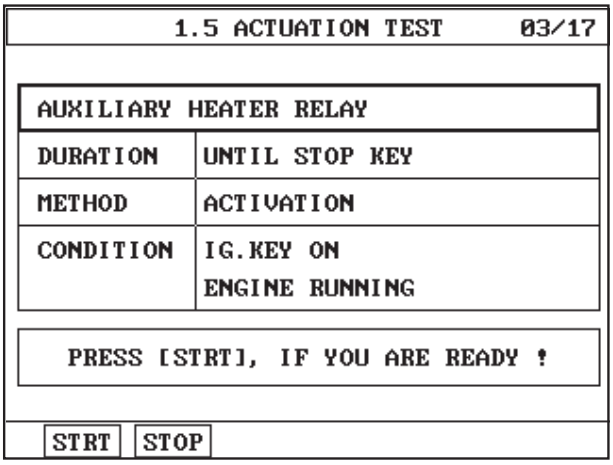


Fig.3

Fig.1) "AUXILIARY HEATER" operates only when Intake air temp. is below 5℃ and Engine coolant temp. is below 70℃.
"ON" state of "AUXILIARY HEATER" lasts till Engine coolant temp. reaches 70℃.
Fig.2) "AUXILIARY HEATER" 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" operating condition, check relay operation using "ACTUATION TEST" function on the Scantool.

LFIG493A

TERMINAL AND CONNECTOR INSPECTION EE5C6C40

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 E3849909

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 5.

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 50A PTR HTR #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 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 SNSR2 FUSE and related circuit and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION EF7657E4

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 4.

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(C244-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".

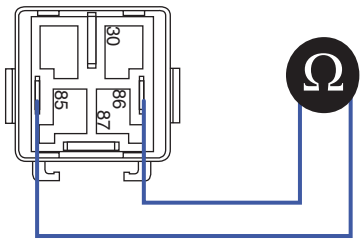
COMPONENT INSPECTION EFFBE24C

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 of PTC heater relay #1 component coil.



KFQG438A

Specification : 52±5 Ω (20℃)

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".

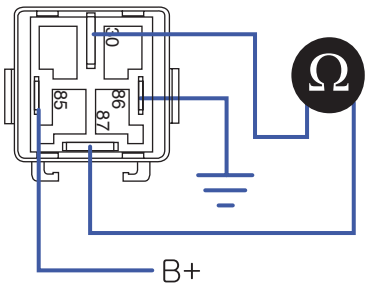
2. Check PTC heater relay #1 component operation

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, 86)

4) Check continuity between PTC heater relay #1 terminal 30 and terminal 87.



KFQG439A

specification : When power is supplied : Continuity (below 1.0Ω)
When power is not supplied : Discontinuity (Infinite Ω)

5) Is the measured resistance 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 E032A36B

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 E642BD67

When a driver turns on IG KEY, IG KEY ON signal is inputted to ECM connector(C244-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 EA1CA742

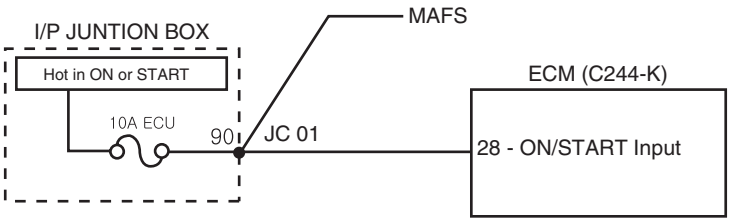
When the condition that IG KEY ON signal turns OFF while ECM, to which IG signal inputted, is initialized (booting, Approx. 25ms is required), IG KEY switch error is recognized and P1652 is set (monitored only once every IG KEY ON initialization process). This code is due to poor connection in IG KEY ON signal circuit.

DTC DETECTING CONDITION E12F403E

<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">• IG KEY "ON"signal circuit
• IG KEY switch</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• No signal through IG line after IG KEY "ON"</td></tr>
<tr><td>Diagnostic Time</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>Check Lamp</td><td>NO</td></tr>
</table>

SCHEMATIC DIAGRAM E4EEBE7A

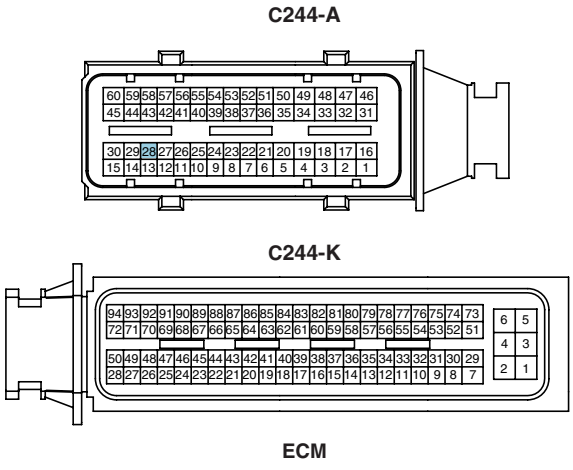
[CIRCUIT DIAGRAM]



[CONNECTOR INFORMATION]

Terminal	Connected to	Function
28	JC 01 (90)	ON/START Input

[HARNESS CONNECTOR]



STGFL7528L

SIGNAL WAVEFORM AND DAT E8C889F7

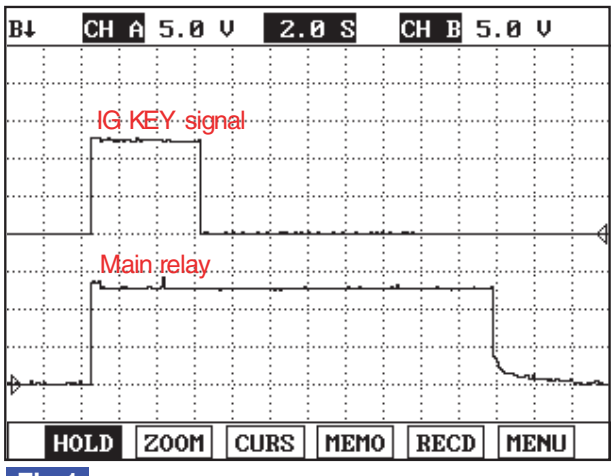


Fig.1

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".

LFIG501A

TERMINAL AND CONNECTOR INSPECTION EAB886D1

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

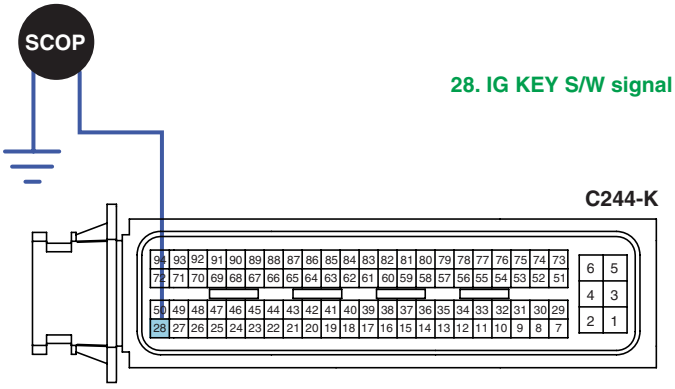
▶ Repair the trouble causing part and go to "Verification of Vehicle Repair".

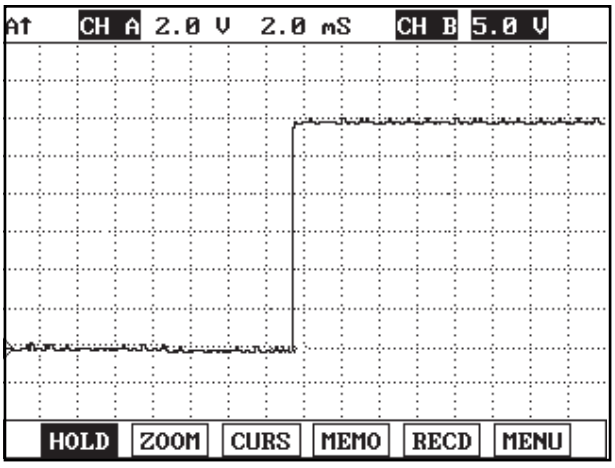
NO

▶ Go to "Signal Circuit Inspection".

SIGNAL CIRCUIT INSPECTION E622514F

1. IG KEY "OFF", ENGINE "OFF"
2. Connect Oscilloscope to ECM connector(C244-K) terminal 28 with ECM connector being connected.
3. Check IG KEY "ON" signal waveform at IG KEY "ON".





STGFL7609L

specification : The signals indicate poor connection should not exist at IG KEY "ON" range.

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 ECU FUSE, JC01 joint connector terminal 90 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 E8AFD11E

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

GENERAL DESCRIPTION E59E39E4

IQA (Injector Quantity Adjustment) 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.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.

DTC DESCRIPTION E7BCED66

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 EC1B54FF

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• EEP ROM monitoring</td><td rowspan="6">• ECM internal error</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• incorrect input of IQA code to ECM.</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• Immediately</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel cut</td><td>NO</td><td rowspan="4">• Engine Check Lamp blinks.</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>Check Lamp</td><td>BLINK</td></tr>
</table>

COMPONENT INSPECTION E918A224

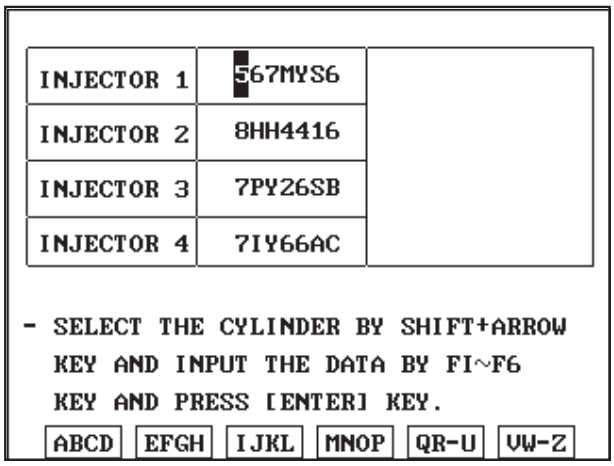
1. Check injector class input state

   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.



LFIG504A

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 E02F40D4

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

GENERAL DESCRIPTION E0471CED

IQA (Injector Quantity Adjustment) 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.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.

DTC DESCRIPTION EA89C6FE

P1671 is set when IQA data is not inputted to ECM during initialization of ECM.

DTC DETECTING CONDITION E8CC34CE

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• EEP ROM monitoring</td><td rowspan="8">• IQA not inputted to ECM</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• IQA code not inputted to ECM</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• Immediately</td></tr>
<tr><td rowspan="4">Fail Safe</td><td>Fuel cut</td><td>NO</td><td rowspan="4">• Engine Check Lamp blinks.</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>Check Lamp</td><td>BLINK</td></tr>
</table>

COMPONENT INSPECTION EEA2B9A6

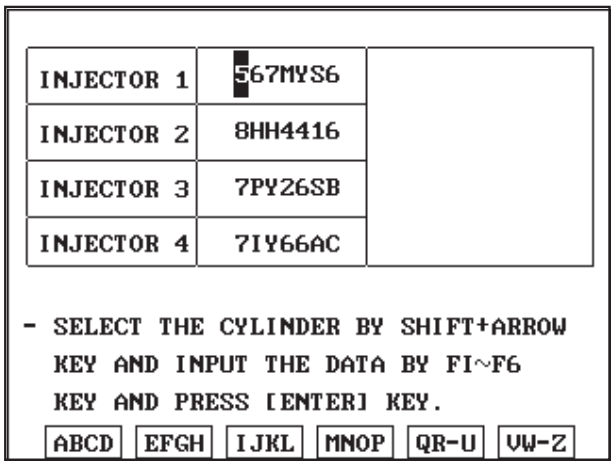
1. Check injector class input state

   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.



LFIG504A

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 EF565CD3

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 P1815 ESP/FTCS AUTO RECOGNITION SIGNAL CIRCUIT MALFUNCTION

GENERAL DESCRIPTION E691CA7F

Because both ESP and Non ESP control map is inputted in one type of ECM and selecting option is possible, one type is applied to both ESP and Non ESP option.
When ECM is installed to vehicle, ESP and Non ESP recognition is performed by ECM automatically as checking whether ground line(ECM connector C244-K terminal 19) is grounded or opened.(ESP and Non ESP recognition is performed every IG KEY ON process.)
If ESP, Non ESP recognition is not fulfilled well or any error occurs during the process, engine power generation is not sufficient.
ESP : ECM connector C244-K terminal 19 is grounded
Non ESP : ECM connector C244-K terminal 19 is opened(no wiring exists)

DTC DESCRIPTION E4FC0C35

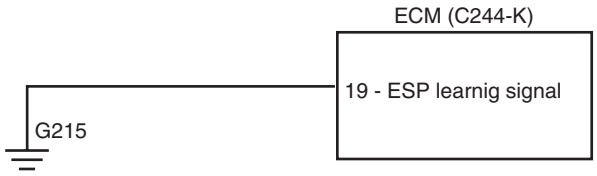
P1815 is set when recognized ESP data based on ECM C244-K terminal 19 state(grounded or opened) is not readable or writable at EEP ROM. This code is due to ECM failure.

DTC DETECTING CONDITION EC2BF26D

<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/T, M/T recognition terminal circuit
• ECM component failure</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• ESP learning error</td></tr>
<tr><td>Diagnostic Time</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>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>Check Lamp</td><td>NO</td></tr>
</table>

SCHEMATIC DIAGRAM E707C6C0

[CIRCUIT DIAGRAM]

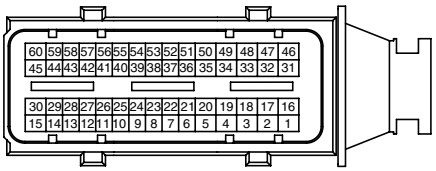


[CONNECTOR INFORMATION]

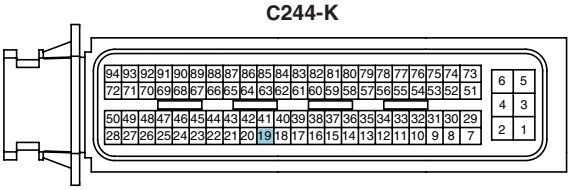
Terminal	Connected to	Function
19	G215 ground point	ESP learning

[HARNESS CONNECTOR]

C244-A



C244-K



ECM

STGFL7614L

TERMINAL AND CONNECTOR INSPECTION E7FABFEB

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 "Ground Circuit Inspection".

GROUND CIRCUIT INSPECTION EBCBC2FF

1. IG KEY "OFF", ENGINE "OFF".
2. Disconnect ECM connector.
3. Check continuity between ECM connector(C244-K) terminal 19 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(C244-K) terminal 19 and ground point G215 and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E0F9BD2F

1. ECM Component Inspection
   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 EA0F05AA

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

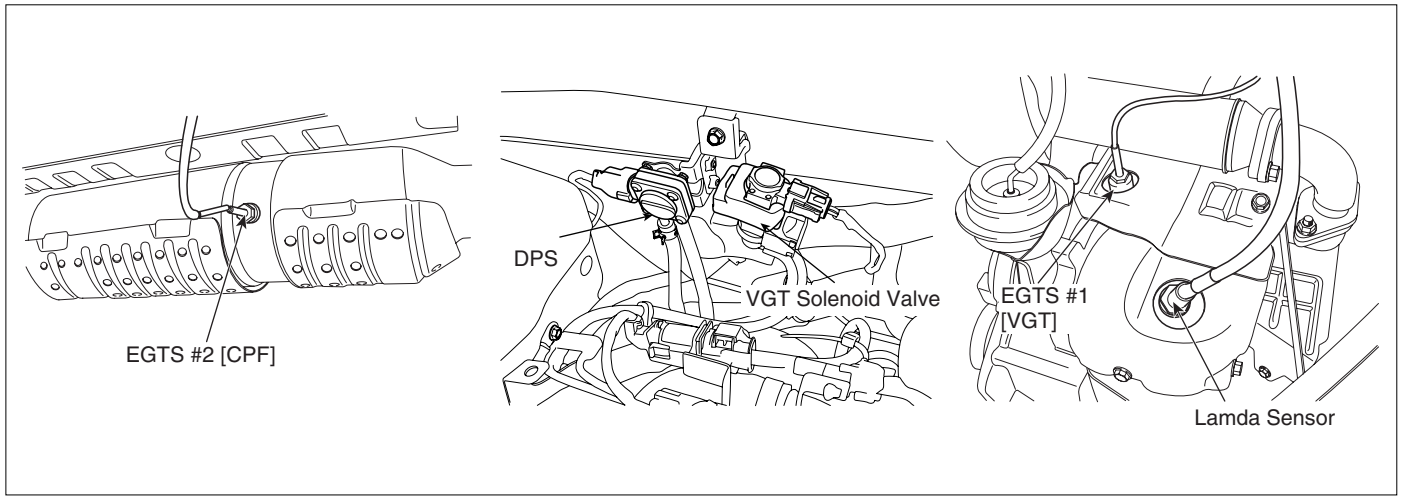
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P2002 PARTICULATE TRAP EFFICIENCY BELOW THRESHOLD

COMPONENT LOCATION EA05E30F



SNFFL6232L

GENERAL DESCRIPTION EC8EC13F

Comparing with gasoline engine, one of the worst point of diesel engine is that a lot of particle material(PM) are generated after combustion process. In order to decrease the amount of PM, CPF is equipped in EURO-4 diesel engine. CPF is the device which gathers PM with installed filter then burns it up as raising the tempt. inside of CPF above the ignition point of PM. The process which burns up PM is called "CPF regeneration".

※CPF regeneration : When vehicle is in steady speed condition and above normal engine loading condition, if differential pressure between before and after CPF is above the specified pressure, ECM considers that stored soot inside of CPF is excessive. In this condition, exhaust gas tempt. is raised by post injection 1 and 2 to warm CPF up to 550℃~650℃. In this high tempt, soot inside of CPF burns up naturally and this mechanism is called as "CPF regeneration".

Most of soot is burned up during regeneration process but a little amount of soot is not burned up and stored inside of CPF continuously. The stored soot decreases the efficiency of CPF slowly. DPS corrects CPF regeneration period and duration as comparing and calculating the differential pressure due to stored soot with the total distance covered.

DTC DESCRIPTION ED6D8521

P2002 is set when 1) Differncial pressure below lower limit value at exhaust flow above specified value(Case 1) or 2) Differential pressure above maximum acceptable value(Case 2) or 3) too slight change of differential pressure compared to exhaust flow(Case 3) is detected.

DTC DETECTING CONDITION ED84EBD1

<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">• Differncial pressure sensor wiring
• Differncial pressure sensor component
• Differncial pressure sensor hose line Misinstalla-tion/Clogging/Freezing/Crack
• Failed CPF
• Too much soot loading inside CPF</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Refer to DTC description</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• Differential pressure below lower limit value at exhaust flow above specified value - 15sec
• Differential pressure above maximum acceptable value - 0sec
• too slight change of differential pressure compared to exhaust flow - 2sec</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>Check Lamp</td><td>BLINK</td></tr>
</table>

MONITOR SCANTOOL DATA EF05FBFD

1. Data analysis about CPF

   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 "DIFFERENTIAL PRESSURE" and "PRESSURE PRE CPF" parameter on the scantool.

specification : "DIFFERENTIAL PRESSURE" and "PRESSURE PRE CPF" data must not be too high or low.

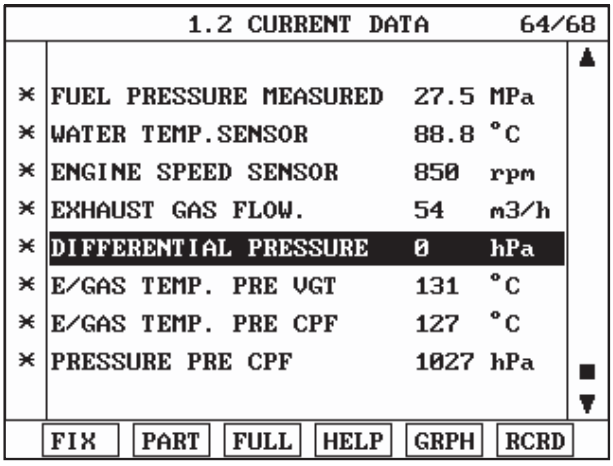


Fig.1

Fig. 1) Check if "DIFFERENTIAL PRESSURE" and "PRESSURE PRE CPF" data is abnormally too high or low.

STGFL7535L

NOTE

The "Scantool Data" shown above is measured at the vehicle with new CPF component. Therfore, data varies depending on CPF used duration and total driven distance.

☞ *When "DIFFERENTIAL PRESSURE" is too high : Check if excessive soot is accumulated inside of CPF before inspecting DPS related problem. If needed, perform "CPF SERVICE REGENERATION" to burn the soot inside of CPF and monitor data change.*

☞ *When "DIFFERENTIAL PRESSURE" is too low : "DIFFERENTIAL PRESSURE" and "PRESSURE PRE CPF" data rises depending on engine load increase and the amount of soot inside of CPF. If differential pressure is not generated or soot is emitted without the rise of "PRESSURE PRE CPF" during excceleration, check CPF component failure.*

☞ *When "DIFFERENTIAL PRESSURE" doesn't change : If the not only Black smoke is not exhausted but the pressure difference also is not measred between at the front and rear of CPF, check disconnection, clog or leakage of DPS pressure hose.*

2. CPF SERVICE REGENERATION procedure.

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

   2) Warm engine up to normal operating temperature.

   3) Turn the all the electrocity (Head lamp -HIGH, Blower motor - Max speed, Defroster)and air conditioner "ON".

   4) Perform the "CPF SERVICE REGENERATION" procedure with scantool.

■ specification : CPF regeneration should be O.K when performing CPF service mode.

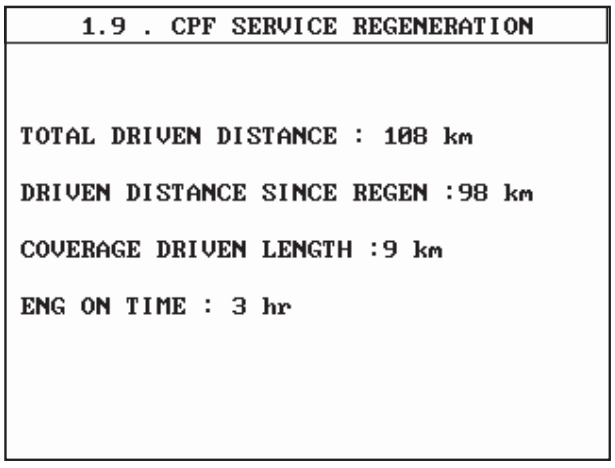


Fig.2

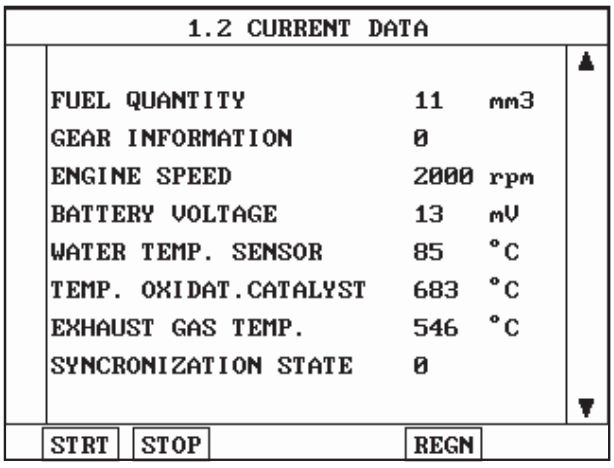


Fig.3

Fig 2) Check "COVERAGE DRIVEN LENGTH" will be change to "0"km by checking the initial display after performing the CPF Service mode.
Fig 3) Check the temperature both EGTS(CPF) and EGTS(VGT) are within 500¡ ~700¡ after performing CPF service mode with scantool displaying in the middle of procedure.

SNFFL6536L

TERMINAL AND CONNECTOR INSPECTION E4C44F78

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 EB6EAB2D

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect DPS connector.
3. IG KEY "ON"
4. Measure the voltage of DPS 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 power circuit and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION E6D6A3A3

1. Check signal circuit voltage
   1) IG KEY "OFF", ENGINE "OFF"
   2) Disconnect DPS connector.
   3) IG KEY "ON"
   4) Measure the voltage of DPS 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".

2. Check open in signal circuit

   1) IG KEY "OFF", ENGINE "OFF"

   2) Disconnect DPS connector and ECM connector.

   3) Check continuity between DPS connector terminal 2 and ECM connector(C244-K) terminal 36.

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification?

YES

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

NO

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

3. Check short in signal circuit

   1) IG KEY "OFF", ENGINE "OFF"

   2) Disconnect DPS connector and ECM connector.

   3) IG KEY "ON"

   4) Check continutity between DPS connector terminal 2 and chassis ground. (Test for short to ground)

   5) Check voltage between DPS connector terminal 2 and chassis ground. (Test for short to battery)

Specification : Test for short to ground : Discontinuity (Infinite Ω)
Test for short to battery : below 0.1 V

   6) Is the isolation of DPS signal circuit normal?

YES

▶ Go to "Ground Circuit Inspection".

NO

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

GROUND CIRCUIT INSPECTION ECD51B44

1. IG KEY "OFF", ENGINE "OFF"

2. Disconnect EGTS connector.

3. IG KEY "ON"

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

5. Measure the voltage between DPS connector terminal 2 and 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 E4267965

1. DPS visual inspection

   1) IG KEY "OFF", ENGINE "OFF"

   2) Disconnect DPS connector.

   3) Check DPS terminals for corrosion and contamination.

   4) Check (1)connecting condition of DPS and pressure sensing hose, (2)exhaust gas pressure leakate, (3)miss connection of pressure sensing hose (reverse connection) is detected.

   5) Is DPS related problem detected?

   YES

   ▶ If needed, replace DPS or pressure sensing hose and go to "Verification of Vehicle Repair".

   NO

   ▶ Go to "2. Monitor DPS signal waveform" as follows.

2. Monitor DPS signal waveform

   1) IG KEY "ON", ENGINE "OFF"

   2) Connect DPS connector.

   3) Connect oscilloscope to DPS connector terminal 2.

   4) After warming engine up, monitor the waveform at idle and during acceleration.

Specification : Refer to "Signal Waveform & Data" of "General Information".

   5) Is DPS signal waveform is similar to the waveform of "Signal Waveform & Data"?

YES

▶ Go to "3. CPF component visual inspection".

NO

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

3. CPF component visual inspection

   1) IG KEY "OFF", ENGINE "OFF"

   2) Visually inspect any evidence of exhaust gas leakage on the connection of the exhaust pipe.

   3) After removing CPF assembly, check any Inside of CPF is contaminated or Catalyst converter is damaged, disengaged or melted.

Specification : Catalyst Converter and PM filter in the CPF should be normal.

   4) Is CPF related problem detected?

YES

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

NO

▶ Go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E86783F3

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

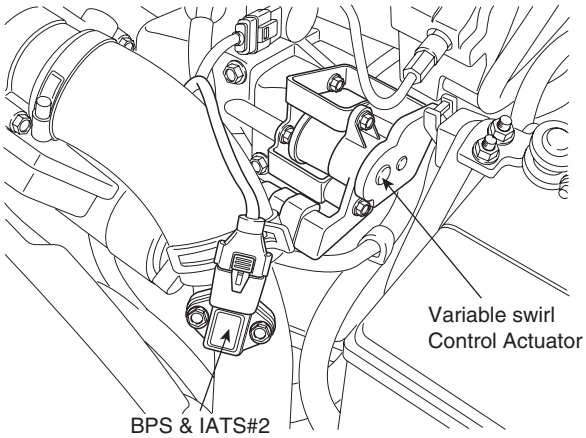
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P2009 INTAKE MANIFOLD RUNNER CONTROL CIRCUIT LOW(BANK 1)

COMPONENT LOCATION EFE7A7B3



SNFFL6210L

GENERAL DESCRIPTION E872448D

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.

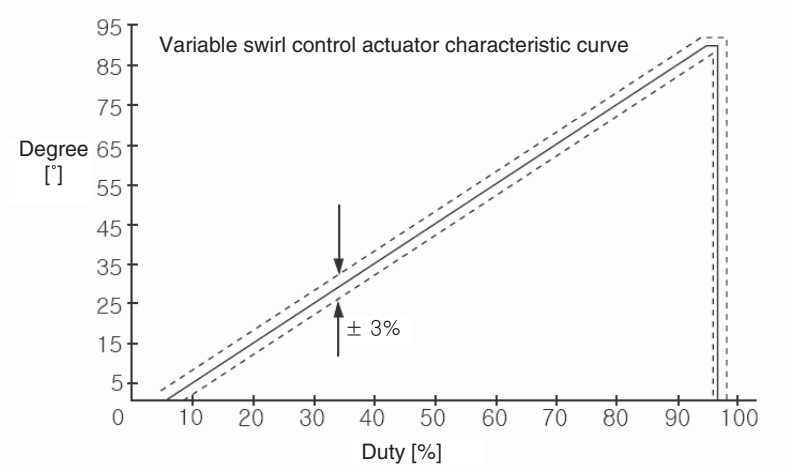
DTC DESCRIPTION E52AFD3E

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 E37B62CE

<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">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Short to battery in motor output terminal
• Tiny short to ground in motor circuit</td></tr>
<tr><td>Diagnostic Time</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>Check Lamp</td><td>NO</td></tr>
</table>

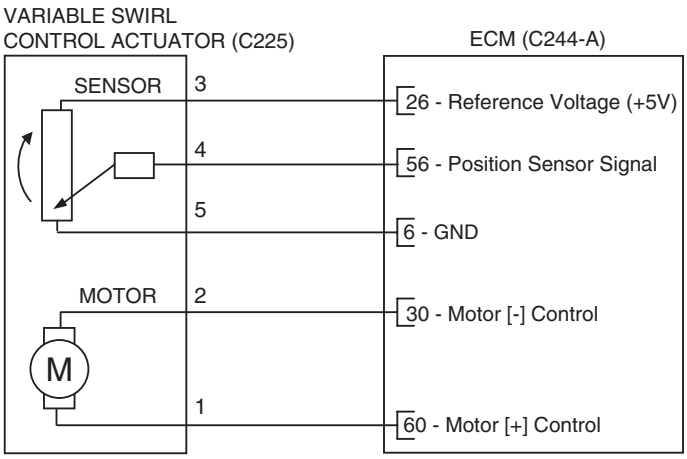
SPECIFICATION E045EB87



LFIG510A

SCHEMATIC DIAGRAM E203F9F1

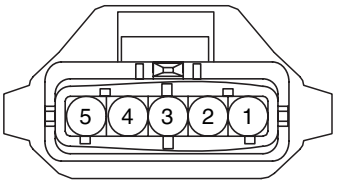
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-A (60)	Motor [+] Control
2	ECM C244-A (30)	Motor [-] Control
3	ECM C244-A (26)	Reference Voltage (+5V)
4	ECM C244-A (56)	Position Signal
5	ECM C244-A (6)	Sensor Ground

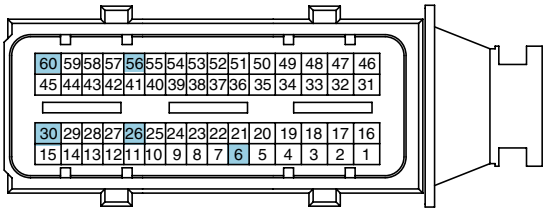
[HARNESS CONNECTORS]



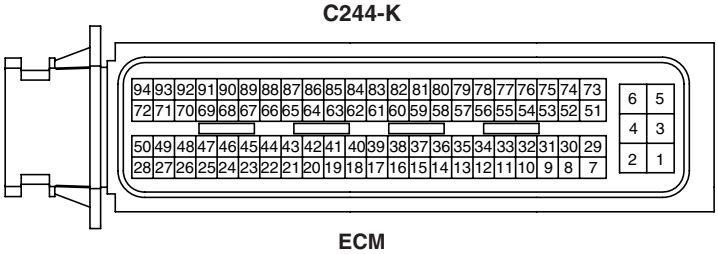
C225

VARIABLE SWIRL CONTROL ACTUATOR

C244-A



C244-K



ECM

STGFL7159L

SIGNAL WAVEFORM AND DATA E7262BC4

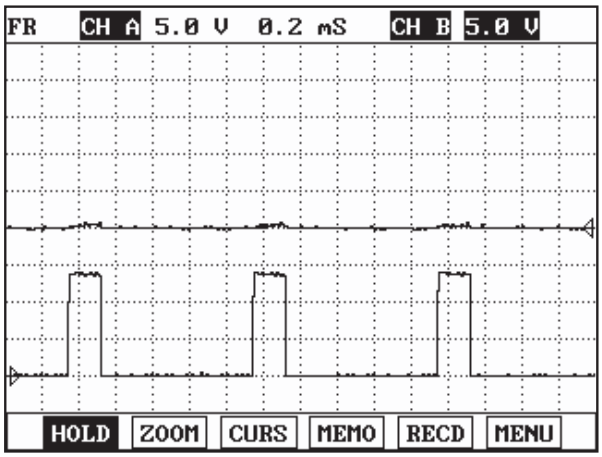


Fig.1

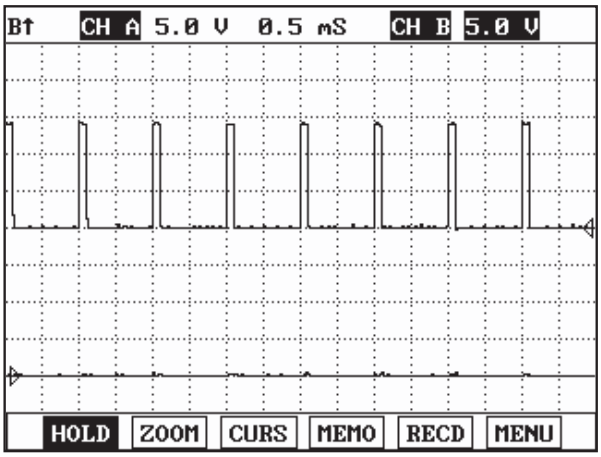


Fig.2

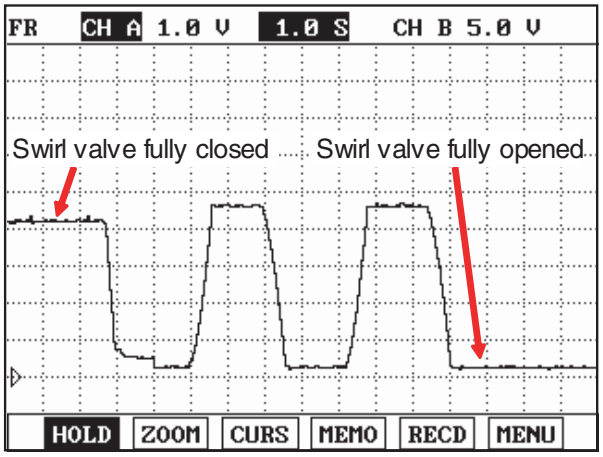


Fig.3

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".(at terminal 4)

SNFFL6544L

TERMINAL AND CONNECTOR INSPECTION E41E065B

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 EC7554F9

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, 2 and chassis ground.

Specification : Discontinuity(Infinite Ω)

   4) 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(C244-A) terminal 60.

   4) Check continuity between variable swirl control actuator connector terminal 2 and ECM connecor(C244-A) 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".

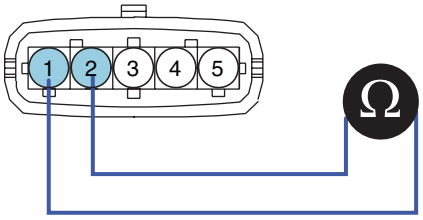
COMPONENT INSPECTION E9387396

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 2.



SNFFL6473D

Specification : 15.0 ± 3 Ω (20℃)

4) Is the measured resistance within the specification?

YES

▶ Go to "2. Check motor operation".

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 2 with two channel oscilloscope.

4) Accelerating engine to above 3000RPM, let variable swirl control actuator be opened(operates).

Specification : Refer to Signal Waveform & Data "Fig.1)", " Fig.2)".

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 EAF94093

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 EEDFACA0

Refer to DTC P2009.

GENERAL DESCRIPTION E06EF539

Refer to DTC P2009.

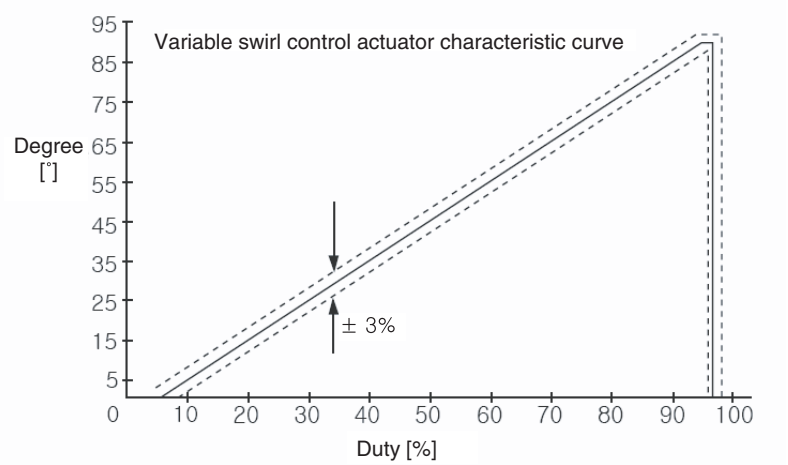
DTC DESCRIPTION EF654F44

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 E44CD13C

<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">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Short to battery in motor output terminal
• Tiny short to ground in motor circuit</td></tr>
<tr><td>Diagnostic Time</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>Check Lamp</td><td>NO</td></tr>
</table>

SPECIFICATION E9C79534



LFIG510A

SCHEMATIC DIAGRAM E1961792

Refer to DTC P2009.

SIGNAL WAVEFORM AND DATA E1EC83F6

Refer to DTC P2009.

TERMINAL AND CONNECTOR INSPECTION EAADC0F4

Refer to DTC P2009.

CONTROL CIRCUIT INSPECTION E15F7283

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 and 2.

Specification : 0.0V~0.1V

   5) Is the measured voltage within the specification?

YES

▶ Check "2. Check open in motor circuitt" .

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(C244-A) terminal 60.
   4) Check continuity between variable swirl control actuator connector terminal 2 and ECM connecor(C244-A) terminal 30.

Specification : Discontinuity(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".

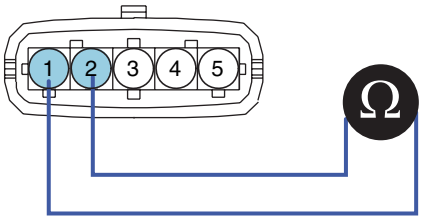
COMPONENT INSPECTION E2271805

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 2.



SNFFL6473D

Specification : 15.0 ± 3 Ω (20℃)

   4) Is the measured resistance within the specification?

YES

▶ Go to "2. Check motor operation".

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 2 with two channel oscilloscope.

   4) Accelerating engine to above 3000RPM, let variable swirl control actuator be opened(operates).

Specification : Refer to Signal Waveform & Data "Fig.1)", " Fig.2)".

   5) Does variable swirl control actuator operate correctly?

YES

▶ Go to "Verification of Vehicle Repair".

NO

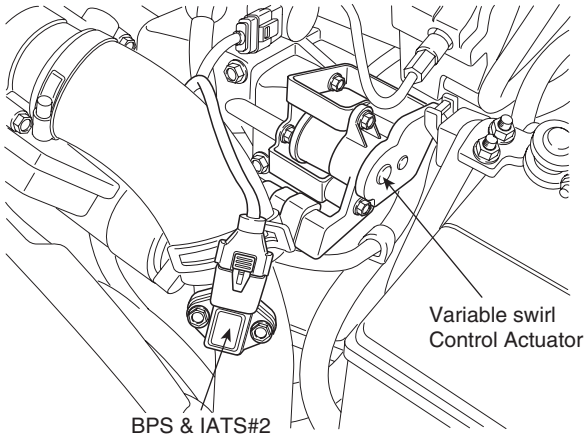
▶ Replace variable swirl control actuator assy' and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E11F06B8

Refer to DTC P2009.

DTC P2015 INTAKE MANIFOLD RUNNER POSITION SENSOR/SWITCH CIRCUIT RANGE/PERFORMANCE(BANK 1)

COMPONENT LOCATION EA2B3D8F



SNFFL6210L

GENERAL DESCRIPTION E986FEF3

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.

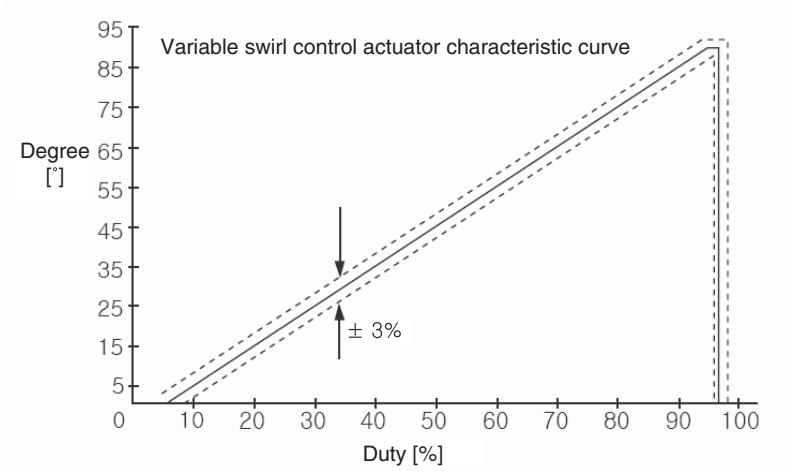
DTC DESCRIPTION E1BFA188

P2015 is set if variable swirl valve position fails to reach target position within 1 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 E5E34C80

<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 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>Threshold Value</td><td colspan="3">• VSCA value difference between target and actual is higher than 5% - 1000ms
• VSCA value difference between target and actual is lower than -7% - 1000ms
• VSCA Moter is stuck (normal condition) - 1000ms
• VSCA is stuck (offset learning) - 3000ms</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>Check Lamp</td><td>YES</td></tr>
</table>

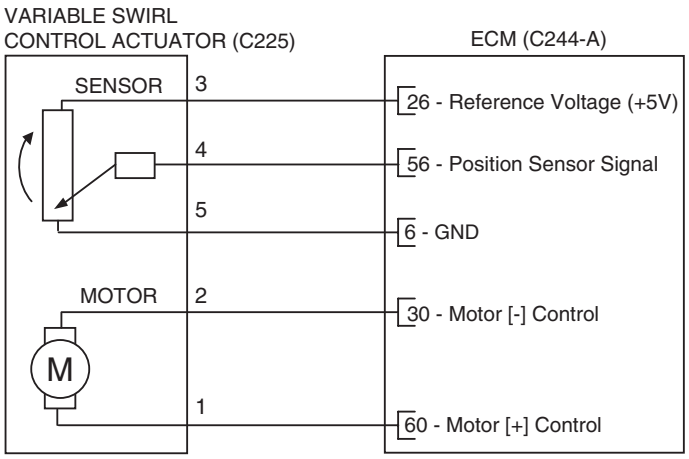
SPECIFICATION E5DFC840



LFIG510A

SCHEMATIC DIAGRAM EAF5B795

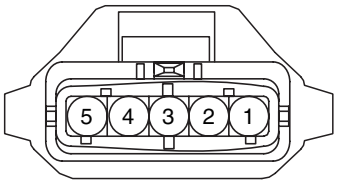
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-A (60)	Motor [+] Control
2	ECM C244-A (30)	Motor [-] Control
3	ECM C244-A (26)	Reference Voltage (+5V)
4	ECM C244-A (56)	Position Signal
5	ECM C244-A (6)	Sensor Ground

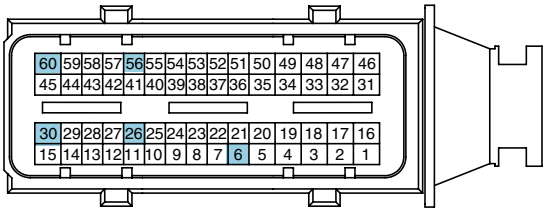
[HARNESS CONNECTORS]



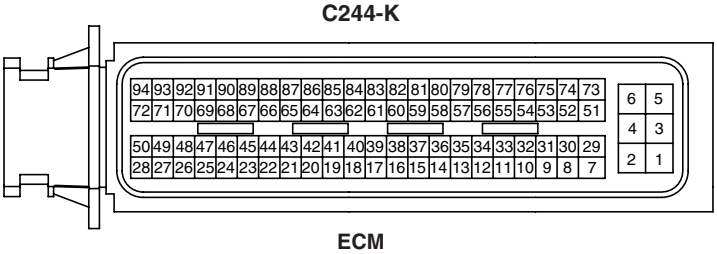
C225

VARIABLE SWIRL CONTROL ACTUATOR

C244-A



C244-K



ECM

STGFL7159L

SIGNAL WAVEFORM AND DATA EB73D03E

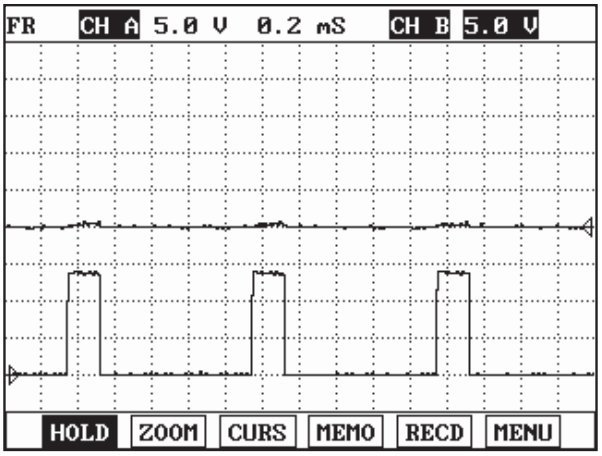


Fig.1

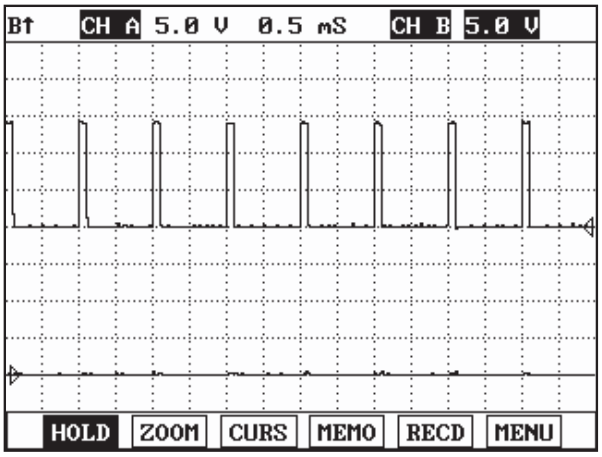


Fig.2

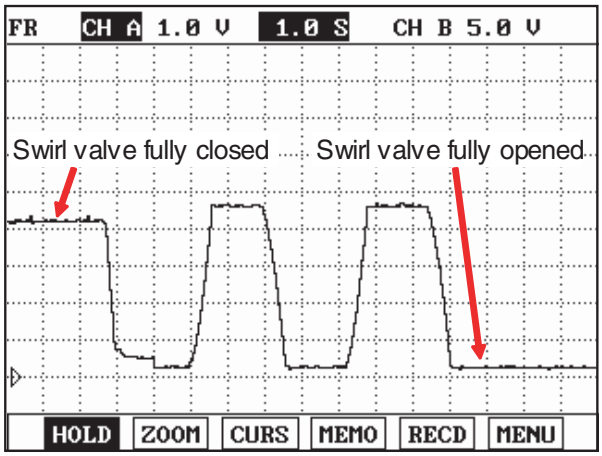


Fig.3

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".(at terminal 4)

SNFFL6544L

COMPONENT INSPECTION E52F7BF8

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 : variable swirl control actuator link device should move smoothly.

   5) Does variable swirl control actuator move slowly?

YES

▶ Go to "2. Check motor coil resistance".

NO

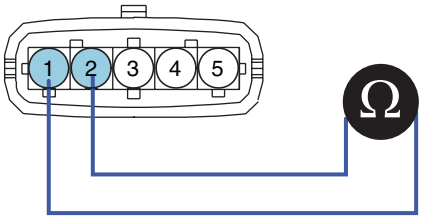
▶ Replace stuck or too tight parts of component(intake manifold assy' or swirl actuator) and go to "Verification of Vehicle Repair".

2. Check motor coil resistance

1) IG KEY "OFF", ENGINE "OFF"

2) Disconnect variable swirl control actuator.

3) Measure the resistance between variable swirl control actuator component terminal 1 and 2.



SNFFL6473D

Specification : 15.0 ± 3 Ω (20℃)

4) Is the measured resistance within the specification?

YES

▶ Go to "3. Check variable swirl control actuator position sensor resistance".

NO

▶ Replace variable swirl control actuator and go to "Verification of Vehicle Repair".

3. Check variable swirl control actuator position sensor resistance

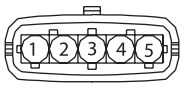
1) IG KEY "OFF", ENGINE "OFF"

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	 KFQG474A
	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 2 with two channel oscilloscope.

4) Accelerating engine to above 3000RPM, let variable swirl control actuator be opened(operates).

Specification : Refer to Signal Waveform & Data "Fig.1)", " Fig.2)".

5) Does variable swirl control actuator operate correctly?

YES

▶ Go to "5. Check variable swirl control actuator position sensor operation".

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 : Refer to Signal Waveform & Data "Fig.3)"

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 E0179541

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 P2016 INTAKE MANIFOLD RUNNER POSITION SENSOR/SWITCH CIRCUIT LOW(BANK 1)

COMPONENT LOCATION E9AACE7C

Refer to DTC P2015.

GENERAL DESCRIPTION E7CE2C79

Refer to DTC P2015.

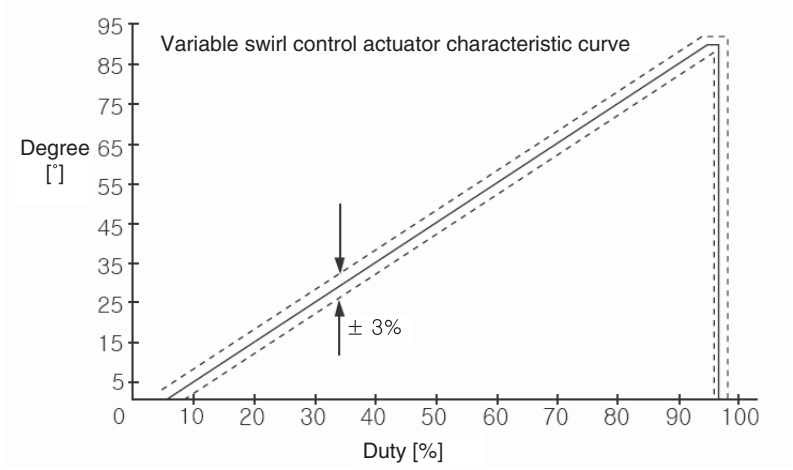
DTC DESCRIPTION E14A7F8B

P2016 is set when variable swirl valve position sensor output voltage below 0.18V 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 E65F18F8

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Variable swirl valve position sensor circuit • Variable swirl valve position sensor component
Enable Conditions	• IG KEY "ON"			
Threshold Value	• Output voltage below minimum value(below 180mV)			
Diagnostic Time	• 2500ms			
Fail Safe	Fuel cut	NO		
	EGR Off	NO		
	Fuel Limit	NO		
	Check Lamp	NO		

SPECIFICATION E639AC6F



LFIG510A

SCHEMATIC DIAGRAM E9FEFF6B

Refer to DTC P2015.

SIGNAL WAVEFORM AND DATA E74D69BE

Refer to DTC P2015.

TERMINAL AND CONNECTOR INSPECTION EE274E69

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 EA348F51

1. Check power 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 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 EFC18B64

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 E2DFC158

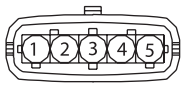
1. Check variable swirl control actuator position sensor resistance

   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	 KFQG474A
	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

▶ "2. Check variable swirl control actuator position sensor operation".

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 : Refer to Signal Waveform & Data "Fig.3)"

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 E883AB14

Refer to DTC P2015.

DTC P2017 INTAKE MANIFOLD RUNNER POSITION SENSOR/SWITCH CIRCUIT HIGH(BANK 1)

COMPONENT LOCATION EA2FD03A

Refer to DTC P2015.

GENERAL DESCRIPTION E7F85AB5

Refer to DTC P2015.

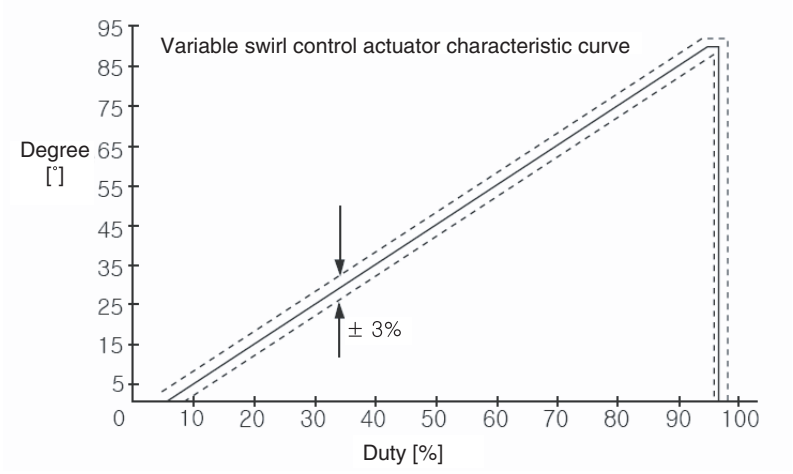
DTC DESCRIPTION EA66DCC8

P2017 is set when variable swirl valve position sensor output voltage above 4.9V 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 EA06271E

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Variable swirl valve position sensor circuit • Variable swirl valve position sensor component
Enable Conditions	• IG KEY "ON"			
Threshold Value	• Output voltage above minimum value(above 4900mV)			
Diagnostic Time	• 2500ms			
Fail Safe	Fuel cut	NO		
	EGR Off	NO		
	Fuel Limit	NO		
	Check Lamp	NO		

SPECIFICATION E146C4CD



LFIG510A

SCHEMATIC DIAGRAM E1AB3993

Refer to DTC P2015.

SIGNAL WAVEFORM AND DATA E13B161F

Refer to DTC P2015.

TERMINAL AND CONNECTOR INSPECTION E838F660

Refer to DTC P2015.

POWER CIRCUIT INSPECTION E0AD542B

1. Check power 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 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 ED08E1E3

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 "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 variable swirl control actuator connector and ECM connector.

   3) Check continuity between variable swirl control actuator connector terminal 4 and ECM connector(C244-A) terminal 56.

specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specificaiton?

YES

▶ Go to "Ground Circuit Inspection".

NO

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

GROUND CIRCUIT INSPECTION E6B6E0CD

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 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 E4687A25

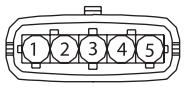
1. Check variable swirl control actuator position sensor resistance

   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	 KFQG474A
	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

▶ "2. Check variable swirl control actuator position sensor operation".

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 : Refer to Signal Waveform & Data "Fig.3)"

5) Does variable swirl control actuator and position sensor operations are OK?

YES

▶ Go to "Verification of Vehicle Repair".

NO

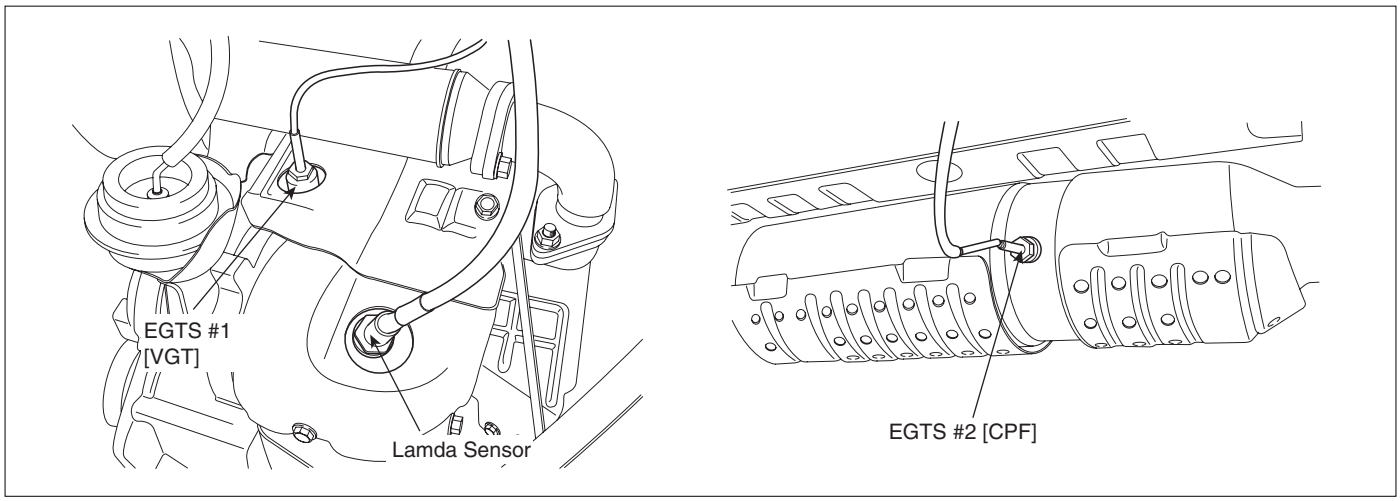
▶ Replace variable swirl control actuator assy' and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E291FD79

Refer to DTC P2015.

DTC P2030 EXHAUST TEMPERTURE VALUE NOT PLAUSIBLE WITH SENSOR 1 AND 2

COMPONENT LOCATION EF90217C



SNFFL6518L

GENERAL DESCRIPTION E8420835

In EURO4 diesel engine with CPF, injection is devided into 2 pilot, 1 main, 2 post injections. Among these injections, pilot and main injections are for the operation of engine, however post injections are for CPF regeneration. Only in activating condition of CPF regeneration during driving, post injection starts. 1st post injection happens at the end of combustion cycle then, injected fuel is used to raise exhaust temperature. that temp. is sensed at T3 exhaust tempt. sensor which is ahead of Turbo charger. 2nd post injection happens at exhaust cycle then, injected fuel is also used to raise exhaust temperature. that temp. is sensed T5 exhaust tempt. sensor which is between Oxydation catalyst and CPF. The reason of raising exhaust tempt. is because exhaust tempt. in diesel engine is too low for CPF regeneration. The optimum tempt. for CPF regeneration is 550~600℃ thus, the goal of post injection is raise exhaust tempt. to that range of tempt.. However if exhaust tempt. is too high, turbo charger or CPF are likely to be damaged. Therefore if tempt. measured at each sensor is out of permittable value(specification), ECM deactivates CPF regeneration.

DTC DESCRIPTION EA0772AE

P2030 is set when the temperature difference between front Exhaust temp. sensor(T3) and rear Exhaust temp. sensor(T5) is above 40℃ at cold idle.
This code is set to prevent CPF from damaging due to inaccurate sensing of exhaust gas temp.

DTC DETECTING CONDITION EAE3BBE7

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Exhaust Gas temp. sensor circuit • Exhaust Gas temp. sensor component
Enable Conditions	• IG KEY "ON"			
Threshold Value	• | front Exhaust temp.- rear Exhaust temp. | is above 40℃ at cold idle.			
Diagnostic Time	• 1 sec.			
Fail Safe	Fuel cut	NO		
	EGR Off	NO		
	Fuel Limit	NO		
	Check Lamp	NO		

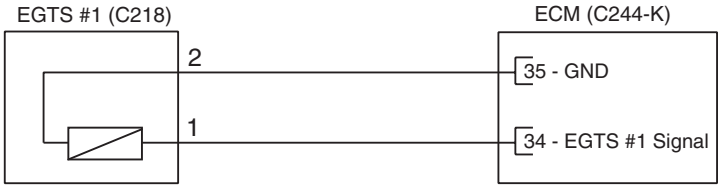
SPECIFICATION EA287AD8

RESISTANCE/TEMPERATURE CHARACTERISTICS

Temp. (℃)	Nominal (kΩ)	NEW		AGED	
		Min(kΩ)	Max(kΩ)	Min(kΩ)	Max(kΩ)
100	371	289	481	272	515
300	5.92	5.3	6.61	5.15	6.79
600	0.363	0.347	0.379	0.341	0.386
900	0.0893	0.0842	0.0949	0.0833	0.096

SCHEMATIC DIAGRAM E8F1111D

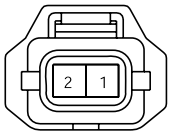
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-K (34)	EGTS #1 Signal
2	ECM C244-K (35)	Sensor ground

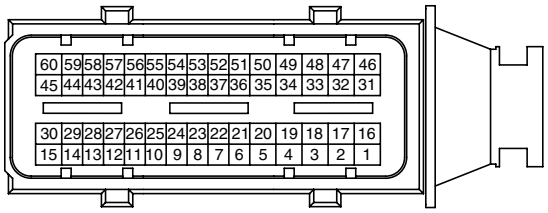
[HARNESS CONNECTORS]



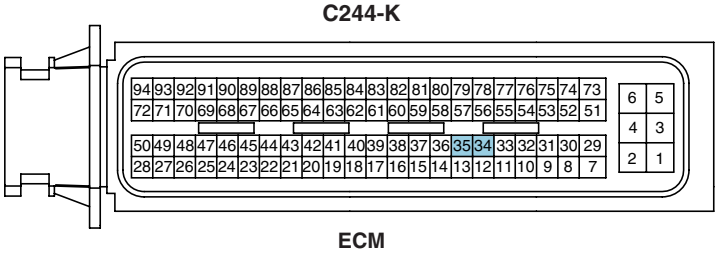
C218

EGTS #1

C244-A



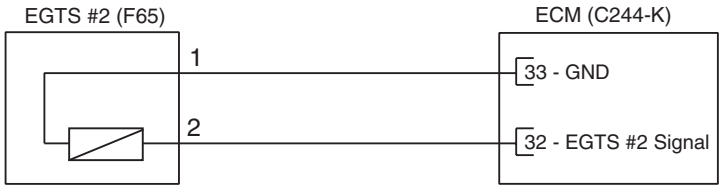
C244-K



ECM

STGFL7164L

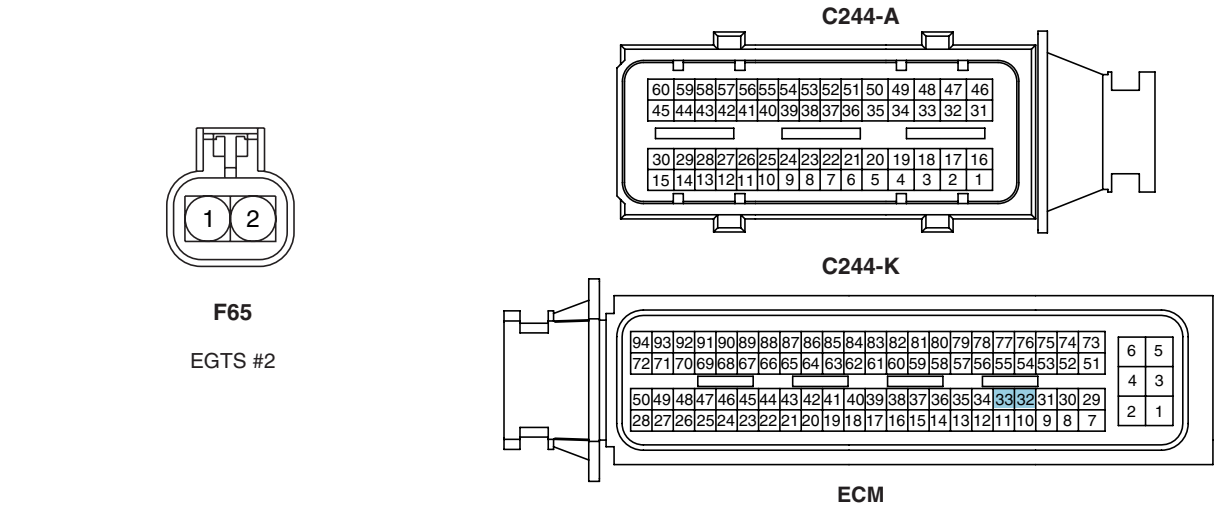
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-K (33)	Sensor ground
2	ECM C244-K (32)	EGTS #2 Signal

[HARNESS CONNECTORS]



STGFL7166L

SIGNAL WAVEFORM AND DATA E8B89A7A

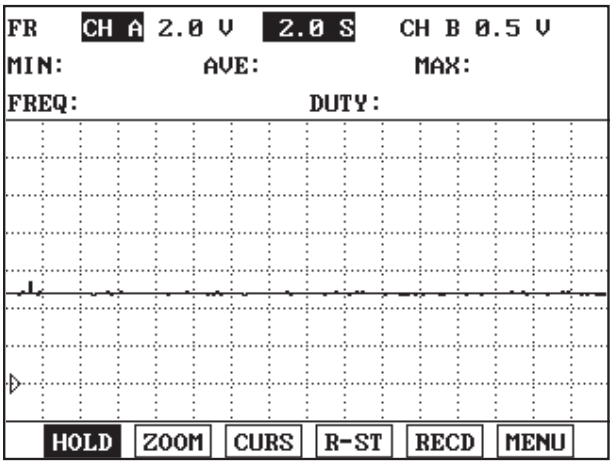


Fig.1

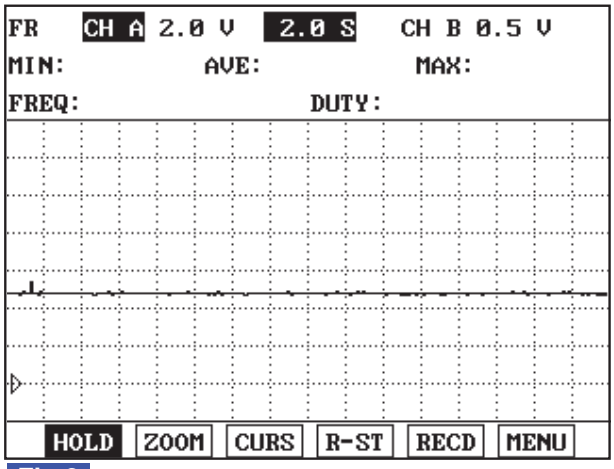


Fig.2

Fig.1) 4.8V is outputted at EGTS(T3-VGT) output signal circuit at IG KEY ON.
Fig.1) 4.8V is outputted at EGTS(T5-CPF) output signal circuit at IG KEY ON.

LFIG448A

※ At IG KEY ON state and as soon as turning engine ON, the difference of output voltage between EGTS(T3-VGT) and EGTS(T5-CPF) must be small to be neglectable.

MONITOR SCANTOOL DATA E829767A

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

2. Monitoring should be performed at cold idle.

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

4. IG KEY "ON"

5. Monitor "E/GAS TEMP. PRE VGT","E/GAS TEMP. PRE CPF" parameter on the Scantool.

Specification : The difference between "E/GAS TEMP. PRE VGT" and "E/GAS TEMP. PRE CPF" is below 40℃

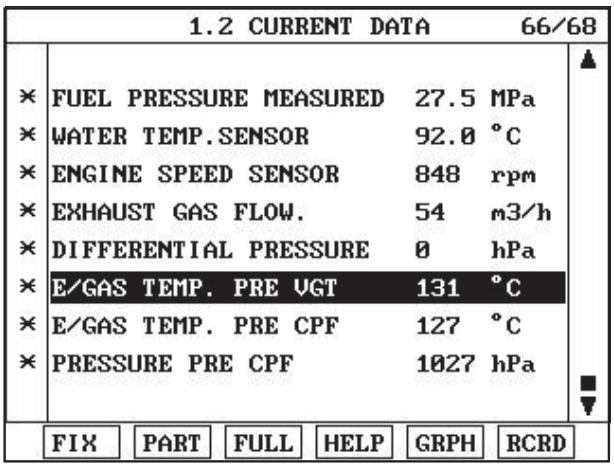


Fig.1

STGFL7610L

※ At IG KEY ON state and as soon as turning engine ON, the difference of output voltage between "E/GAS TEMP. PRE VGT" and "E/GAS TEMP. PRE CPF" must be small to be neglectable.

TERMINAL AND CONNECTOR INSPECTION EDC3564A

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 EF0EB579

1. EGTS(T3-VGT) circuit inspection
   Refer to "Signal Circuit Inspection" of "P0545" DTC guide.

2. EGTS(T5-CPF) circuit inspection
   Refer to "Signal Circuit Inspection" of "P2032" DTC guide.

GROUND CIRCUIT INSPECTION E6839A39

1. EGTS(T3-VGT) circuit inspection
   Refer to "Ground Circuit Inspection" of "P0545" DTC guide.

2. EGTS(T5-CPF) circuit inspection
   Refer to "Ground Circuit Inspection" of "P2032" DTC guide.

COMPONENT INSPECTION EC1D9EF8

1. EGTS(T3-VGT) circuit inspection
   Refer to "Component Inspection" of "P0545" DTC guide.

2. EGTS(T5-CPF) circuit inspection
   Refer to "Component Inspection" of "P2032" DTC guide.

VERIFICATION OF VEHICLE REPAIR EBED4372

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

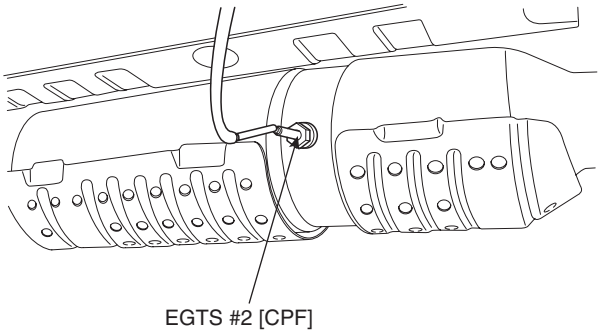
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P2032 EXHAUST GAS TEMPERATURE SENSOR CIRCUIT LOW (BANK 1 / SENSOR 2)

COMPONENT LOCATION E7EE0FA5



KFQG122A

GENERAL DESCRIPTION E4A3D25A

Refer to DTC P2030.

DTC DESCRIPTION EE80D999

P2032 is set when rear exhaust temp. sensor signal is below 0.2V - the lower limiting value - for more than 0.6 sec..

DTC DETECTING CONDITION EE3D2842

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Exhaust temp. sensor(T5-CPF) wiring • Exhaust temp. sensor(T5-CPF) component
Enable Conditions	• IG KEY "ON"			
Threshold Value	• Rear exhaust temp. sensor signal voltage below 0.2V			
Diagnostic Time	• 0.6 sec.			
Fail Safe	Fuel cut	NO	• Exhaust temp. is considered as 300℃ • Engine check lamp blinks.	
	EGR Off	NO		
	Fuel Limit	NO		
	Check Lamp	BLINK		

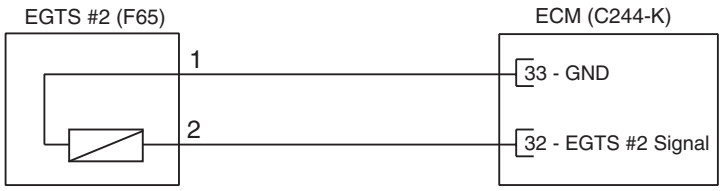
SPECIFICATION ED76ABD2

RESISTANCE/TEMPERATURE CHARACTERISTICS

Temp. (℃)	Nominal (kΩ)	NEW		AGED	
		Min(kΩ)	Max(kΩ)	Min(kΩ)	Max(kΩ)
100	371	289	481	272	515
300	5.92	5.3	6.61	5.15	6.79
600	0.363	0.347	0.379	0.341	0.386
900	0.0893	0.0842	0.0949	0.0833	0.096

SCHEMATIC DIAGRAM EC67C562

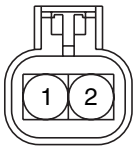
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-K (33)	Sensor ground
2	ECM C244-K (32)	EGTS #2 Signal

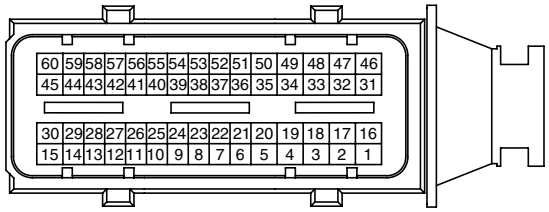
[HARNESS CONNECTORS]



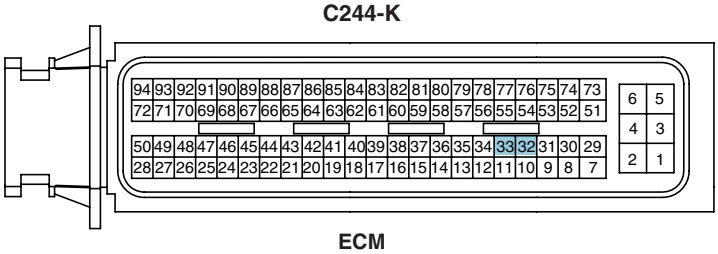
F65

EGTS #2

C244-A



C244-K



ECM

STGFL7166L

SIGNAL WAVEFORM AND DATA E9434F8C

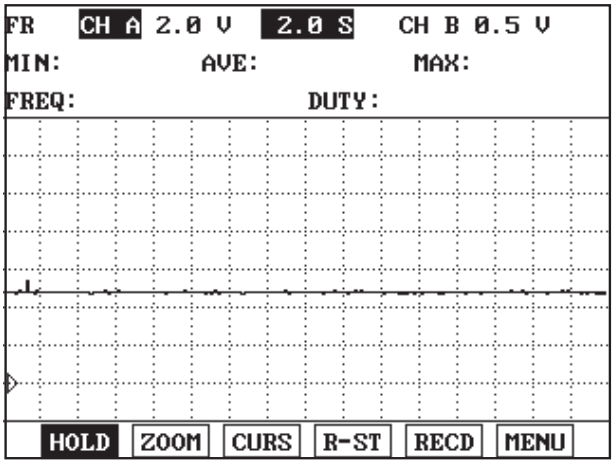


Fig.1

Fig. 1) Signal waveform when exhaust gas temperature(T5-CPF) shows the higher temperature increases, lower the voltage decreases.
If the exhaust gas temperature increases up to approx. 600℃, output voltage will decreases in 0.3~0.4V

SNFFL6543L

MONITOR SCANTOOL DATA E7F62C29

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 "E/GAS TEMP. PRE VGT","E/GAS TEMP. PRE CPF" parameter on the Scantool.

Specification : Current "E/GAS TEMP." is displayed.

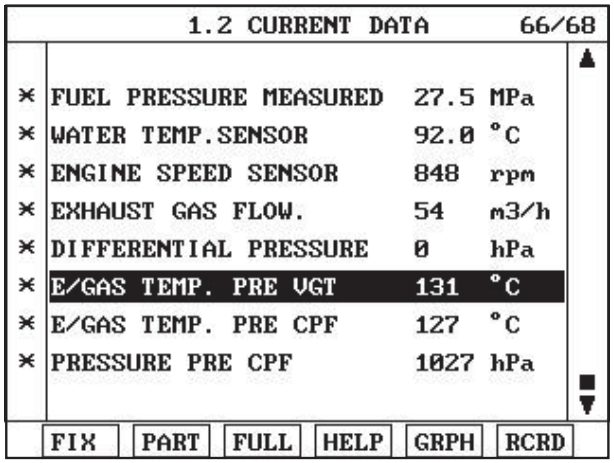


Fig.1

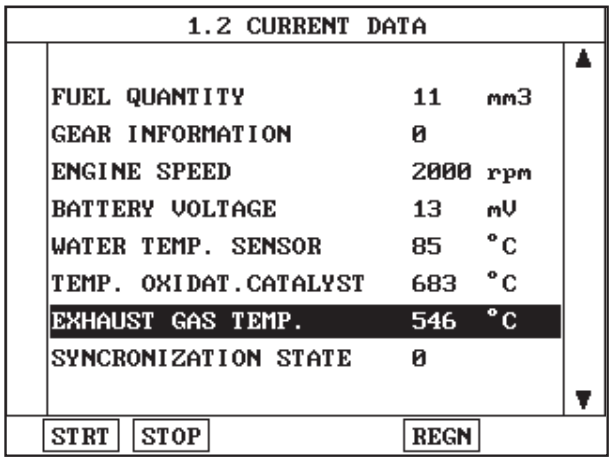


Fig.2

Fig.1) "EXHAUST GAS TEMP." at idle is shown. Monitor if abnormall difference between "Fig. 1) data" and the data from the vehicle to test.
Fig.2) The display during performing CPF regeneration after selecting "CPF SERVICE REGENERATION" mode is shown. Monitor if "EXHAUST GAS TEMP." varies correctly.

STGFL7539L

TERMINAL AND CONNECTOR INSPECTION E947779F

Refer to DTC P2030.

SIGNAL CIRCUIT INSPECTION EB6C1638

1. Check signal circuit voltage
   1) IG KEY "OFF", ENGINE "OFF"
   2) Disconnect EGTS(T5-CPF) connector.
   3) IG KEY "ON"
   4) Measure the voltage of EGTS(T5-CPF) 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 EGTS(T5-CPF) connector and ECM connector.
   3) Check continuity between EGTS(T5-CPF) connector terminal 2 and ECM connector(C244-K) terminal 32.

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification?

YES

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

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 EGTS(T5-CPF) connector and ECM connector.
   3) Check continuity between EGTS(T5-CPF) connector terminal 2 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 E018161C

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect EGTS(T5-CPF) connector.
3. IG KEY "ON"
4. Measure the voltage of EGTS(T5-CPF) connector terminal 2. [TEST "A"]
5. Measure the voltage between EGTS(T5-CPF) connector terminal 2 and 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".

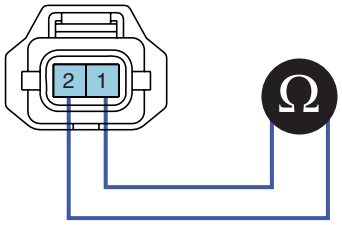
NO

▶ 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 E158FF49

1. IG KEY "OFF", ENGINE "OFF".
2. Disconnect EGTS(T5-CPF) connector.
3. Measure resistance between EGTS(T5-CPF) terminal 1 and 2, referring to resistance characteristic table of specification of General information.

Specification : Refer to Specification of General Information



SNFFL6169D

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

YES

▶ Go to "Verification of Vehicle Repair".

NO

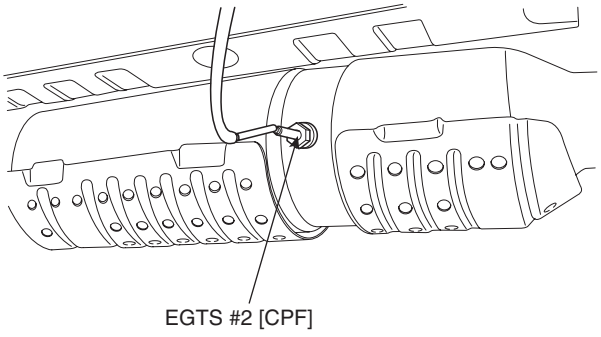
▶ Replace EGTS(T5-CPF) and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E39E56A1

Refer to DTC P2030.

DTC P2033 EXHAUST GAS TEMPERATURE SENSOR CIRCUIT HIGH (BANK 1 / SENSOR 2)

COMPONENT LOCATION EF4D38BC



KFQG122A

GENERAL DESCRIPTION E15B09F6

Refer to DTC P2030.

DTC DESCRIPTION E71ADA63

P2033 is set when the Exhaust gas temperature sensor(EGTS) - CPF signal is detected over maximum set temperature(890℃),- In case that exhaust gas temperature on the rear side of CPF is abnormally increased -, for more than 1sec. Therefore, check component or vehicle is driven in severe driving condition. or Check that HC gas is flown to catalyst converter at front side of CPF which is resulting from low compression ratio and faulty in/exhaust valve or backleak at injector nozzle.
*. In case that real exhaust gas temperature reaches up to 890℃, engine and exhaust line(Turbo charger), CPF can be damaged.

DTC DETECTING CONDITION EEDBF661

<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">• abnormal over-load (driving) condition
• Engine misfire
• Injector nozzle back leak
• Exhaust temp. sensor(T5-CPF) circuit
• Exhaust temp. sensor(T5-CPF) component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Rear exhaust temperature above 890℃</td></tr>
<tr><td>Diagnostic Time</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">• Engine check lamp blinks.</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>Check Lamp</td><td>BLINK</td></tr>
</table>

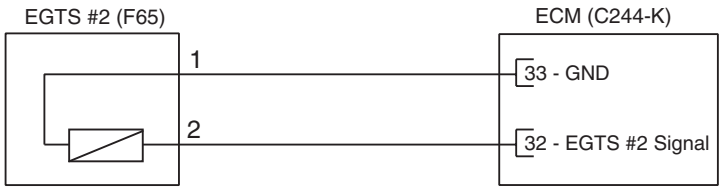
SPECIFICATION E3909643

RESISTANCE/TEMPERATURE CHARACTERISTICS

Temp. (℃)	Nominal (kΩ)	NEW		AGED	
		Min(kΩ)	Max(kΩ)	Min(kΩ)	Max(kΩ)
100	371	289	481	272	515
300	5.92	5.3	6.61	5.15	6.79
600	0.363	0.347	0.379	0.341	0.386
900	0.0893	0.0842	0.0949	0.0833	0.096

SCHEMATIC DIAGRAM E0959B10

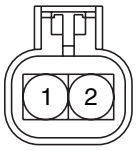
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-K (33)	Sensor ground
2	ECM C244-K (32)	EGTS #2 Signal

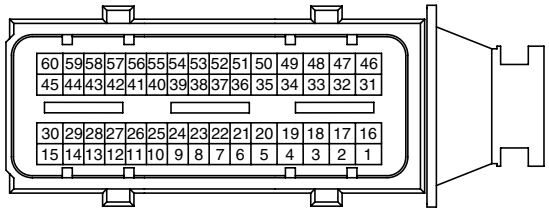
[HARNESS CONNECTORS]



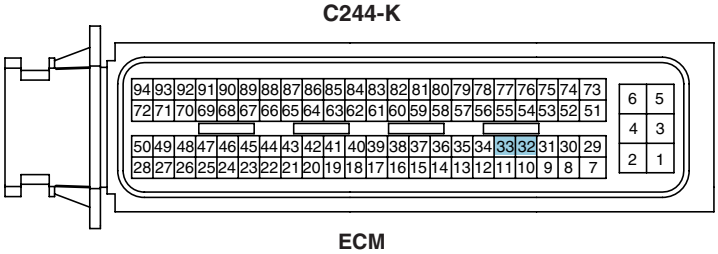
F65

EGTS #2

C244-A



C244-K



ECM

STGFL7166L

SIGNAL WAVEFORM AND DATA E1A8388E

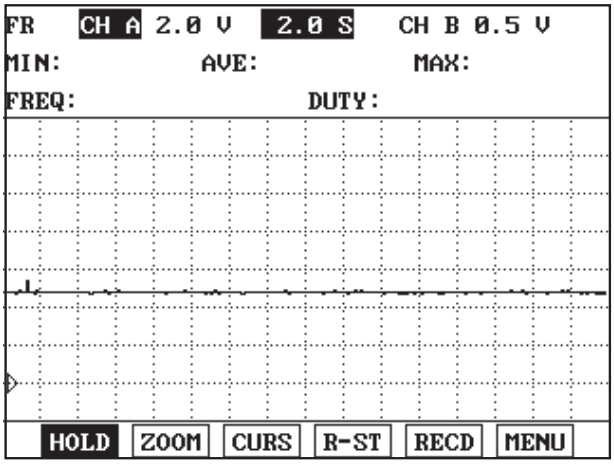


Fig.1

Fig. 1) Signal waveform when exhaust gas temperature(T5-CPF) shows the higher temperature increases, lower the voltage decreases.
If the exhaust gas temperature increases up to approx. 600℃, output voltage will decreases in 0.3~0.4V

SNFFL6543L

MONITOR SCANTOOL DATA EB4B7E65

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 "E/GAS TEMP. PRE VGT","E/GAS TEMP. PRE CPF" parameter on the Scantool.

Specification : Current "E/GAS TEMP." is displayed.

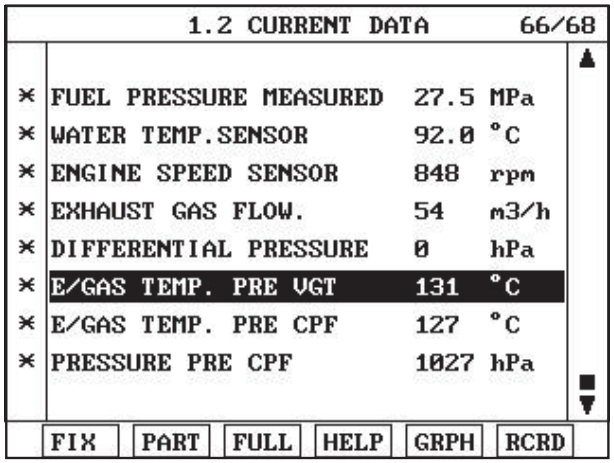


Fig.1

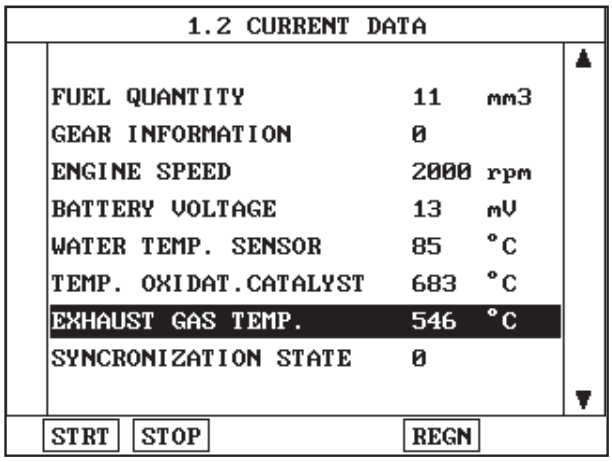


Fig.2

Fig.1) "EXHAUST GAS TEMP." at idle is shown. Monitor if abnormall difference between "Fig. 1) data" and the data from the vehicle to test.
Fig.2) The display during performing CPF regeneration after selecting "CPF SERVICE REGENERATION" mode is shown. Monitor if "EXHAUST GAS TEMP." varies correctly.

STGFL7539L

TERMINAL AND CONNECTOR INSPECTION E5150B48

Refer to DTC P2030.

SIGNAL CIRCUIT INSPECTION E050972D

1. Check signal circuit voltage
   1) IG KEY "OFF", ENGINE "OFF"
   2) Disconnect EGTS(T5-CPF) connector.
   3) IG KEY "ON"
   4) Measure the voltage of EGTS(T5-CPF) 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 EGTS(T5-CPF) connector and ECM connector.
   3) Check continuity between EGTS(T5-CPF) connector terminal 2 and ECM connector(C244-K) terminal 32.

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification?

YES

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

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 EGTS(T5-CPF) connector and ECM connector.
   3) Check continuity between EGTS(T5-CPF) connector terminal 2 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 E5F77316

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect EGTS(T5-CPF) connector.
3. IG KEY "ON"
4. Measure the voltage of EGTS(T5-CPF) connector terminal 2. [TEST "A"]
5. Measure the voltage between EGTS(T5-CPF) connector terminal 2 and 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".

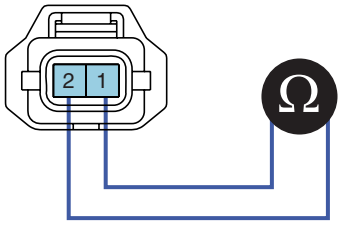
NO

▶ 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 E8432129

1. IG KEY "OFF", ENGINE "OFF".
2. Disconnect EGTS(T5-CPF) connector.
3. Measure resistance between EGTS(T5-CPF) terminal 1 and 2, referring to resistance characteristic table of specification of General information.

Specification : Refer to Specification of General Information



SNFFL6169D

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 EGTS(T5-CPF) and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR EDDBECAF

Refer to DTC P2030.

DTC P2034 EXHAUST GAS TEMPERATURE SENSOR PERFORMANCE (SENSOR 2)-CPF

COMPONENT LOCATION EBDD4B02

Refer to DTC P2033.

GENERAL DESCRIPTION E8AA5CAE

Refer to DTC P2033.

DTC DESCRIPTION E42B8DF0

P2034 is set when Exhaust gas temperature sensor(EGTS) - CPF signal is higher than 200℃. Check open or short circuit and EGTS.
*. In case that real exhaust gas temperature reaches up to 890℃, engine and exhaust line(Turbo charger), CPF can be damaged.

DTC DETECTING CONDITION EFBA75B0

<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">• Exhaust temp. sensor(T5-CPF) circuit
• Exhaust temp. sensor(T5-CPF) component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• In case that Exhaust gas temperature (CPF) is higher than 200℃</td></tr>
<tr><td>Diagnostic Time</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">• Engine check lamp blinks.</td></tr>
<tr><td>EGR Off</td><td>NO</td></tr>
<tr><td>Fuel Limit</td><td>NO</td></tr>
<tr><td>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION E8B86E66

RESISTANCE/TEMPERATURE CHARACTERISTICS

Temp. (℃)	Nominal (kΩ)	NEW		AGED	
		Min(kΩ)	Max(kΩ)	Min(kΩ)	Max(kΩ)
100	371	289	481	272	515
300	5.92	5.3	6.61	5.15	6.79
600	0.363	0.347	0.379	0.341	0.386
900	0.0893	0.0842	0.0949	0.0833	0.096

SCHEMATIC DIAGRAM EDCC8B04

Refer to DTC P2033.

SIGNAL WAVEFORM AND DATA E4CAA90C

Refer to DTC P2033.

MONITOR SCANTOOL DATA E3F208C9

Refer to DTC P2033.

TERMINAL AND CONNECTOR INSPECTION E1EEDBDC

Refer to DTC P2033.

SIGNAL CIRCUIT INSPECTION ECC1EED6

1. Check signal circuit voltage
   1) IG KEY "OFF", ENGINE "OFF"
   2) Disconnect EGTS(T5-CPF) connector.
   3) IG KEY "ON"
   4) Measure the voltage of EGTS(T5-CPF) 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 EGTS(T5-CPF) connector and ECM connector.
   3) Check continuity between EGTS(T5-CPF) connector terminal 2 and ECM connector(C244-K) terminal 32.

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification?

YES

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

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 EGTS(T5-CPF) connector and ECM connector.

3) Check continuity between EGTS(T5-CPF) connector terminal 2 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 E5C36BDE

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect EGTS(T5-CPF) connector.
3. IG KEY "ON"
4. Measure the voltage of EGTS(T5-CPF) connector terminal 2. [TEST "A"]
5. Measure the voltage between EGTS(T5-CPF) connector terminal 2 and 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".

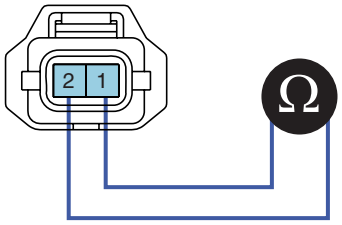
NO

▶ 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 EC9076D6

1. IG KEY "OFF", ENGINE "OFF".
2. Disconnect EGTS(T5-CPF) connector.
3. Measure resistance between EGTS(T5-CPF) terminal 1 and 2, referring to resistance characteristic table of specification of General information.

Specification : Refer to Specification of General Information



SNFFL6169D

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

YES

▶ Go to "Verification of Vehicle Repair".

NO

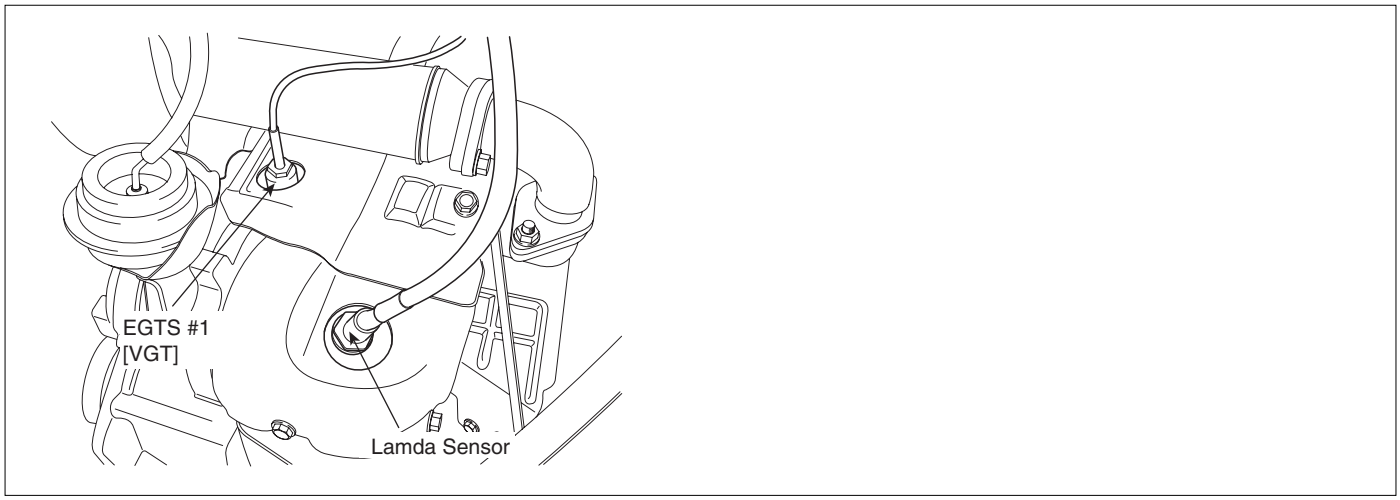
▶ Replace EGTS(T5-CPF) and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR EA4D64BA

Refer to DTC P2033.

DTC P2080 EXHAUST GAS TEMPERATURE SENSOR PERFORMANCE (SENSOR1)-VGT

COMPONENT LOCATION E775A39A



SNFFL6238L

GENERAL DESCRIPTION E55BFAE8

In EURO4 diesel engine with CPF, injection is devided into 2 pilot, 1 main, 2 post injections. Among these injections, pilot and main injections are for the operation of engine, however post injections are for CPF regeneration. Only in activating condition of CPF regeneration during driving, post injection starts. 1st post injection happens at the end of combustion cycle then, injected fuel is used to raise exhaust temperature. that temp. is sensed at T3 exhaust tempt. sensor which is ahead of Turbo charger. 2nd post injection happens at exhaust cycle then, injected fuel is also used to raise exhaust temperature. that temp. is sensed T5 exhaust tempt. sensor which is between Oxydation catalyst and CPF. The reason of raising exhaust tempt. is because exhaust tempt. in diesel engine is too low for CPF regeneration. The optimum tempt. for CPF regeneration is 550~600℃ thus, the goal of post injection is raise exhaust tempt. to that range of tempt.. However if exhaust tempt. is too high, turbo charger or CPF are likely to be damaged. Therefore if tempt. measured at each sensor is out of permittable value(specification), ECM deactivates CPF regeneration.

DTC DESCRIPTION EDAB49B0

P2080 is set when Exhaust gas temperature sensor(EGTS) - VGT signal is higher than 200℃. Check open or short circuit and EGTS.
*. In case that real exhaust gas temperature reaches up to 890℃, engine and exhaust line(Turbo charger), CPF can be damaged.

DTC DETECTING CONDITION E5A9AAB7

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Exhaust gas temp. sensor(T3-VGT) wiring • Exhaust gas temp. sensor(T3-VGT) component
Enable Conditions	• IG KEY "ON" or Engine running			
Threshold Value	• In case that Exhaust gas temperature (VGT) is higher than 200℃			
Diagnostic Time	• 1.0 sec.			
Fail Safe	Fuel cut	NO		
	EGR Off	NO		
	Fuel Limit	NO		
	Check Lamp	NO		

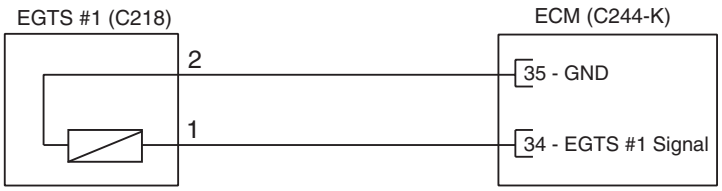
SPECIFICATION E19A6087

RESISTANCE/TEMPERATURE CHARACTERISTICS

Temp. (℃)	Nominal (kΩ)	NEW		AGED	
		Min(kΩ)	Max(kΩ)	Min(kΩ)	Max(kΩ)
100	371	289	481	272	515
300	5.92	5.3	6.61	5.15	6.79
600	0.363	0.347	0.379	0.341	0.386
900	0.0893	0.0842	0.0949	0.0833	0.096

SCHEMATIC DIAGRAM E8FE3B7D

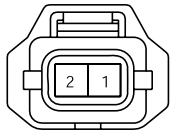
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-K (34)	EGTS #1 Signal
2	ECM C244-K (35)	Sensor ground

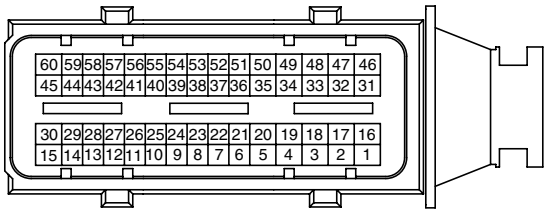
[HARNESS CONNECTORS]



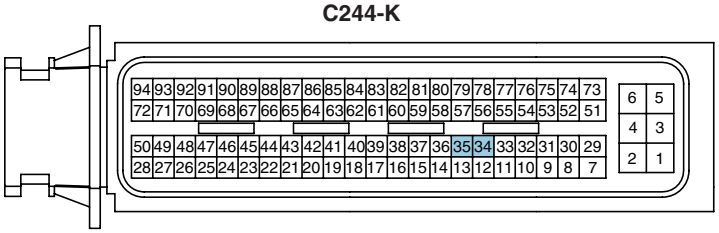
C218

EGTS #1

C244-A



C244-K



ECM

STGFL7164L

SIGNAL WAVEFORM AND DATA EAE4EE29

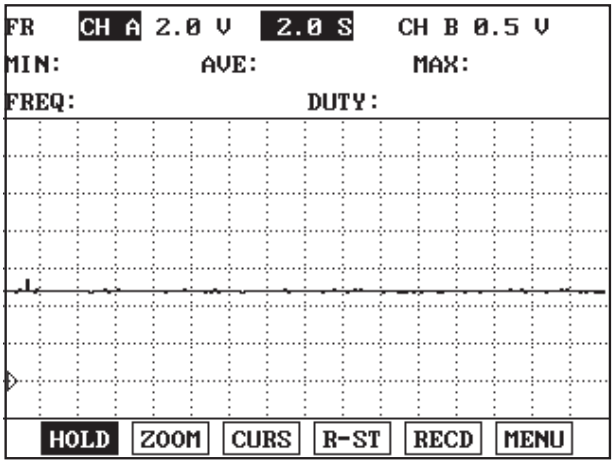


Fig.1

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

SNFFL6538L

MONITOR SCANTOOL DATA E2B0AC7B

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 "E/GAS TEMP. PRE VGT","E/GAS TEMP. PRE CPF" parameter on the Scantool.

Specification : Current "E/GAS TEMP." is displayed.

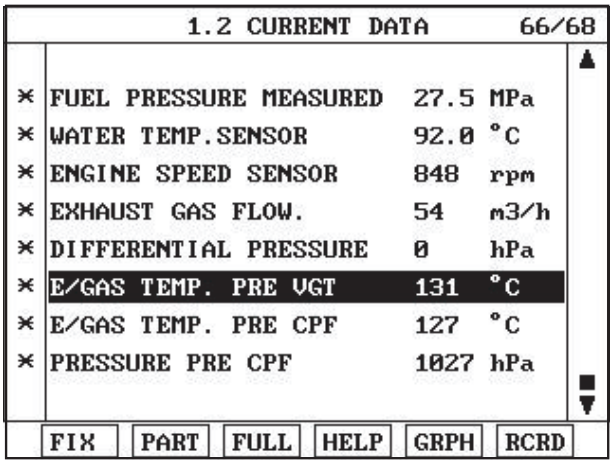


Fig.1

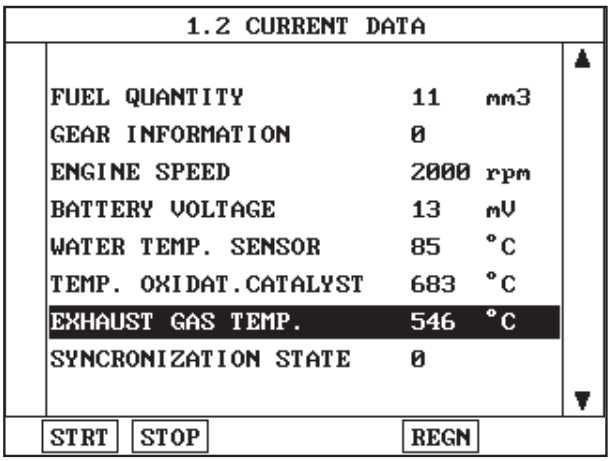


Fig.2

Fig.1) "EXHAUST GAS TEMP." at idle is shown. Monitor if abnormall difference between "Fig. 1) data" and the data from the vehicle to test.
Fig.2) The display during performing CPF regeneration after selecting "CPF SERVICE REGENERATION" mode is shown. Monitor if "EXHAUST GAS TEMP." varies correctly.

STGFL7539L

TERMINAL AND CONNECTOR INSPECTION ECB93159

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 E5CAABCA

1. Check signal circuit voltage

   1) IG KEY "OFF", ENGINE "OFF"

   2) Disconnect EGTS(T3-VGT) connector.

   3) IG KEY "ON"

   4) Measure the voltage of EGTS(T3-VGT) 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 EGTS(T3-VGT) connector and ECM connector.

   3) Check continuity between EGTS(T3-VGT) connector terminal 1 and ECM connector(C244-K) terminal 34.

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification?

YES

▶ Go to "Check short to ground in signal circuit".

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 EGTS(T3-VGT) connector and ECM connector.

   3) Check continuity between EGTS(T3-VGT) connector terminal 1 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 EECAAAF5

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect EGTS(T3-VGT) connector.
3. IG KEY "ON"
4. Measure the voltage of EGTS(T3-VGT) connector terminal 1. [TEST "A"]
5. Measure the voltage between EGTS(T3-VGT) connector terminal 1 and 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".

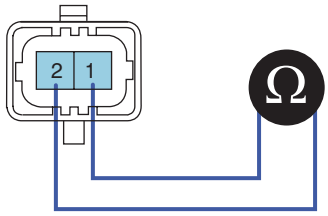
NO

▶ 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 EC7EABA3

1. IG KEY "OFF", ENGINE "OFF".
2. Disconnect EGTS(T3-VGT) connector.
3. Measure resistance between EGTS(T3-VGT) terminal 1 and 2, referring to resistance characteristic table of specification of General information.

Specification : Refer to Specification of General Information



KFQG320A

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 EGTS(T3-VGT) and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E04ADA12

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

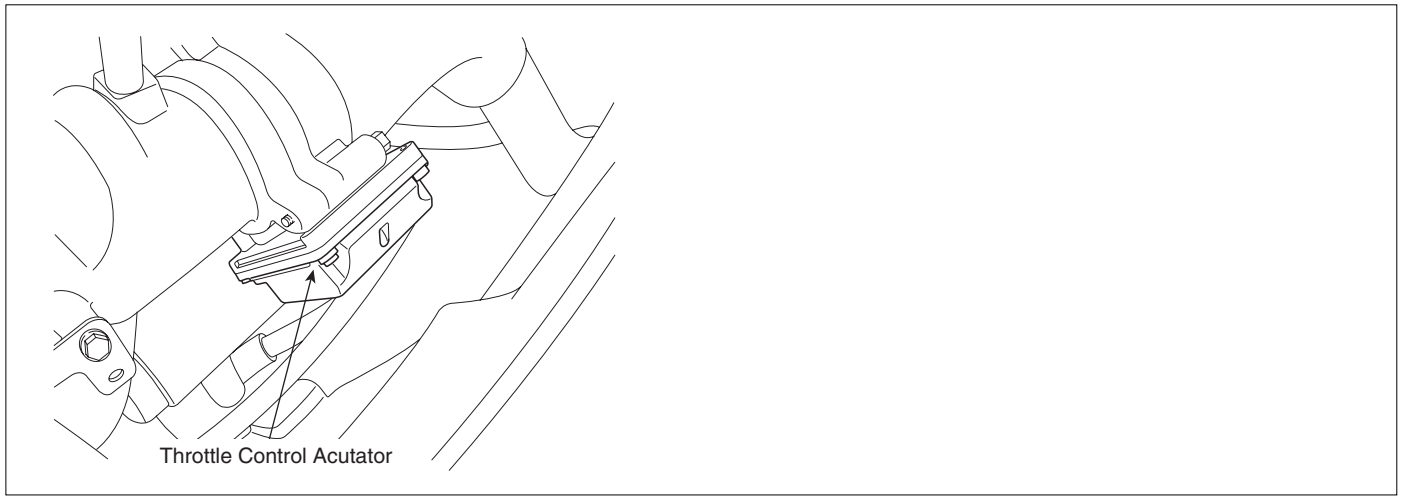
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P2111 THROTTLE CONTROL ACTUATOR CIRCUIT HIGH

COMPONENT LOCATION E38EFF63



SNFFL6519L

GENERAL DESCRIPTION E8BABCEB

Throttle Control actuator(TCA) helps EEGR actuator in EGR control as controlling throttle flap position with the method of duty control. In EURO 3 diesel engine, precise EGR control is more difficult than in EURO 4 engine. Even though EGR actuator opens exhaust gas outlet fully, it is difficult for exhaust gas to be inhaled at intake manifold because intake air is already exist to be inhaled at there in EURO 3 engine. However in EURO 4 engine, controlling throttle flap position, it is possible to regulate the differential pressure between exhaust and intake air. With the control of the differential pressure, the amount of exhaust air to be recirculated is regulated. Besides, When turning engines OFF, Throttle control actuator cuts intake air to prevent dieselling.(In spite of turning engine OFF, engine does not stop and runs for a while due to rotating inertia of engine and fuel leakage at injector.

DTC DESCRIPTION E2D105F3

P2111 is set when excessive current in throttle control actuator is detected for more than 1 sec. this code is due to short to battery in control circuit or internal short of actuator component.

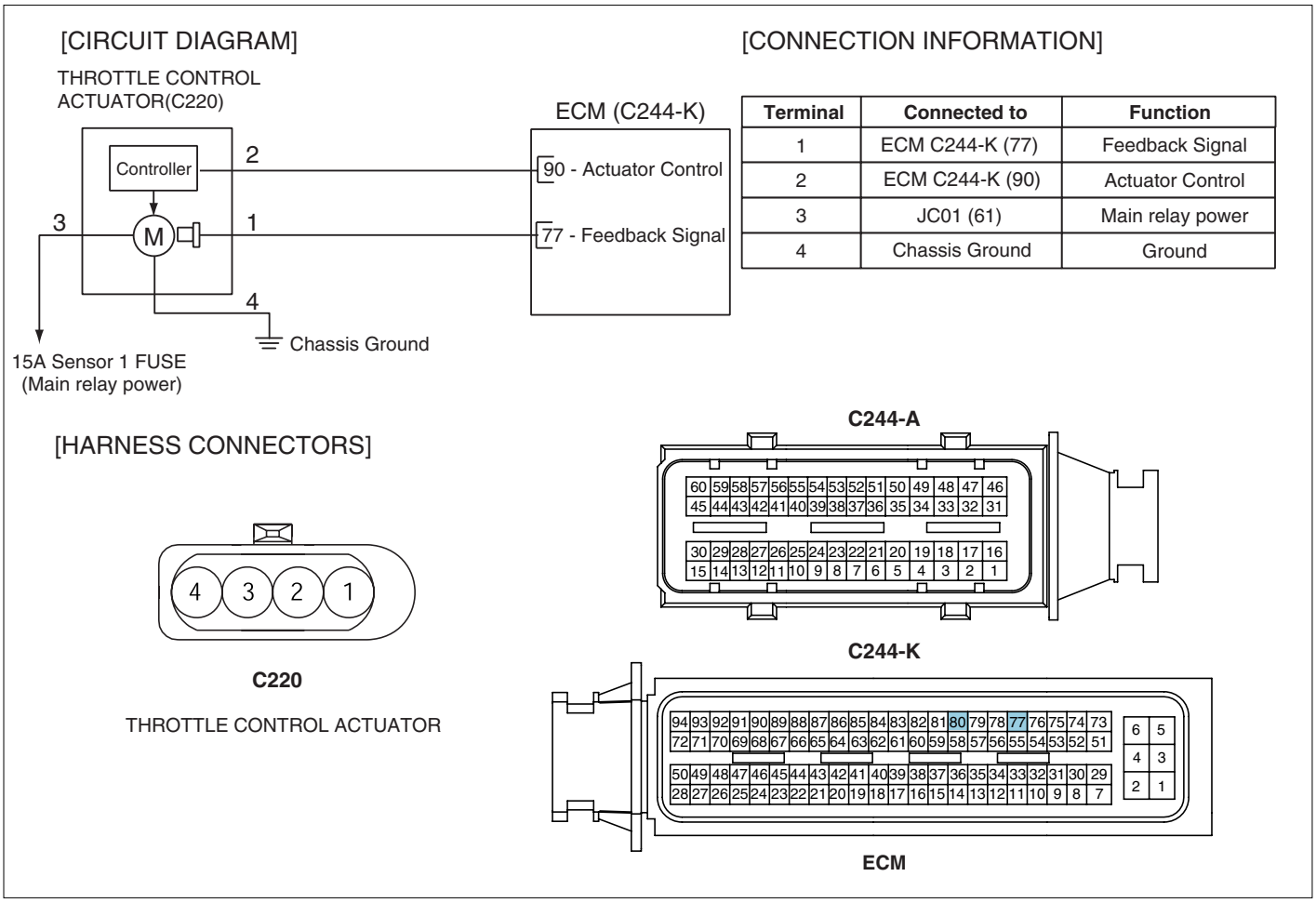
DTC DETECTING CONDITION E124CCFF

<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">• Throttle Control Actuator circuit
• Throttle Control Actuator component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Short to battery</td></tr>
<tr><td>Diagnostic Time</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>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION E8392C38

Throttle control actuator fully opened	Throttle control actuator fully closed	Throttle control actuator operating Hz
5%	95%	250±7.5 Hz

SCHEMATIC DIAGRAM EB2F80B9



Terminal	Connected to	Function
1	ECM C244-K (77)	Feedback Signal
2	ECM C244-K (90)	Actuator Control
3	JC01 (61)	Main relay power
4	Chassis Ground	Ground

STGFL7197L

SIGNAL WAVEFORM AND DATA E4992CB8

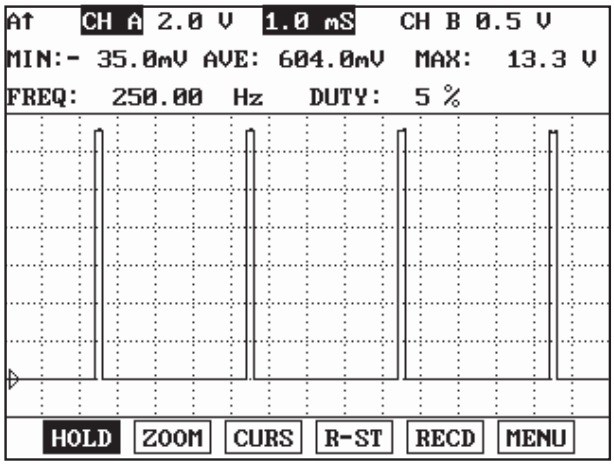


Fig.1

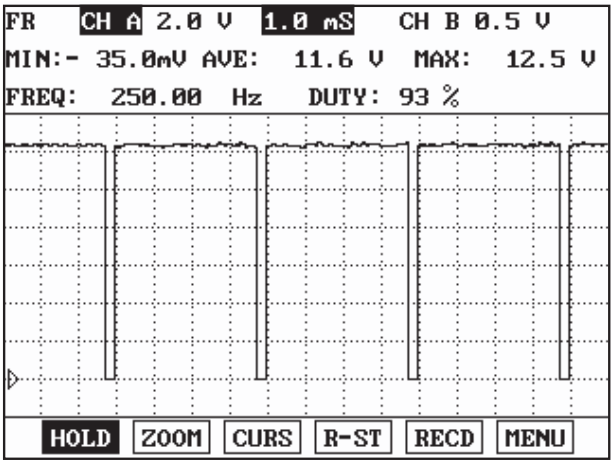


Fig.2

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

LFIG529A

MONITOR SCANTOOL DATA E79AD9E7

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 "INLET THROTTLE ACTUATOR." parameter on the Scantool.

Specification : 4.7% duty outputted except the operation of throttle flap
95% duty outputted at the operation of throttle flap

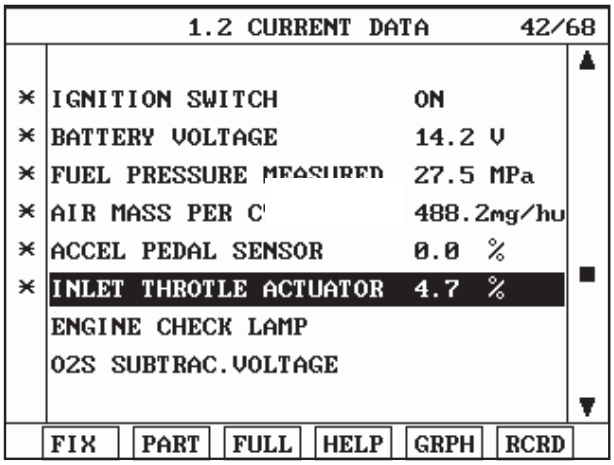


Fig.1

Fig 1) The duty of "INLET THROTTLE ACTUATOR." is 4.7% at IG KEY "ON" and ENGINE "ON".
The duty of "INLET THROTTLE ACTUATOR." is 95% at the point of turning IG KEY "OFF".

STGFL7611L

※Monitoring if the state of throttle control actuator changes at turning engine OFF because the communication through Scantool is comleted 3 sec. after turning engine ON. It is the easiest way to check if throttle control actuator is closed for about 1 sec. and opened again with eyes(visually) or ears(sound) in order to inspect component operation.

TERMINAL AND CONNECTOR INSPECTION EE1C7082

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 E4008048

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect Throttle control actuator.
3. IG KEY "ON"
4. Measure the voltage of Throttle control actuator connector terminal 3.

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 SNSR1 FUSE and related circuit and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION EE9A0946

1. Check control circuit voltage

1) IG KEY "OFF", ENGINE "OFF"

2) Disconnect Throttle control actuator connector.

3) IG KEY "ON"

4) Measure the voltage of Throttle control actuator connector terminal 2.

specification : 0.0V~0.1V

5) Is the measured voltage within the specification?

YES

▶ Go to "2.Check open in control circuit".

NO

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

2. Check open in control circuit

1) IG KEY "OFF", ENGINE "OFF"

2) Disconnect Throttle control actuator connector and ECM connector.

3) Check continuity between throttle control actuator connector terminal 2 and ECM connector(C244-K) terminal 90.

specification : Continuity (below 1.0Ω)

4) Is the measured resistance within the specification? (Is continuity confirmed?)

YES

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

NO

▶ Repair open in throttle control actuator control circuit and go to "Varification of Vehicle Repair".

3. Check short to ground in control circuit

1) IG KEY "OFF", ENGINE "OFF"

2) Disconnect Throttle control actuator connector.

3) Check continuity between throttle control actuator connector terminal 2 and chassis ground.

specification : Discontinuity (Infinite Ω)

4) Is the measured resistance within the specification? (Is control circuit insulated with ground?)

YES

▶ Go to "Ground Circuit Inspection".

NO

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

GROUND CIRCUIT INSPECTION E23E1D41

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect Throttle control actuator connector.
3. IG KEY "ON"
4. Measure the voltage of Throttle control actuator connector terminal 3. [TEST "A"]
5. Measure the voltage between Throttle control actuator connector terminal 3 and 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(G221 ground point related 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 E020B09C

1. Throttle control actuator component visual inspection
   1) IG KEY "OFF", ENGINE "OFF"
   2) Disconnect intake hose connected to throttle control actuator.
   3) Check if throttle control actuator is contaminated with carbon fraction.
   4) Check if throttle flap moves smoothly as touching it with hand (perform this process at IG KEY "OFF" state.)
      ※ Check if abnormal noise, valve shaft stuck, too much wear are detected.

Specification : Flap moves smoothly and carbon fraction, too much wear, abnormal noise are not detected.

   5) Is throttle control actuator is OK after performing visual inspection?

YES

▶ Go to "2. Throttle control actuator operating test" as follows.

NO

▶ If same symptom is detected after clear carbon fraction up, replace throttle control actuator and go to "Verification of Vehicle Repair".

2. Throttle control actuator operating test

1) IG KEY "OFF", ENGINE "OFF"

2) Disconnect intake hose connected to throttle control actuator.

3) ENGINE "ON"

4) Check if throttle control actuator is in wide open state during engine running.

5) ENGINE "OFF"

6) Check if throttle flap is closed once and opened again at the point of turning engine OFF.
※ Check if abnormal noise or irregular moving of flap is detected.

Specification : Throttle flap moves smoothly.
at engine ON : Throttle control actuator opened
at the point of turning engine OFF : Throttle flap is closed once and opened again

7) Is throttle flap moves smoothly?

YES

▶ Go to "Verification of Vehicle Repair".

NO

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

VERIFICATION OF VEHICLE REPAIR E4B7EB2A

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 P2112 THROTTLE CONTROL ACTUATOR CIRCUIT LOW

COMPONENT LOCATION EBE9595E

Refer to DTC P2111.

GENERAL DESCRIPTION E2EE2EE3

Refer to DTC P2111.

DTC DESCRIPTION ECD1FA6B

P2112 is set when "0"A in throttle control actuator is detected for more than 1 sec. this code is due to 1)open or short to ground in control circuit or 2)internal open in actuator component.

DTC DETECTING CONDITION EC050951

<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">• Throttle Control Actuator circuit
• Throttle Control Actuator component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Short to GND, Wiring open</td></tr>
<tr><td>Diagnostic Time</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>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION ED3A85AF

Throttle control actuator fully opened	Throttle control actuator fully closed	Throttle control actuator operating Hz
5%	95%	250±7.5 Hz

SCHEMATIC DIAGRAM EC5BAD6C

Refer to DTC P2111.

SIGNAL WAVEFORM AND DATA ED7511DA

Refer to DTC P2111.

MONITOR SCANTOOL DATA E1E829F3

Refer to DTC P2111.

TERMINAL AND CONNECTOR INSPECTION E04398C7

Refer to DTC P2111.

POWER CIRCUIT INSPECTION E270CBA6

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect Throttle control actuator.
3. IG KEY "ON"
4. Measure the voltage of Throttle control actuator connector terminal 3.

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 SNSR1 FUSE and related circuit and go to "Verification of Vehicle Repair".

CONTROL CIRCUIT INSPECTION E9A6D565

1. Check control circuit voltage
   1) IG KEY "OFF", ENGINE "OFF"
   2) Disconnect Throttle control actuator connector.
   3) IG KEY "ON"
   4) Measure the voltage of Throttle control actuator connector terminal 2.

specification : 0.0V~0.1V

   5) Is the measured voltage within the specification?

YES

▶ Go to "2.Check open in control circuit".

NO

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

2. Check open in control circuit
   1) IG KEY "OFF", ENGINE "OFF"
   2) Disconnect Throttle control actuator connector and ECM connector.
   3) Check continuity between throttle control actuator connector terminal 2 and ECM connector(C244-K) terminal 90.

specification : Continuity (below 1.0Ω)

4) Is the measured resistance within the specification? (Is continuity confirmed?)

YES

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

NO

▶ Repair open in throttle control actuator control circuit and go to "Varification of Vehicle Repair".

3. Check short to ground in control circuit

1) IG KEY "OFF", ENGINE "OFF"

2) Disconnect Throttle control actuator connector.

3) Check continuity between throttle control actuator connector terminal 2 and chassis ground.

specification : Discontinuity (Infinite Ω)

4) Is the measured resistance within the specification? (Is control circuit insulated with ground?)

YES

▶ Go to "Ground Circuit Inspection".

NO

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

GROUND CIRCUIT INSPECTION EFA6C51B

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect Throttle control actuator connector.
3. IG KEY "ON"
4. Measure the voltage of Throttle control actuator connector terminal 3. [TEST "A"]
5. Measure the voltage between Throttle control actuator connector terminal 3 and 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(G221 ground point related 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 E2550ECE

1. Throttle control actuator component visual inspection

   1) IG KEY "OFF", ENGINE "OFF"

   2) Disconnect intake hose connected to throttle control actuator.

   3) Check if throttle control actuator is contaminated with carbon fraction.

   4) Check if throttle flap moves smoothly as touching it with hand (perform this process at IG KEY "OFF" state.)
      ※ Check if abnormal noise, valve shaft stuck, too much wear are detected.

Specification : Flap moves smoothly and carbon fraction, too much wear, abnormal noise are not detected.

   5) Is throttle control actuator is OK after performing visual inspection?

      YES

      ▶ Go to "2. Throttle control actuator operating test" as follows.

      NO

      ▶ If same symptom is detected after clear carbon fraction up, replace throttle control actuator and go to "Verification of Vehicle Repair".

2. Throttle control actuator operating test

   1) IG KEY "OFF", ENGINE "OFF"

   2) Disconnect intake hose connected to throttle control actuator.

   3) ENGINE "ON"

   4) Check if throttle control actuator is in wide open state during engine running.

   5) ENGINE "OFF"

   6) Check if throttle flap is closed once and opened again at the point of turning engine OFF.
      ※ Check if abnormal noise or irregular moving of flap is detected.

Specification : Throttle flap moves smoothly.
at engine ON : Throttle control actuator opened
at the point of turning engine OFF : Throttle flap is closed once and opened again

   7) Is throttle flap moves smoothly?

      YES

      ▶ Go to "Verification of Vehicle Repair".

      NO

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

VERIFICATION OF VEHICLE REPAIR EDAC463F

Refer to DTC P2111.

DTC P2113 THROTTLE CONTROL ACTUATOR CIRCUIT MALFUNCTION - RANGE/PERFORMANCE

COMPONENT LOCATION E5AC6BA2

Refer to DTC P2111.

GENERAL DESCRIPTION E3E3F31A

Refer to DTC P2111.

DTC DESCRIPTION E5D7EAAD

P2113 is set when 1)throttle control actuator error or 2)open or short of Feedback line is detected for more than 5 sec. This code is due to throttle control actuator stuck, open or short in feed back signal circuit.

DTC DETECTING CONDITION E1936057

<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">• TCA circuit
• TCA component
• TCA component sticking</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Short to GND, Wiring open</td></tr>
<tr><td>Diagnostic Time</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>YES</td></tr>
<tr><td>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION EF22E9DB

Throttle control actuator fully opened	Throttle control actuator fully closed	Throttle control actuator operating Hz
5%	95%	250±7.5 Hz

SCHEMATIC DIAGRAM E0B599E0

Refer to DTC P2111.

SIGNAL WAVEFORM AND DATA E607CE8C

Refer to DTC P2111.

MONITOR SCANTOOL DATA E53D0401

Refer to DTC P2111.

TERMINAL AND CONNECTOR INSPECTION EAB64BF3

Refer to DTC P2111.

SIGNAL CIRCUIT INSPECTION E44F6A4E

1. Check feed back signal circuit voltage

   1) IG KEY "OFF", ENGINE "OFF"

   2) Disconnect Throttle control actuator connector.

   3) IG KEY "ON"

   4) Measure the voltage of Throttle control actuator connector terminal 1.

specification : 0.0V~0.1V

   5) Is the measured voltage within the specification?

   YES

   ▶ Go to "2.Check open in feed back signal circuit".

   NO

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

2. Check open in feed back signal circuit

   1) IG KEY "OFF", ENGINE "OFF"

   2) Disconnect Throttle control actuator connector and ECM connector.

   3) Check continuity between throttle control actuator connector terminal 1 and ECM connector (C244-K) terminal 77.

specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification? (Is continuity confirmed?)

   YES

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

   NO

   ▶ Repair open in throttle control actuator feed back signal circuit and go to "Varification of Vehicle Repair".

3. Check short to ground in feed back signal circuit

   1) IG KEY "OFF", ENGINE "OFF"

   2) Disconnect Throttle control actuator connector.

   3) Check continuity between throttle control actuator connector terminal 1 and chassis ground.

specification : Discontinuity (Infinite Ω)

4) Is the measured resistance within the specification? (Is feed back signal circuit insulated with ground?)

YES

▶ Go to "Ground Circuit Inspection".

NO

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

GROUND CIRCUIT INSPECTION E5F5FFFD

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect Throttle control actuator connector.
3. IG KEY "ON"
4. Measure the voltage of Throttle control actuator connector terminal 3. [TEST "A"]
5. Measure the voltage between Throttle control actuator connector terminal 3 and 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(G221 ground point related 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 ED512F85

1. Throttle control actuator component visual inspection

   1) IG KEY "OFF", ENGINE "OFF"

   2) Disconnect intake hose connected to throttle control actuator.

   3) Check if throttle control actuator is contaminated with carbon fraction.

   4) Check if throttle flap moves smoothly as touching it with hand (perform this process at IG KEY "OFF" state.)
      ※ Check if abnormal noise, valve shaft stuck, too much wear are detected.

Specification : Flap moves smoothly and carbon fraction, too much wear, abnormal noise are not detected.

   5) Is throttle control actuator is OK after performing visual inspection?

YES

▶ Go to "2. Throttle control actuator operating test" as follows.

NO

▶ If same symptom is detected after clear carbon fraction up, replace throttle control actuator and go to "Verification of Vehicle Repair".

2. Throttle control actuator operating test

1) IG KEY "OFF", ENGINE "OFF"

2) Disconnect intake hose connected to throttle control actuator.

3) ENGINE "ON"

4) Check if throttle control actuator is in wide open state during engine running.

5) ENGINE "OFF"

6) Check if throttle flap is closed once and opened again at the point of turning engine OFF.
※ Check if abnormal noise or irregular moving of flap is detected.

Specification : Throttle flap moves smoothly.
at engine ON : Throttle control actuator opened
at the point of turning engine OFF : Throttle flap is closed once and opened again

7) Is throttle flap moves smoothly?

YES

▶ Go to "Verification of Vehicle Repair".

NO

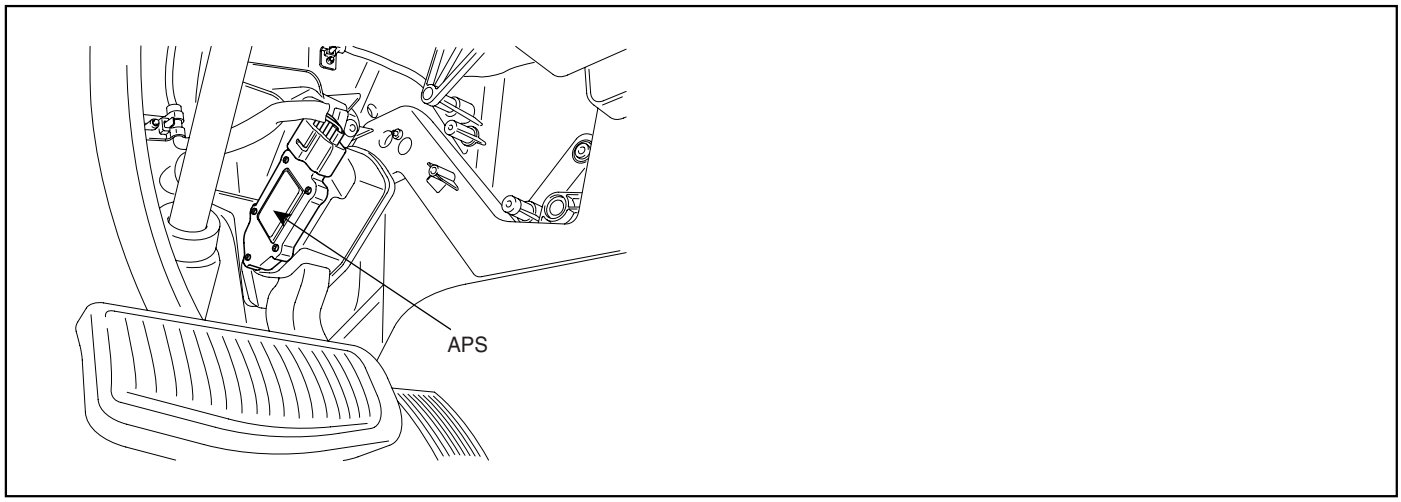
▶ Replace throttle control actuator and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E33F6F74

Refer to DTC P2111.

DTC P2123 THROTTLE/PEDAL POSITION SENSOR/SWITCH "D" CIRCUIT HIGH INPUT

COMPONENT LOCATION EB2AF71B



SNFFL6237D

GENERAL DESCRIPTION EAE6CA62

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 ECD47C82

P2123 is set when output voltage of APS 1 is above the maximum value of 4.79V for more than 0.18 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 E5C0DED3

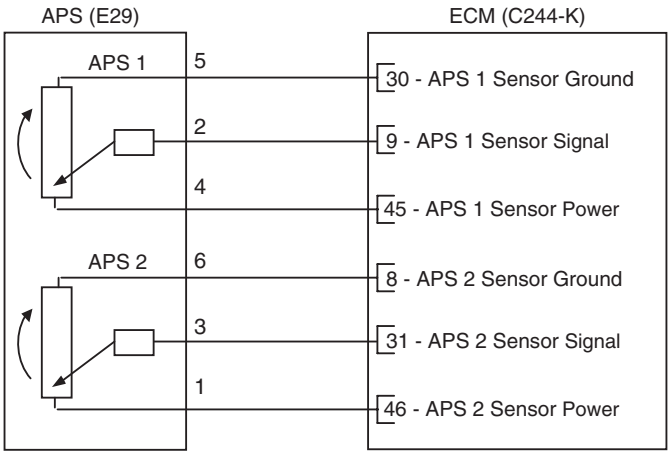
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="7">• APS 1 Circuit
• APS component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• When output signal is above the maximum value (above 4.79V)</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• 0.18 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 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>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION E53B94F4

	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 E19C315B

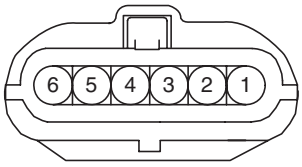
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

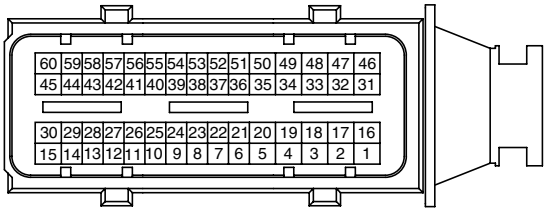
Terminal	Connected to	Function
1	ECM C244-K (46)	APS 2 Sensor Power
2	ECM C244-K (9)	APS 1 Sensor Signal
3	ECM C244-K (31)	APS 2 Sensor Signal
4	ECM C244-K (45)	APS 1 Sensor Power
5	ECM C244-K (30)	APS 1 Sensor Ground
6	ECM C244-K (8)	APS 2 Sensor Ground

[HARNESS CONNECTORS]

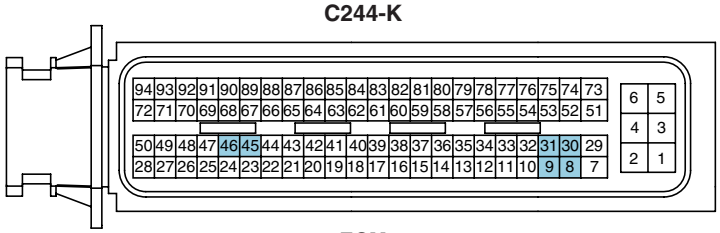


E29
APS

C244-A



C244-K



ECM

STGFL7149L

SIGNAL WAVEFORM AND DATA E025434E

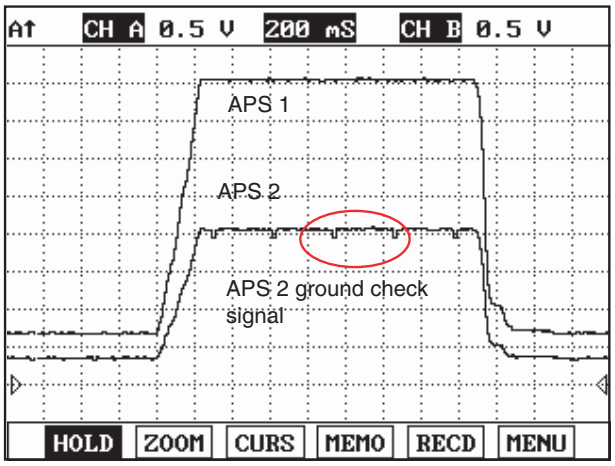


Fig.1

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

LFIG541A

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 E9A1D4B3

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 "Accelerator position sensor", "Accelerator position sensor 1", "Accelerator position sensor 2 " parameter on the scantool.

Specification : at idle(0%) Accelerator position sensor 1 : 600mV~800mV
Accelerator position sensor 2 : 1/2 of Accelerator position sensor 1

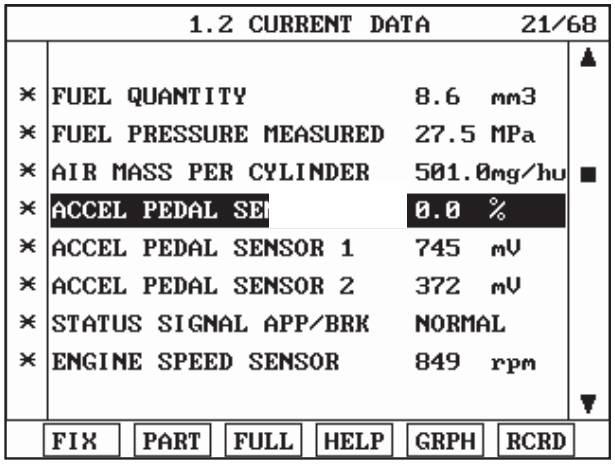


Fig.1

Fig.1) APS output data at warm idle. Check if output value is rising and "Accelerator position sensor 2" is 1/2 of "Accelerator position sensor 1" signal.

STGFL7612L

TERMINAL AND CONNECTOR INSPECTION E3725B2E

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" as follows.

POWER CIRCUIT INSPECTION EFDB4451

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect APS connector.
3. IG KEY "ON"
4. Measure the voltage of terminal 4 of APS connector.

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 E475F142

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 2 and ECM connector(C244-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 terminal 2of APS connector.

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 E1D944BB

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect APS connector.
3. IG KEY "ON"
4. Measure the voltage of APS terminal 4. [TEST "A"]
5. Measure the voltage of APS terminal 4 and terminal 5. [TEST "B"]
   (terminal 4 : 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".

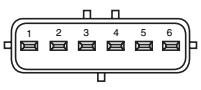
NO

▶ 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 E351FBBE

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	4(power)-5(ground)	1.0±0.1KΩ	1.0±0.1KΩ	Unchanged	 AFIG496A
	4(power)-2(signal)	1.8±0.1KΩ	1.1±0.1KΩ	Resistance drops	
	2(signal)-5(ground)	1.1±0.1KΩ	1.8±0.1KΩ	Resistance rises	
APS 2	1(power)-6(ground)	2.0±0.1KΩ	2.0±0.1KΩ	Unchanged	
	1(power)-3(signal)	2.9±0.1KΩ	2.1±0.1KΩ	Resistance drops	
	3(signal)-6(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 E2C70B13

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 E004DBE2

Refer to DTC P2123.

GENERAL DESCRIPTION E300F66C

Refer to DTC P2123.

DTC DESCRIPTION E8F8F8E8

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 E25721DC

<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>Threshold Value</td><td colspan="3">• When output signal is above the maximum value (above 2.463V)</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• 0.18 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 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>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION E2D40DF9

	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 E4ADA7C5

Refer to DTC P2123.

SIGNAL WAVEFORM AND DATA EB237EBA

Refer to DTC P2123.

MONITOR SCANTOOL DATA E8E6469B

Refer to DTC P2123.

TERMINAL AND CONNECTOR INSPECTION EF3928C7

Refer to DTC P2123.

POWER CIRCUIT INSPECTION EEBAE6DF

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect APS connector.
3. IG KEY "ON"
4. Measure the voltage of terminal 1 of APS connector.

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 EF45BD9E

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(C244-K) terminal 31.

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 terminal 3 of APS connector.

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 E31BE44D

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect APS connector.
3. IG KEY "ON"
4. Measure the voltage of APS terminal 1. [TEST "A"]
5. Measure the voltage of APS terminal 1 and terminal 6. [TEST "B"]
   (terminal 1 : Check + prove , terminal 6 : 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

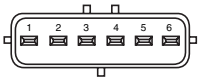
▶ When "B" voltage is not detected : Repair open in ground circuit and go to "Verification of Vehicle Repair".
▶ When the voltage difference between "A" and "B" is above 200mV : Eliminate the causes of excessive resistance and go to "Verification of Vehicle Repair".

COMPONENT INSPECTION E186656E

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	4(power)-5(ground)	1.0±0.1KΩ	1.0±0.1KΩ	Unchanged	 AFIG496A
	4(power)-2(signal)	1.8±0.1KΩ	1.1±0.1KΩ	Resistance drops	
	2(signal)-5(ground)	1.1±0.1KΩ	1.8±0.1KΩ	Resistance rises	
APS 2	1(power)-6(ground)	2.0±0.1KΩ	2.0±0.1KΩ	Unchanged	
	1(power)-3(signal)	2.9±0.1KΩ	2.1±0.1KΩ	Resistance drops	
	3(signal)-6(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 E3E0B5C5

Refer to DTC P2123.

DTC P2138 THROTTLE/PEDAL POSITION SENSOR/SWITCH "D" / "E" VOLTAGE CORRELATION

COMPONENT LOCATION E8B3F1F5

Refer to DTC P2123.

GENERAL DESCRIPTION EB233528

Refer to DTC P2123.

DTC DESCRIPTION E8FA412A

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 EB1C4BF0

<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">• APS 1 Circuit
• APS 2 Circuit
• APS component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"(APS depressed)</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• When APS 1,2 is depressed approx. 7%, the difference between APS1 and 2 is above 308mV
• When APS 1,2 is depressed above 7%, the difference between APS 1and 2 is above 406mV</td></tr>
<tr><td>Diagnostic Time</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 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>Check Lamp</td><td>YES</td></tr>
</table>

SPECIFICATION EBB21B42

	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 E66EF9B8

Refer to DTC P2123.

SIGNAL WAVEFORM AND DATA E529237E

Refer to DTC P2123.

MONITOR SCANTOOL DATA E07DEFFC

Refer to DTC P2123.

TERMINAL AND CONNECTOR INSPECTION E5BA0617

Refer to DTC P2123.

POWER CIRCUIT INSPECTION E00EEDCB

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect APS connector.
3. IG KEY "ON"
4. Measure the voltage of terminal 1 and 4 of APS connector.

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 trouble causing part in circuits and go to "Verification of Vehicle Repair".
When the measured voltage is higher than the specified value :
Refer to P0643 Circuit Inspection. (APS1)
Refer to P0653 Circuit Inspection.(APS2)
When the measured voltage is lower than the specified value :
Refer to P0642 Circuit Inspection.(APS1)
Refer to P0652 Circuit Inspection.(APS2)

SIGNAL CIRCUIT INSPECTION E741395E

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 2 and ECM connector (C244-K) terminal 9. (APS 1)
      Check continuity between APS connector terminal 3 and ECM connector (C244-K) terminal 31. (APS 2)

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification?

YES

▶ Go to "Check short in signal circuit".

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 2 and chassis ground. (check short to ground)
      Measure the voltage of terminal 2 of APS connector. (check short to battery)

Specification : Check short to ground : Discontinuity (Infinite Ω)
Check short to battery : 0.0V~0.1V

---

   5) 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 31 and chassis ground. (check short to ground)
      Measure the voltage of terminal 3 of APS connector. (check short to battery)

Specification : Check short to ground : Discontinuity (Infinite Ω)
Check short to battery : 0.0V~0.1V

---

   5) 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 E13508B2

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 4. [TEST "A"]

5) Measure the voltage of APS terminal 4 and terminal 5. [TEST "B"]
(terminal 4: 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 "2. Check ground circuit (APS2)".

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 1. [TEST "A"]

5) Measure the voltage of APS terminal 1 and terminal 6. [TEST "B"]
(terminal 1: Check + prove , terminal 6 : Check - prove)

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

6) Is the measured voltage within the specification?

YES

▶ Go to "Component Inspection".

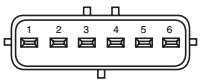
NO

▶ 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 E3AC419F

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	4(power)-5(ground)	1.0±0.1KΩ	1.0±0.1KΩ	Unchanged	 AFIG496A
	4(power)-2(signal)	1.8±0.1KΩ	1.1±0.1KΩ	Resistance drops	
	2(signal)-5(ground)	1.1±0.1KΩ	1.8±0.1KΩ	Resistance rises	
APS 2	1(power)-6(ground)	2.0±0.1KΩ	2.0±0.1KΩ	Unchanged	
	1(power)-3(signal)	2.9±0.1KΩ	2.1±0.1KΩ	Resistance drops	
	3(signal)-6(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

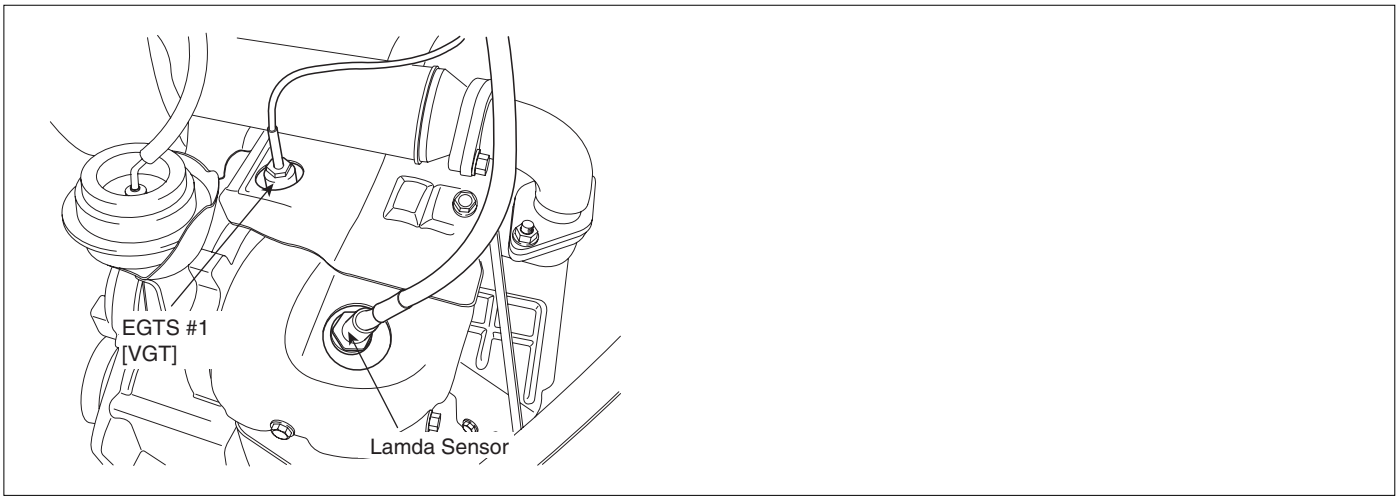
▶ Replace APS and go to "Verification of Vehicle Rapair".

VERIFICATION OF VEHICLE REPAIR E8100675

Refer to DTC P2123.

DTC P2238 LAMBDA SENSOR PUMPING CURRENT CIRCUIT LOW (BANK 1 / SENSOR 1)

COMPONENT LOCATION EFA4220E



SNFFL6238L

GENERAL DESCRIPTION EEE344DB

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($1.0<\lambda<1.1$) : 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($0.9<\lambda<1.0$) : 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℃~600℃) 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.

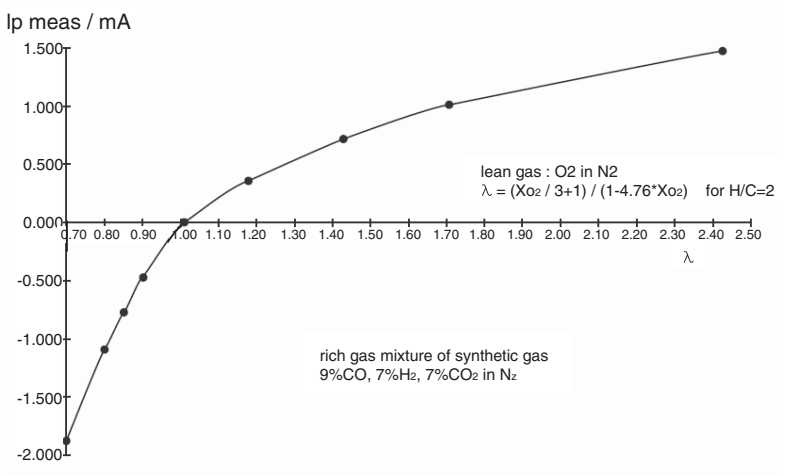
DTC DESCRIPTION E177795B

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 O2 sensor circuit.

DTC DETECTING CONDITION E1AE0F04

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Lambda sensor circuit • Lambda sensor component
Enable Conditions	• Engine running			
Threshold Value	• Short to GND in Lambda sensor circuit • Open in Lambda sensor circuit			
Diagnostic Time	• 2.0 sec.			
Fail Safe	Fuel cut	NO		
	EGR Off	NO		
	Fuel Limit	NO		
	Check Lamp	NO		

SPECIFICATION E65A10F6

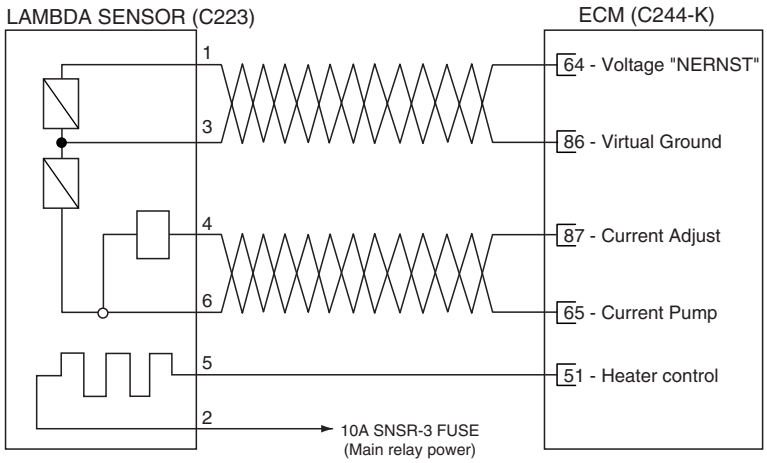


LFIG553A

λ value	0.65	0.70	0.80	0.90	1.01	1.18	1.43	1.70	2.42	Air
Pumping current	-2.22	-1.82	-1.11	-0.50	0.00	0.33	0.67	0.94	1.38	2.54

SCHEMATIC DIAGRAM EC3844FF

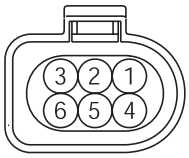
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	ECM C244-K (64)	Voltage "NERNST"
2	10A SNSR-3 FUSE	Main relay power
3	ECM C244-K (86)	Virtual Ground
4	ECM C244-K (87)	Current Adjust
5	ECM C244-K (51)	Heater control
6	ECM C244-K (65)	Current Pump

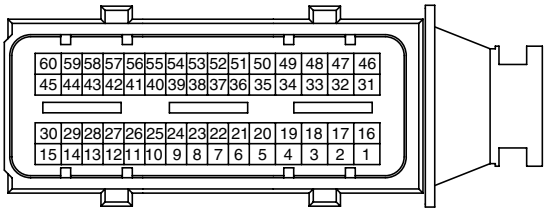
[HARNESS CONNECTORS]



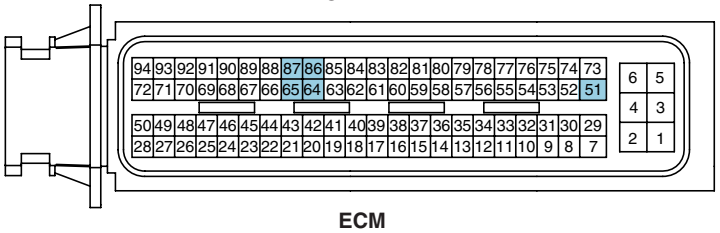
C223

LAMBDA SENSOR

C244-A



C244-K



ECM

STGFL7163L

SIGNAL WAVEFORM AND DATA EF0FB4DB

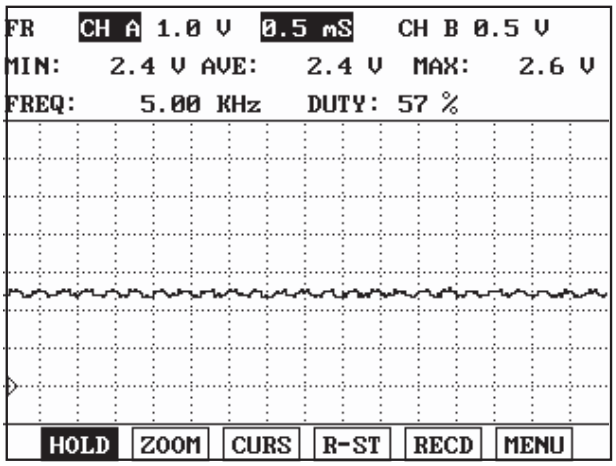


Fig.1

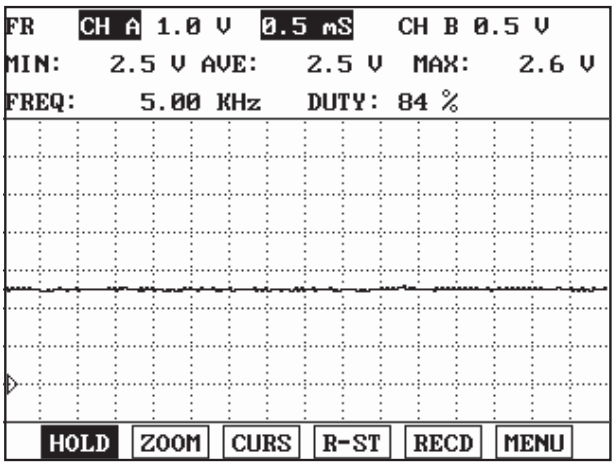


Fig.2

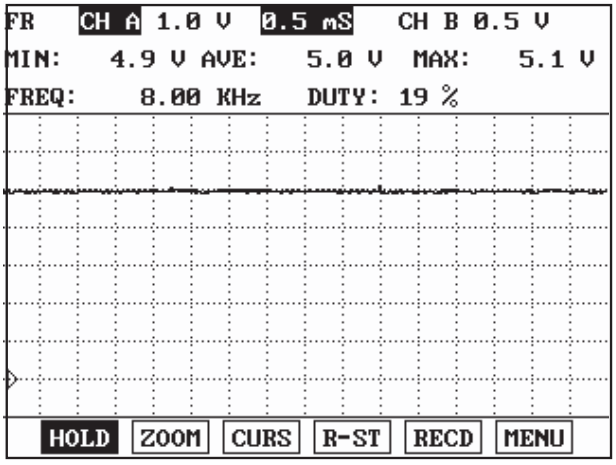


Fig.3

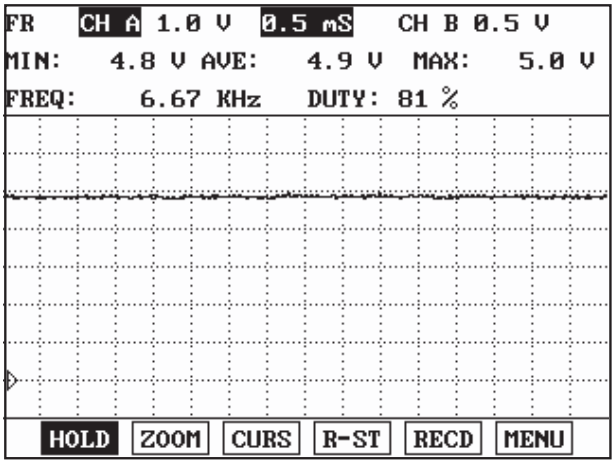


Fig.4

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.

LFIG554A

TERMINAL AND CONNECTOR INSPECTION E2E4B8A5

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" as follows.

POWER CIRCUIT INSPECTION ECCA5BCC

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.

   5) Monitor the waveform in Lambda sensor connector terminal 1.

Specification : Measured voltage : 2.3V~2.7V
waveform : Refer to "Signal Waveform & Data" of "General Information". The waveform similar to Fig.1) is displayed.

   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(C244-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 EB6EB0CF

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".

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(C244-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(C244-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 E3011465

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(C244-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 EEE57571

1. Lambda sensor Visual Inspection

   1) IG KEY "OFF", ENGINE "OFF"

   2) Disconnect Lambda sensor connector.

   3) Perform visual inspection for each checking point as follows.
      a. Check corrosion inside of Lambda sensor terminal.
      b. Check damaged coverring and open in component wiring.
      c. Check connecting torque(poor connection) of Lambda sensor component.
      d. Disconnect Lambda sensor and check deformation, clogging, melting of O2 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 E5A68FC8

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 E87A3B2D

Refer to DTC P2238.

GENERAL DESCRIPTION E34C8FBC

Refer to DTC P2238.

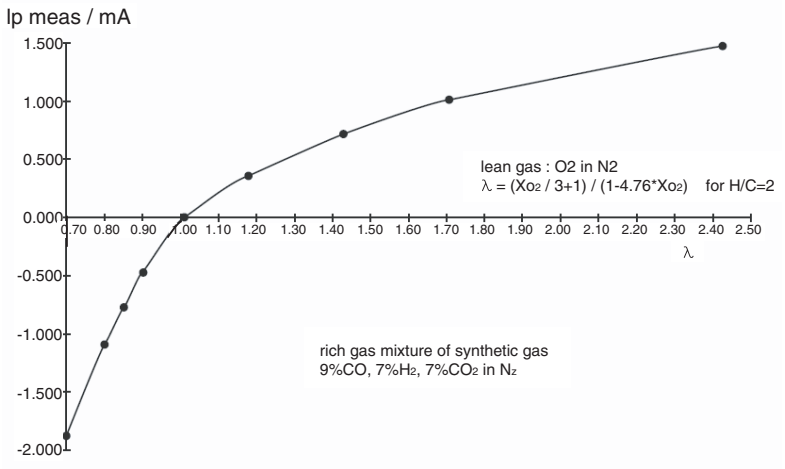
DTC DESCRIPTION E8EEC90D

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 O2 sensor circuit.

DTC DETECTING CONDITION E966B869

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Lambda sensor circuit • Lambda sensor component
Enable Conditions	• Engine running			
Threshold Value	• Short to battery in Lambda sensor circuit • Short to open in Lambda sensor ground circuit			
Diagnostic Time	• 2.0 sec.			
Fail Safe	Fuel cut	NO		
	EGR Off	NO		
	Fuel Limit	NO		
	Check Lamp	NO		

SPECIFICATION EDD665BC



LFIG553A

λ value	0.65	0.70	0.80	0.90	1.01	1.18	1.43	1.70	2.42	Air
Pumping current	-2.22	-1.82	-1.11	-0.50	0.00	0.33	0.67	0.94	1.38	2.54

SCHEMATIC DIAGRAM EE815DD9

Refer to DTC P2238.

SIGNAL WAVEFORM AND DATA E6977EA5

Refer to DTC P2238.

TERMINAL AND CONNECTOR INSPECTION E7ED8A42

Refer to DTC P2238.

POWER CIRCUIT INSPECTION E1137476

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.
   5) Monitor the waveform in Lambda sensor connector terminal 1.

Specification : Measured voltage : 2.3V~2.7V
waveform : Refer to "Signal Waveform & Data" of "General Information". The waveform similar to Fig.1) is displayed.

   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(C244-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 EBB830B4

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".

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(C244-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(C244-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 EFFECCDC

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(C244-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 E47584C6

1. Lambda sensor Visual Inspection

1) IG KEY "OFF", ENGINE "OFF"

2) Disconnect Lambda sensor connector.

3) Perform visual inspection for each checking point as follows.
   a. Check corrosion inside of Lambda sensor terminal.
   b. Check damaged coverring and open in component wiring.
   c. Check connecting torque(poor connection) of Lambda sensor component.
   d. Disconnect Lambda sensor and check deformation, clogging, melting of O2 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 EC3EBFAB

Refer to DTC P2238.

DTC P2251 LAMBDA SENSOR REFERENCE GROUND CIRCUIT/OPEN (BANK 1 / SENSOR 1)

COMPONENT LOCATION E8B1EA7D

Refer to DTC P2238.

GENERAL DESCRIPTION EB646EDF

Refer to DTC P2238.

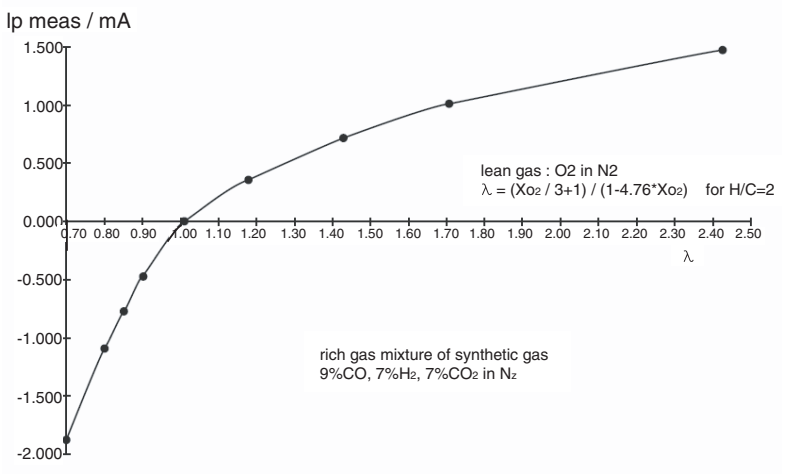
DTC DESCRIPTION E3A3B6F6

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 O2 sensor circuit.

DTC DETECTING CONDITION E82C9083

<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 circuit
• Lambda sensor component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Short to battery or ground in Lambda sensor circuit
• Open in Lambda sensor ground circuit</td></tr>
<tr><td>Diagnostic Time</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>Check Lamp</td><td>NO</td></tr>
</table>

SPECIFICATION E63C4268



LFIG553A

λ value	0.65	0.70	0.80	0.90	1.01	1.18	1.43	1.70	2.42	Air
Pumping current	-2.22	-1.82	-1.11	-0.50	0.00	0.33	0.67	0.94	1.38	2.54

SCHEMATIC DIAGRAM E80B4BAE

Refer to DTC P2238.

SIGNAL WAVEFORM AND DATA E6EE8D4A

Refer to DTC P2238.

TERMINAL AND CONNECTOR INSPECTION E8E0F63E

Refer to DTC P2238.

POWER CIRCUIT INSPECTION EEF0E59B

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.
   5) Monitor the waveform in Lambda sensor connector terminal 1.

Specification : Measured voltage : 2.3V~2.7V
waveform : Refer to "Signal Waveform & Data" of "General Information". The waveform similar to Fig.1) is displayed.

   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(C244-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 E01F93BA

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".

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(C244-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(C244-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 E5DD45A3

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(C244-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 EAA27F70

1. Lambda sensor Visual Inspection

1) IG KEY "OFF", ENGINE "OFF"

2) Disconnect Lambda sensor connector.

3) Perform visual inspection for each checking point as follows.
   a. Check corrosion inside of Lambda sensor terminal.
   b. Check damaged coverring and open in component wiring.
   c. Check connecting torque(poor connection) of Lambda sensor component.
   d. Disconnect Lambda sensor and check deformation, clogging, melting of O2 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

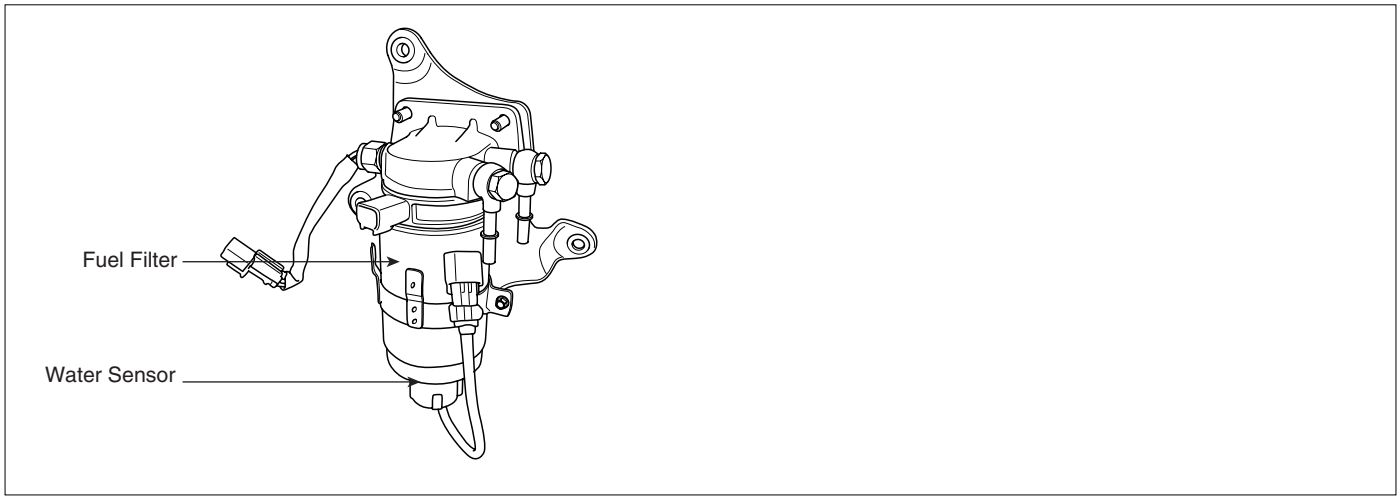
In diesel engine, ultra lean combustion generates at normal operating condition. Therefore, Lambda sensor signal change in accordance with engine acceleration and various loading condition rarely happens, unlikely to linear Lambda sensor of gasoline engine. Moreover, pumping current is not measurable 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 E1A61CF8

Refer to DTC P2238.

DTC P2264 DETECTION OF WATER IN FUEL

COMPONENT LOCATION EFA8FD0B



SNFFL6239L

GENERAL DESCRIPTION E3D65CEF

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 E69BCAA1

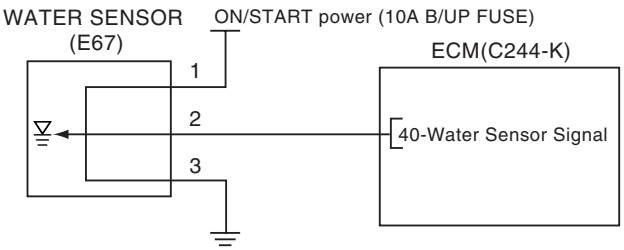
P2264 is set when water in fuel sensor operates for more than 4 sec. Water warning lamp turns on and engine power generation is limited in this condition. When this code is set, water in the filter should be removed to prevent engine from water contained fuel. If same code is set even after removing water, check short to battery in water in fuel sensor signal circuit or component failure.

DTC DETECTING CONDITION E19D153F

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Water stored inside of fuel filter(remove water inside of filter) • Water sensor circuit(short to battery) • Water sensor component
Enable Conditions	• IG KEY "ON"			
Threshold Value	• Signal voltage detected at Water sensor			
Diagnostic Time	• 4.0 sec.			
Fail Safe	Fuel cut	NO		
	EGR Off	NO		
	Fuel Limit	YES		
	Check Lamp	NO		

SCHEMATIC DIAGRAM E40C20A9

[CIRCUIT DIAGRAM]



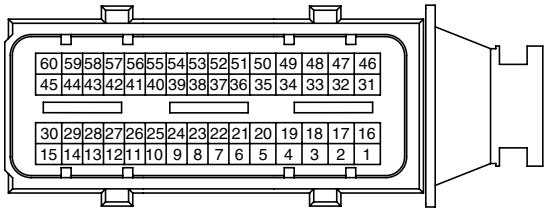
[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	JE02 terminal 42	IG power
2	ECM C244-K (40)	Sensor Signal
3	Chassis ground(G11)	Sensor ground

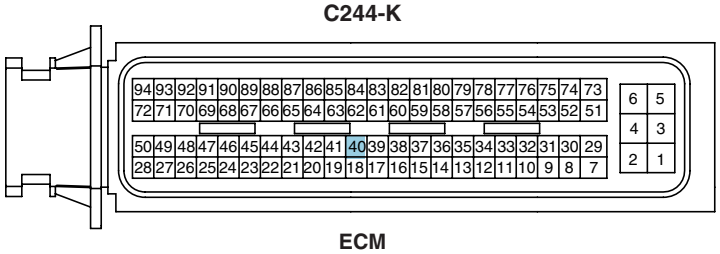
[HARNESS CONNECTOR]

E67
WATER SENSOR

C244-A



C244-K



ECM

STGFL7160L

TERMINAL AND CONNECTOR INSPECTION E048B963

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" as follows.

POWER CIRCUIT INSPECTION E70F622C

1. IG KEY "OFF", ENGINE "OFF".
2. Disconnect Water sensor connector.
3. IG KEY "ON"
4. Measure the voltage of terminal 1 of Water sensor connector.

Specification : 11.0V~12.5V

5. Is the measured voltage within the specification?

YES

▶ Go to "Signal Circuit Inspection".

NO

▶ Repair open in E/R JUNCTION BOX 10A B/UP FUSE and related circuit and go to "Verification of Vehicle Repair".

SIGNAL CIRCUIT INSPECTION EB357380

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 terminal 2 of Water sensor connector.

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 2 using jump wire.

Specification : Water warning lamp on cluster turns ON. 12V battery voltage is detected at ECM connector(C244-K) terminal 40.

5) Does water warning lamp turn ON? And is 12V battery voltage detected at ECM connector(C244-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 E8C42CFA

1. IG KEY "OFF", ENGINE "OFF".
2. Disconnect Water sensor connector
3. Check continuity between Water sensor 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 E056014F

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 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 sensor component" as follows.

2. Check Water 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 sensor to disconnected wiring connector.

6) IG KEY "ON".

7) Touch water sensing prove of Water 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 sensor and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR EB0DCF28

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

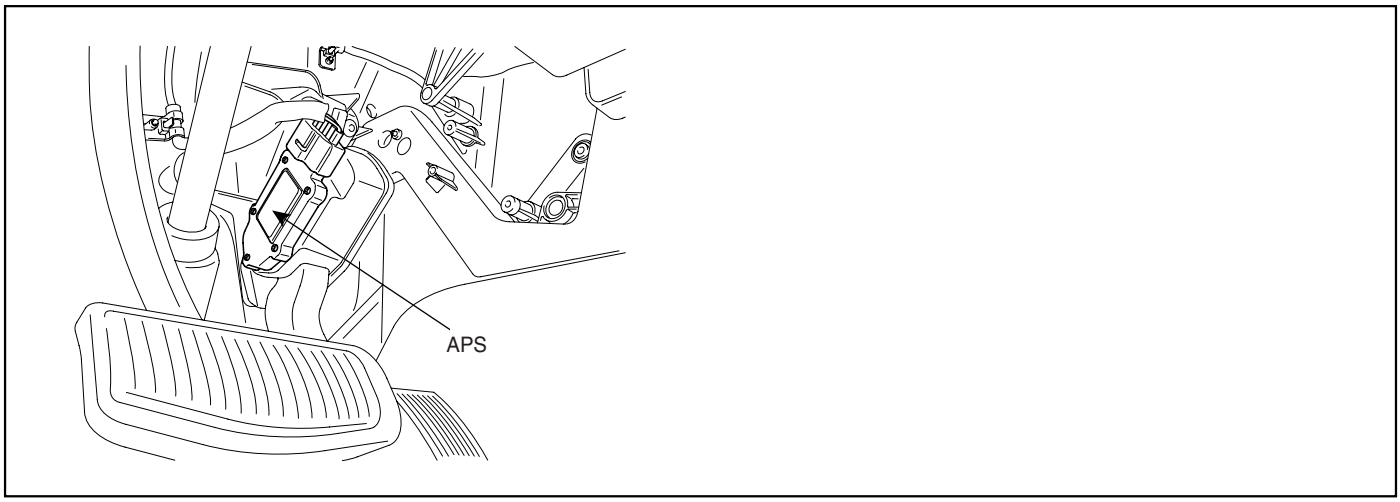
▶ Go to the DTC guide of recorded NO. in Scantool.

NO

▶ System operates within specification.

DTC P2299 BRAKE PEDAL POSITION / ACCELERATOR PEDAL POSITION INCOMPATIBLE

COMPONENT LOCATION E671B891



SNFFL6237D

GENERAL DESCRIPTION E864BC89

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 E626EDFA

P2299 is set when brake signal is inputted to ECM for more than 0.5 sec. while APS is depressed more than 5% at below 770RPM and 4Km/h. 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 EE8CB550

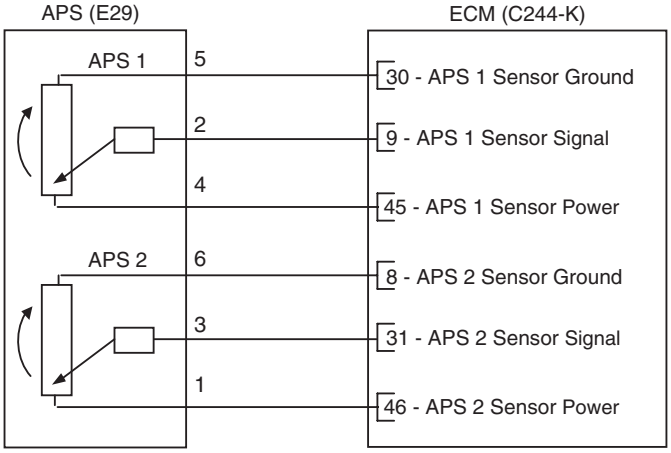
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• APS 1 Circuit
• APS 2 Circuit
• APS component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running (engine speed below 830RPM, vehicle speed below 4Km/h)</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Brake pedal singal inputted at APS output voltage above 5%(Error disappears when brake pedal released or accelerator pedal depressed 200% per sec.)</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• 3.0 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 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>Check Lamp</td><td>NO</td></tr>
</table>

SPECIFICATION E86A2630

	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 E8B475B9

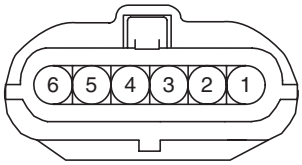
[CIRCUIT DIAGRAM]



[CONNECTION INFORMATION]

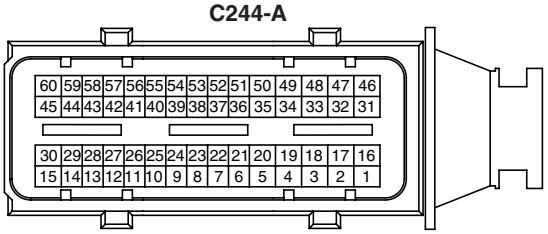
Terminal	Connected to	Function
1	ECM C244-K (46)	APS 2 Sensor Power
2	ECM C244-K (9)	APS 1 Sensor Signal
3	ECM C244-K (31)	APS 2 Sensor Signal
4	ECM C244-K (45)	APS 1 Sensor Power
5	ECM C244-K (30)	APS 1 Sensor Ground
6	ECM C244-K (8)	APS 2 Sensor Ground

[HARNESS CONNECTORS]

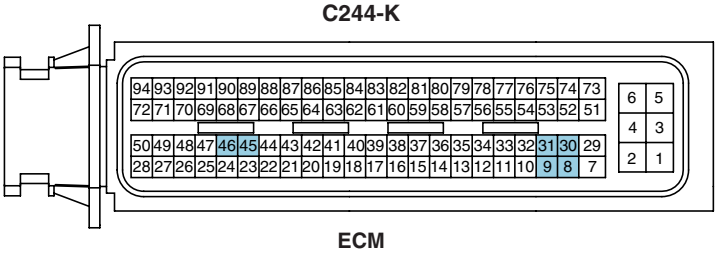


E29
APS

C244-A



C244-K



ECM

STGFL7149L

SIGNAL WAVEFORM AND DATA EAD585F5

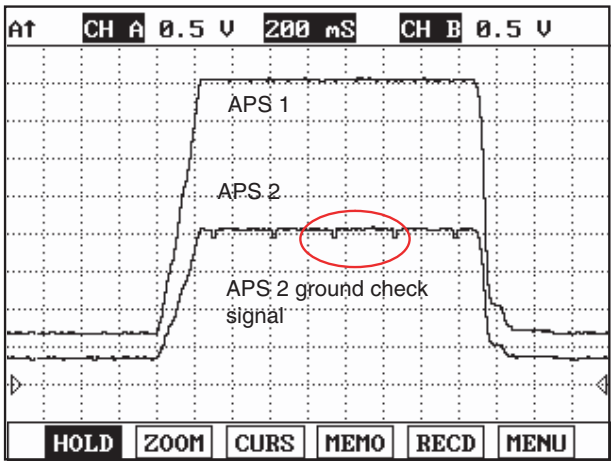


Fig.1

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

LFIG541A

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 E4AF7D82

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 "Accelerator position sensor", "Accelerator position sensor 1", "Accelerator position sensor 2 " parameter on the scantool.

Specification : at idle(0%) Accelerator position sensor 1 : 600mV~800mV
Accelerator position sensor 2 : 1/2 of Accelerator position sensor 1

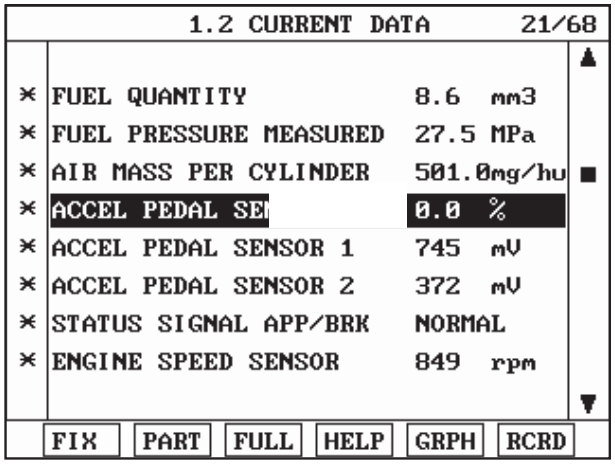


Fig.1

Fig.1) APS output data at warm idle. Check if output value is rising and "Accelerator position sensor 2" is 1/2 of "Accelerator position sensor 1" signal.

STGFL7612L

TERMINAL AND CONNECTOR INSPECTION E166C946

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" as follows.

POWER CIRCUIT INSPECTION EF179E48

1. IG KEY "OFF", ENGINE "OFF"
2. Disconnect APS connector.
3. IG KEY "ON"
4. Measure the voltage of terminal 1 and 4 of APS connector.

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 trouble causing part in circuits and go to "Verification of Vehicle Repair".
When the measured voltage is higher than the specified value :
Refer to P0643 Circuit Inspection. (APS1)
Refer to P0653 Circuit Inspection.(APS2)
When the measured voltage is lower than the specified value :
Refer to P0642 Circuit Inspection.(APS1)
Refer to P0652 Circuit Inspection.(APS2)

SIGNAL CIRCUIT INSPECTION E57B08BC

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 2 and ECM connector(C244-K) terminal 9. (APS 1)
   Check continuity between APS connector terminal 3 and ECM connector(C244-K) terminal 31. (APS 2)

Specification : Continuity (below 1.0Ω)

   4) Is the measured resistance within the specification?

   YES

   ▶ Go to "Check short in signal circuit".

   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 2 and chassis ground. (check short to ground)
   Measure the voltage of terminal 2 of APS connector. (check short to battery)

Specification : Check short to ground : Discontinuity (Infinite Ω)
Check short to battery : 0.0V~0.1V

   5) 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 31 and chassis ground. (check short to ground)
Measure the voltage of terminal 3 of APS connector. (check short to battery)

Specification : Check short to ground : Discontinuity (Infinite Ω)
Check short to battery : 0.0V~0.1V

5) 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 EC2B824F

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 4. [TEST "A"]

5) Measure the voltage of APS terminal 4 and terminal 5. [TEST "B"]
(terminal 4: 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 "2. Check ground circuit (APS2)".

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 1. [TEST "A"]

   5) Measure the voltage of APS terminal 1 and terminal 6. [TEST "B"]
   (terminal 1: Check + prove , terminal 6 : 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".

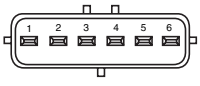
COMPONENT INSPECTION E2EEDFD4

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	4(power)-5(ground)	1.0±0.1KΩ	1.0±0.1KΩ	Unchanged	 AFIG496A
	4(power)-2(signal)	1.8±0.1KΩ	1.1±0.1KΩ	Resistance drops	
	2(signal)-5(ground)	1.1±0.1KΩ	1.8±0.1KΩ	Resistance rises	
APS 2	1(power)-6(ground)	2.0±0.1KΩ	2.0±0.1KΩ	Unchanged	
	1(power)-3(signal)	2.9±0.1KΩ	2.1±0.1KΩ	Resistance drops	
	3(signal)-6(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 E7030046

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

GENERAL DESCRIPTION E2EB7B04

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 E3BCF2BA

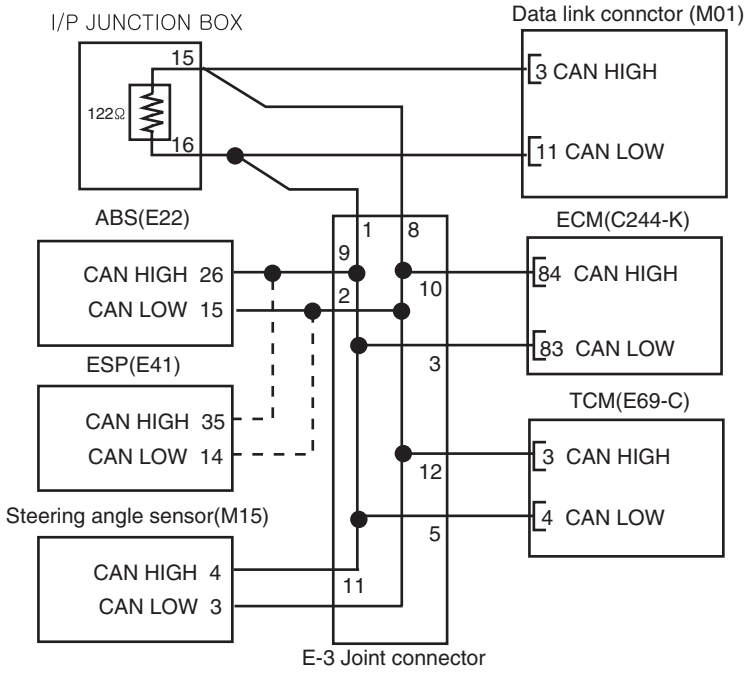
U0001 is set when signal transmission through CAN communication line is impossible for more than 0.1 sec. because of open or short to ground in CAN communication line. Checking CAN communication BUS and signals from ECM, TCM module is required.

DTC DETECTING CONDITION E85B8363

<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="9">• CAN BUS
• CAN communication module component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• CAN BUS error</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• 100ms</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>Check Lamp</td><td>NO</td></tr>
</table>

SCHEMATIC DIAGRAM EF09716C

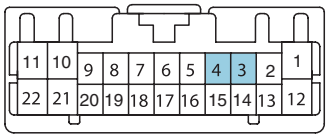
[CIRCUIT DIAGRAM]



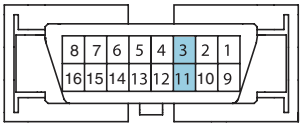
[CONNECTOR INFORMATION]

Terminal	Connected to	Function
84	I/P-G terminal 5 E69-C terminal 3(TCM) E22 terminal 26 (ABS) E41 terminal 35 (VDC) M15 terminal 3 (Steering angle sensor) M05 terminal 3 (Data link connctor)	CAN HIGH
83	I/P-C terminal 16 E69-C terminal 4 (TCM) E22 terminal 15 (ABS) E41 terminal 14 (VDC) M15 terminal 4 (Steering angle sensor) M05 terminal 11 (Data link connctor)	CAN LOW

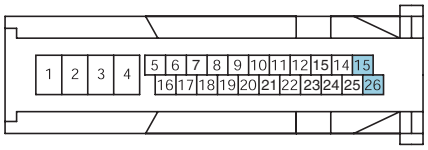
[HARNESS CONNECTOR]



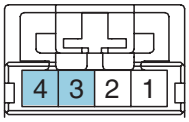
E69-C
TCM



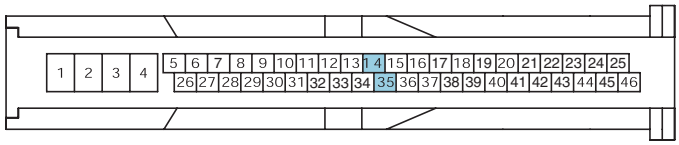
M04
Data Link Connect



E22
ABS

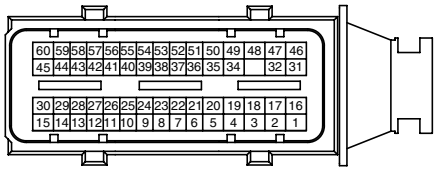


M15
Steering angle sensor

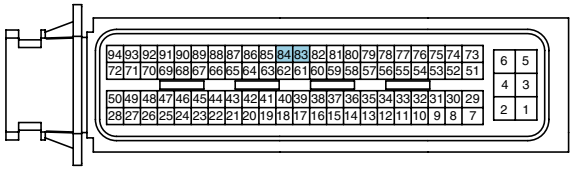


E41
ESP

C244-A



C244-K



ECM

STGFL7529L

SIGNAL WAVEFORM AND DATA E61058EF

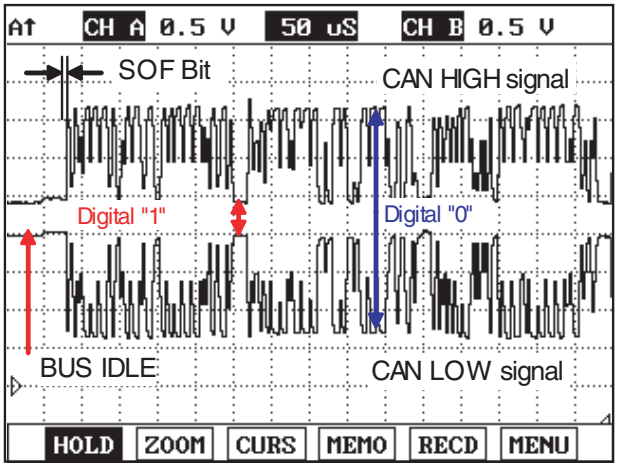


Fig.1

Fig. 1) CAN communication waveform

SNFFL6545L

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.

TERMINAL AND CONNECTOR INSPECTION EDF72DC8

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" as follows.

SIGNAL CIRCUIT INSPECTION EB80CA5A

1. Check CAN BUS resistance

   1) IG KEY "OFF", ENGINE "OFF"

   2) Measure the resistance between diagnostic connector 3 and 11. (TEST 1)

   3) Disconnect ECM, TCM, ABS(ESP), and Steering angle sensor connector.

   4) Measure the resistance between diagnostic connector 3 and 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".
   ▶ 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, TCM, ABS(ESP), and Steering angle sensor 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".

   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, TCM, ABS(ESP), and Steering angle sensor 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 voltage 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

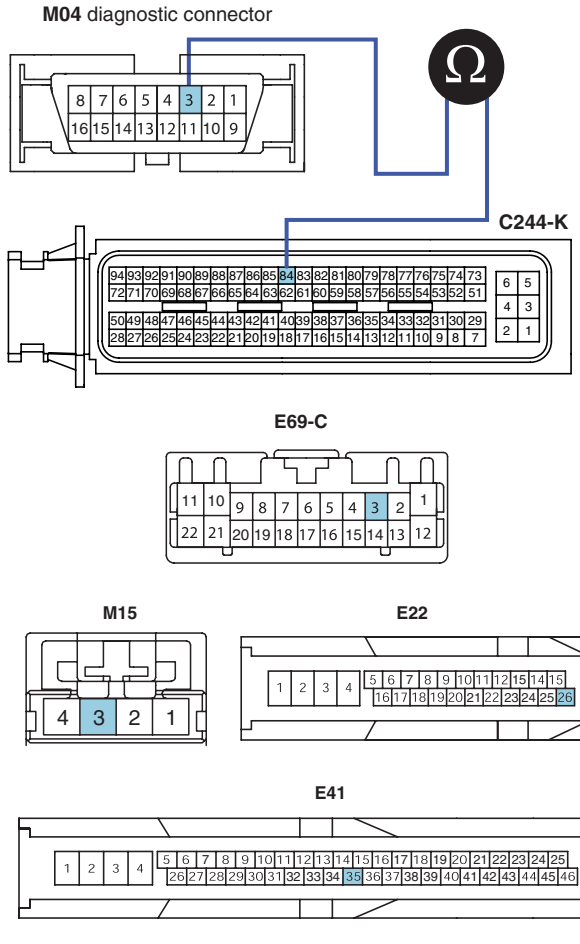
1) IG KEY "OFF", ENGINE "OFF"

2) Disconnect ECM, TCM, ABS(ESP), and Steering angle sensor connector.

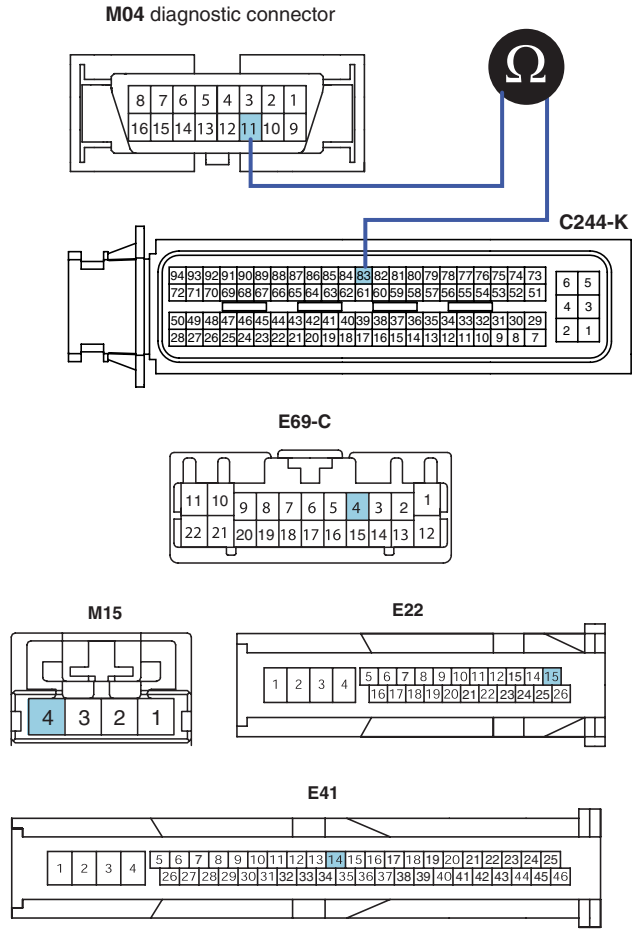
3) Check continuity between DLC terminal 3 and CAN HIGH terminal of each module.

4) Check continuity between DLC terminal 11 and CAN LOW terminal of each module.

[CAN HIGH]



[CAN LOW]



STGFL7180L

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 EC816D64

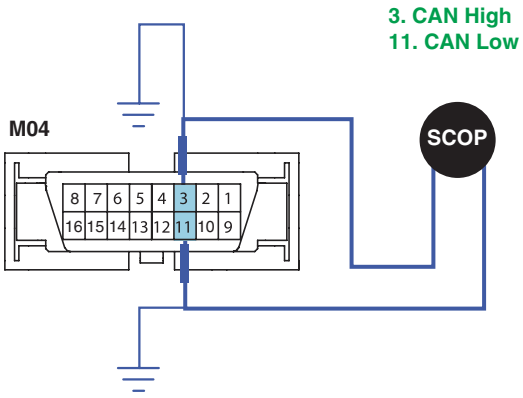
1. Check CAN communication waveform generation

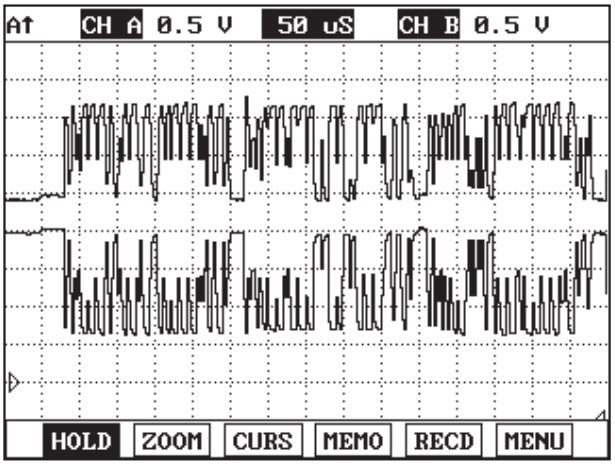
   1) IG KEY "OFF", ENGINE "OFF"

   2) Disconnect ECM, TCM, ABS(ESP), and Steering angle sensor connector.

   3) Connect 2 channel scope to DLC terminal 3(CAN HIGH) and 11(CAN LOW).

   4) IG KEY "ON" after connecting only "the Control Module(s) to be checked" to CAN BUS.





STGFL7181L

Specification : At IG KEY "ON", the waveform same as "Signal Waveform & Data" of this code generates.

NOTE

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.

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 EB364533

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

GENERAL DESCRIPTION EAC6E664

Refer to DTC U0001.

DTC DESCRIPTION E01390F7

U0100 is set when no signal transmission through CAN BUS occurs for more than 0.5 sec.. This code is due to CAN BUS problem or CAN communication module failure.

DTC DETECTING CONDITION E335968F

<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="9">• CAN BUS
• CAN communication module component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• No signal transmission through CAN BUS</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• 500ms</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>Check Lamp</td><td>NO</td></tr>
</table>

SCHEMATIC DIAGRAM ED95DB2D

Refer to DTC U0001.

SIGNAL WAVEFORM AND DATA E7B0A7FD

Refer to DTC U0001.

TERMINAL AND CONNECTOR INSPECTION E6DEE53D

Refer to DTC U0001.

SIGNAL CIRCUIT INSPECTION E1D02F9B

1. Check CAN BUS resistance

   1) IG KEY "OFF", ENGINE "OFF"

   2) Measure the resistance between diagnostic connector 3 and 11. (TEST 1)

   3) Disconnect ECM, TCM, ABS(ESP), and Steering angle sensor connector.

   4) Measure the resistance between diagnostic connector 3 and 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".
▶ 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, TCM, ABS(ESP), and Steering angle sensor 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".

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, TCM, ABS(ESP), and Steering angle sensor 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 voltage 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".

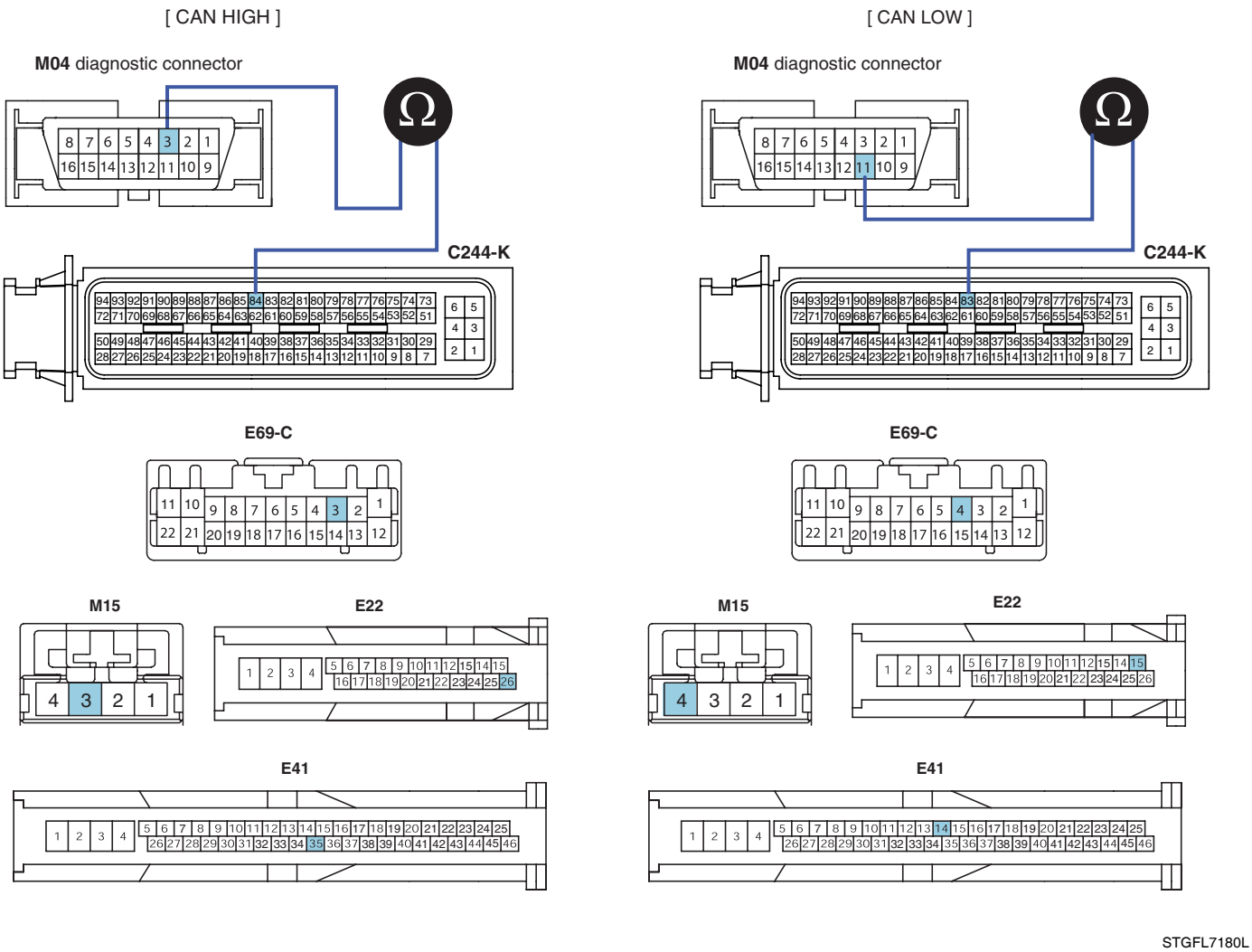
4. Check CAN BUS continuity

   1) IG KEY "OFF", ENGINE "OFF"

   2) Disconnect ECM, TCM, ABS(ESP), and Steering angle sensor connector.

   3) Check continuity between DLC terminal 3 and CAN HIGH terminal of each module.

   4) Check continuity between DLC terminal 11 and CAN LOW terminal of each module.



STGFL7180L

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 E41551E1

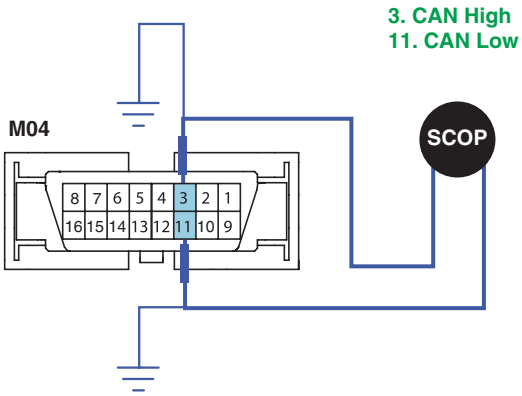
1. Check CAN communication waveform generation

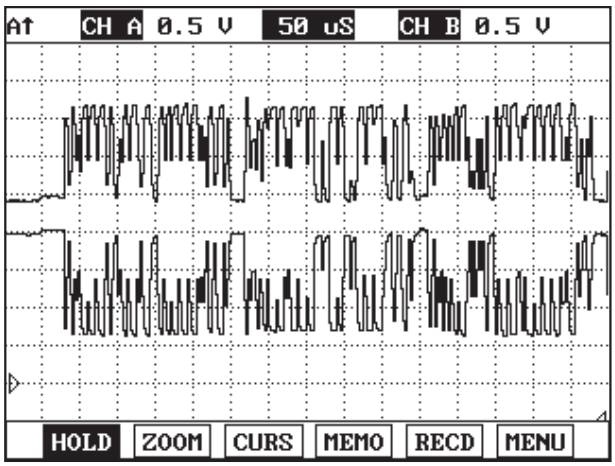
   1) IG KEY "OFF", ENGINE "OFF"

   2) Disconnect ECM, TCM, ABS(ESP), and Steering angle sensor connector.

   3) Connect 2 channel scope to DLC terminal 3(CAN HIGH) and 11(CAN LOW).

   4) IG KEY "ON" after connecting only "the Control Module(s) to be checked" to CAN BUS.





STGFL7181L

Specification : At IG KEY "ON", the waveform same as "Signal Waveform & Data" of this code generates.

NOTE

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.

   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 EFF38206

Refer to DTC U0001.

DTC U0101 SERIAL COMMUNICATION PROBLEM WITH TCU (TIMEOUT)

GENERAL DESCRIPTION EDFB96F9

Refer to DTC U0001.

DTC DESCRIPTION E1A7DC6C

U0101 is set when ECM send data requiring signal to TCM, but no return signal is transmitted to ECM within 0.5 sec.. This code is due to TCM CAN line related problem or TCM module failure.

DTC DETECTING CONDITION E9F5A220

<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">• CAN BUS
• CAN communication module component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• CAN communication error between ECM and TCM</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• 500ms</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>Check Lamp</td><td>NO</td></tr>
</table>

SCHEMATIC DIAGRAM E6130108

Refer to DTC U0001.

SIGNAL WAVEFORM AND DATA E0C57010

Refer to DTC U0001.

TERMINAL AND CONNECTOR INSPECTION EB32A8C8

Refer to DTC U0001.

SIGNAL CIRCUIT INSPECTION ECD26831

1. Check CAN BUS resistance
   1) IG KEY "OFF", ENGINE "OFF"
   2) Measure the resistance between diagnostic connector 3 and 11. (TEST 1)
   3) Disconnect ECM, TCM, ABS(ESP), and Steering angle sensor connector.
   4) Measure the resistance between diagnostic connector 3 and 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".
▶ 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, TCM, ABS(ESP), and Steering angle sensor 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".

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, TCM, ABS(ESP), and Steering angle sensor 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 voltage 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".

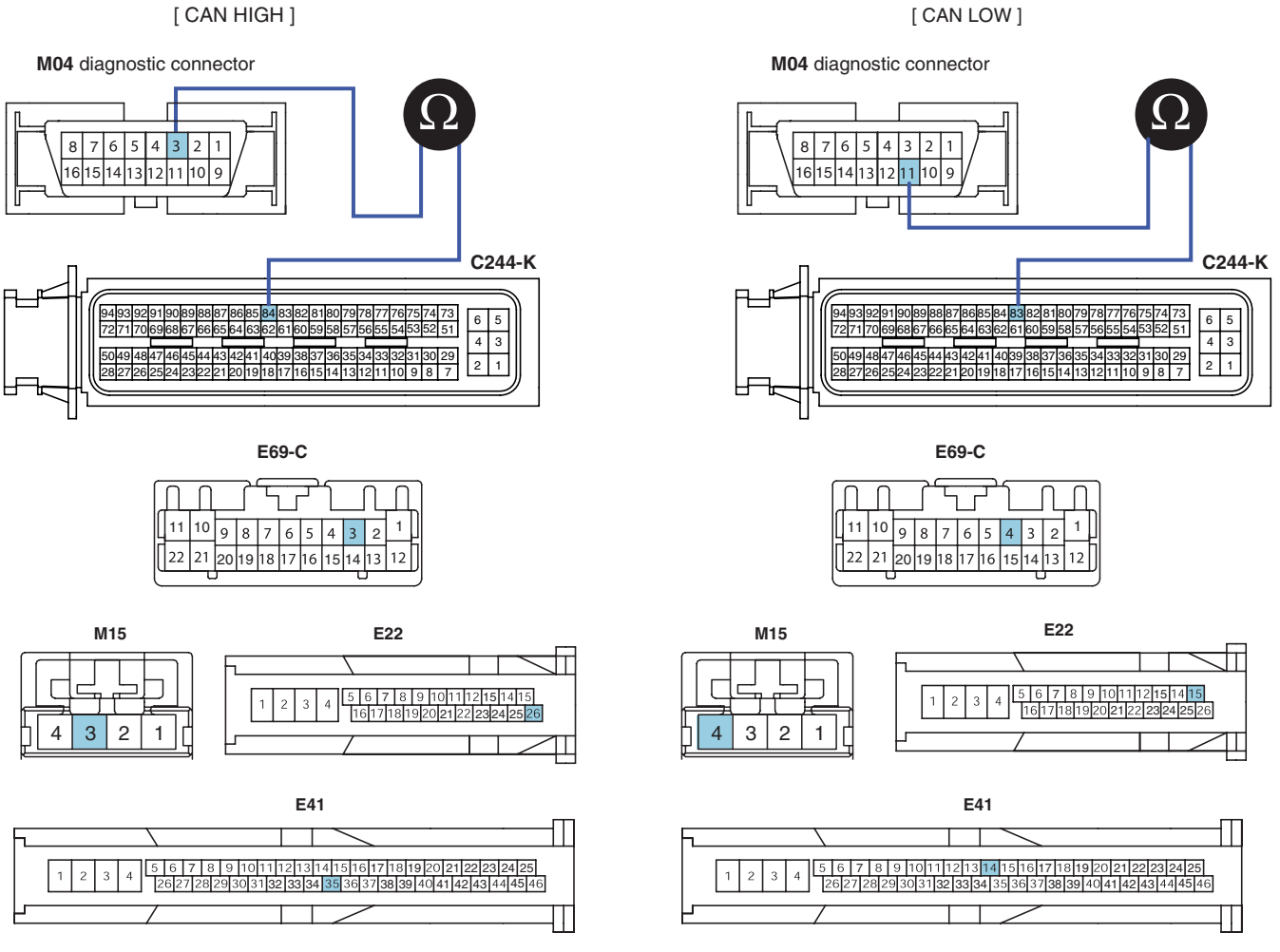
4. Check CAN BUS continuity

   1) IG KEY "OFF", ENGINE "OFF"

   2) Disconnect ECM, TCM, ABS(ESP), and Steering angle sensor connector.

   3) Check continuity between DLC terminal 3 and CAN HIGH terminal of each module.

   4) Check continuity between DLC terminal 11 and CAN LOW terminal of each module.



STGFL7180L

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 E129A3FF

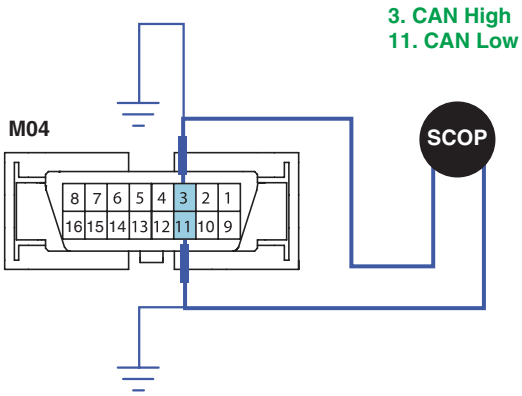
1. Check CAN communication waveform generation

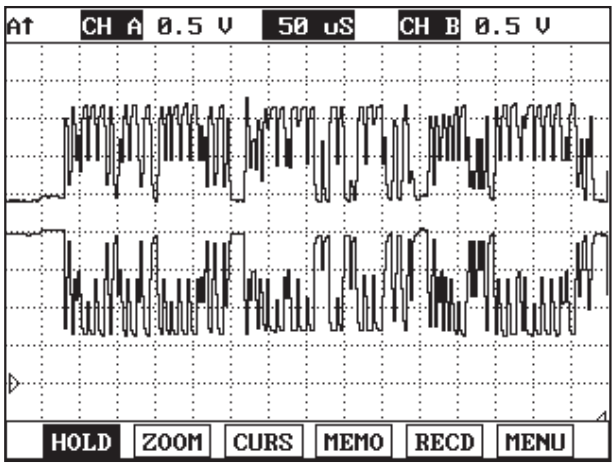
   1) IG KEY "OFF", ENGINE "OFF"

   2) Disconnect ECM, TCM, ABS(ESP), and Steering angle sensor connector.

   3) Connect 2 channel scope to DLC terminal 3(CAN HIGH) and 11(CAN LOW).

   4) IG KEY "ON" after connecting only "the Control Module(s) to be checked" to CAN BUS.





STGFL7181L

Specification : At IG KEY "ON", the waveform same as "Signal Waveform & Data" of this code generates.

NOTE

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.

   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 E13D969B

Refer to DTC U0001.

DTC U0122 ECM-TCS CAN ERROR

GENERAL DESCRIPTION E9F277E1

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 E63FA664

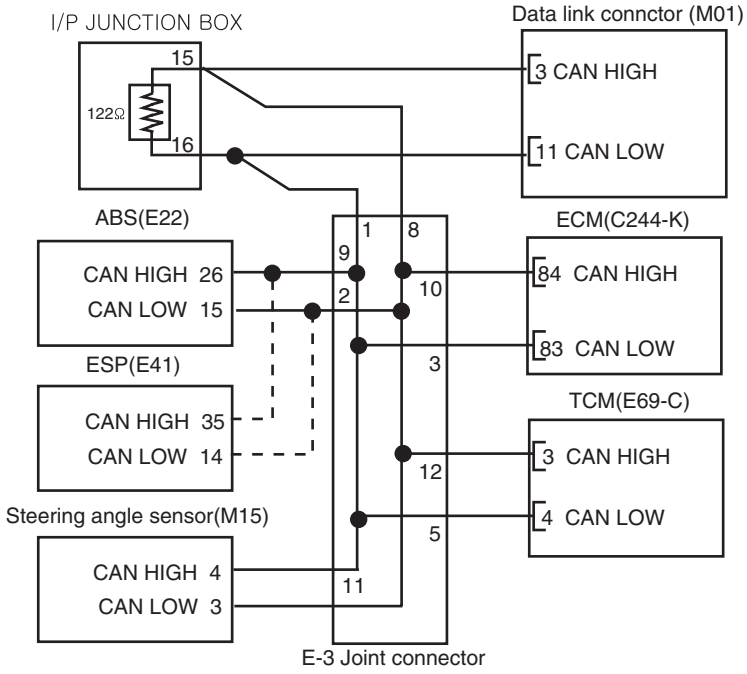
U0122 is set when ECM sends data requiring signal to TCS, but no return signal is transmitted to ECM by within 0.5 sec.. This code is due to TCS CAN line related problem or TCS module failure.

DTC DETECTING CONDITION E7CA5E20

<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">• CAN BUS
• CAN communication module component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• IG KEY "ON"</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• CAN communication error between ECM and TCS1</td></tr>
<tr><td>Diagnostic Time</td><td colspan="3">• 500ms</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>Check Lamp</td><td>NO</td></tr>
</table>

SCHEMATIC DIAGRAM ECD0BB15

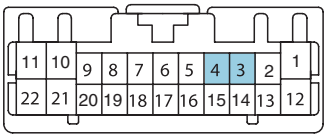
[CIRCUIT DIAGRAM]



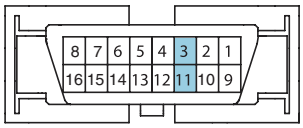
[CONNECTOR INFORMATION]

Terminal	Connected to	Function
84	I/P-G terminal 5 E69-C terminal 3(TCM) E22 terminal 26 (ABS) E41 terminal 35 (VDC) M15 terminal 3 (Steering angle sensor) M05 terminal 3 (Data link connctor)	CAN HIGH
83	I/P-C terminal 16 E69-C terminal 4 (TCM) E22 terminal 15 (ABS) E41 terminal 14 (VDC) M15 terminal 4 (Steering angle sensor) M05 terminal 11 (Data link connctor)	CAN LOW

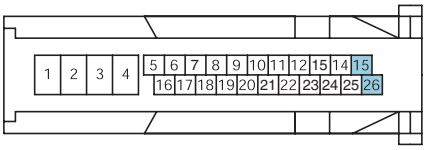
[HARNESS CONNECTOR]



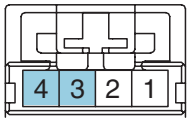
E69-C
TCM



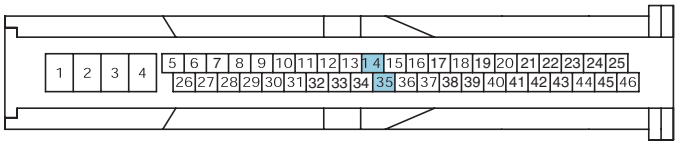
M04
Data Link Connect



E22
ABS

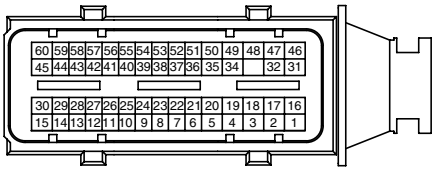


M15
Steering angle sensor

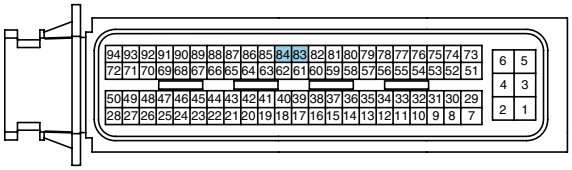


E41
ESP

C244-A



C244-K



ECM

STGFL7529L

SIGNAL WAVEFORM AND DATA ECAFF51B

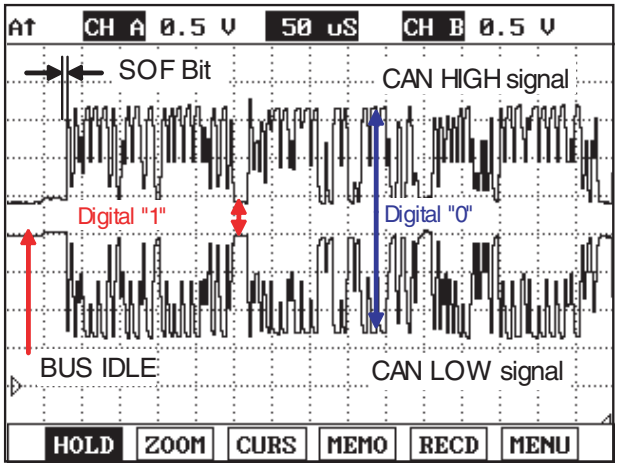


Fig.1

Fig. 1) CAN communication waveform

SNFFL6545L

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.

TERMINAL AND CONNECTOR INSPECTION E9ED193F

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" as follows.

SIGNAL CIRCUIT INSPECTION EDAD8DA2

1. Check CAN BUS resistance

   1) IG KEY "OFF", ENGINE "OFF"

   2) Measure the resistance between diagnostic connector 3 and 11. (TEST 1)

   3) Disconnect ECM, TCM, ABS(ESP), and Steering angle sensor connector.

   4) Measure the resistance between diagnostic connector 3 and 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".
▶ 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, TCM, ABS(ESP), and Steering angle sensor 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".

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, TCM, ABS(ESP), and Steering angle sensor 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 voltage 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

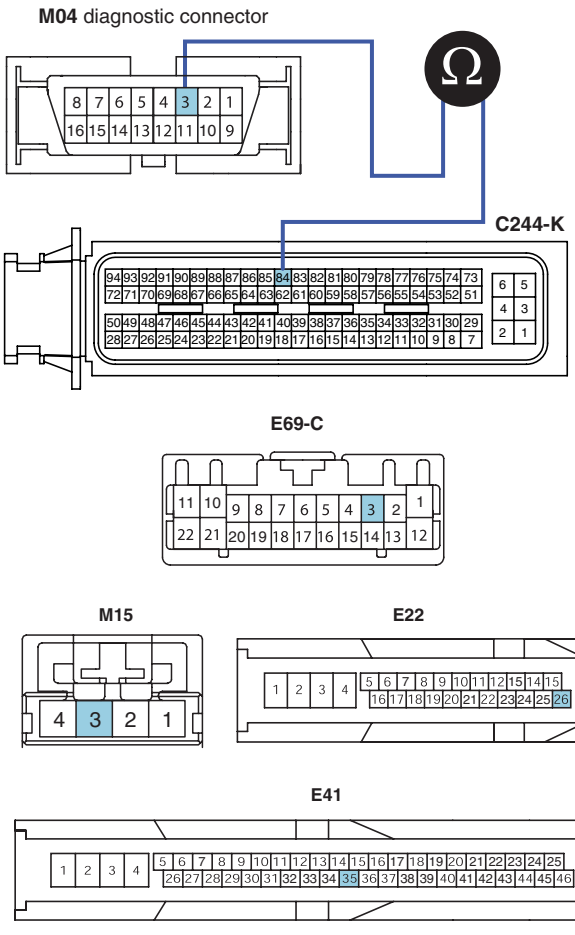
1) IG KEY "OFF", ENGINE "OFF"

2) Disconnect ECM, TCM, ABS(ESP), and Steering angle sensor connector.

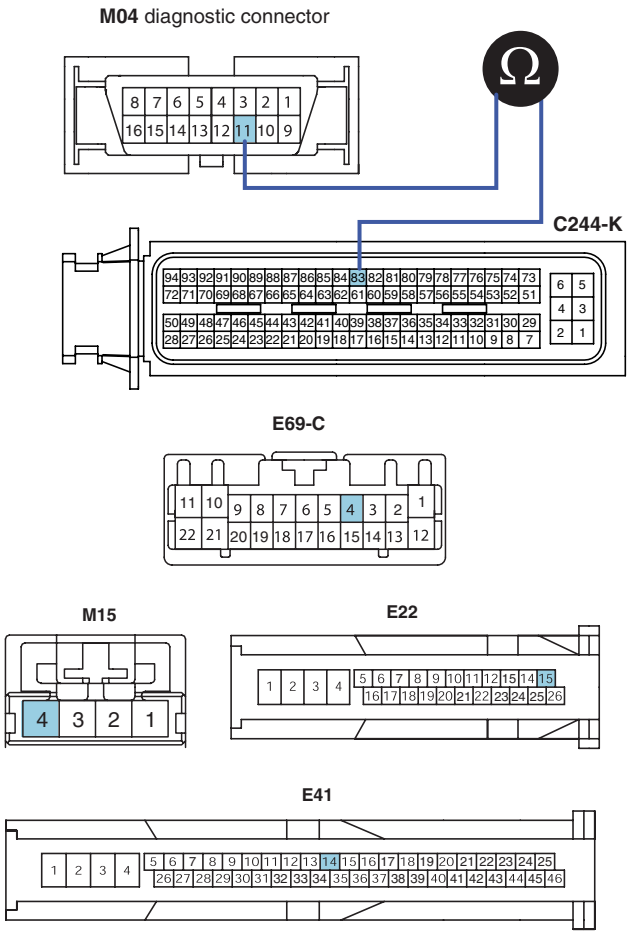
3) Check continuity between DLC terminal 3 and CAN HIGH terminal of each module.

4) Check continuity between DLC terminal 11 and CAN LOW terminal of each module.

[CAN HIGH]



[CAN LOW]



STGFL7180L

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 EC215F03

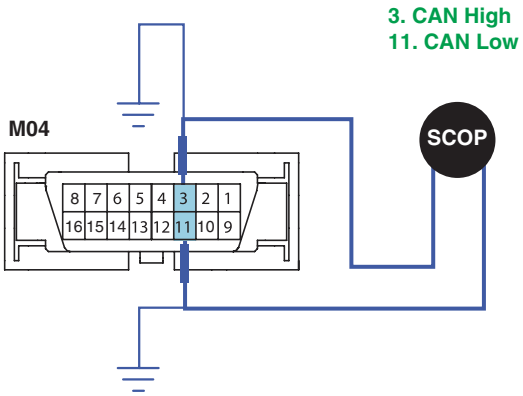
1. Check CAN communication waveform generation

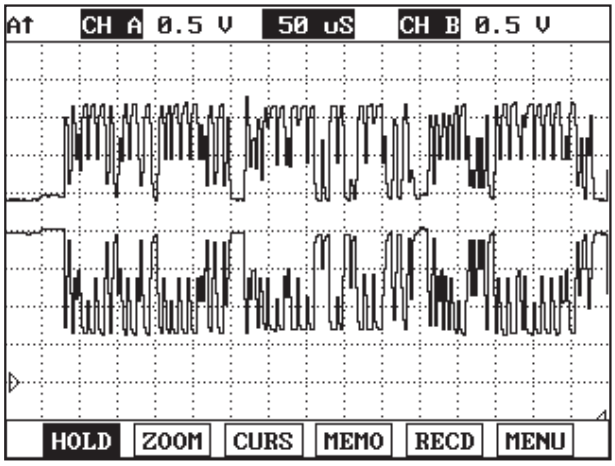
   1) IG KEY "OFF", ENGINE "OFF"

   2) Disconnect ECM, TCM, ABS(ESP), and Steering angle sensor connector.

   3) Connect 2 channel scope to DLC terminal 3(CAN HIGH) and 11(CAN LOW).

   4) IG KEY "ON" after connecting only "the Control Module(s) to be checked" to CAN BUS.





STGFL7181L

Specification : At IG KEY "ON", the waveform same as "Signal Waveform & Data" of this code generates.

NOTE

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.

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 E63D10D7

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

GENERAL DESCRIPTION EE02DF25

Refer to DTC U0122.

DTC DESCRIPTION EE1483B6

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 E146BFC2

Item	Detecting Condition			Possible Cause
DTC Strategy	• Signal monitoring			• CAN BUS • CAN communication module component
Enable Conditions	• IG KEY "ON"			
Threshold Value	• Abnormal torque increase request from TCS			
Diagnostic Time	• 500ms			
Fail Safe	Fuel cut	NO		
	EGR Off	NO		
	Fuel Limit	NO		
	Check Lamp	NO		

SCHEMATIC DIAGRAM E5C9B5C7

Refer to DTC U0122.

SIGNAL WAVEFORM AND DATA E16656CE

Refer to DTC U0122.

TERMINAL AND CONNECTOR INSPECTION E600B44A

Refer to DTC U0122.

SIGNAL CIRCUIT INSPECTION E7F6AEF5

1. Check CAN BUS resistance

   1) IG KEY "OFF", ENGINE "OFF"

   2) Measure the resistance between diagnostic connector 3 and 11. (TEST 1)

   3) Disconnect ECM, TCM, ABS(ESP), and Steering angle sensor connector.

   4) Measure the resistance between diagnostic connector 3 and 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".
▶ 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, TCM, ABS(ESP), and Steering angle sensor 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".

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, TCM, ABS(ESP), and Steering angle sensor 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 voltage 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".

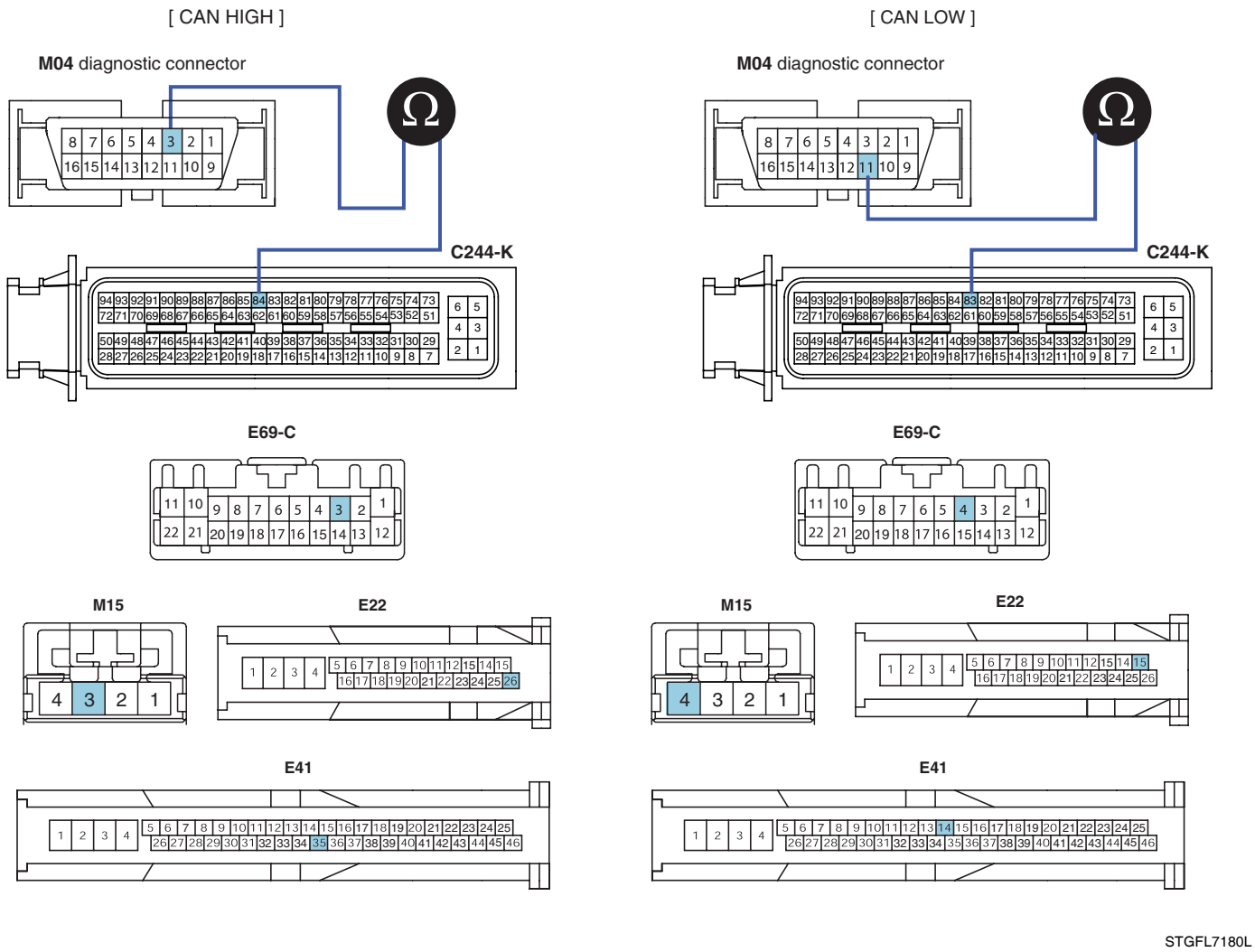
4. Check CAN BUS continuity

   1) IG KEY "OFF", ENGINE "OFF"

   2) Disconnect ECM, TCM, ABS(ESP), and Steering angle sensor connector.

   3) Check continuity between DLC terminal 3 and CAN HIGH terminal of each module.

   4) Check continuity between DLC terminal 11 and CAN LOW terminal of each module.



STGFL7180L

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 E82E83E2

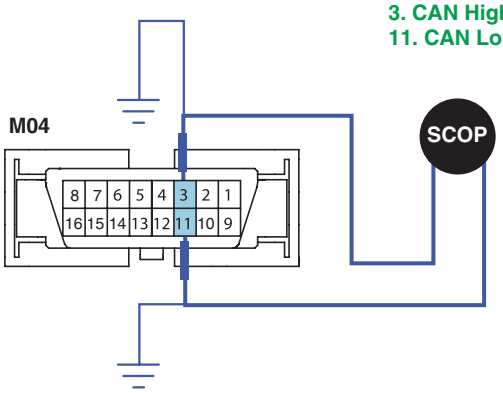
1. Check CAN communication waveform generation

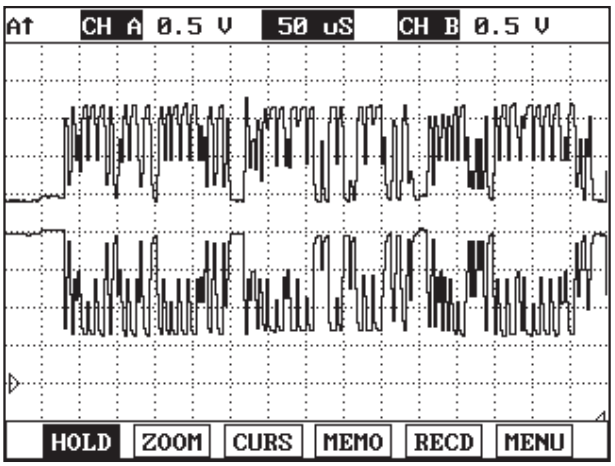
   1) IG KEY "OFF", ENGINE "OFF"

   2) Disconnect ECM, TCM, ABS(ESP), and Steering angle sensor connector.

   3) Connect 2 channel scope to DLC terminal 3(CAN HIGH) and 11(CAN LOW).

   4) IG KEY "ON" after connecting only "the Control Module(s) to be checked" to CAN BUS.





STGFL7181L

Specification : At IG KEY "ON", the waveform same as "Signal Waveform & Data" of this code generates.

NOTE

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.

   5) Does correct waveform generate from each module?

YES

▶ Go to "Verification of Vehicle Repair".

NO

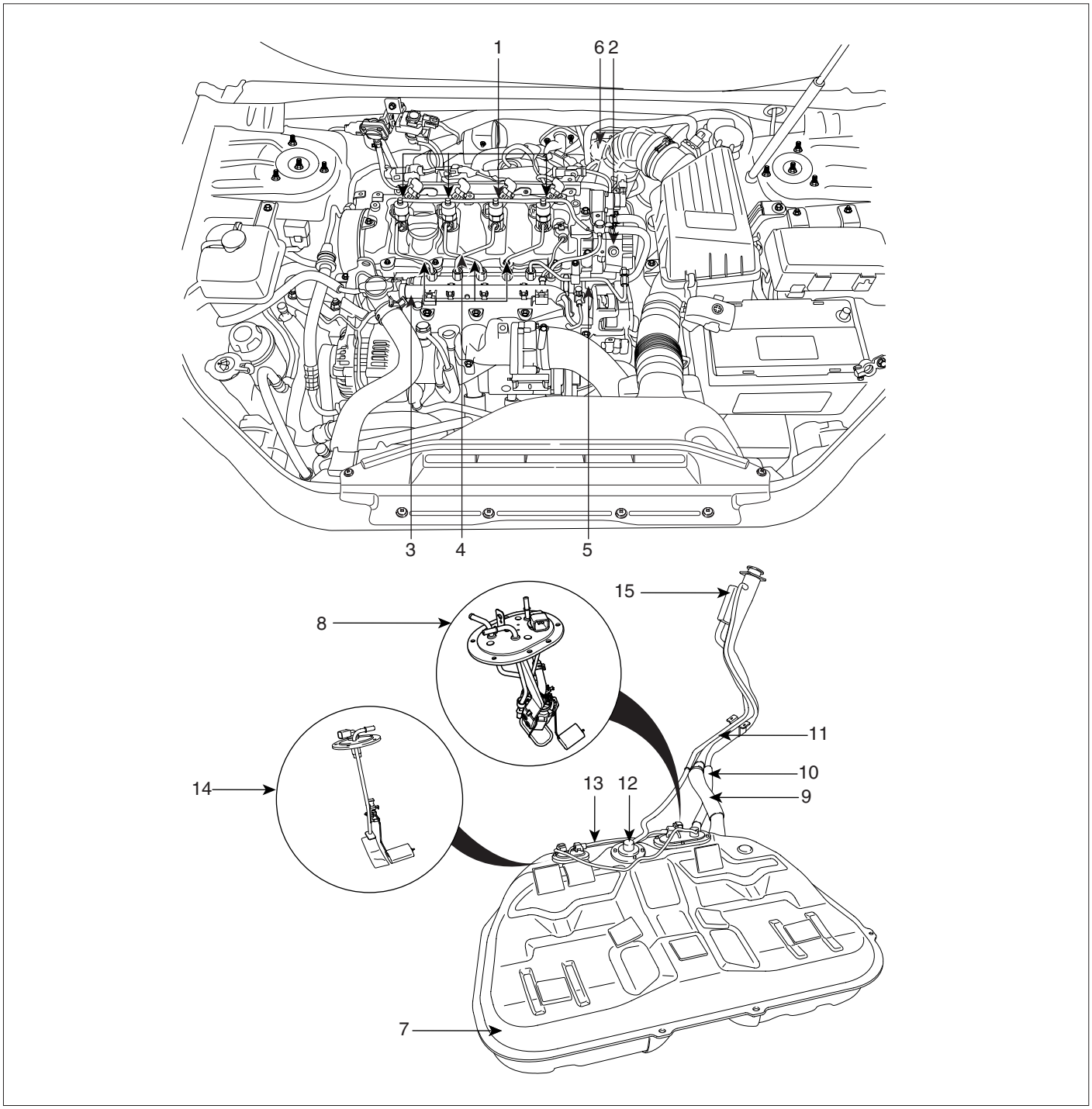
▶ Replace the module which generates poor communication waveform, and go to "Verification of Vehicle Repair".

VERIFICATION OF VEHICLE REPAIR E57EFCA4

Refer to DTC U0122.

FUEL DELIVERY SYSTEM-DIESEL

COMPONENT LOCATION E10AFDE9



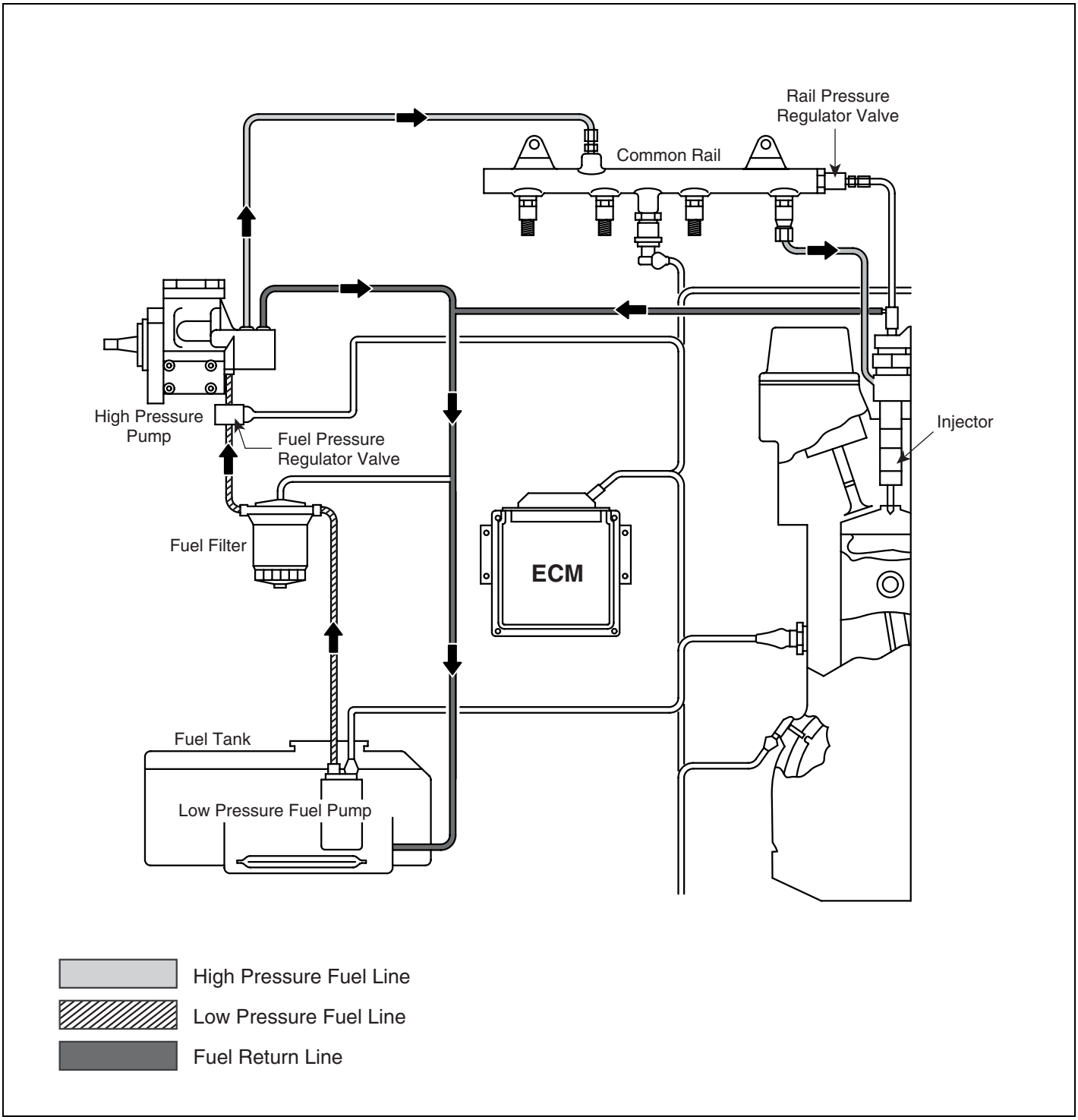
1. Injector
2. High Pressure Fuel Pump
3. Common Rail
4. High Pressure Pipe (Injector → Common Rail)
5. High Pressure Pipe (Common Rail → High Pressure Fuel Pump)
6. Fuel Filter
7. Fuel Tank
8. Fuel Pump (Low Pressure)
9. Fuel Filler Hose
10. Leveling Hose
11. Ventilation Hose
12. Fuel-cut valve
13. Suction hose
14. Sub fuel sender
15. Fuel tank air filter

STGFL7142L

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 E61F31CB



LFIG701A

COMPONENTS

● LOW PRESSURE FUEL SYSTEM COMPONENTS

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

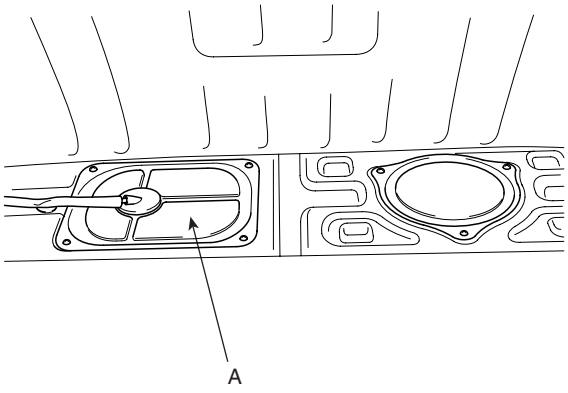
INJECTORS
The nozzles of these injectors open when the solenoid valve is triggered and permit the flow of fuel. They inject the fuel directly into the engine's combustion chamber. The excess fuel which was needed for opening the injector nozzles flows back to the tank through a collector line. The return 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

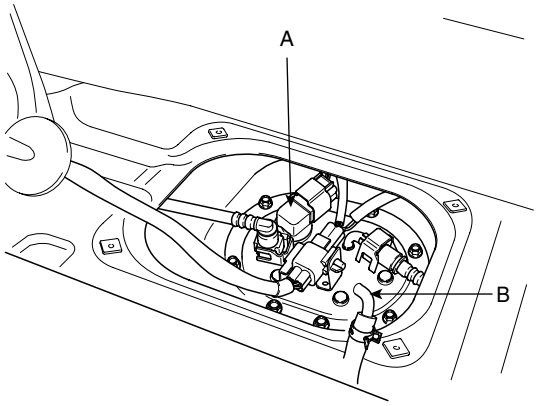
REMOVAL E2BD0AF1

1. Remove the Service Cover (A) in the trunk.



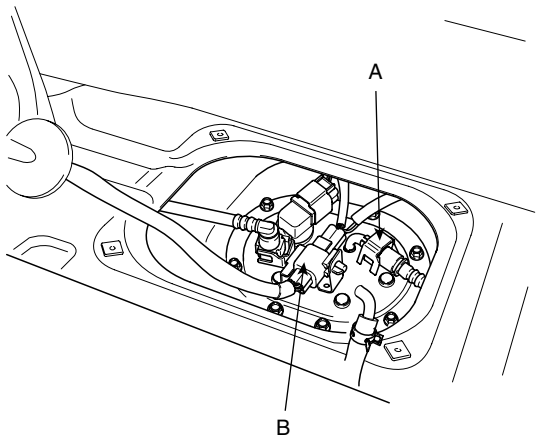
KFBF261A

2. Disconnect the Fuel Pump Connector (A) and the return hose (B).



STGFL6110D

3. Disconnect the Fuel Feed Quick-Connector (A) and Electric Connector (B).

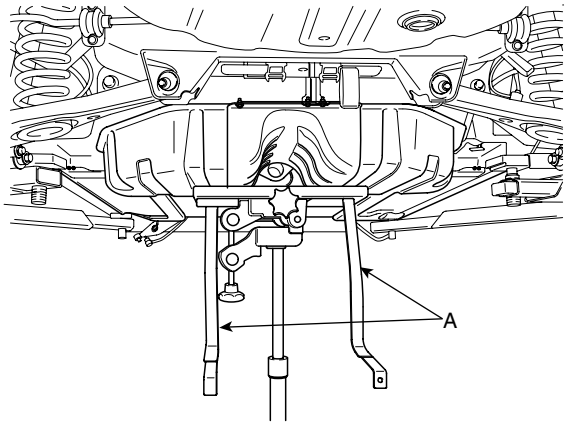


STGFL6111D

4. Lift the vehicle.

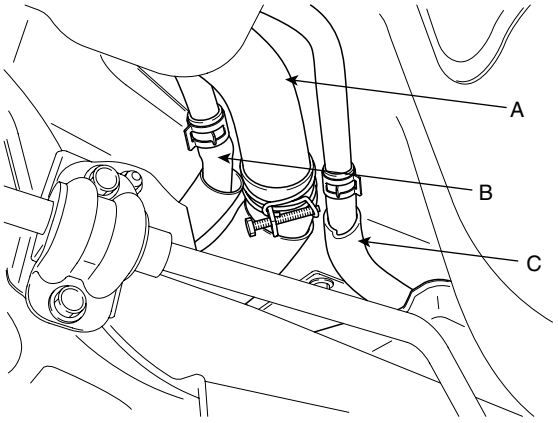
5. Remove the center and main mufflers (Refer to the group "EM").

6. Support the fuel tank with a jack and remove the Fuel Tank band (A).



KFBF266A

7. Disconnect the Fuel Feed Hose (A), Leveling Hose (B) and Ventilation Hose (C).



KFBF267A

8. With moving the jack down slowly, remove the Fuel Tank from the vehicle.

INSTALLATION E4CAC9E6

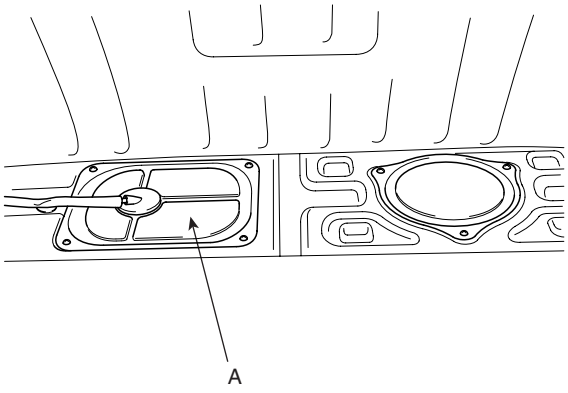
1. Install the Fuel Tank according to the reverse order of "REMOVAL" procedure.

Tightening Torque
39.2 ~ 53.9 N·m (40. ~ 5.5 kgf·m, 28.9 ~ 39.8 lbf·ft)

FUEL PUMP

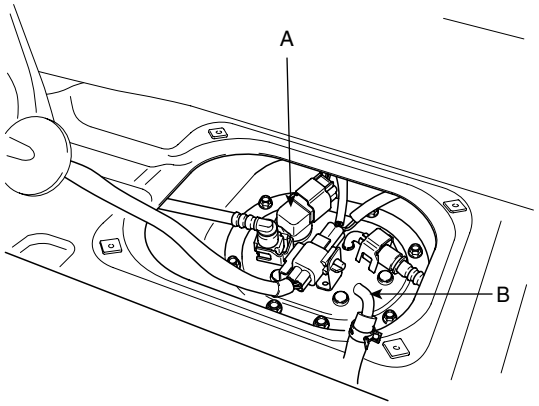
REMOVAL EE3AAFEB

1. Remove the Service Cover (A) in the trunk.



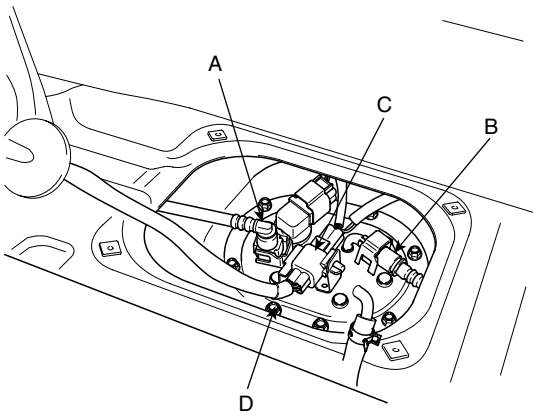
KFBF261A

2. Disconnect the Fuel Pump Connector (A) and the return hose (B).



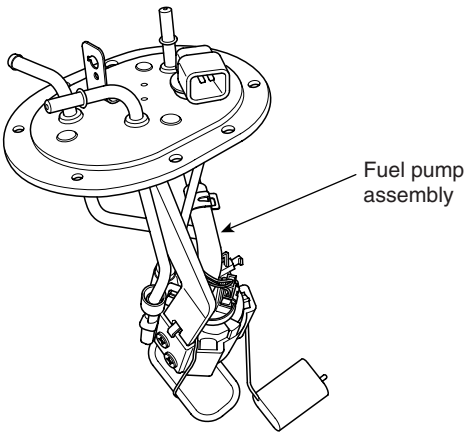
STGFL6110D

3. Disconnect Suction Tube Quick-Connector (A), Fuel Feed Quick-Connector (B) and integrated Connector (C).



STGFL6112D

4. Unfasten the Fuel Pump mounting bolts (D) and remove the fuel pump assembly.



STGFL7613L

INSTALLATION E27FCC5B

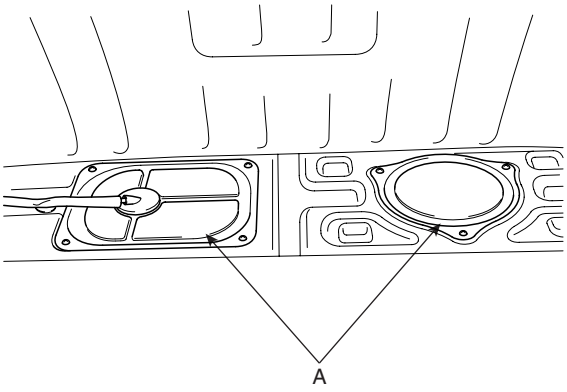
1. Install the Fuel Pump assembly according to the reverse order of "REMOVAL" procedure.

Tightening Torque
2.0 ~ 2.9 N·m (0.2 ~ 0.3 kgf·m, 1.4 ~ 2.2 lbf·ft)

SUB FUEL SENDER

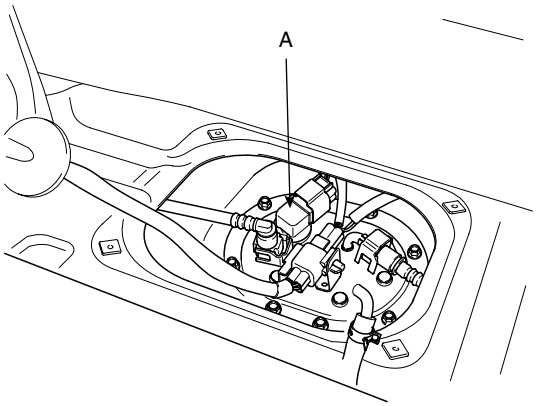
REMOVAL E14E0E6B

1. Remove the Service Cover (A) in the trunk.



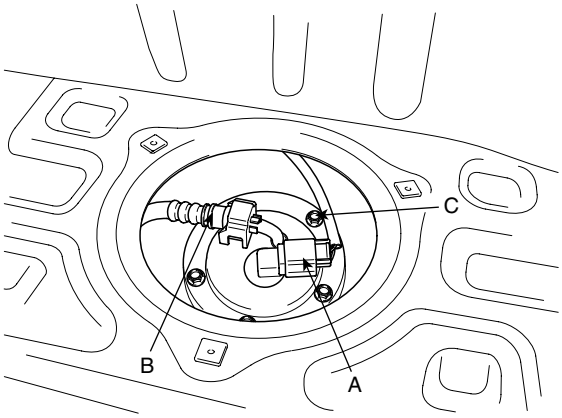
STGFL7900L

2. Disconnect the Fuel Pump Connector (A).



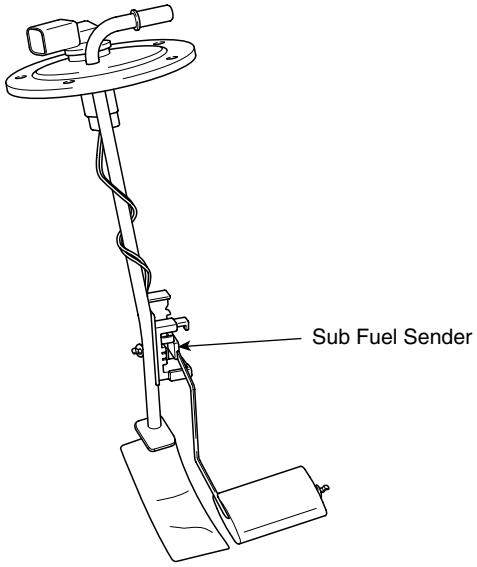
STGFL6114D

3. Disconnect Sub Fuel Sender Connector (A) and Suction Tube Quick-Connector (B).



KFBF268A

4. Unfasten the Sub Fuel Sender mounting bolts (C) and remove the Sub Fuel Sender.



EFBF269A

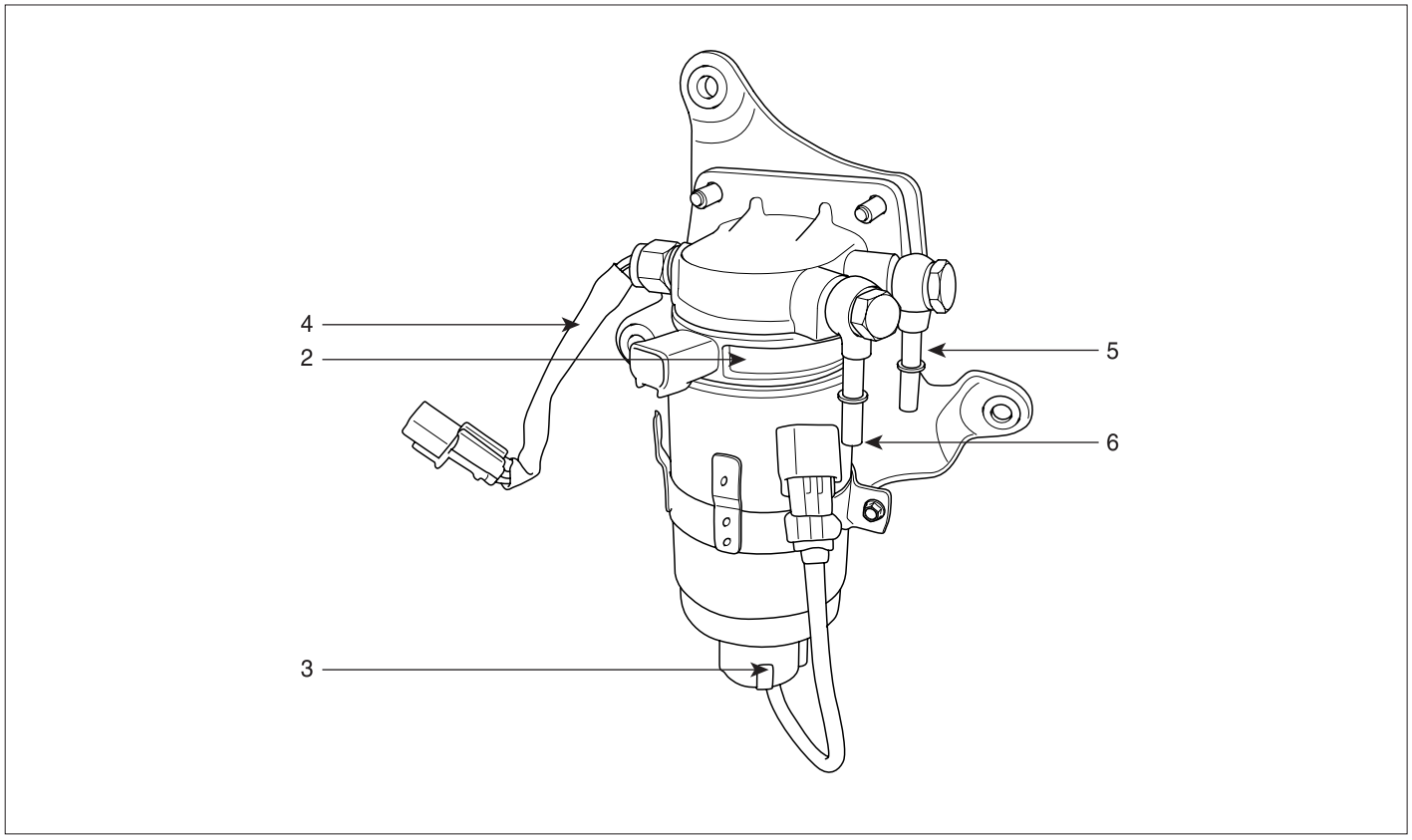
INSTALLATION E2D9EB3E

1. Install the Sub Fuel Sener according to the reverse order of "REMOVAL" procedure.

Tightening Torque
2.0 ~ 2.9 N·m (0.2 ~ 0.3 kgf·m, 1.4 ~ 2.2 lbf·ft)

FUEL FILTER

COMPONENTS E3D2FD2A

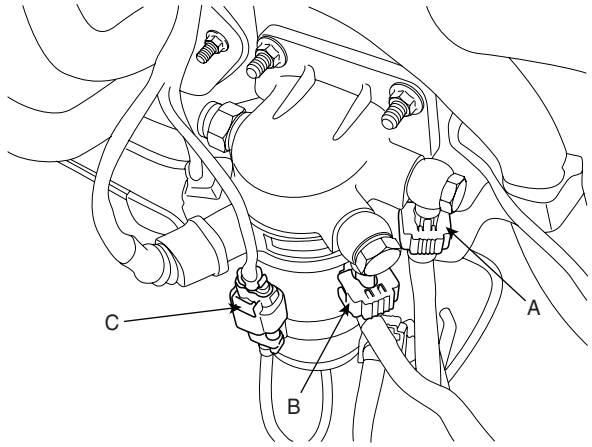


1. Fuel Filter
2. Heater
3. Water Sensor
4. Thermostat
5. Nipple (From Fuel Tank)
6. Nipple (To High Pressure Pump)

SNFFL6151L

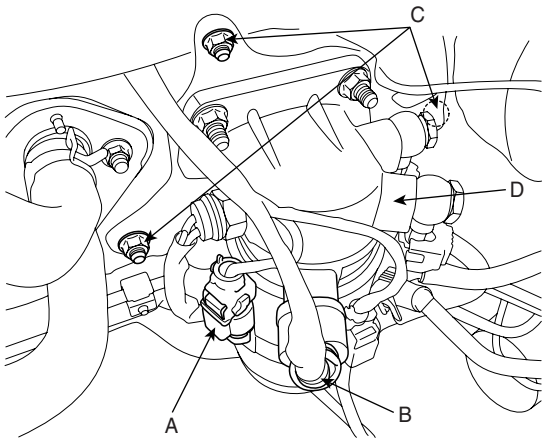
REMOVAL EB3C2386

1. Disconnet the fuel input quick-connector (A) and the output connector (B), the water sensor connector (C).



SNFFL6151D

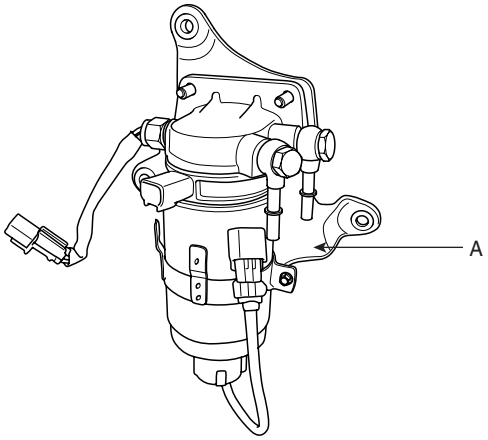
2. Disconnect the thermostat connector (A) and the heater connector (B).



SNFFL6150D

3. Unscrew the three fuel filter bfacket mounting nuts (C).

4. Remove the fuel filter assembly (A)



SNFFL6152D

INSTALLATION EB836034

1. Installation is the reverse order of "REMOVAL" procedure.

HIGH PRESSURE FUEL PUMP

DESCRIPTION E1846D0A

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.

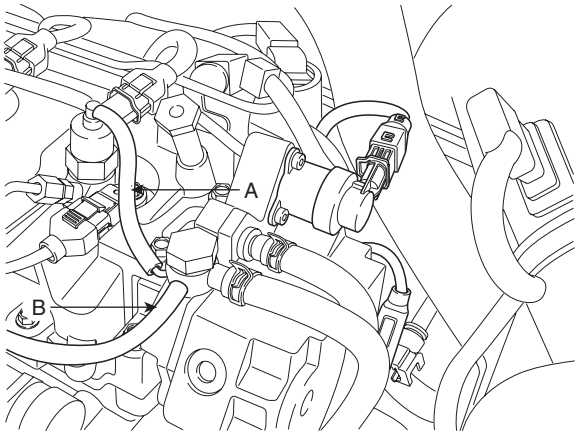
REMOVAL E124AF9F

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.**

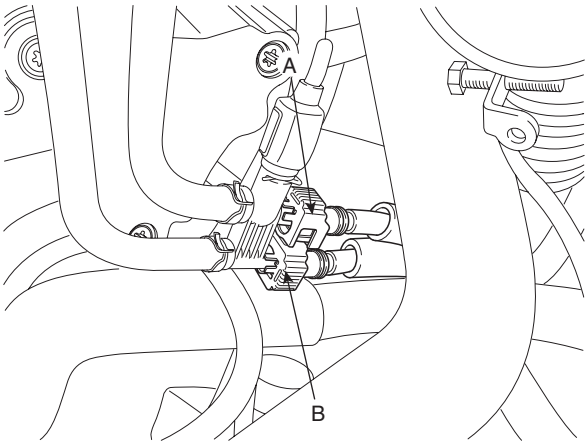
1. Remove the air cleaner assembly (Refer to group "EM" in this Shop Manual).

2. Disconnect the return hoses (A,B) connected with the injectors and the common rail.



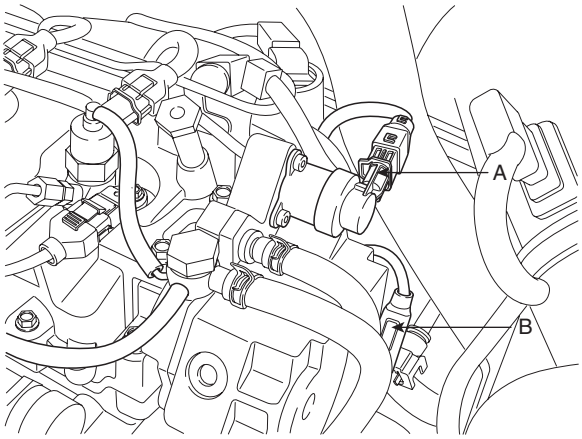
LFIG076A

3. Disconnet the fuel feed hose quick-connector (A) and the return hose quick-connector (B).



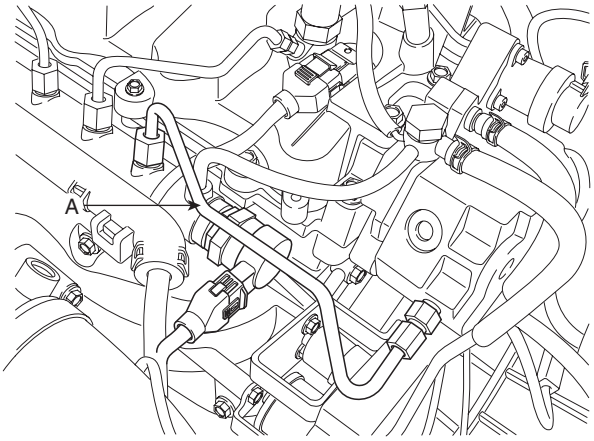
LFIG077A

4. Disconnect the fuel pressure regulator valve connector (A) and the fuel temperature sensor connector (B).



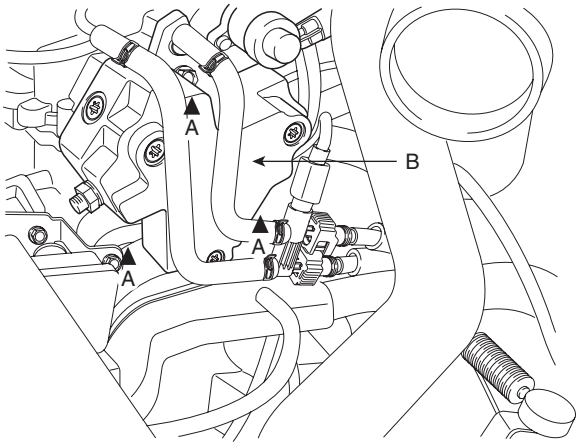
LFIG078A

5. Disconenct the high pressure pipe (A) connecting the common rail with the high pressure pump.

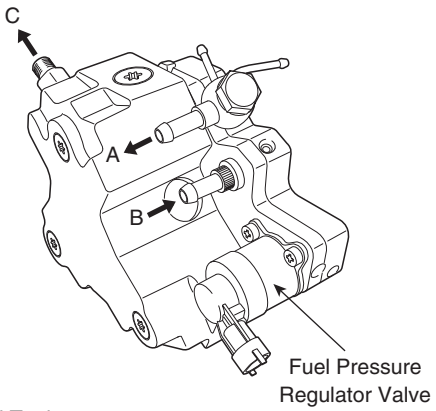


LFIG079A

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



LFIG080A



A : To Fuel Tank
(Return Line)
B : From Fuel Tank
C : To High Pressure Fuel Pump

LFIG081A

INSTALLATION E6B56913

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 mounting bolts: 19.6 ~ 26.5 N·m (2.0 ~ 2.7 kgf·m, 14.5 ~ 19.5 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)

COMMON RAIL

DESCRIPTION EDCDAA09

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.

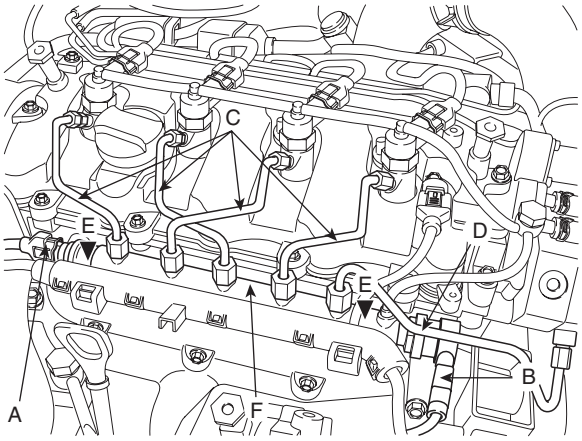
In order to comply with the wide variety of engine installation conditions, the common rail with its flow limiters and the provistions for attaching rail pressure sensor, fuel pressure control valve, and pressure limiter valve is available in a number of different designs.
The available common rail volume 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 E0F2CC99

WARNING

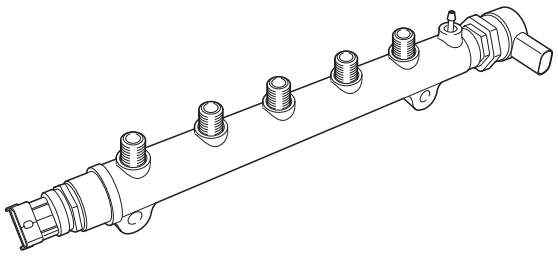
- **Common Rail Fuel Injection System is subject to extremely high pressure (Approximately 1,600 bar)**
- **Never perform any work on injection system with engine running or within 30 seconds after the engine stops.**
- **Always pay attention to safety precaution.**
- **Ensure the absolute cleanliness.**
- **It is not recommended to remove the injectors without any notice.**

1. Disconnect the rail pressure sensor connector (A) and rail pressure regulator valve connector (B).



LFIG082A

2. Disconnect the high pressure pipe (C) connecting the injectors with the common rail.
3. Disconnect the high pressure pipe (D) connecting the common rail with the high pressure fuel pump.
4. Unscrew the two mounting bolts (E) and remove the common rail (F).



LFIG083A

INSTALLATION EDD55345

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).

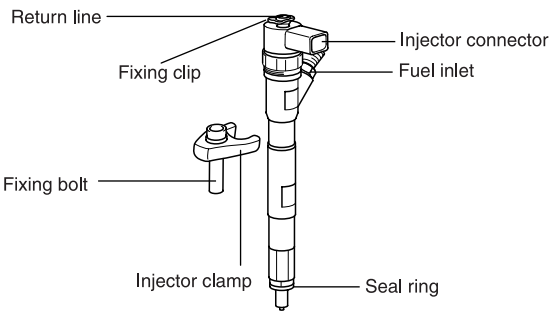
Item	Dimension	SST No.
Flange Nut (Injector Side)	14 mm (0.551 in)	09314-27110
Flange Nut (HP Pump Side)		
Flange Nut (Common Rail Side)	17 mm (0.669 in)	09314-27120

· Common rail mounting bolts: 19.6 ~ 26.5 N·m (2.0 ~ 2.7 kgf·m, 14.5 ~ 19.5 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 EE4DD145

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.



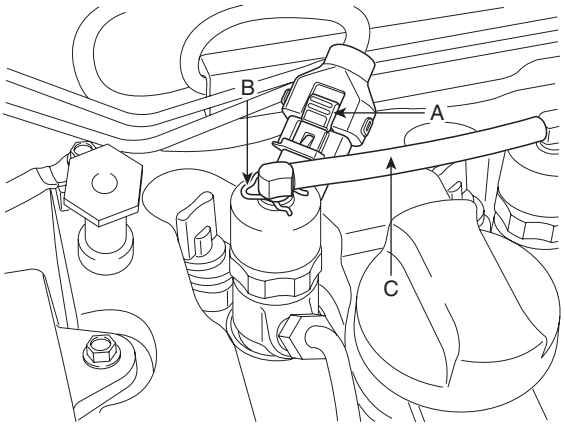
LFIG101A

REMOVAL E99E9BCE

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.**

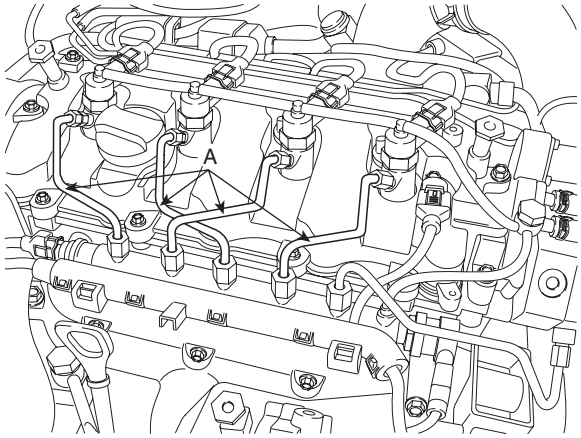
1. Disconnect the injector connector (A).



LFIG084A

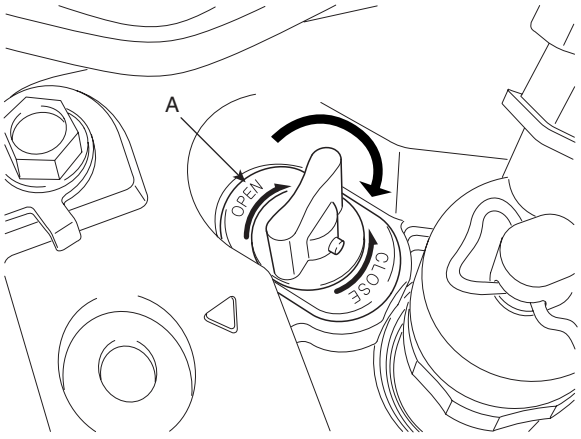
2. After removing the clip (B), disconnect the retun hose (C) from the injectors

3. Disconnect the high pressure pipe (A) connecting the injectors with the common rail.



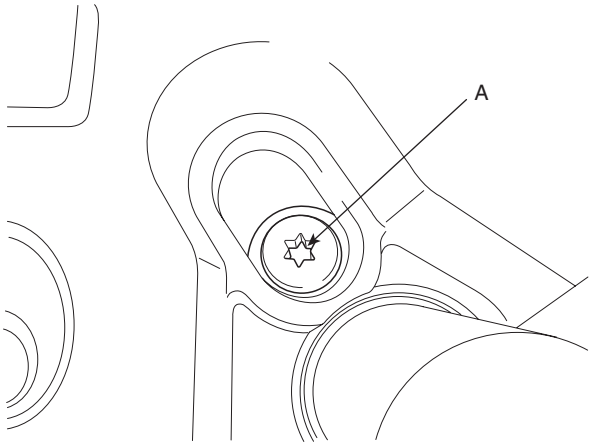
LFIG085A

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

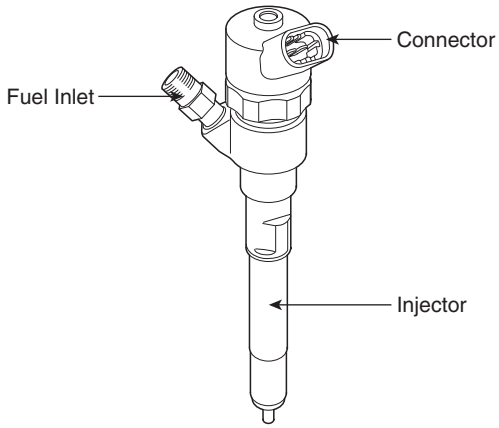


SNFFL6186L

5. Unscrew the clamp tightening bolt (A) and pull the injector upward with the "Injector Remover" and the "Injector Remover Adapter" (Refer to "SPECIAL SERVICE TOOL" section).



LFIG087A



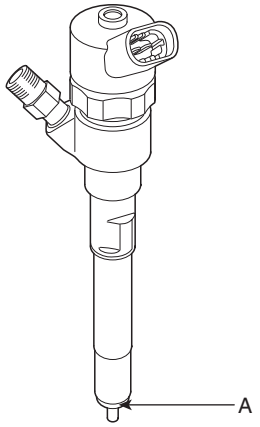
LFIG088A

INSTALLATION E63E0B78

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.



LFIG089A

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

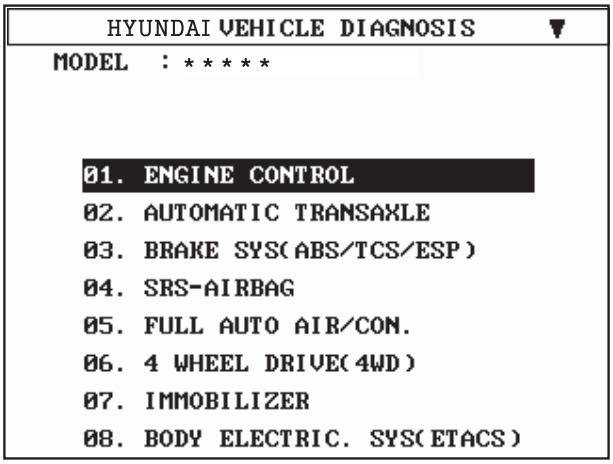
· Injector clamp mounting bolts: 24.5 ~ 28.4 N·m (2.5 ~ 2.9 kgf·m, 18.1 ~ 20.1 lbf·ft)
· High pressure pipe flange nuts (Injectors ↔ Common Rail): 24.5 ~ 28.4 N·m (2.5 ~ 2.9 kgf·m, 18.1 ~ 20.1 lbf·ft)

REPLACEMENT E16A29BC

CAUTION

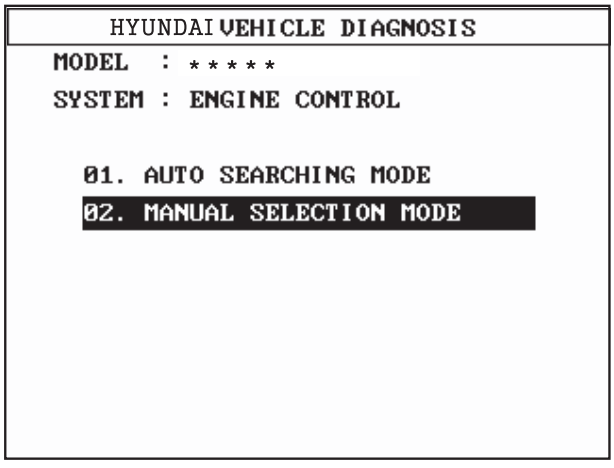
After replacing (an) injector(s), MUST input the injector data (7 digit) into the ECM.

1. Turn ignition switch OFF.
2. Replace the injector with a new one according to the "REMOVAL" and "INSTALLATION" procedures.
3. Connect a scan tool to Data Link Connector (DLC) and turn ignition switch on.
4. Select "ENGINE CONTROL".



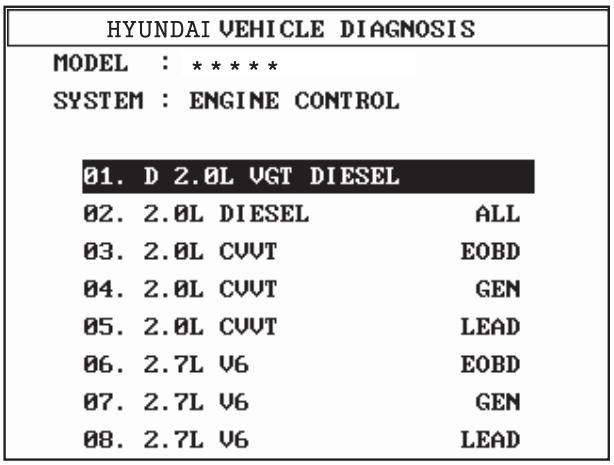
STGFL7115L

5. Select "MANUAL SELECTION MODE".



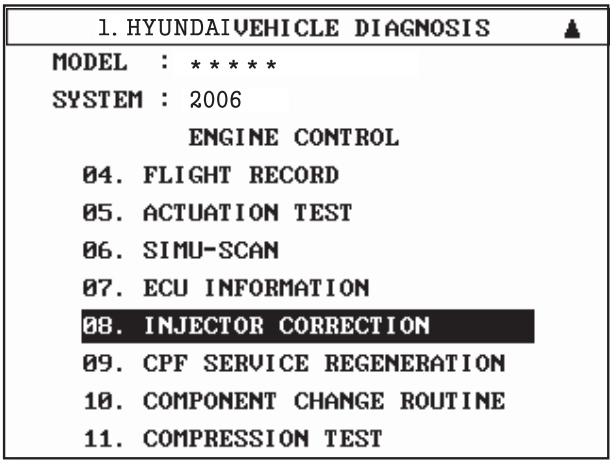
STGFL7116L

6. Select "D 2.0L VGT DIESEL".



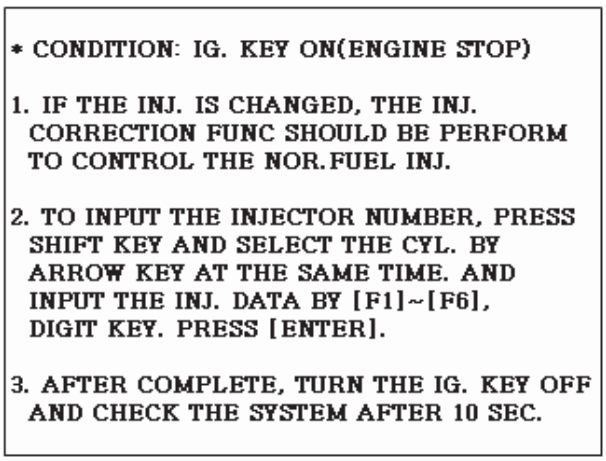
STGFL7117L

7. Select "INJECTOR CORRECTION".



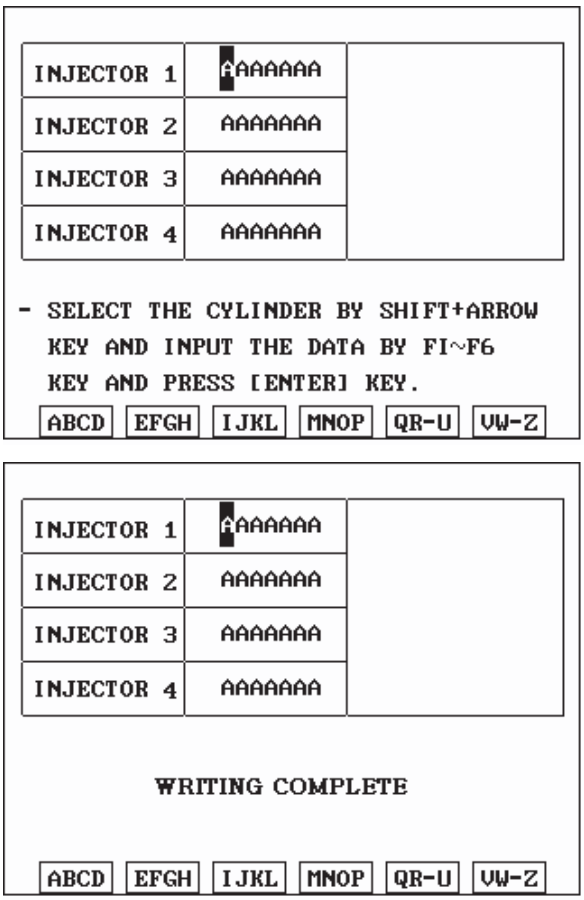
STGFL7134L

8. Press "ENTER" key.



LFIG135A

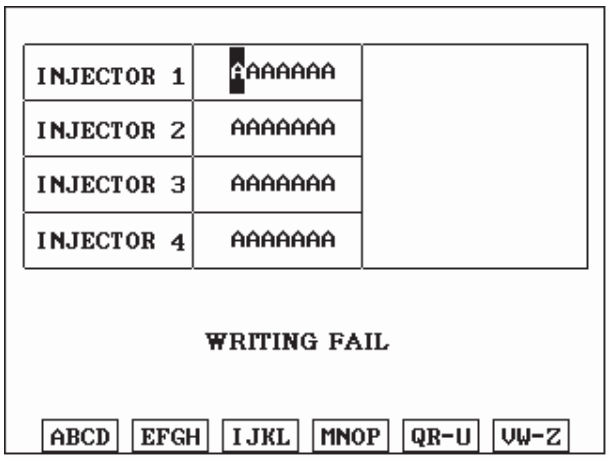
9. Input the injector data (7 digit) written on the top of each injector with function keys ([F1] ~ [F6]) and number keys.



LFIG136A

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.



LFIG137A

INSPECTION E67C26FA

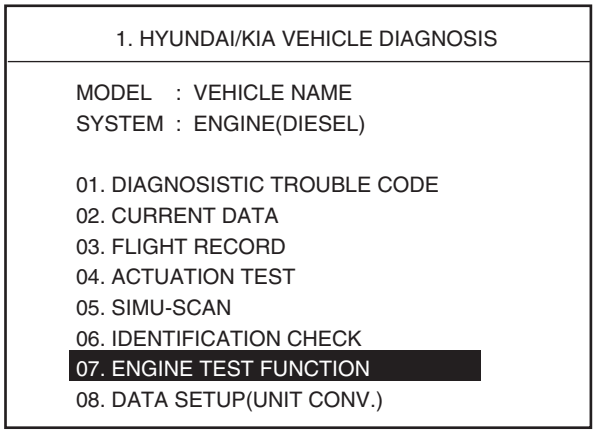
USING HI-SCAN(PRO)

TEST MODE

- COMPRESSION TEST
- IDLE SPEED COMPARISON
- INJECT QUANTITY COMPARISON

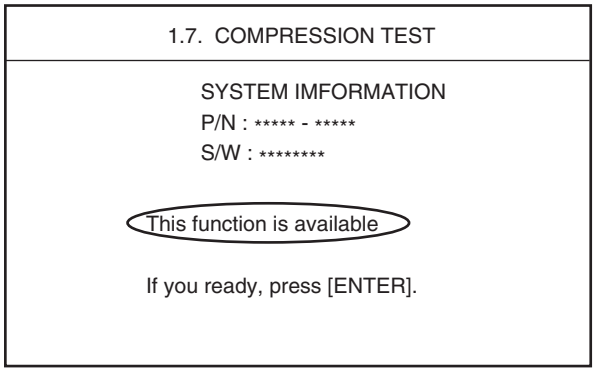
TEST PROCEDURE

1. Connect Scan tool to the DLC and select "Vehicle" and "Engine Test Function".

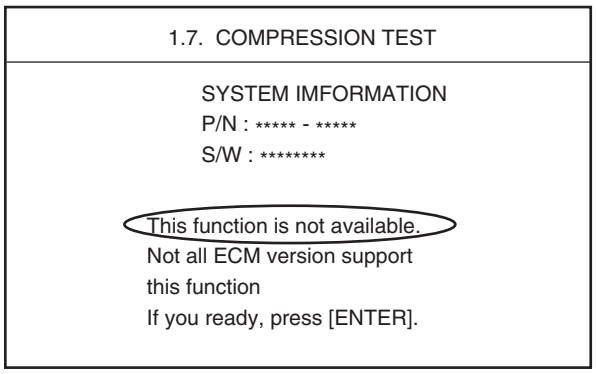


LFIG090A

2. Information for ECM version is displayed as below.



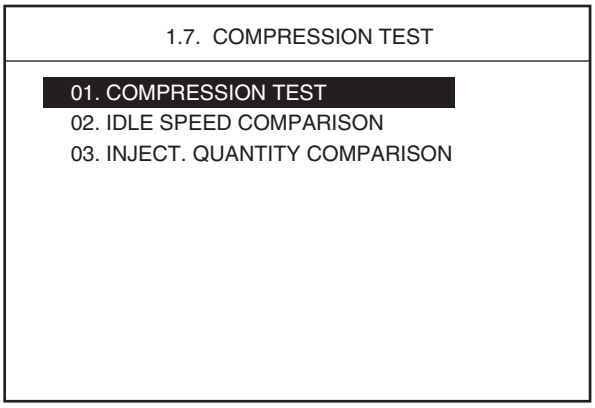
<Available system>



<Not available system>

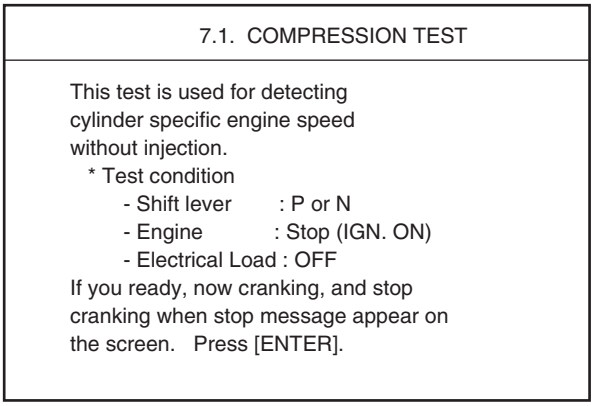
LFIF660B

3. After pressing "[ENTER]" select "COMPRESSION TEST" mode and press "[ENTER]".



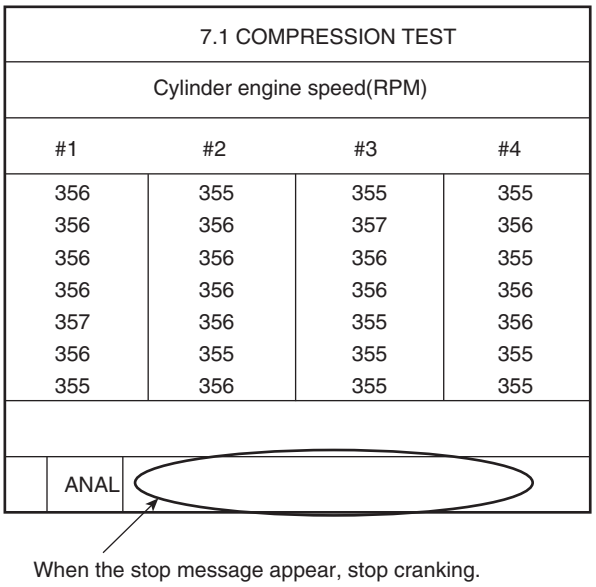
LFIF660D

4. Set the test condition described as below screen and then, crank engine. When engine stop message being appeared, stop cranking.



LFIF660E

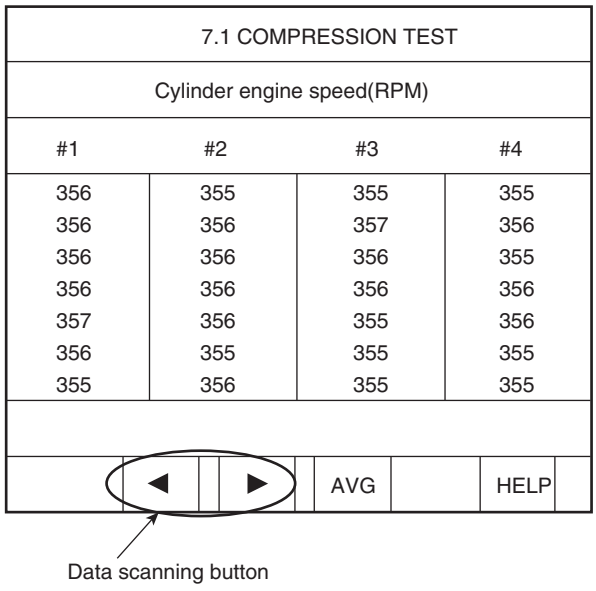
5. Press "ANAL" and the test result is appeared.



LFIF660F

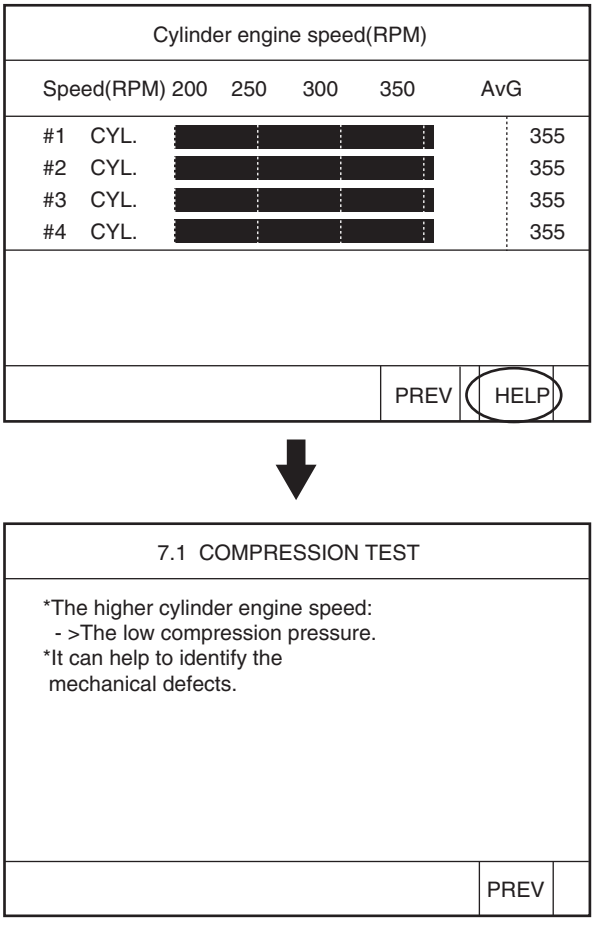
NOTE

During cranking engine does not start.



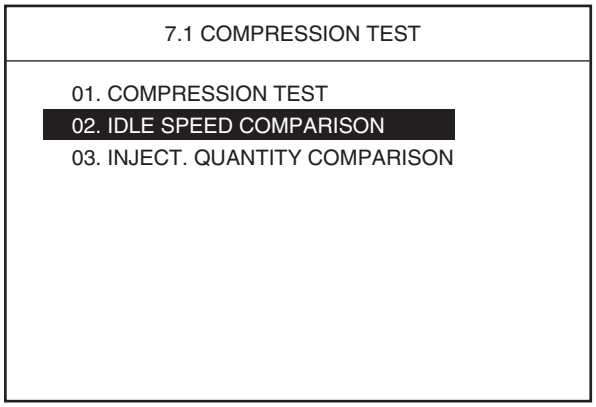
LFIF660G

6. Press "AVG" and the data average of each cylinder is appeared.
Press "HELP" and description of the data is appeared.



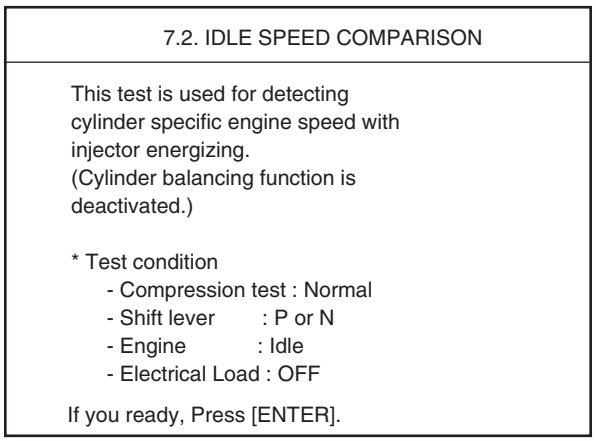
LFIF660H

7. After pressing "ESC", select "IDLE SPEED COMPARISON" and press "[ENTER]".



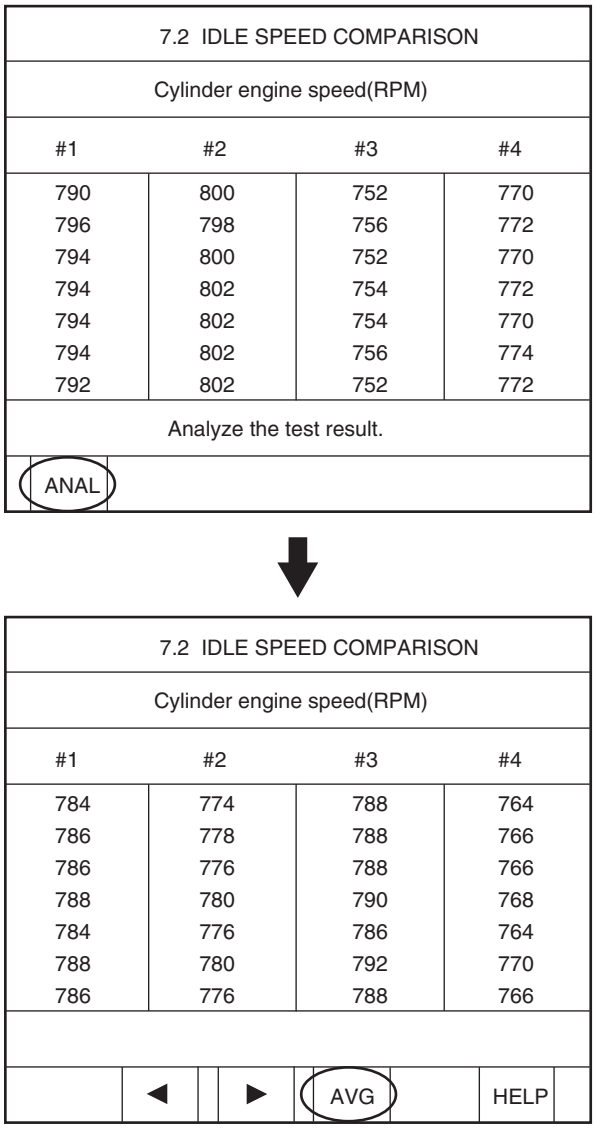
LFIF002A

8. Set the test condition described as below screen and press "[ENTER]".



LFIF660J

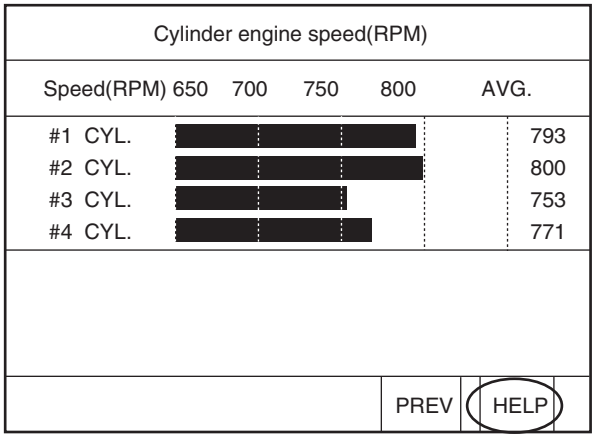
9. The rpm data of each cylinder is appeared.

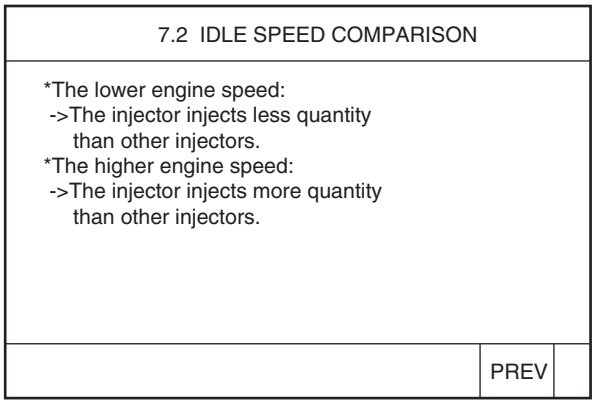


LFIF660K

10. Press "AVG" and teh data average of each cylinder is appeared.

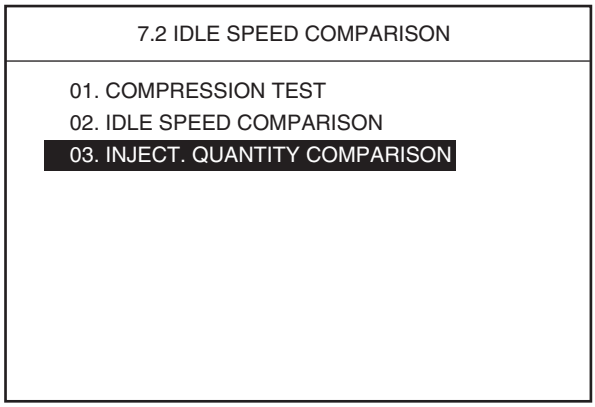
    Press "HELP" and description of the data is appeared.





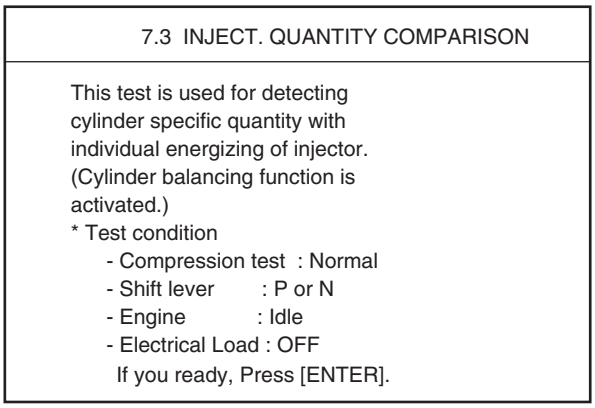
LFIF660M

11. After pressing "ESC", select "INJECT QUANTITY COMPARISON" and press "[ENTER]".



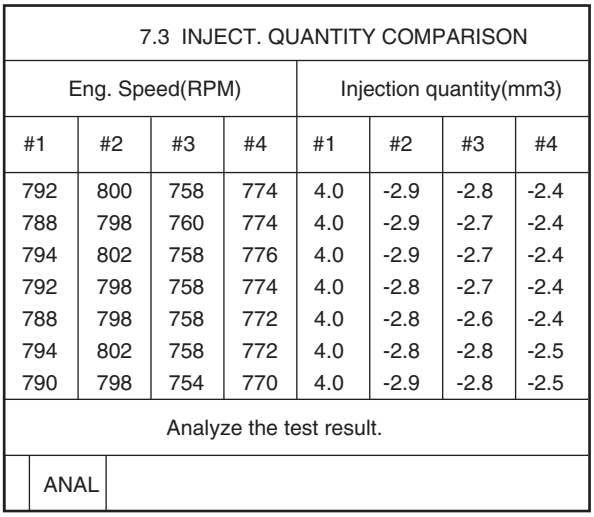
LFIF700A

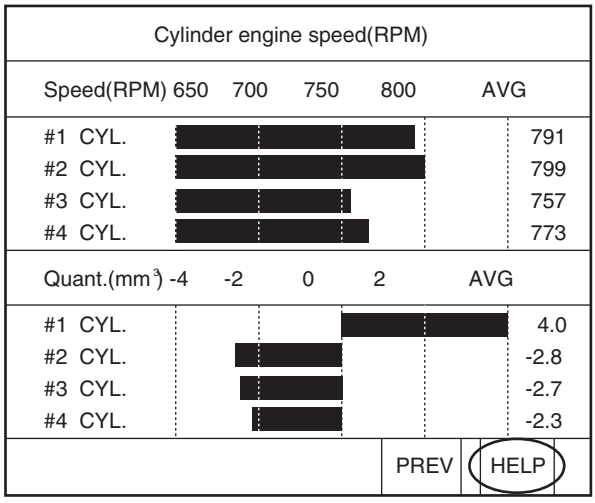
12. Set the test condition described as below screen and press "[ENTER]".



LFIF660O

13. The data of each cylinder about RPM and compensating injection quantity is appeared.





<Abnormal state>

LFIF660P

14. Press "HELP" and description of the data is displayed as below.

7.3 INJECT. QUANTITY COMPARISON
*The positive correction value: ->The fuel injection of the cylinder is less than that of other cylinder. *The negative correction value: ->The fuel injection of the cylinder is more than that of other cylinder. *Extreme correction value identifies a problematic injector. After replacinga injector with new one, reset & confirm the engine condition.

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 the injector connector.
3. Measure resistance between terminal 1 and 2.

Specification : 0.33Ω at 20℃(68˚F)