Specifications

Fuel Delivery System

Items	Specification	
Fuel Tank	Capacity	65 lit. (17.2 U.S.gal., 68.7 U.S.qt., 57.2 Imp.qt.)
Fuel Filter	Type	Paper type
Fuel Pressure Regulator	Regulated Fuel Pressure	379.5kpa (3.87 kgf/cm², 55.0 psi)
Fuel Pump	Type	Electrical, in-tank type
	Driven by	Electric motor

Sensors

Manifold Absolute Pressure Sensor (MAPS) #1
▷ Type: Piezo-resistive pressure sensor type
▷ Specification

Pressure (kPa)	Output Voltage (V)
25.4	0.5
50.0	0.95
220.0	4.10
241.9	4.5

Intake Air Temperature Sensor (IATS)
▷ Type: Thermistor type
▷ Specification

Temperature [°C(°F)]	Resistance (kΩ)
-40(-40)	40.93 ~ 48.35
-20(-4)	13.89 ~ 16.03
0(32)	5.38 ~ 6.09
10(50)	3.48 ~ 3.90
20(68)	2.31 ~ 2.57
40(104)	1.08 ~ 1.21
50(122)	1.56 ~ 1.74
60(140)	0.54 ~ 0.62
80(176)	0.29 ~ 0.34

Manifold Absolute Pressure Sensor (MAPS) #2
▷ Type: Piezo-resistive pressure sensor type
▷ Specification

Pressure (kPa)	Output Voltage (V)
25.4	0.5
50.0	0.95
220.0	4.10

241.9	4.5

Ambient Temperature Sensor (ATS)
▷ Type: Thermistor type
▷ Specification

Temperature [°C(°F)]	Resistance (kΩ)
-40(-40)	55.61 ~ 66.21
-20(-4)	18.76 ~ 21.37
0(32)	7.26 ~ 7.95
20(68)	3.18 ~ 3.37
25(77)	2.63 ~ 2.77
40(104)	1.50 ~ 1.62
60(140)	0.76 ~ 0.84
80(176)	0.40 ~ 0.45

Engine Coolant Temperature Sensor (ECTS)
▷ Type: Thermistor type
▷ Specification

Temperature [°C(°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

Throttle Position Sensor (TPS) [integrated into ETC Module]
▷ Type: Variable resistor type
▷ Specification

Throttle Angle(°)	Output Voltage (V)	
	TPS1	TPS2
0	0	5.0
10	0.48	4.52
20	0.95	4.05
30	1.43	3.57
40	1.90	3.10
50	2.38	2.62
60	2.86	2.14
70	3.33	1.67
80	3.81	1.19
90	4.29	0.71

100	4.76	0.24
105	5.0	0
C.T (6~15°)	0.29 ~ 0.71	4.29 ~ 4.71
W.O.T (93~102°)	4.43 ~ 4.86	0.14 ~ 0.57

Item	Resistance (kΩ)
TPS1	0.875 ~ 1.625 [20°C(68°F)]
TPS2	0.875 ~ 1.625 [20°C(68°F)]

Crankshaft Position Sensor (CKPS)
▷ Type: Hall effect type
Camshaft Position Sensor (CMPS)
▷ Type: Hall effect type
Knock Sensor (KS)
▷ Type: Piezo-electricity type
▷ Specification

Item	Specification
Capacitance (pF)	1,480 ~ 2,220

Heated Oxygen Sensor (HO2S)
▷ Type: Zirconia (ZrO2) Type
▷ Specification

A/F Ratio (λ)	Output Voltage(V)
RICH	0.80 ~ 0.92
LEAN	0.04 ~ 0.1

Item	Specification
Heater Resistance (Ω)	3.3 ~ 4.1 [21°C(69.8°F)]

CVVT Oil Temperature Sensor (OTS)
▷ Type: Thermistor type
▷ Specification

Temperature [°C(°F)]	Resistance (kΩ)
-40(-40)	52.15
-20(-4)	16.52
0(32)	6.0
20(68)	2.45
40(104)	1.11
60(140)	0.54
80(176)	0.29

Accelerator Position Sensor (APS)
▷ Type: Magnetic field sensitive sensor
▷ Specification

Accelerator Position	Output Voltage (V)	
	APS1	APS2
C.T	0.58 ~ 0.93	0.29 ~ 0.46
W.O.T	3.85 ~ 4.35	1.93 ~ 2.18

Fuel Tank Pressure Sensor (FTPS)
▷ Type: Piezo - Resistivity type
▷ Specification

Pressure (kPa)	Output Voltage (V)
-6.67	0.5
0	2.5
+6.67	4.5

Actuators

Injector
▷ Specification

Item	Specification
Coil Resistance (Ω)	13.8 ~ 15.2 [20°C(68°F)]

ETC Motor [integrated into ETC Module]
▷ Specification

Item	Specification
Coil Resistance (Ω)	1.2 ~ 1.8 [20°C(68°F)]

Purge Control Solenoid Valve (PCSV)
▷ Specification

Item	Specification
Coil Resistance (Ω)	19.0 ~ 22.0 [20°C(68°F)]

CVVT Oil Control Valve (OCV)
▷ Specification

Item	Specification
Coil Resistance (Ω)	6.9 ~ 7.9 [20°C(68°F)]

WGT Control Solenoid Valve
▷ Specification

Item	Specification
Coil Resistance (Ω)	28.3 ~ 31.1 [20°C(68°F)]

RCV Control Solenoid Valve
▷ Specification

Item	Specification
Coil Resistance (Ω)	28.3 ~ 31.1 [20°C(68°F)]

Ignition Coil
▷ Type: Stick type
▷ Specification

Item	Specification
1st Coil Resistance (Ω)	0.62 ± 10%[20°C(68°F)]
2nd Coil Resistance (kΩ)	7.0 ± 15%[20°C(68°F)]

Canister Close Valve (CCV)
▷ Specification

Item	Specification
Coil Resistance (Ω)	23.0 ~ 26.0 [20°C(68°F)]

Service Standard

Item		Specification	
Ignition Timing (°)		BTDC 5 ± 10	
Idle Speed (rpm)	A/C OFF	Neutral, N, P-range	720±100
		D-range	720±100
	A/C ON	Neutral, N, P-range	720±100
		D-range	720±100

Tightening Torques

Engine Control System

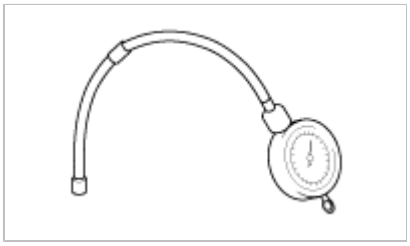
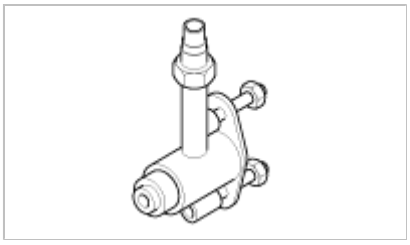
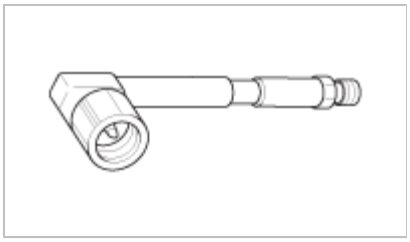
Item	kgf.m	N.m	lb-ft
ECM bracket installation bolt / nut	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Manifold absolute pressure sensor #1 installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Manifold absolute pressure sensor #2 installation bolt	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7
Engine coolant temperature sensor installation	3.0 ~ 4.0	29.4 ~ 39.2	21.7 ~ 28.9
Crankshaft position sensor installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Camshaft position sensor (Bank 1 / Intake) installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Camshaft position sensor (Bank 1 / Exhaust) installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Knock sensor installation bolt	1.9 ~ 2.4	18.6 ~ 23.5	13.7 ~ 17.4
Heated oxygen sensor (Bank 1 / sensor 1) installation	4.0 ~ 5.0	39.2 ~ 49.1	28.9 ~ 36.2
Heated oxygen sensor (Bank 1 / sensor 2) installation	4.0 ~ 5.0	39.2 ~ 49.1	28.9 ~ 36.2
CVVT oil temperature sensor installation	2.0 ~ 4.0	19.6 ~ 39.2	14.5 ~ 28.9
Fuel tank pressure sensor installation bolt	0.4 ~ 0.6	3.9 ~ 5.9	2.9~4.3
Electronic throttle body installation bolt / nut	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Purge control solenoid valve bracket installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
CVVT oil control valve (Bank 1 / Intake) installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
CVVT oil control valve (Bank 1 / Exhaust) installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
WGT & RCV control solenoid valve bracket installation bolt	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7

Ignition coil installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Canister close valve installation bolt	0.4 ~ 0.6	3.9 ~ 5.9	2.9 ~ 4.3

Fuel Delivery System

Item	kgf.m	N.m	lb-ft
Fuel tank band installation nut	4.0 ~ 5.5	39.2 ~ 54.0	28.9 ~ 39.8
Fuel pump installation bolt	0.2 ~ 0.3	2.0 ~ 2.9	1.4 ~ 2.2
Sub fuel sender installation bolt	0.2 ~ 0.3	2.0 ~ 2.9	1.4 ~ 2.2
Filler-neck assembly installation bolt	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7
Filler-neck assembly installation nut	0.4 ~ 0.6	3.9 ~ 5.9	2.9 ~ 4.3
Accelerator pedal module installation bolt	0.9 ~ 1.4	8.8 ~ 13.7	6.5 ~ 10.1
Deliver pipe installation nut (↔ Fuel feed tube)	0.4 ~ 0.6	3.9 ~ 5.9	2.9 ~ 4.3

Special Service Tools

Tool (Number and Name)	Illustration	Application
Fuel Pressure Gauge (09353-24100)		Measuring the fuel line pressure
Fuel Pressure Gauge Adapter (09353-38000)		Connection between the delivery pipe and the fuel feed line
Fuel Pressure Gauge Connector (09353-24000)		Connection between the Fuel Pressure Gauge (09353-24100) and the Fuel Pressure Gauge Adapter (09353-38000)

Basic Troubleshooting

Basic Troubleshooting Guide

1	**Bring Vehicle to Workshop**
2	**Analyze Customer's Problem**
	• Ask the customer about the conditions and environment relative to the issue (Use CUSTOMER PROBLEM ANALYSIS SHEET).
3	**Verify Symptom, and then Check DTC and Freeze Frame Data**
	• Connect Hi-Scan (Pro) to Diagnostic Link Connector (DLC). • Record the DTC and freeze frame data. ***NOTE*** *To erase DTC and freeze frame data, refer to Step 5.*
4	**Confirm the Inspection Procedure for the System or Part**
	• Using the SYMPTOM TROUBLESHOOTING GUIDE CHART, choose the correct inspection procedure for the system or part to be checked.
5	**Erase the DTC and Freeze Frame Data**
	WARNING **NEVER erase DTC and freeze frame data before completing Step 2 MIL/DTC in "CUSTOMER PROBLEM ANALYSIS SHEET".**
6	**Inspect Vehicle Visually**
	• Go to Step 11, if you recognize the problem.
7	**Recreate (Simulate) Symptoms of the DTC**
	• Try to recreate or simulate the symptoms and conditions of the malfunction as described by customer. • If DTC(s) is/are displayed, simulate the condition according to troubleshooting procedure for the DTC.
8	**Confirm Symptoms of Problem**
	• If DTC(s) is/are not displayed, go to Step 9. • If DTC(s) is/are displayed, go to Step 11.
9	**Recreate (Simulate) Symptom**
	• Try to recreate or simulate the condition of the malfunction as described by the customer.
10	**Check the DTC**
	• If DTC(s) does(do) not occur, refer to INTERMITTENT PROBLEM PROCEDURE in BASIC INSPECTION PROCEDURE. • If DTC(s) occur(s), go to Step 11.
11	**Perform troubleshooting procedure for DTC**
12	**Adjust or repair the vehicle**
13	**Confirmation test**
14	**END**

Customer Problem Analysis Sheet

1. VEHICLE INFORMAITON

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

2. SYMPTOMS

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

3. ENVIRONMENT

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

4. MIL/DTC

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

5. ECM/PCM INFORMATION

ECM/PCM Part No.	
ROM ID	

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°C, 68°F), unless stated otherwise.

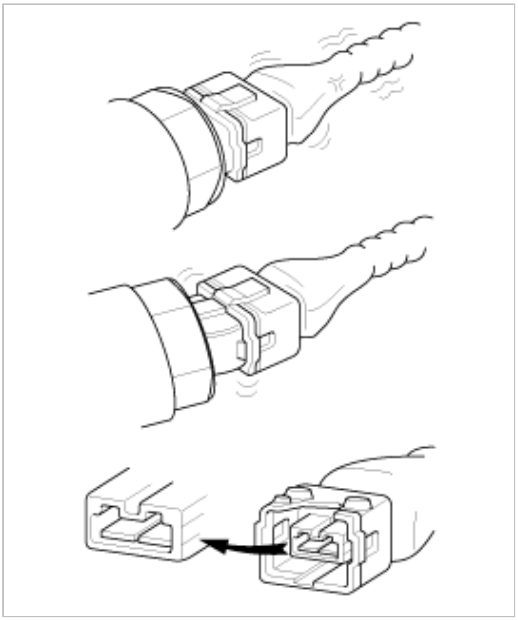
NOTE

The measured resistance in except for ambient temperature (20°C, 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.



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

● Simulating Vibration

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

> WARNING
>
> Strong vibration may break sensors, actuators or relays

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

● Simulating Heat

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

> WARNING
>
> • DO NOT heat components to the point where they may be damaged.
> • DO NOT heat the ECM directly.

● Simulating Water Sprinkling

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

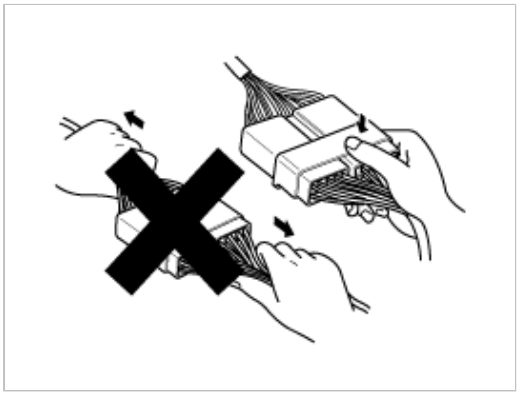
> WARNING
>
> DO NOT sprinkle water directly into the engine compartment or electronic components.

● Simulating Electrical Load

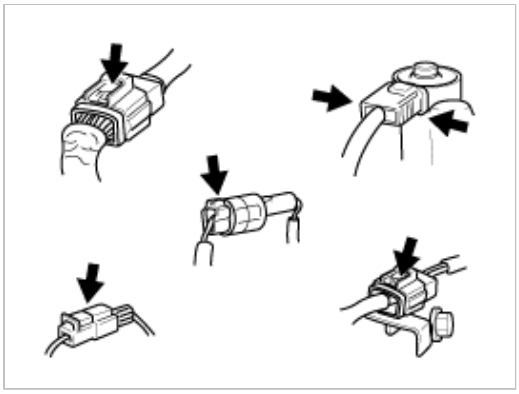
1) Turn on all electrical systems to simulate excessive electrical loads (Radios, fans, lights, rear window defogger, etc.).

Connector Inspection Procedure

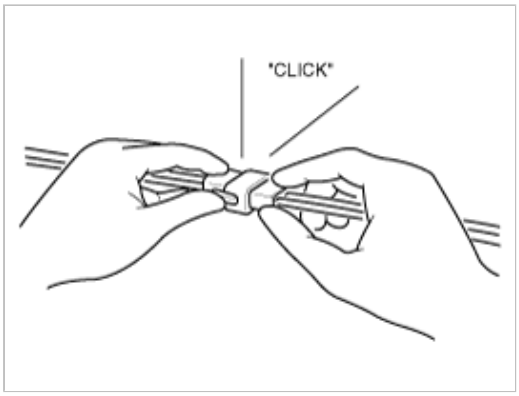
1. Handling of Connector
   A. Never pull on the wiring harness when disconnecting connectors.



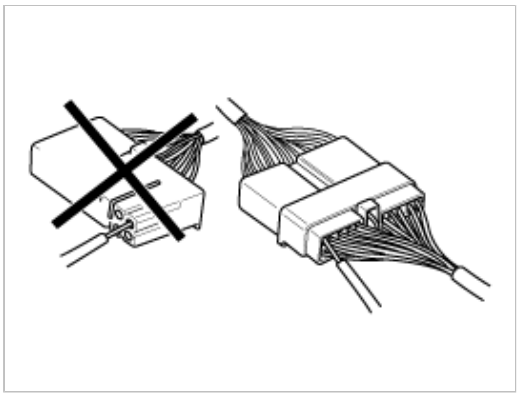
   B. When removing the connector with a lock, press or pull locking lever.



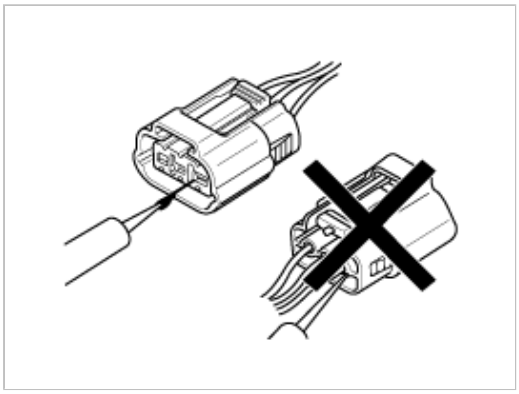
   C. Listen for a click when locking connectors. This sound indicates that they are securely locked.



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



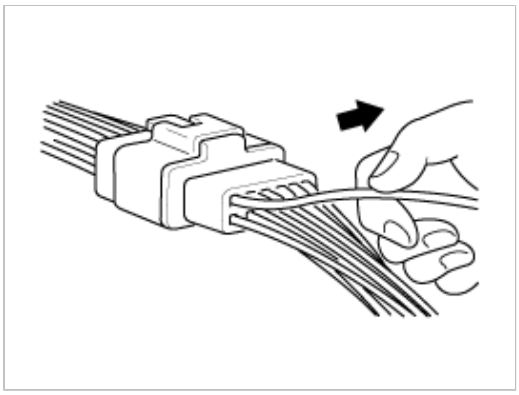
   E. Check waterproof connector terminals from the connector side. Waterproof connectors cannot be accessed from harness side.



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.



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.

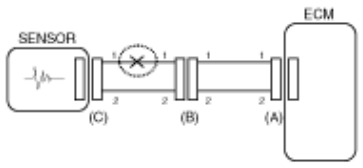
Electrical Circuit Inspection Procedure

● Check Open Circuit

1. Procedures for Open Circuit
   A. Continuity Check
   B. 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



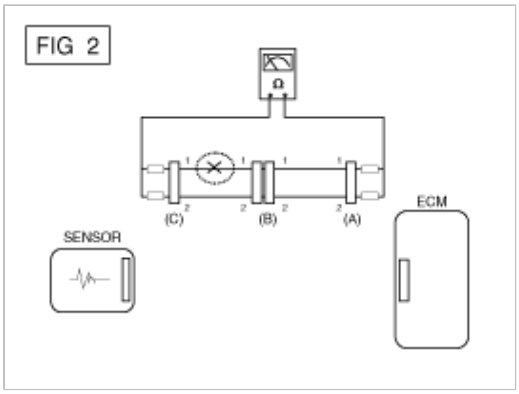
2. Continuity Check Method

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

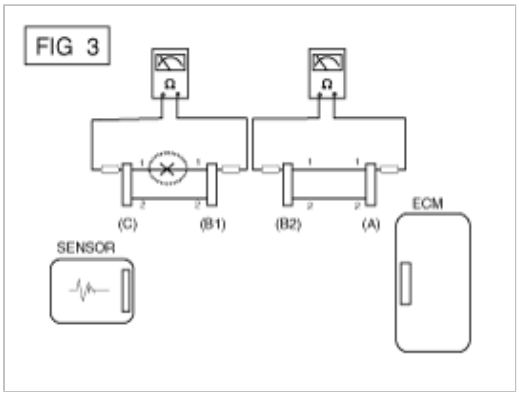
Specification (Resistance)
1Ω or less → Normal Circuit
1MΩ or Higher → Open Circuit

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

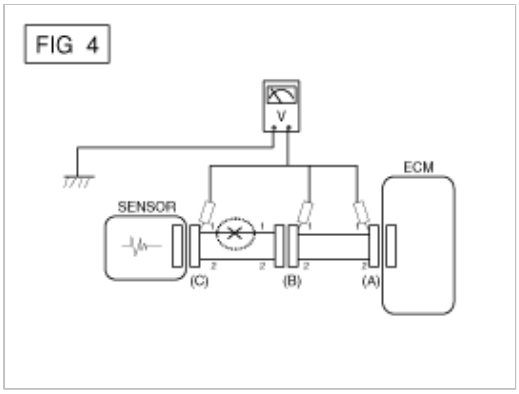
FIG 2



   B. Disconnect connector (B), and measure for resistance between connector (C) and (B1) and between (B2) and (A) as shown in [FIG. 3].
      In this case the measured resistance between connector (C) and (B1) is higher than 1MΩ and the open circuit is between terminal 1 of connector (C) and terminal 1 of connector (B1).

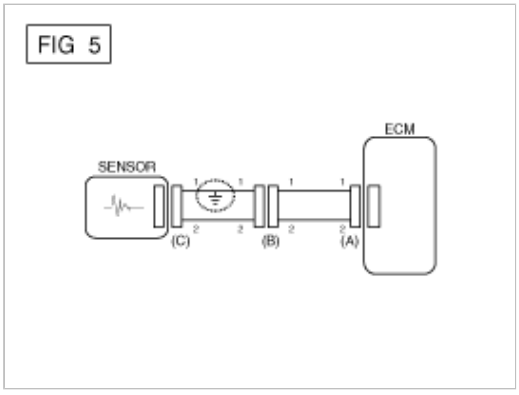


3. Voltage Check Method
   A. With each connector still connected, measure the voltage between the chassis ground and terminal 1 of each connectors (A), (B) and (C) as shown in [FIG. 4].
   The measured voltage of each connector is 5V, 5V and 0V respectively. So the open circuit is between connector (C) and (B).



● Check Short Circuit

1. Test Method for Short to Ground Circuit
   A. 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.

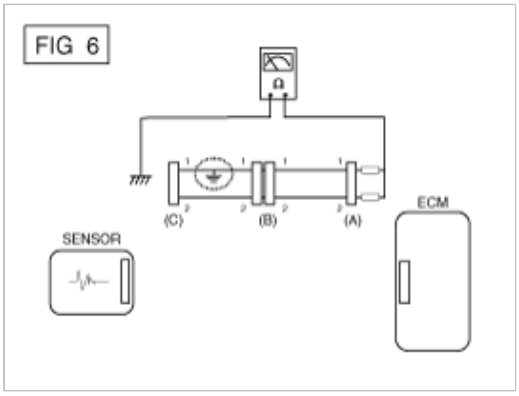


2. Continuity Check Method (with Chassis Ground)

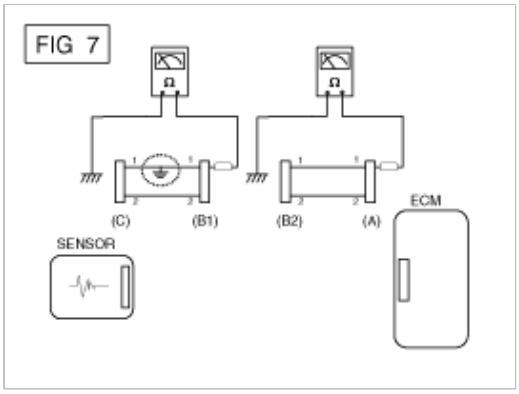
> NOTE
>
> Lightly shake the wire harness above and below, or from side to side when measuring the resistance.

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.



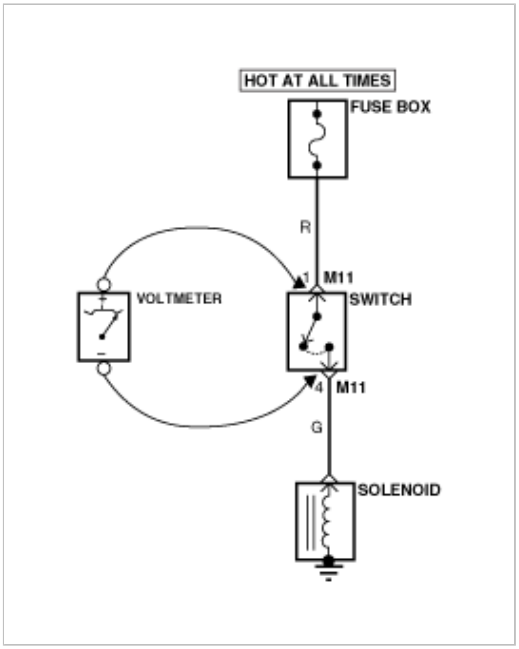
B. Disconnect connector (B), and measure the resistance between connector (A) and chassis ground, and between (B1) and chassis ground as shown in [FIG. 7].
The measured resistance between connector (B1) and chassis ground is 1Ω or less. The short to ground circuit is between terminal 1 of connector (C) and terminal 1 of connector (B1).



● Testing For Voltage Drop

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

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



Symptom Troubleshooting Guide Chart

Main symptom	Diagnostic procedure	Also check for
Unable to start (Engine does not turn over)	1. Test the battery 2. Test the starter 3. Inhibitor switch (A/T) or clutch start switch (M/T)	
Unable to start (Incomplete combustion)	1. Test the battery 2. Check the fuel pressure 3. Check the ignition circuit 4. Troubleshooting the immobilizer system (In case of immobilizer lamp flashing)	• DTC • Low compression • Intake air leaks • Slipped or broken timing belt • Contaminated fuel
Difficult to start	1. Test the battery 2. Check the fuel pressure 3. Check the ECT sensor and circuit (Check DTC) 4. Check the ignition circuit	• DTC • Low compression • Intake air leaks • Contaminated fuel • Weak ignition spark
Poor idling (Rough, unstable or incorrect Idle)	1. Check the fuel pressure 2. Check the Injector 3. Check the long term fuel trim and short term fuel trim (Refer to CUSTOMER DATASTREAM) 4. Check the idle speed control circuit (Check DTC) 5. Inspect and test the Throttle Body 6. Check the ECT sensor and circuit (Check DTC)	• DTC • Low compression • Intake air leaks • Contaminated fuel • Weak ignition spark
Engine stall	1. Test the Battery 2. Check the fuel pressure 3. Check the idle speed control circuit (Check DTC) 4. Check the ignition circuit 5. Check the CKPS Circuit (Check DTC)	• DTC • Intake air leaks • Contaminated fuel • Weak ignition spark
Poor driving (Surge)	1. Check the fuel pressure 2. Inspect and test Throttle Body 3. Check the ignition circuit	• DTC • Low compression

	4. Check the ECT Sensor and Circuit (Check DTC) 5. Test the exhaust system for a possible restriction 6. Check the long term fuel trim and short term fuel trim (Refer to CUSTOMER DATASTREAM)	• Intake air leaks • Contaminated fuel • Weak ignition spark
Knocking	1. Check the fuel pressure 2. Inspect the engine coolant 3. Inspect the radiator and the electric cooling fan 4. Check the spark plugs	• DTC • Contaminated fuel
Poor fuel economy	1. Check customer's driving habitsIs · A/C on full time or the defroster mode on? · Are tires at correct pressure? · Is excessively heavy load being carried? · Is acceleration too much, too often? 2. Check the fuel pressure 3. Check the injector 4. Test the exhaust system for a possible restriction 5. Check the ECT sensor and circuit	• DTC • Low compression • Intake air leaks • Contaminated fuel • Weak ignition spark
Hard to refuel (Overflow during refueling)	1. Test the canister close valve 2. Inspect the fuel filler hose/pipe · Pinched, kinked or blocked? · Filler hose is torn 3. Inspect the fuel tank vapor vent hose between the EVAP. canister and air filter 4. Check the EVAP. canister	• Malfunctioning gas station filling nozzle (If this problem occurs at a specific gas station during refueling)