Tightening Torques

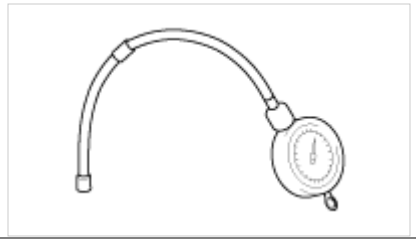
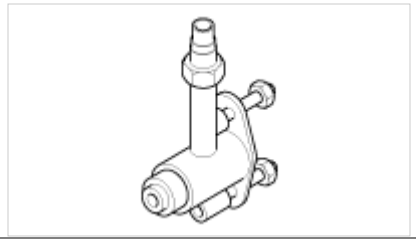
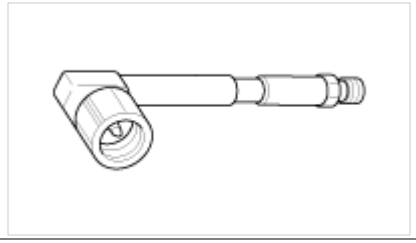
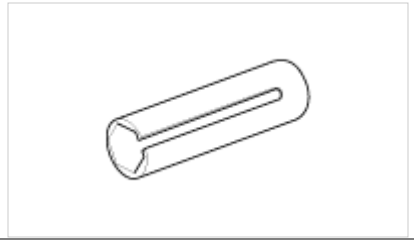
Engine Control System

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 installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Boost pressure sensor installation	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7
Intake air temperature sensor installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 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
RCV control solenoid valve bracket installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Ignition coil installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Electric WGT control actuator installation bolt	0.75 ~ 0.85	7.35 ~ 8.34	5.42 ~ 6.08
Canister close valve installaiton 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)
Heated Oxygen Sensor Socket Wrench (09392-2H100)		Removal and installation of the heated oxygen sensor

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

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.

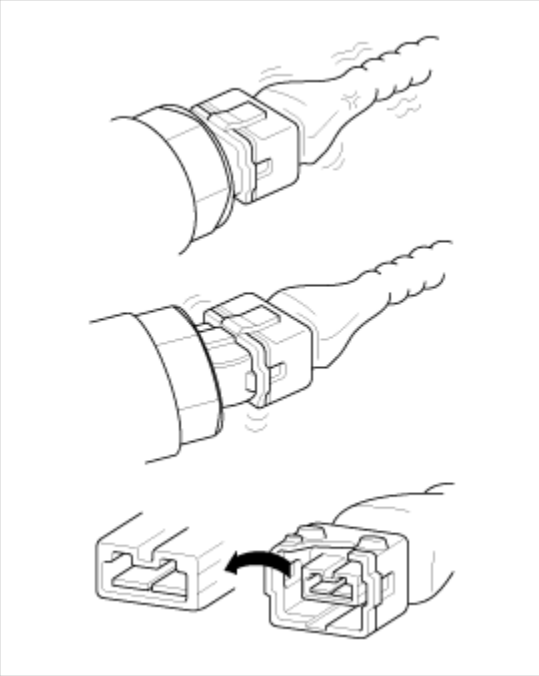
NOTICE

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.

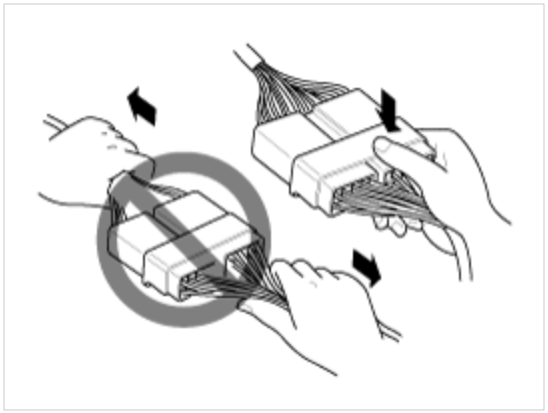
● Simulating Electrical Load

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

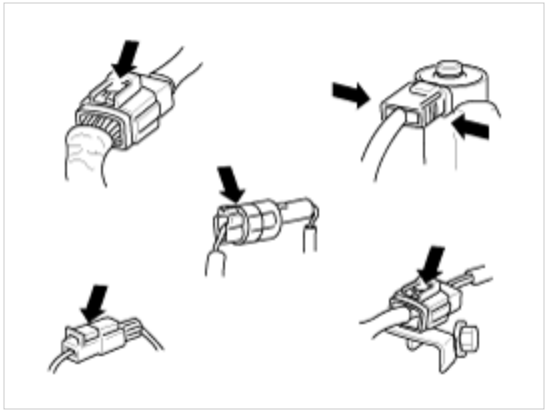
Connector Inspection Procedure

1. Handling of Connector

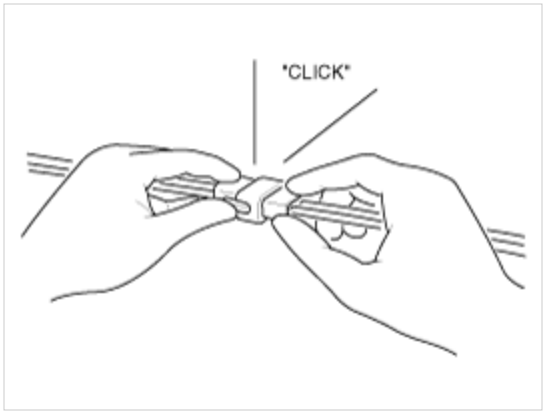
A. Never pull on the wiring harness when disconnecting connectors.



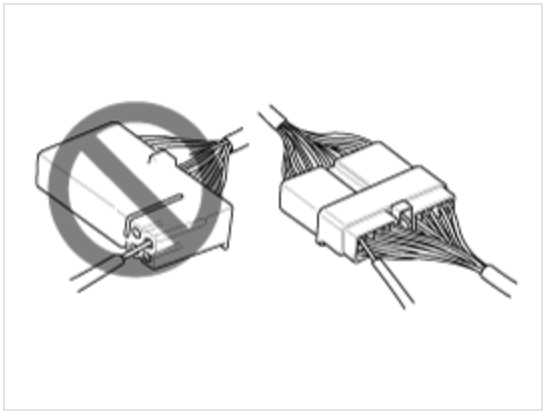
B. When removing the connector with a lock, press or pull locking lever.



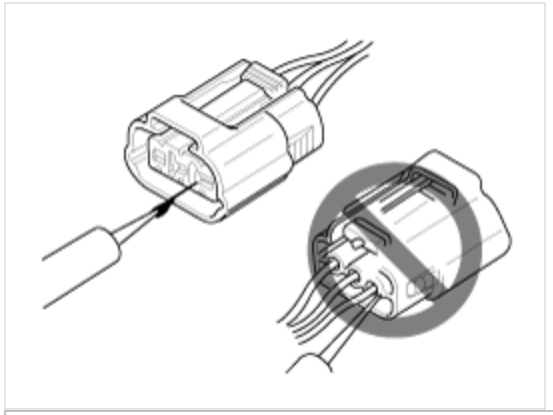
C. Listen for a click when locking connectors. This sound indicates that they are securely locked.



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



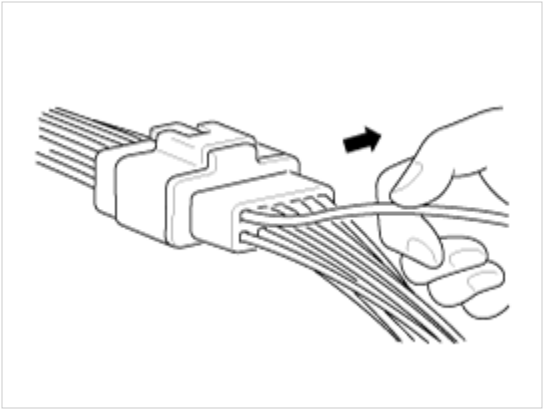
E. Check waterproof connector terminals from the connector side. Waterproof connectors cannot be accessed from harness side.



NOTICE

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

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



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

NOTICE

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

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

Wire Harness Inspection Procedure

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

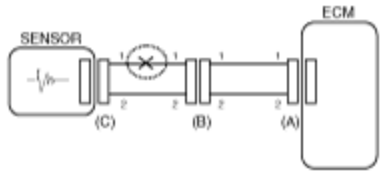
Electrical Circuit Inspection Procedure

● Check Open Circuit

1. Procedures for Open Circuit
   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

NOTICE

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

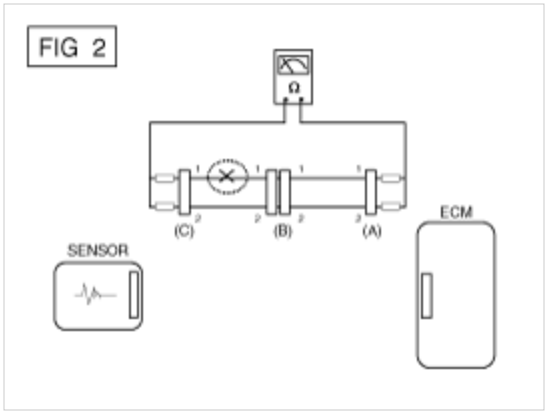
Specification (Resistance)

1Ω or less → Normal Circuit

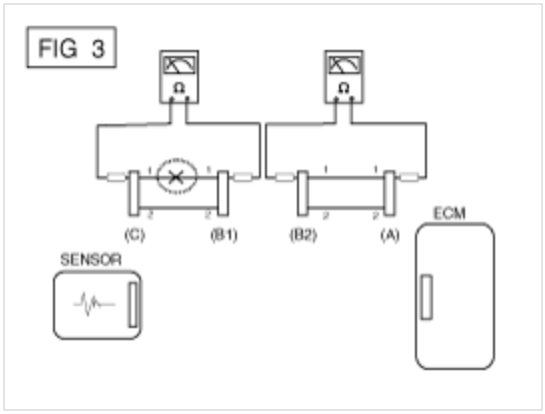
1MΩ or Higher → Open Circuit

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.

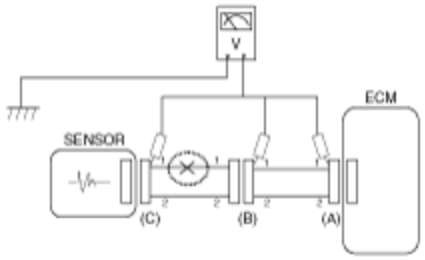


B. Disconnect connector (B), and measure for resistance between connector (C) and (B1) and between (B2) and (A) as shown in [FIG. 3].
In this case the measured resistance between connector (C) and (B1) is higher than 1MΩ and the open circuit is between terminal 1 of connector (C) and terminal 1 of connector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

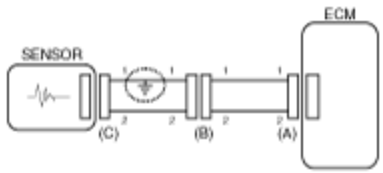
FIG 4



● 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.

FIG 5



2. Continuity Check Method (with Chassis Ground)

NOTICE

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

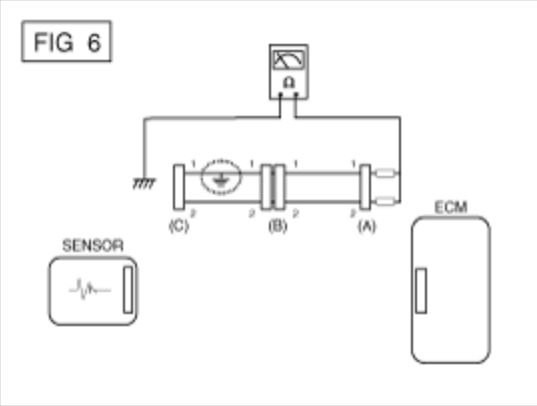
Specification (Resistance)

1Ω or less → Short to Ground Circuit

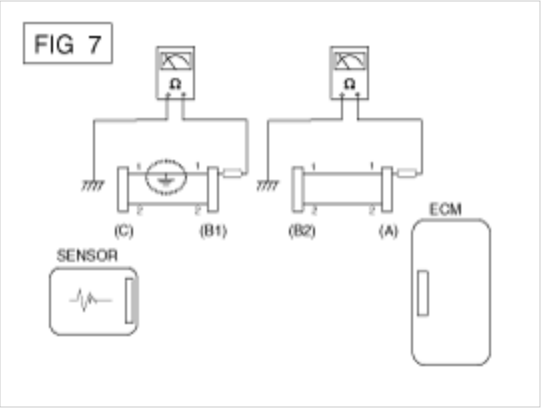
1MΩ or Higher → Normal Circuit

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).



Symptom Troubleshooting Guide Chart

Main Symptom	Diagnostic Procedure	Also Check For
Unable to start (Engine does not turn over)	1. Test the battery. (Refer to Engine Electrical System - "Battery") 2. Test the starter. (Refer to Engine Electrical System - "Starter") 3. Inhibitor switch (A/T) or clutch start switch (M/T)	
Unable to start (Incomplete combustion)	1. Test the battery. (Refer to Engine Electrical System - "Battery") 2. Check the fuel pressure. (Refer to Fuel Delivery System - "Fuel Pressure Test") 3. Check the ignition circuit. (Refer to Engine Electrical System - "Ignition System")	• DTC • Low compression •

	4. Troubleshooting the immobilizer system. (Refer to Body Electrical System - "Immobilizer System") (In case of immobilizer lamp flashing)	Intake air leaks • Slipped or broken timing belt • Contaminated fuel
Difficult to start	1. Test the battery. (Refer to Engine Electrical System - "Battery") 2. Check the fuel pressure. (Refer to Fuel Delivery System - "Fuel Pressure Test") 3. Check the ECT sensor and circuit (Check DTC) 4. Check the ignition circuit. (Refer to Engine Electrical System - "Ignition System")	• DTC • Low compression • Intake air leaks • Contaminated fuel • Weak ignition spark
Poor idling (Rough, unstable or incorrect Idle)	1. Check the fuel pressure. (Refer to Fuel Delivery System - "Fuel Pressure Test") 2. Check the Injector. (Refer to Engine Control System - "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. (Refer to Engine Electrical System - "Battery") 2. Check the fuel pressure. (Refer to Fuel Delivery System - "Fuel Pressure Test") 3. Check the idle speed control circuit (Check DTC) 4. . Check the ignition circuit. (Refer to Engine Electrical System-"IgnitionSystem") 5. Check the CKPS Circuit (Check DTC)	• DTC • Intake air leaks • Contaminated fuel • Weak ignition spark
Poor driving (Surge)	1. Check the fuel pressure. (Refer to Fuel Delivery System - "Fuel Pressure Test") 2. Inspect and test Throttle Body 3. Check the ignition circuit. (Refer to Engine Electrical System - "Ignition System") 4. Check the ECT Sensor and Circuit (Check DTC) 5. Test the exhaust system for a possible restriction. (Refer to Engine Mechanical System - "Exhaust Manifold") 6. Check the long term fuel trim and short term fuel trim (Refer to CUSTOMER DATASTREAM)	• DTC • Low compression • Intake air leaks • Contaminated fuel • Weak ignition spark
Knocking	1. Check the fuel pressure. (Refer to Fuel Delivery System - "Fuel Pressure Test") 2. Inspect the engine coolant. (Engine Mechanical System - "Radiator") 3. Inspect the radiator and the electric cooling fan. (Engine Mechanical System - "Radiator") 4. Check the spark plugs. (Refer to Engine Electrical System - "Ignition System")	• DTC • Contaminated fuel
Poor fuel economy	1. Check customer's driving habits • Is 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. (Refer to Fuel Delivery System - "Fuel Pressure Test")	• DTC • Low compression • Intake air leaks • Contaminated fuel • Weak ignition spark

	3. Check the injector. (Refer to Engine Control System - "Injector") 4. Test the exhaust system for a possible restriction 5. Check the ECT sensor and circuit	
Hard to refuel (Overflow during refueling)	1. Test the canister close valve. (Refer to Fuel Delivery System - "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)

Fuel System

Description

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

1. Engine is hard to start or does not start at all.
2. Unstable 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, incorrect engine adjustment, etc.). Then, inspect the Gasoline Engine Control system components with the HI-SCAN (Pro).

NOTICE

- Before removing or installing any part, read the diagnostic trouble codes and 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 operation or while the ignition switch is ON could cause damage to the ECM.
- The control harnesses between the ECM and heated oxygen sensor are shielded with the shielded ground wires to the body in order to prevent the influence of ignition noises and radio interference. When the shielded wire is faulty, the control harness must be replaced.
- When checking the generator for the charging state, do not disconnect the battery '+' terminal to prevent the ECM from damage due to the voltage.
- When charging the battery with the external charger, disconnect the vehicle side battery terminals to prevent damage to the ECM.

Malfunction Indicator Lamp (MIL)

[EOBD]

A malfunction indicator lamp illuminates to notify the driver that there is a problem with the vehicle. However, the MIL will go off automatically after 3 subsequent sequential driving cycles without the same malfunction. Immediately after the ignition switch is turned on (ON position - do not start), the MIL will illuminate continuously to indicate that the MIL operates normally.

Faults with the following items will illuminate the MIL.

- Catalyst
- Fuel system

- Manifold Absolute Pressure Sensor (MAPS)
- Intake Air Temperature Sensor (IATS)
- Engine Coolant Temperature Sensor (ECTS)
- Throttle Position Sensor (TPS)
- Upstream Oxygen Sensor
- Upstream Oxygen Sensor Heater
- Downstream Oxygen Sensor
- Downstream Oxygen Sensor Heater
- Injector
- Misfire
- Crankshaft Position Sensor (CKPS)
- Camshaft Position Sensor (CMPS)
- Evaporative Emission Control System
- Vehicle Speed Sensor (VSS)
- ETC Motor [integrated into ETC module]
- Power Supply
- ECM/ PCM
- MT/AT Encoding
- Acceleration Sensor
- MIL-on Request Signal
- Power Stage

NOTICE

Refer to "Inspection Chart For Diagnostic Trouble Codes (DTC)" for more information.

[NON-EOBD]

A malfunction indicator lamp illuminates to notify the driver that there is a problem with the vehicle. However, the MIL will go off automatically after 3 subsequent sequential driving cycles without the same malfunction. Immediately after the ignition switch is turned on (ON position - do not start), the MIL will illuminate continuously to indicate that the MIL operates normally.

Faults with the following items will illuminate the MIL

- Heated oxygen sensor (HO2S)
- Manifold Absolute Pressure Sensor (MAPS)
- Throttle position sensor (TPS) [integrated into ETC module]
- Engine coolant temperature sensor (ECTS)
- ETC Motor [integrated into ETC module]
- Injectors
- ECM

NOTICE

Refer to "Inspection Chart For Diagnostic Trouble Codes (DTC)" for more information.

[INSPECTION]

1. After turning ON the ignition key, ensure that the light illuminates for about 5 seconds and then goes out.
2. If the light does not illuminate, check for an open circuit in the harness, a blown fuse or a blown bulb.

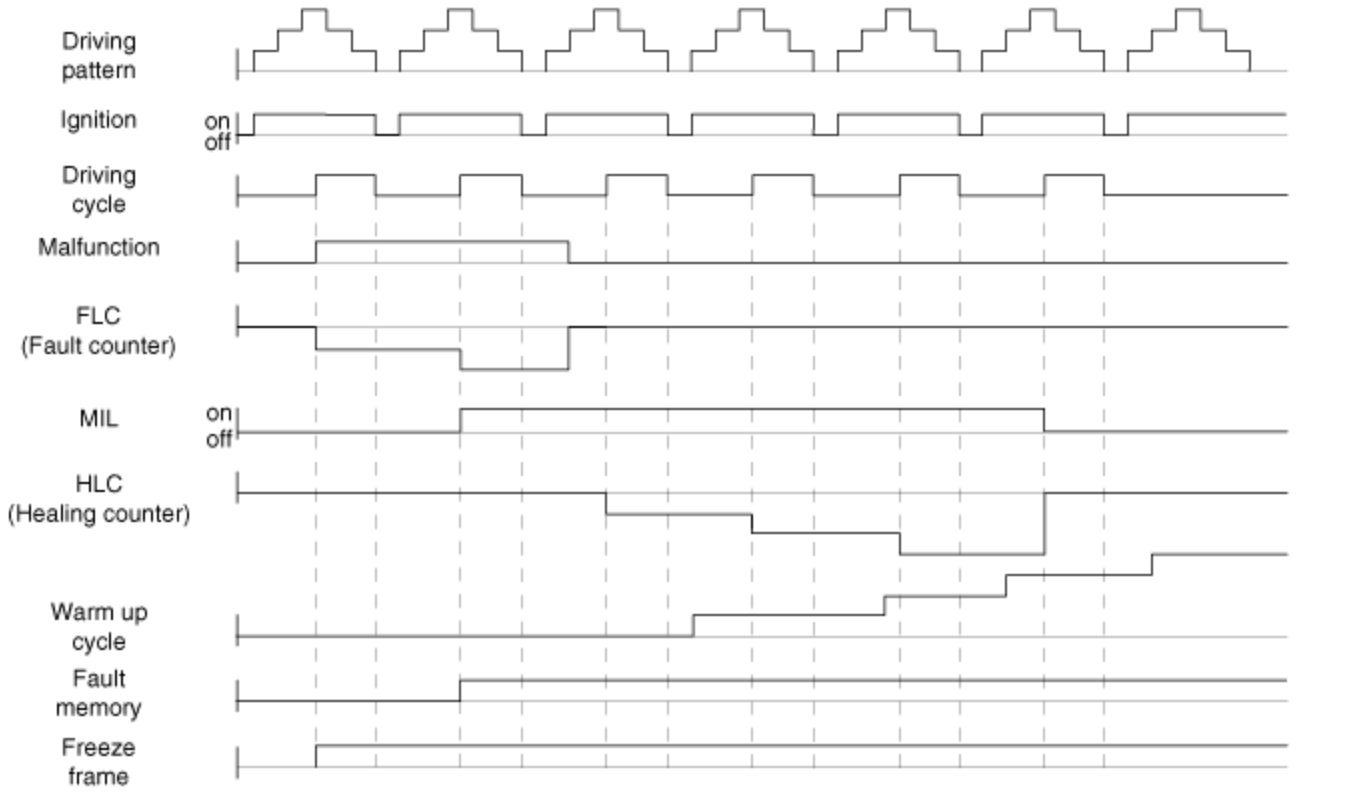
Self-Diagnosis

The ECM monitors the input/output signals (some signals at all times and the others 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 ECM connector is disconnected, or by the HI-SCAN (Pro).

NOTICE

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

The Relation Between DTC And Driving Pattern In EOBD System

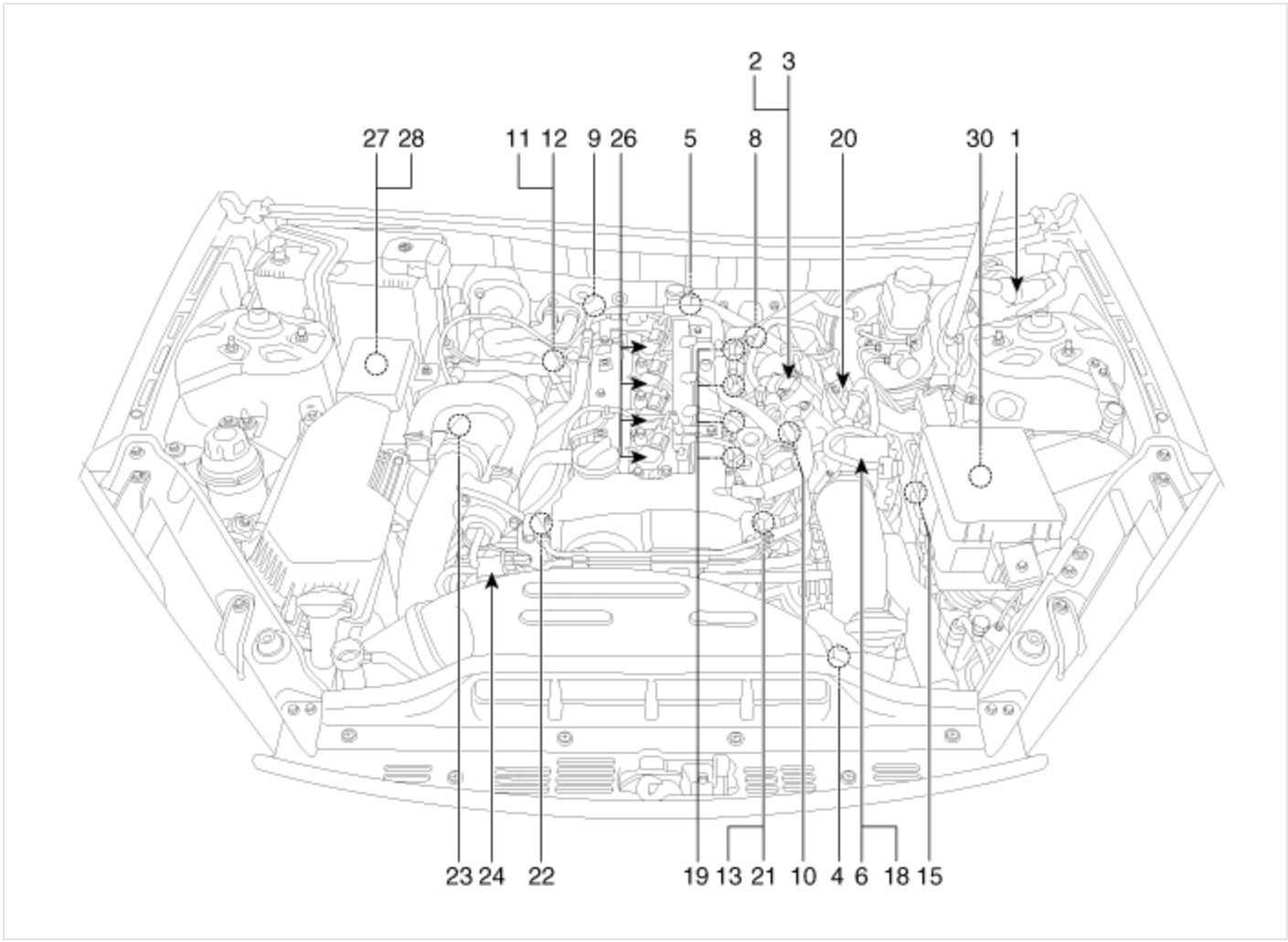


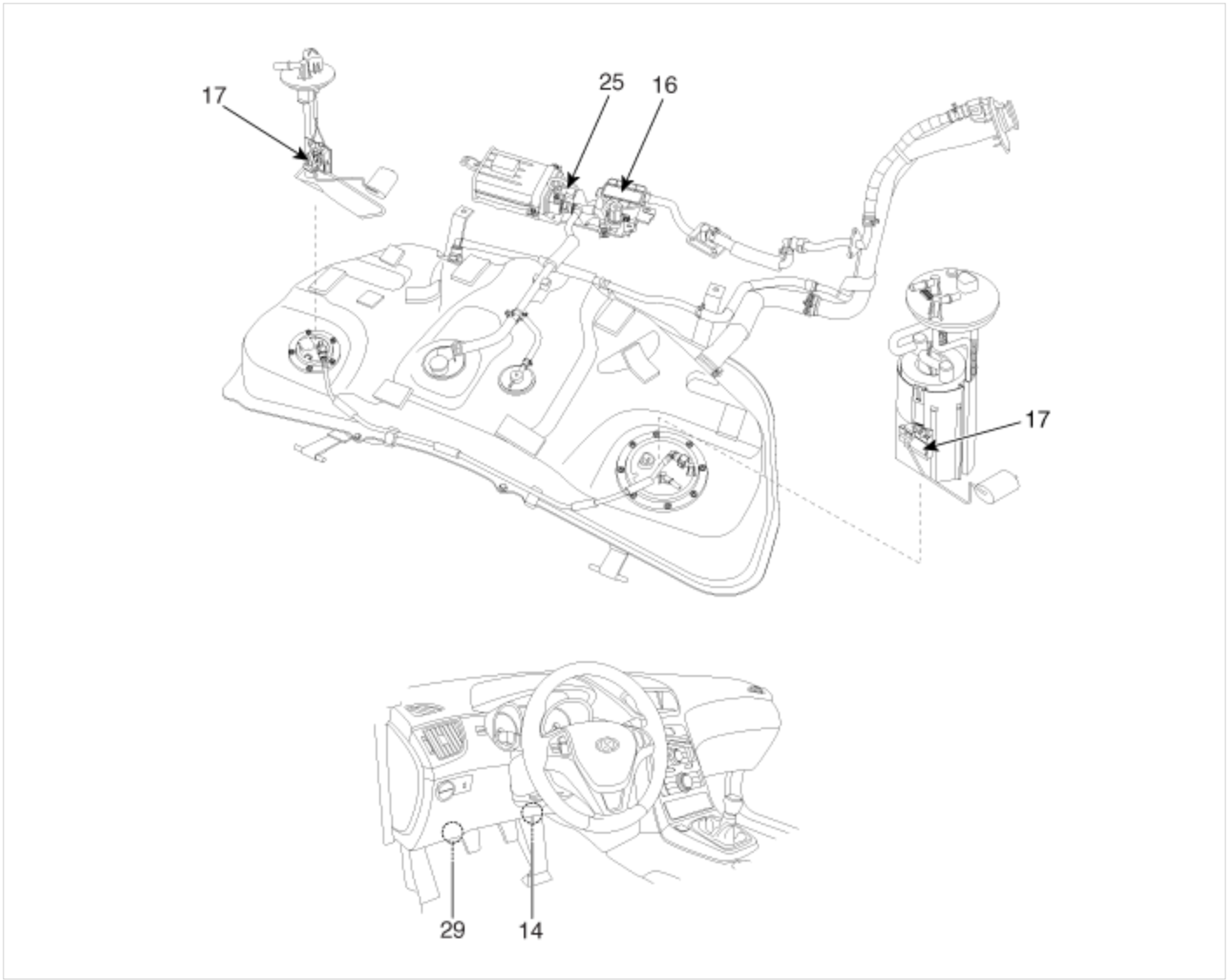
1. When the same malfunction is detected and maintained during two sequential driving cycles, the MIL will automatically illuminate.
2. The MIL will go off automatically if no fault is detected after 3 sequential driving cycles.
3. A Diagnostic Trouble Code(DTC) is recorded in ECM memory when a malfunction is detected after two sequential driving cycles. The MIL will illuminate when the malfunction is detected on the second driving cycle.
   If a misfire is detected, a DTC will be recorded, and the MIL will illuminate, immediately after a fault is first detected.
4. A Diagnostic Trouble Code(DTC) will automatically erase from ECM memory if the same malfunction is not detected for 40 driving cycles.

NOTICE

- A "warm-up cycle" means sufficient vehicle operation such that the coolant temperature has risen by at least 40 degrees Fahrenheit from engine starting and reaches a minimum temperature of 160 degress Fahrenheit.
- A "driving cycle" consists of engine startup, vehicle operation beyond the beginning of closed loop operation.

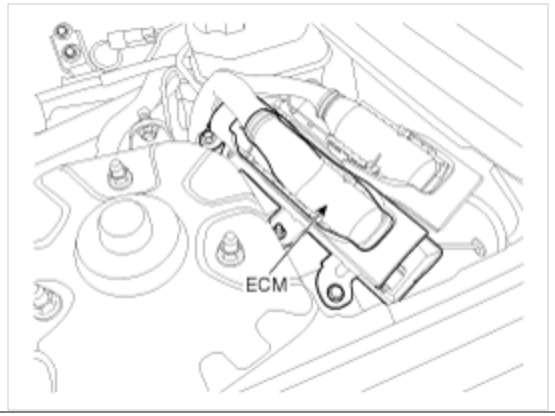
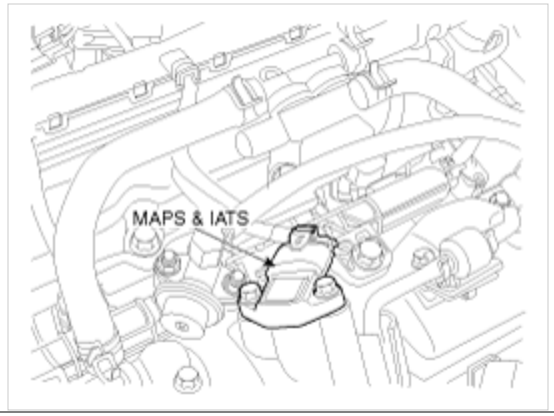
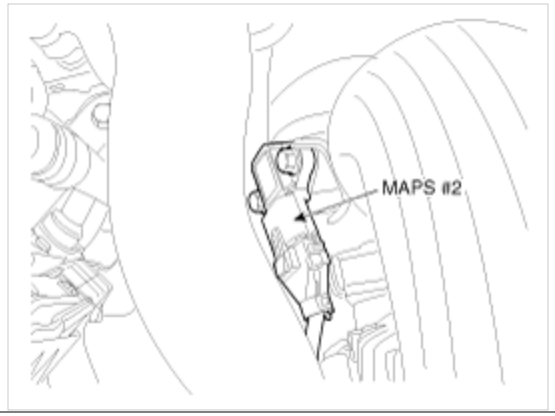
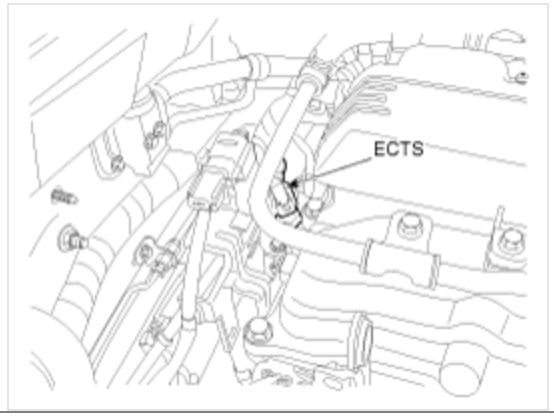
Components Location

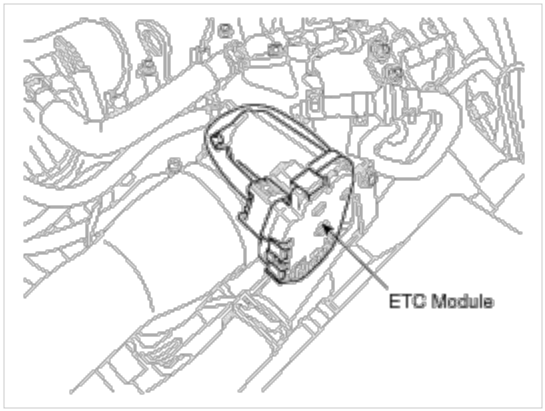
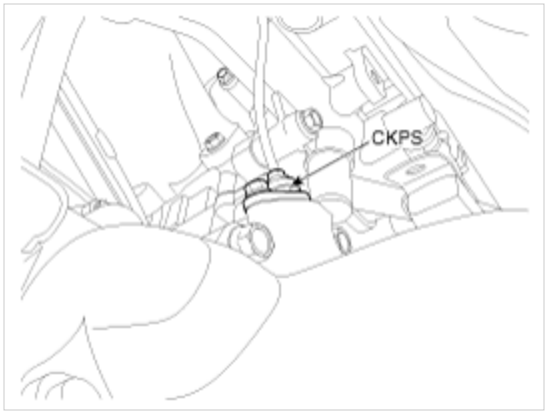
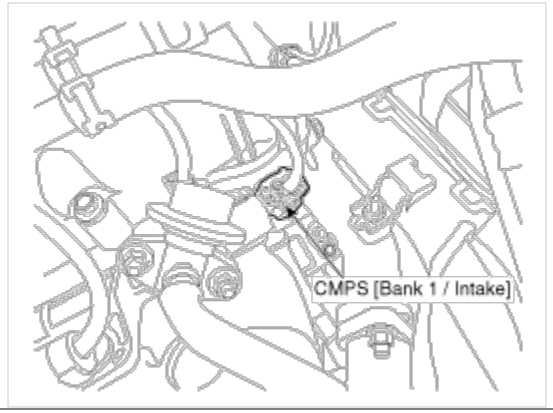
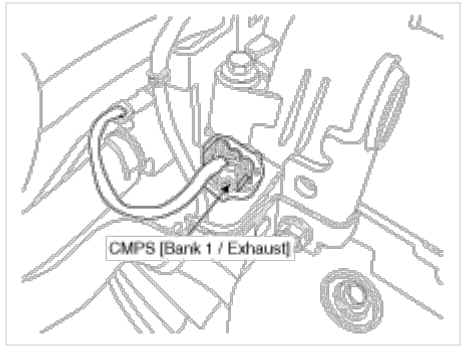

2 3
27 28
11 12
9 26
5
8
20
30 1
23 24 22
19 13 21 10 4 6 18 15

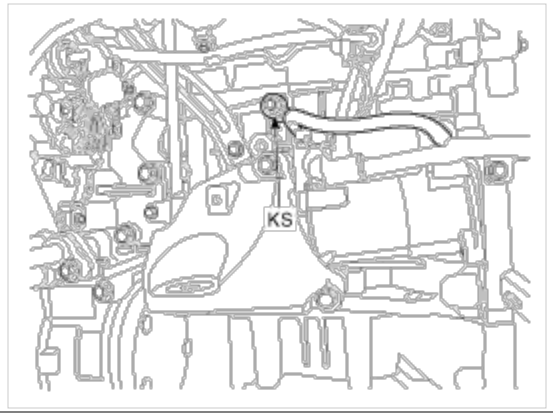


1. Engine Control Module (ECM)	16. Fuel Tank Pressrue Sensor (FTPS)
2. Manifold Absolute Pressure Sensor (MAPS)	17. Fuel Level Sensor (FLS)
3. Intake Air Temperature Sensor (IATS)	18. ETC Motor [integrated into ETC Module]
4. Boost Pressure Sensor (BPS)	19. Injector
5. Engine Coolant Temperature Sensor (ECTS)	20. Purge Control Solenoid Valve (PCSV)
6. Throttle Position Sensor (TPS) [integrated into ETC Module]	21. CVVT Oil Control Valve (OCV) [Bank 1 / Intake]

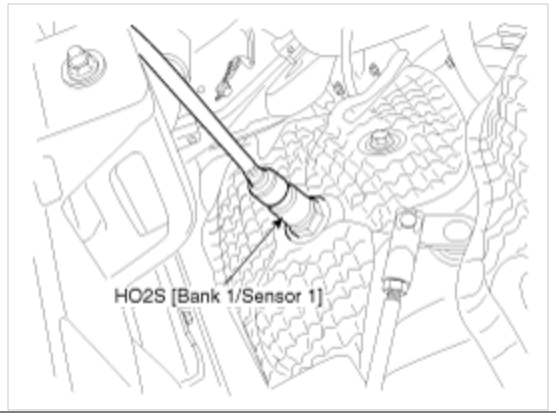
7. Crankshaft Position Sensor (CKPS)	22. CVVT Oil Control Valve (OCV) [Bank 1 / Exhaust]
8. Camshaft Position Sensor (CMPS) [Bank 1 / Intake]	23. Electric Waste Gate Actuator (EWGA)
9. Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust]	24. RCV Control Solenoid Valve
10. Knock Sensor (KS)	25. Canister Close Valve (CCV)
11. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 1]	26. Ignition Coil
12. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 2]	27. Main Relay
13. CVVT Oil Temperature Sensor (OTS)	28. Fuel Pump Relay
14. Accelerator Position Sensor (APS)	29. Data Link Connector (DLC) [16 Pin]
15. A/C Pressure Transducer (APT)	30. Multi-Purpose Check Connector [20 Pin]

1. Engine Control Module (ECM)	2. Manifold Absolute Pressure Sensor (MAPS) 3. Intake Air Temperature Sensor (IATS)
	
4. Boost Pressure Sensor (BPS)	5. Engine Coolant Temperature Sensor (ECTS)
	

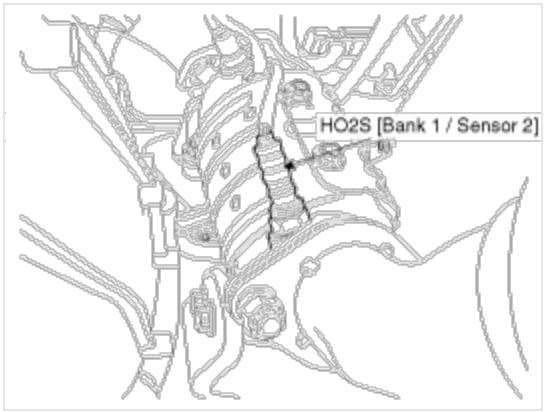
6. Throttle Position Sensor (TPS) [integrated into ETC Module] 18. ETC Motor [integrated into ETC Module]	7. Crankshaft Position Sensor (CKPS)
	
8. Camshaft Position Sensor (CMPS) [Bank 1 / Intake]	9. Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust]
	
10. Knock Sensor (KS)	11. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 1]



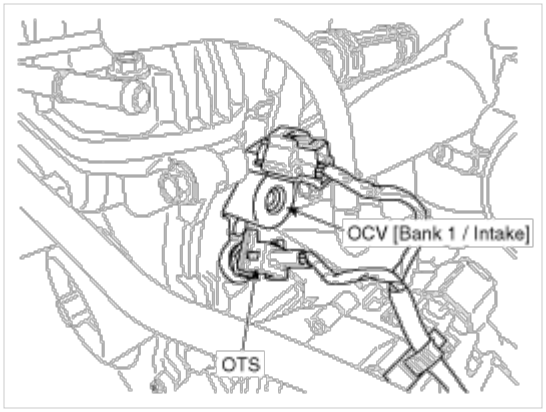
12. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 2]



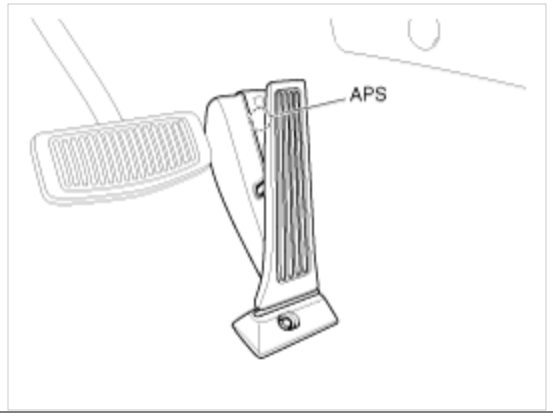
13. CVVT Oil Temperature Sensor (OTS)
21. CVVT Oil Control Valve (OCV) [Bank 1 / Intake]

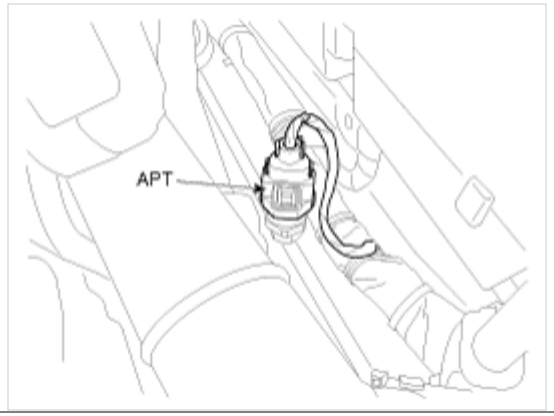


14. Accelerator Position Sensor (APS)



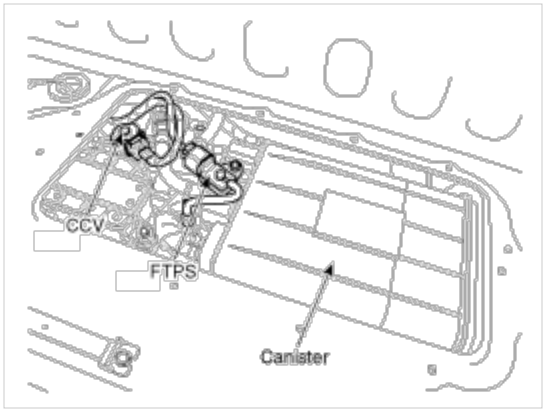
15. A/C Pressure Transducer (APT)

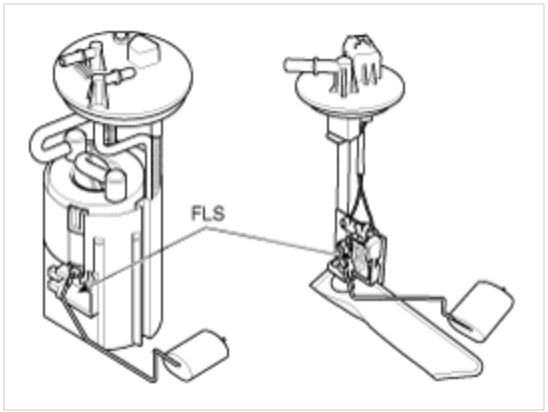




16. Fuel Tank Pressrue Sensor (FTPS)
25. Canister Close Valve (CCV)

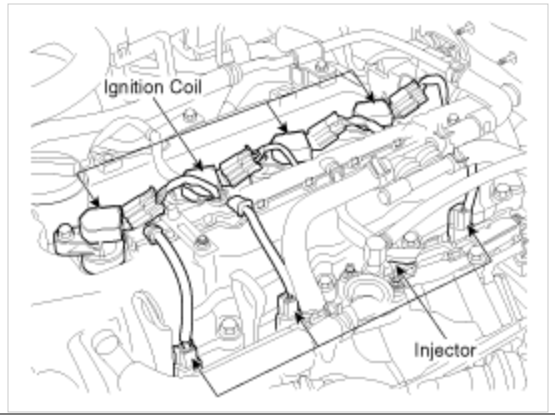
17. Fuel Level Sensor (FLS)



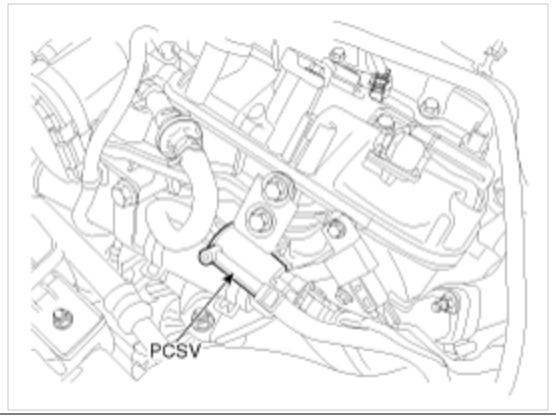


19. Injector
26. Ignition Coil

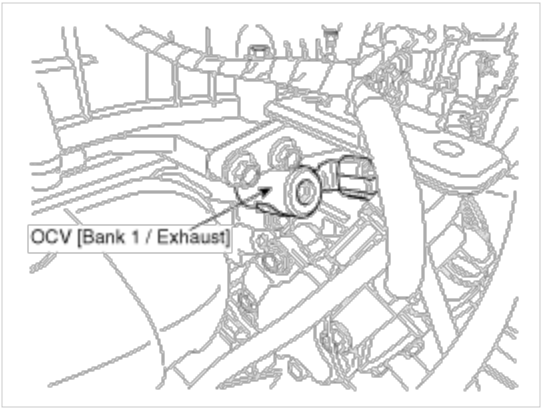
20. Purge Control Solenoid Valve (PCSV)



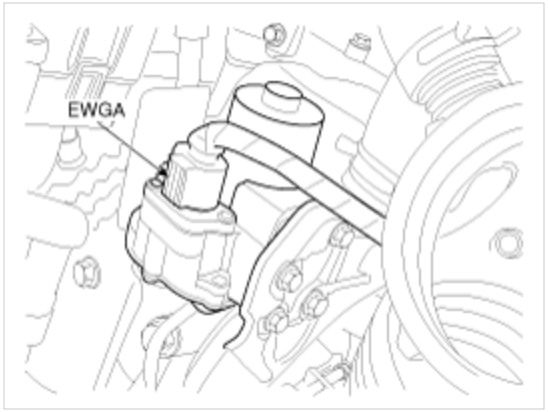
22. CVVT Oil Control Valve (OCV) [Bank 1 / Exhaust]



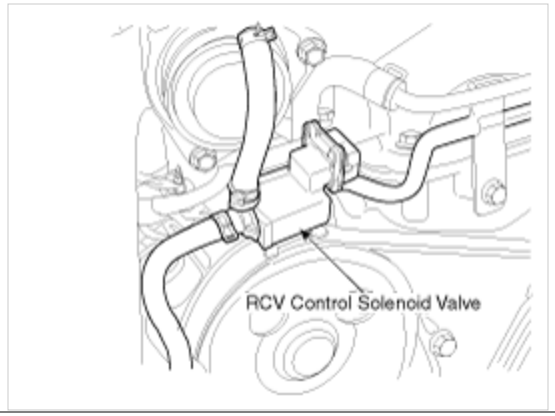
23. Electric Waste Gate Actuator (EWGA)

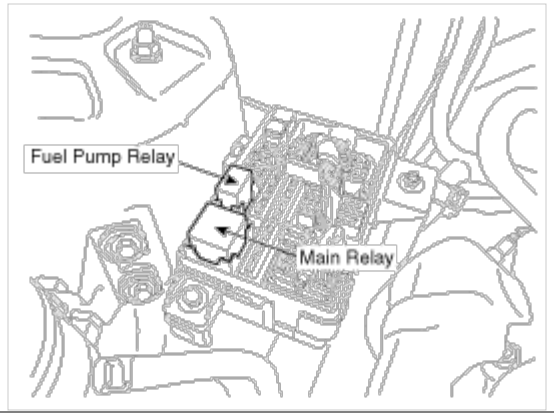


24. RCV Control Solenoid Valve

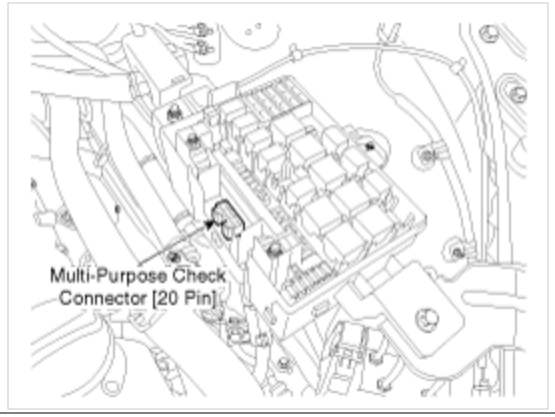


27. Main Relay
28. Fuel Pump Relay



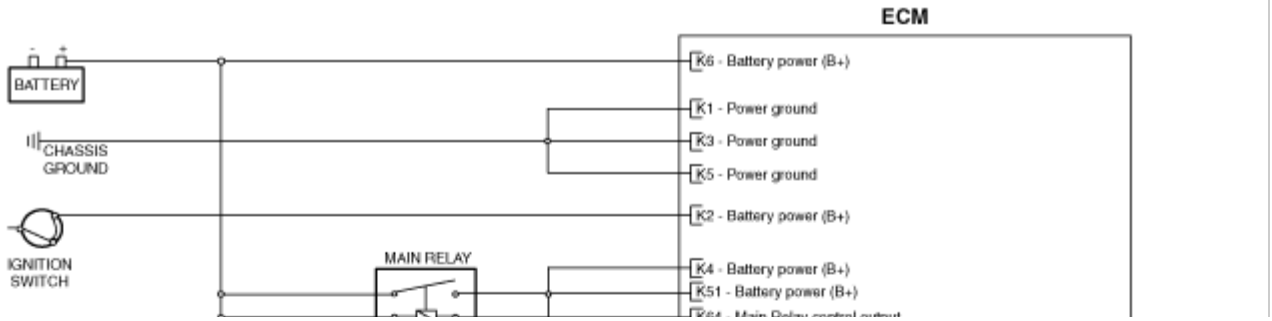


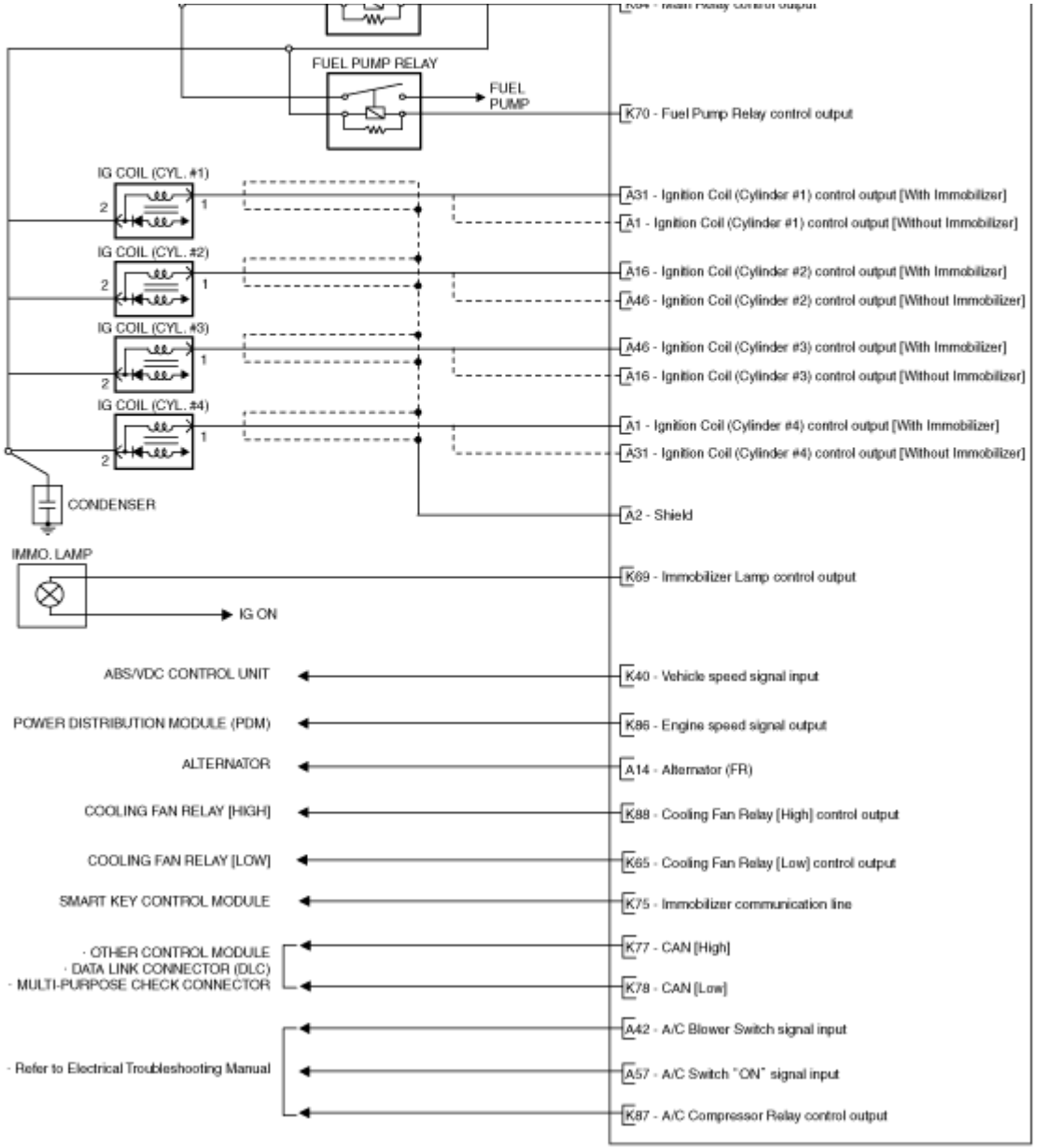
30. Multi-Purpose Check Connector [20 Pin]



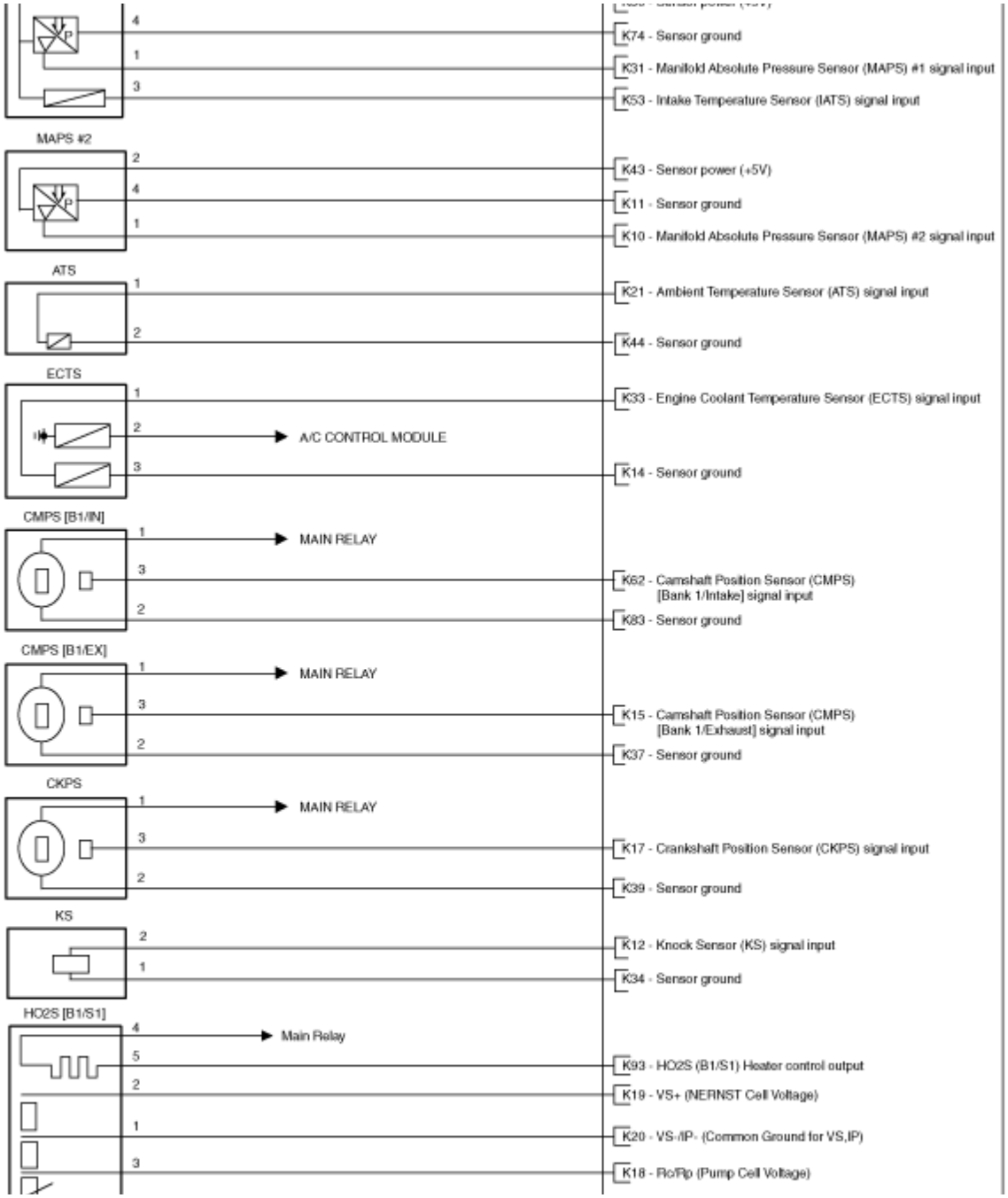
Fuel System

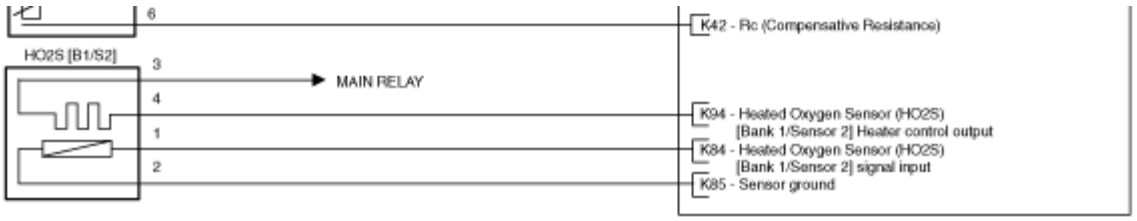
Circuit Diagram

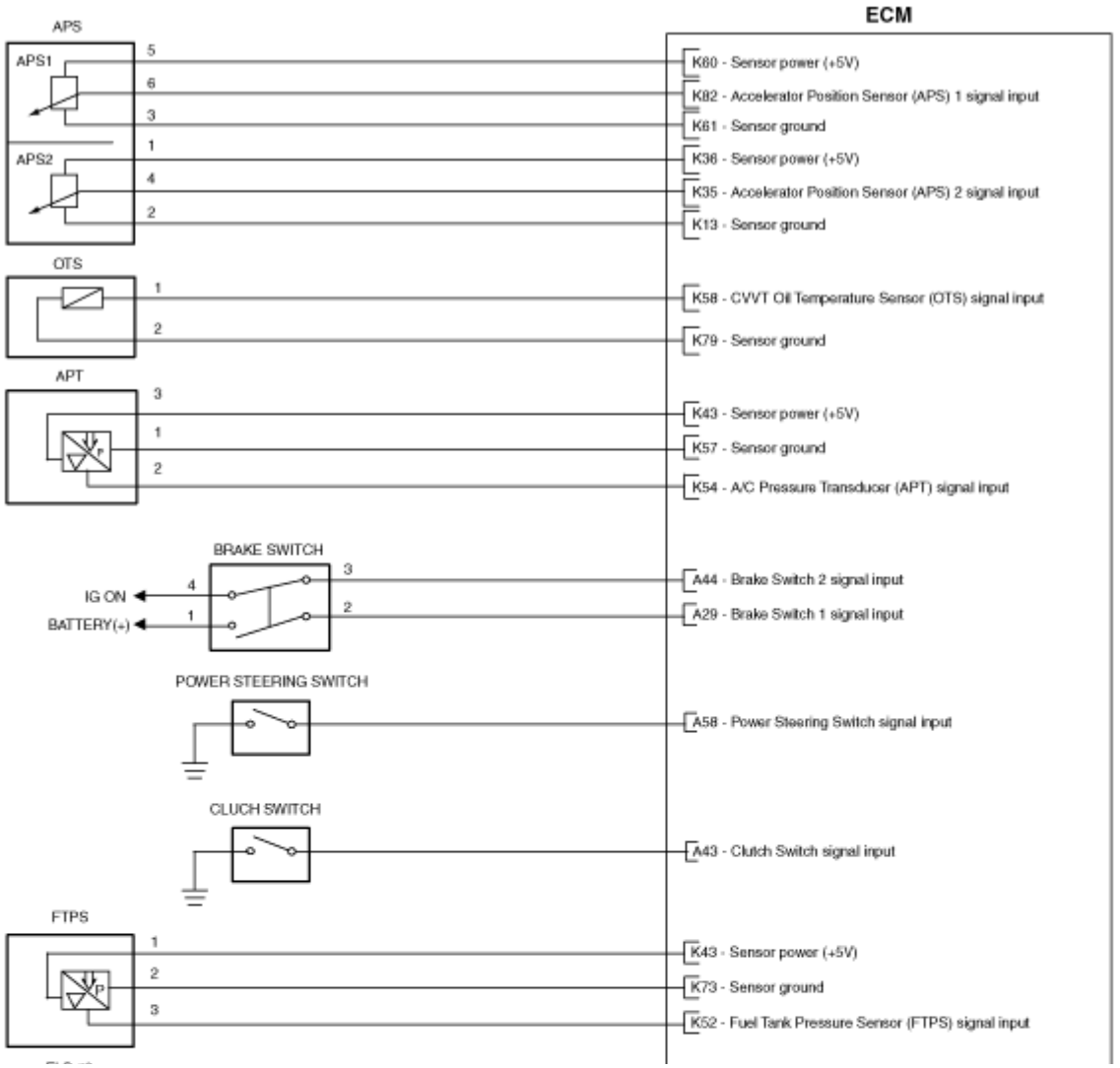


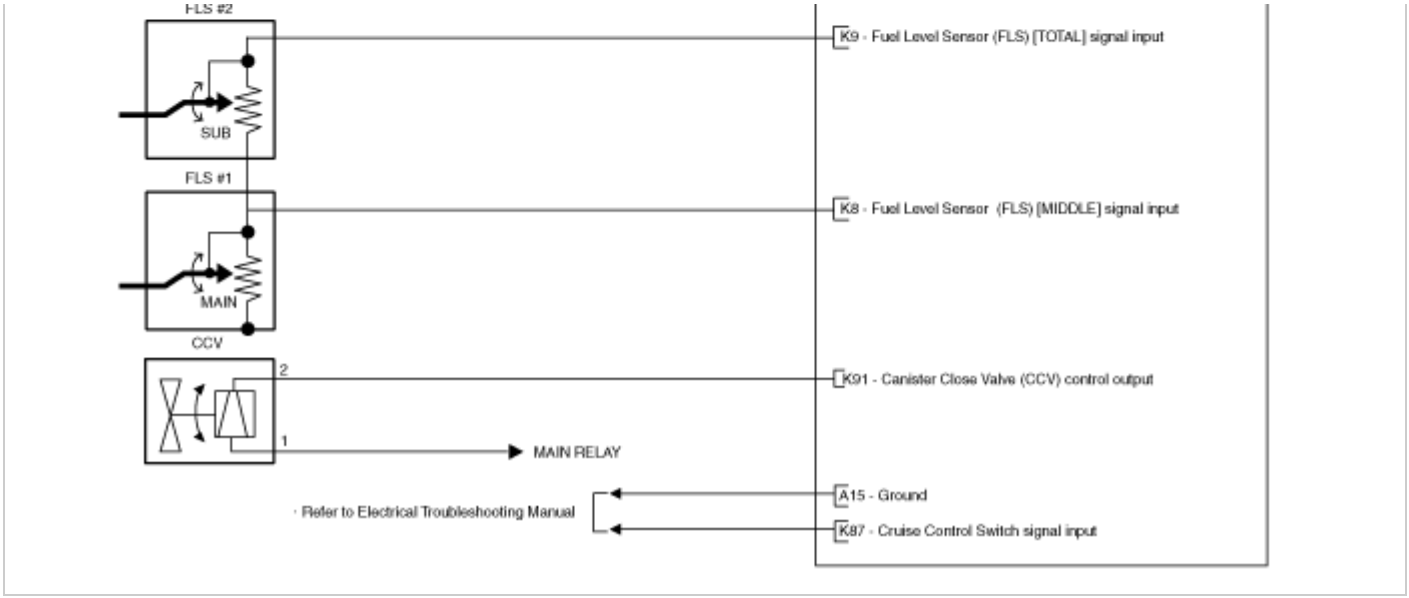

FUEL PUMP RELAY
FUEL PUMP
K70 - Fuel Pump Relay control output
IG COIL (CYL. #1)
A31 - Ignition Coil (Cylinder #1) control output [With Immobilizer]
A1 - Ignition Coil (Cylinder #1) control output [Without Immobilizer]
IG COIL (CYL. #2)
A16 - Ignition Coil (Cylinder #2) control output [With Immobilizer]
A46 - Ignition Coil (Cylinder #2) control output [Without Immobilizer]
IG COIL (CYL. #3)
A46 - Ignition Coil (Cylinder #3) control output [With Immobilizer]
A16 - Ignition Coil (Cylinder #3) control output [Without Immobilizer]
IG COIL (CYL. #4)
A1 - Ignition Coil (Cylinder #4) control output [With Immobilizer]
A31 - Ignition Coil (Cylinder #4) control output [Without Immobilizer]
CONDENSER
A2 - Shield
IMMO. LAMP
IG ON
K89 - Immobilizer Lamp control output
ABS/VDC CONTROL UNIT
K40 - Vehicle speed signal input
POWER DISTRIBUTION MODULE (PDM)
K86 - Engine speed signal output
ALTERNATOR
A14 - Alternator (FR)
COOLING FAN RELAY [HIGH]
K88 - Cooling Fan Relay [High] control output
COOLING FAN RELAY [LOW]
K65 - Cooling Fan Relay [Low] control output
SMART KEY CONTROL MODULE
K75 - Immobilizer communication line
· OTHER CONTROL MODULE
· DATA LINK CONNECTOR (DLC)
· MULTI-PURPOSE CHECK CONNECTOR
K77 - CAN [High]
K78 - CAN [Low]
· Refer to Electrical Troubleshooting Manual
A42 - A/C Blower Switch signal input
A57 - A/C Switch "ON" signal input
K87 - A/C Compressor Relay control output

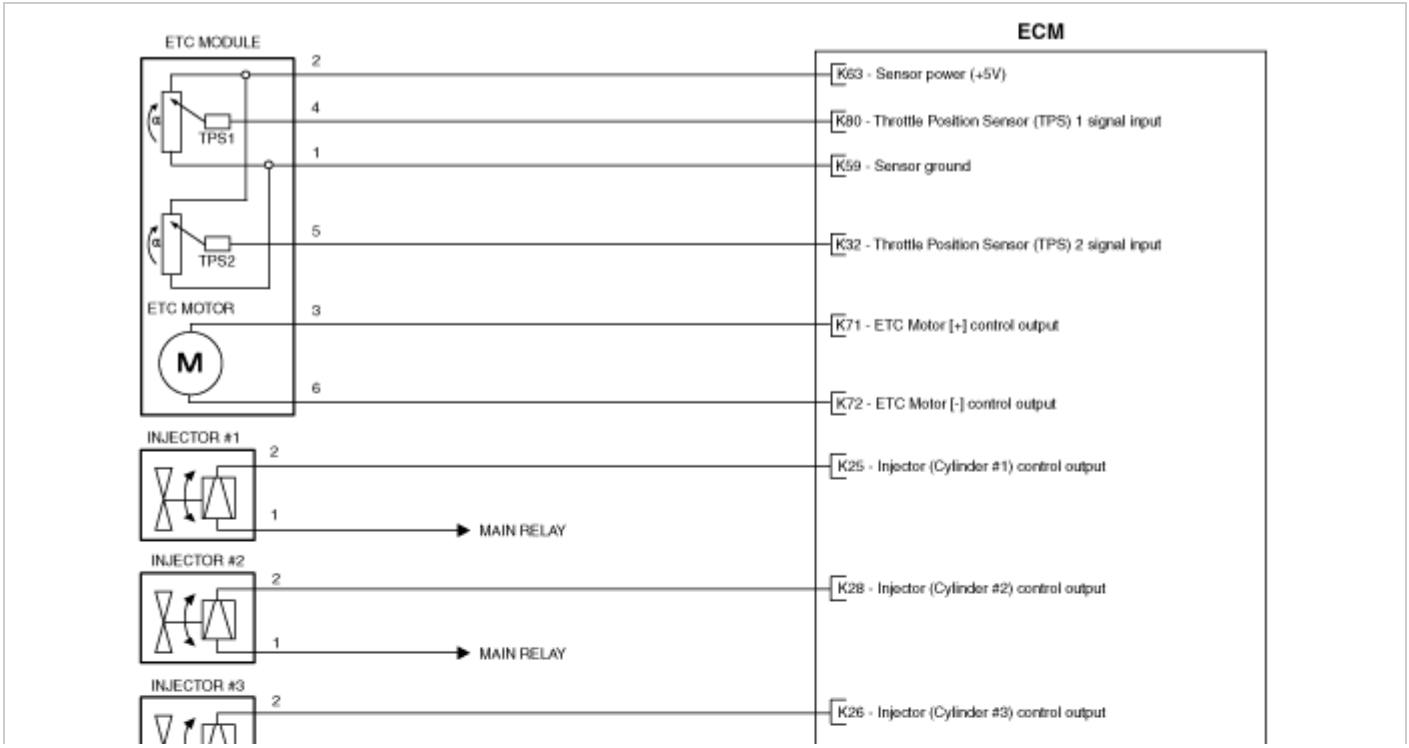

MAPS #1 & IATS
ECM

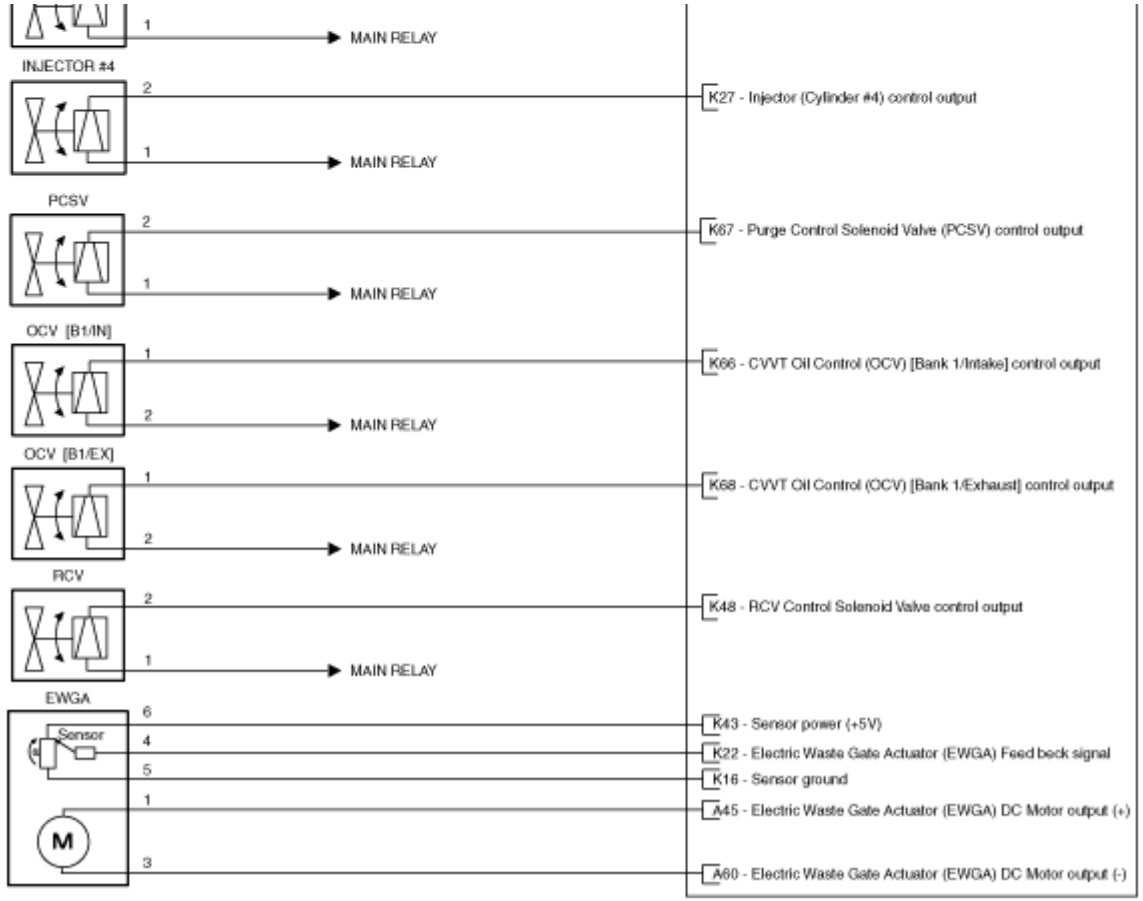

4
K74 - Sensor ground
1
K31 - Manifold Absolute Pressure Sensor (MAPS) #1 signal input
3
K53 - Intake Temperature Sensor (IATS) signal input
MAPS #2
2
K43 - Sensor power (+5V)
4
K11 - Sensor ground
1
K10 - Manifold Absolute Pressure Sensor (MAPS) #2 signal input
ATS
1
K21 - Ambient Temperature Sensor (ATS) signal input
2
K44 - Sensor ground
ECTS
1
K33 - Engine Coolant Temperature Sensor (ECTS) signal input
2
A/C CONTROL MODULE
3
K14 - Sensor ground
CMPS [B1/IN]
1
MAIN RELAY
3
K62 - Camshaft Position Sensor (CMPS) [Bank 1/Intake] signal input
2
K83 - Sensor ground
CMPS [B1/EX]
1
MAIN RELAY
3
K15 - Camshaft Position Sensor (CMPS) [Bank 1/Exhaust] signal input
2
K37 - Sensor ground
CKPS
1
MAIN RELAY
3
K17 - Crankshaft Position Sensor (CKPS) signal input
2
K39 - Sensor ground
KS
2
K12 - Knock Sensor (KS) signal input
1
K34 - Sensor ground
HO2S [B1/S1]
4
Main Relay
5
K93 - HO2S (B1/S1) Heater control output
2
K19 - VS+ (NERNST Cell Voltage)
1
K20 - VS-/IP- (Common Ground for VS,IP)
3
K18 - Ro/Rp (Pump Cell Voltage)


6
K42 - Rc (Compensative Resistance)
HO2S [B1/S2]
3
MAIN RELAY
4
1
2
K94 - Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2] Heater control output
K84 - Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2] signal input
K85 - Sensor ground


ECM
APS
APS1
5
6
3
APS2
1
4
2
K80 - Sensor power (+5V)
K82 - Accelerator Position Sensor (APS) 1 signal input
K61 - Sensor ground
K36 - Sensor power (+5V)
K35 - Accelerator Position Sensor (APS) 2 signal input
K13 - Sensor ground
OTS
1
2
K58 - CVVT Oil Temperature Sensor (OTS) signal input
K79 - Sensor ground
APT
3
1
2
K43 - Sensor power (+5V)
K57 - Sensor ground
K54 - A/C Pressure Transducer (APT) signal input
BRAKE SWITCH
IG ON
BATTERY(+)
4
1
3
2
A44 - Brake Switch 2 signal input
A29 - Brake Switch 1 signal input
POWER STEERING SWITCH
A58 - Power Steering Switch signal input
CLUCH SWITCH
A43 - Clutch Switch signal input
FTPS
1
2
3
K43 - Sensor power (+5V)
K73 - Sensor ground
K52 - Fuel Tank Pressure Sensor (FTPS) signal input


FLS #2
SUB
FLS #1
MAIN
CCV
2
1
MAIN RELAY
Refer to Electrical Troubleshooting Manual
K9 - Fuel Level Sensor (FLS) [TOTAL] signal input
K8 - Fuel Level Sensor (FLS) [MIDDLE] signal input
K91 - Canister Close Valve (CCV) control output
A15 - Ground
K87 - Cruise Control Switch signal input


ECM
ETC MODULE
TPS1
TPS2
ETC MOTOR
M
2
4
1
5
3
6
INJECTOR #1
INJECTOR #2
INJECTOR #3
MAIN RELAY
MAIN RELAY
K63 - Sensor power (+5V)
K80 - Throttle Position Sensor (TPS) 1 signal input
K59 - Sensor ground
K32 - Throttle Position Sensor (TPS) 2 signal input
K71 - ETC Motor [+] control output
K72 - ETC Motor [-] control output
K25 - Injector (Cylinder #1) control output
K28 - Injector (Cylinder #2) control output
K26 - Injector (Cylinder #3) control output



Fuel System

ECM Problem Inspection Procedure

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

   Specification: Below 1Ω
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 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 Inspection Procedure” in Basic Inspection Procedure).

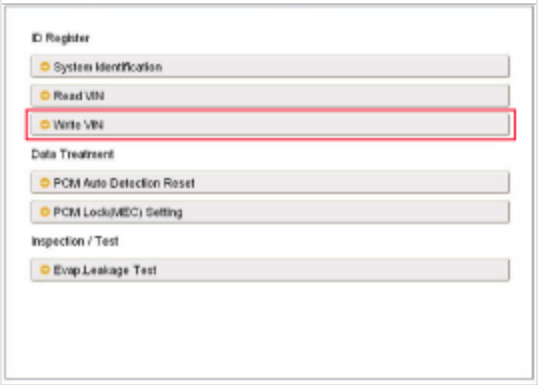
VIN Programming Procedure

VIN (Vehicle Identification Number) is a number that has the vehicle's information (Maker, Vehicle Type, Vehicle Line/Series, Body Type, Engine Type, Transmission Type, Model Year, Plant Location and so forth. For more information, please refer to the group "GI" in this SERVICE MANUAL). When replacing an ECM, the VIN must be programmed in the ECM. If there is no VIN in ECM memory, the fault code (DTC P0630) is set.

⚠ CAUTION

The programmed VIN cannot be changed. When writing the VIN, confirm the VIN carefully

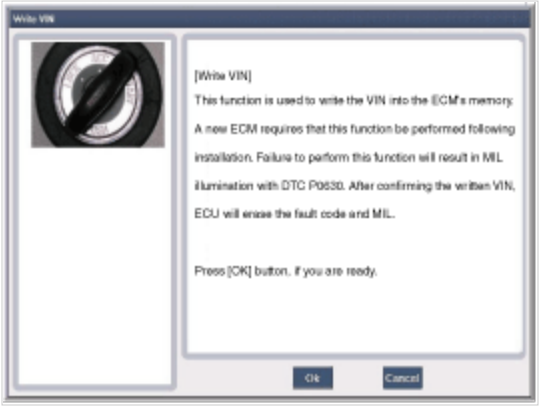
1. Select "VIN Writing" function in "Vehicle S/W Management".
2. Select "Write VIN" in "ID Resister".



3. Input the VIN.

⚠ WARNING

Before inputing the VIN, confirm the VIN again because the programmed VIN cannot be changed.

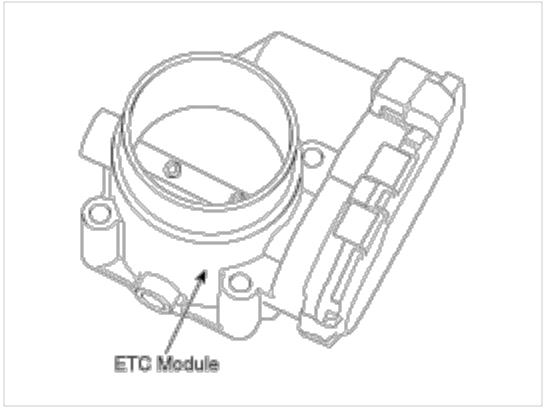


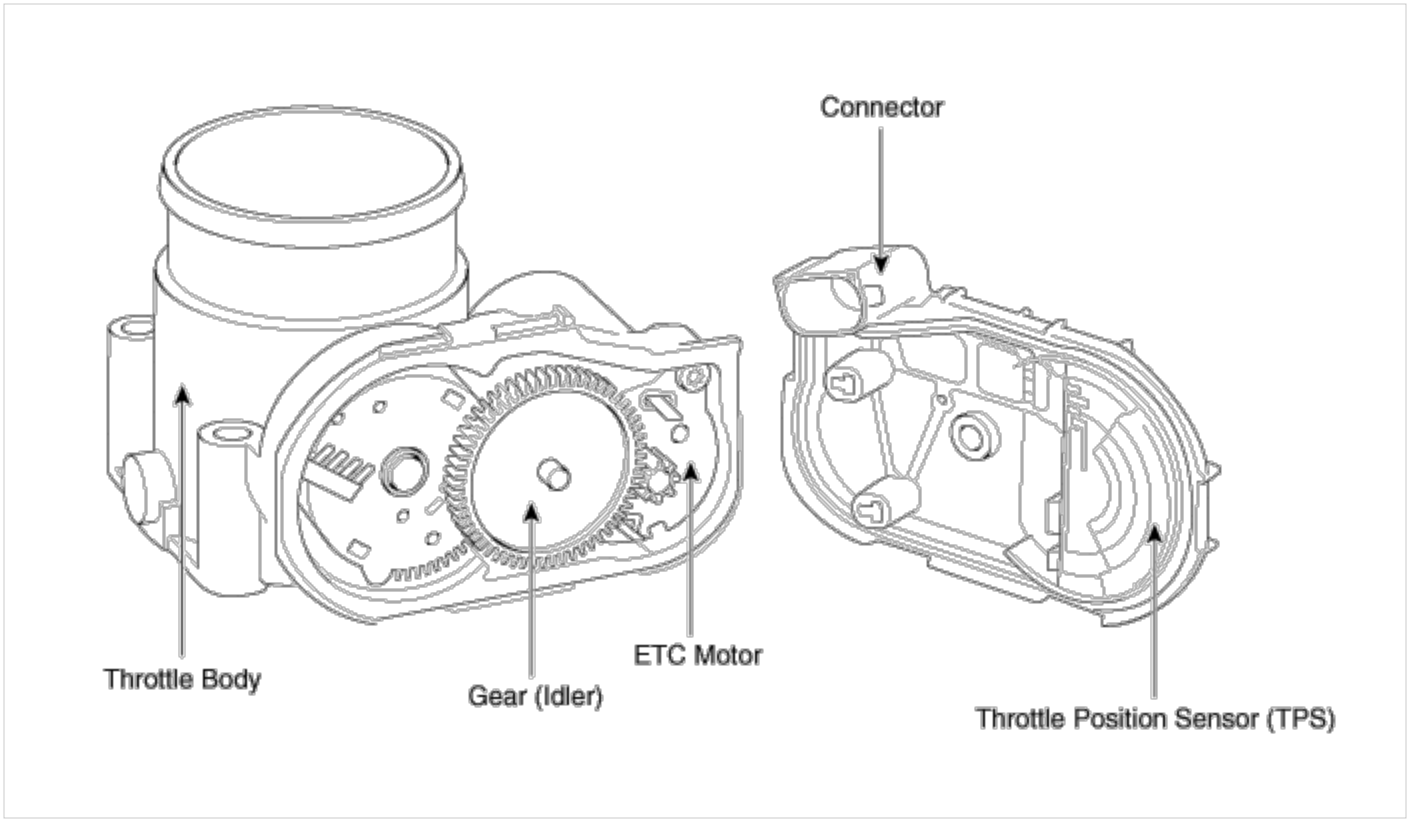
4. Turn the ignition switch OFF, then back ON.

Fuel System

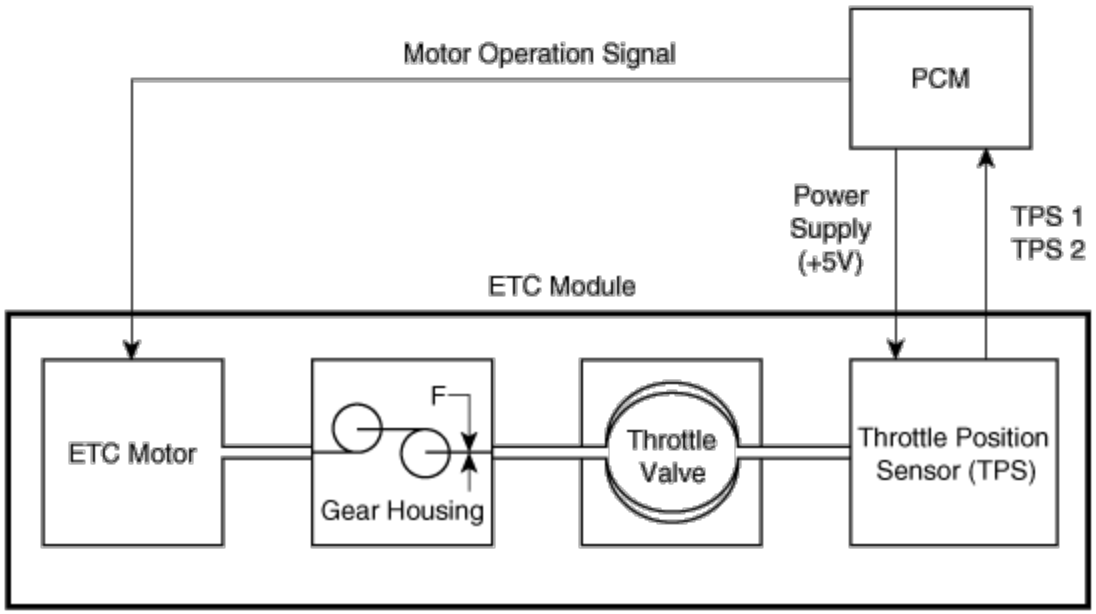
Description

The Electronic Throttle Control (ETC) System consists of a throttle body with an integrated control motor and throttle position sensor (TPS). Instead of the traditional throttle cable, an Accelerator Position Sensor (APS) is used to receive driver input. The ECM uses the APS signal to calculate the target throttle angle; the position of the throttle is then adjusted via ECM control of the ETC motor. The TPS signal is used to provide feedback regarding throttle position to the ECM. Using ETC, precise control over throttle position is possible; the need for external cruise control modules/cables is eliminated.





Schematic Diagram



Fail-Safe Mode

Item	Fail-Safe	
ETC Motor	Throttle valve stuck at 5°	
TPS	TPS 1 fault	Replace it with TPS2
	TPS 2 fault	Replace it with TPS1
	TPS 1,2 fault	Throttle valve stuck at 5°
APS	TPS 1 fault	Replace it with TPS2
	TPS 2 fault	Replace it with TPS1
	TPS 1,2 fault	Throttle valve stuck at 5°

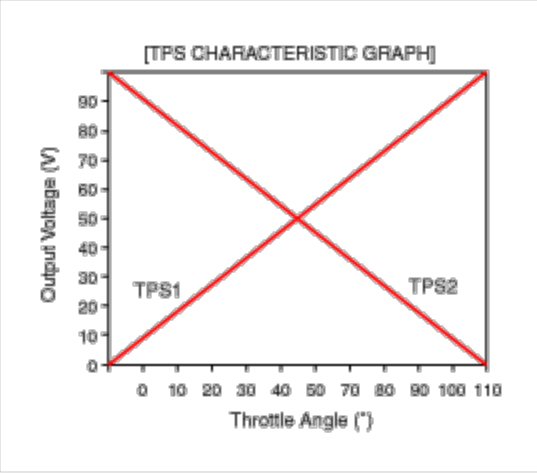
NOTICE

When throttle value is stuck at 5°, engine speed is limited at below 1,500rpm and vehicle speed at maximum 40 ~ 50 km/h (25 ~ 31 mph)

Specification

[Throttle Position Sensor (TPS)]

Throttle Angle(°)	Output Voltage(V)	
	TPS1	TPS2
0	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



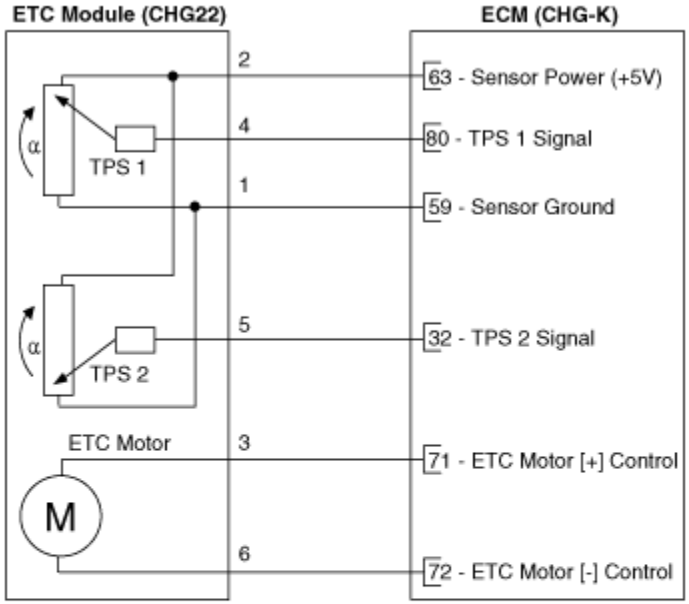
Item	Sensor Resistance(kΩ)
TPS1	0.875 ~ 1.625 [20°C(68°F)]
TPS2	0.875 ~ 1.625 [20°C(68°F)]

[ETC Motor]

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

Circuit Diagram

[Circuit Diagram]



[Connection Information]

Terminal	Connected to	Function
1	ECM CHG-K (59)	Sensor Ground
2	ECM CHG-K (63)	Sensor Power (+5V)
3	ECM CHG-K (71)	ETC Motor [+] Control
4	ECM CHG-K (80)	TPS 1 Signal
5	ECM CHG-K (82)	TPS 2 Signal
6	ECM CHG-K (72)	ETC Motor [-] Control

[Harness Connector]

CHG22
ETC Module

CHG-K
ECM

Inspection

Throttle Position Sensor (TPS)

1. Connect a scantool on the Data Link Connector (DLC).
2. Start the engine and measure the output voltage of TPS 1 and 2 at C.T. and W.O.T.

Throttle Angle	Output Voltage (V)	
	TPS 1	TPS 2
C.T	0.25 ~ 0.9	Min.4.0
W.O.T	Min.4.0	0.25 ~ 0.9

3. Turn the ignition switch OFF and disconnect the scantool from the DLC.
4. Disconnect the ETC module connector and measure the resistance between the ETC module terminals 1 and 2.

Specification: Refer to “Specification”

ETC Motor

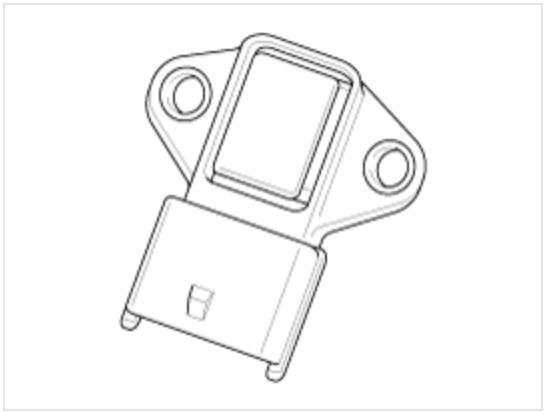
1. Turn the ignition switch OFF.
2. Disconnect the ETC module connector.
3. Measure resistance between the ETC module terminals 3 and 6.
4. Check that the resistance is within the specification.

Specification: Refer to “Specification”

Description

Manifold Absolute Pressure Sensor (MAPS) are installed on the surge tank and sense pressure in front of the throttle body and pressure in intake manifold. It calculates mass air flow indirectly (Speed-density type) and transfers this analog signal proportional to the pressure to the ECM. The ECM calculates the intake air quantity and engine speed based on this signal.

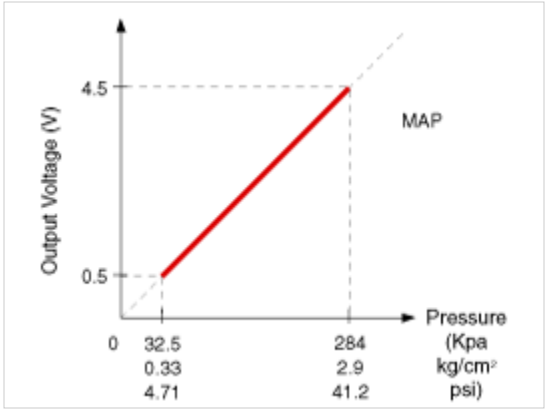
This MAPS consists of a piezo-electric element and a hybrid IC that amplifies the element output signal. The element is silicon diaphragm type and adapts pressure sensitive variable resistor effect of semi-conductor.100% vacuum and the manifold pressure apply to the both sides of it respectively. That is, this sensor outputs the silicon variation proportional to pressure change by voltage.



Fuel System

Specification

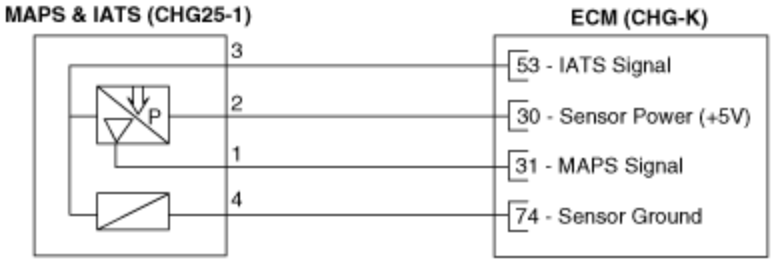
Pressure [kPa (kg/cm², psi)]	Output Voltage (V)
32.5 (0.33, 4.71)	0.5
284 (2.90, 41.20)	4.5



Fuel System

Circuit Diagram

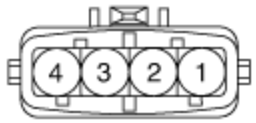
[Circuit Diagram]



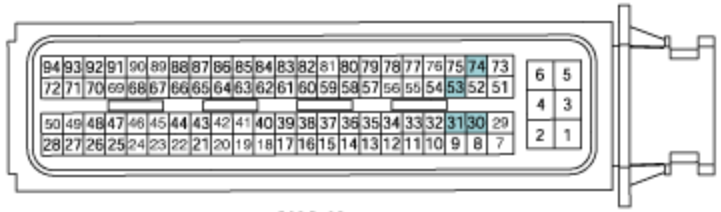
[Connection Information]

Terminal	Connected to	Function
1	ECM CHG-K (31)	MAPS #1 Signal
2	ECM CHG-K (30)	Sensor Power (+5V)
3	ECM CHG-K (53)	IATS Signal
4	ECM CHG-K (74)	Sensor Ground

[Harness Connector]



CHG25-1
MAPS & IATS



CHG-K
ECM

Fuel System

Inspection

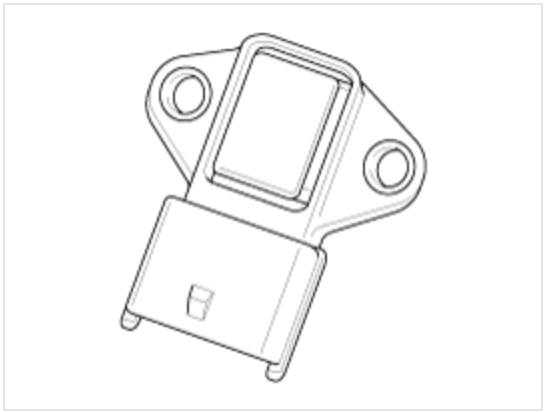
1. Connect a GDS on the Data Link Connector (DLC).
2. Measure the output voltage of the MAPS at idle and IG ON.

Specification: Refer to "Specification"

Fuel System

Description

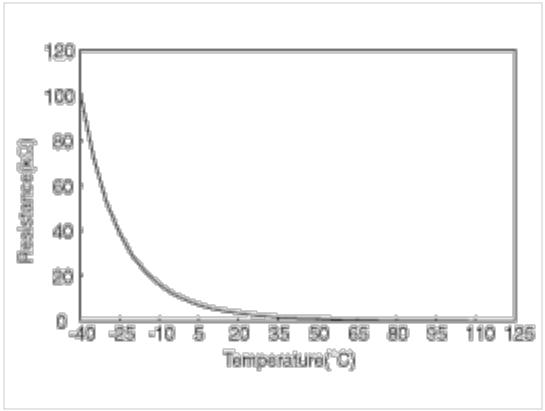
Intake Air Temperature Sensor (IATS) is installed inside the Manifold Absolute Pressure Sensor (MAPS) and detects the intake air temperature. To calculate precise air quantity, correction of the air temperature is needed because air density varies according to the temperature. So the ECM uses not only MAPS signal but also IATS signal. This sensor has a Negative Temperature Coefficient (NTC) and its resistance is in inverse proportion to the temperature.



Fuel System

Specification

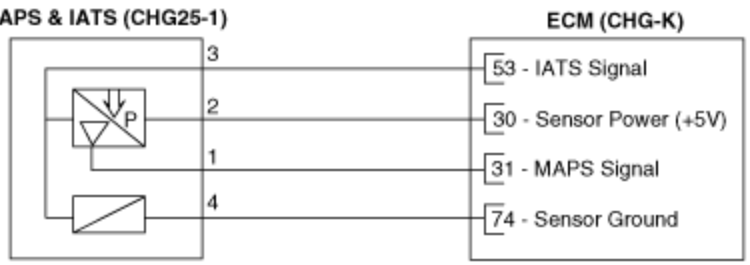
Temperature [°C(°F)]	Resistance (kΩ)
-40(-40)	40.93 ~ 48.35
-20(-4)	13.89 ~ 16.03
0(32)	5.38 ~ 6.09
10(50)	3.48 ~ 3.90
20(68)	2.31 ~ 2.57
40(104)	1.08 ~ 1.21
50(122)	1.56 ~ 1.74
60(140)	0.54 ~ 0.62
80(176)	0.29 ~ 0.34



Fuel System

Circuit Diagram

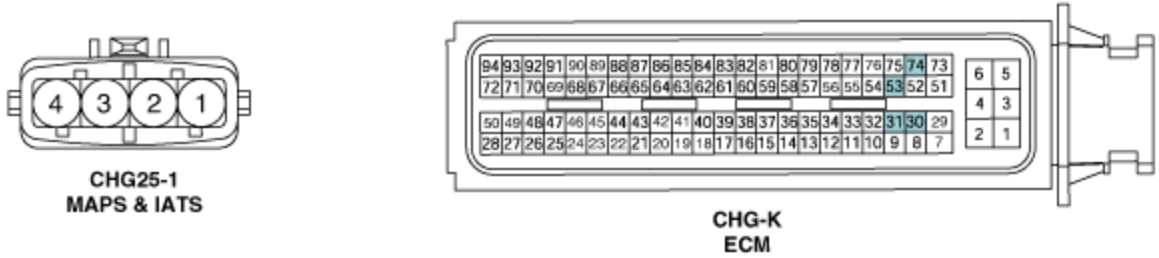
[Circuit Diagram]



[Connection Information]

Terminal	Connected to	Function
1	ECM CHG-K (31)	MAPS #1 Signal
2	ECM CHG-K (30)	Sensor Power (+5V)
3	ECM CHG-K (53)	IATS Signal
4	ECM CHG-K (74)	Sensor Ground

[Harness Connector]



Fuel System

Inspection

1. Turn the ignition switch OFF.
2. Disconnect the IATS connector.
3. Measure resistance between the IATS terminals 3 and 4.
4. Check that the resistance is within the specification.

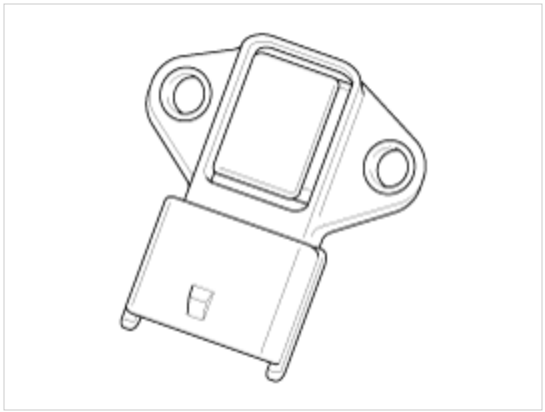
Specification: Refer to “Specification”

Fuel System

Description

The Boost Pressure Sensor (BPS) is installed on the intercooler assembly and measures the pressure of the compressed air in turbocharger.

The BPS consists of a piezo-electric element and a hybrid IC amplifying the element output signal. The element is silicon diaphragm type and adapts pressure sensitive variable resistor effect of semi-conductor. Because 100% vacuum and the turbocharger pressure apply to both sides of the sensor respectively, this sensor can output analog signal by using the silicon variation proportional to pressure change.



Fuel System

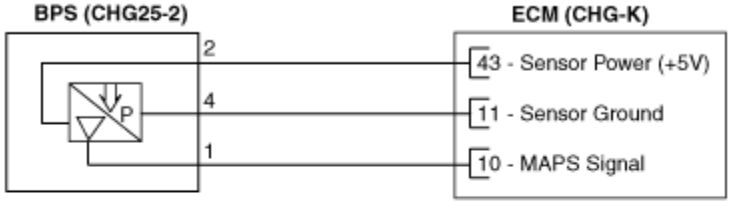
Specification

Pressure [kPa (kg/cm², psi)]	Output Voltage (V)
32.5 (0.33, 4.71)	0.5
284 (2.90, 41.20)	4.5

Fuel System

Circuit Diagram

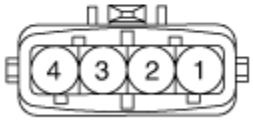
[Circuit Diagram]



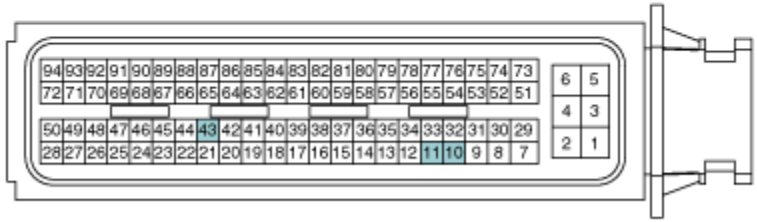
[Connection Information]

Terminal	Connected to	Function
1	ECM CHG-K (10)	BPS signal
2	ECM CHG-K (43)	Sensor power (+5V)
3	-	-
4	ECM CHG-K (11)	Sensor ground

[Harness Connector]



CHG25-2
BPS



CHG-K
ECM

Fuel System

Inspection

1. Connect a GDS on the Data Link Connector (DLC).
2. Measure the output voltage of the MAPS at idle and IG ON.

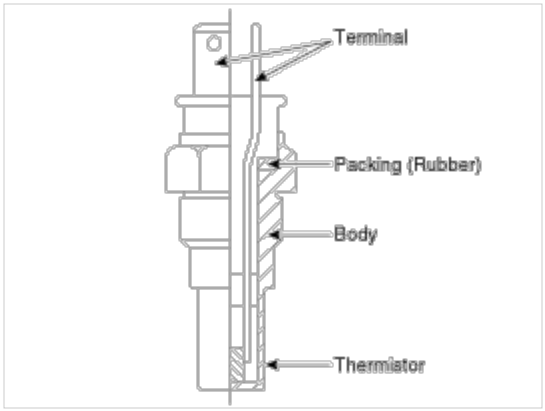
Specification: Refer to "Specification"

Fuel System

Description

Engine Coolant Temperature Sensor (ECTS) is located in the engine coolant passage of the cylinder head for detecting the engine coolant temperature.The ECTS uses a thermistor whose resistance changes with the temperature. The electrical resistance of the ECTS decreases as the temperature increases, and increases as the temperature decreases. The reference 5 V 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.



Fuel System

Specification

Temperature		Resistance (kΩ)
°C	°F	
-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

Fuel System

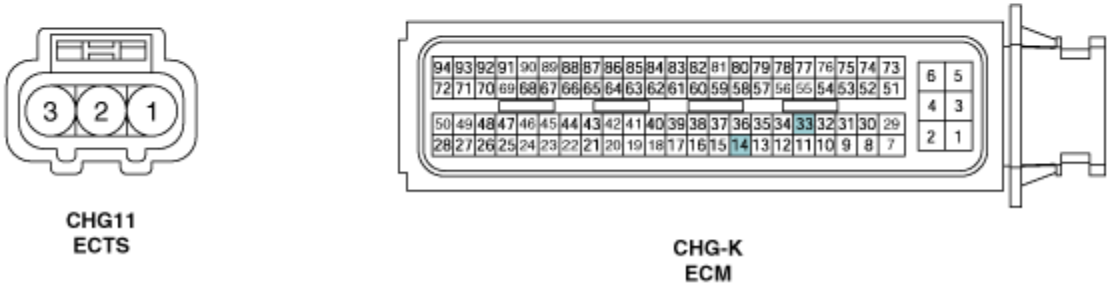
Circuit Diagram

[Circuit Diagram]

[Connection Information]

Terminal	Connected to	Function
1	ECM CHG-K (33)	ECTS Signal
2	-	-
3	ECM CHG-K (14)	Sensor Ground

[Harness Connector]



Fuel System

Inspection

1. Turn the ignition switch OFF.
2. Disconnect the ECTS connector.
3. Remove the ECTS.
4. After immersing the thermistor of the sensor into engine coolant, measure resistance between the ECTS terminals 1 and 3.
5. Check that the resistance is within the specification.

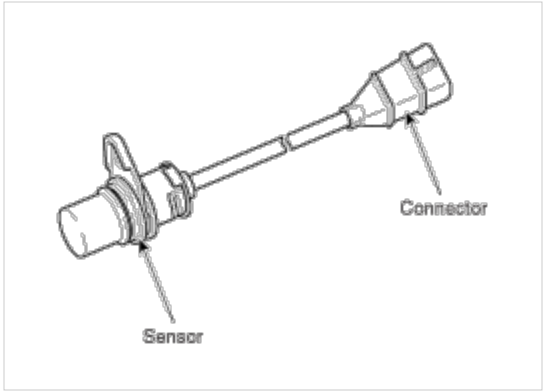
Specification: Refer to “Specification”

Fuel System

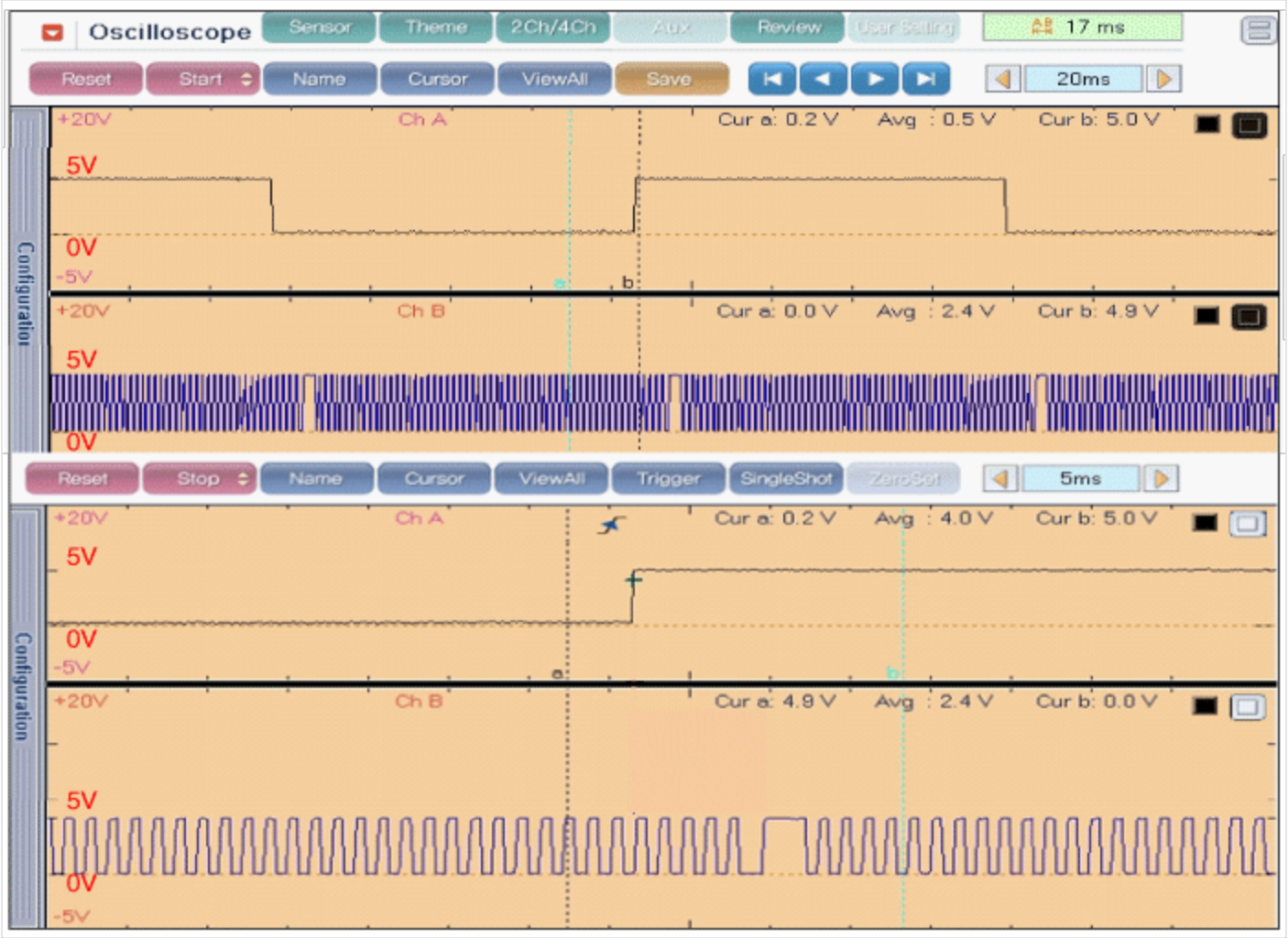
Description

Crankshaft Position Sensor (CKPS) detects the crankshaft position and is one of the most important sensors of the engine control system. If there is no CKPS signal input, the engine may stop because of CKPS signal missing.

This sensor is installed on transaxle housing or the cylinder block and generates alternating current by magnetic flux field which is made by the sensor and the target wheel when the engine rotates. The target wheel consists of 58 slots and 2 missing slots on 360 CA (Crank Angle).



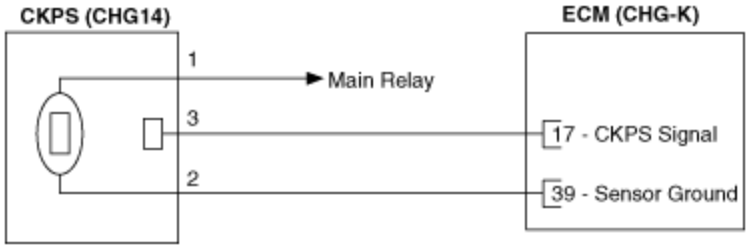
Signal Waveform



Fuel System

Circuit Diagram

[Circuit Diagram]

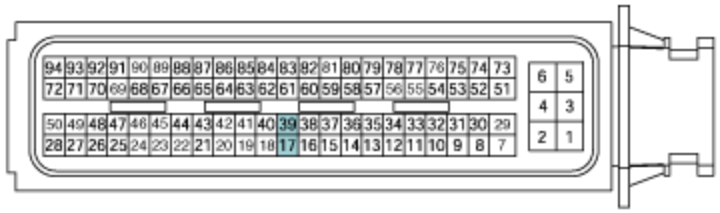


[Connection Information]

Terminal	Connected to	Function
1	Main Relay	Battery Power (B+)
2	ECM CHG-K (39)	CKPS Signal
3	ECM CHG-K (17)	Sensor Ground

[Harness Connector]

CHG14
CKPS



CHG-K
ECM

Fuel System

Inspection

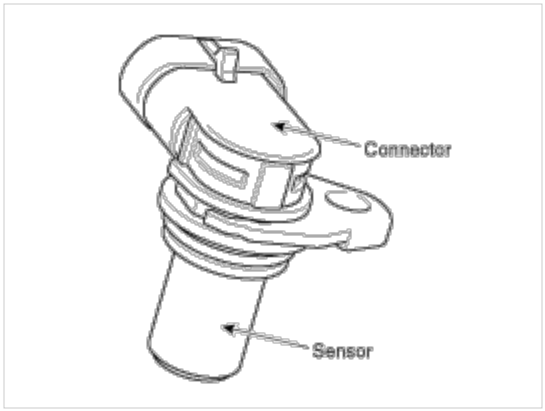
1. Check the signal waveform of the CMPS and CKPS using a scantool.

Specification: Refer to “Wave Form”

Fuel System

Description

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 each cylinder which the CKPS can’t detect. The two CMPS are installed on engine head cover of bank 1 and 2 respectively and use 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 6 cylinders is impossible without CMPS signal.



Fuel System

Signal Waveform