Rio
CAR MANUALS
TECHNICAL INFO

Kia Rio UB 2012-2020 Service Manual

ENGINE CONTROL/FUEL SYSTEM

5 ENGINE CONTROL/FUEL SYSTEM

ENGINE CONTROL/FUEL SYSTEM (CONT...)

5.1 Specifications

5.1.1 Fuel Delivery System

Items	Specification	
Fuel Tank	Capacity	43 lit. (11.4 U.S.gal., 45.4 U.S.qt., 37.8 Imp.qt.)
Fuel Filter	Type	Paper type
Fuel Pressure	Low Pressure Fuel Line	480 ~ 520 kPa (4.89 ~ 5.30 kgf/cm², 69.6 ~ 75.4 psi)
	High Pressure Fuel Line	2.0 ~ 15.0 MPa (20.4 ~ 153.0 kgf/cm², 290.1 ~ 2175.6 psi)
Fuel Pump	Type	Electrical, in-tank type
	Driven by	Electric motor
High Pressure Fuel Pump	Type	Mechanical type
	Driven by	Camshaft

5.1.2 Sensors

Manifold Absolute Pressure Sensor (MAPS)

▷ Type: Piezo-resistive pressure sensor type

▷ Specification

Pressure [kPa (kgf/cm², psi)]	Output Voltage (V)
20.0 (0.20, 2.9)	0.79
46.7 (0.47, 6.77)	1.84
101.3 (1.03, 14.7)	4.0

Intake Air Temperature Sensor (IATS)

▷ Type: Thermistor type

▷ Specification

Temperature		Resistance (kΩ)
°C	°F	
-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

Engine Coolant Temperature Sensor (ECTS)

▷ Type: Thermistor type

▷ 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

Throttle Position Sensor (TPS) [integrated into ETC module]

▷ Type: Hall IC Non-contact sensor type
▷ Specification

Throttle angle(°)	Output Voltage (V)	
	TPS1	TPS2
0	0.5	4.5
10	0.96	4.05
20	1.41	3.59
30	1.87	3.14
40	2.32	2.68
50	2.78	2.23
60	3.23	1.77
70	3.69	1.32
80	4.14	0.86
90	4.6	0.41
98	4.65	0.35
C.T (0)	0.5	4.5
W.O.T (86)	4.41	0.59

Crankshaft Position Sensor (CKPS)
▷ Type: Magnetic field sensitive Type
▷ Specification

Item	Specification
Coil Resistance (Ω)	774 ~ 946 [20°C (68°F)]

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

Item	Specification
Capacitance (pF)	950 ~ 1,350
Resistance(MΩ)	4.87

Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 1]
▷ Type: Zirconia (ZrO2) [Linear] Type
▷ Specification

Item	Specification
Heater Resistance (Ω)	2.4 ~ 4.0 [20°C(69.8°F)]

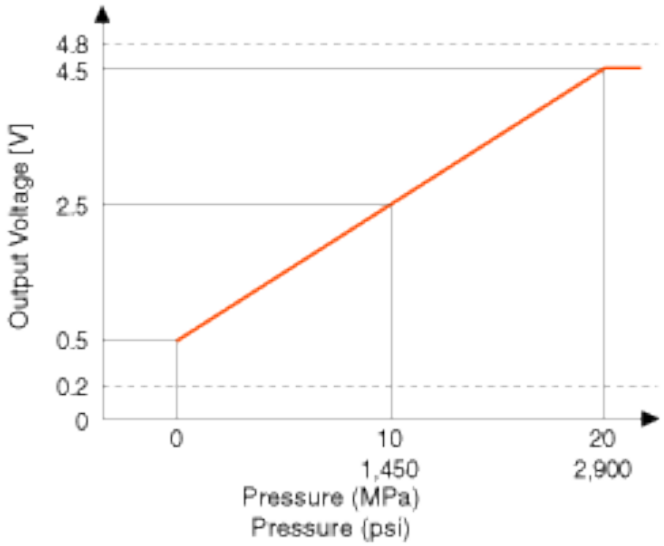
Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2]
▷ Type: Zirconia (ZrO2) [Binary] Type
▷ Specification

A/F Ratio (λ)	Output Voltage(V)
RICH	0.6 ~ 1.0
LEAN	0 ~ 0.4

Item	Specification
Heater Resistance (Ω)	Approx. 9.0 [21°C(69.8°F)]

Rail Pressure Sensor (RPS)

▷ Type: Piezo-electricity type
▷ Specification



Accelerator Position Sensor (APS)
▷ Type: Variable resistor type
▷ Specification

Accelerator Position	Output Voltage (V)	
	APS1	APS2
C.T	0.7 ~ 0.8	0.275 ~ 0.475
W.O.T	3.8 ~ 4.4	1.75 ~ 2.35

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

Pressure [kPa (kgf/cm², in H2O)	Output Voltage (V)
-6.67 (-0.068, -26.8)	0.5
0	2.5
+6.67 (0.068, 26.8)	4.5

5.1.3 Actuators

Injector
▷ Specification

Item	Specification
Coil Resistance (Ω)	1.5 [20°C(68°F)]

ETC Motor [integrated into ETC Module]
▷ Specification

Item	Specification
Coil Resistance (Ω)	0.3 ~ 100 [20°C(68°F)]

Purge Control Solenoid Valve (PCSV)
▷ Specification

Item	Specification
Coil Resistance (Ω)	22.0 ~ 26.0 [20°C(68°F)]

CVVT Oil Control Valve (OCV)
▷ Specification

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

Variable Intake Solenoid (VIS) Valve
▷ Specification

Item	Specification
Coil Resistance (Ω)	30.0 ~ 35.0 [20°C(68°F)]

Fuel Pressure Regulator Valve
▷ Specification

Item	Specification
Coil Resistance (Ω)	0.5 [20°C(68°F)]

Ignition Coil
▷ Type: Stick type
▷ Specification

Item	Specification
Primary Coil Resistance (Ω)	0.75 ± 15%[20°C(68°F)]
Secondary Coil Resistance (kΩ)	5.9 [20°C(68°F)]

Canister Close Valve (CCV)
▷ Specification

Item	Specification
Coil Resistance (Ω)	19.8 ~ 20.8 (20°C)

5.2 Service Standards

▷5.2.1 Idle Speed & Ignition Timing

Item		Specification	
Ignition Timing (°)		BTDC 3 ± 10	
Idle Speed (rpm)	A/C OFF	Neutral, N, P-range	630 ± 100
		D-range	630 ± 100
	A/C ON	Neutral, N, P-range	700 ± 100
		D-range	5 ± 100

5.3 Tightening Torques

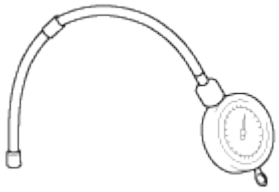
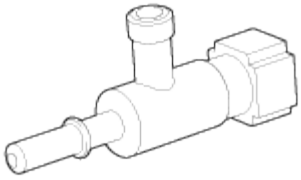
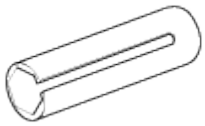
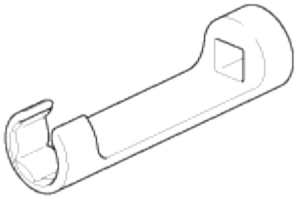
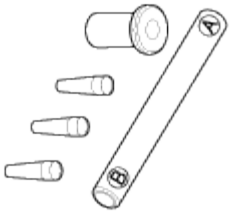
5.3.1 Engine Control System

Item	kgf.m	N.m	lb-ft
ECM installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
ECM bracket installation bolt/nut	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.
Manifold absolute pressure 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	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7
Camshaft position sensor (Bank 1 / Intake) installation bolt	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7
Camshaft position sensor (Bank 1 / Exhaust) installation bolt	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7
Knock sensor installation bolt	1.9 ~ 2.5	18.6 ~ 24.5	13.7 ~ 18.1
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
Rail pressure sensor installation	3.0 ~ 3.5	29.4 ~ 34.3	21.7 ~ 25.3
Electronic throttle body installation bolt	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
Ignition coil installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7

5.3.2 Fuel Delivery System

Item	kgf.m	N.m	lb-ft
Fuel tank installation nut	4.0 ~ 5.5	39.2 ~ 54.0	28.9 ~ 39.8
Fuel pump plate cover installation bolt	0.2 ~ 0.3	2.0 ~ 2.9	1.4 ~ 2.2
Filler-neck assembly bracket installation bolt	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7
Filler-neck assembly installation bolt	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7
Accelerator pedal module installation nut	1.3 ~ 1.6	12.8 ~ 15.7	9.4 ~ 11.6
Accelerator pedal module installation bolt	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7
Delivery pipe installation bolt	1.9 ~ 2.4	18.6 ~ 23.5	13.7 ~ 17.4
High pressure fuel pump installation bolt	1.3 ~ 1.5	12.8 ~ 14.7	9.4 ~ 10.9
High pressure fuel pipe installation nut	2.7 ~ 3.3	26.5 ~ 32.4	19.5 ~ 23.9
High pressure fuel pipe function block installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7

5.4 Special Service Tools

Item	Illustration	Application
Fuel Pressure Gauge (09353-24100)		Measuring the fuel line pressure
Fuel Pressure Gauge Adapter (09353-02100)		Connection between the high pressure fuel pump and the fuel feed line
Heated Oxygen Sensor Socket Wrench (09392-2H100)		Removal and installation of the heated oxygen sensor
Torque Wrench Socket (09314-3Q100) or (09314-27130) (19mm)		Removal and installation of the high pressure fuel pipe
Injector Combustion Seal Guide & Sizing tool (09353-2B000)		Installation of the injector combustion seal

5.5 Basic Troubleshooting

5.5.1 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 the GDS 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**

5.5.2 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	DPF (Diesel Engine)	☐ With DPF ☐ Without DPF

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	

5.5.3 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.

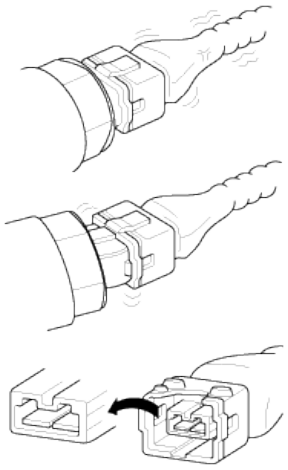
NOTICE

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

5.5.4 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.

5.5.4.1 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.

5.5.4.2 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.

5.5.4.3 Simulating Water Sprinkling

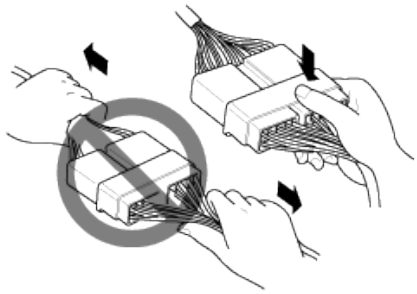
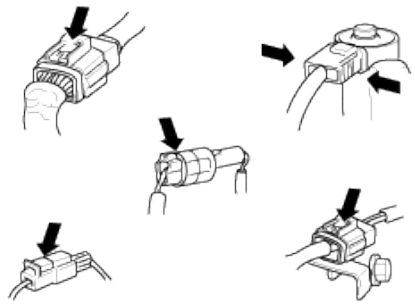
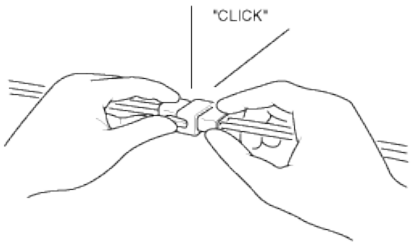
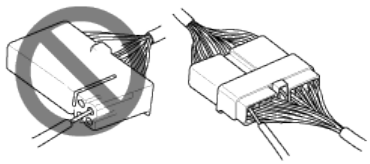
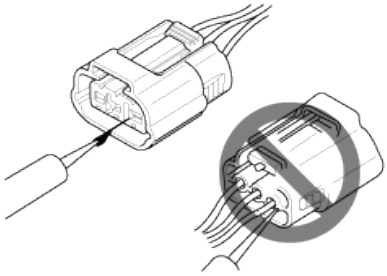
1)Sprinkle water onto vehicle to simulate a rainy day or a high humidity condition.

5.5.4.4 Simulating Electrical Load

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

5.5.5 Connector Inspection Procedure

5.5.5.1 Handling of Connector

A. Never pull on the wiring herness 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.	

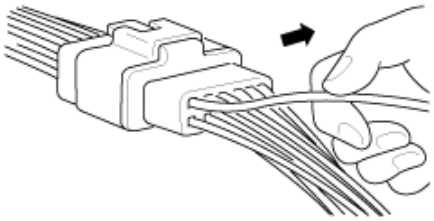
5.5.5.2 Checking Point for Connector

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.



5.5.5.3 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.

5.5.6 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.

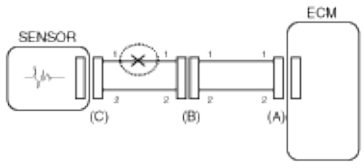
5.5.7 Electrical Circuit Inspection Procedure

5.5.7.1 Check Open Circuit

1. Procedures for Open Circuit

A. Continuity CheckK
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 from side to side.

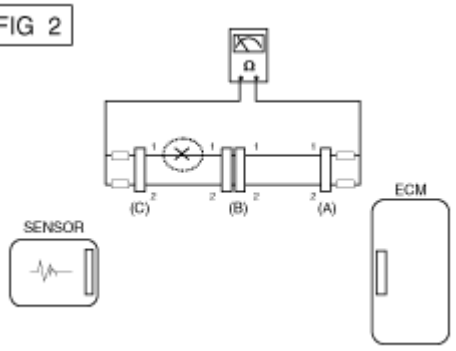
Specification (Resistance)

1Ω or less → Normal Circuit

1MΩ or Higher → Open Circuit

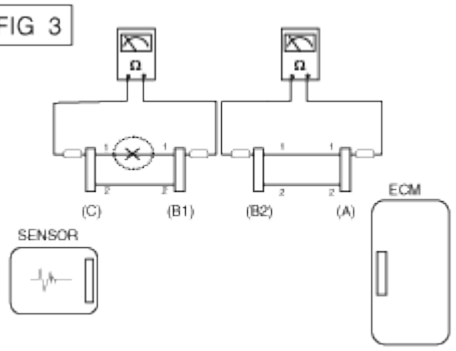
A Disconnect connectors (A), (C) and measure resistance between connector (A) and (C) as shown in [FIG. 2].
In [FIG.2.] the measured resistance of line 1 and 2 is higher than 1MΩ and below 1 Ω respectively. Specifically the open circuit is line 1 (Line 2 is normal). To find exact break point, check sub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

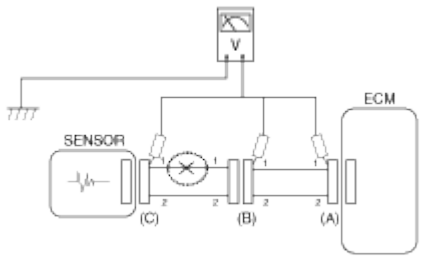
FIG 3



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



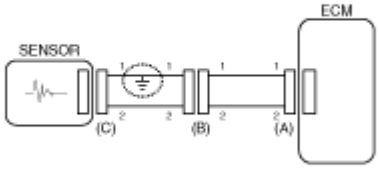
5.5.7.2 Check Short Circuit

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 from side to side when measuring the resistance.

Specification (Resistance)

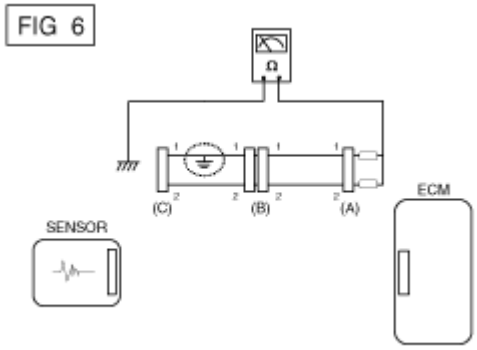
1Ω or less → Short to Ground Circuit

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].

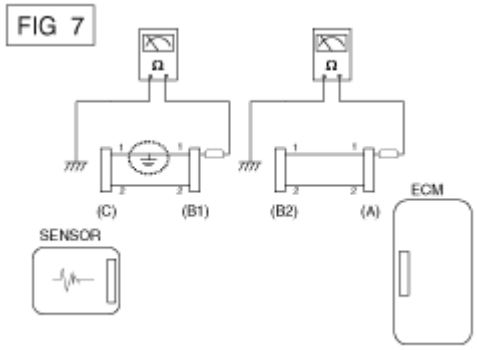
The measured resistance of line 1 and 2 in this example is below 1 Ω and higher than 1MΩ respectively.
Specifically the short to ground circuit is line 1 (Line 2 is normal).
To find exact broken point, check the sub line of line 1 as described in the following step.

FIG 6



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).

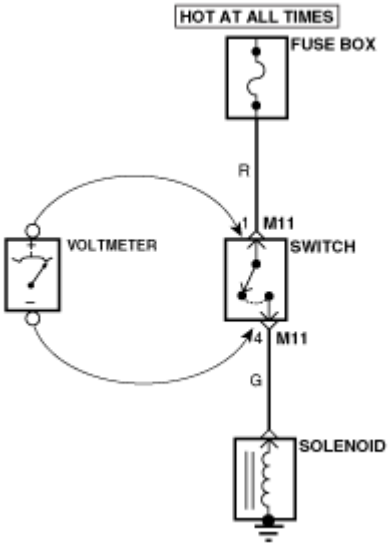
FIG 7



5.5.7.3 Testing For Voltage Drop

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

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.



5.5.8 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 circuit4. 4. Troubleshooting the immobilizer system (In case of immobilizer lamp flashing)	• DTC • Low compression • Intake air leaks • Slipped/broken timing belt • Contaminated fuel
Difficult to start	1. Test the battery 2. Check the fuel pressure 3. Check the ECTS 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 ECTS 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 4. Check the ECTS 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)	• DTC • Low compression • 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? 2. Is acceleration too much, too often? 3. Check the fuel pressure 4. Check the injector 5. Test the exhaust system for a possible restriction 6. Check the ECTS 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 a. Pinched, kinked or blocked? b. Filler hose is torn 3. Inspect the fuel tank vapor vent hose between the canister and fuel tank air filter 4. Check the canister	• Malfunctioning gas station filling nozzle (If this problem occurs at a specific gas station during refueling)

5.6 ENGINE CONTROL SYSTEM

5.6.1 OBD-II review

5.6.1.1 Overview

The California Air Resources Board (CARB) began regulation of On Board Diagnostics (OBD) for vehicles sold in California beginning with the 1988 model year. The first phase, OBD-I, required monitoring of the fuel metering system, Exhaust Gas Recirculation (EGR) system and additional emission related components. The Malfunction Indicator Lamp (MIL) was required to light and alert the driver of the fault and the need for repair of the emission control system. Associated with the MIL was a fault code or Diagnostic Trouble Code (DTC) idenfying the specific area of the fault.

The OBD system was proposed by CARB to improve air quality by identifying vehicle exceeding emission standards. Passage of the Federal Clean Air Act Amendments in 1990 has also prompted the Environmental Protection Agency (EPA) to develop On Board Diagnostic requirements. CARB OBD-II regulations were followed until 1999 when the federal regulations were used.

The OBD-II system meets government regulations by monitoring the emission control system. When a system or component exceeds emission threshold or a component operates outside tolerance, a DTC will be stored and the MIL illuminated.

The diagnostic executive is a computer program in the Engine Control Module (ECM) or Powertrain Control Module (PCM) that coordinates the OBD-II self-monitoring system. This program controls all the monitors and interactions, DTC and MIL operation, freeze frame data and scan tool interface.

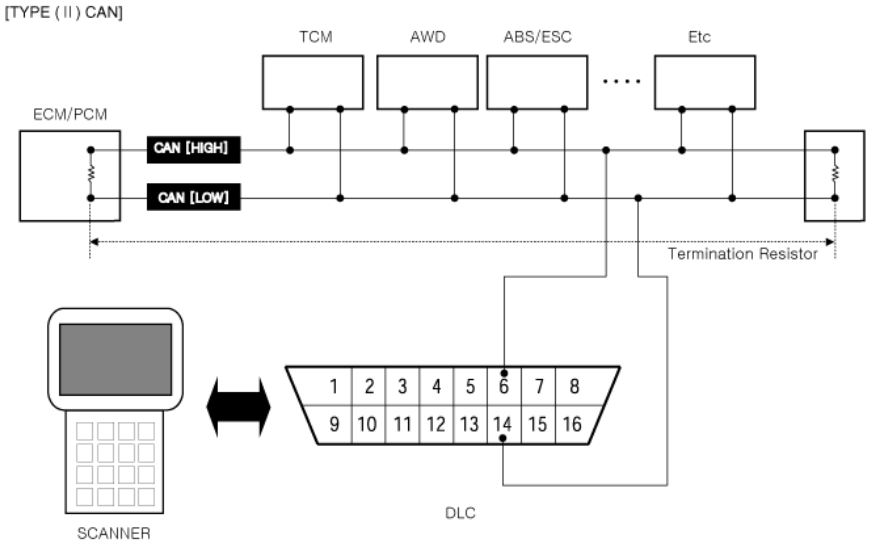
Freeze frame data describes stored engine conditions, such as state of the engine, state of fuel control, spark, RPM, load and warm status at the point the first fault is detected. Previously stored conditions will be replaced only if a fuel or misfire fault is detected. This data is accessible with the scan tool to assist in repairing the vehicle.

The center of the OBD-II system is a microprocessor called the Engine Control Module (ECM) or Powertrain Control Module (PCM).

The ECM or PCM receives input from sensors and other electronic components (switches, relays, and others) based on information received and programmed into its memory (keep alive random access memory, and others), the ECM or PCM generates output signals to control various relays, solenoids and actuators.

5.6.1.2 Configuration of hardware and related terms

1) GST (Generic scan tool)



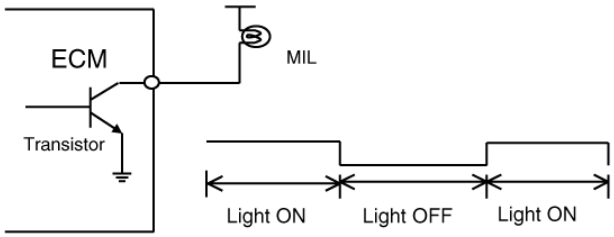
2) MIL (Malfunction indication lamp) - MIL activity by transistor

The Malfunction Indicator Lamp (MIL) is connected between ECM or PCM-terminal Malfunction Indicator Lamp and battery supply (open collector amplifier).

In most cars, the MIL will be installed in the instrument panel. The lamp amplifier can not be damaged by a short circuit.

Lamps with a power dissipation much greater than total dissipation of the MIL and lamp in the tester may cause a fault indication.

▷ At ignition ON and engine revolution (RPM)< MIN. RPM, the MIL is switched ON for an optical check by the driver.



3) MIL illumination

When the ECM or PCM detects a malfunction related emission during the first driving cycle, the DTC and engine data are stored in the freeze frame memory. The MIL is illuminated only when the ECM or PCM detects the same malfunction related to the DTC in two consecutive driving cycles.

4) MIL elimination

•Misfire and Fuel System Malfunctions:

For misfire or fuel system malfunctions, the MIL may be eliminated if the same fault does not reoccur during monitoring in three subsequent sequential driving cycles in which conditions are similar to those under which the malfunction was first detected.

•All Other Malfunctions:

For all other faults, the MIL may be extinguished after three subsequent sequential driving cycles during which the monitoring system responsible for illuminating the MIL functions without detecting the malfunction and if no other malfunction has been identified that would independently illuminate the MIL according to the requirements outlined above.

5) Erasing a fault code

The diagnostic system may erase a fault code if the same fault is not re-registered in at least 40 engine warm-up cycles, and the MIL is not illuminated for that fault code.

6) Communication Line (CAN)

•Bus Topology: Line (bus) structure

•Wiring: Twisted pair wire

•Off Board DLC Cable Length: Max. 5m

•Data Transfer Rate

-Diagnostic: 500 kbps

-Service Mode (Upgrade, Writing VIN): 500 or 1Mbps)

7) Driving cycle

A driving cycle consists of engine start up, and engine shut off.

8) Warm-up cycle

A warm-up cycle means sufficient vehicle operation such that the engine coolant temperature has risen by at least 40 degrees Fahrenheit (4.4 °C) from engine starting and reaches a minimum temperature of at least 160 degrees Fahrenheit (71.1°C).

9) DTC format

•Diagnostic Trouble Code (SAE J2012)

•DTCs used in OBD-II vehicles will begin with a letter and are followed by four numbers.

The letter of the beginning of the DTC identifies the function of the monitored device that has failed. A "P" indicates a powertrain device, "C" indicates a chassis device. "B" is for body device and "U" indicates a network or data link code. The first number indicates if the code is generic (common to all manufacturers) or if it is manufacturer specific. A "0" & "2" indicates generic, "1" indicates manufacturer-specific. The second number indicates the system that is affected with a number between 1 and 7.

The following is a list showing what numbers are assigned to each system.

•1: Fuel and air metering

•2: Fuel and air metering (injector circuit malfunction only)

•3: Ignition system or misfire

•4: Auxiliary emission controls

•5: Vehicle speed controls and idle control system

•6: Computer output circuits

•7: Transmission

The last two numbers of the DTC Indicates the component or section of the system where the fault is located.

10) Freeze frame data

When a freeze frame event is triggered by an emission related DTC, the ECM or PCM stores various vehicle information as it existed the moment the fault ocurred. The DTC number along with the engine data

can be useful in aiding a technician in locating the cause of the fault. Once the data from the 1st driving cycle DTC ocurrence is stored in the freeze frame memory, it will remain there even when the fault ocurrs again (2nd driving cycle) and the MIL is illuminated.

•Freeze Frame List

1)Calculated Load Value
2)Engine RPM
3)Fuel Trim
4)Fuel Pressure (if available)
5)Vehicle Speed (if available)
6)Coolant Temperature
7)Intake Manifold Pressure (if available)
8)Closed-or Open-loop operation
9)Fault code

5.6.1.3 OBD-II Readiness Test

[Kia Motors Drive Cycle]

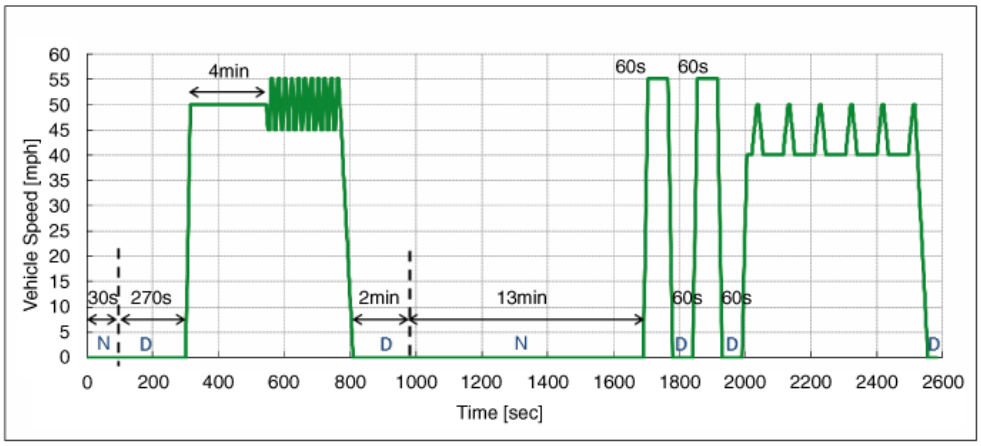
Kia OBDII Drive Cycle is designed to execute and complete the OBDII monitors. To complete a specific monitor for repair verification, follow the Drive Cycle chart below.

Kia OBDII Drive Cycle consists of two modes (Mode 1 and Mode 2) and the Mode 2 is to perform the catalyst diagnostics on Dephi EMS only.

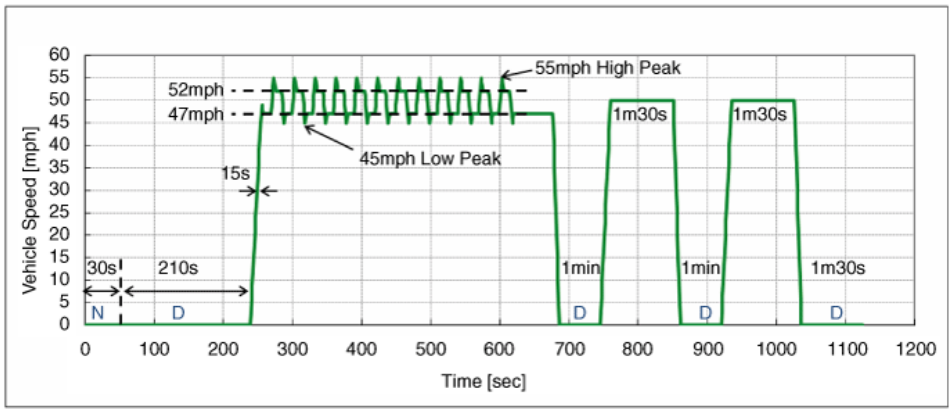
-Continental, Bosch or Kefico EMS : Mode 1 drive cycle should be done one time for diagnostics on all systems.

-Dephi EMS : Mode 2 drive cycle should be done two times in a row after Mode 1 is carried out one time for diagnostics on all systems

•Mode 1

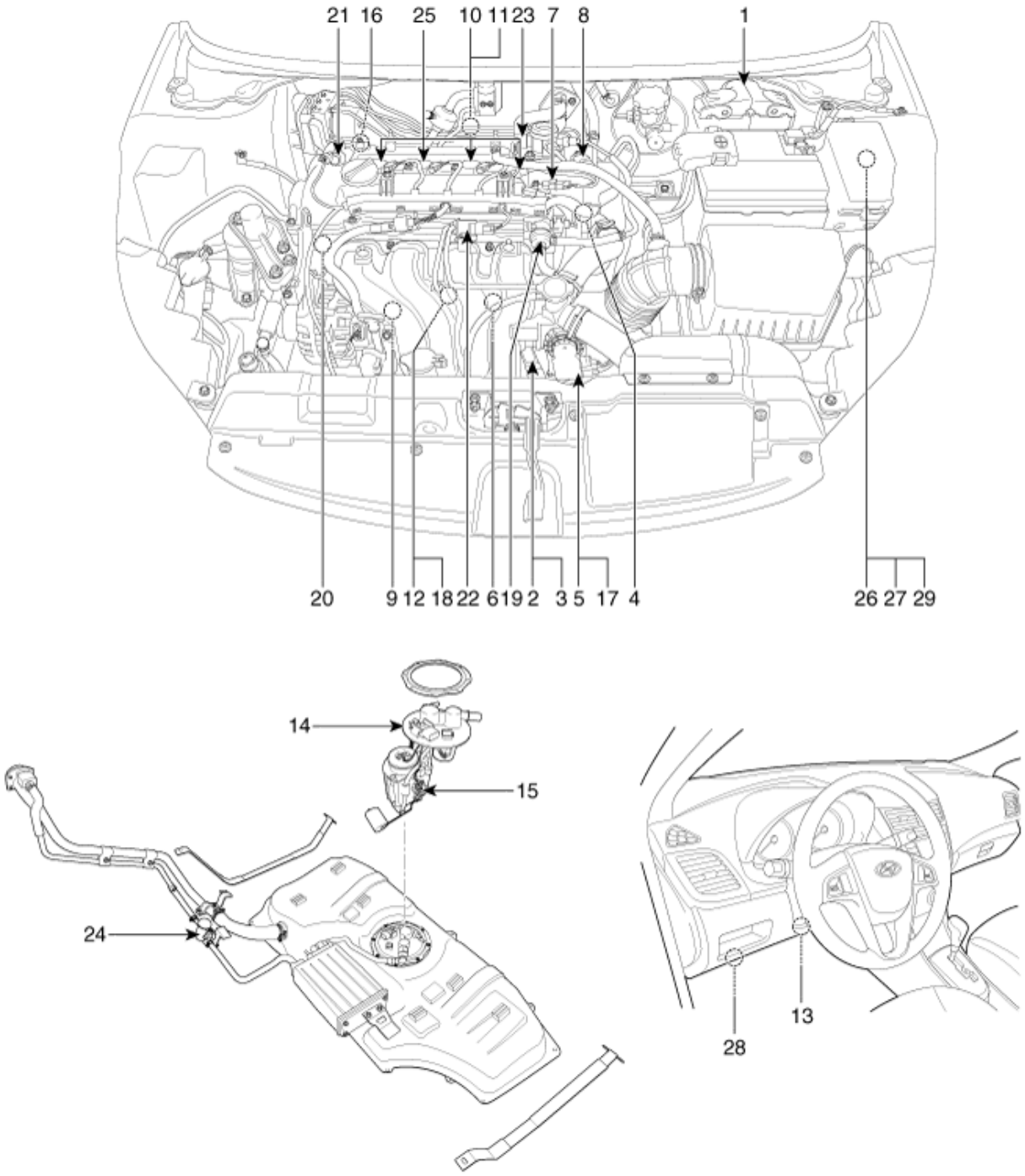


•Mode 2

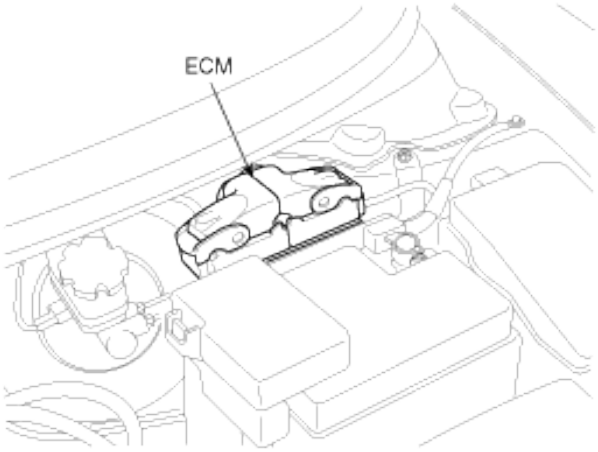
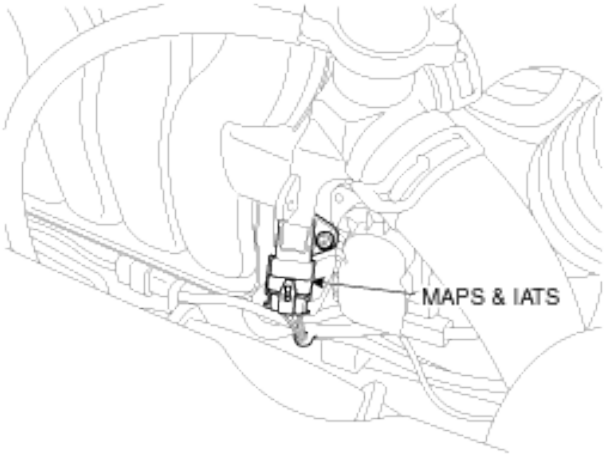
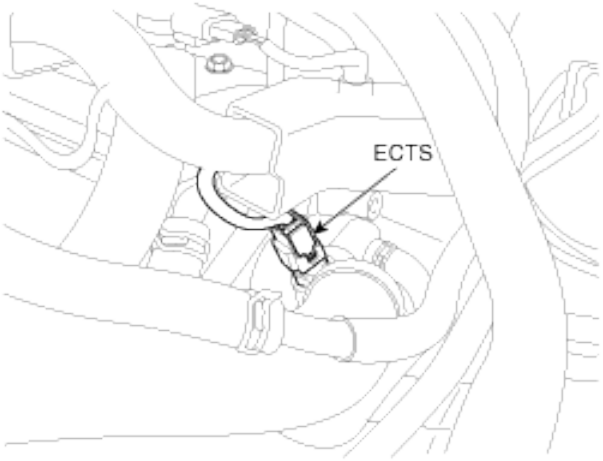
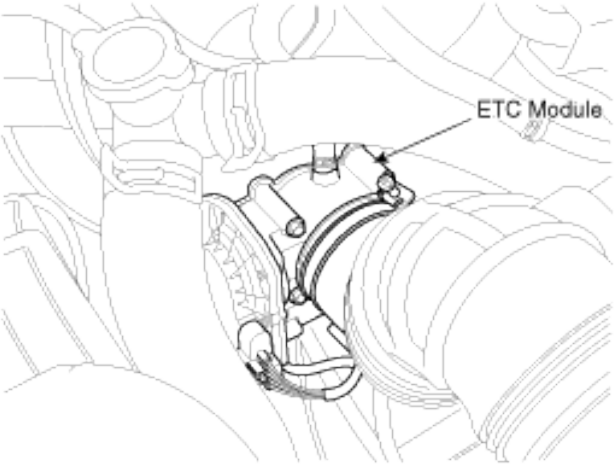


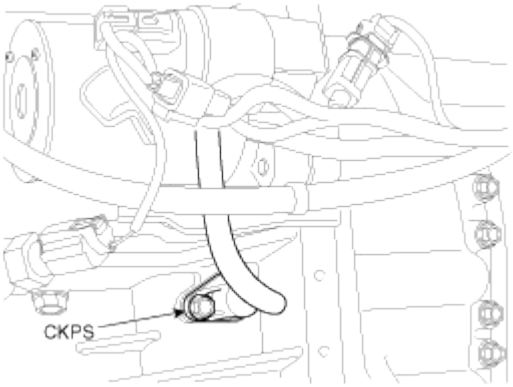
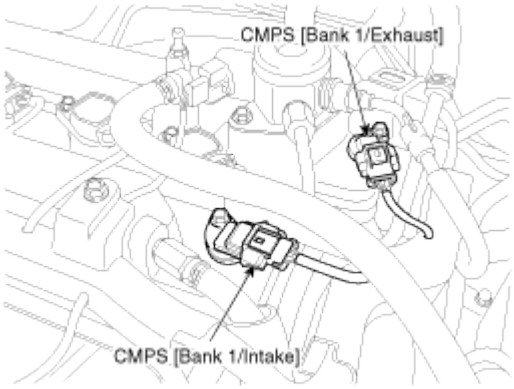
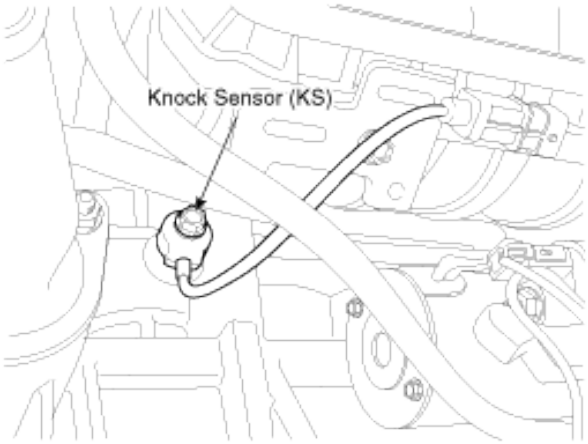
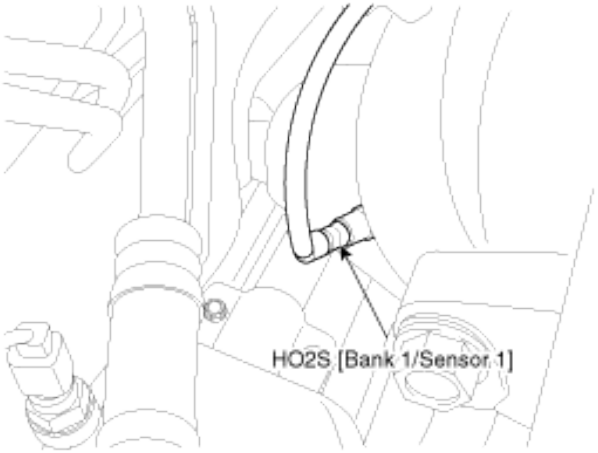
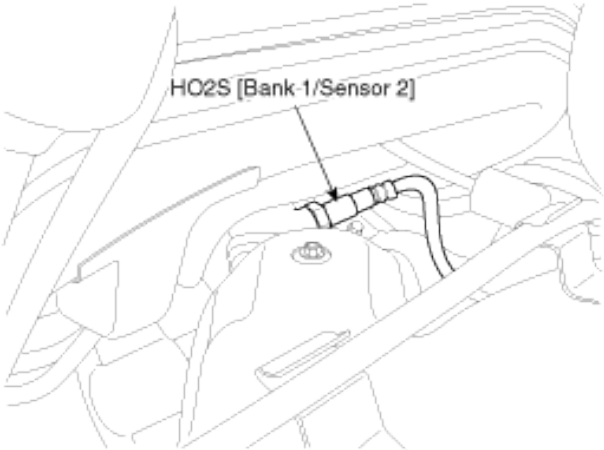
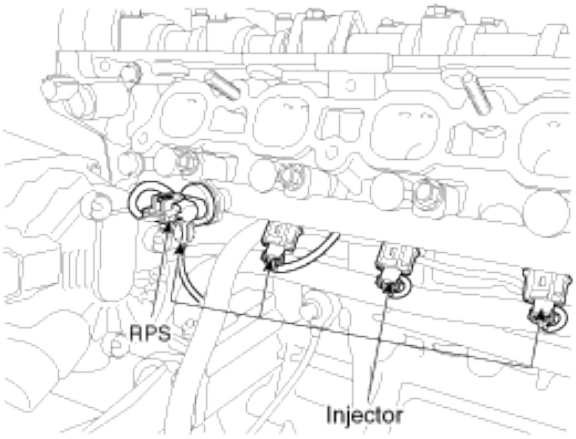
Mode	No	Operation	Speed (mph)	Duration (s)	E/Time (s)	Remarks
Mode 1	1	Engine Start	0	0	0	ECT @ Start 32~104°F
	2	Idling (N)	0	30	30	Neutral Range
	3	Idling (D)	0	270	300	D Range
	4	Acceleration	0 → 50	15	315	
	5	Steady Speed	50	230	545	
	6	Deceleration	50 → 45	5	550	
	7	Steady Speed	45	5	555	
	8	Acceleration	45 → 55	5	560	
	9	Steady Speed	55	5	565	
	10	Deceleration	55 → 45	5	570	
	11	Steady Speed	45	5	575	
	12	Repeat 8 through 11 ten times.	-	180	755	
	13	Acceleration	45 → 55	5	760	
	14	Steady Speed	55	5	765	
	15	Deceleration	55 → 0	45	810	
	16	Idling (D)	0	120	930	D Range
	17	Idling (N)	0	760	1690	Neutral Range
	18	Acceleration	0 → 55	15	1705	
	19	Steady Speed	55	60	1765	
	20	Deceleration	55 → 0	15	1780	
	21	Idling (D)	0	60	1840	D Range
	22	Acceleration	0 → 55	15	1855	
	23	Steady Speed	55	60	1915	
	24	Deceleration	55 → 0	15	1930	
	25	Idling (D)	0	60	1990	D Range
	26	Acceleration	0 → 40	15	2005	
	27	Steady Speed	40	15	2020	
	28	Acceleration	40 → 50	15	2035	
	29	Steady Speed	50	5	2040	
	30	Deceleration	50 → 40	15	2055	
	31	Steady Speed	40	60	2115	
	32	Repeat 28 through 31 five times.	-	380	2495	
	33	Acceleration	40 → 50	15	2510	
	34	Steady Speed	50	5	2515	
Mode 1	35	Deceleration	50 → 0	40	2555	
	36	Idling (D)	0	25	2580	D Range
Mode 2	1	Engine Start	0	0	0	
	2	Idling (N)	0	30	30	Neutral Range
	3	Idling (D)	0	210	240	D Range
	4	Acceleration	0 → 49	16	256	
	5	Deceleration	49 → 47	2	258	Lift Foot Up : APS = 0
	6	Steady Speed	47	10	268	
	7	Acceleration	47 → 55	4	272	Middle Tip In or Deep Accel
	8	Deceleration	55 → 52	3	275	Lift Foot Up : APS = 0
	9	Steady Speed	52	10	285	
	10	Deceleration	52 → 45	3	288	Lift Foot Up : APS = 0
	11	Acceleration	45 → 47	2	290	
	12	Repeat 6 through 11 twelve times.	-	330	620	
	13	Steady Speed	47	57	677	
	14	Deceleration	47 → 0	8	685	
	15	Idling (D)	0	60	745	D Range

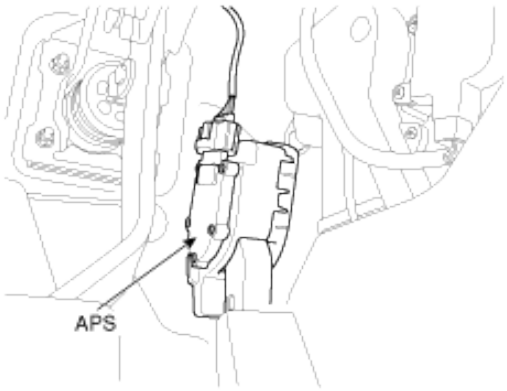
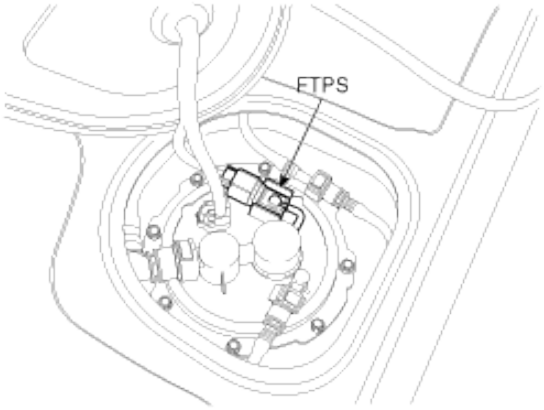
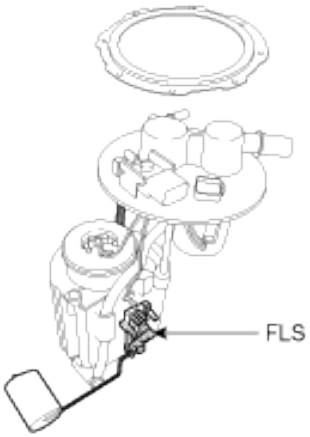
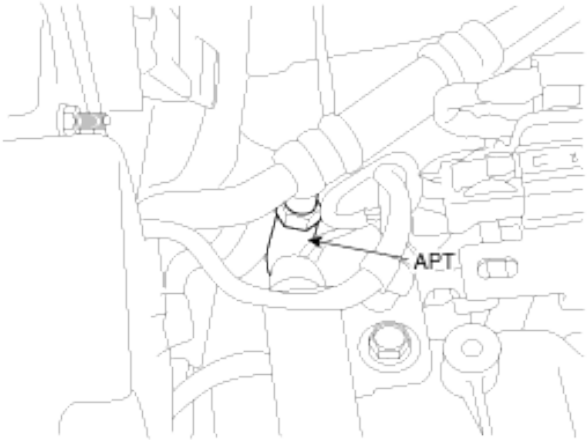
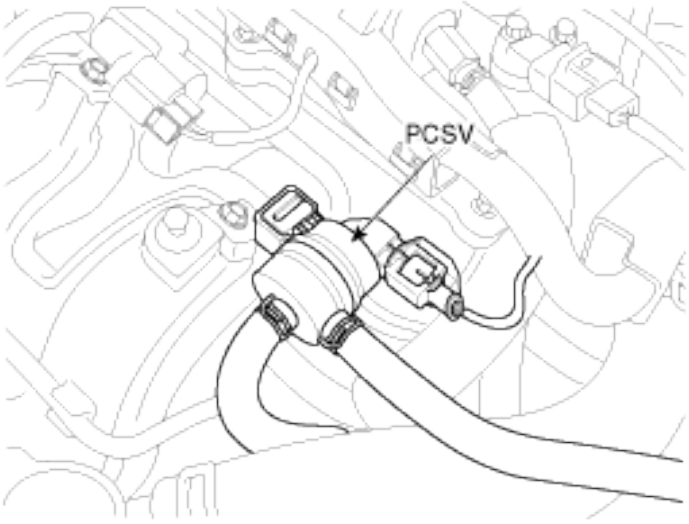
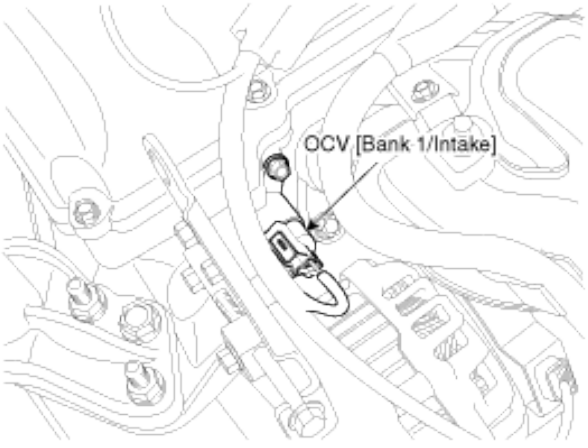
5.6.2 Components Location

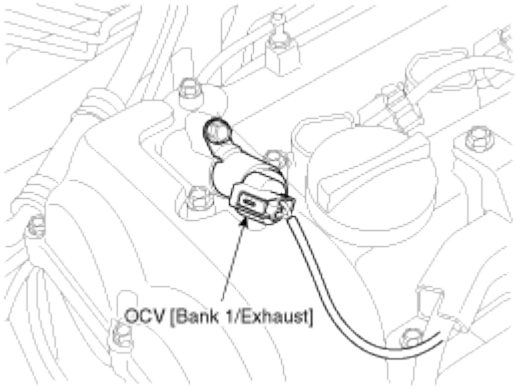
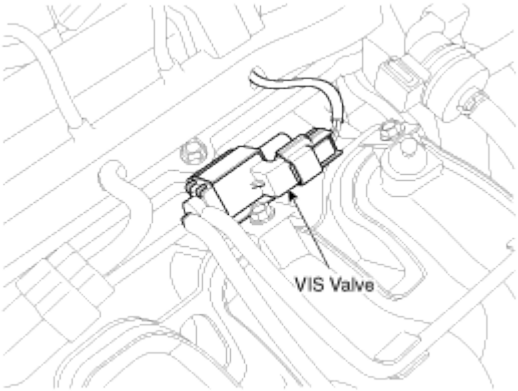
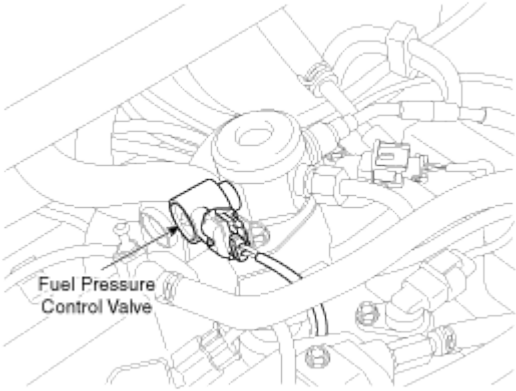
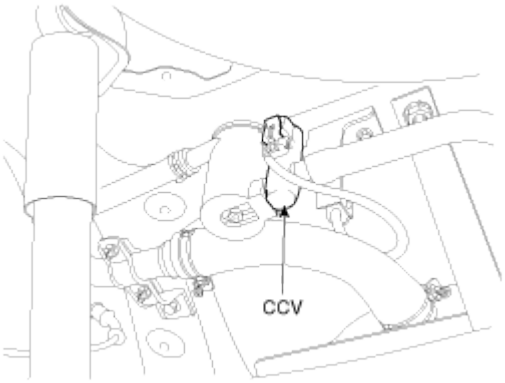
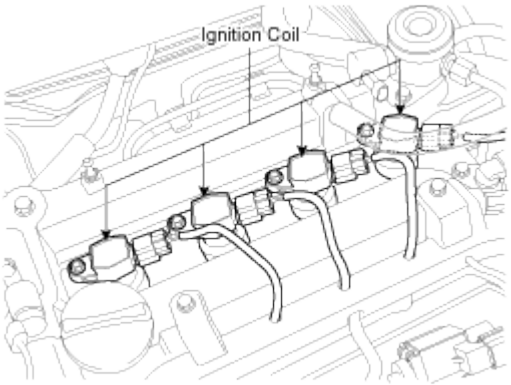
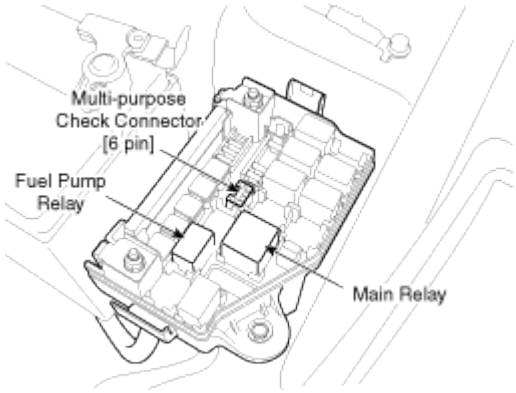


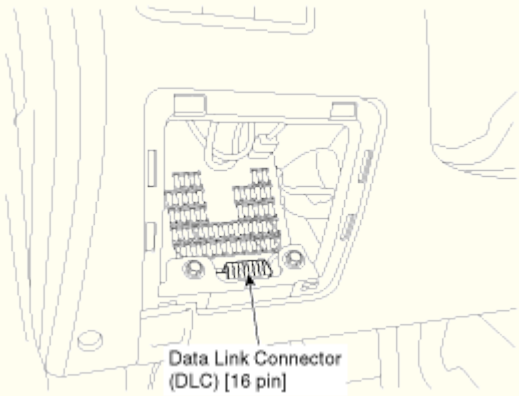
1. Engine Control Module (ECM) 2. Manifold Absolute Pressure Sensor (MAPS) 3. Intake Air Temperature Sensor (IATS) 4. Engine Coolant Temperature Sensor (ECTS) 5. Throttle Position Sensor (TPS) [integrated into ETC Module] 6. Crankshaft Position Sensor (CKPS) 7. Camshaft Position Sensor (CMPS) [Bank 1 / Intake] 8. Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust] 9. Knock Sensor (KS) 10. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 1] 11. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 2] 12. Rail Pressure Sensor (RPS) 13. Accelerator Position Sensor (APS) 14. Fuel Tank Pressure Sensor (FTPS) 15. Fuel Level Sender (FLS)	16. A/C Pressure Transducer (APT) 17. ETC Motor [integrated into ETC Module] 18. Injector 19. Purge Control Solenoid Valve (PCSV) 20. CVVT Oil Control Valve (OCV) [Bank 1 / Intake] 21. CVVT Oil Control Valve (OCV) [Bank 1 / Exhaust] 22. Variable Intake Solenoid (VIS) Valve 23. Fuel Pressure Control Valve (FPCV) 24. Canister Close Valve (CCV) 25. Ignition Coil 26. Main Relay 27. Fuel Pump Relay 28. Data Link Connector (DLC) [16-Pin] 29. Multi-Purpose Check Connector [20-Pin]

1. Engine Control Module (ECM)	2. Manifold Absolute Pressure Sensor (MAPS) 3. Intake Air Temperature Sensor (IATS)
	
4. Engine Coolant Temperature Sensor (ECTS)	5. Throttle Position Sensor (TPS) 17. ETC Motor
	

6. Crankshaft Position Sensor (CKPS)	7. Camshaft Position Sensor (CMPS) [Bank 1 / Intake] 8. Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust]
	
9. Knock Sensor (KS)	10. Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 1]
	
11. Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2]	12. Rail Pressure Sensor (RPS) 18. Injector
	

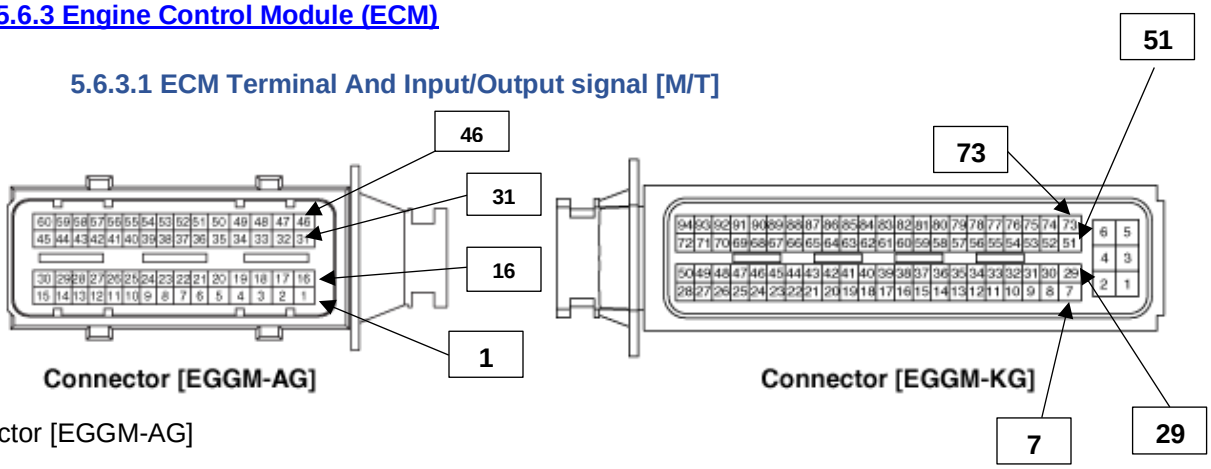
13. Accelerator Position Sensor (APS)	14. Fuel Tank Pressure Sensor (FTPS)
	
15. Fuel Level Sender (FLS)	16. A/C Pressure Transducer (APT)
	
19. Purge Control Solenoid Valve (PCSV)	20. CVVT Oil Control Valve (OCV) [Bank 1 / Intake]
	

21. CVVT Oil Control Valve (OCV) [Bank 1 / Exhaust]	22. Variable Intake Solenoid (VIS) Valve
	
23. Fuel Pressure Control Valve (FPCV)	24. Canister Close Valve (CCV)
	
25. Ignition Coil	26. Main Relay 27. Fuel Pump Relay 29. Multi-Purpose Check Connector [20-Pin]
	

28. Data Link Connector (DLC) [16-Pin]	
	

5.6.3 Engine Control Module (ECM)

5.6.3.1 ECM Terminal And Input/Output signal [M/T]



Connector [EGGM-AG]

Pin No.	Description	Connected to
1	Injector (Cylinder #3) [High] control output	Injector (Cylinder #3)
2	Injector (Cylinder #4) [High] control output	Injector (Cylinder #4)
3	Injector (Cylinder #2) [Low] control output	Injector (Cylinder #2)
4	-	
5	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 1] heater control output	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 1]
6	-	
7	Supply power (+5V)	Cruise control switch
8	-	
9	-	
10	-	
11	-	
12	Immobilizer indication lamp control output	Cluster
13	-	

14	Cooling fan relay [High] control output	Cooling fan relay [High]
15	CVVT Oil Control Valve (OCV) [Bank 1/Exhaust] control output	CVVT Oil Control Valve (OCV) [Bank 1/Exhaust]
16	Injector (Cylinder #2) [High] control output	Injector (Cylinder #2)
17	Injector (Cylinder #1) [High] control output	Injector (Cylinder #1)
18	Injector (Cylinder #3) [Low] control output	Injector (Cylinder #3)
19	-	
20	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor2] heater control output	Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2]
21	-	
22	-	
23	Engine Coolant Temperature Sensor (ECTS) signal input	Engine Coolant Temperature Sensor (ECTS)
24	Sensor ground	Engine Coolant Temperature Sensor (ECTS)
25	-	
26	Fuel Tank Pressure Sensor (FTPS) Signal input	Fuel Tank Pressure Sensor (FTPS)
27	Fuel pump relay control output (Without Immobilizer)	Fuel pump relay
	Canister Close Valve (CCV) control output (With Immobilizer)	Canister Close Valve (CCV)
28	-	
29	A/C compressor relay control output	A/C compressor relay
30	-	
31	Ignition coil (Cylinder #3) control output	Ignition coil (Cylinder #3)
32	Ignition coil (Cylinder #1) control output	Ignition coil (Cylinder #1)
33	Injector (Cylinder #1) [Low] control output	Injector (Cylinder #1)
34	Fuel Pressure Control Valve (FPCV) [High] control output	Fuel Pressure Control Valve (FPCV)
35	ETC motor [-] control output	ETC motor
36	-	
37	Knock Sensor (KS) signal input	Knock Sensor (KS)
38	Sensor ground	Knock Sensor (KS)
39	Blower switch Max. siganl input	Heater control module
40	Brake Light switch signal input	Brake switch
41	Wheel Speed Sensor [B] signal input [without ABS/ESC]	Wheel Speed Sensor (WSS)

42	Wheel Speed Sensor [A] signal input [without ABS/ESC]	Wheel Speed Sensor (WSS)
43	-	
44	-	
45	CVVT Oil Control Valve (OCV) [Bank 1/Intake] control output	CVVT Oil Control Valve (OCV) [Bank 1/Intake]
46	Ignition coil (Cylinder #4) control output	Ignition coil (Cylinder #4)
47	Ignition coil (Cylinder #2) control output	Ignition coil (Cylinder #2)
48	Injector (Cylinder #4) [Low] control output	Injector (Cylinder #4)
49	Fuel Pressure Control Valve (FPCV) [Low] control output	Fuel Pressure Control Valve (FPCV)
50	ETC motor [+] control output	ETC motor
51	-	
52	-	
53	Brake Test switch signal input	Brake switch
54	-	
55	Clutch switch signal input	Clutch switch
56	Electric load signal input [Defrost]	Alternator
57	Alternator COM signal output	Alternator
58	-	
59	Cooling fan relay [Low] control output	Cooling fan relay
60	Variable Intake Solenoid (VIS) valve control output	Variable Intake Solenoid (VIS) valve

Connector [EGGM-KG]

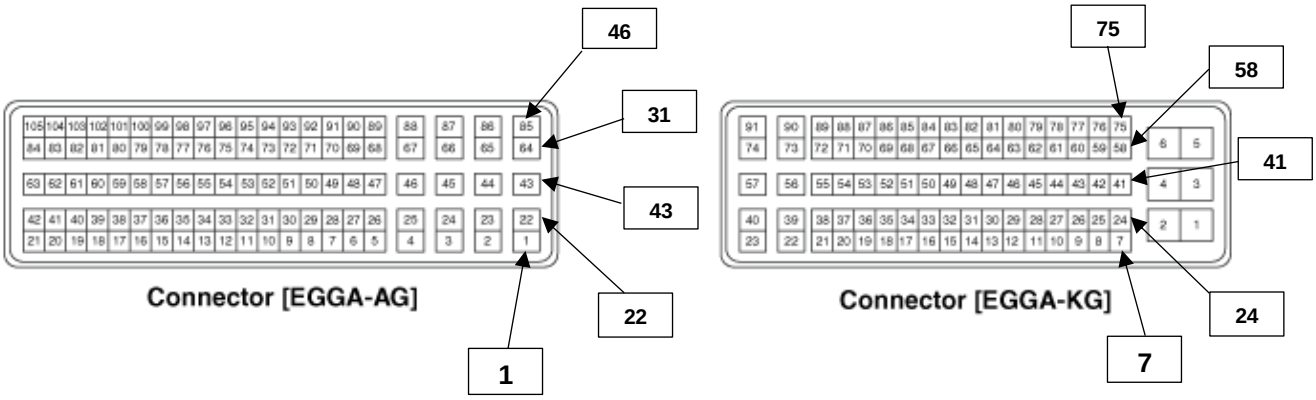
Pin No.	Description	Connected to
1	ECM ground	Chassis ground
2	ECM ground	Chassis ground
3	ECM ground	Chassis ground
4	Battery power (B+)	Main relay
5	Battery power (B+)	Battery
6	Battery power (B+)	Battery
7	Battery power (B+)	Main relay
8	Sensor ground	Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 2]
9	Accelerator Position Sensor (APS) 1 signal input	Accelerator Position Sensor (APS) 1
10	Sensor ground	Accelerator Position Sensor (APS) 2

11	-	
12	Sensor ground	Fuel Tank Pressure Sensor (FTPS)
13	-	
14	Throttle Position Sensor (TPS) 1 signal input	Throttle Position Sensor (TPS) 1
15	-	
16	-	
17	Fuel Level signal input	Fuel Level Sender (FLS)
18	Sensor power (+5V)	Accelerator Position Sensor (APS) 2
19	-	
20	Sensor power (+5V)	Rail Pressure Sensor (RPS)
		A/C Pressure Transducer (APT)
21	-	
22	Wiper switch signal input	Wiper switch
23	-	
24	Alternator PWM signal output	Alternator
25	-	
26	-	
27	-	
28	-	
29	Ignition switch signal input	
30	Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 2] signal input	Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 2]
31	Accelerator Position Sensor (APS) 2 signal input	Accelerator Position Sensor (APS) 2
32	Sensor ground	Accelerator Position Sensor (APS) 1
33	-	
34	-	
35	Sensor ground	Throttle Position Sensor (TPS)
36	Throttle Position Sensor (TPS) 2 signal input	Throttle Position Sensor (TPS) 2
37	-	
38	-	
39	Sensor power (+5V)	Throttle Position Sensor (TPS) 1,2
40	Sensor power (+5V)	Accelerator Position Sensor (APS) 1

41	Sensor power (+5V)	Manifold Absolute Pressure Sensor (MAPS)
		Fuel Tank Pressure Sensor (FTPS)
42	Sensor power (+5V)	Camshaft Position Sensor (CMPS) [Bank 1 / Intake]
		Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust]
43	A/C switch input	A/C control module
44	A/C pressure switch	A/C control module
45	A/C Pressure Transducer (APT) signal input	A/C Pressure Transducer (APT)
46	Vehicle speed signal input	Vehicle Speed Sensor
47	-	
48	-	
49	-	
50	Malfunction Indicator Lamp (MIL) control output	Malfunction Indicator Lamp (MIL)
51	-	
52	VS-/IP- (Common Ground for VS, IP)	Heated Oxygen Sensor [Bank 1/Sensor 1]
53	Rc/Rp (Pump Cell Voltage)	Heated Oxygen Sensor [Bank 1/Sensor 1]
54	-	
55	-	
56	Ground	Cruise Control Switch
57	-	
58	Rail Pressure Sensor (RPS) signal input	Rail Pressure Sensor (RPS)
59	Cruise Control Switch signal input	Cruise Control Switch
60	Start signal input	PDM module
61	LIN communication signal input	Battery sensor
62	-	
63	CAN [Low]	Other control module, Data Link Connector (DLC), Multi-Purpose Check Connector
64	Sensor ground	Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust]
65	Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust] signal input	Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust]
66	-	

67	Crankshaft Position Sensor (CKPS) [B] signal input	Crankshaft Position Sensor (CKPS)
68	-	
69	-	
70	-	
71	-	

5.6.3.2 ECM Terminal And Input/Output signal [A/T]



Connector [EGGA-AG]

Pin No.	Description	Connected to
1	Injector (Cylinder #1) [High] control output	Injector (Cylinder #1)
2	Injector (Cylinder #4) [High] control output	Injector (Cylinder #4)
3	Injector (Cylinder #2) [High] control output	Injector (Cylinder #2)
4	Injector (Cylinder #3) [High] control output	Injector (Cylinder #3)
5	-	
6	-	
7	Purge Control Solenoid Valve (PCSV) control output	Purge Control Solenoid Valve (PCSV)
8	Start relay control output	Start relay
9	-	
10	-	
11	Sensor power (+5V)	Manifold Absolute Pressure Sensor (MAPS) Fuel Tank Pressure Sensor (FTPS)
12	Throttle Position Sensor (TPS) 1 signal input	Throttle Position Sensor (TPS) 1
13	Sensor ground	Engine Coolant Temperature Sensor (ECTS)
14	-	
15	Sensor power (+5V)	Accelerator Position Sensor (APS) 2
16	-	
17	-	
18	Sensor power (+5V)	Throttle Position Sensor (TPS) 1,2
19	Sensor power (+5V)	Accelerator Position Sensor (APS) 1
20	Ground	Cruise control switch
21	-	
22	-	
23	-	

24	Heated Oxygen Sensor [Bank 1/Sensor 1] heater control output	Heated Oxygen Sensor [Bank 1/Sensor 1]
25	Heated Oxygen Sensor [Bank 1/Sensor 2] heater control output	Heated Oxygen Sensor [Bank 1/Sensor 2]
26	-	
27	-	
28	-	
29	-	
30	A/C pressure switch signal input	A/C pressure switch
31	A/C switch signal input	A/C switch
32	Sensor ground	Throttle Position Sensor (TPS) 1,2
33	-	
34	Throttle Position Sensor (TPS) 2 signal input	Throttle Position Sensor (TPS) 2
35	-	
36	-	
37	-	
38	-	
39	-	
40	-	
41	Sensor ground	Heated Oxygen Sensor [Bank 1/Sensor 2]
42	-	
43	-	
44	-	
45	-	
46	-	
47	-	
48	-	
49	-	
50	-	
51	Alternator PWM signal output	Alternator
52	-	
53	Brake switch signal input	Brake switch
54	Accelerator Position Sensor (APS) 1 signal input	Accelerator Position Sensor (APS) 1
55	Blower switch Max. signal input	Heater & A/C control module
56	Accelerator Position Sensor (APS) 2 signal input	Accelerator Position Sensor (APS) 2
57	-	
58	-	
59	-	
60	Sensor ground	Knock Sensor (KS)
61	Knock Sensor (KS) signal input	Knock Sensor (KS)
62	Sensor ground	Accelerator Position Sensor (APS) 1
63	Sensor ground	Accelerator Position Sensor (APS) 2
64	Injector (Cylinder #1) [Low] control output	Injector (Cylinder #1)
65	Injector (Cylinder #4) [Low] control output	Injector (Cylinder #4)
66	Injector (Cylinder #2) [Low] control output	Injector (Cylinder #2)
67	Injector (Cylinder #3) [Low] control output	Injector (Cylinder #3)
68	-	
69	-	
70	-	
71	-	

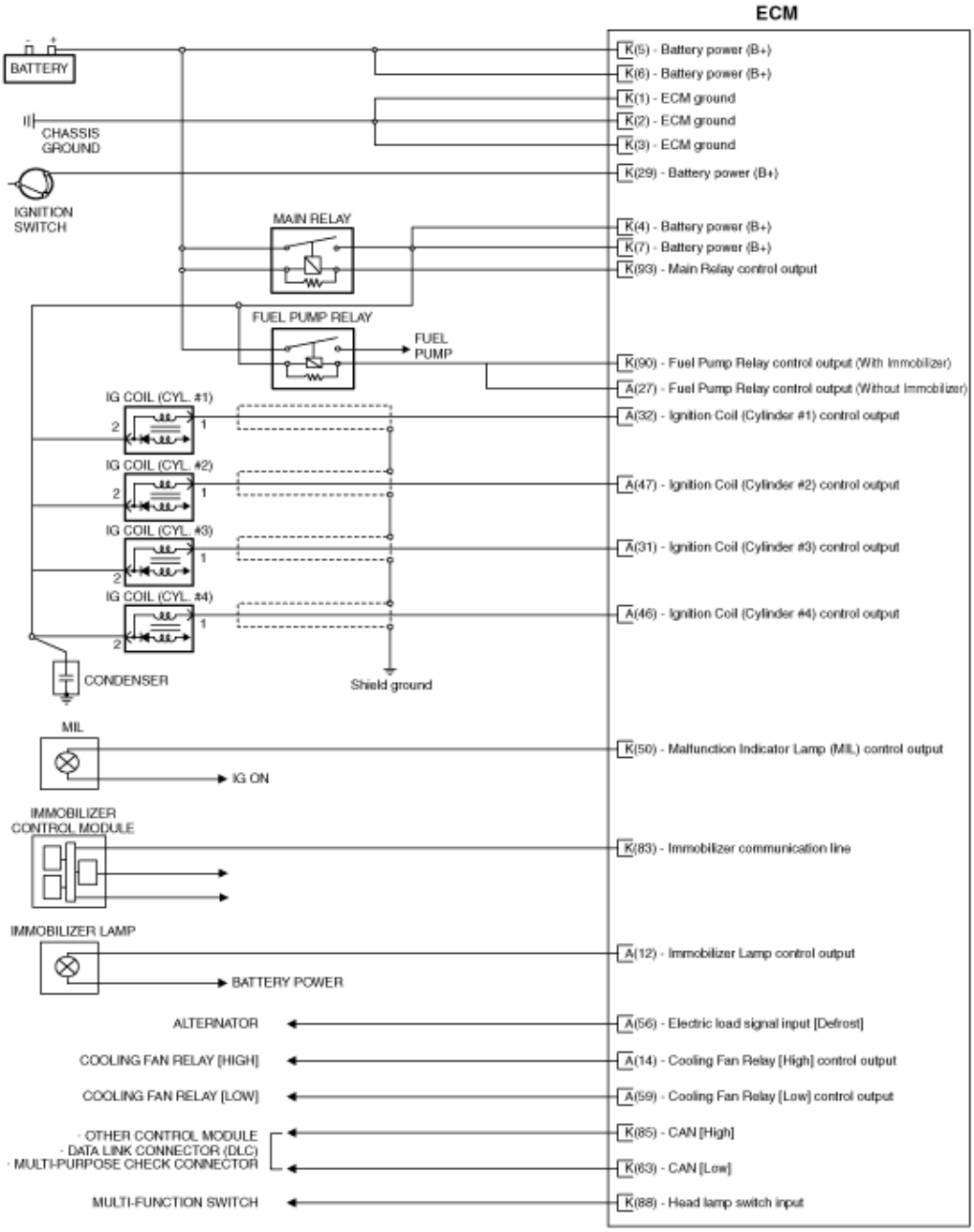
72	-	
73	-	
74	-	
75	-	
76	-	
77	Fuel Tank Pressure Sensor (FTPS) signal input	Fuel Tank Pressure Sensor (FTPS)
78	Fuel Level Sender (FLS) signal input	Fuel Level Sender (FLS)
79	Cruise control switch signal	Cruise control switch
80	-	
81	-	
82	Engine Coolant Temperature Sensor (ECTS) signal input	Engine Coolant Temperature Sensor (ECTS)
83	VS-/IP- (Common Ground for VS, IP)	Heated Oxygen Sensor [Bank 1/Sensor 1]
84	VS+ (NERNST Cell Voltage)	Heated Oxygen Sensor [Bank 1/Sensor 1]
85	Fuel Pressure Control Valve (FPCV) [Low] control output	Fuel Pressure Control Valve (FPCV)
86	Fuel Pressure Control Valve (FPCV) [High] control output	Fuel Pressure Control Valve (FPCV)
87	-	
88	-	
89	-	
90	-	
91	-	
92	-	
93	-	
94	-	
95	-	
96	-	
97	-	
98	-	
99	-	
100	-	
101	-	
102	-	
103	Heated Oxygen Sensor [Bank 1/Sensor 2] signal input	Heated Oxygen Sensor [Bank 1/Sensor 2]
104	Rc/Rp (Pump Cell Voltage)	Heated Oxygen Sensor [Bank 1/Sensor 1]
105	Rc (Compensative Resistance)	Heated Oxygen Sensor [Bank 1/Sensor 1]

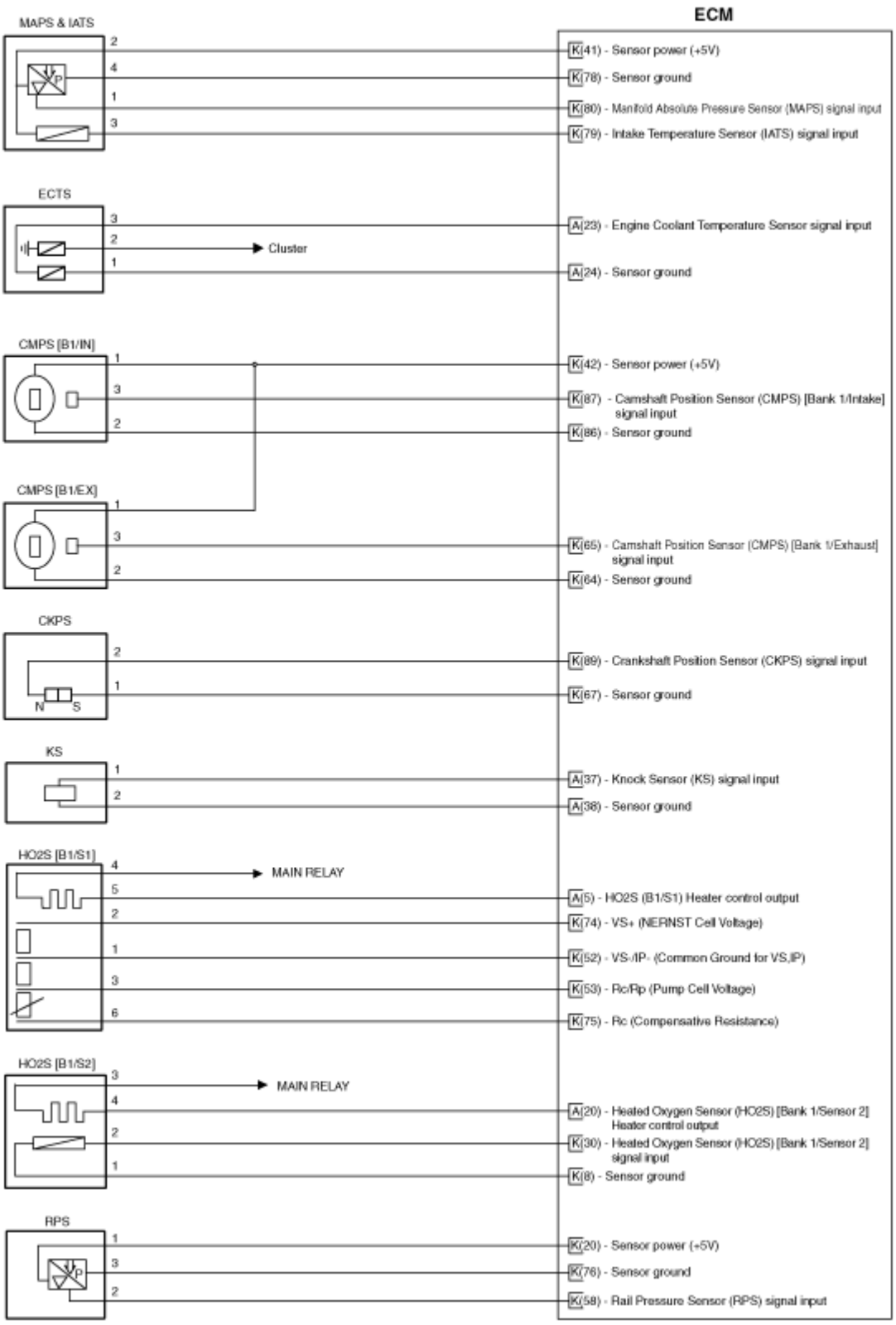
Connector [EGGA-KG]

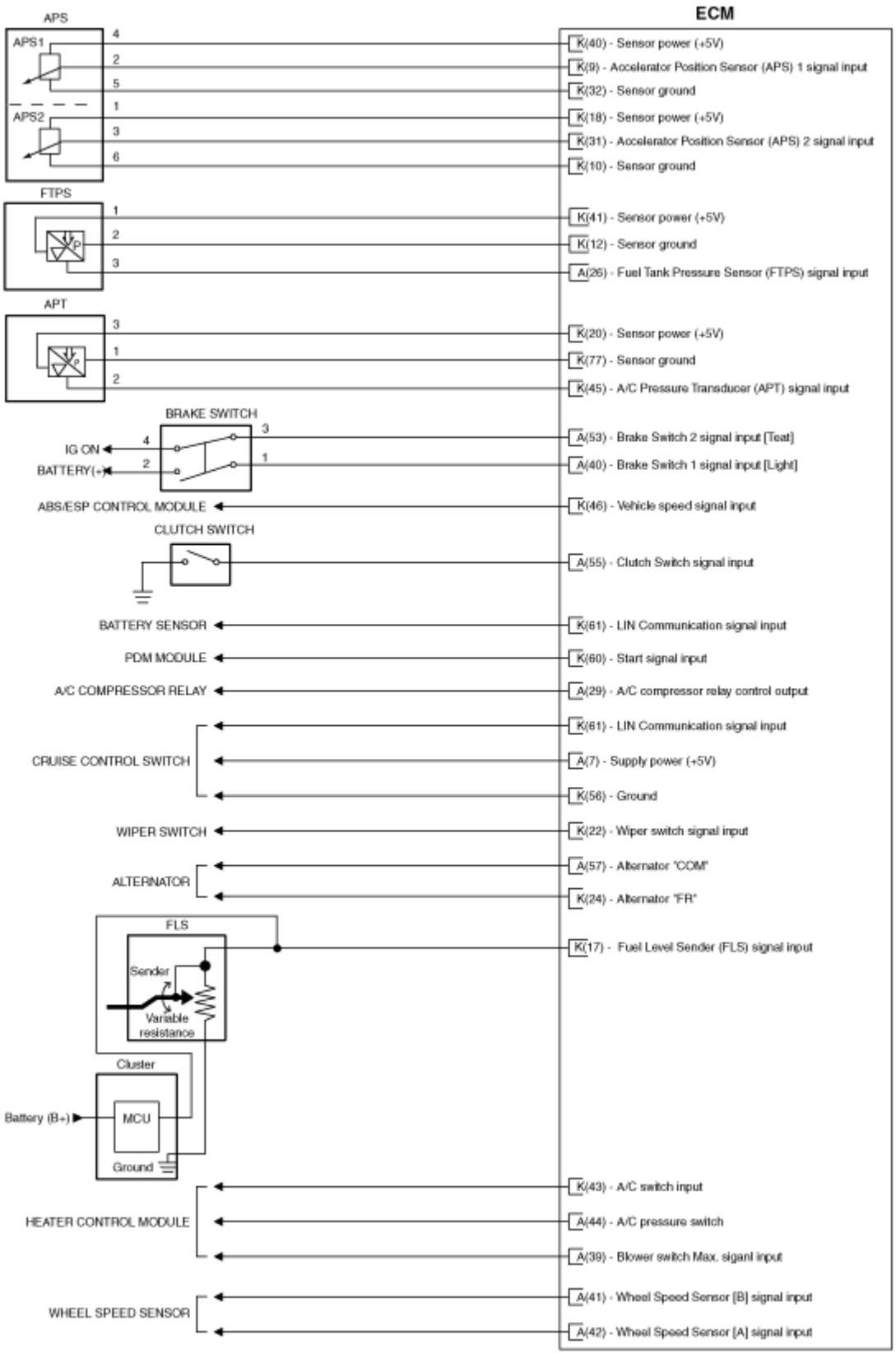
Pin No.	Description	Connected to
1	ECM ground	Chassis ground
2	ECM ground	Chassis ground
3	Battery power (B+)	Ignition switch
4	ECM ground	Chassis ground
5	Battery power (B+)	Ignition switch
6	Battery power (B+)	Main relay
7	Sensor ground	Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust]
8	Sensor ground	Manifold Absolute Pressure Sensor (MAPS)
9	-	
10	Sensor ground	Rail Pressure Sensor (RPS)
11	-	
12	-	
13	Sensor power (+5V)	Camshaft Position Sensor (CMPS) [Bank 1 / Intake] Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust]
14	-	
15	Sensor power (+5V)	Rail Pressure Sensor (RPS) A/C Pressure Transducer (APT)
16	Alternator COM signal output	Alternator
17	-	
18	-	
19	-	
20	Cooling fan relay [Low] control output	Cooling fan relay
21	-	
22	ETC motor [-] control output	ETC motor
23	ETC motor [+] control output	ETC motor
24	-	
25	Sensor ground	A/C Pressure Transducer (APT)
26	Manifold Absolute Pressure Sensor (MAPS) signal input	Manifold Absolute Pressure Sensor (MAPS)
27	Rail Pressure Sensor (RPS) signal input	Rail Pressure Sensor (RPS)
28	Intake Air Temperature Sensor (IATS) signal input	Intake Air Temperature Sensor (IATS)
29	Electric load signal input [Defrost]<	

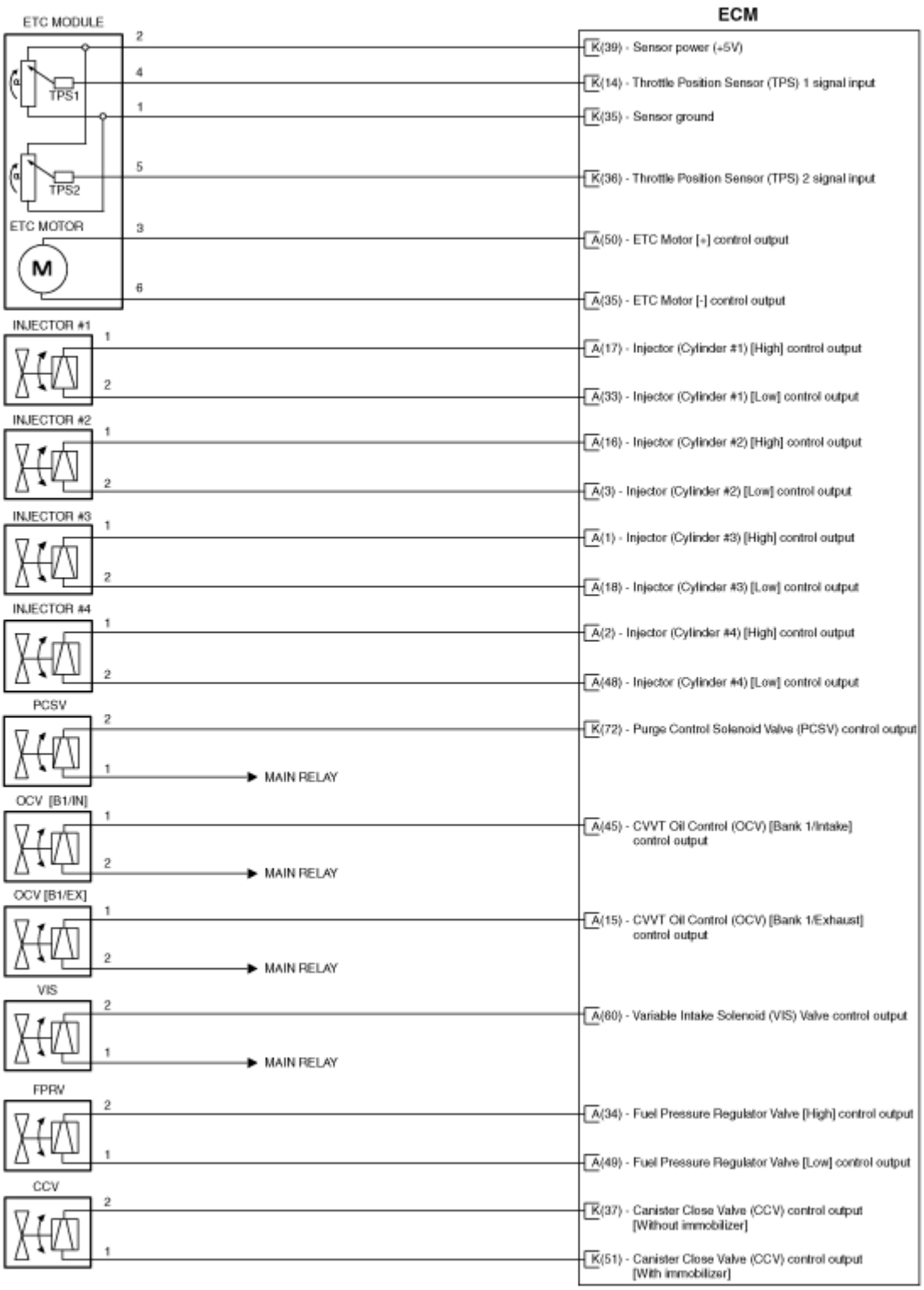
5.6.3.3 Circuit Diagram

5.6.3.3.1 Manual Trans

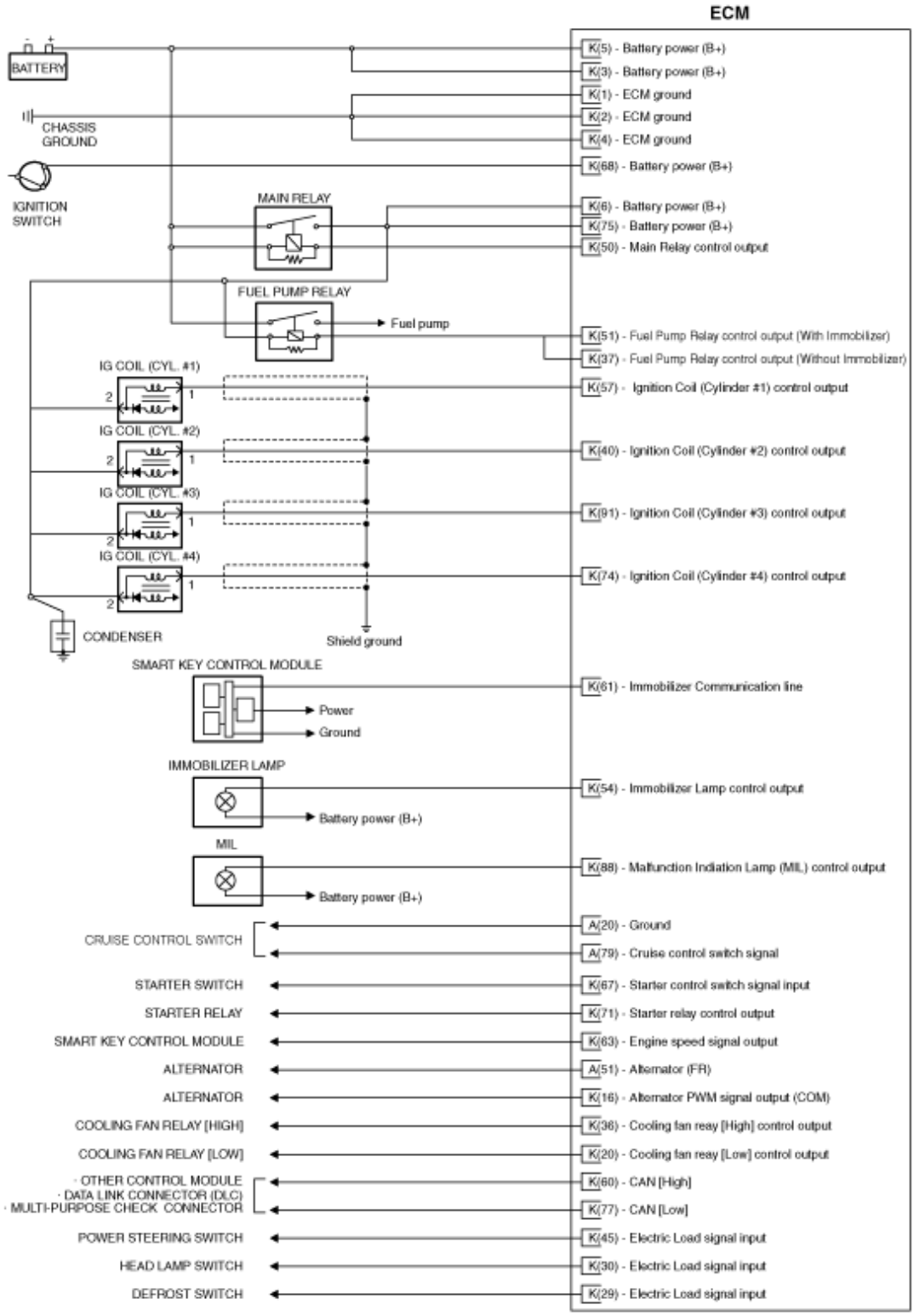


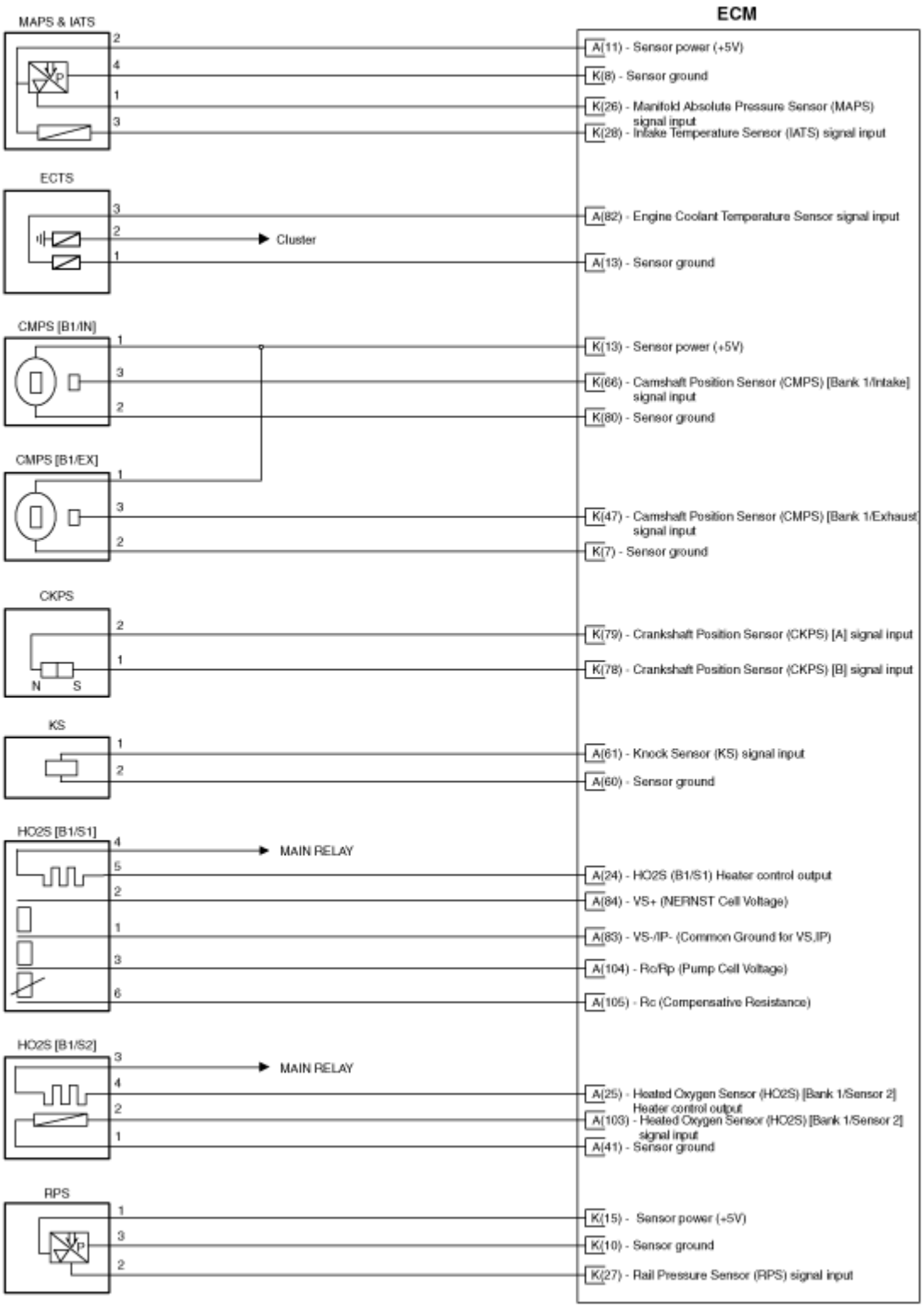

ECM
MAPS & IATS
2
4
1
3
K(41) - Sensor power (+5V)
K(78) - Sensor ground
K(80) - Manifold Absolute Pressure Sensor (MAPS) signal input
K(79) - Intake Temperature Sensor (IATS) signal input
ECTS
3
2
1
Cluster
A(23) - Engine Coolant Temperature Sensor signal input
A(24) - Sensor ground
CMPS [B1/IN]
1
3
2
K(42) - Sensor power (+5V)
K(87) - Camshaft Position Sensor (CMPS) [Bank 1/Intake] signal input
K(86) - Sensor ground
CMPS [B1/EX]
1
3
2
K(65) - Camshaft Position Sensor (CMPS) [Bank 1/Exhaust] signal input
K(64) - Sensor ground
CKPS
2
1
N
S
K(89) - Crankshaft Position Sensor (CKPS) signal input
K(67) - Sensor ground
KS
1
2
A(37) - Knock Sensor (KS) signal input
A(38) - Sensor ground
HO2S [B1/S1]
4
5
2
1
3
6
MAIN RELAY
A(5) - HO2S (B1/S1) Heater control output
K(74) - VS+ (NERNST Cell Voltage)
K(52) - VS-/IP- (Common Ground for VS,IP)
K(53) - Rc/Rp (Pump Cell Voltage)
K(75) - Rc (Compensative Resistance)
HO2S [B1/S2]
3
4
2
1
MAIN RELAY
A(20) - Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2] Heater control output
K(30) - Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2] signal input
K(8) - Sensor ground
RPS
1
3
2
K(20) - Sensor power (+5V)
K(76) - Sensor ground
K(58) - Rail Pressure Sensor (RPS) signal input

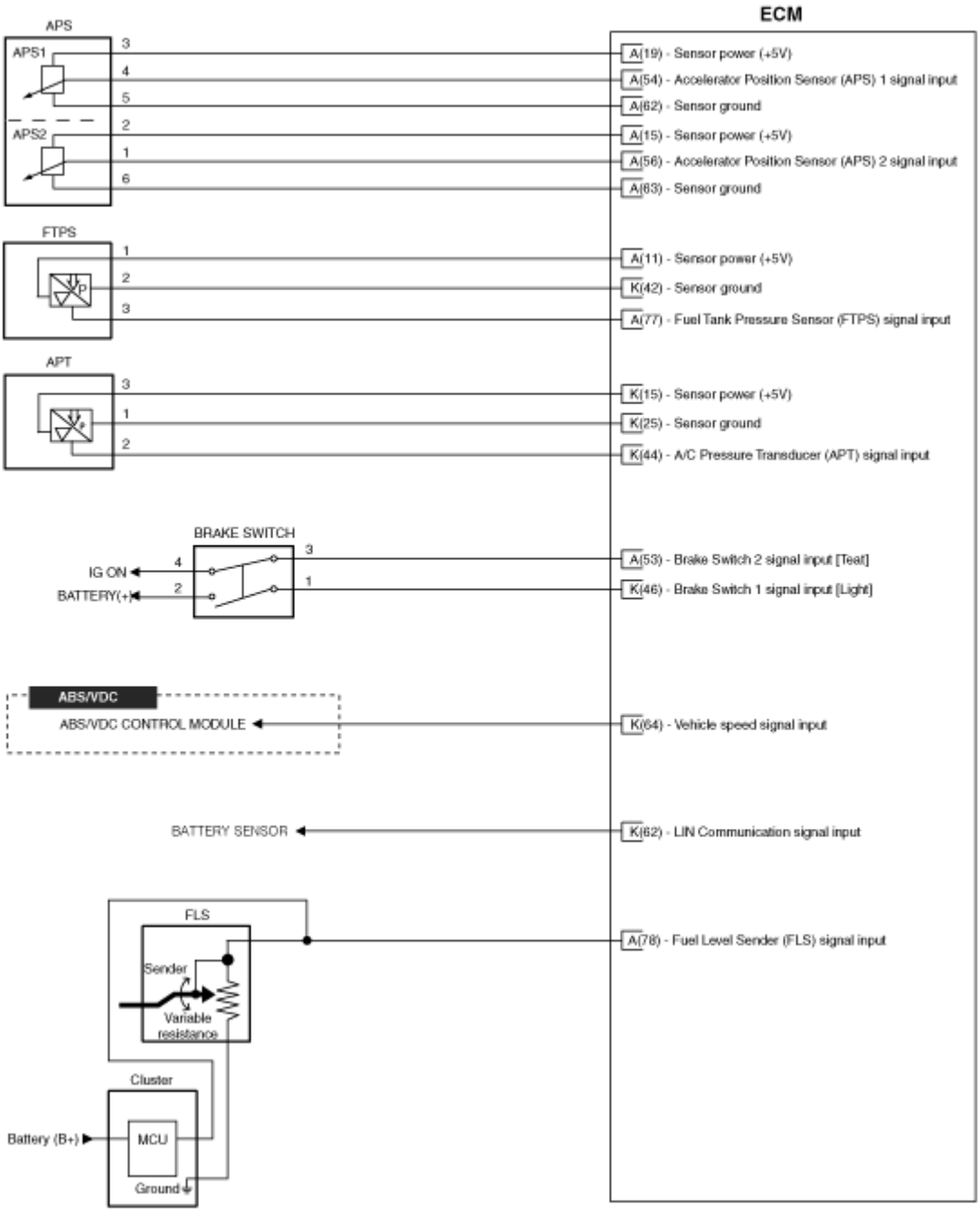

ECM
APS
APS1
APS2
4
2
5
1
3
6
K(40) - Sensor power (+5V)
K(9) - Accelerator Position Sensor (APS) 1 signal input
K(32) - Sensor ground
K(18) - Sensor power (+5V)
K(31) - Accelerator Position Sensor (APS) 2 signal input
K(10) - Sensor ground
FTPS
1
2
3
K(41) - Sensor power (+5V)
K(12) - Sensor ground
A(26) - Fuel Tank Pressure Sensor (FTPS) signal input
APT
3
1
2
K(20) - Sensor power (+5V)
K(77) - Sensor ground
K(45) - A/C Pressure Transducer (APT) signal input
BRAKE SWITCH
IG ON
BATTERY(+)
4
2
3
1
A(53) - Brake Switch 2 signal input [Teat]
A(40) - Brake Switch 1 signal input [Light]
ABS/ESP CONTROL MODULE
K(46) - Vehicle speed signal input
CLUTCH SWITCH
A(55) - Clutch Switch signal input
BATTERY SENSOR
K(61) - LIN Communication signal input
PDM MODULE
K(60) - Start signal input
A/C COMPRESSOR RELAY
A(29) - A/C compressor relay control output
CRUISE CONTROL SWITCH
K(61) - LIN Communication signal input
A(7) - Supply power (+5V)
K(58) - Ground
WIPER SWITCH
K(22) - Wiper switch signal input
ALTERNATOR
A(57) - Alternator "COM"
K(24) - Alternator "FR"
FLS
Sender
Variable resistance
K(17) - Fuel Level Sender (FLS) signal input
Cluster
Battery (B+)
MCU
Ground
HEATER CONTROL MODULE
K(43) - A/C switch input
A(44) - A/C pressure switch
A(39) - Blower switch Max. siganl input
WHEEL SPEED SENSOR
A(41) - Wheel Speed Sensor [B] signal input
A(42) - Wheel Speed Sensor [A] signal input

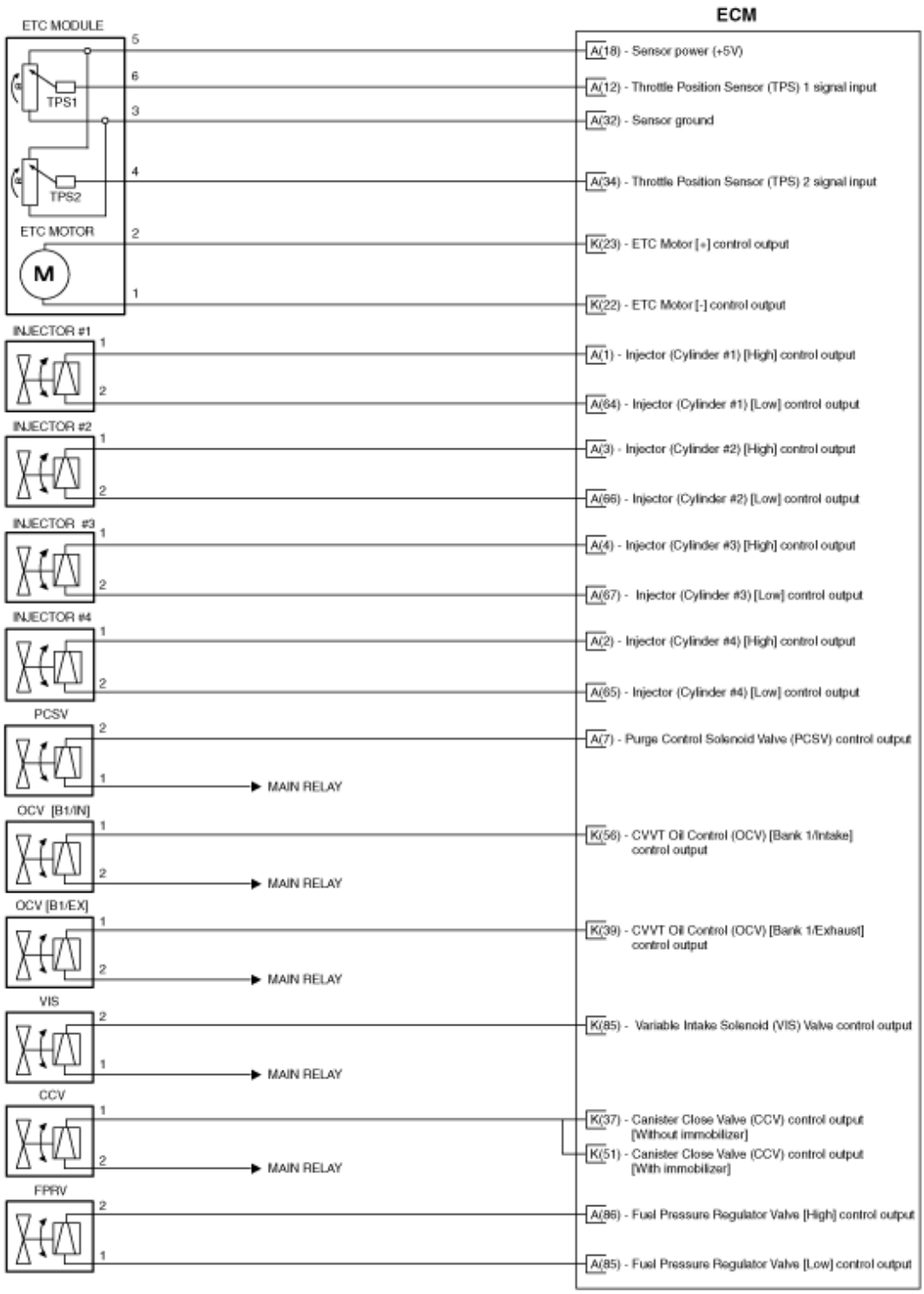

ECM
ETC MODULE
TPS1
TPS2
ETC MOTOR
M
INJECTOR #1
INJECTOR #2
INJECTOR #3
INJECTOR #4
PCSV
OCV [B1/IN]
OCV [B1/EX]
VIS
FPRV
CCV
MAIN RELAY
K(39) - Sensor power (+5V)
K(14) - Throttle Position Sensor (TPS) 1 signal input
K(35) - Sensor ground
K(36) - Throttle Position Sensor (TPS) 2 signal input
A(50) - ETC Motor [+] control output
A(35) - ETC Motor [-] control output
A(17) - Injector (Cylinder #1) [High] control output
A(33) - Injector (Cylinder #1) [Low] control output
A(16) - Injector (Cylinder #2) [High] control output
A(3) - Injector (Cylinder #2) [Low] control output
A(1) - Injector (Cylinder #3) [High] control output
A(18) - Injector (Cylinder #3) [Low] control output
A(2) - Injector (Cylinder #4) [High] control output
A(48) - Injector (Cylinder #4) [Low] control output
K(72) - Purge Control Solenoid Valve (PCSV) control output
A(45) - CVVT Oil Control (OCV) [Bank 1/Intake] control output
A(15) - CVVT Oil Control (OCV) [Bank 1/Exhaust] control output
A(60) - Variable Intake Solenoid (VIS) Valve control output
A(34) - Fuel Pressure Regulator Valve [High] control output
A(49) - Fuel Pressure Regulator Valve [Low] control output
K(37) - Canister Close Valve (CCV) control output [Without immobilizer]
K(51) - Canister Close Valve (CCV) control output [With immobilizer]

5.6.3.3.2 Automatic Trans




ECM
MAPS & IATS
2
4
1
3
A(11) - Sensor power (+5V)
K(8) - Sensor ground
K(26) - Manifold Absolute Pressure Sensor (MAPS) signal input
K(28) - Intake Temperature Sensor (IATS) signal input
ECTS
3
2
1
Cluster
A(82) - Engine Coolant Temperature Sensor signal input
A(13) - Sensor ground
CMPS [B1/IN]
1
3
2
K(13) - Sensor power (+5V)
K(66) - Camshaft Position Sensor (CMPS) [Bank 1/Intake] signal input
K(80) - Sensor ground
CMPS [B1/EX]
1
3
2
K(47) - Camshaft Position Sensor (CMPS) [Bank 1/Exhaust] signal input
K(7) - Sensor ground
CKPS
2
1
N
S
K(79) - Crankshaft Position Sensor (CKPS) [A] signal input
K(78) - Crankshaft Position Sensor (CKPS) [B] signal input
KS
1
2
A(61) - Knock Sensor (KS) signal input
A(60) - Sensor ground
HO2S [B1/S1]
4
5
2
1
3
6
MAIN RELAY
A(24) - HO2S (B1/S1) Heater control output
A(84) - VS+ (NERNST Cell Voltage)
A(83) - VS-/IP- (Common Ground for VS,IP)
A(104) - Rc/Rp (Pump Cell Voltage)
A(105) - Rc (Compensative Resistance)
HO2S [B1/S2]
3
4
2
1
MAIN RELAY
A(25) - Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2] Heater control output
A(103) - Heated Oxygen Sensor (HO2S) [Bank 1/Sensor 2] signal input
A(41) - Sensor ground
RPS
1
3
2
K(15) - Sensor power (+5V)
K(10) - Sensor ground
K(27) - Rail Pressure Sensor (RPS) signal input


ECM
APS
APS1
APS2
3
4
5
2
1
6
A(19) - Sensor power (+5V)
A(54) - Accelerator Position Sensor (APS) 1 signal input
A(62) - Sensor ground
A(15) - Sensor power (+5V)
A(56) - Accelerator Position Sensor (APS) 2 signal input
A(63) - Sensor ground
FTPS
1
2
3
A(11) - Sensor power (+5V)
K(42) - Sensor ground
A(77) - Fuel Tank Pressure Sensor (FTPS) signal input
APT
3
1
2
K(15) - Sensor power (+5V)
K(25) - Sensor ground
K(44) - A/C Pressure Transducer (APT) signal input
BRAKE SWITCH
IG ON
BATTERY(+)
4
2
3
1
A(53) - Brake Switch 2 signal input [Test]
K(46) - Brake Switch 1 signal input [Light]
ABS/VDC
ABS/VDC CONTROL MODULE
K(64) - Vehicle speed signal input
BATTERY SENSOR
K(62) - LIN Communication signal input
FLS
Sender
Variable resistance
A(78) - Fuel Level Sender (FLS) signal input
Cluster
Battery (B+)
MCU
Ground


ECM
ETC MODULE
5
6
3
4
TPS1
TPS2
ETC MOTOR
2
1
M
A(18) - Sensor power (+5V)
A(12) - Throttle Position Sensor (TPS) 1 signal input
A(32) - Sensor ground
A(34) - Throttle Position Sensor (TPS) 2 signal input
K(23) - ETC Motor [+] control output
K(22) - ETC Motor [-] control output
INJECTOR #1
A(1) - Injector (Cylinder #1) [High] control output
A(64) - Injector (Cylinder #1) [Low] control output
INJECTOR #2
A(3) - Injector (Cylinder #2) [High] control output
A(66) - Injector (Cylinder #2) [Low] control output
INJECTOR #3
A(4) - Injector (Cylinder #3) [High] control output
A(67) - Injector (Cylinder #3) [Low] control output
INJECTOR #4
A(2) - Injector (Cylinder #4) [High] control output
A(65) - Injector (Cylinder #4) [Low] control output
PCSV
A(7) - Purge Control Solenoid Valve (PCSV) control output
MAIN RELAY
OCV [B1/IN]
K(56) - CVVT Oil Control (OCV) [Bank 1/Intake] control output
MAIN RELAY
OCV [B1/EX]
K(39) - CVVT Oil Control (OCV) [Bank 1/Exhaust] control output
MAIN RELAY
VIS
K(85) - Variable Intake Solenoid (VIS) Valve control output
MAIN RELAY
CCV
K(37) - Canister Close Valve (CCV) control output [Without immobilizer]
K(51) - Canister Close Valve (CCV) control output [With immobilizer]
MAIN RELAY
FPRV
A(86) - Fuel Pressure Regulator Valve [High] control output
A(85) - Fuel Pressure Regulator Valve [Low] control output

5.6.3.4 Removal

NOTICE

When replacing the ECM, the vehicle equipped with immobilizer must be performed the procedure as below.

[In the case of installing used ECM]

1.Perform "Neutral mode" procedure with GDS. (Refer to "Immobilizer" in BE group)

2.Insert the key and turn it to the IGN ON and OFF position.

Then the ECM key register process is completed automatically.

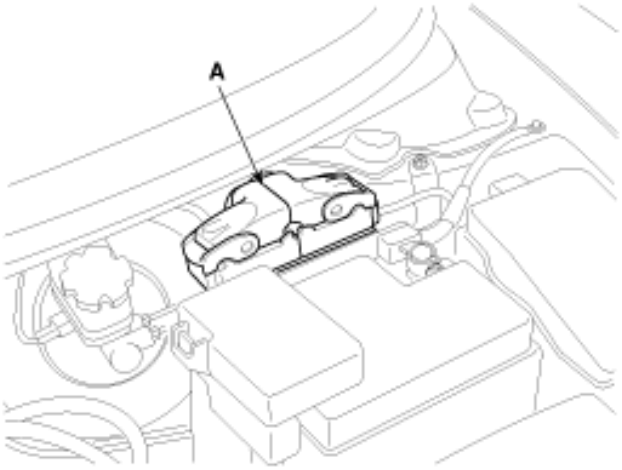
[In the case of installing new ECM]

-Insert the key and turn it to the IGN ON and OFF position.

Then the ECM key register process is completed automatically.

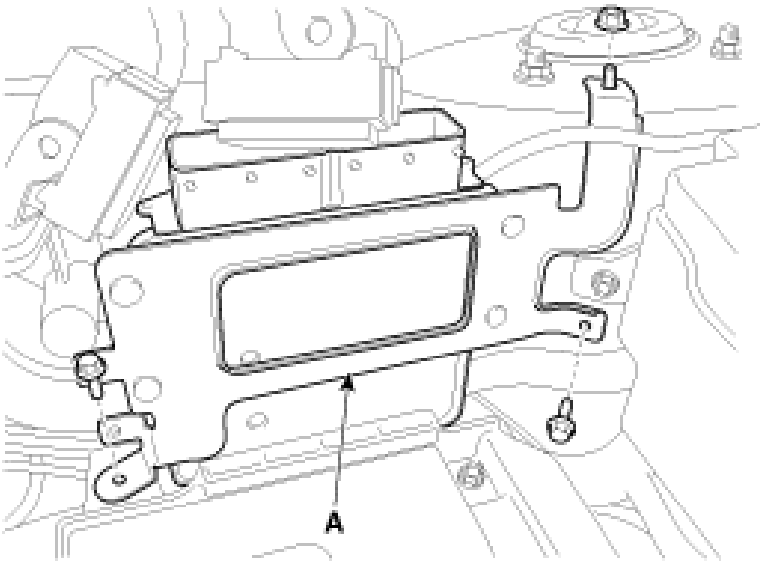
1.Turn ignition switch OFF and disconnect the negative (-) battery cable.

2.Disconnect the ECM Connector (A).



3.Remove the battery (Refer to "Charging System" in EM group).

4.Remove the mounting bolts and nut, and then remove the ECM bracket assembly (A).



5.6.3.5 Installation

NOTICE

When replacing the ECM, the vehicle equipped with immobilizer must be performed the procedure as below.

[In the case of installing used ECM]

1.Perform "Neutral mode" procedure with GDS. (Refer to "Immobilizer" in BE group)

2.Insert the key and turn it to the IGN ON and OFF position.

Then the ECM key register process is completed automatically.

[In the case of installing new ECM]

-Insert the key and turn it to the IGN ON and OFF position.

Then the ECM key register process is completed automatically.

1.Installation is reverse of removal.

ECM installation bolt:

9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)

ECM bracket installation bolt:

9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)

5.6.3.6 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.

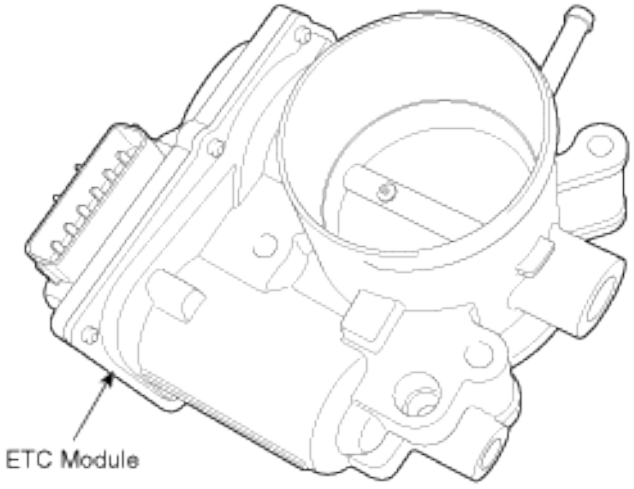
3. If problem is not found in Step 1 and 2, the ECM could be faulty. If so, make sure there were no DTC's before swapping the ECM with a new one, and then check the vehicle again. If DTC's were found, examine this first before swapping ECM.

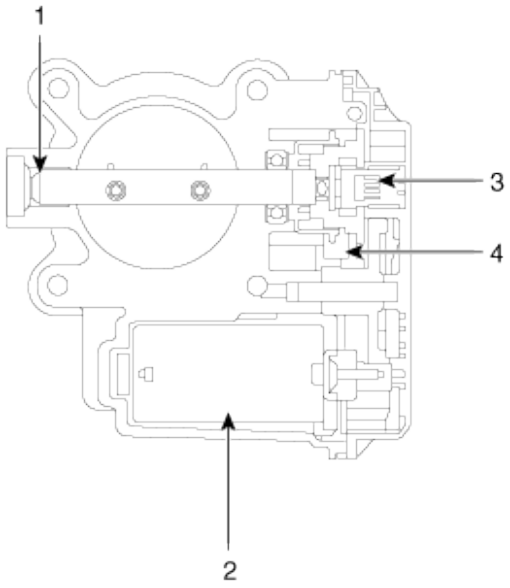
4.RE-TEST THE ORIGINAL ECM: Install the original ECM (may be broken) into a known-good vehicle and check the vehicle. If the problem occurs again, replace the original ECM with a new one. If problem does not occur, this is intermittent problem (Refer to “Intermittent Problem Inspection Procedure” in Basic Inspection Procedure).

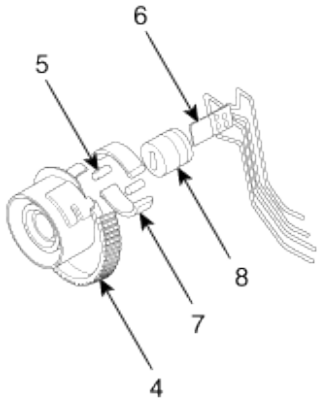
5.6.4 ETC (Electronic Throttle Control) System

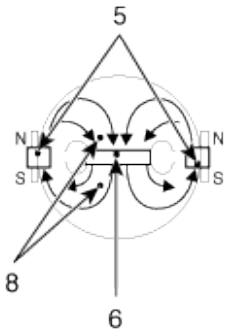
5.6.4.1 Description

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.



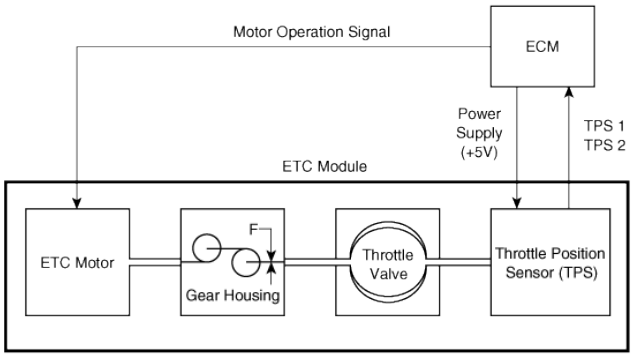






1. Dry bearing	5. Magnet
2. DC motor	6. Hall IC
3. Non-contact hall sensor	7. Yoke
4. Gear	8. Stator

5.6.4.2 Schematic Diagram



5.6.4.3 Fail-Safe Mode

Item	Fail-Safe	
ETC Motor	Throttle valve stuck at 7°	
TPS	TPS 1 fault	ECM looks at TPS2
	TPS 2 fault	ECM looks at TPS1
	TPS 1,2 fault	Throttle valve stuck at 7°
APS	APS 1 fault	ECM looks at APS 2
	APS 2 fault	ECM looks at APS 1
	APS 1,2 fault	Engine idle state

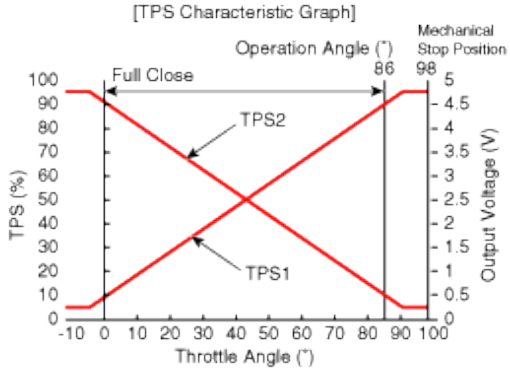
NOTICE

When throttle value is stuck at 7°, engine speed is limited at below 1,500rpm and vehicle speed at maximum 40 ~ 50 km/h (25 ~ 31 mph)

5.6.4.4 Specification

5.6.4.4.1 [Throttle Position Sensor (TPS)]

Throttle angle(°)	Output Voltage (V)		Throttle angle(°)	Output Voltage (V)	
	TPS1	TPS2		TPS1	TPS2
0	0.5	4.5	70	3.69	1.32
10	0.96	4.05	80	4.14	0.86
20	1.41	3.59	90	4.6	0.41
30	1.87	3.14	98	4.65	0.35
40	2.32	2.68	C.T (0)	0.5	4.5
50	2.78	2.23	W.O.T (86)	4.41	0.59
60	3.23	1.77			



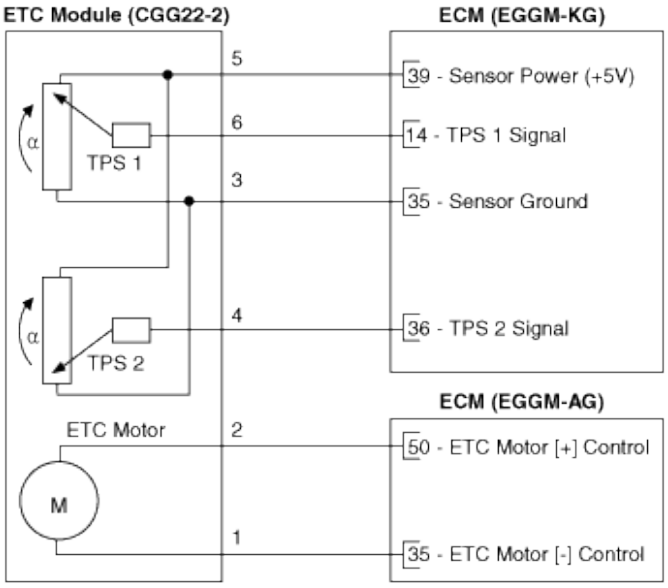
5.6.4.4.2 [ETC Motor]

Item	Specification
Coil Resistance (Ω)	0.3 ~100 [20°C(68°F)]

5.6.4.5 Circuit Diagram

5.6.4.5.1 Manual Transmision

[Circuit Diagram]

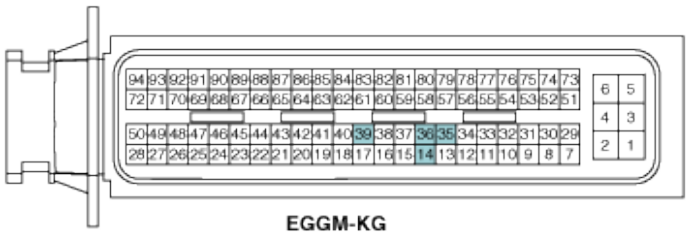


[Connection Information]

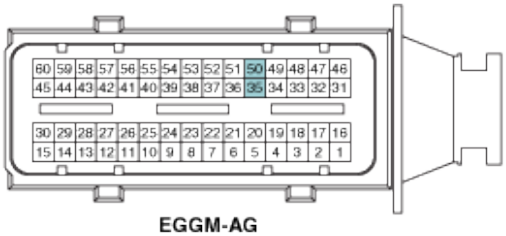
Terminal	Connected to	Function
1	ECM EGGM-AG (35)	ETC Motor [-] Control
2	ECM EGGM-AG (50)	ETC Motor [+] Control
3	ECM EGGM-KG (35)	Sensor Ground
4	ECM EGGM-KG (36)	TPS 2 Signal
5	ECM EGGM-KG (39)	Sensor Power (+5V)
6	ECM EGGM-KG (14)	TPS 1 Signal

[Harness Connector]

CGG22-2
ETC Module



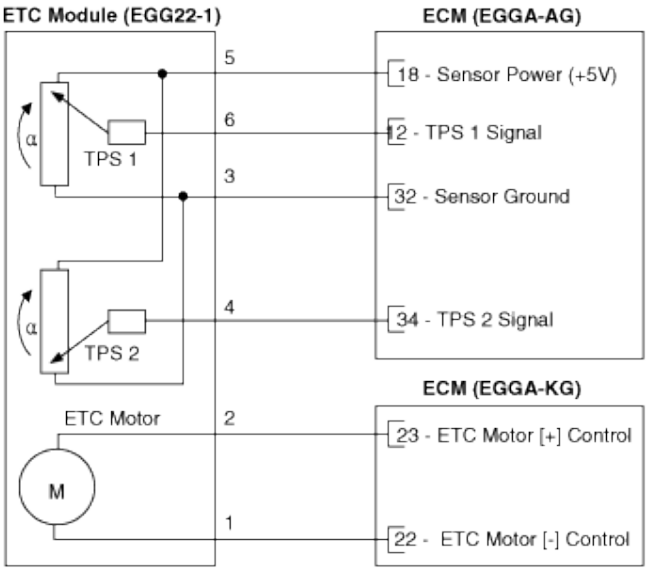
EGGM-KG



EGGM-AG
ECM

5.6.4.5.2 Automatic Transmision

[Circuit Diagram]

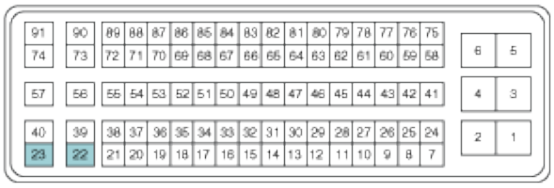


[Connection Information]

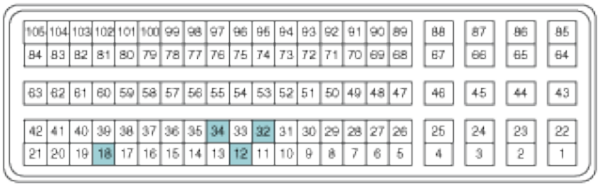
Terminal	Connected to	Function
1	ECM EGGA-KG (22)	ETC Motor [-] Control
2	ECM EGGA-KG (23)	ETC Motor [+] Control
3	ECM EGGA-AG (32)	Sensor Ground
4	ECM EGGA-AG (34)	TPS 2 Signal
5	ECM EGGA-AG (18)	Sensor Power (+5V)
6	ECM EGGA-AG (12)	TPS 1 Signal

[Harness Connector]

EGG22-1
ETC Module



EGGA-KG



EGGA-AG
ECM

5.6.4.6 Inspection

Throttle Position Sensor (TPS)

1. Connect the GDS 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.

Specification: Refer to “Specification”

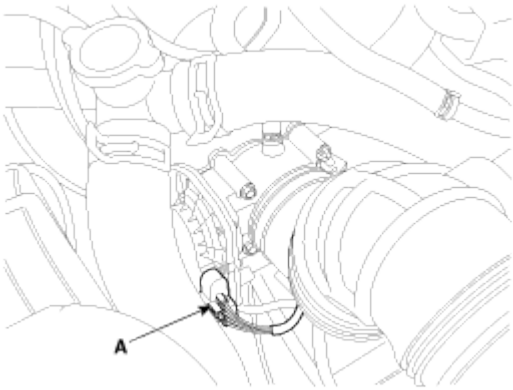
ETC Motor

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

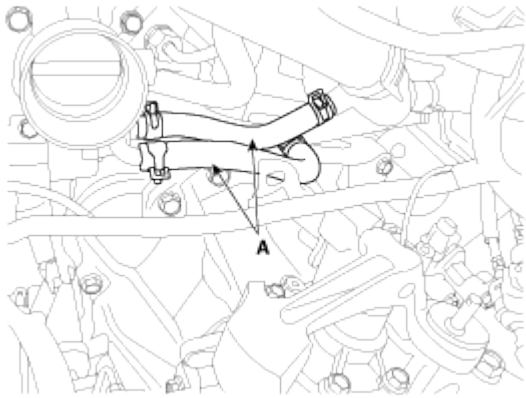
Specification: Refer to “Specification”

5.6.4.7 Removal

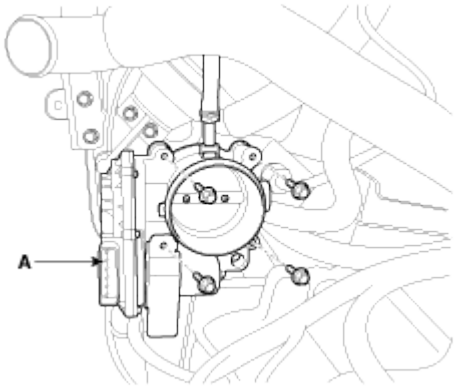
1. Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2. Remove the resonator and the air intake hose (Refer to “Intake And Exhaust System” in EM group).
3. Disconnect the ETC module connector (A).



4. Disconnect the coolant hoses (A).



5. Remove the installation bolts, and then remove the ETC module (A) from the engine.



5.6.4.8 Installation

CAUTION

•Install the component with the specified torques.

•Note that internal damage may occur when the component is dropped. If the component has been dropped, inspect before installing

Installation is reverse of removal.

Electronic throttle body Installation bolt: 9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)

5.6.4.9 Adjustment

ETC module learning procedure

When installing new ETC module or re-installing it, ETC module learning procedure must be performed.

1. Hold the ignition key or the start button at the IG ON position during 5 seconds.
2. Turn ignition swich OFF and then start the engine.

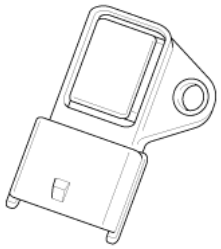
CAUTION

DTC codes (P0638, P2110) might be displayed if ETC module learning procedure does not performed after replacing ETC module.

5.6.5 Manifold Absolute Pressure Sensor (MAPS)

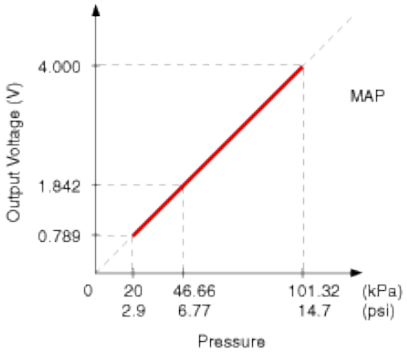
5.6.5.1 Description

Manifold Absolute Pressure Sensor (MAPS) is a speed-density type sensor and is installed on the surge tank. It senses absolute pressure of the surge tank and transfers the analog signal proportional to the pressure to the ECM. By using this signal, the ECM calculates the intake air quantity and engine speed. The MAPS 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 manifold pressure apply to both sides of the sensor respectively, this sensor can output analog signal by using the silicon variation proportional to pressure change.

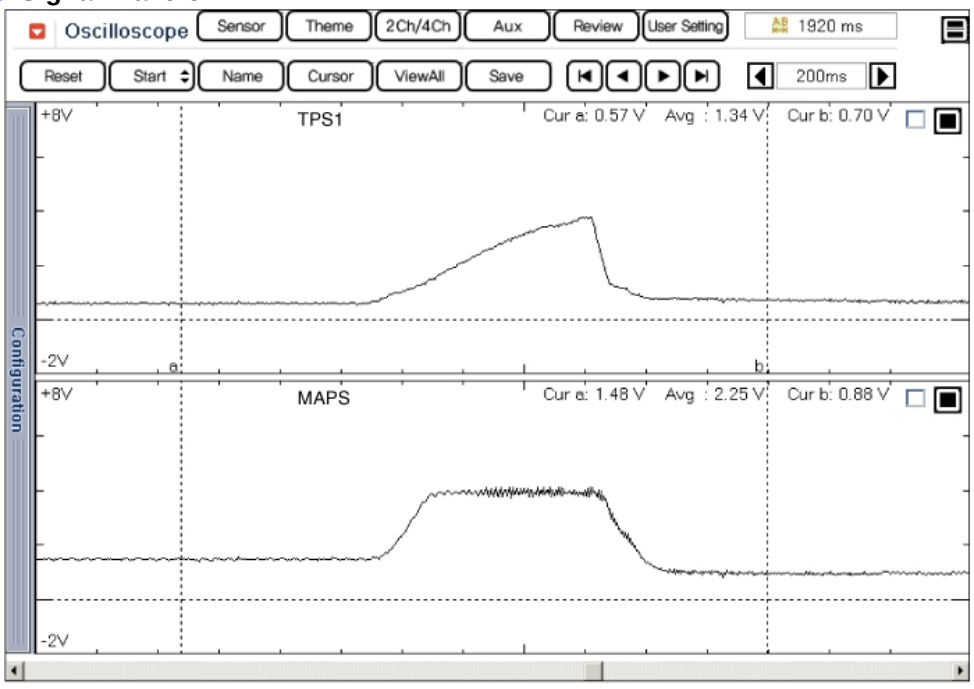


5.6.5.2 Specification

Pressure [kPa (kgf/cm², psi)]	Output Voltage (V)
20.0 (0.20, 2.9)	0.79
46.7 (0.47, 6.77)	1.84
101.3 (1.03, 14.7)	4.0

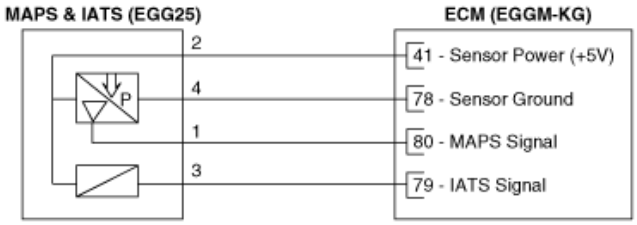


5.6.5.3 Signal Waveform



5.6.5.4 Circuit Diagram
Manual Transmission

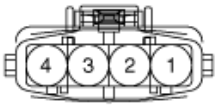
[Circuit Diagram]



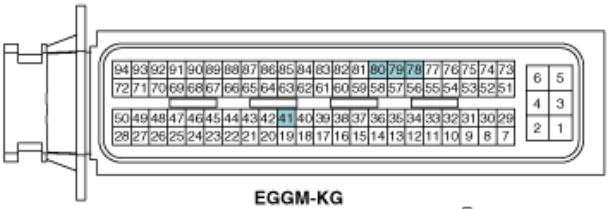
[Connection Information]

Terminal	Connected to	Function
1	ECM EGGM-KG (80)	MAPS Signal
2	ECM EGGM-KG (41)	Sensor Power (+5V)
3	ECM EGGM-KG (79)	IATS Signal
4	ECM EGGM-KG (78)	Sensor Ground

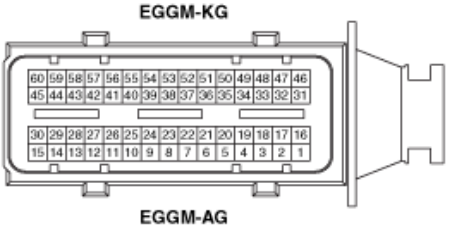
[Harness Connector]



EGG25
MAPS & IATS



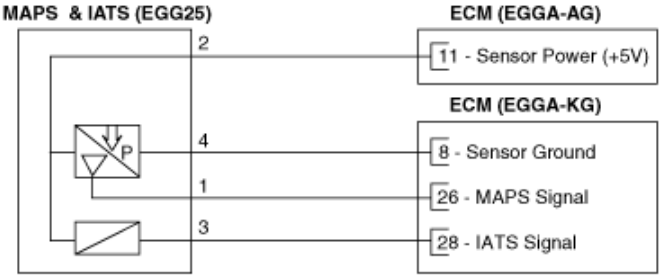
EGGM-KG



EGGM-AG
ECM

Automatic Transmission

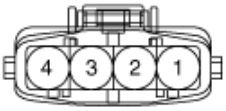
[Circuit Diagram]



[Connection Information]

Terminal	Connected to	Function
1	ECM EGGA-KG (26)	MAPS Signal
2	ECM EGGA-AG (11)	Sensor Power (+5V)
3	ECM EGGA-KG (28)	IATS Signal
4	ECM EGGA-KG (8)	Sensor Ground

[Harness Connector]



EGG25
MAPS & IATS

EGGA-KG

EGGA-AG
ECM

5.6.5.5 Inspection

1.Connect the GDS on the Data Link Connector (DLC).

2.Measure the output voltage of the MAPS at idle and IG ON.

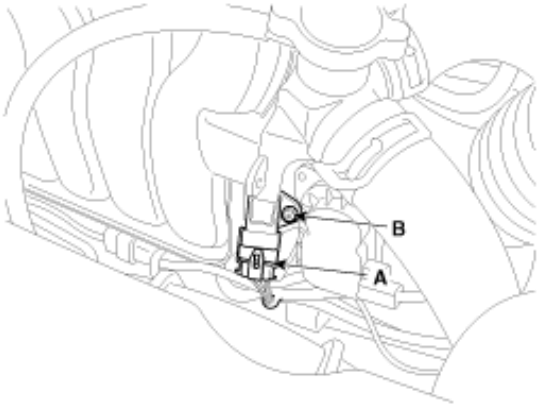
Specification: Refer to "Specification"

5.6.5.6 Removal

1.Turn the ignition switch OFF and disconnect the battery negative (-) cable.

2.Disconnect the manifold absolute pressure sensor connector (A).

3.Remove the installation bolt (B), and then remove the sensor from the surge tank.



5.6.5.7 Installation

CAUTION

- Install the component with the specified torques.
- Note that internal damage may occur when the component is dropped. If the component has been dropped, inspect before installing.

CAUTION

- Insert the sensor in the installation hole and be careful not to damage

1.Installation is reverse of removal.

Manifold absolute pressure sensor installation bolt: 9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)

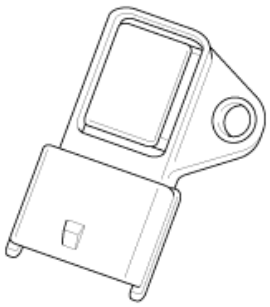
5.6.6 Intake Air Temperature Sensor (IATS)

5.6.6.1 Description

Intake Air Temperature Sensor (IATS) is included inside Manifold Absolute Pressure Sensor 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) Thermister and it's resistance changes in reverse proportion to the temperature.



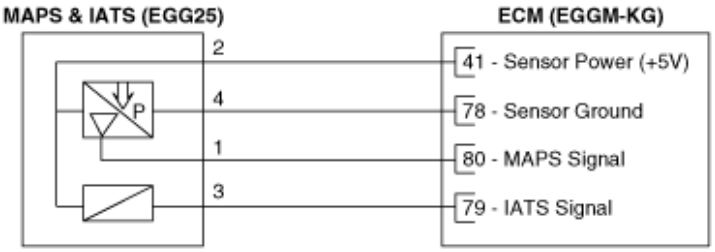
5.6.6.2 Specification

Temperature		Resistance (kΩ)
°C	°F	
-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

5.6.6.3 Circuit Diagram

Manual Transmission

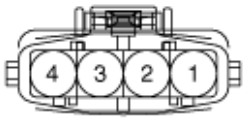
[Circuit Diagram]



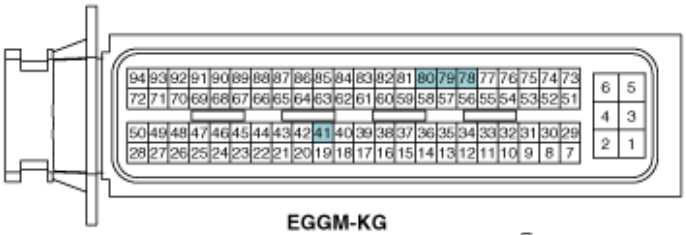
[Connection Information]

Terminal	Connected to	Function
1	ECM EGGM-KG (80)	MAPS Signal
2	ECM EGGM-KG (41)	Sensor Power (+5V)
3	ECM EGGM-KG (79)	IATS Signal
4	ECM EGGM-KG (78)	Sensor Ground

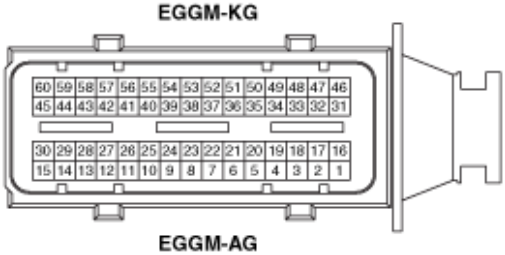
[Harness Connector]



EGG25
MAPS & IATS



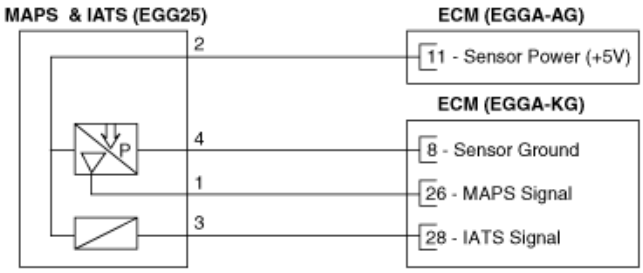
EGGM-KG



EGGM-AG
ECM

Automatic Transmision

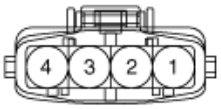
[Circuit Diagram]



[Connection Information]

Terminal	Connected to	Function
1	ECM EGGA-KG (26)	MAPS Signal
2	ECM EGGA-AG (11)	Sensor Power (+5V)
3	ECM EGGA-KG (28)	IATS Signal
4	ECM EGGA-KG (8)	Sensor Ground

[Harness Connector]



EGG25
MAPS & IATS

EGGA-KG

EGGA-AG
ECM

5.6.6.4 Inspection

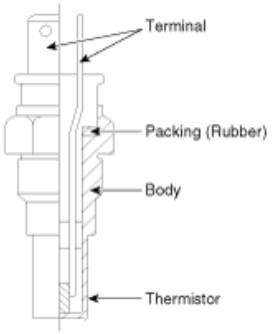
1.Turn the ignition switch OFF.
2.Disconnect the IATS connector.
3.Measure resistance between the IATS terminals 3 and 4.
4.Check that the resistance is within the specification.

Specification: Refer to “Specification”

5.6.7 Engine Coolant Temperature Sensor (ECTS)

5.6.7.1 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 that changes resistance with the temperature.
The electrical resistance of the ECTS decreases as the temperature increases, and increases as the temperature decreases. The reference +5V 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.



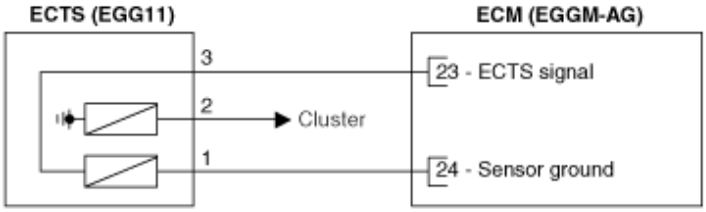
5.6.7.2 Specification

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

5.6.7.3 Circuit Diagram

Manual Transmission

[Circuit Diagram]



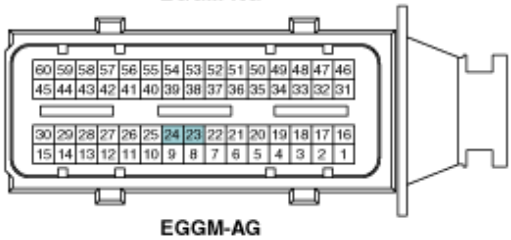
[Connection Information]

Terminal	Connected to	Function
1	ECM EGGM-AG (24)	Sensor ground
2	Cluster	-
3	ECM EGGM-AG (23)	ECTS signal

[Harness Connector]

EGG11
ECTS

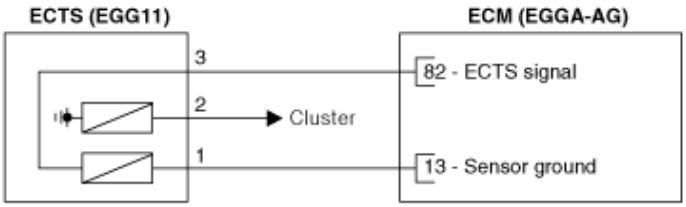
EGGM-KG



EGGM-AG
ECM

Automatic Transmision

[Circuit Diagram]



[Connection Information]

Terminal	Connected to	Function
1	ECM EGGA-AG (13)	Sensor ground
2	Cluster	-
3	ECM EGGA-AG (82)	ECTS signal

[Harness Connector]

EGG11
ECTS

5.6.7.4 Inspection

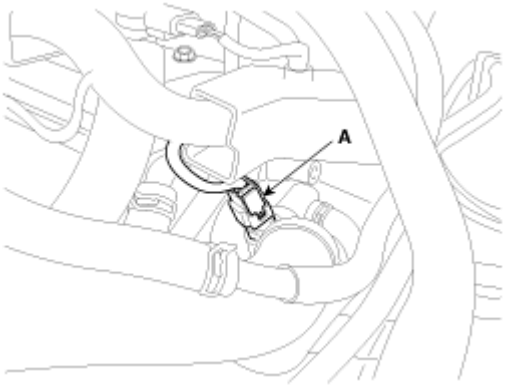
1.Turn the ignition switch OFF.
2.Remove the ECTS (Refer to "Removal").
3.After immersing the thermistor of the sensor into engine coolant, measure resistance between the ECTS terminals 3 and 4.
4.Check that the resistance is within the specification.
Specification: Refer to “Specification”

5.6.7.5 Removal

1.Turn the ignition switch OFF and disconnect the battery negative (-) cable.

2.Disconnect the engine coolant temperature sensor connector (A).

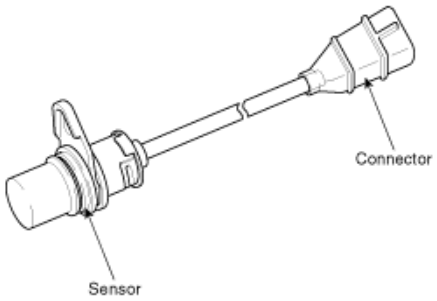
3.Supplement the engine coolant (Refer to “Cooling System” in EM group).



5.6.8 Crankshaft Position Sensor (CKPS)

5.6.8.1 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 in ladder frame 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).

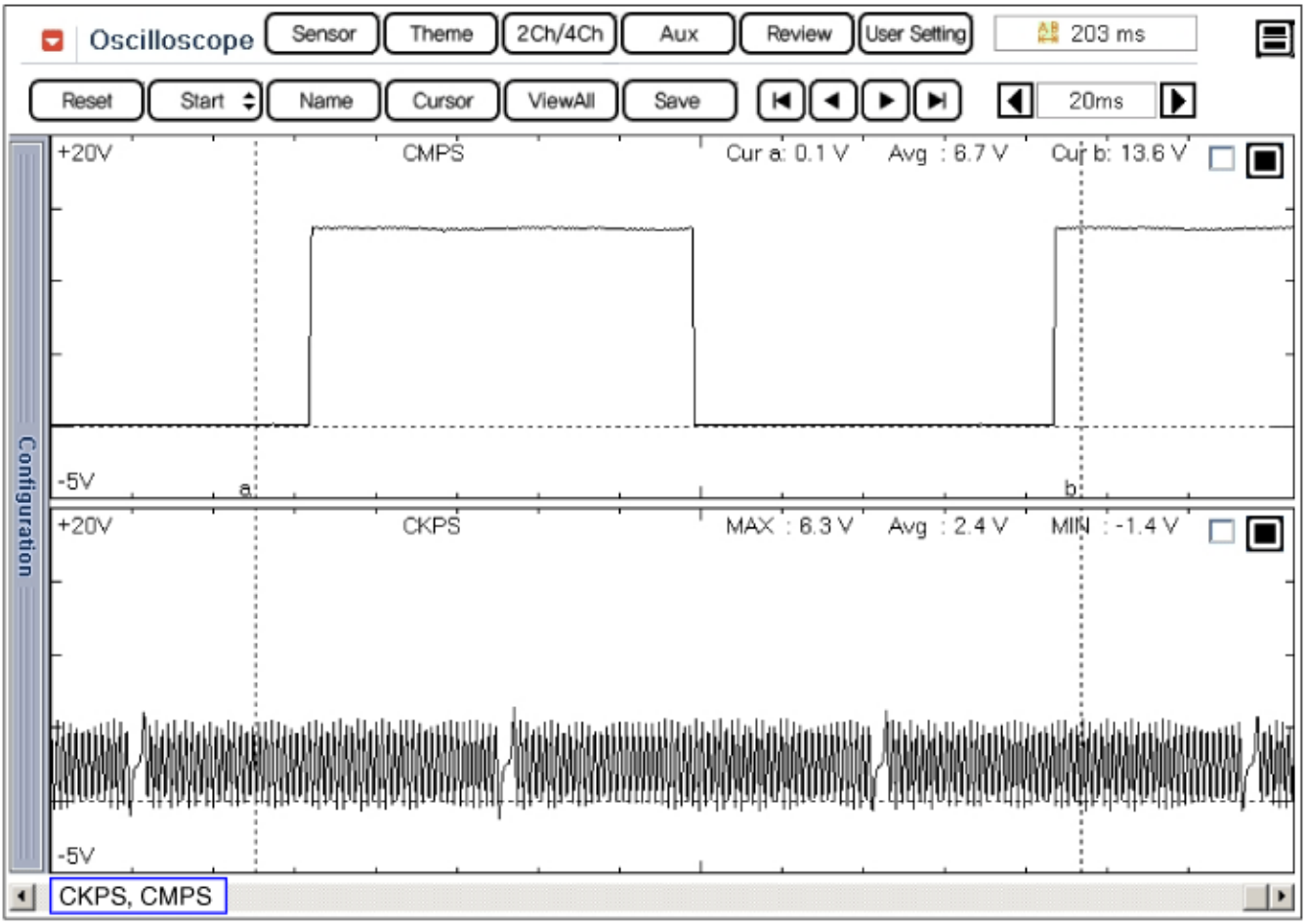


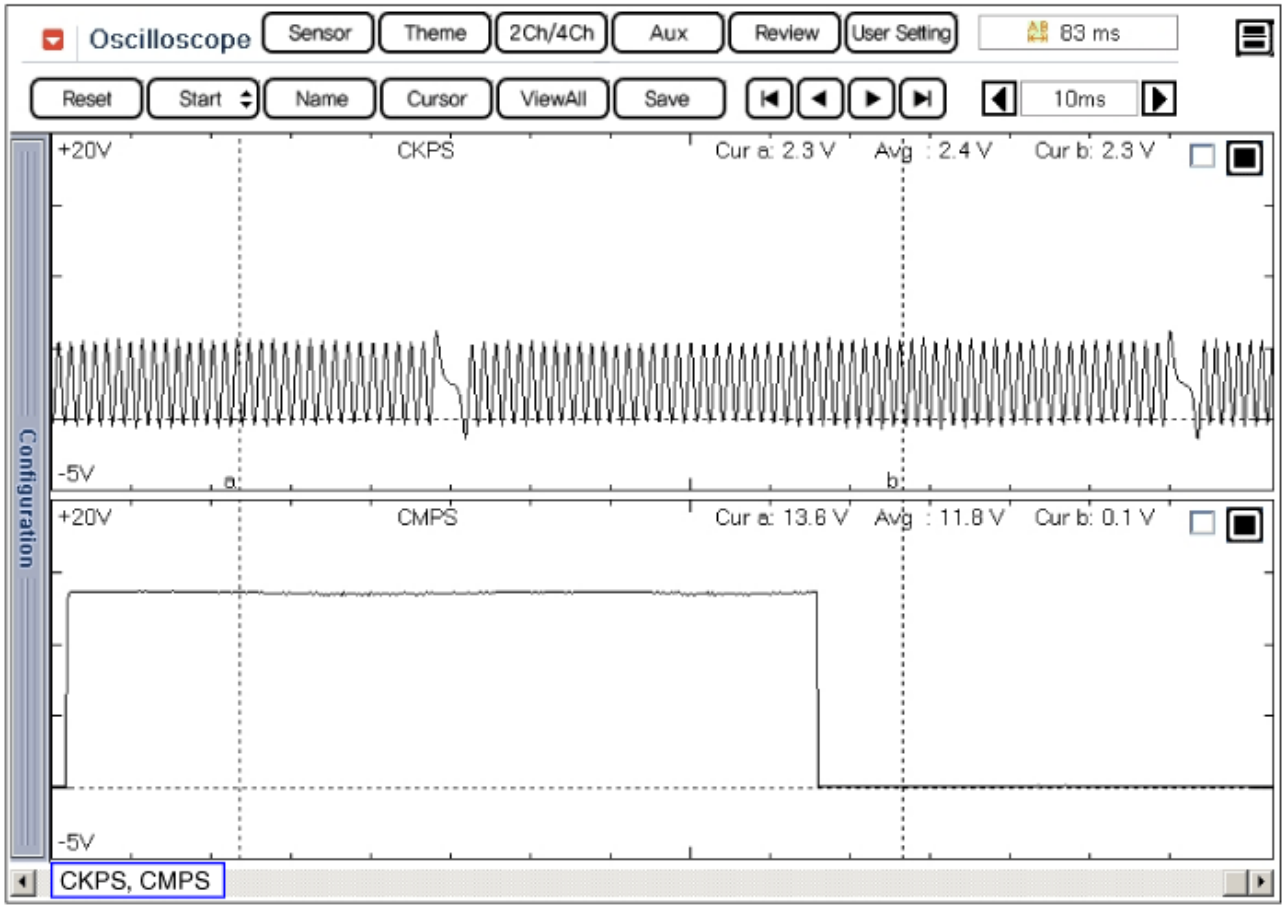
5.6.8.2 Specification

Item	Specification
Coil Resistance (Ω)	774 ~ 946 [20°C (68°F)]

5.6.8.3 Waveform

These examples shows a typical Crankshaft Position Sensor(CkPS) and Camshaft Position Sensor(CMPS) waveform at idle.The PCM controls the injection and ignition timing by using these signals.
Generally CkPS signal is used to detect the piston's position and CMPS signal is used to detect the Top Dead Center of each cylinder.

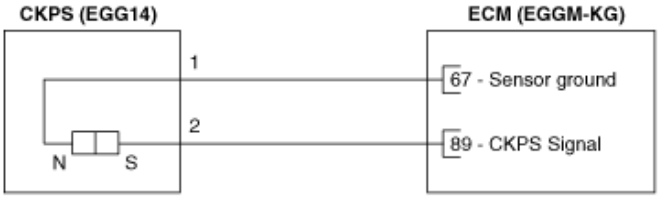




5.6.8.4 Circuit Diagram

Manual Transmission

[Circuit Diagram]

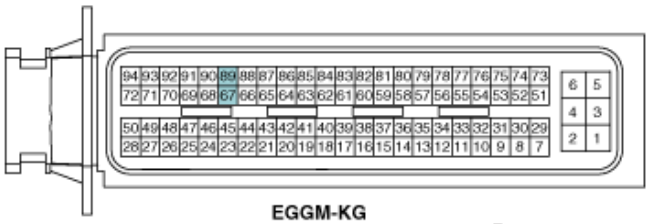


[Conection Information]

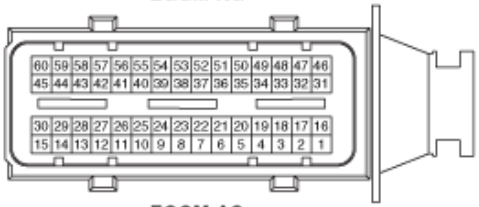
Terminal	Conected to	Function
1	ECM EGGM-KG (67)	Sensor ground
2	ECM EGGM-KG (89)	CKPS Signal

[Harness Connector]

EGG14
CKPS



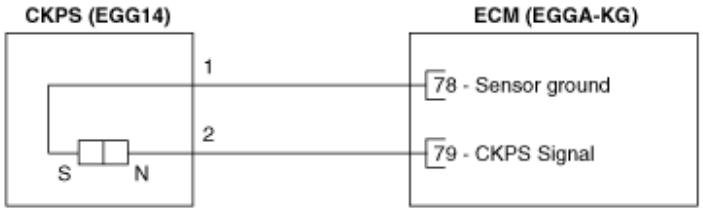
EGGM-KG



EGGM-AG
ECM

Automatic Transmision

[Circuit Diagram]

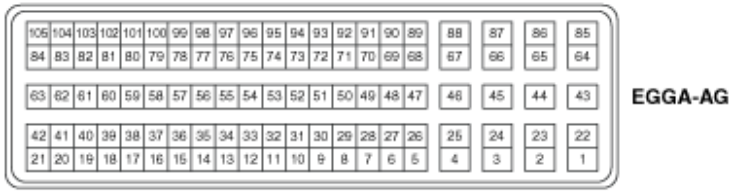


[Conection Information]

Terminal	Conected to	Function
1	ECM EGGA-KG (78)	Sensor ground
2	ECM EGGA-KG (79)	CKPS Signal

[Harness Connector]

EGG14
CKPS



ECM

5.6.8.5 Inspection

1.Check signal waveform of CKPS and CMPS using a GDS.
Specification: Refer to “Waveform”

5.6.8.6 Removal

1.Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2.Disconnect the crankshaft position sensor connector (A) and remove the sensor (B) after removing the installation bolt.

5.6.8.7 Installation

CAUTION

- •Install the component with the specified torques.
- •Note that internal damage may occur when the component is dropped. If the component has been dropped, inspect before installing.
- •Apply the engine oil to the O-ring.
- •Insert the sensor in the installation hole and be careful not to damage.

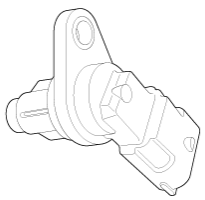
1.Installation is reverse of removal.

Crankshaft position sensor installation bolt: 7.8 ~ 11.8 N.m (0.8 ~ 1.2 kgf.m, 5.8 ~ 8.7 lb-ft)

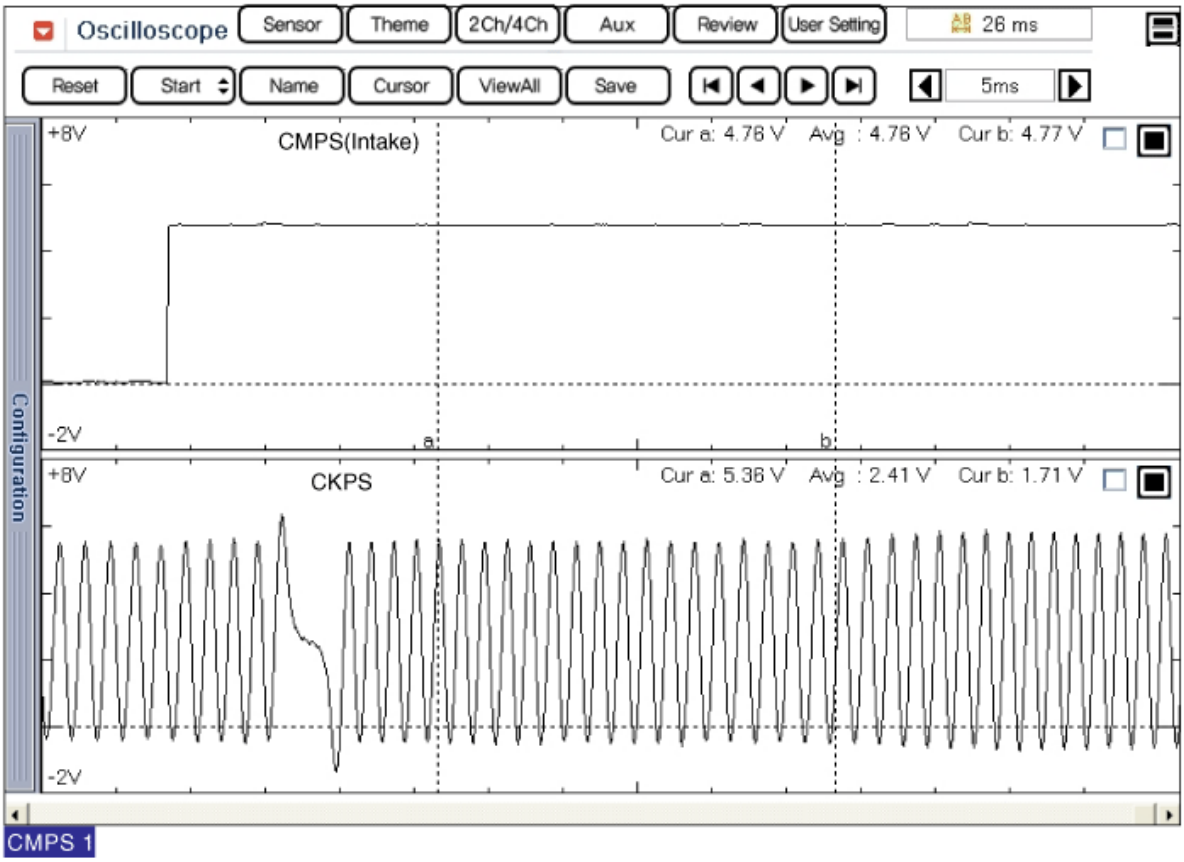
5.6.9 Camshaft Position Sensor (CMPS)

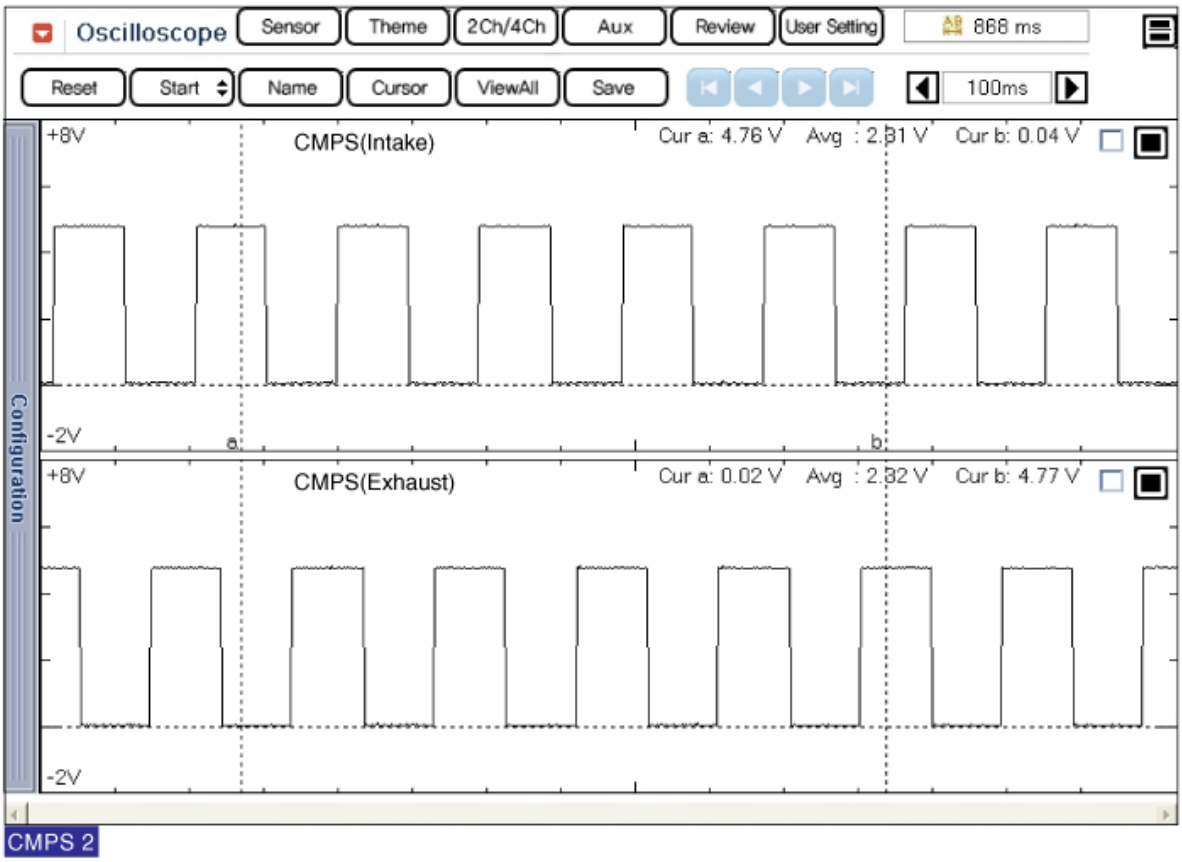
5.6.9.1 Description

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 CMPS is installed on engine head cover and uses a target wheel installed on the camshaft. The Cam Position sensor is a hall-effect type sensor. As the target wheel passes the Hall sensor, the magnetic field changes in the sensor. The sensor then switches a signal which creates a square wave.



5.6.9.2 Wave Form

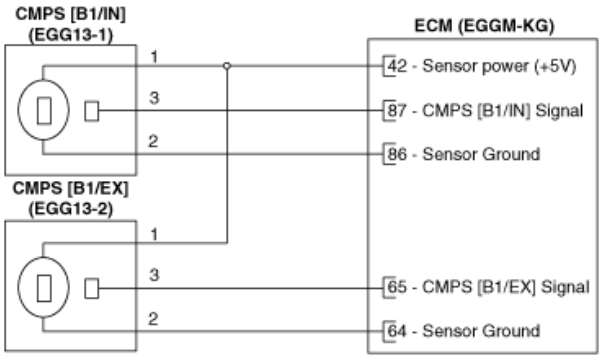




5.6.9.3 Circuit Diagram

MANUAL TRANSMISSION

[Circuit Diagram]



[Connection Information]

CMPS [B1/IN] (EGG13-1)

Terminal	Connected to	Function
1	Main Relay	Battery Power (B+)
2	ECM EGGM-KG (86)	Sensor Ground
3	ECM EGGM-KG (87)	CMPS [B1/IN] Signal

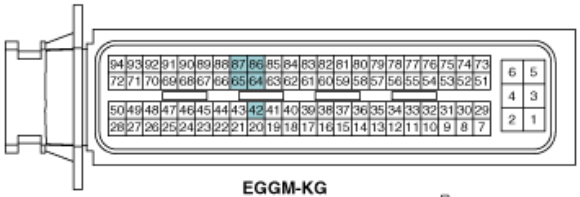
CMPS [B1/EX] (EGG13-2)

Terminal	Connected to	Function
1	Main Relay	Battery Power (B+)
2	ECM EGGM-KG (64)	Sensor Ground
3	ECM EGGM-KG (65)	CMPS [B1/EX] Signal

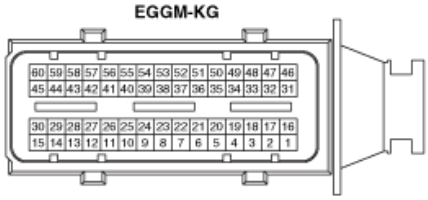
[Harness Connector]

EGG13-1
CMPS [B1/IN]

EGG13-2
CMPS [B1/EX]



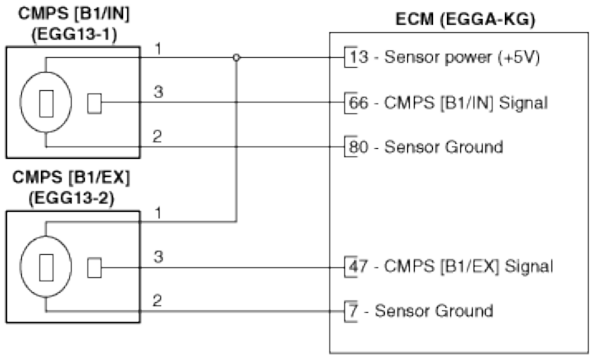
EGGM-KG



EGGM-AG
ECM

AUTOMATIC TRANSMISSION

[Circuit Diagram]



[Connection Information]

CMPS [B1/IN] (EGG13-1)

Terminal	Connected to	Function
1	Main Relay	Battery Power (B+)
2	ECM EGGA-KG (80)	Sensor Ground
3	ECM EGGA-KG (66)	CMPS [B1/IN] Signal

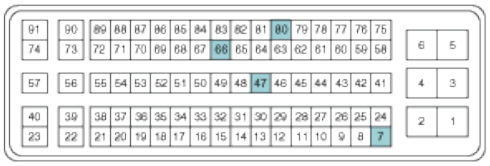
CMPS [B1/EX] (EGG13-2)

Terminal	Connected to	Function
1	Main Relay	Battery Power (B+)
2	ECM EGGA-KG (7)	Sensor Ground
3	ECM EGGA-KG (47)	CMPS [B1/EX] Signal

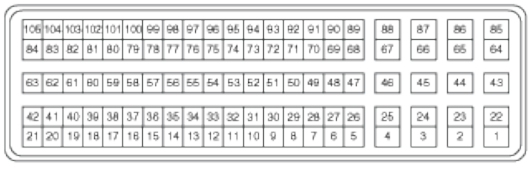
[Harness Connector]

EGG13-1
CMPS [B1/IN]

EGG13-2
CMPS [B1/EX]



EGGA-KG



EGGA-AG
ECM

5.6.9.4 Inspection

1.Check the signal waveform of the CMPS and CKPS using the GDS.
Specification: Refer to “Wave Form”

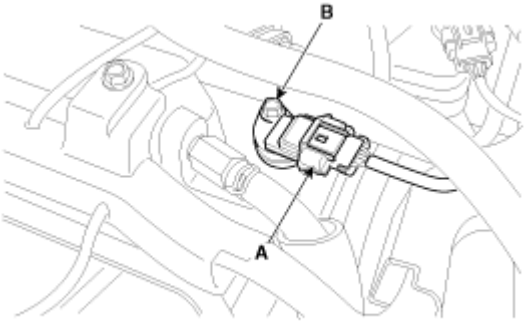
5.6.9.5 Removal

CAUTION

• DON’T remove the camshaft position sensor while the engine is running or right after engine is turned off. The part and engine oil is hot and can cause burns.

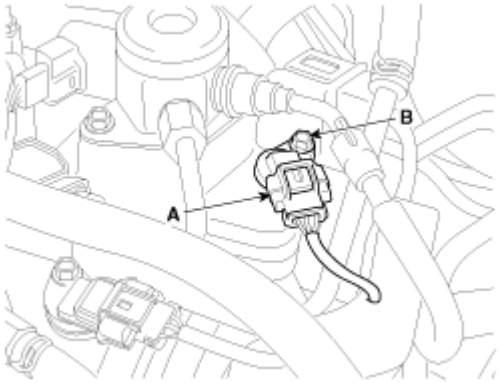
[Bank 1 / Intake]

1.Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2.Disconnect the camshaft position sensor connector (A).
3.Remove the installation bolt (B), and then remove the sensor.



[Bank 1 / Exhaust]

1.Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2.Disconnect the camshaft position sensor connector (A).
3.Remove the hanger and the protector.
4.Remove the installation bolt (B), and then remove the sensor.



5.6.9.6 Installation

CAUTION

- Install the component with the specified torques.
- Note that internal damage may occur when the component is dropped. If the component has been dropped, inspect before installing.
- Apply the engine oil to the O-ring.
- Insert the sensor in the installation hole and be careful not to damage.
- Be careful not to damage the sensor housing and the connector.
- Be careful not to damage the O-ring.

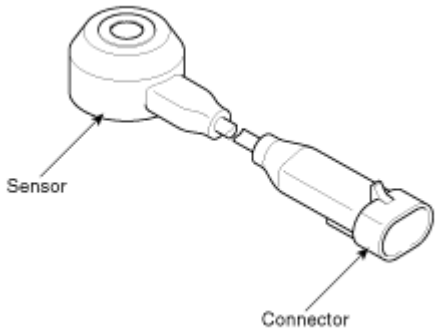
1. Installation is reverse of removal.

Camshaft position sensor installation bolt: 7.8 ~ 11.8 N.m (0.8 ~ 1.2 kgf.m, 5.8 ~ 8.7 lb-ft)

5.6.10 Knock Sensor (KS)

5.6.10.1 Description

Knocking is a phenomenon characterized by undesirable vibration and noise and can cause engine damage. Knock Sensor (KS) is installed on the cylinder block and senses engine knocking.
When knocking occurs, the vibration from the cylinder block is applied as pressure to the piezoelectric element. When a knock occurs, the sensor produces voltage signal. The ECM retards the ignition timing when knocking occurs. If the knocking disappears after retarding the ignition timing, the ECM will advance the ignition timing. This sequential control can improve engine power, torque and fuel economy.



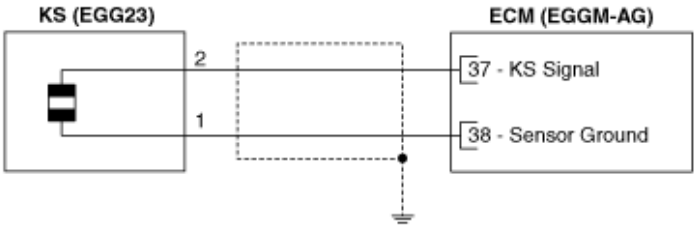
5.6.10.2 Specification

Item	Specification
Capacitance (pF)	950 ~ 1,350
Resistance (MΩ)	4.87

5.6.10.3 Circuit Diagram

MANUAL TRANSMISSION

[Circuit Diagram]

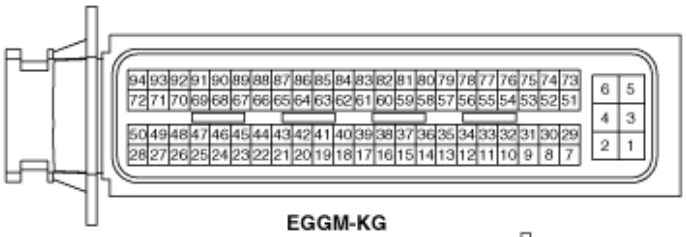


[Connection Information]

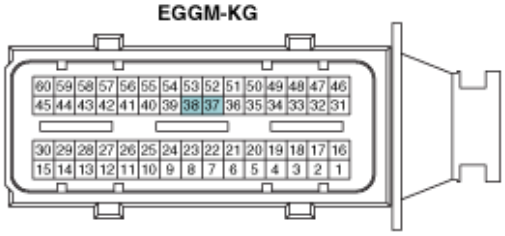
Terminal	Connected to	Function
1	ECM EGGM-AG (38)	Sensor Ground
2	ECM EGGM-AG (37)	KS Signal

[Harness Connector]

EGG23
Knock Sensor



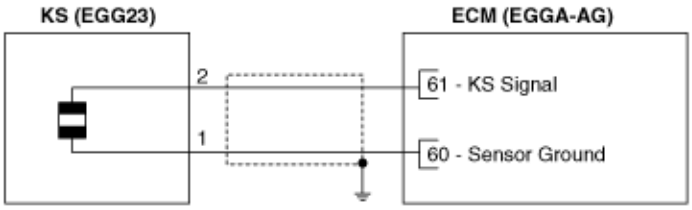
EGGM-KG



EGGM-AG
ECM

Automatic Transmision

[Circuit Diagram]

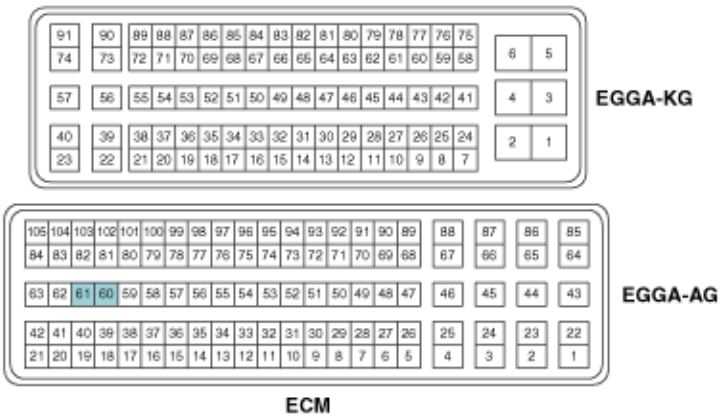


[Connection Information]

Terminal	Connected to	Function
1	ECM EGGA-AG (60)	Sensor Ground
2	ECM EGGA-AG (61)	KS Signal

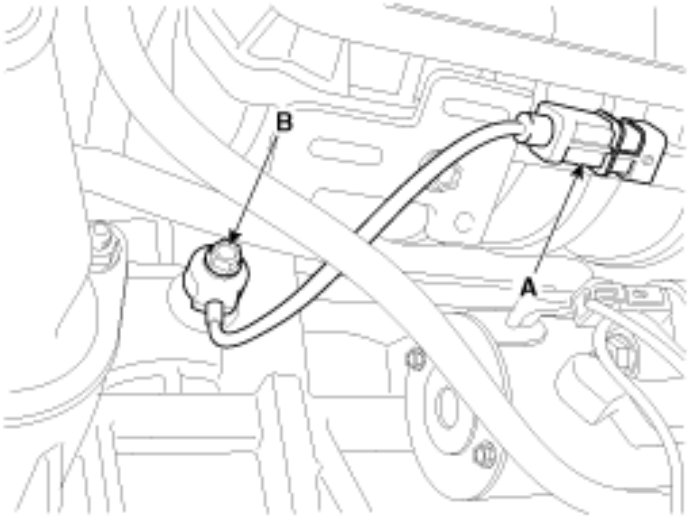
[Harness Connector]

EGG23
Knock Sensor



5.6.10.4 Removal

1.Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2.Remove the intake manifold (Refer to “Intake And Exhaust System” in EM group).
3.Disconnect the injector connector (A).
4.Remove the installation bolt (B), and then remove the sensor from the cylinder block.



5.6.10.5 Installation

CAUTION

•Install the component with the specified torques.

•Note that internal damage may occur when the component is dropped. If the component has been dropped, inspect before installing.

1.Installation is reverse of removal.

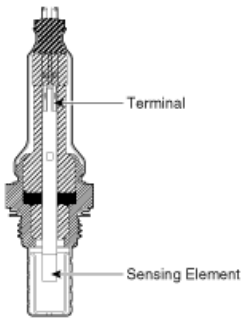
Knock sensor installation bolt:18.6 ~ 24.5 N.m (1.9 ~ 2.5 kgf.m, 13.7 ~ 18.1 lb-ft)

5.6.11 Heated Oxygen Sensor (HO2S)

5.6.11.1 Description

Heated Oxygen Sensor (HO2S) consists of zirconium and alumina and is installed both upstream and downstream of the Manifold Catalytic Converter. The sensor output voltage varies in accordance with the air/fuel ratio.

The sensor must be hot in order to operate normally. To keep it hot, the sensor has a heater which is controlled by the ECM via a duty cycle signal. When the exhaust gas temperature is lower than the specified value, the heater warms the sensor tip.



5.6.11.2 Specification

HO2S [Bank 1/Sensor 1]

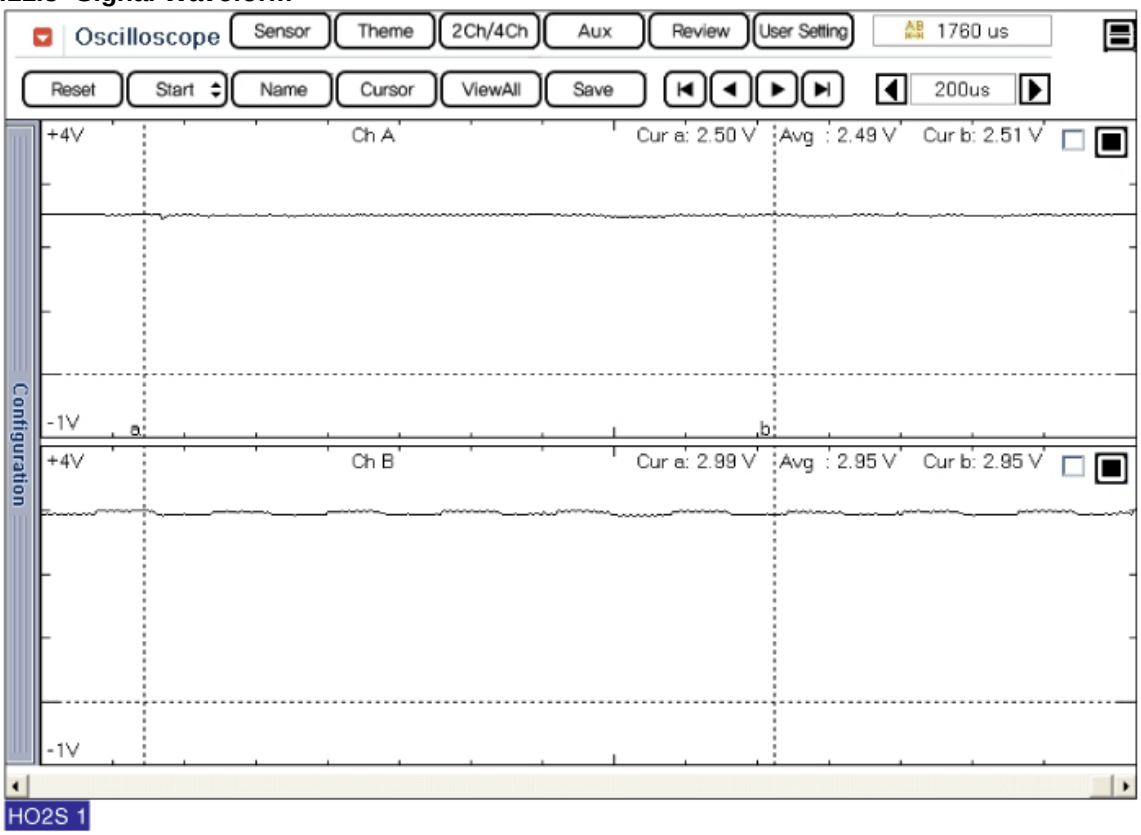
Item	Specification
Heater Resistance (Ω)	2.4 ~ 4.0 [20°C(68°F)]

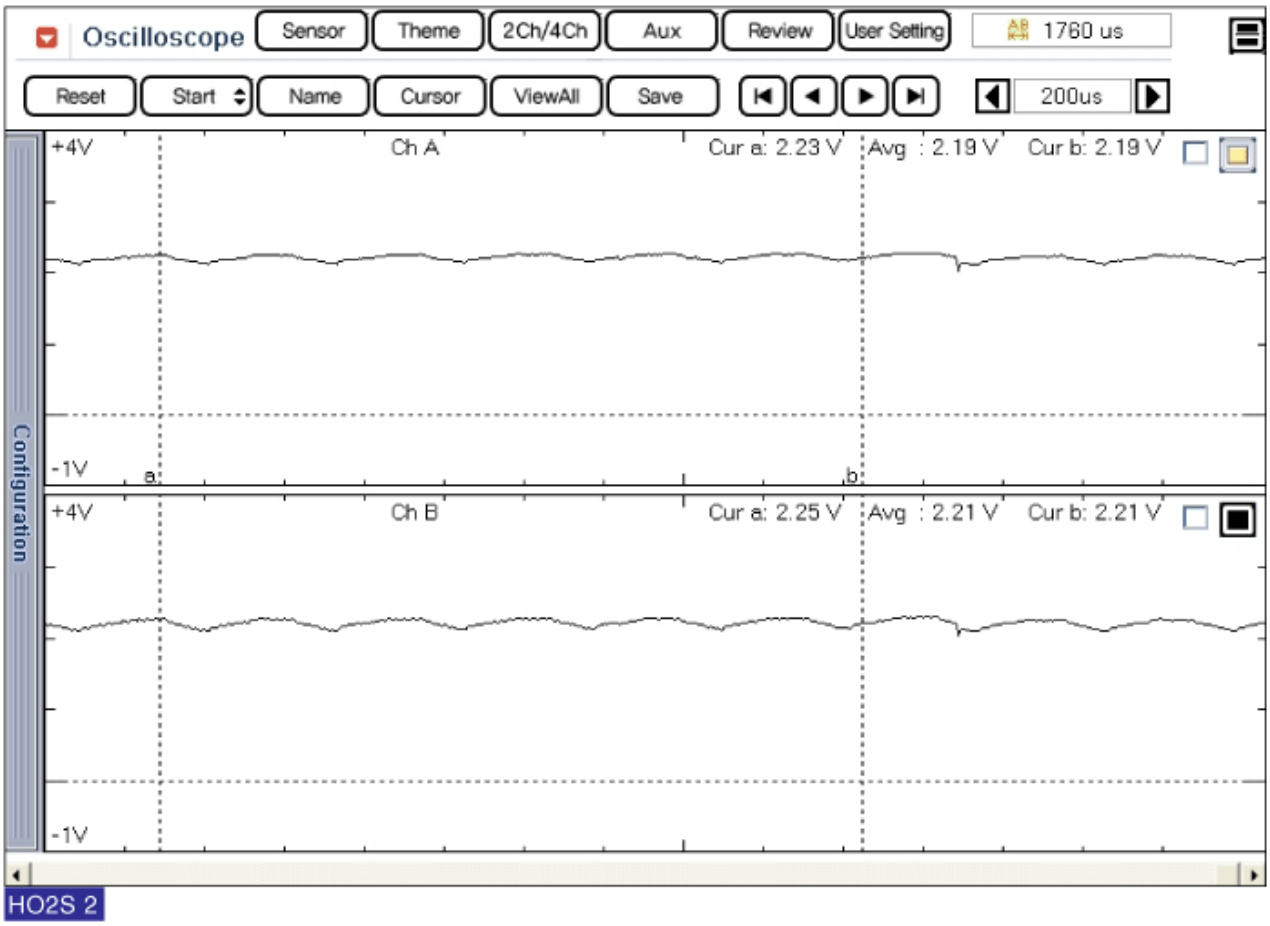
HO2S [Bank 1/Sensor 2]

A/F Ratio (λ)	Output Voltage(V)
RICH	0.6 ~ 1.0
LEAN	0 ~ 0.4

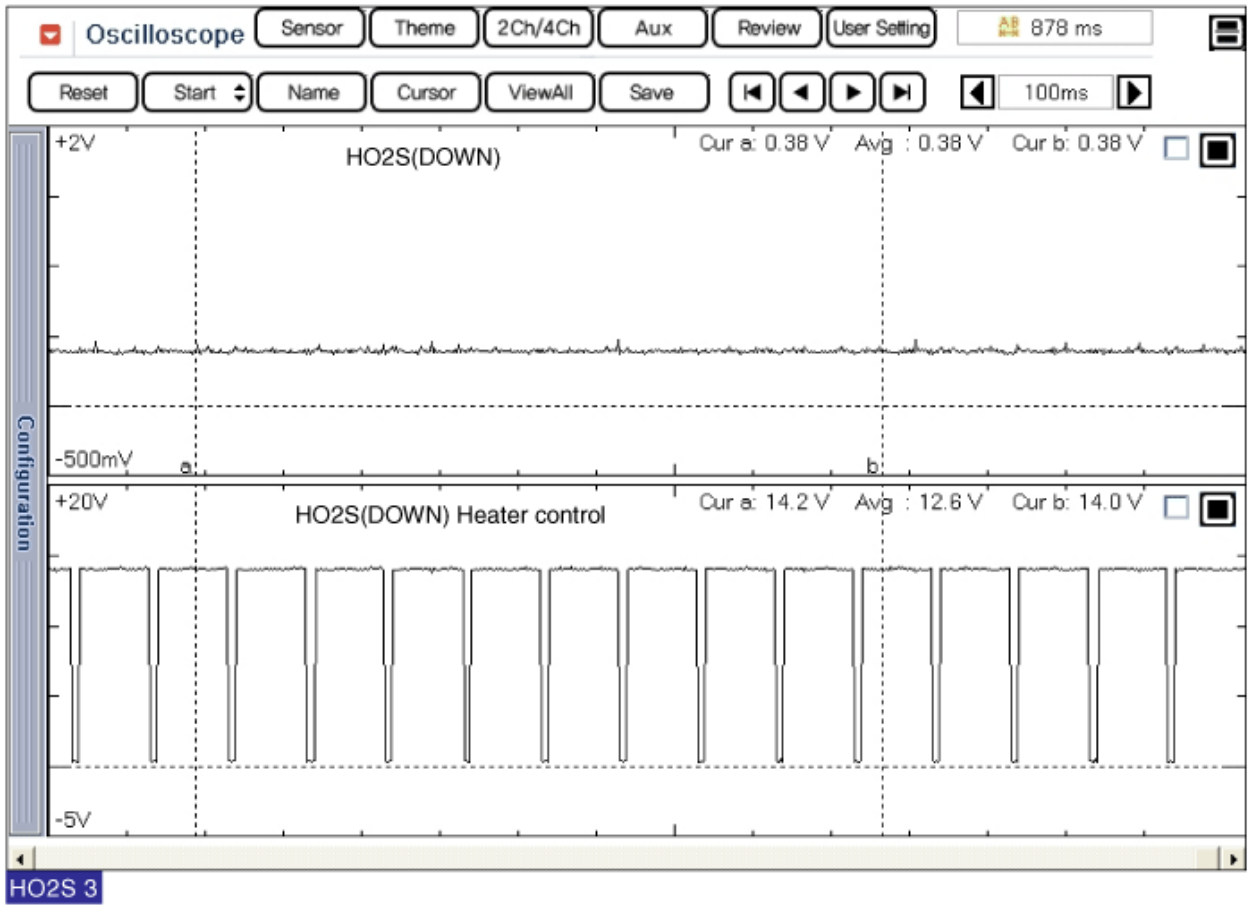
Item	Specification
Heater Resistance	Approx. 9.0 [21°C(69.8°F)]

5.6.11.3 Signal Waveform




Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
1760 us
Reset
Start
Name
Cursor
ViewAll
Save
200us
Configuration
+4V
Ch A
Cur a: 2.23 V
Avg : 2.19 V
Cur b: 2.19 V
-1V
a
b
+4V
Ch B
Cur a: 2.25 V
Avg : 2.21 V
Cur b: 2.21 V
-1V

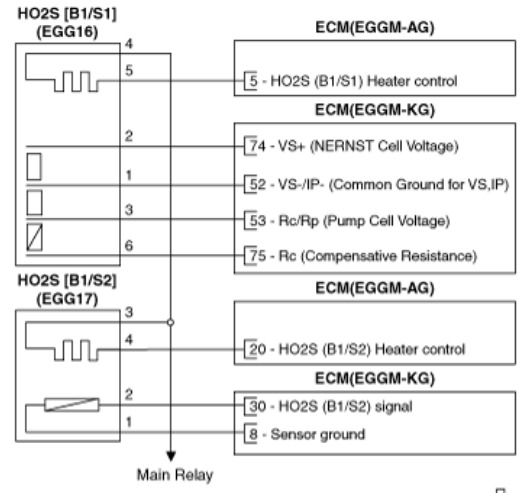
HO2S 2


Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
878 ms
Reset
Start
Name
Cursor
ViewAll
Save
100ms
Configuration
+2V
HO2S(DOWN)
Cur a: 0.38 V
Avg : 0.38 V
Cur b: 0.38 V
-500mV
a
b
+20V
HO2S(DOWN) Heater control
Cur a: 14.2 V
Avg : 12.6 V
Cur b: 14.0 V
-5V

HO2S 3

5.6.11.4 Circuit Diagram MANUAL TRANS

[Circuit Diagram]



[Connection Information]

HO2S [B1/S1] (EGG16)

Terminal	Connected to	Function
1	ECM EGGM-KG (52)	VS-/IP- (Common Ground for VS,IP)
2	ECM EGGM-KG (74)	VS+ (NERNST Cell Voltage)
3	ECM EGGM-KG (53)	Rc/Rp (Pump Cell Voltage)
4	Main Relay	Power Supply (B+)
5	ECM EGGM-AG (5)	Heater control
6	ECM EGGM-KG (75)	Rc (Compensative Resistance)

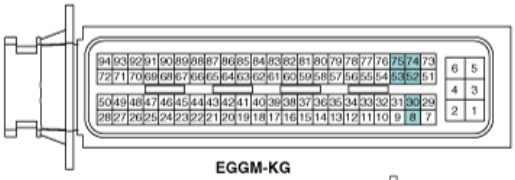
HO2S [B1/S2] (EGG17)

Terminal	Connected to	Function
1	ECM EGGM-KG (8)	Sensor Ground
2	ECM EGGM-KG (30)	HO2S (B1/S2) Signal
3	Main Relay	Power Supply (B+)
4	ECM EGGM-AG (20)	Heater control

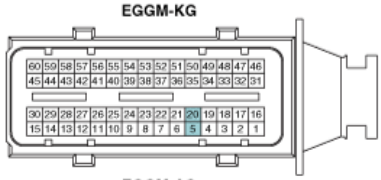
[Harness Connector]

EGG16
HO2S [B1/S1]

EGG17
HO2S [B1/S2]



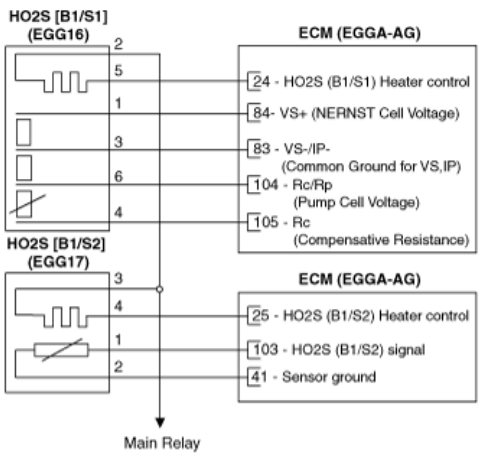
EGGM-KG



EGGM-AG
ECM

AUTOMATIC TRANS

[Circuit Diagram]



[Connection Information]

HO2S [B1/S1](EGG16)

Terminal	Connected to	Function
1	ECM EGGA-AG (84)	VS+ (NERNST Cell Voltage)
2	Main Relay	Power Supply (B+)
3	ECM EGGA-AG (83)	VS-/IP- (Common Ground for VS,IP)
4	ECM EGGA-AG (105)	Rc (Compensative Resistance)
5	ECM EGGA-AG (24)	HO2S (B1/S1) Heater control
6	ECM EGGA-AG (104)	Rc/Rp (Pump Cell Voltage)

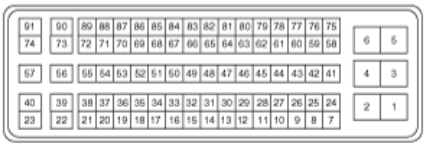
HO2S [B1/S2] (EGG17)

Terminal	Connected to	Function
1	ECM EGGA-AG (103)	HO2S (B1/S2) signal
2	ECM EGGA-AG (41)	Sensor Ground
3	Main Relay	Power Supply (B+)
4	ECM EGGA-AG (25)	HO2S (B1/S2) Heater control

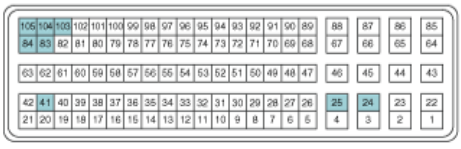
[Harness Connector]

EGG16
HO2S [B1/S1]

EGG17
HO2S [B1/S2]



EGGA-KG



EGGA-AG
ECM

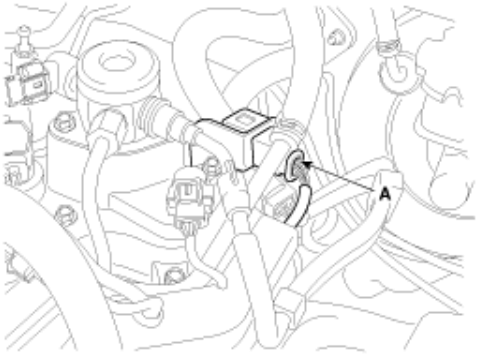
5.6.11.5 Inspection

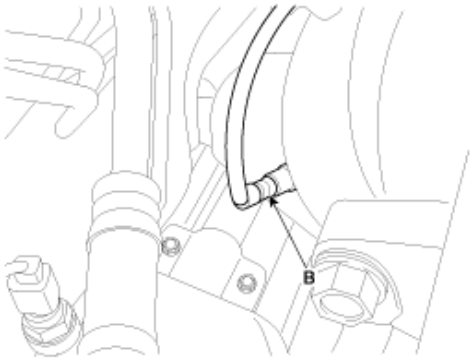
1.Turn the ignition switch OFF.
2.Disconnect the HO2S connector.
3.Measure resistance between the HO2S terminals 4 and 5 [B1/S1].
4.Measure resistance between the HO2S terminals 3 and 4 [B1/S2].
5.Check that the resistance is within the specification.
Specification: Refer to “Specification”

5.6.11.6 Removal

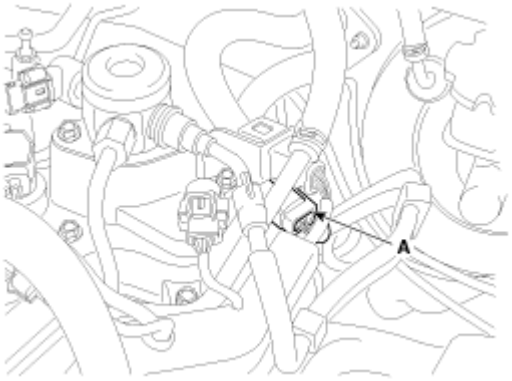
1.Turn the ignition switch OFF and disconnect the battery negative (-) cable.
2.Disconnect the connector (A), and then remove the sensor (B).
Note that the SST (Part No.: 09392-2H100) is useful when removing the heated oxygen sensor.

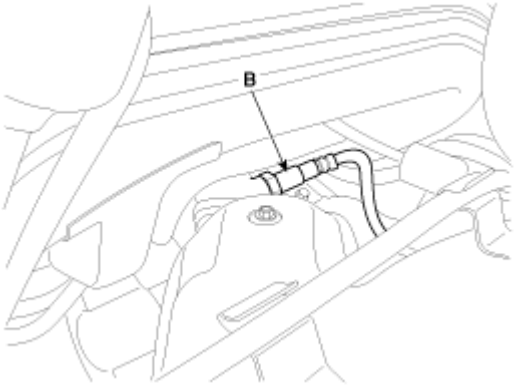
[Bank 1 / Sensor 1]





[Bank 1 / Sensor 2]





5.6.11.7 Installation

CAUTION

•Install the component with the specified torques.
•Note that internal damage may occur when the component is dropped. If the component has been dropped, inspect before installing.
•DON’T use a cleaner, spray, or grease to sensing element and connector of the sensor because oil component in them may malfunction the sensor performance.
•Sensor and its wiring may be damaged in case of contacting with the exhaust system (Exhaust Manifold, Catalytic Converter, and so on).
1.Installation is reverse of removal.
Heated oxygen sensor installation: 39.2 ~ 49.1 N.m (4.0 ~ 5.0 kgf.m, 28.9 ~ 36.2 lb-ft)