Fuel System > General Information > Specifications

Specifications

Fuel Delivery System

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

Sensors

Mass Air Flow Sensor (MAFS)

▷ Type: Hot-film type

▷ Specification

Air Flow (kg/h)	Frequency (Hz)
12.6	2,320
18.0	2,645
23.4	2,903
32.4	3,263
43.2	3,622
57.6	3,986
72.0	4,288
108.0	4,876
144.0	5,380
198.0	5,983
270.0	6,636
360.0	7,286
486.0	8,002
666.0	8,843
900.0	9,699

Intake Air Temperature Sensor (IATS)

▷ Type: Thermistor type

▷ Specification

Temperature		Resistance (kΩ)
°C	°F	
-40	-40	100.87

-20	-4	28.58
0	32	9.40
10	50	5.66
20	68	3.51
40	104	1.47
60	140	0.67
80	176	0.33

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

Pressure (kPa)	Output Voltage (V)
20.0	0.79
46.66	1.84
101.32	4.0

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: Variable resistor type
▷ Specification

Throttle Angle(°)	Output Voltage(V)	
	TPS1	TPS2
0	0.0	5.0
10	0.5	4.5
20	0.9	4.1
30	1.4	3.6
40	1.8	3.2
50	2.3	2.7
60	2.7	2.3

70	3.2	1.8
80	3.6	1.4
90	4.1	0.9
100	4.5	0.5
110	5.0	0.0

Item	Sensor Resistance(kΩ)
TPS1	3.6 ~ 6.0 [20°C(68°F)]
TPS2	2.7 ~ 4.1 [20°C(68°F)]

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

Item	Specification
Coil Resistance (Ω)	630 ~ 770 [25°C(77°F)]
Air Gap (mm)	0.5 ~ 1.5

Camshaft Position Sensor (CMPS)
▷ Type: Hall effect type
▷ Specification

Item	Specification
Output Voltage (V)	High: 5.0
	Low: 0.7
Air Gap (mm)	0.5 ~ 1.5

Knock Sensor (KS)
▷ Type: Piezo-electricity type
▷ Specification

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

Heated Oxygen Sensor (HO2S)
▷ Type: Zirconia (ZrO_2) Type
▷ Specification

A/F Ratio (λ)	Output Voltage(V)
RICH	0.75 ~ 0.92
LEAN	0.04 ~ 0.1

Item	Specification
Heater Resistance (Ω)	8.1 ~ 11.1 [21°C(69.8°F)]

CVVT Oil Temperature Sensor (OTS)

▷ Type: Thermistor type
▷ Specification

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

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

Accelerator Position	Output Voltage (V)	
	APS1	APS2
C.T	0.7 ~ 0.8	0.33 ~ 0.43
W.O.T	3.85 ~ 4.35	1.93 ~ 2.18

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

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

Actuators

Injector
▷ Specification

Item	Specification
Coil Resistance (Ω)	11.6 ~ 12.4 [20°C(68°F)]

ETC Motor [integrated into ETC Module]
▷ Specification

Item	Specification
Coil Resistance (Ω)	1.275 ~ 1.725 [20°C(68°F)]

Purge Control Solenoid Valve (PCSV)
▷ Specification

Item	Specification

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

CVVT Oil Control Valve (OCV)
▷ Specification

Item	Specification
Coil Resistance (Ω)	6.7 ~ 7.7 [20°C(68°F)]

Ignition Coil
▷ Type: Stick type
▷ Specification

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

Canister Close Valve (CCV)
▷ Specification

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

Service Standard

Item		Specification	
Ignition Timing (°)		BTDC 10 ± 5	
Idle Speed (rpm)	A/C OFF	Neutral, N, P-range	600 ± 100
		D-range	600 ± 100
	A/C ON	Neutral, N, P-range	600 ± 100
		D-range	600 ± 100

Tightening Torques

Engine Control System

Item	kgf.m	N.m	lb-ft
ECM bracket installation bolt/nut	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Mass air flow sensor installation bolt	0.4 ~ 0.6	3.9 ~ 5.9	2.9 ~ 4.3
Engine coolant temperature sensor installation	2.0 ~ 4.0	19.6 ~ 39.2	14.5 ~ 28.9
Manifold absolute pressure sensor installation bolt	0.9 ~ 1.2	8.8 ~ 11.8	6.5 ~ 8.7
Crankshaft position sensor installation bolt	0.7 ~ 1.0	6.9 ~ 9.8	5.1 ~ 7.2
Camshaft position sensor (Bank 1 / Intake) installation bolt	0.7 ~ 1.0	6.9 ~ 9.8	5.1 ~ 7.2
Camshaft position sensor (Bank 1 / Exhaust) installation bolt	0.7 ~ 1.0	6.9 ~ 9.8	5.1 ~ 7.2
Camshaft position sensor (Bank 2 / Intake) installation bolt	0.7 ~ 1.0	6.9 ~ 9.8	5.1 ~ 7.2

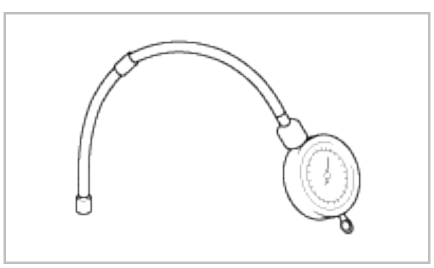
Camshaft position sensor (Bank 2 / Exhaust) installation bolt	0.7 ~ 1.0	6.9 ~ 9.8	5.1 ~ 7.2
Knock sensor #1 (Bank 1) installation bolt	1.6 ~ 2.4	15.7 ~ 23.5	11.6 ~ 17.4
Knock sensor #2 (Bank 2) installation bolt	1.6 ~ 2.4	15.7 ~ 23.5	11.6 ~ 17.4
Heated oxygen sensor (Bank 1 / sensor 1) installation	4.0 ~ 5.0	39.2 ~ 49.1	28.9 ~ 36.2
Heated oxygen sensor (Bank 1 / sensor 2) installation	4.0 ~ 5.0	39.2 ~ 49.1	28.9 ~ 36.2
Heated oxygen sensor (Bank 2 / sensor 1) installation	4.0 ~ 5.0	39.2 ~ 49.1	28.9 ~ 36.2
Heated oxygen sensor (Bank 2 / sensor 2) installation	4.0 ~ 5.0	39.2 ~ 49.1	28.9 ~ 36.2
CVVT oil temperature sensor installation	3.5 ~ 4.5	34.3 ~ 44.1	25.3 ~ 32.6
Electronic throttle body installation bolt	0.9 ~ 1.2	8.8 ~ 11.8	6.5 ~ 8.7
Purge control solenoid valve bracket installation bolt	0.9 ~ 1.2	8.8 ~ 11.8	6.5 ~ 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
CVVT oil control valve (Bank 2 / Intake) installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
CVVT oil control valve (Bank 2 / 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
Ignition coil condenser installation bolt	1.0 ~ 1.2	9.8 ~ 11.8	7.2 ~ 8.7
Fuel tank pressure sensor installation bolt	0.4 ~ 0.6	3.9 ~ 5.9	2.9 ~ 4.3
Canister close valve installation bolt	0.4 ~ 0.6	3.9 ~ 5.9	2.9 ~ 4.3

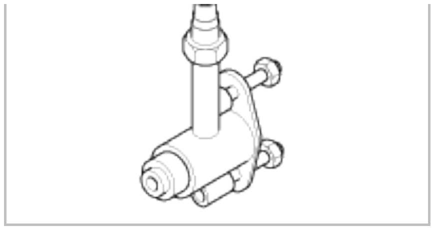
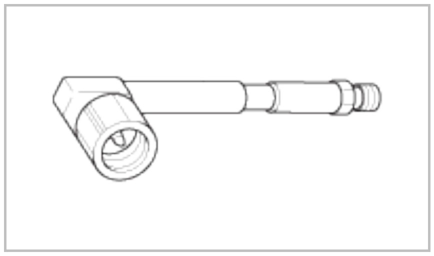
Fuel Delivery System

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

Fuel System > General Information > Special Service Tools

Special Service Tools

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

(09353-38000)		and the fuel feed line
Fuel Pressure Gauge Connector (09353-24000)		Connection between the Fuel Pressure Gauge (09353-24100) and the Fuel Pressure Gauge Adapter (09353-38000)

Fuel System > General Information > Troubleshooting

Basic Troubleshooting

Basic Troubleshooting Guide

1	**Bring Vehicle to Workshop**

2	**Analyze Customer's Problem**
• Ask the customer about the conditions and environment relative to the issue (Use CUSTOMER PROBLEM ANALYSIS SHEET).	

3	**Verify Symptom, and then Check DTC and Freeze Frame Data**
• Connect Hi-Scan (Pro) to Diagnostic Link Connector (DLC). • Record the DTC and freeze frame data. ***NOTE*** *To erase DTC and freeze frame data, refer to Step 5.*	

4	**Confirm the Inspection Procedure for the System or Part**
• Using the SYMPTOM TROUBLESHOOTING GUIDE CHART, choose the correct inspection procedure for the system or part to be checked.	

5	**Erase the DTC and Freeze Frame Data**
WARNING **NEVER erase DTC and freeze frame data before completing Step 2 MIL/DTC in "CUSTOMER PROBLEM ANALYSIS SHEET".**	

6	**Inspect Vehicle Visually**
• Go to Step 11, if you recognize the problem.	

7	**Recreate (Simulate) Symptoms of the DTC**
• Try to recreate or simulate the symptoms and conditions of the malfunction as described by customer. • If DTC(s) is/are displayed, simulate the condition according to troubleshooting procedure for the DTC.	

8	**Confirm Symptoms of Problem**
• If DTC(s) is/are not displayed, go to Step 9. • If DTC(s) is/are displayed, go to Step 11.	

9	**Recreate (Simulate) Symptom**
• Try to recreate or simulate the condition of the malfunction as described by the customer.	

10	**Check the DTC**
• If DTC(s) does(do) not occur, refer to INTERMITTENT PROBLEM PROCEDURE in BASIC INSPECTION PROCEDURE. • If DTC(s) occur(s), go to Step 11.	

11	**Perform troubleshooting procedure for DTC**
12	**Adjust or repair the vehicle**
13	**Confirmation test**
14	**END**

Customer Problem Analysis Sheet

1. VEHICLE INFORMAITON

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

2. SYMPTOMS

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

3. ENVIRONMENT

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

4. MIL/DTC

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

5. ECM/PCM INFORMATION

ECM/PCM Part No.	
ROM ID	

Basic Inspection Procedure

Measuring Condition of Electronic Parts' Resistance

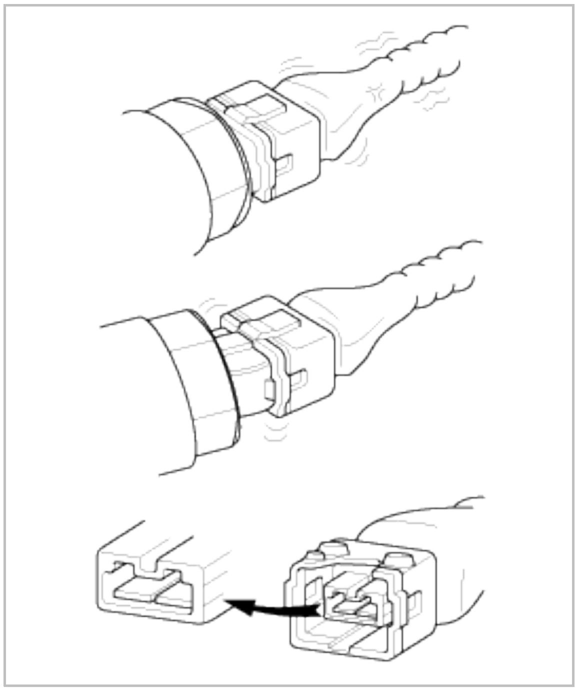
The measured resistance at high temperature after vehicle running may be high or low. So all resistance must be measured at ambient temperature (20°C, 68°F), unless stated otherwise.

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

Intermittent Problem Inspection Procedure

Sometimes the most difficult case in troubleshooting is when a problem symptom occurs but does not occur again during testing. An example would be if a problem appears only when the vehicle is cold but has not appeared when warm. In this case, the technician should thoroughly make out a "Customer Problem Analysis Sheet" and recreate (simulate) the environment and condition which occurred when the vehicle was having the issue.

1. Clear Diagnostic Trouble Code (DTC).
2. Inspect connector connection, and check terminal for poor connections, loose wires, bent, broken or corroded pins, and then verify that the connectors are always securely fastened.



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

● Simulating Vibration

1) Sensors and Actuators

: Slightly vibrate sensors, actuators or relays with finger.

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

2) Connectors and Harness

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

● Simulating Heat

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

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

● Simulating Water Sprinkling

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

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

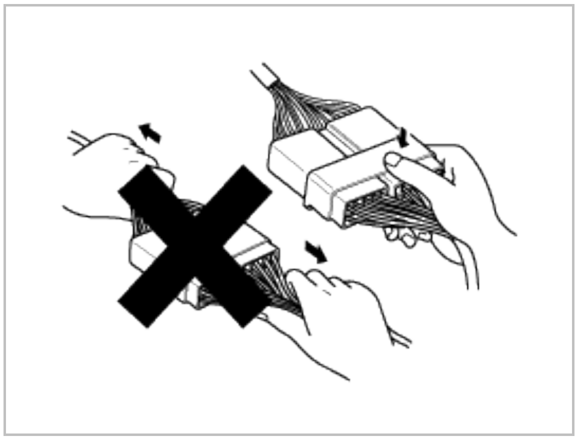
● Simulating Electrical Load

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

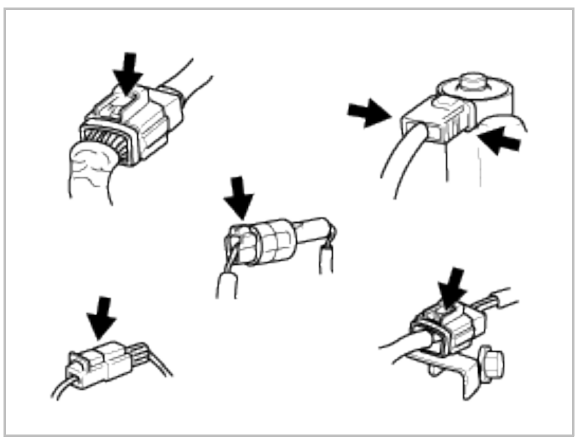
Connector Inspection Procedure

1. Handling of Connector

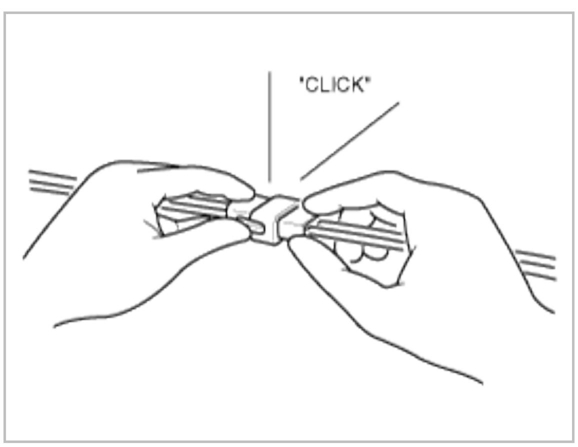
A. Never pull on the wiring harness when disconnecting connectors.



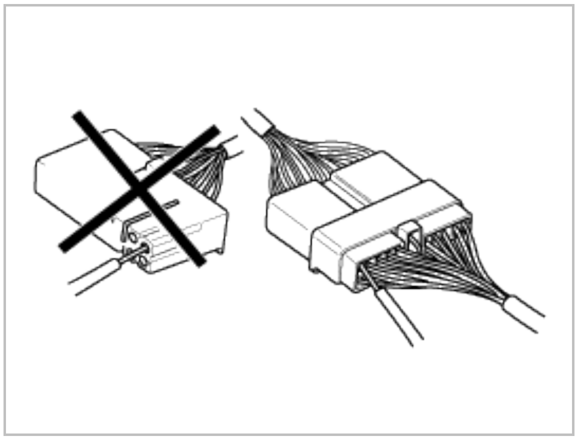
B. When removing the connector with a lock, press or pull locking lever.



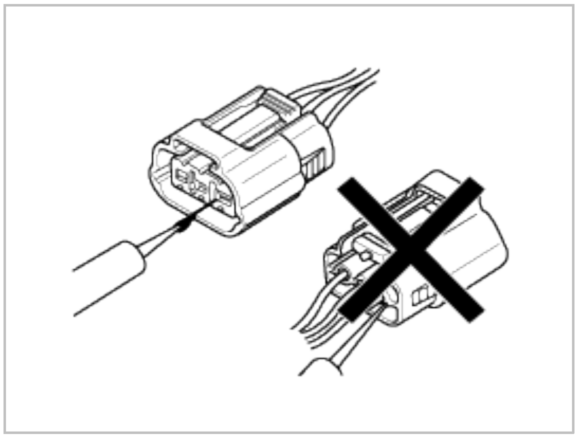
C. Listen for a click when locking connectors. This sound indicates that they are securely locked.



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

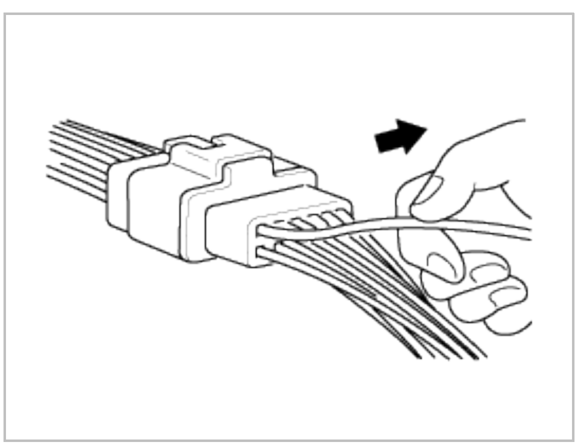


E. Check waterproof connector terminals from the connector side. Waterproof connectors cannot be accessed from harness side.



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

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



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

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

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

Wire Harness Inspection Procedure

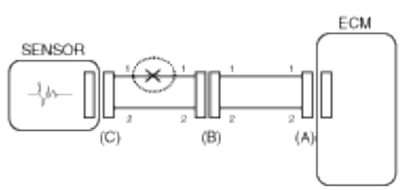
1. Before removing the wire harness, check the wire harness position and crimping in order to restore it correctly.
2. Check whether the wire harness is twisted, pulled or loosened.
3. Check whether the temperature of the wire harness is abnormally high.
4. Check whether the wire harness is rotating,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

Electrical Circuit Inspection Procedure

● Check Open Circuit

1. Procedures for Open Circuit
    A. Continuity Check
    B. Voltage Check
    If an open circuit occurs (as seen in [FIG. 1]), it can be found by performing Step 2 (Continuity Check Method) or Step 3 (Voltage Check Method) as shown below.

FIG 1

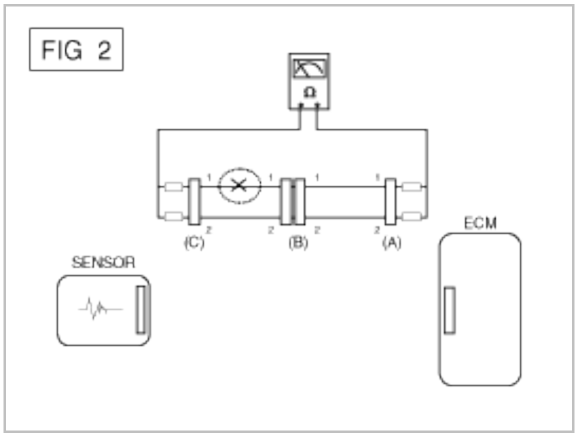


2. Continuity Check Method

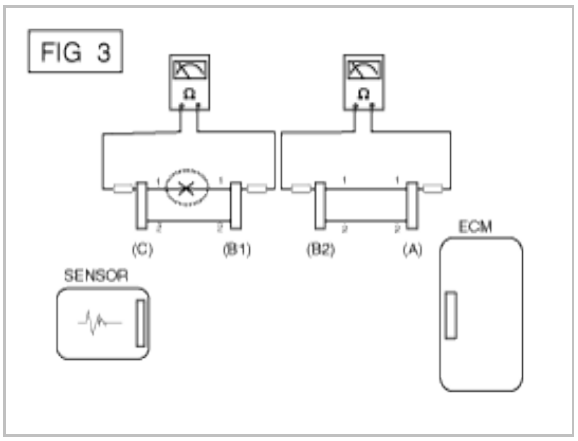
> **NOTE**
>
> When measuring for resistance, lightly shake the wire harness above and below or from side to side.

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

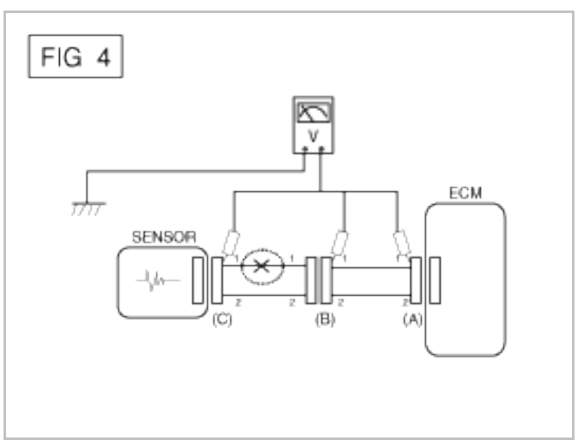
    A. Disconnect connectors (A), (C) and measure resistance between connector (A) and (C) as shown in [FIG. 2]. In [FIG.2.] the measured resistance of line 1 and 2 is higher than 1MΩ and below 1 Ω respectively. Specifically the open circuit is line 1 (Line 2 is normal). To find exact break point, check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



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



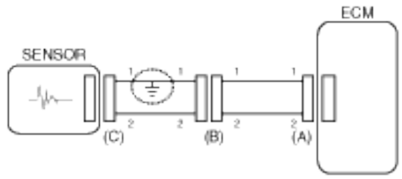
3. Voltage Check Method
   A. With each connector still connected, measure the voltage between the chassis ground and terminal 1 of each connectors (A), (B) and (C) as shown in [FIG. 4].
   The measured voltage of each connector is 5V, 5V and 0V respectively. So the open circuit is between connector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



● Check Short Circuit

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

FIG 5



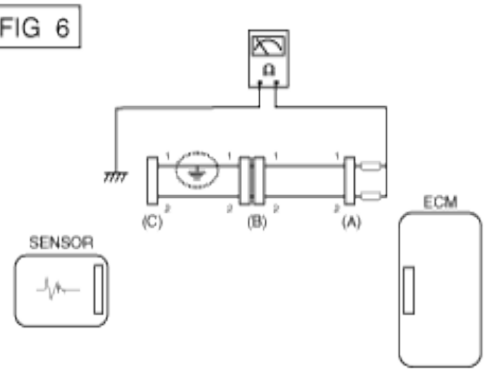
2. Continuity Check Method (with Chassis Ground)

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

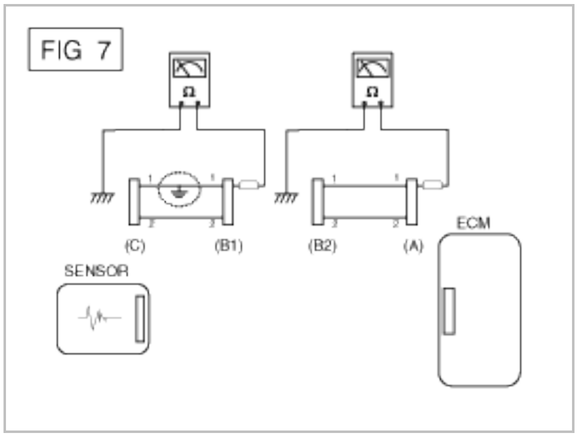
Specification (Resistance)
1Ω or less → Short to Ground Circuit
1MΩ or Higher → Normal Circuit

A. Disconnect connectors (A), (C) and measure for resistance between connector (A) and Chassis Ground as shown in [FIG. 6].
The measured resistance of line 1 and 2 in this example is below 1 Ω and higher than 1MΩ respectively.
Specifically the short to ground circuit is line 1 (Line 2 is normal). To find exact broken point, check the sub line of line 1 as described in the following step.

FIG 6



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



Symptom Troubleshooting Guide Chart

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

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

Fuel System > Engine Control System > Description and Operation

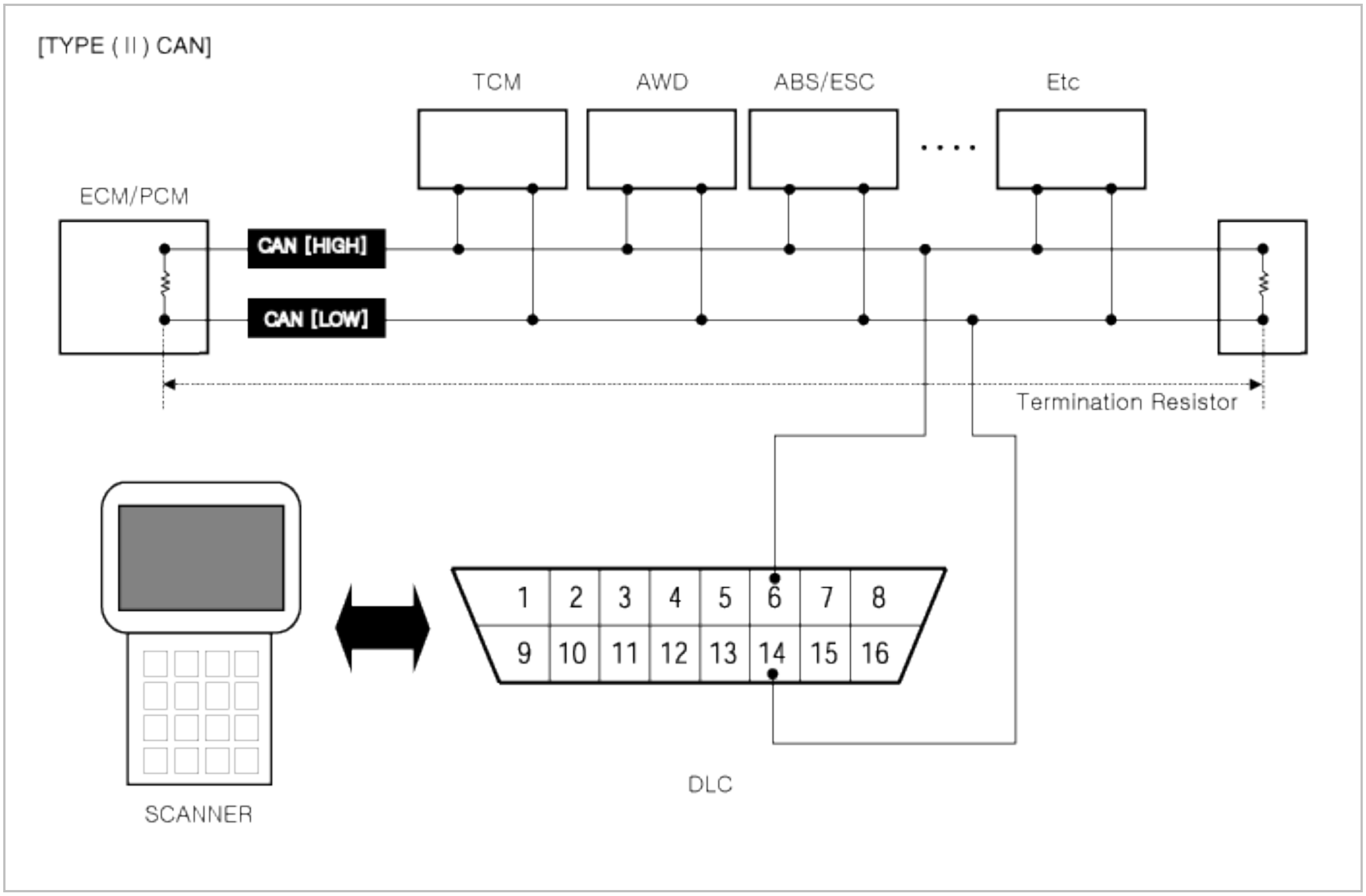
OBD-II review

1. Overview

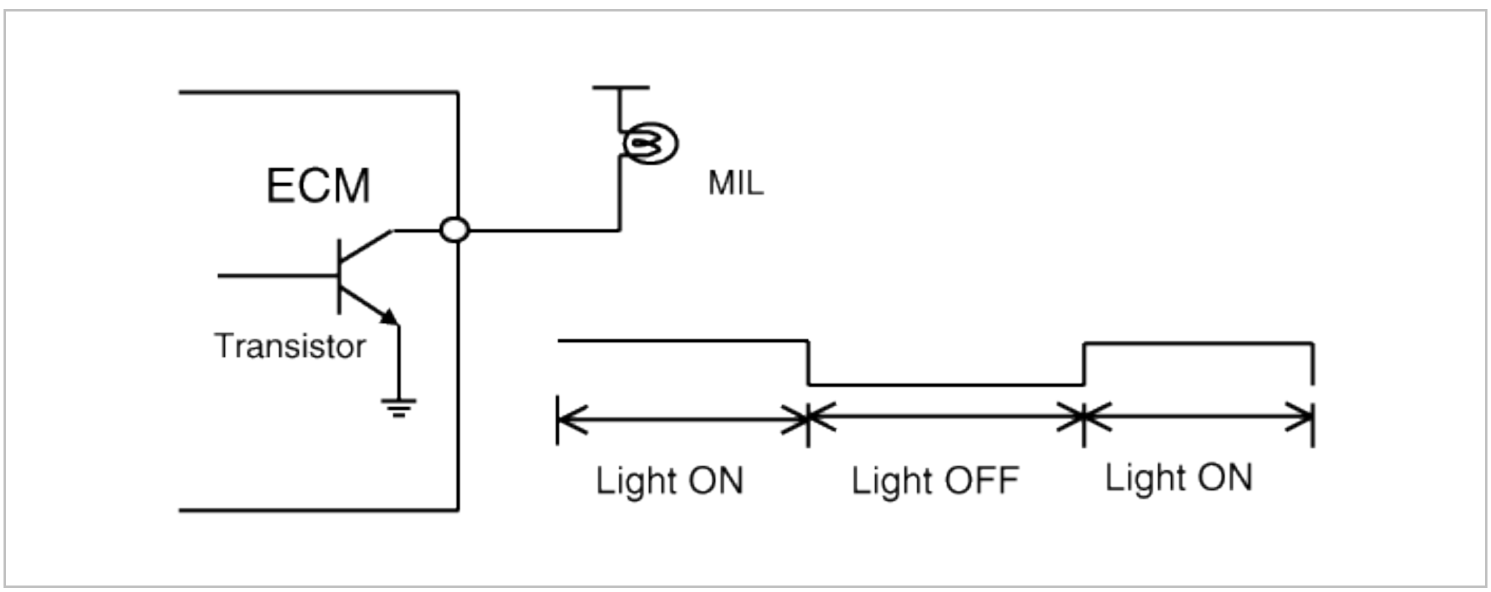
The California Air Resources Board (CARB) began regulation of On Board Diagnostics (OBD) for vehicles sold in california beginning with the 1988 model year. The first phase, OBD-I, required monitoring of the fuel metering system, Exhust Gas Recirculation (EGR) system and additional emission related components. 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 PowertrainControl 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.

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 from engine starting and reaches a minimum temperature of at least 160 degrees Fahrenheit.

9) Trip cycle

A trip means vehicle operation (following an engine-off period) of duration and driving mode such that all components and systems are monitored at least once by the diagnostic system except catalyst efficiency or evaporative system monitoring when a steady-speed check is used, subject to the limitation that the manufacturer-defined trip monitoring conditions shall all be encountered at least once during the first engine start portion of the applicable FTP cycle.

10) 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.

11) 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

3. OBD-II system readiness tests

1) Catalyst monitoring

The catalyst efficiency monitor is a self-test strategy within the ECM or PCM that uses the downstream Heated Oxygen Sensor (HO2S) to determine when a catalyst has fallen below the minimum level of effectiveness in its ability to control exhaust emission.

2) Misfire monitoring

Misfire is defined as the lack of proper combustion in the cylinder due to the absence of spark, poor fuel metering, or poor compression. Any combustion that does not occur within the cylinder at the proper time is also a misfire. The misfire detection monitor detects fuel, ignition or mechanically induced misfires. The intent is to protect the catalyst from permanent damage and to alert the customer of an emission failure or an inspection maintenance failure by illuminating the MIL . When a misfire is detected, special software called freeze frame data is enabled. The freeze frame data captures the operational state of the vehicle when a fault is detected from misfire detection monitor strategy.

3) Fuel system monitoring

The fuel system monitor is a self-test strategy within the ECM or PCM that monitors the adaptive fuel table The fuel control system uses the adaptive fuel table to compensate for normal variability of the fuel system components caused by wear or aging. During normal vehicle operation, if the fuel system appears biased lean or rich, the adaptive value table will shift the fuel delivery calculations to remove bias.

4) Engine cooling system monitoring

The cooling system monitoring is a self-test strategy within the ECM or PCM that monitors ECTS (Engine Coolant Temperature Sensor) and thermostat about circuit continuity, output range, rationality faults.

5) O2 sensor monitoring

OBD-II regulations require monitoring of the upstream Heated O2 Sensor (H2OS) to detect if the deterioration of the sensor has exceeded thresholds. An additional HO2S is located downstream of the Warm-Up Three Way Catalytic Converter (WU-TWC) to determine the efficiency of the catalyst.
Although the downstream H2OS is similar to the type used for fuel control, it functions differently. The downstream HO2S is monitored to determine if a voltage is generated. That voltage is compared to a calibrated acceptable range.

6) Evaporative emission system monitoring

The EVAP. monitoring is a self-test strategy within the ECM or PCM that tests the integrity of the EVAP. system. The complete evaporative system detects a leak or leaks that cumulatively are greater than or equal to a leak caused by a 0.040 inch and 0.020 inch diameter orifice.

7) Air conditioning system monitoring

The A/C system monitoring is a self-test strategy within the ECM or PCM that monitors malfunction of all A/C system components at A/C ON.

8) Comprehensive components monitoring

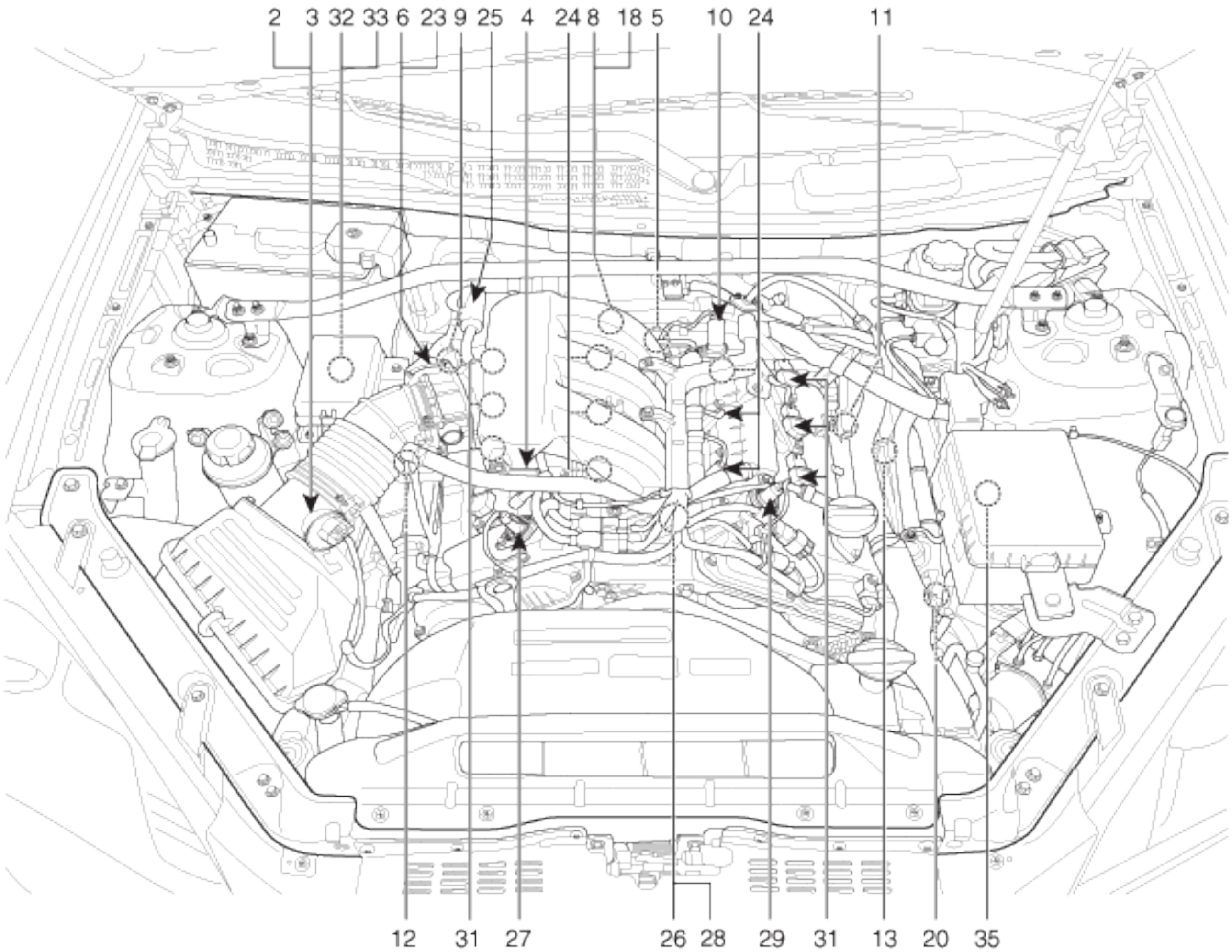
The comprehensive components monitoring is a self-test strategy within the ECM or PCM that detects fault of any electronic powertrain components or system that provides input to the ECM or PCM and is not exclusively an input to any other OBD-II monitor.

9) A/C system component monitoring

Requirement:
If a vehicle incorporates an engine control strategy that alters off idle fuel and/or spark control when the A/C system is on, the OBD II system shall monitor all electronic air conditioning system components for malfunctions that cause the system to fail to invoke the alternate control while the A/C system is on or cause the system to invoke the alternate control while the A/C system is off.
Additionally, the OBD II system shall monitor for malfunction all electronic air conditioning system components that are used as part of the diagnostic strategy for any other monitored system or component.
Implementation plan:
No engine control strategy incorporated that alters offidle fuel and/or spark control when A/C system is on. Malfuction of A/C system components is not used as a part of the diagnostic strategy for other monitored system or component.

Fuel System > Engine Control System > Components and Components Location

Components Location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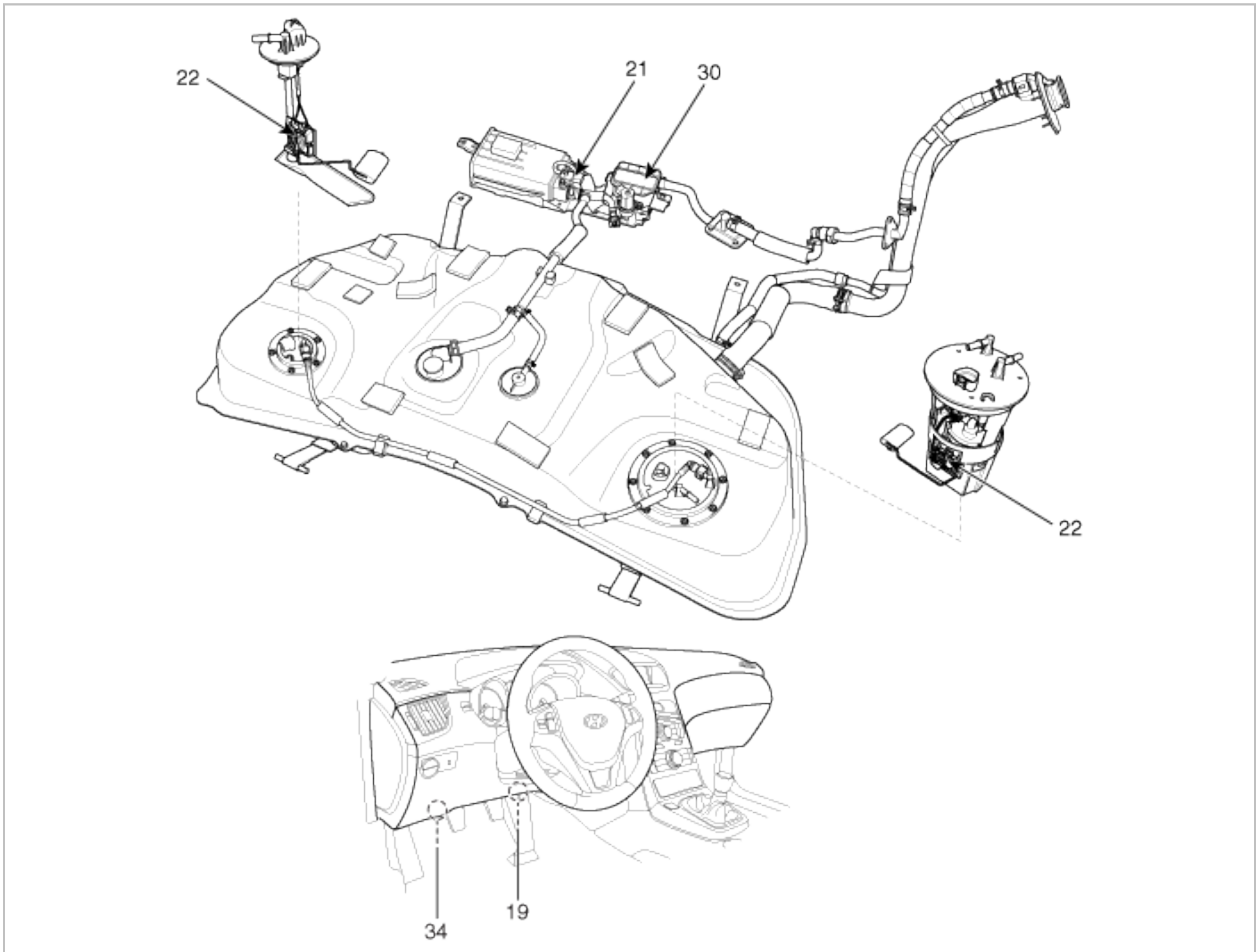
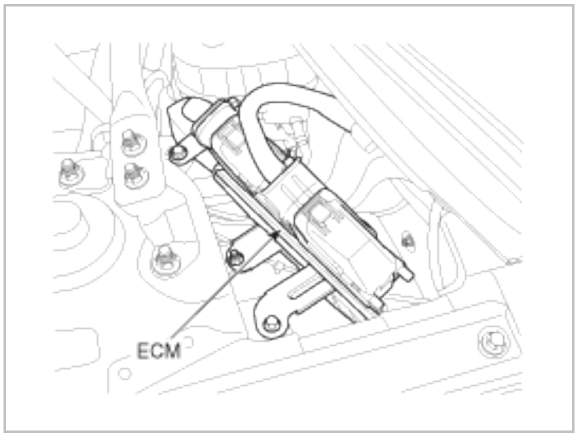
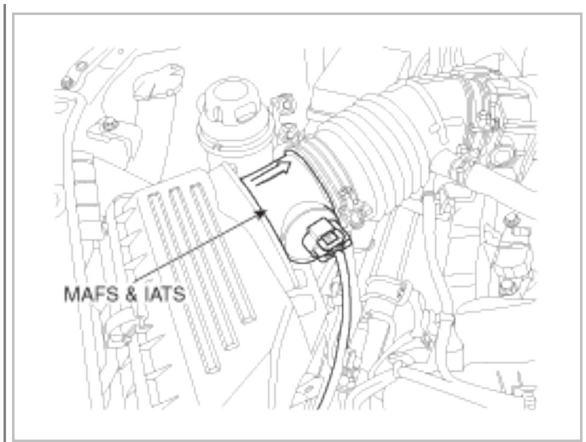
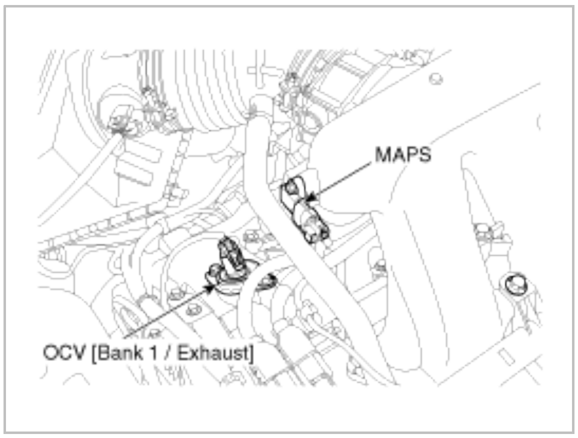
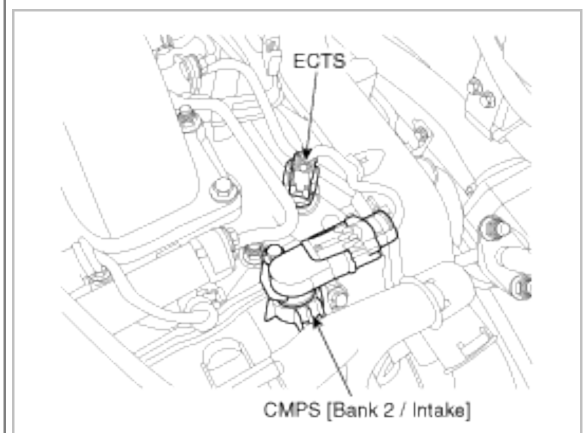
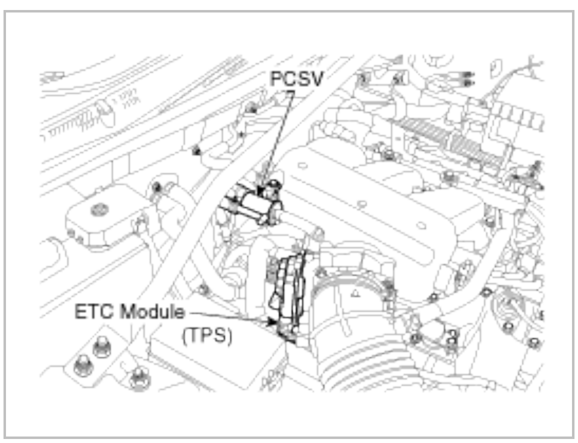


1. ECM (Engine Control Module) 2. Mass Air Flow Sensor (MAFS) 3. Intake Air Temperature Sensor (IATS) 4. Manifold Absolute Pressure Sensor (MAPS) 5. Engine Coolant Temperature Sensor (ECTS) 6. Throttle Position Sensor (TPS) [integrated into ETC Module] 7. Crankshaft Position Sensor (CKPS) 8. Camshaft Position Sensor (CMPS) [Bank 1 / Intake] 9. Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust] 10. Camshaft Position Sensor (CMPS) [Bank 2 / Intake] 11. Camshaft Position Sensor (CMPS) [Bank 2 / Exhaust] 12. Knock Sensor (KS) [Bank 1] 13. Knock Sensor (KS) [Bank 2] 14. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 1] 15. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 2] 16. Heated Oxygen Sensor (HO2S) [Bank 2 / Sensor 1] 17. Heated Oxygen Sensor (HO2S) [Bank 2 / Sensor 2] 18. CVVT Oil Temperature Sensor (OTS)	19. Accelerator Position Sensor (APS) 20. A/C Pressure Transducer (APT) 21. Fuel Tank Pressure Sensor (FTPS) 22. Fuel Level Sensor (FLS) 23. ETC Motor [integrated into ETC Module] 24. Injector 25. Purge Control Solenoid Valve (PCSV) 26. CVVT Oil Control Valve (OCV) [Bank 1 / Intake] 27. CVVT Oil Control Valve (OCV) [Bank 1 / Exhaust] 28. CVVT Oil Control Valve (OCV) [Bank 2 / Intake] 29. CVVT Oil Control Valve (OCV) [Bank 2 / Exhaust] 30. Canister Close Valve (CCV) 31. Ignition Coil 32. Main Relay 33. Fuel Pump Relay 34. Data Link Connector (DLC) [16 Pin] 35. Multi-Purpose Check Connector [20 Pin]

1. ECM (Engine Control Module)	2. Mass Air Flow Sensor (MAFS) 3. Intake Air Temperature Sensor (IATS)

	
4. Manifold Absolute Pressure Sensor (MAPS) 27. CVVT Oil Control Valve (OCV) [Bank 1 / Exhaust]	5. Engine Coolant Temperature Sensor (ECTS) 10. Camshaft Position Sensor (CMPS) [Bank 2 / Intake]
	
6. Throttle Position Sensor (TPS) [integrated into ETC Module] 23. ETC Motor [integrated into ETC Module] 25. Purge Control Solenoid Valve (PCSV)	7. Crankshaft Position Sensor (CKPS)
	
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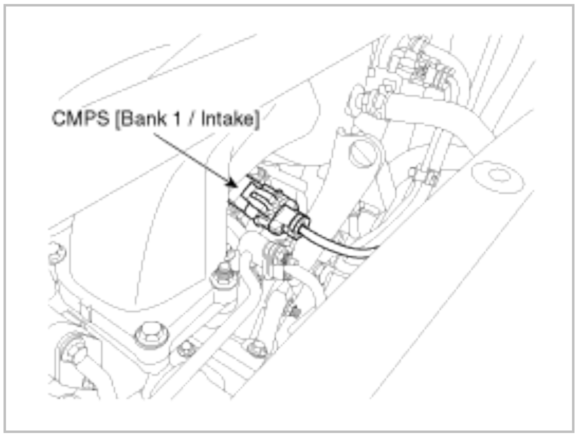
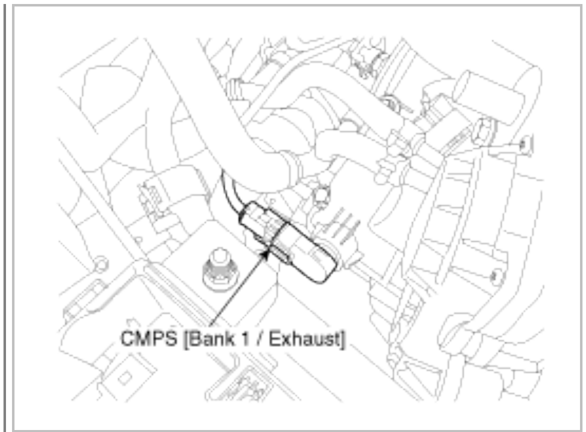
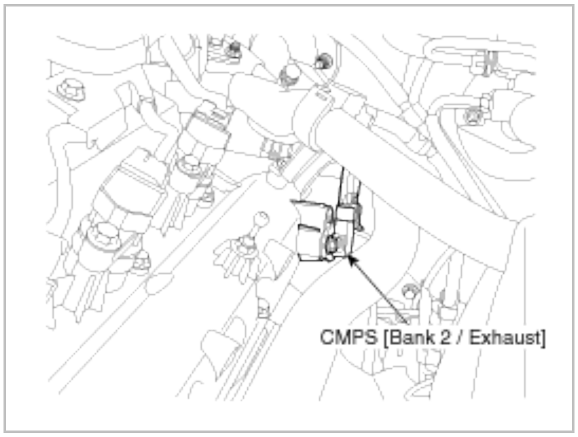
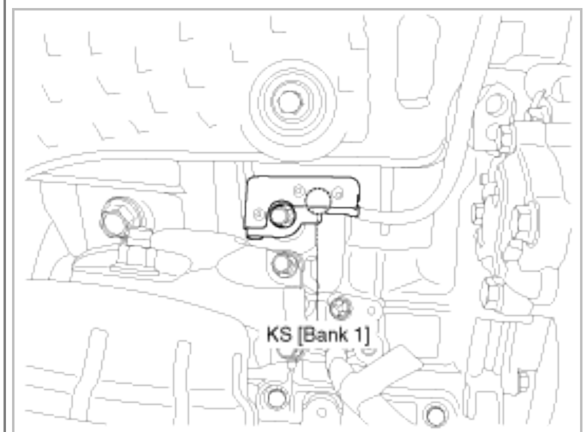
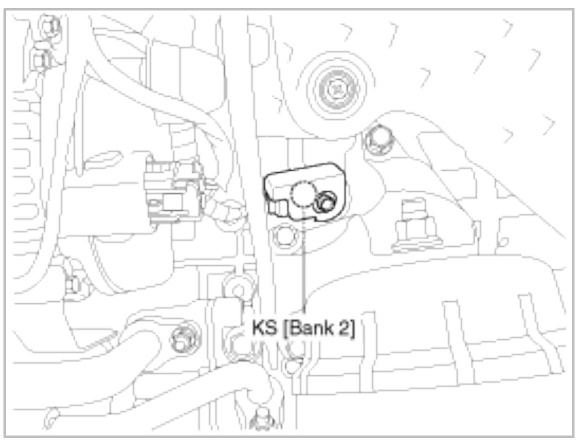
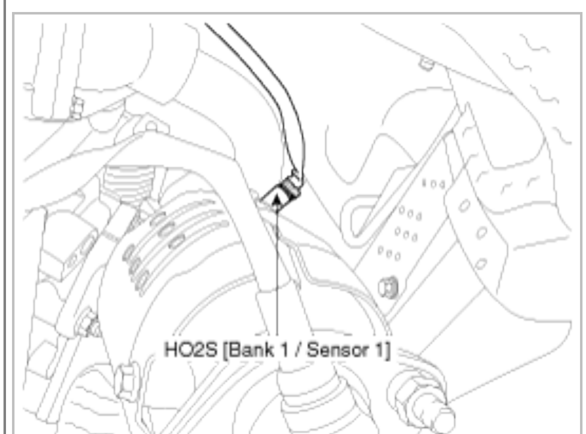
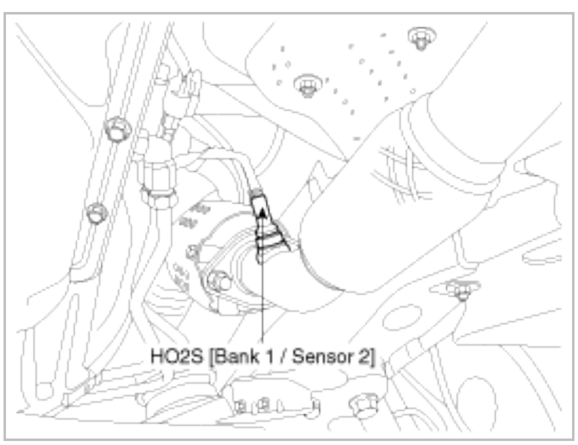
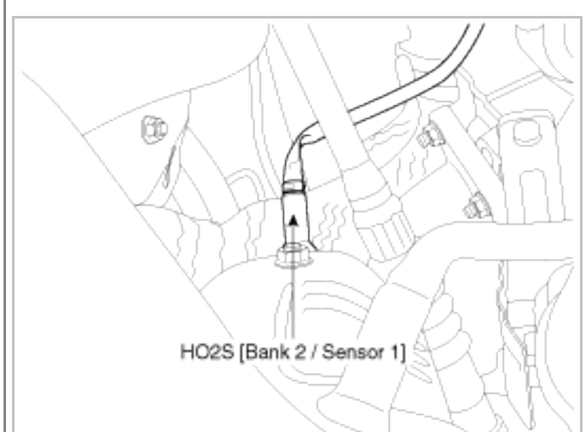
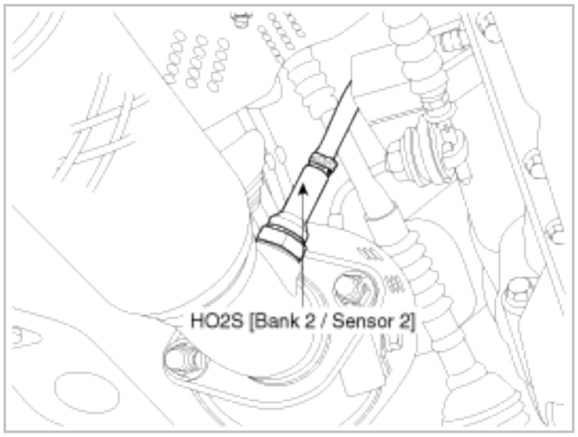
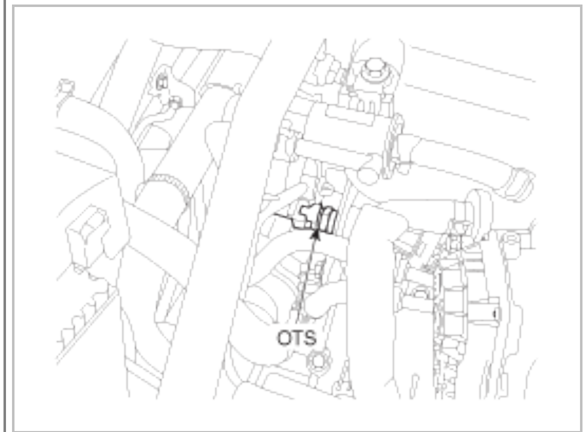
	
11. Camshaft Position Sensor (CMPS) [Bank 2 / Exhaust]	12. Knock Sensor (KS) [Bank 1]
	
13. Knock Sensor (KS) [Bank 2]	14. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 1]
	
15. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 2]	16. Heated Oxygen Sensor (HO2S) [Bank 2 / Sensor 1]
	

17. Heated Oxygen Sensor (HO2S) [Bank 2 / Sensor 2]	18. CVVT Oil Temperature Sensor (OTS)
	
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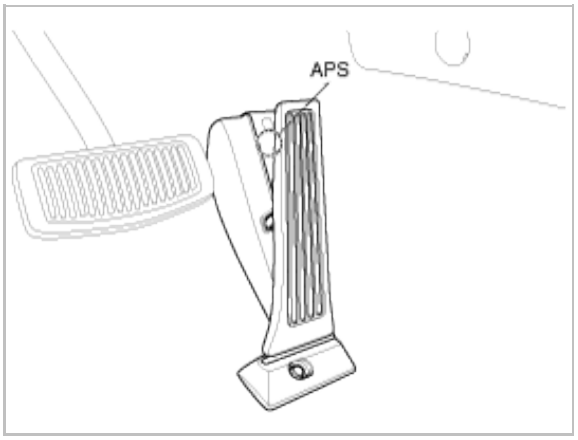
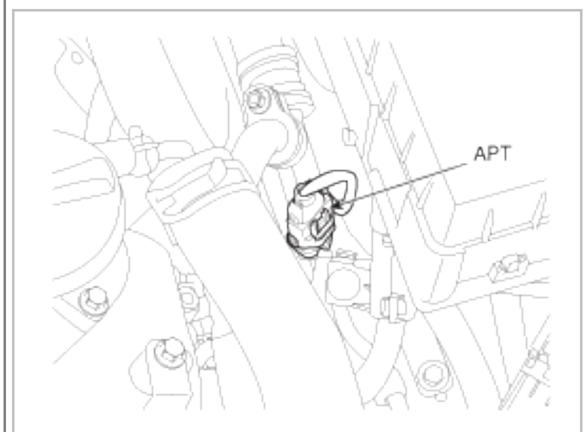
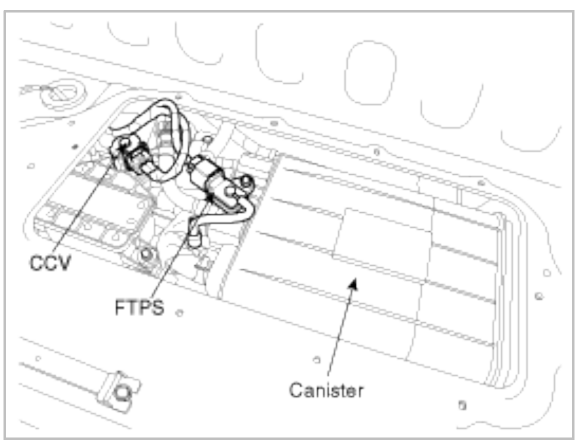
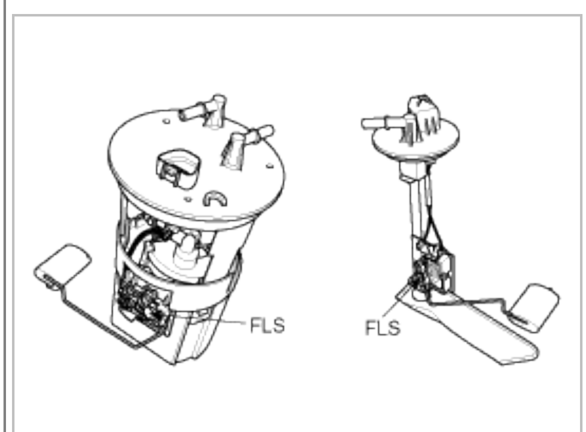
	
21. Fuel Tank Pressure Sensor (FTPS) 30. Canister Close Valve (CCV)	22. Fuel Level Sensor (FLS)
	
24. Injector 31. Ignition Coil	26. CVVT Oil Control Valve (OCV) [Bank 1 / Intake] 28. CVVT Oil Control Valve (OCV) [Bank 2 / Intake]

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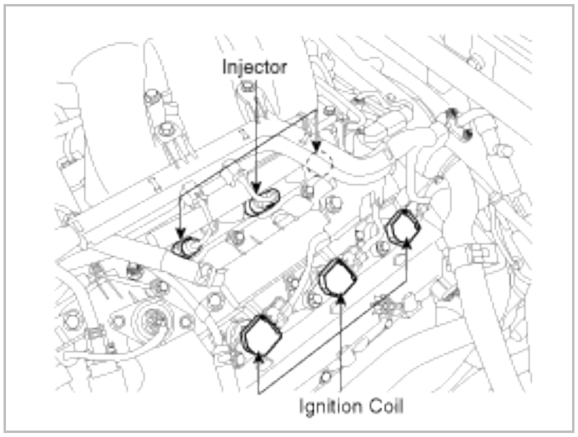
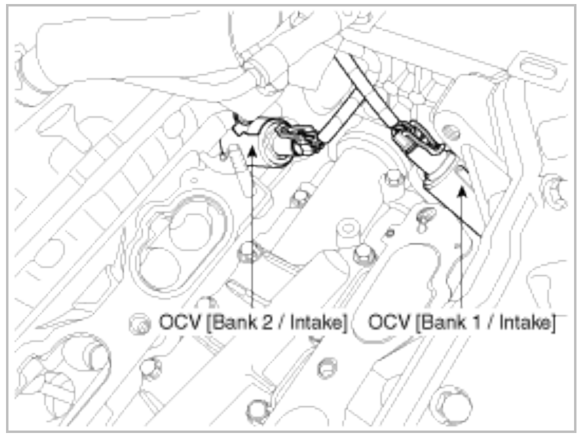
<tr><td>
</td><td>
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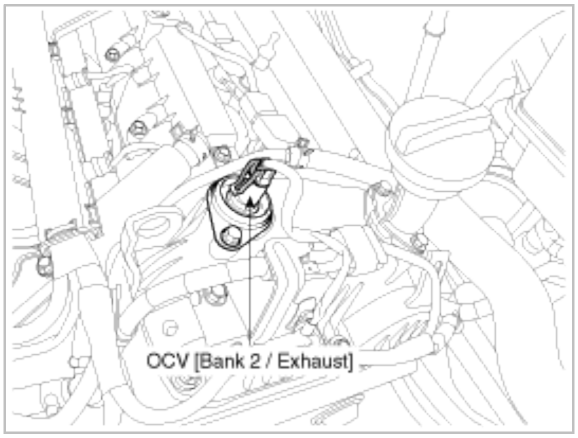
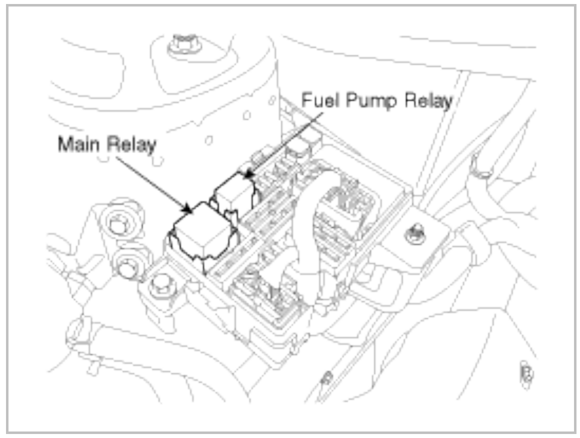
<tr><td>29. CVVT Oil Control Valve (OCV) [Bank 2 / Exhaust]</td><td>32. Main Relay
33. Fuel Pump Relay</td></tr>
<tr><td>
</td><td>
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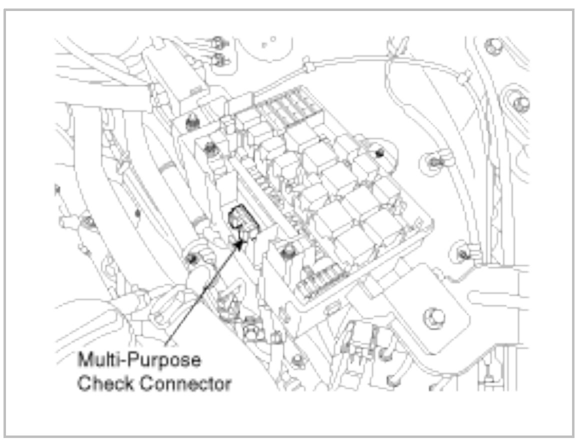
<tr><td>35. Multi-Purpose Check Connector [20 Pin]</td><td></td></tr>
<tr><td>
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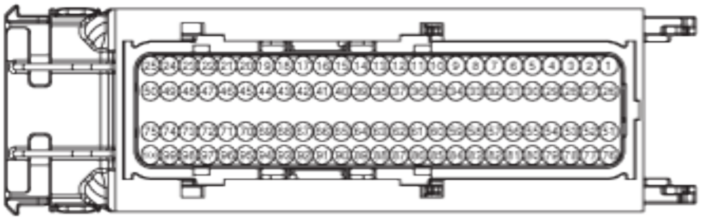
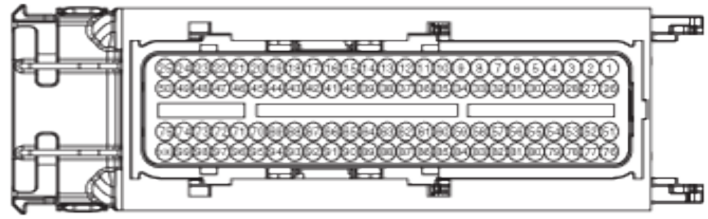
Fuel System > Engine Control System > Engine Control Module (ECM) > Specifications

ECM Terminal And Input/Output signal

ECM Harness Connector



ELG-A



CLG-B

ECM Terminal Function

Connector [ELG-A]

Pin No.	Description	Connected to
1	-	
2	-	
3	-	
4	Immobilizer lamp control output	Immobilizer lamp
5	Power ground	Chassis ground
6	Power ground	Chassis ground
7	-	
8	-	
9	CAN 2 [High]	Multi-purpose check connector
10	CAN 1 [High]	Other control module
11	Fuel Tank Pressure Sensor (FTPS) signal input	Fuel Tank Pressure Sensor (FTPS)
12	-	
13	-	
14	Sensor ground	Accelerator Position Sensor(APS) 1
15	Sensor ground	A/C Pressure Transducer(APT)
16	Fuel Level Sensor (FLS) 1 signal input	Fuel Level Sensor (FLS)
17	Power Steering Pressure Switch signal input	Power Steering Pressure Switch
18	Clutch Switch signal input	Clutch Switch
19	-	
20	A/C Thermal switch signal input	A/C Thermal switch
21	Brake pedal switch signal input	Brake pedal switch
22	-	
23	-	
24	Alternator FR signal input	Alternator
25	Malfunction Indicator Lamp(MIL)control output	Malfunction Indicator Lamp(MIL)
26	-	
27	Battery power(B+)	Ignition switch
28	-	
29	-	

30	Power ground	Chassis ground
31	-	
32	-	
33	-	
34	CAN 2 [Low]	Multi-purpose check connector
35	CAN 1 [Low]	Other control module
36	-	
37	-	
38	Accelerator Position Sensor(APS) 1 signal input	Accelerator Position Sensor(APS) 1
39	-	
40	-	
41	Fuel Level Sensor (FLS) 2 signal input	Fuel Level Sensor (FLS)
42	A/C Request switch signal input	A/C Request switch
43	Brake lamp switch signal input	Brake lamp switch
44	-	
45	-	
46	-	
47	-	
48	-	
49	-	
50	-	
51	-	
52	Battery power(B+)	Battery
53	-	
54	-	
55	Power ground	Chassis ground
56	-	
57	Fuel pump relay control output	Fuel pump relay
58	-	
59	Sensor ground	Accelerator Position Sensor(APS) 2
60	Sensor ground	Accelerator Position Sensor(APS) 1
61	Sensor ground	Fuel Tank Pressure Sensor (FTPS)
62	-	
63	Sensor ground	A/C Pressure Transducer(APT)
64	-	
65	Sensor power(+5V)	Fuel Tank Pressure Sensor (FTPS)
66	-	
67	A/C Pressure Transducer(APT) signal input	A/C Pressure Transducer(APT)

68	Accelerator Position Sensor(APS) 2 signal input	Accelerator Position Sensor(APS) 2
69	-	
70	Engine speed signal output	
71	Cooling fan control output signal(PWM) output [High]	Cooling fan control output module
72	-	
73	-	
74	Immobilizer communication line	Immobilizer control unit [Without Immobilizer]
		Instrument panel module [With Immobilizer]
75	Main relay control output	Main relay
76	-	
77	Battery power(B+)	Battery
78	-	
79	-	
80	Power ground	Chassis ground
81	-	
82	-	
83	-	
84	-	
85	-	
86	-	
87	-	
88	-	
89	-	
90	Sensor power(+5V)	Accelerator Position Sensor(APS) 2
91	Cooling fan control output signal output [Low]	Cooling fan control output module
92	-	
93	Start Motor relay control output	Start Motor relay
94	Main relay control output	Main relay
95	A/C Compressor relay control output	A/C Compressor relay
96	Canister Close Valve (CCV) control output	Canister Close Valve (CCV)
97	-	
98	-	
99	Main relay control output	Main relay
100	Main relay control output	Main relay

Connector [CLG-B]

Pin No.	Description	Connected to
1	-	

2	-	
3	-	
4	-	
5	Sensor power(+5V)	Camshaft Position Sensor(CMPS) [Bank1/Intake]
		Camshaft Position Sensor(CMPS) [Bank2/Exhaust]
6	Sensor power(+5V)	Throttle Position Sensor(TPS) 1
7	Throttle Position Sensor(TPS) PWM output	ECS/EPS
8	Crank Request	Power distribution module (PDM)
9	-	
10	CVVT Oil Temperature Sensor(OTS) signal input	CVVTOil Temperature Sensor(OTS)
11	-	
12	Throttle Position Sensor(TPS) 1 signal input	Throttle Position Sensor(TPS) 1
13	Manifold Absolute Pressure Sensor(MAPS) signal input	Manifold Absolute Pressure Sensor(MAPS)
14	Intake Temperature Sensor(IATS) signal input	Intake Temperature Sensor(IATS)
15	Vehicle speed signal input	VDC control unit
16	Knock Sensor(KS) [Bank2] signal input	Knock Sensor(KS) [Bank2]
17	Knock Sensor(KS) [Bank1] signal input	Knock Sensor(KS) [Bank1]
18	Crankshaft Position Sensor(CKPS) [High] signal input	Crankshaft Position Sensor(CKPS)
19	Sensor ground	CVVTOil Temperature Sensor(OTS)
20	-	
21	Camshaft Position Sensor(CMPS) [Bank2/Intake] signal input	Camshaft Position Sensor(CMPS) [Bank2/Intake]
22	-	
23	Sensor power(+5V)	Throttle Position Sensor(TPS) 2
24	Ignition coil(Cylinder#1) control output	Ignition coil(Cylinder#1)
25	-	
26	-	
27	-	
28	-	
29	-	
30	Mass Air Flow Sensor(MAFS) signal input	Mass Air Flow Sensor(MAFS)
31	Sensor ground	Throttle Position Sensor(TPS) 1
32	Sensor ground	Camshaft Position Sensor(CMPS) [Bank1/Intake]
		Camshaft Position Sensor(CMPS) [Bank2/Exhaust]
33	Heated Oxygen Sensor(HO2S) [Bank2/Sensor2] signal input	Heated Oxygen Sensor(HO2S) [Bank2/Sensor2]
34	Throttle Position Sensor(TPS) 2 signal input	Throttle Position Sensor(TPS) 2
35	Engine Coolant Temperature Sensor(ECTS) signal	Engine Coolant Temperature Sensor(ECTS)

35	input	Engine Coolant Temperature Sensor(ECTS)
36	-	
37	-	
38	Heated Oxygen Sensor(HO2S) [Bank1/Sensor1] signal input	Heated Oxygen Sensor(HO2S) [Bank1/Sensor1]
39	Heated Oxygen Sensor(HO2S) [Bank1/Sensor2] signal input	Heated Oxygen Sensor(HO2S) [Bank1/Sensor2]
40	Sensor shield	Knock Sensor(KS) #1 [Bank1] Knock Sensor(KS) #2 [Bank2]
41	Sensor ground	Knock Sensor(KS) [Bank2]
42	Sensor ground	Knock Sensor(KS) [Bank1]
43	Sensor ground	Crankshaft Position Sensor(CKPS)
44	Sensor ground	
45	Sensor ground	Throttle Position Sensor(TPS) 2
46	Camshaft Position Sensor(CMPS) [Bank2/Exhaust] signal input	Camshaft Position Sensor(CMPS) [Bank2/Exhaust]
47	-	
48	Sensor power(+5V)	Manifold Absolute Pressure Sensor(MAPS)
49	Ignition coil(Cylinder#3) control output	Ignition coil(Cylinder#3)
50	-	
51	-	
52	-	
53	-	
54	-	
55	-	
56	Sensor ground	Manifold Absolute Pressure Sensor(MAPS)
57	-	
58	Heated Oxygen Sensor(HO2S) [Bank2/Sensor2] signal input	Heated Oxygen Sensor(HO2S) [Bank1/Sensor1]
59	Heated Oxygen Sensor(HO2S) [Bank1/Sensor2] signal input	Heated Oxygen Sensor(HO2S) [Bank1/Sensor2]
60	Sensor ground	Heated Oxygen Sensor(HO2S) [Bank1/Sensor2]
61	-	
62	-	
63	Heated Oxygen Sensor(HO2S) [Bank2/Sensor1] signal input	Heated Oxygen Sensor(HO2S) [Bank2/Sensor1]
64	Sensor ground	Heated Oxygen Sensor(HO2S) [Bank2/Sensor1]
65	-	
66	Purge Control Solenid Valve(PCSV) control output	Purge Control Solenid Valve(PCSV)
67	-	

68	-	
69	-	
70	Camshaft Position Sensor(CMPS) [Bank1/Exhaust] signal input	Camshaft Position Sensor(CMPS) [Bank1/Exhaust]
71	Camshaft Position Sensor(CMPS) [Bank1/Intake] signal input	Camshaft Position Sensor(CMPS) [Bank1/Intake]
72	-	
73	Sensor power(+5V)	Camshaft Position Sensor(CMPS) [Bank1/Exhaust] Camshaft Position Sensor(CMPS) [Bank2/Intake]
74	Ignition coil(Cylinder#5) control output	Ignition coil(Cylinder#5)
75	-	
76	-	
77	-	
78	-	
79	-	
80	ETC Motor[High] control output	ETC Motor
81	ETC Motor[Low] control output	ETC Motor
82	Heated Oxygen Sensor(HO2S) [Bank1/Sensor2] heater control output	Heated Oxygen Sensor(HO2S) [Bank1/Sensor2]
83	Heated Oxygen Sensor(HO2S) [Bank2/Sensor2] heater control output	Heated Oxygen Sensor(HO2S) [Bank2/Sensor2]
84	-	
85	Injector(Cylinder#2) control output	Injector(Cylinder#2)
86	Injector(Cylinder#5) control output	Injector(Cylinder#5)
87	Injector(Cylinder#3) control output	Injector(Cylinder#3)
88	Injector(Cylinder#6) control output	Injector(Cylinder#6)
89	Injector(Cylinder#4) control output	Injector(Cylinder#4)
90	Injector(Cylinder#1) control output	Injector(Cylinder#1)
91	Heated Oxygen Sensor(HO2S) [Bank1/Sensor1] heater control output	Heated Oxygen Sensor(HO2S) [Bank1/Sensor1]
92	Heated Oxygen Sensor(HO2S) [Bank2/Sensor1] heater control output	Heated Oxygen Sensor(HO2S) [Bank2/Sensor1]
93	CVVT Oil Control Valve(OCV) [Bank2/Exhaust] control output	CVVT Oil Control Valve(OCV) [Bank2/Exhaust]
94	CVVT Oil Control Valve(OCV) [Bank1/Exhaust] control output	CVVT Oil Control Valve(OCV) [Bank1/Exhaust]
95	CVVT Oil Control Valve(OCV) [Bank2/Intake] control output	CVVT Oil Control Valve(OCV) [Bank2/Intake]
96	CVVT Oil Control Valve(OCV) [Bank1/Intake] control output	CVVT Oil Control Valve(OCV) [Bank1/Intake]
97	Ignition coil(Cylinder#2) control output	Ignition coil(Cylinder#2)

98	Ignition coil(Cylinder#6) control output	Ignition coil(Cylinder#6)
99	Ignition coil(Cylinder#4) control output	Ignition coil(Cylinder#4)

ECM Terminal Input/Output Signal

Connector [ELG-A]

Pin No.	Description	Condition	Type	Level
1	-			
2	-			
3	-			
4	Immobilizer lamp control output	Lamp ON	DC	Max. 1.1V
		Lamp OFF		Battery voltage
5	Power ground	Idle	DC	Max. 150mV
6	Power ground	Idle	DC	Max. 150mV
7	-			
8	-			
9	2nd CAN [High]	RECESSIVE	Pulse	2.0 ~ 3.0V
		DOMINANT		2.75 ~ 4.5V
10	1st CAN [High]	RECESSIVE	Pulse	2.0 ~ 3.0V
		DOMINANT		0.5 ~ 2.25V
11	Fuel Tank Pressure Sensor (FTPS) signal input	Idle	DC	0.14 ~ 4.86V
12	-			
13	-			
14	Sensor ground	Idle	DC	Max. 150mV
15	Sensor ground	Idle	DC	Max. 150mV
16	Fuel Level Sensor (FLS) [TOTAL] signal input	Idle	DC	0.88 ~ 8.45V
17	Power Steering Pressure switch signal input			
18	Clutch switch signal input	RELEASE	DC voltage	Max. 0.5V
		PUSH		Batteryvoltage
19	-			
20	Blower switch signal input	S/W ON	DC	Battery voltage
		S/W OFF	DC	Max. 0.5V
21	Brake pedal switch signal input	BrakeON	DC	Battery voltage
		BrakeOFF		Max. 0.5V
22	-			
23	-			
24	Alternator"FR"PWM signal input	Idle	PWM	High:Battery voltage
				Low:Max. 1.5V

				133 <Frequency< 200Hz
				5 <Duty< 95%
25	Malfunction Indicator Lamp(MIL)control output	Lamp ON	DC	Max. 0.5V
		Lamp OFF		Battery voltage
26	-			
27	Battery power(B+)	Idle	DC	Battery voltage
28	-			
29	-			
30	Power ground	Idle	DC	Max. 150mV
31	-			
32	-			
33	-			
34	2nd CAN [Low]	RECESSIVE	Pulse	2.0 ~ 3.0V
		DOMINANT		0.5 ~ 2.25V
34	1st CAN [Low]	RECESSIVE	Pulse	2.0 ~ 3.0V
		DOMINANT		0.5 ~ 2.25V
36	-			
37	-			
38	Accelerator Position Sensor(APS) 1 signal input	C.T	DC	0.58 ~ 0.93V
		W.O.T		3.85 ~ 4.35V
39	-			
40	-			
41	Fuel Level Sensor (FLS) [MIDDLE] signal input	Idle	DC	0.3 ~ 4.9V
42	A/C switch ON signal input	A/C OFF	DC voltage	Max. 0.5V
		A/C ON		Batteryvoltage
43	Brake lamp switch signal input	Brake ON	DC voltage	Batteryvoltage
		Brake OFF		Max. 0.5 V
44	-			
45	-			
46	-			
47	-			
48	-			
49	-			
50	-			
51	-			
52	Battery power(B+)	Idle	DC	Battery voltage
53	-			
54	-			

55	Power ground	Idle	DC	Max. 150mV
56	-			
57	Fuel pump relay control output	Relay ON	DC	Max. 1.1V
58		Relay OFF		Battery voltage
59	Sensor ground	Idle	DC	Max. 150mV
60	Sensor ground	Idle	DC	Max. 150mV
61	Sensor ground	Idle	DC	Max. 150mV
62	-			
63	Sensor ground	Idle	DC	Max. 150mV
64	-			
65	Sensor power(+5V)	Idle	DC	4.9 ~ 5.1V
66	Sensor power (+5V)	Idle	DC	4.9 ~ 5.1V
67	A/C Pressure Transducer(APT) signal input	A/C ON	DC	0.5 ~ 4.5V
68	Accelerator Position Sensor(APS) 2 signal input	C.T	DC	0.29 ~ 0.46V
		W.O.T		1.93 ~ 2.18V
69	-			
70	Engine speed signal output	Idle	Pulse	High:Battery voltage
				Low:Max. 1.1V
				0 <Frequency< 350Hz
				47.5 <Duty< 52.5%
71	Cooling fan control output signal(PWM) output [High]	Idle	Pulse	High:Battery voltage
				Low:Max. 0.5V
				Frequency= 300Hz
				0 <Duty< 100%
72	-			
73	-			
74	Immobilizer communication line	When transmitting	DC	High:Battery voltage×80%
				Low:Battery voltage×20%
		When receiving		High:Battery voltage×70%
				Low:Battery voltage×30%
75	Main relay control output	Relay ON	DC	Max. 1.7V
		Relay OFF		Battery voltage
76	-			
77	Battery power(B+)	Idle	DC	Battery voltage
78	-			
79	-			
80	Power ground	Idle	DC	Max. 150mV
81	-			

82	-			
83	-			
84	-			
85	-			
86	-			
87	-			
88	-			
89	-			
90	Sensor power(+5V)	Idle	DC	4.9 ~ 5.1V
91	Cooling fan control output signal output [Low]			
92	-			
93	Start Motor relay control output			
94	Main relay control output	Relay ON	DC	Max. 1.7V
		Relay OFF		Battery voltage
95	A/C Compressor relay control output	Relay ON	DC	Max. 1.7V
		Relay OFF		Battery voltage
96	Canister Close Valve (CCV) control output	Open	DC	Battery Voltage
		Close		Max. 1.0V
97	-			
98	-			
99	Main relay control output	Relay ON	DC	Max. 1.7V
		Relay OFF		Battery voltage
100	Main relay control output	Relay ON	DC	Max. 1.7V
		Relay OFF		Battery voltage

Connector [CLG-B]

Pin No.	Description	Condition	Type	Level
1	-			
2	-			
3	-			
4	-			
5	Sensor power(+5V)	Idle	DC	4.9 ~ 5.1V
6	Sensor power(+5V)	Idle	DC	4.9 ~ 5.1V
7	Throttle Position Sensor(TPS) PWM output			
8	Crank Request			
9	-			
10	CVVT Oil Air Temperature Sensor(OTS) signal input	Idle	DC	0.15(150°C) ~ 4.85V(-40°C)

11	-			
12	Throttle Position Sensor(TPS) 1 signal input	C.T	DC	0.25 ~ 0.9V
		W.O.T		Min. 4.0V
13	Manifold Absolute Pressure Sensor(MAPS) signal input	Idle	DC	4.43V (107kPa)
				0.75V (20kPa)
14	Intake Air Temperature Sensor(IATS) signal input	Idle	DC	4.85V (-40°C)
				0.07V (150°C)
15	Vehicle speed signal input	주행시	Pulse	High:Min. 4.0V
				Low:Max. 1.1V
				6.4 <Frequency< 1,534Hz
				Duty= 50%
16	Knock Sensor(KS) [Bank2] [High] signal input	Knocking	Variable Frequency	-0.3 ~ 0.3V
		Normal	Frequency	0V
17	Knock Sensor(KS) [Bank2] [High] signal input	Knocking	Variable Frequency	-0.3 ~ 0.3V
		Normal	Frequency	0V
18	Crankshaft Position Sensor(CKPS) [High] signal input	Idle	SINE wave	0.4 < Vp_p < 200V
				55 <Frequency< 7,000Hz
19	Sensor ground	Idle	DC	Max. 150mV
20	-			
21	Camshaft Position Sensor(CMPS) [Bank2/Intake] signal input	Idle	Pulse	High: 3.2 ~ Vcc
				Low:Max. 0.7V
				0 <Frequency< 350Hz
22	-			
23	Sensor power(+5V)	Idle	DC	4.9 ~ 5.1V
24	Ignition coil(Cylinder#1) control output	Idle	Pulse	Vpeak = 400V
				0 <Frequency< 58.3Hz
25	-			
26	-			
27	-			
28	-			
29	-			
30	Mass Air Flow Sensor(MAFS) signal input	Idle	Pulse	High:Min. 4.5V
				Low:Max. 0.6V
				768 <Frequency< 12,032Hz
				Duty= 50%
31	Sensor ground	Idle	DC	Max. 150mV
32	Sensor ground	Idle	DC	Max. 150mV

33	Heated Oxygen Sensor(HO2S) [Bank2/Sensor2] signal input	RICH	DC	0.75 ~ 0.92V
		LEAN		0.04 ~ 0.1V
34	Throttle Position Sensor(TPS) 2 signal input	C.T	DC	Min. 4.0V
		W.O.T		0.25 ~ 0.9V
35	Engine Coolant Temperature Sensor(ECTS) signal input	Idle	DC	0 ~ 5.0V
36	-			
37	-			
38	Heated Oxygen Sensor(HO2S) [Bank1/Sensor1] signal input	RICH	DC	0.75 ~ 0.92V
		LEAN		0.04 ~ 0.1V
39	Heated Oxygen Sensor(HO2S) [Bank1/Sensor2] signal input	RICH	DC	0.75 ~ 0.92V
		LEAN		0.04 ~ 0.1V
40	Sensor shield	Idle	DC	Max. 150mV
41	Sensor ground	Idle	DC	Max. 150mV
42	Sensor ground	Idle	DC	Max. 150mV
43	Sensor ground	Idle	DC	Max. 150mV
44	Sensor ground	Idle	DC	Max. 150mV
45	Sensor ground	Idle	DC	Max. 150mV
46	Camshaft Position Sensor(CMPS) [Bank2/Exhaust] signal input	Idle	Pulse	High: 3.2 ~ Vcc
				Low:Max. 0.7V
				0 <Frequency< 350Hz
47	-			
48	Sensor power(+5V)	Idle	DC	4.9 ~ 5.1V
49	Ignition coil(Cylinder#3) control output	Idle	Pulse	Vpeak = 400V
				0 <Frequency< 58.3Hz
50	-			
51	-			
52	-			
53	-			
54	-			
55	-			
56	Sensor ground	Idle	DC	Max. 150mV
57	-			
58	Heated Oxygen Sensor(HO2S) [Bank2/Sensor2] signal input	RICH	DC	0.75 ~ 0.92V
		LEAN		0.04 ~ 0.1V
59	Heated Oxygen Sensor(HO2S) [Bank1/Sensor2] signal input	RICH	DC	0.75 ~ 0.92V
		LEAN		0.04 ~ 0.1V
60	Sensor ground	Idle	DC	Max. 150mV
61	-			

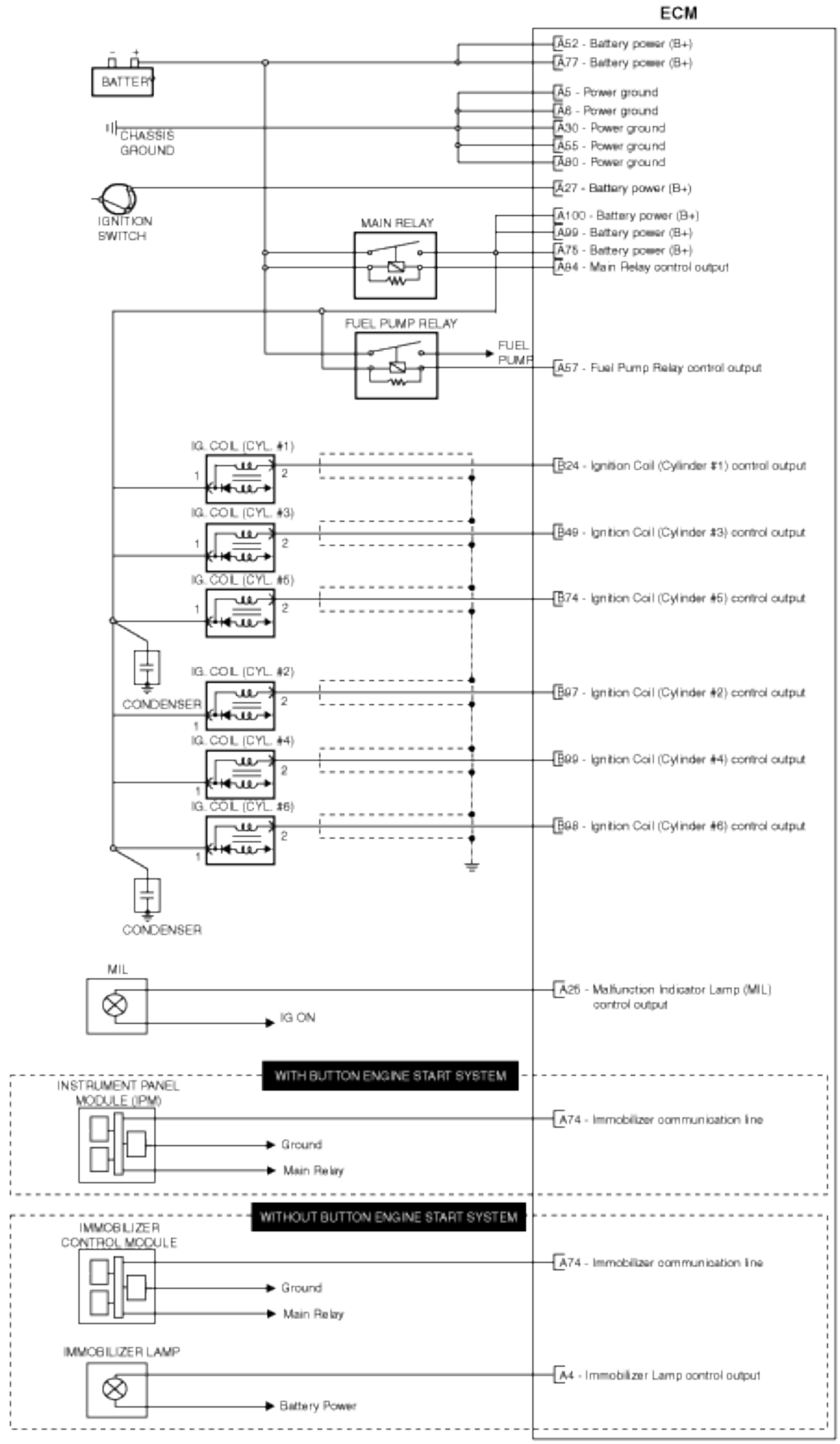
62	-			
63	Heated Oxygen Sensor(HO2S) [Bank2/Sensor1] signal input	RICH	DC	0.75 ~ 0.92V
		LEAN		0.04 ~ 0.1V
64	Sensor ground	Idle	DC	Max. 150mV
65	-			
66	Purge Control Solenid Valve(PCSV) control output	Idle	Pulse	High:Battery voltage
				Low:Max. 1.0V
				Frequency= 30Hz
				0 <Duty< 100%
67	-			
68	-			
69	-			
70	Camshaft Position Sensor(CMPS) [Bank1/Exhaust] signal input	Idle	Pulse	High: 3.2 ~ Vcc
				Low:Max. 0.7V
				0 <Frequency< 350Hz
71	Camshaft Position Sensor(CMPS) [Bank1/Intake] signal input	Idle	Pulse	High: 3.2 ~ Vcc
				Low:Max. 0.7V
				0 <Frequency< 350Hz
72	-			
73	Sensor power(+5V)	Idle	DC	4.9 ~ 5.1V
74	Ignition coil(Cylinder#5) control output	Idle	Pulse	Vpeak = 400V
				0 <Frequency< 58.3Hz
75	-			
76	-			
77	-			
78	-			
79	-			
80	ETC Motor[High] control output	Idle	Pulse	High:Battery voltage
				Low:Max.1.0V
				1,500 <Frequency< 2,400Hz
				0 <Duty< 98%
81	ETC Motor[Low] control output	Idle	PWM	Battery voltage
82	Heated Oxygen Sensor(HO2S) [Bank1/Sensor2] heater control output	Idle	PWM	High:Battery voltage
				Low:Max. 1.15V
				0 <Duty<100%
83	Heated Oxygen Sensor(HO2S) [Bank2/Sensor2] heater control output	Idle	PWM	High:Battery voltage
				Low:Max. 1.15V
				0 <Duty<100%

84	-			
85	Injector(Cylinder#2)control output	Idle	PWM	High:Battery voltage Low:Max. 1.0V 0 <Frequency< 58.3Hz 47 < Vpeak < 64V
86	Injector(Cylinder#5)control output	Idle	PWM	High:Battery voltage Low:Max. 1.0V 0 <Frequency< 58.3Hz 47 < Vpeak < 64V
87	Injector(Cylinder#3)control output	Idle	PWM	High:Battery voltage Low:Max. 1.0V 0 <Frequency< 58.3Hz 47 < Vpeak < 64V
88	Injector(Cylinder#6)control output	Idle	PWM	High:Battery voltage Low:Max. 1.0V 0 <Frequency< 58.3Hz 47 < Vpeak < 64V
89	Injector(Cylinder#4)control output	Idle	PWM	High:Battery voltage Low:Max. 1.0V 0 <Frequency< 58.3Hz 47 < Vpeak < 64V
90	Injector(Cylinder#1)control output	Idle	PWM	High:Battery voltage Low:Max. 1.0V 0 <Frequency< 58.3Hz 47 < Vpeak < 64V
91	Heated Oxygen Sensor(HO2S) [Bank1/Sensor1] heater control output	Idle	PWM	High:Battery voltage Low:Max. 1.15V 0 <Duty<100%
92	Heated Oxygen Sensor(HO2S) [Bank2/Sensor1] heater control output	Idle	PWM	High:Battery voltage Low:Max. 1.15V 0 <Duty<100%
93	CVVT Oil Control Valve(OCV) [Bank2/Exhaust] control output	Idle	PWM	High:Battery voltage Low:Max. 1.0V Frequency= 128Hz 0 <Duty< 100%
94	CVVT Oil Control Valve(OCV) [Bank1/Exhaust] control output	Idle	PWM	High:Battery voltage Low:Max. 1.0V Frequency= 128Hz

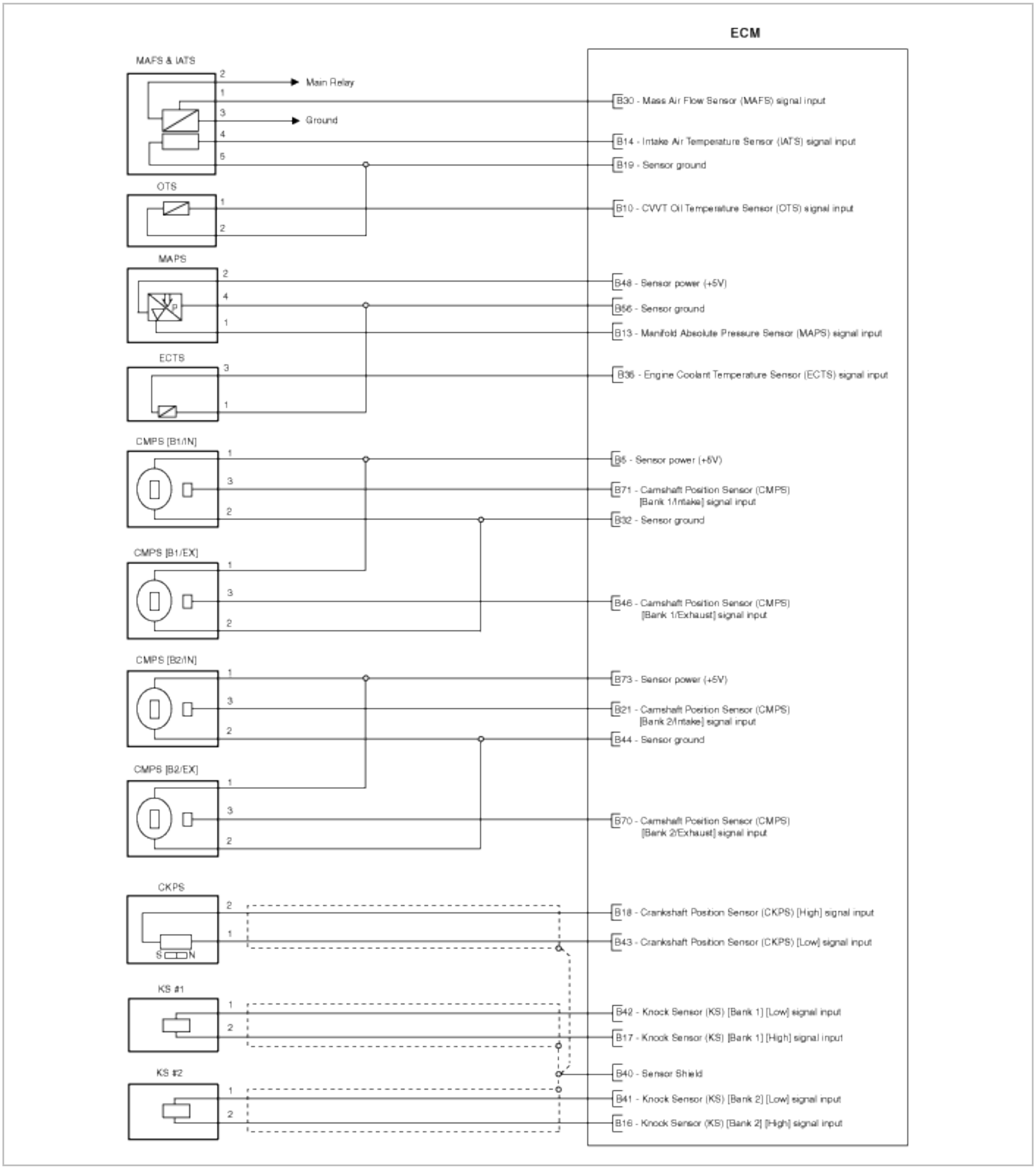
				0 <Duty< 100%
95	CVVT Oil Control Valve(OCV) [Bank2/Intake] control output	Idle	PWM	High:Battery voltage
				Low:Max. 1.0V
				Frequency= 128Hz
				0 <Duty< 100%
96	CVVT Oil Control Valve(OCV) [Bank1/Intake] control output	Idle	PWM	High:Battery voltage
				Low:Max. 1.0V
				Frequency= 128Hz
				0 <Duty< 100%
97	Ignition coil(Cylinder#2) control output	Idle	Pulse	Vpeak = 400V
				0 <Frequency< 58.3Hz
98	Ignition coil(Cylinder#6) control output	Idle	Pulse	Vpeak = 400V
				0 <Frequency< 58.3Hz
99	Ignition coil(Cylinder#4) control output	Idle	Pulse	Vpeak = 400V
				0 <Frequency< 58.3Hz

Fuel System > Engine Control System > Engine Control Module (ECM) > Schematic Diagrams

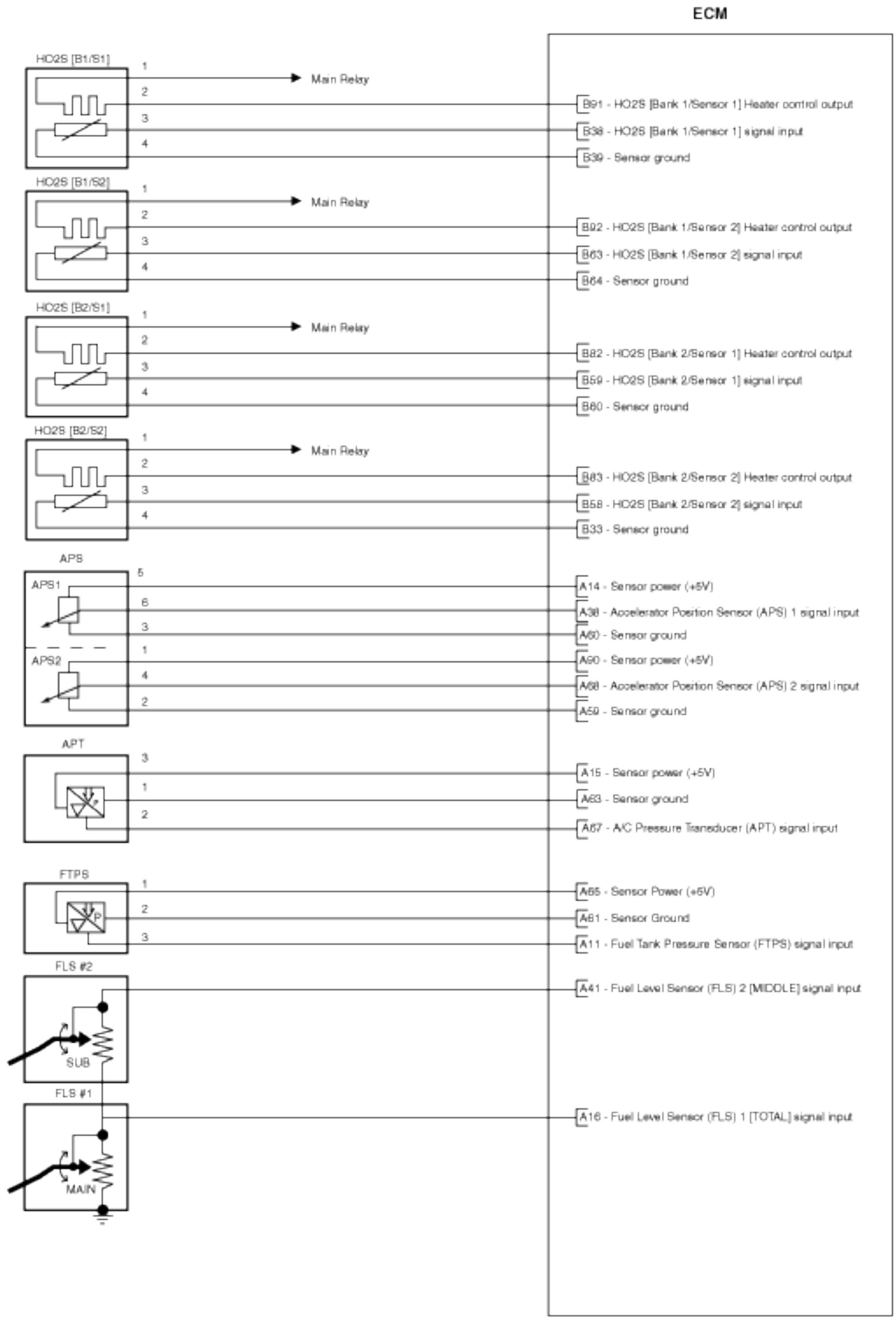
Circuit Diagram



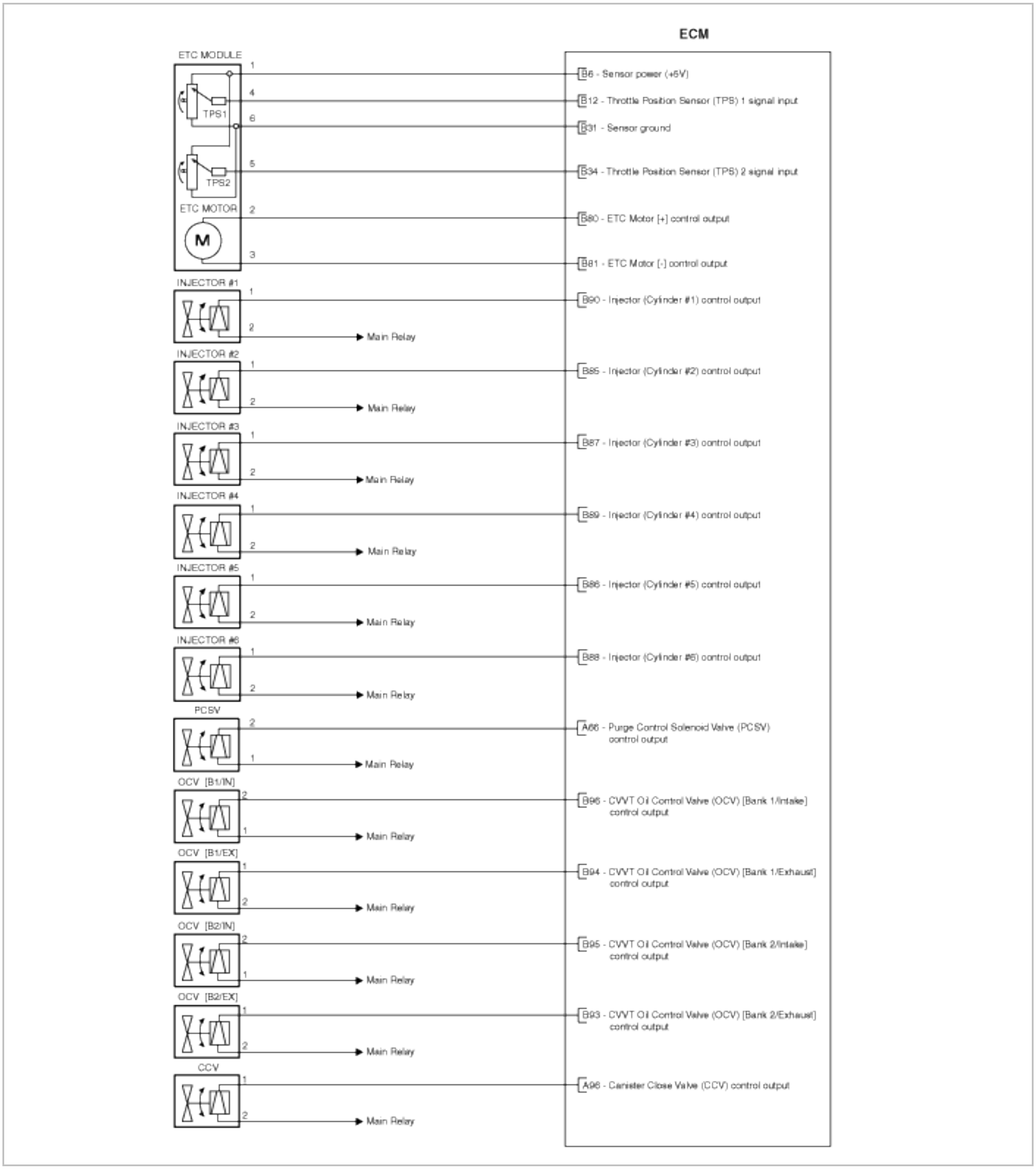
ECM
BATTERY
CHASSIS GROUND
IGNITION SWITCH
MAIN RELAY
FUEL PUMP RELAY
FUEL PUMP
IG. COIL (CYL. #1)
IG. COIL (CYL. #3)
IG. COIL (CYL. #5)
CONDENSER
IG. COIL (CYL. #2)
IG. COIL (CYL. #4)
IG. COIL (CYL. #6)
CONDENSER
MIL
IG ON
WITH BUTTON ENGINE START SYSTEM
INSTRUMENT PANEL MODULE (IPM)
Ground
Main Relay
WITHOUT BUTTON ENGINE START SYSTEM
IMMOBILIZER CONTROL MODULE
Ground
Main Relay
IMMOBILIZER LAMP
Battery Power
A52 - Battery power (B+)
A77 - Battery power (B+)
A5 - Power ground
A6 - Power ground
A30 - Power ground
A55 - Power ground
A80 - Power ground
A27 - Battery power (B+)
A100 - Battery power (B+)
A99 - Battery power (B+)
A75 - Battery power (B+)
A84 - Main Relay control output
A57 - Fuel Pump Relay control output
B24 - Ignition Coil (Cylinder #1) control output
B49 - Ignition Coil (Cylinder #3) control output
B74 - Ignition Coil (Cylinder #5) control output
B97 - Ignition Coil (Cylinder #2) control output
B99 - Ignition Coil (Cylinder #4) control output
B98 - Ignition Coil (Cylinder #6) control output
A25 - Malfunction Indicator Lamp (MIL) control output
A74 - Immobilizer communication line
A74 - Immobilizer communication line
A4 - Immobilizer Lamp control output

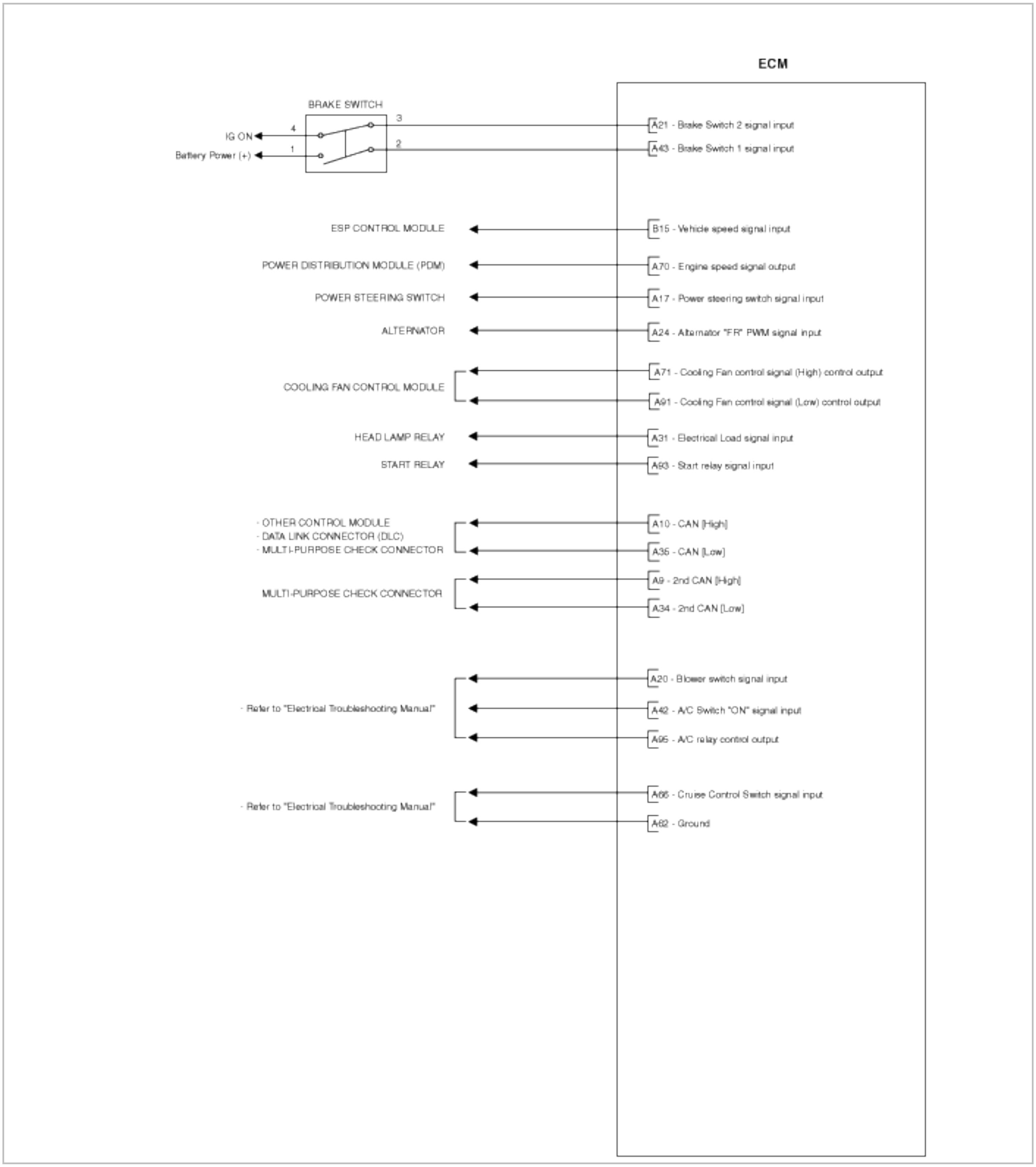


ECM
MAFS & IATS
Main Relay
Ground
B30 - Mass Air Flow Sensor (MAFS) signal input
B14 - Intake Air Temperature Sensor (IATS) signal input
B19 - Sensor ground
OTS
B10 - CVVT Oil Temperature Sensor (OTS) signal input
MAPS
B48 - Sensor power (+5V)
B56 - Sensor ground
B13 - Manifold Absolute Pressure Sensor (MAPS) signal input
ECTS
B36 - Engine Coolant Temperature Sensor (ECTS) signal input
CMPS [B1/IN]
B5 - Sensor power (+5V)
B71 - Camshaft Position Sensor (CMPS) [Bank 1/Intake] signal input
B32 - Sensor ground
CMPS [B1/EX]
B46 - Camshaft Position Sensor (CMPS) [Bank 1/Exhaust] signal input
CMPS [B2/IN]
B73 - Sensor power (+5V)
B21 - Camshaft Position Sensor (CMPS) [Bank 2/Intake] signal input
B44 - Sensor ground
CMPS [B2/EX]
B70 - Camshaft Position Sensor (CMPS) [Bank 2/Exhaust] signal input
CKPS
B18 - Crankshaft Position Sensor (CKPS) [High] signal input
B43 - Crankshaft Position Sensor (CKPS) [Low] signal input
KS #1
B42 - Knock Sensor (KS) [Bank 1] [Low] signal input
B17 - Knock Sensor (KS) [Bank 1] [High] signal input
B40 - Sensor Shield
KS #2
B41 - Knock Sensor (KS) [Bank 2] [Low] signal input
B16 - Knock Sensor (KS) [Bank 2] [High] signal input



ECM
HO2S [B1/S1]
Main Relay
B91 - HO2S [Bank 1/Sensor 1] Heater control output
B38 - HO2S [Bank 1/Sensor 1] signal input
B39 - Sensor ground
HO2S [B1/S2]
Main Relay
B92 - HO2S [Bank 1/Sensor 2] Heater control output
B63 - HO2S [Bank 1/Sensor 2] signal input
B64 - Sensor ground
HO2S [B2/S1]
Main Relay
B82 - HO2S [Bank 2/Sensor 1] Heater control output
B59 - HO2S [Bank 2/Sensor 1] signal input
B60 - Sensor ground
HO2S [B2/S2]
Main Relay
B83 - HO2S [Bank 2/Sensor 2] Heater control output
B58 - HO2S [Bank 2/Sensor 2] signal input
B33 - Sensor ground
APS
APS1
APS2
A14 - Sensor power (+5V)
A38 - Accelerator Position Sensor (APS) 1 signal input
A60 - Sensor ground
A90 - Sensor power (+5V)
A68 - Accelerator Position Sensor (APS) 2 signal input
A59 - Sensor ground
APT
A15 - Sensor power (+5V)
A63 - Sensor ground
A67 - A/C Pressure Transducer (APT) signal input
FTPS
A65 - Sensor Power (+5V)
A61 - Sensor Ground
A11 - Fuel Tank Pressure Sensor (FTPS) signal input
FLS #2
SUB
A41 - Fuel Level Sensor (FLS) 2 [MIDDLE] signal input
FLS #1
MAIN
A16 - Fuel Level Sensor (FLS) 1 [TOTAL] signal input


ECM
ETC MODULE
TPS1
TPS2
ETC MOTOR
M
B6 - Sensor power (+5V)
B12 - Throttle Position Sensor (TPS) 1 signal input
B31 - Sensor ground
B34 - Throttle Position Sensor (TPS) 2 signal input
B80 - ETC Motor [+] control output
B81 - ETC Motor [-] control output
INJECTOR #1
B90 - Injector (Cylinder #1) control output
INJECTOR #2
B85 - Injector (Cylinder #2) control output
INJECTOR #3
B87 - Injector (Cylinder #3) control output
INJECTOR #4
B89 - Injector (Cylinder #4) control output
INJECTOR #5
B86 - Injector (Cylinder #5) control output
INJECTOR #6
B88 - Injector (Cylinder #6) control output
PCSV
A66 - Purge Control Solenoid Valve (PCSV) control output
OCV [B1/IN]
B96 - CVVT Oil Control Valve (OCV) [Bank 1/Intake] control output
OCV [B1/EX]
B94 - CVVT Oil Control Valve (OCV) [Bank 1/Exhaust] control output
OCV [B2/IN]
B95 - CVVT Oil Control Valve (OCV) [Bank 2/Intake] control output
OCV [B2/EX]
B93 - CVVT Oil Control Valve (OCV) [Bank 2/Exhaust] control output
CCV
A96 - Canister Close Valve (CCV) control output
Main Relay



Fuel System > Engine Control System > Engine Control Module (ECM) > Repair procedures

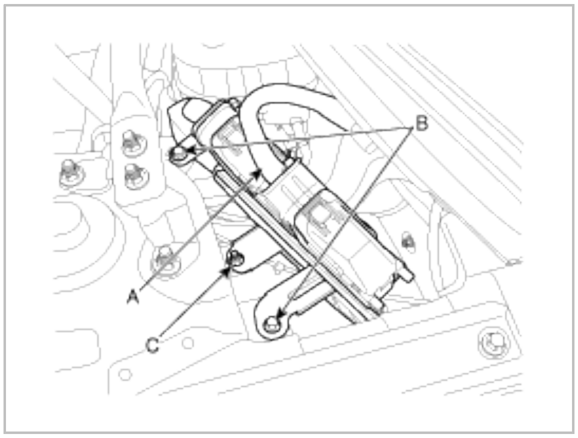
Removal

NOTE

In the case of the vehicle equipped with immobilizer, perform "Key Teaching" procedure together (Refer to

"Immobilizer" in BE group).

1. Turn ignition switch OFF and disconnect the negative (-) battery cable.
2. Remove the cover.
3. Disconnect the ECM connector (A).



4. Remove the ECM bracket installation bolts (B) and nut (C).
5. After removing the installation bolts, remove the ECM from the bracket.

Installation

NOTE

In the case of the vehicle equipped with immobilizer, perform "Key Teaching" procedure together (Refer to "Immobilizer" in BE group).

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 lbf.ft)

ECM Problem Inspection Procedure

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

   Specification: Below 1Ω

2. TEST ECM CONNECTOR: Disconnect the ECM connector and visually check the ground terminals on ECM side and harness side for bent pins or poor contact pressure. If the problem is found, repair it.
3. If problem is not found in Step 1 and 2, the ECM could be faulty. If so, replace the ECM with a new one, and then check the vehicle again. If the vehicle operates normally then the problem was likely with the ECM.
4. RE-TEST THE ORIGINAL ECM: Install the original ECM (may be broken) into a known-good vehicle and check the vehicle. If the problem occurs again, replace the original ECM with a new one. If problem does not occur, this is intermittent problem (Refer to “Intermittent Problem Inspection Procedure” in Basic Inspection Procedure).

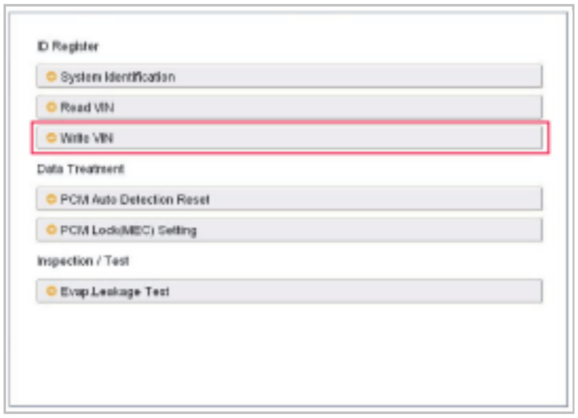
VIN programming procedure

VIN (Vehicle Identification Number) is a number that has the vehicle's information (Maker, Vehicle Type, Vehicle

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

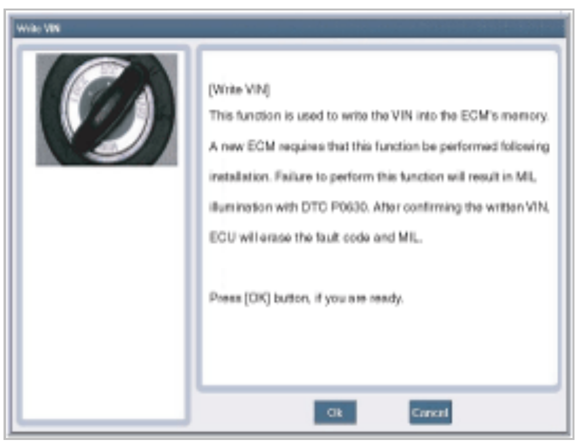
> **CAUTION**
>
> The programmed VIN cannot be changed. When writing the VIN, confirm the VIN carefully.

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



3. Input the VIN.

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

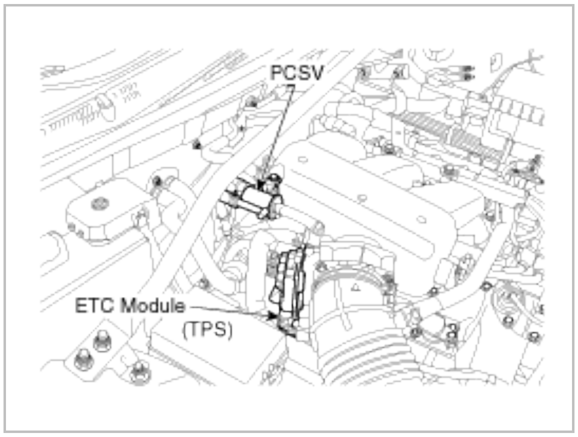


4. Turn the ignition switch OFF, then back ON.

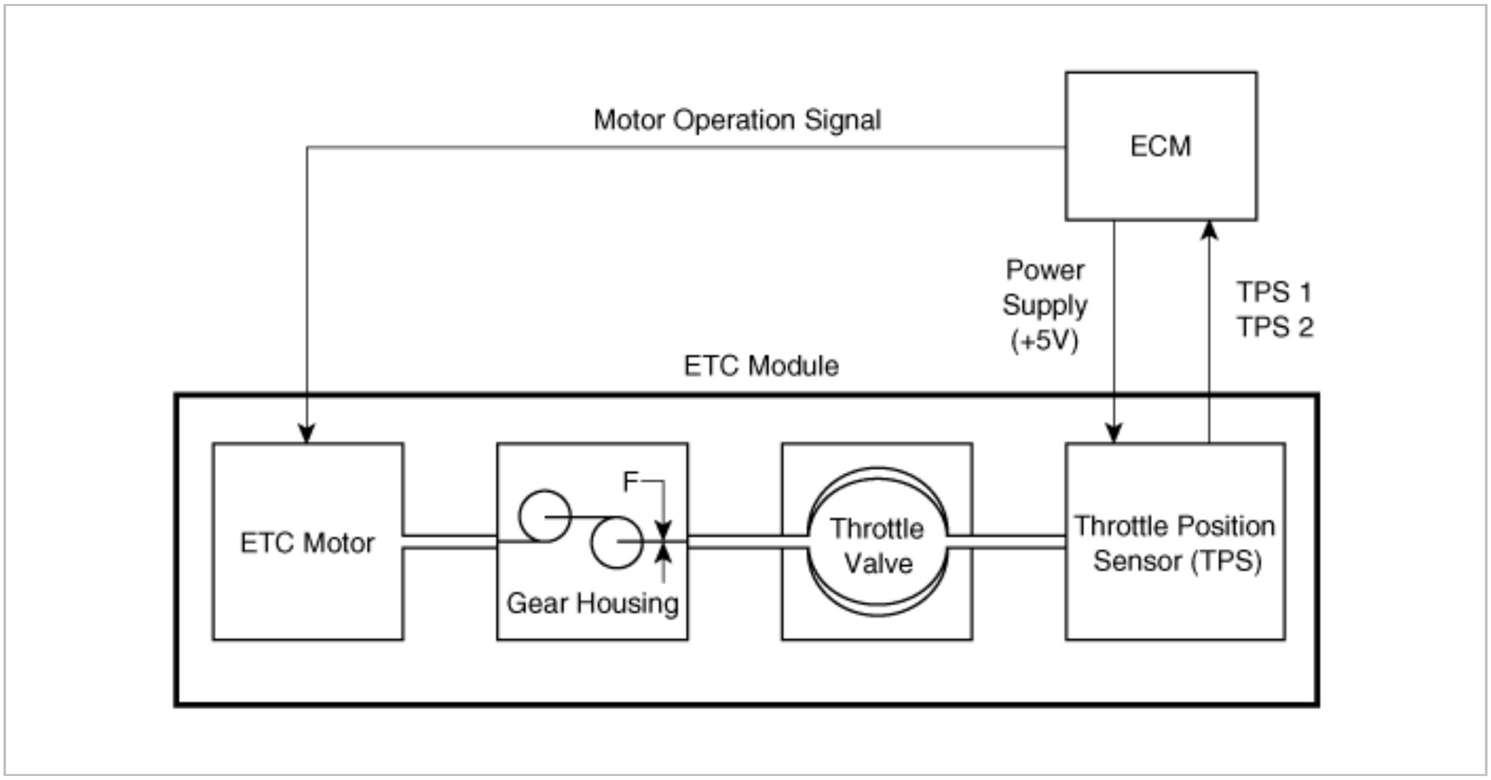
Fuel System > Engine Control System > ETC (Electronic Throttle Control) System > Description and Operation

Description

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



Schematic Diagram



Fuel System > Engine Control System > ETC (Electronic Throttle Control) System > Troubleshooting

Fail-Safe Mode

Mode	Symptom	Possible Cause
[MODE 1] FORCED ENGINE SHUTDOWN	• Engine stop	• ETC system can't proceed reliable algorithm procedure - Fatal ECM internal programming error - Faulty intake system or throttle body
[MODE 2] FORCED IDLE&POWER MANAGEMENT	• Forced idle state controlled by fuel quantity regulation and ignition timing adjustment	• ETC system can't control engine power via throttle device • Disabled throttle control or broken throttle position information
[MODE 3] FORCED IDLE	• No response for accelerator activation	• No information about the accelerator position

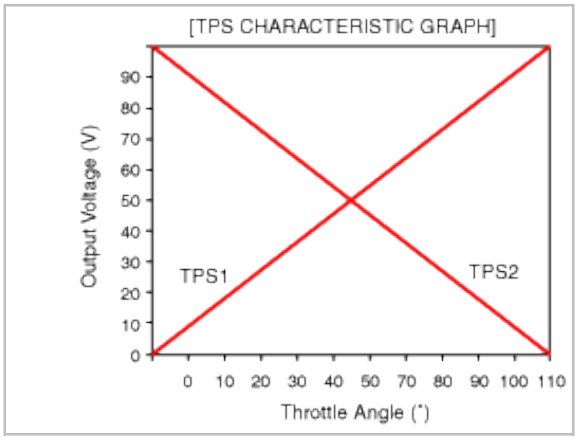
	• Forced idle state	- Broken APS 1 and 2, faulty A/D converter or internal controller
[MODE 4] LIMIT PERFORMANCE&POWER MANAGEMENT	• Engine power is determined by accelerator position and idle power requirement (Limited vehicle running)	• ETC system can't securely control engine power
[MODE 5] LIMIT PERFORMANCE	• Engine power varies with accelerator position • Driver perceives lack of engine power. • MIL ON (Normalvehicle running)	• Not reliable accelerator position signal or bad maximum power generation - Faulty APS, ignition voltage or internal controller
[MODE 6] NORMAL	• Normal	

Fuel System > Engine Control System > ETC (Electronic Throttle Control) System > Specifications

Specification

[Throttle Position Sensor (TPS)]

Throttle Angle(°)	Output Voltage(V)	
	TPS1	TPS2
0	0.0	5.0
10	0.5	4.5
20	0.9	4.1
30	1.4	3.6
40	1.8	3.2
50	2.3	2.7
60	2.7	2.3
70	3.2	1.8
80	3.6	1.4
90	4.1	0.9
100	4.5	0.5
110	5.0	0.0



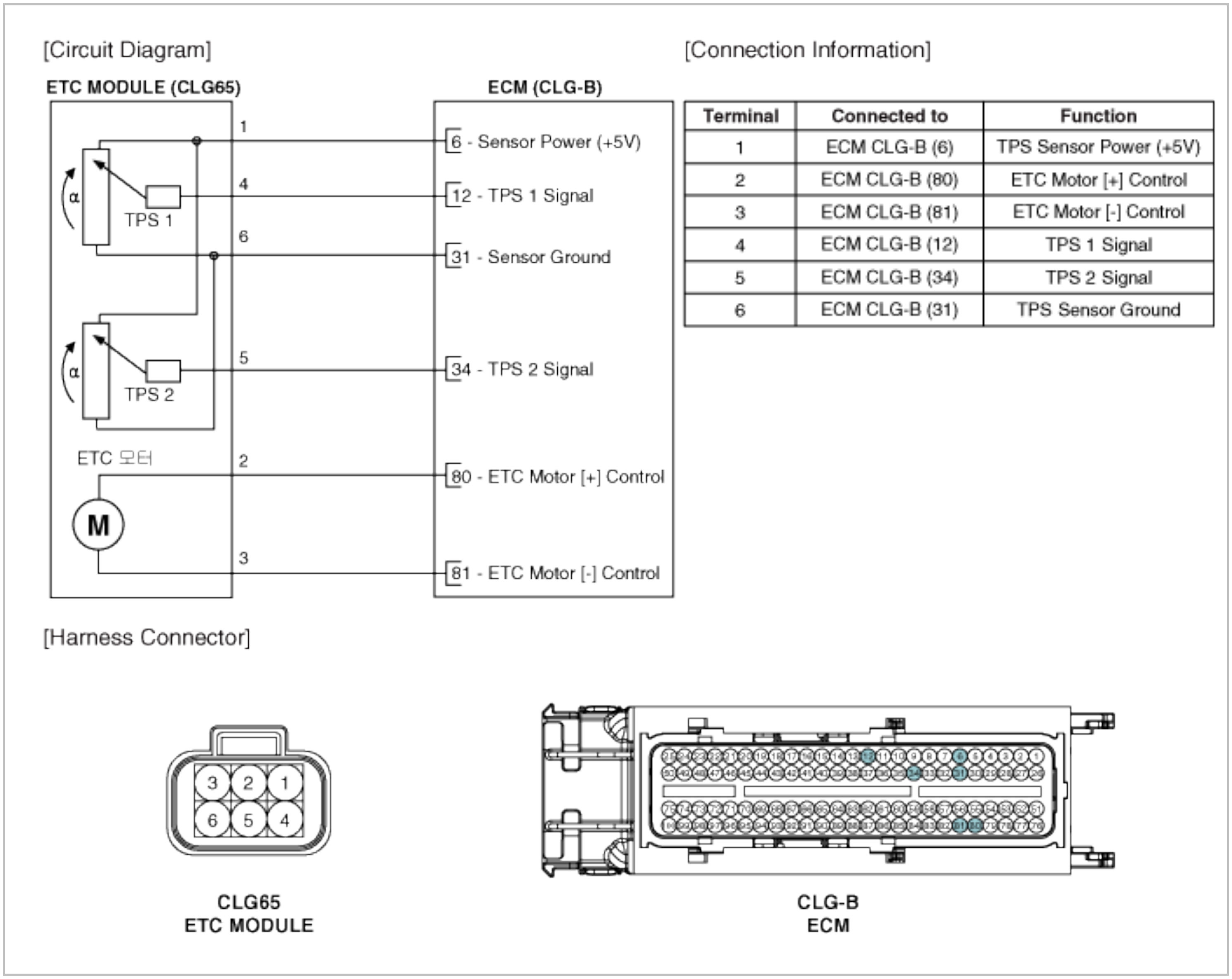
Item	Sensor Resistance(kΩ)
TPS1	3.6 ~ 6.0 [20°C(68°F)]
TPS2	2.7 ~ 4.1 [20°C(68°F)]

[ETC Motor]

Item	Specification
Coil Resistance (Ω)	1.275 ~ 1.725 [20°C(68°F)]

Fuel System > Engine Control System > ETC (Electronic Throttle Control) System > Schematic Diagrams

Circuit Diagram



Terminal	Connected to	Function
1	ECM CLG-B (6)	TPS Sensor Power (+5V)
2	ECM CLG-B (80)	ETC Motor [+] Control
3	ECM CLG-B (81)	ETC Motor [-] Control
4	ECM CLG-B (12)	TPS 1 Signal
5	ECM CLG-B (34)	TPS 2 Signal
6	ECM CLG-B (31)	TPS Sensor Ground

Fuel System > Engine Control System > ETC (Electronic Throttle Control) System > Repair procedures

Inspection

Throttle Position Sensor (TPS)

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

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

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

Specification: Refer to “Specification”

5. Measure resistance between the ETC module terminals 1 and 5 (TPS 2).

Specification: Refer to “Specification”

ETC Motor

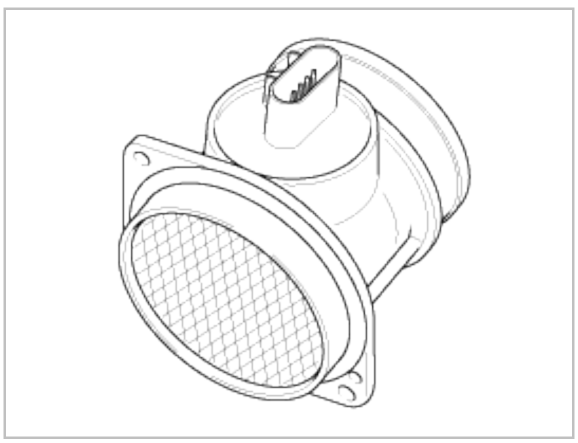
1. Turn the ignition switch OFF.
2. Disconnect the ETC module connector.
3. Measure resistance between the ETC module terminals 2 and 3.
4. Check that the resistance is within the specification.

Specification: Refer to “Specification”

Fuel System > Engine Control System > Mass Air Flow Sensor (MAFS) > Description and Operation

Description

Mass Air Flow Sensor (MAFS) is a hot-film type sensor and is located in between the air cleaner and the throttle body. It consists of a tube, a sensor assembly and a honey cell and detects the intake air quantity flowing into the intake manifold.
While the intake air coming out of the air cleaner flows by the honey cell, it becomes laminar flow, and then it passes the hot-film. At this time, heat transfer is generated by convection and this sensor loses its energy. This sensor detects the mass air flow by using the energy loss and transfers the information to the ECM by frequency. By using this signal, the ECM can calculate fuel quantity and ignition timing.



Fuel System > Engine Control System > Mass Air Flow Sensor (MAFS) > Specifications

Specification

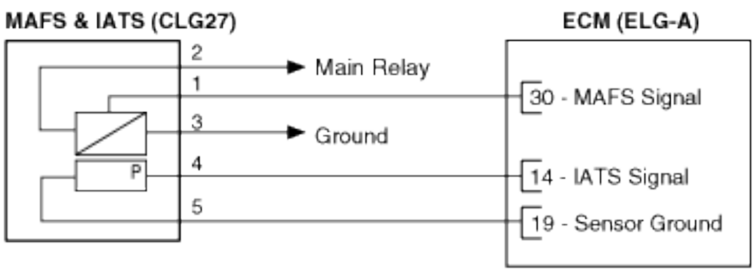
Air Flow (kg/h)	Frequency (Hz)
12.6	2,320
18.0	2,645
23.4	2,903
32.4	3,263
43.2	3,622

57.6	3,986
72.0	4,288
108.0	4,876
144.0	5,380
198.0	5,983
270.0	6,636
360.0	7,286
486.0	8,002
666.0	8,843
900.0	9,699

Fuel System > Engine Control System > Mass Air Flow Sensor (MAFS) > Schematic Diagrams

Circuit Diagram

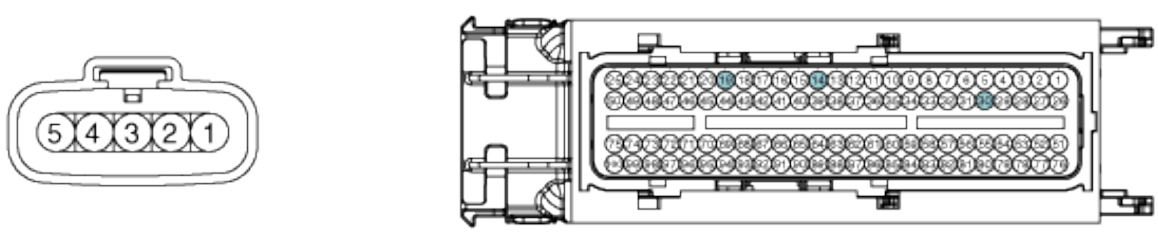
[Circuit Diagram]



[Connection Information]

Terminal	Connected to	Function
1	ECM ELG-A (30)	MAFS Signal
2	Main Relay	Sersor Power (B+)
3	Chassis Ground	Power Ground
4	ECM ELG-A (14)	IATS Signal
5	ECM ELG-A (19)	Sensor Ground

[Harness Connector]



CLG27
MAFS & IATS

CLG-B
ECM

Fuel System > Engine Control System > Mass Air Flow Sensor (MAFS) > Repair procedures

Inspection

1. Check the mass air flow sensor visually.
   A. Mounting direction of the sensor
   B. Any contamination, corrosion or damage of connector

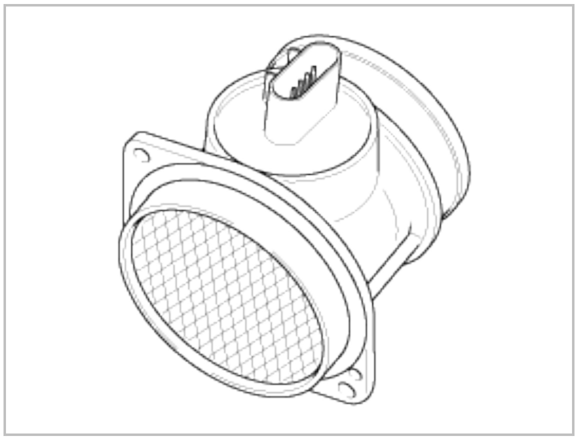
C. Air cleaner’s clogging or wet
D. Sensor cylinder’s deforming or blocking by any foreign material

2. Check any leakage on intake system.

Fuel System > Engine Control System > Intake Air Temperature Sensor (IATS) > Description and Operation

Description

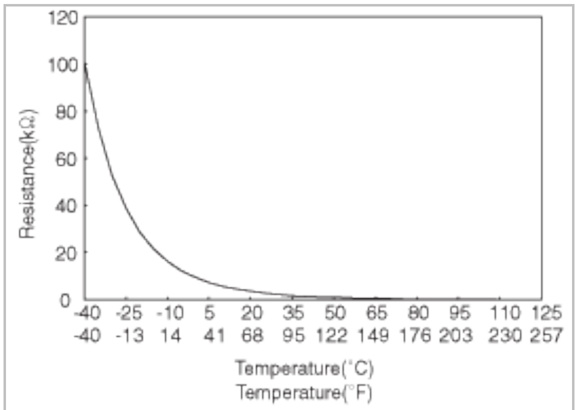
Intake Air Temperature Sensor (IATS) is installed inside the Mass Air Flow Sensor (MAFS) and detects the intake air temperature. To calculate precise air quantity, correction of the air temperature is needed because air density varies according to the temperature. So the ECM uses not only MAFS signal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



Fuel System > Engine Control System > Intake Air Temperature Sensor (IATS) > Specifications

Specification

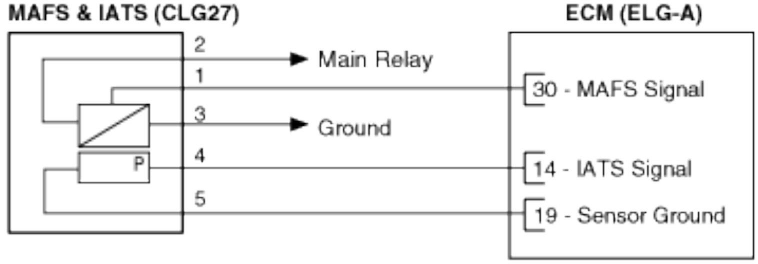
Temperature		Resistance (kΩ)
°C	°F	
-40	-40	100.87
-20	-4	28.58
0	32	9.40
10	50	5.66
20	68	3.51
40	104	1.47
60	140	0.67
80	176	0.33



Fuel System > Engine Control System > Intake Air Temperature Sensor (IATS) > Schematic Diagrams

Circuit Diagram

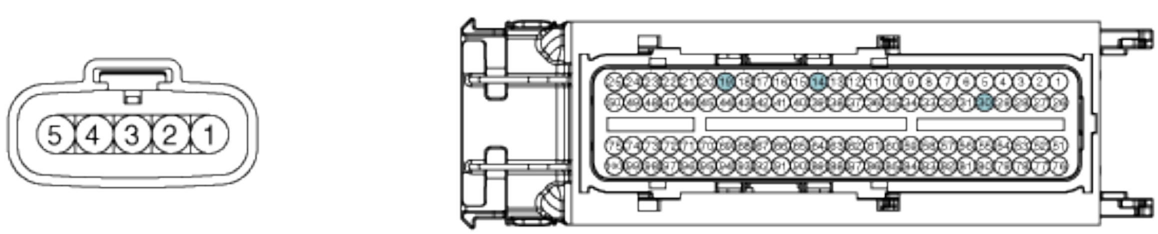
[Circuit Diagram]



[Connection Information]

Terminal	Connected to	Function
1	ECM ELG-A (30)	MAFS Signal
2	Main Relay	Sersor Power (B+)
3	Chassis Ground	Power Ground
4	ECM ELG-A (14)	IATS Signal
5	ECM ELG-A (19)	Sensor Ground

[Harness Connector]



CLG27
MAFS & IATS

CLG-B
ECM

Fuel System > Engine Control System > Intake Air Temperature Sensor (IATS) > Repair procedures

Inspection

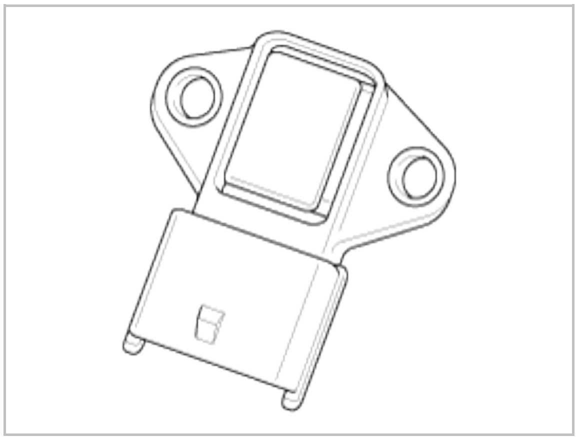
1. Turn the ignition switch OFF.
2. Disconnect the IATS connector.
3. Measure resistance between the IATS terminals 4 and 5.
4. Check that the resistance is within the specification.

Specification: Refer to “Specification”

Fuel System > Engine Control System > Manifold Absolute Pressure Sensor (MAPS) > Description and Operation

Description

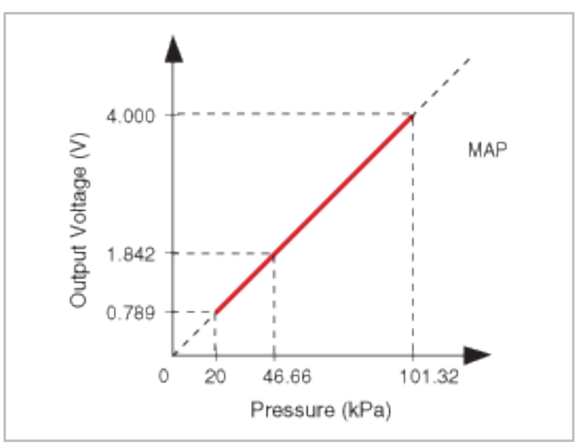
Manifold Absolute Pressure Sensor (MAPS) is a speed-density type sensor and is installed on the surge tank.
The MAPS senses absolute pressure in surge tank and transfers this analog signal proportional to the pressure to the ECM. The ECM calculates the intake air quantity and engine speed based on this signal.
This MAPS consists of a piezo-electric element and a hybrid IC that amplifies the element output signal. The element is silicon diaphragm type and adapts pressure sensitive variable resistor effect of semi-conductor.100% vacuum and the manifold pressure apply to the both sides of it respectively. That is, this sensor outputs the silicon variation proportional to pressure change by voltage.



Fuel System > Engine Control System > Manifold Absolute Pressure Sensor (MAPS) > Specifications

Specification

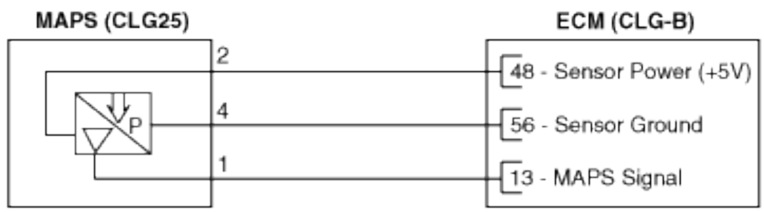
Pressure (kPa)	Output Voltage (V)
20.0	0.79
46.66	1.84
101.32	4.0



Fuel System > Engine Control System > Manifold Absolute Pressure Sensor (MAPS) > Schematic Diagrams

Circuit Diagram

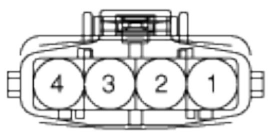
[Circuit Diagram]



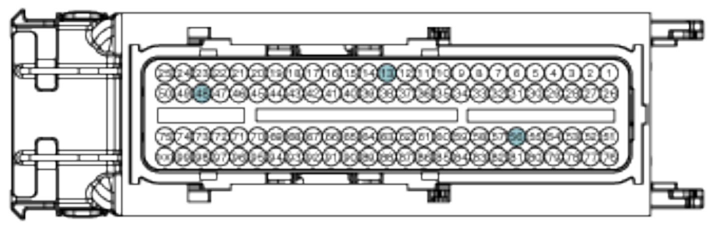
[Connection Information]

Terminal	Connected to	Function
1	ECM CLG-B (13)	MAPS Signal
2	ECM CLG-B (48)	Sensor Power (+5V)
3	-	-
4	ECM CLG-B (56)	Sensor Ground

[Harness Connector]



CLG25
MAPS



CLG-B
ECM

Fuel System > Engine Control System > Manifold Absolute Pressure Sensor (MAPS) > Repair procedures

Inspection

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

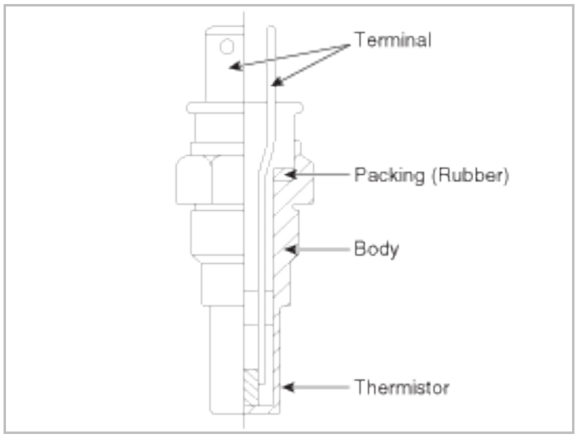
Condition	Output Voltage (V)
IG ON	3.9 ~ 4.1
Idle	0.8 ~ 1.6

Fuel System > Engine Control System > Engine Coolant Temperature Sensor (ECTS) > Description and Operation

Description

Engine Coolant Temperature Sensor (ECTS) is located in the engine coolant passage of the cylinder head for detecting the engine coolant temperature.The ECTS uses a thermistor whose resistance changes with the temperature. The electrical resistance of the ECTS decreases as the temperature increases, and increases as the temperature decreases. The reference 5 V in the ECM is supplied to the ECTS via a resistor in the ECM. That is, the resistor in the ECM and the thermistor in the ECTS are connected in series. When the resistance value of the thermistor in the ECTS changes according to the engine coolant temperature, the output voltage also changes.
During cold engine operation the ECM increases the fuel injection duration and controls the ignition timing using the

information of engine coolant temperature to avoid engine stalling and improve drivability.



Fuel System > Engine Control System > Engine Coolant Temperature Sensor (ECTS) > Specifications

Specification

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

Fuel System > Engine Control System > Engine Coolant Temperature Sensor (ECTS) > Schematic Diagrams

Circuit Diagram

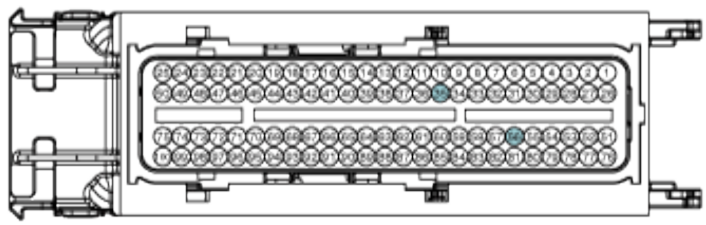
[Circuit Diagram]

[Connection Information]

Terminal	Connected to	Function
1	ECM CLG-B (56)	Sensor Ground
2	-	-
3	ECM CLG-B (35)	ECTS Signal

[Harness Connector]

CLG11
ECTS



CLG-B
ECM

Fuel System > Engine Control System > Engine Coolant Temperature Sensor (ECTS) > Repair procedures

Inspection

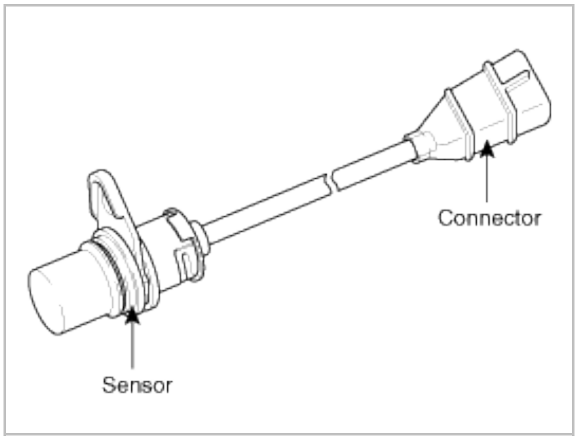
1. Turn the ignition switch OFF.
2. Disconnect the ECTS connector.
3. Remove the ECTS.
4. After immersing the thermistor of the sensor into engine coolant, measure resistance between the ECTS terminals 1 and 3.
5. Check that the resistance is within the specification.

Specification: Refer to “Specification”

Fuel System > Engine Control System > Crankshaft Position Sensor (CKPS) > Description and Operation

Description

Crankshaft Position Sensor (CKPS) detects the crankshaft position and is one of the most important sensors of the engine control system. If there is no CKPS signal input, the engine may stop because of CKPS signal missing.
This sensor is installed on transaxle housing or the cylinder block and generates alternating current by magnetic flux field which is made by the sensor and the target wheel when the engine rotates. The target wheel consists of 58 slots and 2 missing slots on 360 CA (Crank Angle).



Fuel System > Engine Control System > Crankshaft Position Sensor (CKPS) > Specifications

Specification

Item	Specification
Coil Resistance (Ω)	630 ~ 770 [25°C(77°F)]
Air Gap (mm)	0.5 ~ 1.5

Fuel System > Engine Control System > Crankshaft Position Sensor (CKPS) > Troubleshooting

Wave Form

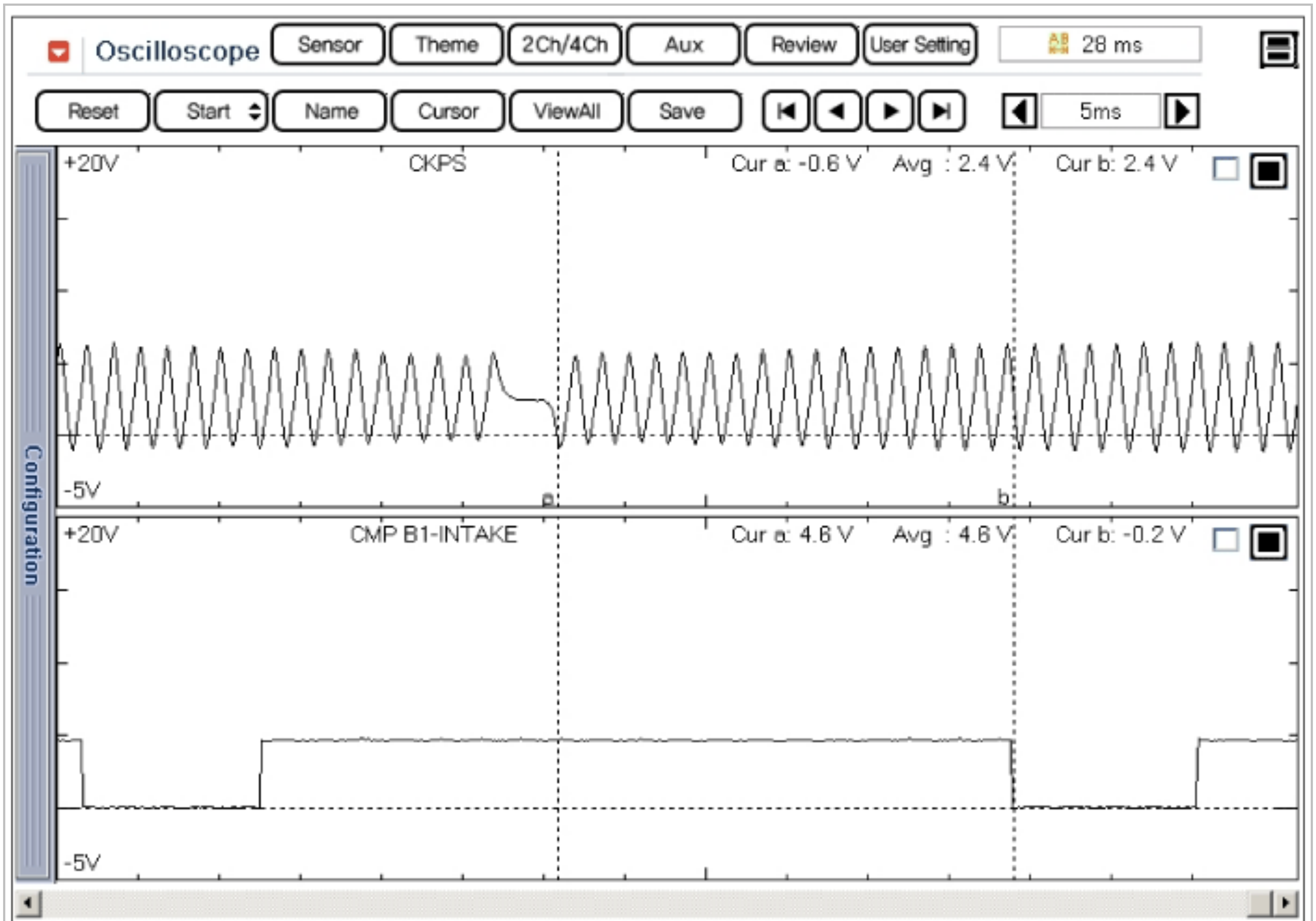
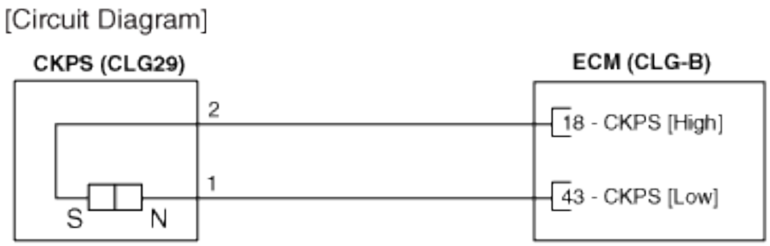


Fig.1

Fig 1) Normal waveform of CKPS & CMPS at idle.

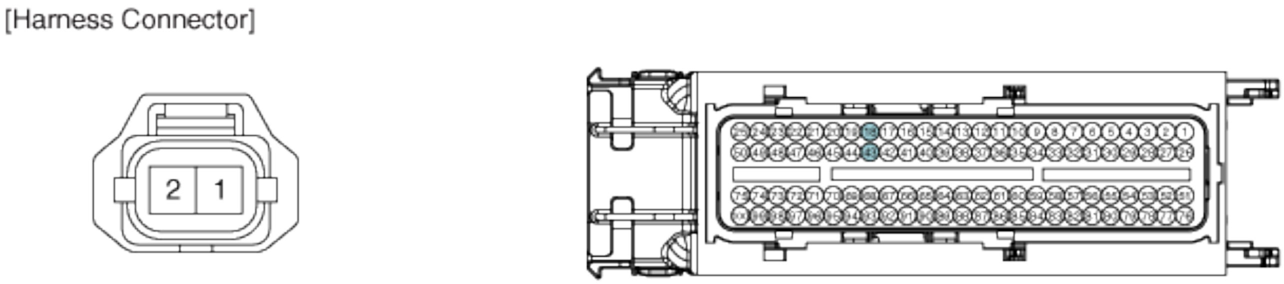
Fuel System > Engine Control System > Crankshaft Position Sensor (CKPS) > Schematic Diagrams

Circuit Diagram



[Connection Information]

Terminal	Connected to	Function
1	ECM CLG-B (43)	CKPS [Low] Signal
2	ECM CLG-B (18)	CKPS [High] Signal



CLG29
CKPS

CLG-B
ECM

Fuel System > Engine Control System > Crankshaft Position Sensor (CKPS) > Repair procedures

Inspection

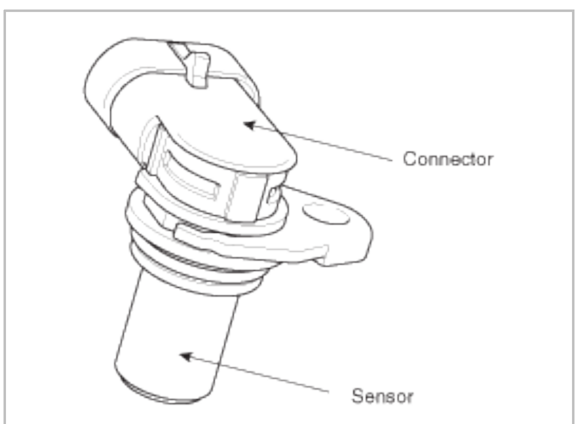
1. Check the signal waveform of the CMPS and CKPS using a scantool.

Specification: Refer to “Wave Form”

Fuel System > Engine Control System > Camshaft Position Sensor (CMPS) > Description and Operation

Description

Camshaft Position Sensor (CMPS) is a hall sensor and detects the camshaft position by using a hall element. It is related with Crankshaft Position Sensor (CKPS) and detects the piston position of each cylinder which the CKPS can’t detect. The two CMPS are installed on engine head cover of bank 1 and 2 respectively and use a target wheel installed on the camshaft. This sensor has a hall-effect IC which output voltage changes when magnetic field is made on the IC with current flow. So the sequential injection of the 6 cylinders is impossible without CMPS signal.



Fuel System > Engine Control System > Camshaft Position Sensor (CMPS) > Specifications

Specification

Item	Specification
Output Voltage (V)	High: 5.0
	Low: 0.7
Air Gap (mm)	0.5 ~ 1.5

Fuel System > Engine Control System > Camshaft Position Sensor (CMPS) > Troubleshooting

Wave Form

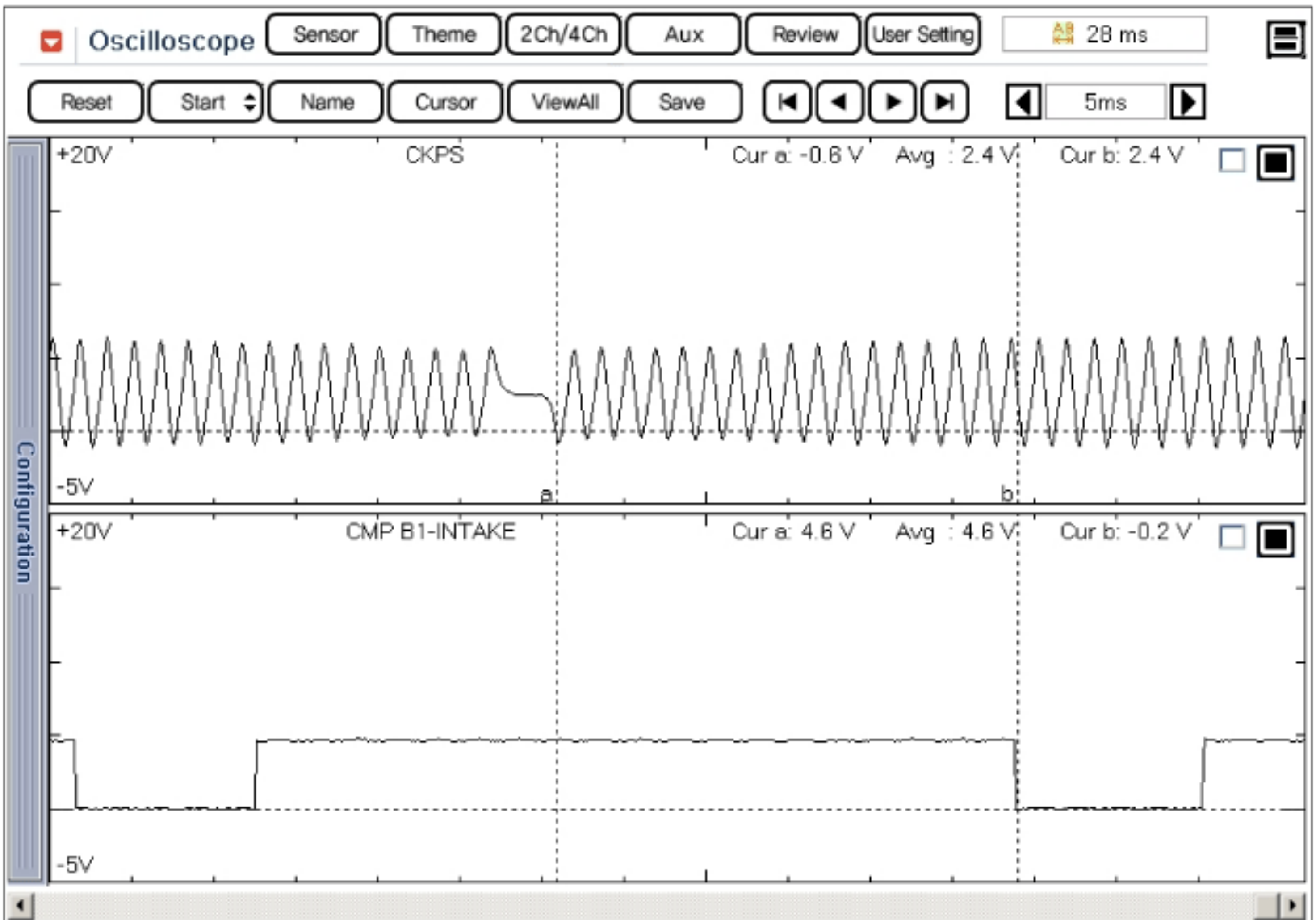


Fig.1

Fig 1) Normal waveform of CKPS & CMPS.

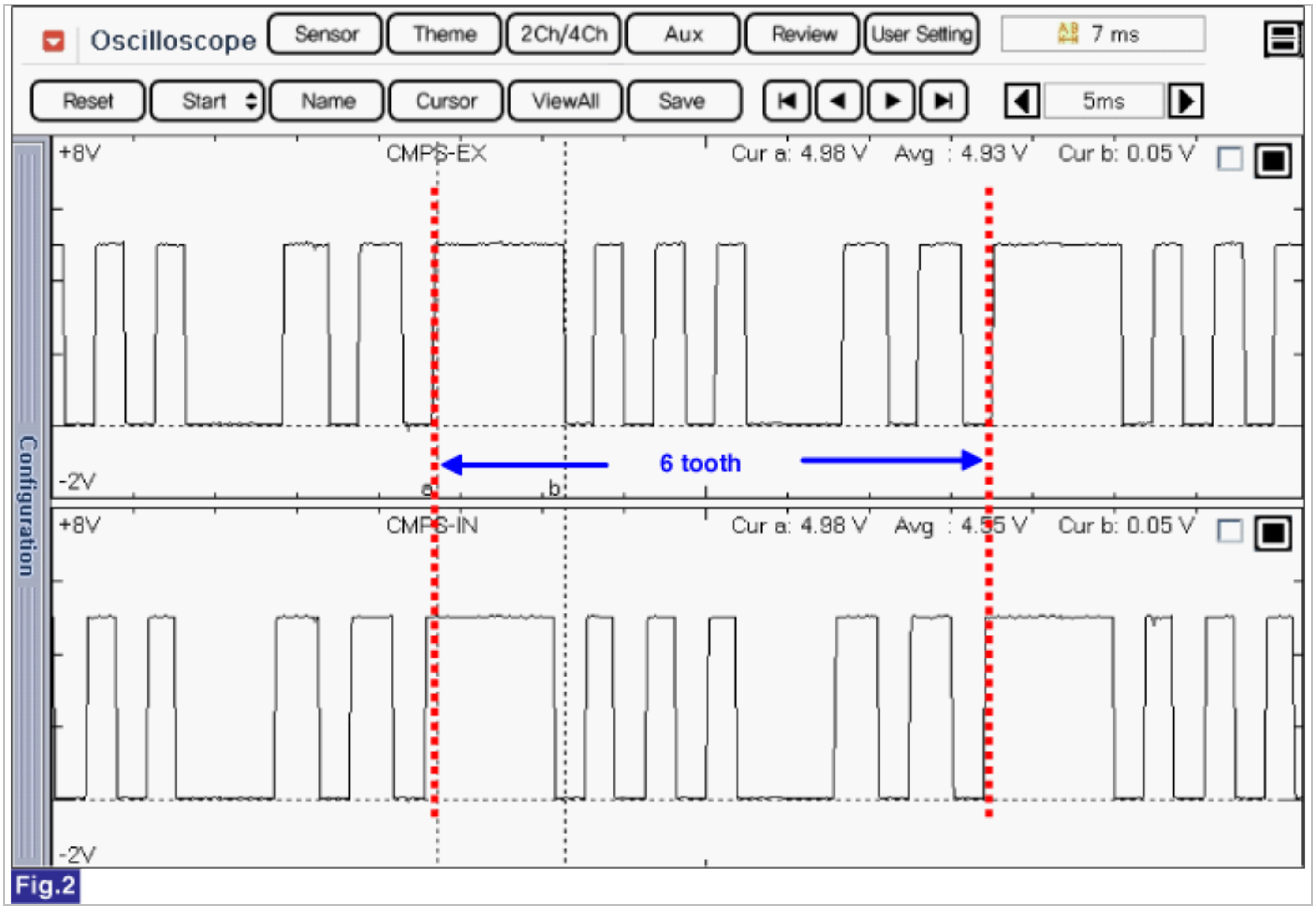
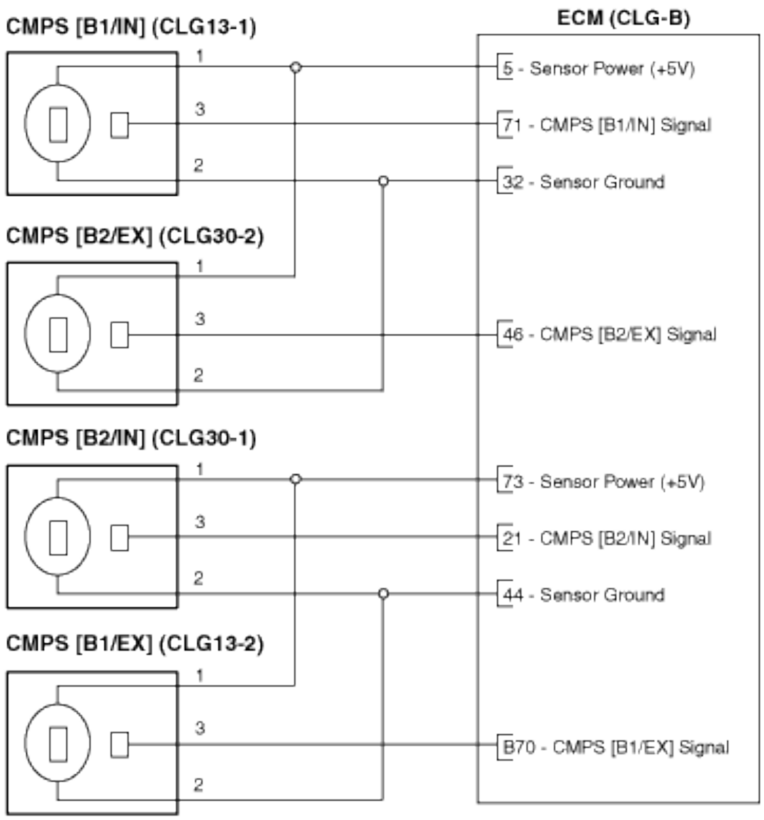


Fig 2) Normal waveform of CMPS.

Fuel System > Engine Control System > Camshaft Position Sensor (CMPS) > Schematic Diagrams

Circuit Diagram

[Circuit Diagram]



[Connection Information]

CMPS [BANK 1/INTAKE] (CLG13-1)

Terminal	Connected to	Function
1	ECM CLG-B (5)	Sensor Power (+5V)
2	ECM CLG-B (32)	Sensor Ground
3	ECM CLG-B (71)	CMPS [B1/IN] Signal

CMPS [BANK 1/EXHAUST] (CLG13-2)

Terminal	Connected to	Function
1	ECM CLG-B (73)	Sensor Power (+5V)
2	ECM CLG-B (44)	Sensor Ground
3	ECM CLG-B (71)	CMPS [B1/EX] Signal

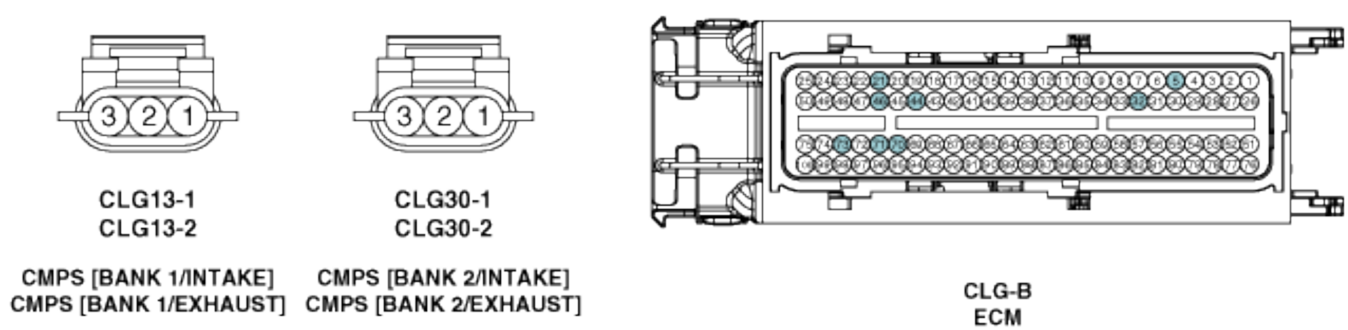
CMPS [BANK 2/INTAKE] (CLG30-1)

Terminal	Connected to	Function
1	ECM CLG-B (73)	Sensor Power (+5V)
2	ECM CLG-B (44)	Sensor Ground
3	ECM CLG-B (21)	CMPS [B2/IN] Signal

CMPS [BANK 2/EXHAUST] (CLG30-2)

Terminal	Connected to	Function
1	ECM CLG-B (5)	Sensor Power (+5V)
2	ECM CLG-B (32)	Sensor Ground
3	ECM CLG-B (46)	CMPS [B2/EX] Signal

[Harness Connector]



Fuel System > Engine Control System > Camshaft Position Sensor (CMPS) > Repair procedures

Inspection

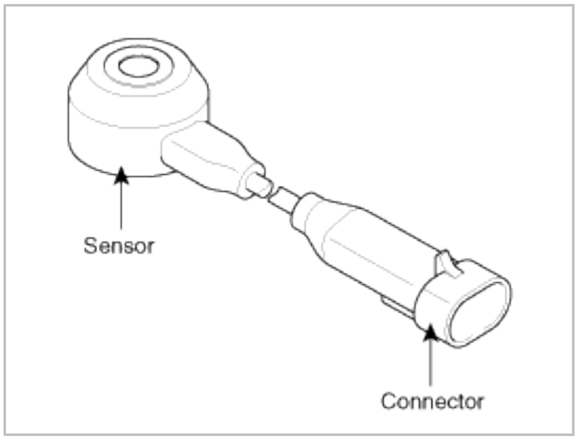
1. Check the signal waveform of the CMPS and CKPS using a scantool.

Specification: Refer to “Wave Form”

Fuel System > Engine Control System > Knock Sensor (KS) > Description and Operation

Description

Knocking is a phenomenon characterized by undesirable vibration and noise and can cause engine damage. Knock Sensor (KS) senses engine knocking and the two sensors are installed inside the V-valley of the cylinder block. When knocking occurs, the vibration from the cylinder block is applied as pressure to the piezoelectric element. At this time, this sensor transfers the voltage signal higher than the specified value to the ECM and the ECM retards the ignition timing. 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.



Fuel System > Engine Control System > Knock Sensor (KS) > Specifications

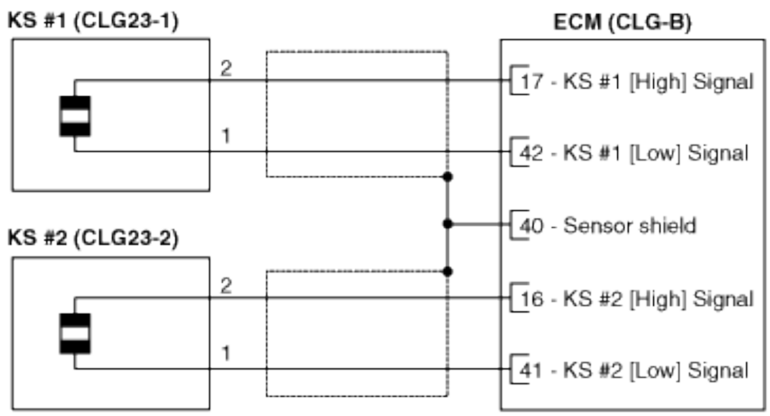
Specification

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

Fuel System > Engine Control System > Knock Sensor (KS) > Schematic Diagrams

Circuit Diagram

[Circuit Diagram]



[Connection Information]

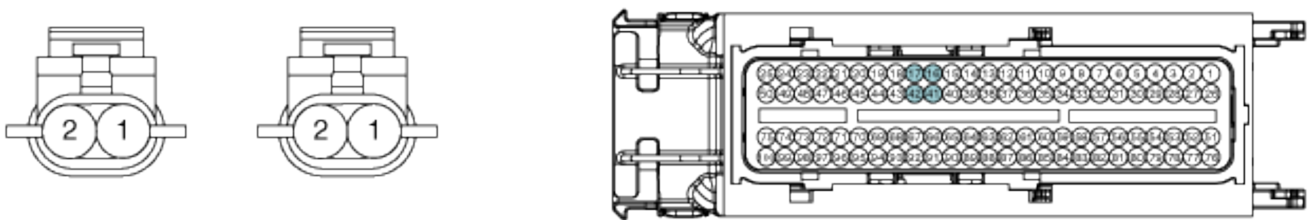
KNOCK SENSOR #1 (CLG23-1)

Terminal	Connected to	Function
1	ECM CLG-B (42)	KS #1 [Low] Signal
2	ECM CLG-B (17)	KS #1 [High] Signal

KNOCK SENSOR #2 (CLG23-2)

Terminal	Connected to	Function
1	ECM CLG-B (41)	KS #2 [Low] Signal
2	ECM CLG-B (16)	KS #2 [High] Signal

[Harness Connector]



CLG23-1 KNOCK SENSOR #1

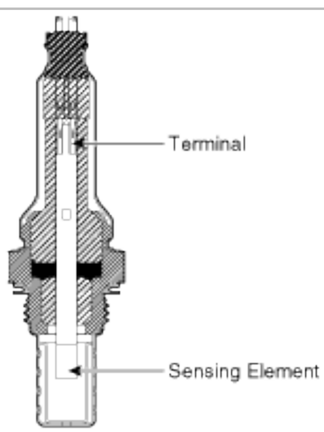
CLG23-2 KNOCK SENSOR #2

CLG-B ECM

Fuel System > Engine Control System > Heated Oxygen Sensor (HO2S) > Description and Operation

Description

Heated Oxygen Sensor (HO2S) consists of the zirconium and the alumina and is installed on upstream and downstream of the Manifold Catalyst Converter (MCC).
After it compares oxygen consistency of the atmosphere with the exhaust gas, it transfers the oxygen consistency of the exhaust gas to the ECM. When A/F ratio is rich or lean, it generates approximately 1V or 0V respectively. In order that this sensor normally operates, the temperature of the sensor tip is higher than 370°C (698°F). So it has a heater which is controlled by the ECM duty signal.
When the exhaust gas temperature is lower than the specified value, the heater warms the sensor tip.



Fuel System > Engine Control System > Heated Oxygen Sensor (HO2S) > Specifications

Specification

A/F Ratio (λ)	Output Voltage(V)
RICH	0.75 ~ 1.0
LEAN	0.2 ~ 0.12

Item	Specification
Heater Resistance (Ω)	8.1 ~ 11.1 [21°C(69.8°F)]

Fuel System > Engine Control System > Heated Oxygen Sensor (HO2S) > Troubleshooting

Wave Form

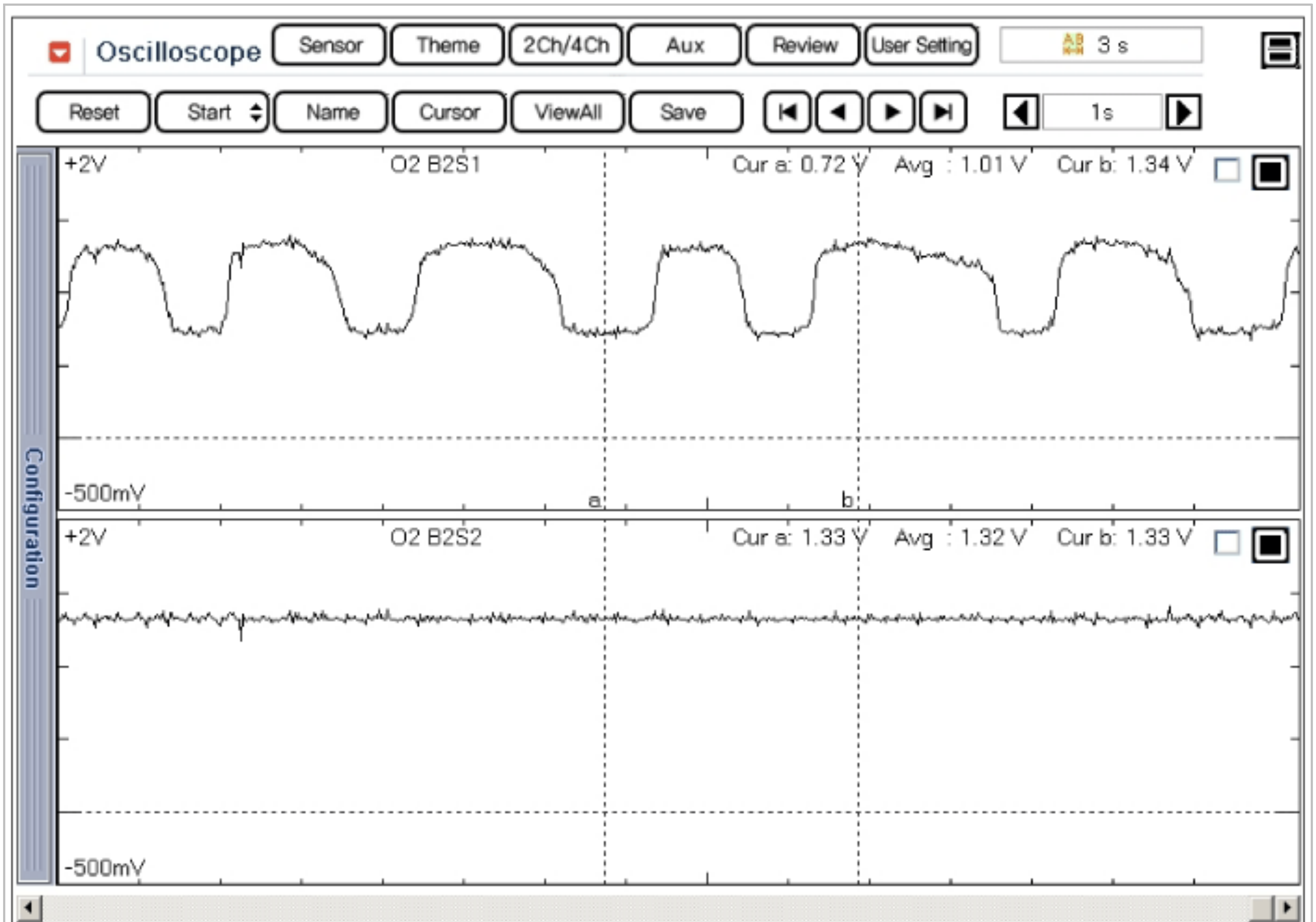


Fig.1

Fig 1) Normal waveform of front HO2S (Sensor 1) and rear HO2S (Sensor 2).

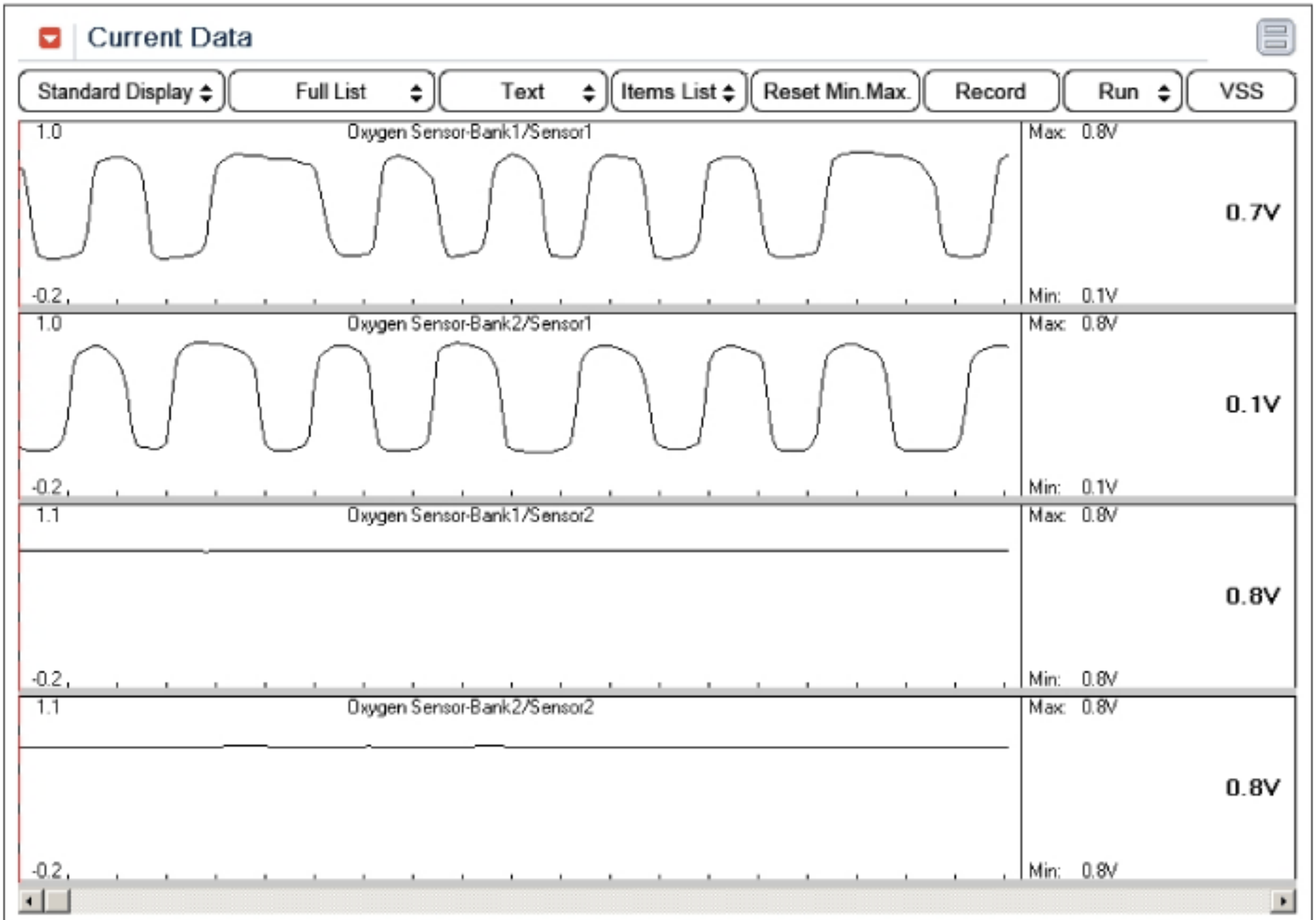


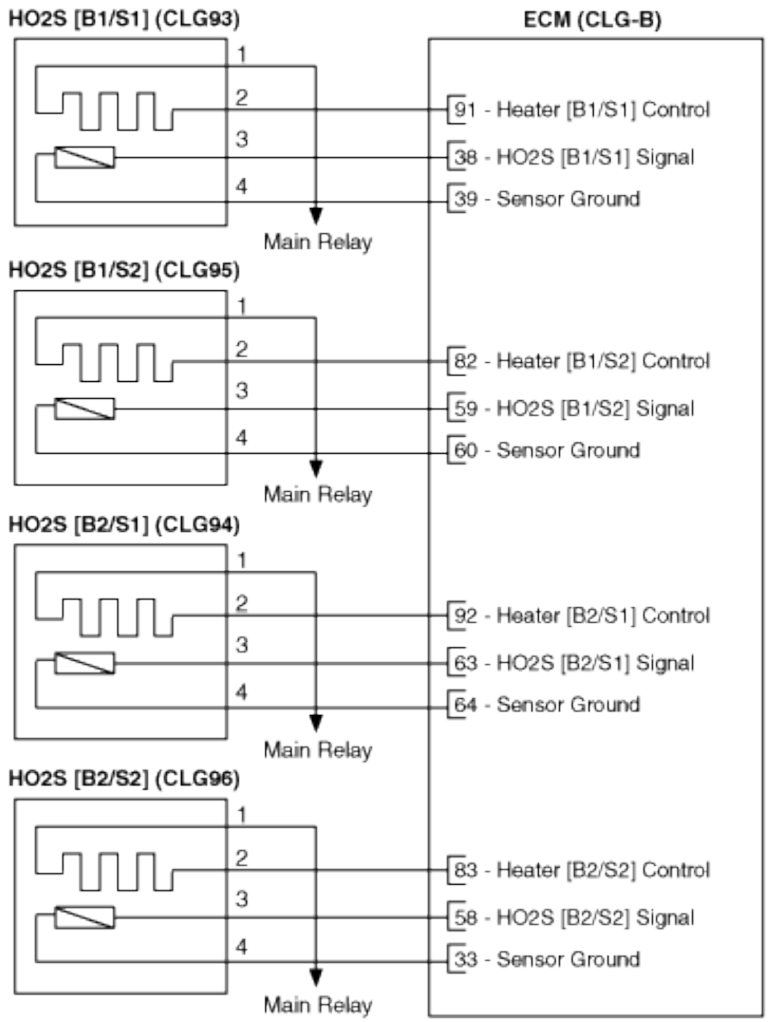
Fig.2

Fig 2) Normal graph of Sensor 1 and Sensor 2 at idle.

Fuel System > Engine Control System > Heated Oxygen Sensor (HO2S) > Schematic Diagrams

Circuit Diagram

[Circuit Diagram]



[Connection Information]

HO2S [BANK 1/SENSOR 1] (CLG93)

Terminal	Connected to	Function
1	Main Relay	Battery Power (B+)
2	ECM CLG-B (19)	Heater [B1/S1] Control
3	ECM CLG-B (38)	HO2S [B1/S1] Signal
4	ECM CLG-B (39)	Sensor Ground

HO2S [BANK 1/SENSOR 2] (CLG95)

Terminal	Connected to	Function
1	Main Relay	Battery Power (B+)
2	ECM CLG-B (82)	Heater [B1/S2] Control
3	ECM CLG-B (59)	HO2S [B1/S2] Signal
4	ECM CLG-B (60)	Sensor Ground

HO2S [BANK 2/SENSOR 1] (CLG94)

Terminal	Connected to	Function
1	Main Relay	Battery Power (B+)
2	ECM CLG-B (92)	Heater [B2/S1] Control
3	ECM CLG-B (63)	HO2S [B2/S1] Signal
4	ECM CLG-B (64)	Sensor Ground

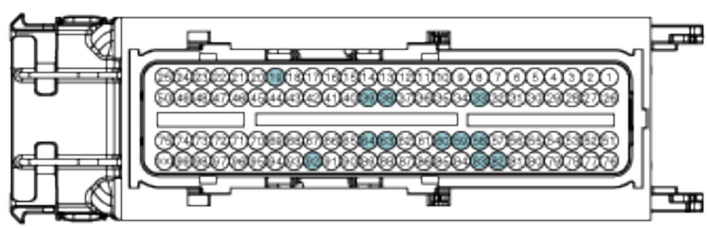
HO2S [BANK 2/SENSOR 2] (CLG96)

Terminal	Connected to	Function
1	Main Relay	Battery Power (B+)
2	ECM CLG-B (83)	Heater [B2/S2] Control
3	ECM CLG-B (58)	HO2S [B2/S2] Signal
4	ECM CLG-B (33)	Sensor Ground

[Harness Connector]

CLG93, CLG95, CLG94, CLG96

HO2S [BANK 1/SENSOR 1]
HO2S [BANK 1/SENSOR 2]
HO2S [BANK 2/SENSOR 1]
HO2S [BANK 2/SENSOR 2]



CLG-B
ECM

Fuel System > Engine Control System > Heated Oxygen Sensor (HO2S) > Repair procedures

Inspection

1. Turn the ignition switch OFF.
2. Disconnect the HO2S connector.
3. Measure resistance between the HO2S terminals 1 and 2.
4. Check that the resistance is within the specification.

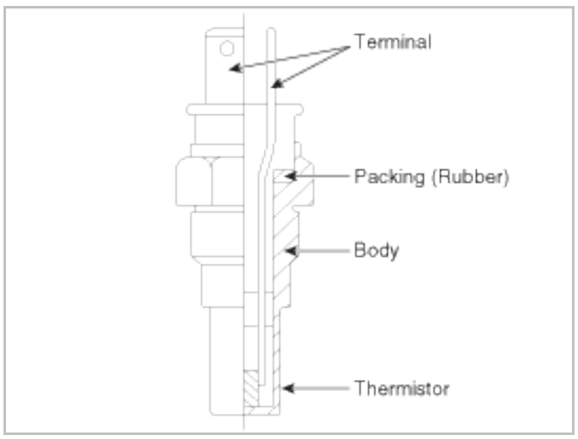
Specification: Refer to “Specification”

Fuel System > Engine Control System > CVVT Oil Temperature Sensor (OTS) > Description and Operation

Description

Continuous Variable Valve Timing (CVVT) system advances or retards the valve timing of the intake and exhaust valve in accordance with the ECM control signal which is calculated by the engine speed and load.
By controlling CVVT, the valve over-lap or under-lap occurs, which makes better fuel economy and reduces exhaust gases (NOx, HC) and improves engine performance through reduction of pumping loss, internal EGR effect, improvement of combustion stability, improvement of volumetric efficiency, and increase of expansion work.
This system consist of
- the CVVT Oil Control Valve (OCV) which supplies the engine oil to the cam phaser or runs out the engine oil from the cam phaser in accordance with the ECM PWM (Pulse With Modulation) control signal,
- the CVVT Oil Temperature Sensor (OTS) which measures the engine oil temperature,
- and the Cam Phaser which varies the cam phase by using the hydraulic force of the engine oil.

The engine oil getting out of the CVVT oil control valve varies the cam phase in the direction (Intake Advance/Exhaust Retard) or opposite direction (Intake Retard/Exhaust Advance) of the engine rotation by rotating the rotor connected with the camshaft inside the cam phaser.



Fuel System > Engine Control System > CVVT Oil Temperature Sensor (OTS) > Specifications

Specification

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

Fuel System > Engine Control System > CVVT Oil Temperature Sensor (OTS) > Schematic

Diagrams

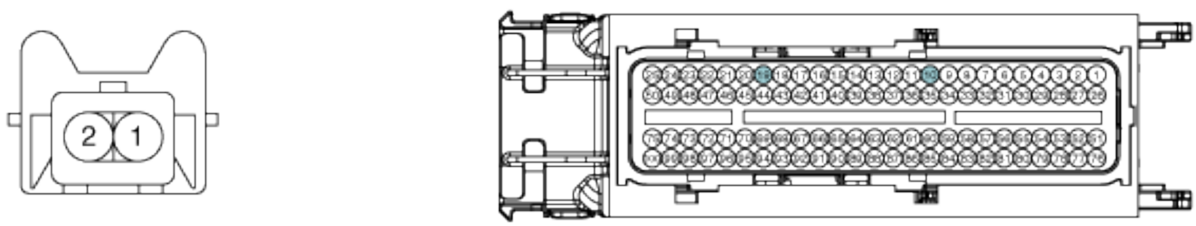
Circuit Diagram

[Circuit Diagram]

[Connection Information]

Terminal	Connected to	Function
1	ECM CLG-B (10)	OTS Signal
2	ECM CLG-B (19)	Sensor Ground

[Harness Connector]



CLG03
OTS

CLG-B
ECM

Fuel System > Engine Control System > CVVT Oil Temperature Sensor (OTS) > Repair procedures

Inspection

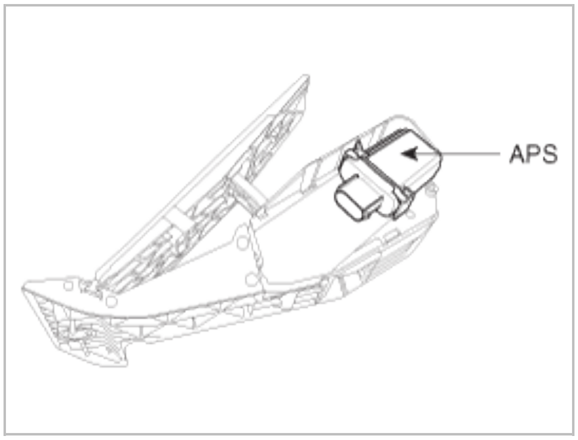
1. Turn the ignition switch OFF.
2. Disconnect the OTS connector.
3. Remove the OTS.
4. After immersing the thermistor of the sensor into engine coolant, measure resistance between the OTS terminals 1 and 2.
5. Check that the resistance is within the specification.

Specification: Refer to “Specification”

Fuel System > Engine Control System > Accelerator Position Sensor (APS) > Description and Operation

Description

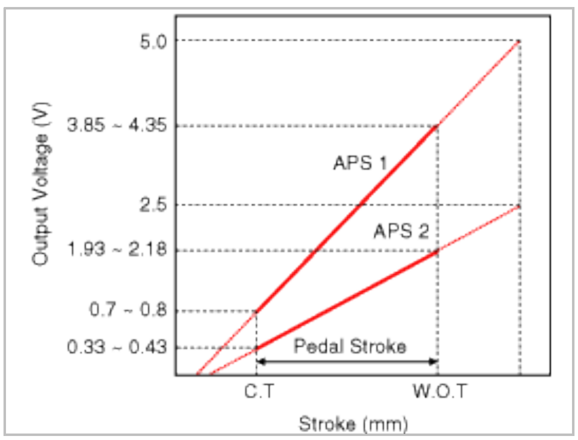
Accelerator Position Sensor (APS) is installed on the accelerator pedal module and detects the rotation angle of the accelerator pedal. The APS is one of the most important sensors in engine control system, so it consists of the two sensors which adapt individual sensor power and ground line. The second sensor monitors the first sensor and its output voltage is half of the first one. If the ratio of the sensor 1 and 2 is out of the range (approximately 1/2), the diagnostic system judges that it is abnormal.



Fuel System > Engine Control System > Accelerator Position Sensor (APS) > Specifications

Specification

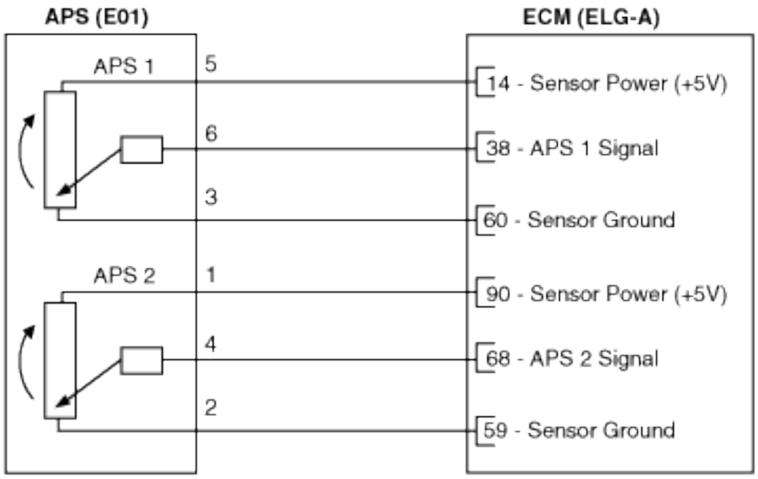
Accelerator Position	Output Voltage (V)	
	APS1	APS2
C.T	0.7 ~ 0.8	0.33 ~ 0.43
W.O.T	3.85 ~ 4.35	1.93 ~ 2.18



Fuel System > Engine Control System > Accelerator Position Sensor (APS) > Schematic Diagrams

Circuit Diagram

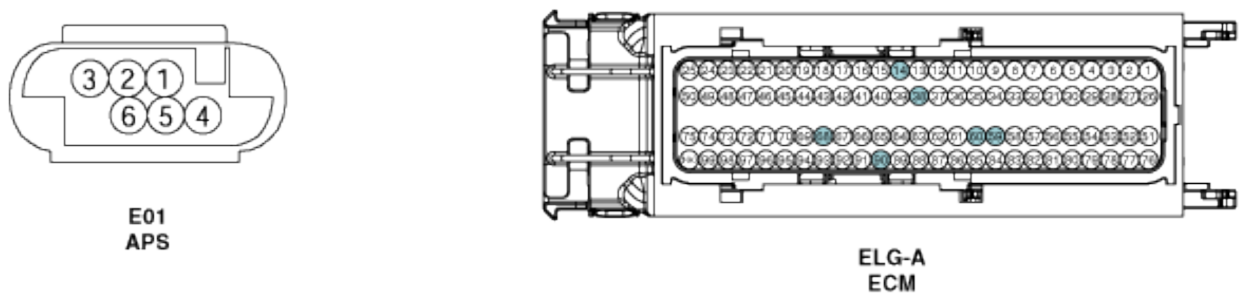
[Circuit Diagram]



[Connection Information]

Terminal	Connected to	Function
1	ECM ELG-A (90)	APS 2 Sensor Power (+5V)
2	ECM ELG-A (59)	APS 2 Sensor Ground
3	ECM ELG-A (60)	APS 1 Sensor Ground
4	ECM ELG-A (68)	APS 2 Signal
5	ECM ELG-A (14)	APS 1 Sensor Power (+5V)
6	ECM ELG-A (38)	APS 1 Signal

[Harness Connector]



Fuel System > Engine Control System > Accelerator Position Sensor (APS) > Repair procedures

Inspection

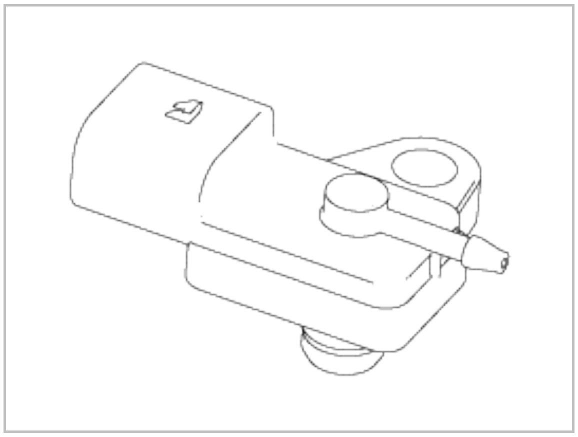
1. Connect a scantool on the Data Link Connector (DLC).
2. Turn the ignition switch ON.
3. Measure the output voltage of the APS 1 and 2 at C.T and W.O.T.

Specification: Refer to “Specification”

Fuel System > Engine Control System > Fuel Tank Pressure Sensor (FTPS) > Description and Operation

Description

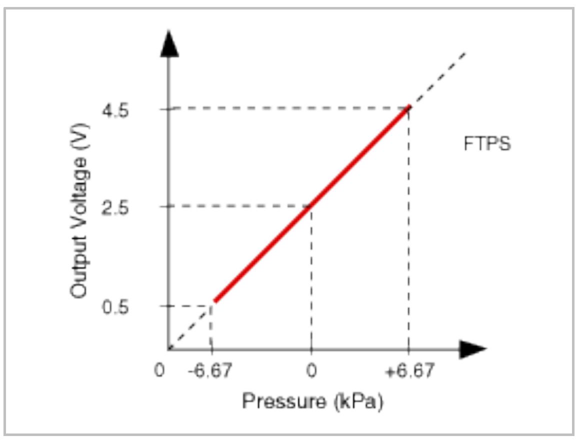
Fuel Tank Pressure Sensor (FTPS) is a component of the evaporative emission control system and is installed on the fuel tank, the fuel pump, or the canister. It checks the purge control solenoid valve operation and detects a leakage of the system.



Fuel System > Engine Control System > Fuel Tank Pressure Sensor (FTPS) > Specifications

Specification

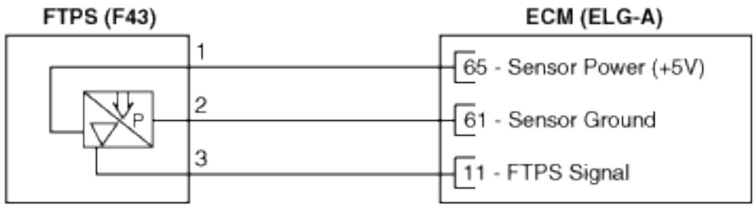
Pressure (kPa)	Output Voltage (V)
-6.67	0.5
0	2.5
+6.67	4.5



Fuel System > Engine Control System > Fuel Tank Pressure Sensor (FTPS) > Schematic Diagrams

Circuit Diagram

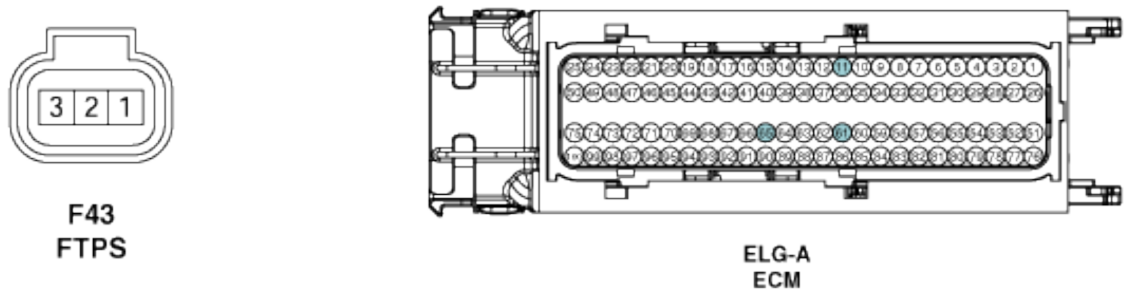
[Circuit Diagram]



[Connection Information]

Terminal	Connected to	Function
1	ECM ELG-A (65)	Sensor Power (+5V)
2	ECM ELG-A (61)	Sensor Ground
3	ECM ELG-A (11)	FTPS Signal

[Harness Connector]



Fuel System > Engine Control System > Fuel Tank Pressure Sensor (FTPS) > Repair procedures

Inspection

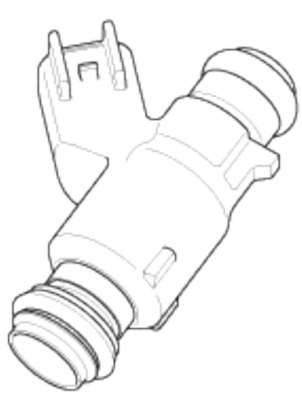
1. Connect a scantool on the Data Link Connector (DLC).
2. Measure the output voltage of the FTPS.

Specification: Refer to "Specification"

Fuel System > Engine Control System > Injector > Description and Operation

Description

Based on information from various sensors, the ECM determines the fuel injection amount. The fuel injector is a solenoid-operated valve and the fuel injection amount is controlled by length of time that the fuel injector is held open. The ECM controls each injector by grounding the control circuit. When the ECM energizes the injector by grounding the control circuit, the circuit voltage should be low (theoretically 0V) and the fuel is injected. When the ECM de-energizes the injector by opening control circuit, the fuel injector is closed and circuit voltage should be peak for a moment.



CAUTION

- If an injector connector is disconnected for more than 46 seconds while the engine runs, the ECM will determine that the cylinder is misfiring and cut fuel supply. So be careful not to exceed 46 seconds.
- But the engine runs normally in 10 seconds after turning the ignition key off.

Fuel System > Engine Control System > Injector > Specifications

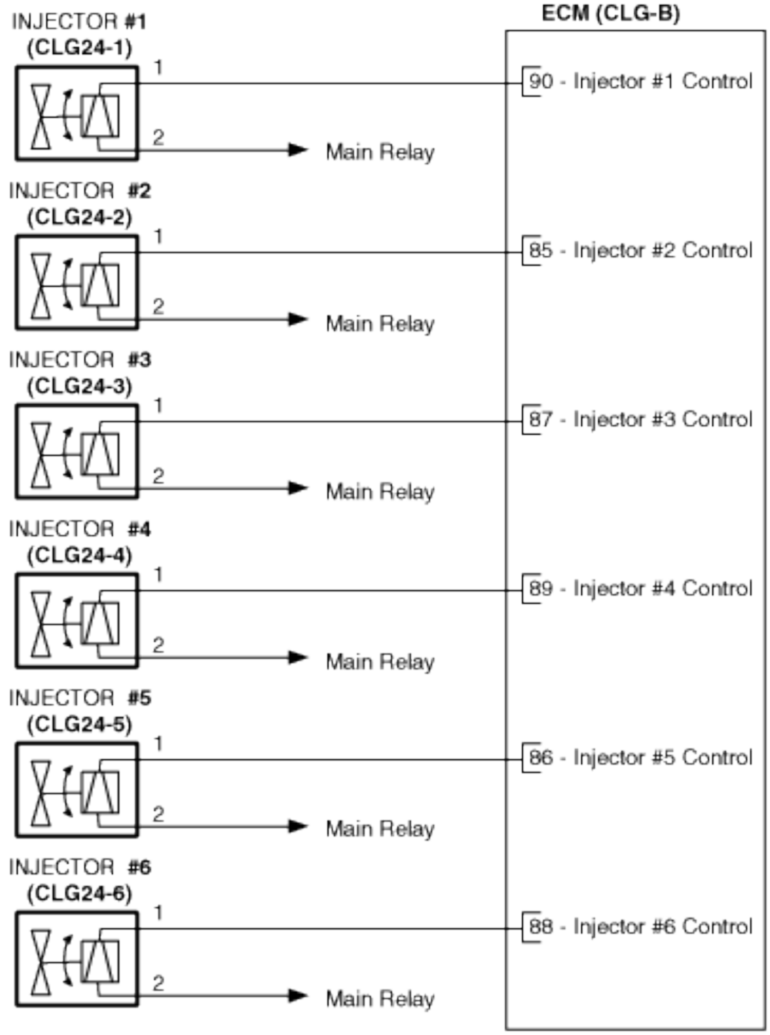
Specification

Item	Specification
Coil Resistance (Ω)	11.6 ~ 12.4 [20°C(68°F)]

Fuel System > Engine Control System > Injector > Schematic Diagrams

Circuit Diagram

[Circuit Diagram]



[Connection Information]

INJECTOR #1 (CLG24-1)

Terminal	Connected to	Function
1	ECM CLG-B (90)	Injector #1 Control
2	Main Relay	Battery Power (B+)

INJECTOR #2 (CLG24-2)

Terminal	Connected to	Function
1	ECM CLG-B (85)	Injector #2 Control
2	Main Relay	Battery Power (B+)

INJECTOR #3 (CLG24-3)

Terminal	Connected to	Function
1	ECM CLG-B (87)	Injector #3 Control
2	Main Relay	Battery Power (B+)

INJECTOR #4 (CLG24-4)

Terminal	Connected to	Function
1	ECM CLG-B (89)	Injector #4 Control
2	Main Relay	Battery Power (B+)

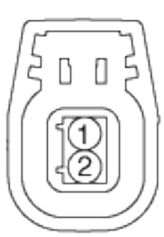
INJECTOR #5 (CLG24-5)

Terminal	Connected to	Function
1	ECM CLG-B (86)	Injector #5 Control
2	Main Relay	Battery Power (B+)

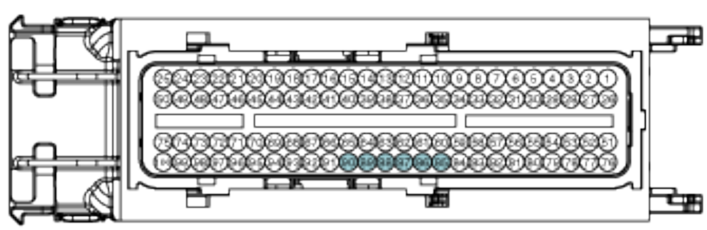
INJECTOR #6 (CLG24-6)

Terminal	Connected to	Function
1	ECM CLG-B (88)	Injector #6 Control
2	Main Relay	Battery Power (B+)

[Harness Connector]



CLG24-1,2,3,4,5,6
INJECTOR #1,2,3,4,5,6



CLG-B
ECM

Fuel System > Engine Control System > Injector > Repair procedures

Inspection

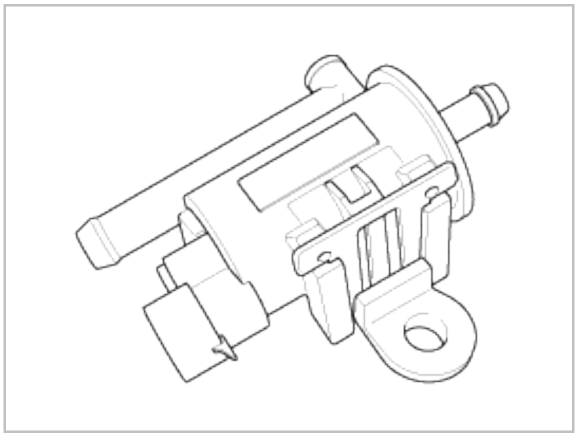
1. Turn the ignition switch OFF.
2. Disconnect the injector connector.
3. Measure resistance between the injector terminals 1 and 2.
4. Check that the resistance is within the specification.

Specification: Refer to "Specification"

Fuel System > Engine Control System > Purge Control Solenoid Valve (PCSV) > Description and Operation

Description

Purge Control Solenoid Valve (PCSV) is installed on the surge tank and controls the passage between the canister and the intake manifold. It is a solenoid valve and is open when the ECM grounds the valve control line. When the passage is open (PCSV ON), fuel vapor stored in the canister is transferred to the intake manifold.



Fuel System > Engine Control System > Purge Control Solenoid Valve (PCSV) > Specifications

Specification

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

Fuel System > Engine Control System > Purge Control Solenoid Valve (PCSV) > Schematic Diagrams

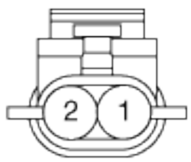
Circuit Diagram

[Circuit Diagram]

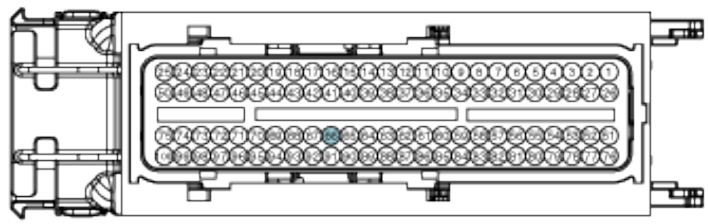
[Connection Information]

Terminal	Connected to	Function
1	Main Relay	Battery Power(B+)
2	ECM ELG-A (66)	PCSV Control

[Harness Connector]



CLG21
PCSV



CLG-B
ECM

Fuel System > Engine Control System > Purge Control Solenoid Valve (PCSV) > Repair procedures

Inspection

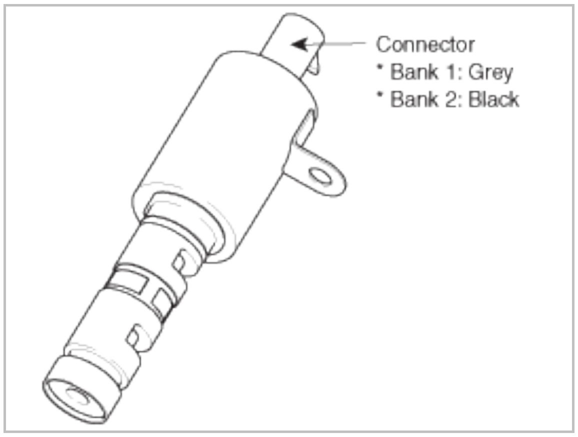
1. Turn the ignition switch OFF.
2. Disconnect the PCSV connector.
3. Measure resistance between the PCSV terminals 1 and 2.
4. Check that the resistance is within the specification.

Specification: Refer to “Specification”

Fuel System > Engine Control System > CVVT Oil Control Valve (OCV) > Description and Operation

Description

Continuous Variable Valve Timing (CVVT) system advances or retards the valve timing of the intake and exhaust valve in accordance with the ECM control signal which is calculated by the engine speed and load.
By controlling CVVT, the valve over-lap or under-lap occurs, which makes better fuel economy and reduces exhaust gases (NOx, HC) and improves engine performance through reduction of pumping loss, internal EGR effect, improvement of combustion stability, improvement of volumetric efficiency, and increase of expansion work.
This system consist of
-the CVVT Oil Control Valve (OCV) which supplies the engine oil to the cam phaser or runs out the engine oil from the cam phaser in accordance with the ECM PWM (Pulse With Modulation) control signal,
- the CVVT Oil Temperature Sensor (OTS) which measures the engine oil temperature,
-and the Cam Phaser which varies the cam phase by using the hydraulic force of the engine oil.
The engine oil getting out of the CVVT oil control valve varies the cam phase in the direction (Intake Advance/Exhaust Retard) or opposite direction (Intake Retard/Exhaust Advance) of the engine rotation by rotating the rotor connected with the camshaft inside the cam phaser.



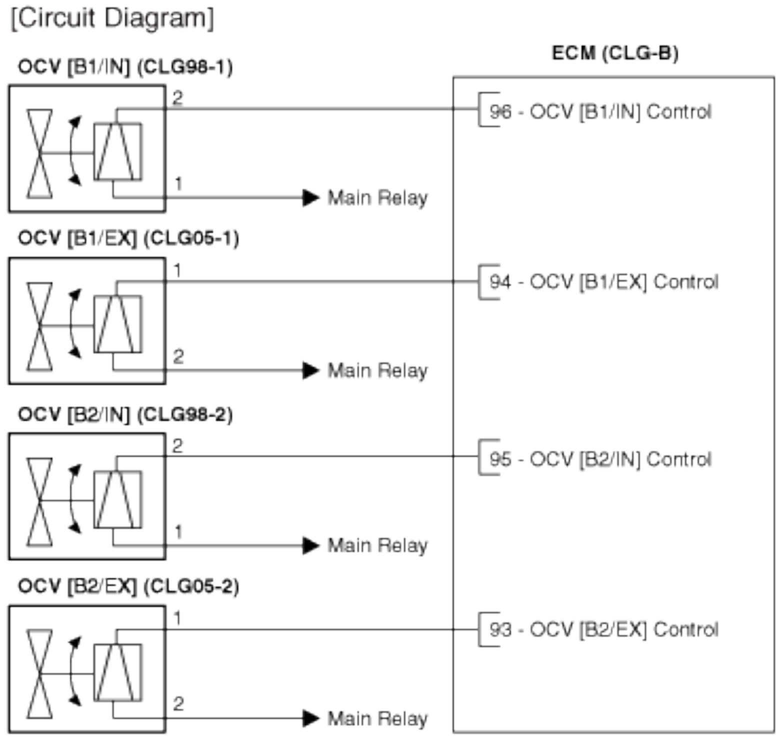
Fuel System > Engine Control System > CVVT Oil Control Valve (OCV) > Specifications

Specification

Item	Specification
Coil Resistance (Ω)	6.7 ~ 7.7 [20°C(68°F)]

Fuel System > Engine Control System > CVVT Oil Control Valve (OCV) > Schematic Diagrams

Circuit Diagram



[Connection Information]

OCV [BANK 1/INTAKE] (CLG98-1)

Terminal	Connected to	Function
1	Main Relay	Battery Power (B+)
2	ECM CLG-B (96)	OCV [B1/IN] Control

OCV [BANK 1/EXHAUST] (CLG05-1)

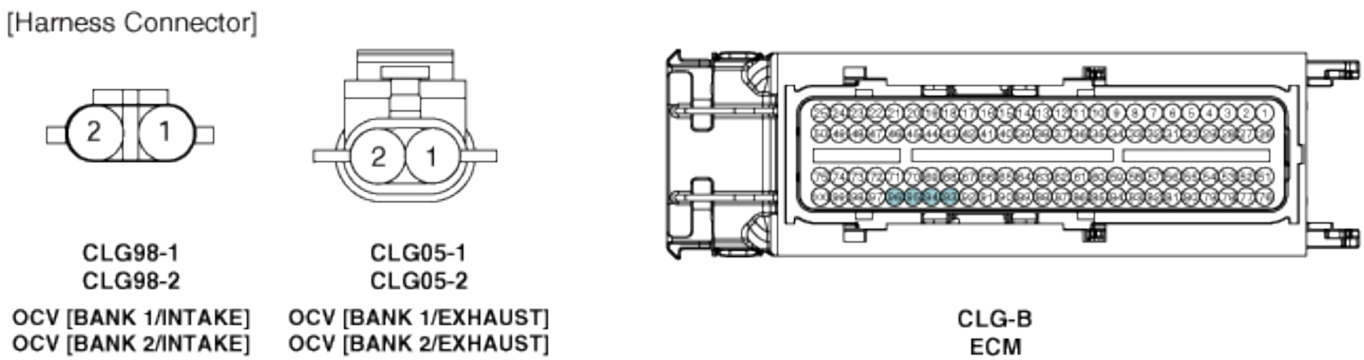
Terminal	Connected to	Function
1	Main Relay	Battery Power (B+)
2	ECM CLG-B (94)	OCV [B1/EX] Control

OCV [BANK 2/INTAKE] (CLG98-2)

Terminal	Connected to	Function
1	Main Relay	Battery Power (B+)
2	ECM CLG-B (95)	OCV [B2/IN] Control

OCV [BANK 2/EXHAUST] (CLG05-2)

Terminal	Connected to	Function
1	Main Relay	Battery Power (B+)
2	ECM CLG-B (93)	OCV [B2/EX] Control



Fuel System > Engine Control System > CVVT Oil Control Valve (OCV) > Repair procedures

Inspection

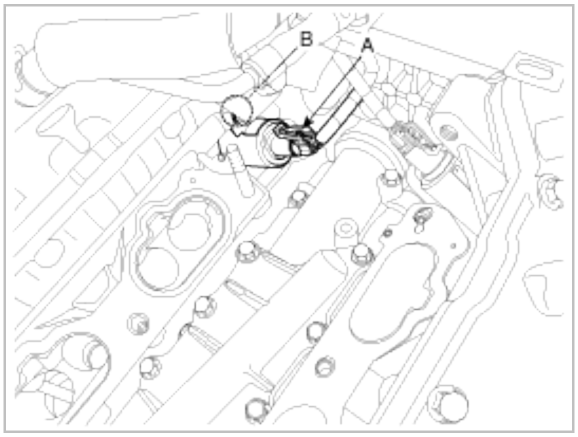
1. Turn the ignition switch OFF.
2. Disconnect the OCV connector.
3. Measure resistance between the OCV terminals 1 and 2.
4. Check that the resistance is within the specification.

Specification: Refer to “Specification”

Removal

[CVVT Oil Control Valve (Intake)]

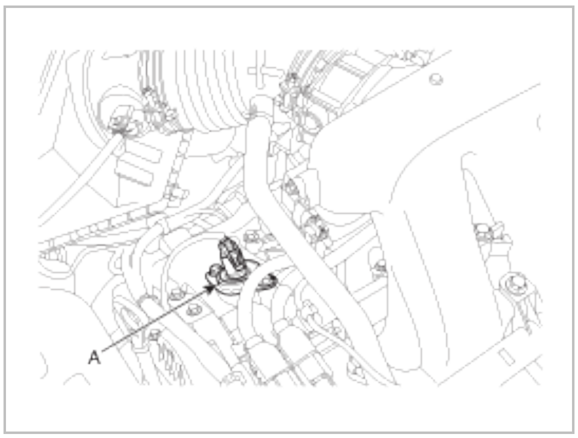
1. Turn ignition switch OFF and disconnect the negative (-) battery cable.
2. Remove the intake manifold (Refer to “Intake And Exhaust System” in EM group).
3. Disconnect the CVVT oil control valve connector (A).



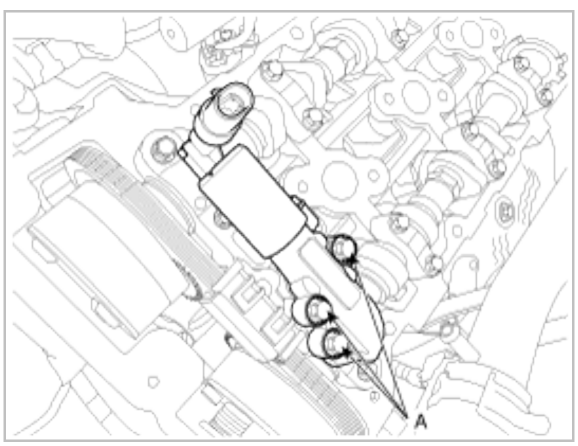
4. Remove the mounting bolt (B), and then remove the valve from the engine.

[CVVT Oil Control Valve (Exhaust)]

1. Turn ignition switch OFF and disconnect the negative (-) battery cable.
2. Disconnect the CVVT oil control valve connector (A).



3. Remove the cylinder head cover (Refer to “Cylinder Head Assembly” in EM group).
4. Remove the mounting bolt (A), and then remove the valve from the engine.



Installation

1. Installation is reverse of removal.

CVVT oil control valve installation bolt:
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lbf.ft)

CAUTION

Pay attention to color of valve connector (Component and harness side) when installing. If an OCV is installed on opposite bank, the engine may be damaged.

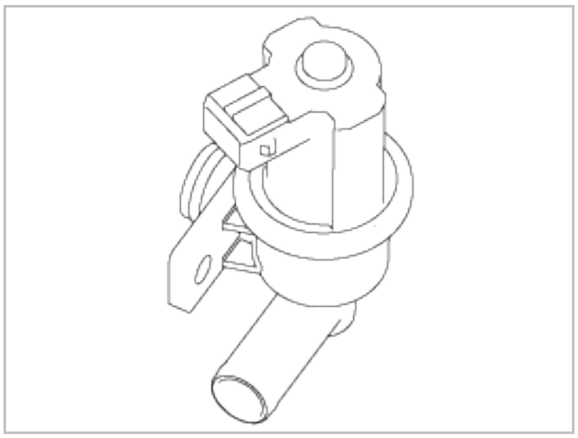
[Connector Color]

Item	Component Side	Harness Side
Bank1 (RH)	Grey	
Bank 2(LH)	Black	

Fuel System > Engine Control System > Canister Close Valve (CCV) > Description and Operation

Description

Canister Close Valve (CCV) is installed on the canister ventilation line. It seals evaporative emission control system by shutting the canister from the atmosphere when leakage detecting system operates.



Fuel System > Engine Control System > Canister Close Valve (CCV) > Specifications

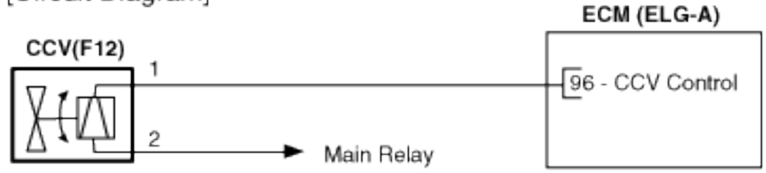
Specification

Item	Specification
Coil Resistance (Ω)	23.0 ~ 26.0 (20°C)

Fuel System > Engine Control System > Canister Close Valve (CCV) > Schematic Diagrams

Circuit Diagram

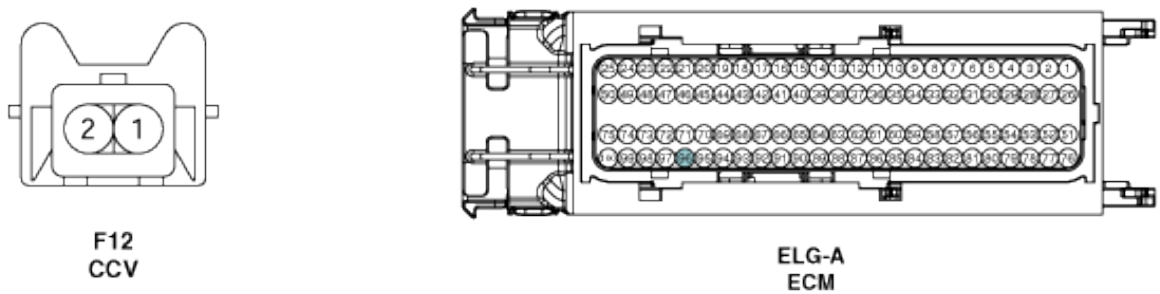
[Circuit Diagram]



[Connection Information]

Terminal	Connected to	Function
1	ECM ELG-A (96)	CCV Control
2	Main Relay	Battery Power (B+)

[Harness Connector]



Fuel System > Engine Control System > Canister Close Valve (CCV) > Repair procedures

Inspection

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

Specification: Refer to "Specification"

5. Disconnect the vapor hose connected with the canister from the CCV.
6. Connect a vacuum pump to the nipple.
7. Ground the CCV control line and apply battery voltage to the CCV power supply line.
8. Apply vacuum and check the valve operation.

Specification: Vacuum maintained

Fuel System > Engine Control System > Troubleshooting

Inspection Chart For Diagnostic Trouble Codes (DTC)

DTC	Description	MIL
P0011	"A" Camshaft Position-Timing Over-Advanced or System Performance (Bank 1)	●
P0012	"A" Camshaft Position-Timing Over-Retarded (Bank 1)	●
P0014	"B" Camshaft Position -Timing Over-Advanced or System Performance (Bank 1)	●
P0015	"B" Camshaft Position -Timing Over-Retarded (Bank 1)	●
P0016	Crankshaft Position–Camshaft Position Correlation (Bank 1 Sensor A)	●

P0017	Crankshaft Position–Camshaft Position Correlation (Bank 1 Sensor B)	●
P0018	Crankshaft Position-Camshaft Position Correlation (Bank 2 Sensor A)	●
P0019	Crankshaft Position–Camshaft Position Correlation (Bank 2 Sensor B)	●
P0021	"A" Camshaft Position-Timing Over-Advanced or System Performance (Bank 2)	●
P0022	"A" Camshaft Position-Timing Over-Retarded (Bank 2)	●
P0024	"B" Camshaft Position-Timing Over-Advanced or System Performance (Bank 2)	●
P0025	"B" Camshaft Position-Timing Over-Retarded (Bank 2)	●
P0026	Intake Valve Control Solenoid Circuit Range/Performance (Bank 1)	●
P0027	Exhaust Valve Control Solenoid Circuit Range/Performance (Bank 1)	●
P0028	Intake Valve Control Solenoid Circuit Range/Performance (Bank 2)	●
P0029	Exhaust Valve Control Solenoid Circuit Range/Performance (Bank 2)	●
P0030	HO2S Heater Control Circuit (Bank 1/Sensor 1)	●
P0031	HO2S Heater Control Circuit Low (Bank 1/Sensor 1)	●
P0032	HO2S Heater Control Circuit High (Bank 1/Sensor 1)	●
P0036	HO2S Heater Control Circuit (Bank 1/Sensor 2)	●
P0037	HO2S Heater Control Circuit Low (Bank 1/Sensor 2)	●
P0038	HO2S Heater Control Circuit High (Bank 1/Sensor 2)	●
P0050	HO2S Heater Control Circuit (Bank 2/Sensor 1)	●
P0051	HO2S Heater Control Circuit Low (Bank 2/Sensor 1)	●
P0052	HO2S Heater Control Circuit High (Bank 2/Sensor 1)	●
P0056	HO2S Heater Control Circuit (Bank 2/Sensor 2)	●
P0057	HO2S Heater Control Circuit Low (Bank 2/Sensor 2)	●
P0058	HO2S Heater Control Circuit High (Bank 2/Sensor 2)	●
P0076	Intake Valve Control Solenoid Circuit-Low (Bank 1)	●
P0077	Intake Valve Control Solenoid Circuit-High (Bank 1)	●
P0079	Exhaust Valve Control Solenoid Circuit Low (Bank 1)	●
P0080	Exhaust Valve Control Solenoid Circuit High (Bank 1)	●
P0082	Intake Valve Control Solenoid Circuit-Low (Bank 2)	●
P0083	Intake Valve Control Solenoid Circuit-High (Bank 2)	●
P0085	Exhaust Valve Control Solenoid Circuit Low (Bank 2)	●
P0086	Exhaust Valve Control Solenoid Circuit High (Bank 2)	●
P0101	Mass or Volume Air Flow "A" Circuit Range/Performance	●
P0102	Mass or Volume Air Flow "A" Circuit Low Input	●
P0103	Mass or Volume Air Flow "A" Circuit High Input	●
P0105	Manifold Absolute Pressure/Barometric Pressure Circuit	●
P0106	Manifold Absolute Pressure/Barometric Pressure Circuit Range/Performance	●
P0107	Manifold Absolute Pressure/Barometric Pressure Circuit Low Input	●
P0108	Manifold Absolute Pressure/Barometric Pressure Circuit High Input	●

P0109	Manifold Absolute Pressure/Barometric Pressure Circuit Intermittent	▲
P0110	Intake Air Temperature Sensor 1 Circuit	●
P0111	Intake Air Temperature Sensor 1 Circuit Range/Performance	●
P0112	Intake Air Temperature Sensor 1 Circuit Low Input	●
P0113	Intake Air Temperature Sensor 1 Circuit High Input	●
P0115	Engine Coolant Temperature Circuit	●
P0116	Engine Coolant Temperature Circuit Range/Performance	●
P0117	Engine Coolant Temperature Circuit Low Input	●
P0118	Engine Coolant Temperature Circuit High Input	●
P0122	Throttle/Pedal Position Sensor/Switch "A" Circuit Low Input	●
P0123	Throttle/Pedal Position Sensor/Switch "A" Circuit High Input	●
P0125	Insufficient Coolant Temperature for Closed Loop Fuel Control	●
P0128	Coolant Thermostat (Coolant Temperature below Thermostat Regulating Temperature)	●
P0131	O2 Sensor Circuit Low Voltage (Bank 1/Sensor 1)	●
P0132	O2 Sensor Circuit High Voltage (Bank 1/Sensor 1)	●
P0133	O2 Sensor Circuit Slow Response (Bank 1/Sensor 1)	●
P0134	O2 Sensor Circuit No Activity Detected (Bank 1 Sensor 1)	●
P0137	O2 Sensor Circuit Low Voltage (Bank 1/Sensor 2)	●
P0138	O2 Sensor Circuit High Voltage (Bank 1/Sensor 2)	●
P0139	O2 Sensor Circuit Slow Response (Bank 1/Sensor 2)	●
P0140	O2 Sensor Circuit No Activity Detected (Bank 1/Sensor 2)	●
P0151	O2 Sensor Circuit Low Voltage (Bank 2/Sensor 1)	●
P0152	O2 Sensor Circuit High Voltage (Bank 2/Sensor 1)	●
P0153	O2 Sensor Circuit Slow Response (Bank 2/Sensor 1)	●
P0154	O2 Sensor Circuit No Activity Detected (Bank 2/Sensor 1)	●
P0157	O2 Sensor Circuit Low Voltage (Bank 2/Sensor 2)	●
P0158	O2 Sensor Circuit High Voltage (Bank 2/Sensor 2)	●
P0159	O2 Sensor Circuit Slow Response (Bank 2/Sensor 2)	●
P0160	O2 Sensor Circuit No Activity Detected (Bank 2/Sensor 2)	●
P0171	System too Lean (Bank 1)	●
P0172	System too Rich (Bank 1)	●
P0174	System too Lean (Bank 2)	●
P0175	System too Rich (Bank 2)	●
P0196	Engine Oil Temperature Sensor-Range/Performance	●
P0197	Engine Oil Temperature Sensor Low Input	●
P0198	Engine Oil Temperature Sensor High Input	●
P0217	Engine Coolant Over Temperature Condition	●
P0222	Throttle/Pedal Position Sensor/Switch "B" Circuit Low Input	●

P0223	Throttle/Pedal Position Sensor/Switch "B" Circuit High Input	●
P0230	Fuel Pump Primary Circuit	▲
P0261	Cylinder 1 Injector Circuit Low	●
P0262	Cylinder 1 Injector Circuit High	●
P0264	Cylinder 2 Injector Circuit Low	●
P0265	Cylinder 2 Injector Circuit High	●
P0267	Cylinder 3 Injector Circuit Low	●
P0268	Cylinder 3 Injector Circuit High	●
P0270	Cylinder 4 Injector Circuit Low	●
P0271	Cylinder 4 Injector Circuit High	●
P0273	Cylinder 5 Injector Circuit Low	●
P0274	Cylinder 5 Injector Circuit High	●
P0276	Cylinder 6 Injector Circuit Low	●
P0277	Cylinder 6 Injector Circuit High	●
P0300	Random/Multiple Cylinder Misfire Detected	●
P0301	Cylinder 1-Misfire detected	●
P0302	Cylinder 2-Misfire detected	●
P0303	Cylinder 3-Misfire detected	●
P0304	Cylinder 4-Misfire detected	●
P0305	Cylinder 5-Misfire detected	●
P0306	Cylinder 6-Misfire detected	●
P0315	Crankshaft Position (CKP) Sensor Error	▲
P0325	Knock Sensor 1 Circuit (Bank 1 or Single Sensor)	●
P0326	Knock Sensor 1 Circuit Range/Performance (Bank 1 or Single Sensor)	●
P0330	Knock Sensor 2 Circuit (Bank 2)	●
P0331	Knock Sensor 2 Circuit Range/Performance (Bank 2)	●
P0335	Crankshaft Position Sensor "A" Circuit	●
P0336	Crankshaft Position Sensor "A" Circuit Range/Performance	●
P0340	Camshaft Position Sensor "A" Circuit (Single Sensor)	●
P0341	Camshaft Position Sensor "A" Circuit Range/Performance (Bank 1)	●
P0346	Camshaft Position Sensor "A" Circuit Range/Performance (Bank 2)	●
P0351	Ignition Coil 'A' Primary/Secondary Circuit	●
P0352	Ignition Coil 'B' Primary/Secondary Circuit	●
P0353	Ignition Coil 'C' Primary/Secondary Circuit	●
P0354	Ignition Coil 'D' Primary/Secondary Circuit	●
P0355	Ignition Coil 'E' Primary/Secondary Circuit	●
P0356	Ignition Coil 'F' Primary/Secondary Circuit	●
P0366	Camshaft Position Sensor "B" Circuit Range/Performance (Bank 1)	●

P0391	Camshaft Position Sensor "B" Circuit Range/Performance (Bank 2)	●
P0420	Catalyst System Efficiency below Threshold (Bank 1)	●
P0430	Catalyst System Efficiency Below Threshold (Bank 2)	●
P0441	Evaporative Emission System-Incorrect Purge Flow	●
P0442	Evaporative Emission System-Leak detected (Small Leak)	●
P0444	Evaporative Emission System-Purge Control Valve Circuit Open	●
P0445	Evaporative Emission System-Purge Control Valve Circuit Shorted	●
P0447	Evaporative Emission System-Vent Control Circuit Open	●
P0448	Evaporative Emission System-Vent Control Circuit Shorted	●
P0451	Evaporative Emission System-Pressure Sensor Range/Performance	●
P0452	Evaporative Emission System-Pressure Sensor Low Input	●
P0453	Evaporative Emission System-Pressure Sensor High Input	●
P0454	Evaporative Emission System-Pressure Sensor Intermittent	●
P0455	Evaporative Emission System-Leak detected (Large leak)	●
P0456	Evaporative Emission System-Leak detected (Very Small Leak)	●
P0461	Fuel Level Sensor "A" Circuit Range/Performance	●
P0462	Fuel Level Sensor "A" Circuit Low Input	●
P0463	Fuel Level Sensor "A" Circuit High Input	●
P0464	Fuel Level Sensor "A" Circuit Intermittent	●
P0480	Fan 1 Control Circuit	●
P0481	Fan 2 Control Circuit Malfunction	●
P0501	Vehicle Speed Sensor "A" Range/Performance	●
P0504	Brake Switch "A"/"B" Correlation	●
P0506	Idle Air Control System-RPM Lower than Expected	●
P0507	Idle Air Control System-RPM Higher than Expected	●
P050B	Cold Start Ignition Timing Performance	●
P0532	A/C Refrigerant Pressure Sensor "A" Circuit Low Input	▲
P0533	A/C Refrigerant Pressure Sensor "A" Circuit High Input	▲
P0562	System Voltage Low	●
P0563	System Voltage High	●
P0571	Brake Switch "A" Circuit	●
P0601	Internal Control Module Memory Check Sum Error	●
P0602	Control Module Programming Error	●
P0604	Internal Control Module Random Access Memory (RAM) Error	●
P0606	ECM/PCM Processor	●
P061B	Internal Control Module Torque Calculation Performance	▲
P0630	VIN Not Programmed or Incompatible-ECM/PCM	●
P0638	Throttle Actuator Control Range/Performance (Bank 1)	●

P0641	Sensor Reference Voltage "A" Circuit/Open	●
P0646	A/C Clutch Relay Control Circuit Low	▲
P0647	A/C Clutch Relay Control Circuit High	▲
P0650	Malfunction Indicator Lamp (MIL) Control Circuit	▲
P0685	ECM/PCM Power Relay Control Circuit /Open	▲
P0700	Transmission Control System (MIL Request)	●
P1106	Manifold Absolute Pressure Sensor Circuit Intermittent High	▲
P1107	Manifold Absolute Pressure Sensor Circuit Intermittent Low	▲
P1111	Intake Air Temperature Sensor Circuit Intermittent High	▲
P1112	Intake Air Temperature Sensor Circuit Intermittent Low	▲
P1114	Engine Coolant Temperature Sensor Circuit Intermittent Low	▲
P1115	Engine Coolant Temperature Sensor Circuit Intermittent High	▲
P1295	Throttle Actuator Control System-Power Management	●
P1523	Throttle Actuator Control System-Throttle Valve Stuck	▲
P161B	ECM Torque Calculation Performance	●
P2065	Fuel Level Sensor "B" Circuit	●
P2066	Fuel Level Sensor "B" Performance	●
P2067	Fuel Level Sensor "B" Circuit Low	●
P2068	Fuel Level Sensor "B" Circuit High	●
P2096	Post Catalyst Fuel Trim System Too Lean (Bank 1)	●
P2097	Post Catalyst Fuel Trim System Too Rich (Bank 1)	●
P2098	Post Catalyst Fuel Trim System Too Lean (Bank 2)	●
P2099	Post Catalyst Fuel Trim System Too Rich (Bank 2)	●
P2104	Throttle Actuator Control System-Forced Idle	●
P2105	Throttle Actuator Control System-Force Engine Shutdown	●
P2106	Throttle Actuator Control System-Force Limited Power	●
P2122	Throttle/Pedal Position Sensor/Switch "D" Circuit Low Input	●
P2123	Throttle/Pedal Position Sensor/Switch "D" Circuit High Input	●
P2127	Throttle/Pedal Position Sensor/Switch "E" Circuit Low Input	●
P2128	Throttle/Pedal Position Sensor/Switch "E" Circuit-High Input	●
P2135	Throttle/Pedal Position Sensor/Switch A/B Voltage Correlation	●
P2138	Throttle/Pedal Position Sensor/Switch D/E Voltage Correlation	●
P2173	Throttle Actuator Control System-High Air Flow Detected	●
P2187	System too Lean at Idle (←Additive) (Bank 1)	●
P2188	System too Rich at Idle (Bank 1)	●
P2189	System too Lean at Idle (←Additive) (Bank 2)	●
P2190	System too Rich at Idle (Bank 2)	●
P2195	O2 Sensor Signal Stuck Lean (Bank 1 Sensor 1)	●

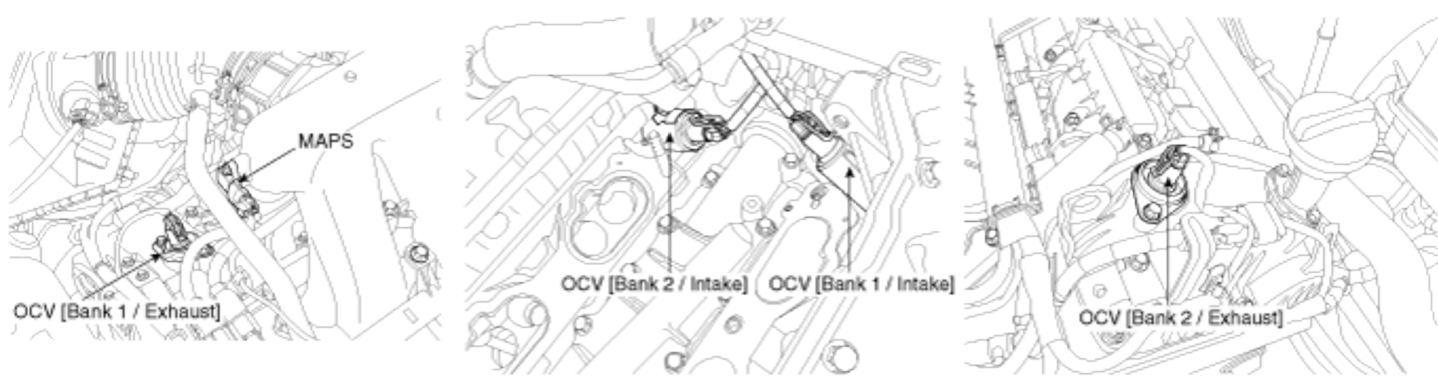
P2196	O2 Sensor Signal Stuck Rich (Bank 1 Sensor 1)	●
P2197	O2 Sensor Signal Stuck Lean (Bank 2 Sensor 1)	●
P2198	O2 Sensor Signal Stuck Rich (Bank 2 Sensor 1)	●
P2270	O2 Sensor Signal Stuck Lean (Bank 1 Sensor 2)	●
P2271	O2 Sensor Signal Stuck Rich (Bank 1 Sensor 2)	●
P2272	O2 Sensor Signal Stuck Lean (Bank 2 Sensor 2)	●
P2273	O2 Sensor Signal Stuck Rich (Bank 2 Sensor 2)	●
P2422	Evaporative Emission System Vent Valve Stuck Closed	●
P2507	ECM/PCM power Input Signal Low	●
P2610	ECM/PCM-Engine Off Timer Performance	●
P2A00	HO2S Not Ready (Bank 1/Sensor 1)	●
P2A01	HO2S Sensor Circuit Range/Performance(Bank1/Sensor2)	●
P2A03	HO2S Not Ready (Bank 2/Sensor 1)	●
P2A04	HO2S Sensor Circuit Range/Performance(Bank2/Sensor2)	●
U0001	High Speed CAN Communication Bus off	●
U0101	Lost Communication With TCM	●

NOTE

●: MIL ON & Memory
▲: MIL OFF & Memory

Fuel System > Engine Control System > P0011 \'A\' Camshaft Position-Timing Over-Advanced or System Performance (Bank 1)

Component Location



General Description

The CVVT (Continuously Variable Valve Timing) system is installed to the chain sprocket of the intake camshaft. This system controls the intake camshaft to provide the optimal valve timing for every driving condition. The ECM controls the Oil Control Valve(OCV), based on the signals output from mass air flow, throttle position and engine coolant temperature. The CVVT controller regulates the intake camshaft angle using oil pressure through the OCV. As result, the relative position between the camshaft and the crankshaft becomes optimal, and the engine torque improves, fuel economy improves, exhaust emissions decrease under over all driving conditions.

DTC Description

ECM detects CAM phasing average rate while cam signal is normally generating.
ECM determines that a fault exists and a DTC is stored while vehicle is tip - in and out driving for 5 minutes.

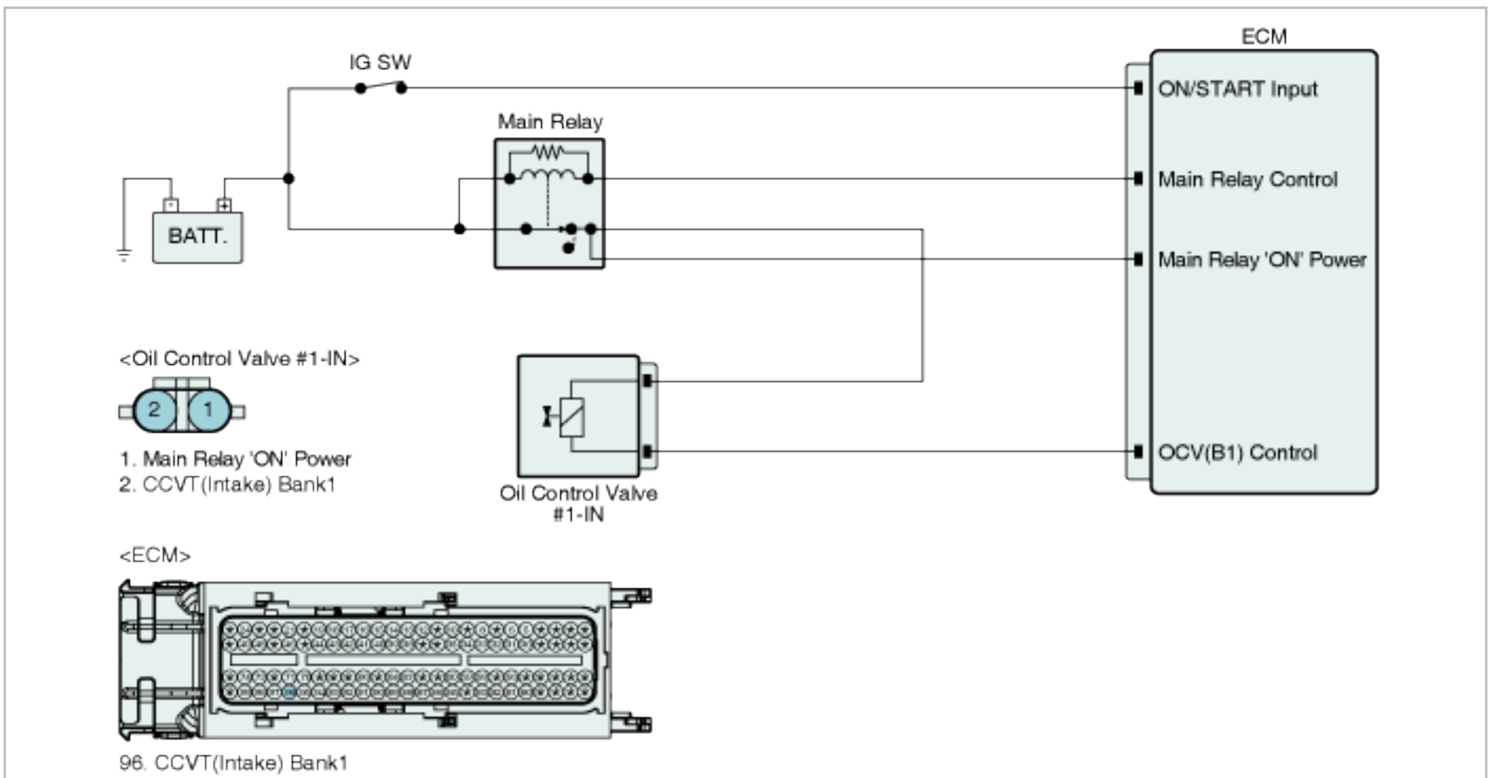
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Determines if the phaser is moving at an expected rate	• Excessive phasing system leakage • Binding Oil pressure (ex. Blockage in OCV filter) • Faulty OCV
Enable Conditions	• CAM signal is normally generating • Accelerate and decelerate more than 10 times within 5 minutes – while driving	
Threshold value	• Cam phasing is abnormally fast or slow	
Diagnosis Time	• Continuous (Within 5min.)	
MIL On Condition	• 2 Driving Cycles	

Specification

OCV	Specification
Coil Resistance (Ω)	6.7 ~ 7.7 at 20°C (68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data

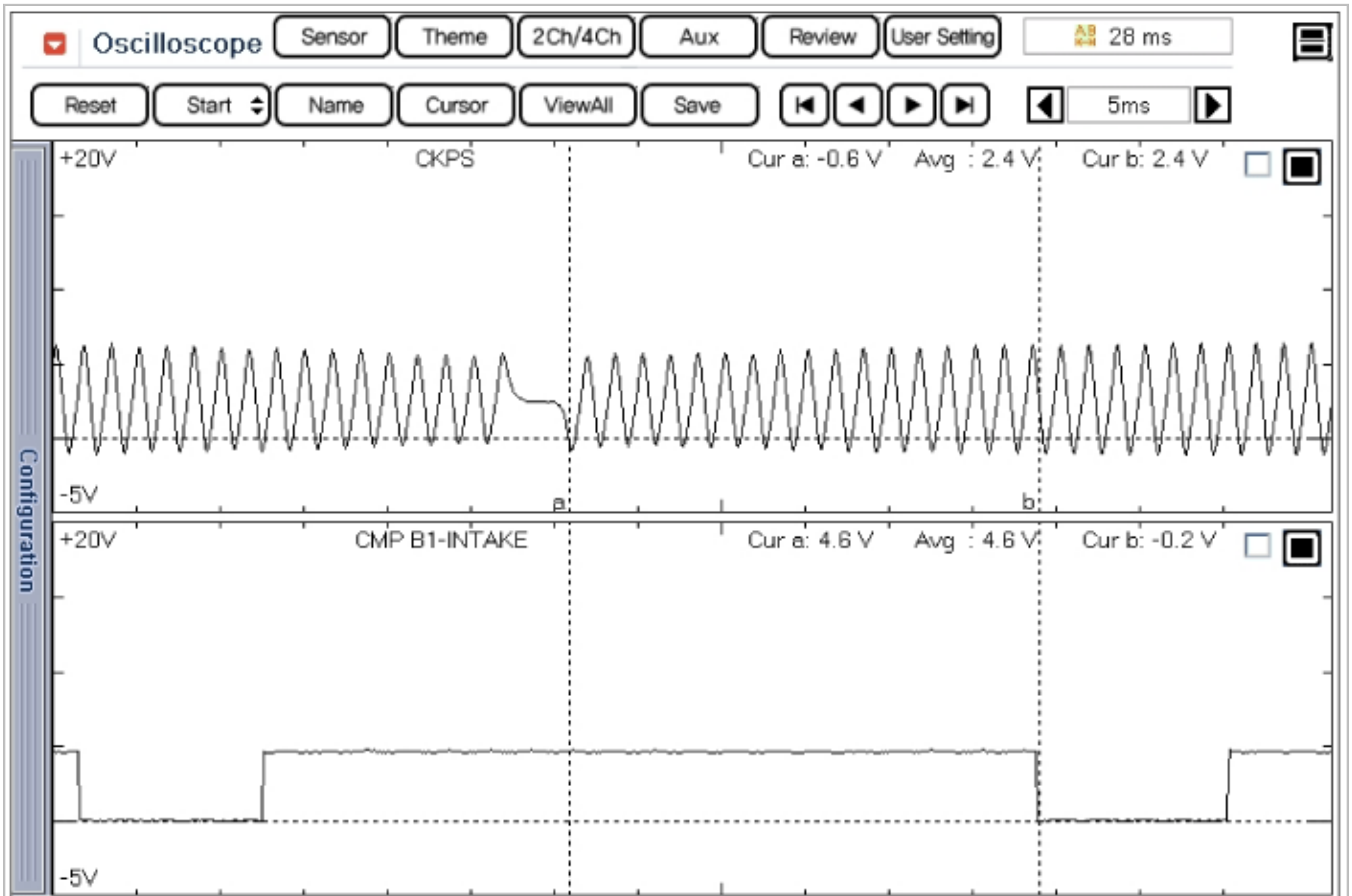


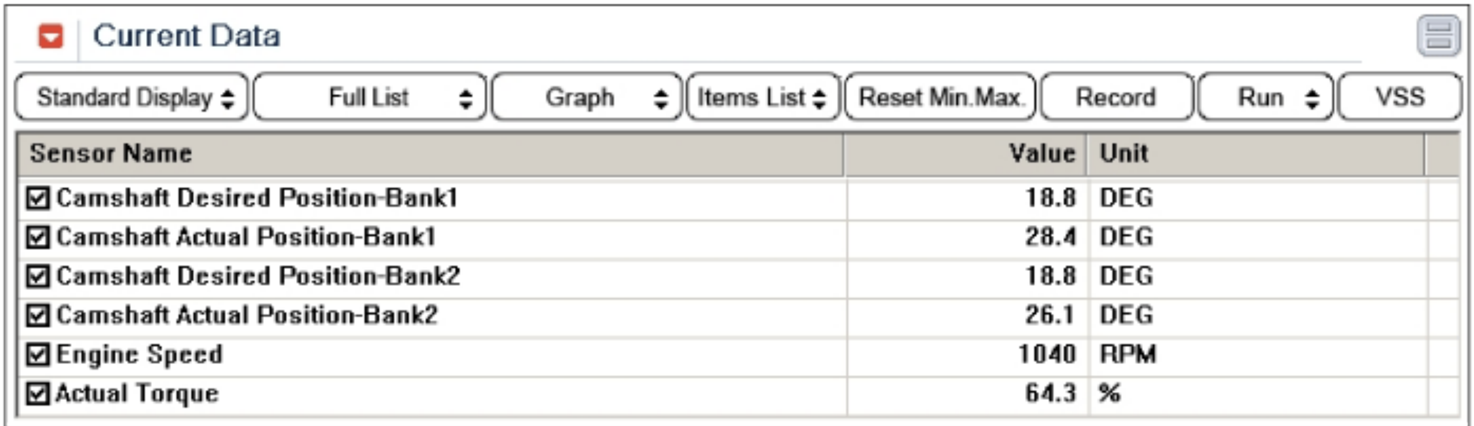
Fig.1

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | VSS

Sensor Name	Value	Unit
☑ Camshaft Desired Position-Bank1	0.0	DEG
☑ Camshaft Actual Position-Bank1	0.3	DEG
☑ Camshaft Desired Position-Bank2	0.0	DEG
☑ Camshaft Actual Position-Bank2	-0.3	DEG
☑ Engine Speed	600	RPM

Fig.2



Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Run | VSS

Sensor Name	Value	Unit
☑ Camshaft Desired Position-Bank1	18.8	DEG
☑ Camshaft Actual Position-Bank1	28.4	DEG
☑ Camshaft Desired Position-Bank2	18.8	DEG
☑ Camshaft Actual Position-Bank2	26.1	DEG
☑ Engine Speed	1040	RPM
☑ Actual Torque	64.3	%

Fig.3

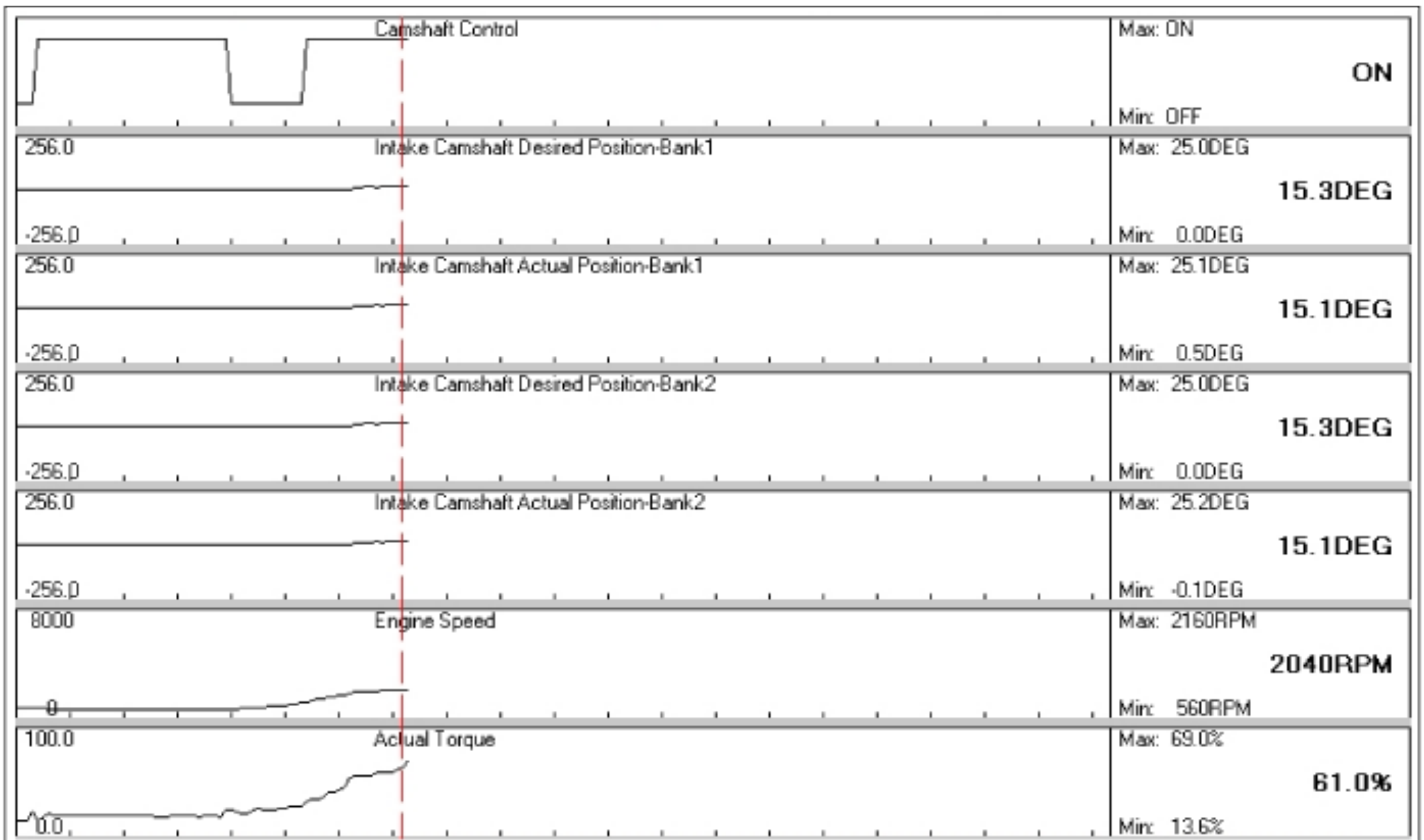


Fig.4

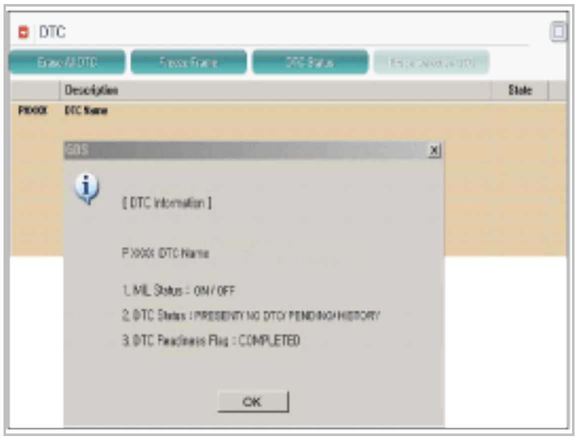
Fig.1) Normal waveform of CKPS & IN-CMPS at idle.
Fig.2) Normal data of IN-CVVT at idle.
Fig.3) Normal data of IN-CVVT at acceleration with load.
Fig.4) Normal graph of IN-CVVT at acceleration with load.

This example shows a typical Crankshaft Position Sensor (CKPS) and Camshaft Position Sensor (CMPS) waveform at idle.(Fig1.) If the 17th signal of the CKPS after missing tooth is aligned with the high signal of the CMPS at idle, ECM recognizes that Synchronization between CKPS and CMPS is completed. Under acceleracting condition, the number of tooth between missing tooth and tooth aligned with edge of the CMPS high signal is decreased than idle condition.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.

4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "System Inspection" procedure.
NO	▶ Fault is intermittent caused by ECM memory was not cleared after repair. Erase DTC and drive the vehicle to satisfy the enable codition then, go to "System Inspection" procedure.

System Inspection

■ Visual Inspection

1. Check oil level is O.K.
2. Check oil and OCV is contaminated.
3. Check for oil leakage around OCV.
4. Has a problem been found ?

YES	▶ Repair or replace as necessary and then, go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Component Inspection" procedure.

Component Inspection

■ Check OCV resistance

1. IG "OFF" and disconnect OCV connector.
2. Measure resistance between power and signal terminals of OCV. (Component Side)

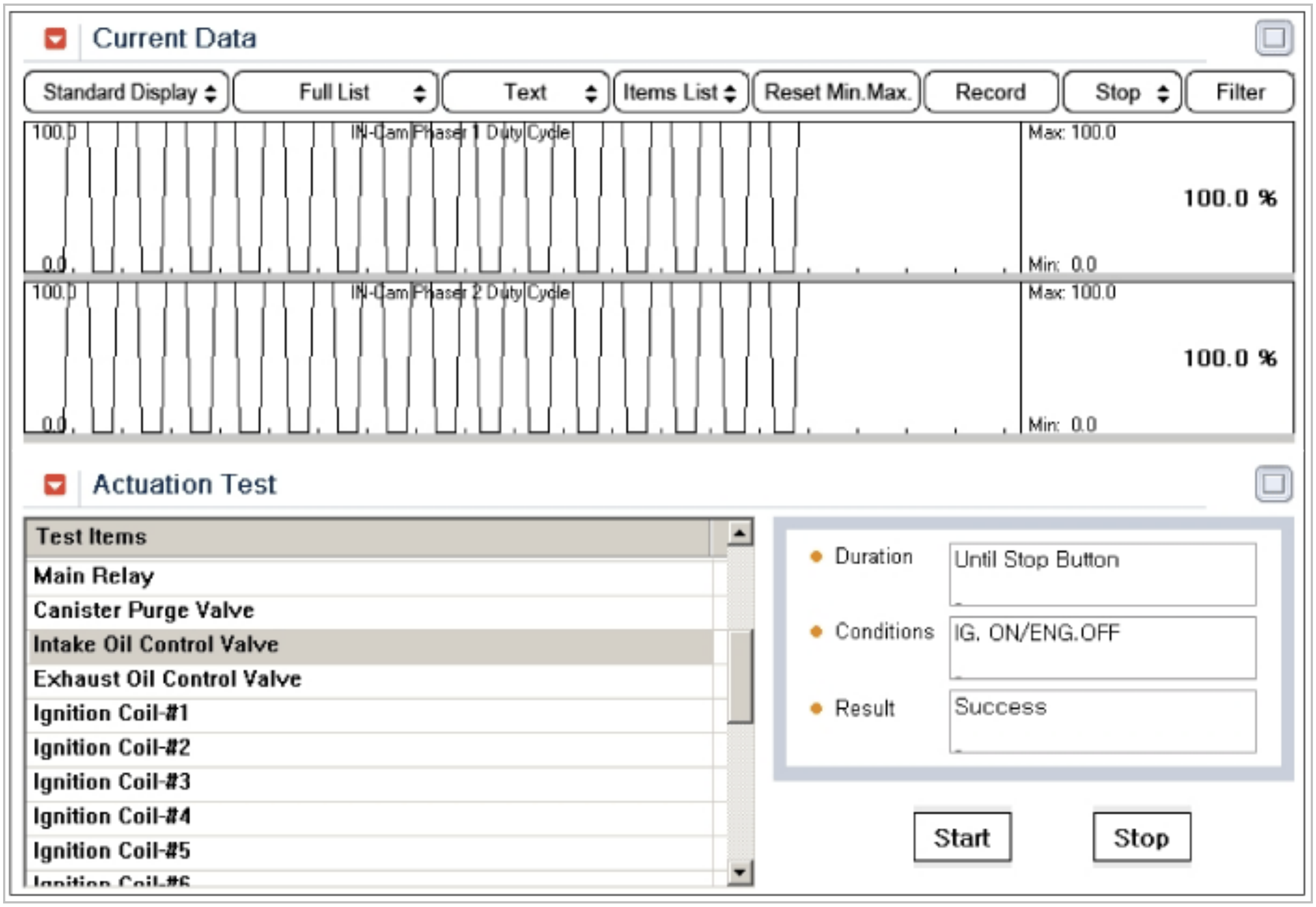
Specification : 6.7 ~ 7.7 at 20°C (68°F)

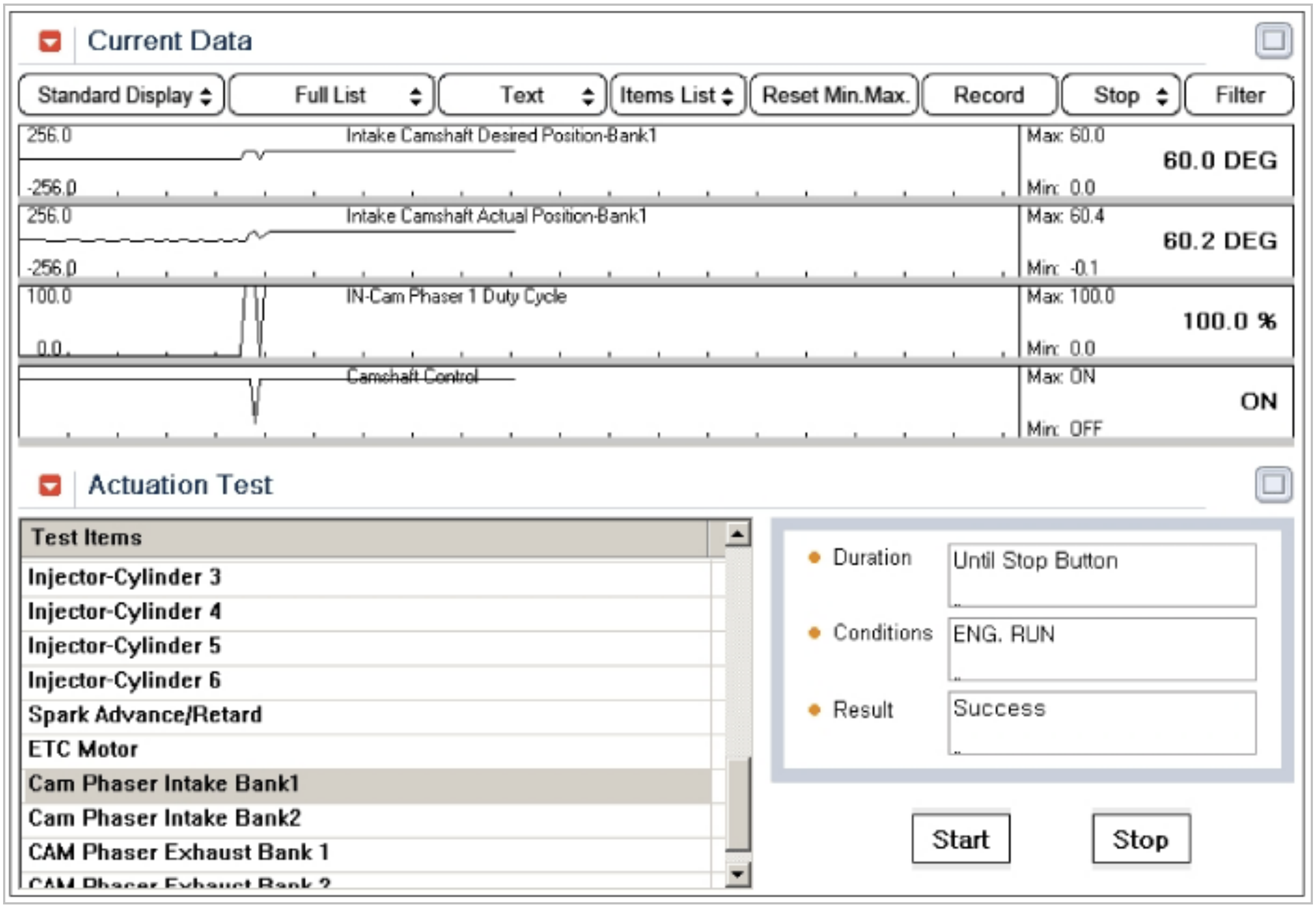
3. Is the measured resistance within specification?

YES	▶ Go to "Check CAM PHASER with actuation test" as follows.
NO	▶ Substitute with a known - good OCV and check for proper operation. If the problem is corrected, replace OCV and go to "Verification of Vehicle Repair" procedure.

■ Check CAM PHASER with actuation test

1. Connect GDS and IG "ON"
2. Select "Cam Phaser Intake Bank1" on the Actuation Test
3. Select "Intake Oil Control Valve" on the Actuation Test
4. Activates "Cam Phaser Intake Bank1" by pressing "START" button
5. Activates "Intake Oil Control Valve" by pressing "START" button
6. Repeat this procedure 4 or 5 times to ensure CAM PHASER and valve control solenoid reliability





7. Has a problem been found ?

YES	▶ Substitute with a known - good CVVT or OCV and check for proper operation. If the problem is corrected, replace CVVT or OCV and go to "Verification of Vehicle Repair" procedure.
NO	▶ Fault is intermittent. Drive the vehicle to meet the enable condition for the DTC. and Go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

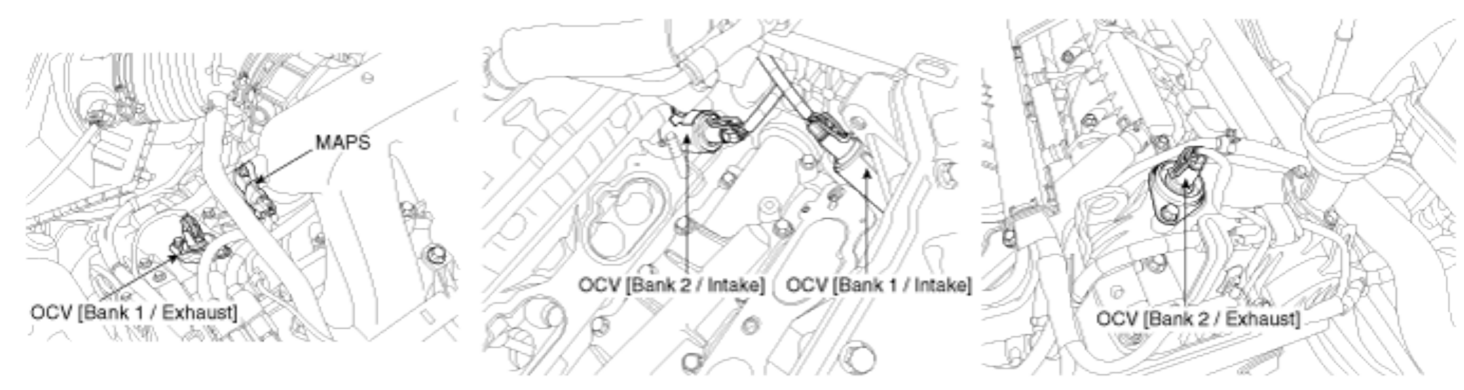
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0012 \'A\' Camshaft Position-Timing Over-

Retarded (Bank 1)

Component Location



General Description

The CVVT (Continuously Variable Valve Timing) system is installed to the chain sprocket of the intake camshaft. This system controls the intake camshaft to provide the optimal valve timing for every driving condition. The ECM controls the Oil Control Valve(OCV), based on the signals output from mass air flow, throttle position and engine coolant temperature. The CVVT controller regulates the intake camshaft angle using oil pressure through the OCV. As result, the relative position between the camshaft and the crankshaft becomes optimal, and the engine torque improves, fuel economy improves, exhaust emissions decrease under over all driving conditions.

DTC Description

ECM monitors CAM phaser error while CMP signal is normally generating and vehicle is driving in 2000 ~ 3000rpm. If the CAM phaser does not move although ECM commands OCV duty cycle ECM determines that a faultexists and a DTC is stored.

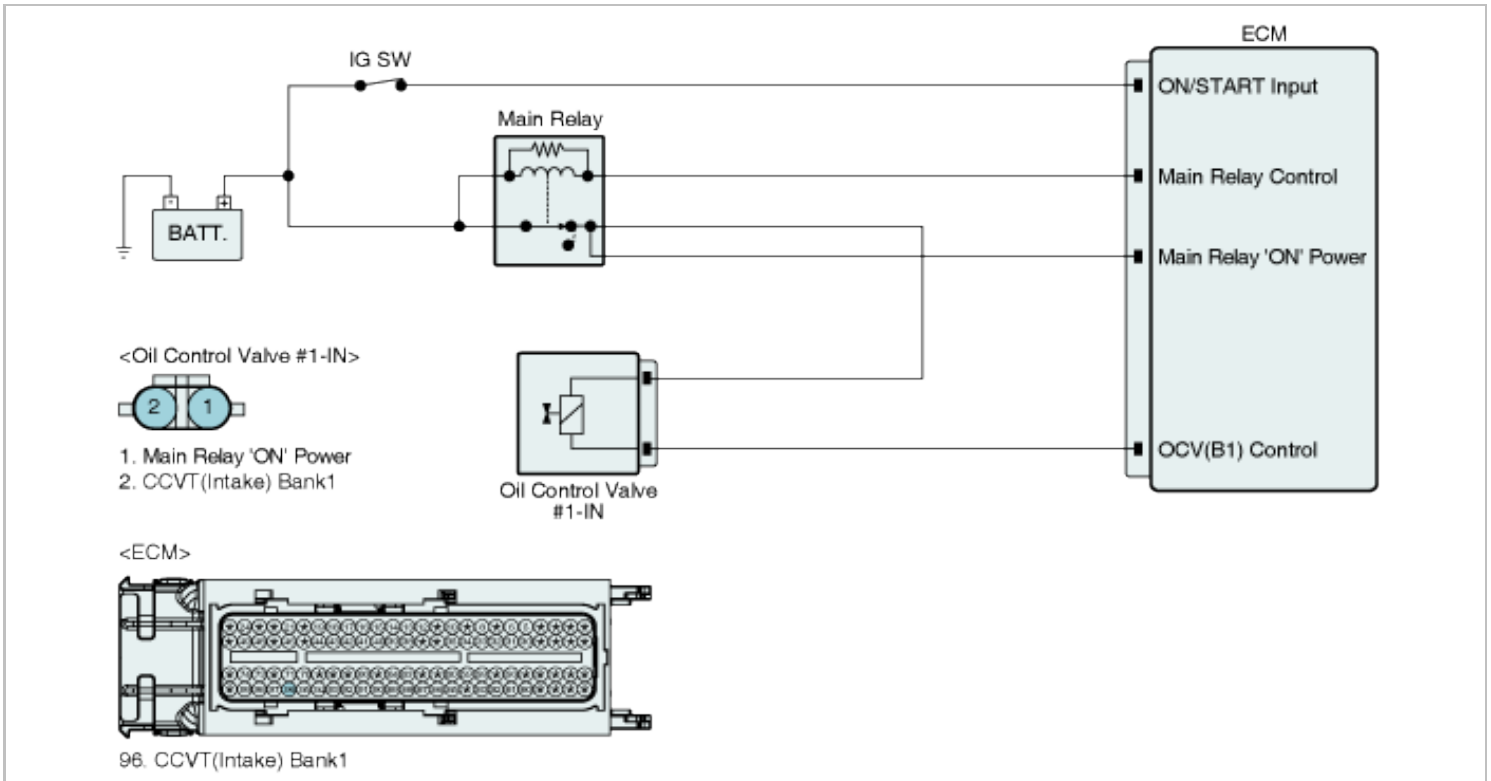
DTC Detecting Condition

Item		Detecting Condition	Possible Cause
DTC Strategy		• Determines if the phaser is stuck or has steady-state error	• Engine Oil • OCV stuck • CVVT stuck
Enable Conditions		• CAM signal is normally generating • Vehicle is on driving (2000 ~ 3000RPM) for 5 minutes	
Threshold value	Case 1	• 5 CAD < Cam Actual Position < 50 CAD • Duty Cycle > 90% or Duty Cycle < 10%	
	Case 2	• Cam Position error > 15 CAD (Difference between Actual Postion and Desire Position is more than 15°) • Timing Counter > 80	
Diagnosis Time		• Continuous (within 5min.)	
MIL On Condition		• 2 Driving Cycles	

Specification

OCV	Specification
Coil Resistance (Ω)	6.7 ~ 7.7 at 20°C (68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data

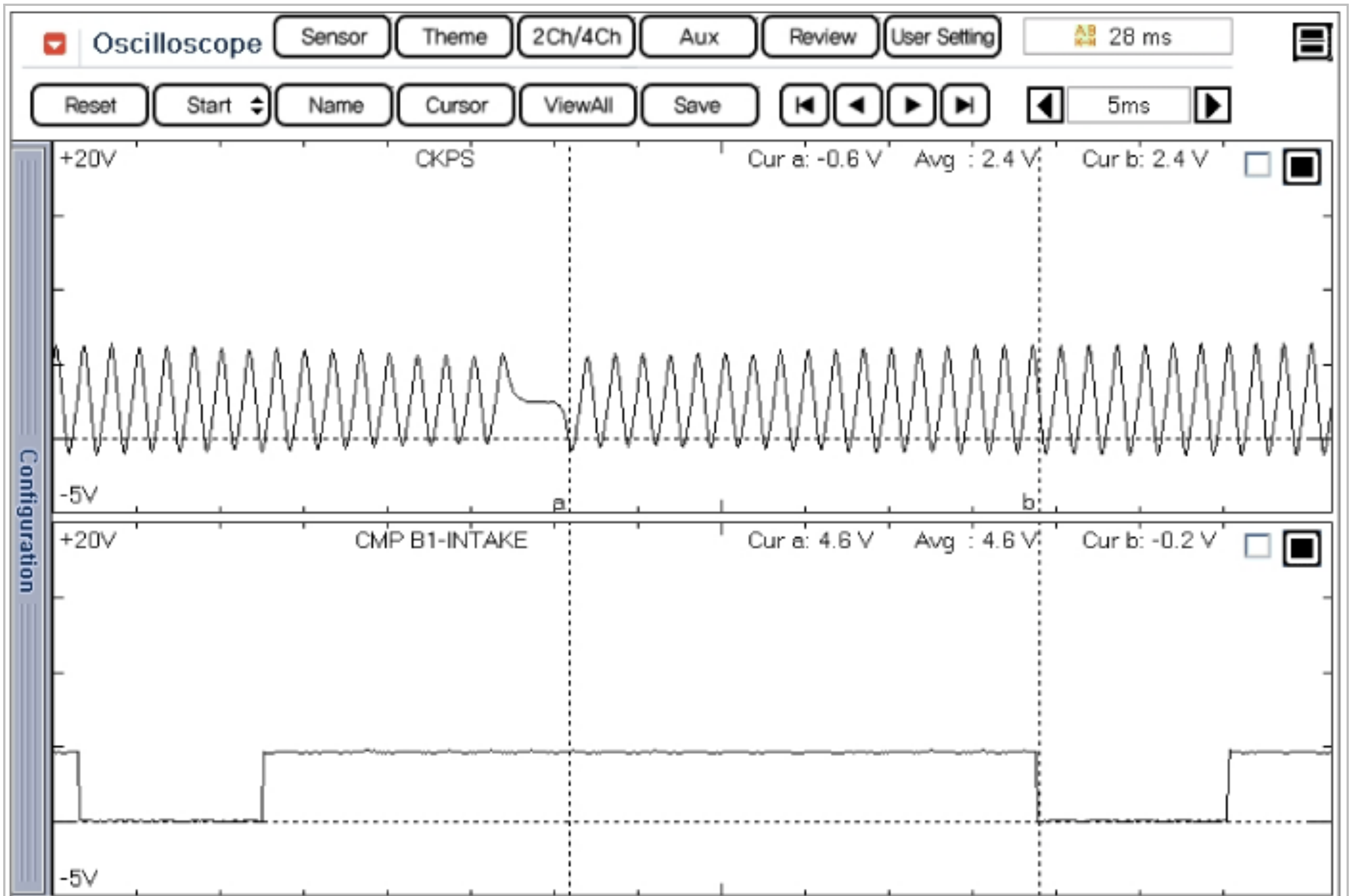
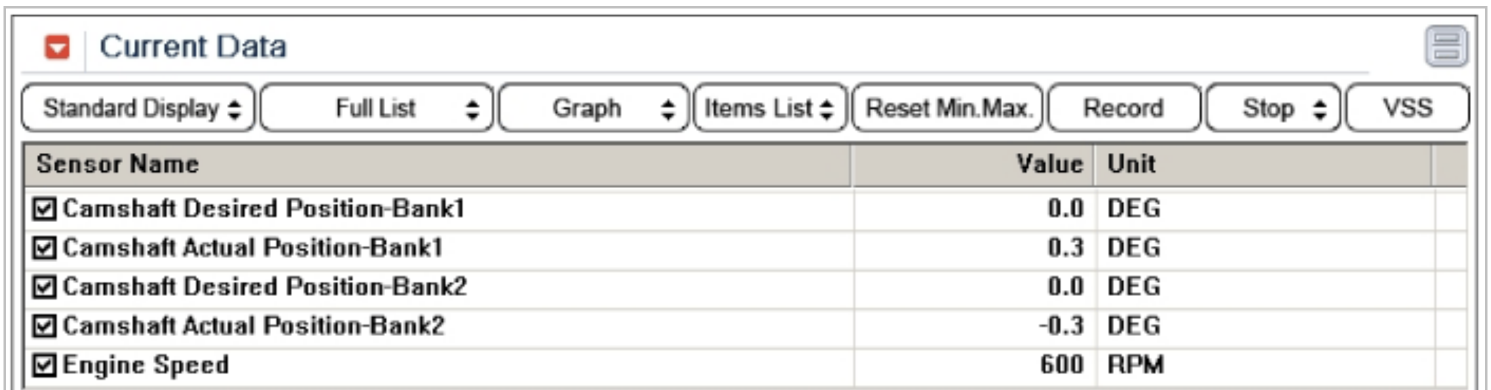


Fig.1



Sensor Name	Value	Unit
☑ Camshaft Desired Position-Bank1	0.0	DEG
☑ Camshaft Actual Position-Bank1	0.3	DEG
☑ Camshaft Desired Position-Bank2	0.0	DEG
☑ Camshaft Actual Position-Bank2	-0.3	DEG
☑ Engine Speed	600	RPM

Fig.2

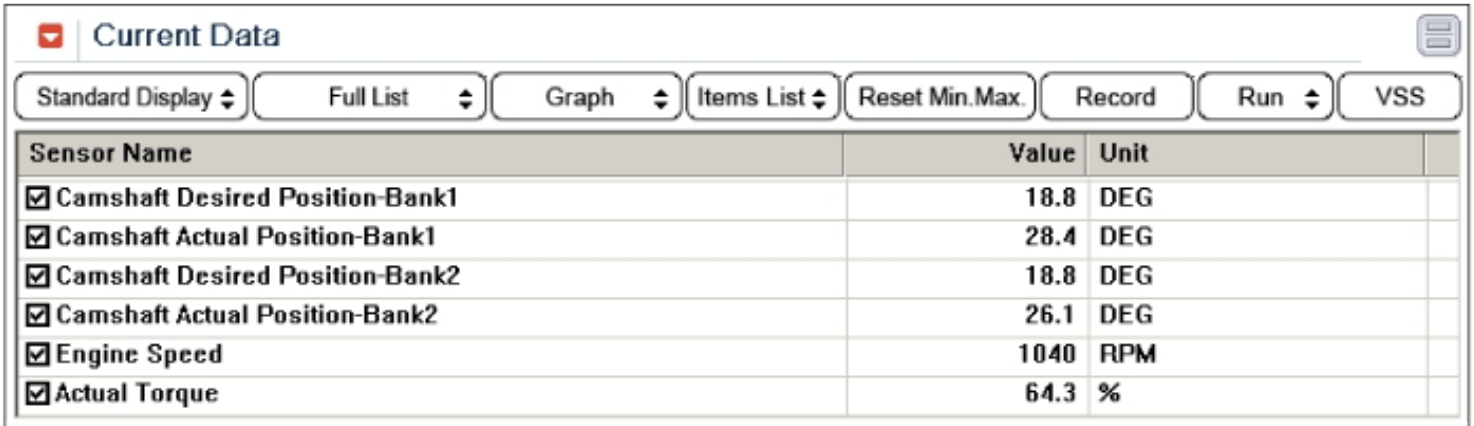


Fig.3

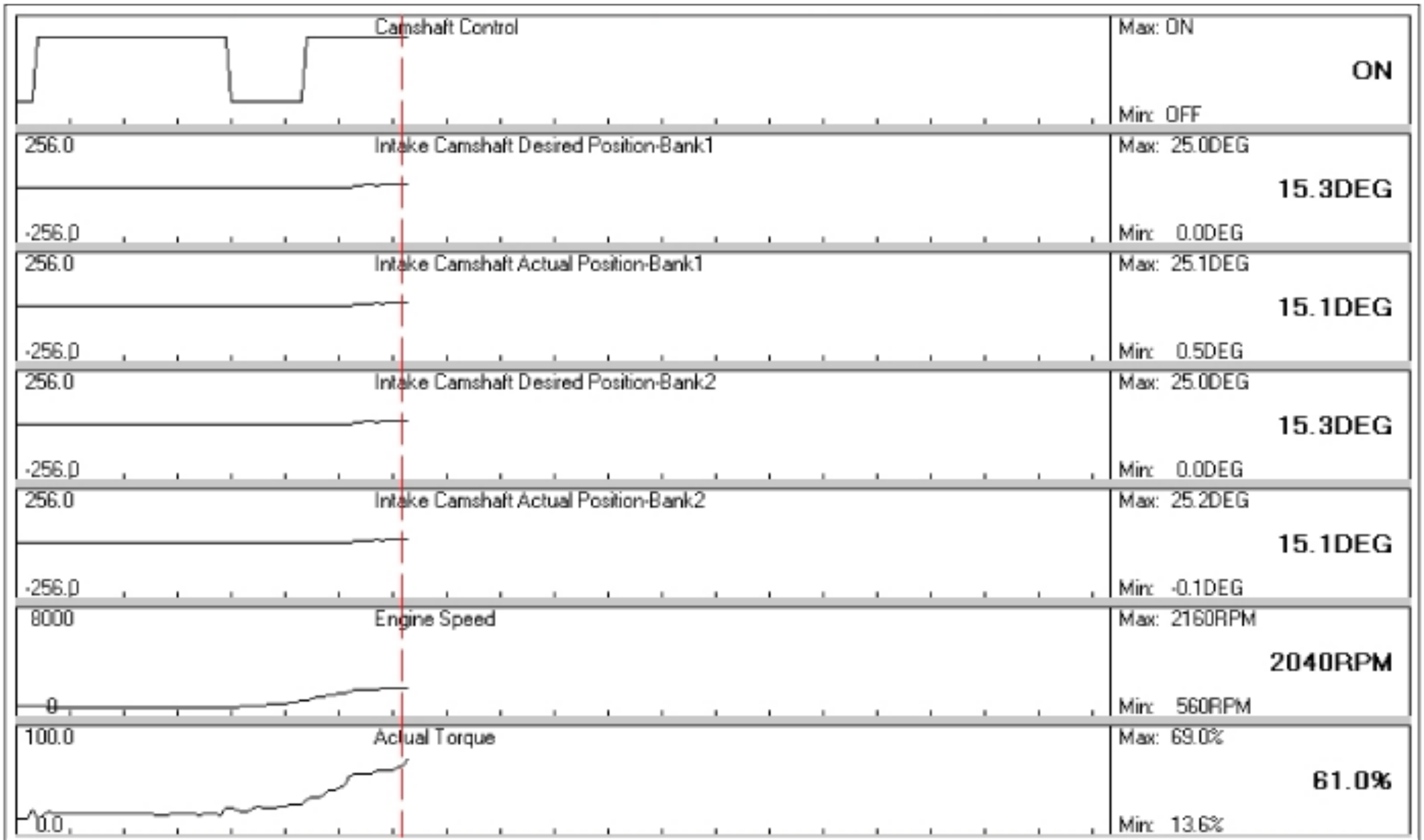


Fig.4

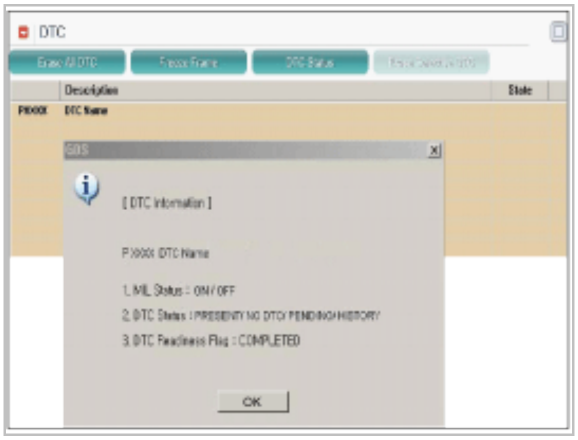
Fig.1) Normal waveform of CKPS & IN-CMPS at idle.
Fig.2) Normal data of IN-CVVT at idle.
Fig.3) Normal data of IN-CVVT at acceleration with load.
Fig.4) Normal graph of IN-CVVT at acceleration with load.

This example shows a typical Crankshaft Position Sensor (CKPS) and Camshaft Position Sensor (CMPS) waveform at idle.(Fig1.) If the 17th signal of the CKPS after missing tooth is aligned with the high signal of the CMPS at idle, ECM recognizes that Synchronization between CKPS and CMPS is completed. Under acceleracting condition, the number of tooth between missing tooth and tooth aligned with edge of the CMPS high signal is decreased than idle condition.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.

4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "System Inspection" procedure.
NO	▶ Fault is intermittent caused by ECM memory was not cleared after repair. Erase DTC and drive the vehicle to satisfy the enable codition then, go to " System Inspection" procedure.

System Inspection

■ Visual Inspection

1. Check oil level is O.K.
2. Check Oil and OCV is contaminated.
3. Check for oil leakage around OCV.
4. Has a problem been found ?

YES	▶ Repair or replace as necessary and then, go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Component Inspection" procedure.

Component Inspection

■ Check OCV resistance

1. IG "OFF" and disconnect OCV connector.
2. Measure resistance between power and signal terminals of OCV. (Component Side)

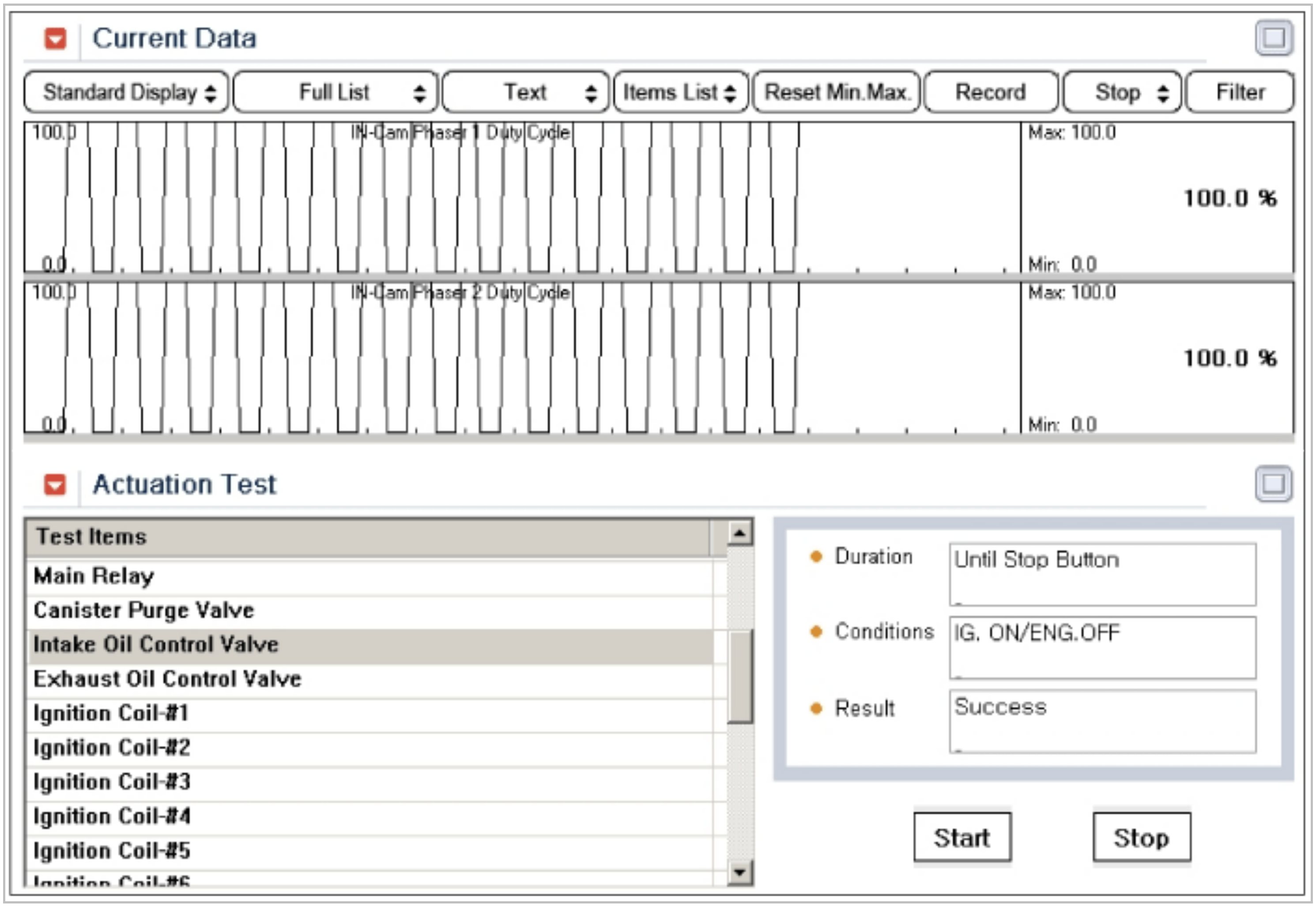
Specification : 6.7 ~ 7.7 at 20°C (68°F)

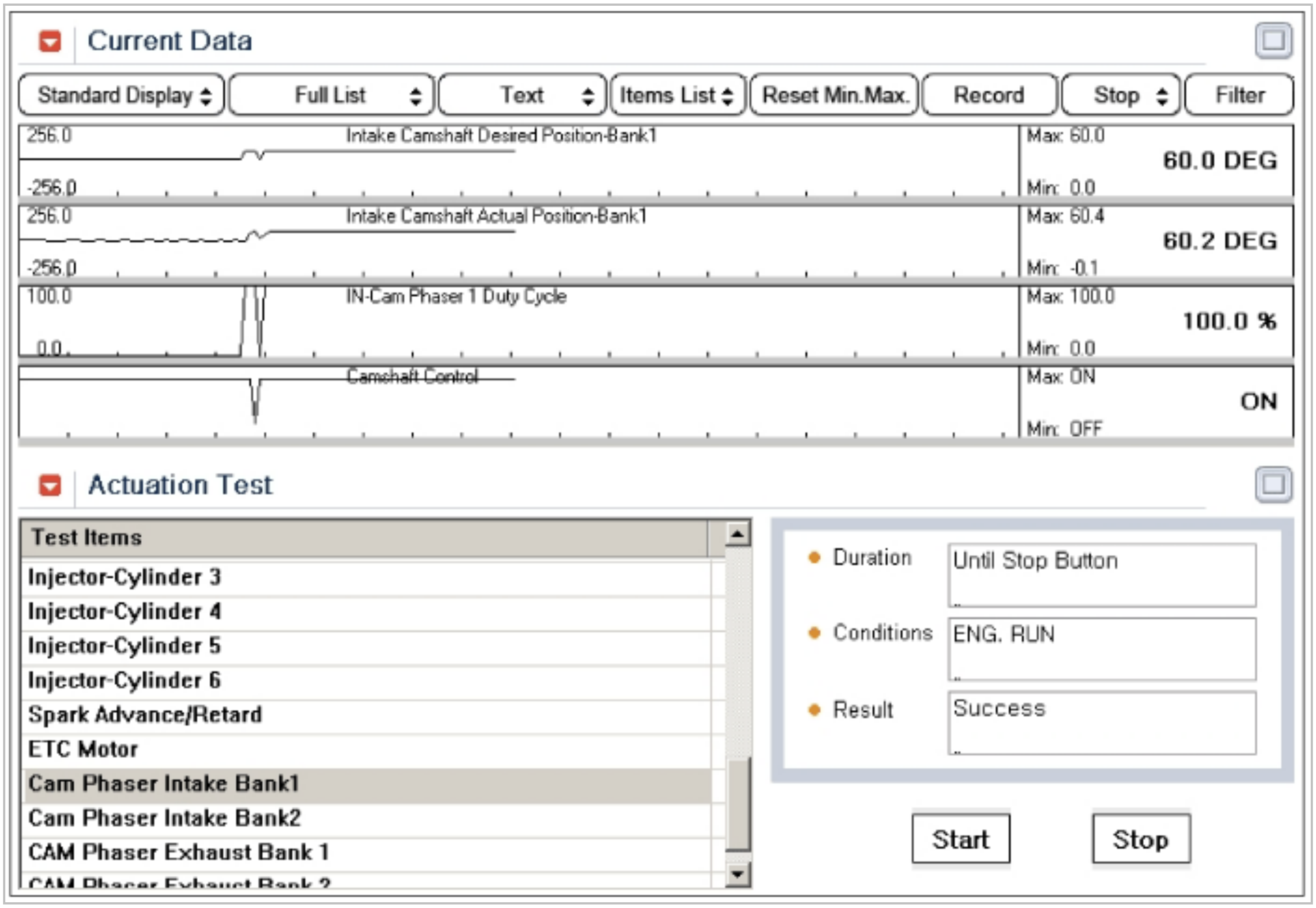
3. Is the measured resistance within specification?

YES	▶ Go to "Check CAM PHASER with actuation test" as follows.
NO	▶ Substitute with a known - good OCV and check for proper operation. If the problem is corrected, replace OCV and go to "Verification of Vehicle Repair" procedure.

■ Check CAM PHASER with actuation test

1. Connect GDS and IG "ON"
2. Select "Cam Phaser Intake Bank1" on the Actuation Test
3. Select "Intake Oil Control Valve" on the Actuation Test
4. Activates "Cam Phaser Intake Bank1" by pressing "START" button
5. Activates "Intake Oil Control Valve" by pressing "START" button
6. Repeat this procedure 4 or 5 times to ensure CAM PHASER and valve control solenoid reliability





7. Has a problem been found ?

YES	▶ Substitute with a known - good CVVT or OCV and check for proper operation. If the problem is corrected, replace CVVT or OCV and go to "Verification of Vehicle Repair" procedure.
NO	▶ Fault is intermittent. Drive the vehicle to meet the enable condition for the DTC. and Go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

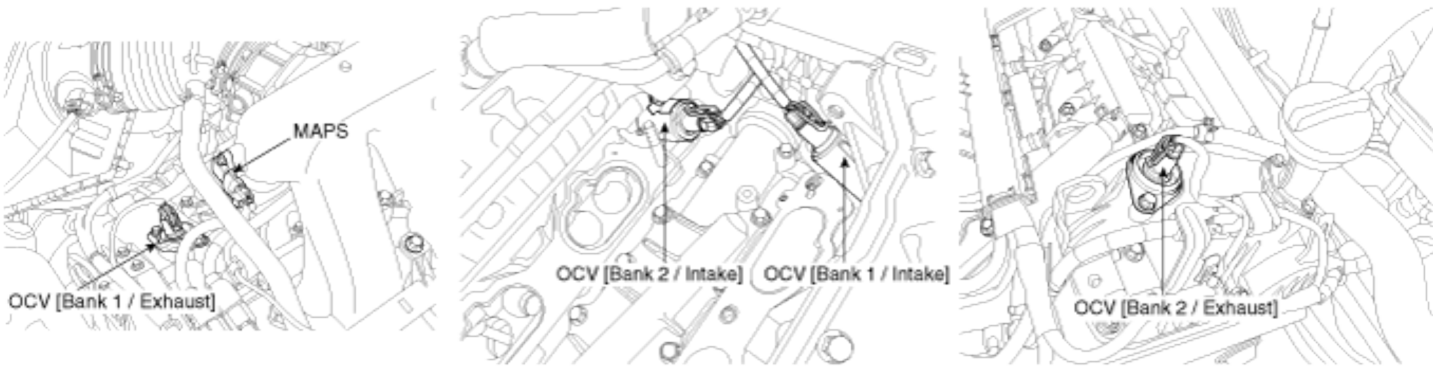
1. Connect scantool and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0014 \'B\' Camshaft Position - Timing Over-

Advanced or System Performance (Bank 1)

Component Location



General Description

The CVVT (Continuously Variable Valve Timing) system is installed to the chain sprocket of the camshaft. This system controls the camshaft to provide the optimal valve timing for every driving condition. The ECM controls the Oil Control Valve(OCV), based on the signals output from mass air flow, throttle position and engine coolant temperature. The CVVT controller regulates the camshaft angle using oil pressure through the OCV. As result, the relative position between the camshaft and the crankshaft becomes optimal, and the engine torque improves, fuel economy improves, exhaust emissions decrease under over all driving conditions.

DTC Description

ECM detects CAM phasing average rate while cam signal is normally generating.
ECM determines that a fault exists and a DTC is stored while vehicle is tip - in and out driving for 5 minutes.

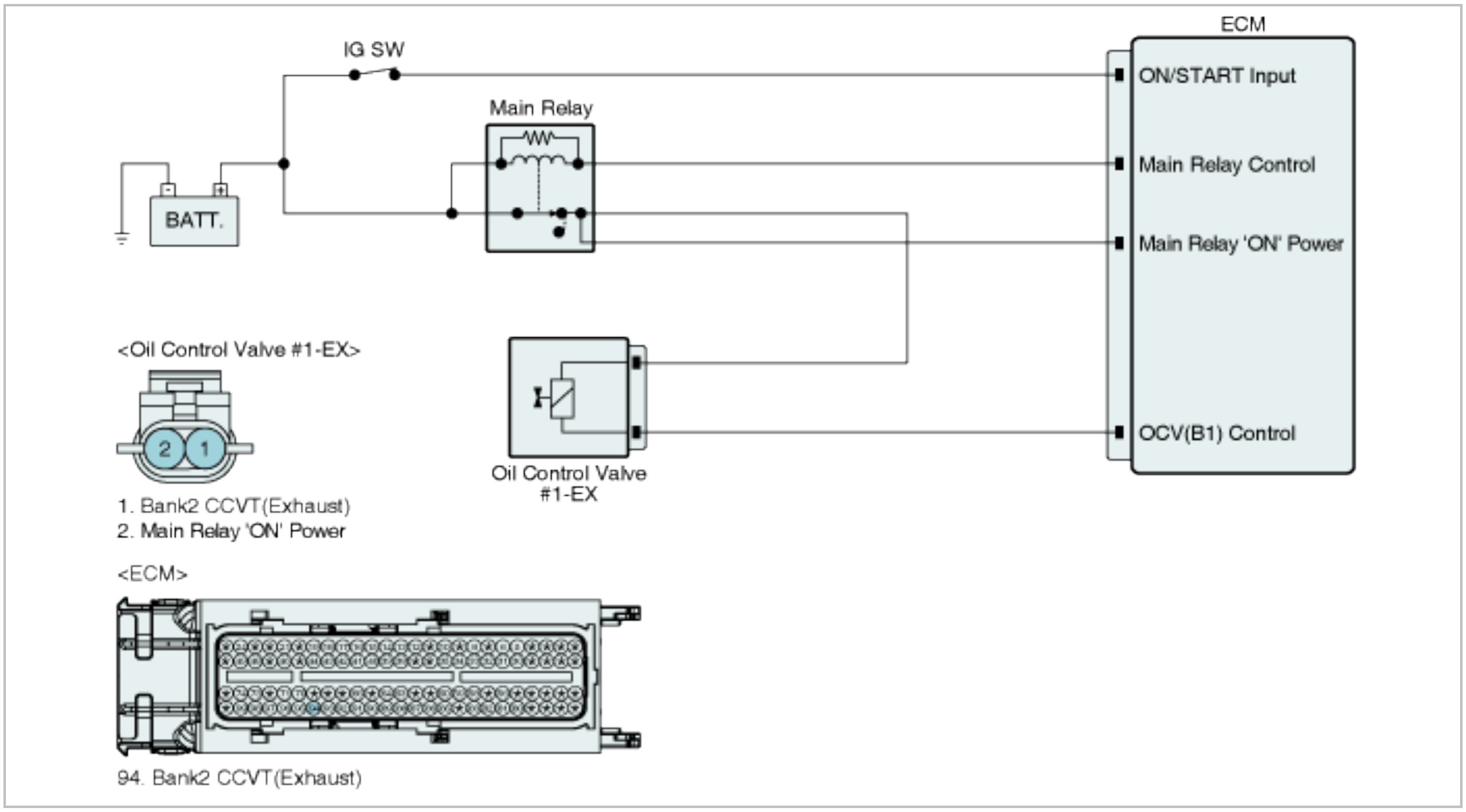
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Determines if the phaser is moving at an expected rate	• Excessive phasing system leakage • Binding Oil ressure (ex. Blockage in OCV filter) • Faulty OCV
Enable Conditions	• CAM signal is normally generating • Accelerate and decelerate more than 10 times within 5 minutes – while driving	
Threshold value	• Cam phasing is abnormally fast or slow	
Diagnosis Time	• Continuous (Within 5min.)	
MIL On Condition	• 2 Driving Cycles	

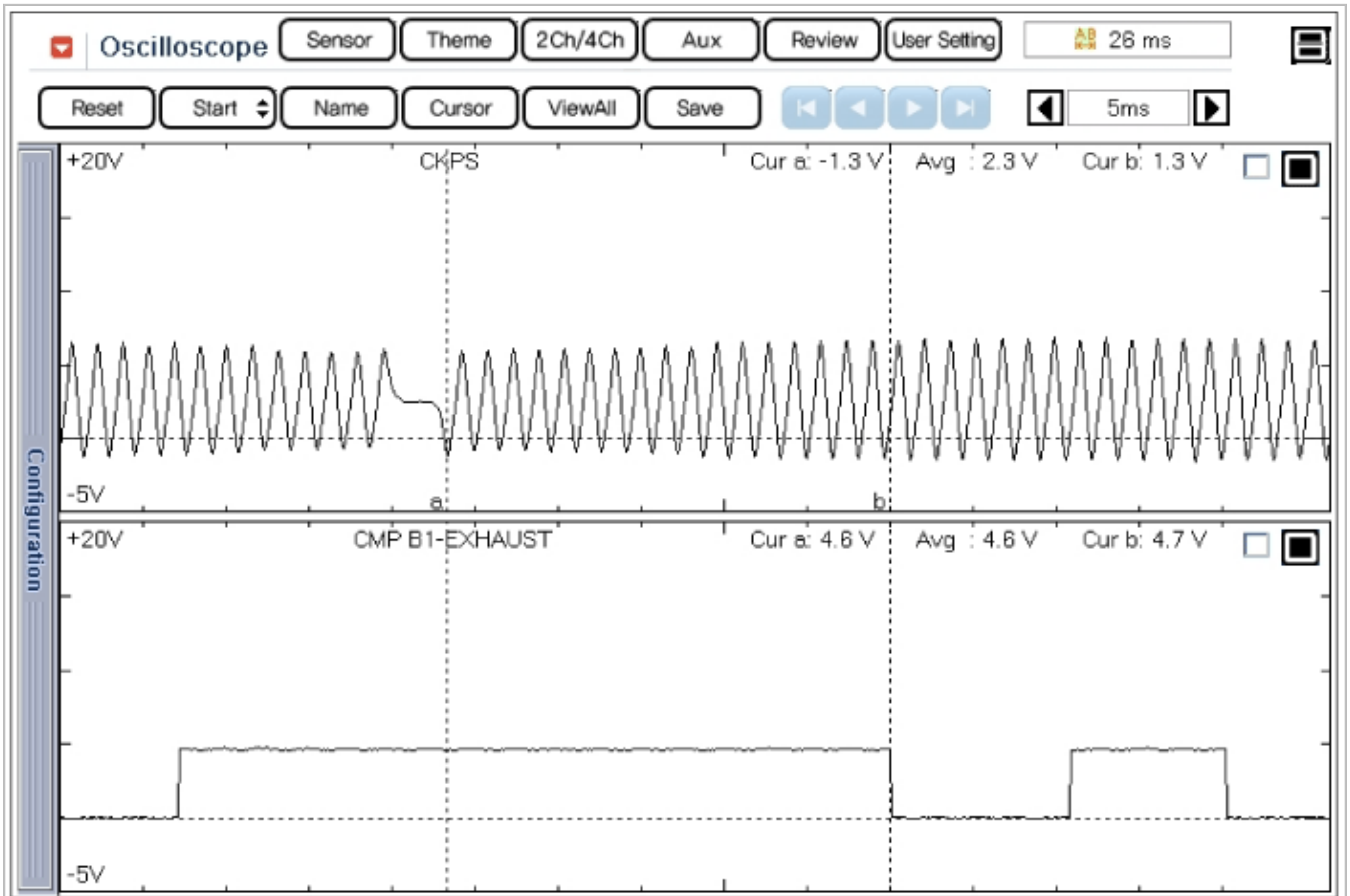
Specification

OCV	Specification
Coil Resistance (Ω)	6.7 ~ 7.7 at 20°C (68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data



Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
26 ms
Reset
Start
Name
Cursor
ViewAll
Save
5ms
+20V
CKPS
Cur a: -1.3 V
Avg : 2.3 V
Cur b: 1.3 V
-5V
a
b
+20V
CMP B1-EXHAUST
Cur a: 4.6 V
Avg : 4.6 V
Cur b: 4.7 V
-5V
Configuration

Fig.1

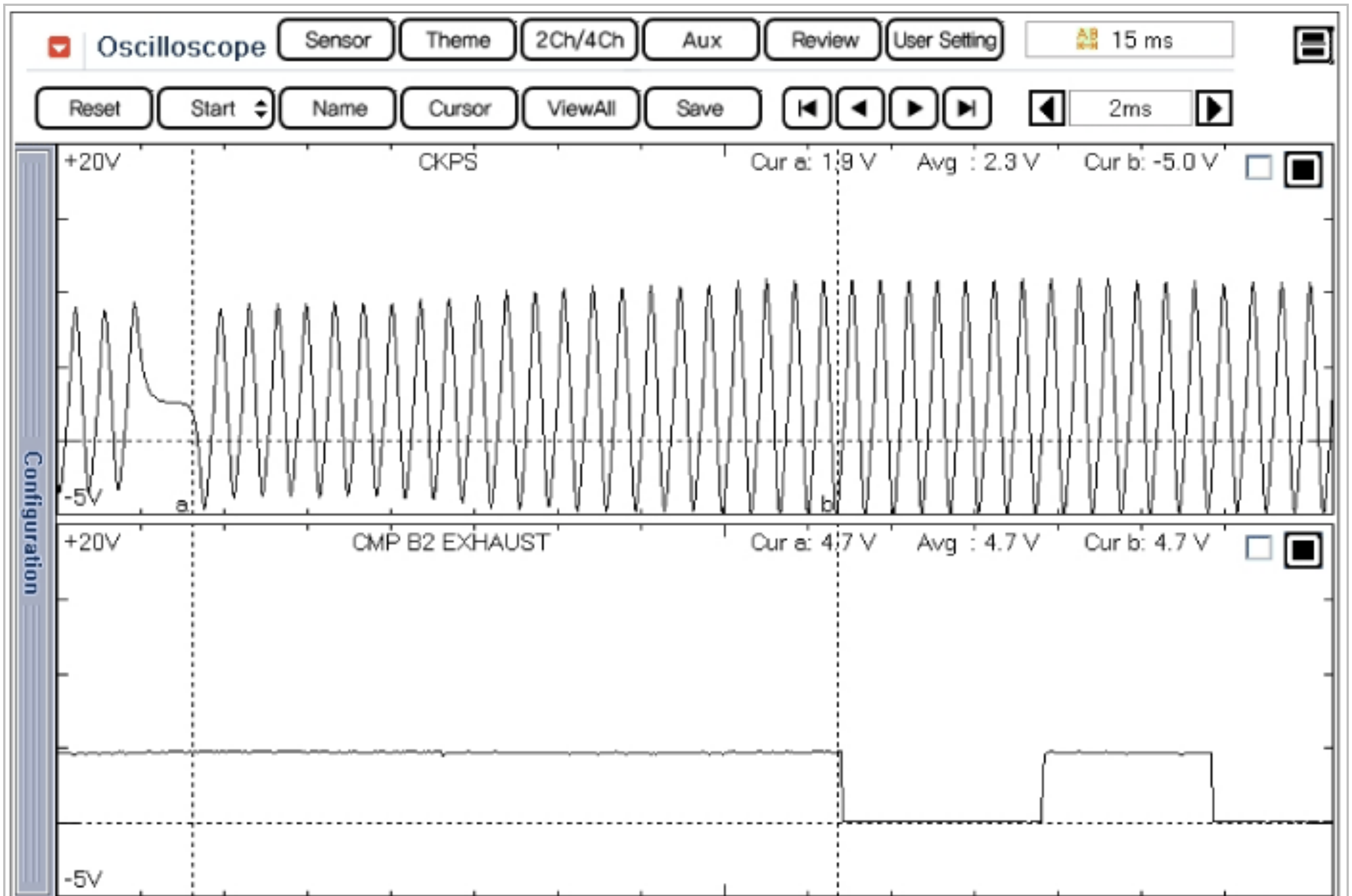


Fig.2

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | VSS

Sensor Name	Value	Unit
EX-Cam Bank1 Desired Position	0	DEG
EX-Cam Bank1 Actual Position	0	DEG
EX-Cam Bank2 Desired Position	0	DEG
EX-Cam Bank2 Actual Position	0	DEG
EX-Cam Phaser 1 Duty Cycle	0	%
EX-Cam Phaser 2 Duty Cycle	0	%

Fig.3

Sensor Name	Value	Unit
☑ Camshaft Control	ON	-
☑ Engine Speed	3840	RPM
☑ EX-Cam Bank1 Actual Position	-15	DEG
☑ EX-Cam Bank1 Desired Position	-14	DEG
☑ EX-Cam Bank2 Desired Position	-14	DEG
☑ EX-Cam Bank2 Actual Position	-15	DEG
☑ EX-Cam Phaser 1 Duty Cycle	43	%
☑ EX-Cam Phaser 2 Duty Cycle	44	%

Fig.4

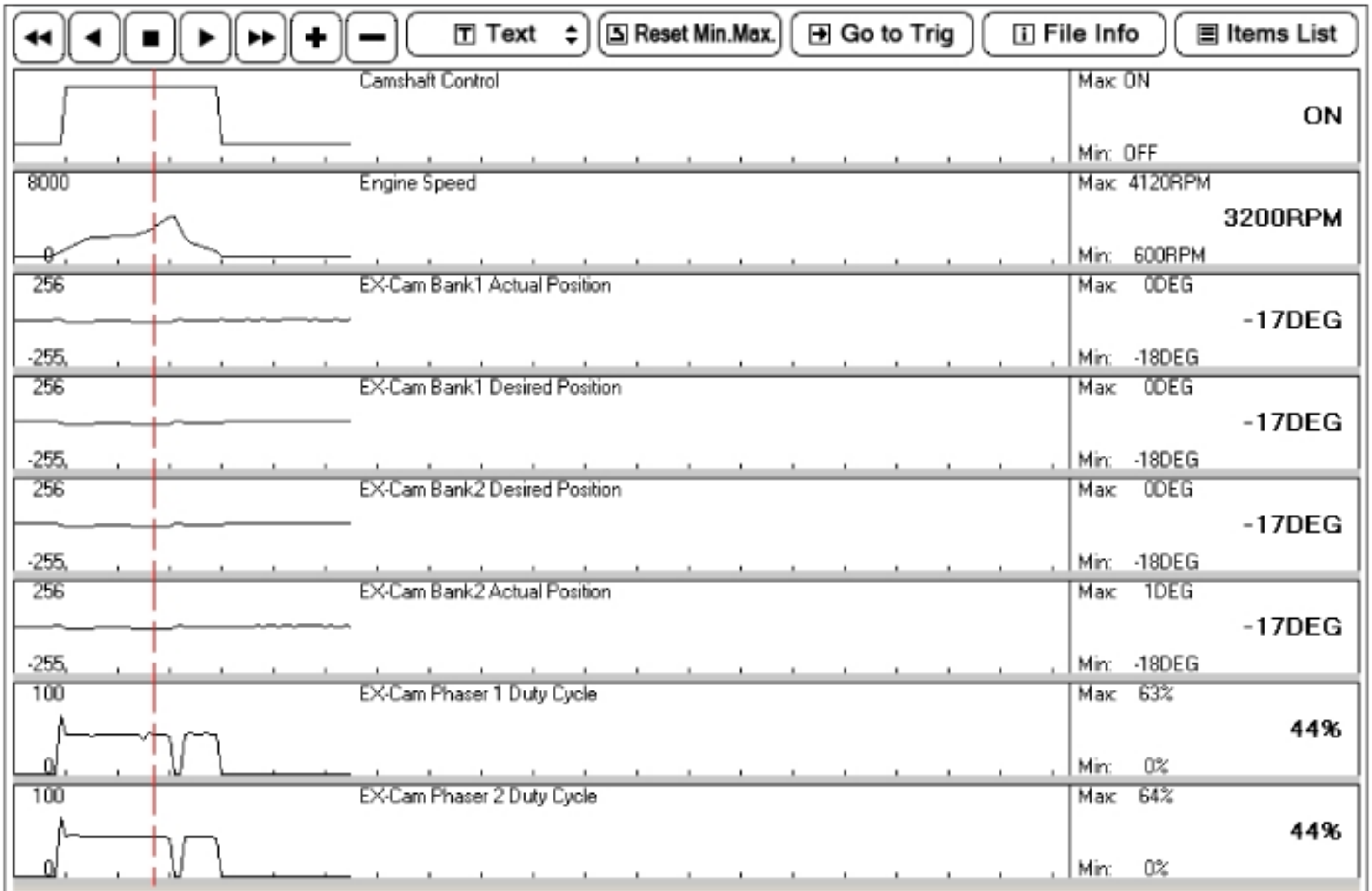


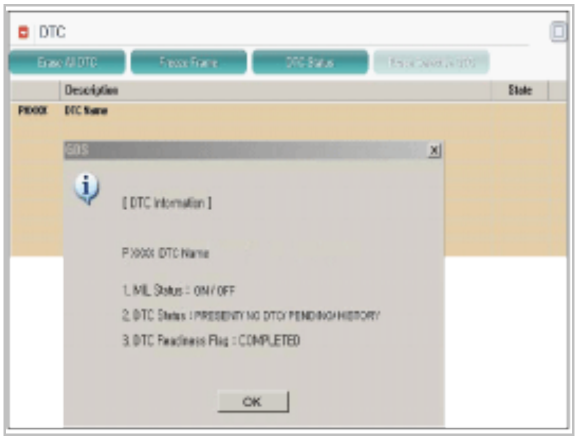
Fig.5

Fig.1) Normal waveform of CKPS & EX-CMPS at idle.
Fig.2) Normal waveform of CKPS & EX-CMPS at acceleration.
Fig.3) Normal data of EX-CVVT at idle.
Fig.4) Normal data of EX-CVVT at acceleration.
Fig.5) Normal graph of EX-CVVT at acceleration.

This example shows a typical Crankshaft Position Sensor (CKPS) and Camshaft Position Sensor (CMPS) waveform at idle.(Fig1.) If the 17th signal of the CKPS after missing tooth is aligned with the high signal of the CMPS at idle, ECM recognizes that Synchronization between CKPS and CMPS is completed. Under acceleracting condition, the number of teeth between missing tooth and tooth aligned with edge of the CMPS high signal is increased from idle condition.(Fig2.)

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "System Inspection" procedure.
NO	▶ Fault is intermittent caused by ECM memory was not cleared after repair. Erase DTC and drive the vehicle to satisfy the enable codition then, go to " System Inspection" procedure.

System Inspection

■ Visual Inspection

1. Check oil level is O.K.
2. Check oil and OCV is contaminated.
3. Check for oil leakage around OCV.
4. Has a problem been found ?

YES	▶ Repair or replace as necessary and then, go to " Verification of Vehicle Repair" procedure.
NO	▶ Go to "Component Inspection" procedure

Component Inspection

■ Check OCV resistance

1. IG "OFF" and disconnect OCV connector.
2. Measure resistance between power and signal terminals of OCV. (Component Side)

Specification : 6.7 ~ 7.7 at 20°C (68°F)

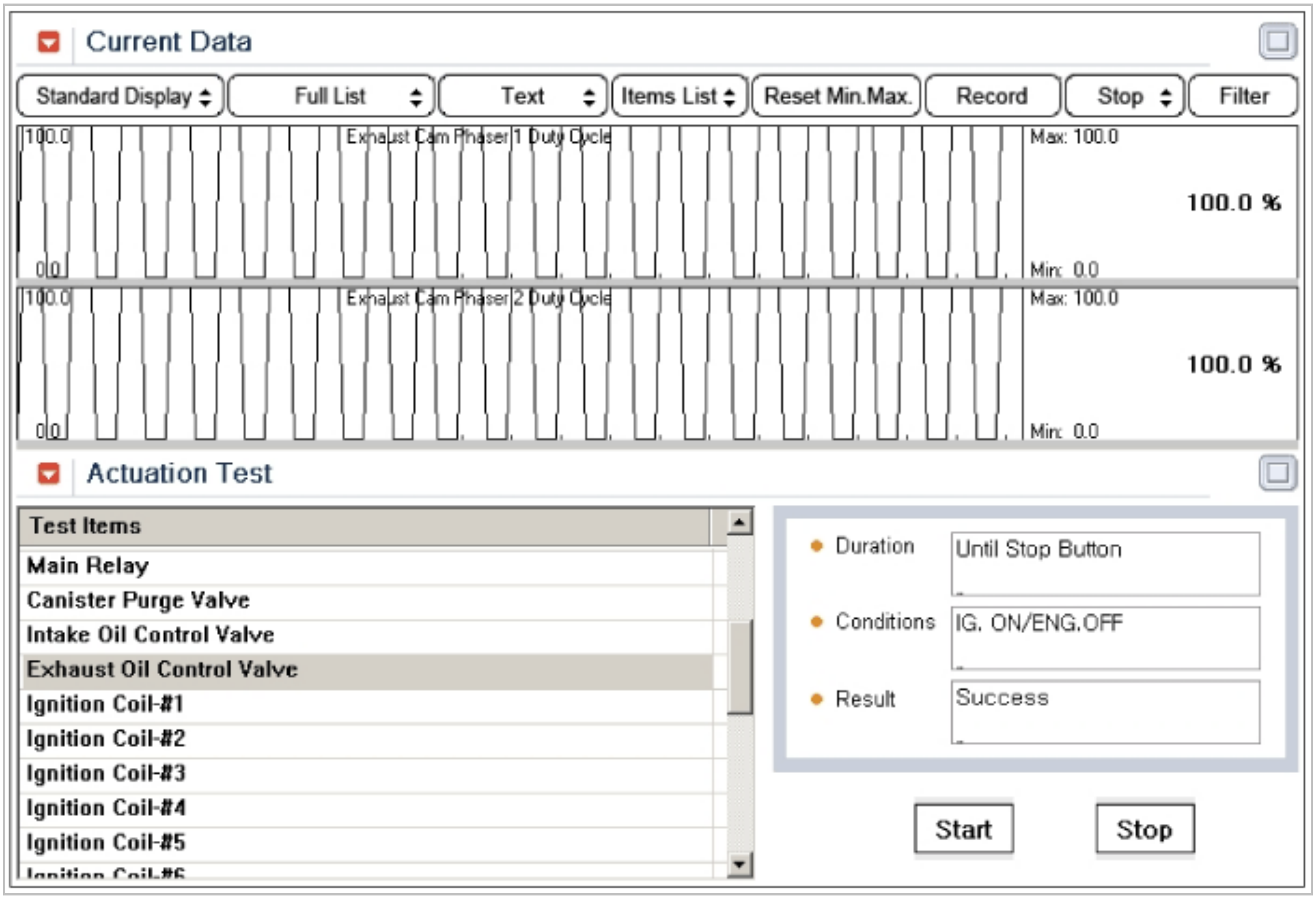
3. Is the measured resistance within specification?

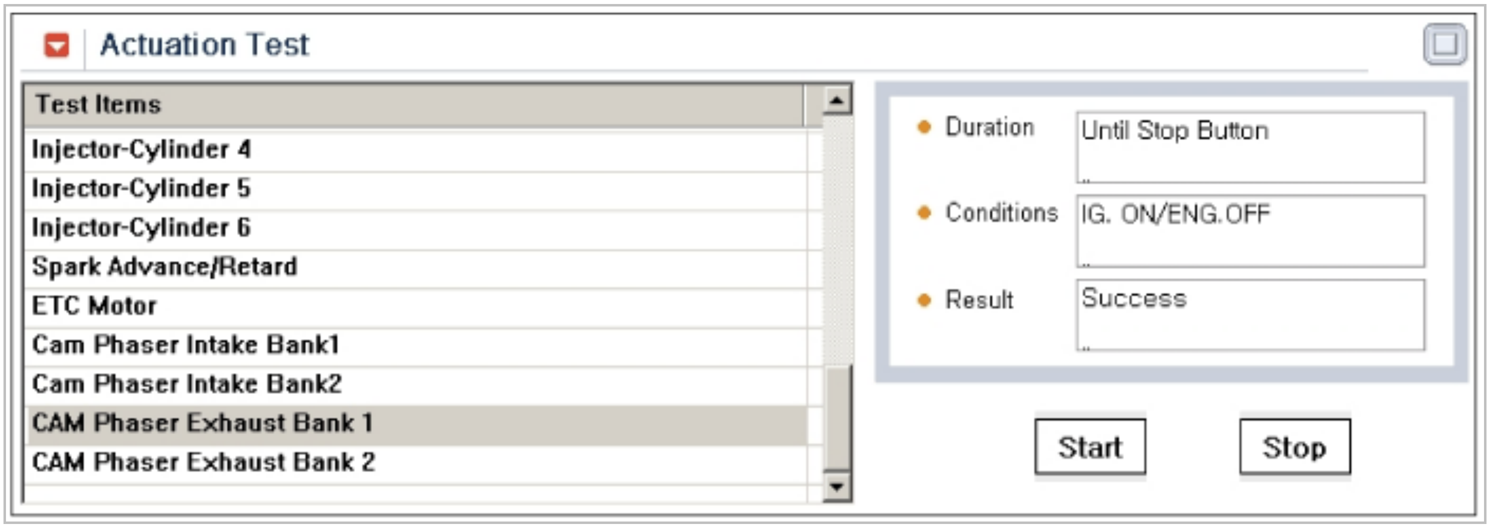
YES	▶ Go to "Check CAM PHASER with actuation test" as follows.
NO	▶ Substitute with a known - good OCV and check for proper operation. If the problem is corrected,

	replace OCV and go to "Verification of Vehicle Repair" procedure.

■ Check CAM PHASER with actuation test

1. Connect GDS and IG "ON"
2. Select "Cam Phaser Intake Bank1" on the Actuation Test
3. Select "Exhaust Oil Control Valve" on the Actuation Test
4. Activates "Cam Phaser Intake Bank1" by pressing "START" button
5. Activates "Exhaust Oil Control Valve" by pressing "START" button
6. Repeat this procedure 4 or 5 times to ensure CAM PHASER and valve control solenoid reliability





7. Has a problem been found ?

YES	▶ Substitute with a known - good CVVT or OCV and check for proper operation. If the problem is corrected, replace CVVT or OCV and go to "Verification of Vehicle Repair" procedure.
NO	▶ Fault is intermittent. Drive the vehicle to meet the enable condition for the DTC. and Go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

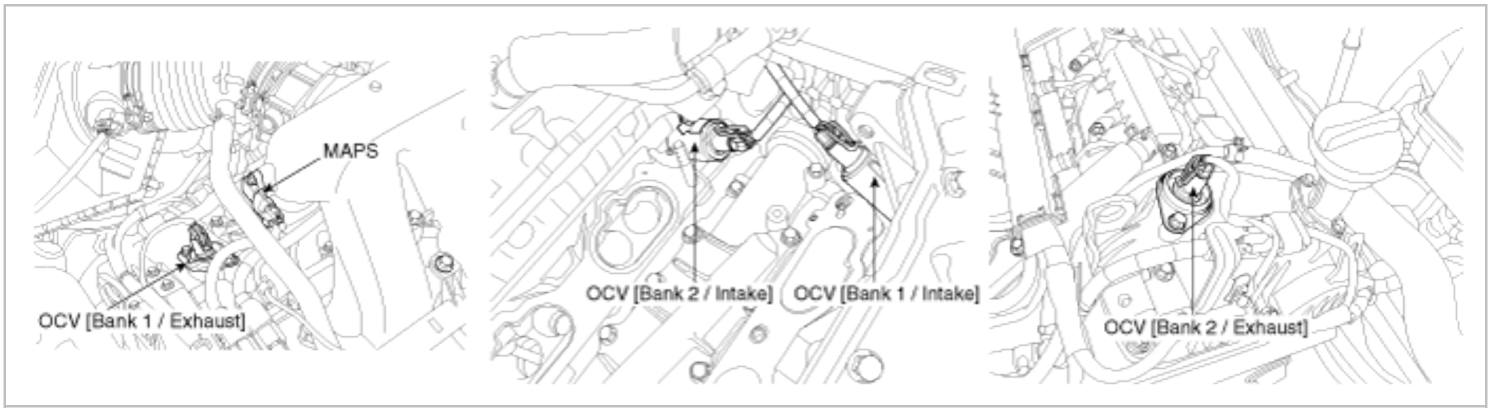
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0015 \'B\' Camshaft Position - Timing Over-Retarded (Bank 1)

Component Location



General Description

The CVVT (Continuously Variable Valve Timing) system is installed to the chain sprocket of the intake camshaft. This system controls the intake camshaft to provide the optimal valve timing for every driving condition. The ECM controls the Oil Control Valve(OCV), based on the signals output from mass air flow, throttle position and engine coolant temperature. The CVVT controller regulates the intake camshaft angle using oil pressure through the OCV. As result, the relative position between the camshaft and the crankshaft becomes optimal, and the engine torque improves, fuel economy improves, exhaust emissions decrease under overall driving conditions.

DTC Description

ECM monitors CAM phaser error while CMP signal is normally generating and vehicle is driving in 2000 ~ 3000rpm.
If the CAM phaser does not move although ECM commands OCV duty cycle ECM determines that a faultexists and a DTC is stored.

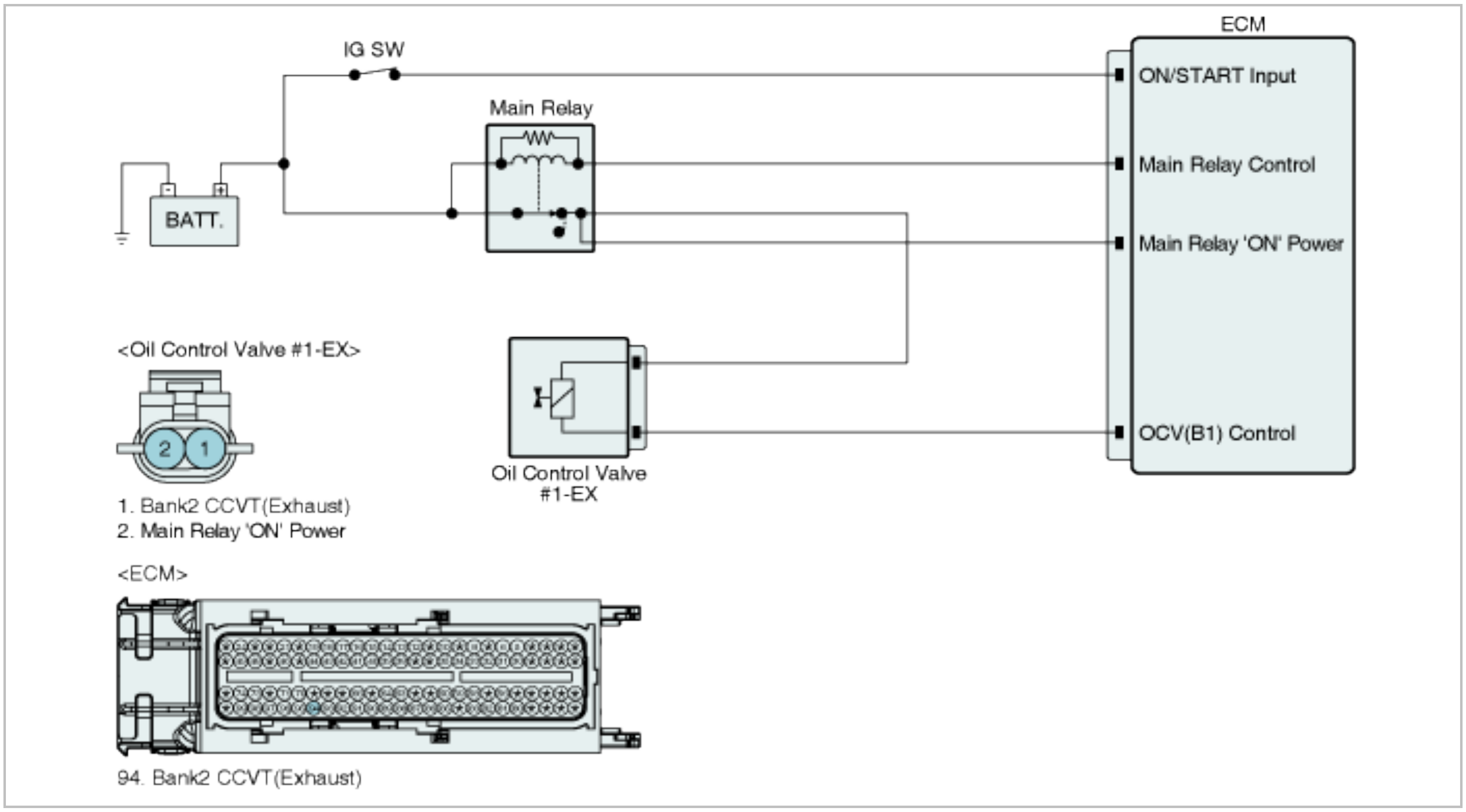
DTC Detecting Condition

Item		Detecting Condition	Possible Cause
DTC Strategy		• Determines if the phaser is stuck or has steady-state error	• Engine Oil • OCV stuck • CVVT stuck
Enable Conditions		• CAM signal is normally generating • Vehicle is on driving (2000 ~ 3000RPM) for 5 minutes	
Threshold value	Case 1	• 5 CAD < Cam Actual Position < 50 CAD • Duty Cycle > 90% or Duty Cycle < 10%	
	Case 2	• Cam Position error > 15 CAD (Difference between Actual Postion and Desire Position is more than 15°) • Timing Counter > 80	
Diagnosis Time		• Continuous (within 5min.)	
MIL On Condition		• 2 Driving Cycles	

Specification

OCV	Specification
Coil Resistance (Ω)	6.7 ~ 7.7 at 20°C (68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data

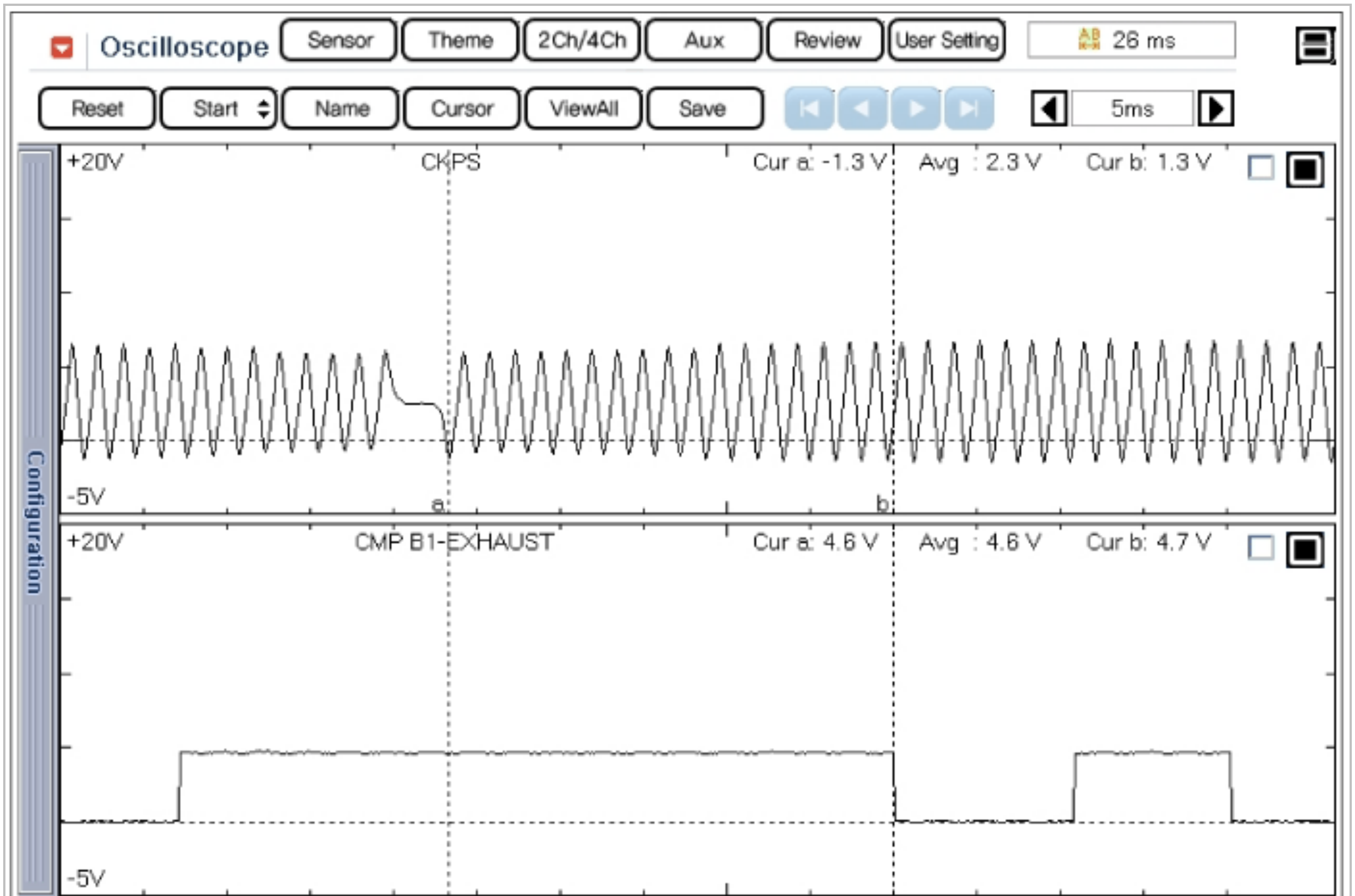

Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
26 ms
Reset
Start
Name
Cursor
ViewAll
Save
5ms
Configuration
+20V
CKPS
Cur a: -1.3 V
Avg : 2.3 V
Cur b: 1.3 V
-5V
a
b
+20V
CMP B1-EXHAUST
Cur a: 4.6 V
Avg : 4.6 V
Cur b: 4.7 V
-5V

Fig.1

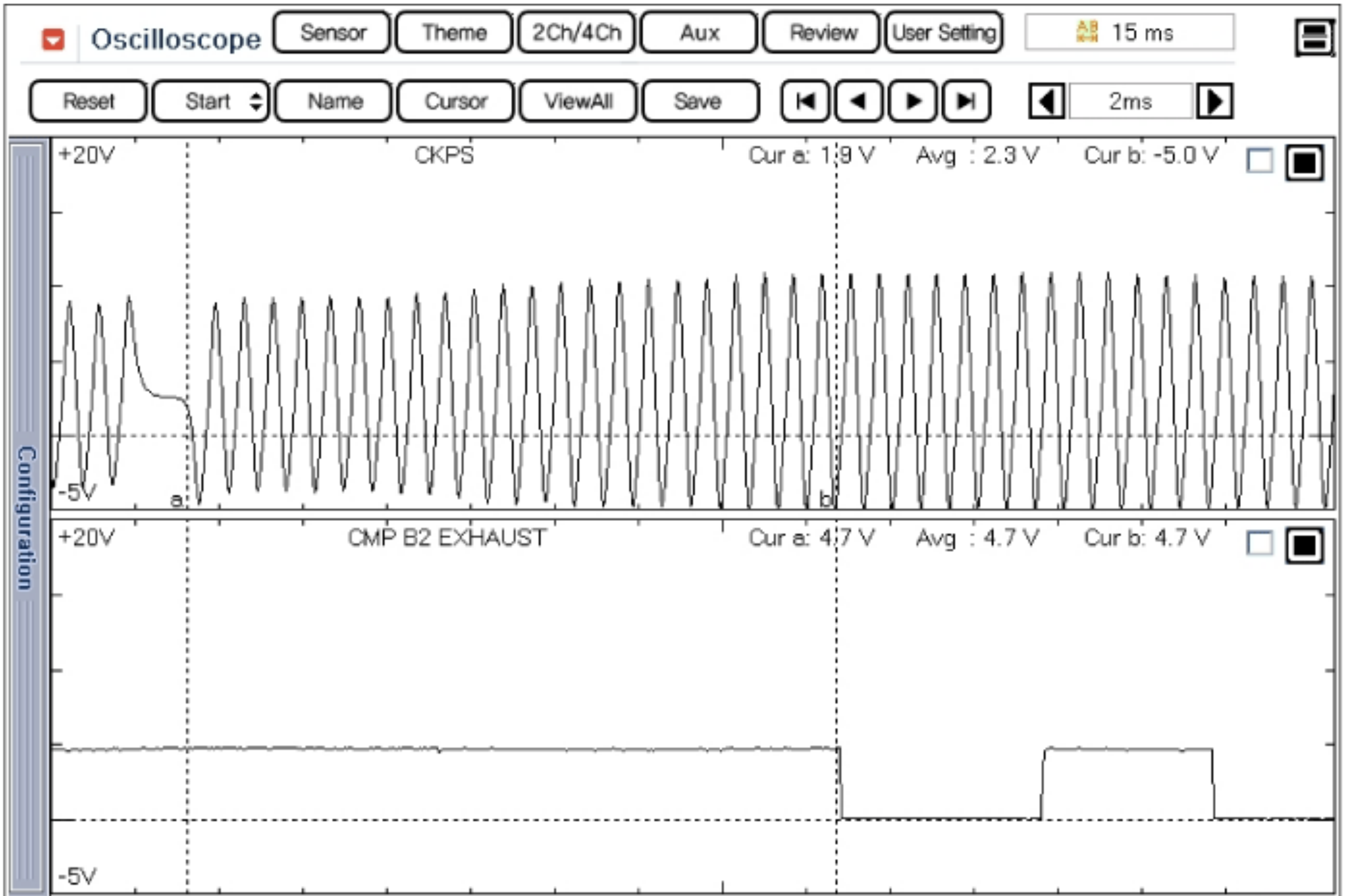
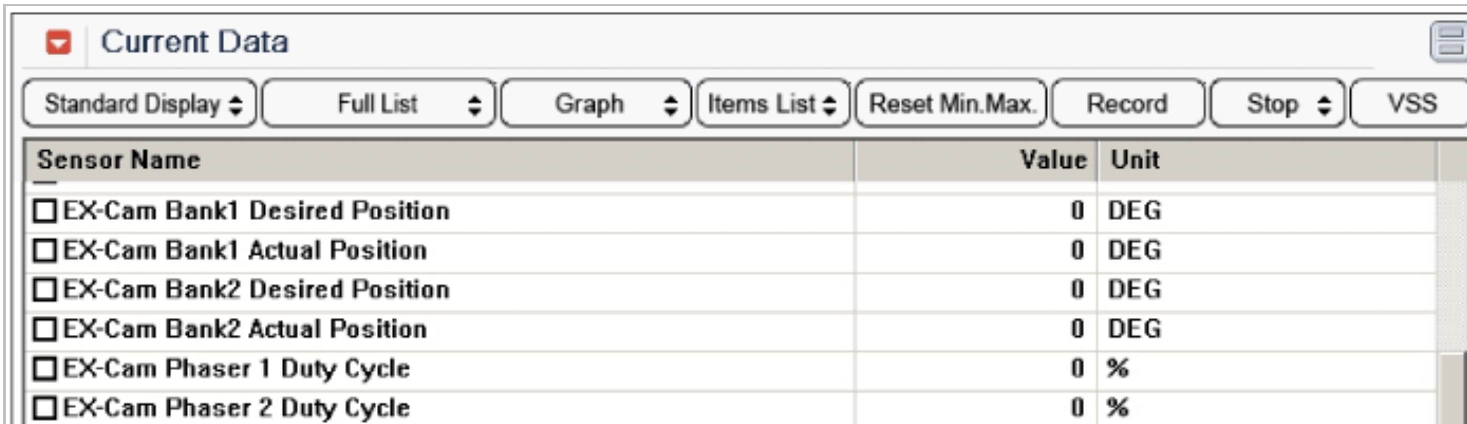


Fig.2



Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | VSS

Sensor Name	Value	Unit
EX-Cam Bank1 Desired Position	0	DEG
EX-Cam Bank1 Actual Position	0	DEG
EX-Cam Bank2 Desired Position	0	DEG
EX-Cam Bank2 Actual Position	0	DEG
EX-Cam Phaser 1 Duty Cycle	0	%
EX-Cam Phaser 2 Duty Cycle	0	%

Fig.3

Sensor Name	Value	Unit
☑ Camshaft Control	ON	-
☑ Engine Speed	3840	RPM
☑ EX-Cam Bank1 Actual Position	-15	DEG
☑ EX-Cam Bank1 Desired Position	-14	DEG
☑ EX-Cam Bank2 Desired Position	-14	DEG
☑ EX-Cam Bank2 Actual Position	-15	DEG
☑ EX-Cam Phaser 1 Duty Cycle	43	%
☑ EX-Cam Phaser 2 Duty Cycle	44	%

Fig.4

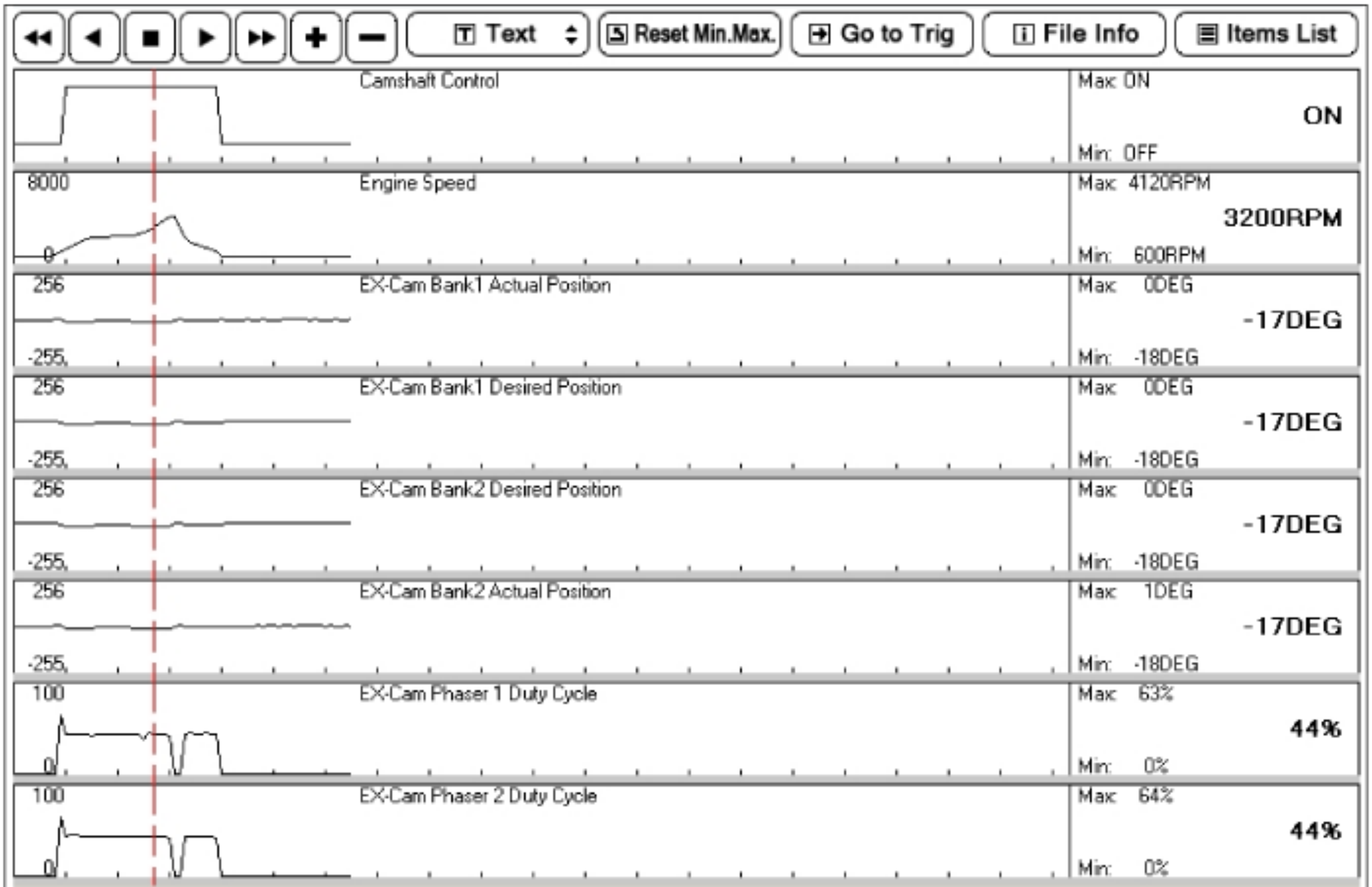


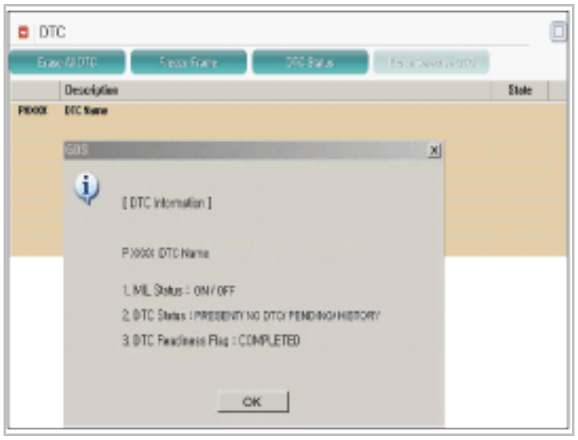
Fig.5

Fig.1) Normal waveform of CKPS & EX-CMPS at idle.
Fig.2) Normal waveform of CKPS & EX-CMPS at acceleration.
Fig.3) Normal data of EX-CVVT at idle.
Fig.4) Normal data of EX-CVVT at acceleration.
Fig.5) Normal graph of EX-CVVT at acceleration.

This example shows a typical Crankshaft Position Sensor (CKPS) and Camshaft Position Sensor (CMPS) waveform at idle.(Fig1.) If the 17th signal of the CKPS after missing tooth is aligned with the high signal of the CMPS at idle, ECM recognizes that Synchronization between CKPS and CMPS is completed. Under acceleracting condition, the number of teeth between missing tooth and tooth aligned with edge of the CMPS high signal is increased from idle condition.(Fig2.)

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "System Inspection" procedure.
NO	▶ Fault is intermittent caused by ECM memory was not cleared after repair. Erase DTC and drive the vehicle to satisfy the enable codition then, go to " System Inspection" procedure.

System Inspection

■ Visual Inspection

1. Check oil level is O.K.
2. Check Oil and OCV is contaminated.
3. Check for oil leakage around OCV.
4. Has a problem been found ?

YES	▶ Repair or replace as necessary and then, go to " Verification of Vehicle Repair" procedure.
NO	▶ Go to "Component Inspection" procedure.

Component Inspection

■ Check OCV resistance

1. IG "OFF" and disconnect OCV connector.
2. Measure resistance between power and signal terminals of OCV. (Component Side)

Specification : 6.7 ~ 7.7 at 20°C (68°F)

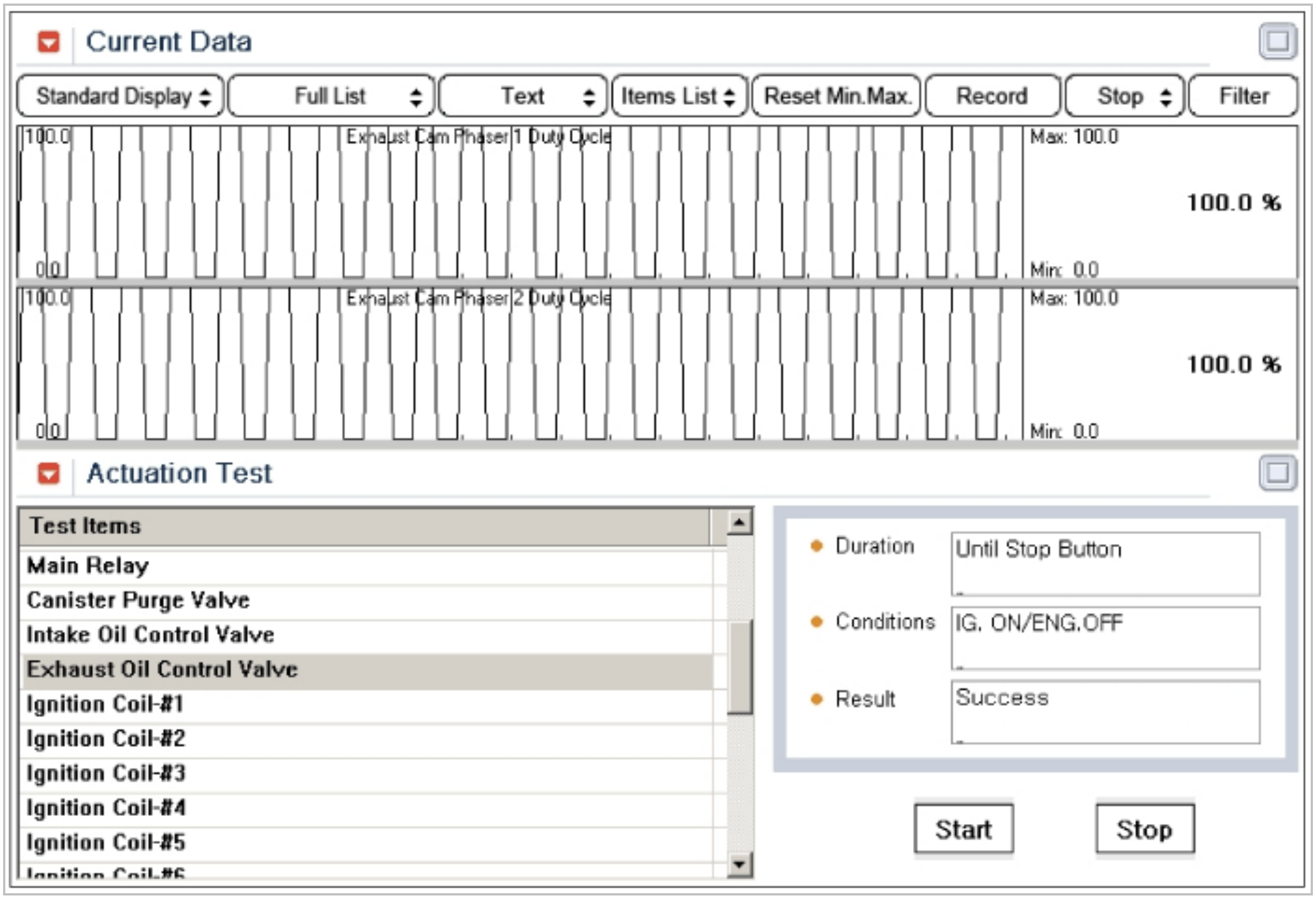
3. Is the measured resistance within specification?

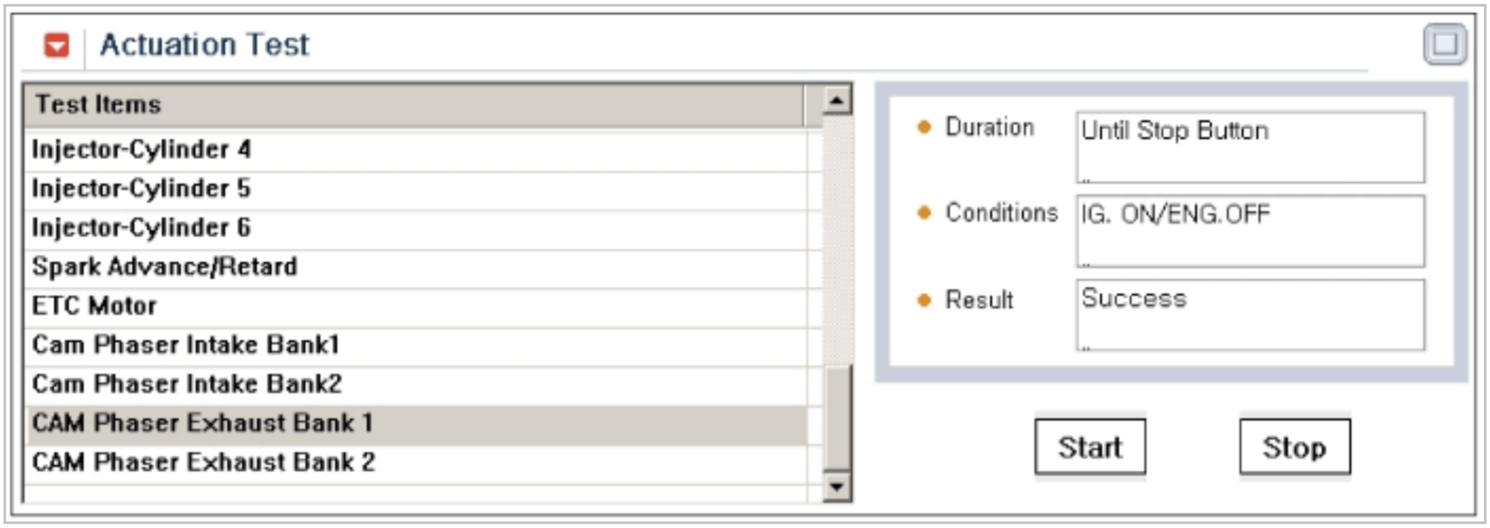
YES	▶ Go to "Check CAM PHASER with actuation test" as follows.
NO	▶ Substitute with a known - good OCV and check for proper operation. If the problem is corrected,

	replace OCV and go to "Verification of Vehicle Repair" procedure.

■ **Check CAM PHASER with actuation test**

1. Connect GDS and IG "ON"
2. Select "Cam Phaser Intake Bank1" on the Actuation Test
3. Select "Exhaust Oil Control Valve" on the Actuation Test
4. Activates "Cam Phaser Intake Bank1" by pressing "START" button
5. Activates "Exhaust Oil Control Valve" by pressing "START" button
6. Repeat this procedure 4 or 5 times to ensure CAM PHASER and valve control solenoid reliability





7. Has a problem been found ?

YES	▶ Substitute with a known - good CVVT or OCV and check for proper operation. If the problem is corrected, replace CVVT or OCV and go to "Verification of Vehicle Repair" procedure.
NO	▶ Fault is intermittent. Drive the vehicle to meet the enable condition for the DTC. and Go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

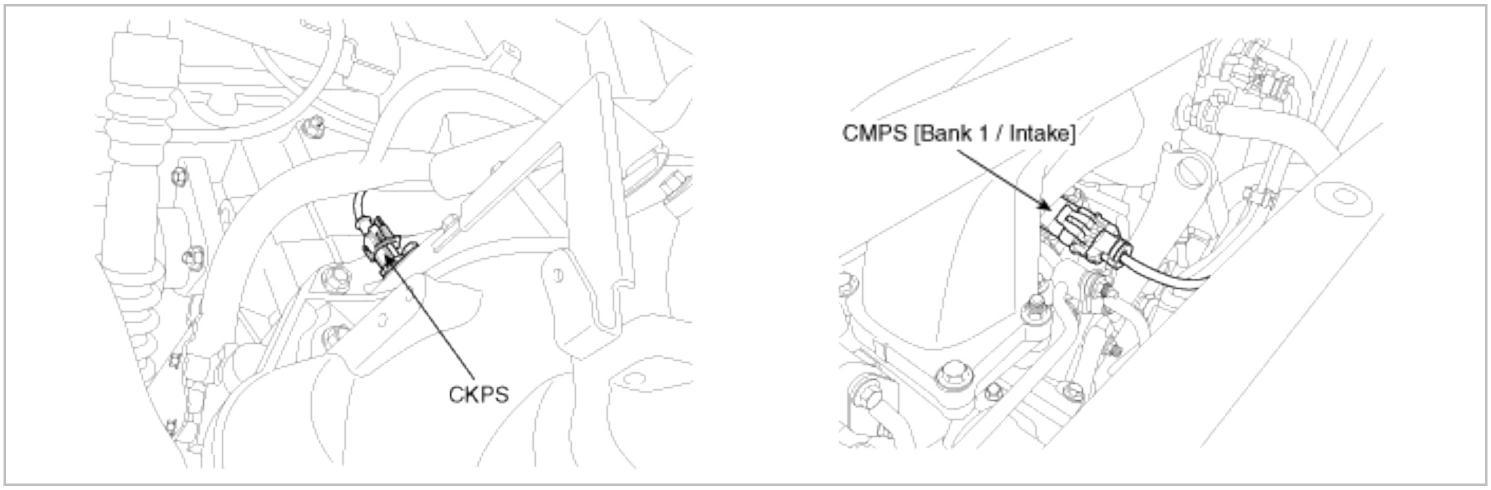
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0016 Crankshaft Position–Camshaft Position Correlation (Bank 1 Sensor A)

Component Location



General Description

The CVVT (Continuously Variable Valve Timing) system is installed to the chain sprocket of the camshaft. This system controls the camshaft to provide the optimal valve timing for every driving condition. The ECM controls the Oil Control Valve(OCV), based on the signals output from mass air flow, throttle position and engine coolant temperature. The CVVT controller regulates the camshaft angle using oil pressure through the OCV. As result, the relative position between the camshaft and the crankshaft becomes optimal, and the engine torque improves, fuel economy improves, exhaust emissions decrease under over all driving conditions.

DTC Description

ECM monitors timing misalignment while no active faults is present and fully warmed up engine oil at idle.
If the timing is misaligned ECM determines that a fault exists and a DTC is stored.

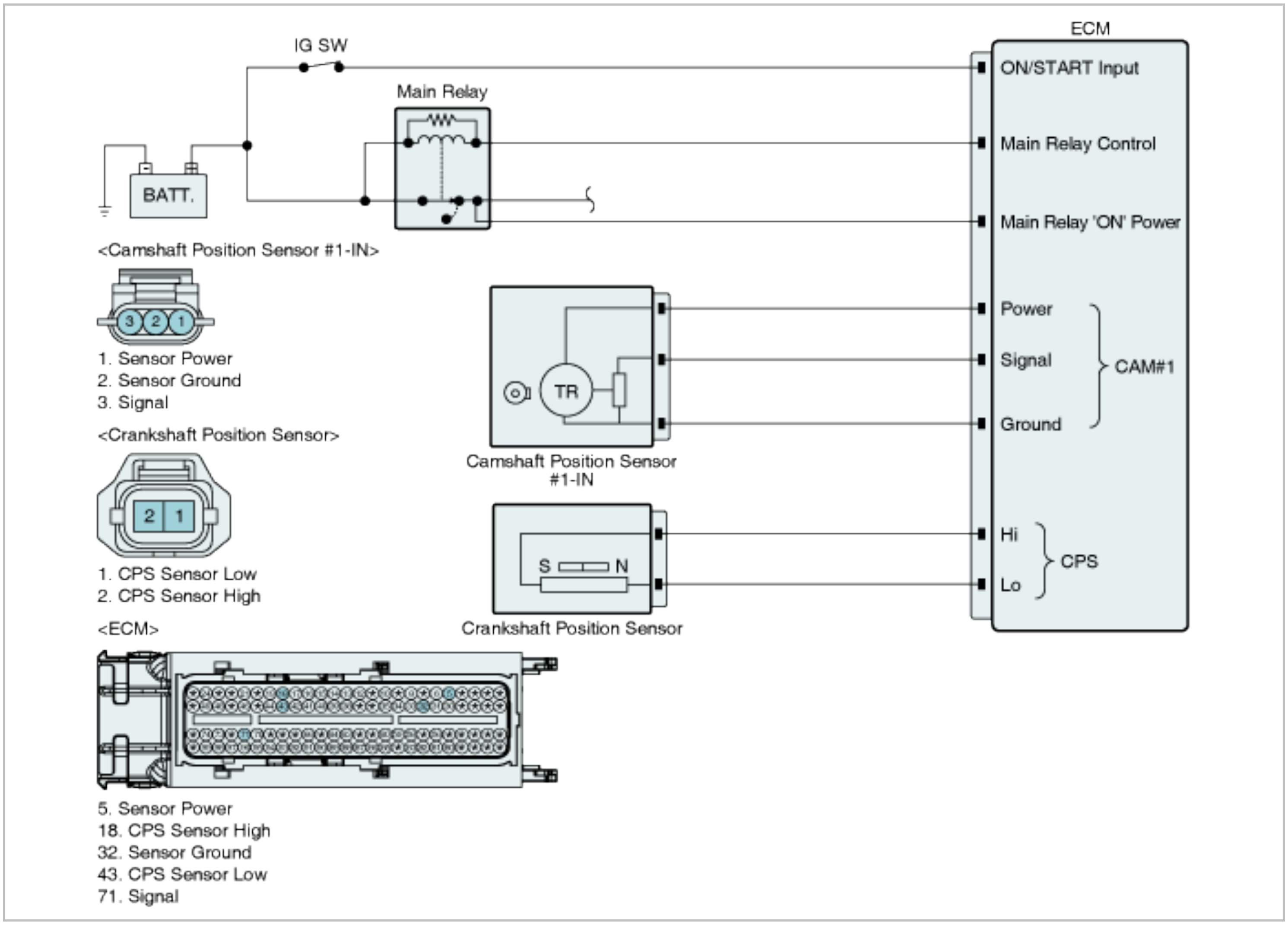
DTC Detecting Condition

<table>
<tr><th colspan="2">Item</th><th>Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td colspan="2">DTC Strategy</td><td>• Determines if CAM target is aligned correctly to crank</td><td rowspan="6">• loosened CKPS
• Timing Misalignment</td></tr>
<tr><td colspan="2">Enable Conditions</td><td>• No active faults
• Fully warmed up at idle</td></tr>
<tr><td rowspan="2">Threshold value</td><td>Case 1</td><td>• 1 teeth misalignment at 80 °C(176 °F) < Oil Temperature < 90 °C(194°F)</td></tr>
<tr><td>Case 2</td><td>• 2 tooth misalignment at Lower than 80 °C(176 °F) or Higher than 90 °C(194°F)</td></tr>
<tr><td colspan="2">Diagnosis Time</td><td>• Continuous (Within 1min.)</td></tr>
<tr><td colspan="2">MIL On Condition</td><td>• 2 Driving Cycles</td></tr>
</table>

Specification

Engine Oil Temperature	Misalignment
80 °C(176 °F) < ENgine Oil Temperature < 90 °C(194°F)	1 tooth
Less than 80 °C(176 °F) or Higher than 90 °C(194°F)	2 teeth

Diagnostic Circuit Diagram



Signal Waveform & Data

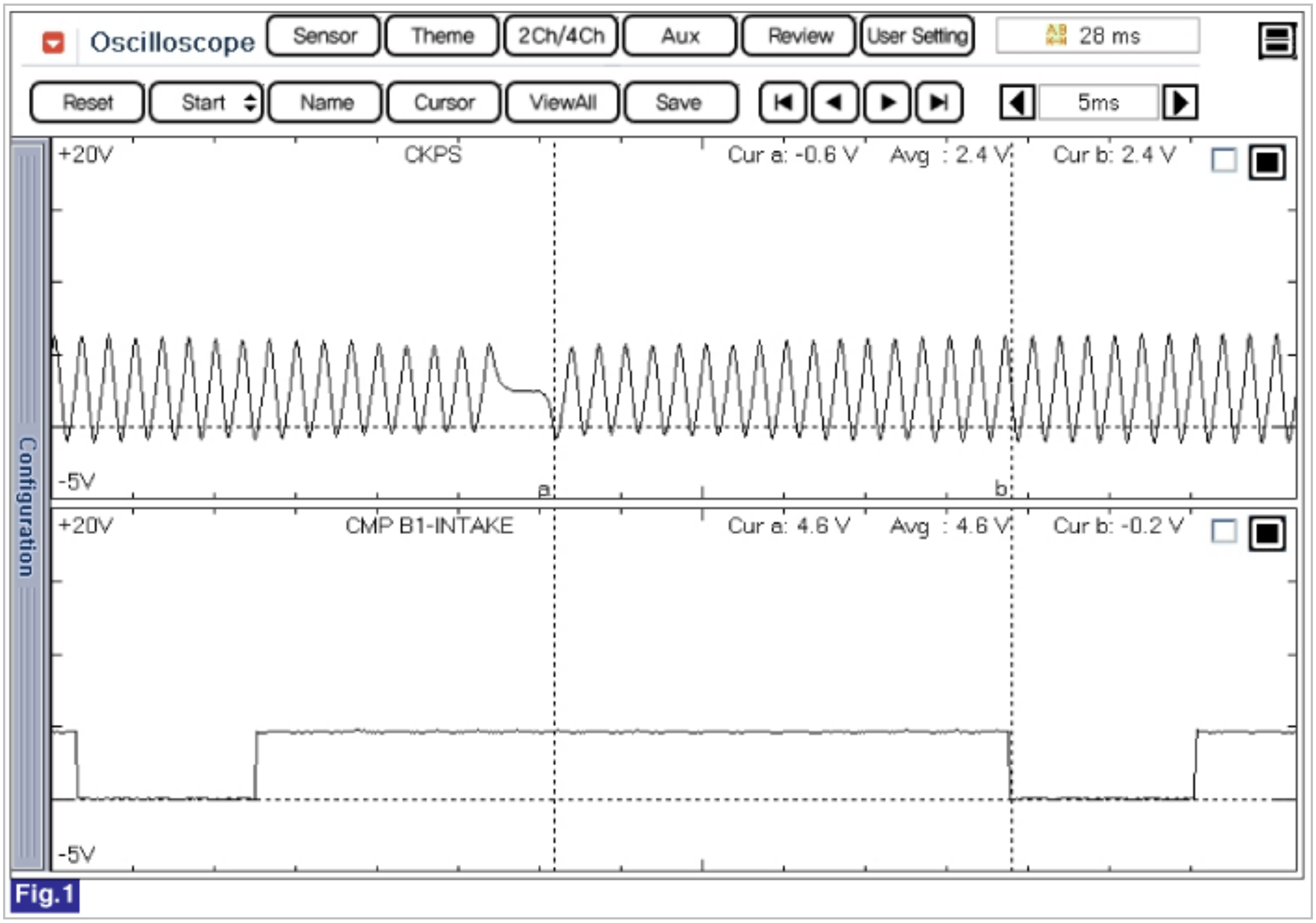
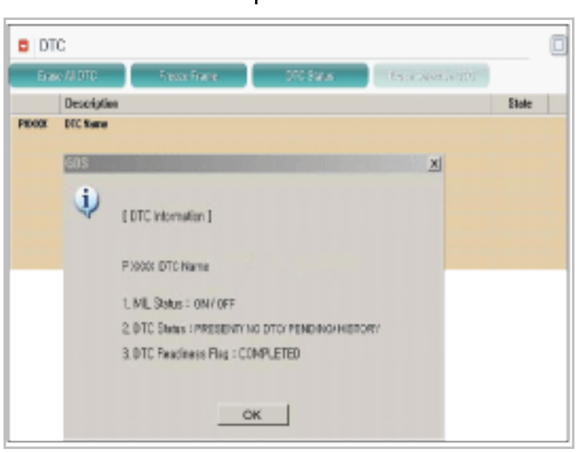


Fig.1) Normal waveform of CKPS & CMPS at idle.

This example shows a typical Crankshaft Position Sensor (CKPS) and Camshaft Position Sensor (CMPS) waveform at idle. If the 17th signal of the CKPS after missing tooth is aligned with the high signal of the CMPS at idle, ECM recognizes that Synchronization between CKPS and CMPS is completed.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "System Inspection" procedure.
NO	▶ Fault is intermittent caused by ECM memory was not cleared after repair. Erase DTC and drive the vehicle to satisfy the enable codition then, go to " System Inspection" procedure.

Component Inspection

■ Visual Inspection

1. Check oil level is O.K.
2. Check Oil and OCV is contaminated.
3. Has a problem been found ?

YES	▶ Repair or replace as necessary and then, go to " Verification of Vehicle Repair" procedure.
NO	▶ Go to "Visually check CKPS and target wheel" as follow

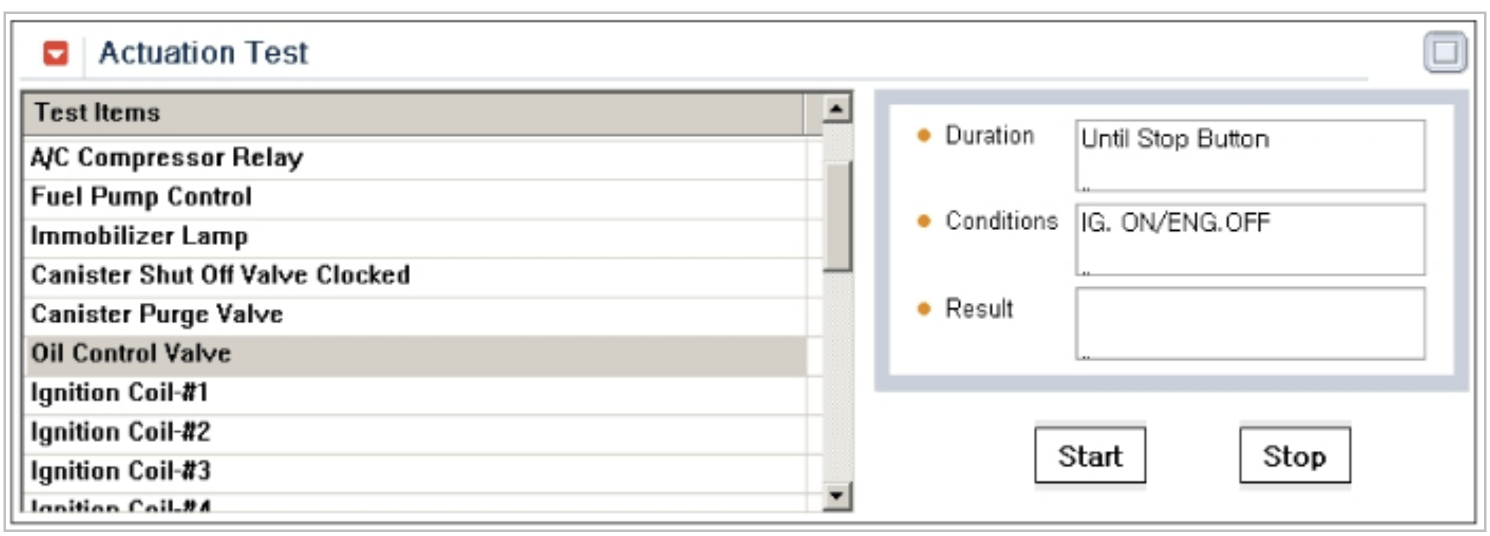
■ Visually check CKPS and target wheel

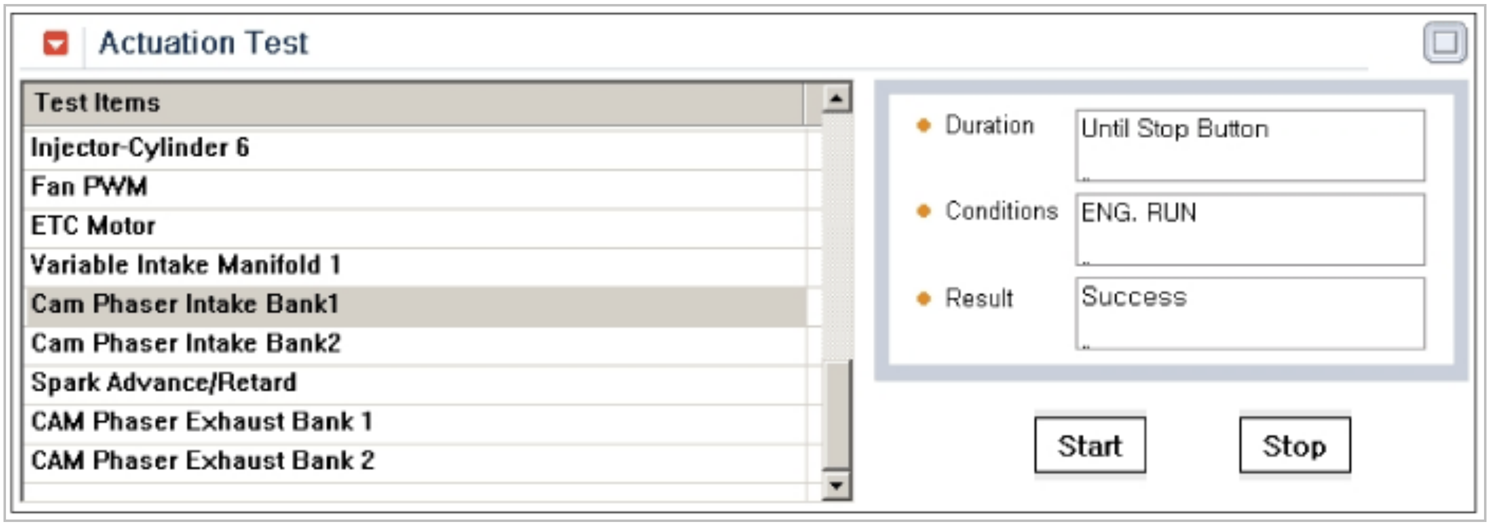
1. IG "OFF".
2. Visually check CKPS is loosened or target wheel is deformed or damaged.
3. Is the above items normal ?

YES	▶ Go to " Check CAM PHASER with actuation test" as follows
NO	▶ Repair or replace as necessary and then go to"Verification of Vehicle Repair" procedure.

■ Check CAM PHASER with actuation test

1. connect GDS and IG "ON"
2. Select "CAM PHASER INTAKE BANK 1" on the Actuation Test
3. Select "OIL CONTROL VALVE" on the Actuation Test
4. Activates "CAM PHASER INTAKE BANK 1" by pressing "START" button
5. Activates "OIL CONTROL VALVE" by pressing "START" button
6. Repeat this procedure 4 or 5 times to ensure CAM PHASER and valve control solenoid reliability





7. Has a problem been found ?

YES	▶ Substitute with a known - good CVVT or OCV and check for proper operation. If the problem is corrected, replace CVVT or OCV and go to "Verification of Vehicle Repair" procedure.
NO	▶ Fault is intermittent. Drive the vehicle to meet the enable condition for the DTC. and Go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ CMPS, CKPS Inspection

1. IG "OFF" and connect GDS.
2. ENG "ON" and Measure signal waveform at signal terminal of CMPS.
3. Measure signal waveform at signal terminal of CKPS.

Specification : 17th signal of the CKPS after missing tooth is aligned with the high signal of the CMPS at idle, ECM recognizes that Synchronization between CKPS and CMPS is completed.
※ Refer to Signal Waveform & Data

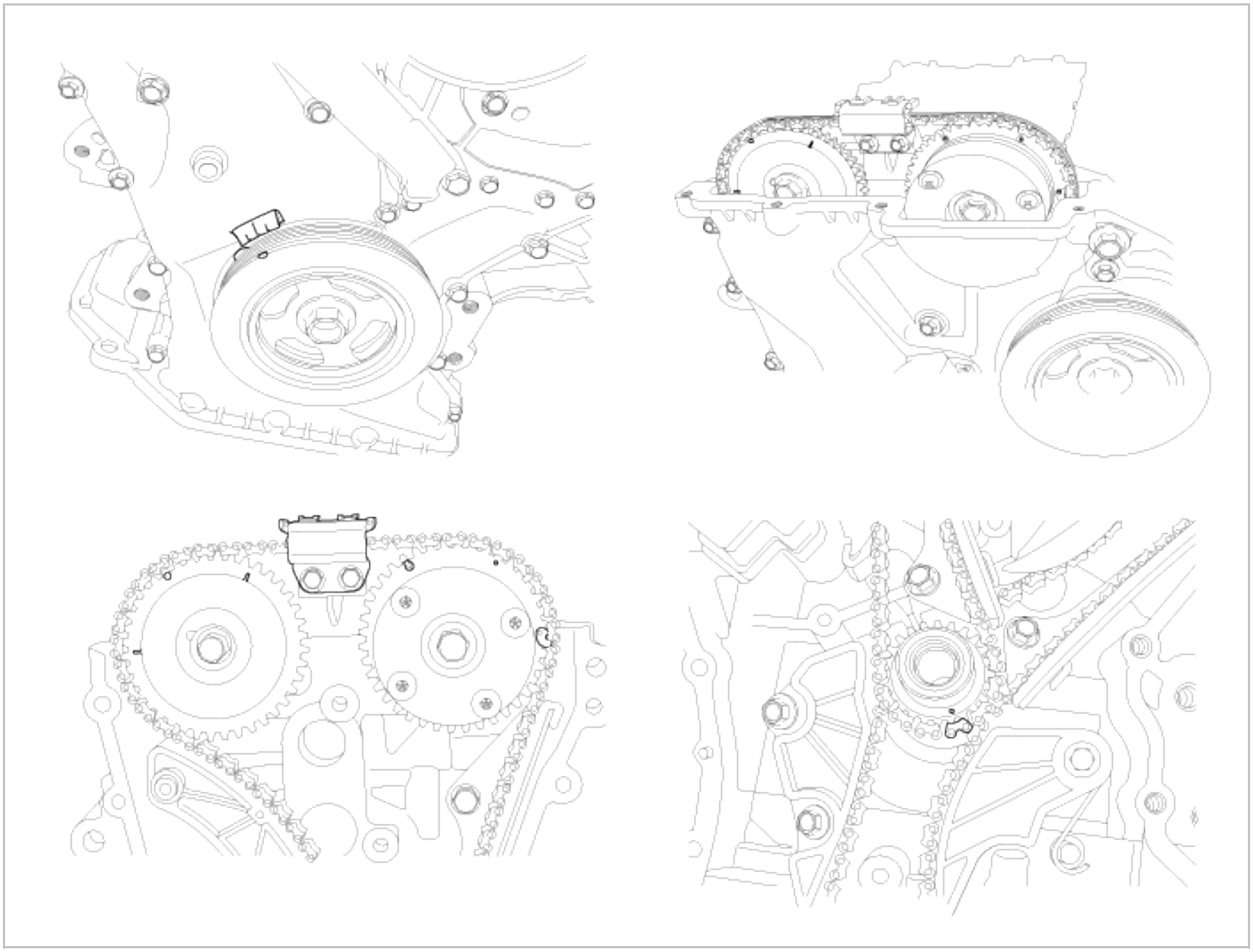
4. Is the measured signal waveform O.K ?

YES	▶ Fault is intermittent. Drive the vehicle to meet the enable condition for the DTC. and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Timing Mark Inspection" procedure as follow.

■ Timing Mark Inspection

1. IG "OFF" and check the timing mark is correctly aligned.

Reference :



2. Is the timing mark correctly aligned ?

YES	▶ Fault is intermittent. Drive the vehicle to meet the enable condition for the DTC. and go to "Verification of Vehicle Repair" procedure.
NO	▶ Repair or replace as necessary and then, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

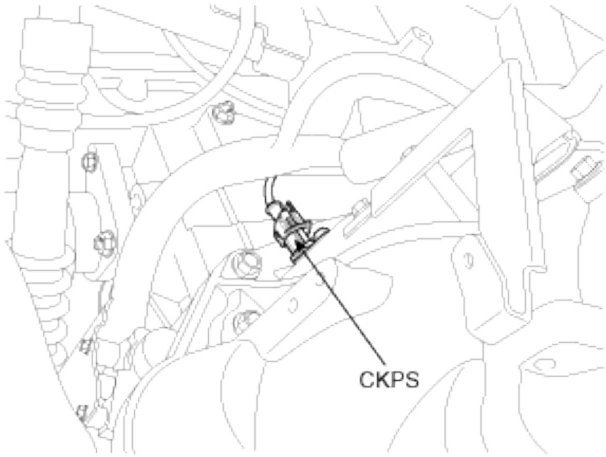
After a repair, it is essential to verify that the fault has been corrected.

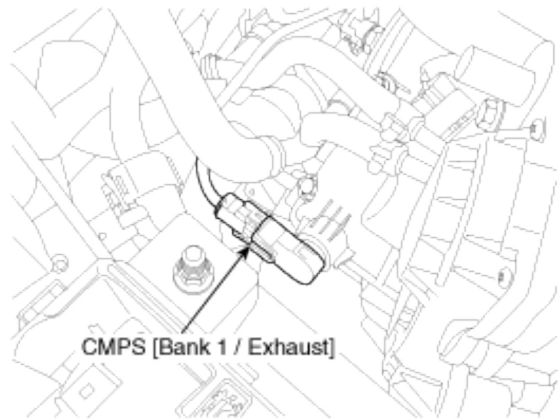
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0017 Crankshaft Position – Camshaft Position Correlation (Bank 1 Sensor B)

Component Location





General Description

The CVVT (Continuously Variable Valve Timing) system is installed to the chain sprocket of the camshaft. This system controls the camshaft to provide the optimal valve timing for every driving condition. The ECM controls the Oil Control Valve(OCV), based on the signals output from mass air flow, throttle position and engine coolant temperature. The CVVT controller regulates the camshaft angle using oil pressure through the OCV. As result, the relative position between the camshaft and the crankshaft becomes optimal, and the engine torque improves, fuel economy improves, exhaust emissions decrease under over all driving conditions.

DTC Description

ECM monitors timing misalignment while no active faults is present and fully warmed up engine oil at idle.
If the timing is misaligned ECM determines that a fault exists and a DTC is stored.

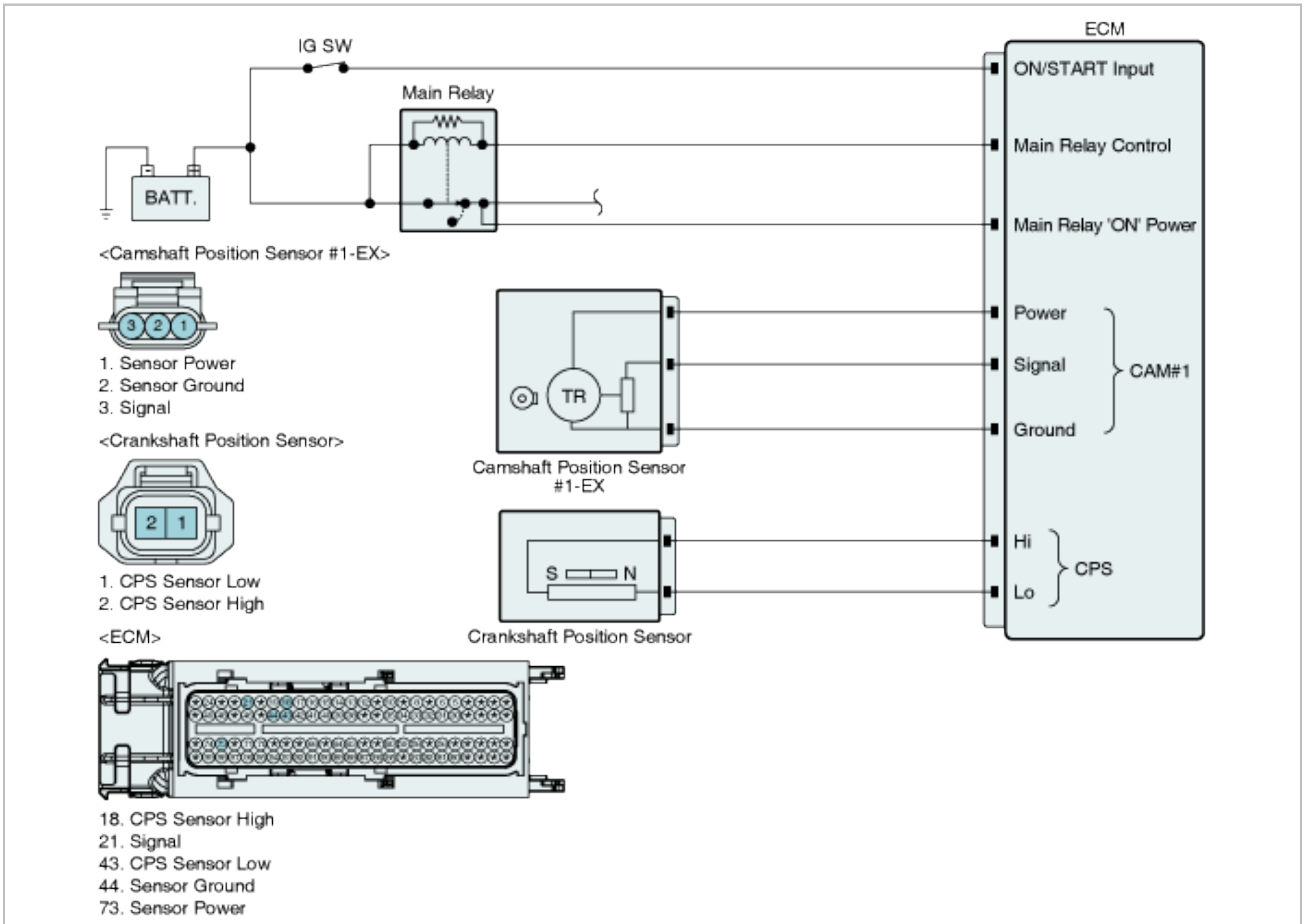
DTC Detecting Condition

Item		Detecting Condition	Possible Cause
DTC Strategy		• Determines if CAM target is aligned correctly to crank	• loosened CKPS • Timing Misalignment
Enable Conditions		• No active faults • Fully warmed up at idle	
Threshold value	Case 1	• 1 teeth misalignment at 80 °C(176 °F) < Oil Temperature < 90 °C(194°F)	
	Case 2	• 2 tooth misalignment at Lower than 80 °C(176 °F) or Higher than 90 °C(194°F)	
Diagnosis Time		• Continuous (Within 1min.)	
MIL On Condition		• 2 Driving Cycles	

Specification

Engine Oil Temperature	Misalignment
80 °C(176 °F) < ENgine Oil Temperature < 90 °C(194°F)	1 tooth
Less than 80 °C(176 °F) or Higher than 90 °C(194°F)	2 teeth

Diagnostic Circuit Diagram



Signal Waveform & Data

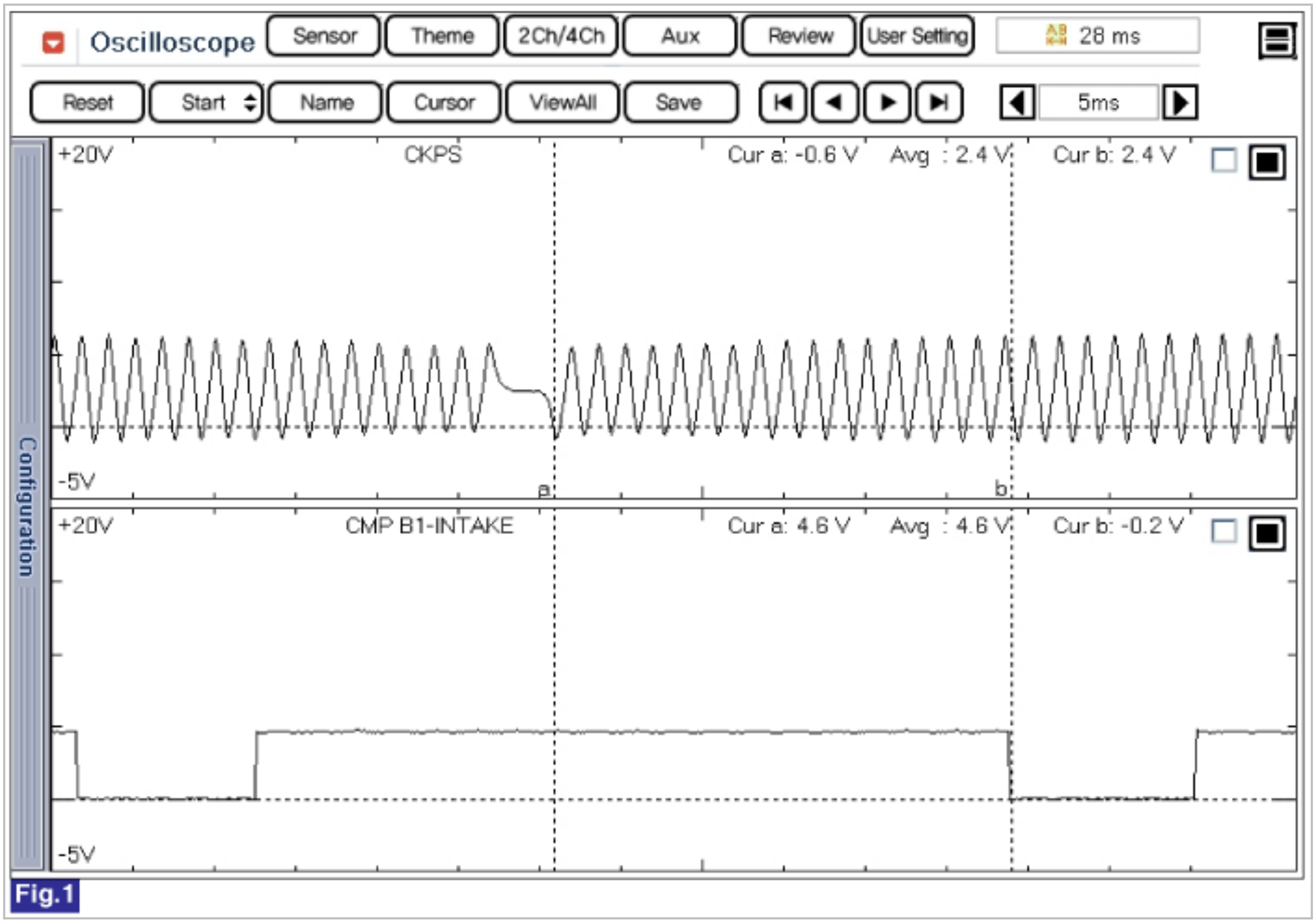
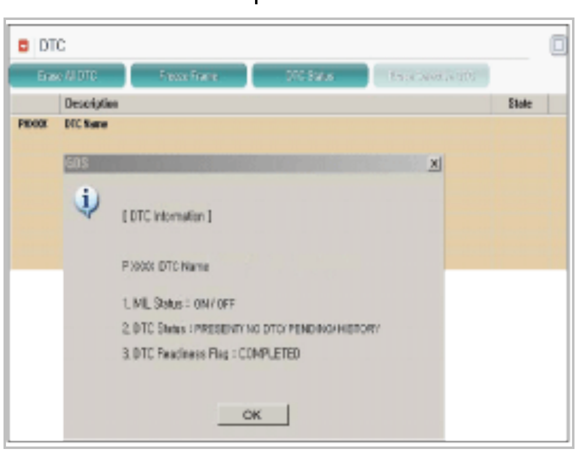


Fig.1) Normal waveform of CKPS & CMPS at idle.

This example shows a typical Crankshaft Position Sensor (CKPS) and Camshaft Position Sensor (CMPS) waveform at idle. If the 17th signal of the CKPS after missing tooth is aligned with the high signal of the CMPS at idle, ECM recognizes that Synchronization between CKPS and CMPS is completed.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "System Inspection" procedure.
NO	▶ Fault is intermittent caused by ECM memory was not cleared after repair. Erase DTC and drive the vehicle to satisfy the enable codition then, go to " System Inspection" procedure.

System Inspection

■ Visual Inspection

1. Check oil level is O.K.
2. Check Oil and OCV is contaminated.
3. Has a problem been found ?

YES	▶ Repair or replace as necessary and then, go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Visually check CKPS and target wheel" as follow.

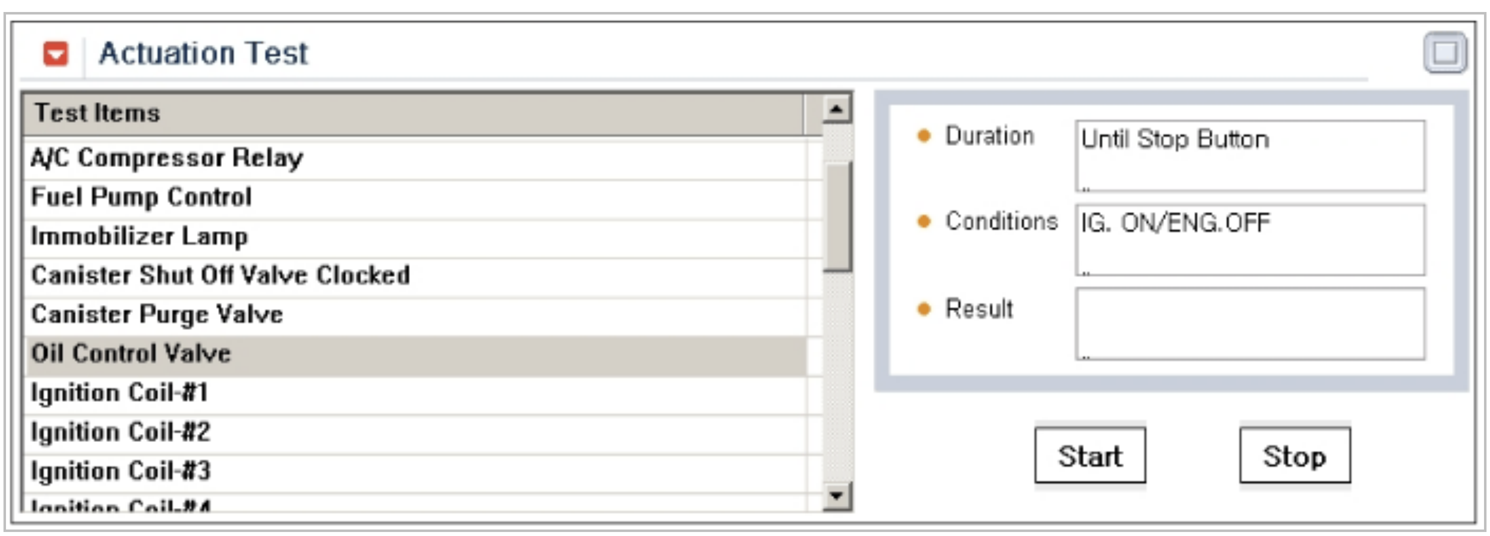
■ Visually check CKPS and target wheel

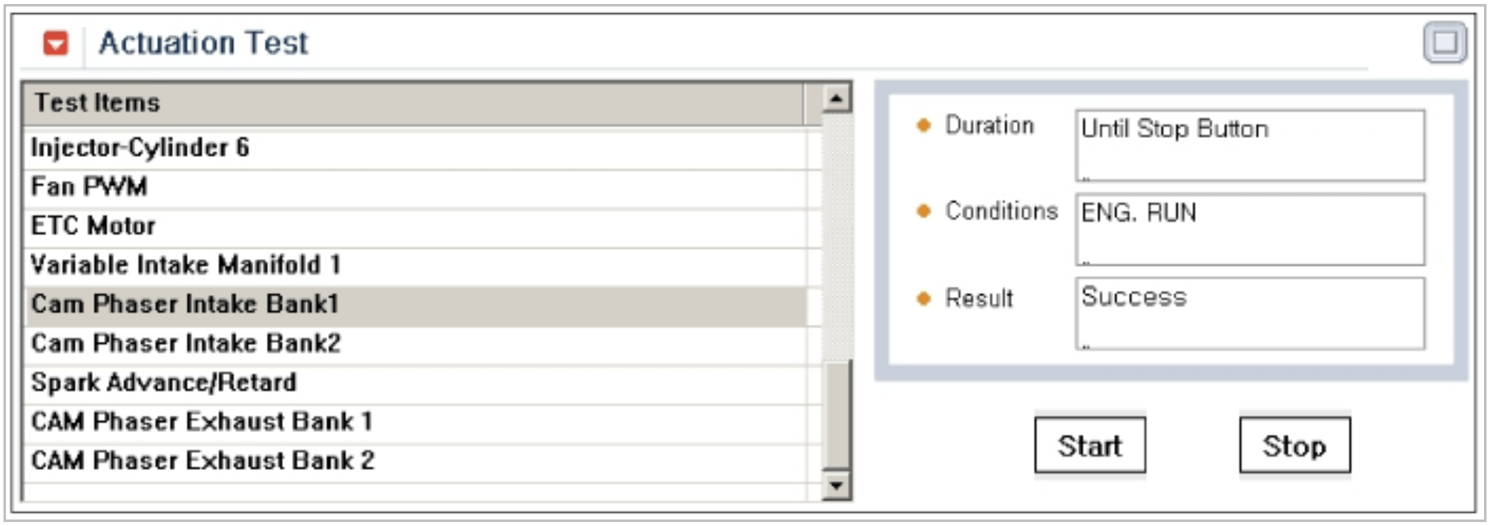
1. IG "OFF".
2. Visually check CKPS is loosened or target wheel is deformed or damaged.
3. Is the above items normal ?

YES	▶ Go to " Check CAM PHASER with actuation test" as follows
NO	▶ Repair or replace as necessary and then go to "Verification of Vehicle Repair" procedure.

■ Check CAM PHASER with actuation test

1. Connect GDS and IG "ON"
2. Select "CAM PHASER EXHAUST BANK 1" on the Actuation Test
3. Select "OIL CONTROL VALVE" on the Actuation Test
4. Activates "CAM PHASER EXHAUST BANK 1" by pressing "START" button
5. Activates "OIL CONTROL VALVE" by pressing "START" button
6. Repeat this procedure 4 or 5 times to ensure CAM PHASER and valve control solenoid reliability





7. Has a problem been found ?

YES	▶ Substitute with a known - good CVVT or OCV and check for proper operation. If the problem is corrected, replace CVVT or OCV and go to "Verification of Vehicle Repair" procedure.
NO	▶ Fault is intermittent. Drive the vehicle to meet the enable condition for the DTC. and Go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ CMPS, CKPS Inspection

1. IG "OFF" and connect GDS.
2. ENG "ON" and Measure signal waveform at signal terminal of CMPS.
3. Measure signal waveform at signal terminal of CKPS.

Specification : 17th signal of the CKPS after missing tooth is aligned with the high signal of the CMPS at idle, ECM recognizes that Synchronization between CKPS and CMPS is completed.
※ Refer to Signal Waveform & Data

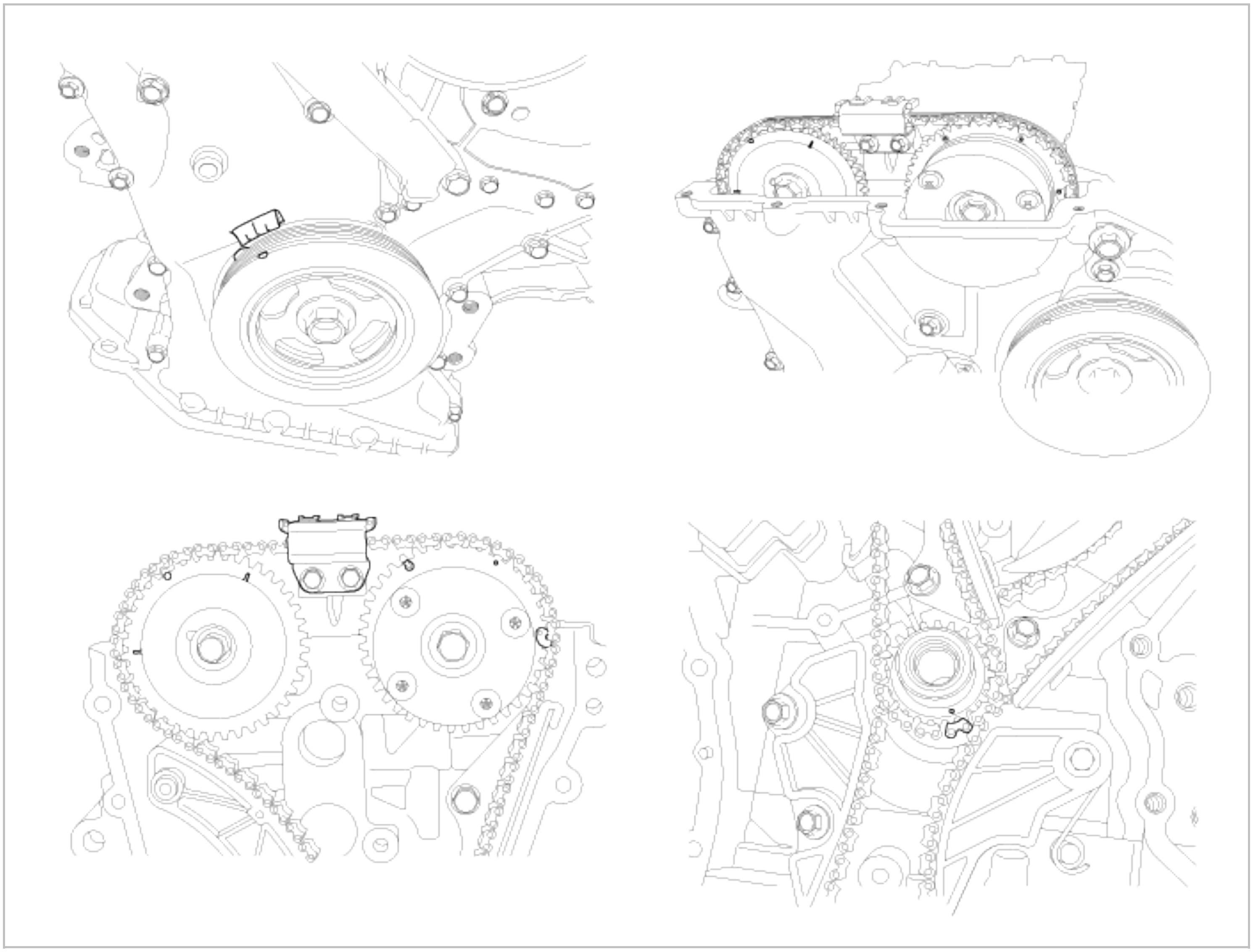
4. Is the measured signal waveform O.K ?

YES	▶ Fault is intermittent. Drive the vehicle to meet the enable condition for the DTC. and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Timing Mark Inspection" procedure as follow.

■ Timing Mark Inspection

1. IG "OFF" and check the timing mark is correctly aligned.

Reference :



2. Is the timing mark correctly aligned ?

YES	▶ Fault is intermittent. Drive the vehicle to meet the enable condition for the DTC. and go to "Verification of Vehicle Repair" procedure.
NO	▶ Repair or replace as necessary and then, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

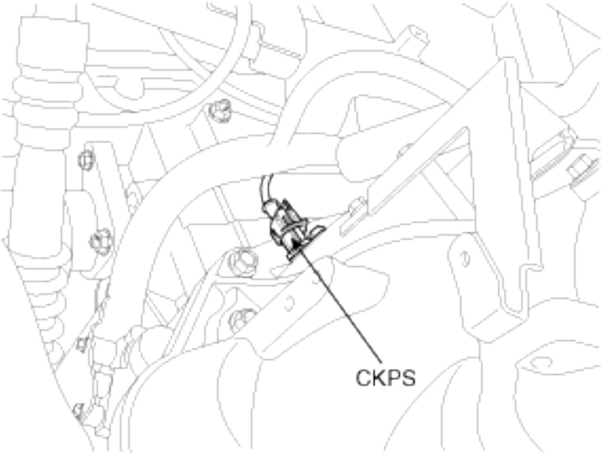
After a repair, it is essential to verify that the fault has been corrected.

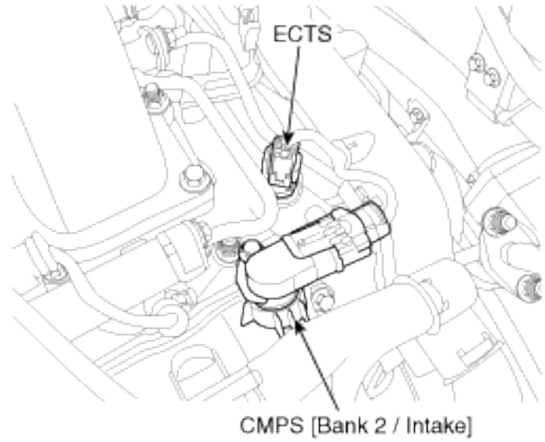
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0018 Crankshaft Position-Camshaft Position Correlation (Bank 2 Sensor A)

Component Location





General Description

The CVVT (Continuously Variable Valve Timing) system is installed to the chain sprocket of the camshaft. This system controls the camshaft to provide the optimal valve timing for every driving condition. The ECM controls the Oil Control Valve(OCV), based on the signals output from mass air flow, throttle position and engine coolant temperature. The CVVT controller regulates the camshaft angle using oil pressure through the OCV. As result, the relative position between the camshaft and the crankshaft becomes optimal, and the engine torque improves, fuel economy improves, exhaust emissions decrease under over all driving conditions.

DTC Description

ECM monitors timing misalignment while no active faults is present and fully warmed up engine oil at idle.
If the timing is misaligned ECM determines that a fault exists and a DTC is stored.

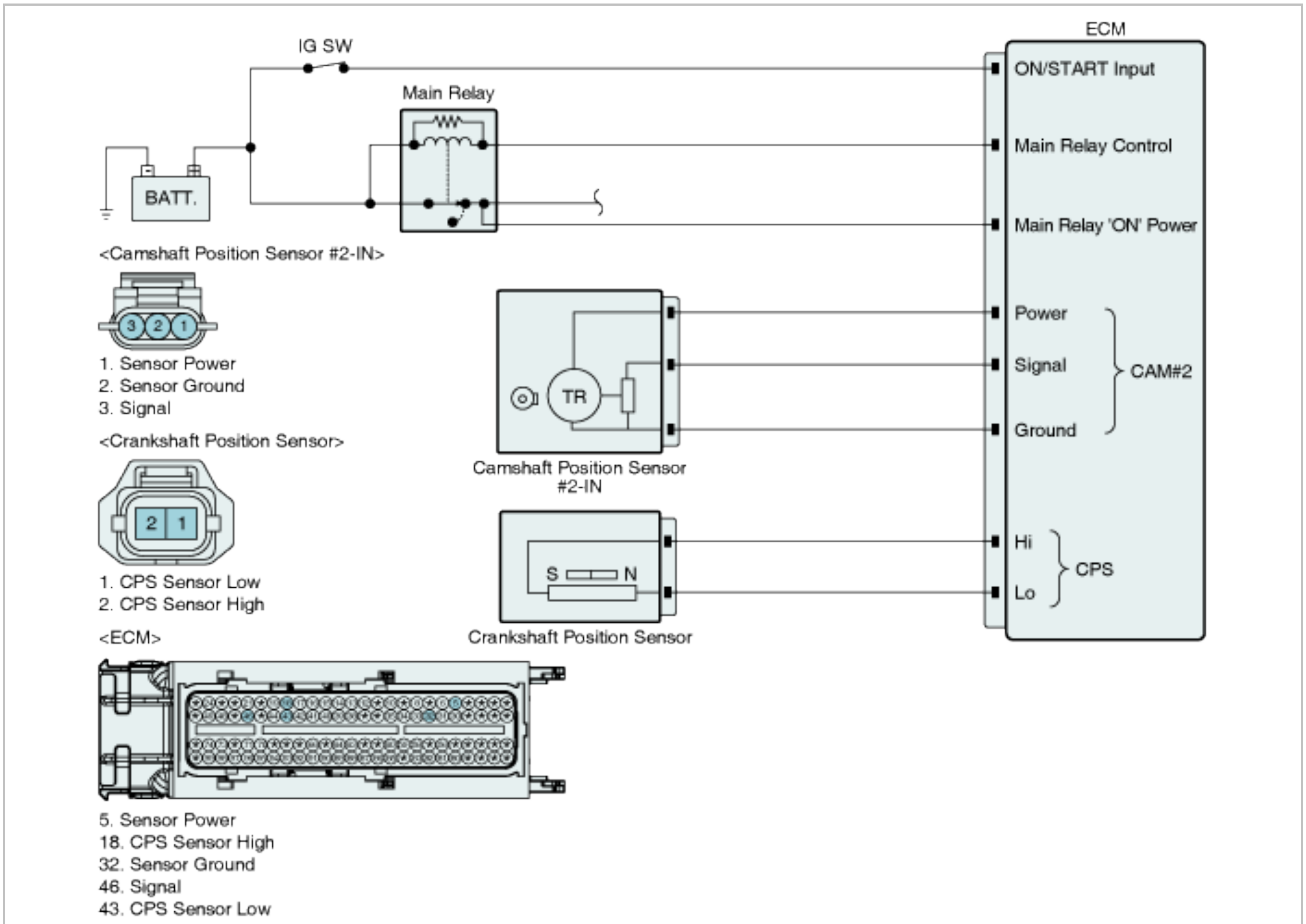
DTC Detecting Condition

Item		Detecting Condition	Possible Cause
DTC Strategy		• Determines if CAM target is aligned correctly to crank	• loosened CKPS • Timing Misalignment
Enable Conditions		• No active faults • Fully warmed up at idle	
Threshold value	Case 1	• 1 teeth misalignment at 80 °C(176 °F) < Oil Temperature < 90 °C(194°F)	
	Case 2	• 2 tooth misalignment at Lower than 80 °C(176 °F) or Higher than 90 °C(194°F)	
Diagnosis Time		• Continuous (Within 1min.)	
MIL On Condition		• 2 Driving Cycles	

Specification

Engine Oil Temperature	Misalignment
80 °C(176 °F) < ENgine Oil Temperature < 90 °C(194°F)	1 tooth
Less than 80 °C(176 °F) or Higher than 90 °C(194°F)	2 teeth

Diagnostic Circuit Diagram



Signal Waveform & Data

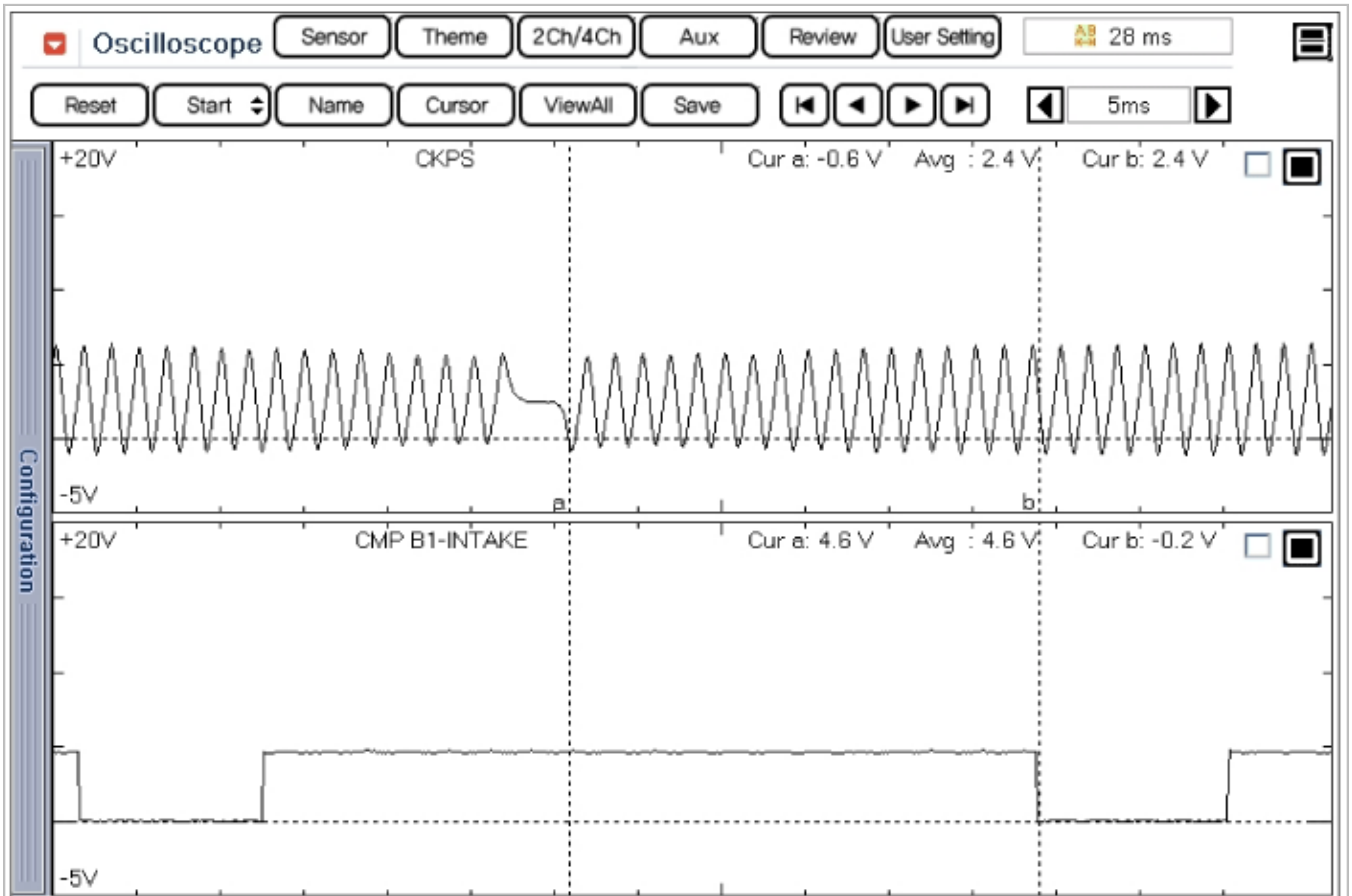


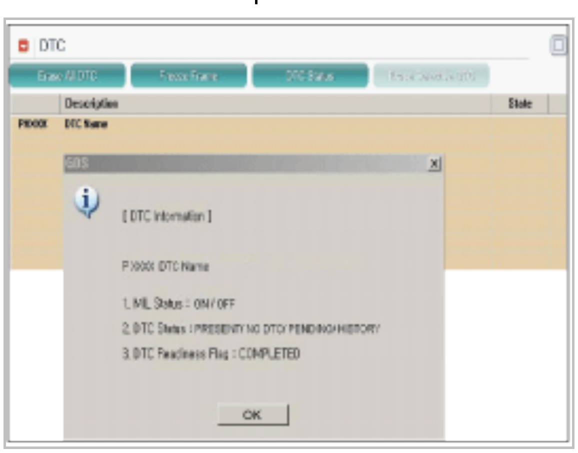
Fig.1

Fig.1) Normal waveform of CKPS & CMPS at idle.

This example shows a typical Crankshaft Position Sensor (CKPS) and Camshaft Position Sensor (CMPS) waveform at idle. If the 17th signal of the CKPS after missing tooth is aligned with the high signal of the CMPS at idle, ECM recognizes that Synchronization between CKPS and CMPS is completed.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "System Inspection" procedure.
NO	▶ Fault is intermittent caused by ECM memory was not cleared after repair. Erase DTC and drive the vehicle to satisfy the enable codition then, go to " System Inspection" procedure.

System Inspection

■ Visual Inspection

1. Check oil level is O.K.
2. Check Oil and OCV is contaminated.
3. Has a problem been found ?

YES	▶ Repair or replace as necessary and then, go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Visually check CKPS and target wheel" as follow

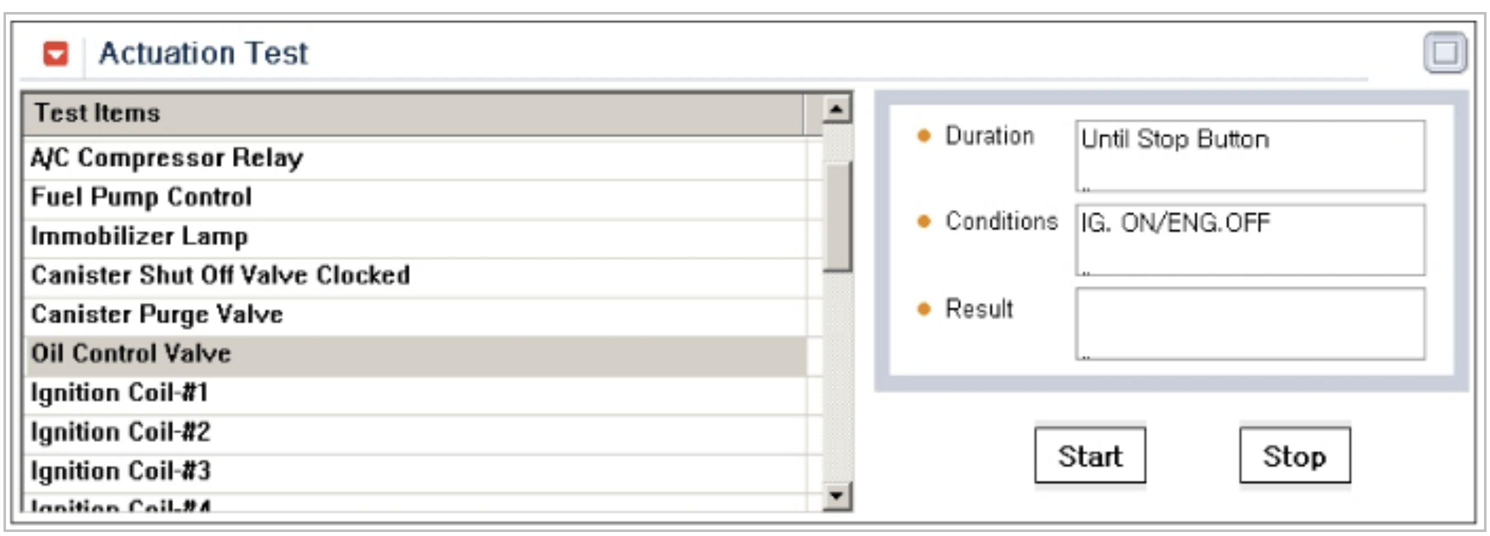
■ Visually check CKPS and target wheel

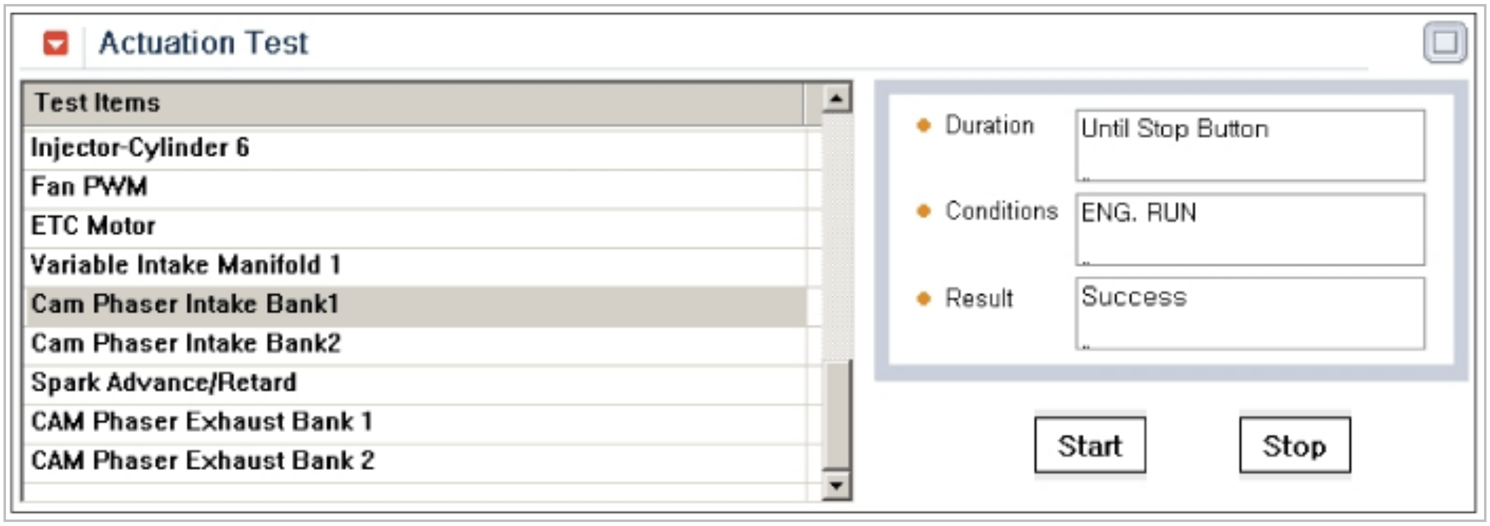
1. IG "OFF".
2. Visually check CKPS is loosened or target wheel is deformed or damaged.
3. Is the above items normal ?

YES	▶ Go to "Check CAM PHASER with actuation test" as follows
NO	▶ Repair or replace as necessary and then go to"Verification of Vehicle Repair" procedure.

■ Check CAM PHASER with actuation test

1. connect GDS and IG "ON"
2. Select "CAM PHASER INTAKE BANK 2" on the Actuation Test
3. Select "OIL CONTROL VALVE" on the Actuation Test
4. Activates "CAM PHASER INTAKE BANK 2" by pressing "START" button
5. Activates "OIL CONTROL VALVE" by pressing "START" button
6. Repeat this procedure 4 or 5 times to ensure CAM PHASER and valve control solenoid reliability





7. Has a problem been found ?

YES	▶ Substitute with a known - good CVVT or OCV and check for proper operation. If the problem is corrected, replace CVVT or OCV and go to "Verification of Vehicle Repair" procedure.
NO	▶ Fault is intermittent. Drive the vehicle to meet the enable condition for the DTC. and Go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ CMPS, CKPS Inspection

1. IG "OFF" and connect GDS.
2. ENG "ON" and Measure signal waveform at signal terminal of CMPS.
3. Measure signal waveform at signal terminal of CKPS.

Specification : 17th signal of the CKPS after missing tooth is aligned with the high signal of the CMPS at idle, ECM recognizes that Synchronization between CKPS and CMPS is completed.
※ Refer to Signal Waveform & Data

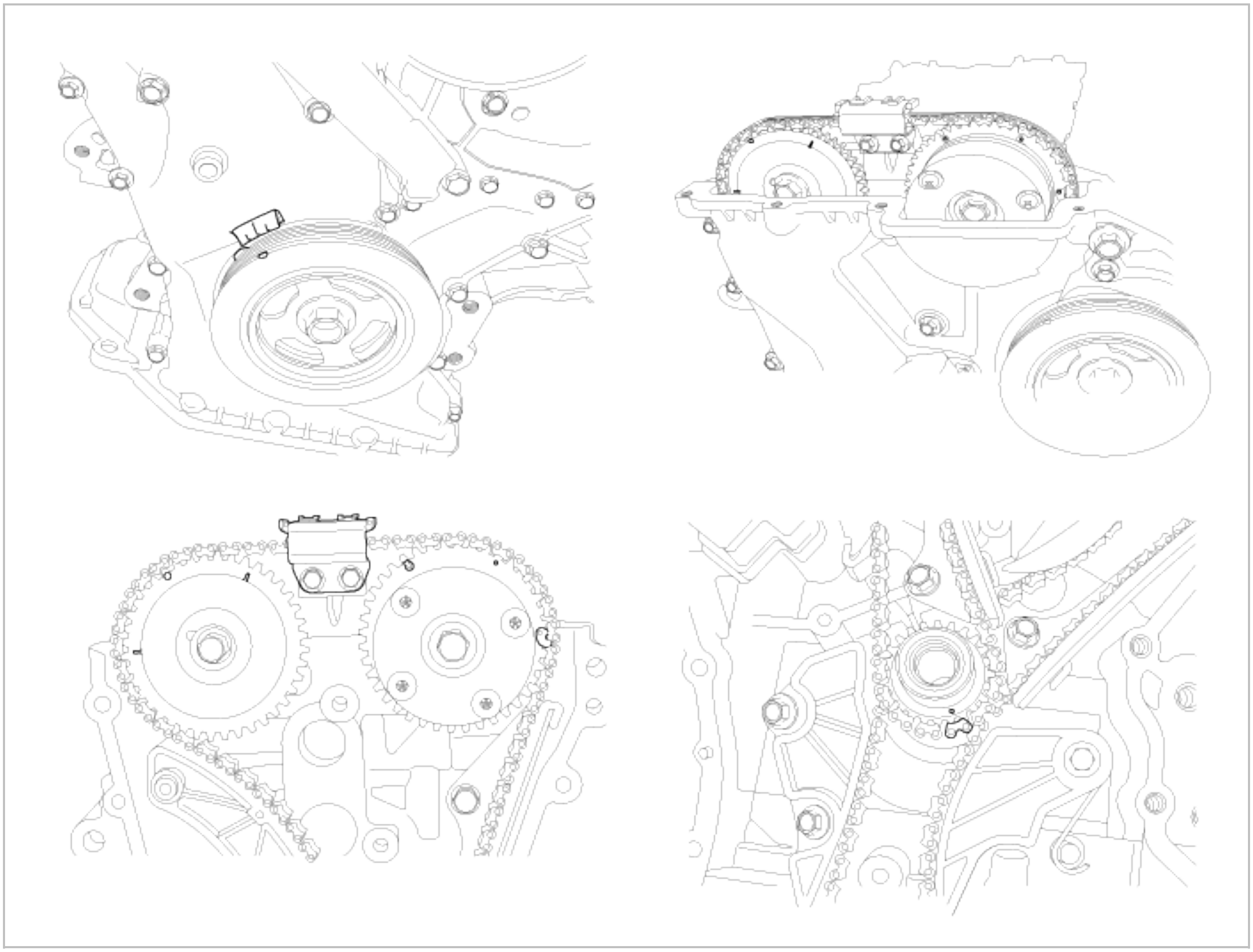
4. Is the measured signal waveform O.K ?

YES	▶ Fault is intermittent. Drive the vehicle to meet the enable condition for the DTC. and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Timing Mark Inspection" procedure as follow.

■ Timing Mark Inspection

1. IG "OFF" and check the timing mark is correctly aligned.

Reference :



2. Is the timing mark correctly aligned ?

YES	▶ Fault is intermittent. Drive the vehicle to meet the enable condition for the DTC. and go to "Verification of Vehicle Repair" procedure.
NO	▶ Repair or replace as necessary and then, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

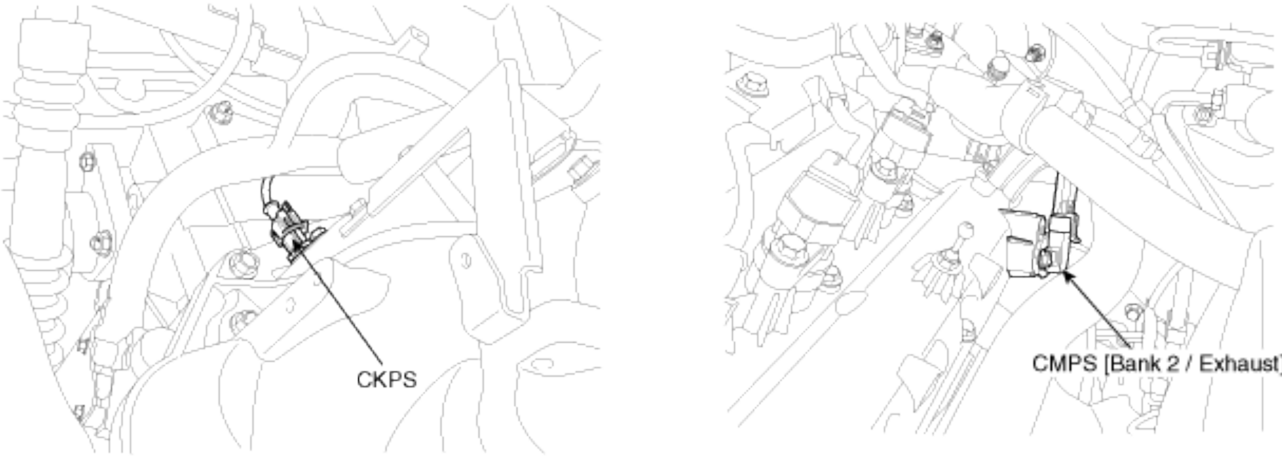
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0019 Crankshaft Position – Camshaft Position Correlation (Bank 2 Sensor B)

Component Location



General Description

The CVVT (Continuously Variable Valve Timing) system is installed to the chain sprocket of the camshaft. This system controls the camshaft to provide the optimal valve timing for every driving condition. The ECM controls the Oil Control Valve(OCV), based on the signals output from mass air flow, throttle position and engine coolant temperature. The CVVT controller regulates the camshaft angle using oil pressure through the OCV. As result, the relative position between the camshaft and the crankshaft becomes optimal, and the engine torque improves, fuel economy improves, exhaust emissions decrease under over all driving conditions.

DTC Description

ECM monitors timing misalignment while no active faults is present and fully warmed up engine oil at idle.
If the timing is misaligned ECM determines that a fault exists and a DTC is stored.

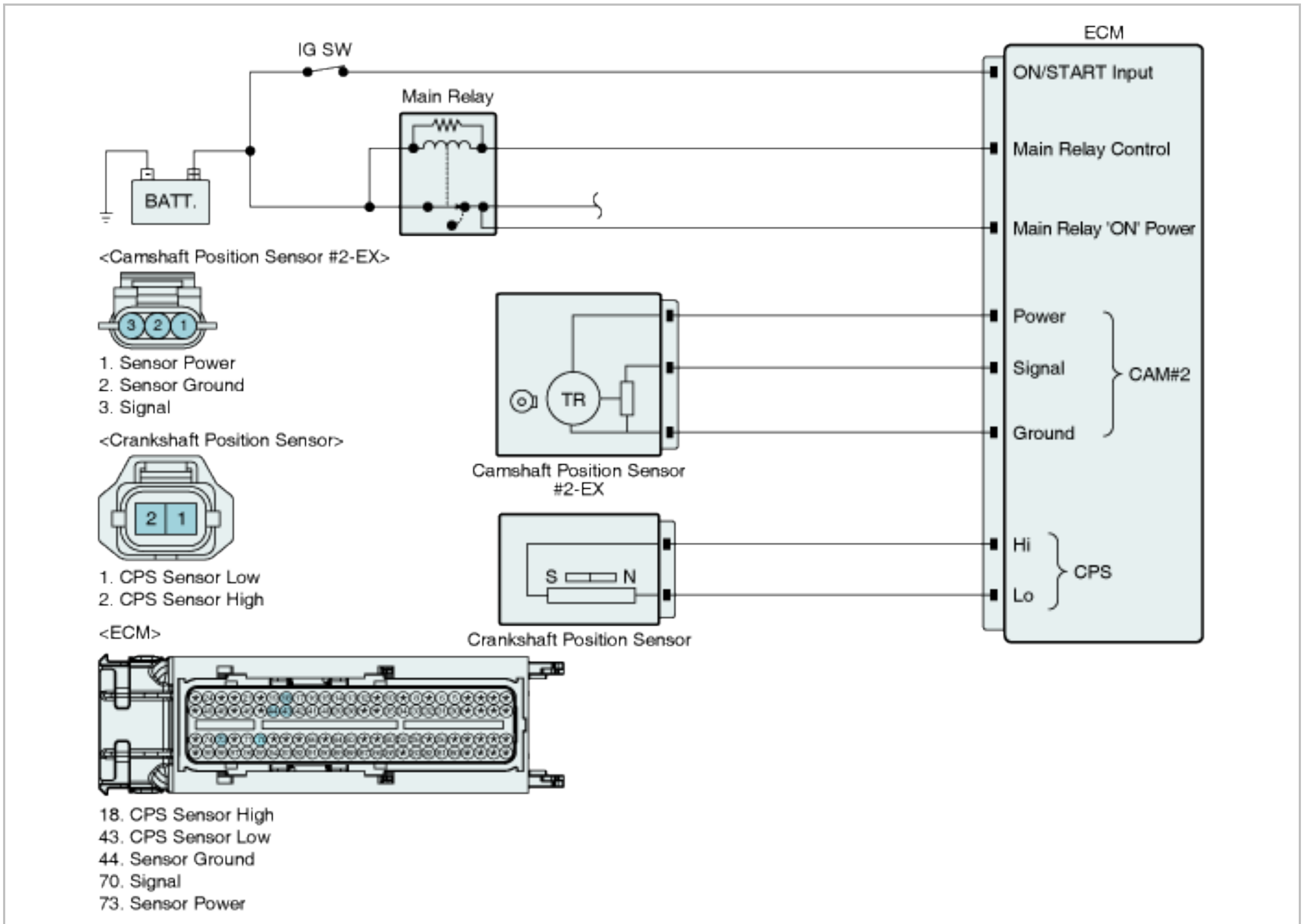
DTC Detecting Condition

<table>
<tr><th colspan="2">Item</th><th>Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td colspan="2">DTC Strategy</td><td>• Determines if CAM target is aligned correctly to crank</td><td rowspan="6">• loosened CKPS
• Timing Misalignment</td></tr>
<tr><td colspan="2">Enable Conditions</td><td>• No active faults
• Fully warmed up at idle</td></tr>
<tr><td rowspan="2">Threshold value</td><td>Case 1</td><td>• 1 teeth misalignment at 80 °C(176 °F)
< Oil Temperature < 90 °C(194°F)</td></tr>
<tr><td>Case 2</td><td>• 2 tooth misalignment at Lower than 80 °C(176 °F) or Higher than 90 °C(194°F)</td></tr>
<tr><td colspan="2">Diagnosis Time</td><td>• Continuous (Within 1min.)</td></tr>
<tr><td colspan="2">MIL On Condition</td><td>• 2 Driving Cycles</td></tr>
</table>

Specification

Engine Oil Temperature	Misalignment
80 °C(176 °F) < ENgine Oil Temperature < 90 °C(194°F)	1 tooth
Less than 80 °C(176 °F) or Higher than 90 °C(194°F)	2 teeth

Diagnostic Circuit Diagram



Signal Waveform & Data

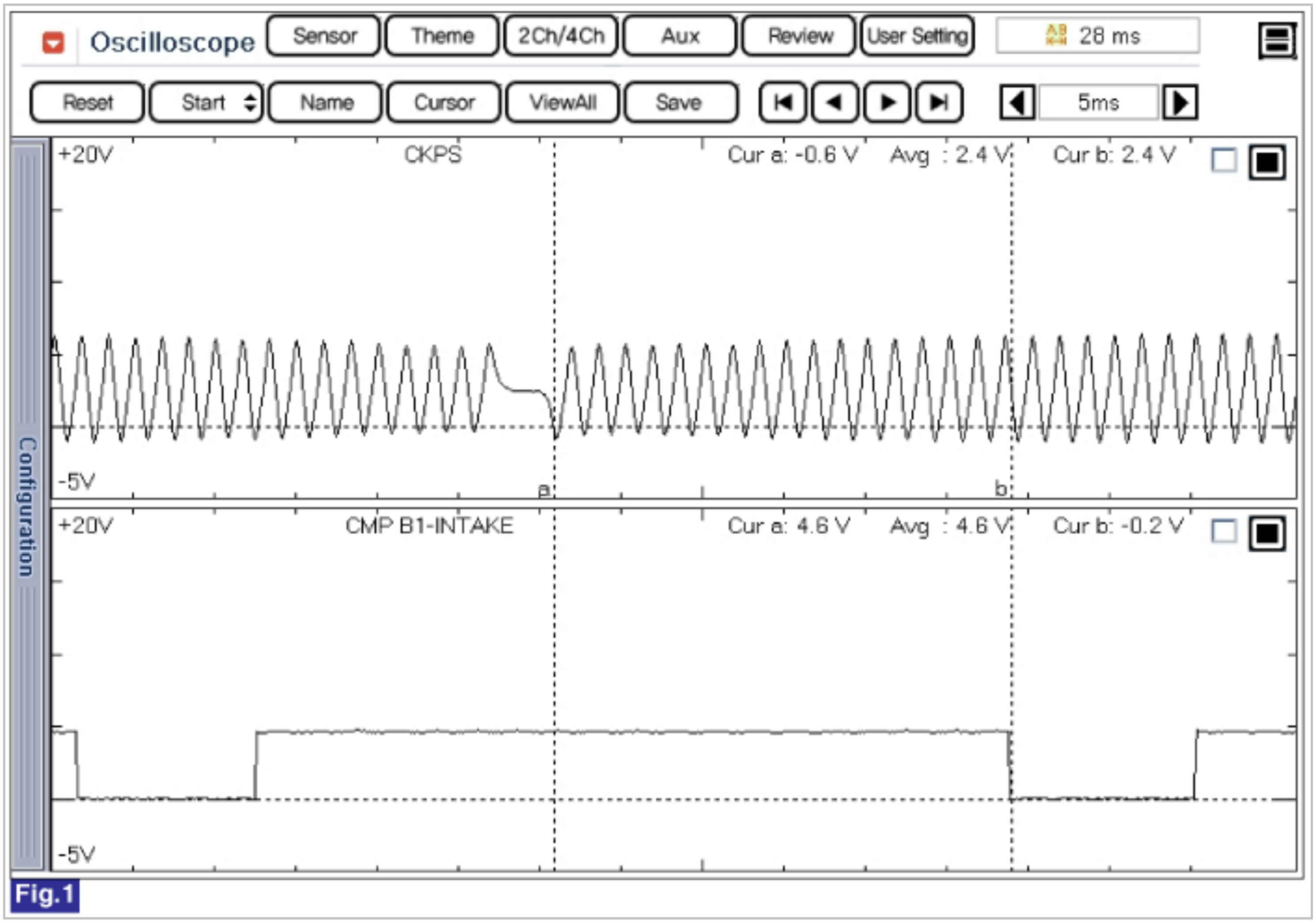
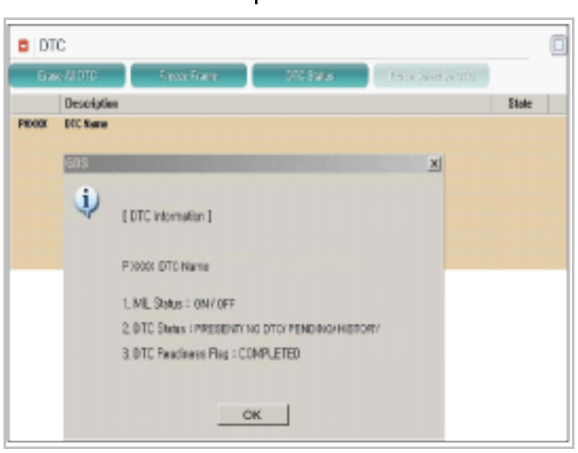


Fig.1) Normal waveform of CKPS & CMPS at idle.

This example shows a typical Crankshaft Position Sensor (CKPS) and Camshaft Position Sensor (CMPS) waveform at idle. If the 17th signal of the CKPS after missing tooth is aligned with the high signal of the CMPS at idle, ECM recognizes that Synchronization between CKPS and CMPS is completed.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "System Inspection" procedure.
NO	▶ Fault is intermittent caused by ECM memory was not cleared after repair. Erase DTC and drive the vehicle to satisfy the enable codition then, go to " System Inspection" procedure.

System Inspection

■ Visual Inspection

1. Check oil level is O.K.
2. Check Oil and OCV is contaminated.
3. Has a problem been found ?

YES	▶ Repair or replace as necessary and then, go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Visually check CKPS and target wheel" as follow

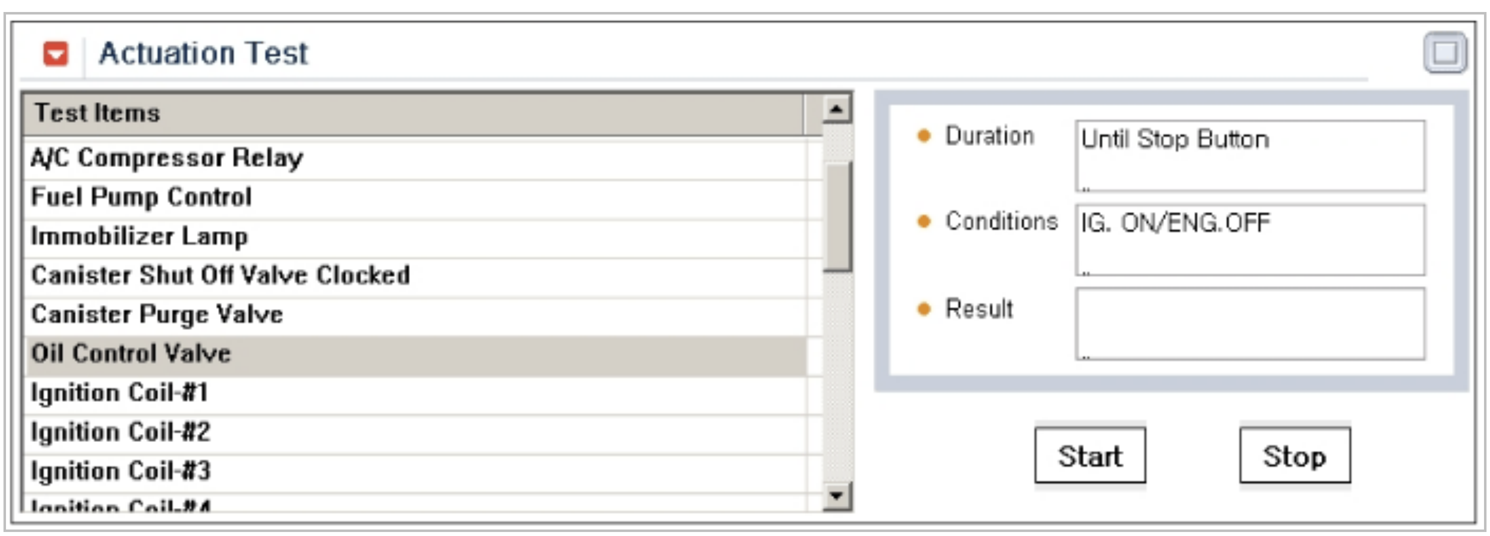
■ Visually check CKPS and target wheel

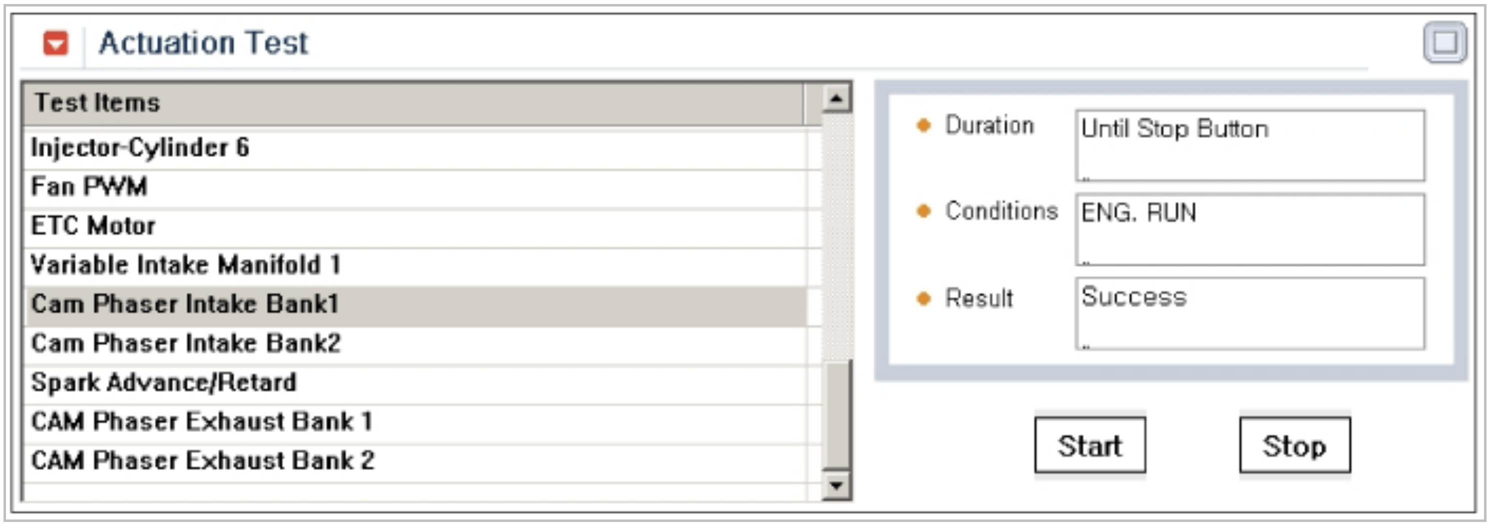
1. IG "OFF".
2. Visually check CKPS is loosened or target wheel is deformed or damaged.
3. Is the above items normal ?

YES	▶ Go to " Check CAM PHASER with actuation test" as follows
NO	▶ Repair or replace as necessary and then go to"Verification of Vehicle Repair" procedure.

■ Check CAM PHASER with actuation test

1. Connect scantool and IG "ON"
2. Select "CAM PHASER EXHAUST BANK 2" on the Actuation Test
3. Select "OIL CONTROL VALVE" on the Actuation Test
4. Activates "CAM PHASER EXHAUST BANK 2" by pressing "START" button
5. Activates "OIL CONTROL VALVE" by pressing "START" button
6. Repeat this procedure 4 or 5 times to ensure CAM PHASER and valve control solenoid reliability





7. Has a problem been found ?

YES	▶ Substitute with a known - good CVVT or OCV and check for proper operation. If the problem is corrected, replace CVVT or OCV and go to "Verification of Vehicle Repair" procedure.
NO	▶ Fault is intermittent. Drive the vehicle to meet the enable condition for the DTC. and Go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ CMPS, CKPS Inspection

1. IG "OFF" and connect GDS.
2. ENG "ON" and Measure signal waveform at signal terminal of CMPS.
3. Measure signal waveform at signal terminal of CKPS.

Specification : 17th signal of the CKPS after missing tooth is aligned with the high signal of the CMPS at idle, ECM recognizes that Synchronization between CKPS and CMPS is completed.
※ Refer to Signal Waveform & Data

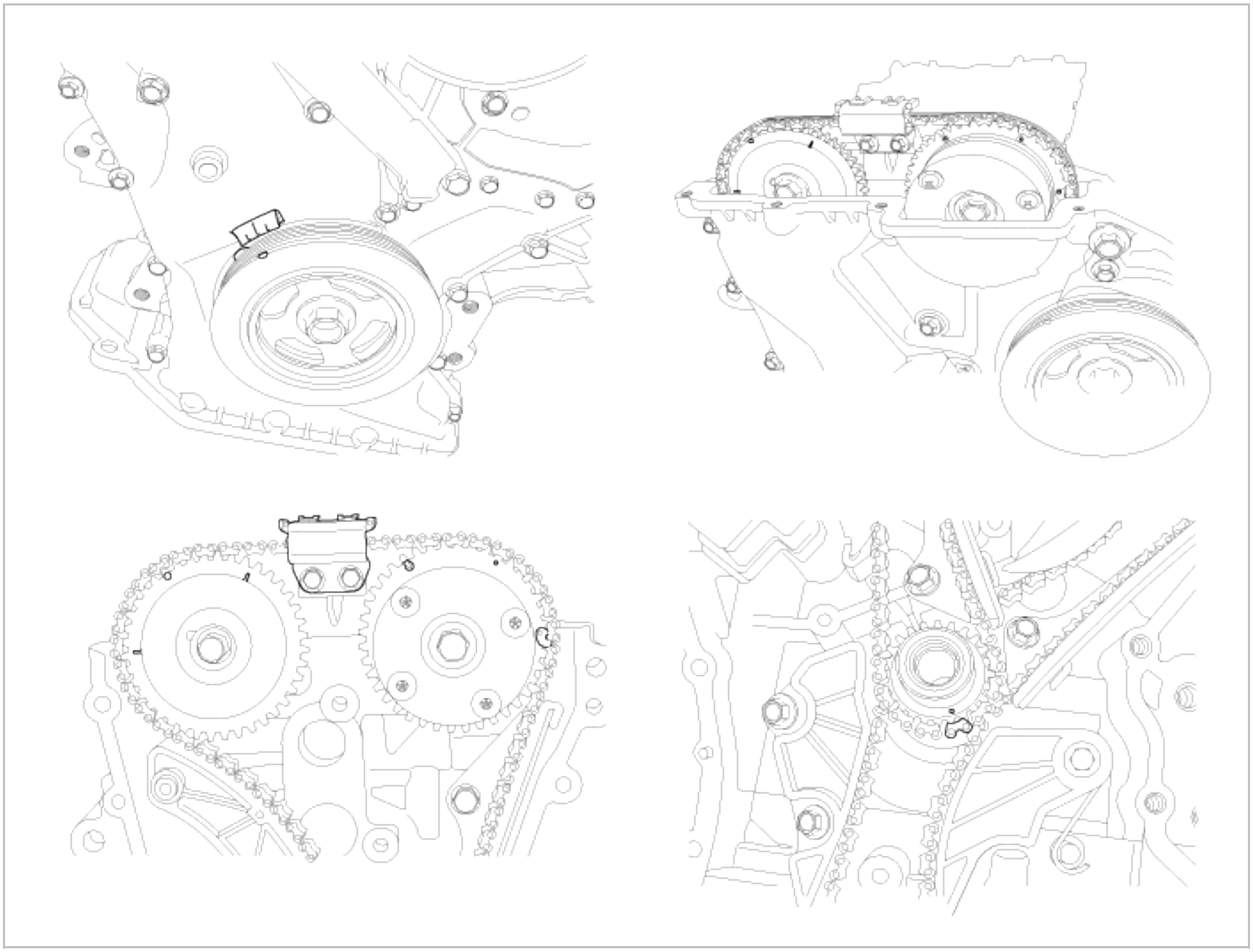
4. Is the measured signal waveform O.K ?

YES	▶ Fault is intermittent. Drive the vehicle to meet the enable condition for the DTC. and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Timing Mark Inspection" procedure as follow.

■ Timing Mark Inspection

1. IG "OFF" and check the timing mark is correctly aligned.

Reference :



2. Is the timing mark correctly aligned ?

YES	▶ Fault is intermittent. Drive the vehicle to meet the enable condition for the DTC. and go to "Verification of Vehicle Repair" procedure.
NO	▶ Repair or replace as necessary and then, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

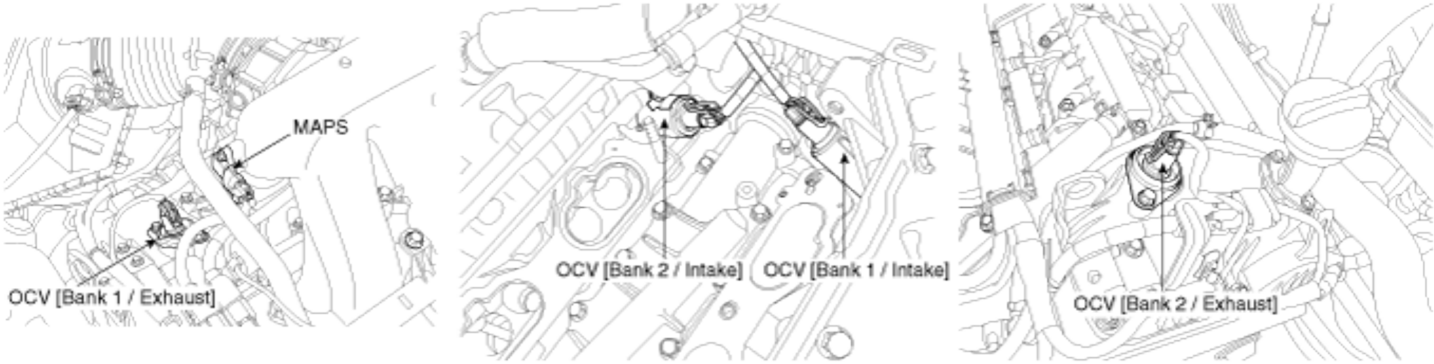
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0021 \'A\' Camshaft Position-Timing Over-Advanced or System Performance (Bank 2)

Component Location



General Description

The CVVT (Continuously Variable Valve Timing) system is installed to the chain sprocket of the camshaft. This system controls the camshaft to provide the optimal valve timing for every driving condition. The ECM controls the Oil Control Valve(OCV), based on the signals output from mass air flow, throttle position and engine coolant temperature. The CVVT controller regulates the camshaft angle using oil pressure through the OCV. As result, the relative position between the camshaft and the crankshaft becomes optimal, and the engine torque improves, fuel economy improves, exhaust emissions decrease under over all driving conditions.

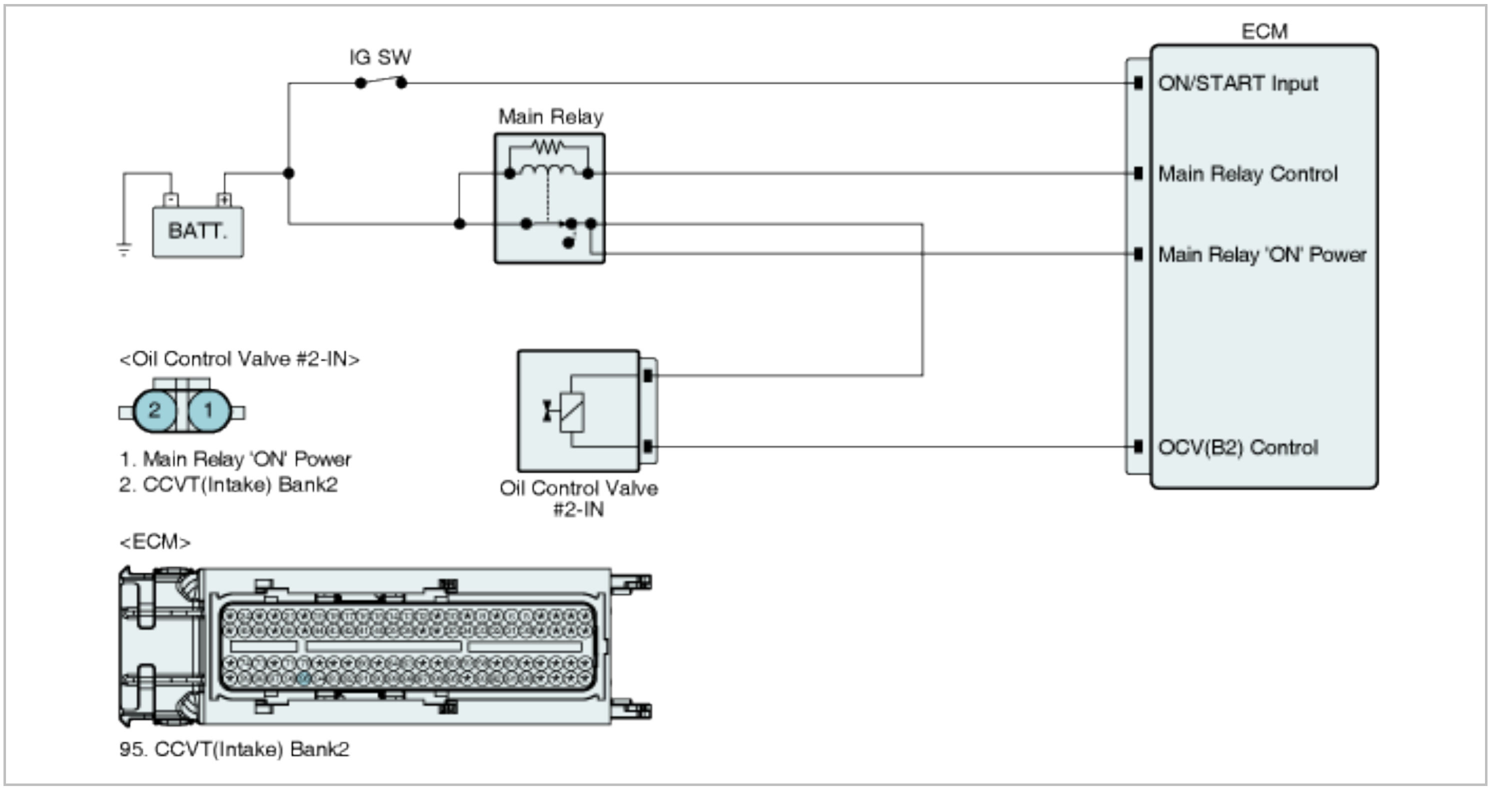
DTC Description

ECM detects CAM phasing average rate while cam signal is normally generating.
ECM determines that a fault exists and a DTC is stored while vehicle is tip - in and out driving for 5 minutes.

DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Determines if the phaser is moving at an expected rate	• Excessive phasing system leakage • Binding Oil pressure (ex. Blockage in OCV filter) • Faulty OCV
Enable Conditions	• CAM signal is normally generating • Accelerate and decelerate more than 10 times within 5 minutes – while driving	
Threshold value	• Cam phasing is abnormally fast or slow	
Diagnosis Time	• Continuous (Within 5min.)	
MIL On Condition	• 2 Driving Cycles	

Diagnostic Circuit Diagram



Specification

OCV	Specification
Coil Resistance (Ω)	6.7 ~ 7.7 at 20°C (68°F)

Signal Waveform & Data

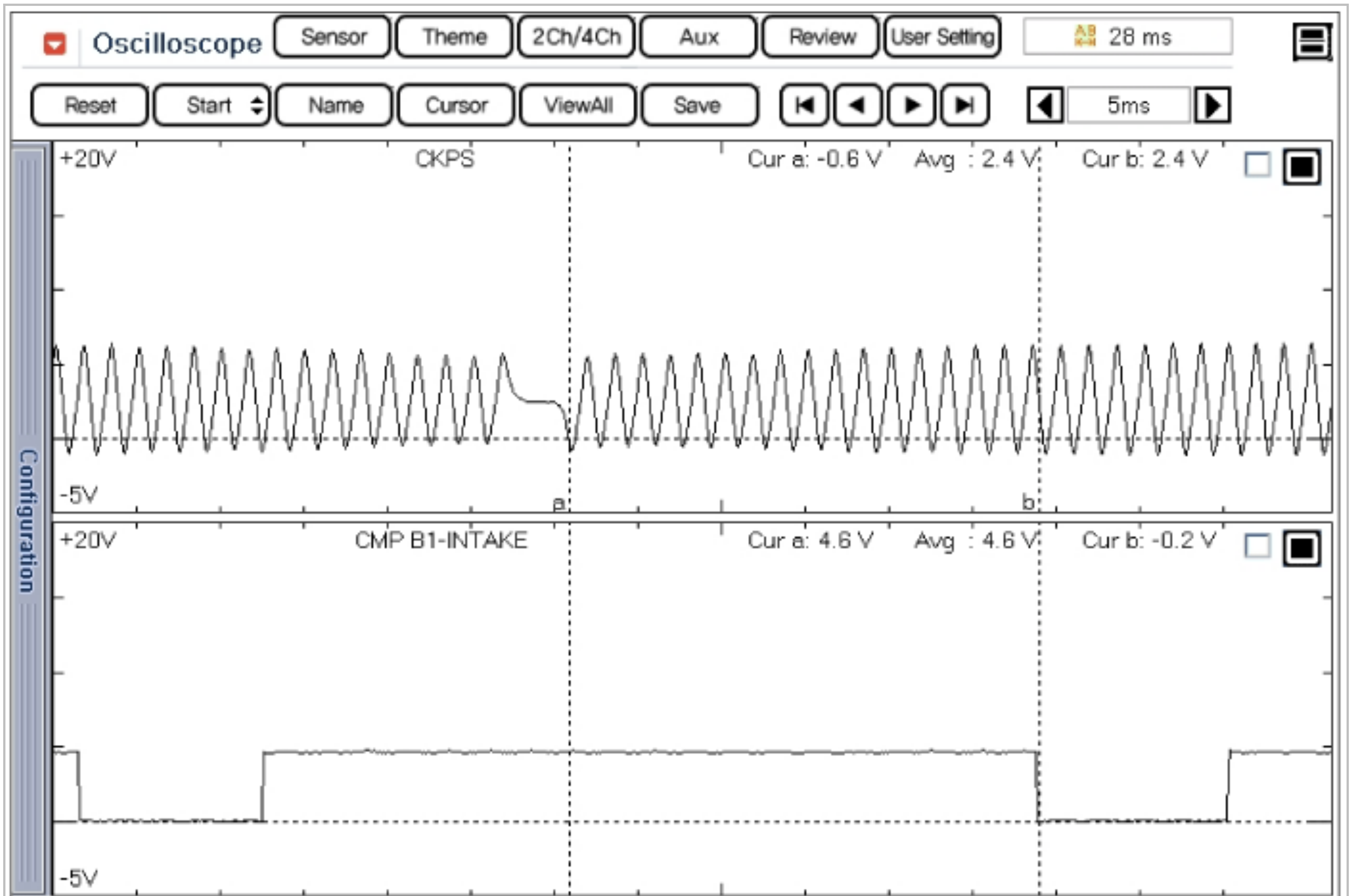
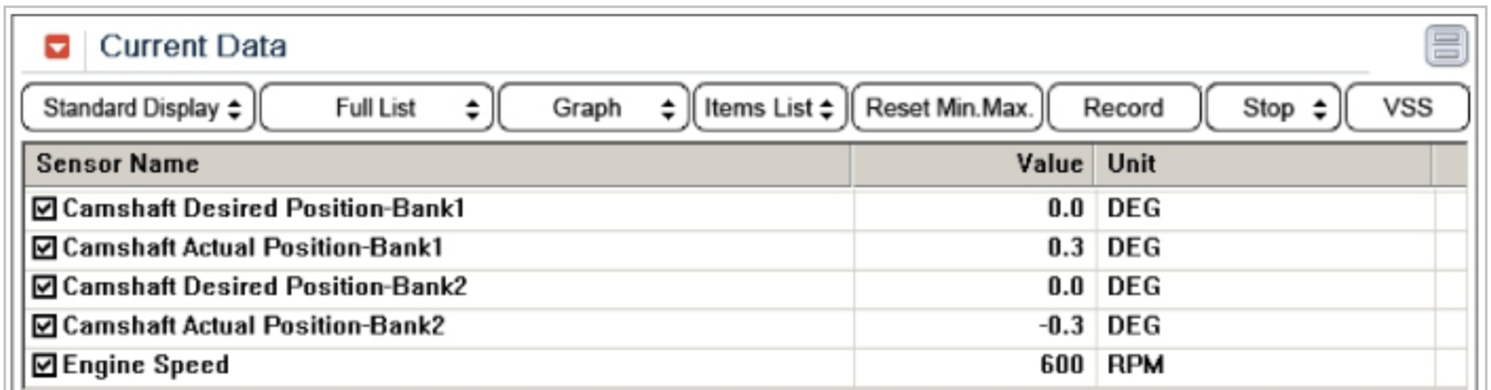


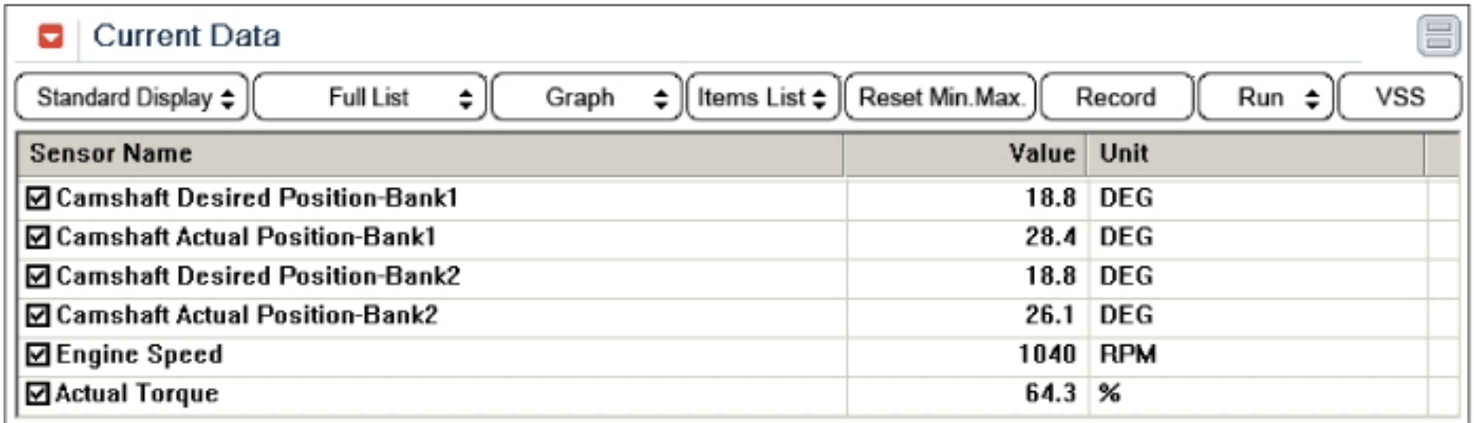
Fig.1


Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | VSS

Sensor Name	Value	Unit
☑ Camshaft Desired Position-Bank1	0.0	DEG
☑ Camshaft Actual Position-Bank1	0.3	DEG
☑ Camshaft Desired Position-Bank2	0.0	DEG
☑ Camshaft Actual Position-Bank2	-0.3	DEG
☑ Engine Speed	600	RPM

Fig.2



Sensor Name	Value	Unit
Camshaft Desired Position-Bank1	18.8	DEG
Camshaft Actual Position-Bank1	28.4	DEG
Camshaft Desired Position-Bank2	18.8	DEG
Camshaft Actual Position-Bank2	26.1	DEG
Engine Speed	1040	RPM
Actual Torque	64.3	%

Fig.3

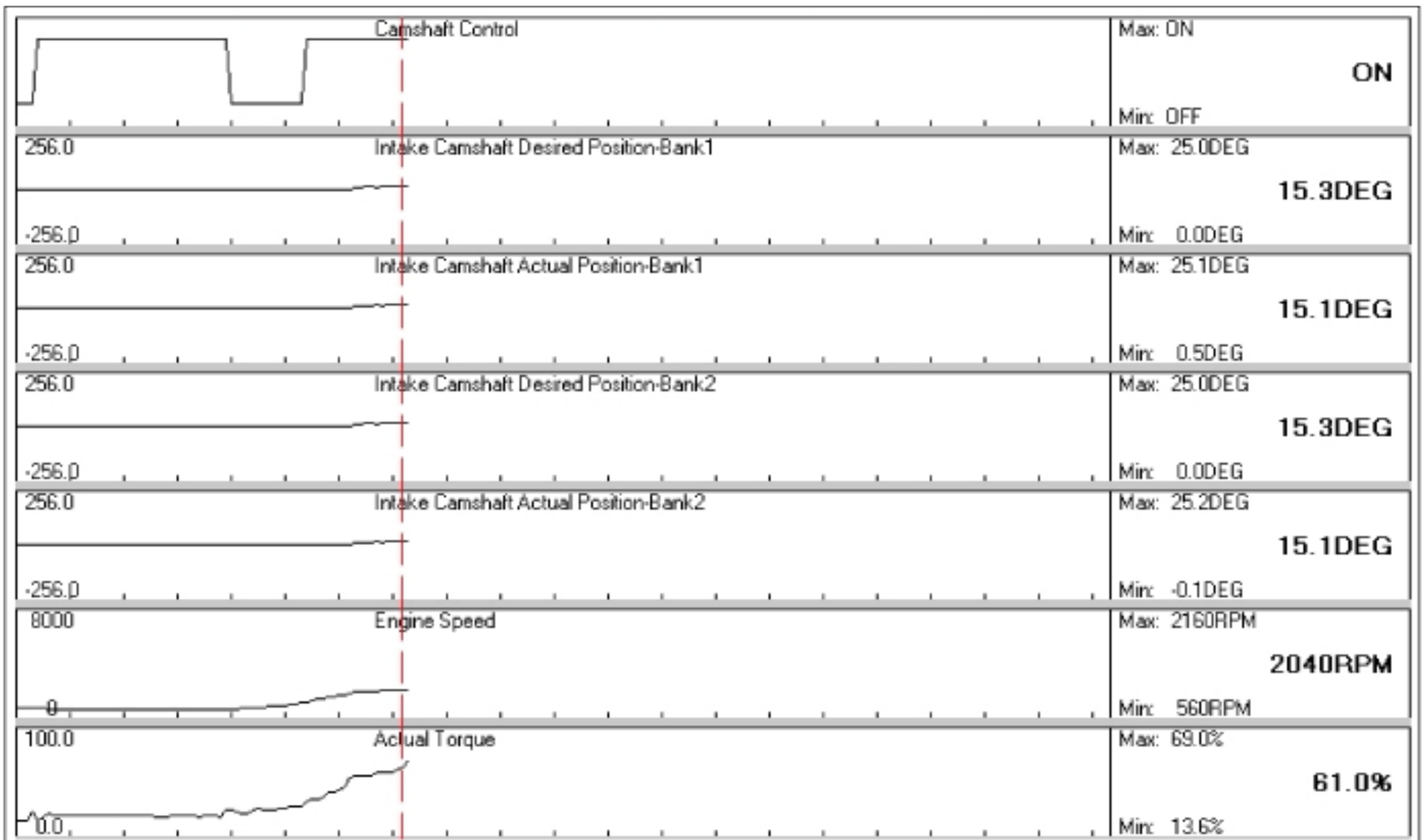


Fig.4

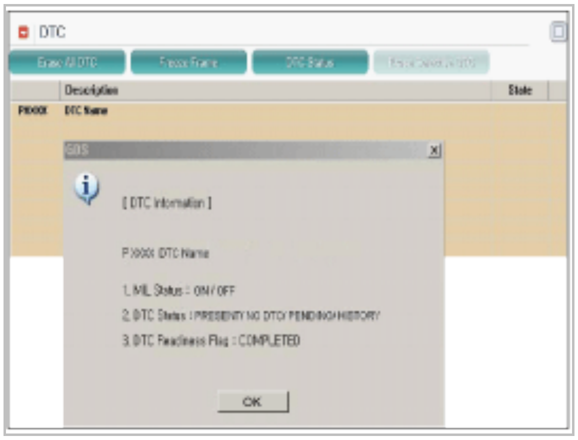
Fig.1) Normal waveform of CKPS & IN-CMPS at idle.
Fig.2) Normal data of IN-CVVT at idle.
Fig.3) Normal data of IN-CVVT at acceleration with load.
Fig.4) Normal graph of IN-CVVT at acceleration with load.

This example shows a typical Crankshaft Position Sensor (CKPS) and Camshaft Position Sensor (CMPS) waveform at idle.(Fig1.) If the 17th signal of the CKPS after missing tooth is aligned with the high signal of the CMPS at idle, ECM recognizes that Synchronization between CKPS and CMPS is completed. Under acceleracting condition, the number of tooth between missing tooth and tooth aligned with edge of the CMPS high signal is decreased than idle condition.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.

4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "System Inspection" procedure.
NO	▶ Fault is intermittent caused by ECM memory was not cleared after repair. Erase DTC and drive the vehicle to satisfy the enable codition then, go to " System Inspection" procedure.

System Inspection

■ Visual Inspection

1. Check oil level is O.K.
2. Check oil and OCV is contaminated.
3. Check for oil leakage around OCV
4. Has a problem been found ?

YES	▶ Repair or replace as necessary and then, go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Component Inspection" procedure

Component Inspection

■ Check OCV resistance

1. IG "OFF" and disconnect OCV connector.
2. Measure resistance between power and signal terminals of OCV. (Component Side)

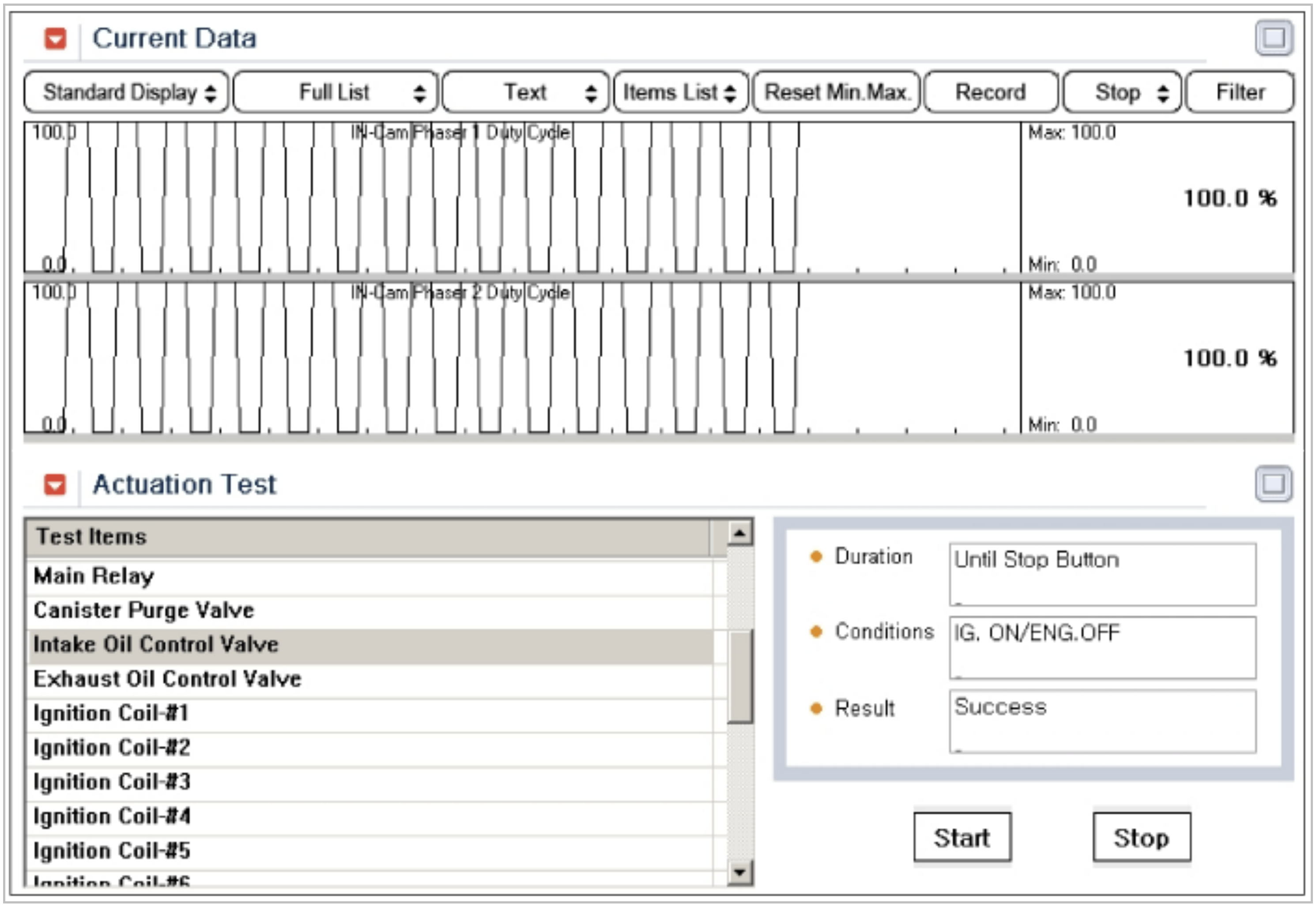
Specification : 6.7 ~ 7.7 at 20°C (68°F)

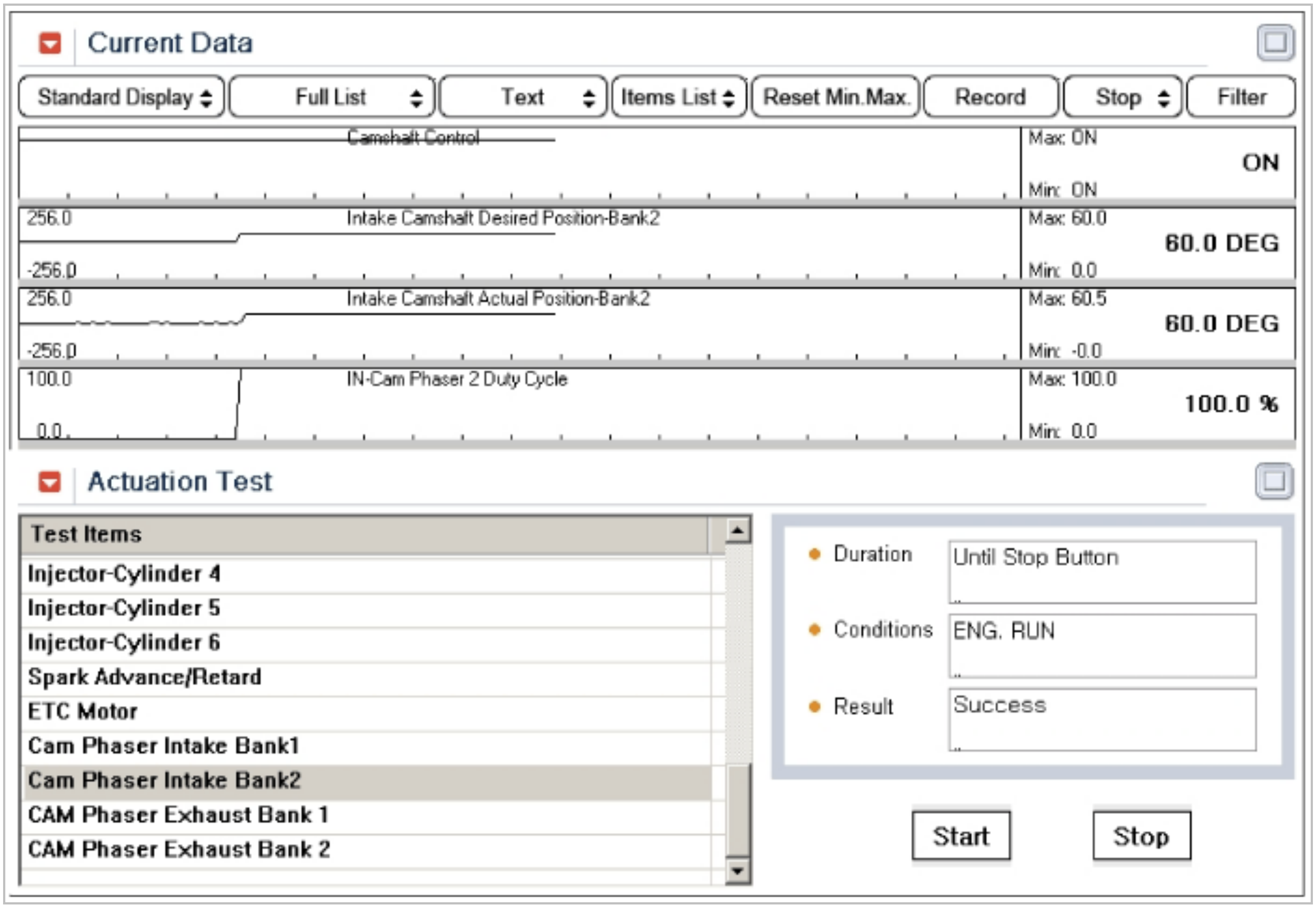
3. Is the measured resistance within specification ?

YES	▶ Go to "Check CAM PHASER with actuation test" as follows.
NO	▶ Substitute with a known - good OCV and check for proper operation. If the problem is corrected, replace OCV and go to "Verification of Vehicle Repair" procedure.

■ Check CAM PHASER with actuation test

1. Connect GDS and IG "ON"
2. Select "Cam Phaser Intake Bank2" on the Actuation Test
3. Select "Intake Oil Control Valve" on the Actuation Test
4. Activates "Cam Phaser Intake Bank2" by pressing "START" button
5. Activates "Intake Oil Control Valve" by pressing "START" button
6. Repeat this procedure 4 or 5 times to ensure CAM PHASER and valve control solenoid reliability





7. Has a problem been found ?

YES	▶ Substitute with a known - good CVVT or OCV and check for proper operation. If the problem is corrected, replace CVVT or OCV and go to "Verification of Vehicle Repair" procedure.
NO	▶ Fault is intermittent. Drive the vehicle to meet the enable condition for the DTC. and Go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

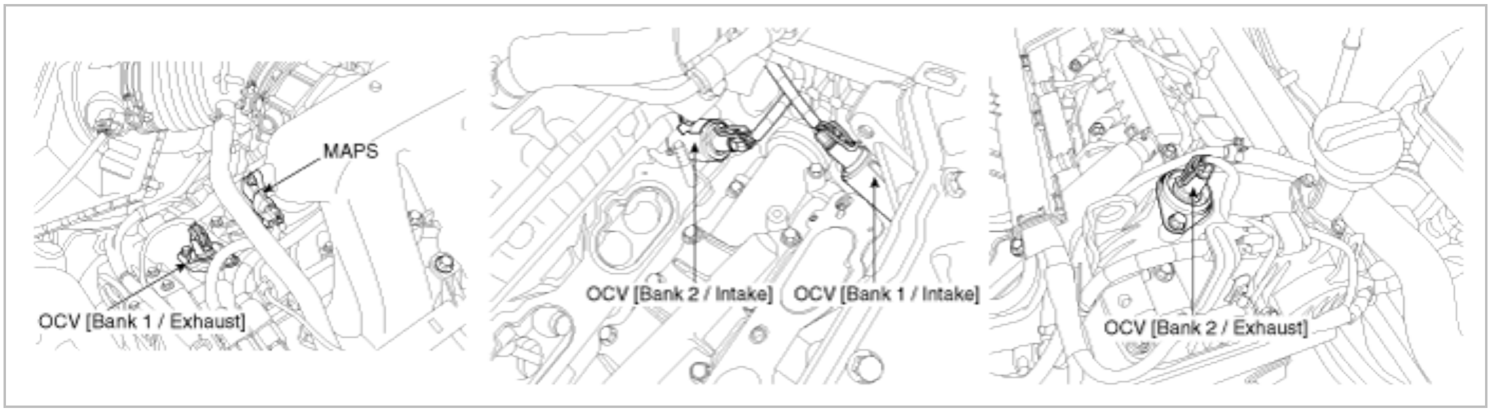
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0022 \'A\' Camshaft Position-Timing Over-

Retarded (Bank 2)

Component Location



General Description

The CVVT (Continuously Variable Valve Timing) system is installed to the chain sprocket of the intake camshaft. This system controls the intake camshaft to provide the optimal valve timing for every driving condition. The ECM controls the Oil Control Valve(OCV), based on the signals output from mass air flow, throttle position and engine coolant temperature. The CVVT controller regulates the intake camshaft angle using oil pressure through the OCV. As result, the relative position between the camshaft and the crankshaft becomes optimal, and the engine torque improves, fuel economy improves, exhaust emissions decrease under over all driving conditions.

DTC Description

ECM monitors CAM phaser error while CMP signal is normally generating and vehicle is driving in 2000 ~ 3000rpm . If the CAM phaser does not move although ECM commands OCV duty cycle ECM determines that a faultexists and a DTC is stored.

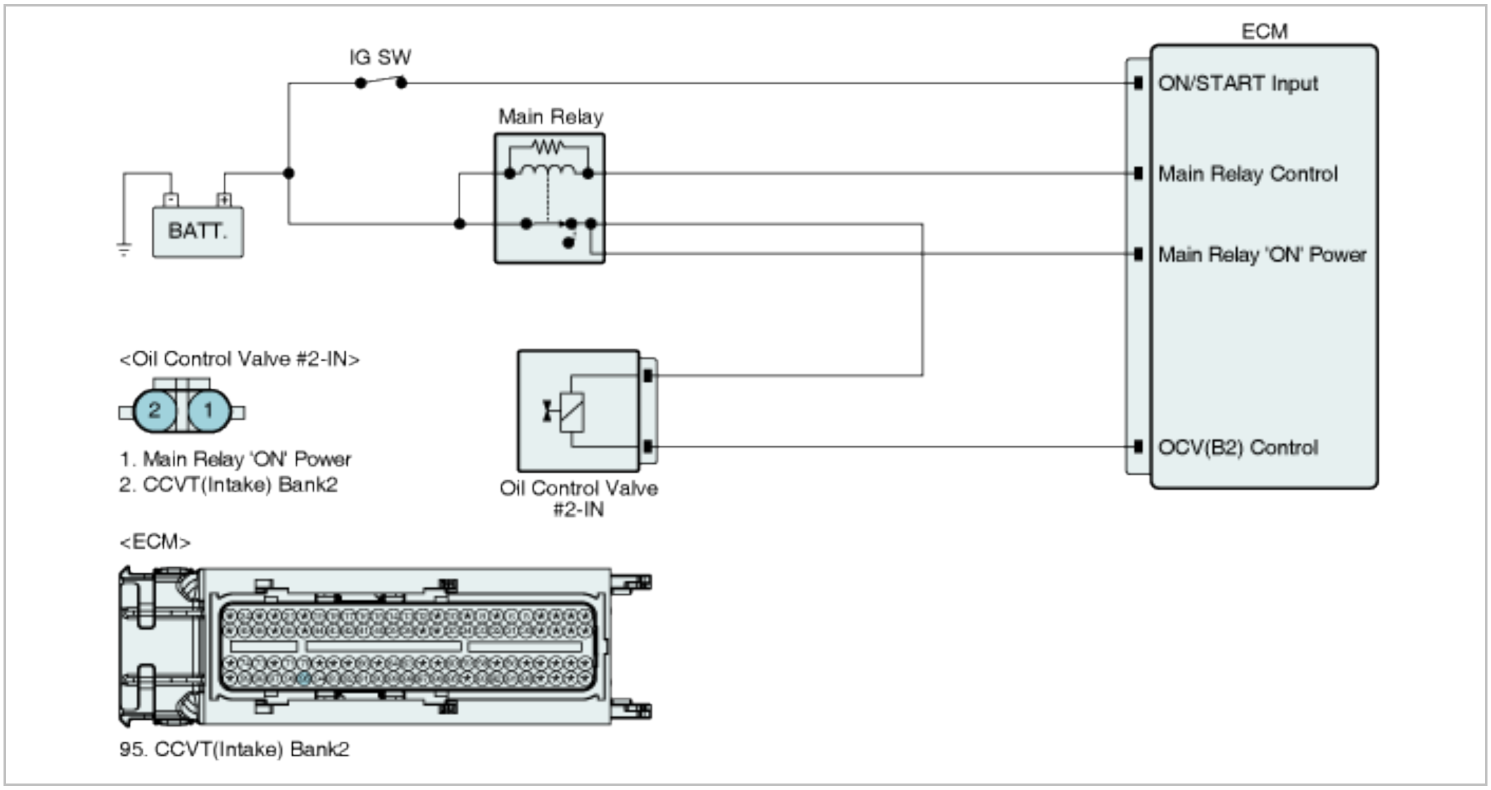
DTC Detecting Condition

Item		Detecting Condition	Possible Cause
DTC Strategy		• Determines if the phaser is stuck or has steady-state error	• Engine Oil • OCV stuck • CVVT stuck
Enable Conditions		• CAM signal is normally generating • Vehicle is on driving (2000 ~ 3000RPM) for 5 minutes	
Threshold value	Case 1	• 5 CAD < Cam Actual Position < 50 CAD • Duty Cycle > 90% or Duty Cycle < 10%	
	Case 2	• Cam Position error > 15 CAD (Difference between Actual Postion and Desire Position is more than 15°) • Timing Counter > 80	
Diagnosis Time		• Continuous (within 5min.)	
MIL On Condition		• 2 Driving Cycles	

Specification

OCV	Specification
Coil Resistance (Ω)	6.7 ~ 7.7 at 20°C (68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data

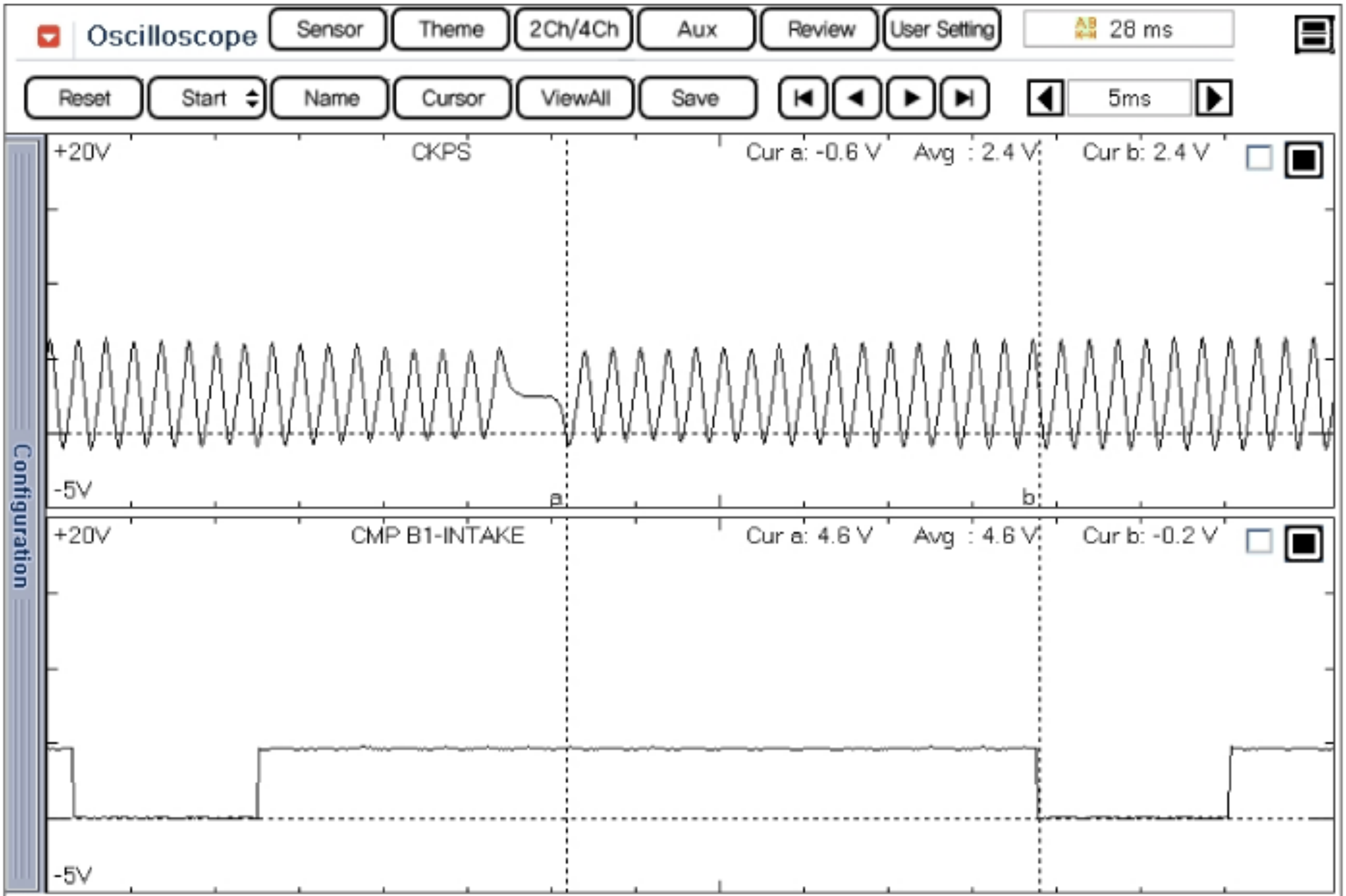
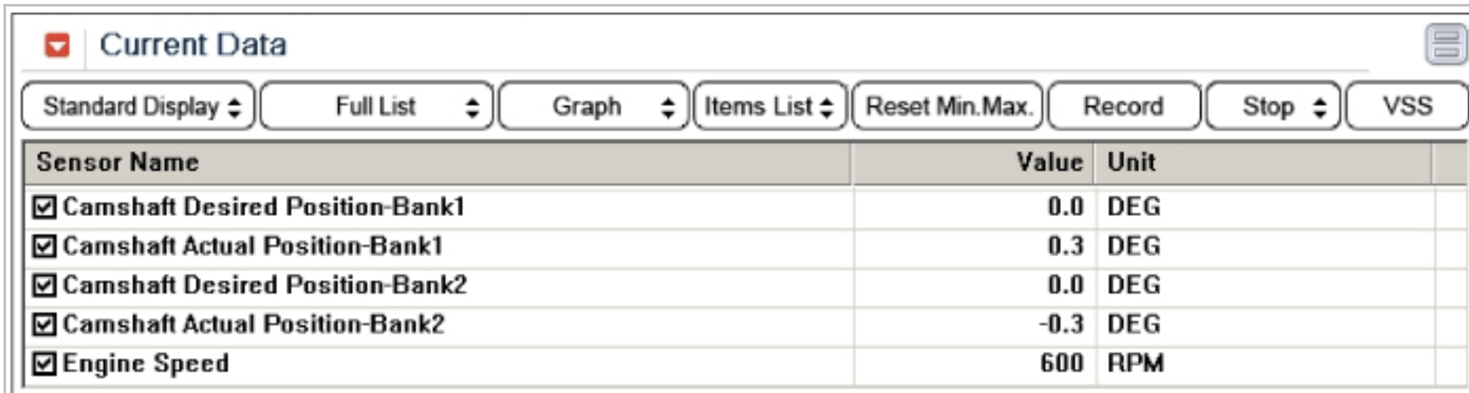
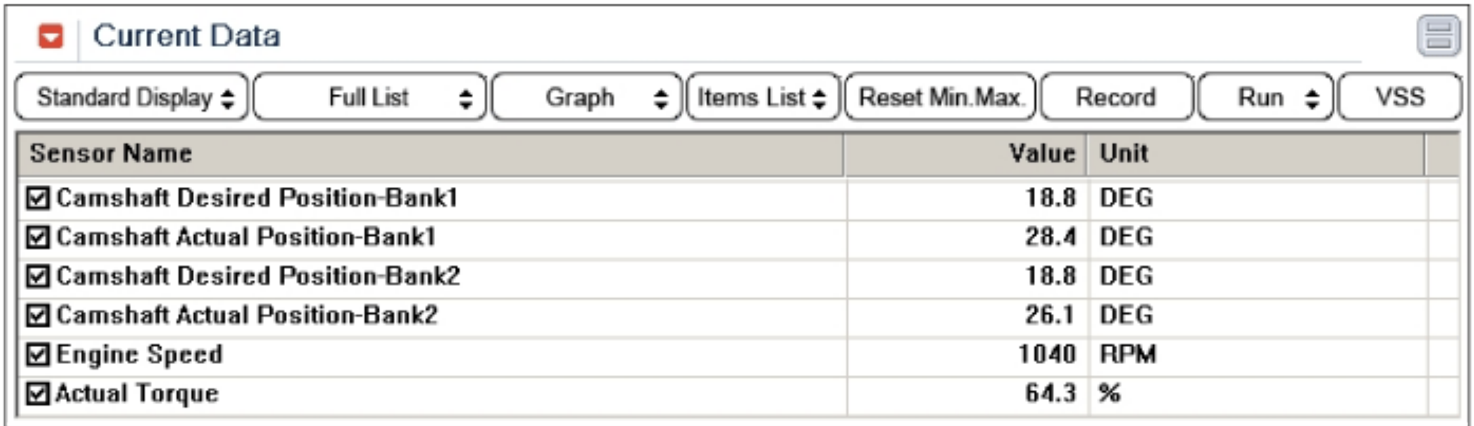


Fig.1



Sensor Name	Value	Unit
☑ Camshaft Desired Position-Bank1	0.0	DEG
☑ Camshaft Actual Position-Bank1	0.3	DEG
☑ Camshaft Desired Position-Bank2	0.0	DEG
☑ Camshaft Actual Position-Bank2	-0.3	DEG
☑ Engine Speed	600	RPM

Fig.2


Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Run | VSS

Sensor Name	Value	Unit
Camshaft Desired Position-Bank1	18.8	DEG
Camshaft Actual Position-Bank1	28.4	DEG
Camshaft Desired Position-Bank2	18.8	DEG
Camshaft Actual Position-Bank2	26.1	DEG
Engine Speed	1040	RPM
Actual Torque	64.3	%

Fig.3

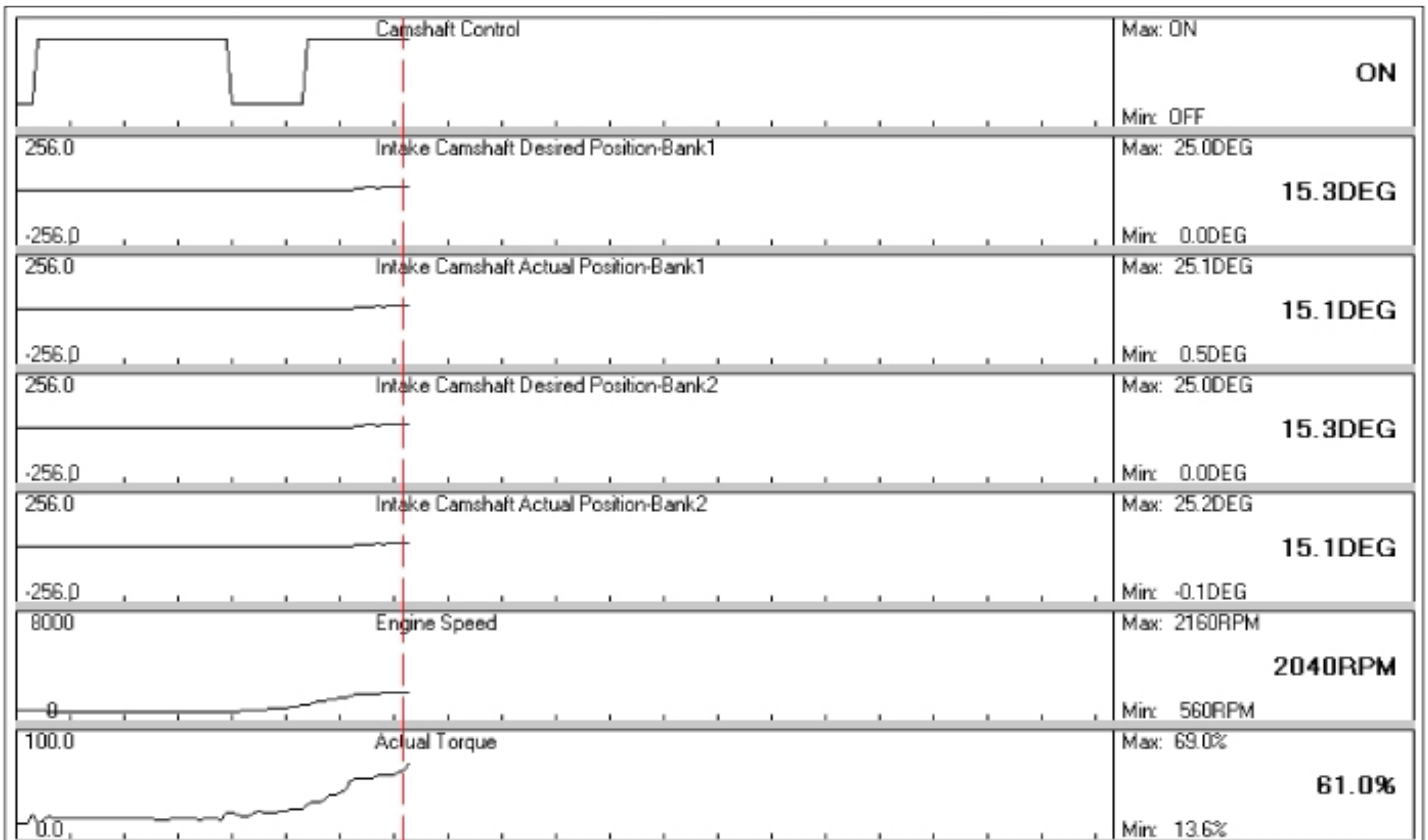


Fig.4

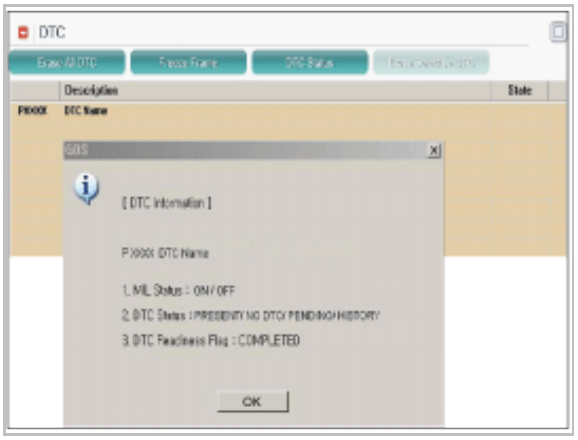
Fig.1) Normal waveform of CKPS & IN-CMPS at idle.
Fig.2) Normal data of IN-CVVT at idle.
Fig.3) Normal data of IN-CVVT at acceleration with load.
Fig.4) Normal graph of IN-CVVT at acceleration with load.

This example shows a typical Crankshaft Position Sensor (CKPS) and Camshaft Position Sensor (CMPS) waveform at idle.(Fig1.) If the 17th signal of the CKPS after missing tooth is aligned with the high signal of the CMPS at idle, ECM recognizes that Synchronization between CKPS and CMPS is completed. Under acceleracting condition, the number of tooth between missing tooth and tooth aligned with edge of the CMPS high signal is decreased than idle condition.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.

4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "System Inspection" procedure.
NO	▶ Fault is intermittent caused by ECM memory was not cleared after repair. Erase DTC and drive the vehicle to satisfy the enable codition then, go to " System Inspection" procedure.

System Inspection

■ Visual Inspection

1. Check oil level is O.K.
2. Check Oil and OCV is contaminated.
3. Check for oil leakage around OCV
4. Has a problem been found ?

YES	▶ Repair or replace as necessary and then, go to " Verification of Vehicle Repair" procedure.
NO	▶ Go to "Component Inspection" procedure.

Component Inspection

■ Check OCV resistance

1. IG "OFF" and disconnect OCV connector.
2. Measure resistance between power and signal terminals of OCV. (Component Side)

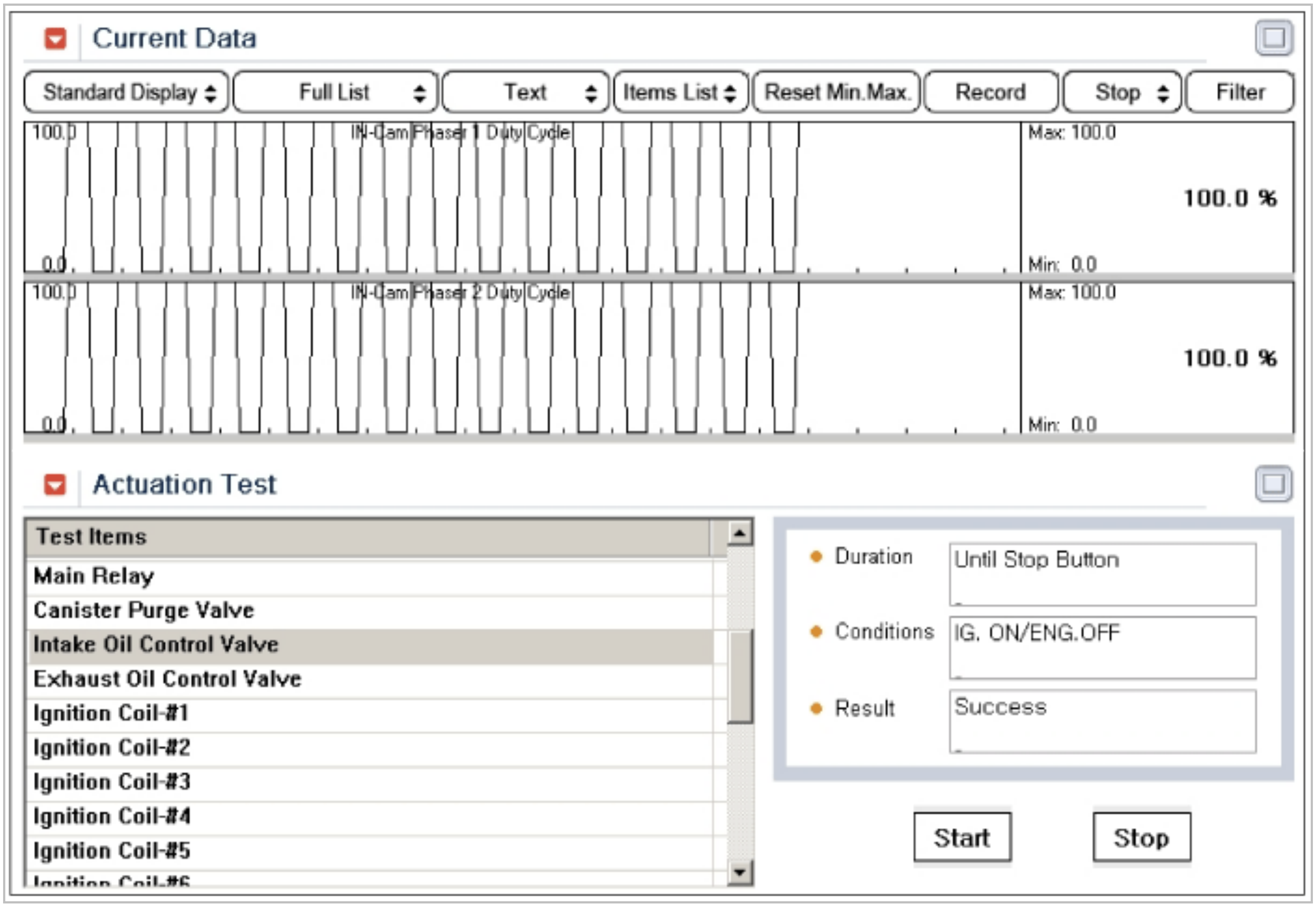
Specification : 6.7 ~ 7.7 at 20°C (68°F)

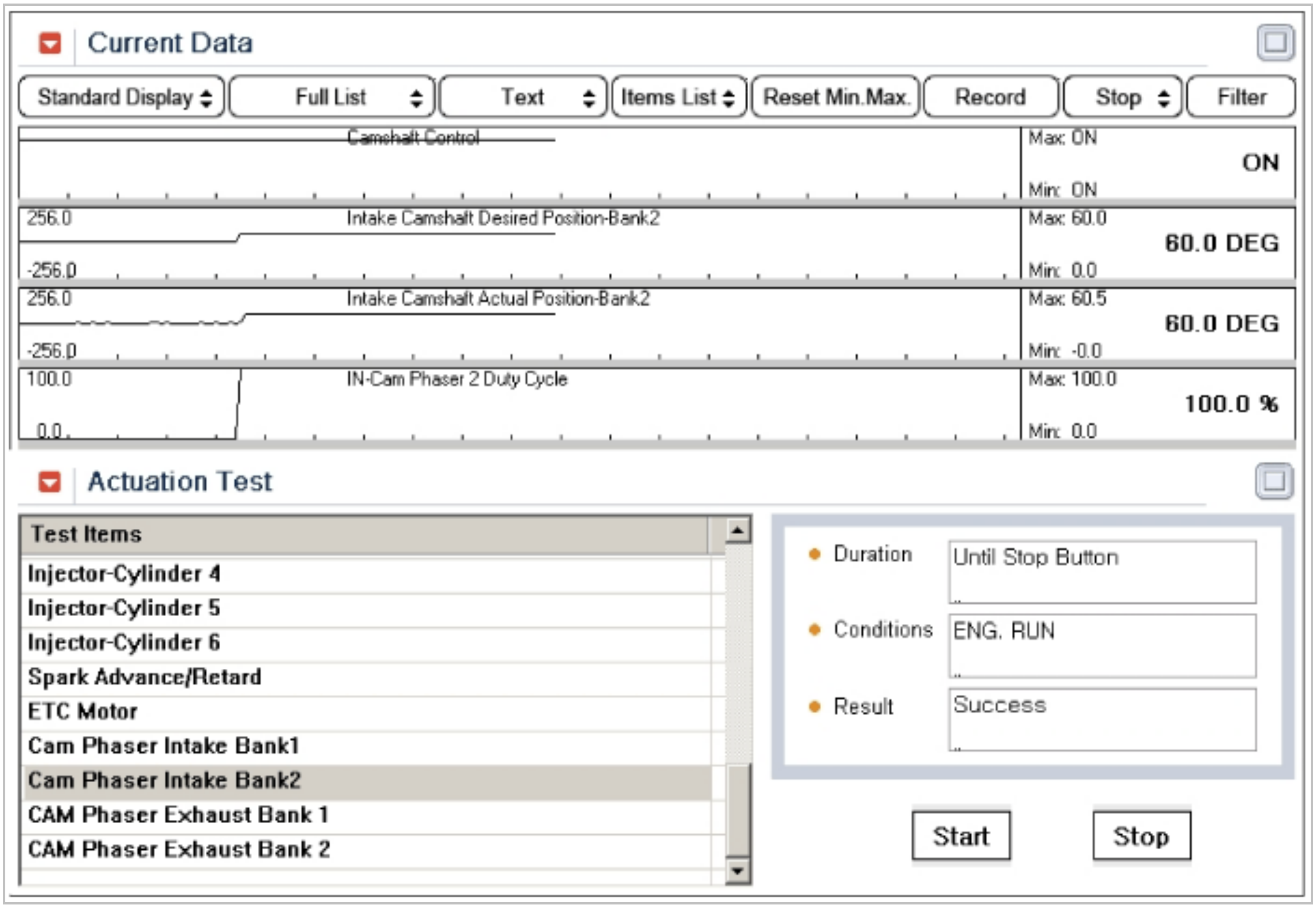
3. Is the measured resistance within specification?

YES	▶ Go to "Check CAM PHASER with actuation test" as follows.
NO	▶ Substitute with a known - good OCV and check for proper operation. If the problem is corrected, replace OCV and go to "Verification of Vehicle Repair" procedure.

■ Check CAM PHASER with actuation test

1. Connect GDS and IG "ON"
2. Select "Cam Phaser Intake Bank2" on the Actuation Test
3. Select "Intake Oil Control Valve" on the Actuation Test
4. Activates "Cam Phaser Intake Bank2" by pressing "START" button
5. Activates "Intake Oil Control Valve" by pressing "START" button
6. Repeat this procedure 4 or 5 times to ensure CAM PHASER and valve control solenoid reliability





7. Has a problem been found ?

YES	▶ Substitute with a known - good CVVT or OCV and check for proper operation. If the problem is corrected, replace CVVT or OCV and go to "Verification of Vehicle Repair" procedure.
NO	▶ Fault is intermittent. Drive the vehicle to meet the enable condition for the DTC. and Go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

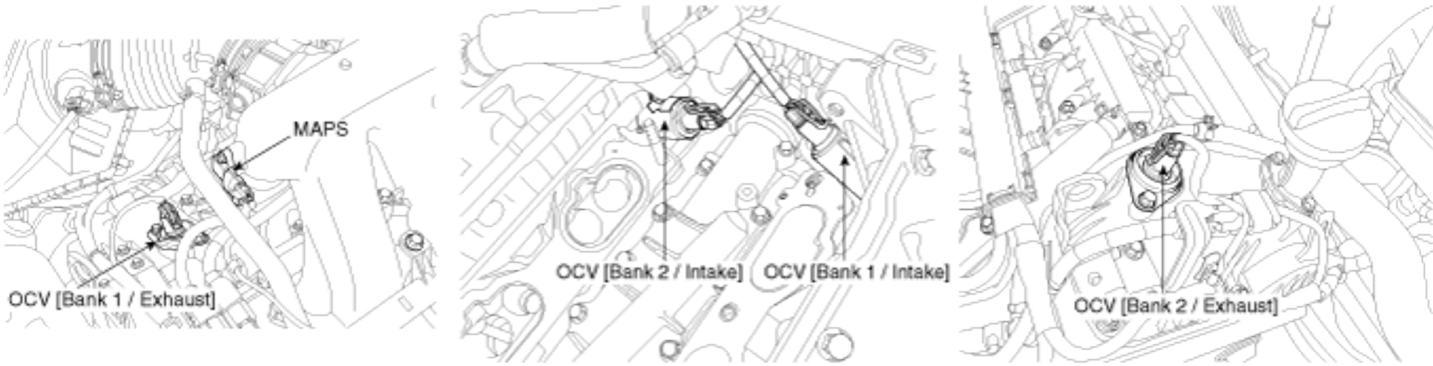
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0024 \'B\' Camshaft Position - Timing Over-

Advanced or System Performance (Bank 2)

Component Location



General Description

The CVVT (Continuously Variable Valve Timing) system is installed to the chain sprocket of the camshaft. This system controls the camshaft to provide the optimal valve timing for every driving condition. The ECM controls the Oil Control Valve(OCV), based on the signals output from mass air flow, throttle position and engine coolant temperature. The CVVT controller regulates the camshaft angle using oil pressure through the OCV. As result, the relative position between the camshaft and the crankshaft becomes optimal, and the engine torque improves, fuel economy improves, exhaust emissions decrease under over all driving conditions.

DTC Description

ECM detects CAM phasing average rate while cam signal is normally generating.
ECM determines that a fault exists and a DTC is stored while vehicle is tip - in and out driving for 5 minutes.

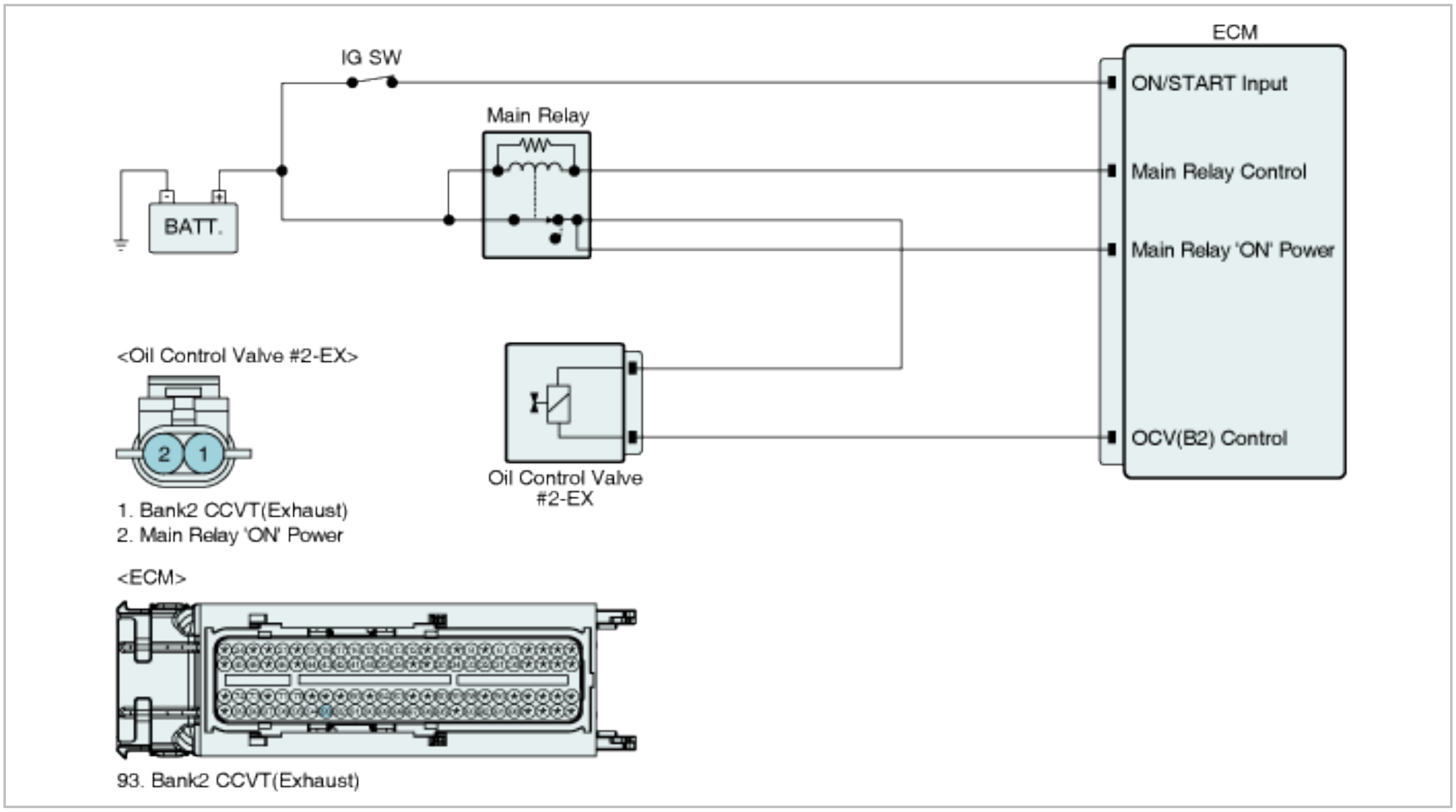
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Determines if the phaser is moving at an expected rate	• Excessive phasing system leakage • Binding Oil ressure (ex. Blockage in OCV filter) • Faulty OCV
Enable Conditions	• CAM signal is normally generating • Accelerate and decelerate more than 10 times within 5 minutes – while driving	
Threshold value	• Cam phasing is abnormally fast or slow	
Diagnosis Time	• Continuous (Within 5min.)	
MIL On Condition	• 2 Driving Cycles	

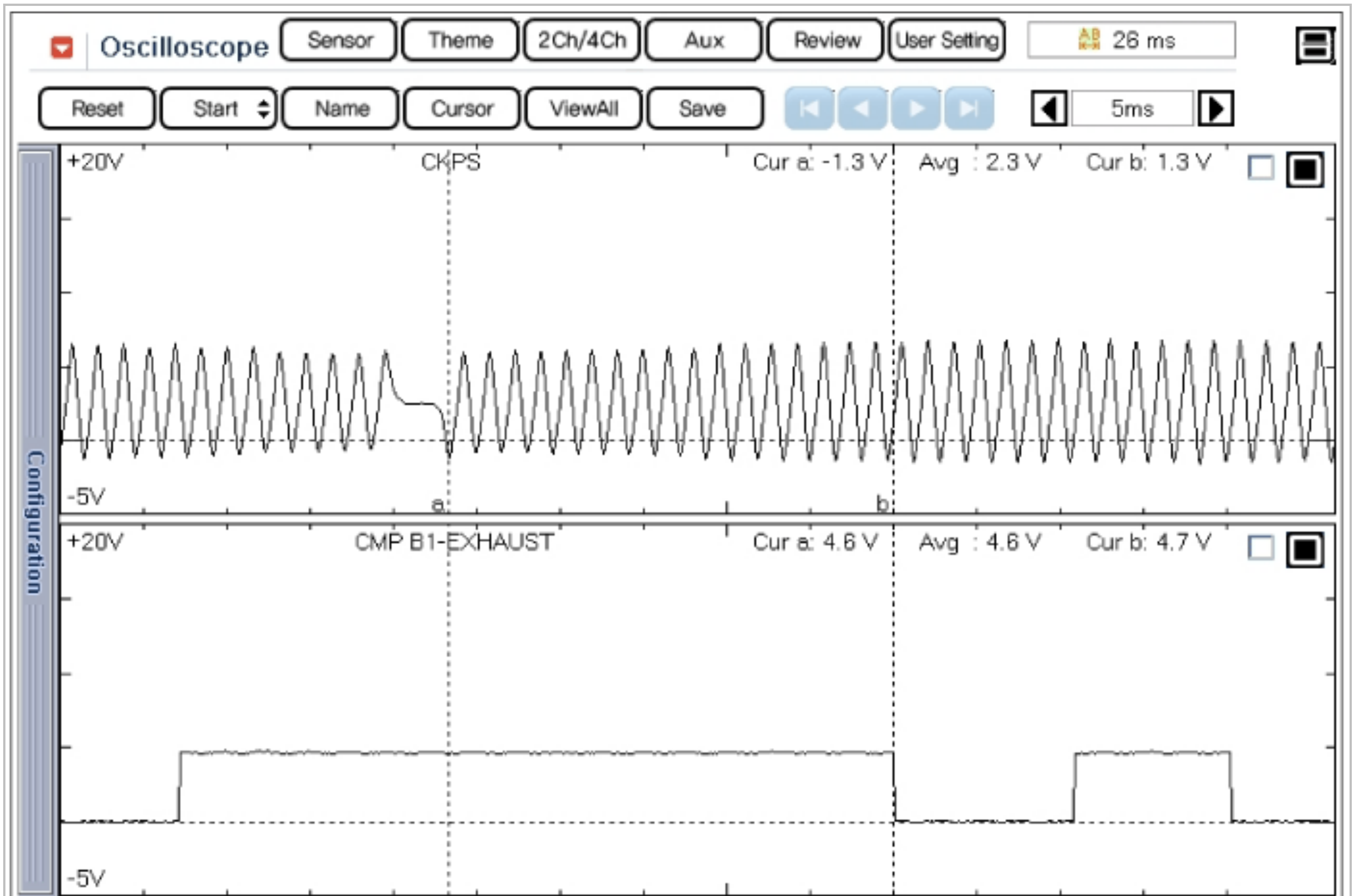
Specification

OCV	Specification
Coil Resistance (Ω)	6.7 ~ 7.7 at 20°C (68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data



Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
26 ms
Reset
Start
Name
Cursor
ViewAll
Save
5ms
+20V
CKPS
Cur a: -1.3 V
Avg : 2.3 V
Cur b: 1.3 V
-5V
a
b
+20V
CMP B1-EXHAUST
Cur a: 4.6 V
Avg : 4.6 V
Cur b: 4.7 V
-5V
Configuration

Fig.1

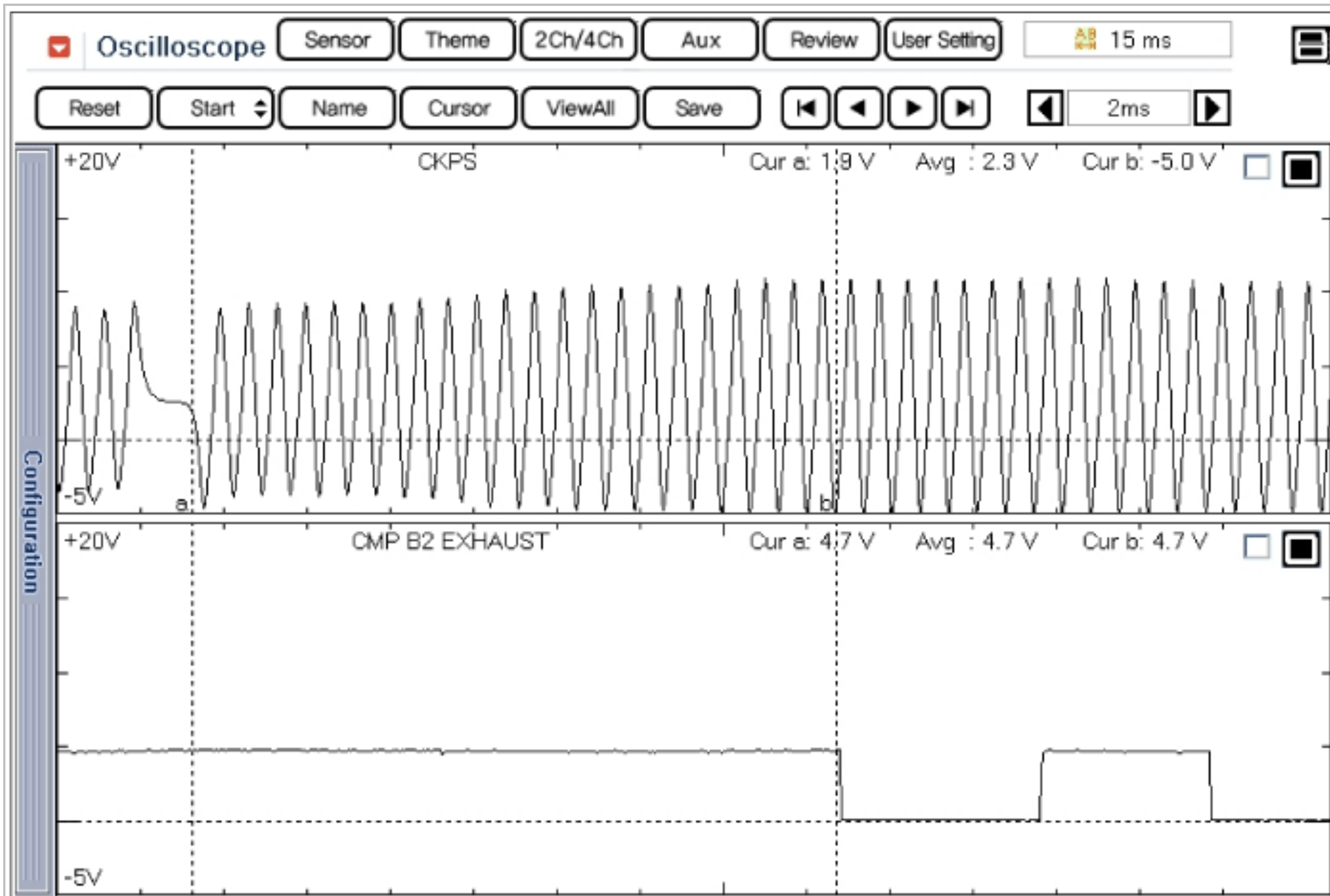
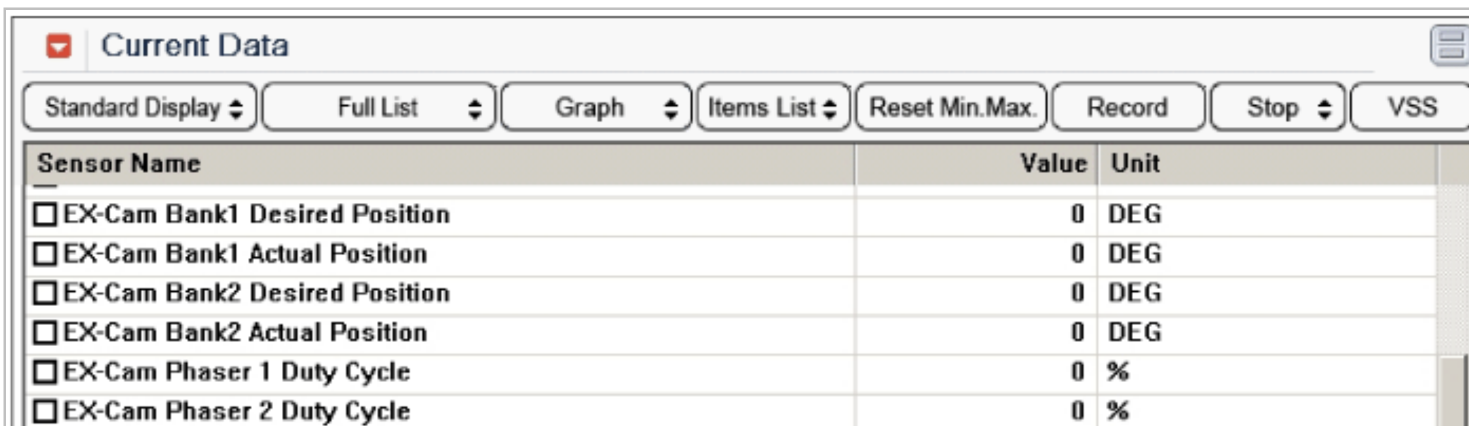


Fig.2



Sensor Name	Value	Unit
EX-Cam Bank1 Desired Position	0	DEG
EX-Cam Bank1 Actual Position	0	DEG
EX-Cam Bank2 Desired Position	0	DEG
EX-Cam Bank2 Actual Position	0	DEG
EX-Cam Phaser 1 Duty Cycle	0	%
EX-Cam Phaser 2 Duty Cycle	0	%

Fig.3

Sensor Name	Value	Unit
☑ Camshaft Control	ON	-
☑ Engine Speed	3840	RPM
☑ EX-Cam Bank1 Actual Position	-15	DEG
☑ EX-Cam Bank1 Desired Position	-14	DEG
☑ EX-Cam Bank2 Desired Position	-14	DEG
☑ EX-Cam Bank2 Actual Position	-15	DEG
☑ EX-Cam Phaser 1 Duty Cycle	43	%
☑ EX-Cam Phaser 2 Duty Cycle	44	%

Fig.4

Fig.5

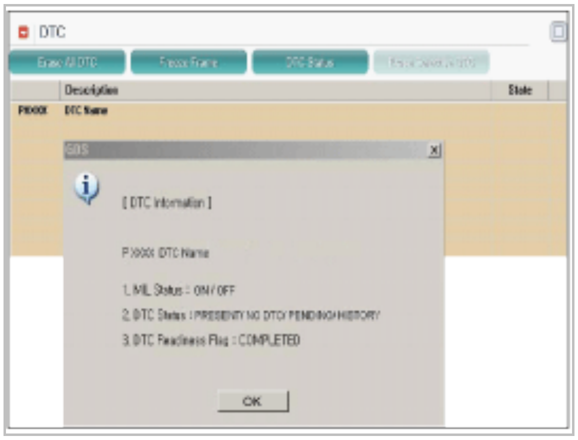
Fig.1) Normal waveform of CKPS & EX-CMPS at idle.
Fig .2) Normal waveform of CKPS & EX-CMPS at acceleration.
Fig.3) Normal data of EX-CVVT at idle.
Fig.4) Normal data of EX-CVVT at acceleration.
Fig.5) Normal graph of EX-CVVT at acceleration.

This example shows a typical Crankshaft Position Sensor (CKPS) and Camshaft Position Sensor (CMPS) waveform at idle.(Fig1.) If the 17th signal of the CKPS after missing tooth is aligned with the high signal of the CMPS at idle, ECM recognizes that Synchronization between CKPS and CMPS is completed. Under acceleracting condition, the number of tooth between missing tooth and tooth aligned with edge of the CMPS high signal is increased than idle conditon.(Fig2.)

Monitor GDS Data

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

2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "System Inspection" procedure.
NO	▶ Fault is intermittent caused by ECM memory was not cleared after repair. Erase DTC and drive the vehicle to satisfy the enable codition then, go to " System Inspection" procedure.

System Inspection

■ Visual Inspection

1. Check oil level is O.K.
2. Check oil and OCV is contaminated.
3. Check for oil leakage around OCV.
4. Has a problem been found ?

YES	▶ Repair or replace as necessary and then, go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Component Inspection" procedure

Component Inspection

■ Check OCV resistance

1. IG "OFF" and disconnect OCV connector..
2. Measure resistance between power and signal terminals of OCV. (Component Side)

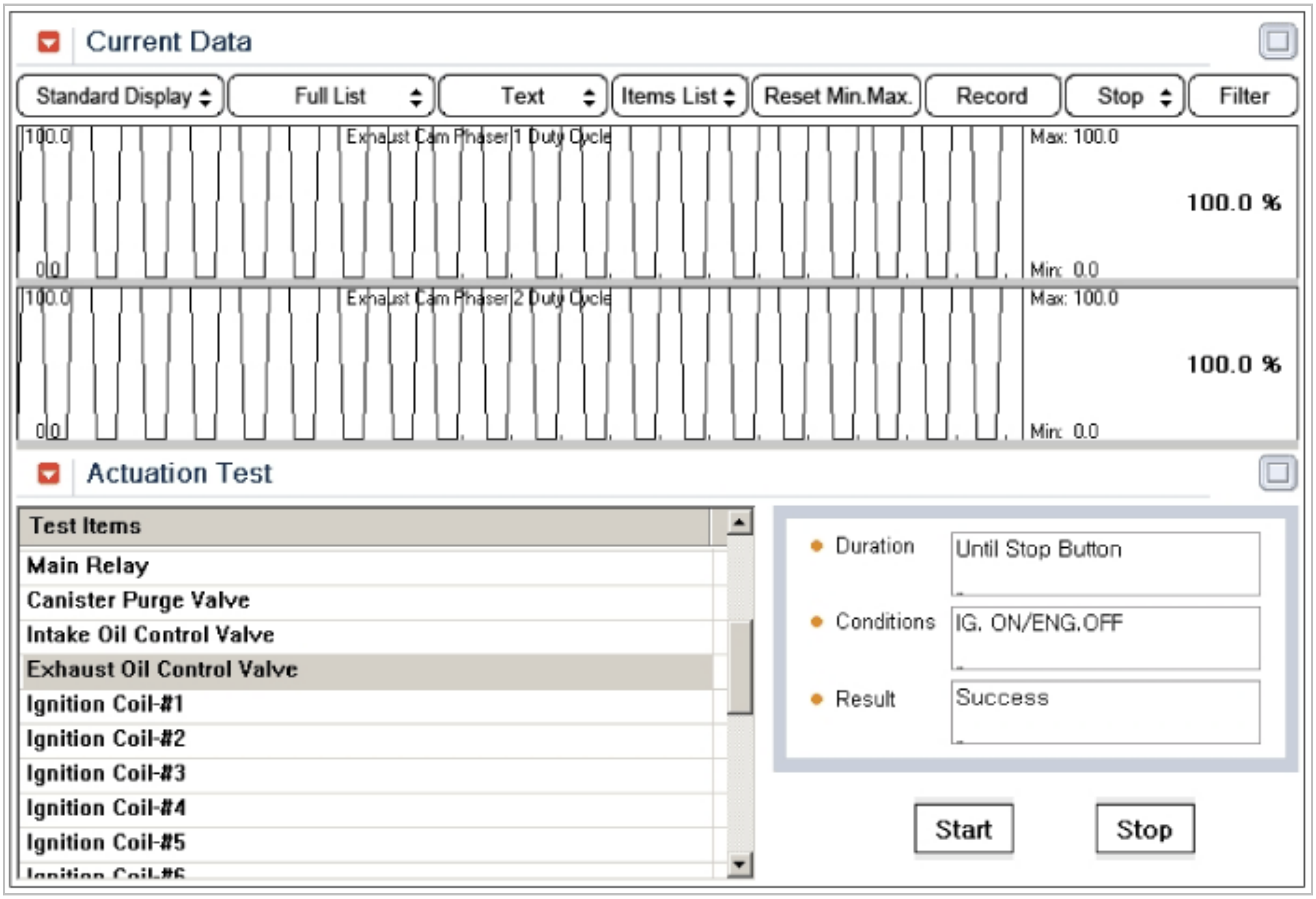
Specification : 6.7 ~ 7.7 at 20°C (68°F)

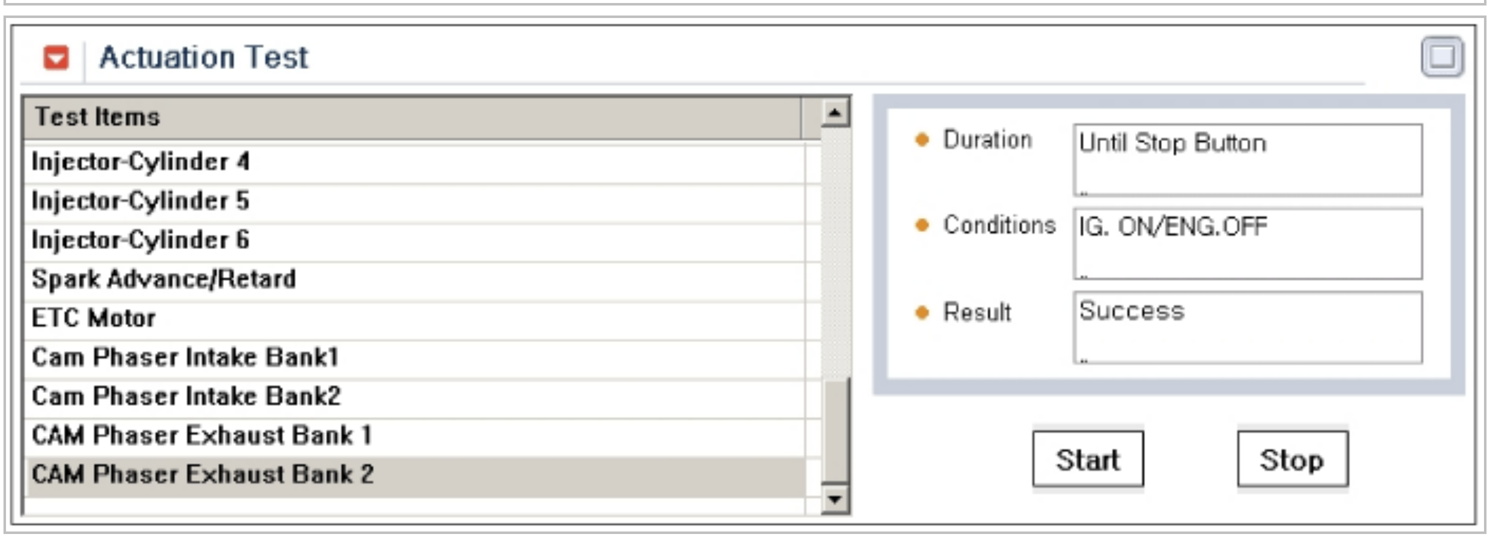
3. Is the measured resistance within specification ?

YES	▶ Go to "Check CAM PHASER with actuation test" as follows.
NO	▶ Substitute with a known - good OCV and check for proper operation. If the problem is corrected, replace OCV and go to "Verification of Vehicle Repair" procedure.

■ Check CAM PHASER with actuation test

1. Connect GDS and IG "ON"
2. Select "Cam Phaser Intake Bank2" on the Actuation Test
3. Select "Exhaust Oil Control Valve" on the Actuation Test
4. Activates "Cam Phaser Intake Bank2" by pressing "START" button
5. Activates "Exhaust Oil Control Valve" by pressing "START" button
6. Repeat this procedure 4 or 5 times to ensure CAM PHASER and valve control solenoid reliability





7. Has a problem been found ?

YES	▶ Substitute with a known - good CVVT or OCV and check for proper operation. If the problem is corrected, replace CVVT or OCV and go to "Verification of Vehicle Repair" procedure.
NO	▶ Fault is intermittent. Drive the vehicle to meet the enable condition for the DTC. and Go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

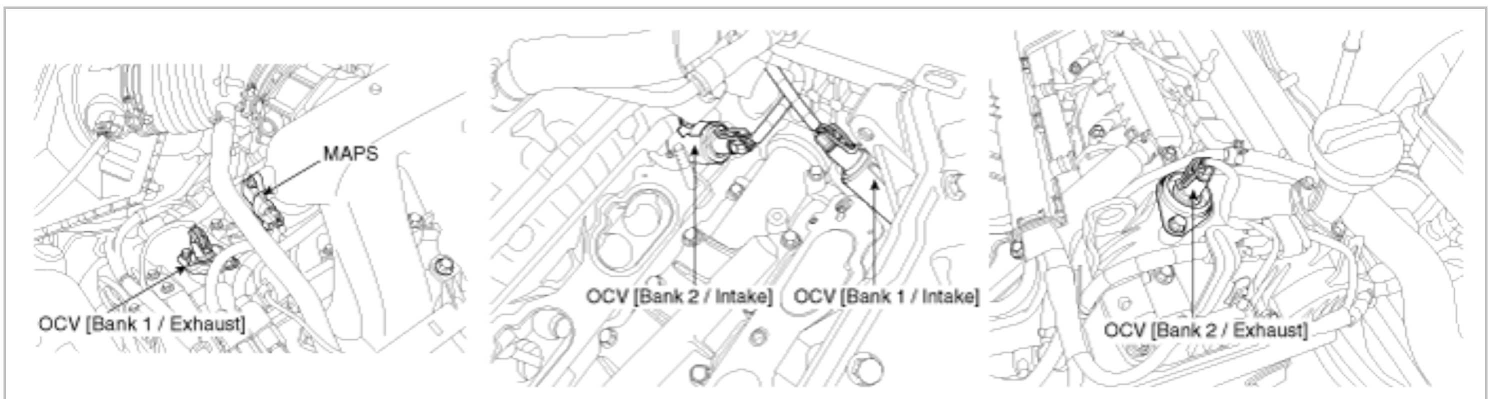
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0025 \'B\' Camshaft Position - Timing Over-Retarded (Bank 2)

Component Location



General Description

The CVVT (Continuously Variable Valve Timing) system is installed to the chain sprocket of the camshaft. This system controls the camshaft to provide the optimal valve timing for every driving condition. The ECM controls the Oil Control Valve(OCV), based on the signals output from mass air flow, throttle position and engine coolant temperature. The CVVT controller regulates the camshaft angle using oil pressure through the OCV. As result, the relative position between the camshaft and the crankshaft becomes optimal, and the engine torque improves, fuel economy improves, exhaust emissions decrease under over all driving conditions.

DTC Description

ECM monitors CAM phaser error while CMP signal is normally generating and vehicle is driving in 2000 ~ 3000rpm. If the CAM phaser does not move although ECM commands OCV duty cycle ECM determines that a faultexists and a

DTC is stored.

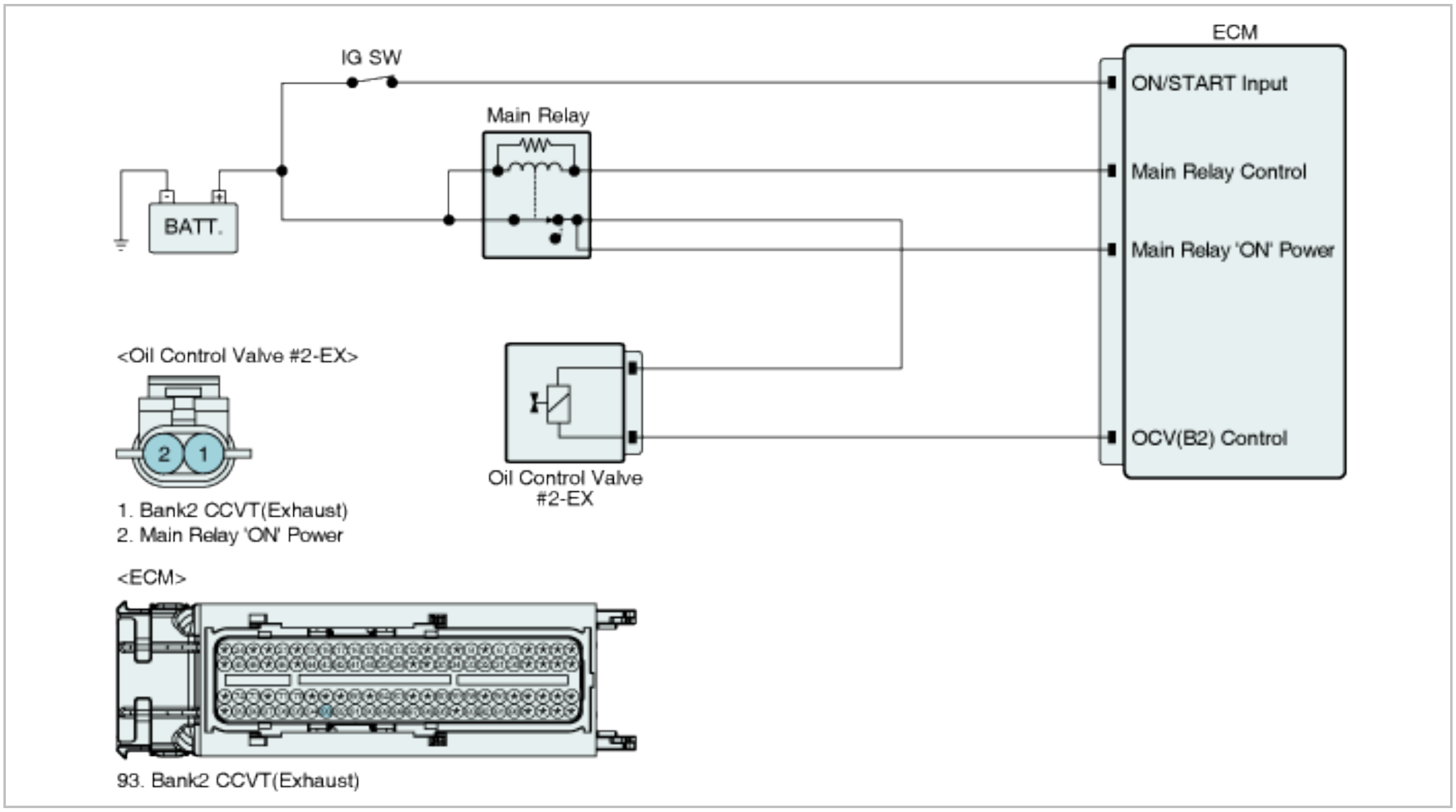
DTC Detecting Condition

Item		Detecting Condition	Possible Cause
DTC Strategy		• Determines if the phaser is stuck or has steady-state error	• Engine Oil • OCV stuck • CVVT stuck
Enable Conditions		• CAM signal is normally generating • Vehicle is on driving (2000 ~ 3000RPM) for 5 minutes	
Threshold value	Case 1	• 5 CAD < Cam Actual Position < 50 CAD • Duty Cycle > 90% or Duty Cycle < 10%	
	Case 2	• Cam Position error > 15 CAD (Difference between Actual Postion and Desire Position is more than 15°) • Timing Counter > 80	
Diagnosis Time		• Continuous (within 5min.)	
MIL On Condition		• 2 Driving Cycles	

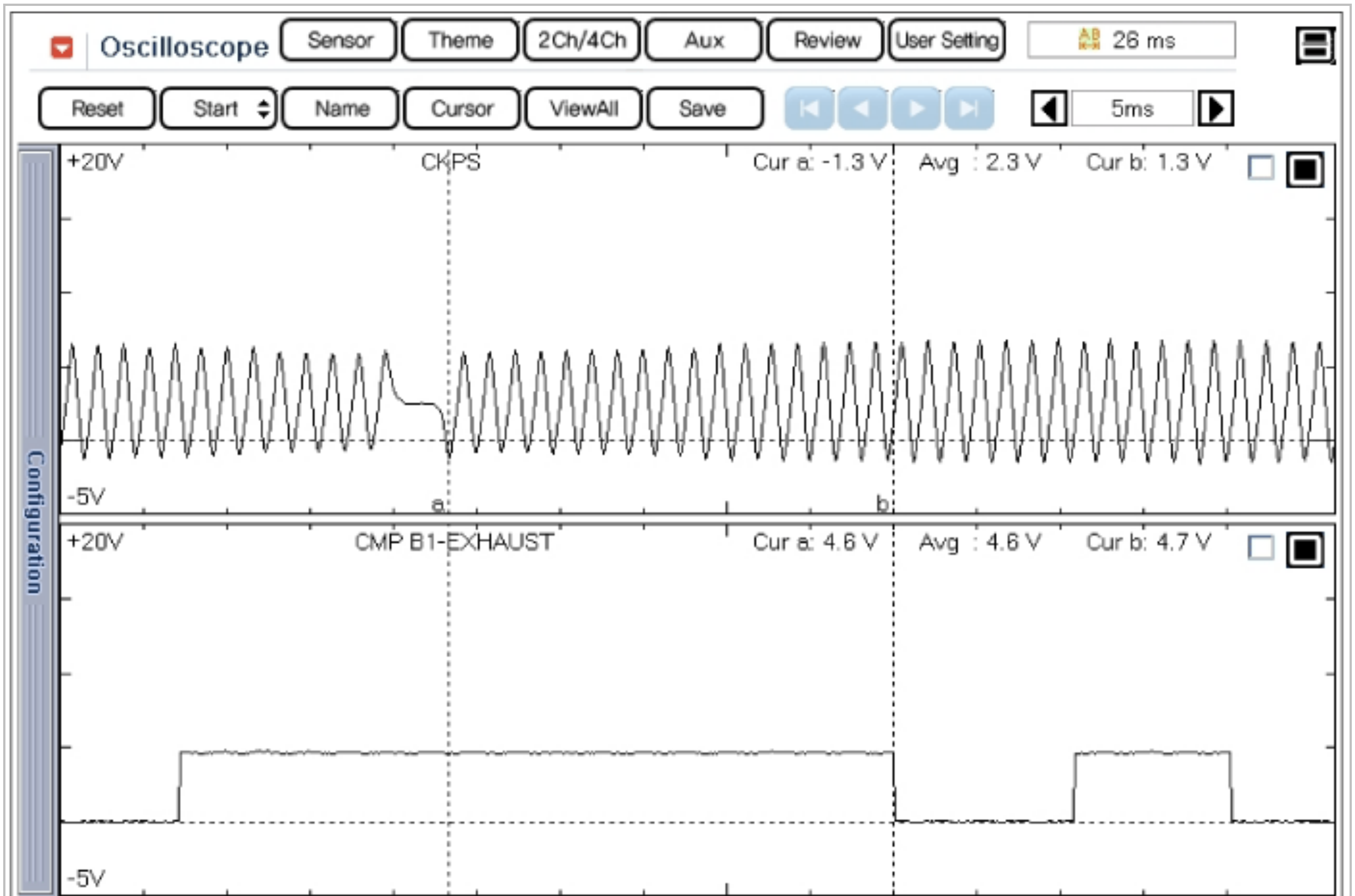
Specification

OCV	Specification
Coil Resistance (Ω)	6.7 ~ 7.7 at 20°C (68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data



Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
26 ms
Reset
Start
Name
Cursor
ViewAll
Save
5ms
Configuration
+20V
CKPS
Cur a: -1.3 V
Avg : 2.3 V
Cur b: 1.3 V
-5V
a
b
+20V
CMP B1-EXHAUST
Cur a: 4.6 V
Avg : 4.6 V
Cur b: 4.7 V
-5V

Fig.1

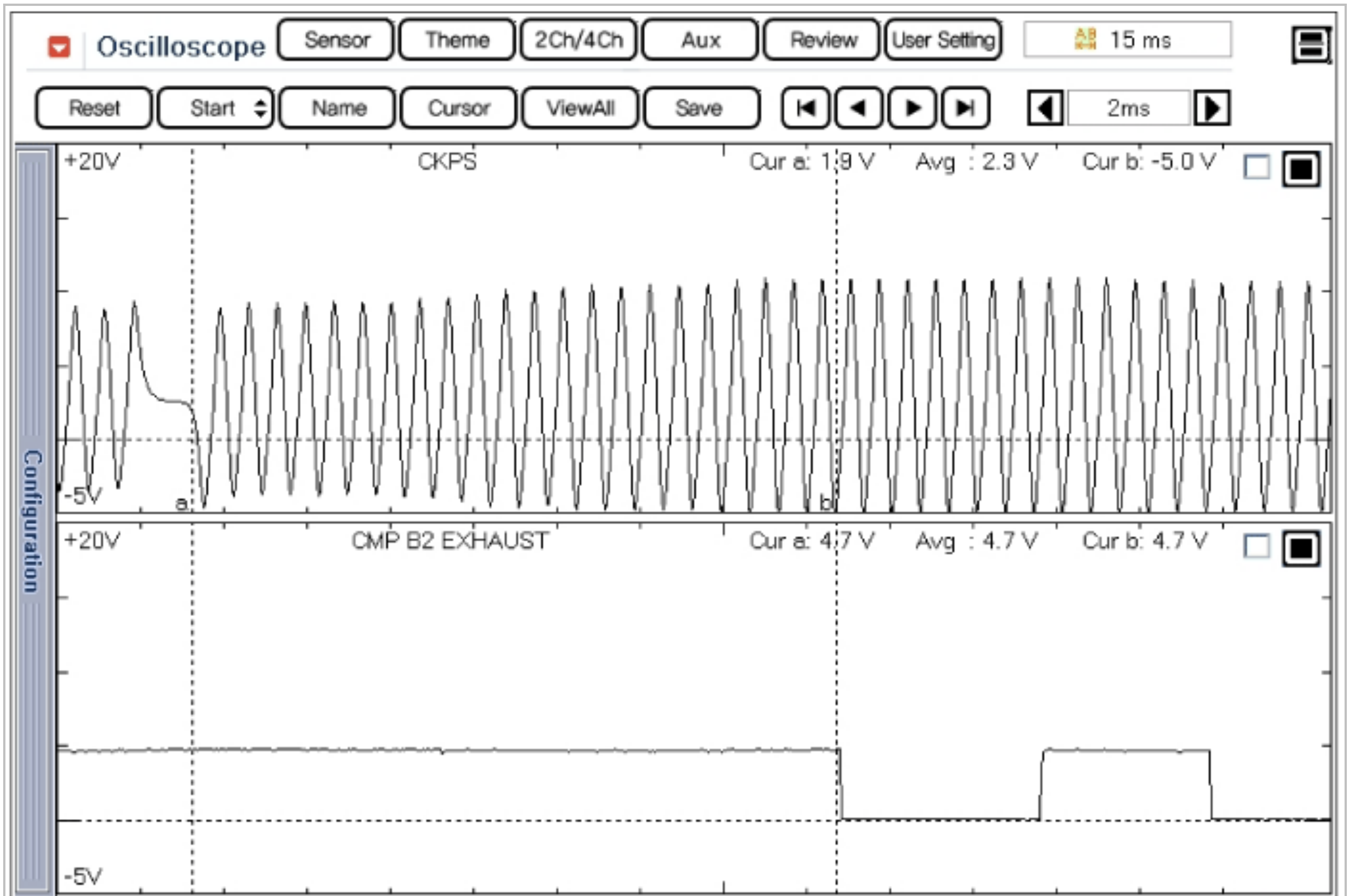


Fig.2

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | VSS

Sensor Name	Value	Unit
EX-Cam Bank1 Desired Position	0	DEG
EX-Cam Bank1 Actual Position	0	DEG
EX-Cam Bank2 Desired Position	0	DEG
EX-Cam Bank2 Actual Position	0	DEG
EX-Cam Phaser 1 Duty Cycle	0	%
EX-Cam Phaser 2 Duty Cycle	0	%

Fig.3

Sensor Name	Value	Unit
☑ Camshaft Control	ON	-
☑ Engine Speed	3840	RPM
☑ EX-Cam Bank1 Actual Position	-15	DEG
☑ EX-Cam Bank1 Desired Position	-14	DEG
☑ EX-Cam Bank2 Desired Position	-14	DEG
☑ EX-Cam Bank2 Actual Position	-15	DEG
☑ EX-Cam Phaser 1 Duty Cycle	43	%
☑ EX-Cam Phaser 2 Duty Cycle	44	%

Fig.4

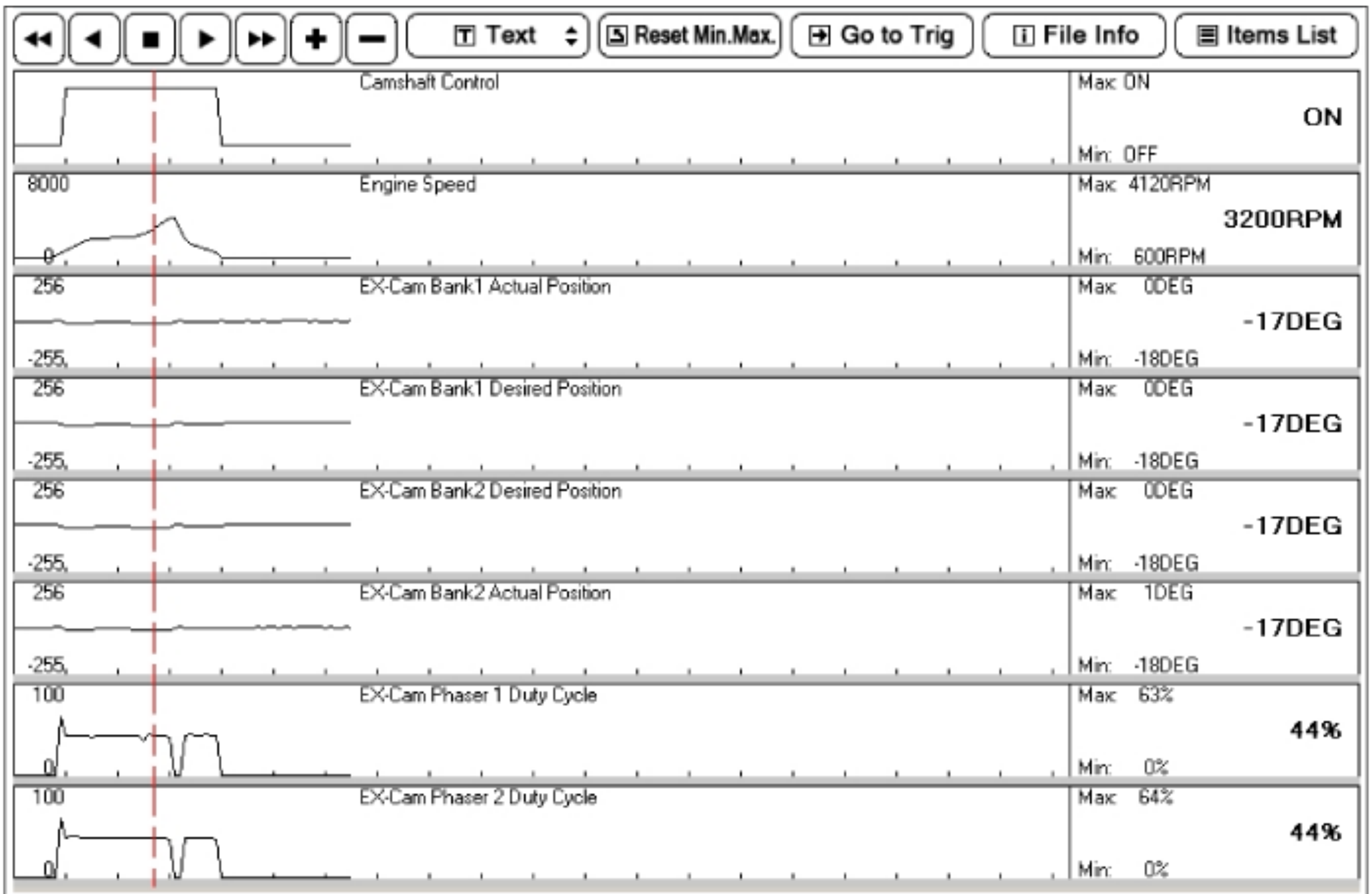


Fig.5

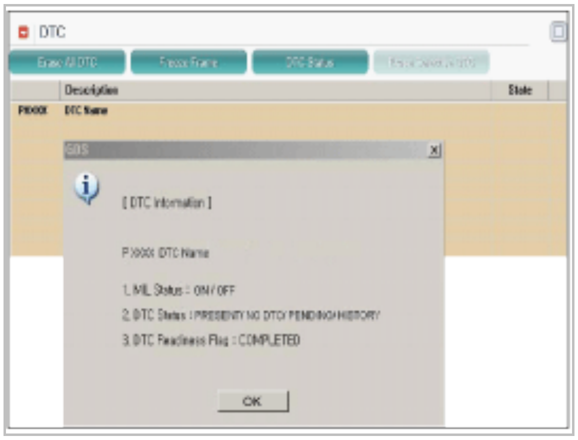
Fig.1) Normal waveform of CKPS & EX-CMPS at idle.
Fig.2) Normal waveform of CKPS & EX-CMPS at acceleration.
Fig.3) Normal data of EX-CVVT at idle.
Fig.4) Normal data of EX-CVVT at acceleration.
Fig.5) Normal graph of EX-CVVT at acceleration.

This example shows a typical Crankshaft Position Sensor (CKPS) and Camshaft Position Sensor (CMPS) waveform at idle.(Fig1.) If the 17th signal of the CKPS after missing tooth is aligned with the high signal of the CMPS at idle, ECM recognizes that Synchronization between CKPS and CMPS is completed. Under acceleracting condition, the number of tooth between missing tooth and tooth aligned with edge of the CMPS high signal is increased than idle conditon.(Fig2.)

Monitor GDS Data

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

2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "System Inspection" procedure.
NO	▶ Fault is intermittent caused by ECM memory was not cleared after repair. Erase DTC and drive the vehicle to satisfy the enable codition then, go to "System Inspection" procedure.

System Inspection

■ Visual Inspection

1. Check oil level is O.K.
2. Check Oil and OCV is contaminated.
3. Check for oil leakage around OCV.
4. Has a problem been found ?

YES	▶ Repair or replace as necessary and then, go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Component Inspection" procedure.

Component Inspection

■ Check OCV resistance

1. IG "OFF" and disconnect OCV connector.
2. Measure resistance between power and signal terminals of OCV. (Component Side)

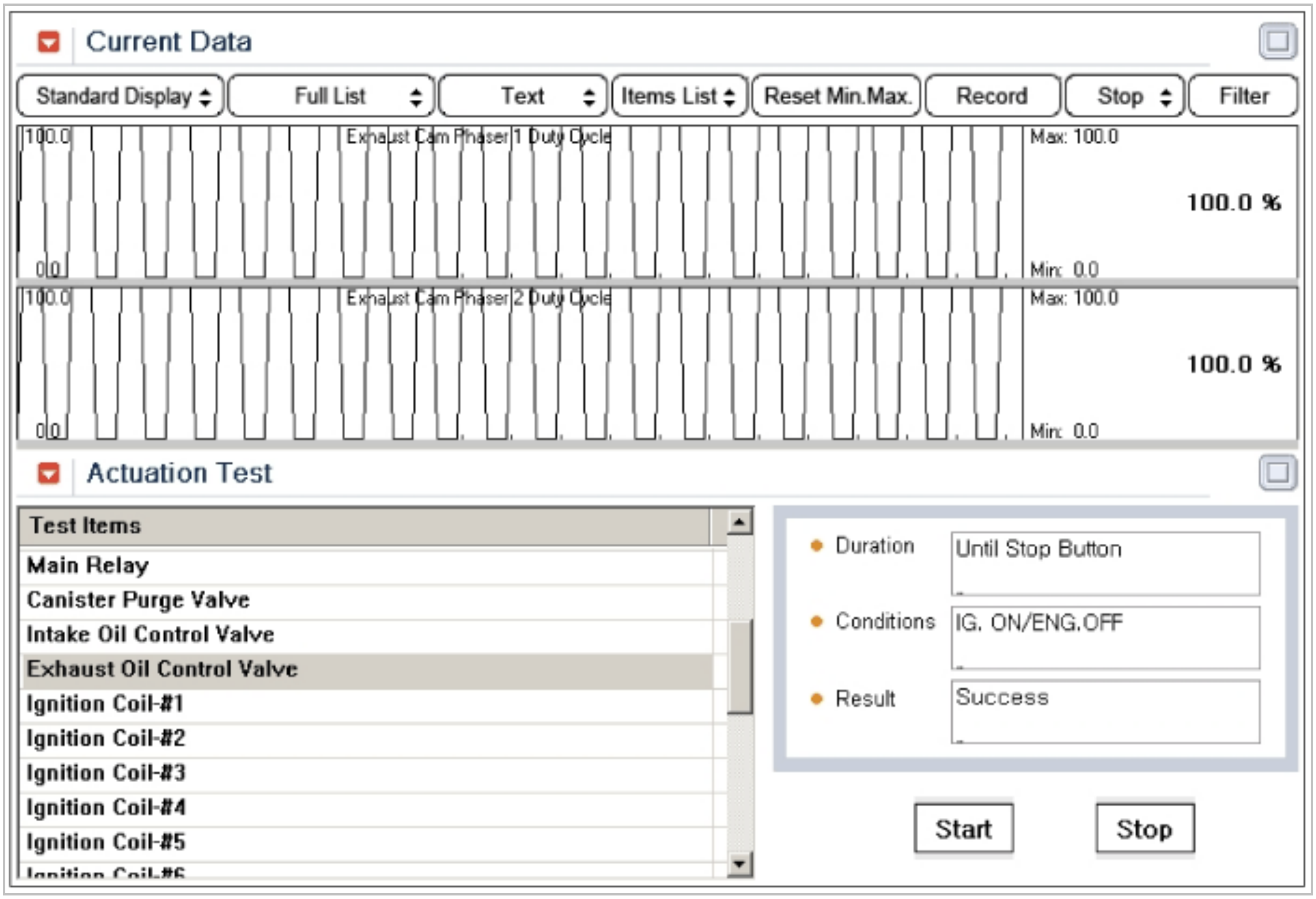
Specification : 6.7 ~ 7.7 at 20°C (68°F)

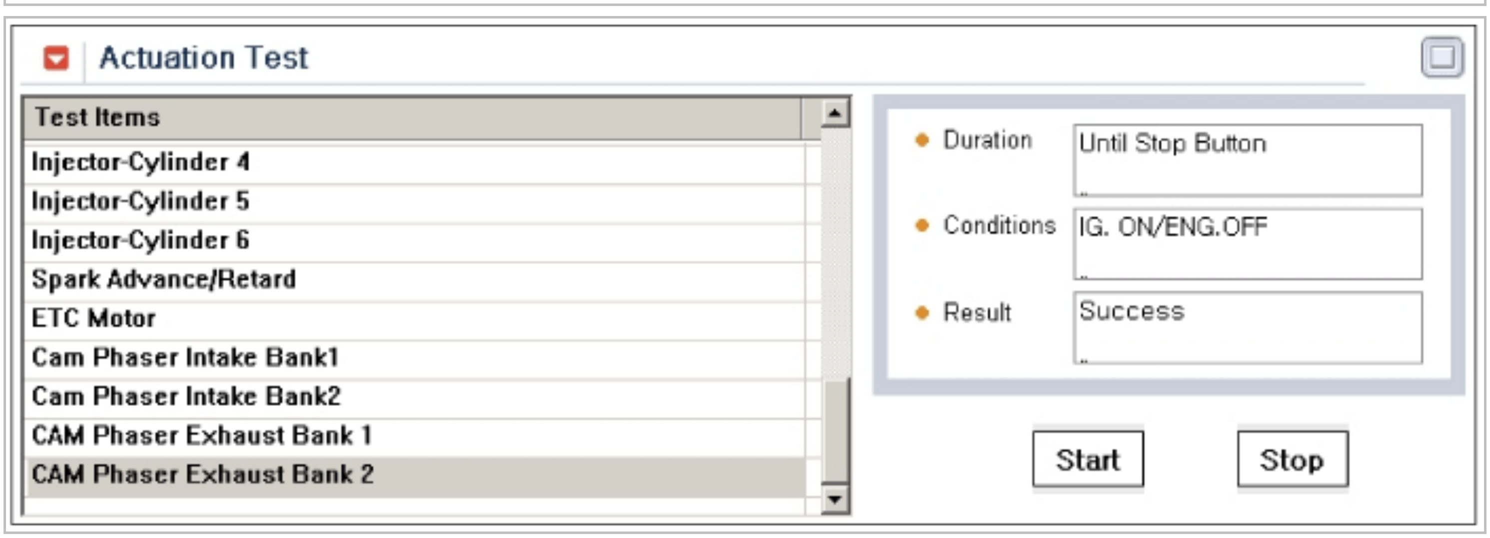
3. Is the measured resistance within specification?

YES	▶ Go to "Check CAM PHASER with actuation test" as follows.
NO	▶ Substitute with a known - good OCV and check for proper operation. If the problem is corrected, replace OCV and go to "Verification of Vehicle Repair" procedure.

■ Check CAM PHASER with actuation test

1. Connect GDS and IG "ON"
2. Select "Cam Phaser Intake Bank2" on the Actuation Test
3. Select "Exhaust Oil Control Valve" on the Actuation Test
4. Activates "Cam Phaser Intake Bank2" by pressing "START" button
5. Activates "Exhaust Oil Control Valve" by pressing "START" button
6. Repeat this procedure 4 or 5 times to ensure CAM PHASER and valve control solenoid reliability





7. Has a problem been found ?

YES	▶ Substitute with a known - good CVVT or OCV and check for proper operation. If the problem is corrected, replace CVVT or OCV and go to "Verification of Vehicle Repair" procedure.
NO	▶ Fault is intermittent. Drive the vehicle to meet the enable condition for the DTC. and Go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

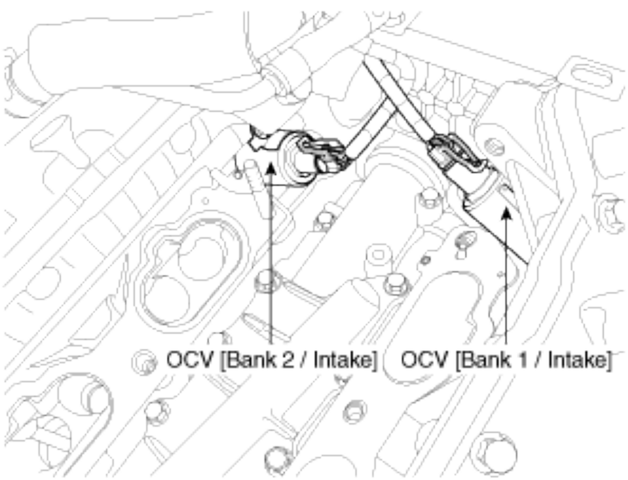
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0026 Intake Valve Control Solenoid Circuit Range/Performance (Bank 1)

Component Location



General Description

The CVVT (Continuously Variable Valve Timing) system is installed to the chain sprocket of the camshaft. This system controls the camshaft to provide the optimal valve timing for every driving condition. The ECM controls the Oil Control Valve(OCV), based on the signals output from mass air flow, throttle position and engine coolant temperature. The CVVT controller regulates the camshaft angle using oil pressure through the OCV. As result, the relative position between the camshaft and the crankshaft becomes optimal, and the engine torque improves, fuel economy improves, exhaust emissions decrease under over all driving conditions.

DTC Description

ECM monitors OCV stuck while cam sinal is normally generating and Valve cleaning is not in progress.

If the CAM Acutal Position is too high or low and Difference between Cam Actual Positionand Desire Position is higher than 20° ECM determines that a fault exists and a DTC is stored.

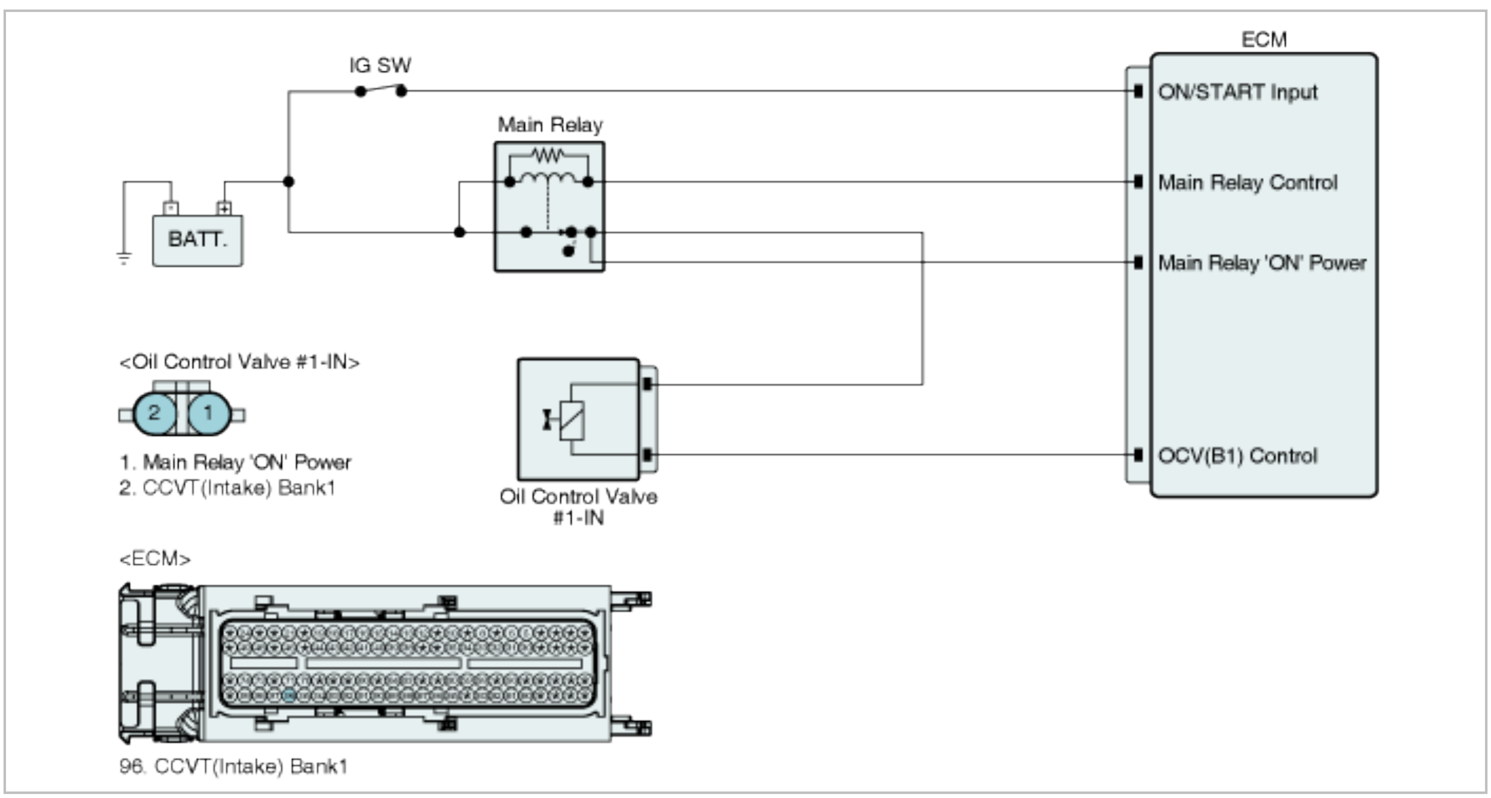
DTC Detecting Condition

Item		Detecting Condition	Possible Cause
DTC Strategy		• Determines if oil control valve is stuck	• Oil Pressure Loss • OCV seizure
Enable Conditions		• Valve cleaning not in progress • CAM signal is normally generating	
Threshold value	Case 1	• Cam Actual Position > 50 CAD and Difference between CAM Actual Position and Desire Position > 20 CAD	
	Case 2	• Cam Actual Position < 5 CAD and Difference between CAM Actual Position and Desire Position > 20 CAD	
Diagnosis Time		• Continuous (Within 1min.)	
MIL On Condition		• 2 Driving Cycles	

Specification

OCV	Specification
Coil Resistance (Ω)	6.7 ~ 7.7 at 20°C (68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data

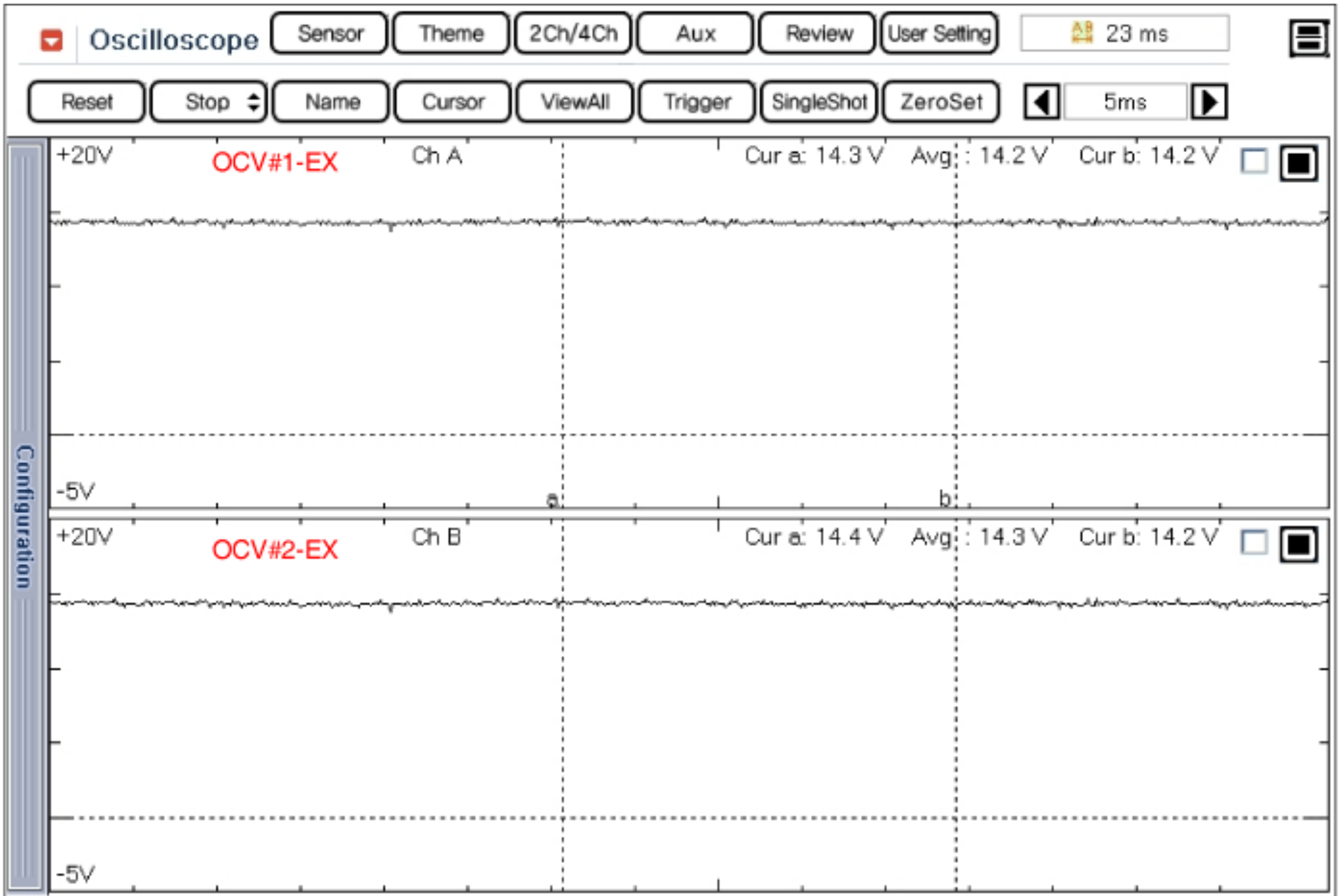


Fig.1

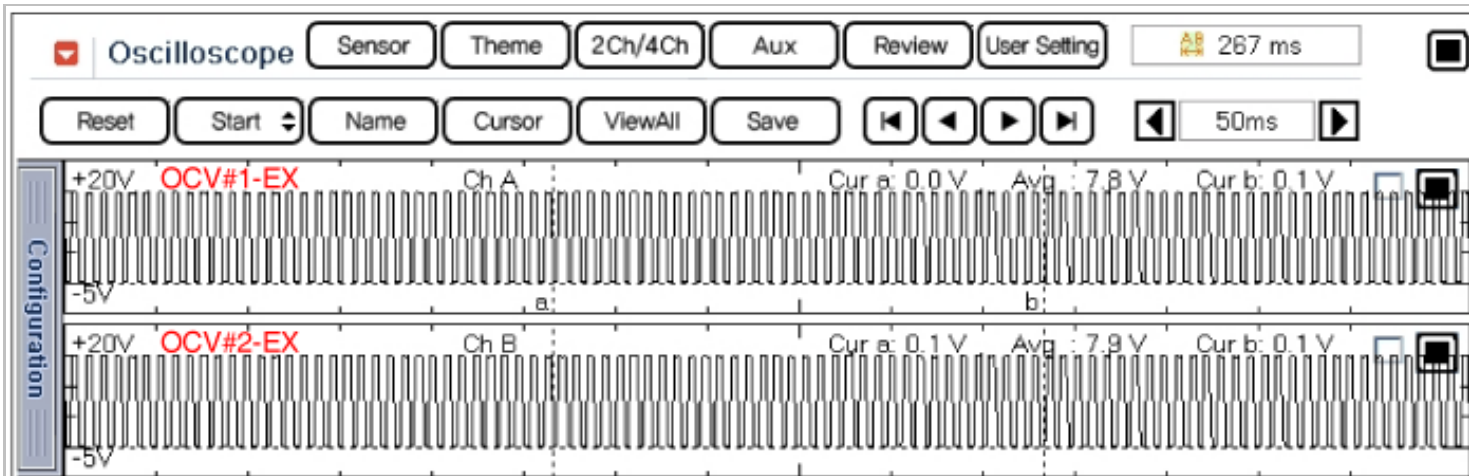


Fig.2

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | VSS

Sensor Name	Value	Unit
Camshaft Desired Position-Bank1	0.0	DEG
Camshaft Actual Position-Bank1	0.3	DEG
Camshaft Desired Position-Bank2	0.0	DEG
Camshaft Actual Position-Bank2	-0.3	DEG
Engine Speed	600	RPM

Fig.3

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Run | VSS

Sensor Name	Value	Unit
Camshaft Desired Position-Bank1	18.8	DEG
Camshaft Actual Position-Bank1	28.4	DEG
Camshaft Desired Position-Bank2	18.8	DEG
Camshaft Actual Position-Bank2	26.1	DEG
Engine Speed	1040	RPM
Actual Torque	64.3	%

Fig.4

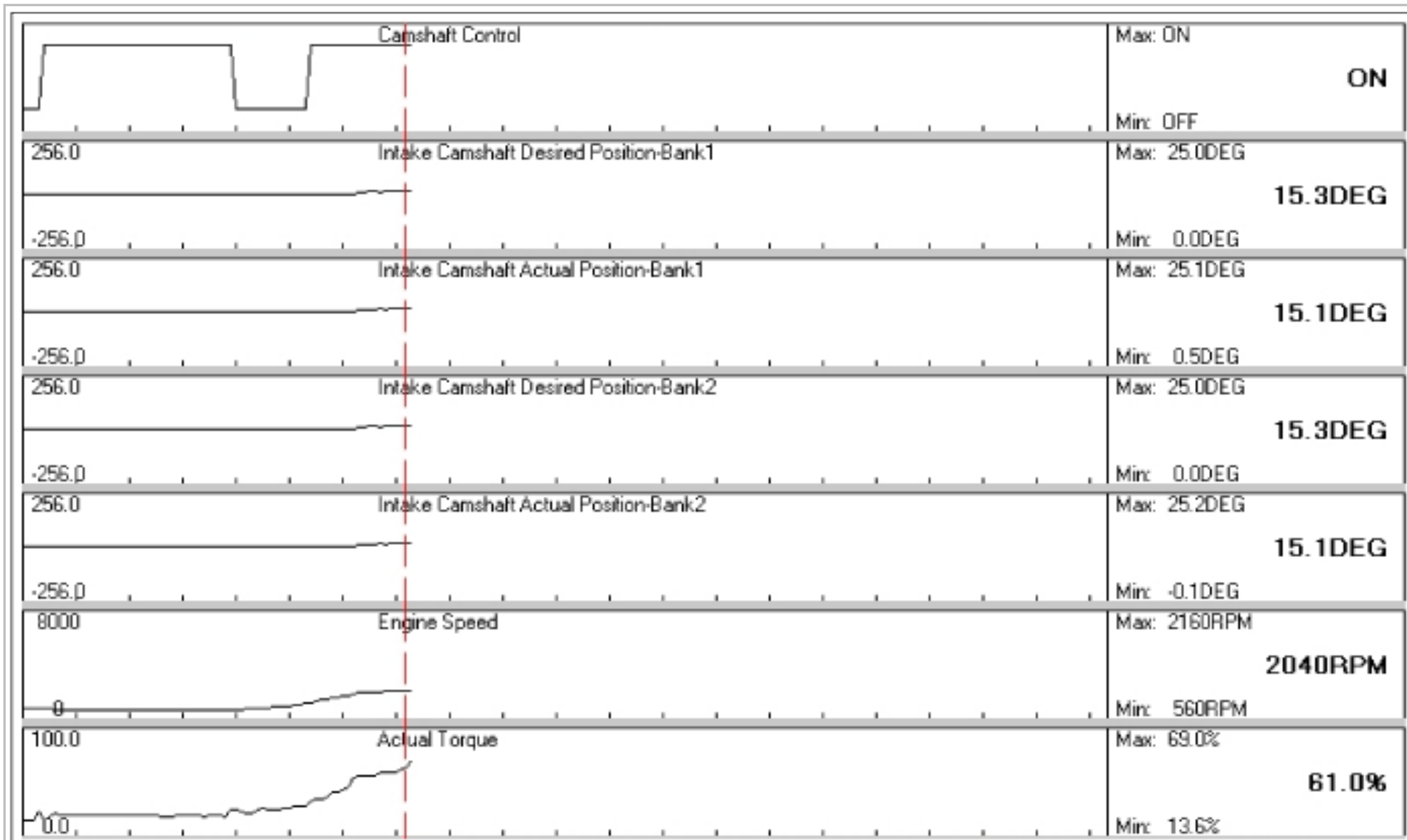


Fig.5

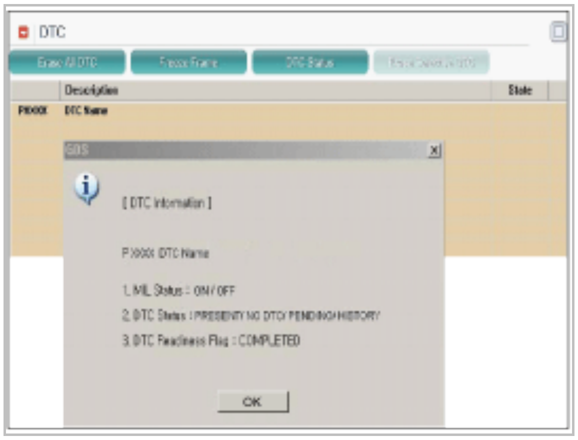
Fig.1) Normal waveform of OCV at idle.

Fig.2) Normal waveform of OCV at acceleration. (3500rpm)

Fig.3) Normal data of IN-CVVT at idle.
Fig.4) Normal data of IN-CVVT at acceleration with load.
Fig.5) Normal graph of IN-CVVT at acceleration with load.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "System Inspection" procedure.
NO	▶ Fault is intermittent caused by ECM memory was not cleared after repair. Erase DTC and drive the vehicle to satisfy the enable codition then, go to " System Inspection" procedure.

System Inspection

■ Visual Inspection

1. Check oil level and oil cleanness is O.K.
2. Check OCV is contaminated.
3. Check for oil leakage around OCV
4. Has a problem been found ?

YES	▶ Repair or replace as necessary and then, go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Component Inspection" procedure.

Component Inspection

■ Check OCV resistance

1. IG "OFF" and disconnect OCV connector.
2. Measure resistance between power and signal terminals of OCV. (Component Side)

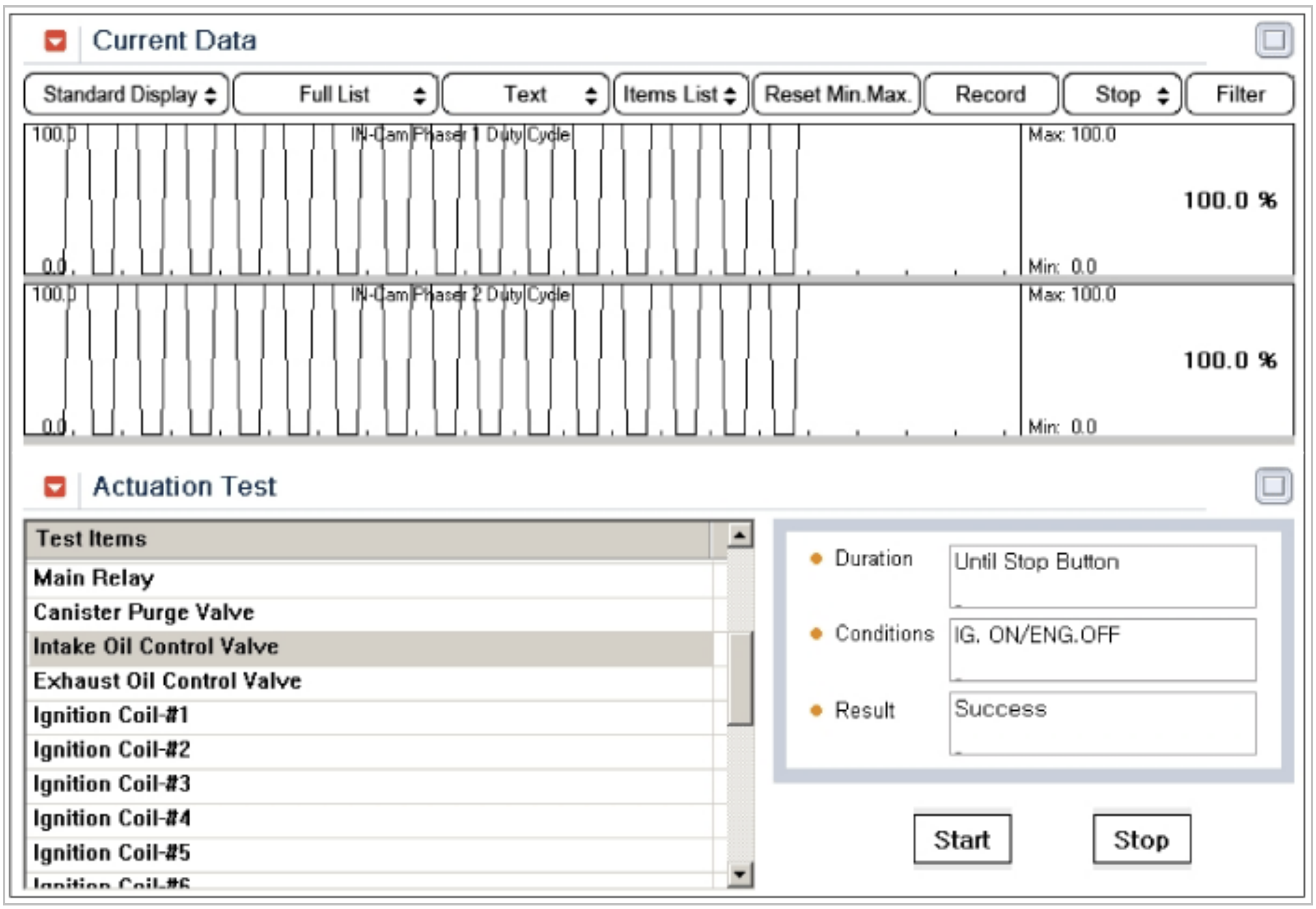
Specification : 6.7 ~ 7.7 at 20°C (68°F)

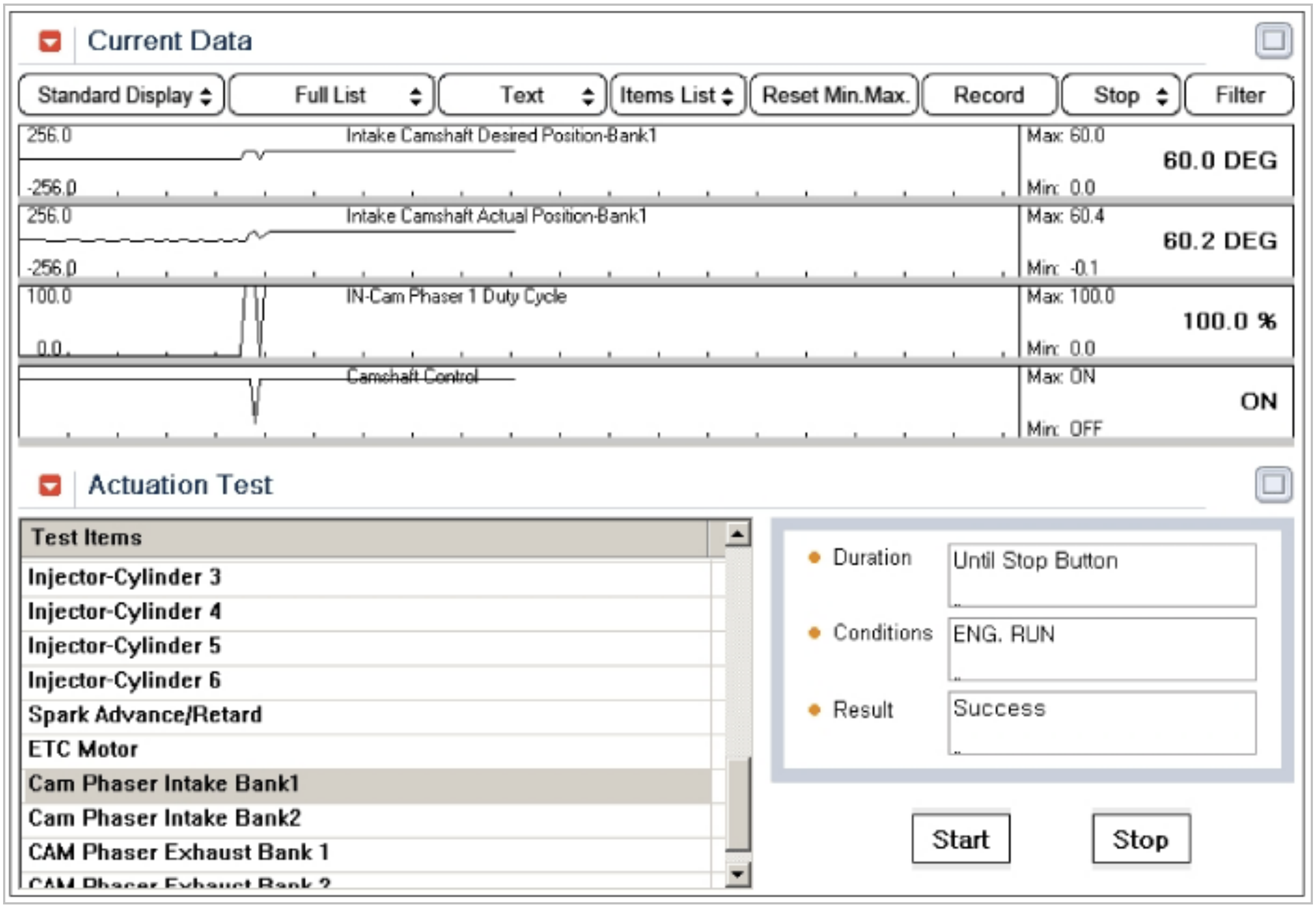
3. Is the measured resistance within specification?

YES	▶ Go to "Check CAM PHASER with actuation test" as follows.
NO	▶ Substitute with a known - good OCV and check for proper operation. If the problem is corrected, replace OCV and go to "Verification of Vehicle Repair" procedure.

■ **Check CAM PHASER with actuation test**

1. Connect GDS and IG "ON"
2. Select "Cam Phaser Intake Bank1" on the Actuation Test
3. Select "Intake Oil Control Valve" on the Actuation Test
4. Activates "Cam Phaser Intake Bank1" by pressing "START" button
5. Activates "Intake Oil Control Valve" by pressing "START" button
6. Repeat this procedure 4 or 5 times to ensure CAM PHASER and valve control solenoid reliability





7. Has a problem been found ?

YES	▶ Substitute with a known - good CVVT or OCV and check for proper operation. If the problem is corrected, replace CVVT or OCV and go to "Verification of Vehicle Repair" procedure.
NO	▶ Fault is intermittent. Drive the vehicle to meet the enable condition for the DTC. and Go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

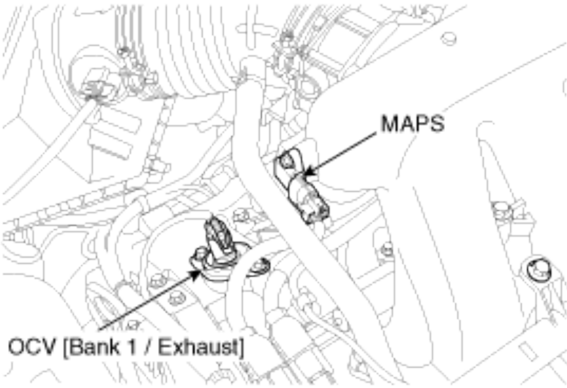
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0027 Exhaust Valve Control Solenoid Circuit

Range/Performance (Bank 1)

Component Location



General Description

The CVVT (Continuously Variable Valve Timing) system is installed to the chain sprocket of the camshaft. This system controls the camshaft to provide the optimal valve timing for every driving condition. The ECM controls the Oil Control Valve(OCV), based on the signals output from mass air flow, throttle position and engine coolant temperature. The CVVT controller regulates the camshaft angle using oil pressure through the OCV. As result, the relative position between the camshaft and the crankshaft becomes optimal, and the engine torque improves, fuel economy improves, exhaust emissions decrease under over all driving conditions.

DTC Description

ECM monitors OCV stuck while cam sinal is normally generating and Valve cleaning is not in progress .
If the CAM Acutal Position is too high or low and Difference between Cam Actual Positionand Desire Position is higher than 20° ECM determines that a fault exists and a DTC is stored.

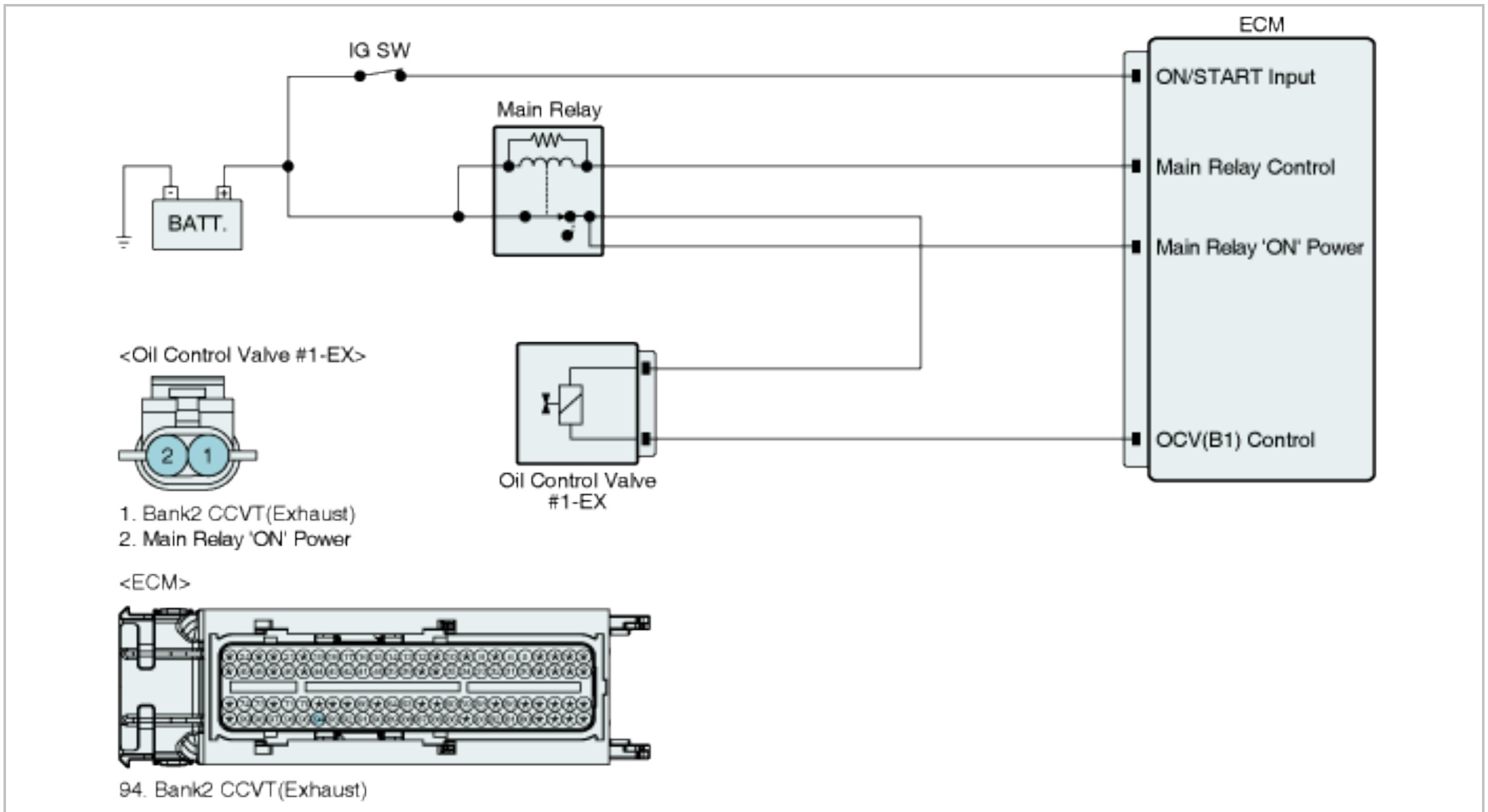
DTC Detecting Condition

Item		Detecting Condition	Possible Cause
DTC Strategy		• Determines if oil control valve is stuck	• Oil Pressure Loss • OCV seizure
Enable Conditions		• Valve cleaning not in progress • CAM signal is normally generating	
Threshold value	Case 1	• Cam Actual Position > 50 CAD and Difference between CAM Actual Position and Desire Position > 20 CAD	
	Case 2	• Cam Actual Position < 5 CAD and Difference between CAM Actual Position and Desire Position > 20 CAD	
Diagnosis Time		• Continuous (Within 1min.)	
MIL On Condition		• 2 Driving Cycles	

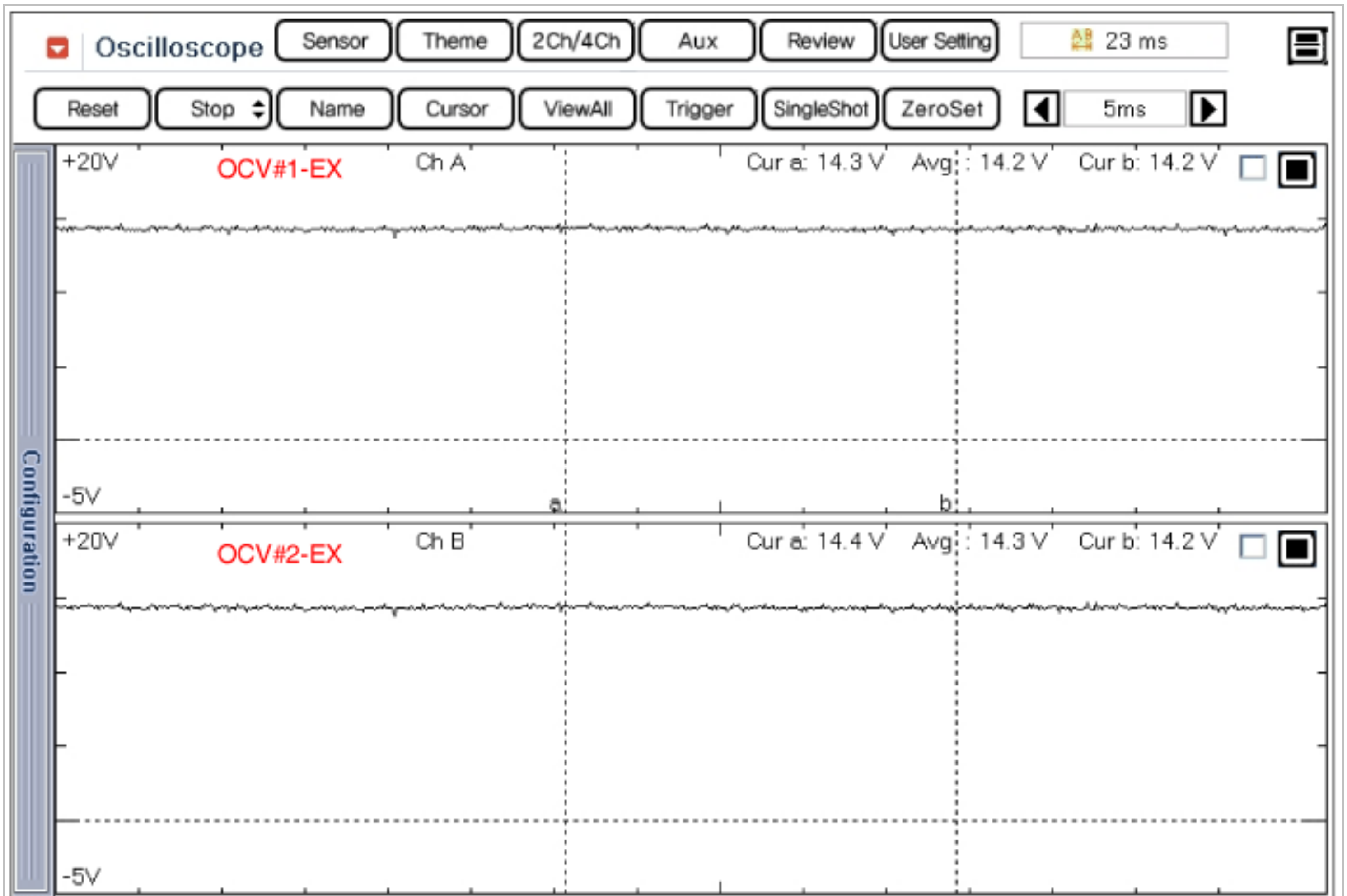
Specification

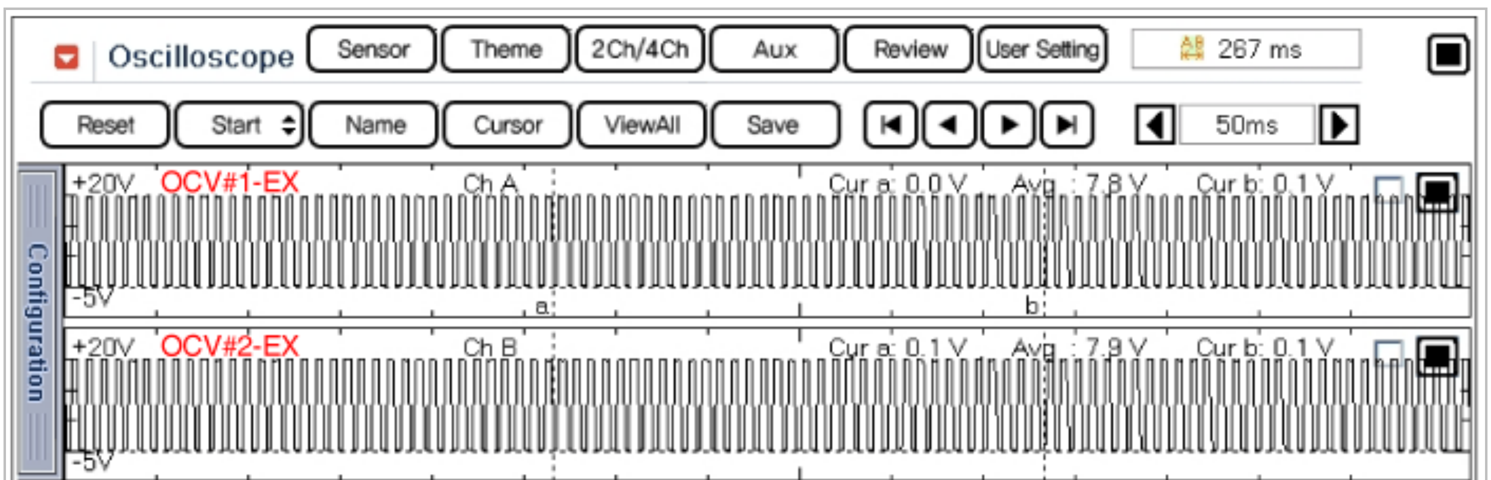
OCV	Specification
Coil Resistance (Ω)	6.7 ~ 7.7 at 20°C (68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data


Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
23 ms
Reset
Stop
Name
Cursor
ViewAll
Trigger
SingleShot
ZeroSet
5ms
Configuration
+20V
OCV#1-EX
Ch A
Cur a: 14.3 V
Avg : 14.2 V
Cur b: 14.2 V
-5V
a
b
+20V
OCV#2-EX
Ch B
Cur a: 14.4 V
Avg : 14.3 V
Cur b: 14.2 V
-5V
Fig.1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Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
267 ms
Reset
Start
Name
Cursor
ViewAll
Save
50ms
Configuration
+20V
OCV#1-EX
Ch A
Cur a: 0.0 V
Avg : 7.8 V
Cur b: 0.1 V
-5V
a
b
+20V
OCV#2-EX
Ch B
Cur a: 0.1 V
Avg : 7.9 V
Cur b: 0.1 V
-5V
Fig.2

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | VSS

Sensor Name	Value	Unit
☐ EX-Cam Bank1 Desired Position	0	DEG
☐ EX-Cam Bank1 Actual Position	0	DEG
☐ EX-Cam Bank2 Desired Position	0	DEG
☐ EX-Cam Bank2 Actual Position	0	DEG
☐ EX-Cam Phaser 1 Duty Cycle	0	%
☐ EX-Cam Phaser 2 Duty Cycle	0	%

Fig.3

Sensor Name	Value	Unit
☑ Camshaft Control	ON	-
☑ Engine Speed	3840	RPM
☑ EX-Cam Bank1 Actual Position	-15	DEG
☑ EX-Cam Bank1 Desired Position	-14	DEG
☑ EX-Cam Bank2 Desired Position	-14	DEG
☑ EX-Cam Bank2 Actual Position	-15	DEG
☑ EX-Cam Phaser 1 Duty Cycle	43	%
☑ EX-Cam Phaser 2 Duty Cycle	44	%

Fig.4

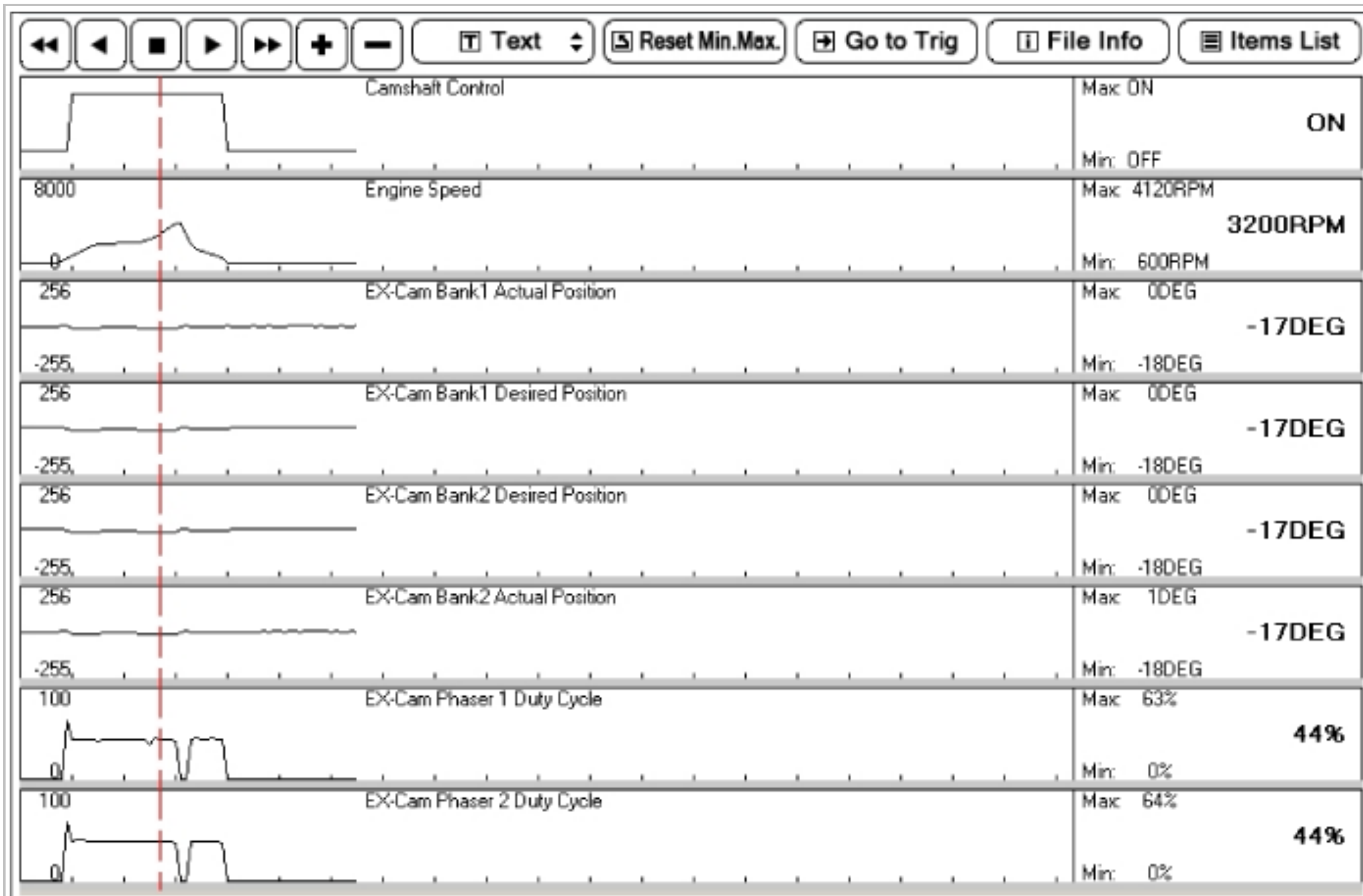
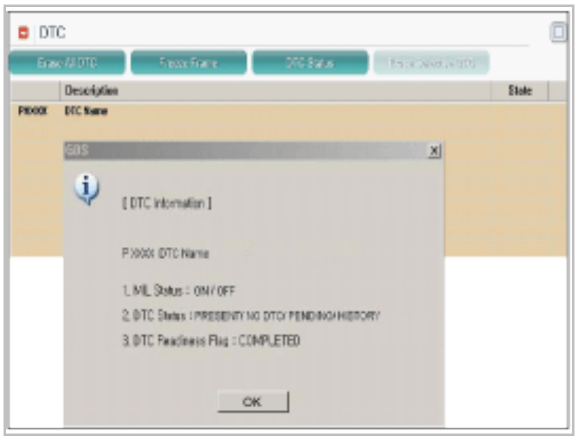


Fig.5

Fig.1) Normal waveform of OCV at idle.
Fig.2) Normal waveform of OCV at acceleration. (3500rpm)
Fig.3) Normal data of EX-CVVT at idle.
Fig.4) Normal data of EX-CVVT at acceleration.
Fig.5) Normal graph of EX-CVVT at acceleration.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "System Inspection" procedure.
NO	▶ Fault is intermittent caused by ECM memory was not cleared after repair. Erase DTC and drive the vehicle to satisfy the enable codition then, go to "System Inspection" procedure.

System Inspection

■ Visual Inspection

1. Check oil level and oil cleanness is O.K.
2. Check OCV is contaminated.
3. Check for oil leakage around OCV
4. Has a problem been found ?

YES	▶ Repair or replace as necessary and then, go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Component Inspection" procedure.

Component Inspection

■ Check OCV resistance

1. IG "OFF" and disconnect OCV connector.
2. Measure resistance between power and signal terminals of OCV. (Component Side)

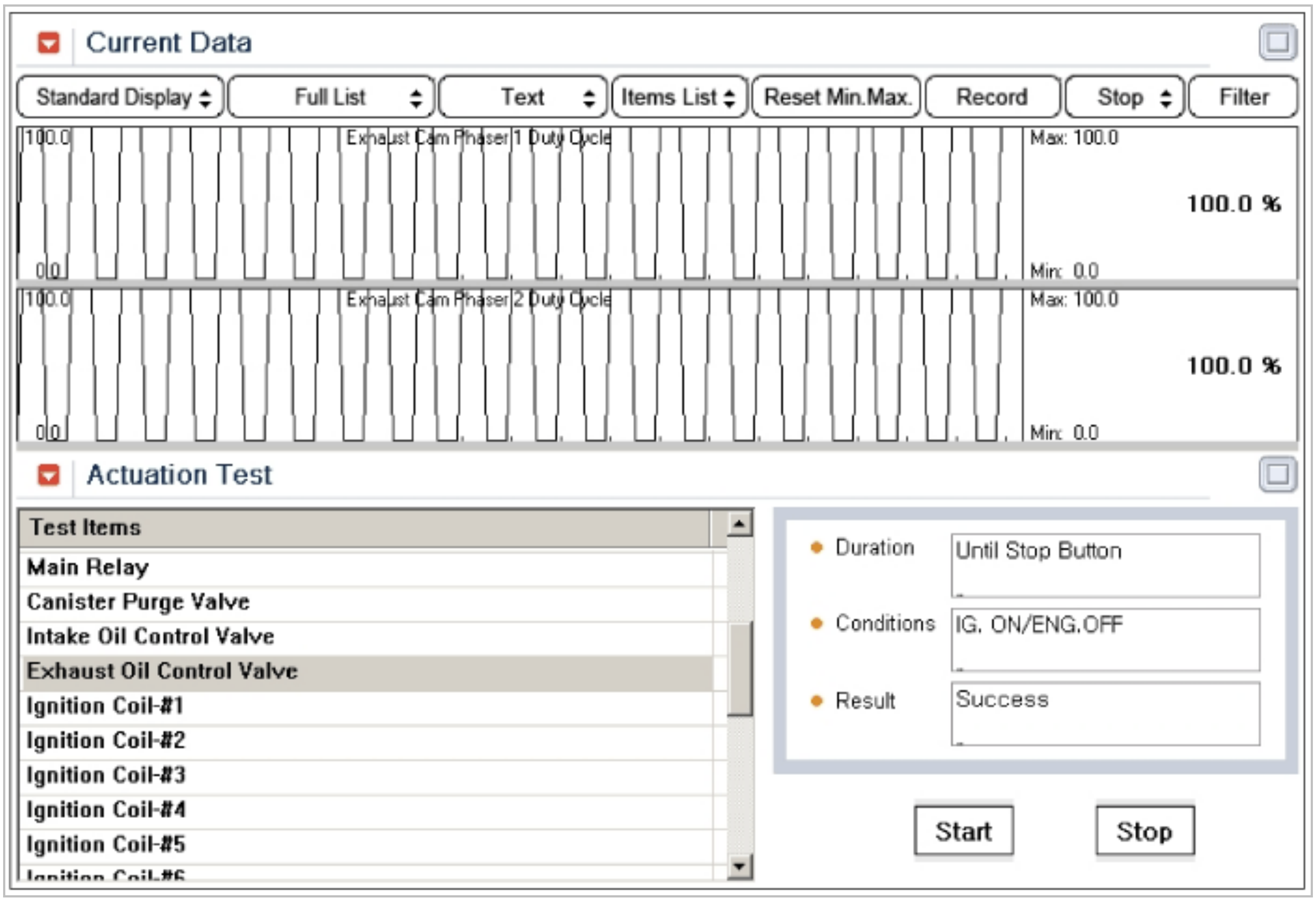
Specification : 6.7 ~ 7.7 at 20°C (68°F)

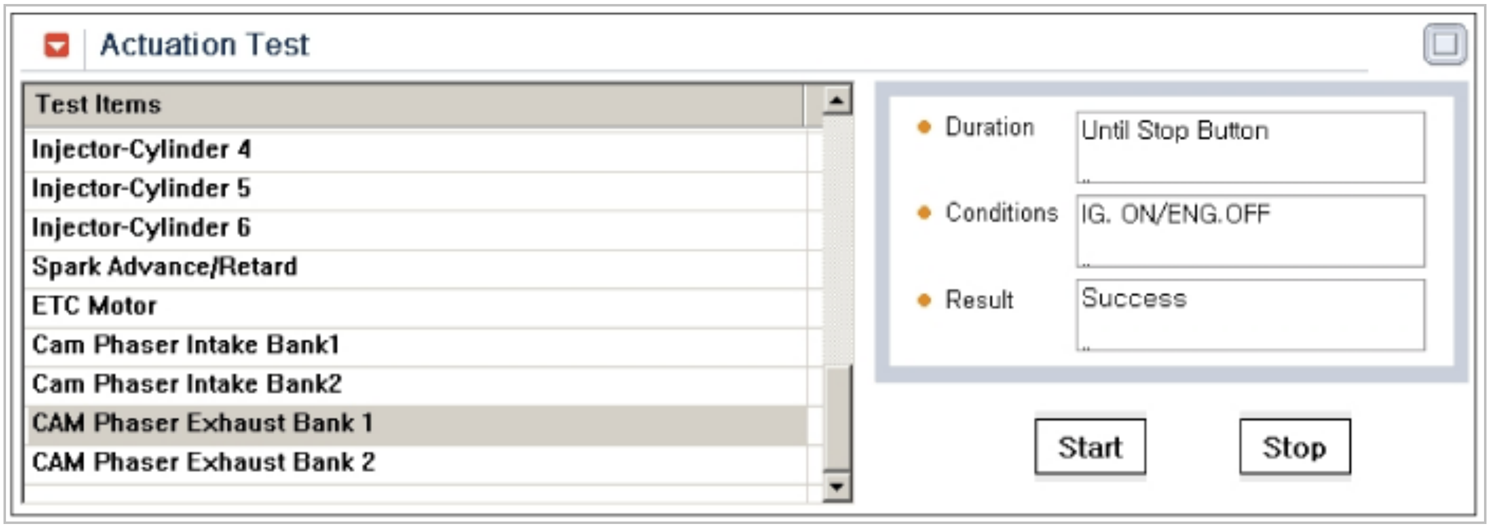
3. Is the measured resistance within specification?

YES	▶ Go to "Check CAM PHASER with actuation test" as follows.
NO	▶ Substitute with a known - good OCV and check for proper operation. If the problem is corrected, replace OCV and go to "Verification of Vehicle Repair" procedure.

■ Check CAM PHASER with actuation test

1. Connect GDS and IG "ON"
2. Select "Cam Phaser Intake Bank1" on the Actuation Test
3. Select "Exhaust Oil Control Valve" on the Actuation Test
4. Activates "Cam Phaser Intake Bank1" by pressing "START" button
5. Activates "Exhaust Oil Control Valve" by pressing "START" button
6. Repeat this procedure 4 or 5 times to ensure CAM PHASER and valve control solenoid reliability





7. Has a problem been found ?

YES	▶ Substitute with a known - good CVVT or OCV and check for proper operation. If the problem is corrected, replace CVVT or OCV and go to "Verification of Vehicle Repair" procedure.
NO	▶ Fault is intermittent. Drive the vehicle to meet the enable condition for the DTC. and Go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

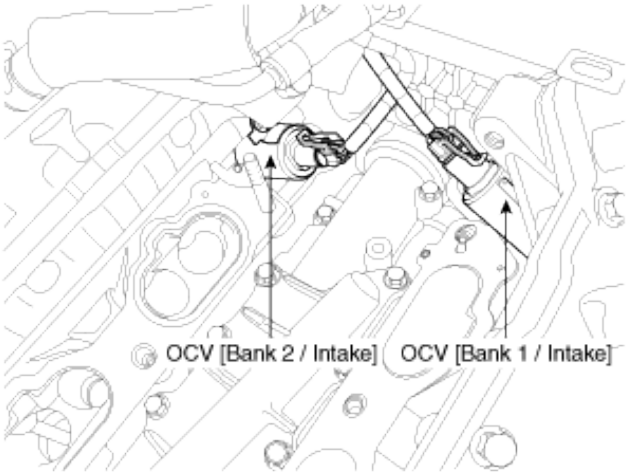
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0028 Intake Valve Control Solenoid Circuit Range/Performance (Bank 2)

Component Location



General Description

The CVVT (Continuously Variable Valve Timing) system is installed to the chain sprocket of the camshaft. This system controls the camshaft to provide the optimal valve timing for every driving condition. The ECM controls the Oil Control Valve(OCV), based on the signals output from mass air flow, throttle position and engine coolant temperature. The CVVT controller regulates the camshaft angle using oil pressure through the OCV. As result, the relative position between the camshaft and the crankshaft becomes optimal, and the engine torque improves, fuel economy improves, exhaust emissions decrease under over all driving conditions.

DTC Description

ECM monitors OCV stuck while cam sinal is normally generating and Valve cleaning is not in progress .
If the CAM Acutal Position is too high or low and Difference between Cam Actual Positionand Desire Position is higher than 20° ECM determines that a fault exists and a DTC is stored.

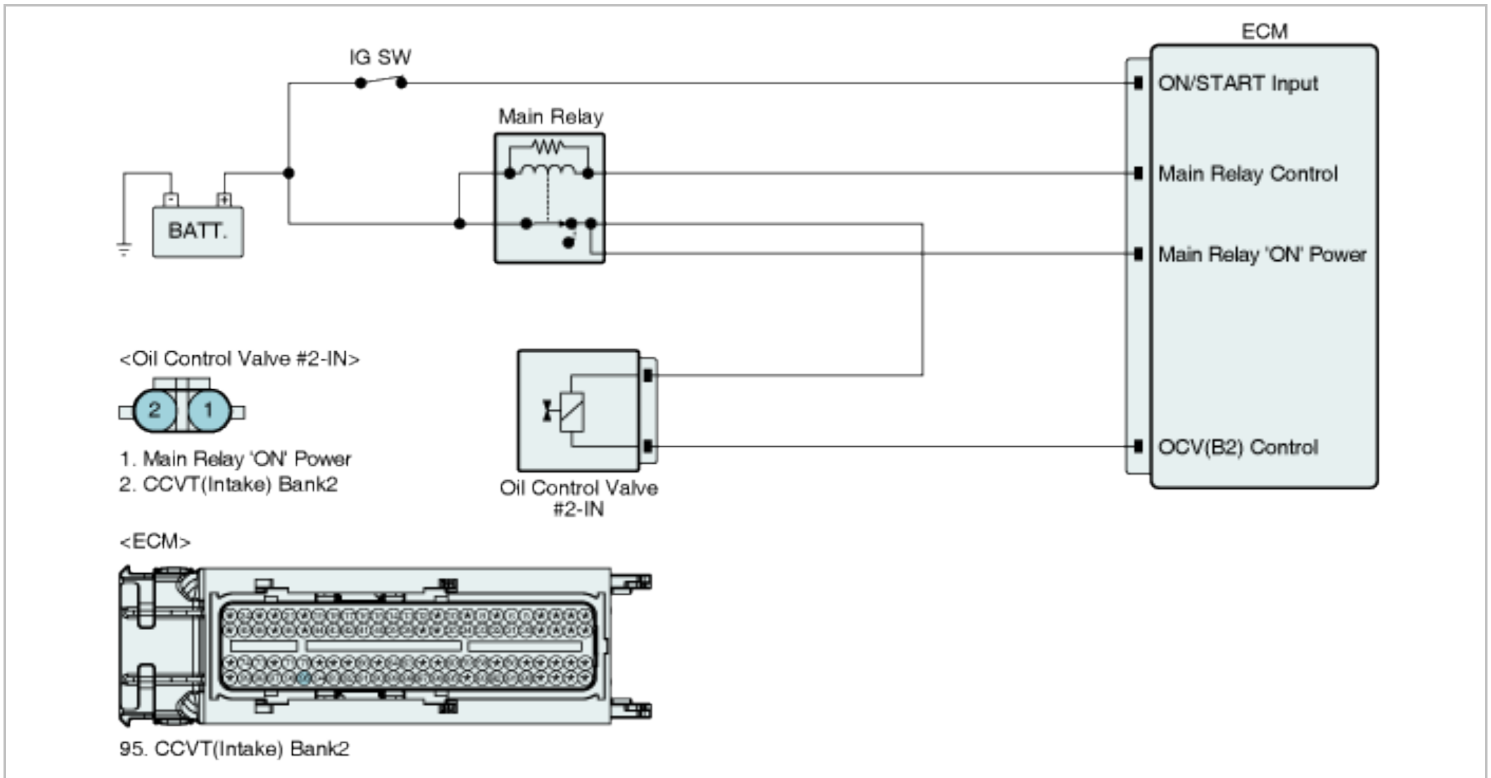
DTC Detecting Condition

<table>
<tr><th colspan="2">Item</th><th>Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td colspan="2">DTC Strategy</td><td>• Determines if oil control valve is stuck</td><td rowspan="6">• Oil Pressure Loss
• OCV seizure</td></tr>
<tr><td colspan="2">Enable Conditions</td><td>• Valve cleaning not in progress
• CAM signal is normally generating</td></tr>
<tr><td rowspan="2">Threshold value</td><td>Case 1</td><td>• Cam Actual Position > 50 CAD and Difference between CAM Actual Position and Desire Position > 20 CAD</td></tr>
<tr><td>Case 2</td><td>• Cam Actual Position < 5 CAD and Difference between CAM Actual Position and Desire Position > 20 CAD</td></tr>
<tr><td colspan="2">Diagnosis Time</td><td>• Continuous (Within 1min.)</td></tr>
<tr><td colspan="2">MIL On Condition</td><td>• 2 Driving Cycles</td></tr>
</table>

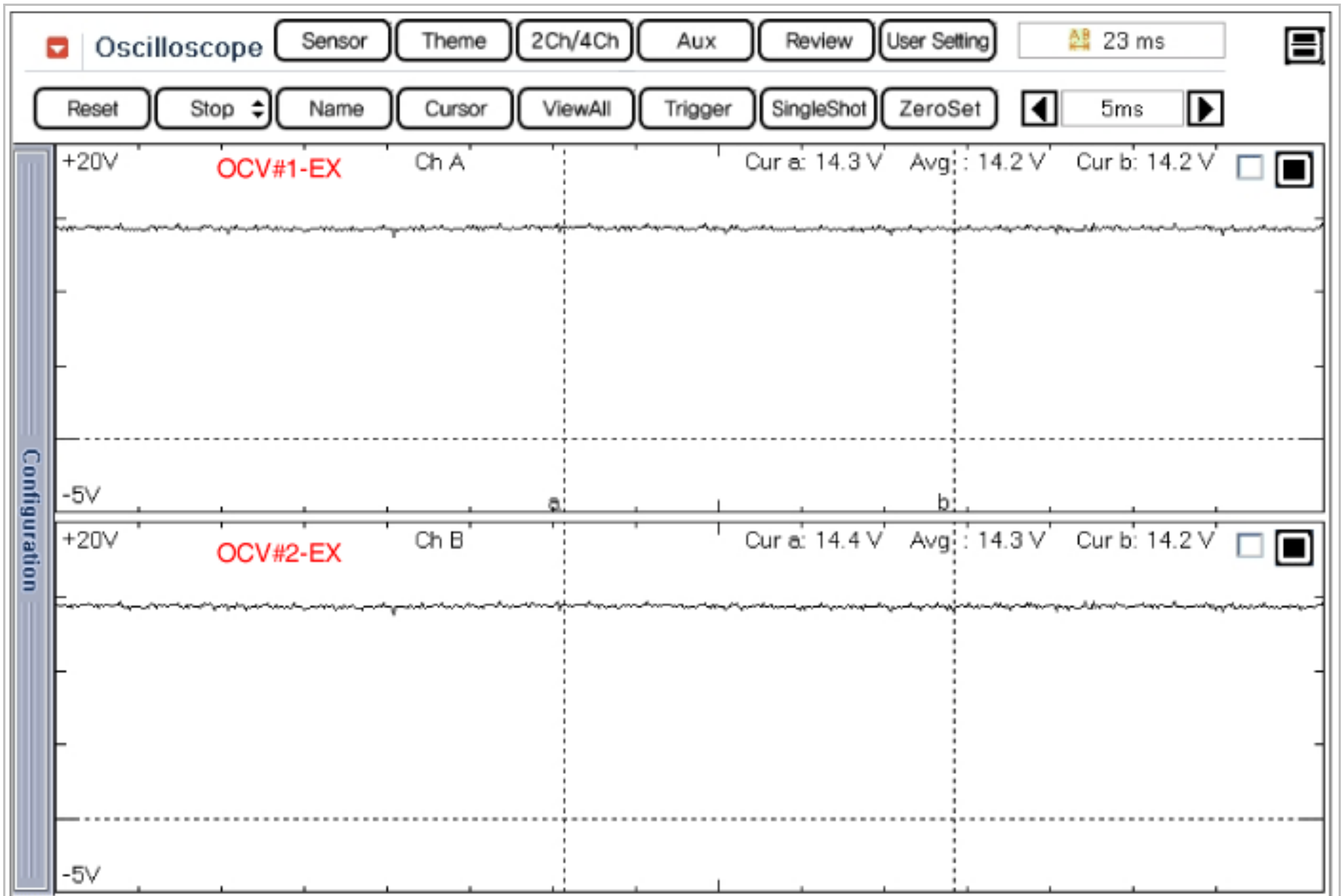
Specification

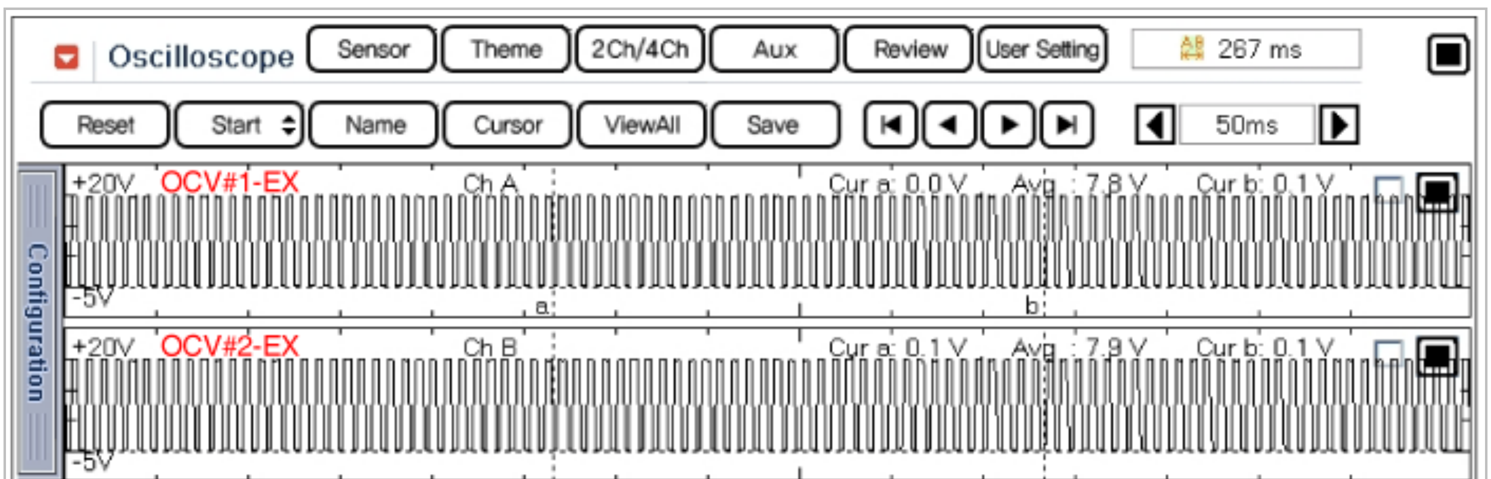
OCV	Specification
Coil Resistance (Ω)	6.7 ~ 7.7 at 20°C (68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data


Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
23 ms
Reset
Stop
Name
Cursor
ViewAll
Trigger
SingleShot
ZeroSet
5ms
Configuration
+20V
OCV#1-EX
Ch A
Cur a: 14.3 V
Avg : 14.2 V
Cur b: 14.2 V
-5V
a
b
+20V
OCV#2-EX
Ch B
Cur a: 14.4 V
Avg : 14.3 V
Cur b: 14.2 V
-5V
Fig.1


Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
267 ms
Reset
Start
Name
Cursor
ViewAll
Save
50ms
Configuration
+20V
OCV#1-EX
Ch A
Cur a: 0.0 V
Avg : 7.8 V
Cur b: 0.1 V
-5V
a
b
+20V
OCV#2-EX
Ch B
Cur a: 0.1 V
Avg : 7.9 V
Cur b: 0.1 V
-5V
Fig.2

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | VSS

Sensor Name	Value	Unit
Camshaft Desired Position-Bank1	0.0	DEG
Camshaft Actual Position-Bank1	0.3	DEG
Camshaft Desired Position-Bank2	0.0	DEG
Camshaft Actual Position-Bank2	-0.3	DEG
Engine Speed	600	RPM

Fig.3

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Run | VSS

Sensor Name	Value	Unit
Camshaft Desired Position-Bank1	18.8	DEG
Camshaft Actual Position-Bank1	28.4	DEG
Camshaft Desired Position-Bank2	18.8	DEG
Camshaft Actual Position-Bank2	26.1	DEG
Engine Speed	1040	RPM
Actual Torque	64.3	%

Fig.4

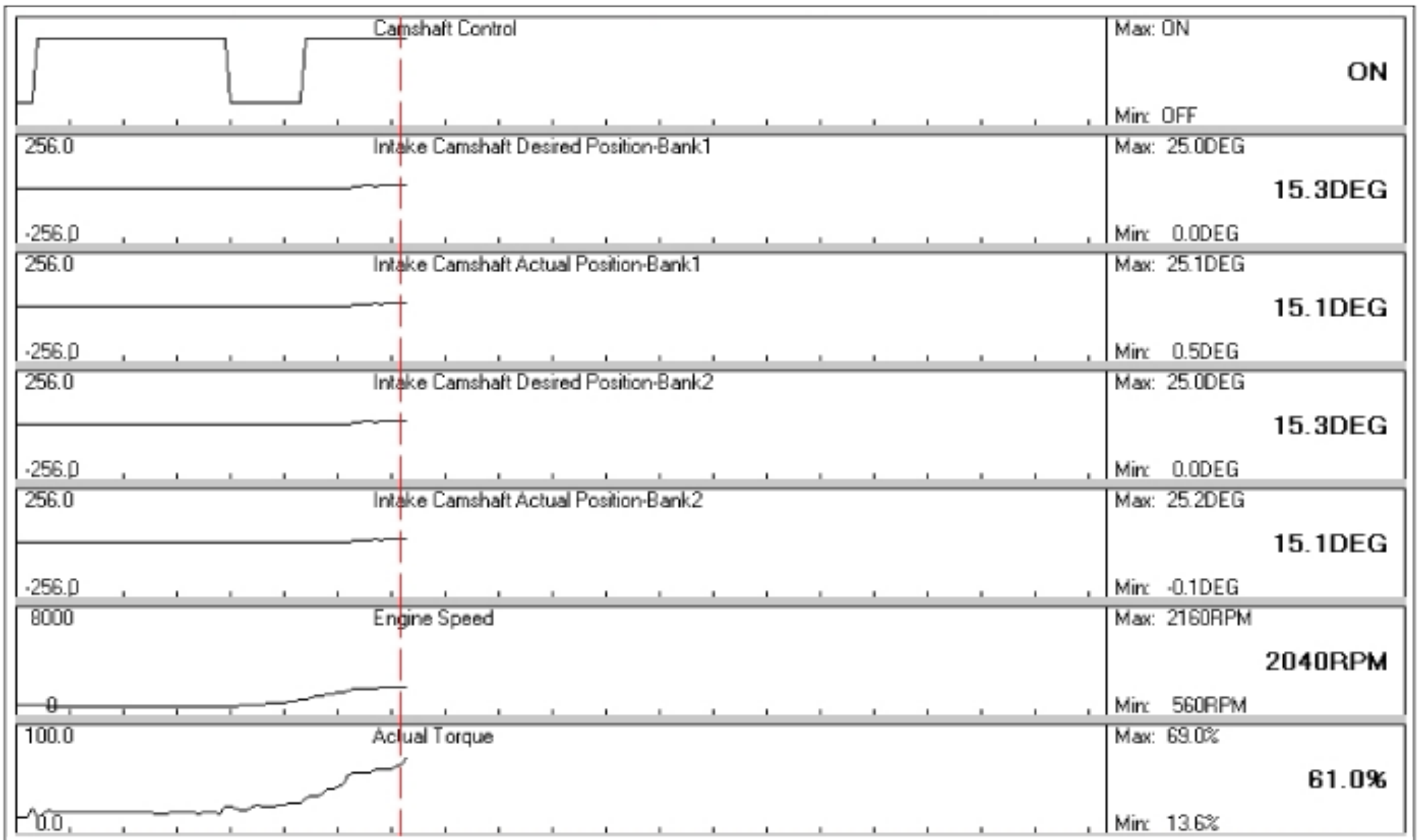


Fig.5

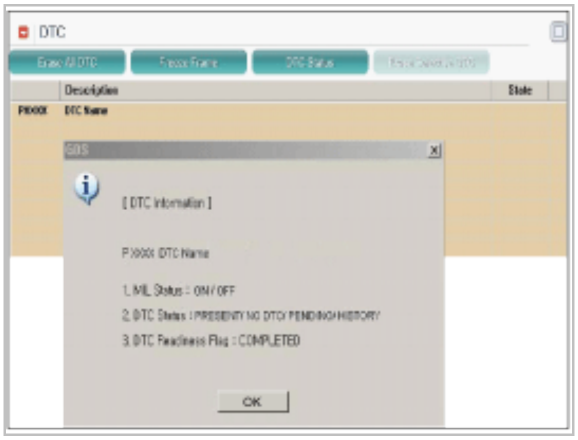
Fig 1) Normal waveform of OCV at idle.

Fig 2) Normal waveform of OCV at acceleration. (3500rpm)

Fig 3) Normal data of IN-CVVT at idle.
Fig 4) Normal data of IN-CVVT at acceleration with load.
Fig.5) Normal graph of IN-CVVT at acceleration with load.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "System Inspection" procedure.
NO	▶ Fault is intermittent caused by ECM memory was not cleared after repair. Erase DTC and drive the vehicle to satisfy the enable codition then, go to " System Inspection" procedure.

System Inspection

■ Visual Inspection

1. Check oil level and oil cleanness is O.K.
2. Check OCV is contaminated.
3. Check for oil leakage around OCV
4. Has a problem been found ?

YES	▶ Repair or replace as necessary and then, go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Component Inspection" procedure.

Component Inspection

■ Check OCV resistance

1. IG "OFF" and disconnect OCV connector.
2. Measure resistance between power and signal terminals of OCV. (Component Side)

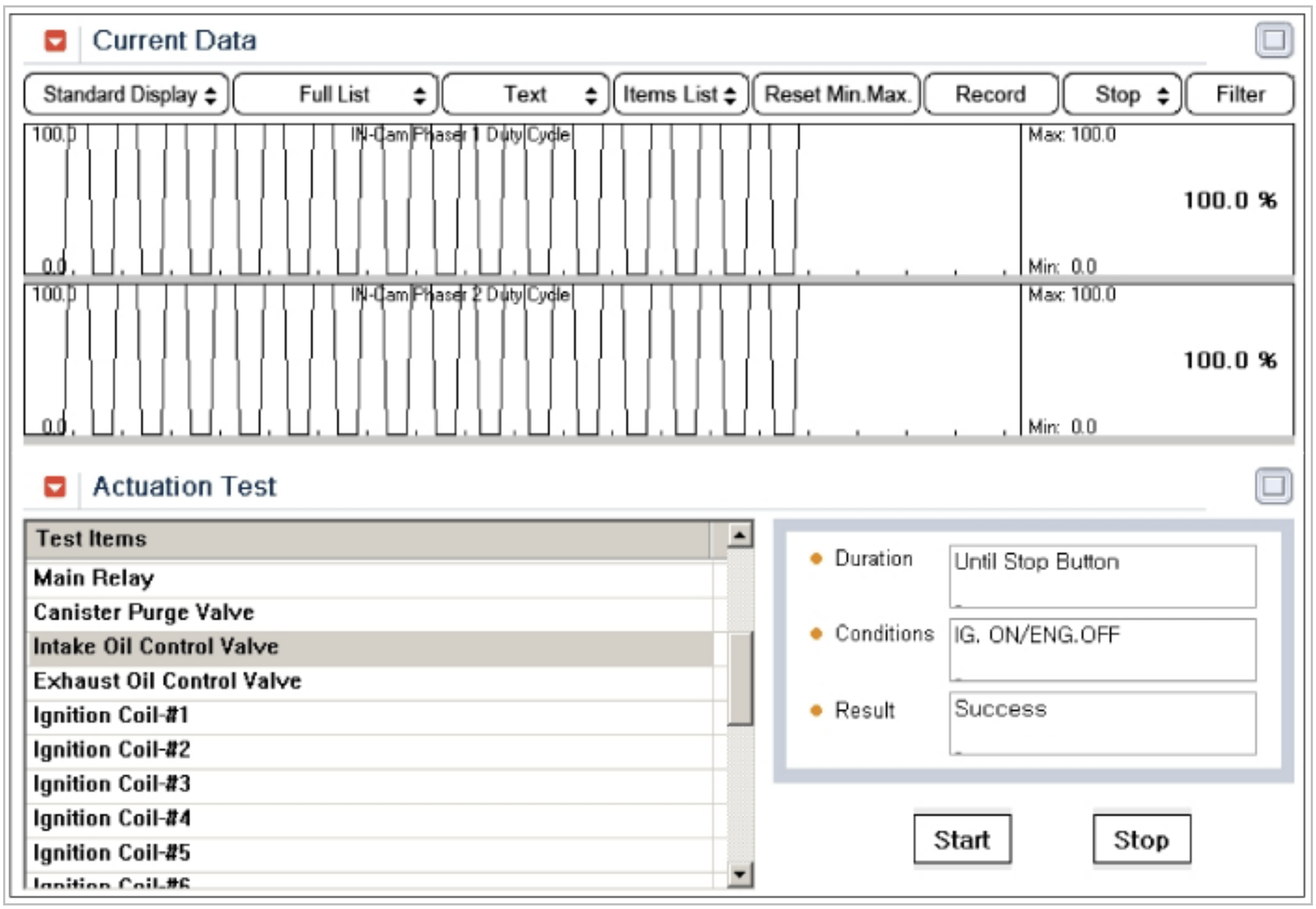
Specification : 6.7 ~ 7.7 at 20°C (68°F)

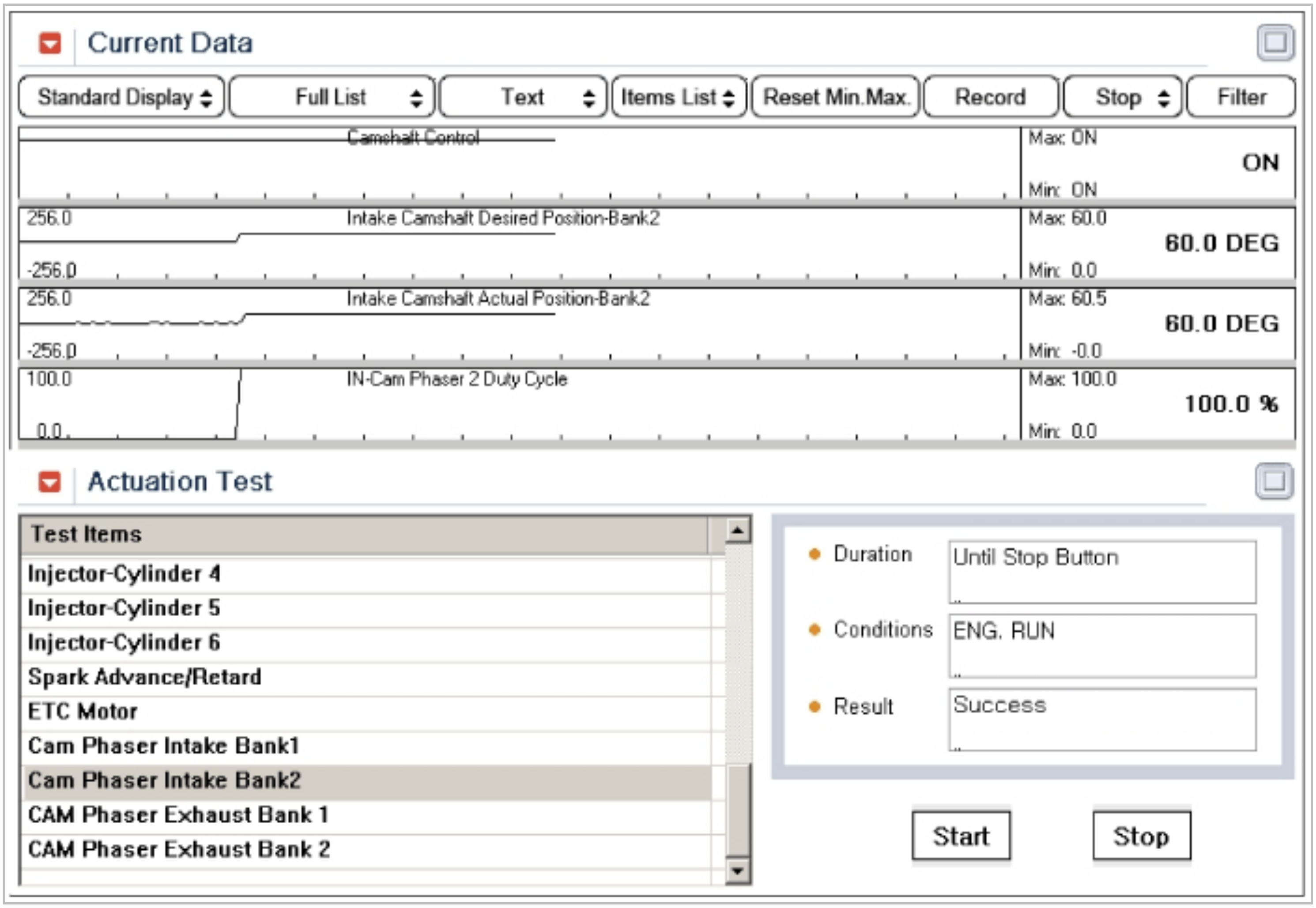
3. Is the measured resistance within specification?

YES	▶ Go to "Check CAM PHASER with actuation test" as follows.
NO	▶ Substitute with a known - good OCV and check for proper operation. If the problem is corrected, replace OCV and go to "Verification of Vehicle Repair" procedure.

■ **Check CAM PHASER with actuation test**

1. Connect GDS and IG "ON"
2. Select "Cam Phaser Intake Bank2" on the Actuation Test
3. Select "Intake Oil Control Valve" on the Actuation Test
4. Activates "Cam Phaser Intake Bank2" by pressing "START" button
5. Activates "Intake Oil Control Valve" by pressing "START" button
6. Repeat this procedure 4 or 5 times to ensure CAM PHASER and valve control solenoid reliability





7. Has a problem been found ?

YES	▶ Substitute with a known - good CVVT or OCV and check for proper operation. If the problem is corrected, replace CVVT or OCV and go to "Verification of Vehicle Repair" procedure.
NO	▶ Fault is intermittent. Drive the vehicle to meet the enable condition for the DTC. and Go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

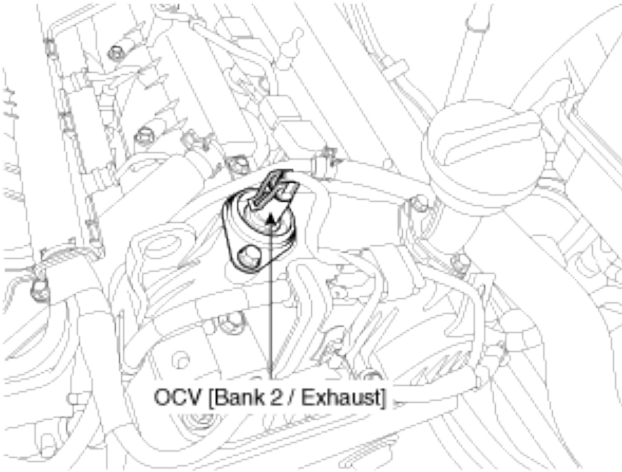
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0029 Exhaust Valve Control Solenoid Circuit

Range/Performance (Bank 2)

Component Location



General Description

The CVVT (Continuously Variable Valve Timing) system is installed to the chain sprocket of the camshaft. This system controls the camshaft to provide the optimal valve timing for every driving condition. The ECM controls the Oil Control Valve(OCV), based on the signals output from mass air flow, throttle position and engine coolant temperature. The CVVT controller regulates the camshaft angle using oil pressure through the OCV. As result, the relative position between the camshaft and the crankshaft becomes optimal, and the engine torque improves, fuel economy improves, exhaust emissions decrease under over all driving conditions.

DTC Description

ECM monitors OCV stuck while cam sinal is normally generating and Valve cleaning is not in progress .
If the CAM Acutal Position is too high or low and Difference between Cam Actual Positionand Desire Position is higher than 20° ECM determines that a fault exists and a DTC is stored.

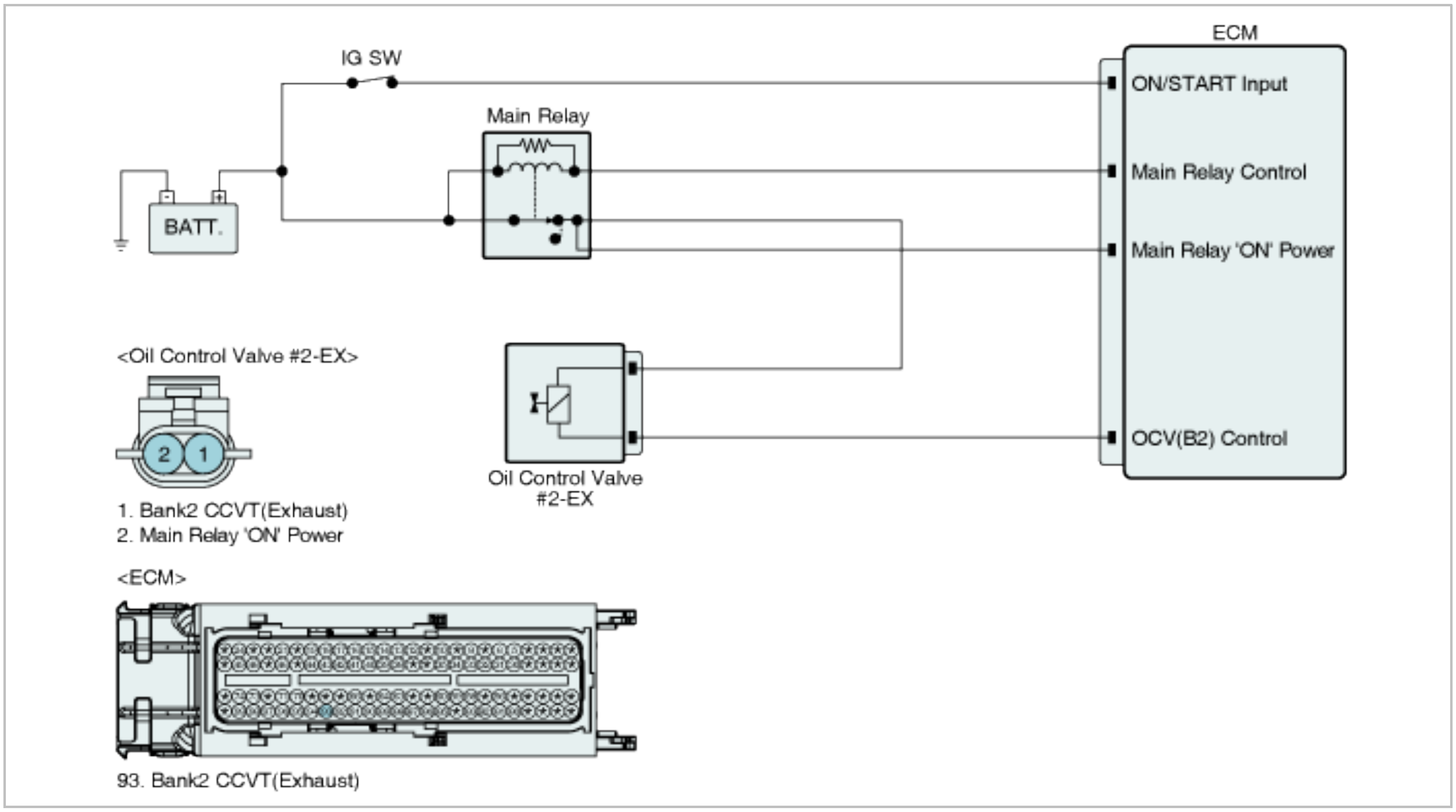
DTC Detecting Condition

Item		Detecting Condition	Possible Cause
DTC Strategy		• Determines if oil control valve is stuck	• Oil Pressure Loss • OCV seizure
Enable Conditions		• Valve cleaning not in progress • CAM signal is normally generating	
Threshold value	Case 1	• Cam Actual Position > 50 CAD and Difference between CAM Actual Position and Desire Position > 20 CAD	
	Case 2	• Cam Actual Position < 5 CAD and Difference between CAM Actual Position and Desire Position > 20 CAD	
Diagnosis Time		• Continuous (Within 1min.)	
MIL On Condition		• 2 Driving Cycles	

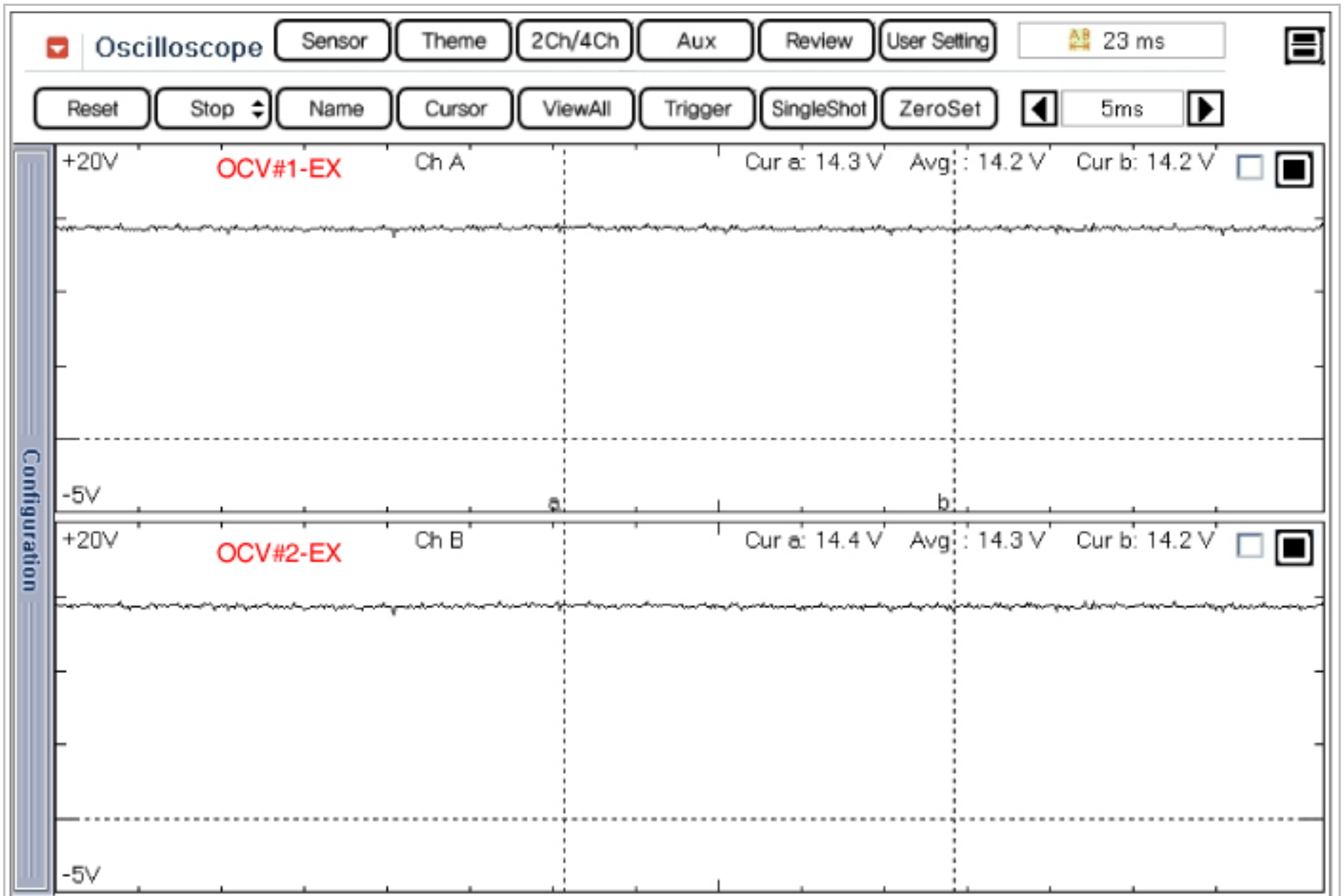
Specification

OCV	Specification
Coil Resistance (Ω)	6.7 ~ 7.7 at 20°C (68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data


Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
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23 ms
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Configuration
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OCV#1-EX
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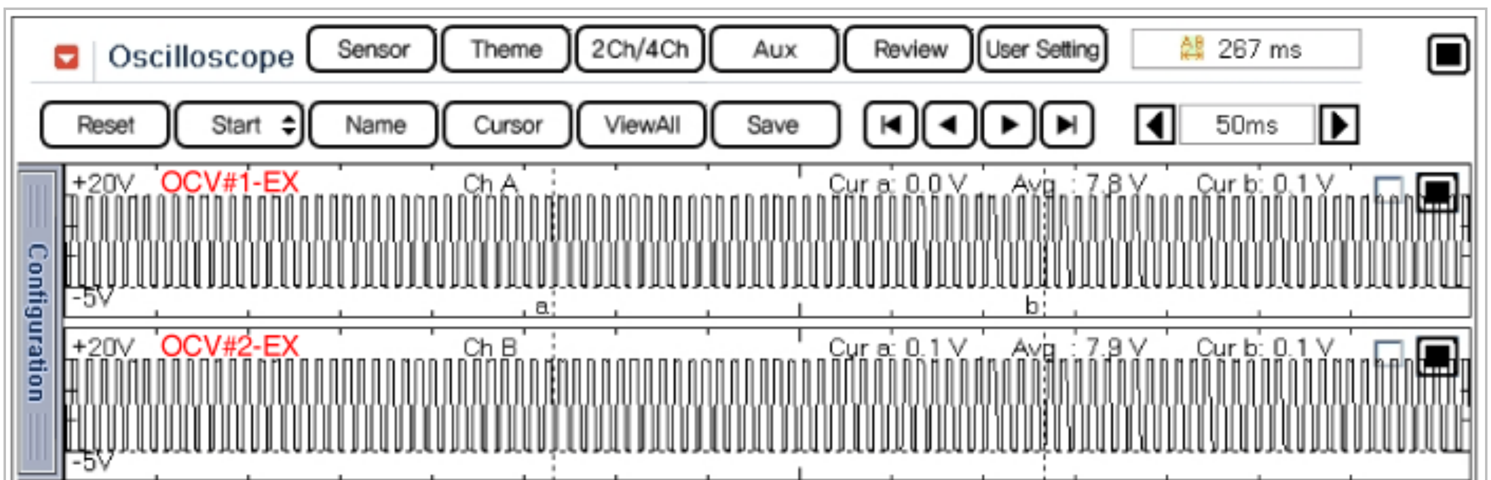
Cur a: 14.3 V
Avg : 14.2 V
Cur b: 14.2 V
-5V
a
b
+20V
OCV#2-EX
Ch B
Cur a: 14.4 V
Avg : 14.3 V
Cur b: 14.2 V
-5V

Fig.1


Oscilloscope
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Theme
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267 ms
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Configuration
+20V
OCV#1-EX
Ch A
Cur a: 0.0 V
Avg : 7.8 V
Cur b: 0.1 V
-5V
a
b
+20V
OCV#2-EX
Ch B
Cur a: 0.1 V
Avg : 7.9 V
Cur b: 0.1 V
-5V

Fig.2

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | VSS

Sensor Name	Value	Unit
☐ EX-Cam Bank1 Desired Position	0	DEG
☐ EX-Cam Bank1 Actual Position	0	DEG
☐ EX-Cam Bank2 Desired Position	0	DEG
☐ EX-Cam Bank2 Actual Position	0	DEG
☐ EX-Cam Phaser 1 Duty Cycle	0	%
☐ EX-Cam Phaser 2 Duty Cycle	0	%

Fig.3

Sensor Name	Value	Unit
☑ Camshaft Control	ON	-
☑ Engine Speed	3840	RPM
☑ EX-Cam Bank1 Actual Position	-15	DEG
☑ EX-Cam Bank1 Desired Position	-14	DEG
☑ EX-Cam Bank2 Desired Position	-14	DEG
☑ EX-Cam Bank2 Actual Position	-15	DEG
☑ EX-Cam Phaser 1 Duty Cycle	43	%
☑ EX-Cam Phaser 2 Duty Cycle	44	%

Fig.4

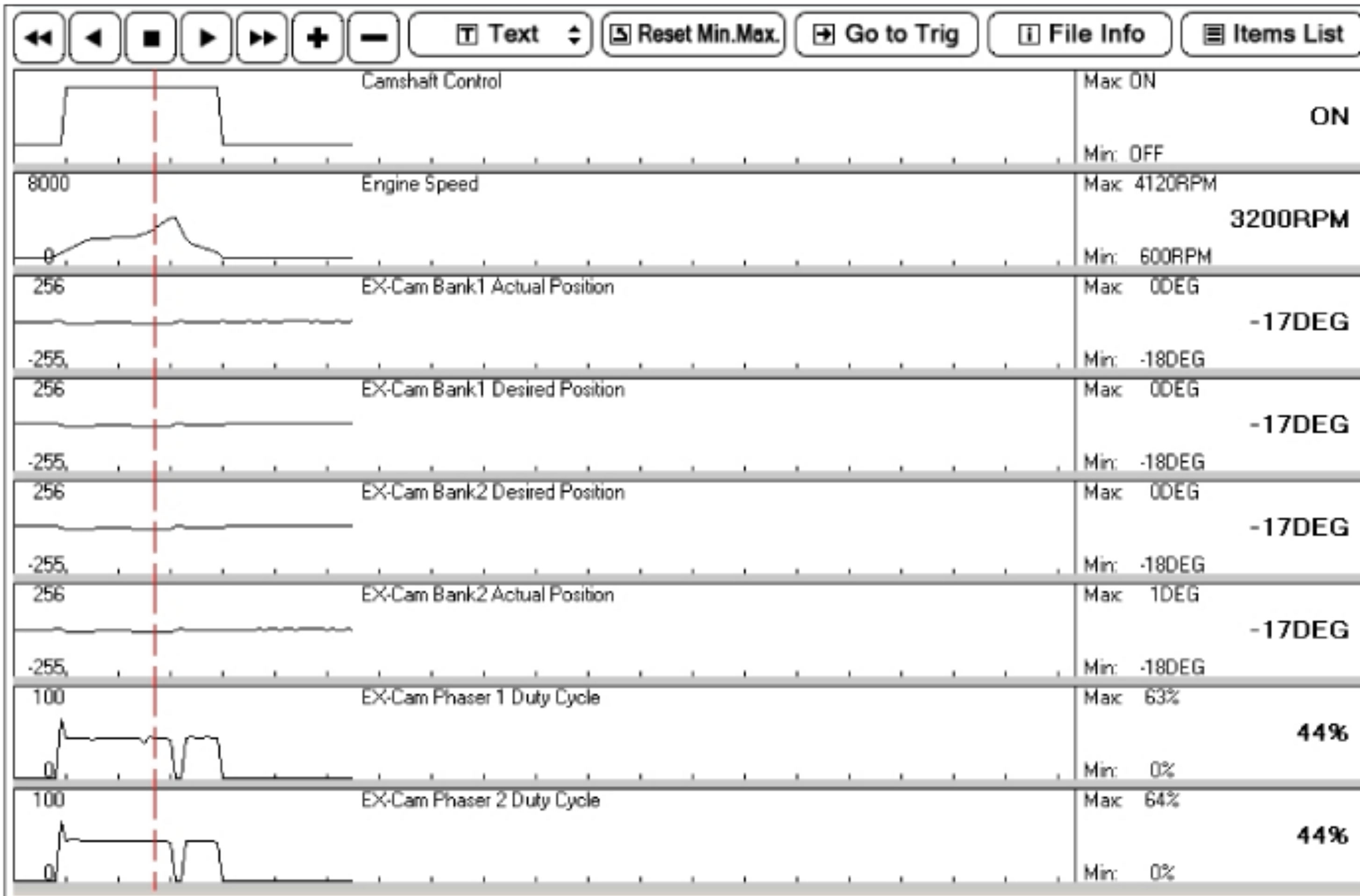
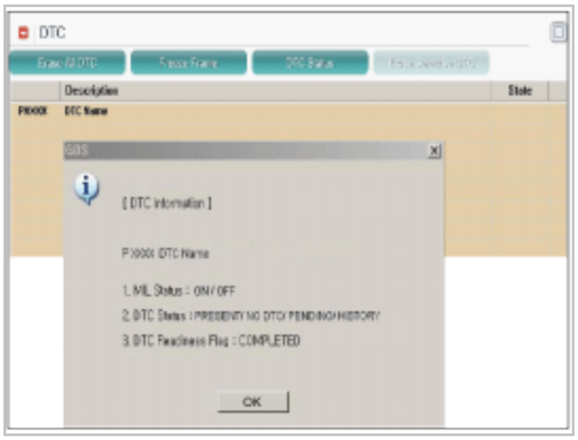


Fig.5

Fig.1) Normal waveform of OCV at idle.
Fig.2) Normal waveform of OCV at acceleration. (3500rpm)
Fig.3) Normal data of IN-CVVT at idle.
Fig.4) Normal data of EX-CVVT at acceleration.
Fig.5) Normal graph of EX-CVVT at acceleration.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "System Inspection" procedure.
NO	▶ Fault is intermittent caused by ECM memory was not cleared after repair. Erase DTC and drive the vehicle to satisfy the enable codition then, go to " System Inspection" procedure.

System Inspection

■ Visual Inspection

1. Check oil level and oil cleanness is O.K.
2. Check OCV is contaminated.
3. Check for oil leakage around OCV
4. Has a problem been found ?

YES	▶ Repair or replace as necessary and then, go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Component Inspection" procedure.

Component Inspection

■ Check OCV resistance

1. IG "OFF" and disconnect OCV connector.
2. Measure resistance between power and signal terminals of OCV. (Component Side)

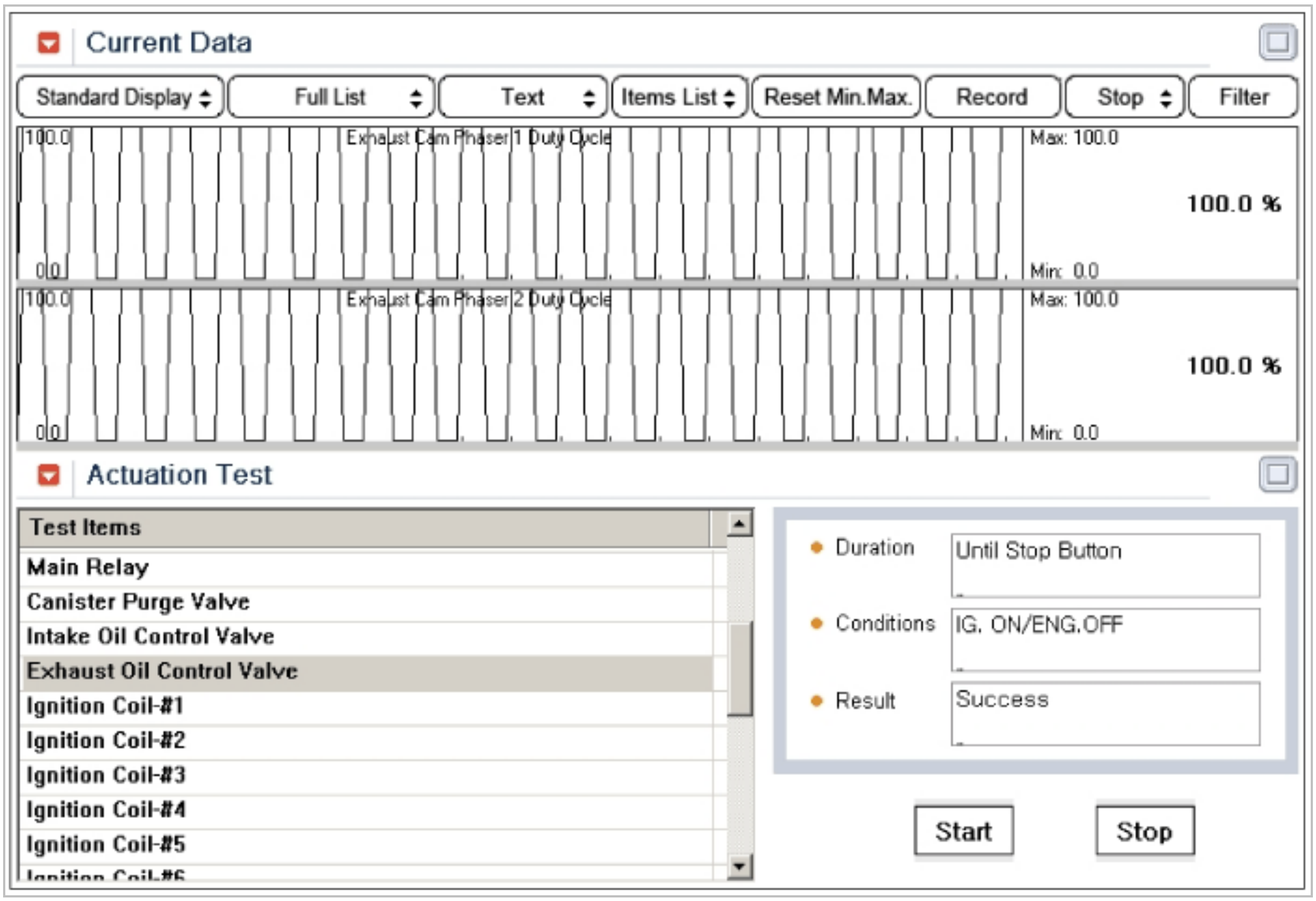
Specification : 6.7 ~ 7.7 at 20°C (68°F)

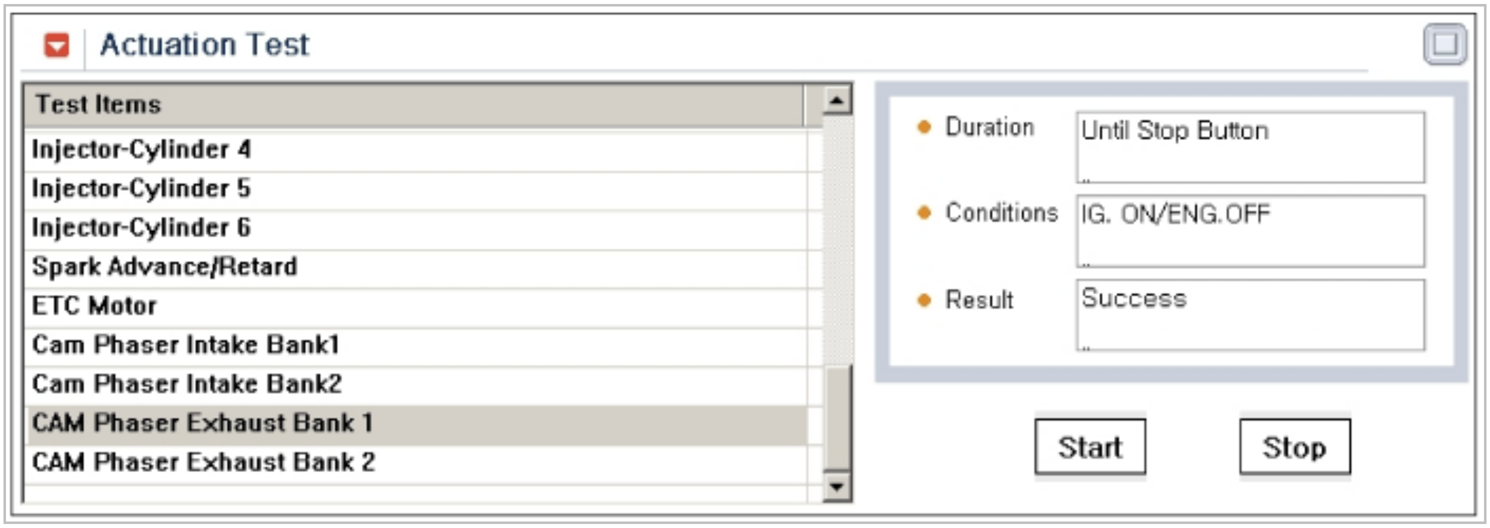
3. Is the measured resistance within specification?

YES	▶ Go to "Check CAM PHASER with actuation test" as follows.
NO	▶ Substitute with a known - good OCV and check for proper operation. If the problem is corrected, replace OCV and go to "Verification of Vehicle Repair" procedure.

■ **Check CAM PHASER with actuation test**

1. Connect GDS and IG "ON"
2. Select "Cam Phaser Intake Bank2" on the Actuation Test
3. Select "Exhaust Oil Control Valve" on the Actuation Test
4. Activates "Cam Phaser Intake Bank2" by pressing "START" button
5. Activates "Exhaust Oil Control Valve" by pressing "START" button
6. Repeat this procedure 4 or 5 times to ensure CAM PHASER and valve control solenoid reliability





7. Has a problem been found ?

YES	▶ Substitute with a known - good CVVT or OCV and check for proper operation. If the problem is corrected, replace CVVT or OCV and go to "Verification of Vehicle Repair" procedure.
NO	▶ Fault is intermittent. Drive the vehicle to meet the enable condition for the DTC. and Go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

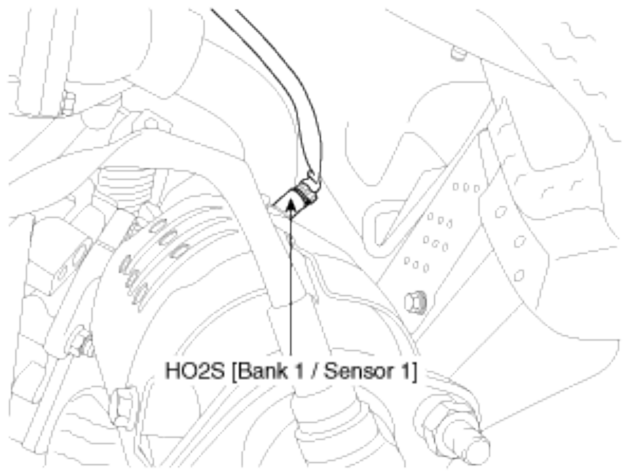
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0030 HO2S Heater Control Circuit (Bank 1 / Sensor 1)

Component Location



General Description

The normal operating temperature of the HO2S(Heated Oxygen Sensor) ranges from 350 to 850°C(662 to 1562°F). The HO2S heater greatly decreases the amount of time required for fuel control to become active. The ECM provides a pulse width modulated control circuit to adjust current through the heater. When the HO2S is cold, the value of the resistance is low and the current in the circuit is high. On the contrary, if the temperature in the resistor of the sensor rises, the current drops gradually.

DTC Description

Checking current from HO2S under detecting condition,if the heater current is below a certain threshold for more than predeterminate time, ECM sets P0030. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

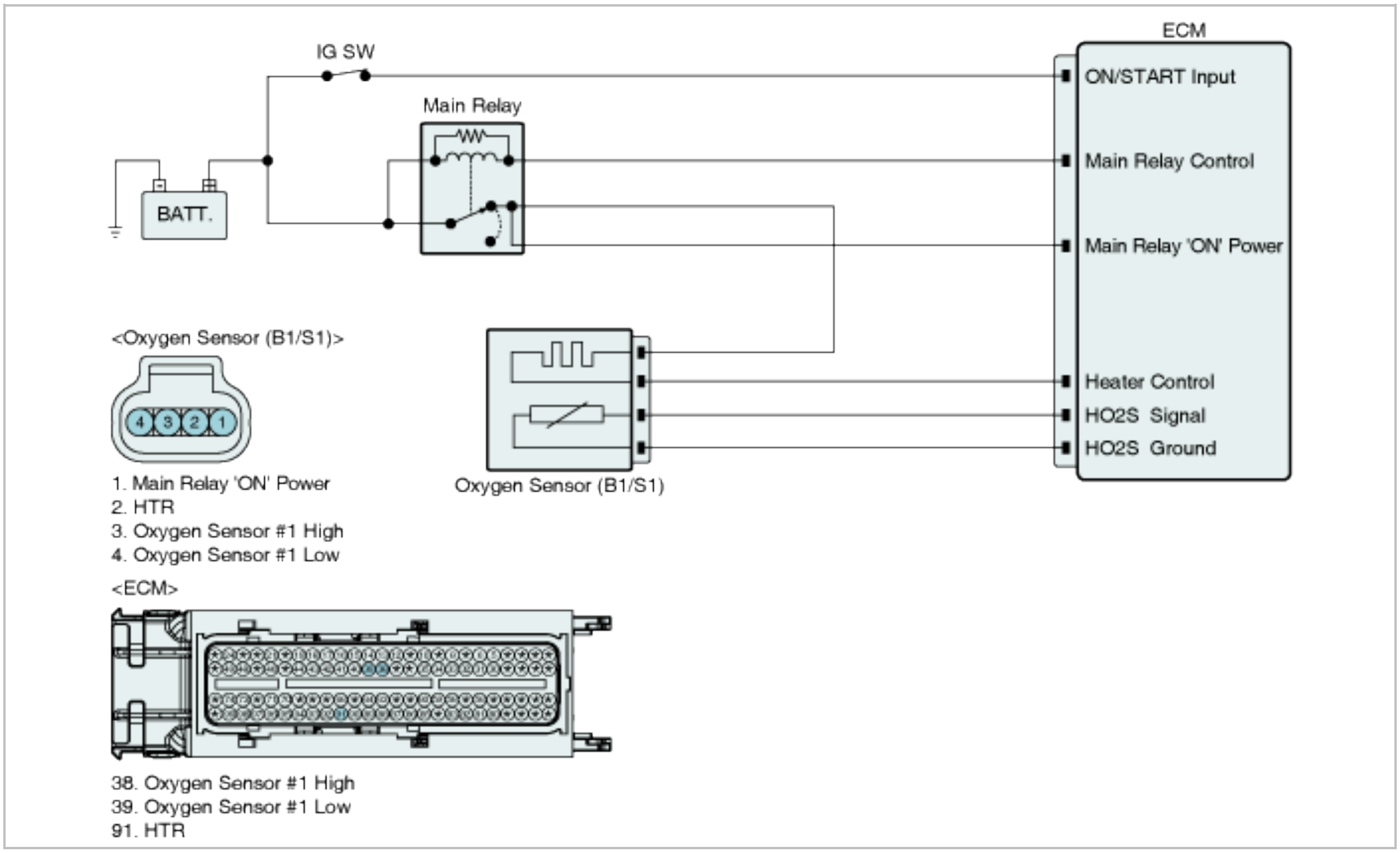
Item	Detecting Condition	Possible Cause
DTC Strategy	• Monitor the current through the heater	• Poor Connection • HO2S(B1/S1) • ECM
Enable Conditions	• Engine Running > 60 sec • Heater Duty Cycle > 40% • Max. Duty Cycle - Min. Duty Cycle < 5%	
Threshold value	• Filtered Heater Current < threshold value	
Diagnosis Time	• Continuous (More than 2.5 second failure for every 5 second test)	
MIL On Condition	• 2 Driving Cycles	

Specification

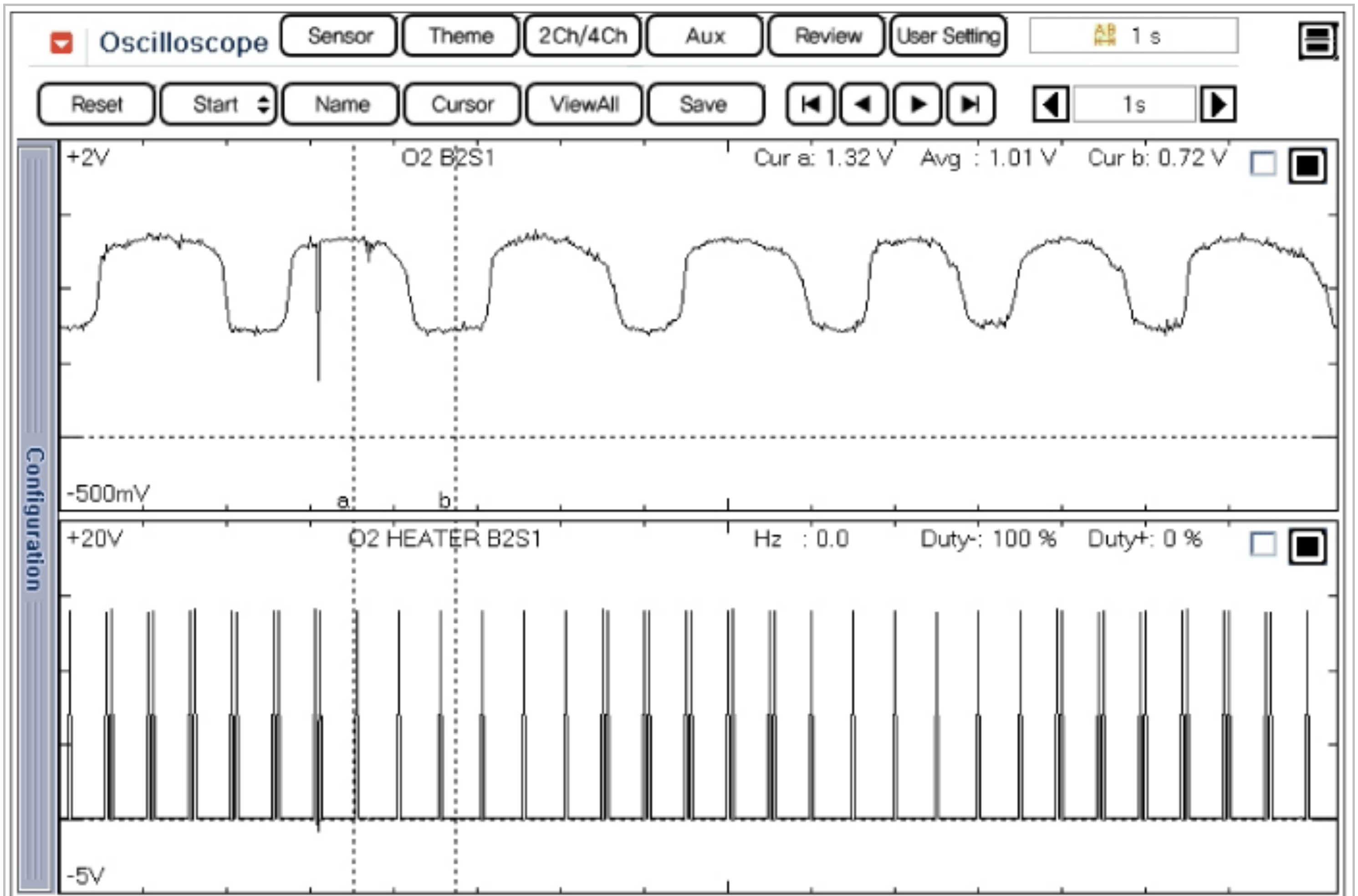
(Reference only)

Condition	Current(A)
Heater Current at 13.5V, 450°C(842°F) Exhaust	0.52 ± 0.1

Diagnostic Circuit Diagram



Signal Waveform & Data


Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
1 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 1.32 V
Avg : 1.01 V
Cur b: 0.72 V
-500mV
a
b
+20V
O2 HEATER B2S1
Hz : 0.0
Duty-: 100 %
Duty+: 0 %
-5V
Fig.1

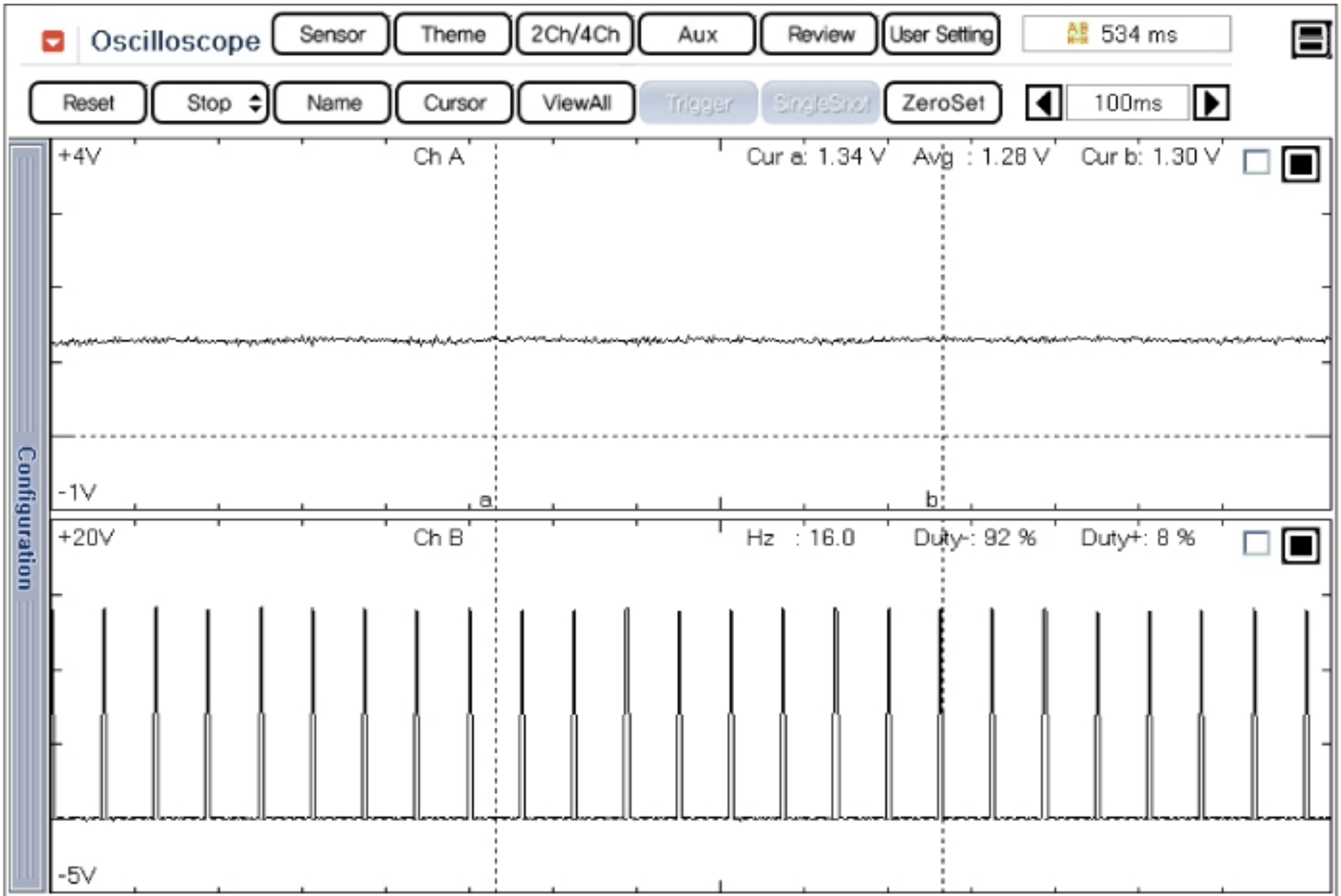
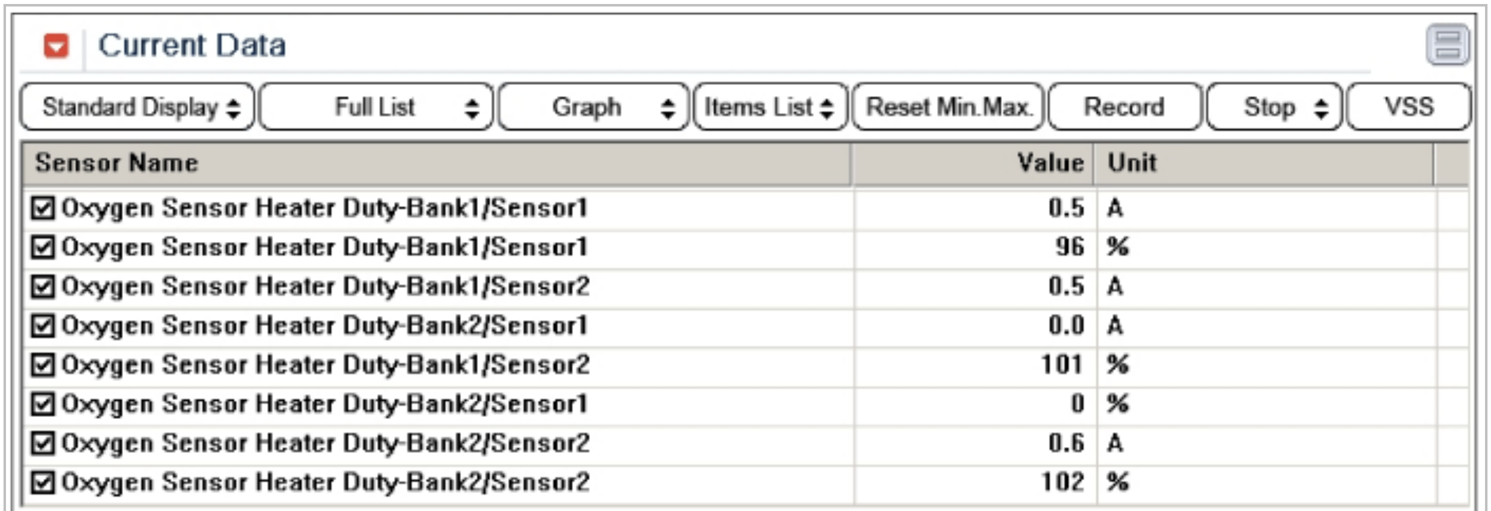


Fig.2

Sensor Name	Value	Unit
☑ Oxygen Sensor Heater Duty-Bank1/Sensor1	0.5	A
☑ Oxygen Sensor Heater Duty-Bank1/Sensor1	97	%
☑ Oxygen Sensor Heater Duty-Bank1/Sensor2	0.5	A
☑ Oxygen Sensor Heater Duty-Bank2/Sensor1	0.5	A
☑ Oxygen Sensor Heater Duty-Bank1/Sensor2	100	%
☑ Oxygen Sensor Heater Duty-Bank2/Sensor1	97	%
☑ Oxygen Sensor Heater Duty-Bank2/Sensor2	0.6	A
☑ Oxygen Sensor Heater Duty-Bank2/Sensor2	100	%

Fig.3



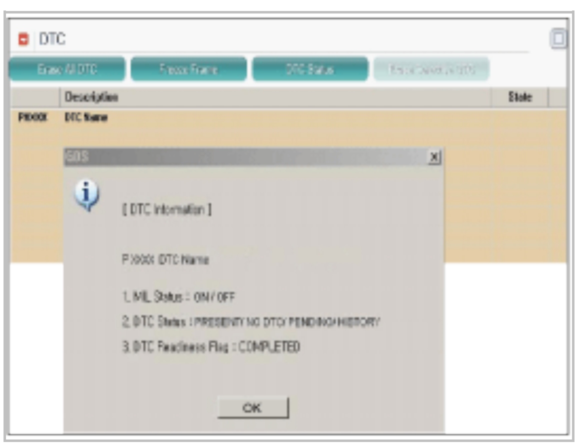
Sensor Name	Value	Unit
Oxygen Sensor Heater Duty-Bank1/Sensor1	0.5	A
Oxygen Sensor Heater Duty-Bank1/Sensor1	96	%
Oxygen Sensor Heater Duty-Bank1/Sensor2	0.5	A
Oxygen Sensor Heater Duty-Bank2/Sensor1	0.0	A
Oxygen Sensor Heater Duty-Bank1/Sensor2	101	%
Oxygen Sensor Heater Duty-Bank2/Sensor1	0	%
Oxygen Sensor Heater Duty-Bank2/Sensor2	0.6	A
Oxygen Sensor Heater Duty-Bank2/Sensor2	102	%

Fig.4

Fig.1) The signal waveforms of front HO2S(the upper) and heater(the lower) at idle
Fig.2) The signal waveforms of rear HO2S(the upper) and heater(the lower) at idle
Fig.3) The Normal data of HO2S heaters at idle
Fig.4) he data of HO2S heaters at open condition in HO2S(B2S1) circuit
The output voltage of front HO2S is changed continuously accroding to air/fuel ratio, ECM controls fuel amount based on this value. Preheating is necessary for HO2S normal operation. Therefore heater unit is installed in HO2S, ECM can control air/fuel ratio with the output signal of HO2S simultaneous with engine run by reducing preheating time. ECM controls heater with duty cycle. HO2S' power source is main relay and ECM operates heater by ground control.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to " Component Inspection " procedure.

Component Inspection

■ Check HO2S(B1/S1) Heater resistance

1. IG "OFF" and disconnect HO2S(B1/S1) connector
2. Measure resistance between power and control terminals of HO2S(B1/S1) heater(Component Side)

Specification : 8.1 ~ 11.1 Ω at 21°C(69.8°F)

3. Is the measured resistance within specification?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

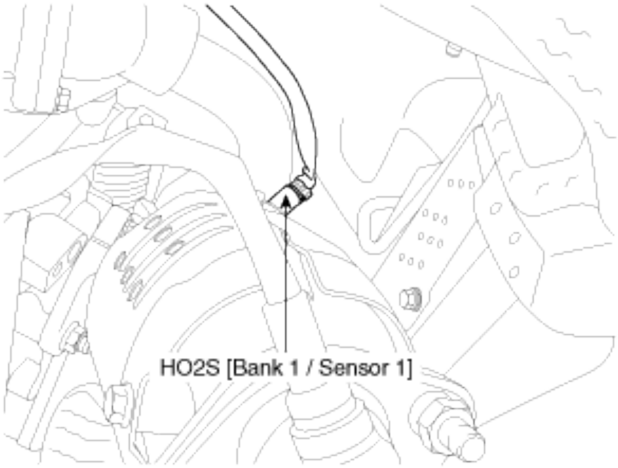
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0031 HO2S Heater Control Circuit Low (Bank 1 /

Sensor 1)

Component Location



General Description

The normal operating temperature of the HO2S(Heated Oxygen Sensor) ranges from 350 to 850°C(662 to 1562°F). The HO2S heater greatly decreases the amount of time required for fuel control to become active. The ECM provides a pulse width modulated control circuit to adjust current through the heater. When the HO2S is cold, the value of the resistance is low and the current in the circuit is high. On the contrary, if the temperature in the resistor of the sensor rises, the current drops gradually.

DTC Description

If the ECM detects short to ground or open in heater under detecting conditions, ECM sets P0031. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

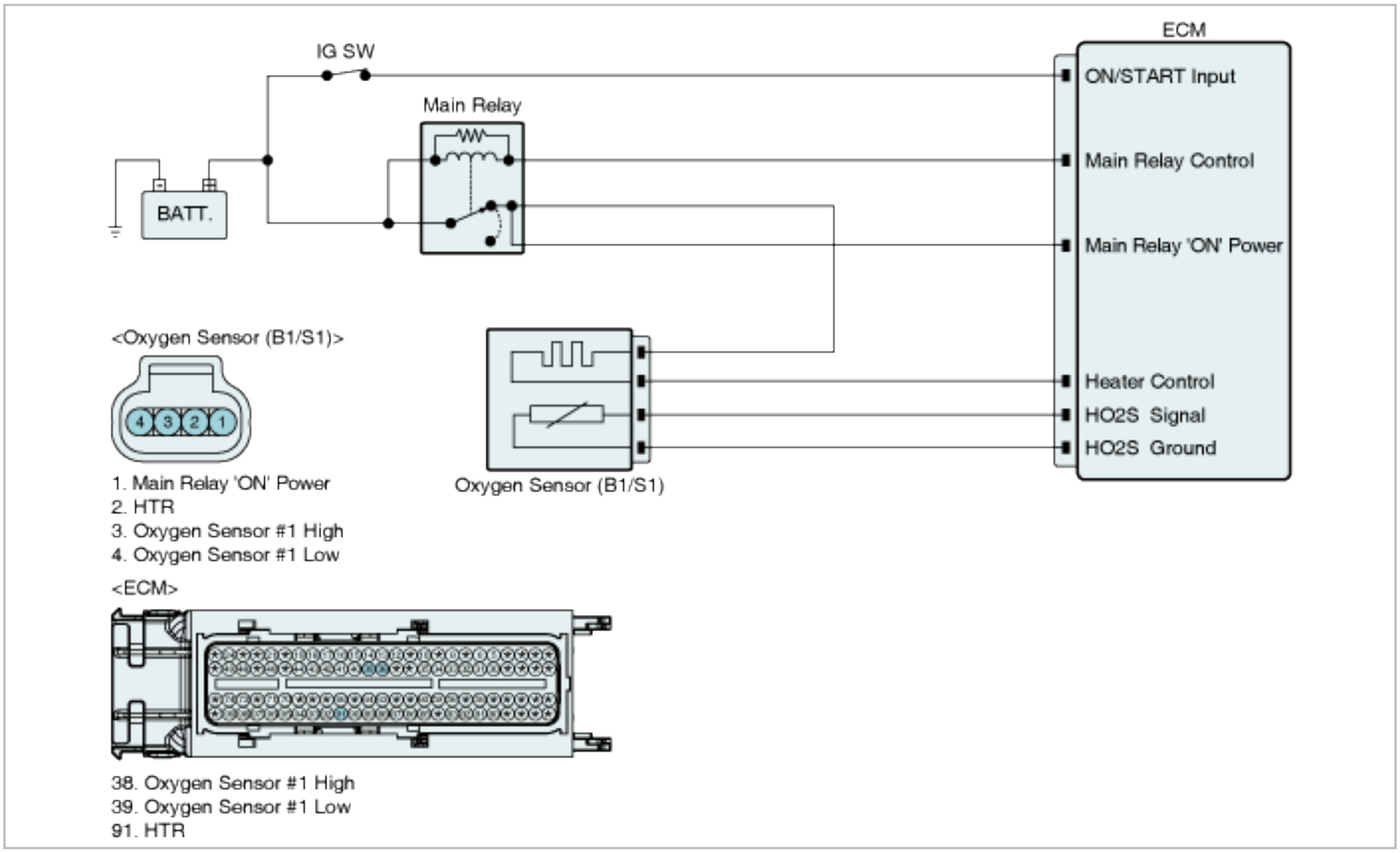
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Detects a short to ground or open	• Poor Connection • Open in Power Circuit • Open or short to ground in control circuit • HO2S(B1/S1) • ECM
Enable Conditions	• No disabling Faults • Engine Running • 11V ≤ Battery Voltage ≤ 16V	
Threshold value	• Short to ground or open circuit	
Diagnosis Time	• Continuous (More than 5 seconds failure for every 10 seconds test)	
MIL On Condition	• 2 Driving Cycles	

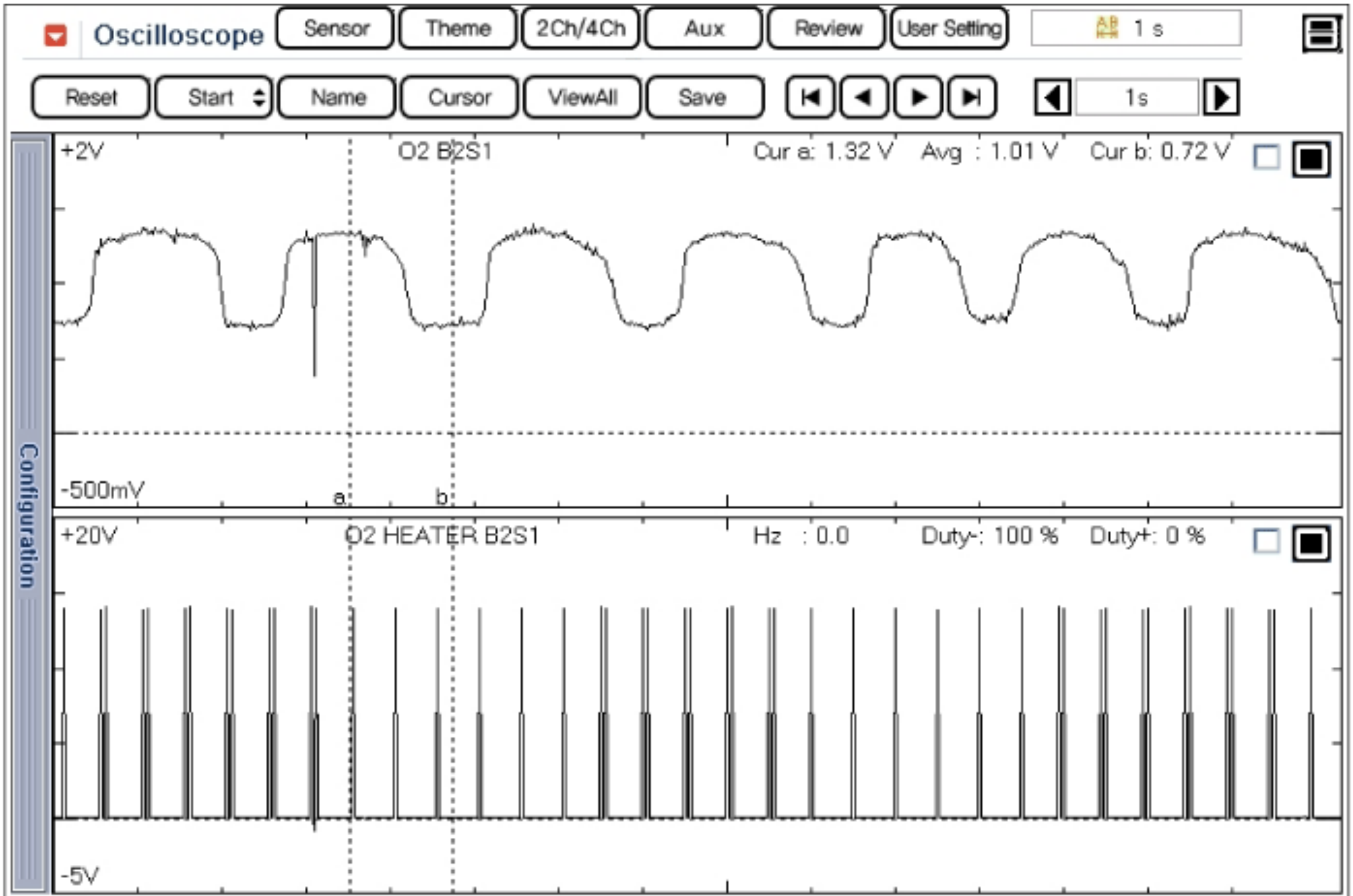
Specification

Heater	
Resistance (Ω)	8.1 ~ 11.1 Ω at 21°C(69.8°F)

Diagnostic Circuit Diagram



Signal Waveform & Data



Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
1 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
+2V
O2 B2S1
Cur a: 1.32 V
Avg : 1.01 V
Cur b: 0.72 V
-500mV
a
b
+20V
O2 HEATER B2S1
Hz : 0.0
Duty-: 100 %
Duty+: 0 %
-5V
Configuration

Fig.1

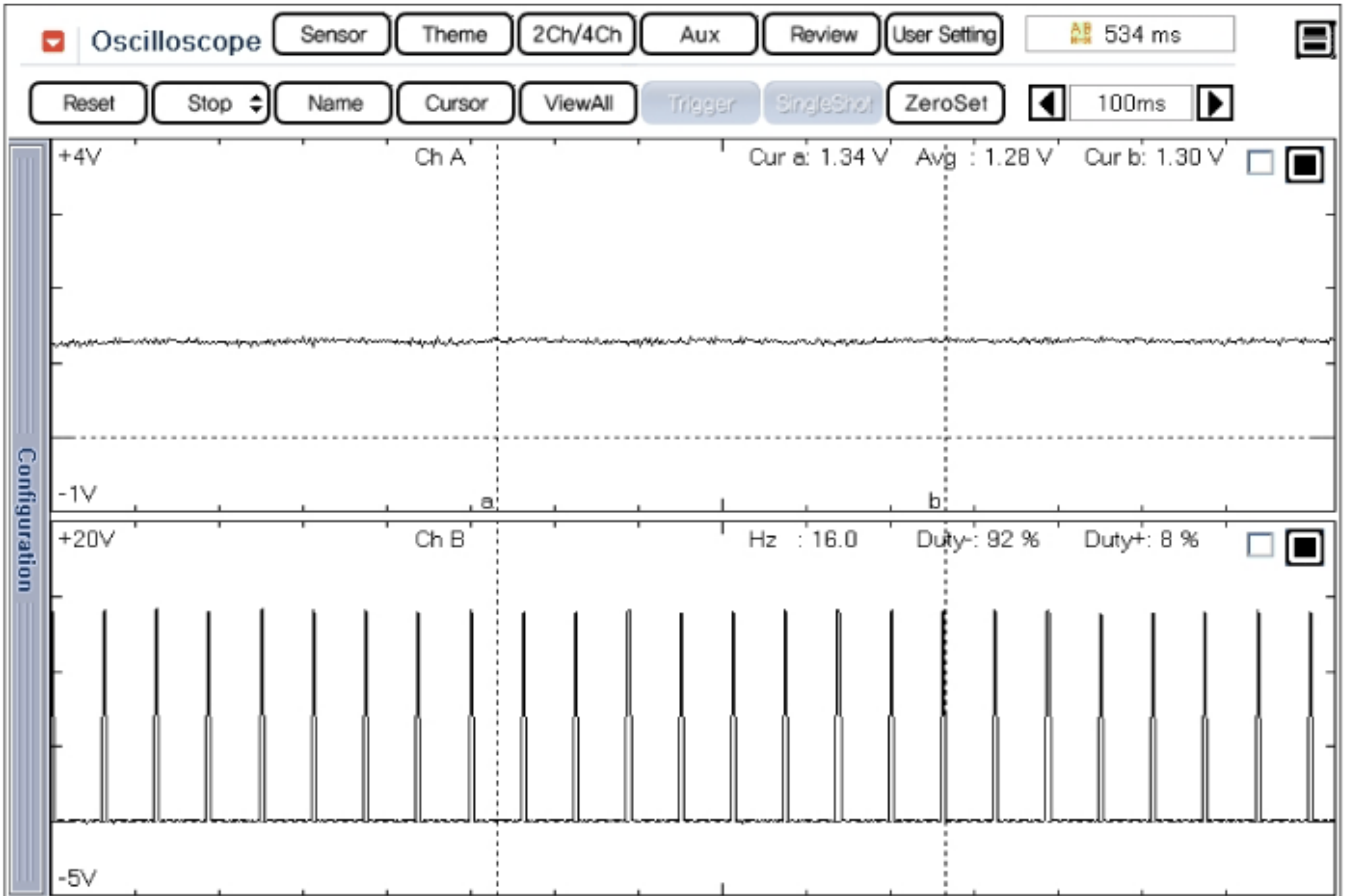
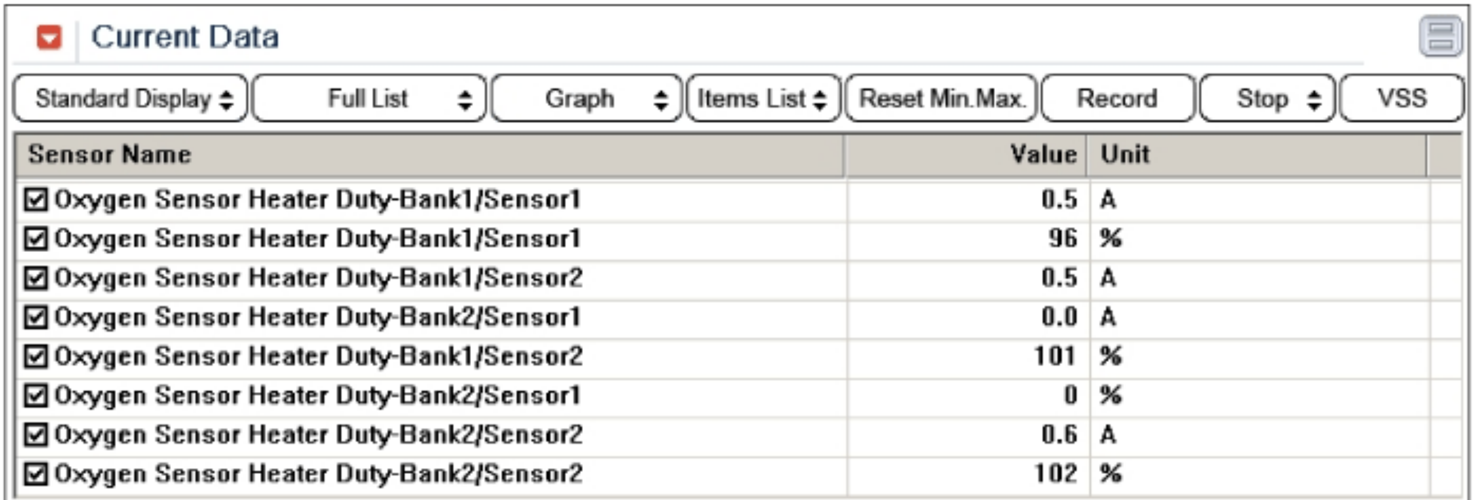


Fig.2

Sensor Name	Value	Unit
☑ Oxygen Sensor Heater Duty-Bank1/Sensor1	0.5	A
☑ Oxygen Sensor Heater Duty-Bank1/Sensor1	97	%
☑ Oxygen Sensor Heater Duty-Bank1/Sensor2	0.5	A
☑ Oxygen Sensor Heater Duty-Bank2/Sensor1	0.5	A
☑ Oxygen Sensor Heater Duty-Bank1/Sensor2	100	%
☑ Oxygen Sensor Heater Duty-Bank2/Sensor1	97	%
☑ Oxygen Sensor Heater Duty-Bank2/Sensor2	0.6	A
☑ Oxygen Sensor Heater Duty-Bank2/Sensor2	100	%

Fig.3



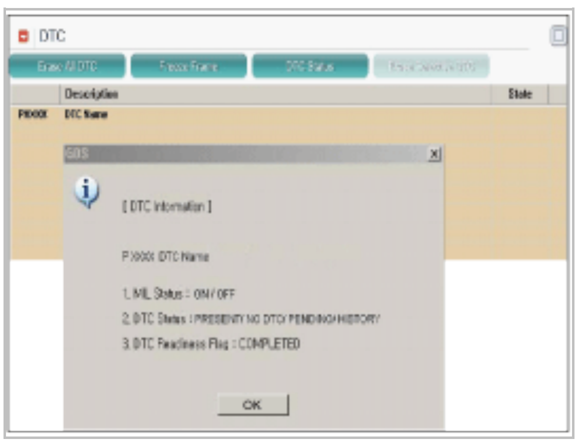
Sensor Name	Value	Unit
Oxygen Sensor Heater Duty-Bank1/Sensor1	0.5	A
Oxygen Sensor Heater Duty-Bank1/Sensor1	96	%
Oxygen Sensor Heater Duty-Bank1/Sensor2	0.5	A
Oxygen Sensor Heater Duty-Bank2/Sensor1	0.0	A
Oxygen Sensor Heater Duty-Bank1/Sensor2	101	%
Oxygen Sensor Heater Duty-Bank2/Sensor1	0	%
Oxygen Sensor Heater Duty-Bank2/Sensor2	0.6	A
Oxygen Sensor Heater Duty-Bank2/Sensor2	102	%

Fig.4

Fig.1) The signal waveforms of front HO2S(the upper) and heater(the lower) at idle
Fig.2) The signal waveforms of rear HO2S(the upper) and heater(the lower) at idle
Fig.3) The Normal data of HO2S heaters at idle
Fig.4) The data of HO2S heaters at open condition in HO2S(B2S1) circuit
The output voltage of front HO2S is changed continuously accroding to air/fuel ratio, ECM controls fuel amount based on this value. Preheating is necessary for HO2S normal operation. Therefore heater unit is installed in HO2S, ECM can control air/fuel ratio with the output signal of HO2S simultaneous with engine run by reducing preheating time. ECM controls heater with duty cycle. HO2S' power source is main relay and ECM operates heater by ground control.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Power Circuit Inspection" procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" & Disconnect HO2S(B1/S1) connector.
2. IG "ON".
3. Measure voltage between power terminal of HO2S(B1/S1) heater harness connector and chassis ground.

Specification : B+

4. Is the measured voltage within specification ?

YES	▶ Go to " Control Circuit Inspection" procedure.
NO	▶ Repair open or short to ground in HO2S(B1/S1) Heater power circuit then, go to "Verification of Vehicle Repair" procedure.

Control Circuit Inspection

■ Check short to ground

1. IG "OFF" & Disconnect HO2S(B1/S1) connector.
2. Measure resistance between control terminal of HO2S(B1/S1) heater harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.
NO	▶ Repair short to ground in HO2S (B1/S1) heater control circuit and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect HO2S(B1/S1) and ECM connector.
2. Measure resistance between control terminal of HO2S(B1/S1) heater harness connector and heater control terminal of ECM harness connector.

Specification : Approx. below 1Ω

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in HO2S(B1/S1) heater control circuit and go to "Verifiction of Vehicle Repair" procedure.

Component Inspection

■ **Check HO2S(B1/S1) Heater resistance**

1. IG "OFF" and disconnect HO2S(B1/S1) connector
2. Measure resistance between power and control terminals of HO2S(B1/S1) heater(Component Side)

Specification : 8.1 ~ 11.1 Ω at 21°C(69.8°F)

3. Is the measured resistance within specification?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

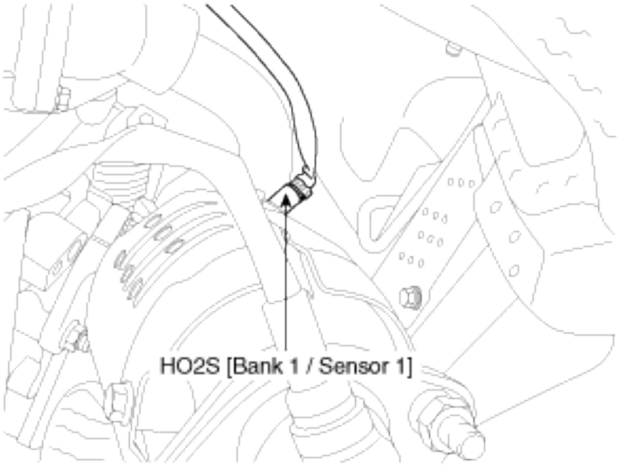
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0032 HO2S Heater Control Circuit High (Bank 1 / Sensor 1)

Component Location



General Description

The normal operating temperature of the HO2S(Heated Oxygen Sensor) ranges from 350 to 850°C(662 to 1562°F). The HO2S heater greatly decreases the amount of time required for fuel control to become active. The ECM provides a pulse width modulated control circuit to adjust current through the heater. When the HO2S is cold, the value of the resistance is low and the current in the circuit is high. On the contrary, if the temperature in the resistor of the sensor rises, the current drops gradually.

DTC Description

If the ECM detects short to battery in heater under detecting conditions, ECM sets P0032. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

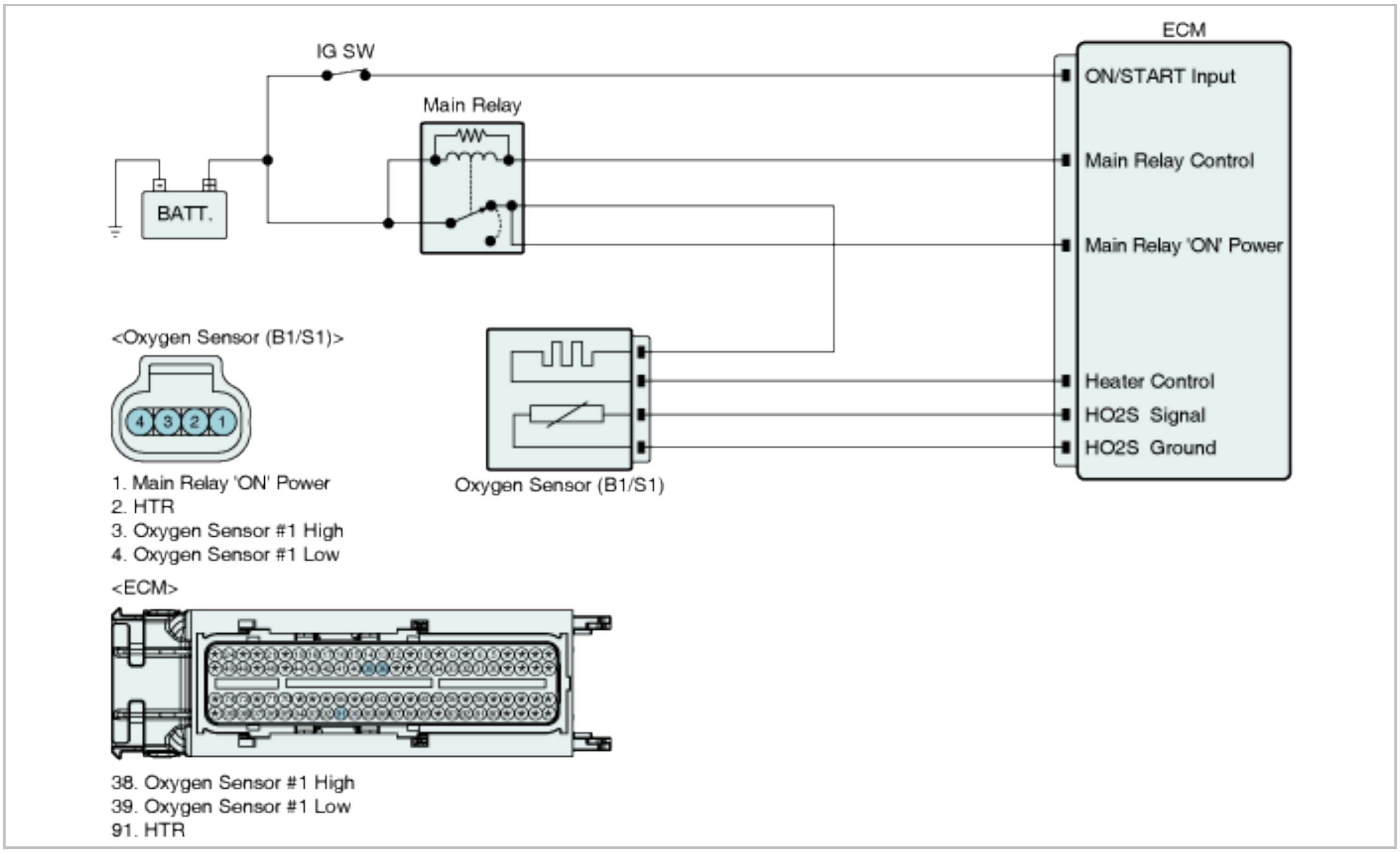
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Detects a short to battery	• Poor Connection • Short to battery in control circuit • HO2S(B1/S1) • ECM
Enable Conditions	• No disabling Faults • Engine Running • 11V ≤ Battery Voltage ≤ 16V	
Threshold value	• Short to battery	
Diagnosis Time	• Continuous (More than 5 seconds failure for every 10 seconds test)	
MIL On Condition	• 2 Driving Cycles	

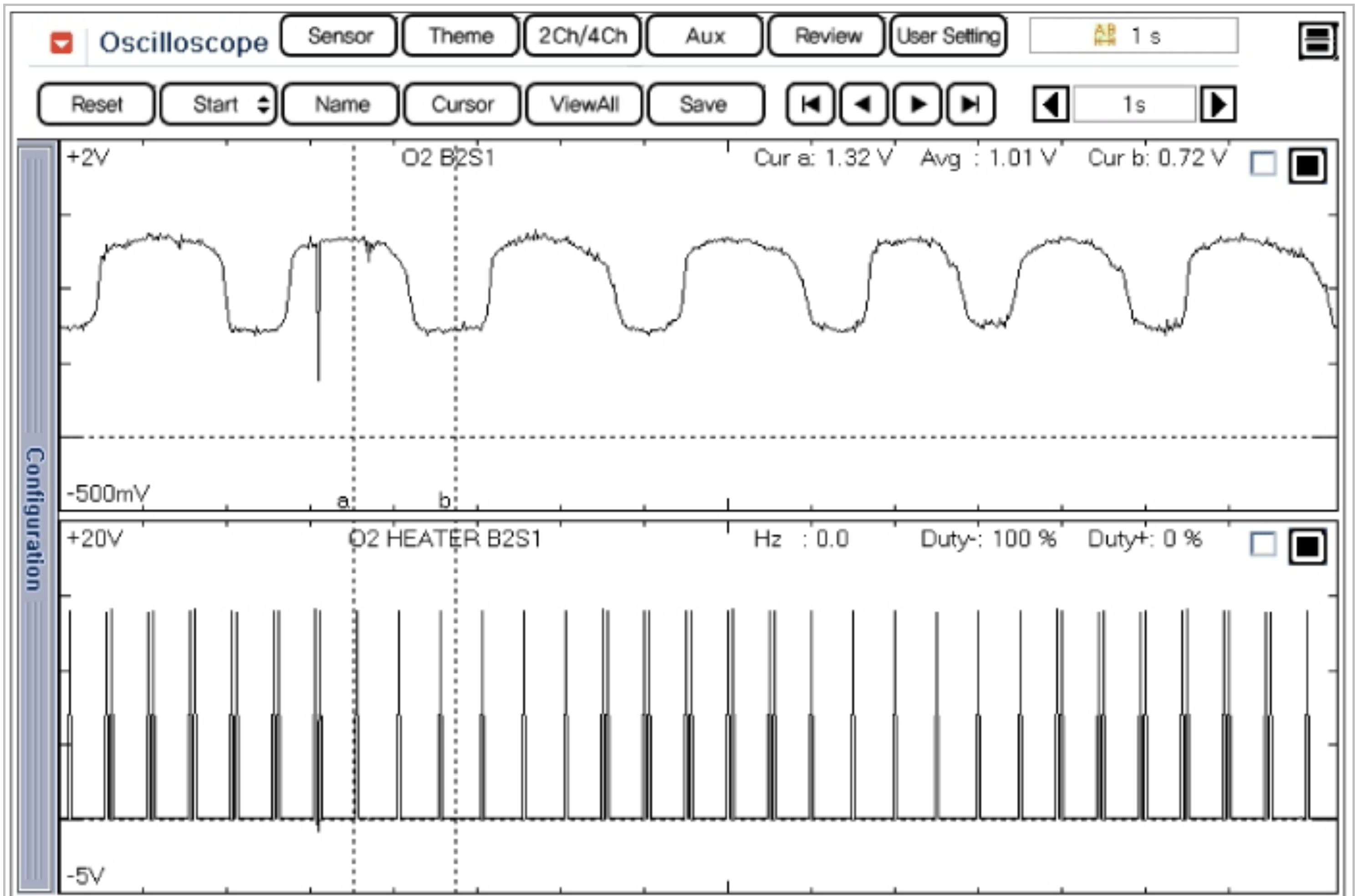
Specification

Heater	
Resistance (Ω)	8.1 ~ 11.1 Ω at 21°C(69.8°F)

Diagnostic Circuit Diagram



Signal Waveform & Data


Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
1 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 1.32 V
Avg : 1.01 V
Cur b: 0.72 V
-500mV
a
b
+20V
O2 HEATER B2S1
Hz : 0.0
Duty-: 100 %
Duty+: 0 %
-5V
Fig.1

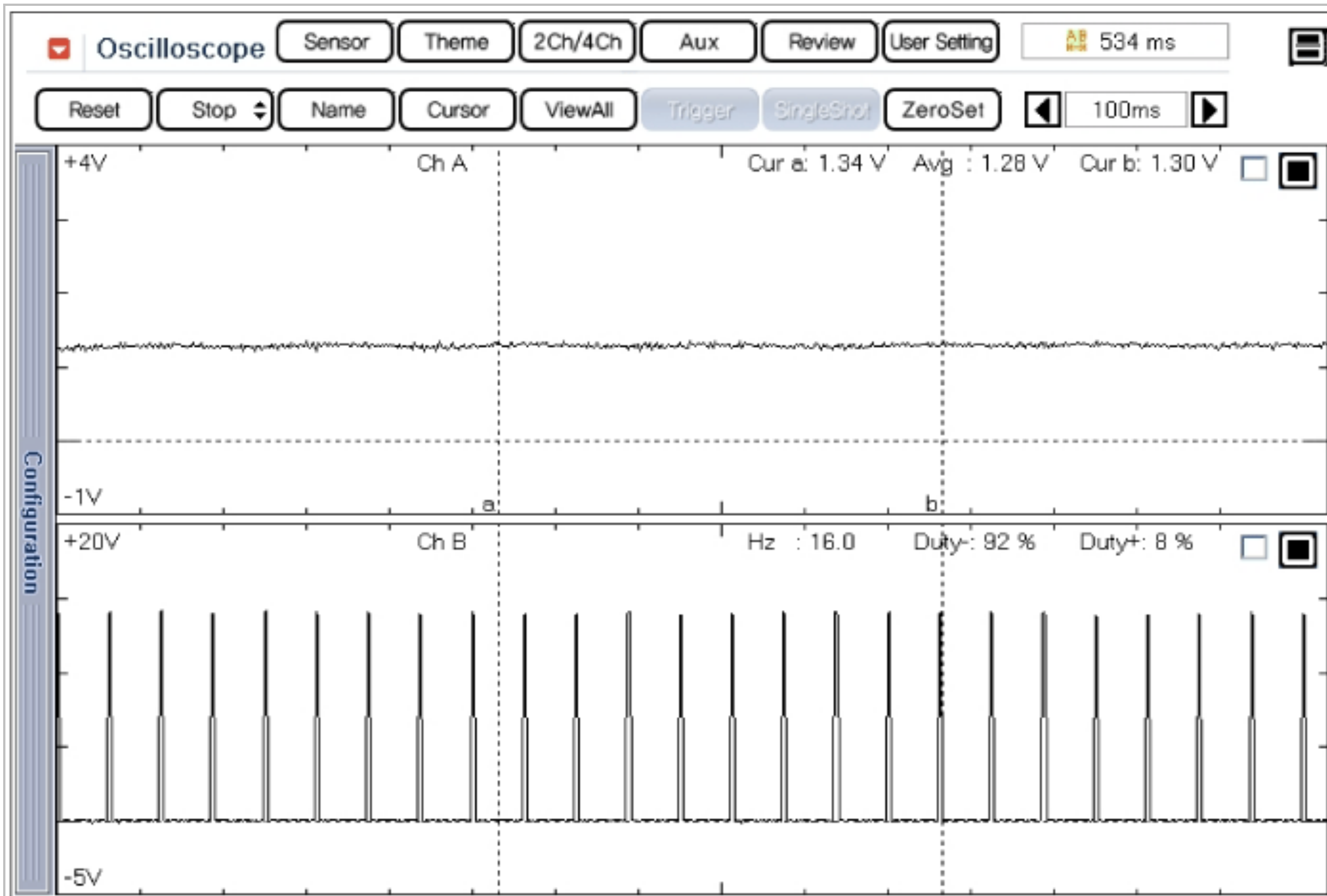
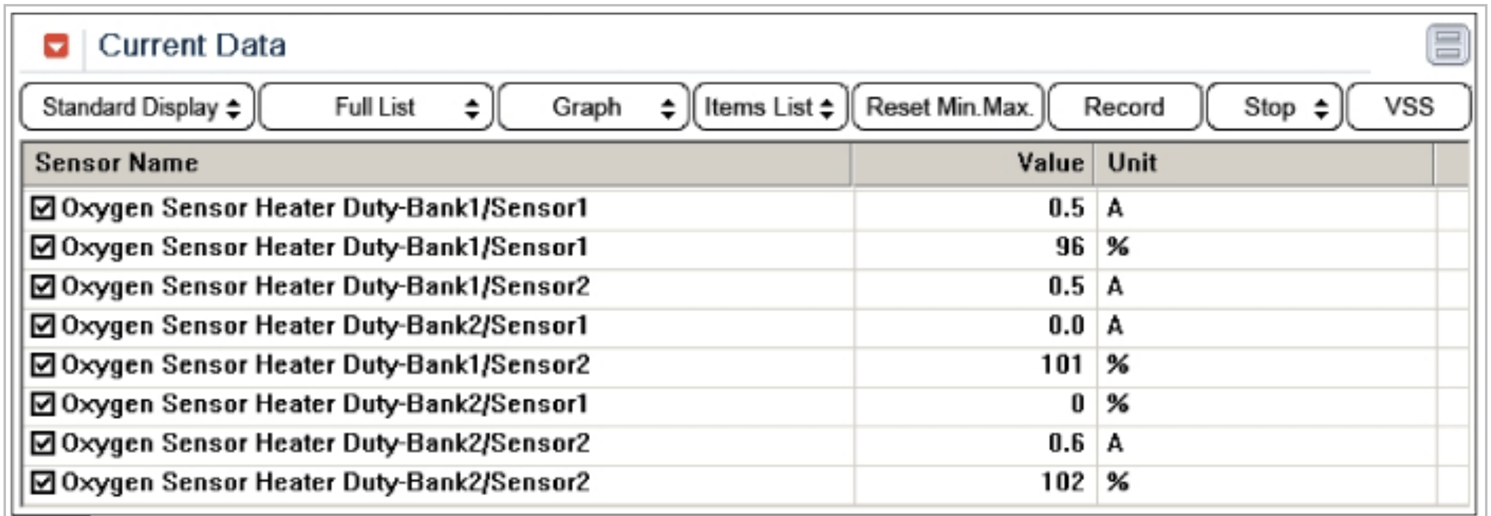


Fig.2

Sensor Name	Value	Unit
☑ Oxygen Sensor Heater Duty-Bank1/Sensor1	0.5	A
☑ Oxygen Sensor Heater Duty-Bank1/Sensor1	97	%
☑ Oxygen Sensor Heater Duty-Bank1/Sensor2	0.5	A
☑ Oxygen Sensor Heater Duty-Bank2/Sensor1	0.5	A
☑ Oxygen Sensor Heater Duty-Bank1/Sensor2	100	%
☑ Oxygen Sensor Heater Duty-Bank2/Sensor1	97	%
☑ Oxygen Sensor Heater Duty-Bank2/Sensor2	0.6	A
☑ Oxygen Sensor Heater Duty-Bank2/Sensor2	100	%

Fig.3



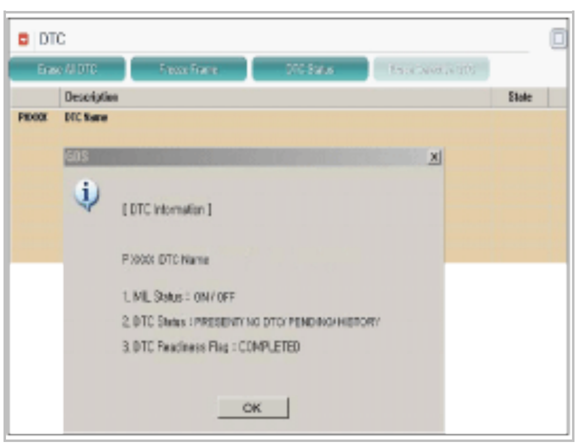
Sensor Name	Value	Unit
Oxygen Sensor Heater Duty-Bank1/Sensor1	0.5	A
Oxygen Sensor Heater Duty-Bank1/Sensor1	96	%
Oxygen Sensor Heater Duty-Bank1/Sensor2	0.5	A
Oxygen Sensor Heater Duty-Bank2/Sensor1	0.0	A
Oxygen Sensor Heater Duty-Bank1/Sensor2	101	%
Oxygen Sensor Heater Duty-Bank2/Sensor1	0	%
Oxygen Sensor Heater Duty-Bank2/Sensor2	0.6	A
Oxygen Sensor Heater Duty-Bank2/Sensor2	102	%

Fig.4

Fig.1)The signal waveforms of front HO2S(the upper) and heater(the lower) at idle
Fig.2) The signal waveforms of rear HO2S(the upper) and heater(the lower) at idle
Fig.3) The Normal data of HO2S heaters at idle
Fig.4) The data of HO2S heaters at open condition in HO2S(B2S1) circuit
The output voltage of front HO2S is changed continuously accroding to air/fuel ratio, ECM controls fuel amount based on this value. Preheating is necessary for HO2S normal operation. Therefore heater unit is installed in HO2S, ECM can control air/fuel ratio with the output signal of HO2S simultaneous with engine run by reducing preheating time. ECM controls heater with duty cycle. HO2S' power source is main relay and ECM operates heater by ground control.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Control Circuit Inspection" procedure.

Control Circuit Inspection

■ Check voltage

1. IG "OFF" & Disconnect HO2S(B1/S1) connector.
2. IG "ON".
3. Measure voltage between control terminal of HO2S(B1/S1) heater harness connector and chassis ground.

Specification : Approx. 3.5 V

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to battery in HO2S(B1/S1) Heater control circuit and go to "Verification of Vhicle Repair" procedure.

Component Inspection

■ Check HO2S(B1/S1) Heater resistance

1. IG "OFF" and disconnect HO2S(B1/S1) connector
2. Measure resistance between power and control terminals of HO2S(B1/S1) heater(Component Side)

Specification : 8.1 ~ 11.1 Ω at 21°C(69.8°F)

3. Is the measured resistance within specification?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

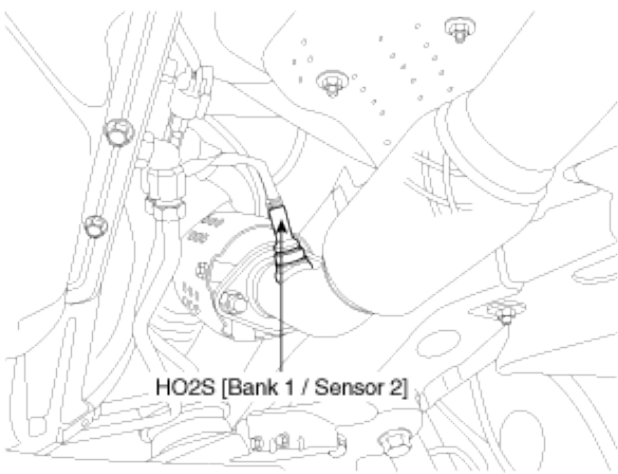
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0036 HO2S Heater Control Circuit (Bank 1 / Sensor 2)

Component Location



General Description

The normal operating temperature of the HO2S(Heated Oxygen Sensor) ranges from 350 to 850°C(662 to 1562°F). The HO2S heater greatly decreases the amount of time required for fuel control to become active. The ECM provides a pulse width modulated control circuit to adjust current through the heater. When the HO2S is cold, the value of the resistance is low and the current in the circuit is high. On the contrary, if the temperature in the resistor of the sensor rises, the current drops gradually.

DTC Description

Checking current from HO2S under detecting condition,if the heater current is below a certain threshold for more than predeterminate time, ECM sets P0036. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Monitor the current through the heater	

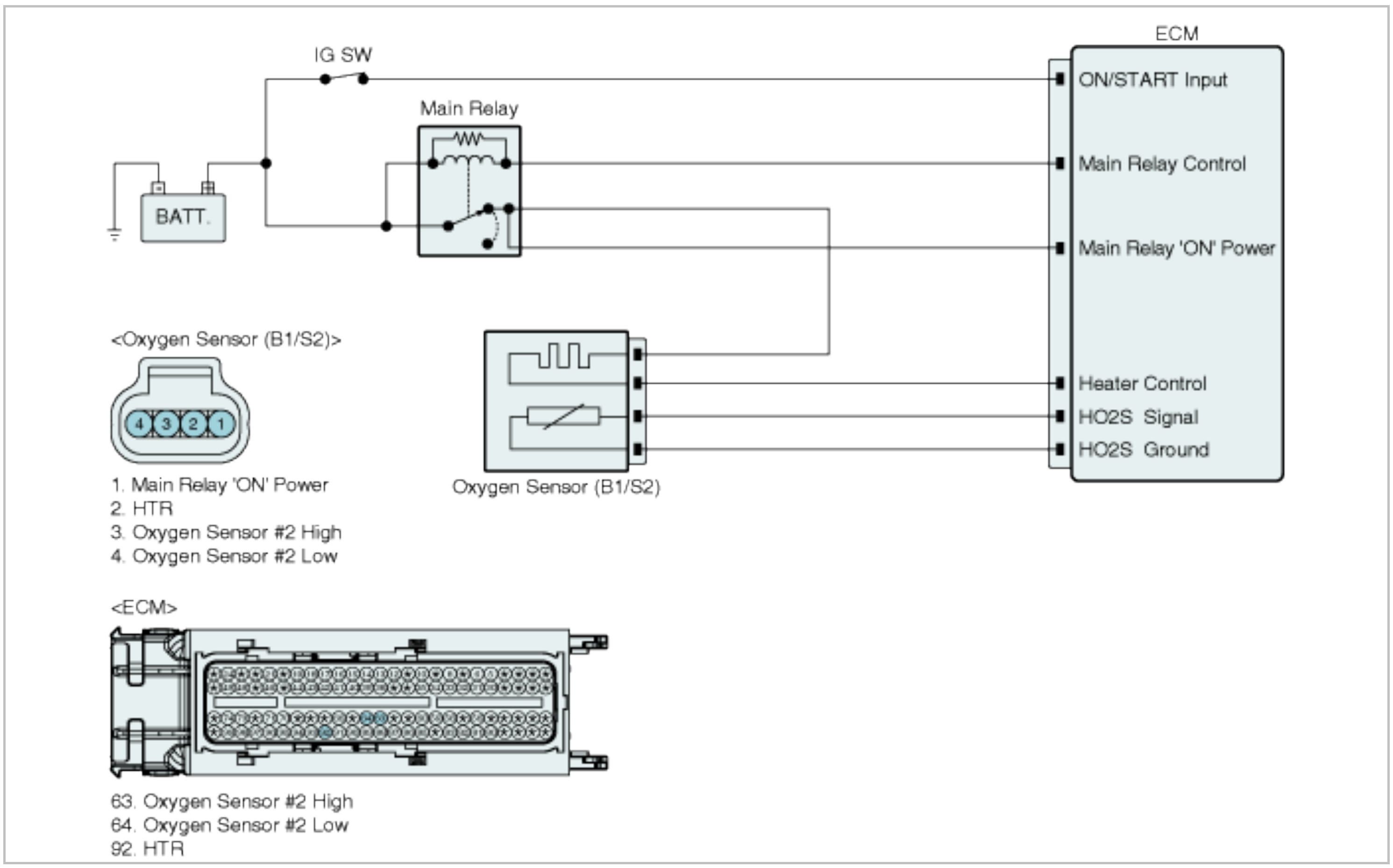
Enable Conditions	• Engine Running > 60 sec. • Heater Duty Cycle > 40% • Max. Duty Cycle - Min. Duty Cycle < 5%	• Poor Connection • HO2S(B1/S2) • ECM
Threshold value	• Filtered Heater Current < threshold value	
Diagnosis Time	• Continuous (More than 2.5 second failure for every 5 second test)	
MIL On Condition	• 2 Driving Cycles	

Specification

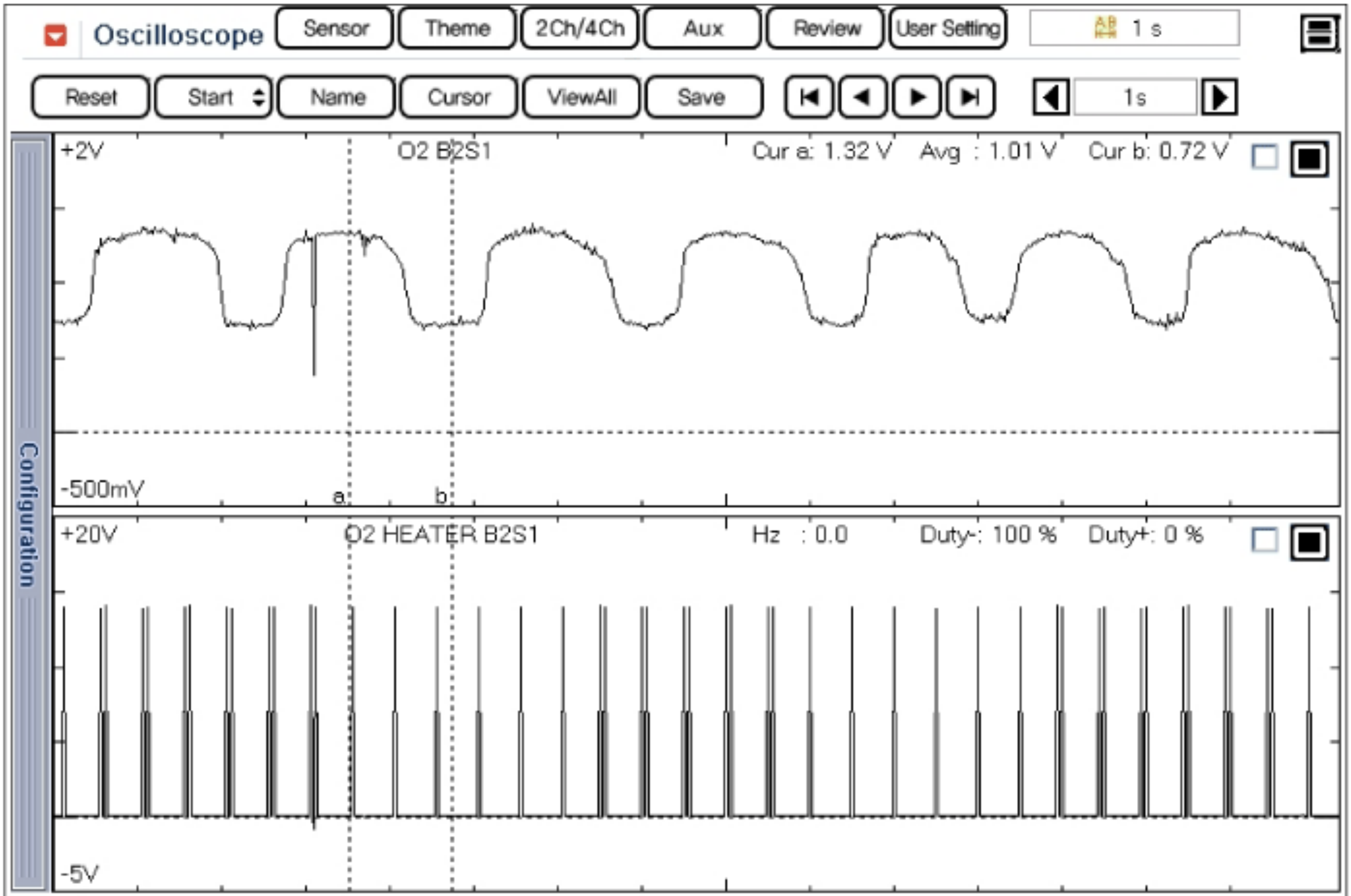
(Reference only)

Condition	Current(A)
Heater Current at 13.5V, 450°C(842°F) Exhaust	0.52 ± 0.1

Diagnostic Circuit Diagram



Signal Waveform & Data



Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
1 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
+2V
O2 B2S1
Cur a: 1.32 V
Avg : 1.01 V
Cur b: 0.72 V
-500mV
a
b
+20V
O2 HEATER B2S1
Hz : 0.0
Duty-: 100 %
Duty+: 0 %
-5V
Configuration

Fig.1

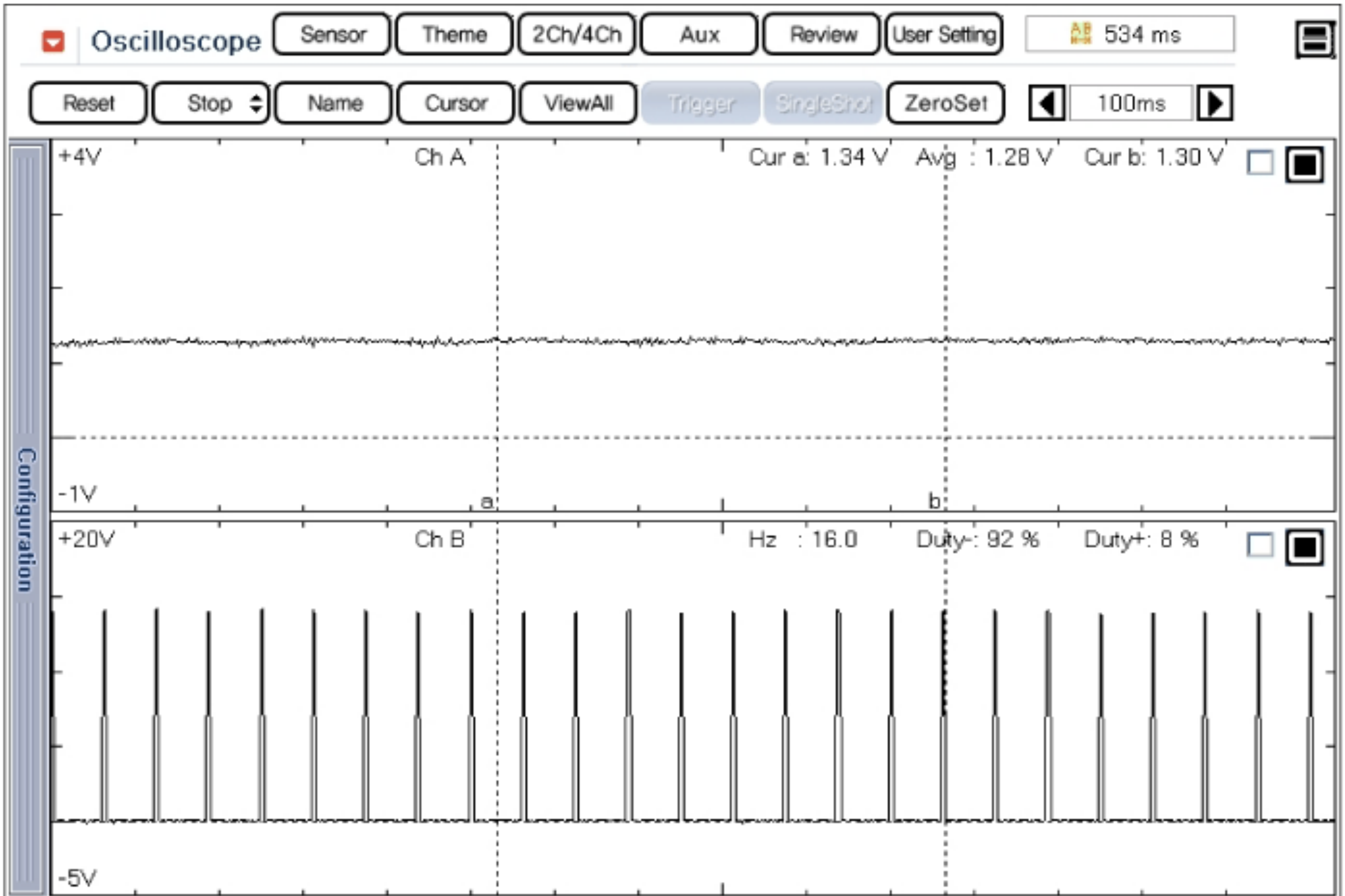
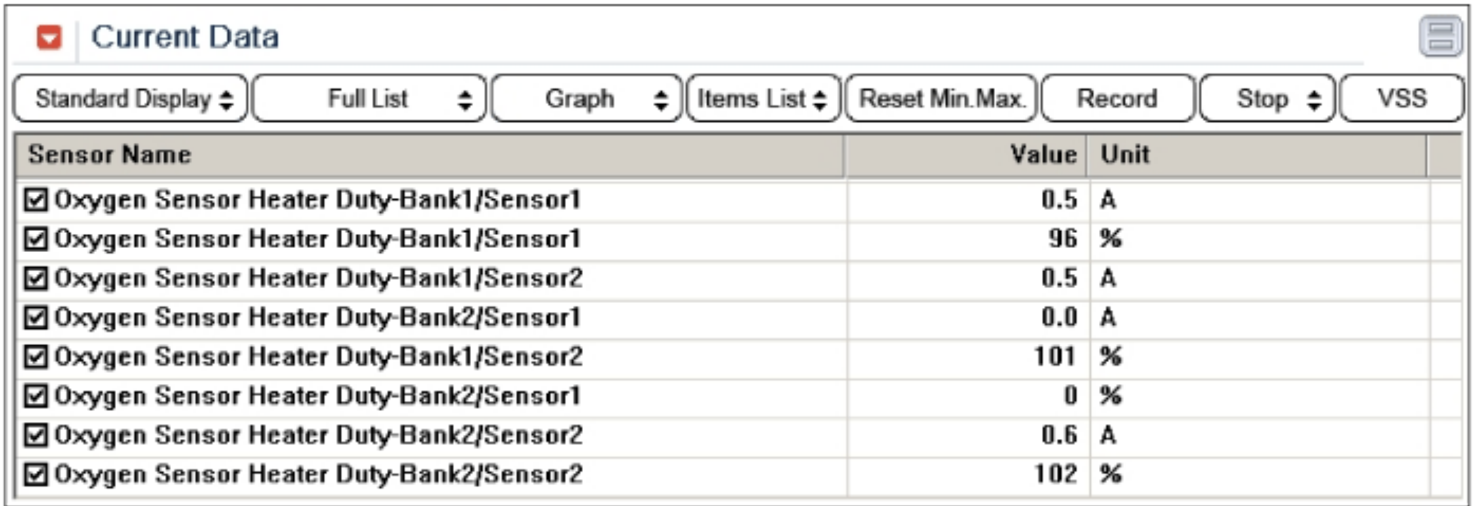


Fig.2

Sensor Name	Value	Unit
☑ Oxygen Sensor Heater Duty-Bank1/Sensor1	0.5	A
☑ Oxygen Sensor Heater Duty-Bank1/Sensor1	97	%
☑ Oxygen Sensor Heater Duty-Bank1/Sensor2	0.5	A
☑ Oxygen Sensor Heater Duty-Bank2/Sensor1	0.5	A
☑ Oxygen Sensor Heater Duty-Bank1/Sensor2	100	%
☑ Oxygen Sensor Heater Duty-Bank2/Sensor1	97	%
☑ Oxygen Sensor Heater Duty-Bank2/Sensor2	0.6	A
☑ Oxygen Sensor Heater Duty-Bank2/Sensor2	100	%

Fig.3



Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | VSS

Sensor Name	Value	Unit
Oxygen Sensor Heater Duty-Bank1/Sensor1	0.5	A
Oxygen Sensor Heater Duty-Bank1/Sensor1	96	%
Oxygen Sensor Heater Duty-Bank1/Sensor2	0.5	A
Oxygen Sensor Heater Duty-Bank2/Sensor1	0.0	A
Oxygen Sensor Heater Duty-Bank1/Sensor2	101	%
Oxygen Sensor Heater Duty-Bank2/Sensor1	0	%
Oxygen Sensor Heater Duty-Bank2/Sensor2	0.6	A
Oxygen Sensor Heater Duty-Bank2/Sensor2	102	%

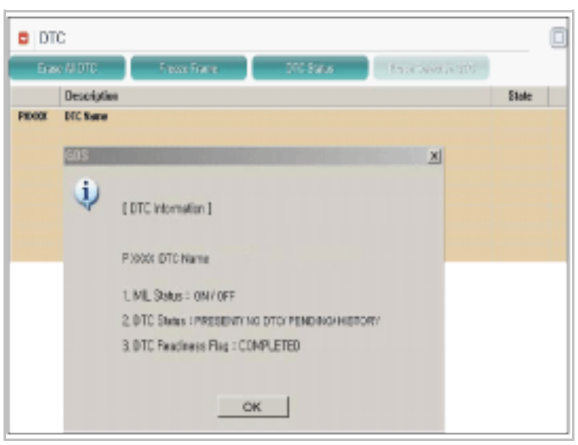
Fig.4

Fig.1) The signal waveforms of front HO2S(the lower) and heater(the upper) at idle
Fig.2) The signal waveforms of rear HO2S(the upper) and heater(the lower) at idle
Fig.3) The Normal data of HO2S heaters at idle
Fig.4) The data of HO2S heaters at open condition in HO2S(B2S1) circuit

The output voltage of front HO2S is changed continuously accroding to air/fuel ratio, ECM controls fuel amount based on this value. Preheating is necessary for HO2S normal operation. Therefore heater unit is installed in HO2S, ECM can control air/fuel ratio with the output signal of HO2S simultaneous with engine run by reducing preheating time. ECM controls heater with duty cycle. HO2S' power source is main relay and ECM operates heater by ground control.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Component Inspection" procedure.

Component Inspection

■ Check HO2S(B1/S2) Heater resistance

1. IG "OFF" and disconnect HO2S(B1/S2) connector
2. Measure resistance between power and control terminals of HO2S(B1/S2) heater(Component Side)

Specification : 8.1 ~ 11.1 Ω at 21°C(69.8°F)

3. Is the measured resistance within specification?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

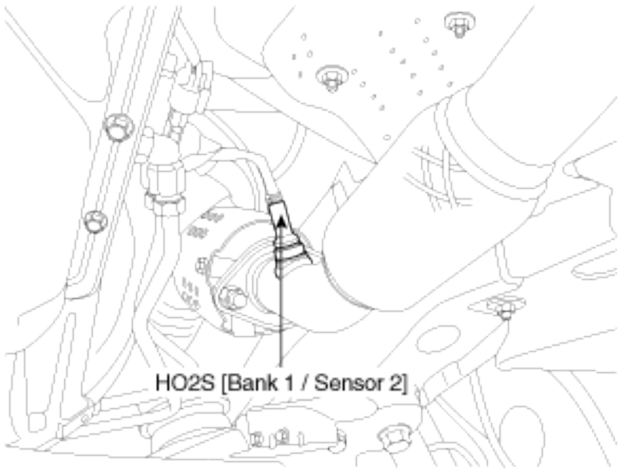
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0037 HO2S Heater Control Circuit Low (Bank 1 /

Sensor 2)

Component Location



General Description

The normal operating temperature of the HO2S(Heated Oxygen Sensor) ranges from 350 to 850°C(662 to 1562°F). The HO2S heater greatly decreases the amount of time required for fuel control to become active. The ECM provides a pulse width modulated control circuit to adjust current through the heater. When the HO2S is cold, the value of the resistance is low and the current in the circuit is high. On the contrary, if the temperature in the resistor of the sensor rises, the current drops gradually.

DTC Description

If the ECM detects short to ground or open in heater under detecting conditions, ECM sets P0037. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

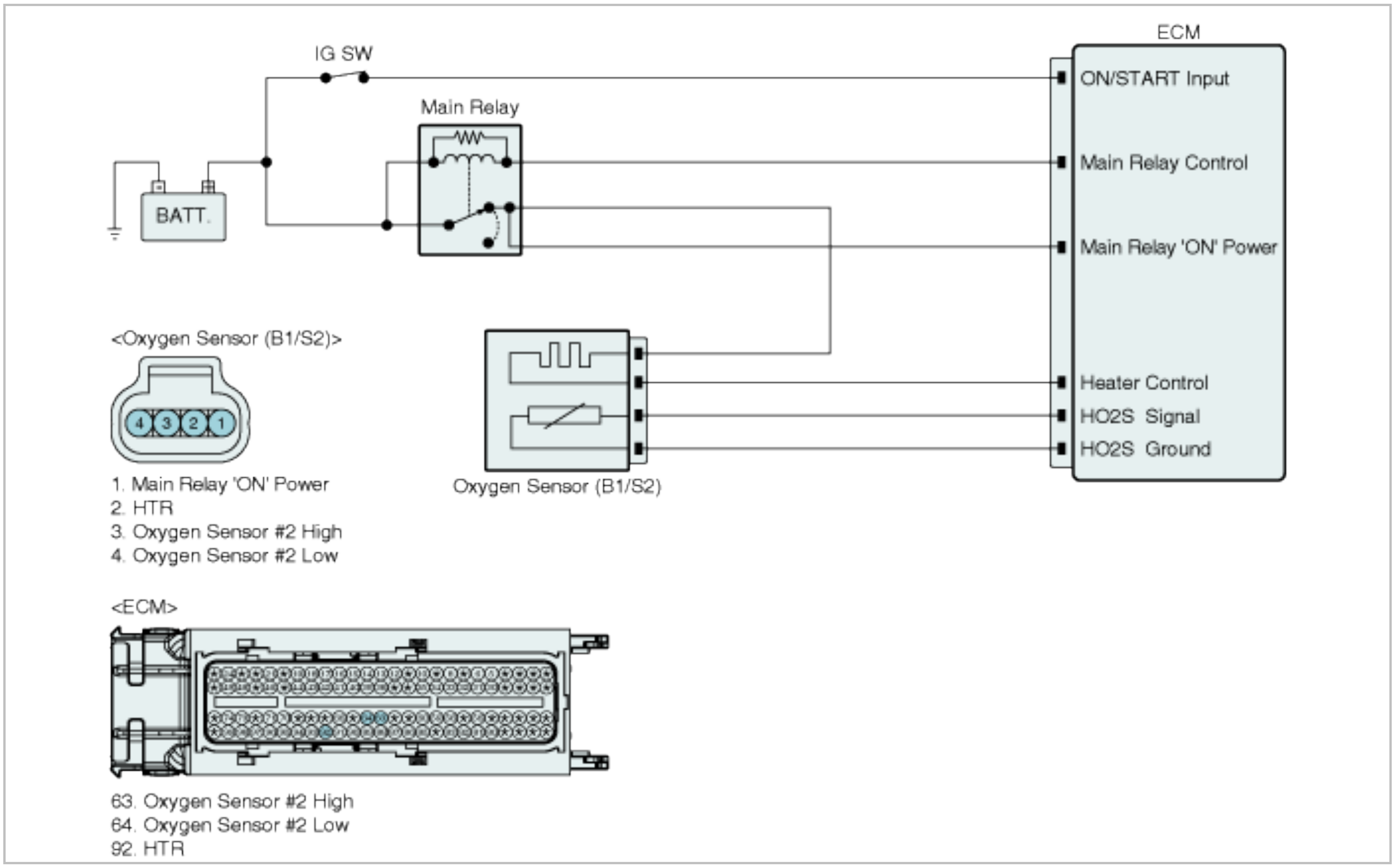
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Detects a short to ground or open	• Poor Connection • Open in Power Circuit • Open or short to ground in control circuit • HO2S(B1/S2) • ECM
Enable Conditions	• No disabling Faults • Engine Running • 11V ≤ Battery Voltage ≤ 16V	
Threshold value	• Short to ground or open circuit	
Diagnosis Time	• Continuous (More than 5 seconds failure for every 10 seconds test)	
MIL On Condition	• 2 Driving Cycles	

Specification

Heater	
Resistance (Ω)	8.1 ~ 11.1 Ω at 21°C(69.8°F)

Diagnostic Circuit Diagram



Signal Waveform & Data

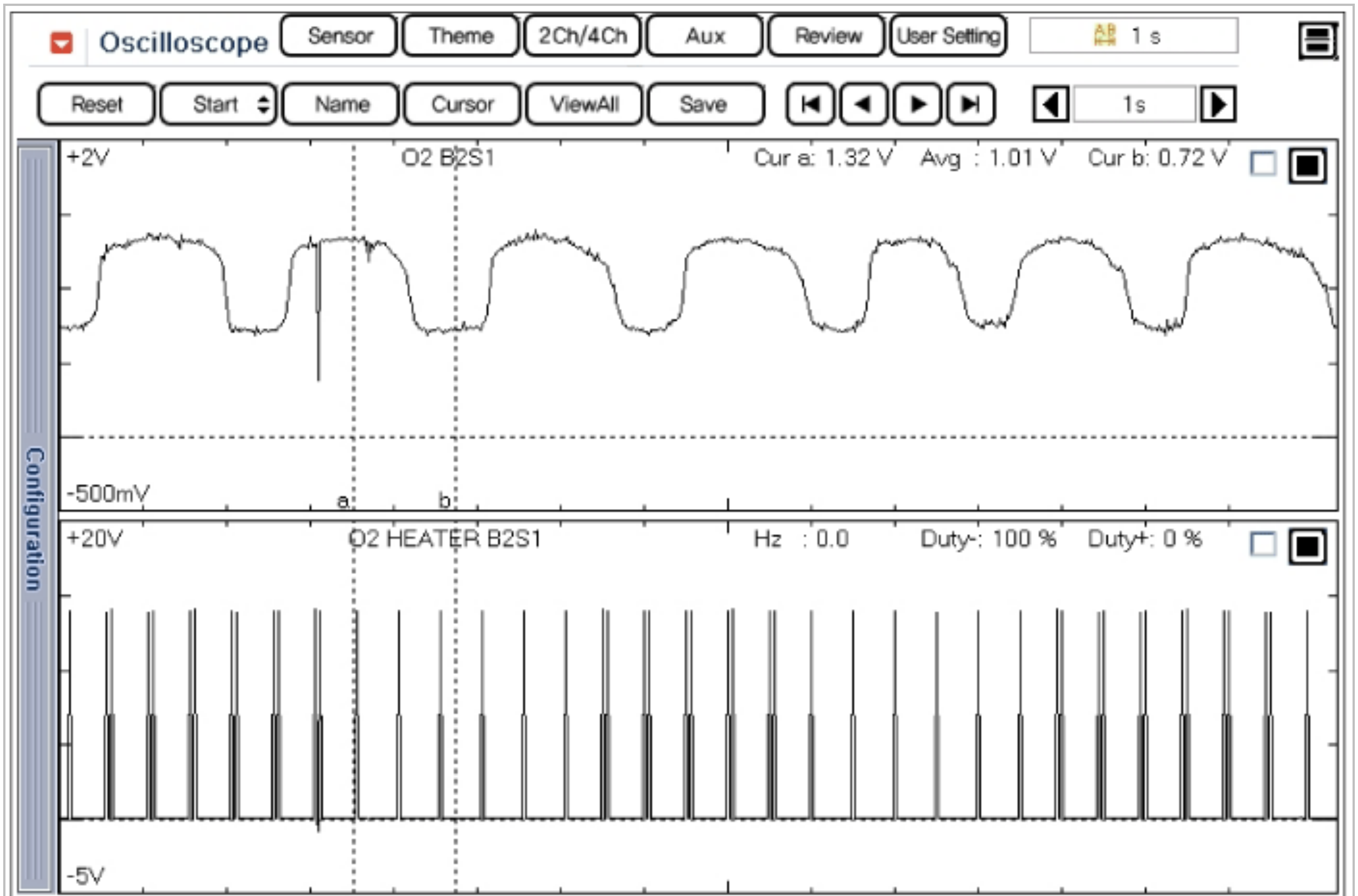

Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
1 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
+2V
O2 B2S1
Cur a: 1.32 V
Avg : 1.01 V
Cur b: 0.72 V
-500mV
a
b
+20V
O2 HEATER B2S1
Hz : 0.0
Duty-: 100 %
Duty+: 0 %
-5V
Configuration

Fig.1

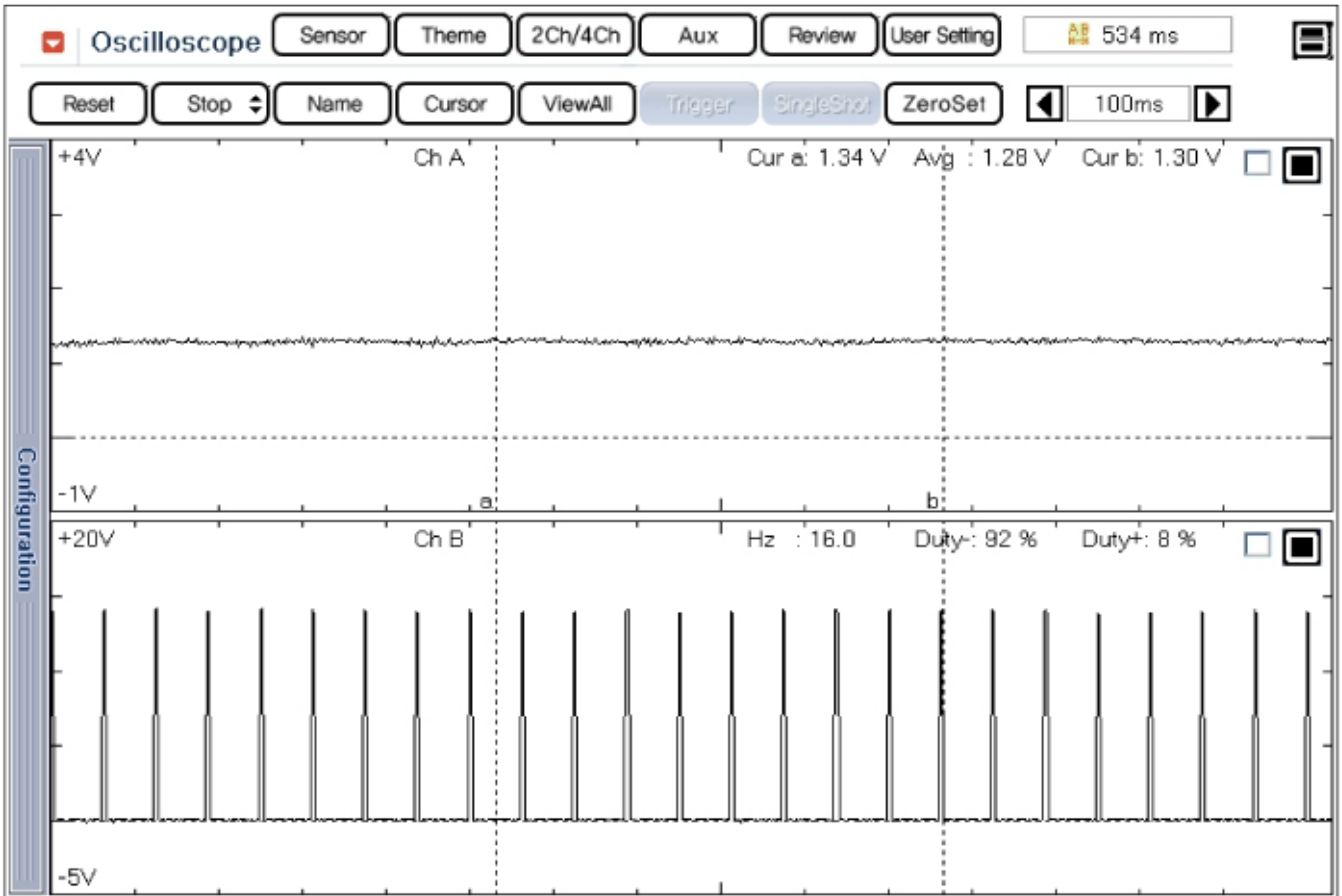
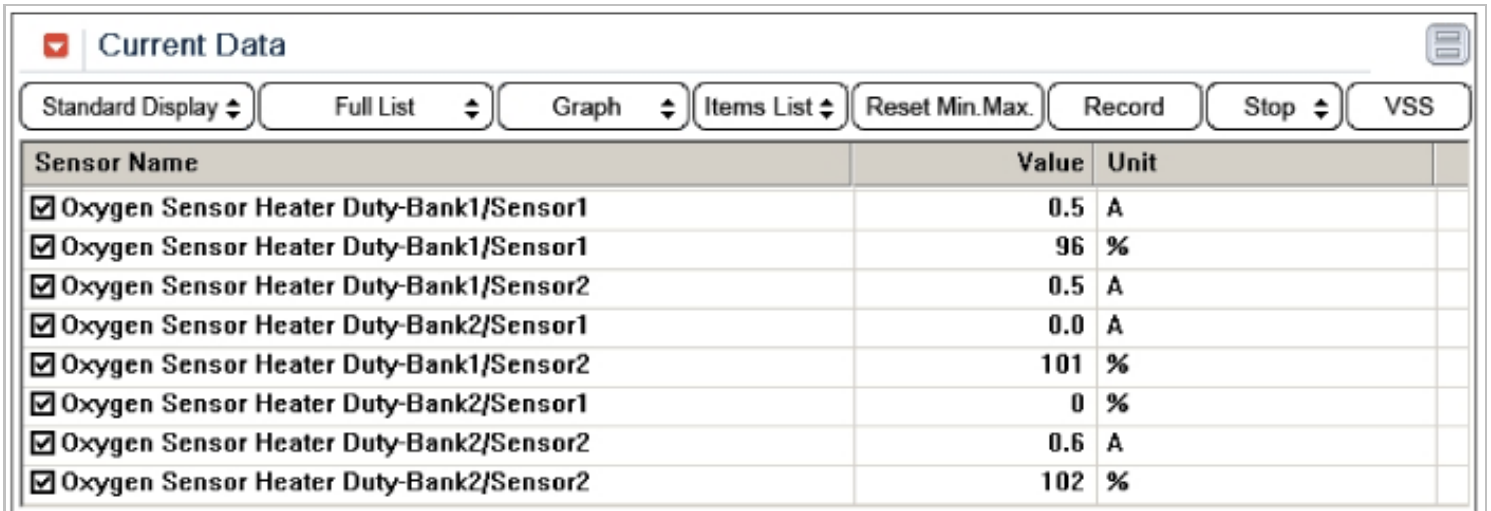


Fig.2

Sensor Name	Value	Unit
☑ Oxygen Sensor Heater Duty-Bank1/Sensor1	0.5	A
☑ Oxygen Sensor Heater Duty-Bank1/Sensor1	97	%
☑ Oxygen Sensor Heater Duty-Bank1/Sensor2	0.5	A
☑ Oxygen Sensor Heater Duty-Bank2/Sensor1	0.5	A
☑ Oxygen Sensor Heater Duty-Bank1/Sensor2	100	%
☑ Oxygen Sensor Heater Duty-Bank2/Sensor1	97	%
☑ Oxygen Sensor Heater Duty-Bank2/Sensor2	0.6	A
☑ Oxygen Sensor Heater Duty-Bank2/Sensor2	100	%

Fig.3



Sensor Name	Value	Unit
Oxygen Sensor Heater Duty-Bank1/Sensor1	0.5	A
Oxygen Sensor Heater Duty-Bank1/Sensor1	96	%
Oxygen Sensor Heater Duty-Bank1/Sensor2	0.5	A
Oxygen Sensor Heater Duty-Bank2/Sensor1	0.0	A
Oxygen Sensor Heater Duty-Bank1/Sensor2	101	%
Oxygen Sensor Heater Duty-Bank2/Sensor1	0	%
Oxygen Sensor Heater Duty-Bank2/Sensor2	0.6	A
Oxygen Sensor Heater Duty-Bank2/Sensor2	102	%

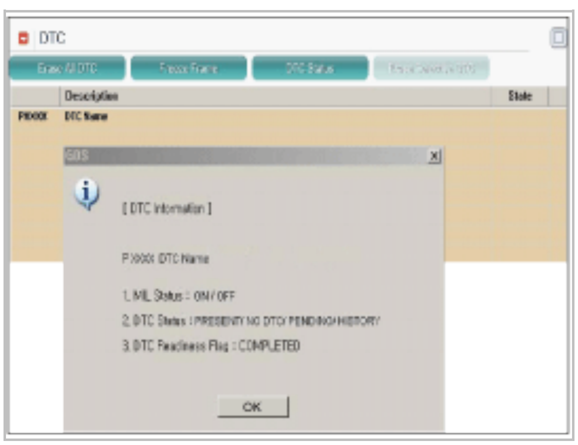
Fig.4

Fig.1) The signal waveforms of front HO2S(the lower) and heater(the upper) at idle
Fig.2) The signal waveforms of rear HO2S(the upper) and heater(the lower) at idle
Fig.3) The Normal data of HO2S heaters at idle
Fig.4) The data of HO2S heaters at open condition in HO2S(B2S1) circuit

The output voltage of front HO2S is changed continuously accroding to air/fuel ratio, ECM controls fuel amount based on this value. Preheating is necessary for HO2S normal operation. Therefore heater unit is installed in HO2S, ECM can control air/fuel ratio with the output signal of HO2S simultaneous with engine run by reducing preheating time. ECM controls heater with duty cycle. HO2S' power source is main relay and ECM operates heater by ground control.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor’s and/or ECM’s connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Power Circuit Inspection" procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" & Disconnect HO2S(B1/S2) connector.
2. IG "ON".
3. Measure voltage between power terminal of HO2S(B1/S2) heater harness connector and chassis ground.

Specification : B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.
NO	▶ Repair open or short to ground in HO2S(B1/S2) Heater power circuit then, go to "Verification of Vehicle Repair" procedure.

Control Circuit Inspection

■ Check short to ground

1. IG "OFF" & Disconnect HO2S(B1/S2) connector.
2. Measure resistance between control terminal of HO2S(B1/S2) heater harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.
NO	▶ Repair short to ground in HO2S(B1/S2) heater control circuit and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect HO2S(B1/S2) and ECM connector.
2. Measure resistance between control terminal of HO2S(B1/S2) heater harness connector and heater control terminal of ECM harness connector.

Specification : Approx. below 1Ω

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in HO2S(B1/S2) heater control circuit and go to "Verifiction of Vehicle Repair" procedure.

Component Inspection

■ **Check HO2S(B1/S2) Heater resistance**

1. IG "OFF" and disconnect HO2S(B1/S2) connector
2. Measure resistance between power and control terminals of HO2S(B1/S2) heater(Component Side)

Specification : 8.1 ~ 11.1 Ω at 21°C(69.8°F)

3. Is the measured resistance within specification?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

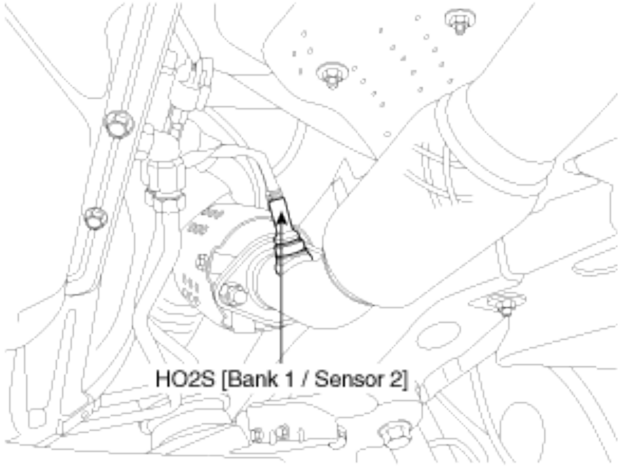
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0038 HO2S Heater Control Circuit High (Bank 1 / Sensor 2)

Component Location



General Description

The normal operating temperature of the HO2S(Heated Oxygen Sensor) ranges from 350 to 850°C(662 to 1562°F). The HO2S heater greatly decreases the amount of time required for fuel control to become active. The ECM provides a pulse width modulated control circuit to adjust current through the heater. When the HO2S is cold, the value of the resistance is low and the current in the circuit is high. On the contrary, if the temperature in the resistor of the sensor rises, the current drops gradually.

DTC Description

If the ECM detects short to battery in heater under detecting conditions, ECM sets P0038. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

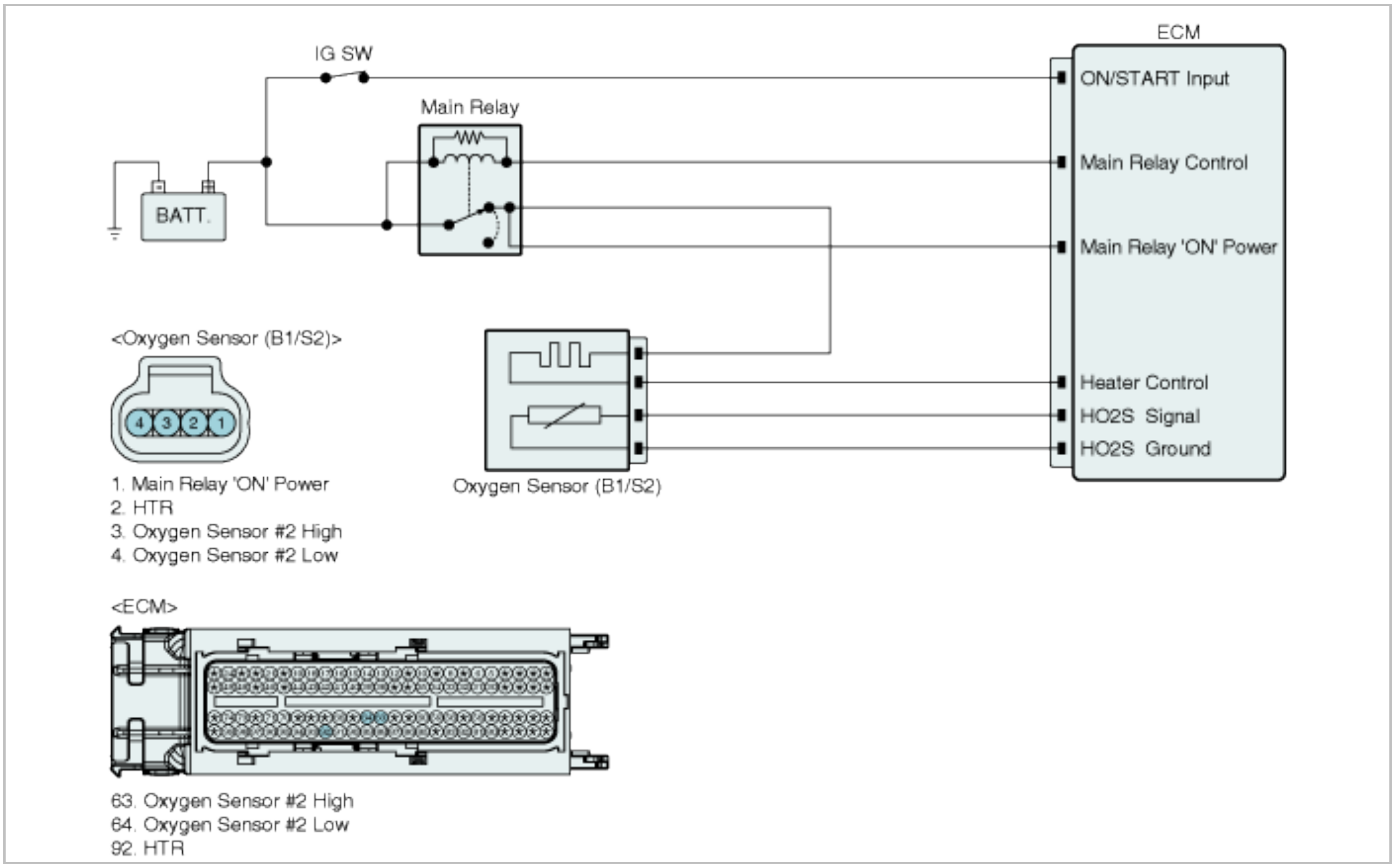
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Detects a short to battery	• Poor Connection • Short to battery in control circuit • HO2S(B1/S2) • ECM
Enable Conditions	• No disabling Faults • Engine Running • 11V ≤ Battery Voltage ≤ 16V	
Threshold value	• Short to battery	
Diagnosis Time	• Continuous (More than 5 seconds failure for every 10 seconds test)	
MIL On Condition	• 2 Driving Cycles	

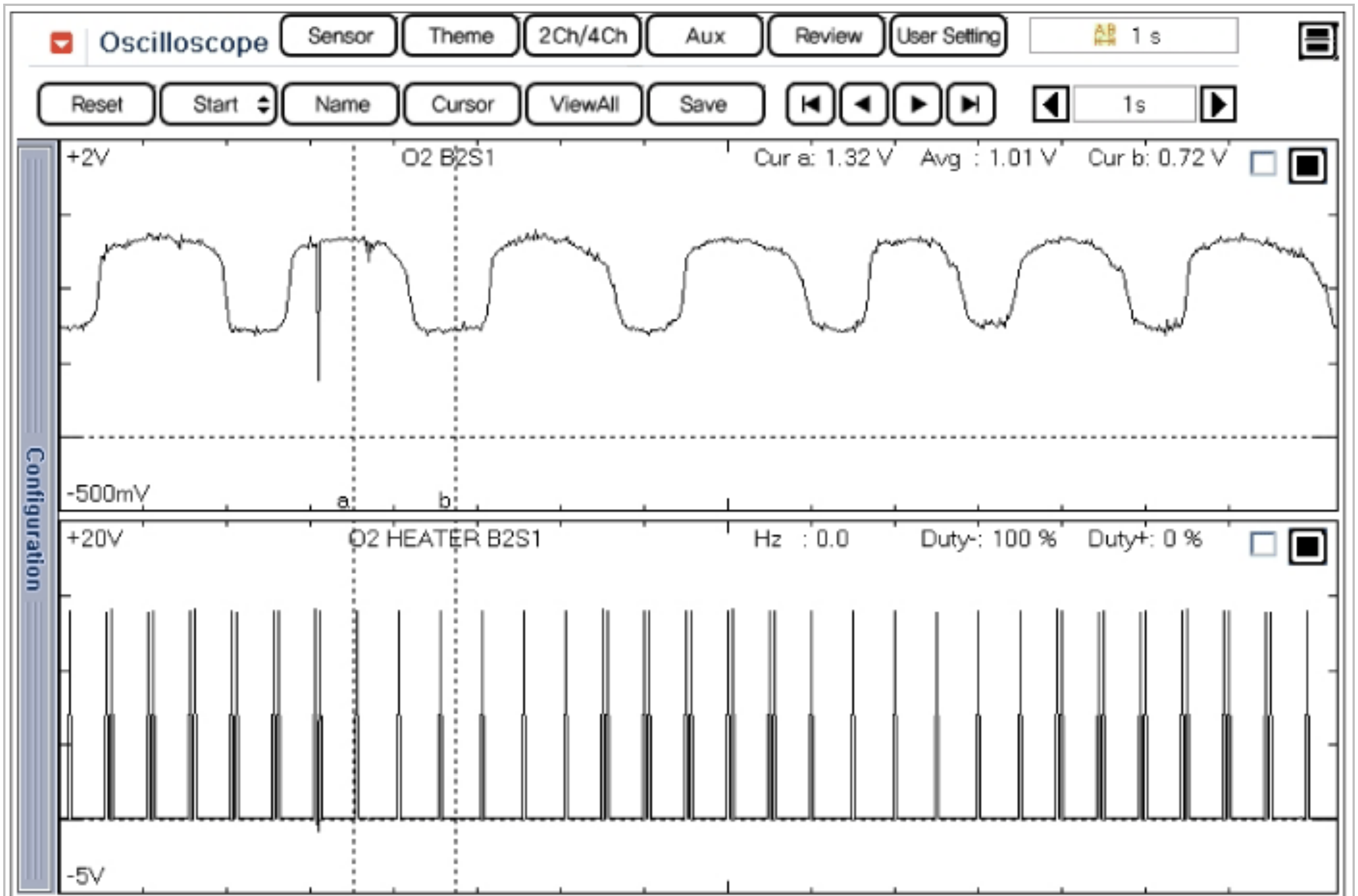
Specification

Heater	
Resistance (Ω)	8.1 ~ 11.1 Ω at 21°C(69.8°F)

Diagnostic Circuit Diagram



Signal Waveform & Data


Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
1 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 1.32 V
Avg : 1.01 V
Cur b: 0.72 V
-500mV
a
b
+20V
O2 HEATER B2S1
Hz : 0.0
Duty-: 100 %
Duty+: 0 %
-5V
Fig.1

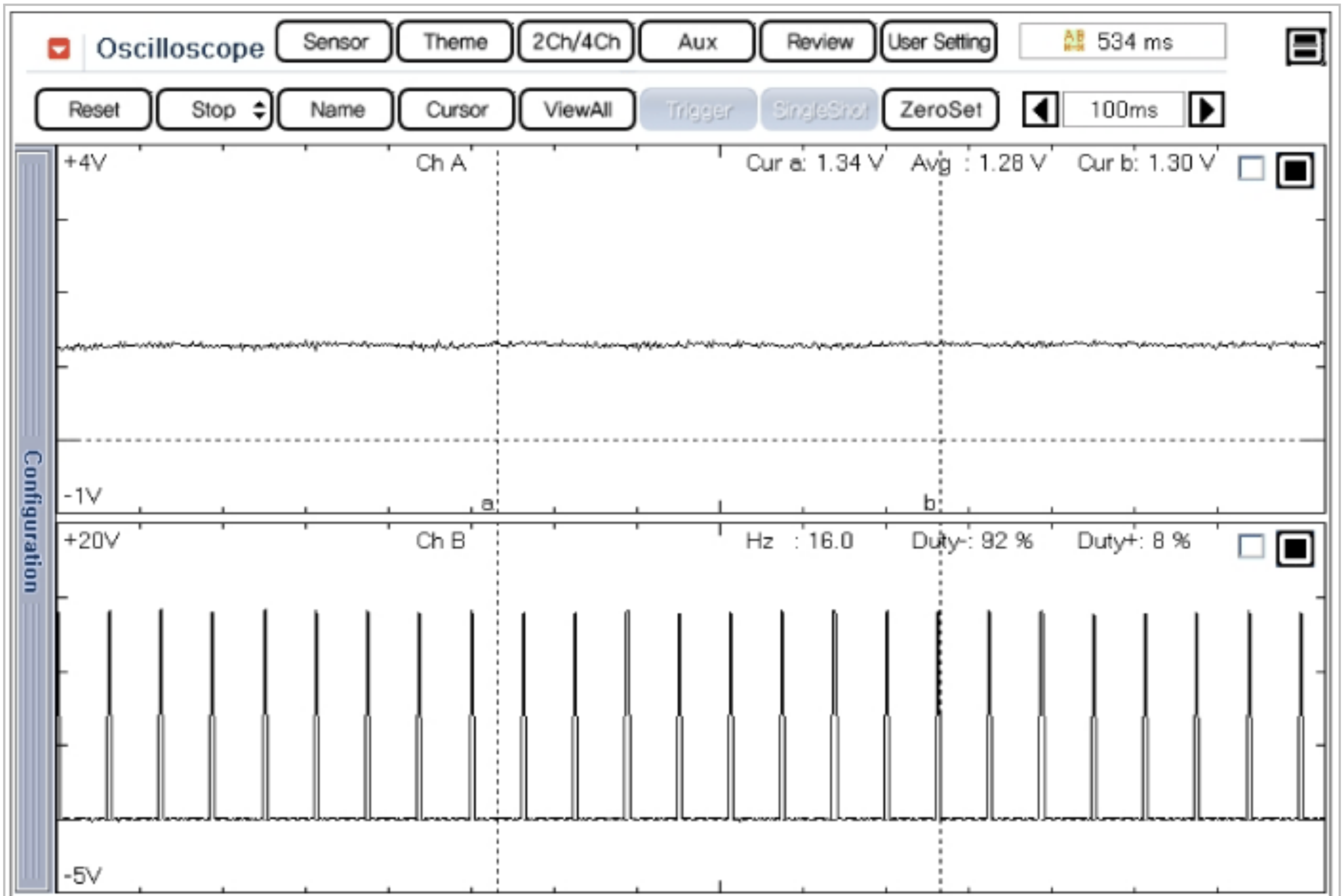
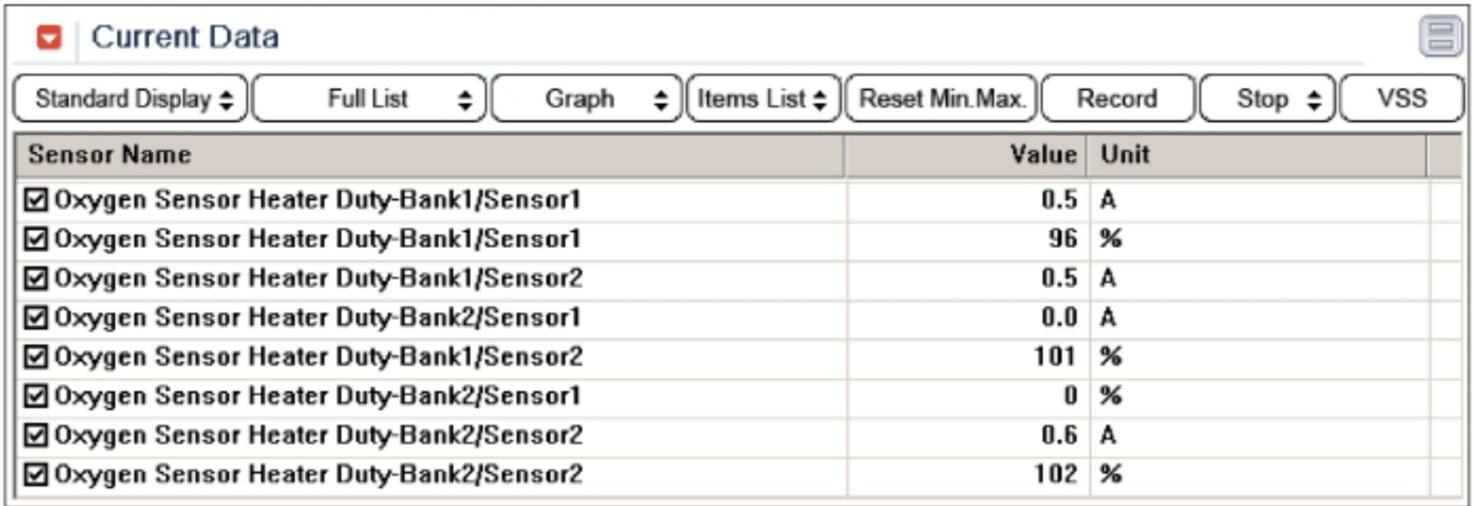


Fig.2

Sensor Name	Value	Unit
☑ Oxygen Sensor Heater Duty-Bank1/Sensor1	0.5	A
☑ Oxygen Sensor Heater Duty-Bank1/Sensor1	97	%
☑ Oxygen Sensor Heater Duty-Bank1/Sensor2	0.5	A
☑ Oxygen Sensor Heater Duty-Bank2/Sensor1	0.5	A
☑ Oxygen Sensor Heater Duty-Bank1/Sensor2	100	%
☑ Oxygen Sensor Heater Duty-Bank2/Sensor1	97	%
☑ Oxygen Sensor Heater Duty-Bank2/Sensor2	0.6	A
☑ Oxygen Sensor Heater Duty-Bank2/Sensor2	100	%

Fig.3



Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | VSS

Sensor Name	Value	Unit
☑ Oxygen Sensor Heater Duty-Bank1/Sensor1	0.5	A
☑ Oxygen Sensor Heater Duty-Bank1/Sensor1	96	%
☑ Oxygen Sensor Heater Duty-Bank1/Sensor2	0.5	A
☑ Oxygen Sensor Heater Duty-Bank2/Sensor1	0.0	A
☑ Oxygen Sensor Heater Duty-Bank1/Sensor2	101	%
☑ Oxygen Sensor Heater Duty-Bank2/Sensor1	0	%
☑ Oxygen Sensor Heater Duty-Bank2/Sensor2	0.6	A
☑ Oxygen Sensor Heater Duty-Bank2/Sensor2	102	%

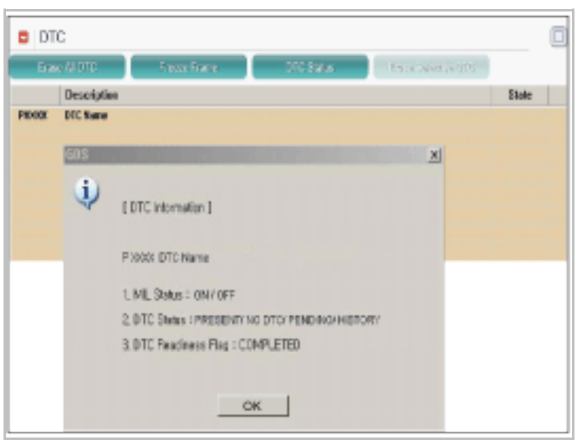
Fig.4

Fig.1) The signal waveforms of front HO2S(the lower) and heater(the upper) at idle
Fig.2) The signal waveforms of rear HO2S(the upper) and heater(the lower) at idle
Fig.3) The Normal data of HO2S heaters at idle
Fig.4) The data of HO2S heaters at open condition in HO2S(B2S1) circuit

The output voltage of front HO2S is changed continuously accroding to air/fuel ratio, ECM controls fuel amount based on this value. Preheating is necessary for HO2S normal operation. Therefore heater unit is installed in HO2S, ECM can control air/fuel ratio with the output signal of HO2S simultaneous with engine run by reducing preheating time. ECM controls heater with duty cycle. HO2S' power source is main relay and ECM operates heater by ground control.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Control Circuit Inspection" procedure.

Control Circuit Inspection

■ Check voltage

1. IG "OFF" & Disconnect HO2S(B1/S2) connector.
2. IG "ON".
3. Measure voltage between control terminal of HO2S(B1/S2) heater harness connector and chassis ground.

Specification : Approx. 3.5 V

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to battery in HO2S(B1/S2) Heater control circuit and go to "Verification of Vhicle Repair" procedure.

Component Inspection

■ Check HO2S(B1/S2) Heater resistance

1. IG "OFF" and disconnect HO2S(B1/S2) connector
2. Measure resistance between power and control terminals of HO2S(B1/S2) heater(Component Side)

Specification : 8.1 ~ 11.1 Ω at 21°C(69.8°F)

3. Is the measured resistance within specification?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

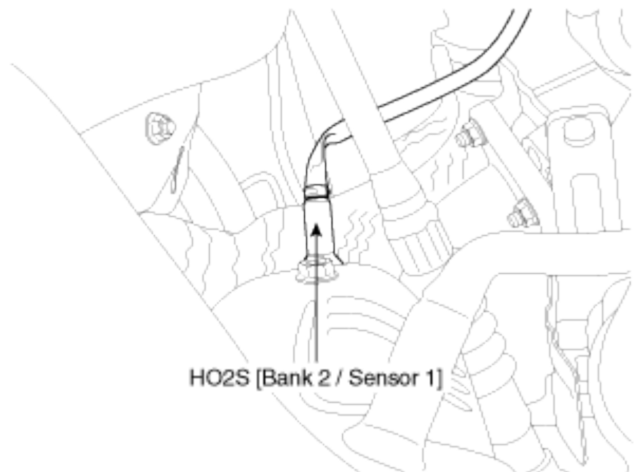
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0050 HO2S Heater Control Circuit (Bank 2 / Sensor 1)

Component Location



General Description

The normal operating temperature of the HO2S(Heated Oxygen Sensor) ranges from 350 to 850°C(662 to 1562°F). The HO2S heater greatly decreases the amount of time required for fuel control to become active. The ECM provides a pulse width modulated control circuit to adjust current through the heater. When the HO2S is cold, the value of the resistance is low and the current in the circuit is high. On the contrary, if the temperature in the resistor of the sensor rises, the current drops gradually.

DTC Description

Checking current from HO2S under detecting condition,if the heater current is below a certain threshold for more than predeterminate time, ECM sets P0050. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Monitor the current through the heater	

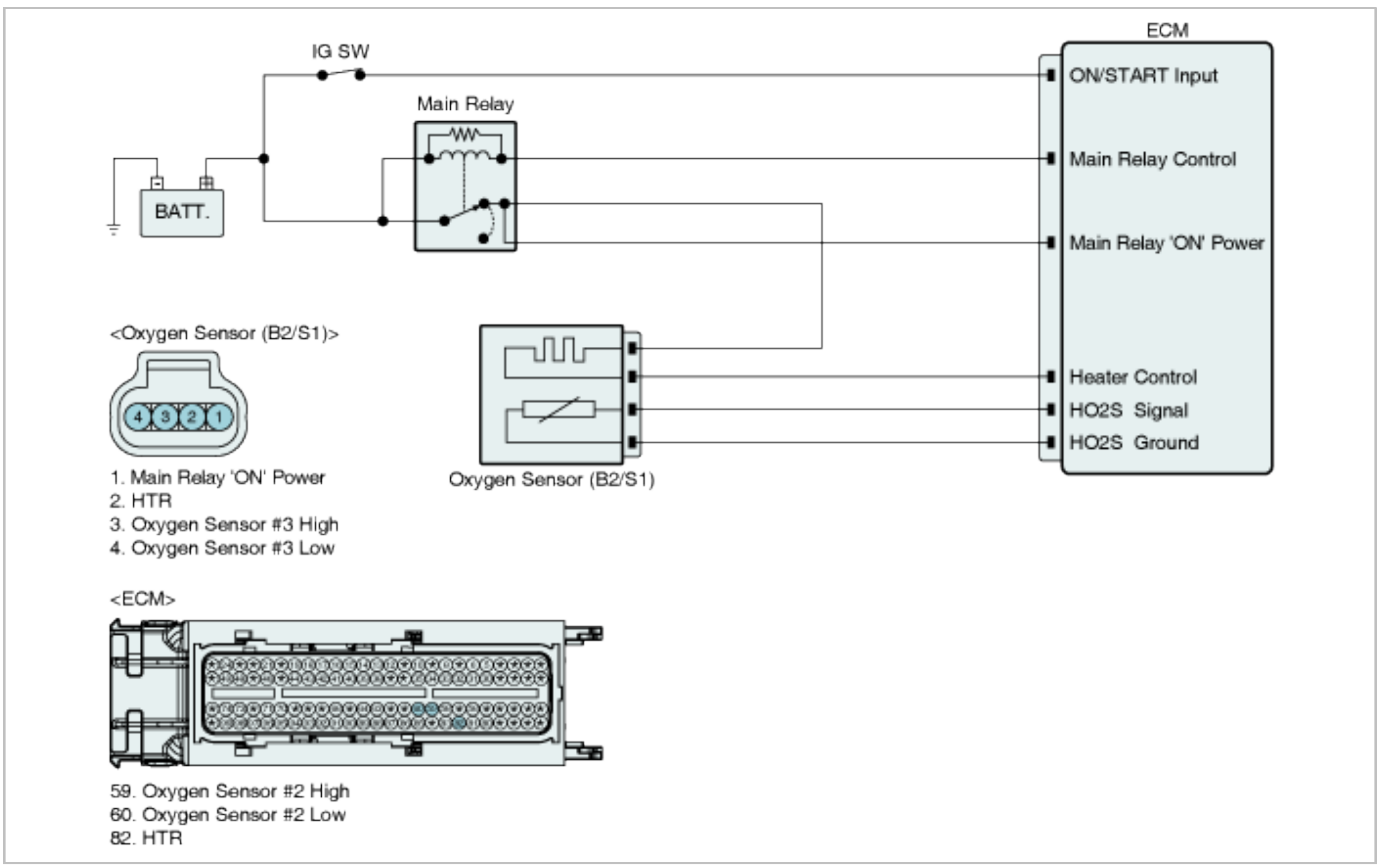
Enable Conditions	• Engine Running > 60 sec • Heater Duty Cycle > 40% • Max. Duty Cycle - Min. Duty Cycle < 5%	• Poor Connection • HO2S(B2/S1) • ECM
Threshold value	• Filtered Heater Current < threshold value	
Diagnosis Time	• Continuous (More than 2.5 second failure for every 5 second test)	
MIL On Condition	• 2 Driving Cycles	

Specification

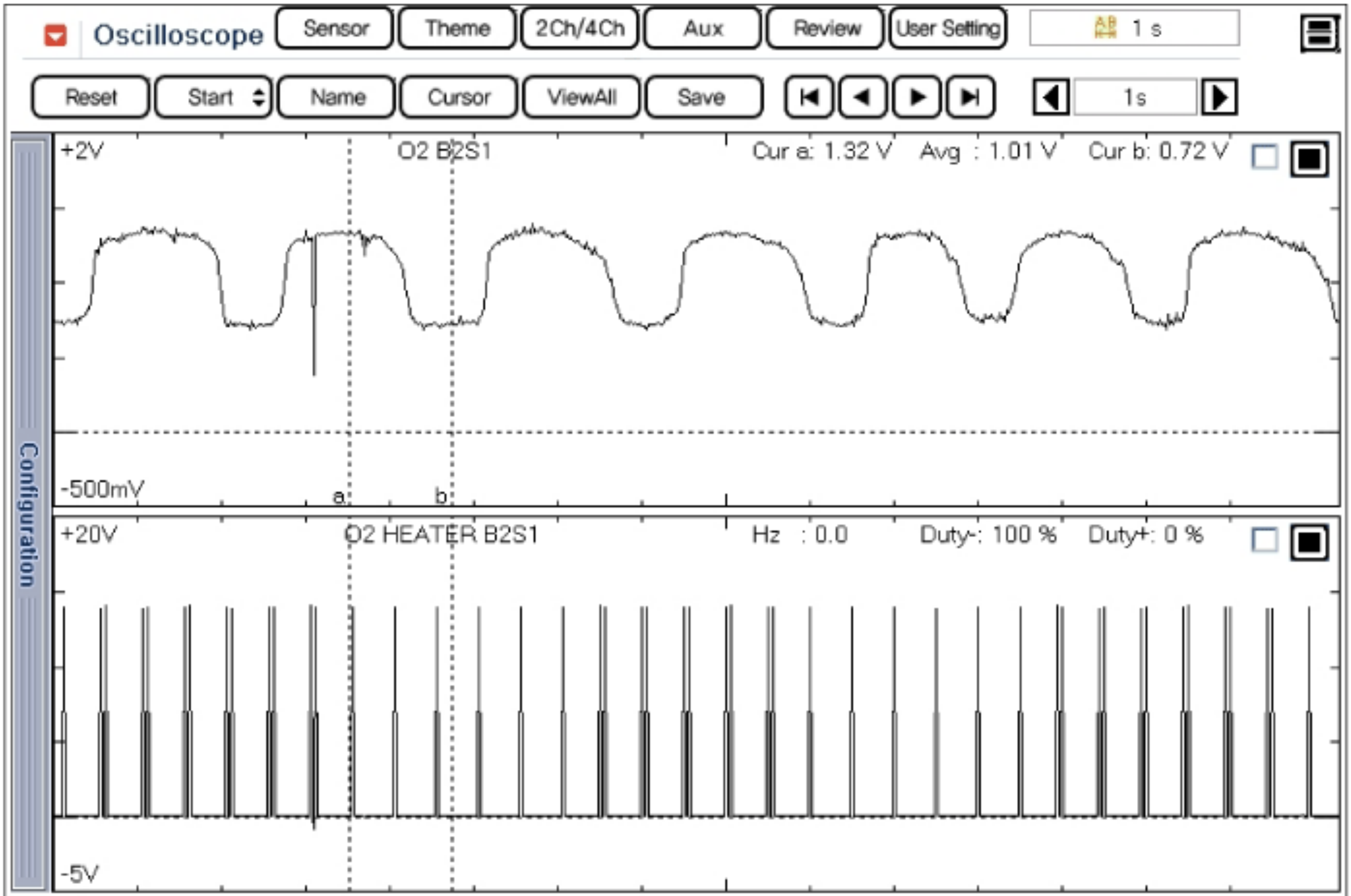
(Reference only)

Condition	Current(A)
Heater Current at 13.5V, 450°C(842°F) Exhaust	0.52 ± 0.1

Diagnostic Circuit Diagram



Signal Waveform & Data



Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
1 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
+2V
O2 B2S1
Cur a: 1.32 V
Avg : 1.01 V
Cur b: 0.72 V
-500mV
a
b
+20V
O2 HEATER B2S1
Hz : 0.0
Duty-: 100 %
Duty+: 0 %
-5V
Configuration

Fig.1

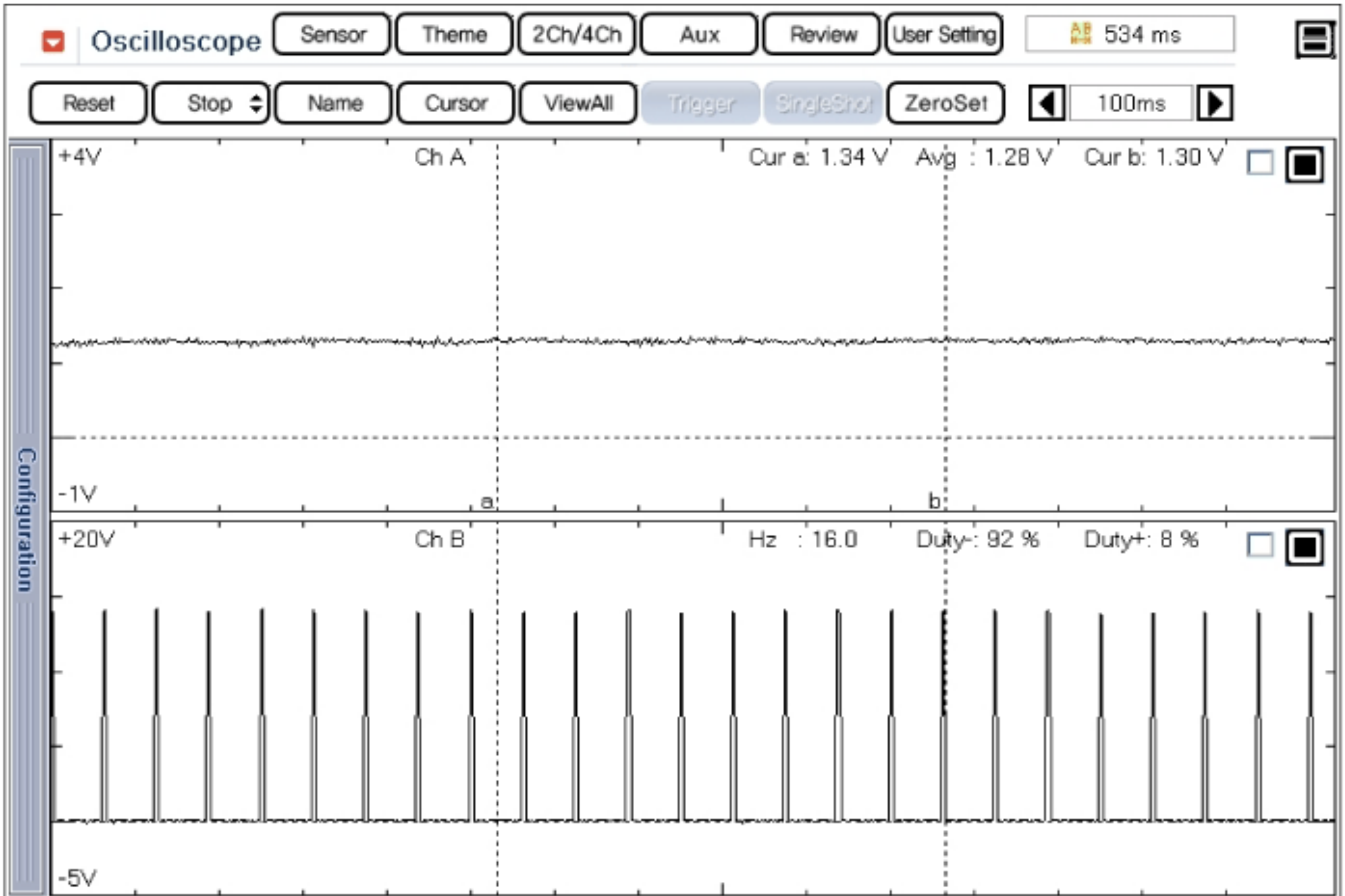
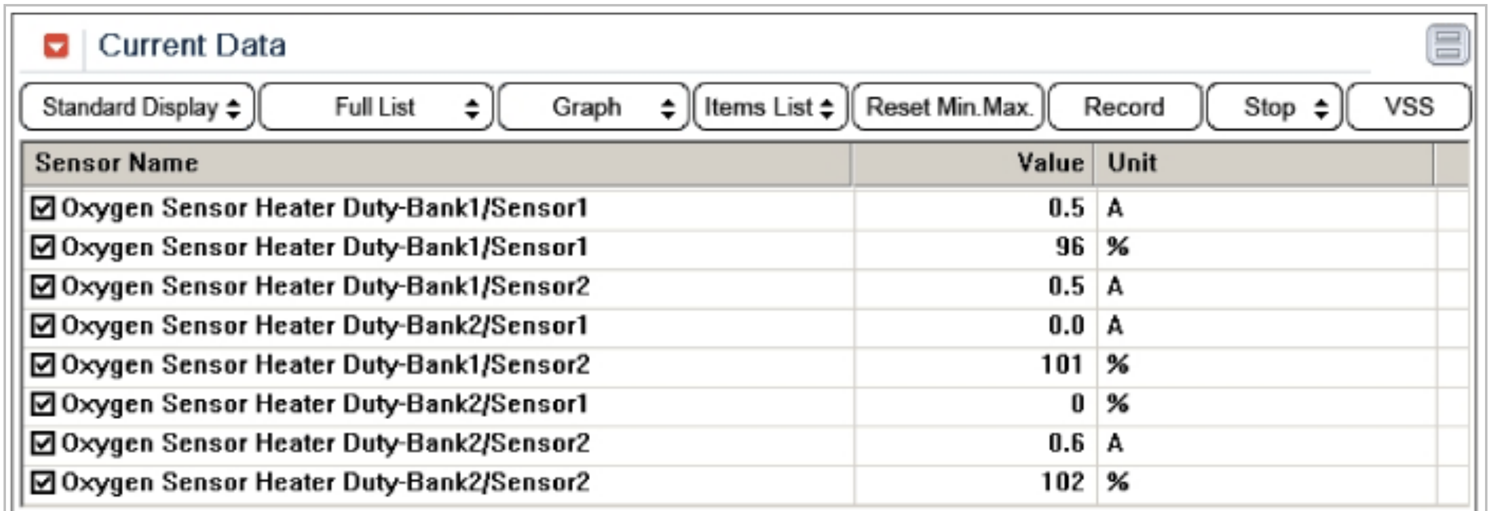


Fig.2

Sensor Name	Value	Unit
☑ Oxygen Sensor Heater Duty-Bank1/Sensor1	0.5	A
☑ Oxygen Sensor Heater Duty-Bank1/Sensor1	97	%
☑ Oxygen Sensor Heater Duty-Bank1/Sensor2	0.5	A
☑ Oxygen Sensor Heater Duty-Bank2/Sensor1	0.5	A
☑ Oxygen Sensor Heater Duty-Bank1/Sensor2	100	%
☑ Oxygen Sensor Heater Duty-Bank2/Sensor1	97	%
☑ Oxygen Sensor Heater Duty-Bank2/Sensor2	0.6	A
☑ Oxygen Sensor Heater Duty-Bank2/Sensor2	100	%

Fig.3



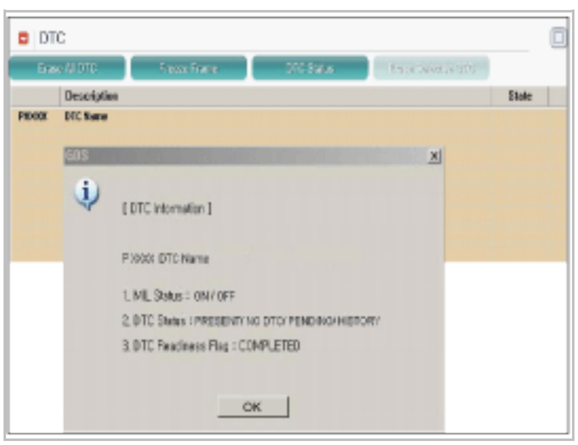
Sensor Name	Value	Unit
Oxygen Sensor Heater Duty-Bank1/Sensor1	0.5	A
Oxygen Sensor Heater Duty-Bank1/Sensor1	96	%
Oxygen Sensor Heater Duty-Bank1/Sensor2	0.5	A
Oxygen Sensor Heater Duty-Bank2/Sensor1	0.0	A
Oxygen Sensor Heater Duty-Bank1/Sensor2	101	%
Oxygen Sensor Heater Duty-Bank2/Sensor1	0	%
Oxygen Sensor Heater Duty-Bank2/Sensor2	0.6	A
Oxygen Sensor Heater Duty-Bank2/Sensor2	102	%

Fig.4

Fig.1) The signal waveforms of front HO2S(the lower) and heater(the upper) at idle
Fig.2) The signal waveforms of rear HO2S(the upper) and heater(the lower) at idle
Fig.3) The Normal data of HO2S heaters at idle
Fig.4) The data of HO2S heaters at open condition in HO2S(B2S1) circuit
The output voltage of front HO2S is changed continuously accroding to air/fuel ratio, ECM controls fuel amount based on this value. Preheating is necessary for HO2S normal operation. Therefore heater unit is installed in HO2S, ECM can control air/fuel ratio with the output signal of HO2S simultaneous with engine run by reducing preheating time. ECM controls heater with duty cycle. HO2S' power source is main relay and ECM operates heater by ground control.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Component Inspection" procedure.

Component Inspection

■ **Check HO2S(B2/S1) Heater resistance**

1. IG "OFF" and disconnect HO2S(B2/S1) connector
2. Measure resistance between power and control terminals of HO2S(B2/S1) heater(Component Side)

Specification : 8.1 ~ 11.1 Ω at 21°C(69.8°F)

3. Is the measured resistance within specification?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

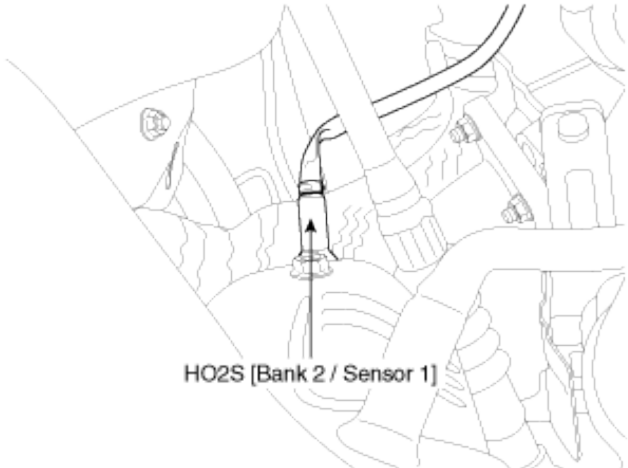
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0051 HO2S Heater Control Circuit Low (Bank 2 /

Sensor 1)

Component Location



General Description

The normal operating temperature of the HO2S(Heated Oxygen Sensor) ranges from 350 to 850°C(662 to 1562°F). The HO2S heater greatly decreases the amount of time required for fuel control to become active. The ECM provides a pulse width modulated control circuit to adjust current through the heater. When the HO2S is cold, the value of the resistance is low and the current in the circuit is high. On the contrary, if the temperature in the resistor of the sensor rises, the current drops gradually.

DTC Description

If the ECM detects short to ground or open in heater under detecting conditions, ECM sets P0051. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

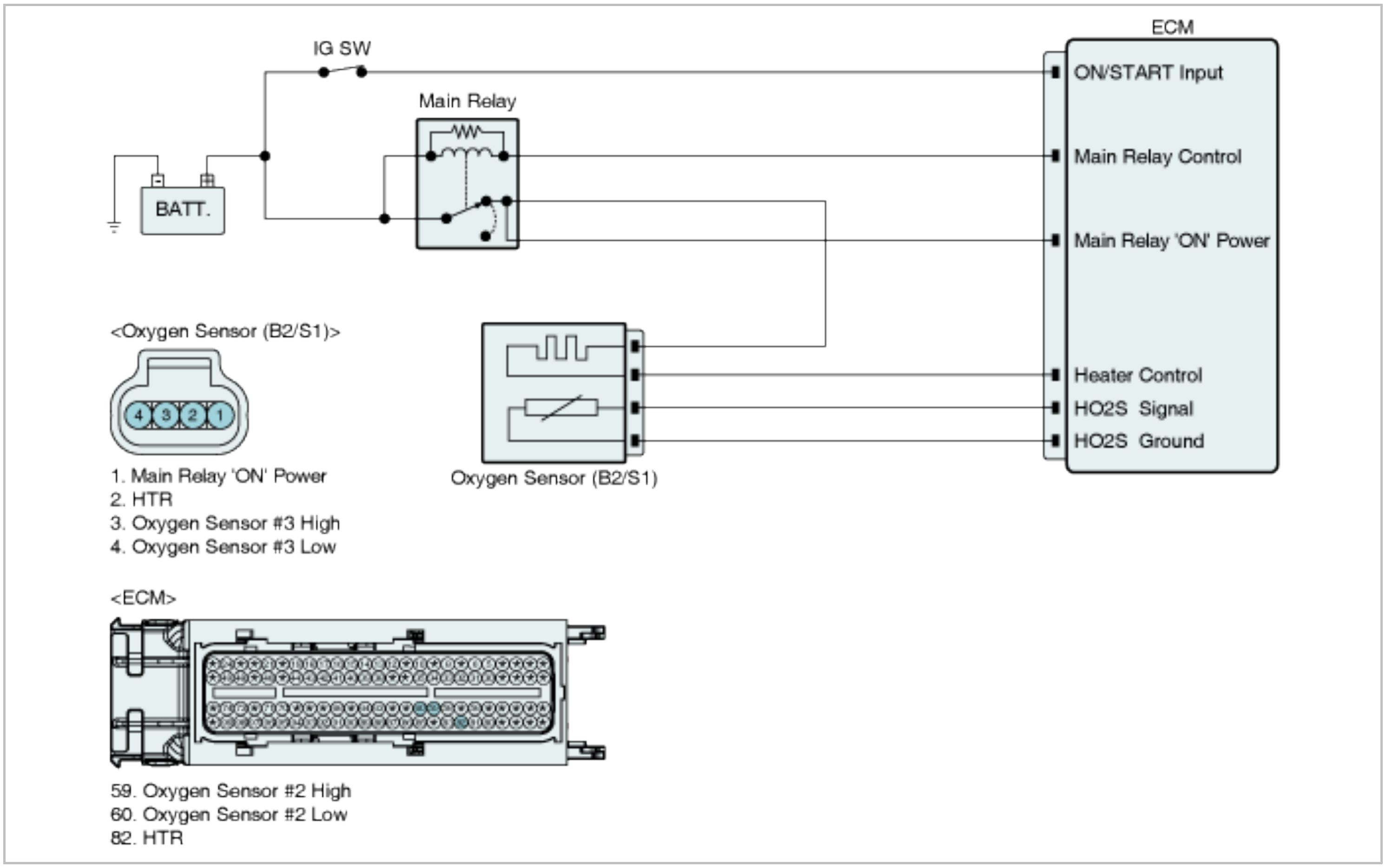
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Detects a short to ground or open	• Poor Connection • Open in Power Circuit • Open or short to ground in control circuit • HO2S(B2/S1) • ECM
Enable Conditions	• No disabling Faults • Engine Running • 11V ≤ Battery Voltage ≤ 16V	
Threshold value	• Short to ground or open circuit	
Diagnosis Time	• Continuous (More than 5 seconds failure for every 10 seconds test)	
MIL On Condition	• 2 Driving Cycles	

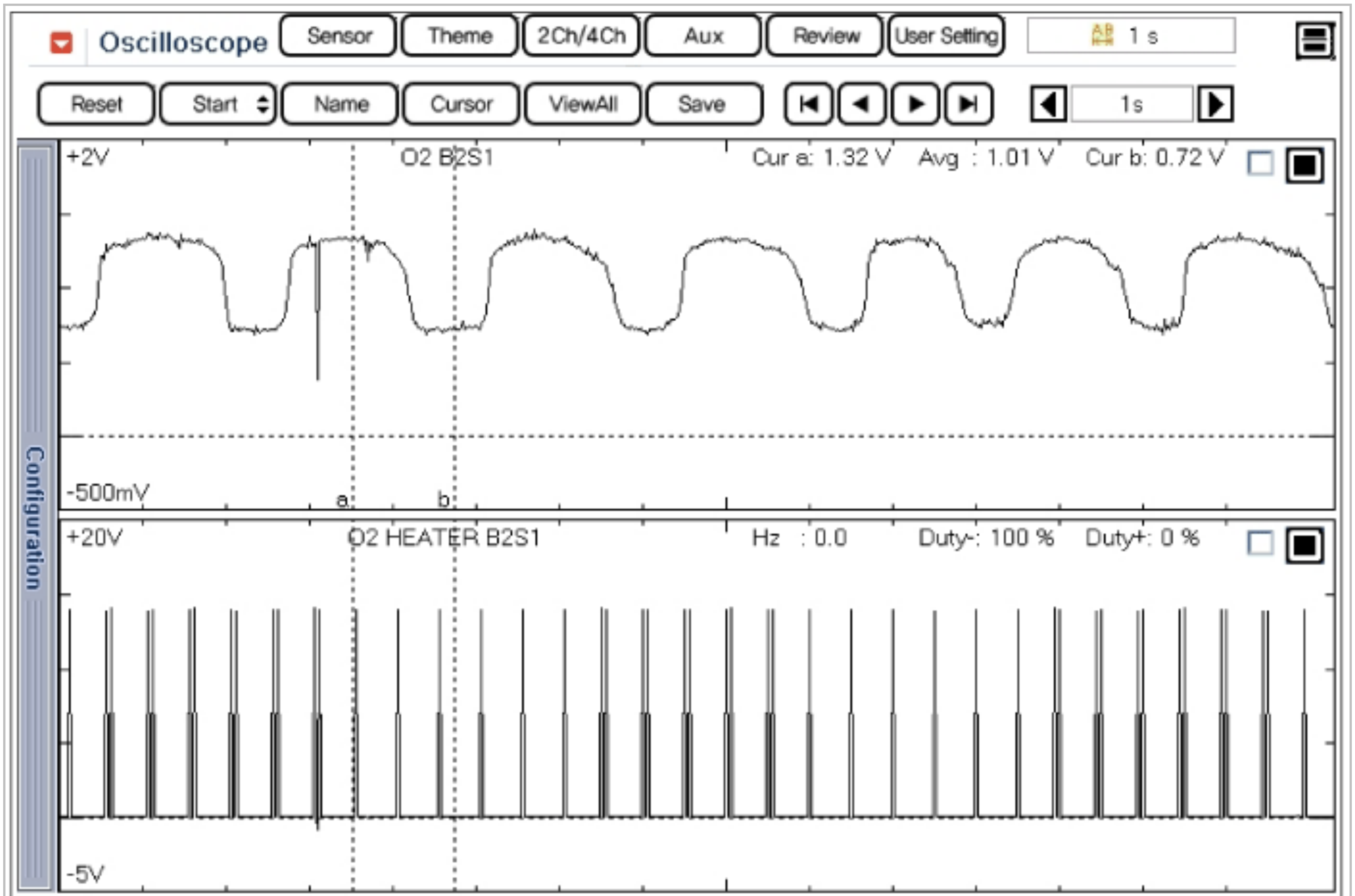
Specification

Heater	
Resistance (Ω)	8.1 ~ 11.1 Ω at 21°C(69.8°F)

Diagnostic Circuit Diagram



Signal Waveform & Data


Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
1 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 1.32 V
Avg : 1.01 V
Cur b: 0.72 V
-500mV
a
b
+20V
O2 HEATER B2S1
Hz : 0.0
Duty-: 100 %
Duty+: 0 %
-5V
Fig.1

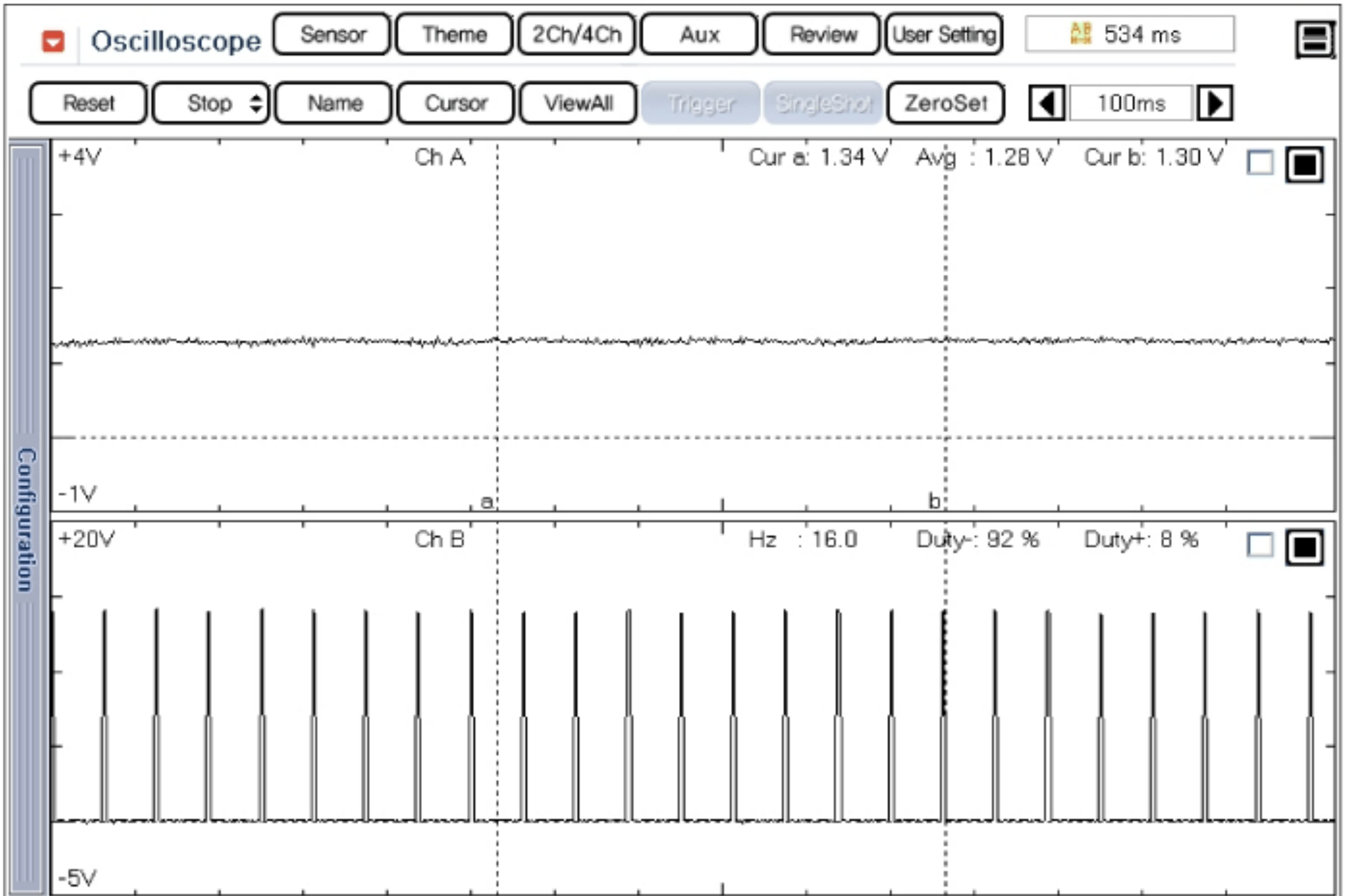
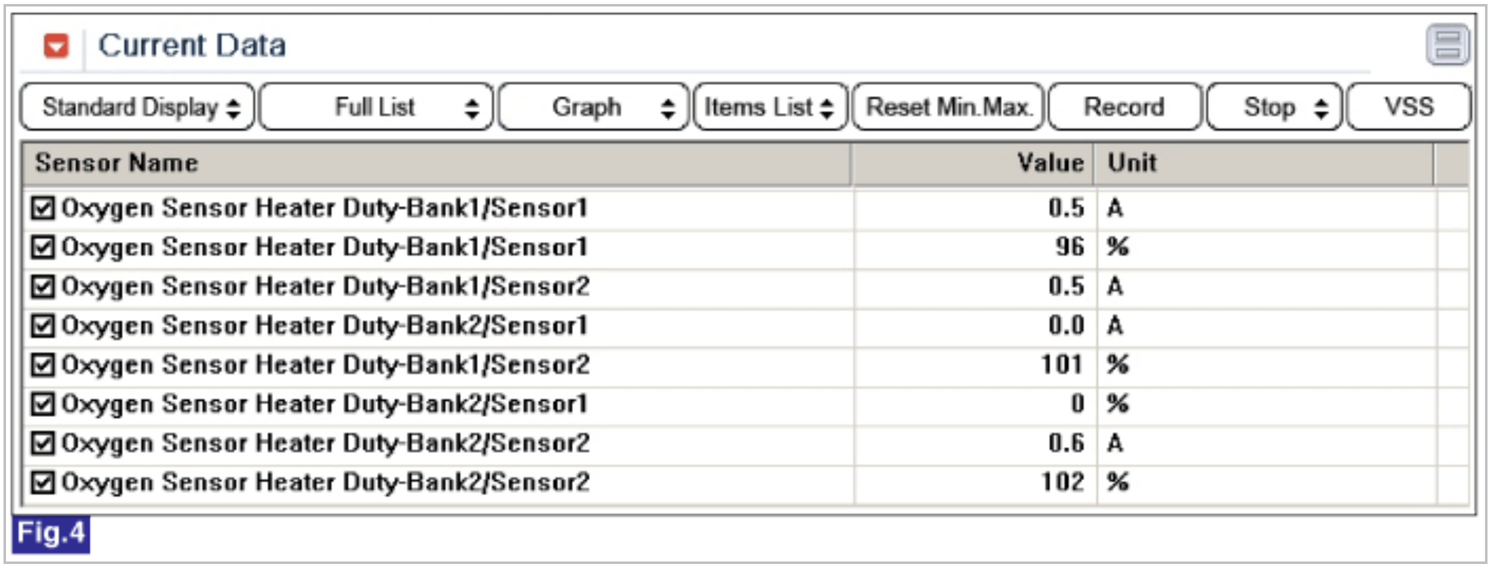


Fig.2

Sensor Name	Value	Unit
☑ Oxygen Sensor Heater Duty-Bank1/Sensor1	0.5	A
☑ Oxygen Sensor Heater Duty-Bank1/Sensor1	97	%
☑ Oxygen Sensor Heater Duty-Bank1/Sensor2	0.5	A
☑ Oxygen Sensor Heater Duty-Bank2/Sensor1	0.5	A
☑ Oxygen Sensor Heater Duty-Bank1/Sensor2	100	%
☑ Oxygen Sensor Heater Duty-Bank2/Sensor1	97	%
☑ Oxygen Sensor Heater Duty-Bank2/Sensor2	0.6	A
☑ Oxygen Sensor Heater Duty-Bank2/Sensor2	100	%

Fig.3



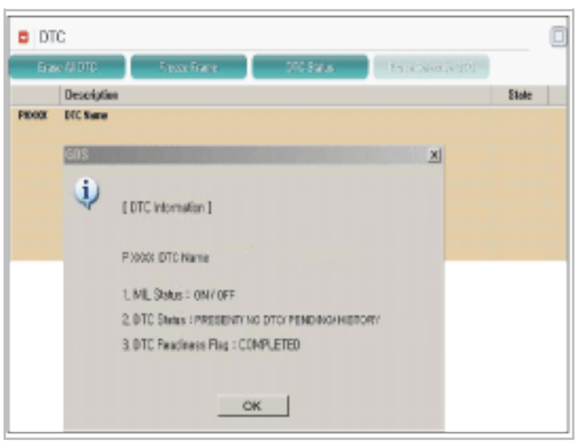
Sensor Name	Value	Unit
Oxygen Sensor Heater Duty-Bank1/Sensor1	0.5	A
Oxygen Sensor Heater Duty-Bank1/Sensor1	96	%
Oxygen Sensor Heater Duty-Bank1/Sensor2	0.5	A
Oxygen Sensor Heater Duty-Bank2/Sensor1	0.0	A
Oxygen Sensor Heater Duty-Bank1/Sensor2	101	%
Oxygen Sensor Heater Duty-Bank2/Sensor1	0	%
Oxygen Sensor Heater Duty-Bank2/Sensor2	0.6	A
Oxygen Sensor Heater Duty-Bank2/Sensor2	102	%

Fig.4

Fig.1) The signal waveforms of front HO2S(the lower) and heater(the upper) at idle
Fig.2) The signal waveforms of rear HO2S(the upper) and heater(the lower) at idle
Fig.3) The Normal data of HO2S heaters at idle
Fig.4) The data of HO2S heaters at open condition in HO2S(B2S1) circuit
The output voltage of front HO2S is changed continuously accroding to air/fuel ratio, ECM controls fuel amount based on this value. Preheating is necessary for HO2S normal operation. Therefore heater unit is installed in HO2S, ECM can control air/fuel ratio with the output signal of HO2S simultaneous with engine run by reducing preheating time. ECM controls heater with duty cycle. HO2S' power source is main relay and ECM operates heater by ground control.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Power Circuit Inspection" procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" & Disconnect HO2S(B2/S1) connector.
2. IG "ON".
3. Measure voltage between power terminal of HO2S(B2/S1) heater harness connector and chassis ground.

Specification : B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.
NO	▶ Repair open or short to ground in HO2S(B2/S1) Heater power circuit then, go to "Verification of Vehicle Repair" procedure.

Control Circuit Inspection

■ Check short to ground

1. IG "OFF" & Disconnect HO2S(B2/S1) connector.
2. Measure resistance between control terminal of HO2S(B2/S1) heater harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.
NO	▶ Repair short to ground in HO2S(B2/S1) heater control circuit and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect HO2S(B2/S1) and ECM connector.
2. Measure resistance between control terminal of HO2S(B2/S1) heater harness connector and heater control terminal of ECM harness connector.

Specification : Approx. below 1Ω

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in HO2S(B2/S1) heater control circuit and go to "Verifiction of Vehicle Repair" procedure.

Component Inspection

■ Check HO2S(B2/S1) Heater resistance

1. IG "OFF" and disconnect HO2S(B2/S1) connector
2. Measure resistance between power and control terminals of HO2S(B2/S1) heater(Component Side)

Specification : 8.1 ~ 11.1 Ω at 21°C(69.8°F)

3. Is the measured resistance within specification?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

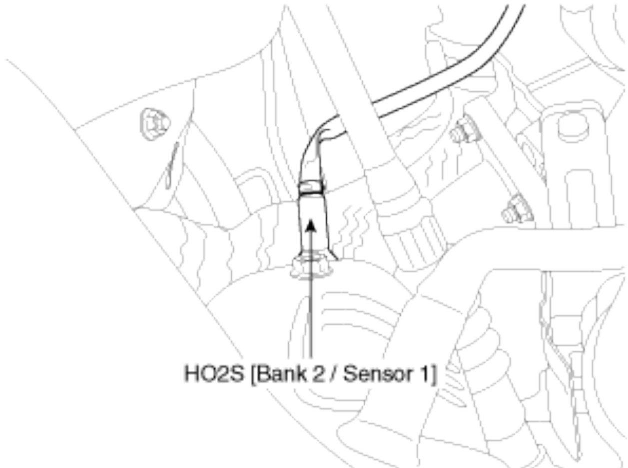
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0052 HO2S Heater Control Circuit High (Bank 2 / Sensor 1)

Component Location



General Description

The normal operating temperature of the HO2S(Heated Oxygen Sensor) ranges from 350 to 850°C(662 to 1562°F). The HO2S heater greatly decreases the amount of time required for fuel control to become active. The ECM provides a pulse width modulated control circuit to adjust current through the heater. When the HO2S is cold, the value of the resistance is low and the current in the circuit is high. On the contrary, if the temperature in the resistor of the sensor rises, the current drops gradually.

DTC Description

If the ECM detects short to battery in heater under detecting conditions, ECM sets P0052. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

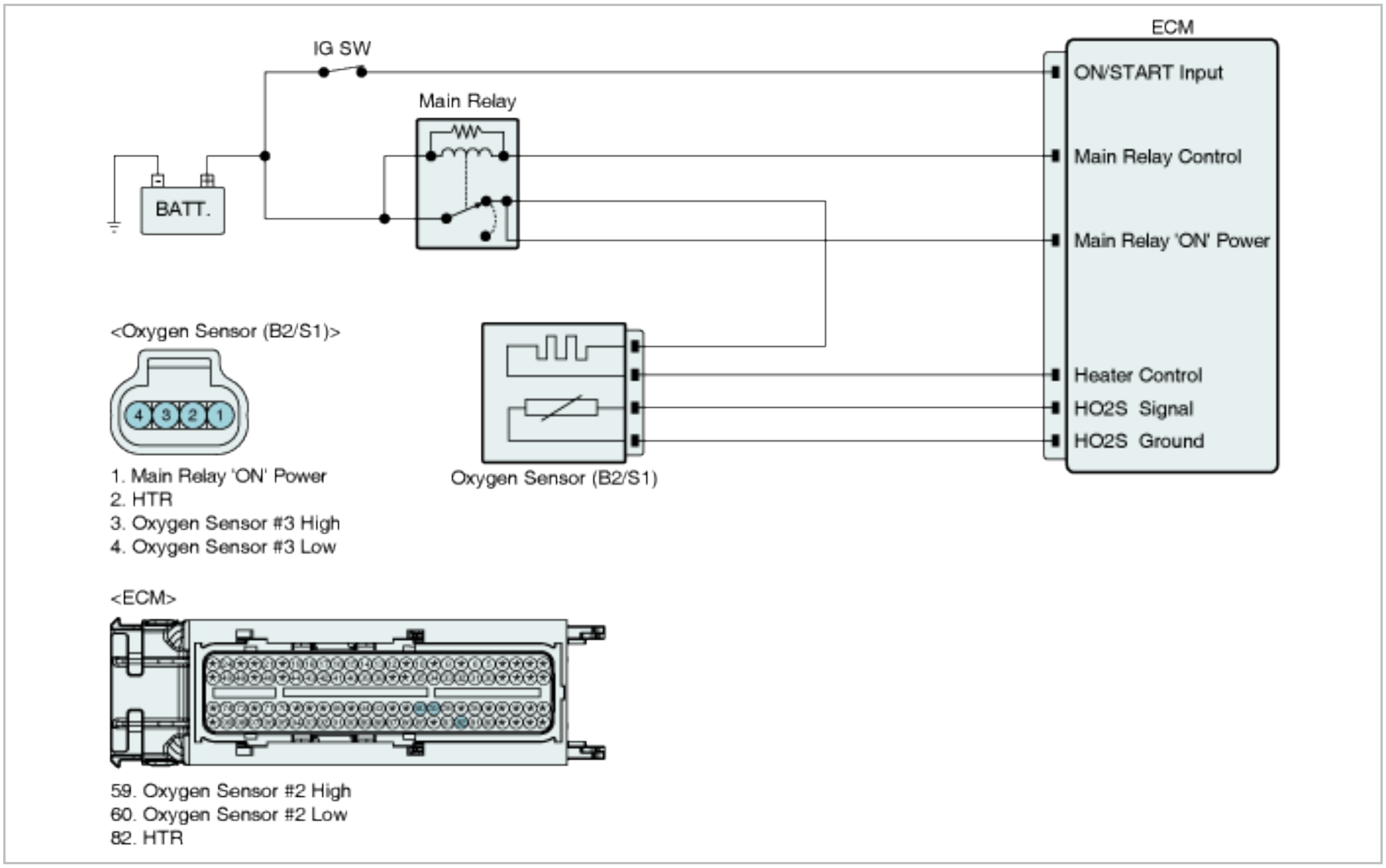
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Detects a short to battery	• Poor Connection • Short to battery in control circuit • HO2S(B2/S1) • ECM
Enable Conditions	• No disabling Faults • Engine Running • 11V ≤ Battery Voltage ≤ 16V	
Threshold value	• Short to battery	
Diagnosis Time	• Continuous (More than 5 seconds failure for every 10 seconds test)	
MIL On Condition	• 2 Driving Cycles	

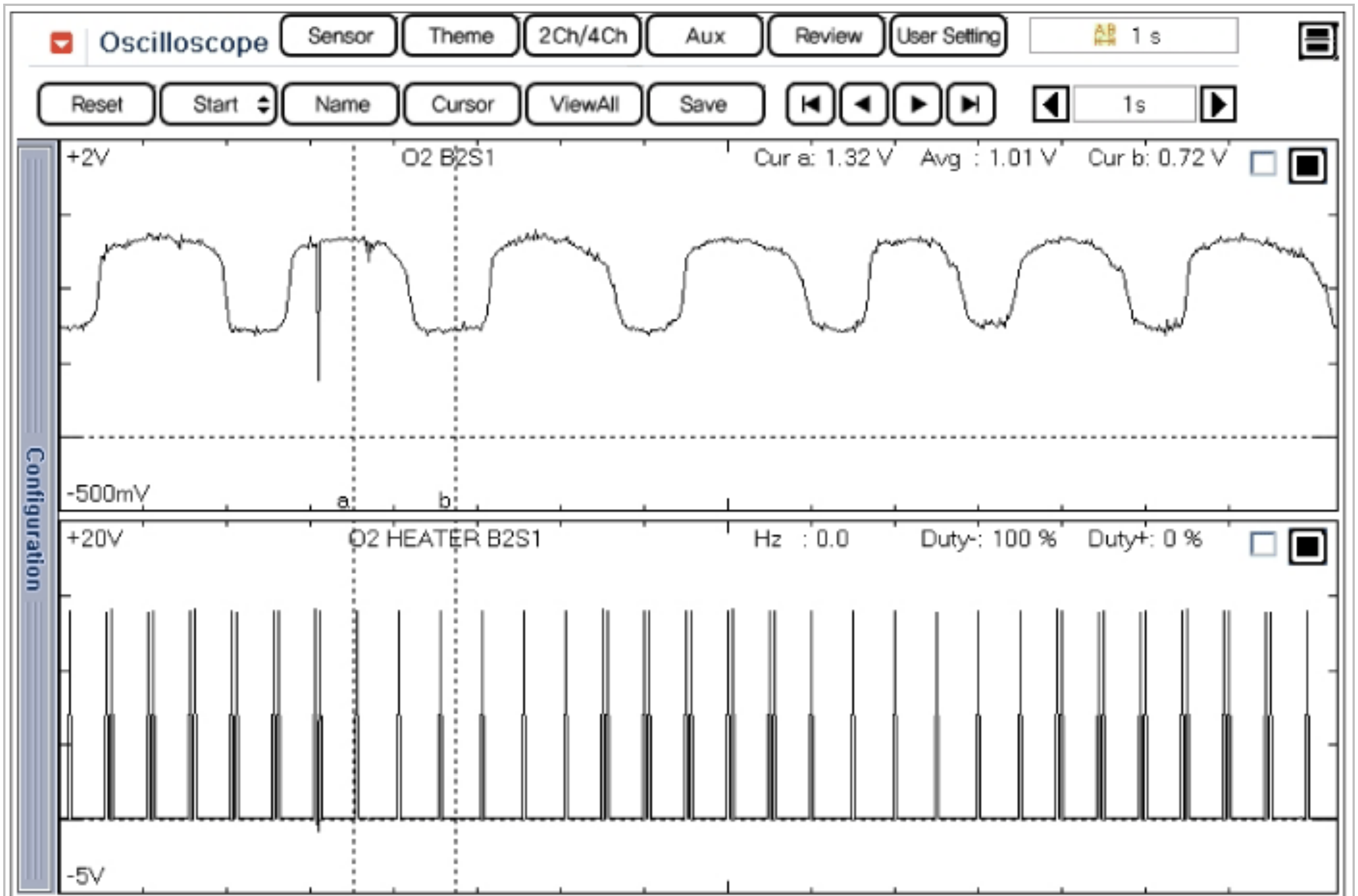
Specification

Heater	
Resistance (Ω)	8.1 ~ 11.1 Ω at 21°C(69.8°F)

Diagnostic Circuit Diagram



Signal Waveform & Data



Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
1 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 1.32 V
Avg : 1.01 V
Cur b: 0.72 V
-500mV
a
b
+20V
O2 HEATER B2S1
Hz : 0.0
Duty-: 100 %
Duty+: 0 %
-5V

Fig.1

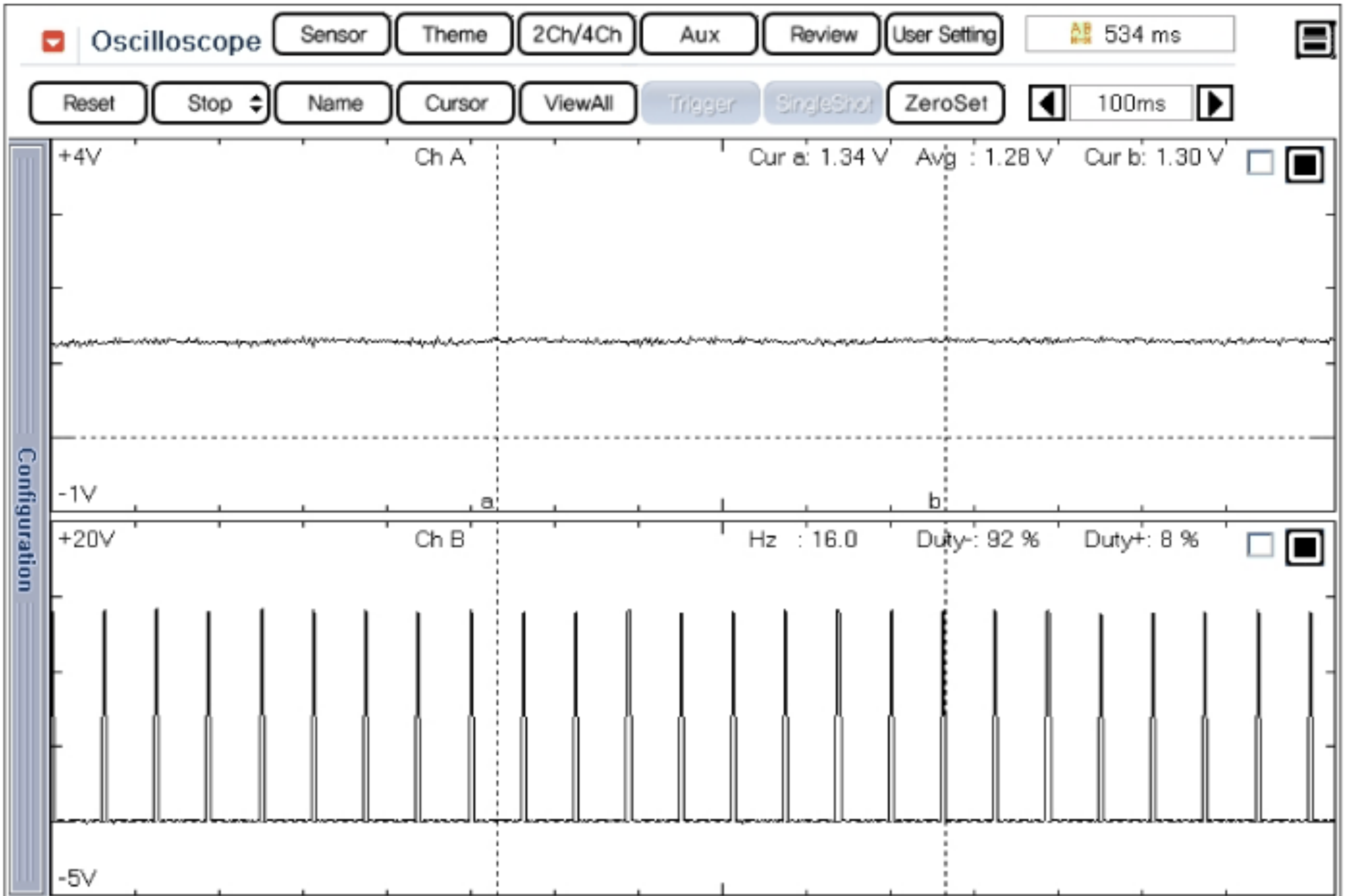
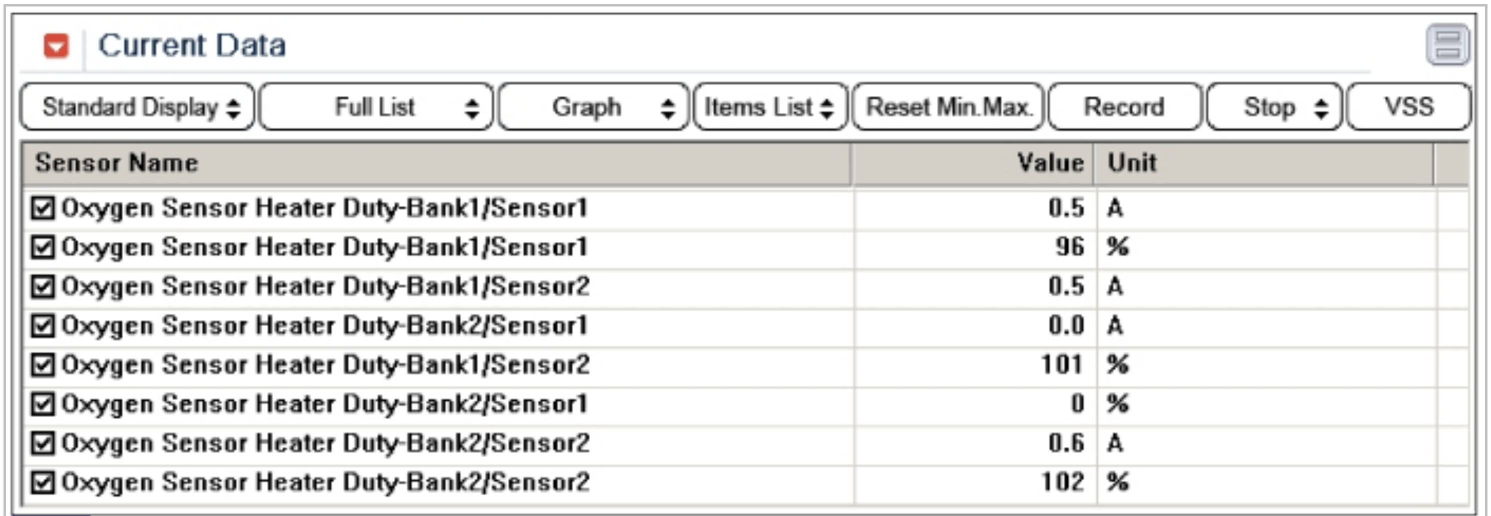


Fig.2

Sensor Name	Value	Unit
☑ Oxygen Sensor Heater Duty-Bank1/Sensor1	0.5	A
☑ Oxygen Sensor Heater Duty-Bank1/Sensor1	97	%
☑ Oxygen Sensor Heater Duty-Bank1/Sensor2	0.5	A
☑ Oxygen Sensor Heater Duty-Bank2/Sensor1	0.5	A
☑ Oxygen Sensor Heater Duty-Bank1/Sensor2	100	%
☑ Oxygen Sensor Heater Duty-Bank2/Sensor1	97	%
☑ Oxygen Sensor Heater Duty-Bank2/Sensor2	0.6	A
☑ Oxygen Sensor Heater Duty-Bank2/Sensor2	100	%

Fig.3



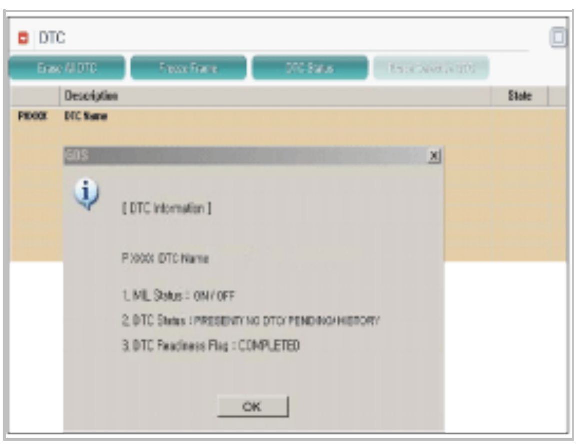
Sensor Name	Value	Unit
Oxygen Sensor Heater Duty-Bank1/Sensor1	0.5	A
Oxygen Sensor Heater Duty-Bank1/Sensor1	96	%
Oxygen Sensor Heater Duty-Bank1/Sensor2	0.5	A
Oxygen Sensor Heater Duty-Bank2/Sensor1	0.0	A
Oxygen Sensor Heater Duty-Bank1/Sensor2	101	%
Oxygen Sensor Heater Duty-Bank2/Sensor1	0	%
Oxygen Sensor Heater Duty-Bank2/Sensor2	0.6	A
Oxygen Sensor Heater Duty-Bank2/Sensor2	102	%

Fig.4

Fig.1) The signal waveforms of front HO2S(the lower) and heater(the upper) at idle
Fig.2) The signal waveforms of rear HO2S(the upper) and heater(the lower) at idle
Fig.3) The Normal data of HO2S heaters at idle
Fig.4) The data of HO2S heaters at open condition in HO2S(B2S1) circuit
The output voltage of front HO2S is changed continuously accroding to air/fuel ratio, ECM controls fuel amount based on this value. Preheating is necessary for HO2S normal operation. Therefore heater unit is installed in HO2S, ECM can control air/fuel ratio with the output signal of HO2S simultaneous with engine run by reducing preheating time. ECM controls heater with duty cycle. HO2S' power source is main relay and ECM operates heater by ground control.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Control Circuit Inspection" procedure.

Control Circuit Inspection

■ Check voltage

1. IG "OFF" & Disconnect HO2S(B2/S1) connector.
2. IG "ON".
3. Measure voltage between control terminal of HO2S(B2/S1) heater harness connector and chassis ground.

Specification : Approx. 3.5 V

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to battery in HO2S(B2/S1) Heater control circuit and go to "Verification of Vhicle Repair" procedure.

Component Inspection

■ Check HO2S(B2/S1) Heater resistance

1. IG "OFF" and disconnect HO2S(B2/S1) connector
2. Measure resistance between power and control terminals of HO2S(B2/S1) heater(Component Side)

Specification : 8.1 ~ 11.1 Ω at 21°C(69.8°F)

3. Is the measured resistance within specification?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

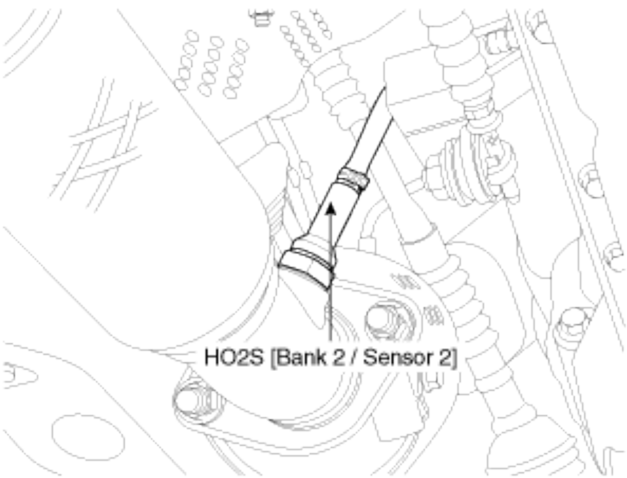
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0056 HO2S Heater Control Circuit (Bank 2 / Sensor 2)

Component Location



General Description

The normal operating temperature of the HO2S(Heated Oxygen Sensor) ranges from 350 to 850°C(662 to 1562°F). The HO2S heater greatly decreases the amount of time required for fuel control to become active. The ECM provides a pulse width modulated control circuit to adjust current through the heater. When the HO2S is cold, the value of the resistance is low and the current in the circuit is high. On the contrary, if the temperature in the resistor of the sensor rises, the current drops gradually.

DTC Description

Checking current from HO2S under detecting condition,if the heater current is below a certain threshold for more than predeterminate time, ECM sets P0056. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Monitor the current through the heater	

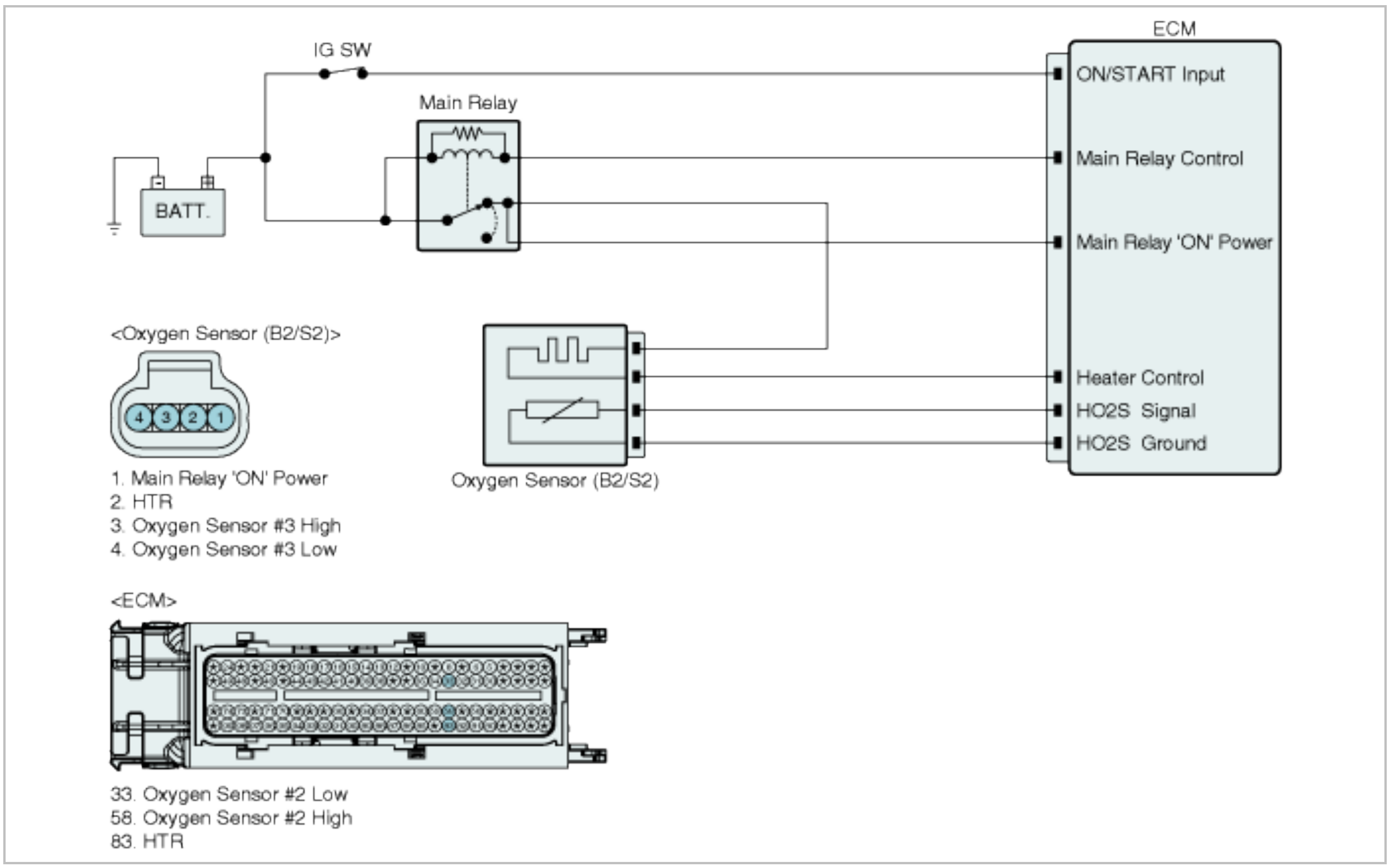
Enable Conditions	• Engine Running > 60 sec • Heater Duty Cycle > 40% • Max. Duty Cycle - Min. Duty Cycle < 5%	• Poor Connection • HO2S(B2/S2) • ECM
Threshold value	• Filtered Heater Current < threshold value	
Diagnosis Time	• Continuous (More than 2.5 second failure for every 5 second test)	
MIL On Condition	• 2 Driving Cycles	

Specification

(Reference only)

Condition	Current(A)
Heater Current at 13.5V, 450°C(842°F) Exhaust	0.52 ± 0.1

Diagnostic Circuit Diagram



Signal Waveform & Data

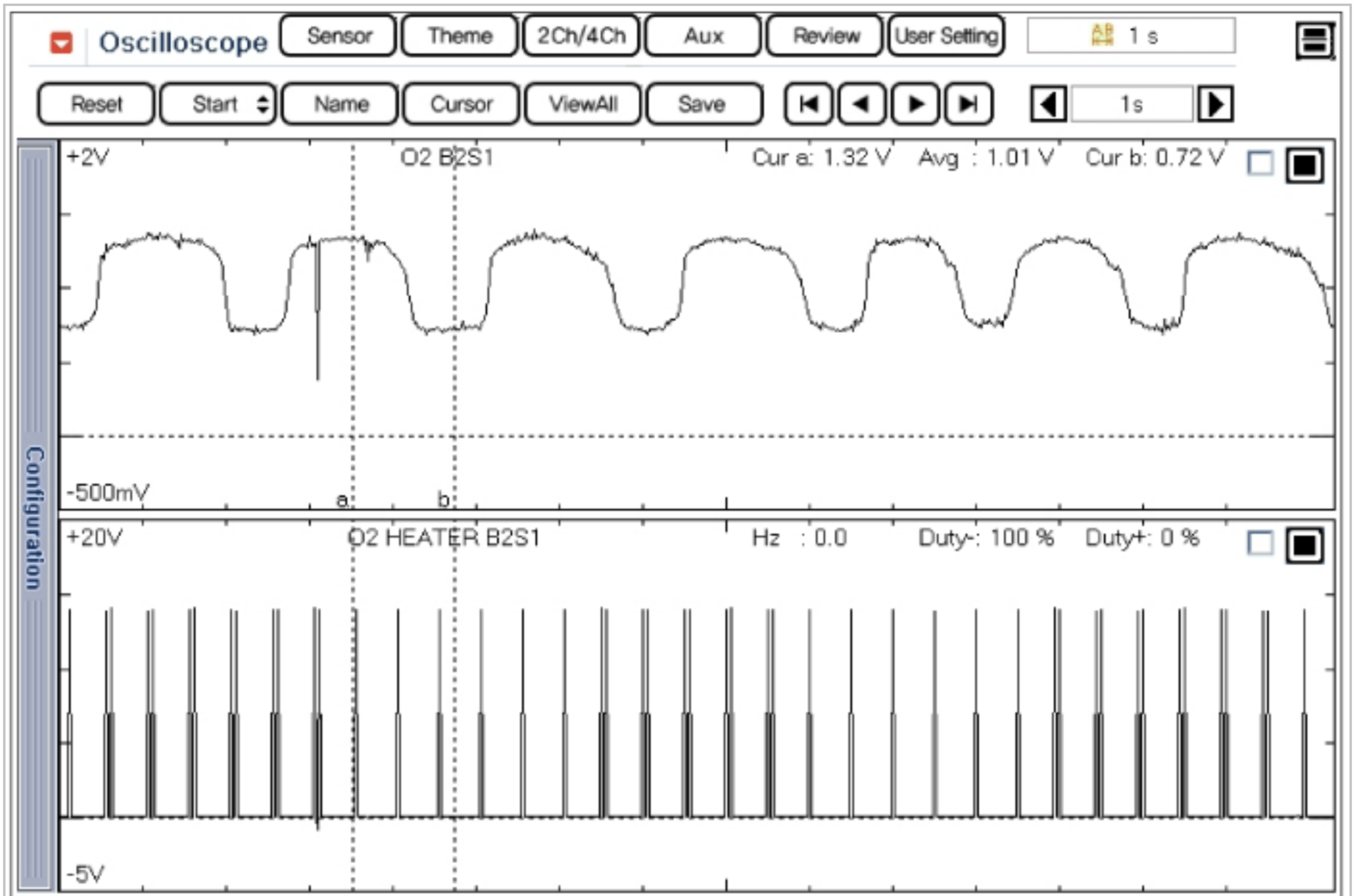

Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
1 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 1.32 V
Avg : 1.01 V
Cur b: 0.72 V
-500mV
a
b
+20V
O2 HEATER B2S1
Hz : 0.0
Duty-: 100 %
Duty+: 0 %
-5V

Fig.1

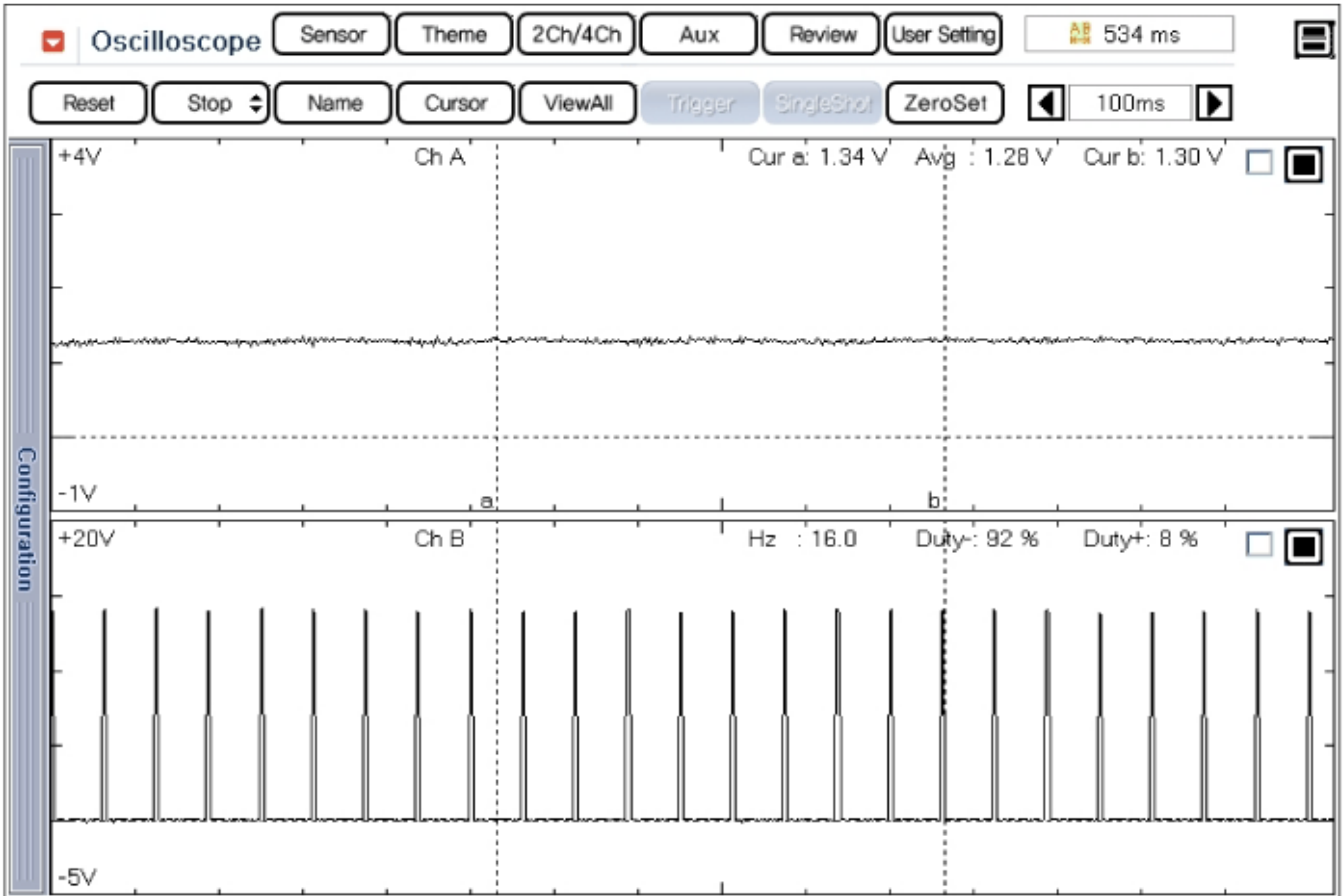
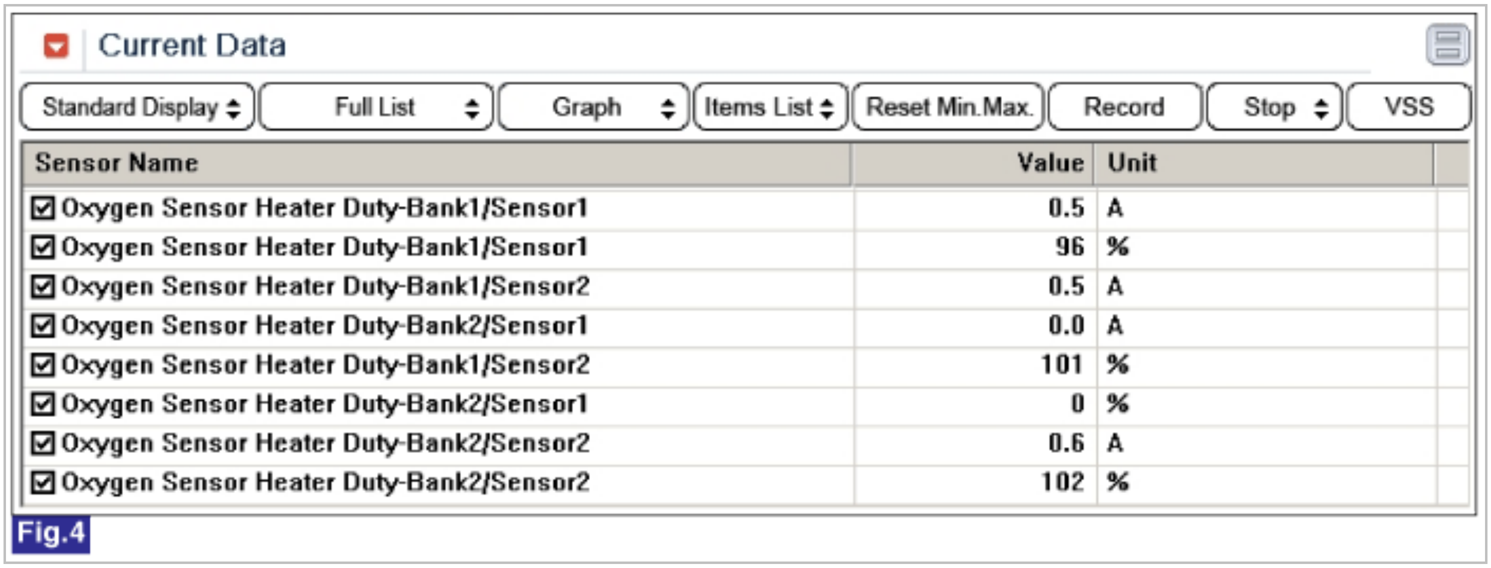


Fig.2

Sensor Name	Value	Unit
☑ Oxygen Sensor Heater Duty-Bank1/Sensor1	0.5	A
☑ Oxygen Sensor Heater Duty-Bank1/Sensor1	97	%
☑ Oxygen Sensor Heater Duty-Bank1/Sensor2	0.5	A
☑ Oxygen Sensor Heater Duty-Bank2/Sensor1	0.5	A
☑ Oxygen Sensor Heater Duty-Bank1/Sensor2	100	%
☑ Oxygen Sensor Heater Duty-Bank2/Sensor1	97	%
☑ Oxygen Sensor Heater Duty-Bank2/Sensor2	0.6	A
☑ Oxygen Sensor Heater Duty-Bank2/Sensor2	100	%

Fig.3



Sensor Name	Value	Unit
☑ Oxygen Sensor Heater Duty-Bank1/Sensor1	0.5	A
☑ Oxygen Sensor Heater Duty-Bank1/Sensor1	96	%
☑ Oxygen Sensor Heater Duty-Bank1/Sensor2	0.5	A
☑ Oxygen Sensor Heater Duty-Bank2/Sensor1	0.0	A
☑ Oxygen Sensor Heater Duty-Bank1/Sensor2	101	%
☑ Oxygen Sensor Heater Duty-Bank2/Sensor1	0	%
☑ Oxygen Sensor Heater Duty-Bank2/Sensor2	0.6	A
☑ Oxygen Sensor Heater Duty-Bank2/Sensor2	102	%

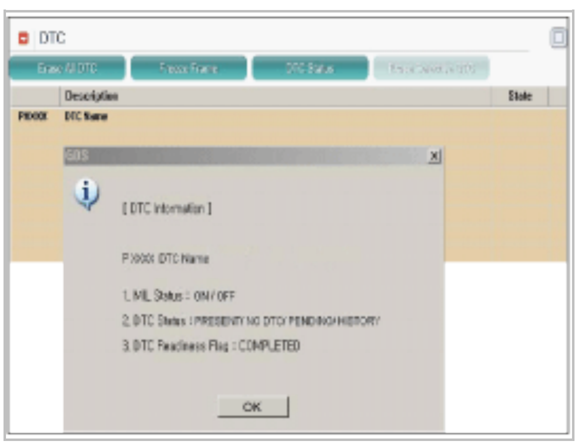
Fig.4

Fig.1) The signal waveforms of front HO2S(the lower) and heater(the upper) at idle
Fig.2) The signal waveforms of rear HO2S(the upper) and heater(the lower) at idle
Fig.3) The Normal data of HO2S heaters at idle
Fig.4) The data of HO2S heaters at open condition in HO2S(B2S1) circuit

The output voltage of front HO2S is changed continuously accroding to air/fuel ratio, ECM controls fuel amount based on this value. Preheating is necessary for HO2S normal operation. Therefore heater unit is installed in HO2S, ECM can control air/fuel ratio with the output signal of HO2S simultaneous with engine run by reducing preheating time. ECM controls heater with duty cycle. HO2S' power source is main relay and ECM operates heater by ground control.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Component Inspection" procedure.

Component Inspection

■ Check HO2S(B2/S2) Heater resistance

1. IG "OFF" and disconnect HO2S(B2/S2) connector
2. Measure resistance between power and control terminals of HO2S(B2/S2) heater(Component Side)

Specification : 8.1 ~ 11.1 Ω at 21°C(69.8°F)

3. Is the measured resistance within specification?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

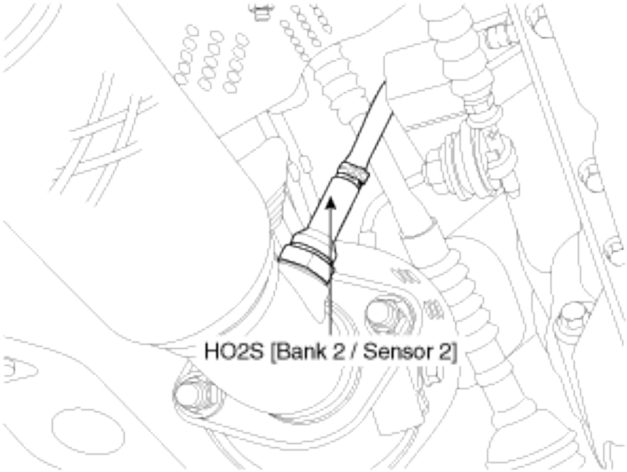
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0057 HO2S Heater Control Circuit Low (Bank 2 /

Sensor 2)

Component Location



General Description

The normal operating temperature of the HO2S(Heated Oxygen Sensor) ranges from 350 to 850°C(662 to 1562°F). The HO2S heater greatly decreases the amount of time required for fuel control to become active. The ECM provides a pulse width modulated control circuit to adjust current through the heater. When the HO2S is cold, the value of the resistance is low and the current in the circuit is high. On the contrary, if the temperature in the resistor of the sensor rises, the current drops gradually.

DTC Description

If the ECM detects short to ground or open in heater under detecting conditions, ECM sets P0057. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

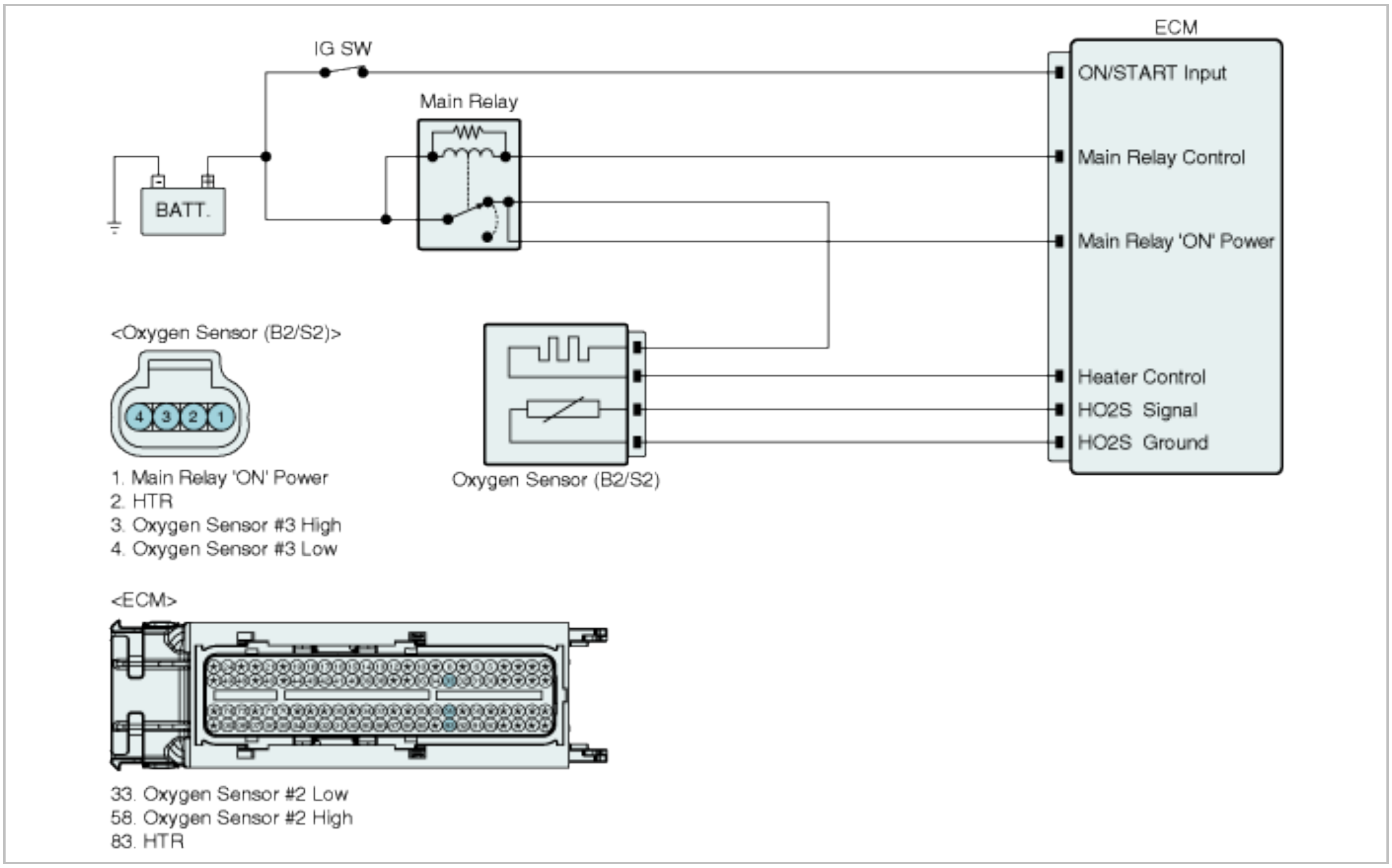
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Detects a short to ground or open	• Poor Connection • Open in Power Circuit • Open or short to ground in control circuit • HO2S(B2/S2) • ECM
Enable Conditions	• No disabling Faults • Engine Running • 11V ≤ Battery Voltage ≤ 16V	
Threshold value	• Short to ground or open circuit	
Diagnosis Time	• Continuous (More than 5 seconds failure for every 10 seconds test)	
MIL On Condition	• 2 Driving Cycles	

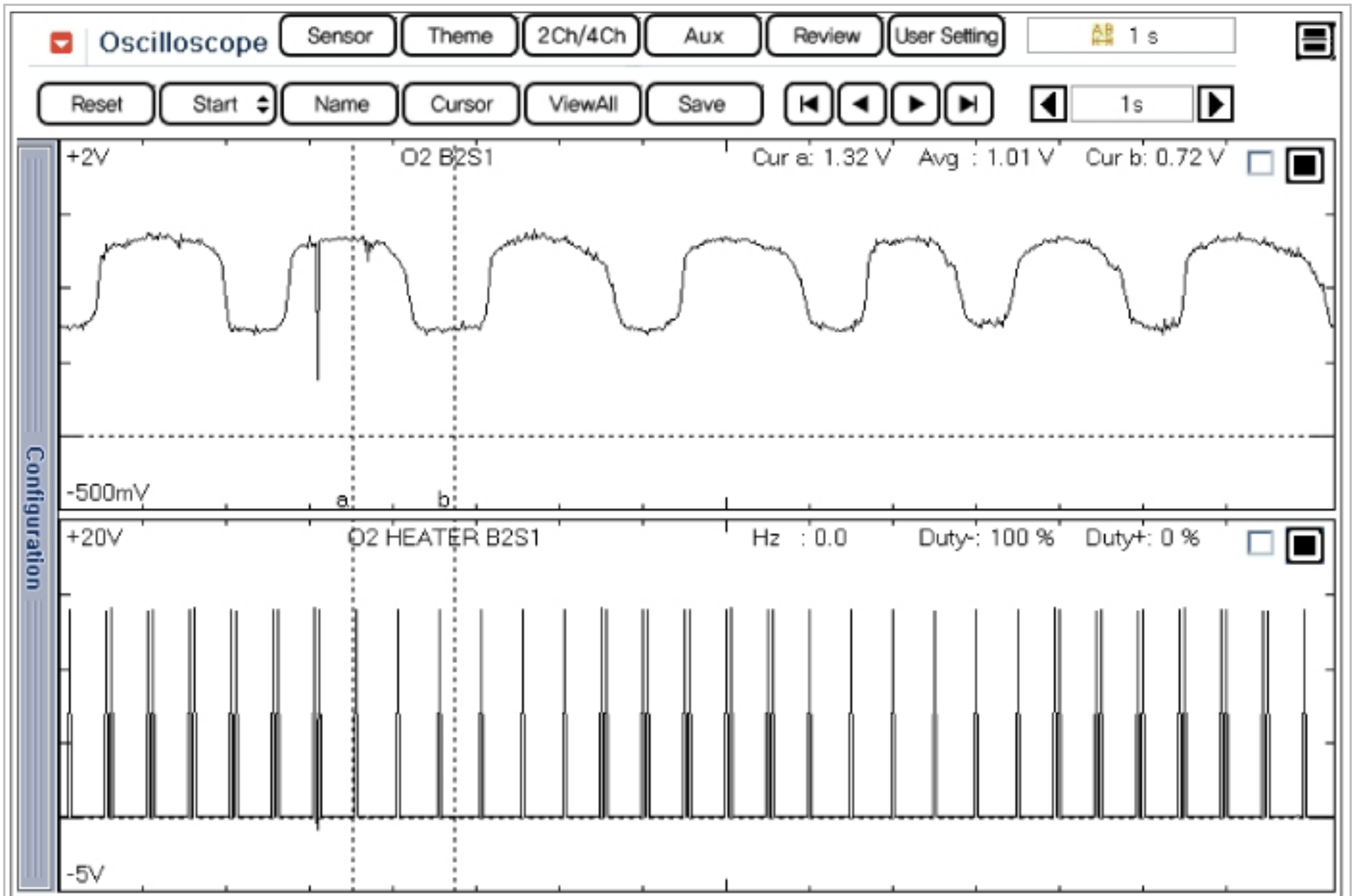
Specification

Heater	
Resistance (Ω)	8.1 ~ 11.1 Ω at 21°C(69.8°F)

Diagnostic Circuit Diagram



Signal Waveform & Data


Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
1 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 1.32 V
Avg : 1.01 V
Cur b: 0.72 V
-500mV
a
b
+20V
O2 HEATER B2S1
Hz : 0.0
Duty-: 100 %
Duty+: 0 %
-5V
Fig.1

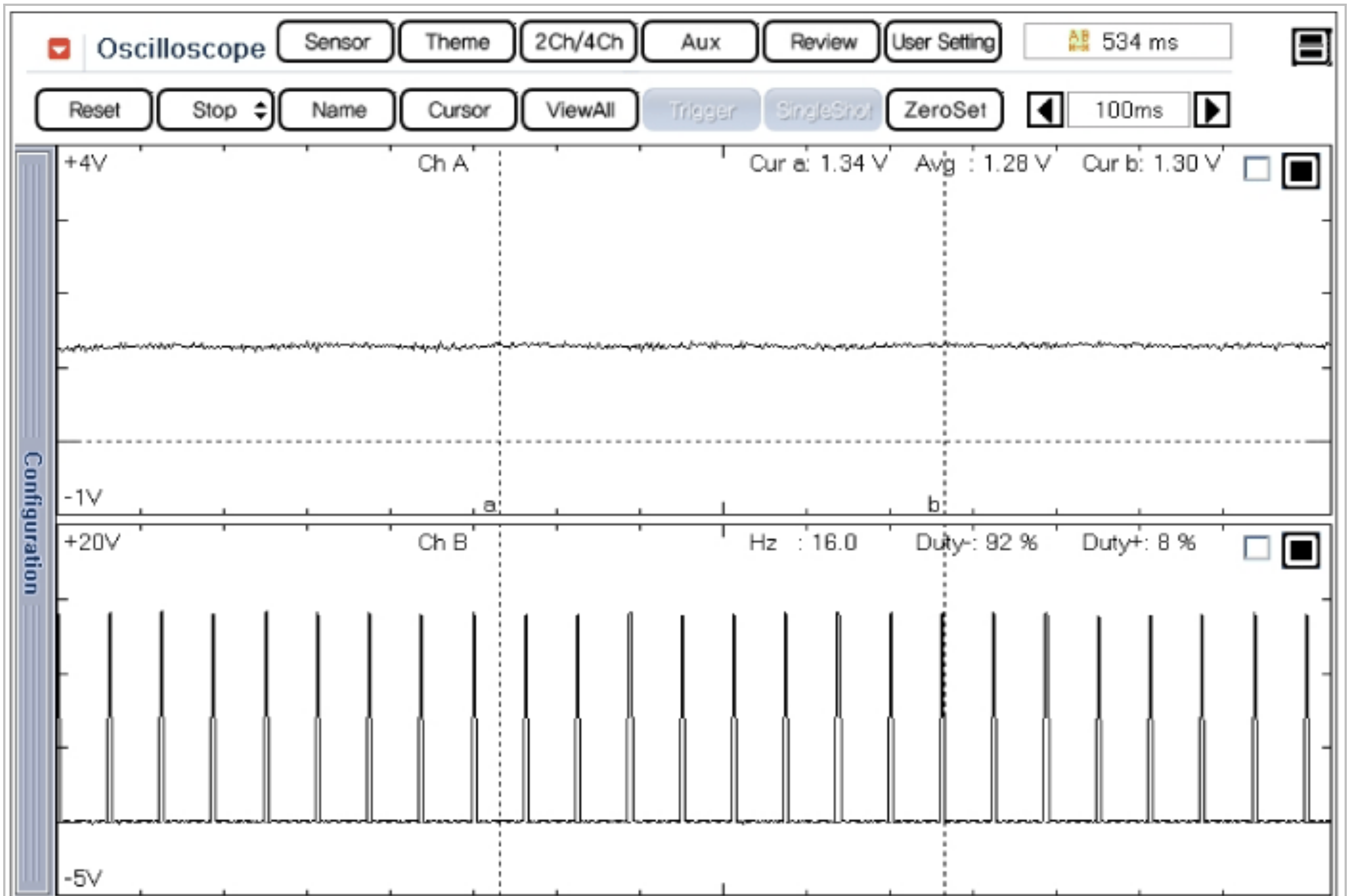
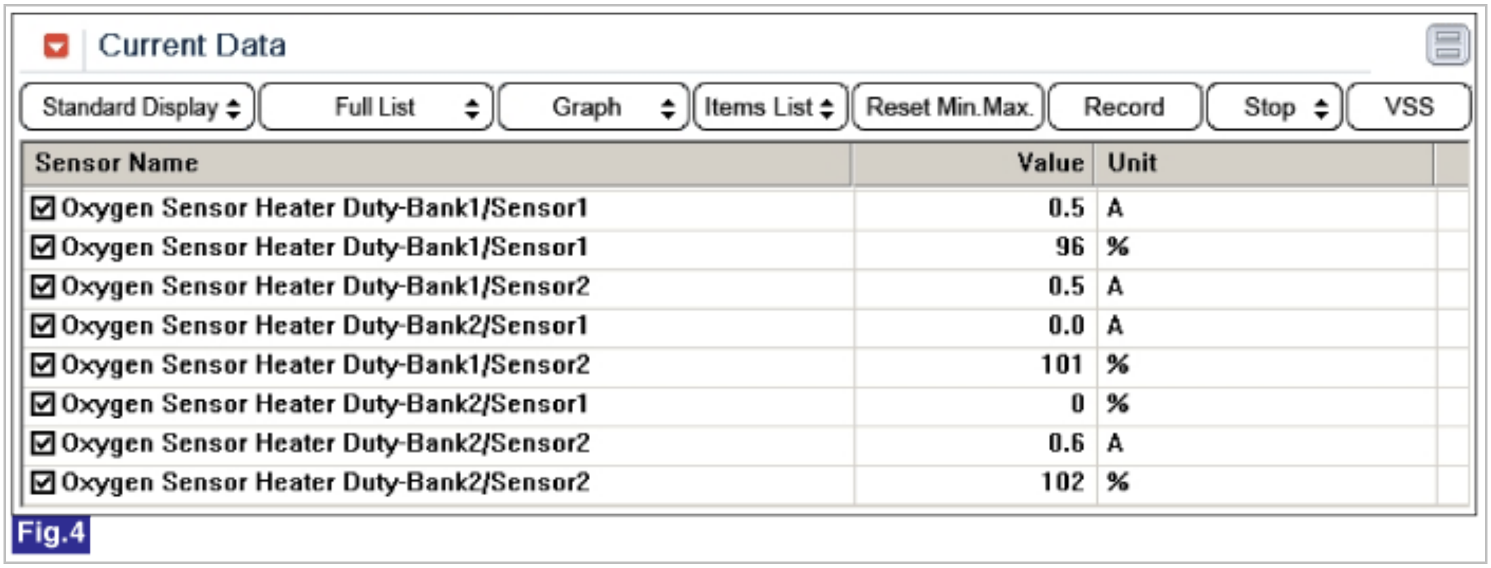


Fig.2

Sensor Name	Value	Unit
☑ Oxygen Sensor Heater Duty-Bank1/Sensor1	0.5	A
☑ Oxygen Sensor Heater Duty-Bank1/Sensor1	97	%
☑ Oxygen Sensor Heater Duty-Bank1/Sensor2	0.5	A
☑ Oxygen Sensor Heater Duty-Bank2/Sensor1	0.5	A
☑ Oxygen Sensor Heater Duty-Bank1/Sensor2	100	%
☑ Oxygen Sensor Heater Duty-Bank2/Sensor1	97	%
☑ Oxygen Sensor Heater Duty-Bank2/Sensor2	0.6	A
☑ Oxygen Sensor Heater Duty-Bank2/Sensor2	100	%

Fig.3



Sensor Name	Value	Unit
Oxygen Sensor Heater Duty-Bank1/Sensor1	0.5	A
Oxygen Sensor Heater Duty-Bank1/Sensor1	96	%
Oxygen Sensor Heater Duty-Bank1/Sensor2	0.5	A
Oxygen Sensor Heater Duty-Bank2/Sensor1	0.0	A
Oxygen Sensor Heater Duty-Bank1/Sensor2	101	%
Oxygen Sensor Heater Duty-Bank2/Sensor1	0	%
Oxygen Sensor Heater Duty-Bank2/Sensor2	0.6	A
Oxygen Sensor Heater Duty-Bank2/Sensor2	102	%

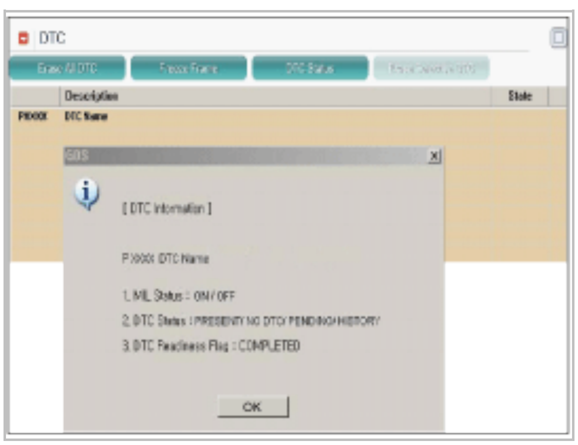
Fig.4

Fig.1) The signal waveforms of front HO2S(the lower) and heater(the upper) at idle
Fig.2) The signal waveforms of rear HO2S(the upper) and heater(the lower) at idle
Fig.3) The Normal data of HO2S heaters at idle
Fig.4) The data of HO2S heaters at open condition in HO2S(B2S1) circuit

The output voltage of front HO2S is changed continuously accroding to air/fuel ratio, ECM controls fuel amount based on this value. Preheating is necessary for HO2S normal operation. Therefore heater unit is installed in HO2S, ECM can control air/fuel ratio with the output signal of HO2S simultaneous with engine run by reducing preheating time. ECM controls heater with duty cycle. HO2S' power source is main relay and ECM operates heater by ground control.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Power Circuit Inspection" procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" & Disconnect HO2S(B2/S2) connector.
2. IG "ON".
3. Measure voltage between power terminal of HO2S(B2/S2) heater harness connector and chassis ground.

Specification : B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.
NO	▶ Repair open or short to ground in HO2S(B2/S2) Heater power circuit then, go to "Verification of Vehicle Repair" procedure.

Control Circuit Inspection

■ Check short to ground

1. IG "OFF" & Disconnect HO2S(B2/S2) connector.
2. Measure resistance between control terminal of HO2S(B2/S2) heater harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.
NO	▶ Repair short to ground in HO2S(B2/S2) heater control circuit and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect HO2S(B2/S2) and ECM connector.
2. Measure resistance between control terminal of HO2S(B2/S2) heater harness connector and heater control terminal of ECM harness connector.

Specification : Approx. below 1Ω

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in HO2S(B2/S2) heater control circuit and go to "Verifiction of Vehicle Repair" procedure.

Component Inspection

■ Check HO2S(B2/S2) Heater resistance

1. IG "OFF" and disconnect HO2S(B2/S2) connector
2. Measure resistance between power and control terminals of HO2S(B2/S2) heater(Component Side)

Specification : 8.1 ~ 11.1 Ω at 21°C(69.8°F)

3. Is the measured resistance within specification?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

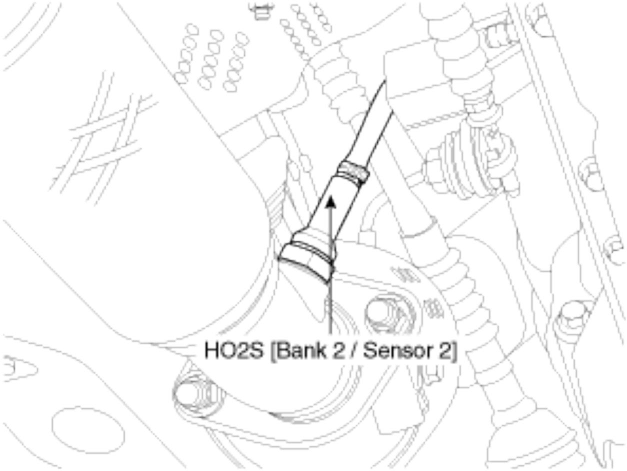
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0058 HO2S Heater Control Circuit High (Bank 2 / Sensor 2)

Component Location



General Description

The normal operating temperature of the HO2S(Heated Oxygen Sensor) ranges from 350 to 850°C(662 to 1562°F). The HO2S heater greatly decreases the amount of time required for fuel control to become active. The ECM provides a pulse width modulated control circuit to adjust current through the heater. When the HO2S is cold, the value of the resistance is low and the current in the circuit is high. On the contrary, if the temperature in the resistor of the sensor rises, the current drops gradually.

DTC Description

If the ECM detects short to battery in heater under detecting conditions, ECM sets P0058. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

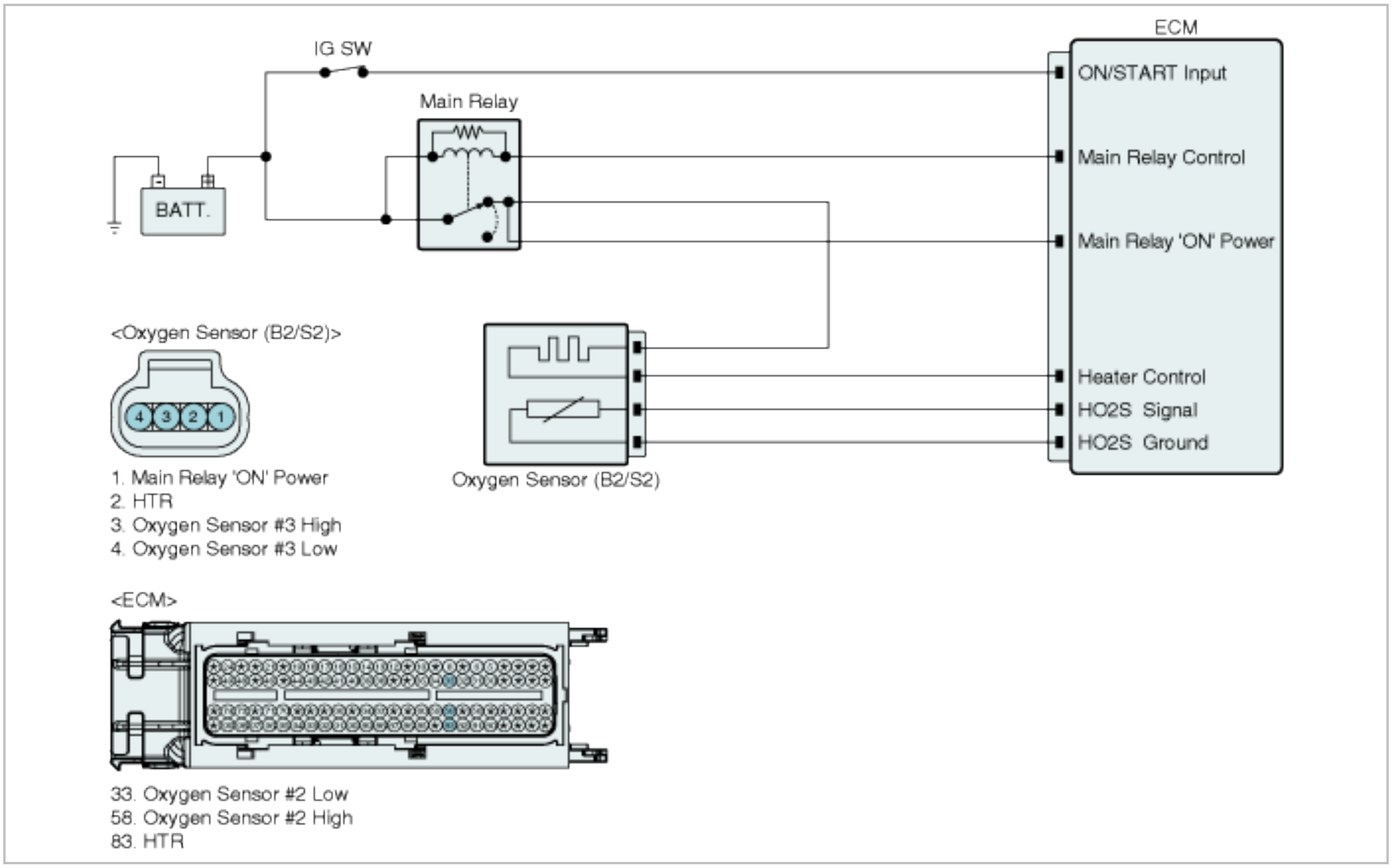
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Detects a short to battery	• Poor Connection • Short to battery in control circuit • HO2S(B2/S2) • ECM
Enable Conditions	• No disabling Faults • Engine Running • 11V ≤ Battery Voltage ≤ 16V	
Threshold value	• Short to battery	
Diagnosis Time	• Continuous (More than 5 seconds failure for every 10 seconds test)	
MIL On Condition	• 2 Driving Cycles	

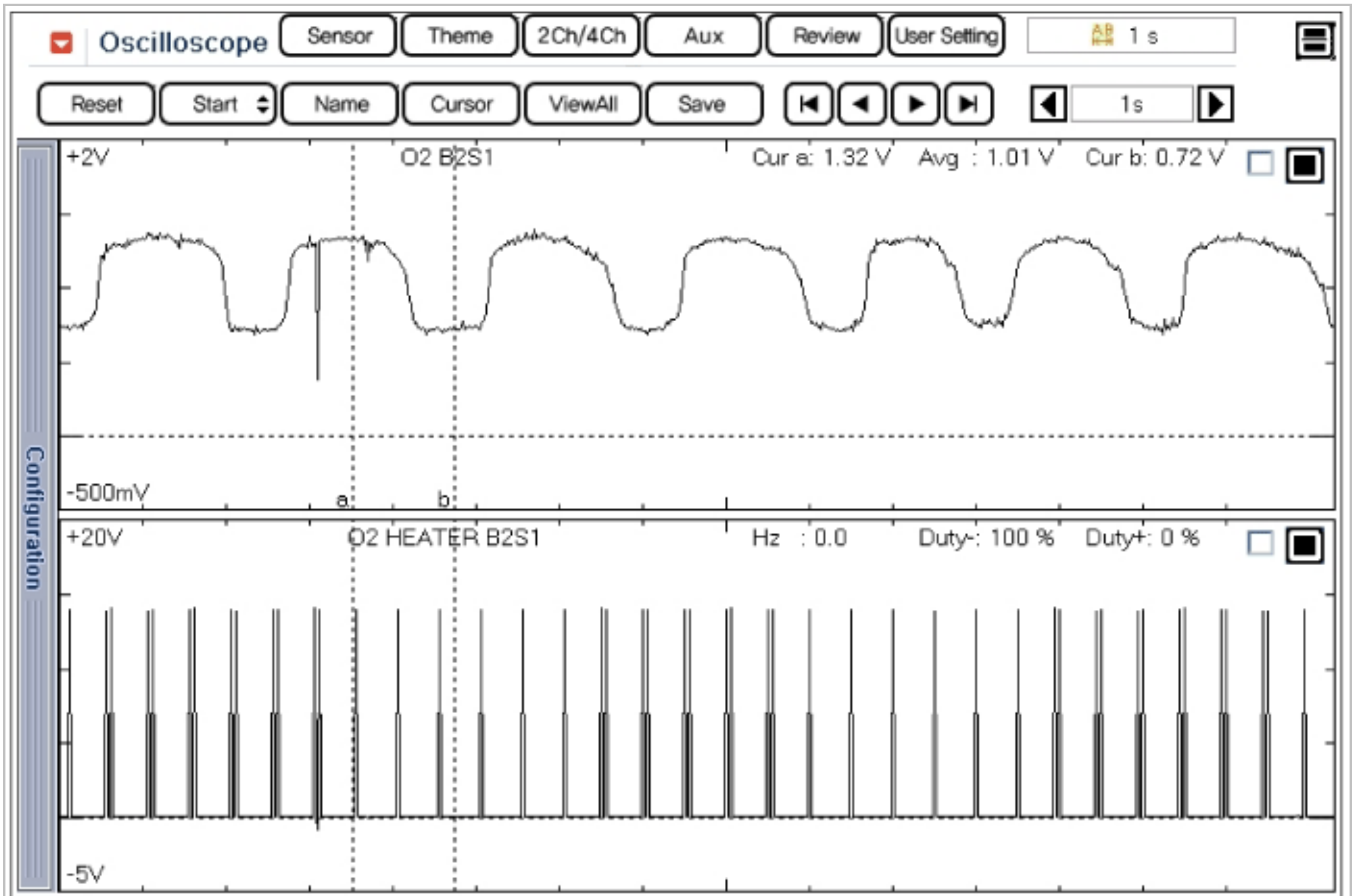
Specification

Heater	
Resistance (Ω)	8.1 ~ 11.1 Ω at 21°C(69.8°F)

Diagnostic Circuit Diagram



Signal Waveform & Data



Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
1 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
+2V
O2 B2S1
Cur a: 1.32 V
Avg : 1.01 V
Cur b: 0.72 V
-500mV
a
b
+20V
O2 HEATER B2S1
Hz : 0.0
Duty-: 100 %
Duty+: 0 %
-5V
Configuration

Fig.1

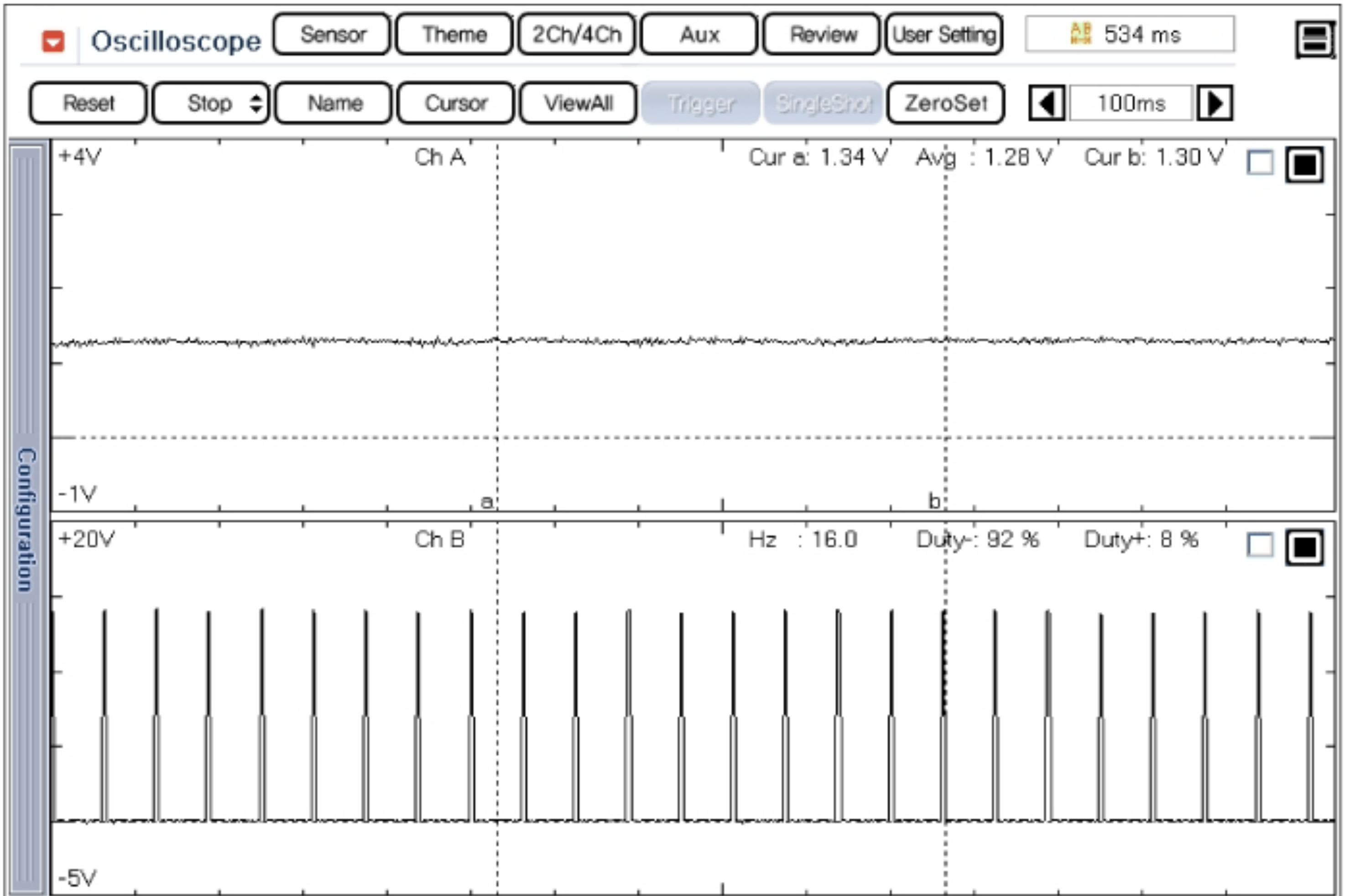


Fig.2

Sensor Name	Value	Unit
☑ Oxygen Sensor Heater Duty-Bank1/Sensor1	0.5	A
☑ Oxygen Sensor Heater Duty-Bank1/Sensor1	97	%
☑ Oxygen Sensor Heater Duty-Bank1/Sensor2	0.5	A
☑ Oxygen Sensor Heater Duty-Bank2/Sensor1	0.5	A
☑ Oxygen Sensor Heater Duty-Bank1/Sensor2	100	%
☑ Oxygen Sensor Heater Duty-Bank2/Sensor1	97	%
☑ Oxygen Sensor Heater Duty-Bank2/Sensor2	0.6	A
☑ Oxygen Sensor Heater Duty-Bank2/Sensor2	100	%

Fig.3

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | VSS

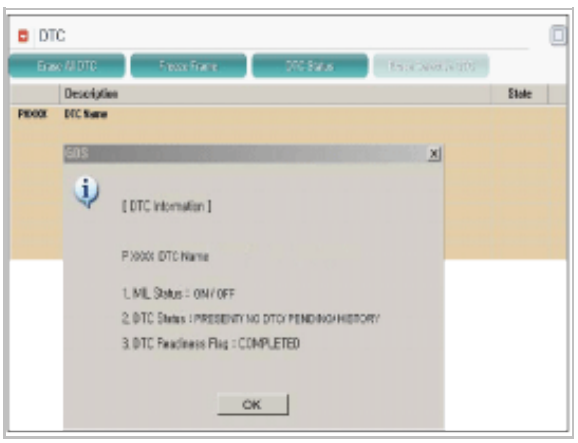
Sensor Name	Value	Unit
☑ Oxygen Sensor Heater Duty-Bank1/Sensor1	0.5	A
☑ Oxygen Sensor Heater Duty-Bank1/Sensor1	96	%
☑ Oxygen Sensor Heater Duty-Bank1/Sensor2	0.5	A
☑ Oxygen Sensor Heater Duty-Bank2/Sensor1	0.0	A
☑ Oxygen Sensor Heater Duty-Bank1/Sensor2	101	%
☑ Oxygen Sensor Heater Duty-Bank2/Sensor1	0	%
☑ Oxygen Sensor Heater Duty-Bank2/Sensor2	0.6	A
☑ Oxygen Sensor Heater Duty-Bank2/Sensor2	102	%

Fig.4

Fig.1) The signal waveforms of front HO2S(the upper) and heater(the lower) at idle
Fig.2) The signal waveforms of rear HO2S(the upper) and heater(the lower) at idle
Fig.3) The Normal data of HO2S heaters at idle
Fig.4) The data of HO2S heaters at open condition in HO2S(B2S1) circuit
The output voltage of front HO2S is changed continuously accroding to air/fuel ratio, ECM controls fuel amount based on this value. Preheating is necessary for HO2S normal operation. Therefore heater unit is installed in HO2S, ECM can control air/fuel ratio with the output signal of HO2S simultaneous with engine run by reducing preheating time. ECM controls heater with duty cycle. HO2S' power source is main relay and ECM operates heater by ground control.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor’s and/or ECM’s connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Control Circuit Inspection" procedure.

Control Circuit Inspection

■ Check voltage

1. IG "OFF" & Disconnect HO2S(B2/S2) connector.
2. IG "ON".
3. Measure voltage between control terminal of HO2S(B2/S2) heater harness connector and chassis ground.

Specification : Approx. 3.5 V

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to battery in HO2S(B2/S2) Heater control circuit and go to "Verification of Vhicle Repair" procedure.

Component Inspection

■ Check HO2S(B2/S2) Heater resistance

1. IG "OFF" and disconnect HO2S(B2/S2) connector
2. Measure resistance between power and control terminals of HO2S(B2/S2) heater(Component Side)

Specification : 8.1 ~ 11.1 Ω at 21°C(69.8°F)

3. Is the measured resistance within specification?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

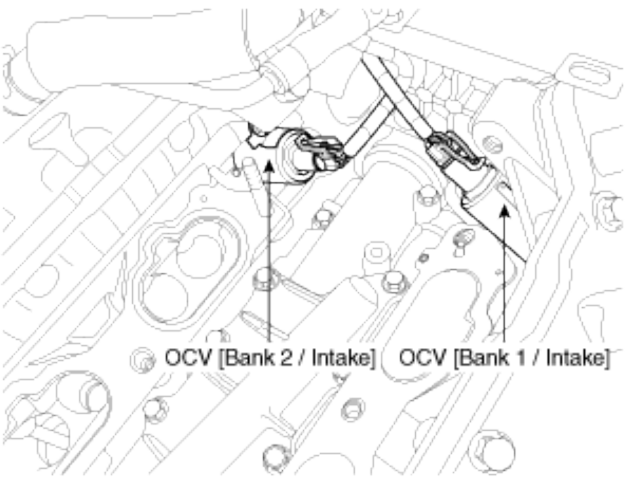
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0076 Intake Valve Control Solenoid Circuit-Low (Bank 1)

Component Location



General Description

The CVVT (Continuously Variable Valve Timing) system is installed to the chain sprocket of the camshaft. This system controls the camshaft to provide the optimal valve timing for every driving condition. The ECM controls the Oil Control Valve(OCV), based on the signals output from mass air flow, throttle position and engine coolant temperature. The CVVT controller regulates the camshaft angle using oil pressure through the OCV. As result, the relative position between the camshaft and the crankshaft becomes optimal, and the engine torque improves, fuel economy improves, exhaust emissions decrease under over all driving conditions.

DTC Description

When the enable condition is satisfied The ECM checks that high and low outputs (Voltage level) are observed when OCVs are commanded. When a OCV output failure is detected, the appropriate fail counter is incremented.
If the failure threshold is exceeded 5 seconds during one diagnostic test(10 second),the test is failed and DTC is stored.
MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

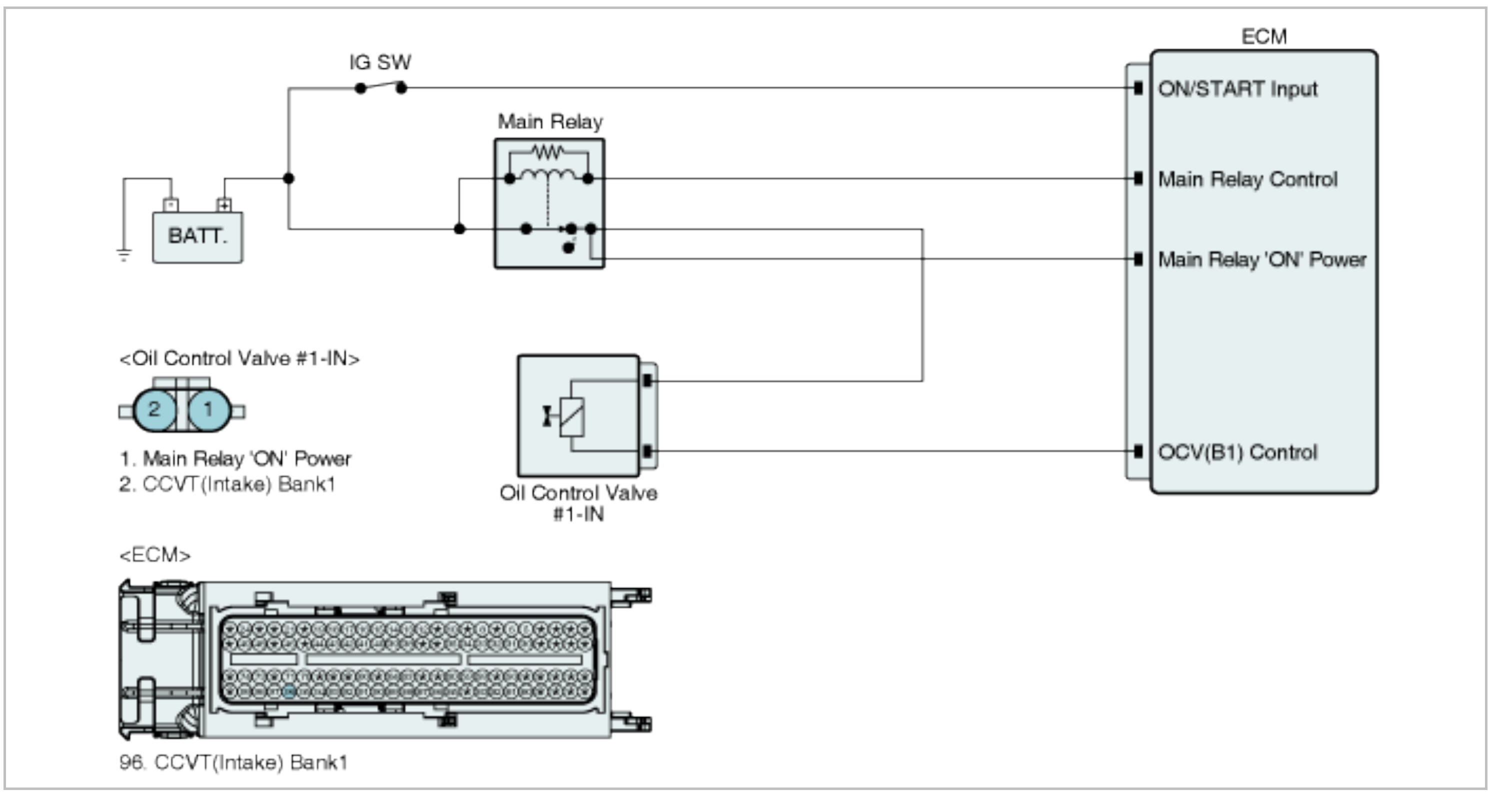
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Detects a short to ground or open	• Poor Connection • Open in Power circuit • Open or short to ground in Control Circuit • OCV • ECM
Enable Conditions	• No disabling Faults Present • Engine Running • 11V ≤ Battery Voltage ≤ 16V	
Threshold value	• Short to ground or open circuit	
Diagnosis Time	• Continuous (More than 5 seconds failure for every 10 seconds test)	
MIL On Condition	• 2 Driving Cycles	

Specification

Item	Specification
Resistance (Ω)	6.7 ~ 7.7 at 20°C(68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data

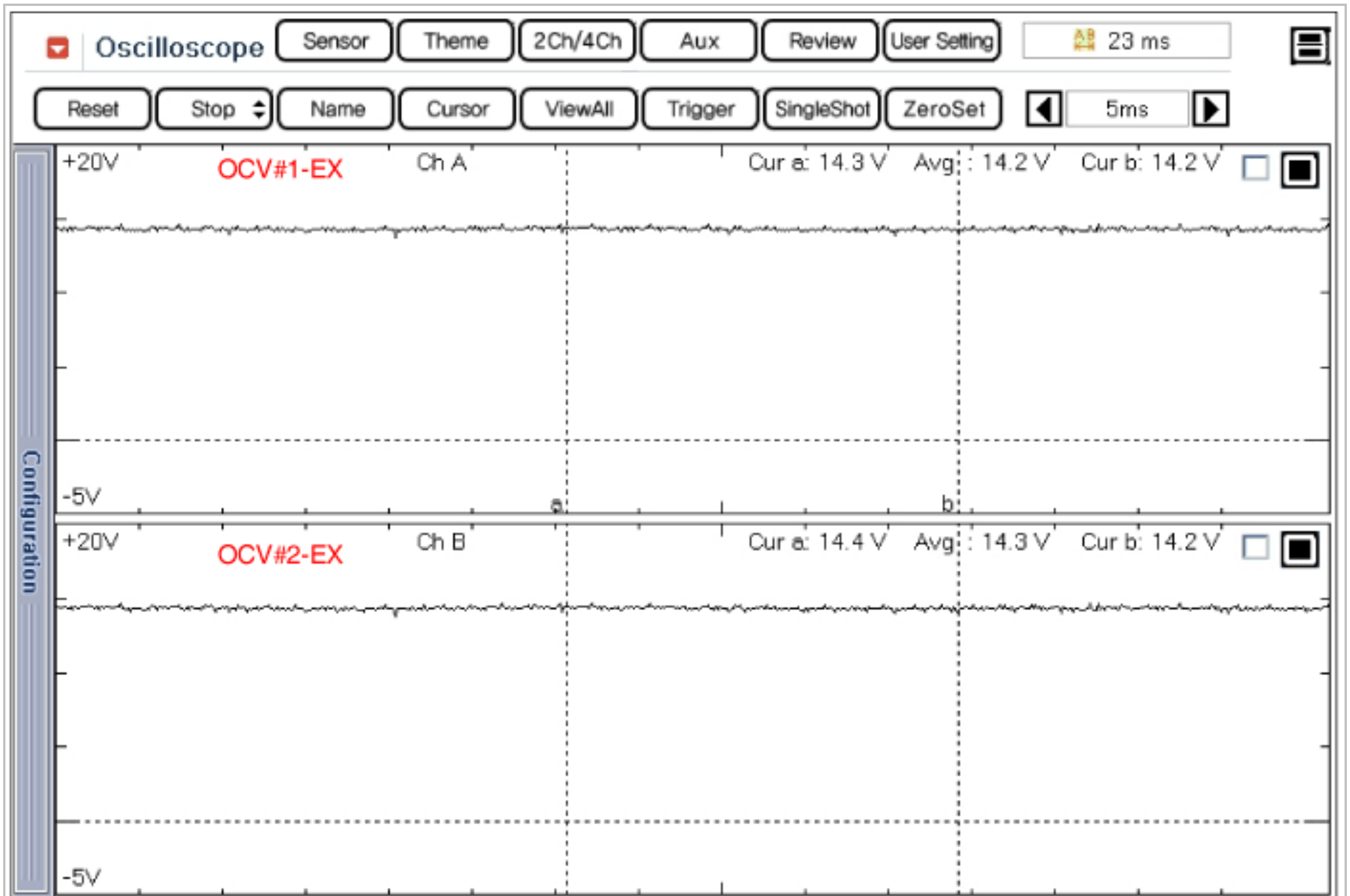


Fig.1

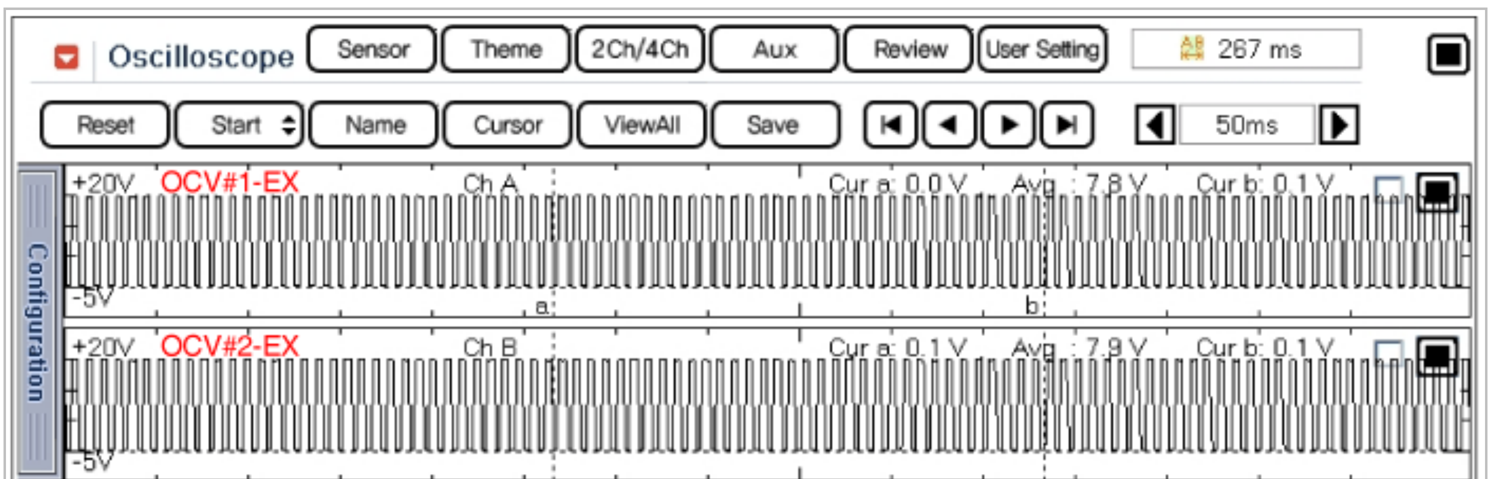


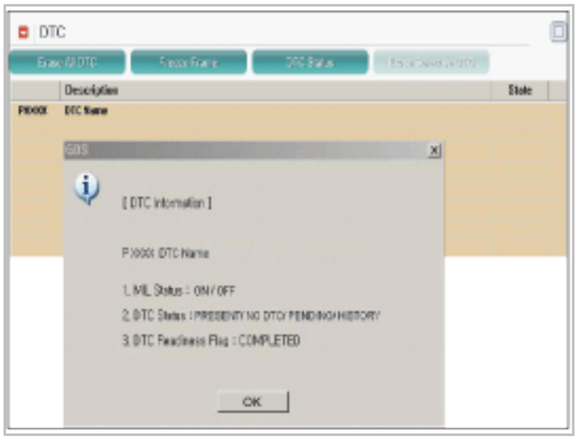
Fig.2

Fig.1) Normal waveform of OCV at idle.
Fig.2) Normal waveform of OCV at acceleration. (3500rpm)

The oil control valve is commanded by a pulse-with-modulated signal from the engine control unit. A duty cycle of zero commands the cam phaser to its default position. A duty cycle of 100% commands the cam phaser to its maximum phased position. When the phaser must be controlled to an intermediate position, the duty ccle is maintained in the region of the 'hold position'. This is a medium duty cycle, usually between 35% and 65%, depending on temperature and voltage conditions.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Power Circuit Inspection" as follow.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" & Disconnect OCV connector.
2. IG "ON".
3. Measure voltage between power terminal of OCV harness connector and chassis ground.

Specification : B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.

NO	▶ Check fuse between Main Relay and OCV is open or not installed. ▶ Check open in power circuit between Main Relay and OCV power circuit. ▶ Check short to ground in power circuit between Main Relay and OCV power circuit. ▶ Repair or replace as necessay go to "Verification of Vehicle Repair" procedure.

Control Circuit Inspection

■ Check resistance

1. IG "OFF" and disconnect OCV and ECM connector.
2. Measure resistance between control terminal of OCV harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Check open in harness" as follows .
NO	▶ Repair short to ground in OCV control circuit and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect OCV and ECM connector.
2. Measure resistance between control terminal of OCV harness connector and OCV control terminal of ECM harness connector.

Specification : Approx. below 1Ω

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in OCV control circuit and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check OCV resistance

1. IG "OFF" and disconnect OCV connector.
2. Measure resistance between power and signal terminals of OCV. (Component Side)

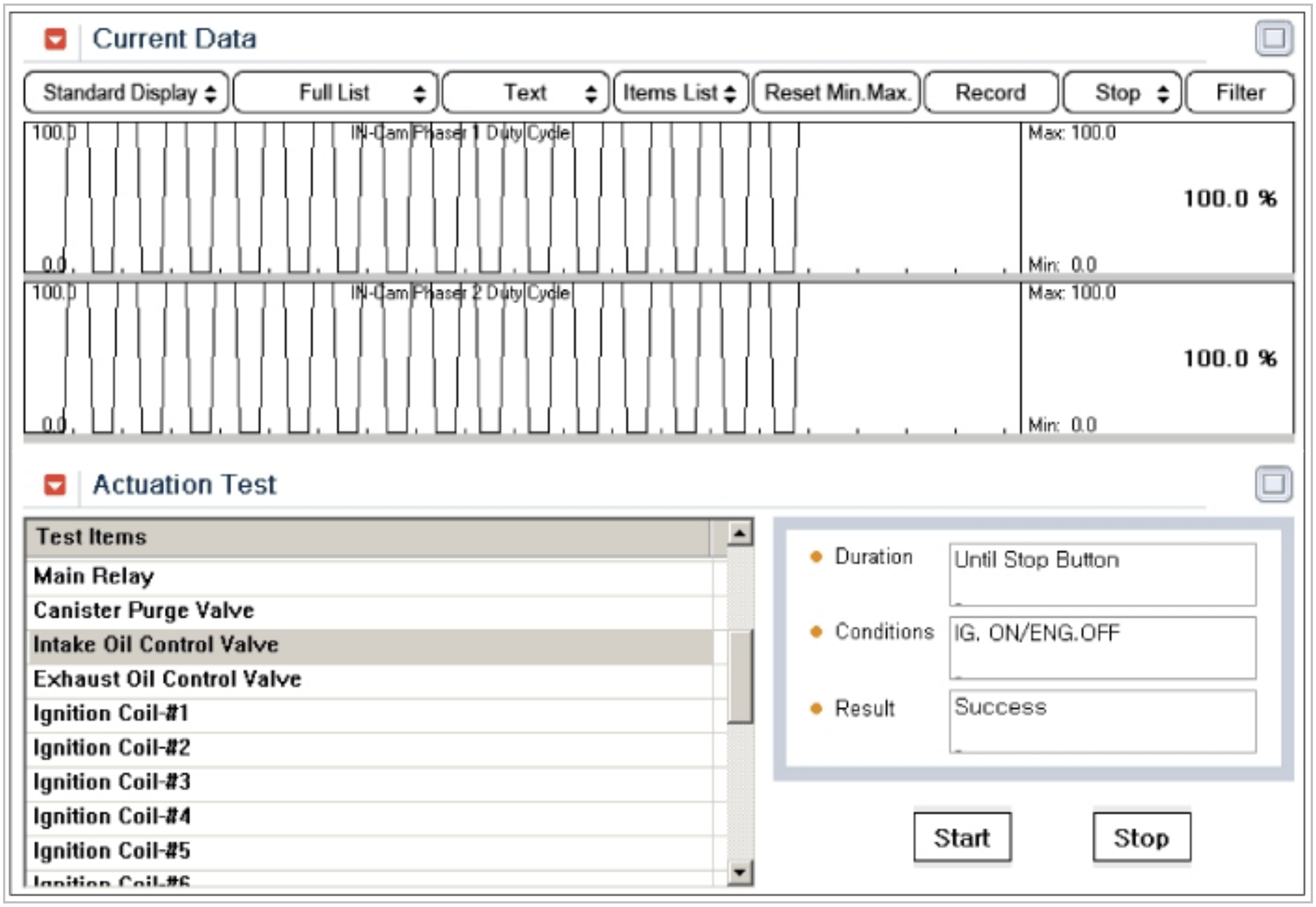
Specification : 6.7 ~ 7.7 at 20°C (68°F)

3. Is the measured resistance within specification?

YES	▶ Go to "OCV Actuation Test" as follows.
NO	▶ Substitute with a known - good OCV and check for proper operation. If the problem is corrected, replace OCV and go to "Verification of Vehicle Repair" procedure.

■ **OCV Actuation Test**

1. Connect GDS and IG "ON"
2. Select "Intake Oil Control Valve" on the Actuation Test
3. Activates "Intake Oil Control Valve" by pressing "START" button
   (should hear a faint click from Oil Control solenoid Valve)
4. Repeat this procedure 4 or 5 times to ensure oil control solenoid valve reliability



5. Does OCV generate click sound during acutation test ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others.
NO	▶ Substitute with a known - good OCV and check for proper operation. If the problem is corrected, replace OCV and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

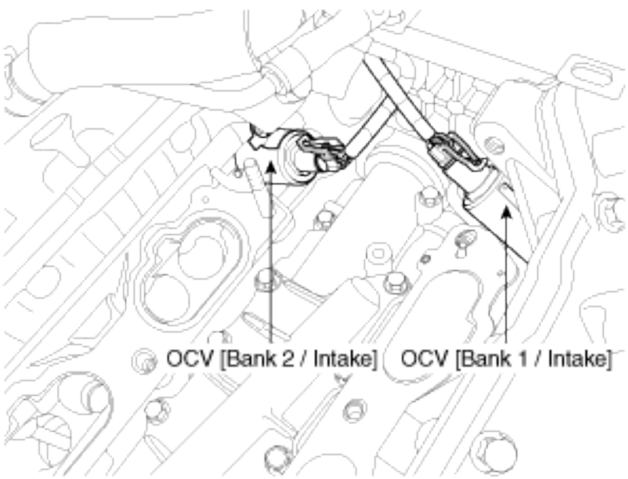
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0077 Intake Valve Control Solenoid Circuit-High (Bank 1)

Component Location



General Description

The CVVT (Continuously Variable Valve Timing) system is installed to the chain sprocket of the intake camshaft. This system controls the intake camshaft to provide the optimal valve timing for every driving condition. The ECM controls the Oil Control Valve(OCV), based on the signals output from mass air flow, throttle position and engine coolant temperature. The CVVT controller regulates the intake camshaft angle using oil pressure through the OCV. As result, the relative position between the camshaft and the crankshaft becomes optimal, and the engine torque improves, fuel economy improves, exhaust emissions decrease under overall driving conditions.

DTC Description

When the enable condition is satisfied The ECM checks that high and low outputs (Voltage level) are observed when OCVs are commanded. When a OCV output failure is detected, the appropriate fail counter is incremented.
If the failure threshold is exceeded 5 seconds during one diagnostic test(10 second),the test is failed and DTC is stored.
MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

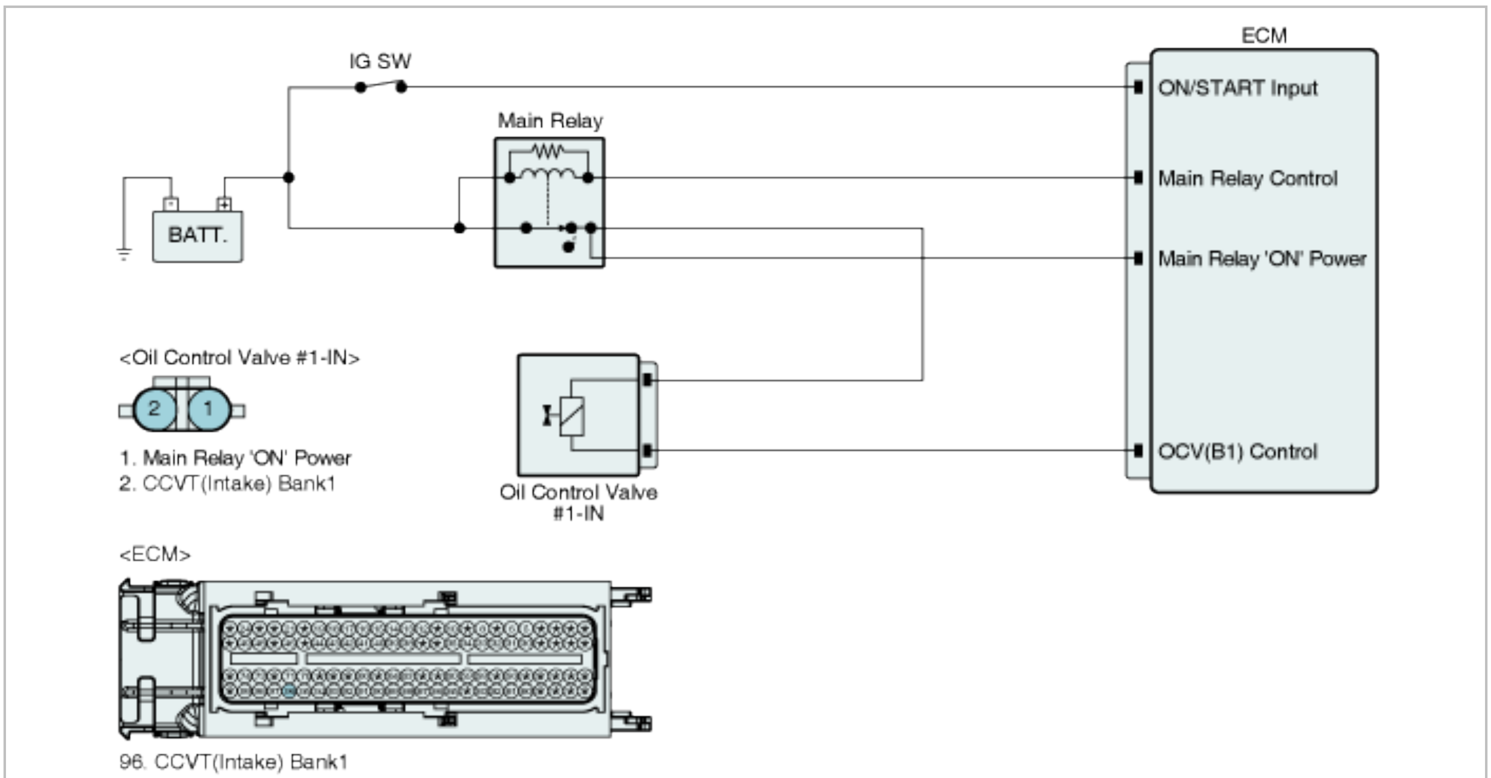
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Detects a short to battery	• Poor Connection • Short to battery in Control Circuit • OCV • ECM
Enable Conditions	• No disabling Faults Present • Engine Running • 11V ≤ Battery Voltage ≤ 16V	
Threshold value	• Short to battery	
Diagnosis Time	• Continuous (More than 5 seconds failure for every 10 seconds test)	
MIL On Condition	• 2 Driving Cycles	

Specification

Item	Specification
Resistance (Ω)	6.7 ~ 7.7 at 20°C(68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data

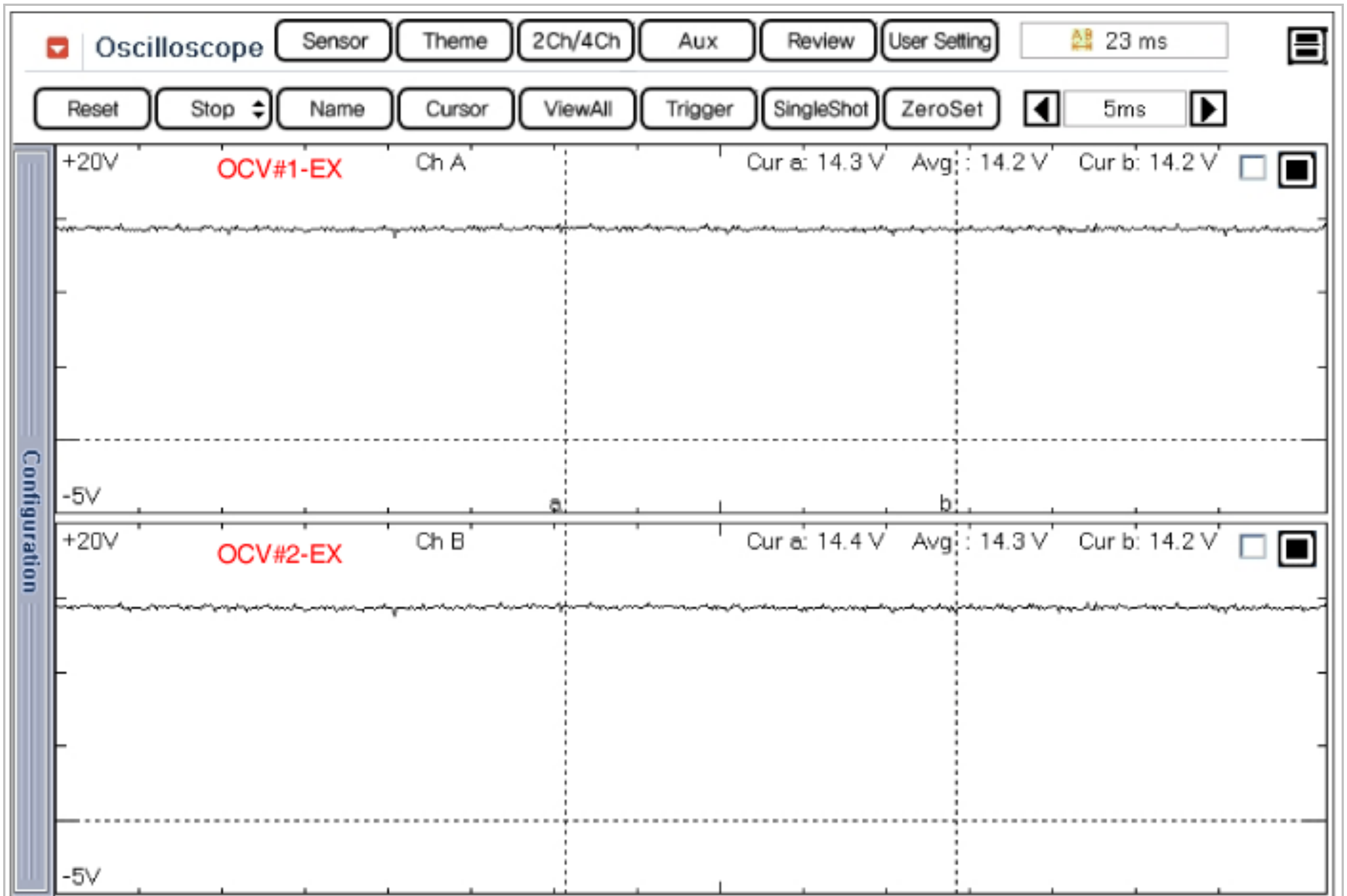


Fig.1

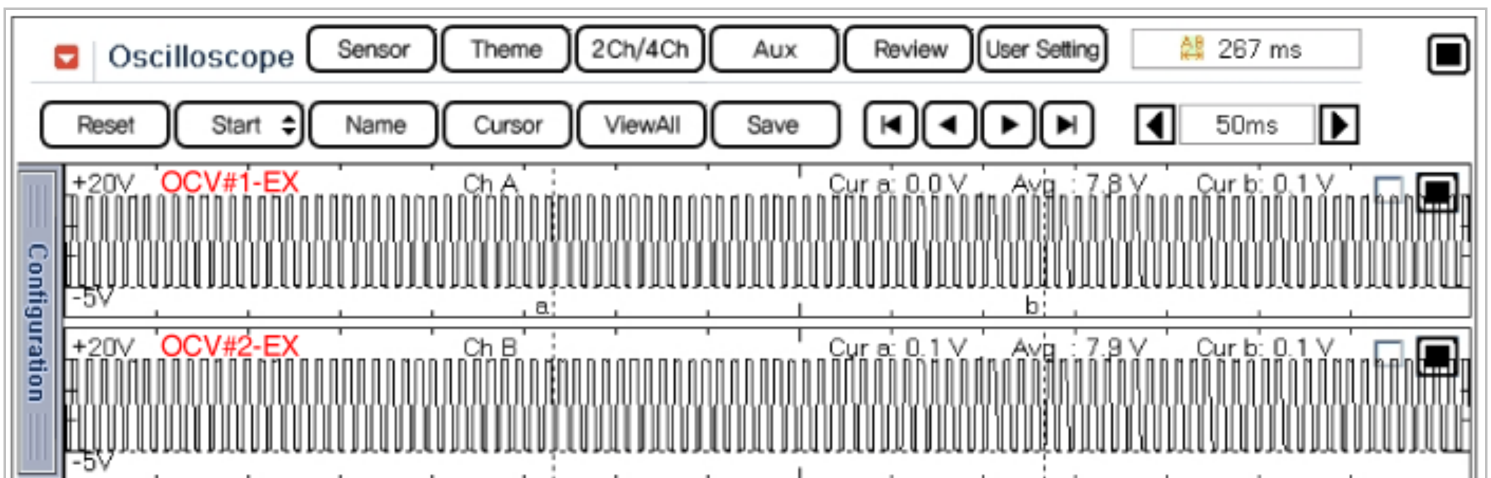


Fig.2

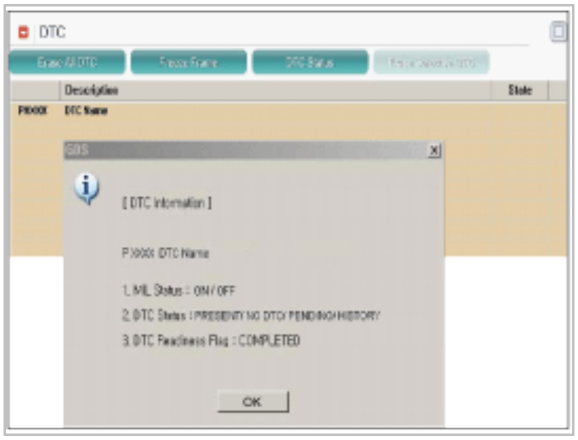
Fig.1) Normal waveform of OCV at idle.

Fig.2) Normal waveform of OCV at acceleration. (3500rpm)

The oil control valve is commanded by a pulse-with-modulated signal from the engine control unit. A duty cycle of zero commands the cam phaser to its default position. A duty cycle of 100% commands the cam phaser to its maximum phased position. When the phaser must be controlled to an intermediate position, the duty ccle is maintained in the region of the 'hold position'. This is a medium duty cycle, usually between 35% and 65%, depending on temperature and voltage conditions.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Control Circuit Inspection" procedure.

Control Circuit Inspection

■ Check short to battery in harness

1. IG "OFF" & Disconnect OCV connector.
2. Measure resistance between power and control terminals of OCV harness connector.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to battery in OCV control circuit and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check OCV resistance

1. IG "OFF" and disconnect OCV connector.
2. Measure resistance between power and signal terminals of OCV. (Component Side)

Specification : 6.7 ~ 7.7 at 20°C (68°F)

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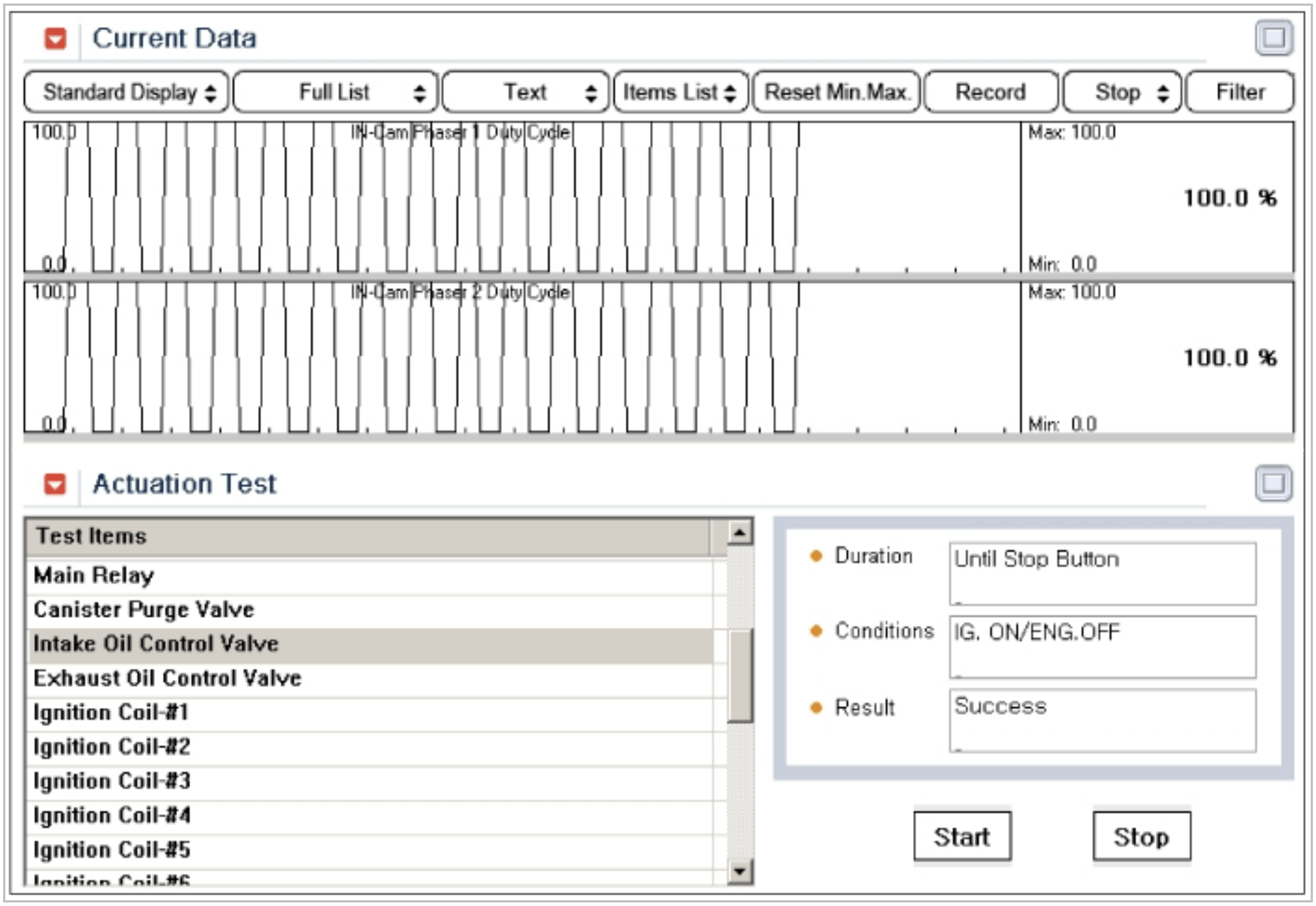
3. Is the measured resistance within specification?

YES	▶ Go to "OCV Actuation Test" as follows.
NO	▶ Substitute with a known - good OCV and check for proper operation. If the problem is corrected, replace OCV and go to "Verification of Vehicle Repair" procedure.

■ OCV Actuation Test

1. Connect GDS and IG "ON"
2. Select "Intake Oil Control Valve" on the Actuation Test
3. Activates "Intake Oil Control Valve" by pressing "START" button
   (Should hear a faint click from Oil Control solenoid Valve)
4. Repeat this procedure 4 or 5 times to ensure oil control solenoid valve reliability



5. Does OCV generate click sound during acutation test ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others.
NO	▶ Substitute with a known - good OCV and check for proper operation. If the problem is corrected, replace OCV and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

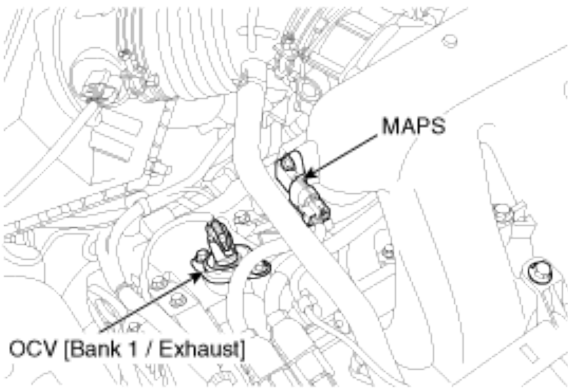
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.

4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0079 Exhaust Valve Control Solenoid Circuit Low (Bank 1)

Component Location



General Description

The CVVT (Continuously Variable Valve Timing) system is installed to the chain sprocket of the camshaft. This system controls the camshaft to provide the optimal valve timing for every driving condition. The ECM controls the Oil Control Valve(OCV), based on the signals output from mass air flow, throttle position and engine coolant temperature. The CVVT controller regulates the camshaft angle using oil pressure through the OCV. As result, the relative position between the camshaft and the crankshaft becomes optimal, and the engine torque improves, fuel economy improves, exhaust emissions decrease under over all driving conditions.

DTC Description

When the enable condition is satisfied The ECM checks that high and low outputs (Voltage level) are observed when OCVs are commanded. When a OCV output failure is detected, the appropriate fail counter is incremented.
If the failure threshold is exceeded 5 seconds during one diagnostic test(10 second),the test is failed and DTC is stored.
MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

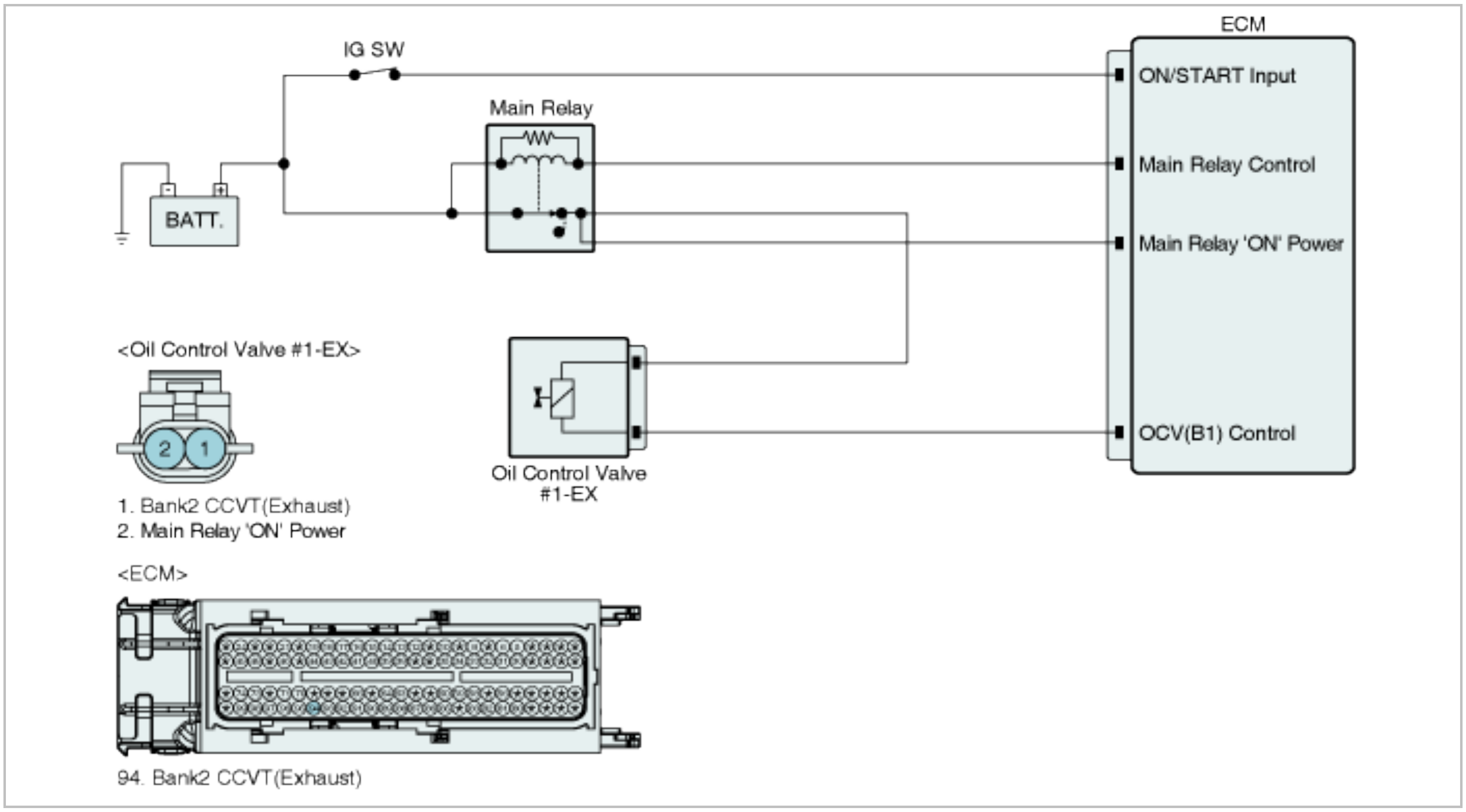
Item	Detecting Condition	Possible Cause
DTC Strategy	• Detects a short to ground or open	• Poor Connection • Open in Power circuit • Open or short to ground in Control Circuit • OCV
Enable Conditions	• No disabling Faults Present • Engine Running • 11V ≤ Battery Voltage ≤ 16V	
Threshold value	• Short to ground or open circuit	

Diagnosis Time	• Continuous (More than 5 seconds failure for every 10 seconds test)	• OCV • ECM
MIL On Condition	• 2 Driving Cycles	

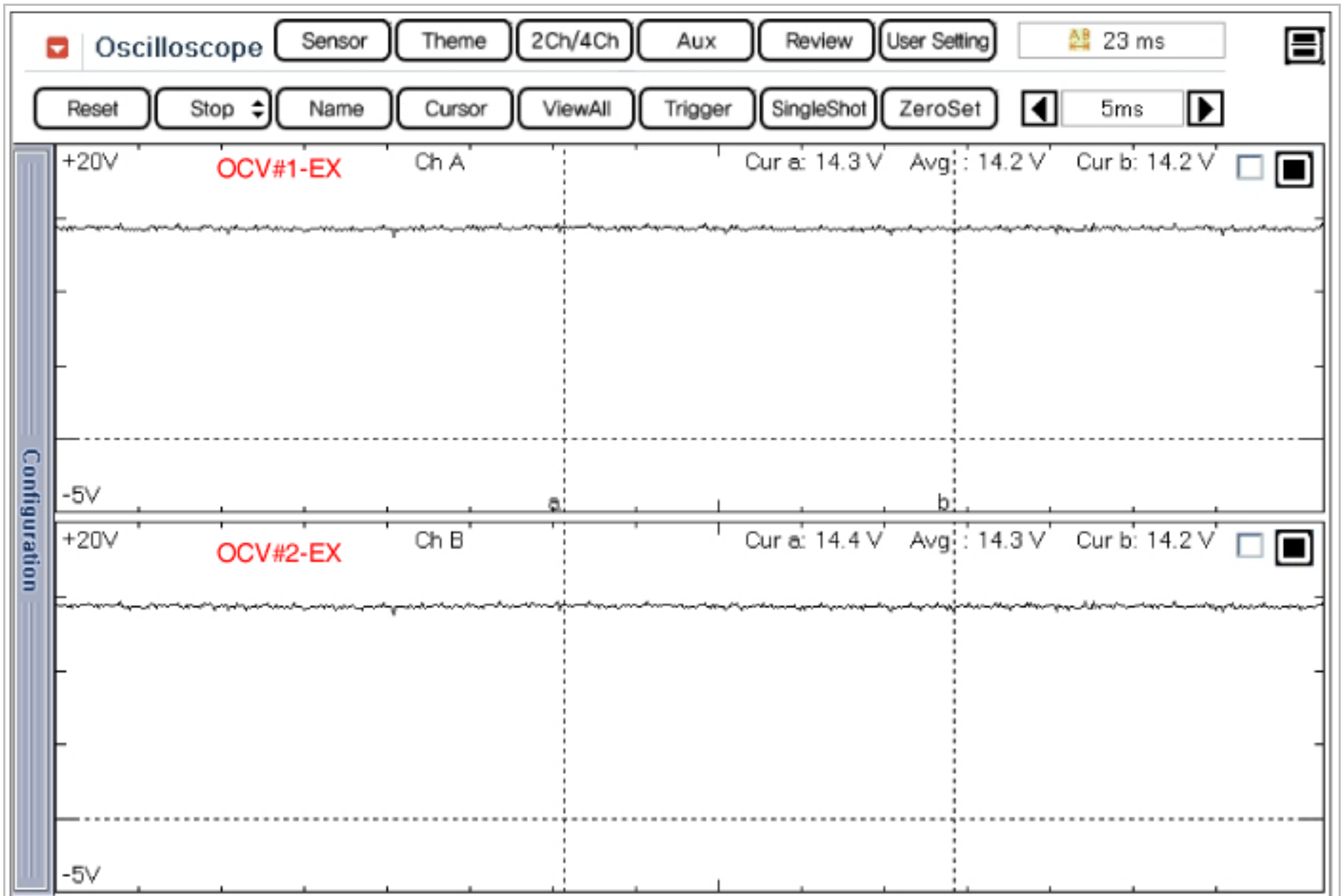
Specification

Item	Specification
Resistance (Ω)	6.7 ~ 7.7 at 20°C(68°F)

Diagnostic Circuit Diagram

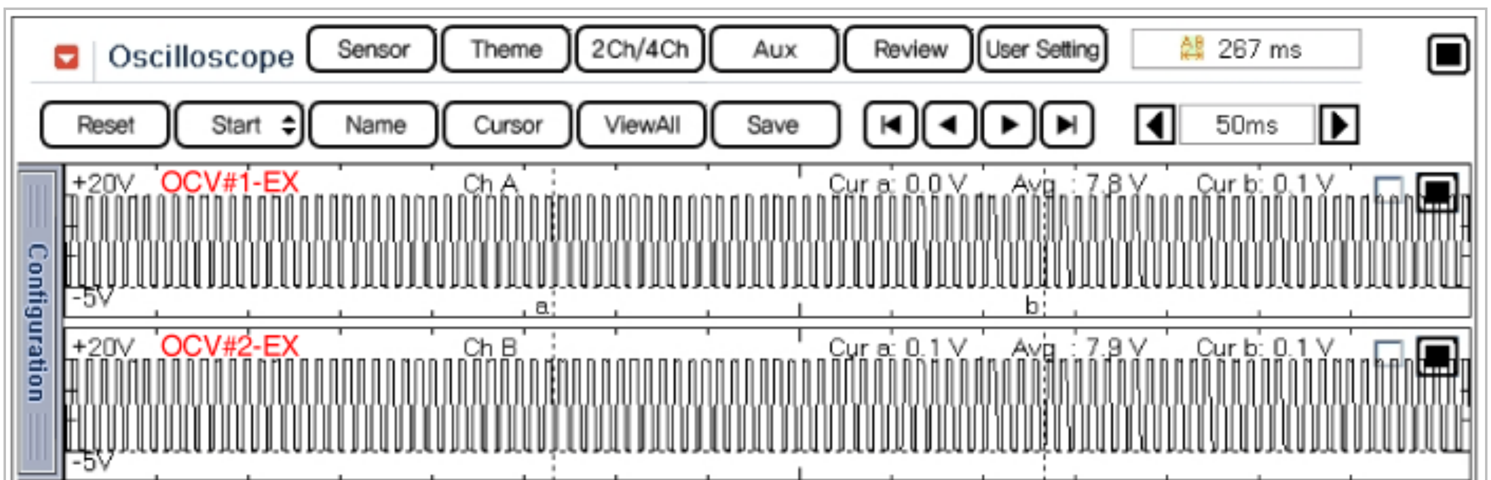


Signal Waveform & Data



Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
23 ms
Reset
Stop
Name
Cursor
ViewAll
Trigger
SingleShot
ZeroSet
5ms
Configuration
+20V
OCV#1-EX
Ch A
Cur a: 14.3 V
Avg : 14.2 V
Cur b: 14.2 V
-5V
a
b
+20V
OCV#2-EX
Ch B
Cur a: 14.4 V
Avg : 14.3 V
Cur b: 14.2 V
-5V

Fig.1



Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
267 ms
Reset
Start
Name
Cursor
ViewAll
Save
50ms
Configuration
+20V
OCV#1-EX
Ch A
Cur a: 0.0 V
Avg : 7.8 V
Cur b: 0.1 V
-5V
a
b
+20V
OCV#2-EX
Ch B
Cur a: 0.1 V
Avg : 7.9 V
Cur b: 0.1 V
-5V

Fig.2

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | VSS

Sensor Name	Value	Unit
☐ EX-Cam Bank1 Desired Position	0	DEG
☐ EX-Cam Bank1 Actual Position	0	DEG
☐ EX-Cam Bank2 Desired Position	0	DEG
☐ EX-Cam Bank2 Actual Position	0	DEG
☐ EX-Cam Phaser 1 Duty Cycle	0	%
☐ EX-Cam Phaser 2 Duty Cycle	0	%

Fig.3

Sensor Name	Value	Unit
☑ Camshaft Control	ON	-
☑ Engine Speed	3840	RPM
☑ EX-Cam Bank1 Actual Position	-15	DEG
☑ EX-Cam Bank1 Desired Position	-14	DEG
☑ EX-Cam Bank2 Desired Position	-14	DEG
☑ EX-Cam Bank2 Actual Position	-15	DEG
☑ EX-Cam Phaser 1 Duty Cycle	43	%
☑ EX-Cam Phaser 2 Duty Cycle	44	%

Fig.4

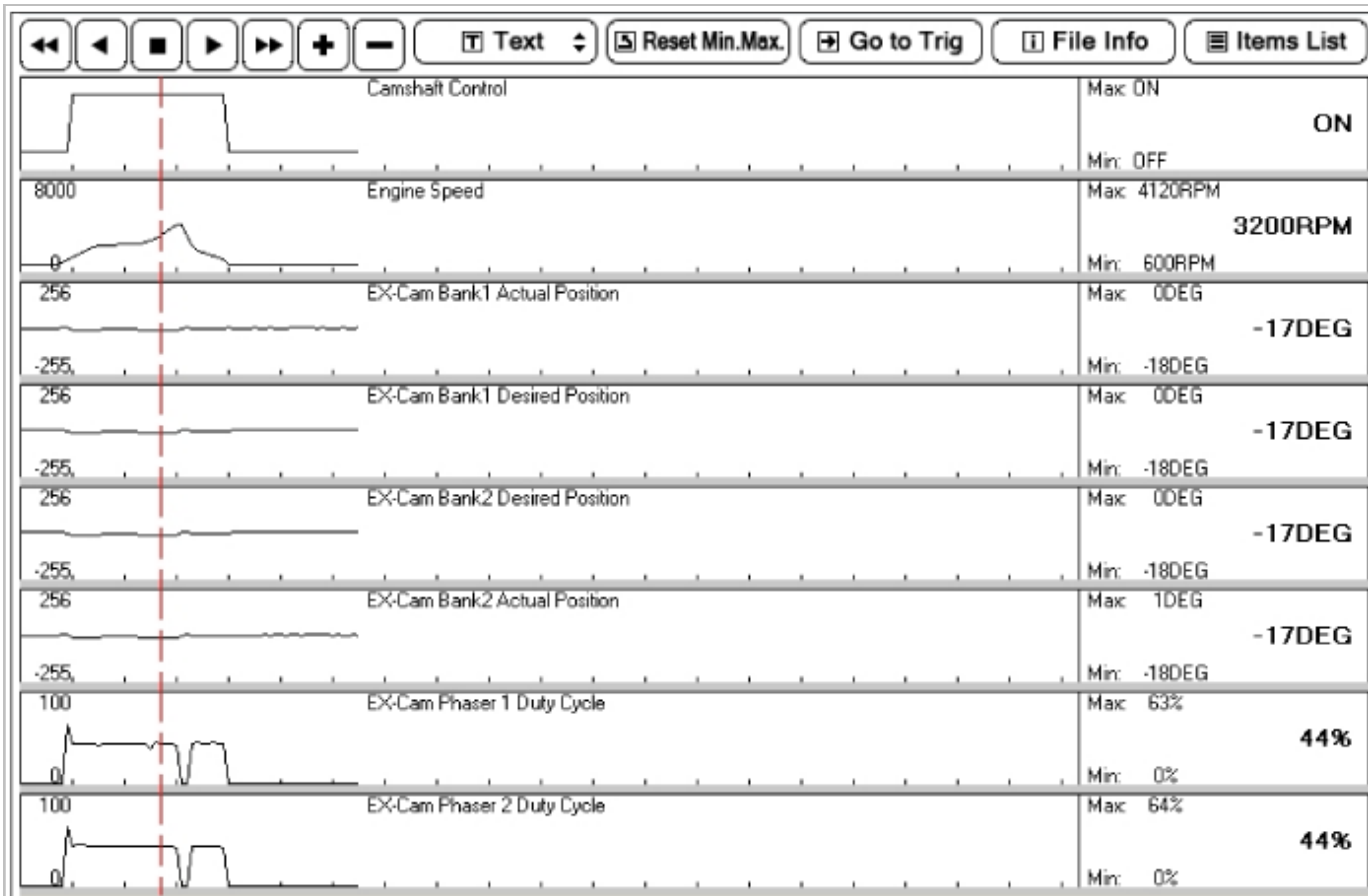
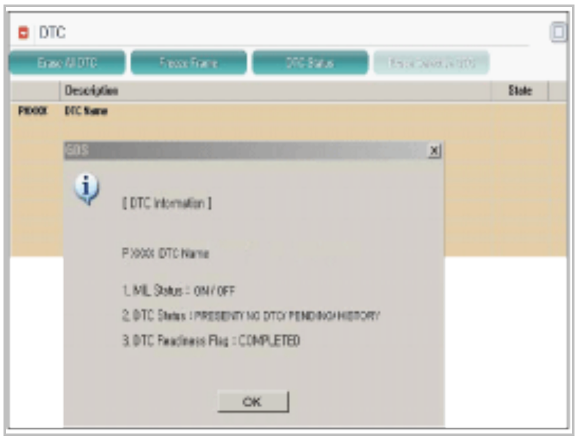


Fig.5

Fig.1) Normal waveform of OCV at idle.
Fig.2) Normal waveform of OCV at acceleration. (3500rpm)
Fig.3) Normal data of EX-CVVT at idle.
Fig.4) Normal data of EX-CVVT at acceleration.
Fig.5) Normal graph of EX-CVVT at acceleration.
The oil control valve is commanded by a pulse-with-modulated signal from the engine control unit. A duty cycle of zero commands the cam phaser to its default position. A duty cycle of 100% commands the cam phaser to its maximum phased position. When the phaser must be controlled to an intermediate position, the duty ccle is maintained in the region of the 'hold position'. This is a medium duty cycle, usually between 35% and 65%, depending on temperature and voltage conditions.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Power Circuit Inspection" as follow.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" & Disconnect OCV connector.
2. IG "ON".
3. Measure voltage between power terminal of OCV harness connector and chassis ground.

Specification : B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.
NO	▶ Check fuse between Main Relay and OCV is open or not installed. ▶ Check open in power circuit between Main Relay and OCV power circuit. ▶ Check short to ground in power circuit between Main Relay and OCV power circuit. ▶ Repair or replace as necessay go to "Verification of Vehicle Repair" procedure.

Control Circuit Inspection

■ Check resistance

1. IG "OFF" and disconnect OCV and ECM connector.
2. Measure resistance between control terminal of OCV harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Check open in harness" as follows .
NO	▶ Repair short to ground in OCV control circuit and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect OCV and ECM connector.
2. Measure resistance between control terminal of OCV harness connector and OCV control terminal of ECM harness connector.

Specification : Approx. below 1Ω

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in OCV control circuit and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check OCV resistance

1. IG "OFF" and disconnect OCV connector.

2. Measure resistance between power and signal terminals of OCV. (Component Side)

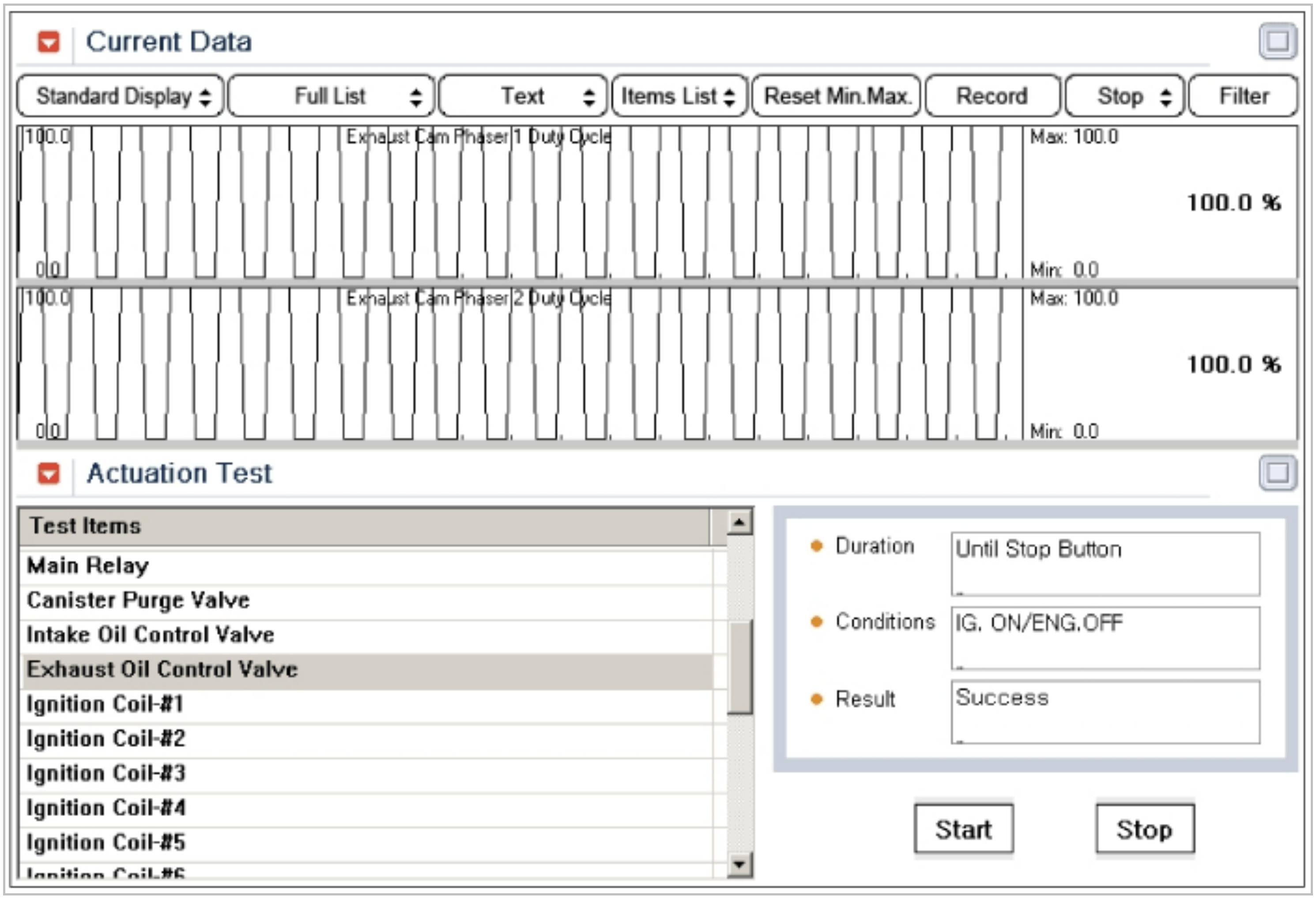
Specification : 6.7 ~ 7.7 at 20°C (68°F)

3. Is the measured resistance within specification?

YES	▶ Go to "OCV Actuation Test" as follows.
NO	▶ Substitute with a known - good OCV and check for proper operation. If the problem is corrected, replace OCV and go to "Verification of Vehicle Repair" procedure.

■ **OCV Actuation Test**

1. Connect GDS and IG "ON"
2. Select "Exhaust Oil Control Valve" on the Actuation Test
3. Activates "Exhaust Oil Control Valve" by pressing "START" button
   (Should hear a faint click from Oil Control solenoid Valve)
4. Repeat this procedure 4 or 5 times to ensure oil control solenoid valve reliability



5. Does OCV generate click sound during acutation test ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure.

	NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others.
NO	▶ Substitute with a known - good OCV and check for proper operation. If the problem is corrected, replace OCV and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

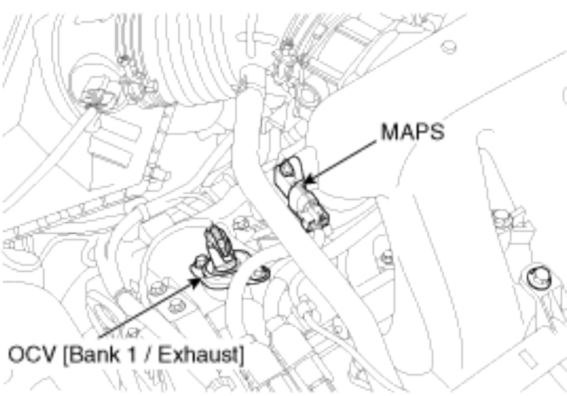
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0080 Exhaust Valve Control Solenoid Circuit High (Bank 1)

Component Location



General Description

The CVVT (Continuously Variable Valve Timing) system is installed to the chain sprocket of the intake camshaft. This system controls the intake camshaft to provide the optimal valve timing for every driving condition. The ECM controls the Oil Control Valve(OCV), based on the signals output from mass air flow, throttle position and engine coolant temperature. The CVVT controller regulates the intake camshaft angle using oil pressure through the OCV. As result, the relative position between the camshaft and the crankshaft becomes optimal, and the engine torque improves, fuel economy improves, exhaust emissions decrease under overall driving conditions.

DTC Description

When the enable condition is satisfied The ECM checks that high and low outputs (Voltage level) are observed when OCVs are commanded. When a OCV output failure is detected, the appropriate fail counter is incremented.
If the failure threshold is exceeded 5 seconds during one diagnostic test(10 second), the test is failed and DTC is stored.
MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

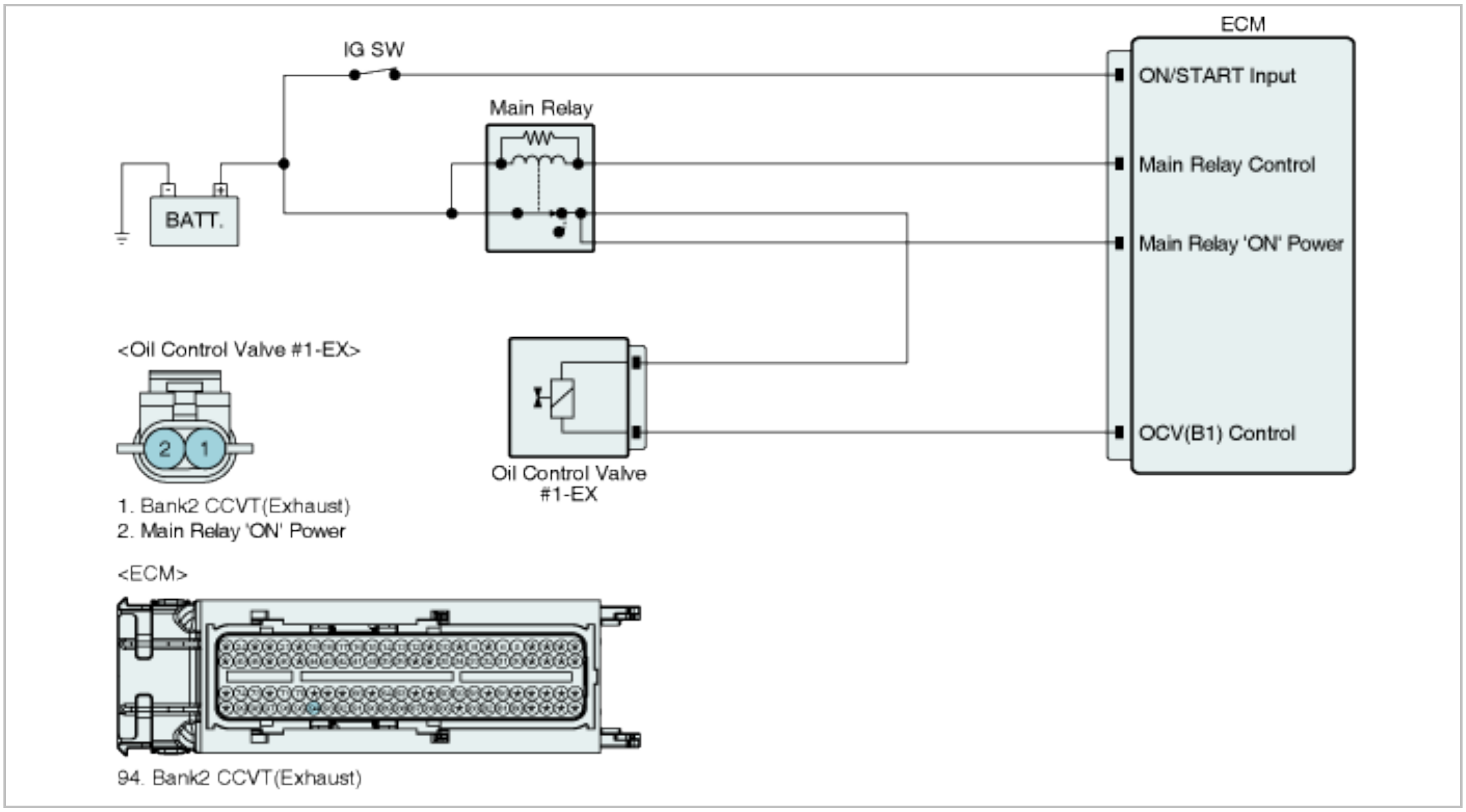
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Detects a short to battery	• Poor Connection • Short to battery in Control Circuit • OCV • ECM
Enable Conditions	• No disabling Faults Present • Engine Running • 11V ≤ Battery Voltage ≤ 16V	
Threshold value	• Short to battery	
Diagnosis Time	• Continuous (More than 5 seconds failure for every 10 seconds test)	
MIL On Condition	• 2 Driving Cycles	

Specification

Item	Specification
Resistance (Ω)	6.7 ~ 7.7 at 20°C(68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data

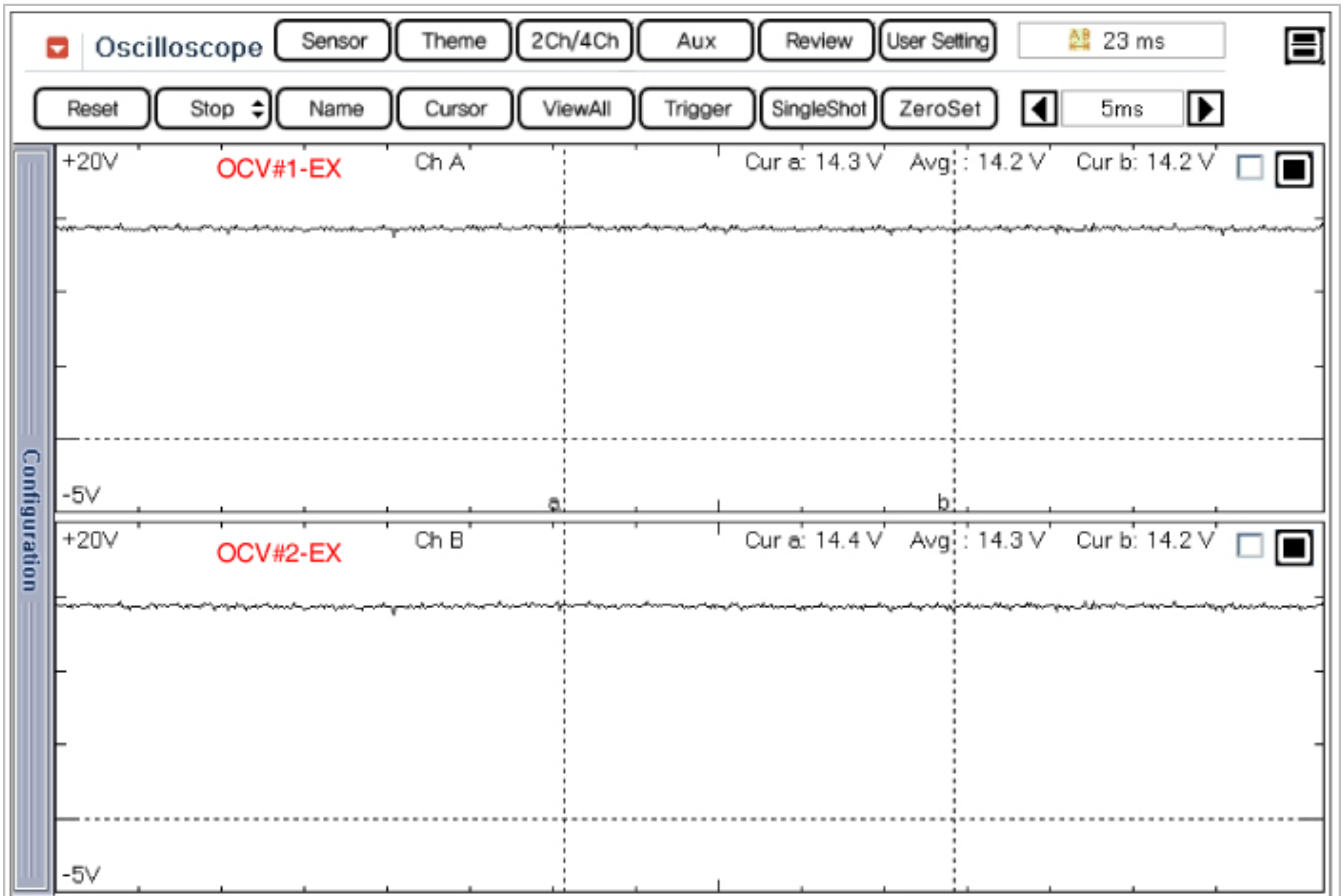

Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
23 ms
Reset
Stop
Name
Cursor
ViewAll
Trigger
SingleShot
ZeroSet
5ms
Configuration
+20V
OCV#1-EX
Ch A
Cur a: 14.3 V
Avg : 14.2 V
Cur b: 14.2 V
-5V
a
b
+20V
OCV#2-EX
Ch B
Cur a: 14.4 V
Avg : 14.3 V
Cur b: 14.2 V
-5V

Fig.1

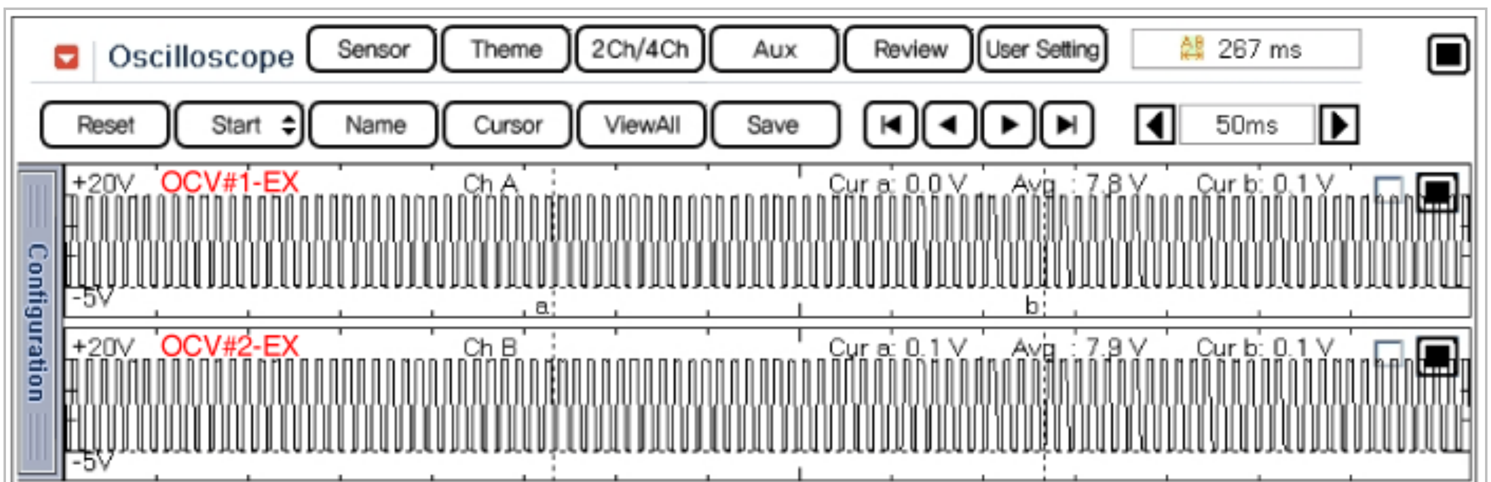

Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
267 ms
Reset
Start
Name
Cursor
ViewAll
Save
50ms
Configuration
+20V
OCV#1-EX
Ch A
Cur a: 0.0 V
Avg : 7.8 V
Cur b: 0.1 V
-5V
a
b
+20V
OCV#2-EX
Ch B
Cur a: 0.1 V
Avg : 7.9 V
Cur b: 0.1 V
-5V

Fig.2

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | VSS

Sensor Name	Value	Unit
☐ EX-Cam Bank1 Desired Position	0	DEG
☐ EX-Cam Bank1 Actual Position	0	DEG
☐ EX-Cam Bank2 Desired Position	0	DEG
☐ EX-Cam Bank2 Actual Position	0	DEG
☐ EX-Cam Phaser 1 Duty Cycle	0	%
☐ EX-Cam Phaser 2 Duty Cycle	0	%

Fig.3

Sensor Name	Value	Unit
☑ Camshaft Control	ON	-
☑ Engine Speed	3840	RPM
☑ EX-Cam Bank1 Actual Position	-15	DEG
☑ EX-Cam Bank1 Desired Position	-14	DEG
☑ EX-Cam Bank2 Desired Position	-14	DEG
☑ EX-Cam Bank2 Actual Position	-15	DEG
☑ EX-Cam Phaser 1 Duty Cycle	43	%
☑ EX-Cam Phaser 2 Duty Cycle	44	%

Fig.4

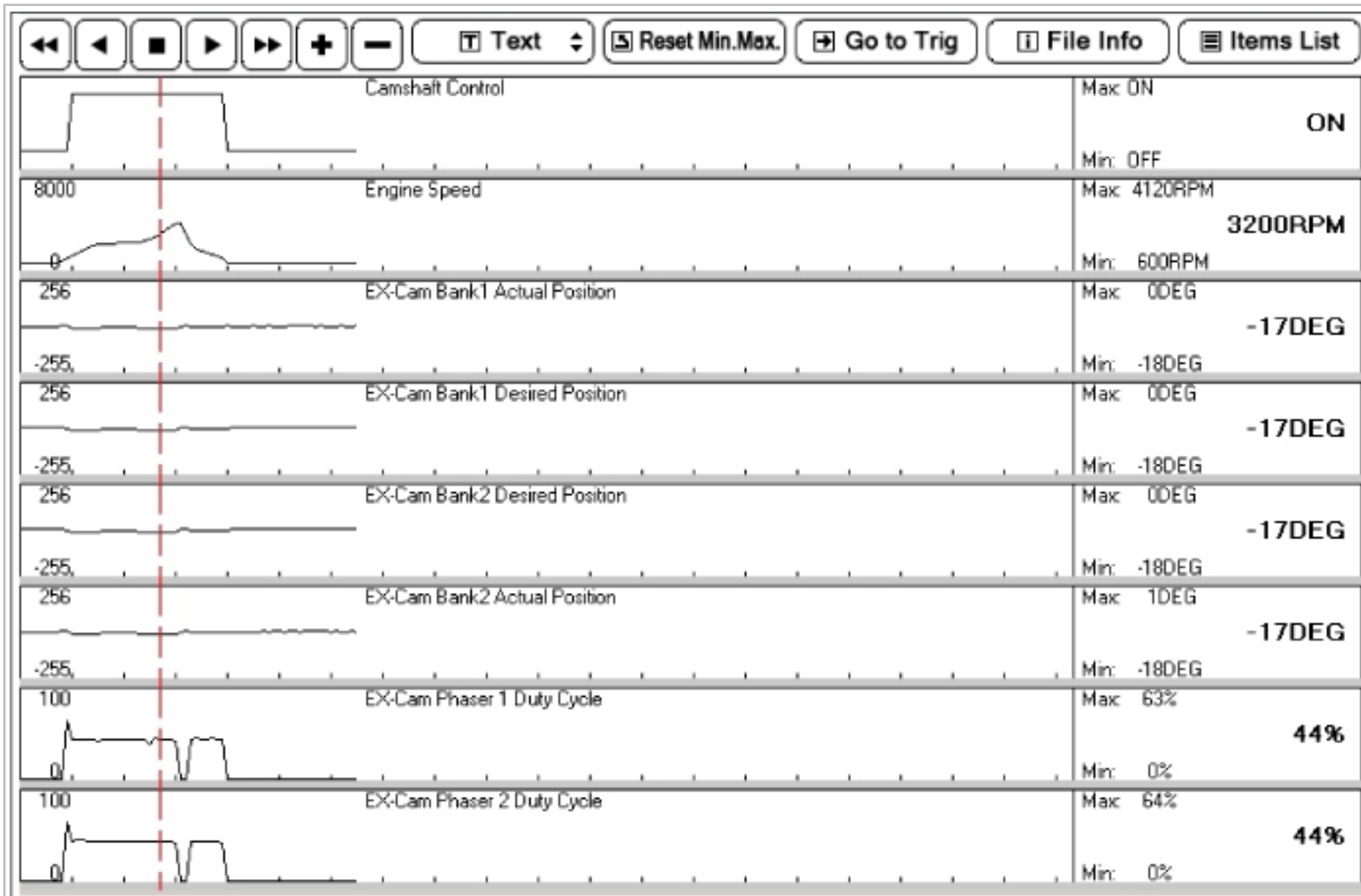
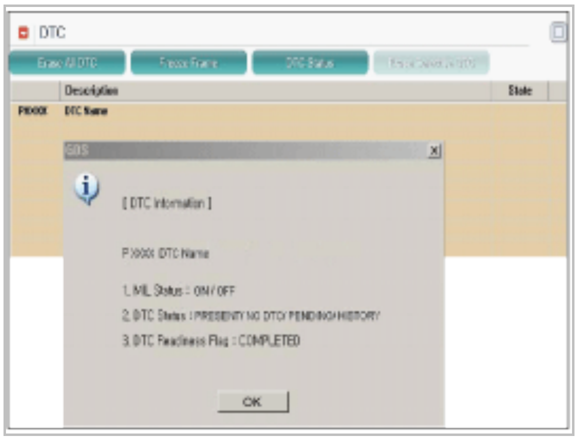


Fig.5

Fig.1) Normal waveform of OCV at idle.
Fig.2) Normal waveform of OCV at acceleration. (3500rpm)
Fig.3) Normal data of EX-CVVT at idle.
Fig.4) Normal data of EX-CVVT at acceleration.
Fig.5) Normal graph of EX-CVVT at acceleration.
The oil control valve is commanded by a pulse-with-modulated signal from the engine control unit. A duty cycle of zero commands the cam phaser to its default position. A duty cycle of 100% commands the cam phaser to its maximum phased position. When the phaser must be controlled to an intermediate position, the duty ccle is maintained in the region of the 'hold position'. This is a medium duty cycle, usually between 35% and 65%, depending on temperature and voltage conditions.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Control Circuit Inspection" procedure.

Control Circuit Inspection

■ Check short to battery in harness

1. IG "OFF" & Disconnect OCV connector.
2. Measure resistance between power and control terminals of OCV harness connector.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to battery in OCV control circuit and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check OCV resistance

1. IG "OFF" and disconnect OCV connector.
2. Measure resistance between power and signal terminals of OCV. (Component Side)

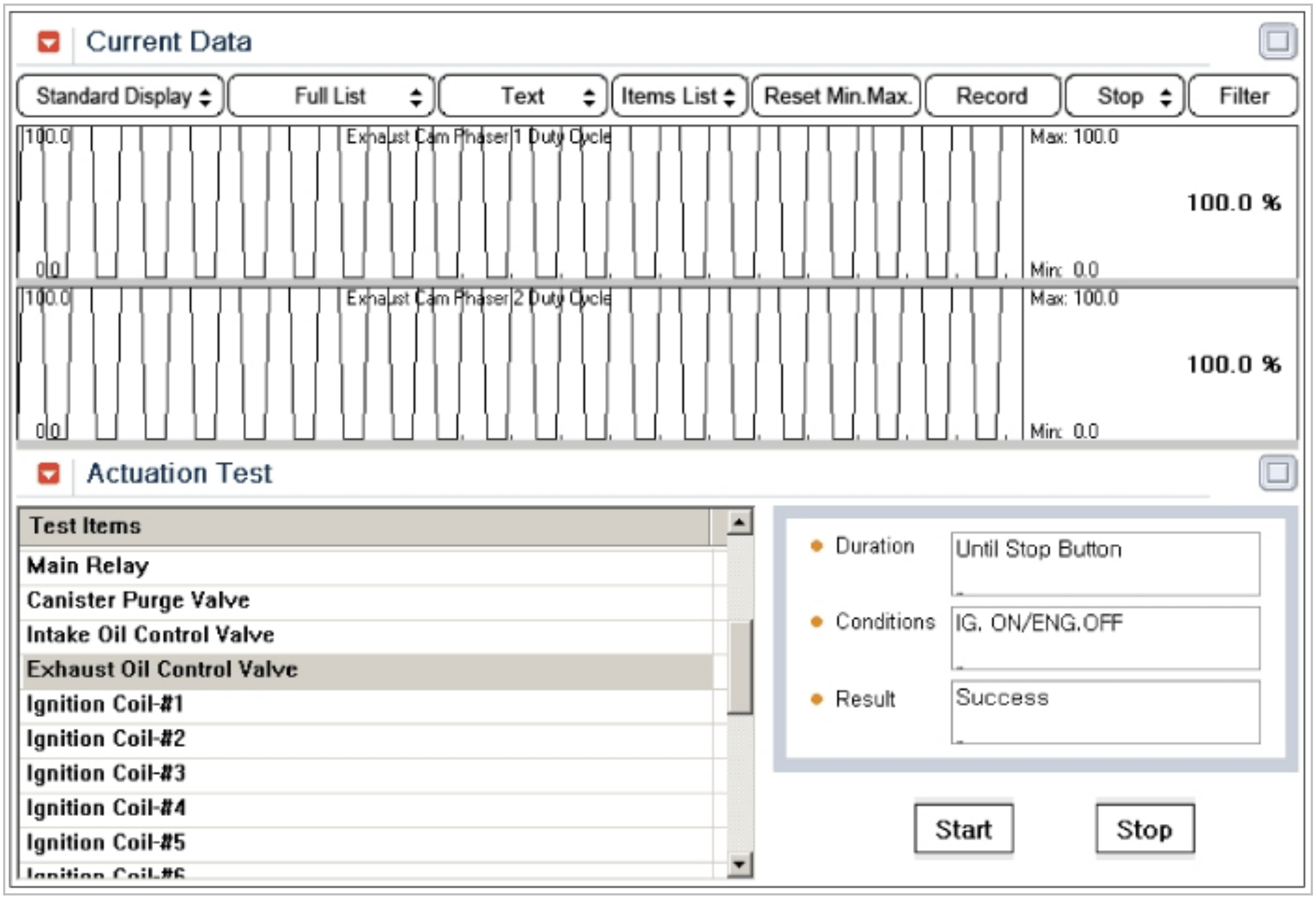
Specification : 6.7 ~ 7.7 at 20°C (68°F)

3. Is the measured resistance within specification?

YES	▶ Go to "OCV Actuation Test" as follows.
NO	▶ Substitute with a known - good OCV and check for proper operation. If the problem is corrected, replace OCV and go to "Verification of Vehicle Repair" procedure.

■ OCV Actuation Test

1. Connect GDS and IG "ON"
2. Select "Exhaust Oil Control Valve" on the Actuation Test
3. Activates "Exhaust Oil Control Valve" by pressing "START" button
   (should hear a faint click from Oil Control solenoid Valve)
4. Repeat this procedure 4 or 5 times to ensure oil control solenoid valve reliability



5. Does OCV generate click sound during acutation test ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others.
NO	▶ Substitute with a known - good OCV and check for proper operation. If the problem is corrected, replace OCV and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

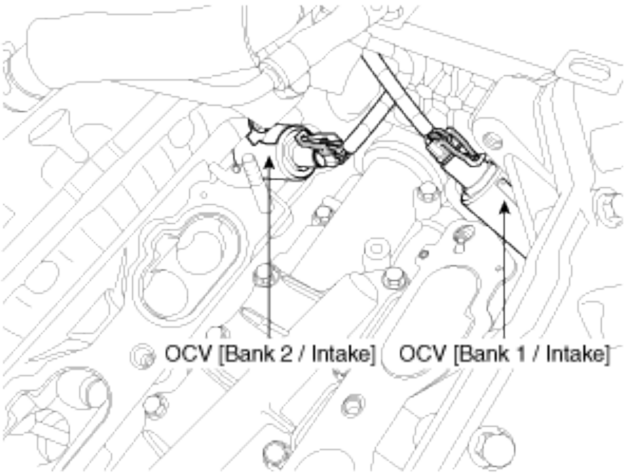
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0082 Intake Valve Control Solenoid Circuit-Low (Bank 2)

Component Location



General Description

The CVVT (Continuously Variable Valve Timing) system is installed to the chain sprocket of the intake camshaft. This system controls the intake camshaft to provide the optimal valve timing for every driving condition. The ECM controls the Oil Control Valve(OCV), based on the signals output from mass air flow, throttle position and engine coolant temperature. The CVVT controller regulates the intake camshaft angle using oil pressure through the OCV. As result, the relative position between the camshaft and the crankshaft becomes optimal, and the engine torque improves, fuel economy improves, exhaust emissions decrease under overall driving conditions.

DTC Description

When the enable condition is satisfied The ECM checks that high and low outputs (Voltage level) are observed when OCVs are commanded. When a OCV output failure is detected, the appropriate fail counter is incremented.
If the failure threshold is exceeded 5 seconds during one diagnostic test(10 second),the test is failed and DTC is stored.
MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

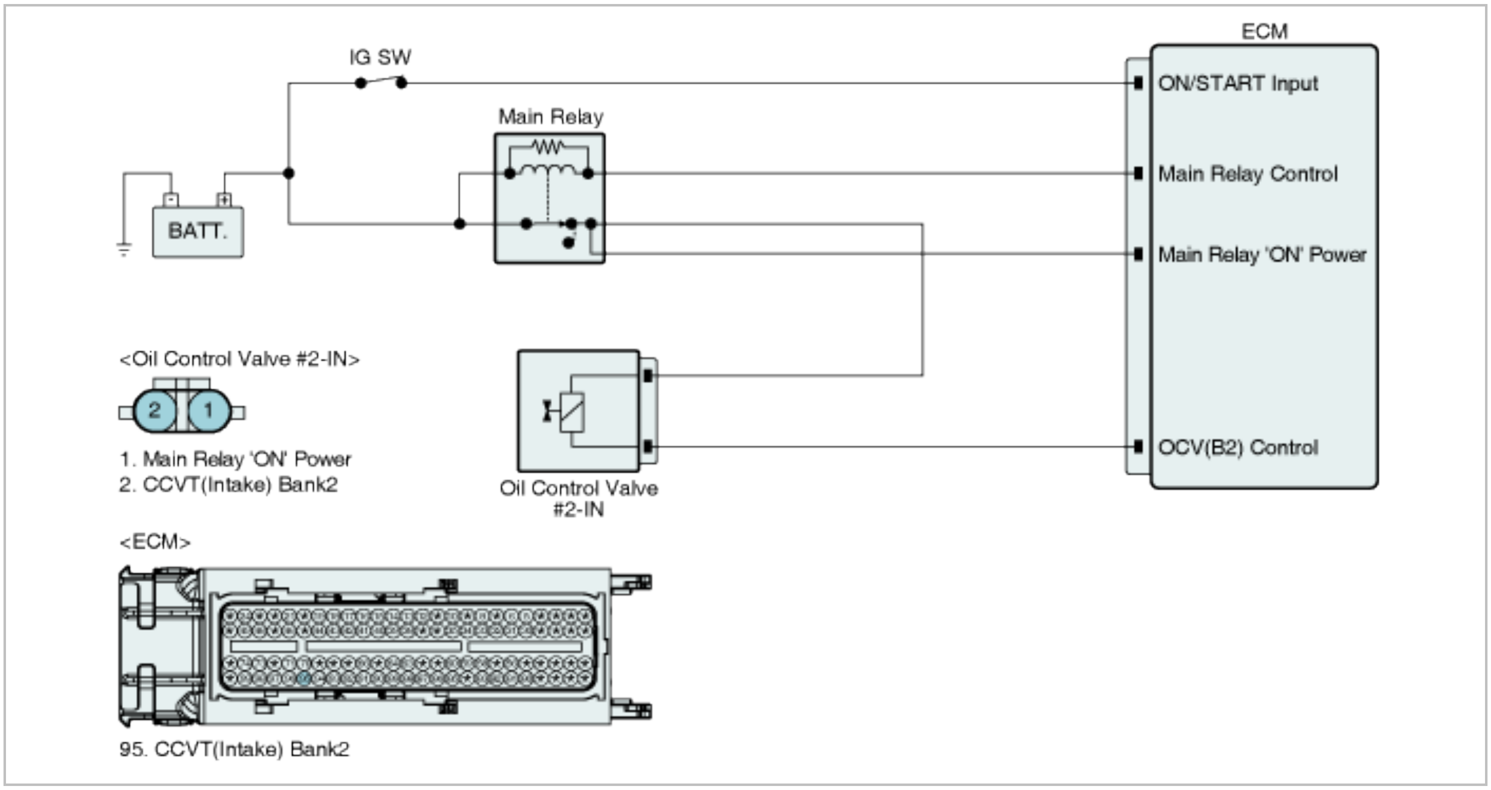
Item	Detecting Condition	Possible Cause
DTC Strategy	• Detects a short to ground or open	• Poor Connection • Open in Power circuit • Open or short to ground in Control Circuit • OCV
Enable Conditions	• No disabling Faults Present • Engine Running • 11V ≤ Battery Voltage ≤ 16V	
Threshold value	• Short to ground or open circuit	

Diagnosis Time	• Continuous (More than 5 seconds failure for every 10 seconds test)	• ECM
MIL On Condition	• 2 Driving Cycles	

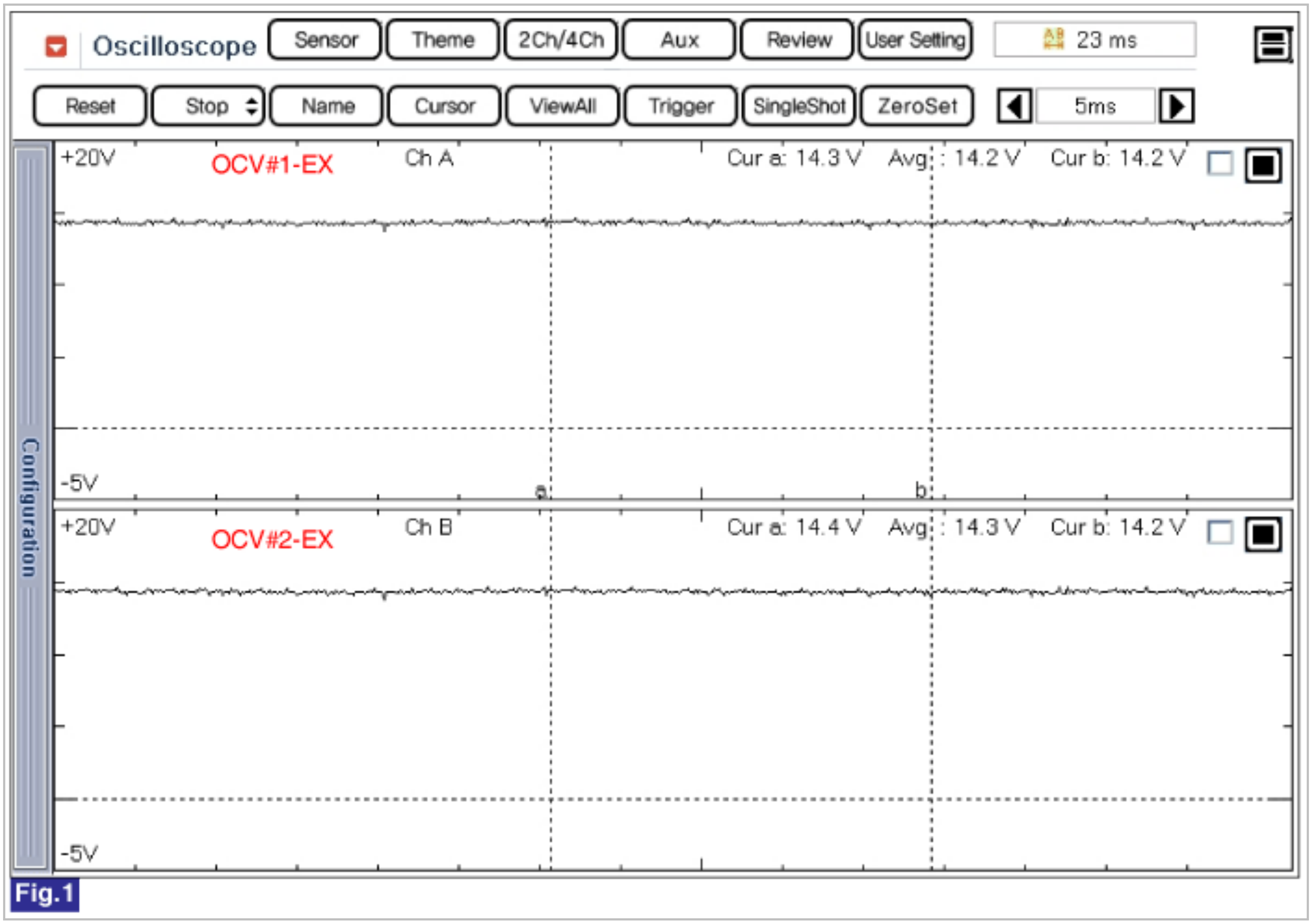
Specification

Item	Specification
Resistance (Ω)	6.7 ~ 7.7 at 20°C(68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data



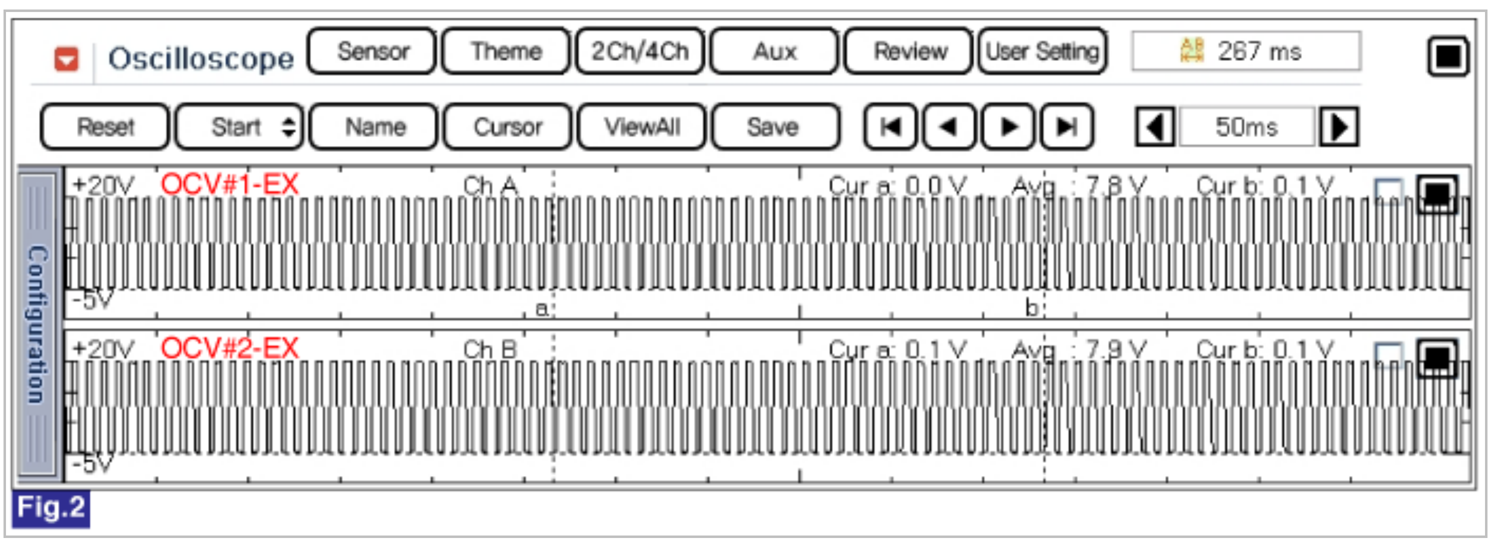
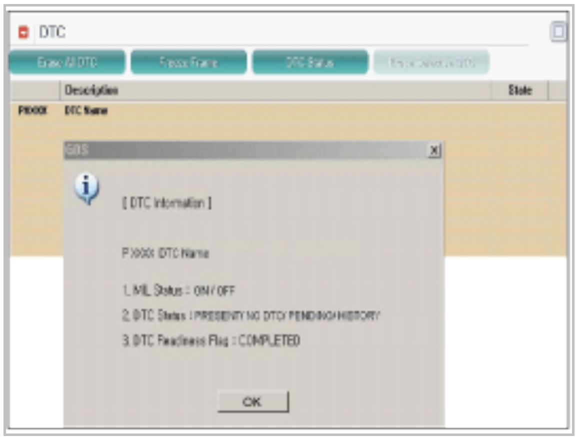


Fig.1) Normal waveform of OCV at idle.
Fig.2) Normal waveform of OCV at acceleration. (3500rpm)

The oil control valve is commanded by a pulse-with-modulated signal from the engine control unit. A duty cycle of zero commands the cam phaser to its default position. A duty cycle of 100% commands the cam phaser to its maximum phased position. When the phaser must be controlled to an intermediate position, the duty ccle is maintained in the region of the 'hold position'. This is a medium duty cycle, usually between 35% and 65%, depending on temperature and voltage conditions.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Power Circuit Inspection" as follow.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" & Disconnect OCV connector.
2. IG "ON".
3. Measure voltage between power terminal of OCV harness connector and chassis ground.

Specification : B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.

NO	▶ Check fuse between Main Relay and OCV is open or not installed. ▶ Check open in power circuit between Main Relay and OCV power circuit. ▶ Check short to ground in power circuit between Main Relay and OCV power circuit. ▶ Repair or replace as necessay go to "Verification of Vehicle Repair" procedure.

Control Circuit Inspection

■ Check resistance

1. IG "OFF" and disconnect OCV and ECM connector.
2. Measure resistance between control terminal of OCV harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Check open in harness" as follows.
NO	▶ Repair short to ground in OCV control circuit and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect OCV and ECM connector.
2. Measure resistance between control terminal of OCV harness connector and OCV control terminal of ECM harness connector.

Specification : Approx. below 1Ω

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in OCV control circuit and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check OCV resistance

1. IG "OFF" and disconnect OCV connector.
2. Measure resistance between power and signal terminals of OCV. (Component Side)

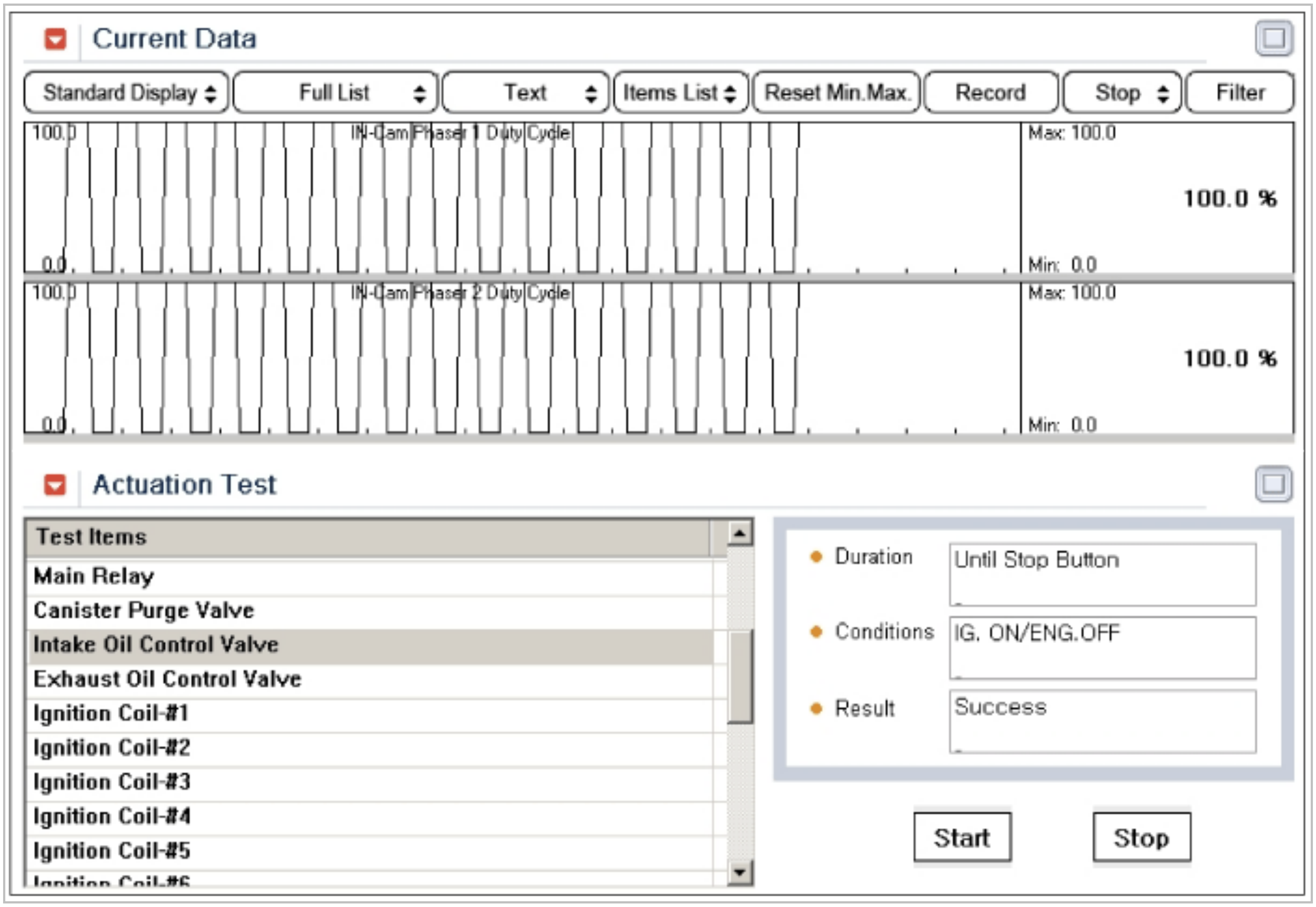
Specification : 6.7 ~ 7.7 at 20°C (68°F)

3. Is the measured resistance within specification?

YES	▶ Go to "OCV Actuation Test" as follows.
NO	▶ Substitute with a known - good OCV and check for proper operation. If the problem is corrected, replace OCV and go to "Verification of Vehicle Repair" procedure.

■ **OCV Actuation Test**

1. Connect GDS and IG "ON"
2. Select "Intake Oil Control Valve" on the Actuation Test
3. Activates "Intake Oil Control Valve" by pressing "START" button
   (should hear a faint click from Oil Control solenoid Valve)
4. Repeat this procedure 4 or 5 times to ensure oil control solenoid valve reliability



5. Does OCV generate click sound during acutation test ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others.
NO	▶ Substitute with a known - good OCV and check for proper operation. If the problem is corrected, replace OCV and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

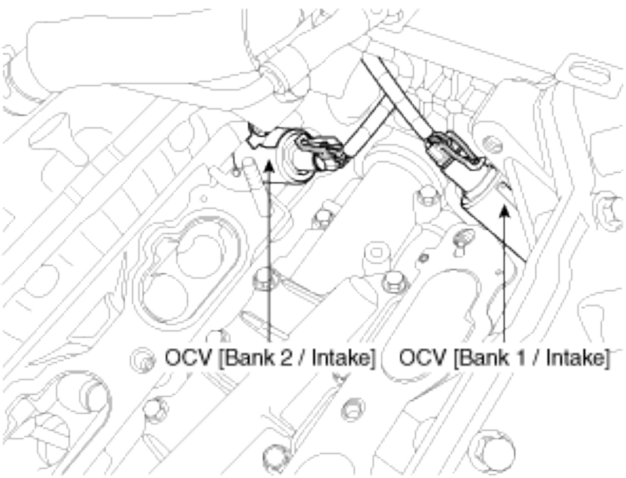
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0083 Intake Valve Control Solenoid Circuit-High (Bank 2)

Component Location



General Description

The CVVT (Continuously Variable Valve Timing) system is installed to the chain sprocket of the intake camshaft. This system controls the intake camshaft to provide the optimal valve timing for every driving condition. The ECM controls the Oil Control Valve(OCV), based on the signals output from mass air flow, throttle position and engine coolant temperature. The CVVT controller regulates the intake camshaft angle using oil pressure through the OCV. As result, the relative position between the camshaft and the crankshaft becomes optimal, and the engine torque improves, fuel economy improves, exhaust emissions decrease under overall driving conditions.

DTC Description

When the enable condition is satisfied The ECM checks that high and low outputs (Voltage level) are observed when OCVs are commanded. When a OCV output failure is detected, the appropriate fail counter is incremented.
If the failure threshold is exceeded 5 seconds during one diagnostic test(10 second), the test is failed and DTC is stored.
MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

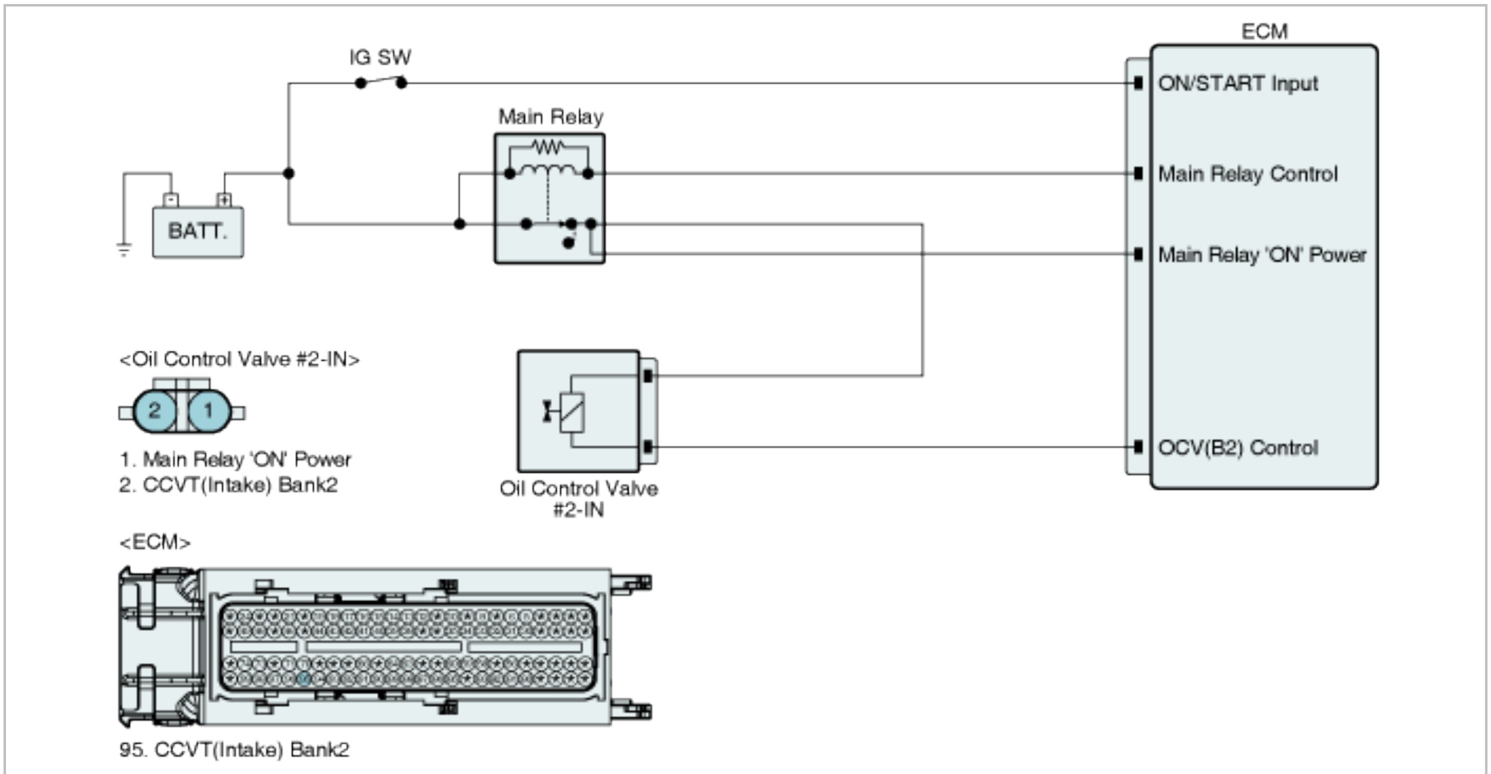
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Detects a short to battery	• Poor Connection • Short to battery in Control Circuit • OCV • ECM
Enable Conditions	• No disabling Faults Present • Engine Running • 11V ≤ Battery Voltage ≤ 16V	
Threshold value	• Short to battery	
Diagnosis Time	• Continuous (More than 5 seconds failure for every 10 seconds test)	
MIL On Condition	• 2 Driving Cycles	

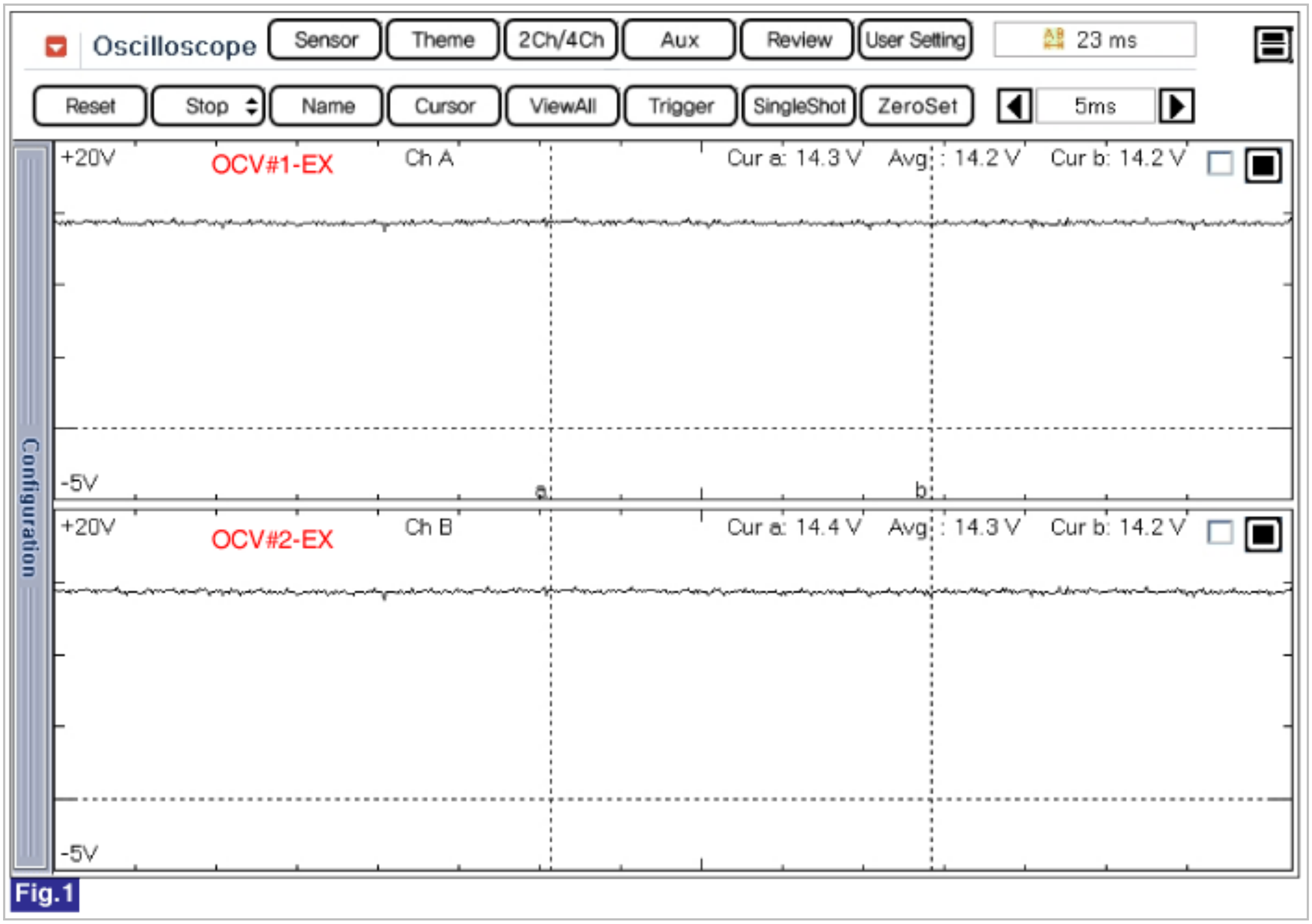
Specification

Item	Specification
Resistance (Ω)	6.7 ~ 7.7 at 20°C(68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data



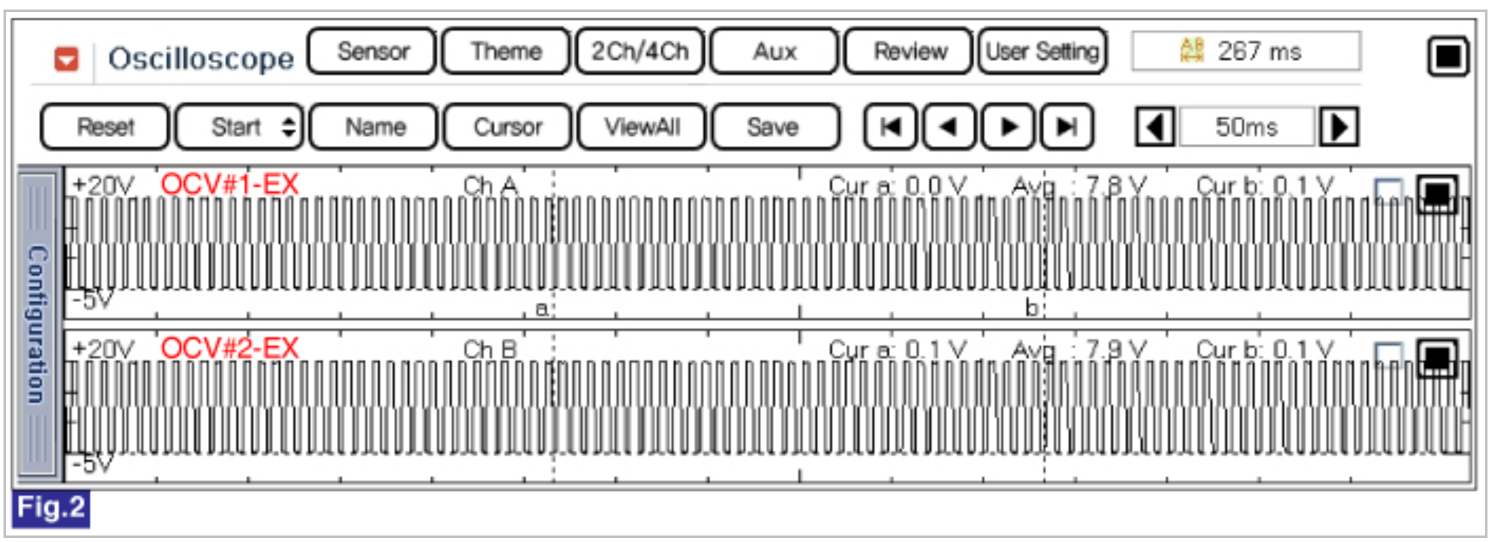
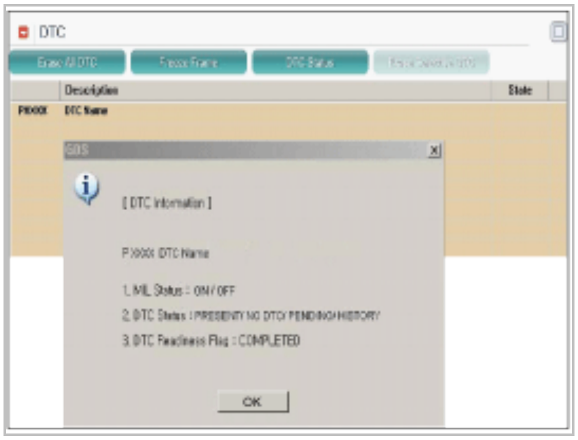


Fig.1) Normal waveform of OCV at idle.
Fig.2) Normal waveform of OCV at acceleration. (3500rpm)

The oil control valve is commanded by a pulse-with-modulated signal from the engine control unit. A duty cycle of zero commands the cam phaser to its default position. A duty cycle of 100% commands the cam phaser to its maximum phased position. When the phaser must be controlled to an intermediate position, the duty ccle is maintained in the region of the 'hold position'. This is a medium duty cycle, usually between 35% and 65%, depending on temperature and voltage conditions.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Control Circuit Inspection" procedure.

Control Circuit Inspection

■ Check short to battery in harness

1. IG "OFF" & Disconnect OCV connector.
2. Measure resistance between power and control terminals of OCV harness connector.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to battery in OCV control circuit and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check OCV resistance

1. IG "OFF" and disconnect OCV connector.
2. Measure resistance between power and signal terminals of OCV. (Component Side)

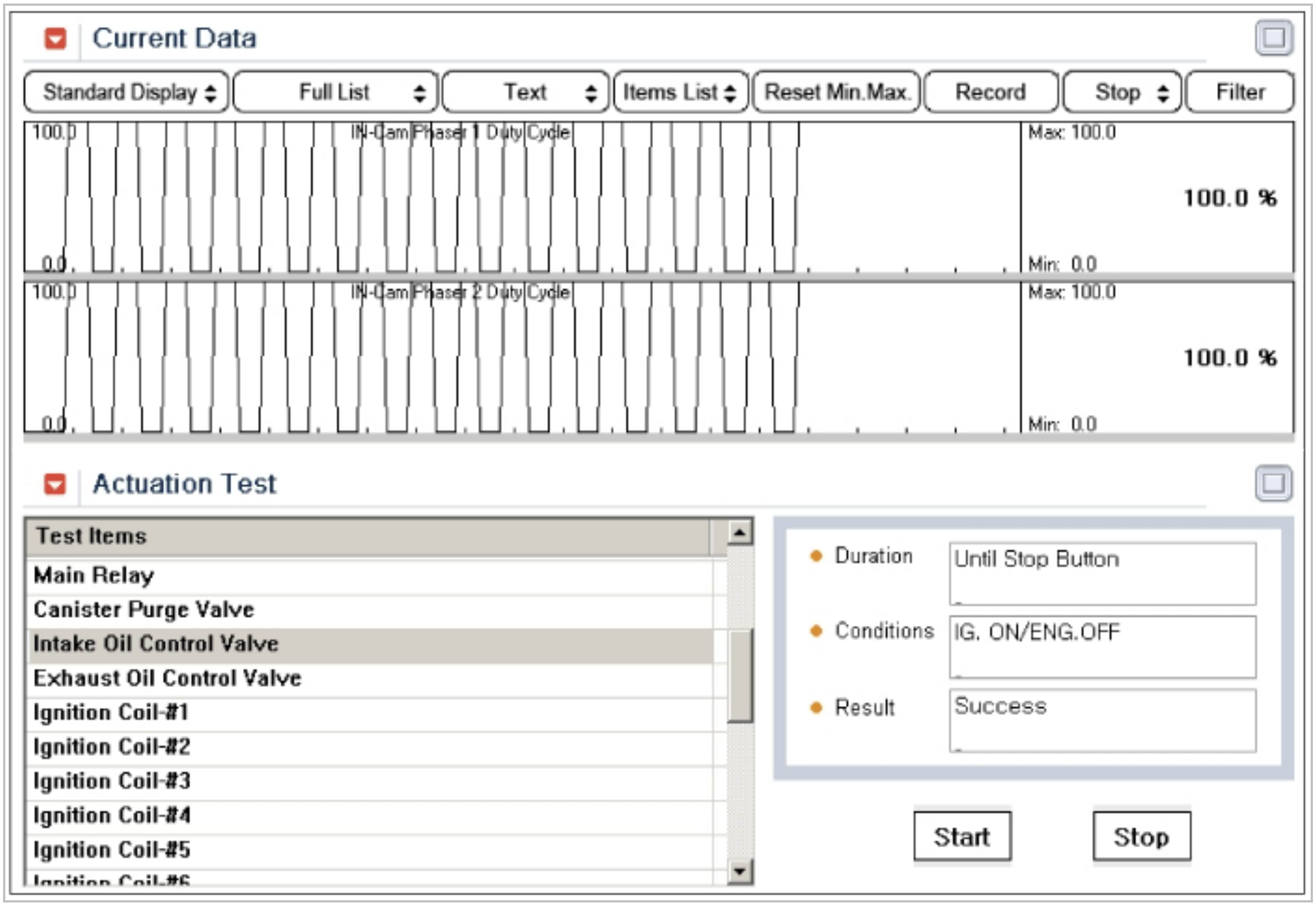
Specification : 6.7 ~ 7.7 at 20°C (68°F)

3. Is the measured resistance within specification?

YES	▶ Go to "OCV Actuation Test" as follows.
NO	▶ Substitute with a known - good OCV and check for proper operation. If the problem is corrected, replace OCV and go to "Verification of Vehicle Repair" procedure.

■ OCV Actuation Test

1. Connect GDS and IG "ON"
2. Select "Intake Oil Control Valve" on the Actuation Test
3. Activates "Intake Oil Control Valve" by pressing "START" button
   (Should hear a faint click from Oil Control solenoid Valve)
4. Repeat this procedure 4 or 5 times to ensure oil control solenoid valve reliability



5. Does OCV generate click sound during acutation test ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others.
NO	▶ Substitute with a known - good OCV and check for proper operation. If the problem is corrected, replace OCV and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

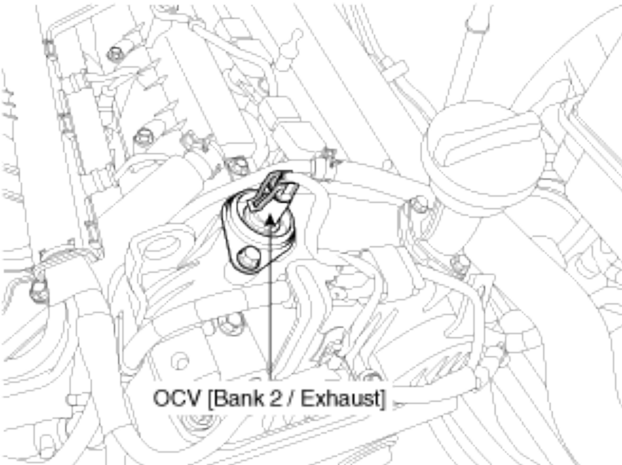
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.

4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0085 Exhaust Valve Control Solenoid Circuit Low (Bank 2)

Component Location



General Description

The CVVT (Continuously Variable Valve Timing) system is installed to the chain sprocket of the intake camshaft. This system controls the intake camshaft to provide the optimal valve timing for every driving condition. The ECM controls the Oil Control Valve(OCV), based on the signals output from mass air flow, throttle position and engine coolant temperature. The CVVT controller regulates the intake camshaft angle using oil pressure through the OCV. As result, the relative position between the camshaft and the crankshaft becomes optimal, and the engine torque improves, fuel economy improves, exhaust emissions decrease under overall driving conditions.

DTC Description

When the enable condition is satisfied The ECM checks that high and low outputs (Voltage level) are observed when OCVs are commanded. When a OCV output failure is detected, the appropriate fail counter is incremented.
If the failure threshold is exceeded 5 seconds during one diagnostic test(10 second),the test is failed and DTC is stored.
MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

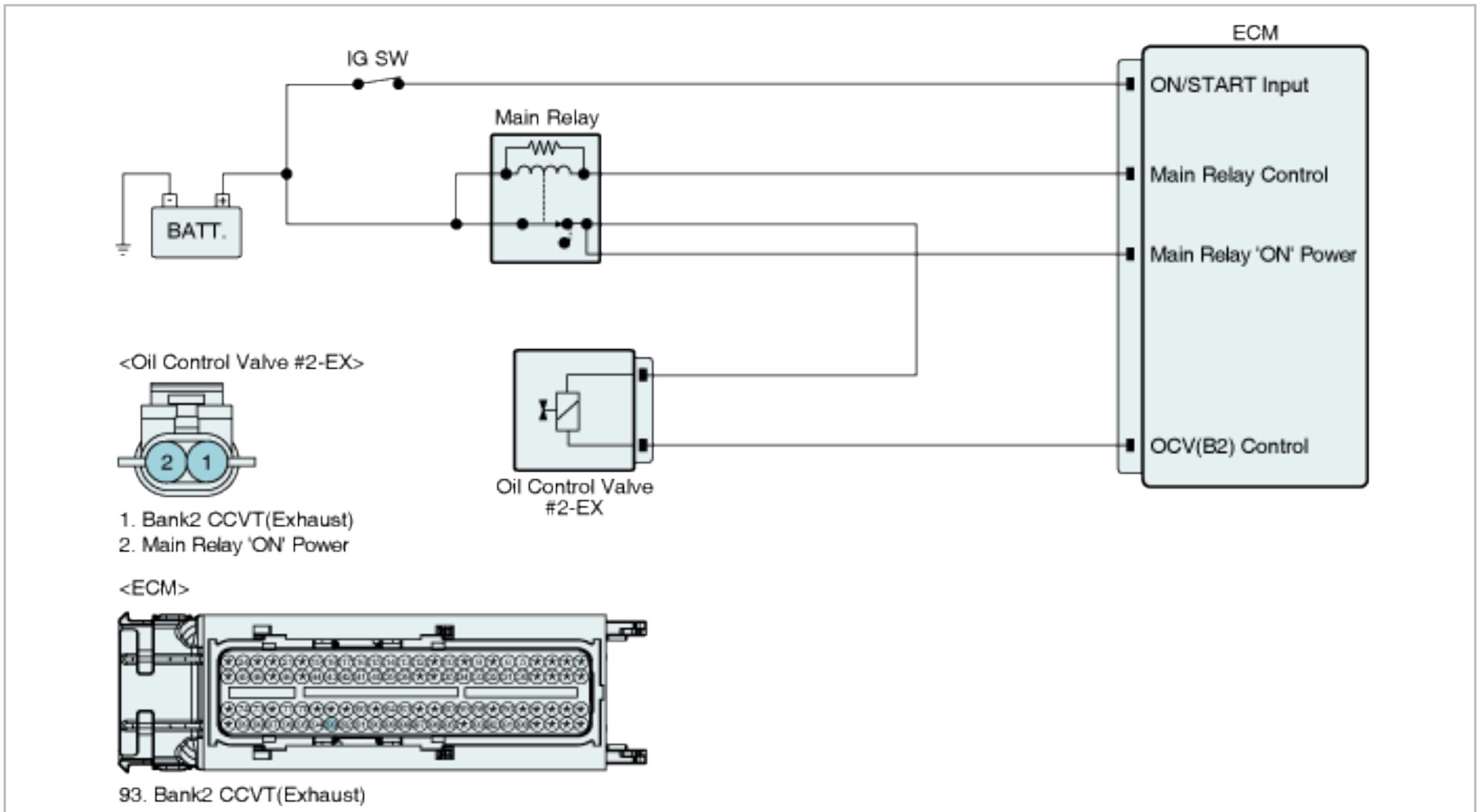
Item	Detecting Condition	Possible Cause
DTC Strategy	• Detects a short to ground or open	• Poor Connection • Open in Power circuit • Open or short to ground in Control Circuit
Enable Conditions	• No disabling Faults Present • Engine Running • 11V ≤ Battery Voltage ≤ 16V	
Threshold value	• Short to ground or open circuit	

Diagnosis Time	• Continuous (More than 5 seconds failure for every 10 seconds test)	• OCV • ECM
MIL On Condition	• 2 Driving Cycles	

Specification

Item	Specification
Resistance (Ω)	6.7 ~ 7.7 at 20°C(68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data

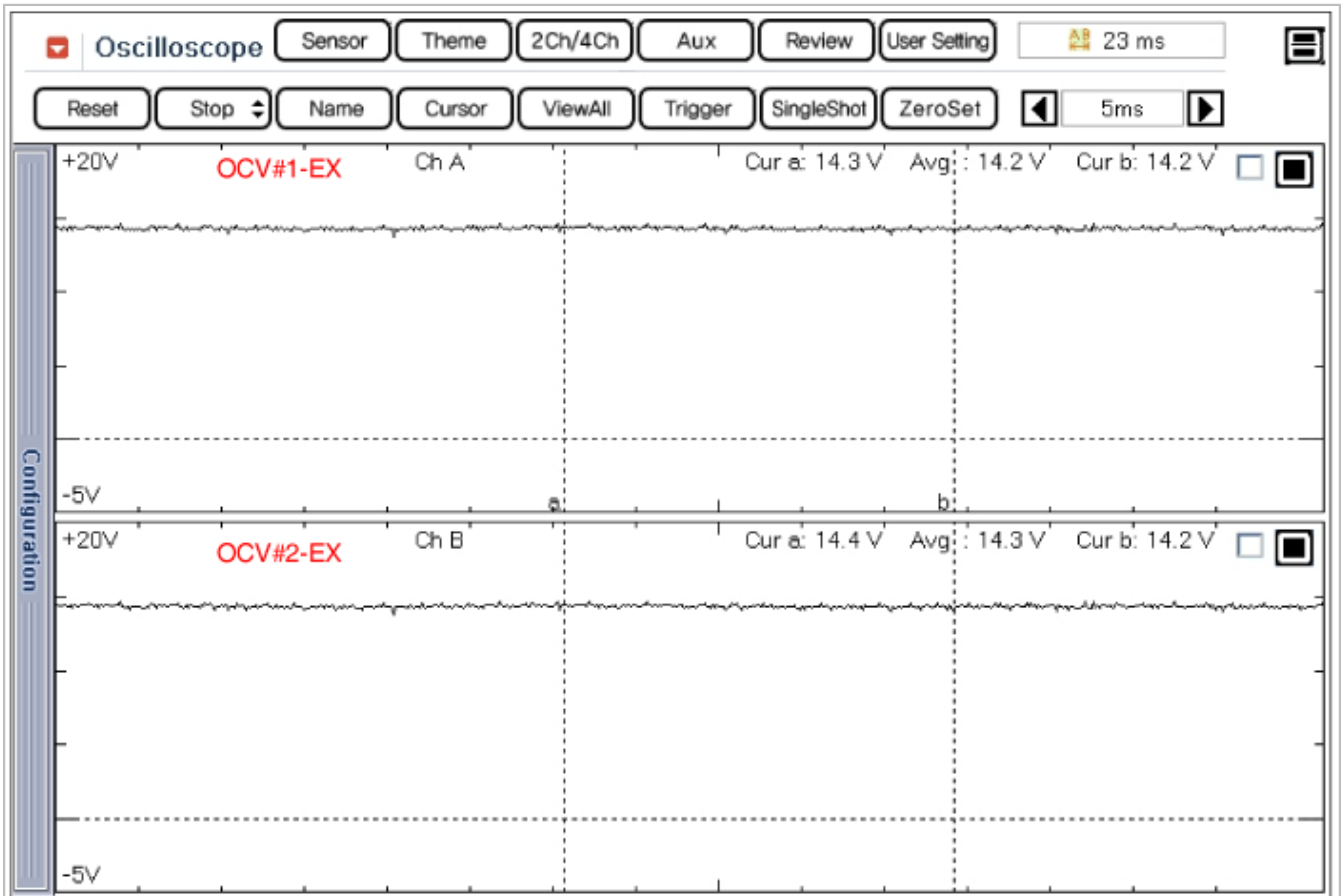

Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
23 ms
Reset
Stop
Name
Cursor
ViewAll
Trigger
SingleShot
ZeroSet
5ms
Configuration
+20V
OCV#1-EX
Ch A
Cur a: 14.3 V
Avg : 14.2 V
Cur b: 14.2 V
-5V
+20V
OCV#2-EX
Ch B
Cur a: 14.4 V
Avg : 14.3 V
Cur b: 14.2 V
-5V

Fig.1

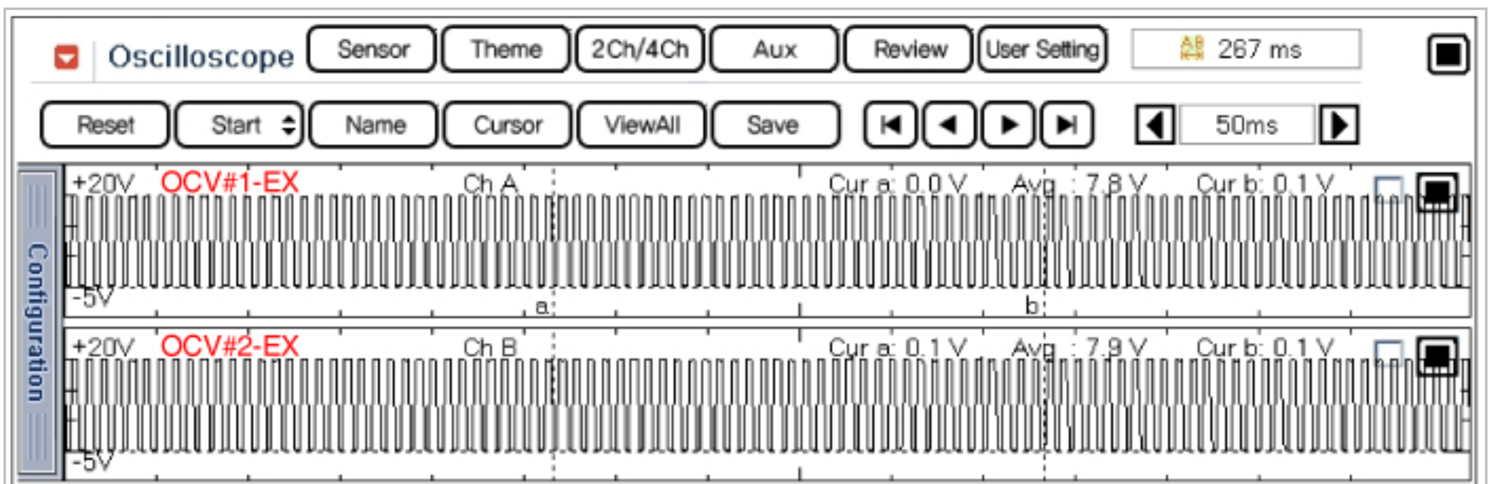

Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
267 ms
Reset
Start
Name
Cursor
ViewAll
Save
50ms
Configuration
+20V
OCV#1-EX
Ch A
Cur a: 0.0 V
Avg : 7.8 V
Cur b: 0.1 V
-5V
+20V
OCV#2-EX
Ch B
Cur a: 0.1 V
Avg : 7.9 V
Cur b: 0.1 V
-5V

Fig.2

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | VSS

Sensor Name	Value	Unit
☐ EX-Cam Bank1 Desired Position	0	DEG
☐ EX-Cam Bank1 Actual Position	0	DEG
☐ EX-Cam Bank2 Desired Position	0	DEG
☐ EX-Cam Bank2 Actual Position	0	DEG
☐ EX-Cam Phaser 1 Duty Cycle	0	%
☐ EX-Cam Phaser 2 Duty Cycle	0	%

Fig.3

Sensor Name	Value	Unit
☑ Camshaft Control	ON	-
☑ Engine Speed	3840	RPM
☑ EX-Cam Bank1 Actual Position	-15	DEG
☑ EX-Cam Bank1 Desired Position	-14	DEG
☑ EX-Cam Bank2 Desired Position	-14	DEG
☑ EX-Cam Bank2 Actual Position	-15	DEG
☑ EX-Cam Phaser 1 Duty Cycle	43	%
☑ EX-Cam Phaser 2 Duty Cycle	44	%

Fig.4

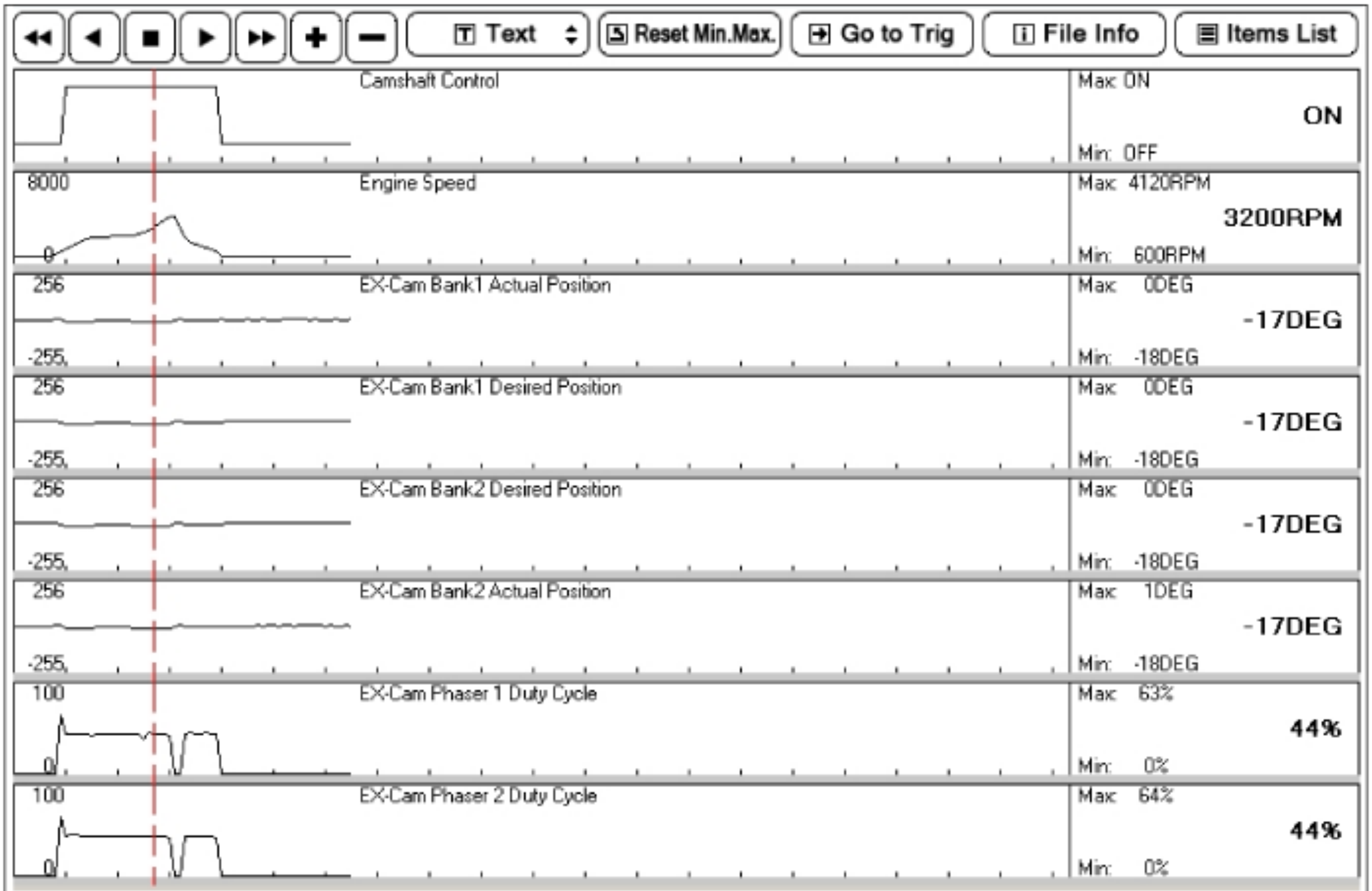
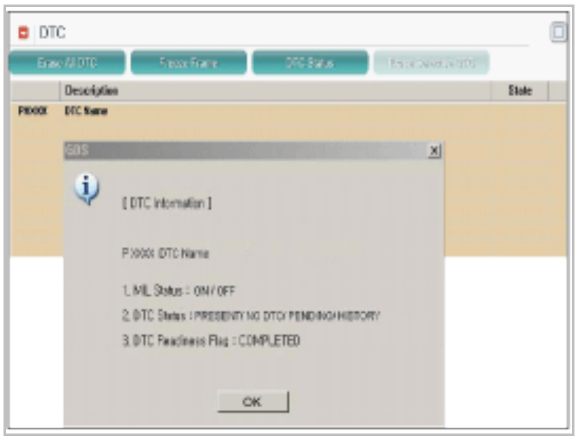


Fig.5

Fig.1) Normal waveform of OCV at idle.
Fig.2) Normal waveform of OCV at acceleration. (3500rpm)
Fig.3) Normal data of EX-CVVT at idle.
Fig.4) Normal data of EX-CVVT at acceleration.
Fig.5) Normal graph of EX-CVVT at acceleration.
The oil control valve is commanded by a pulse-with-modulated signal from the engine control unit. A duty cycle of zero commands the cam phaser to its default position. A duty cycle of 100% commands the cam phaser to its maximum phased position. When the phaser must be controlled to an intermediate position, the duty ccle is maintained in the region of the 'hold position'. This is a medium duty cycle, usually between 35% and 65%, depending on temperature and voltage conditions.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Power Circuit Inspection" as follow.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" & Disconnect OCV connector.
2. IG "ON".
3. Measure voltage between power terminal of OCV harness connector and chassis ground.

Specification : B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.
NO	▶ Check fuse between Main Relay and OCV is open or not installed. ▶ Check open in power circuit between Main Relay and OCV power circuit. ▶ Check short to ground in power circuit between Main Relay and OCV power circuit. ▶ Repair or replace as necessay go to "Verification of Vehicle Repair" procedure.

Control Circuit Inspection

■ Check resistance

1. IG "OFF" and disconnect OCV and ECM connector.
2. Measure resistance between control terminal of OCV harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Check open in harness" as follows .
NO	▶ Repair short to ground in OCV control circuit and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect OCV and ECM connector.
2. Measure resistance between control terminal of OCV harness connector and OCV control terminal of ECM harness connector.

Specification : Approx. below 1Ω

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in OCV control circuit and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check OCV resistance

1. IG "OFF" and disconnect OCV connector.

2. Measure resistance between power and signal terminals of OCV. (Component Side)

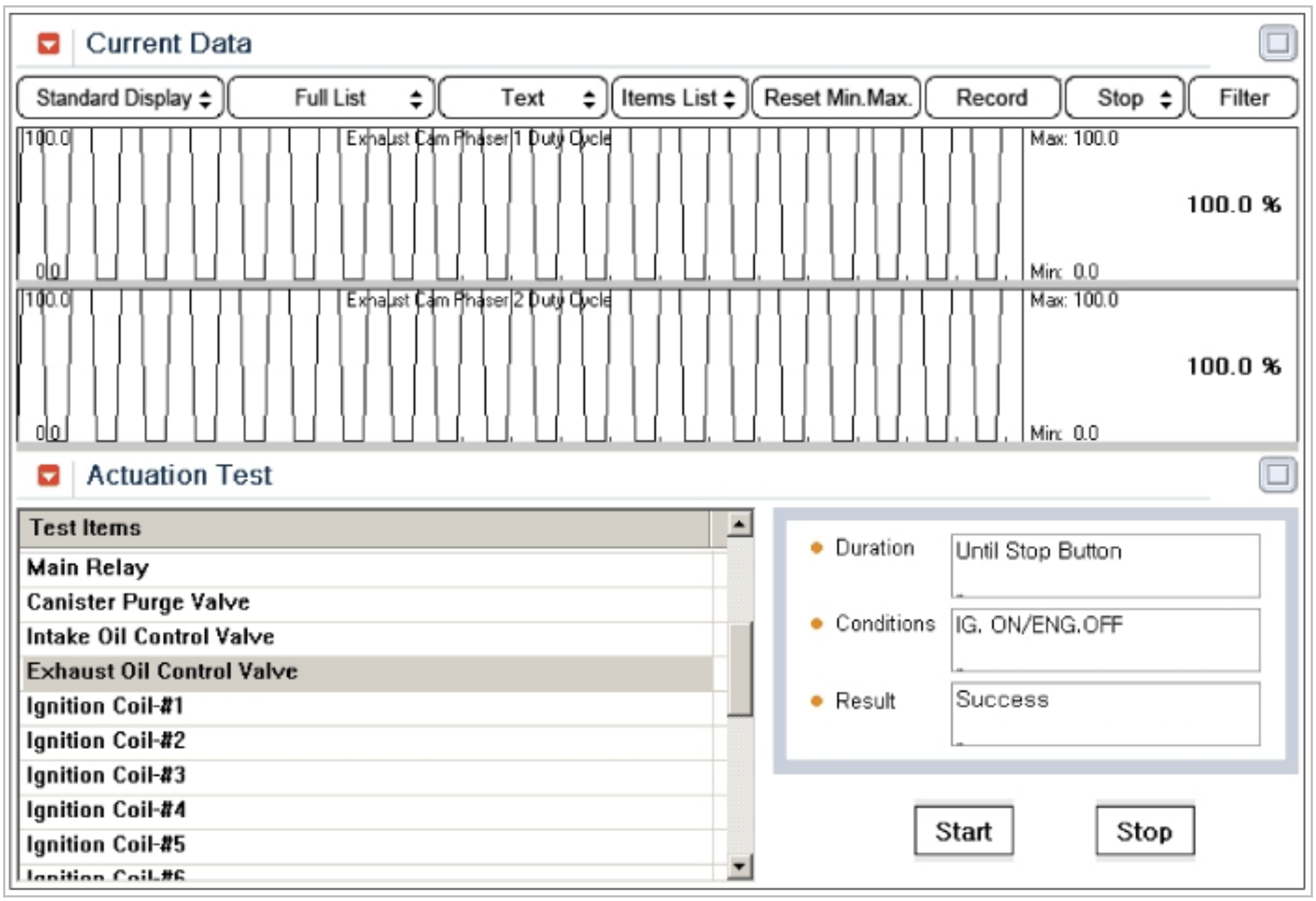
Specification : 6.7 ~ 7.7 at 20°C (68°F)

3. Is the measured resistance within specification?

YES	▶ Go to "OCV Actuation Test" as follows.
NO	▶ Substitute with a known - good OCV and check for proper operation. If the problem is corrected, replace OCV and go to "Verification of Vehicle Repair" procedure.

■ OCV Actuation Test

1. Connect GDS and IG "ON"
2. Select "Exhaust Oil Control Valve" on the Actuation Test
3. Activates "Exhaust Oil Control Valve" by pressing "START" button
   (should hear a faint click from Oil Control solenoid Valve)
4. Repeat this procedure 4 or 5 times to ensure oil control solenoid valve reliability



5. Does OCV generate click sound during acutation test ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure.

	NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others.
NO	▶ Substitute with a known - good OCV and check for proper operation. If the problem is corrected, replace OCV and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

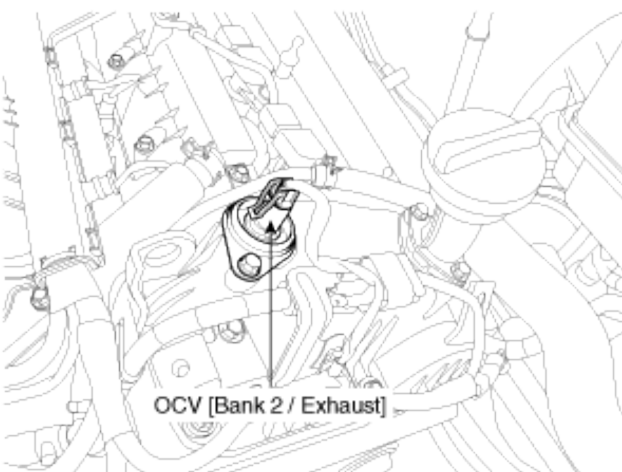
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0086 Exhaust Valve Control Solenoid Circuit High (Bank 2)

Component Location



General Description

The CVVT (Continuously Variable Valve Timing) system is installed to the chain sprocket of the intake camshaft. This system controls the intake camshaft to provide the optimal valve timing for every driving condition. The ECM controls the Oil Control Valve(OCV), based on the signals output from mass air flow, throttle position and engine coolant temperature. The CVVT controller regulates the intake camshaft angle using oil pressure through the OCV. As result, the relative position between the camshaft and the crankshaft becomes optimal, and the engine torque improves, fuel economy improves, exhaust emissions decrease under overall driving conditions.

DTC Description

When the enable condition is satisfied The ECM checks that high and low outputs (Voltage level) are observed when OCVs are commanded. When a OCV output failure is detected, the appropriate fail counter is incremented.
If the failure threshold is exceeded 5 seconds during one diagnostic test(10 second), the test is failed and DTC is stored.
MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

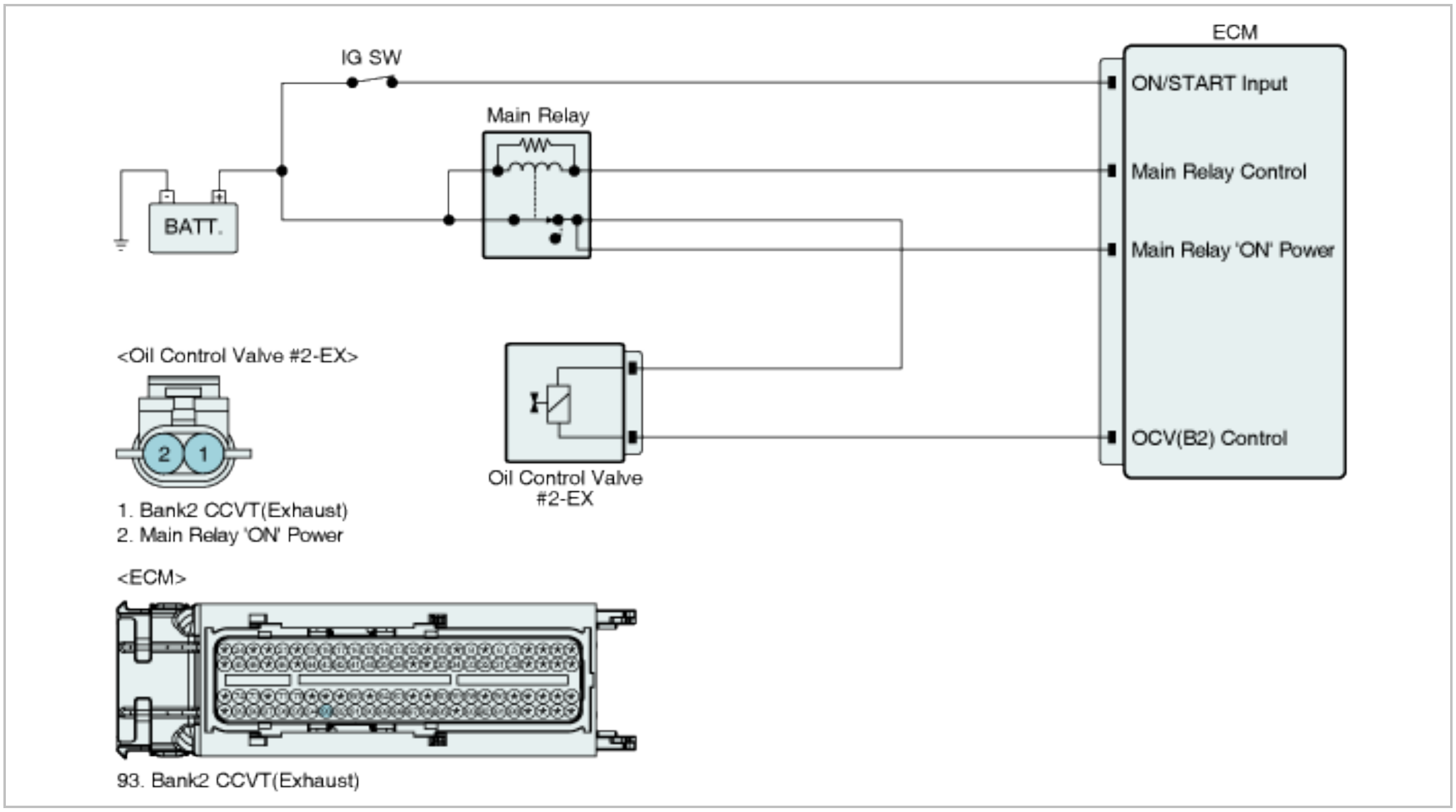
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Detects a short to battery	• Poor Connection • Short to battery in Control Circuit • OCV • ECM
Enable Conditions	• No disabling Faults Present • Engine Running • 11V ≤ Battery Voltage ≤ 16V	
Threshold value	• Short to battery	
Diagnosis Time	• Continuous (More than 5 seconds failure for every 10 seconds test)	
MIL On Condition	• 2 Driving Cycles	

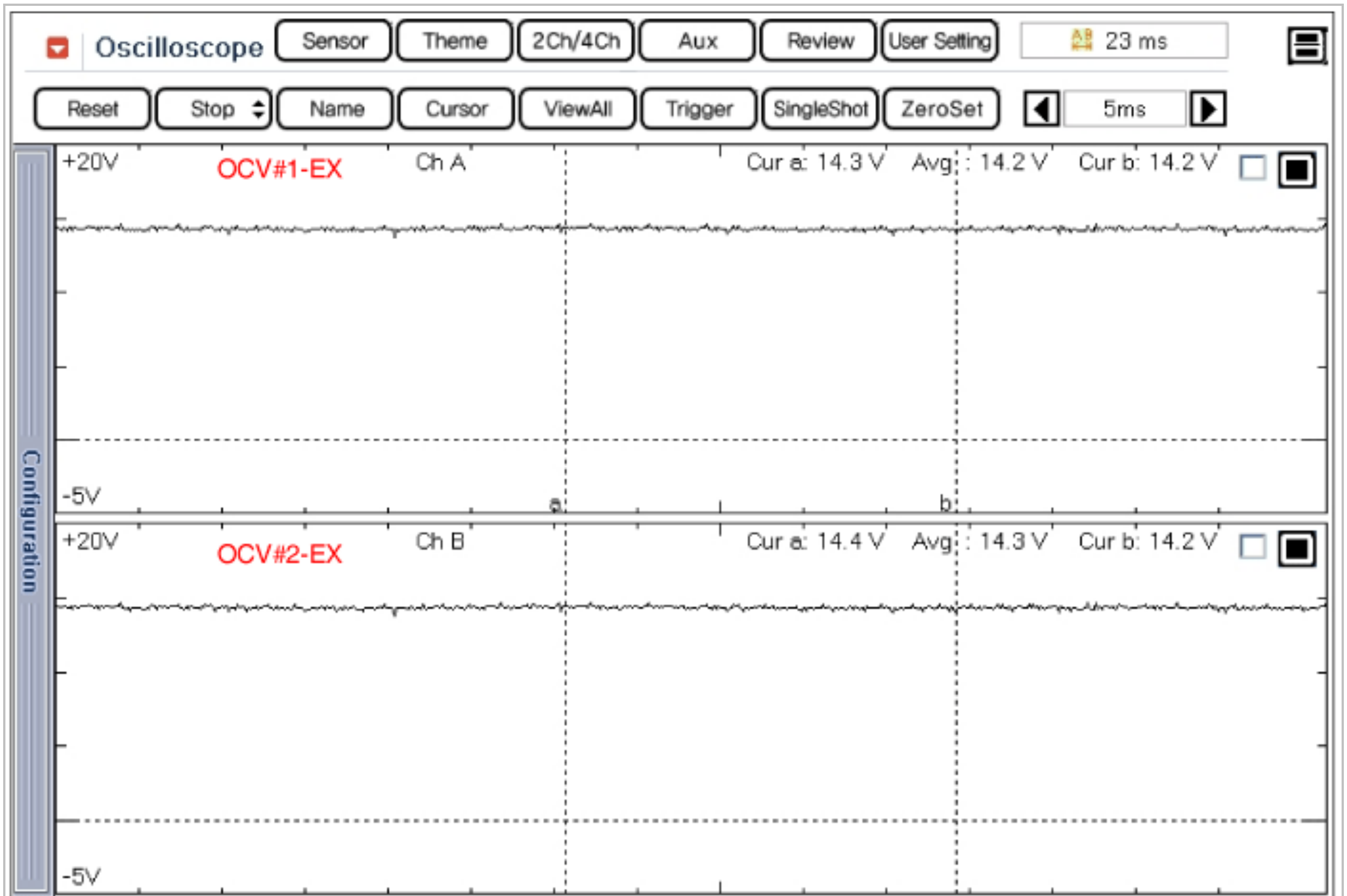
Specification

Item	Specification
Resistance (Ω)	6.7 ~ 7.7 at 20°C(68°F)

Diagnostic Circuit Diagram

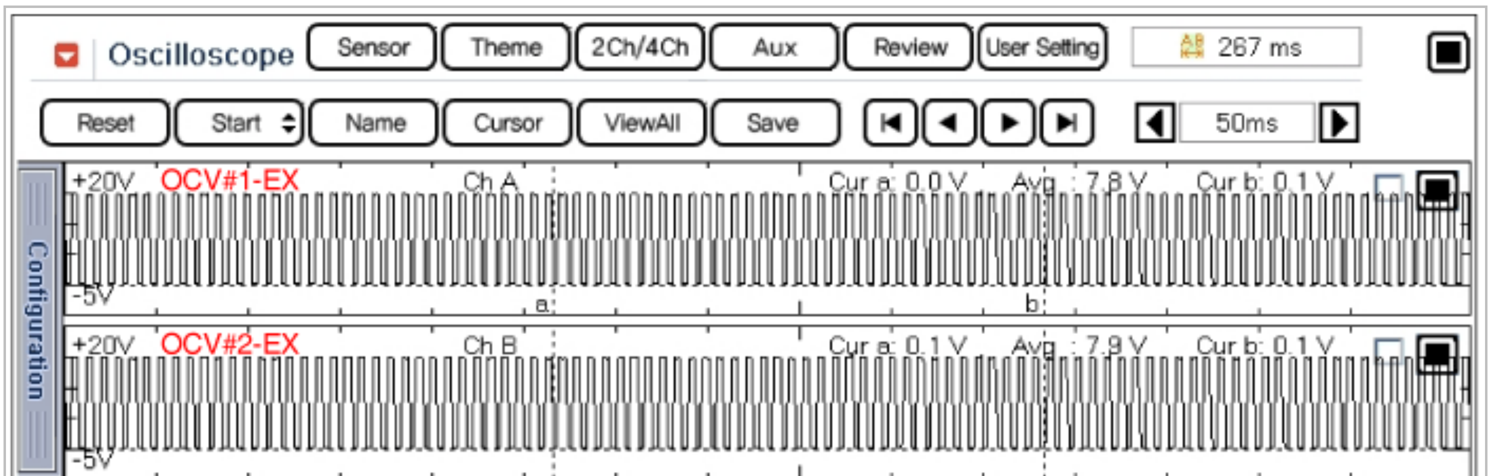


Signal Waveform & Data



Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
23 ms
Reset
Stop
Name
Cursor
ViewAll
Trigger
SingleShot
ZeroSet
5ms
Configuration
+20V
OCV#1-EX
Ch A
Cur a: 14.3 V
Avg : 14.2 V
Cur b: 14.2 V
-5V
a
b
+20V
OCV#2-EX
Ch B
Cur a: 14.4 V
Avg : 14.3 V
Cur b: 14.2 V
-5V

Fig.1



Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
267 ms
Reset
Start
Name
Cursor
ViewAll
Save
50ms
Configuration
+20V
OCV#1-EX
Ch A
Cur a: 0.0 V
Avg : 7.8 V
Cur b: 0.1 V
-5V
a
b
+20V
OCV#2-EX
Ch B
Cur a: 0.1 V
Avg : 7.9 V
Cur b: 0.1 V
-5V

Fig.2

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | VSS

Sensor Name	Value	Unit
☐ EX-Cam Bank1 Desired Position	0	DEG
☐ EX-Cam Bank1 Actual Position	0	DEG
☐ EX-Cam Bank2 Desired Position	0	DEG
☐ EX-Cam Bank2 Actual Position	0	DEG
☐ EX-Cam Phaser 1 Duty Cycle	0	%
☐ EX-Cam Phaser 2 Duty Cycle	0	%

Fig.3

Sensor Name	Value	Unit
☑ Camshaft Control	ON	-
☑ Engine Speed	3840	RPM
☑ EX-Cam Bank1 Actual Position	-15	DEG
☑ EX-Cam Bank1 Desired Position	-14	DEG
☑ EX-Cam Bank2 Desired Position	-14	DEG
☑ EX-Cam Bank2 Actual Position	-15	DEG
☑ EX-Cam Phaser 1 Duty Cycle	43	%
☑ EX-Cam Phaser 2 Duty Cycle	44	%

Fig.4

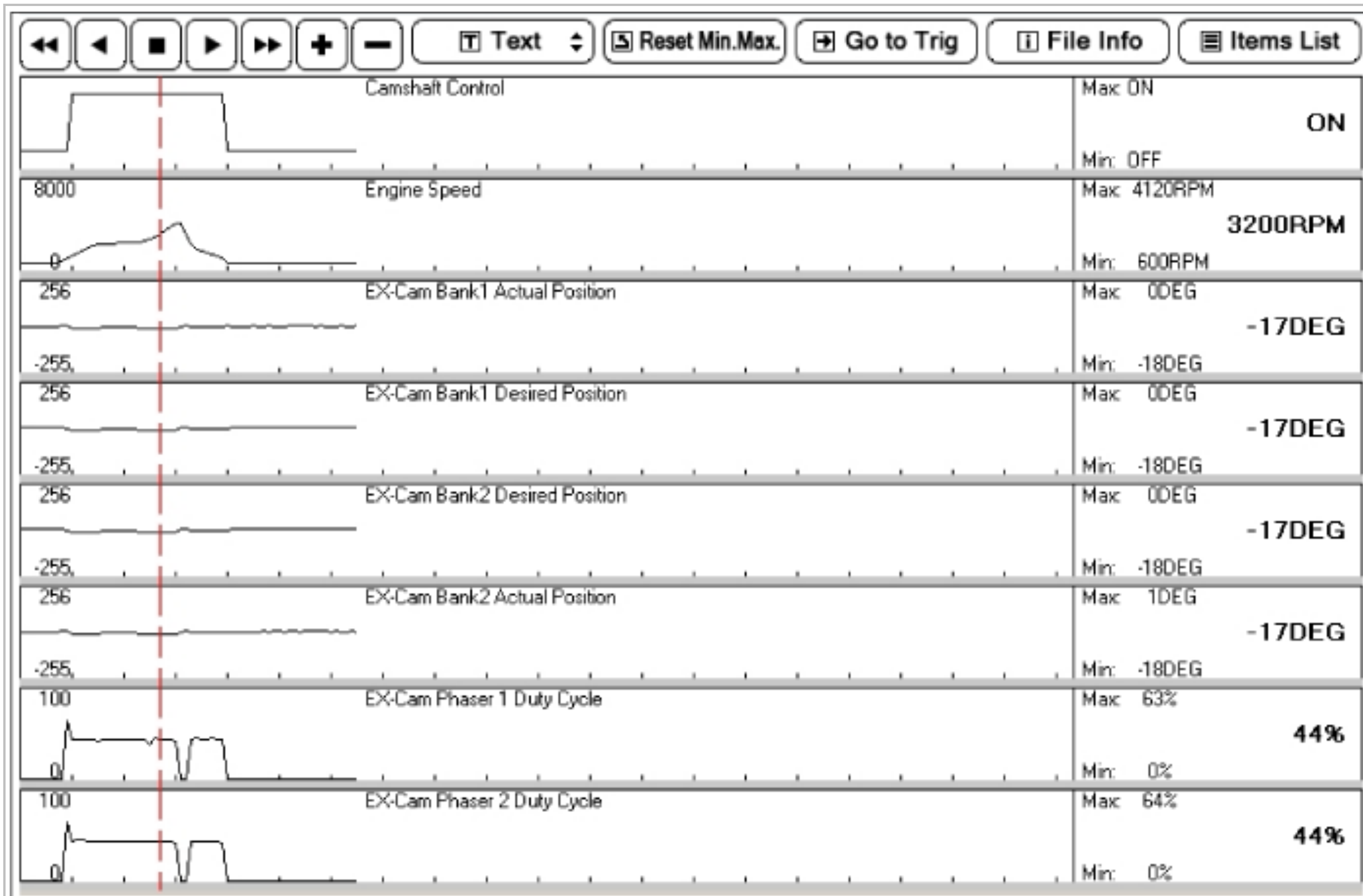
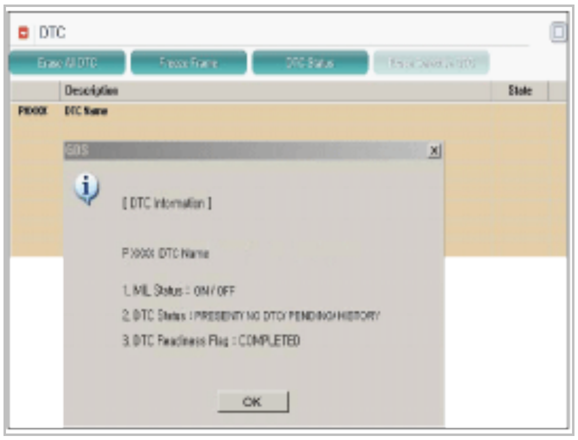


Fig.5

Fig.1) Normal waveform of OCV at idle.
Fig.2) Normal waveform of OCV at acceleration. (3500rpm)
Fig.3) Normal data of EX-CVVT at idle.
Fig.4) Normal data of EX-CVVT at acceleration.
Fig.5) Normal graph of EX-CVVT at acceleration.
The oil control valve is commanded by a pulse-with-modulated signal from the engine control unit. A duty cycle of zero commands the cam phaser to its default position. A duty cycle of 100% commands the cam phaser to its maximum phased position. When the phaser must be controlled to an intermediate position, the duty ccle is maintained in the region of the 'hold position'. This is a medium duty cycle, usually between 35% and 65%, depending on temperature and voltage conditions.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Control Circuit Inspection" procedure.

Control Circuit Inspection

■ Check short to battery in harness

1. IG "OFF" & Disconnect OCV connector.
2. Measure resistance between power and control terminals of OCV harness connector.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to battery in OCV control circuit and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check OCV resistance

1. IG "OFF" and disconnect OCV connector.
2. Measure resistance between power and signal terminals of OCV. (Component Side)

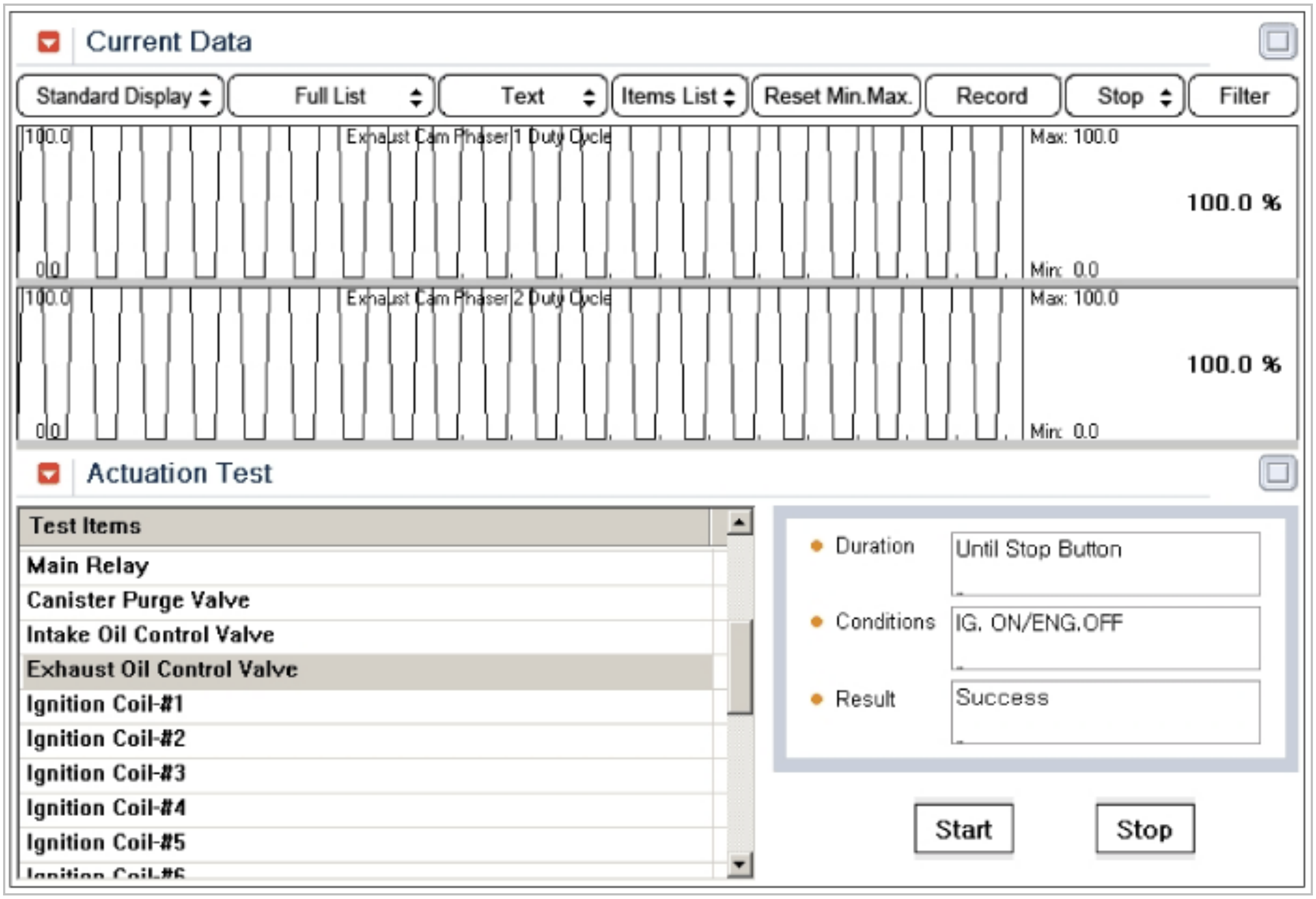
Specification : 6.7 ~ 7.7 at 20°C (68°F)

3. Is the measured resistance within specification?

YES	▶ Go to "OCV Actuation Test" as follows.
NO	▶ Substitute with a known - good OCV and check for proper operation. If the problem is corrected, replace OCV and go to "Verification of Vehicle Repair" procedure.

■ OCV Actuation Test

1. Connect GDS and IG "ON"
2. Select "Exhaust Oil Control Valve" on the Actuation Test
3. Activates "Exhaust Oil Control Valve" by pressing "START" button
   (Should hear a faint click from Oil Control solenoid Valve)
4. Repeat this procedure 4 or 5 times to ensure oil control solenoid valve reliability



5. Does OCV generate click sound during acutation test ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others.
NO	▶ Substitute with a known - good OCV and check for proper operation. If the problem is corrected, replace OCV and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

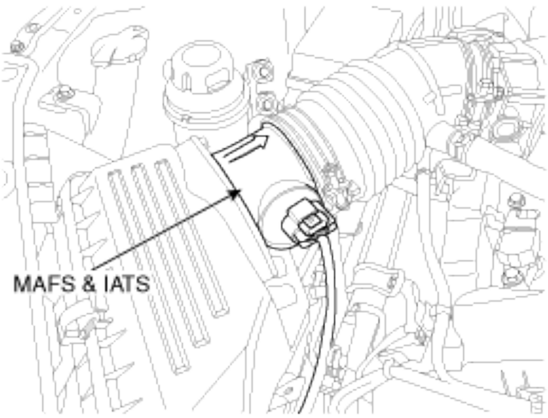
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0101 Mass or Volume Air Flow \'A\' Circuit Range / Performance

Component Location



General Description

The Mass Air Flow Sensor (MAFS) is located between the air cleaner assembly and the throttle body. The MAFS uses a hot film type sensing element to measure the mass of intake air entering the engine. This hot film type air flow sensor consists of a hot film sensor, housing and metering ducts. Mass air flow rate is measured by detection of heat transfer from a hot film probe. The change in air flow rate causes change in the amount of heat being transferred from the hot film probe surface to the air. A large amount of intake air represents acceleration or high load conditions while a small amount of intake air represents deceleration or idle. The mass of intake air should increase at acceleration and be stable during constant engine speed. The ECM uses this information to determine the injection duration and ignition timing for the desired air/fuel ratio.

DTC Description

The difference between values coming from the MAF Sensor and those are calculated is analyzed. This difference, or error, is then compared to high and low limit calibration values, which are functions of engine speed. ECM compares the difference between MAFS output and calculated flow rate value while enable condition is met.
If the acutal air flow is higher or lower than calculated value(threshold) for more than 2min.
ECM determines that a fault exists and a DTC is stored.
MIL(Malfunction Indicatin Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

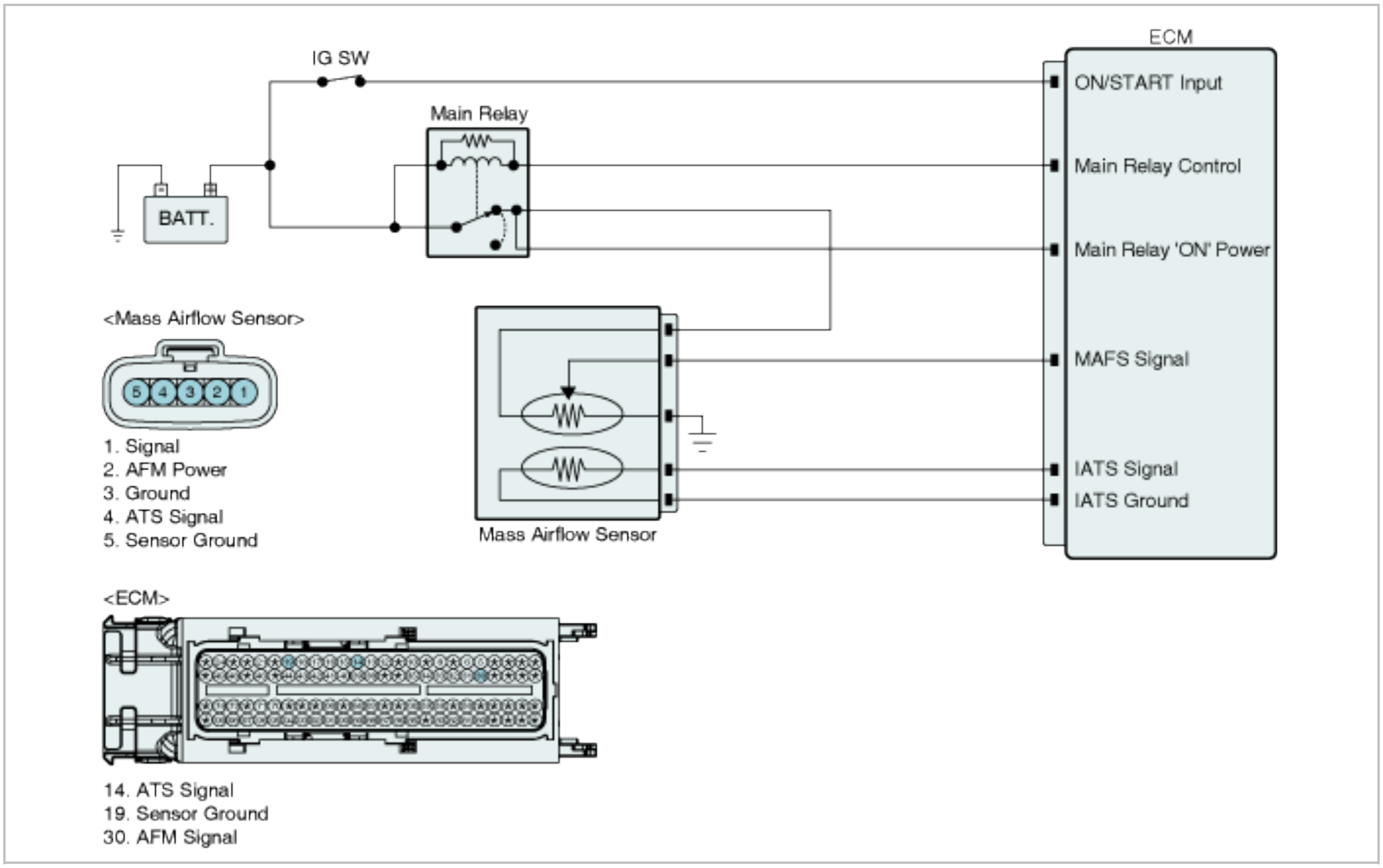
Item	Detecting Condition	Possible Cause
DTC Strategy	• The MAF Rationality Diagnostic compares the difference between MAF Sensor output and calculated flow rate value to a calibration value	
	• Engine Coolant Temperature ≥ 60°C	

Enable Conditions	(Fully Warmed up state) • 600rpm < Engine Speed < 3000rpm	• Clogged air cleaner • MAFS
Threshold value	• Acutal Air Mass Value is higher or lower than calculated value	
Diagnosis Time	• Continuous (within 2min.)	
MIL On Condition	• 2 Driving Cycles	

Specification

Air Flow(kg/h)	Frequency(Hz)
12.6	2320
18	2645
23.4	2903
32.4	3263
43.2	3622
57.6	3986
72	4288
108	4876
144	5380
198	5983
270	6636
360	7286
486	8002
666	8843
900	9699

Diagnostic Circuit Diagram



Signal Waveform & Data

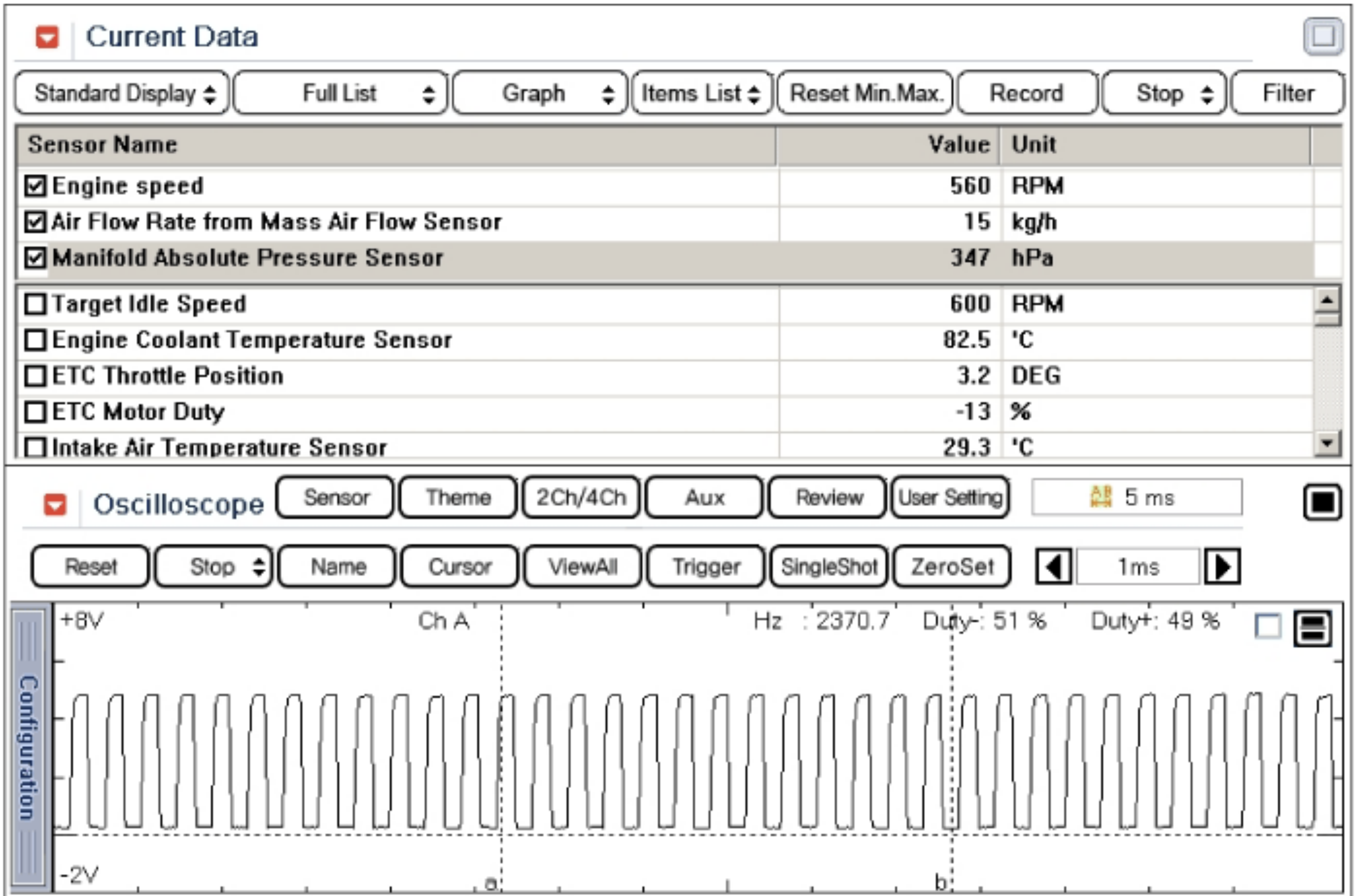

Current Data
Standard Display
Full List
Graph
Items List
Reset Min.Max.
Record
Stop
Filter
Sensor Name
Value
Unit
Engine speed 560 RPM
Air Flow Rate from Mass Air Flow Sensor 15 kg/h
Manifold Absolute Pressure Sensor 347 hPa
Target Idle Speed 600 RPM
Engine Coolant Temperature Sensor 82.5 'C
ETC Throttle Position 3.2 DEG
ETC Motor Duty -13 %
Intake Air Temperature Sensor 29.3 'C
Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
5 ms
Reset
Stop
Name
Cursor
ViewAll
Trigger
SingleShot
ZeroSet
1ms
+8V
Ch A
Hz : 2370.7
Duty-: 51 %
Duty+: 49 %
-2V
a
b
Configuration

Fig.1

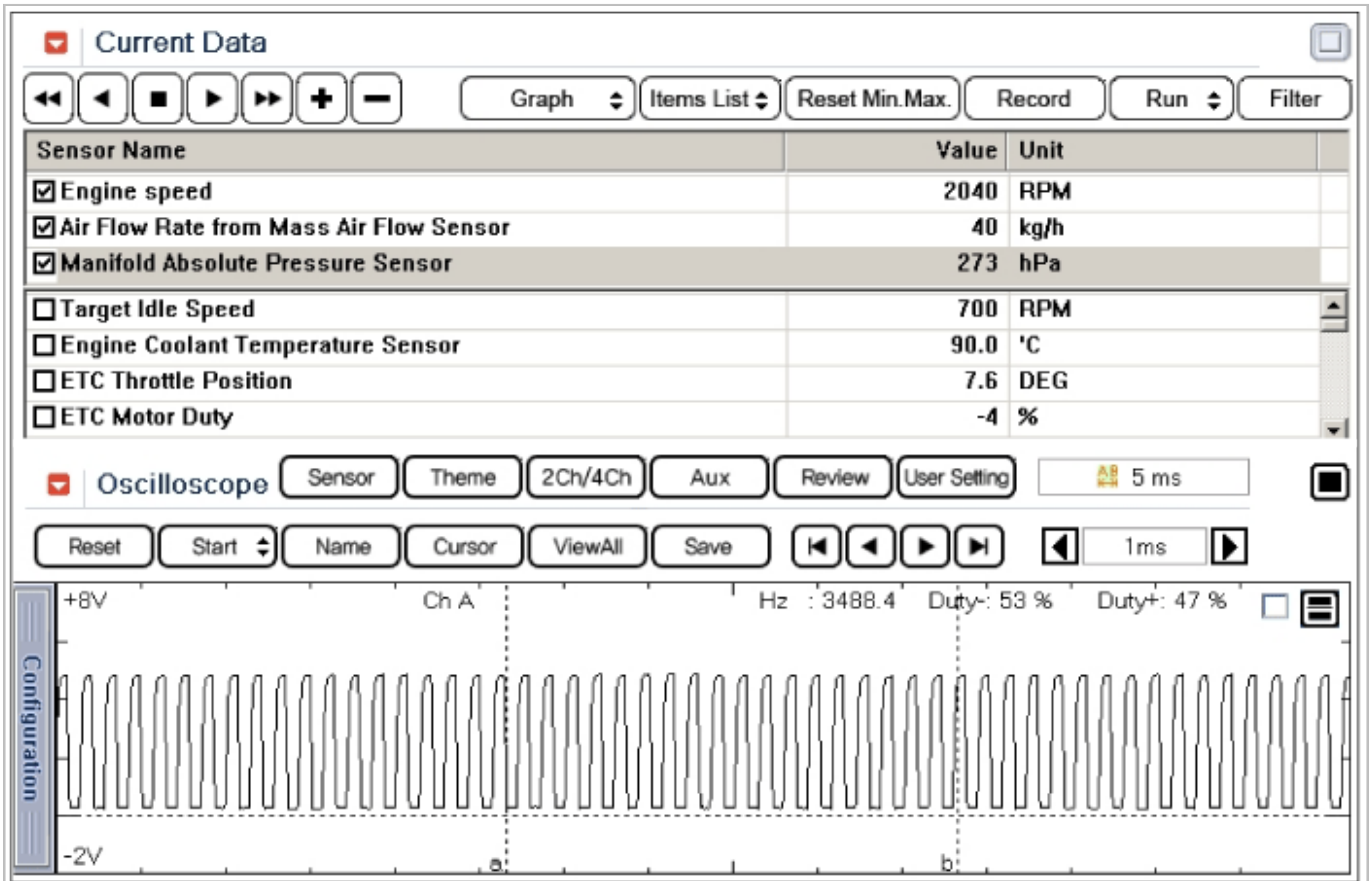


Fig.2

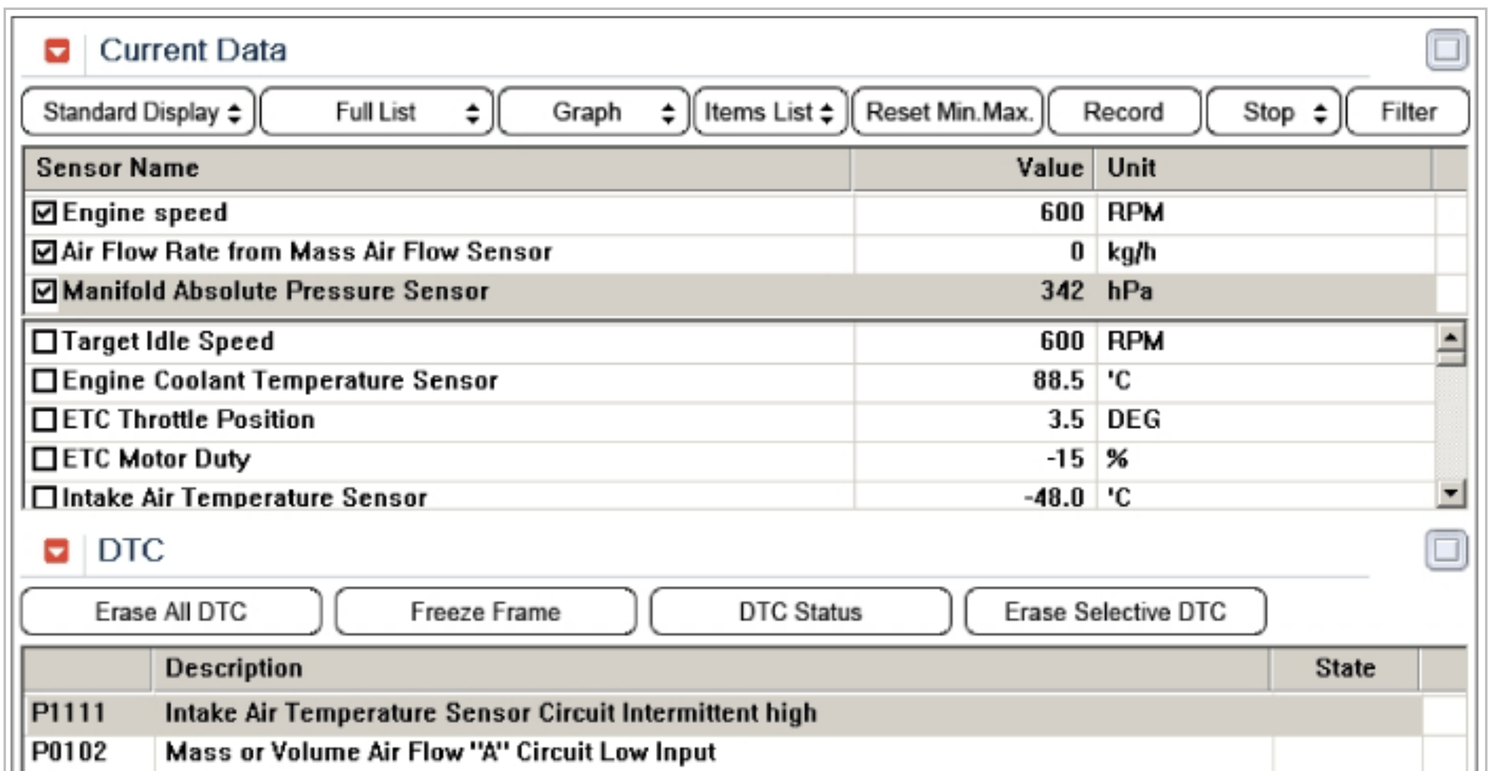
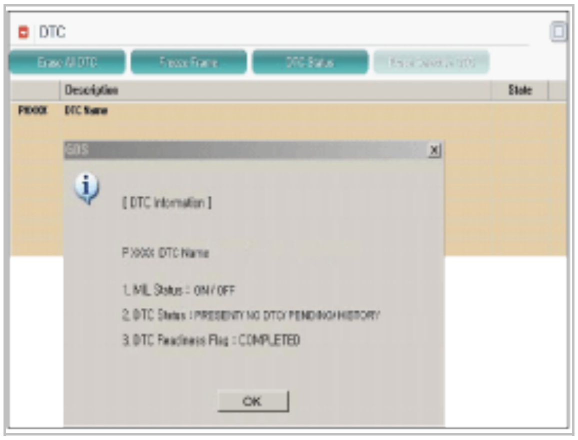


Fig.3

Fig.1) Normal data & waveform of MAFS at idle.
Fig.2) Normal data & waveform of MAFS at acceleration.
Fig.3) Abnormal data of MAFS at open or short condition.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Fault is intermittent caused by ECMmemory was not cleared after repair. Erase DTC and drive the vehicle to satisfy the enable codition then, go to "Component Inspection" procedure.

Component Inspection

■ Visual Inspection

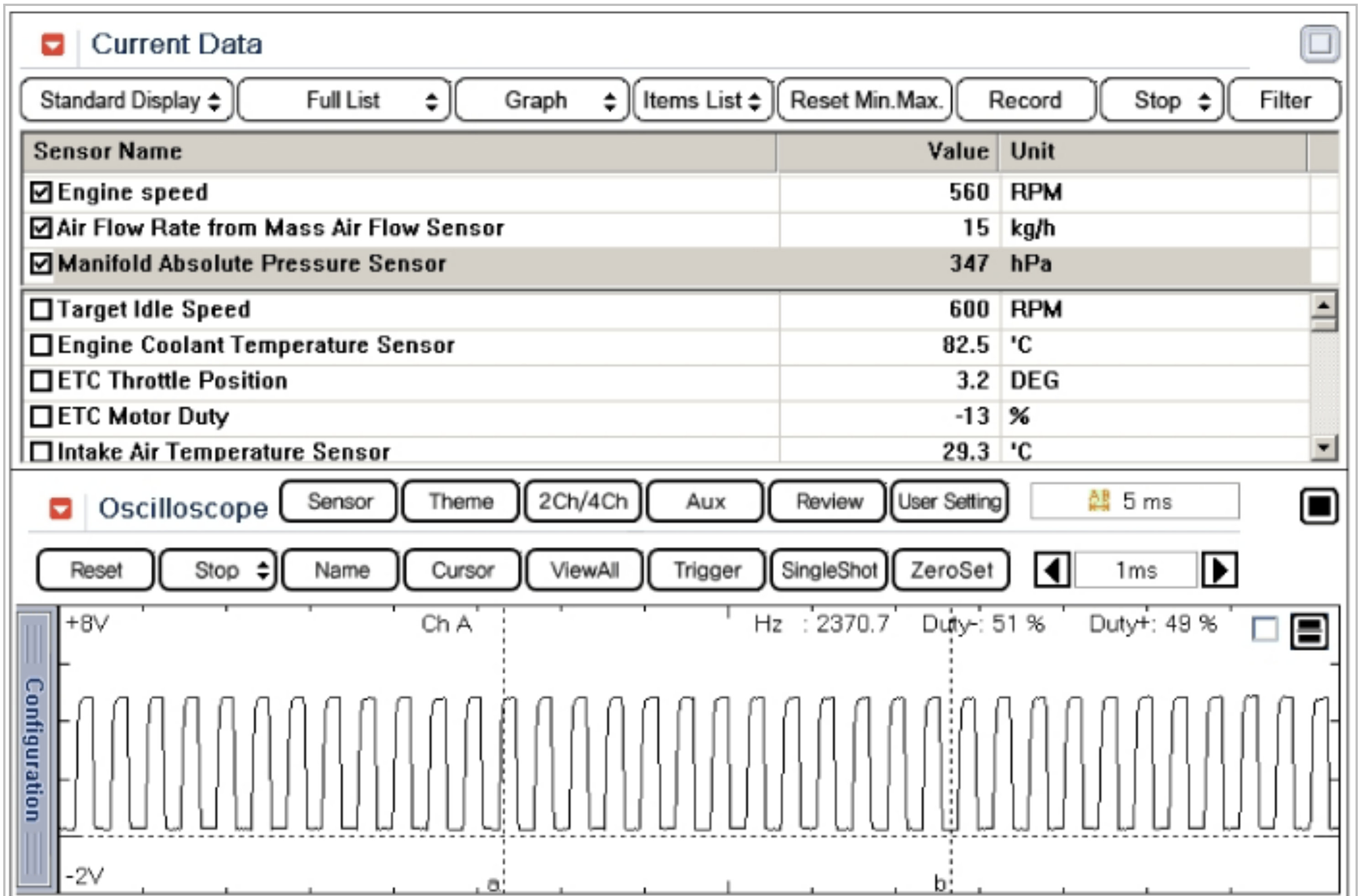
1. Check for damage or contamination to the MAF.
2. Check for restriction in the air filter.
3. Has a problem been found ?

YES	▶ Repair or replace as necessary and then go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check MAFS" as follows.

■ Check MAFS

1. IG "OFF" and install a GDS.
2. ENG "ON" and monitor "MAFS" data on the service data.
3. Monitor signal waveform at signal terminal of MAFS with GDS.

Specification : Signal waveform will be displayed as follows. Frenquency will be increased during acceleration. (Be aware that the signal of MAFS is not voltage display but frequency display.)



Current Data
Standard Display
Full List
Graph
Items List
Reset Min.Max.
Record
Stop
Filter
Sensor Name
Value
Unit
Engine speed
560
RPM
Air Flow Rate from Mass Air Flow Sensor
15
kg/h
Manifold Absolute Pressure Sensor
347
hPa
Target Idle Speed
600
RPM
Engine Coolant Temperature Sensor
82.5
'C
ETC Throttle Position
3.2
DEG
ETC Motor Duty
-13
%
Intake Air Temperature Sensor
29.3
'C
Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
5 ms
Reset
Stop
Name
Cursor
ViewAll
Trigger
SingleShot
ZeroSet
1ms
+8V
Ch A
Hz : 2370.7
Duty-: 51 %
Duty+: 49 %
Configuration
-2V
a
b

Fig.1

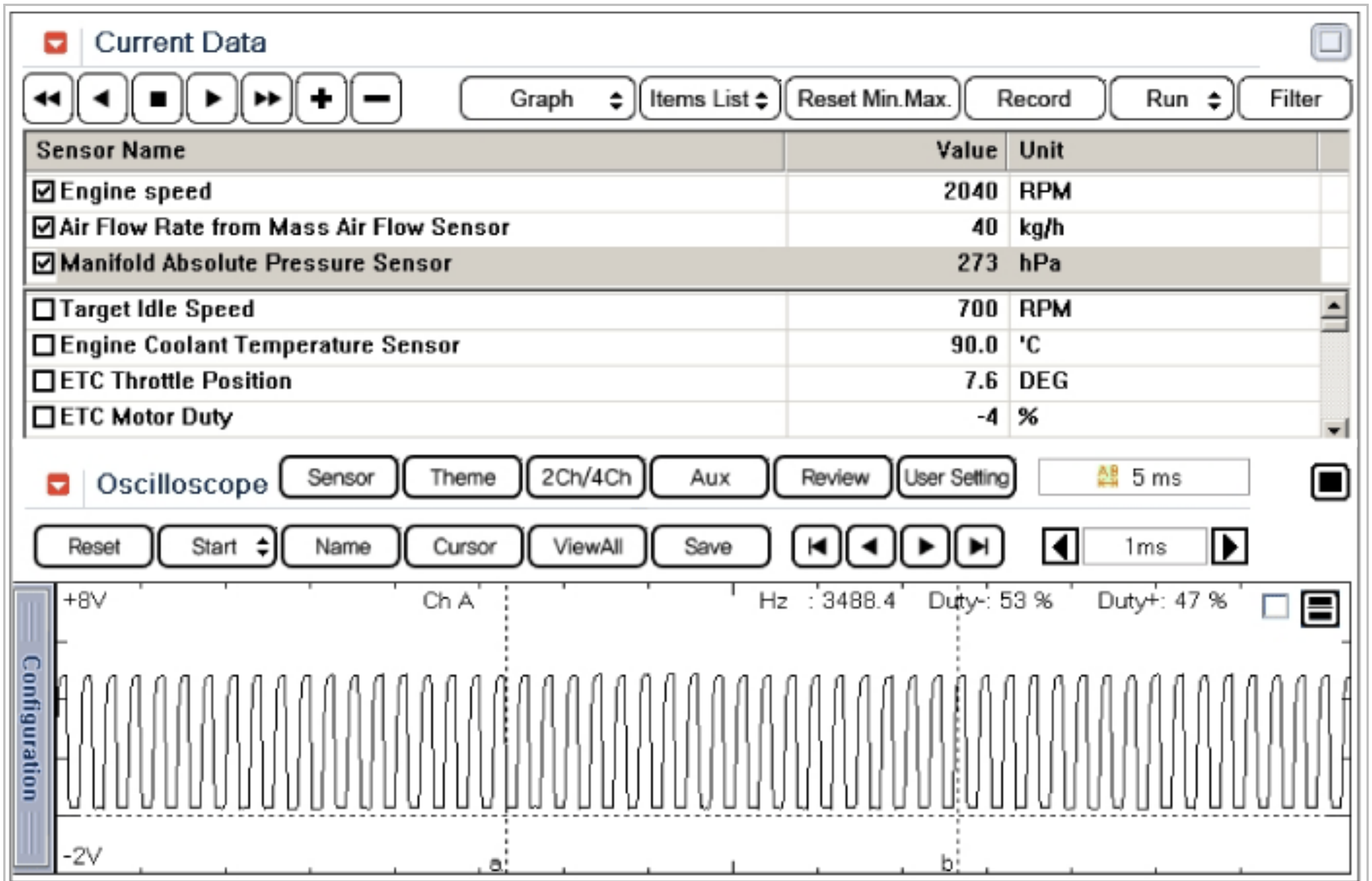


Fig.2

Fig.1) Normal data & waveform of MAFS at idle.
Fig.2) Normal data & waveform of MAFS at acceleration.

4. Are both service data and signal waveform dispayed correctly ?

YES	▶ Go to "Verification of Vehicle Repair" procedure.
NO	▶ Substitute with a known - good MAFS and check for proper operation. If the problem is corrected, replace MAFS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

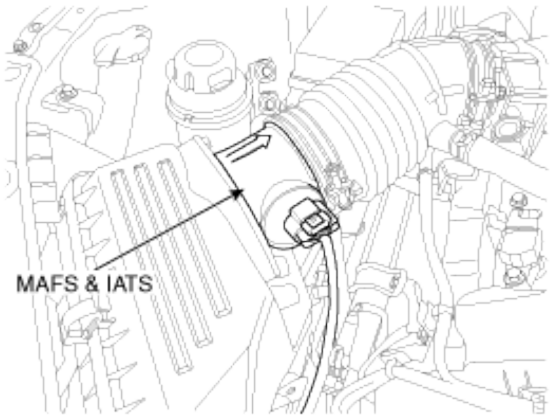
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0102 Mass or Volume Air Flow \'A\' Circuit Low Input

Component Location



General Description

The Mass Air Flow Sensor (MAFS) is located between the air cleaner assembly and the throttle body. The MAFS uses a hot film type sensing element to measure the mass of intake air entering the engine. This hot film type air flow sensor consists of a hot film sensor, housing and metering ducts. Mass air flow rate is measured by detection of heat transfer from a hot film probe. The change in air flow rate causes change in the amount of heat being transferred from the hot film probe surface to the air. A large amount of intake air represents acceleration or high load conditions while a small amount of intake air represents deceleration or idle. The mass of intake air should increase at acceleration and be stable during constant engine speed. The ECM uses this information to determine the injection duration and ignition timing for the desired air/fuel ratio.

DTC Description

If ECM detects that frequency signal of MAFS is lower than1000 Hz for more than 3.9 second during one dignostic test(7.8 second) while enable condition is me,t ECM determines that a fault exists and a DTC is stored.
MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

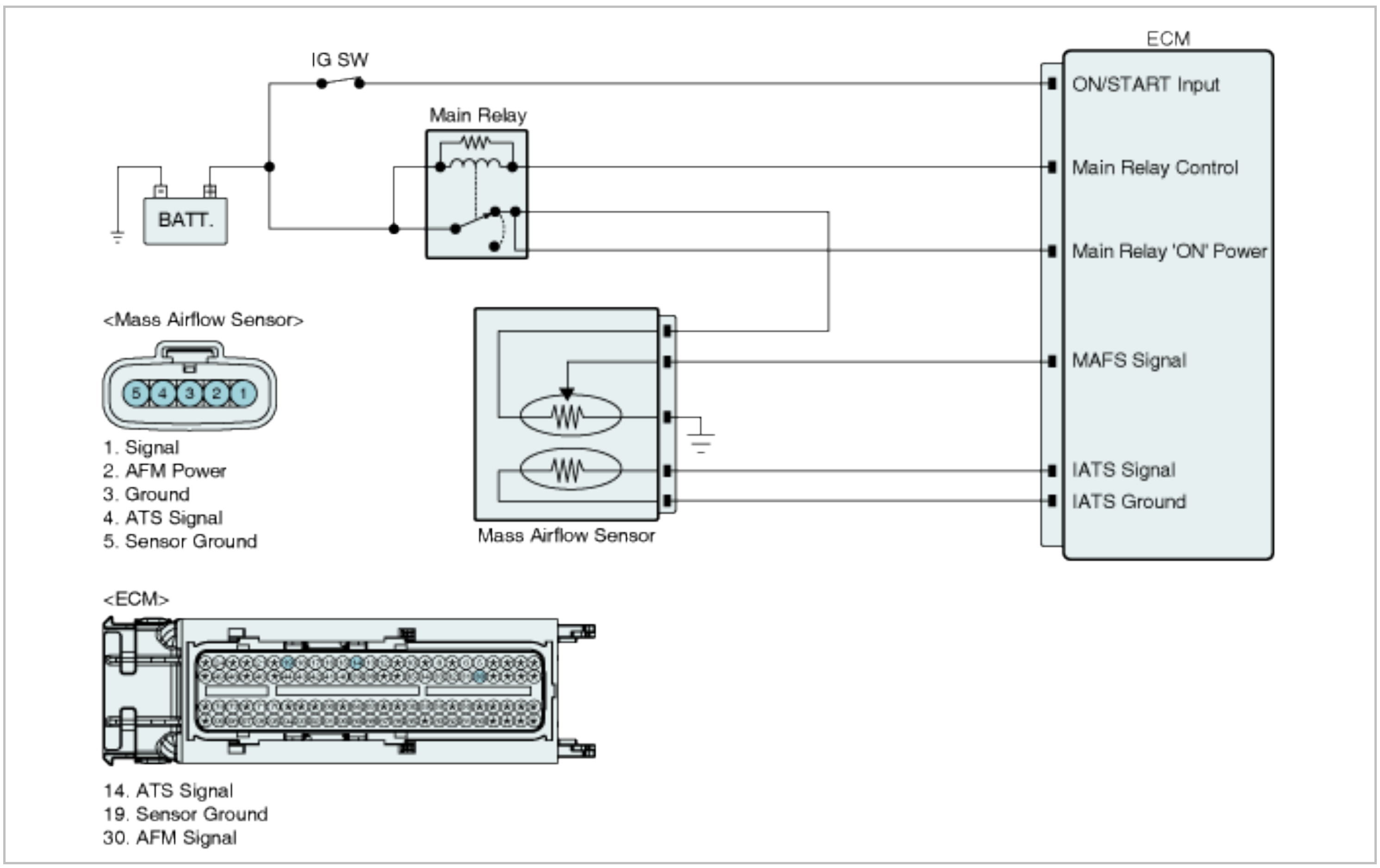
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Compares the airmeter input frequency to a high limit	• Poor Connection • Open or short in harness • MAFS • ECM
Enable Conditions	• Engine Speed ≥ 500 rpm • Engine Running Time ≥ 5 second • Ignition Voltage ≥ 11V	
Threshold value	• MAF frequency signal < 1000Hz	
Diagnosis Time	• Continuous (More than 3.9 second failure for every 7.8 second tests)	
MIL On Condition	• 2 Driving Cycles	

Specification

Air Flow(kg/h)	Frequency(Hz)
12.6	2320
18	2645
23.4	2903
32.4	3263
43.2	3622
57.6	3986
72	4288
108	4876
144	5380
198	5983
270	6636
360	7286
486	8002
666	8843
900	9699

Diagnostic Circuit Diagram



Signal Waveform & Data

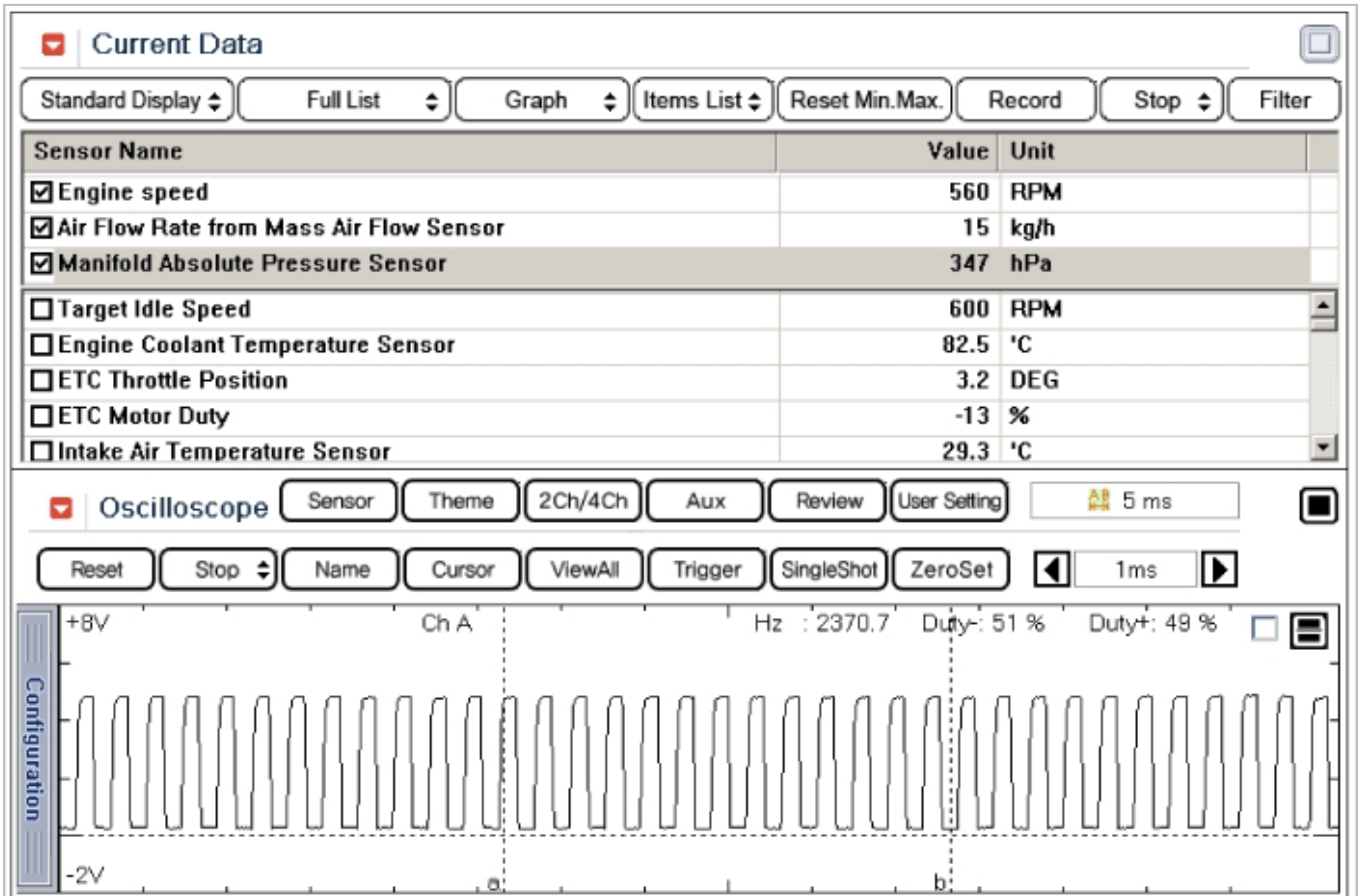
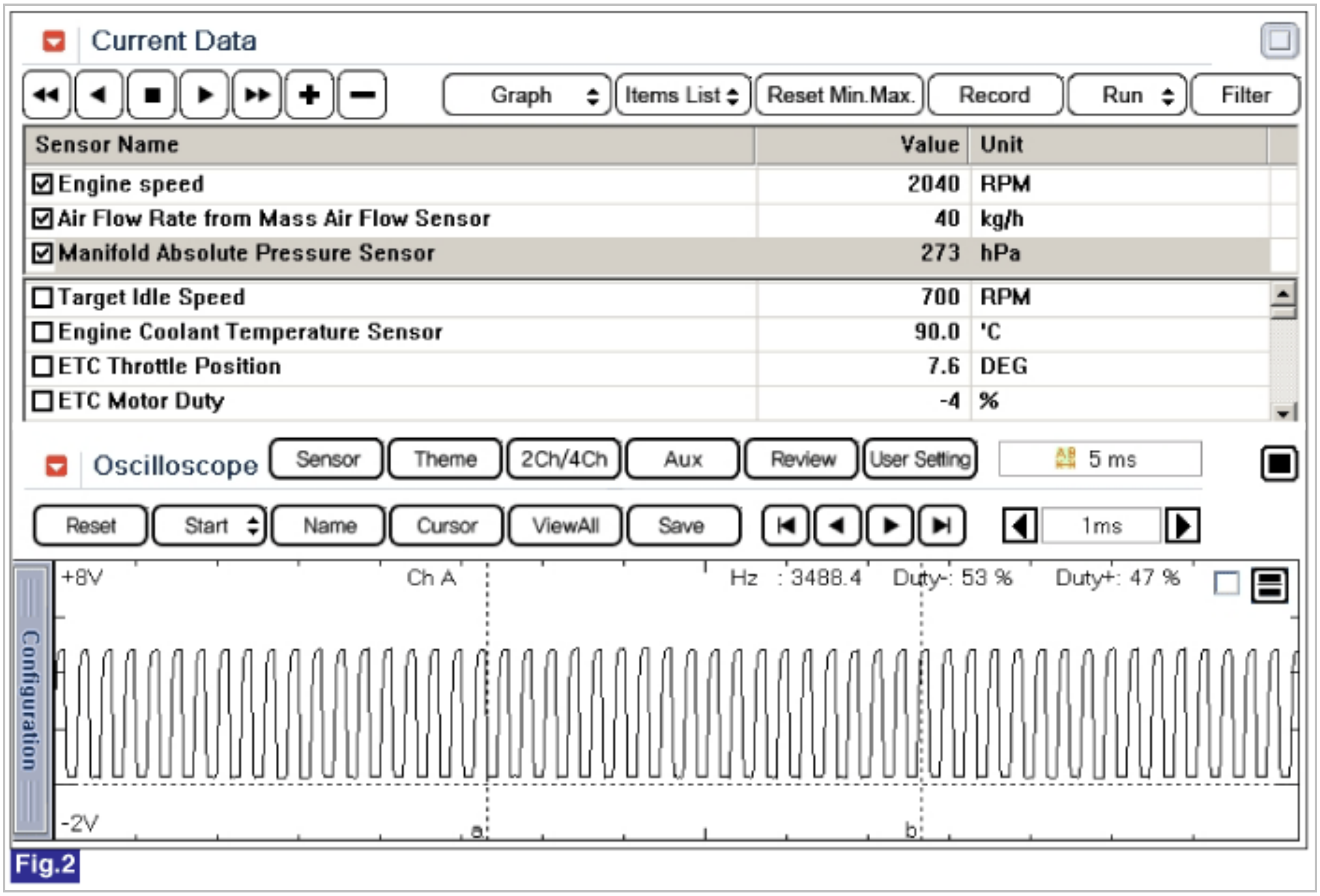


Fig.1



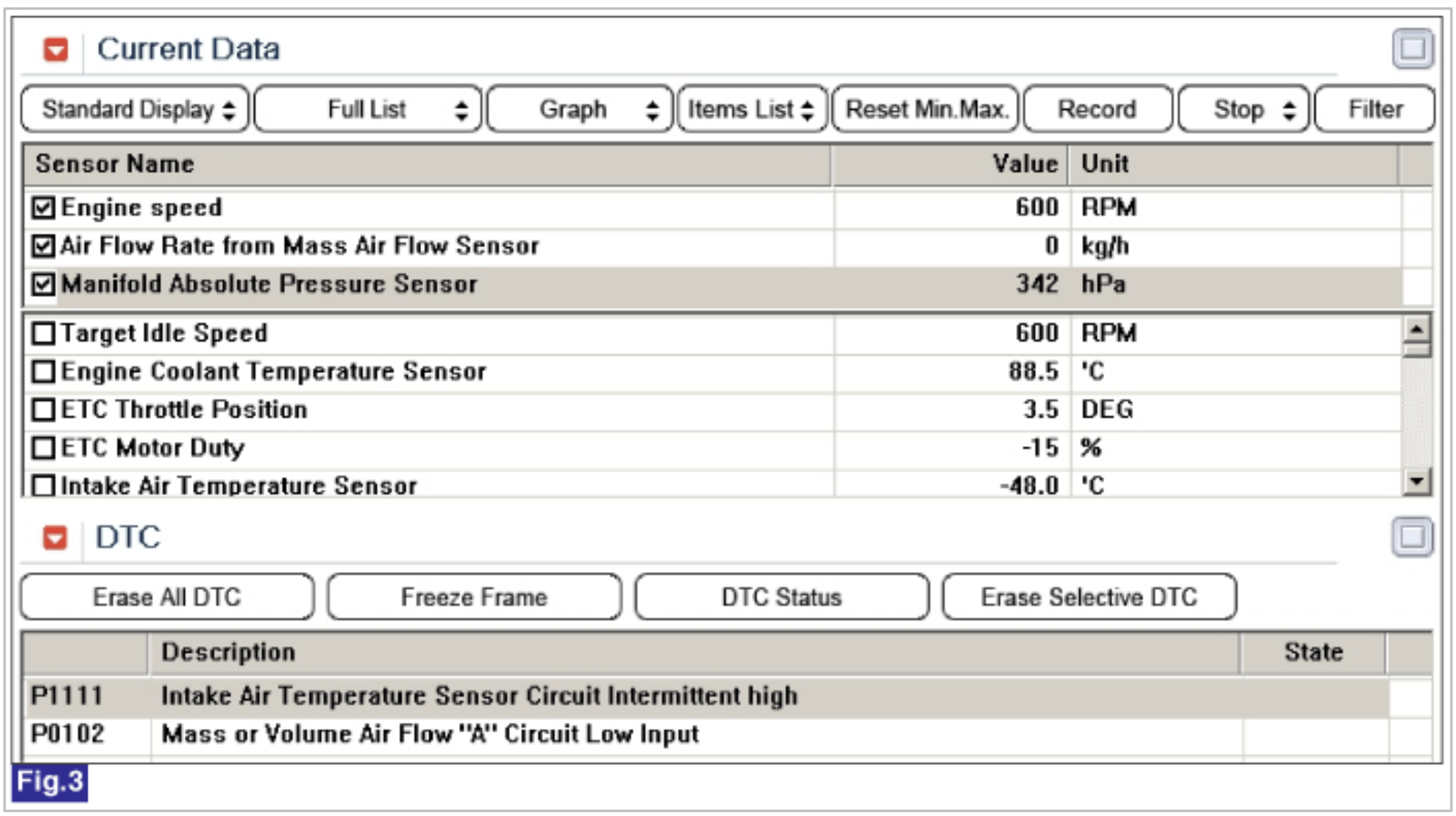
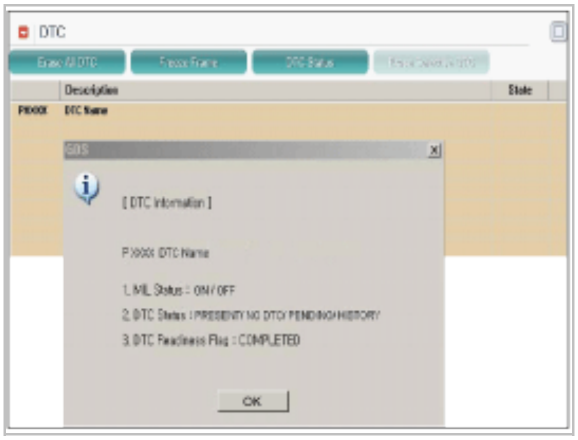


Fig.1) Normal data & waveform of MAFS at idle.
Fig.2) Normal data & waveform of MAFS at acceleration.
Fig.3) Abnormal data of MAFS at open or short condition.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Power Circuit Inspection" procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and Disconnect MAFS connector.
2. IG "ON".
3. Measure voltage between power terminal of MAFS harness connector and chassis ground.

Specification : B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Signal Circuit Inspection" Procedure.
NO	▶ Check fuse between MAFS and main relay is open or not installed.

Signal Circuit Inspection

■ Check voltage

1. IG "OFF" and Disconnect MAFS connector.
2. IG "ON".
3. Measure voltage between signal terminal of MAFS harness connector and chassis ground.

Specification : Approx. 5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Ground circuit inspection" procedure.
NO	▶ If the measured voltage is "0", go to "Check open in harness" as follows. If the measured voltage is over "5V", go to "Check short to battery in harness" as follows.

■ Check short to battery in harness

1. IG "OFF" and disconnect MAFS and ECM connector.
2. Measure resistance between signal and power terminals of MAFS harness connector.
3. Measure resistance between signal terminal of MAFS harness connector and signal terminal of IATS harness connector.

Specification : Infinite

4. Is the measured resistance within specification ?

YES	▶ Go to "Check short to ground in harness" as follows.
NO	▶ Repair short to battery in harness and go to "Verification of Vehicle Repair" procedure.

■ Check short to ground in harness

1. IG "OFF" and disconnect MAFS and ECM connector.
2. Measure resistance between signal terminal of MAFS harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Check open in harness" as follows.
NO	▶ Repair short to ground in harness and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect MAFS and ECM connector.
2. Measure resistance between signal terminal of MAFS harness connector and MAFS signal terminal of ECM harness

connector.

Specification : Approx. below 1Ω.

3. Is the measured resistance within specification ?

YES	▶ Go to "Ground circuit Inspection" procedure.
NO	▶ Repair open in harness and go to "Verification of Vehicle Repair" procedure.

Ground Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect MAFS connector and then IG "ON".
2. Measure voltage between signal terminal of MAFS harness connector and chassis ground (Measurement "A")
3. Measure voltage between signal and ground terminals of MAFS harness connector (Measurement "B")

Specification : Voltage difference between Measurement "A" and "B" is below 200mV.

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair contact resistance or open in harnesss and then go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Visual Inspection

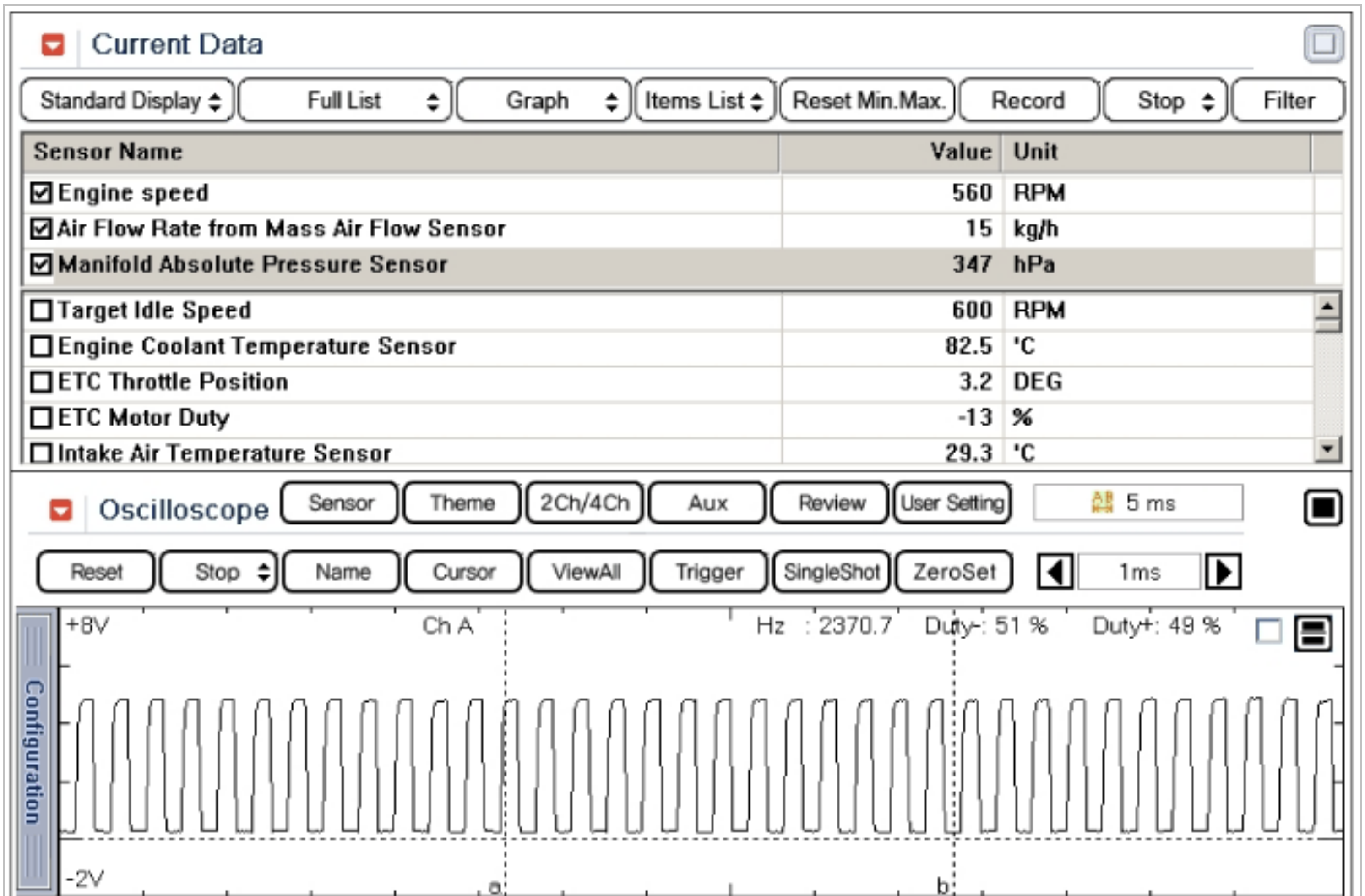
1. Check for damage or contamination to the MAF.
2. Check for restriction in the air filter.
3. Has a problem been found ?

YES	▶ Repair or replace as necessary and then go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check MAFS" as follows.

■ Check MAFS

1. IG "OFF" and install a GDS
2. ENG "ON" and monitor "MAFS" data on the service data.
3. Monitor signal waveform at signal terminal of MAFS with GDS.

Specification : Signal waveform will be displayed as follows. Frenquency will be increased during acceleration. (Be aware that the signal of MAFS is not voltage display but frequency display.)


Current Data
Standard Display
Full List
Graph
Items List
Reset Min.Max.
Record
Stop
Filter
Sensor Name
Value
Unit
Engine speed 560 RPM
Air Flow Rate from Mass Air Flow Sensor 15 kg/h
Manifold Absolute Pressure Sensor 347 hPa
Target Idle Speed 600 RPM
Engine Coolant Temperature Sensor 82.5 'C
ETC Throttle Position 3.2 DEG
ETC Motor Duty -13 %
Intake Air Temperature Sensor 29.3 'C
Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
5 ms
Reset
Stop
Name
Cursor
ViewAll
Trigger
SingleShot
ZeroSet
1ms
+8V
Ch A
Hz : 2370.7
Duty-: 51 %
Duty+: 49 %
Configuration
-2V
a
b
Fig.1

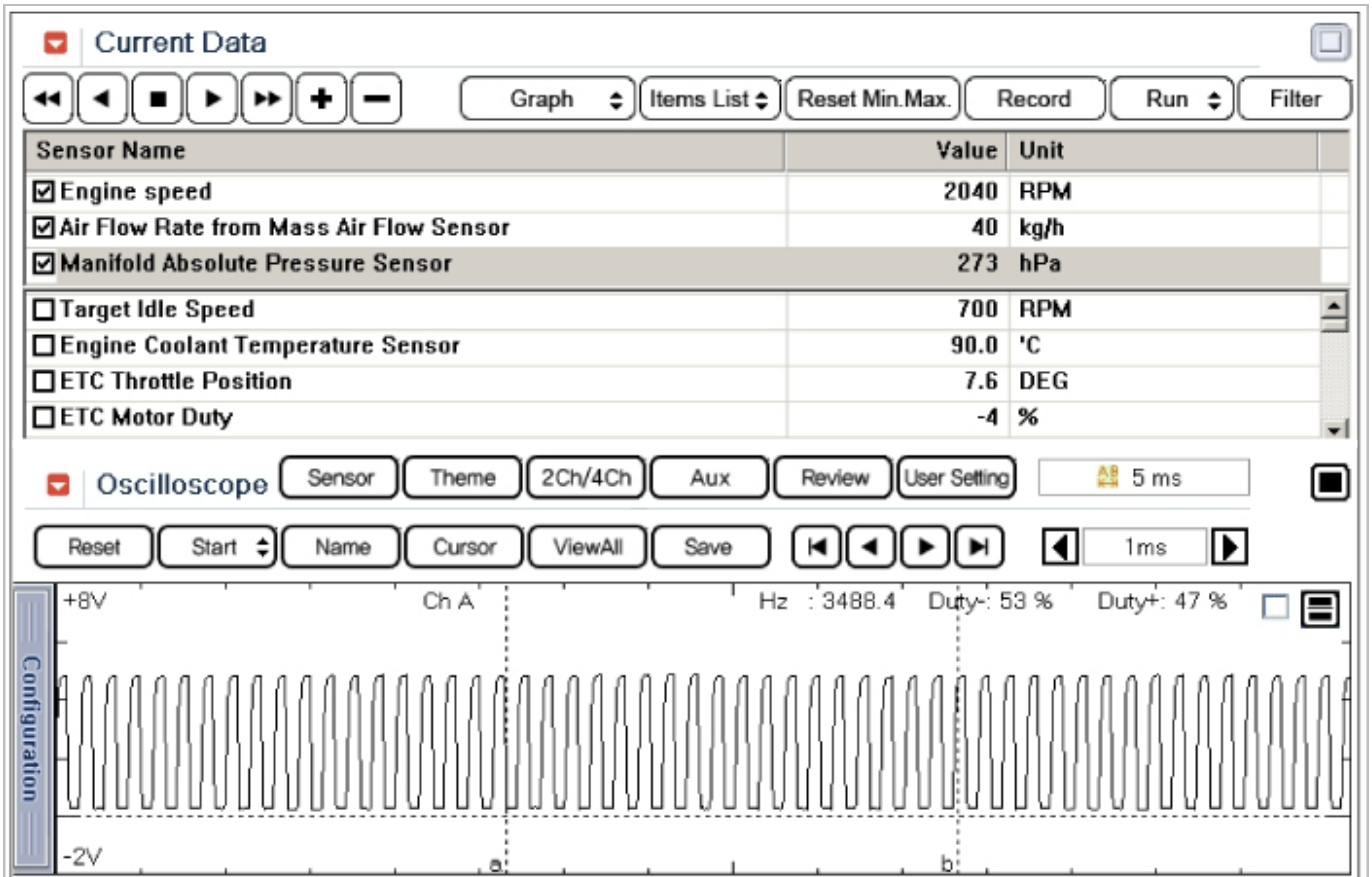


Fig.2

Fig.1) Normal data & waveform of MAFS at idle.
Fig.2) Normal data & waveform of MAFS at acceleration.

4. Are both service data and signal waveform dispayed correctly ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others.
NO	▶ Substitute with a known - good MAFS and check for proper operation. If the problem is corrected, replace MAFS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

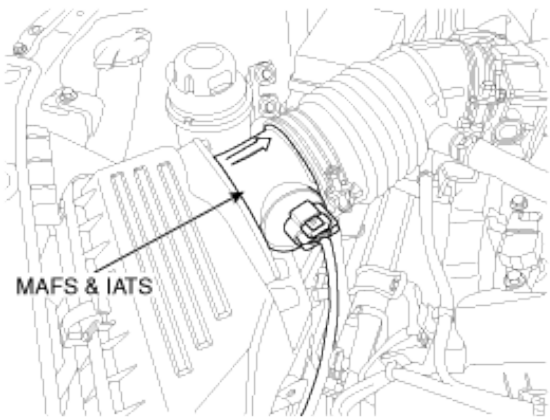
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.

4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0103 Mass or Volume Air Flow \'A\' Circuit High Input

Component Location



General Description

The Mass Air Flow Sensor (MAFS) is located between the air cleaner assembly and the throttle body. The MAFS uses a hot film type sensing element to measure the mass of intake air entering the engine. This hot film type air flow sensor consists of a hot film sensor, housing and metering ducts. Mass air flow rate is measured by detection of heat transfer from a hot film probe. The change in air flow rate causes change in the amount of heat being transferred from the hot film probe surface to the air. A large amount of intake air represents acceleration or high load conditions while a small amount of intake air represents deceleration or idle. The mass of intake air should increase at acceleration and be stable during constant engine speed. The ECM uses this information to determine the injection duration and ignition timing for the desired air/fuel ratio.

DTC Description

If ECM detects that frequency signal of MAFS is higher thatn 11900 Hz for more than 3.9 second during 7.5 second dignostic test while enable condition is met, ECM determines that a fault exists and a DTC is stored. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

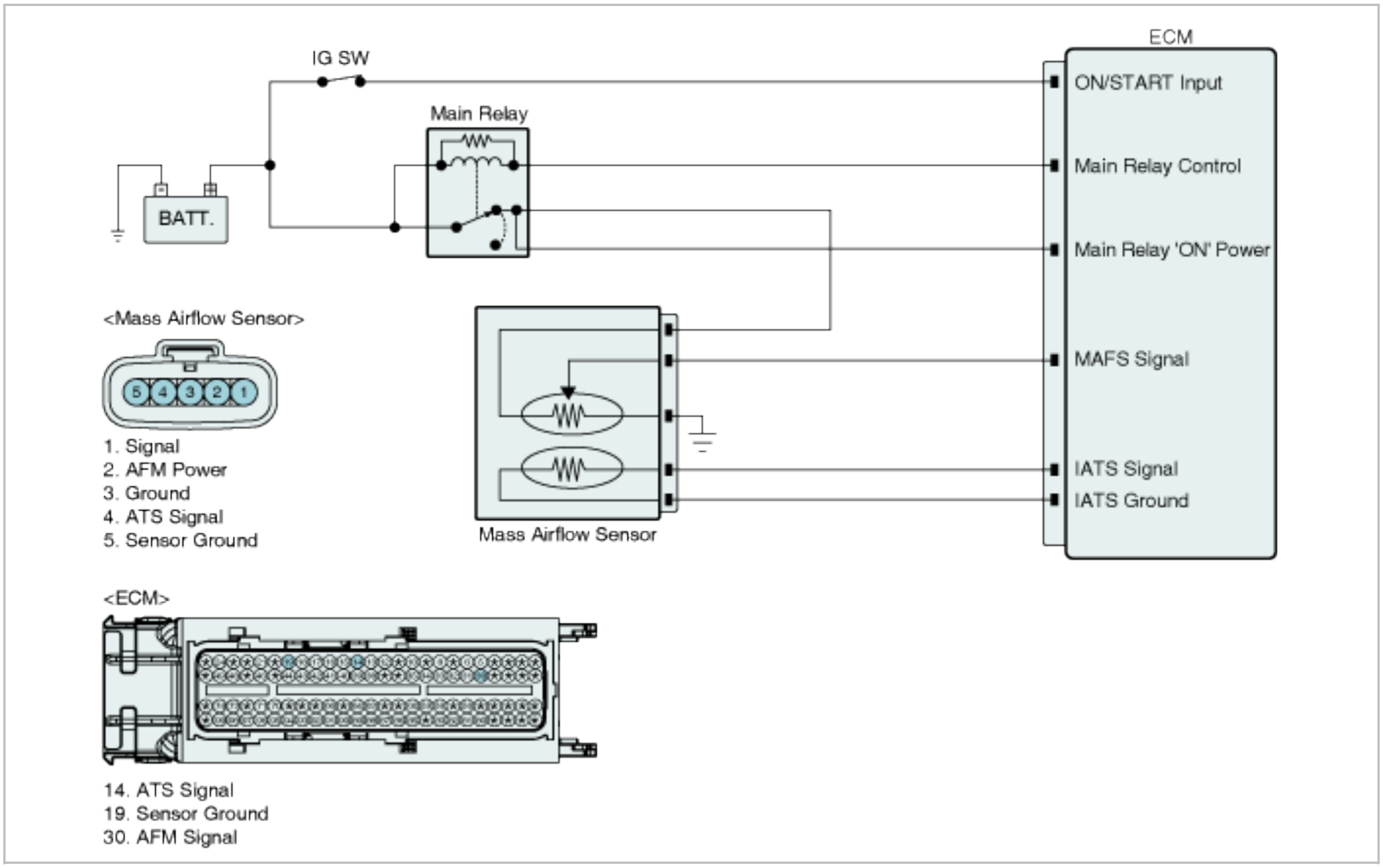
Item	Detecting Condition	Possible Cause
DTC Strategy	• Compares the airmeter input frequency to a high limit	• Noise • MAFS • ECM
Enable Conditions	• Engine Speed ≥ 500 rpm • Engine Running Time ≥ 5 second • Ignition Voltage ≥ 11V	
Threshold value	• MAF frequency signal > 11900Hz	

Diagnosis Time	• Continuous (More than 3.9 second failure for every 7.8 second tests)	
MIL On Condition	• 2 Driving Cycles	

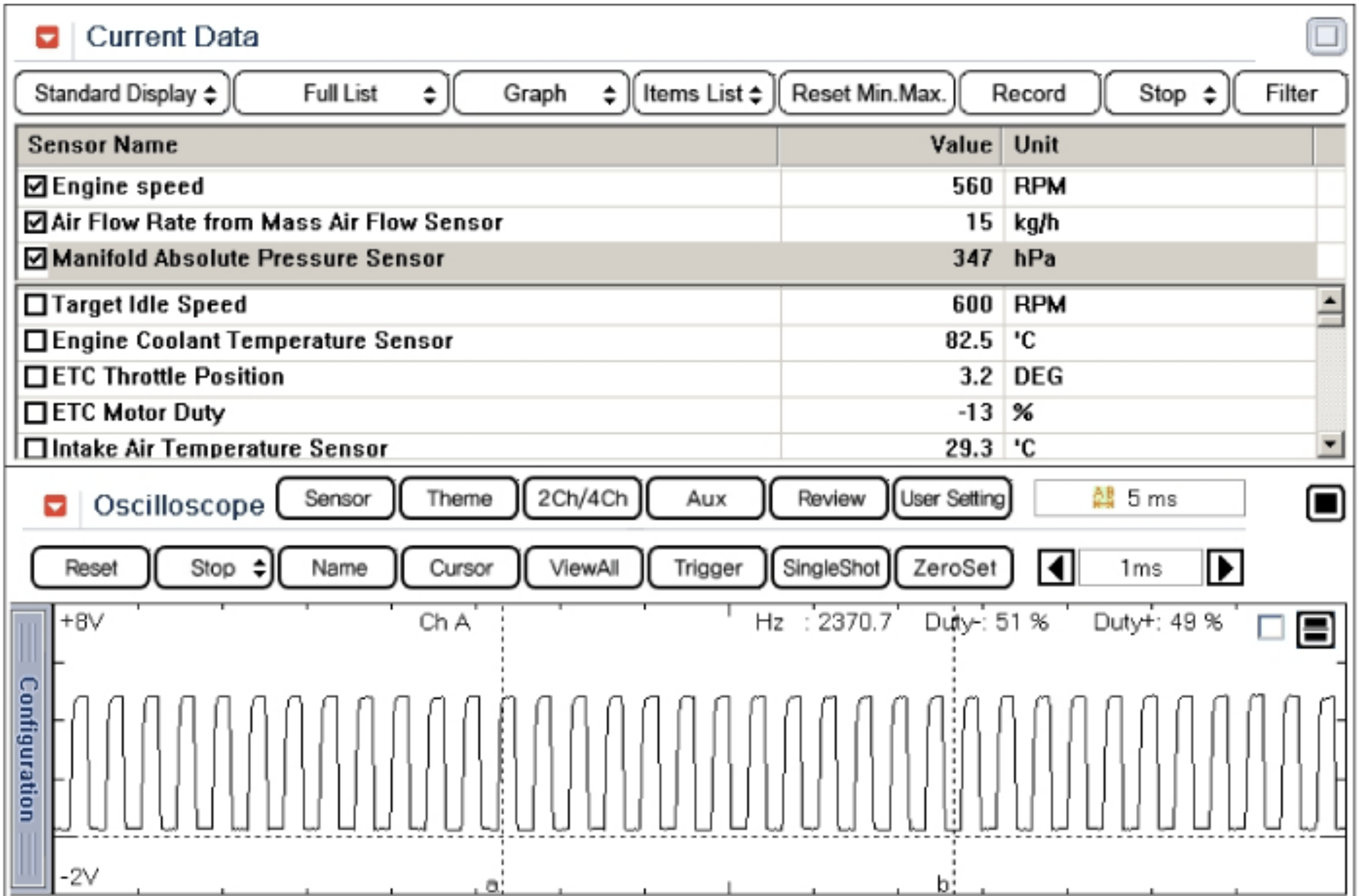
Specification

Air Flow(kg/h)	Frequency(Hz)
12.6	2320
18	2645
23.4	2903
32.4	3263
43.2	3622
57.6	3986
72	4288
108	4876
144	5380
198	5983
270	6636
360	7286
486	8002
666	8843
900	9699

Diagnostic Circuit Diagram



Signal Waveform & Data



Sensor Name	Value	Unit
☑ Engine speed	560	RPM
☑ Air Flow Rate from Mass Air Flow Sensor	15	kg/h
☑ Manifold Absolute Pressure Sensor	347	hPa
☐ Target Idle Speed	600	RPM
☐ Engine Coolant Temperature Sensor	82.5	'C
☐ ETC Throttle Position	3.2	DEG
☐ ETC Motor Duty	-13	%
☐ Intake Air Temperature Sensor	29.3	'C

Fig.1

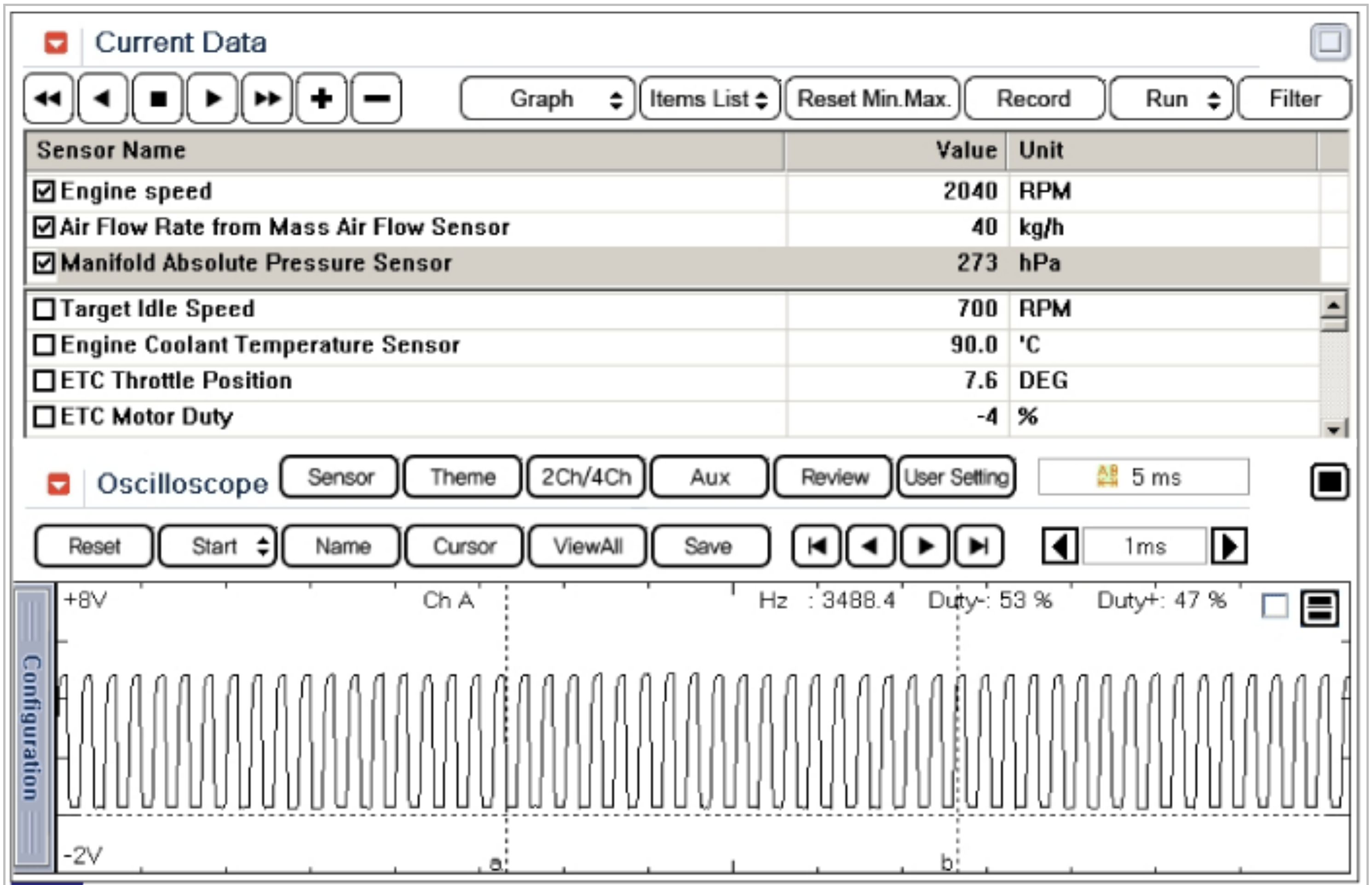


Fig.2

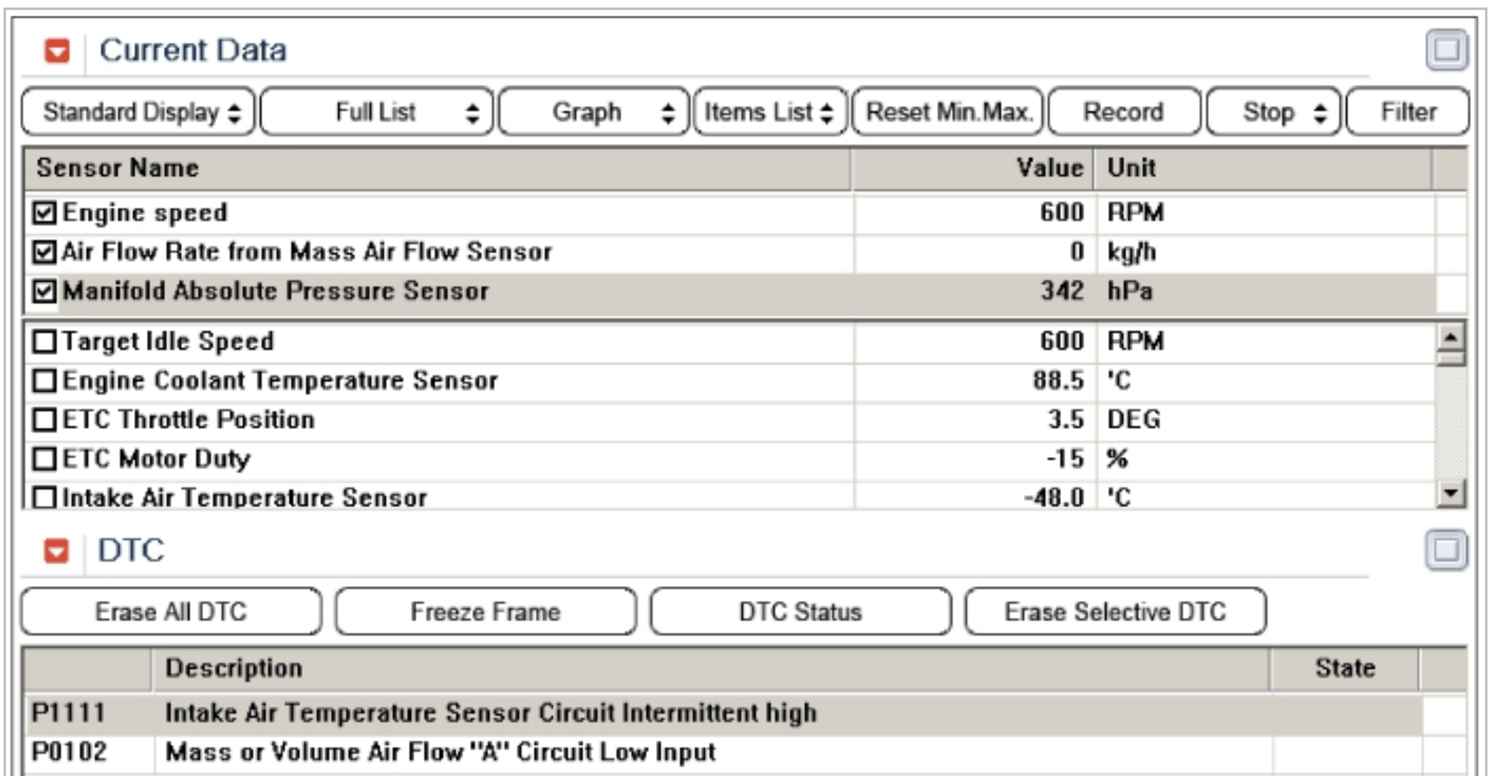
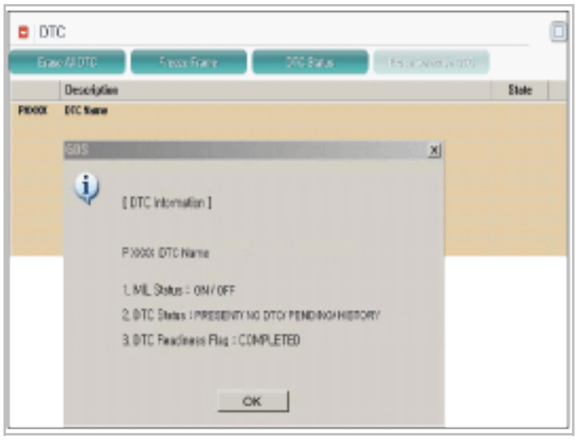


Fig.3

Fig.1) Normal data & waveform of MAFS at idle.
Fig.2) Normal data & waveform of MAFS at acceleration.
Fig.3) Abnormal data of MAFS at open or short condition.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Ground Circuit Inspection" procedure.

Ground Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect MAFS connector and then IG "ON".
2. IG "ON" & ENG "OFF"
3. Measure voltage between signal and ground terminals of MAFS harness connector (Measurement "B")

Specification : Voltage difference between Measurement "A" and "B" is below 200mV.

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair contact resistance or open in harnesss and then go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Visual Inspection

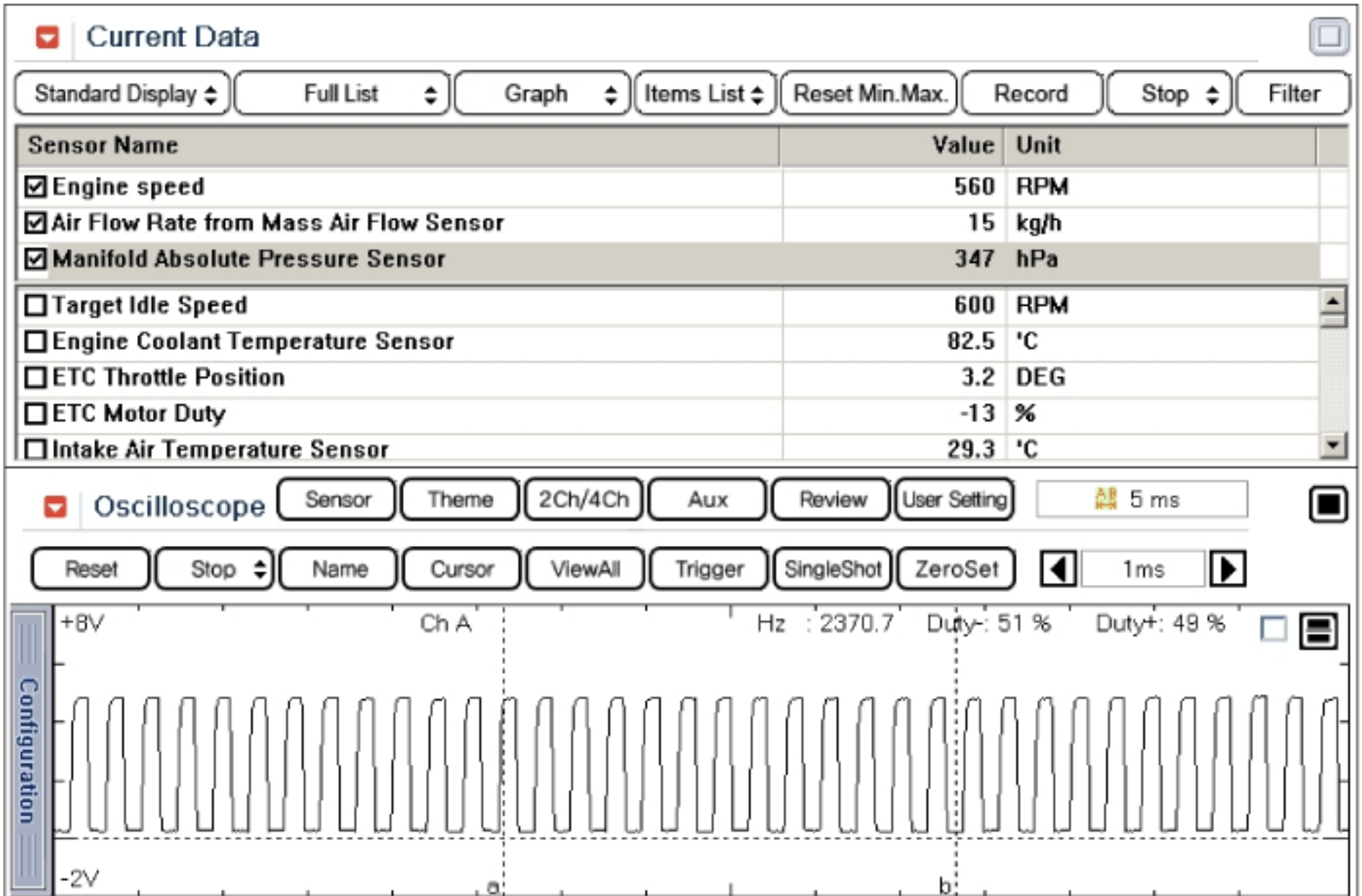
1. Check for damage or contamination to the MAF.
2. Check for restriction in the air filter.
3. Has a problem been found ?

YES	▶ Repair or replace as necessary and then go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check MAFS" as follows.

■ Check MAFS

1. IG "OFF" and install a GDS
2. ENG "ON" and monitor "MAFS" data on the service data.
3. Monitor signal waveform at signal terminal of MAFS with GDS.

Specification : Signal waveform will be displayed as follows. Frenquency will be increased during acceleration. (Be aware that the signal of MAFS is not voltage display but frequency display.)



Current Data
Standard Display
Full List
Graph
Items List
Reset Min.Max.
Record
Stop
Filter
Sensor Name
Value
Unit
Engine speed 560 RPM
Air Flow Rate from Mass Air Flow Sensor 15 kg/h
Manifold Absolute Pressure Sensor 347 hPa
Target Idle Speed 600 RPM
Engine Coolant Temperature Sensor 82.5 'C
ETC Throttle Position 3.2 DEG
ETC Motor Duty -13 %
Intake Air Temperature Sensor 29.3 'C
Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
5 ms
Reset
Stop
Name
Cursor
ViewAll
Trigger
SingleShot
ZeroSet
1ms
+8V
Ch A
Hz : 2370.7
Duty-: 51 %
Duty+: 49 %
Configuration
-2V
a
b

Fig.1

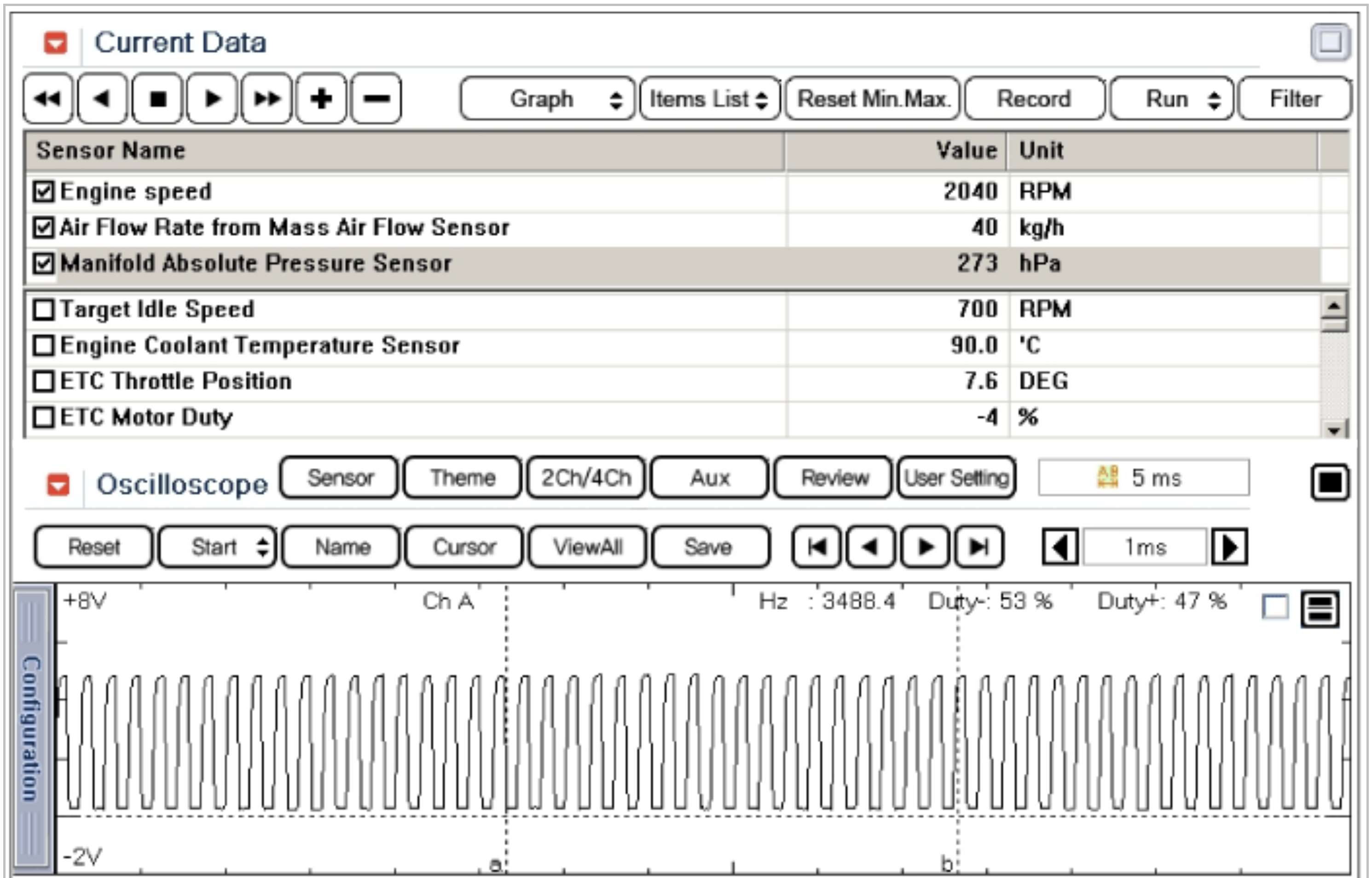


Fig.2

Fig.1) Normal data & waveform of MAFS at idle.
Fig.2) Normal data & waveform of MAFS at acceleration.

4. Are both service data and signal waveform dispayed correctly ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others.
NO	▶ Substitute with a known - good MAFS and check for proper operation. If the problem is corrected, replace MAFS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

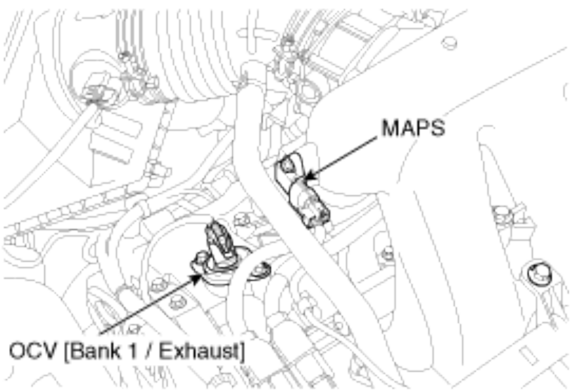
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.

4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0105 Manifold ABSolute Pressure/Barometric Pressure Circuit

Component Location



General Description

The amount of intake air flow must be inputted to ECM in order to determine the fuel injection quantity. To measure the pressure inside of intake manifold, MAFS is used at idle and MAPS is required at accelerating. MAPS(Manifold Absolute Pressure) calculates the amount of air indirectly as measuring the pressure inside of intake manifold. This system is called a Speed-Density type.
MAPS transfers analog output signal which is proportional to the change of intake manifold pressure, then, with this signal and RPM, ECM calculates the amount of intake air flow.
The MAPS is mounted on surge tank to measure the pressure inside of intake manifold, and it consists of a piezo electric element and hybrid IC which amplifies output signal from the element. A piezo electric element is a sort of a diaphragm using piezo electric effect. One side of the diaphragm is surrounded with vacuum chamber while intake pressure is applied to the other side. Thus, signals are output by the transformation of diagphragm according to the change of pressure inside of intake manifold.

DTC Description

If the signal output of MAP sensor is stuck under enable conditions, ECM determines that a fault exists and a DTC is stored. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

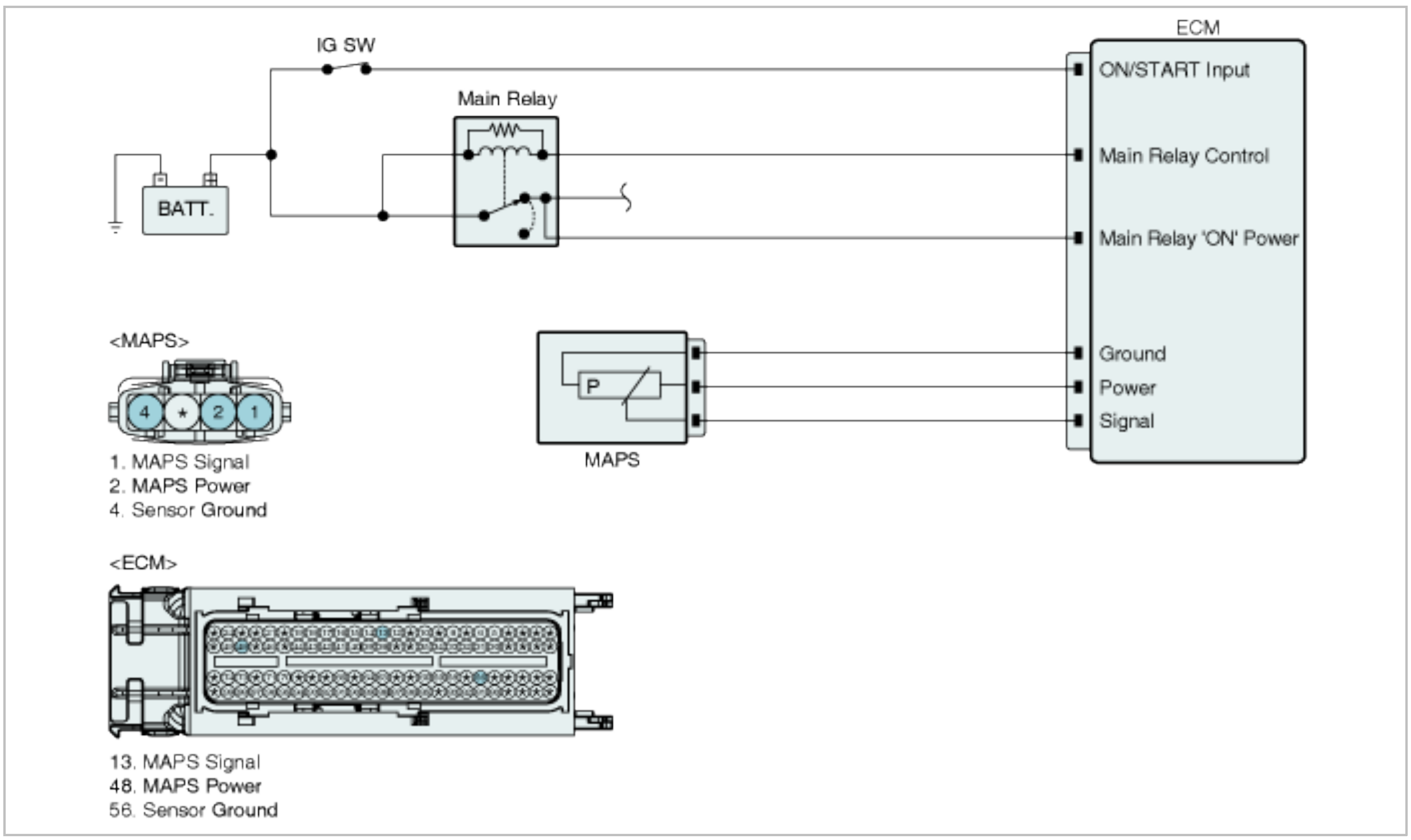
Item	Detecting Condition	Possible Cause
DTC Strategy	• Monitor the MAP sensor's signal	
Enable Conditions	• No Disabling Fault Present • Shutdown time > 20 minutes • Engine running	

Threshold value	• The difference between the signal at key-on and the signal at engine start < 0.5 kPa	• Faulty MAPS
Diagnosis Time	• For 3 seconds out of 5 seconds	
MIL On Condition	• 2 Driving Cycles	

Specification

Pressure(kPa)	Voltage(V)
20	0.79
46.66	1.84
101.32	4.0

Diagnostic Circuit Diagram



Signal Waveform & Data

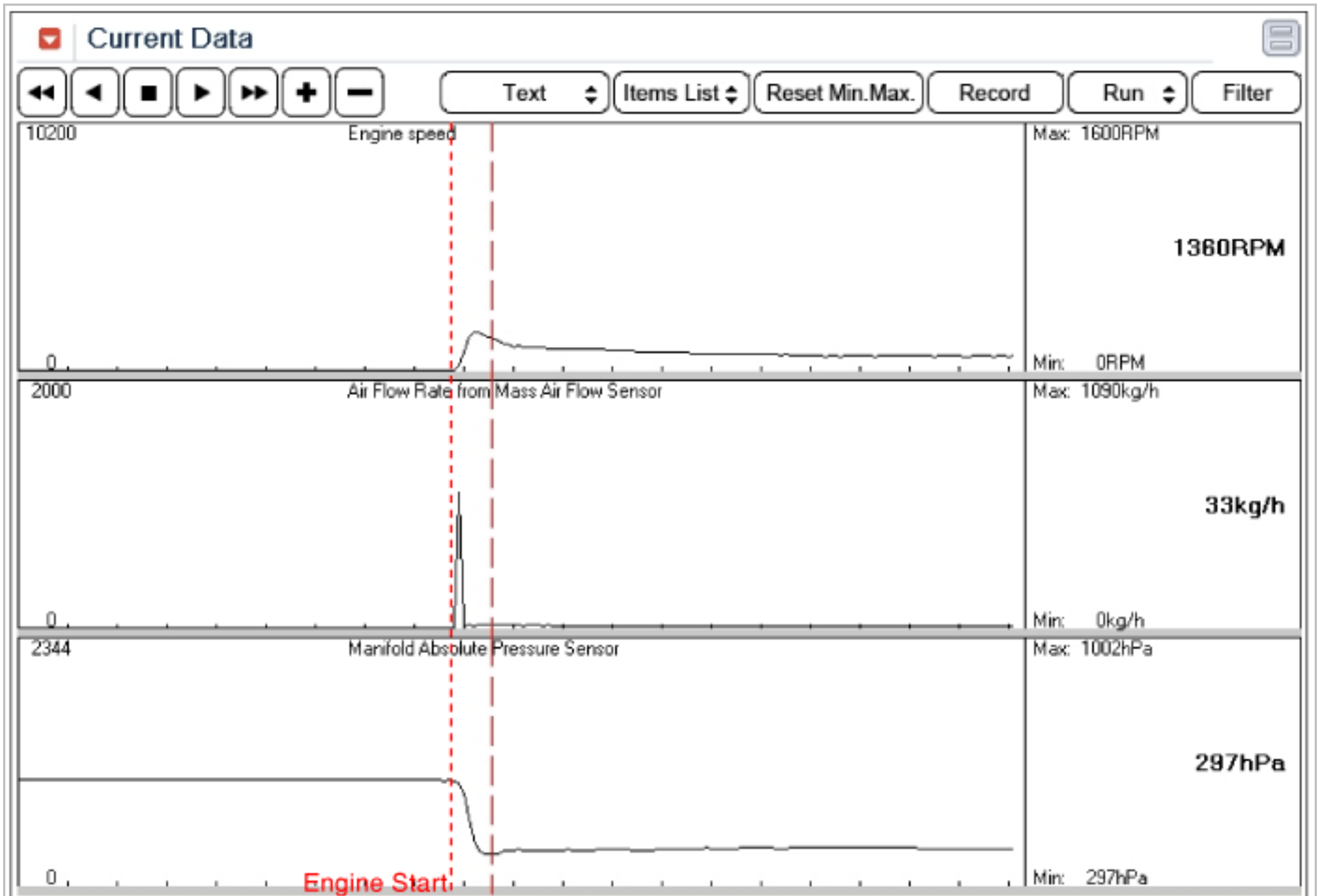
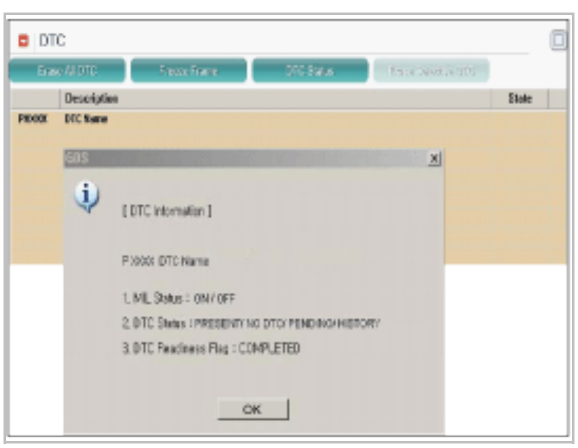


Fig.1

Fig.1) Normal graph of the MAP at the time when engine starts.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Component Inspection" procedure.

NO	▶ Fault is intermittent caused by ECM memory was not cleared after repair. Erase DTC and drive the vehicle to satisfy the enable codition then, go to "Component Inspection" procedure.

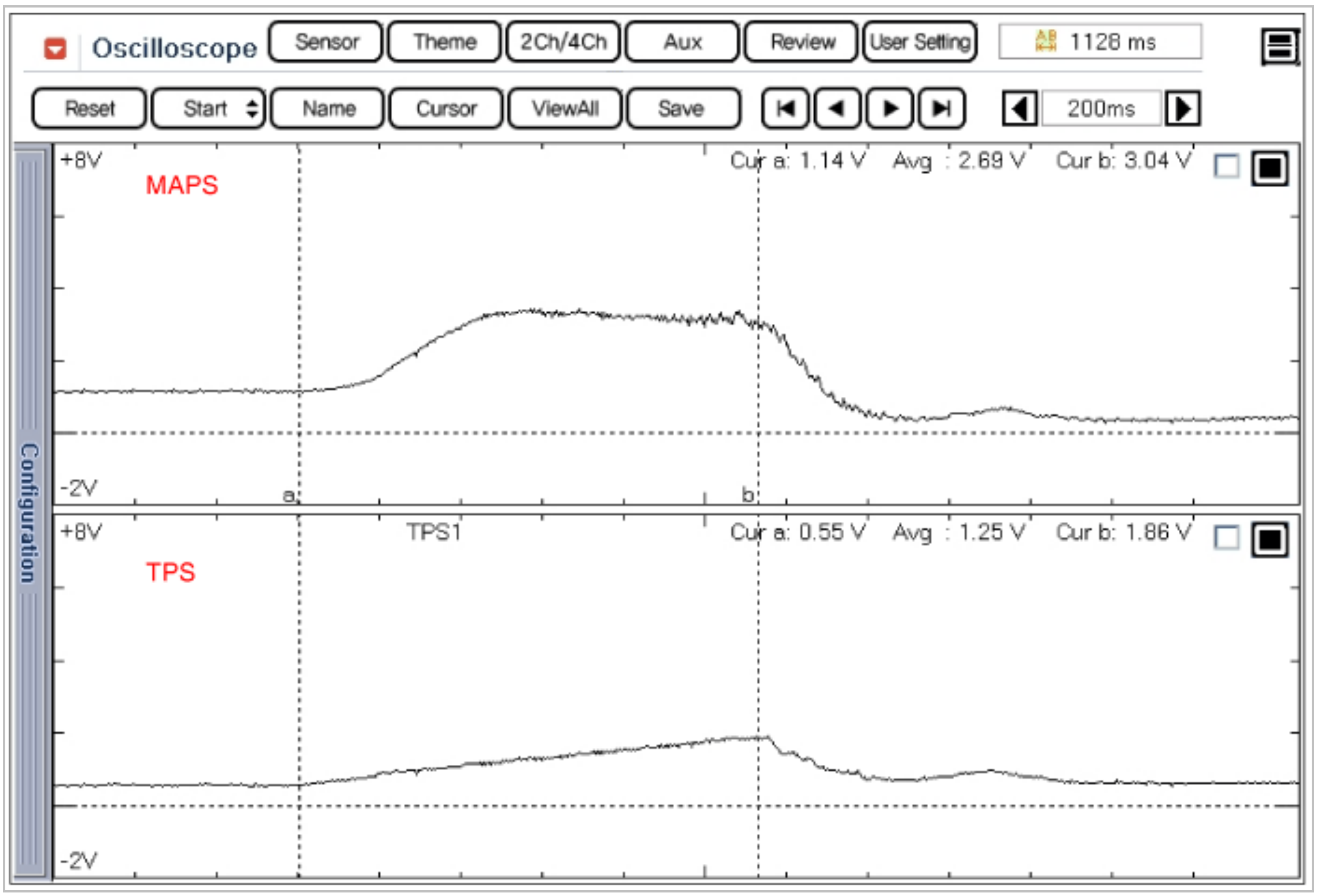
Component Inspection

■ Check MAPS Performance

1. IG "OFF" and install a GDS.
2. Connect probe to MAPS and TPS to check signal waveform by using oscilloscope function.
3. ENG "ON" and monitor signal waveform during accelleration and decelleration.

Specification : Signal waveform will be displayed as follows.

Pressure(kPa)	Voltage(V)
20	0.79
46.66	1.84
101.32	4.0



4. . Is the relationship between the MAP and the TPS correct ?

YES	▶ Go to "Verification of Vehicle Repair" procedure.

NO	▶ Substitute with a known - good MAPS and check for proper operation. If the problem is corrected, replace MAPS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

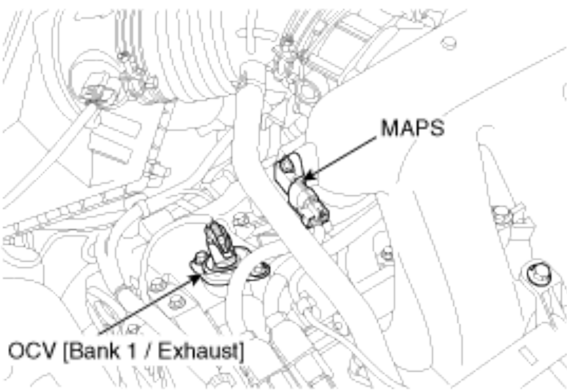
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0106 Manifold Absolute Pressure/Barometric Pressure Circuit Range/Performance

Component Location



General Description

The amount of intake air flow must be inputted to ECM in order to determine the fuel injection quantity. To measure the pressure inside of intake manifold, MAFS is used at idle and MAPS is required at accelerating. MAPS(Manifold Absolute Pressure) calculates the amount of air indirectly as measuring the pressure inside of intake manifold. This system is called a Speed-Density type.
MAPS transfers analog output signal which is proportional to the change of intake manifold pressure, then, with this signal and RPM, ECM calculates the amount of intake air flow.
The MAPS is mounted on surge tank to measure the pressure inside of intake manifold, and it consists of a piezo electric element and hybrid IC which amplifies output signal from the element. A piezo electric element is a sort of a diaphragm using piezo electric effect. One side of the diaphragm is surrounded with vacuum chamber while intake pressure is applied to the other side. Thus, signals are output by the transformation of diagphragm according to the change of pressure inside of intake manifold.

DTC Description

ECM compares the difference between MAPS output and calculated MAPS value while enable condition is met. If the acutal MAP value or lower than calculated(threshold) value for 2 min failure during tip in-out driving, ECM determines that a fault exists and a DTC is stored.
MIL(Malfunction Indicatin Lamp) turns on when the malfunction lasts till cosecutive 2 driving cycle.

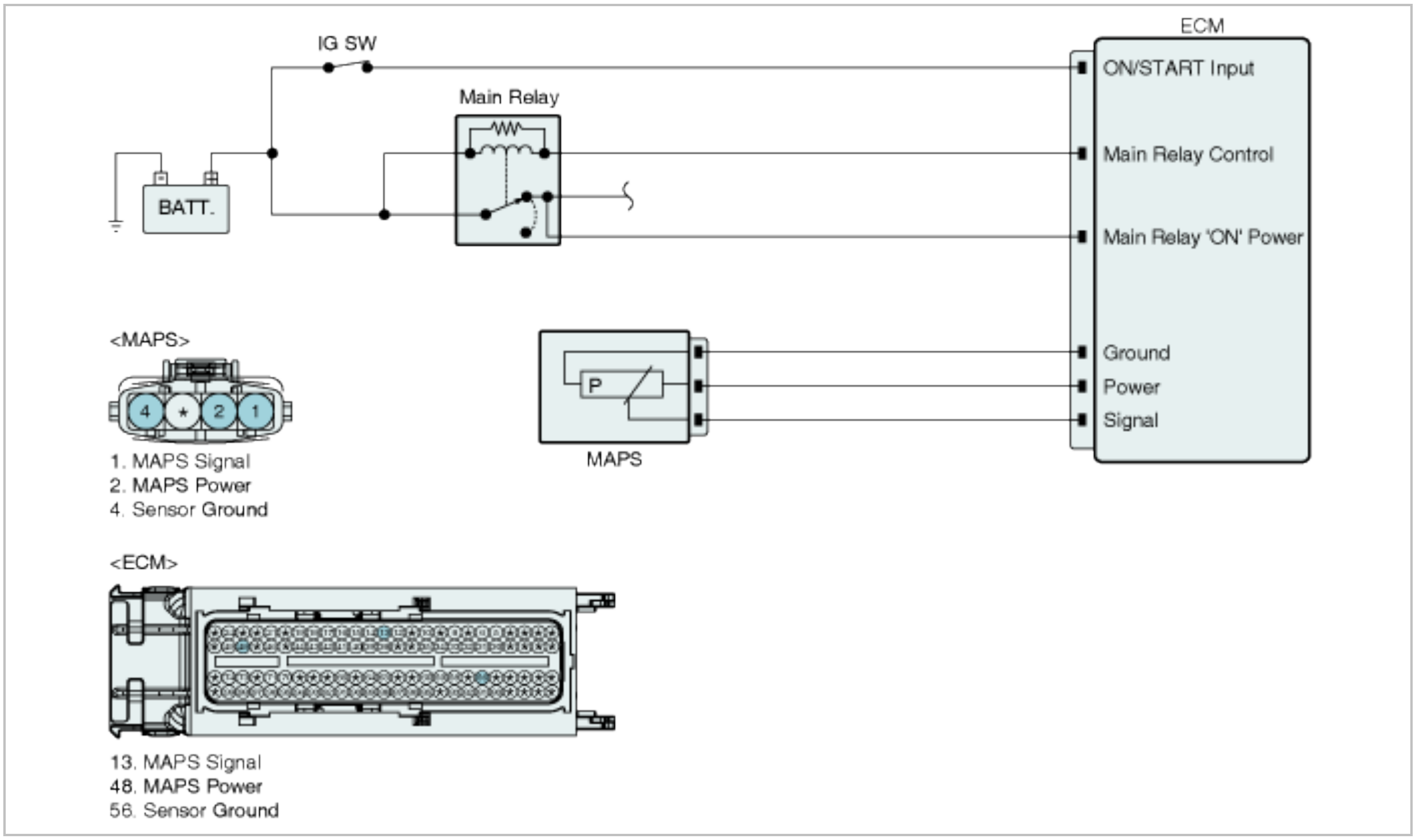
DTC Detecting Condition

Item		Detecting Condition	Possible Cause
DTC Strategy		• The MAP reading is compared to expected MAP high and low limits based on engine speed & Throttle Position	• Faulty TPS • Faulty MAPS
Enable Conditions		• Engine Coolant Temperature ≥ 60°C (Fully Warmed up state) • 600rpm < Engine Speed < 3000rpm	
Threshold value	Case 1	- Power Test • Altitude compensated MAP < Calculated min. MAP data • Altitude compensated MAP > Calculated max. MAP data	
	Case 2	- Decelleration Test • Altitude compensated MAP < Calculated MAP data	
Diagnosis Time		• Continuous (within 5min.)	
MIL On Condition		• NO MIL ON(DTC only)	

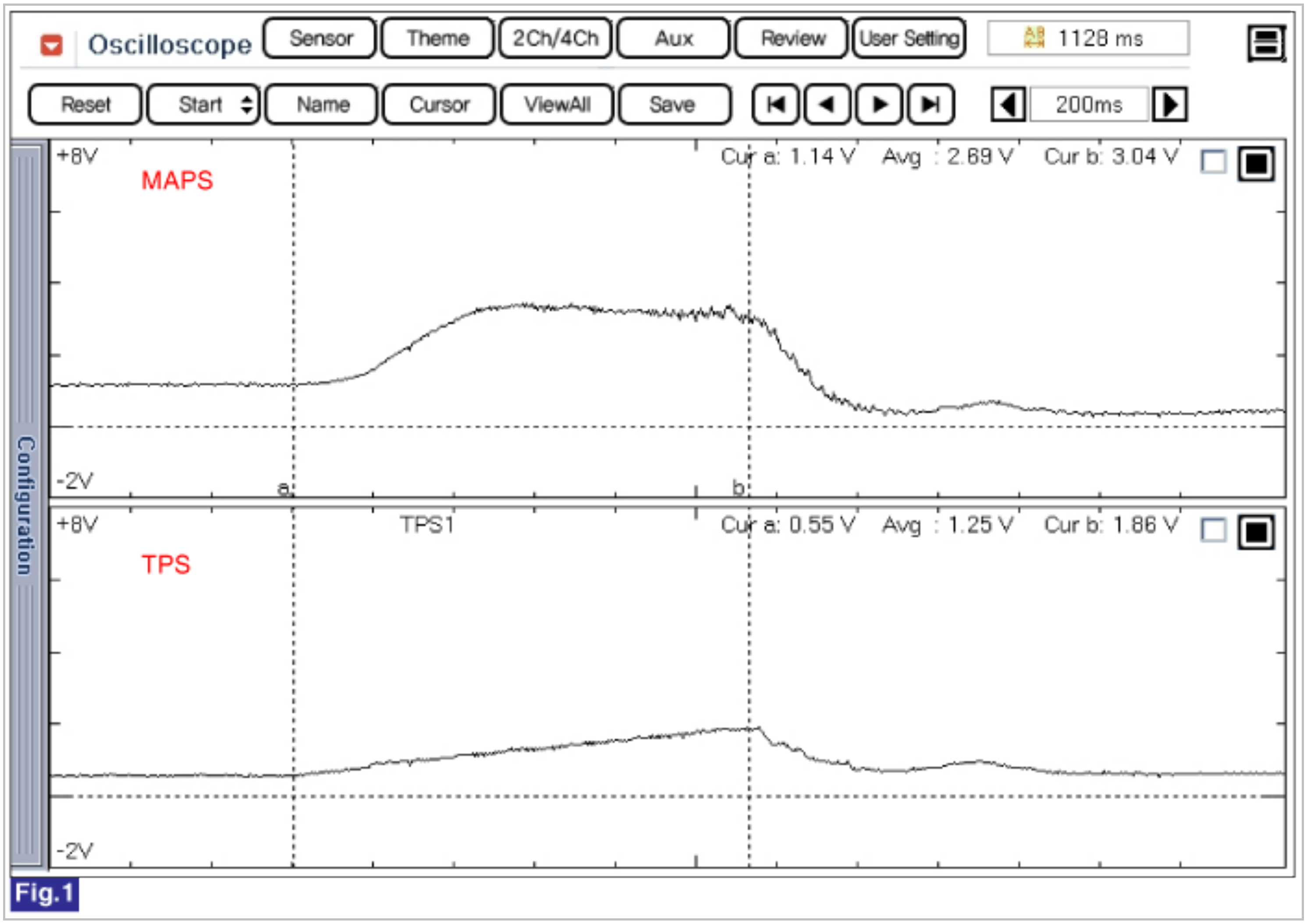
Specification

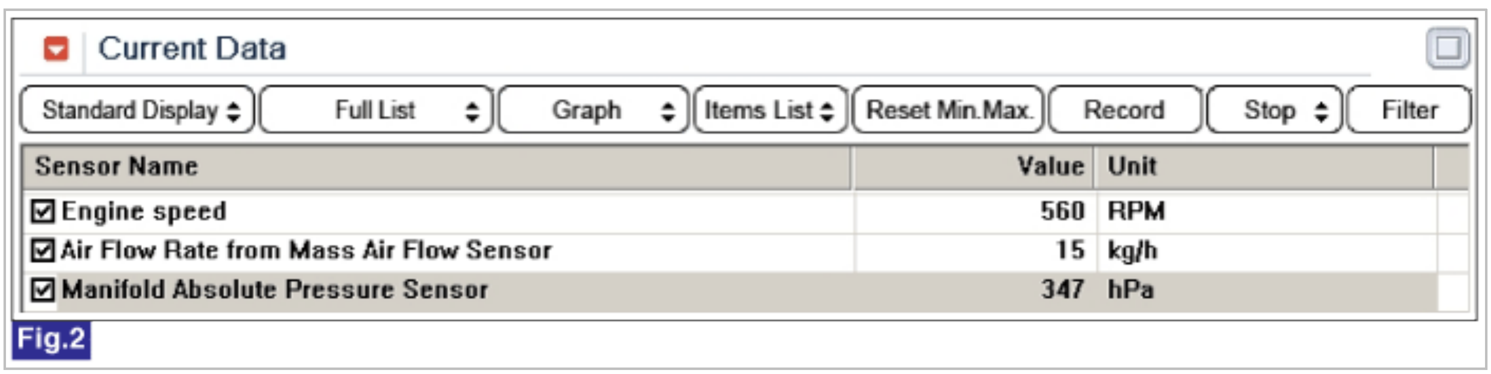
Pressure(kPa)	Voltage(V)
20	0.79
46.66	1.84
101.32	4.0

Diagnostic Circuit Diagram



Signal Waveform & Data





Sensor Name	Value	Unit
☑ Engine speed	560	RPM
☑ Air Flow Rate from Mass Air Flow Sensor	15	kg/h
☑ Manifold Absolute Pressure Sensor	347	hPa

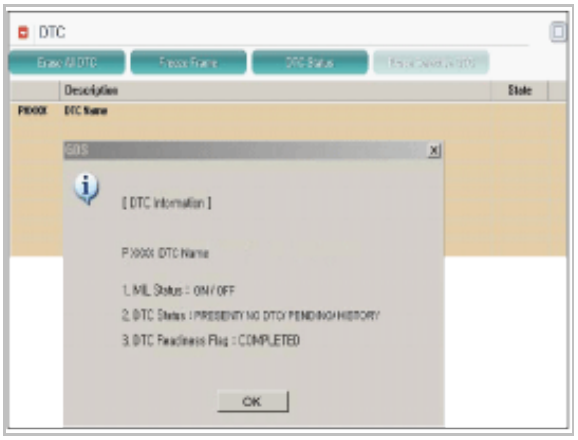
Fig.1) Normal waveform of MAPS & TPS with acceleration.
Fig.2) Normal data of MAPS at idle.

It is necessary that MAPS should be checked along with TPS. Because the MAP/TPS rationality diagnostic is comprised of two tests. A deceleration test is performed to provide a robust method for detection of an altitude compensated MAP value that is too high for the deceleration condition. The second test compares the altitude compensated MAP value to both high and low limits, dependent upon throttle position and engine speed. When the MAP value is out of the threshold range, the MAP/TPS system is determined to be failed.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.

4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Fault is intermittent caused by ECM memory was not cleared after repair. Erase DTC and drive the vehicle to satisfy the enable codition then, go to "Component Inspection" procedure.

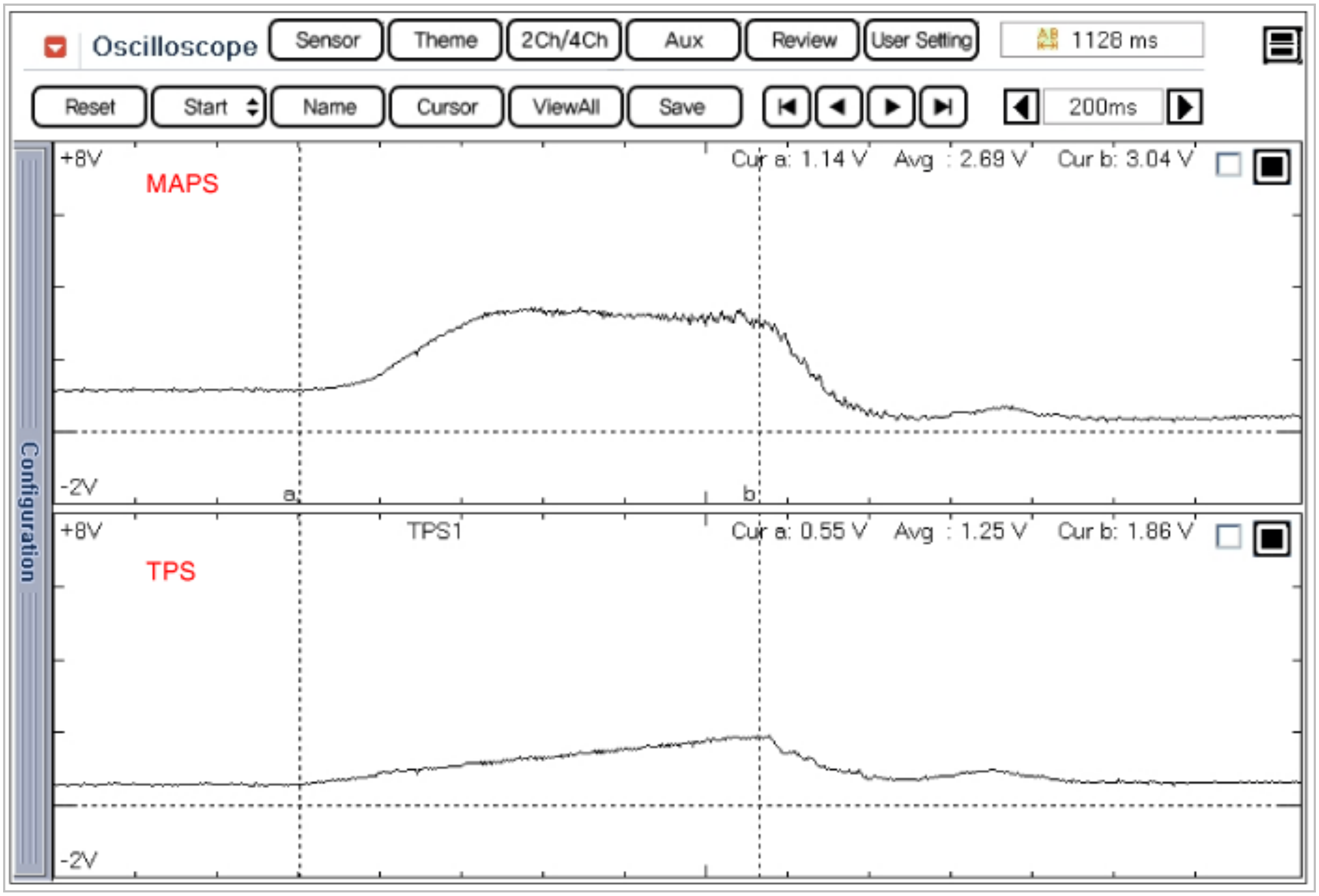
Component Inspection

■ Check MAPS Performance

1. IG "OFF" and install a GDS.
2. Connect probe to MAPS and TPS to check signal waveform by using oscilloscope function.
3. ENG "ON" and monitor signal waveform during accelleration and decelleration.

Specification : Signal waveform will be displayed as follows.

Pressure(kPa)	Voltage(V)
20	0.79
46.66	1.84
101.32	4.0



4. Is the relationship between the MAP and the TPS correct ?

YES	▶ Go to "Verification of Vehicle Repair" procedure.
NO	▶ Substitute with a known - good MAPS and check for proper operation. If the problem is corrected, replace MAPS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

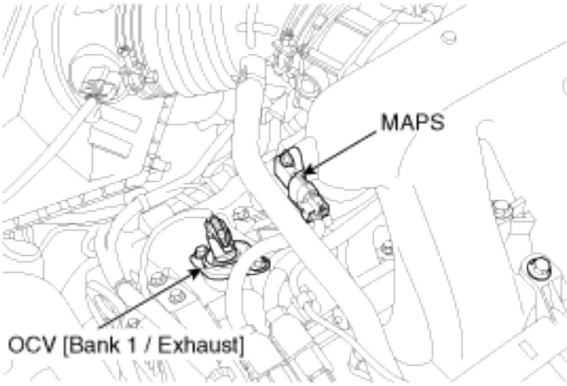
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0107 Manifold Absolute Pressure/Barometric Pressure Circuit Low Input

Component Location



General Description

The amount of intake air flow must be inputted to ECM in order to determine the fuel injection quantity. To measure the pressure inside of intake manifold, MAFS is used at idle and MAPS is required at accelerating. MAPS(Manifold Absolute Pressure) calculates the amount of air indirectly as measuring the pressure inside of intake manifold. This system is called a Speed-Density type.
MAPS transfers analog output signal which is proportional to the change of intake manifold pressure, then, with this signal and RPM, ECM calculates the amount of intake air flow.
The MAPS is mounted on surge tank to measure the pressure inside of intake manifold, and it consists of a piezo electric element and hybrid IC which amplifies output signal from the element. A piezo electric element is a sort of a diaphragm using piezo electric effect. One side of the diaphragm is surrounded with vacuum chamber while intake pressure is applied to the other side. Thus, signals are output by the transformation of diagphragm according to the change of pressure inside of intake manifold.

DTC Description

Checking output signals of MAPS every 5 sec. under detecting condition, if an output signal is below 0.25V for more than 2.5 sec., ECM sets P0107. Warning lamp turns on when the malfunction lasts till continuous 2 driving cycle.

DTC Detecting Condition

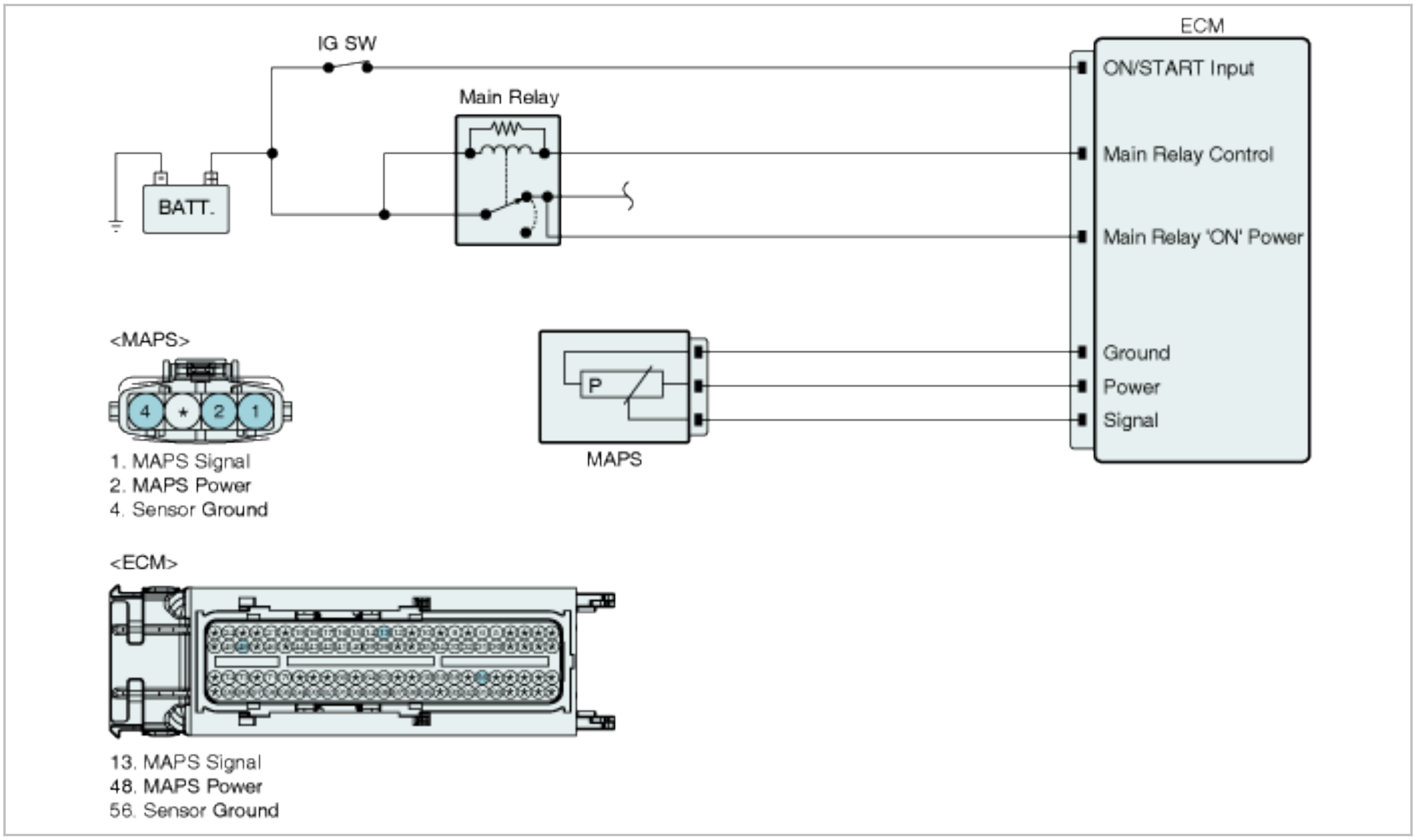
Item		Detecting Condition	Possible Cause
DTC Strategy		• This code detects a continuous short to low or open in either the signal circuit or the MAP	• Connecting Condition • Open or short to ground in power circuit • Open or short to ground in signal circuit • MAPS • ECM
Enable Conditions	Case 1	• No TPS Active Fault Present • Ignition Voltage ≥ 11V • Engine Speed ≤ 1000rpm • Throttle Position ≥ 0%	
	Case 2	• No TPS Active Fault Present • Ignition Voltage ≥ 11V • Engine Speed > 1000rpm • Throttle Position ≥ 30%	
Threshold value		• MAP Signal < 0.25V	
Diagnosis Time		• Contineous (More than 2.5 seconds failure for every 5	

Diagnosis Time	seconds test)	
MIL On Condition	• 2 Driving Cycles	

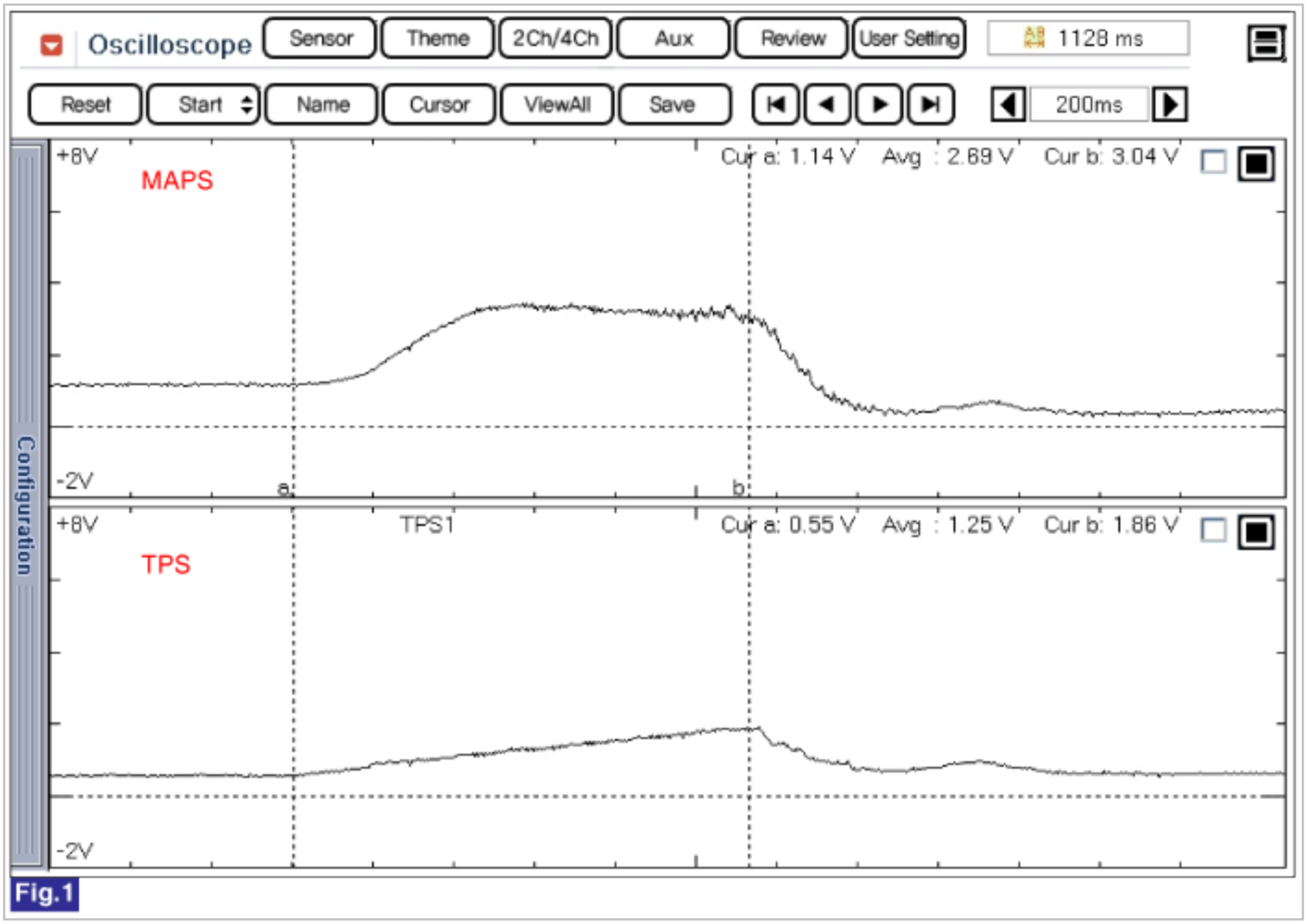
Specification

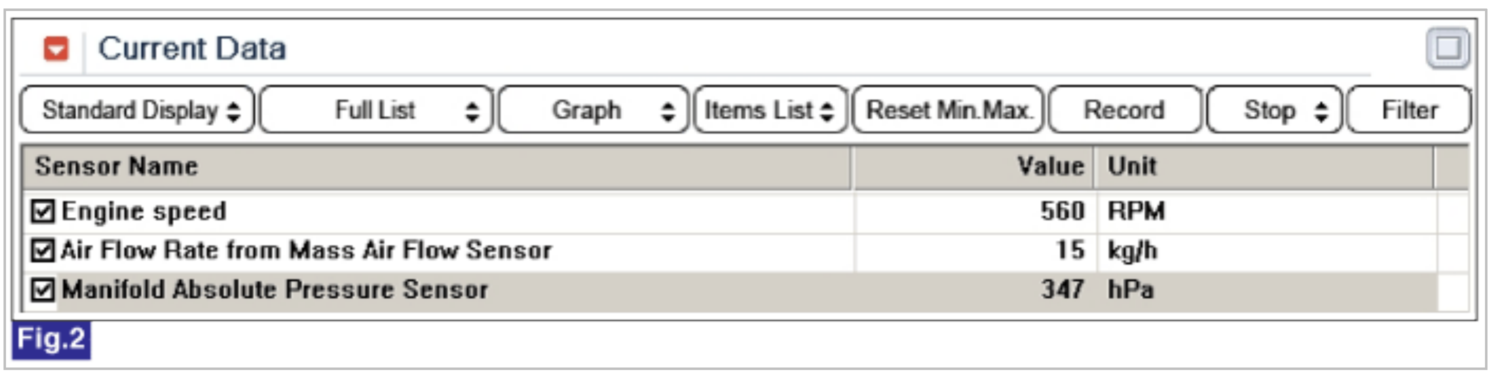
Pressure(kPa)	Voltage(V)
20	0.79
46.66	1.84
101.32	4.0

Diagnostic Circuit Diagram



Signal Waveform & Data





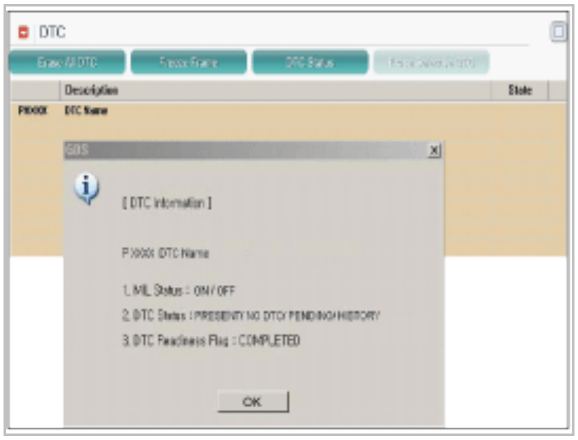
Sensor Name	Value	Unit
Engine speed	560	RPM
Air Flow Rate from Mass Air Flow Sensor	15	kg/h
Manifold Absolute Pressure Sensor	347	hPa

Fig.1) Normal waveform of MAPS & TPS with acceleration.
Fig.2) Normal data of MAPS at idle.
It is necessary that MAPS should be checked along with TPS. Because the MAP/TPS rationality diagnostic is comprised of two tests. A deceleration test is performed to provide a robust method for detection of an altitude compensated MAP value that is too high for the deceleration condition. The second test compares the altitude compensated MAP value to both high and low limits, dependent upon throttle position and engine speed. When the MAP value is out of the threshold range, the MAP/TPS system is determined to be failed.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.

4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Power Circuit Inspection" procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and Disconnect MAPS connector.
2. IG "ON".
3. Measure voltage between power terminal of MAPS harness connector and chassis ground.

Specification : Approx. 5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Signal Circuit Inspection" Procedure.
NO	▶ Repair open or short in harness and go to "Verification of Vehicle Repair" procedure.

Signal Circuit Inspection

■ **Check short to ground in harness**

1. IG "OFF".
2. Disconnect MAPS and ECM connector.
3. Measure the resistance between signal terminal of MAPS harness connector and ground.

Specification : Infinite

4. Is the measured resistance within specification ?

YES	▶ Go to "Check open in harness" as follows.
NO	▶ Repair short to ground in harness and go to "Verification of Vehicle Repair" procedure.

■ **Check open in harness**

1. IG "OFF" and disconnect MAPS and ECM connector.
2. Measure resistance between signal terminal of MAPS harness connector and MAPS signal terminal of ECM harness connector.

Specification : Approx. below 1Ω.

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in harness and go to "Verification of Vehicle Repair" procedure.

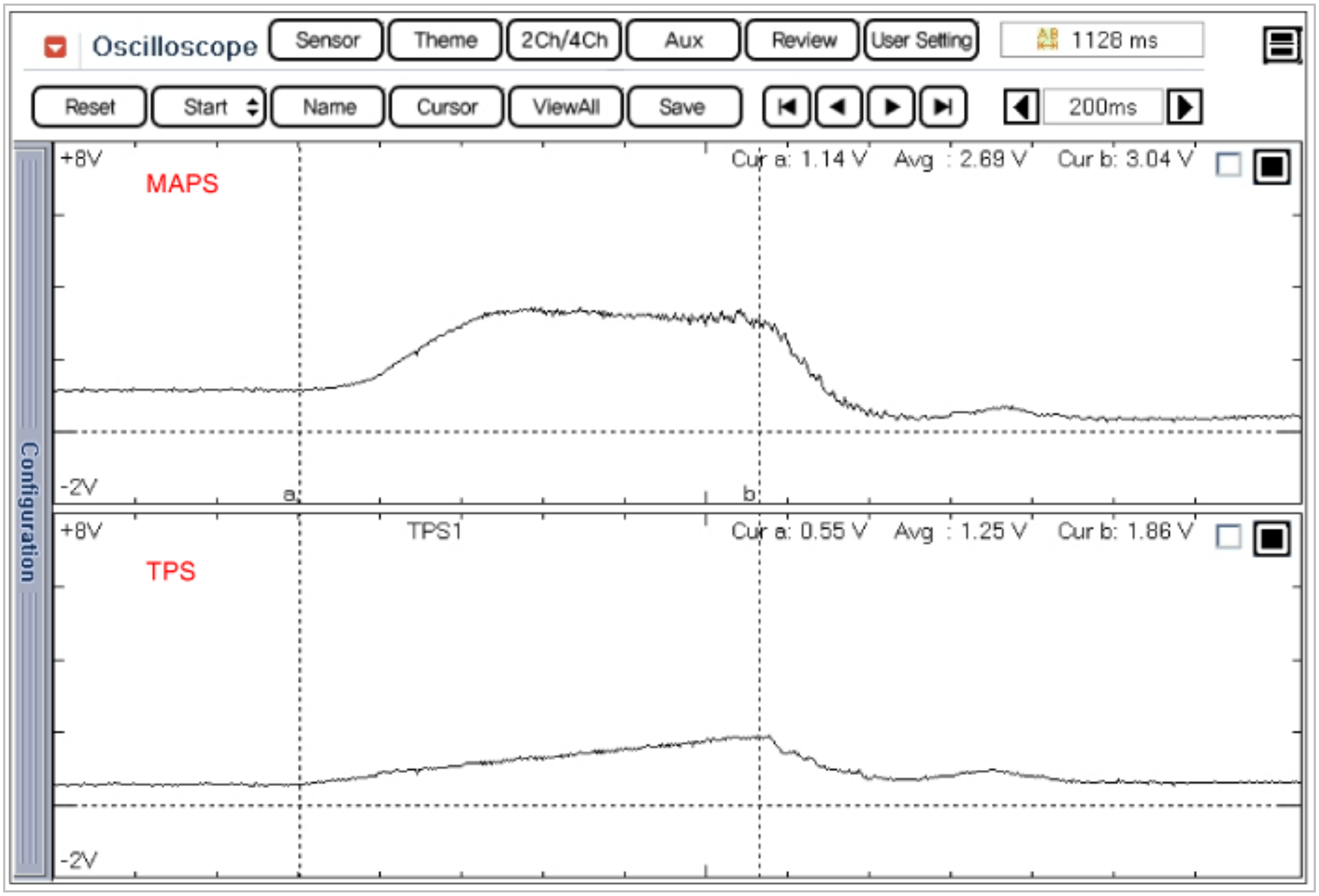
Component Inspection

■ **Check MAPS Performance**

1. IG "OFF" and install a GDS.
2. Connect probe to MAPS and TPS to check signal waveform by using oscilloscope function.
3. ENG "ON" and monitor signal waveform during accelleration and decelleration.

Specification : Signal waveform will be displayed as follows.

Pressure(kPa)	Voltage(V)
20	0.79
46.66	1.84
101.32	4.0



4. Is the relationship between the MAP and the TPS correct ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good MAPS and check for proper operation. If the problem is corrected, replace MAPS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

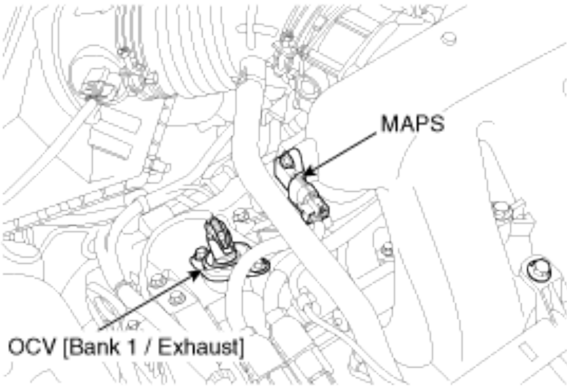
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0108 Manifold Absolute Pressure/Barometric Pressure Circuit High Input

Component Location



General Description

The amount of intake air flow must be inputted to ECM in order to determine the fuel injection quantity. To measure the pressure inside of intake manifold, MAFS is used at idle and MAPS is required at accelerating. MAPS(Manifold Absolute Pressure) calculates the amount of air indirectly as measuring the pressure inside of intake manifold. This system is called a Speed-Density type.
MAPS transfers analog output signal which is proportional to the change of intake manifold pressure, then, with this signal and RPM, ECM calculates the amount of intake air flow.
The MAPS is mounted on surge tank to measure the pressure inside of intake manifold, and it consists of a piezo electric element and hybrid IC which amplifies output signal from the element. A piezo electric element is a sort of a diaphragm using piezo electric effect. One side of the diaphragm is surrounded with vacuum chamber while intake pressure is applied to the other side. Thus, signals are output by the transformation of diagphragm according to the change of pressure inside of intake manifold.

DTC Description

Checking output signals of MAPS every 5 sec. under detecting condition, if an output signal is above 4.5V for more than 2.5 sec., ECM sets P0108. MIL(Malfunction Indicatin Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

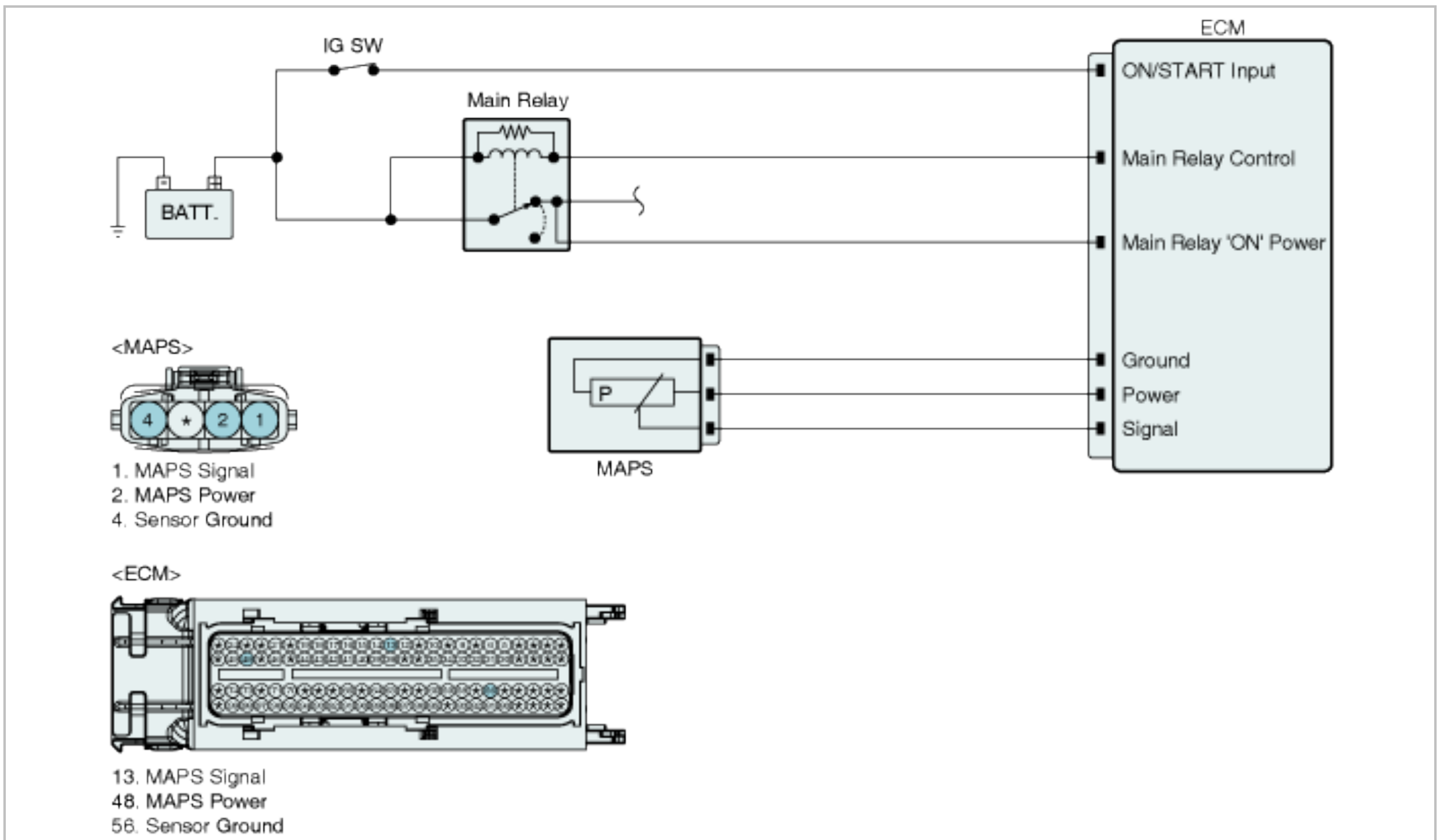
Item		Detecting Condition	Possible Cause
DTC Strategy		• This code detects a continuous short to high in either the signal circuit or the MAP sensor	
	Case 1	• No TPS Active Fault Present • Engine Running Time > 10sec • Engine Speed ≤ 2500rpm	

Enable Conditions		• Throttle Position ≤ 30%	• Connecting Condition • Short in Signal Circuit • Open in Ground Circuit • Faulty MAPS • Faulty ECM
	Case 2	• No TPS Active Fault Present • Engine Running Time > 10sec • Engine Speed > 2500rpm • Throttle Position ≤ 40%	
Threshold value		• MAP Signal > 4.5V	
Diagnosis Time		• Contineous (More than 2.5 seconds failure for every 5 seconds test)	
MIL On Condition		• 2 Driving Cycles	

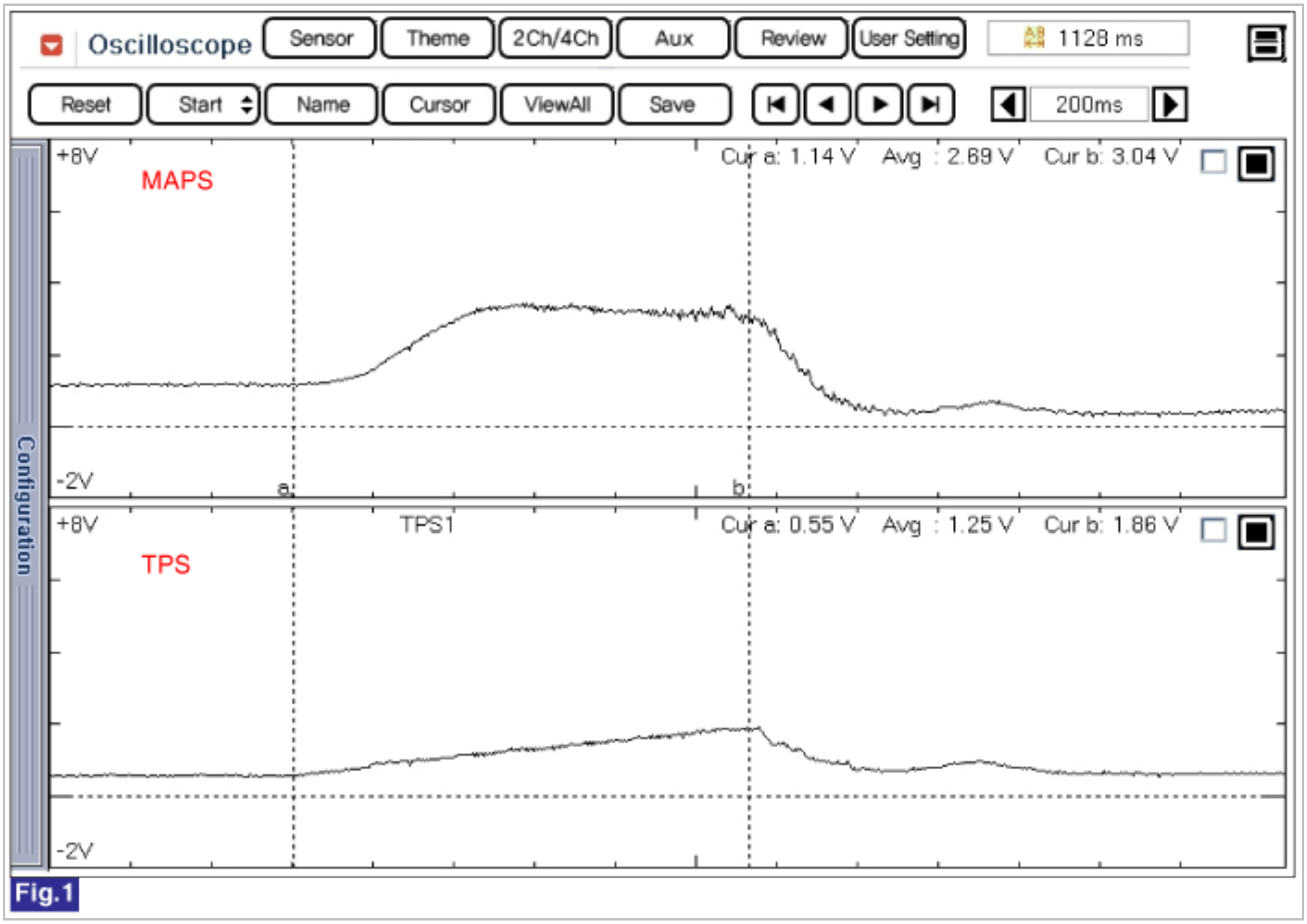
Specification

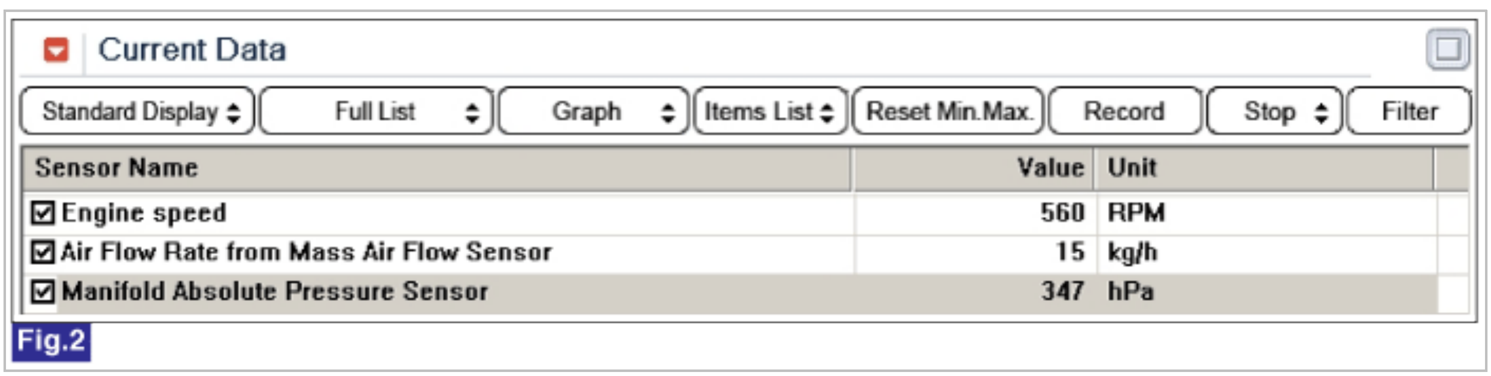
Pressure(kPa)	Voltage(V)
20	0.79
46.66	1.84
101.32	4.0

Diagnostic Circuit Diagram



Signal Waveform & Data





Sensor Name	Value	Unit
Engine speed	560	RPM
Air Flow Rate from Mass Air Flow Sensor	15	kg/h
Manifold Absolute Pressure Sensor	347	hPa

Fig.1) Normal waveform of MAPS & TPS with acceleration.

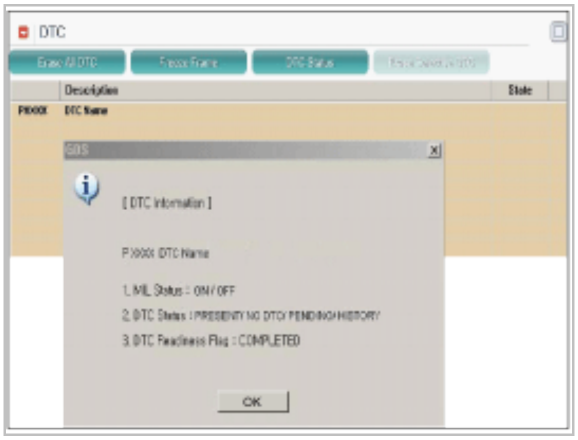
Fig.2) Normal data of MAPS at idle.

It is necessary that MAPS should be checked along with TPS. Because the MAP/TPS rationality diagnostic is comprised of two tests. A deceleration test is performed to provide a robust method for detection of an altitude compensated MAP value that is too high for the deceleration condition. The second test compares the altitude compensated MAP value to both high and low limits, dependent upon throttle position and engine speed. When the MAP value is out of the threshold range, the MAP/TPS system is determined to be failed.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.

4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Power Circuit Inspection" procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and Disconnect MAPS connector.
2. IG "ON".
3. Measure voltage between power terminal of MAPS harness connector and chassis ground.

Specification : Approx. 5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Ground Circuit Inspection" Procedure.
NO	▶ Repair open or short in harness and go to "Verification of Vehicle Repair" procedure.

Ground Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect MAPS connector and then IG "ON".
2. Measure voltage between signal terminal of MAPS harness connector and chassis ground (Measurement "A")
3. Measure voltage between signal and ground terminals of MAPS harness connector (Measurement "B")

Specification : Voltage difference between Measurement "A" and "B" is below 200mV.

4. Is the measured voltage within specification ?

YES	▶ Go to "Signal Circuit Inspection" procedure.
NO	▶ Repair contact resistance or open in harnesss and then go to "Verification of Vehicle Repair" procedure.

Signal Circuit Inspection

■ Check short to battery in harness

1. IG "OFF".
2. Disconnect MAPS and ECM connector.
3. Measure the resistance between signal terminal of MAPS harness connector and ground.

Specification : Infinite

4. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" as follows.
NO	▶ Repair short in harnesss and then go to "Verification of Vehicle Repair" procedure.

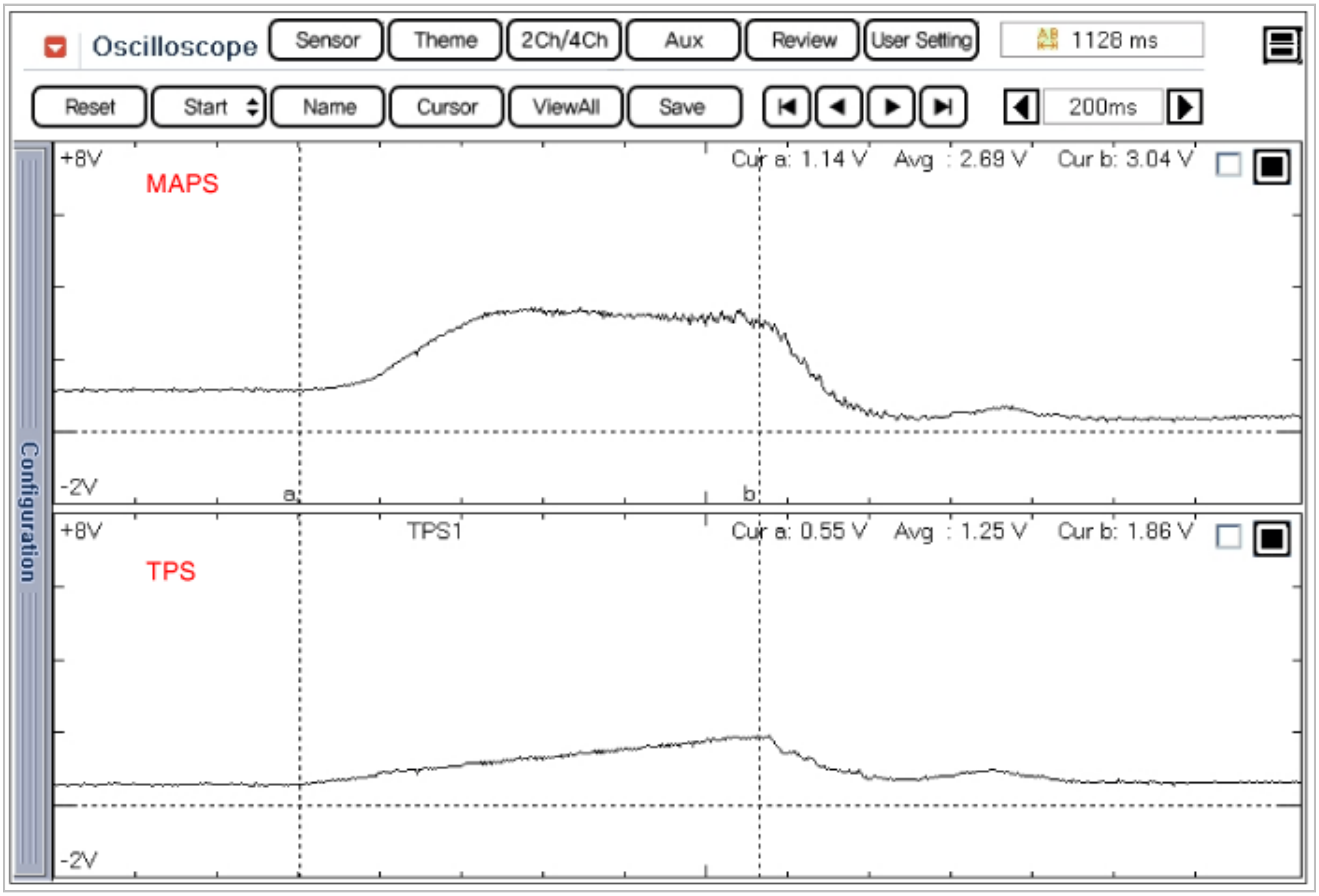
Component Inspection

■ Check MAPS Performance

1. IG "OFF" and install a GDS.
2. Connect probe to MAPS and TPS to check signal waveform by using oscilloscope function.
3. ENG "ON" and monitor signal waveform during accelleration and decelleration.

Specification : Signal waveform will be displayed as follows.

Pressure(kPa)	Voltage(V)
20	0.79
46.66	1.84
101.32	4.0



4. Is the relationship between the MAP and the TPS correct ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others.
NO	▶ Substitute with a known - good MAPS and check for proper operation. If the problem is corrected, replace MAPS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

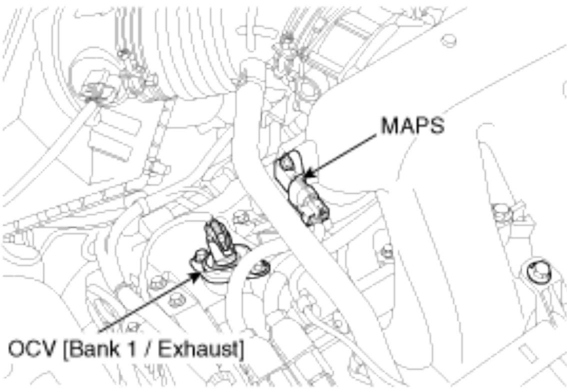
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0109 Manifold Absolute Pressure/Barometric Pressure Circuit Intermittent

Component Location



General Description

The amount of intake air flow must be inputted to ECM in order to determine the fuel injection quantity. To measure the pressure inside of intake manifold, MAFS is used at idle and MAPS is required at accelerating. MAPS(Manifold Absolute Pressure) calculates the amount of air indirectly as measuring the pressure inside of intake manifold. This system is called a Speed-Density type.
MAPS transfers analog output signal which is proportional to the change of intake manifold pressure, then, with this signal and RPM, ECM calculates the amount of intake air flow.
The MAPS is mounted on surge tank to measure the pressure inside of intake manifold, and it consists of a piezo electric element and hybrid IC which amplifies output signal from the element. A piezo electric element is a sort of a diaphragm using piezo electric effect. One side of the diaphragm is surrounded with vacuum chamber while intake pressure is applied to the other side. Thus, signals are output by the transformation of diagphragm according to the change of pressure inside of intake manifold.

DTC Description

ECM monitors MAP output signal continuously. If there is the signal change over 10% momently without the operation of accel pedal, ECM determines that a fault exists and a DTC is stored.

DTC Detecting Condition

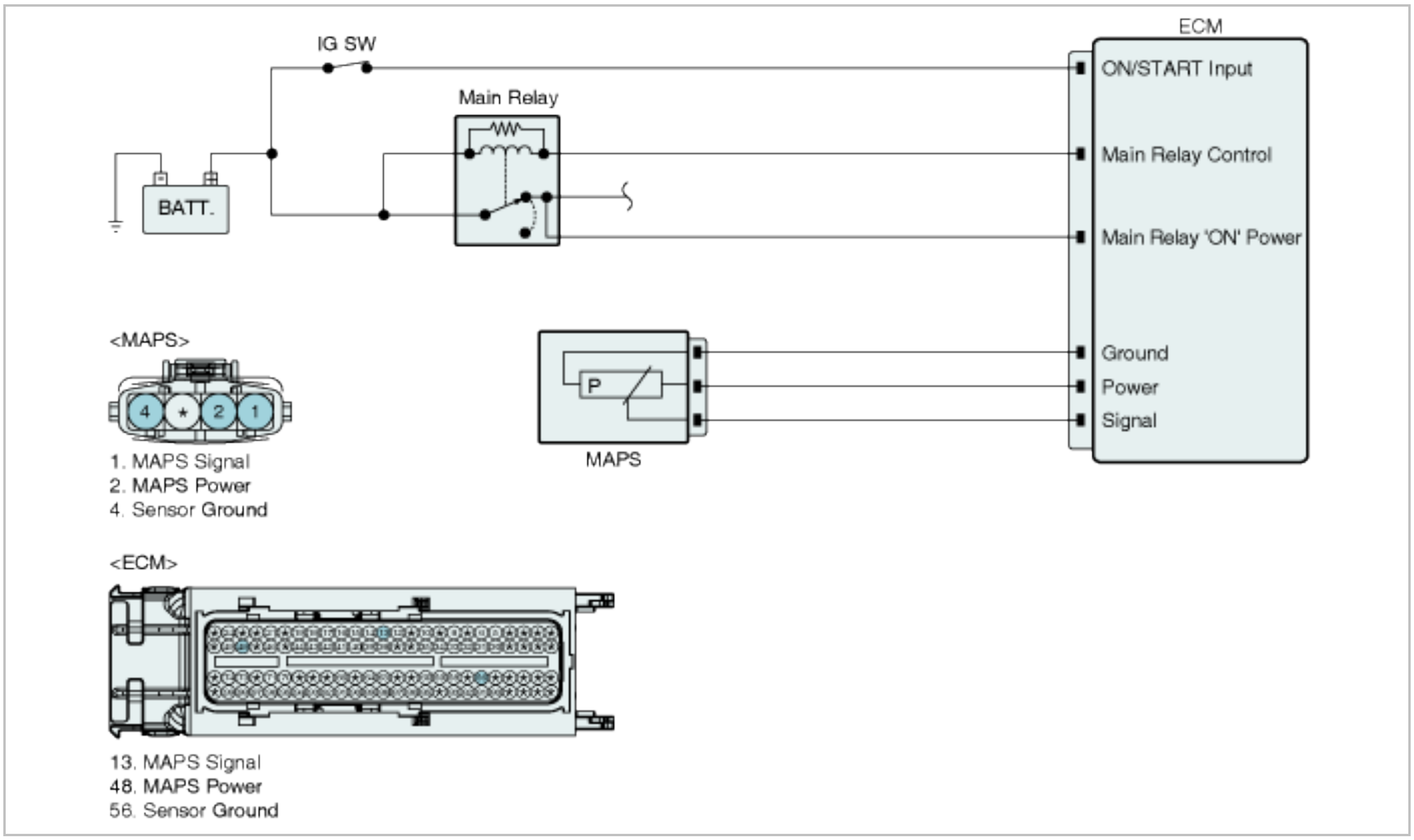
Item	Detecting Condition	Possible Cause
DTC Strategy	• This code detects a continuous short to low or open in either the signal circuit or the MAP	• Connecting condition • Open or short to ground in power circuit • Open or short to ground in signal circuit
Enable Conditions	• Engine running • I ΔAPS I < 5% • Engine Speed > 800rpm	

Threshold value	• MAP_stable –MAP_current| >10 %	• MAPS • ECM
Diagnosis Time	• -	
MIL On Condition	• NO MIL ON(DTC only)	

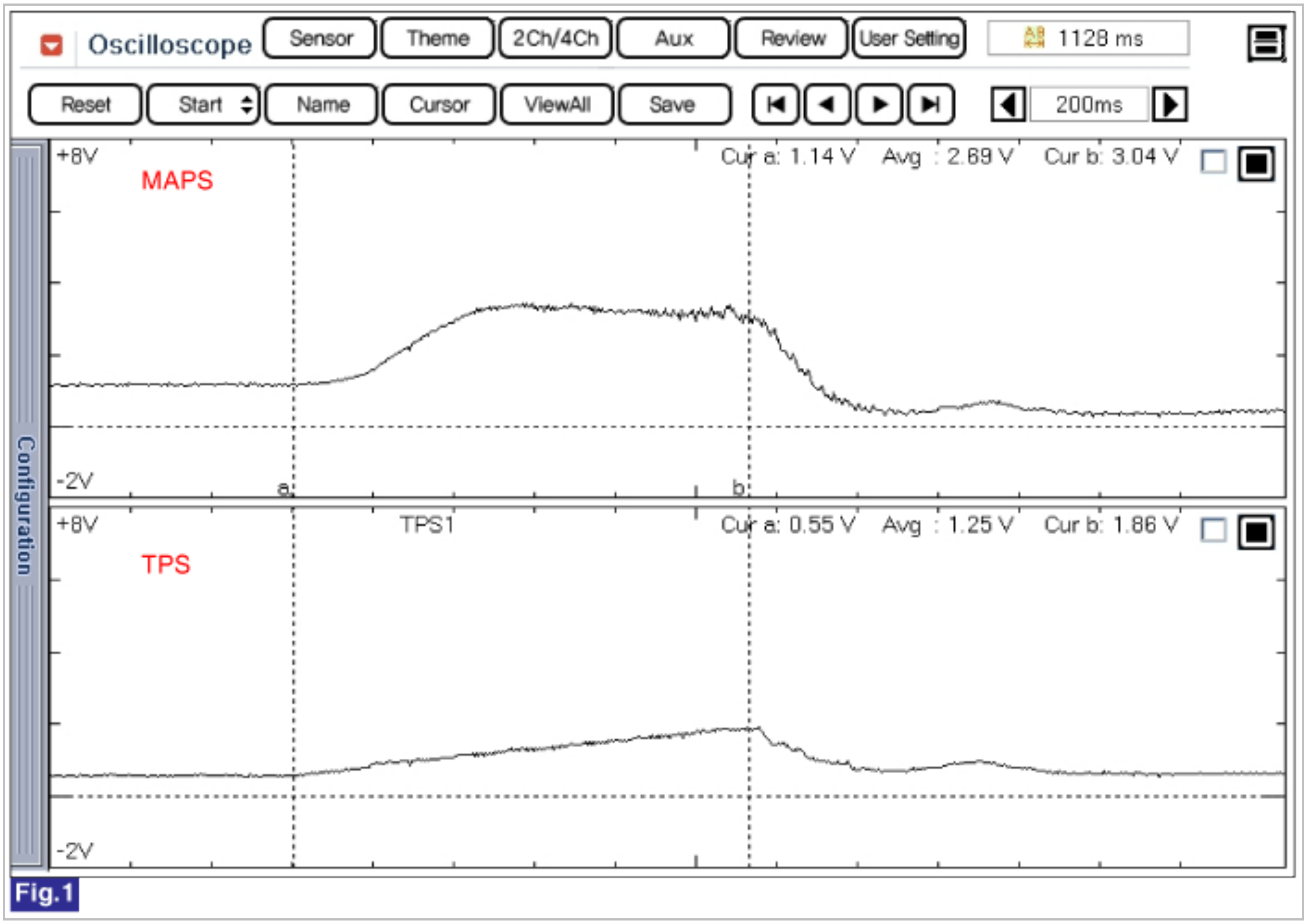
Specification

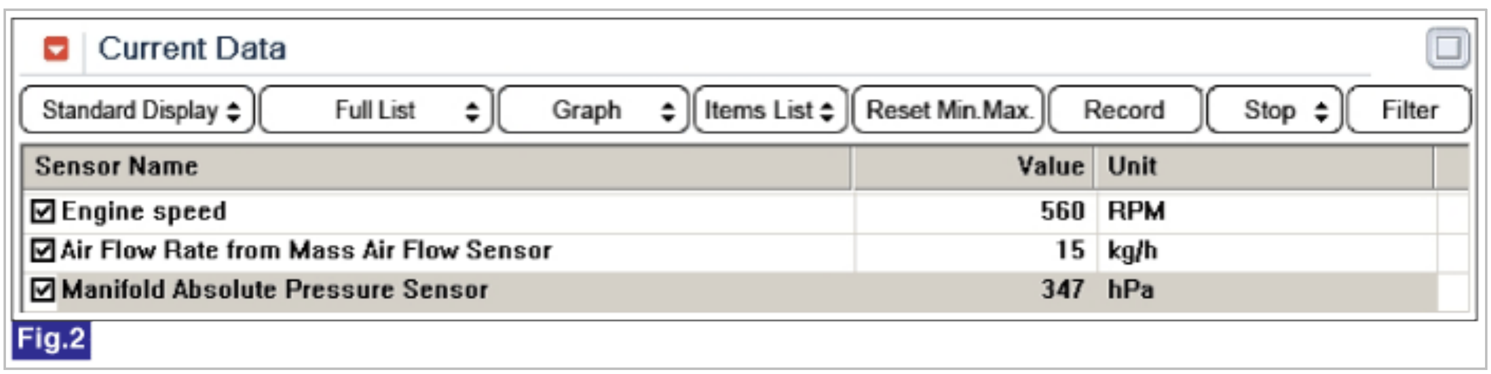
Pressure(kPa)	Voltage(V)
20	0.79
46.66	1.84
101.32	4.0

Diagnostic Circuit Diagram



Signal Waveform & Data





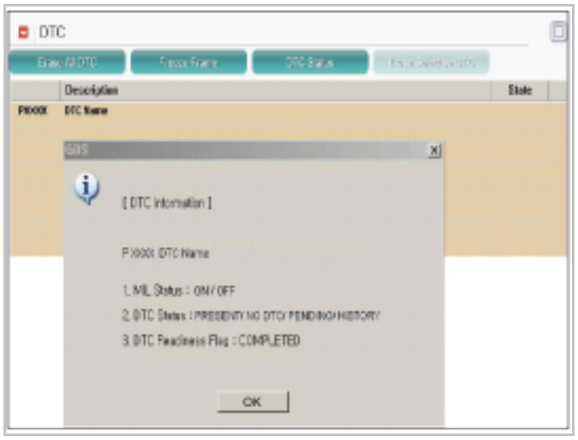
Sensor Name	Value	Unit
☑ Engine speed	560	RPM
☑ Air Flow Rate from Mass Air Flow Sensor	15	kg/h
☑ Manifold Absolute Pressure Sensor	347	hPa

Fig.1) Normal waveform of MAPS & TPS with acceleration.
Fig.2) Normal data of MAPS at idle.
It is necessary that MAPS should be checked along with TPS. Because the MAP/TPS rationality diagnostic is comprised of two tests. A deceleration test is performed to provide a robust method for detection of an altitude compensated MAP value that is too high for the deceleration condition. The second test compares the altitude compensated MAP value to both high and low limits, dependent upon throttle position and engine speed. When the MAP value is out of the threshold range, the MAP/TPS system is determined to be failed.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.

4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor’s and/or ECM’s connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Power Circuit Inspection" procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and Disconnect MAPS connector.
2. IG "ON".
3. Measure voltage between power terminal of MAPS harness connector and chassis ground.

Specification : Approx. 5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Signal Circuit Inspection" Procedure.
NO	▶ Repair open or short in harness and go to "Verification of Vehicle Repair" procedure.

Signal circuit Inspection

■ **Check short to ground in harness**

1. IG "OFF".
2. Disconnect MAPS and ECM connector.
3. Measure the resistance between signal terminal of MAPS harness connector and ground.

Specification : Infinite

4. Is the measured resistance within specification ?

YES	▶ Go to "Check open in harness" as follows.
NO	▶ Repair short to ground in harness and go to "Verification of Vehicle Repair" procedure.

■ **Check open in harness**

1. IG "OFF" and disconnect MAPS and ECM connector.
2. Measure resistance between signal terminal of MAPS harness connector and MAPS signal terminal of ECM harness connector.

Specification : Approx. below 1Ω.

3. Is the measured resistance within specification ?

YES	▶ Go to "Ground Inspection" procedure.
NO	▶ Repair open in harness and go to "Verification of Vehicle Repair" procedure.

Ground Circuit Inspection

■ **Check voltage**

1. IG "OFF" and disconnect MAPS connector and then IG "ON".
2. Measure voltage between signal terminal of MAPS harness connector and chassis ground (Measurement "A")
3. Measure voltage between signal and ground terminals of MAPS harness connector (Measurement "B")

Specification : Voltage difference between Measurement "A" and "B" is below 200mV.

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Circuit Inspection" procedure.
NO	▶ Repair contact resistance or open in harnesss and then go to "Verification of Vehicle Repair" procedure.

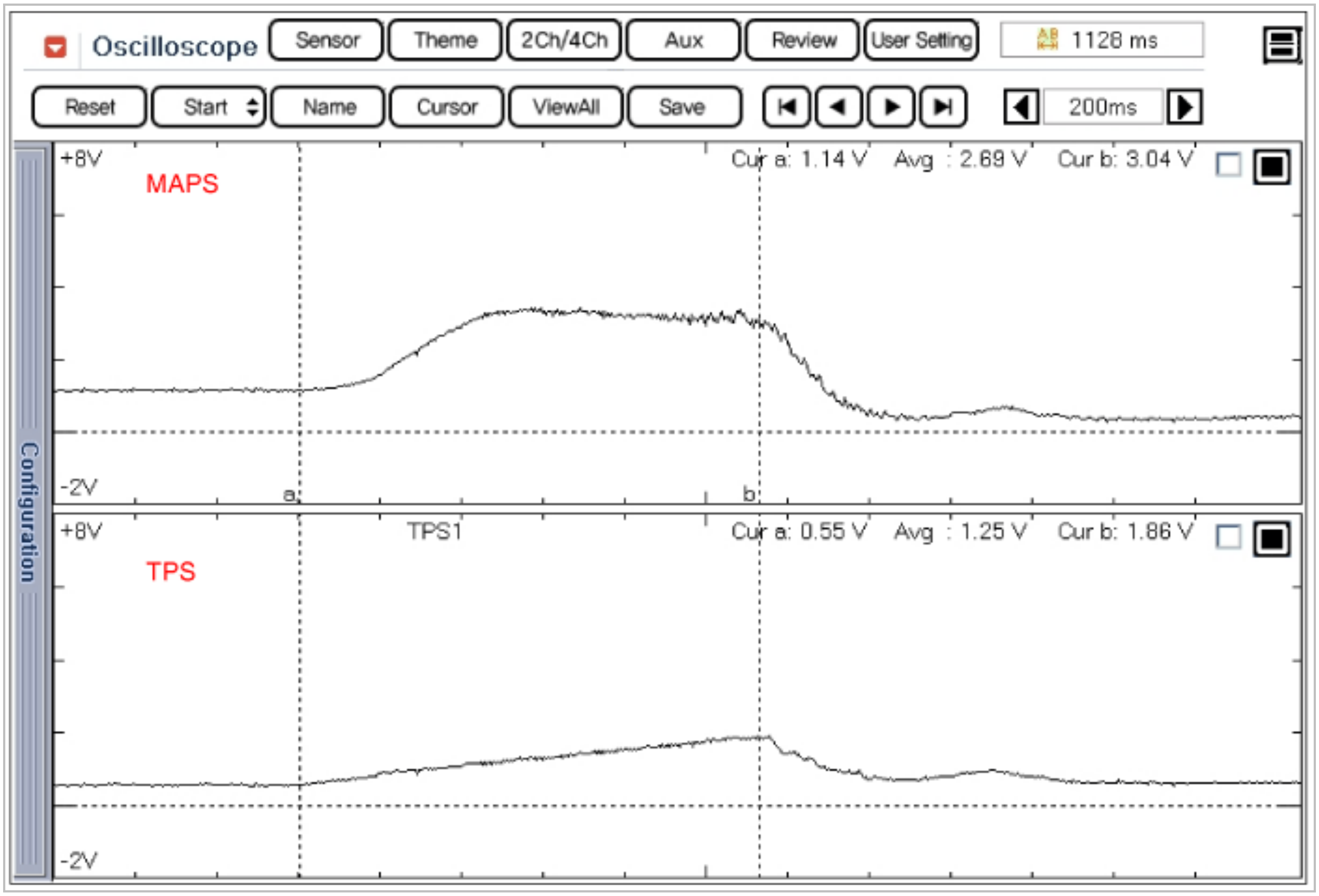
Component Inspection

■ **Check MAPS Performance**

1. IG "OFF" and install a GDS.
2. Connect probe to MAPS and TPS to check signal waveform by using oscilloscope function.
3. ENG "ON" and monitor signal waveform during accelleration and decelleration.

Specification : Signal waveform will be displayed as follows.

Pressure(kPa)	Voltage(V)
20	0.79
46.66	1.84
101.32	4.0



4. Is the relationship between the MAP and the TPS correct ?

YES	▶Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good MAPS and check for proper operation. If the problem is corrected, replace MAPS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

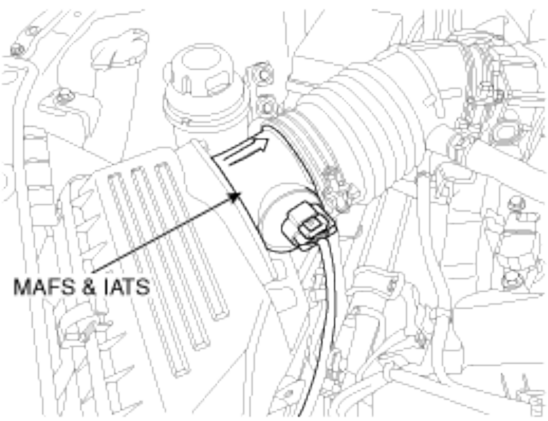
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0110 Intake Air Temperature Sensor 1 Circuit

Component Location



General Description

The Intake Air Temperature Sensor (IATS) is installed into the Mass Air Flow Sensor (MAFS). The IATS uses a thermistor whose resistance changes with the temperature. The electrical resistance of the IATS decreases as the temperature increases, and increases as the temperature decreases. The 5 V power source in the ECM is supplied to the IATS via a resistor in the ECM. That is, the resistor in the ECM and the thermistor in the IATS are connected in series. When the resistance value of the thermistor in IATS changes according to the intake air temperature, the signal voltage also changes. Using this signal, the information of the intake air temperature, the ECM corrects basic fuel injection duration and ignition timing

DTC Description

ECM monitors temperature difference betwen MAX. and MIN IATS in order to detect movement in IATS not only Start Test but Drive Test while enable condition is met. If ECM detects intake air temperature changes less than 5.4 °F ECM determines that a fault exists and a DTC is stored.
MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

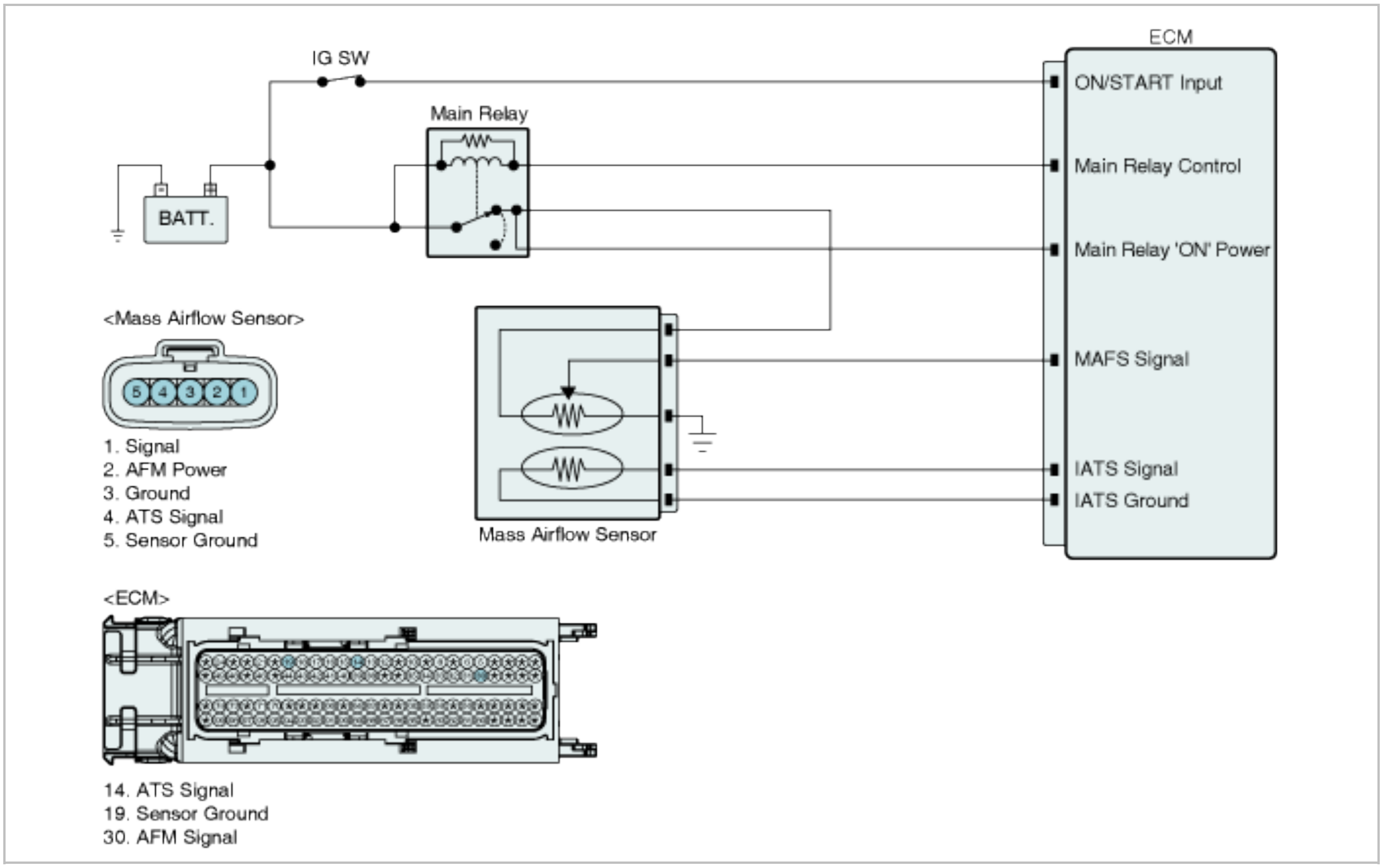
Item	Detecting Condition	Possible Cause

<table>
<tr><td rowspan="2">DTC Strategy</td><td>Case 1</td><td>• Start Test : Monitors the difference between max and min IAT in order to detect movement in IAT for a certain time.</td><td rowspan="6">• Faulty IATS</td></tr>
<tr><td>Case 2</td><td>• Drive test : Performs the max and min delta check while driving under load for a length of time followed by an idle for a certain time.</td></tr>
<tr><td colspan="2">Enable Conditions</td><td>• Engine soaked time > 360min
• Engine Running State
• No fault present
• IAT stored previous trip
• No IAT Tests pending</td></tr>
<tr><td colspan="2">Threshold value</td><td>• Max IAT - Min IAT ≤ 3°C(5.4 °F)</td></tr>
<tr><td colspan="2">Diagnosis Time</td><td>• Continuous (10 min.)</td></tr>
<tr><td colspan="2">MIL On Condition</td><td>• 2 Driving Cycles</td></tr>
</table>

Specification

Temp. (°C)	Resistance (kΩ)	Temp. (°C)	Resistance (kΩ)
-40 (-40°F)	95.95 ~ 105.78	20 (68°F)	3.42 ~ 3.61
-20 (-4°F)	27.4 ~ 29.77	40 (104°F)	1.43 ~ 1.5
0 (32°F)	9.08 ~ 9.72	60 (140°F)	0.66 ~ 0.69
10 (50°F)	5.49 ~ 5.83	80 (176°F)	0.33 ~ 0.34

Diagnostic Circuit Diagram



Signal Waveform & Data

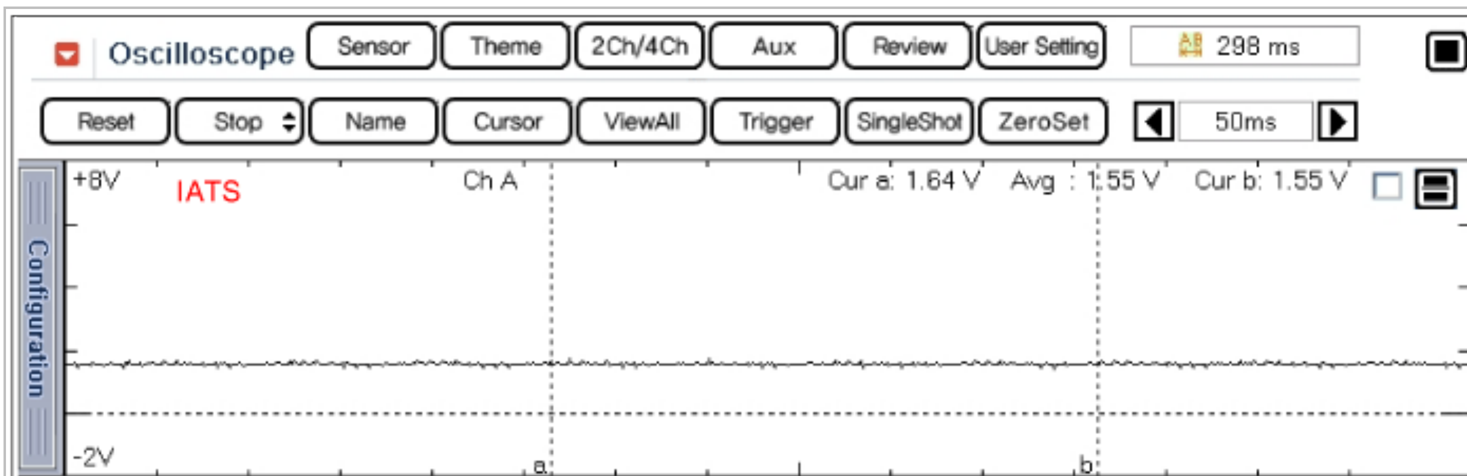
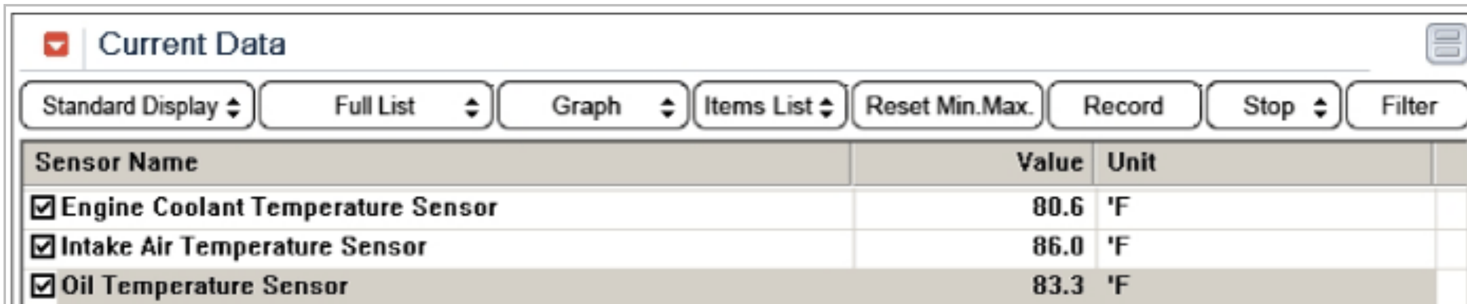


Fig.1



Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	80.6	'F
☑ Intake Air Temperature Sensor	86.0	'F
☑ Oil Temperature Sensor	83.3	'F

Fig.2

Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	194.0	'F
☑ Intake Air Temperature Sensor	106.3	'F
☑ Oil Temperature Sensor	194.0	'F

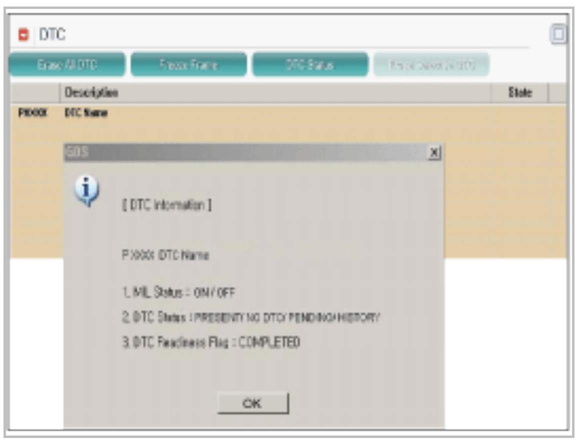
Fig.3

Fig.1) Normal waveform of IATS at 43°C (109°F)
Fig.2) Normal data of IATS & ECTS & EOTS at ig on
Fig.3) Normal data of IATS & ECTS & EOTS after warming up.
Fig.4) Abnormal data of IATS at open condition.

The output signals of IATS & ECTS change smoothly without any rapid changes. Those have almost same characteristic signal during the early period after start. It means that the temperatures of intake air and engine coolant are depended on the temperature of atmosphere. Meanwhile, during the warming up, the output signal of ECTS is going up increasingly. but, the output signal of IATS changes a little bit. even it may not change almost. It means that the heat of engine does not affect on the temperature of intake air.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Fault is intermittent caused by ECM memory was not cleared after repair. Erase DTC and drive the vehicle to satisfy the enable codition then, go to "Component Inspection" procedure.

Component Inspection

■ Check IATS resistance

1. IG "OFF" and disconnect IATS connector.
2. Measure resistance between signal and ground terminals of IATS connector after checking out the temperature of IATS with GDS (Component Side)
   Specification :

Temp. (°C)	Resistance (kΩ)
-40(-40°F)	95.95 ~ 105.78
-20(-4°F)	27.4 ~ 29.77
0 (32°F)	9.08 ~ 9.72
10 (50°F)	5.49 ~ 5.83
20 (68°F)	3.42 ~ 3.61
40 (104°F)	1.43 ~ 1.5
60 (140°F)	0.66 ~ 0.69
80 (176°F)	0.33 ~ 0.34

3. Is the measured resistance within specification ?

YES	▶ Go to "Verification of Vehicle Repair" procedure.
NO	▶ Substitute with a known - good IATS and check for proper operation. If the problem is corrected, replace IATS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

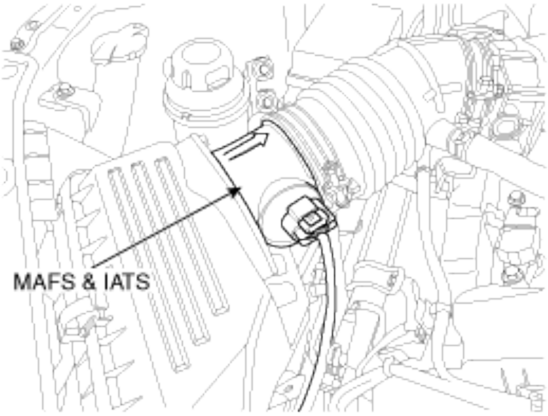
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0111 Intake Air Temperature Sensor 1 Circuit Range / Performance

Component Location



General Description

The Intake Air Temperature Sensor (IATS) is installed into the Mass Air Flow Sensor (MAFS). The IATS uses a thermistor whose resistance changes with the temperature. The electrical resistance of the IATS decreases as the temperature increases, and increases as the temperature decreases. The 5 V power source in the ECM is supplied to the IATS via a resistor in the ECM. That is, the resistor in the ECM and the thermistor in the IATS are connected in series. When the resistance value of the thermistor in IATS changes according to the intake air temperature, the signal voltage also changes. Using this signal, the information of the intake air temperature, the ECM corrects basic fuel injection duration and ignition timing.

DTC Description

ECM monitors temperature changes resulting from soaking the vehicle. Therefore, Coolant temperature and Intake temperature should be changed. If ECM detects intake air temperature correlated to coolant temperature does not change ECM determines that a fault exists and a DTC is stored. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

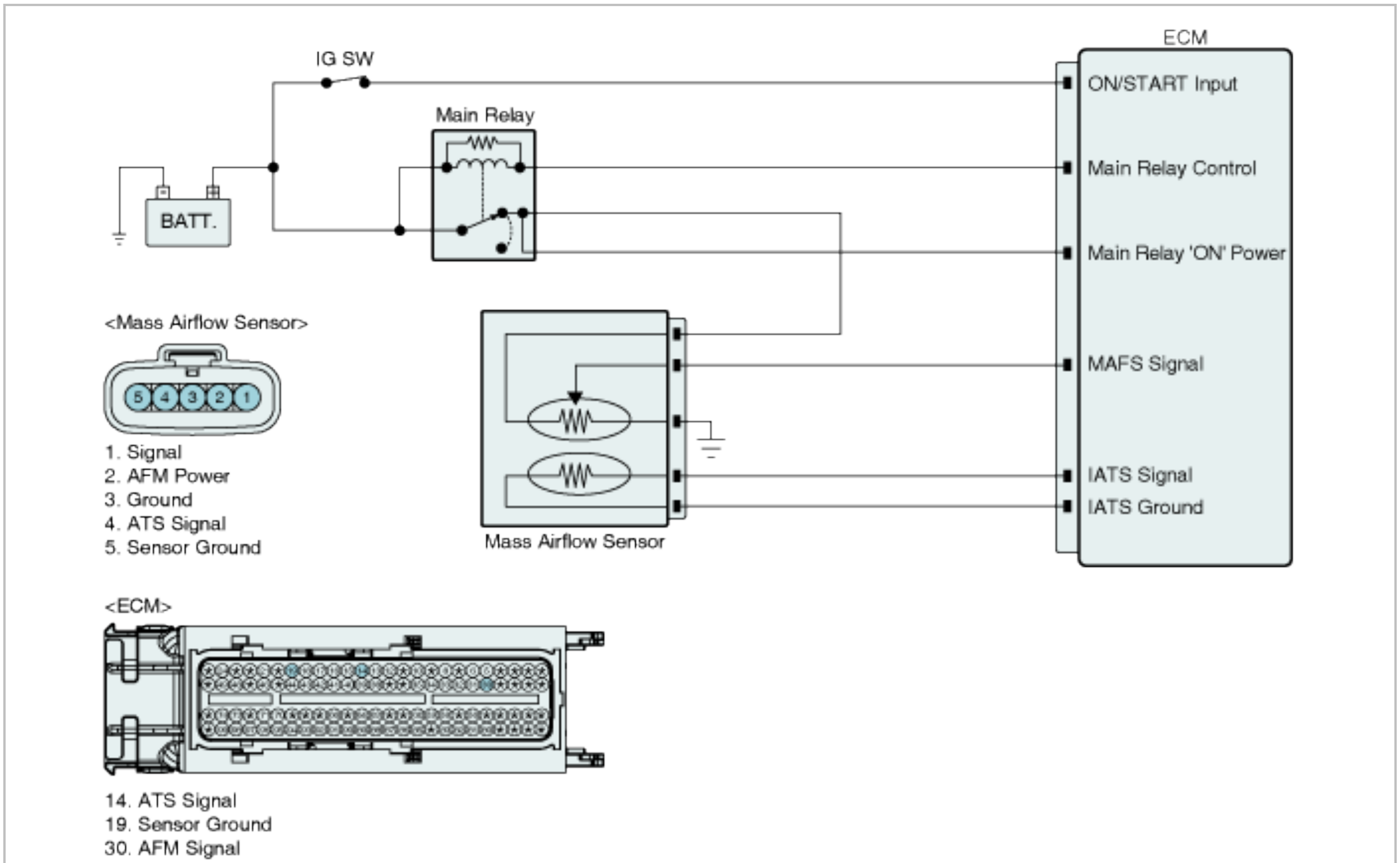
Item		Detecting Condition	Possible Cause
DTC Strategy	Case 1	• Monitors the difference between the startup coolant and IAT values	• IATS
	Case 2	• Monitors the difference between the startup IAT and coolant values	
Enable Conditions	Case 1	• Engine soaked time ≥ 360min • Engine running state • No faults present • IAT stored previous trip • Startup Coolant Temperature > -20°C • Airflow > 15 g/s • Vehicle speed > 40kph	
	Case 2	• Engine soaked time ≥ 360min • Engine running state • No faults present • IAT stored previous trip • Airflow > 15 g/s	

		• Vehicle speed > 40kph
Threshold value	Case 1	• Startup Coolant - Startup IAT ≥ 22°C
	Case 2	• Startup IAT - Startup Coolant ≥ 17°C
Diagnosis Time		• Continuous (More than 1.25 second failure)
MIL On Condition		• 2 Driving Cycles

Specification

Temp. (°C)	Resistance (kΩ)	Temp. (°C)	Resistance (kΩ)
-40 (-40°F)	95.95 ~ 105.78	20 (68°F)	3.42 ~ 3.61
-20 (-4°F)	27.4 ~ 29.77	40 (104°F)	1.43 ~ 1.5
0 (32°F)	9.08 ~ 9.72	60 (140°F)	0.66 ~ 0.69
10 (50°F)	5.49 ~ 5.83	80 (176°F)	0.33 ~ 0.34

Diagnostic Circuit Diagram



Signal Waveform & Data

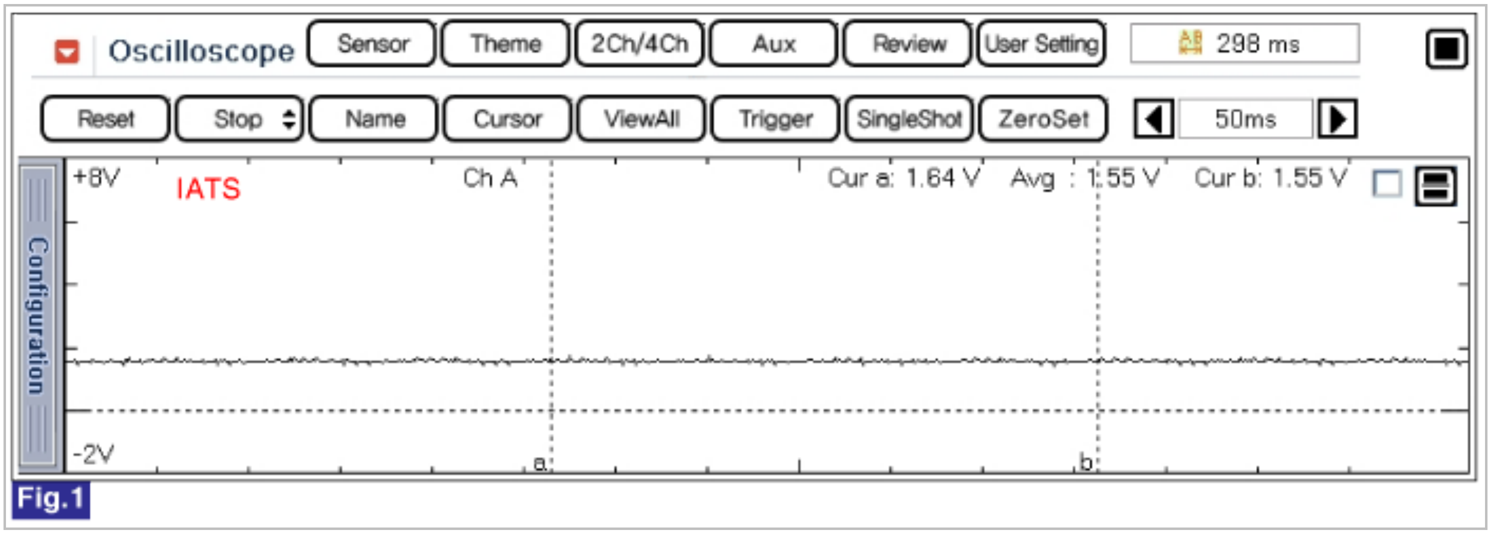


Fig.1

Current Data

Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	80.6	'F
☑ Intake Air Temperature Sensor	86.0	'F
☑ Oil Temperature Sensor	83.3	'F

Fig.2

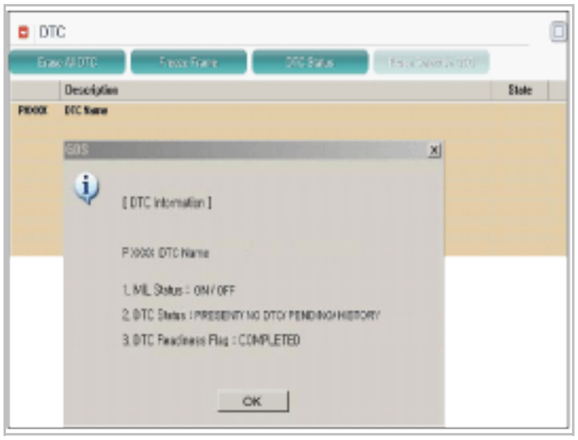
Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	194.0	'F
☑ Intake Air Temperature Sensor	106.3	'F
☑ Oil Temperature Sensor	194.0	'F

Fig.3

Fig.1) Normal waveform of IATS at 43°C (109°F)
Fig.2) Normal data of IATS & ECTS & EOTS at ig on
Fig.3) Normal data of IATS & ECTS & EOTS after warming up.
Fig.4) Abnormal data of IATS at open condition.
The output signals of IATS & ECTS change smoothly without any rapid changes. Those have almost same characteristic signal during the early period after start. It means that the temperatures of intake air and engine coolant are depended on the temperature of atmosphere. Meanwhile, during the warming up, the output signal of ECTS is going up increasingly. but, the output signal of IATS changes a little bit. even it may not change almost. It means that the heat of engine does not affect on the temperature of intake air.

MonitorGDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Fault is intermittent caused by ECM memory was not cleared after repair. Erase DTC and drive the vehicle to satisfy the enable codition then, go to "Component Inspection" procedure.

Component Inspection

■ Check IATS resistance

1. IG "OFF" and disconnect IATS connector.
2. Measure resistance between signal and ground terminals of IATS connector after checking out the temperature of IATS with GDS (Component Side)
   Specification :

Temp. (°C)	Resistance (kΩ)
-40(-40°F)	95.95 ~ 105.78
-20(-4°F)	27.4 ~ 29.77
0 (32°F)	9.08 ~ 9.72
10 (50°F)	5.49 ~ 5.83
20 (68°F)	3.42 ~ 3.61
40 (104°F)	1.43 ~ 1.5
60 (140°F)	0.66 ~ 0.69
80 (176°F)	0.33 ~ 0.34

3. Is the measured resistance within specification ?

YES	▶ Go to "Verification of Vehicle Repair" procedure.
NO	▶ Substitute with a known - good IATS and check for proper operation. If the problem is corrected, replace IATS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

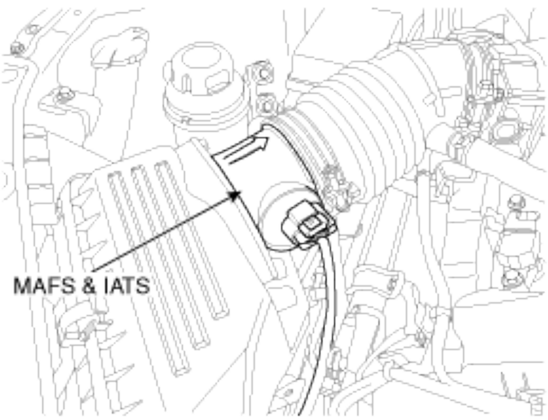
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0112 Intake Air Temperature Sensor 1 Circuit Low Input

Component Location



General Description

The Intake Air Temperature Sensor (IATS) is installed into the Mass Air Flow Sensor (MAFS). The IATS uses a thermistor whose resistance changes with the temperature. The electrical resistance of the IATS decreases as the temperature increases, and increases as the temperature decreases. The 5 V power source in the ECM is supplied to the IATS via a resistor in the ECM. That is, the resistor in the ECM and the thermistor in the IATS are connected in series. When the resistance value of the thermistor in IATS changes according to the intake air temperature, the signal voltage also changes. Using this signal, the information of the intake air temperature, the ECM corrects basic fuel injection duration and ignition timing.

DTC Description

Checking output signals of IATS every 20 sec. under detecting condition, if an ouput signal is below 0.1V for more than 10 sec., ECM sets P0112. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

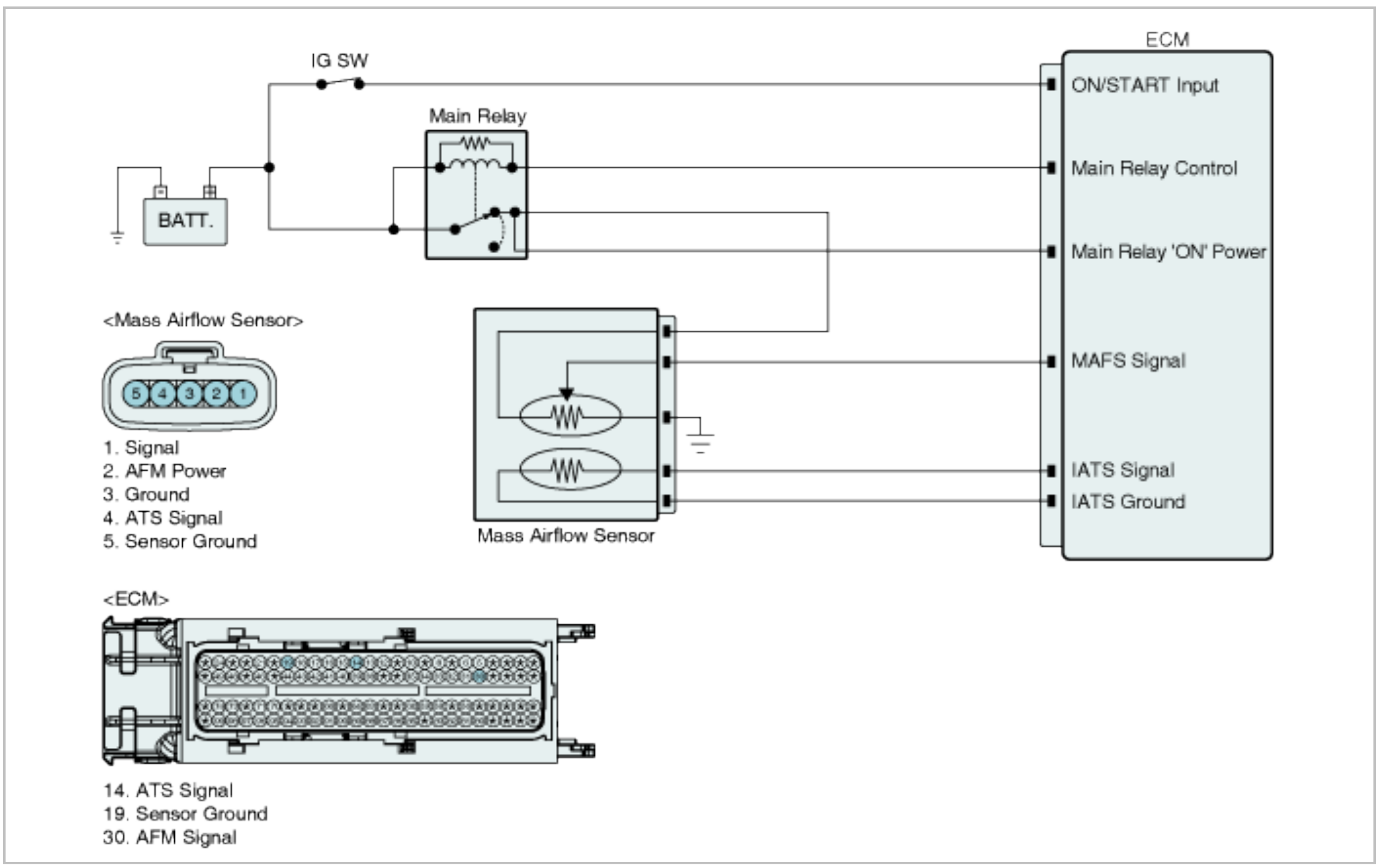
Item	Detecting Condition	Possible Cause
DTC Strategy	• This code detects a continuous short to ground in either the signal circuit or the sensor	

Enable Conditions	Case 1	• Engine running state • No Vehicle speed sensor fault • Vehicle speed > 50kph(30mph)	• Poor connection • Short to ground in harness • IATS • ECM
	Case 2	• Engine running time >120 sec • Time from IG "OFF" to IG "ON" > 360 min	
Threshold value		• Intake air temperature sensor's voltage < 0.1V	
Diagnosis Time		• Continuous (More than 10 seconds failure for every 20 seconds test)	
MIL On Condition		• 2 Driving Cycles	

Specification

Temp. (°C)	Resistance (kΩ)	Temp. (°C)	Resistance (kΩ)
-40 (-40°F)	95.95 ~ 105.78	20 (68°F)	3.42 ~ 3.61
-20 (-4°F)	27.4 ~ 29.77	40 (104°F)	1.43 ~ 1.5
0 (32°F)	9.08 ~ 9.72	60 (140°F)	0.66 ~ 0.69
10 (50°F)	5.49 ~ 5.83	80 (176°F)	0.33 ~ 0.34

Diagnostic Circuit Diagram



Signal Waveform & Data

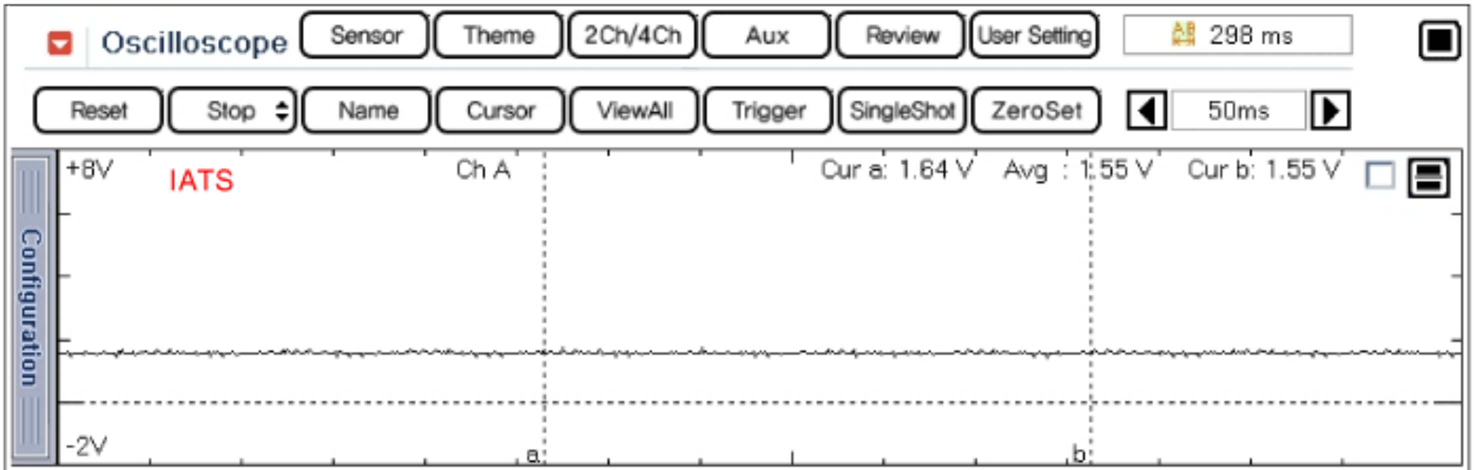


Fig.1

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | Filter

Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	80.6	'F
☑ Intake Air Temperature Sensor	86.0	'F
☑ Oil Temperature Sensor	83.3	'F

Fig.2

Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	194.0	'F
☑ Intake Air Temperature Sensor	106.3	'F
☑ Oil Temperature Sensor	194.0	'F

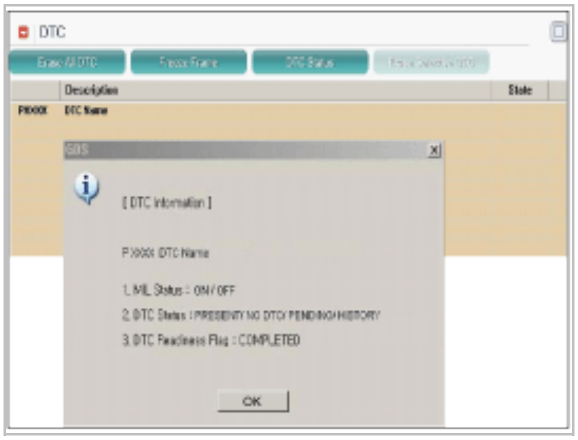
Fig.3

Fig.1) Normal waveform of IATS at 43°C (109°F)
Fig.2) Normal data of IATS & ECTS & EOTS at ig on
Fig.3) Normal data of IATS & ECTS & EOTS after warming up.
Fig.4) Abnormal data of IATS at open condition.

The output signals of IATS & ECTS change smoothly without any rapid changes. Those have almost same characteristic signal during the early period after start. It means that the temperatures of intake air and engine coolant are depended on the temperature of atmosphere. Meanwhile, during the warming up, the output signal of ECTS is going up increasingly. but, the output signal of IATS changes a little bit. even it may not change almost. It means that the heat of engine does not affect on the temperature of intake air.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor’s and/or ECM’s connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Signal Circuit Inspection" procedure.

Signal Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect IATS connector.
2. IG "ON"
3. Measure voltage between signal terminal of IATS harness connector and chassis ground.

Specification : Approx. 3.2V

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Go to "Check short to ground in harness" procedure.

■ Check short to ground in harness

1. IG "OFF" and disconnect IATS connector and ECM connector.

2. Measure resistance between signal terminal of IATS harness connector and chassis ground.(Measurement "A")
3. Measure resistance between signal and ground terminals of IATS harness connector.(Measurement "B")
4. Measure resistance between signal terminal of IATS harness connector and ground terminal of MAFS harness connector.(Measurement "B")

Specification : Infinite

5. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to ground in harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check IATS resistance

1. IG "OFF" and disconnect IATS connector.
2. Measure resistance between signal and ground terminals of IATS connector after checking out the temperature of IATS with GDS (Component Side)
Specification :

Temp. (°C)	Resistance (kΩ)
-40(-40°F)	95.95 ~ 105.78
-20(-4°F)	27.4 ~ 29.77
0 (32°F)	9.08 ~ 9.72
10 (50°F)	5.49 ~ 5.83
20 (68°F)	3.42 ~ 3.61
40 (104°F)	1.43 ~ 1.5
60 (140°F)	0.66 ~ 0.69
80 (176°F)	0.33 ~ 0.34

3. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good IATS and check for proper operation. If the problem is corrected, replace IATS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

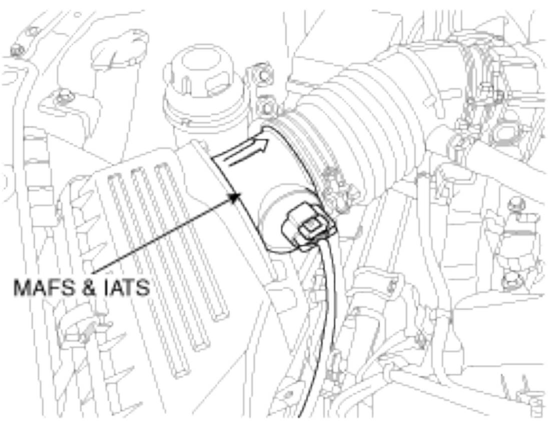
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0113 Intake Air Temperature Sensor 1 Circuit High Input

Component Location



General Description

The Intake Air Temperature Sensor (IATS) is installed into the Mass Air Flow Sensor (MAFS). The IATS uses a thermistor whose resistance changes with the temperature. The electrical resistance of the IATS decreases as the temperature increases, and increases as the temperature decreases. The 5 V power source in the ECM is supplied to the IATS via a resistor in the ECM. That is, the resistor in the ECM and the thermistor in the IATS are connected in series. When the resistance value of the thermistor in IATS changes according to the intake air temperature, the signal voltage also changes. Using this signal, the information of the intake air temperature, the ECM corrects basic fuel injection duration and ignition timing.

DTC Description

Checking output signals of IATS every 20 sec. under detecting condition, if an ouput signal is over 4.9V for more than 10 sec., ECM sets P0113. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

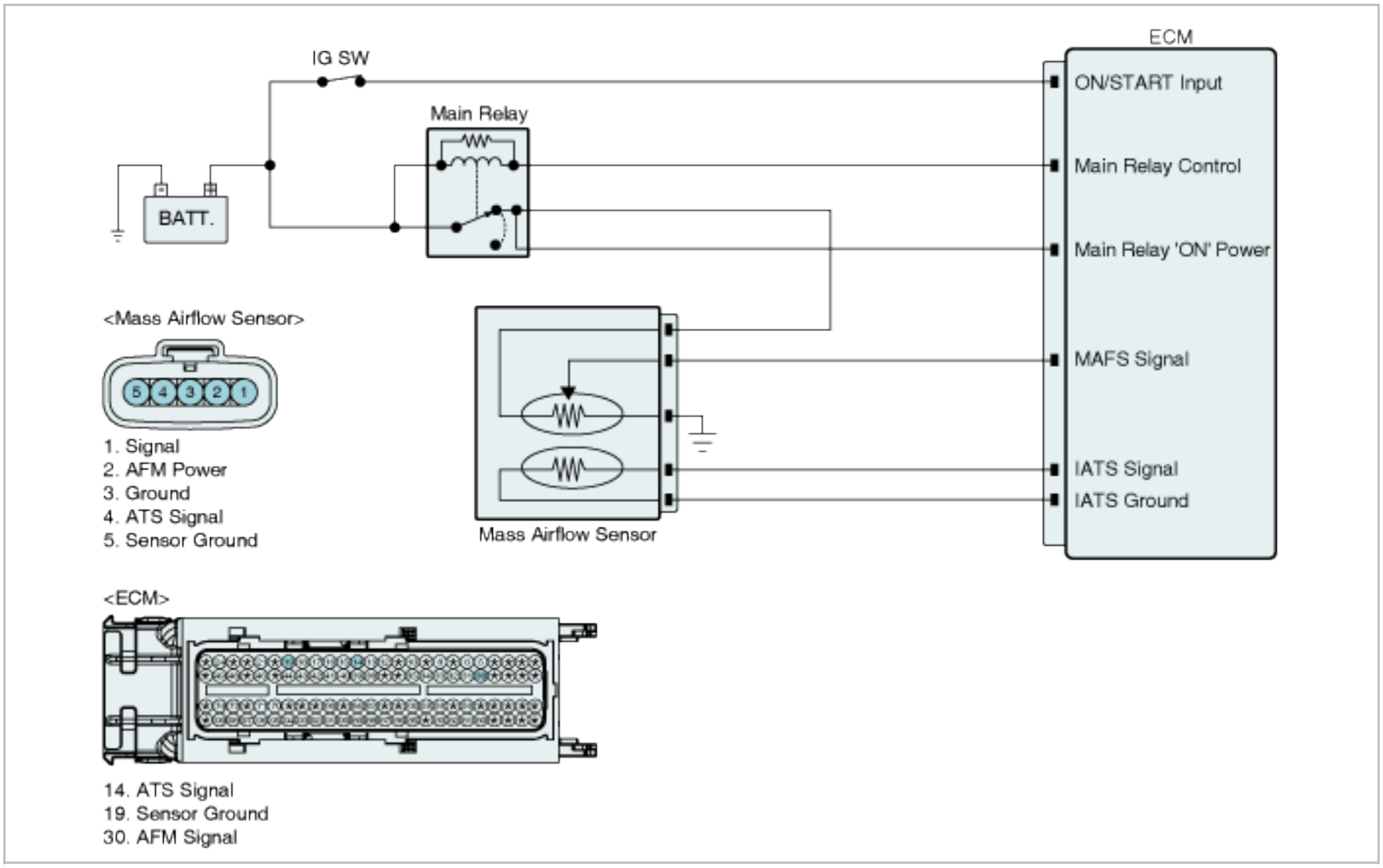
Item	Detecting Condition	Possible Cause

<table>
<tr><td>DTC Strategy</td><td>• This code detects a continuous short to high in either the signal circuit or the sensor</td><td rowspan="5">• Connecting condition
• Open or short to battery in harness
• Open in ground harness
• IATS
• ECM</td></tr>
<tr><td>Enable Conditions</td><td>• Engine running state
• No Vehicle speed sensor fault
• No ECTS fault
• No MAFS fault
• Intake airflow < 15 g/s
• Vehicle speed < 25kph(9.3mph)
• Engine coolant temperature > 50°C(122°F)</td></tr>
<tr><td>Threshold value</td><td>• Intake air temperature sensor's voltage > 4.9V</td></tr>
<tr><td>Diagnosis Time</td><td>• Continuous (More than 10 seconds failure for every 20 seconds test)</td></tr>
<tr><td>MIL On Condition</td><td>• 2 Driving Cycles</td></tr>
</table>

Specification

Temp. (°C)	Resistance (kΩ)	Temp. (°C)	Resistance (kΩ)
-40 (-40°F)	95.95 ~ 105.78	20 (68°F)	3.42 ~ 3.61
-20 (-4°F)	27.4 ~ 29.77	40 (104°F)	1.43 ~ 1.5
0 (32°F)	9.08 ~ 9.72	60 (140°F)	0.66 ~ 0.69
10 (50°F)	5.49 ~ 5.83	80 (176°F)	0.33 ~ 0.34

Diagnostic Circuit Diagram



Signal Waveform & Data

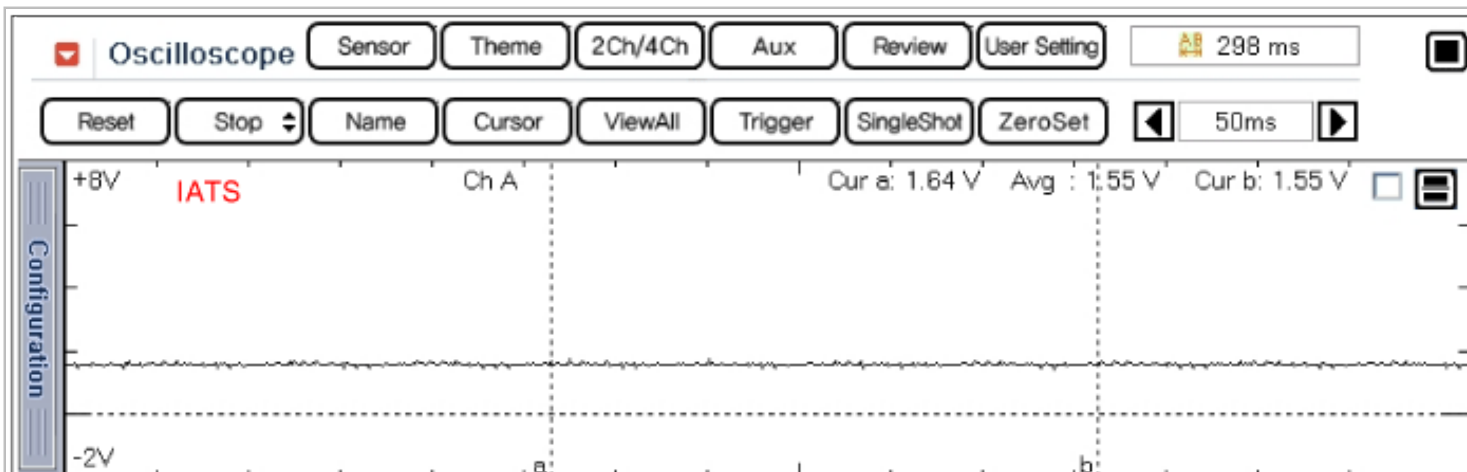
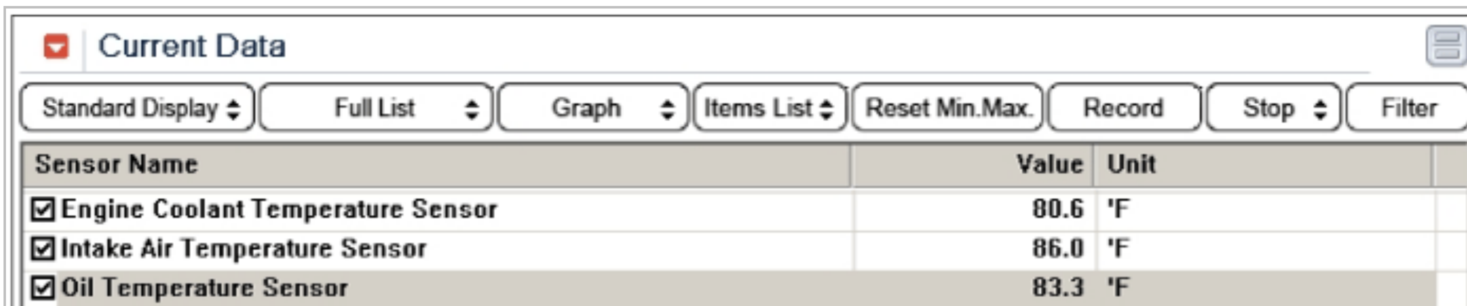
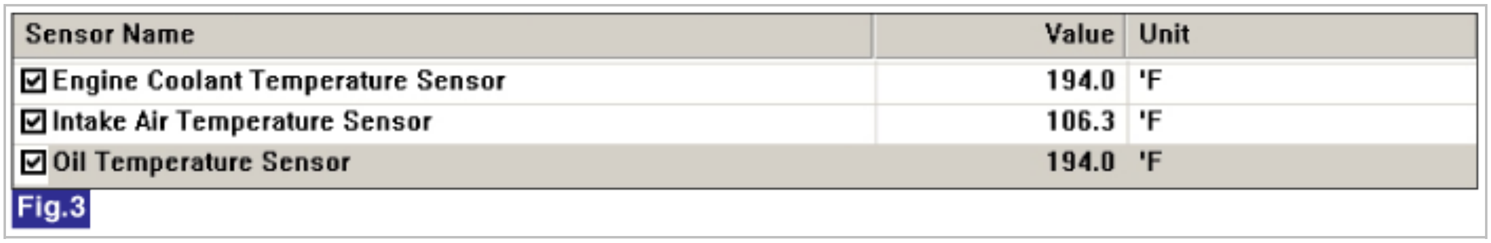


Fig.1



Sensor Name	Value	Unit
Engine Coolant Temperature Sensor	80.6	'F
Intake Air Temperature Sensor	86.0	'F
Oil Temperature Sensor	83.3	'F

Fig.2



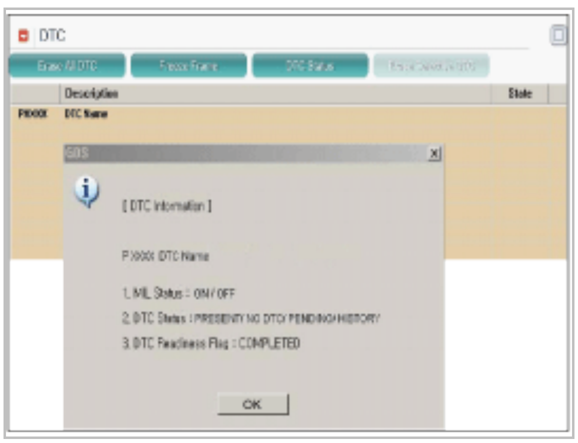
Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	194.0	'F
☑ Intake Air Temperature Sensor	106.3	'F
☑ Oil Temperature Sensor	194.0	'F

Fig.3

Fig.1) Normal waveform of IATS at 43°C (109°F)
Fig.2) Normal data of IATS & ECTS & EOTS at ig on
Fig.3) Normal data of IATS & ECTS & EOTS after warming up.
Fig.4) Abnormal data of IATS at open condition.
The output signals of IATS & ECTS change smoothly without any rapid changes. Those have almost same characteristic signal during the early period after start. It means that the temperatures of intake air and engine coolant are depended on the temperature of atmosphere. Meanwhile, during the warming up, the output signal of ECTS is going up increasingly. but, the output signal of IATS changes a little bit. even it may not change almost. It means that the heat of engine does not affect on the temperature of intake air.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.

3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Signal Circuit Inspection" procedure.

Signal Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect IATS connector.
2. IG "ON"
3. Measure voltage between signal terminal of IATS harness connector and chassis ground.

Specification : Approx. 3.2V

4. Is the measured voltage within specification ?

YES	▶ Go to "Ground Circuit Inspection" procedure.
NO	▶ If the voltage is 0V, go to "Check open in harness" as follows. If the voltage is more than 5.1V, go to "Check short to battery in harness" as follows.

■ Check short to battery in harness

1. IG "OFF" and disconnect IATS connector and ECM connector.
2. Measure resistance between signal terminal of IATS harness connector and power terminal of MAFS harness connector.
3. Measure resistance between signal terminal of IATS harness connector and signal terminal of MAFS harness connector.

Specification : Infinite

4. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to battery in harness and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect IATS connector and ECM connector.
2. Measure resistance between signal terminal of IATS harness connector and IATS signal terminal of ECM harness connector.

Specification : below 1Ω

3. Is the measured resistance within specification ?

YES	▶ Go to "Ground Circuit Inspection" procedure.
NO	▶ Repair open in harness and go to "Verification of Vehicle Repair" procedure.

Ground Circuit Inspection

■ Check open in harness

1. IG "OFF" and disconnect IATS connector and then IG "ON".
2. Measure voltage between signal terminal of IATS harness connector and chassis ground.(Measurement "A")
3. Measure voltage between signal and ground terminals of IATS harness connector.(Measurement "B")

Specification : Voltage difference between measurement "A" and "B" is below 200mV.

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair contact resistance or open in harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check IATS resistance

1. IG "OFF" and disconnect IATS connector.
2. Measure resistance between signal and ground terminals of IATS connector after checking out the temperature of IATS with GDS (Component Side)
   Specification :

Temp. (°C)	Resistance (kΩ)
-40(-40°F)	95.95 ~ 105.78
-20(-4°F)	27.4 ~ 29.77
0 (32°F)	9.08 ~ 9.72
10 (50°F)	5.49 ~ 5.83
20 (68°F)	3.42 ~ 3.61
40 (104°F)	1.43 ~ 1.5
60 (140°F)	0.66 ~ 0.69
80 (176°F)	0.33 ~ 0.34

3. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good IATS and check for proper operation. If the problem is corrected, replace IATS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

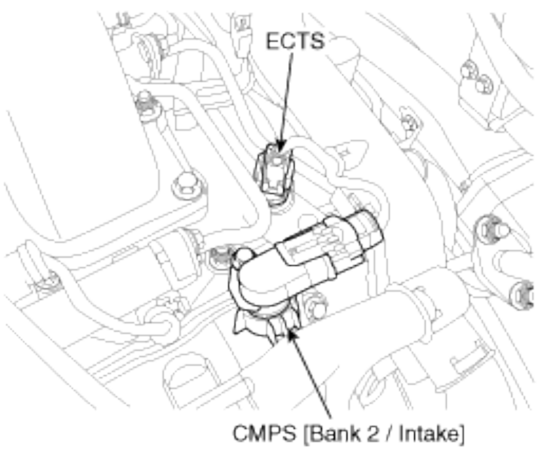
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0115 Engine Coolant Temperature Circuit

Component Location



General Description

The Engine Coolant Temperature Sensor (ECTS) is located in the engine coolant passage of the cylinder head for detecting the engine coolant temperature. The ECTS uses a thermistor whose resistance changes with the temperature. The electrical resistance of the ECTS decreases as the temperature increases, and increases as the temperature decreases. The reference 5 V in the ECM is supplied to the ECTS via a resistor in the ECM. That is, the resistor in the ECM and the thermistor in the ECTS are connected in series. When the resistance value of the thermistor in the ECTS changes according to the engine coolant temperature, the output voltage also changes. During cold engine operation the ECM increases the fuel injection duration and controls the ignition timing using the information of engine coolant temperature to avoid engine stalling and improve drivability.

DTC Description

Checking the engine coolant temperature under detecting condition, if the difference between its current temperature and startup temperature is less than threshold value over predeterminated period, ECM sets P0115. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

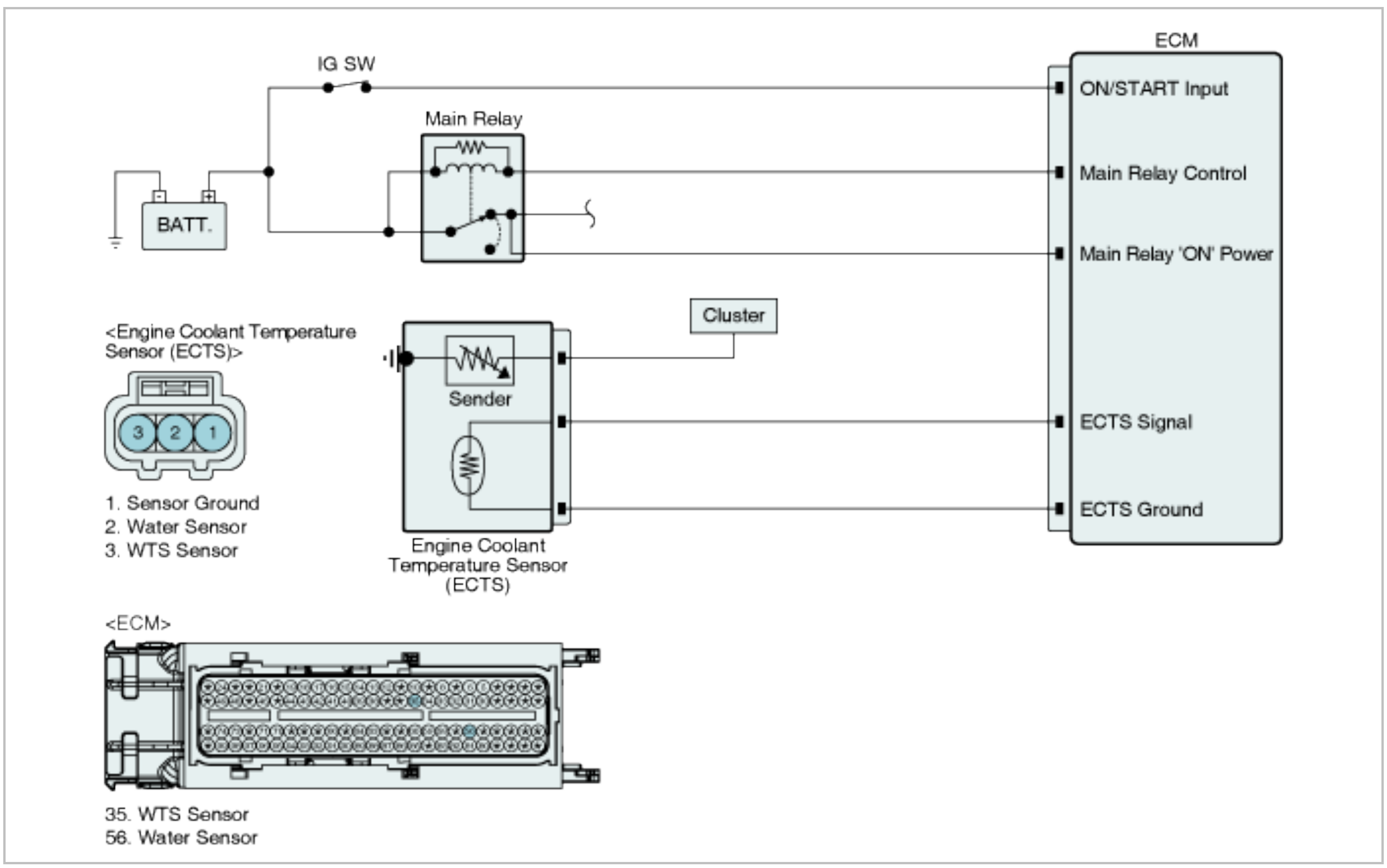
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Monitor the engine coolant temperature	• ECTS
Enable Conditions	• Engine running state • Before startup, leave it under IG-OFF over 6 hours • No disabling faults(DTCs related to HO2S, MAFS/MAPS, catalyst, fuel system, ECTS, or misfire)	
Threshold value	• The difference between the current its temperature and the startup temperature < 3 °C(5.4°F)	
Diagnosis Time	• Once per driving cycle (More than 120 seconds failure)	
MIL On Condition	• 2 Driving Cycles	

Specification

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

Diagnostic Circuit Diagram



Signal Waveform & Data

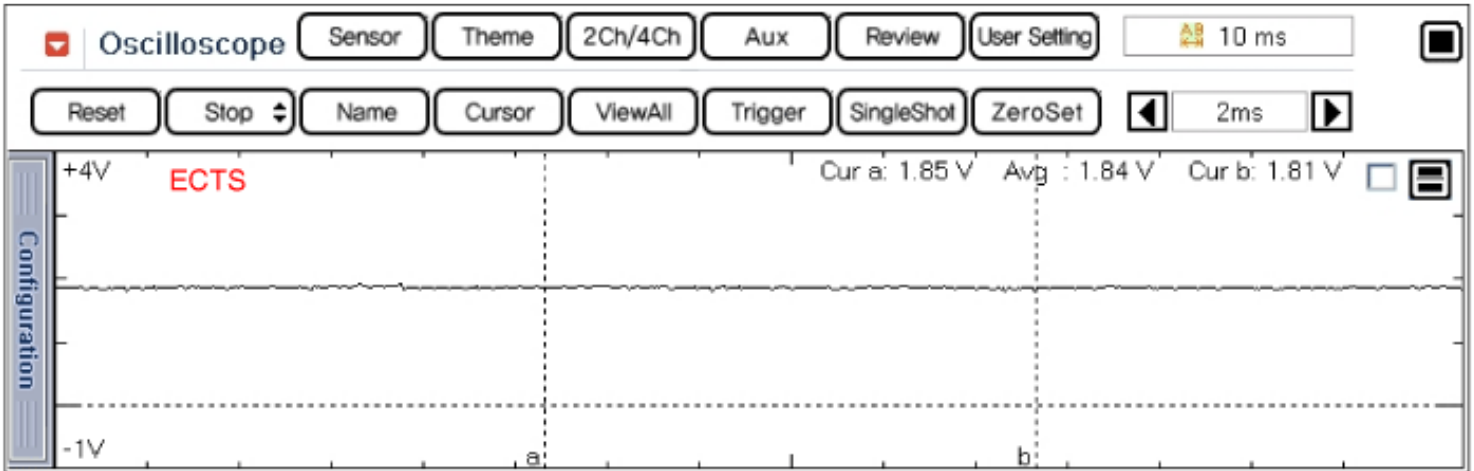
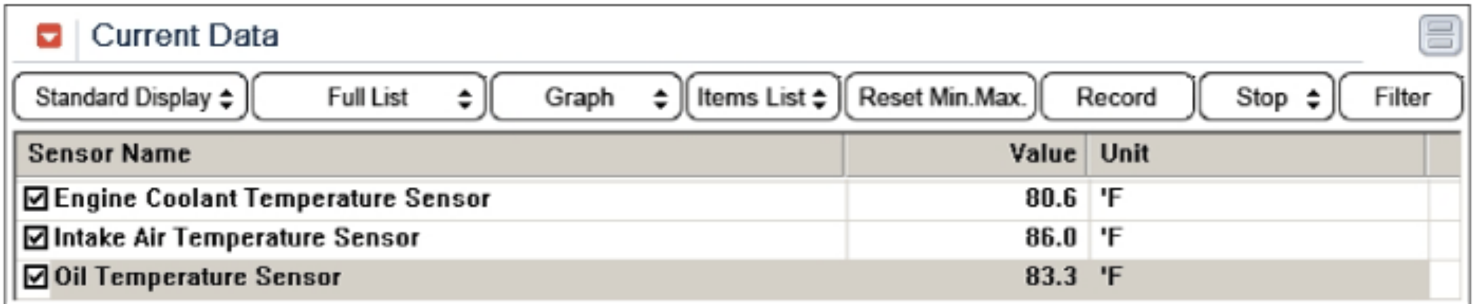


Fig.1



Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	80.6	'F
☑ Intake Air Temperature Sensor	86.0	'F
☑ Oil Temperature Sensor	83.3	'F

Fig.2

Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	194.0	'F
☑ Intake Air Temperature Sensor	106.3	'F
☑ Oil Temperature Sensor	194.0	'F

Fig.3

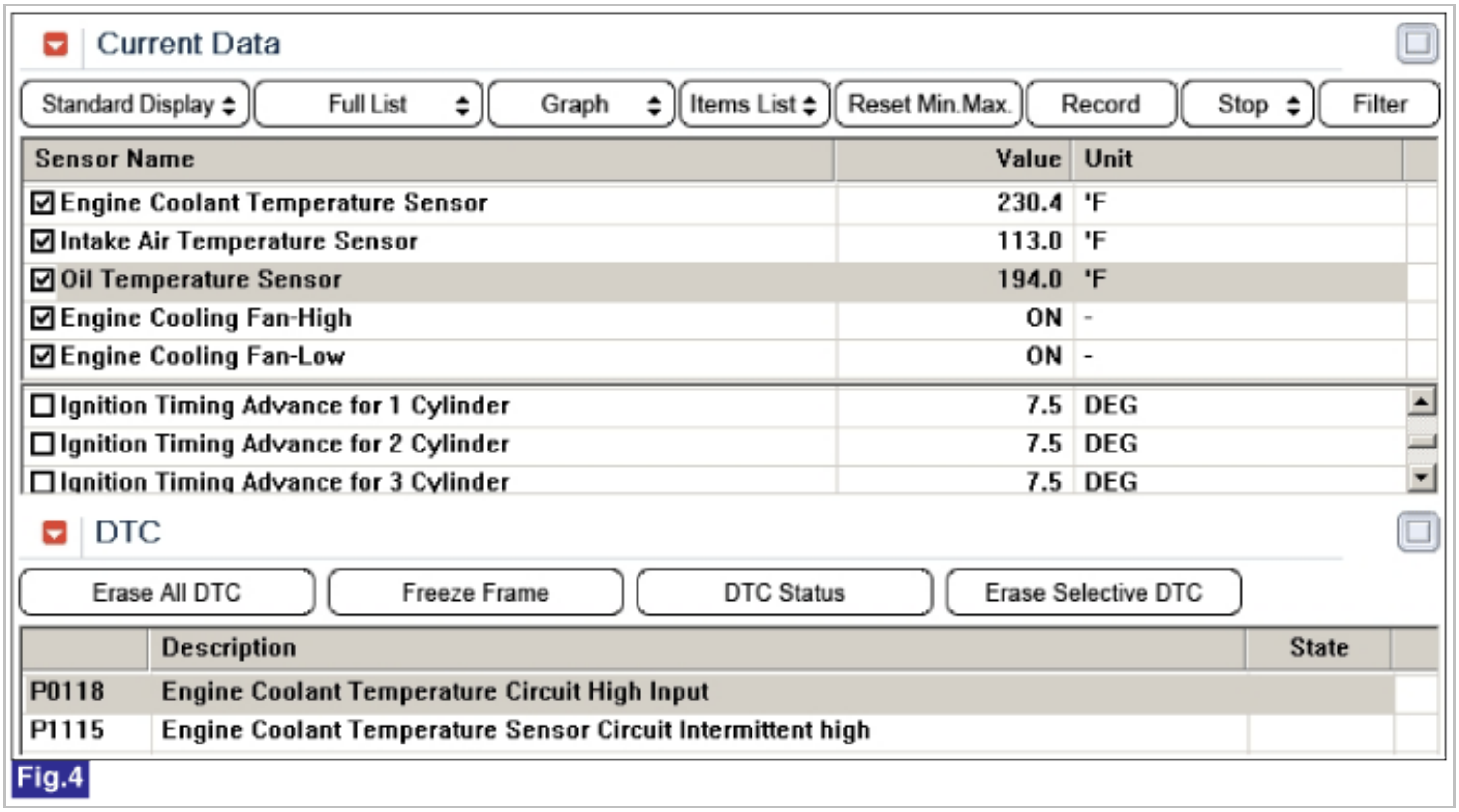
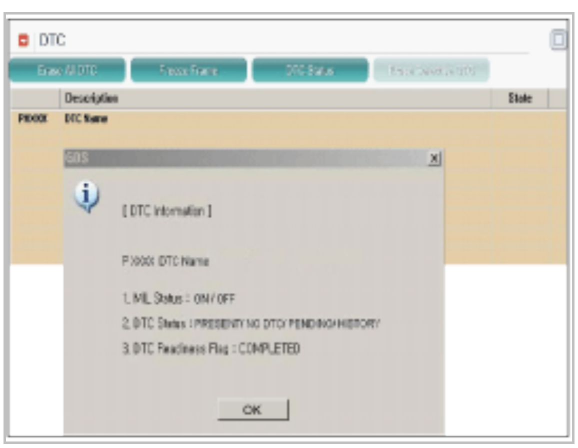


Fig.1) Normal waveform of IATS at 90°C (194°F)
Fig. 2) Normal data of IATS & ECTS & EOTS at ig on
Fig. 3) Normal data of IATS & ECTS & EOTS after warming up.
Fig.4) Abnormal data of IATS at open condition.
The output signals of IATS & ECTS change smoothly without any rapid changes. Those have almost same characteristic signal during the early period after start. It means that the temperatures of intake air and engine coolant are depended on the temperature of atmosphere. Meanwhile, during the warming up, the output signal of ECTS is going up increasingly. but, the output signal of IATS changes a little bit. even it may not change almost. It means that the heat of engine does not affect on the temperature of intake air.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Fault is intermittent, go to "Verification of vehicle Repair" procedure.

Component Inspection

■ Check ECTS resistance

1. IG "OFF" and disconnect ECTS connector.
2. Measure resistance between signal and ground terminals of ECTS connector after checking out the temperature of ECTS with GDS (Component Side)
   Specification :

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

3. Is the measured resistance within specification ?

YES	▶ Clear DTC and Test-drive under enable conditions above-mentioned. After the test, If this DTC is set, recheck it thoroughly. If not, it is intermittent fault, go to "Verification of vehicle Repair" procedure.
NO	▶ Substitute with a known - good ECTS and check for proper operation. If the problem is corrected, Go to "Verification of Vehicle Repair"procedure.

Verification of Vehicle Repair

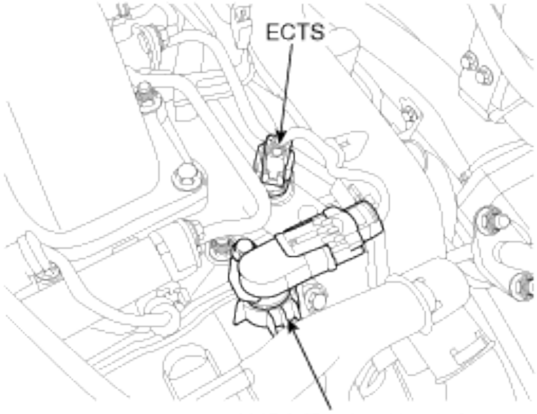
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0116 Engine Coolant Temperature Circuit Range / Performance

Component Location



General Description

The Engine Coolant Temperature Sensor (ECTS) is located in the engine coolant passage of the cylinder head for detecting the engine coolant temperature. The ECTS uses a thermistor whose resistance changes with the temperature. The electrical resistance of the ECTS decreases as the temperature increases, and increases as the temperature decreases. The reference 5 V in the ECM is supplied to the ECTS via a resistor in the ECM. That is, the resistor in the ECM and the thermistor in the ECTS are connected in series. When the resistance value of the thermistor in the ECTS changes according to the engine coolant temperature, the output voltage also changes. During cold engine operation the ECM increases the fuel injection duration and controls the ignition timing using the information of engine coolant temperature to avoid engine stalling and improve drivability.

DTC Description

Checking the engine coolant temperature under detecting condition, if the engine coolant temperature's signal is temporarily stuck above the lowest enable temperature to enable other diagnostic, ECM sets P0116. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

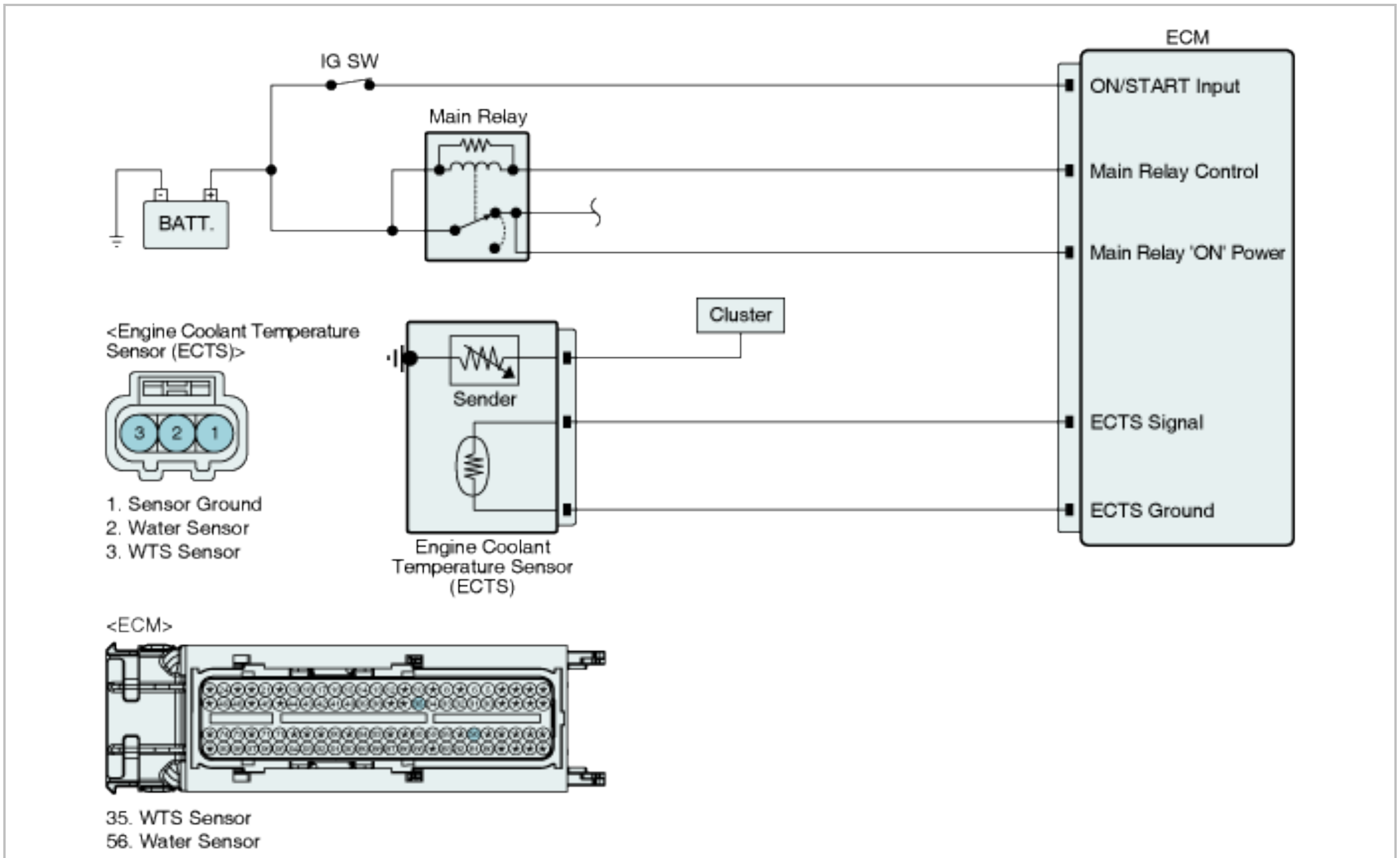
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Monitor the engine coolant temperature	• ECTS
Enable Conditions	• Shutdown time > 180 minutes • Intake air-temperature at start-up < 40°C(104°F) • No disabling faults(ECTS) • Engine running > 60 seconds • Minimum airflow is satisfied for a certain time.	
Threshold value	• When the start-up engine coolant temperature does not rise by 3 °C(5.4°F).	
Diagnosis Time	• Immediately	
MIL On Condition	• 2 Driving Cycles	

Specification

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

Diagnostic Circuit Diagram



Signal Waveform & Data

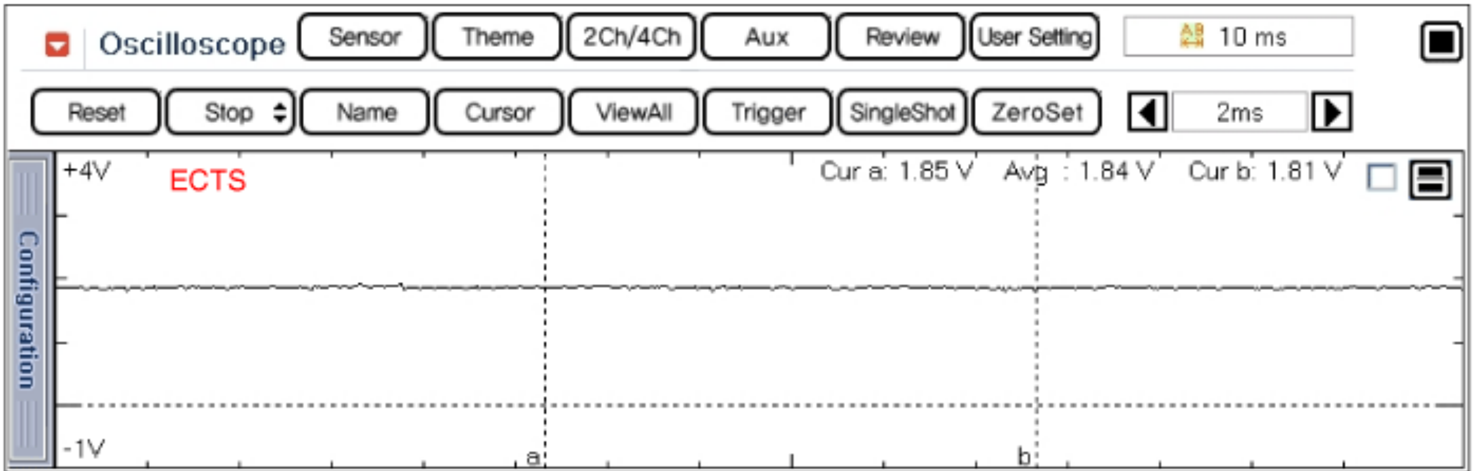


Fig.1

Current Data

Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	80.6	'F
☑ Intake Air Temperature Sensor	86.0	'F
☑ Oil Temperature Sensor	83.3	'F

Fig.2

Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	194.0	'F
☑ Intake Air Temperature Sensor	106.3	'F
☑ Oil Temperature Sensor	194.0	'F

Fig.3

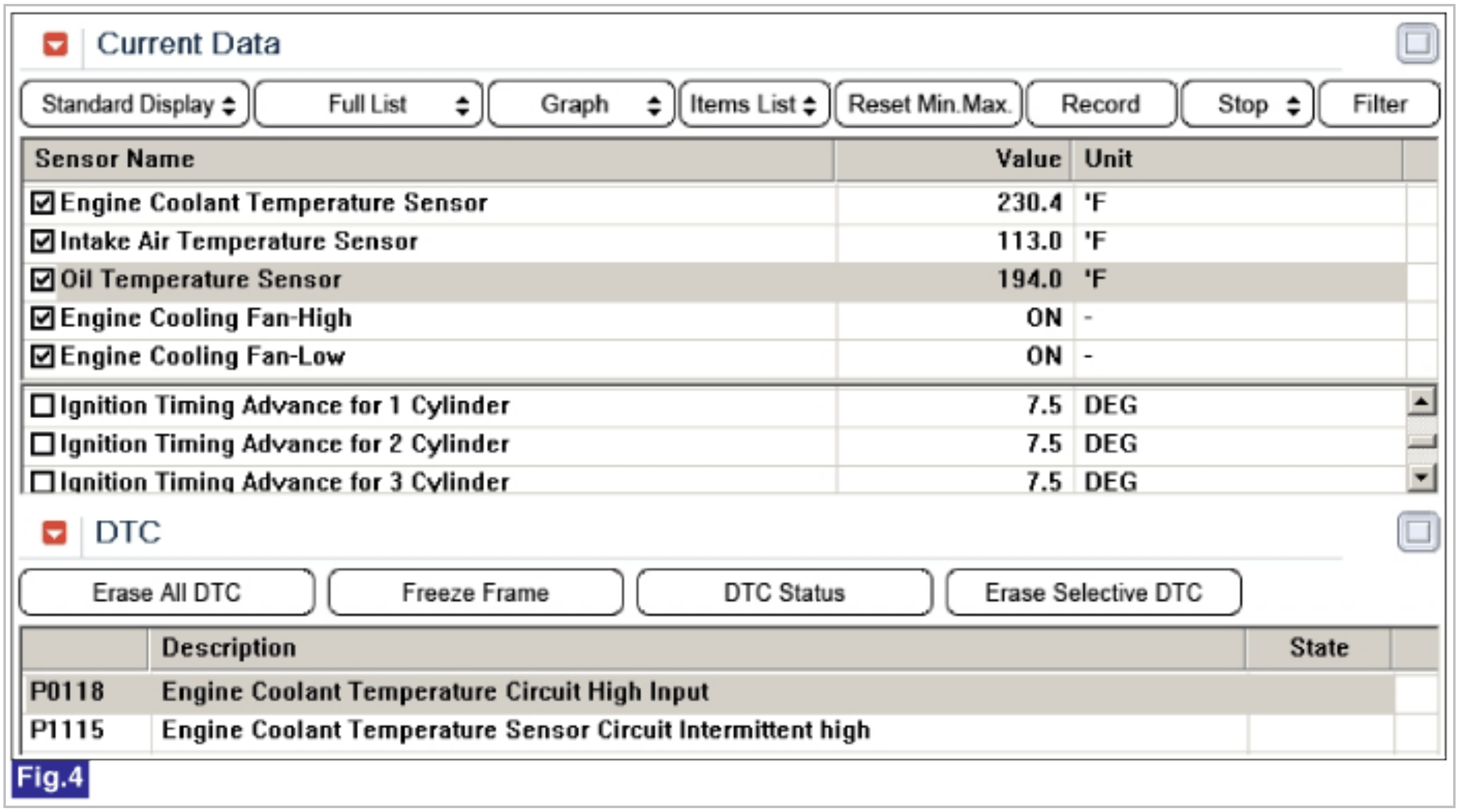
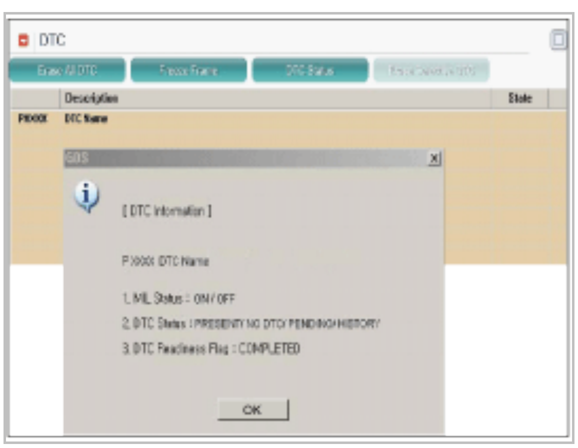


Fig.4

Fig.1) Normal waveform of IATS at 90°C (194°F)
Fig. 2) Normal data of IATS & ECTS & EOTS at ig on
Fig. 3) Normal data of IATS & ECTS & EOTS after warming up.
Fig.4) Abnormal data of IATS at open condition.
The output signals of IATS & ECTS change smoothly without any rapid changes. Those have almost same characteristic signal during the early period after start. It means that the temperatures of intake air and engine coolant are depended on the temperature of atmosphere. Meanwhile, during the warming up, the output signal of ECTS is going up increasingly. but, the output signal of IATS changes a little bit. even it may not change almost. It means that the heat of engine does not affect on the temperature of intake air.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Fault is intermittent, go to "Verification of vehicle Repair" procedure.

Component Inspection

■ Check ECTS resistance

1. IG "OFF" and disconnect ECTS connector.
2. Measure resistance between signal and ground terminals of ECTS connector after checking out the temperature of ECTS with GDS (Component Side)
   Specification :

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

3. Is the measured resistance within specification ?

YES	▶ Clear DTC and Test-drive under enable conditions above-mentioned. After the test, If this DTC is set, recheck it thoroughly. If not, it is intermittent fault, go to "Verification of vehicle Repair" procedure.
NO	▶ Substitute with a known - good ECTS and check for proper operation. If the problem is corrected, Go to "Verification of Vehicle Repair"procedure.

Verification of Vehicle Repair

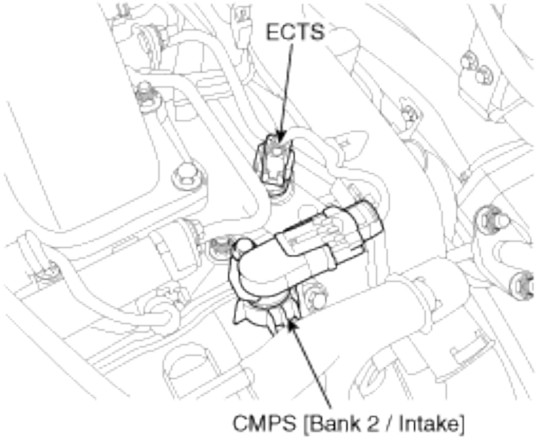
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0117 Engine Coolant Temperature Circuit Low Input

Component Location



General Description

The Engine Coolant Temperature Sensor (ECTS) is located in the engine coolant passage of the cylinder head for detecting the engine coolant temperature. The ECTS uses a thermistor whose resistance changes with the temperature. The electrical resistance of the ECTS decreases as the temperature increases, and increases as the temperature decreases. The reference 5 V in the ECM is supplied to the ECTS via a resistor in the ECM. That is, the resistor in the ECM and the thermistor in the ECTS are connected in series. When the resistance value of the thermistor in the ECTS changes according to the engine coolant temperature, the output voltage also changes. During cold engine operation the ECM increases the fuel injection duration and controls the ignition timing using the information of engine coolant temperature to avoid engine stalling and improve drivability.

DTC Description

Checking output signals from ECTS every 80 sec. under detecting condition, if an output signal is below 0.1V for morethan 40 sec., ECM sets P0117. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2driving cycle.

DTC Detecting Condition

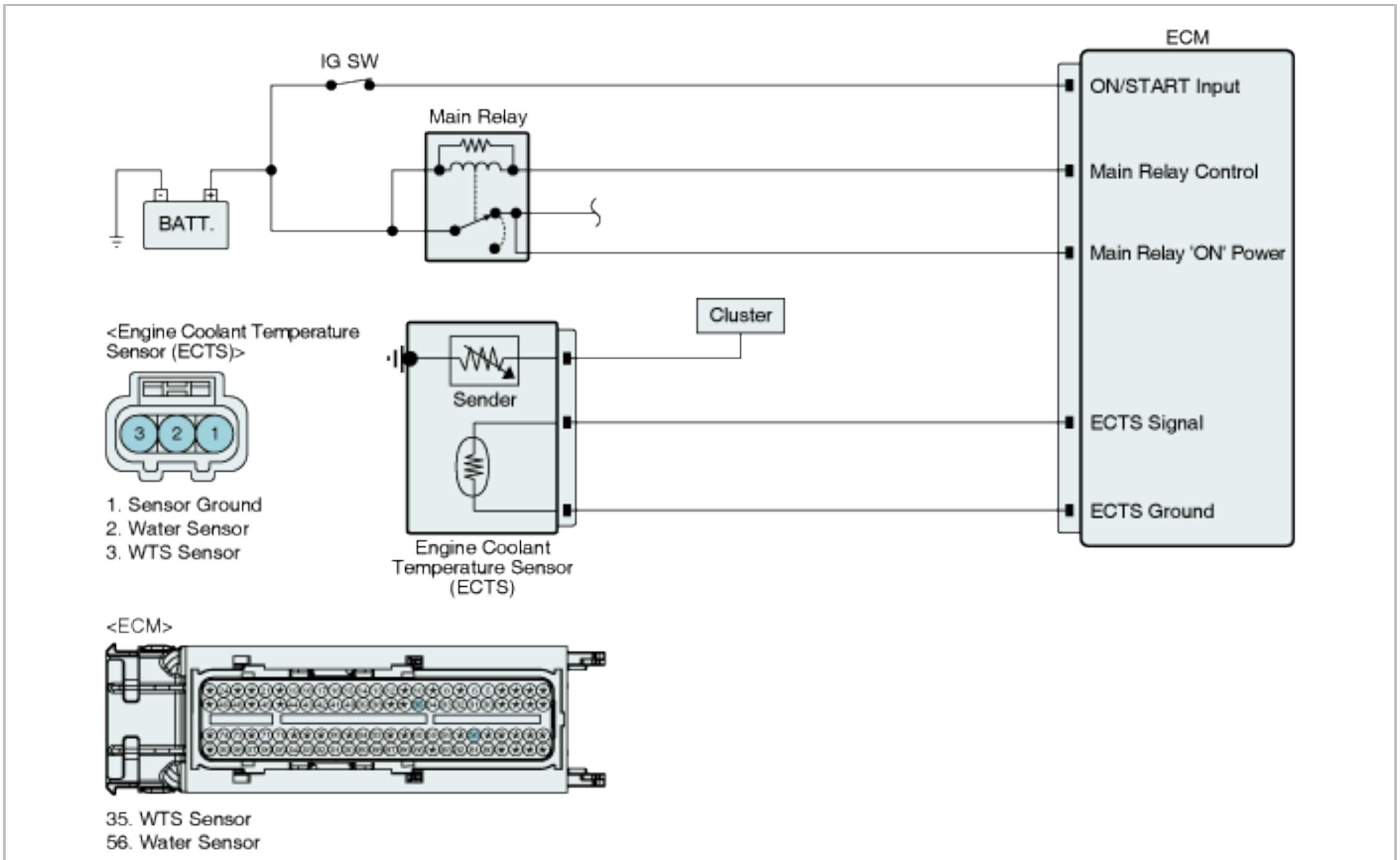
Item		Detecting Condition	Possible Cause
DTC Strategy		• Signal low	• Poor connection • Short to ground in harness • ECTS • ECM
Enable Conditions	Case 1	• Time after start-up > 120 sec.	
	Case 2	• Time from IG "OFF" to IG "ON" > 360 min • Engine running state	
Threshold value		• Engine coolant temperature sensor's voltage < 0.1V	
Diagnosis Time		• Continuous (More than 40 seconds failure for every 80 second test)	
MIL On Condition		• 2 Driving Cycles	

Specification

Temp. (°C)	Resistance (kΩ)	Temp. (°C)	Resistance (kΩ)

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

Diagnostic Circuit Diagram



Signal Waveform & Data

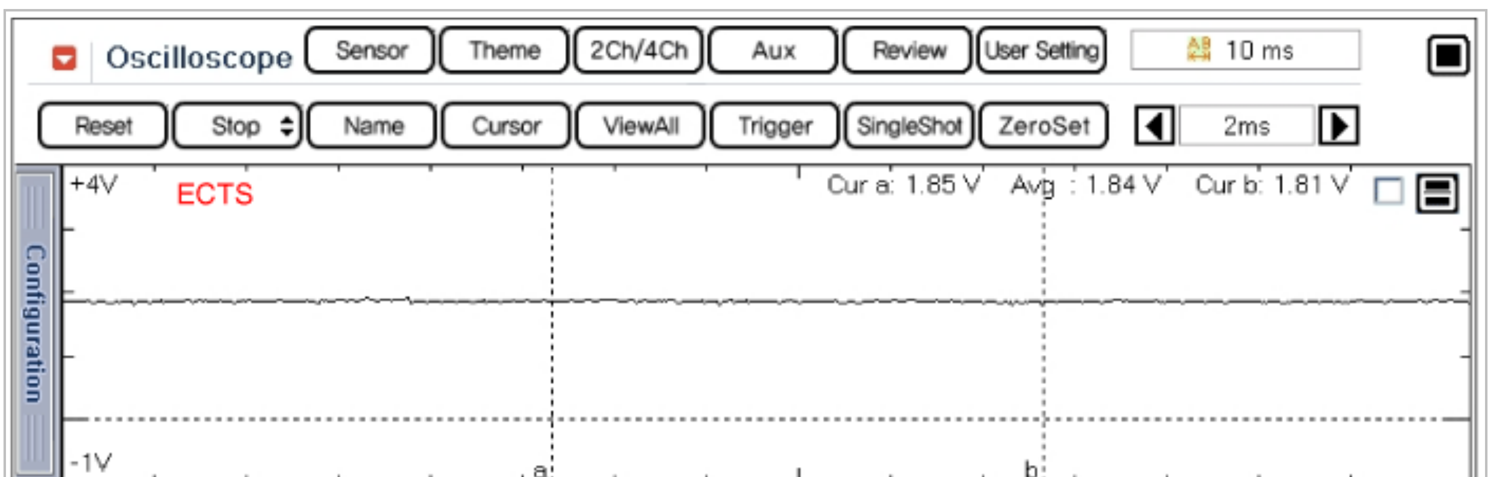
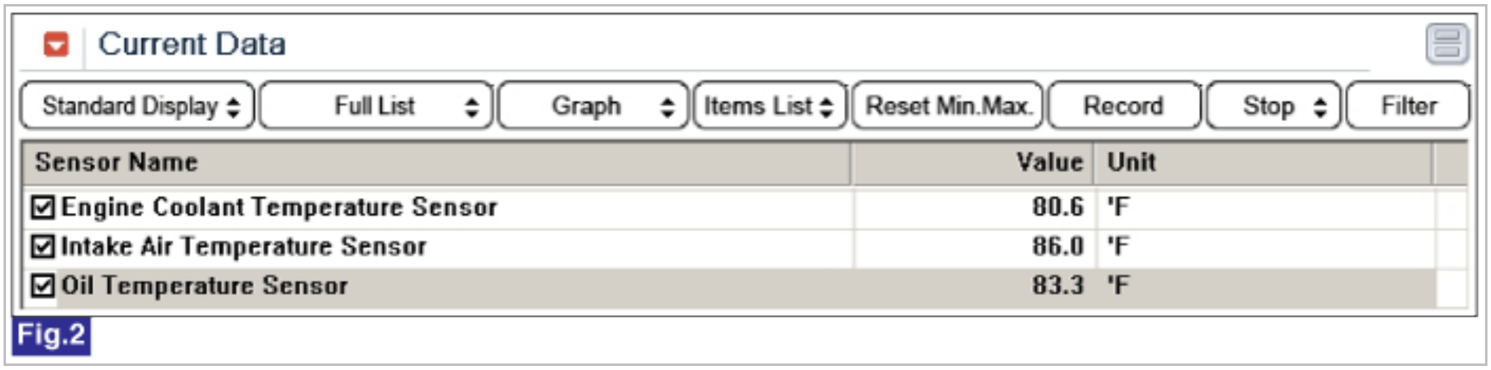
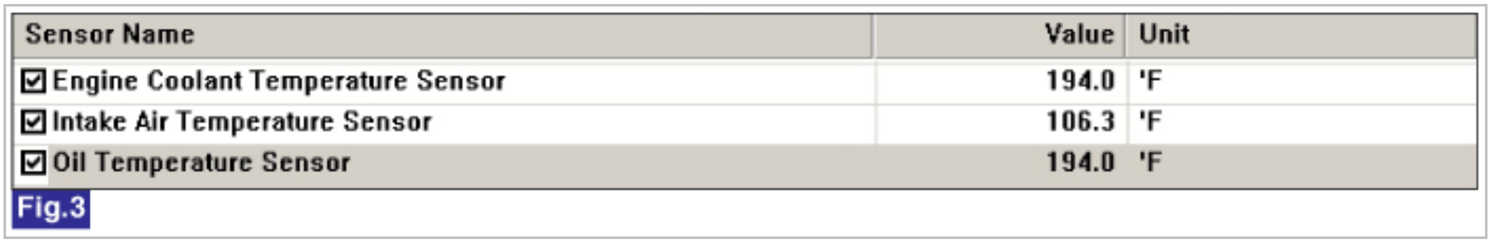


Fig.1



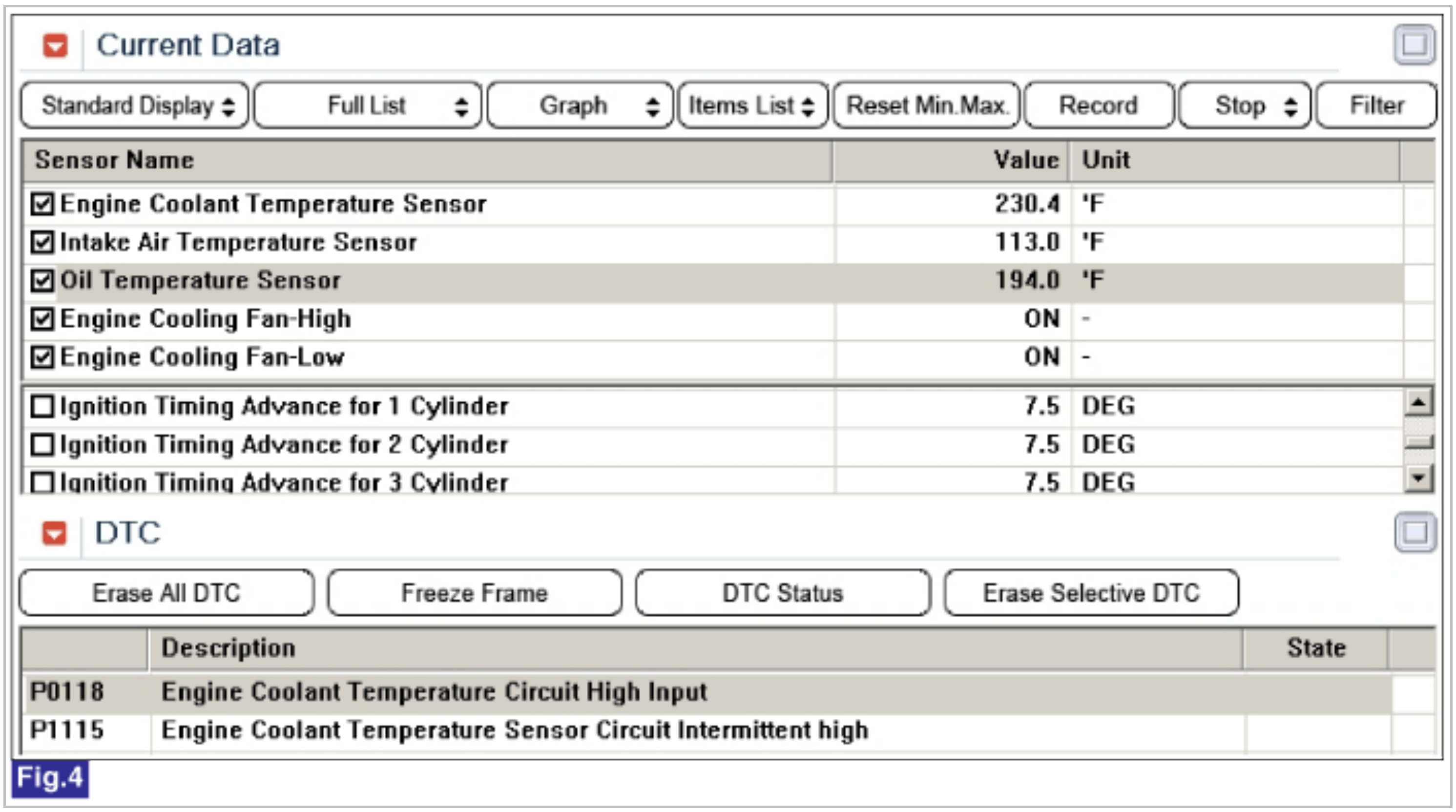
Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	80.6	'F
☑ Intake Air Temperature Sensor	86.0	'F
☑ Oil Temperature Sensor	83.3	'F

Fig.2



Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	194.0	'F
☑ Intake Air Temperature Sensor	106.3	'F
☑ Oil Temperature Sensor	194.0	'F

Fig.3



Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	230.4	'F
☑ Intake Air Temperature Sensor	113.0	'F
☑ Oil Temperature Sensor	194.0	'F
☑ Engine Cooling Fan-High	ON	-
☑ Engine Cooling Fan-Low	ON	-
☐ Ignition Timing Advance for 1 Cylinder	7.5	DEG
☐ Ignition Timing Advance for 2 Cylinder	7.5	DEG
☐ Ignition Timing Advance for 3 Cylinder	7.5	DEG

	Description	State
P0118	Engine Coolant Temperature Circuit High Input	
P1115	Engine Coolant Temperature Sensor Circuit Intermittent high	

Fig.4

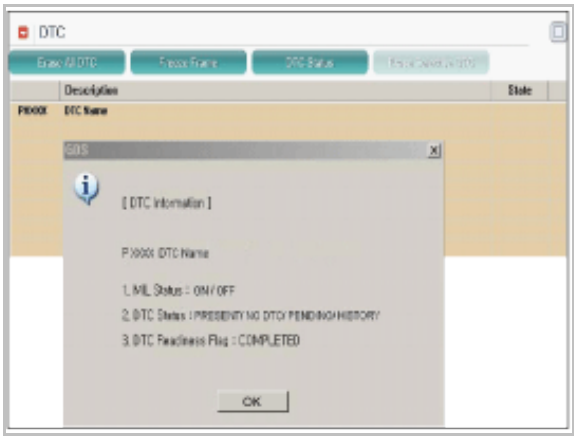
Fig.1) Normal waveform of IATS at 90°C (194°F)
Fig. 2) Normal data of IATS & ECTS & EOTS at ig on
Fig. 3) Normal data of IATS & ECTS & EOTS after warming up.
Fig.4) Abnormal data of IATS at open condition.

The output signals of IATS & ECTS change smoothly without any rapid changes. Those have almost same characteristic signal during the early period after start. It means that the temperatures of intake air and engine coolant are depended on the temperature of atmosphere. Meanwhile, during the warming up, the output signal of ECTS is going up increasingly. but, the output signal of IATS changes a little bit. even it may not change almost. It means that the heat of engine does not affect on the temperature of intake air.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".

3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Signal Circuit Inspection" procedure.

Signal Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect ECTS connector.
2. IG "ON"
3. Measure voltage between signal terminal of ECTS harness connector and chassis ground.

Specification : Approx. 3.3V

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Go to "Check short to ground in harness" as follows.

■ **Check short to ground in harness**

1. IG "OFF" and disconnect ECTS connector and ECM connector.
2. Measure resistance between signal terminal of ECTS harness connector and chassis ground.(Measurement "A")
3. Measure resistance between signal and ground terminals of ECTS harness connector.(Measurement "B")

Specification : Infinite

4. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to ground in harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ **Check ECTS resistance**

1. IG "OFF" and disconnect ECTS connector.
2. Measure resistance between signal and ground terminals of ECTS connector after checking out the temperature of ECTS with GDS (Component Side)
Specification :

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

3. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good ECTS and check for proper operation. If the problem is corrected, Go to "Verification of Vehicle Repair"procedure.

Verification of Vehicle Repair

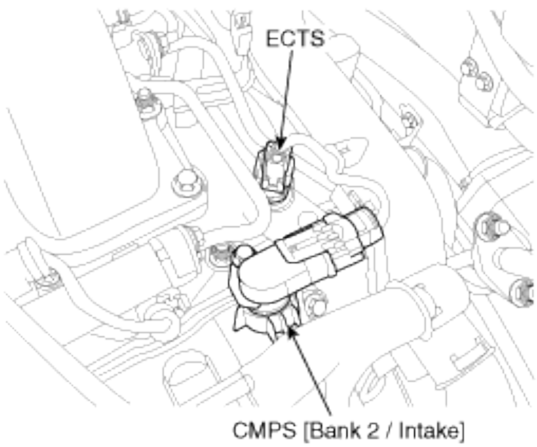
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0118 Engine Coolant Temperature Circuit High Input

Component Location



General Description

The Engine Coolant Temperature Sensor (ECTS) is located in the engine coolant passage of the cylinder head for detecting the engine coolant temperature. The ECTS uses a thermistor whose resistance changes with the temperature. The electrical resistance of the ECTS decreases as the temperature increases, and increases as the temperature decreases. The reference 5 V in the ECM is supplied to the ECTS via a resistor in the ECM. That is, the resistor in the ECM and the thermistor in the ECTS are connected in series. When the resistance value of the thermistor in the ECTS changes according to the engine coolant temperature, the output voltage also changes. During cold engine operation the ECM increases the fuel injection duration and controls the ignition timing using the information of engine coolant temperature to avoid engine stalling and improve drivability.

DTC Description

Checking output signals from ECTS every 80 sec. under detecting condition, if an output signal is above 4.9V for morethan 40 sec., ECM sets P0118. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2driving cycle.

DTC Detecting Condition

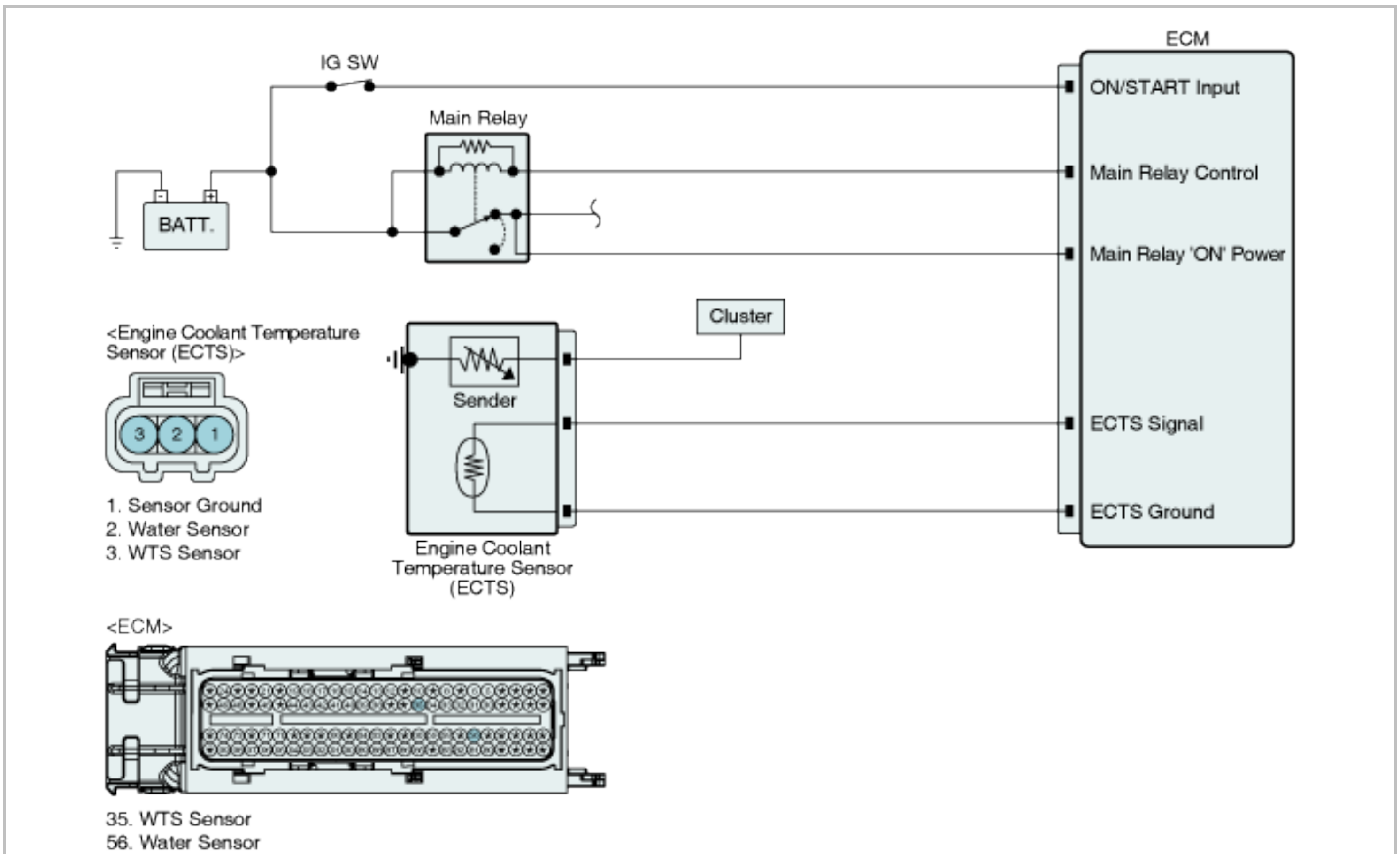
Item	Detecting Condition	Possible Cause
DTC Strategy	• Open, Signal high	

Enable Conditions	Case 1	• Time after start-up > 120 sec.	• Poor connection • Open or short to battery in signal harness • Open in ground harness • ECTS • ECM
	Case 2	• Time from IG "OFF" to IG "ON" > 360 min • Intake air temperature ≥ -10°C(14°F) • Engine running state	
Threshold value		• Engine coolant temperature sensor's voltage > 4.9V	
Diagnosis Time		• Continuous (More than 10 sec. failure for every 20 sec. test)	
MIL On Condition		• 2 Driving Cycles	

Specification

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

Diagnostic Circuit Diagram



Signal Waveform & Data

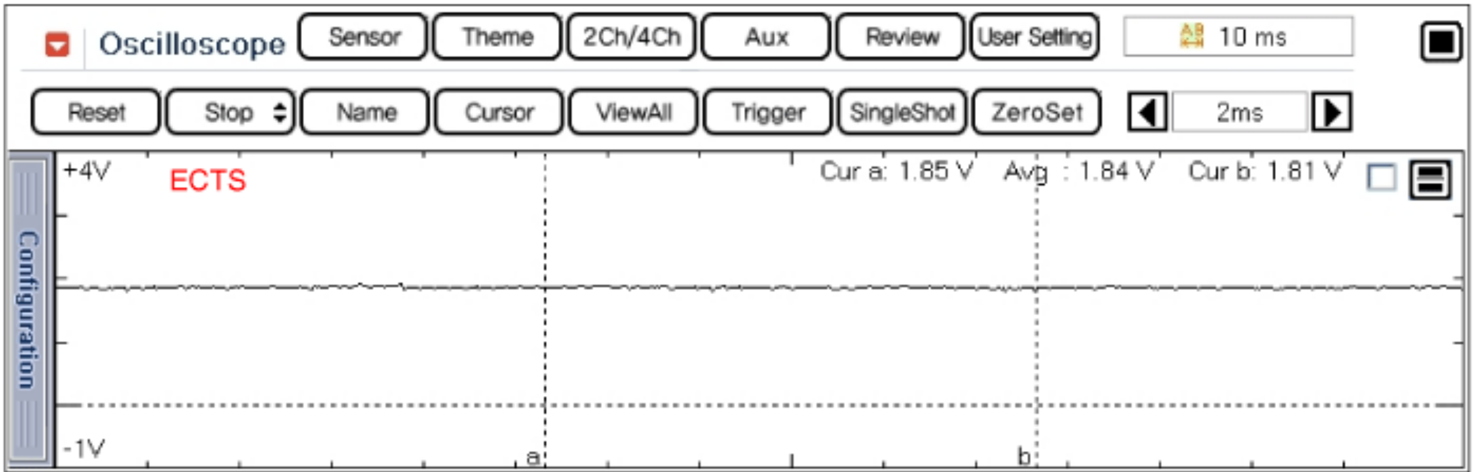


Fig.1

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | Filter

Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	80.6	'F
☑ Intake Air Temperature Sensor	86.0	'F
☑ Oil Temperature Sensor	83.3	'F

Fig.2

Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	194.0	'F
☑ Intake Air Temperature Sensor	106.3	'F
☑ Oil Temperature Sensor	194.0	'F

Fig.3

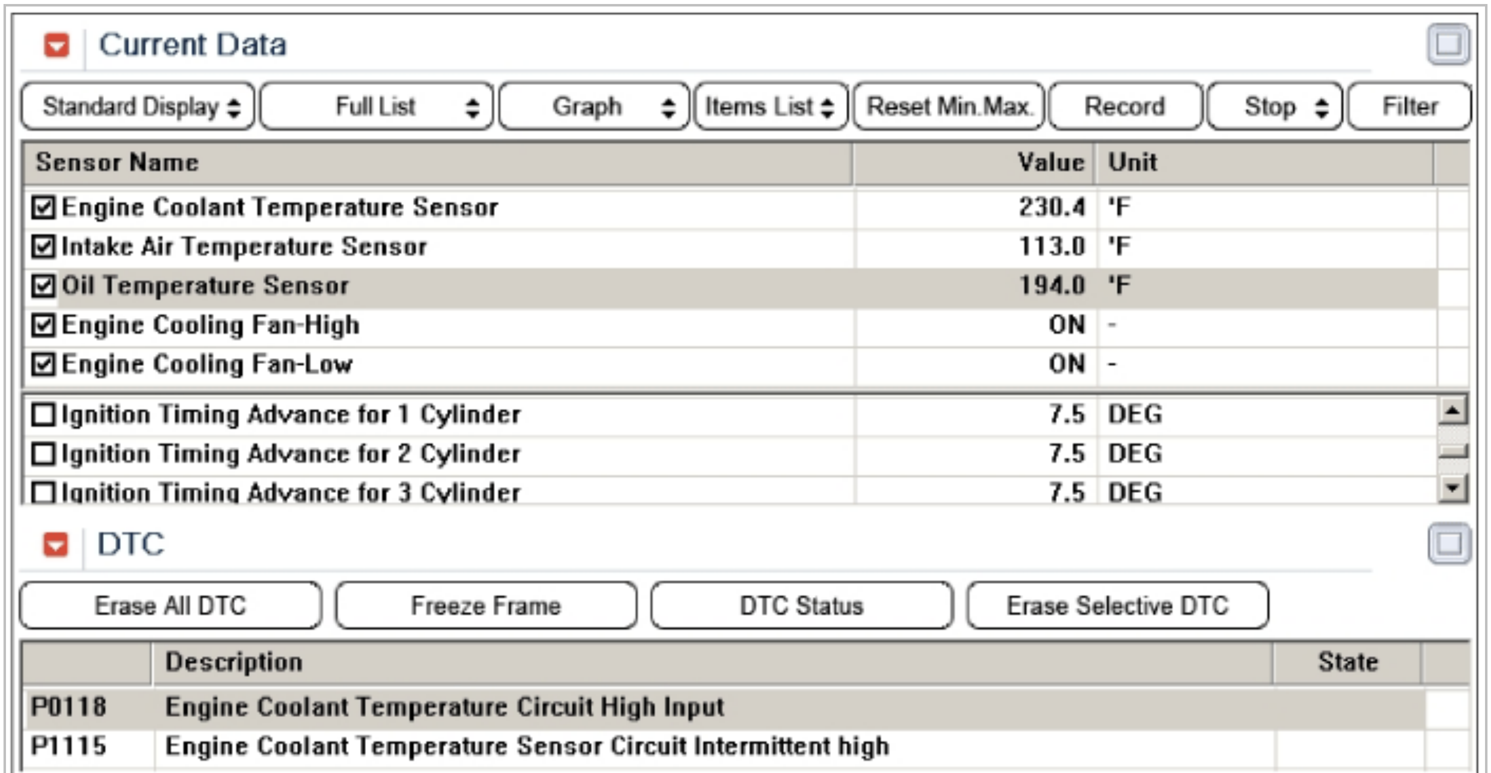


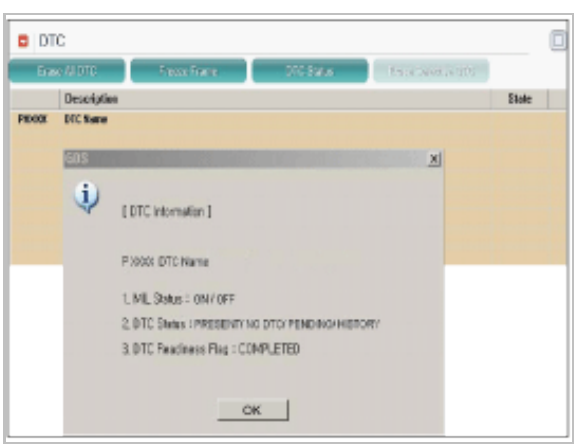
Fig.4

Fig.1) Normal waveform of IATS at 90°C (194°F)
Fig. 2) Normal data of IATS & ECTS & EOTS at ig on
Fig. 3) Normal data of IATS & ECTS & EOTS after warming up.
Fig.4) Abnormal data of IATS at open condition.

The output signals of IATS & ECTS change smoothly without any rapid changes. Those have almost same characteristic signal during the early period after start. It means that the temperatures of intake air and engine coolant are depended on the temperature of atmosphere. Meanwhile, during the warming up, the output signal of ECTS is going up increasingly. but, the output signal of IATS changes a little bit. even it may not change almost. It means that the heat of engine does not affect on the temperature of intake air.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Signal Circuit Inspection" procedure.

Signal Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect ECTS connector.
2. IG "ON"
3. Measure voltage between signal terminal of ECTS harness connector and chassis ground.

Specification : Approx. 3.3V

4. Is the measured voltage within specification ?

YES	▶ Go to "Ground Circuit Inspection" procedure.
NO	▶ If the voltage is 0V, go to "Check open in harness" as follows. If the voltage is more than 5.1V, go to "Check short to battery in harness" as follows.

■ Check open in harness

1. IG "OFF" and disconnect ECTS connector and ECM connector.
2. Measure resistance between signal terminal of ECTS harness connector and ECTS signal terminal of ECM harness connector.

Specification : below 1Ω

3. Is the measured resistance within specification ?

YES	▶ Go to "Ground Circuit Inspection" procedure.
NO	▶ Repair open in harness and go to "Verification of Vehicle Repair" procedure.

Ground Circuit Inspection

■ **Check open in harness**

1. IG "OFF" and disconnect ECTS connector and then IG "ON".
2. Measure voltage between signal terminal of ECTS harness connector and chassis ground.(Measurement "A")
3. Measure voltage between signal and ground terminals of ECTS harness connector.(Measurement "B")

Specification : Voltage difference between measurement "A" and "B" is below 200mV.

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair contact resistance or open in harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ **Check ECTS resistance**

1. IG "OFF" and disconnect ECTS connector.
2. Measure resistance between signal and ground terminals of ECTS connector after checking out the temperature of ECTS with GDS (Component Side)
   Specification :

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

3. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good ECTS and check for proper operation. If the problem is corrected, Go to "Verification of Vehicle Repair"procedure.

Verification of Vehicle Repair

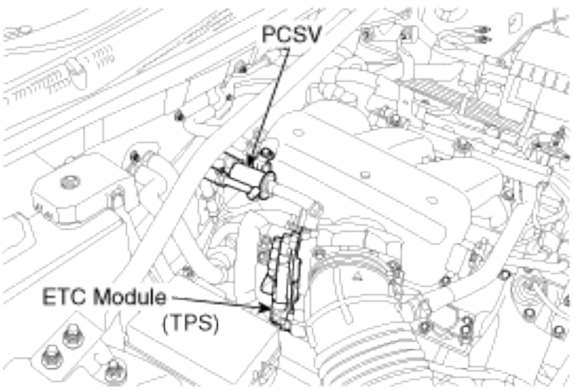
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0122 Throttle Position Sensor 1 Signal Circuit Low Input

Component Location



General Description

The Electronic Throttle Control(ETC) system is made of the components throttle body, Throttle Position Sensor(TPS)1&2 and Accelerator Position Sensor(APS) 1&2. TPS1&2 are sharing the same source voltage and ground.The throttle valve opening is control by throttle motor which is controlled by Engine Control Module(ECM).The opposite position indicator shows inverted signal characteristics.TPS1 output voltage increases smoothly in proportion with the throttle valve opening angle after starting. TPS2 output voltage decreases in inverse proportion with the throttle valve opening angle after starting. TPS provides feedback to the ECM to control the throttle motor in order to control the throttle valve opening angle properly in response to the driving condition.

DTC Description

Checking output signals from TPS1 every 8.5 sec. under detecting condition, if an output signal is below 0.25V for more than 0.1 sec., ECM sets P0122. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

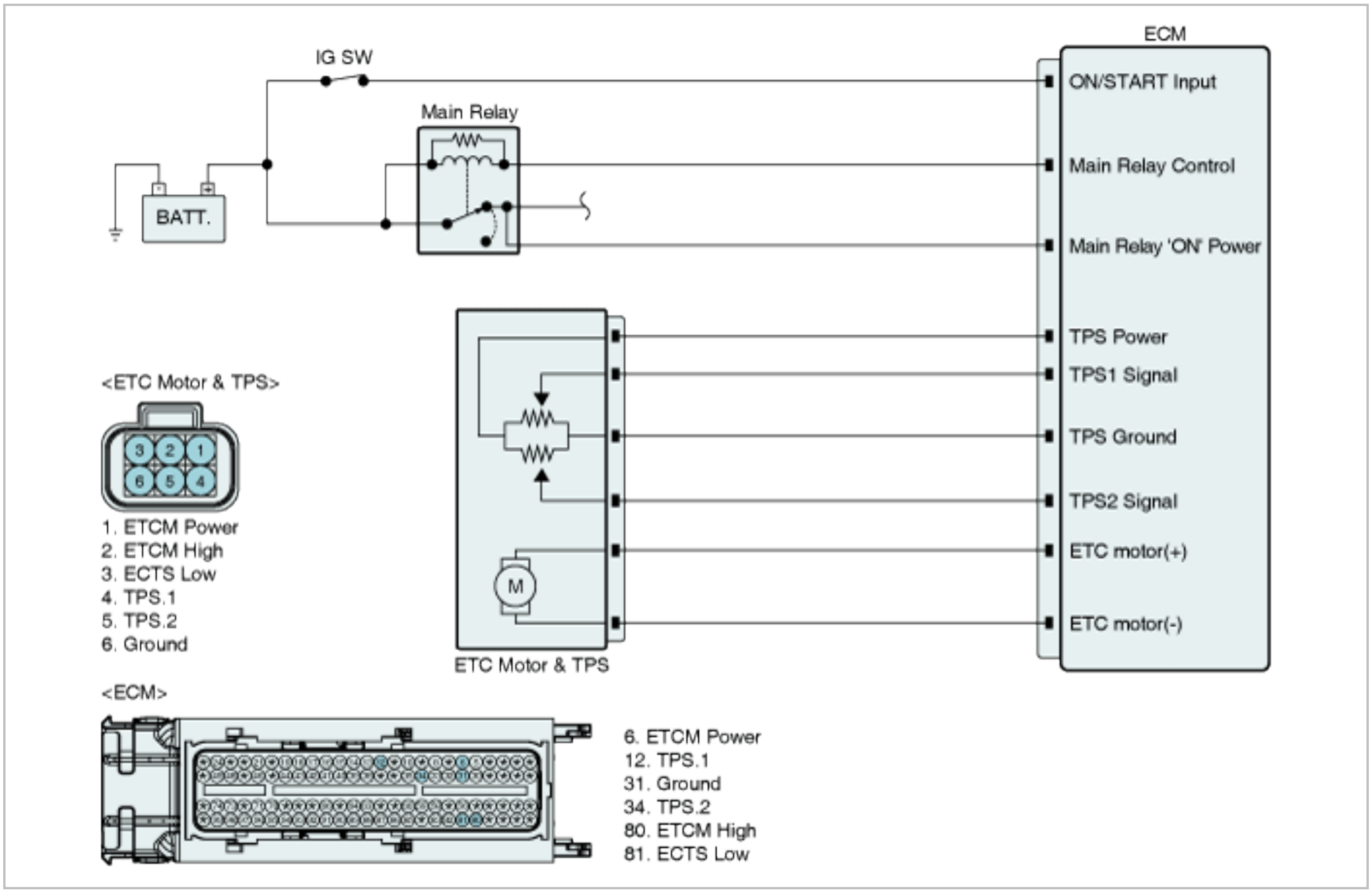
Item	Detecting Condition	Possible Cause
DTC Strategy	• Signal low	• Poor connection

Enable Conditions	• IG "ON"	• Open or short to ground in power harness • Short to ground in signal harness • TPS • ECM
Threshold value	• The voltage of TPS < 0.25V	
Diagnosis Time	• Continuous (more than 0.1 sec. failure for every 8.5 sec.test)	
MIL On Condition	• 1 driving cycles	

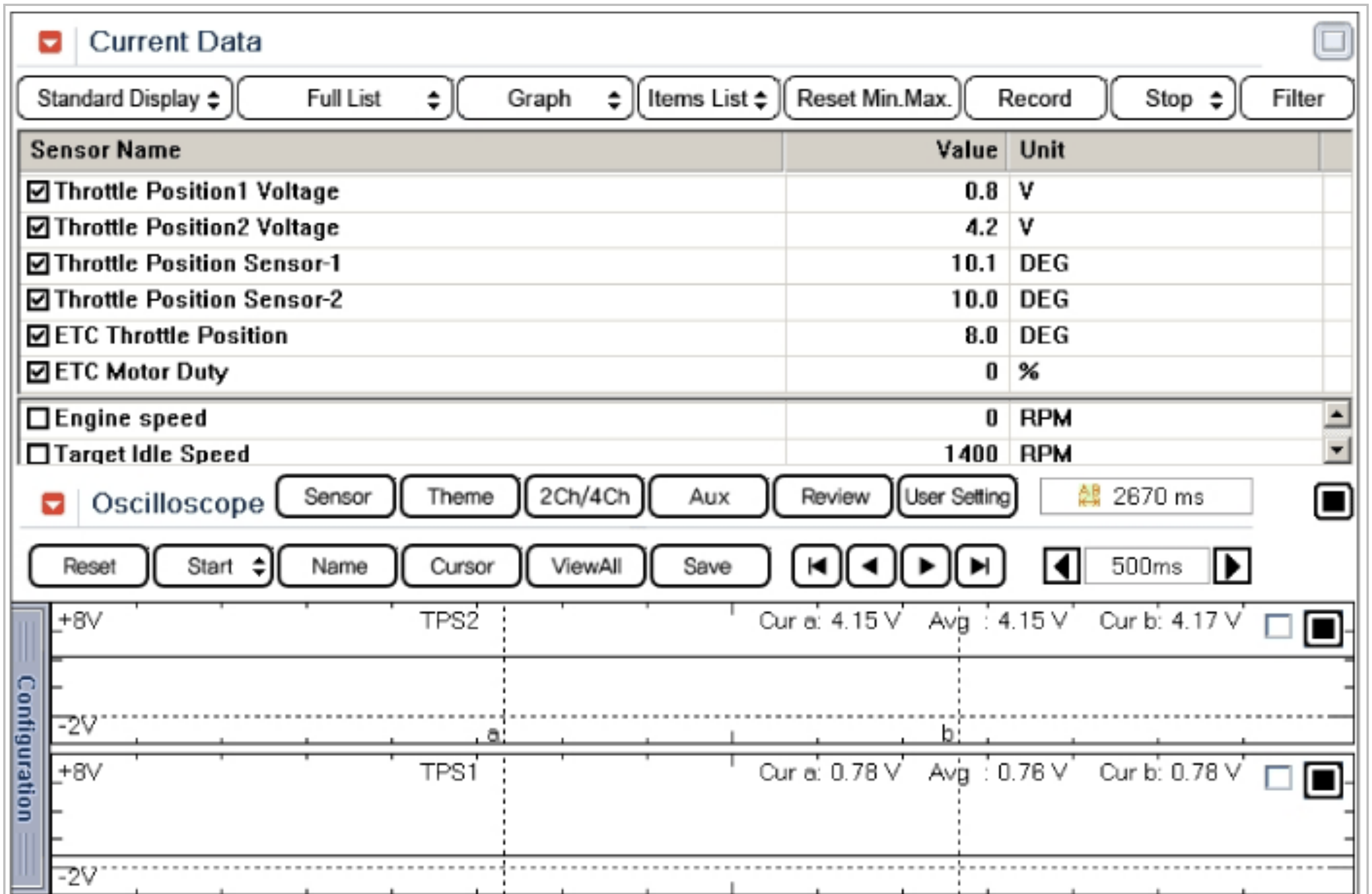
Specification

Throttle Opening (°)	Output Voltage (V) [Vref=5.0]	
	TPS1	**TPS2**
0°	0.0V	5.0V
10°	0.5V	4.5V
20°	0.9V	4.1V
30°	1.4V	3.6V
40°	1.8V	3.2V
50°	2.3V	2.7V
60°	2.7V	2.3V
70°	3.2V	1.8V
80°	3.6V	1.4V
90°	4.1V	0.9V
100°	4.5V	0.5V
110°	5.0V	0.0V

Diagnostic Circuit Diagram



Signal Waveform & Data


Current Data
Standard Display
Full List
Graph
Items List
Reset Min.Max.
Record
Stop
Filter
Sensor Name
Value
Unit
Throttle Position1 Voltage 0.8 V
Throttle Position2 Voltage 4.2 V
Throttle Position Sensor-1 10.1 DEG
Throttle Position Sensor-2 10.0 DEG
ETC Throttle Position 8.0 DEG
ETC Motor Duty 0 %
Engine speed 0 RPM
Target Idle Speed 1400 RPM
Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
2670 ms
Reset
Start
Name
Cursor
ViewAll
Save
500ms
Configuration
+8V
TPS2
Cur a: 4.15 V
Avg : 4.15 V
Cur b: 4.17 V
-2V
a
b
+8V
TPS1
Cur a: 0.78 V
Avg : 0.76 V
Cur b: 0.78 V
-2V
Fig.1

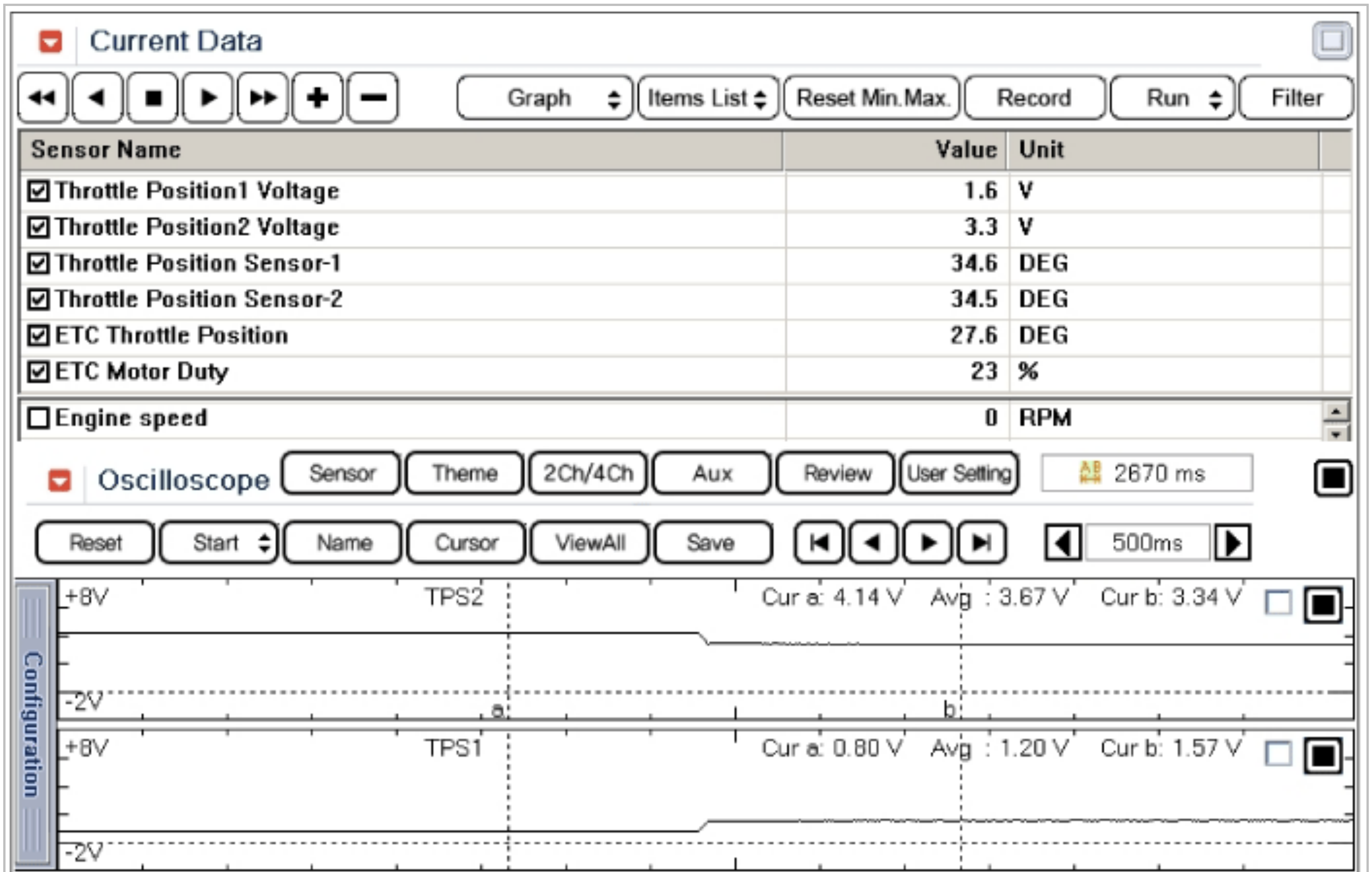


Fig.2

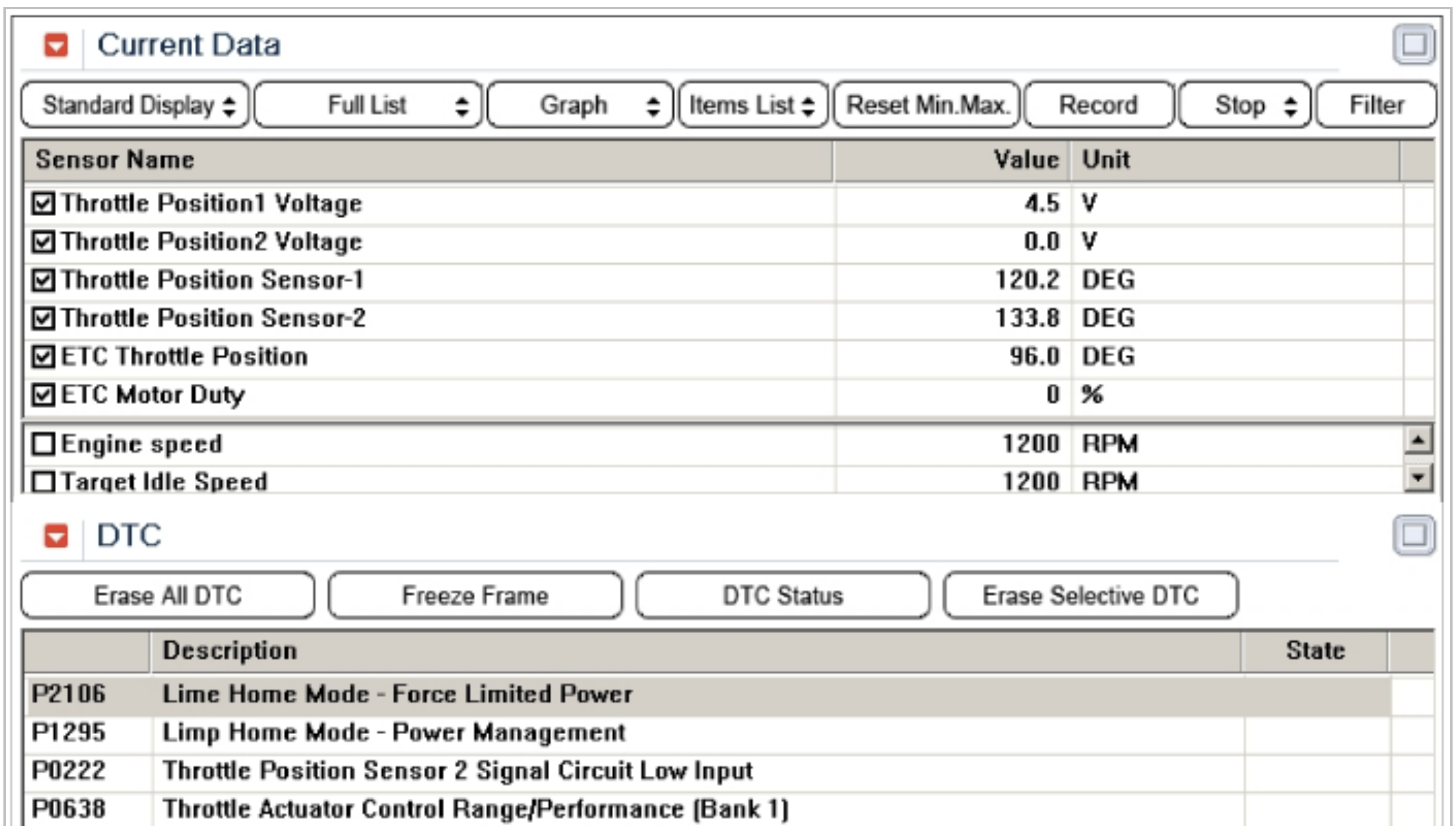


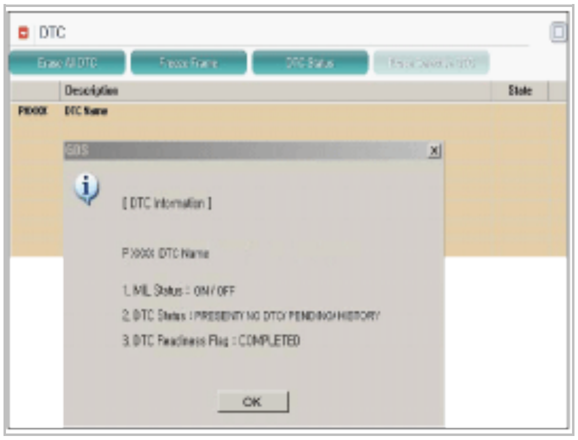
Fig.3

Fig.1) Normal data & waveform of TPS1 & TPS2 with no accel padal depressed under IG ON condition

Fig.2) Normal data & waveform of TPS1 & TPS2 with accel padal depressed under IG ON condition
Fig.3) Abnormal data of TPS1 & TPS2 at open condition

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Power Circuit Inspection" procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect ETC Motor & TPS connector.
2. IG "ON".
3. Measure voltage between TPS power terminal of ETC Motor & TPS harness connector and chassis ground.

Specification : Approx. 5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Signal circuit inspection" procedure.
NO	▶ Repair open or short to ground in power harness, and go to "Verification of Vehicle Repair" procedure.

Signal Circuit Inspection

■ Check short to ground in harness

1. IG "OFF" and disconnect ETC Motor & TPS connector and ECM connector.
2. Measure resistance between TPS1 signal terminal of ETC Motor & TPS harness connector and chassis ground.(Measurement "A")
3. Measure resistance between TPS1 signal and TPS ground terminals of ETC Motor & TPS harness connector.(Measurement "B")

Specification : Infinite

4. Is the measured resistance within specification ?

YES	▶ Go to "Component inspection" procedure.
NO	▶ Repair short to ground in harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check TPS resistance

1. IG "OFF" and disconnect ETC Motor & TPS connector.
2. Measure resistance between TPS power and TPS ground terminals of ETC Motor & TPS connector.(component side)

Specification : 1.6 ~ 2.4kΩ

3. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good ECT motor & TPS and check for proper operation. If the problem is corrected, replace ECT motor & TPS and go to "Verification of Vehicle Repair" procedure.

※ Procedure of ETS Initialization

A. Erase the trouble codes on ECM

B. Turn the ignition key off and keep this condition until the main relay is turned off.(It will take 10sec.)
C. Turn ignition key on more than 1second to record the throttle motor position on the EEPROM

Verification of Vehicle Repair

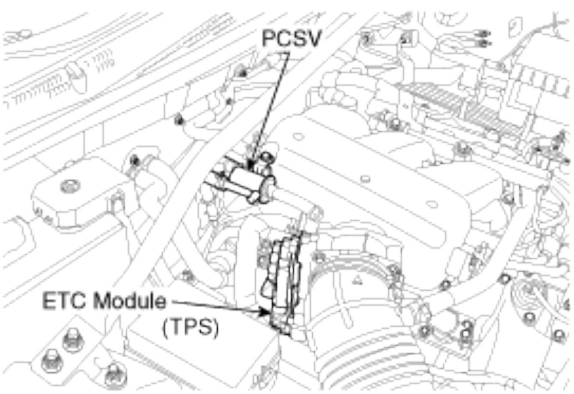
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0123 Throttle Position Sensor 1 Signal Circuit High Input

Component Location



General Description

The Electronic Throttle Control(ETC) system is made of the components throttle body, Throttle Position Sensor(TPS)1&2 and Accelerator Position Sensor(APS) 1&2. TPS1&2 are sharing the same source voltage and ground.The throttle valve opening is control by throttle motor which is controlled by Engine Control Module(ECM).The opposite position indicator shows inverted signal characteristics.TPS1 output voltage increases smoothly in proportion with the throttle valve opening angle after starting. TPS2 output voltage decreases in inverse proportion with the throttle valve opening angle after starting. TPS provides feedback to the ECM to control the throttle motor in order to control the throttle valve opening angle properly in response to the driving condition.

DTC Description

Checking output signals from TPS1 every 8.5 sec. under detecting condition, if an output signal is above 4.75V for more than 0.1 sec., ECM sets P0123. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

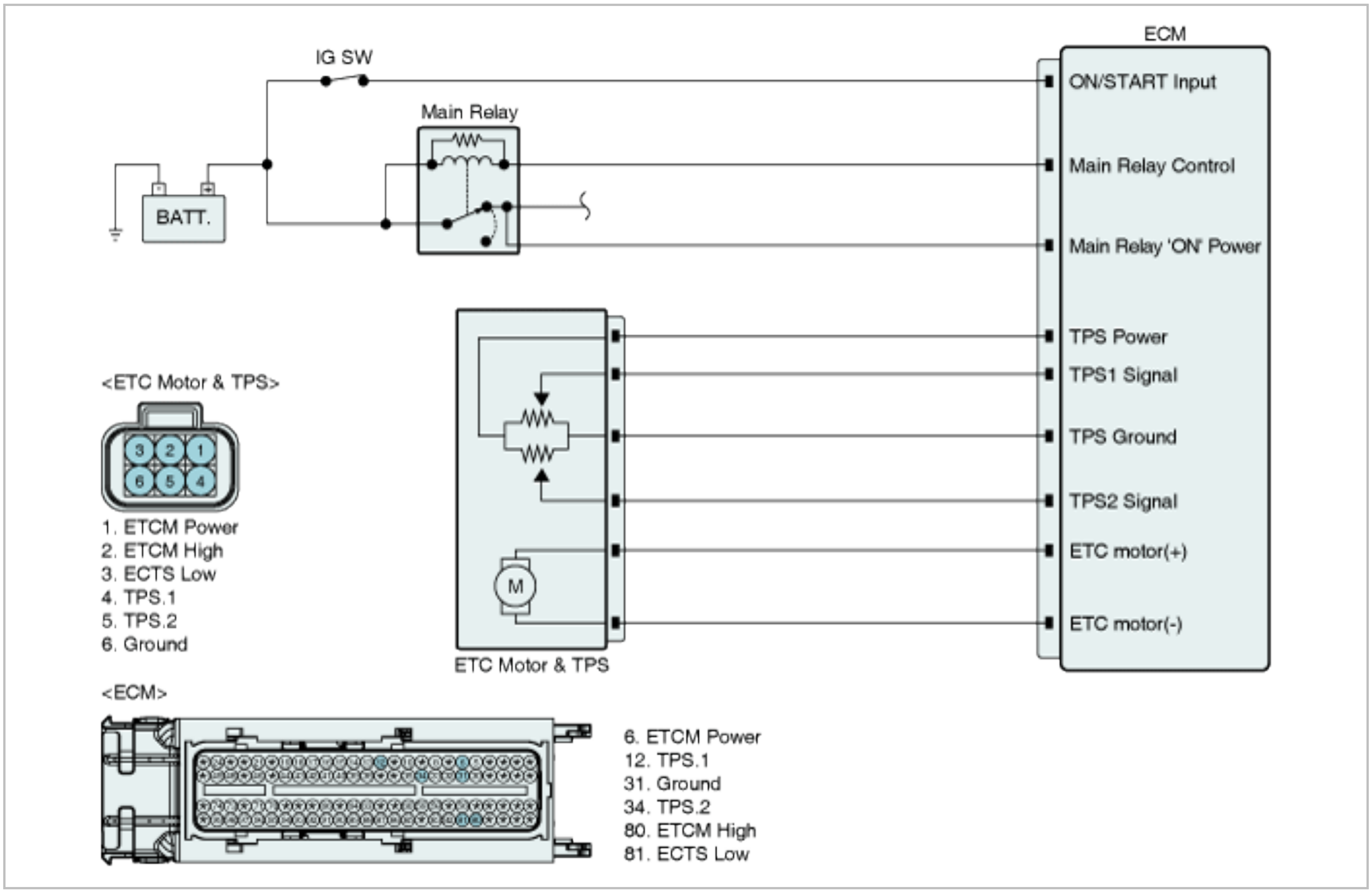
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Signal high	• Poor connection • Open or short to battery in signal harness • Open in ground harness • TPS • ECM
Enable Conditions	• IG "ON"	
Threshold value	• The voltage of TPS > 4.75V	
Diagnosis Time	• Continuous (more than 0.1 sec. failure for every 8.5 sec.test)	
MIL On Condition	• 1 driving cycles	

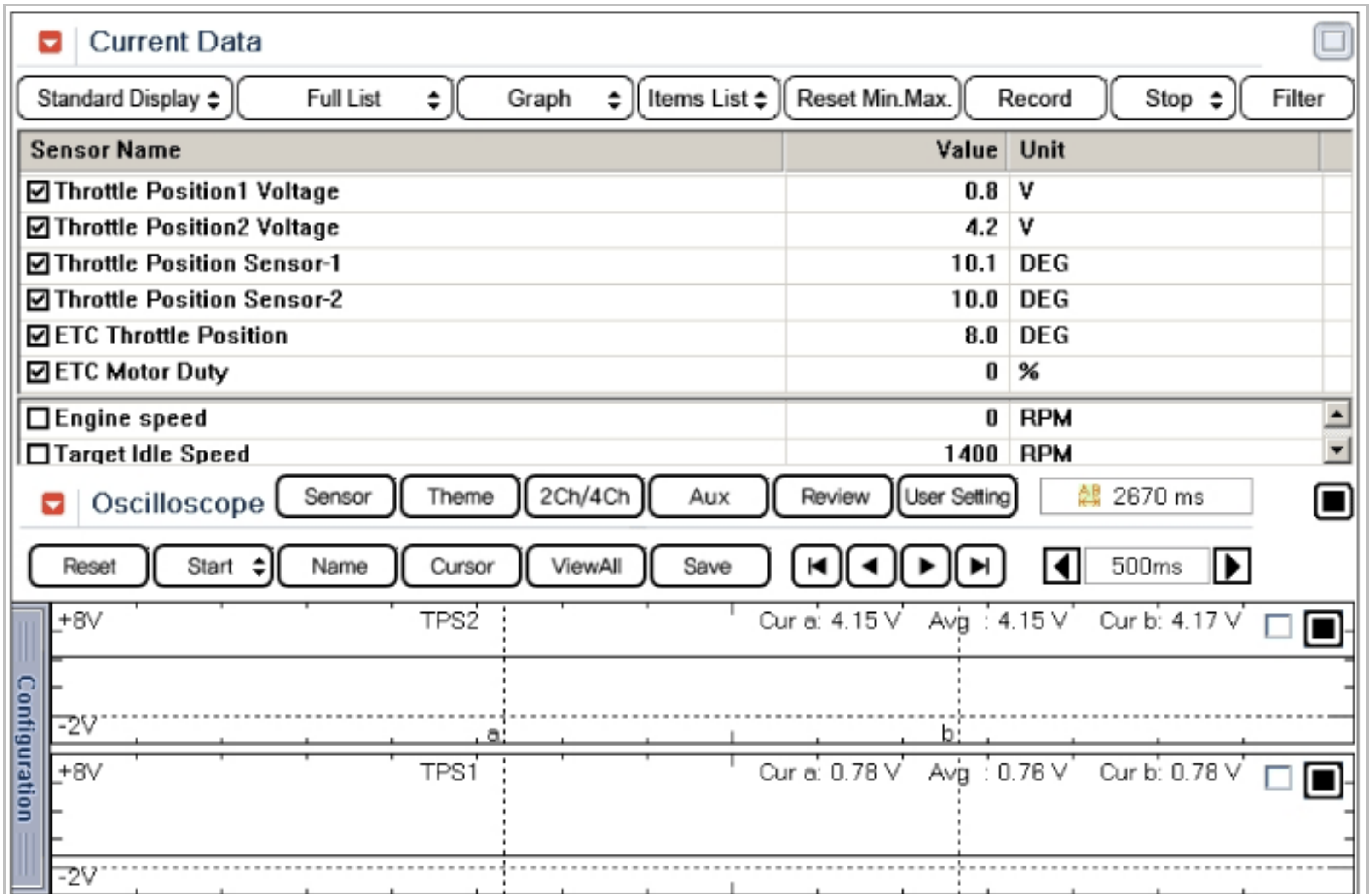
Specification

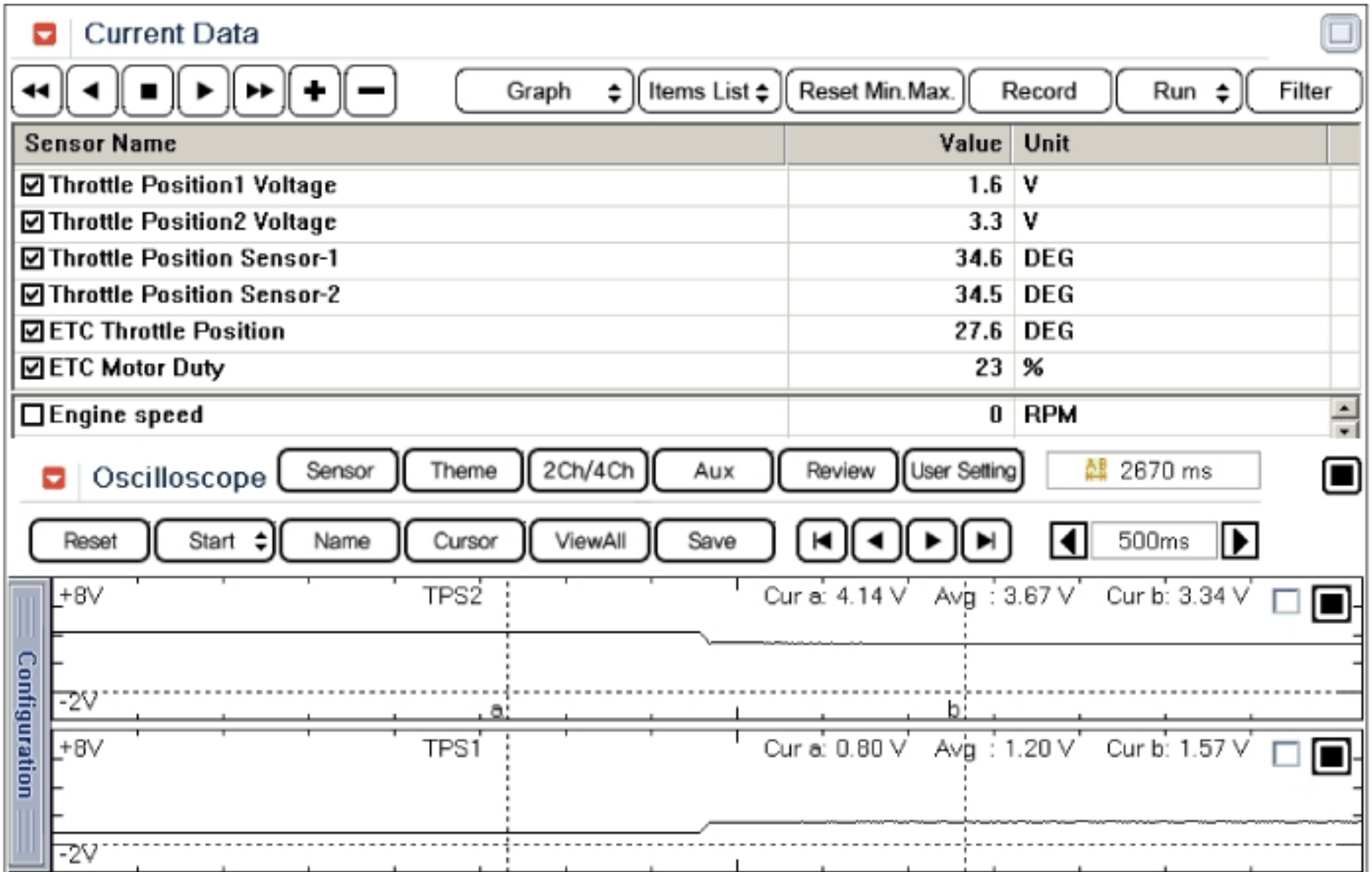
Throttle Opening (°)	Output Voltage (V) [Vref=5.0]	
	TPS1	TPS2
0°	0.0V	5.0V
10°	0.5V	4.5V
20°	0.9V	4.1V
30°	1.4V	3.6V
40°	1.8V	3.2V
50°	2.3V	2.7V
60°	2.7V	2.3V
70°	3.2V	1.8V
80°	3.6V	1.4V
90°	4.1V	0.9V
100°	4.5V	0.5V
110°	5.0V	0.0V

Diagnostic Circuit Diagram



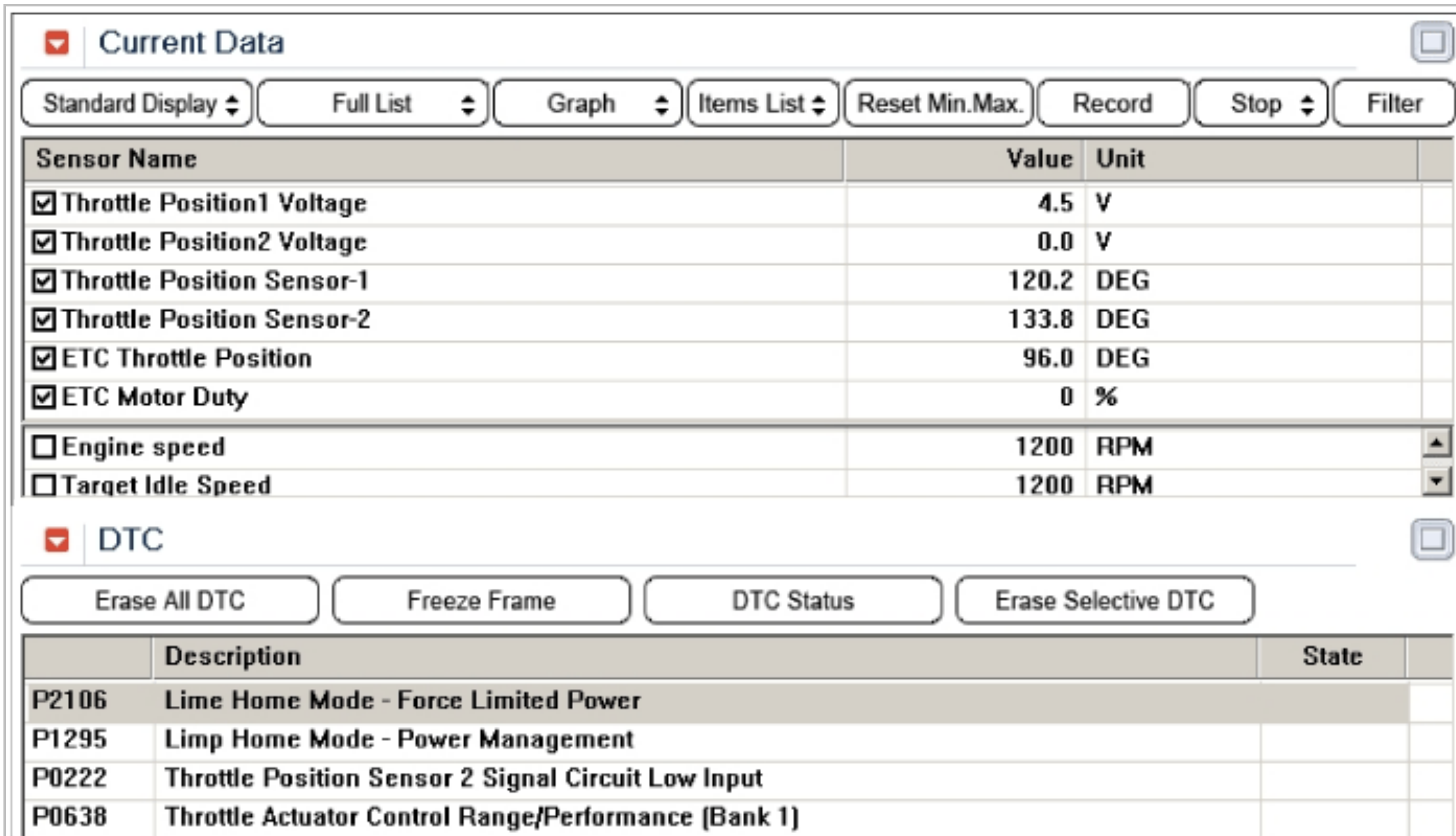
Signal Waveform & Data


Current Data
Standard Display
Full List
Graph
Items List
Reset Min.Max.
Record
Stop
Filter
Sensor Name
Value
Unit
Throttle Position1 Voltage 0.8 V
Throttle Position2 Voltage 4.2 V
Throttle Position Sensor-1 10.1 DEG
Throttle Position Sensor-2 10.0 DEG
ETC Throttle Position 8.0 DEG
ETC Motor Duty 0 %
Engine speed 0 RPM
Target Idle Speed 1400 RPM
Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
2670 ms
Reset
Start
Name
Cursor
ViewAll
Save
500ms
+8V
TPS2
Cur a: 4.15 V
Avg : 4.15 V
Cur b: 4.17 V
-2V
a
b
+8V
TPS1
Cur a: 0.78 V
Avg : 0.76 V
Cur b: 0.78 V
-2V
Configuration
Fig.1



Sensor Name	Value	Unit
☑ Throttle Position1 Voltage	1.6	V
☑ Throttle Position2 Voltage	3.3	V
☑ Throttle Position Sensor-1	34.6	DEG
☑ Throttle Position Sensor-2	34.5	DEG
☑ ETC Throttle Position	27.6	DEG
☑ ETC Motor Duty	23	%
☐ Engine speed	0	RPM

Fig.2



Sensor Name	Value	Unit
☑ Throttle Position1 Voltage	4.5	V
☑ Throttle Position2 Voltage	0.0	V
☑ Throttle Position Sensor-1	120.2	DEG
☑ Throttle Position Sensor-2	133.8	DEG
☑ ETC Throttle Position	96.0	DEG
☑ ETC Motor Duty	0	%
☐ Engine speed	1200	RPM
☐ Target Idle Speed	1200	RPM

	Description	State
P2106	Lime Home Mode - Force Limited Power	
P1295	Limp Home Mode - Power Management	
P0222	Throttle Position Sensor 2 Signal Circuit Low Input	
P0638	Throttle Actuator Control Range/Performance (Bank 1)	

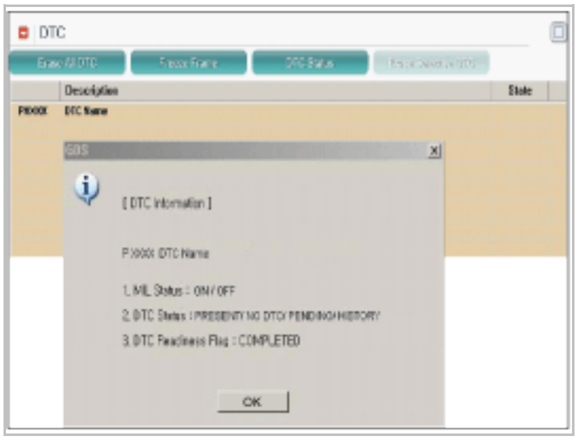
Fig.3

Fig.1) Normal data & waveform of TPS1 & TPS2 with no accel padal depressed under IG ON condition

Fig.2) Normal data & waveform of TPS1 & TPS2 with accel padal depressed under IG ON condition
Fig.3) Abnormal data of TPS1 & TPS2 at open condition

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Signal Circuit Inspection" procedure.

Signal Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect ETC Motor & TPS connector.
2. IG "ON".
3. Measure voltage between TPS1 signal terminal of ETC Motor & TPS harness connector and chassis ground.

Specification : Approx. 5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Check open in harness" as follows.
NO	▶ Go to "Check short to battery in harness" as follows.

■ **Check open in harness**

1. IG "OFF" and disconnect ETC Motor & TPS connector and ECM connector.
2. Measure resistance between TPS1 signal terminal of ETC Motor & TPS harness connector and TPS1 signal terminal of ECM harness connector.

Specification : Below 1Ω

3. Is the measured resistance within specification ?

YES	▶ Go to "Ground Circuit Inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

■ **Check short to battery in harness**

1. IG "OFF" and disconnect ETC Motor & TPS connector and ECM connector.
2. Measure resistance between TPS1 signal and TPS power terminals of ETC Motor & TPS harness connector.(Measurement "A")
3. Measure resistance between TPS1 signal and ETC motor(+) terminals of ETC Motor & TPS harness connector.(Measurement "B")
4. Measure resistance between TPS1 signal and ETC motor(-) terminals of ETC Motor & TPS harness connector.(Measurement "B")

Specification : Infinite

5. Is the measured resistance within specification ?

YES	▶ Go to "Ground Circuit Inspection" procedure.
NO	▶ Repair short to battery in harness, and go to "Verification of Vehicle Repair" procedure.

Ground Circuit Inspection

■ **Check open in harness**

1. IG "OFF" and disconnect ECTS connector and then IG "ON".
2. Measure voltage between TPS power terminal of ETC Motor & TPS harness connector and chassis ground.(Measurement "A")
3. Measure voltage between TPS power and TPS ground terminals of ETC Motor & TPS harness connector.(Measurement "B")

Specification : Voltage difference between measurement "A" and "B" is below 200mV.

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.

NO	▶ Repair contact resistance or open in harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ **Check TPS resistance**

1. IG "OFF" and disconnect ETC Motor & TPS connector.
2. Measure resistance between TPS power and TPS ground terminals of ETC Motor & TPS connector.(component side)

Specification : 1.6 ~ 2.4kΩ

3. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good ECT motor & TPS and check for proper operation. If the problem is corrected, replace ECT motor & TPS and go to "Verification of Vehicle Repair" procedure.

※ Procedure of ETS Initialization

A. Erase the trouble codes on ECM

B. Turn the ignition key off and keep this condition until the main relay is turned off. (It will take 10sec.)

C. Turn ignition key on more than 1second to record the throttle motor position on the EEPROM

Verification of Vehicle Repair

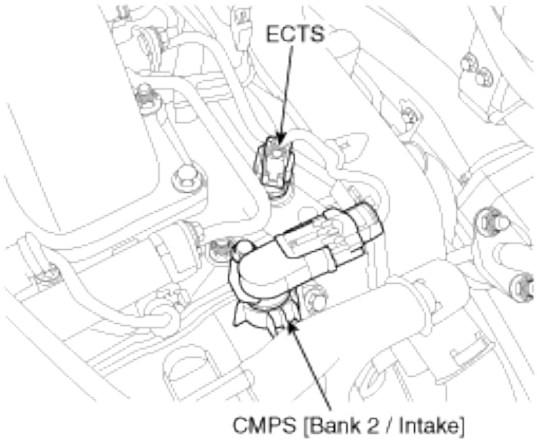
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0125 Insufficient Coolant Temperature for Closed Loop Fuel Control

Component Location



General Description

When the engine is first started, the fuel control system operates in an open loop operation, ignoring the HO2S(Heated Oxygen Sensor) signal and calculating the air/fuel ratio based on inputs from the engine coolant temperature, the throttle position and the mass air flow sensors. The ECM will begin by using the oxygen sensor signal for controlling the fuel delivery(closed loop) when the following conditions are met:
-The engine has run a minimum amount of time at engine start up.
-The HO2S has a varying voltage output showing that it is hot enough to operate properly.
-The ECT has increased a minimum amount based on the ECT at start up.
The ECM monitors the amount of time for the cooling system to achieve closed loop operating temperature. The engine coolant temperature sufficient to allow closed loop operation is not achieved within a predetermined time frame, ECM sets DTC.

DTC Description

Checking time and coolant temperature under detecting condition, if the engine coolant temperature dose not exceed the coolant temperature threshold before the determinated period elapses, ECM sets P0125. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

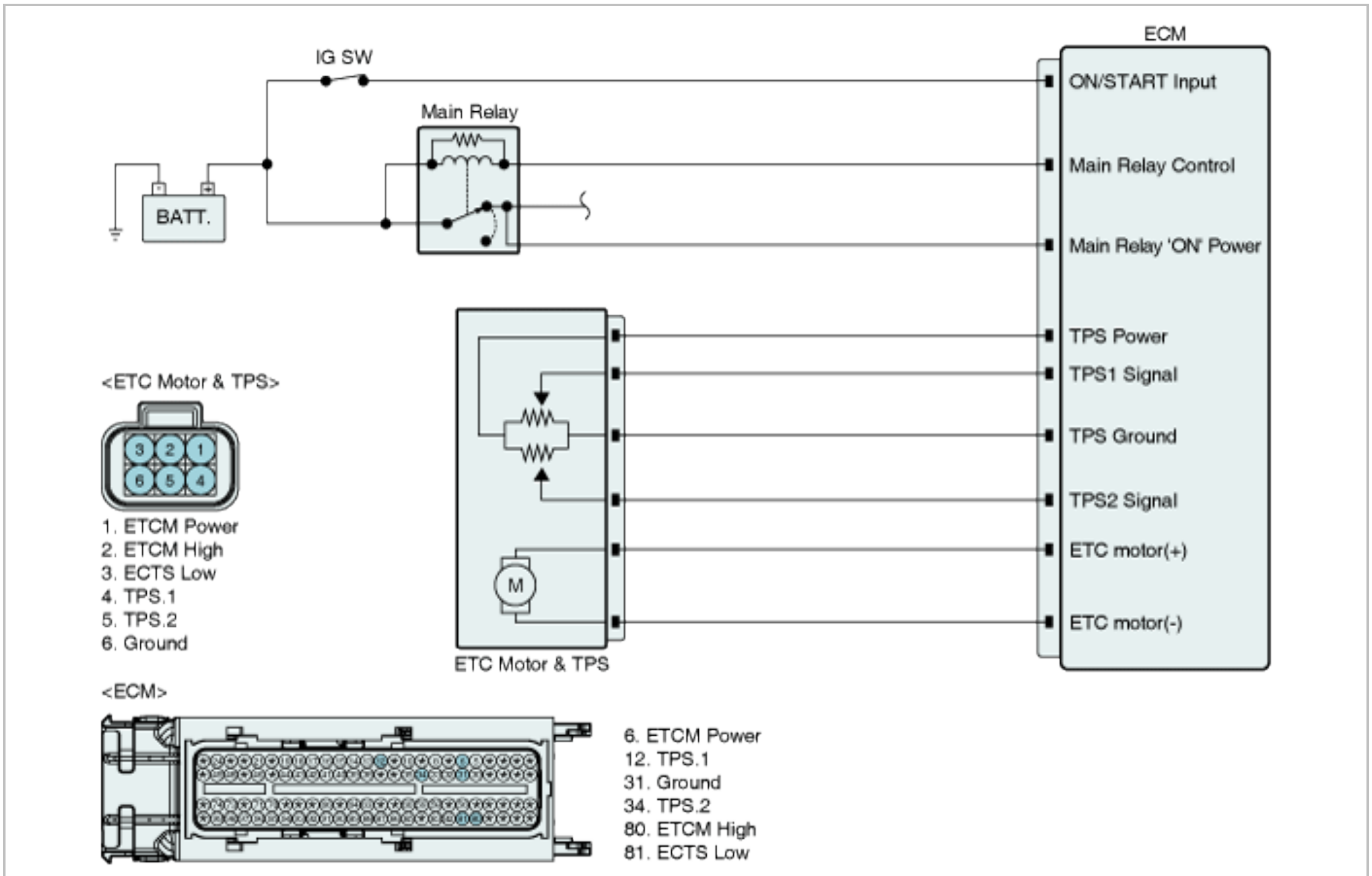
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Monitor the engine coolant temperature and time	• ECTS
Enable Conditions	• Engine running • Coolant sensor is normal • Startup coolant temp ≤ 10°C(50 °F) • No disabling faults(DTCs related to MAFS/MAPS, catalyst, fuel system or engine oil temperature sensor)	
Threshold value	• The engine coolant temperature dosen't reach the coolant temperature threshold within predetermined period	
Diagnosis Time	• Once per driving cycle	
MIL On Condition	• 2 Driving Cycles	

Specification

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

Diagnostic Circuit Diagram



Signal Waveform & Data

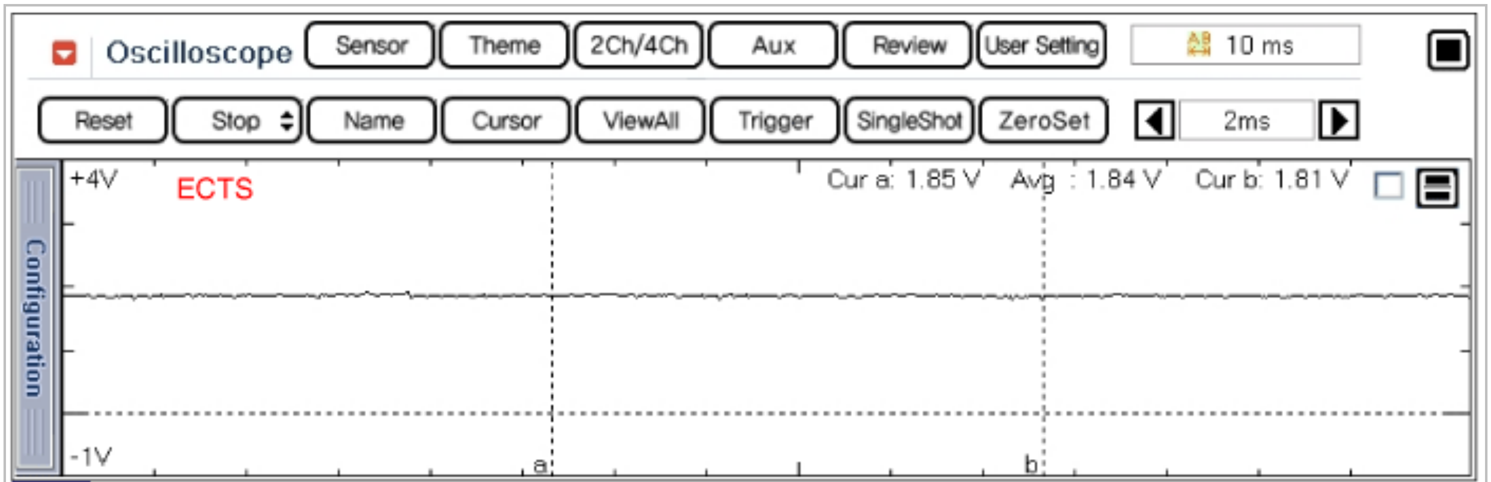


Fig.1

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | Filter

Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	80.6	'F
☑ Intake Air Temperature Sensor	86.0	'F
☑ Oil Temperature Sensor	83.3	'F

Fig.2

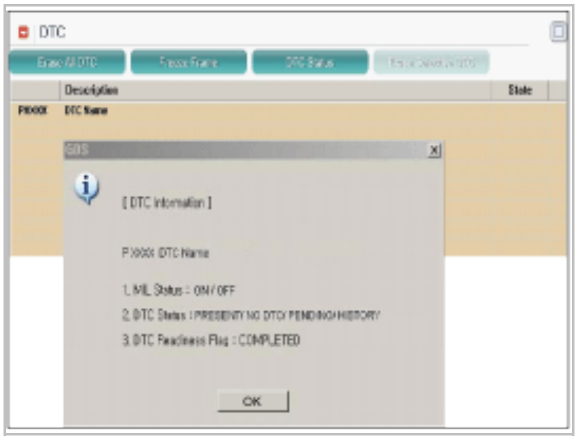
Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	194.0	'F
☑ Intake Air Temperature Sensor	106.3	'F
☑ Oil Temperature Sensor	194.0	'F

Fig.3

Fig.1) Normal waveform of ECTS at 90°C (194°F)
Fig.2) Normal data of IATS & ECTS & EOTS at ig on
Fig.3) Normal data of IATS & ECTS & EOTS after warming up.
The output signals of IATS & ECTS change smoothly without any rapid changes. Those have almost same characteristic signal during the early period after start. It means that the temperatures of intake air and engine coolant are depended on the temperature of atmosphere. Meanwhile, during the warming up, the output signal of ECTS is going up increasingly. but, the output signal of IATS changes a little bit. even it may not change almost. It means that the heat of engine does not affect on the temperature of intake air.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Fault is intermittent, go to "Verification of vehicle Repair" procedure.

Component Inspection

■ Check ECTS resistance

1. IG "OFF" and disconnect ECTS connector.
2. Measure resistance between signal and ground terminals of ECTS connector after checking out the temperature of ECTS with GDS (Component Side)
   Specification :

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

3. Is the measured resistance within specification ?

YES	▶ Clear DTC and Test-drive under enable conditions above - mentioned. After the test, If this DTC is set, recheck it thoroughly. If not, it is intermittent fault, go to "Verification of vehicle Repair" procedure.
NO	▶ Substitute with a known - good ECTS and check for proper operation. If the problem is corrected, Go to "Verification of Vehicle Repair"procedure.

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.

2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0128 Coolant Thermostat (Coolant Temperature below Thermostat Regulating Temperature)

General Description

When the engine is first started, the fuel control system operates in an open loop operation, ignoring the HO2S(Heated Oxygen Sensor) signal and calculating the air/fuel ratio based on inputs from the engine coolant temperature, the throttle position and the mass air flow sensors. The ECM will begin by using the oxygen sensor signal for controlling the fuel delivery(closed loop) when the following conditions are met:
- The engine has run a minimum amount of time at engine start up.
- The HO2S has a varying voltage output showing that it is hot enough to operate properly.
- The ECT has increased a minimum amount based on the ECT at start up.

The ECM monitors the amount of time for the cooling system to achieve closed loop operating temperature. The engine coolant temperature sufficient to allow closed loop operation is not achieved within a predetermined time frame, ECM sets DTC.

DTC Description

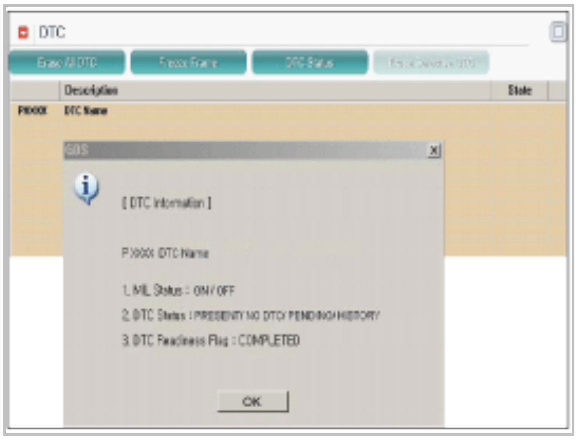
Checking time and coolant temperature under detecting condition, if the coolant temperature dose not reach the target temperature as the test timer reaches the threshold time, ECM sets P0128. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

<table>
<tr><th>Item</th><th>Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td>• Monitor the engine coolant temperature and time</td><td rowspan="5">• Thermostat stuck</td></tr>
<tr><td>Enable Conditions</td><td>• Coolant sensor is normal
• Thermostat target temperature - Startup coolant temperature ≥ 20°C(36°F)
• Intake air temperature > - 10°C(14°F)
• Engine Running</td></tr>
<tr><td>Threshold value</td><td>• The coolant temperature dose not reach the target temperature as the test timer reaches the threshold time.</td></tr>
<tr><td>Diagnosis Time</td><td>• Once per driving cycle</td></tr>
<tr><td>MIL On Condition</td><td>• 2 Driving Cycles</td></tr>
</table>

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Fault is intermittent, go to "Verification of vehicle Repair" procedure.

Component Inspection

1. Remove the thermostat and check the following items:.
   (1) Stuck or damaged
   (2) Verify the temperature at which the valve is open
      - Valve opening temperature : 82°C(177°F)
      - Full opening temperature : 95°C(205°F)
2. Is the thermostat noraml?

YES	▶ Clear DTC and Test-drive under enable conditions above - mentioned. After the test, If this DTC is set, recheck it thoroughly. If not, it is intermittent fault, go to "Verification of vehicle Repair" procedure.
NO	▶ Substitute with a known - good Thermostat and check for proper operation. If the problem is corrected, Go to "Verification of Vehicle Repair"procedure.

Verification of Vehicle Repair

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

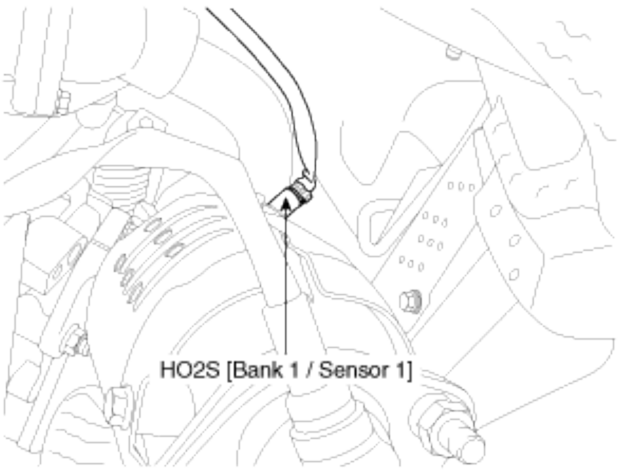
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.

NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0131 O2 Sensor Circuit Low Voltage(Bank 1 / Sensor 1)

Component Location



General Description

In order to control emissions of the CO, HC and NOx components of the exhaust gas, heated oxygen sensor (HO2S), mounted on the front side and rear side of catalytic converter, detects the oxygen content in the exhaust gas. The front HO2S signal is used to control air/fuel ratio (closed loop fuel control) and the rear HO2S signal is used to monitor front HO2S and catalyst for proper operation. The HO2S requires a minimum temperature to operate properly and provide a closed loop fuel control system. The HO2S contains the heater element to reduce its warming-up time and ensure its performance during all driving conditions. The oxygen sensor generates a voltage that indicates the difference between the oxygen content of the exhaust stream and the oxygen content of ambient air. When the exhaust stream is “rich,” there is more oxygen in the ambient air than in the exhaust stream, so the voltage will be higher.

DTC Description

Checking output signals from HO2S under detecting condition, if an output signal is below 0.04V for more than predeterminate time, ECM sets P0131. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Monitor signal voltage	• Poor connection • Short to ground in harness • HO2S(B1/S1) • ECM
Enable Conditions	• Battery voltage ≥ 10V • Engine running ≥ 60 sec • Engine warm-up state	
Threshold value	• The voltage of HO2S(B1/S1) < 0.04V	
Diagnosis Time	• Continuous (more than 12.5 sec. failure for every 15 sec.test)	

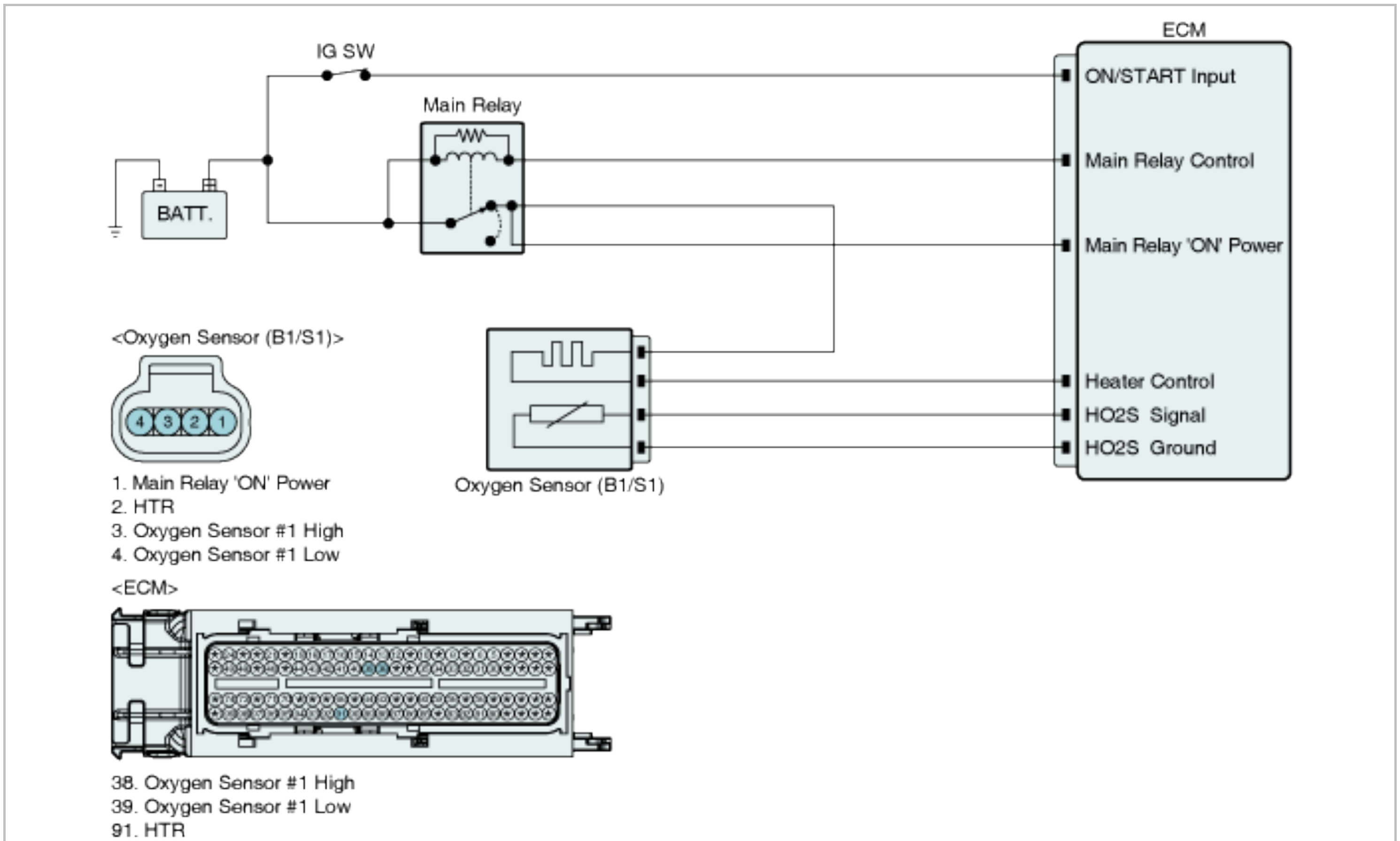
MIL On Condition	• 2 Driving Cycles	

Specification

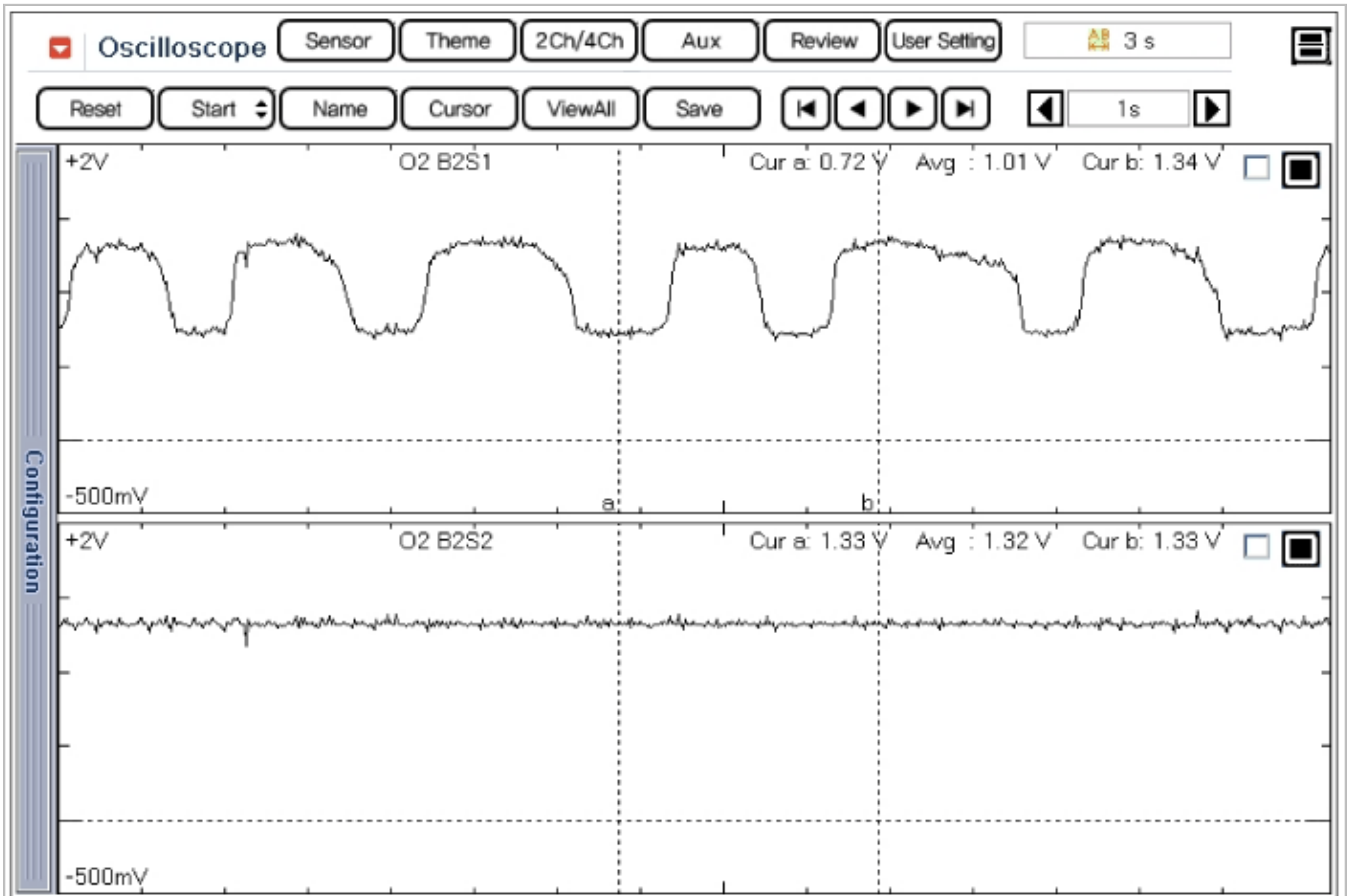
(Reference only)

Test Condition	HO2S Voltage(Sensor1)	HO2S Voltage(Sensor2)
HO2S Signal at idle after warm-up	Signal is commonly switching from rich to lean more than 3 times in 10 sec.	Signal is commonly above 0.6V.
HO2S signal at open circuit (Pumping current OFF)	Approx. 0.45V	
HO2S signal at open circuit (Pumping current ON)	Approx. 2.2V	

Diagnostic Circuit Diagram



Signal Waveform & Data


Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
3 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 0.72 V
Avg : 1.01 V
Cur b: 1.34 V
-500mV
a
b
+2V
O2 B2S2
Cur a: 1.33 V
Avg : 1.32 V
Cur b: 1.33 V
-500mV
Fig.1

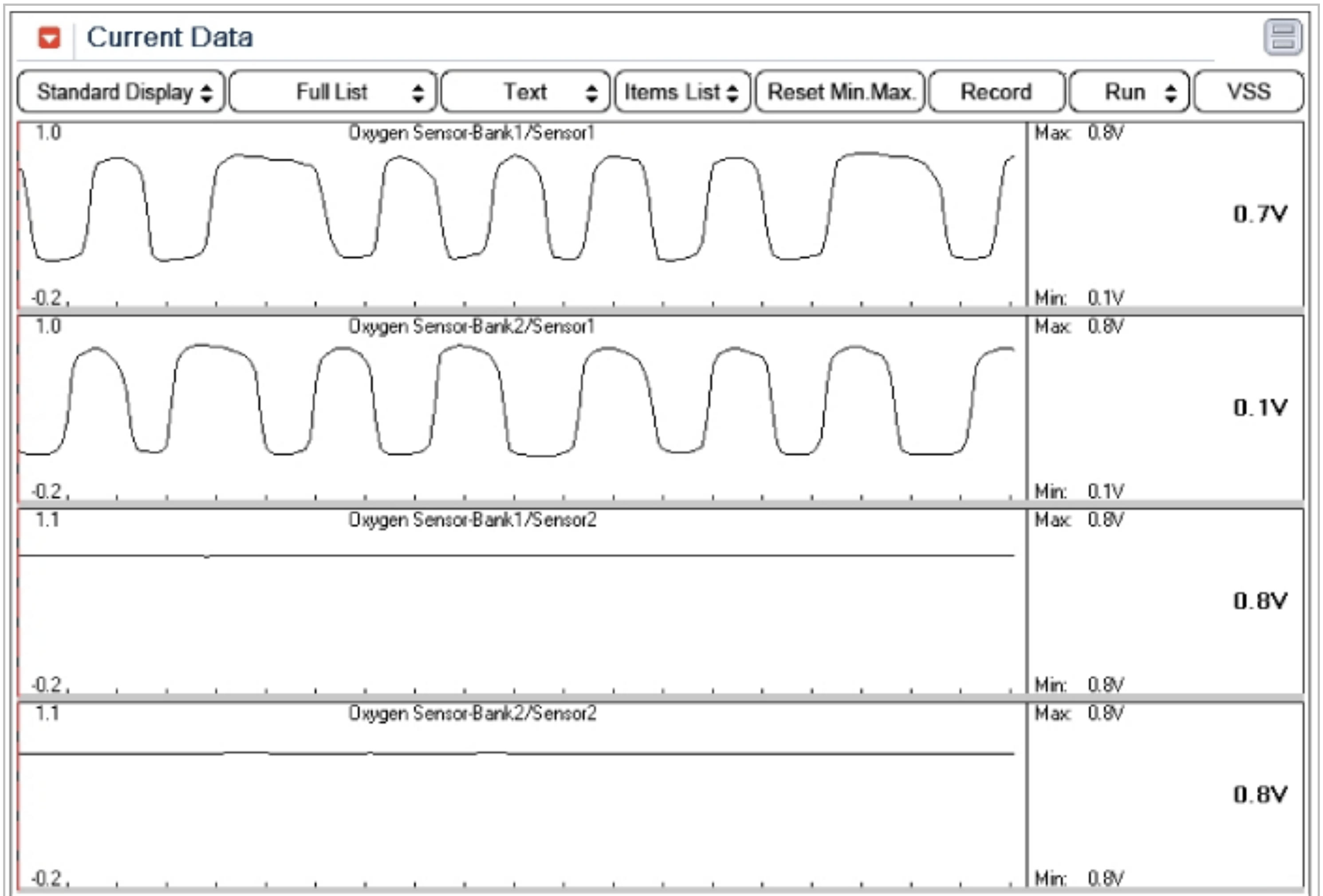


Fig.2

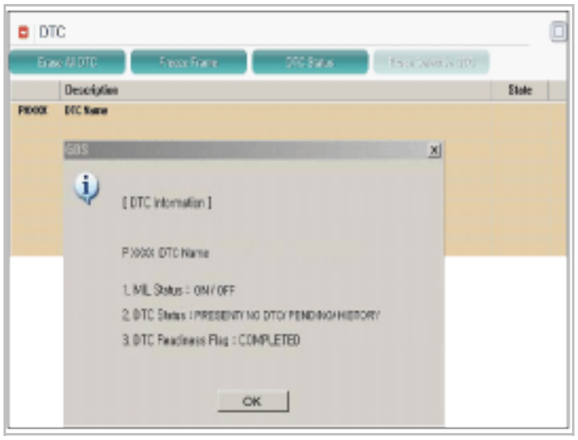
Fig.1) Normal waveforms of front HO2S(the upper) and rear HO2S(the lower). (Waveform between HIGH signal line of HO2S and chassis ground)

Fig.2) Normal graph of front HO2S and rear HO2S at idle.

After warming-up, if accelerator pedal is released suddenly around 4000rpm, the HO2S signal reading will be lower than 200mV resulting from Fuel cut-off for the moment. Conversely, if suddenly accelerator pedal is depressed, HO2S signal reading will be around 0.6V ~1.0V. At idle, Normally HO2S signal will switch from lean to rich with 3 Hz. And as racing, Its frequency rises.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Signal Circuit Inspection" procedure.

Signal Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect HO2S(B1/S1) connector.
2. IG "ON".
3. Measure voltage between signal terminal of HO2S(B1/S1) harness connector and chassis ground.

Specification : Approx. 2.2V - when pumping current is ON
Approx. 0.45V - when pumping current is OFF

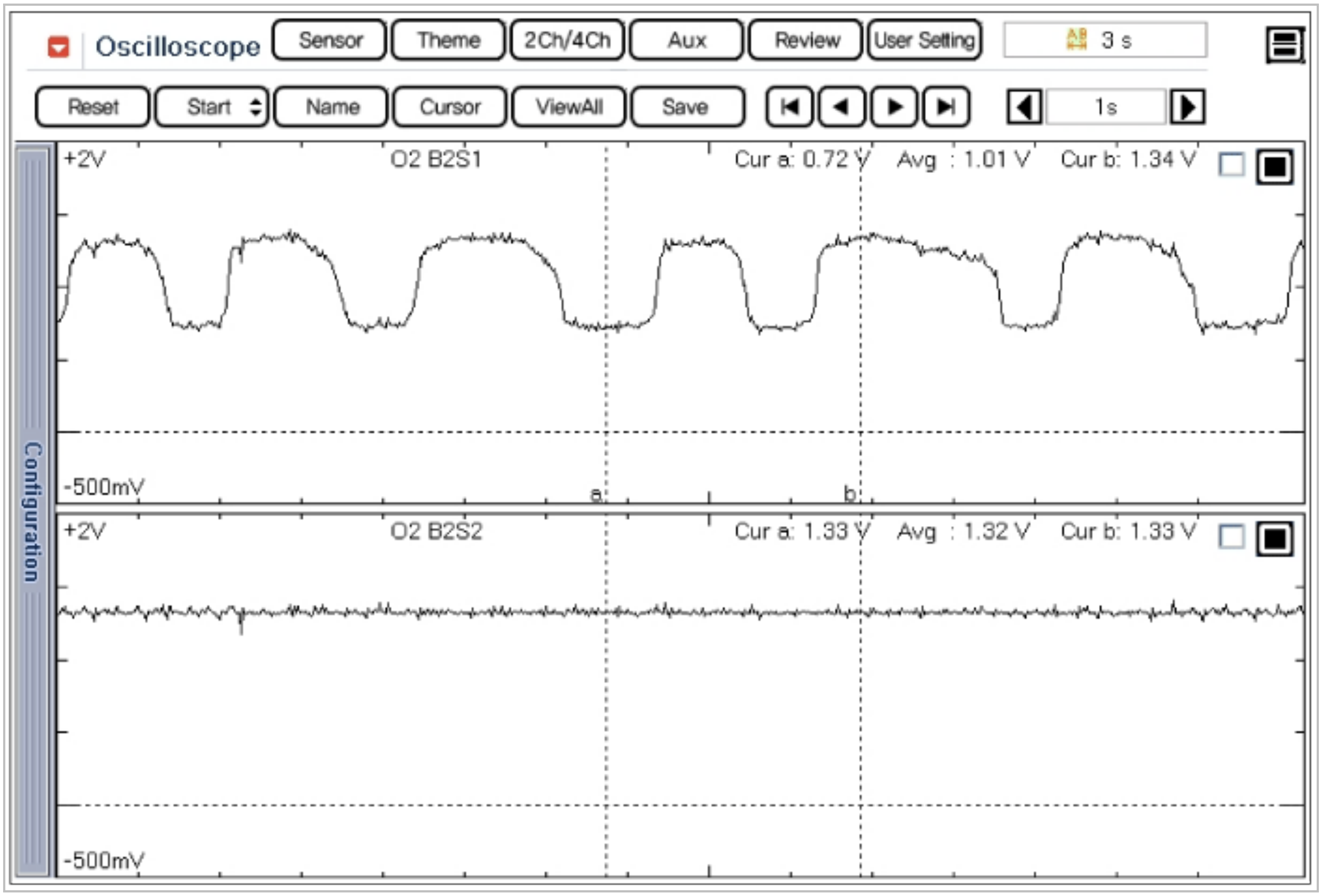
4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to ground in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check the Signal waveform of HO2S

1. IG "OFF" and connect HO2S connector.
2. Engine start.
3. After warming-up, monitor signal waveform of HO2S with GDS.



4. Is the sensor switching properly ?

YES	▶ Go to "Check HO2S" as below.
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

■ Check HO2S

1. IG "OFF" and disconnect HO2S connector.
2. Check that the HO2S is securely installed.
3. Check the HO2S for contamination or damage
4. Is the sensor normal?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE

	There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

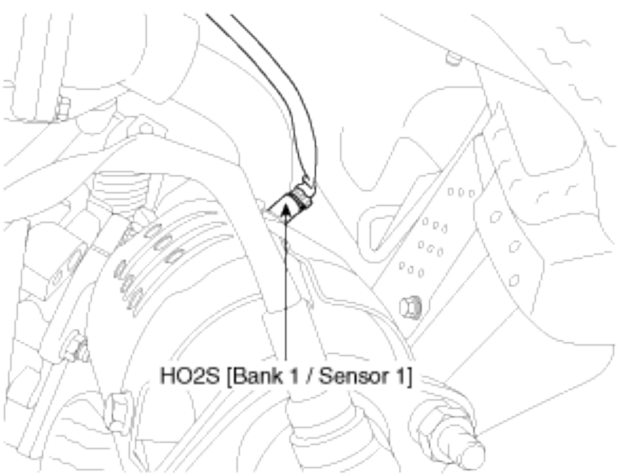
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0132 O2 Sensor Circuit High Voltage(Bank 1 / Sensor 1)

Component Location



General Description

In order to control emissions of the CO, HC and NOx components of the exhaust gas, heated oxygen sensor (HO2S), mounted on the front side and rear side of catalytic converter, detects the oxygen content in the exhaust gas. The front HO2S signal is used to control air/fuel ratio (closed loop fuel control) and the rear HO2S signal is used to monitor front HO2S and catalyst for proper operation. The HO2S requires a minimum temperature to operate properly and provide a closed loop fuel control system. The HO2S contains the heater element to reduce its warming-up time and ensure its performance during all driving conditions. The oxygen sensor generates a voltage that indicates the difference between the oxygen content of the exhaust stream and the oxygen content of ambient air. When the exhaust stream is “rich,” there is more oxygen in the ambient air than in the exhaust stream, so the voltage will be higher.

DTC Description

Checking output signals from HO2S under detecting condition, if an output signal is above 1.3V for more than predeterminate time, ECM sets P0132. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

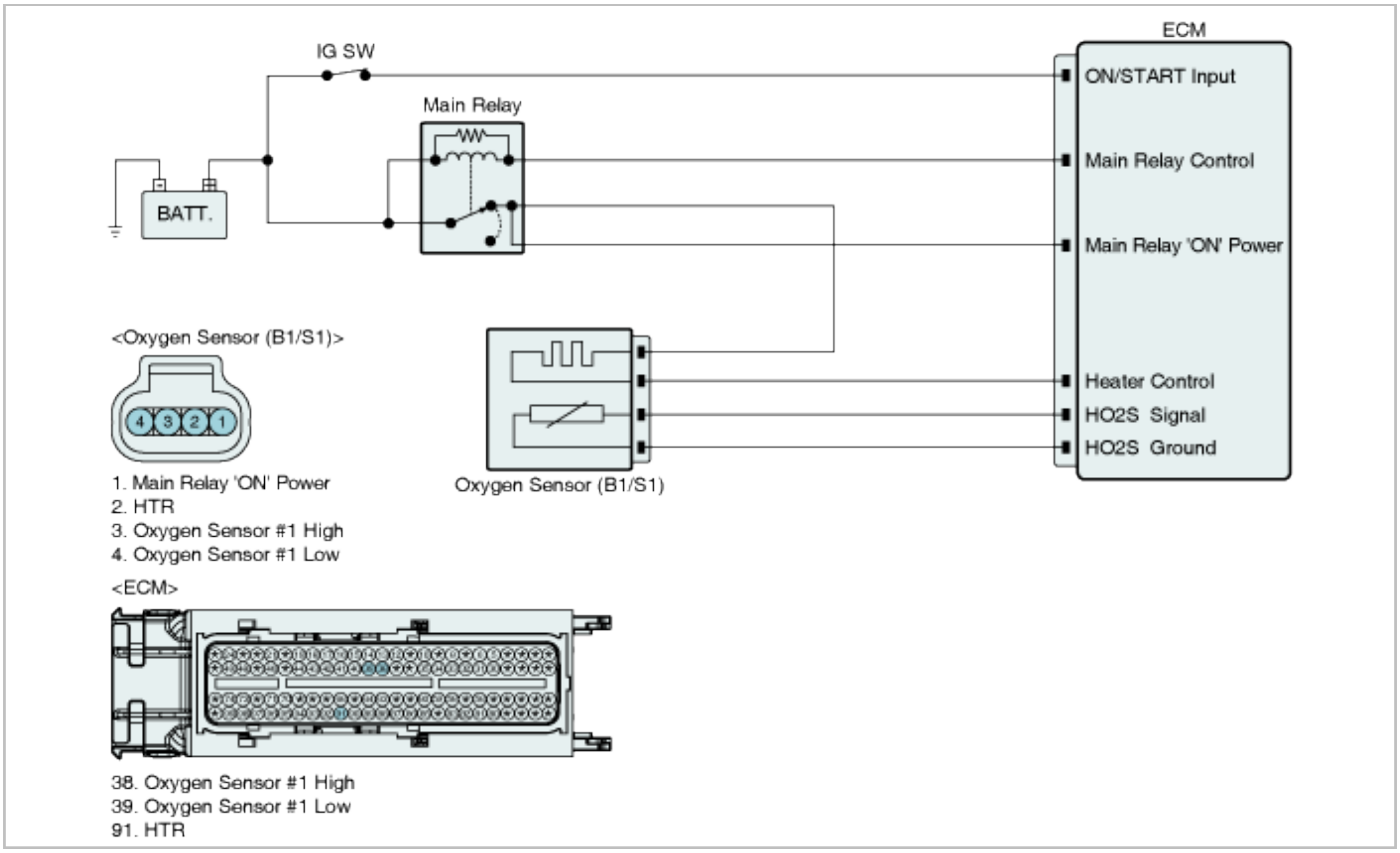
Item	Detecting Condition	Possible Cause
DTC Strategy	• Monitor signal voltage	• Poor connection • Short to battery in harness • HO2S(B1/S1) • ECM
Enable Conditions	• Battery voltage ≥ 10V • Engine running ≥ 60 sec • Engine warm-up state	
Threshold value	• The voltage of HO2S(B1/S1) > 1.3V	
Diagnosis Time	• Continous (more than 12.5 sec.failure for every 15 sec.test)	
MIL On Condition	• 2 Driving Cycles	

Specification

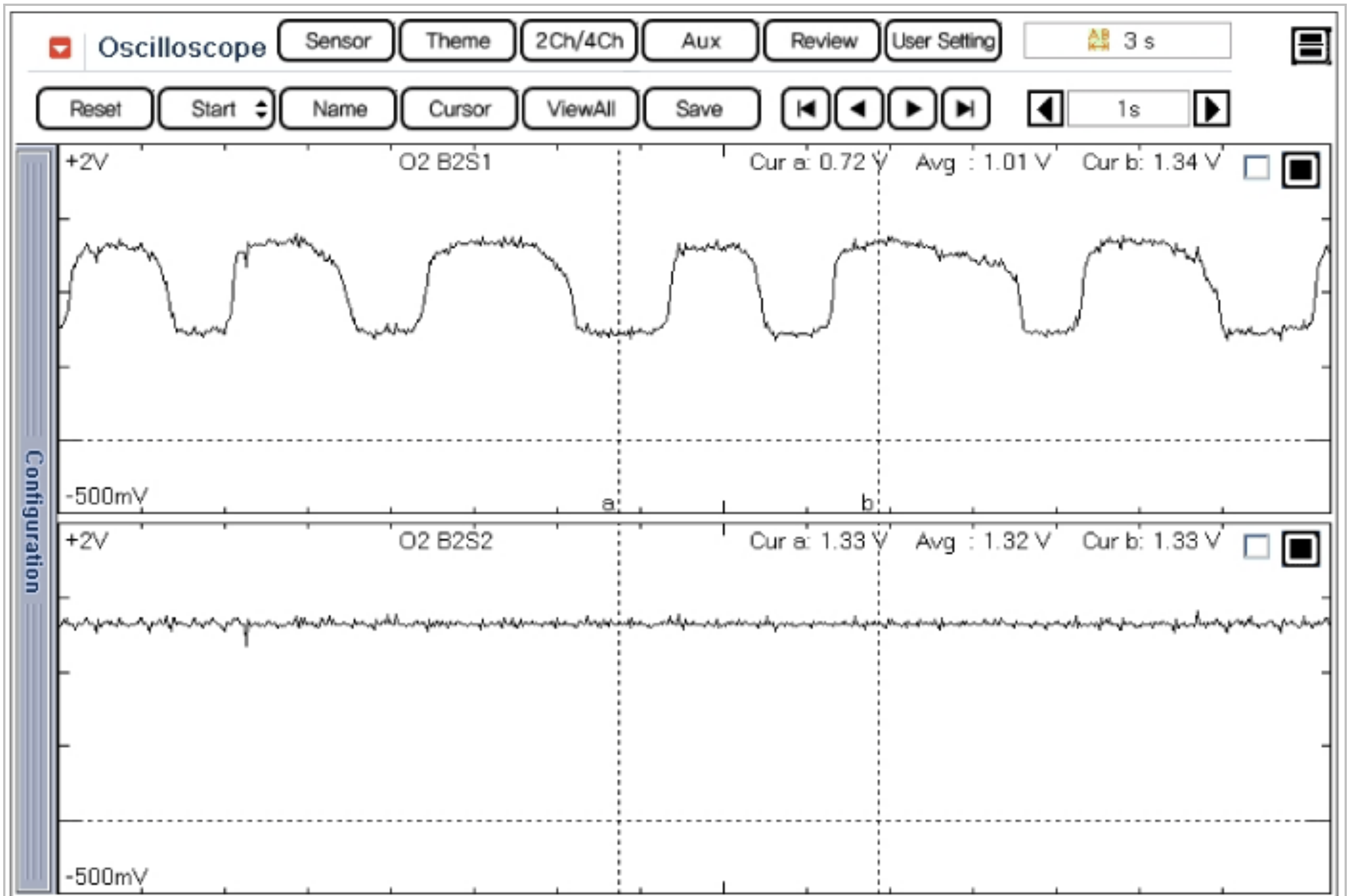
(Reference only)

Test Condition	HO2S Voltage(Sensor1)	HO2S Voltage(Sensor2)
HO2S Signal at idle after warm-up	Signal is commonly switching from rich to lean more than 3 times in 10 sec.	Signal is commonly above 0.6V.
HO2S signal at open circuit (Pumping current OFF)	Approx. 0.45V	
HO2S signal at open circuit (Pumping current ON)	Approx. 2.2V	

Diagnostic Circuit Diagram



Signal Waveform & Data


Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
3 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 0.72 V
Avg : 1.01 V
Cur b: 1.34 V
-500mV
a
b
+2V
O2 B2S2
Cur a: 1.33 V
Avg : 1.32 V
Cur b: 1.33 V
-500mV
Fig.1

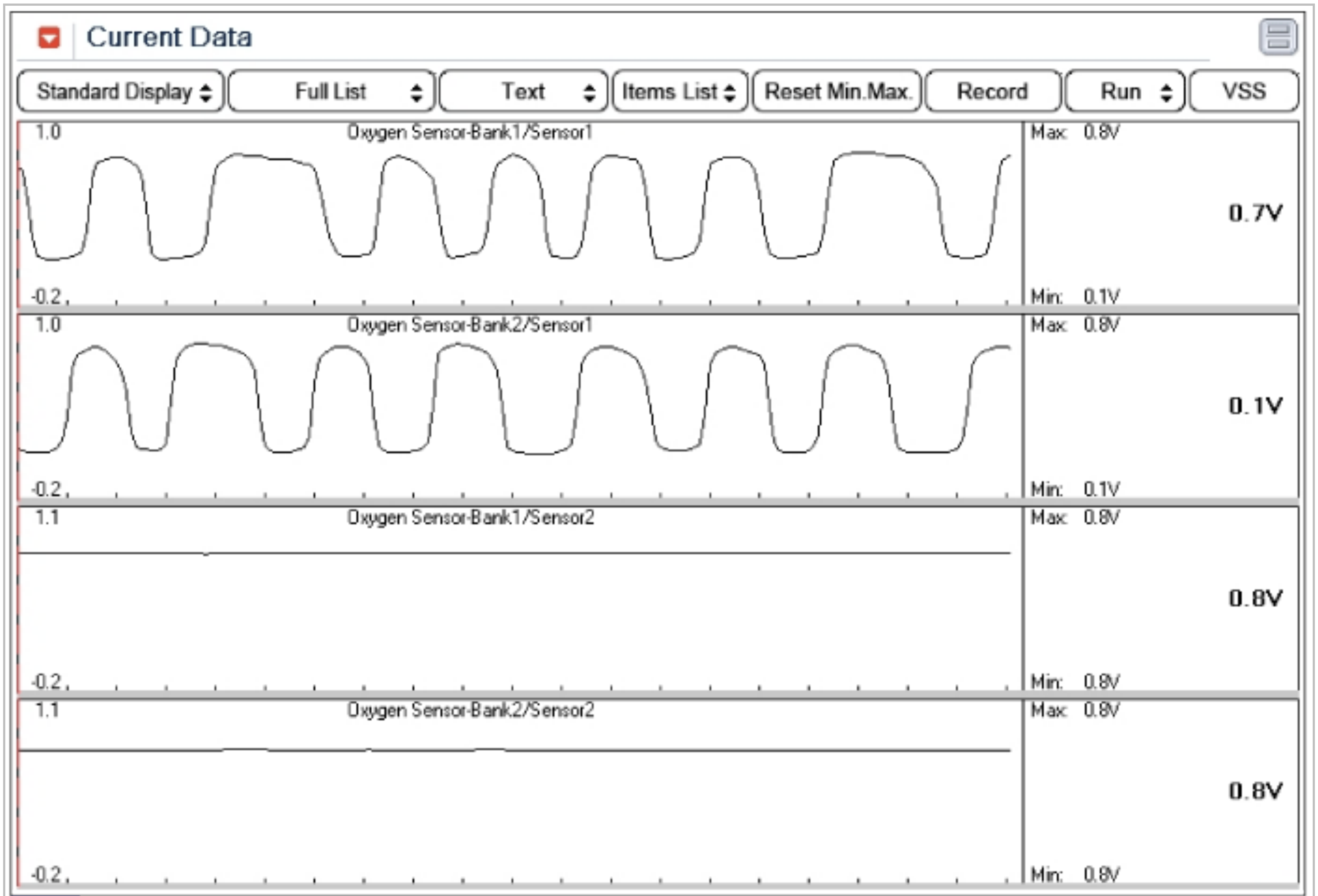


Fig.2

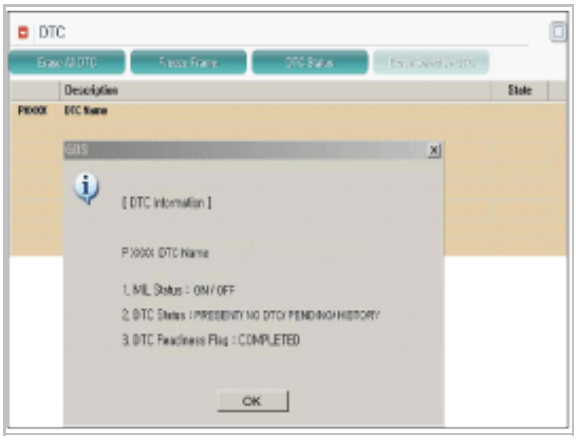
Fig.1) Normal waveforms of front HO2S(the upper) and rear HO2S(the lower). (Waveform between HIGH signal line of HO2S and chassis ground)

Fig.2) Normal graph of front HO2S and rear HO2S at idle.

After warming-up, if accelerator pedal is released suddenly around 4000rpm, the HO2S signal reading will be lower than 200mV resulting from Fuel cut-off for the moment. Conversely, if suddenly accelerator pedal is depressed, HO2S signal reading will be around 0.6V ~1.0V. At idle, Normally HO2S signal will switch from lean to rich with 3 Hz. And as racing, Its frequency rises.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor’s and/or ECM’s connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found ?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Signal Circuit Inspection" procedure.

Signal Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect HO2S(B1/S1) connector.
2. IG "ON".
3. Measure voltage between signal terminal of HO2S(B1/S1) harness connector and chassis ground.

Specification : Approx. 2.2V - when pumping current is ON
Approx. 0.45V - when pumping current is OFF

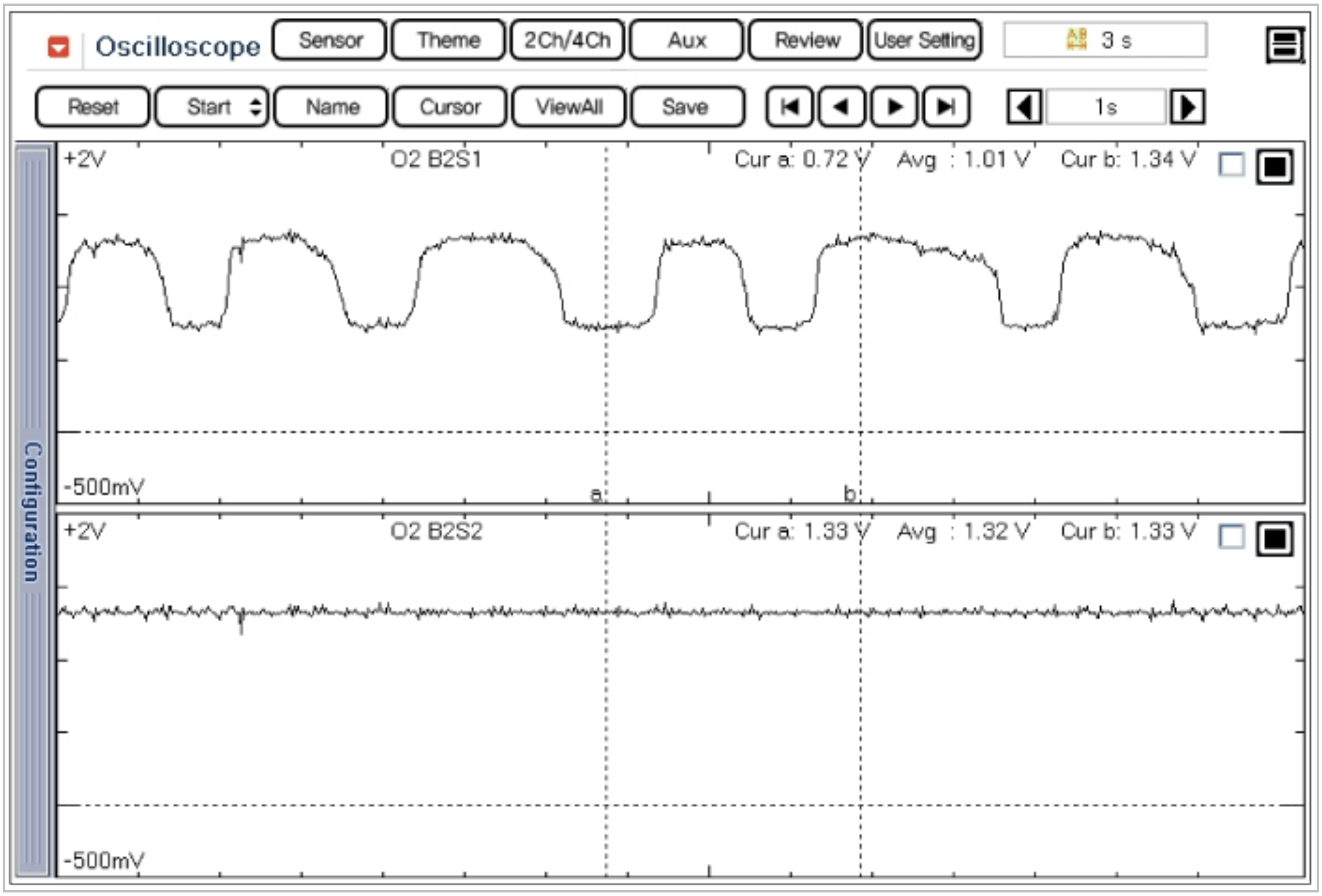
4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to battery in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check the Signal waveform of HO2S

1. IG "OFF" and connect HO2S connector.
2. Engine start.
3. After warming-up, monitor signal waveform of HO2S with GDS.



4. Is the sensor switching properly ?

YES	▶ Go to "Check HO2S" as below.
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

■ Check HO2S

1. IG "OFF" and disconnect HO2S connector.
2. Check that the HO2S is securely installed.
3. Check the HO2S for contamination or damage
4. Is the sensor normal?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE

	There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

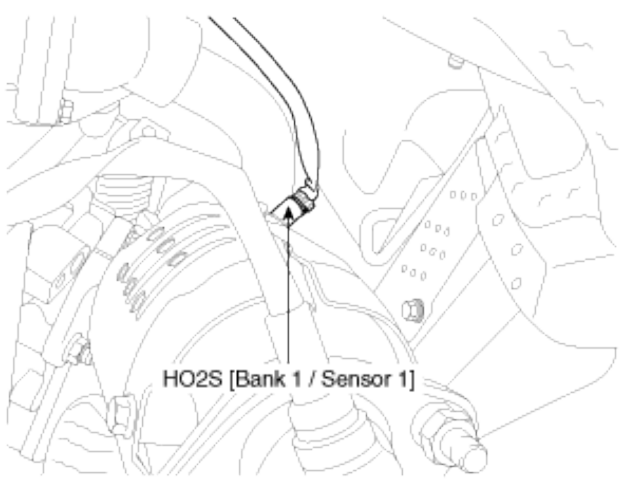
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0133 O2 Sensor Circuit Slow Response (Bank 1 / Sensor 1)

Component Location



General Description

In order to control emissions of the CO, HC and NOx components of the exhaust gas, heated oxygen sensor (HO2S), mounted on the front side and rear side of catalytic converter, detects the oxygen content in the exhaust gas. The front HO2S signal is used to control air/fuel ratio (closed loop fuel control) and the rear HO2S signal is used to monitor front HO2S and catalyst for proper operation. The HO2S requires a minimum temperature to operate properly and provide a closed loop fuel control system. The HO2S contains the heater element to reduce its warming-up time and ensure its performance during all driving conditions. The oxygen sensor generates a voltage that indicates the difference between the oxygen content of the exhaust stream and the oxygen content of ambient air. When the exhaust stream is “rich,” there is more oxygen in the ambient air than in the exhaust stream, so the voltage will be higher.

DTC Description

Checking output signals from HO2S under detecting condition, if ECM judges it's signals too slow, ECM sets P0133.
MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

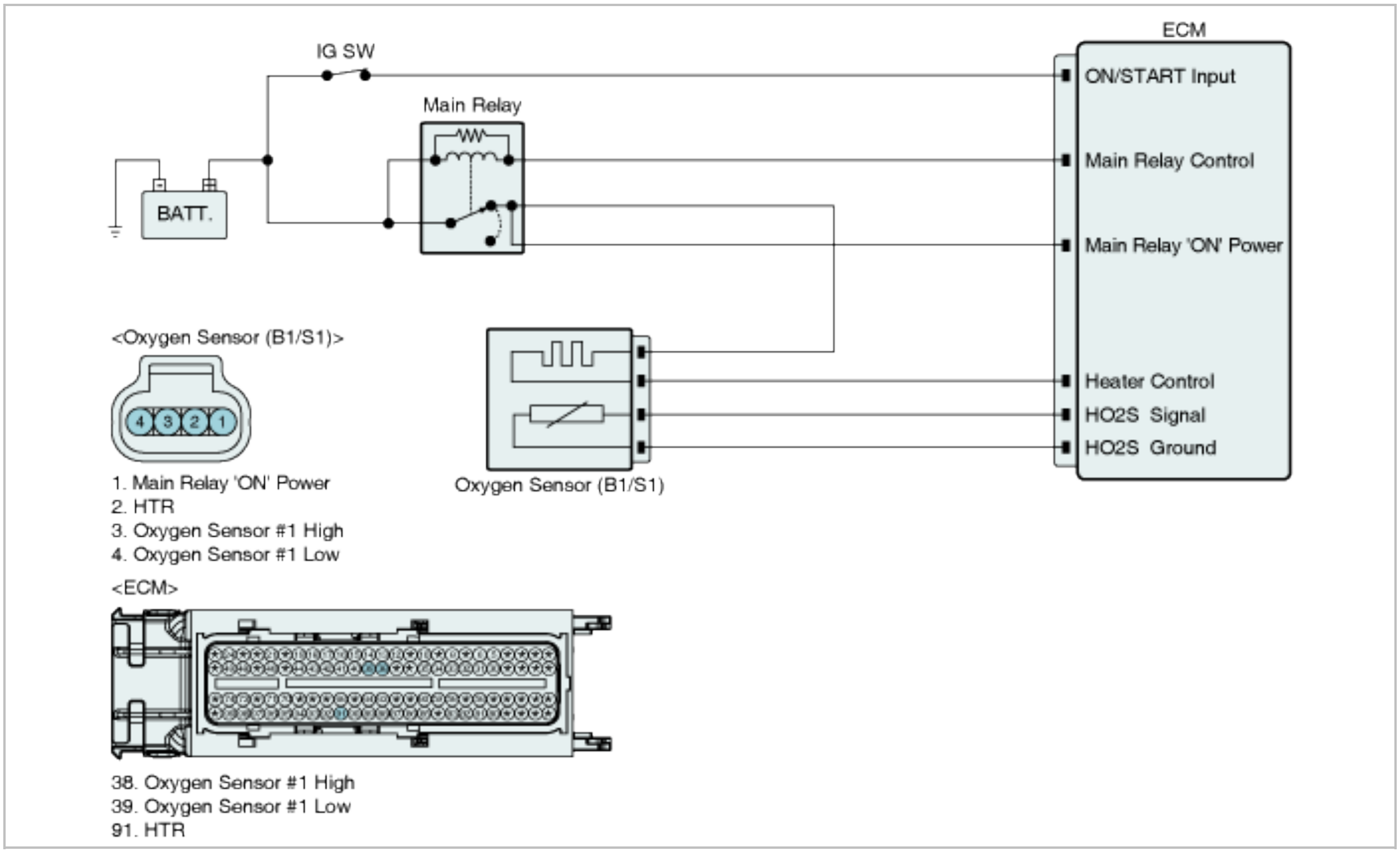
Item	Detecting Condition	Possible Cause
DTC Strategy	• Monitor HO2S's response rate	• Poor connection • Faulty HO2S • Faulty ECM
Enable Conditions	• Engine warm-up sufficiently • Engine run time > 60sec • Drive at a steady speed between 45-55 mph(72-88 km/h) • Engine Coolant > 70°C(158 °F) • No disabling faults	
Threshold value	• The calculated response rate is too slow (out of threshold in ECM)	
Diagnosis Time	• Continuous	
MIL On Condition	• 2 Driving Cycles	

Specification

(Reference only)

Test Condition	HO2S Voltage(Sensor1)	HO2S Voltage(Sensor2)
HO2S Signal at idle after warm-up	Signal is commonly switching from rich to lean more than 3 times in 10 sec.	Signal is commonly above 0.6V.
HO2S signal at open circuit (Pumping current OFF)	Approx. 0.45V	
HO2S signal at open circuit (Pumping current ON)	Approx. 2.2V	

Diagnostic Circuit Diagram



Signal Waveform & Data

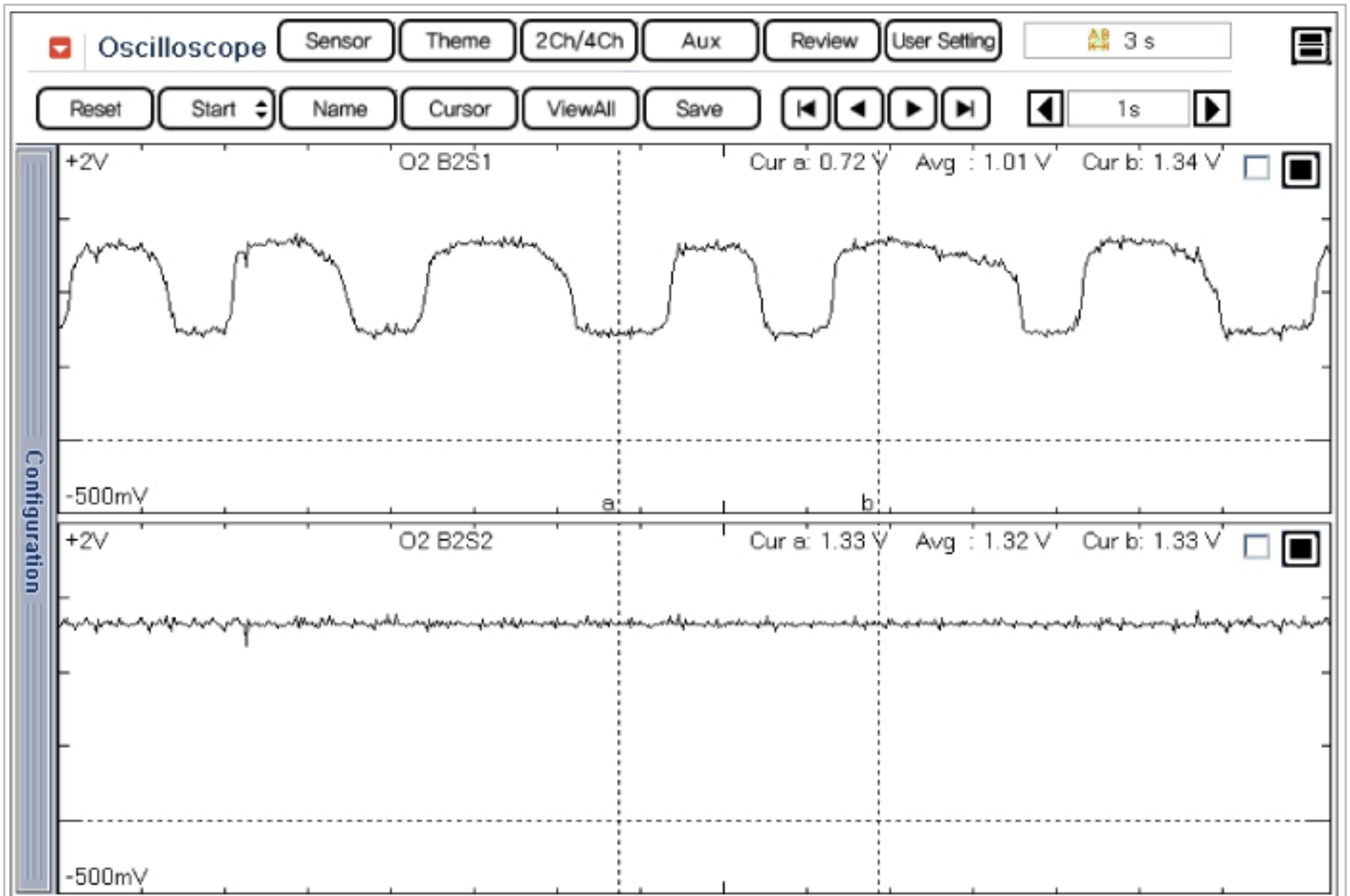

Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
3 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 0.72 V
Avg : 1.01 V
Cur b: 1.34 V
-500mV
a
b
+2V
O2 B2S2
Cur a: 1.33 V
Avg : 1.32 V
Cur b: 1.33 V
-500mV

Fig.1

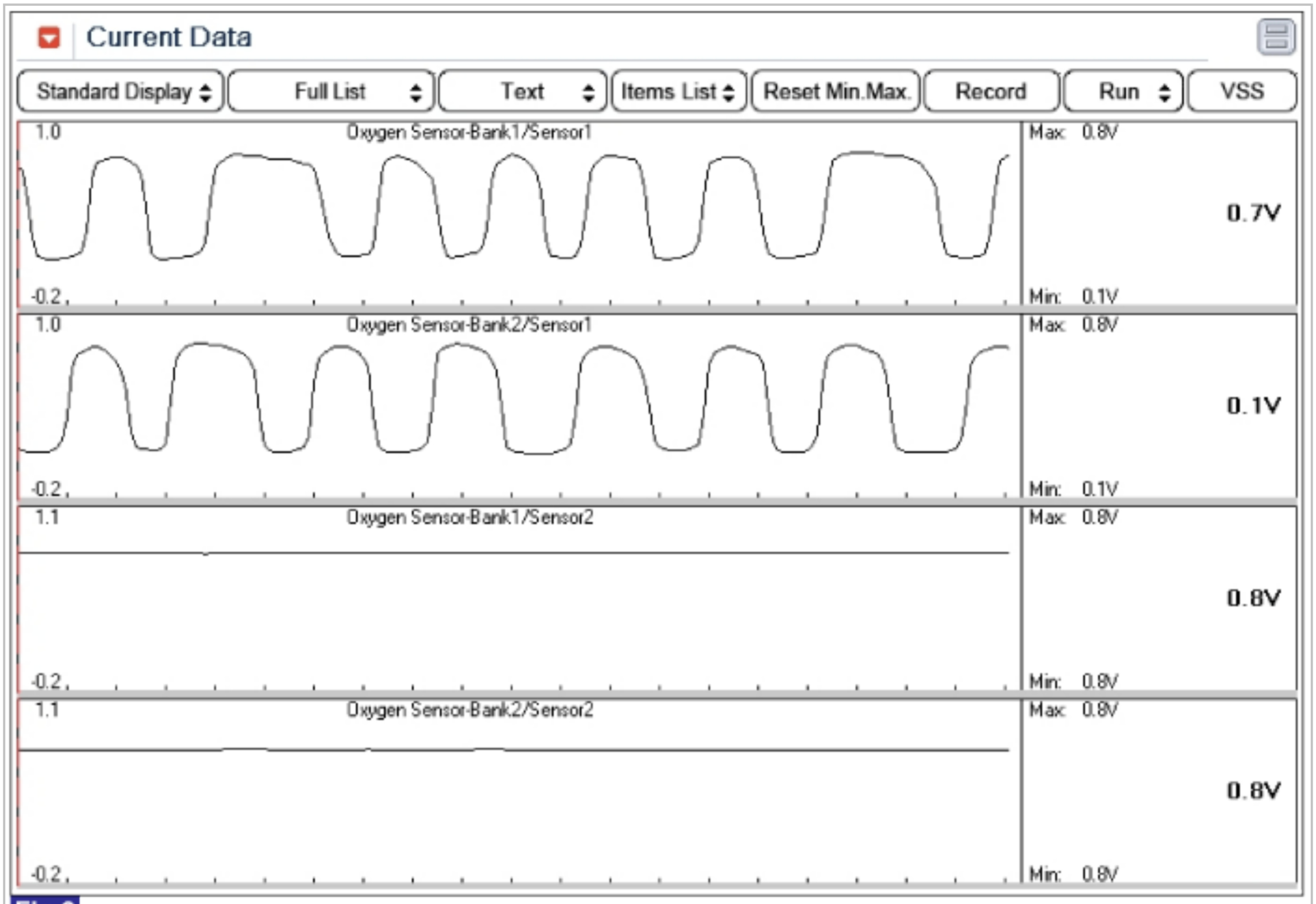


Fig.2

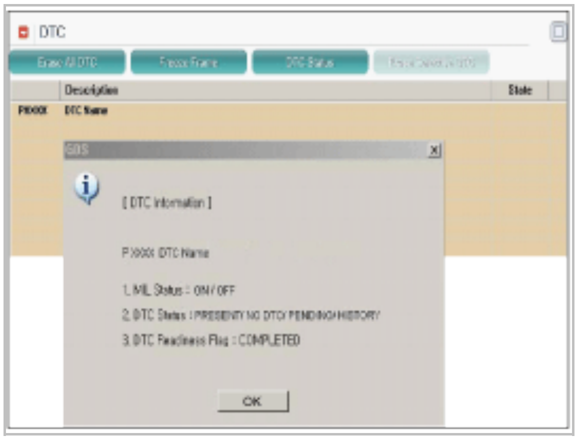
Fig.1) Normal waveforms of front HO2S(the upper) and rear HO2S(the lower). (Waveform between HIGH signal line of HO2S and chassis ground)

Fig.2) Normal graph of front HO2S and rear HO2S at idle.

After warming-up, if accelerator pedal is released suddenly around 4000rpm, the HO2S signal reading will be lower than 200mV resulting from Fuel cut-off for the moment. Conversely, if suddenly accelerator pedal is depressed, HO2S signal reading will be around 0.6V ~1.0V. At idle, Normally HO2S signal will switch from lean to rich with 3 Hz. And as racing, Its frequency rises.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Clear DTC and check if this DTC is set after test-driving under enable conditions. If DTC isn't displayed after the test, it was intermittent fault. Go to "Verification of Vehicle Repair" procedure.

Component Inspection

1. Replace the HO2S.
2. Clear DTC with GDS.
3. Start the engine and warm it up until the radiator fan comes on(more than at least 10 minutes).
4. Drive at a steady speed between 45-55 mph(72-88 km/h) for 120 sec.
5. Stop and then maintain idle state.
6. Check if O2 sensor monitoring readiness is complete.
7. Does the scan tool show DTC P0133?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Troubleshooting is finished

Verification of Vehicle Repair

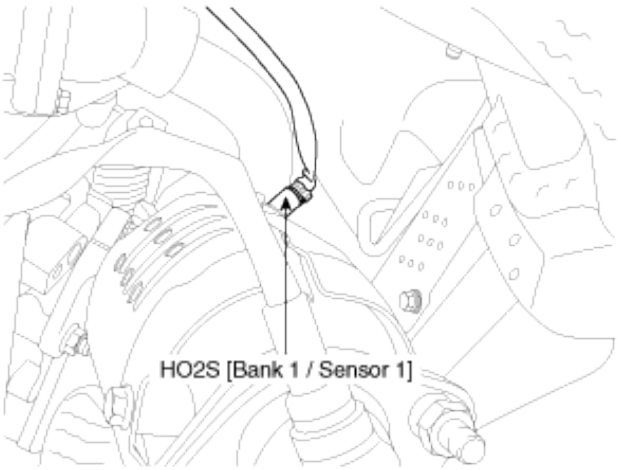
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0134 O2 Sensor Circuit No Activity Detected (Bank 1 Sensor 1)

Component Location



General Description

In order to control emissions of the CO, HC and NOx components of the exhaust gas, heated oxygen sensor (HO2S), mounted on the front side and rear side of catalytic converter, detects the oxygen content in the exhaust gas. The front HO2S signal is used to control air/fuel ratio (closed loop fuel control) and the rear HO2S signal is used to monitor front HO2S and catalyst for proper operation. The HO2S requires a minimum temperature to operate properly and provide a closed loop fuel control system. The HO2S contains the heater element to reduce its warming-up time and ensure its performance during all driving conditions. The oxygen sensor generates a voltage that indicates the difference between the oxygen content of the exhaust stream and the oxygen content of ambient air. When the exhaust stream is “rich,” there is more oxygen in the ambient air than in the exhaust stream, so the voltage will be higher.

DTC Description

Checking output signals from HO2S under detecting condition, if an output voltage is approx. 0.45V or 3.5V for more than predeterminate time, ECM sets P0134. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

Item		Detecting Condition	Possible Cause
DTC Strategy		• Monitor signal voltage	• Poor connection • Open in harness
Enable Conditions		• Battery voltage ≥ 10V • Engine running ≥ 60 sec • Engine warm-up state • No disable faults	
	Case 1	• 1.2V ≤ Voltage of HO2S ≤ 3.9V	

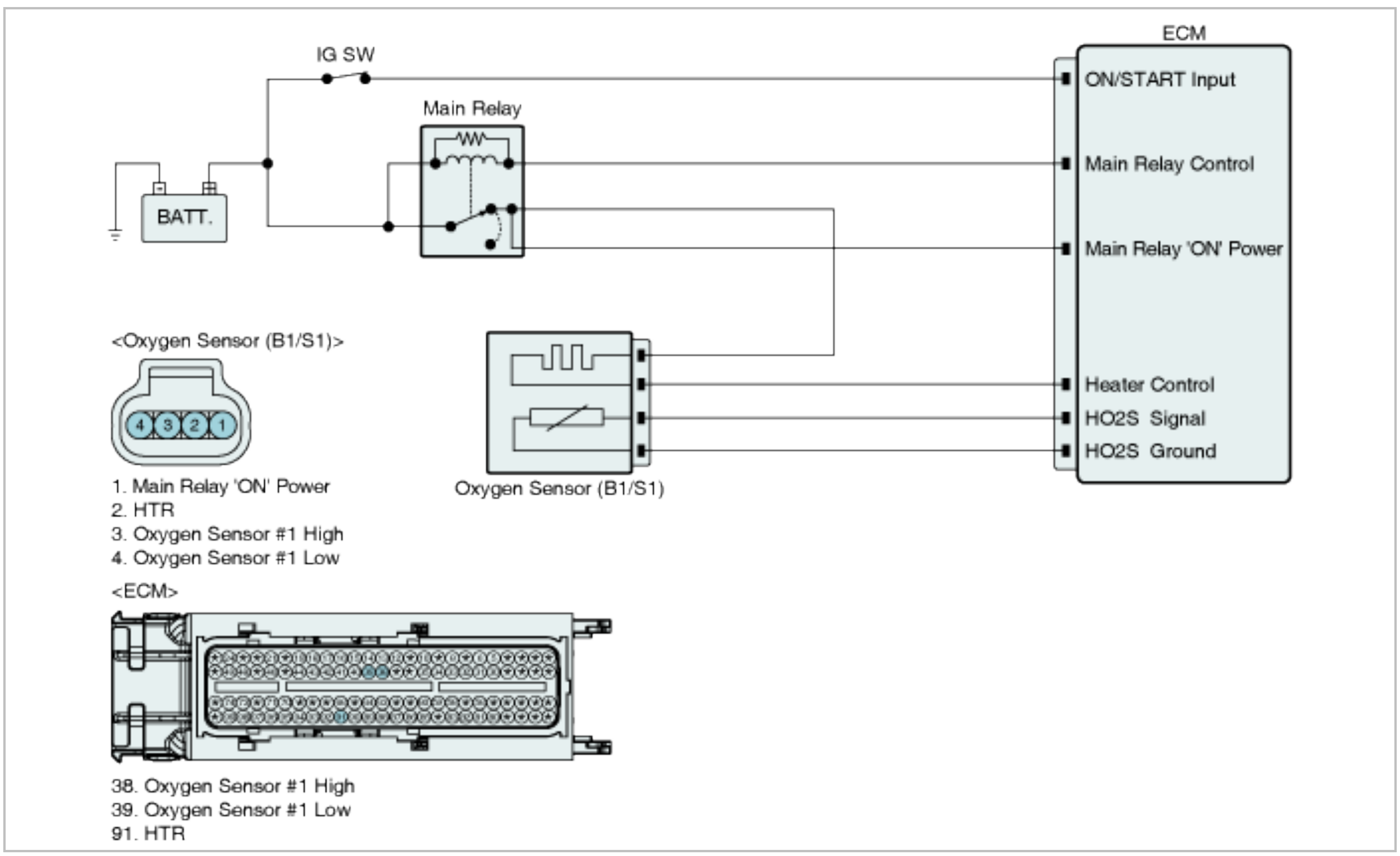
Threshold value	Case 1	(at pumping current ON)	• HO2S(B1/S1) • ECM
	Case 2	• 0.415V ≤ Voltage of HO2S ≤ 0.515V (at pumping current OFF)	
Diagnosis Time		• Continuous (more than 76.5 sec.failure for every 90 sec.test)	
MIL On Condition		• 2 Driving Cycles	

Specification

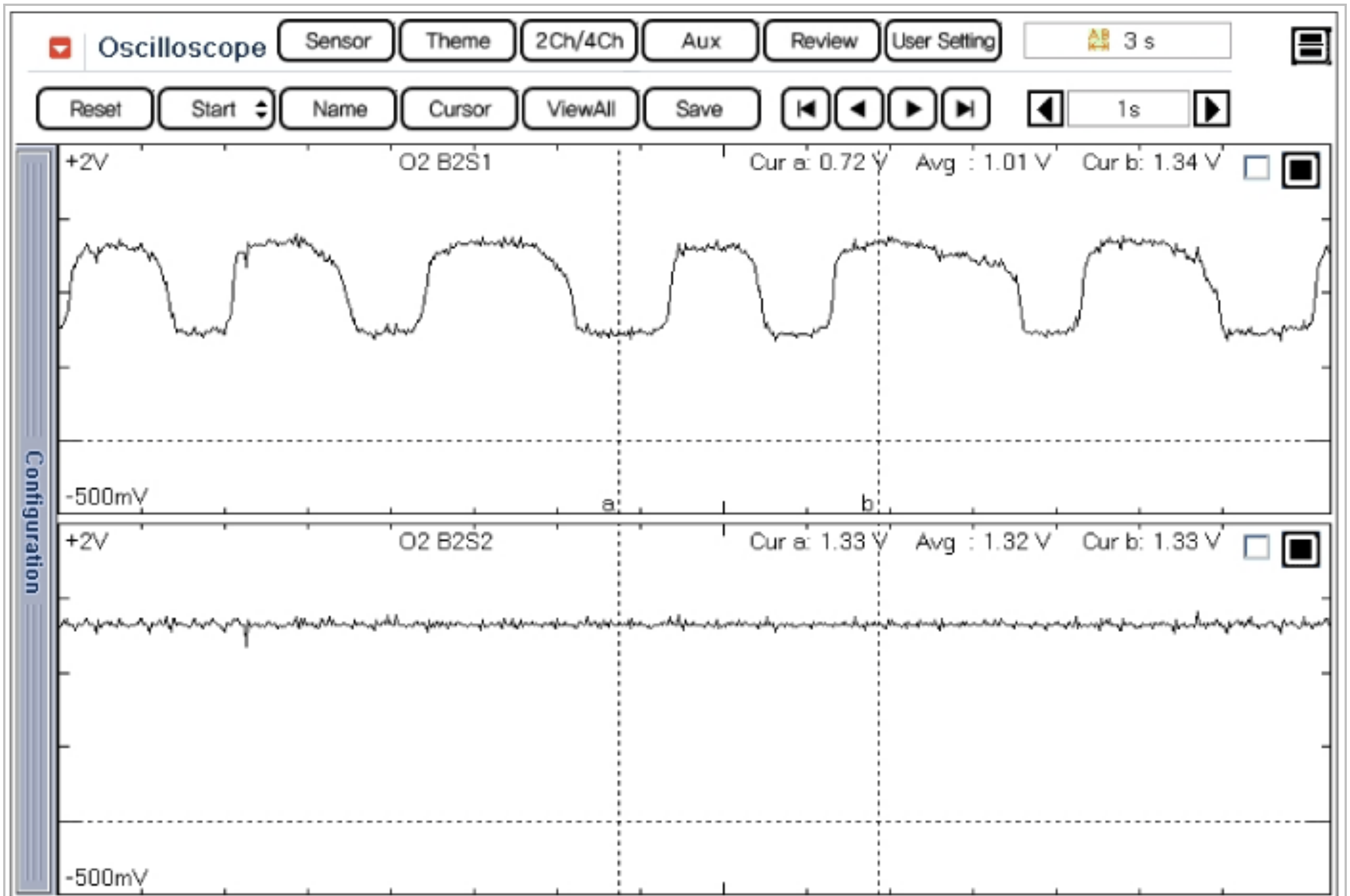
(Reference only)

Test Condition	HO2S Voltage(Sensor1)	HO2S Voltage(Sensor2)
HO2S Signal at idle after warm-up	Signal is commonly switching from rich to lean more than 3 times in 10 sec.	Signal is commonly above 0.6V.
HO2S signal at open circuit (Pumping current OFF)	Approx. 0.45V	
HO2S signal at open circuit (Pumping current ON)	Approx. 2.2V	

Diagnostic Circuit Diagram



Signal Waveform & Data


Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
3 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 0.72 V
Avg : 1.01 V
Cur b: 1.34 V
-500mV
a
b
+2V
O2 B2S2
Cur a: 1.33 V
Avg : 1.32 V
Cur b: 1.33 V
-500mV
Fig.1

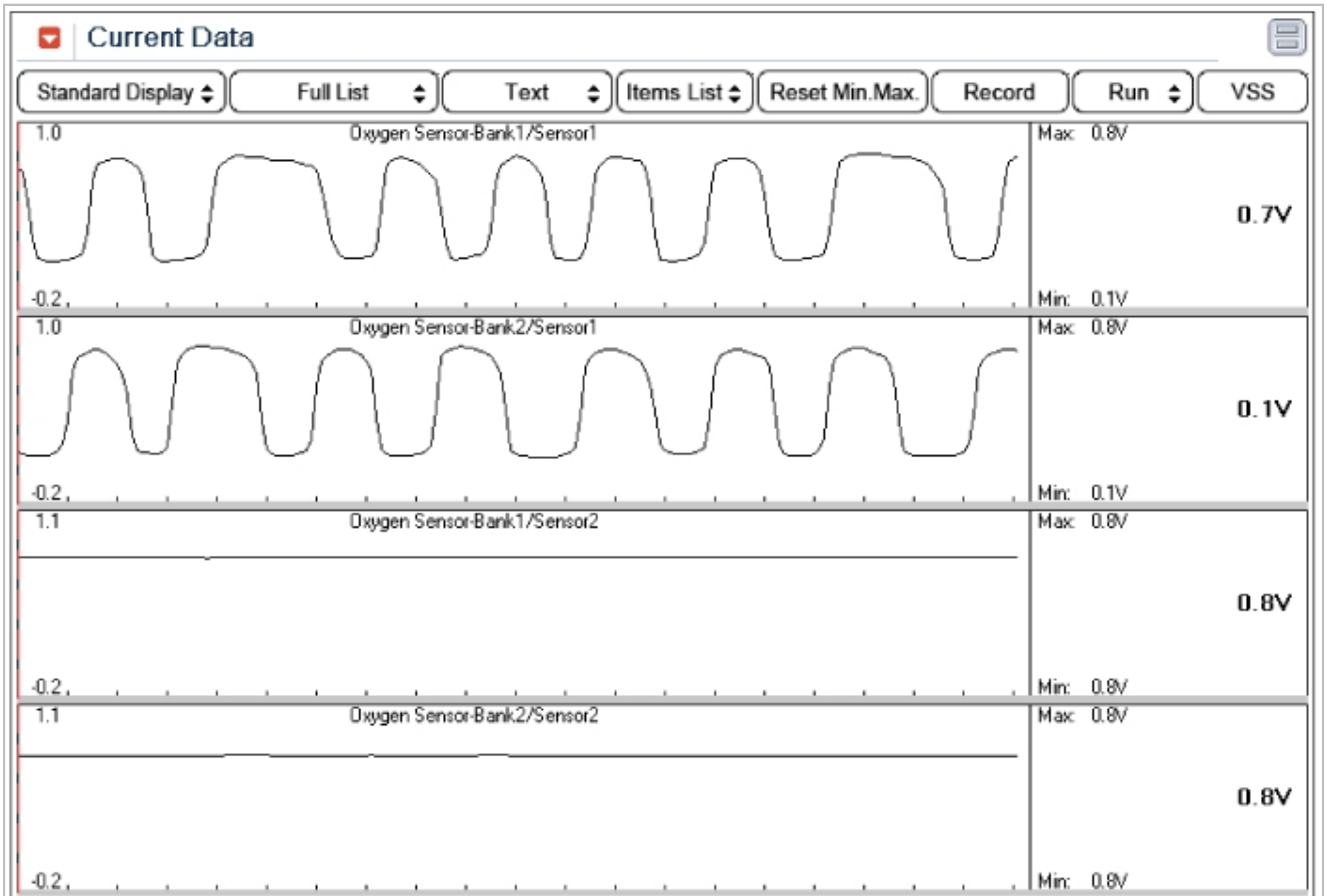


Fig.2

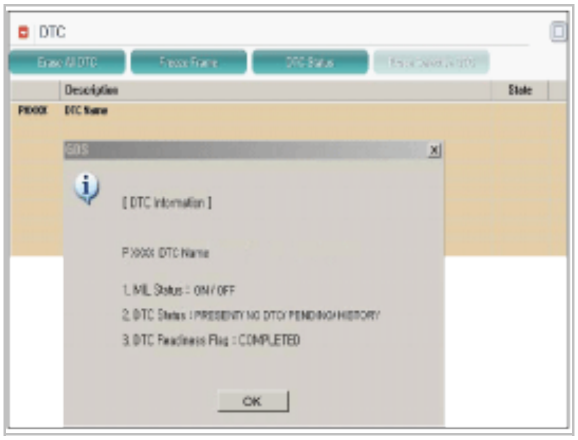
Fig.1) Normal waveforms of front HO2S(the upper) and rear HO2S(the lower). (Waveform between HIGH signal line of HO2S and chassis ground)

Fig.2) Normal graph of front HO2S and rear HO2S at idle.

After warming-up, if accelerator pedal is released suddenly around 4000rpm, the HO2S signal reading will be lower than 200mV resulting from Fuel cut-off for the moment. Conversely, if suddenly accelerator pedal is depressed, HO2S signal reading will be around 0.6V ~1.0V. At idle, Normally HO2S signal will switch from lean to rich with 3 Hz. And as racing, Its frequency rises.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Signal Circuit Inspection" procedure.

Signal Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect HO2S(B1/S1) connector.
2. IG "ON".
3. Measure voltage between signal terminal of HO2S(B1/S1) harness connector and chassis ground.

Specification : Approx. 2.2V - when pumping current is ON
Approx. 0.45V - when pumping current is OFF

4. Is the measured voltage within specification ?

YES	▶ Go to "Ground circuit inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" prcedure.

Ground Circuit Inspection

■ **Check open in harness**

1. IG "ON" and disconnect HO2S(B1/S1) connector.
2. Measure voltage between signal terminal of HO2S(B1/S1) harness connector and chassis ground.(Measurement "A")
3. Measure voltage between signal and ground terminals of HO2S(B1/S1) harness connector.(Measurement "B")

Specification : Voltage difference between measurement "A" and "B" is below 200mV.

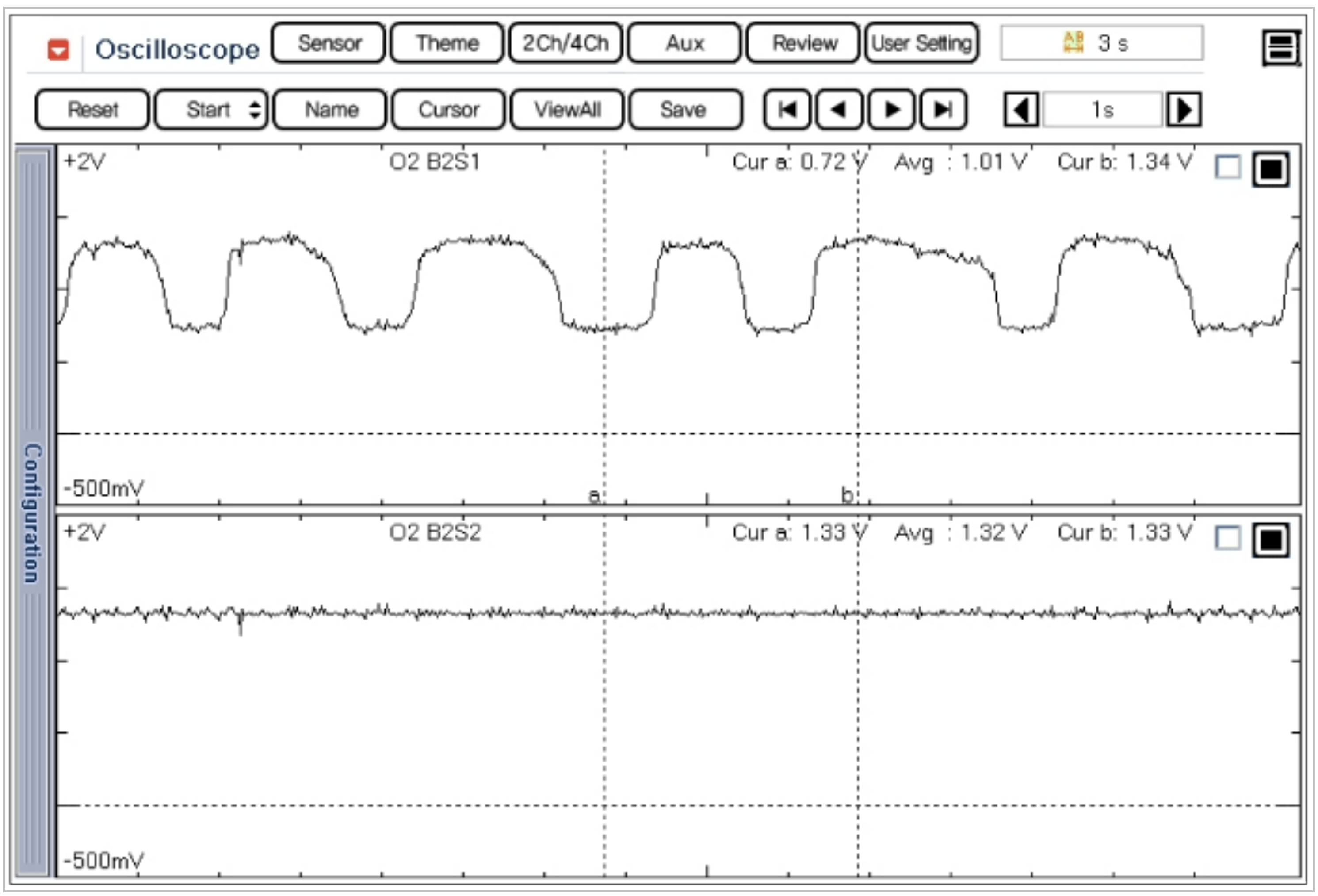
4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair contact resistance or open in harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ **Check the Signal waveform of HO2S**

1. IG "OFF" and connect HO2S connector.
2. Engine start.
3. After warming-up, monitor signal waveform of HO2S with GDS.



4. Is the sensor switching properly ?

YES	▶ Go to "Check HO2S" as below.

NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

■ Check HO2S

1. IG "OFF" and disconnect HO2S connector.
2. Check that the HO2S is securely installed.
3. Check the HO2S for contamination or damage
4. Is the sensor normal ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

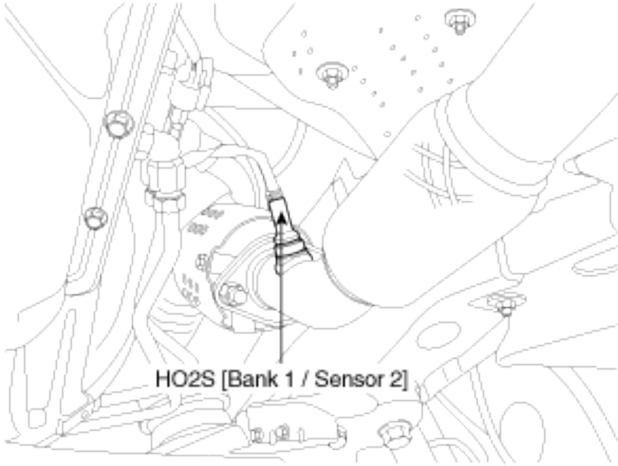
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0137 O2 Sensor Circuit Low Voltage (Bank 1 / Sensor 2)

Component Location



General Description

The rear heated oxygen sensor is mounted on the rear side of the Catalytic Converter (warm-up catalytic converter) or in the rear exhaust pipe, which is able to detect catalyst efficiency. The rear heated oxygen sensor (HO2S) produces a voltage between 0V and 1V. This rear heated oxygen sensor is used to estimate the oxygen storage capability. If a catalyst has good conversion properties, the oxygen fluctuations are smoothed by the oxygen storage capacity of the catalyst. If the conversion provided by the catalyst is low due to aging, poisoning or misfiring, then the oxygen fluctuations are similar to signals from the front oxygen sensor.

DTC Description

Checking output signals from HO2S under detecting condition, if an output signal is below 0.04V for more than predeterminate time, ECM sets P0137. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Monitor signal voltage	• Poor connection • Short to ground in harness • HO2S(B1/S2) • ECM
Enable Conditions	• Battery voltage ≥ 10V • Engine running ≥ 60 sec • Engine warm-up state	
Threshold value	• The voltage of HO2S(B1/S2) < 0.04V	
Diagnosis Time	• Continuous (more than 12.5 sec. failure for every 15 sec.test)	
MIL On Condition	• 2 Driving Cycles	

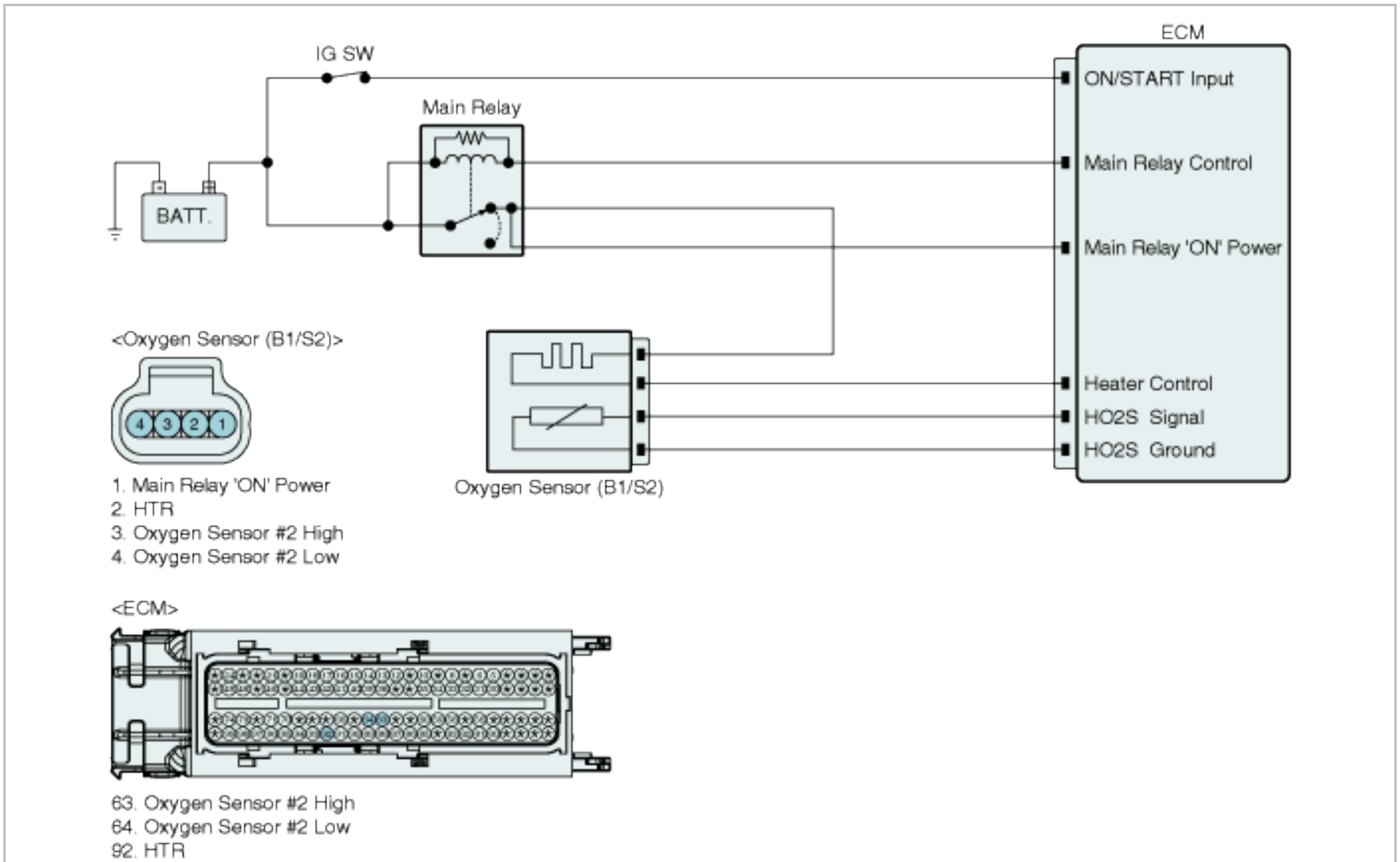
Specification

(Reference only)

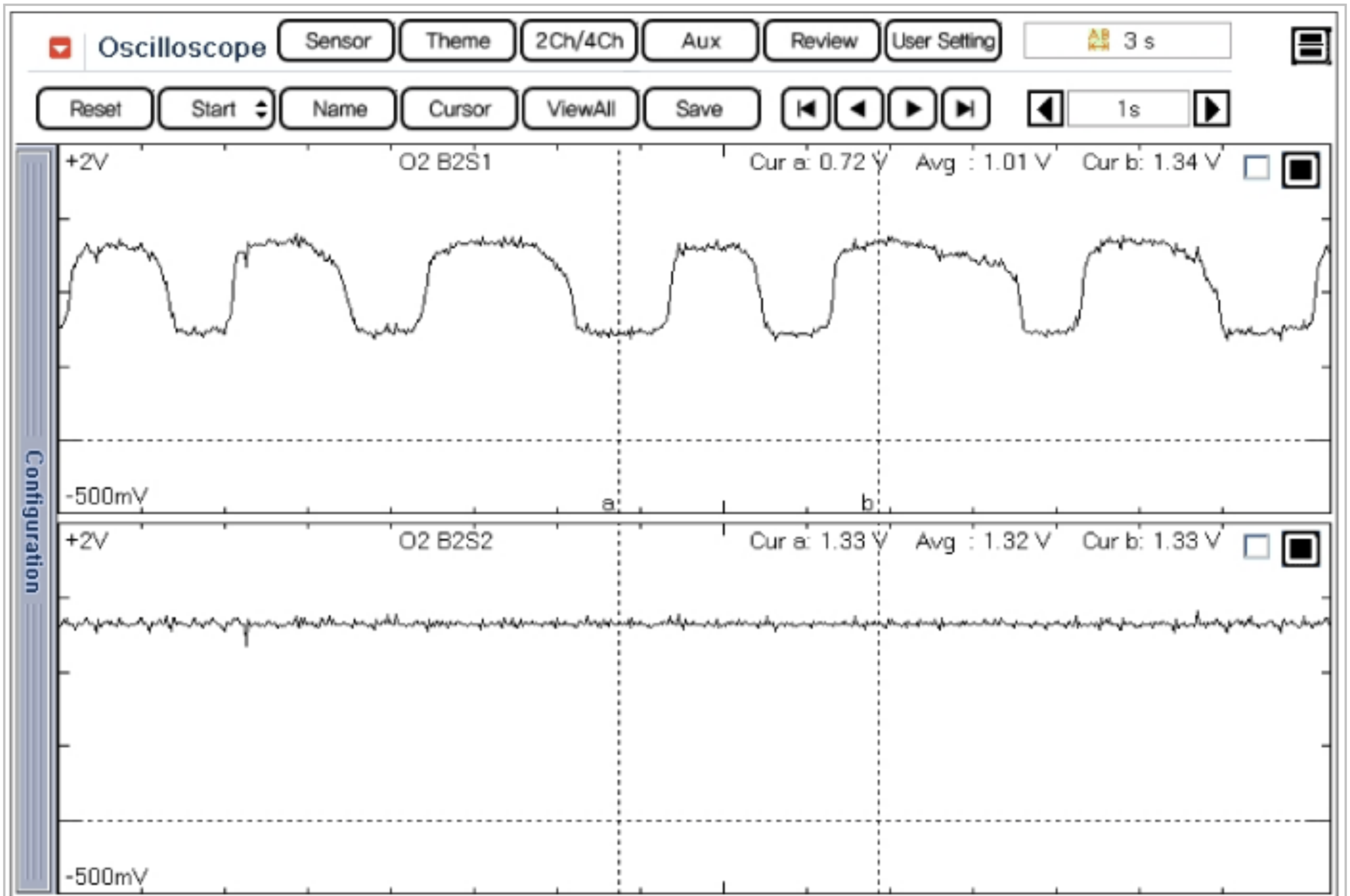
Test Condition	HO2S Voltage(Sensor1)	HO2S Voltage(Sensor2)
HO2S Signal at idle after warm-up	Signal is commonly switching from rich to lean more than 3 times in 10 sec.	Signal is commonly above 0.6V.

HO2S signal at open circuit (Pumping current OFF)	Approx. 0.45V
HO2S signal at open circuit (Pumping current ON)	Approx. 2.2V

Diagnostic Circuit Diagram



Signal Waveform & Data


Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
3 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 0.72 V
Avg : 1.01 V
Cur b: 1.34 V
-500mV
a
b
+2V
O2 B2S2
Cur a: 1.33 V
Avg : 1.32 V
Cur b: 1.33 V
-500mV
Fig.1

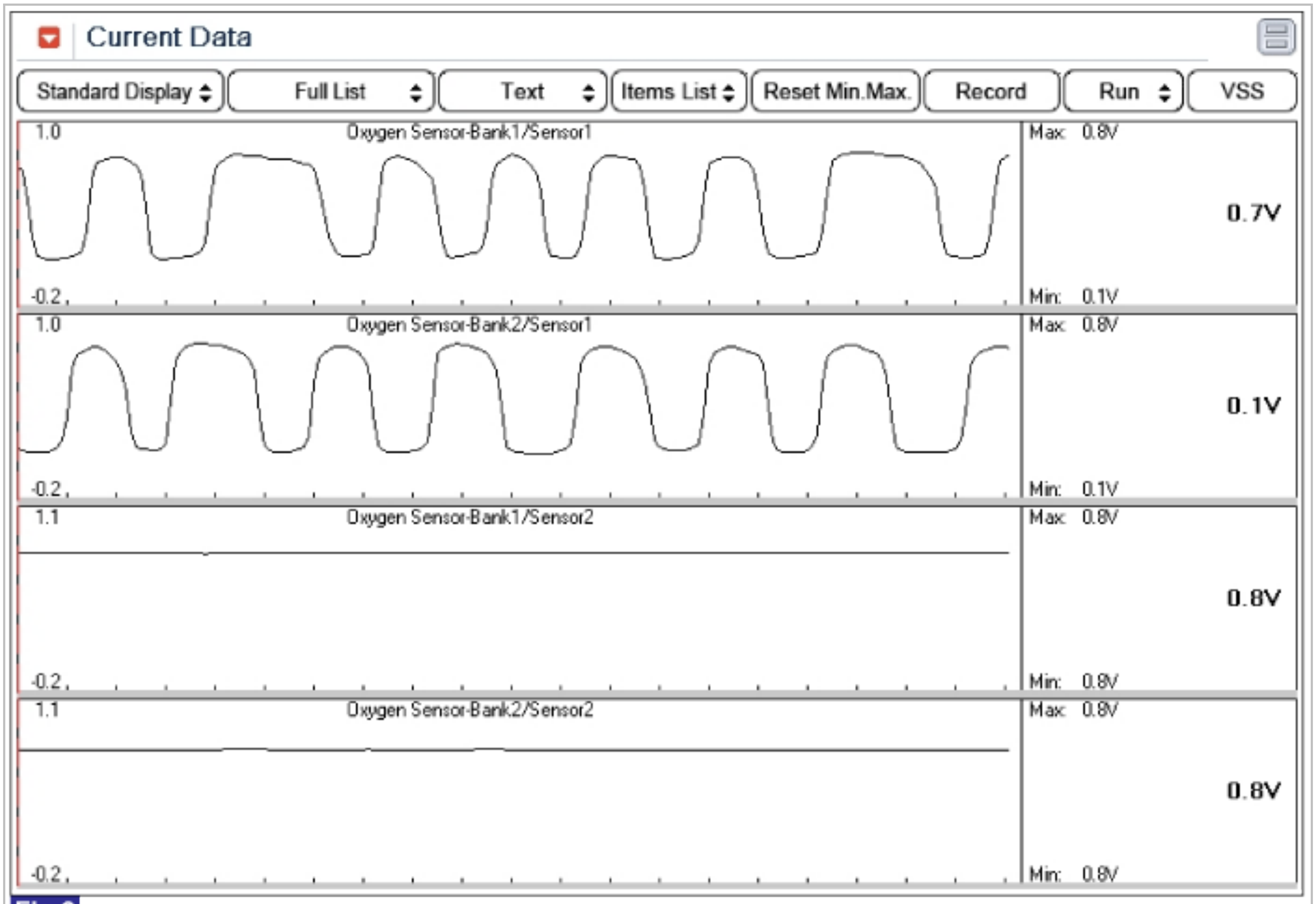


Fig.2

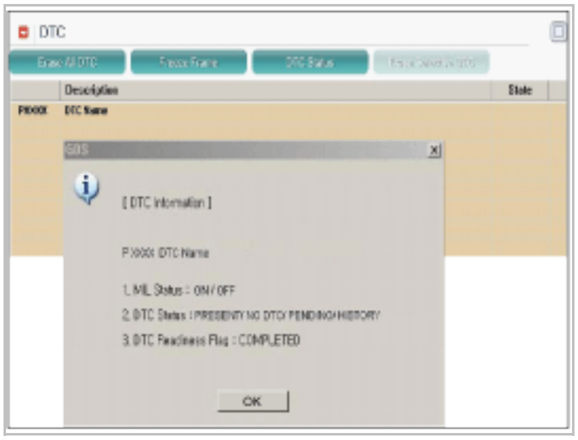
Fig.1) Normal waveforms of front HO2S(the upper) and rear HO2S(the lower). (Waveform between HIGH signal line of HO2S and chassis ground)

Fig.2) Normal graph of front HO2S and rear HO2S at idle.

After warming-up, if accelerator pedal is released suddenly around 4000rpm, the HO2S signal reading will be lower than 200mV resulting from Fuel cut-off for the moment. Conversely, if suddenly accelerator pedal is depressed, HO2S signal reading will be around 0.6V ~1.0V. At idle, Normally HO2S signal will switch from lean to rich with 3 Hz. And as racing, Its frequency rises.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found ?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Signal Circuit Inspection" procedure.

Signal Circuit Inspection

■ **Check voltage**

1. IG "OFF" and disconnect HO2S(B1/S2) connector.
2. IG "ON".
3. Measure voltage between signal terminal of HO2S(B1/S2) harness connector and chassis ground.

Specification : Approx. 2.2V - when pumping current is ON
Approx. 0.45V - when pumping current is OFF

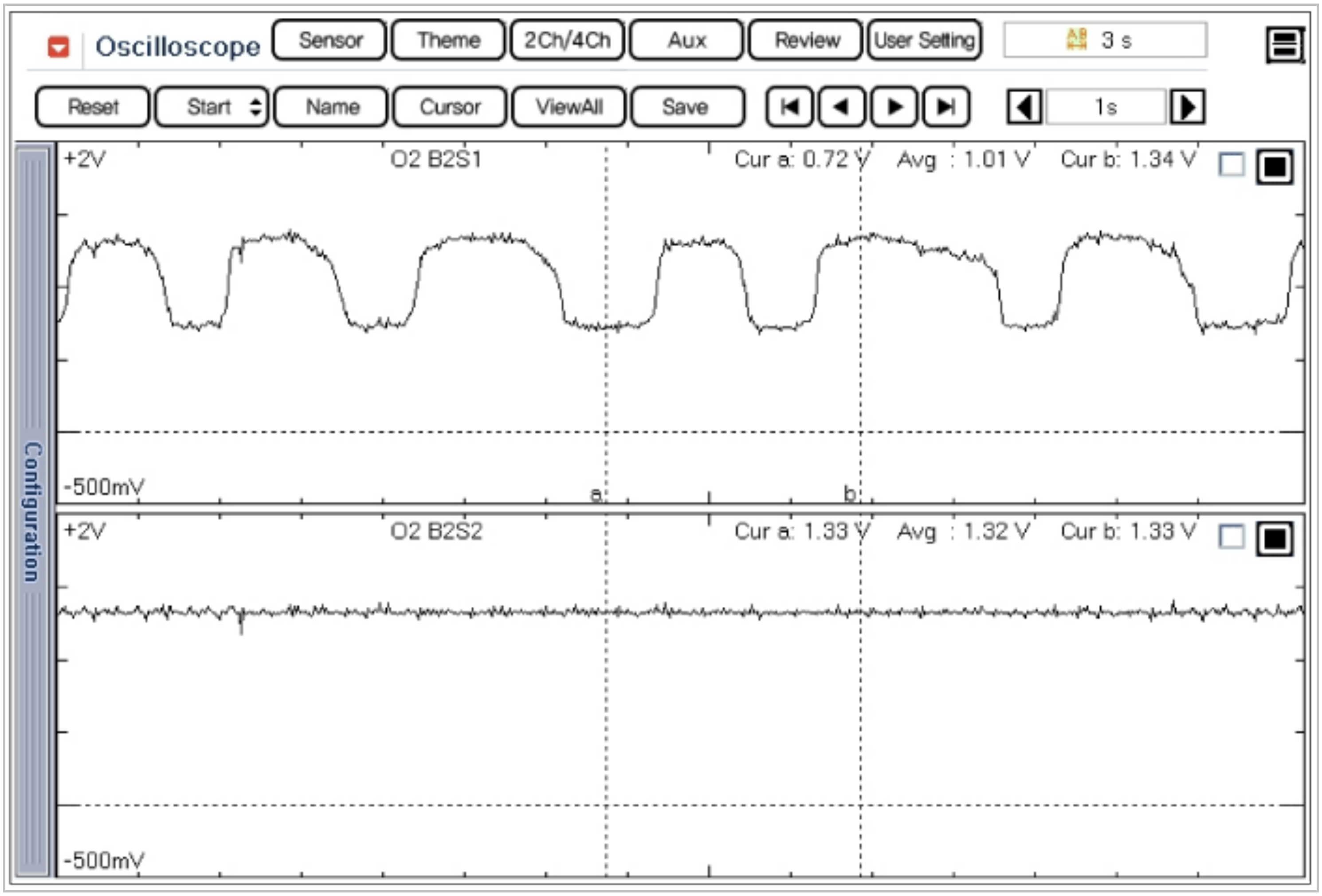
4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to ground in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check the Signal waveform of HO2S

1. IG "OFF" and connect HO2S connector.
2. Engine start.
3. After warming-up, monitor signal waveform of HO2S with GDS.



4. Is the sensor switching properly ?

YES	▶ Go to "Check HO2S" as below.
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

■ Check HO2S

1. IG "OFF" and disconnect HO2S connector.
2. Check that the HO2S is securely installed.
3. Check the HO2S for contamination or damage
4. Is the sensor normal ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE

	There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

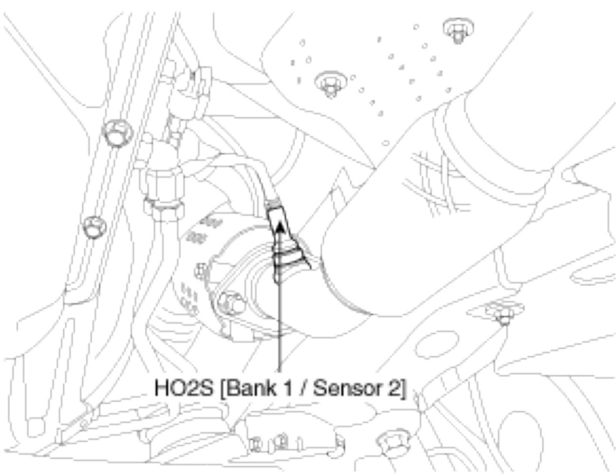
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0138 O2 Sensor Circuit High Voltage (Bank 1 / Sensor 2)

Component Location



General Description

The rear heated oxygen sensor is mounted on the rear side of the Catalytic Converter (warm-up catalytic converter) or in the rear exhaust pipe, which is able to detect catalyst efficiency. The rear heated oxygen sensor (HO2S) produces a voltage between 0V and 1V. This rear heated oxygen sensor is used to estimate the oxygen storage capability. If a catalyst has good conversion properties, the oxygen fluctuations are smoothed by the oxygen storage capacity of the catalyst. If the conversion provided by the catalyst is low due to aging, poisoning or misfiring, then the oxygen fluctuations are similar to signals from the front oxygen sensor.

DTC Description

Checking output signals from HO2S under detecting condition, if an output signal is above 1.3V for more than predeterminate time, ECM sets P0138. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

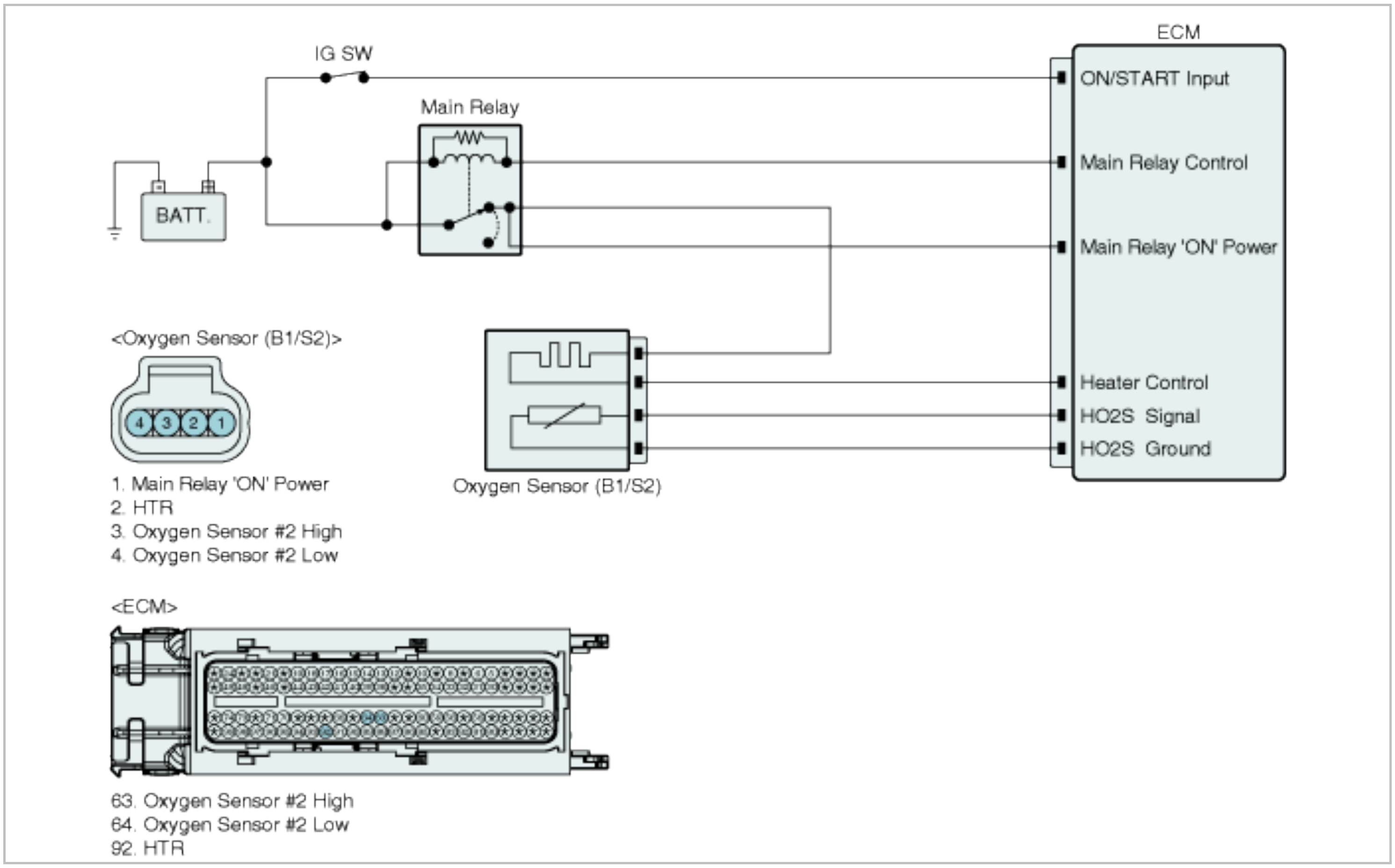
Item	Detecting Condition	Possible Cause
DTC Strategy	• Monitor signal voltage	• Poor connection • Short to battery in harness • HO2S(B1/S2) • ECM
Enable Conditions	• Battery voltage ≥ 10V • Engine running ≥ 60 sec • Engine warm-up state	
Threshold value	• The voltage of HO2S(B1/S2) > 1.3V	
Diagnosis Time	• Continous (more than 12.5 sec.failure for every 15 sec.test)	
MIL On Condition	• 2 Driving Cycles	

Specification

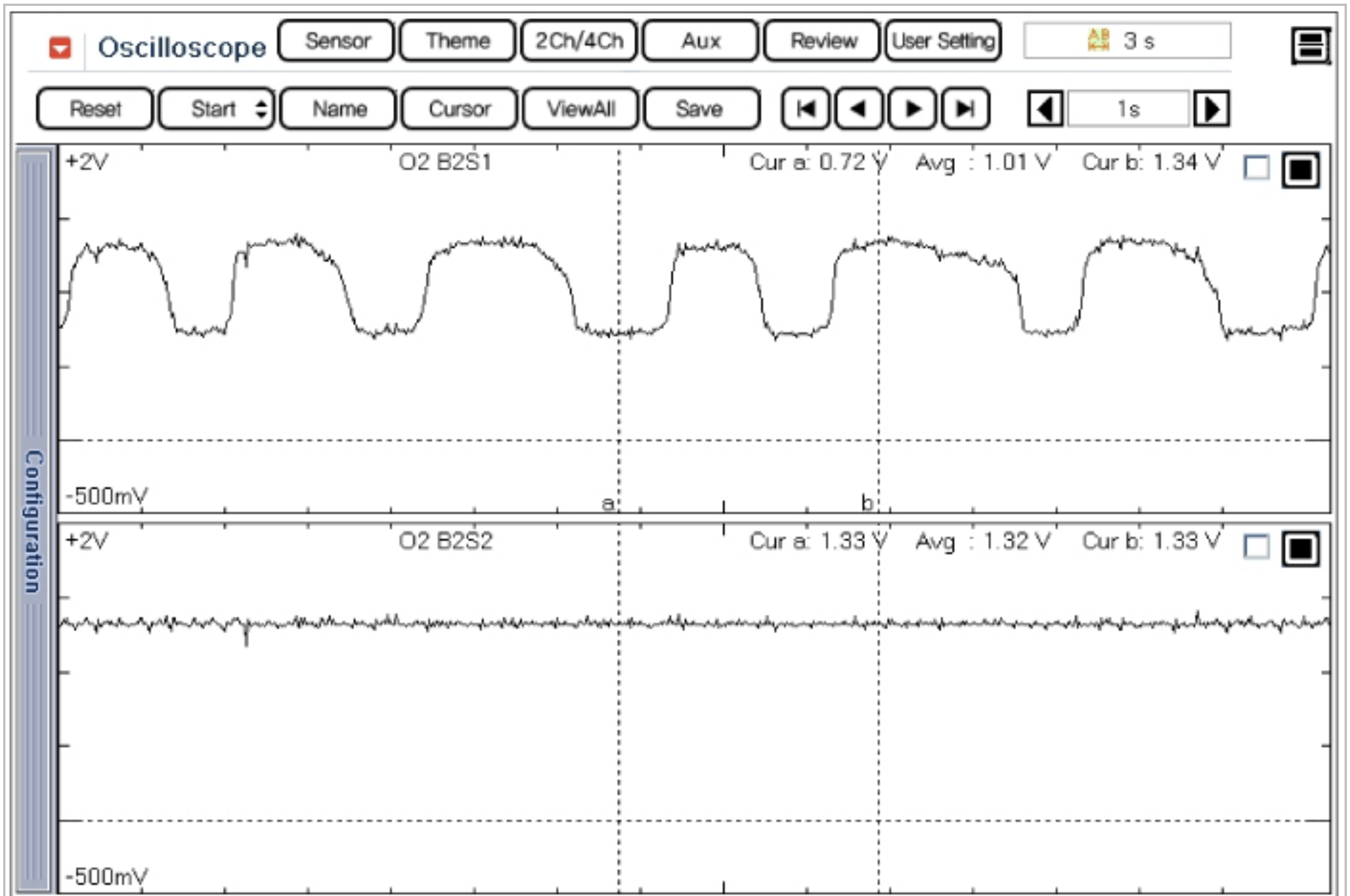
(Reference only)

Test Condition	HO2S Voltage(Sensor1)	HO2S Voltage(Sensor2)
HO2S Signal at idle after warm-up	Signal is commonly switching from rich to lean more than 3 times in 10 sec.	Signal is commonly above 0.6V.
HO2S signal at open circuit (Pumping current OFF)	Approx. 0.45V	
HO2S signal at open circuit (Pumping current ON)	Approx. 2.2V	

Diagnostic Circuit Diagram



Signal Waveform & Data


Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
3 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 0.72 V
Avg : 1.01 V
Cur b: 1.34 V
-500mV
a
b
+2V
O2 B2S2
Cur a: 1.33 V
Avg : 1.32 V
Cur b: 1.33 V
-500mV
Fig.1

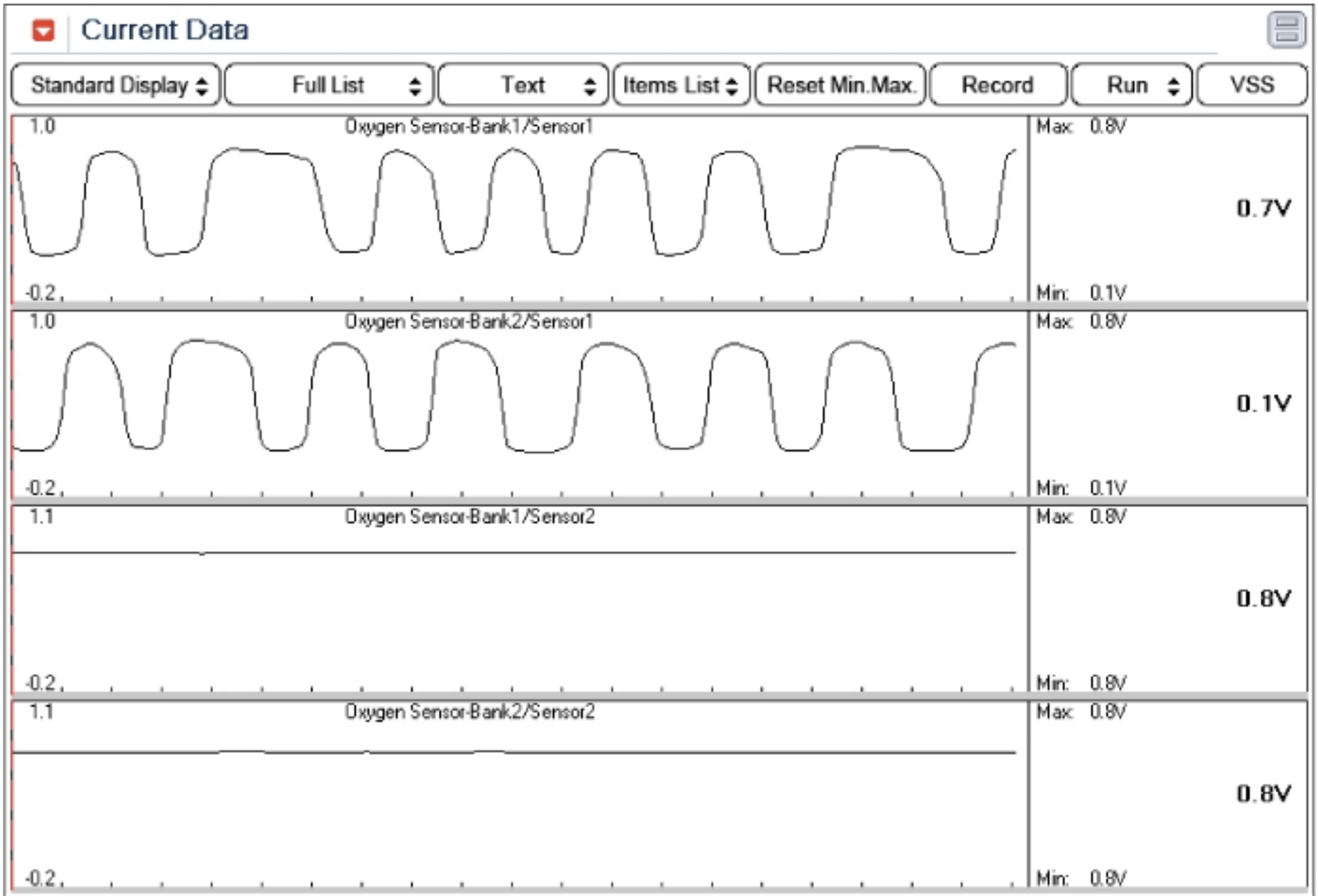


Fig.2

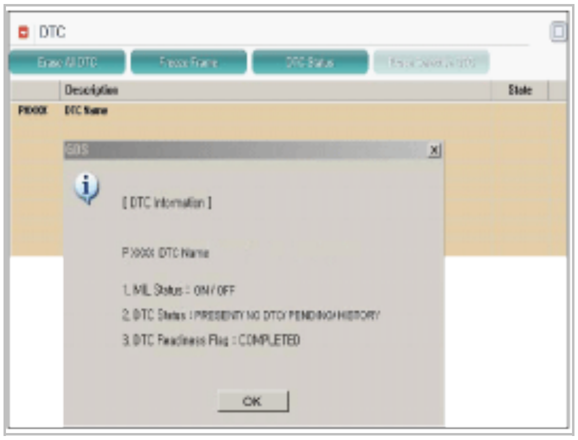
Fig.1) Normal waveforms of front HO2S(the upper) and rear HO2S(the lower). (Waveform between HIGH signal line of HO2S and chassis ground)

Fig.2) Normal graph of front HO2S and rear HO2S at idle.

After warming-up, if accelerator pedal is released suddenly around 4000rpm, the HO2S signal reading will be lower than 200mV resulting from Fuel cut-off for the moment. Conversely, if suddenly accelerator pedal is depressed, HO2S signal reading will be around 0.6V ~1.0V. At idle, Normally HO2S signal will switch from lean to rich with 3 Hz. And as racing, Its frequency rises.

Monitor Scantool Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found ?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Signal Circuit Inspection" procedure.

Signal Circuit Inspection

■ **Check voltage**

1. IG "OFF" and disconnect HO2S(B1/S2) connector.
2. IG "ON".
3. Measure voltage between signal terminal of HO2S(B1/S2) harness connector and chassis ground.

Specification : Approx. 2.2V - when pumping current is ON
Approx. 0.45V - when pumping current is OFF

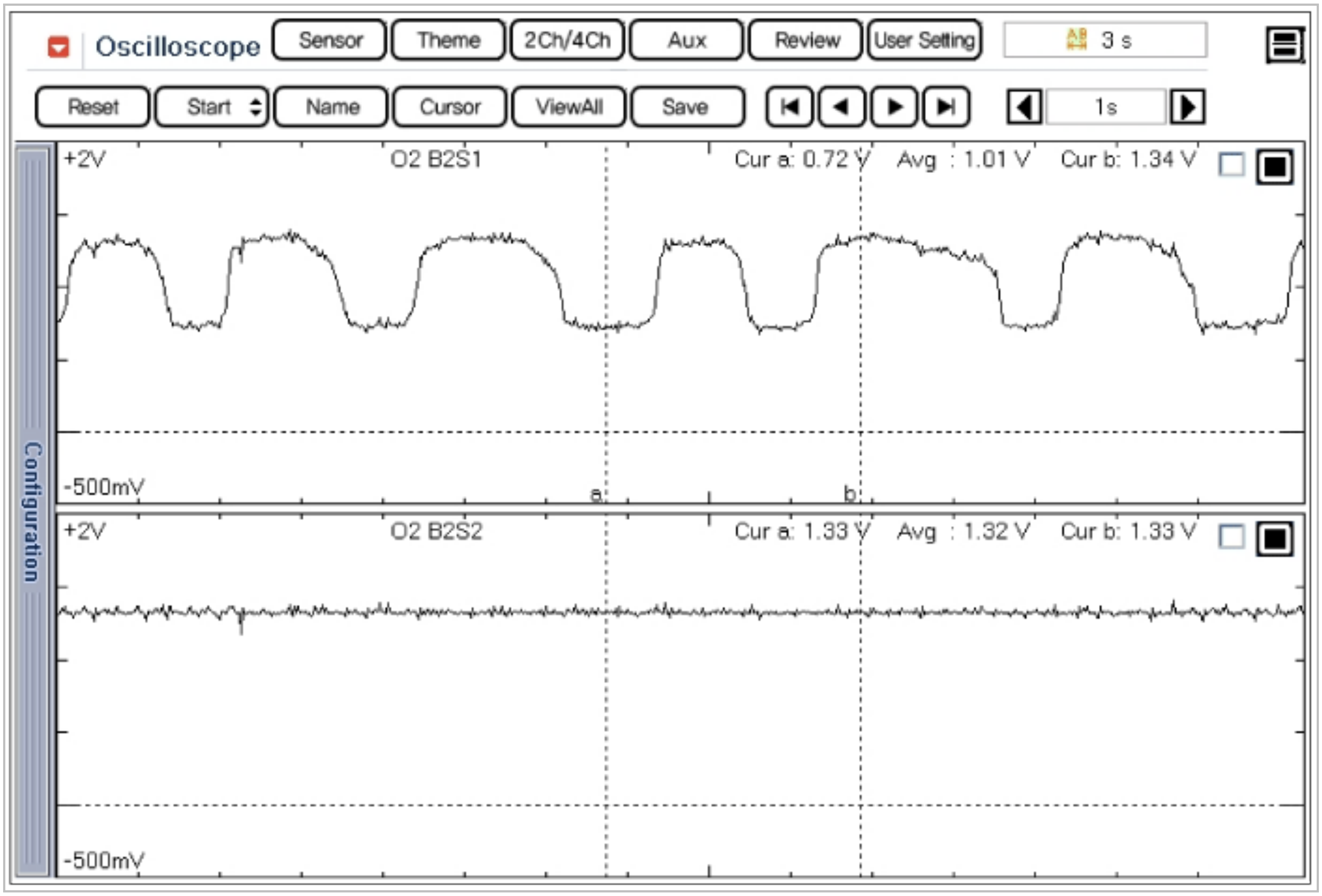
4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to battery in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check the Signal waveform of HO2S

1. IG "OFF" and connect HO2S connector.
2. Engine start.
3. After warming-up, monitor signal waveform of HO2S with GDS.



4. Is the sensor switching properly ?

YES	▶ Go to "Check HO2S" as below.
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

■ Check HO2S

1. IG "OFF" and disconnect HO2S connector.
2. Check that the HO2S is securely installed.
3. Check the HO2S for contamination or damage
4. Is the sensor normal ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE

	There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

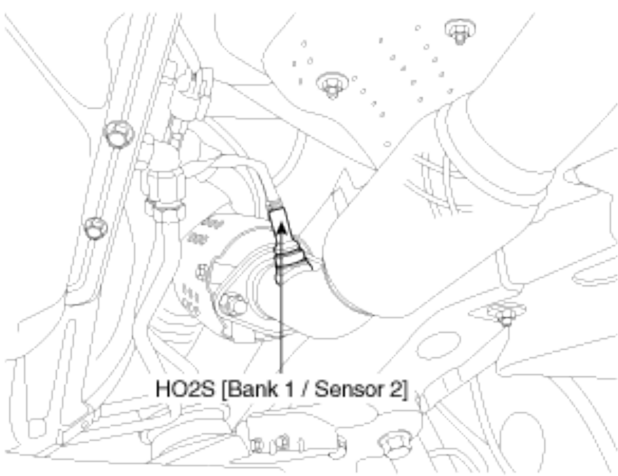
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0139 O2 Sensor Circuit Slow Response(Bank 1 / Sensor 2)

Component Location



General Description

The rear heated oxygen sensor is mounted on the rear side of the Catalytic Converter (warm-up catalytic converter) or in the rear exhaust pipe, which is able to detect catalyst efficiency. The rear heated oxygen sensor (HO2S) produces a voltage between 0V and 1V. This rear heated oxygen sensor is used to estimate the oxygen storage capability. If a catalyst has good conversion properties, the oxygen fluctuations are smoothed by the oxygen storage capacity of the catalyst. If the conversion provided by the catalyst is low due to aging, poisoning or misfiring, then the oxygen fluctuations are similar to signals from the front oxygen sensor.

DTC Description

Checking output signals from HO2S under detecting condition, if ECM judges it's signals too slow, ECM sets P0139. The MIL (Malfunction Indicator Lamp) will illuminate when the fault remains for 2 consecutive drive cycles

DTC Detecting Condition

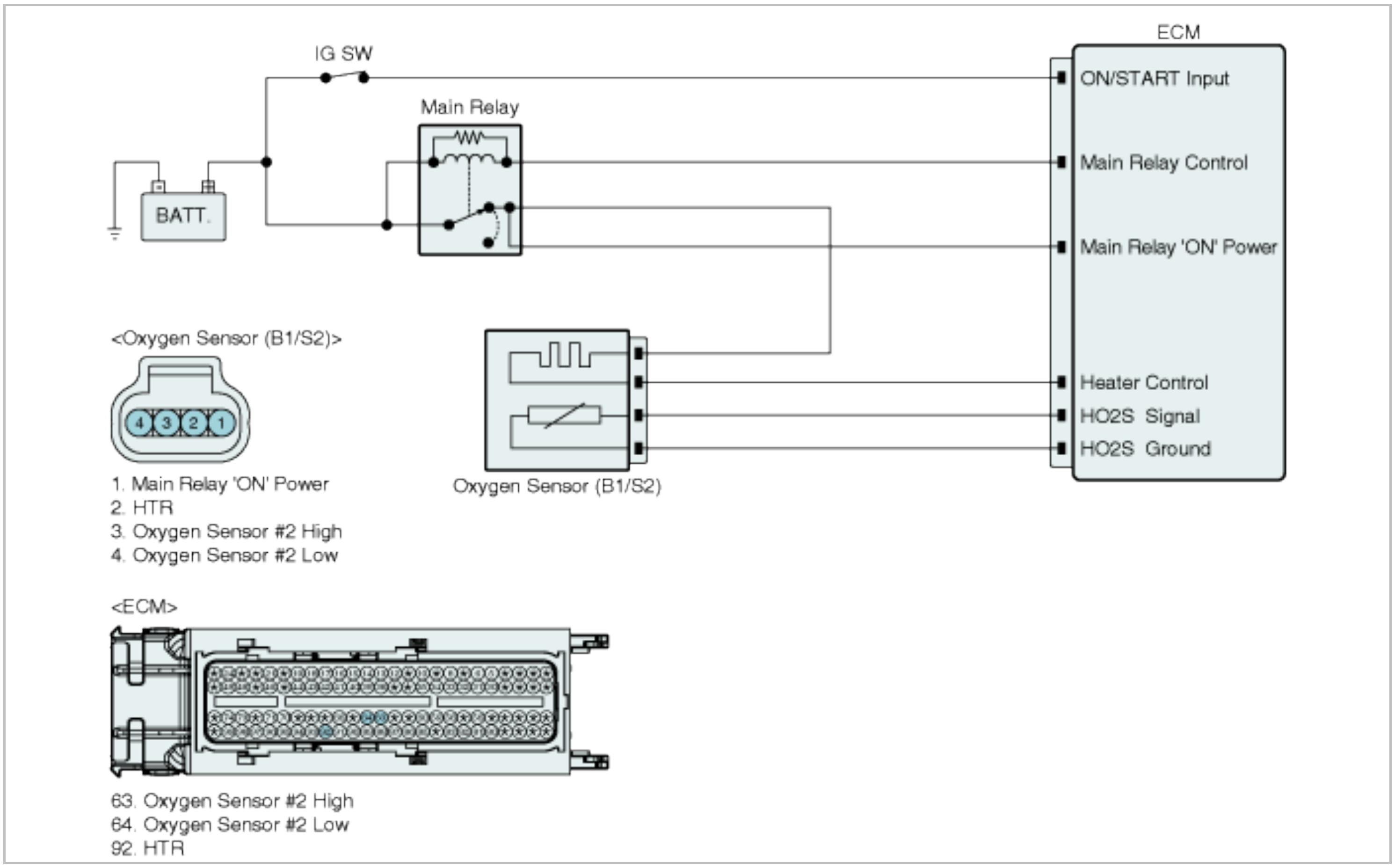
Item	Detecting Condition	Possible Cause
DTC Strategy	• Monitor HO2S's response rate	• Poor connection • Faulty HO2S • Faulty ECM
Enable Conditions	• Engine warm-up sufficiently • Engine run time > 60sec • Drive at a steady speed between 45-55 mph(72-88 km/h) • Engine Coolant > 70°C(158 °F) • No disabling faults	
Threshold value	• The calculated response rate is too slow (out of threshold in ECM)	
Diagnosis Time	• Continuous	
MIL On Condition	• 2 Driving Cycles	

Specification

(Reference only)

Test Condition	HO2S Voltage(Sensor1)	HO2S Voltage(Sensor2)
HO2S Signal at idle after warm-up	Signal is commonly switching from rich to lean more than 3 times in 10 sec.	Signal is commonly above 0.6V.
HO2S signal at open circuit (Pumping current OFF)	Approx. 0.45V	
HO2S signal at open circuit (Pumping current ON)	Approx. 2.2V	

Diagnostic Circuit Diagram



Signal Waveform & Data

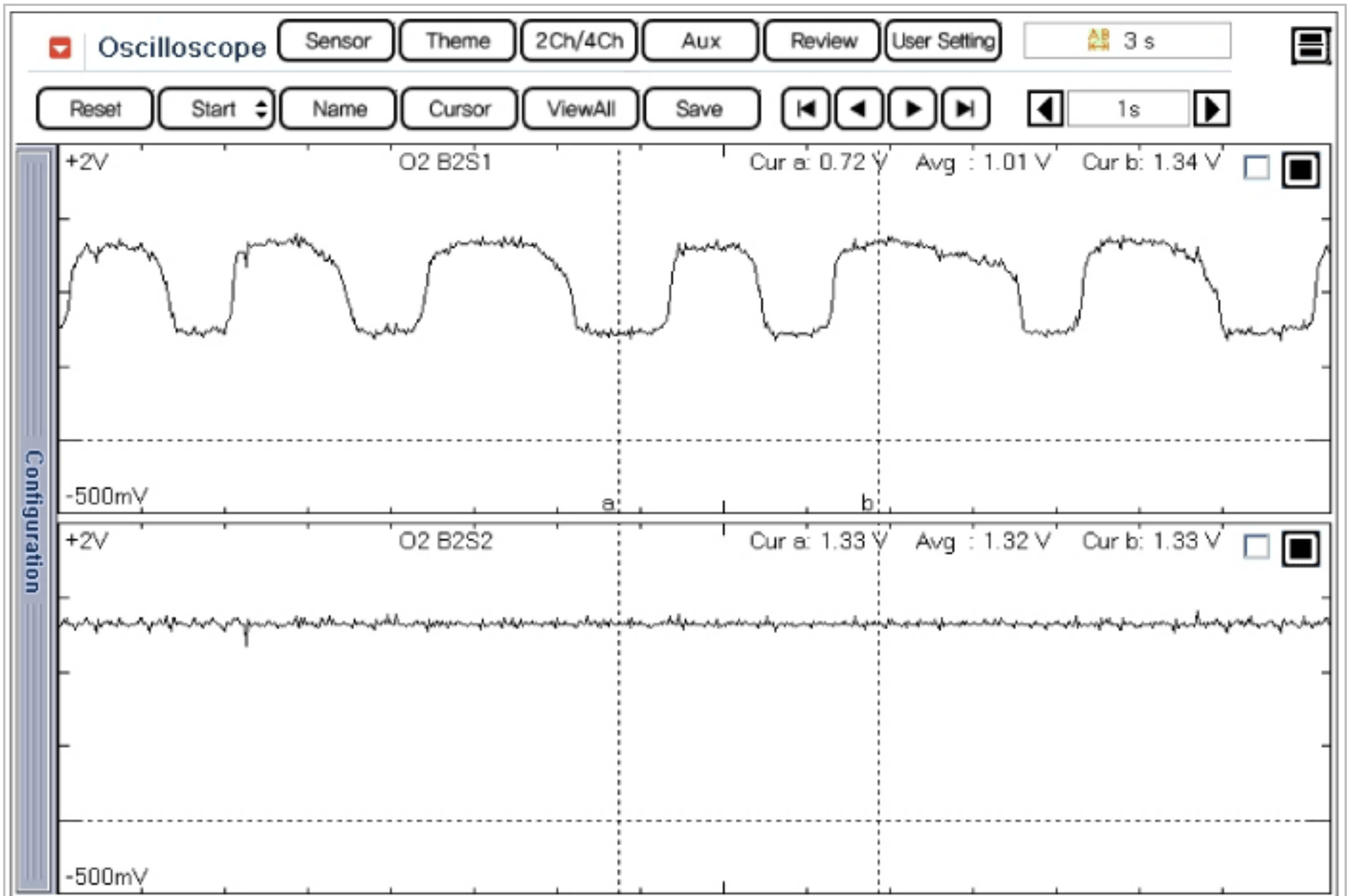

Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
3 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 0.72 V
Avg : 1.01 V
Cur b: 1.34 V
-500mV
a
b
+2V
O2 B2S2
Cur a: 1.33 V
Avg : 1.32 V
Cur b: 1.33 V
-500mV

Fig.1

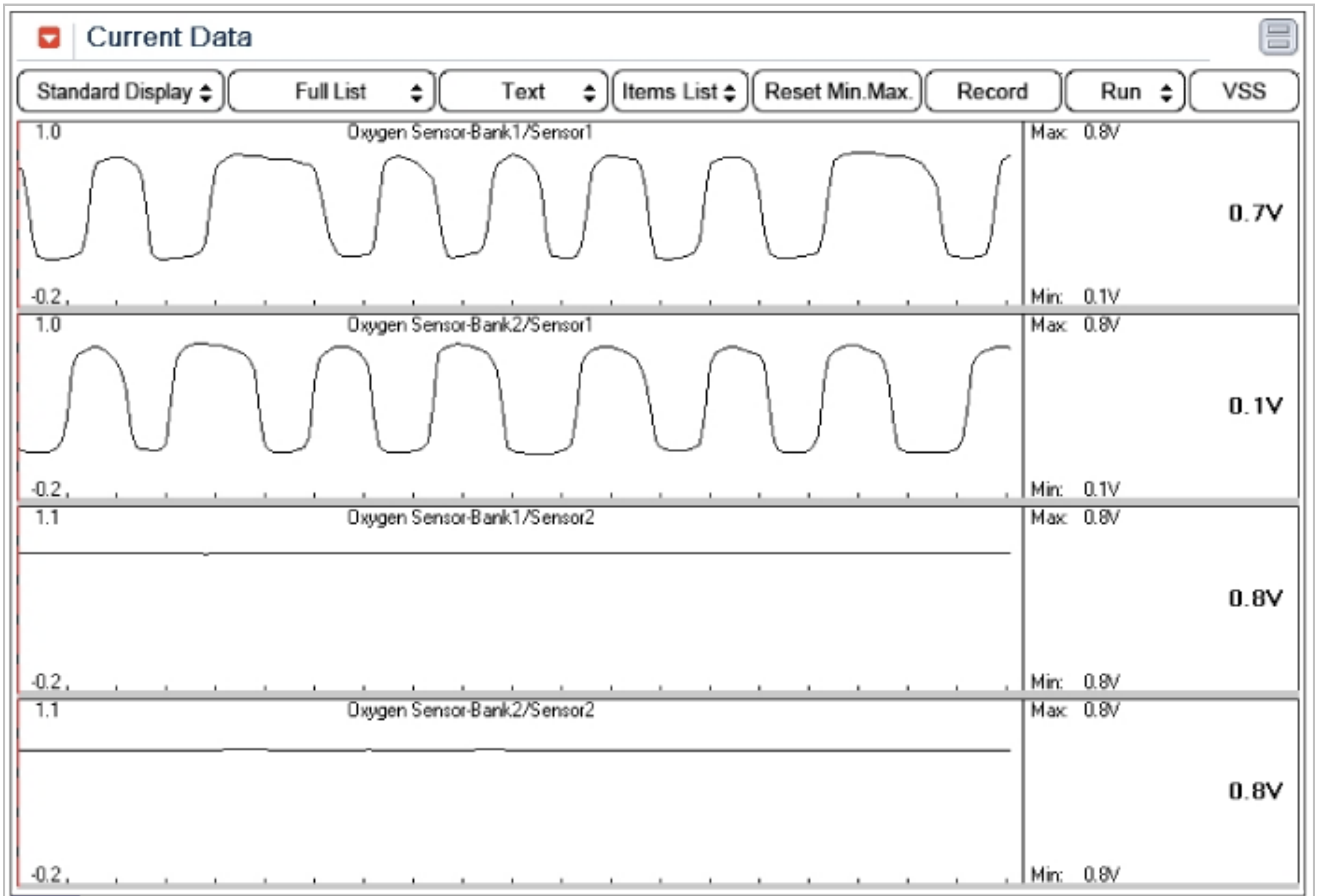


Fig.2

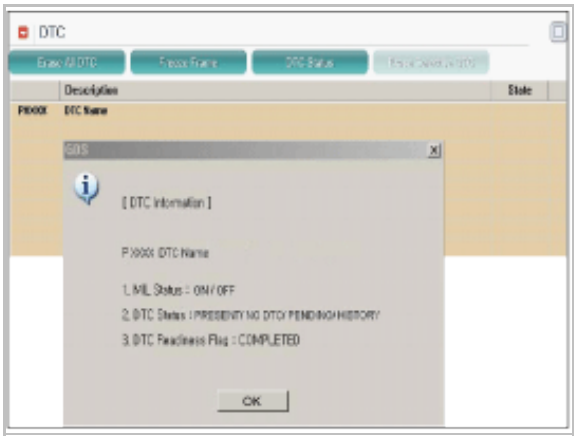
Fig.1) Normal waveforms of front HO2S(the upper) and rear HO2S(the lower). (Waveform between HIGH signal line of HO2S and chassis ground)

Fig.2) Normal graph of front HO2S and rear HO2S at idle.

After warming-up, if accelerator pedal is released suddenly around 4000rpm, the HO2S signal reading will be lower than 200mV resulting from Fuel cut-off for the moment. Conversely, if suddenly accelerator pedal is depressed, HO2S signal reading will be around 0.6V ~1.0V. At idle, Normally HO2S signal will switch from lean to rich with 3 Hz. And as racing, Its frequency rises.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Clear DTC and check if this DTC is set after test-driving under enable conditions. If DTC isn't displayed after the test, it was intermittent fault. Go to "Verification of Vehicle Repair" procedure.

Component Inspection

1. Replace the HO2S.
2. Clear DTC with GDS.
3. Start the engine and warm it up until the radiator fan comes on(more than at least 10 minutes).
4. Drive at a steady speed between 45-55 mph(72-88 km/h) for 120 sec.
5. Stop and then maintain idle state.
6. Check if O2 sensor monitoring readiness is complete.
7. Does the scan tool show DTC P0139 ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Troubleshooting is finished.

Verification of Vehicle Repair

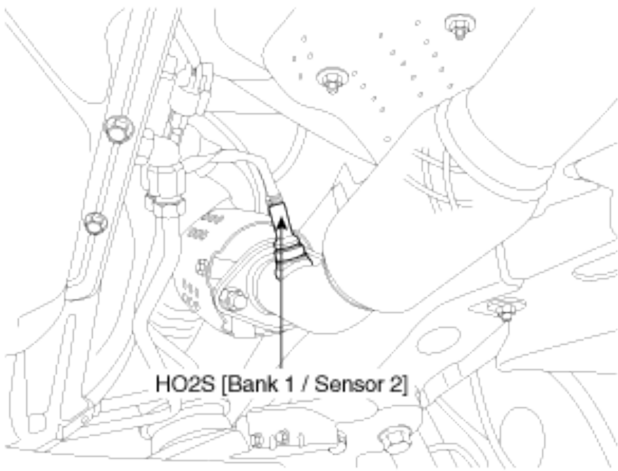
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0140 O2 Sensor Circuit No Activity Detected (Bank 1 / Sensor 2)

Component Location



General Description

The rear heated oxygen sensor is mounted on the rear side of the Catalytic Converter (warm-up catalytic converter) or in the rear exhaust pipe, which is able to detect catalyst efficiency. The rear heated oxygen sensor (HO2S) produces a voltage between 0V and 1V. This rear heated oxygen sensor is used to estimate the oxygen storage capability. If a catalyst has good conversion properties, the oxygen fluctuations are smoothed by the oxygen storage capacity of the catalyst. If the conversion provided by the catalyst is low due to aging, poisoning or misfiring, then the oxygen fluctuations are similar to signals from the front oxygen sensor.

DTC Description

Checking output signals from HO2S under detecting condition, if an output voltage is Approx. 0.45V or 3.5V for more than predeterminate time, ECM sets P0140. The MIL(Malfunction Indicator Lamp) will illuminate when the fault remains for 2 consecutive drive cycles.

DTC Detecting Condition

Item		Detecting Condition	Possible Cause
DTC Strategy		• Monitor signal voltage	• Poor connection • Open in harness • HO2S(B1/S2)
Enable Conditions		• Battery voltage ≥ 10V • Engine running ≥ 60 sec • Engine warm-up state • No disable faults	
Threshold	Case 1	• 1.2V ≤ Voltage of HO2S ≤ 3.9V (at pumping current ON)	

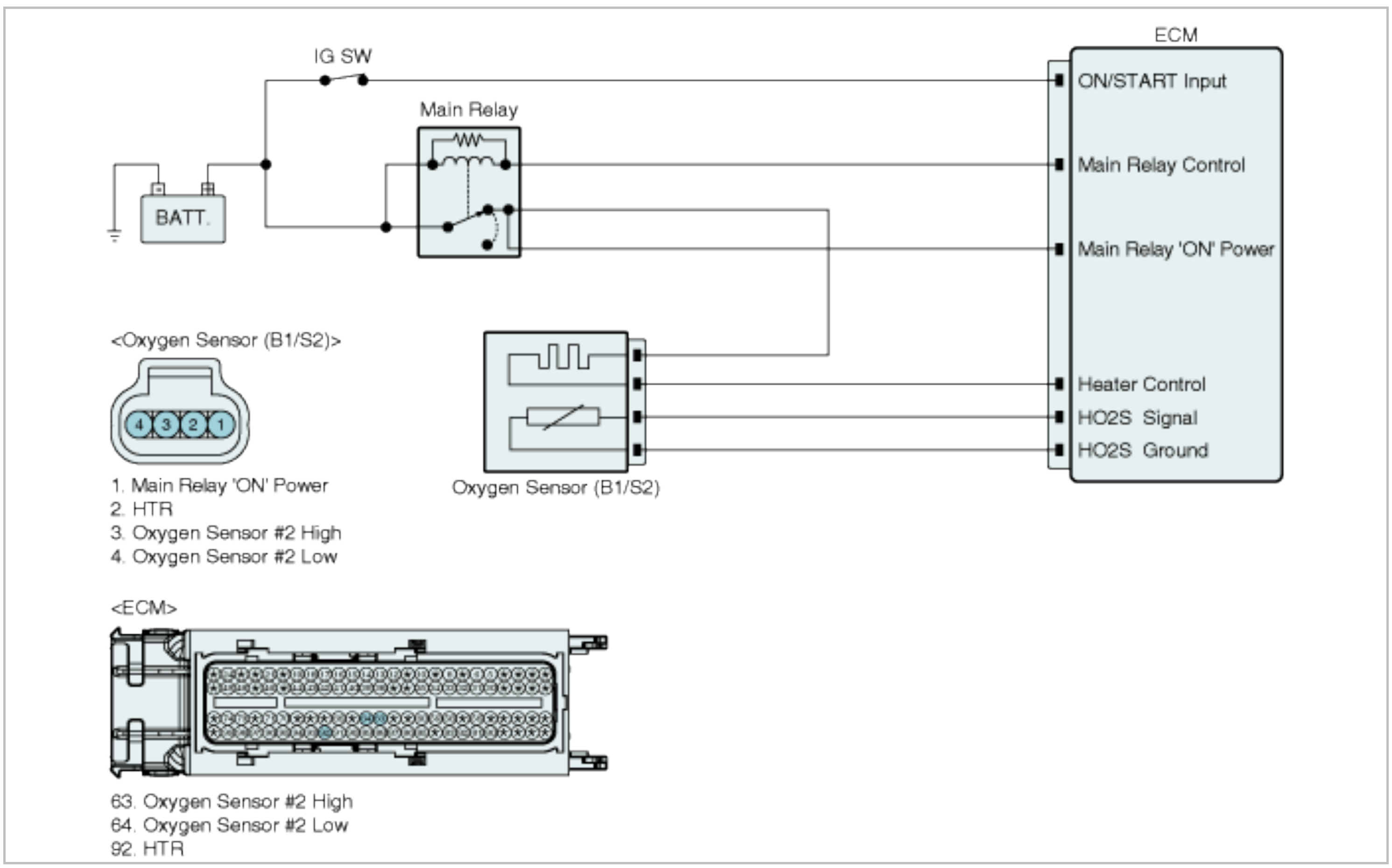
value	Case 2	• 0.415V ≤ Voltage of HO2S ≤ 0.515V (at pumping current OFF)	• ECM
Diagnosis Time		• Continuous (more than 76.5 sec.failure for every 90 sec.test)	
MIL On Condition		• 2 Driving Cycles	

Specification

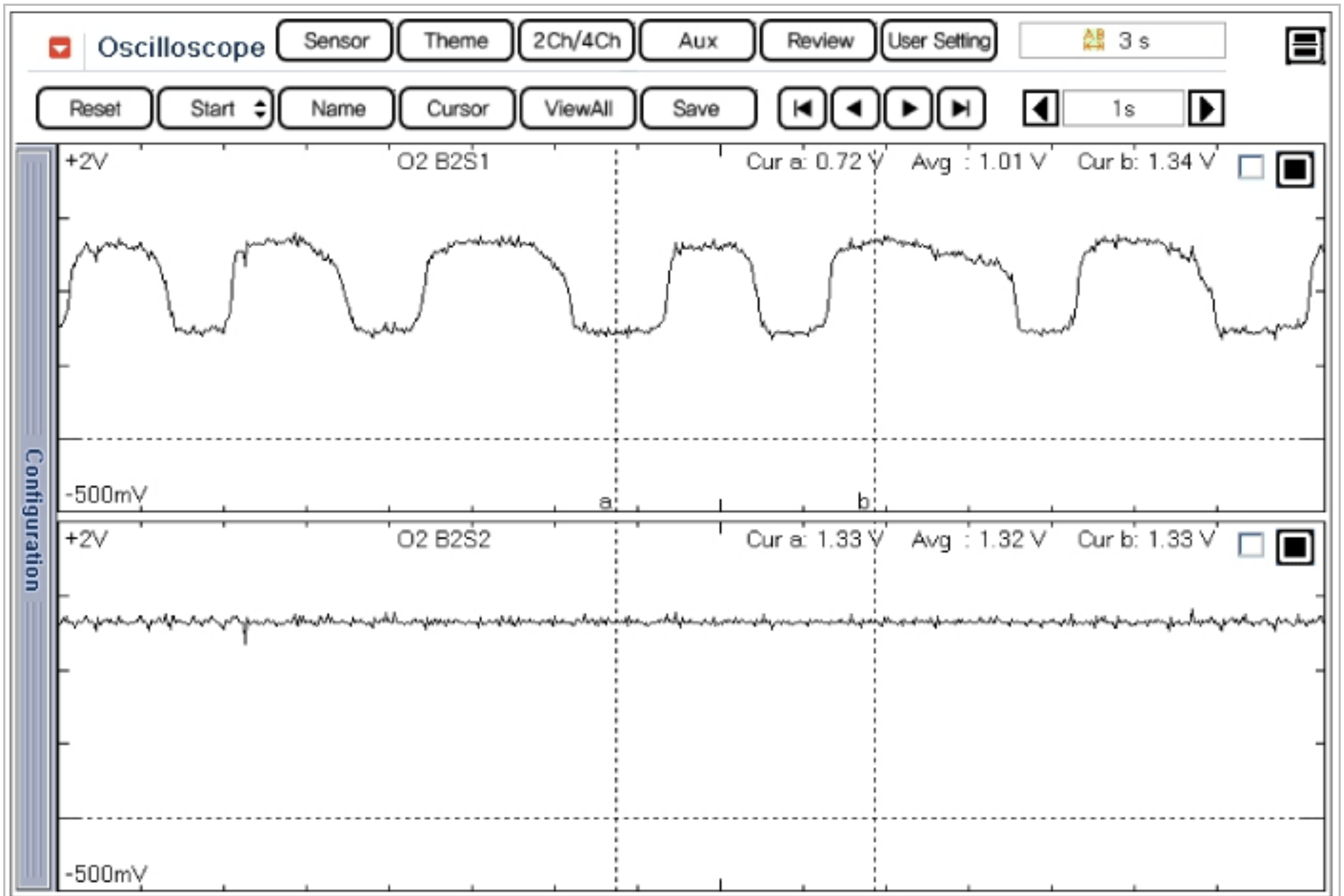
(Reference only)

Test Condition	HO2S Voltage(Sensor1)	HO2S Voltage(Sensor2)
HO2S Signal at idle after warm-up	Signal is commonly switching from rich to lean more than 3 times in 10 sec.	Signal is commonly above 0.6V.
HO2S signal at open circuit (Pumping current OFF)	Approx. 0.45V	
HO2S signal at open circuit (Pumping current ON)	Approx. 2.2V	

Diagnostic Circuit Diagram



Signal Waveform & Data



Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
3 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 0.72 V
Avg : 1.01 V
Cur b: 1.34 V
-500mV
a
b
+2V
O2 B2S2
Cur a: 1.33 V
Avg : 1.32 V
Cur b: 1.33 V
-500mV

Fig.1

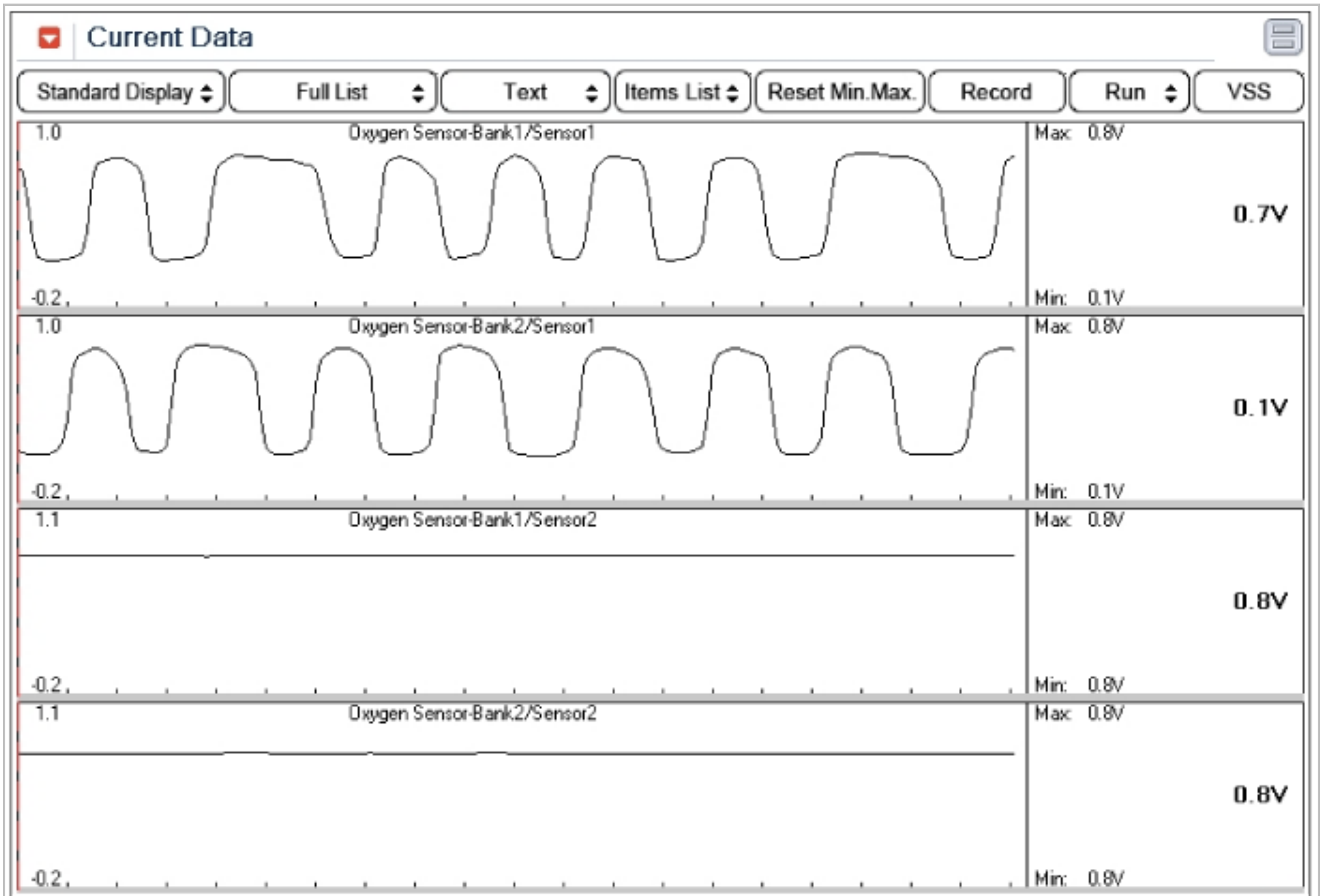


Fig.2

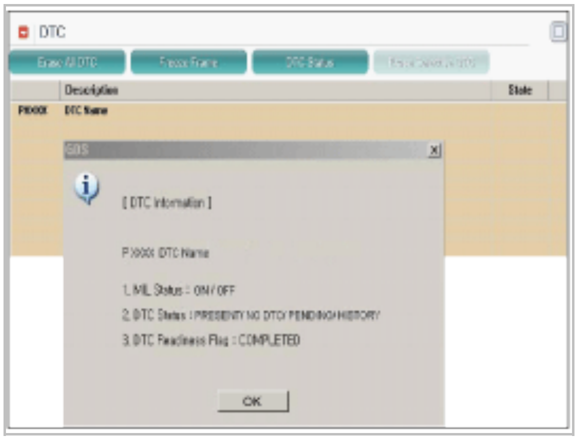
Fig.1) Normal waveforms of front HO2S(the upper) and rear HO2S(the lower). (Waveform between HIGH signal line of HO2S and chassis ground)

Fig.2) Normal graph of front HO2S and rear HO2S at idle.

After warming-up, if accelerator pedal is released suddenly around 4000rpm, the HO2S signal reading will be lower than 200mV resulting from Fuel cut-off for the moment. Conversely, if suddenly accelerator pedal is depressed, HO2S signal reading will be around 0.6V ~1.0V. At idle, Normally HO2S signal will switch from lean to rich with 3 Hz. And as racing, Its frequency rises.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found ?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Signal Circuit Inspection" procedure.

Signal Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect HO2S(B1/S2) connector.
2. IG "ON".
3. Measure voltage between signal terminal of HO2S(B1/S2) harness connector and chassis ground.

Specification : Approx.2.2V - when pumping current is ON
Approx. 0.45V - when pumping current is OFF

4. Is the measured voltage within specification ?

YES	▶ Go to "Ground circuit inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" prcedure.

Ground Circuit Inspection

■ Check open in harness

1. IG "ON" and disconnect HO2S(B1/S2) connector.
2. Measure voltage between signal terminal of HO2S(B1/S2) harness connector and chassis ground.(Measurement "A")
3. Measure voltage between signal and ground terminals of HO2S(B1/S2) harness connector.(Measurement "B")

Specification : Voltage difference between measurement "A" and "B" is below 200mV.

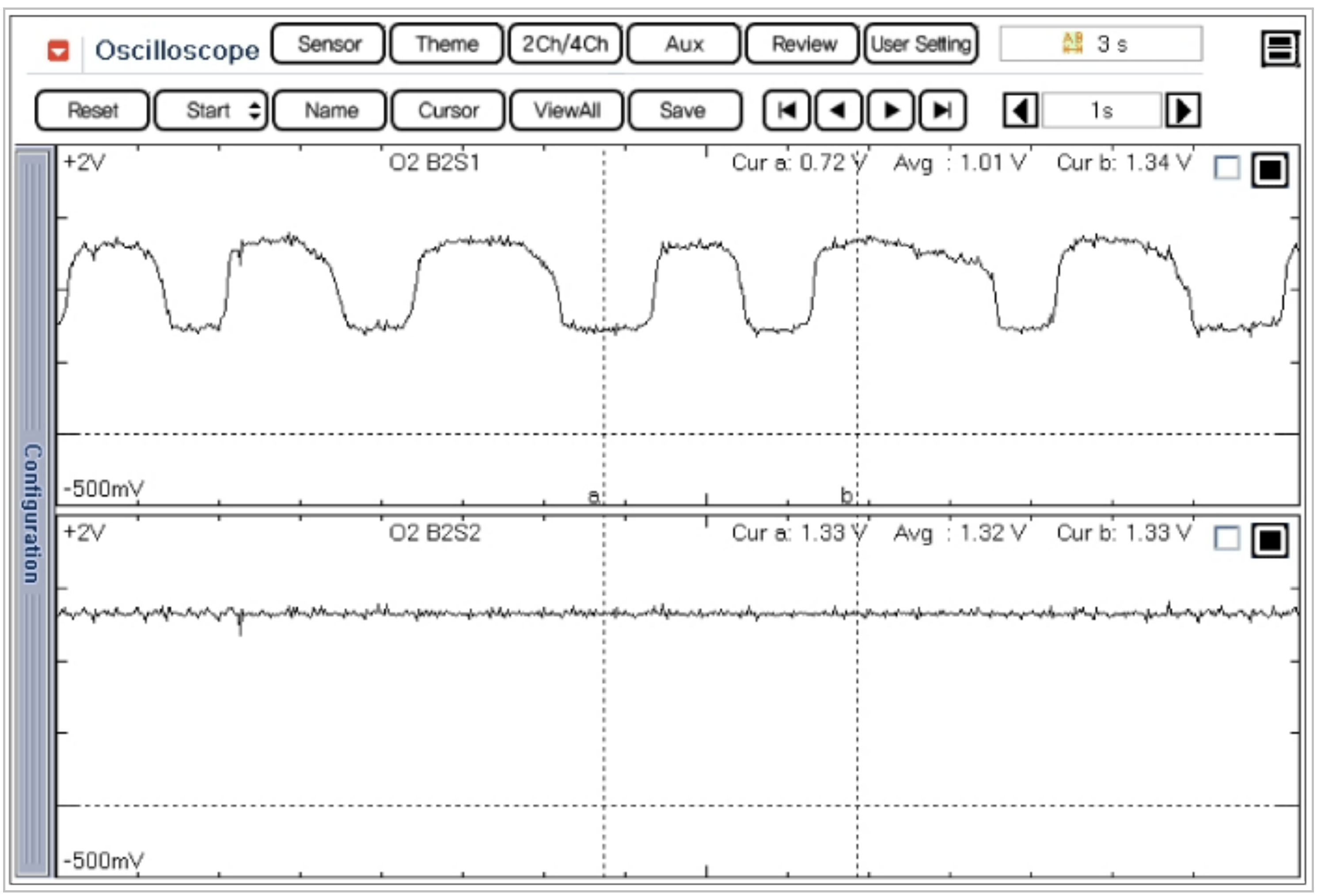
4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair contact resistance or open in harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check the Signal waveform of HO2S

1. IG "OFF" and connect HO2S connector.
2. Engine start.
3. After warming-up, monitor signal waveform of HO2S with GDS.



4. Is the sensor switching properly ?

YES	▶ Go to "Check HO2S" as below.

NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

■ **Check HO2S**

1. IG "OFF" and disconnect HO2S connector.
2. Check that the HO2S is securely installed.
3. Check the HO2S for contamination or damage
4. Is the sensor normal ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

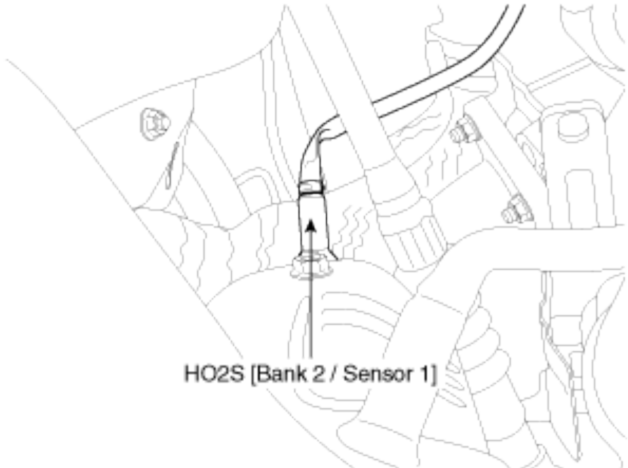
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0151 O2 Sensor Circuit Low Voltage (Bank 2 / Sensor 1)

Component Location



General Description

In order to control emissions of the CO, HC and NOx components of the exhaust gas, heated oxygen sensor (HO2S), mounted on the front side and rear side of catalytic converter, detects the oxygen content in the exhaust gas. The front HO2S signal is used to control air/fuel ratio (closed loop fuel control) and the rear HO2S signal is used to monitor front HO2S and catalyst for proper operation. The HO2S requires a minimum temperature to operate properly and provide a closed loop fuel control system. The HO2S contains the heater element to reduce its warming-up time and ensure its performance during all driving conditions. The oxygen sensor generates a voltage that indicates the difference between the oxygen content of the exhaust stream and the oxygen content of ambient air. When the exhaust stream is “rich,” there is more oxygen in the ambient air than in the exhaust stream, so the voltage will be higher.

DTC Description

Checking output signals from HO2S under detecting condition, if an output signal is below 0.04V for more than predeterminate time, ECM sets P0151. The MIL(Malfunction Indicator Lamp) will illuminate when the fault remains for 2 consecutive drive cycles

DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Monitor signal voltage	• Poor connection • Short to ground in harness • HO2S(B2/S1) • ECM
Enable Conditions	• Battery voltage ≥ 10V • Engine running ≥ 60 sec • Engine warm-up state	
Threshold value	• The voltage of HO2S(B2/S1) < 0.04V	
Diagnosis Time	• Continuous (more than 12.5 sec. failure for every 15 sec.test)	
MIL On Condition	• 2 Driving Cycles	

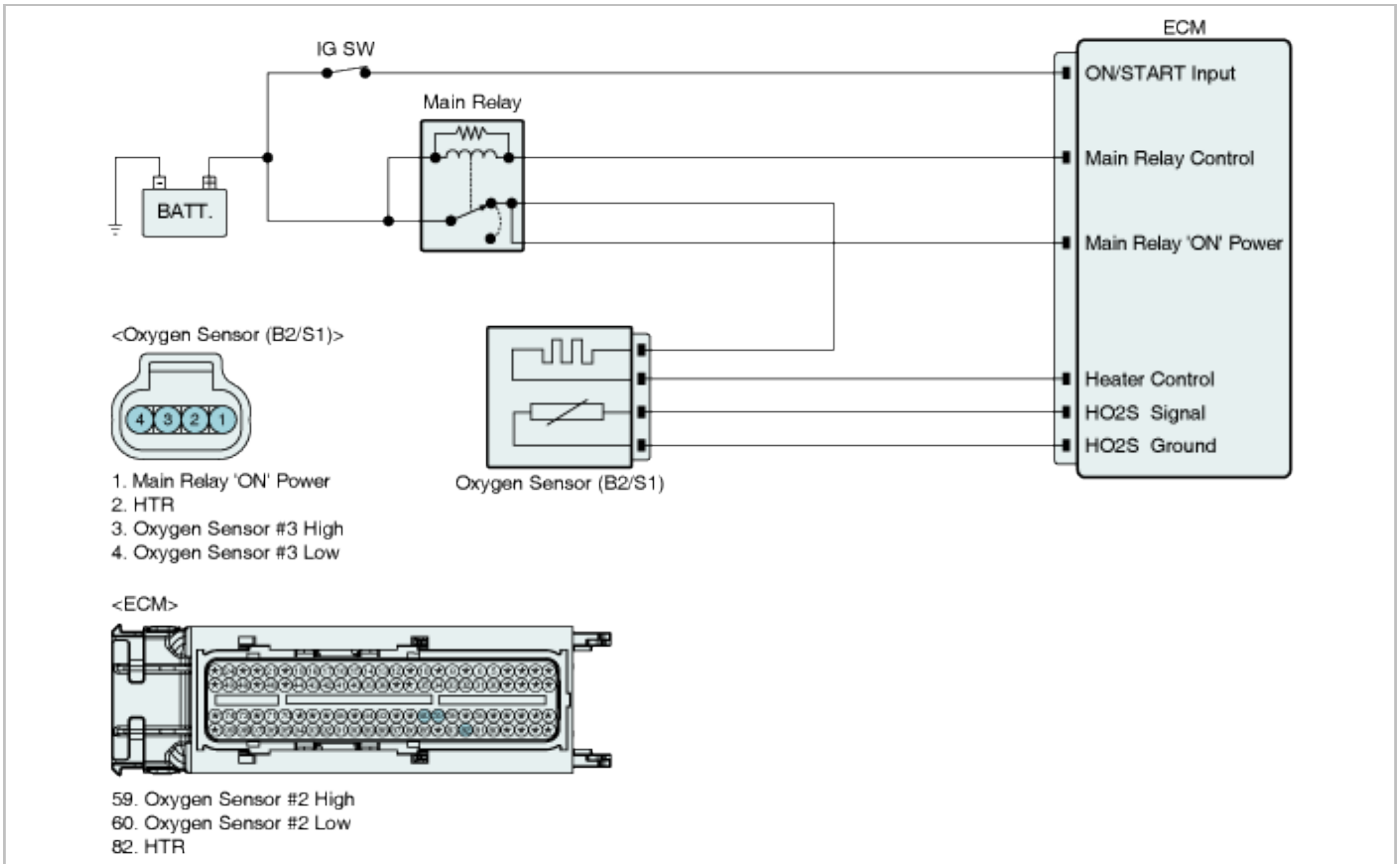
Specification

(Reference only)

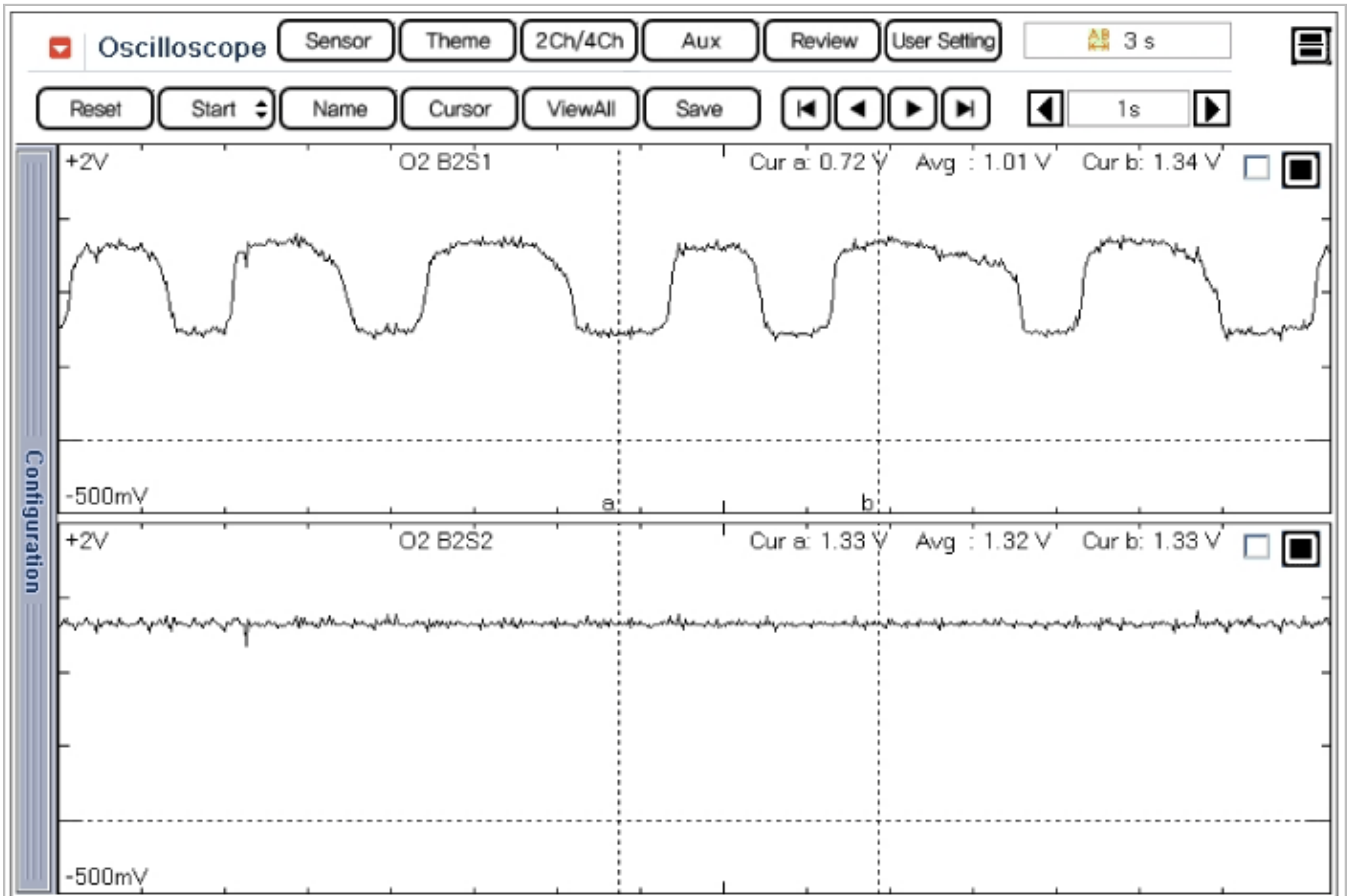
Test Condition	HO2S Voltage(Sensor1)	HO2S Voltage(Sensor2)

HO2S Signal at idle after warm-up	Signal is commonly switching from rich to lean more than 3 times in 10 sec.	Signal is commonly above 0.6V.
HO2S signal at open circuit (Pumping current OFF)	Approx. 0.45V	
HO2S signal at open circuit (Pumping current ON)	Approx. 2.2V	

Diagnostic Circuit Diagram



Signal Waveform & Data



Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
3 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 0.72 V
Avg : 1.01 V
Cur b: 1.34 V
-500mV
a
b
+2V
O2 B2S2
Cur a: 1.33 V
Avg : 1.32 V
Cur b: 1.33 V
-500mV

Fig.1

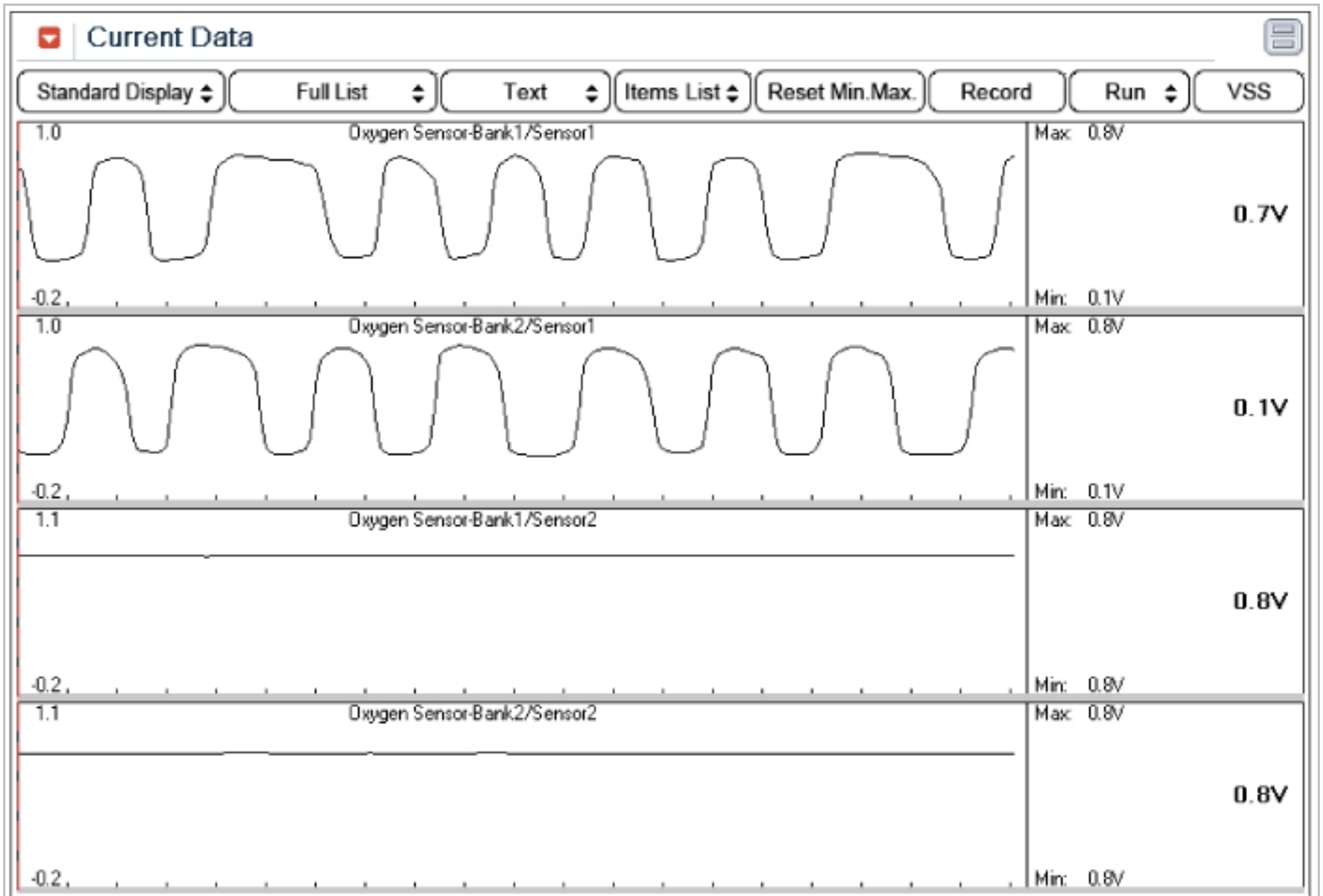


Fig.2

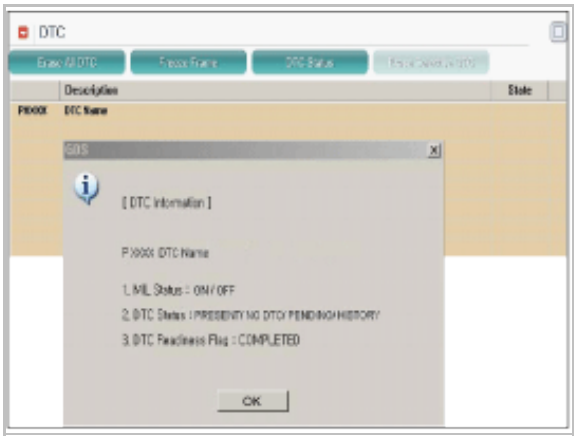
Fig.1) Normal waveforms of front HO2S(the upper) and rear HO2S(the lower). (Waveform between HIGH signal line of HO2S and chassis ground)

Fig.2) Normal graph of front HO2S and rear HO2S at idle.

After warming-up, if accelerator pedal is released suddenly around 4000rpm, the HO2S signal reading will be lower than 200mV resulting from Fuel cut-off for the moment. Conversely, if suddenly accelerator pedal is depressed, HO2S signal reading will be around 0.6V ~1.0V. At idle, Normally HO2S signal will switch from lean to rich with 3 Hz. And as racing, Its frequency rises.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor’s and/or ECM’s connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found ?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Signal Circuit Inspection" procedure.

Signal Circuit Inspection

■ **Check voltage**

1. IG "OFF" and disconnect HO2S(B2/S1) connector.
2. IG "ON".
3. Measure voltage between signal terminal of HO2S(B2/S1) harness connector and chassis ground.

Specification : Approx. 2.2V - when pumping current is ON
Approx. 0.45V - when pumping current is OFF

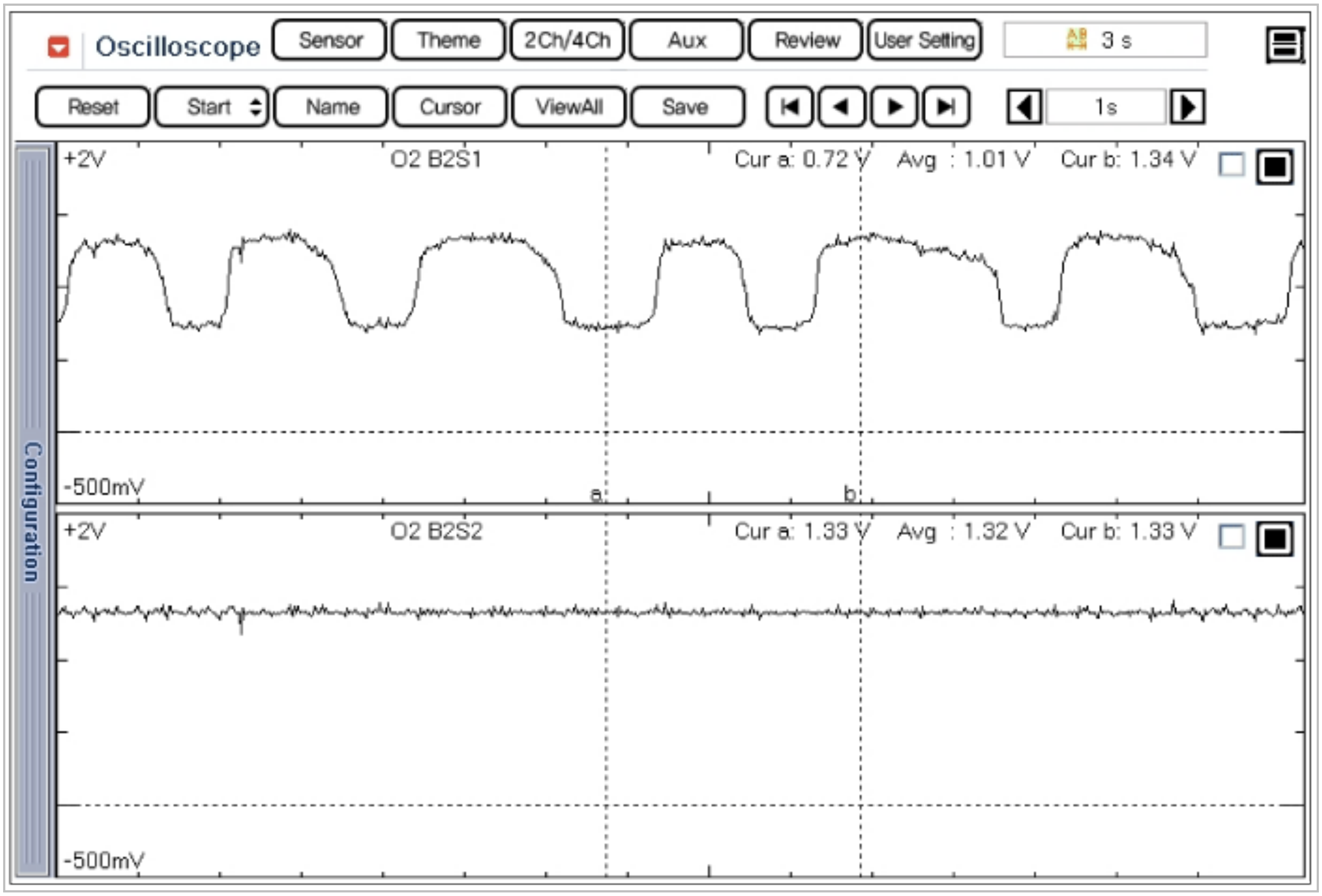
4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to ground in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check the Signal waveform of HO2S

1. IG "OFF" and connect HO2S connector.
2. Engine start.
3. After warming-up, monitor signal waveform of HO2S with GDS.



4. Is the sensor switching properly ?

YES	▶ Go to "Check HO2S" as below.
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

■ Check HO2S

1. IG "OFF" and disconnect HO2S connector.
2. Check that the HO2S is securely installed.
3. Check the HO2S for contamination or damage
4. Is the sensor normal ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE

	There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

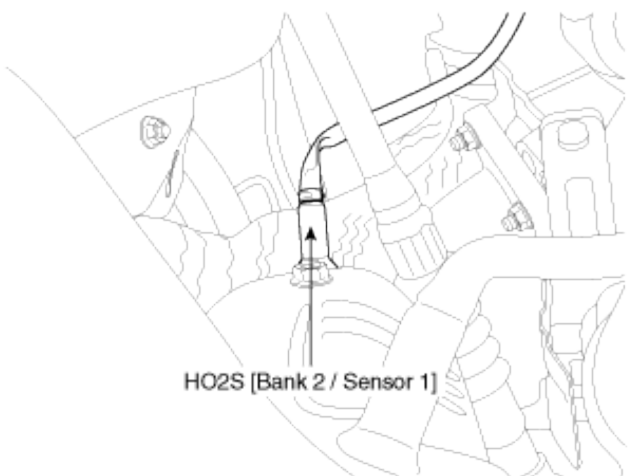
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0152 O2 Sensor Circuit High Voltage (Bank 2 / Sensor 1)

Component Location



General Description

In order to control emissions of the CO, HC and NOx components of the exhaust gas, heated oxygen sensor (HO2S), mounted on the front side and rear side of catalytic converter, detects the oxygen content in the exhaust gas. The front HO2S signal is used to control air/fuel ratio (closed loop fuel control) and the rear HO2S signal is used to monitor front HO2S and catalyst for proper operation. The HO2S requires a minimum temperature to operate properly and provide a closed loop fuel control system. The HO2S contains the heater element to reduce its warming-up time and ensure its performance during all driving conditions. The oxygen sensor generates a voltage that indicates the difference between the oxygen content of the exhaust stream and the oxygen content of ambient air. When the exhaust stream is “rich,” there is more oxygen in the ambient air than in the exhaust stream, so the voltage will be higher.

DTC Description

Checking output signals from HO2S under detecting condition, if an output signal is above 1.3V for more than predeterminate time, ECM sets P0152. The MIL(Malfunction Indicator Lamp) will illuminate when the fault remains for 2 consecutive drive cycles

DTC Detecting Condition

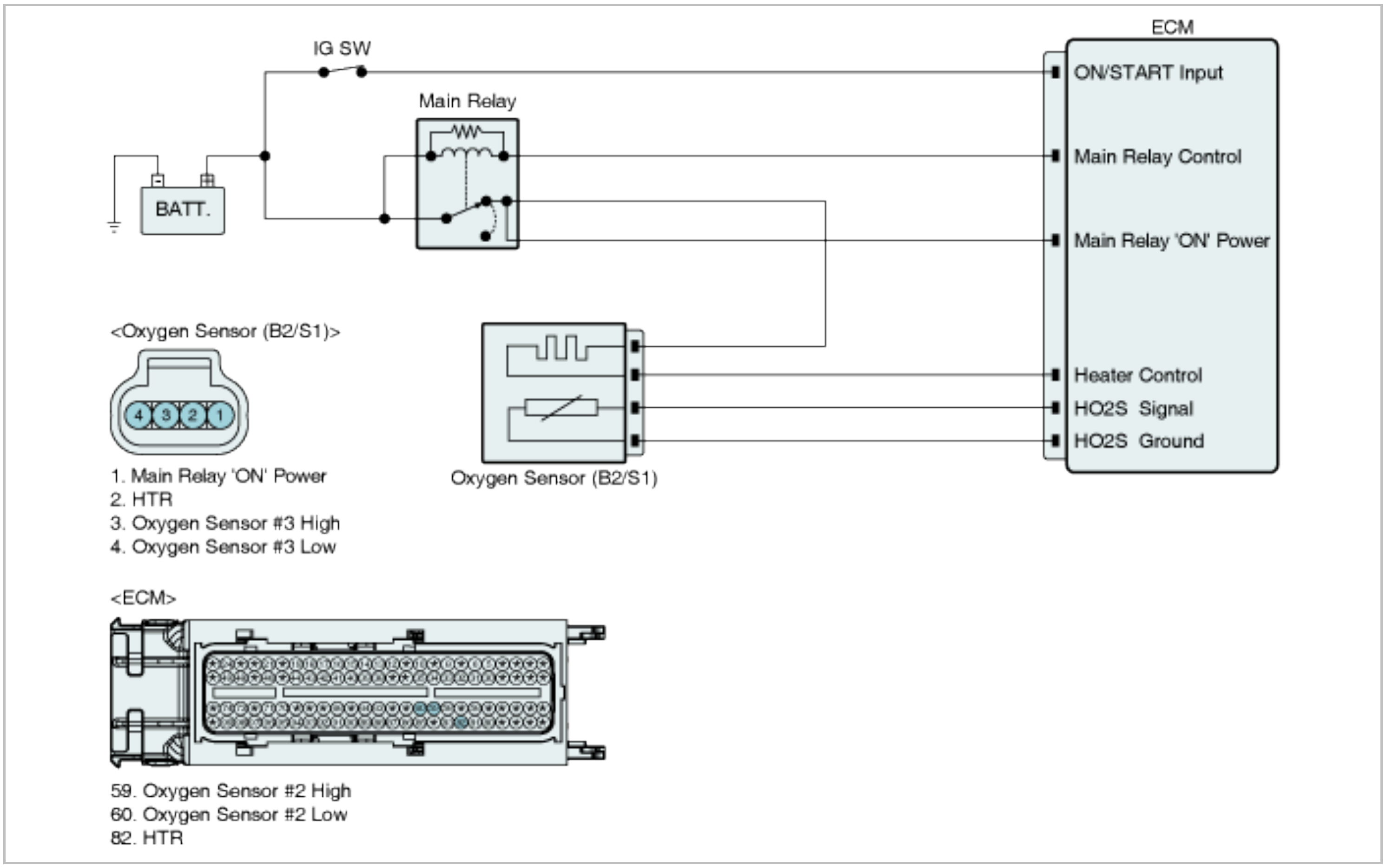
Item	Detecting Condition	Possible Cause
DTC Strategy	• Monitor signal voltage	• Poor connection • Short to battery in harness • HO2S(B2/S1) • ECM
Enable Conditions	• Battery voltage ≥ 10V • Engine running ≥ 60 sec • Engine warm-up state	
Threshold value	• The voltage of HO2S(B2/S1) > 1.3V	
Diagnosis Time	• Continous (more than 12.5 sec.failure for every 15 sec.test)	
MIL On Condition	• 2 Driving Cycles	

Specification

(Reference only)

Test Condition	HO2S Voltage(Sensor1)	HO2S Voltage(Sensor2)
HO2S Signal at idle after warm-up	Signal is commonly switching from rich to lean more than 3 times in 10 sec.	Signal is commonly above 0.6V.
HO2S signal at open circuit (Pumping current OFF)	Approx. 0.45V	
HO2S signal at open circuit (Pumping current ON)	Approx. 2.2V	

Diagnostic Circuit Diagram



Signal Waveform & Data

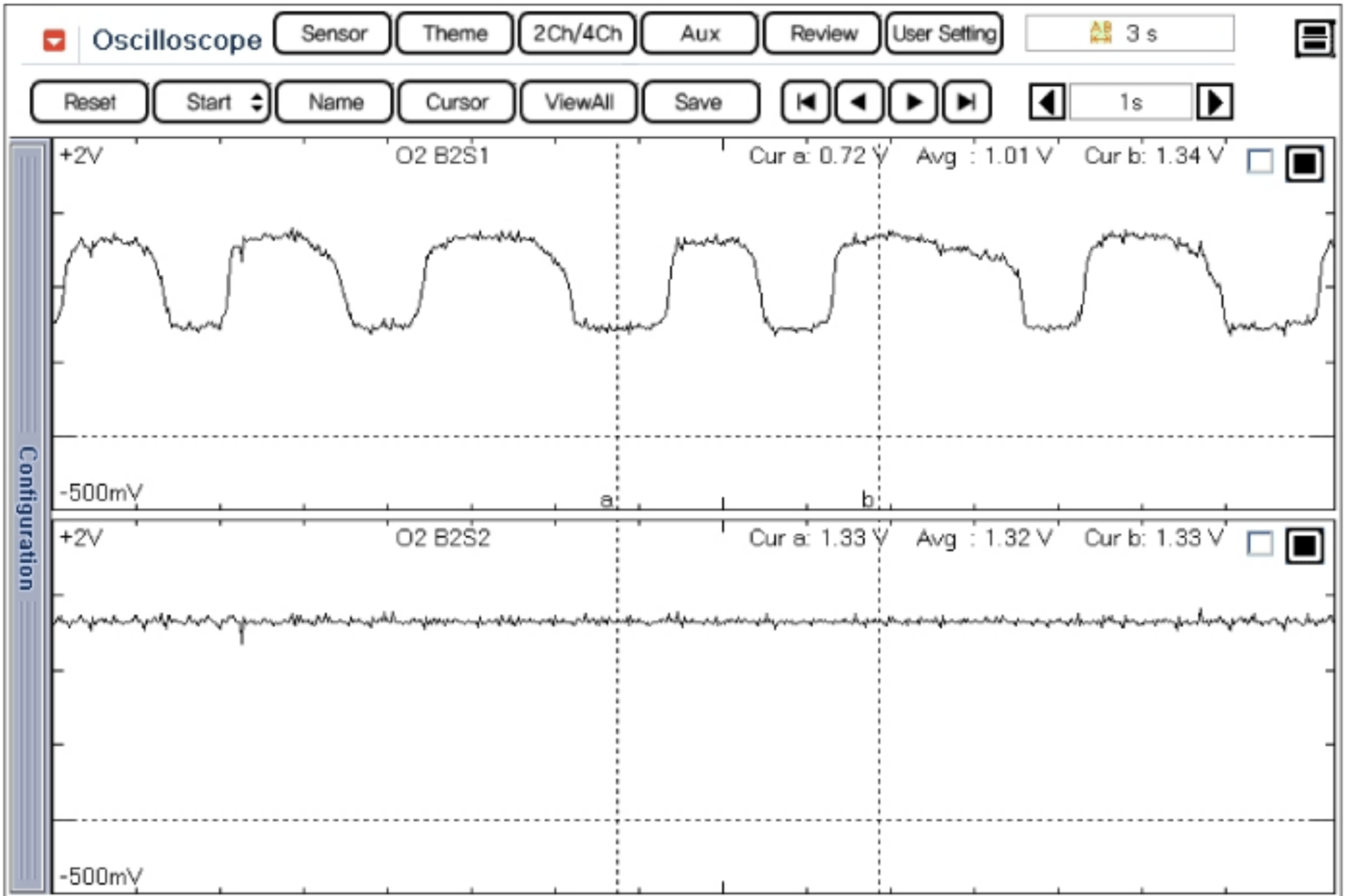

Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
3 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 0.72 V
Avg : 1.01 V
Cur b: 1.34 V
-500mV
a
b
+2V
O2 B2S2
Cur a: 1.33 V
Avg : 1.32 V
Cur b: 1.33 V
-500mV

Fig.1

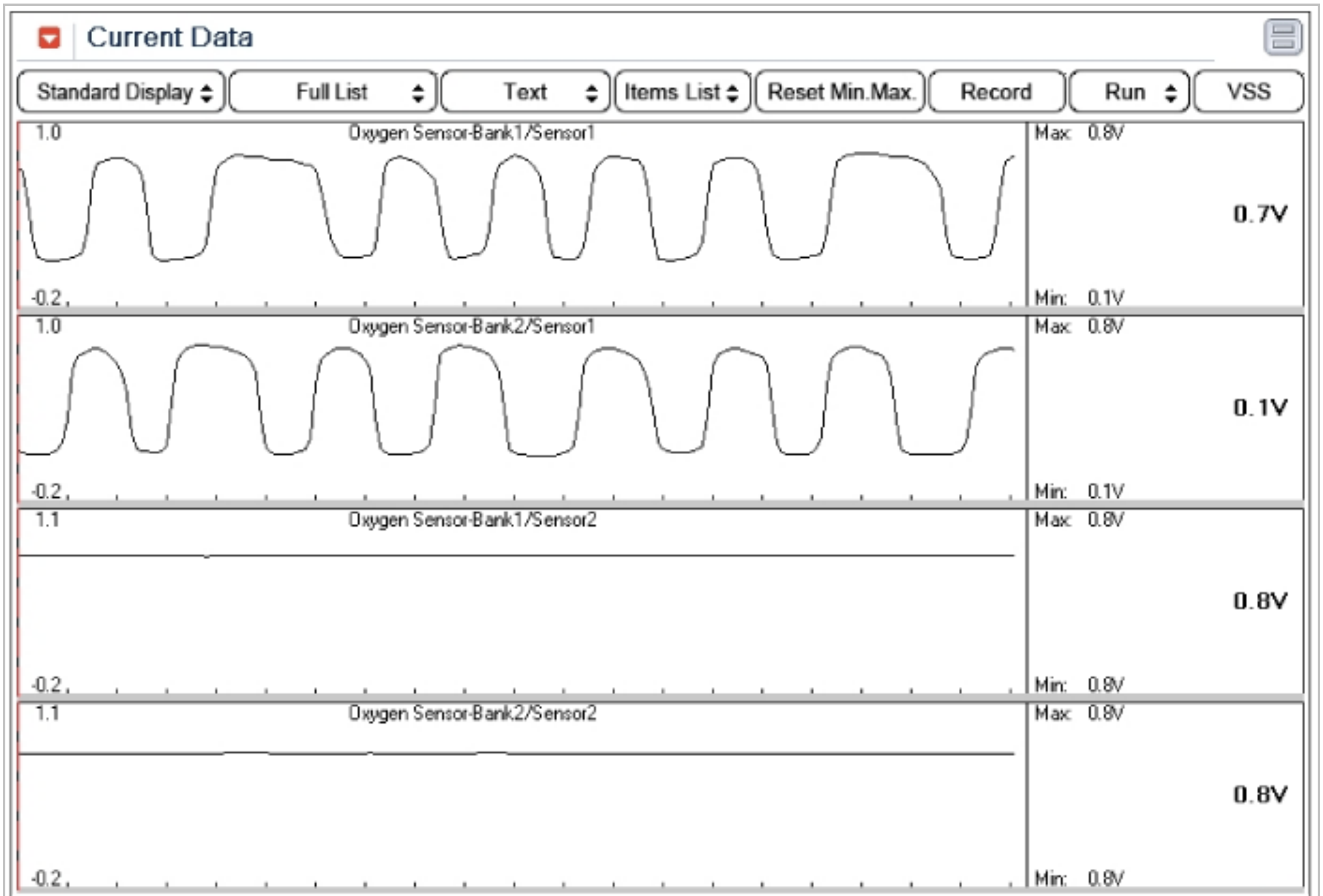


Fig.2

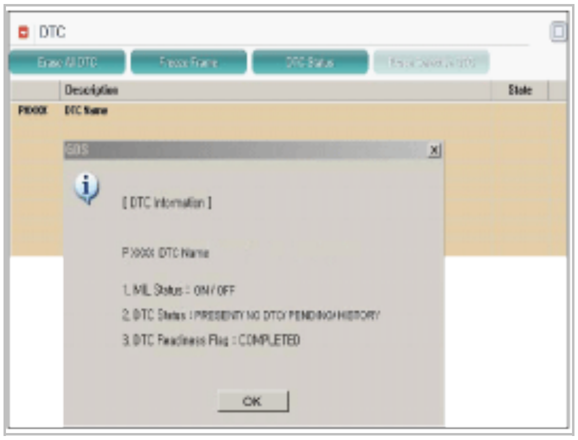
Fig.1) Normal waveforms of front HO2S(the upper) and rear HO2S(the lower). (Waveform between HIGH signal line of HO2S and chassis ground)

Fig.2) Normal graph of front HO2S and rear HO2S at idle.

After warming-up, if accelerator pedal is released suddenly around 4000rpm, the HO2S signal reading will be lower than 200mV resulting from Fuel cut-off for the moment. Conversely, if suddenly accelerator pedal is depressed, HO2S signal reading will be around 0.6V ~1.0V. At idle, Normally HO2S signal will switch from lean to rich with 3 Hz. And as racing, Its frequency rises.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found ?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Signal Circuit Inspection" procedure.

Signal Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect HO2S(B2/S1) connector.
2. IG "ON".
3. Measure voltage between signal terminal of HO2S(B2/S1) harness connector and chassis ground.

Specification : Approx.2.2V - when pumping current is ON
Approx. 0.45V - when pumping current is OFF

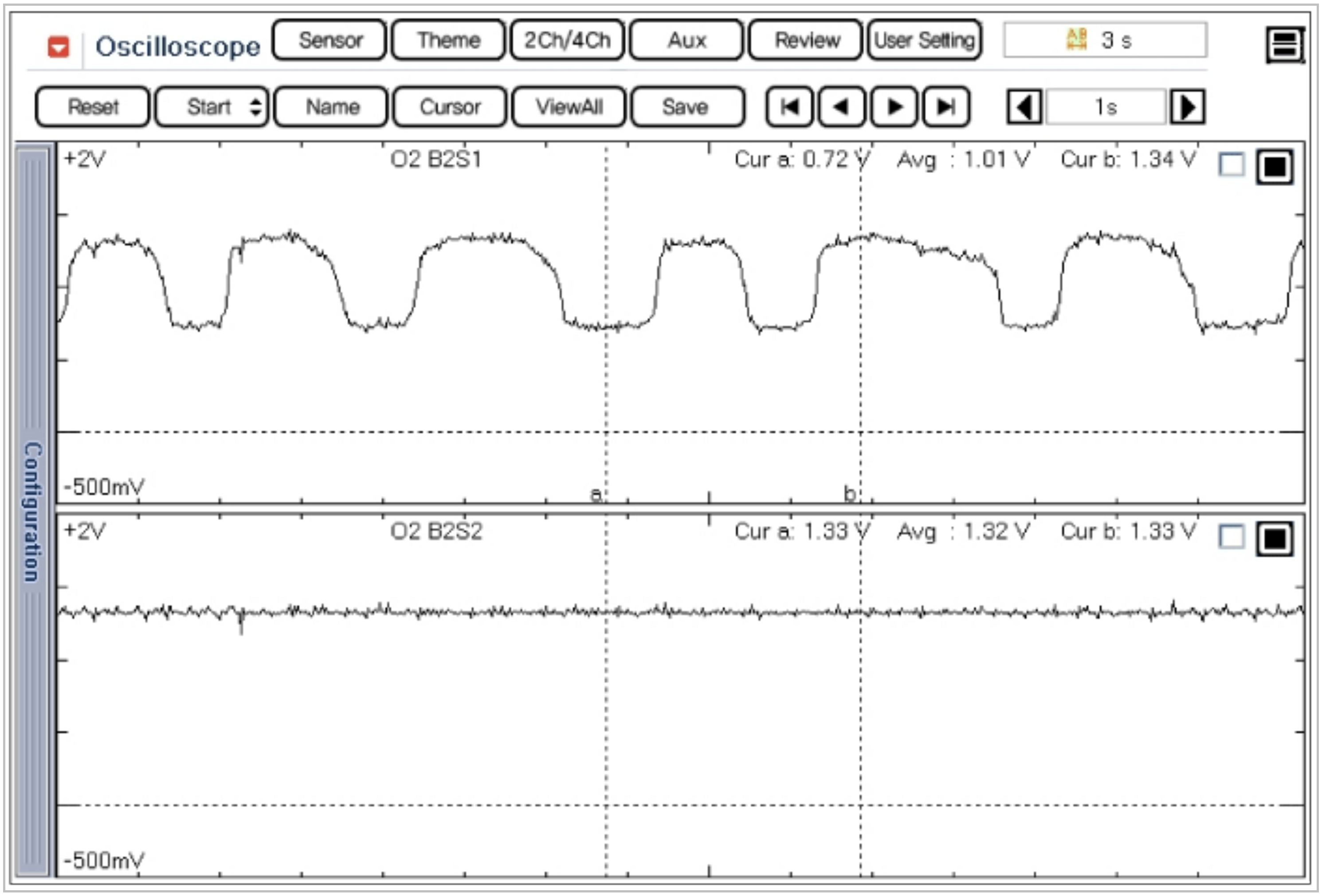
4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to battery in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check the Signal waveform of HO2S

1. IG "OFF" and connect HO2S connector.
2. Engine start.
3. After warming-up, monitor signal waveform of HO2S with GDS.



4. Is the sensor switching properly ?

YES	▶ Go to "Check HO2S" as below.
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

■ Check HO2S

1. IG "OFF" and disconnect HO2S connector.
2. Check that the HO2S is securely installed.
3. Check the HO2S for contamination or damage
4. Is the sensor normal ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE

	There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

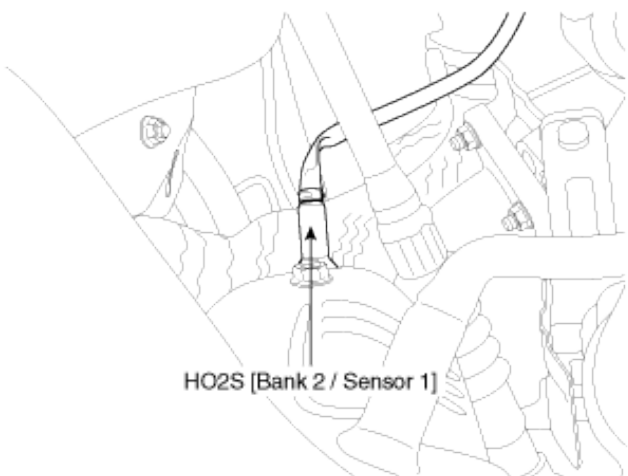
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0153 O2 Sensor Circuit Slow Response (Bank 2 / Sensor 1)

Component Location



General Description

In order to control emissions of the CO, HC and NOx components of the exhaust gas, heated oxygen sensor (HO2S), mounted on the front side and rear side of catalytic converter, detects the oxygen content in the exhaust gas. The front HO2S signal is used to control air/fuel ratio (closed loop fuel control) and the rear HO2S signal is used to monitor front HO2S and catalyst for proper operation. The HO2S requires a minimum temperature to operate properly and provide a closed loop fuel control system. The HO2S contains the heater element to reduce its warming-up time and ensure its performance during all driving conditions. The oxygen sensor generates a voltage that indicates the difference between the oxygen content of the exhaust stream and the oxygen content of ambient air. When the exhaust stream is “rich,” there is more oxygen in the ambient air than in the exhaust stream, so the voltage will be higher.

DTC Description

Checking output signals from HO2S under detecting condition, if ECM judges it's signals too slow, ECM sets P0153. The MIL (Malfunction Indicator Lamp) will illuminate when the fault remains for 2 consecutive drive cycles

DTC Detecting Condition

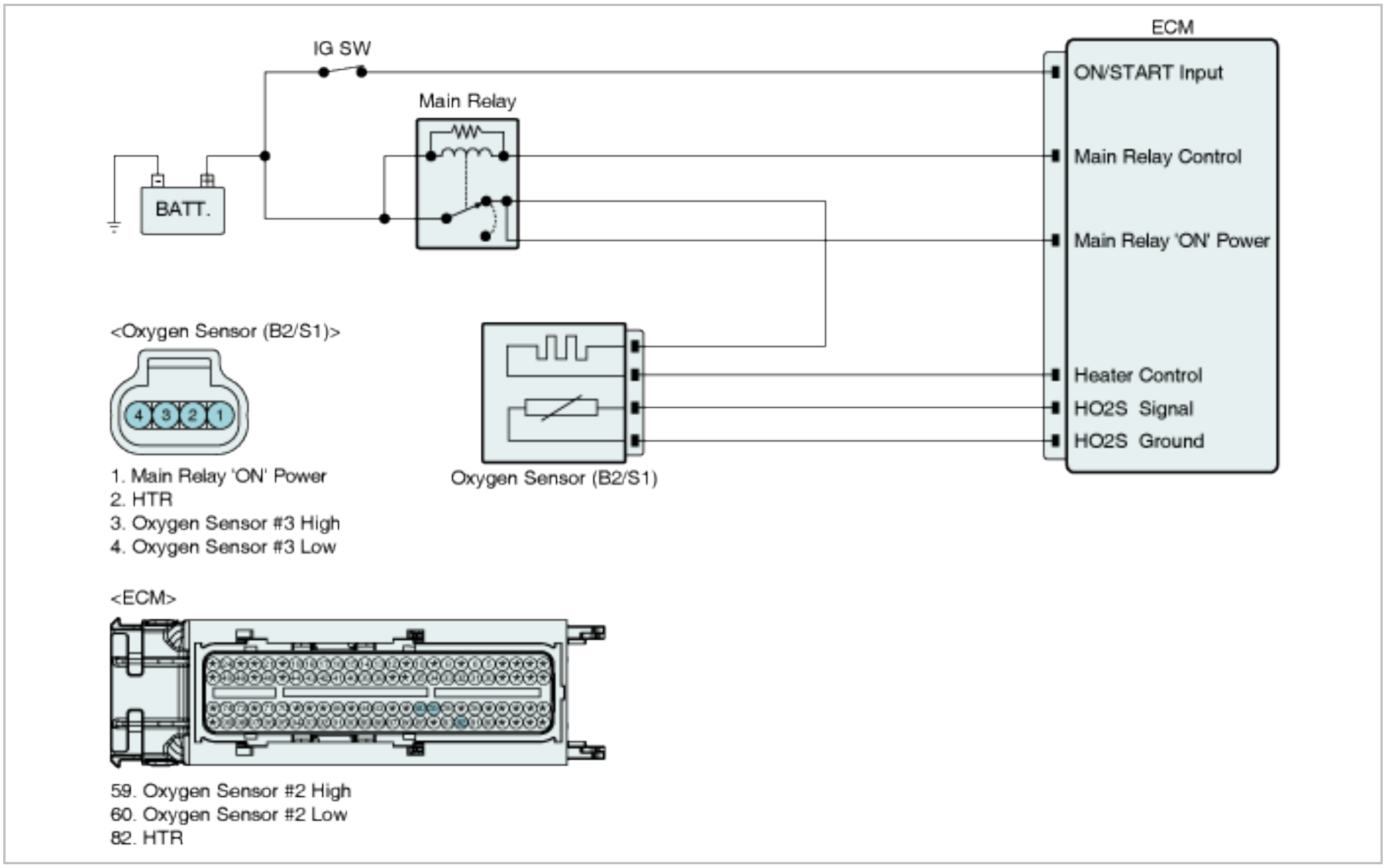
Item	Detecting Condition	Possible Cause
DTC Strategy	• Monitor HO2S's response rate	• Poor connection • Faulty HO2S • Faulty ECM
Enable Conditions	• Engine warm-up sufficiently • Engine run time > 60sec • Drive at a steady speed between 45-55 mph(72-88 km/h) • Engine Coolant > 70°C(158 °F) • No disabling faults	
Threshold value	• The calculated response rate is too slow (out of threshold in ECM)	
Diagnosis Time	• Continuous	
MIL On Condition	• 2 Driving Cycles	

Specification

(Reference only)

Test Condition	HO2S Voltage(Sensor1)	HO2S Voltage(Sensor2)
HO2S Signal at idle after warm-up	Signal is commonly switching from rich to lean more than 3 times in 10 sec.	Signal is commonly above 0.6V.
HO2S signal at open circuit (Pumping current OFF)	Approx. 0.45V	
HO2S signal at open circuit (Pumping current ON)	Approx. 2.2V	

Diagnostic Circuit Diagram



Signal Waveform & Data

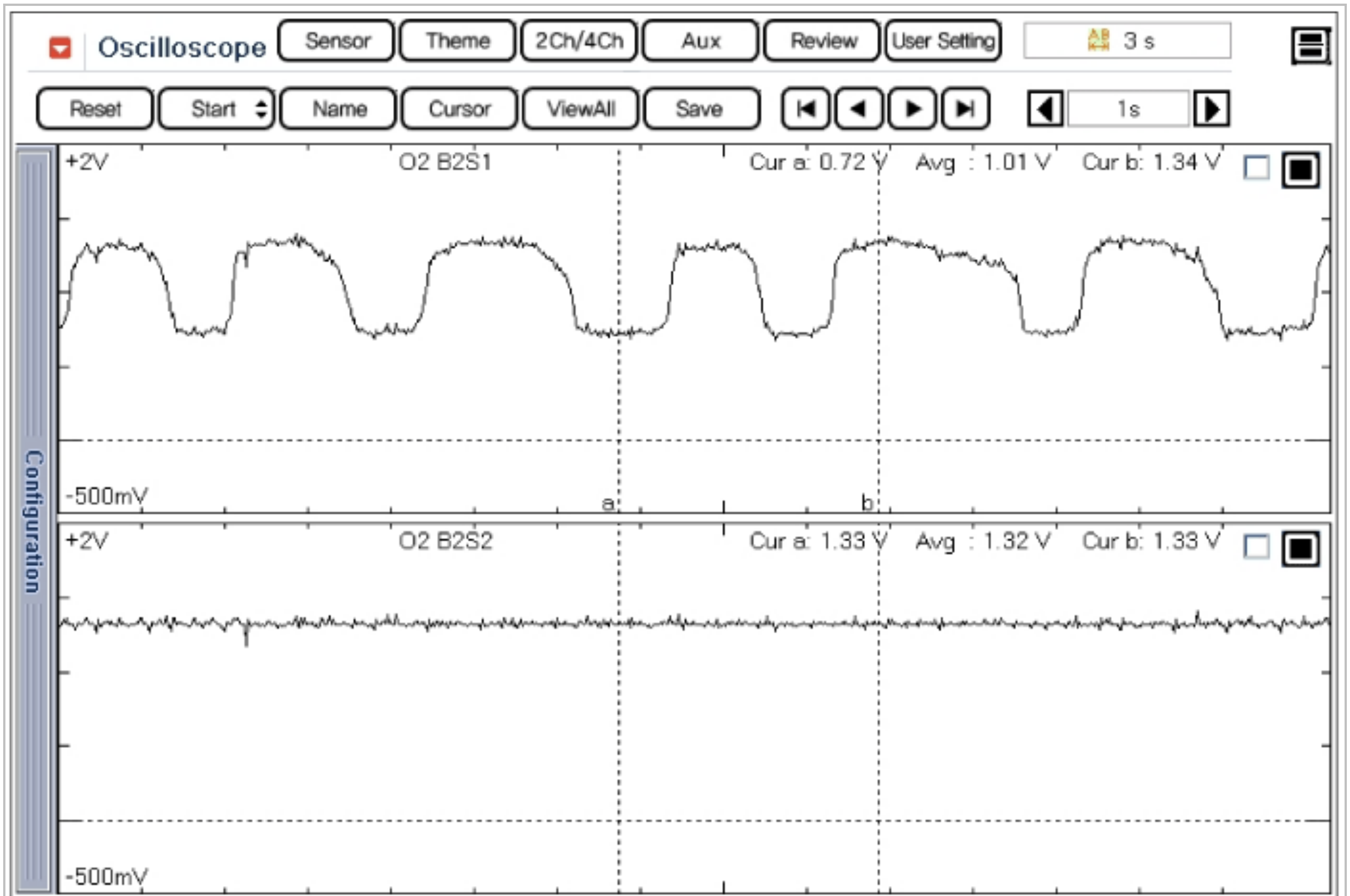

Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
3 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 0.72 V
Avg : 1.01 V
Cur b: 1.34 V
-500mV
a
b
+2V
O2 B2S2
Cur a: 1.33 V
Avg : 1.32 V
Cur b: 1.33 V
-500mV

Fig.1

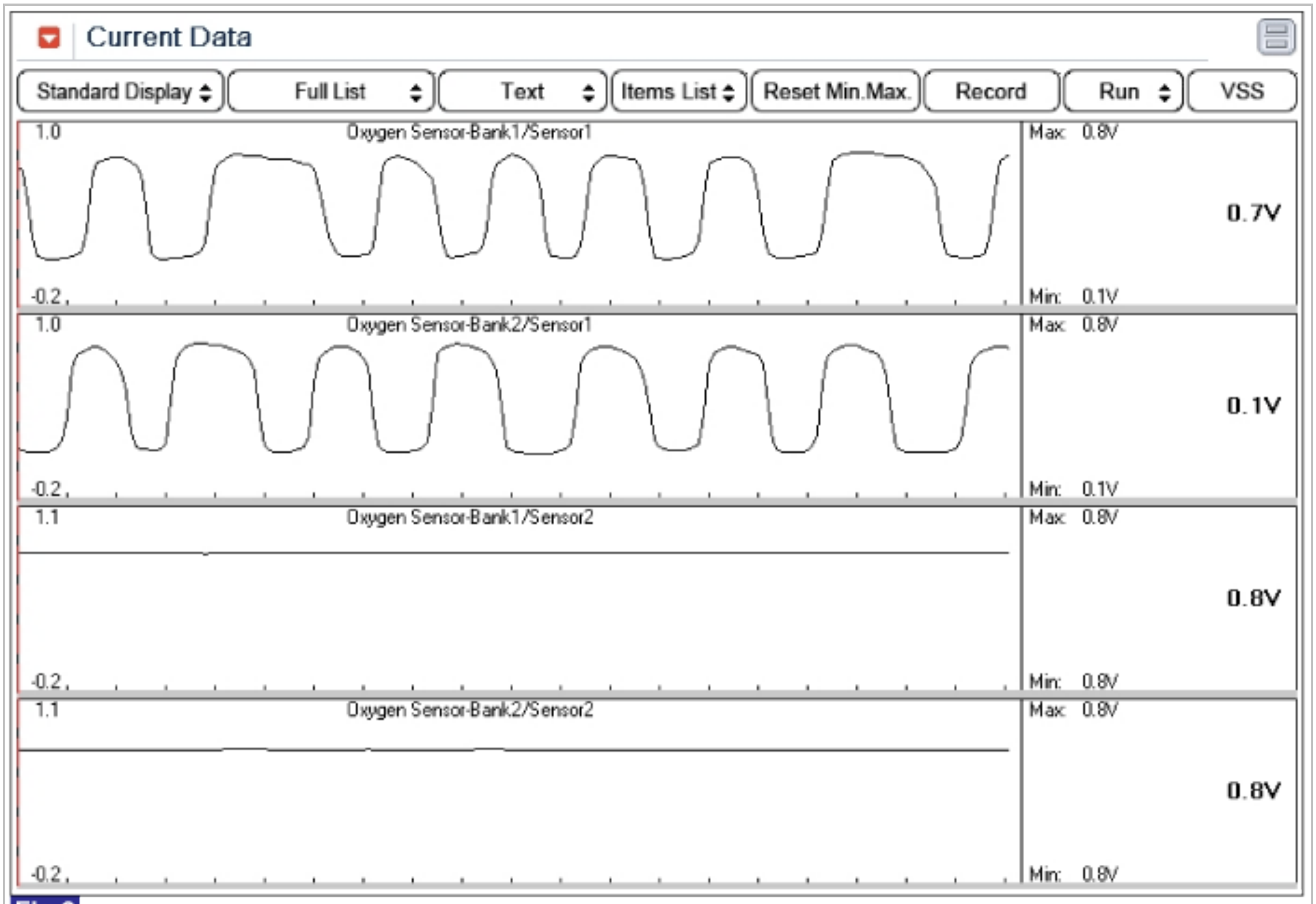
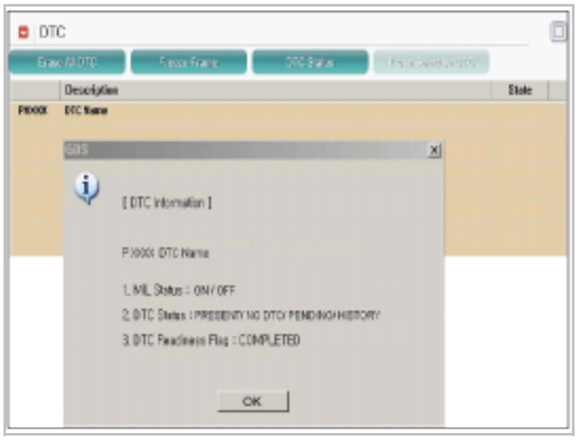


Fig.2

Fig.1) Normal waveforms of front HO2S(the upper) and rear HO2S(the lower). (Waveform between HIGH signal line of HO2S and chassis ground)
Fig.2) Normal graph of front HO2S and rear HO2S at idle.
After warming-up, if accelerator pedal is released suddenly around 4000rpm, the HO2S signal reading will be lower than 200mV resulting from Fuel cut-off for the moment. Conversely, if suddenly accelerator pedal is depressed, HO2S signal reading will be around 0.6V ~1.0V. At idle, Normally HO2S signal will switch from lean to rich with 3 Hz. And as racing, Its frequency rises.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Clear DTC and check if this DTC is set after test-driving under enable conditions. If DTC isn't displayed after the test, it was intermittent fault. Go to "Verification of Vehicle Repair" procedure.

Component Inspection

1. Replace the HO2S.
2. Clear DTC with GDS.
3. Start the engine and warm it up until the radiator fan comes on(more than at least 10 minutes).
4. Drive at a steady speed between 45-55 mph(72-88 km/h) for 120 sec.
5. Stop and then maintain idle state.
6. Check if O2 sensor monitoring readiness is complete.
7. Does the scan tool show DTC P0153 ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Troubleshooting is finished.

Verification of Vehicle Repair

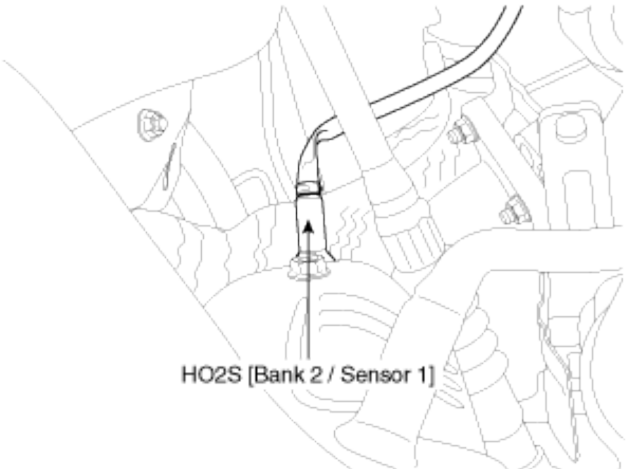
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0154 O2 Sensor Circuit No Activity Detected (Bank 2 / Sensor 1)

Component Location



General Description

In order to control emissions of the CO, HC and NOx components of the exhaust gas, heated oxygen sensor (HO2S), mounted on the front side and rear side of catalytic converter, detects the oxygen content in the exhaust gas. The front HO2S signal is used to control air/fuel ratio (closed loop fuel control) and the rear HO2S signal is used to monitor front HO2S and catalyst for proper operation. The HO2S requires a minimum temperature to operate properly and provide a closed loop fuel control system. The HO2S contains the heater element to reduce its warming-up time and ensure its performance during all driving conditions. The oxygen sensor generates a voltage that indicates the difference between the oxygen content of the exhaust stream and the oxygen content of ambient air. When the exhaust stream is “rich,” there is more oxygen in the ambient air than in the exhaust stream, so the voltage will be higher.

DTC Description

Checking output signals from HO2S under detecting condition, if an output voltage is Approx. 0.45V or 3.5V for more than predeterminate time, ECM sets P0154. The MIL(Malfunction Indicator Lamp) will illuminate when the fault remains for 2 consecutive drive cycles

DTC Detecting Condition

Item		Detecting Condition	Possible Cause
DTC Strategy		• Monitor signal voltage	• Poor connection • Open in harness
Enable Conditions		• Battery voltage ≥ 10V • Engine running ≥ 60 sec • Engine warm-up state • No disable faults	
	Case 1	• 1.2V ≤ Voltage of HO2S ≤ 3.9V	

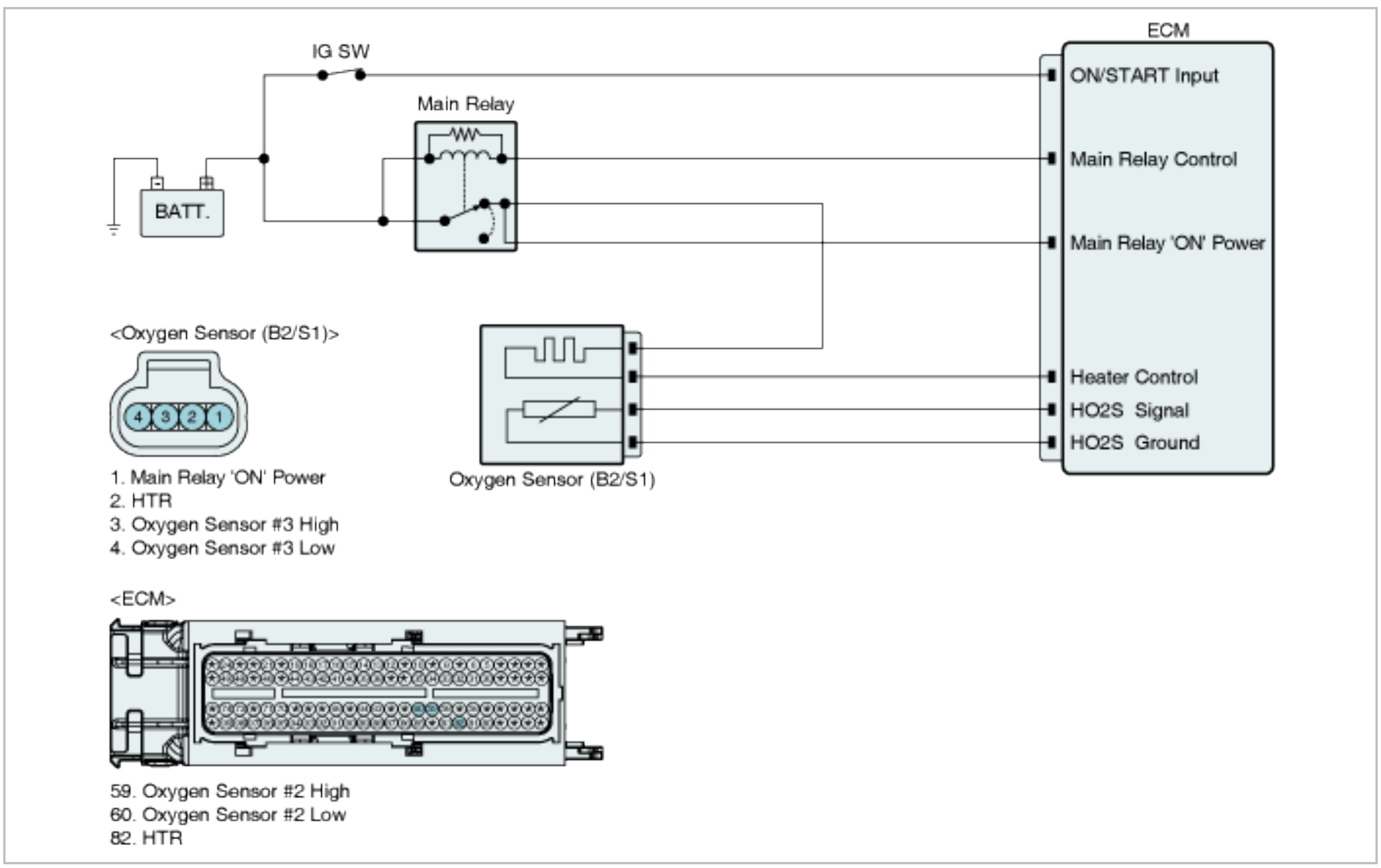
Threshold value	Case 1	(at pumping current ON)	• HO2S(B2/S1) • ECM
	Case 2	• 0.415V ≤ Voltage of HO2S ≤ 0.515V (at pumping current OFF)	
Diagnosis Time		• Continuous (more than 76.5 sec.failure for every 90 sec.test)	
MIL On Condition		• 2 Driving Cycles	

Specification

(Reference only)

Test Condition	HO2S Voltage(Sensor1)	HO2S Voltage(Sensor2)
HO2S Signal at idle after warm-up	Signal is commonly switching from rich to lean more than 3 times in 10 sec.	Signal is commonly above 0.6V.
HO2S signal at open circuit (Pumping current OFF)	Approx. 0.45V	
HO2S signal at open circuit (Pumping current ON)	Approx. 2.2V	

Diagnostic Circuit Diagram



Signal Waveform & Data

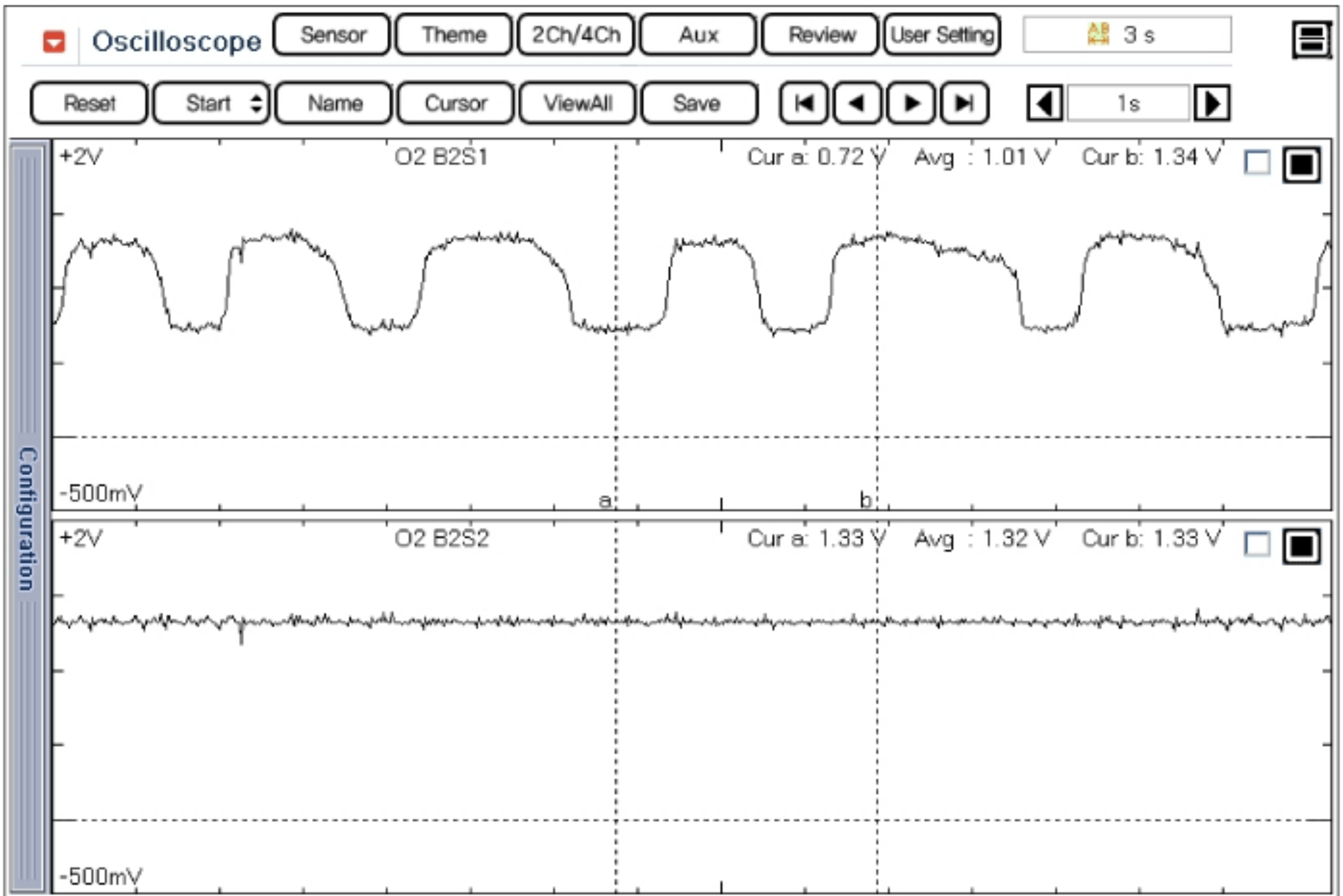


Fig.1

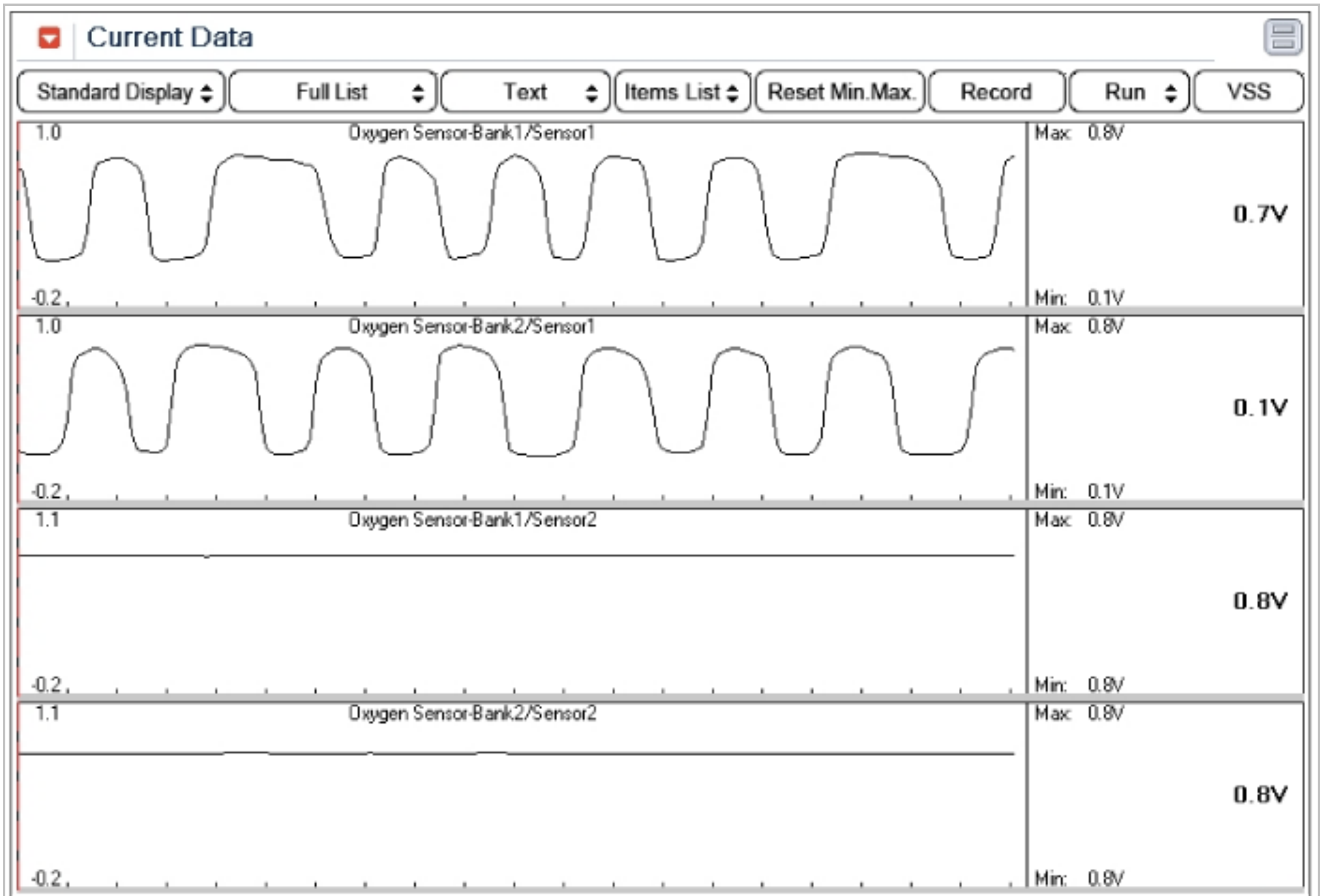


Fig.2

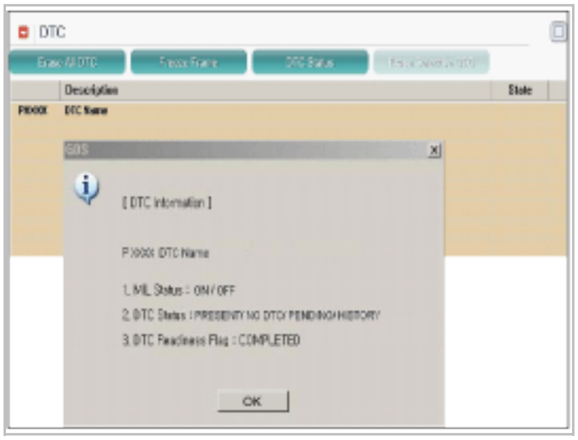
Fig.1) Normal waveforms of front HO2S(the upper) and rear HO2S(the lower). (Waveform between HIGH signal line of HO2S and chassis ground)

Fig.2) Normal graph of front HO2S and rear HO2S at idle.

After warming-up, if accelerator pedal is released suddenly around 4000rpm, the HO2S signal reading will be lower than 200mV resulting from Fuel cut-off for the moment. Conversely, if suddenly accelerator pedal is depressed, HO2S signal reading will be around 0.6V ~1.0V. At idle, Normally HO2S signal will switch from lean to rich with 3 Hz. And as racing, Its frequency rises.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found ?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Signal Circuit Inspection" procedure.

Signal Circuit Inspection

■ **Check voltage**

1. IG "OFF" and disconnect HO2S(B2/S1) connector.
2. IG "ON".
3. Measure voltage between signal terminal of HO2S(B2/S1) harness connector and chassis ground.

Specification : Approx. 2.2V - when pumping current is ON
Approx. 0.45V - when pumping current is OFF

4. Is the measured voltage within specification ?

YES	▶ Go to "Ground circuit inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" prcedure.

Ground Circuit Inspection

■ **Check open in harness**

1. IG "ON" and disconnect HO2S(B2/S1) connector.
2. Measure voltage between signal terminal of HO2S(B2/S1) harness connector and chassis ground.(Measurement "A")
3. Measure voltage between signal and ground terminals of HO2S(B2/S1) harness connector.(Measurement "B")

Specification : Voltage difference between measurement "A" and "B" is below 200mV.

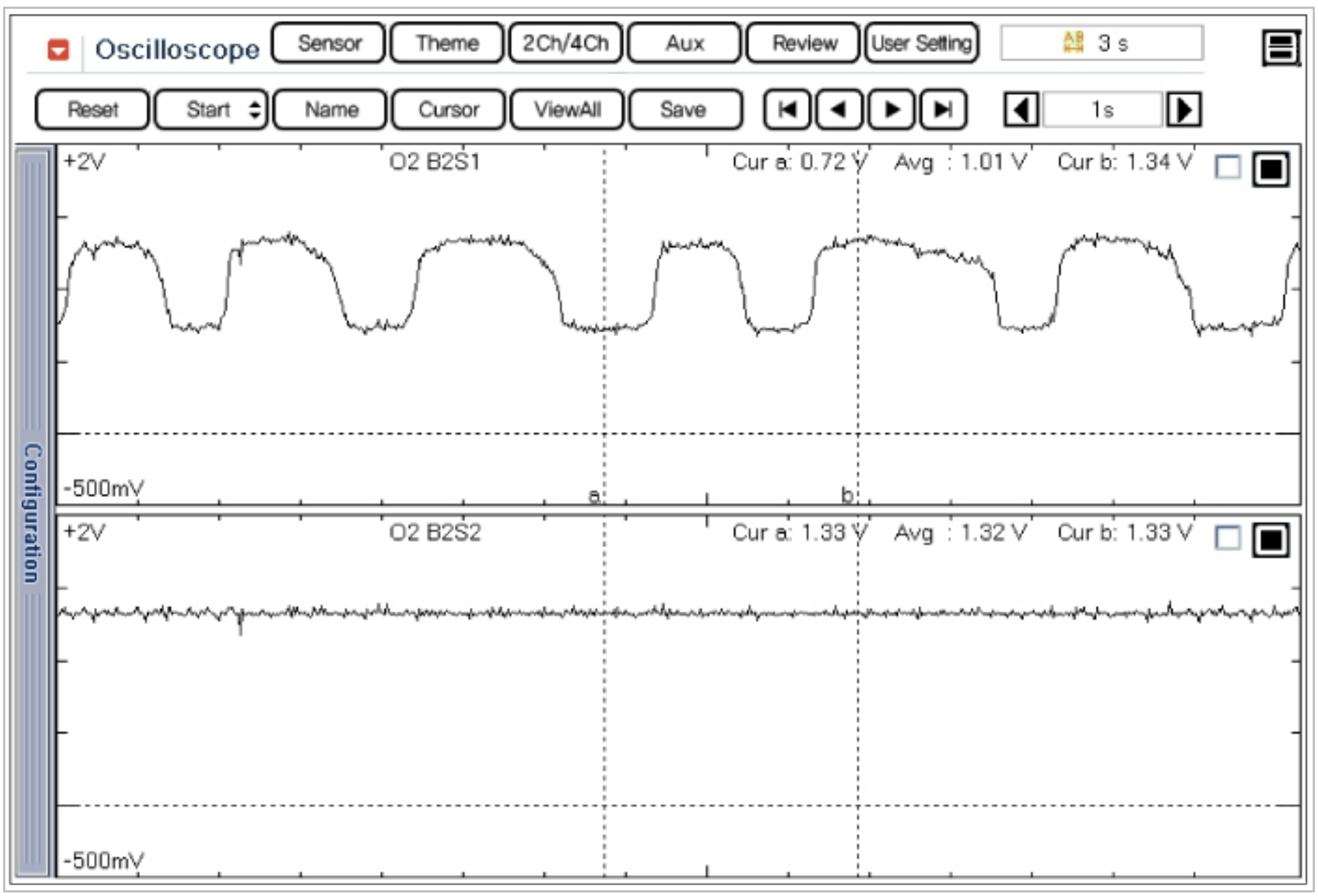
4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair contact resistance or open in harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ **Check the Signal waveform of HO2S**

1. IG "OFF" and connect HO2S connector.
2. Engine start.
3. After warming-up, monitor signal waveform of HO2S with GDS.



4. Is the sensor switching properly ?

YES	▶ Go to "Check HO2S" as below.

NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

■ **Check HO2S**

1. IG "OFF" and disconnect HO2S connector.
2. Check that the HO2S is securely installed.
3. Check the HO2S for contamination or damage
4. Is the sensor normal ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

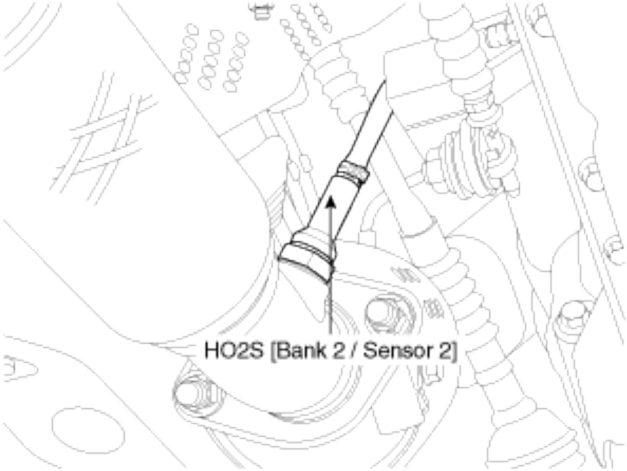
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0157 O2 Sensor Circuit Low Voltage (Bank 2 / Sensor 2)

Component Location



General Description

The rear heated oxygen sensor is mounted on the rear side of the Catalytic Converter (warm-up catalytic converter) or in the rear exhaust pipe, which is able to detect catalyst efficiency. The rear heated oxygen sensor (HO2S) produces a voltage between 0V and 1V. This rear heated oxygen sensor is used to estimate the oxygen storage capability. If a catalyst has good conversion properties, the oxygen fluctuations are smoothed by the oxygen storage capacity of the catalyst. If the conversion provided by the catalyst is low due to aging, poisoning or misfiring, then the oxygen fluctuations are similar to signals from the front oxygen sensor.

DTC Description

Checking output signals from HO2S under detecting condition, if an output signal is below 0.04V for more than predeterminate time, ECM sets P0157. The MIL(Malfunction Indicator Lamp) will illuminate when the fault remains for 2 consecutive drive cycles

DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Monitor signal voltage	• Poor connection • Short to ground in harness • HO2S(B2/S2) • ECM
Enable Conditions	• Battery voltage ≥ 10V • Engine running ≥ 60 sec • Engine warm-up state	
Threshold value	• The voltage of HO2S(B2/S2) < 0.04V	
Diagnosis Time	• Continuous (more than 12.5 sec. failure for every 15 sec.test)	
MIL On Condition	• 2 Driving Cycles	

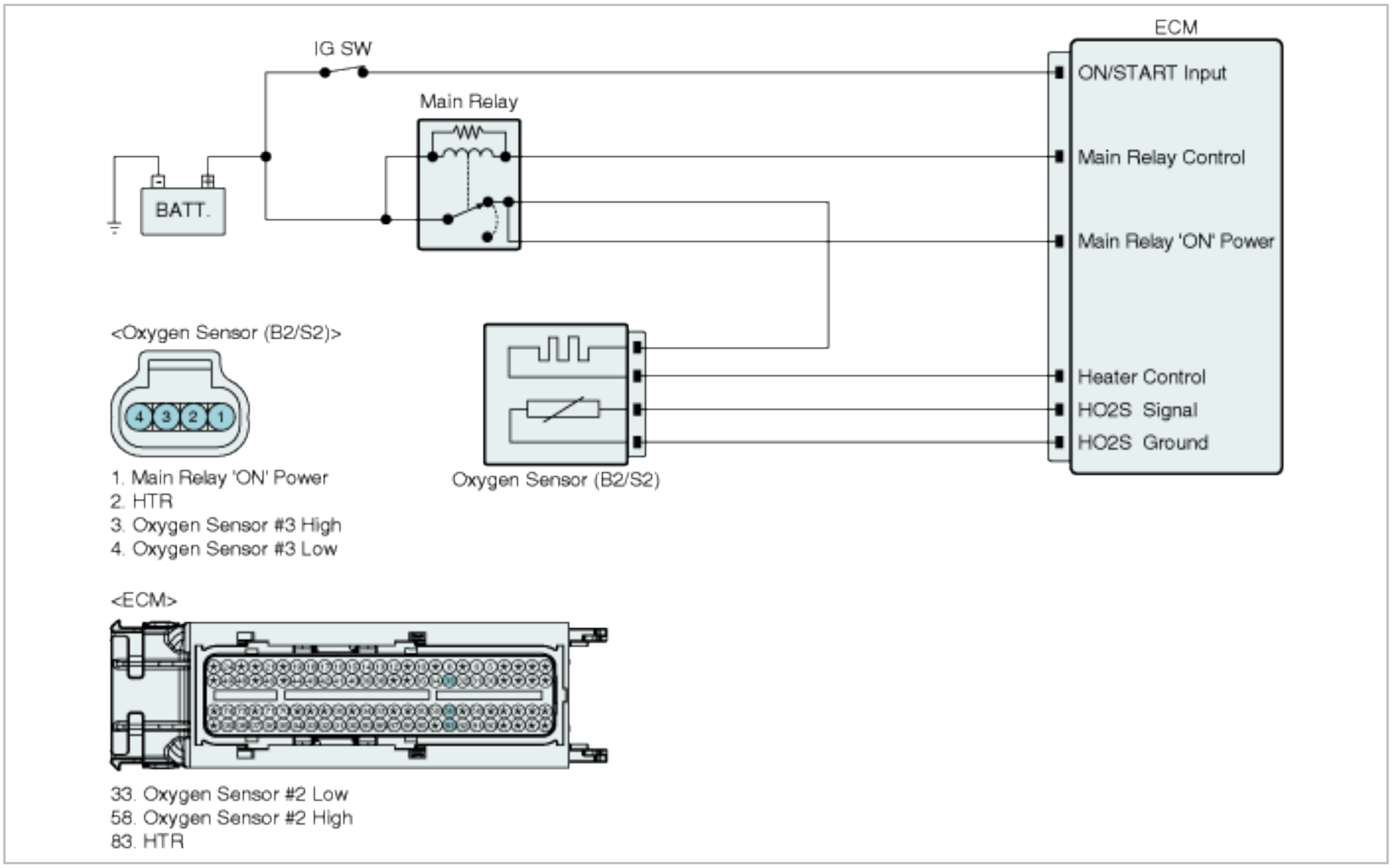
Specification

(Reference only)

Test Condition	HO2S Voltage(Sensor1)	HO2S Voltage(Sensor2)
HO2S Signal at idle after warm-up	Signal is commonly switching from rich to lean more than 3 times in 10 sec.	Signal is commonly above 0.6V.

HO2S signal at open circuit (Pumping current OFF)	Approx. 0.45V
HO2S signal at open circuit (Pumping current ON)	Approx. 2.2V

Diagnostic Circuit Diagram



Signal Waveform & Data

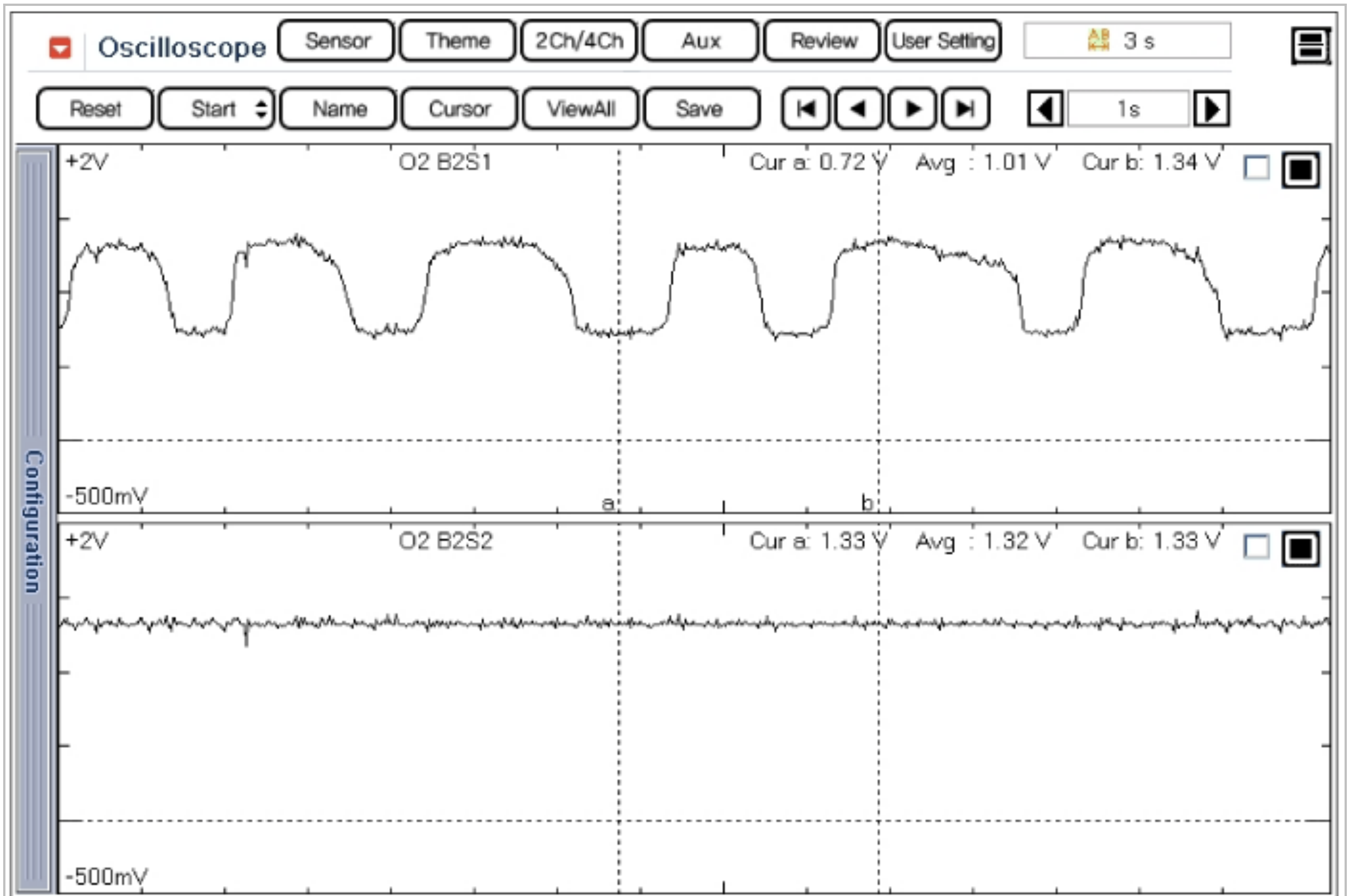

Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
3 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 0.72 V
Avg : 1.01 V
Cur b: 1.34 V
-500mV
a
b
+2V
O2 B2S2
Cur a: 1.33 V
Avg : 1.32 V
Cur b: 1.33 V
-500mV

Fig.1

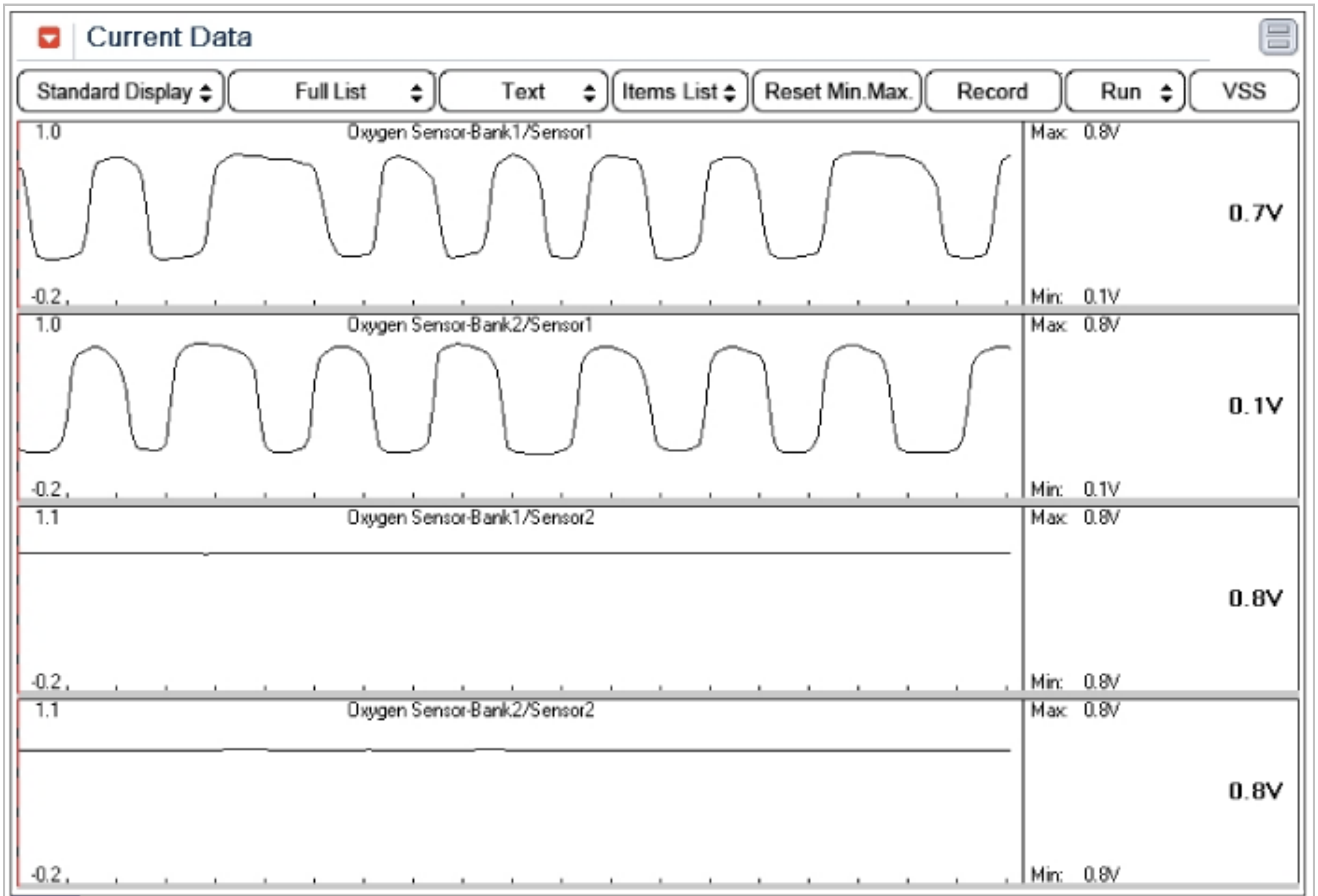
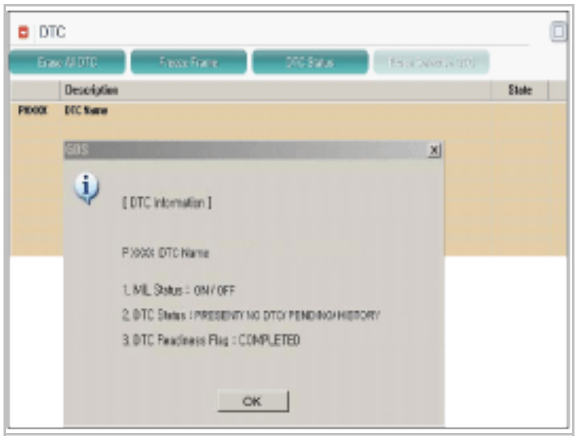


Fig.2

Fig.1) Normal waveforms of front HO2S(the upper) and rear HO2S(the lower). (Waveform between HIGH signal line of HO2S and chassis ground)
Fig.2) Normal graph of front HO2S and rear HO2S at idle.
After warming-up, if accelerator pedal is released suddenly around 4000rpm, the HO2S signal reading will be lower than 200mV resulting from Fuel cut-off for the moment. Conversely, if suddenly accelerator pedal is depressed, HO2S signal reading will be around 0.6V ~1.0V. At idle, Normally HO2S signal will switch from lean to rich with 3 Hz. And as racing, Its frequency rises.

Monitor Scantool Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor’s and/or ECM’s connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found ?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Signal Circuit Inspection" procedure.

Signal Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect HO2S(B2/S2) connector.
2. IG "ON".
3. Measure voltage between signal terminal of HO2S(B2/S2) harness connector and chassis ground.

Specification : Approx. 2.2V - when pumping current is ON
Approx. 0.45V - when pumping current is OFF

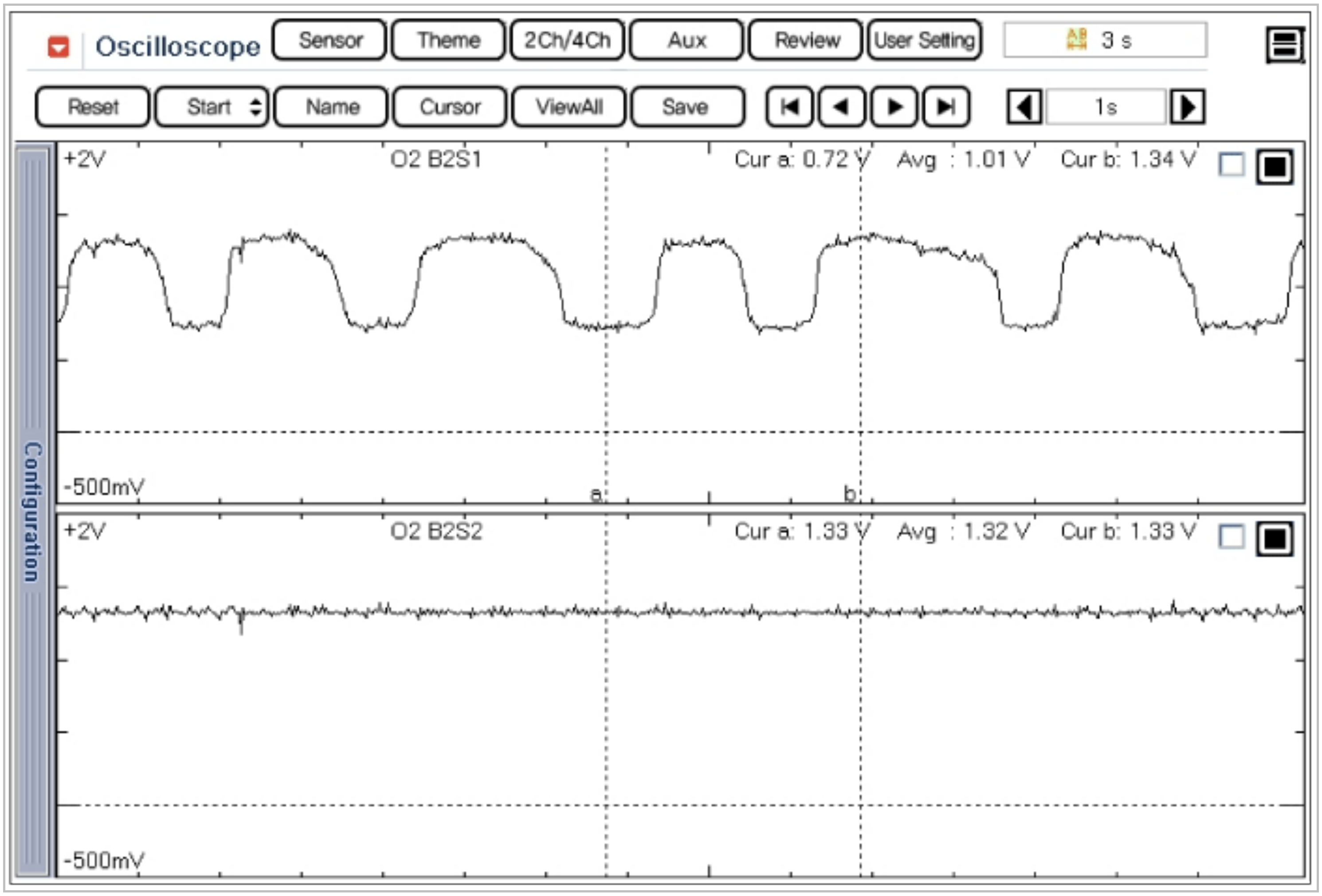
4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to ground in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check the Signal waveform of HO2S

1. IG "OFF" and connect HO2S connector.
2. Engine start.
3. After warming-up, monitor signal waveform of HO2S with GDS.



4. Is the sensor switching properly ?

YES	▶ Go to "Check HO2S" as below.
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

■ Check HO2S

1. IG "OFF" and disconnect HO2S connector.
2. Check that the HO2S is securely installed.
3. Check the HO2S for contamination or damage
4. Is the sensor normal ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE

	There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

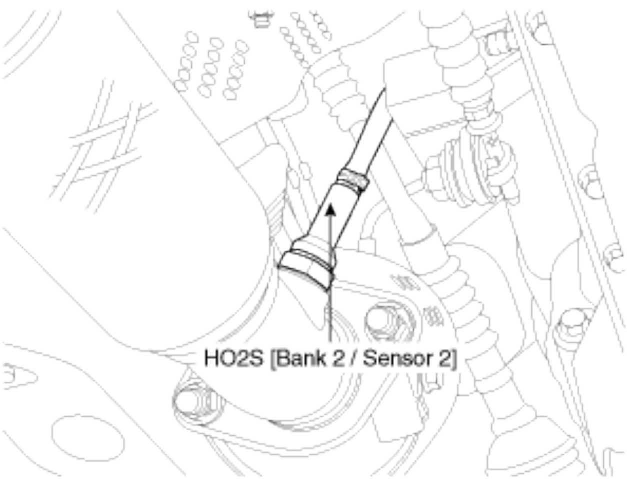
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0158 O2 Sensor Circuit High Voltage (Bank 2 / Sensor 2)

Component Location



General Description

The rear heated oxygen sensor is mounted on the rear side of the Catalytic Converter (warm-up catalytic converter) or in the rear exhaust pipe, which is able to detect catalyst efficiency. The rear heated oxygen sensor (HO2S) produces a voltage between 0V and 1V. This rear heated oxygen sensor is used to estimate the oxygen storage capability. If a catalyst has good conversion properties, the oxygen fluctuations are smoothed by the oxygen storage capacity of the catalyst. If the conversion provided by the catalyst is low due to aging, poisoning or misfiring, then the oxygen fluctuations are similar to signals from the front oxygen sensor.

DTC Description

Checking output signals from HO2S under detecting condition, if an output signal is above 1.3V for more than predeterminate time, ECM sets P0158. The MIL (Malfunction Indicator Lamp) will illuminate when the fault remains for 2 consecutive drive cycles

DTC Detecting Condition

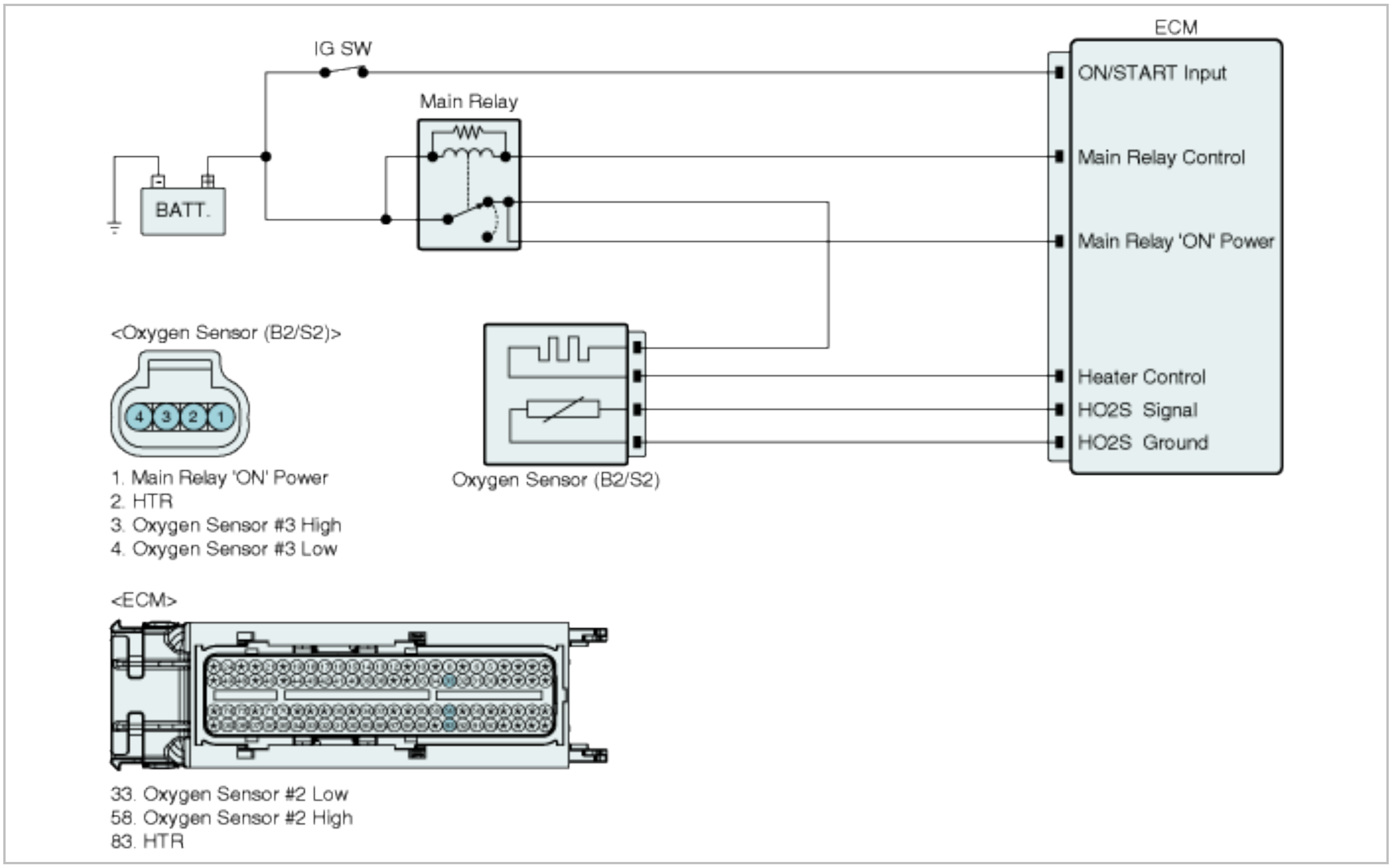
Item	Detecting Condition	Possible Cause
DTC Strategy	• Monitor signal voltage	• Poor connection • Short to battery in harness • HO2S(B2/S2) • ECM
Enable Conditions	• Battery voltage ≥ 10V • Engine running ≥ 60 sec • Engine warm-up state	
Threshold value	• The voltage of HO2S(B2/S2) > 1.3V	
Diagnosis Time	• Continous (more than 12.5 sec.failure for every 15 sec.test)	
MIL On Condition	• 2 Driving Cycles	

Specification

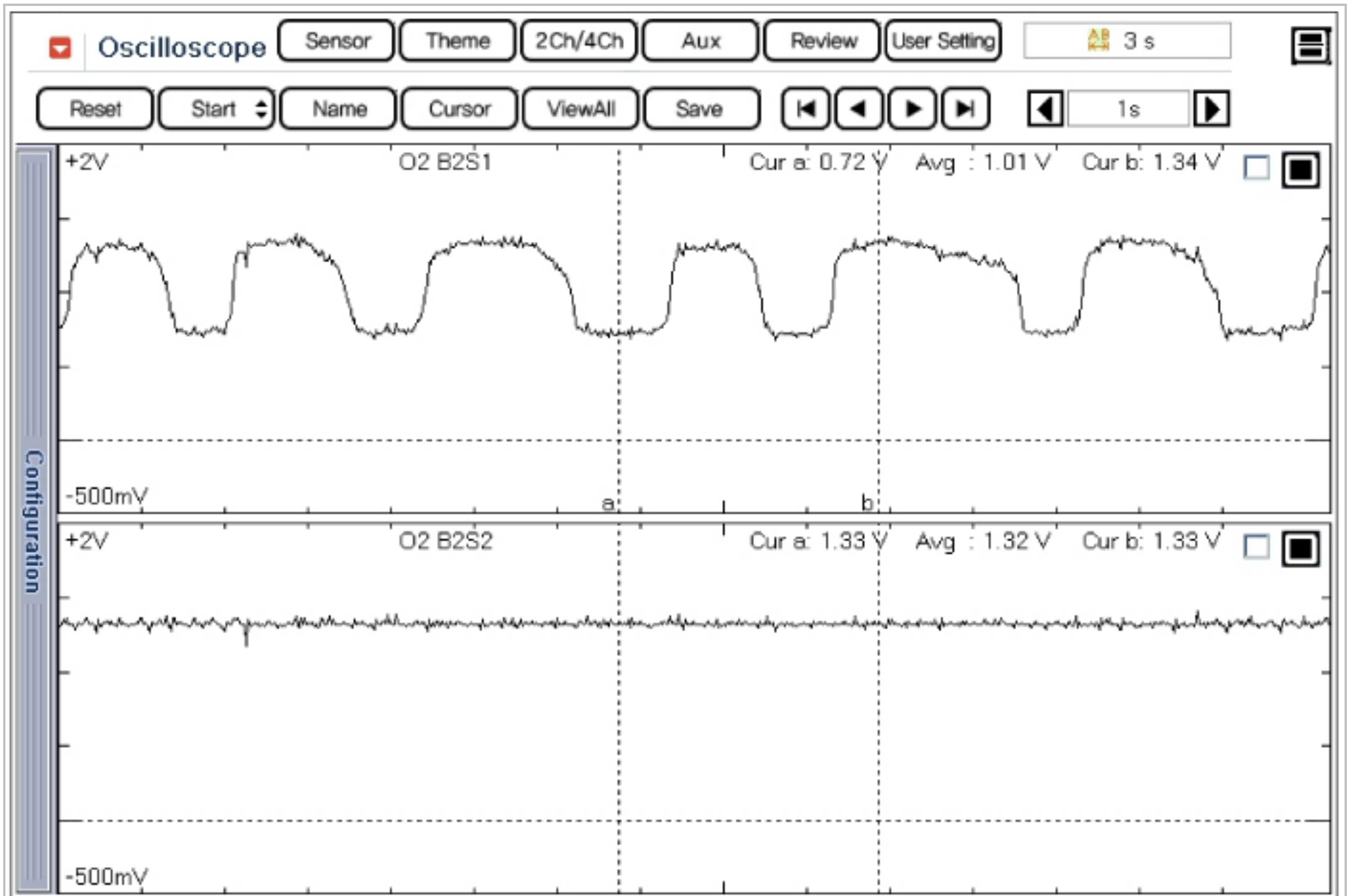
(Reference only)

Test Condition	HO2S Voltage(Sensor1)	HO2S Voltage(Sensor2)
HO2S Signal at idle after warm-up	Signal is commonly switching from rich to lean more than 3 times in 10 sec.	Signal is commonly above 0.6V.
HO2S signal at open circuit (Pumping current OFF)	Approx. 0.45V	
HO2S signal at open circuit (Pumping current ON)	Approx. 2.2V	

Diagnostic Circuit Diagram



Signal Waveform & Data



Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
3 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 0.72 V
Avg : 1.01 V
Cur b: 1.34 V
-500mV
a
b
+2V
O2 B2S2
Cur a: 1.33 V
Avg : 1.32 V
Cur b: 1.33 V
-500mV

Fig.1

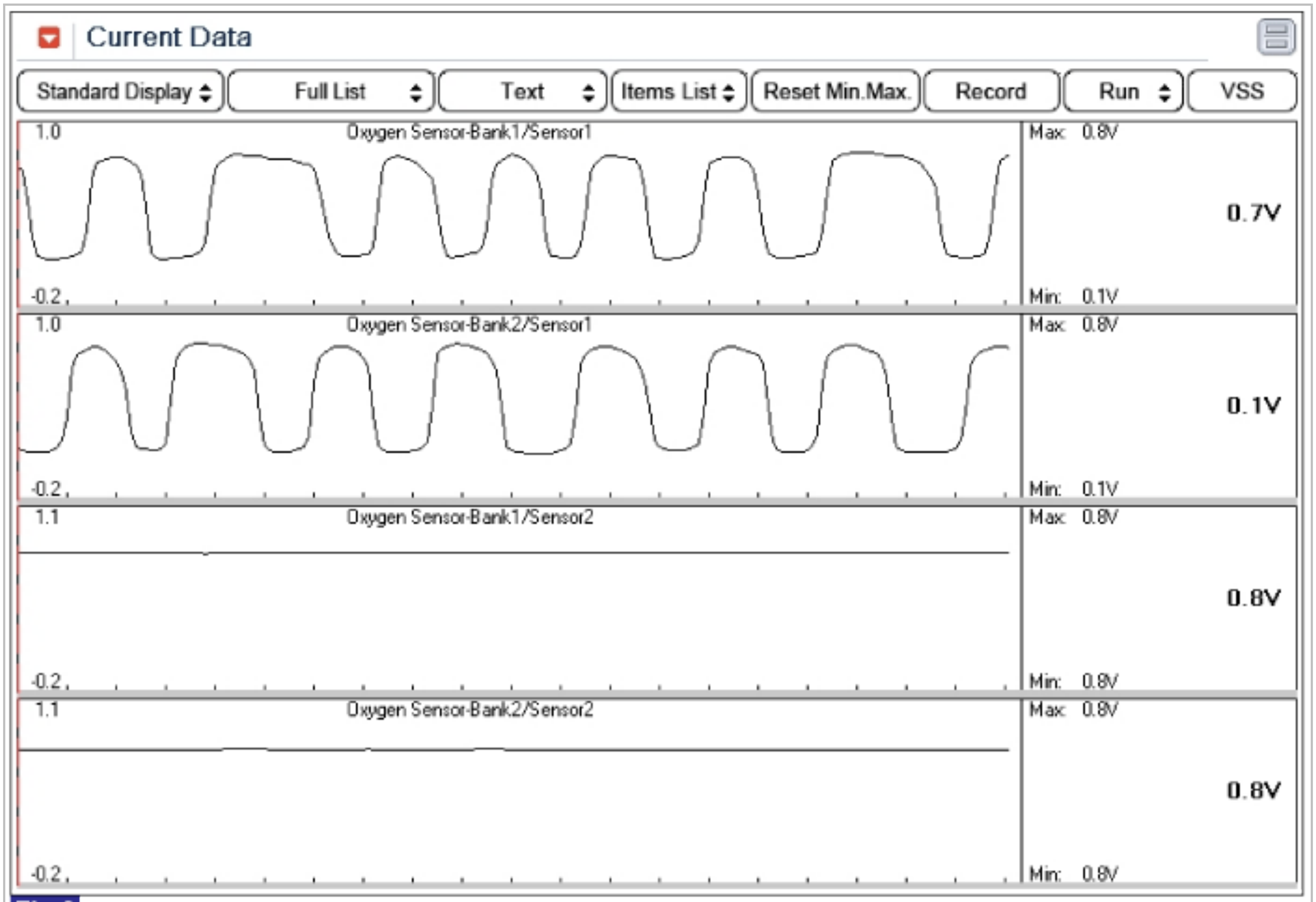


Fig.2

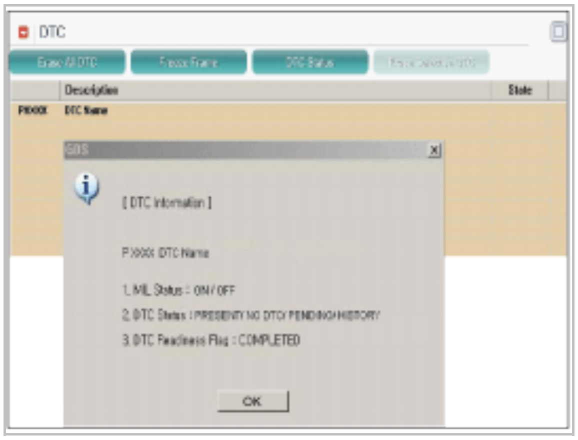
Fig.1) Normal waveforms of front HO2S(the upper) and rear HO2S(the lower). (Waveform between HIGH signal line of HO2S and chassis ground)

Fig.2) Normal graph of front HO2S and rear HO2S at idle.

After warming-up, if accelerator pedal is released suddenly around 4000rpm, the HO2S signal reading will be lower than 200mV resulting from Fuel cut-off for the moment. Conversely, if suddenly accelerator pedal is depressed, HO2S signal reading will be around 0.6V ~1.0V. At idle, Normally HO2S signal will switch from lean to rich with 3 Hz. And as racing, Its frequency rises.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor’s and/or ECM’s connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found ?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Signal Circuit Inspection" procedure.

Signal Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect HO2S(B2/S2) connector.
2. IG "ON".
3. Measure voltage between signal terminal of HO2S(B2/S2) harness connector and chassis ground.

Specification : Approx. 2.2V - when pumping current is ON
Approx. 0.45V - when pumping current is OFF

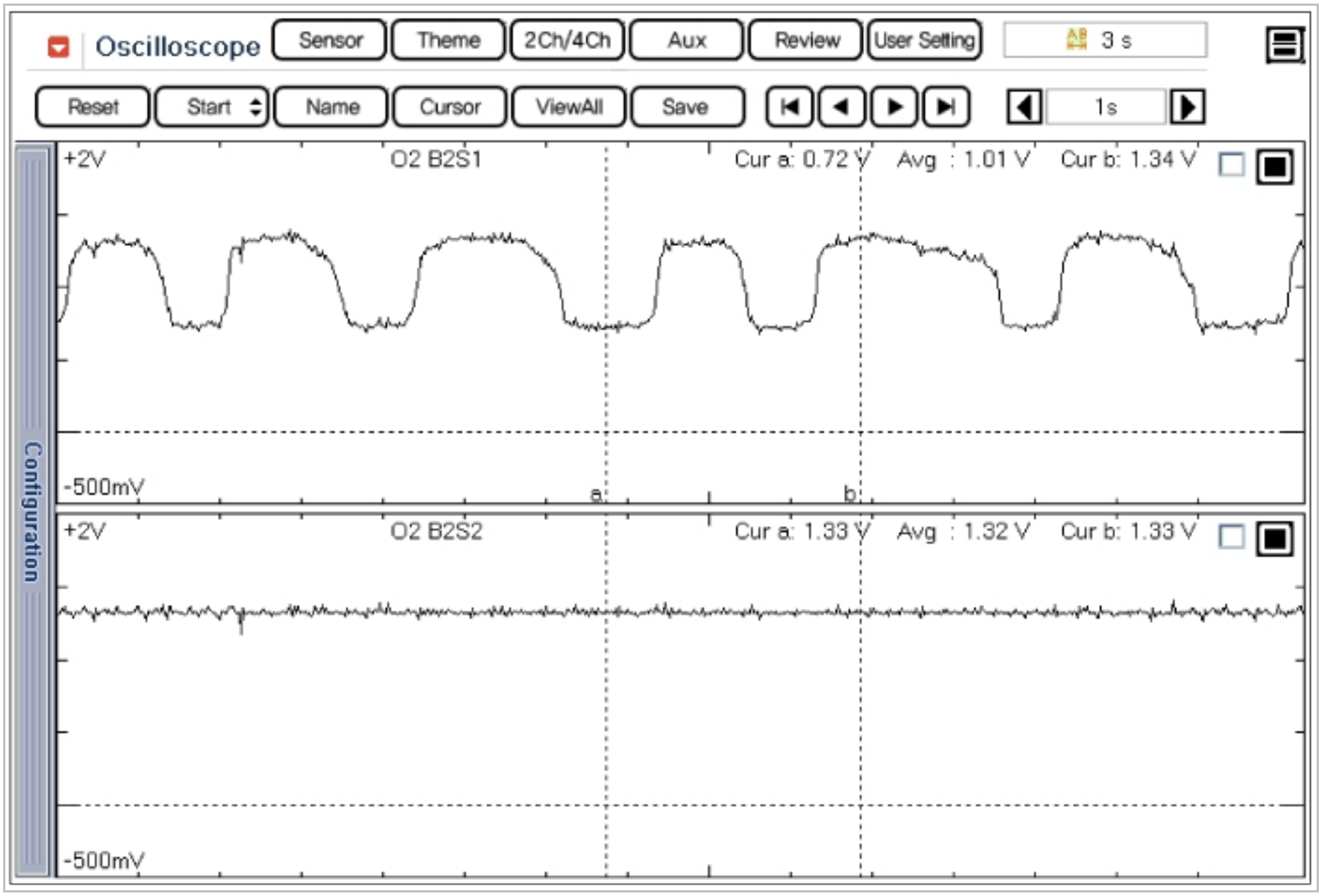
4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to battery in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check the Signal waveform of HO2S

1. IG "OFF" and connect HO2S connector.
2. Engine start.
3. After warming-up, monitor signal waveform of HO2S with GDS.



4. Is the sensor switching properly ?

YES	▶ Go to "Check HO2S" as below.
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

■ Check HO2S

1. IG "OFF" and disconnect HO2S connector.
2. Check that the HO2S is securely installed.
3. Check the HO2S for contamination or damage
4. Is the sensor normal ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE

	There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

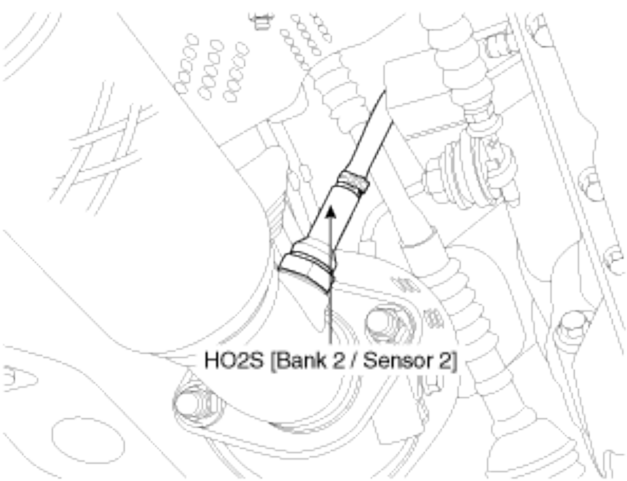
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0159 O2 Sensor Circuit Slow Response (Bank 2 / Sensor 2)

Component Location



General Description

The rear heated oxygen sensor is mounted on the rear side of the Catalytic Converter (warm-up catalytic converter) or in the rear exhaust pipe, which is able to detect catalyst efficiency. The rear heated oxygen sensor (HO2S) produces a voltage between 0V and 1V. This rear heated oxygen sensor is used to estimate the oxygen storage capability. If a catalyst has good conversion properties, the oxygen fluctuations are smoothed by the oxygen storage capacity of the catalyst. If the conversion provided by the catalyst is low due to aging, poisoning or misfiring, then the oxygen fluctuations are similar to signals from the front oxygen sensor.

DTC Description

Checking output signals from HO2S under detecting condition, if ECM judges it's signals too slow, ECM sets P0159. The MIL (Malfunction Indicator Lamp) will illuminate when the fault remains for 2 consecutive drive cycles

DTC Detecting Condition

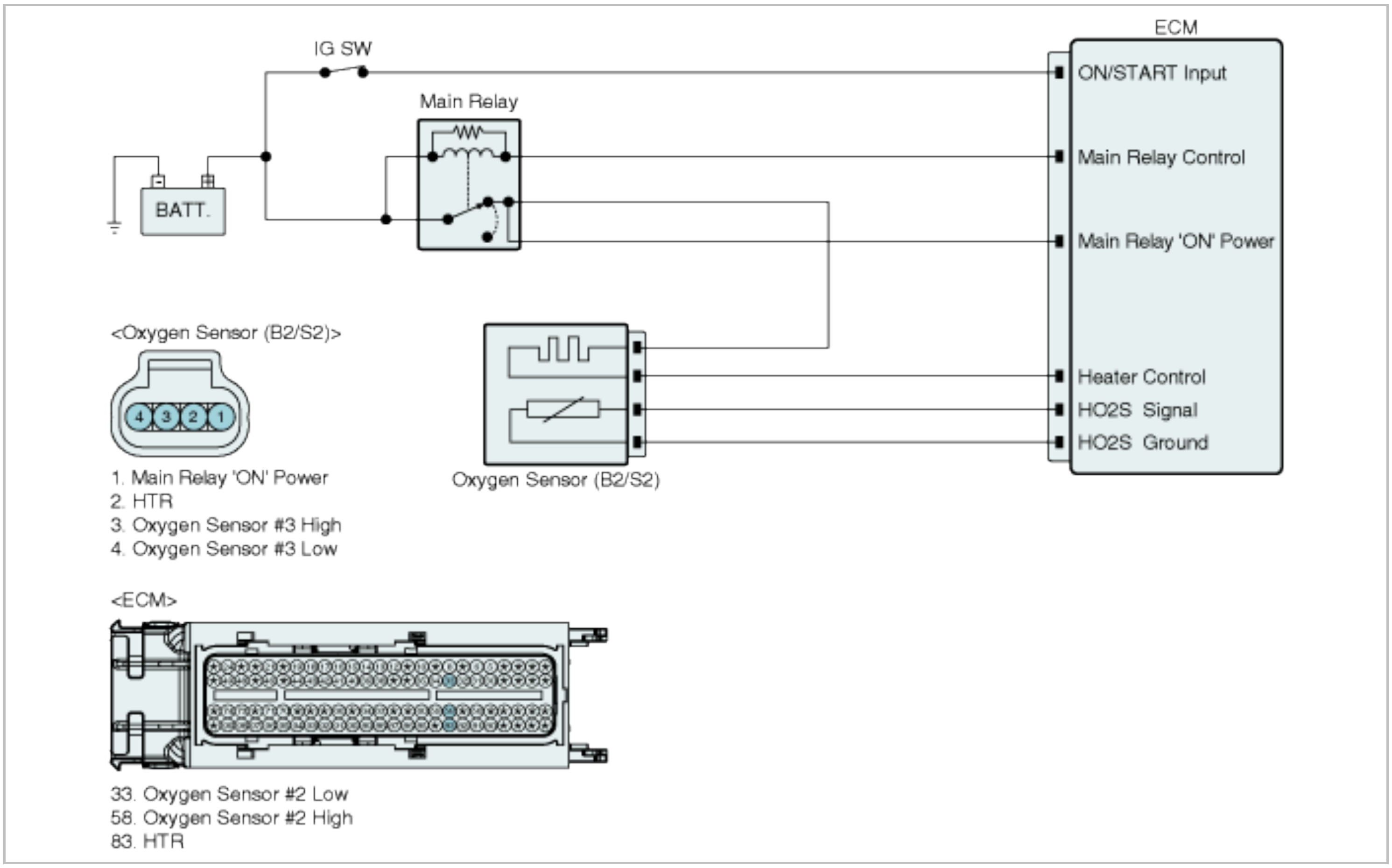
<table>
<tr><th>Item</th><th>Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td>• Monitor HO2S's response rate</td><td rowspan="5">• Poor connection
• Faulty HO2S
• Faulty ECM</td></tr>
<tr><td>Enable Conditions</td><td>• Engine warm-up sufficiently
• Engine run time > 60sec
• Drive at a steady speed between 45-55 mph(72-88 km/h)
• Engine Coolant > 70°C(158 °F)
• No disabling faults</td></tr>
<tr><td>Threshold value</td><td>• The calculated response rate is too slow (out of threshold in ECM)</td></tr>
<tr><td>Diagnosis Time</td><td>• Continuous</td></tr>
<tr><td>MIL On Condition</td><td>• 2 Driving Cycles</td></tr>
</table>

Specification

(Reference only)

<table>
<tr><th>Test Condition</th><th>HO2S Voltage(Sensor1)</th><th>HO2S Voltage(Sensor2)</th></tr>
<tr><td>HO2S Signal at idle after warm-up</td><td>Signal is commonly switching from rich to lean more than 3 times in 10 sec.</td><td>Signal is commonly above 0.6V.</td></tr>
<tr><td>HO2S signal at open circuit
(Pumping current OFF)</td><td colspan="2">Approx. 0.45V</td></tr>
<tr><td>HO2S signal at open circuit
(Pumping current ON)</td><td colspan="2">Approx. 2.2V</td></tr>
</table>

Diagnostic Circuit Diagram



Signal Waveform & Data

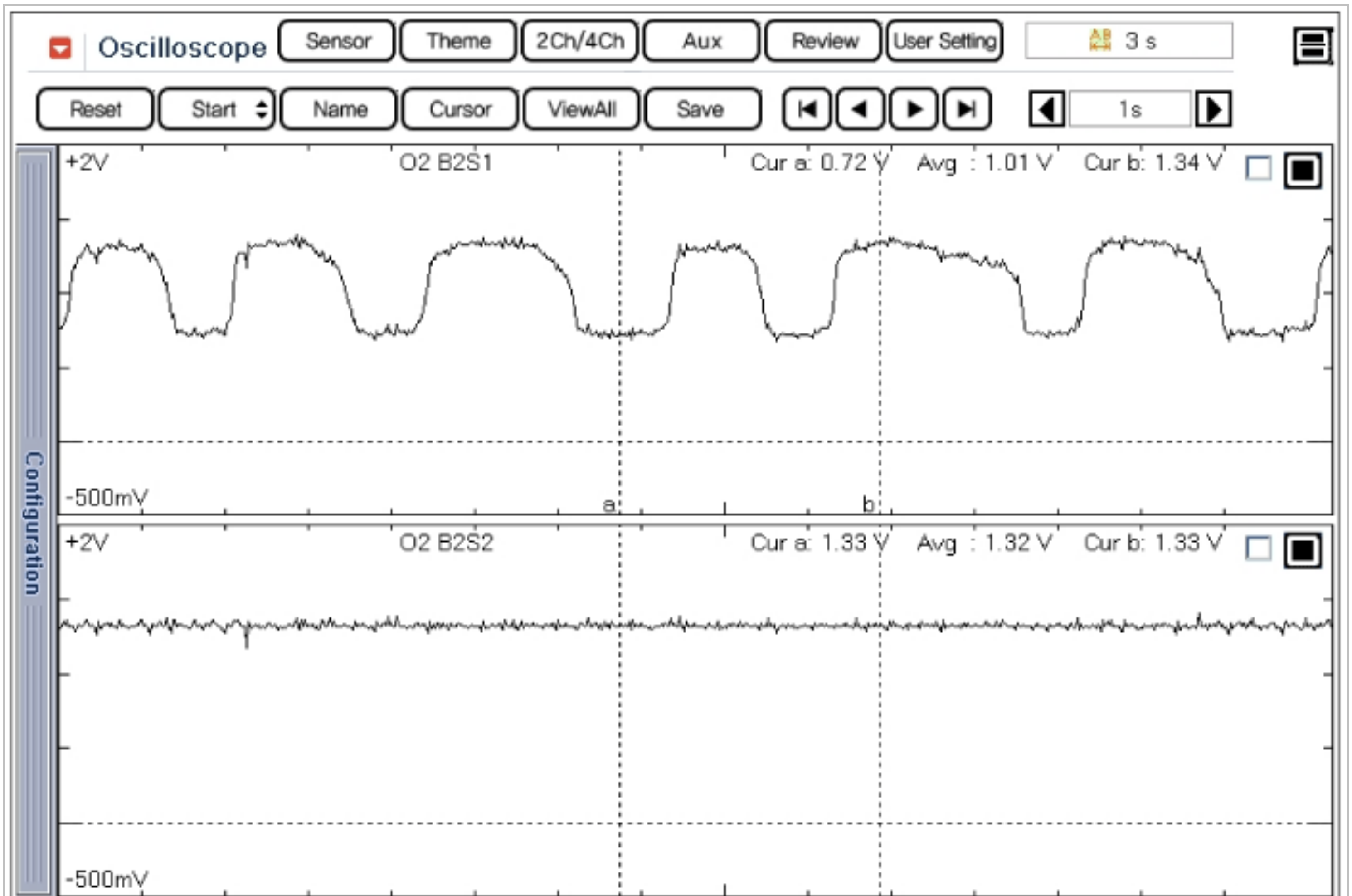

Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
3 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 0.72 V
Avg : 1.01 V
Cur b: 1.34 V
-500mV
a
b
+2V
O2 B2S2
Cur a: 1.33 V
Avg : 1.32 V
Cur b: 1.33 V
-500mV

Fig.1

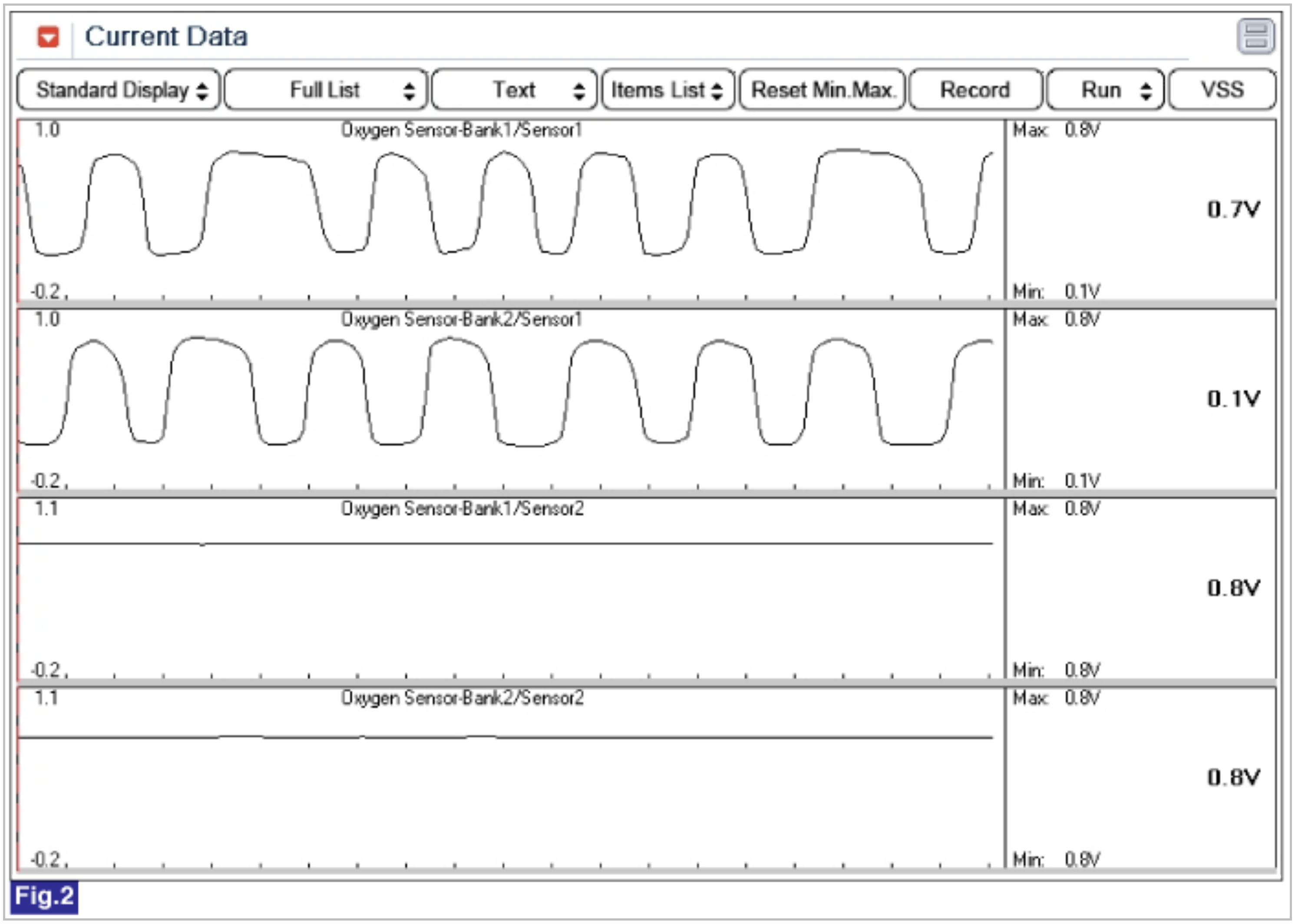


Fig.2

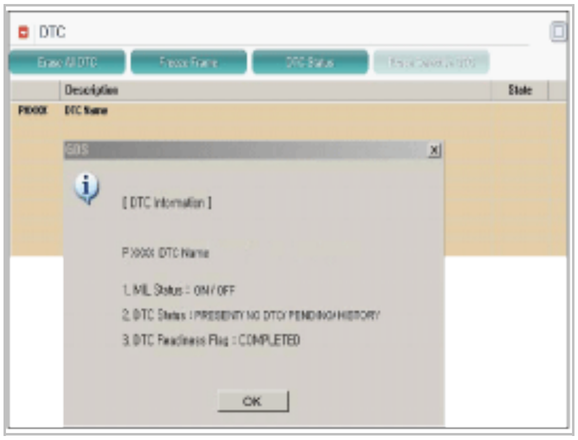
Fig.1) Normal waveforms of front HO2S(the upper) and rear HO2S(the lower). (Waveform between HIGH signal line of HO2S and chassis ground)

Fig.2) Normal graph of front HO2S and rear HO2S at idle.

After warming-up, if accelerator pedal is released suddenly around 4000rpm, the HO2S signal reading will be lower than 200mV resulting from Fuel cut-off for the moment. Conversely, if suddenly accelerator pedal is depressed, HO2S signal reading will be around 0.6V ~1.0V. At idle, Normally HO2S signal will switch from lean to rich with 3 Hz. And as racing, Its frequency rises.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Clear DTC and check if this DTC is set after test-driving under enable conditions. If DTC isn't displayed after the test, it was intermittent fault. Go to "Verification of Vehicle Repair" procedure.

Component Inspection

1. Replace the HO2S.
2. Clear DTC with GDS.
3. Start the engine and warm it up until the radiator fan comes on(more than at least 10 minutes).
4. Drive at a steady speed between 45-55 mph(72-88 km/h) for 120 sec.
5. Stop and then maintain idle state.
6. Check if O2 sensor monitoring readiness is complete.
7. Does the scan tool show DTC P0159 ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Troubleshooting is finished.

Verification of Vehicle Repair

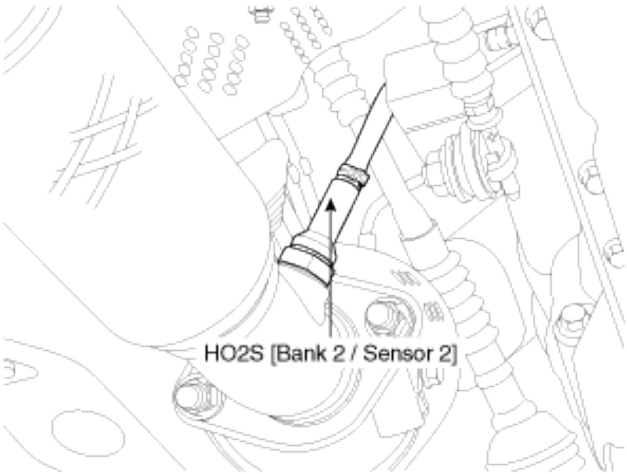
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0160 O2 Sensor Circuit No Activity Detected (Bank 2 / Sensor 2)

Component Location



General Description

The rear heated oxygen sensor is mounted on the rear side of the Catalytic Converter (warm-up catalytic converter) or in the rear exhaust pipe, which is able to detect catalyst efficiency. The rear heated oxygen sensor (HO2S) produces a voltage between 0V and 1V. This rear heated oxygen sensor is used to estimate the oxygen storage capability. If a catalyst has good conversion properties, the oxygen fluctuations are smoothed by the oxygen storage capacity of the catalyst. If the conversion provided by the catalyst is low due to aging, poisoning or misfiring, then the oxygen fluctuations are similar to signals from the front oxygen sensor.

DTC Description

Checking output signals from HO2S under detecting condition, if an output voltage is Approx. 0.45V or 3.5V for more than predeterminate time, ECM sets P0160. The MIL(Malfunction Indicator Lamp) will illuminate when the fault remains for 2 consecutive drive cycles

DTC Detecting Condition

Item		Detecting Condition	Possible Cause
DTC Strategy		• Monitor signal voltage	• Poor connection • Open in harness • HO2S(B2/S2)
Enable Conditions		• Battery voltage ≥ 10V • Engine running ≥ 60 sec • Engine warm-up state • No disable faults	
Threshold	Case 1	• 1.2V ≤ Voltage of HO2S ≤ 3.9V (at pumping current ON)	

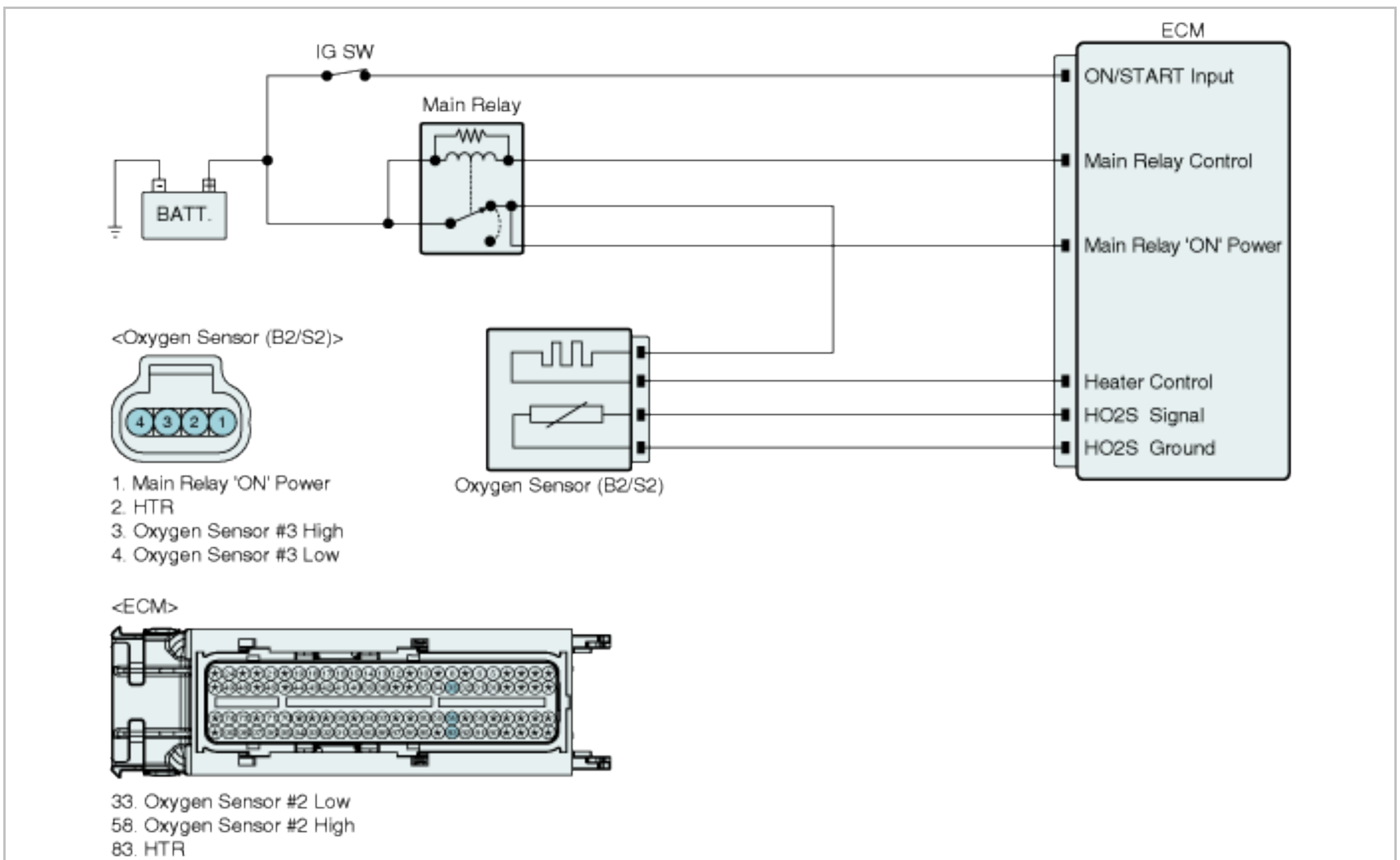
value	Case 2	• 0.415V ≤ Voltage of HO2S ≤ 0.515V (at pumping current OFF)	• ECM
Diagnosis Time		• Continuous (more than 76.5 sec.failure for every 90 sec.test)	
MIL On Condition		• 2 Driving Cycles	

Specification

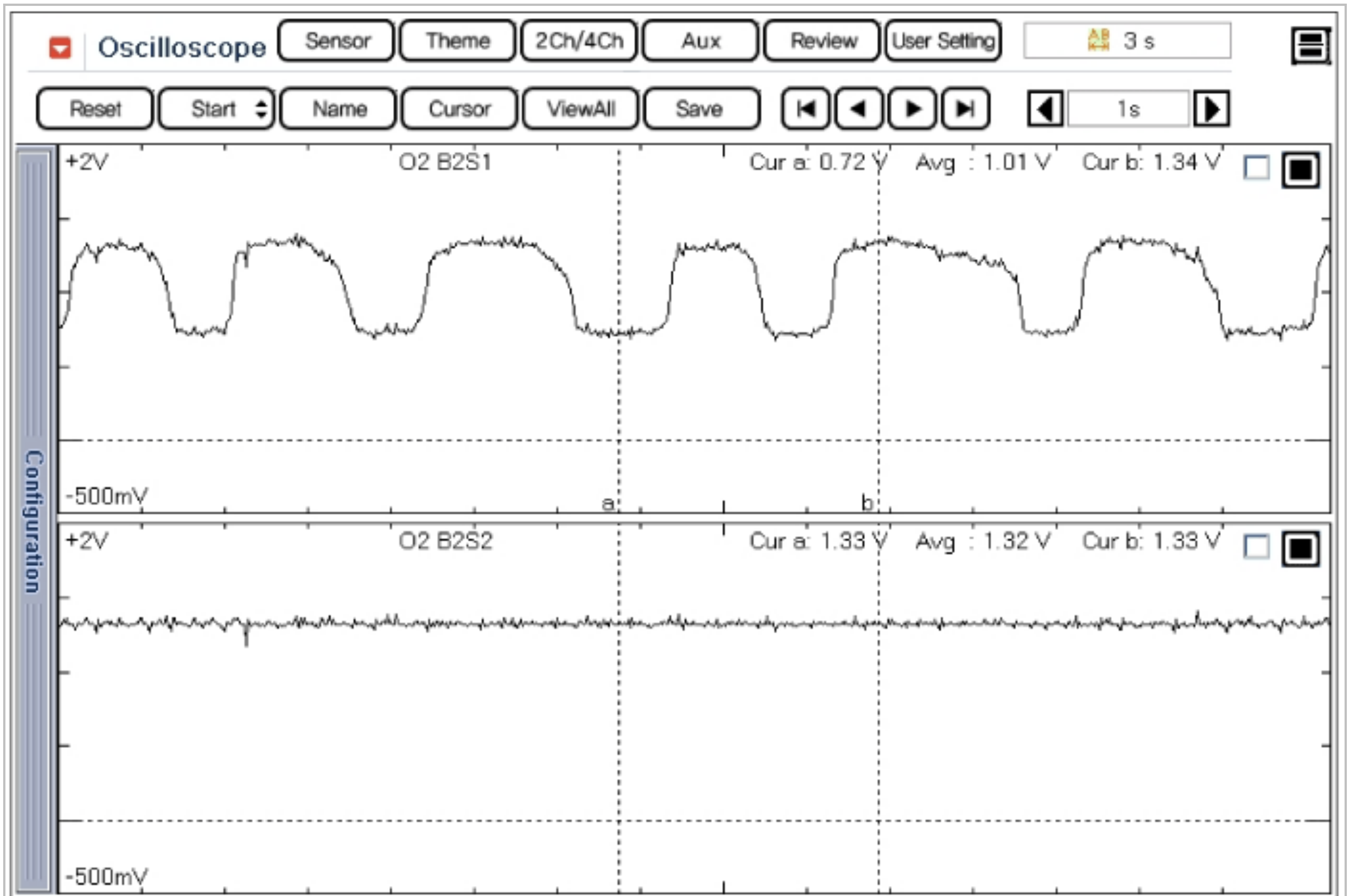
(Reference only)

Test Condition	HO2S Voltage(Sensor1)	HO2S Voltage(Sensor2)
HO2S Signal at idle after warm-up	Signal is commonly switching from rich to lean more than 3 times in 10 sec.	Signal is commonly above 0.6V.
HO2S signal at open circuit (Pumping current OFF)	Approx. 0.45V	
HO2S signal at open circuit (Pumping current ON)	Approx. 2.2V	

Diagnostic Circuit Diagram



Signal Waveform & Data



Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
3 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 0.72 V
Avg : 1.01 V
Cur b: 1.34 V
-500mV
a
b
+2V
O2 B2S2
Cur a: 1.33 V
Avg : 1.32 V
Cur b: 1.33 V
-500mV

Fig.1

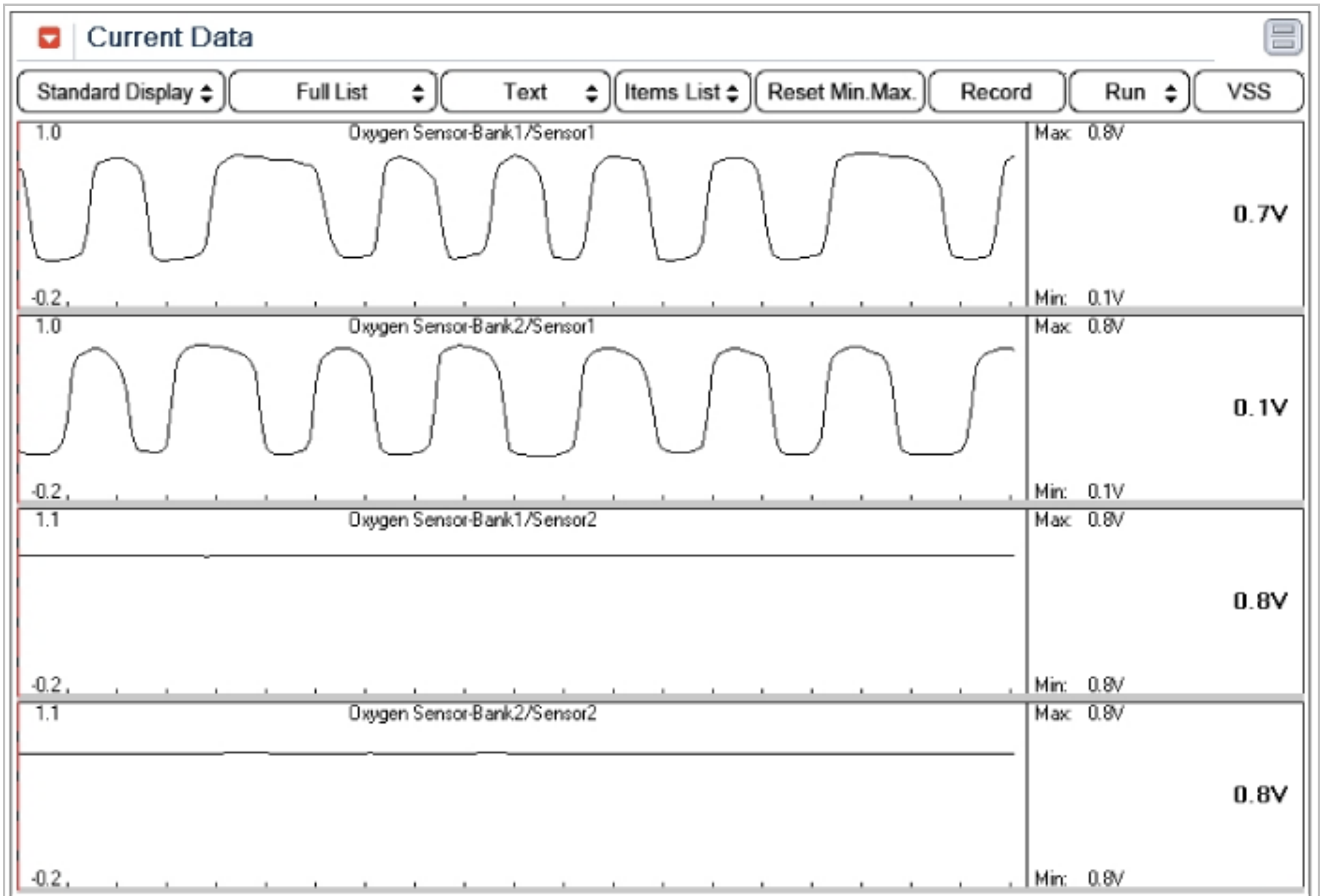


Fig.2

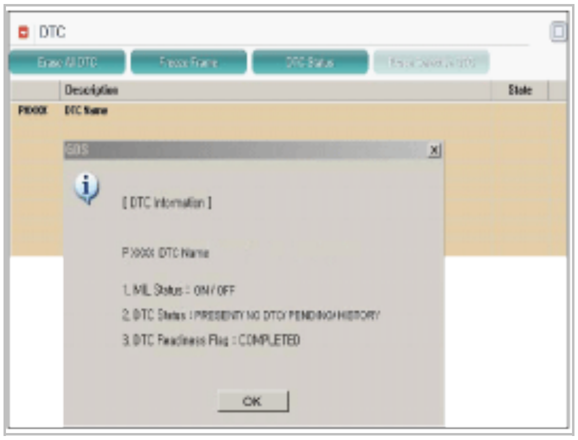
Fig.1) Normal waveforms of front HO2S(the upper) and rear HO2S(the lower). (Waveform between HIGH signal line of HO2S and chassis ground)

Fig.2) Normal graph of front HO2S and rear HO2S at idle.

After warming-up, if accelerator pedal is released suddenly around 4000rpm, the HO2S signal reading will be lower than 200mV resulting from Fuel cut-off for the moment. Conversely, if suddenly accelerator pedal is depressed, HO2S signal reading will be around 0.6V ~1.0V. At idle, Normally HO2S signal will switch from lean to rich with 3 Hz. And as racing, Its frequency rises.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor’s and/or ECM’s connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found ?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Signal Circuit Inspection" procedure.

Signal Circuit Inspection

■ **Check voltage**

1. IG "OFF" and disconnect HO2S(B2/S1) connector.
2. IG "ON".
3. Measure voltage between signal terminal of HO2S(B2/S2) harness connector and chassis ground.

Specification : Approx. 2.2V - when pumping current is ON
Approx. 0.45V - when pumping current is OFF

4. Is the measured voltage within specification ?

YES	▶ Go to "Ground circuit inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" prcedure.

Ground Circuit Inspection

■ **Check open in harness**

1. IG "ON" and disconnect HO2S(B2/S2) connector.
2. Measure voltage between signal terminal of HO2S(B2/S2) harness connector and chassis ground.(Measurement "A")
3. Measure voltage between signal and ground terminals of HO2S(B2/S2) harness connector.(Measurement "B")

Specification : Voltage difference between measurement "A" and "B" is below 200mV.

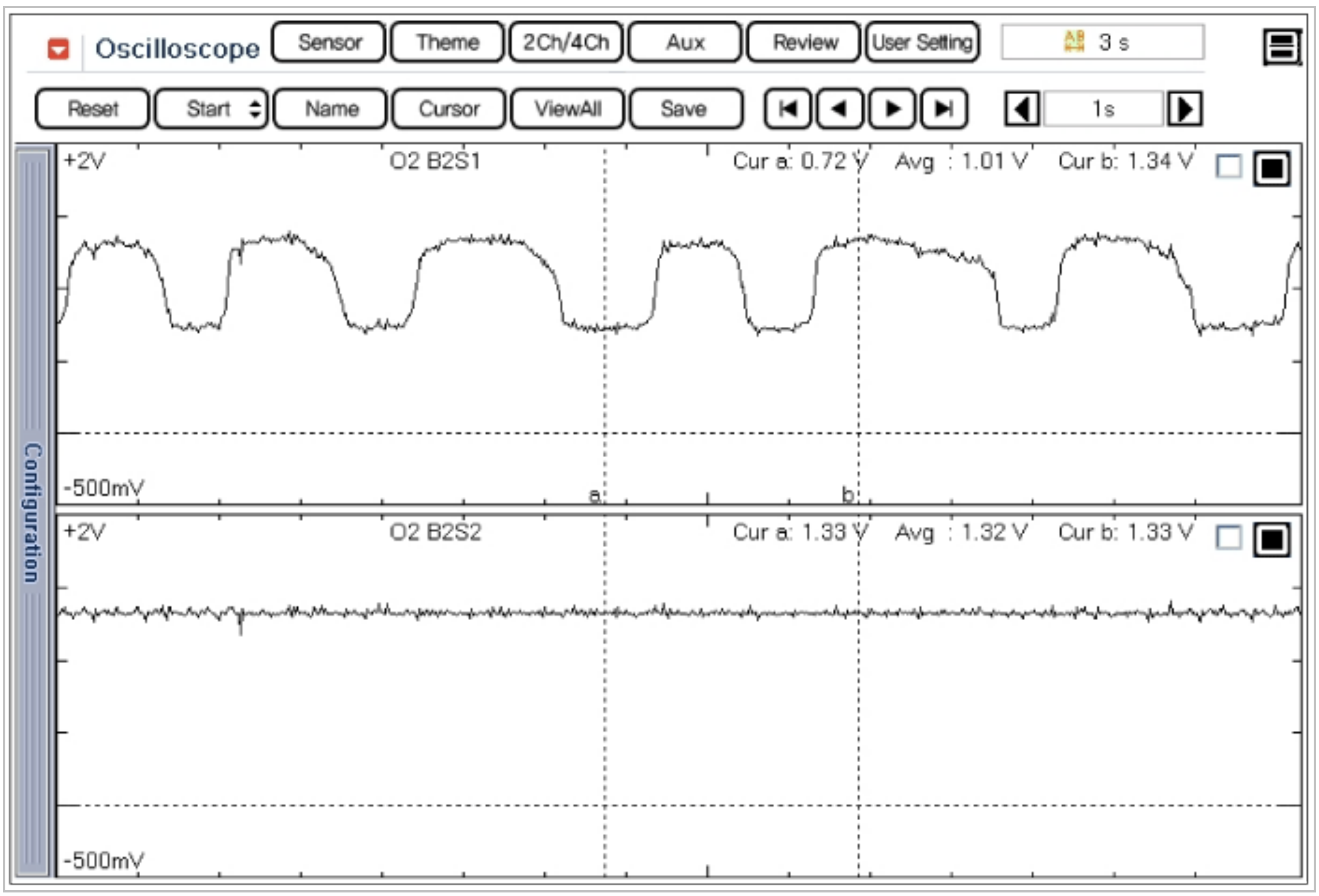
4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair contact resistance or open in harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ **Check the Signal waveform of HO2S**

1. IG "OFF" and connect HO2S connector.
2. Engine start.
3. After warming-up, monitor signal waveform of HO2S with GDS.



4. Is the sensor switching properly ?

YES	▶ Go to "Check HO2S" as below.

NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

■ **Check HO2S**

1. IG "OFF" and disconnect HO2S connector.
2. Check that the HO2S is securely installed.
3. Check the HO2S for contamination or damage
4. Is the sensor normal ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0171 System too Lean (Bank 1)

General Description

In order to provide the best possible combination of drivability, fuel economy and emission control, the PCM uses a closed loop air/fuel metering system. The PCM monitors the HO2S signal voltage and adjusts fuel delivery based it in closed loop fuel control. Changes in fuel delivery will be indicated by the long-term and the short-term fuel trim values. The ideal fuel trim value is around 0%. The PCM will add fuel when the HO2S signal is indicating a lean condition. Additional fuel is indicated by fuel trim values that are above 0%. The PCM will reduce fuel when the HO2S signal is indicating a rich condition. Reduction in fuel is indicated by fuel trim values that are below 0%. The DTC relevant to fuel trim will be set when the amount reaches excessive levels because of a lean or rich condition.

DTC Description

Checking the fuel trime value under detecting condition, if its average exceeds the limit over certain period, PCM sets P0171. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Monitor the fuel trim value	• Air leakage • Improper fuel pressure • PCV valve stuck • Clogging of injector
Enable Conditions	• Engine warm-up sufficiently • Drive at a steady speed over 5 minutes (Vehicle speed ≤ 130km/h) • 60°C(140°F) ≤ Engine coolant temperature ≤ 115°C(239°F) • No disabling faults (DTCs related to HO2S, purge valve,catalyst)	
Threshold value	• Average of long term fuel trim > 1.25	
Diagnosis Time	• Continuous	
MIL On Condition	• 2 Driving Cycles	

Monitor GDS Data

1. Monitor DTCs related to MAFS, MAPS, ECTS, Injector or CVVT items with GDS.
2. Are there the DTCs above-mentioned ?

YES	▶ Do all repairs associated with those codes before proceeding with this procedure.
NO	▶ Go to "System Inspection" procedure

System Inspection

■ Check air leakage

1. Visually/ physically inspect the air leakage in intake/ exhaust system for following items.
   ▶ Vacuum hoses for splits, kinks and improper connections.
   ▶ Throttle body gasket
   ▶ Gasket between intake manifold and cylinder head
   ▶ Seals between intake manifold and fuel injectors
   ▶ Exhaust system between HO2S and three way catalyst for air leakage
2. Has a problem found in this procedure?

YES	▶ Repair or replace it which has a problem, and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check the fuel line" as follows.

■ Check the fuel line

1. Check the fuel line for following items
   ▶ Connector connection state
   ▶ Damage/ connection state for vacuum hoses connected to fuel line

▶ Bent/ pressed/ twisted fuel line or fuel leakage

2. Has a problem found in this procedure?

YES	▶ Repair or replace it which has a problem, and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check fuel pressure" as follows.

■ Check fuel pressure

NOTE

1. Be cautious that Fuel is explosive and an empty fuel tank can still contain explosive gases. When working on fuel system make sure to supply adequate ventilation to the work area. Do not smoke, and keep sparks and open flames away.
2. The fuel system remains under pressure when the engine is not running. Release fuel system pressure before disconnecting any fuel line to reduce the chance of presonal injury or fire damage to vehicle components.

1. IG "OFF" and disconnect Fuel Pump Relay in Junction Box.
2. Start-up and wait until it stops itself.
3. IG "OFF" and connect Fuel Pump Relay.
4. Install the fuel pressure gauge to the delivery pipe with the fuel pressure gauge adaptor.
5. Activate the fuel pump, and with fuel pressure applied, check that there is no fuel leakage from the pressure gauge or connection part.
6. Measure the fuel pressure at idle.

Specification : 373.6 ~ 387.4 kPa(3.81 ~ 3.95 kg/cm², 54.2 ~ 56.1 psi)

7. Is the measured fuel pressure within specifications ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair or replace according to the below table. And then, go to "Verification of Vehicle Repair" procedure.

Condition	Possible Cause
Fuel Pressure is too low	Fuel filter, fuel pressure regulator, in- tank fuel hose or the fuel pump
Fuel Pressure is too high	Fuel pressure regulator, hose or pipe

Component Inspection

■ Check PCV

1. IG "OFF" and remove PCV valve from rocker cover.
2. Insert a thin stick into the PCV valve from the threaded side and verify that the plunger is moving.
3. Is the PCV valve normally moving?

YES	▶ Go to "Check injector" as follows
NO	▶ Replace it, and go to "Verification of Vehicle Repair" procedure.

■ **Check injector for normal operation**

1. Start engine.
2. Check its RPM decrease when doing the injector's actuation test.
3. Is there any cylinder with no change in RPM or only a small change in RPM?

YES	▶ Replace injector, and go to "Verification of Vehicle Repair" procedure.
NO	▶ Clear DTC and Test-drive under enable conditions above-mentioned. After the test, If this DTC is set, go to "Inspection & Repair" procedure. If not, troubleshooting is completed.

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0172 System too Rich (Bank 1)

General Description

In order to provide the best possible combination of drivability, fuel economy and emission control, the PCM uses a closed loop air/fuel metering system. The PCM monitors the HO2S signal voltage and adjusts fuel delivery based it in closed loop fuel control. Changes in fuel delivery will be indicated by the long-term and the short-term fuel trim values. The ideal fuel trim value is around 0%. The PCM will add fuel when the HO2S signal is indicating a lean condition. Additional fuel is indicated by fuel trim values that are above 0%. The PCM will reduce fuel when the HO2S signal is indicating a rich condition. Reduction in fuel is indicated by fuel trim values that are below 0%. The DTC relevant to fuel trim will be set when the amount reaches excessive levels because of a lean or rich condition.

DTC Description

Checking the fuel trime value under detecting condition, if its average exceeds the limit over certain period, PCM sets P0172. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Monitor the fuel trim value	
	• Engine warm-up sufficiently • Drive at a steady speed over 5 minutes (Vehicle speed ≤ 130km/h)	

Enable Conditions	• 60°C(140°F) ≤ Engine coolant temperature ≤ 115°C(239°F) • No disabling faults (DTCs related to HO2S, purge valve,catalyst)	• Blocking of intake system • Fuel leakage in injector • Improper fuel pressure
Threshold value	• Average of long term fuel trim < 0.75	
Diagnosis Time	• Continuous	
MIL On Condition	• 2 Driving Cycles	

Monitor GDS Data

1. Monitor DTCs related to MAFS, MAPS, ECTS, Injector or CVVT items with GDS.
2. Are there the DTCs above-mentioned ?

YES	▶ Do all repairs associated with those codes before proceeding with this procedure.
NO	▶ Go to "System Inspection" procedure

System Inspection

■ Check blocking of intake system

1. Visually/physically inspect the blocking in intake system for following items.
   ▶ Throttle body gasket and damage
   ▶ Blocking in intake manifold and injector caused by any foreign substance
2. Has a problem found in this procedure ?

YES	▶ Repair or replace it which has a problem, and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check fuel pressure" as follows.

■ Check fuel pressure

NOTE

1. Be cautious that Fuel is explosive and an empty fuel tank can still contain explosive gases. When working on fuel system make sure to supply adequate ventilation to the work area. Do not smoke, and keep sparks and open flames away.
2. The fuel system remains under pressure when the engine is not running. Release fuel system pressure before disconnecting any fuel line to reduce the chance of presonal injury or fire damage to vehicle components.

1. IG "OFF" and disconnect Fuel Pump Relay in Junction Box.
2. Start-up and wait until it stops itself.
3. IG "OFF" and connect Fuel Pump Relay.
4. Install the fuel pressure gauge to the delivery pipe with the fuel pressure gauge adaptor.
5. Activate the fuel pump, and with fuel pressure applied, check that there is no fuel leakage from the pressure gauge or connection part.
6. Measure the fuel pressure at idle.

Specification : 373.6 ~ 387.4 kPa(3.81 ~ 3.95 kg/cm², 54.2 ~ 56.1 psi)

7. Is the measured fuel pressure within specifications ?

YES	▶ Go to "Check fuel leakage in injector" as follow.
NO	▶ Repair or replace according to the below table. And then, go to " Verification of Vehicle Repair" procedure.

Condition	Possible Cause
Fuel Pressure is too low	Fuel filter, fuel pressure regulator, in - tank fuel hose or the fuel pump
Fuel Pressure is too high	Fuel pressure regulator, hose or pipe

■ **Check fuel leakage in injector**

1. IG "OFF" after checking the fuel pressure test.
2. Stop engine and check for a change in the fuel pressure gauge reading for 5 minutes.

Specification : After engine stops, fuel gauge reading is maintained for 5 minutes.

3. Is the fuel gauge reading maintained ?

YES	▶ Clear DTC and Test-drive under enable conditions above-mentioned. After the test, If this DTC is set, go to "Inspection & Repair" procedure. If not, troubleshooting is completed.
NO	▶ There is a fuel leakage in injector. Replace it, and go to " Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0174 System too Lean (Bank 2)

General Description

In order to provide the best possible combination of drivability, fuel economy and emission control, the PCM uses a closed loop air/fuel metering system. The PCM monitors the HO2S signal voltage and adjusts fuel delivery based it in closed loop fuel control. Changes in fuel delivery will be indicated by the long-term and the short-term fuel trim values. The ideal fuel trim value is around 0%. The PCM will add fuel when the HO2S signal is indicating a lean condition.

Additional fuel is indicated by fuel trim values that are above 0%. The PCM will reduce fuel when the HO2S signal is indicating a rich condition. Reduction in fuel is indicated by fuel trim values that are below 0%. The DTC relevant to fuel trim will be set when the amount reaches excessive levels because of a lean or rich condition.

DTC Description

Checking the fuel trime value under detecting condition, if its average exceeds the limit over certain period, PCM sets P0174. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Monitor the fuel trim value	• Air leakage • Improper fuel pressure • PCV valve stuck • Clogging of injector
Enable Conditions	• Engine warm-up sufficiently • Drive at a steady speed over 5 minutes (Vehicle speed ≤ 130km/h) • 60°C(140°F) ≤ Engine coolant temperature ≤ 115°C(239°F) • No disabling faults (DTCs related to HO2S, purge valve,catalyst)	
Threshold value	• Average of long term fuel trim > 1.25	
Diagnosis Time	• Continuous	
MIL On Condition	• 2 Driving Cycles	

Monitor GDS Data

1. Monitor DTCs related to MAFS, MAPS, ECTS, Injector or CVVT items with GDS.
2. Are there the DTCs above-mentioned ?

YES	▶ Do all repairs associated with those codes before proceeding with this procedure.
NO	▶ Go to "System Inspection" procedure

System Inspection

■ Check air leakage

1. Visually/ physically inspect the air leakage in intake/ exhaust system for following items.
   - ▶ Vacuum hoses for splits, kinks and improper connections.
   - ▶ Throttle body gasket
   - ▶ Gasket between intake manifold and cylinder head
   - ▶ Seals between intake manifold and fuel injectors
   - ▶ Exhaust system between HO2S and three way catalyst for air leakage
2. Has a problem found in this procedure ?

YES	▶ Repair or replace it which has a problem, and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check the fuel line" as follows.

■ Check the fuel line

1. Check the fuel line for following items
   - ▶ Connector connection state
   - ▶ Damage/ connection state for vacuum hoses connected to fuel line
   - ▶ Bent/ pressed/ twisted fuel line or fuel leakage
2. Has a problem found in this procedure?

YES	▶ Repair or replace it which has a problem, and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check fuel pressure" as follows.

■ Check fuel pressure

NOTE

1. Be cautious that Fuel is explosive and an empty fuel tank can still contain explosive gases. When working on fuel system make sure to supply adequate ventilation to the work area. Do not smoke, and keep sparks and open flames away.
2. The fuel system remains under pressure when the engine is not running. Release fuel system pressure before disconnecting any fuel line to reduce the chance of presonal injury or fire damage to vehicle components.

1. IG "OFF" and disconnect Fuel Pump Relay in Junction Box.
2. Start-up and wait until it stops itself.
3. IG "OFF" and connect Fuel Pump Relay.
4. Install the fuel pressure gauge to the delivery pipe with the fuel pressure gauge adaptor.
5. Activate the fuel pump, and with fuel pressure applied, check that there is no fuel leakage from the pressure gauge or connection part.
6. Measure the fuel pressure at idle.

   Specification : 373.6 ~ 387.4 kPa(3.81 ~ 3.95 kg/cm², 54.2 ~ 56.1 psi)

7. Is the measured fuel pressure within specifications ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair or replace according to the below table. And then, go to "Verification of Vehicle Repair" procedure.

Condition	Possible Cause
Fuel Pressure is too low	Fuel filter, fuel pressure regulator, in - tank fuel hose or the fuel pump
Fuel Pressure is too high	Fuel pressure regulator, hose or pipe

Component Inspection

■ Check PCV

1. IG "OFF" and remove PCV valve from rocker cover.

2. Insert a thin stick into the PCV valve from the threaded side and verify that the plunger is moving.
3. Is the PCV valve normally moving ?

YES	▶ Go to "Check injector" as follows
NO	▶ Replace it, and go to "Verification of Vehicle Repair" procedure.

■ Check injector for normal operation

1. Start engine.
2. Check its RPM decrease when doing the injector's actuation test.
3. Is there any cylinder with no change in RPM or only a small change in RPM?

YES	▶ Replace injector, and go to "Verification of Vehicle Repair" procedure.
NO	▶ Clear DTC and Test-drive under enable conditions above-mentioned. After the test, If this DTC is set, go to "Inspection & Repair" procedure. If not, troubleshooting is completed.

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0175 System too Rich (Bank 2)

General Description

In order to provide the best possible combination of drivability, fuel economy and emission control, the PCM uses a closed loop air/fuel metering system. The PCM monitors the HO2S signal voltage and adjusts fuel delivery based it in closed loop fuel control. Changes in fuel delivery will be indicated by the long-term and the short-term fuel trim values. The ideal fuel trim value is around 0%. The PCM will add fuel when the HO2S signal is indicating a lean condition. Additional fuel is indicated by fuel trim values that are above 0%. The PCM will reduce fuel when the HO2S signal is indicating a rich condition. Reduction in fuel is indicated by fuel trim values that are below 0%. The DTC relevant to fuel trim will be set when the amount reaches excessive levels because of a lean or rich condition.

DTC Description

Checking the fuel trime value under detecting condition, if its average exceeds the limit over certain period, PCM sets P0175. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Monitor the fuel trim value	• Blocking of intake system • Fuel leakage in injector • Improper fuel pressure
Enable Conditions	• Engine warm-up sufficiently • Drive at a steady speed over 5 minutes (Vehicle speed ≤ 130km/h) • 60°C(140°F) ≤ Engine coolant temperature ≤ 115°C(239°F) • No disabling faults (DTCs related to HO2S, purge valve,catalyst)	
Threshold value	• Average of long term fuel trim < 0.75	
Diagnosis Time	• Continuous	
MIL On Condition	• 2 Driving Cycles	

Monitor GDS Data

1. Monitor DTCs related to MAFS, MAPS, ECTS, Injector or CVVT items with GDS.
2. Are there the DTCs above-mentioned?

YES	▶ Do all repairs associated with those codes before proceeding with this procedure.
NO	▶ Go to "System Inspection" procedure

System Inspection

■ Check blocking of intake system

1. Visually/ physically inspect the blocking in intake system for following items.
   ▶ Throttle body gasket and damage
   ▶ Blocking in intake manifold and injector caused by any foreign substance
2. Has a problem found in this procedure ?

YES	▶ Repair or replace it which has a problem, and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check fuel pressure" as follows.

■ Check fuel pressure

> **NOTE**
>
> 1. Be cautious that Fuel is explosive and an empty fuel tank can still contain explosive gases. When working on fuel system make sure to supply adequate ventilation to the work area. Do not smoke, and keep sparks and open flames away.
> 2. The fuel system remains under pressure when the engine is not running. Release fuel system pressure before disconnecting any fuel line to reduce the chance of presonal injury or fire damage to vehicle components.

1. IG "OFF" and disconnect Fuel Pump Relay in Junction Box.
2. Start-up and wait until it stops itself.
3. IG "OFF" and connect Fuel Pump Relay.

4. Install the fuel pressure gauge to the delivery pipe with the fuel pressure gauge adaptor.
5. Activate the fuel pump, and with fuel pressure applied, check that there is no fuel leakage from the pressure gauge or connection part.
6. Measure the fuel pressure at idle.

Specification : 373.6 ~ 387.4 kPa(3.81 ~ 3.95 kg/cm², 54.2 ~ 56.1 psi)

7. Is the measured fuel pressure within specifications ?

YES	▶ Go to "Check fuel leakage in injector" as follow.
NO	▶ Repair or replace according to the below table. And then, go to "Verification of Vehicle Repair" procedure.

Condition	Possible Cause
Fuel Pressure is too low	Fuel filter, fuel pressure regulator, in - tank fuel hose or the fuel pump
Fuel Pressure is too high	Fuel pressure regulator, hose or pipe

■ **Check fuel leakage in injector**

1. IG "OFF" after checking the fuel pressure test.
2. Stop engine and check for a change in the fuel pressure gauge reading for 5 minutes.

Specification : After engine stops, fuel gauge reading is maintained for 5 minutes.

3. Is the fuel gauge reading maintained ?

YES	▶ Clear DTC and Test-drive under enable conditions above - mentioned. After the test, If this DTC is set, go to "Inspection & Repair" procedure. If not, troubleshooting is completed.
NO	▶ There is a fuel leakage in injector. Replace it, and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

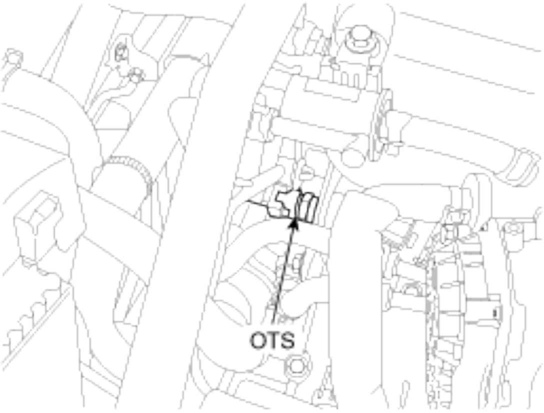
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0196 Engine Oil Temperature Sensor-Range / Performance

Component Location



General Description

The fluid of the CVVT is the engine oil and its density changes according to the engine oil temperature. At this time the Oil Temperature Sensor(OTS) helps compensation against the temperature differences. The Oil Temperature Sensor measures the engine oil temperature before the engine oil comes into the Oil-flow Control Valve (OCV).
According to the measured temperature, the Engine Control Module(ECM) compensates the oil-flow control valve operation times.

DTC Description

Checking the oil temperture, coolant temperature and intake air temperature every 25 sec. under detecting condition, if the difference in temperature at start-up exceeds threshold value, ECM sets P0196. MIL(Malfunction Indicatin Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

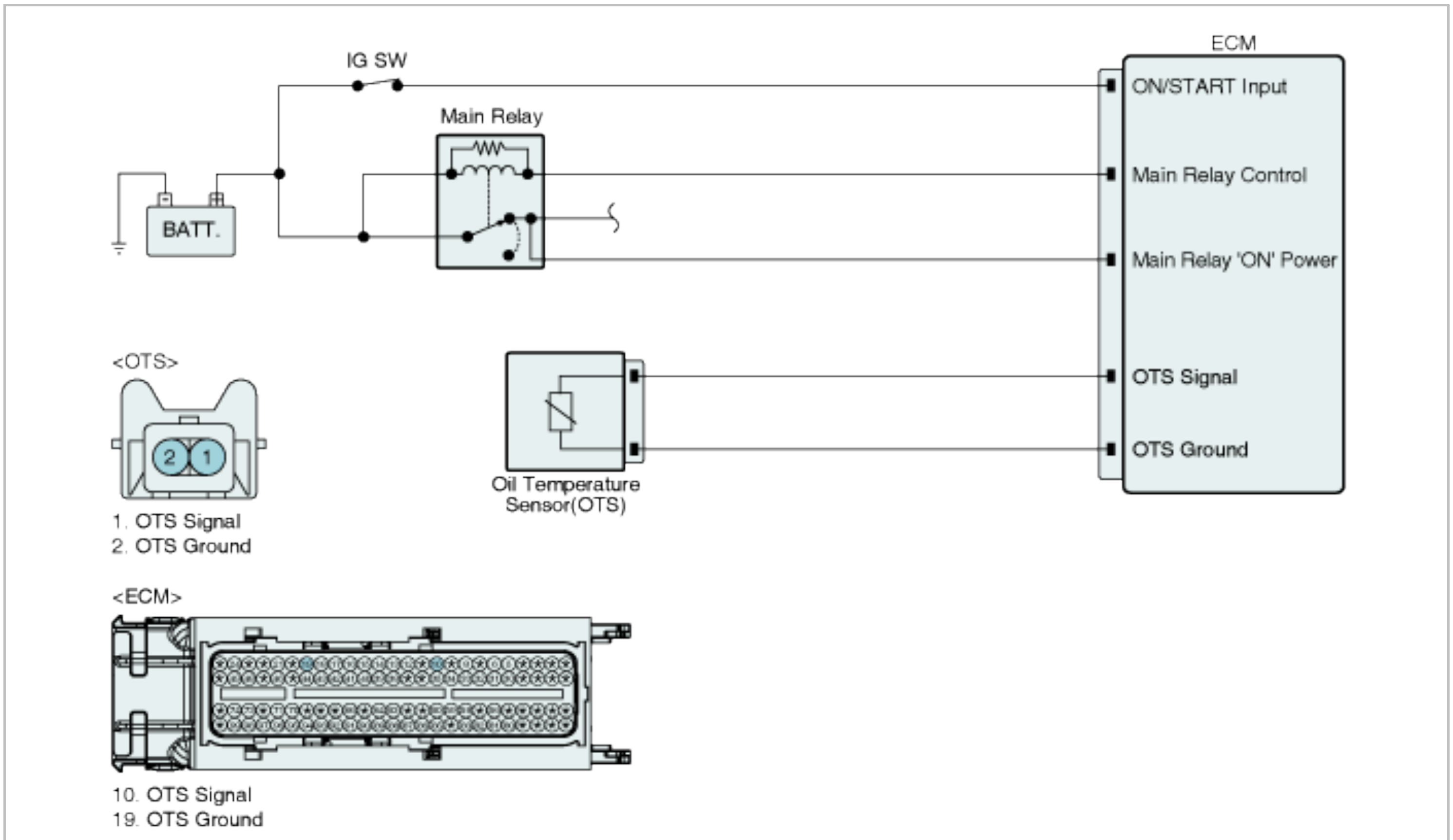
DTC Detecting Condition

<table>
<tr><th colspan="2">Item</th><th>Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td colspan="2">DTC Strategy</td><td>• Determines if the oil temperature value is rational, compared to coolant and intake air temperature.</td><td rowspan="7">• Faulty OTS</td></tr>
<tr><td rowspan="2">Enable Conditions</td><td>Case 1</td><td>• Engine run time after startup < 30 sec
• Soak period required > 300 min</td></tr>
<tr><td>Case 2</td><td>• Minimum engine run time > 800 sec</td></tr>
<tr><td rowspan="2">Threshold value</td><td>Case 1</td><td>• The difference in temperature between oil and coolant temperatures at startup. > 35°C(63°F)</td></tr>
<tr><td>Case 2</td><td>• The difference in temperature between oil temperature and intake air temperature at startup > 35°C(63°F)</td></tr>
<tr><td colspan="2">Diagnosis Time</td><td>• Continous (More than 800 sec.)</td></tr>
<tr><td colspan="2">MIL On Condition</td><td>• 2 Driving Cycles</td></tr>
</table>

Specification

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

Diagnostic Circuit Diagram



Signal Waveform & Data

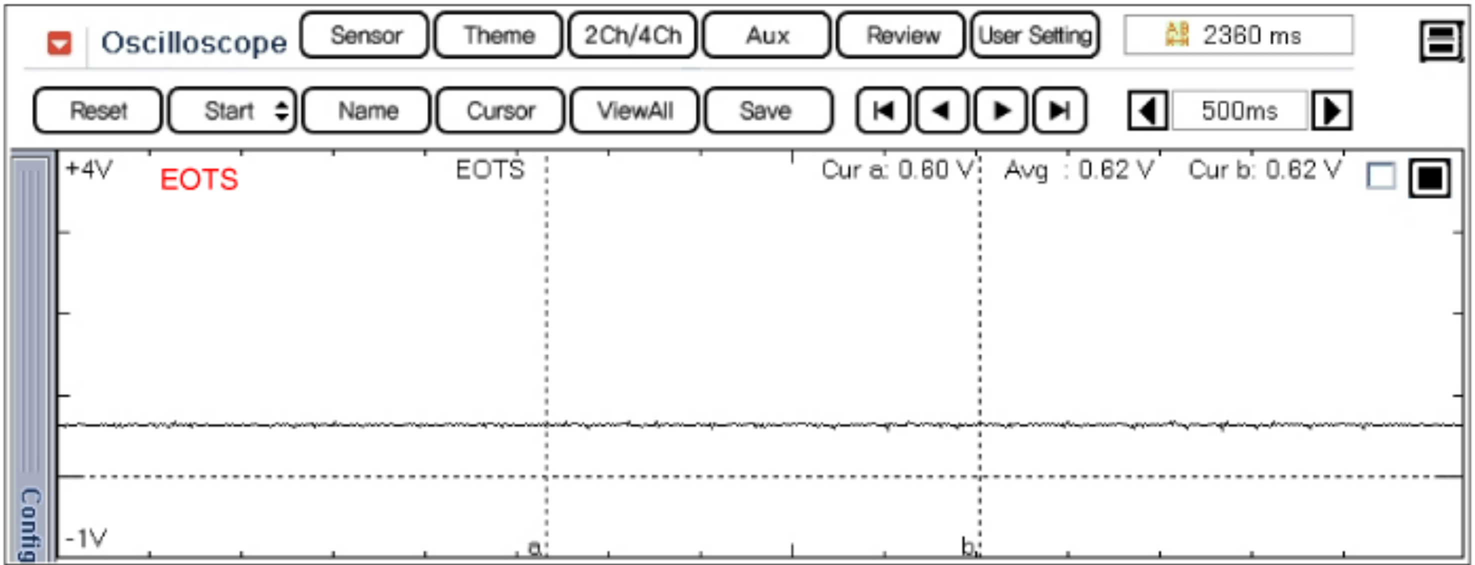
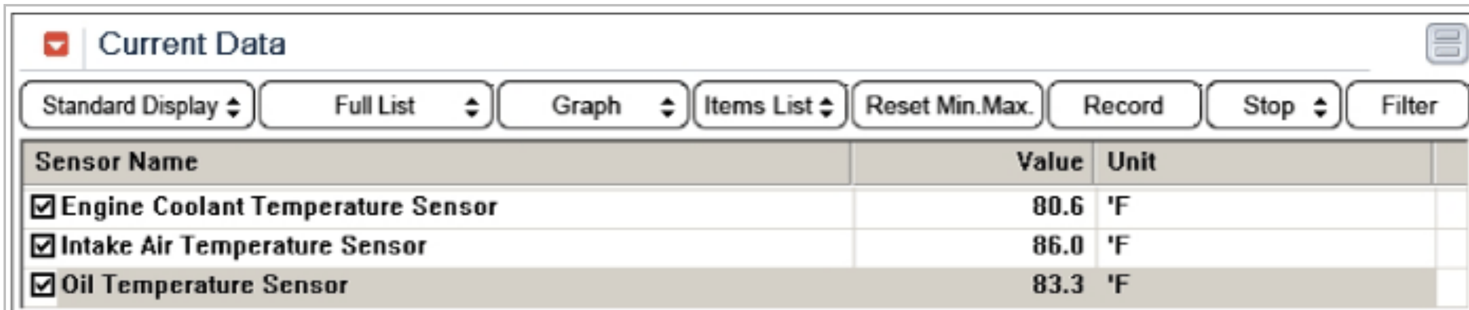
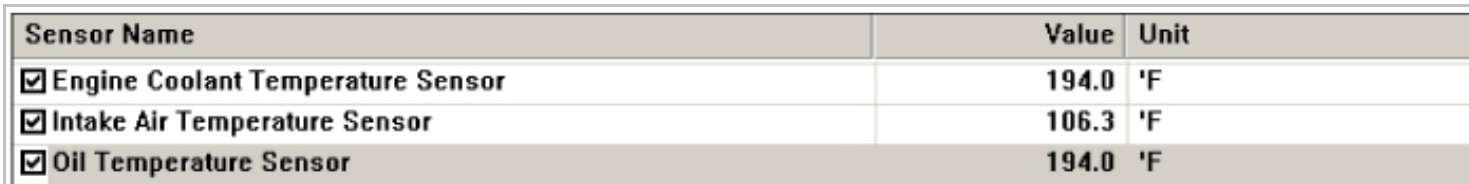


Fig.1



Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	80.6	'F
☑ Intake Air Temperature Sensor	86.0	'F
☑ Oil Temperature Sensor	83.3	'F

Fig.2



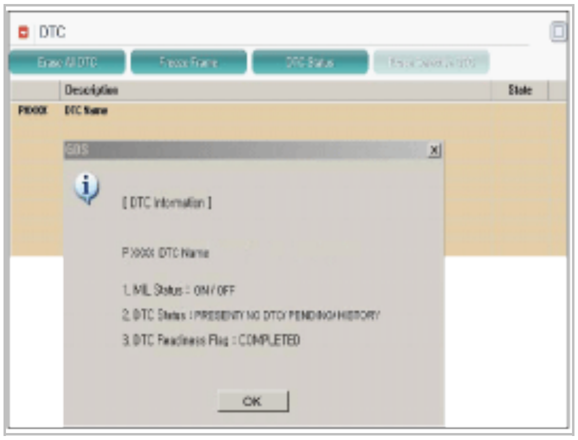
Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	194.0	'F
☑ Intake Air Temperature Sensor	106.3	'F
☑ Oil Temperature Sensor	194.0	'F

Fig.3

Fig.1) Normal waveform of EOTS at 88.5°C(191°F)
Fig.2) Normal data of IATS & ECTS & EOTS at ig on
Fig.3) Normal data of IATS & ECTS & EOTS after warming up.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Fault is intermittent caused by ECM memory was not cleared after repair. Erase DTC and drive the vehicle to satisfy the enable codition then, go to "Component Inspection" procedure.

Component Inspection

■ Check OTS resistance

1. IG "OFF" and disconnect OTS connector.
2. Measure resistance between signal and ground terminals of OTS connector after checking out the temperature of EOTS with GDS (Component Side)
   Specification :

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

3. Is the measured resistance within specification ?

YES	▶ Go to "Verification of Vehicle Repair" procedure.
NO	▶ Substitute with a known - good OTS and check for proper operation. If the problem is corrected, replace OTS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

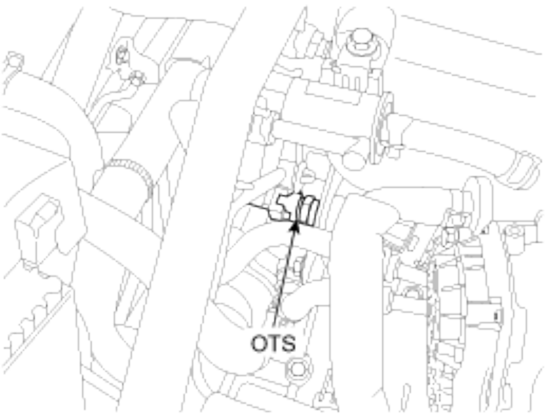
1. Connect GDS and select "DTC" button.

2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0197 Engine Oil Temperature Sensor Low Input

Component Location



General Description

The fluid of the CVVT is the engine oil and its density changes according to the engine oil temperature. At this time the Oil Temperature Sensor (OTS) helps compensation against the temperature differences. The Oil Temperature Sensor measures the engine oil temperature before the engine oil comes into the Oil-flow Control Valve (OCV).
According to the measured temperature, the Engine Control Module (ECM) compensates the oil-flow control valve operation time.

DTC Description

Checking output signals from oil temperture sensor every 15 sec. under detecting condition, if an signal is low for more than 12.5 sec., ECM sets P0197. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

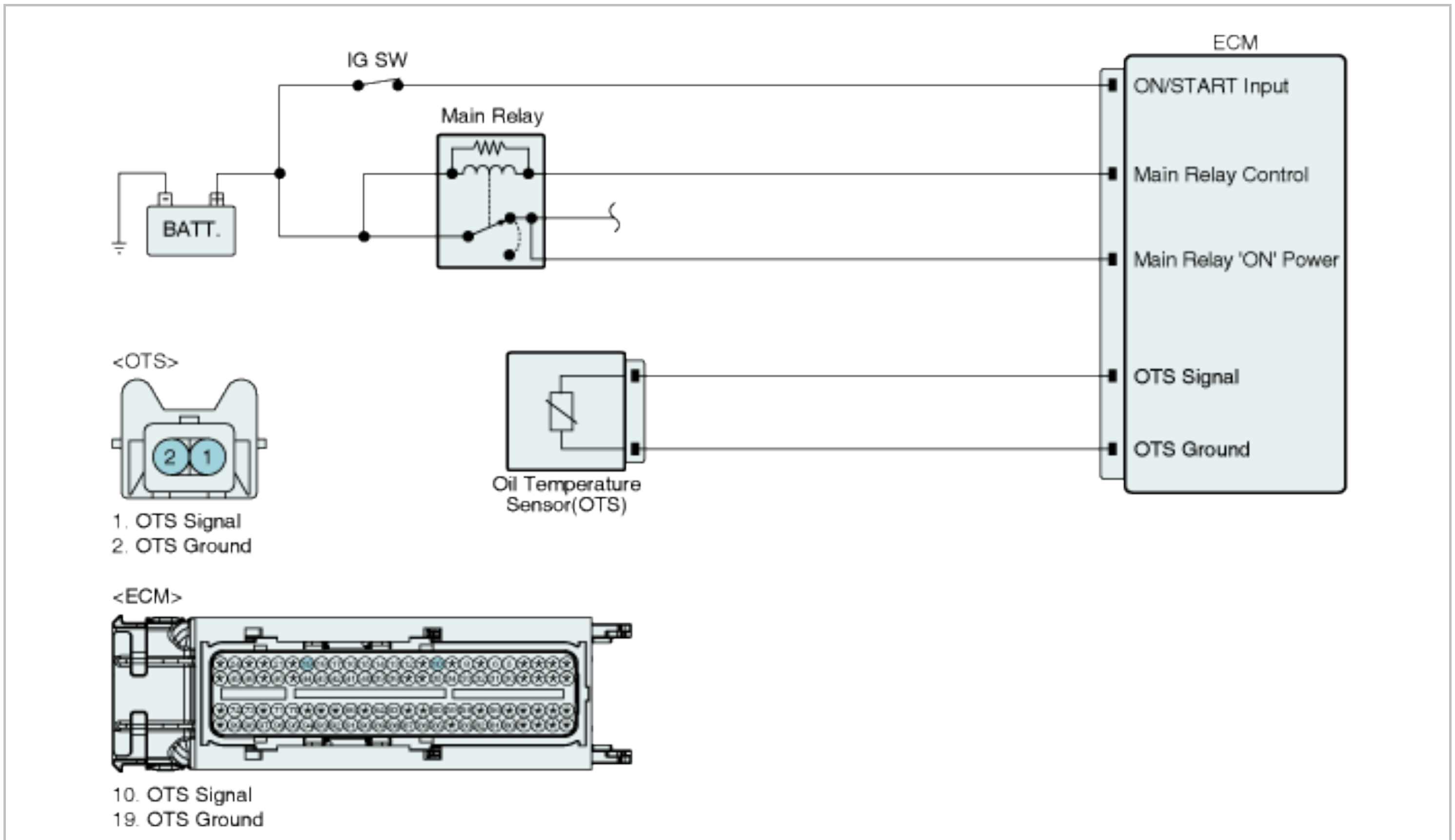
Item		Detecting Condition	Possible Cause
DTC Strategy		• Signal low	• Poor connection • Short to ground in harness • Oil temp.sensor • ECM
Enable Conditions	Case 1	• Engine running state > 60 sec • Coolant temperature < 110 °C(230°F)	
	Case 2	• Engine running state > 90 sec	
Threshold value		• Oil temperature sensor's signal < 0.1V	

Diagnosis Time	• Continuous (More than 12.5 sec.failure for every 15 sec.test)	
MIL On Condition	• 2 Driving Cycles	

Specification

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

Diagnostic Circuit Diagram



Signal Waveform & Data

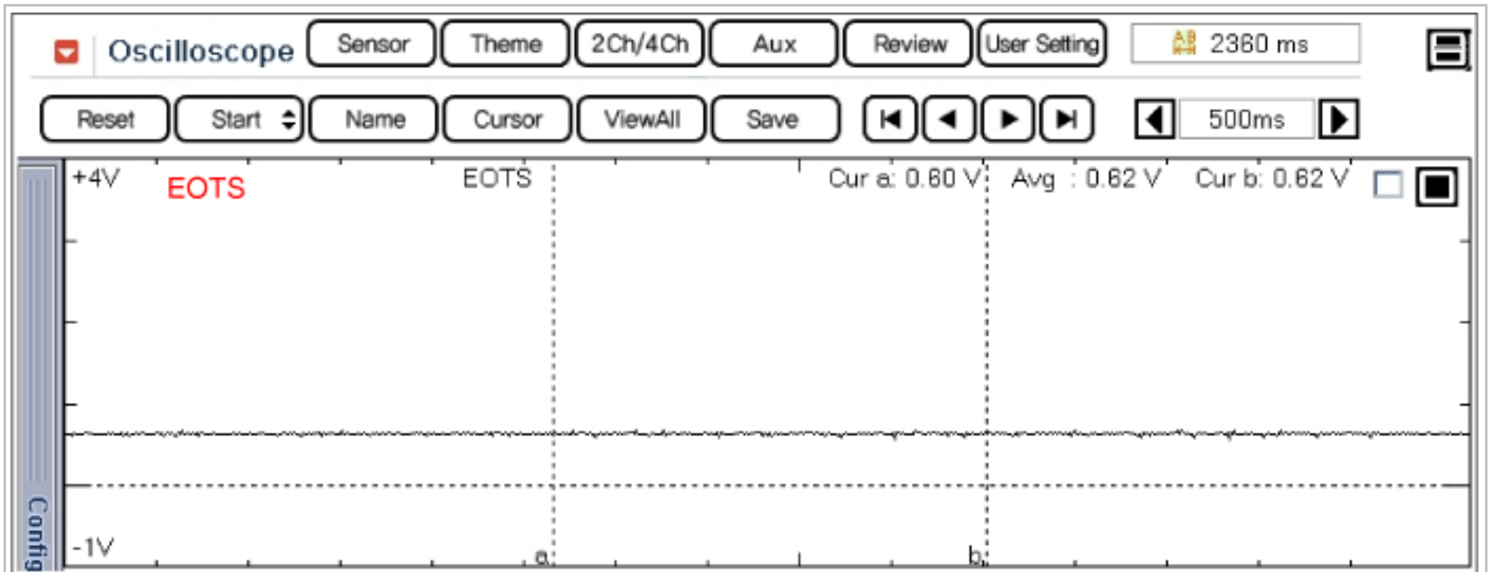


Fig.1

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | Filter

Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	80.6	'F
☑ Intake Air Temperature Sensor	86.0	'F
☑ Oil Temperature Sensor	83.3	'F

Fig.2

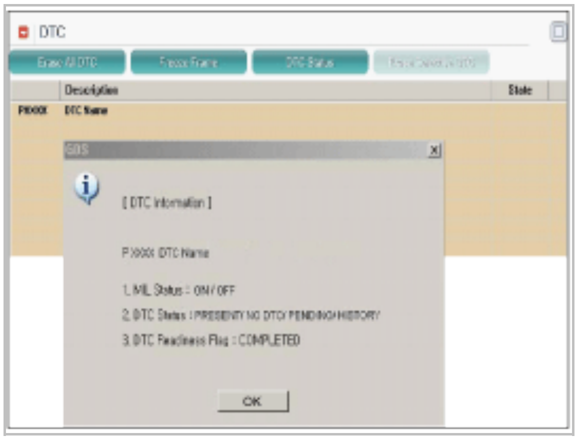
Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	194.0	'F
☑ Intake Air Temperature Sensor	106.3	'F
☑ Oil Temperature Sensor	194.0	'F

Fig.3

Fig.1) Normal waveform of EOTS at 88.5°C(191°F)
Fig.2) Normal data of IATS & ECTS & EOTS at ig on
Fig.3) Normal data of IATS & ECTS & EOTS after warming up.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.Go to "Component Inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found ?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Signal Circuit Inspection" procedure.

Signal Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect OTS connector.
2. IG "ON"
3. Measure voltage between signal terminal of OTS harness connector and chassis ground.

Specification : Approx. 3.3V

4. Is the measured voltage within specification ?

YES	▶ Go to " Component Inspection" procedure.
NO	▶ Repair short to ground in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ **Check OTS resistance**

1. IG "OFF" and disconnect OTS connector.
2. Measure resistance between signal and ground terminals of OTS connector after checking out the temperature of EOTS with GDS (Component Side)
   Specification :

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

3. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good OTS and check for proper operation. If the problem is corrected, replace OTS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

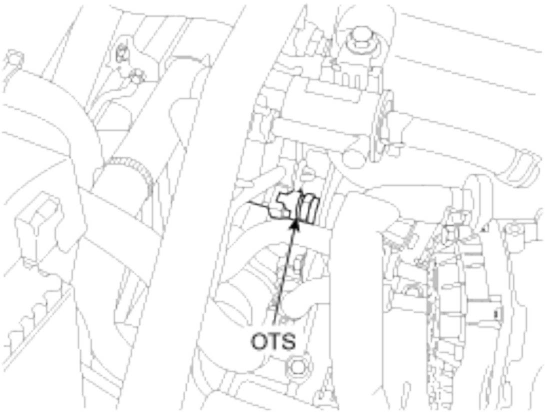
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0198 Engine Oil Temperature Sensor High Input

Component Location



General Description

The fluid of the CVVT is the engine oil and its density changes according to the engine oil temperature. At this time the Oil Temperature Sensor (OTS) helps compensation against the temperature differences. The Oil Temperature Sensor measures the engine oil temperature before the engine oil comes into the Oil-flow Control Valve (OCV).
According to the measured temperature, the Engine Control Module (ECM) compensates the oil-flow control valve operation time.

DTC Description

Checking output signals from oil temperture sensor every 15 sec. under detecting condition, if an signal is high for more than 12.5 sec., ECM sets P0198. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

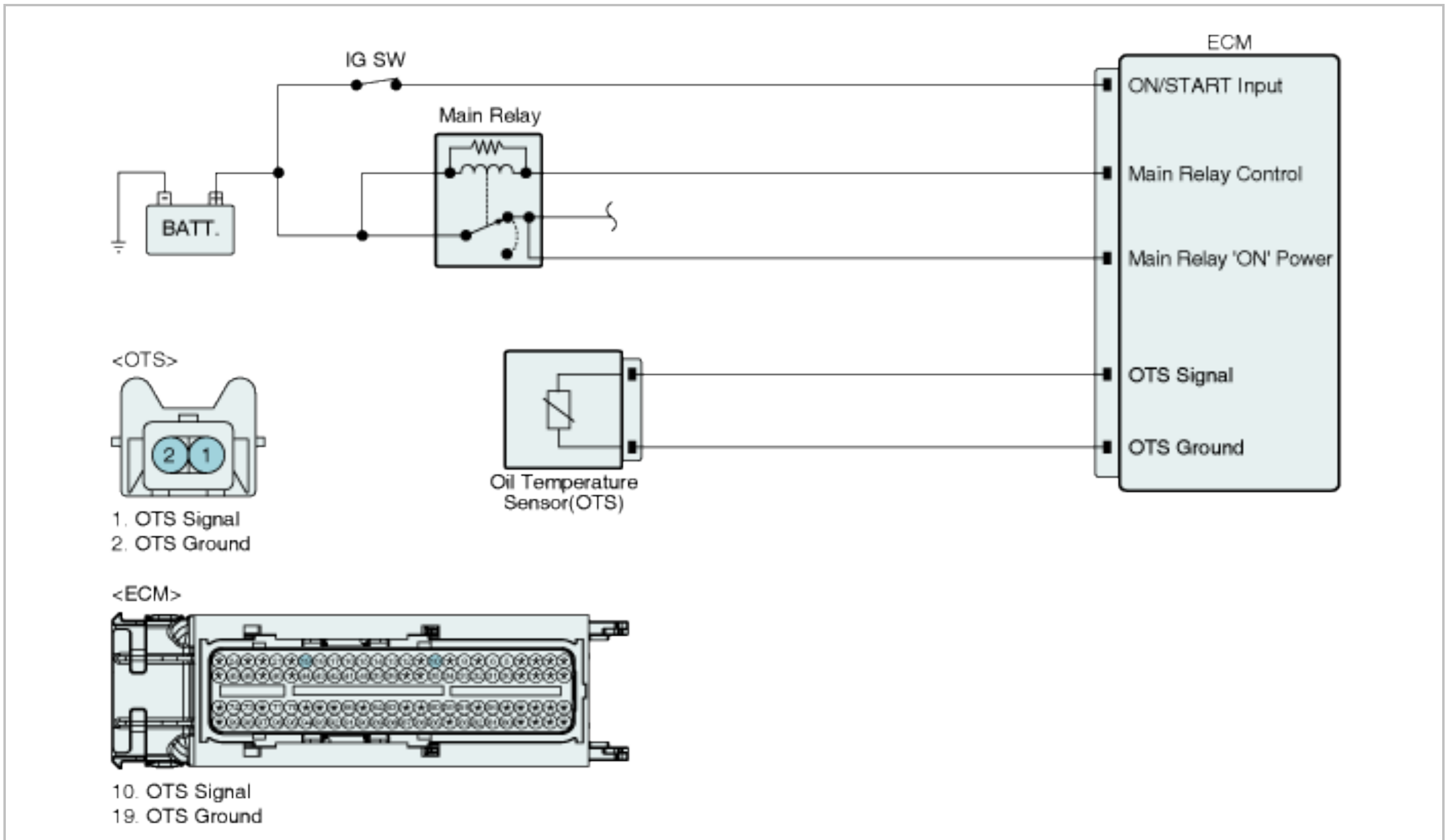
Item		Detecting Condition	Possible Cause
DTC Strategy		• Signal High	• Poor connection • Open or short to battery in signal harness • Open in ground harness • Oil temp. sensor • ECM
Enable Conditions	Case 1	• Engine running state > 60 sec • Coolant temperature < 110 °C(230°F)	
	Case 2	• Engine running state > 90 sec	
Threshold value		• Oil temperature sensor's signal > 4.9V	
Diagnosis Time		• Continuous (More than 12.5 sec.failure for every 15 sec.test)	
MIL On Condition		• 2 Driving Cycles	

Specification

Temperature(°C/°F)	Resistance(kΩ)
-40 (-40°F)	52.15kΩ
-20 (-4°F)	16.52kΩ

0 (32°F)	6.0kΩ
20 (68°F)	2.45kΩ
40 (104°F)	1.11kΩ
60 (140°F)	0.54kΩ
80 (176°F)	0.29kΩ

Diagnostic Circuit Diagram



Signal Waveform & Data

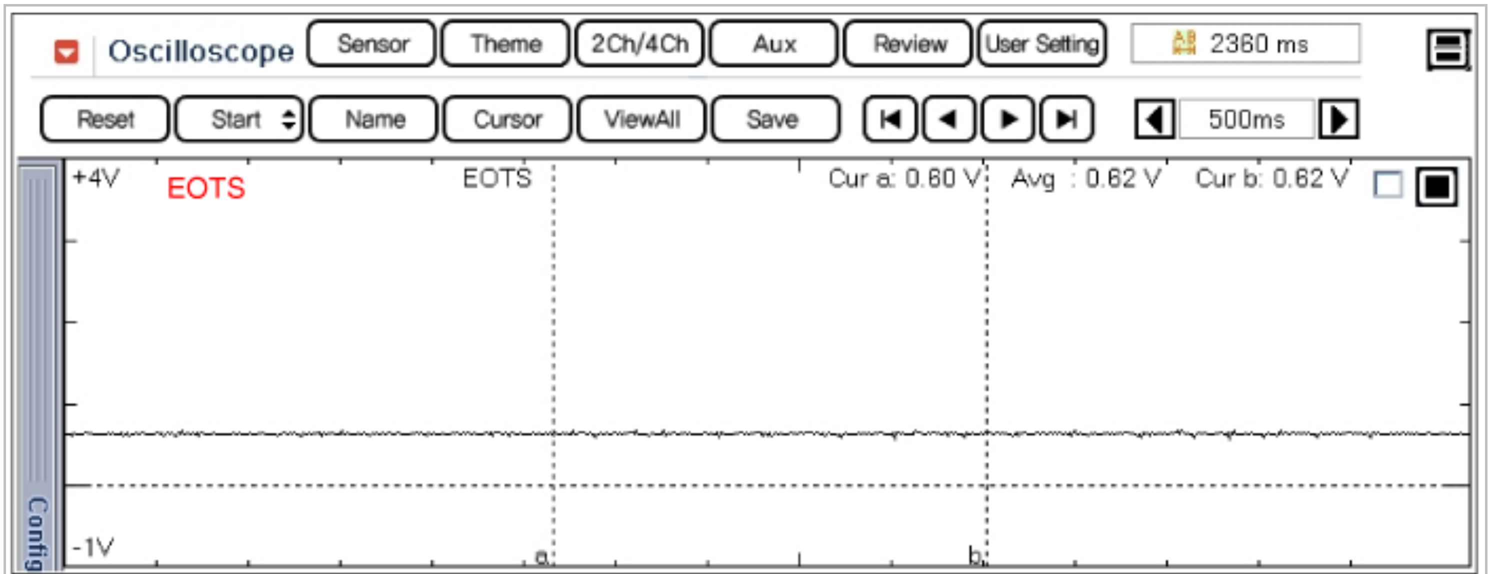


Fig.1

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | Filter

Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	80.6	'F
☑ Intake Air Temperature Sensor	86.0	'F
☑ Oil Temperature Sensor	83.3	'F

Fig.2

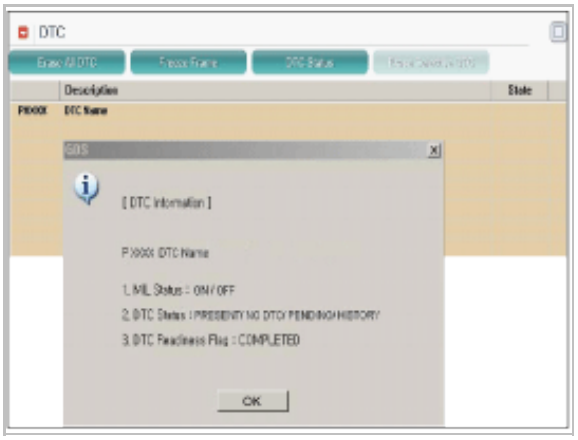
Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	194.0	'F
☑ Intake Air Temperature Sensor	106.3	'F
☑ Oil Temperature Sensor	194.0	'F

Fig.3

Fig.1) Normal waveform of EOTS at 88.5°C(191°F)
Fig.2) Normal data of IATS & ECTS & EOTS at ig on
Fig.3) Normal data of IATS & ECTS & EOTS after warming up.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found ?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Signal Circuit Inspection" procedure.

Signal Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect OTS connector.
2. IG "ON"
3. Measure voltage between signal terminal of OTS harness connector and chassis ground.

Specification : Approx. 3.3V

4. Is the measured voltage within specification ?

YES	▶ Go to "Ground Circuit Inspection" procedure.
NO	▶ Go to "Check open in harness" as follow.

■ Check open in harness

1. IG "OFF" and disconnect OTS connector and ECM connector.

2. Measure resistance between signal terminal of OTS harness connector and OTS signal terminal of ECM harness connector.

Specification : Below 1Ω

3. Is the measured resistance within specification ?

YES	▶ Go to "Ground Circuit Inspection" procedure.
NO	▶ Repair open in harness and go to "Verification of Vehicle Repair" procedure.

Ground Circuit Inspection

■ Check open in harness

1. IG "OFF" and disconnect OTS connector and then IG "ON".
2. Measure voltage between signal terminal of OTS harness connector and chassis ground.(Measurement "A")
3. Measure voltage between signal and ground terminals of OTS harness connector.(Measurement "B")

Specification : Voltage difference between measurement "A" and "B" is below 200mV.

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair contact resistance or open in harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check OTS resistance

1. IG "OFF" and disconnect OTS connector.
2. Measure resistance between signal and ground terminals of OTS connector after checking out the temperature of EOTS with GDS (Component Side)
Specification :

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

3. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure.

	NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good OTS and check for proper operation. If the problem is corrected, replace OTS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

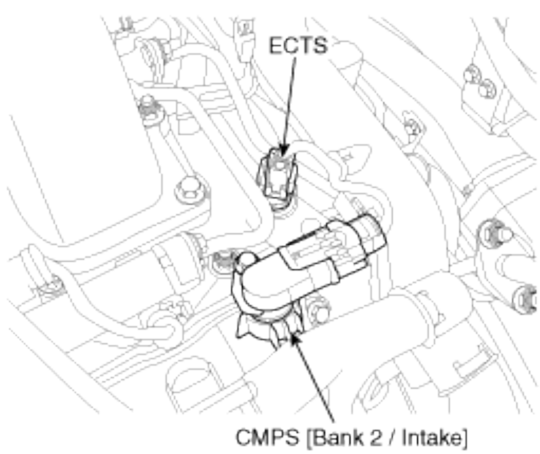
After a repair, it is essential to verify that the fault has been corrected.

1. Connect scantool and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0217 Engine Coolant Over Temperature Condition

Component Location



General Description

The Engine Coolant Temperature Sensor (ECTS) is located in the engine coolant passage of the cylinder head for detecting the engine coolant temperature. The ECTS uses a thermistor whose resistance changes with the temperature. The electrical resistance of the ECTS decreases as the temperature increases, and increases as the temperature decreases. The reference 5V in the ECM is supplied to the ECTS via a resistor in the ECM. That is, the resistor in the ECM and the thermistor in the ECTS are connected in series. When the resistance value of the thermistor in the ECTS changes according to the engine coolant temperature, the output voltage also changes. During cold engine operation the ECM increases the fuel injection duration and controls the ignition timing using the information of engine coolant temperature to avoid engine stalling and improve drivability.

DTC Description

Checking the coolant temperature under detecting condition, if the coolant temperature exceeds the threshold temperature under normal operation loads, ECM sets P0217. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

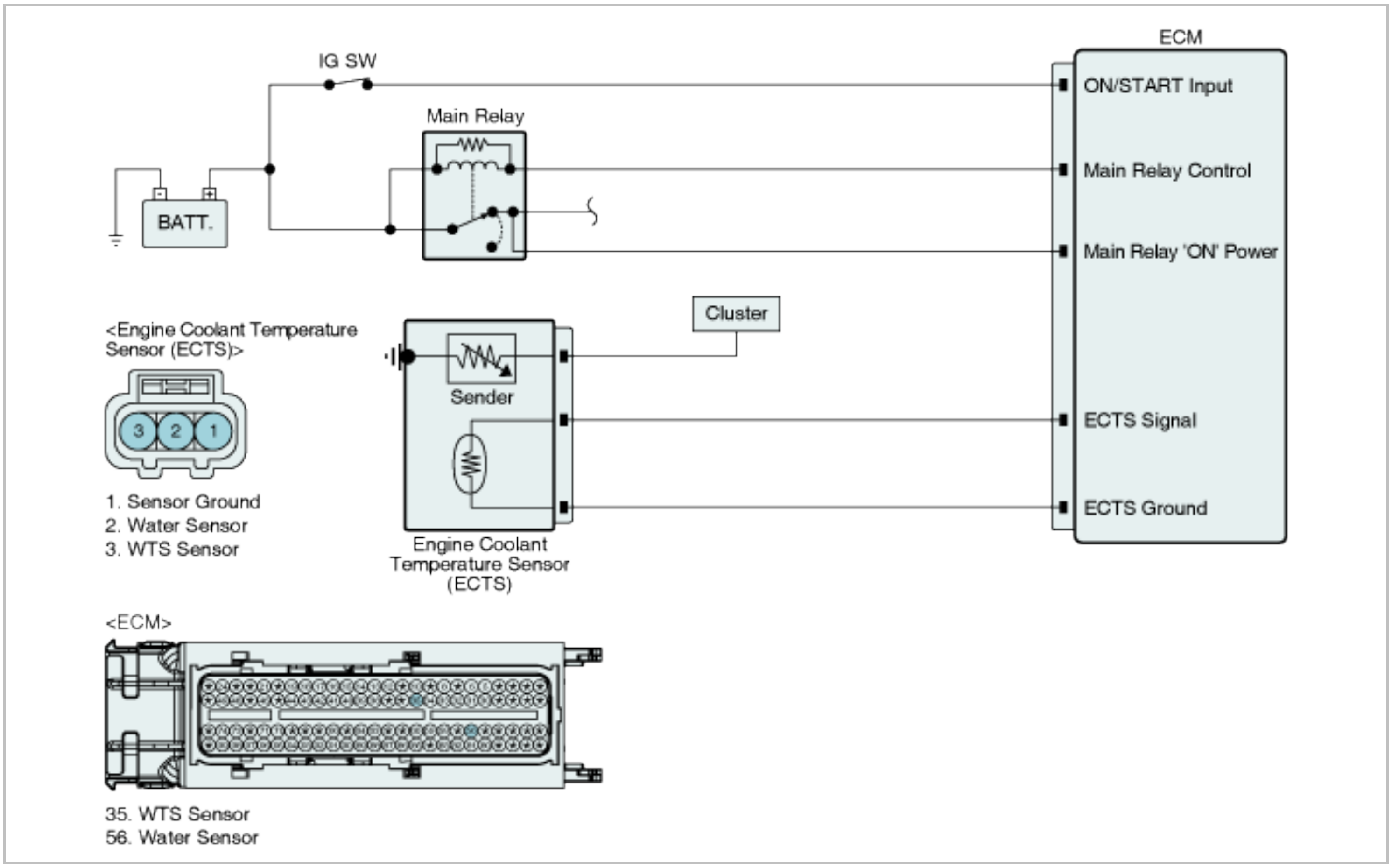
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Monitor the coolant temperature	• ECTS
Enable Conditions	• Coolant sensor is normal • No disabling faults present(DTCs related to MAFS/MAPS, catalyst, fuel system or engine oil temperature sensor) • Coolant Temperature at startup < 45°C(113 °F) • Engine running state • Coolant temperature > 50°C(122 °F) • Intake air temperature < 35°C(95 °F)	
Threshold value	• Coolant temperature ≥ 110°C (230 °F)(Average airflow< 30 g/sec and filtered airflow< 50 g/sec)	
Diagnosis Time	• Once per driving cycle (about 2 minutes)	
MIL On Condition	• 2 Driving Cycles	

Specification

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

Diagnostic Circuit Diagram



Signal Waveform & Data

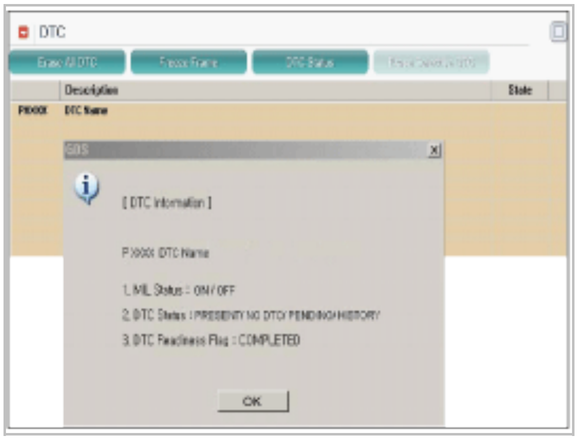
Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	194.0	'F
☑ Intake Air Temperature Sensor	106.3	'F
☑ Oil Temperature Sensor	194.0	'F

Fig.1

Fig.1) Normal data of IATS & ECTS & EOTS after warming up.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Fault is intermittent caused by ECM memory was not cleared after repair. Erase DTC and drive the vehicle to satisfy the enable codition then, go to "Component Inspection" procedure.

Component Inspection

■ Check EOTS resistance

1. IG "OFF" and disconnect ECTS connector.
2. Measure resistance between signal and ground terminals of EOTS connector after checking out the temperature of EOTS with GDS (Component Side)
   Specification :

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

3. Is the measured resistance within specification ?

YES	▶ Clear DTC and Test-drive under enable conditions above-mentioned. After the test, If this DTC is set, recheck it thoroughly. If not, it is intermittent fault, go to "Verification of vehicle Repair" procedure.
NO	▶ Substitute with a known - good ECTS and check for proper operation. If the problem is corrected, Go to "Verification of Vehicle Repair"procedure.

Verification of Vehicle Repair

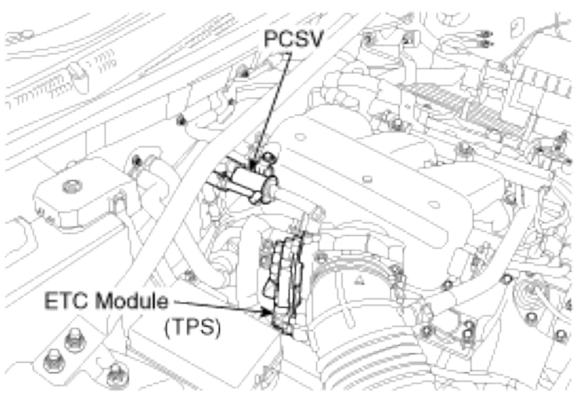
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0222 Throttle Position Sensor 2 Signal Circuit Low Input

Component Location



General Description

The Electronic Throttle Control(ETC) system is made of the components throttle body, Throttle Position Sensor(TPS)1&2 and Accelerator Position Sensor(APS) 1&2. TPS1&2 are sharing the same source voltage and ground.The throttle valve opening is control by throttle motor which is controlled by Engine Control Module(ECM).The opposite position indicator shows inverted signal characteristics.TPS1 output voltage increases smoothly in proportion with the throttle valve opening angle after starting. TPS2 output voltage decreases in inverse proportion with the throttle valve opening angle after starting. TPS provides feedback to the ECM to control the throttle motor in order to control the throttle valve opening angle properly in response to the driving condition.

DTC Description

Checking output signals from TPS2 every 8.5 sec. under detecting condition, if an output signal is below 0.25V for more than 0.1 sec., ECM sets P0222. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

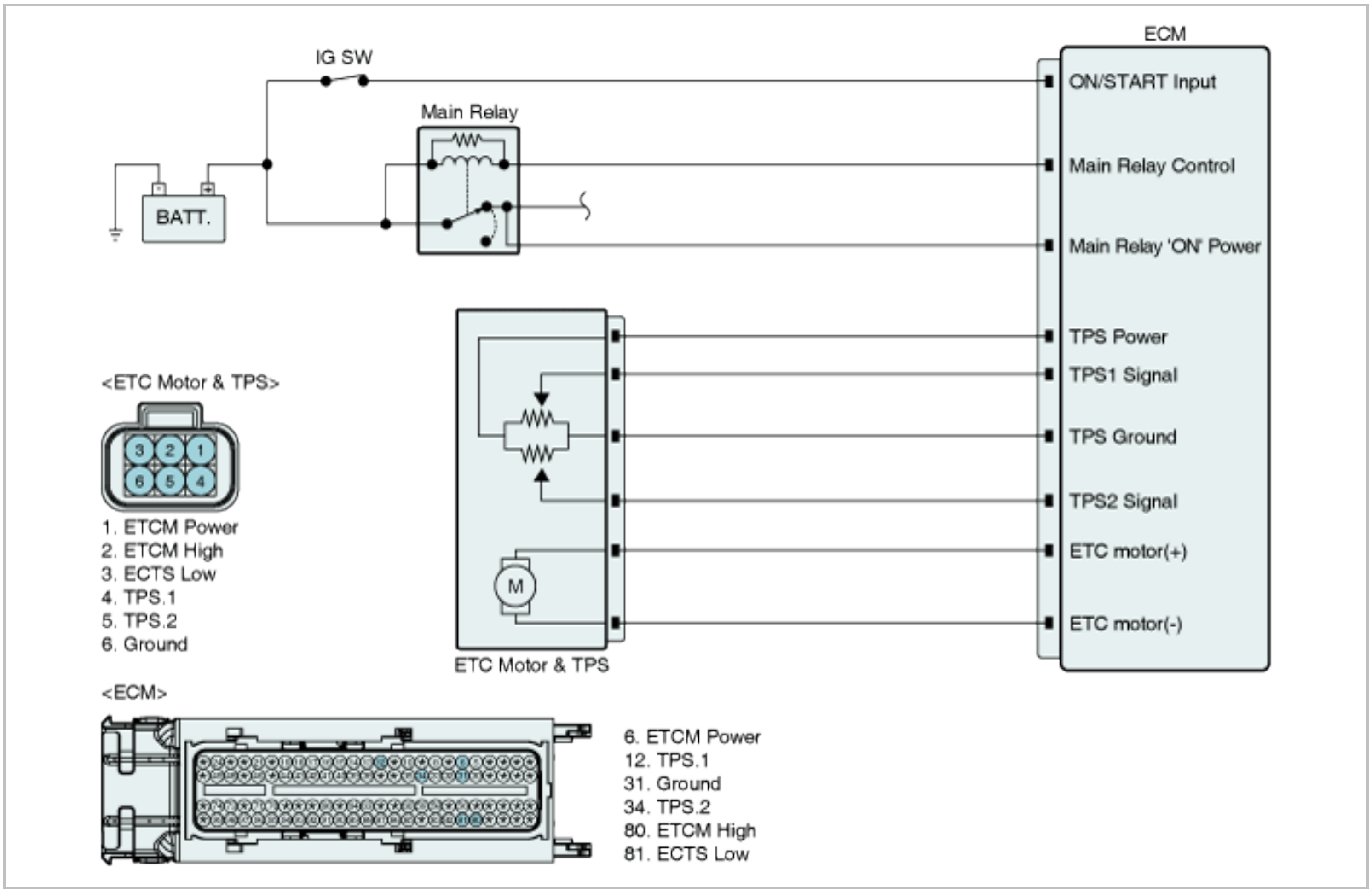
Item	Detecting Condition	Possible Cause
DTC Strategy	• Signal low	• Poor connection • Open or short to ground in power harness
Enable Conditions	• IG "ON"	

Threshold value	• The voltage of TPS < 0.25V	power harness • Open or Short to ground in signal harness • TPS • ECM
Diagnosis Time	• Continuous (more than 0.1 sec. failure for every 8.5 sec.test)	
MIL On Condition	• 1 driving cycles	

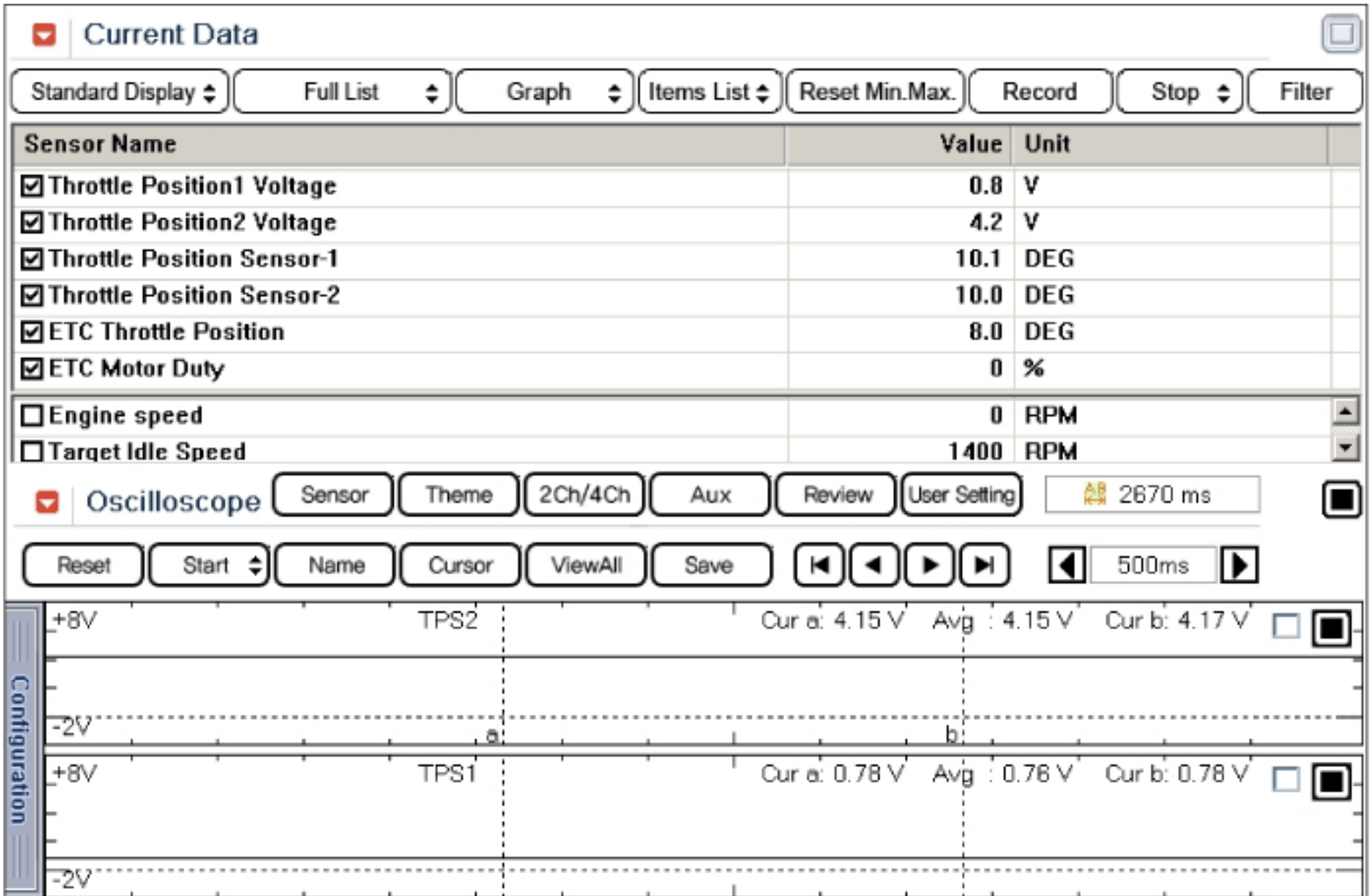
Specification

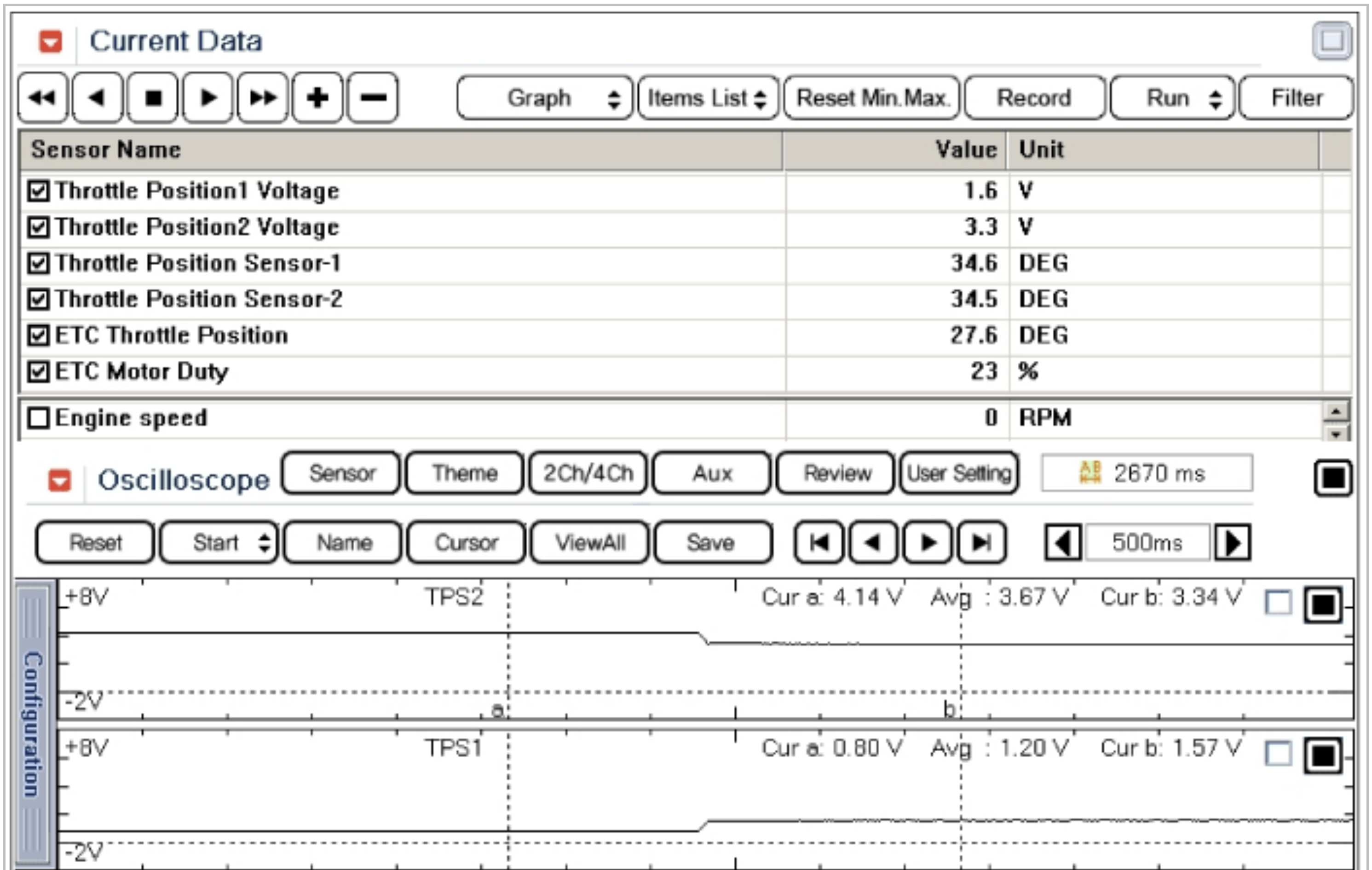
Throttle Opening (°)	Output Voltage (V) [Vref=5.0]	
	TPS1	TPS2
0°	0.0V	5.0V
10°	0.5V	4.5V
20°	0.9V	4.1V
30°	1.4V	3.6V
40°	1.8V	3.2V
50°	2.3V	2.7V
60°	2.7V	2.3V
70°	3.2V	1.8V
80°	3.6V	1.4V
90°	4.1V	0.9V
100°	4.5V	0.5V
110°	5.0V	0.0V

Diagnostic Circuit Diagram



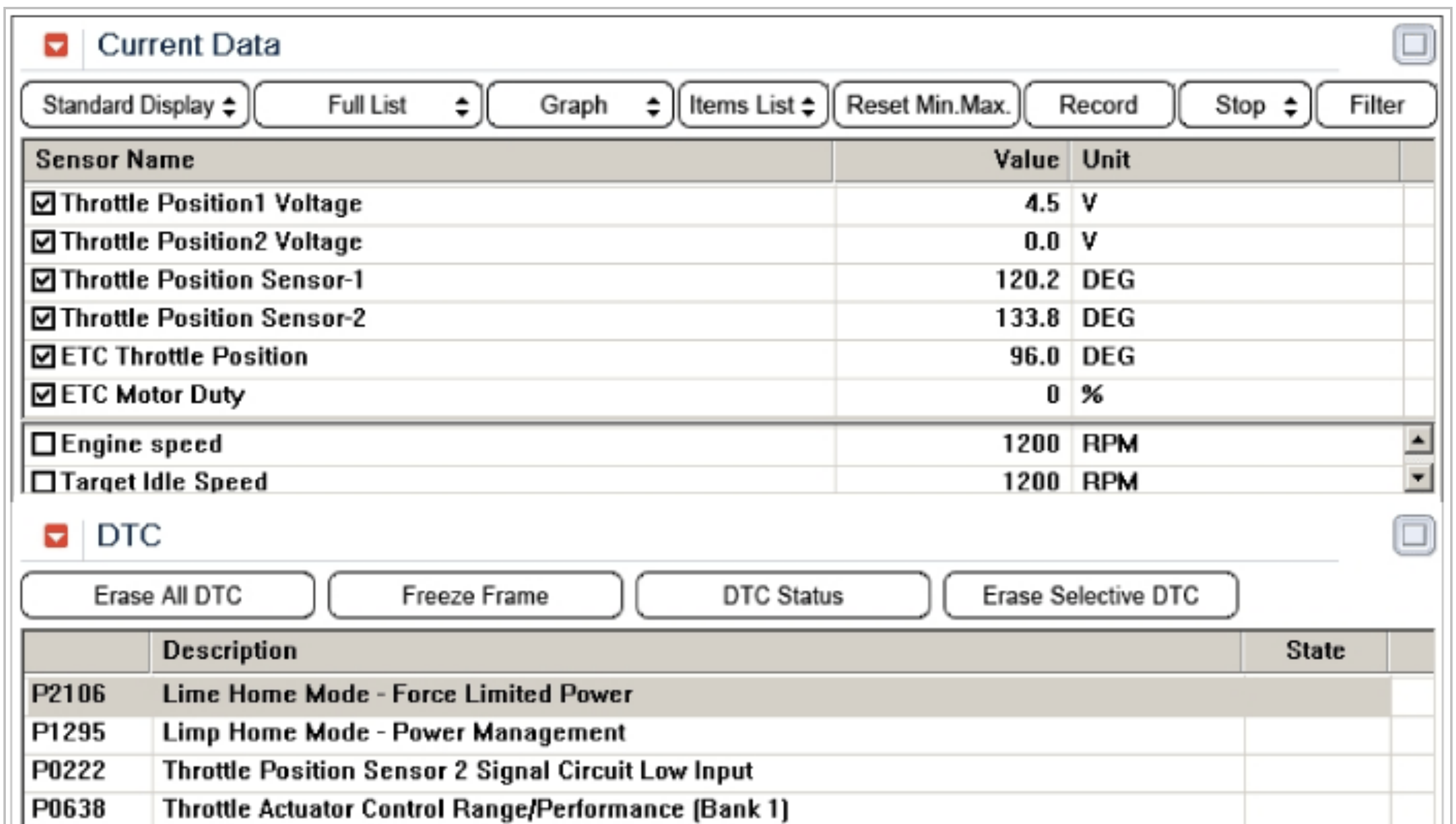
Signal Waveform & Data


Current Data
Standard Display
Full List
Graph
Items List
Reset Min.Max.
Record
Stop
Filter
Sensor Name
Value
Unit
Throttle Position1 Voltage 0.8 V
Throttle Position2 Voltage 4.2 V
Throttle Position Sensor-1 10.1 DEG
Throttle Position Sensor-2 10.0 DEG
ETC Throttle Position 8.0 DEG
ETC Motor Duty 0 %
Engine speed 0 RPM
Target Idle Speed 1400 RPM
Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
2670 ms
Reset
Start
Name
Cursor
ViewAll
Save
500ms
+8V
TPS2
Cur a: 4.15 V
Avg : 4.15 V
Cur b: 4.17 V
-2V
a
b
+8V
TPS1
Cur a: 0.78 V
Avg : 0.76 V
Cur b: 0.78 V
-2V
Configuration
Fig.1



Sensor Name	Value	Unit
☑ Throttle Position1 Voltage	1.6	V
☑ Throttle Position2 Voltage	3.3	V
☑ Throttle Position Sensor-1	34.6	DEG
☑ Throttle Position Sensor-2	34.5	DEG
☑ ETC Throttle Position	27.6	DEG
☑ ETC Motor Duty	23	%
☐ Engine speed	0	RPM

Fig.2



Sensor Name	Value	Unit
☑ Throttle Position1 Voltage	4.5	V
☑ Throttle Position2 Voltage	0.0	V
☑ Throttle Position Sensor-1	120.2	DEG
☑ Throttle Position Sensor-2	133.8	DEG
☑ ETC Throttle Position	96.0	DEG
☑ ETC Motor Duty	0	%
☐ Engine speed	1200	RPM
☐ Target Idle Speed	1200	RPM

	Description	State
P2106	Lime Home Mode - Force Limited Power	
P1295	Limp Home Mode - Power Management	
P0222	Throttle Position Sensor 2 Signal Circuit Low Input	
P0638	Throttle Actuator Control Range/Performance (Bank 1)	

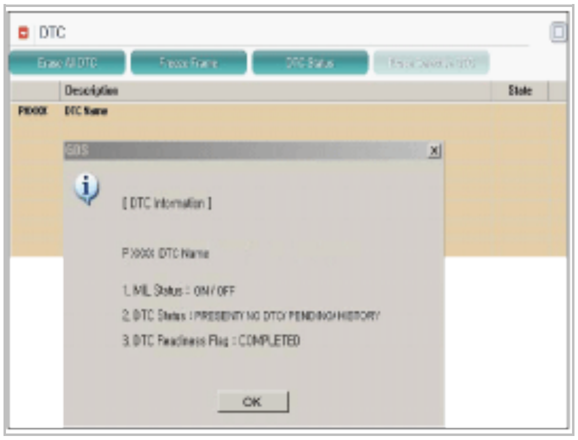
Fig.3

Fig.1) Normal data & waveform of TPS1 & TPS2 with no accel padal depressed under IG ON condition

Fig.2) Normal data & waveform of TPS1 & TPS2 with accel padal depressed under IG ON condition
Fig.3) Abnormal data of TPS1 & TPS2 at open condition

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found ?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Power Circuit Inspection" procedure.

Power Circuit Inspection

■ **Check voltage**

1. IG "OFF" and disconnect ETC Motor & TPS connector.
2. IG "ON".
3. Measure voltage between TPS power terminal of ETC Motor & TPS harness connector and chassis ground.

Specification : Approx. 5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Signal circuit inspection" procedure.
NO	▶ Repair open or short to ground in power harness, and go to "Verification of Vehicle Repair" procedure.

Signal Circuit Inspection

■ Check short to ground in harness

1. IG "OFF" and disconnect ETC Motor & TPS connector and ECM connector.
2. Measure resistance between TPS2 signal terminal of ETC Motor & TPS harness connector and chassis ground.(Measurement "A")
3. Measure resistance between TPS2 signal and TPS ground terminals of ETC Motor & TPS harness connector.(Measurement "B")

Specification : Infinite

4. Is the measured resistance within specification ?

YES	▶ Go to "Check open in harness" as follows.
NO	▶ Repair short to ground in harness and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect ETC Motor & TPS connector and ECM connector.
2. Measure resistance between TPS2 signal terminal of ETC Motor & TPS harness connector and TPS2 signal terminal of ECM harness connector.

Specification : Below 1Ω

3. Is the measured resistance within specification ?

YES	▶ Go to "Ground Circuit Inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check TPS resistance

1. IG "OFF" and disconnect ETC Motor & TPS connector.
2. Measure resistance between TPS power and TPS ground terminals of ETC Motor & TPS connector.(component side)

Specification : 1.6 ~ 2.4kΩ

3. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected,

	replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good ECT motor & TPS and check for proper operation. If the problem is corrected, replace ECT motor & TPS and go to "Verification of Vehicle Repair" procedure.

※ Procedure of ETS Initialization

A. Erase the trouble codes on ECM

B. Turn the ignition key off and keep this condition until the main relay is turned off.(It will take 10sec.)

C. Turn ignition key on more than 1second to record the throttle motor position on the EEPROM

Verification of Vehicle Repair

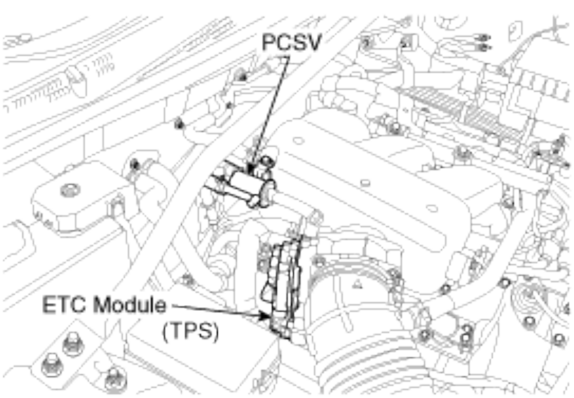
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0223 Throttle Position Sensor 2 Signal Circuit High Input

Component Location



General Description

The Electronic Throttle Control(ETC) system is made of the components throttle body, Throttle Position Sensor(TPS)1&2 and Accelerator Position Sensor(APS) 1&2. TPS1&2 are sharing the same source voltage and ground.The throttle valve opening is control by throttle motor which is controlled by Engine Control Module(ECM).The opposite position indicator shows inverted signal characteristics.TPS1 output voltage increases smoothly in proportion with the throttle valve opening angle after starting. TPS2 output voltage decreases in inverse proportion with the throttle valve opening angle after starting. TPS provides feedback to the ECM to control the throttle motor in order to control the throttle valve opening angle properly in response to the driving condition.

DTC Description

Checking output signals from TPS2 every 8.5 sec. under detecting condition, if an output signal is above 4.75V for more than 0.1 sec., ECM sets P0223. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

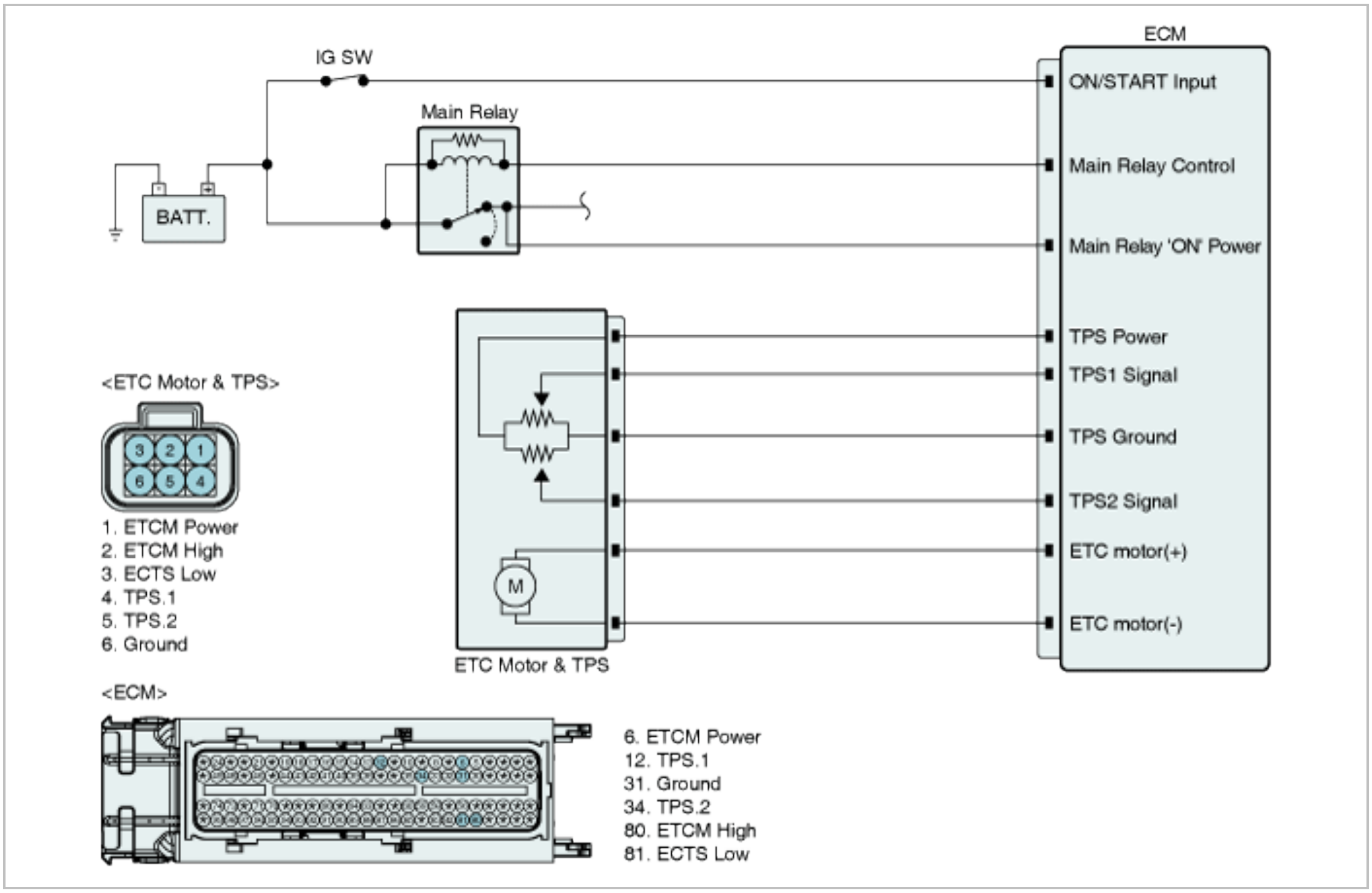
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Signal high	• Poor connection • Short to battery in signal harness • Open in ground harness • TPS • ECM
Enable Conditions	• IG "ON"	
Threshold value	• The voltage of TPS > 4.75V	
Diagnosis Time	• Continuous (more than 0.1 sec. failure for every 8.5 sec.test)	
MIL On Condition	• 1 driving cycles	

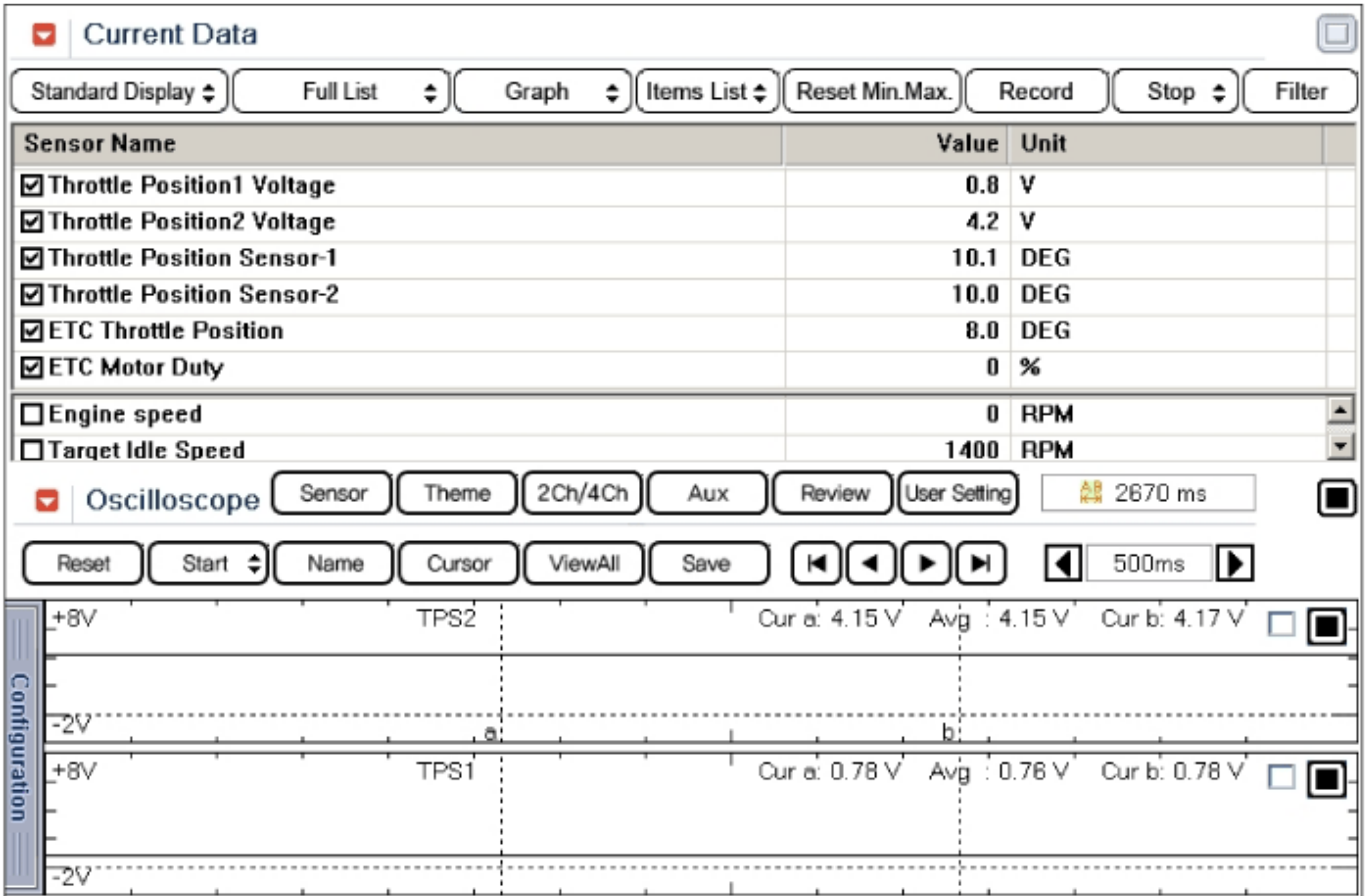
Specification

Throttle Opening (°)	Output Voltage (V) [Vref=5.0]	
	TPS1	TPS2
0°	0.0V	5.0V
10°	0.5V	4.5V
20°	0.9V	4.1V
30°	1.4V	3.6V
40°	1.8V	3.2V
50°	2.3V	2.7V
60°	2.7V	2.3V
70°	3.2V	1.8V
80°	3.6V	1.4V
90°	4.1V	0.9V
100°	4.5V	0.5V
110°	5.0V	0.0V

Diagnostic Circuit Diagram

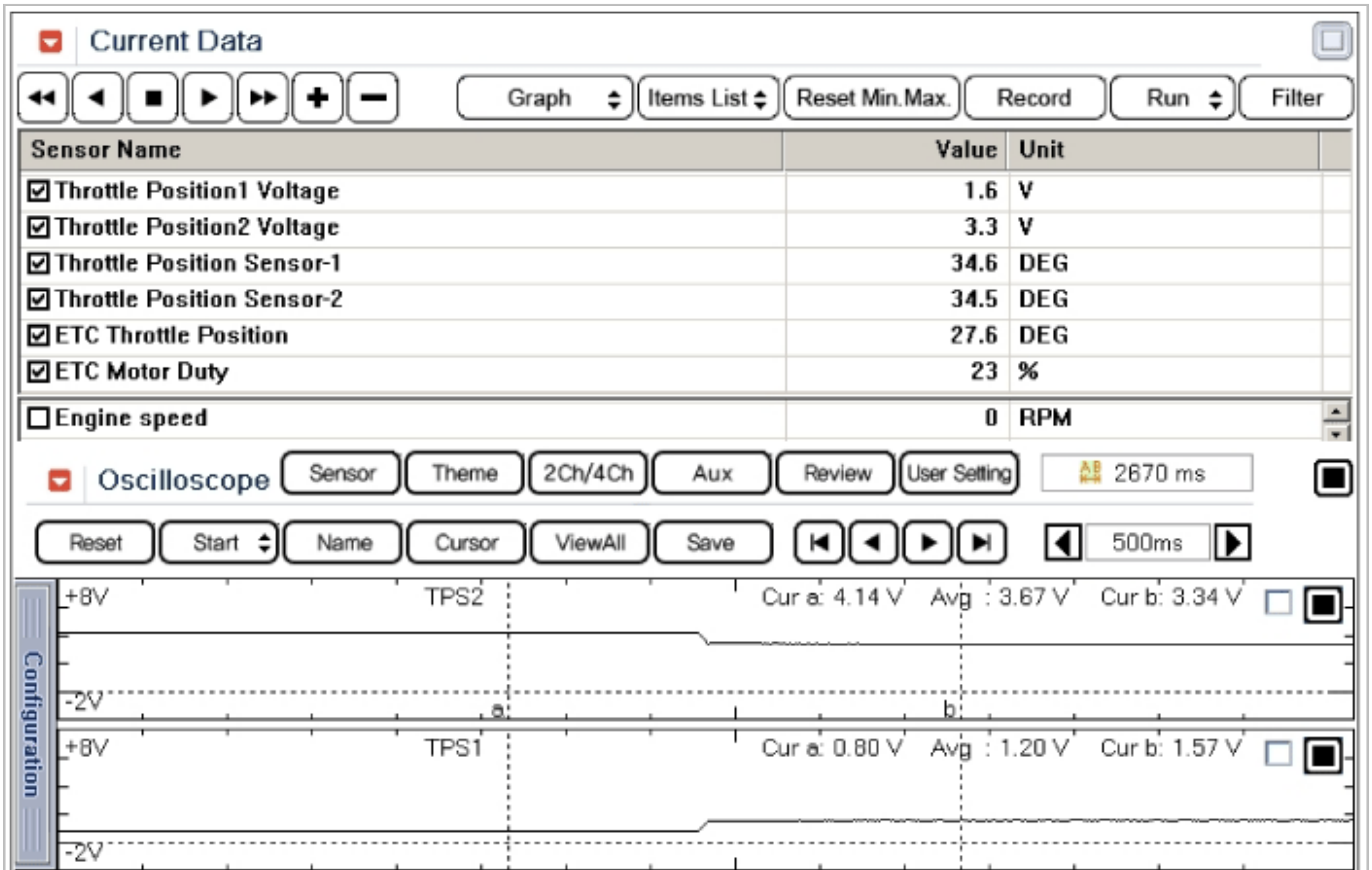


Signal Waveform & Data



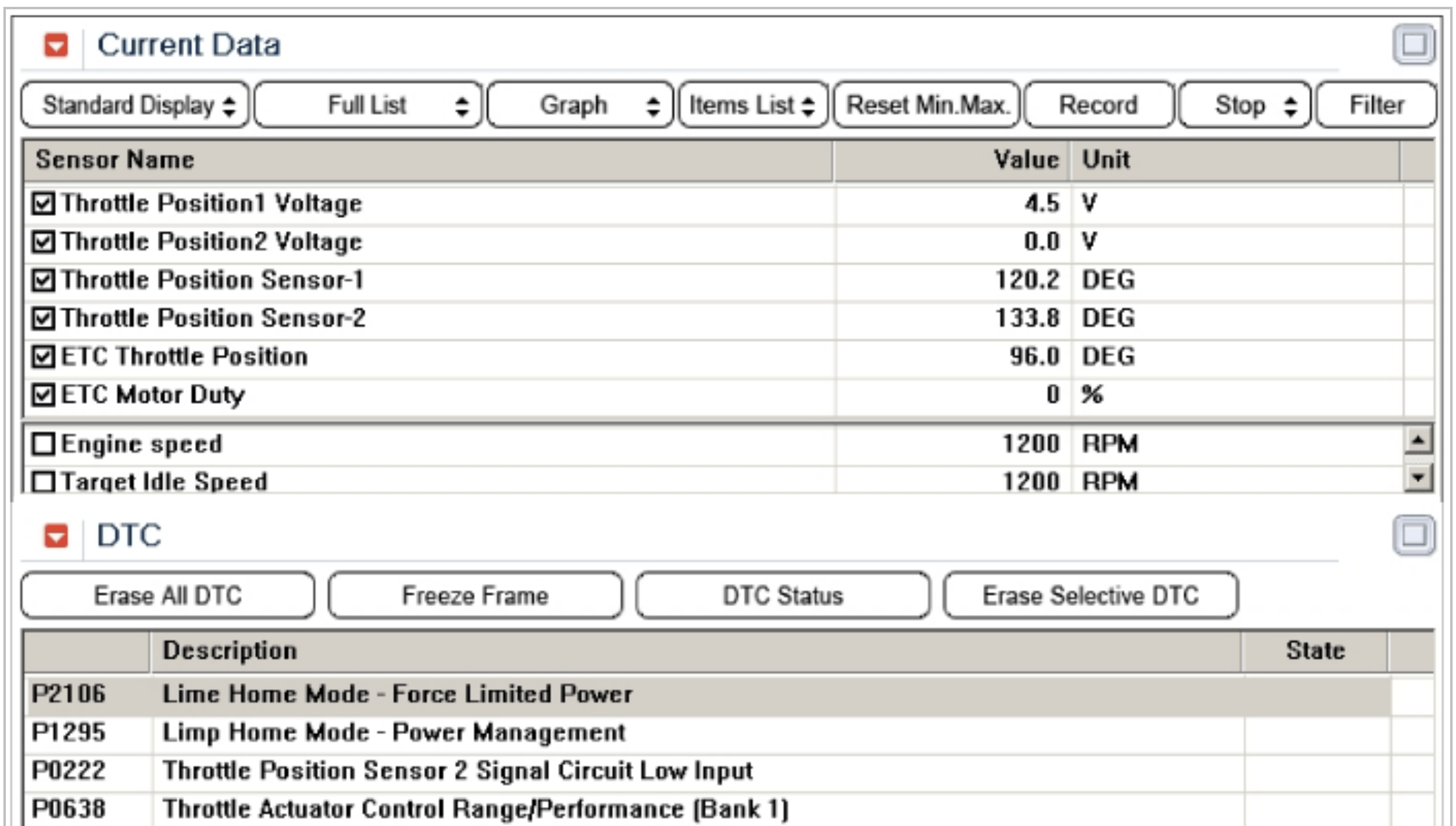
Current Data
Standard Display
Full List
Graph
Items List
Reset Min.Max.
Record
Stop
Filter
Sensor Name
Value
Unit
Throttle Position1 Voltage
0.8
V
Throttle Position2 Voltage
4.2
V
Throttle Position Sensor-1
10.1
DEG
Throttle Position Sensor-2
10.0
DEG
ETC Throttle Position
8.0
DEG
ETC Motor Duty
0
%
Engine speed
0
RPM
Target Idle Speed
1400
RPM
Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
2670 ms
Reset
Start
Name
Cursor
ViewAll
Save
500ms
+8V
TPS2
Cur a: 4.15 V
Avg : 4.15 V
Cur b: 4.17 V
-2V
a
b
+8V
TPS1
Cur a: 0.78 V
Avg : 0.76 V
Cur b: 0.78 V
-2V
Configuration

Fig.1



Sensor Name	Value	Unit
☑ Throttle Position1 Voltage	1.6	V
☑ Throttle Position2 Voltage	3.3	V
☑ Throttle Position Sensor-1	34.6	DEG
☑ Throttle Position Sensor-2	34.5	DEG
☑ ETC Throttle Position	27.6	DEG
☑ ETC Motor Duty	23	%
☐ Engine speed	0	RPM

Fig.2



Sensor Name	Value	Unit
☑ Throttle Position1 Voltage	4.5	V
☑ Throttle Position2 Voltage	0.0	V
☑ Throttle Position Sensor-1	120.2	DEG
☑ Throttle Position Sensor-2	133.8	DEG
☑ ETC Throttle Position	96.0	DEG
☑ ETC Motor Duty	0	%
☐ Engine speed	1200	RPM
☐ Target Idle Speed	1200	RPM

	Description	State
P2106	Lime Home Mode - Force Limited Power	
P1295	Limp Home Mode - Power Management	
P0222	Throttle Position Sensor 2 Signal Circuit Low Input	
P0638	Throttle Actuator Control Range/Performance (Bank 1)	

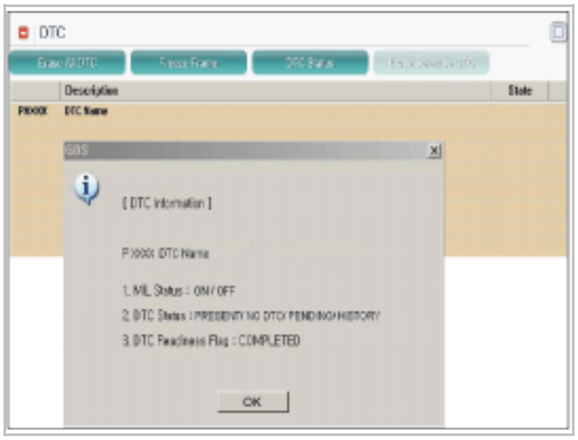
Fig.3

Fig.1) Normal data & waveform of TPS1 & TPS2 with no accel padal depressed under IG ON condition

Fig.2) Normal data & waveform of TPS1 & TPS2 with accel padal depressed under IG ON condition
Fig.3) Abnormal data of TPS1 & TPS2 at open condition

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found ?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Signal Circuit Inspection" procedure.

Signal Circuit Inspection

■ **Check voltage**

1. IG "OFF" and disconnect ETC Motor & TPS connector.
2. IG "ON".
3. Measure voltage between TPS2 signal terminal of ETC Motor & TPS harness connector and chassis ground.

Specification : Approx. 0V

4. Is the measured voltage within specification ?

YES	▶ Go to "Ground Circuit Inspection" procedure.
NO	▶ Go to "Check short to battery in harness" as follows.

■ **Check short to battery in harness**

1. IG "OFF" and disconnect ETC Motor & TPS connector and ECM connector.
2. Measure resistance between TPS2 signal and TPS power terminals of ETC Motor & TPS harness connector.(Measurement "A")
3. Measure resistance between TPS2 signal and ETC motor(+) terminals of ETC Motor & TPS harness connector.(Measurement "B")
4. Measure resistance between TPS2 signal and ETC motor(-) terminals of ETC Motor & TPS harness connector.(Measurement "B")

Specification : Infinite

5. Is the measured resistance within specification ?

YES	▶ Go to "Ground Circuit Inspection" procedure.
NO	▶ Repair short to battery in harness, and go to "Verification of Vehicle Repair" procedure.

Ground Circuit Inspection

■ **Check open in harness**

1. IG "OFF" and disconnect ECTS connector and then IG "ON".
2. Measure voltage between TPS power terminal of ETC Motor & TPS harness connector and chassis ground.(Measurement "A")
3. Measure voltage between TPS power and TPS ground terminals of ETC Motor & TPS harness connector.(Measurement "B")

Specification : Voltage difference between measurement "A" and "B" is below 200mV.

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair contact resistance or open in harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ **Check TPS resistance**

1. IG "OFF" and disconnect ETC Motor & TPS connector.
2. Measure resistance between TPS power and TPS ground terminals of ETC Motor & TPS connector.(component side)

Specification : 1.6 ~ 2.4kΩ

3. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good ECT motor & TPS and check for proper operation. If the problem is corrected, replace ECT motor & TPS and go to "Verification of Vehicle Repair" procedure.

※ Procedure of ETS Initialization

A. Erase the trouble codes on ECM

B. Turn the ignition key off and keep this condition until the main relay is turned off.(It will take 10sec.)

C. Turn ignition key on more than 1second to record the throttle motor position on the EEPROM

Verification of Vehicle Repair

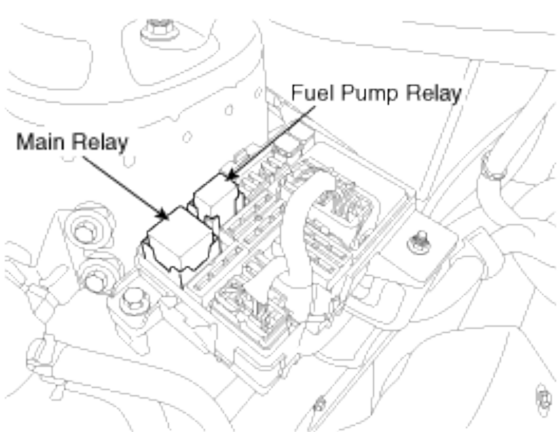
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0230 Fuel Pump Primary Circuit

Component Location



General Description

The ECM provides ground to one side of the coil in the fuel pump relay to control the fuel pump relay. The other side of the fuel pump relay coil is connected to main relay, which activates when the ignition switch is ON. The ECM monitors the control circuit between the fuel pump relay and the ECM. When the ignition switch is turned ON, the ECM energizes the fuel pump relay, which sends power to the fuel pump.

DTC Description

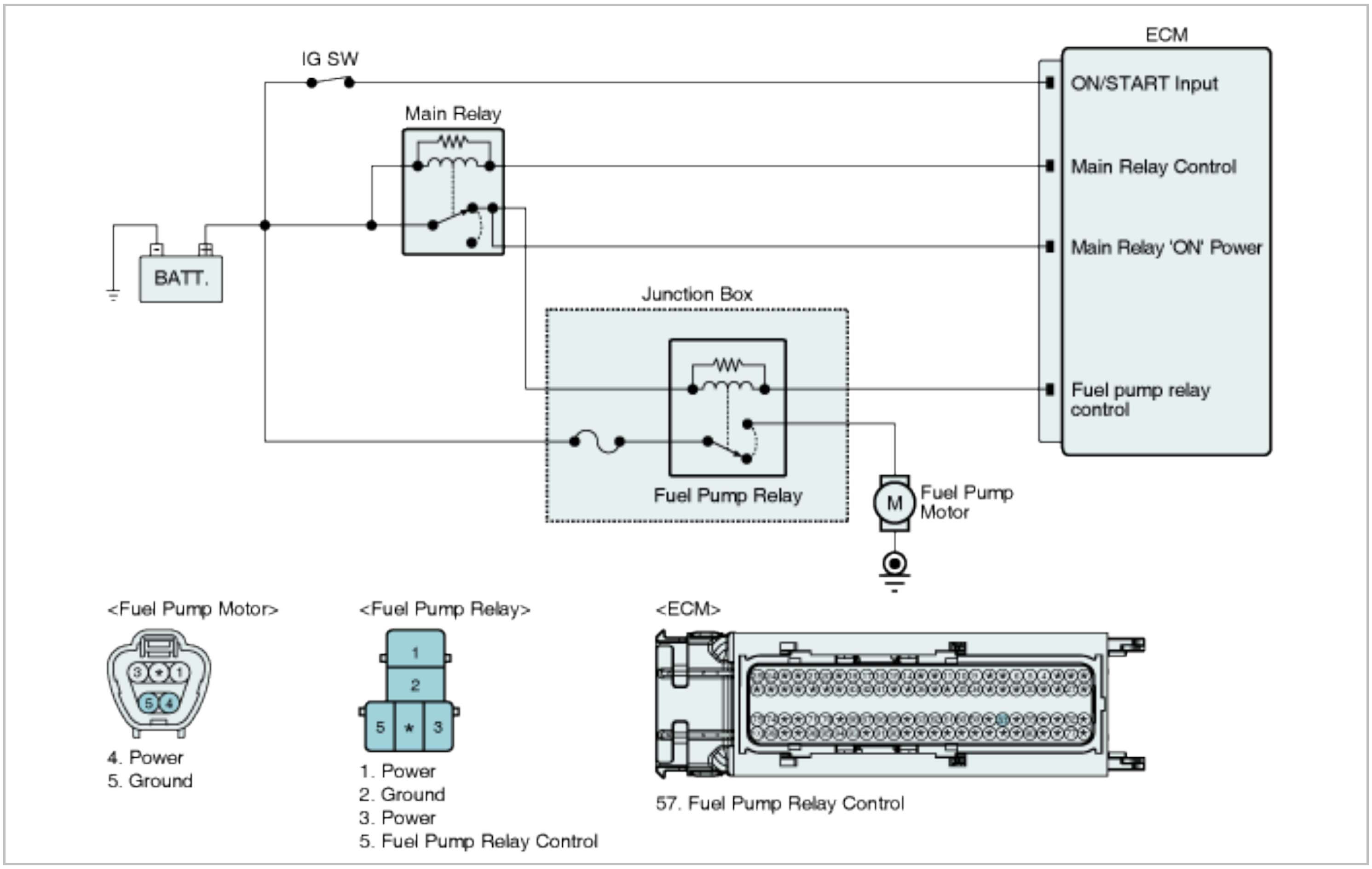
Checking fuel pump relay circuit continuously under detecting condition, if open or short in the circuit is detected ECM sets P0230.

※ In addition, Take note that open circuit in Main Relay may cause this P0230 code.

DTC Detecting Condition

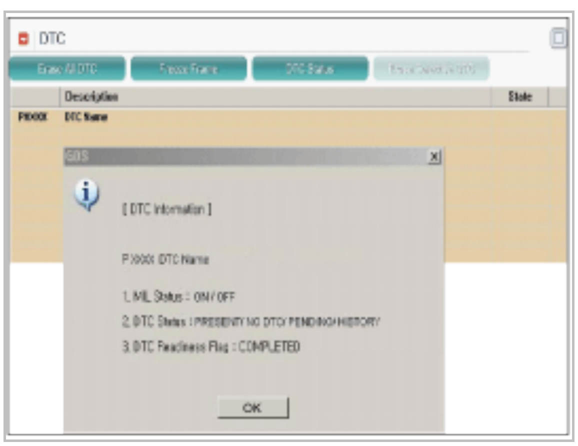
Item	Detecting Condition	Possible Cause
DTC Strategy	• Signal Low or High	• Poor connection • Open or short in fuel pump relay circuit • Open in Main Relay circuit • Fuel Pump Relay • ECM
Enable Conditions	• 11V ≤ Battery Voltage ≤ 16V	
Threshold value	• Open or short	
Diagnosis Time	• Continuous (more than 5 sec. failure for every 10 sec.test)	
MIL On Condition	• NO MIL ON(DTC only)	

Diagnostic Circuit Diagram



Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found ?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Power Circuit Inspection" procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect fuel pump relay connector.
2. IG "ON".
3. Measure voltage between battery power supply terminals of fuel pump relay harness and chassis ground.

Specification : Approx. B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Signal circuit inspection" procedure.
NO	▶ Check "Fuse" between fuel pump relay and main relay is not installed or blown off. ▶ Check "Fuse" between fuel pump relay and battery is not installed or blown off. ▶ Check the Main relay that is not installed or blown off. ▶ Repair or replace as necessary and then, go to "Verification of Vehicle Repair" procedure.

Control Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect fuel pump relay connector.
2. IG "ON".
3. Measure voltage between fuel pump relay control terminal of Fuel pump relay harness and chassis ground.

Specification : Approx. 0V

4. Is the measured voltage within specification ?

YES	▶ Repair open or short to ground in harness, and go to "Verification of Vehicle Repair" procedure ▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to battery in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ **Check fuel pump relay**

1. IG "OFF" and disconnect Fuel Pump Relay connector.
2. Measure resistance between battery power supply and power supply to fuel pump motor terminals of fuel pump relay. (Measurement "A")
3. Measure resistance between battery power supply and fuel pump relay control terminals of fuel pump relay.(Measurement "B")

   Specification :

Terminal	Continuity
Battery power supply - Power supply to Fuel pump motor	NO
Battery power supply - Fuel pump relay control	YES(Approx. 70Ω ~ 120Ω)

4. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good Fuel Pump Relay and check for proper operation. If the problem is corrected, replace Fuel Pump Relay and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

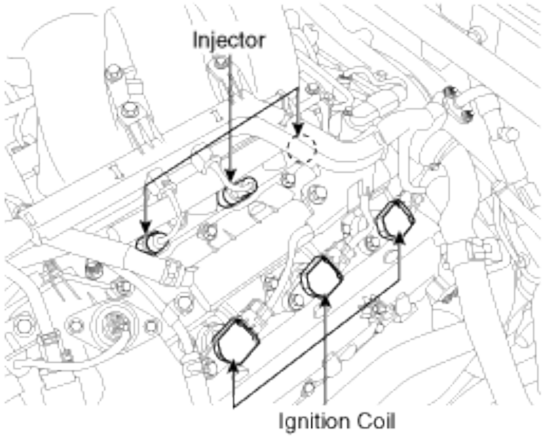
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0261 Cylinder 1 Injector Circuit Low

Component Location



General Description

Based on information from various sensors, the ECM measures the fuel injection amount. The fuel injector is a solenoid-operated valve and the fuel injection amount is controlled by length of time the fuel injector is held open. The ECM controls each injector by grounding the control circuit. When the ECM energizes the injector by grounding the control circuit, the circuit voltage should be low (theoretically 0V) and the fuel is injected. When the ECM de-energizes the injector by opening the control circuit, the fuel injector is closed and circuit voltage should momentarily peak.

DTC Description

Checking output signals from injectors. Under detecting condition, if an output signal is low, ECM sets P0261. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

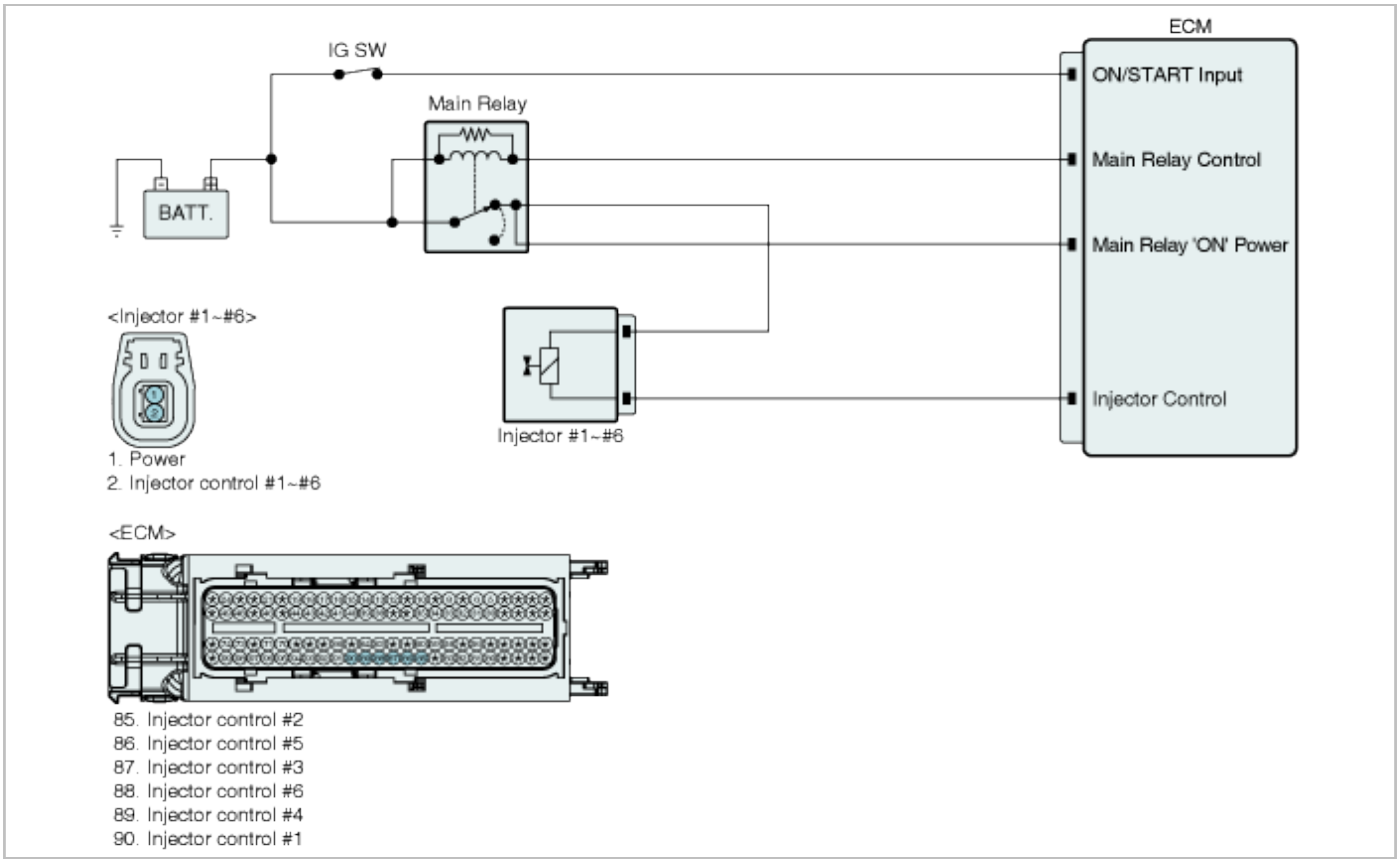
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Signal Low	• Poor connection • Open or short to ground in power harness • Open or short to ground in control harness • Injector • ECM
Enable Conditions	• Engine running state • 11V ≤ Battery voltage ≤ 16V • Above conditions are met > 0.5sec.	
Threshold value	• Open or short to ground	
Diagnosis Time	• Continuous (more than 5 sec. failure for every 10 sec.test)	
MIL On Condition	• 2 Driving Cycles	

Specification

Item	Coil resistance(Ω)
Injector	11.4 ~ 12.6Ω (at 20°C/ 68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data

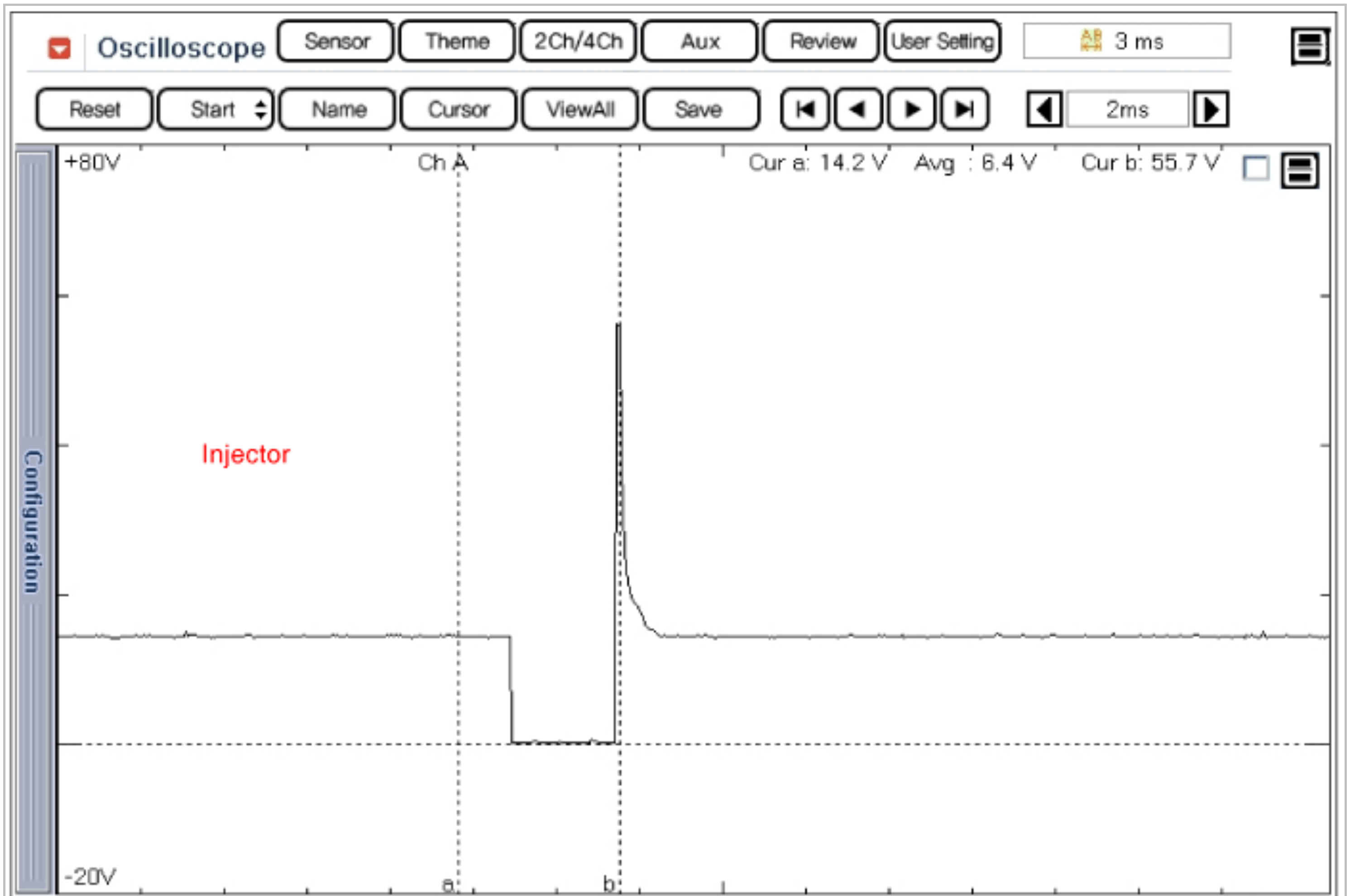


Fig.1

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | VSS

Sensor Name	Value	Unit
☑ Cylinder 1 Injection Time	0.8	mS
☑ Cylinder 2 Injection Time	0.8	mS
☑ Cylinder 3 Injection Time	0.8	mS
☑ Cylinder 4 Injection Time	0.8	mS
☑ Cylinder 5 Injection Time	0.8	mS
☑ Cylinder 6 Injection Time	0.8	mS

Fig.2

Sensor Name	Value	Unit
☑ Cylinder 1 Injection Time	1.6	mS
☑ Cylinder 2 Injection Time	0.0	mS
☑ Cylinder 3 Injection Time	1.6	mS
☑ Cylinder 4 Injection Time	1.6	mS
☑ Cylinder 5 Injection Time	1.6	mS
☑ Cylinder 6 Injection Time	1.6	mS

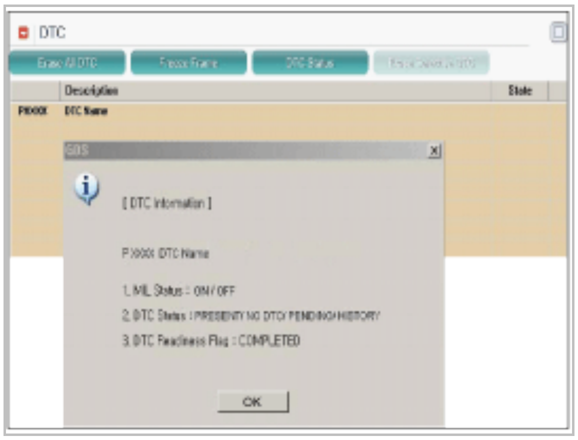
Fig.3

Fig.1) Normal waveforms of Injector under idle condition.

Fig.2) Normal data of Injector at idle.
Fig.3) Abnormal data of Injector when cylinder 2 injector has an open circuit
When the ECM energizes the injector by grounding control circuit, the circuit voltage should be low (theoretically 0V) and the fuel is injected. When the ECM de-energizes the injector by opening control circuit, the fuel injector is closed and circuit voltage should be peak at a moment.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found ?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Power Circuit Inspection" procedure.

Power Circuit Inspection

■ **Check voltage**

1. IG "OFF" and disconnect injector connector.
2. IG "ON".

3. Measure voltage between power terminal of injector harness connector and chassis ground.

Specification : Approx. B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.
NO	▶ Check open or connection of the fuse connected to injector power supply. ▶ Repair open or short to ground in harness, and go to "Verification of Vehicle Repair' procedure.

Control Circuit Inspection

■ Check short to ground in harness

1. IG "OFF" and disconnect injector connector and ECM connector.
2. Measure resistance between injector control terminal of injector harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Check open in harness" as follows.
NO	▶ Repair short to ground in harness, and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect injector connector and ECM connector.
2. Measure resistance between injector control terminal of injector harness connector and injector control terminal of ECM harness connector.

Specification : Below 1Ω

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check injector

1. IG "OFF" and disconnect injector connector.
2. Measure resistance between power and control terminals of injector connector.(Component side)

Specification : 11.4 ~ 12.6Ω (at 20°C/ 68°F)

3. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure.

	NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good Fuel Pump Relay and check for proper operation. If the problem is corrected, replace Fuel Pump Relay and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

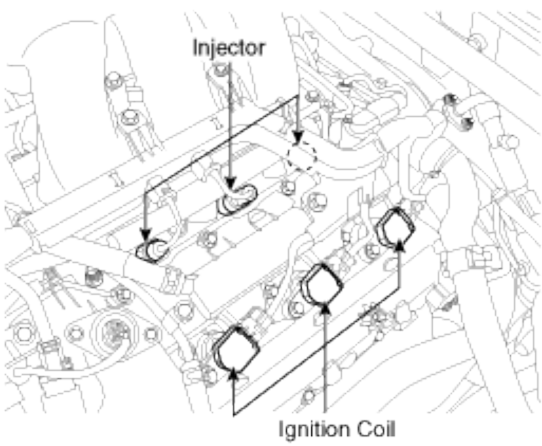
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0262 Cylinder 1 Injector Circuit High

Component Location



General Description

Based on information from various sensors, the ECM measures the fuel injection amount. The fuel injector is a solenoid-operated valve and the fuel injection amount is controlled by length of time the fuel injector is held open. The ECM controls each injector by grounding the control circuit. When the ECM energizes the injector by grounding the control circuit, the circuit voltage should be low (theoretically 0V) and the fuel is injected. When the ECM de-energizes the injector by opening the control circuit, the fuel injector is closed and circuit voltage should momentarily peak.

DTC Description

Checking output signals from injectors. Under detecting condition, if an output signal is high, ECM sets P0262.
MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

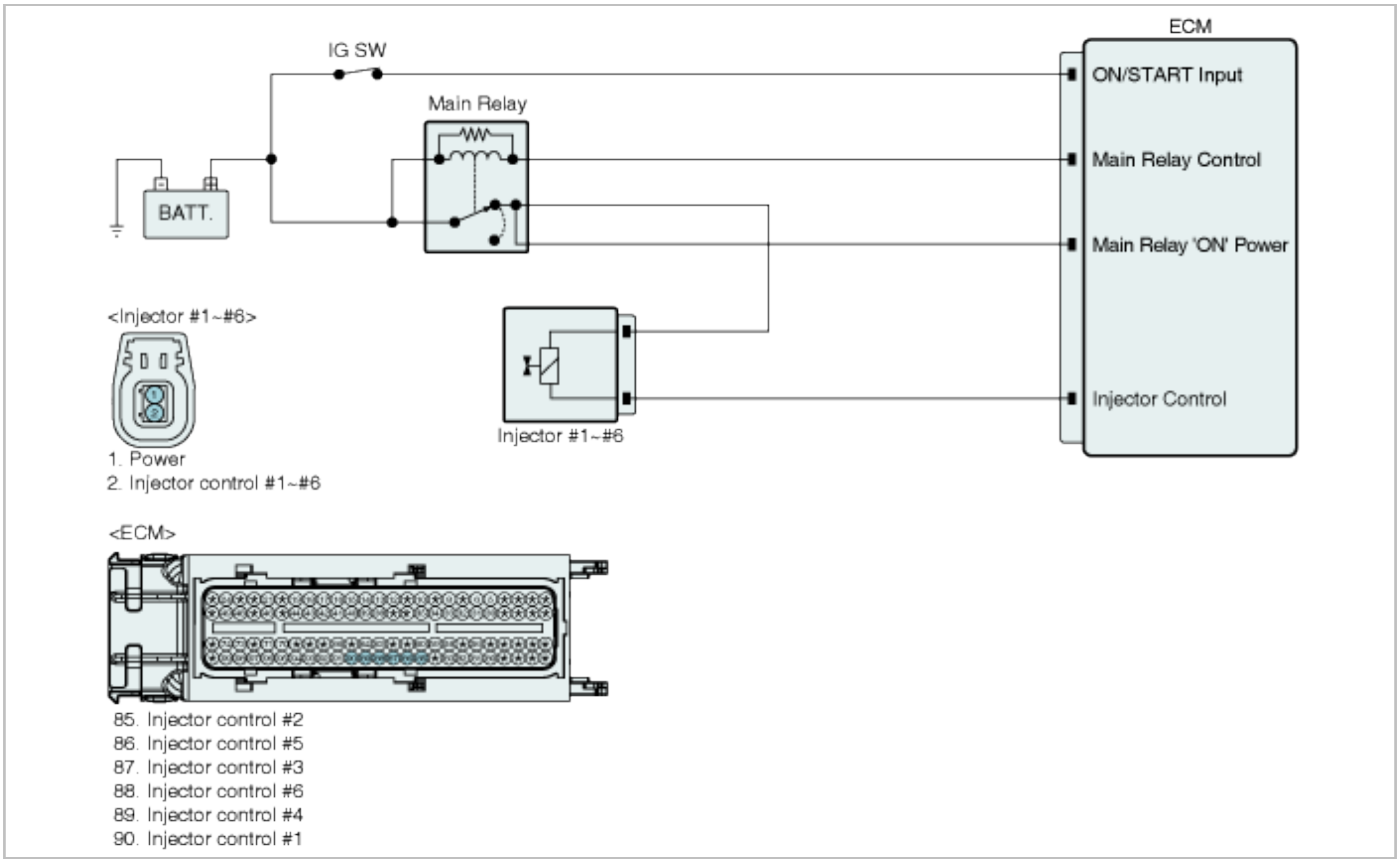
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Signal High	• Poor connection • Short to battery in harness • Injector • ECM
Enable Conditions	• Engine running state • 11V ≤ Battery voltage ≤ 16V • Above conditions are met > 0.5sec.	
Threshold value	• Short to battery	
Diagnosis Time	• Continuous (more than 5 sec. failure for every 10 sec.test)	
MIL On Condition	• 2 Driving Cycles	

Specification

Item	Coil resistance(Ω)
Injector	11.4 ~ 12.6Ω (at 20°C/ 68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data

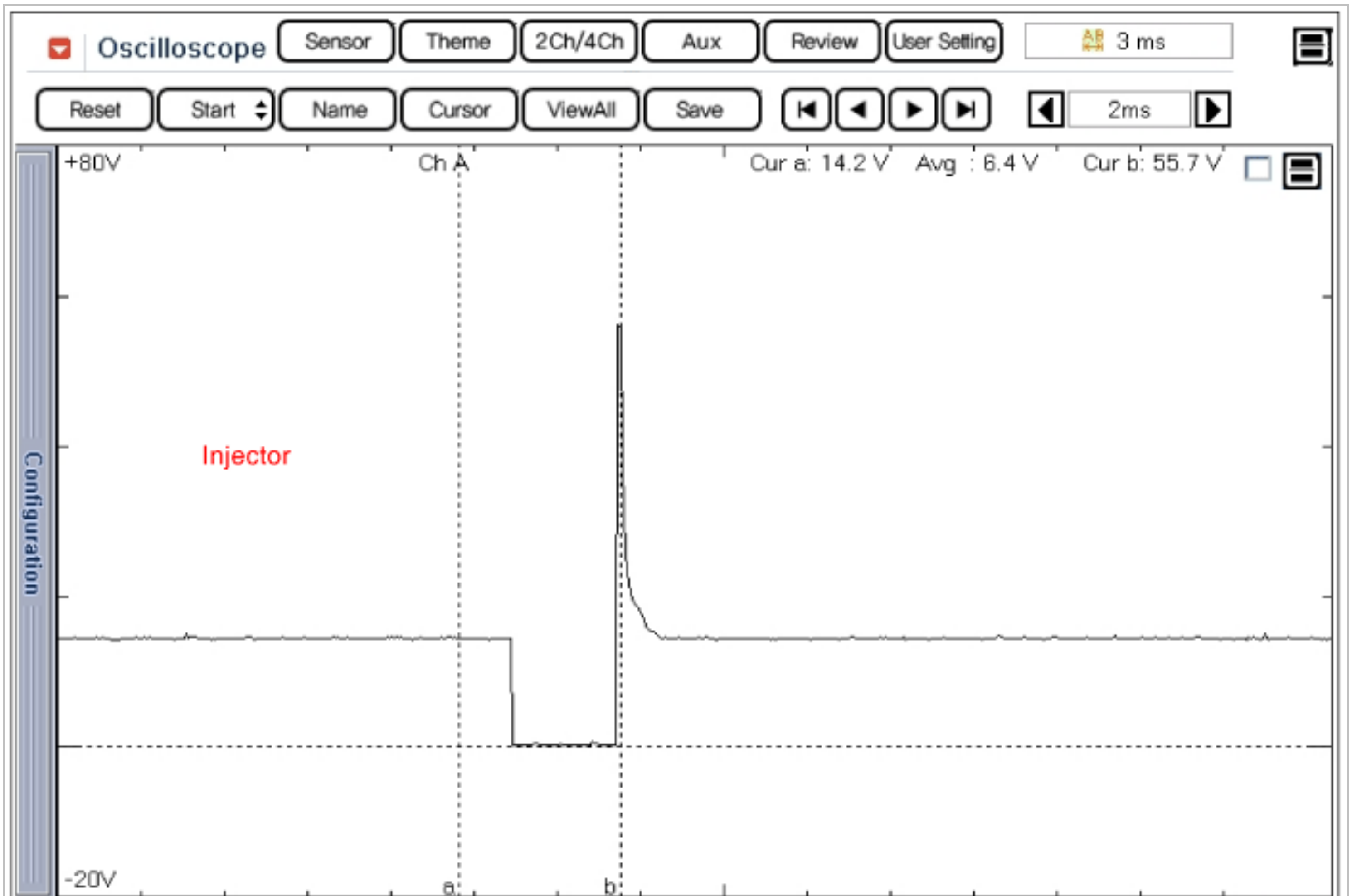


Fig.1

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | VSS

Sensor Name	Value	Unit
☑ Cylinder 1 Injection Time	0.8	mS
☑ Cylinder 2 Injection Time	0.8	mS
☑ Cylinder 3 Injection Time	0.8	mS
☑ Cylinder 4 Injection Time	0.8	mS
☑ Cylinder 5 Injection Time	0.8	mS
☑ Cylinder 6 Injection Time	0.8	mS

Fig.2

Sensor Name	Value	Unit
☑ Cylinder 1 Injection Time	1.6	mS
☑ Cylinder 2 Injection Time	0.0	mS
☑ Cylinder 3 Injection Time	1.6	mS
☑ Cylinder 4 Injection Time	1.6	mS
☑ Cylinder 5 Injection Time	1.6	mS
☑ Cylinder 6 Injection Time	1.6	mS

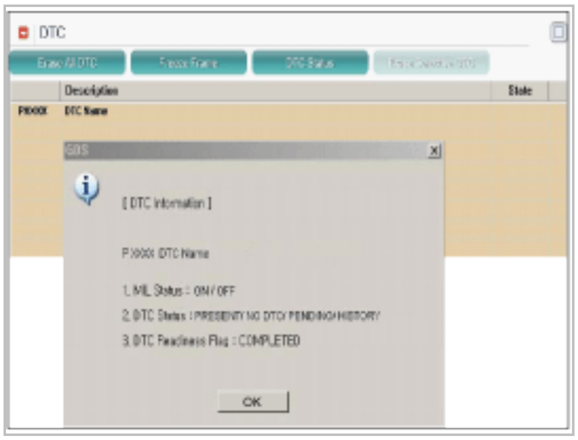
Fig.3

Fig.1) Normal waveforms of Injector under idle condition.

Fig.2) Normal data of Injector at idle.
Fig.3) Abnormal data of Injector when cylinder 2 injector has an open circuit
When the ECM energizes the injector by grounding control circuit, the circuit voltage should be low (theoretically 0V) and the fuel is injected. When the ECM de-energizes the injector by opening control circuit, the fuel injector is closed and circuit voltage should be peak at a moment.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Control Circuit Inspection" procedure.

Control Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect injector connector.
2. IG "ON".

3. Measure voltage between injector control terminal of injector harness connector and chassis ground.

Specification : Approx. 3.5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Go to "Check short to battery in harness" as follows.

■ Check short to battery in harness

1. IG "OFF" and disconnect injector connector and ECM connector.
2. Measure resistance between power and control terminals of injector harness connector.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to battery in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check injector

1. IG "OFF" and disconnect injector connector.
2. Measure resistance between power and control terminals of injector connector.(Component side)

Specification : 11.4 ~ 12.6Ω (at 20°C/ 68°F)

3. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good Fuel Pump Relay and check for proper operation. If the problem is corrected, replace Fuel Pump Relay and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

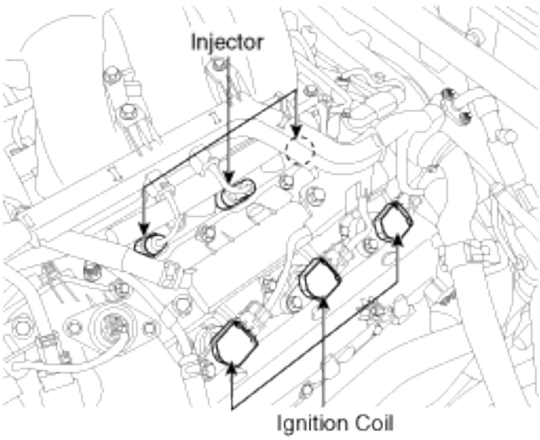
1. Connect GDS and select "DTC" button.

2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0264 Cylinder 2 Injector Circuit Low

Component Location



General Description

Based on information from various sensors, the ECM measures the fuel injection amount. The fuel injector is a solenoid-operated valve and the fuel injection amount is controlled by length of time the fuel injector is held open. The ECM controls each injector by grounding the control circuit. When the ECM energizes the injector by grounding the control circuit, the circuit voltage should be low (theoretically 0V) and the fuel is injected. When the ECM de-energizes the injector by opening the control circuit, the fuel injector is closed and circuit voltage should momentarily peak.

DTC Description

Checking output signals from injectors. under detecting condition, if an output signal is low, ECM sets P0264. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

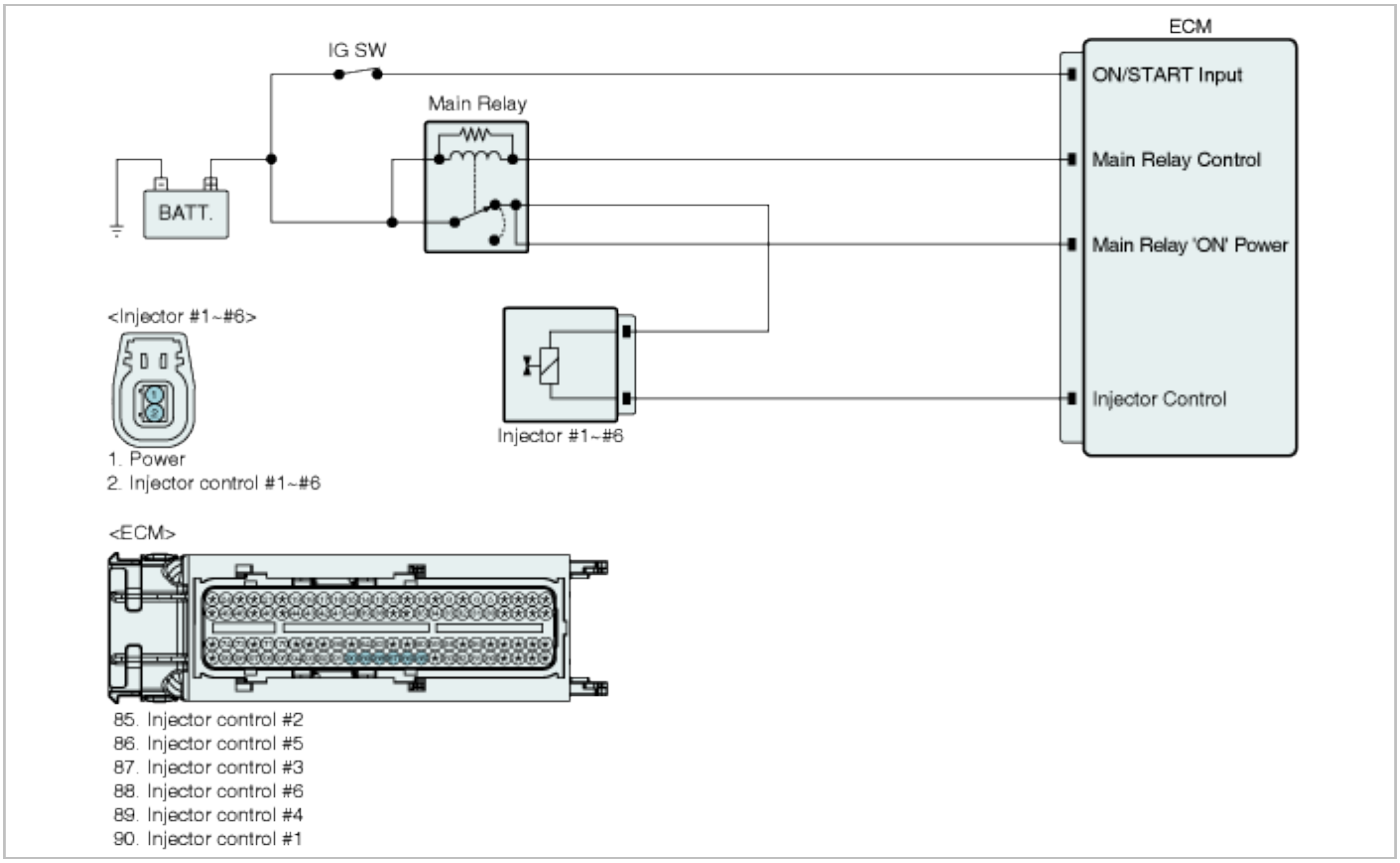
Item	Detecting Condition	Possible Cause
DTC Strategy	• Signal Low	• Poor connection • Open or short to ground in power harness • Open or short to ground in control harness • Injector
Enable Conditions	• Engine running state • 11V ≤ Battery voltage ≤ 16V • Above conditions are met > 0.5sec.	
Threshold value	• Open or short to ground	
Diagnosis Time	• Continuous (more than 5 sec. failure for every 10	

Diagnosis Time	sec.test)	• ECM
MIL On Condition	• 2 Driving Cycles	

Specification

Item	Coil resistance(Ω)
Injector	11.4 ~ 12.6Ω (at 20°C/ 68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data

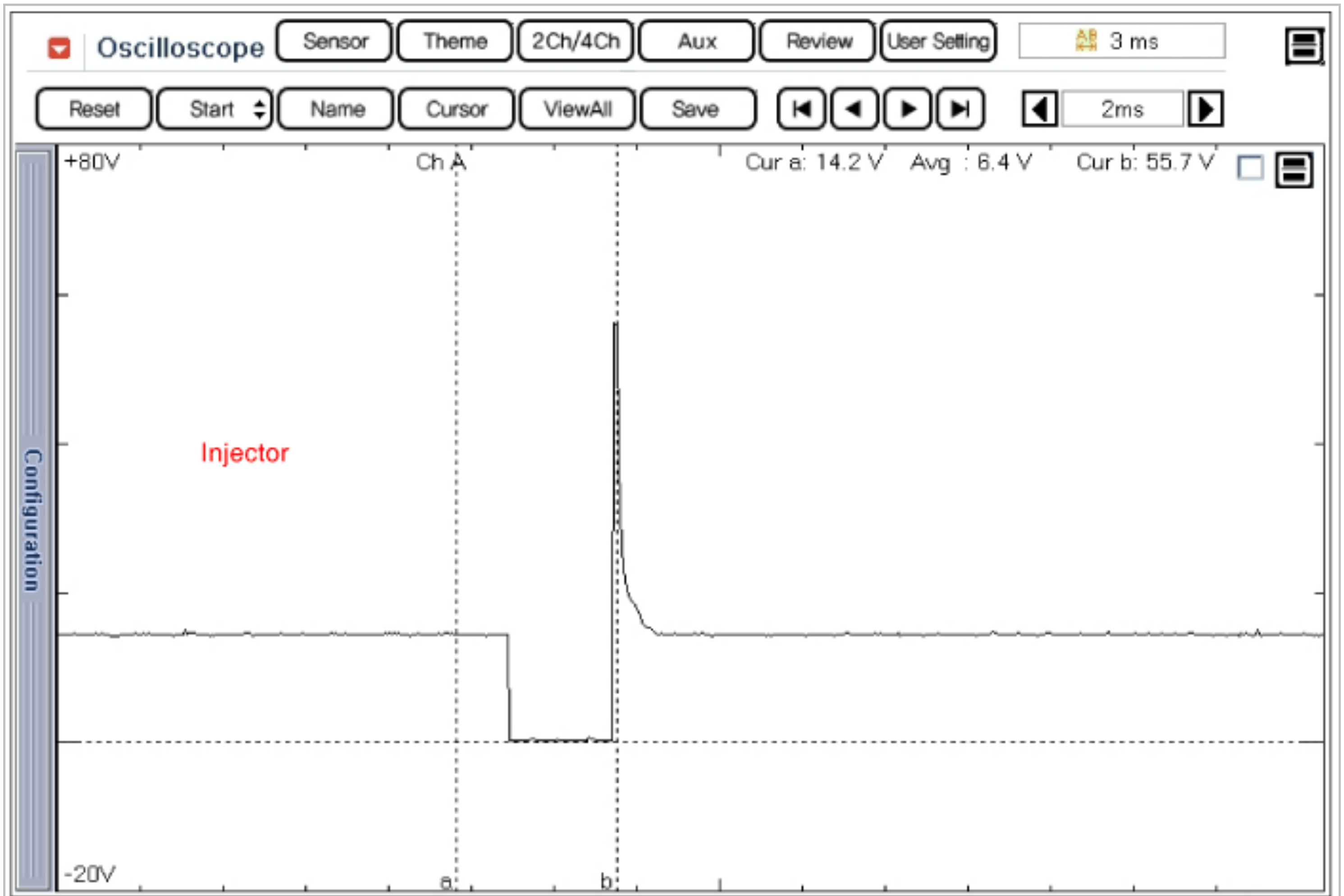
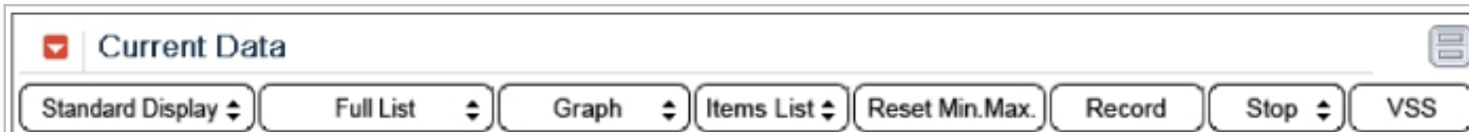


Fig.1



Sensor Name	Value	Unit
☑ Cylinder 1 Injection Time	0.8	mS
☑ Cylinder 2 Injection Time	0.8	mS
☑ Cylinder 3 Injection Time	0.8	mS
☑ Cylinder 4 Injection Time	0.8	mS
☑ Cylinder 5 Injection Time	0.8	mS
☑ Cylinder 6 Injection Time	0.8	mS

Fig.2

Sensor Name	Value	Unit
☑ Cylinder 1 Injection Time	1.6	mS
☑ Cylinder 2 Injection Time	0.0	mS
☑ Cylinder 3 Injection Time	1.6	mS
☑ Cylinder 4 Injection Time	1.6	mS
☑ Cylinder 5 Injection Time	1.6	mS
☑ Cylinder 6 Injection Time	1.6	mS

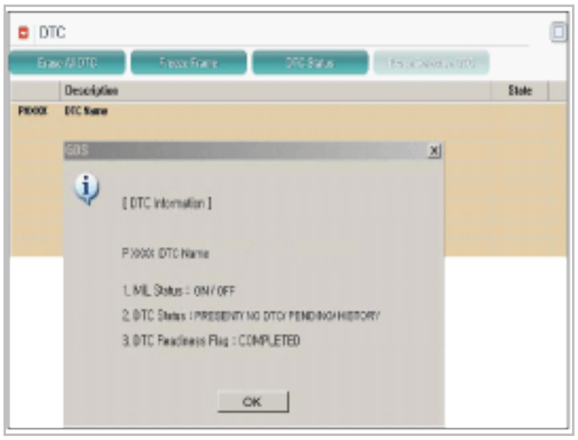
Fig.3

Fig.1) Normal waveforms of Injector under idle condition.

Fig.2) Normal data of Injector at idle.
Fig.3) Abnormal data of Injector when cylinder 2 injector has an open circuit
When the ECM energizes the injector by grounding control circuit, the circuit voltage should be low (theoretically 0V) and the fuel is injected. When the ECM de-energizes the injector by opening control circuit, the fuel injector is closed and circuit voltage should be peak at a moment.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found ?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Power Circuit Inspection" procedure.

Power Circuit Inspection

■ **Check voltage**

1. IG "OFF" and disconnect injector connector.
2. IG "ON".

3. Measure voltage between power terminal of injector harness connector and chassis ground.

Specification : Approx. B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.
NO	▶ Check open or connection of the fuse connected to injector power supply. ▶ Repair open or short to ground in harness, and go to "Verification of Vehicle Repair' procedure.

Control Circuit Inspection

■ Check short to ground in harness

1. IG "OFF" and disconnect injector connector and ECM connector.
2. Measure resistance between injector control terminal of injector harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Check open in harness" as follows.
NO	▶ Repair short to ground in harness, and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect injector connector and ECM connector.
2. Measure resistance between injector control terminal of injector harness connector and injector control terminal of ECM harness connector.

Specification : Below 1Ω

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check injector

1. IG "OFF" and disconnect injector connector.
2. Measure resistance between power and control terminals of injector connector.(Component side)

Specification : 11.4 ~ 12.6Ω (at 20°C/ 68°F)

3. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure.

	NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good Fuel Pump Relay and check for proper operation. If the problem is corrected, replace Fuel Pump Relay and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

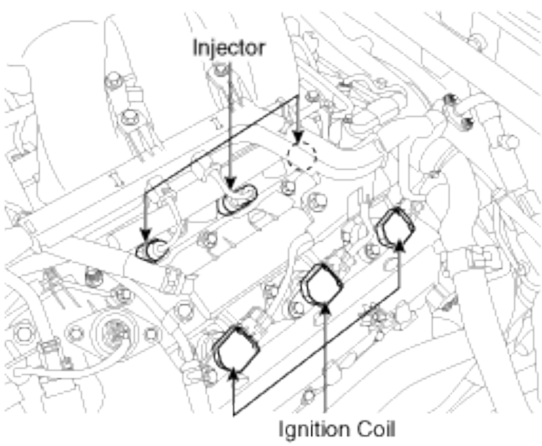
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0265 Cylinder 2 Injector Circuit High

Component Location



General Description

Based on information from various sensors, the ECM measures the fuel injection amount. The fuel injector is a solenoid-operated valve and the fuel injection amount is controlled by length of time the fuel injector is held open. The ECM controls each injector by grounding the control circuit. When the ECM energizes the injector by grounding the control circuit, the circuit voltage should be low (theoretically 0V) and the fuel is injected. When the ECM de-energizes the injector by opening the control circuit, the fuel injector is closed and circuit voltage should momentarily peak.

DTC Description

Checking output signals from injectors. Under detecting condition, if an output signal is high, ECM sets P0265. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

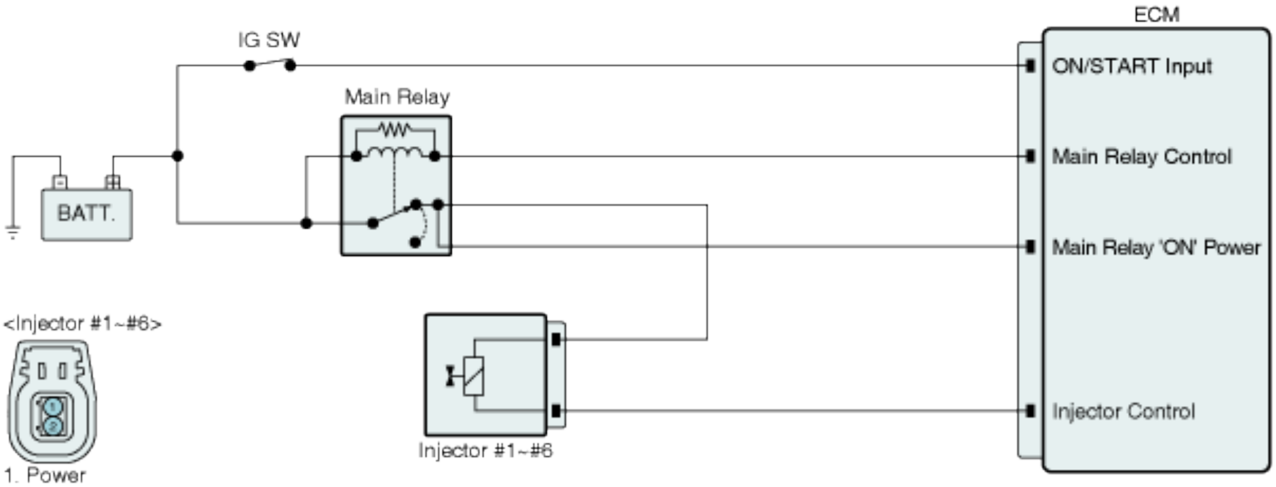
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Signal High	• Poor connection • Short to battery in harness • Injector • ECM
Enable Conditions	• Engine running state • 11V ≤ Battery voltage ≤ 16V • Above conditions are met > 0.5sec.	
Threshold value	• Short to battery	
Diagnosis Time	• Continuous (more than 5 sec. failure for every 10 sec.test)	
MIL On Condition	• 2 Driving Cycles	

Specification

Item	Coil resistance(Ω)
Injector	11.4 ~ 12.6Ω (at 20°C/ 68°F)

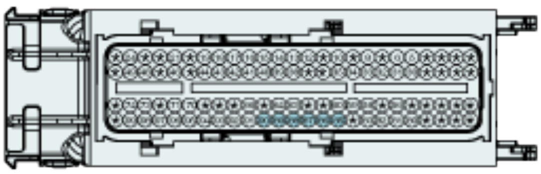
Diagnostic Circuit Diagram



<Injector #1~#6>

1. Power
2. Injector control #1~#6

<ECM>



85. Injector control #2
86. Injector control #5
87. Injector control #3
88. Injector control #6
89. Injector control #4
90. Injector control #1

Signal Waveform & Data

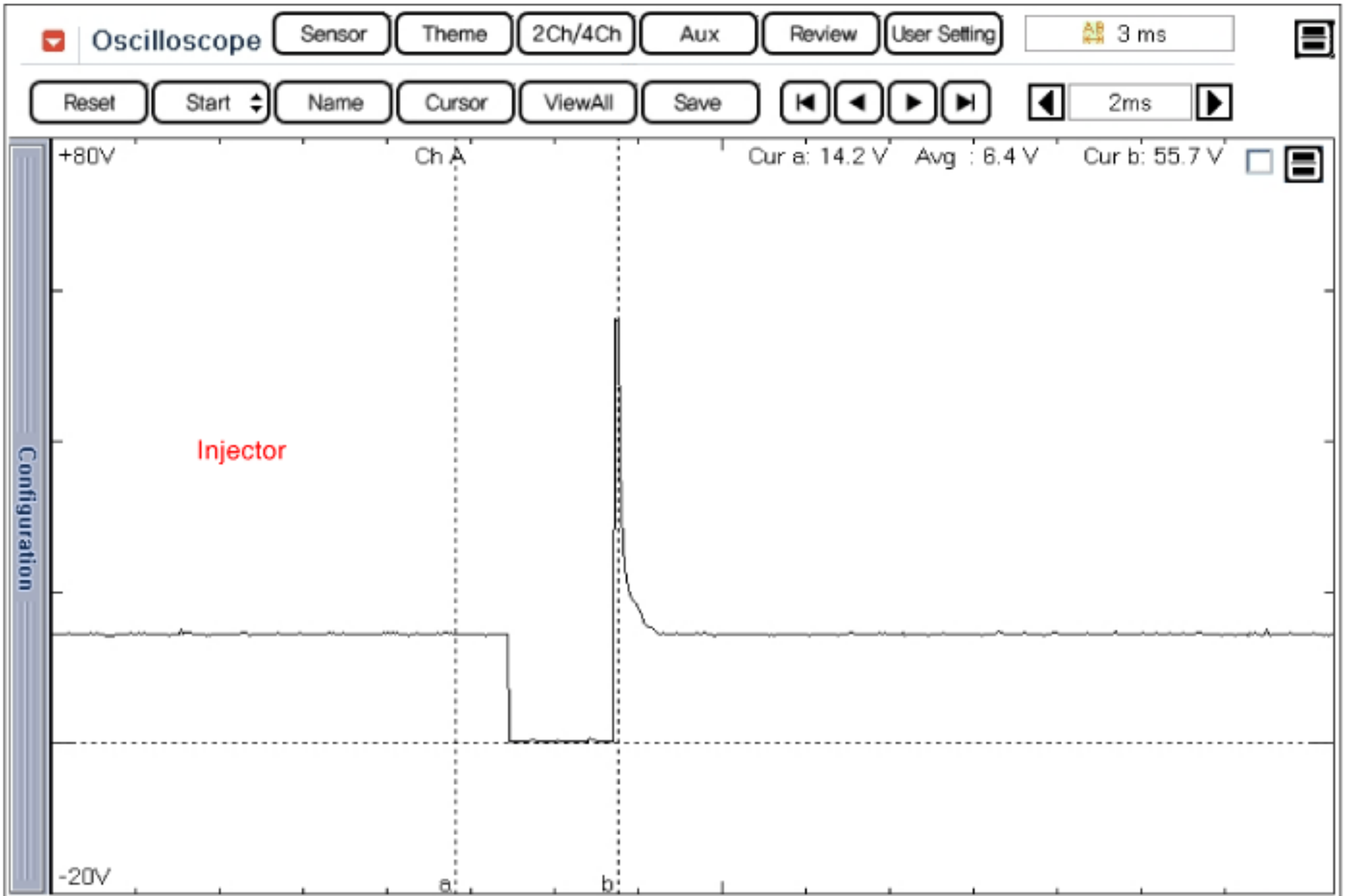


Fig.1

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | VSS

Sensor Name	Value	Unit
☑ Cylinder 1 Injection Time	0.8	mS
☑ Cylinder 2 Injection Time	0.8	mS
☑ Cylinder 3 Injection Time	0.8	mS
☑ Cylinder 4 Injection Time	0.8	mS
☑ Cylinder 5 Injection Time	0.8	mS
☑ Cylinder 6 Injection Time	0.8	mS

Fig.2

Sensor Name	Value	Unit
☑ Cylinder 1 Injection Time	1.6	mS
☑ Cylinder 2 Injection Time	0.0	mS
☑ Cylinder 3 Injection Time	1.6	mS
☑ Cylinder 4 Injection Time	1.6	mS
☑ Cylinder 5 Injection Time	1.6	mS
☑ Cylinder 6 Injection Time	1.6	mS

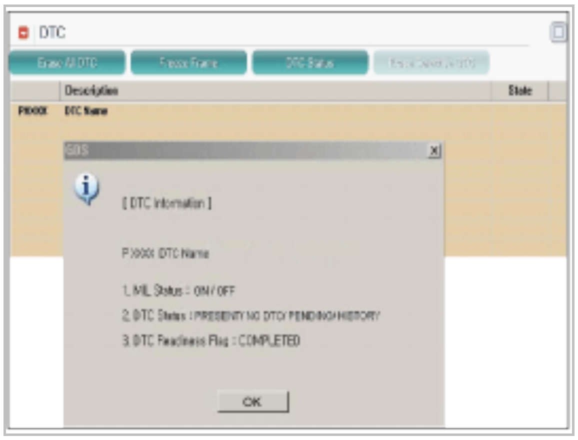
Fig.3

Fig.1) Normal waveforms of Injector under idle condition.

Fig.2) Normal data of Injector at idle.
Fig.3) Abnormal data of Injector when cylinder 2 injector has an open circuit
When the ECM energizes the injector by grounding control circuit, the circuit voltage should be low (theoretically 0V) and the fuel is injected. When the ECM de-energizes the injector by opening control circuit, the fuel injector is closed and circuit voltage should be peak at a moment.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found ?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Control Circuit Inspection" procedure.

Control Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect injector connector.
2. IG "ON".

3. Measure voltage between injector control terminal of injector harness connector and chassis ground.

Specification : Approx. 3.5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Go to "Check short to battery in harness" as follows.

■ **Check short to battery in harness**

1. IG "OFF" and disconnect injector connector and ECM connector.
2. Measure resistance between power and control terminals of injector harness connector.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to battery in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ **Check injector**

1. IG "OFF" and disconnect injector connector.
2. Measure resistance between power and control terminals of injector connector.(Component side)

Specification : 11.4 ~ 12.6Ω (at 20°C/ 68°F)

3. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good Fuel Pump Relay and check for proper operation. If the problem is corrected, replace Fuel Pump Relay and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

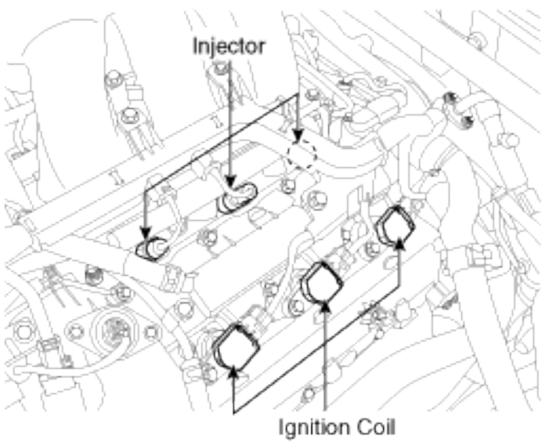
1. Connect GDS and select "DTC" button.

2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0267 Cylinder 3 Injector Circuit Low

Component Location



General Description

Based on information from various sensors, the ECM measures the fuel injection amount. The fuel injector is a solenoid-operated valve and the fuel injection amount is controlled by length of time the fuel injector is held open. The ECM controls each injector by grounding the control circuit. When the ECM energizes the injector by grounding the control circuit, the circuit voltage should be low (theoretically 0V) and the fuel is injected. When the ECM de-energizes the injector by opening the control circuit, the fuel injector is closed and circuit voltage should momentarily peak.

DTC Description

Checking output signals from injectors. Under detecting condition, if an output signal is low, ECM sets P0267. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

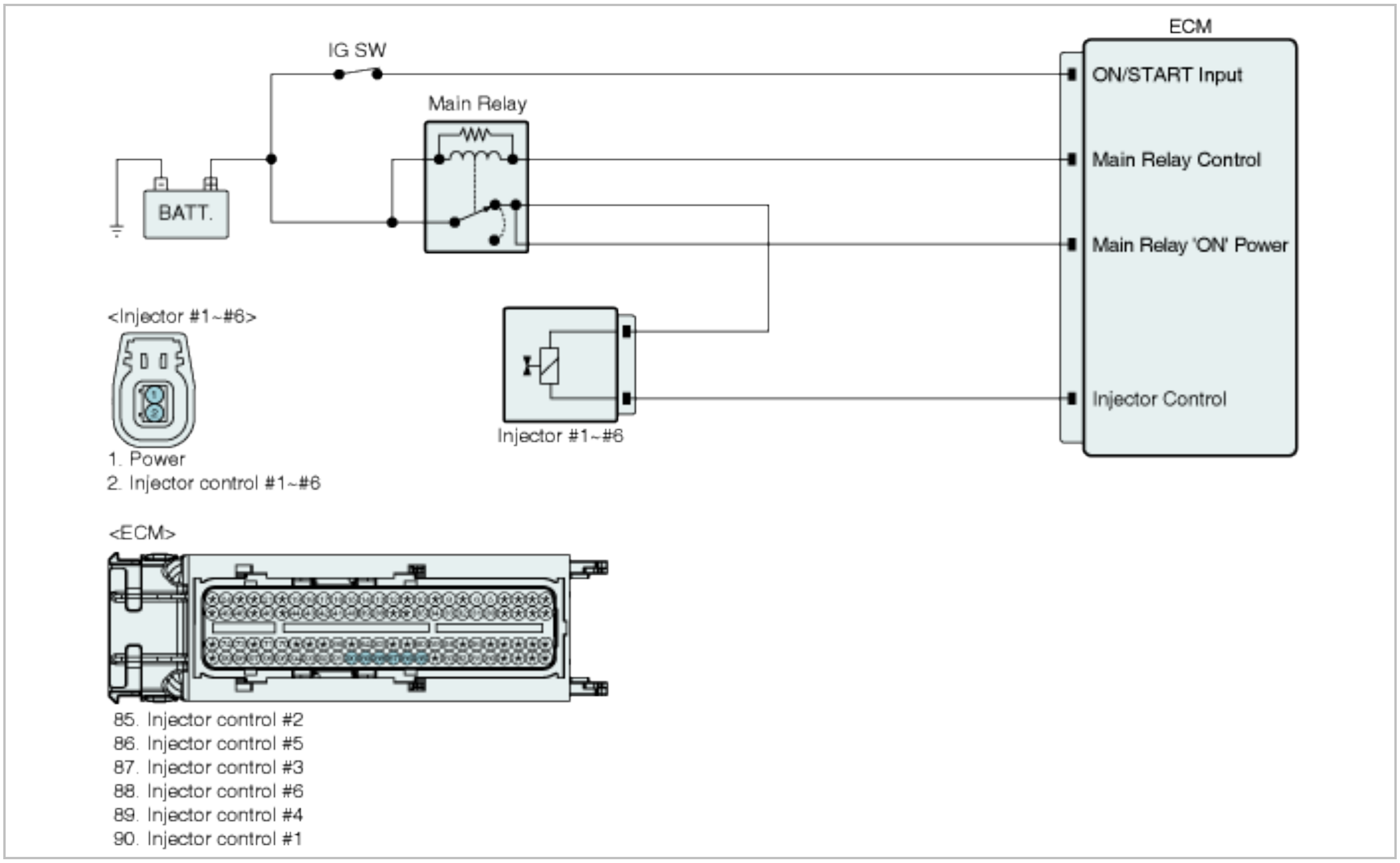
Item	Detecting Condition	Possible Cause
DTC Strategy	• Signal Low	• Poor connection • Open or short to ground in power harness • Open or short to ground in control harness • Injector
Enable Conditions	• Engine running state • 11V ≤ Battery voltage ≤ 16V • Above conditions are met > 0.5sec.	
Threshold value	• Open or short to ground	
Diagnosis Time	• Continuous (more than 5 sec. failure for every 10	

Diagnosis Time	sec.test)	• ECM
MIL On Condition	• 2 Driving Cycles	

Specification

Item	Coil resistance(Ω)
Injector	11.4 ~ 12.6Ω (at 20°C/ 68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data

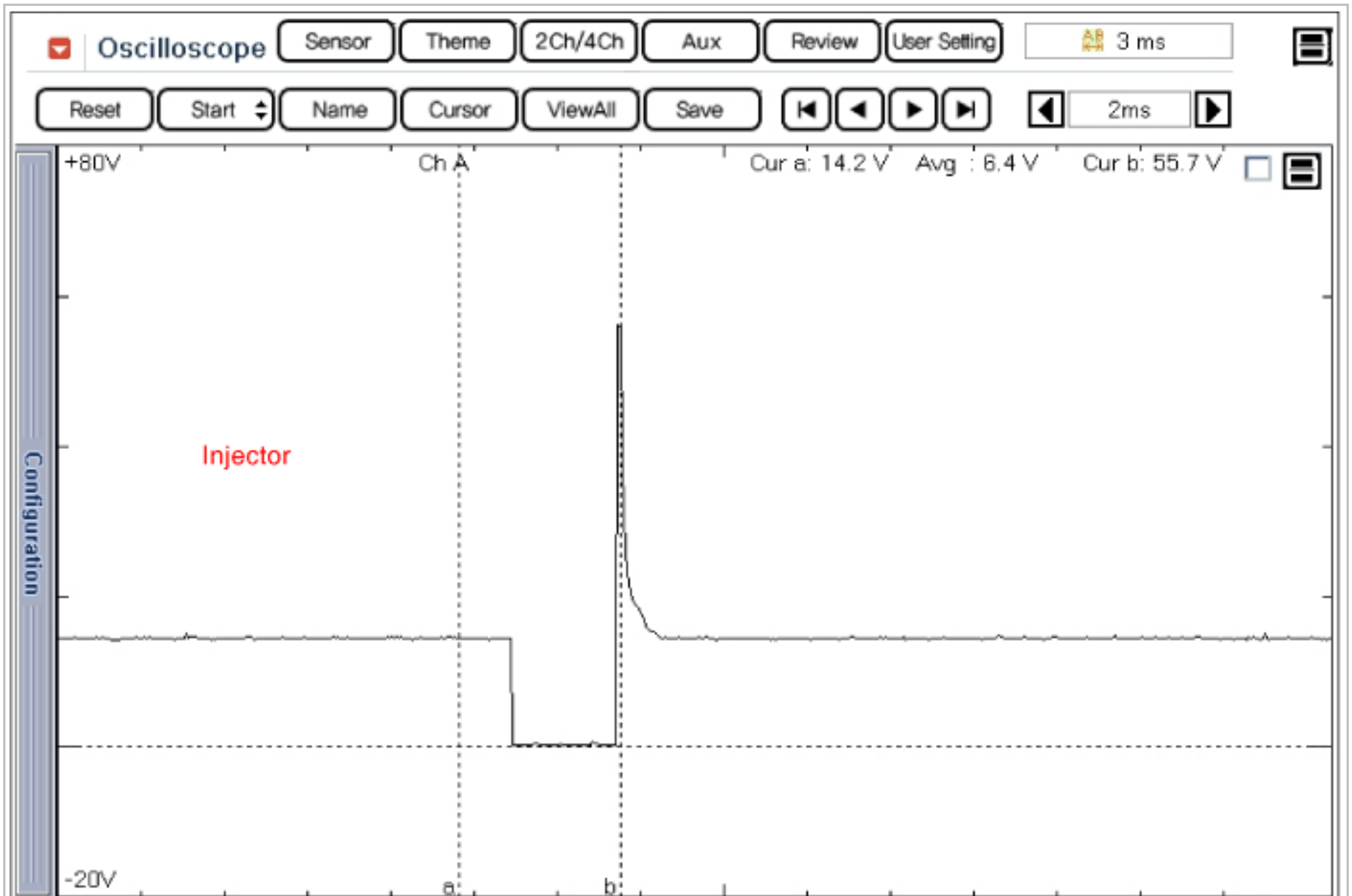


Fig.1

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | VSS

Sensor Name	Value	Unit
☑ Cylinder 1 Injection Time	0.8	mS
☑ Cylinder 2 Injection Time	0.8	mS
☑ Cylinder 3 Injection Time	0.8	mS
☑ Cylinder 4 Injection Time	0.8	mS
☑ Cylinder 5 Injection Time	0.8	mS
☑ Cylinder 6 Injection Time	0.8	mS

Fig.2

Sensor Name	Value	Unit
☑ Cylinder 1 Injection Time	1.6	mS
☑ Cylinder 2 Injection Time	0.0	mS
☑ Cylinder 3 Injection Time	1.6	mS
☑ Cylinder 4 Injection Time	1.6	mS
☑ Cylinder 5 Injection Time	1.6	mS
☑ Cylinder 6 Injection Time	1.6	mS

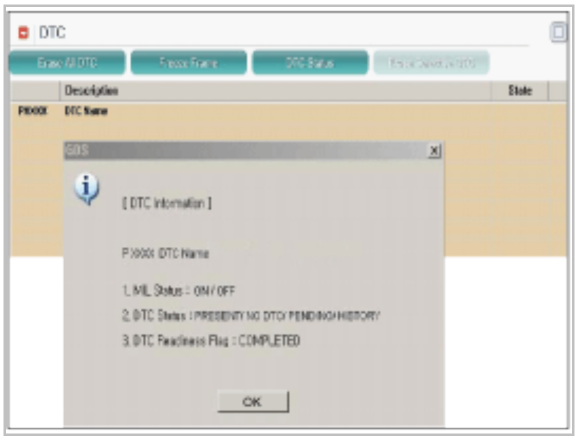
Fig.3

Fig.1) Normal waveforms of Injector under idle condition.

Fig.2) Normal data of Injector at idle.
Fig.3) Abnormal data of Injector when cylinder 2 injector has an open circuit
When the ECM energizes the injector by grounding control circuit, the circuit voltage should be low (theoretically 0V) and the fuel is injected. When the ECM de-energizes the injector by opening control circuit, the fuel injector is closed and circuit voltage should be peak at a moment.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found ?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Power Circuit Inspection" procedure.

Power Circuit Inspection

■ **Check voltage**

1. IG "OFF" and disconnect injector connector.
2. IG "ON".

3. Measure voltage between power terminal of injector harness connector and chassis ground.

Specification : Approx. B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.
NO	▶ Check open or connection of the fuse connected to injector power supply. ▶ Repair open or short to ground in harness, and go to "Verification of Vehicle Repair' procedure.

Control Circuit Inspection

■ Check short to ground in harness

1. IG "OFF" and disconnect injector connector and ECM connector.
2. Measure resistance between injector control terminal of injector harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Check open in harness" as follows.
NO	▶ Repair short to ground in harness, and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect injector connector and ECM connector.
2. Measure resistance between injector control terminal of injector harness connector and injector control terminal of ECM harness connector.

Specification : Below 1Ω

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check injector

1. IG "OFF" and disconnect injector connector.
2. Measure resistance between power and control terminals of injector connector.(Component side)

Specification : 11.4 ~ 12.6Ω (at 20°C/ 68°F)

3. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure.

	NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good Fuel Pump Relay and check for proper operation. If the problem is corrected, replace Fuel Pump Relay and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

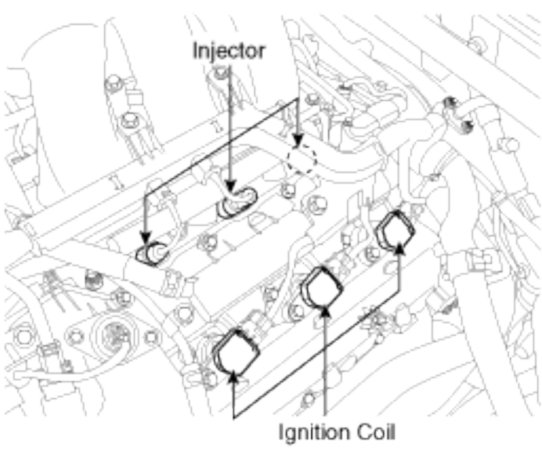
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0268 Cylinder 3 Injector Circuit High

Component Location



General Description

Based on information from various sensors, the ECM measures the fuel injection amount. The fuel injector is a solenoid-operated valve and the fuel injection amount is controlled by length of time the fuel injector is held open. The ECM controls each injector by grounding the control circuit. When the ECM energizes the injector by grounding the control circuit, the circuit voltage should be low (theoretically 0V) and the fuel is injected. When the ECM de-energizes the injector by opening the control circuit, the fuel injector is closed and circuit voltage should momentarily peak.

DTC Description

Checking output signals from injectors. Under detecting condition, if an output signal is high, ECM sets P0268. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

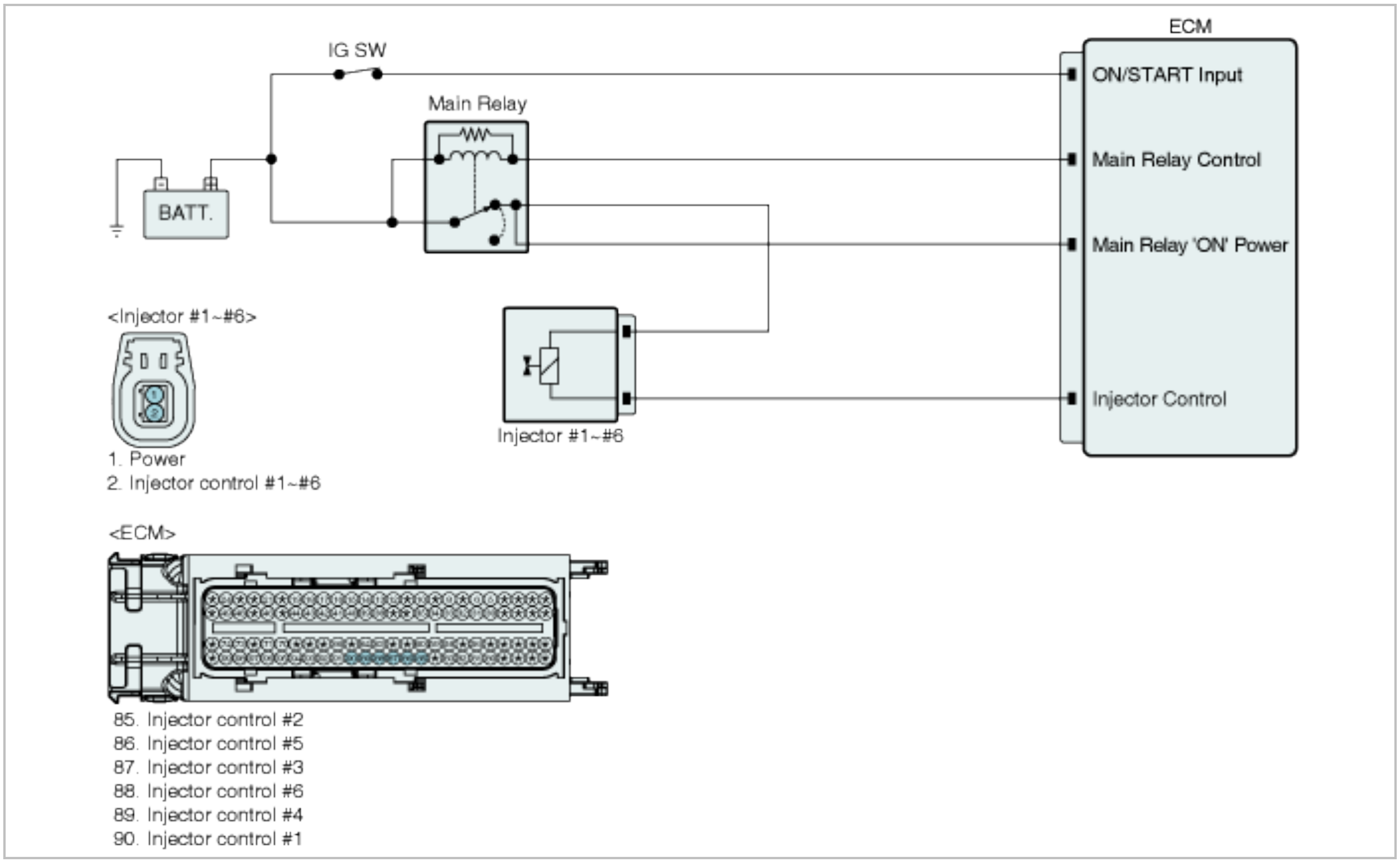
DTC Detecting Condition

<table>
<tr><th>Item</th><th>Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td>• Signal High</td><td rowspan="5">• Poor connection
• Short to battery in harness
• Injector
• ECM</td></tr>
<tr><td>Enable Conditions</td><td>• Engine running state
• 11V ≤ Battery voltage ≤ 16V
• Above conditions are met > 0.5sec.</td></tr>
<tr><td>Threshold value</td><td>• Short to battery</td></tr>
<tr><td>Diagnosis Time</td><td>• Continuous (more than 5 sec. failure for every 10 sec.test)</td></tr>
<tr><td>MIL On Condition</td><td>• 2 Driving Cycles</td></tr>
</table>

Specification

Item	Coil resistance(Ω)
Injector	11.4 ~ 12.6Ω (at 20°C/ 68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data

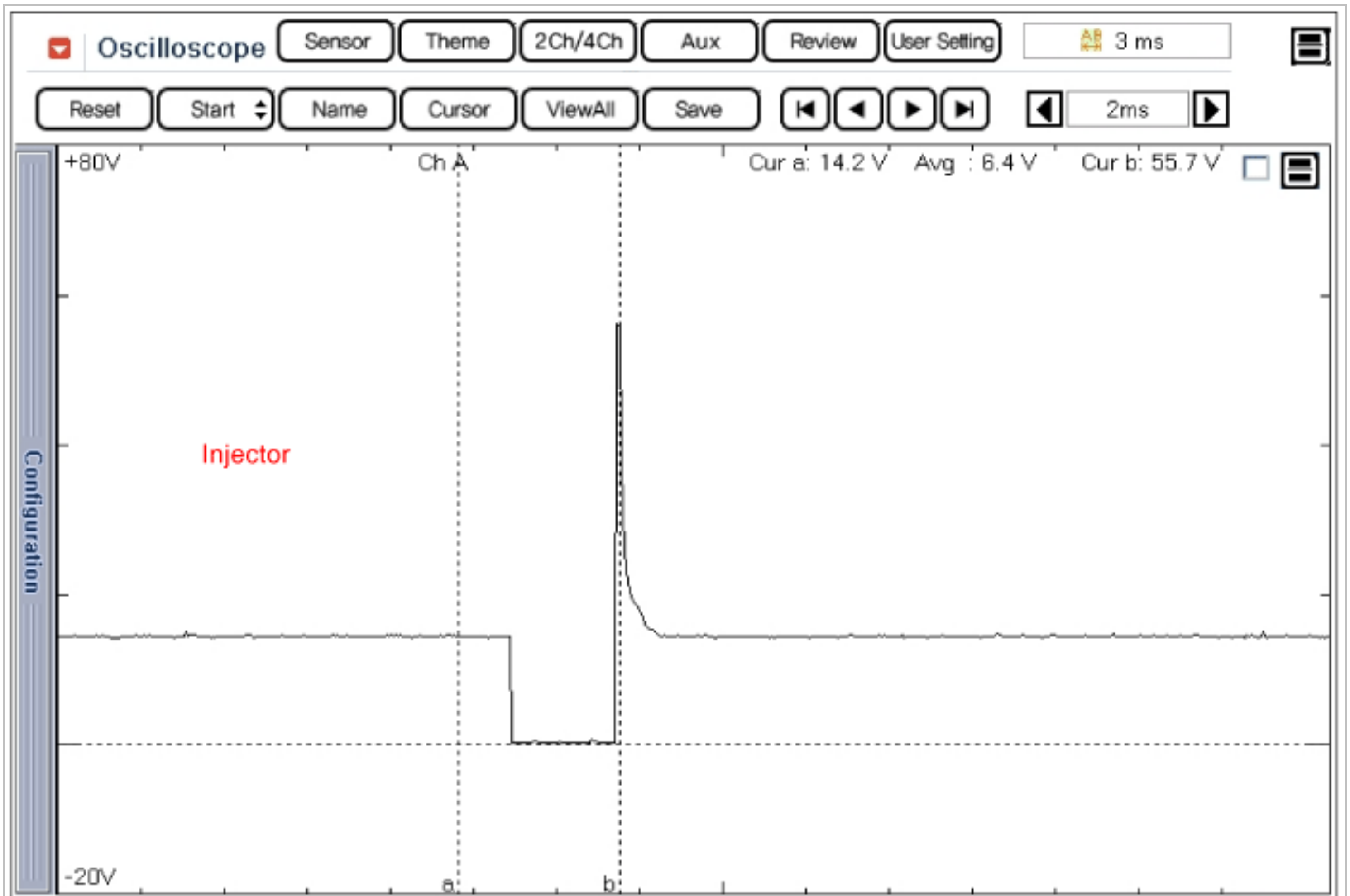


Fig.1

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | VSS

Sensor Name	Value	Unit
☑ Cylinder 1 Injection Time	0.8	mS
☑ Cylinder 2 Injection Time	0.8	mS
☑ Cylinder 3 Injection Time	0.8	mS
☑ Cylinder 4 Injection Time	0.8	mS
☑ Cylinder 5 Injection Time	0.8	mS
☑ Cylinder 6 Injection Time	0.8	mS

Fig.2

Sensor Name	Value	Unit
☑ Cylinder 1 Injection Time	1.6	mS
☑ Cylinder 2 Injection Time	0.0	mS
☑ Cylinder 3 Injection Time	1.6	mS
☑ Cylinder 4 Injection Time	1.6	mS
☑ Cylinder 5 Injection Time	1.6	mS
☑ Cylinder 6 Injection Time	1.6	mS

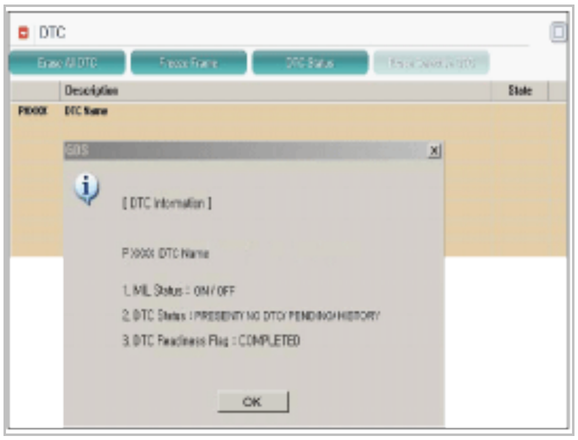
Fig.3

Fig.1) Normal waveforms of Injector under idle condition.

Fig.2) Normal data of Injector at idle.
Fig.3) Abnormal data of Injector when cylinder 2 injector has an open circuit
When the ECM energizes the injector by grounding control circuit, the circuit voltage should be low (theoretically 0V) and the fuel is injected. When the ECM de-energizes the injector by opening control circuit, the fuel injector is closed and circuit voltage should be peak at a moment.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found ?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Control Circuit Inspection" procedure.

Control Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect injector connector.

2. IG "ON".
3. Measure voltage between injector control terminal of injector harness connector and chassis ground.

Specification : Approx. 3.5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Go to "Check short to battery in harness" as follows.

■ Check short to battery in harness

1. IG "OFF" and disconnect injector connector and ECM connector.
2. Measure resistance between power and control terminals of injector harness connector.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to battery in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check injector

1. IG "OFF" and disconnect injector connector.
2. Measure resistance between power and control terminals of injector connector.(Component side)

Specification : 11.4 ~ 12.6Ω (at 20°C/ 68°F)

3. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good Fuel Pump Relay and check for proper operation. If the problem is corrected, replace Fuel Pump Relay and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

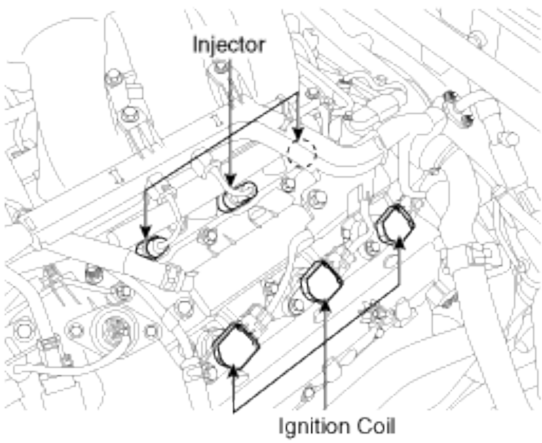
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0270 Cylinder 4 Injector Circuit Low

Component Location



General Description

Based on information from various sensors, the ECM measures the fuel injection amount. The fuel injector is a solenoid-operated valve and the fuel injection amount is controlled by length of time the fuel injector is held open. The ECM controls each injector by grounding the control circuit. When the ECM energizes the injector by grounding the control circuit, the circuit voltage should be low (theoretically 0V) and the fuel is injected. When the ECM de-energizes the injector by opening the control circuit, the fuel injector is closed and circuit voltage should momentarily peak.

DTC Description

Checking output signals from injectors. Under detecting condition, if an output signal is low, ECM sets P0270. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

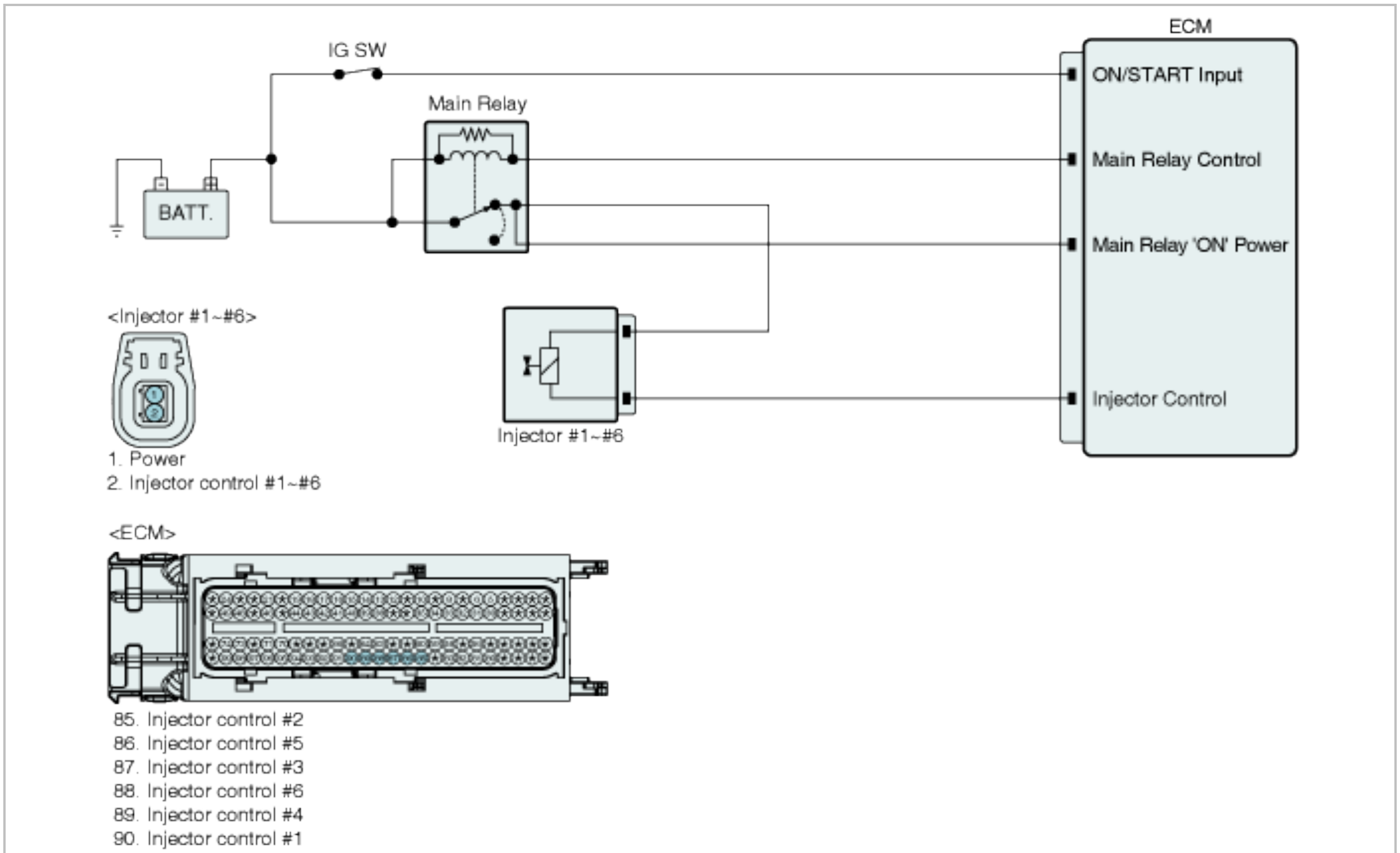
Item	Detecting Condition	Possible Cause
DTC Strategy	• Signal Low	• Poor connection • Open or short to ground in power harness • Open or short to ground in control harness
Enable Conditions	• Engine running state • 11V ≤ Battery voltage ≤ 16V • Above conditions are met > 0.5sec.	
Threshold value	• Open or short to ground	

Diagnosis Time	• Continuous (more than 5 sec. failure for every 10 sec.test)	• Injector • ECM
MIL On Condition	• 2 Driving Cycles	

Specification

Item	Coil resistance(Ω)
Injector	11.4 ~ 12.6Ω (at 20°C/ 68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data

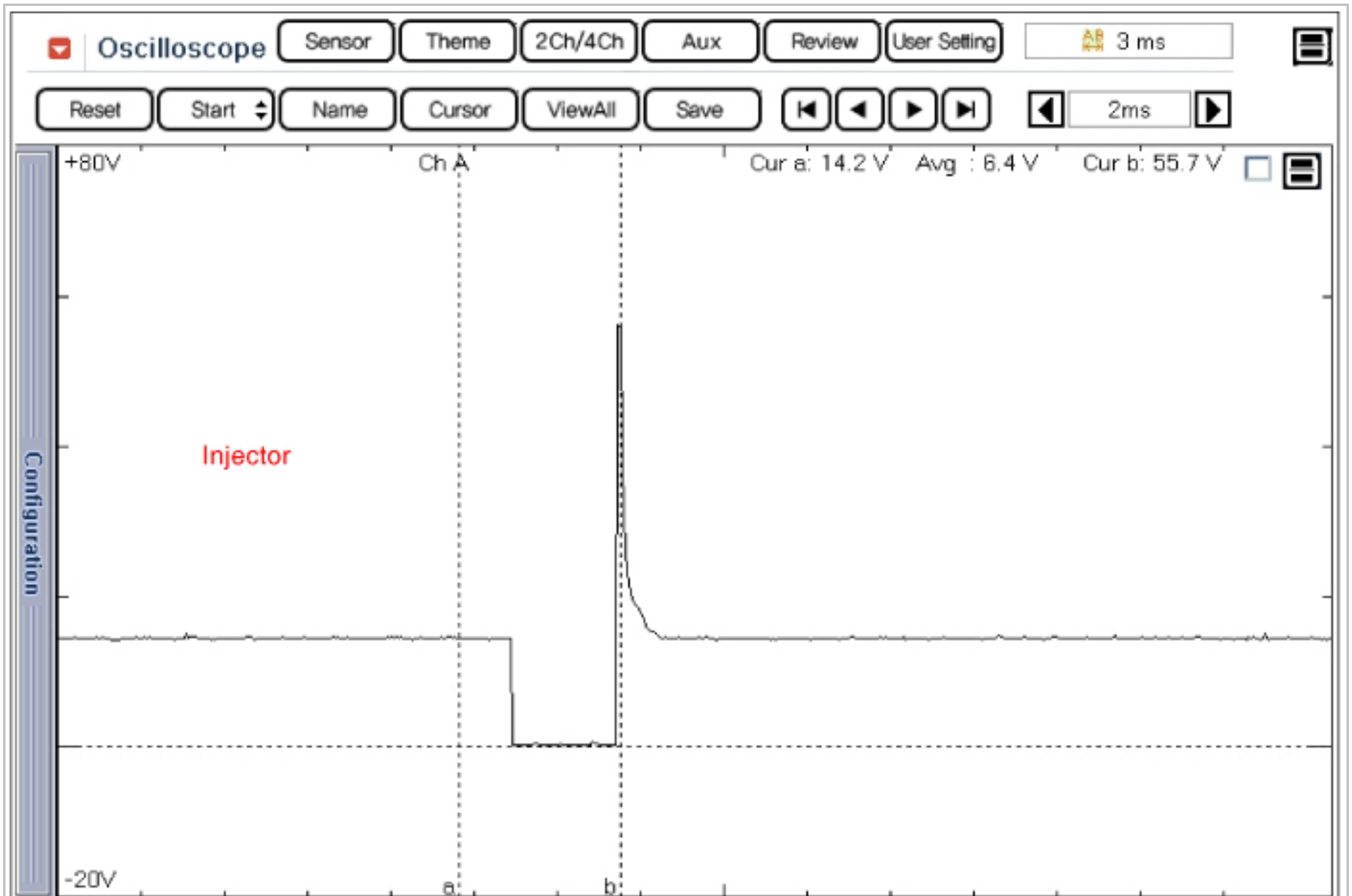


Fig.1

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | VSS

Sensor Name	Value	Unit
☑ Cylinder 1 Injection Time	0.8	mS
☑ Cylinder 2 Injection Time	0.8	mS
☑ Cylinder 3 Injection Time	0.8	mS
☑ Cylinder 4 Injection Time	0.8	mS
☑ Cylinder 5 Injection Time	0.8	mS
☑ Cylinder 6 Injection Time	0.8	mS

Fig.2

Sensor Name	Value	Unit
☑ Cylinder 1 Injection Time	1.6	mS
☑ Cylinder 2 Injection Time	0.0	mS
☑ Cylinder 3 Injection Time	1.6	mS
☑ Cylinder 4 Injection Time	1.6	mS
☑ Cylinder 5 Injection Time	1.6	mS
☑ Cylinder 6 Injection Time	1.6	mS

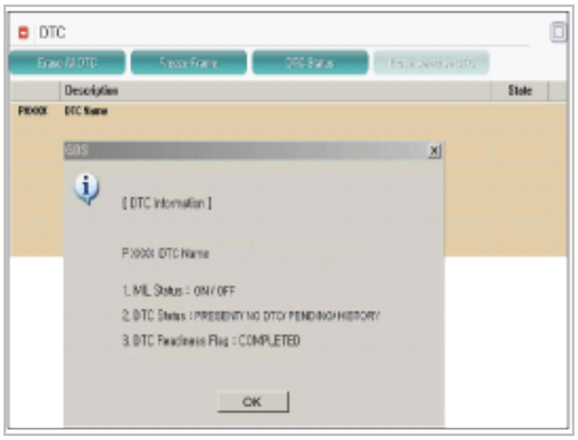
Fig.3

Fig.1) Normal waveforms of Injector under idle condition.

Fig.2) Normal data of Injector at idle.
Fig.3) Abnormal data of Injector when cylinder 2 injector has an open circuit
When the ECM energizes the injector by grounding control circuit, the circuit voltage should be low (theoretically 0V) and the fuel is injected. When the ECM de-energizes the injector by opening control circuit, the fuel injector is closed and circuit voltage should be peak at a moment.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found ?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Power Circuit Inspection" procedure.

Power Circuit Inspection

■ **Check voltage**

1. IG "OFF" and disconnect injector connector.
2. IG "ON".

3. Measure voltage between power terminal of injector harness connector and chassis ground.

Specification : Approx. B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.
NO	▶ Check open or connection of the fuse connected to injector power supply. ▶ Repair open or short to ground in harness, and go to "Verification of Vehicle Repair' procedure.

Control Circuit Inspection

■ Check short to ground in harness

1. IG "OFF" and disconnect injector connector and ECM connector.
2. Measure resistance between injector control terminal of injector harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Check open in harness" as follows.
NO	▶ Repair short to ground in harness, and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect injector connector and ECM connector.
2. Measure resistance between injector control terminal of injector harness connector and injector control terminal of ECM harness connector.

Specification : Below 1Ω

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check injector

1. IG "OFF" and disconnect injector connector.
2. Measure resistance between power and control terminals of injector connector.(Component side)

Specification : 11.4 ~ 12.6Ω (at 20°C/ 68°F)

3. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure.

	NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good Fuel Pump Relay and check for proper operation. If the problem is corrected, replace Fuel Pump Relay and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

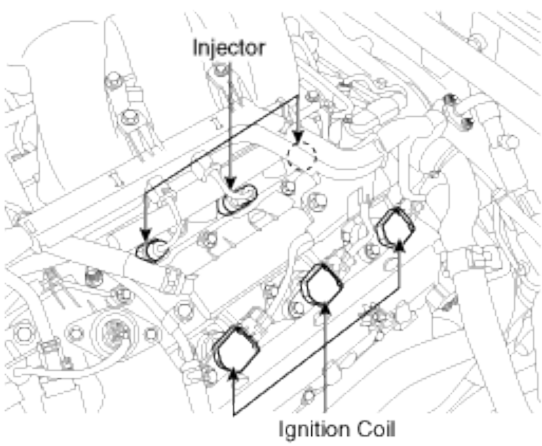
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0271 Cylinder 4 Injector Circuit High

Component Location



General Description

Based on information from various sensors, the ECM measures the fuel injection amount. The fuel injector is a solenoid-operated valve and the fuel injection amount is controlled by length of time the fuel injector is held open. The ECM controls each injector by grounding the control circuit. When the ECM energizes the injector by grounding the control circuit, the circuit voltage should be low (theoretically 0V) and the fuel is injected. When the ECM de-energizes the injector by opening the control circuit, the fuel injector is closed and circuit voltage should momentarily peak.

DTC Description

Checking output signals from injectors every 10 sec. under detecting condition, if an output signal is high for more than 5 sec., ECM sets P0271. MIL(Malfunction Indicatin Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

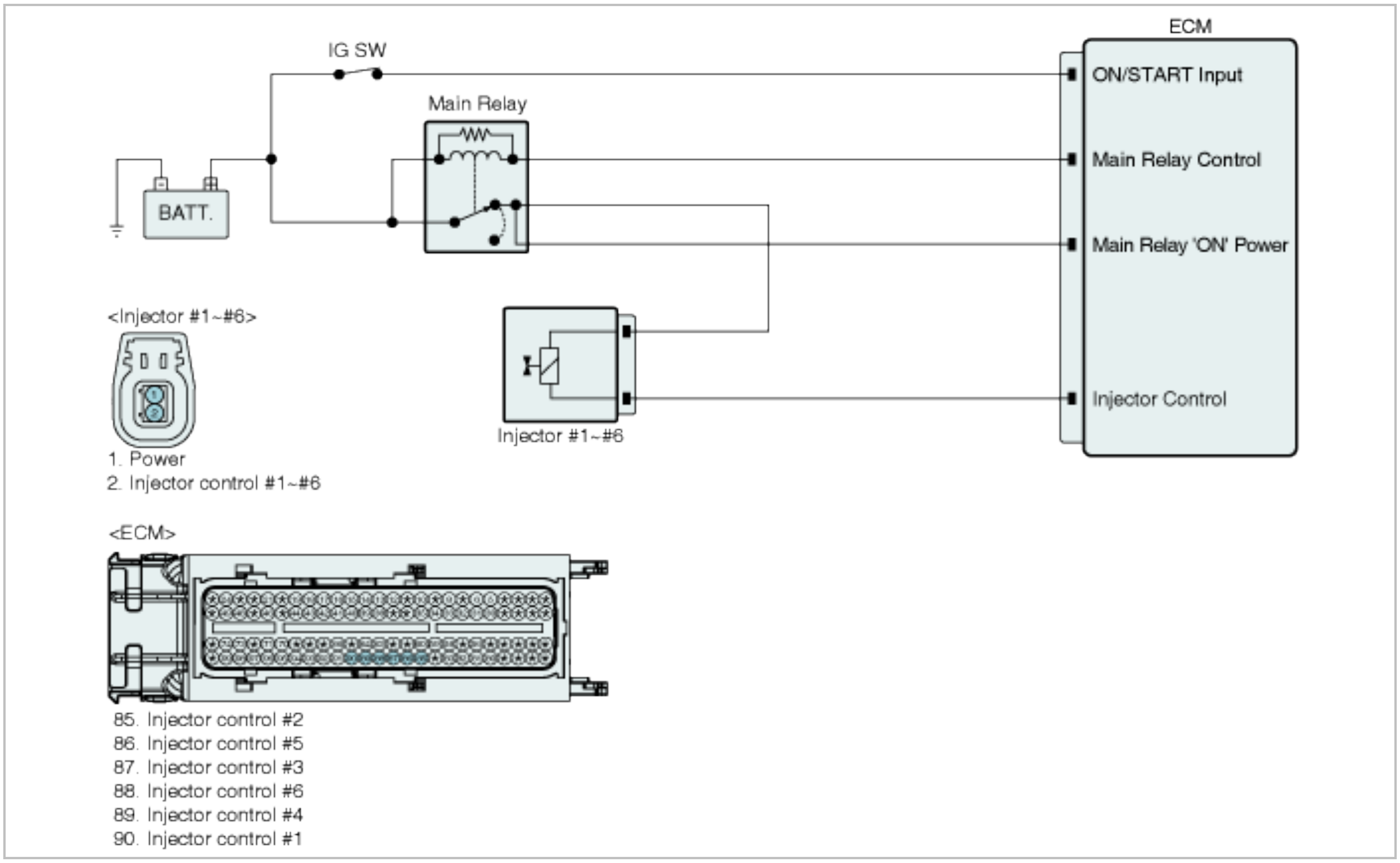
DTC Detecting Condition

<table>
<tr><th>Item</th><th>Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td>• Signal High</td><td rowspan="5">• Poor connection
• Short to battery in harness
• Injector
• ECM</td></tr>
<tr><td>Enable Conditions</td><td>• Engine running state
• 11V ≤ Battery voltage ≤ 16V
• Above conditions are met > 0.5sec.</td></tr>
<tr><td>Threshold value</td><td>• Short to battery</td></tr>
<tr><td>Diagnosis Time</td><td>• Continuous (more than 5 sec. failure for every 10 sec.test)</td></tr>
<tr><td>MIL On Condition</td><td>• 2 Driving Cycles</td></tr>
</table>

Specification

Item	Coil resistance(Ω)
Injector	11.4 ~ 12.6Ω (at 20°C/ 68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data

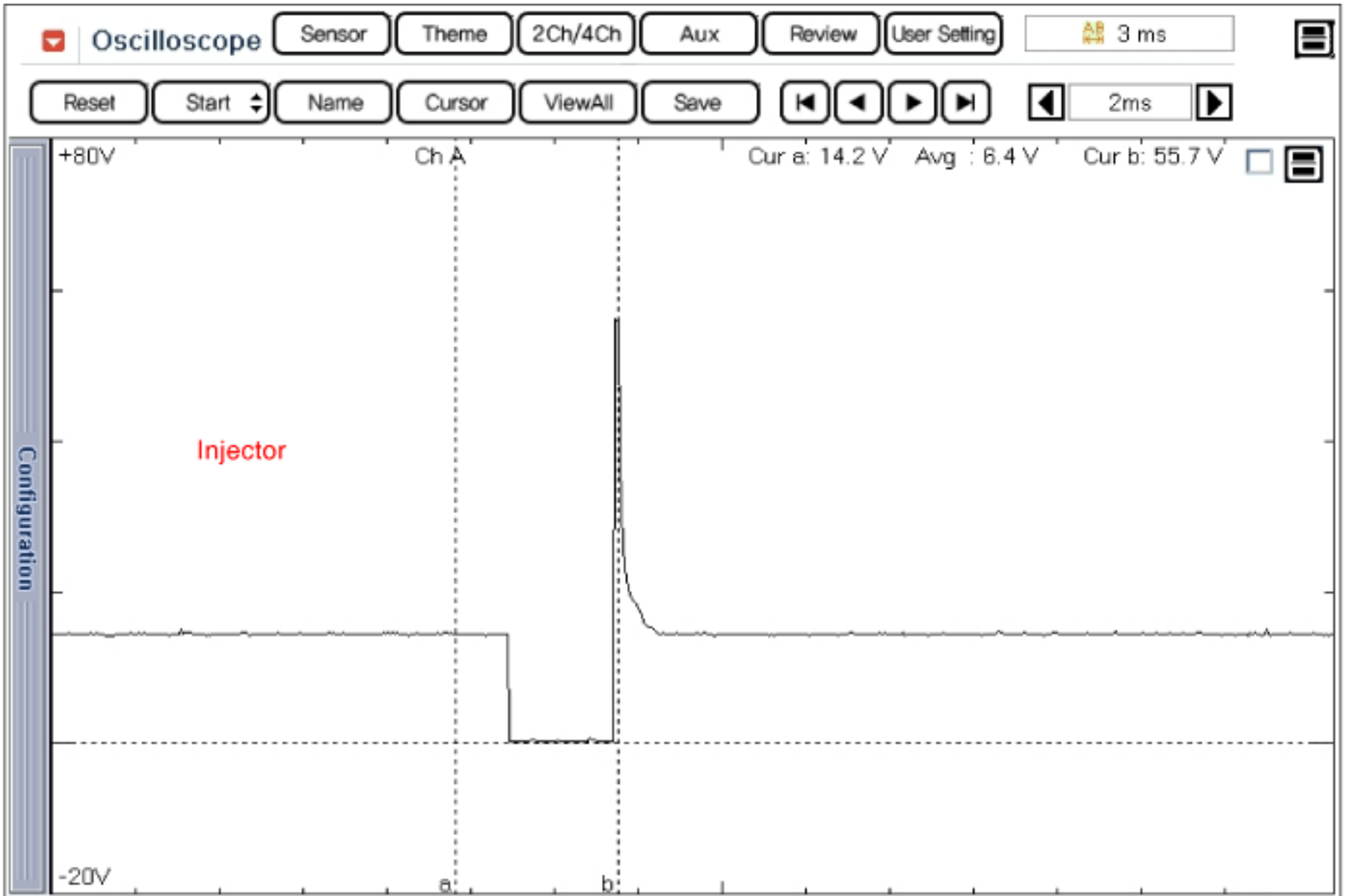


Fig.1

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | VSS

Sensor Name	Value	Unit
☑ Cylinder 1 Injection Time	0.8	mS
☑ Cylinder 2 Injection Time	0.8	mS
☑ Cylinder 3 Injection Time	0.8	mS
☑ Cylinder 4 Injection Time	0.8	mS
☑ Cylinder 5 Injection Time	0.8	mS
☑ Cylinder 6 Injection Time	0.8	mS

Fig.2

Sensor Name	Value	Unit
☑ Cylinder 1 Injection Time	1.6	mS
☑ Cylinder 2 Injection Time	0.0	mS
☑ Cylinder 3 Injection Time	1.6	mS
☑ Cylinder 4 Injection Time	1.6	mS
☑ Cylinder 5 Injection Time	1.6	mS
☑ Cylinder 6 Injection Time	1.6	mS

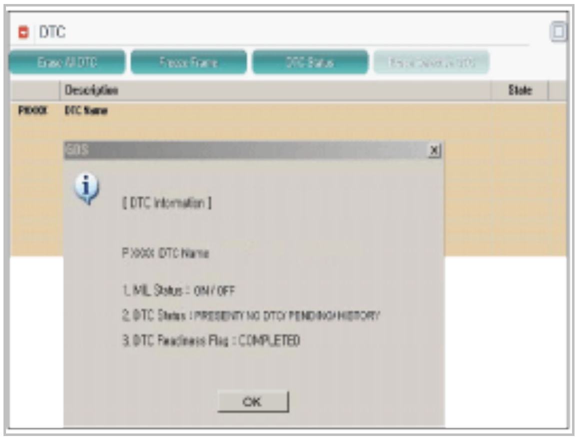
Fig.3

Fig.1) Normal waveforms of Injector under idle condition.

Fig.2) Normal data of Injector at idle.
Fig.3) Abnormal data of Injector when cylinder 2 injector has an open circuit
When the ECM energizes the injector by grounding control circuit, the circuit voltage should be low (theoretically 0V) and the fuel is injected. When the ECM de-energizes the injector by opening control circuit, the fuel injector is closed and circuit voltage should be peak at a moment.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found ?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Control Circuit Inspection" procedure.

Control Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect injector connector.
2. IG "ON".

3. Measure voltage between injector control terminal of injector harness connector and chassis ground.

Specification : Approx. 3.5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Go to "Check short to battery in harness" as follows.

■ Check short to battery in harness

1. IG "OFF" and disconnect injector connector and ECM connector.
2. Measure resistance between power and control terminals of injector harness connector.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to battery in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check injector

1. IG "OFF" and disconnect injector connector.
2. Measure resistance between power and control terminals of injector connector.(Component side)

Specification : 11.4 ~ 12.6Ω (at 20°C/ 68°F)

3. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good Fuel Pump Relay and check for proper operation. If the problem is corrected, replace Fuel Pump Relay and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

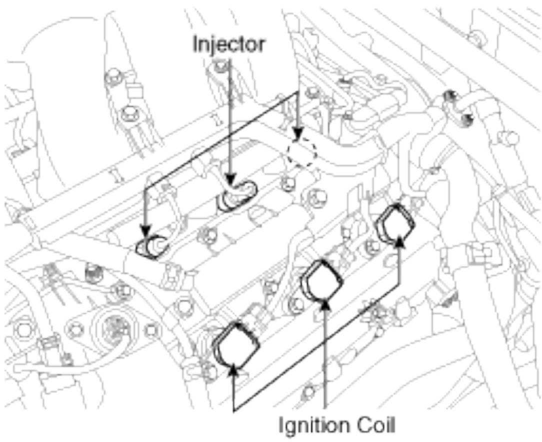
1. Connect GDS and select "DTC" button.

2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0273 Cylinder 5 Injector Circuit Low

Component Location



General Description

Based on information from various sensors, the ECM measures the fuel injection amount. The fuel injector is a solenoid-operated valve and the fuel injection amount is controlled by length of time the fuel injector is held open. The ECM controls each injector by grounding the control circuit. When the ECM energizes the injector by grounding the control circuit, the circuit voltage should be low (theoretically 0V) and the fuel is injected. When the ECM de-energizes the injector by opening the control circuit, the fuel injector is closed and circuit voltage should momentarily peak.

DTC Description

Checking output signals from injectors. Under detecting condition, if an output signal is low, ECM sets P0273. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

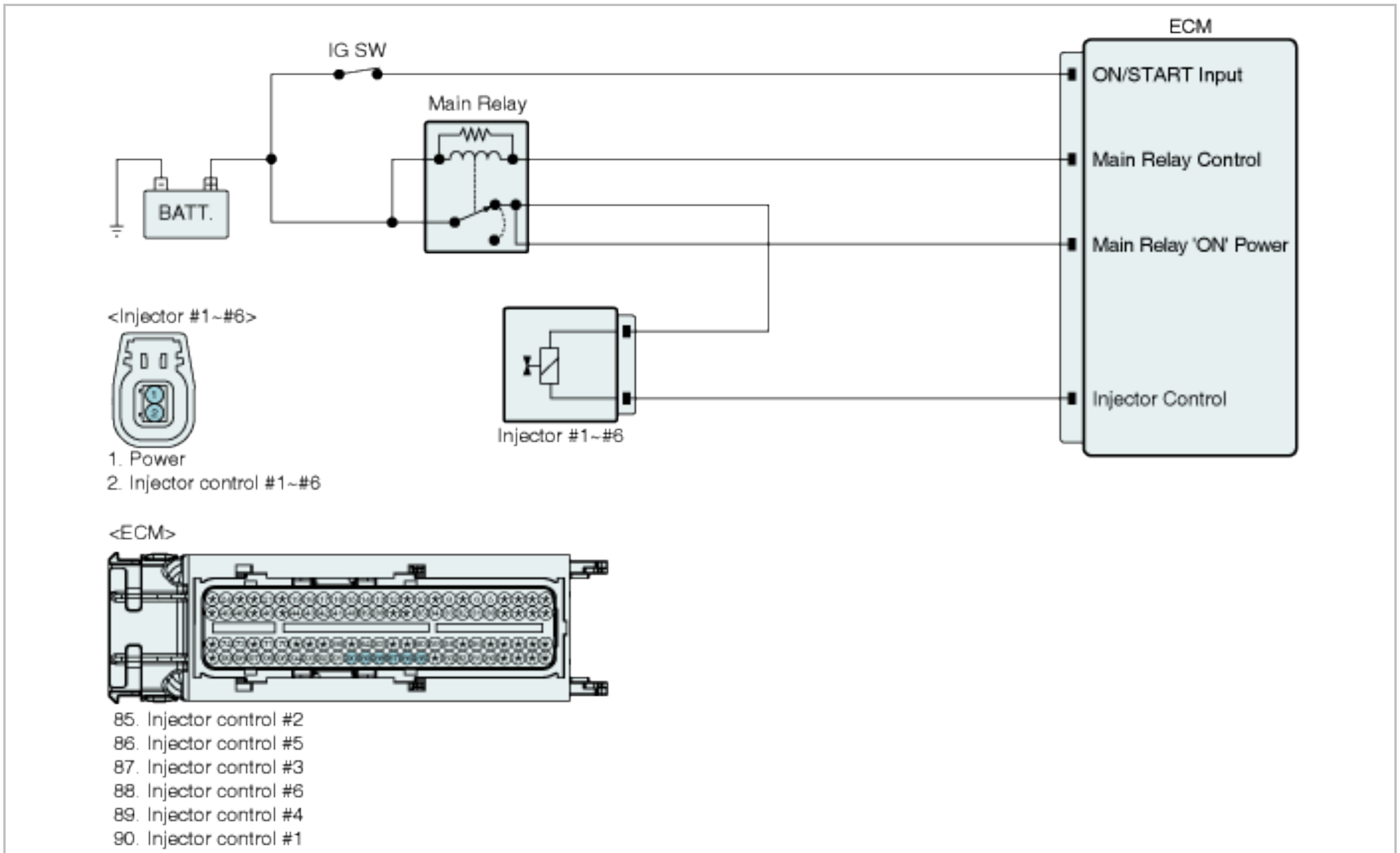
Item	Detecting Condition	Possible Cause
DTC Strategy	• Signal Low	• Poor connection • Open or short to ground in power harness • Open or short to ground in control harness • Injector
Enable Conditions	• Engine running state • 11V ≤ Battery voltage ≤ 16V • Above conditions are met > 0.5sec.	
Threshold value	• Open or short to ground	
Diagnosis Time	• Continuous (more than 5 sec. failure for every 10	

Diagnosis Time	sec.test)	• ECM
MIL On Condition	• 2 Driving Cycles	

Specification

Item	Coil resistance(Ω)
Injector	11.4 ~ 12.6Ω (at 20°C/ 68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data

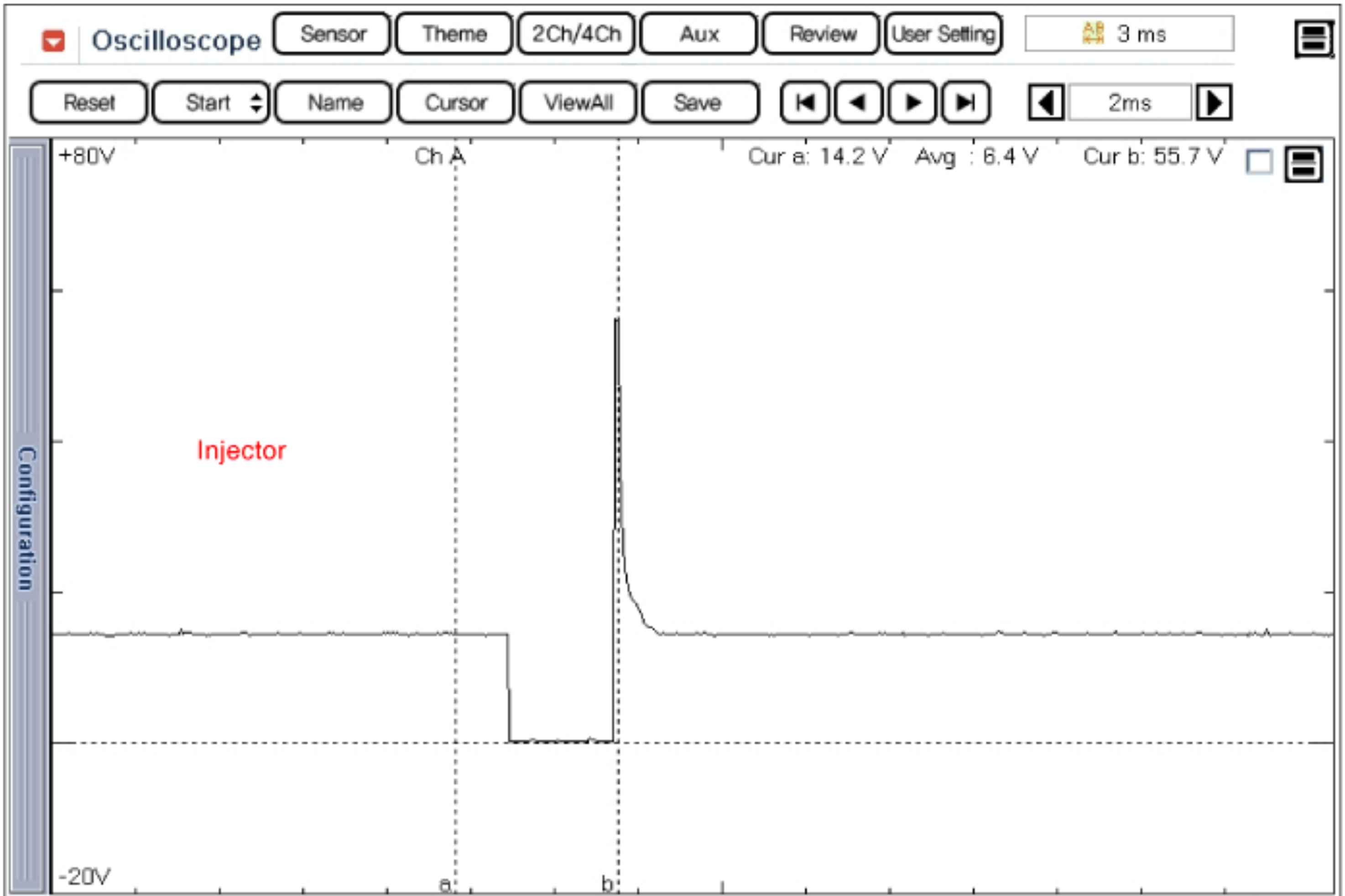


Fig.1

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | VSS

Sensor Name	Value	Unit
☑ Cylinder 1 Injection Time	0.8	mS
☑ Cylinder 2 Injection Time	0.8	mS
☑ Cylinder 3 Injection Time	0.8	mS
☑ Cylinder 4 Injection Time	0.8	mS
☑ Cylinder 5 Injection Time	0.8	mS
☑ Cylinder 6 Injection Time	0.8	mS

Fig.2

Sensor Name	Value	Unit
☑ Cylinder 1 Injection Time	1.6	mS
☑ Cylinder 2 Injection Time	0.0	mS
☑ Cylinder 3 Injection Time	1.6	mS
☑ Cylinder 4 Injection Time	1.6	mS
☑ Cylinder 5 Injection Time	1.6	mS
☑ Cylinder 6 Injection Time	1.6	mS

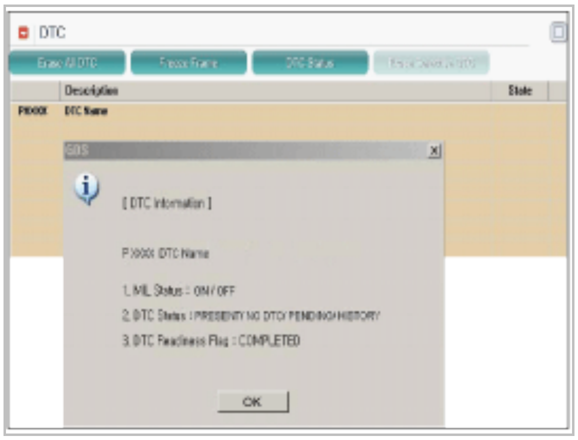
Fig.3

Fig.1) Normal waveforms of Injector under idle condition.

Fig.2) Normal data of Injector at idle.
Fig.3) Abnormal data of Injector when cylinder 2 injector has an open circuit
When the ECM energizes the injector by grounding control circuit, the circuit voltage should be low (theoretically 0V) and the fuel is injected. When the ECM de-energizes the injector by opening control circuit, the fuel injector is closed and circuit voltage should be peak at a moment.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found ?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Power Circuit Inspection" procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect injector connector.
2. IG "ON".

3. Measure voltage between power terminal of injector harness connector and chassis ground.

Specification : Approx. B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.
NO	▶ Check open or connection of the fuse connected to injector power supply. ▶ Repair open or short to ground in harness, and go to "Verification of Vehicle Repair' procedure.

Control Circuit Inspection

■ Check short to ground in harness

1. IG "OFF" and disconnect injector connector and ECM connector.
2. Measure resistance between injector control terminal of injector harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Check open in harness" as follows.
NO	▶ Repair short to ground in harness, and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect injector connector and ECM connector.
2. Measure resistance between injector control terminal of injector harness connector and injector control terminal of ECM harness connector.

Specification : Below 1Ω

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check injector

1. IG "OFF" and disconnect injector connector.
2. Measure resistance between power and control terminals of injector connector.(Component side)

Specification : 11.4 ~ 12.6Ω (at 20°C/ 68°F)

3. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure.

	NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good Fuel Pump Relay and check for proper operation. If the problem is corrected, replace Fuel Pump Relay and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

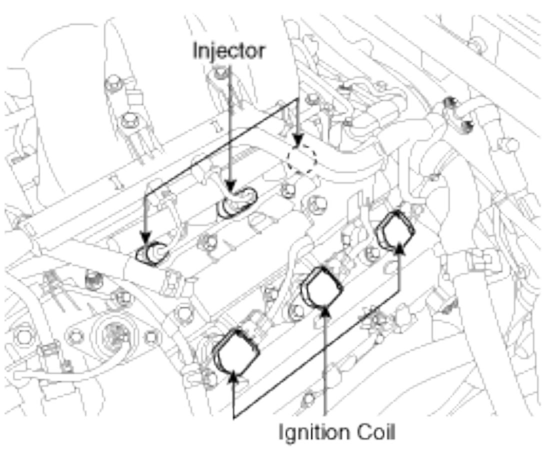
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0274 Cylinder 5 Injector Circuit High

Component Location



General Description

Based on information from various sensors, the ECM measures the fuel injection amount. The fuel injector is a solenoid-operated valve and the fuel injection amount is controlled by length of time the fuel injector is held open. The ECM controls each injector by grounding the control circuit. When the ECM energizes the injector by grounding the control circuit, the circuit voltage should be low (theoretically 0V) and the fuel is injected. When the ECM de-energizes the injector by opening the control circuit, the fuel injector is closed and circuit voltage should momentarily peak.

DTC Description

Checking output signals from injectors. Under detecting condition, if an output signal is high, ECM sets P0274. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

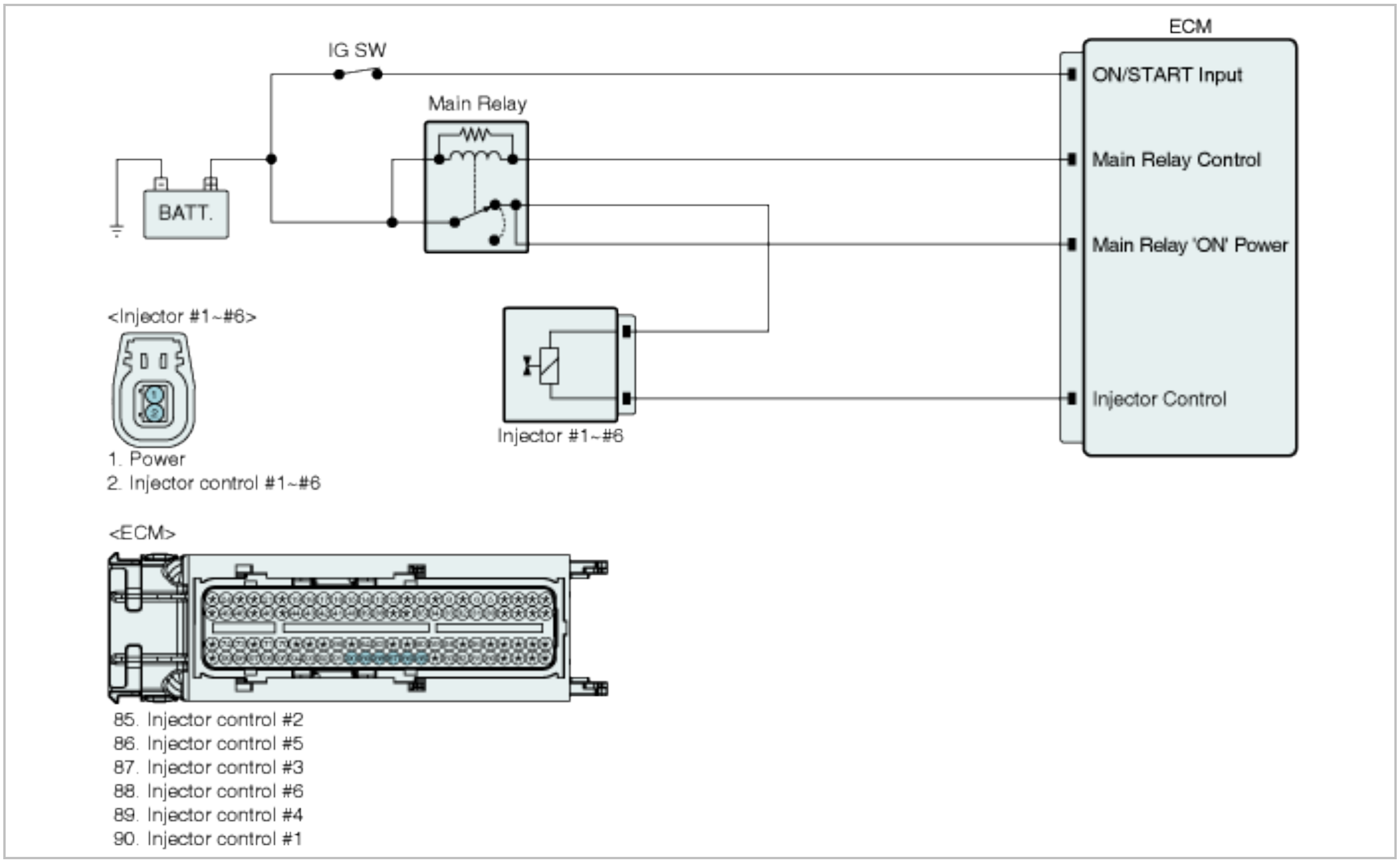
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Signal High	• Poor connection • Short to battery in harness • Injector • ECM
Enable Conditions	• Engine running state • 11V ≤ Battery voltage ≤ 16V • Above conditions are met > 0.5sec.	
Threshold value	• Short to battery	
Diagnosis Time	• Continuous (more than 5 sec. failure for every 10 sec.test)	
MIL On Condition	• 2 Driving Cycles	

Specification

Item	Coil resistance(Ω)
Injector	11.4 ~ 12.6Ω (at 20°C/ 68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data

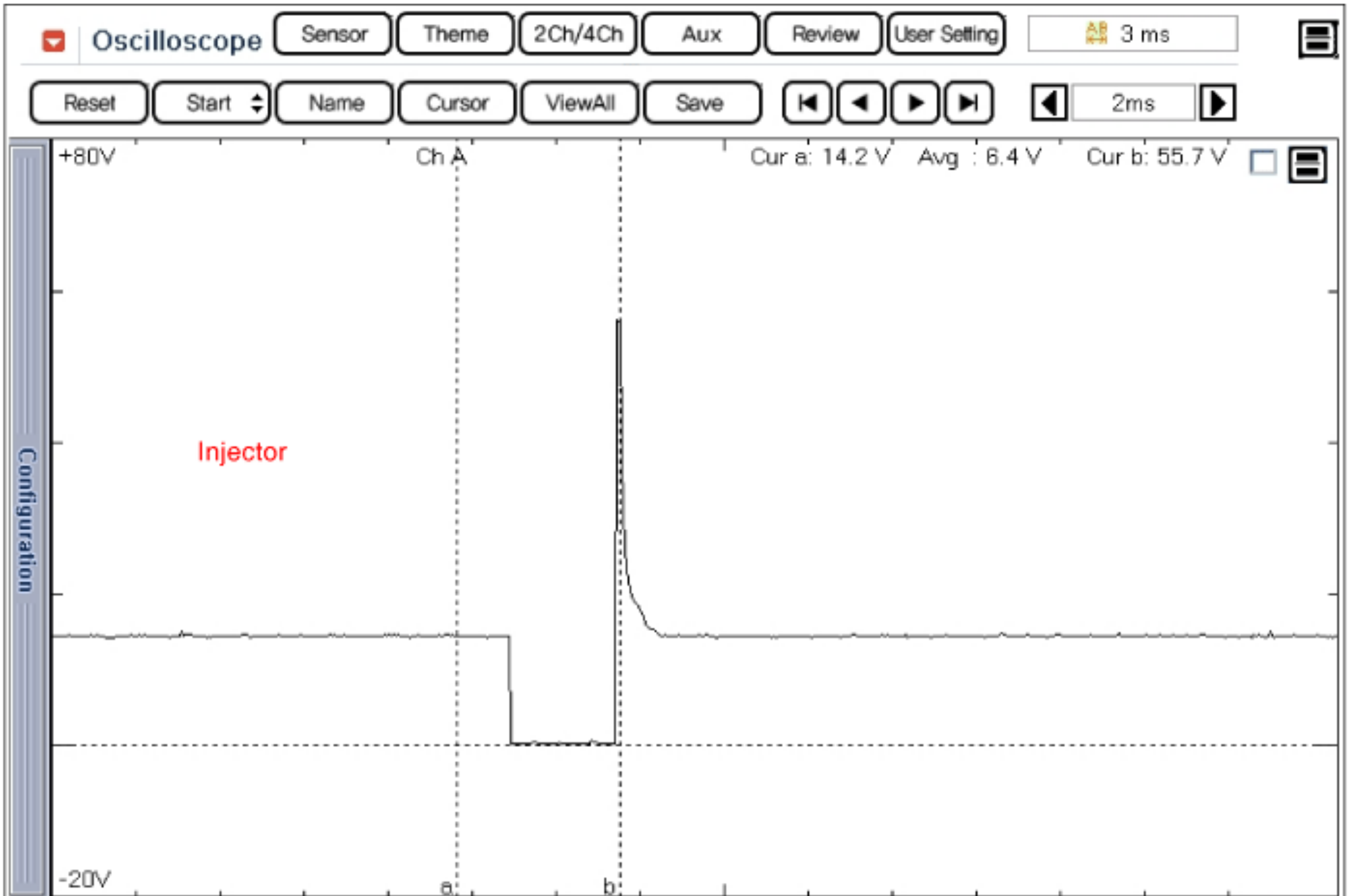


Fig.1

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | VSS

Sensor Name	Value	Unit
☑ Cylinder 1 Injection Time	0.8	mS
☑ Cylinder 2 Injection Time	0.8	mS
☑ Cylinder 3 Injection Time	0.8	mS
☑ Cylinder 4 Injection Time	0.8	mS
☑ Cylinder 5 Injection Time	0.8	mS
☑ Cylinder 6 Injection Time	0.8	mS

Fig.2

Sensor Name	Value	Unit
☑ Cylinder 1 Injection Time	1.6	mS
☑ Cylinder 2 Injection Time	0.0	mS
☑ Cylinder 3 Injection Time	1.6	mS
☑ Cylinder 4 Injection Time	1.6	mS
☑ Cylinder 5 Injection Time	1.6	mS
☑ Cylinder 6 Injection Time	1.6	mS

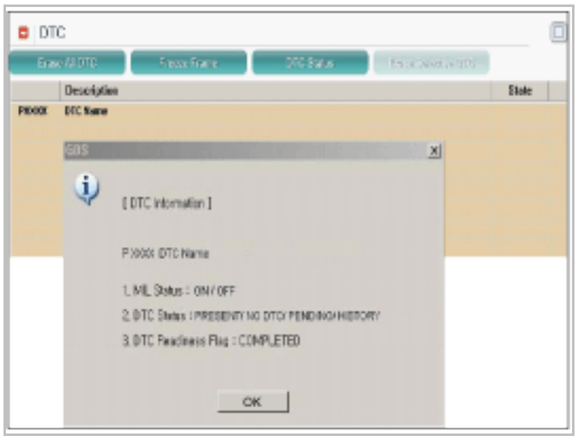
Fig.3

Fig.1) Normal waveforms of Injector under idle condition.

Fig.2) Normal data of Injector at idle.
Fig.3) Abnormal data of Injector when cylinder 2 injector has an open circuit
When the ECM energizes the injector by grounding control circuit, the circuit voltage should be low (theoretically 0V) and the fuel is injected. When the ECM de-energizes the injector by opening control circuit, the fuel injector is closed and circuit voltage should be peak at a moment.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found ?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Control Circuit Inspection" procedure.

Control Circuit Inspection

■ **Check voltage**

1. IG "OFF" and disconnect injector connector.
2. IG "ON".

3. Measure voltage between injector control terminal of injector harness connector and chassis ground.

Specification : Approx. 3.5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Go to "Check short to battery in harness" as follows.

■ Check short to battery in harness

1. IG "OFF" and disconnect injector connector and ECM connector.
2. Measure resistance between power and control terminals of injector harness connector.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to battery in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check injector

1. IG "OFF" and disconnect injector connector.
2. Measure resistance between power and control terminals of injector connector.(Component side)

Specification : 11.4 ~ 12.6Ω (at 20°C/ 68°F)

3. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good Fuel Pump Relay and check for proper operation. If the problem is corrected, replace Fuel Pump Relay and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

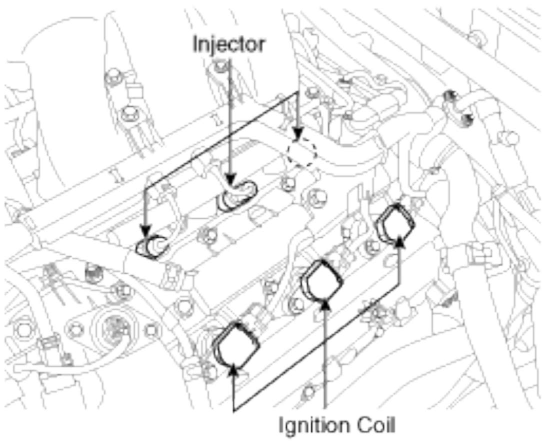
1. Connect GDS and select "DTC" button.

2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0276 Cylinder 6 Injector Circuit Low

Component Location



General Description

Based on information from various sensors, the ECM measures the fuel injection amount. The fuel injector is a solenoid-operated valve and the fuel injection amount is controlled by length of time the fuel injector is held open. The ECM controls each injector by grounding the control circuit. When the ECM energizes the injector by grounding the control circuit, the circuit voltage should be low (theoretically 0V) and the fuel is injected. When the ECM de-energizes the injector by opening the control circuit, the fuel injector is closed and circuit voltage should momentarily peak.

DTC Description

Checking output signals from injectors. Under detecting condition, if an output signal is low, ECM sets P0276. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

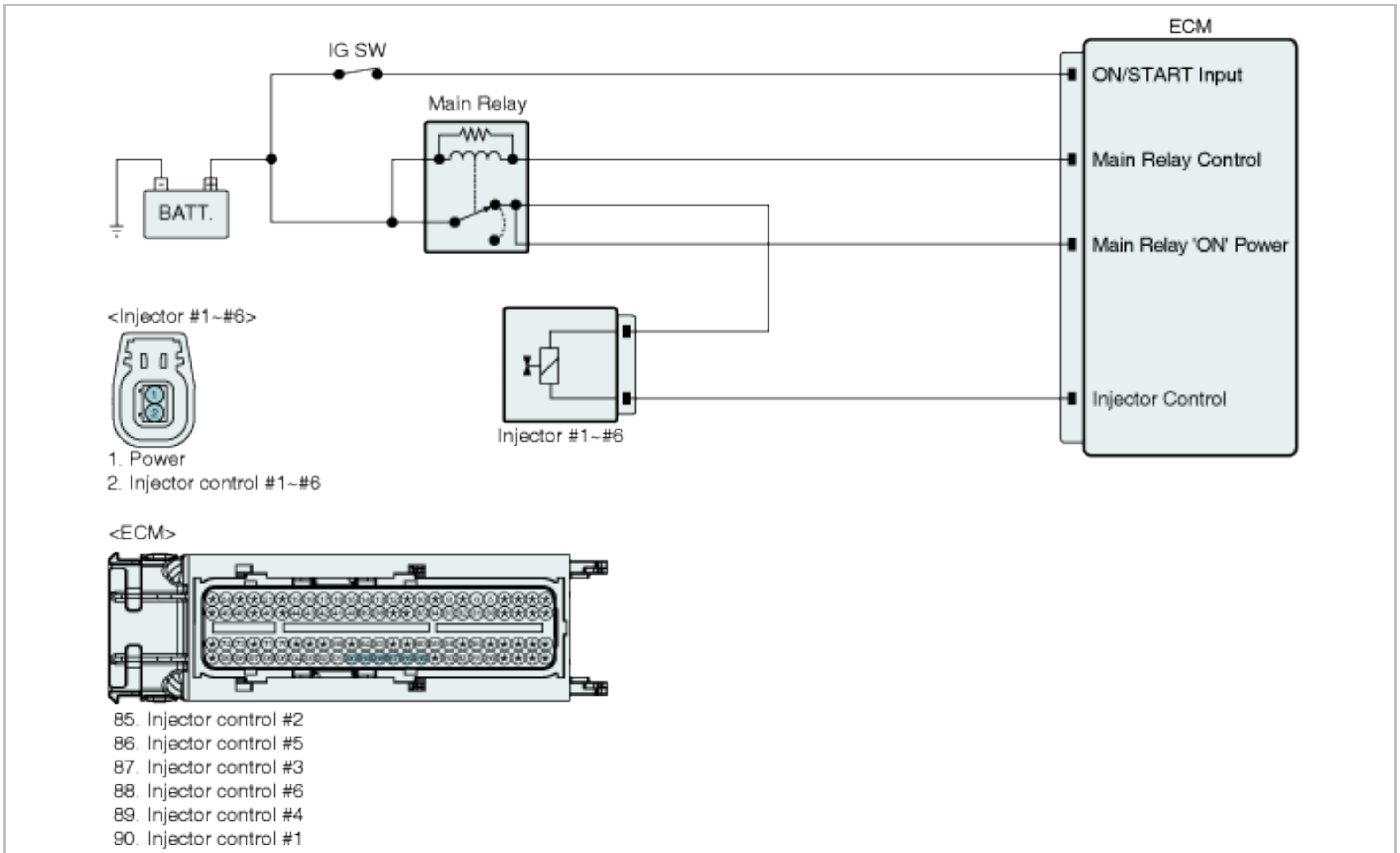
Item	Detecting Condition	Possible Cause
DTC Strategy	• Signal Low	• Poor connection • Open or short to ground in power harness • Open or short to ground in control harness • Injector
Enable Conditions	• Engine running state • 11V ≤ Battery voltage ≤ 16V • Above conditions are met > 0.5sec.	
Threshold value	• Open or short to ground	
Diagnosis Time	• Continuous (more than 5 sec. failure for every 10	

Diagnosis Time	sec.test)	• ECM
MIL On Condition	• 2 Driving Cycles	

Specification

Item	Coil resistance(Ω)
Injector	11.4 ~ 12.6Ω (at 20°C/ 68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data

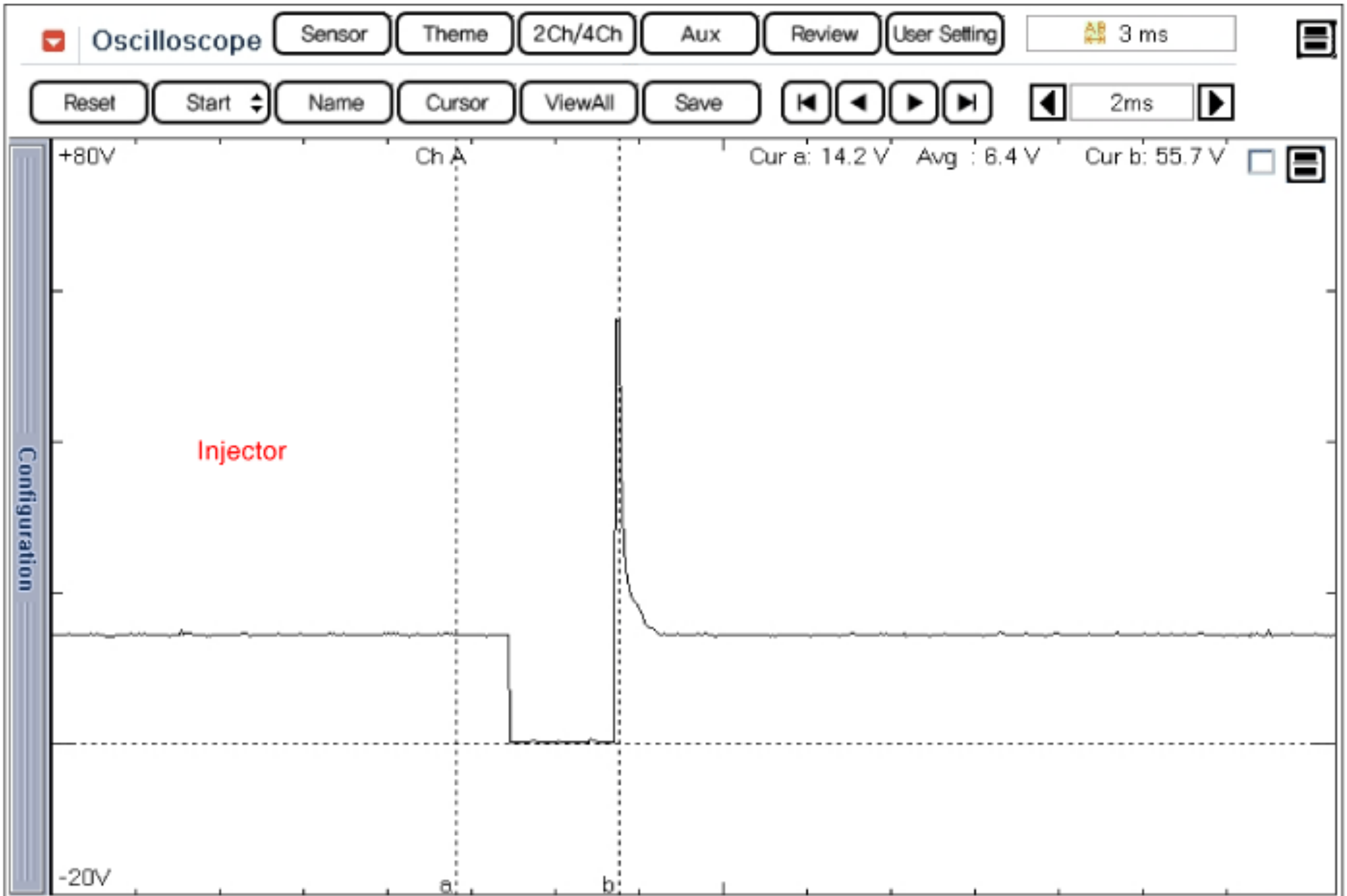
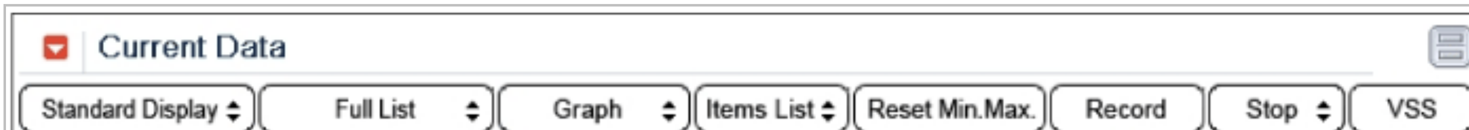


Fig.1



Sensor Name	Value	Unit
☑ Cylinder 1 Injection Time	0.8	mS
☑ Cylinder 2 Injection Time	0.8	mS
☑ Cylinder 3 Injection Time	0.8	mS
☑ Cylinder 4 Injection Time	0.8	mS
☑ Cylinder 5 Injection Time	0.8	mS
☑ Cylinder 6 Injection Time	0.8	mS

Fig.2

Sensor Name	Value	Unit
☑ Cylinder 1 Injection Time	1.6	mS
☑ Cylinder 2 Injection Time	0.0	mS
☑ Cylinder 3 Injection Time	1.6	mS
☑ Cylinder 4 Injection Time	1.6	mS
☑ Cylinder 5 Injection Time	1.6	mS
☑ Cylinder 6 Injection Time	1.6	mS

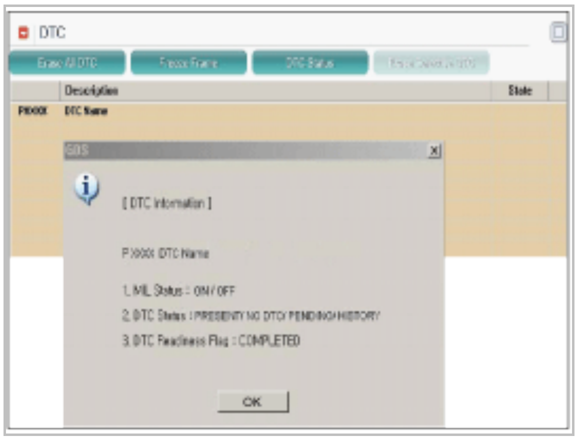
Fig.3

Fig.1) Normal waveforms of Injector under idle condition.

Fig.2) Normal data of Injector at idle.
Fig.3) Abnormal data of Injector when cylinder 2 injector has an open circuit
When the ECM energizes the injector by grounding control circuit, the circuit voltage should be low (theoretically 0V) and the fuel is injected. When the ECM de-energizes the injector by opening control circuit, the fuel injector is closed and circuit voltage should be peak at a moment.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found ?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Power Circuit Inspection" procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect injector connector.
2. IG "ON".

3. Measure voltage between power terminal of injector harness connector and chassis ground.

Specification : Approx. B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.
NO	▶ Check open or connection of the fuse connected to injector power supply. ▶ Repair open or short to ground in harness, and go to "Verification of Vehicle Repair' procedure.

Control Circuit Inspection

■ Check short to ground in harness

1. IG "OFF" and disconnect injector connector and ECM connector.
2. Measure resistance between injector control terminal of injector harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Check open in harness" as follows.
NO	▶ Repair short to ground in harness, and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect injector connector and ECM connector.
2. Measure resistance between injector control terminal of injector harness connector and injector control terminal of ECM harness connector.

Specification : Below 1Ω

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check injector

1. IG "OFF" and disconnect injector connector.
2. Measure resistance between power and control terminals of injector connector.(Component side)

Specification : 11.4 ~ 12.6Ω (at 20°C/ 68°F)

3. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure.

	NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good Fuel Pump Relay and check for proper operation. If the problem is corrected, replace Fuel Pump Relay and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

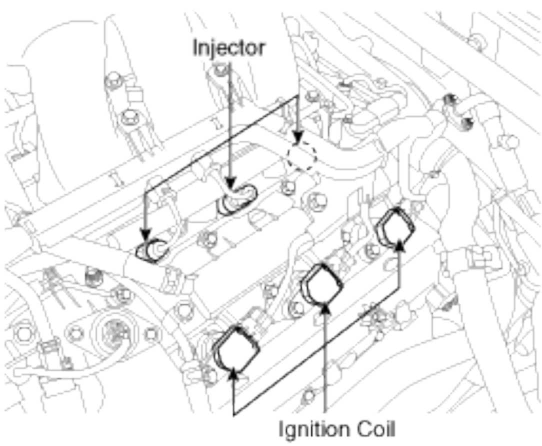
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0277 Cylinder 6 Injector Circuit High

Component Location



General Description

Based on information from various sensors, the ECM measures the fuel injection amount. The fuel injector is a solenoid-operated valve and the fuel injection amount is controlled by length of time the fuel injector is held open. The ECM controls each injector by grounding the control circuit. When the ECM energizes the injector by grounding the control circuit, the circuit voltage should be low (theoretically 0V) and the fuel is injected. When the ECM de-energizes the injector by opening the control circuit, the fuel injector is closed and circuit voltage should momentarily peak.

DTC Description

Checking output signals from injectors. Under detecting condition, if an output signal is high, ECM sets P0277. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

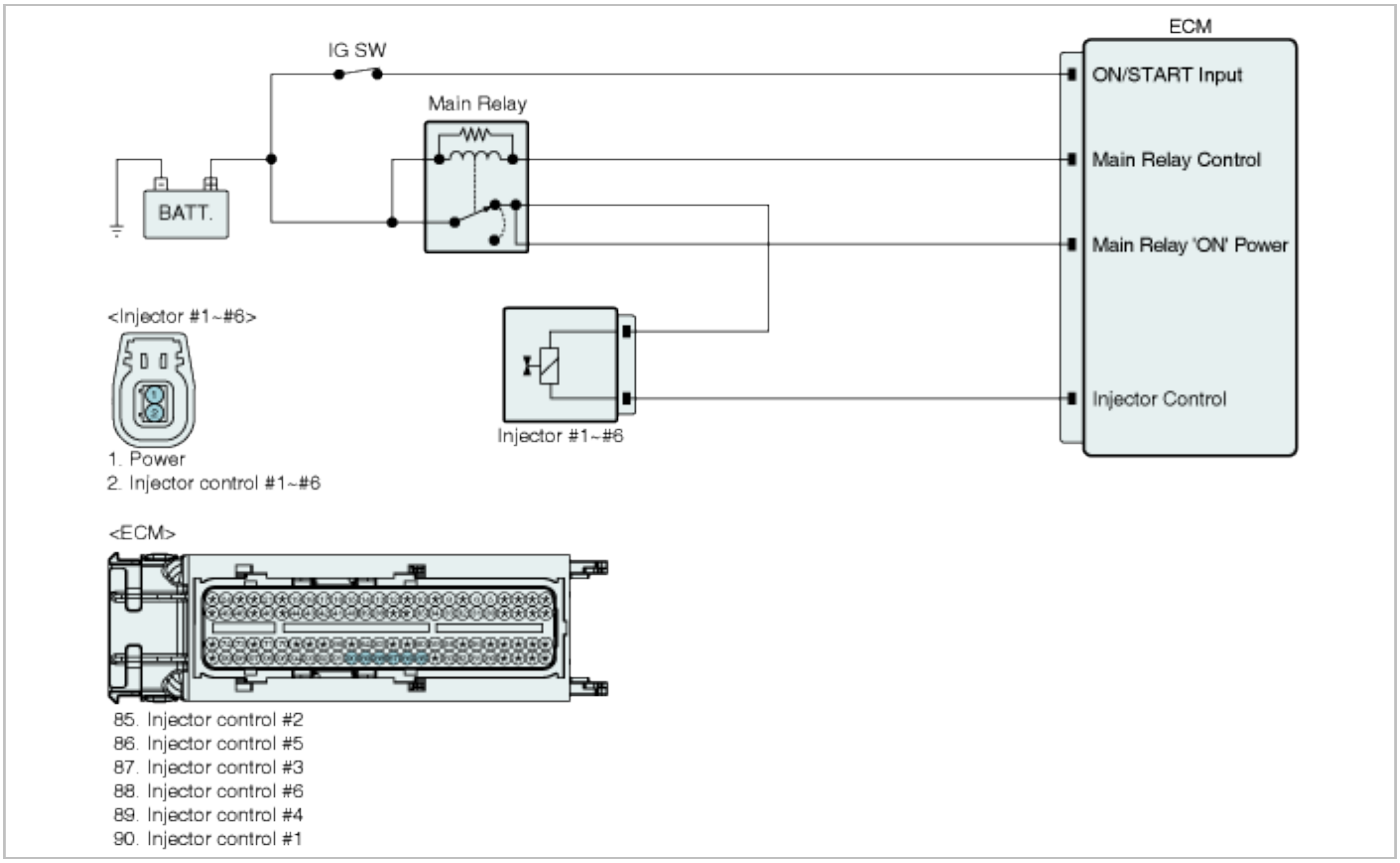
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Signal High	• Poor connection • Short to battery in harness • Injector • ECM
Enable Conditions	• Engine running state • 11V ≤ Battery voltage ≤ 16V • Above conditions are met > 0.5sec.	
Threshold value	• Short to battery	
Diagnosis Time	• Continuous (more than 5 sec. failure for every 10 sec.test)	
MIL On Condition	• 2 Driving Cycles	

Specification

Item	Coil resistance(Ω)
Injector	11.4 ~ 12.6Ω (at 20°C/ 68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data

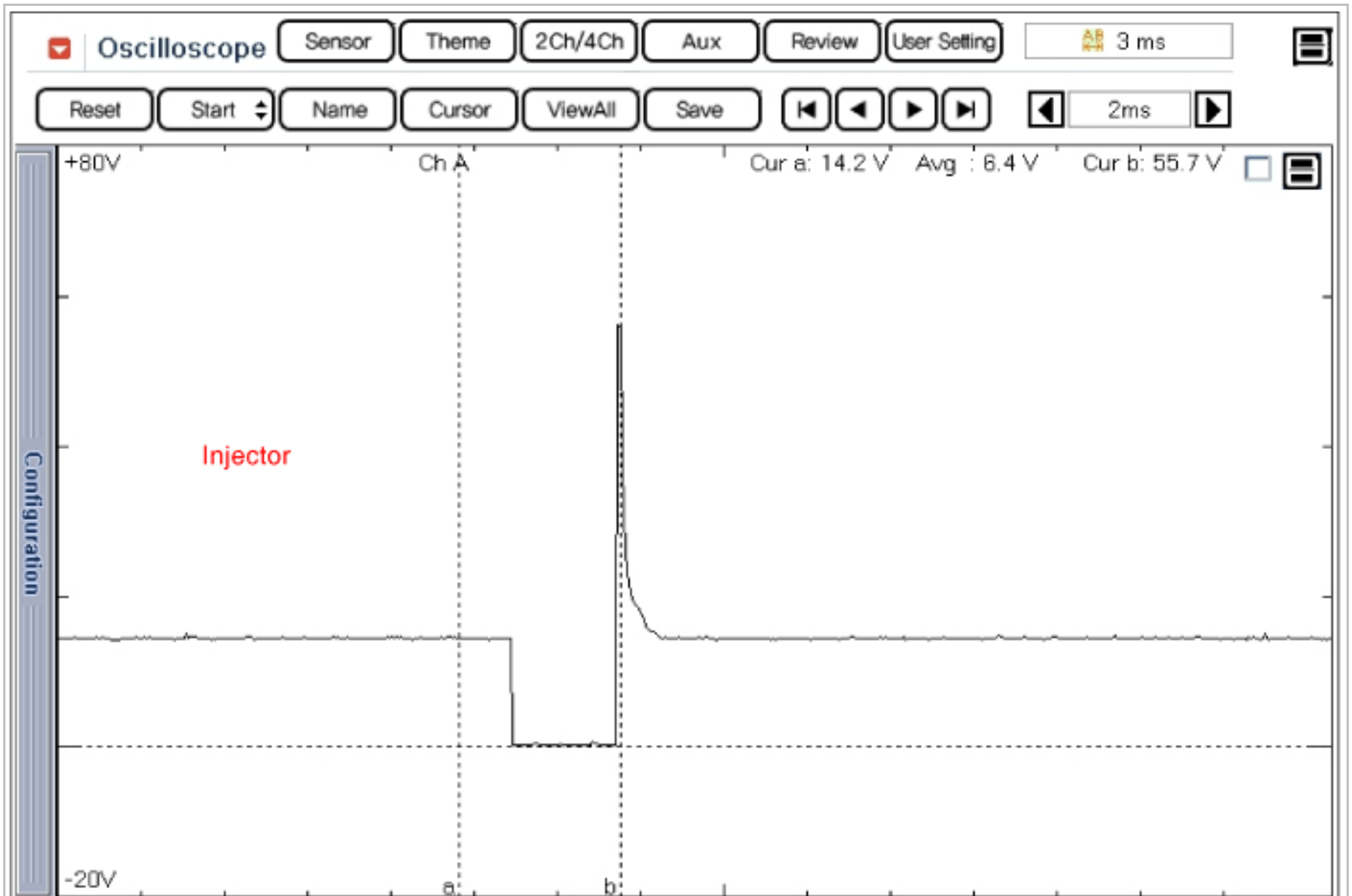


Fig.1

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | VSS

Sensor Name	Value	Unit
☑ Cylinder 1 Injection Time	0.8	mS
☑ Cylinder 2 Injection Time	0.8	mS
☑ Cylinder 3 Injection Time	0.8	mS
☑ Cylinder 4 Injection Time	0.8	mS
☑ Cylinder 5 Injection Time	0.8	mS
☑ Cylinder 6 Injection Time	0.8	mS

Fig.2

Sensor Name	Value	Unit
☑ Cylinder 1 Injection Time	1.6	mS
☑ Cylinder 2 Injection Time	0.0	mS
☑ Cylinder 3 Injection Time	1.6	mS
☑ Cylinder 4 Injection Time	1.6	mS
☑ Cylinder 5 Injection Time	1.6	mS
☑ Cylinder 6 Injection Time	1.6	mS

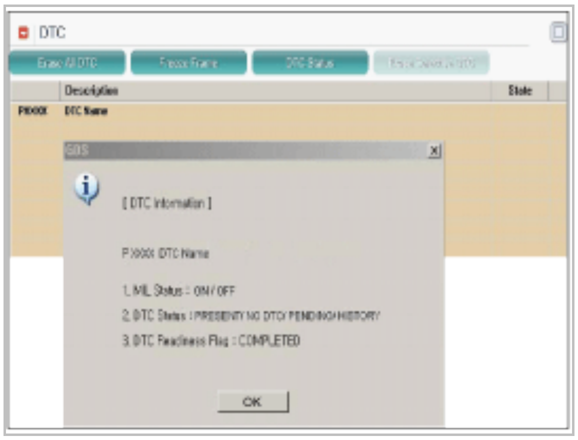
Fig.3

Fig.1) Normal waveforms of Injector under idle condition.

Fig.2) Normal data of Injector at idle.
Fig.3) Abnormal data of Injector when cylinder 2 injector has an open circuit
When the ECM energizes the injector by grounding control circuit, the circuit voltage should be low (theoretically 0V) and the fuel is injected. When the ECM de-energizes the injector by opening control circuit, the fuel injector is closed and circuit voltage should be peak at a moment.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found ?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Control Circuit Inspection" procedure.

Control Circuit Inspection

■ **Check voltage**

1. IG "OFF" and disconnect injector connector.
2. IG "ON".

3. Measure voltage between injector control terminal of injector harness connector and chassis ground.

Specification : Approx. 3.5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Go to "Check short to battery in harness" as follows.

■ Check short to battery in harness

1. IG "OFF" and disconnect injector connector and ECM connector.
2. Measure resistance between power and control terminals of injector harness connector.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to battery in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check injector

1. IG "OFF" and disconnect injector connector.
2. Measure resistance between power and control terminals of injector connector.(Component side)

Specification : 11.4 ~ 12.6Ω (at 20°C/ 68°F)

3. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good Fuel Pump Relay and check for proper operation. If the problem is corrected, replace Fuel Pump Relay and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.

2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0300 Random/Multiple Cylinder Misfire Detected

General Description

Misfires can be caused by lack of combustion in a cylinder due to absence of spark, poor fuel metering, poor compression, or many other causes. Even a small number of misfires may result in excessive exhaust emissions due to the unburned mixture. Increased misfire rates cause damage to the catalytic converter. The ECM monitors the crankshaft speed variation to determine if any misfiring generated. The ECM identifies the specific cylinder in which the misfire has occurred and counts individual misfire events by monitoring changes in the crankshaft rotation for each cylinder. A random misfire indicates two or more cylinders are misfiring.

DTC Description

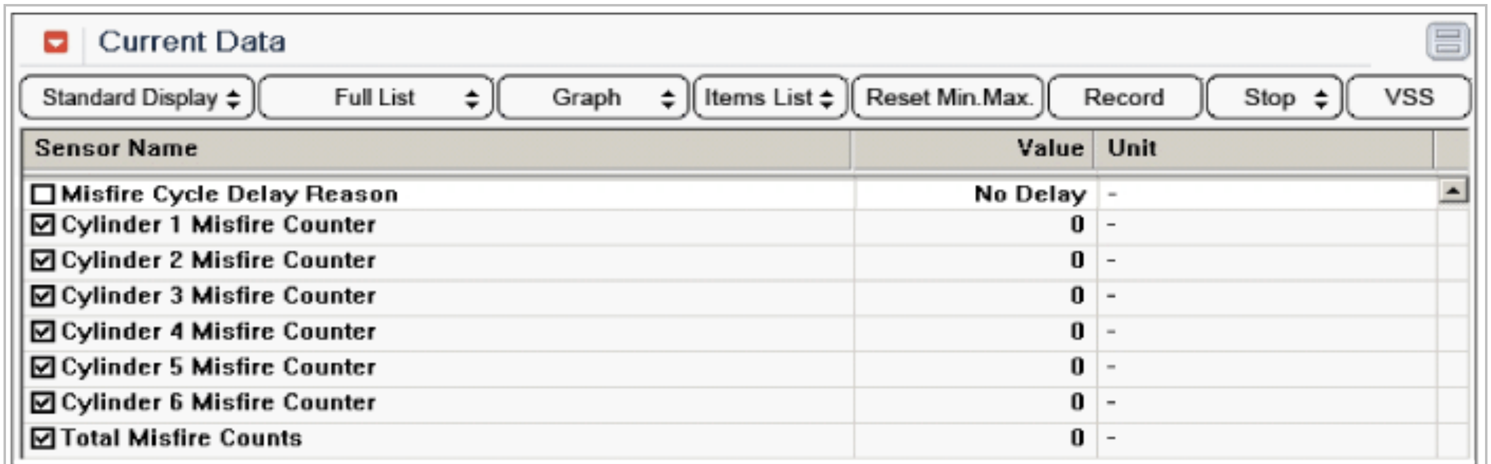
The ECM measures reference event times and calculates the positive and negative acceleration of the crank wheel to detrmine whether a misfire has occurred.
When the rate of misfire exceeds a threshold where the catalyst reaches a temperature where permanent damage can ocur, to the point that tail pipe emissions reach 1.5 times the tailpipe standard or where a cylinder misfire cause a loss of torque produced from that cylinder.
ECM sets this DTC. In case that misfire affects Catalyst damage, MIL(Malfunction Indicatin Lamp) will be illuminating and blinking at 1HZ frequency. However, In case of Indivisual and Emission damaging misfire, MIL will be turned on when the malfunction is detected.

DTC Detecting Condition

Item		Detecting Condition	Possible Cause
DTC Strategy		• Determine if a multiple cylinder misfire or a cylinder specific misfire is occurring by monitoring crankshaft acceleration.	• Faulty Spark plugs • Faulty Spark plug cables • Air Leakage • Belt deflection and Air gap of CKPS • Incorrect timing • Faulty injector • Improper fuel pressure • Improper engine compression
Enable Conditions		No disabling faults present / no disabiling Active Faults • P0340 / P0341 / P0118 / P0117 / P0115 / P0336 / P0335 / P1295 / P0103 / P0102 / 0108 / P0107 / P0106 / P0501 • Engine speed between 550 and 5800 RPM • System voltage between 9 and 18 volts • The ECT indicates an engine temperature between -6°C(20°F) and 120°C(248°F)	
Threshold value	Case 1	• Individual cylinder misfire detection	
	Case 2	• Emissions damaging - 18 times in 600 ignitions (In case that the misfire affects more than 1.5 times than FTP emissins)	

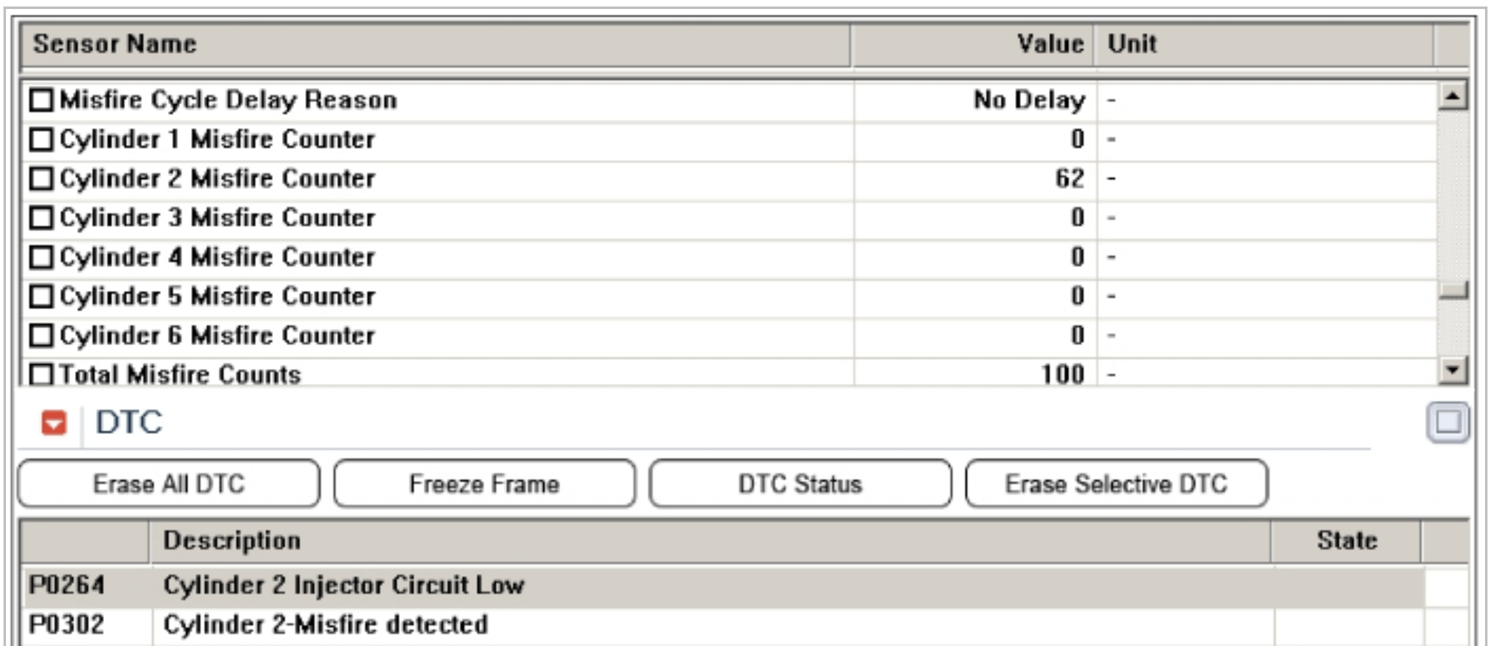
value	Case 3	• Catalyst damaging - 95 times in 600 ignitions at idle (It is going to be changeable according to the load or the temperature which is not in the range where it does not melt catalyst)
Diagnosis Time		• Continuous
MIL On Condition		• 2 Driving Cycles

Signal Waveform & Data



Sensor Name	Value	Unit
Misfire Cycle Delay Reason	No Delay	-
Cylinder 1 Misfire Counter	0	-
Cylinder 2 Misfire Counter	0	-
Cylinder 3 Misfire Counter	0	-
Cylinder 4 Misfire Counter	0	-
Cylinder 5 Misfire Counter	0	-
Cylinder 6 Misfire Counter	0	-
Total Misfire Counts	0	-

Fig.1



Sensor Name	Value	Unit
Misfire Cycle Delay Reason	No Delay	-
Cylinder 1 Misfire Counter	0	-
Cylinder 2 Misfire Counter	62	-
Cylinder 3 Misfire Counter	0	-
Cylinder 4 Misfire Counter	0	-
Cylinder 5 Misfire Counter	0	-
Cylinder 6 Misfire Counter	0	-
Total Misfire Counts	100	-

	Description	State
P0264	Cylinder 2 Injector Circuit Low	
P0302	Cylinder 2-Misfire detected	

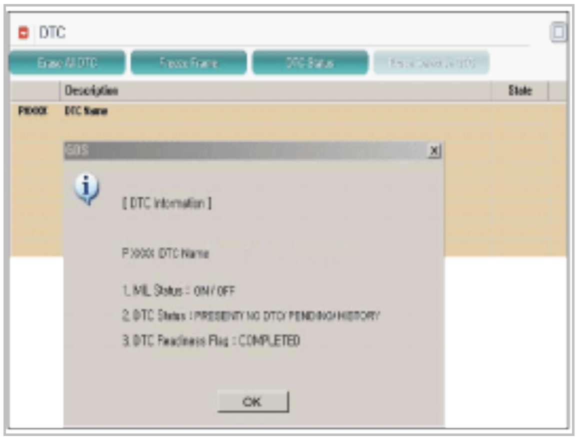
Fig.2

Fig.1) Normal data of misfire counter at idle.
Fig.2) Abnormal data of misfire counter when cyliner 2 injector open.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.

4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "System Inspection" procedure.
NO	▶ Although the misfire does not occur when the vehicle is brought to workshop, misfire can be reproduced when the condition is met. Drive the vehicle according to the freeze frame data in order to satisfy the condition.

System Inspection

■ Check Spark Pulg

1. Remove cylinder’s spark plugs
2. Visually/physically inspect the following items:
   - ▶ Damaged insulation, Worn electrodes, Oil or fuel fouled, Loose terminals and cracks
   - ▶ Check for plug gap : 1.0 - 1.1 mm (0.039 - 0.043 in.)
   - ▶ Check if the spark plug for the relevant cylinder is lighter in color than the other plugs.
3. Has a problem been found in any of the above areas ?

YES	▶ Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check Air Leakage" as below.

■ Check Air Leakage

1. Visually/physically inspect the air leakage in intake/exhaust system as following items,
   - ▶ Vacuum hoses for splits, kinks and improper connections.
   - ▶ Throttle body gasket
   - ▶ Gasket between intake manifold and cylinder head
   - ▶ Seals between intake manifold and fuel injectors
   - ▶ Exhaust system between HO2S and Three way catalyst for air leakage
2. Has a problem been found in any of the above areas ?

YES	▶ Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check for air leakage in Positive Crankcase Ventilation Valve(PCV).

■ Check for air leakage in Positive Crankcase Ventilation Valve(PCV)

1. Remove PCV valve from cylinder head cover by puling ventilation hose.

2. With engine idling block PCV valve opening.
3. Verify that vacuum is felt.
4. Remove PCV valve.
5. Blow through valve from prot "A" and verify that air comes out of prot "B".
6. Blow through valve from prot "B" and verifty that no air comes out of port "A".
7. Has a problem been found in any of the above areas ?

YES	▶ Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check Compression pressure" as below.

■ Check Compression pressure

1. Warm up the engine to normal operating temperature.
2. Disconnect the spark plug cables and remove the spark plugs.
3. Crank the engine to remove any foreign material in the cylinders.
4. Put compression pressure gauge into spark pulg hole.
5. Crank the engine with widely opend throttle valve and check compression pressure at each cylinder.

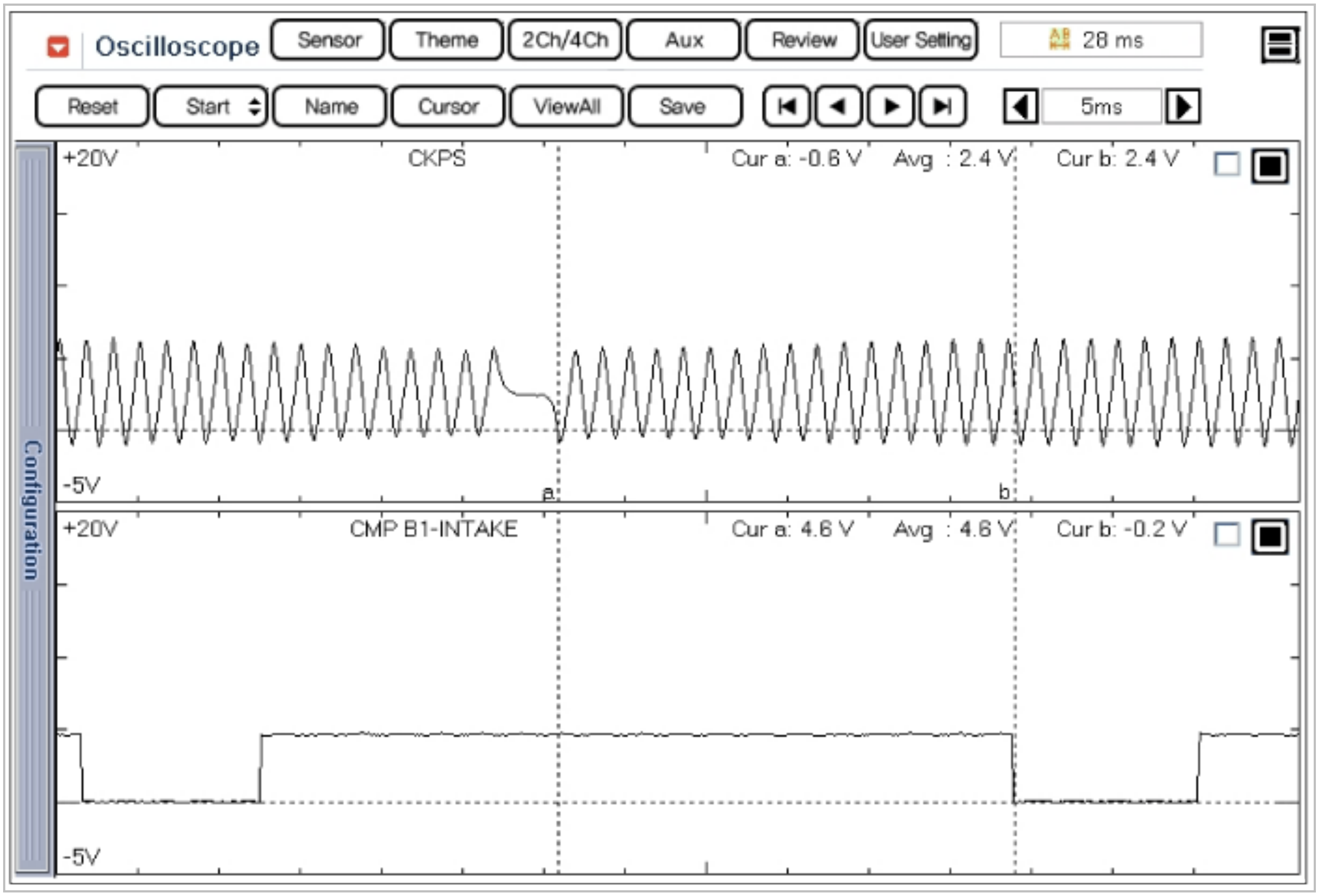
Specification : 1323kPa(13.5 kg/cm²,192 psi)

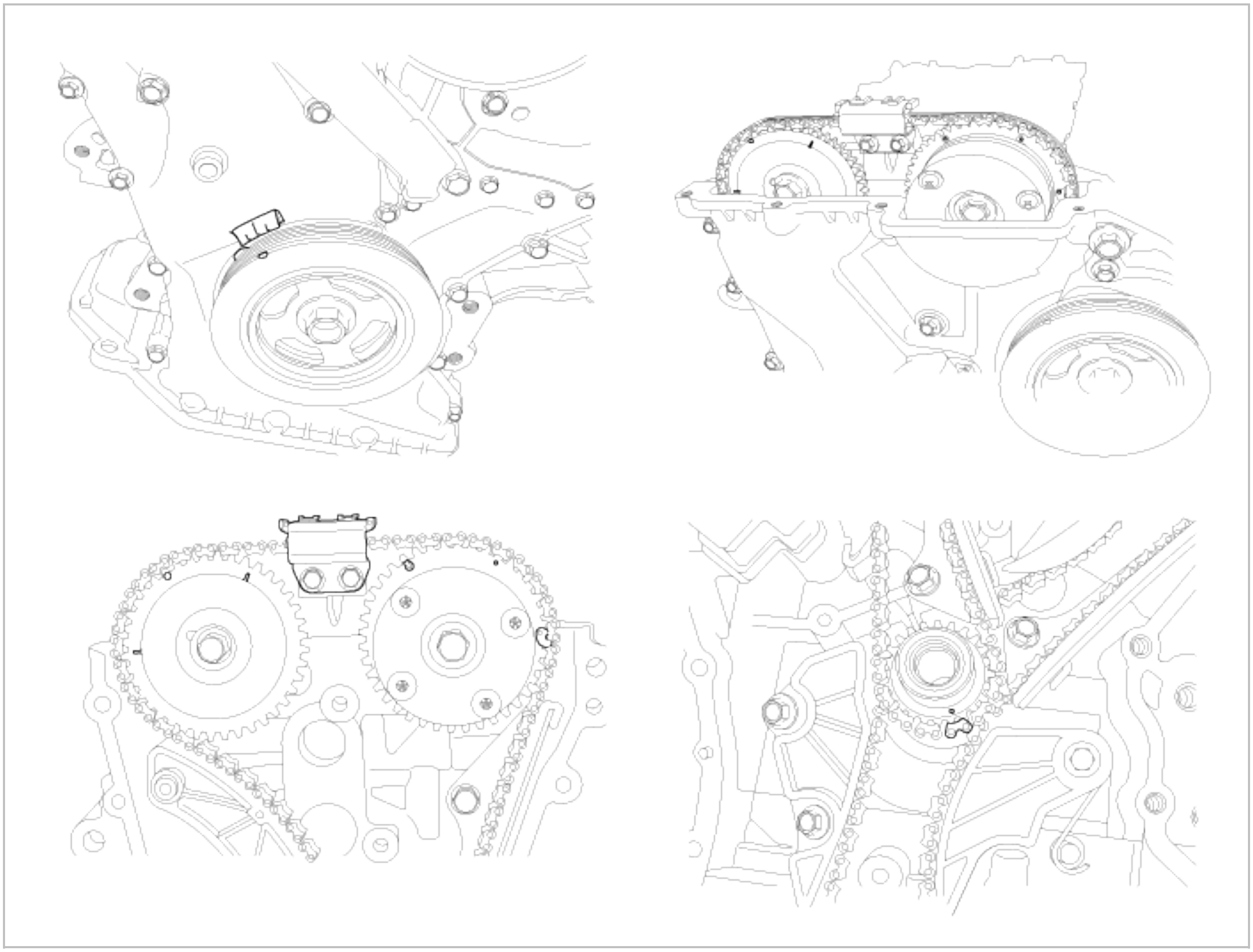
6. Is compression pressure for each cylinder displayed within specifications ?

YES	▶ Go to "Check Timing" as below.
NO	▶ Add a small amount of oil through the spark plug hole, and repeat above steps. If the addition of oil causes the compression to rise, the cause is a worn or damaged piston ring or cylinder inner surface. ▶ If the compression remains the same, the cause is a burnt or defective valve seat, or pressure isleaking from the gasket. Repair as necessary and go to "Verification of Vehicle Repair" procedure

■ Check Timing

1. IG "OFF"
2. Monitor these signal waveforms from CAM and Crank shaft position Sensor are correctly aligned.
   Reference : The 17th of CKP signal from missing tooth is aligned with high of CMP signal.


Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
28 ms
Reset
Start
Name
Cursor
ViewAll
Save
5ms
Configuration
+20V
CKPS
Cur a: -0.6 V
Avg : 2.4 V
Cur b: 2.4 V
-5V
a
b
+20V
CMP B1-INTAKE
Cur a: 4.6 V
Avg : 4.6 V
Cur b: -0.2 V
-5V



3. Are all timing marks alligned correctly ?

YES	▶ Go to "Check Fuel Pressure" as below.
NO	▶ Check that Cam, Crank and Oil pump sprocket timing marks are correctly aligned. Repair or readjust as necessary and go to "Verification of Vehicle Repair" procedure.

■ Check fuel pressure

NOTE

1. Be cautious that Fuel is explosive and an empty fuel tank can still contain explosive gases. When working on fuel system make sure to supply adequate ventilation to the work area. Do not smoke, and keep sparks and open flames away.
2. The fuel system remains under pressure when the engine is not running. Release fuel system pressure before disconnecting any fuel line to reduce the chance of presonal injury or fire damage to vehicle components.

1. IG "OFF" and disconnect Fuel Pump Relay in Junction Box.
2. Start-up and wait until it stops itself.
3. IG "OFF" and connect Fuel Pump Relay.
4. Install the fuel pressure gauge to the delivery pipe with the fuel pressure gauge adaptor.

5. Activate the fuel pump, and with fuel pressure applied, check that there is no fuel leakage from the pressure gauge or connection part.
6. Measure the fuel pressure at idle.

Specification : 374.6 ~ 384.4 kPa(3.82 ~ 3.92 kg/cm², 54.3 ~ 55.8 psi)

---

7. Is the measured fuel pressure within specifications ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Repair or replace according to the below table. And then, go to "Verification of Vehicle Repair"procedure.

Condition	Possible Cause
Fuel Pressure is too low	Fuel filter,fuel pressure regulator, in-tank fuel hose or the fuel pump
Fuel Pressure is too high	Fuel pressure regulator, hose or pipe

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0301 Cylinder 1-Misfire detected

General Description

Misfires can be caused by lack of combustion in a cylinder due to absence of spark, poor fuel metering, poor compression, or many other causes. Even a small number of misfires may result in excessive exhaust emissions due to the unburned mixture. Increased misfire rates cause damage to the catalytic converter. The ECM monitors the crankshaft speed variation to determine if any misfiring generated. The ECM identifies the specific cylinder in which the misfire has occurred and counts individual misfire events by monitoring changes in the crankshaft rotation for each cylinder. A random misfire indicates two or more cylinders are misfiring.

DTC Description

The ECM measures reference event times and calculates the positive and negative acceleration of the crank wheel to detrmine whether a misfire has occurred.
When the rate of misfire exceeds a threshold where the catalyst reaches a temperature where permanent damage can ocur, to the point that tail pipe emissions reach 1.5 times the tailpipe standard or where a cylinder misfire cause a loss of torque produced from that cylinder.
ECM sets this DTC. In case that misfire affects Catalyst damage, MIL(Malfunction Indicatin Lamp) will be illuminating and blinking at 1HZ frequency. However, In case of Indivisual and Emission damaging misfire, MIL will be turned on when the malfunction is detected.

DTC Detecting Condition

<table>
<tr><th colspan="2">Item</th><th>Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td colspan="2">DTC Strategy</td><td>• Determine if a multiple cylinder misfire or a cylinder specific misfire is occurring by monitoring crankshaft acceleration.</td><td rowspan="7">• Faulty Spark plugs
• Faulty Spark plug cables
• Air Leakage
• Belt deflection and Air gap of CKPS
• Incorrect timing
• Faulty injector
• Improper fuel pressure
• Improper engine compression</td></tr>
<tr><td colspan="2">Enable Conditions</td><td>No disabling faults present / no disabiling Active Faults
• P0340 / P0341 / P0118 / P0117 / P0115 / P0336 / P0335 / P1295 / P0103 / P0102 / 0108 / P0107 / P0106 / P0501
• Engine speed between 550 and 5800 RPM
• System voltage between 9 and 18 volts
• The ECT indicates an engine temperature between -6°C(20°F) and 120°C(248°F)</td></tr>
<tr><td rowspan="3">Threshold value</td><td>Case 1</td><td>• Individual cylinder misfire detection</td></tr>
<tr><td>Case 2</td><td>• Emissions damaging - 18 times in 600 ignitions (In case that the misfire affects more than 1.5 times than FTP emissins)</td></tr>
<tr><td>Case 3</td><td>• Catalyst damaging - 95 times in 600 ignitions at idle (It is going to be changeable according to the load or the temperature which is not in the range where it does not melt catalyst)</td></tr>
<tr><td colspan="2">Diagnosis Time</td><td>• Continuous</td></tr>
<tr><td colspan="2">MIL On Condition</td><td>• 2 Driving Cycles</td></tr>
</table>

Signal Waveform & Data

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | VSS

Sensor Name	Value	Unit
☐ Misfire Cycle Delay Reason	No Delay	-
☑ Cylinder 1 Misfire Counter	0	-
☑ Cylinder 2 Misfire Counter	0	-
☑ Cylinder 3 Misfire Counter	0	-
☑ Cylinder 4 Misfire Counter	0	-
☑ Cylinder 5 Misfire Counter	0	-
☑ Cylinder 6 Misfire Counter	0	-
☑ Total Misfire Counts	0	-

Fig.1

Sensor Name	Value	Unit
☐ Misfire Cycle Delay Reason	No Delay	-
☐ Cylinder 1 Misfire Counter	0	-
☐ Cylinder 2 Misfire Counter	62	-
☐ Cylinder 3 Misfire Counter	0	-
☐ Cylinder 4 Misfire Counter	0	-
☐ Cylinder 5 Misfire Counter	0	-
☐ Cylinder 6 Misfire Counter	0	-
☐ Total Misfire Counts	100	-

DTC

Erase All DTC | Freeze Frame | DTC Status | Erase Selective DTC

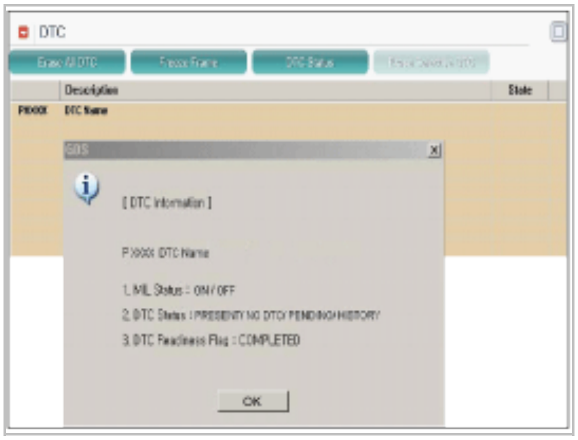
	Description	State
P0264	Cylinder 2 Injector Circuit Low	
P0302	Cylinder 2-Misfire detected	

Fig.2

Fig.1) Normal data of misfire counter at idle.
Fig.2) Abnormal data of misfire counter when cyliner 2 injector open.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "System Inspection" procedure.
NO	▶ Although the misfire does not occur when the vehicle is brought to workshop, misfire can be reproduced when the condition is met. Drive the vehicle according to the freeze frame data in order to satisfy the condition.

System Inspection

■ Check Spark Pulg

1. Remove cylinder's spark plugs
2. Visually/physically inspect the following items:
   - ▶ Damaged insulation, Worn electrodes, Oil or fuel fouled, Loose terminals and cracks
   - ▶ Check for plug gap : 1.0 - 1.1 mm (0.039 - 0.043 in.)
   - ▶ Check if the spark plug for the relevant cylinder is lighter in color than the other plugs.
3. Has a problem been found in any of the above areas ?

YES	▶ Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check Air Leakage" as below.

■ Check Air Leakage

1. Visually/physically inspect the air leakage in intake/exhaust system as following items,
   - ▶ Vacuum hoses for splits, kinks and improper connections.
   - ▶ Throttle body gasket
   - ▶ Gasket between intake manifold and cylinder head
   - ▶ Seals between intake manifold and fuel injectors
   - ▶ Exhaust system between HO2S and Three way catalyst for air leakage
2. Has a problem been found in any of the above areas ?

YES	▶ Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check for air leakage in Positive Crankcase Ventilation Valve(PCV).

■ Check for air leakage in Positive Crankcase Ventilation Valve(PCV)

1. Remove PCV valve from cylinder head cover by puling ventilation hose.
2. With engine idling block PCV valve opening.

3. Verify that vacuum is felt.
4. Remove PCV valve.
5. Blow through valve from prot "A" and verify that air comes out of prot "B".
6. Blow through valve from prot "B" and verifty that no air comes out of port "A".
7. Has a problem been found in any of the above areas ?

YES	▶ Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check Compression pressure" as below.

■ **Check Compression pressure**

1. Warm up the engine to normal operating temperature.
2. Disconnect the spark plug cables and remove the spark plugs.
3. Crank the engine to remove any foreign material in the cylinders.
4. Put compression pressure gauge into spark pulg hole.
5. Crank the engine with widely opend throttle valve and check compression pressure at each cylinder.

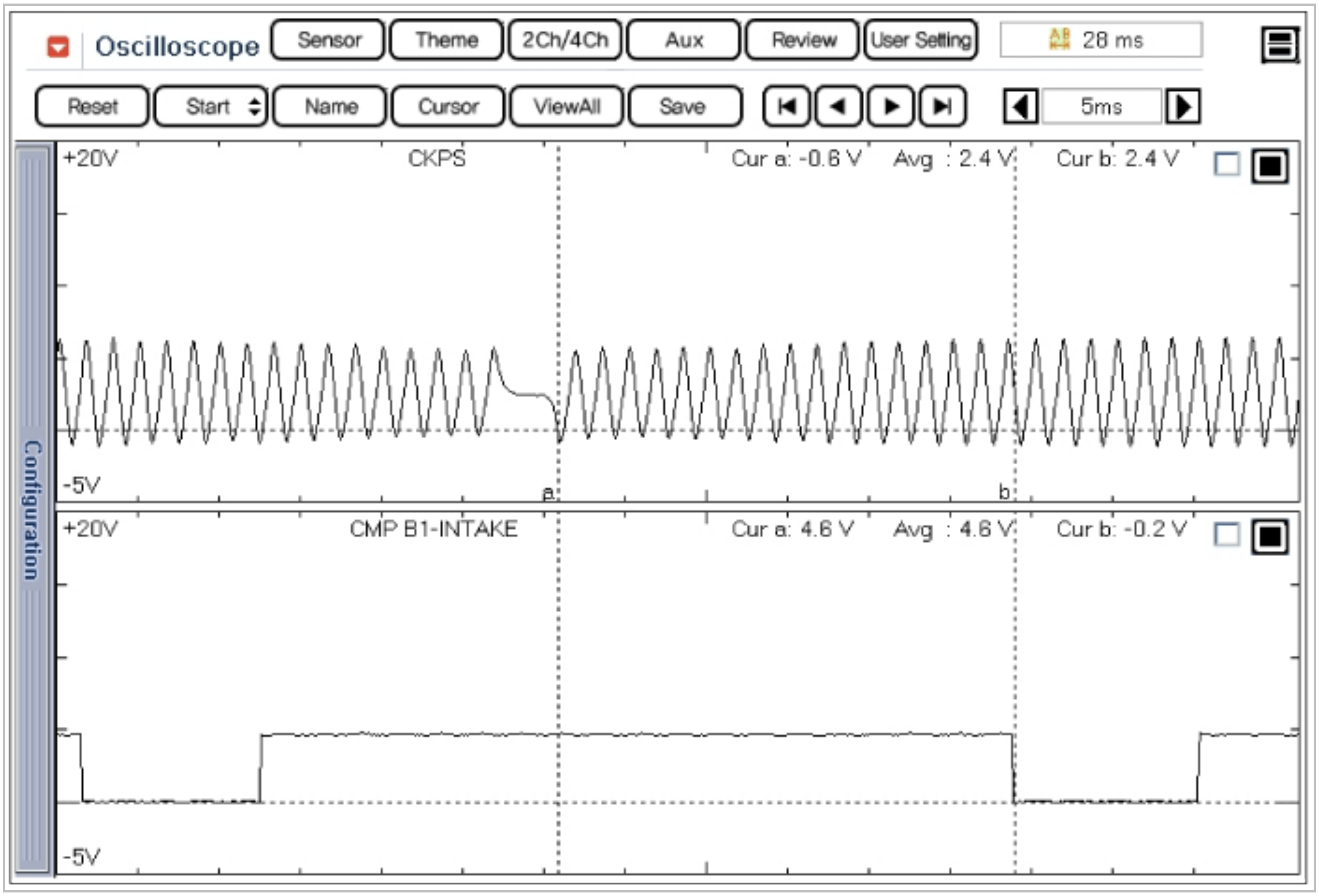
Specification : 1323kPa(13.5 kg/cm²,192 psi)

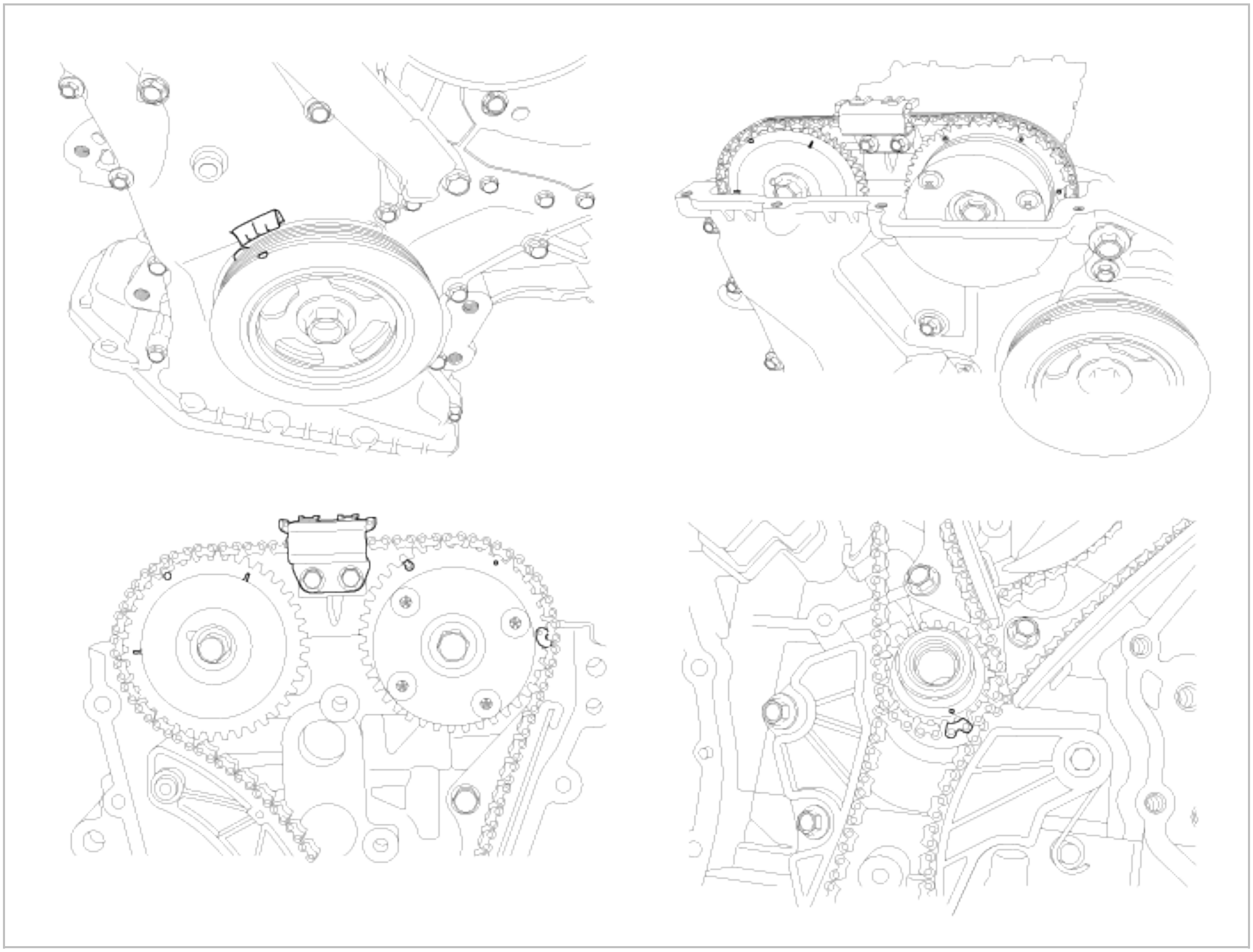
6. Is compression pressure for each cylinder displayed within specifications ?

YES	▶ Go to "Check Timing" as below.
NO	▶ Add a small amount of oil through the spark plug hole, and repeat above steps. If the addition of oil causes the compression to rise, the cause is a worn or damaged piston ring or cylinder inner surface. ▶ If the compression remains the same, the cause is a burnt or defective valve seat, or pressure isleaking from the gasket. Repair as necessary and go to "Verification of Vehicle Repair" procedure

■ **Check Timing**

1. IG "OFF"
2. Monitor these signal waveforms from CAM and Crank shaft position Sensor are correctly aligned.
   Reference : The 17th of CKP signal from missing tooth is aligned with high of CMP signal.


Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
28 ms
Reset
Start
Name
Cursor
ViewAll
Save
5ms
Configuration
+20V
CKPS
Cur a: -0.6 V
Avg : 2.4 V
Cur b: 2.4 V
-5V
a
b
+20V
CMP B1-INTAKE
Cur a: 4.6 V
Avg : 4.6 V
Cur b: -0.2 V
-5V



3. Are all timing marks alligned correctly ?

YES	▶ Go to "Check Fuel Pressure" as below.
NO	▶ Check that Cam, Crank and Oil pump sprocket timing marks are correctly aligned. Repair or readjust as necessary and go to "Verification of Vehicle Repair" procedure.

■ Check fuel pressure

NOTE

1. Be cautious that Fuel is explosive and an empty fuel tank can still contain explosive gases. When working on fuel system make sure to supply adequate ventilation to the work area. Do not smoke, and keep sparks and open flames away.
2. The fuel system remains under pressure when the engine is not running. Release fuel system pressure before disconnecting any fuel line to reduce the chance of presonal injury or fire damage to vehicle components.

1. IG "OFF" and disconnect Fuel Pump Relay in Junction Box.
2. Start-up and wait until it stops itself.
3. IG "OFF" and connect Fuel Pump Relay.
4. Install the fuel pressure gauge to the delivery pipe with the fuel pressure gauge adaptor.

5. Activate the fuel pump, and with fuel pressure applied, check that there is no fuel leakage from the pressure gauge or connection part.
6. Measure the fuel pressure at idle.

Specification : 374.6 ~ 384.4 kPa(3.82 ~ 3.92 kg/cm², 54.3 ~ 55.8 psi)

7. Is the measured fuel pressure within specifications ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Repair or replace according to the below table. And then, go to "Verification of Vehicle Repair"procedure.

Condition	Possible Cause
Fuel Pressure is too low	Fuel filter,fuel pressure regulator, in-tank fuel hose or the fuel pump
Fuel Pressure is too high	Fuel pressure regulator, hose or pipe

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0302 Cylinder 2-Misfire detected

General Description

Misfires can be caused by lack of combustion in a cylinder due to absence of spark, poor fuel metering, poor compression, or many other causes. Even a small number of misfires may result in excessive exhaust emissions due to the unburned mixture. Increased misfire rates cause damage to the catalytic converter. The ECM monitors the crankshaft speed variation to determine if any misfiring generated. The ECM identifies the specific cylinder in which the misfire has occurred and counts individual misfire events by monitoring changes in the crankshaft rotation for each cylinder. A random misfire indicates two or more cylinders are misfiring.

DTC Description

The ECM measures reference event times and calculates the positive and negative acceleration of the crank wheel to detrmine whether a misfire has occurred.
When the rate of misfire exceeds a threshold where the catalyst reaches a temperature where permanent damage can ocur, to the point that tail pipe emissions reach 1.5 times the tailpipe standard or where a cylinder misfire cause a loss of torque produced from that cylinder.
ECM sets this DTC. In case that misfire affects Catalyst damage, MIL(Malfunction Indicatin Lamp) will be illuminating and blinking at 1HZ frequency. However, In case of Indivisual and Emission damaging misfire, MIL will be turned on when the malfunction is detected.

DTC Detecting Condition

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<tr><th colspan="2">Item</th><th>Detecting Condition</th><th>Possible Cause</th></tr>
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• Faulty Spark plug cables
• Air Leakage
• Belt deflection and Air gap of CKPS
• Incorrect timing
• Faulty injector
• Improper fuel pressure
• Improper engine compression</td></tr>
<tr><td colspan="2">Enable Conditions</td><td>No disabling faults present / no disabiling Active Faults
• P0340 / P0341 / P0118 / P0117 / P0115 / P0336 / P0335 / P1295 / P0103 / P0102 / 0108 / P0107 / P0106 / P0501
• Engine speed between 550 and 5800 RPM
• System voltage between 9 and 18 volts
• The ECT indicates an engine temperature between -6°C(20°F) and 120°C(248°F)</td></tr>
<tr><td rowspan="3">Threshold value</td><td>Case 1</td><td>• Individual cylinder misfire detection</td></tr>
<tr><td>Case 2</td><td>• Emissions damaging - 18 times in 600 ignitions (In case that the misfire affects more than 1.5 times than FTP emissins)</td></tr>
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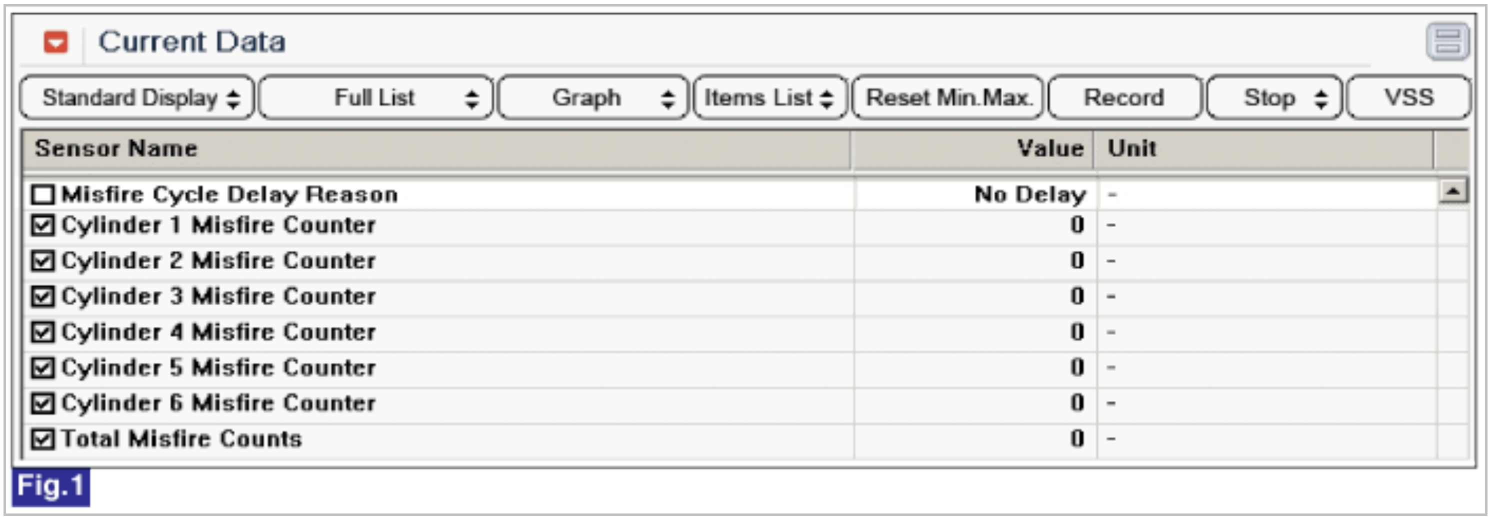
<tr><td colspan="2">Diagnosis Time</td><td>• Continuous</td></tr>
<tr><td colspan="2">MIL On Condition</td><td>• 2 Driving Cycles</td></tr>
</table>

Signal Waveform & Data



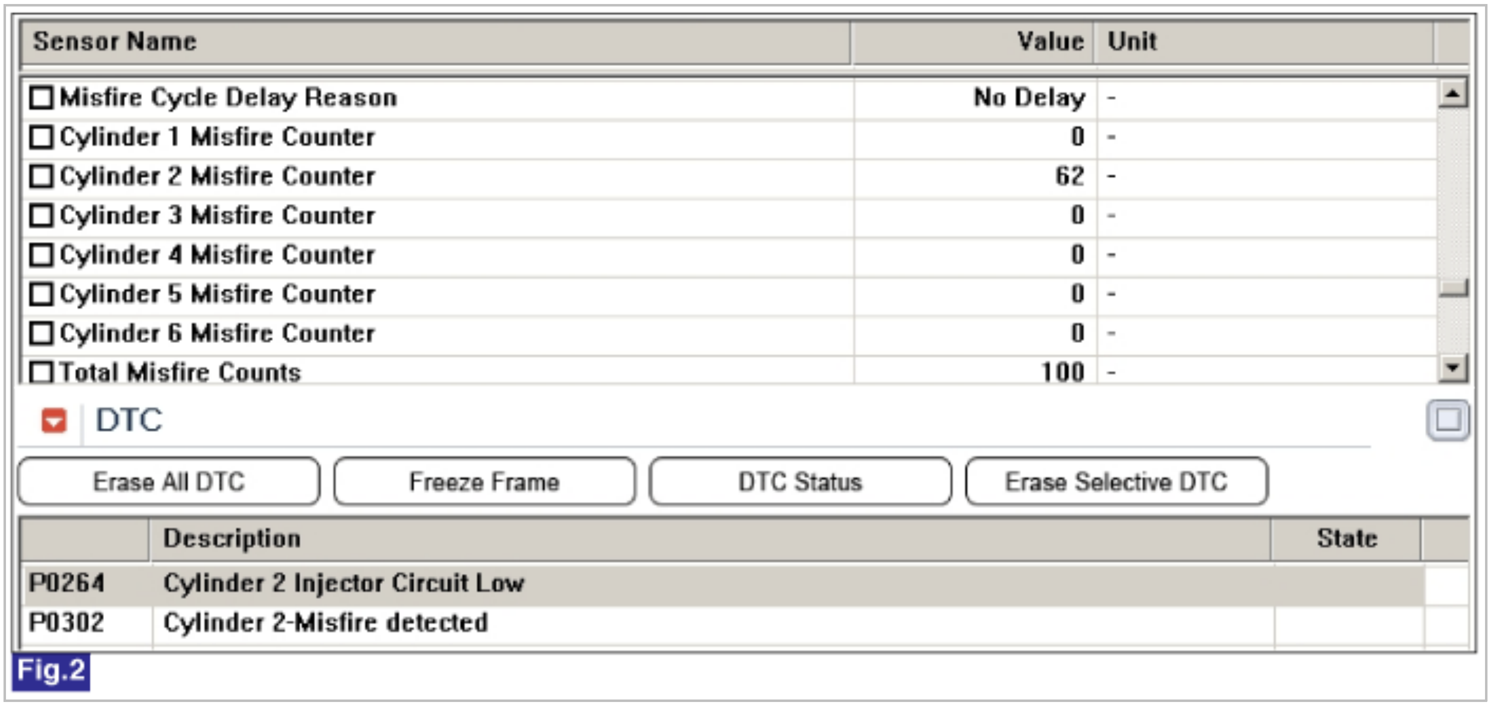
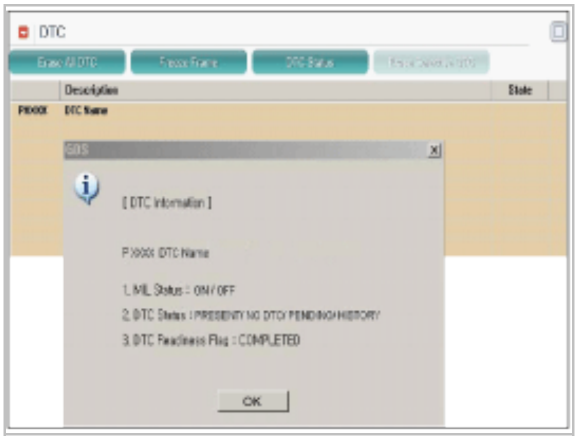


Fig.1) Normal data of misfire counter at idle.
Fig.2) Abnormal data of misfire counter when cyliner 2 injector open.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "System Inspection" procedure.
NO	▶ Although the misfire does not occur when the vehicle is brought to workshop, misfire can be reproduced when the condition is met. Drive the vehicle according to the freeze frame data in order to satisfy the condition.

System Inspection

■ Check Spark Pulg

1. Remove cylinder's spark plugs
2. Visually/physically inspect the following items:
   ▶ Damaged insulation, Worn electrodes, Oil or fuel fouled, Loose terminals and cracks
   ▶ Check for plug gap : 1.0 - 1.1 mm (0.039 - 0.043 in.)
   ▶ Check if the spark plug for the relevant cylinder is lighter in color than the other plugs.
3. Has a problem been found in any of the above areas ?

YES	▶ Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check Air Leakage" as below.

■ Check Air Leakage

1. Visually/physically inspect the air leakage in intake/exhaust system as following items,
   ▶ Vacuum hoses for splits, kinks and improper connections.
   ▶ Throttle body gasket
   ▶ Gasket between intake manifold and cylinder head
   ▶ Seals between intake manifold and fuel injectors
   ▶ Exhaust system between HO2S and Three way catalyst for air leakage
2. Has a problem been found in any of the above areas ?

YES	▶ Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check for air leakage in Positive Crankcase Ventilation Valve(PCV).

■ Check for air leakage in Positive Crankcase Ventilation Valve(PCV)

1. Remove PCV valve from cylinder head cover by puling ventilation hose.
2. With engine idling block PCV valve opening.

3. Verify that vacuum is felt.
4. Remove PCV valve.
5. Blow through valve from prot "A" and verify that air comes out of prot "B".
6. Blow through valve from prot "B" and verifty that no air comes out of port "A".
7. Has a problem been found in any of the above areas ?

YES	▶ Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check Compression pressure" as below.

■ **Check Compression pressure**

1. Warm up the engine to normal operating temperature.
2. Disconnect the spark plug cables and remove the spark plugs.
3. Crank the engine to remove any foreign material in the cylinders.
4. Put compression pressure gauge into spark pulg hole.
5. Crank the engine with widely opend throttle valve and check compression pressure at each cylinder.

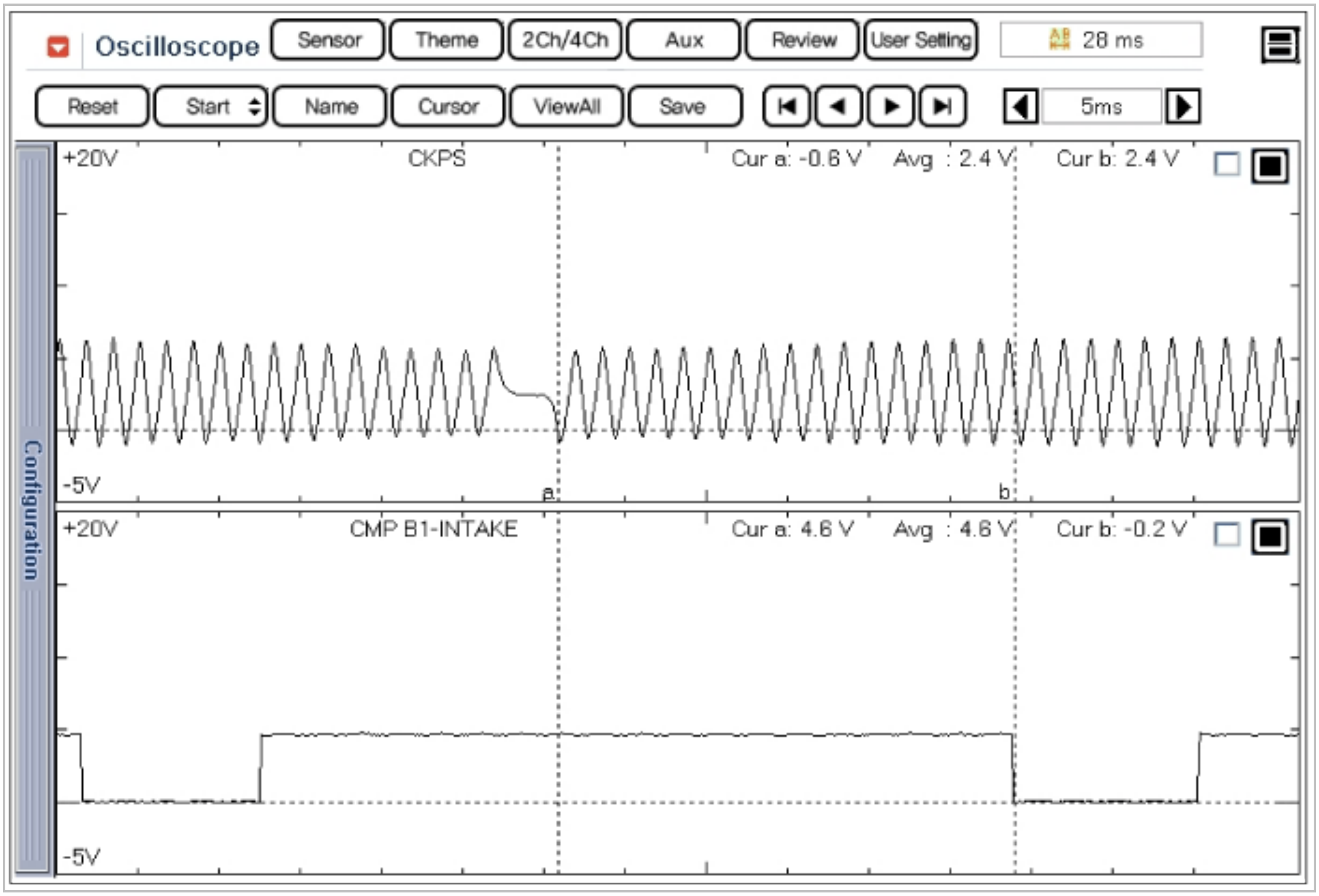
Specification : 1323kPa(13.5 kg/cm²,192 psi)

6. Is compression pressure for each cylinder displayed within specifications ?

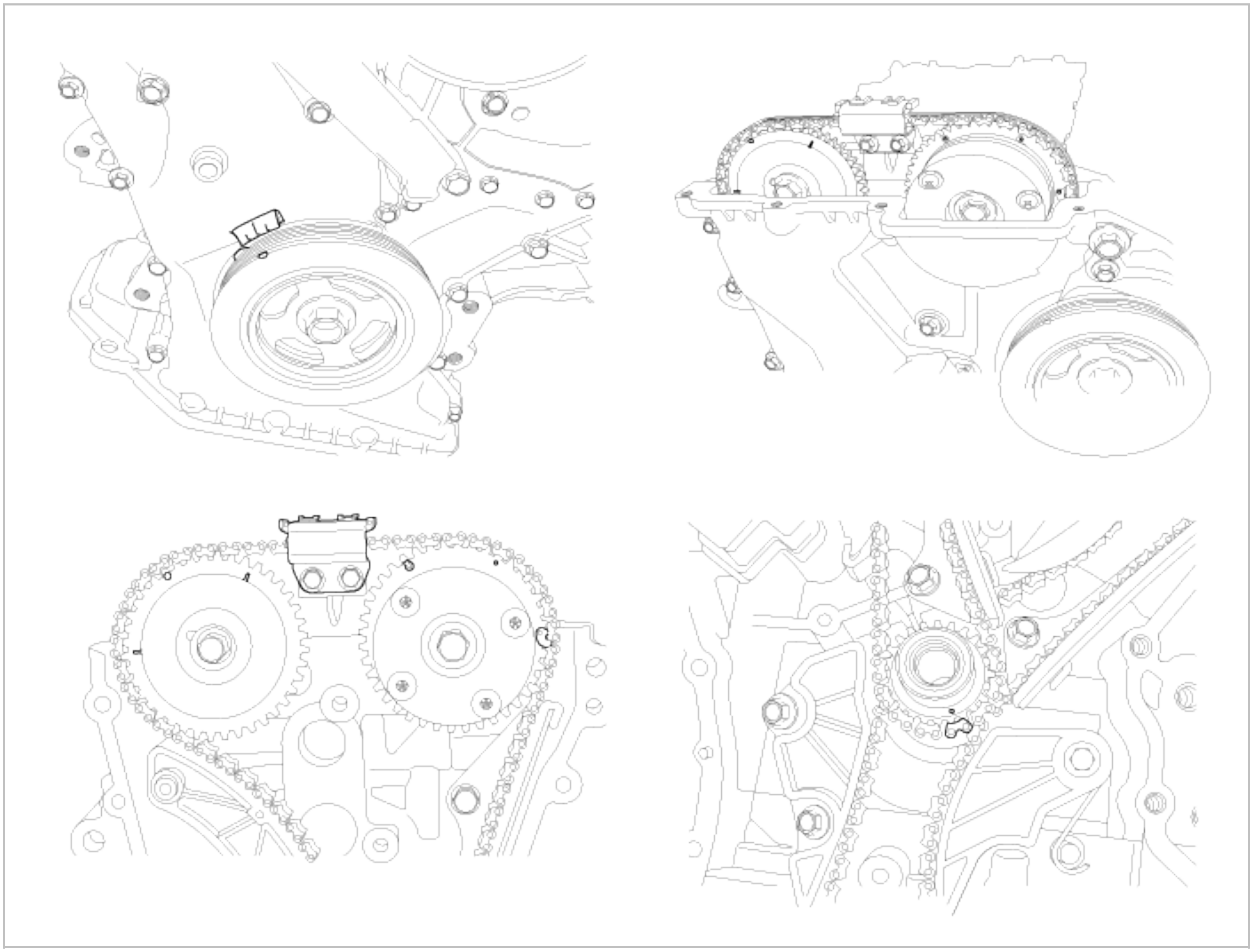
YES	▶ Go to "Check Timing" as below.
NO	▶ Add a small amount of oil through the spark plug hole, and repeat above steps. If the addition of oil causes the compression to rise, the cause is a worn or damaged piston ring or cylinder inner surface. ▶ If the compression remains the same, the cause is a burnt or defective valve seat, or pressure isleaking from the gasket. Repair as necessary and go to "Verification of Vehicle Repair" procedure

■ **Check Timing**

1. IG "OFF"
2. Monitor these signal waveforms from CAM and Crank shaft position Sensor are correctly aligned.
   Reference : The 17th of CKP signal from missing tooth is aligned with high of CMP signal.



Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
28 ms
Reset
Start
Name
Cursor
ViewAll
Save
5ms
Configuration
+20V
CKPS
Cur a: -0.6 V
Avg : 2.4 V
Cur b: 2.4 V
-5V
a
b
+20V
CMP B1-INTAKE
Cur a: 4.6 V
Avg : 4.6 V
Cur b: -0.2 V
-5V



3. Are all timing marks alligned correctly ?

YES	▶ Go to "Check Fuel Pressure" as below.
NO	▶ Check that Cam, Crank and Oil pump sprocket timing marks are correctly aligned. Repair or readjust as necessary and go to "Verification of Vehicle Repair" procedure.

■ Check fuel pressure

NOTE

1. Be cautious that Fuel is explosive and an empty fuel tank can still contain explosive gases. When working on fuel system make sure to supply adequate ventilation to the work area. Do not smoke, and keep sparks and open flames away.
2. The fuel system remains under pressure when the engine is not running. Release fuel system pressure before disconnecting any fuel line to reduce the chance of presonal injury or fire damage to vehicle components.

1. IG "OFF" and disconnect Fuel Pump Relay in Junction Box.
2. Start-up and wait until it stops itself.
3. IG "OFF" and connect Fuel Pump Relay.
4. Install the fuel pressure gauge to the delivery pipe with the fuel pressure gauge adaptor.

5. Activate the fuel pump, and with fuel pressure applied, check that there is no fuel leakage from the pressure gauge or connection part.
6. Measure the fuel pressure at idle.

Specification : 374.6 ~ 384.4 kPa(3.82 ~ 3.92 kg/cm², 54.3 ~ 55.8 psi)

7. Is the measured fuel pressure within specifications ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Repair or replace according to the below table. And then, go to "Verification of Vehicle Repair"procedure.

Condition	Possible Cause
Fuel Pressure is too low	Fuel filter,fuel pressure regulator, in-tank fuel hose or the fuel pump
Fuel Pressure is too high	Fuel pressure regulator, hose or pipe

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0303 Cylinder 3-Misfire detected

General Description

Misfires can be caused by lack of combustion in a cylinder due to absence of spark, poor fuel metering, poor compression, or many other causes. Even a small number of misfires may result in excessive exhaust emissions due to the unburned mixture. Increased misfire rates cause damage to the catalytic converter. The ECM monitors the crankshaft speed variation to determine if any misfiring generated. The ECM identifies the specific cylinder in which the misfire has occurred and counts individual misfire events by monitoring changes in the crankshaft rotation for each cylinder. A random misfire indicates two or more cylinders are misfiring.

DTC Description

The ECM measures reference event times and calculates the positive and negative acceleration of the crank wheel to detrmine whether a misfire has occurred.
When the rate of misfire exceeds a threshold where the catalyst reaches a temperature where permanent damage can ocur, to the point that tail pipe emissions reach 1.5 times the tailpipe standard or where a cylinder misfire cause a loss of torque produced from that cylinder.
ECM sets this DTC. In case that misfire affects Catalyst damage, MIL(Malfunction Indicatin Lamp) will be illuminating and blinking at 1HZ frequency. However, In case of Indivisual and Emission damaging misfire, MIL will be turned on when the malfunction is detected.

DTC Detecting Condition

Item		Detecting Condition	Possible Cause
DTC Strategy		• Determine if a multiple cylinder misfire or a cylinder specific misfire is occurring by monitoring crankshaft acceleration.	• Faulty Spark plugs • Faulty Spark plug cables • Air Leakage • Belt deflection and Air gap of CKPS • Incorrect timing • Faulty injector • Improper fuel pressure • Improper engine compression
Enable Conditions		No disabling faults present / no disabiling Active Faults • P0340 / P0341 / P0118 / P0117 / P0115 / P0336 / P0335 / P1295 / P0103 / P0102 / 0108 / P0107 / P0106 / P0501 • Engine speed between 550 and 5800 RPM • System voltage between 9 and 18 volts • The ECT indicates an engine temperature between -6°C(20°F) and 120°C(248°F)	
Threshold value	Case 1	• Individual cylinder misfire detection	
	Case 2	• Emissions damaging - 18 times in 600 ignitions (In case that the misfire affects more than 1.5 times than FTP emissins)	
	Case 3	• Catalyst damaging - 95 times in 600 ignitions at idle (It is going to be changeable according to the load or the temperature which is not in the range where it does not melt catalyst)	
Diagnosis Time		• Continuous	
MIL On Condition		• 2 Driving Cycles	

Signal Waveform & Data

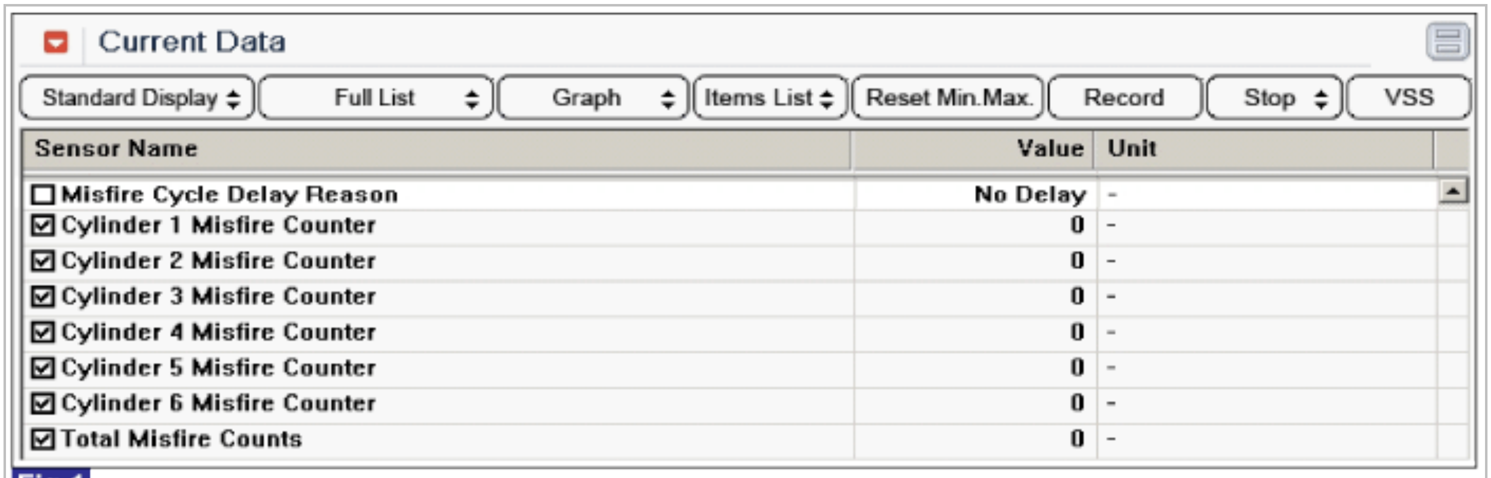


Fig.1

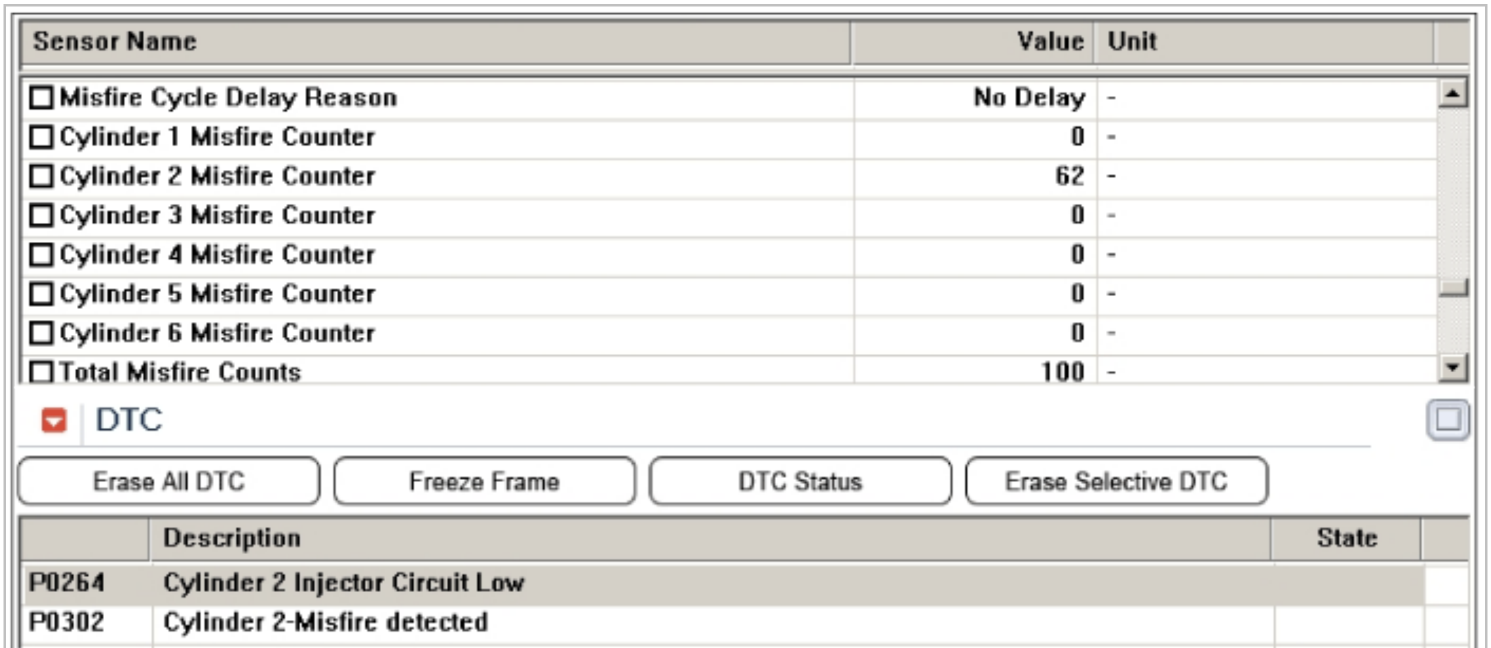
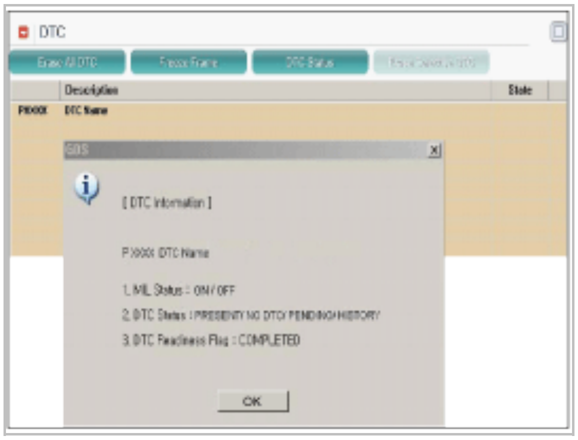


Fig.2

Fig.1) Normal data of misfire counter at idle.
Fig.2) Abnormal data of misfire counter when cyliner 2 injector open.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "System Inspection" procedure.
NO	▶ Although the misfire does not occur when the vehicle is brought to workshop, misfire can be reproduced when the condition is met. Drive the vehicle according to the freeze frame data in order to satisfy the condition.

System Inspection

■ Check Spark Pulg

1. Remove cylinder's spark plugs
2. Visually/physically inspect the following items:
   ▶ Damaged insulation, Worn electrodes, Oil or fuel fouled, Loose terminals and cracks
   ▶ Check for plug gap : 1.0 - 1.1 mm (0.039 - 0.043 in.)
   ▶ Check if the spark plug for the relevant cylinder is lighter in color than the other plugs.
3. Has a problem been found in any of the above areas ?

YES	▶ Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check Air Leakage" as below.

■ Check Air Leakage

1. Visually/physically inspect the air leakage in intake/exhaust system as following items,
   ▶ Vacuum hoses for splits, kinks and improper connections.
   ▶ Throttle body gasket
   ▶ Gasket between intake manifold and cylinder head
   ▶ Seals between intake manifold and fuel injectors
   ▶ Exhaust system between HO2S and Three way catalyst for air leakage
2. Has a problem been found in any of the above areas ?

YES	▶ Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check for air leakage in Positive Crankcase Ventilation Valve(PCV).

■ Check for air leakage in Positive Crankcase Ventilation Valve(PCV)

1. Remove PCV valve from cylinder head cover by puling ventilation hose.
2. With engine idling block PCV valve opening.

3. Verify that vacuum is felt.
4. Remove PCV valve.
5. Blow through valve from prot "A" and verify that air comes out of prot "B".
6. Blow through valve from prot "B" and verifty that no air comes out of port "A".
7. Has a problem been found in any of the above areas ?

YES	▶ Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check Compression pressure" as below.

■ Check Compression pressure

1. Warm up the engine to normal operating temperature.
2. Disconnect the spark plug cables and remove the spark plugs.
3. Crank the engine to remove any foreign material in the cylinders.
4. Put compression pressure gauge into spark pulg hole.
5. Crank the engine with widely opend throttle valve and check compression pressure at each cylinder.

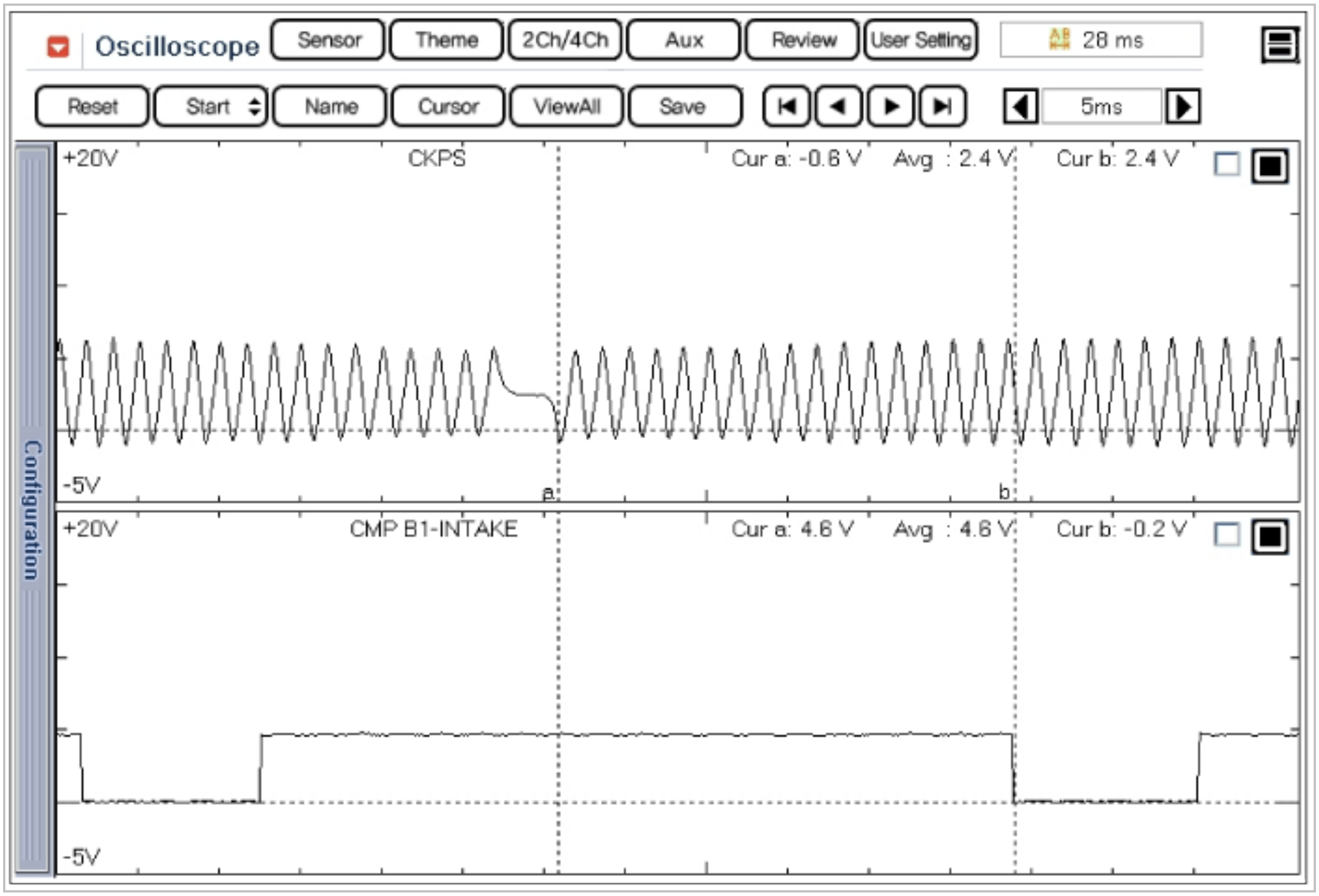
Specification : 1323kPa(13.5 kg/cm²,192 psi)

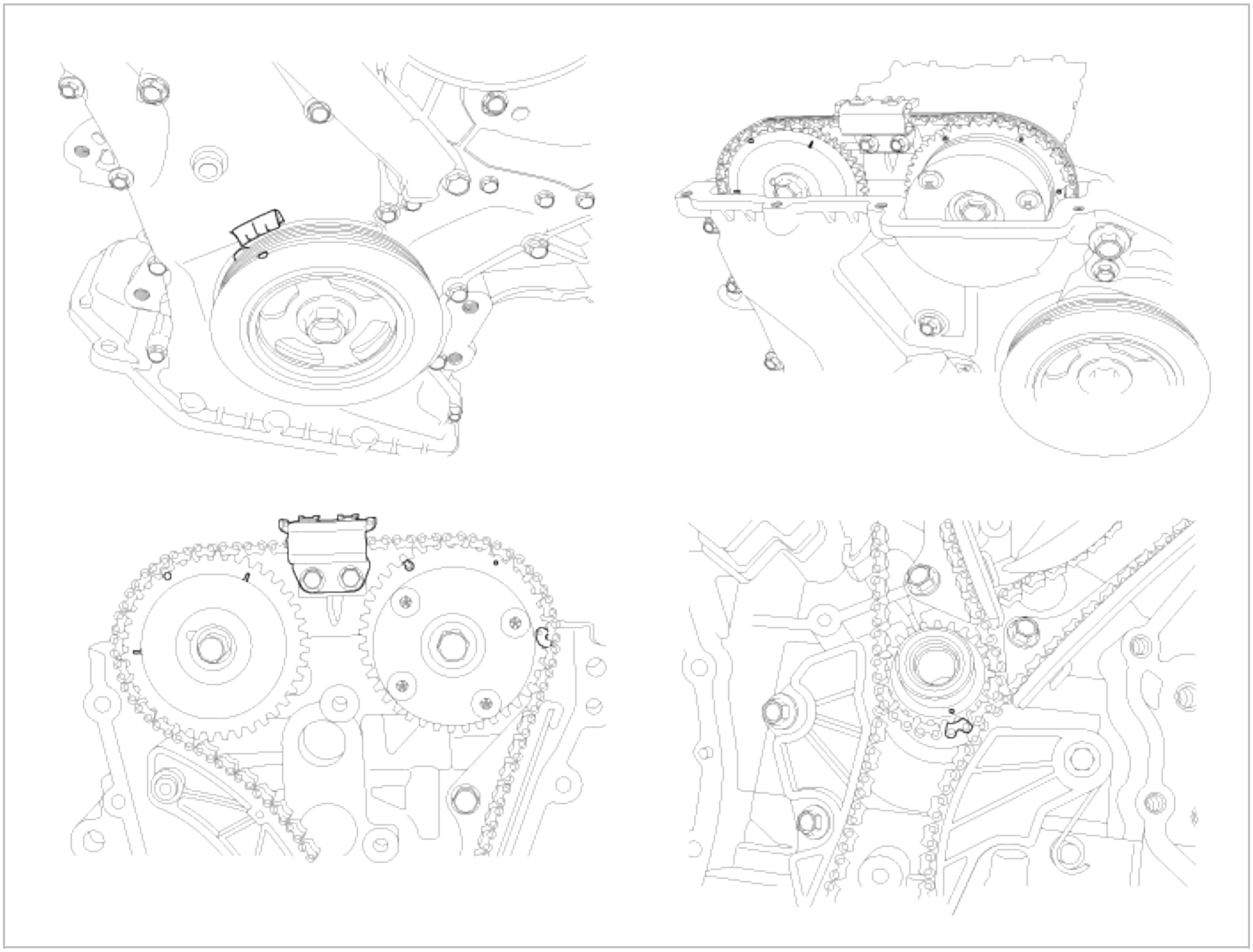
6. Is compression pressure for each cylinder displayed within specifications ?

YES	▶ Go to "Check Timing" as below.
NO	▶ Add a small amount of oil through the spark plug hole, and repeat above steps. If the addition of oil causes the compression to rise, the cause is a worn or damaged piston ring or cylinder inner surface. ▶ If the compression remains the same, the cause is a burnt or defective valve seat, or pressure isleaking from the gasket. Repair as necessary and go to "Verification of Vehicle Repair" procedure

■ Check Timing

1. IG "OFF"
2. Monitor these signal waveforms from CAM and Crank shaft position Sensor are correctly aligned.
   Reference : The 17th of CKP signal from missing tooth is aligned with high of CMP signal.


Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
28 ms
Reset
Start
Name
Cursor
ViewAll
Save
5ms
Configuration
+20V
CKPS
Cur a: -0.6 V
Avg : 2.4 V
Cur b: 2.4 V
-5V
a
b
+20V
CMP B1-INTAKE
Cur a: 4.6 V
Avg : 4.6 V
Cur b: -0.2 V
-5V



3. Are all timing marks alligned correctly ?

YES	▶ Go to "Check Fuel Pressure" as below.
NO	▶ Check that Cam, Crank and Oil pump sprocket timing marks are correctly aligned. Repair or readjust as necessary and go to "Verification of Vehicle Repair" procedure.

■ Check fuel pressure

NOTE

1. Be cautious that Fuel is explosive and an empty fuel tank can still contain explosive gases. When working on fuel system make sure to supply adequate ventilation to the work area. Do not smoke, and keep sparks and open flames away.
2. The fuel system remains under pressure when the engine is not running. Release fuel system pressure before disconnecting any fuel line to reduce the chance of presonal injury or fire damage to vehicle components.

1. IG "OFF" and disconnect Fuel Pump Relay in Junction Box.
2. Start-up and wait until it stops itself.
3. IG "OFF" and connect Fuel Pump Relay.
4. Install the fuel pressure gauge to the delivery pipe with the fuel pressure gauge adaptor.

5. Activate the fuel pump, and with fuel pressure applied, check that there is no fuel leakage from the pressure gauge or connection part.
6. Measure the fuel pressure at idle.

Specification : 374.6 ~ 384.4 kPa(3.82 ~ 3.92 kg/cm², 54.3 ~ 55.8 psi)

7. Is the measured fuel pressure within specifications ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Repair or replace according to the below table. And then, go to "Verification of Vehicle Repair"procedure.

Condition	Possible Cause
Fuel Pressure is too low	Fuel filter,fuel pressure regulator, in-tank fuel hose or the fuel pump
Fuel Pressure is too high	Fuel pressure regulator, hose or pipe

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0304 Cylinder 4-Misfire detected

General Description

Misfires can be caused by lack of combustion in a cylinder due to absence of spark, poor fuel metering, poor compression, or many other causes. Even a small number of misfires may result in excessive exhaust emissions due to the unburned mixture. Increased misfire rates cause damage to the catalytic converter. The ECM monitors the crankshaft speed variation to determine if any misfiring generated. The ECM identifies the specific cylinder in which the misfire has occurred and counts individual misfire events by monitoring changes in the crankshaft rotation for each cylinder. A random misfire indicates two or more cylinders are misfiring.

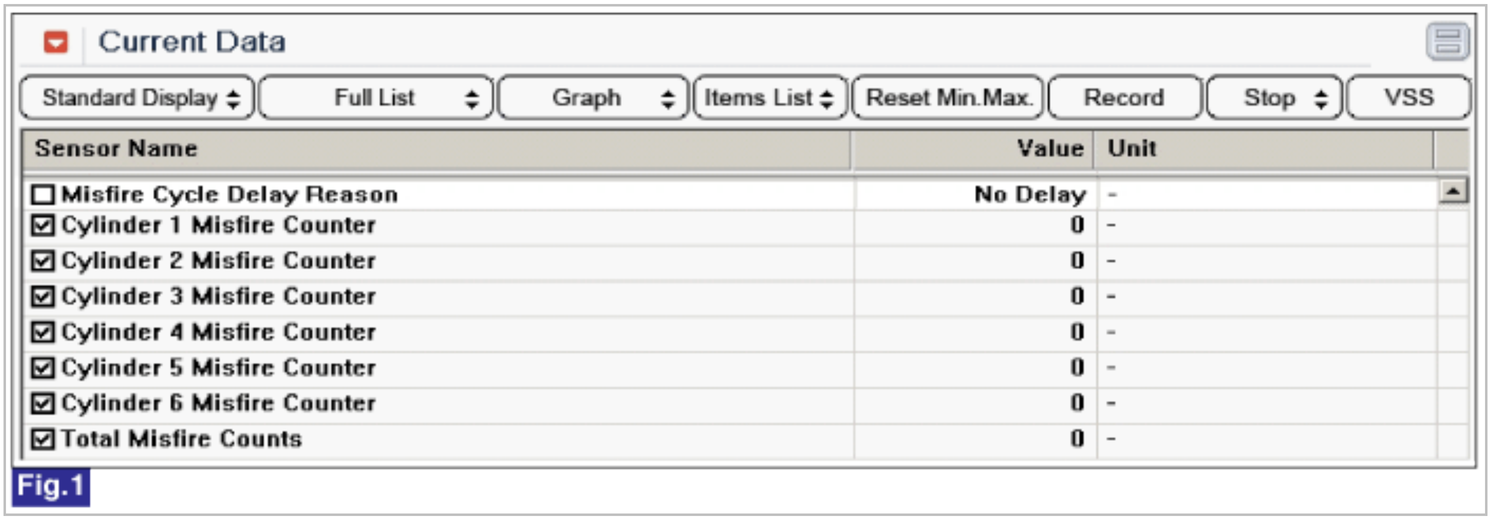
DTC Description

The ECM measures reference event times and calculates the positive and negative acceleration of the crank wheel to detrmine whether a misfire has occurred.
When the rate of misfire exceeds a threshold where the catalyst reaches a temperature where permanent damage can ocur, to the point that tail pipe emissions reach 1.5 times the tailpipe standard or where a cylinder misfire cause a loss of torque produced from that cylinder.
ECM sets this DTC. In case that misfire affects Catalyst damage, MIL(Malfunction Indicatin Lamp) will be illuminating and blinking at 1HZ frequency. However, In case of Indivisual and Emission damaging misfire, MIL will be turned on when the malfunction is detected.

DTC Detecting Condition

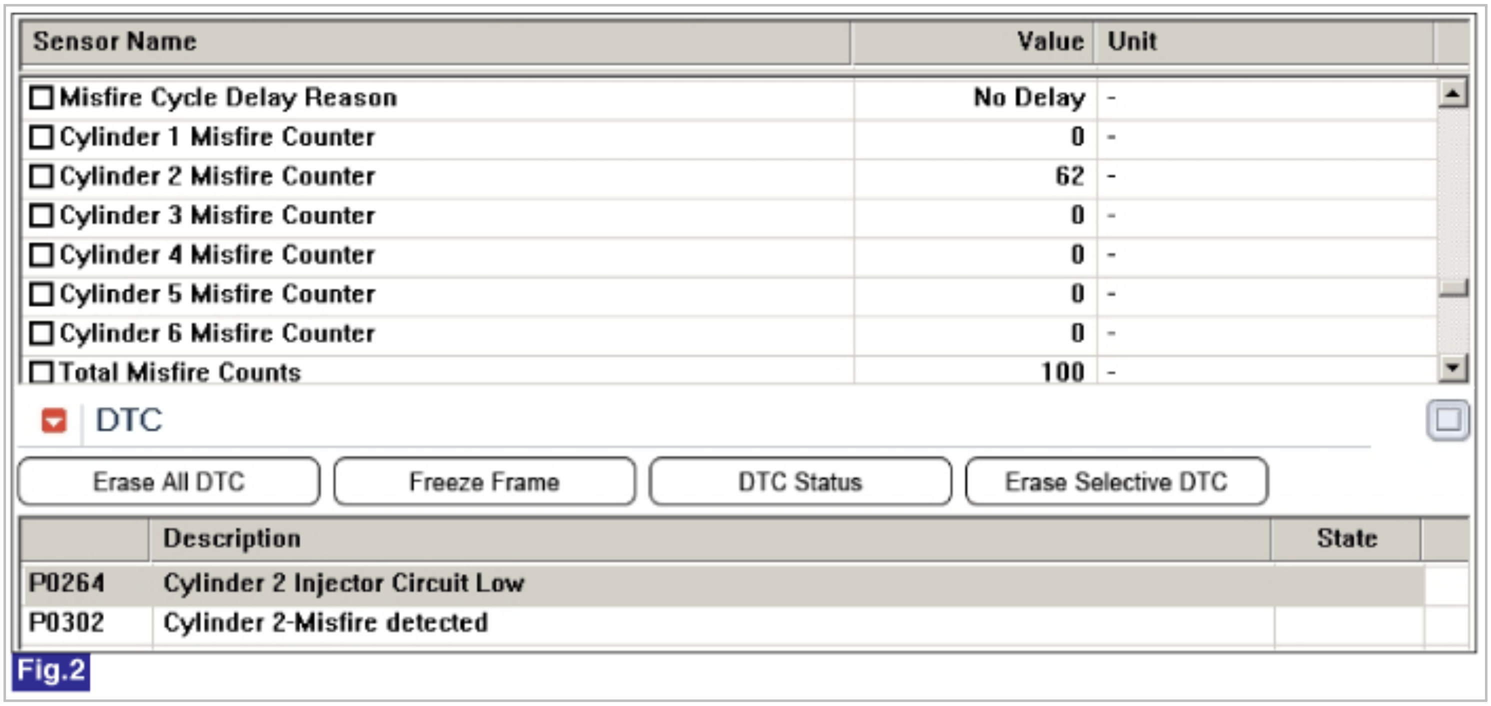
<table>
<tr><th colspan="2">Item</th><th>Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td colspan="2">DTC Strategy</td><td>• Determine if a multiple cylinder misfire or a cylinder specific misfire is occurring by monitoring crankshaft acceleration.</td><td rowspan="7">• Faulty Spark plugs
• Faulty Spark plug cables
• Air Leakage
• Belt deflection and Air gap of CKPS
• Incorrect timing
• Faulty injector
• Improper fuel pressure
• Improper engine compression</td></tr>
<tr><td colspan="2">Enable Conditions</td><td>No disabling faults present / no disabiling Active Faults
• P0340 / P0341 / P0118 / P0117 / P0115 / P0336 / P0335 / P1295 / P0103 / P0102 / 0108 / P0107 / P0106 / P0501
• Engine speed between 550 and 5800 RPM
• System voltage between 9 and 18 volts
• The ECT indicates an engine temperature between -6°C(20°F) and 120°C(248°F)</td></tr>
<tr><td rowspan="3">Threshold value</td><td>Case 1</td><td>• Individual cylinder misfire detection</td></tr>
<tr><td>Case 2</td><td>• Emissions damaging - 18 times in 600 ignitions (In case that the misfire affects more than 1.5 times than FTP emissins)</td></tr>
<tr><td>Case 3</td><td>• Catalyst damaging - 95 times in 600 ignitions at idle (It is going to be changeable according to the load or the temperature which is not in the range where it does not melt catalyst)</td></tr>
<tr><td colspan="2">Diagnosis Time</td><td>• Continuous</td></tr>
<tr><td colspan="2">MIL On Condition</td><td>• 2 Driving Cycles</td></tr>
</table>

Signal Waveform & Data



Sensor Name	Value	Unit
Misfire Cycle Delay Reason	No Delay	-
Cylinder 1 Misfire Counter	0	-
Cylinder 2 Misfire Counter	0	-
Cylinder 3 Misfire Counter	0	-
Cylinder 4 Misfire Counter	0	-
Cylinder 5 Misfire Counter	0	-
Cylinder 6 Misfire Counter	0	-
Total Misfire Counts	0	-

Fig.1



Sensor Name	Value	Unit
Misfire Cycle Delay Reason	No Delay	-
Cylinder 1 Misfire Counter	0	-
Cylinder 2 Misfire Counter	62	-
Cylinder 3 Misfire Counter	0	-
Cylinder 4 Misfire Counter	0	-
Cylinder 5 Misfire Counter	0	-
Cylinder 6 Misfire Counter	0	-
Total Misfire Counts	100	-

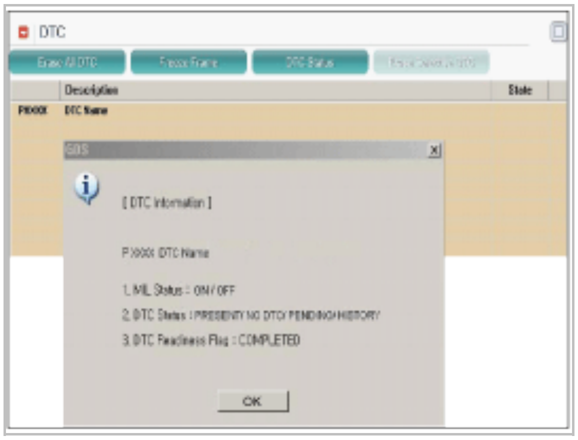
	Description	State
P0264	Cylinder 2 Injector Circuit Low	
P0302	Cylinder 2-Misfire detected	

Fig.2

Fig.1) Normal data of misfire counter at idle.
Fig.2) Abnormal data of misfire counter when cyliner 2 injector open.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "System Inspection" procedure.
NO	▶ Although the misfire does not occur when the vehicle is brought to workshop, misfire can be reproduced when the condition is met. Drive the vehicle according to the freeze frame data in order to satisfy the condition.

System Inspection

■ Check Spark Pulg

1. Remove cylinder’s spark plugs
2. Visually/physically inspect the following items:
   ▶ Damaged insulation, Worn electrodes, Oil or fuel fouled, Loose terminals and cracks
   ▶ Check for plug gap : 1.0 - 1.1 mm (0.039 - 0.043 in.)
   ▶ Check if the spark plug for the relevant cylinder is lighter in color than the other plugs.
3. Has a problem been found in any of the above areas ?

YES	▶ Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check Air Leakage" as below.

■ Check Air Leakage

1. Visually/physically inspect the air leakage in intake/exhaust system as following items,
   ▶ Vacuum hoses for splits, kinks and improper connections.
   ▶ Throttle body gasket
   ▶ Gasket between intake manifold and cylinder head
   ▶ Seals between intake manifold and fuel injectors
   ▶ Exhaust system between HO2S and Three way catalyst for air leakage
2. Has a problem been found in any of the above areas ?

YES	▶ Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check for air leakage in Positive Crankcase Ventilation Valve(PCV).

■ Check for air leakage in Positive Crankcase Ventilation Valve(PCV)

1. Remove PCV valve from cylinder head cover by puling ventilation hose.
2. With engine idling block PCV valve opening.

3. Verify that vacuum is felt.
4. Remove PCV valve.
5. Blow through valve from prot "A" and verify that air comes out of prot "B".
6. Blow through valve from prot "B" and verifty that no air comes out of port "A".
7. Has a problem been found in any of the above areas ?

YES	▶ Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check Compression pressure" as below.

■ **Check Compression pressure**

1. Warm up the engine to normal operating temperature.
2. Disconnect the spark plug cables and remove the spark plugs.
3. Crank the engine to remove any foreign material in the cylinders.
4. Put compression pressure gauge into spark pulg hole.
5. Crank the engine with widely opend throttle valve and check compression pressure at each cylinder.

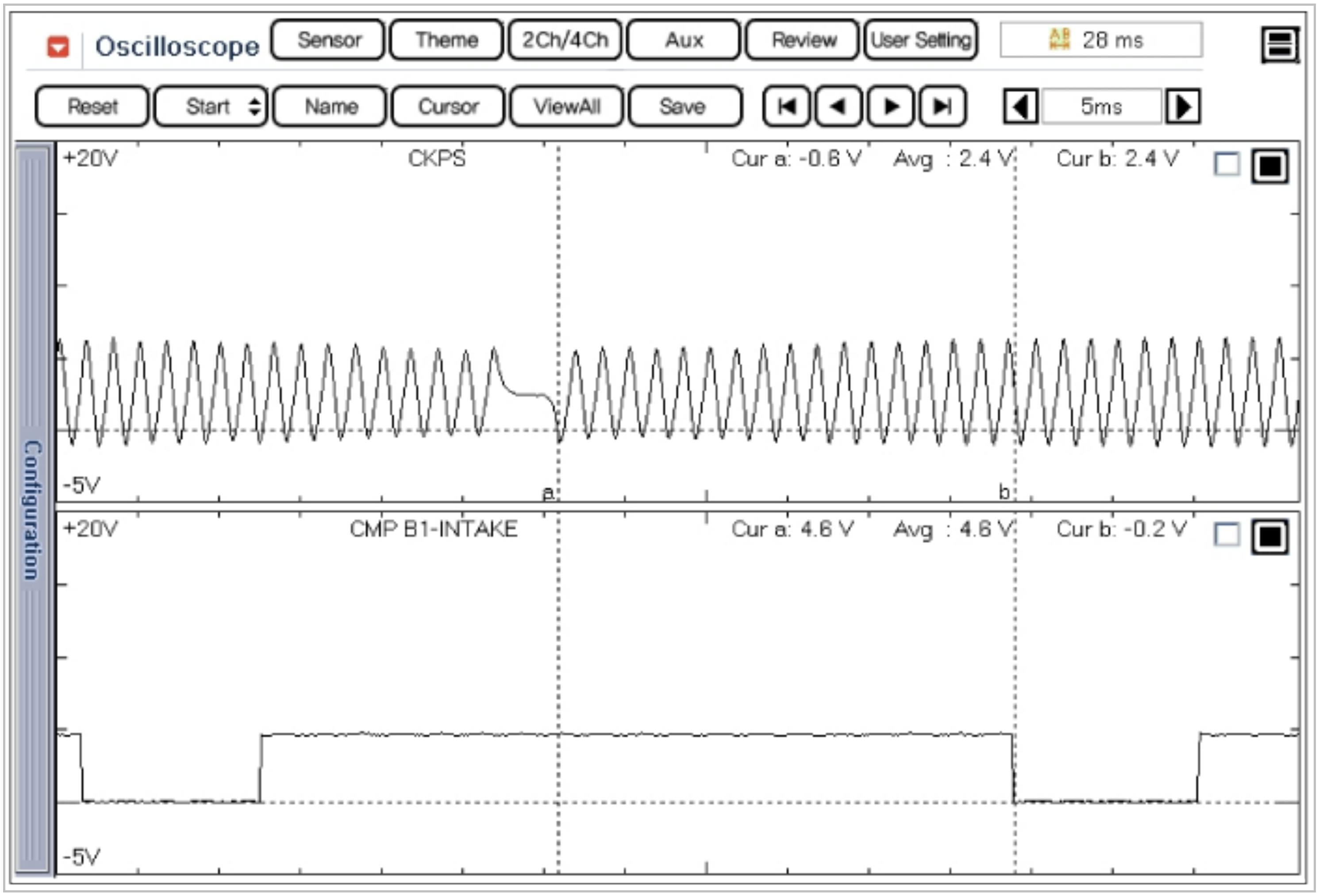
Specification : 1323kPa(13.5 kg/cm²,192 psi)

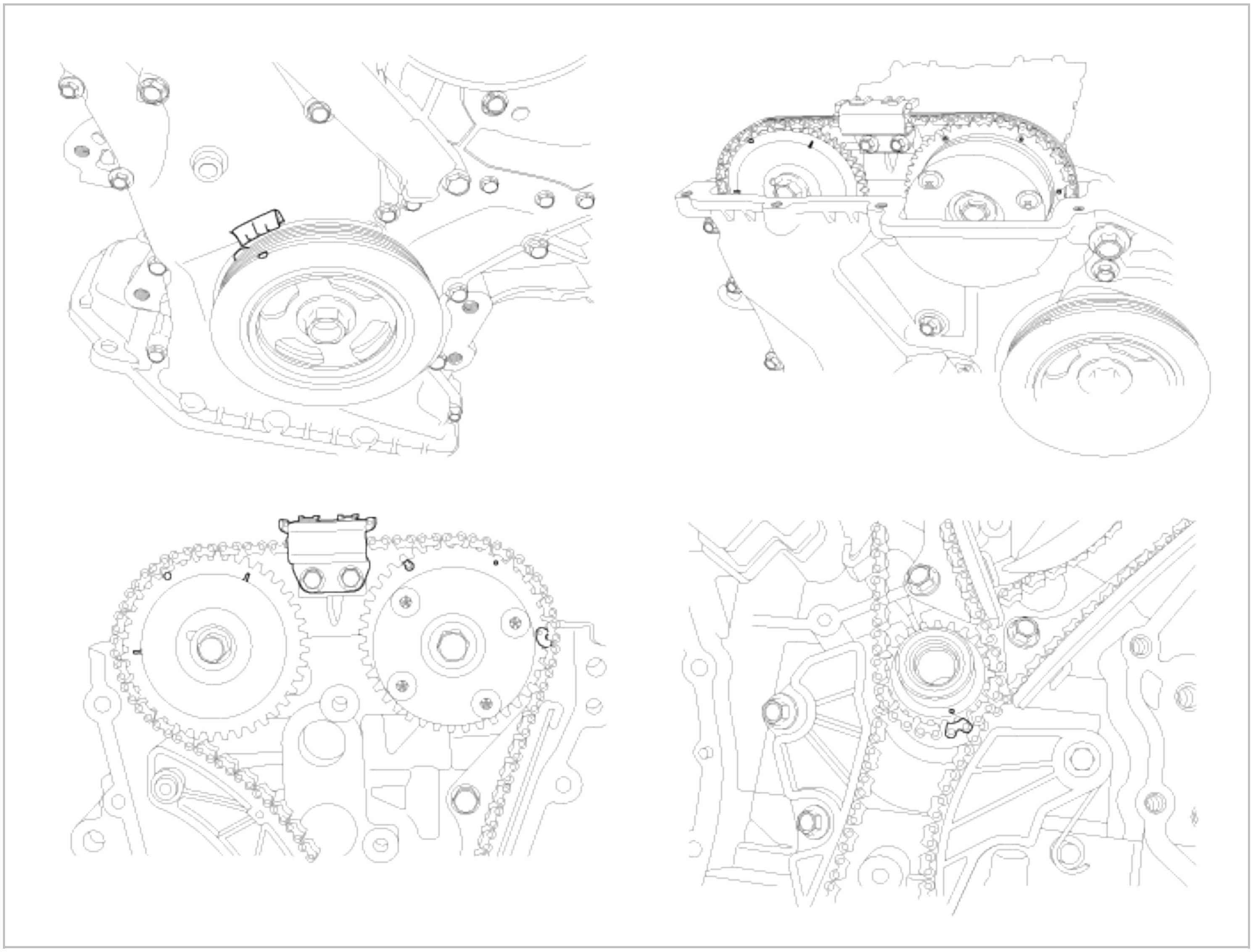
6. Is compression pressure for each cylinder displayed within specifications ?

YES	▶ Go to "Check Timing" as below.
NO	▶ Add a small amount of oil through the spark plug hole, and repeat above steps. If the addition of oil causes the compression to rise, the cause is a worn or damaged piston ring or cylinder inner surface. ▶ If the compression remains the same, the cause is a burnt or defective valve seat, or pressure isleaking from the gasket. Repair as necessary and go to "Verification of Vehicle Repair" procedure

■ **Check Timing**

1. IG "OFF"
2. Monitor these signal waveforms from CAM and Crank shaft position Sensor are correctly aligned.
   Reference : The 17th of CKP signal from missing tooth is aligned with high of CMP signal.


Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
28 ms
Reset
Start
Name
Cursor
ViewAll
Save
5ms
Configuration
+20V
CKPS
Cur a: -0.6 V
Avg : 2.4 V
Cur b: 2.4 V
-5V
a
b
+20V
CMP B1-INTAKE
Cur a: 4.6 V
Avg : 4.6 V
Cur b: -0.2 V
-5V



3. Are all timing marks alligned correctly ?

YES	▶ Go to "Check Fuel Pressure" as below.
NO	▶ Check that Cam, Crank and Oil pump sprocket timing marks are correctly aligned. Repair or readjust as necessary and go to "Verification of Vehicle Repair" procedure.

■ **Check fuel pressure**

NOTE

1. Be cautious that Fuel is explosive and an empty fuel tank can still contain explosive gases. When working on fuel system make sure to supply adequate ventilation to the work area. Do not smoke, and keep sparks and open flames away.
2. The fuel system remains under pressure when the engine is not running. Release fuel system pressure before disconnecting any fuel line to reduce the chance of presonal injury or fire damage to vehicle components.

1. IG "OFF" and disconnect Fuel Pump Relay in Junction Box.
2. Start-up and wait until it stops itself.
3. IG "OFF" and connect Fuel Pump Relay.
4. Install the fuel pressure gauge to the delivery pipe with the fuel pressure gauge adaptor.

5. Activate the fuel pump, and with fuel pressure applied, check that there is no fuel leakage from the pressure gauge or connection part.
6. Measure the fuel pressure at idle.

Specification : 374.6 ~ 384.4 kPa(3.82 ~ 3.92 kg/cm², 54.3 ~ 55.8 psi)

7. Is the measured fuel pressure within specifications ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Repair or replace according to the below table. And then, go to "Verification of Vehicle Repair"procedure.

Condition	Possible Cause
Fuel Pressure is too low	Fuel filter,fuel pressure regulator, in-tank fuel hose or the fuel pump
Fuel Pressure is too high	Fuel pressure regulator, hose or pipe

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0305 Cylinder 5-Misfire detected

General Description

Misfires can be caused by lack of combustion in a cylinder due to absence of spark, poor fuel metering, poor compression, or many other causes. Even a small number of misfires may result in excessive exhaust emissions due to the unburned mixture. Increased misfire rates cause damage to the catalytic converter. The ECM monitors the crankshaft speed variation to determine if any misfiring generated. The ECM identifies the specific cylinder in which the misfire has occurred and counts individual misfire events by monitoring changes in the crankshaft rotation for each cylinder. A random misfire indicates two or more cylinders are misfiring.

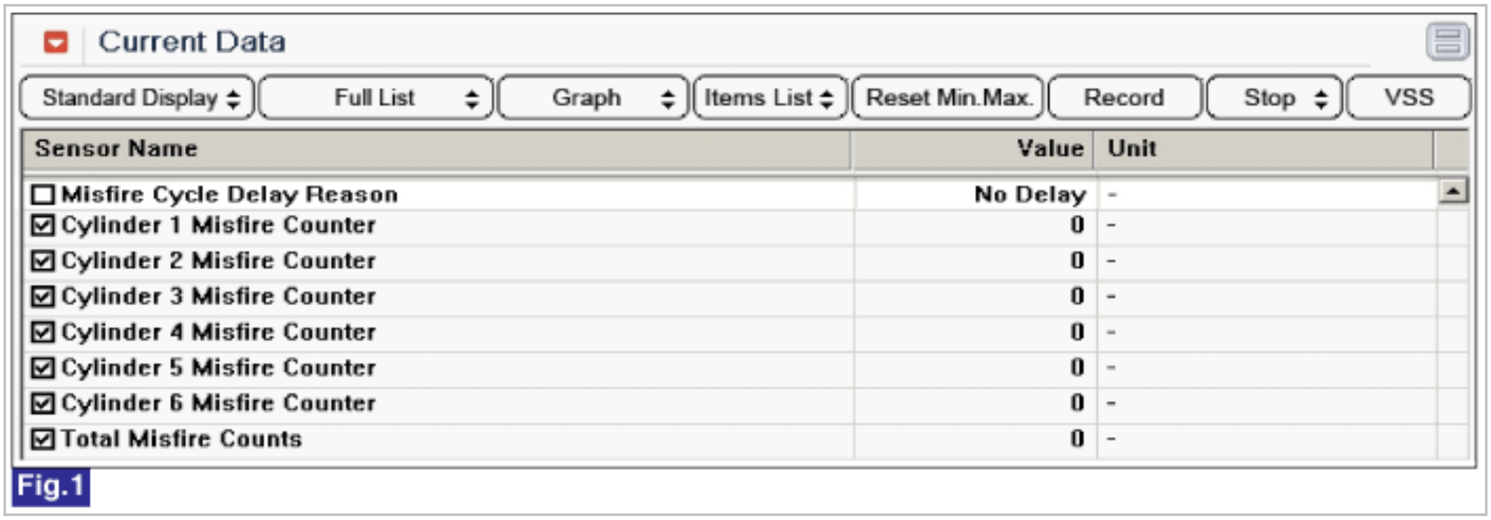
DTC Description

The ECM measures reference event times and calculates the positive and negative acceleration of the crank wheel to detrmine whether a misfire has occurred.
When the rate of misfire exceeds a threshold where the catalyst reaches a temperature where permanent damage can ocur, to the point that tail pipe emissions reach 1.5 times the tailpipe standard or where a cylinder misfire cause a loss of torque produced from that cylinder.
ECM sets this DTC. In case that misfire affects Catalyst damage, MIL(Malfunction Indicatin Lamp) will be illuminating and blinking at 1HZ frequency. However, In case of Indivisual and Emission damaging misfire, MIL will be turned on when the malfunction is detected.

DTC Detecting Condition

<table>
<tr><th colspan="2">Item</th><th>Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td colspan="2">DTC Strategy</td><td>• Determine if a multiple cylinder misfire or a cylinder specific misfire is occurring by monitoring crankshaft acceleration.</td><td rowspan="7">• Faulty Spark plugs
• Faulty Spark plug cables
• Air Leakage
• Belt deflection and Air gap of CKPS
• Incorrect timing
• Faulty injector
• Improper fuel pressure
• Improper engine compression</td></tr>
<tr><td colspan="2">Enable Conditions</td><td>No disabling faults present / no disabiling Active Faults
• P0340 / P0341 / P0118 / P0117 / P0115 / P0336 / P0335 / P1295 / P0103 / P0102 / 0108 / P0107 / P0106 / P0501
• Engine speed between 550 and 5800 RPM
• System voltage between 9 and 18 volts
• The ECT indicates an engine temperature between -6°C(20°F) and 120°C(248°F)</td></tr>
<tr><td rowspan="3">Threshold value</td><td>Case 1</td><td>• Individual cylinder misfire detection</td></tr>
<tr><td>Case 2</td><td>• Emissions damaging - 18 times in 600 ignitions (In case that the misfire affects more than 1.5 times than FTP emissins)</td></tr>
<tr><td>Case 3</td><td>• Catalyst damaging - 95 times in 600 ignitions at idle (It is going to be changeable according to the load or the temperature which is not in the range where it does not melt catalyst)</td></tr>
<tr><td colspan="2">Diagnosis Time</td><td>• Continuous</td></tr>
<tr><td colspan="2">MIL On Condition</td><td>• 2 Driving Cycles</td></tr>
</table>

Signal Waveform & Data



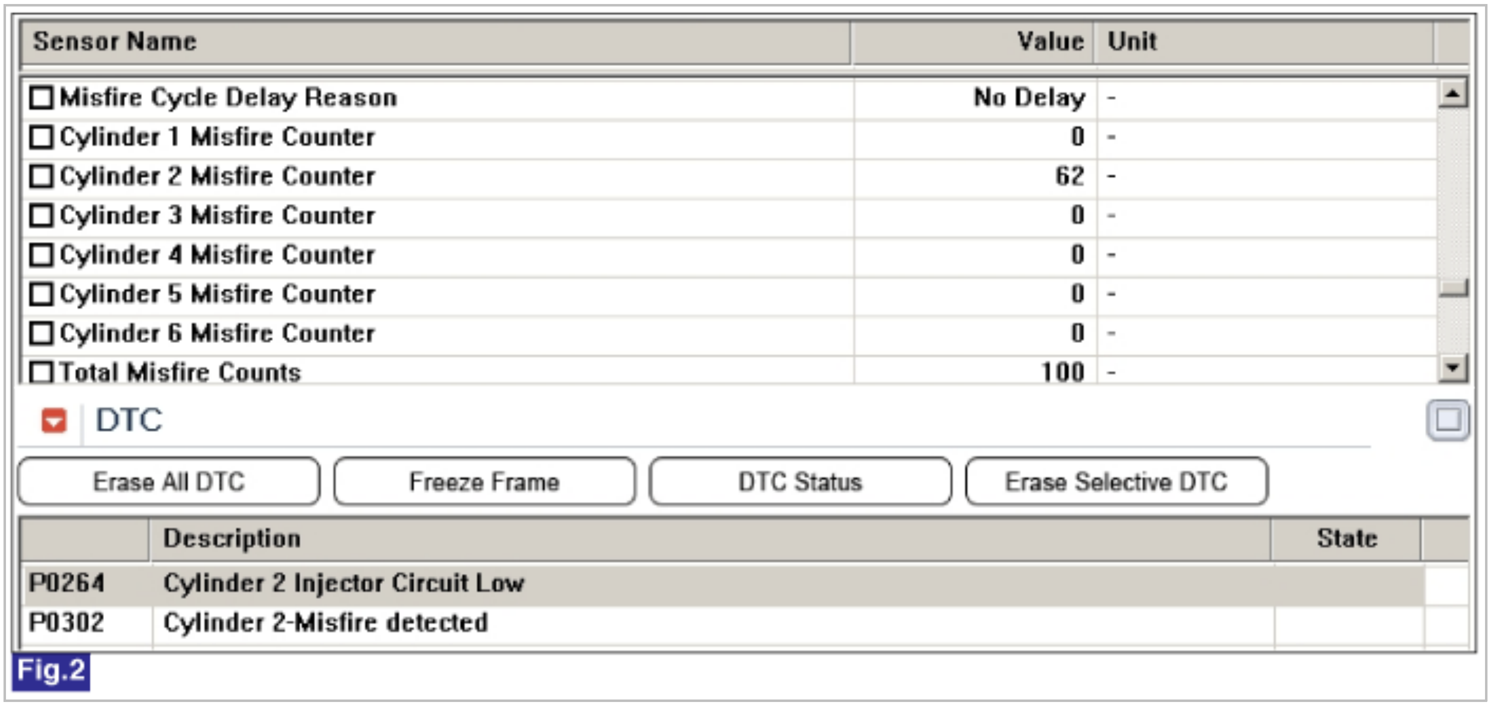
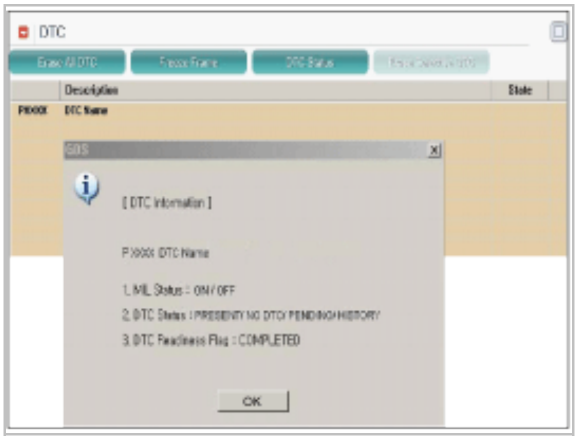


Fig.1) Normal data of misfire counter at idle.
Fig.2) Abnormal data of misfire counter when cyliner 2 injector open.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "System Inspection" procedure.
NO	▶ Although the misfire does not occur when the vehicle is brought to workshop, misfire can be reproduced when the condition is met. Drive the vehicle according to the freeze frame data in order to satisfy the condition.

System Inspection

■ Check Spark Pulg

1. Remove cylinder's spark plugs
2. Visually/physically inspect the following items:
   ▶ Damaged insulation, Worn electrodes, Oil or fuel fouled, Loose terminals and cracks
   ▶ Check for plug gap : 1.0 - 1.1 mm (0.039 - 0.043 in.)
   ▶ Check if the spark plug for the relevant cylinder is lighter in color than the other plugs.
3. Has a problem been found in any of the above areas ?

YES	▶ Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check Air Leakage" as below.

■ Check Air Leakage

1. Visually/physically inspect the air leakage in intake/exhaust system as following items,
   ▶ Vacuum hoses for splits, kinks and improper connections.
   ▶ Throttle body gasket
   ▶ Gasket between intake manifold and cylinder head
   ▶ Seals between intake manifold and fuel injectors
   ▶ Exhaust system between HO2S and Three way catalyst for air leakage
2. Has a problem been found in any of the above areas ?

YES	▶ Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check for air leakage in Positive Crankcase Ventilation Valve(PCV).

■ Check for air leakage in Positive Crankcase Ventilation Valve(PCV)

1. Remove PCV valve from cylinder head cover by puling ventilation hose.
2. With engine idling block PCV valve opening.

3. Verify that vacuum is felt.
4. Remove PCV valve.
5. Blow through valve from prot "A" and verify that air comes out of prot "B".
6. Blow through valve from prot "B" and verifty that no air comes out of port "A".
7. Has a problem been found in any of the above areas ?

YES	▶ Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check Compression pressure" as below.

■ Check Compression pressure

1. Warm up the engine to normal operating temperature.
2. Disconnect the spark plug cables and remove the spark plugs.
3. Crank the engine to remove any foreign material in the cylinders.
4. Put compression pressure gauge into spark pulg hole.
5. Crank the engine with widely opend throttle valve and check compression pressure at each cylinder.

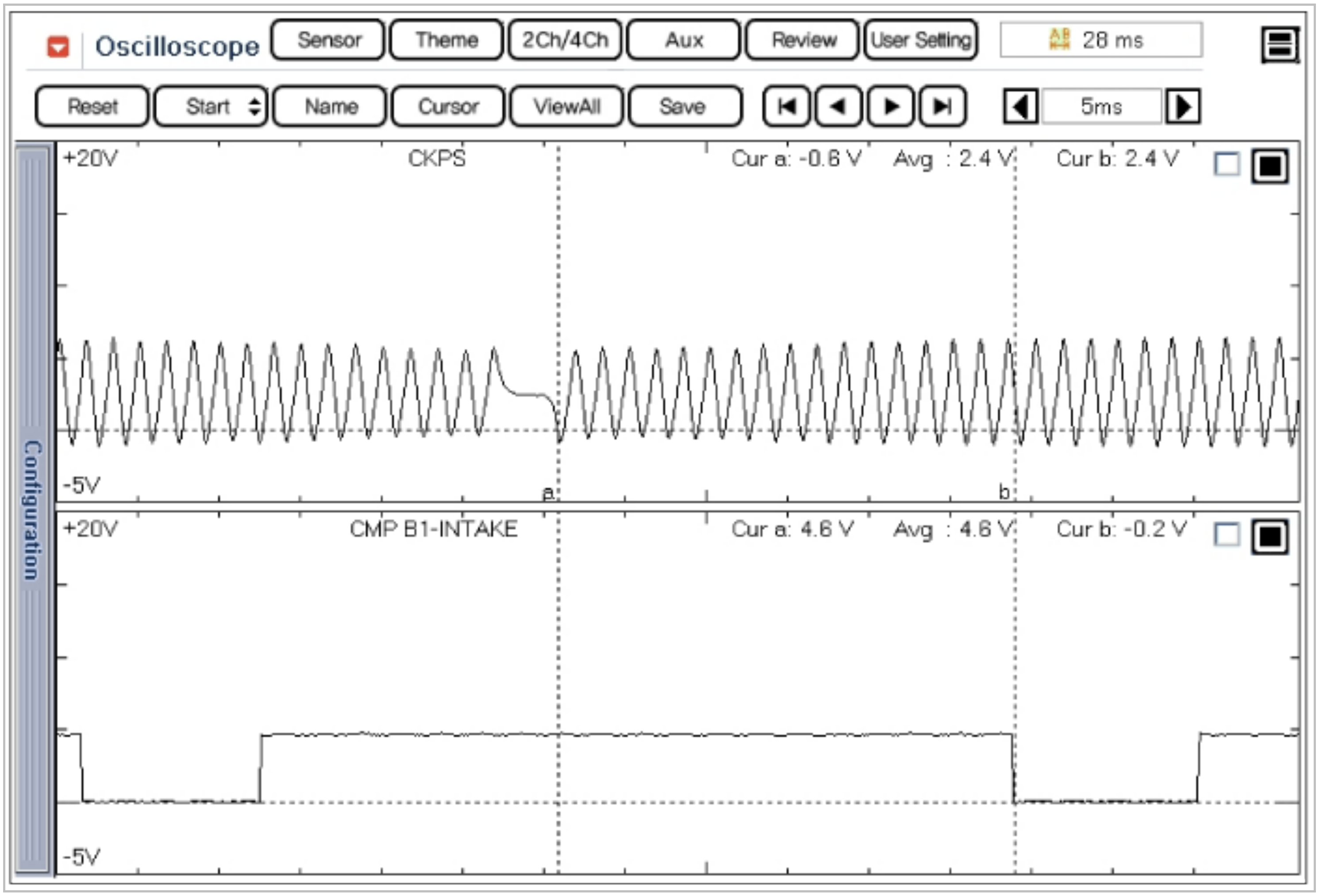
Specification : 1323kPa(13.5 kg/cm²,192 psi)

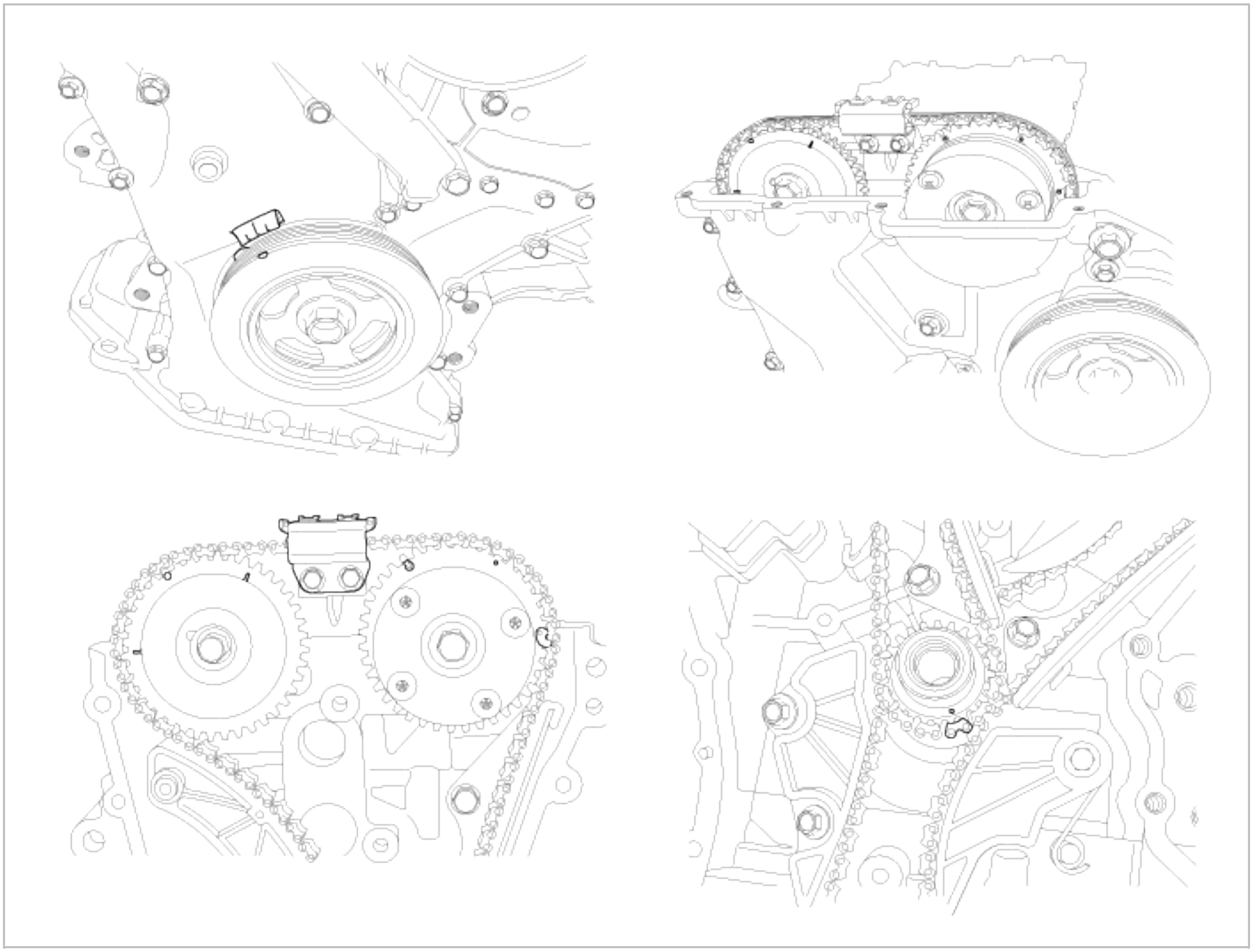
6. Is compression pressure for each cylinder displayed within specifications ?

YES	▶ Go to "Check Timing" as below.
NO	▶ Add a small amount of oil through the spark plug hole, and repeat above steps. If the addition of oil causes the compression to rise, the cause is a worn or damaged piston ring or cylinder inner surface. ▶ If the compression remains the same, the cause is a burnt or defective valve seat, or pressure isleaking from the gasket. Repair as necessary and go to "Verification of Vehicle Repair" procedure

■ Check Timing

1. IG "OFF"
2. Monitor these signal waveforms from CAM and Crank shaft position Sensor are correctly aligned.
   Reference : The 17th of CKP signal from missing tooth is aligned with high of CMP signal.


Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
28 ms
Reset
Start
Name
Cursor
ViewAll
Save
5ms
Configuration
+20V
CKPS
Cur a: -0.6 V
Avg : 2.4 V
Cur b: 2.4 V
-5V
a
b
+20V
CMP B1-INTAKE
Cur a: 4.6 V
Avg : 4.6 V
Cur b: -0.2 V
-5V



3. Are all timing marks alligned correctly ?

YES	▶ Go to "Check Fuel Pressure" as below.
NO	▶ Check that Cam, Crank and Oil pump sprocket timing marks are correctly aligned. Repair or readjust as necessary and go to "Verification of Vehicle Repair" procedure.

■ **Check fuel pressure**

NOTE

1. Be cautious that Fuel is explosive and an empty fuel tank can still contain explosive gases. When working on fuel system make sure to supply adequate ventilation to the work area. Do not smoke, and keep sparks and open flames away.
2. The fuel system remains under pressure when the engine is not running. Release fuel system pressure before disconnecting any fuel line to reduce the chance of presonal injury or fire damage to vehicle components.

1. IG "OFF" and disconnect Fuel Pump Relay in Junction Box.
2. Start-up and wait until it stops itself.
3. IG "OFF" and connect Fuel Pump Relay.
4. Install the fuel pressure gauge to the delivery pipe with the fuel pressure gauge adaptor.

5. Activate the fuel pump, and with fuel pressure applied, check that there is no fuel leakage from the pressure gauge or connection part.
6. Measure the fuel pressure at idle.

Specification : 374.6 ~ 384.4 kPa(3.82 ~ 3.92 kg/cm², 54.3 ~ 55.8 psi)

7. Is the measured fuel pressure within specifications ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Repair or replace according to the below table. And then, go to "Verification of Vehicle Repair"procedure.

Condition	Possible Cause
Fuel Pressure is too low	Fuel filter,fuel pressure regulator, in-tank fuel hose or the fuel pump
Fuel Pressure is too high	Fuel pressure regulator, hose or pipe

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0306 Cylinder 6-Misfire detected

General Description

Misfires can be caused by lack of combustion in a cylinder due to absence of spark, poor fuel metering, poor compression, or many other causes. Even a small number of misfires may result in excessive exhaust emissions due to the unburned mixture. Increased misfire rates cause damage to the catalytic converter. The ECM monitors the crankshaft speed variation to determine if any misfiring generated. The ECM identifies the specific cylinder in which the misfire has occurred and counts individual misfire events by monitoring changes in the crankshaft rotation for each cylinder. A random misfire indicates two or more cylinders are misfiring.

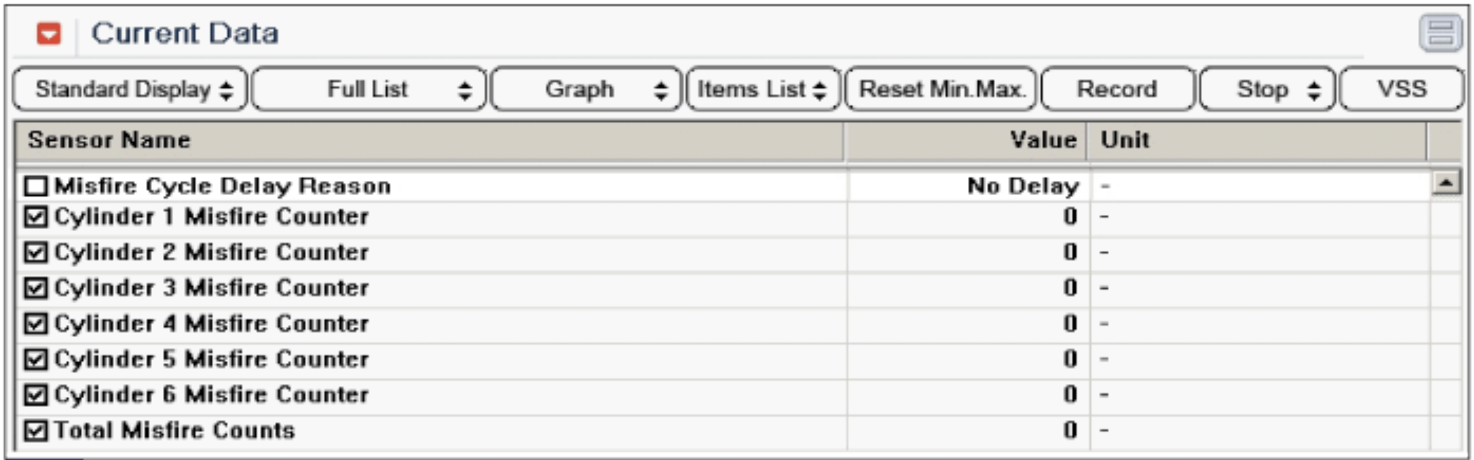
DTC Description

The ECM measures reference event times and calculates the positive and negative acceleration of the crank wheel to detrmine whether a misfire has occurred.
When the rate of misfire exceeds a threshold where the catalyst reaches a temperature where permanent damage can ocur, to the point that tail pipe emissions reach 1.5 times the tailpipe standard or where a cylinder misfire cause a loss of torque produced from that cylinder.
ECM sets this DTC. In case that misfire affects Catalyst damage, MIL(Malfunction Indicatin Lamp) will be illuminating and blinking at 1HZ frequency. However, In case of Indivisual and Emission damaging misfire, MIL will be turned on when the malfunction is detected.

DTC Detecting Condition

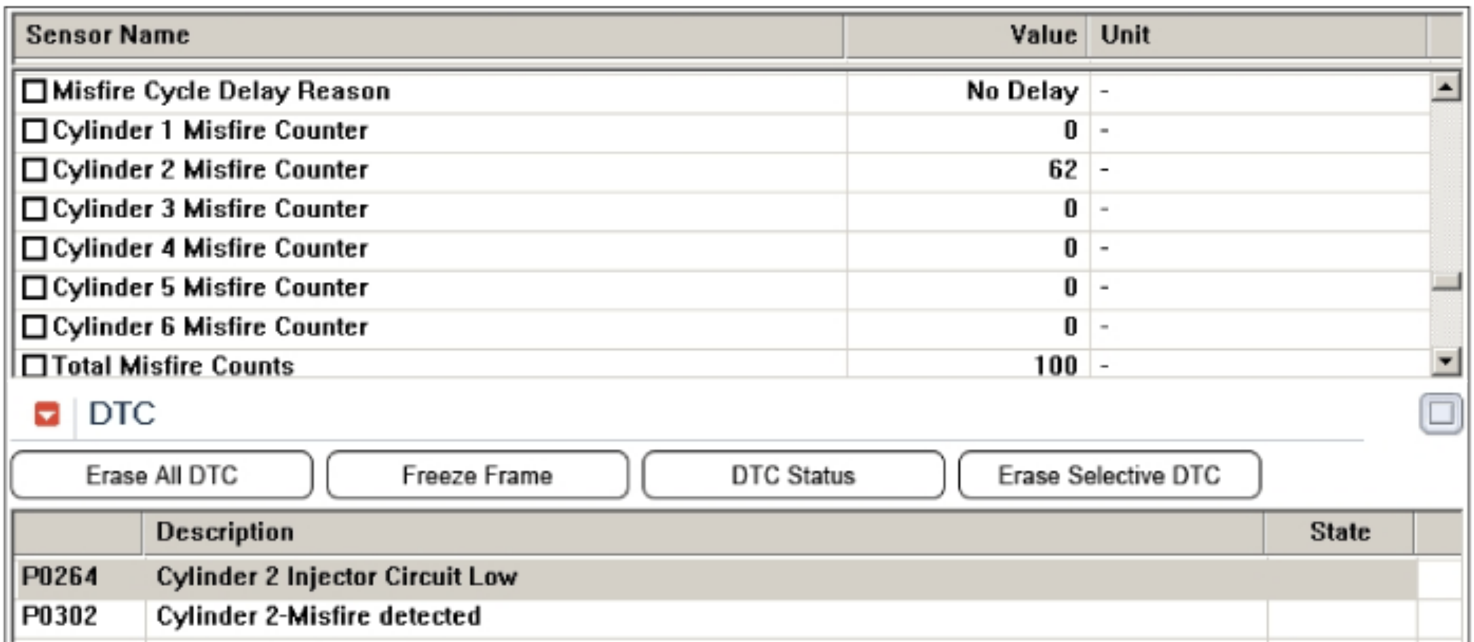
<table>
<tr><th colspan="2">Item</th><th>Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td colspan="2">DTC Strategy</td><td>• Determine if a multiple cylinder misfire or a cylinder specific misfire is occurring by monitoring crankshaft acceleration.</td><td rowspan="7">• Faulty Spark plugs
• Faulty Spark plug cables
• Air Leakage
• Belt deflection and Air gap of CKPS
• Incorrect timing
• Faulty injector
• Improper fuel pressure
• Improper engine compression</td></tr>
<tr><td colspan="2">Enable Conditions</td><td>No disabling faults present / no disabiling Active Faults
• P0340 / P0341 / P0118 / P0117 / P0115 / P0336 / P0335 / P1295 / P0103 / P0102 / 0108 / P0107 / P0106 / P0501
• Engine speed between 550 and 5800 RPM
• System voltage between 9 and 18 volts
• The ECT indicates an engine temperature between -6°C(20°F) and 120°C(248°F)</td></tr>
<tr><td rowspan="3">Threshold value</td><td>Case 1</td><td>• Individual cylinder misfire detection</td></tr>
<tr><td>Case 2</td><td>• Emissions damaging - 18 times in 600 ignitions (In case that the misfire affects more than 1.5 times than FTP emissins)</td></tr>
<tr><td>Case 3</td><td>• Catalyst damaging - 95 times in 600 ignitions at idle (It is going to be changeable according to the load or the temperature which is not in the range where it does not melt catalyst)</td></tr>
<tr><td colspan="2">Diagnosis Time</td><td>• Continuous</td></tr>
<tr><td colspan="2">MIL On Condition</td><td>• 2 Driving Cycles</td></tr>
</table>

Signal Waveform & Data



Sensor Name	Value	Unit
Misfire Cycle Delay Reason	No Delay	-
Cylinder 1 Misfire Counter	0	-
Cylinder 2 Misfire Counter	0	-
Cylinder 3 Misfire Counter	0	-
Cylinder 4 Misfire Counter	0	-
Cylinder 5 Misfire Counter	0	-
Cylinder 6 Misfire Counter	0	-
Total Misfire Counts	0	-

Fig.1



Sensor Name	Value	Unit
Misfire Cycle Delay Reason	No Delay	-
Cylinder 1 Misfire Counter	0	-
Cylinder 2 Misfire Counter	62	-
Cylinder 3 Misfire Counter	0	-
Cylinder 4 Misfire Counter	0	-
Cylinder 5 Misfire Counter	0	-
Cylinder 6 Misfire Counter	0	-
Total Misfire Counts	100	-

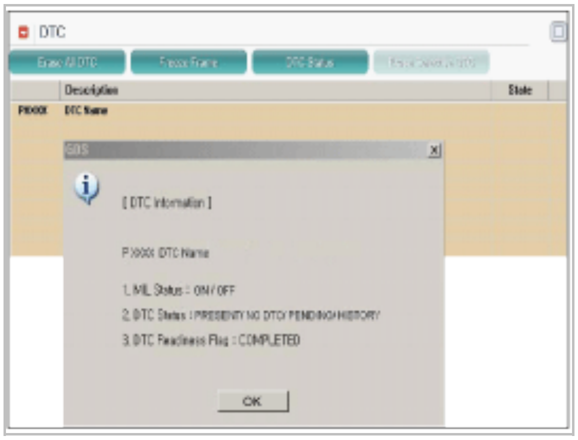
	Description	State
P0264	Cylinder 2 Injector Circuit Low	
P0302	Cylinder 2-Misfire detected	

Fig.2

Fig.1) Normal data of misfire counter at idle.
Fig.2) Abnormal data of misfire counter when cyliner 2 injector open.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "System Inspection" procedure.
NO	▶ Although the misfire does not occur when the vehicle is brought to workshop, misfire can be reproduced when the condition is met. Drive the vehicle according to the freeze frame data in order to satisfy the condition.

System Inspection

■ Check Spark Pulg

1. Remove cylinder’s spark plugs
2. Visually/physically inspect the following items:
   - ▶ Damaged insulation, Worn electrodes, Oil or fuel fouled, Loose terminals and cracks
   - ▶ Check for plug gap : 1.0 - 1.1 mm (0.039 - 0.043 in.)
   - ▶ Check if the spark plug for the relevant cylinder is lighter in color than the other plugs.
3. Has a problem been found in any of the above areas ?

YES	▶ Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check Air Leakage" as below.

■ Check Air Leakage

1. Visually/physically inspect the air leakage in intake/exhaust system as following items,
   - ▶ Vacuum hoses for splits, kinks and improper connections.
   - ▶ Throttle body gasket
   - ▶ Gasket between intake manifold and cylinder head
   - ▶ Seals between intake manifold and fuel injectors
   - ▶ Exhaust system between HO2S and Three way catalyst for air leakage
2. Has a problem been found in any of the above areas ?

YES	▶ Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check for air leakage in Positive Crankcase Ventilation Valve(PCV).

■ Check for air leakage in Positive Crankcase Ventilation Valve(PCV)

1. Remove PCV valve from cylinder head cover by puling ventilation hose.
2. With engine idling block PCV valve opening.

3. Verify that vacuum is felt.
4. Remove PCV valve.
5. Blow through valve from prot "A" and verify that air comes out of prot "B".
6. Blow through valve from prot "B" and verifty that no air comes out of port "A".
7. Has a problem been found in any of the above areas ?

YES	▶ Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check Compression pressure" as below.

■ Check Compression pressure

1. Warm up the engine to normal operating temperature.
2. Disconnect the spark plug cables and remove the spark plugs.
3. Crank the engine to remove any foreign material in the cylinders.
4. Put compression pressure gauge into spark pulg hole.
5. Crank the engine with widely opend throttle valve and check compression pressure at each cylinder.

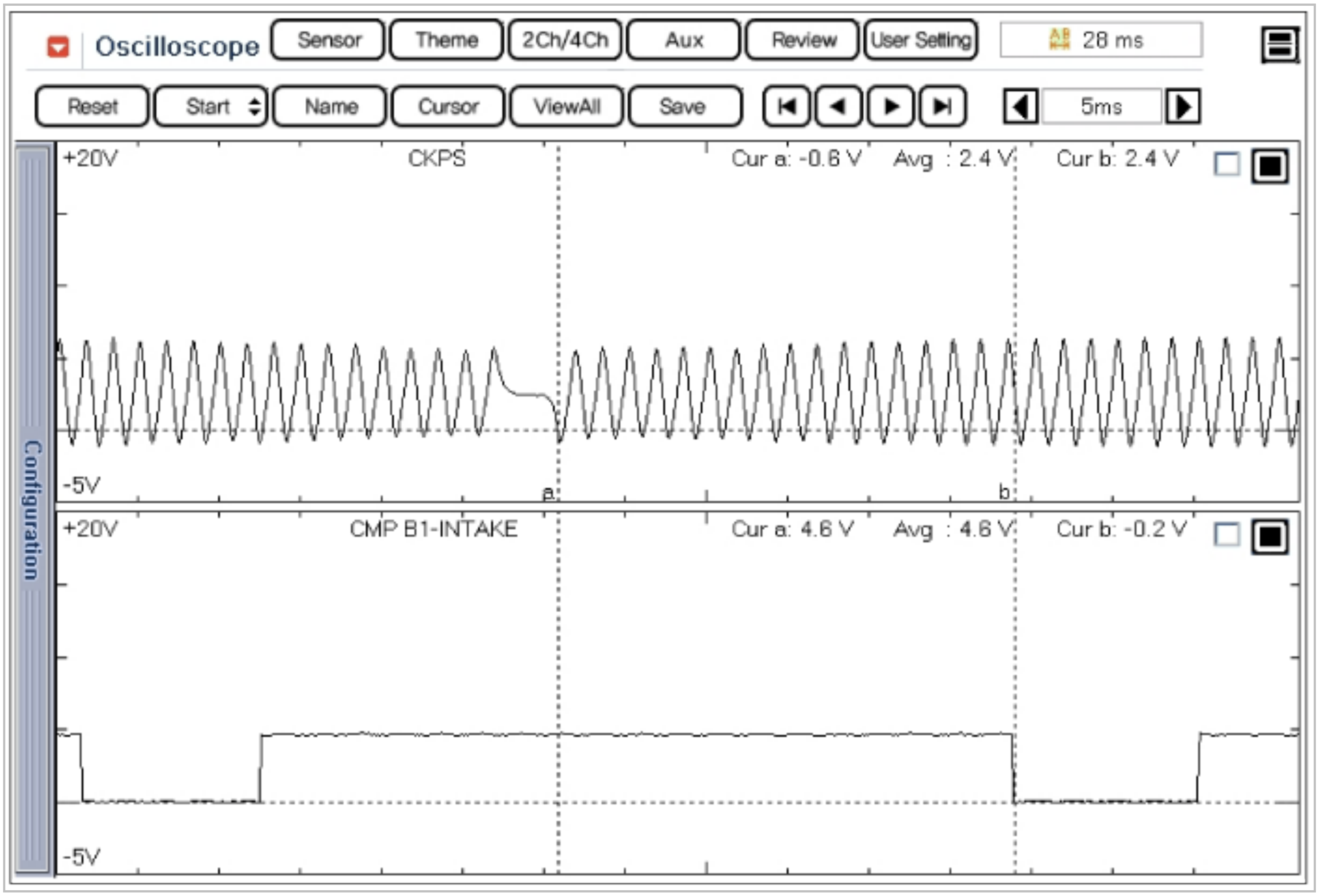
Specification : 1323kPa(13.5 kg/cm²,192 psi)

6. Is compression pressure for each cylinder displayed within specifications ?

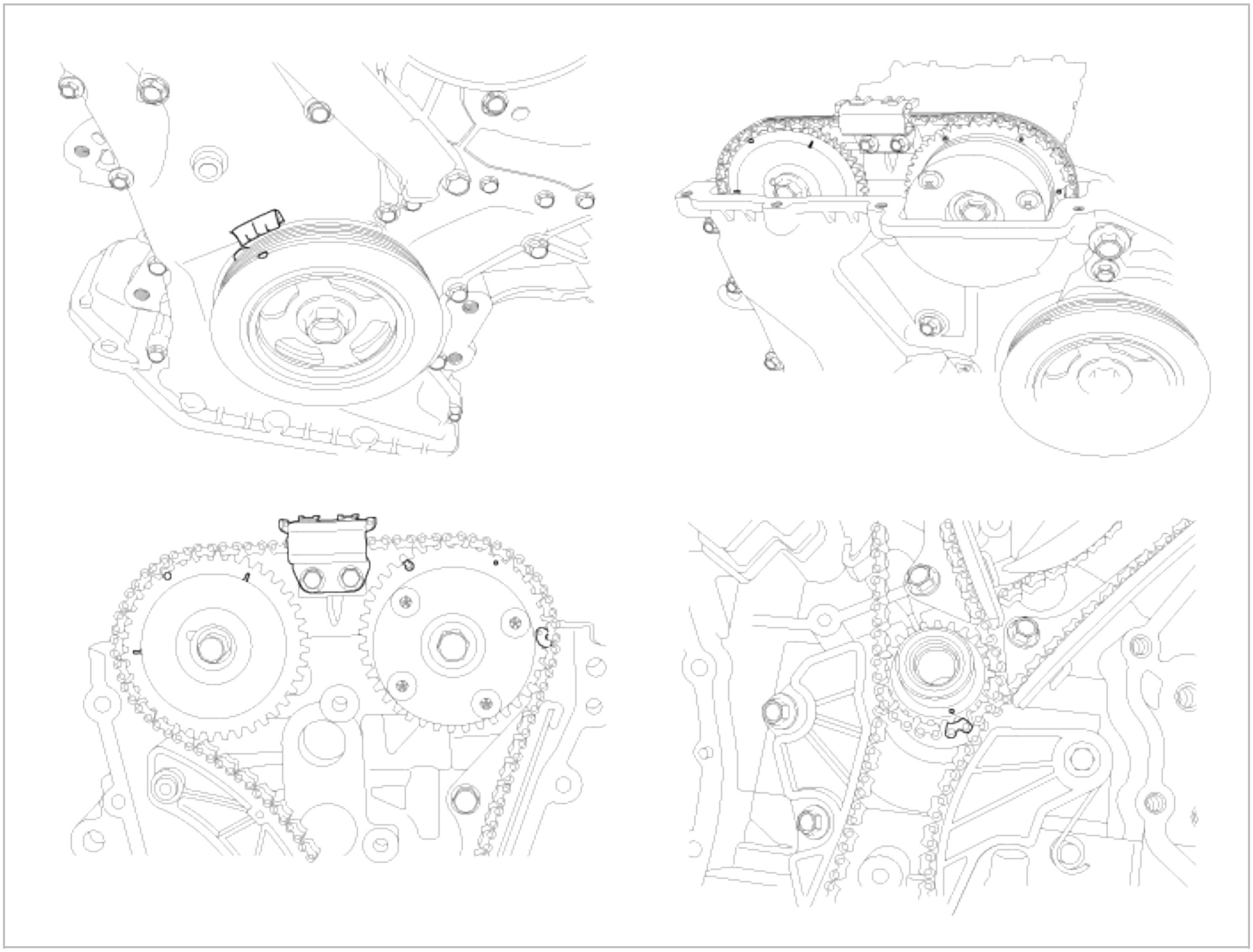
YES	▶ Go to "Check Timing" as below.
NO	▶ Add a small amount of oil through the spark plug hole, and repeat above steps. If the addition of oil causes the compression to rise, the cause is a worn or damaged piston ring or cylinder inner surface. ▶ If the compression remains the same, the cause is a burnt or defective valve seat, or pressure isleaking from the gasket. Repair as necessary and go to "Verification of Vehicle Repair" procedure

■ Check Timing

1. IG "OFF"
2. Monitor these signal waveforms from CAM and Crank shaft position Sensor are correctly aligned.
   Reference : The 17th of CKP signal from missing tooth is aligned with high of CMP signal.



Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
28 ms
Reset
Start
Name
Cursor
ViewAll
Save
5ms
Configuration
+20V
CKPS
Cur a: -0.6 V
Avg : 2.4 V
Cur b: 2.4 V
-5V
a
b
+20V
CMP B1-INTAKE
Cur a: 4.6 V
Avg : 4.6 V
Cur b: -0.2 V
-5V



3. Are all timing marks alligned correctly ?

YES	▶ Go to "Check Fuel Pressure" as below.
NO	▶ Check that Cam, Crank and Oil pump sprocket timing marks are correctly aligned. Repair or readjust as necessary and go to "Verification of Vehicle Repair" procedure.

■ Check fuel pressure

NOTE

1. Be cautious that Fuel is explosive and an empty fuel tank can still contain explosive gases. When working on fuel system make sure to supply adequate ventilation to the work area. Do not smoke, and keep sparks and open flames away.
2. The fuel system remains under pressure when the engine is not running. Release fuel system pressure before disconnecting any fuel line to reduce the chance of presonal injury or fire damage to vehicle components.

1. IG "OFF" and disconnect Fuel Pump Relay in Junction Box.
2. Start-up and wait until it stops itself.
3. IG "OFF" and connect Fuel Pump Relay.
4. Install the fuel pressure gauge to the delivery pipe with the fuel pressure gauge adaptor.

5. Activate the fuel pump, and with fuel pressure applied, check that there is no fuel leakage from the pressure gauge or connection part.
6. Measure the fuel pressure at idle.

Specification : 374.6 ~ 384.4 kPa(3.82 ~ 3.92 kg/cm², 54.3 ~ 55.8 psi)

7. Is the measured fuel pressure within specifications ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Repair or replace according to the below table. And then, go to "Verification of Vehicle Repair"procedure.

Condition	Possible Cause
Fuel Pressure is too low	Fuel filter,fuel pressure regulator, in-tank fuel hose or the fuel pump
Fuel Pressure is too high	Fuel pressure regulator, hose or pipe

Verification of Vehicle Repair

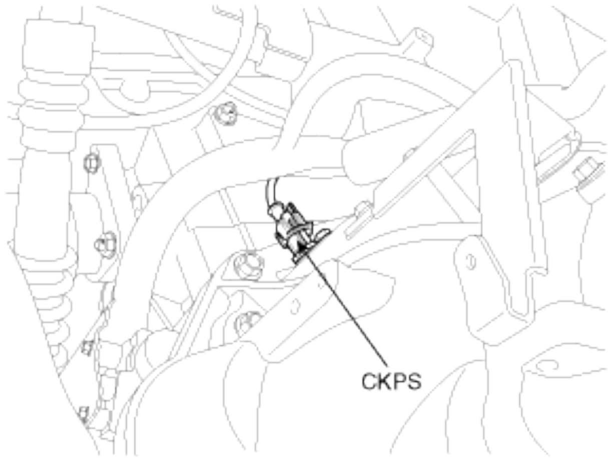
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0315 Crankshaft Position System Variation Not Learned

Component Location



General Description

The Crankshaft Position Sensor (CKPS) is a magnetic field sensitive type sensor that generates voltage using a sensor and a target wheel mounted on the crankshaft; there are 58 slots in the target wheel where one is longer than the others. When the slot in the wheel aligns with the sensor, the sensor voltage outputs low. When the metal (tooth) in the wheel aligns with the sensor, the sensor voltage outputs high. During one crankshaft rotation there are 58 rectangular signals and one longer signal. The ECM calculates engine RPM by using the sensor's signal and controls the injection duration and the ignition timing. Using the signal differences caused by the longer slot, the ECM identifies which cylinder is at top dead center.

DTC Description

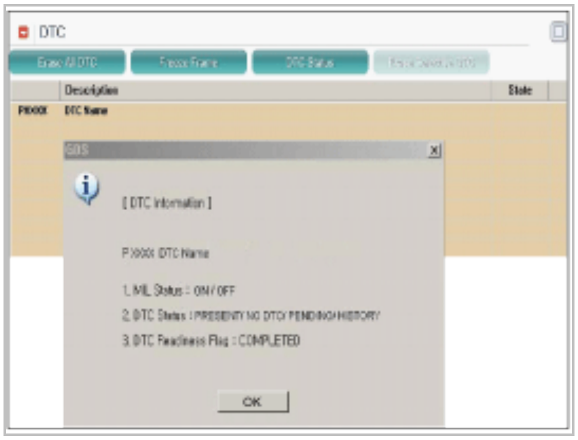
Checking tooth error correction under detecting condition, if the TEC(Tooth Error Correction) is out of Threshold value, ECM sets P0315.

DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• This DTC indicates that crankwheel tooth error has not been learned.	• loosened CKPS • Target wheel • ECM
Enable Conditions	• 10% ≤ Engine load < 90% • 2000 rpm ≤ engine speed ≤ 4000 rpm • TEC(Tooth Error Correction) RPM stability timer > 10sec • 0°C(32°F) < coolant temperature < 110°C(230°F) • Not active disabling faults	
Threshold value	• Distance driven without learning(during fuel cut off) tooth error ≥ 4000km • Acutal Value is higher or lower than calibrated value	
Diagnosis Time	• -	
MIL On Condition	• NO MIL ON(DTC only)	

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault" ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Fault is intermittent caused by ECM memory was not cleared after repair. Erase DTC and drive the vehicle to satisfy the enable codition then, go to "Component Inspection" procedure.

Component Inspection

■ Visually check CKPS and target wheel

1. IG "OFF
2. Visually check CKPS is loosened or target wheel is deformed or damaged.
3. Is the above items normal ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Repair or replace as necessary and then go to"Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

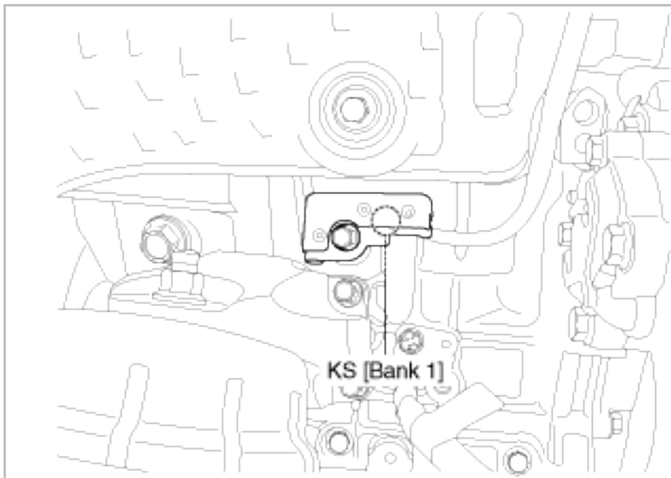
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.

4. Is parameter displayed "History(Not Present) fault" ?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0325 Knock Sensor 1 Circuit (Bank 1 or Single Sensor)

Component Location



General Description

The knock sensor is attached to the cylinder block and senses engine knocking. The sensor contains a piezoelectric element that converts vibration (or noise) into voltage signal and sends this signal to ECM. With input signals from camshaft position and crankshaft position sensor, ECM can identify which cylinder is knocking. ECM filters vibrations and determines if the vibrations are knocking signal. The Engine Control Module (ECM) uses this signal to suppress knocking by retarding ignition timing. The ECM will set a code (Malfunction Indicator Lamp will Not turn on) if during two driving cycles the Knock sensor’s output voltage falls below minimum threshold. This code indicates an unexpected vibration is being read by the Knock sensor or ECM under normal engine operation.

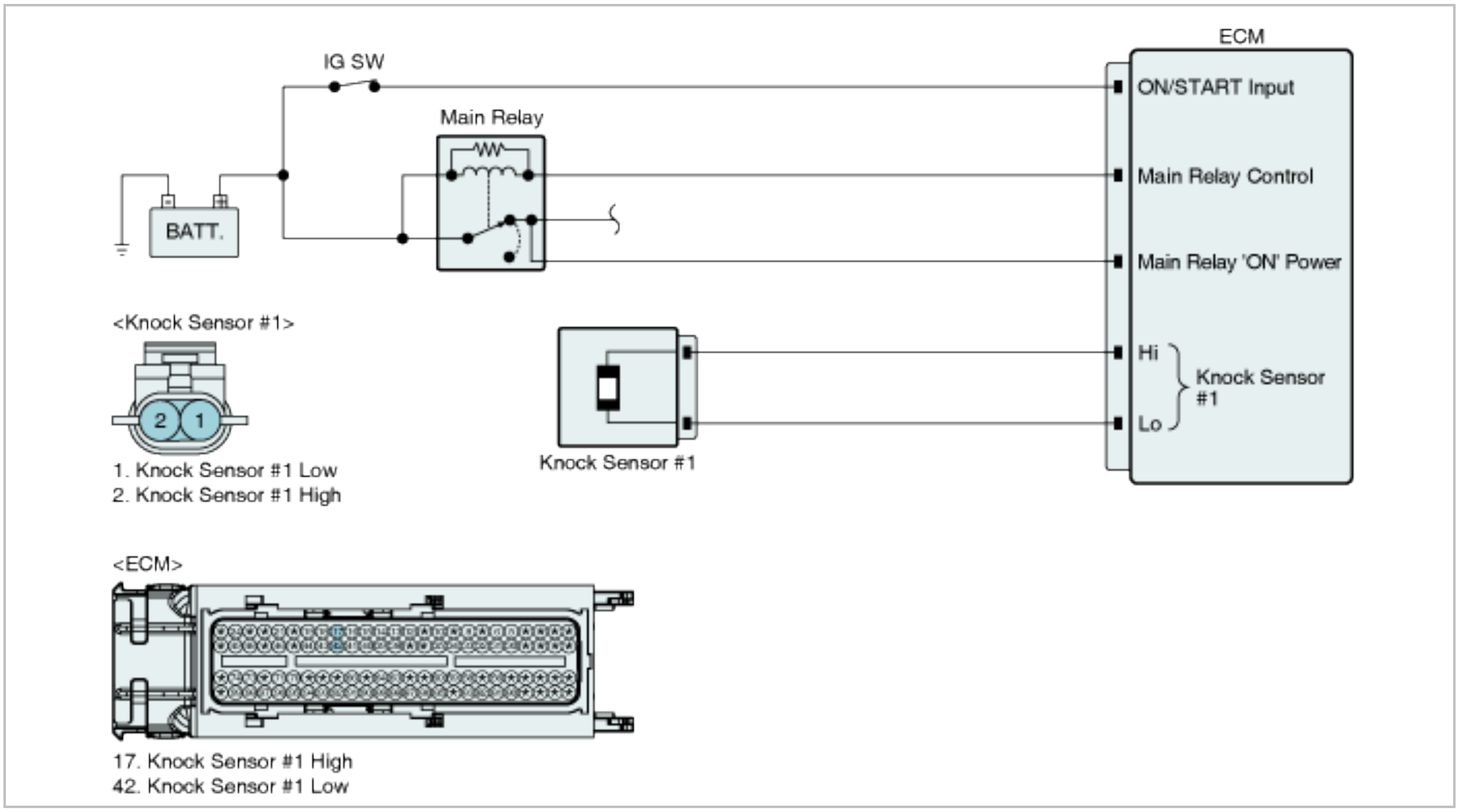
DTC Description

Checking the range of input signal with a knock sensor under detecting condition, ECM senses open in knock sensor circuit or malfunction of sensor. If a knock signal or noise level is inputted without the specified value during standard duration, ECM sets P0325.

DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Signal short	• Poor connection • Open in harness • Knock sensor • ECM
Enable Conditions	• Pressure in intake manifold is normal • Engine speed ≥ 2200rpm	
Threshold value	• Knock Filtered Value < 1.0	
Diagnosis Time	• Continuous	
MIL On Condition	• 2 Driving Cycles	

Diagnostic Circuit Diagram



Signal Waveform & Data

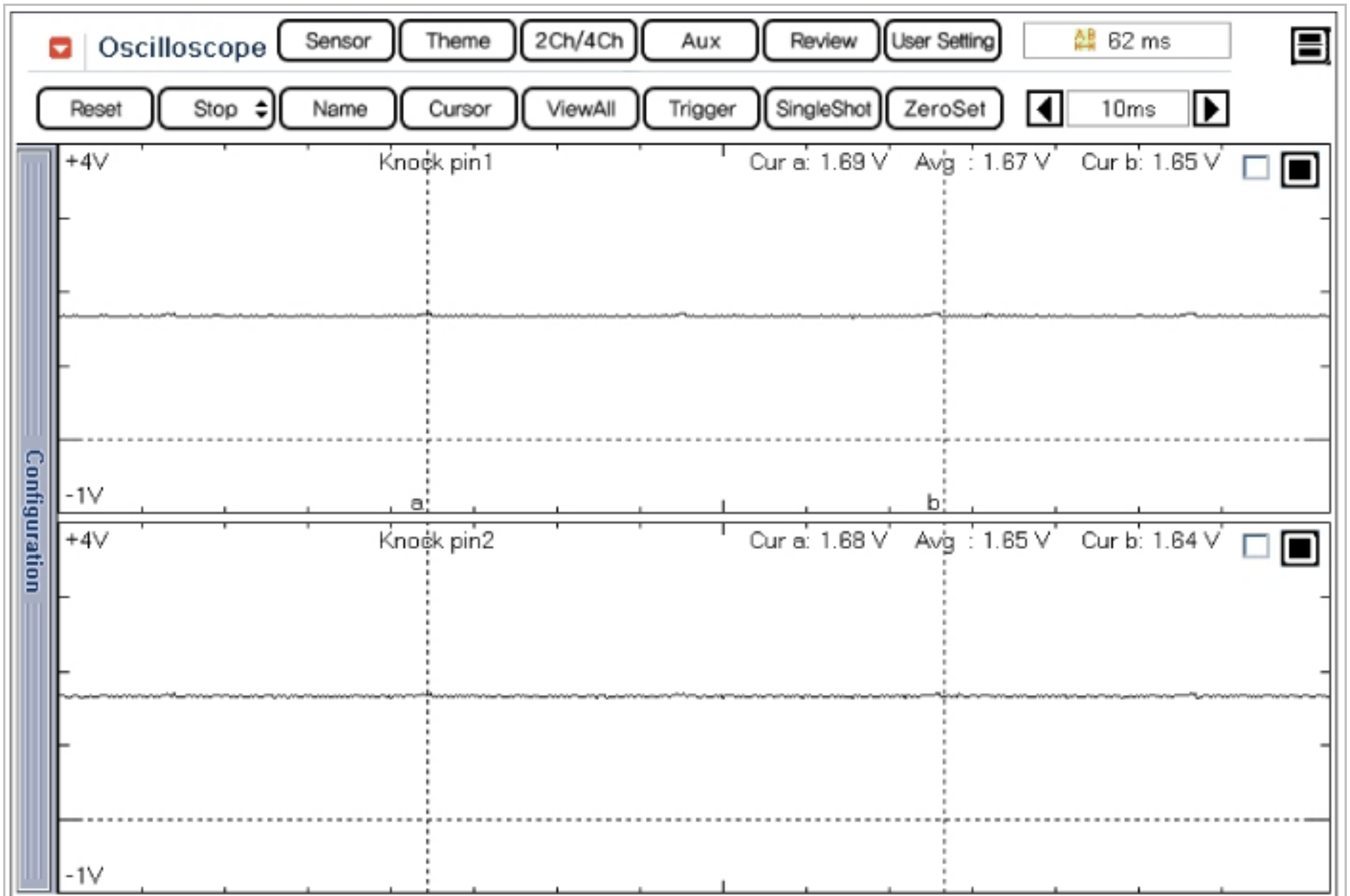


Fig.1

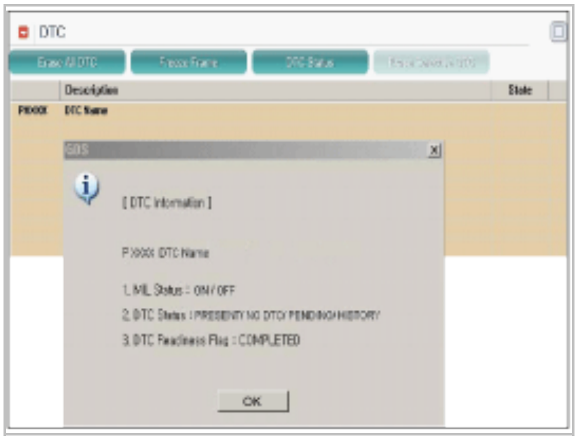
Sensor Name	Value	Unit
Knock Adaption-Cylinder 1	0.0	DEG
Knock Adaption-Cylinder 2	0.0	DEG
Knock Adaption-Cylinder 3	0.0	DEG
Knock Adaption-Cylinder 4	0.0	DEG
Knock Adaption-Cylinder 5	0.0	DEG
Knock Adaption-Cylinder 6	0.0	DEG

Fig.2

Fig.1) Normal waveform of knock sensor at ig on.
Fig.2) Normal data of knock sensor at ig on.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to " Signal Circuit Inspection " procedure.

Signal Circuit Inspection

■ **Check open in harness**

1. IG "OFF" and disconnect knock sensor connector and ECM connector.
2. Measure resistance between low signal terminal of knock sensor harness connector and knock sensor low signal terminal of ECM harness connector.
3. Measure resistance between high signal terminal of knock sensor harness connector and knock sensor high signal terminal of ECM harness connector.

Specification : Below 1Ω

4. Is the measured resistance within specification ?

YES	▶ If the problem is corrected after substituting with a known - good knock sensor, replace it. If the problem is pending, check for proper operating after substituting with a known - good ECM. and then if the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure.

	NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

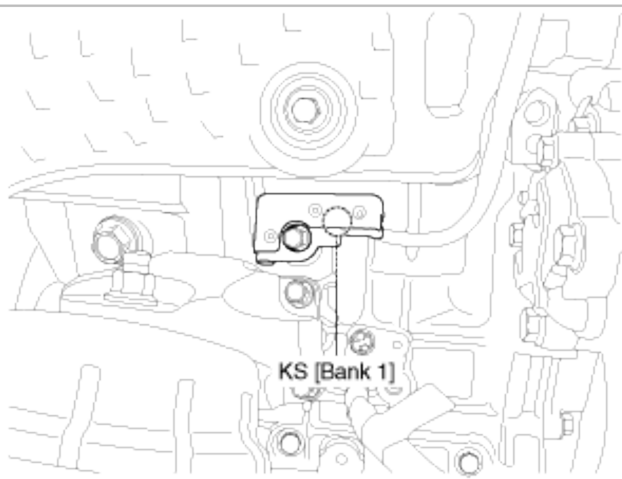
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0326 Knock Sensor 1 Circuit Range/Performance (Bank 1 or Single Sensor)

Component Location



General Description

The knock sensor is attached to the cylinder block and senses engine knocking. The sensor contains a piezoelectric element that converts vibration (or noise) into voltage signal and sends this signal to ECM. With input signals from camshaft position and crankshaft position sensor, ECM can identify which cylinder is knocking. ECM filters vibrations and determines if the vibrations are knocking signal. The Engine Control Module (ECM) uses this signal to suppress knocking by retarding ignition timing. The ECM will set a code (Malfunction Indicator Lamp will Not turn on) if during two driving cycles the Knock sensor’s output voltage falls below minimum threshold. This code indicates an unexpected vibration is being read by the Knock sensor or ECM under normal engine operation.

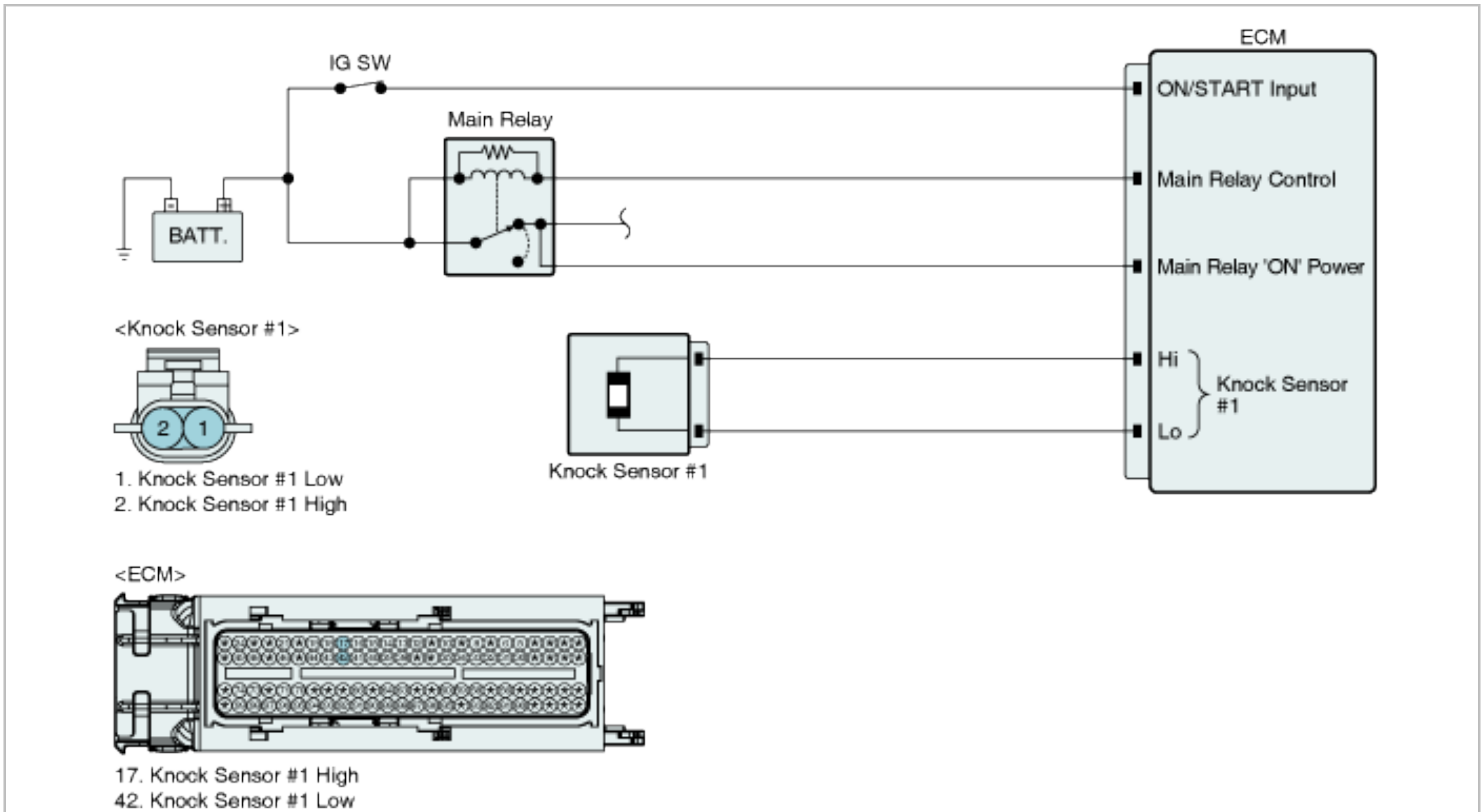
DTC Description

Checking the range of input signal with a knock sensor under detecting condition, ECM senses short in knock sensor circuit or malfunction of sensor. If the average value of the knock signal is out of the threshold value during standard duration, ECM sets P0326.

DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Signal short	• Poor connection • Short in harness • Knock sensor • ECM
Enable Conditions	• Pressure in intake manifold is normal • Engine speed ≥ 2200rpm	
Threshold value	• Knock Filtered Value < 5 or > 65	
Diagnosis Time	• Continuous	
MIL On Condition	• 2 Driving Cycles	

Diagnostic Circuit Diagram



Signal Waveform & Data

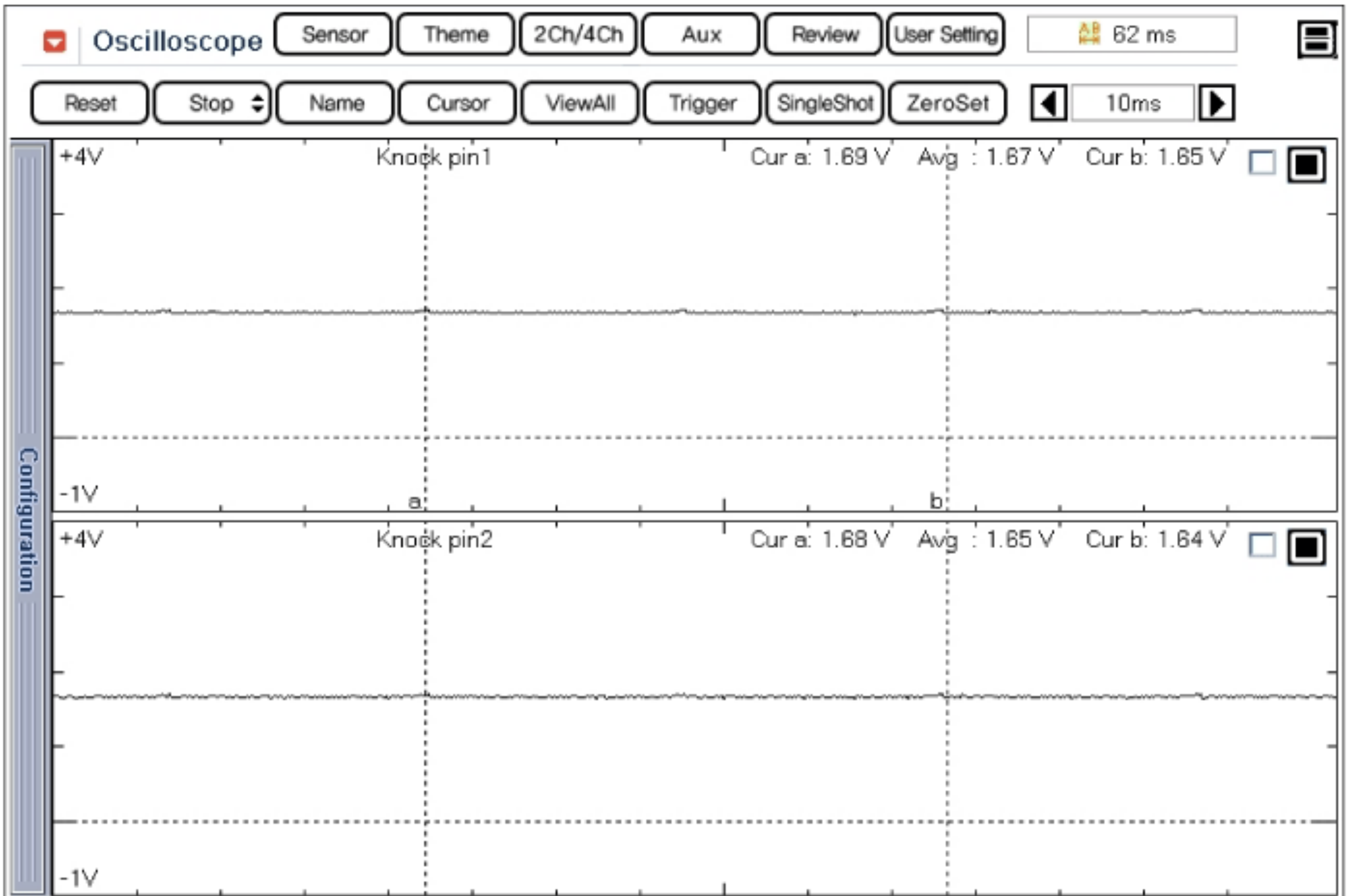


Fig.1

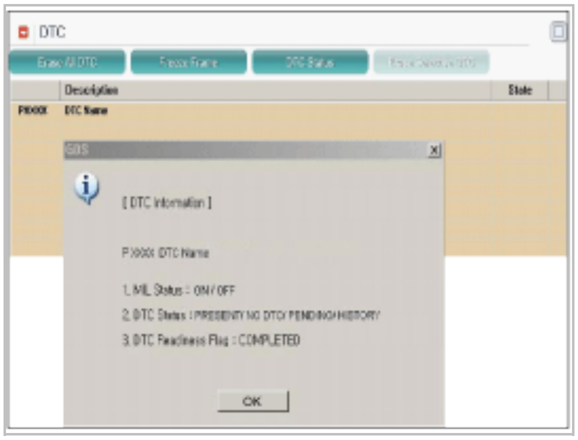
Sensor Name	Value	Unit
Knock Adaption-Cylinder 1	0.0	DEG
Knock Adaption-Cylinder 2	0.0	DEG
Knock Adaption-Cylinder 3	0.0	DEG
Knock Adaption-Cylinder 4	0.0	DEG
Knock Adaption-Cylinder 5	0.0	DEG
Knock Adaption-Cylinder 6	0.0	DEG

Fig.2

Fig.1) Normal waveform of knock sensor at ig on.
Fig.2) Normal data of knock sensor at ig on.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to " Signal Circuit Inspection " procedure.

Signal Circuit Inspection

■ Check short to battery in harness

1. IG "OFF" and disconnect knock sensor connector.
2. IG "ON".
3. Measure voltage between low signal terminal of knock sensor harness connector and chassis ground.
4. Measure voltage between high signal terminal of knock sensor harness connector and chassis ground.

Specification : Approx. 1.5V

5. Is the measured voltage within specification ?

YES	▶ Go to "Check short to ground in harness" as follows.
NO	▶ Repair short to battery in harness, and go to "Verification of Vehicle Repair" procedure.

■ Check short to ground in harness

1. IG "OFF" and disconnect knock sensor connector and ECM connector.
2. Measure resistance between low signal terminal of knock sensor harness connector and chassis ground.
3. Measure resistance between high signal terminal of knock sensor harness connector and chassis ground.

Specification : Infinite

4. Is the measured resistance within specification ?

YES	▶ If the problem is corrected after substituting with a known - good knock sensor, replace it. If the problem is pending, check for proper operating after substituting with a known - good ECM. and then if the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Repair short to ground in harness, and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

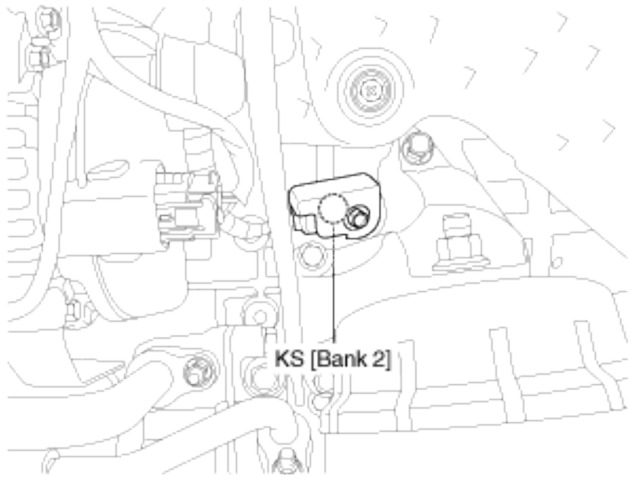
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0330 Knock Sensor 2 Circuit (Bank 2)

Component Location



General Description

The knock sensor is attached to the cylinder block and senses engine knocking. The sensor contains a piezoelectric element that converts vibration (or noise) into voltage signal and sends this signal to ECM. With input signals from camshaft position and crankshaft position sensor, ECM can identify which cylinder is knocking. ECM filters vibrations and determines if the vibrations are knocking signal. The Engine Control Module (ECM) uses this signal to suppress knocking by retarding ignition timing. The ECM will set a code (Malfunction Indicator Lamp will Not turn on) if during two driving cycles the Knock sensor’s output voltage falls below minimum threshold. This code indicates an unexpected vibration is being read by the Knock sensor or ECM under normal engine operation.

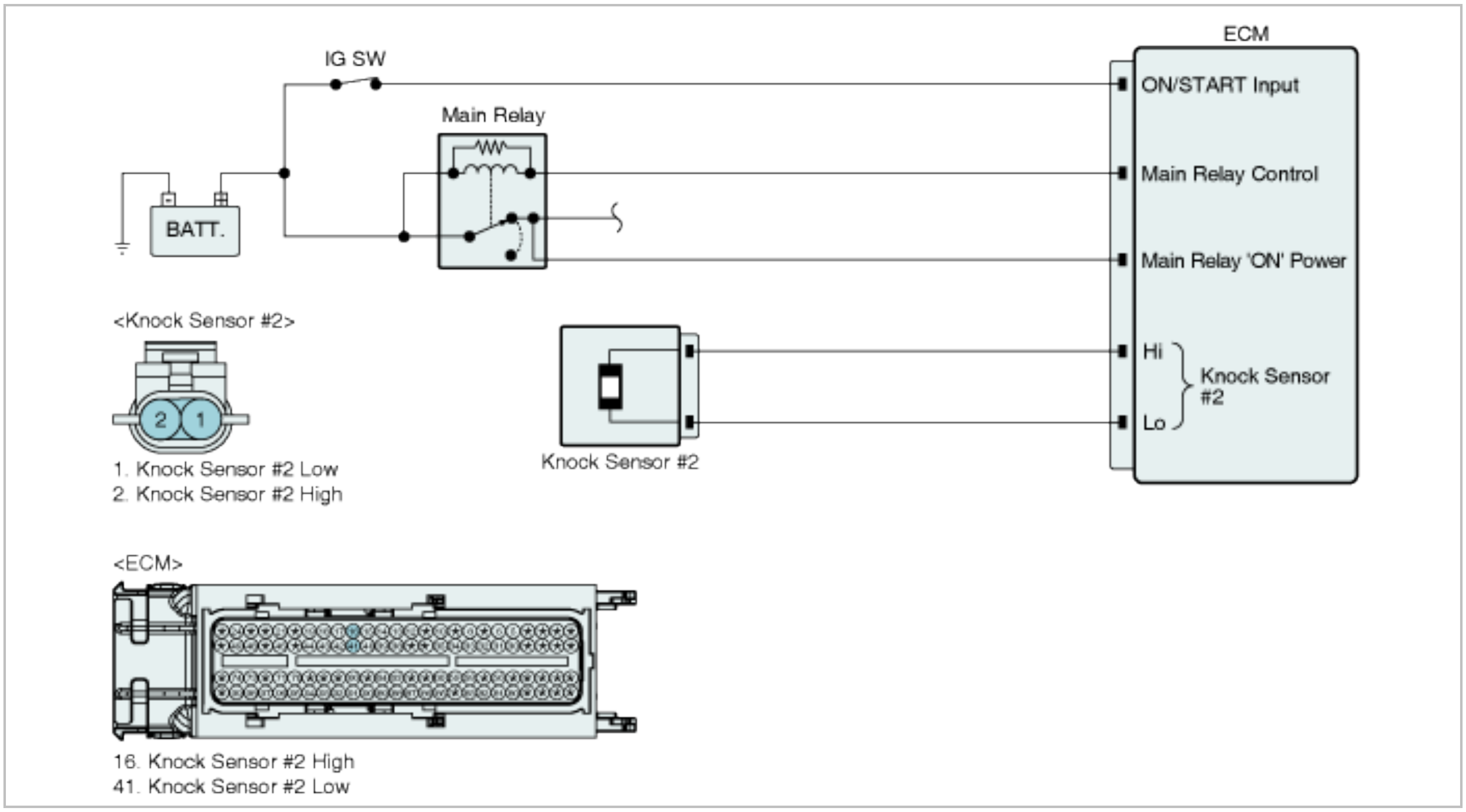
DTC Description

Checking the range of input signal with a knock sensor under detecting condition, ECM senses open in knock sensor circuit or malfunction of sensor. If a knock signal or noise level is inputted without the specified value during standard duration, ECM sets P0330.

DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Signal short	• Poor connection • Open in harness • Knock sensor • ECM
Enable Conditions	• Pressure in intake manifold is normal • Engine speed ≥ 2200rpm	
Threshold value	• Knock Filtered Value < 1.0	
Diagnosis Time	• Continuous	
MIL On Condition	• 2 Driving Cycles	

Diagnostic Circuit Diagram



Signal Waveform & Data

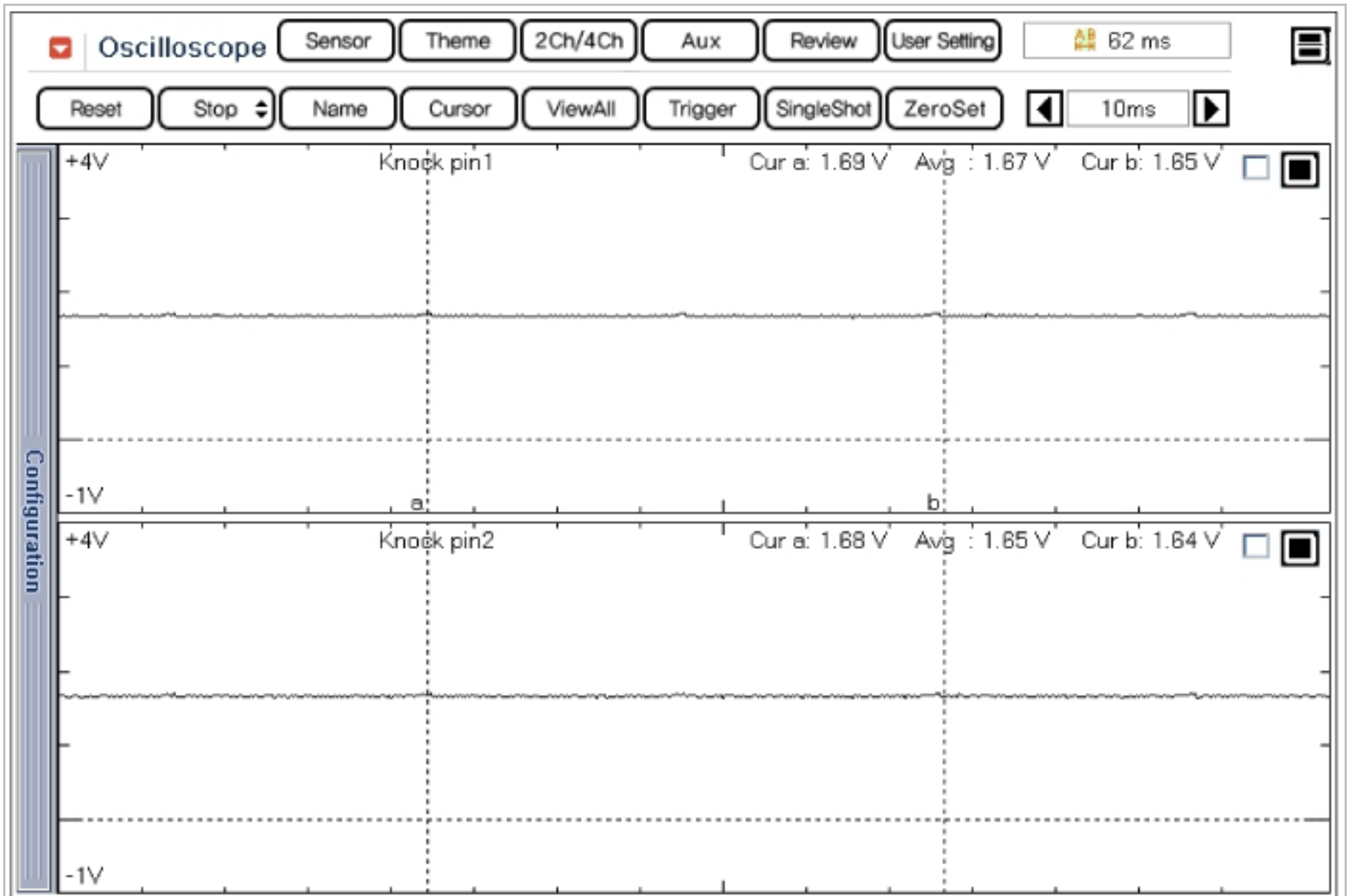
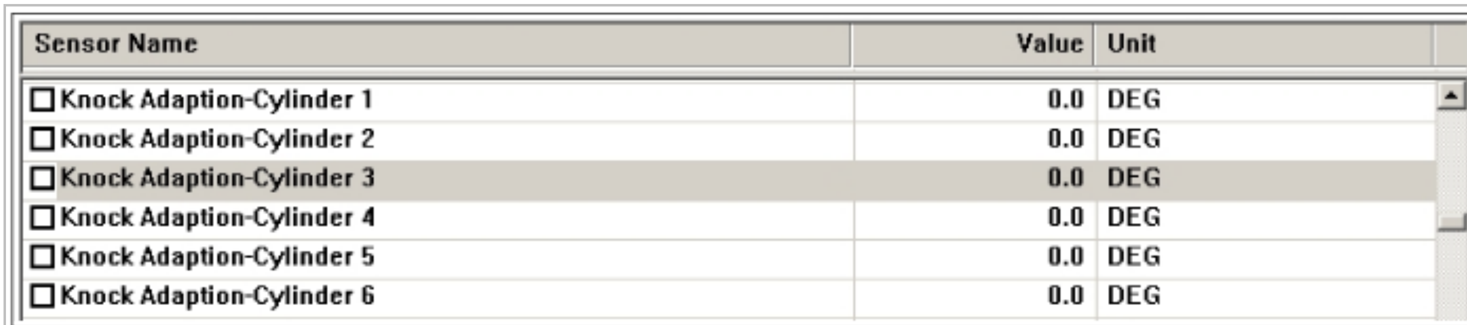


Fig.1



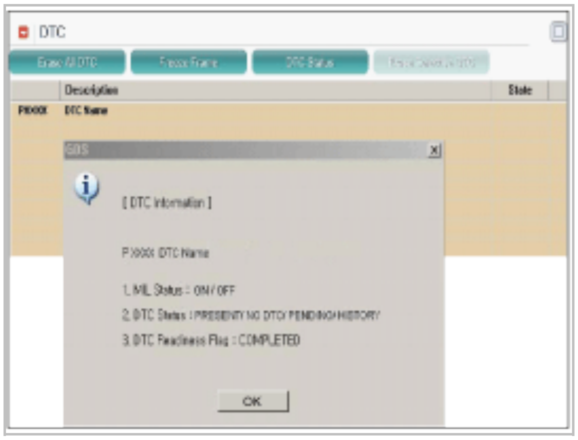
Sensor Name	Value	Unit
Knock Adaption-Cylinder 1	0.0	DEG
Knock Adaption-Cylinder 2	0.0	DEG
Knock Adaption-Cylinder 3	0.0	DEG
Knock Adaption-Cylinder 4	0.0	DEG
Knock Adaption-Cylinder 5	0.0	DEG
Knock Adaption-Cylinder 6	0.0	DEG

Fig.2

Fig.1) Normal waveform of knock sensor at ig on.
Fig.2) Normal data of knock sensor at ig on.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to " Signal Circuit Inspection " procedure.

Signal Circuit Inspection

■ Check open in harness

1. IG "OFF" and disconnect knock sensor connector and ECM connector.
2. Measure resistance between low signal terminal of knock sensor harness connector and knock sensor low signal terminal of ECM harness connector.
3. Measure resistance between high signal terminal of knock sensor harness connector and knock sensor high signal terminal of ECM harness connector.

Specification : Below 1Ω

4. Is the measured resistance within specification ?

YES	▶ If the problem is corrected after substituting with a known - good knock sensor, replace it. If the problem is pending, check for proper operating after substituting with a known - good ECM. and then if the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure.

	NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

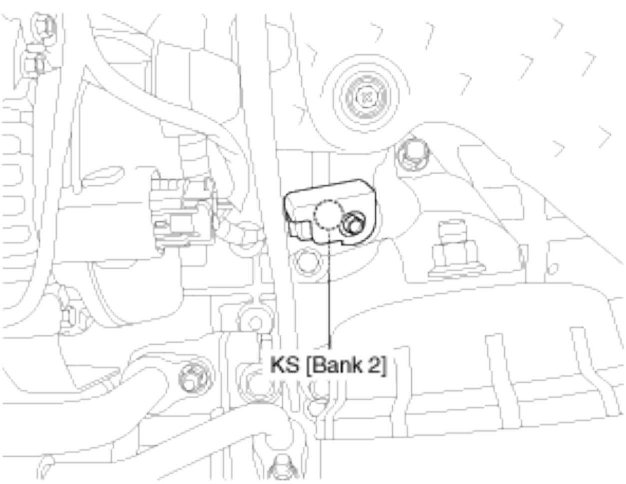
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0331 Knock Sensor 2 Circuit Range/Performance (Bank 2)

Component Location



General Description

The knock sensor is attached to the cylinder block and senses engine knocking. The sensor contains a piezoelectric element that converts vibration (or noise) into voltage signal and sends this signal to ECM. With input signals from camshaft position and crankshaft position sensor, ECM can identify which cylinder is knocking. ECM filters vibrations and determines if the vibrations are knocking signal. The Engine Control Module (ECM) uses this signal to suppress knocking by retarding ignition timing. The ECM will set a code (Malfunction Indicator Lamp will Not turn on) if during two driving cycles the Knock sensor’s output voltage falls below minimum threshold. This code indicates an unexpected vibration is being read by the Knock sensor or ECM under normal engine operation.

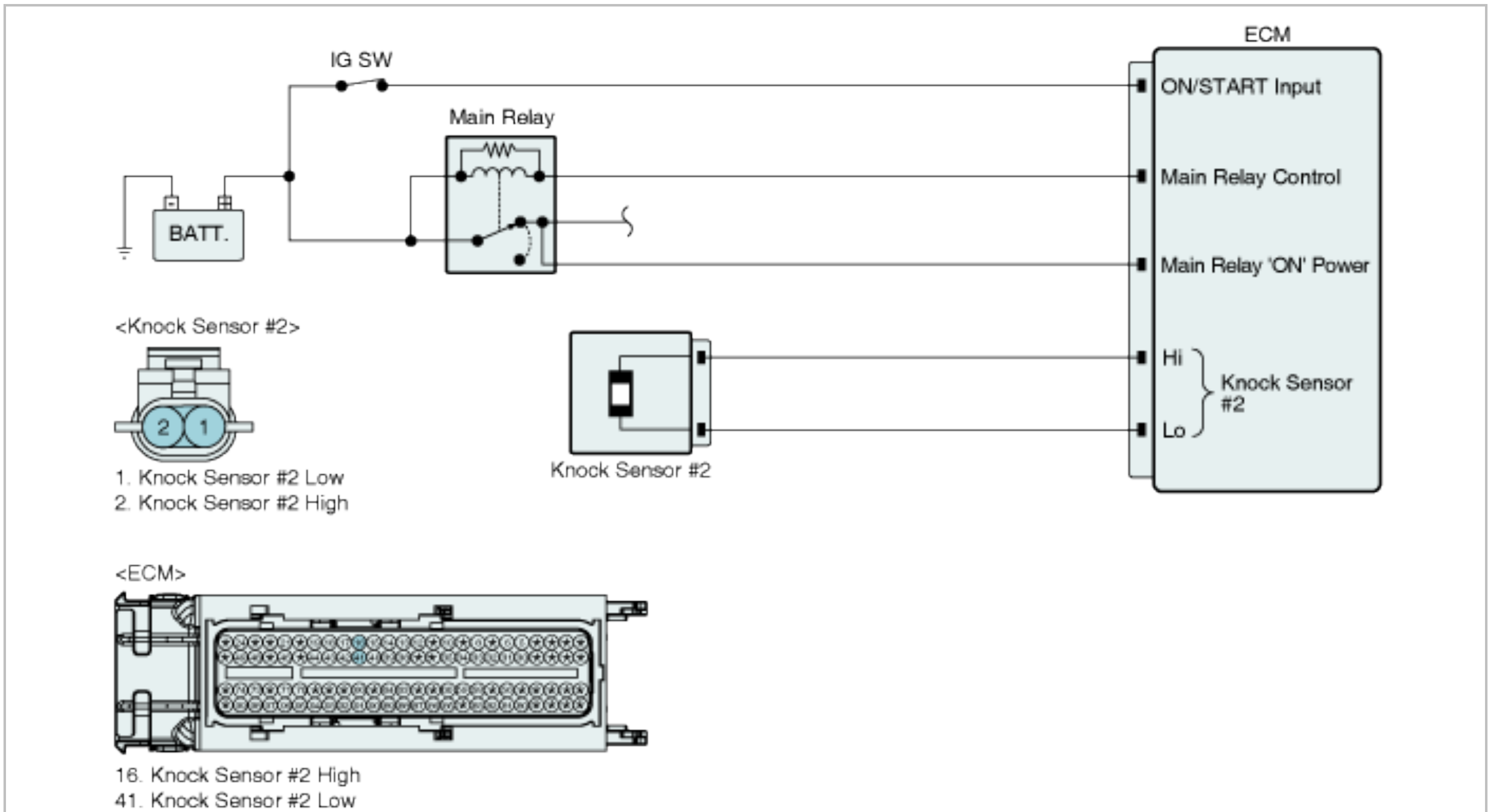
DTC Description

Checking the range of input signal with a knock sensor under detecting condition, ECM senses short in knock sensor circuit or malfunction of sensor. If the average value of the knock signals is out of the threshold value during standard duration, ECM sets P0331.

DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Signal short	• Poor connection • Short in harness • Knock sensor • ECM
Enable Conditions	• Pressure in intake manifold is normal • Engine speed ≥ 2200rpm	
Threshold value	• Knock Filtered Value < 5 or > 65	
Diagnosis Time	• Continuous	
MIL On Condition	• 2 Driving Cycles	

Diagnostic Circuit Diagram



Signal Waveform & Data

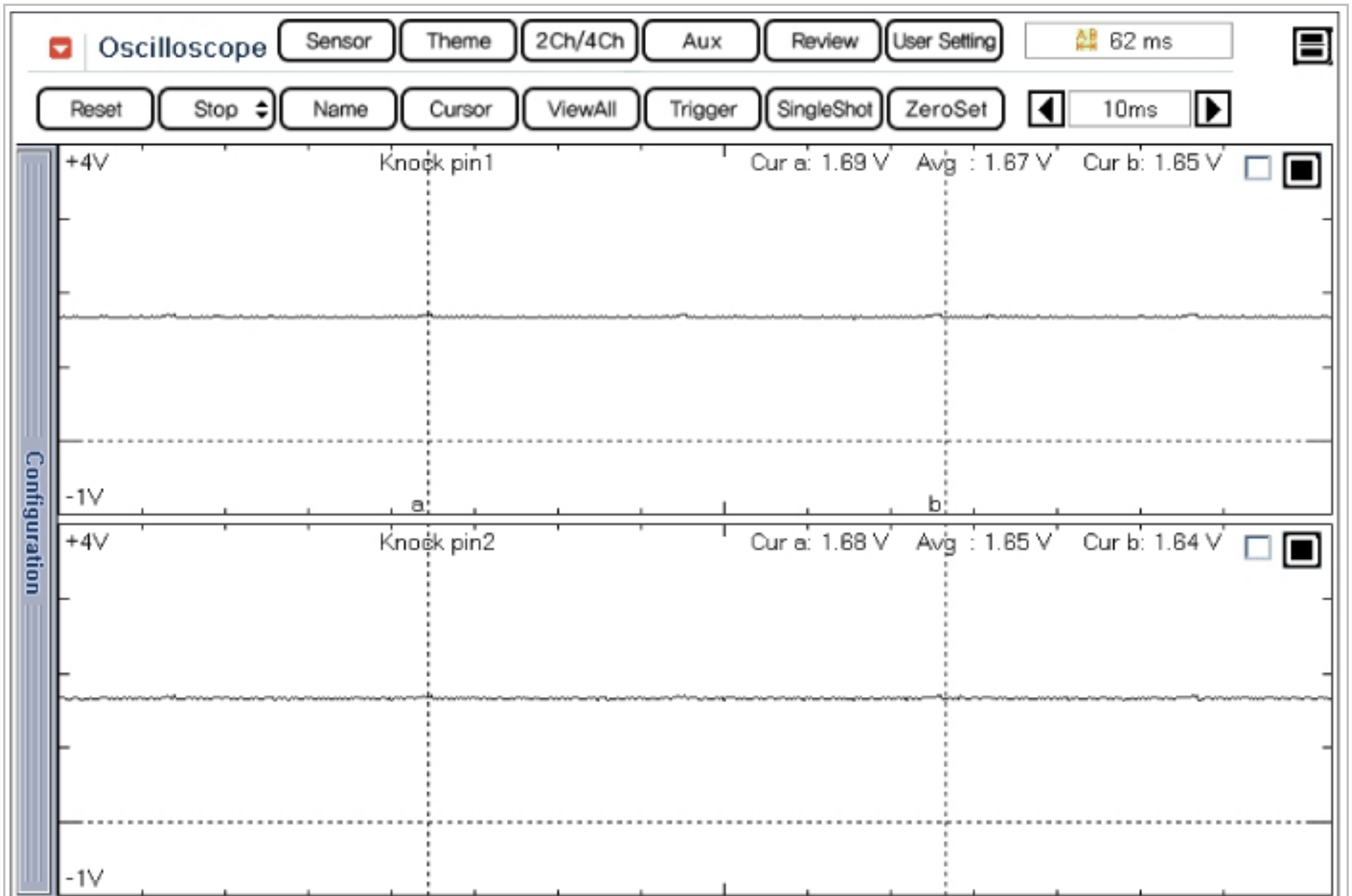


Fig.1

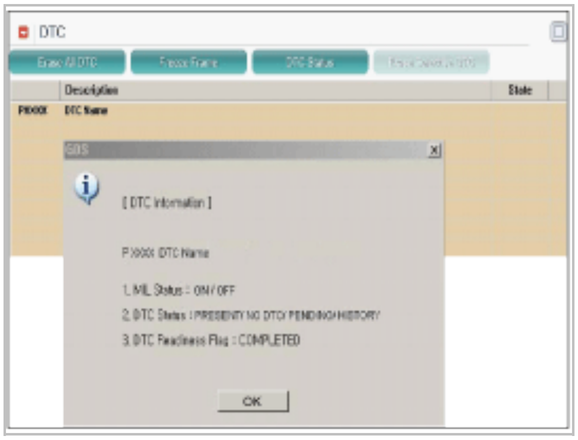
Sensor Name	Value	Unit
Knock Adaption-Cylinder 1	0.0	DEG
Knock Adaption-Cylinder 2	0.0	DEG
Knock Adaption-Cylinder 3	0.0	DEG
Knock Adaption-Cylinder 4	0.0	DEG
Knock Adaption-Cylinder 5	0.0	DEG
Knock Adaption-Cylinder 6	0.0	DEG

Fig.2

Fig.1) Normal waveform of knock sensor at ig on.
Fig.2) Normal data of knock sensor at ig on.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to " Signal Circuit Inspection " procedure.

Signal Circuit Inspection

■ Check short to battery in harness

1. IG "OFF" and disconnect knock sensor connector.
2. IG "ON".
3. Measure voltage between low signal terminal of knock sensor harness connector and chassis ground.
4. Measure voltage between high signal terminal of knock sensor harness connector and chassis ground.

Specification : Approx. 1.5V

5. Is the measured voltage within specification ?

YES	▶ Go to "Check short to ground in harness" as follows.
NO	▶ Repair short to battery in harness, and go to "Verification of Vehicle Repair" procedure.

■ Check short to ground in harness

1. IG "OFF" and disconnect knock sensor connector and ECM connector.
2. Measure resistance between low signal terminal of knock sensor harness connector and chassis ground.
3. Measure resistance between high signal terminal of knock sensor harness connector and chassis ground.

Specification : Infinite

4. Is the measured resistance within specification ?

YES	▶ If the problem is corrected after substituting with a known - good knock sensor, replace it. If the problem is pending, check for proper operating after substituting with a known - good ECM. and then if the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Repair short to ground in harness, and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

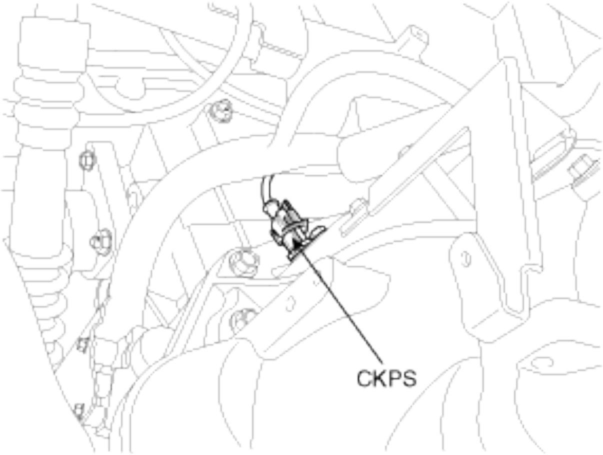
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0335 Crankshaft Position Sensor \'A\' Circuit

Component Location



General Description

The Crankshaft Position Sensor (CKPS) is a magnetic field sensitive type sensor that generates voltage using a sensor and a target wheel mounted on the crankshaft; there are 58 slots in the target wheel where one is longer than the others. During one crankshaft rotation there are 58 rectangular signals and one longer signal. The ECM calculates engine RPM by using the sensor's signal and controls the injection duration and the ignition timing. Using the signal differences caused by the longer slot, the ECM identifies which cylinder is at top dead center.

DTC Description

Checking reference signals from CKPS under detecting condition, if any signal is detected for more than 0.15 sec., ECM sets P0335. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

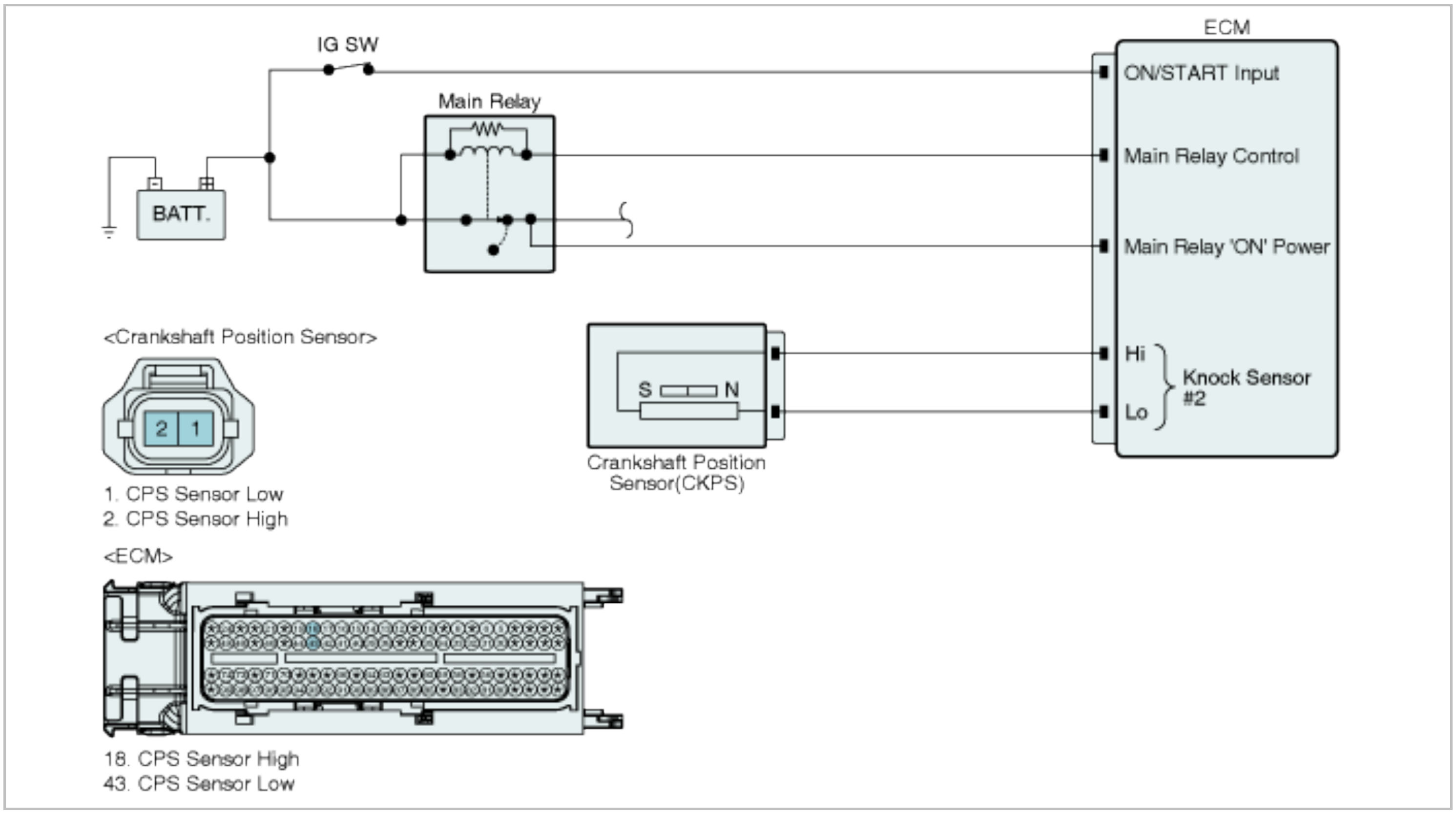
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Check reference wave during cranking	• Poor connection • Open in harness • CKP sensor • ECM
Enable Conditions	• IG "ON", Cranking or engine-off during driving • No DTC related to CAM • Camshaft position sensor state change	
Threshold value	• No reference signal over 0.15 sec.	
Diagnosis Time	• 0.15 sec.	
MIL On Condition	• 2 Driving Cycles	

Specification

Item	Specification
Coil Resistance (Ω)	630 ~ 770Ω (20°C/68°F)
Airgap (mm)	0.5 ~ 1.5 mm

Diagnostic Circuit Diagram



Signal Waveform & Data

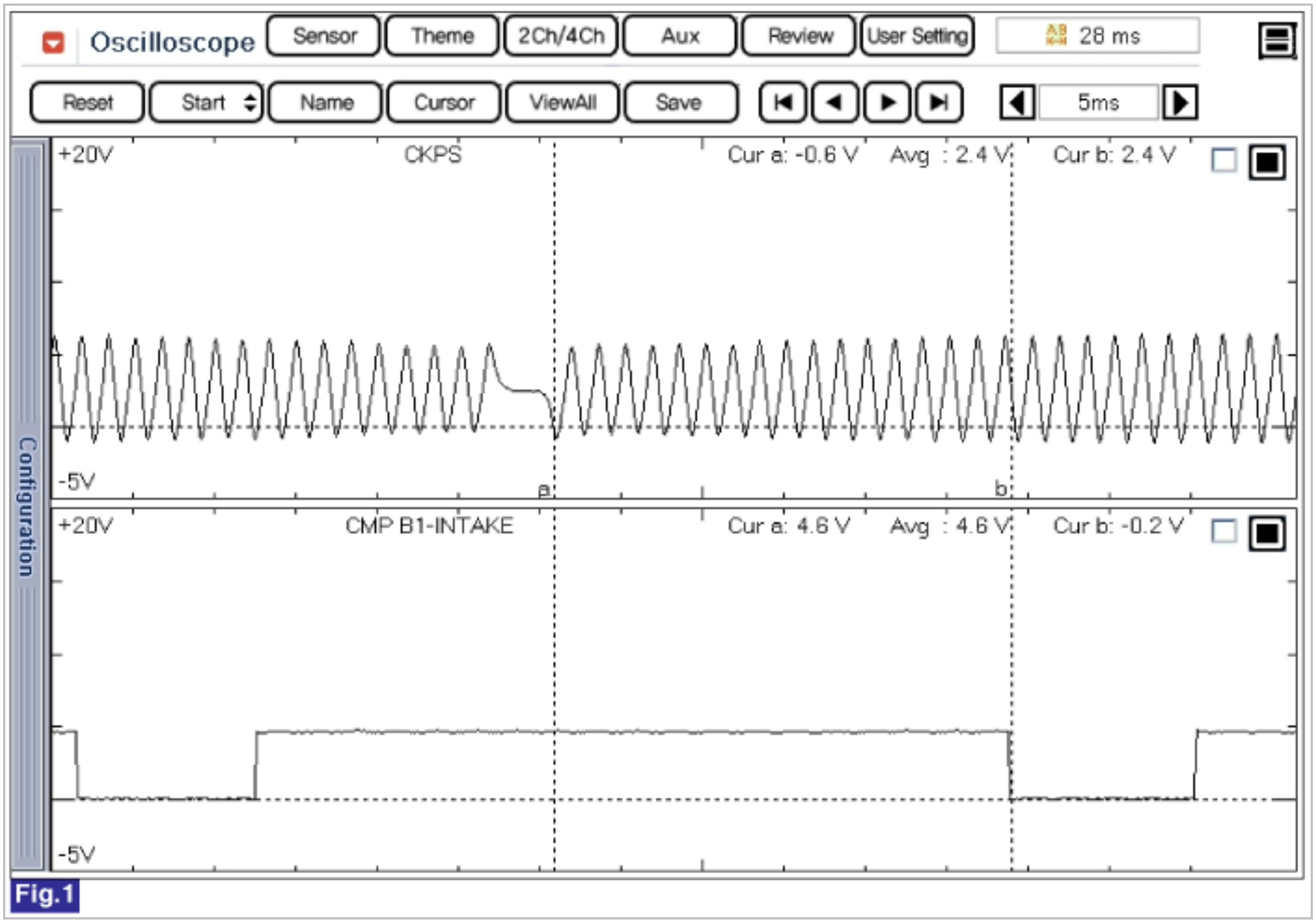
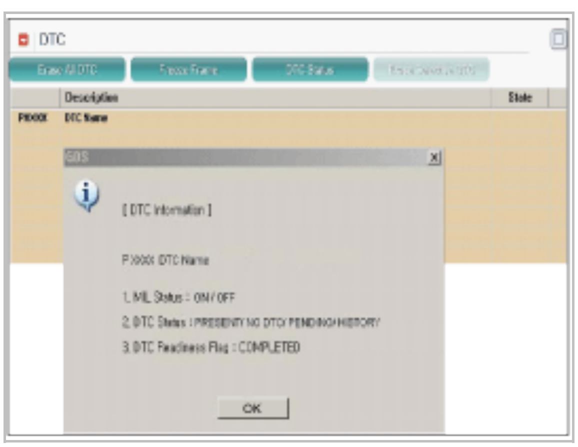


Fig.1) Normal waveforms of CKPS & CMPS

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.

NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to " Signal Circuit Inspection " procedure.

Signal Circuit Inspection

■ Check voltages

1. IG "OFF" and disconnect CKPS connector.
2. IG "ON".
3. Measure voltage between low signal terminal of CKPS harness connector and chassis ground.
4. Measure voltage between high signal terminal of CKPS harness connector and chassis ground.

Specification : Approx. 2.4V

5. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Go to "Check open in harness" as follows.

■ Check open in harness

1. IG "OFF" and disconnect CKPS connector and ECM connector.
2. Measure resistance between low signal terminal of CKPS harness connector and CKPS low signal terminal of ECM harness connector.
3. Measure resistance between high signal terminal of CKPS harness connector and CKPS high signal terminal of ECM harness connector.

Specification : Below 1Ω

4. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check CKPS

1. IG "OFF" and disconnect CKPS connector.
2. Measure resistance between low signal and high signal terminals of CKPS connector.(Component side)

Specification : 700 ± 70Ω (at 20°C/ 68°F)

3. Is the measured resistance within specification ?

YES	▶ Go to "Check signal waveform of CKPS" as follows.
NO	▶ Substitute with a known - good CKPS and check for proper operation. If the problem is corrected, replace CKPS and go to "Verification of Vehicle Repair" procedure.

■ Check signal waveform of CKPS

1. IG "OFF" and connect GDS.
2. NG "ON" and Measure signal waveform at signal terminal of CKPS.

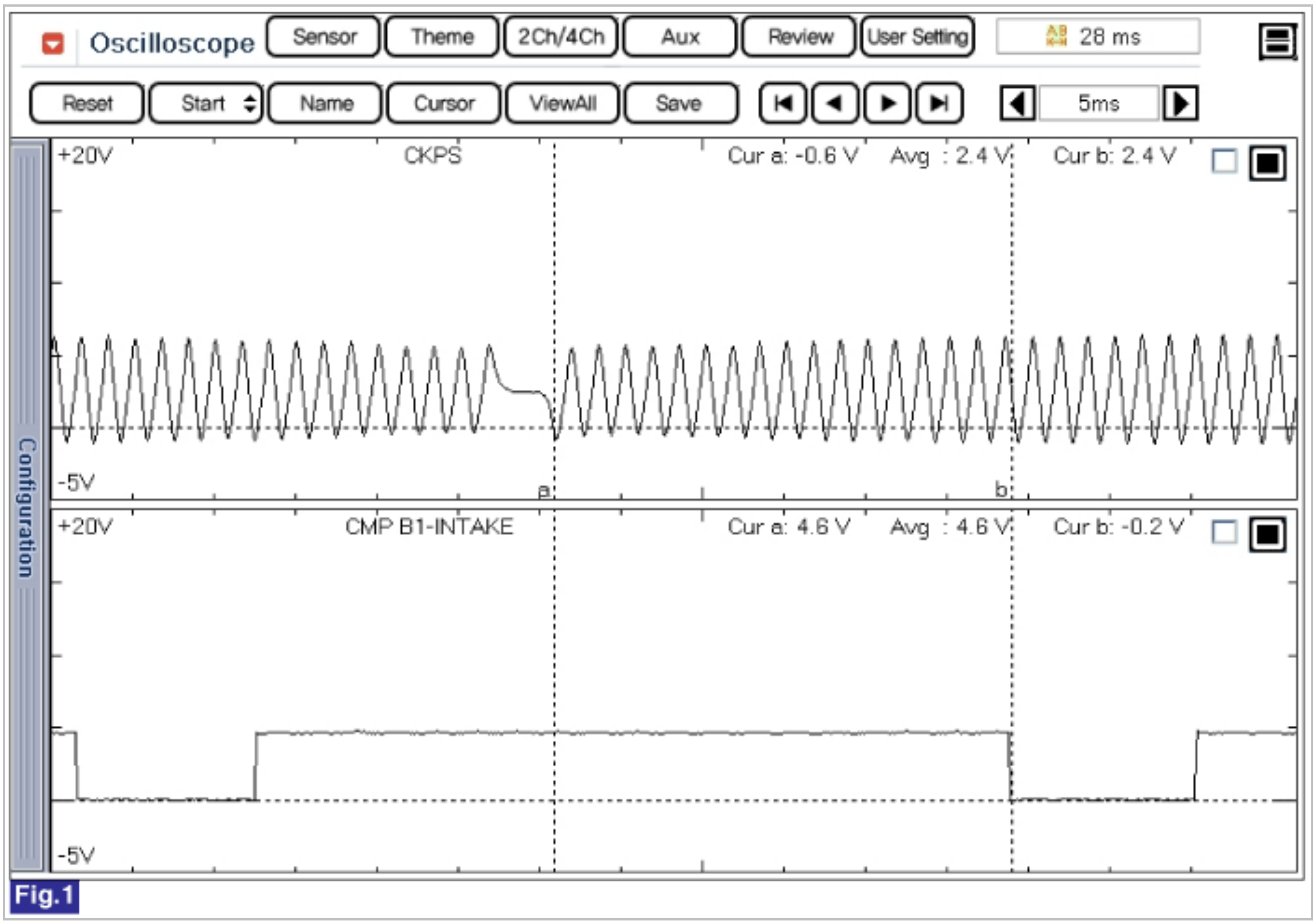


Fig.1) Normal waveforms of CKPS & CMPS

3. Is the measured siganl waveform normal?

YES	▶ Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary, and go to "Verification of Vehicle Repair" procedure.

NO	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure.

NOTE

There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others

Verification of Vehicle Repair

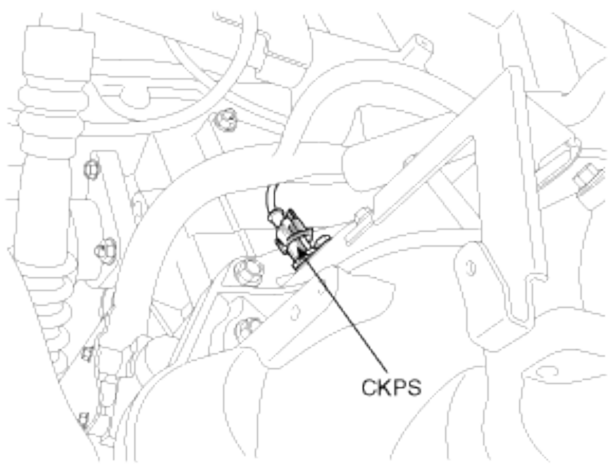
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0336 Crankshaft Position Sensor \'A\' Circuit Range/Performance

Component Location



General Description

The Crankshaft Position Sensor (CKPS) is a magnetic field sensitive type sensor that generates voltage using a sensor and a target wheel mounted on the crankshaft; there are 58 slots in the target wheel where one is longer than the others. During one crankshaft rotation there are 58 rectangular signals and one longer signal. The ECM calculates engine RPM by using the sensor’s signal and controls the injection duration and the ignition timing. Using the signal differences caused by the longer slot, the ECM identifies which cylinder is at top dead center.

DTC Description

Checking output signals from CKPS every 7.8 sec. under detecting condition, if an output signal is missing or redundant for more than 1.56 sec., ECM sets P0336. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

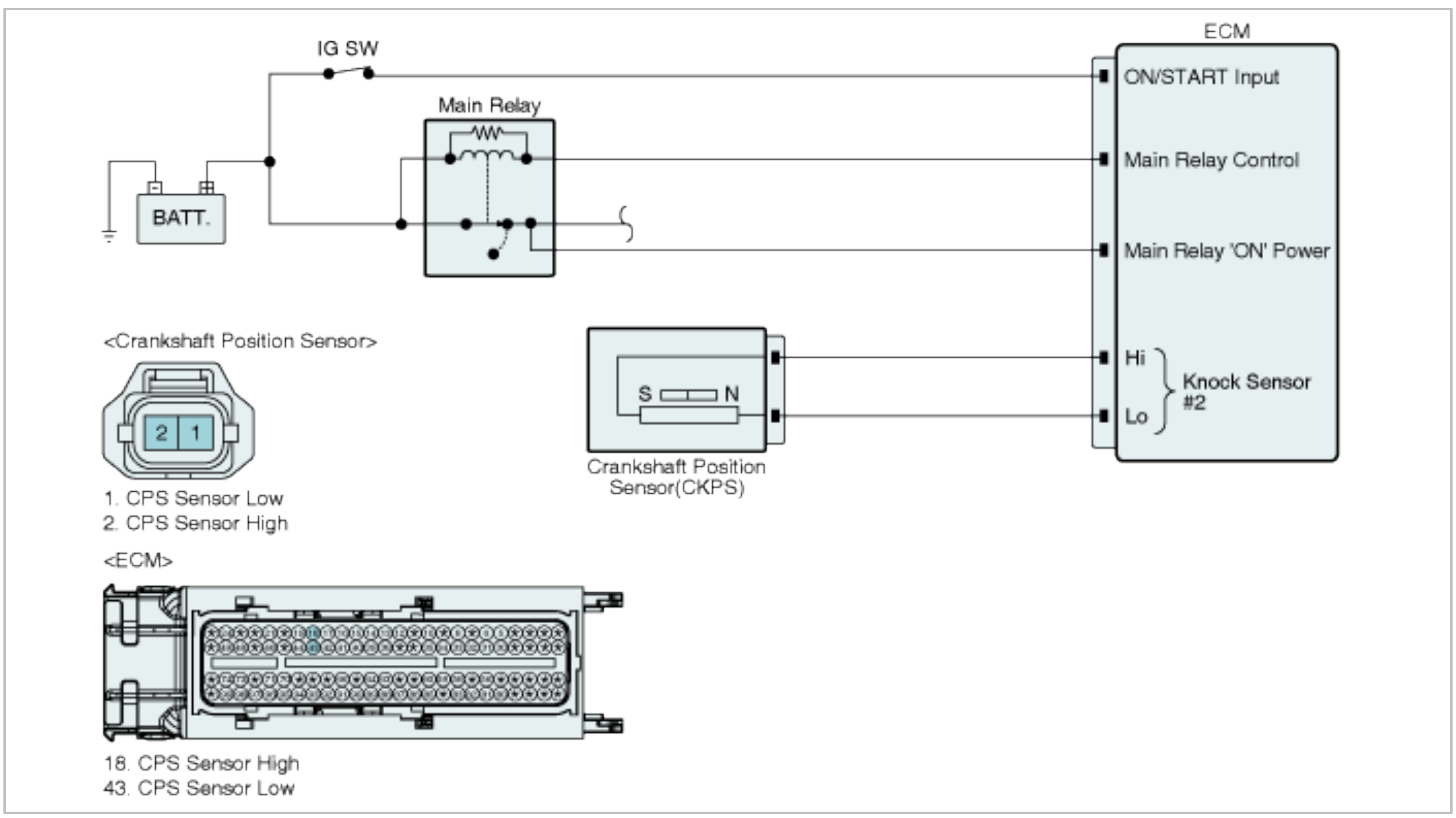
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Detecting extra/missing pulses between consecutive 58X reference pulses	• Poor connection • Noise • Short in harness • Target wheel • ECM
Enable Conditions	• Engine running state	
Threshold value	• Extra / missing pulses > 2 pulses	
Diagnosis Time	• Continuous (More than 1.56 sec.failure for every 7.8 sec.test)	
MIL On Condition	• 2 Driving Cycles	

Specification

Item	Specification
Coil Resistance (Ω)	630 ~ 770Ω (20°C/68°F)
Airgap (mm)	0.5 ~ 1.5 mm

Diagnostic Circuit Diagram



Signal Waveform & Data

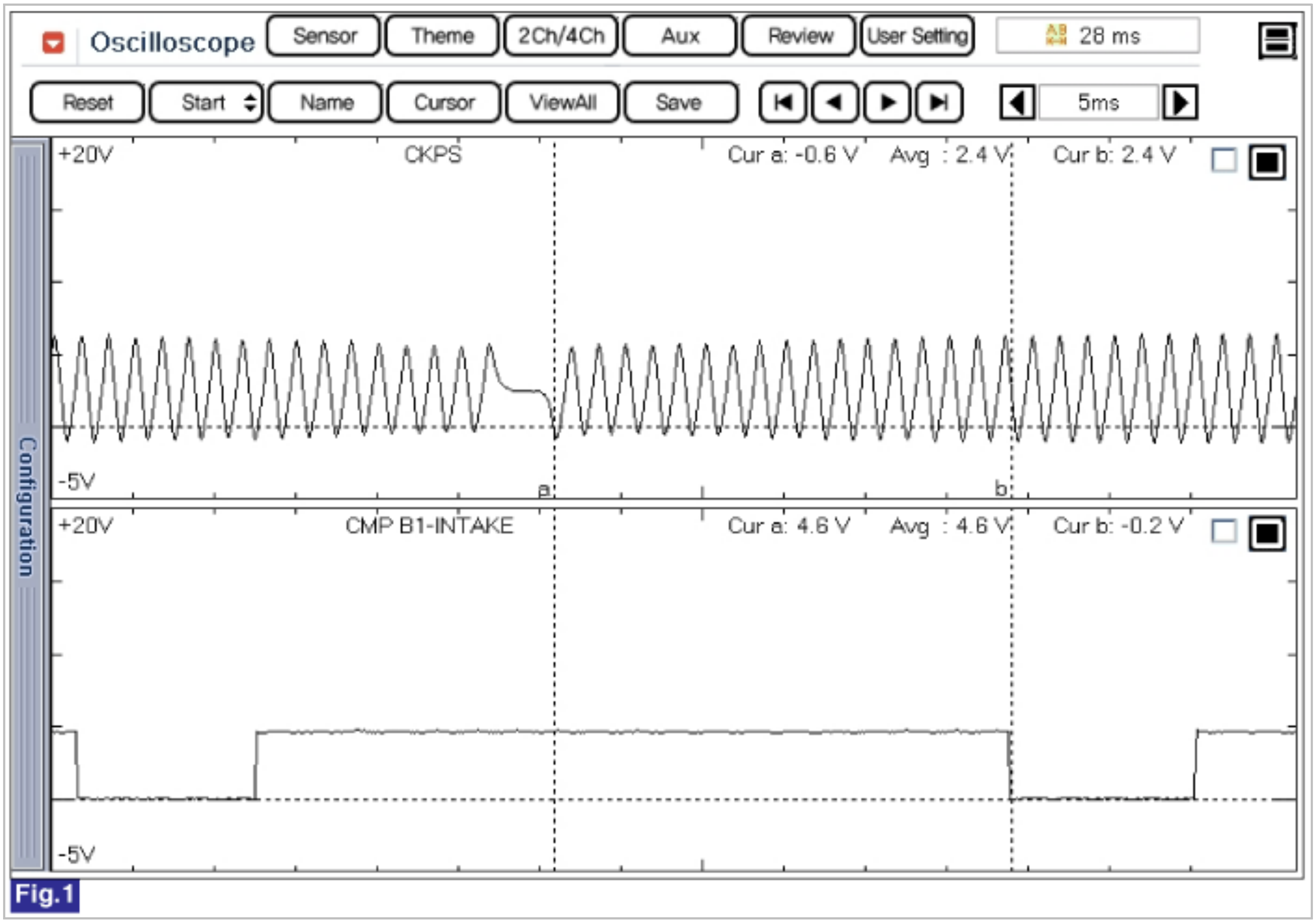
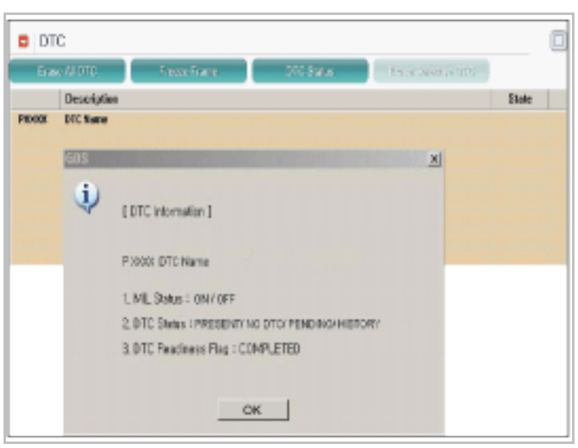


Fig.1) Normal waveforms of CKPS & CMPS

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to " Signal Circuit Inspection " procedure.

Signal Circuit Inspection

■ **Check voltage**

1. IG "OFF" and disconnect CKPS connector.
2. IG "ON".
3. Measure voltage between low signal terminal of CKPS harness connector and chassis ground.
4. Measure voltage between high signal terminal of CKPS harness connector and chassis ground.

Specification : Approx. 2.4V

5. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Go to "Check short in harness" as follows.

■ **Check short in harness**

1. IG "OFF" and disconnect CKPS connector and ECM connector.
2. Measure resistance between low(high) signal terminal of CKPS harness connector and chassis ground.(Measurement "A")
3. Measure resistance between low signal and high signal terminals of CKPS harness connector.(Measurement "B")

Specification : Infinite

4. Is the measured resistance within specification?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Visually check CKPS and target wheel

1. IG "OFF"
2. Check CKPS and target wheel for deformation or damage visually
3. Is the above items normal ?

YES	▶ Go to "Check CKPS resistance" as follows.
NO	▶ Repair or replace it, and go to "Verification of Vehicle Repair" procedure.

■ Check CKPS

1. IG "OFF" and disconnect CKPS connector.
2. Measure resistance between low signal and high signal terminals of CKPS connector.(Component side)

Specifiation : 700 ± 70Ω (at 20°C/ 68°F)

3. Is the measured resistance within specification ?

YES	▶ Go to "Check signal waveform of CKPS" as follows.
NO	▶ Substitute with a known - good CKPS and check for proper operation. If the problem is corrected, replace CKPS and go to "Verification of Vehicle Repair" procedure.

■ Check signal waveform of CKPS

1. IG "OFF" and connect GDS.
2. ENG "ON" and Measure signal waveform at signal terminal of CKPS.

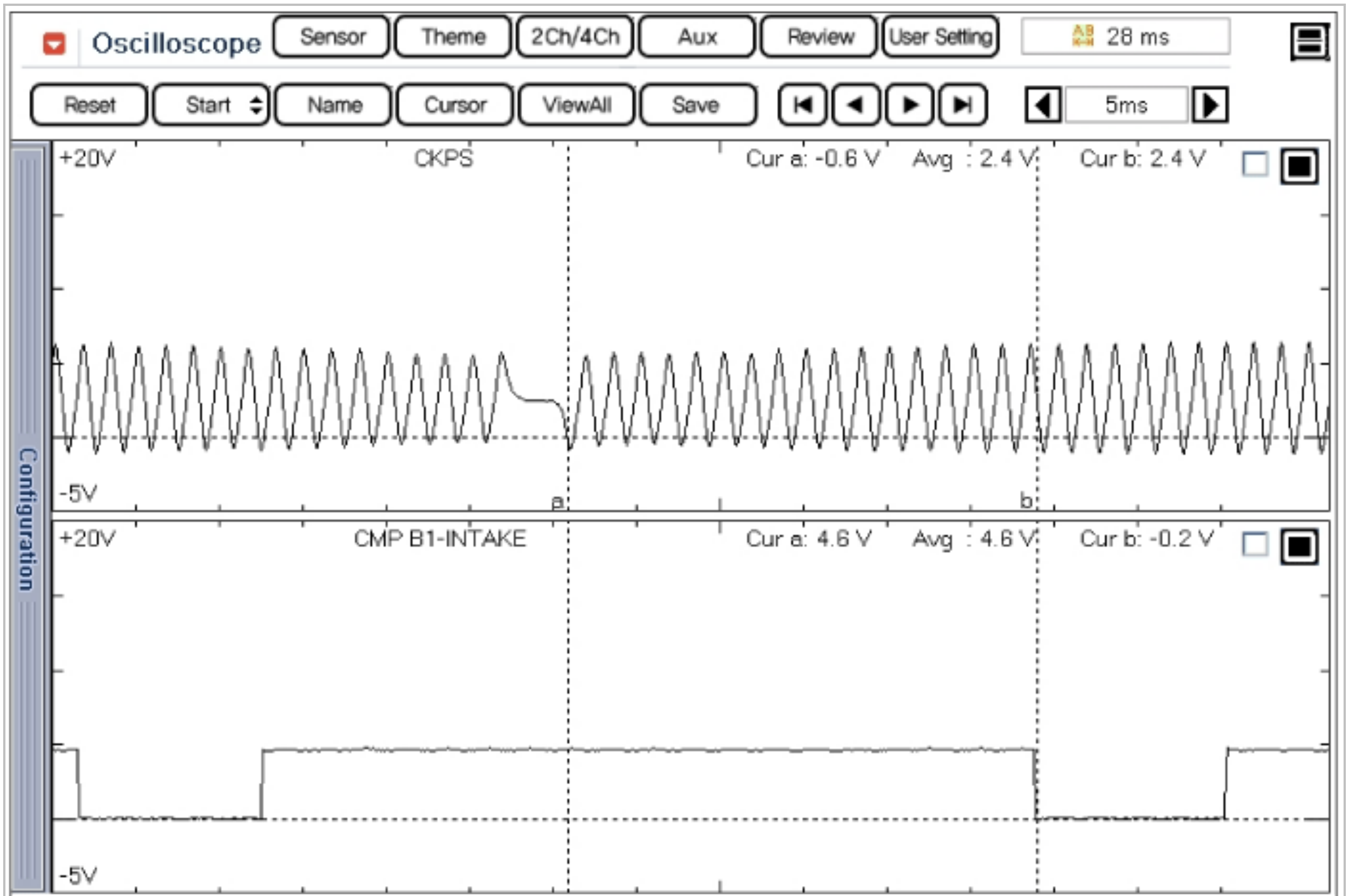


Fig.1

Fig.1) Normal waveforms of CKPS & CMPS

3. Is the measured siganl waveform normal?

YES	▶ Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary, and go to "Verification of Vehicle Repair" procedure.
NO	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure.

NOTE

There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others.

Verification of Vehicle Repair

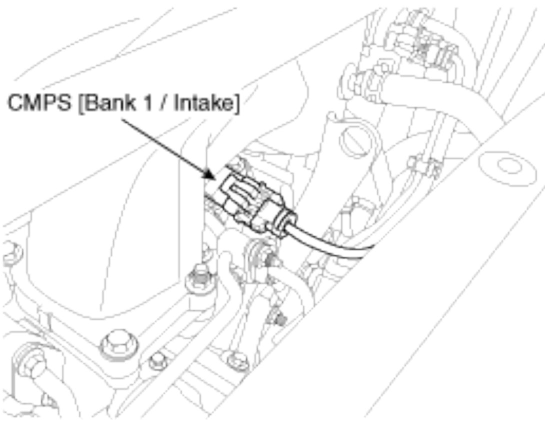
After a repair, it is essential to verify that the fault has been corrected.

1. Connect scantool and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0340 Camshaft Position Sensor \'A\' Circuit (Single Sensor)

Component Location



General Description

The Camshaft Position Sensor (CMPS) is a sensor that detects the compression TDC of the NO. 1 cylinder. The CMPS consists of a hall type sensor and a target on the end of the intake camshaft. When the target triggers the sensor, the sensor voltage is 5V. If not, the sensor voltage is 0V. These CMPS signal is sent to the ECM and the ECM uses the CMPS signal for synchronizing the firing of sequential fuel injectors.

DTC Description

If ECM detects that cam event signal count is over 3 under detecting condition, ECM sets P0340. And MIL(Malfunction Indication Lamp) turns on.

DTC Detecting Condition

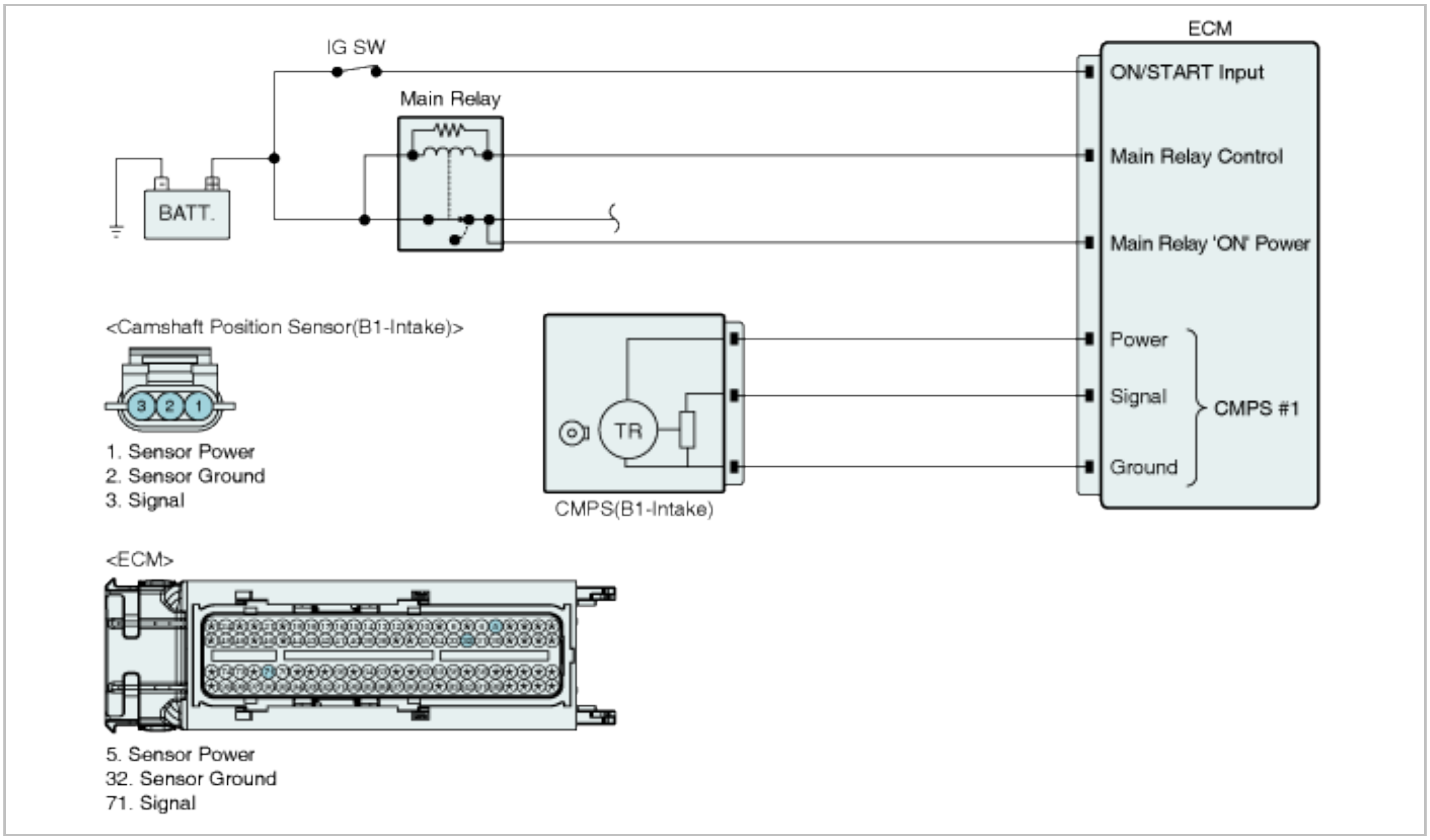
Item	Detecting Condition	Possible Cause
DTC Strategy	• Check if CAM sensor is synchronized correctly	• Poor connection • Open in harness • CMPS(B1-Intake) • CMPS(B2-Intake) • ECM
Enable Conditions	• Engine running state	
Threshold value	• CAM event signal count ≥ 3	
Diagnosis Time	• Continuous	
MIL On Condition	• 1 Driving Cycles	

Specification

Item	Specification	

Output Voltage(V)	Hi : 5.0V	Low : 0.7V
Airgap(mm)	0.5 ~ 1.5	

Diagnostic Circuit Diagram



Signal Waveform & Data

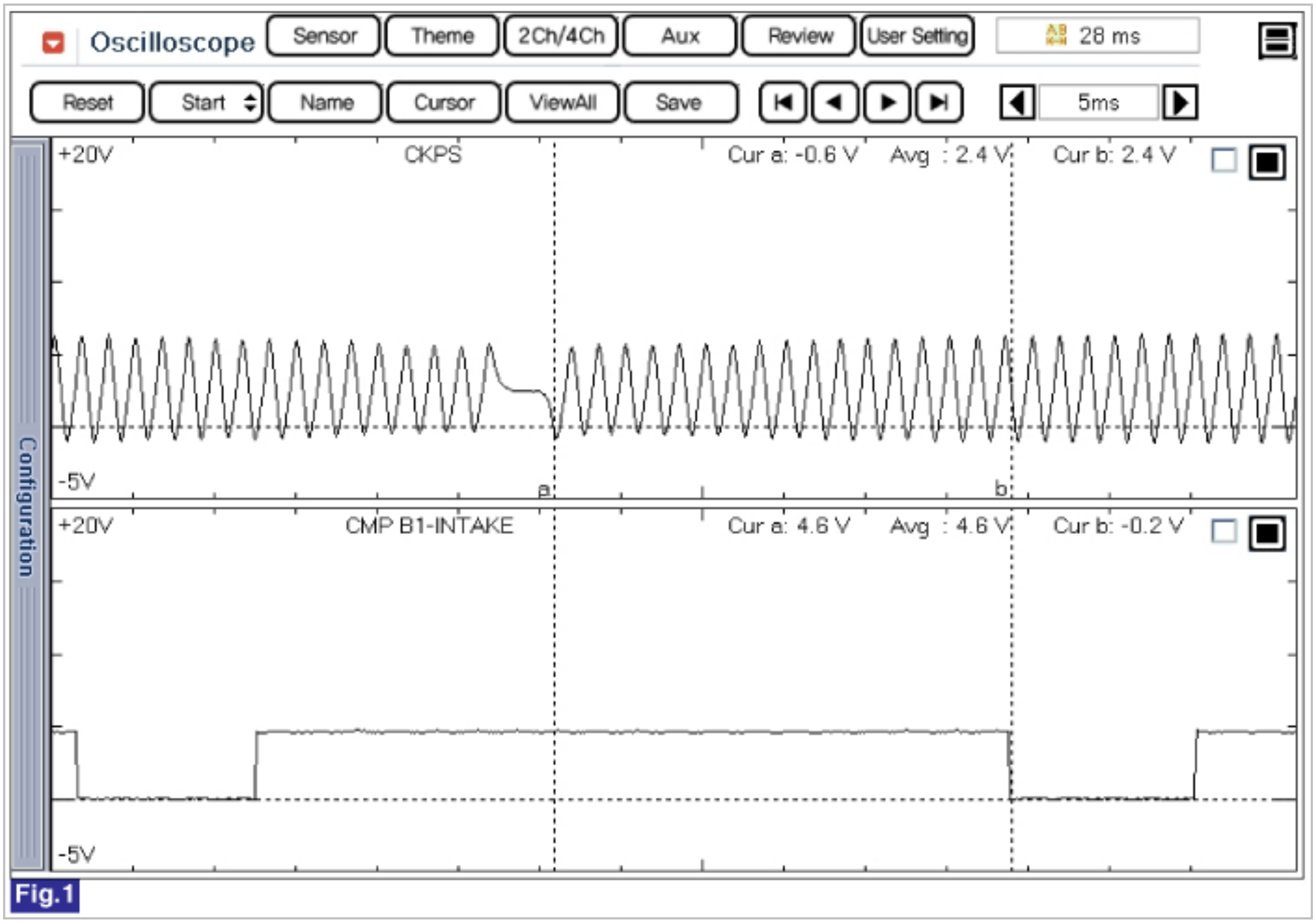
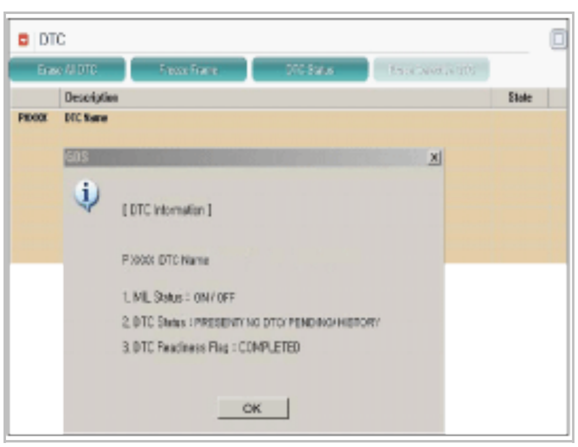


Fig.1) Normal waveforms of CKPS & CMPS

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.

NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect CMPS(B1, B2-Intake) connector.
2. IG "ON".
3. Measure voltage between power terminal of CMPS(B1, B2-Intake) harness connector and chassis ground.

Specification : Approx. 5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Signal Circuit Inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Signal Circuit Inspection

■ Check short to battery in harness

1. IG "OFF" and disconnect CMPS(B1, B2-Intake) connector.
2. IG "ON".
3. Measure voltage between signal terminal of CMPS(B1, B2-Intake) harness connector and chassis ground.

Specification : Approx. 5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Go to "Check open in harness" as follows.

■ Check open in harness

1. IG "OFF" and disconnect CMPS(B1, B2-Intake) connector and ECM connector.

2. Measure resistance between signal terminal of CMPS(B1, B2-Intake) harness connector and CMPS(B1, B2-Intake) signal terminal of ECM harness connector.

Specification : Below 1Ω

3. Is the measured resistance within specification?

YES	▶ Go to "Ground Circuit Inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Ground Circuit Inspection

■ Check open in harness

1. IG "OFF" and disconnect CMPS(B1, B2-Intake) connector and then IG "ON".
2. Measure voltage between signal terminal of CMPS(B1, B2-Intake) harness connector and chassis ground. (Measurement "A")
3. Measure voltage between signal and ground terminals of CMPS(B1, B2-Intake) harness connector. (Measurement "B")

Specification : Voltage difference between measurement "A" and "B" is below 200mV.

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair contact resistance or open in harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check CMPS

1. IG "OFF" and connect GDS.
2. ENG "ON" and Measure signal waveform at signal terminal of CMPS (B1, B2-Intake).

Reference signal waveform :

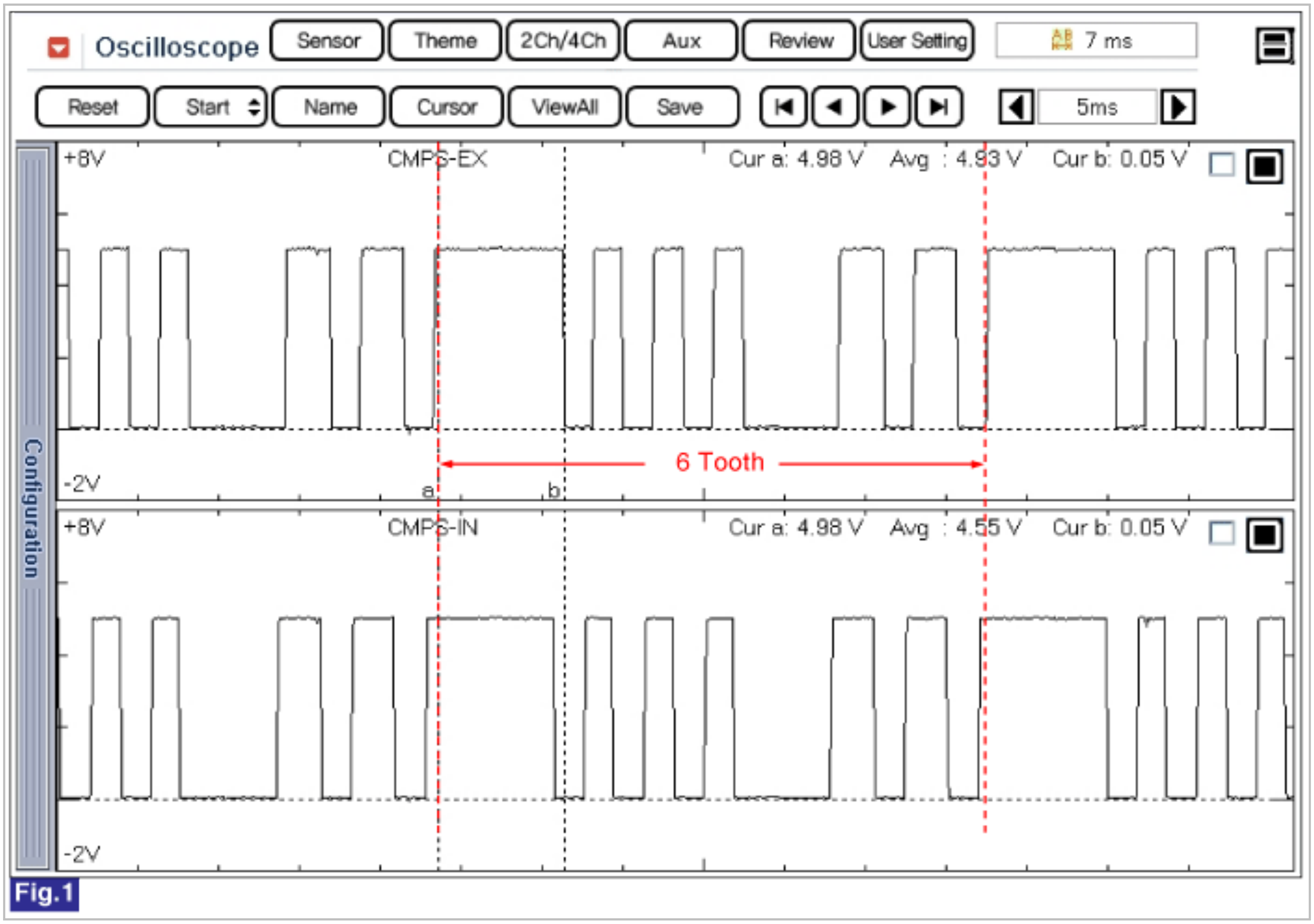


Fig.1) Normal waveform of CMPS1 & 2 at idle.

3. Is the measured siganl waveform normal?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good CMPS and check for proper operation. If the problem is corrected, replace CMPS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

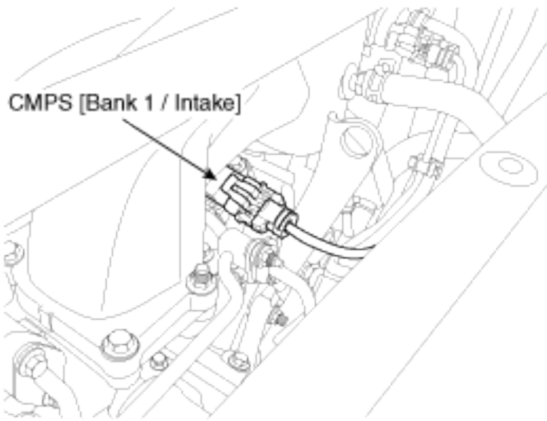
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0341 Camshaft Position Sensor A Circuit Range/Performance (Bank 1)

Component Location



General Description

The Camshaft Position Sensor (CMPS) is a sensor that detects the compression TDC of the NO. 1 cylinder. The CMPS consists of a hall type sensor and a target on the end of the intake camshaft. When the target triggers the sensor, the sensor voltage is 5V. If not, the sensor voltage is 0V. These CMPS signal is sent to the ECM and the ECM uses the CMPS signal for synchronizing the firing of sequential fuel injectors.

DTC Description

Checking oputput signals from CMP during engine running, if the expected number of cam tooth count is not observed, ECM sets P0341. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

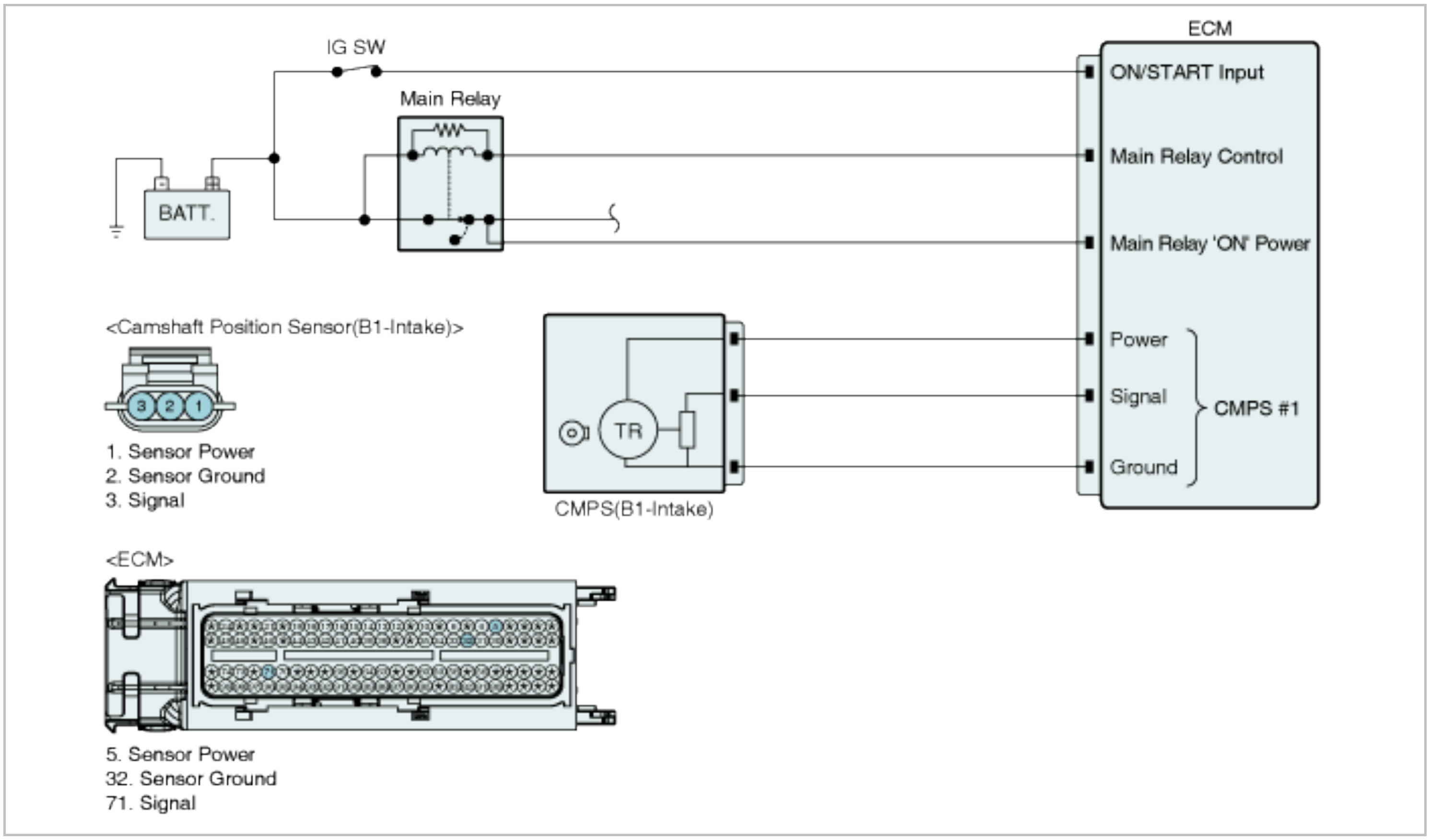
Item	Detecting Condition	Possible Cause
DTC Strategy	• Check if CAM sensor is synchronized correctly	• Poor connection • Short in harness • Electrical noise • Target wheel • CMPS(B1-Intake) • ECM
Enable Conditions	• Engine running state	
Threshold value	• Cam tooth count ≠ 6	
Diagnosis Time	• Continuous	
MIL On Condition	• 2 driving cycles	

Specification

Item	Specification

Output Voltage(V)	Hi : 5.0V	Low : 0.7V
Airgap(mm)	0.5 ~ 1.5	

Diagnostic Circuit Diagram



Signal Waveform & Data

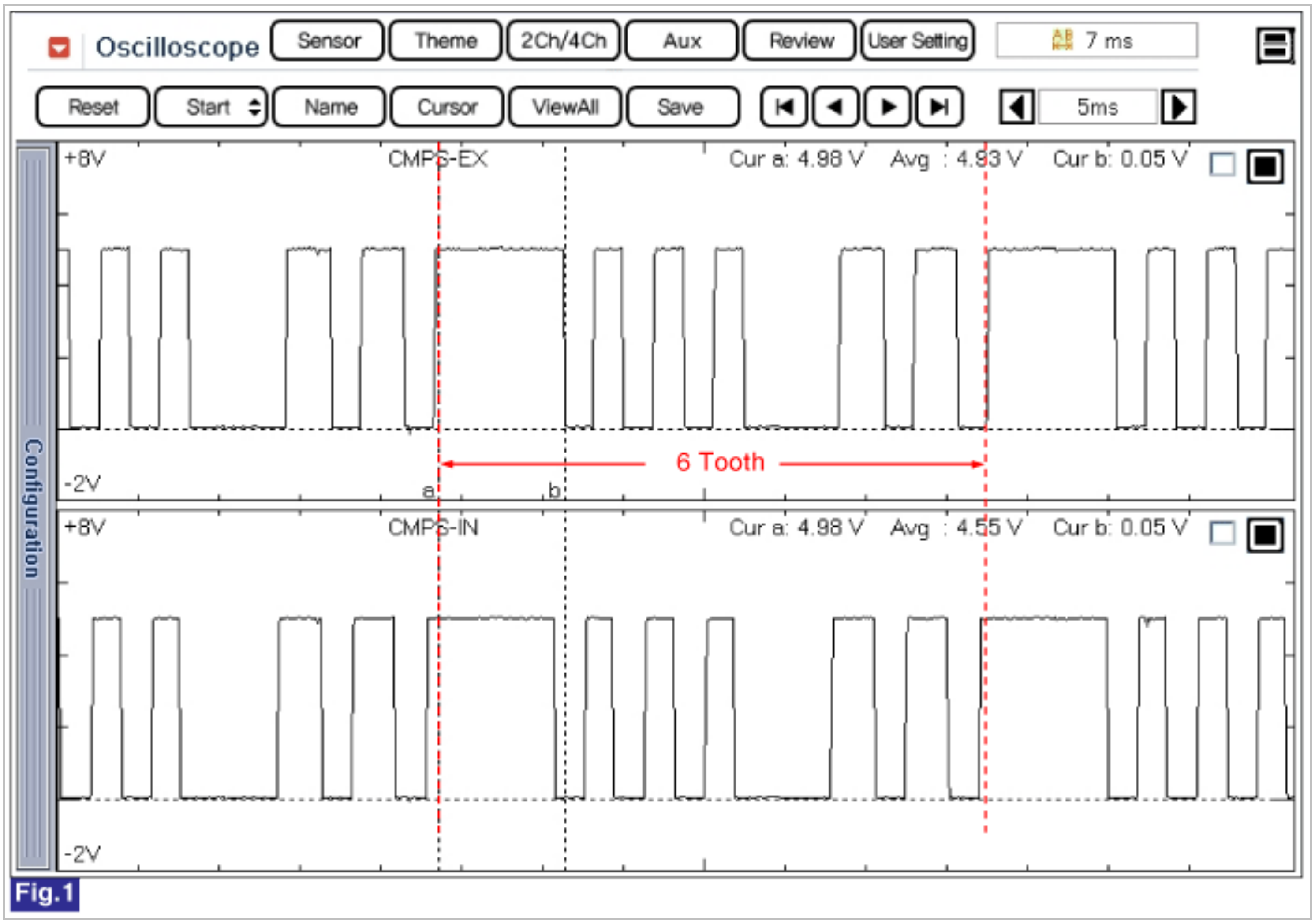
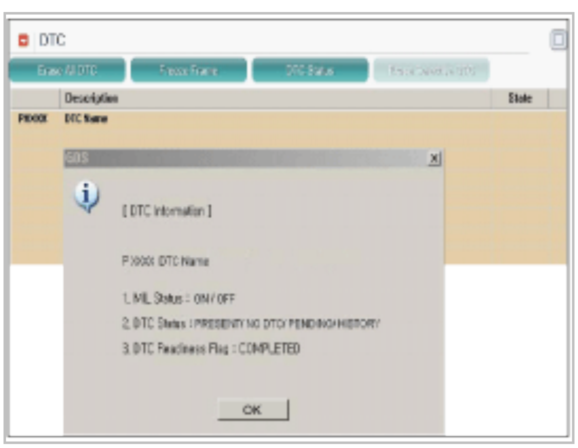


Fig.1) Normal waveforms of CMPS

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.

NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect CMPS(B1-Intake) connector.
2. IG "ON".
3. Measure voltage between power terminal of CMPS(B1-Intake) harness connector and chassis ground.

Specification : Approx. 5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Signal Circuit Inspection" procedure.
NO	▶ Repair open or short to ground in harness, and go to "Verification of Vehicle Repair" procedure.

Signal Circuit Inspection

■ Check short in harness

1. IG "OFF" and disconnect CMPS(B1-Intake) connector.
2. Measure resistance between signal and power terminals of CMPS(B1-Intake) harness connector.

Specification : Infinite

3. Is the measured resistance within specification?

YES	▶ Go to "Check short to ground in harness' as follows.
NO	▶ Repair short in harness, and go to "Verification of Vehicle Repair" procedure.

■ Check short to ground in harness

1. IG "OFF" and disconnect CMPS(B1-Intake) connector and ECM connector.
2. Measure resistance between signal terminal of CMPS(B1-Intake) harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to ground in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check CMPS

1. IG "OFF" and connect GDS.
2. ENG "ON" and Measure signal waveform at signal terminal of CMPS.

Reference signal waveform :

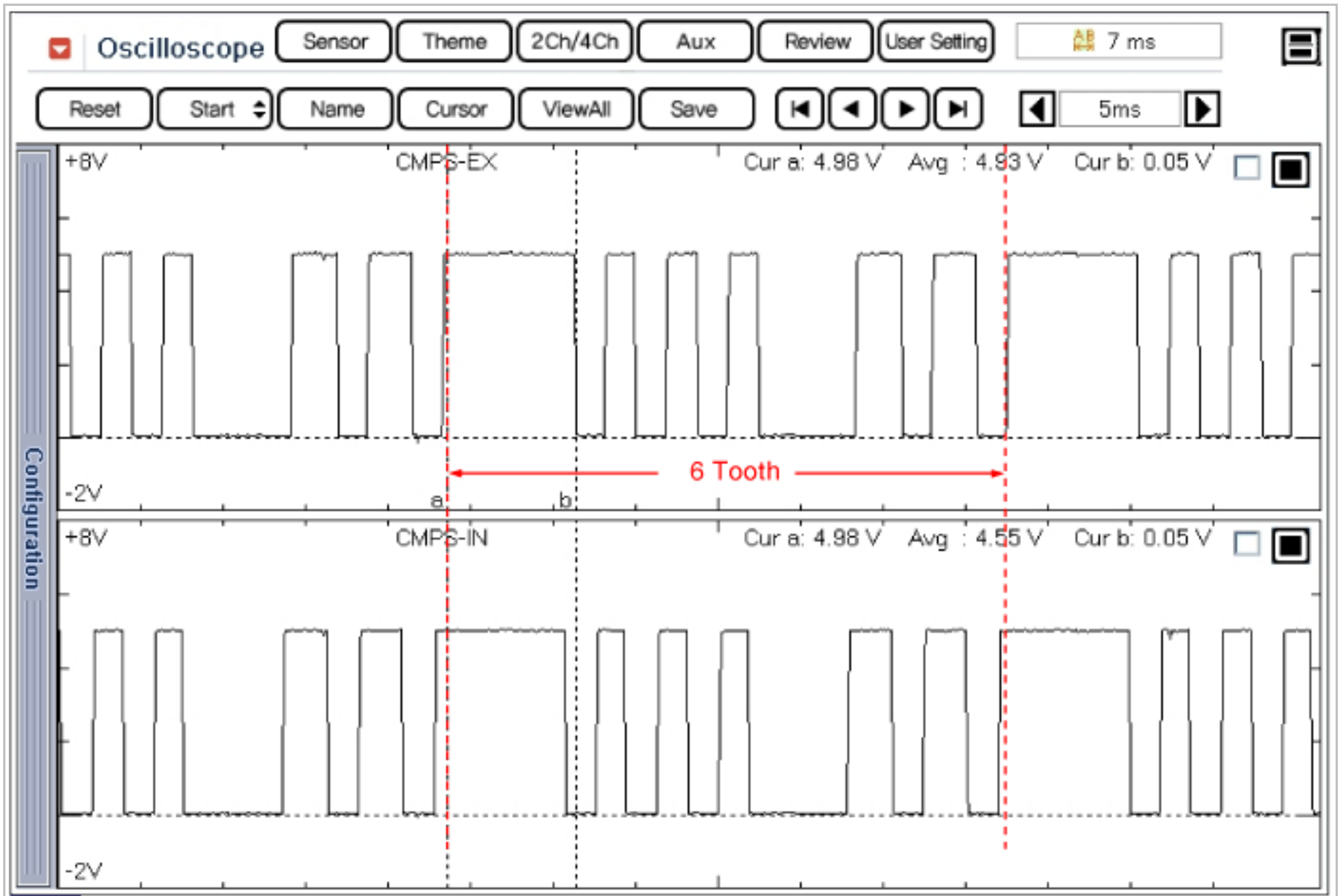


Fig.1

Fig.1) Normal waveform of CMPS1 & 2 at idle.

3. Is the measured siganl waveform normal?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE

	There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good CMPS and check for proper operation. If the problem is corrected, replace CMPS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

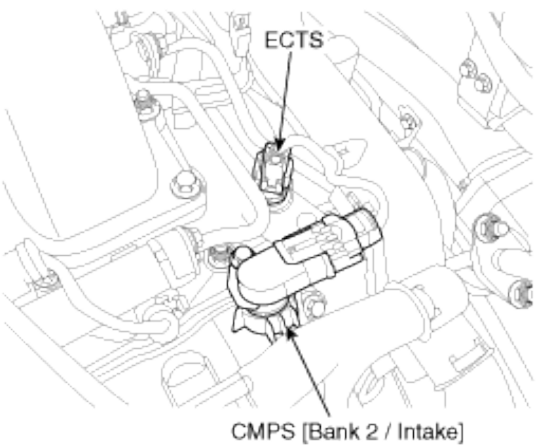
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0346 Camshaft Position Sensor A Circuit Range/Performance (Bank 2)

Component Location



General Description

The Camshaft Position Sensor (CMPS) is a sensor that detects the compression TDC of the NO. 1 cylinder. The CMPS consists of a hall type sensor and a target on the end of the intake camshaft. When the target triggers the sensor, the sensor voltage is 5V. If not, the sensor voltage is 0V. These CMPS signal is sent to the ECM and the ECM uses the CMPS signal for synchronizing the firing of sequential fuel injectors.

DTC Description

Checking oputput signals from CMP during engine running, if the expected number of cam tooth count is not observed, ECM sets P0346.

MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

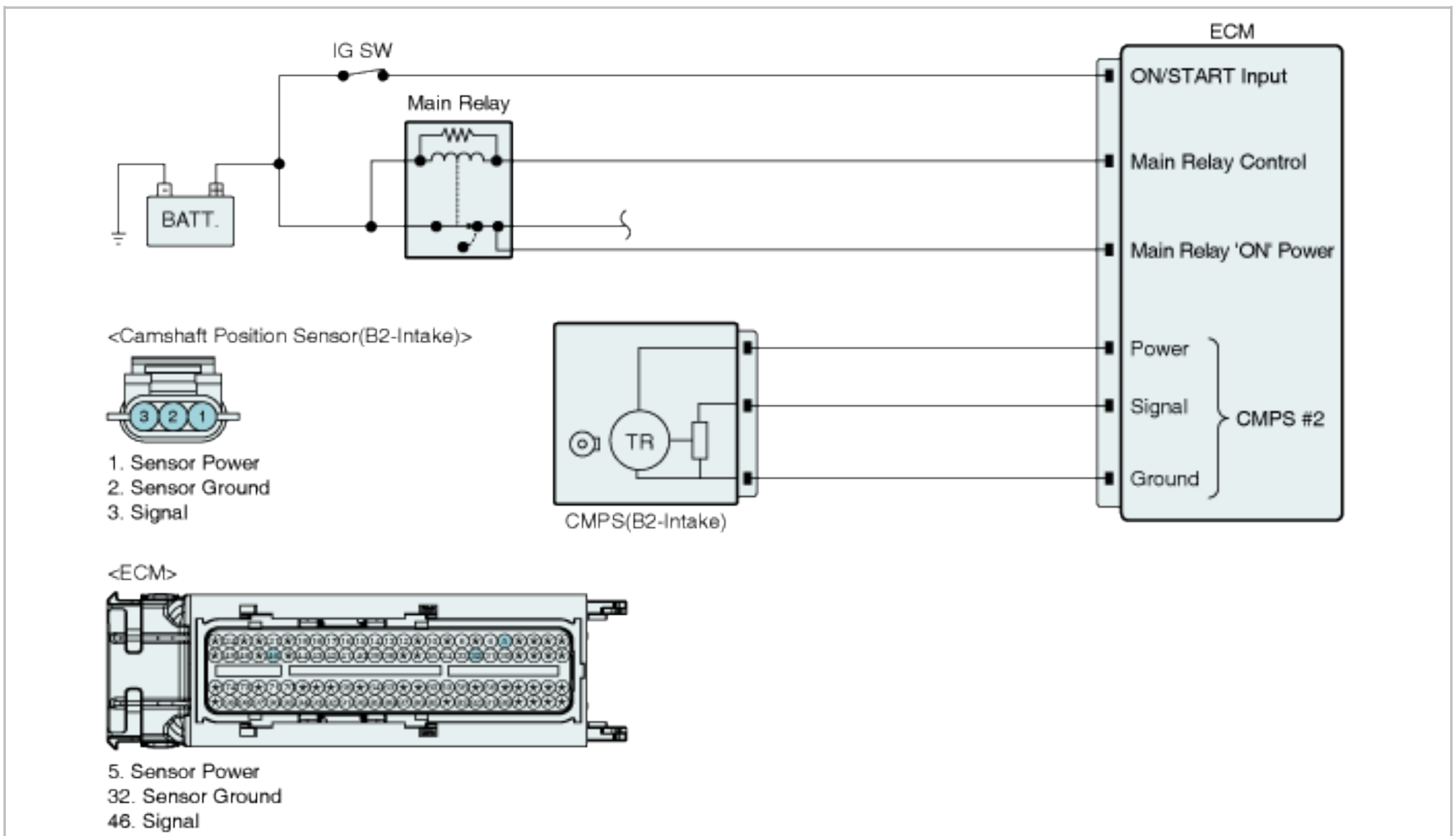
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Check if CAM sensor is synchronized correctly	• Poor connection • Open or short in harness • Electrical noise • Target wheel • CMPS(B2-Intake) • ECM
Enable Conditions	• Engine running state	
Threshold value	• Cam tooth count ≠ 6	
Diagnosis Time	• Continuous	
MIL On Condition	• 2 driving cycles	

Specification

Item	Specification	
Output Voltage(V)	Hi : 5.0V	Low : 0.7V
Airgap(mm)	0.5 ~ 1.5	

Diagnostic Circuit Diagram



Signal Waveform & Data

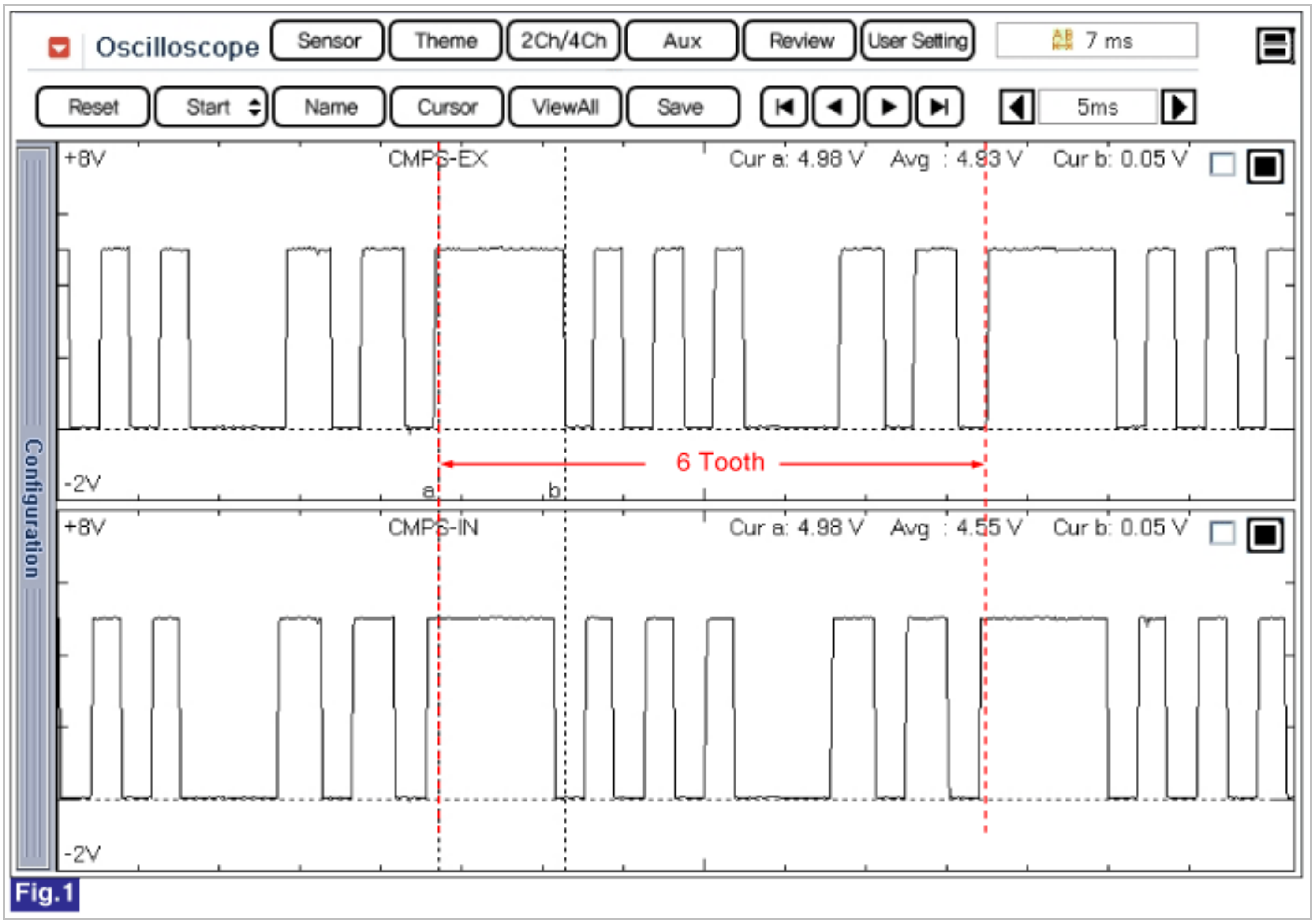
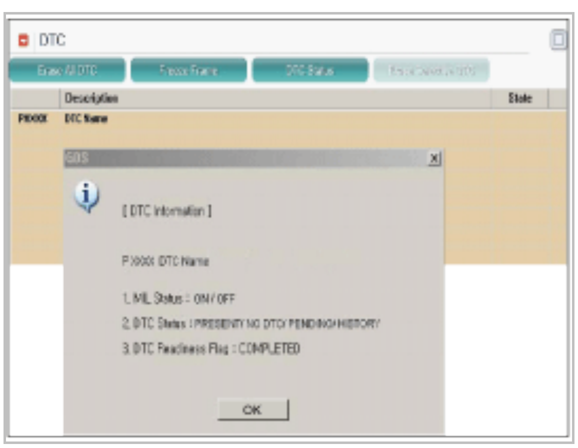


Fig.1) Normal waveforms of CMPS

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.

NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect CMPS(B2-Intake) connector.
2. IG "ON".
3. Measure voltage between power terminal of CMPS(B2-Intake) harness connector and chassis ground.

Specification : Approx. 5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Signal Circuit Inspection" procedure.
NO	▶ Repair open or short to ground inharness, and go to "Verification of Vehicle Repair" procedure.

Signal Circuit Inspection

■ Check short to battery in harness

1. IG "OFF" and disconnect CMPS(B2-Intake) connector.
2. IG "ON".
3. Measure voltage between signal terminal of CMPS(B2-Intake) harness connector and chassis ground.

Specification : Approx. 5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Check short in harness" as follows.
NO	▶ Go to "Check open in harness" as follows.

■ Check short in harness

1. IG "OFF" and disconnect CMPS(B2-Intake) connector.

2. Measure resistance between signal and power terminals of CMPS(B2-Intake) harness connector.

Specification : Infinite

3. Is the measured resistance within specification?

YES	▶ Go to "Check short to ground in harness' as follows.
NO	▶ Repair short in harness, and go to "Verification of Vehicle Repair" procedure.

■ Check short to ground in harness

1. IG "OFF" and disconnect CMPS(B2-Intake) connector and ECM connector.
2. Measure resistance between signal terminal of CMPS(B2-Intake) harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to ground in harness, and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect CMPS(B2-Intake) connector and ECM connector.
2. Measure resistance between signal terminal of CMPS(B2-Intake) harness connector and CMPS(B2-Intake) signal terminal of ECM harness connector.

Specification : Below 1Ω

3. Is the measured resistance within specification?

YES	▶ Go to "Ground Circuit Inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Ground Circuit Inspection

■ Check open in harness

1. IG "OFF" and disconnect CMPS(B2-Intake) connector and then IG "ON".
2. Measure voltage between signal terminal of CMPS(B2-Intake) harness connector and chassis ground.(Measurement "A")
3. Measure voltage between signal and ground terminals of CMPS(B2-Intake) harness connector.(Measurement "B")

Specification : Voltage difference between measurement "A" and "B" is below 200mV.

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair contact resistance or open in harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check CMPS

1. IG "OFF" and connect GDS.
2. ENG "ON" and Measure signal waveform at signal terminal of CMPS.

Reference signal waveform :

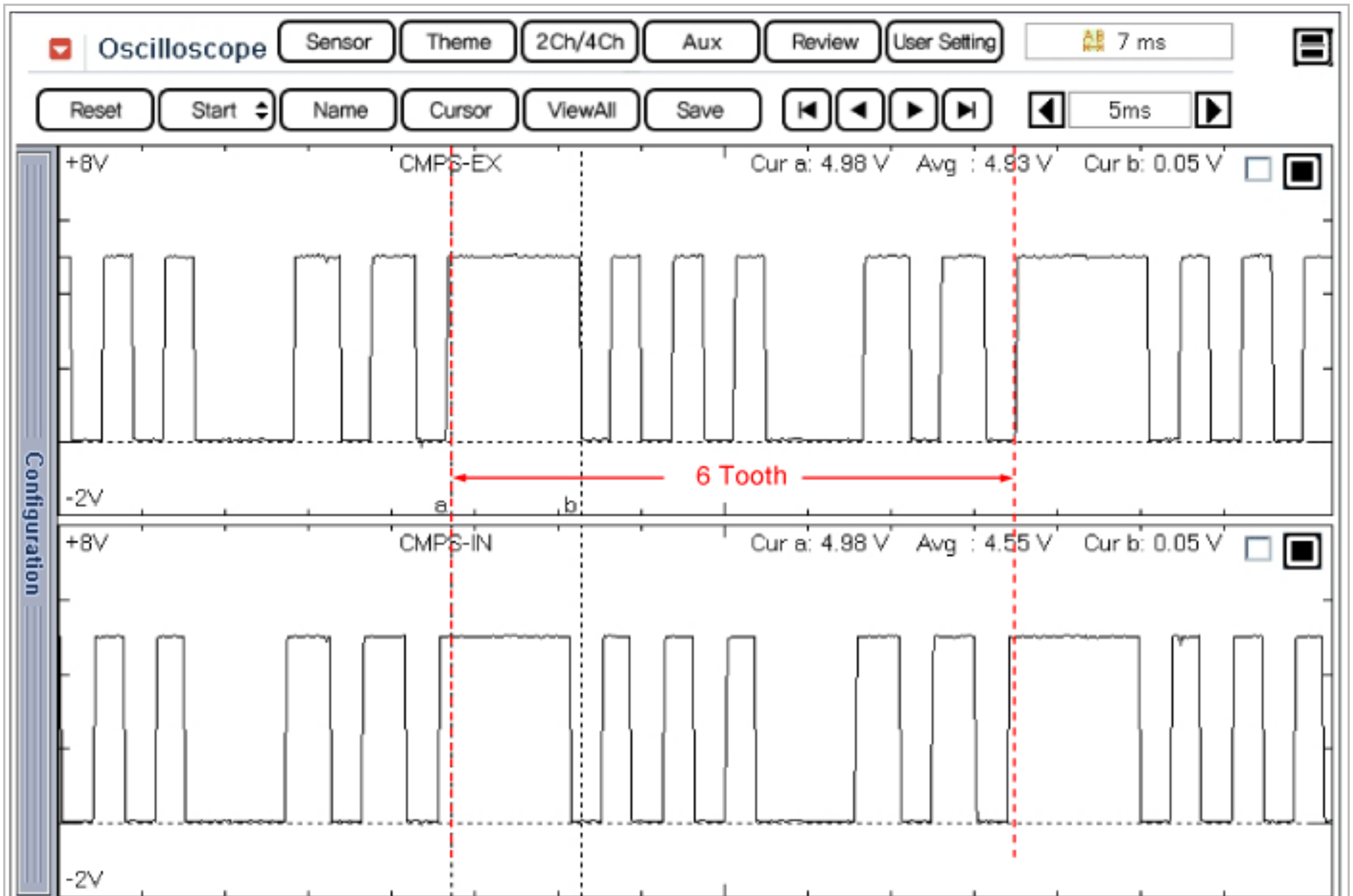


Fig.1

Fig.1) Normal waveform of CMPS1 & 2 at idle.

3. Is the measured siganl waveform normal?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good CMPS and check for proper operation. If the problem is corrected, replace CMPS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

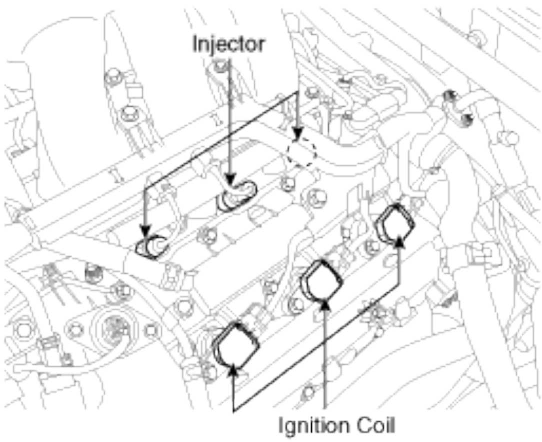
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0351 Ignition Coil 'A' Primary / Secondary Circuit

Component Location



General Description

With the ignition switch in the ON or START position, voltage is applied to the ignition coil. Each ignition coil consists of two coils. High tension leads go to each cylinder from the ignition coils. The ignition coils fire two spark plugs on every power stroke (the cylinder under compression and the cylinder on the exhaust stroke). The Engine Control Module (ECM) provides a switching circuit to ground for energizing the primary ignition coils. The ECM uses the crankshaft position sensor and camshaft position sensor signal to time the energizing of the coil. When a primary ignition coil is energized and de-energized, the secondary coil produces a high voltage spike to the attached spark plugs.

DTC Description

Checking output signals from ignition coils every 10 sec. under detecting condition, if the signals indicating open or short in the circuit are detected for more than 5 sec., ECM sets this DTC. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

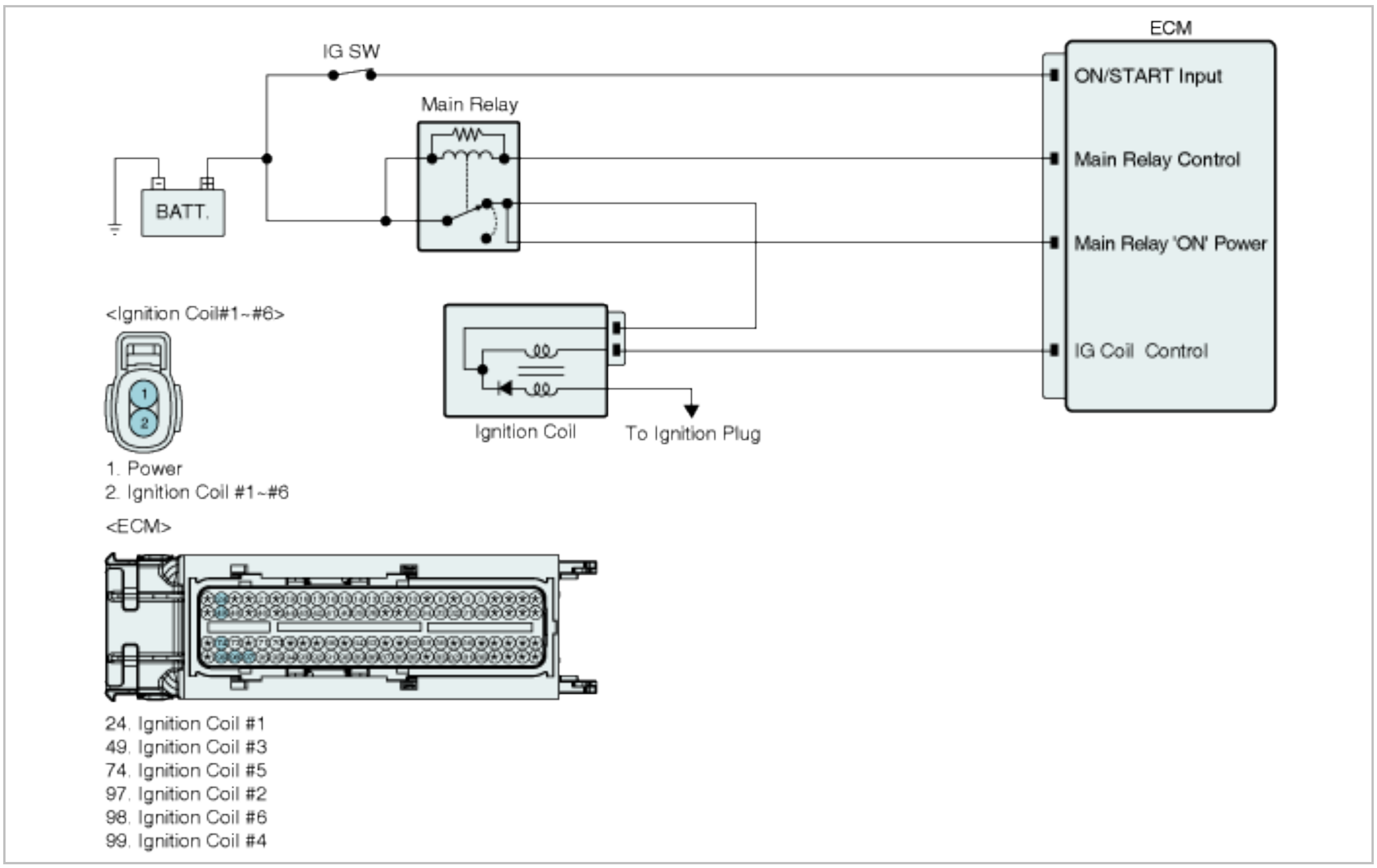
Item	Detecting Condition	Possible Cause
DTC Strategy	• Detects a short to ground, to battery or open circuit	
	• NO DTC related to this item	

Enable Conditions	• Engine running state • 11V ≤ Battery voltage ≤ 16V • The above conditions are met > 0.5 sec.	• Poor connection • Open or short in harness • Ignition Coil • ECM
Threshold value	• Open or short	
Diagnosis Time	• Continuous (More than 5 sec.failure for every 10 sec.test)	
MIL On Condition	• 2 driving cycles	

Specification

Resistance(Ω)	Primary Coil	Secondary Coil
	0.62 ± 10% (20°C/68°F)	7.0k ± 15% (20°C/68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data

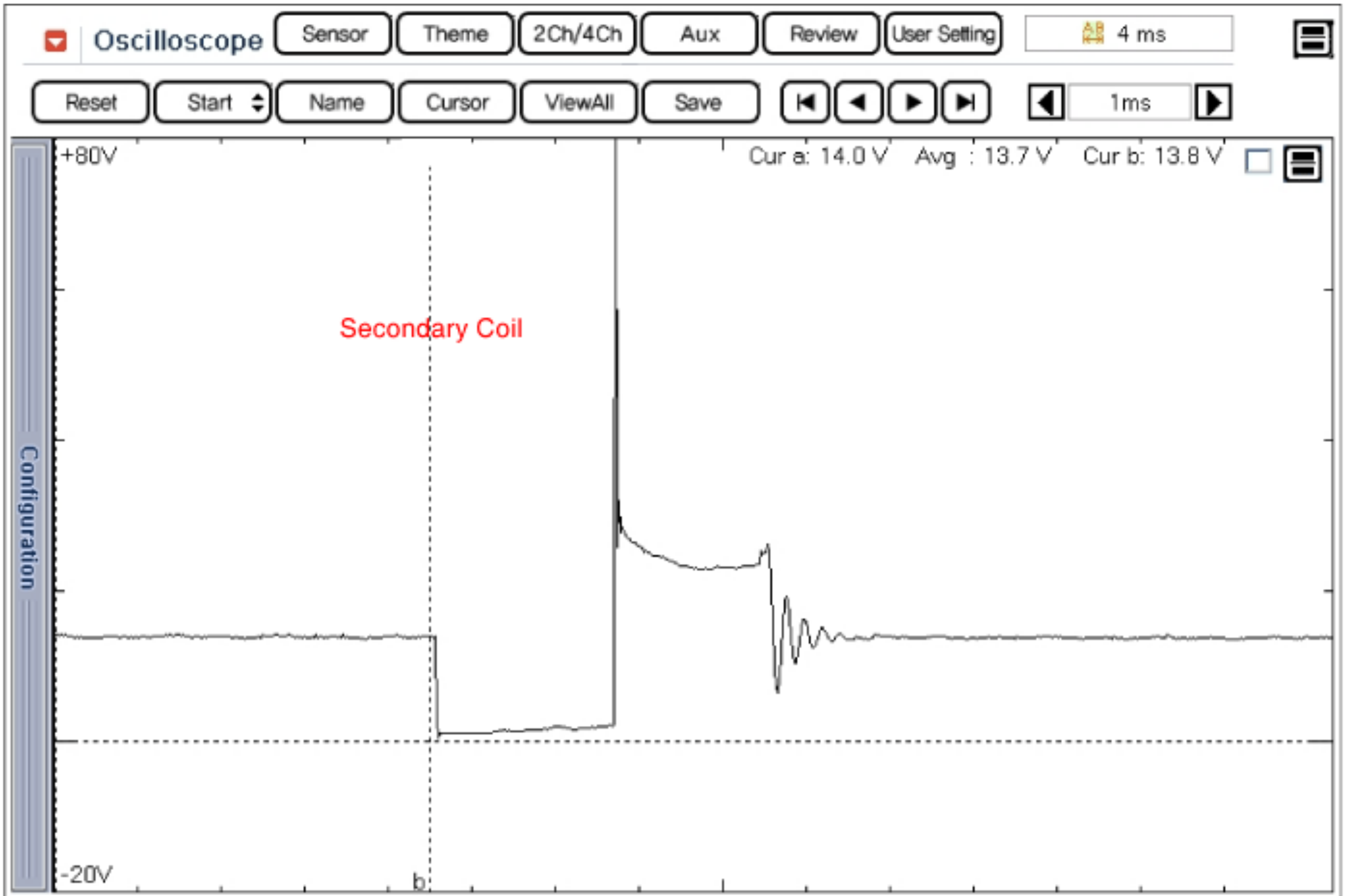


Fig.1

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | VSS

Sensor Name	Value	Unit
☑ Cylinder 1 Injection Time	0.8	mS
☑ Cylinder 2 Injection Time	0.8	mS
☑ Cylinder 3 Injection Time	0.8	mS
☑ Cylinder 4 Injection Time	0.8	mS
☑ Cylinder 5 Injection Time	0.8	mS
☑ Cylinder 6 Injection Time	0.8	mS

Fig.2

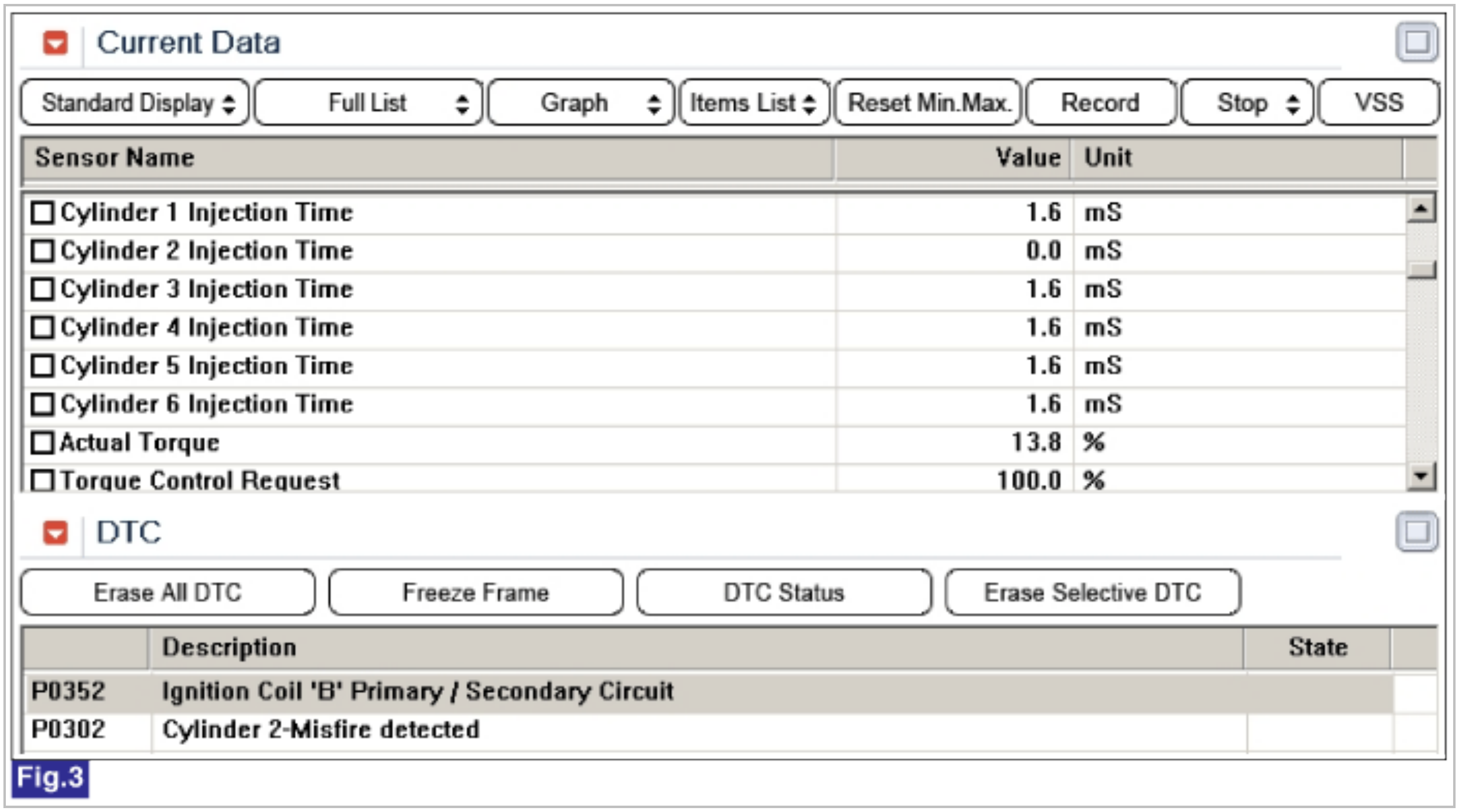
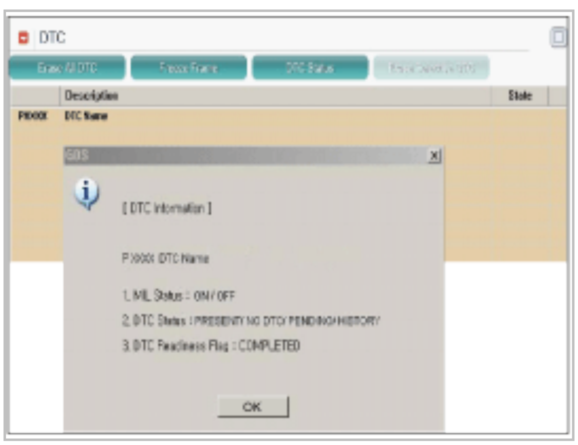


Fig.3

Fig.1) Normal waveforms of secondary coil at idle.
Fig.2) Normal data of Injection time at idle.
Fig.3) Abnormal data of Injection time when ignition coil (cylinder 2) open.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor’s and/or ECM’s connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to "Power Circuit Inspection" procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect Ignition Coil connector.
2. IG "ON".
3. Measure voltage between power terminal of ignition coil harness connector and chassis ground.

Specification : Approx. B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.
NO	▶ Check fuse connected to ignition coil for open. ▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Control Circuit Inspection

■ Check short to battery in harness

1. IG "OFF" and disconnect ignition coil connector and ECM connector.
2. Measure resistance between power and control terminals of ignition coil harness connector.

Specification : Infinite

3. Is the measured resistance within specification?

YES	▶ Go to "Check short to ground in harness" as follows.
NO	▶ Repair short to battery in harness, and go to "Verification of Vehicle Repair" procedure.

■ Check short to ground in harness

1. IG "OFF" and disconnect ignition coil connector and ECM connector.
2. Measure resistance between control terminal of ignition coil harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification?

YES	▶ Go to "Check open in harness" as follows.
NO	▶ Repair short to ground in harness, and go to "Verification of Vehicle Repair" procedure.

■ **Check open in harness**

1. IG "OFF" and disconnect Ignition Coil connector and ECM connector.
2. Measure resistance between control terminal of Ignition Coil harness connector and IG Coil #1 control terminal of ECM harness connector.

Specification : Below 1Ω

3. Is the measured resistance within specification?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ **Check Ignition Coil**

1. IG "OFF" and disconnect ignition coil connector.
2. Measure resistance between power and signal terminals of ignition coil connector.(Measurement "A")
3. Measure resistance between power terminal of ignition coil connector and out terminal of secondary ignition coil.(Measurement "B")

Specification :

Resistance (Ω)	Primary Coil	Secondary Coil
	0.62 ± 10% (20°C)	7.0k ± 15% (20°C)

4. Is the measured resistance within specification?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good Ignition Coil and check for proper operation. If the problem is corrected, replace Ignition Coil and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

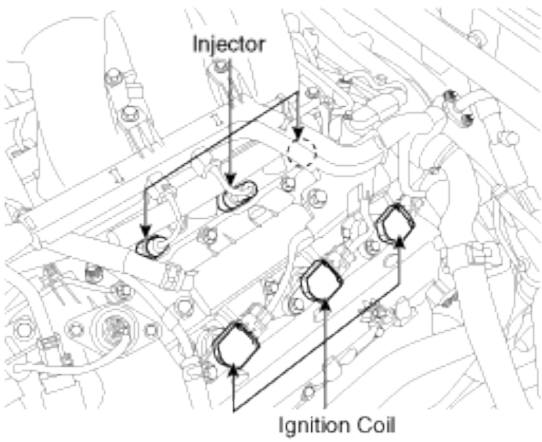
1. Connect GDS and select "DTC" button.

2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0352 Ignition Coil 'B' Primary / Secondary Circuit

Component Location



General Description

With the ignition switch in the ON or START position, voltage is applied to the ignition coil. Each ignition coil consists of two coils. High tension leads go to each cylinder from the ignition coils. The ignition coils fire two spark plugs on every power stroke (the cylinder under compression and the cylinder on the exhaust stroke). The Engine Control Module (ECM) provides a switching circuit to ground for energizing the primary ignition coils. The ECM uses the crankshaft position sensor and camshaft position sensor signal to time the energizing of the coil. When a primary ignition coil is energized and de-energized, the secondary coil produces a high voltage spike to the attached spark plugs.

DTC Description

Checking output signals from ignition coils every 10 sec. under detecting condition, if the signals indicating open or short in the circuit are detected for more than 5 sec., ECM sets this DTC. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

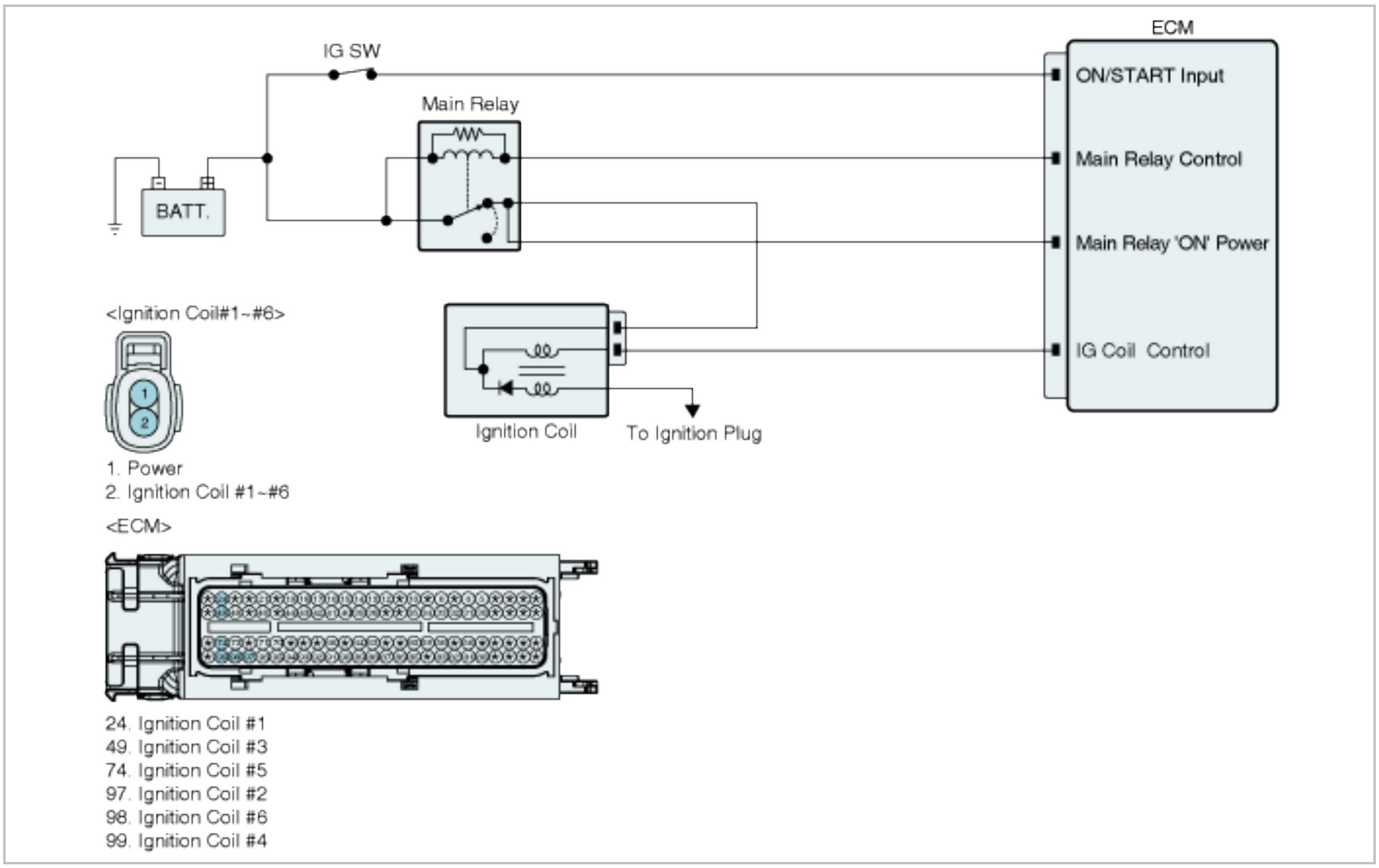
Item	Detecting Condition	Possible Cause
DTC Strategy	• Detects a short to ground, to battery or open circuit	• Poor connection • Open or short in harness • Ignition Coil
Enable Conditions	• NO DTC related to this item • Engine running state • 11V ≤ Battery voltage ≤ 16V • The above conditions are met > 0.5 sec.	

Threshold value	• Open or short	• Ignition Coil • ECM
Diagnosis Time	• Continuous (More than 5 sec.failure for every 10 sec.test)	
MIL On Condition	• 2 driving cycles	

Specification

Resistance(Ω)	Primary Coil	Secondary Coil
	0.62 ± 10% (20°C/68°F)	7.0k ± 15% (20°C/68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data

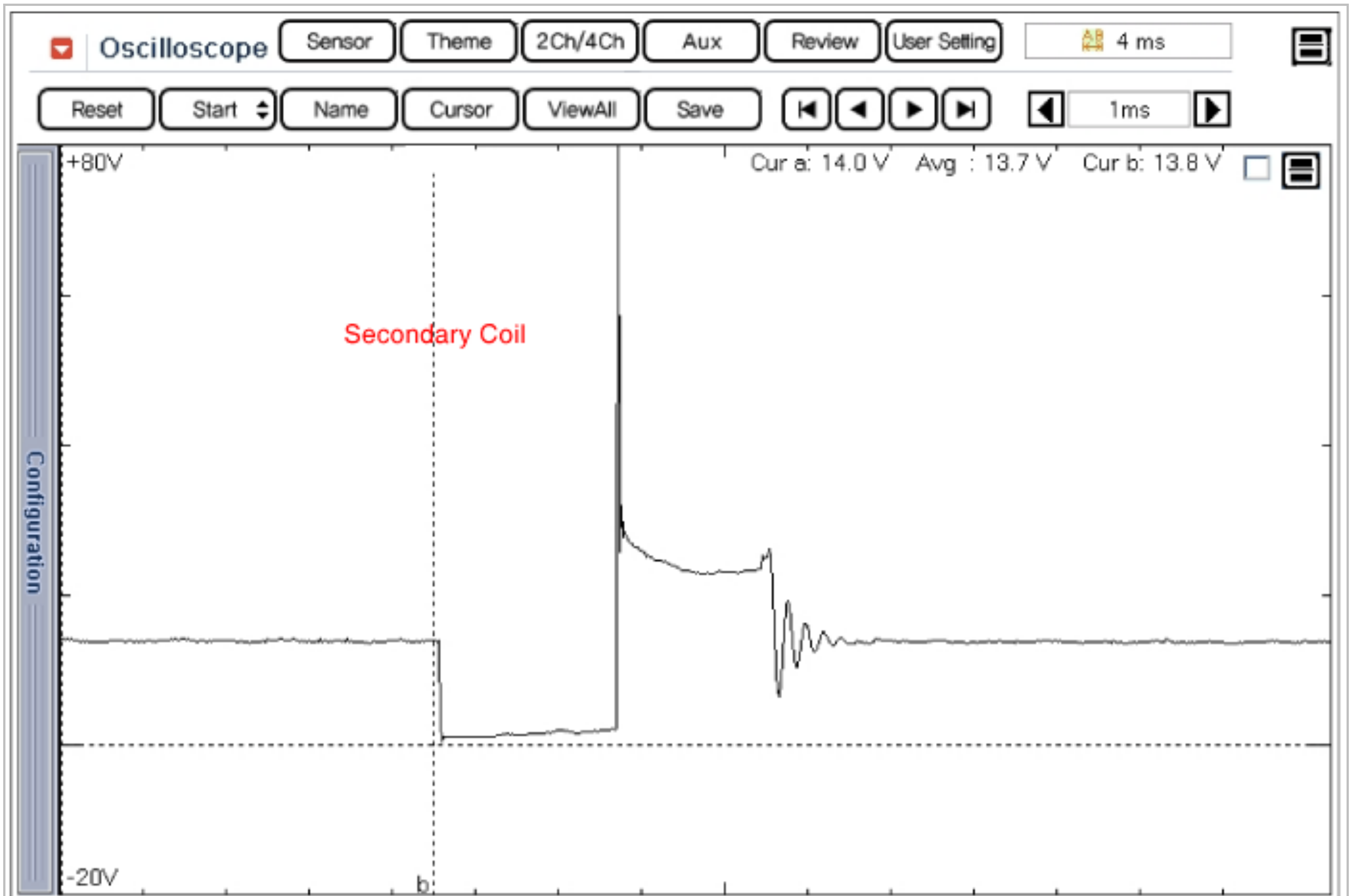
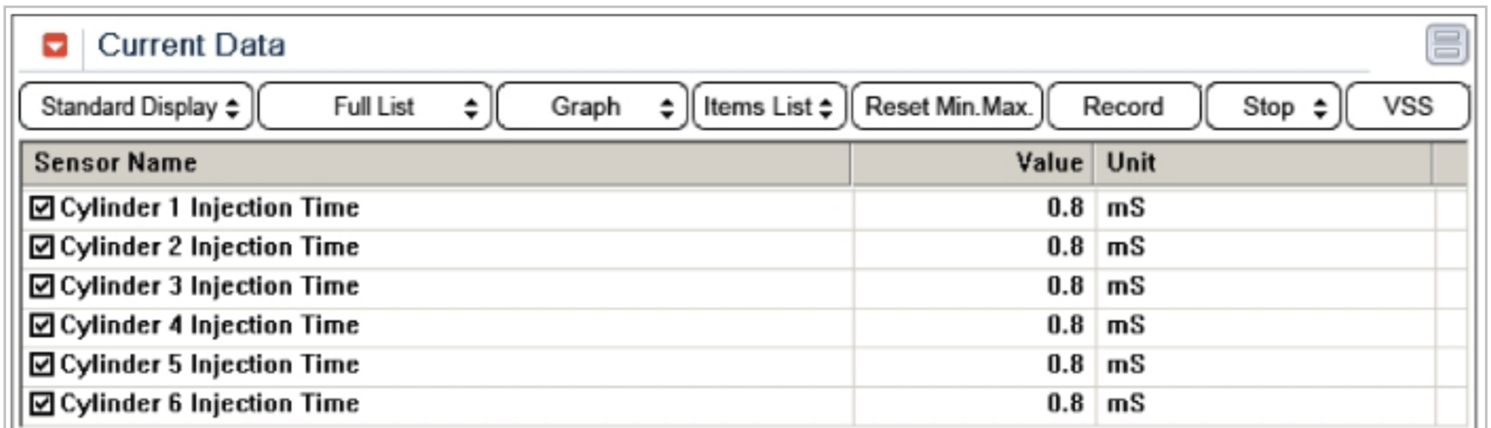


Fig.1



Sensor Name	Value	Unit
Cylinder 1 Injection Time	0.8	mS
Cylinder 2 Injection Time	0.8	mS
Cylinder 3 Injection Time	0.8	mS
Cylinder 4 Injection Time	0.8	mS
Cylinder 5 Injection Time	0.8	mS
Cylinder 6 Injection Time	0.8	mS

Fig.2

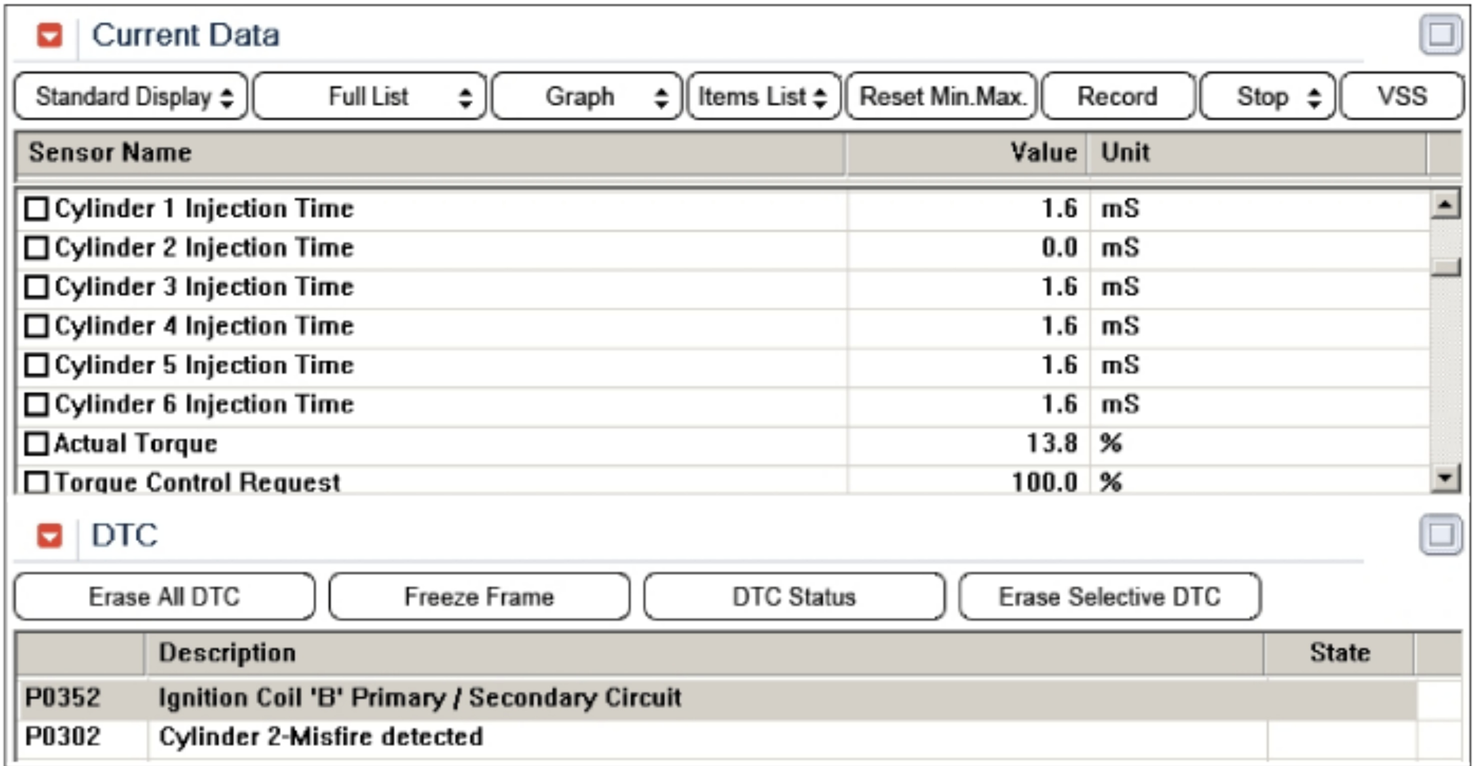
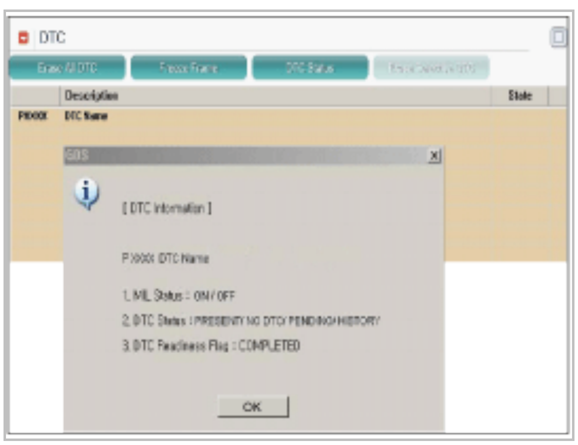


Fig.3

Fig.1) Normal waveforms of secondary coil at idle.
Fig.2) Normal data of Injection time at idle.
Fig.3) Abnormal data of Injection time when ignition coil (cylinder 2) open.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ **Check voltage**

1. IG "OFF" and disconnect Ignition Coil connector.
2. IG "ON".
3. Measure voltage between power terminal of ignition coil harness connector and chassis ground.

Specification : Approx. B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.
NO	▶ Check fuse connected to ignition coil for open. ▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Control Circuit Inspection

■ **Check short to battery in harness**

1. IG "OFF" and disconnect ignition coil connector and ECM connector.
2. Measure resistance between power and control terminals of ignition coil harness connector.

Specification : Infinite

3. Is the measured resistance within specification?

YES	▶ Go to "Check short to ground in harness" as follows.
NO	▶ Repair short to battery in harness, and go to "Verification of Vehicle Repair" procedure.

■ **Check short to ground in harness**

1. IG "OFF" and disconnect ignition coil connector and ECM connector.
2. Measure resistance between control terminal of ignition coil harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification?

YES	▶ Go to "Check open in harness" as follows.
NO	▶ Repair short to ground in harness, and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect Ignition Coil connector and ECM connector.
2. Measure resistance between control terminal of Ignition Coil harness connector and IG Coil #1 control terminal of ECM harness connector.

Specification : Below 1Ω

3. Is the measured resistance within specification?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check Ignition Coil

1. IG "OFF" and disconnect ignition coil connector.
2. Measure resistance between power and signal terminals of ignition coil connector.(Measurement "A")
3. Measure resistance between power terminal of ignition coil connector and out terminal of secondary ignition coil.(Measurement "B")

Specification :

Resistance (Ω)	Primary Coil	Secondary Coil
	0.62 ± 10% (20°C/68°F)	7.0k ± 15% (20°C/68°F)

4. Is the measured resistance within specification?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good Ignition Coil and check for proper operation. If the problem is corrected, replace Ignition Coil and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

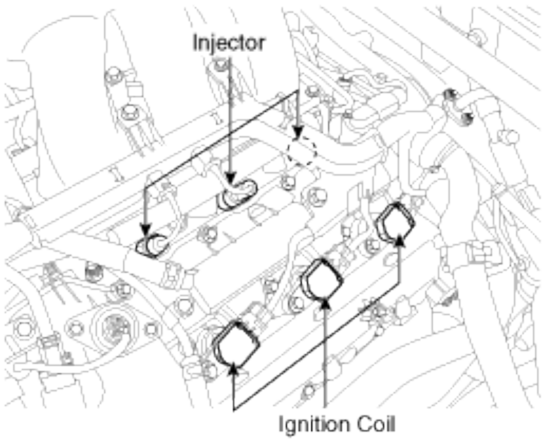
1. Connect GDSI and select "DTC" button.

2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0353 Ignition Coil 'C' Primary / Secondary Circuit

Component Location



General Description

With the ignition switch in the ON or START position, voltage is applied to the ignition coil. Each ignition coil consists of two coils. High tension leads go to each cylinder from the ignition coils. The ignition coils fire two spark plugs on every power stroke (the cylinder under compression and the cylinder on the exhaust stroke). The Engine Control Module (ECM) provides a switching circuit to ground for energizing the primary ignition coils. The ECM uses the crankshaft position sensor and camshaft position sensor signal to time the energizing of the coil. When a primary ignition coil is energized and de-energized, the secondary coil produces a high voltage spike to the attached spark plugs.

DTC Description

Checking output signals from ignition coils every 10 sec. under detecting condition, if the signals indicating open or short in the circuit are detected for more than 5 sec., ECM sets this DTC. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

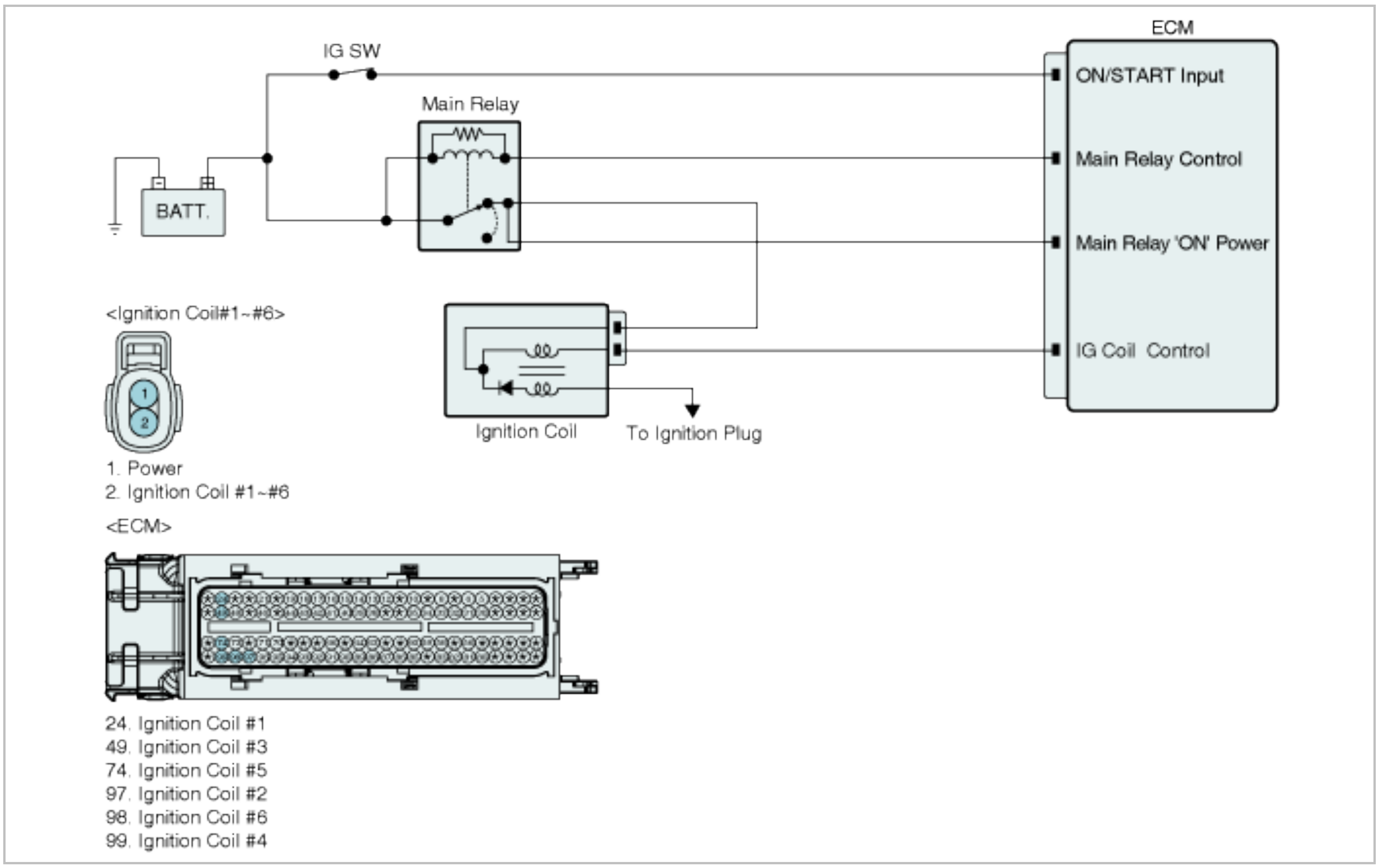
Item	Detecting Condition	Possible Cause
DTC Strategy	• Detects a short to ground, to battery or open circuit	• Poor connection • Open or short in harness
Enable Conditions	• NO DTC related to this item • Engine running state • 11V ≤ Battery voltage ≤ 16V • The above conditions are met > 0.5 sec.	

Threshold value	• Open or short	• Ignition Coil • ECM
Diagnosis Time	• Continuous (More than 5 sec.failure for every 10 sec.test)	
MIL On Condition	• 2 driving cycles	

Specification

Resistance(Ω)	Primary Coil	Secondary Coil
	0.62 ± 10% (20°C/68°F)	7.0k ± 15% (20°C/68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data

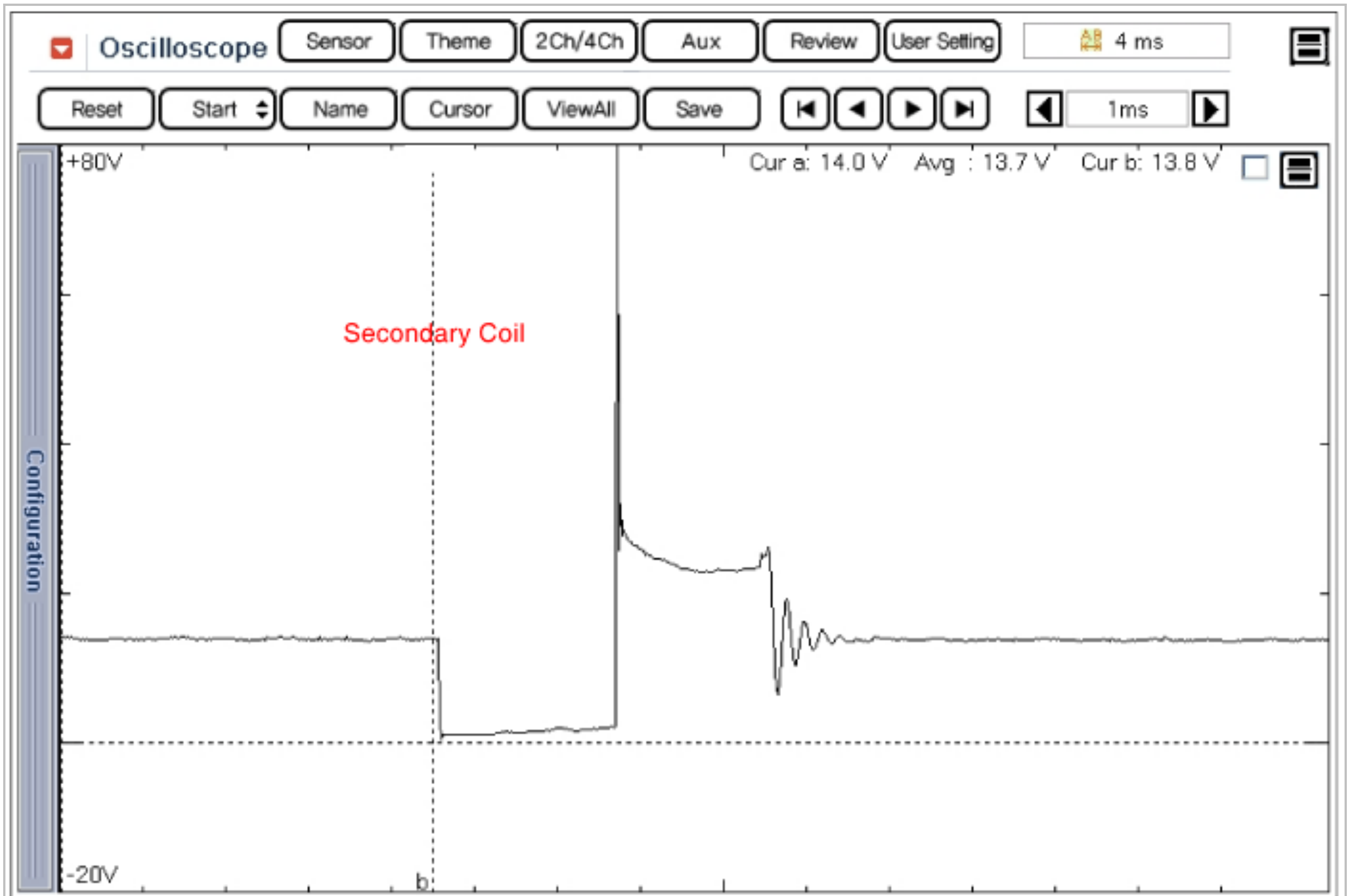
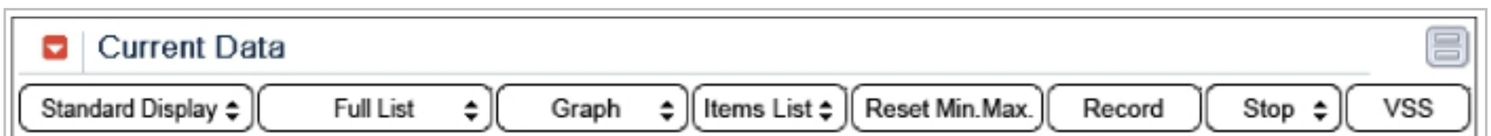


Fig.1



Sensor Name	Value	Unit
Cylinder 1 Injection Time	0.8	mS
Cylinder 2 Injection Time	0.8	mS
Cylinder 3 Injection Time	0.8	mS
Cylinder 4 Injection Time	0.8	mS
Cylinder 5 Injection Time	0.8	mS
Cylinder 6 Injection Time	0.8	mS

Fig.2

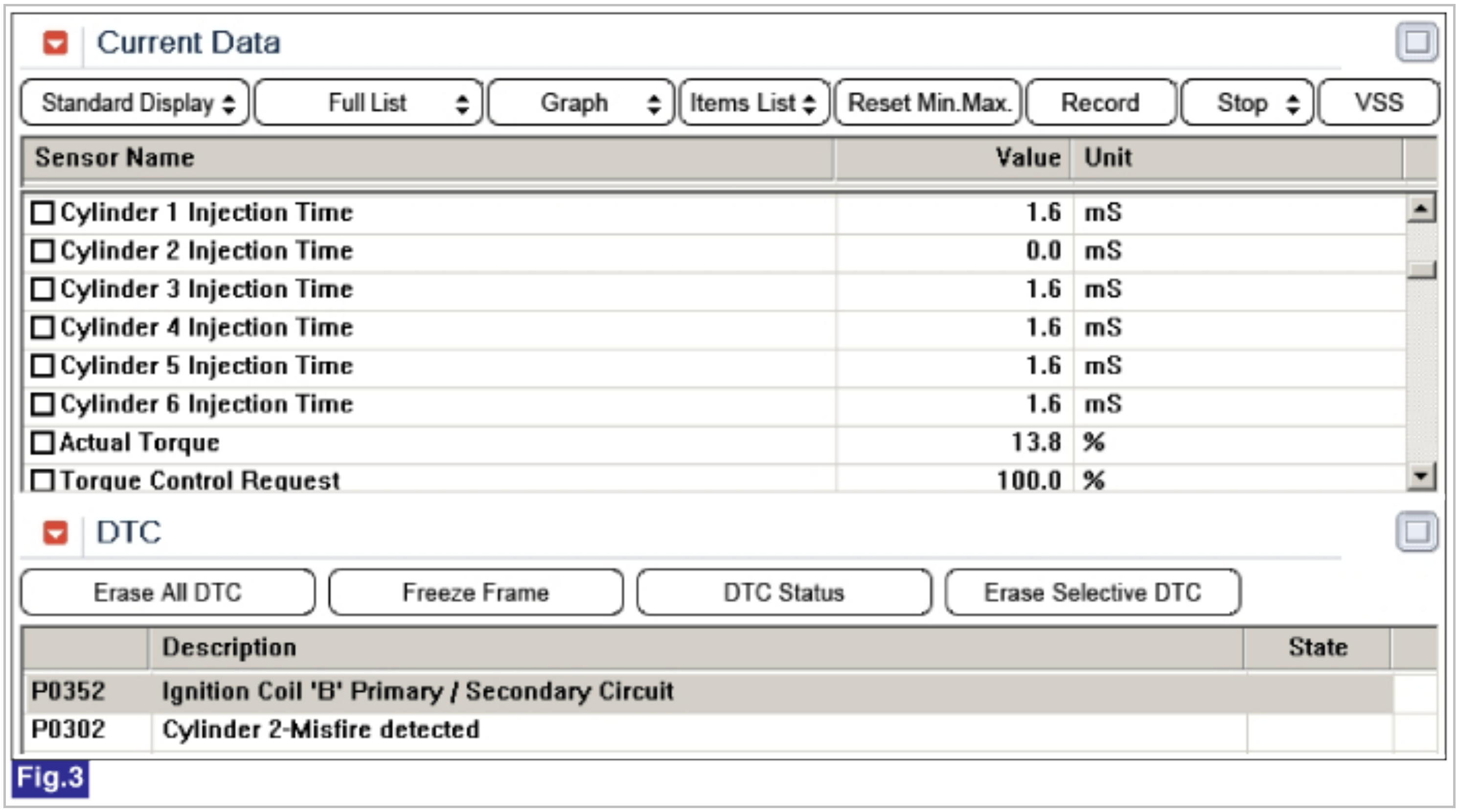
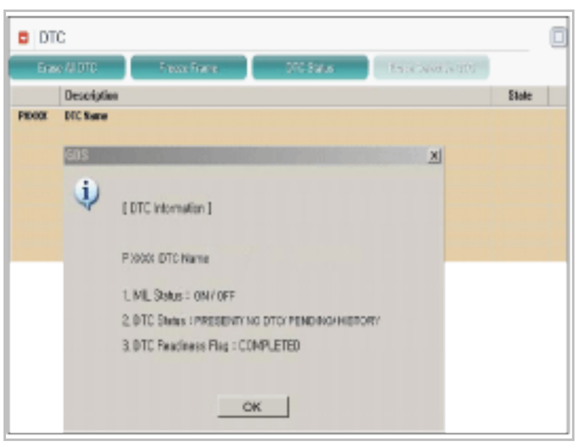


Fig.3

Fig.1) Normal waveforms of secondary coil at idle.
Fig.2) Normal data of Injection time at idle.
Fig.3) Abnormal data of Injection time when ignition coil (cylinder 2) open.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ **Check voltage**

1. IG "OFF" and disconnect Ignition Coil connector.
2. IG "ON".
3. Measure voltage between power terminal of ignition coil harness connector and chassis ground.

Specification : Approx. B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.
NO	▶ Check fuse connected to ignition coil for open. ▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Control Circuit Inspection

■ **Check short to battery in harness**

1. IG "OFF" and disconnect ignition coil connector and ECM connector.
2. Measure resistance between power and control terminals of ignition coil harness connector.

Specification : Infinite

3. Is the measured resistance within specification?

YES	▶ Go to "Check short to ground in harness" as follows.
NO	▶ Repair short to battery in harness, and go to "Verification of Vehicle Repair" procedure.

■ **Check short to ground in harness**

1. IG "OFF" and disconnect ignition coil connector and ECM connector.
2. Measure resistance between control terminal of ignition coil harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification?

YES	▶ Go to "Check open in harness" as follows.
NO	▶ Repair short to ground in harness, and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect Ignition Coil connector and ECM connector.
2. Measure resistance between control terminal of Ignition Coil harness connector and IG Coil #1 control terminal of ECM harness connector.

Specification : Below 1Ω

3. Is the measured resistance within specification?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check Ignition Coil

1. IG "OFF" and disconnect ignition coil connector.
2. Measure resistance between power and signal terminals of ignition coil connector.(Measurement "A")
3. Measure resistance between power terminal of ignition coil connector and out terminal of secondary ignition coil.(Measurement "B")
   Specification :

	Primary Coil	Secondary Coil
Resistance(Ω)	0.62 ± 10% (20°C/68°F)	7.0k ± 15% (20°C/68°F)

4. Is the measured resistance within specification?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good Ignition Coil and check for proper operation. If the problem is corrected, replace Ignition Coil and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

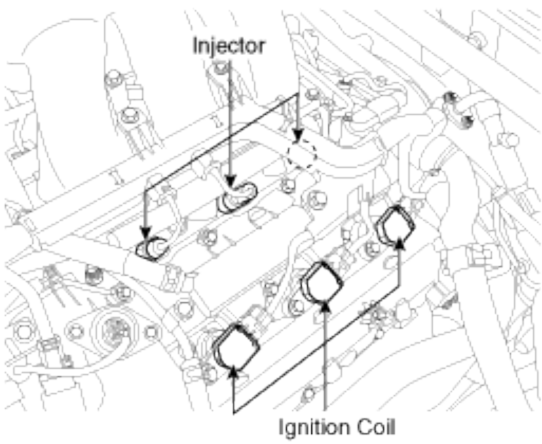
1. Connect GDS and select "DTC" button.

2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0354 Ignition Coil 'D' Primary / Secondary Circuit

Component Location



General Description

With the ignition switch in the ON or START position, voltage is applied to the ignition coil. Each ignition coil consists of two coils. High tension leads go to each cylinder from the ignition coils. The ignition coils fire two spark plugs on every power stroke (the cylinder under compression and the cylinder on the exhaust stroke). The Engine Control Module (ECM) provides a switching circuit to ground for energizing the primary ignition coils. The ECM uses the crankshaft position sensor and camshaft position sensor signal to time the energizing of the coil. When a primary ignition coil is energized and de-energized, the secondary coil produces a high voltage spike to the attached spark plugs.

DTC Description

Checking output signals from ignition coils every 10 sec. under detecting condition, if the signals indicating open or short in the circuit are detected for more than 5 sec., ECM sets this DTC. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

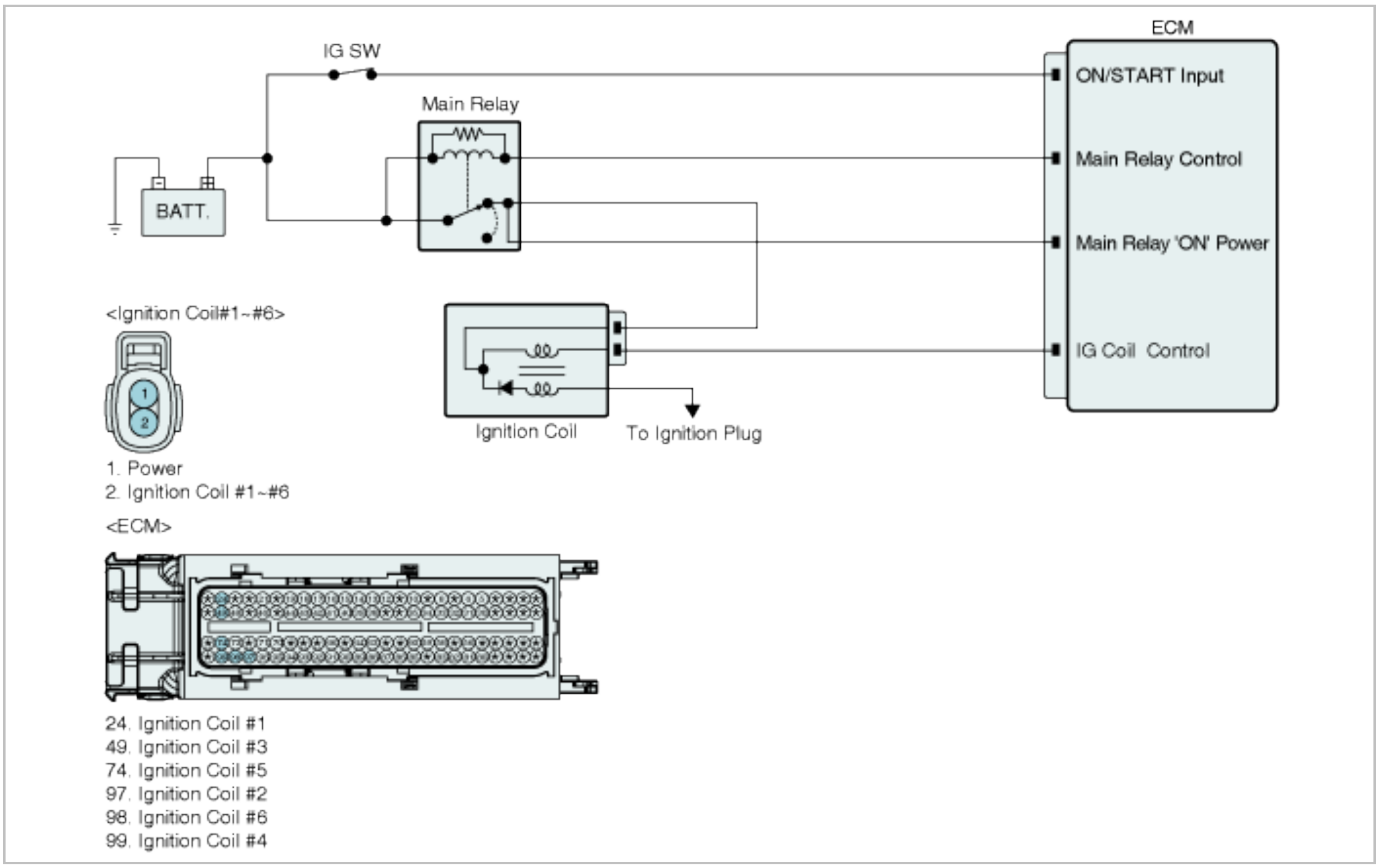
Item	Detecting Condition	Possible Cause
DTC Strategy	• Detects a short to ground, to battery or open circuit	
Enable Conditions	• NO DTC related to this item • Engine running state • 11V ≤ Battery voltage ≤ 16V • The above conditions are met > 0.5 sec.	• Poor connection • Open or short in harness

Threshold value	• Open or short	• Ignition Coil • ECM
Diagnosis Time	• Continuous (More than 5 sec.failure for every 10 sec.test)	
MIL On Condition	• 2 driving cycles	

Specification

Resistance(Ω)	Primary Coil	Secondary Coil
	0.62 ± 10% (20°C/68°F)	7.0k ± 15% (20°C/68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data

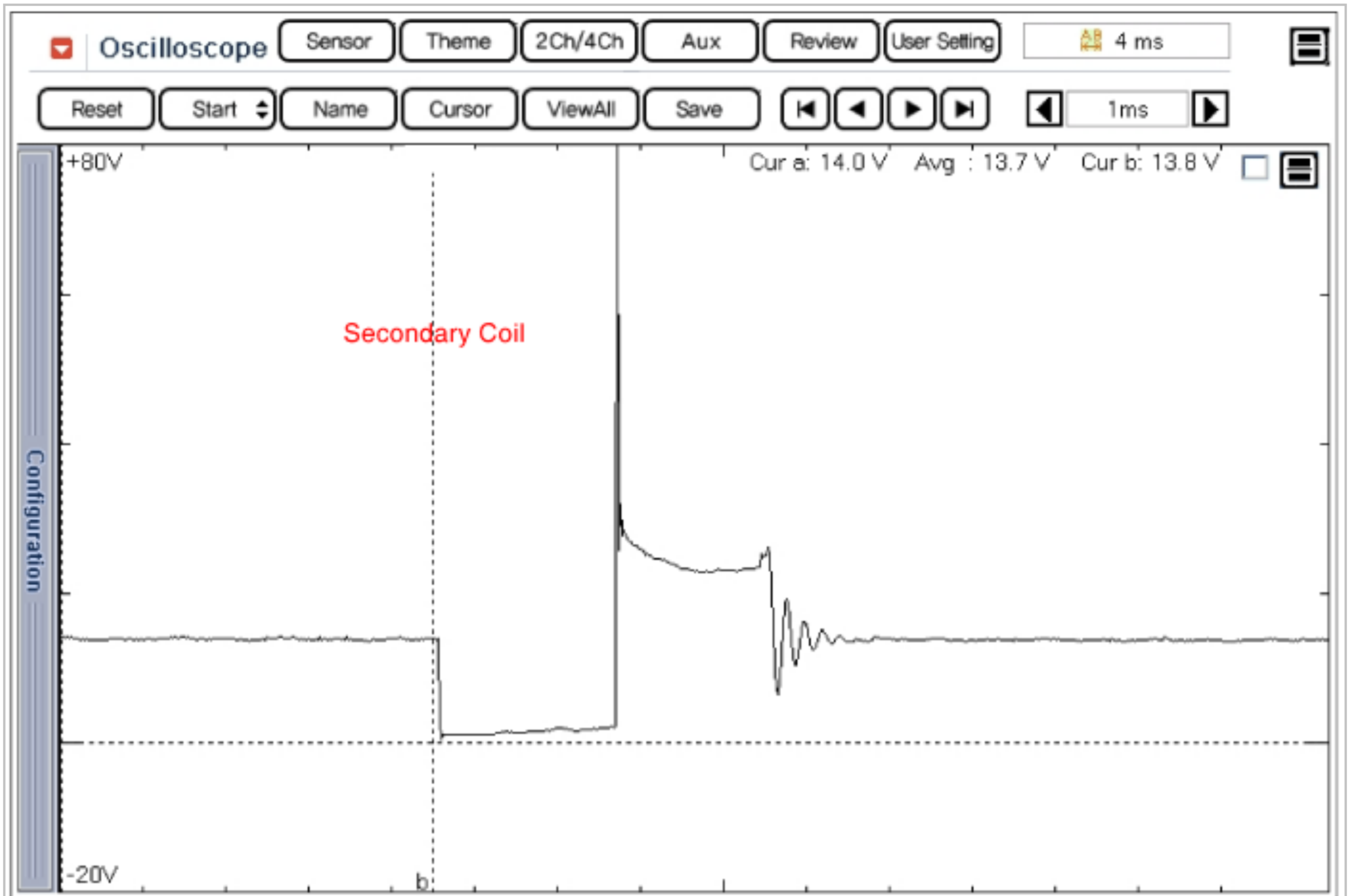
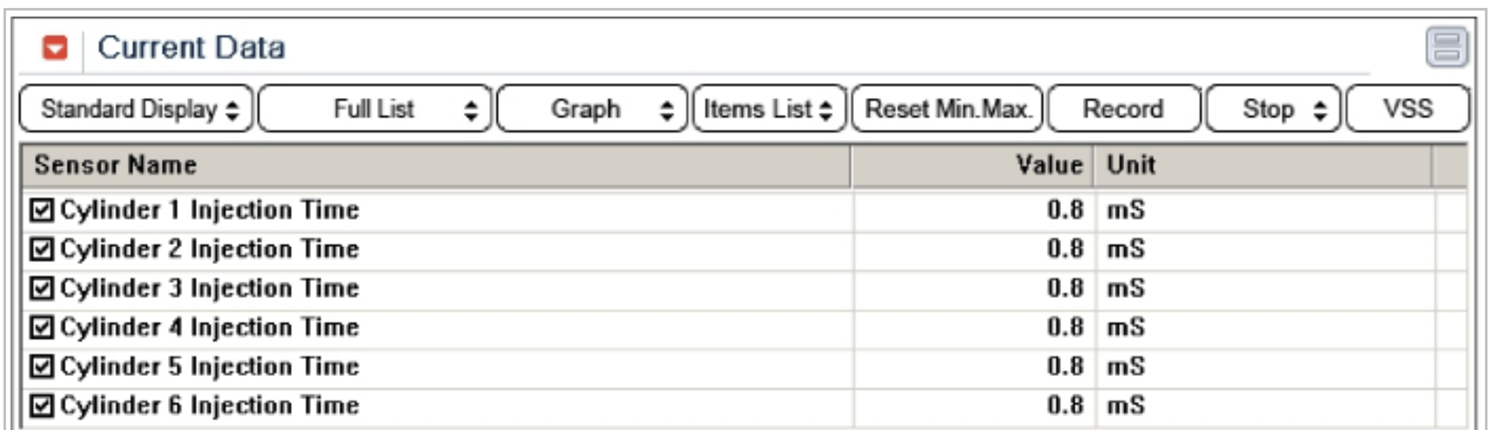


Fig.1



Sensor Name	Value	Unit
☑ Cylinder 1 Injection Time	0.8	mS
☑ Cylinder 2 Injection Time	0.8	mS
☑ Cylinder 3 Injection Time	0.8	mS
☑ Cylinder 4 Injection Time	0.8	mS
☑ Cylinder 5 Injection Time	0.8	mS
☑ Cylinder 6 Injection Time	0.8	mS

Fig.2

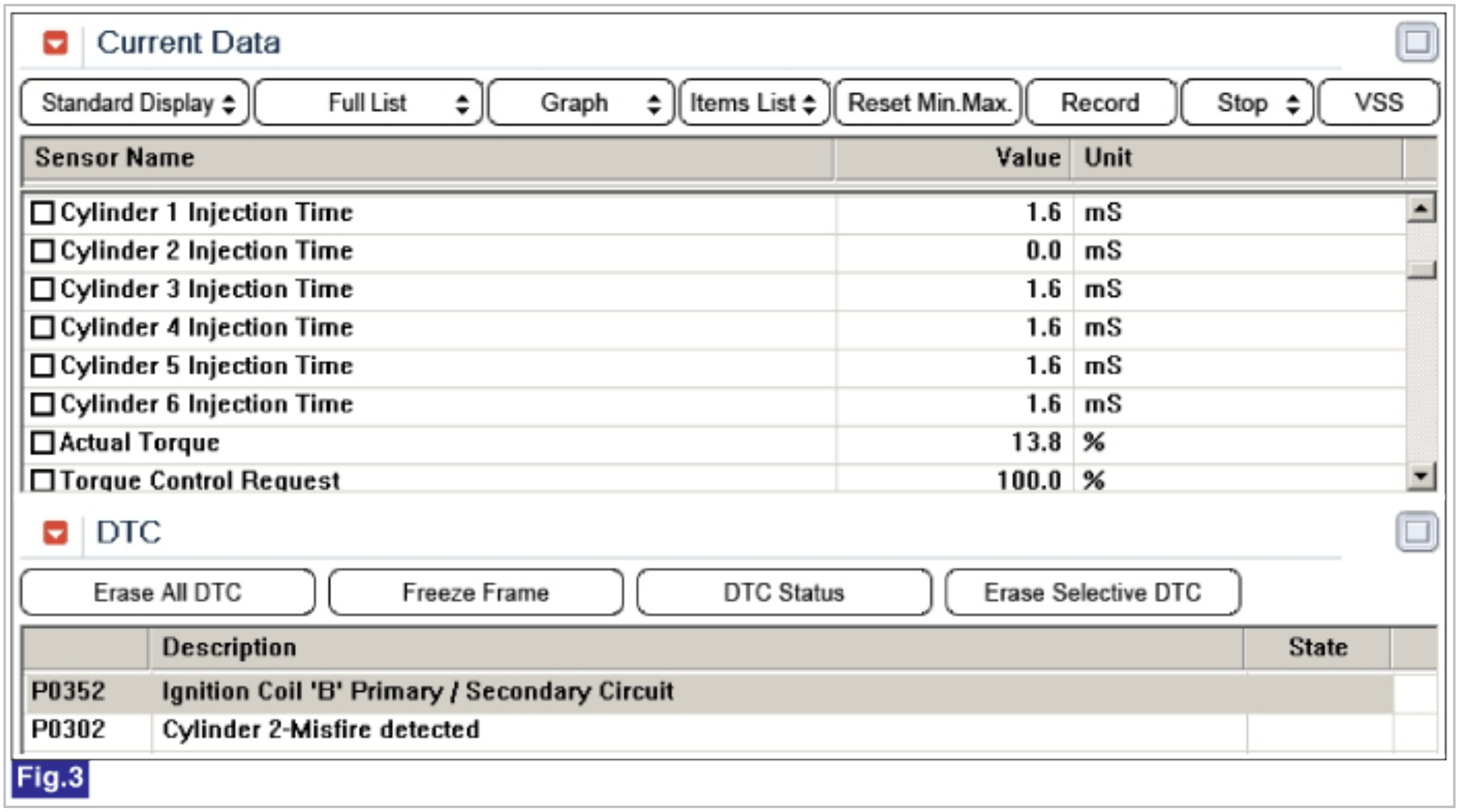
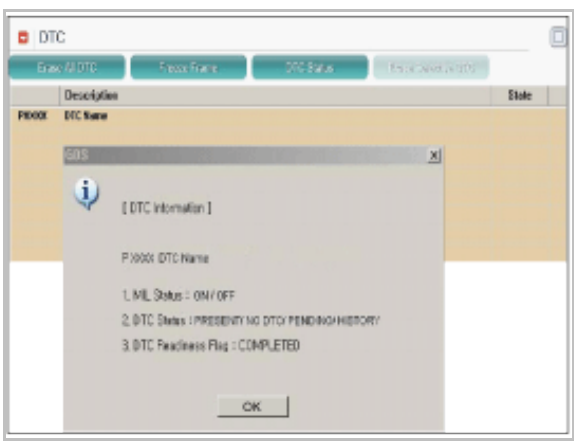


Fig.3

Fig.1) Normal waveforms of secondary coil at idle.
Fig.2) Normal data of Injection time at idle.
Fig.3) Abnormal data of Injection time when ignition coil (cylinder 2) open.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect Ignition Coil connector.
2. IG "ON".
3. Measure voltage between power terminal of ignition coil harness connector and chassis ground.

Specification : Approx. B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.
NO	▶ Check fuse connected to ignition coil for open. ▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Control Circuit Inspection

■ Check short to battery in harness

1. IG "OFF" and disconnect ignition coil connector and ECM connector.
2. Measure resistance between power and control terminals of ignition coil harness connector.

Specification : Infinite

3. Is the measured resistance within specification?

YES	▶ Go to "Check short to ground in harness' as follows.
NO	▶ Repair short to battery in harness, and go to "Verification of Vehicle Repair" procedure.

■ Check short to ground in harness

1. IG "OFF" and disconnect ignition coil connector and ECM connector.
2. Measure resistance between control terminal of ignition coil harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification?

YES	▶ Go to "Check open in harness" as follows.
NO	▶ Repair short to ground in harness, and go to "Verification of Vehicle Repair" procedure.

■ **Check open in harness**

1. IG "OFF" and disconnect Ignition Coil connector and ECM connector.
2. Measure resistance between control terminal of Ignition Coil harness connector and IG Coil #1 control terminal of ECM harness connector.

Specification : Below 1Ω

3. Is the measured resistance within specification?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ **Check Ignition Coil**

1. IG "OFF" and disconnect ignition coil connector.
2. Measure resistance between power and signal terminals of ignition coil connector.(Measurement "A")
3. Measure resistance between power terminal of ignition coil connector and out terminal of secondary ignition coil.(Measurement "B")

Specification :

	Primary Coil	Secondary Coil
Resistance(Ω)	0.62 ± 10% (20°C/68°F)	7.0k ± 15% (20°C/68°F)

4. Is the measured resistance within specification?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good Ignition Coil and check for proper operation. If the problem is corrected, replace Ignition Coil and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

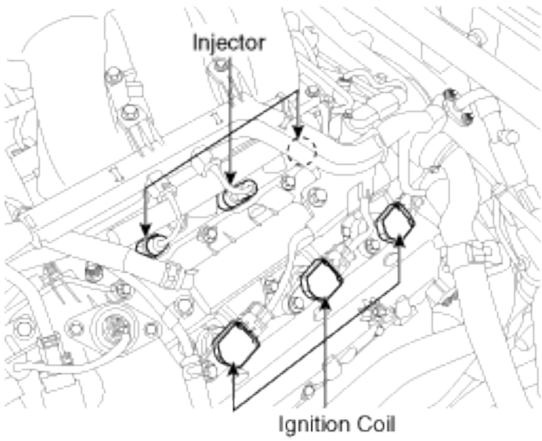
1. Connect scantool and select "DTC" button.

2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0355 Ignition Coil 'E' Primary / Secondary Circuit

Component Location



General Description

With the ignition switch in the ON or START position, voltage is applied to the ignition coil. Each ignition coil consists of two coils. High tension leads go to each cylinder from the ignition coils. The ignition coils fire two spark plugs on every power stroke (the cylinder under compression and the cylinder on the exhaust stroke). The Engine Control Module (ECM) provides a switching circuit to ground for energizing the primary ignition coils. The ECM uses the crankshaft position sensor and camshaft position sensor signal to time the energizing of the coil. When a primary ignition coil is energized and de-energized, the secondary coil produces a high voltage spike to the attached spark plugs.

DTC Description

Checking output signals from ignition coils every 10 sec. under detecting condition, if the signals indicating open or short in the circuit are detected for more than 5 sec., ECM sets this DTC. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

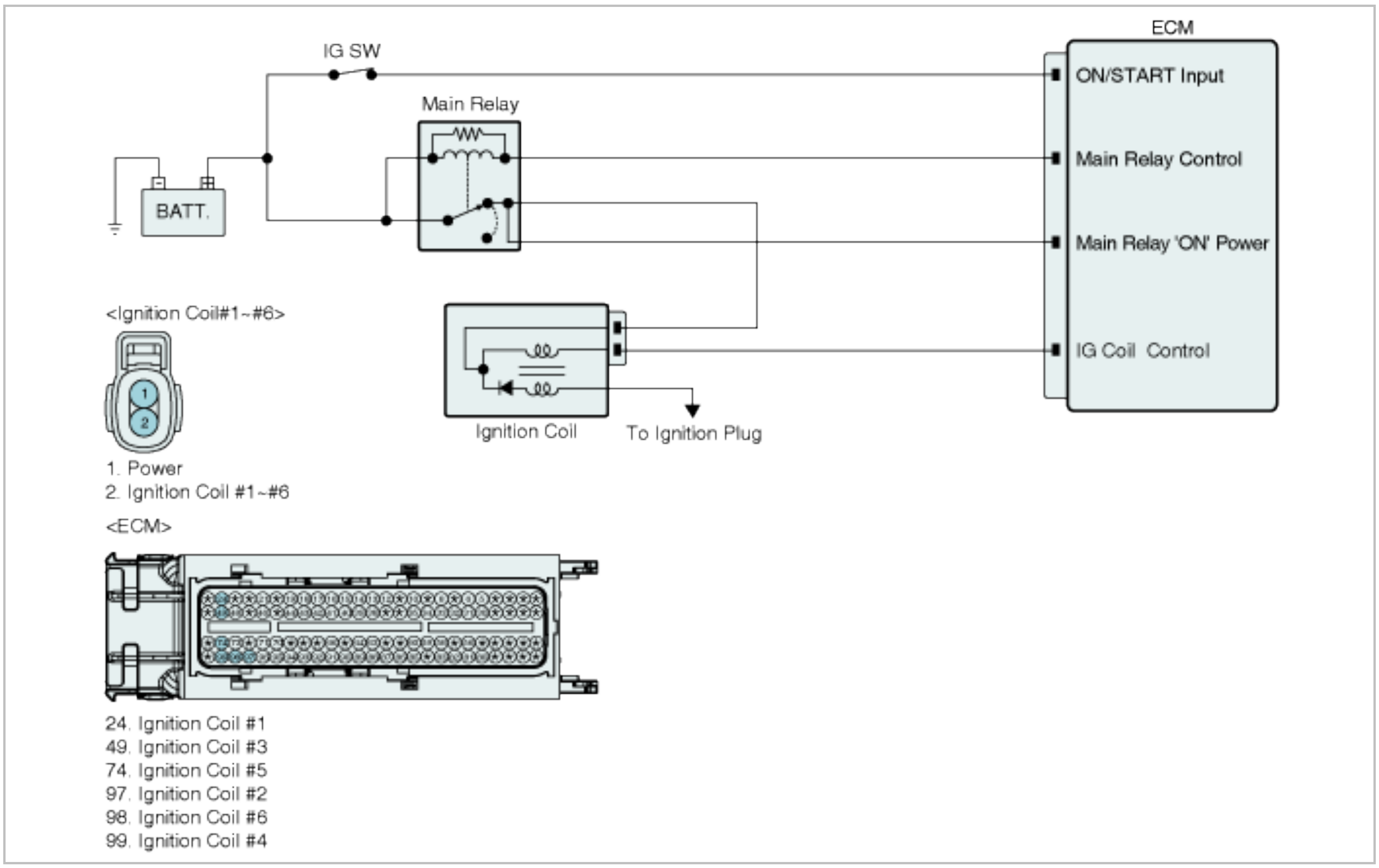
Item	Detecting Condition	Possible Cause
DTC Strategy	• Detects a short to ground, to battery or open circuit	• Poor connection • Open or short in harness
Enable Conditions	• NO DTC related to this item • Engine running state • 11V ≤ Battery voltage ≤ 16V • The above conditions are met > 0.5 sec.	

Threshold value	• Open or short	• Ignition Coil • ECM
Diagnosis Time	• Continuous (More than 5 sec.failure for every 10 sec.test)	
MIL On Condition	• 2 driving cycles	

Specification

Resistance(Ω)	Primary Coil	Secondary Coil
	0.62 ± 10% (20°C/68°F)	7.0k ± 15% (20°C/68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data

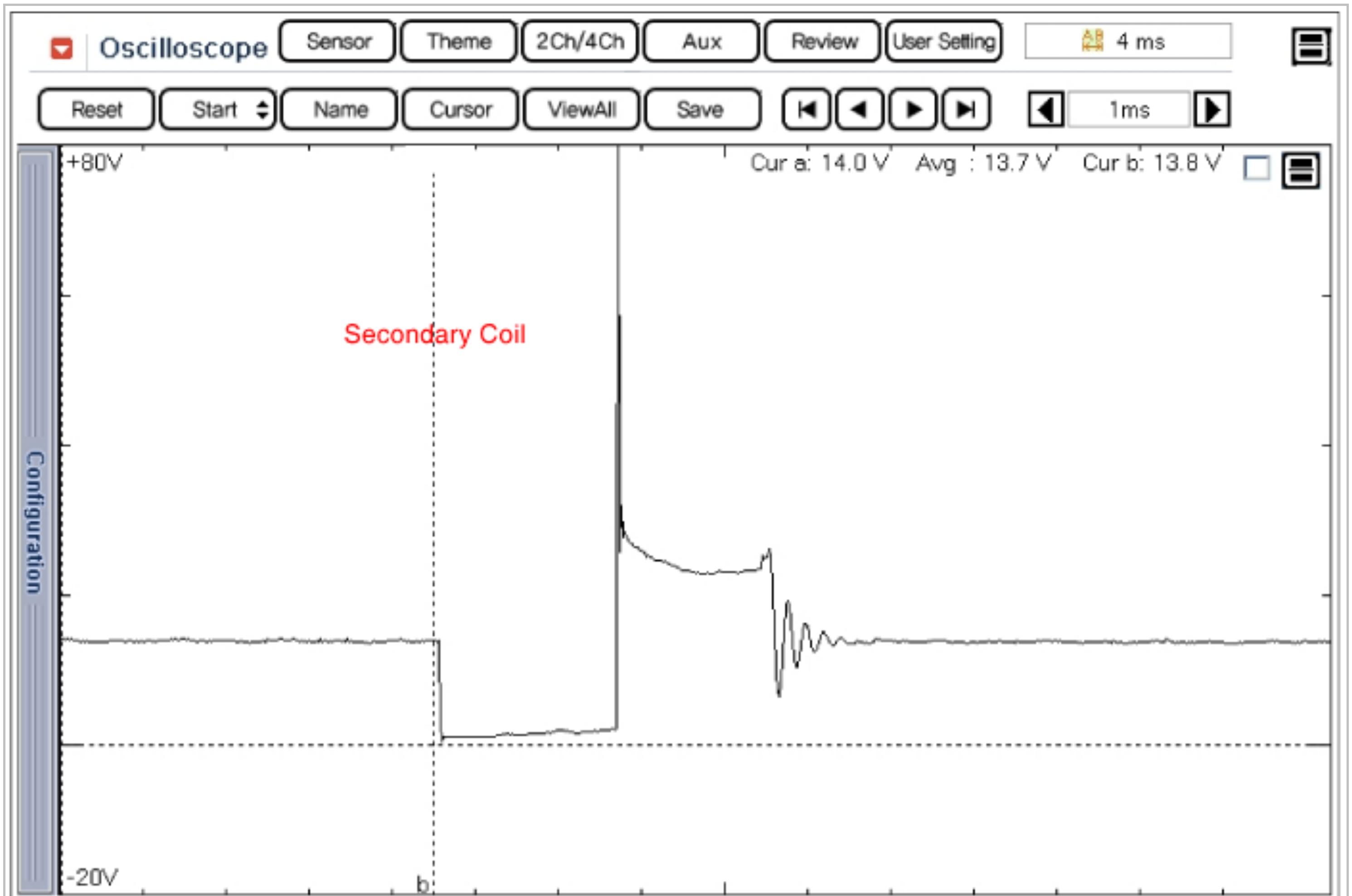


Fig.1

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | VSS

Sensor Name	Value	Unit
☑ Cylinder 1 Injection Time	0.8	mS
☑ Cylinder 2 Injection Time	0.8	mS
☑ Cylinder 3 Injection Time	0.8	mS
☑ Cylinder 4 Injection Time	0.8	mS
☑ Cylinder 5 Injection Time	0.8	mS
☑ Cylinder 6 Injection Time	0.8	mS

Fig.2

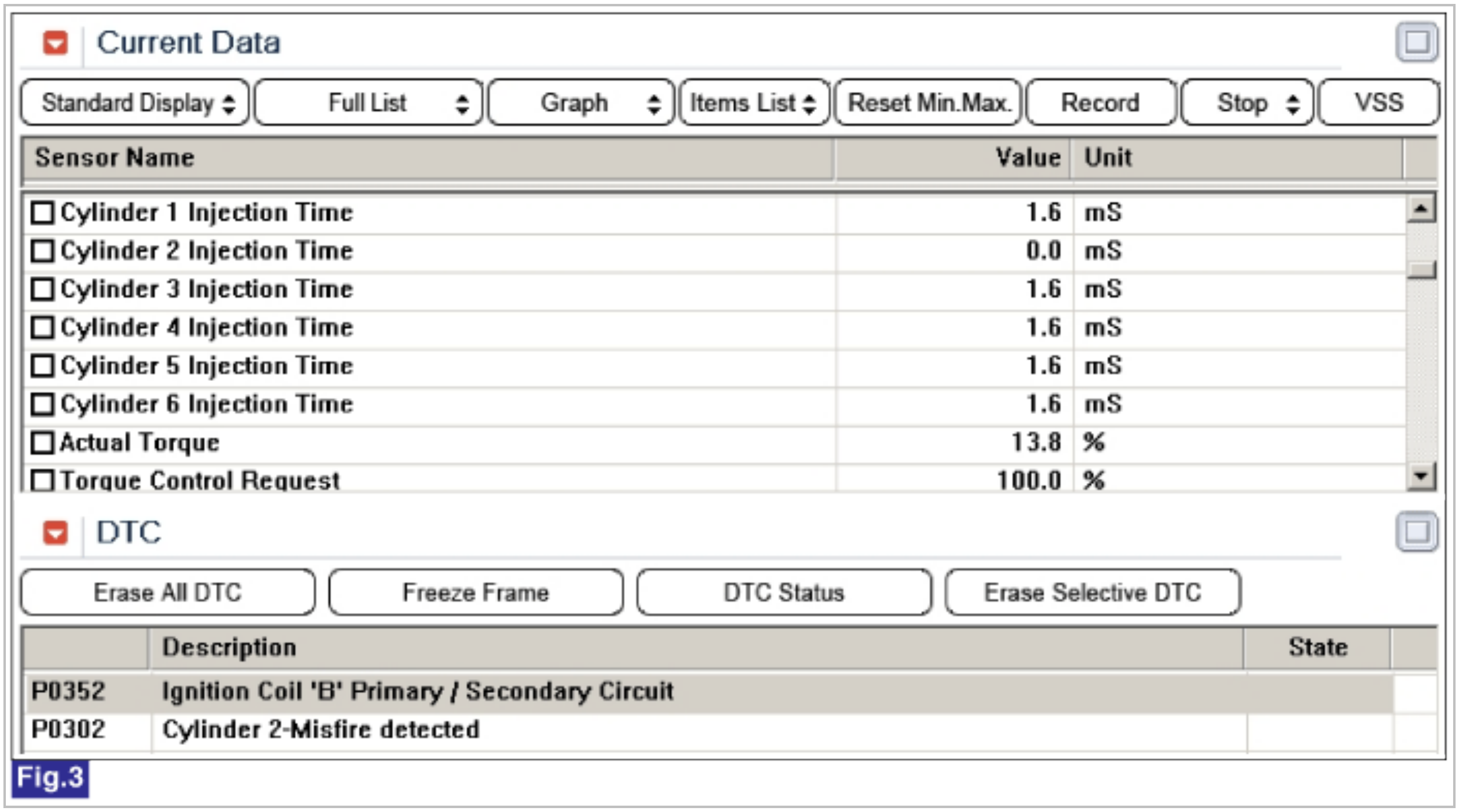
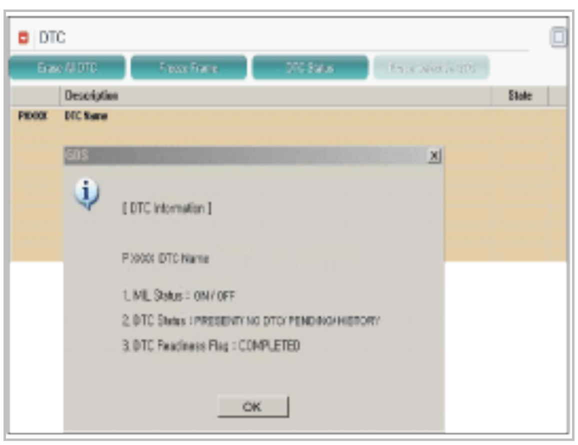


Fig.3

Fig.1) Normal waveforms of secondary coil at idle.
Fig.2) Normal data of Injection time at idle.
Fig.3) Abnormal data of Injection time when ignition coil (cylinder 2) open.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor’s and/or ECM’s connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ **Check voltage**

1. IG "OFF" and disconnect Ignition Coil connector.
2. IG "ON".
3. Measure voltage between power terminal of ignition coil harness connector and chassis ground.

Specification : Approx. B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.
NO	▶ Check fuse connected to ignition coil for open. ▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Control Circuit Inspection

■ **Check short to battery in harness**

1. IG "OFF" and disconnect ignition coil connector and ECM connector.
2. Measure resistance between power and control terminals of ignition coil harness connector.

Specification : Infinite

3. Is the measured resistance within specification?

YES	▶ Go to "Check short to ground in harness' as follows.
NO	▶ Repair short to battery in harness, and go to "Verification of Vehicle Repair" procedure.

■ **Check short to ground in harness**

1. IG "OFF" and disconnect ignition coil connector and ECM connector.
2. Measure resistance between control terminal of ignition coil harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification?

YES	▶ Go to "Check open in harness" as follows.
NO	▶ Repair short to ground in harness, and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect Ignition Coil connector and ECM connector.
2. Measure resistance between control terminal of Ignition Coil harness connector and IG Coil #1 control terminal of ECM harness connector.

Specification : Below 1Ω

3. Is the measured resistance within specification?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check Ignition Coil

1. IG "OFF" and disconnect ignition coil connector.
2. Measure resistance between power and signal terminals of ignition coil connector.(Measurement "A")
3. Measure resistance between power terminal of ignition coil connector and out terminal of secondary ignition coil.(Measurement "B")
Specification :

	Primary Coil	Secondary Coil
Resistance(Ω)	0.62 ± 10% (20°C/68°F)	7.0k ± 15% (20°C/68°F)

4. Is the measured resistance within specification?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good Ignition Coil and check for proper operation. If the problem is corrected, replace Ignition Coil and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

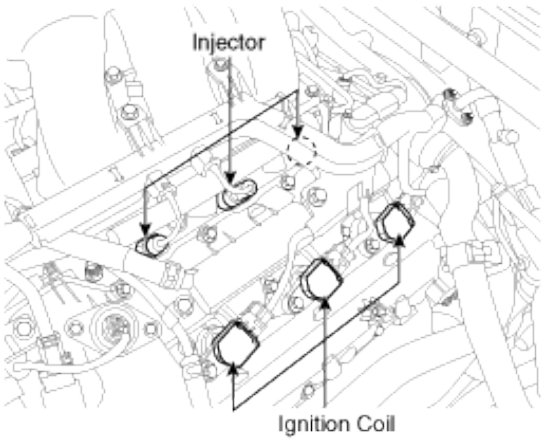
1. Connect GDS and select "DTC" button.

2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0356 Ignition Coil 'F' Primary / Secondary Circuit

Component Location



General Description

With the ignition switch in the ON or START position, voltage is applied to the ignition coil. Each ignition coil consists of two coils. High tension leads go to each cylinder from the ignition coils. The ignition coils fire two spark plugs on every power stroke (the cylinder under compression and the cylinder on the exhaust stroke). The Engine Control Module (ECM) provides a switching circuit to ground for energizing the primary ignition coils. The ECM uses the crankshaft position sensor and camshaft position sensor signal to time the energizing of the coil. When a primary ignition coil is energized and de-energized, the secondary coil produces a high voltage spike to the attached spark plugs.

DTC Description

Checking output signals from ignition coils every 10 sec. under detecting condition, if the signals indicating open or short in the circuit are detected for more than 5 sec., ECM sets this DTC. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

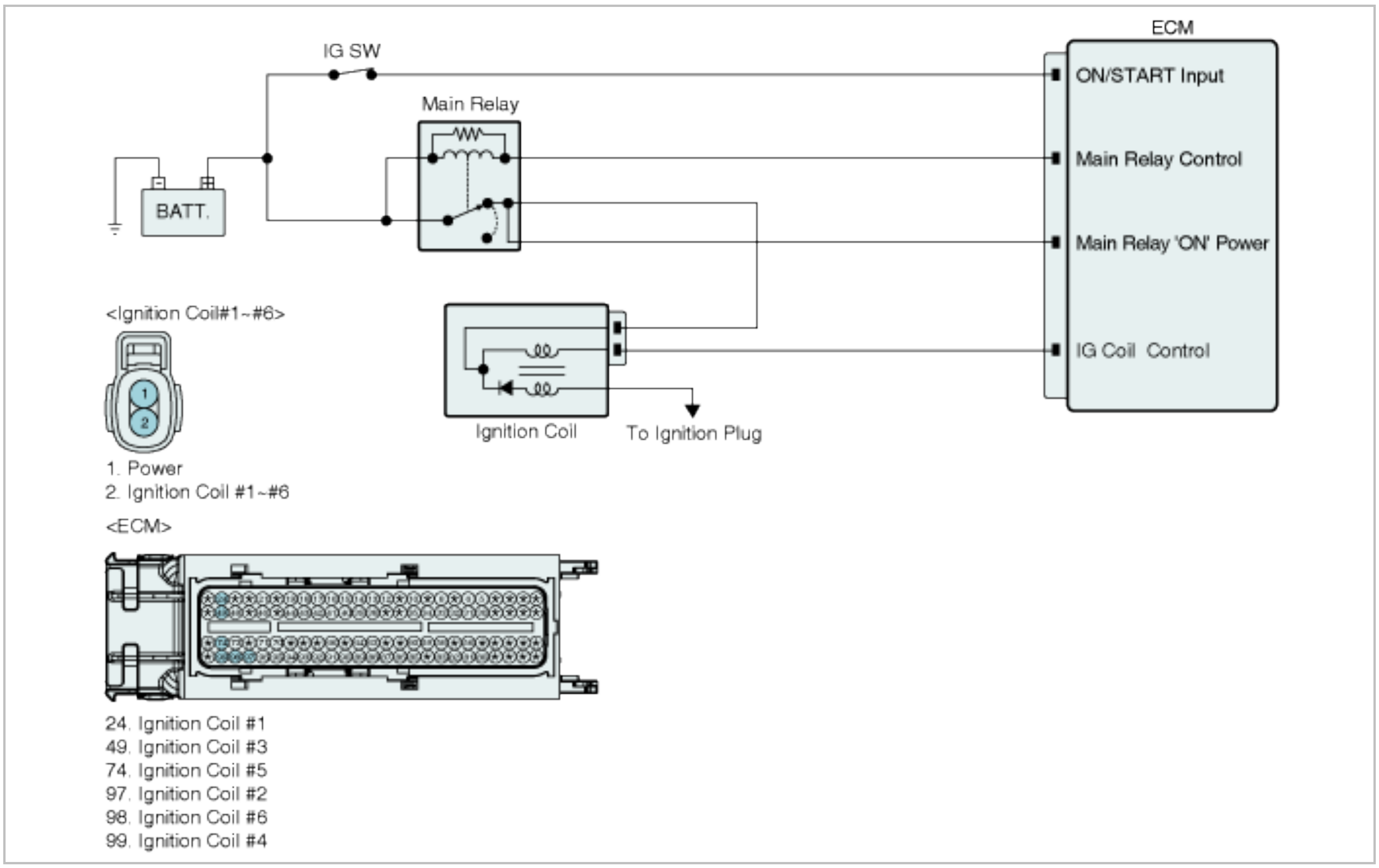
Item	Detecting Condition	Possible Cause
DTC Strategy	• Detects a short to ground, to battery or open circuit	• Poor connection • Open or short in harness
Enable Conditions	• NO DTC related to this item • Engine running state • 11V ≤ Battery voltage ≤ 16V • The above conditions are met > 0.5 sec.	

Threshold value	• Open or short	• Ignition Coil • ECM
Diagnosis Time	• Continuous (More than 5 sec.failure for every 10 sec.test)	
MIL On Condition	• 2 driving cycles	

Specification

Resistance(Ω)	Primary Coil	Secondary Coil
	0.62 ± 10% (20°C/68°F)	7.0k ± 15% (20°C/68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data

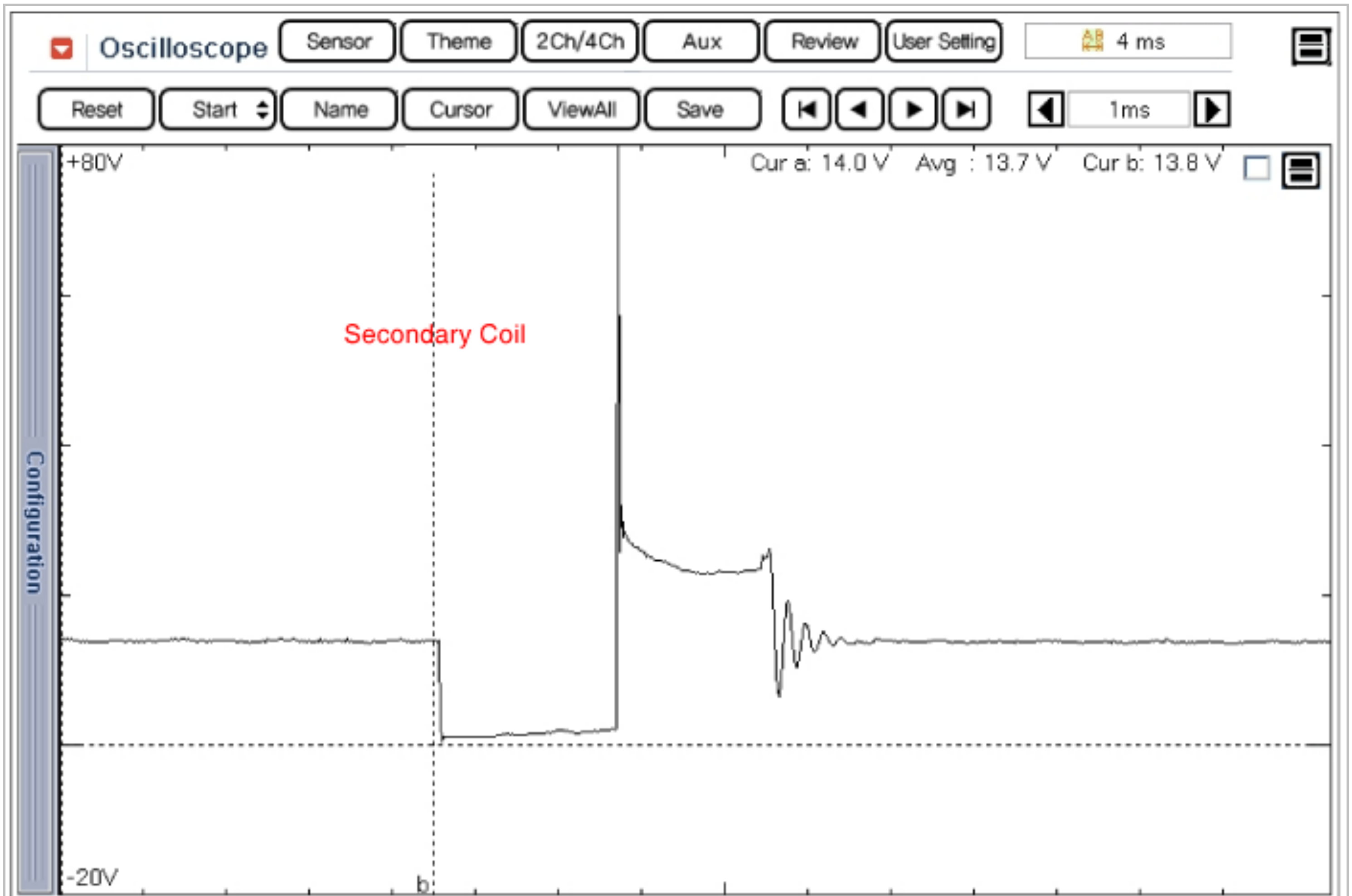
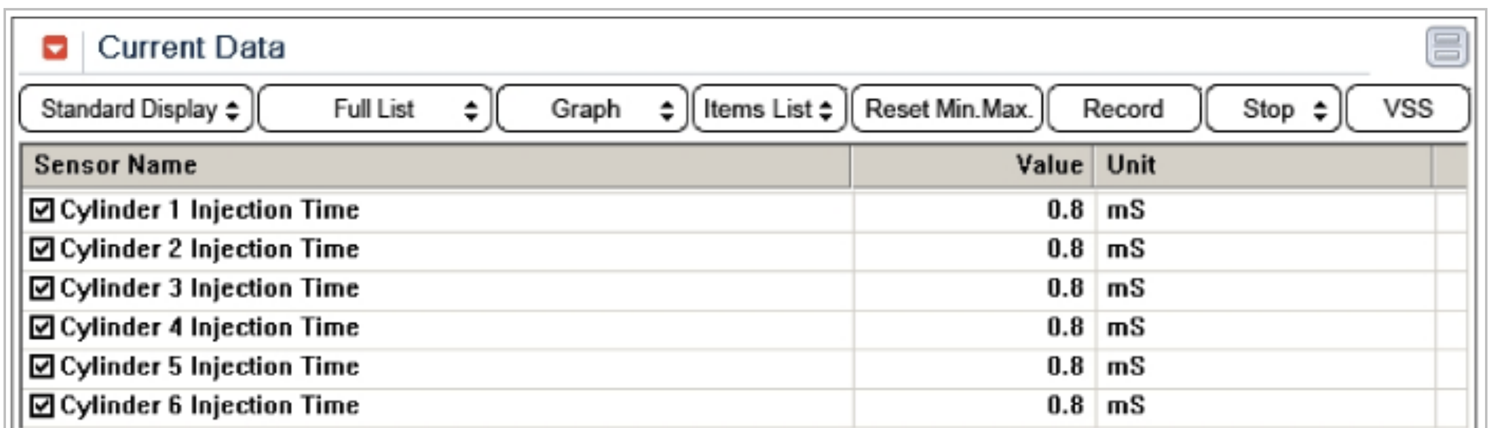
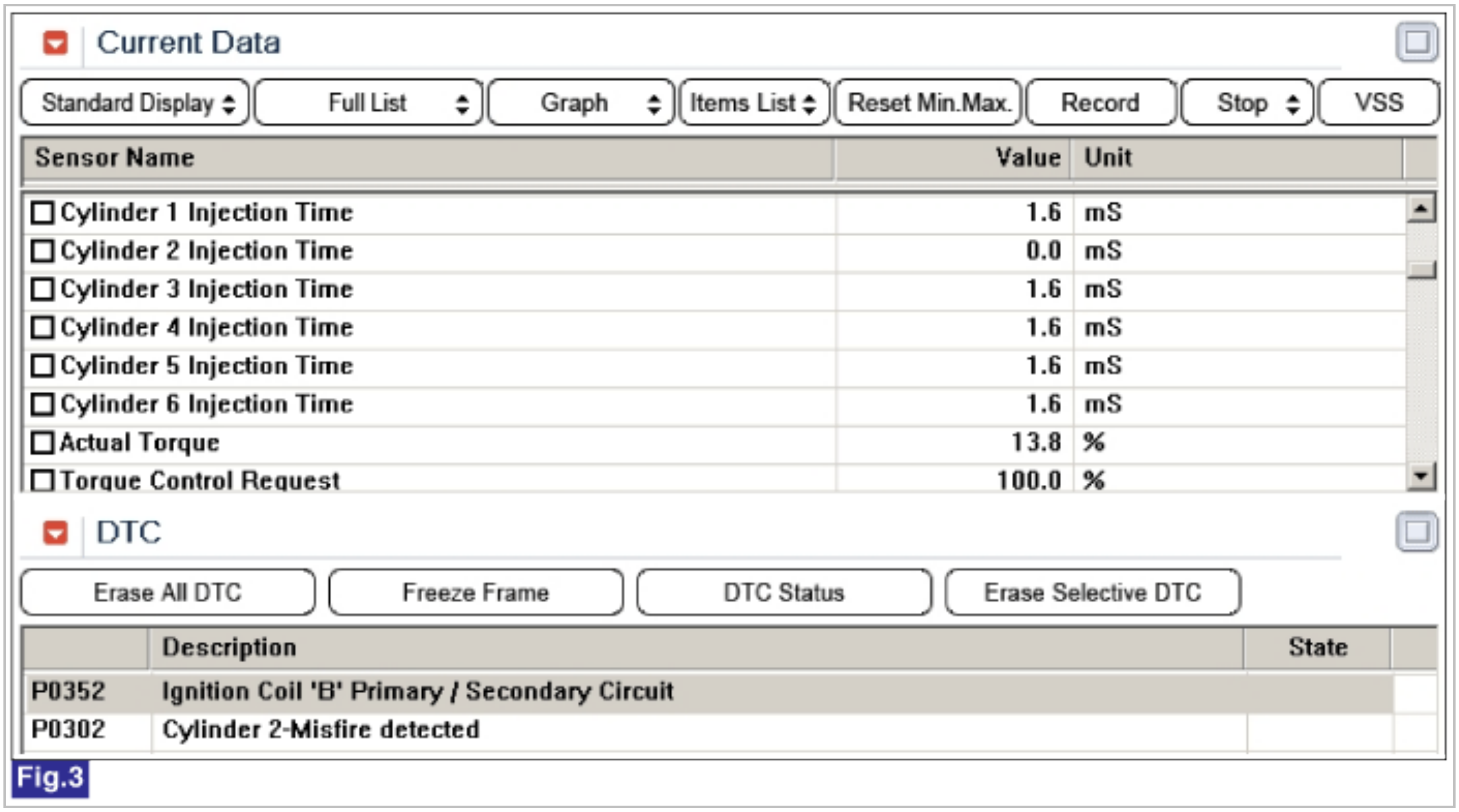


Fig.1



Sensor Name	Value	Unit
☑ Cylinder 1 Injection Time	0.8	mS
☑ Cylinder 2 Injection Time	0.8	mS
☑ Cylinder 3 Injection Time	0.8	mS
☑ Cylinder 4 Injection Time	0.8	mS
☑ Cylinder 5 Injection Time	0.8	mS
☑ Cylinder 6 Injection Time	0.8	mS

Fig.2



Sensor Name	Value	Unit
Cylinder 1 Injection Time	1.6	mS
Cylinder 2 Injection Time	0.0	mS
Cylinder 3 Injection Time	1.6	mS
Cylinder 4 Injection Time	1.6	mS
Cylinder 5 Injection Time	1.6	mS
Cylinder 6 Injection Time	1.6	mS
Actual Torque	13.8	%
Torque Control Request	100.0	%

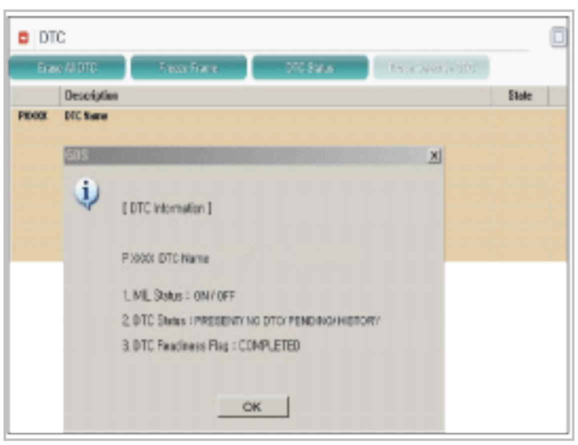
	Description	State
P0352	Ignition Coil 'B' Primary / Secondary Circuit	
P0302	Cylinder 2-Misfire detected	

Fig.3

Fig.1) Normal waveforms of secondary coil at idle.
Fig.2) Normal data of Injection time at idle.
Fig.3) Abnormal data of Injection time when ignition coil (cylinder 2) open.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect Ignition Coil connector.
2. IG "ON".
3. Measure voltage between power terminal of ignition coil harness connector and chassis ground.

Specification : Approx. B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.
NO	▶ Check fuse connected to ignition coil for open. ▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Control Circuit Inspection

■ Check short to battery in harness

1. IG "OFF" and disconnect ignition coil connector and ECM connector.
2. Measure resistance between power and control terminals of ignition coil harness connector.

Specification : Infinite

3. Is the measured resistance within specification?

YES	▶ Go to "Check short to ground in harness" as follows.
NO	▶ Repair short to battery in harness, and go to "Verification of Vehicle Repair" procedure.

■ Check short to ground in harness

1. IG "OFF" and disconnect ignition coil connector and ECM connector.
2. Measure resistance between control terminal of ignition coil harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification?

YES	▶ Go to "Check open in harness" as follows.
NO	▶ Repair short to ground in harness, and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect Ignition Coil connector and ECM connector.
2. Measure resistance between control terminal of Ignition Coil harness connector and IG Coil #1 control terminal of ECM harness connector.

Specification : Below 1Ω

3. Is the measured resistance within specification?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check Ignition Coil

1. IG "OFF" and disconnect ignition coil connector.
2. Measure resistance between power and signal terminals of ignition coil connector.(Measurement "A")
3. Measure resistance between power terminal of ignition coil connector and out terminal of secondary ignition coil.(Measurement "B")
Specification :

	Primary Coil	Secondary Coil
Resistance(Ω)	0.62 ± 10% (20°C/68°F)	7.0k ± 15% (20°C/68°F)

4. Is the measured resistance within specification?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good Ignition Coil and check for proper operation. If the problem is corrected, replace Ignition Coil and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

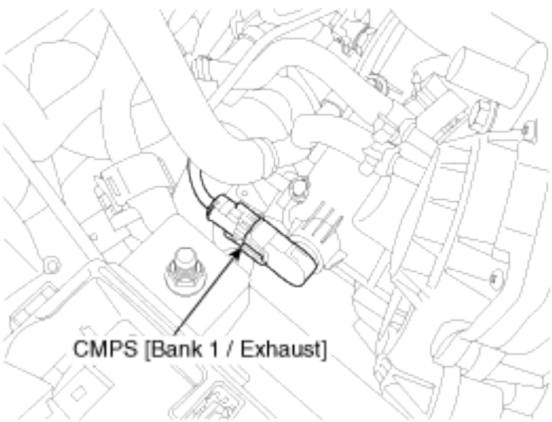
1. Connect GDS and select "DTC" button.

2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0366 Camshaft Position Sensor \'B\' Circuit Range/Performance (Bank 1)

Component Location



General Description

The Camshaft Position Sensor (CMPS) is a sensor that detects the compression TDC of the NO. 1 cylinder. The CMPS consists of a hall type sensor and a target on the end of the intake camshaft. When the target triggers the sensor, the sensor voltage is 5V. If not, the sensor voltage is 0V. These CMPS signal is sent to the ECM and the ECM uses the CMPS signal for synchronizing the firing of sequential fuel injectors.

DTC Description

Checking oputput signals from CMP during engine running, if the expected number of cam tooth count is not observed, ECM sets P0366. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

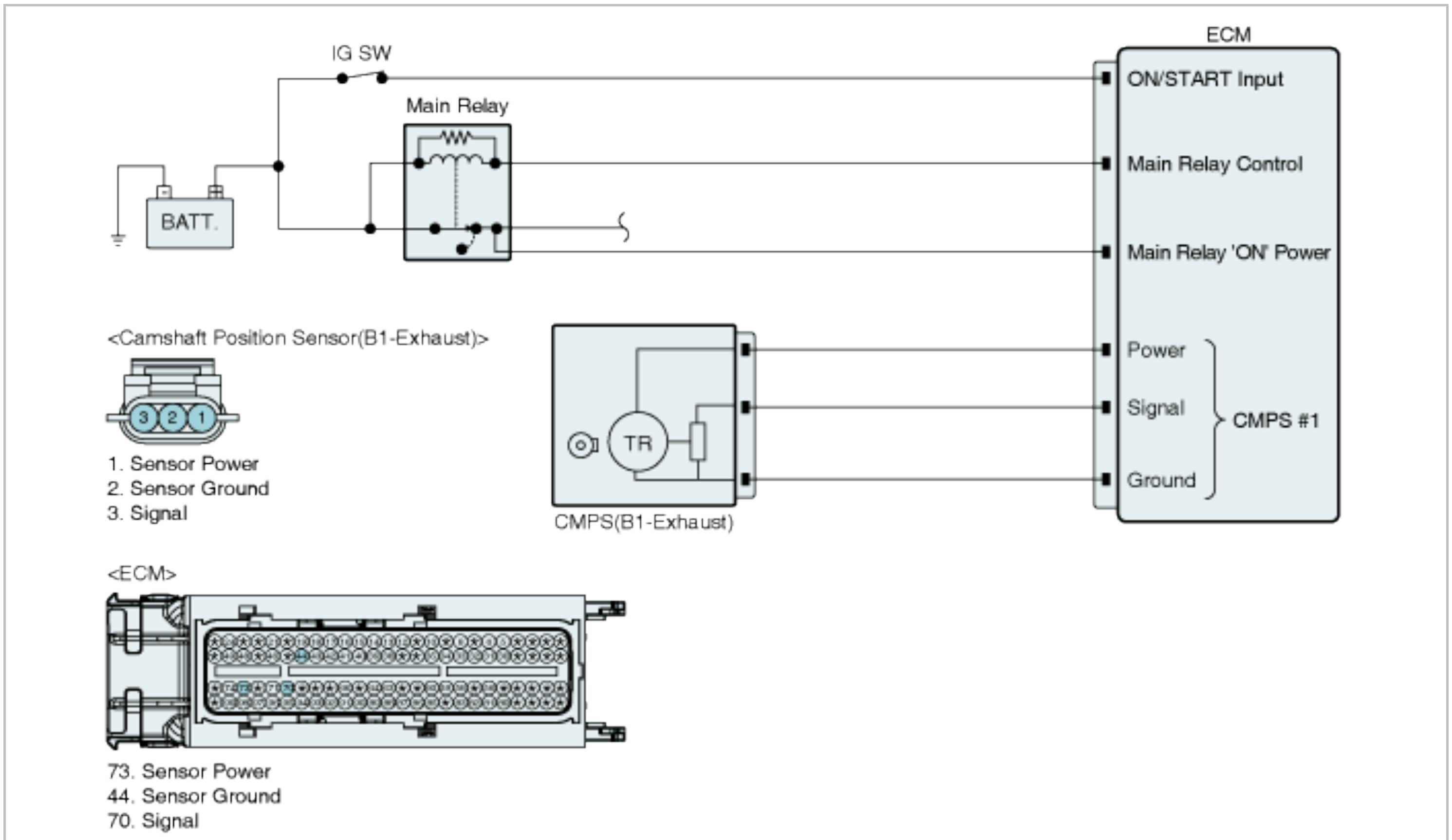
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Check if CAM sensor is synchronized correctly	• Poor connection • Short in harness • Electrical noise • Target wheel • CMPS(B1-Exhaust) • ECM
Enable Conditions	• Engine running state	
Threshold value	• Cam tooth count ≠ 6	
Diagnosis Time	• Continuous	
MIL On Condition	• 2 driving cycles	

Specification

Item	Specification	
Output Voltage(V)	Hi : 5.0V	Low : 0.7V
Airgap(mm)	0.5 ~ 1.5	

Diagnostic Circuit Diagram



Signal Waveform & Data

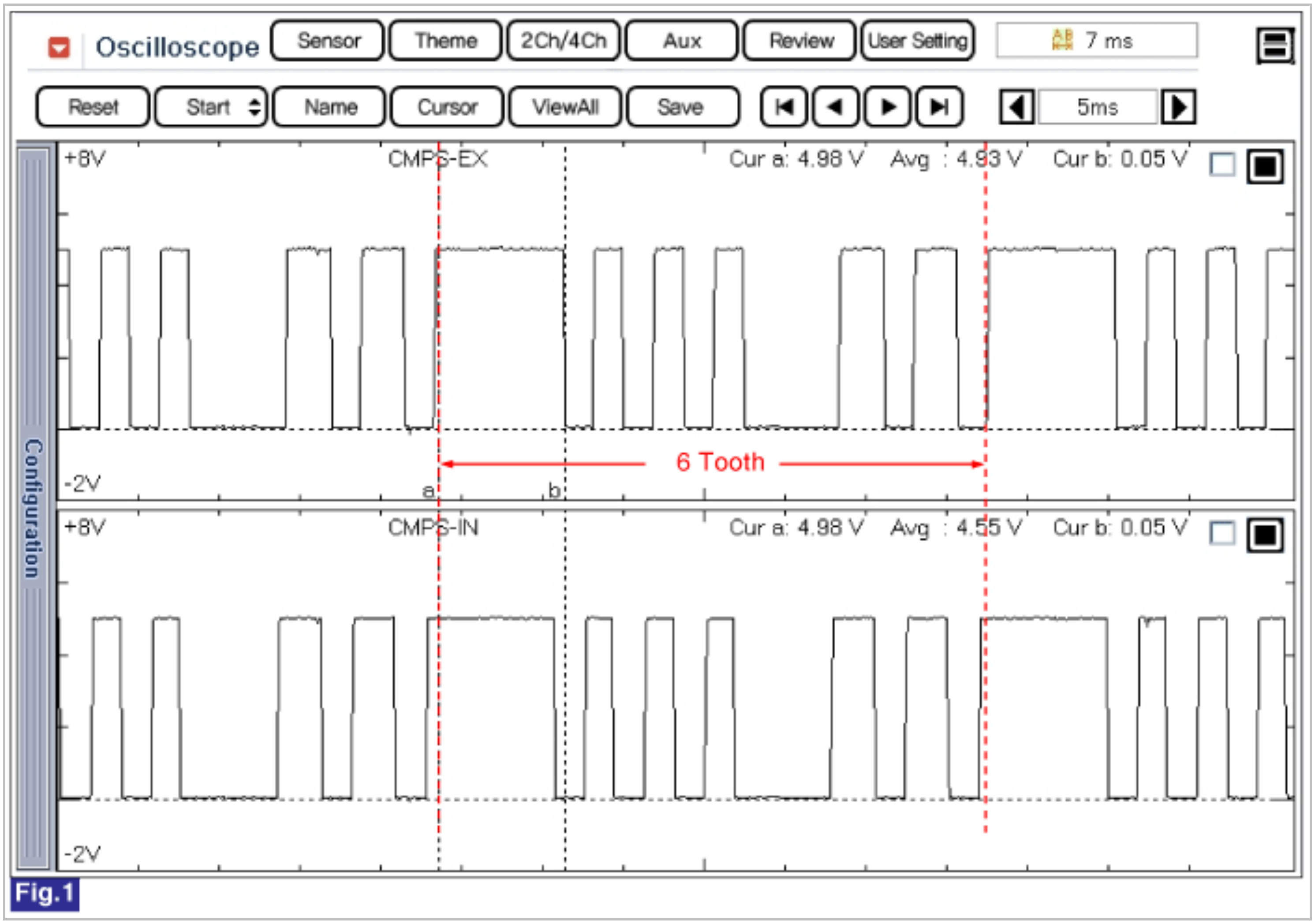
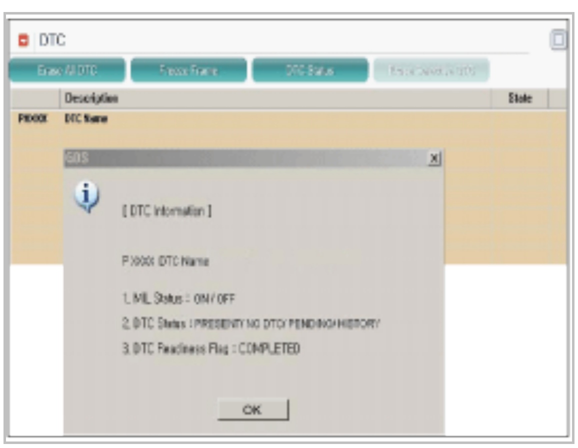


Fig.1) Normal waveforms of CMPS

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.

NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect CMPS(B1-Exhaust) connector.
2. IG "ON".
3. Measure voltage between power terminal of CMPS(B1-Exhaust) harness connector and chassis ground.

Specification : Approx. 5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Signal Circuit Inspection" procedure.
NO	▶ Repair open or short to ground inharness, and go to "Verification of Vehicle Repair" procedure.

Signal Circuit Inspection

■ Check short to battery in harness

1. IG "OFF" and disconnect CMPS(B1-Exhaust) connector.
2. IG "ON".
3. Measure voltage between signal terminal of CMPS(B1-Exhaust) harness connector and chassis ground.

Specification : Approx. 5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Check short in harness" as follows.
NO	▶ Go to "Check open in harness" as follows.

■ Check short in harness

1. IG "OFF" and disconnect CMPS(B1-Exhaust) connector.

2. Measure resistance between signal and power terminals of CMPS(B1-Exhaust) harness connector.

Specification : Infinite

3. Is the measured resistance within specification?

YES	▶ Go to "Check short to ground in harness' as follows.
NO	▶ Repair short in harness, and go to "Verification of Vehicle Repair" procedure.

■ **Check short to ground in harness**

1. IG "OFF" and disconnect CMPS(B1-Exhaust) connector and ECM connector.
2. Measure resistance between signal terminal of CMPS(B1-Exhaust) harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to ground in harness, and go to "Verification of Vehicle Repair" procedure.

■ **Check open in harness**

1. IG "OFF" and disconnect CMPS(B1-Exhaust) connector and ECM connector.
2. Measure resistance between signal terminal of CMPS(B1-Exhaust) harness connector and CMPS(B1-Exhaust) signal terminal of ECM harness connector.

Specification : Below 1Ω

3. Is the measured resistance within specification?

YES	▶ Go to "Ground Circuit Inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Ground Circuit Inspection

■ **Check open in harness**

1. IG "OFF" and disconnect CMPS(B1-Exhaust) connector and then IG "ON".
2. Measure voltage between signal terminal of CMPS(B1-Exhaust) harness connector and chassis ground.(Measurement "A")
3. Measure voltage between signal and ground terminals of CMPS(B1-Exhaust) harness connector.(Measurement "B")

Specification : Voltage difference between measurement "A" and "B" is below 200mV.

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair contact resistance or open in harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check CMPS

1. IG "OFF" and connect GDS.
2. ENG "ON" and Measure signal waveform at signal terminal of CMPS.

Reference signal waveform :

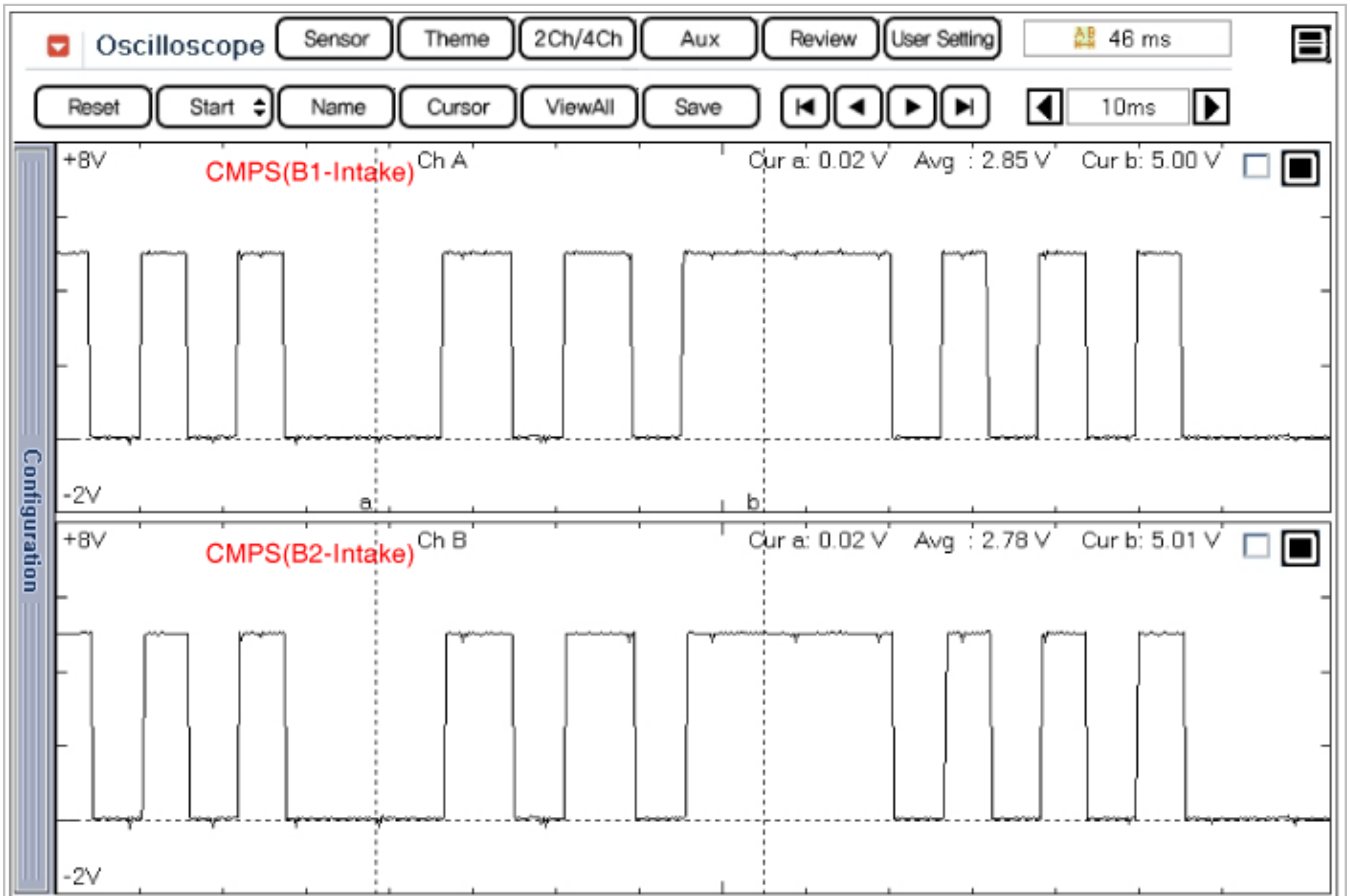


Fig.1

Fig.1) Normal waveform of CMPS1 & 2 at idle.

3. Is the measured siganl waveform normal?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good CMPS and check for proper operation. If the problem is corrected, replace CMPS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

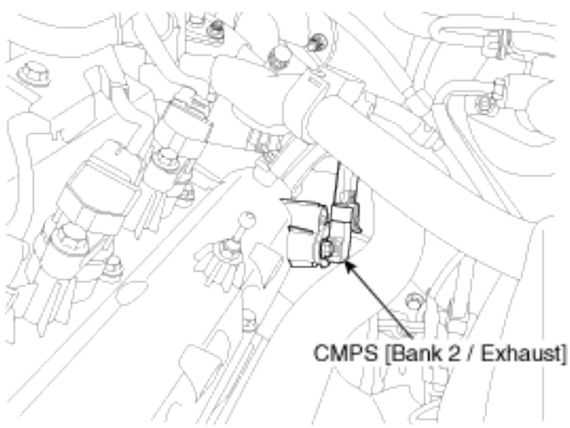
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0391 Camshaft Position Sensor \'B\' Circuit Range/Performance (Bank 2)

Component Location



General Description

The Camshaft Position Sensor (CMPS) is a sensor that detects the compression TDC of the NO. 1 cylinder. The CMPS consists of a hall type sensor and a target on the end of the intake camshaft. When the target triggers the sensor, the sensor voltage is 5V. If not, the sensor voltage is 0V. These CMPS signal is sent to the ECM and the ECM uses the CMPS signal for synchronizing the firing of sequential fuel injectors.

DTC Description

Checking oputput signals from CMP during engine running, if the expected number of cam tooth count is not observed, ECM sets P0391. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

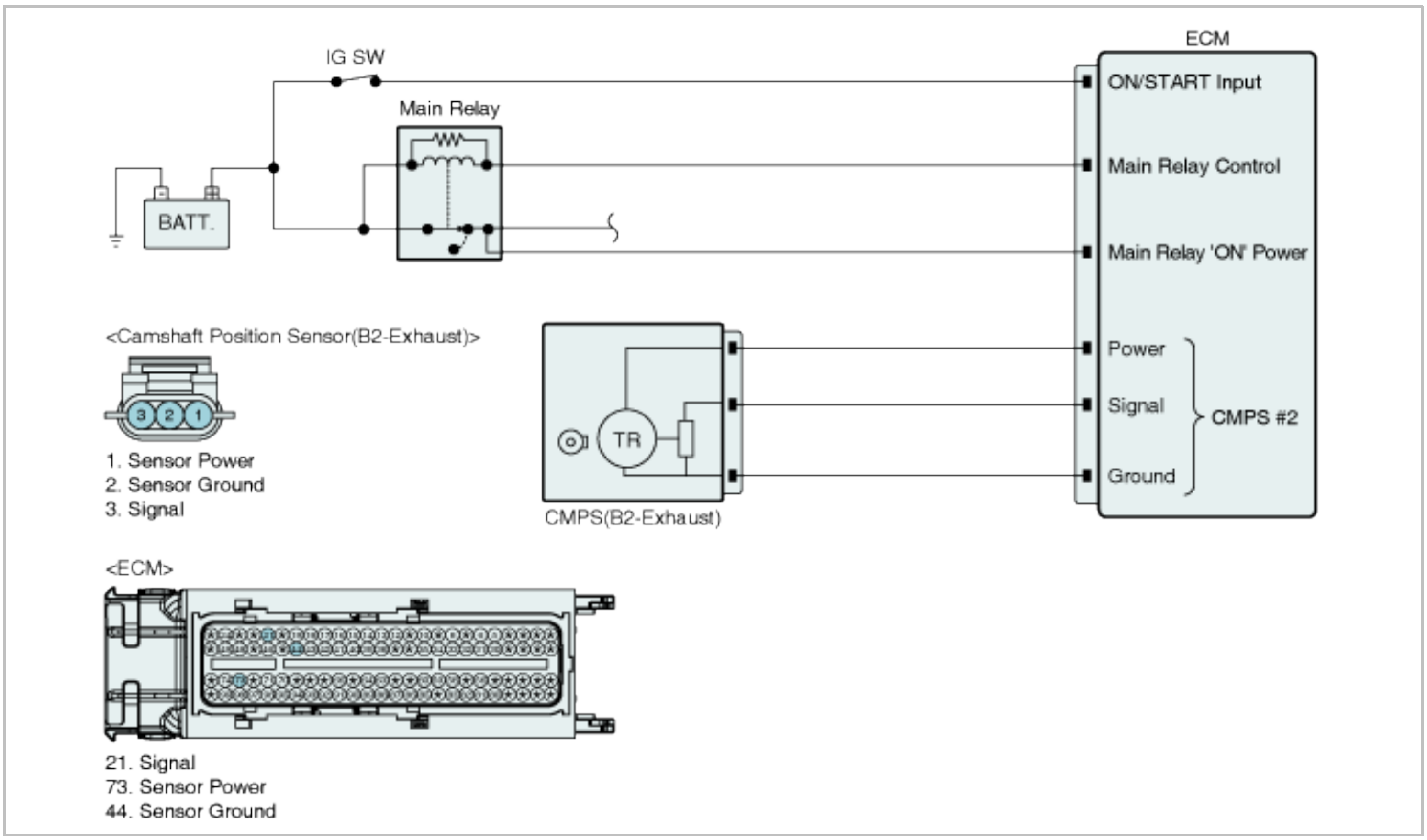
Item	Detecting Condition	Possible cause
DTC Strategy	• Check if CAM sensor is synchronized correctly	• Poor connection • Short in harness • Electrical noise
Enable Conditions	• Engine running state	
Threshold value	• Cam tooth count ≠ 6	

Threshold value	• Cam tooth count ≠ 0	• Target wheel • CMPS(B2-Exhaust) • ECM
Diagnosis Time	• Continuous	
MIL On Condition	• 2 driving cycles	

Specification

Item	Specification	
Output Voltage(V)	Hi : 5.0V	Low : 0.7V
Airgap(mm)	0.5 ~ 1.5	

Diagnostic Circuit Diagram



Signal Waveform & Data

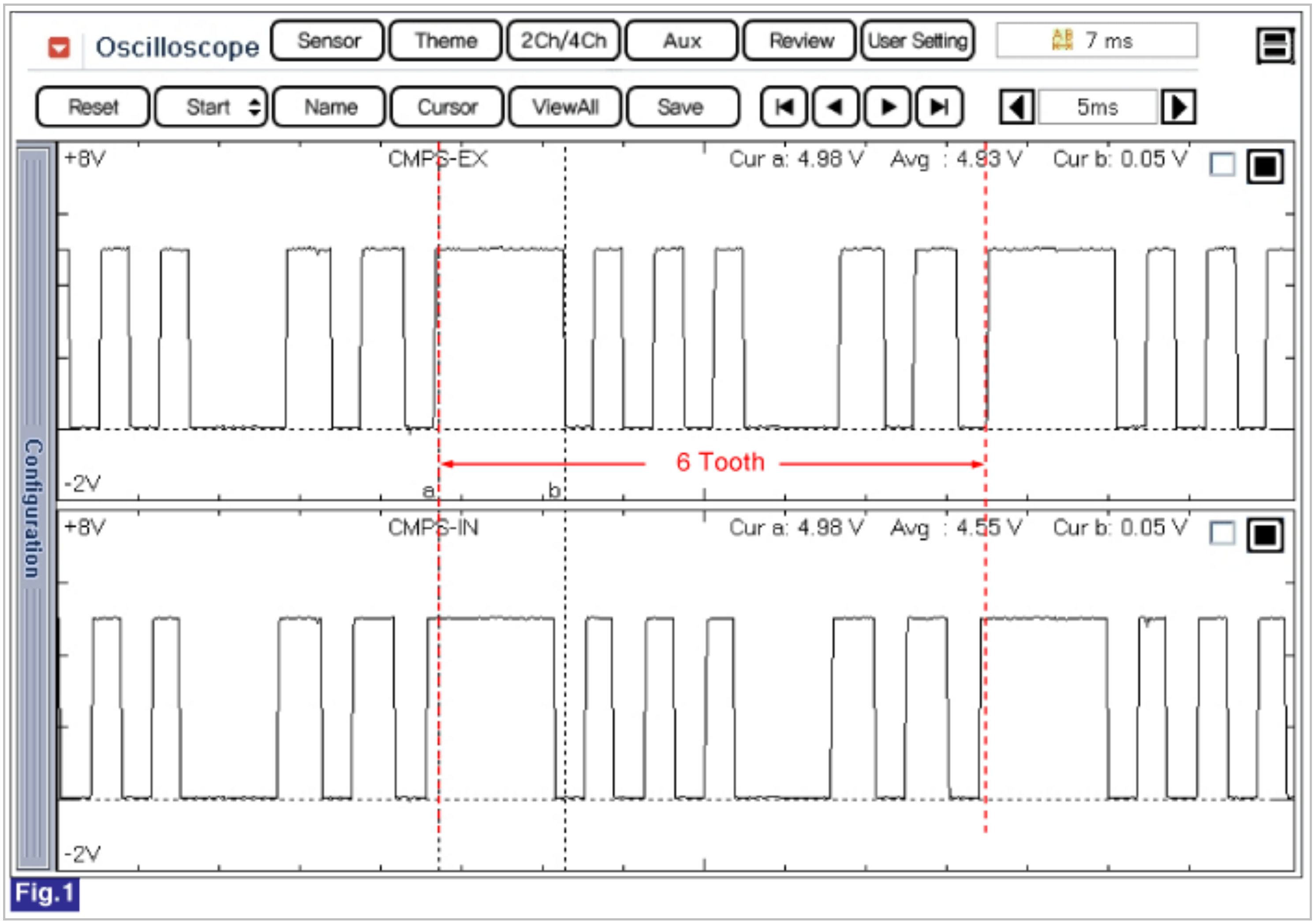
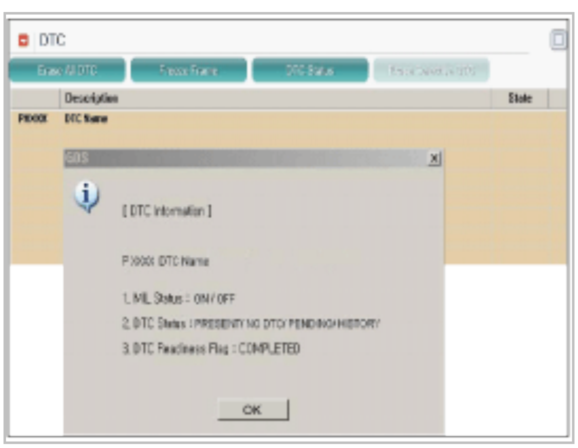


Fig.1) Normal waveforms of CMPS

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.

NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect CMPS(B2-Exhaust) connector.
2. IG "ON".
3. Measure voltage between power terminal of CMPS(B2-Exhaust) harness connector and chassis ground.

Specification : Approx. 5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Signal Circuit Inspection" procedure.
NO	▶ Repair open or short to ground inharness, and go to "Verification of Vehicle Repair" procedure.

Signal Circuit Inspection

■ Check short to battery in harness

1. IG "OFF" and disconnect CMPS(B2-Exhaust) connector.
2. IG "ON".
3. Measure voltage between signal terminal of CMPS(B2-Exhaust) harness connector and chassis ground.

Specification : Approx. 5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Check short in harness" as follows.
NO	▶ Go to "Check open in harness" as follows.

■ Check short in harness

1. IG "OFF" and disconnect CMPS(B2-Exhaust) connector.

2. Measure resistance between signal and power terminals of CMPS(B2-Exhaust) harness connector.

Specification : Infinite

3. Is the measured resistance within specification?

YES	▶ Go to "Check short to ground in harness" as follows.
NO	▶ Repair short in harness, and go to "Verification of Vehicle Repair" procedure.

■ **Check short to ground in harness**

1. IG "OFF" and disconnect CMPS(B2-Exhaust) connector and ECM connector.
2. Measure resistance between signal terminal of CMPS(B2-Exhaust) harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to ground in harness, and go to "Verification of Vehicle Repair" procedure.

■ **Check open in harness**

1. IG "OFF" and disconnect CMPS(B2-Exhaust) connector and ECM connector.
2. Measure resistance between signal terminal of CMPS(B2-Exhaust) harness connector and CMPS(B2-Exhaust) signal terminal of ECM harness connector.

Specification : Below 1Ω

3. Is the measured resistance within specification?

YES	▶ Go to "Ground Circuit Inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Ground Circuit Inspection

■ **Check open in harness**

1. IG "OFF" and disconnect CMPS(B2-Exhaust) connector and then IG "ON".
2. Measure voltage between signal terminal of CMPS(B2-Exhaust) harness connector and chassis ground.(Measurement "A")
3. Measure voltage between signal and ground terminals of CMPS(B2-Exhaust) harness connector.(Measurement "B")

Specification : Voltage difference between measurement "A" and "B" is below 200mV.

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair contact resistance or open in harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check CMPS

1. IG "OFF" and connect GDS.
2. ENG "ON" and Measure signal waveform at signal terminal of CMPS.

Reference signal waveform :

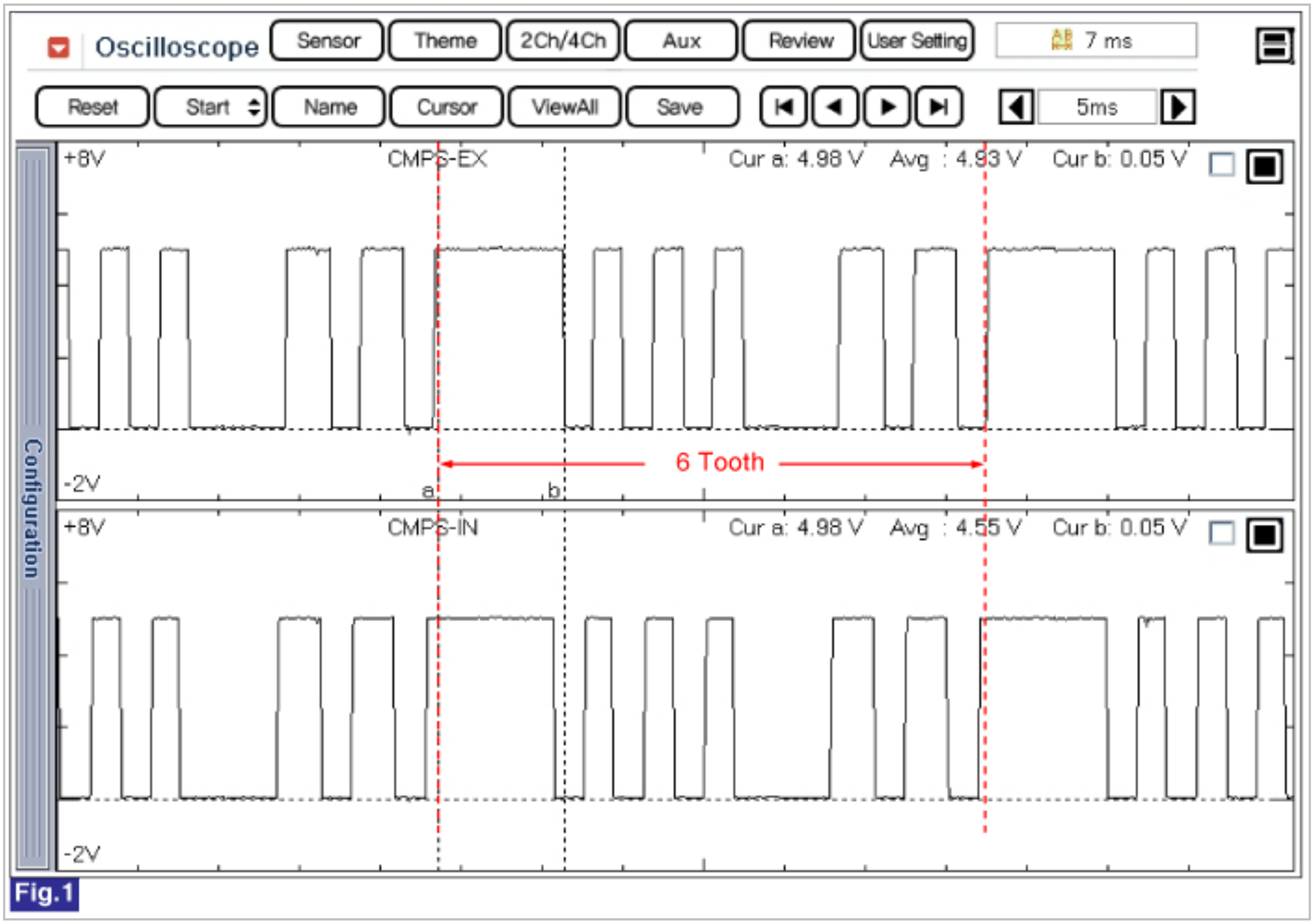


Fig. 1) Normal waveform of CMPS1 & 2 at idle.

3. Is the measured siganl waveform normal?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good CMPS and check for proper operation. If the problem is corrected, replace CMPS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

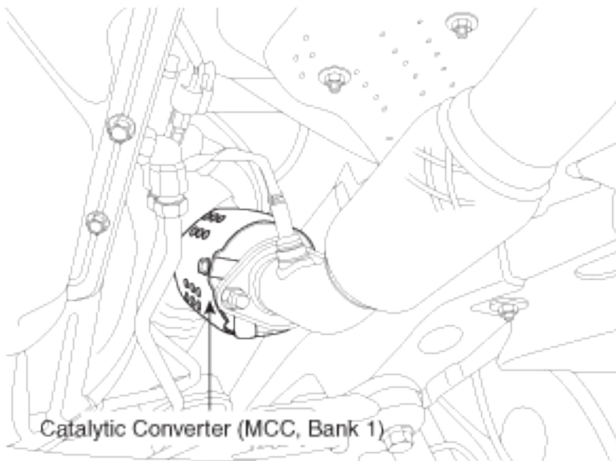
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0420 Catalyst System Efficiency below Threshold (Bank 1)

Component Location



General Description

The ECM uses dual oxygen sensors to monitor the efficiency of the manifold catalytic converter (warm-up catalytic converter). By monitoring the oxygen storage capacity of a catalyst, its efficiency can be indirectly calculated. The upstream (front) HO2S is used to detect the amount of oxygen in the exhaust gas before it enters the catalytic converter. A low voltage indicates high oxygen contents (lean air mixture). A high voltage indicates low oxygen contents (rich air mixture). When the catalyst efficiency drops, no chemical reaction takes place. This means the concentration of oxygen will be the same at the rear as it is at the front.

DTC Description

If the oxygen storage time for Bank 1 is lower than threshold, the ECM determines that a fault exists and a DTC is stored and MIL(Malfunction Indication Lamp) turns on.

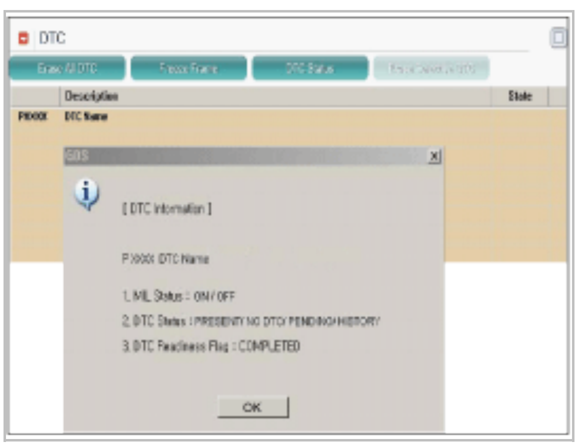
DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Manipulates Airfuel and stores the times it takes for the pre and post converter oxygen sensors to switch.	

EnableConditions	• Engine Runtime ≥ 580 sec. • Purge Concentration Learned • 3 g/s ≤ Airflow ≤ 10 g/s • Throttle closed ≤ 1.5% • 70°C(158 °F) ≤ Coolant Temp. ≤ 120°C(248 °F) • -7°C(19.4 °F) ≤ Ambient Temp. ≤ 105°C(221 °F) • Barometer ≥ 72 kPa • Max number of test attempts ≤ 12 • Closed Loop • 250°C(482 °F) ≤ Catalyst Temp. ≤ 950°C(1742 °F) • Fuel learning completed • Vehicle speed ≤ 3 kph(1.8 mph) • Not airfuel ramping • Max idle time(about 60 sec.) not exceeded • No disabling faults present • No instrumentation slews active	• Catalyst Converter
Threshold value	• Oxygen Storage Time < 3.25 sec.	
Diagnosis Time	• 15 sec.	
MIL On Condition	• 1 Driving cycle	

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Substitute with a known - good Catalyst Converter and check for proper operation.If the problem is corrected, Go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Component Inspection" procedure.

Component Inspection

■ **Monitor the Catalyst Converter**

1. Clear DTC.
2. Start the engine and warm it up until the radiator fan comes on(more than at least 10 minutes).
3. Drive at a steady speed between 45-55 mph(72-88 km/h) for 30 seconds.
4. Stop and then maintain idle state for 120 seconds in D-position.
5. Repeat step 3 once again.
6. Stop and then keep it in idle state(D-positon) for 120 seconds.
7. Repeat step 3 once again.
8. Stop and then maintain idle state for 120 seconds in D-position.
9. IG "OFF"
10. Repeat steps 3 through 9 three times.
11. Check if catalyst monitoring readiness is complete. so, if the readiness is incomplete, repeat steps 2 through 10.
12. Does the GDS show DTC P0420??

YES	▶ Substitute with a known - good Catalyst Converter and check the signal waveform of HO2S for proper operation. If the problem is corrected, Go to "Verification of Vehicle Repair" procedure.
NO	▶ It was intermittent failure.

Verification of Vehicle Repair

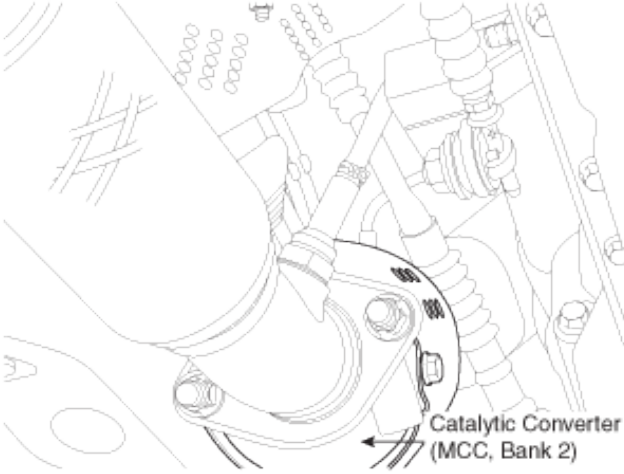
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0430 Catalyst System Efficiency Below Threshold (Bank 2)

Component Location



General Description

The ECM uses dual oxygen sensors to monitor the efficiency of the manifold catalytic converter (warm-up catalytic converter). By monitoring the oxygen storage capacity of a catalyst, its efficiency can be indirectly calculated. The upstream (front) HO2S is used to detect the amount of oxygen in the exhaust gas before it enters the catalytic converter. A low voltage indicates high oxygen contents (lean air mixture). A high voltage indicates low oxygen contents (rich air mixture). When the catalyst efficiency drops, no chemical reaction takes place. This means the concentration of oxygen will be the same at the rear as it is at the front.

DTC Description

If the oxygen storage time for Bank 2 is lower than threshold, the ECM determines that a fault exists and a DTC is stored and MIL(Malfunction Indication Lamp) turns on.

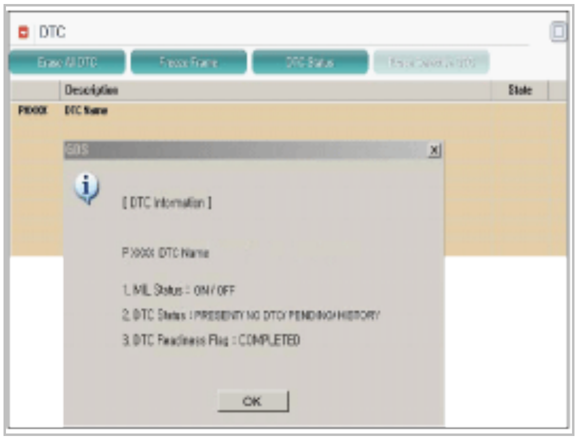
DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Manipulates Airfuel and stores the times it takes for the pre and post converter oxygen sensors to switch.	• Catalyst Converter
EnableConditions	• Engine Runtime ≥ 580 sec. • Purge Concentration Learned • 3 g/s ≤ Airflow ≤ 10 g/s • Throttle closed ≤ 1.5% • 70°C(158 °F) ≤ Coolant Temp. ≤ 120°C(248 °F) • -7°C(19.4 °F) ≤ Ambient Temp. ≤ 105°C(221 °F) • Barometer ≥ 72 kPa • Max number of test attempts ≤ 12 • Closed Loop • 250°C(482 °F) ≤ Catalyst Temp. ≤ 950°C(1742 °F) • Fuel learning completed • Vehicle speed ≤ 3 kph(1.8 mph) • Not airfuel ramping • Max idle time(about 60 sec.) not exceeded • No disabling faults present • No instrumentation slews active	
Threshold value	• Oxygen Storage Time < 3.25 sec.	

Diagnosis Time	• 15 sec.	
MIL On Condition	• 1 Driving cycle	

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Substitute with a known - good Catalyst Converter and check for proper operation.If the problem is corrected, Go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Component Inspection" procedure.

Component Inspection

■ **Monitor the Catalyst Converter**

1. Clear DTC.
2. Start the engine and warm it up until the radiator fan comes on(more than at least 10 minutes).
3. Drive at a steady speed between 45-55 mph(72-88 km/h) for 30 seconds.
4. Stop and then maintain idle state for 120 seconds in D-position.
5. Repeat step 3 once again.
6. Stop and then keep it in idle state(D-positon) for 120 seconds.
7. Repeat step 3 once again.
8. Stop and then maintain idle state for 120 seconds in D-position.
9. IG "OFF"
10. Repeat steps 3 through 9 three times.
11. Check if catalyst monitoring readiness is complete. so, if the readiness is incomplete, repeat steps 2 through 10.
12. Does the GDS show DTC P0430?

YES	▶ Substitute with a known - good Catalyst Converter and check the signal waveform of HO2S

	for proper operation. If the problem is corrected, Go to "Verification of Vehicle Repair" procedure.
NO	▶ It was intermittent failure.

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0441 Evaporative Emission System Incorrect Purge Flow

General Description

The evaporative emission control system prevents hydrocarbon (HC) vapors from the fuel tank from escaping into the atmosphere where they could form photochemical smog. Gasoline vapors are collected in the charcoal canister. The ECM controls the Purge Control Solenoid Valve (PCSV) to purge any collected vapors from the canister back to the engine for combustion. This valve is actuated by the purge control signal from the ECM and controls fuel vapor flow from the canister to the intake manifold.

DTC Description

Checking output signals from fuel tank pressure sensor under evap.system test, if fuel tank's vacuum is higher than prescribed threshold, ECM sets P0441.

DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Monitor the fuel tank's vacuum	• A leak in PCSV
EnableConditions	• 10 V < Battery voltage < 16 V • Barometric pressure > 72 kPa (0.72 bar) • Engine coolant temperature at startup - Intake air temperature at startup < 6.7°C(12 °F) • Engine coolant temperature at startup: 4.5 ~ 35°C(40 ~ 95 °F) • Intake air temperature at startup: 4.5 ~ 35°C(40 ~ 95 °F) • Fuel level: 15 ~ 85 %	
Threshold value	• Fuel tank's vacuum > a prescribed threshold	
Diagnosis Time	• One time during Evaporative system diagnosis	

MIL On Condition	• 2 driving cycles	

Monitor GDS Data

NOTE

Evaporative Emissions Systems (EVAP) Leak Tests can be run by the GDS

1. Install GDS and IG "ON" and then clear DTC.
2. Select and press "EVAP.LEAKAGE TEST" mode in the GDS.
3. Check if the vehicle is under test conditions as below [Fig 1].
4. If OK, Start engine and restart Evap.Leakage Test again[Fig 2].

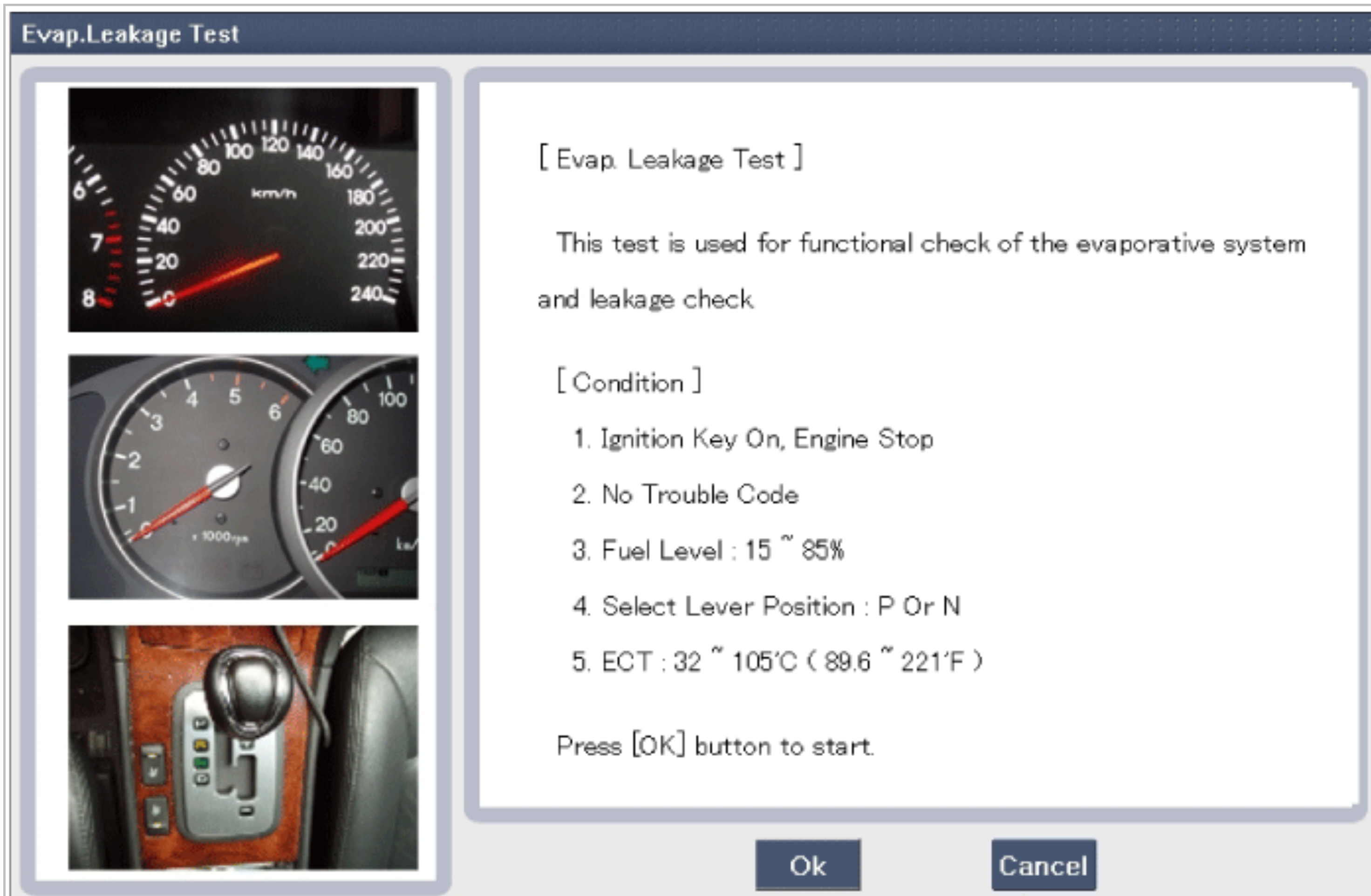


Fig.1

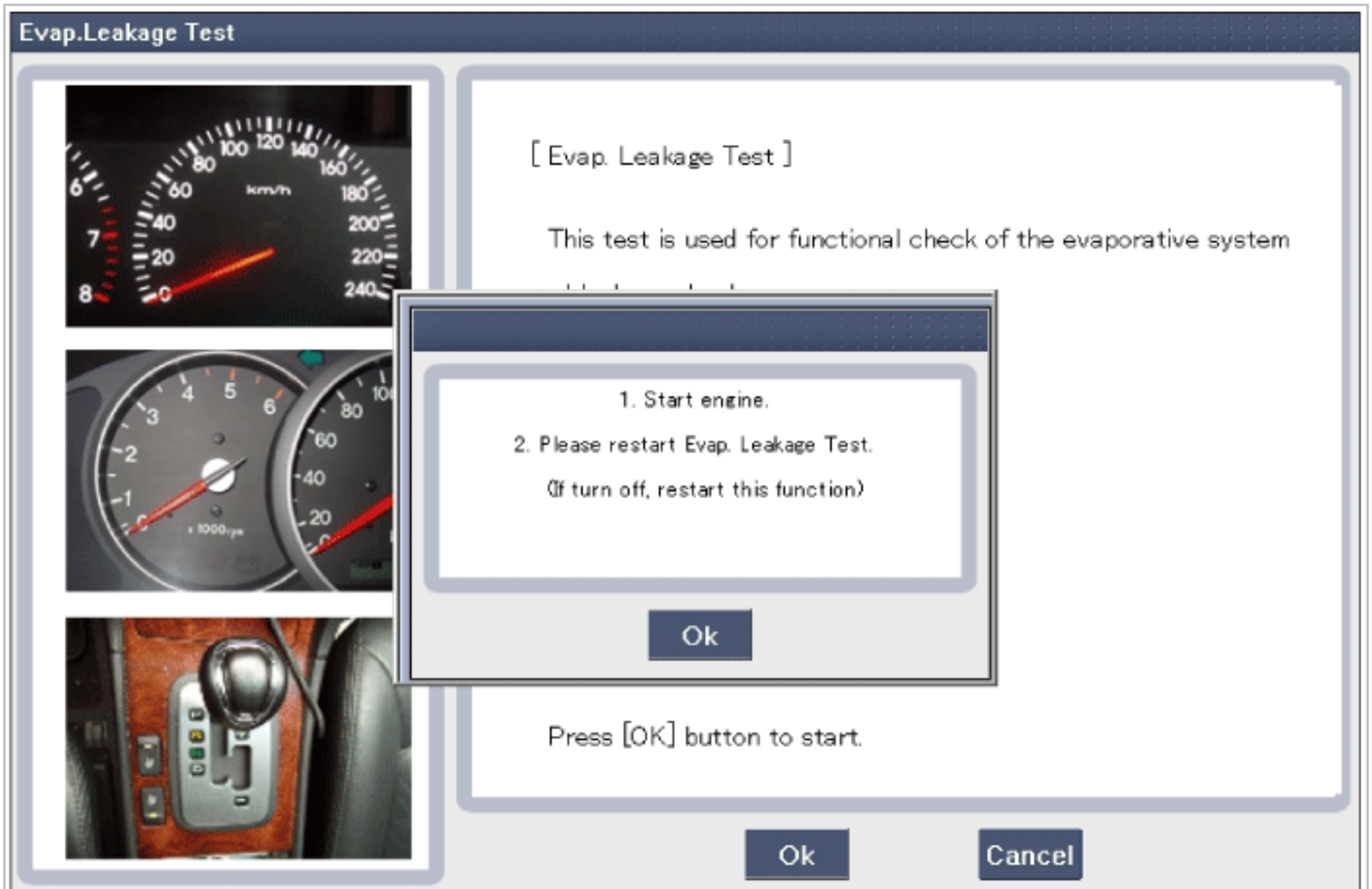


Fig.2

5. Is the same DTC set after the Evap.leakage test with GDS ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Fault is intermittent, go to "Verification of vehicle Repair" procedure.

Component Inspection

■ Check PCSV for leakage

1. IG "OFF"
2. Disconnect the hose leading from the PCSV to the intake manifold at PCSV.
3. Apply a vacuum at the nipple and verify that the PCSV holds vacuum.
4. IG "ON" and perform ACTUATION TEST for PCSV with GDS(should hear a faint click from PCSV)
5. Vacuum should be released.
6. Repeat this procedure 4 or 5 times to ensure PCSV reliability.
7. Is the PCSV working properly?

YES	▶ It was intermittent failure., go to "Verification of Vehicle Repair" procedure.
NO	▶ Substitute with a known - good PCSV and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0442 Evaporative Emission System-Leak detected (small leak)

General Description

The evaporative emission control system prevents hydrocarbon (HC) vapors from the fuel tank from escaping into the atmosphere where they could form photochemical smog. Gasoline vapors are collected in the charcoal canister. The ECM controls the Purge Control Solenoid Valve (PCSV) to purge any collected vapors from the canister back to the engine for combustion. This valve is actuated by the purge control signal from the ECM and controls fuel vapor flow from the canister to the intake manifold.

DTC Description

Checking output signals from fuel tank pressure sensor under evap.system test, if fuel tank's vacuum decay slope is higher than prescribed threshold, ECM sets P0442 and then MIL(Malfunction Indication Lamp) turns on.

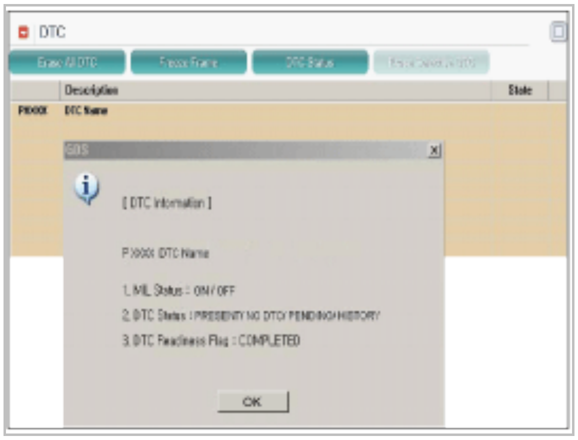
DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Monitor the vacuum decay slope	• Leakage in each hose/fuel filler pipe • Leakage in CCV/Canister/ Fuel tank /Fuel Filler Cap
EnableConditions	• 10 V < Battery voltage < 16 V • Barometric pressure > 72 kPa (0.72 bar) • Engine coolant temperature at startup - Intake air temperature at startup < 6.7°C(12 °F) • Engine coolant temperature at startup: 4.5 ~ 35°C(40 ~ 95 °F) • Intake air temperature at startup: 4.5 ~ 35°C(40 ~ 95 °F) • Fuel level: 15 ~ 85 %	
Threshold value	• The vacuum decay slope > a prescribed threshold	
Diagnosis Time	• One time during Evaporative system diagnosis	
MIL On Condition	• 1 driving cycle	

Monitor GDS Data

■ Check DTC Status

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "System Inspection" procedure.
NO	▶ Go to "Evap.Leakage Test" as below with GDS.

■ Evap. Leakage Test

1. Cool the vehicle down for about two hours to prevent misdiagnosis.
2. Install GDS and IG "ON" and then clear DTC.
3. Select and press "EVAP.LEAKAGE TEST" mode in the GDS.
4. Check if the vehicle is under test conditions as below [Fig 1].
5. If OK, Start engine and restart Evap.Leakage Test again[Fig 2].

Evap.Leakage Test

[Evap. Leakage Test]

This test is used for functional check of the evaporative system and leakage check.

[Condition]

1. Ignition Key On, Engine Stop
2. No Trouble Code
3. Fuel Level : 15 ~ 85%
4. Select Lever Position : P Or N
5. ECT : 32 ~ 105'C (89.6 ~ 221'F)

Press [OK] button to start.

Ok   Cancel

Fig.1

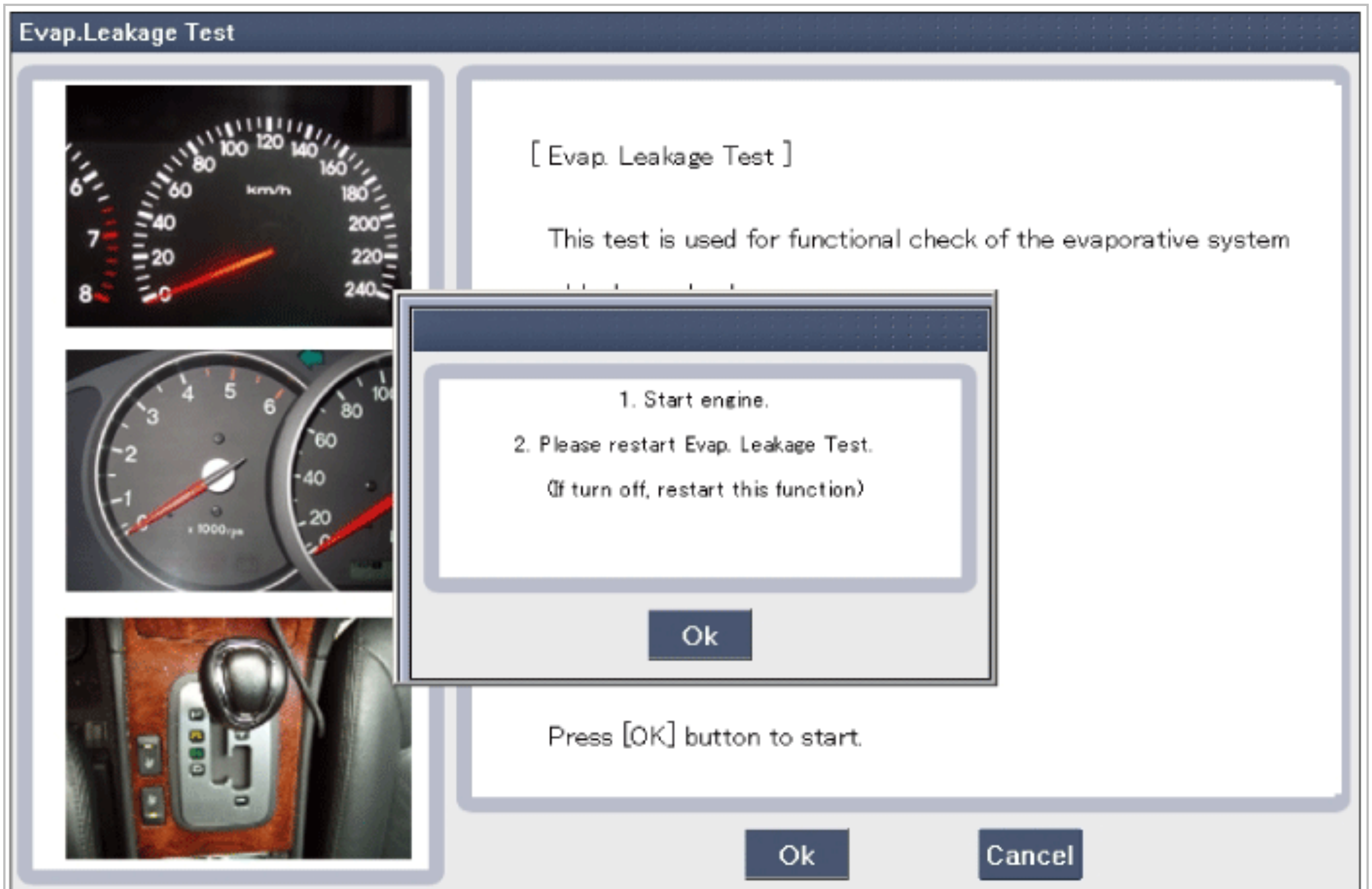


Fig.2

6. Is the same DTC set after the Evap.leakage test with GDS ?

YES	▶ Go to "System Inspection" procedure.
NO	▶ Repeat "Evap.leakage test" with GDS after cool the vehicle down sufficiently. If the same DTC isn't displayed after the test, it was intermittent fault. Go to "Verification of vehicle Repair" procedure.

System Inspection

■ Check Fuel Filler Cap

1. Check the Fuel Filler Cap is installed and properly tightened.
2. Check if the Fuel Filler Cap seal is missing or damaged.
3. Is the Fuel Filler Cap OK?

YES	▶ Go to "Check vapor hoses for leakage in fuel system" as below
NO	▶ Replace the Fuel Filler Cap and go to "Verification of Vehicle Repair" procedure.

■ Check vapor hoses for leakage in fuel system

1. Check vapor hoses between the following components for leakage:
   ▶ Intake manifoled ~ Purge control solenoid valve (PCSV)
   ▶ Purge control solenoid valve (PCSV) ~ Canister

- ▶ Canister ~ Canister close valve (CCV)
- ▶ Canister ~ fuel tank

2. Does a leak exist?

YES	▶ Repair or replace as necessary and then, go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check fuel filler pipe for crack or leakage" as below

■ Check fuel filler pipe for crack or leakage

1. Check that there is crack or leakage in fuel filler pipe
2. Is there any crack or leakage ?

YES	▶ Repair or replace as necessary and then, go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Component inspection" procedure.

Component Inspection

■ Check CCV for leakage

1. Disconnect the hose leading from the CCV to Canister at CCV.
2. Visually Check any tear of the hose leading from the CCV to Canister
3. When the CCV operates, apply a vacuum at the nipple and verify that the CCV holds vacuum.
4. Does a leak exist?

YES	▶ Repair or replace as necessary and then go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check Canister for leakage" as below

■ Check Canister for leakage

1. Disconnect the hose leading from the CCV to Canister at Canister.
2. When the other nipples are plugged, apply a vacuum at the vent nipple and verify that the Canister holds vacuum.
3. Does a leak exist?

YES	▶ Repair or replace as necessary and then go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check fuel tank for leakage" as below

■ Check fuel tank for leakage

1. Check fuel tank for crack or leakage.
2. Does a leak exist?

YES	▶ Repair or replace as necessary and then go to "Verification of Vehicle Repair" procedure.
NO	▶ Carefully perform this troubleshooting procedures all over again from the beginning.

Verification of Vehicle Repair

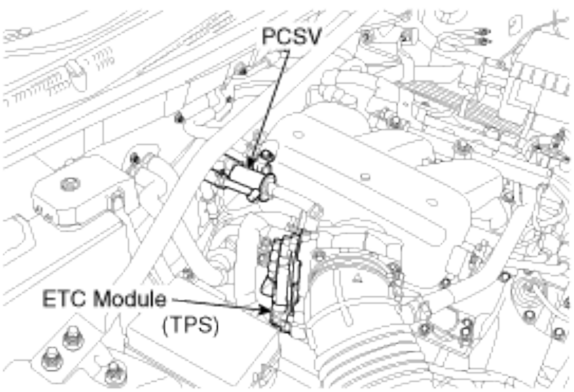
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0444 Evaporative Emission System-Purge Control Valve Circuit Open

Component Location



General Description

The evaporative emission control system prevents hydrocarbon (HC) vapors from the fuel tank from escaping into the atmosphere where they could form photochemical smog. Gasoline vapors are collected in the charcoal canister. The ECM controls the Purge Control Solenoid Valve (PCSV) to purge any collected vapors from the canister back to the engine for combustion. This valve is actuated by the purge control signal from the ECM and controls fuel vapor from the canister to the intake manifold.

DTC Description

Checking output signals from PCSV every 10 sec. under detecting condition, if signals indicating open or short to ground in the circuit are detected for more than 5 sec., ECM sets P0444. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

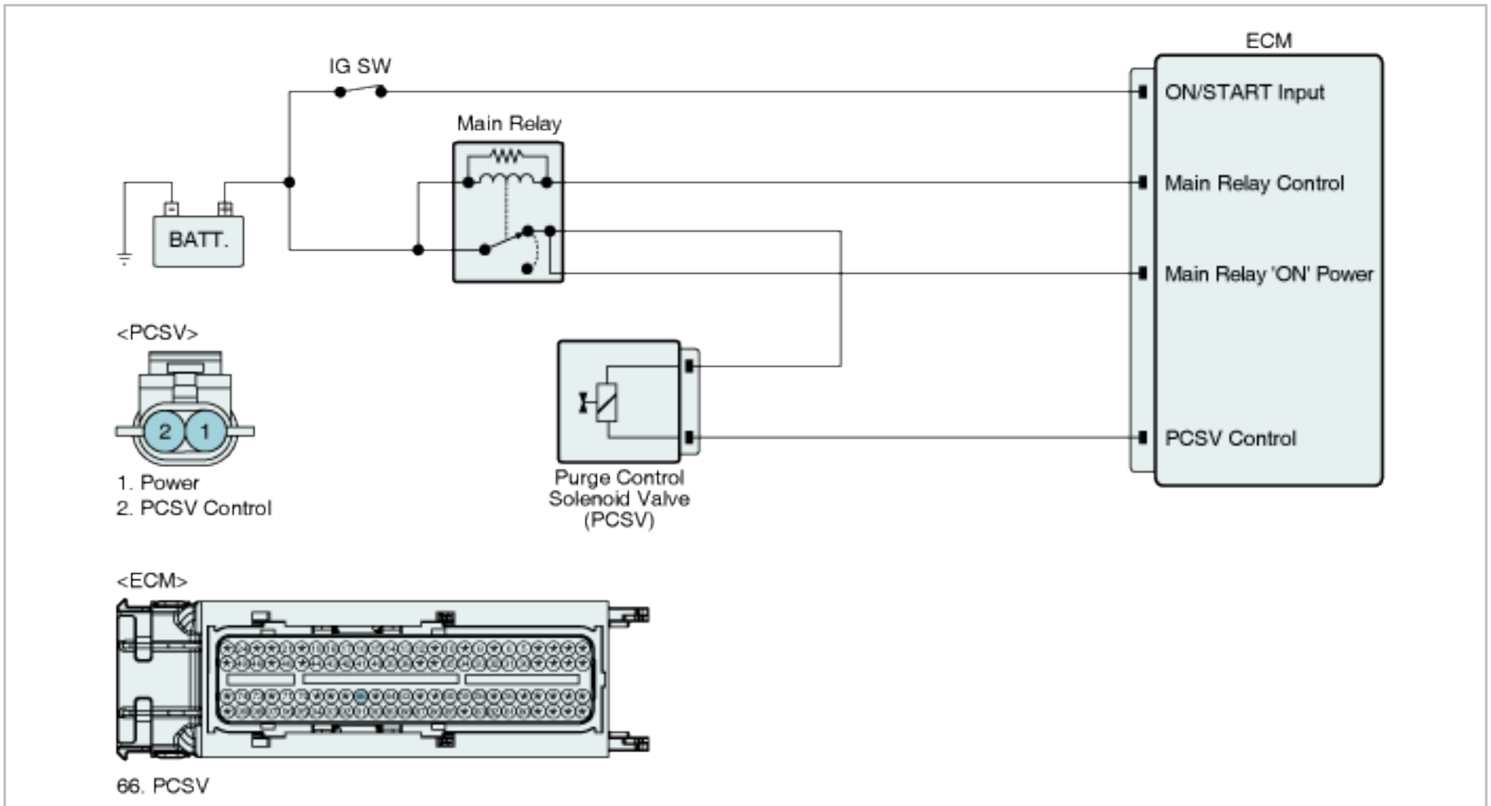
Item	Detecting Condition	Possible cause
DTC Strategy	• Open, short to ground	• Poor connection
Enable Conditions	• Engine running state • 11V ≤ Battery voltage ≤ 16V	

	• Above enable conditions are met > 0.5 sec.	• Open or short to ground in harness • PCSV • ECM
Threshold value	• Open or short to ground	
Diagnosis Time	• Continous (More than 5 sec.failure for every 10 sec.test)	
MIL On Condition	• 2 driving cycles	

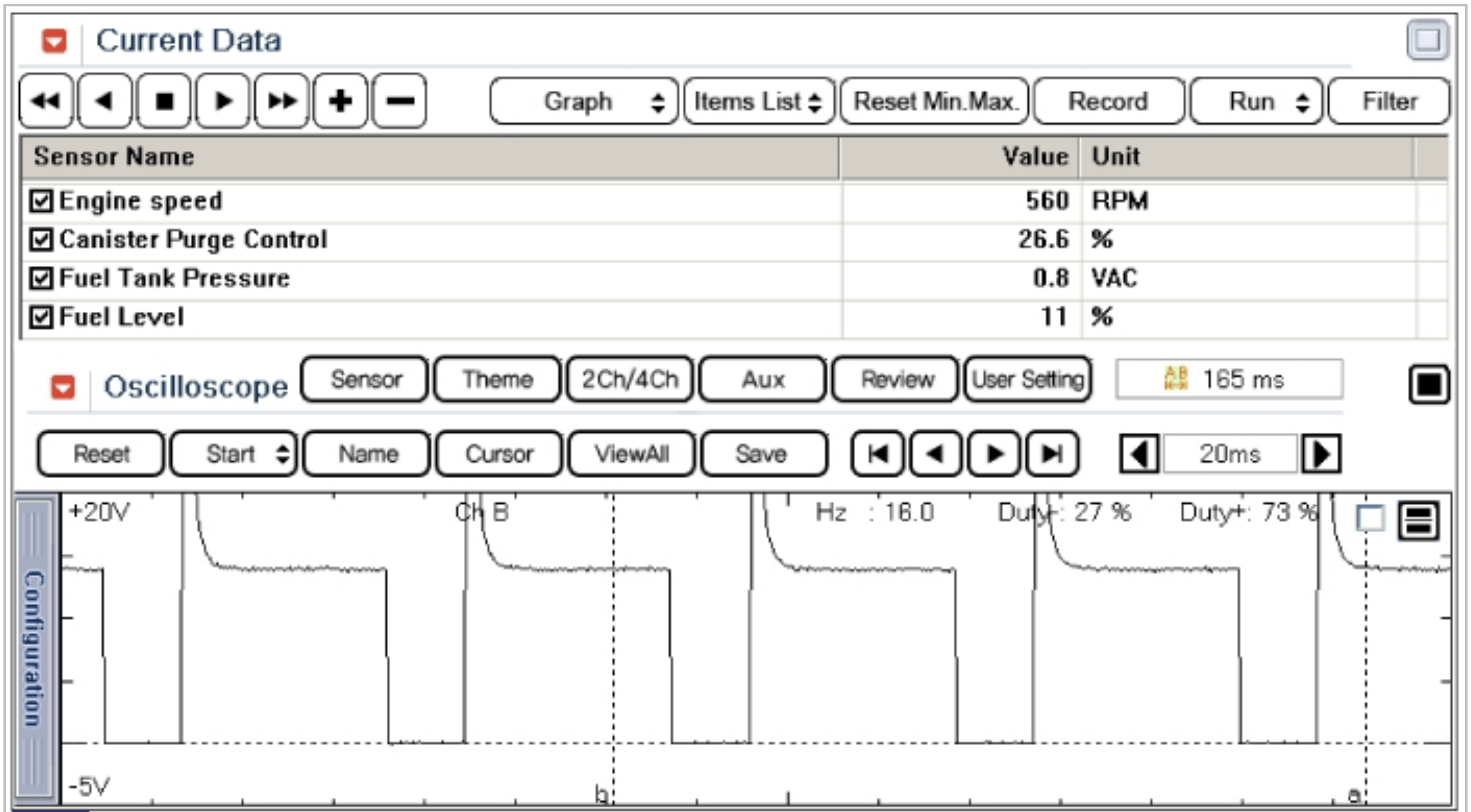
Specification

Item	Coil resistance(Ω)
PCSV	19.0 ~ 22.0Ω (at 20°C/ 68°F)

Diagnostic Circuit Diagram



Signal Waveform & Data



Sensor Name	Value	Unit
☑ Engine speed	560	RPM
☑ Canister Purge Control	26.6	%
☑ Fuel Tank Pressure	0.8	VAC
☑ Fuel Level	11	%

Fig.1

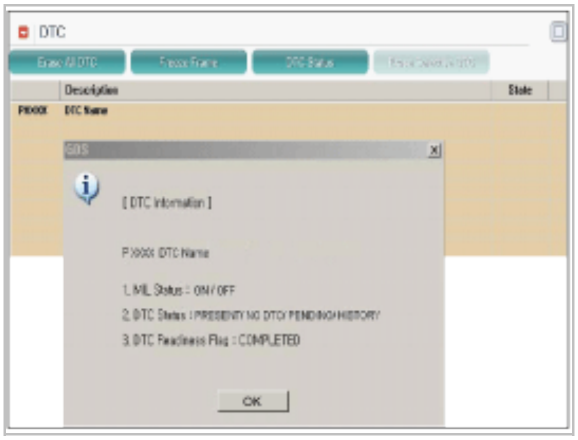
Sensor Name	Value	Unit
☑ Engine speed	600	RPM
☑ Canister Purge Control	8.2	%
☑ Fuel Tank Pressure	-0.5	VAC
☑ Fuel Level	11	%

Fig.2

Fig.1) Normal waveform of PCSV under 27% control condition.
Fig.2) Abnormal data of PCSV when PCSV circuit open. (data is changed 8.2% and 0% repeatedly)
The Purge Control Solenoid Valve(PCSV) is open or closed by ECM and vacuum of intake manifold.
At opening, fuel vapor from canister enters into intake manifold. To prevent vacuum from forming inside canister, ECM controls to open it. This photo shows the signal waveform of PCSV operating normally.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect PCSV connector.
2. IG "ON".
3. Measure voltage between control terminal of PCSV harness connector and chassis ground.

Specification : B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.
NO	▶ Repair open or short to ground inharness, and go to "Verification of Vehicle Repair" procedure.

Control Circuit Inspection

■ Check short to ground in harness

1. IG "OFF" and disconnect PCSV connector and ECM connector.
2. Measure resistance between control terminal of PCSV harness connector and chassis ground.

Specification : Infinite

3. Is the measured voltage within specification ?

YES	▶ Go to "Check open in harness" as follows.
NO	▶ Repair short to ground in harness, and go to " Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect PCSV connector and ECM connector.
2. Measure resistance between control terminal of PCSV harness connector and PCSV control terminal of ECM harness connector.

Specification : Below 1Ω

3. Is the measured resistance within specification?

YES	▶ Go to " Component Inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check PCSV

1. IG "OFF" and disconnect PCSV connector.
2. Measure resistance between power and control terminals of PCSV connector.(Component side)

Specification : 19.0 ~ 22.0Ω (at 20°C/ 68°F)

3. Is the measured siganl waveform normal?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good PCSV and check for proper operation. If the problem is corrected, replace PCSV and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

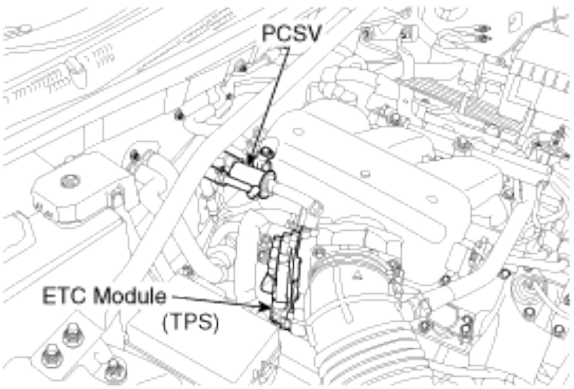
1. Connect GDS and select "DTC" button.

2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0445 Evaporative Emission System-Purge Control Valve Circuit Shorted

Component Location



General Description

The evaporative emission control system prevents hydrocarbon (HC) vapors from the fuel tank from escaping into the atmosphere where they could form photochemical smog. Gasoline vapors are collected in the charcoal canister. The ECM controls the Purge Control Solenoid Valve (PCSV) to purge any collected vapors from the canister back to the engine for combustion. This valve is actuated by the purge control signal from the ECM and controls fuel vapor from the canister to the intake manifold.

DTC Description

Checking output signals from PCSV every 10 sec. under detecting condition, if signals indicating short to battery in the circuit are detected for more than 5 sec., ECM sets P0445. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

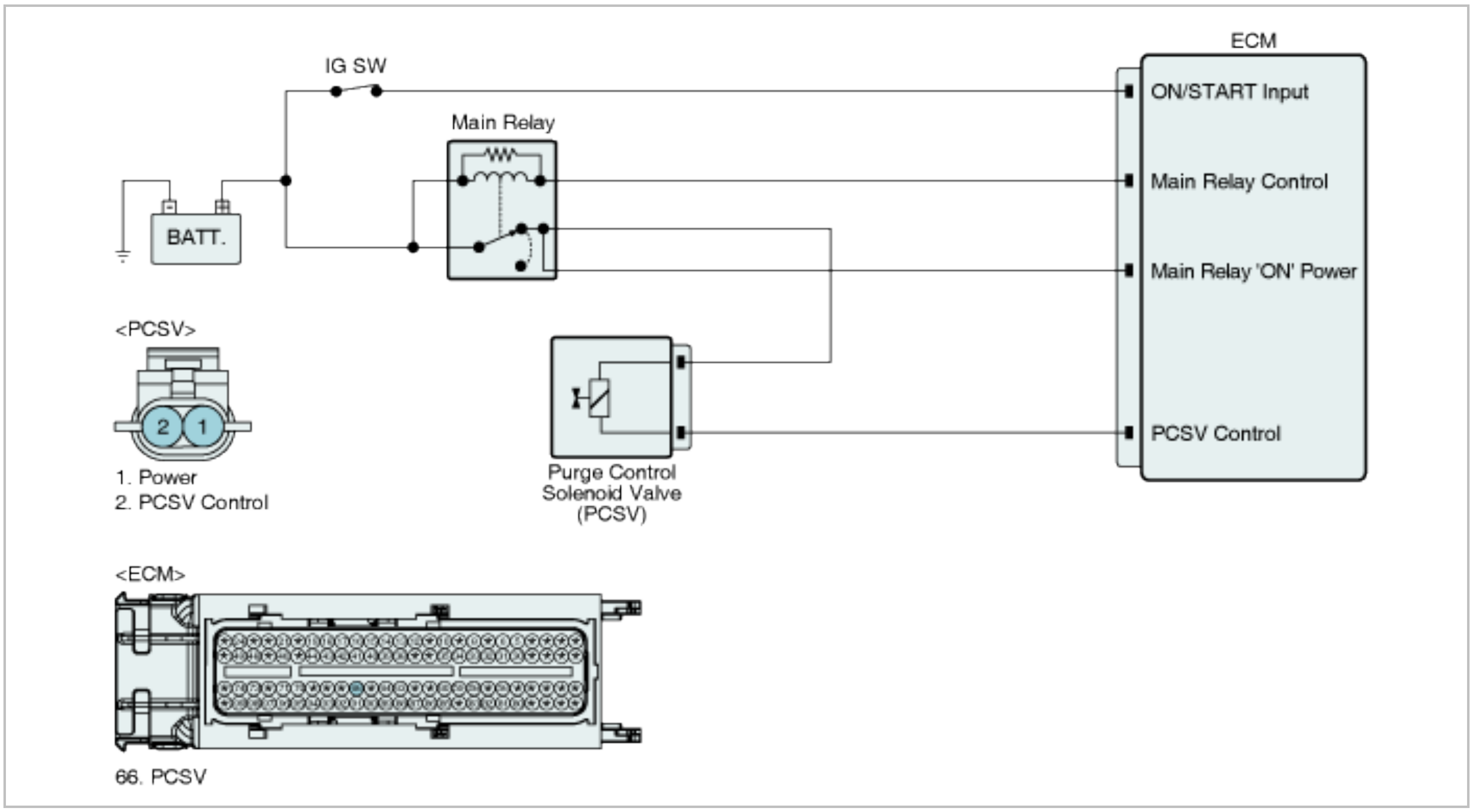
Item	Detecting Condition	Possible cause
DTC Strategy	• Short to battery	• Poor connection • Short to battery in harness • PCSV
Enable Conditions	• Engine running state • 11V ≤ Battery voltage ≤ 16V • Above enable conditions are met > 0.5 sec.	
Threshold value	• Short to battery	

Diagnosis Time	• Continous (More than 5 sec.failure for every 10 sec.test)	• ECM
MIL On Condition	• 2 driving cycles)	

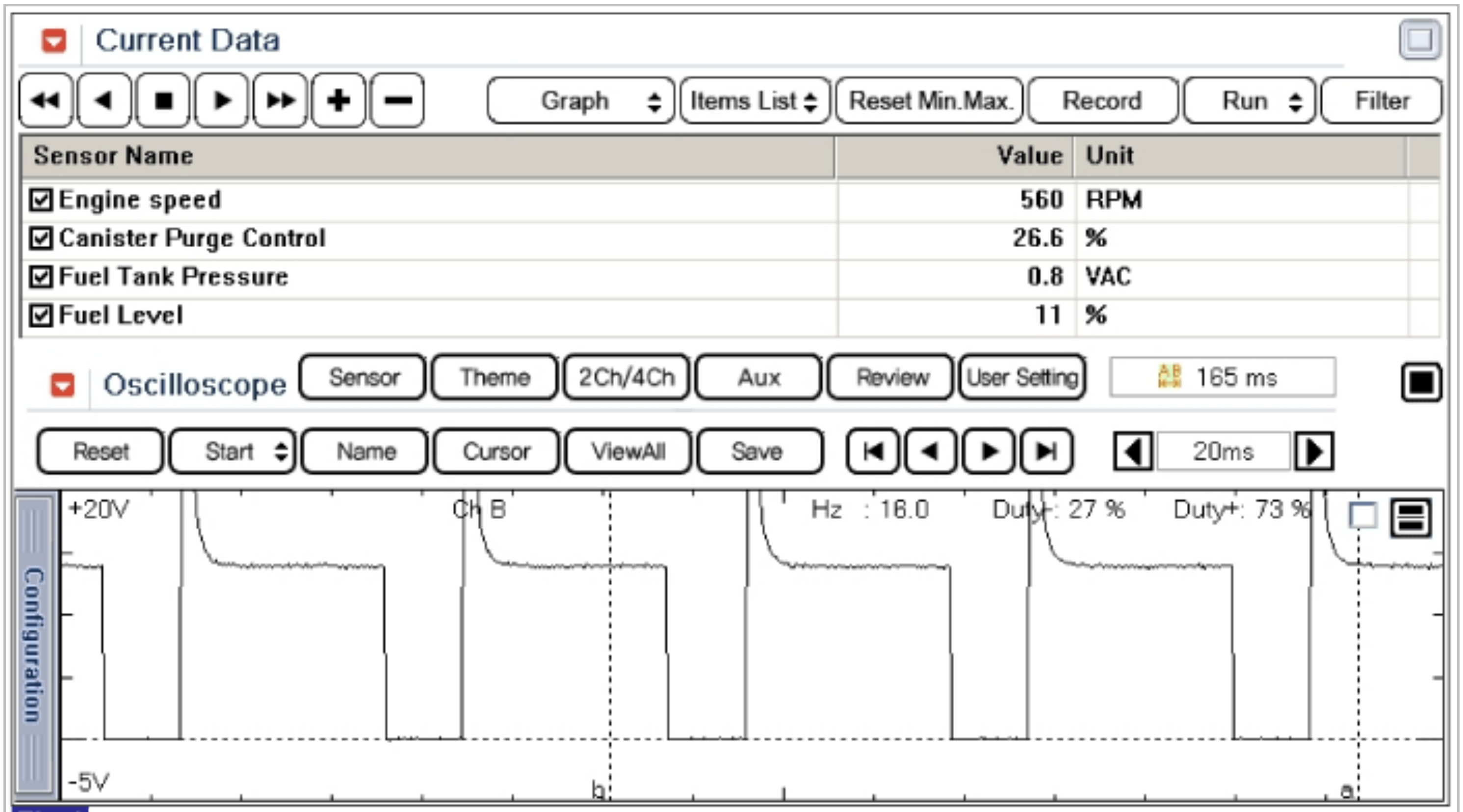
Specification

Item	Coil resistance(Ω)
PCSV	19.0 ~ 22.0Ω (at 20°C/ 68°F)

Diagnostic Circuit Diagram

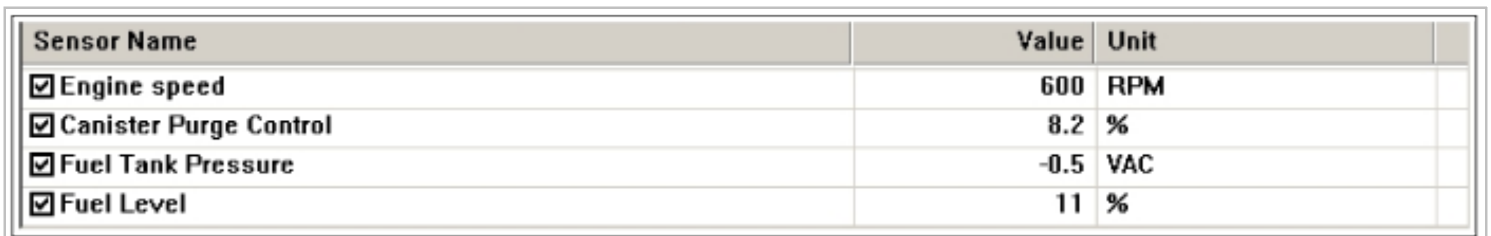


Signal Waveform & Data



Sensor Name	Value	Unit
Engine speed	560	RPM
Canister Purge Control	26.6	%
Fuel Tank Pressure	0.8	VAC
Fuel Level	11	%

Fig.1



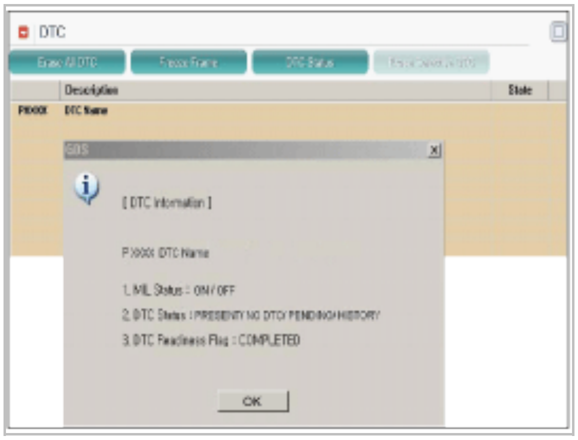
Sensor Name	Value	Unit
Engine speed	600	RPM
Canister Purge Control	8.2	%
Fuel Tank Pressure	-0.5	VAC
Fuel Level	11	%

Fig.2

Fig.1) Normal waveform of PCSV under 27% control condition.
Fig.2) Abnormal data of PCSV when PCSV circuit open. (data is changed 8.2% and 0% repeatedly)
The Purge Control Solenoid Valve(PCSV) is open or closed by ECM and vacuum of intake manifold.
At opening, fuel vapor from canister enters into intake manifold. To prevent vacuum from forming inside canister, ECM controls to open it. This photo shows the signal waveform of PCSV operating normally.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure
NO	▶ Go to " Control Circuit Inspection " procedure.

Control Circuit Inspection

■ Check short to battery in harness

1. IG "OFF" and disconnect PCSV connector.
2. IG "ON".
3. Measure voltage between control terminal of PCSV harness connector and chassis ground.

Specification : Approx.3.5 V

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to battery in harness, and go to " Verification of Vehicle Repair" procedure.

Component Inspection

■ **Check PCSV**

1. IG "OFF" and disconnect PCSV connector.
2. Measure resistance between power and control terminals of PCSV connector.(Component side)

Specification : 19.0 ~ 22.0Ω (at 20°C/ 68°F)

3. Is the measured siganl waveform normal?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE: There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good PCSV and check for proper operation. If the problem is corrected, replace PCSV and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

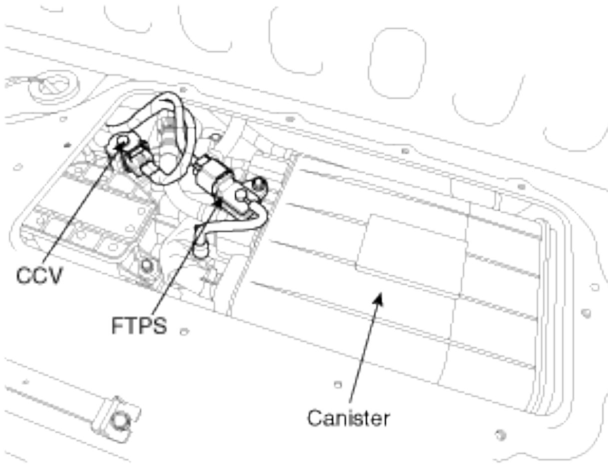
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0447 Evaporative Emission System-Vent Control Circuit Open

Component Location



General Description

The evaporative emissions system prevents hydrocarbon (HC) vapors from the fuel tank from escaping into the atmosphere where they could form photochemical smog. Gasoline vapors are collected in the charcoal canister. The Canister Closing Valve (CCV) closes off the air inlet into the canister for leak detection of the evaporative emission system. The CCV also prevents fuel vapors from escaping from the canister. When the engine purges the HC vapors from the canister, the clean air comes into the canister through the canister air-filter and the CCV.

DTC Description

Checking output signals from CCV every 10 sec. under detecting condition, if signals indicating open or short to ground in the circuit are detected for more than 5 sec., ECM sets P0447. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

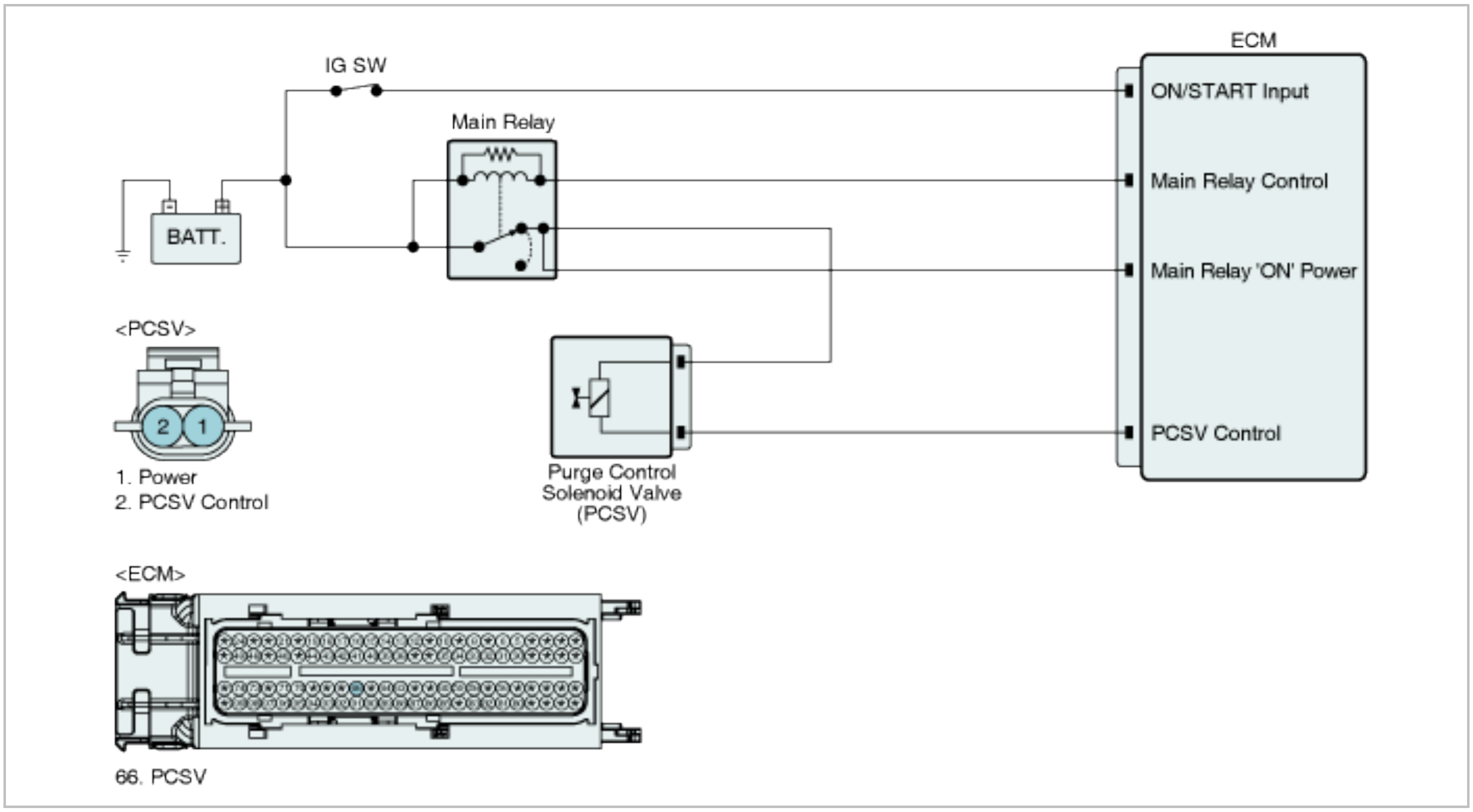
DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Detects a short to ground or open circuit	• Poor Connection • Open or Short in Power Circuit • Open or short in Control Circuit • CCV • ECM
Enable Conditions	• Engine Running • 11V ≤ Ignition Voltage ≤ 16V • Enable Time delay ≥ 0.5sec.	
Threshold value	• Open or short to ground	
Diagnosis Time	• Continous (More than 5 sec.failure for every 10 sec.test)	
MIL On Condition	• 2 driving cycles	

Specification

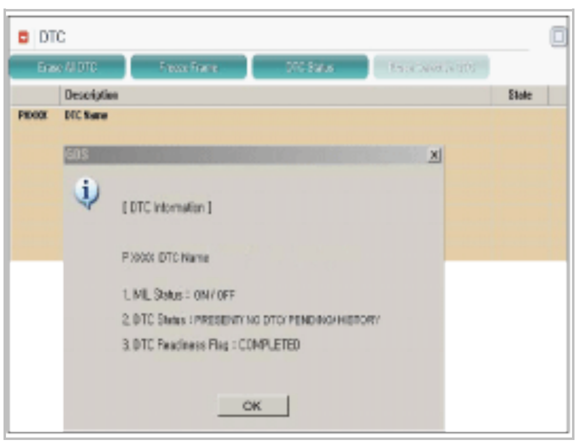
Item	Specification
Coil Resistance(Ω)	23.0 ~ 26.0 Ω (20°C/68°F)

Diagnostic Circuit Diagram



Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect CCV connector.
2. IG "ON".
3. Measure voltage between power terminal of CCV harness connector and chassis ground.

Specification : B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.
NO	▶ Check open or short to ground in harenss between control relay and CCV. ▶ Repair or replace as necessary and then, go to " Verification of Vehicle Repair" procedure.

Control Circuit Inspection

■ Check short to ground in harness

1. IG "OFF" and disconnect CCV connector and ECM connector.
2. Measure resistance between control terminal of CCV harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Check open in harness" as follows.
NO	▶ Repair short to ground in harness, and go to " Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect CCV connector and ECM connector.
2. Measure resistance between control terminal of CCV harness connector and CCV control terminal of ECM harness connector.

Specification : Below 1Ω

3. Is the measured resistance within specification?

YES	▶ Go to " Component Inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ **Check CCV**

1. IG "OFF" and disconnect CCV connector.
2. Measure resistance between power and control terminals of CCV connector.(Component side)

Specification : Approx. 15.5 ~ 18.5Ω (20°C(68°F))

3. Is the measured siganl waveform normal?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good CCV and check for proper operation. If the problem is corrected, replace CCV and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

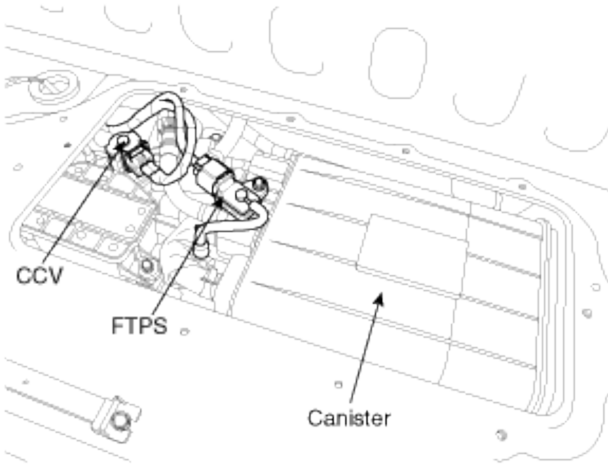
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0448 Evaporative Emission System - Vent Control Circuit Shorted

Component Location



General Description

The evaporative emissions system prevents hydrocarbon (HC) vapors from the fuel tank from escaping into the atmosphere where they could form photochemical smog. Gasoline vapors are collected in the charcoal canister. The Canister Closing Valve (CCV) closes off the air inlet into the canister for leak detection of the evaporative emission system. The CCV also prevents fuel vapors from escaping from the canister. When the engine purges the HC vapors from the canister, the clean air comes into the canister through the canister air-filter and the CCV.

DTC Description

Checking output signals from CCV every 10 sec. under detecting condition, if signals indicating short to battery in the circuit are detected for more than 5 sec., ECM sets P0448. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

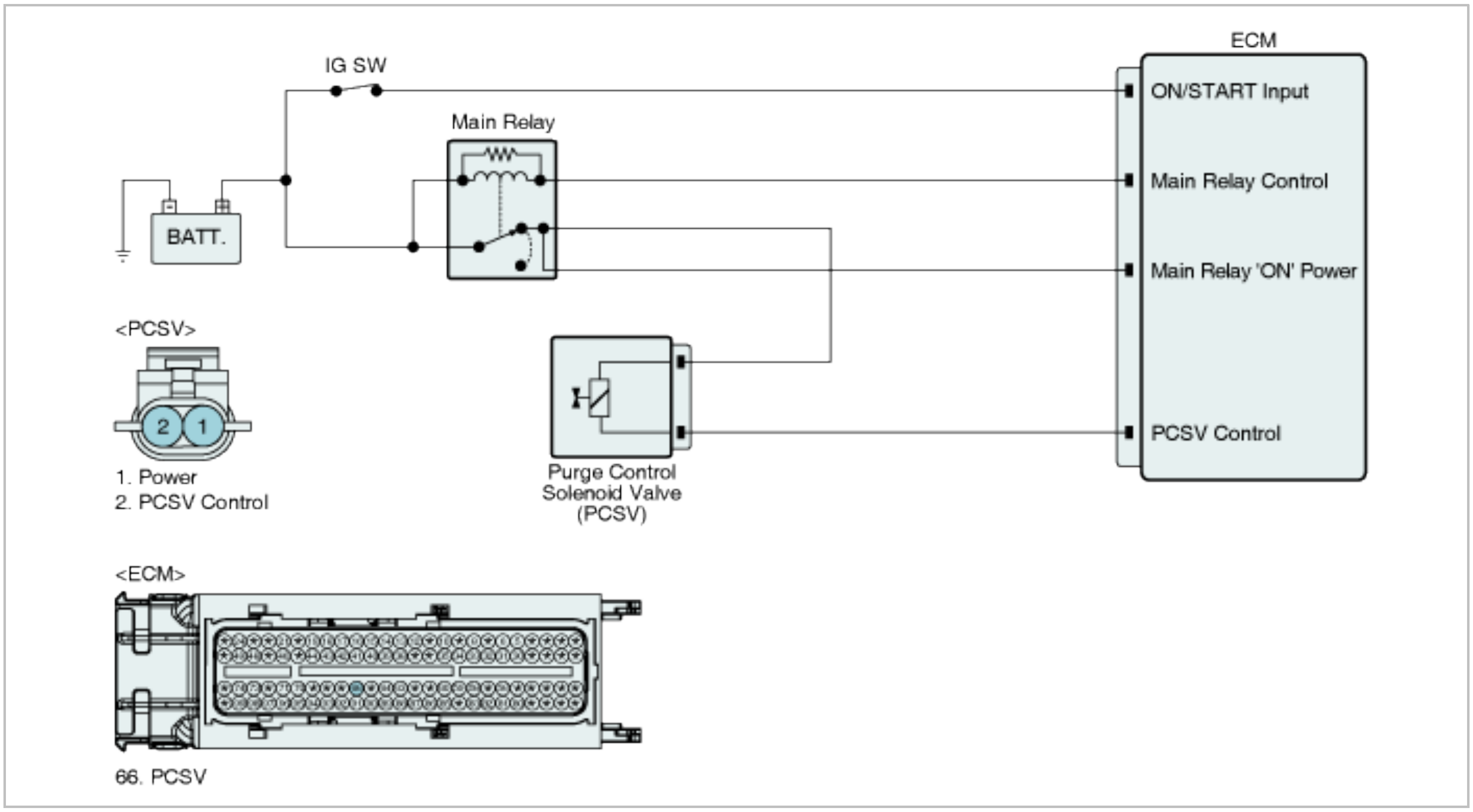
DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Detects a short to battery	• Poor connection • Short to battery in CCV circuit • Faulty CCV • Faulty ECM
Enable Conditions	• Engine Running • 11V ≤ Ignition Voltage ≤ 16V • Enable Time delay ≥ 0.5sec.	
Threshold value	• Short to battery	
Diagnosis Time	• Continous (More than 5 sec.failure for every 10 sec.test)	
MIL On Condition	• 2 driving cycles	

Specification

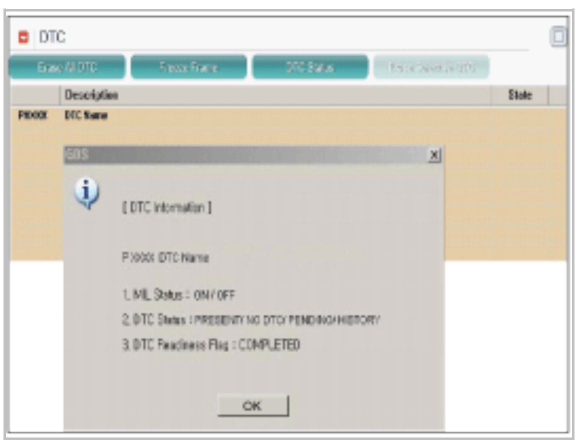
Item	Specification
Coil Resistance(Ω)	23.0 ~ 26.0 Ω (20°C/68°F)

Diagnostic Circuit Diagram



Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure
NO	▶ Go to " Control Circuit Inspection " procedure.

Control Circuit Inspection

■ Check short in harness

1. IG "OFF" and disconnect CCV connector.
2. Measure resistance between power and control terminals of CCV harness connector.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to " Component Inspection " procedure.
NO	▶ Repair short in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check CCV

1. IG "OFF" and disconnect CCV connector.
2. Measure resistance between power and control terminals of CCV connector.(Component side)

Specification : 23.0 ~ 26.0 Ω (20°C(68°F))

3. Is the measured siganl waveform normal?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good CCV and check for proper operation. If the problem is corrected, replace CCV and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

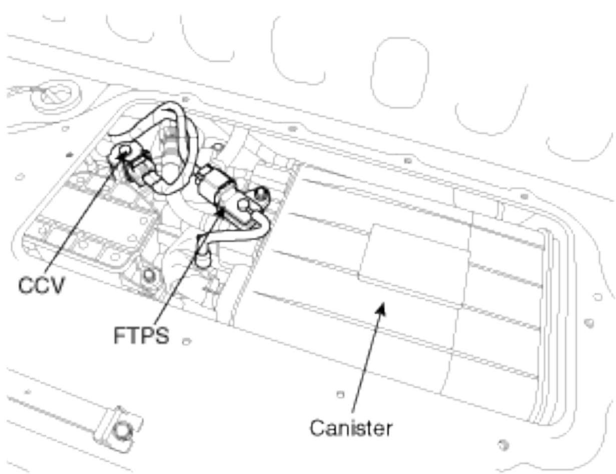
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0451 Evaporative Emission System-Pressure Sensor Range / Performance

Component Location



General Description

The evaporative emission control system prevents hydrocarbon vapors from escaping from the fuel tank into the atmosphere where they could form photochemical smog. Gasoline vapors are collected in the charcoal canister. The Fuel Tank Pressure Sensor (FTPS) is an integral part of the evaporative monitoring system. The ECM monitors the FTPS signal to detect vacuum decay and excess vacuum. The FTPS measures the difference between the air pressure inside the fuel tank and outside air pressure to check the purge control solenoid valve operation and for leak detection in the evaporative emission control system by monitoring pressure and vacuum levels in the fuel tank during the purge control solenoid valve operating cycles.

DTC Description

Checking output signals of tank pressure under detecting condition, if the tank pressure does not change less than 0.2(0.05V) within 3min. , ECM sets P0451. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

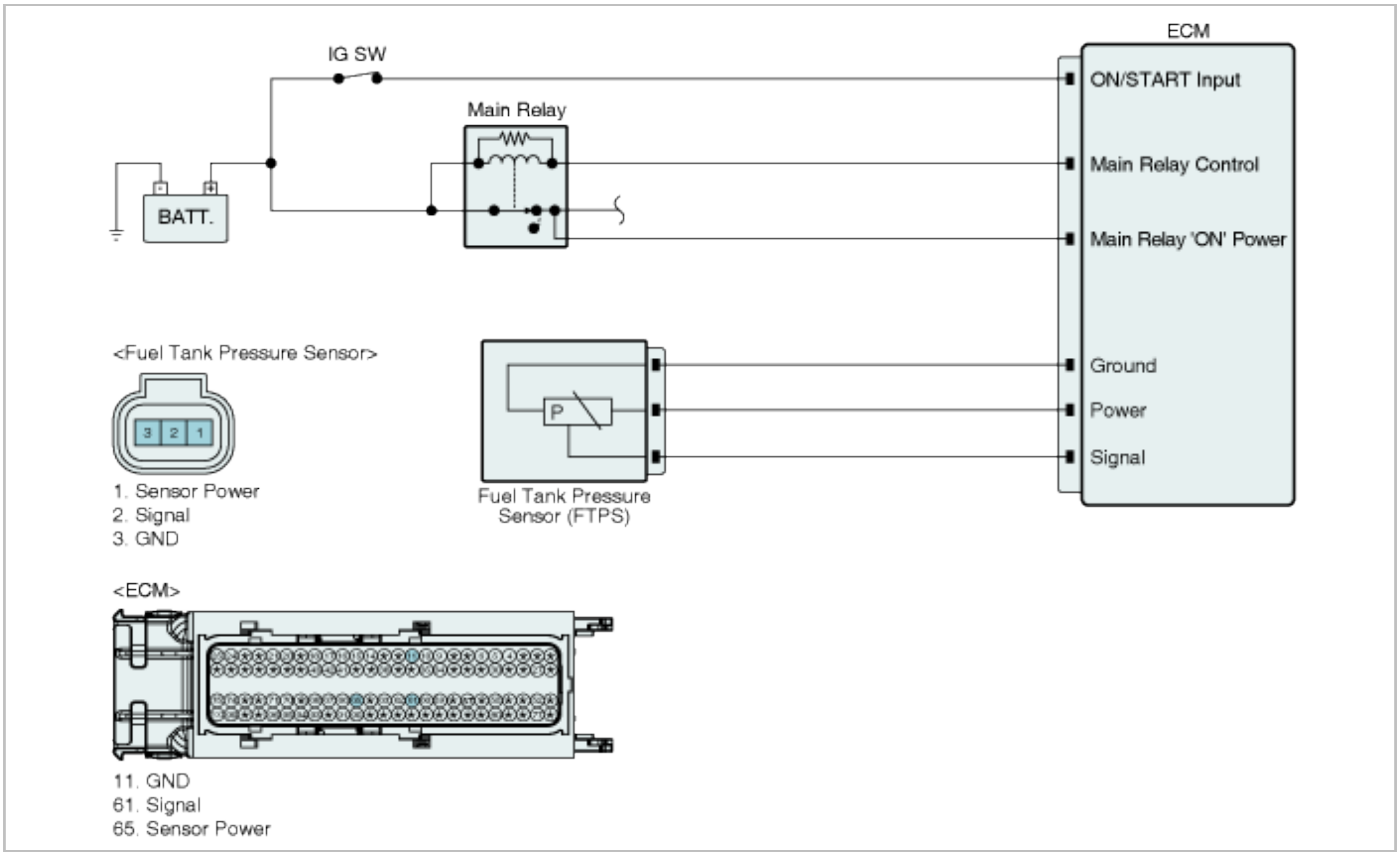
Item	Detecting Condition	Possible cause

DTC Strategy		• Continuously monitors the fuel tank pressure sensor output for a stuck condition	• Hose between Canister and Tank is not connected. • Faulty FTPS
Enable Conditions	Case 1	• Engine Coolant Temperature ≥ 60°C(Fully Warmed up state) • 600rpm < Engine Speed < 3000rpm	
	Case 2	• During the EVAP. Monitoring	
Threshold value	Case 1	• Pressure change in tank < 0.2 (0.05V)	
	Case 2	Before large leak monitoring has completed • Pressure sensor is detected as stuck • Pressure change in tank < 0.2 (0.05V)	
Diagnosis Time		• Continuous (Within 3min : Before EVAP. Monitoring has completed)	
MIL On Condition		• 2 Driving Cycles	

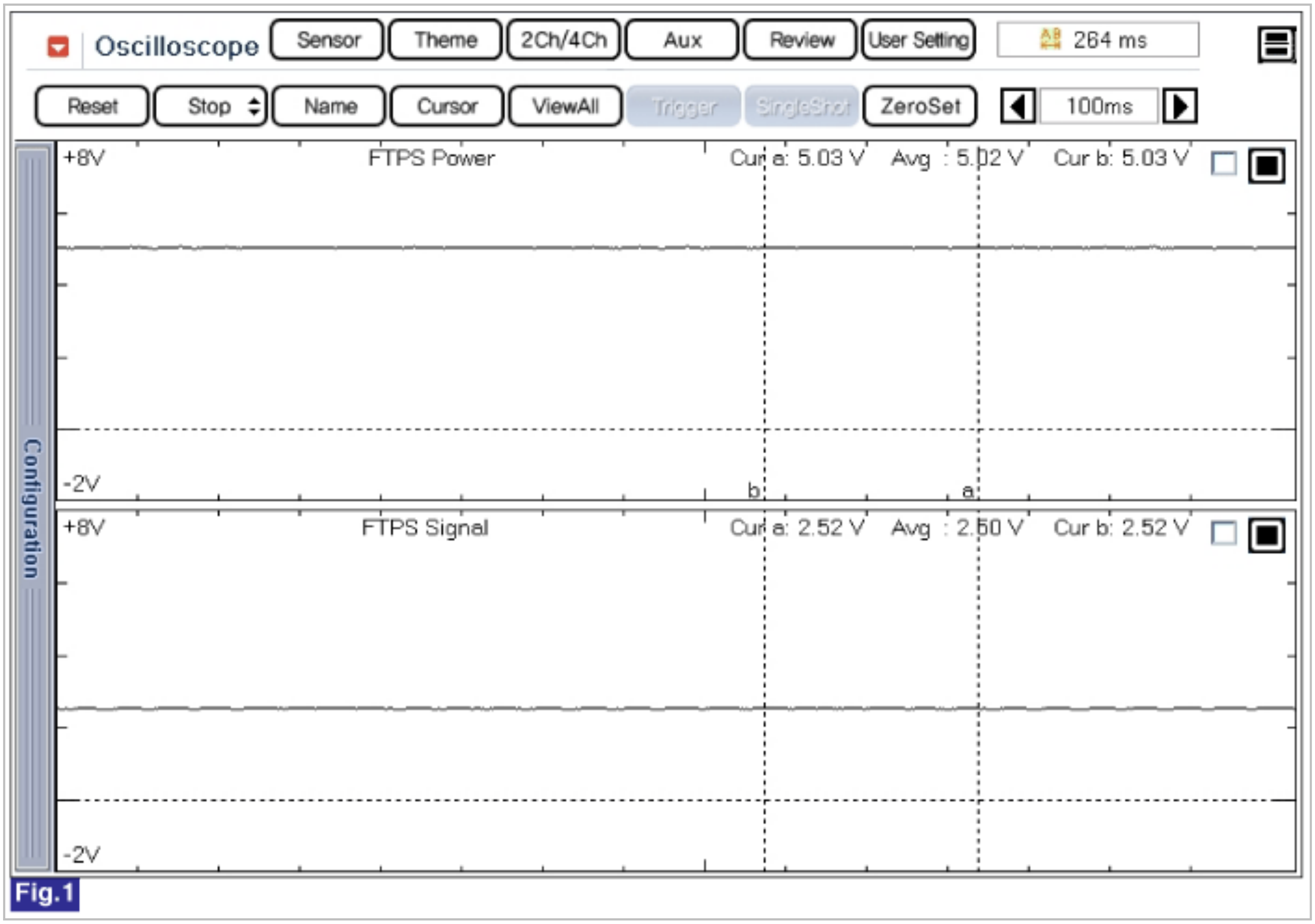
Specification

Pressure (kPa)	Output Voltage (V)
-6.67 (26.7VAC)	0.5
0	2.5
6.67 (-26.7VAC)	4.5

Diagnostic Circuit Diagram



Signal Waveform & Data



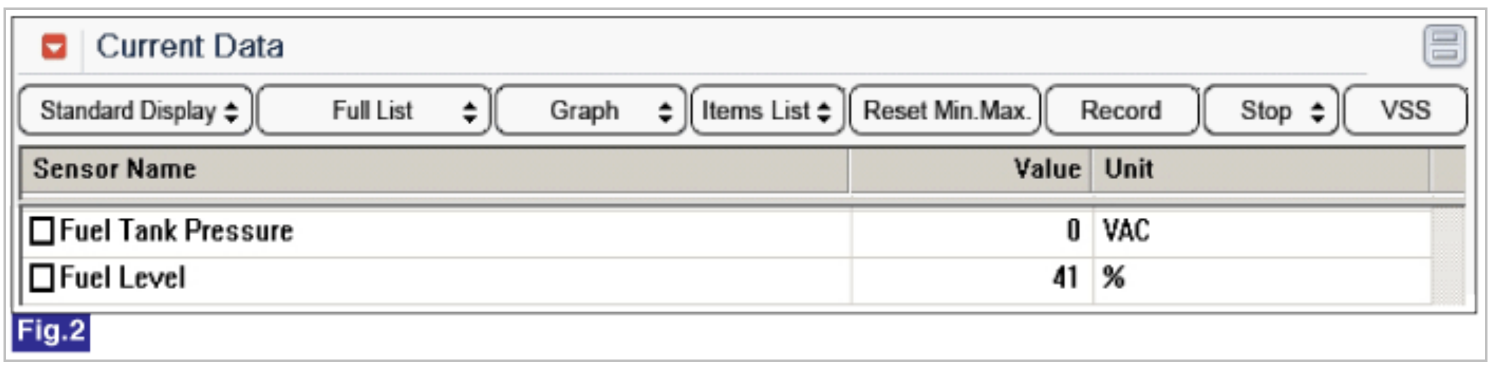
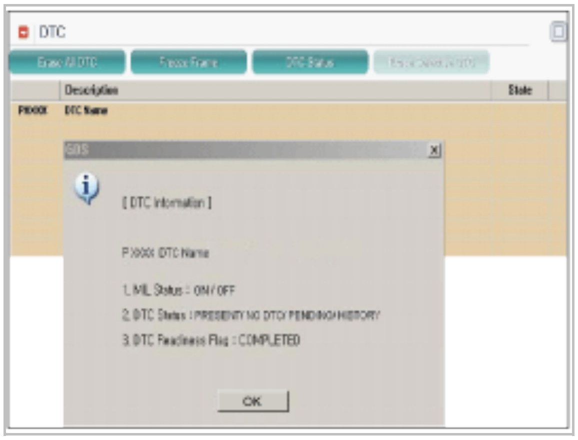


Fig.1) Normal waveform of FTPS at idle.
Fig.2) Normal data of FTPS at idle.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Check that hose between canister and tank is correctly connected or missing. Repair or replace as necessary and then, go to "Component Inspection" procedure.
NO	▶ Fault is intermittent caused by ECM memory was not cleared after repair. Erase DTC and go to " Verification of Vehicle Repair" procedure.

Component Inspection

1. IG "OFF" & connect GDS
2. ENG "ON" and Race the accelerator pedal at idle and Monitor "FTPS" parameter is changing while PCSV is operating on the service data.

Specification : Fuel Tank Pressure is O.K if pressure changes more than 0.2 while racing accelerator padal.

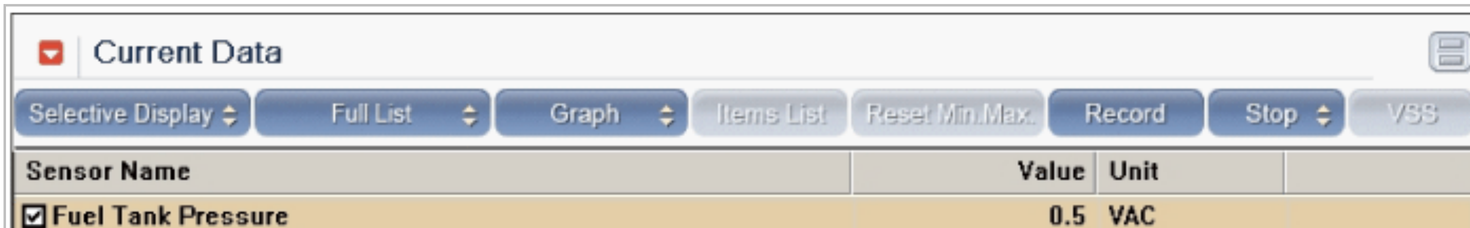


Fig.1

Fig.2

Fig.1) Sample data at idle with no acceleration (It can be different based on purging state)
Fig.2) Sample data at idle with acceleration (It can be different based on purging state)

3. Does the FTPS change while racing the accelerator pedal at idle ?

YES	▶ Fault is intermittent. Drive the vehicle to satisfy the enable codition then, go to "Verification of Vehicle Repair " procedure.
NO	▶ Substitute with a known - good FTPS and check for proper operation. If the problem is corrected, replace FTPS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

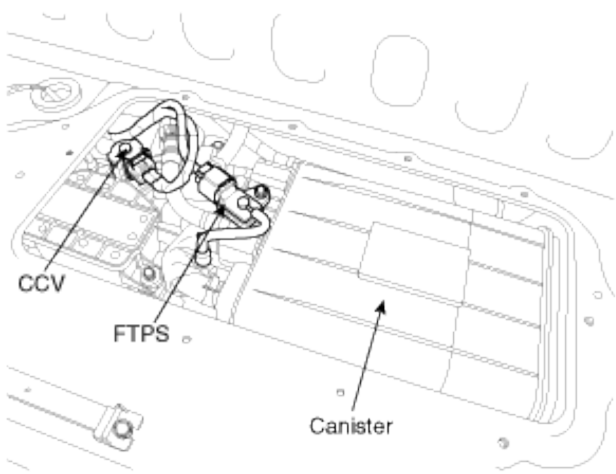
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0452 Evaporative Emission System-Pressure Sensor Low Input

Component Location



General Description

The evaporative emission control system prevents hydrocarbon vapors from escaping from the fuel tank into the atmosphere where they could form photochemical smog. Gasoline vapors are collected in the charcoal canister. The Fuel Tank Pressure Sensor (FTPS) is an integral part of the evaporative monitoring system. The ECM monitors the FTPS signal to detect vacuum decay and excess vacuum. The FTPS measures the difference between the air pressure inside the fuel tank and outside air pressure to check the purge control solenoid valve operation and for leak detection in the evaporative emission control system by monitoring pressure and vacuum levels in the fuel tank during the purge control solenoid valve operating cycles.

DTC Description

Checking output signals of fuel tank pressure sensor under detecting condition, if the tank pressure is lower than threshold, ECM sets P0452. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

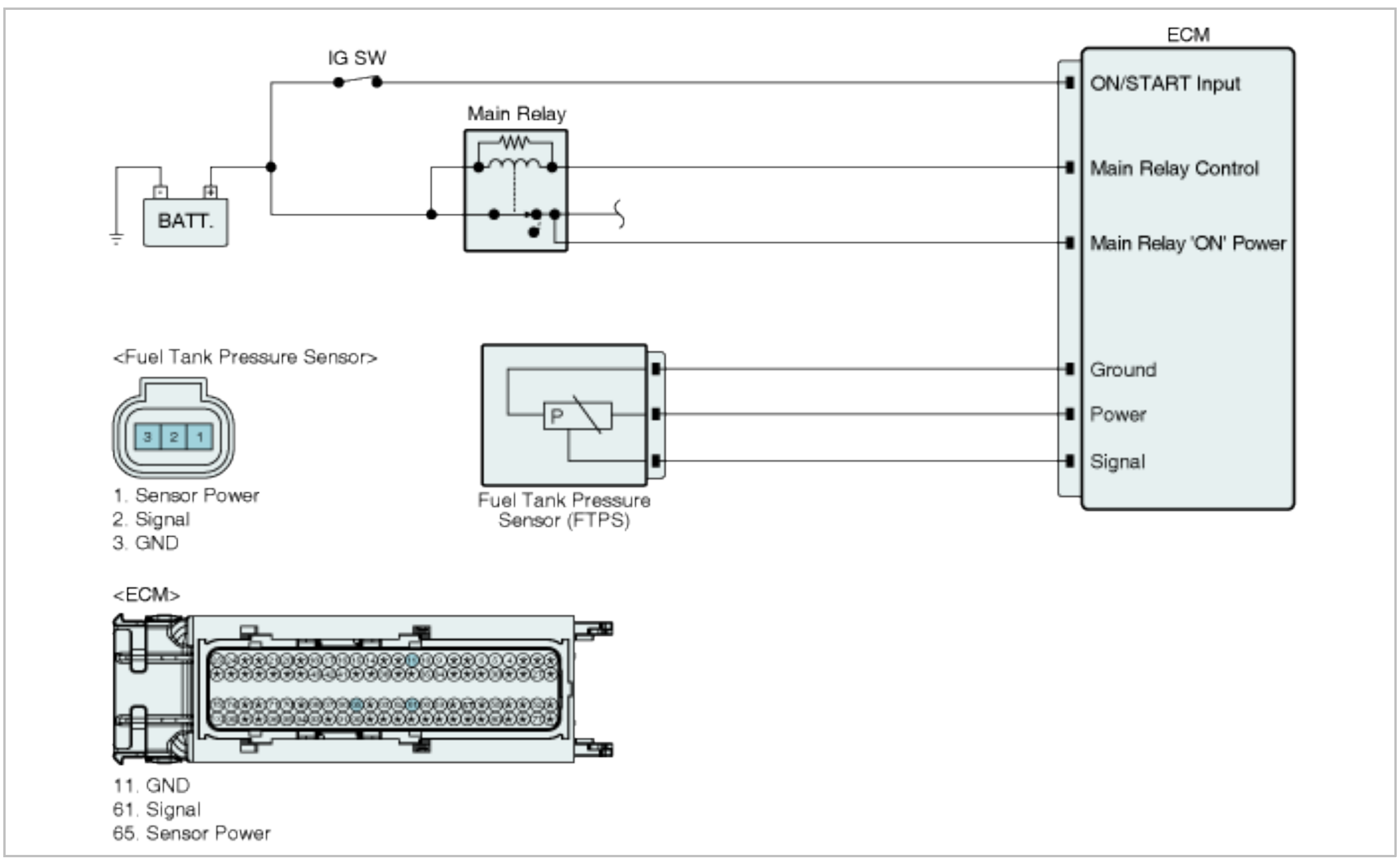
Item	Detecting Condition	Possible cause
DTC Strategy	• Detects the signal short to low voltage	• Poor connection

Enable Conditions	• Ignition ON	• Open in Power Circuit • Open or short to ground in signal Cirucit • Faulty FTPS • Faulty ECM
Threshold value	• Raw Tank Pressure < 0.086V	
Diagnosis Time	• Continuous	
MIL On Condition	• 2 driving cycles	

Specification

Pressure (kPa)	Output Voltage (V)
-6.67 (26.7VAC)	0.5
0	2.5
6.67 (-26.7VAC)	4.5

Diagnostic Circuit Diagram



Signal Waveform & Data

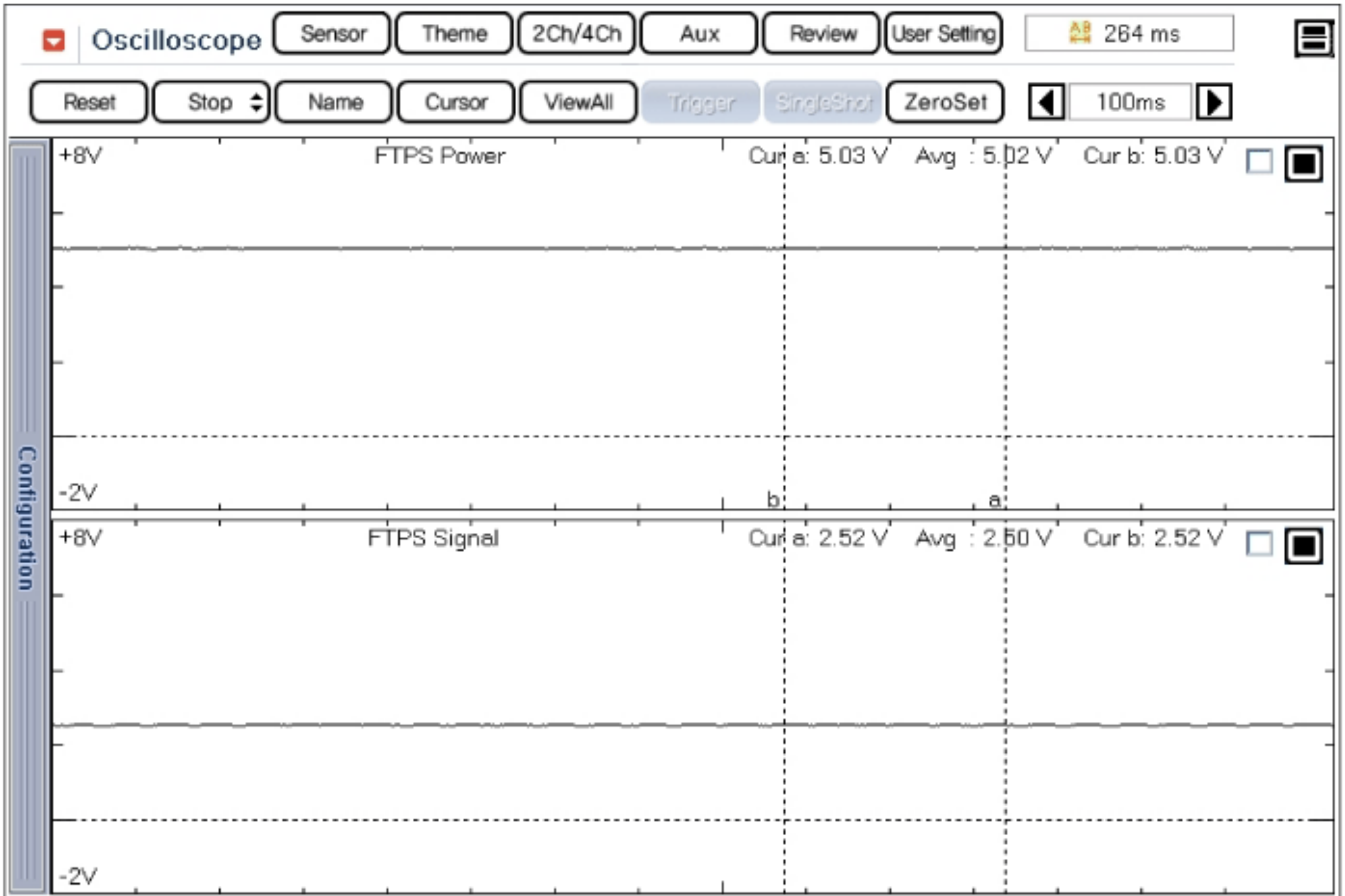


Fig.1

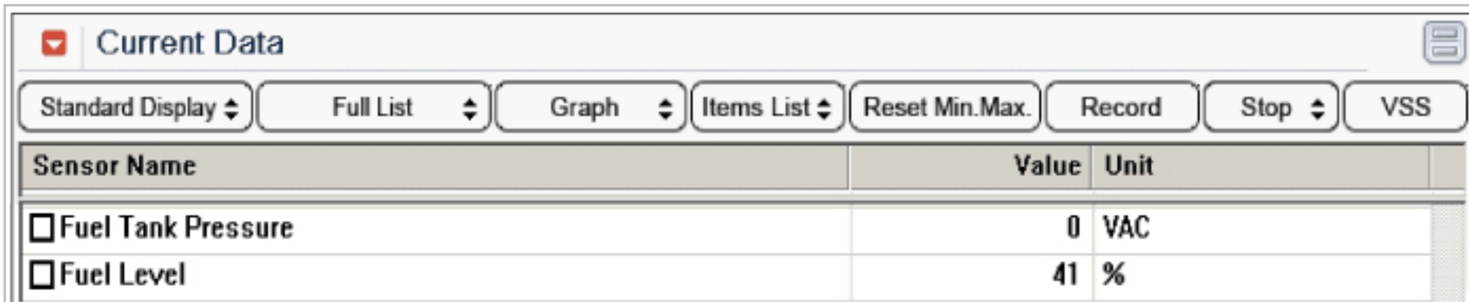
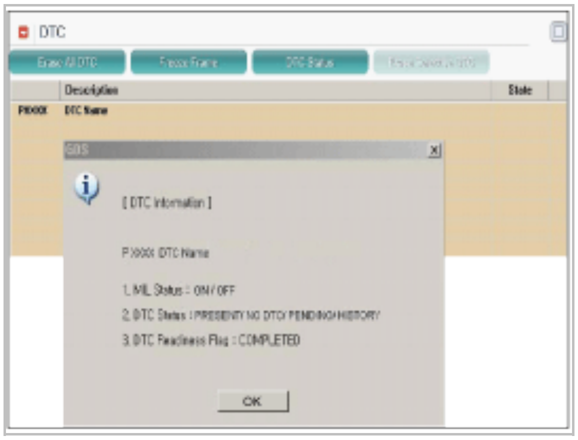


Fig.2

Fig.1) Normal waveform of FTPS at idle.
Fig.2) Normal data of FTPS at idle.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect FTPS connector.
2. IG "ON".
3. Measure voltage between power terminal of FTPS harness connector and chassis ground.

Specification : Approx. 5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Signal Circuit Inspection" procedure.
NO	▶ Repair open or short to ground in harness and go to "Verification of Vehicle Repair" procedure.

Signal Circuit Inspection

■ Check short to ground in harness

1. IG "OFF" and disconnect FTPS connector and ECM connector.
2. Measure the resistance between signal terminal of FTPS harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Check open in harness" as follows.
NO	▶ Repair short to ground in harness, and go to " Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect FTPS connector and ECM connector.
2. Measure the resistance between signal terminal of FTPS harness connector and FTPS signal terminal of ECM harness connector.

Specification : Below 1Ω

3. Is the measured resistance within specification?

YES	▶ Go to " Component Inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check FTPS

1. IG "OFF" and connect scatool to DLC(Data Link Connect).
2. Monitor "FTPS" parameter on service data.

Specification : Approx. 15.5 ~ 18.5Ω (20°C(68°F))

Pressure (kPa)	Output Voltage (V)
-6.67 (26.7VAC)	0.5
0	2.5
6.67 (-26.7VAC)	4.5

3. Is the "FTPS" parameter on the service data O.K ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM.Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good FTPS and check for proper operation. If the problem is corrected, replace FTPS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

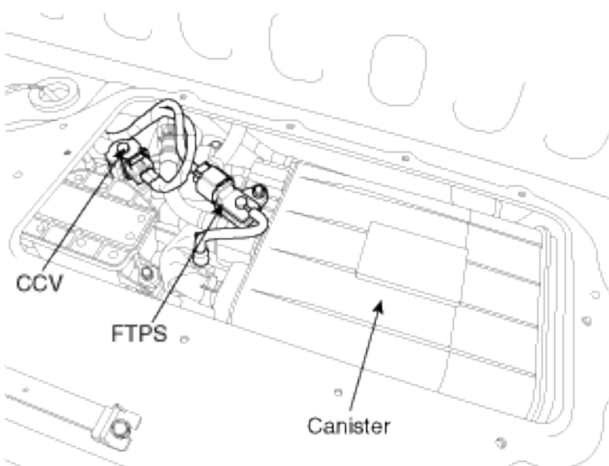
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0453 Evaporative Emission System-Pressure Sensor High Input

Component Location



General Description

The evaporative emission control system prevents hydrocarbon vapors from escaping from the fuel tank into the atmosphere where they could form photochemical smog. Gasoline vapors are collected in the charcoal canister. The Fuel Tank Pressure Sensor (FTPS) is an integral part of the evaporative monitoring system. The ECM monitors the FTPS signal to detect vacuum decay and excess vacuum. The FTPS measures the difference between the air pressure inside the fuel tank and outside air pressure to check the purge control solenoid valve operation and for leak detection in the evaporative emission control system by monitoring pressure and vacuum levels in the fuel tank during the purge control solenoid valve operating cycles.

DTC Description

Checking output signals of fuel tank pressure sensor under detecting condition, if the tank pressure is higher than threthold, ECM sets P0453. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

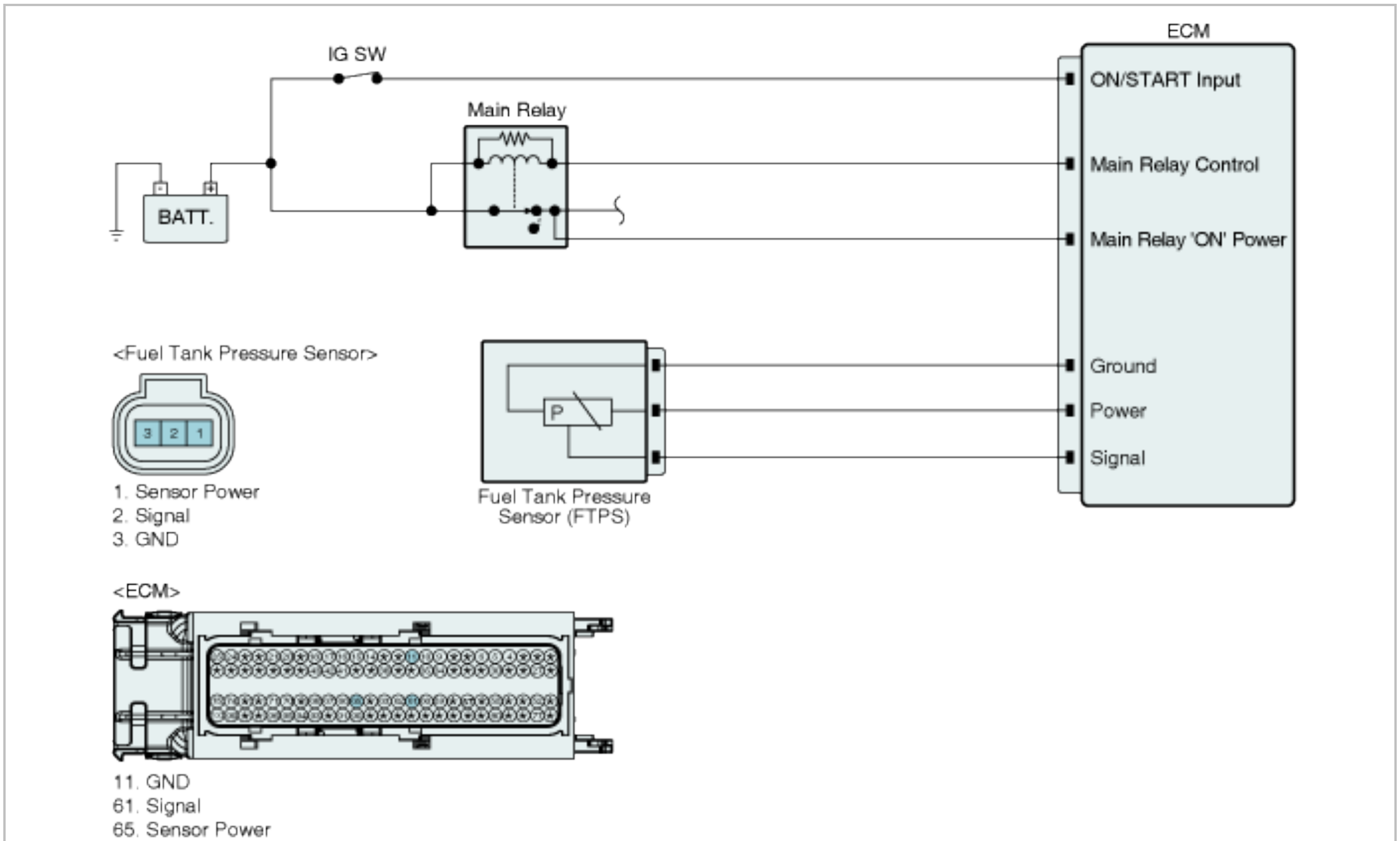
DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Detects short to high voltage	• Poor connection • Short to battery in signal Ciruict • Faulty FTPS • Faulty ECM
Enable Conditions	• Ignition ON	
Threshold value	• Raw Tank Pressure > 4.915V	
Diagnosis Time	• Continuous	
MIL On Condition	• 2 driving cycles	

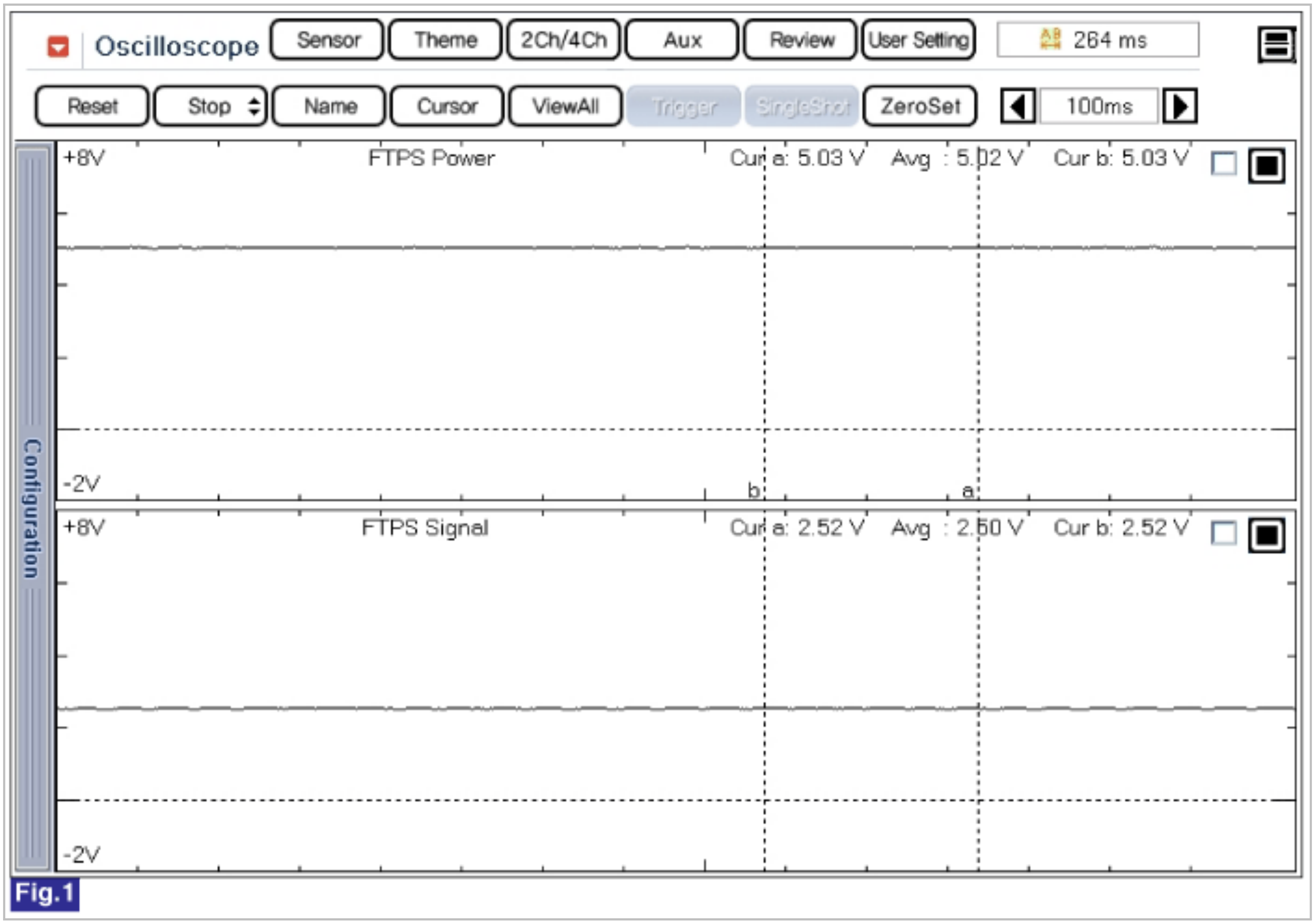
Specification

Pressure (kPa)	Output Voltage (V)
-6.67 (26.7VAC)	0.5
0	2.5
6.67 (-26.7VAC)	4.5

Diagnostic Circuit Diagram



Signal Waveform & Data



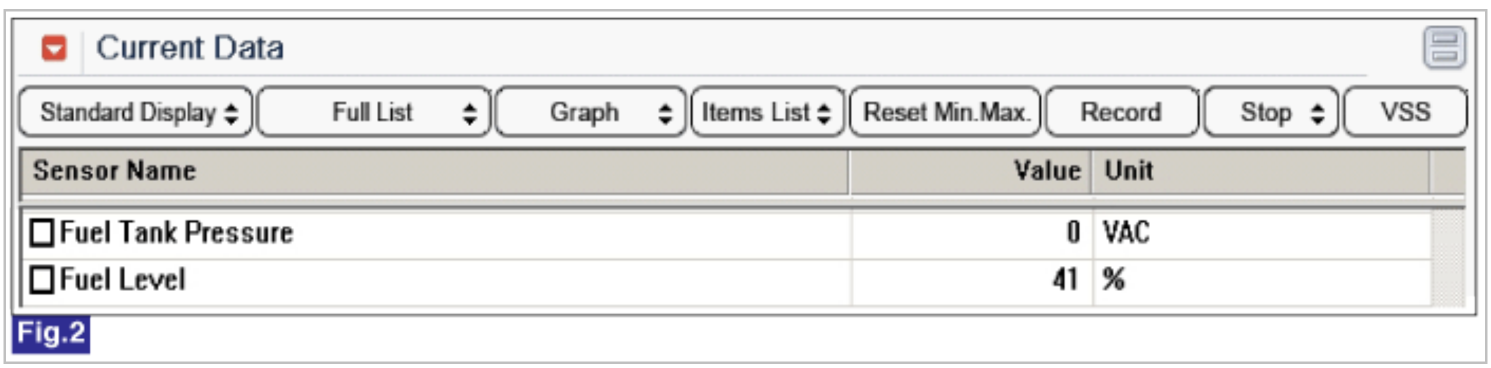
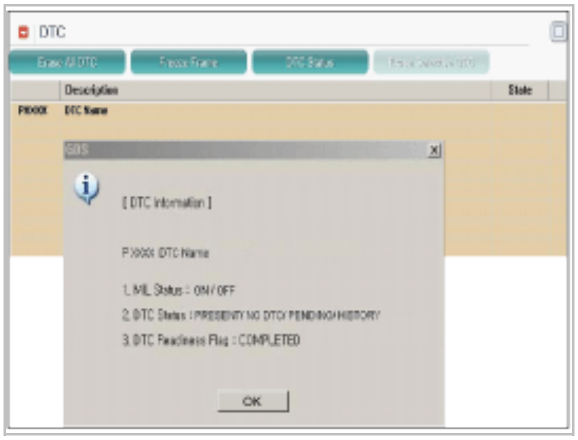


Fig.1) Normal waveform of FTPS at idle.
Fig.2) Normal data of FTPS at idle.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure
NO	▶ Go to " Ground Circuit Inspection " procedure.

Ground Circuit Inspection

■ **Check open in harness**

1. IG "OFF" and disconnect FTPS connector.
2. IG "ON".
3. Measure the voltage between power terminal of FTPS harness connector and chassis ground.(Measurement "A")
4. Measure the voltage between power and ground terminals of FTPS harness connector.(Measurement "B")

Specification : Approx. 5V

5. Is the measured voltage within specification ?

YES	▶ Go to "Signal Circuit Inspection" procedure.
NO	▶ Repair contact reistance or open in harness and then go to "Verification of Vehicle Repair" procedure.

Signal Circuit Inspection

■ Check short to battery in harness

1. IG "OFF" and disconnect FTPS connector and ECM connector.
2. Measure the resistance between signal and power terminals of FTPS harness connector.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to battery in harness, and go to " Verification of Vehicle Repair" procedure.

Component Inspection

■ Check FTPS

1. IG "OFF" and connect scatool to DLC(Data Link Connector).
2. Monitor "FTPS" parameter on service data.

Specification : Approx. 15.5 ~ 18.5Ω (20°C(68°F))

Pressure (kPa)	Output Voltage (V)
-6.67 (26.7VAC)	0.5
0	2.5
6.67 (-26.7VAC)	4.5

3. Is the "FTPS" parameter on the service data O.K ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on scantool that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good FTPS and check for proper operation. If the problem is corrected, replace FTPS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

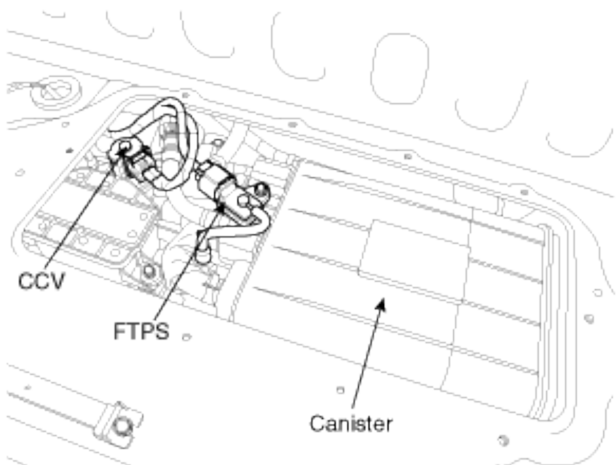
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.

4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0454 Evaporative Emission System-Pressure Sensor Intermittent

Component Location



General Description

The evaporative emission control system prevents hydrocarbon vapors from escaping from the fuel tank into the atmosphere where they could form photochemical smog. Gasoline vapors are collected in the charcoal canister. The Fuel Tank Pressure Sensor (FTPS) is an integral part of the evaporative monitoring system. The ECM monitors the FTPS signal to detect vacuum decay and excess vacuum. The FTPS measures the difference between the air pressure inside the fuel tank and outside air pressure to check the purge control solenoid valve operation and for leak detection in the evaporative emission control system by monitoring pressure and vacuum levels in the fuel tank during the purge control solenoid valve operating cycles.

DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Monitors the fuel tank pressure	• Poor connection • Faulty FTPS
Enable Conditions	• Engine Running • Intake Air Temperature ≥ -4°C(24.8 °F) • No Faults Present	
Threshold value	• Tank Pressure > 5.6 reading displaying on GDS	
Diagnosis Time	• Continuous (Within 10 sec.)	
MIL On Condition	• 2 driving cycles	

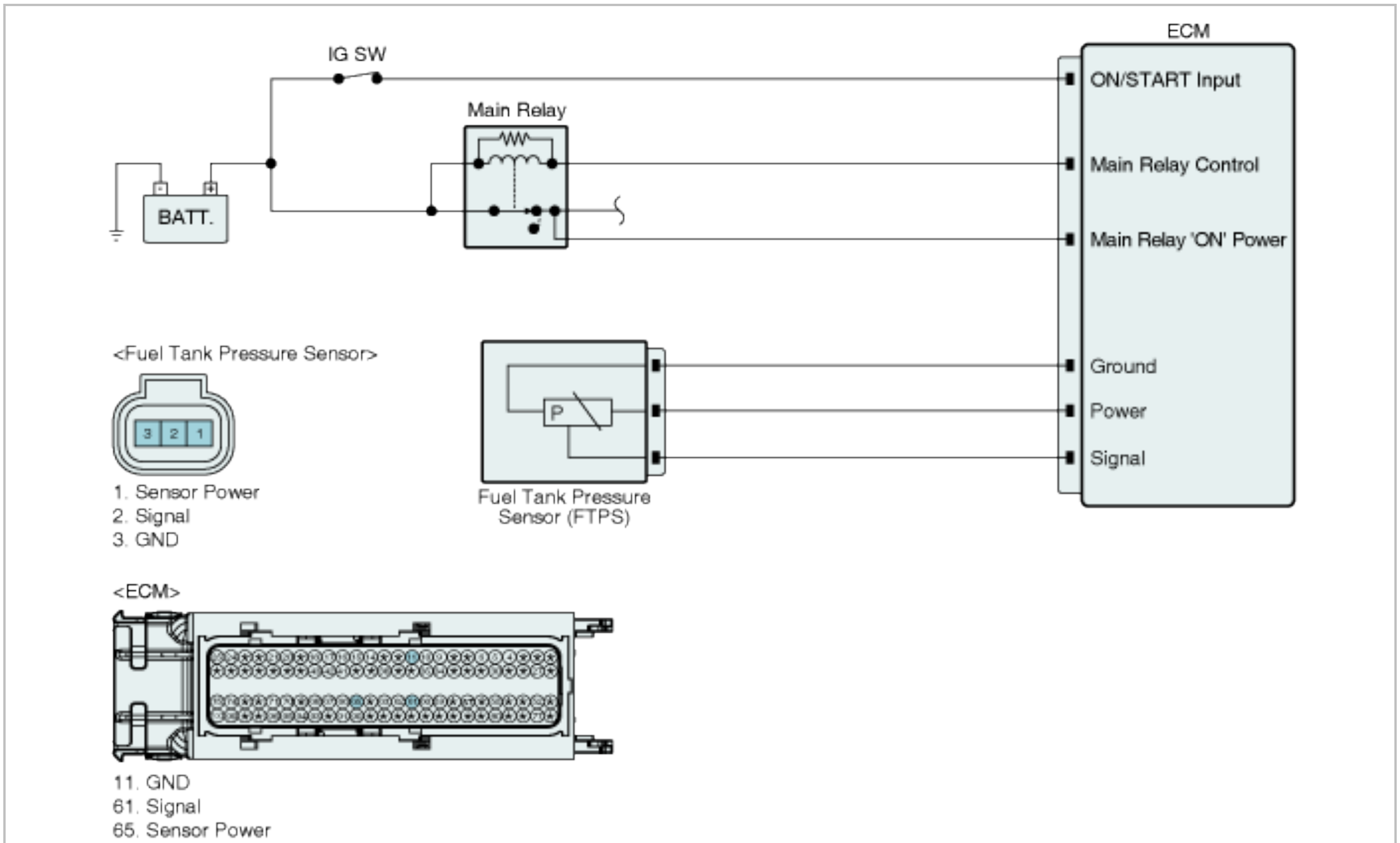
DTC Description

Checking output signals from FTPS under detecting condition, if the FTPS indicates pressure momentarily increased more than 5.6 reading displaying on scantool, ECM sets P0454. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

Specification

Pressure (kPa)	Output Voltage (V)
-6.67 (26.7VAC)	0.5
0	2.5
6.67 (-26.7VAC)	4.5

Diagnostic Circuit Diagram



Signal Waveform & Data

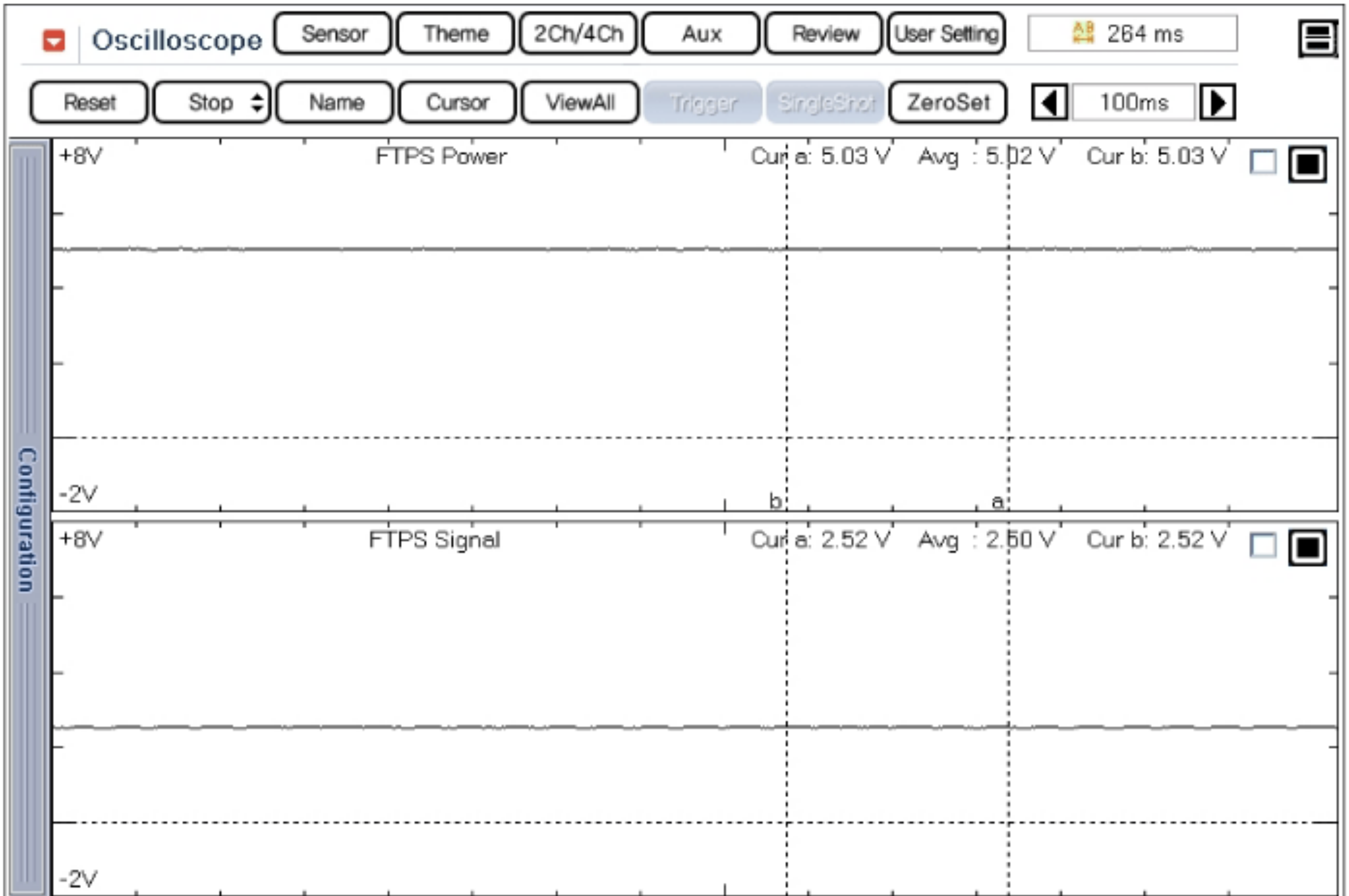


Fig.1

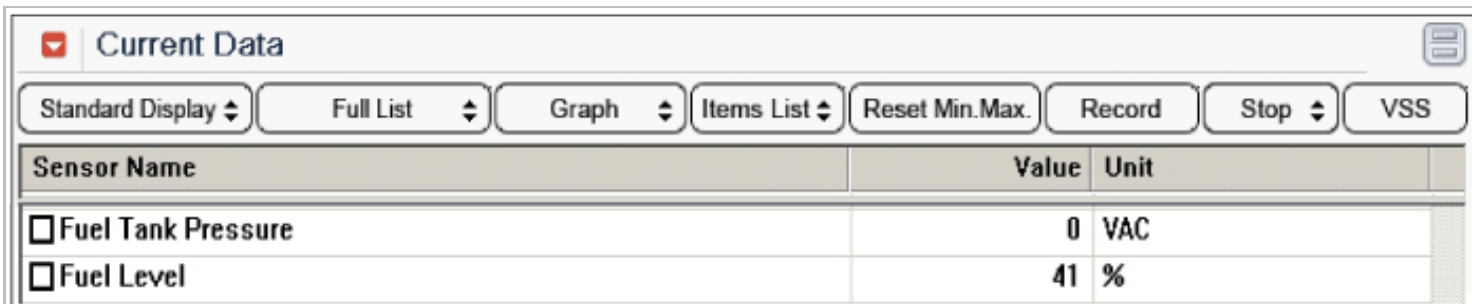
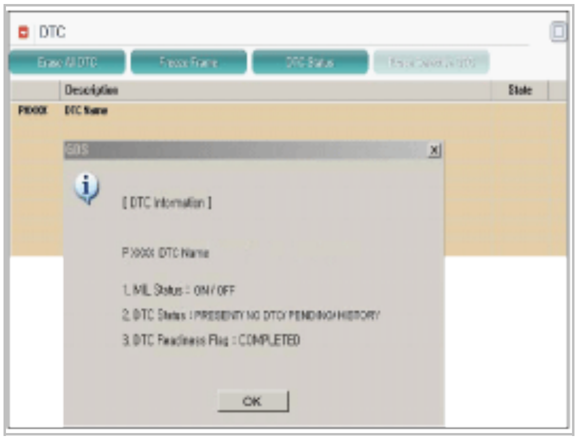


Fig.2

Fig.1) Normal waveform of FTPS at idle.
Fig.2) Normal data of FTPS at idle.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure
NO	▶ Go to " Component Inspection " procedure

Component Inspection

■ Check FTPS

1. IG "OFF" and connect scatool to DLC(Data Link Connector).
2. Monitor "FTPS" parameter on service data.

Specification : Approx. 15.5 ~ 18.5Ω (20°C(68°F))

Pressure (kPa)	Output Voltage (V)
-6.67 (26.7VAC)	0.5
0	2.5
6.67 (-26.7VAC)	4.5

3. Is the "FTPS" parameter on the service data O.K ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on scantool that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good FTPS and check for proper operation. If the problem is corrected, replace FTPS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0455 Evaporative Emission System-Leak detected(Large leak)

General Description

The evaporative emission control system prevents hydrocarbon (HC) vapors from the fuel tank from escaping into the atmosphere where they could form photochemical smog. Gasoline vapors are collected in the charcoal canister. The PCM controls the Purge Control Solenoid Valve (PCSV) to purge any collected vapors from the canister back to the engine for combustion. This valve is actuated by the purge control signal from the PCM and controls fuel vapor flow from the canister to the intake manifold.

DTC Description

Checking output signals from fuel tank pressure sensor under evap.system test, if fuel tank's vacuum is lower than prescribed threshold, PCM sets P0455 and then MIL(Malfunction Indication Lamp) turns on.

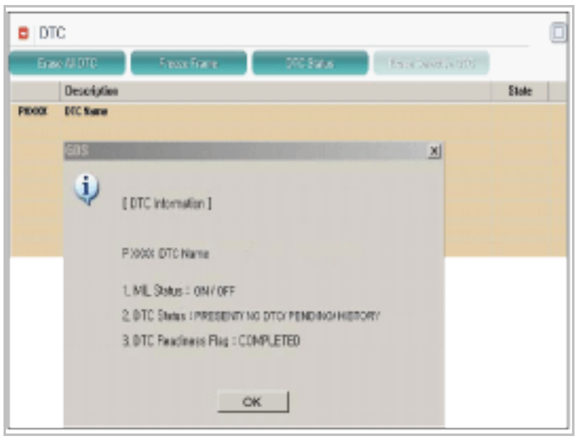
DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Monitor the fuel tank's vacuum	• Fuel Filler Cap missing • Leakage in each hose/fuel
	• 10 V < Battery voltage < 16 V • Barometric pressure > 72 kPa (0.72 bar) • Engine coolant temperature at startup - Intake air temperature at startup < 6.7°C(12 °F)	

Enable Conditions	• Engine coolant temperature at startup: 4.5 ~ 35°C(40 ~ 95 °F) • Intake air temperature at startup: 4.5 ~ 35°C(40 ~ 95 °F) • Fuel level: 15 ~ 85 %	filler pipe • Leakage in CCV/ Canister/ Fuel tank • Stuck in each purge hose/pipe between fuel tank and intake manifold
Threshold value	• Fuel tank's vacuum < a prescribed threshold	
Diagnosis Time	• One time during Evaporative system diagnosis	
MIL On Condition	• 1 driving cycle	

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Check the Fuel Filler Cap is installed. If not, after closing it, go to "Evap.Leakage Test" as below with GDS.
NO	▶ Go to "Evap.Leakage Test" as below with GDS.

■ Evap. Leakage Test

1. Cool the vehicle down for about two hours to prevent misdiagnosis.
2. Install GDS and IG "ON" and then clear DTC.
3. Select and press "EVAP.LEAKAGE TEST" mode in the GDS.
4. Check if the vehicle is under test conditions as below [Fig 1].
5. If OK, Start engine and restart Evap.Leakage Test again[Fig 2].

Evap.Leakage Test

[Evap. Leakage Test]

This test is used for functional check of the evaporative system and leakage check.

[Condition]

1. Ignition Key On, Engine Stop
2. No Trouble Code
3. Fuel Level : 15 ~ 85%
4. Select Lever Position : P Or N
5. ECT : 32 ~ 105'C (89.6 ~ 221'F)

Press [OK] button to start.

Ok   Cancel

Fig.1

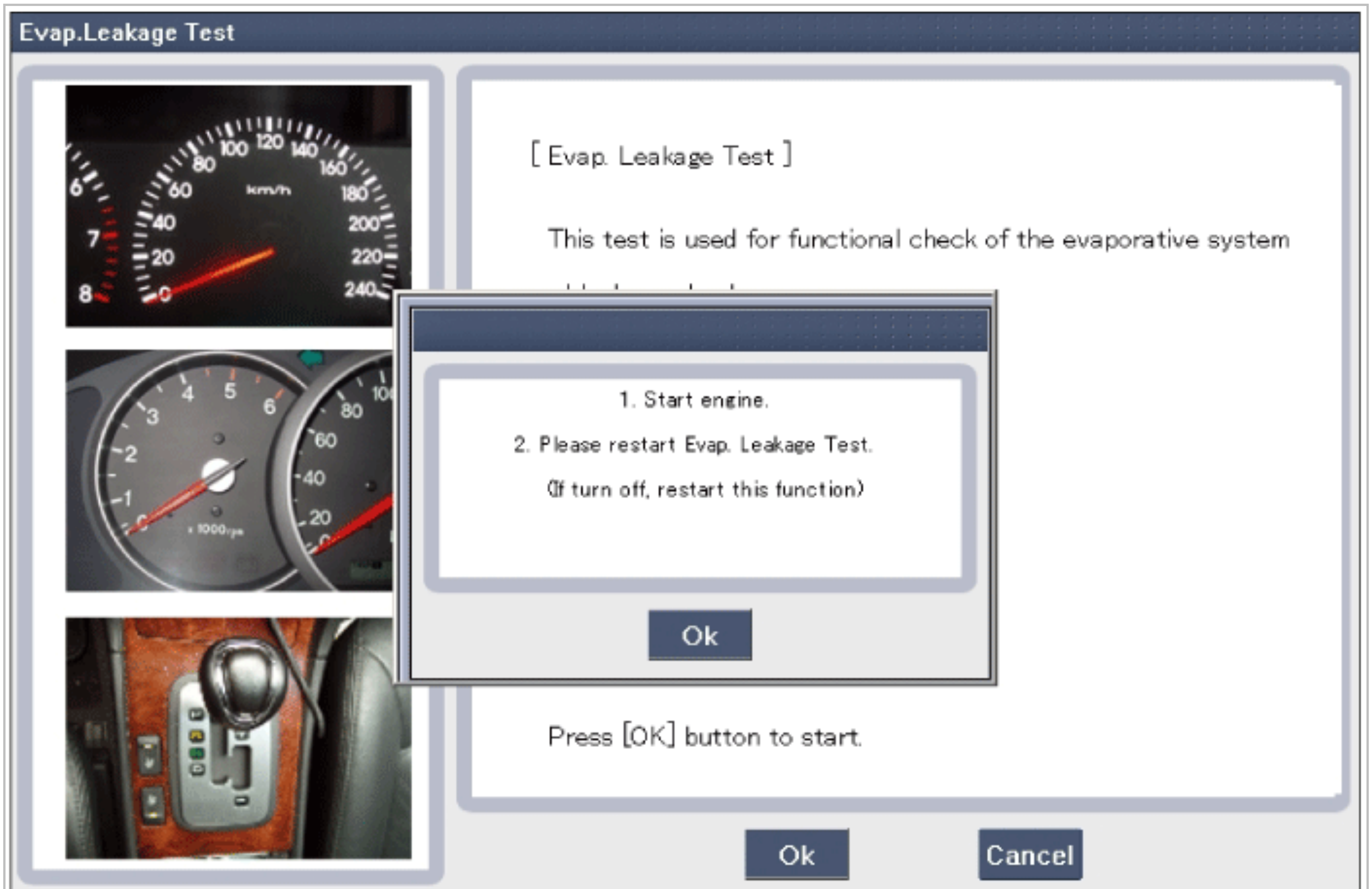


Fig.2

6. Is the same DTC set after the Evap.leakage test with GDS ?

YES	▶ Go to "System Inspection" procedure.
NO	▶ Fault is intermittent caused by the fuel cap missing and go to "Verification of vehicle Repair" procedure.

System Inspection

■ Check Fuel Filler Cap

1. Check the Fuel Filler Cap is installed and properly tightened.
2. Check if the Fuel Filler Cap seal is missing or damaged.
3. Is the Fuel Filler Cap OK?

YES	▶ Go to "Check vapor hoses for leakage in fuel system" as below
NO	▶ Replace the Fuel Filler Cap and go to "Verification of Vehicle Repair" procedure.

■ Check vapor hoses for leakage in fuel system

1. Check vapor hoses between the following components for leakage:
   ▶ Intake manifoled ~ Purge control solenoid valve (PCSV)
   ▶ Purge control solenoid valve (PCSV) ~ Canister
   ▶ Canister ~ Canister close valve (CCV)

▶ Canister ~ fuel tank

2. Does a leak exist?

YES	▶ Repair or replace as necessary and then, go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check vapor hoses for stuck in fuel system" as below.

■ Check vapor hoses for stuck in fuel system

1. Check vapor hoses between the following components for stuck:
   ▶ Intake manifoled ~ Purge control solenoid valve (PCSV)
   ▶ Purge control solenoid valve (PCSV) ~ Canister
   ▶ Canister ~ fuel tank
2. Does a leak exist?

YES	▶ Repair or replace as necessary and then, go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check fuel filler pipe for crack or leakage" as below.

■ Check fuel filler pipe for crack or leakage

1. Check that there is crack or leakage in fuel filler pipe.
2. Is there any crack or leakage ?

YES	▶ Repair or replace as necessary and then, go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Component inspection" procedure.

Component Inspection

■ Check CCV for leakage

1. Disconnect the hose leading from the CCV to Canister at CCV.
2. Visually Check any tear of the hose leading from the CCV to Canister
3. When the CCV operates, apply a vacuum at the nipple and verify that the CCV holds vacuum.
4. Does a leak exist?

YES	▶ Repair or replace as necessary and then go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check Canister for leakage" as below

■ Check Canister for leakage

1. Disconnect the hose leading from the CCV to Canister at Canister.
2. When the other nipples are plugged, apply a vacuum at the vent nipple and verify that the Canister holds vacuum.
3. Does a leak exist?

YES	▶ Repair or replace as necessary and then go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check fuel tank for leakage" as below

■ Check fuel tank for leakage

1. Check fuel tank for crack or leakage.
2. Does a leak exist?

YES	▶ Repair or replace as necessary and then go to "Verification of Vehicle Repair" procedure.
NO	▶ Carefully perform this troubleshooting procedures all over again from the beginning.

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0456 Evaporative Emission System-Leak detected (very small leak)

General Description

The evaporative emission control system prevents hydrocarbon (HC) vapors from the fuel tank from escaping into the atmosphere where they could form photochemical smog. Gasoline vapors are collected in the charcoal canister. The ECM controls the Purge Control Solenoid Valve (PCSV) to purge any collected vapors from the canister back to the engine for combustion. This valve is actuated by the purge control signal from the ECM and controls fuel vapor flow from the canister to the intake manifold.

DTC Description

Checking output signals from fuel tank pressure sensor under evap.system test, if fuel tank's vacuum decay slope is higher than prescribed threshold, ECM sets P0456 and then MIL(Malfunction Indication Lamp) turns on.

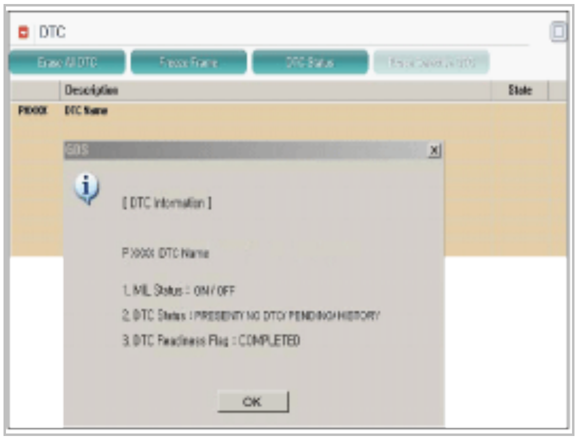
DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Monitor the vacuum decay slope	• Leakage in each hose/fuel filler pipe • Leakage in CCV/ Canister/ Fuel tank
Enable Conditions	• 10 V < Battery voltage < 16 V • Barometric pressure > 72 kPa (0.72 bar) • Engine coolant temperature at startup - Intake air temperature at startup < 6.7°C(12 °F) • Engine coolant temperature at startup: 4.5 ~ 35°C(40 ~ 95 °F) • Intake air temperature at startup: 4.5 ~ 35°C(40 ~ 95 °F) • Fuel level: 15 ~ 85 %	

Threshold value	• The vacuum decay slope > a prescribed threshold	
Diagnosis Time	• One time during Evaporative system diagnosis	
MIL On Condition	• 1 driving cycle	

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Check the Fuel Filler Cap is installed. If not, after closing it, go to "Evap.Leakage Test" as below with GDS.
NO	▶ Go to "Evap.Leakage Test" as below with GDS.

■ **Evap. Leakage Test**

1. Cool the vehicle down for about two hours to prevent misdiagnosis.
2. Install GDS and IG "ON" and then clear DTC.
3. Select and press "EVAP.LEAKAGE TEST" mode in the GDS.
4. Check if the vehicle is under test conditions as below [Fig 1].
5. If OK, Start engine and restart Evap.Leakage Test again[Fig 2].

Evap.Leakage Test

[Evap. Leakage Test]

This test is used for functional check of the evaporative system and leakage check.

[Condition]

1. Ignition Key On, Engine Stop
2. No Trouble Code
3. Fuel Level : 15 ~ 85%
4. Select Lever Position : P Or N
5. ECT : 32 ~ 105℃ (89.6 ~ 221℉)

Press [OK] button to start.

Ok   Cancel

Fig.1

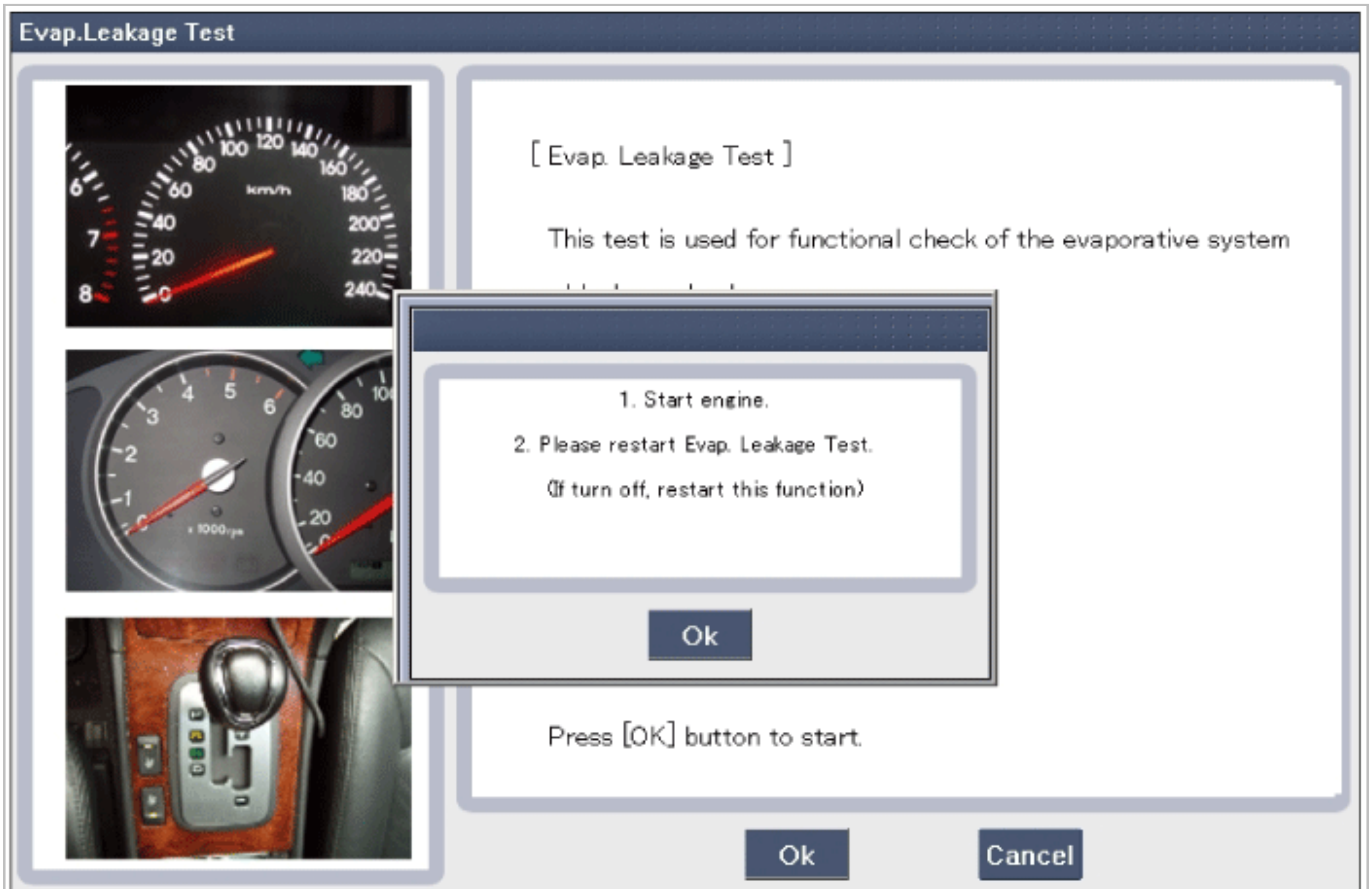


Fig.2

6. Is the same DTC set after the Evap.leakage test with GDS ?

YES	▶ Go to "System Inspection" procedure.
NO	▶ Fault is intermittent caused by the fuel cap missing and go to "Verification of vehicle Repair" procedure.

System Inspection

■ Check Fuel Filler Cap

1. Check the Fuel Filler Cap is installed and properly tightened.
2. Check if the Fuel Filler Cap seal is missing or damaged.
3. Is the Fuel Filler Cap OK?

YES	▶ Go to "Check vapor hoses for leakage in fuel system" as below.
NO	▶ Replace the Fuel Filler Cap and go to "Verification of Vehicle Repair" procedure.

■ Check vapor hoses for leakage in fuel system

1. Check vapor hoses between the following components for leakage:
   - ▶ Intake manifoled ~ Purge control solenoid valve (PCSV)
   - ▶ Purge control solenoid valve (PCSV) ~ Canister
   - ▶ Canister ~ Canister close valve (CCV)

▶ Canister ~ fuel tank

2. Does a leak exist?

YES	▶ Repair or replace as necessary and then, go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check fuel filler pipe for crack or leakage" as below

■ Check fuel filler pipe for crack or leakage

1. Check that there is crack or leakage in fuel filler pipe.
2. Is there any crack or leakage ?

YES	▶ Repair or replace as necessary and then, go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Component inspection" procedure.

Component Inspection

■ Check CCV for leakage

1. Disconnect the hose leading from the CCV to Canister at CCV.
2. Visually Check any tear of the hose leading from the CCV to Canister.
3. When the CCV operates, apply a vacuum at the nipple and verify that the CCV holds vacuum.
4. Does a leak exist?

YES	▶ Repair or replace as necessary and then go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check Canister for leakage" as below

■ Check Canister for leakage

1. Disconnect the hose leading from the CCV to Canister at Canister.
2. When the other nipples are plugged, apply a vacuum at the vent nipple and verify that the Canister holds vacuum.
3. Does a leak exist?

YES	▶ Repair or replace as necessary and then go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check fuel tank for leakage" as below

■ Check fuel tank for leakage

1. Check fuel tank for crack or leakage.
2. Does a leak exist?

YES	▶ Repair or replace as necessary and then go to "Verification of Vehicle Repair" procedure.
NO	▶ Carefully perform this troubleshooting procedures all over again from the beginning.

Verification of Vehicle Repair

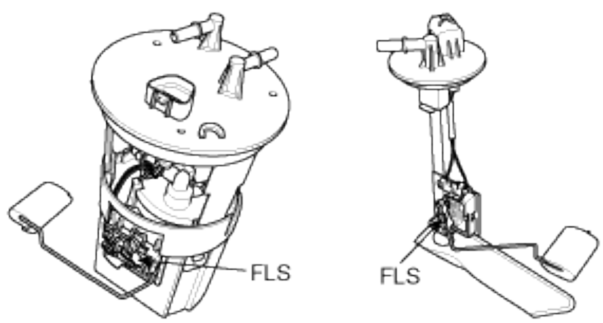
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0461 Fuel Level Sensor \'A\' Circuit Range/Performance

Component Location



General Description

The Fuel Level Sensor(FLS) measures the fuel level in fuel tank and its information is used to supply the ECM with information regarding the monitoring condition of the EVAP canister purge system for leak detection. If the fuel level sensor is monitored for high or low stuck or difference between voltage of fuel level sensor and voltage deviation of fuel level sensor is exceeds limited value while driving, this is interpreted by the ECM as a fault

DTC Description

Checking fuel level change under detecting condition, if the fuel level difference between current and previous is lower than 3.5% while odometer difference between present and previous is higher than 125km, ECM sets P0461. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

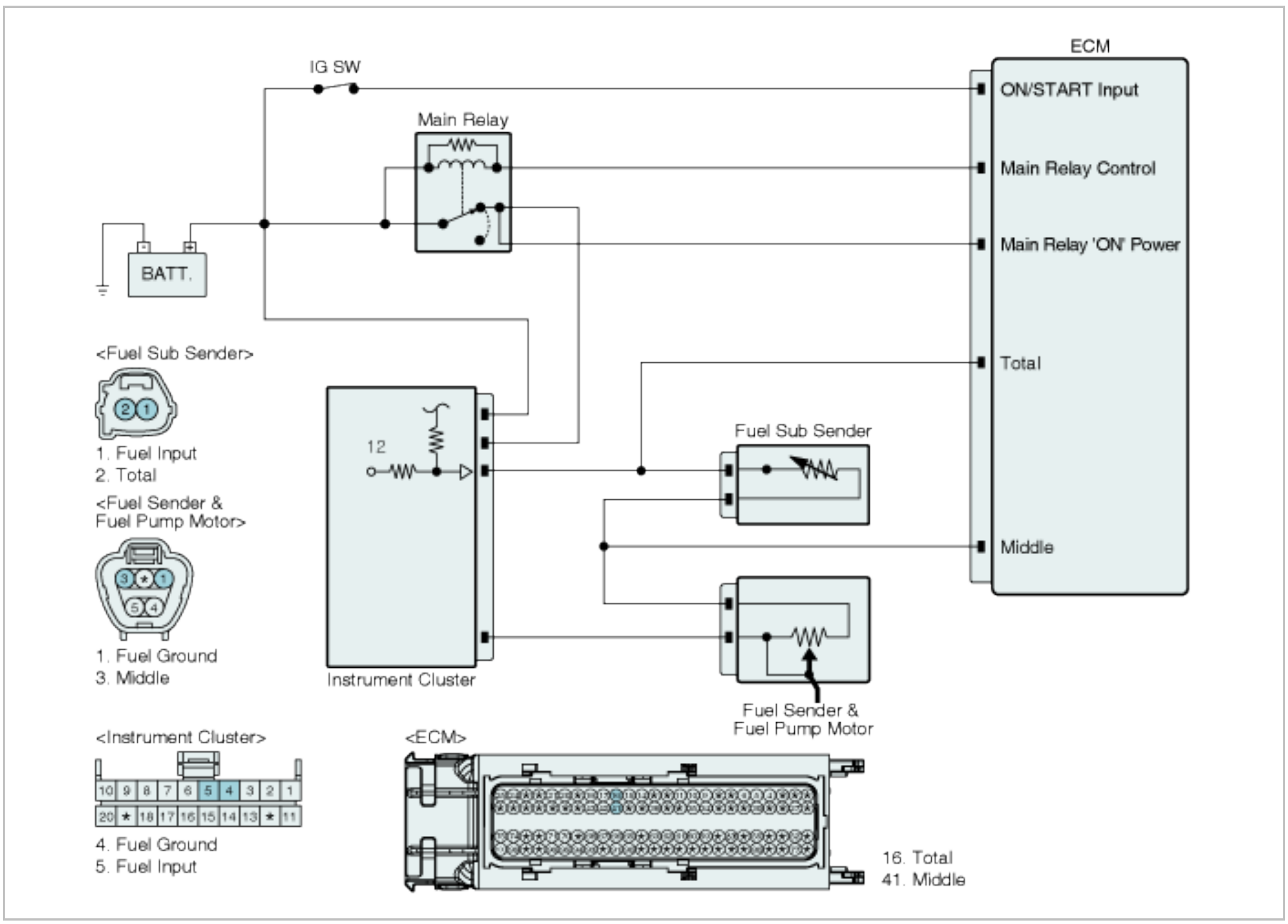
Item	Detecting Condition	Possible cause
DTC Strategy	• Detects a stuck fuel sender	• Poor connection
Enable Conditions	• Engine Running • Fuel Level Fault Not Present	
	• Current fuel sub sender - Previous fuel sub sender ≤ 3.5%	

Threshold value	[illegible] (After Present Odometer - Previous Odometer ≥ 125 km)	• Faulty Fuel Sender Stuck
Diagnosis Time	• -	
MIL On Condition	• 2 driving cycles	

Specification

FLS	Normal Parameter					
Float position	8/8	6/8	1/2	3/8	1/8	Warning Lamp ON
Sender-Resistance(Ω)	6.4±1	9.3±1	9.3±1	16.4±1	61.1±1	71.8±1
Sub Sender-Resistance(Ω)	7.1±1	50.5±1	95±1	110.0±1	110.0±1	-
Fuel volume(ℓ)	61.5	47.5	34.0	27.25	13.75	9.0

Diagnostic Circuit Diagram



Signal Waveform & Data

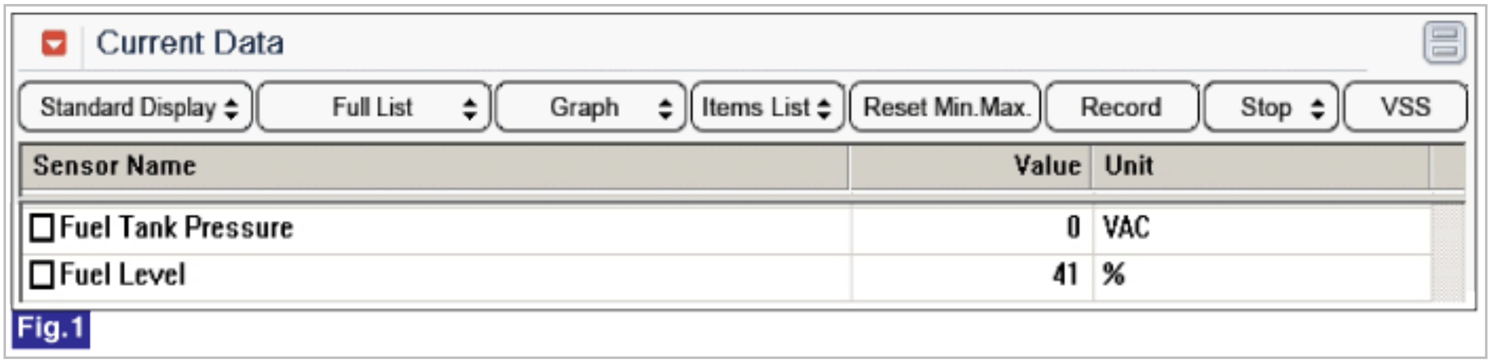
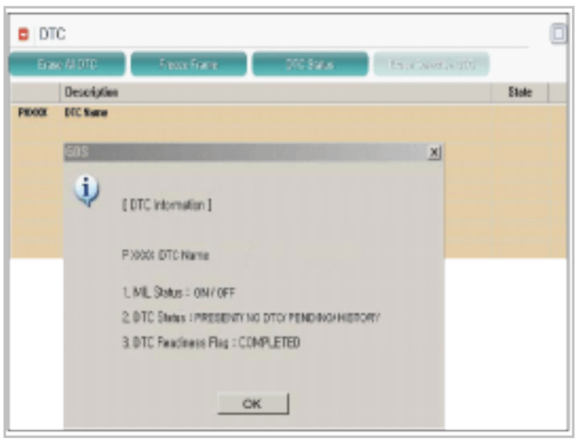


Fig.1) Normal data of Fuel Level at idle (41%).

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by ECM memory was not cleared after repair. Erase DTC and drive the vehicle to satisfy the enable codition then, go to "Component Inspection" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Component Inspection" procedure.

Component Inspection

■ **Check FLS resistance**

1. IG "OFF" and Disconnect Fuel Sender & Fuel Pump Motor connector and Fuel Sub Sender connector.
2. Remove these senders from fuel tank and measure the reistance of Fuel sender while lifting up and down the fuel level float.
3. Does the resistance of FLS change as lifting up and down the fuel level float ?

YES	▶ Fault is intermittent such as Float was stuck by something. Thoroughly check that any foreign material intrupts float moment. Erase DTC and drive the vehicle to satisfy the enable codition then, go to "Verification of Vehicle Repair " procedure.
NO	▶ Substitute with a known - good Fuel Sender and check for proper operation. If the problem is corrected, replace Fuel Sender and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

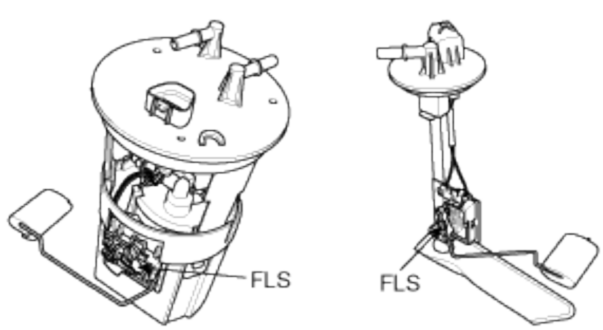
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0462 Fuel Level Sensor \'A\' Circuit Low Input

Component Location



General Description

The Fuel Level Sensor(FLS) measures the fuel level in fuel tank and its information is used to supply the ECM with information regarding the monitoring condition of the EVAP canister purge system for leak detection. If the fuel level sensor is monitored for high or low stuck or difference between voltage of fuel level sensor and voltage deviation of fuel level sensor is exceeds limited value while driving, this is interpreted by the ECM as a fault

DTC Description

Checking output signals of fuel sub sender under detecting condition, if the fuel level voltage is low than 0.36V, ECM sets P0462. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

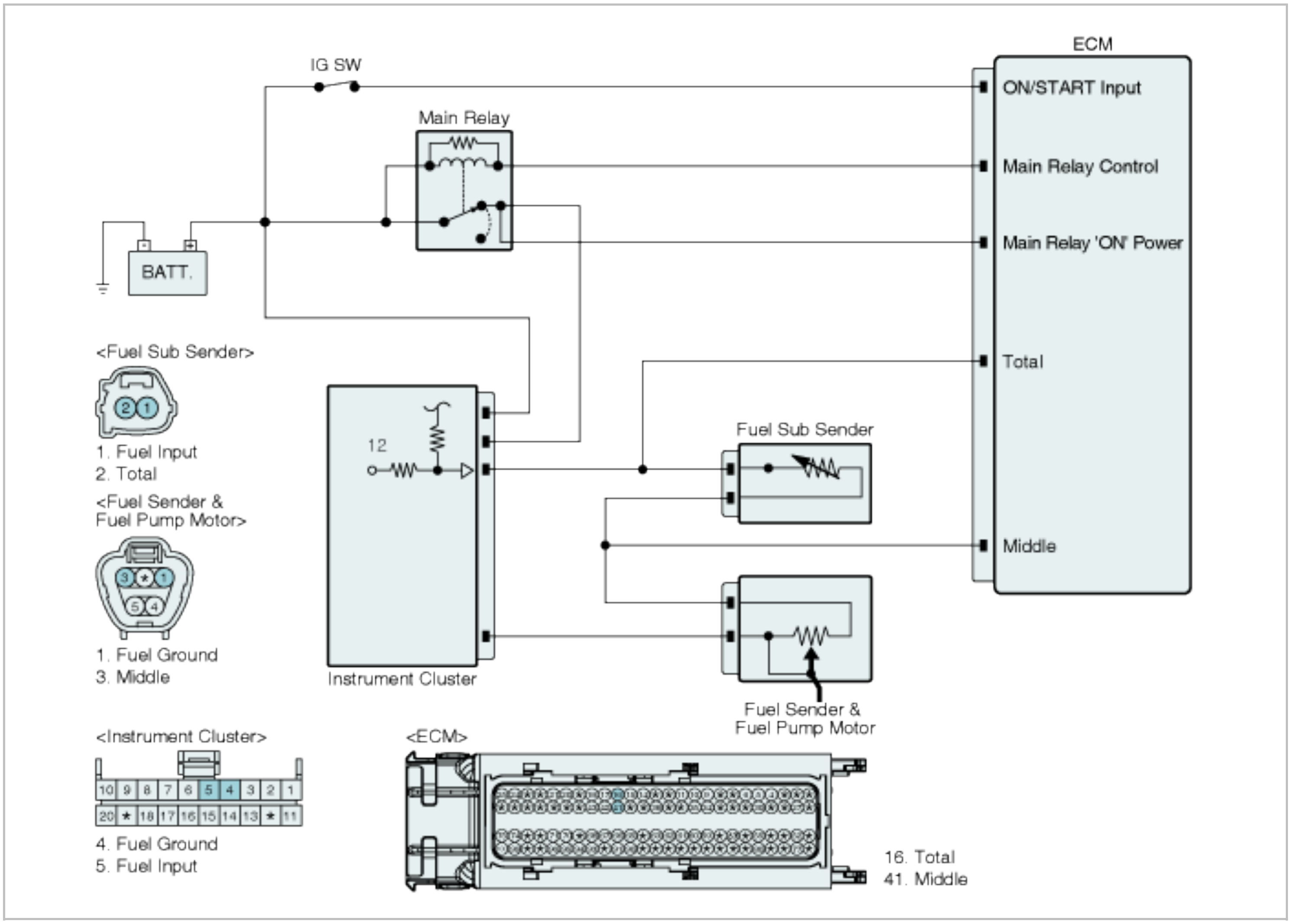
DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Detects a stuck fuel sender	• Poor connection • Open or short to ground in signal circuit • Faulty ECM
Enable Conditions	• Engine Running	
Threshold value	• Raw fuel sub sender output < 0.36V	
Diagnosis Time	• -	
MIL On Condition	• 2 driving cycles	

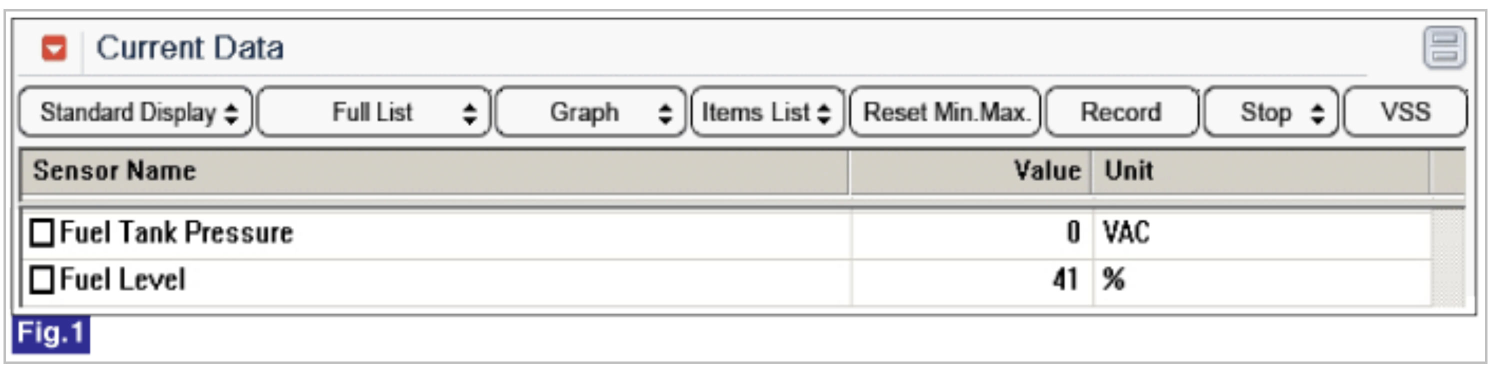
Specification

FLS	Normal Parameter					
Float position	8/8	6/8	1/2	3/8	1/8	Warning Lamp ON
Sender-Resistance(Ω)	6.4±1	9.3±1	9.3±1	16.4±1	61.1±1	71.8±1
Sub Sender-Resistance(Ω)	7.1±1	50.5±1	95±1	110.0±1	110.0±1	-
Fuel volume(ℓ)	61.5	47.5	34.0	27.25	13.75	9.0

Diagnostic Circuit Diagram



Signal Waveform & Data

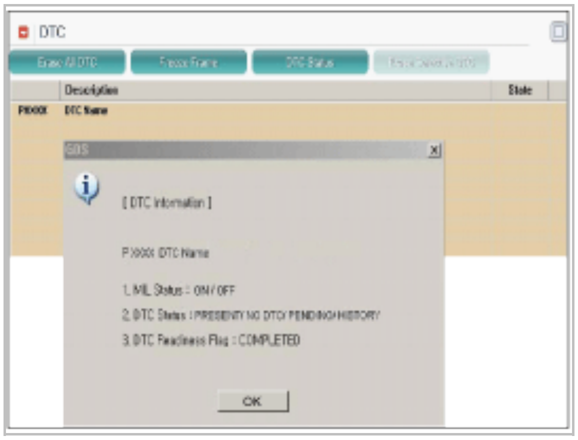


Sensor Name	Value	Unit
Fuel Tank Pressure	0	VAC
Fuel Level	41	%

Fig.1) Normal data of Fuel Level at idle (41%).

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure
NO	▶ Go to " Signal Circuit Inspection " procedure.

Signal Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect Fuel Sub Sender connector and ECM connector.
2. IG "ON".
3. Measure voltage between Total signal terminal of ECM harness connector and chassis ground.

Specification : Approx. 11 ~ 12V

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to ground or open in harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ **Check FLS resistance**

1. IG "OFF" and Disconnect Fuel Sender & Fuel Pump Motor connector and Fuel Sub Sender connector.
2. Remove these senders from fuel tank and measure the reistance of Fuel sender while lifting up and down the fuel level float.
3. Does the resistance of FLS change as lifting up and down the fuel level float ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good Fuel Sender or Fuel Sub Sender and check for proper operation. If the problem is corrected, replace Fuel Sender or Fuel Sub Sender and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

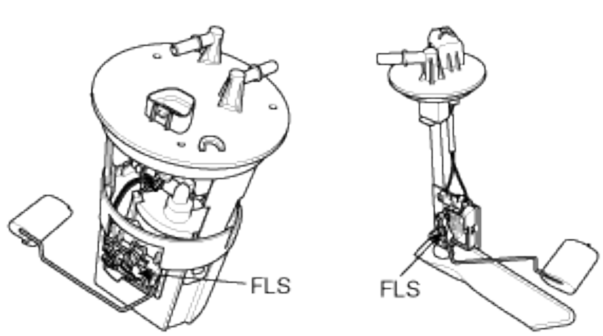
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0463 Fuel Level Sensor \'A\' Circuit High Input

Component Location



General Description

The Fuel Level Sensor(FLS) measures the fuel level in fuel tank and its information is used to supply the ECM with information regarding the monitoring condition of the EVAP canister purge system for leak detection. If the fuel level sensor is monitored for high or low stuck or difference between voltage of fuel level sensor and voltage deviation of fuel level sensor is exceeds limited value while driving, this is interpreted by the ECM as a fault

DTC Description

Checking output signals of fuel level sender under detecting condition, if the fuel level sender's signal is high than 82%, PCM sets P0463. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

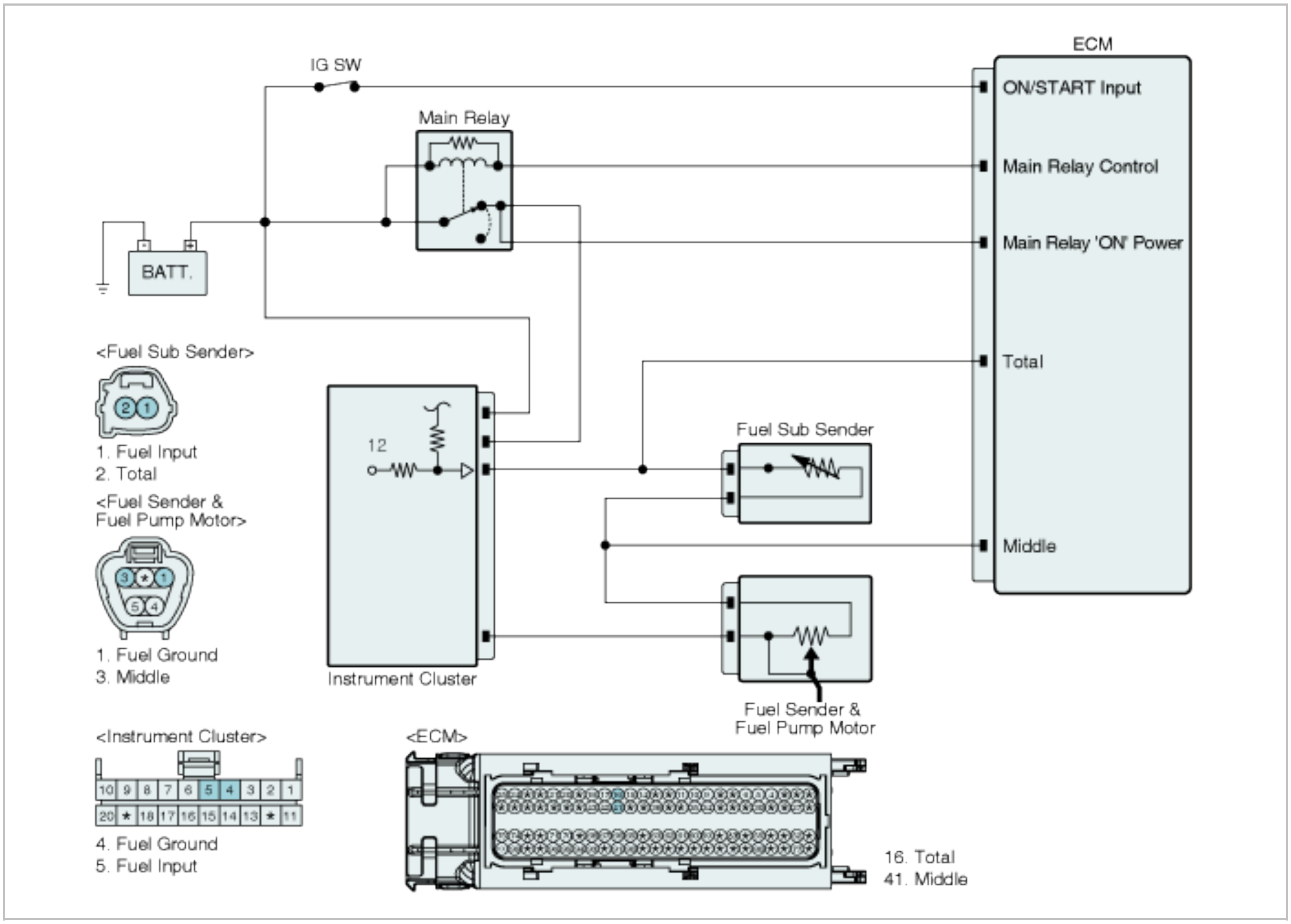
DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Detects a stuck fuel sender	• Poor connection • Open or short to battery in Circuit • Faulty Fuel Sub Sender • Faulty Fuel Sender • Faulty ECM
Enable Conditions	• Engine Running	
Threshold value	• Raw fuel sub sensor output > 9.8V	
Diagnosis Time	• -	
MIL On Condition	• 2 driving cycles	

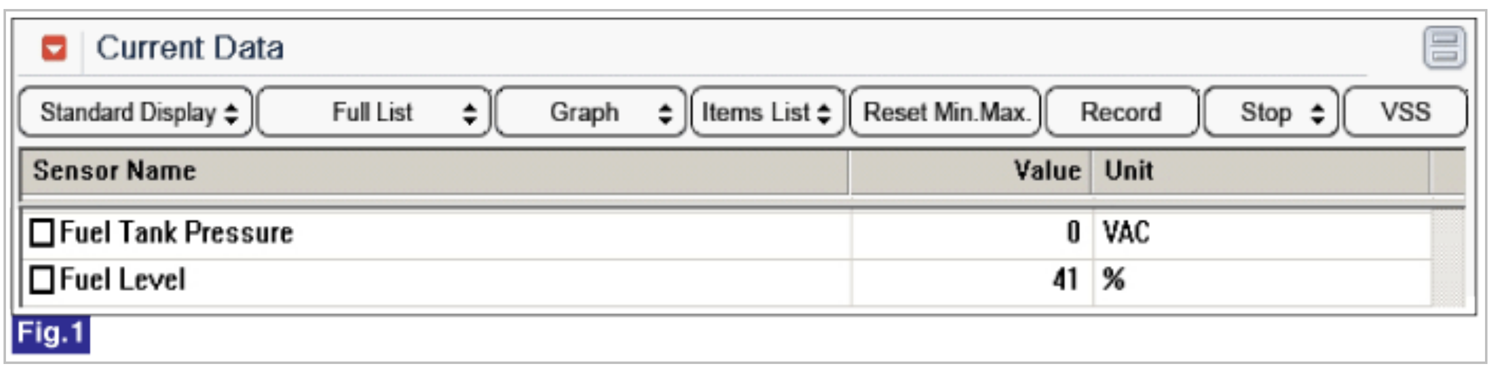
Specification

FLS	Normal Parameter					
Float position	8/8	6/8	1/2	3/8	1/8	Warning Lamp ON
Sender-Resistance(Ω)	6.4±1	9.3±1	9.3±1	16.4±1	61.1±1	71.8±1
Sub Sender-Resistance(Ω)	7.1±1	50.5±1	95±1	110.0±1	110.0±1	-
Fuel volume(ℓ)	61.5	47.5	34.0	27.25	13.75	9.0

Diagnostic Circuit Diagram



Signal Waveform & Data



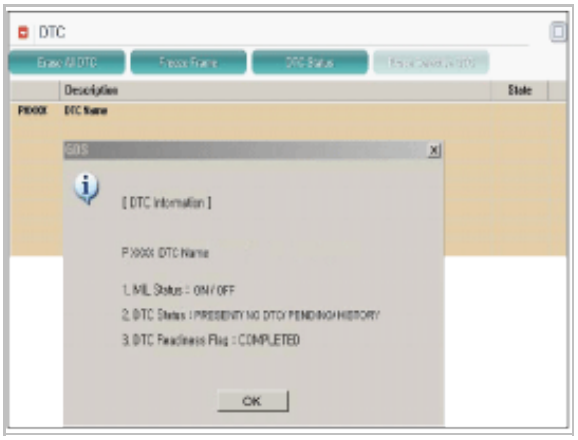
Sensor Name	Value	Unit
Fuel Tank Pressure	0	VAC
Fuel Level	41	%

Fig.1

Fig.1) Normal data of Fuel Level at idle (41%).

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to " Signal Circuit Inspection " procedure.

Signal Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect Fuel Sub Sender connector and ECM connector.
2. IG "ON".
3. Measure voltage between Total signal terminal of Fuel Sub Sender harness connector and chassis ground.

Specification : Approx. 0V

4. Is the measured voltage within specification ?

YES	▶ Go to "Check open in harness" as follows.
NO	▶ Repair short to battery in harness and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect Instrument cluster connector and Fuel Sub Sender connector.

2. Measure resistance between Total signal terminal of Fuel Sub Sender harness connector and Fuel input terminal of Instrument cluster harness connector.

Specification : Below 1Ω

3. Is the measured resistance within specification?

YES	▶ Go to " Ground Circuit Inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Ground Circuit Inspection

■ Check open in harness

1. IG "OFF" and disconnect Instrument cluster connector and Fuel Sender & Fuel pump Motor connector.
2. Measure resistance between ground terminal of Fuel Sender & Fuel pump Motor harness connector and Fuel ground terminal of Instrument cluster harness connector.

Specification : Below 1Ω

3. Is the measured resistance within specification?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check FLS resistance

1. IG "OFF" and Disconnect Fuel Sender & Fuel Pump Motor connector and Fuel Sub Sender connector.
2. Remove these senders from fuel tank and measure the reistance of Fuel sender while lifting up and down the fuel level float.
3. Does the resistance of FLS change as lifting up and down the fuel level float ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good Fuel Sender or Fuel Sub Sender and check for proper operation. If the problem is corrected, replace Fuel Sender or Fuel Sub Sender and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

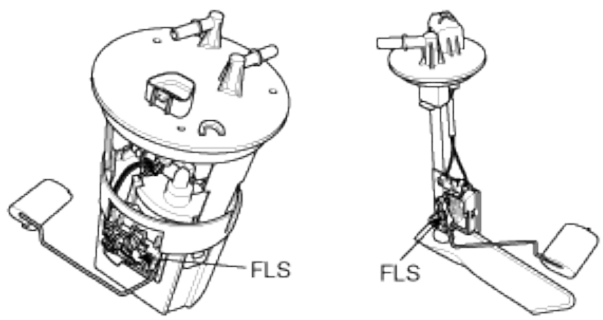
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0464 Fuel Level Sensor \'A\' Circuit Intermittent

Component Location



General Description

The Fuel Level Sensor(FLS) measures the fuel level in fuel tank and its information is used to supply the ECM with information regarding the monitoring condition of the EVAP canister purge system for leak detection. If the fuel level sensor is monitored for high or low stuck or difference between voltage of fuel level sensor and voltage deviation of fuel level sensor is exceeds limited value while driving, this is interpreted by the ECM as a fault

DTC Description

Checking output signals from FLS under detecting condition, if Difference between previous and current Fuel Level Signal is high than 10% , ECM sets P0464. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

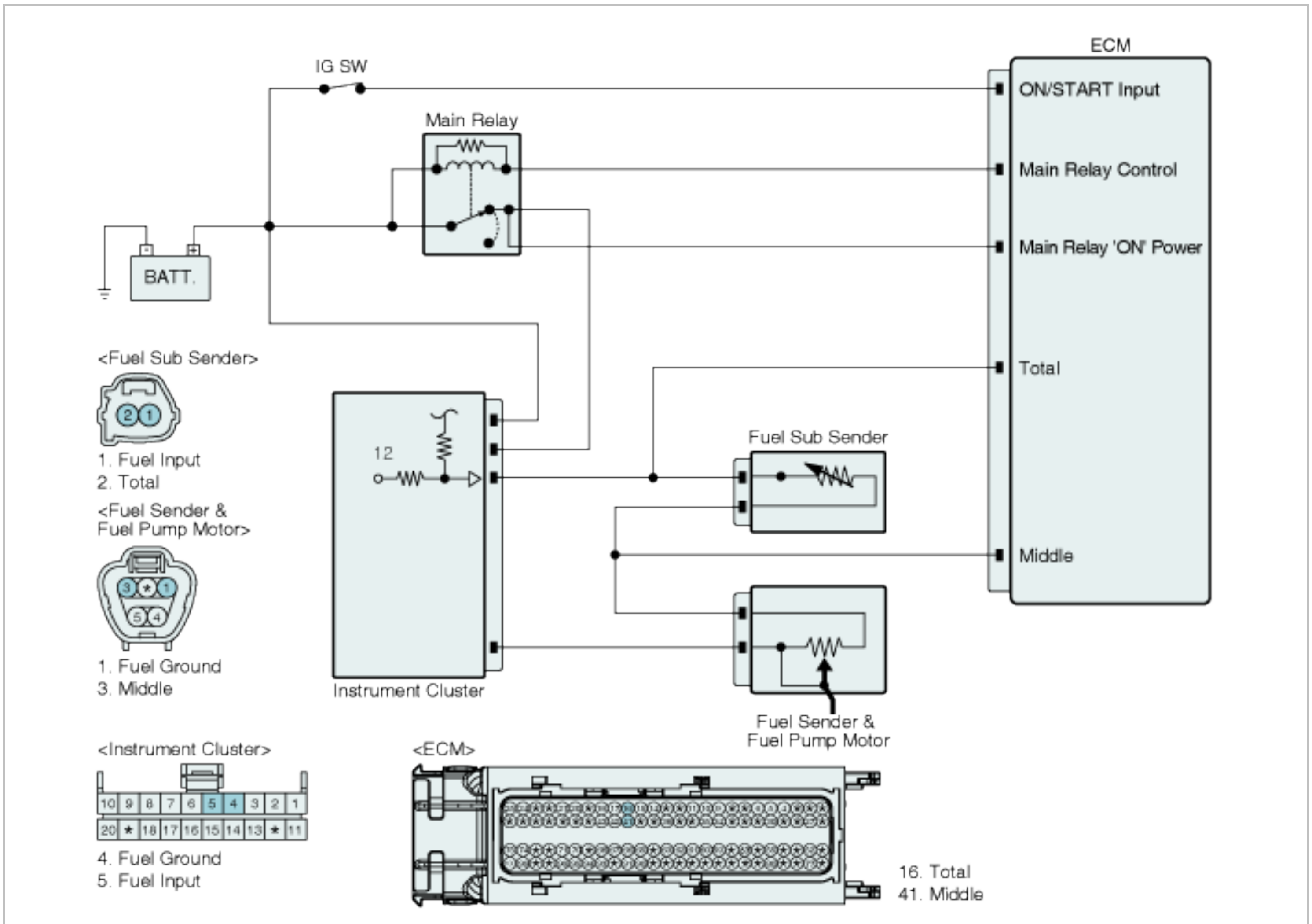
Item	Detecting Condition	Possible cause
DTC Strategy	• Detects a stuck fuel sender	• Poor connection • Faulty Fuel Sub Sender • Faulty Fuel Sender
Enable Conditions	• Engine Coolant Temperature ≥ 60°C (Fully Warmed up state)	
Threshold value	• Difference between previous and current Fuel Level voltage Signal > 10%	

Diagnosis Time	• -	
MIL On Condition	• 2 driving cycles	

Specification

FLS	Normal Parameter					
Float position	8/8	6/8	1/2	3/8	1/8	Warning Lamp ON
Sender-Resistance(Ω)	6.4±1	9.3±1	9.3±1	16.4±1	61.1±1	71.8±1
Sub Sender-Resistance(Ω)	7.1±1	50.5±1	95±1	110.0±1	110.0±1	-
Fuel volume(ℓ)	61.5	47.5	34.0	27.25	13.75	9.0

Diagnostic Circuit Diagram



Signal Waveform & Data

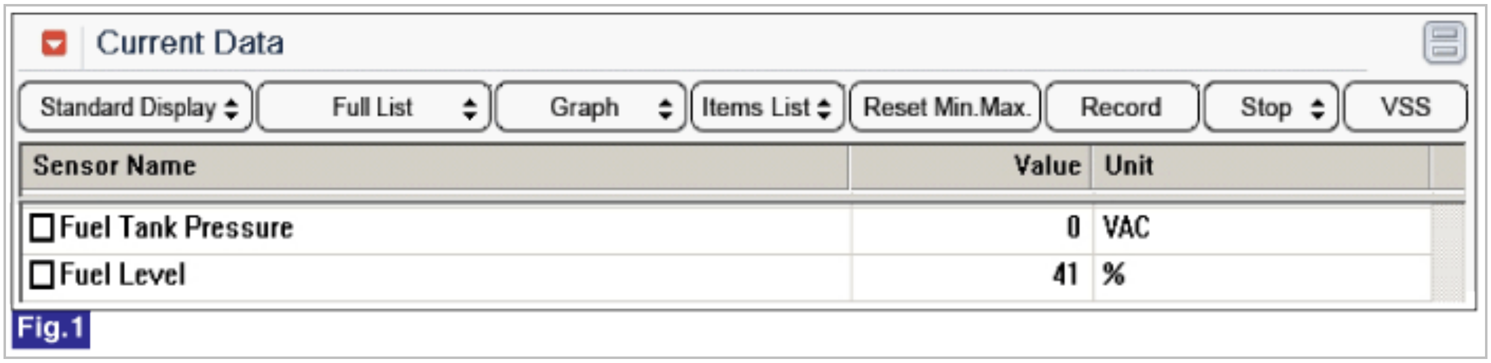
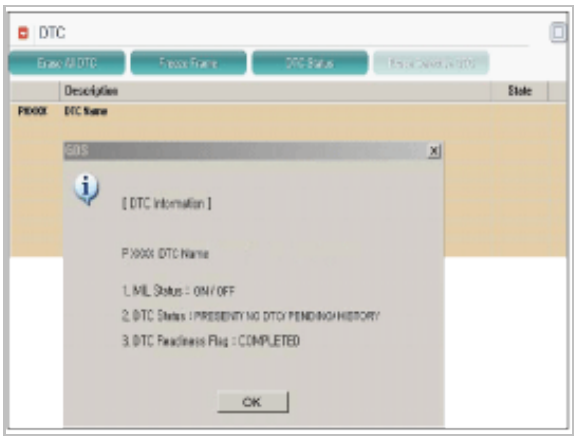


Fig.1) Normal data of Fuel Level at idle (41%).

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure
NO	▶ Go to "Component Inspection" procedure.

Component Inspection

■ **Check FLS resistance**

1. IG "OFF" and Disconnect Fuel Sender & Fuel Pump Motor connector.
2. Remove these senders from fuel tank and measure the reistance of Fuel sender while lifting up and down the fuel level float.
3. Does the resistance of FLS change as lifting up and down the fuel level float ?

YES	▶ There may be scratches on the resistance of Fuel Sender. Thoroughly check that resistance is suddenly changed by lifting up and down the fuel level float. Go to "Verification of Vehicle Repair " procedure.
NO	▶ Substitute with a known - good Fuel Sender or Fuel Sub Sender and check for proper operation. If the problem is corrected, replace Fuel Sender or Fuel Sub Sender and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0480 Fan 1 Control Circuit

General Description

When the ambient air temperature is warm or the airflow across the engine is low, the engine coolant temperature can become hot. If the coolant temperature becomes too hot, it is possible that the engine could be damaged. The purpose of activating the engine compartment ventilation fan is to help reduce the engine coolant temperature to a level that is not threatening to engine performance and maintains the airconditioning system pressure at safe levels.
Electric fan is responsible for causing air movement around the engine coolant radiator. The amount of air movement caused by the fan is controlled based on the Vehicle Speed, coolant temperature, A/C pressure status, A/C switch request status, and A/C clutch state. A duty cycle is determined based on these input parameters. This duty cycle corresponds to fan speed which correlates to the amount of air movement caused by the fan. The increased air movement enhances the heat exchanger function of the radiator in the confined space of the engine-compartment, thereby reducing the engine coolant temperature more quickly.

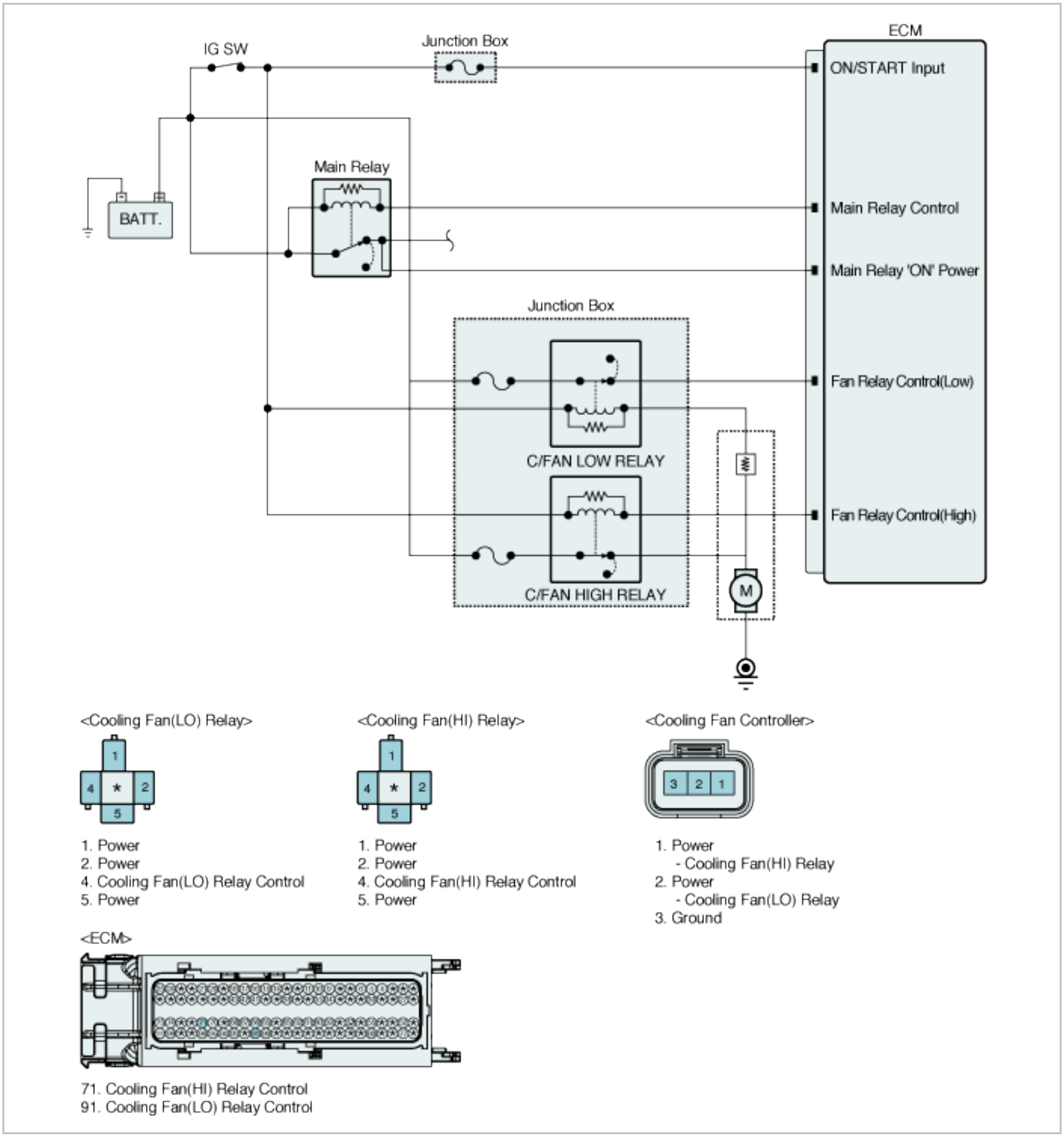
DTC Description

If the ECM detects short to ground, to battery or open circuit in the Cooling fan relay(low) , PCM sets P0480. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

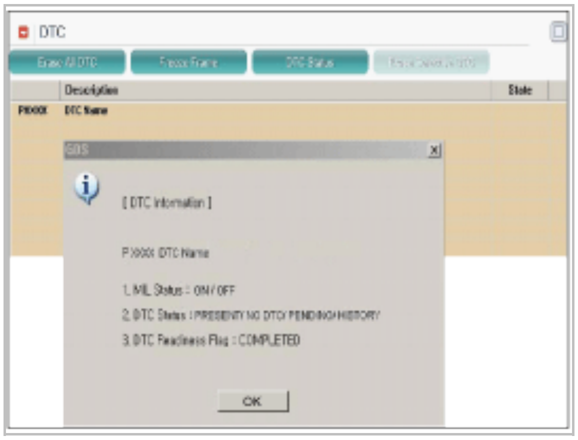
Item	Detecting Condition	Possible cause
DTC Strategy	• Monitor short to ground, to battery or open circuit	• Poor connection • Open or short in Cooling fan relay(low) • Faulty Cooling fan relay(low) • Faulty ECM
Enable Conditions	• No disabling Faults Present • Engine Running • 11V ≤ Ignition Voltage ≤ 16V	
Threshold value	• Open or short on Fan Circuit (Low)	
Diagnosis Time	• Continuous (More than 5sec. failure for every 10 sec. test.)	
MIL On Condition	• 2 driving cycles	

Diagnostic Circuit Diagram



Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor’s and/or ECM’s connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Power Circuit Inspection" procedure

Power Circuit Inspection

■ Check Voltage

1. IG "OFF" and disconnect Cooling fan relay(low).
2. IG "ON".
3. Measure voltage between battery power supply terminals of Cooling fan relay(low) harness connector and chassis ground.

Specification : Approx. B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.
NO	▶ Check if cooling fan fusible link 30A is open or not installed. ▶ Repair or replace as necessary and then, go to "Verification of Vehicle Repair" procedure.

Control Circuit Inspection

■ **Check signal wave form**

1. IG "OFF" and disconnect Cooling fan relay(low).
2. IG "ON".
3. Measure voltage between Cooling fan relay control(Low) terminal of Cooling fan relay(low) harness connector and chassis ground.

   Specification : Changed voltage detected

4. Is the measured voltage within specifications?

YES	▶Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automaticallydetected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Repair open or short in control circuit, and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0481 Fan 2 Control Circuit Malfunction

General Description

When the ambient air temperature is warm or the airflow across the engine is low, the engine coolant temperature can become hot. If the coolant temperature becomes too hot, it is possible that the engine could be damaged. The purpose of activating the engine compartment ventilation fan is to help reduce the engine coolant temperature to a level that is not threatening to engine performance and maintains the airconditioning system pressure at safe levels.
Electric fan is responsible for causing air movement around the engine coolant radiator. The amount of air movement caused by the fan is controlled based on the Vehicle Speed, coolant temperature, A/C pressure status, A/C switch request status, and A/C clutch state. A duty cycle is determined based on these input parameters. This duty cycle corresponds to fan speed which correlates to the amount of air movement caused by the fan. The increased air movement enhances the heat exchanger function of the radiator in the confined space of the engine-compartment, thereby reducing the engine coolant temperature more quickly.

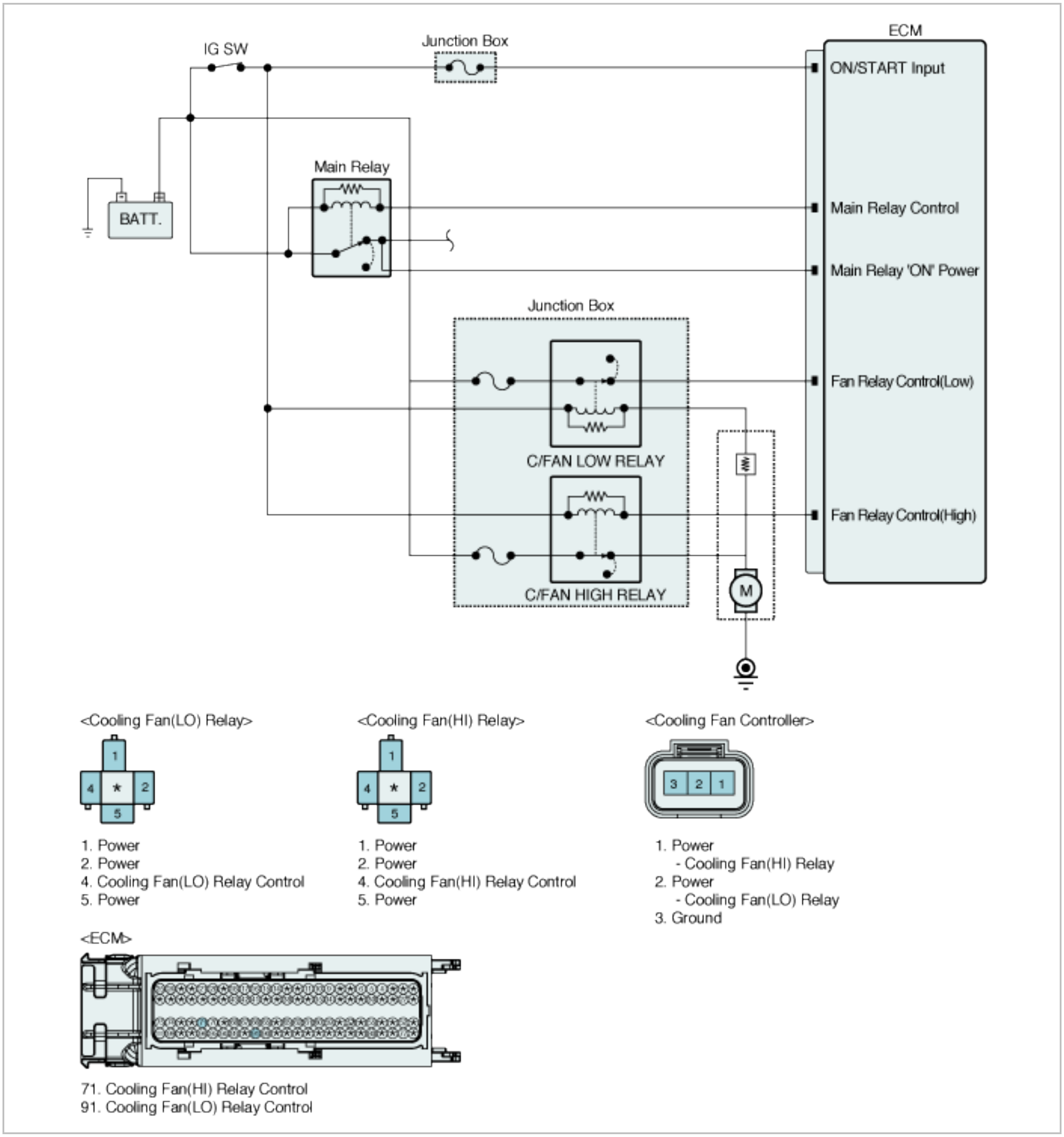
DTC Description

If the ECM detects short to ground, to battery or open circuit in the Cooling fan relay(high) , PCM sets P0481. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

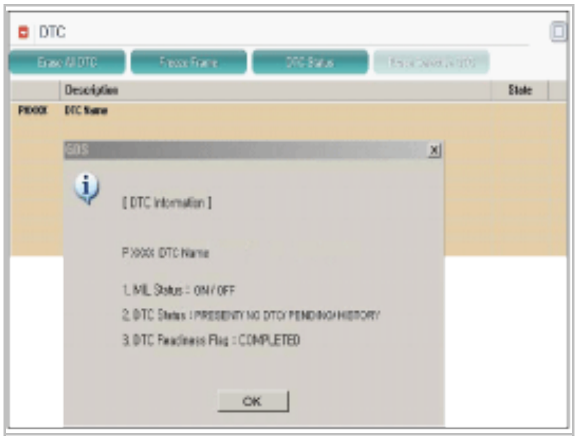
Item	Detecting Condition	Possible cause
DTC Strategy	• Monitor short to ground, to battery or open circuit	• Poor connection • Open or short in Cooling fan relay(high) • Faulty Cooling fan relay(high) • Faulty ECM
Enable Conditions	• No disabling Faults Present • Engine Running • 11V ≤ Ignition Voltage ≤ 16V	
Threshold value	• Open or short on Fan Circuit (High)	
Diagnosis Time	• Continuous (More than 5sec. failure for every 10 sec. test.)	
MIL On Condition	• 2 driving cycles	

Diagnostic Circuit Diagram



Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Power Circuit Inspection" procedure

Power Circuit Inspection

■ Check Voltage

1. IG "OFF" and disconnect Cooling fan relay(high).
2. IG "ON".
3. Measure voltage between battery power supply terminals of Cooling fan relay(high) harness connector and chassis ground.

Specification : Approx. B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.
NO	▶ Check if cooling fan fusible link 30A is open or not installed. ▶ Repair or replace as necessary and then, go to "Verification of Vehicle Repair" procedure.

Control Circuit Inspection

■ **Check signal wave form**

1. IG "OFF" and disconnect Cooling fan relay(high).
2. IG "ON".
3. Measure voltage between Cooling fan relay control(high) terminal of Cooling fan relay(high) harness connector and chassis ground.

   Specification : Approx. 3.5 V

4. Is the measured voltage within specifications?

YES	▶Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automaticallydetected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Repair open or short in control circuit, and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0501 Vehicle Speed Sensor \'A\' Range/Performance

General Description

The Wheel Speed Sensor (WSS) generates a waveform with a frequency proportional to the speed of the vehicle. The signal generated by the WSS informs the ECM not only if the vehicle speed is low or high but also if the vehicle is or is not moving. The ECM uses this signal to control the fuel injection, ignition timing, transaxle shift scheduling and torque converter clutch scheduling. The WSS signal is also used to detect rough road conditions.

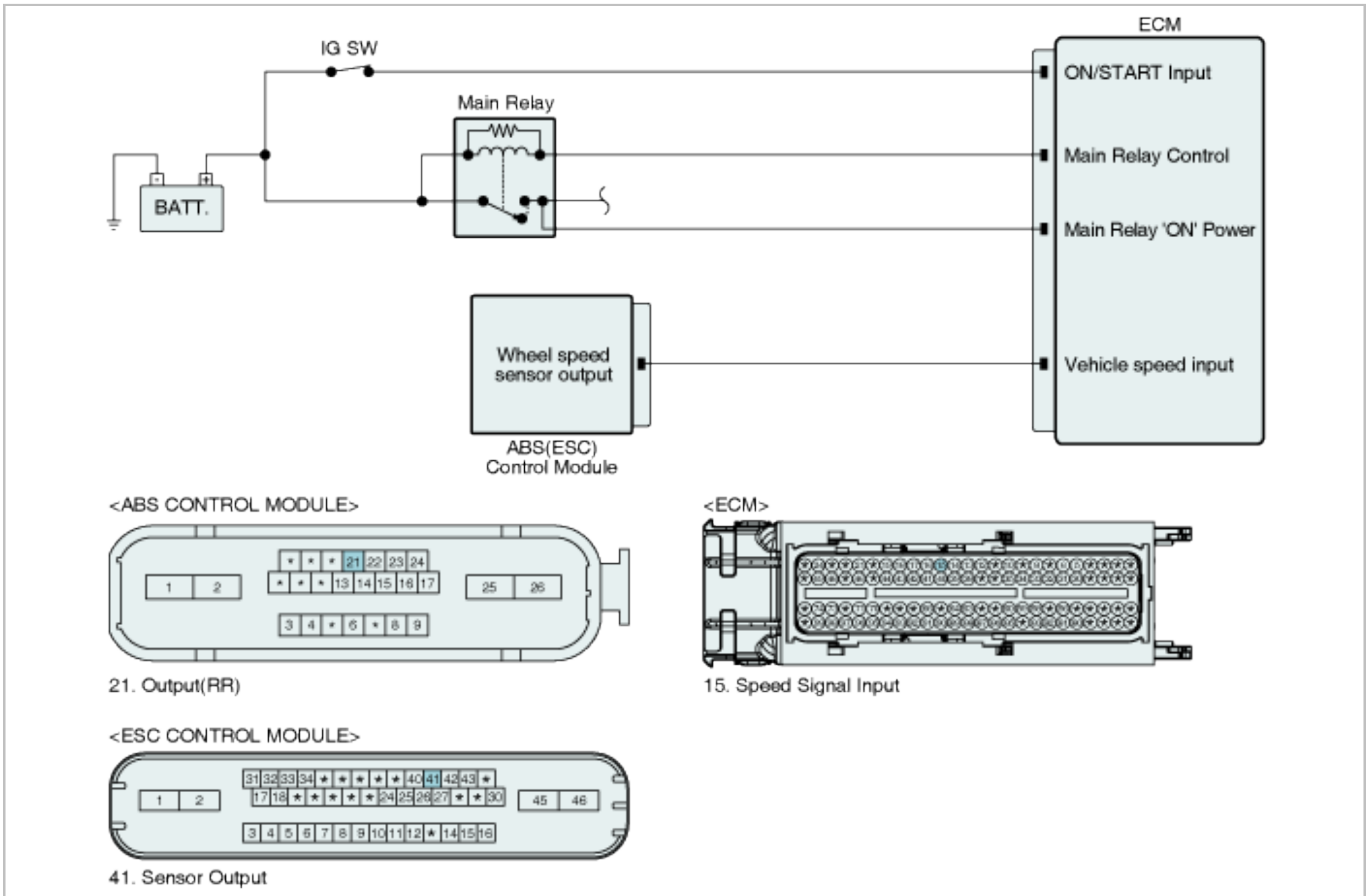
DTC Description

Checking vehicle speed signal every from ABS(or ESC) control every 30 sec. under detecting condition, if an signal is in the detecting condition for more than 20 sec., ECM sets P0501. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

Item		Detecting Condition	Possible cause
DTC Strategy		• Detects the lack of vehicle speed signal	• Poor connection • Open or short in harness • Wheel speed sensor(FR) • ABS or ESC control unit • ECM
Enable Conditions	Case 1	• Engine Running • No VSS disabling malfunction present • No TPS fault present • No MAP fault present • 11V < Ignition Voltage < 16V • Engine Coolant Temperature > 60°C(140°F) • MAP > 55kPa • 25% ≤ TPS ≤ 60% • 1200rpm ≤ Engine Speed ≤ 4000rpm • Vehicle Speed derived from transmission ≥ 10KPH(6.2MPH)	
	Case 2	• Engine Running • No VSS disabling malfunction present • No TPS fault present • No MAP fault present • 11V < Ignition Voltage < 16V • Engine Coolant Temperature > 60°C(140°F) • MAP < 32kPa • TPS < 1% • 1800rpm ≤ Engine Speed ≤ 6000rpm • Transmission in gear	
Threshold value	Case 1	• Vehicle Speed ≤ 10kph	
	Case 2	• Vehicle Speed < 5kph • Delta Engine Speed ≥ 100rpm	
Diagnosis Time		• Continuous (More than 20 seconds failure for every 30 seconds test)	
MIL On Condition		• 2 Driving Cycles	

Diagnostic Circuit Diagram



Signal Waveform & Data

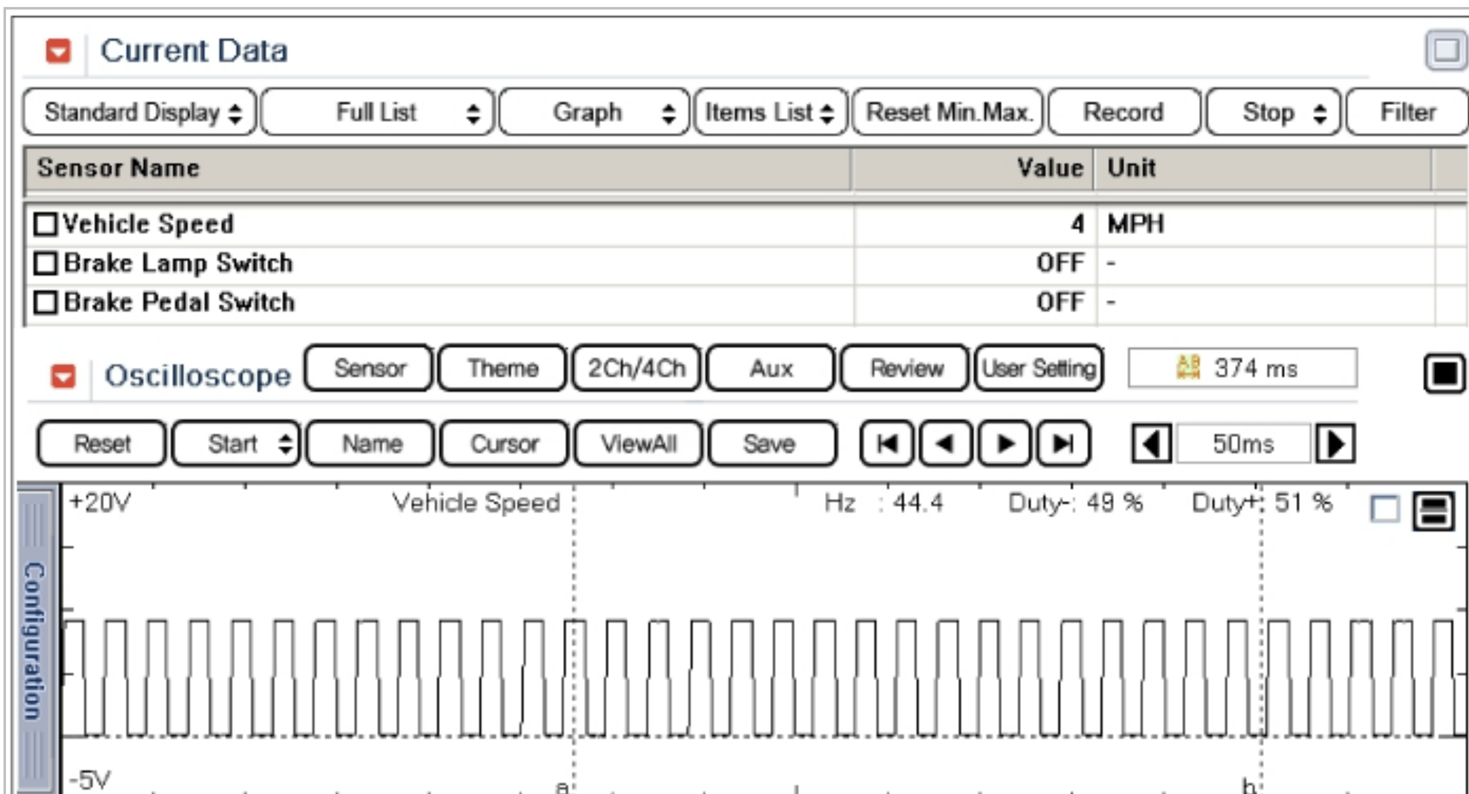


Fig.1

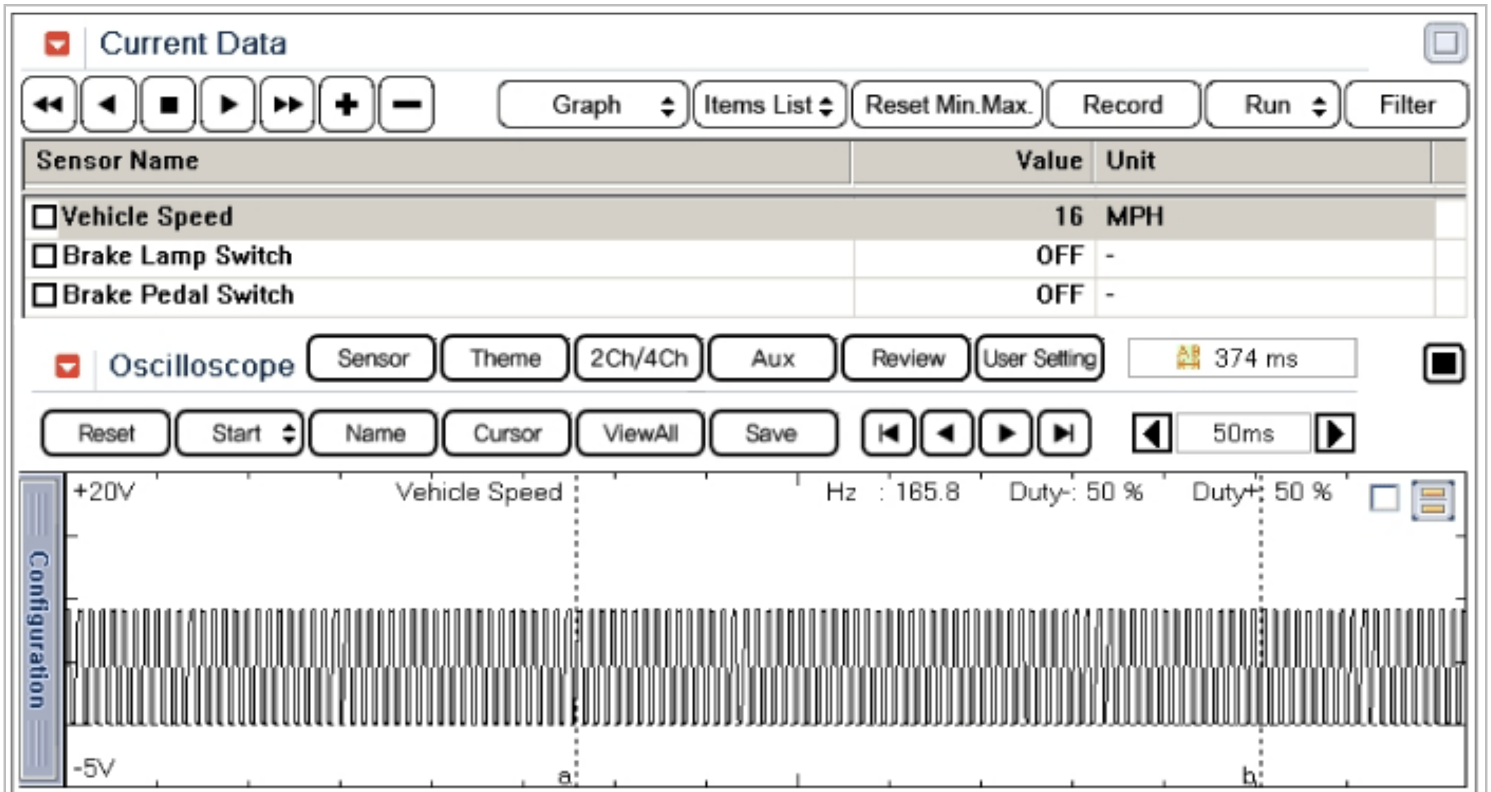
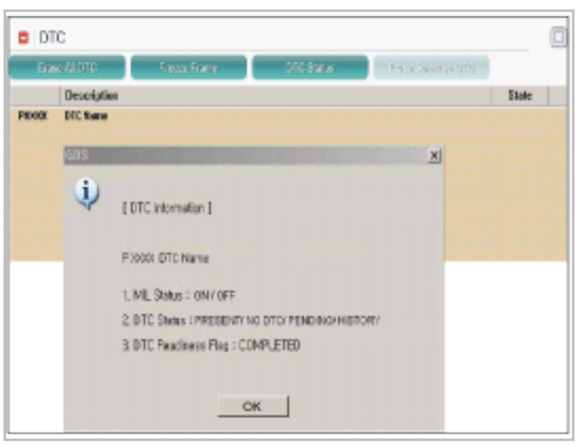


Fig.2

Fig.1) Normal data & waveforms of VSS (from ABS,ESC(ESP) ECU) when vehicle speed is 6km/h.
Fig.2) Normal data & waveforms of VSS (from ABS,ESC(ESP) ECU) when vehicle speed is 25km/h.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure
NO	▶ Go to " Signal Circuit Inspection " procedure.

Signal Circuit Inspection

■ Check Short to Ground

1. IG "OFF" and disconnect ECM connector and ABS(ESC) control module connector.
2. Measure resistance between vehicle speed input signal terminal of ECM harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification?

YES	▶ Go to "Check open in harness" as follows.
NO	▶ Repair short to ground in harness, and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect ECM connector and ABS(ESC) control module connector.
2. Measure resistance between vehicle speed input signal terminal of ECM harness connector and wheel speed sensor output signal terminal of ABS(ESC) control module harness connector.

Specification : Below 1Ω

3. Is the measured resistance within specification?

YES	▶ Go to " Check wheel speed sensor " procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

■ Check wheel speed sensor

1. IG "OFF"
2. Check open or short in wheel speed sensor (Refer to "C1203 Wheel speed sensor front-RH open/short")
3. Is the wheel speed sensor normal?

YES	▶ Substitute with a known - good ECM/ ABS(ESC) control unit and check for proper operation. If the problem is corrected, replace ECM/ ABS(ESC) control unit and go to "Verification of Vehicle Repair" procedure.
NO	▶ Repair or replace it as necessary, and then go to " Verification of Vehicle Repair" procedure.

	NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0504 Brake Switch \'A\' / \'B\' Correlation

General Description

The Stop lamp switch is used to judge whether the acceleration system is abnormal or not. The stop lamp switch has a duplex system(signals brake test or brake light) to memorize the abnormality when the signals of depressing and releasing the brake pedal are detected simultaneously.

DTC Description

Checking output signals from both Stop lamp switch when all of them are On or OFF simultaneously, if abnormal signal is detected for more than 0.5 sec., an error is recognized. And if this condition lasts for certain period, ECM sets P0504. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

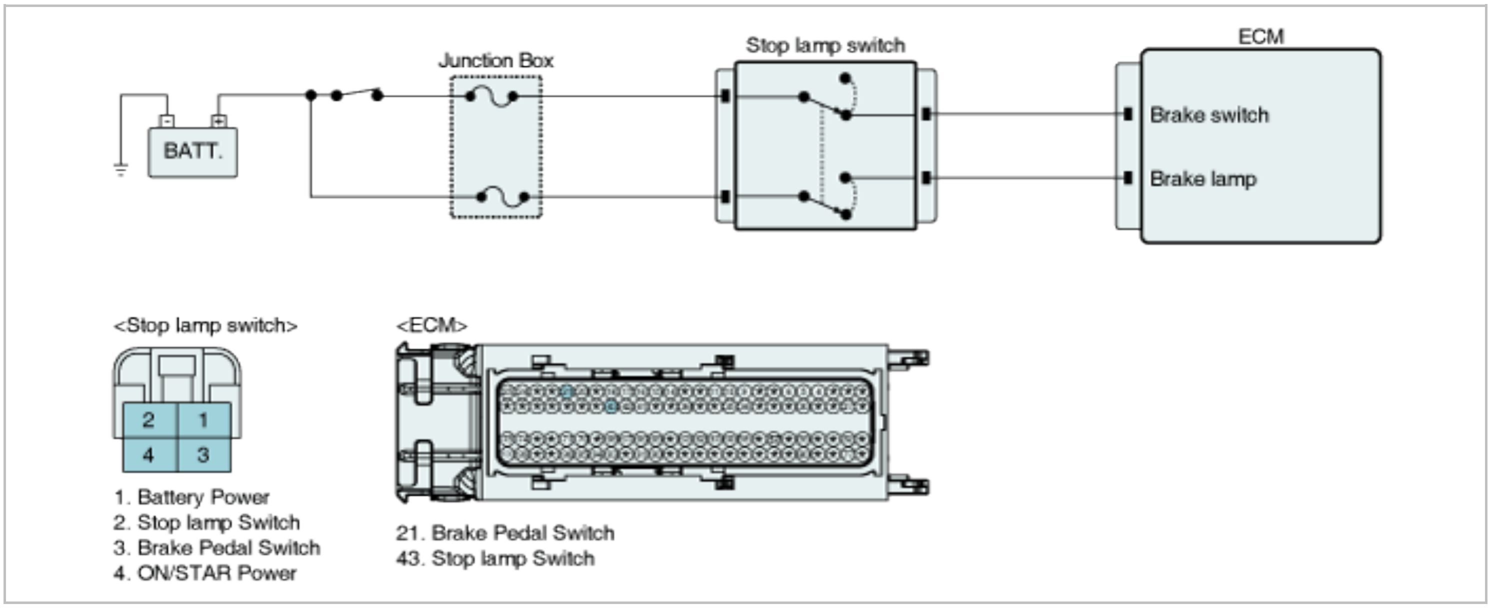
DTC Detecting Condition

Item		Detecting Condition	Possible cause
DTC Strategy		• Comparing 2 brake signals during driving	• Poor connection • Open or short in Stop lamp switch • Faulty Stop lamp switch
Enable Conditions	Case 1	• Engine works • Vehicle Speed Sensor is abnormal.	
	Case 2	• Engine works • Vehicle Speed Sensor is normal and Vehicle Speed is over 20kph dring 1sec or more.	
Threshold value		• The one brake signal's change duration when another signal has been changed > 0.5 sec	
Diagnosis Time		• Continuous	
MIL On Condition		• 2 Driving Cycles	

Specification

Item	During taking off the brake	During stepping on the brake
Stop Lamp	0V	Battery voltage
Stop Lamp Switch	Battery voltage	0V

Diagnostic Circuit Diagram



Signal Waveform & Data

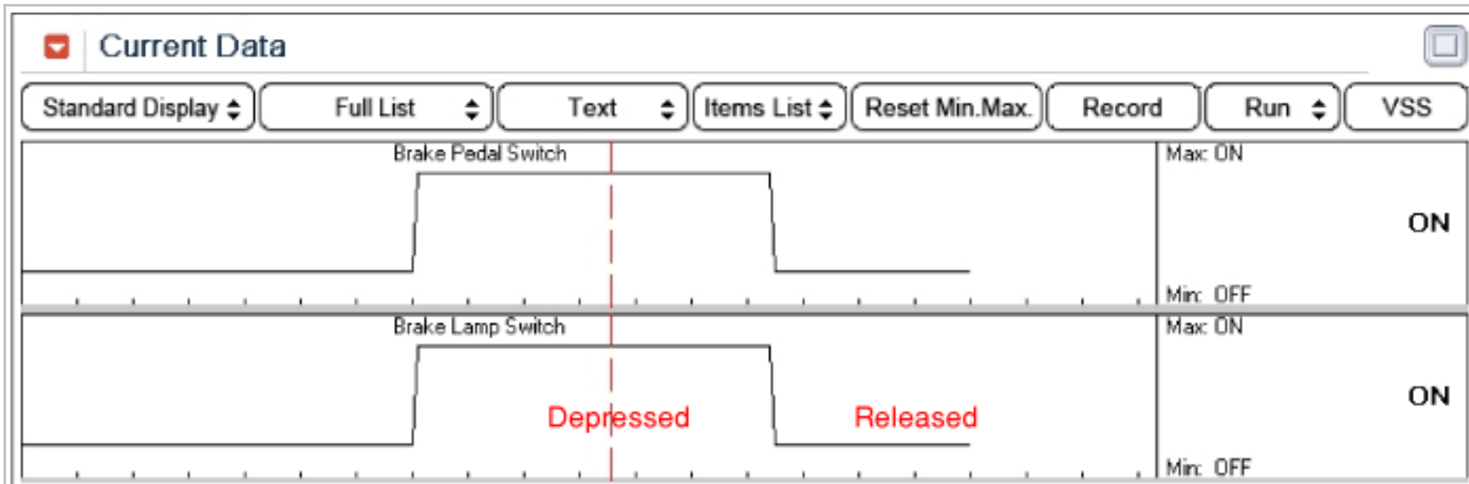


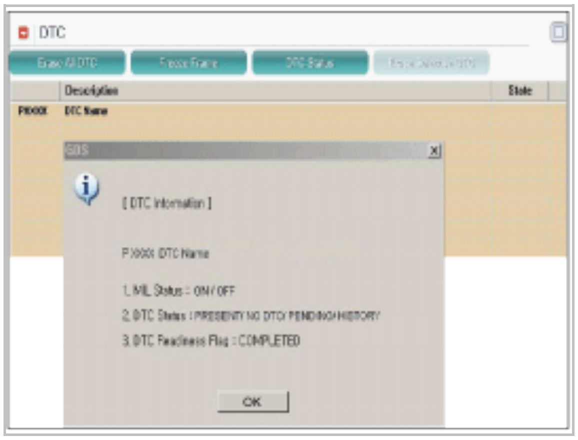
Fig.1

Fig.1) Normal data of Brake Switch during brake pedal released after depressed.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".

3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect ECM connector.
2. IG "ON" and keep the brake taking off. (Measurement "A").
3. Measure the voltage between brake switch signal terminal of ECM harness connector and chassis ground.
4. Measure the voltage between brake lamp signal terminal of ECM harness connector and chassis ground .
5. Keep the brake stepping on.(Measurement "B")
6. Measure the voltage between brake switch signal terminal of ECM harness connector and chassis ground.
7. Measure the voltage between brake lamp signal terminal of ECM harness connector and chassis ground .

Specification : B+

Item	During taking off the brake	During stepping on the brake

Stop Lamp	0V	Battery voltage
Stop Lamp Switch	Battery voltage	0V

8. Is the measured voltage within specification ?

YES	▶ Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check open in harness" as follows.

■ Check open in harness

1. IG "OFF" and disconnect stop lamp switch and ECM connector.
2. Measure the resistance between brake switch signal terminal of ECM harness connector and brake switch signal terminal of Stop lamp switch harness connector.
3. Measure the resistance between brake lamp signal terminal of ECM harness connector and brake lamp signal terminal of Stop lamp switch harness connector.

Specification : Below 1Ω

4. Is the measured resistance within specification ?

YES	▶ Go to "Check Battery voltage" procedure.
NO	▶ Repair open in circuit and go to "Verification of Vehicle Repair" procedure.

■ Check battery voltage

1. IG "OFF" and disconnect stop lamp switch connector.
2. Measure the voltage between power supply terminals of stop lamp switch harness connector and chassis ground.
3. IG "ON"
4. Measure the voltage between power supply terminals of stop lamp switch harness connector and chassis ground.
   Specification :

Item	IG "OFF"	IG "ON"
Power supply to brake switch side	Battery voltage	Battery voltage
Power supply to brake lamp side	0V	Battery voltage

5. Is the measured voltage within specification ?

YES	▶ Substitute with a known - good stop lamp switch and check for proper operation. If the problem is corrected, replace stop lamp switch and go to "Verification of Vehicle Repair" procedure.
NO	▶ Check the fuse between battery and stop lamp switch. ▶ Repair open or short in power circuit of stop lamp switch and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0506 Idle Air Control System-RPM Lower than Expected

General Description

The idle speed is controlled by the Electrical Throttle Control(ETC) System. ETC system is composed of the throttle motor to operate the throttle valve and the throttle position sensor to detect the opening angle of the throttle valve, the accelerator pedal position sensor to detect the accelerator pedal position and the one valve type throttle body. The ECM controls the throttle motor to provide the proper throttle valve opening angle for the target idle speed.

DTC Description

Checking idle RPM under detecting condition, if if the real idle speed is lower than desired idle speed by 100 RPM over 10 sec., ECM sets P0506. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Monitor idle speed	• Intake system for blockage
Enable Conditions	• Normal idle conditions	
Threshold value	• Real engine speed is lower than target engine speed by 100 RPM	
Diagnosis Time	• Continuous	
MIL On Condition	• 2 driving cycles	

Signal Waveform & Data

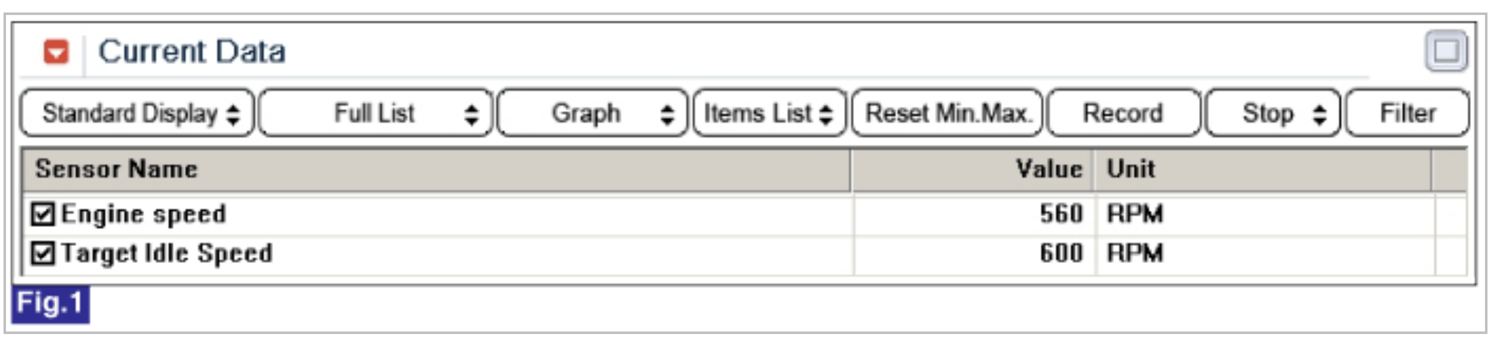


Fig.1) Normal data of Engine RPM after engine warmed up.

Monitor GDS Data

1. Monitor DTCs related to HO2S, MAFS, MAPS, ECTS, PCSV, Injector, CVVT items, ETC system, A/C system, or power steering system with GDS.
2. Are there the DTCs above-mentioned?

YES	▶ Do all repairs associated with those codes before proceeding with this procedure.
NO	▶ Go to "System Inspection" procedure.

System Inspection

■ **Check intake system for blockage**

1. Visually/physically inspect the following items:
   ▶ Air cleaner filter element for excessive dirt or for any foreign objects
   ▶ Hoses of intake system for blockage
   ▶ Throttle body inlet for damage or for any foreign objects
   ▶ Throttle plate for carbon deposits
2. Has a problem been found in any of the above areas?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Clear DTC and Test-drive under enable conditions above-mentioned. After the test, If this DTC is set, go to "Inspection & Repair" procedure. If not, troubleshooting is completed.

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0507 Idle Air Control System-RPM Higher than Expected

General Description

The idle speed is controlled by the Electrical Throttle Control(ETC) System. ETC system is composed of the throttle motor to operate the throttle valve and the throttle position sensor to detect the opening angle of the throttle valve, the accelerator pedal position sensor to detect the accelerator pedal position and the one valve type throttle body. The ECM controls the throttle motor to provide the proper throttle valve opening angle for the target idle speed.

DTC Description

Checking idle RPM under detecting condition, if if the real idle speed is higher than desired idle speed by 200 RPM over 10 sec., ECM sets P0507. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Monitor idle speed	• Intake system for air leakage
Enable Conditions	• Normal idle conditions	
Threshold value	• Real engine speed is higher than target engine speed by 200 RPM	
Diagnosis Time	• Continuous	
MIL On Condition	• 2 driving cycles	

Signal Waveform & Data

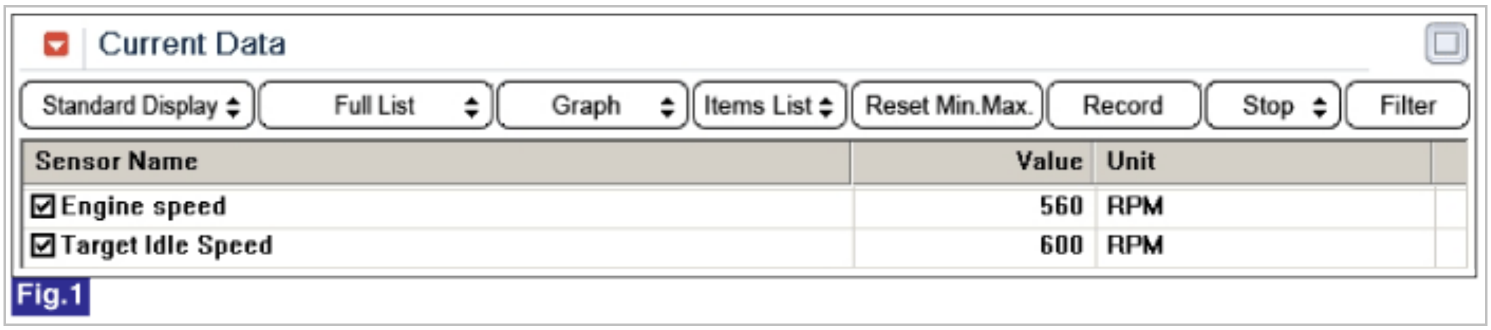


Fig.1) Normal data of Engine RPM after engine warmed up.

Monitor GDS Data

1. Monitor DTCs related to HO2S, MAFS, MAPS, ECTS, PCSV, Injector, CVVT items, ETC system, A/C system, or power steering system with GDS.
2. Are there the DTCs above-mentioned?

YES	▶ Do all repairs associated with those codes before proceeding with this procedure.
NO	▶ Go to "System Inspection" procedure

System Inspection

■ Check intake system/vapor hoses for air leakage or disconnection

1. Visually/physically inspect the following items:
   ▶ Intake system for air leakage
   ▶ Vapor hoses for cracks or disconnection
2. Has a problem been found in any of the above areas?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure

NO	▶ Clear DTC and Test-drive under enable conditions above-mentioned. After the test, If this DTC is set, go to "Inspection & Repair" procedure. If not, troubleshooting is completed.

Verification of Vehicle Repair

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

1. Connect scantool and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P050B Cold Start Ignition Timing Performance

General Description

With the ignition switch in the ON or START position, voltage is applied to the ignition coil. Each ignition coil consists of two coils. High tension leads go to each cylinder from the ignition coils. The ignition coils fire two spark plugs on every power stroke (the cylinder under compression and the cylinder on the exhaust stroke). The Engine Control Module (ECM) provides a switching circuit to ground for energizing the primary ignition coils. The ECM uses the crankshaft position sensor and camshaft position sensor signal to time the energizing of the coil. When a primary ignition coil is energized and de-energized, the secondary coil produces a high voltage spike to the attached spark plugs.

DTC Description

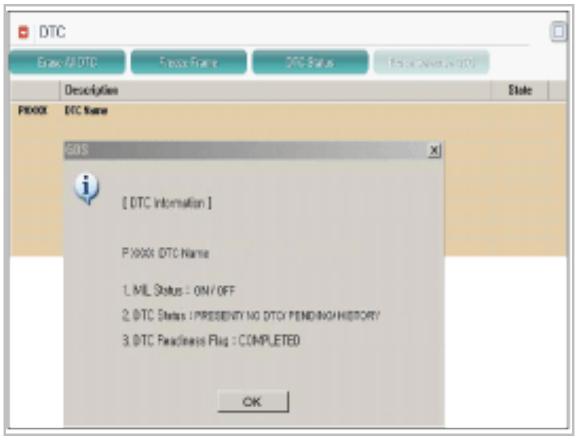
Checking spark timing under detecting condition, if the actual spark timing differs from the commanded spark timing, ECM sets this DTC. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Monitor the spark timing	• Faulty Ignition Coil • Faulty ECM
Enable Conditions	• After engine overnight soaking • Vehicle is not rapidly accelerating or decelerating. • 11V< Battery Voltage < 16V • Engine is running. • NO DTC related to CKPS,Ignition coil, and Misfire	
Threshold value	• The actual spark timing > the commanded spark timing + 15° or < the commanded spark timing -15°	
Diagnosis Time	• Within 1 minute after cold-starting	
MIL On Condition	• 2 driving cycles	

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Fault is intermittent caused by ECM memory was not cleared after repair. Erase DTC and drive the vehicle to satisfy the enable codition then, go to " System Inspection" procedure.

Component Inspection

■ Check Ignition Coil

1. IG "OFF" and disconnect ignition coil connector.
2. Measure resistance between power and signal terminals of ignition coil connector.(Measurement "A")
3. Measure resistance between power terminal of ignition coil connector and out terminal of secondary ignition coil.(Measurement "B")
   Specification :

Resistance (Ω)	Primary Coil	Secondary Coil
	0.62 ± 10% (20°C)	7.0k ± 15% (20°C)

4. Is the measured resistance within specification?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM.Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others

NO	▶ Substitute with a known - good Ignition Coil and check for proper operation. If the problem is corrected, replace Ignition Coil and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

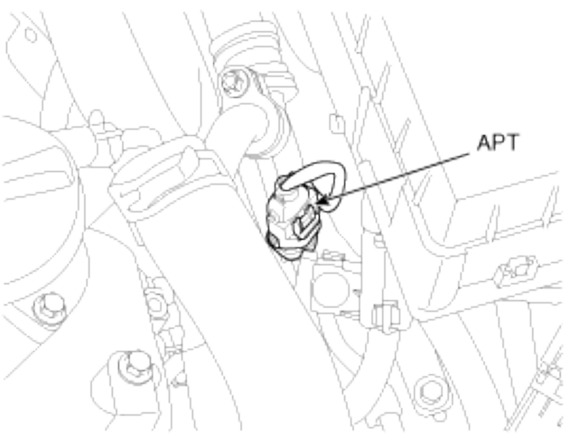
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0532 A/C Refrigerant Pressure Sensor \'A\' Circuit Low Input

Component Location



General Description

he ECM(Engine Control Module) receives pressure signal in the A/C refrigerant high pressure side from the A/C refrigerant pressure sensor. This input indicates how much load the A/C compressor is putting on the engine and is one of the factors used by the ECM in order to determine the idle air control position for the idle speed. The circuits consist of a 5V reference and a ground, both provided by the ECM, and a signal from the sensor. The signal is a voltage which is proportional to the A/C pressure from 0 to 5V. Low pressure produces a low voltage signal and high pressure a high-voltage signal.

DTC Description

Checking output signals from A/C pressure sensor under detecting condition, if an signal below 0.25V lasts for more than 10 sec., ECM sets P0532.

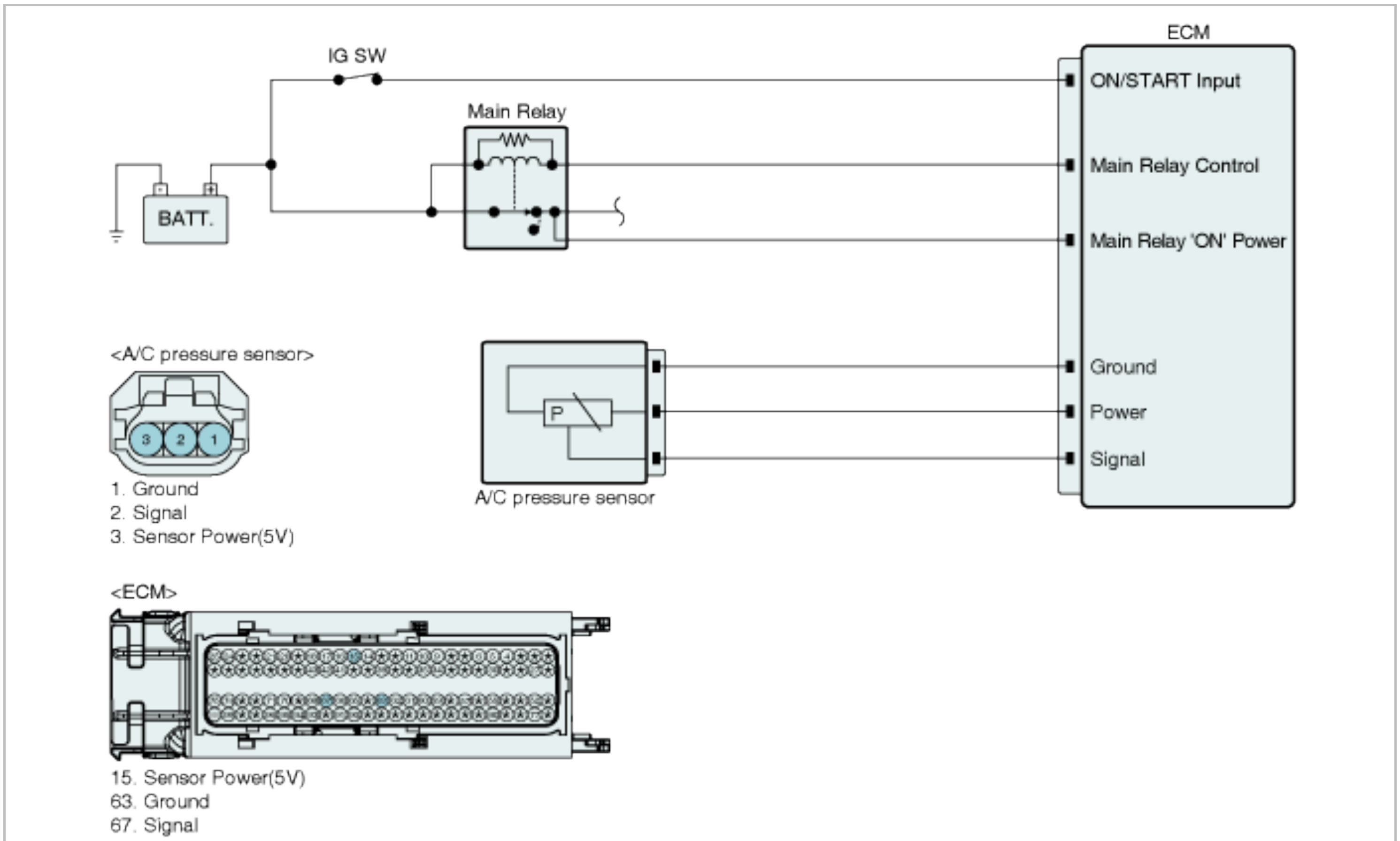
DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Detects sensor signal short to low voltage	• Poor connection • Open in power circuit • Open or short to ground in signal circuit • Faulty A/C pressure sensor • Faulty ECM
Enable Conditions	• Engine works	
Threshold value	• Sensor output voltage < 0.25V	
Diagnosis Time	• Continuous (More than 10 seconds failure for every 20 seconds test)	
MIL On Condition	• DTC only (NO MIL ON)	

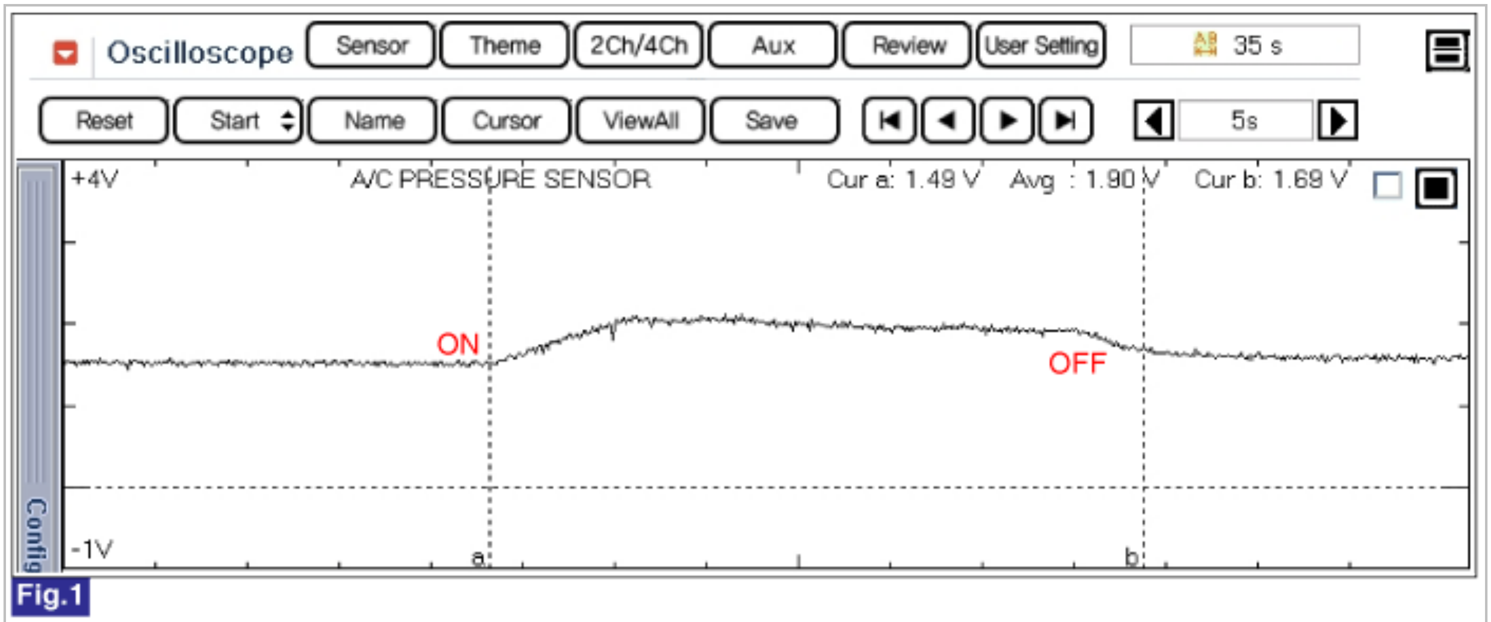
Specification

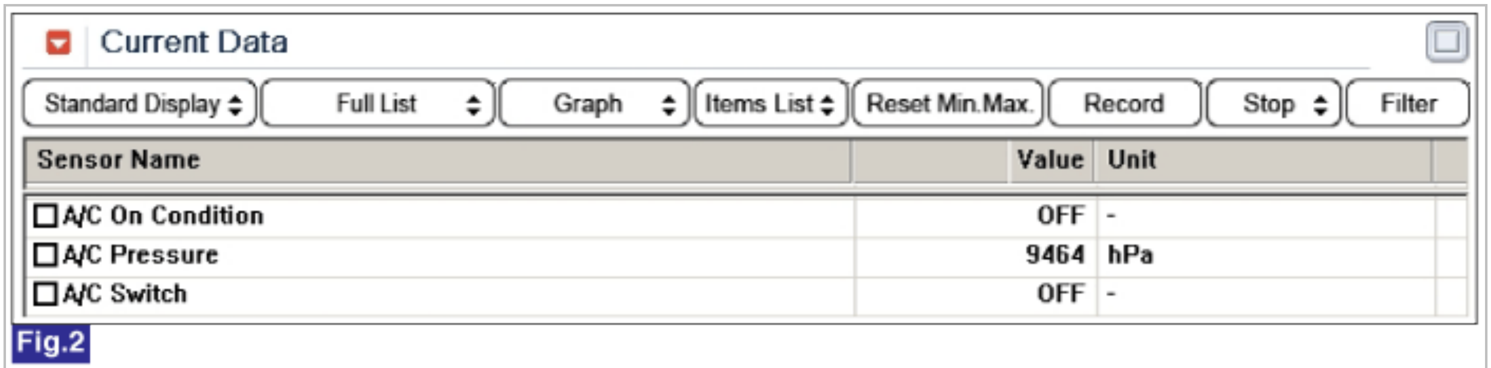
Pressure(kpa)	101.4	390.9	1723.7	3031.6	3206.1
Voltage(V)	0.5	0.87	2.57	4.24	4.46

Diagnostic Circuit Diagram



Signal Waveform & Data

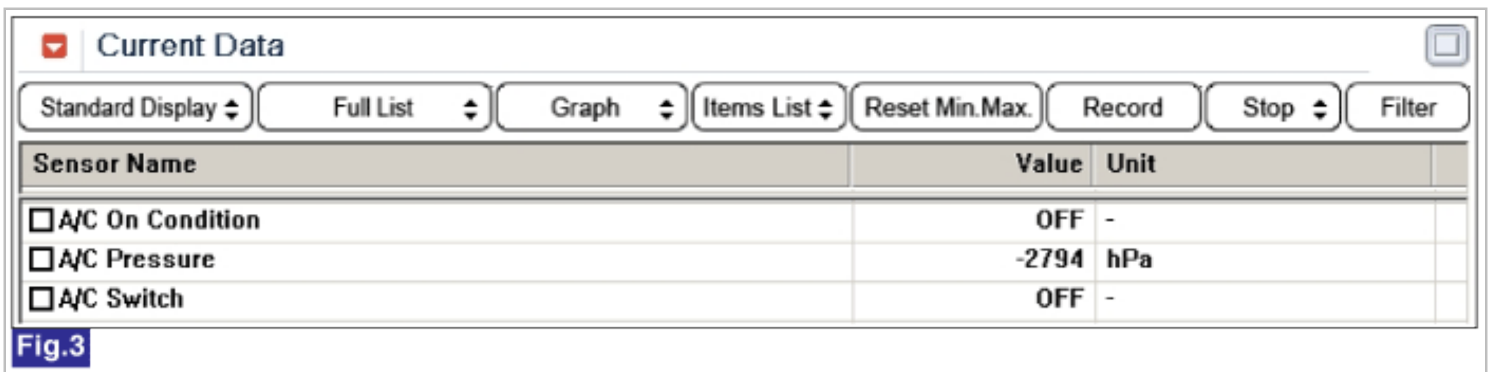



Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | Filter

Sensor Name	Value	Unit
A/C On Condition	OFF	-
A/C Pressure	9464	hPa
A/C Switch	OFF	-

Fig.2


Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | Filter

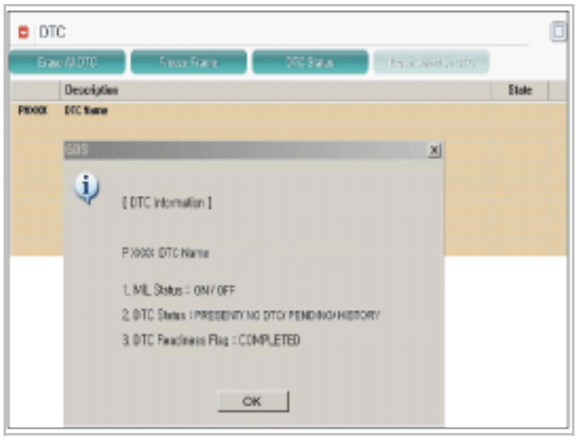
Sensor Name	Value	Unit
A/C On Condition	OFF	-
A/C Pressure	-2794	hPa
A/C Switch	OFF	-

Fig.3

Fig.1) Normal waveforms of A/C pressure sensor during the time from turning on A/C switch to turning off A/C switch.
Fig.2) Normal data of A/C pressure sensor without A/C switch ON.
Fig.3) Abnormal data of A/C pressure sensor when A/C pressure sensor circuit open.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect the A/C pressure sensor connector.
2. IG "ON"
3. Measure the voltage between power terminal of A/C pressure sensor harness connector and chassis ground.

Specification : Approx. 5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Signal Circuit Inspection" procedure.
NO	▶ Repair open or short to ground in harness and go to "Verification of Vehicle Repair" procedure.

Signal Circuit Inspection

■ Check short to ground in harness

1. IG "OFF" and disconnect A/C pressure sensor and ECM connector.
2. Measure the resistance between signal terminal of A/C pressure sensor harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification?

YES	▶ Go to "Check open in harness" as follows.
NO	▶ Repair short to ground in harness, and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect A/C pressure sensor and ECM connector.
2. Measure the resistance between signal terminal of A/C pressure sensor harness connector and A/C pressure sensor signal terminal of ECM harness connector.

Specification : Below 1Ω

3. Is the measured resistance within specification?

YES	▶ Go to "Component inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

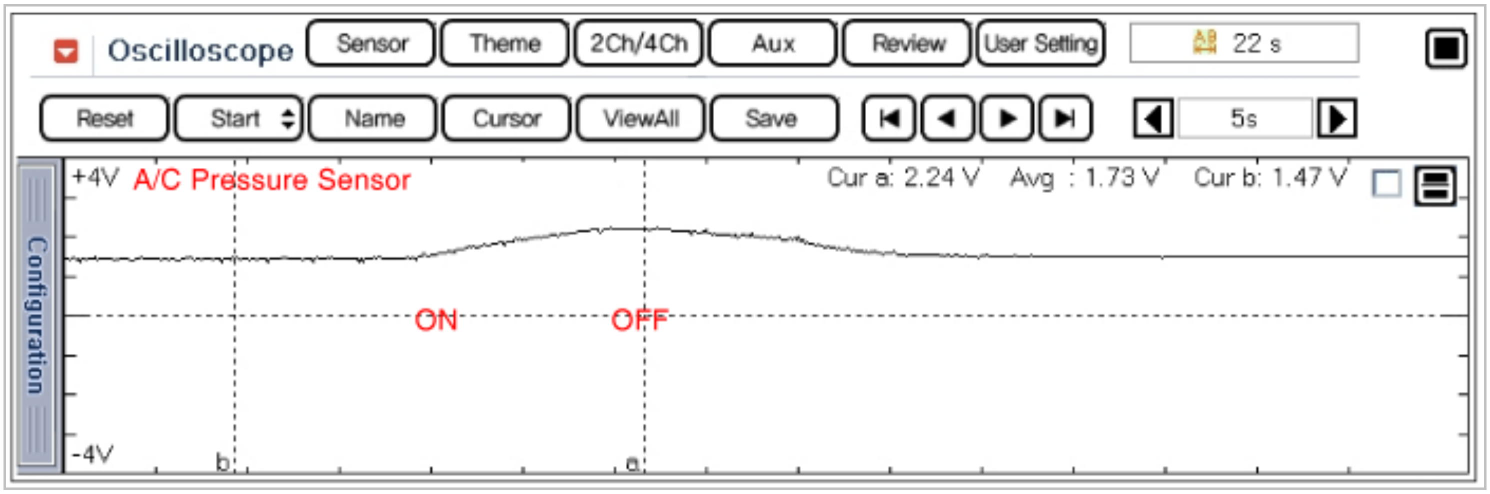
Component Inspection

■ Check A/C pressure sensor

1. IG "OFF" and connect the GDS.
2. Connect the probe to A/C pressure sensor signal and select the oscilloscope in the menu.
3. Check the waveform with turning on and off a/c switch after engine start.

Specification :

Pressure(kpa)	Voltage(V)
101.4	0.5
390.9	0.87
1723.7	2.57
3031.6	4.24
3206.1	4.46



4. Is the measured waveform of A/C pressure sensor normal?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good A/C pressure sensor and check for proper operation. If the problem is corrected, replace A/C pressure sensor and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

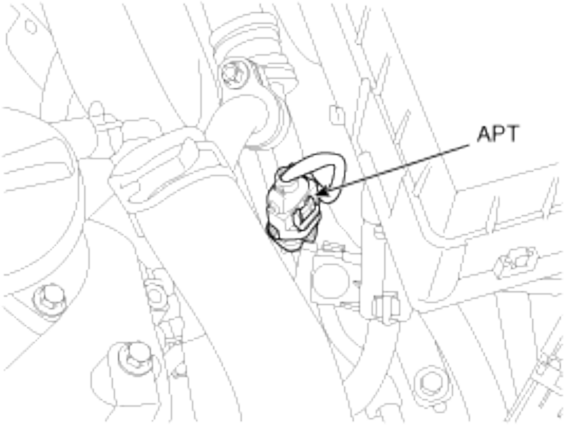
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0533 A/C Refrigerant Pressure Sensor \'A\' Circuit High Input

Component Location



General Description

The ECM(Engine Control Module) receives pressure signal in the A/C refrigerant high pressure side from the A/C refrigerant pressure sensor. This input indicates how much load the A/C compressor is putting on the engine and is one of the factors used by the ECM in order to determine the idle air control position for the idle speed. The circuits consist of a 5V reference and a ground, both provided by the ECM, and a signal from the sensor. The signal is a voltage which is proportional to the A/C pressure from 0 to 5V. Low pressure produces a low voltage signal and high pressure a high-voltage signal.

DTC Description

Checking output signals from A/C pressure sensor under detecting condition, if an signal above 4.65V lasts for more than 10 sec., ECM sets P0533.

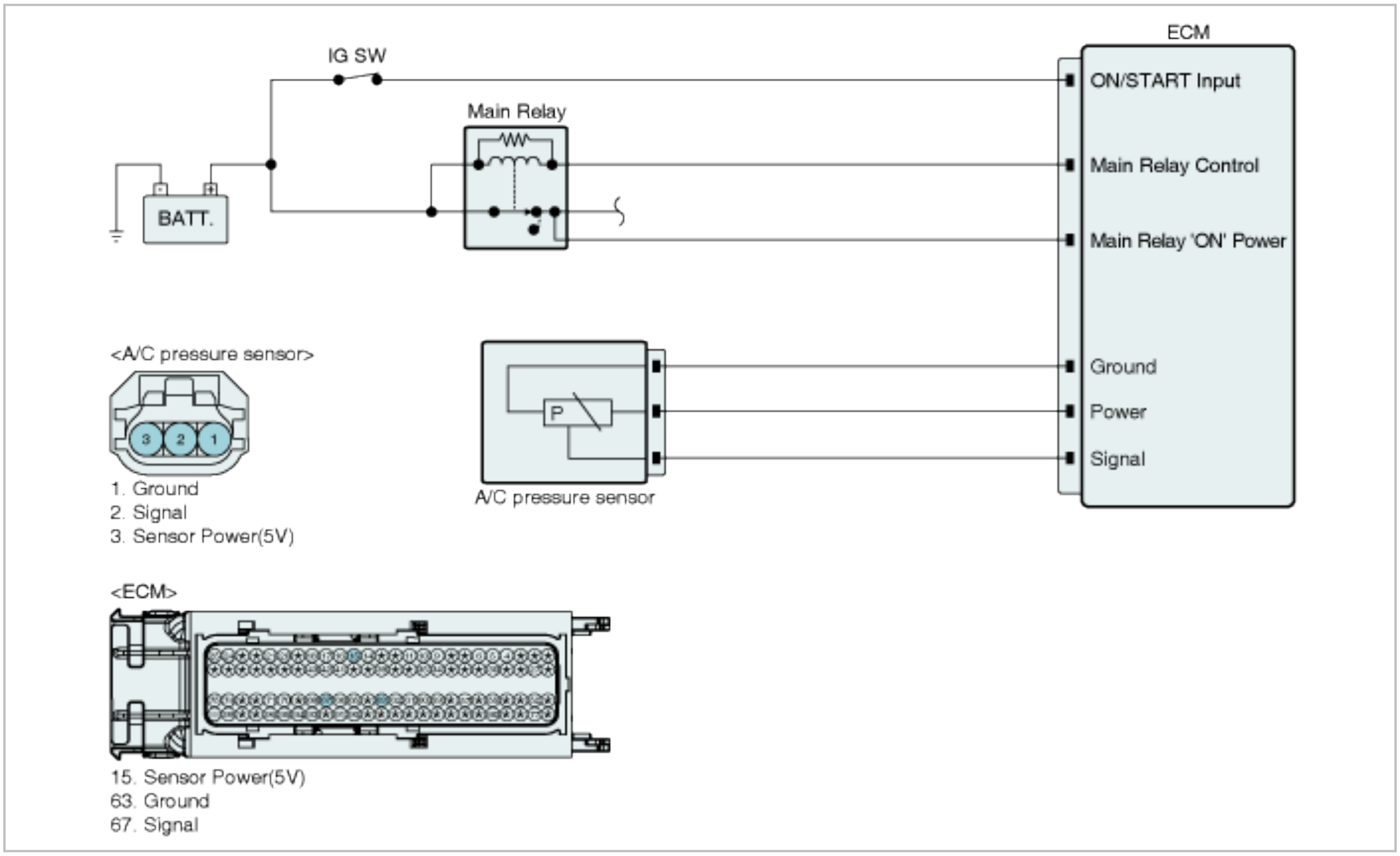
DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Detects sensor signal short to high voltage	• Poor connection • Short in signal circuit • Open in ground circuit • Faulty A/C Pressure sensor • Faulty ECM
Enable Conditions	• Engine works	
Threshold value	• Sensor output voltage > 4.65V	
Diagnosis Time	• Continuous (More than 10 seconds failure for every 20 seconds test)	
MIL On Condition	• DTC only (NO MIL ON)	

Specification

Pressure(kpa)	101.4	390.9	1723.7	3031.6	3206.1
Voltage(V)	0.5	0.87	2.57	4.24	4.46

Diagnostic Circuit Diagram



Signal Waveform & Data

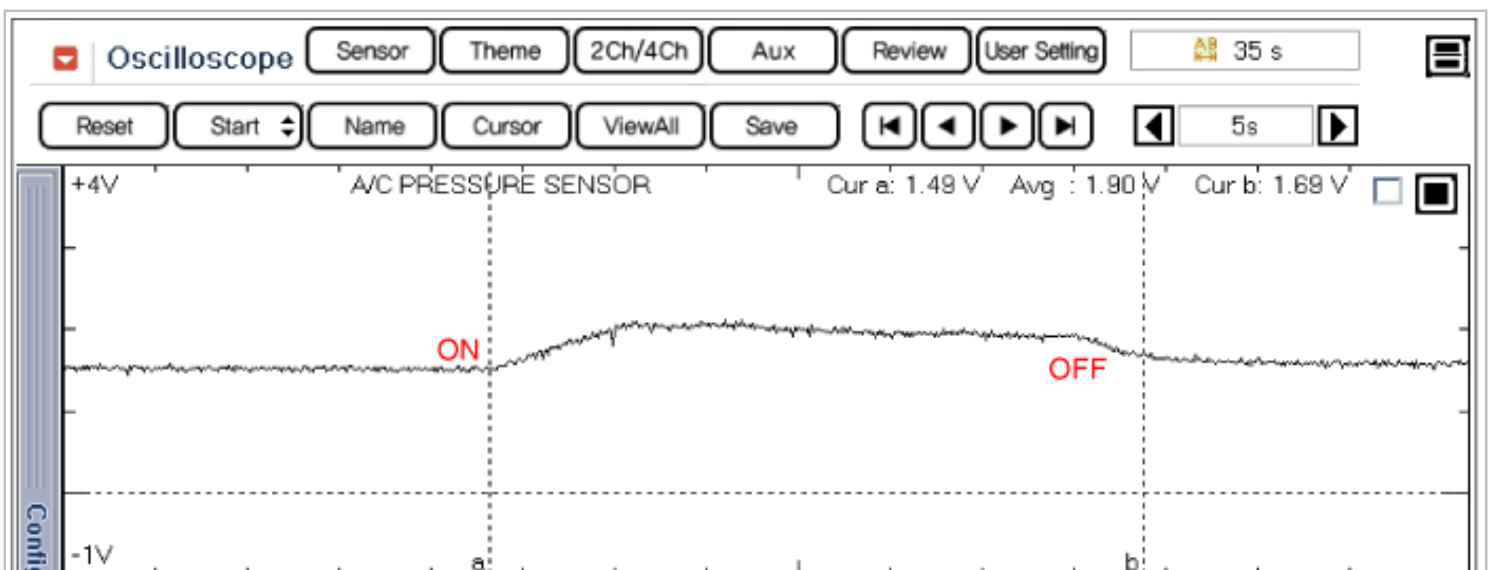


Fig.1

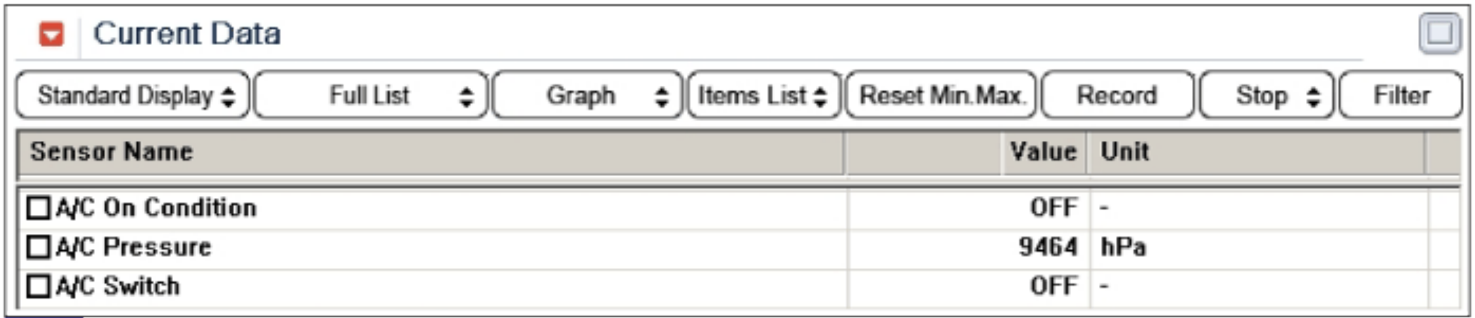


Fig.2

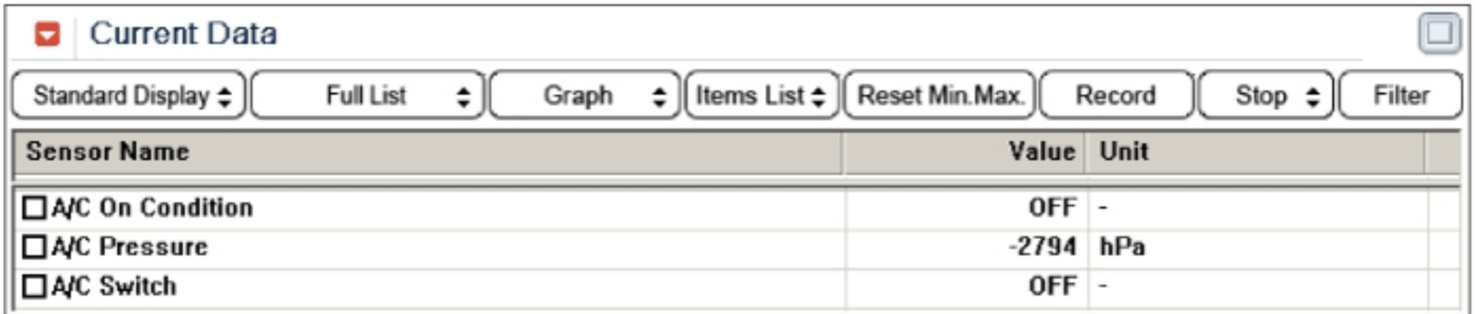
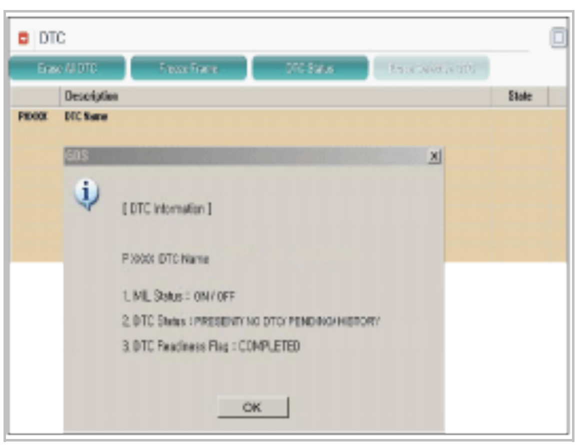


Fig.3

Fig.1) Normal waveforms of A/C pressure sensor during the time from turning on A/C switch to turning off A/C switch.
Fig.2) Normal data of A/C pressure sensor without A/C switch ON.
Fig.3) Abnormal data of A/C pressure sensor when A/C pressure sensor circuit open.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect the A/C pressure sensor connector.
2. IG "ON"
3. Measure the voltage between power terminal of A/C pressure sensor harness connector and chassis ground.

Specification : Approx. 5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Ground Circuit Inspection" procedure.
NO	▶ Repair open or short to ground in harness and go to "Verification of Vehicle Repair" procedure.

Ground Circuit Inspection

■ Check open in harness

1. IG "OFF" and disconnect the A/C pressure sensor connector.
2. IG "ON"
3. Measure the voltage between power terminal of A/C pressure sensor harness connector and chassis ground.(Measurement "A")
4. Measure the voltage between power and ground terminals of A/C pressure sensor harness connector.(Measurement "B")

Specification : The Difference between "A" and "B" is below 200mV.

5. Is the measured voltage within specification ?

YES	▶ Go to "Signal Circuit Inspection" procedure.
NO	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.

Signal Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect the A/C pressure sensor connector.
2. IG "ON"

3. Measure the voltage between signal terminal of A/C pressure sensor harness connector and chassis ground.

Specification : Approx. 0V

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Go to "Check short to battery in harness" procedure.

■ **Check short to battery in harness**

1. IG "OFF" and disconnect A/C pressure sensor and ECM connector.
2. Measure the resistance between signal and power terminals of A/C pressure sensor harness connector.

Specification : Infinite

3. Is the measured resistance within specification?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to battery in harness, and go to "Verification of Vehicle Repair" procedure.

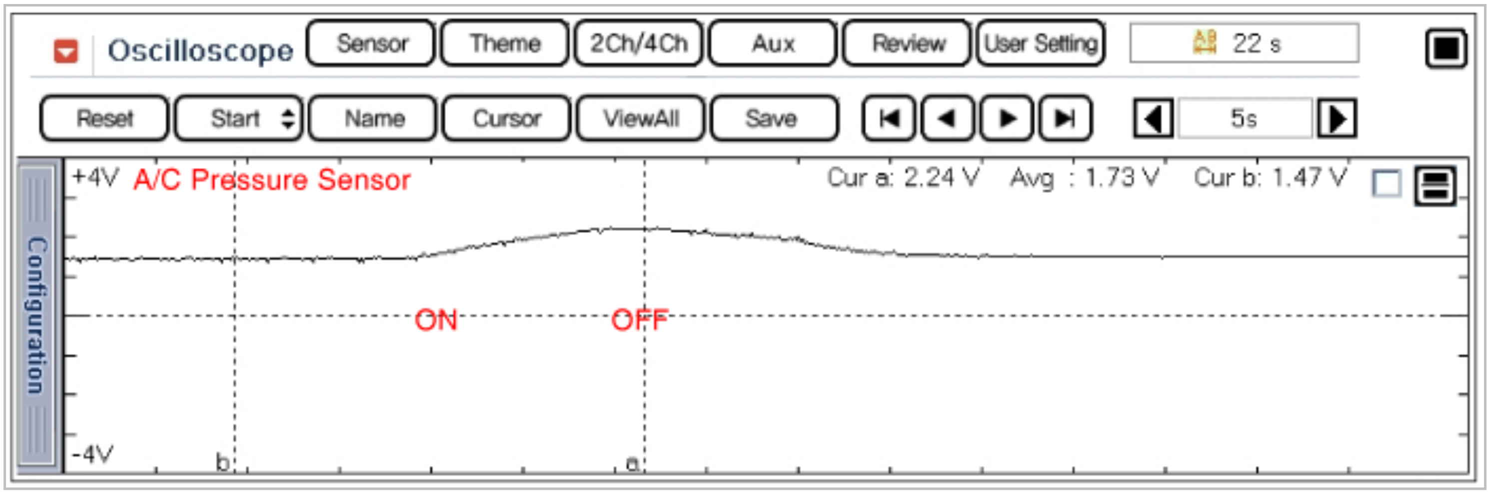
Component Inspection

■ **Check A/C pressure sensor**

1. IG "OFF" and connect the GDS.
2. Connect the probe to A/C pressure sensor signal and select the oscilloscope in the menu.
3. Check the waveform with turning on and off a/c switch after engine start.

Specification :

Pressure(kpa)	Voltage(V)
101.4	0.5
390.9	0.87
1723.7	2.57
3031.6	4.24
3206.1	4.46



4. Is the measured waveform of A/C pressure sensor normal?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good A/C pressure sensor and check for proper operation. If the problem is corrected, replace A/C pressure sensor and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

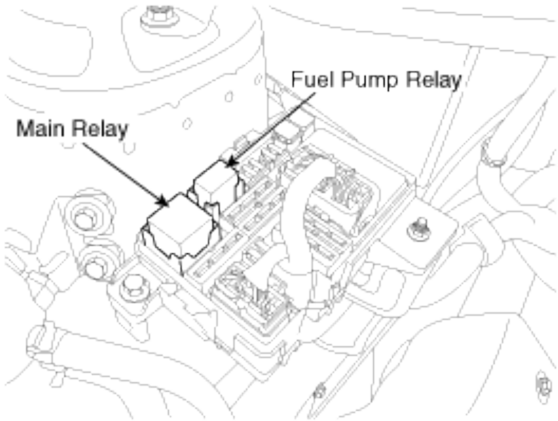
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0562 System Voltage Low

Component Location



General Description

The ECM provides ground to one side of the coil of the main relay and the other side is connected to the battery. The ECM monitors battery voltage and the voltage after the main relay.

DTC Description

During engine running, if system voltage is below 11V, ECM sets P0562. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

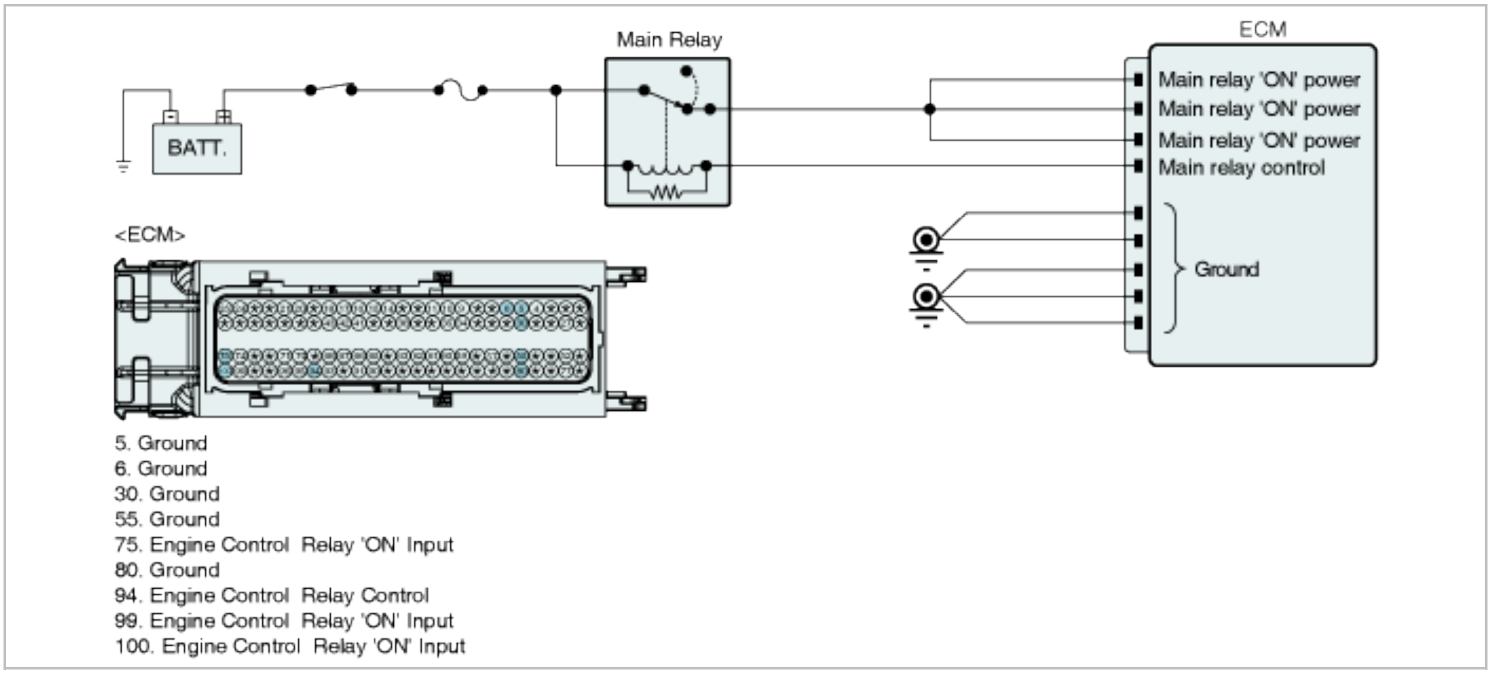
DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Voltage too low	• Poor connection • Open in circuit • Faulty charging system • Faulty main relay • Faulty ECM
Enable Conditions	• Engine works	
Threshold value	• System voltage < 11V	
Diagnosis Time	• Continuous	
MIL On Condition	• 2 driving cycles	

Specification

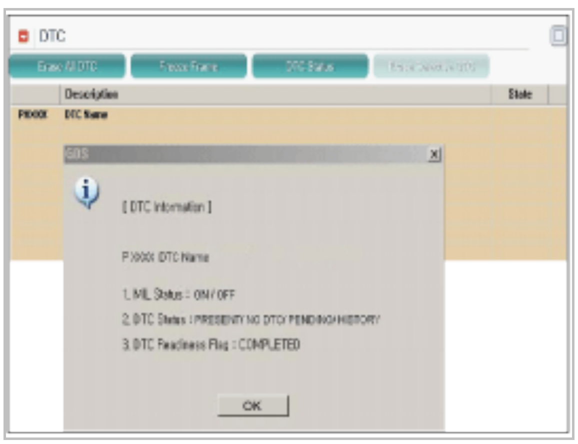
Coil Resistance	70Ω ~ 120Ω

Diagnostic Circuit Diagram



Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor’s and/or ECM’s connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.

2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect the main relay.
2. IG "ON"
3. Measure the voltage between power supply terminals of main relay harness connector and chassis ground.

Specification : Approx. B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Check short in harness" procedure.
NO	▶ Check the fuse between battery and main relay. ▶ Repair open or short to ground in power harness and go to "Verification of Vehicle Repair" procedure .

■ Check open in harness

1. IG "OFF" and disconnect the main relay and ECM connector.
2. Measure the resistance between main relay 'ON' power terminal of main relay harness connector and main relay 'ON' power terminals of ECM harness connector.

Specification : Approx. below 1Ω

3. Is the measured resistance within specification ?

YES	▶ Go to "Check short to ground in harness" procedure.
NO	▶ Repair open in harness and go to "Verification of Vehicle Repair" procedure .

■ Check short to ground in harness

1. IG "OFF" and disconnect the main relay and ECM connector.
2. Measure the resistance between main relay 'ON' power terminal of main relay harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.
NO	▶ Repair short to ground in harness and go to "Verification of Vehicle Repair" procedure.

Control Circuit Inspection

■ Check short to ground in harness

1. IG "OFF" and disconnect the main relay and ECM connector.
2. Measure the resistance between control terminal of main relay harness connector and chasses ground.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Check open in harness" procedure.
NO	▶ Repair short to ground in control harness and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect the main relay and ECM connector.
2. Measure the resistance between control terminal of main relay harness connector and main relay control terminal of ECM harness connector.

Specification : Approx. below 1Ω

3. Is the measured resistance within specification ?

YES	▶ Go to "System Inspection" procedure.
NO	▶ Repair open in control harness and go to "Verification of Vehicle Repair" procedure.

System Inspection

■ Check Generator circuit

1. IG "OFF".
2. Disconnect Generator connector.
3. IG "ON".
4. Measure the voltage between lamp terminal of Generator and chassis gound.
5. Measure the voltage between FR terminal of Generator and chassis gound.

Specification : B+

6. Is the measured voltage within specification?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ In case lamp terminal : Repair MIL circuit, MIL resistor or open in harness and go to "Verification of Vehicle Repair" procedure. ▶ In case FR terminal : Repair the fuse between battery and Ignition switch, the fuse between Ignition switch and alternator or open in harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check Main relay

1. IG "OFF" and disconnect main relay.
2. Measure the resistance between battery power supply and control terminals of main relay.(Measurement "A")
3. Measure the resistance between battery power supply and power supply to ECM terminals of main relay.(Measurement "B")

Specification :

Terminal	Continuity
Battery power supply - Power supply to ECM	NO
Battery power supply - Main relay control	YES(Approx. 70Ω ~ 120Ω)

4. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good Main Relay and check for proper operation. If the problem is corrected, replace Main Relay and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

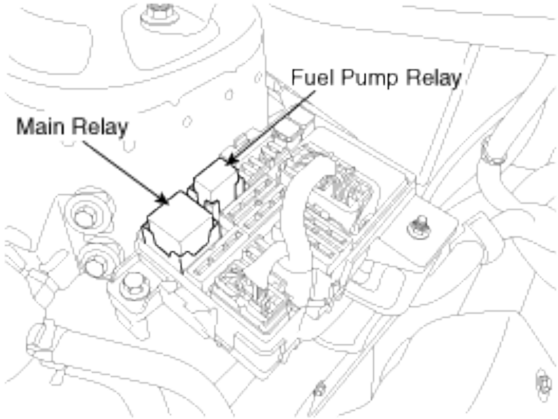
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0563 System Voltage High

Component Location



General Description

The ECM provides ground to one side of the coil of the main relay and the other side is connected to the battery. The ECM monitors battery voltage and the voltage after the main relay.

DTC Description

During engine running, if system voltage is above 16V, ECM sets P0563. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

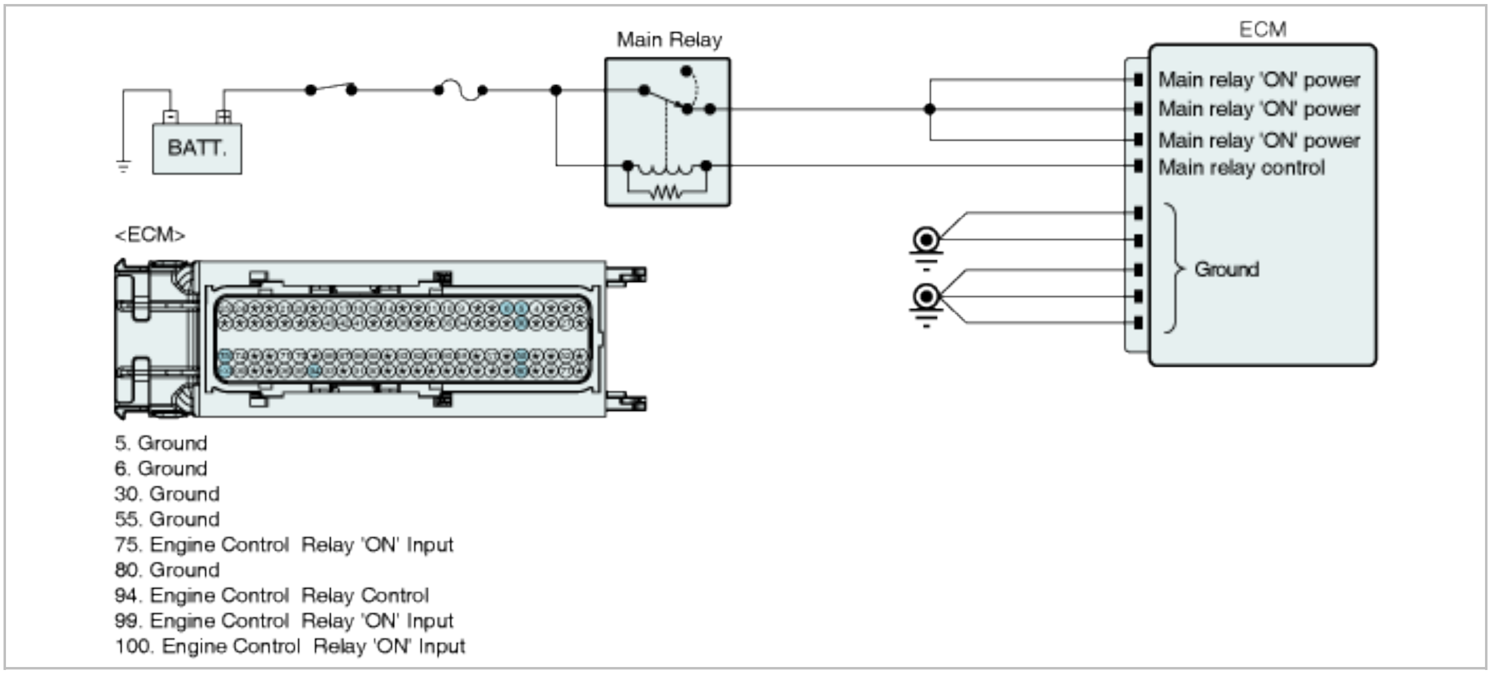
DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Voltage too high	• Poor connection • Short in circuit • Faulty charging system • Faulty main relay • Faulty ECM
Enable Conditions	• Engine works	
Threshold value	• System voltage > 16V	
Diagnosis Time	• Continuous	
MIL On Condition	• 2 driving cycles	

Specification

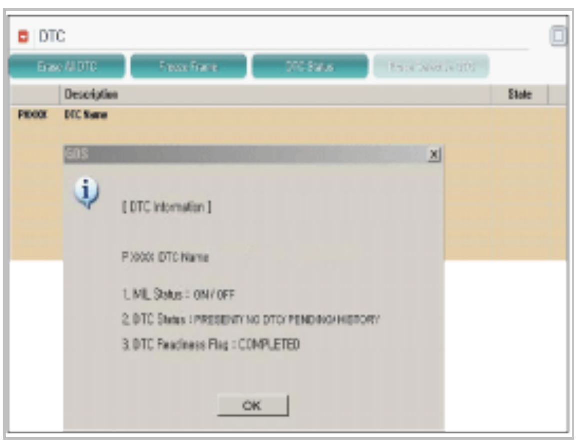
Coil Resistance	70Ω ~ 120Ω

Diagnostic Circuit Diagram



Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.

2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect the main relay.
2. IG "ON"
3. Measure the voltage between power supply terminals of main relay harness connector and chassis ground.

Specification : Approx. B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Check short in harness" procedure.
NO	▶ Repair open or short to ground in harness and go to "Verification of Vehicle Repair" procedure.

■ Check short in harness

1. IG "ON"
2. Measure the voltage between main relay 'ON' power terminals of ECM harness terminal and chassis ground.

Specification : Approx. B+

3. Is the measured voltage within specification ?

YES	▶ Go to "System Inspection" procedure.
NO	▶ Repair short in power harness and go to "Verification of Vehicle Repair" procedure.

System Inspection

■ Check Generator circuit

1. IG "OFF".
2. Disconnect Generator connector.
3. IG "ON".
4. Measure the voltage between lamp terminal of Generator and chassis gound.
5. Measure the voltage between FR terminal of Generator and chassis gound.

Specification : B+

6. Is the measured voltage within specification?

YES	▶ Go to "Component Inspection" procedure.

NO	▶ Repair short in sensing circuit or MIL circuit and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check Main relay

1. IG "OFF" and disconnect main relay.
2. Measure the resistance between battery power supply and control terminals of main relay.(Measurement "A")
3. Measure the resistance between battery power supply and power supply to ECM terminals of main relay.(Measurement "B")

   Specification :

Terminal	Continuity
Battery power supply - Power supply to ECM	NO
Battery power supply - Main relay control	YES(Approx. 70Ω ~ 120Ω)

4. Is the measured resistance within specification ?

YES	▶ Go to "Check Generator" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good Main Relay and check for proper operation. If the problem is corrected, replace Main Relay and go to "Verification of Vehicle Repair" procedure.

■ Check Generator

1. IG "OFF".
2. Check the tension of the belt.
3. Check Battery terminal and Generator B+ terminal for looseness, corrosion or damage.
4. Engine "ON".
5. Operate electric equipments (Head lamp, Hot wire, etc).
6. accelerate engine to 2000 RPM and measure the battery voltage.

   Specification : Approx. 12.5V ~ 14.5V

7. Is the measured voltage within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace PCM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others

NO	▶ Substitute with a known - good Generator and check for proper operation.If the problem is corrected, replace Generator and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0571 Brake Switch \'A\' Circuit

General Description

The Stop lamp switch is used to judge whether the acceleration system is abnormal or not. The stop lamp switch has a duplex system(signals brake test or brake light) to memorize the abnormality when the signals of depressing and releasing the brake pedal are detected simultaneously.

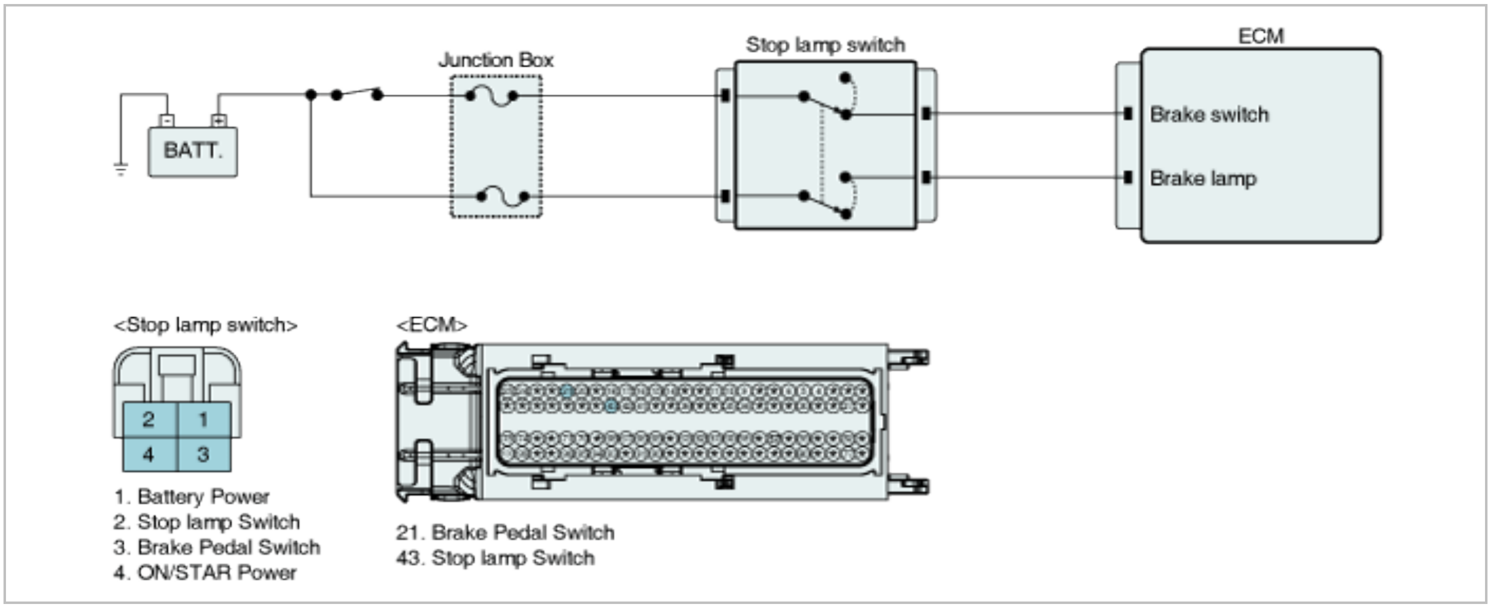
DTC Description

Checking input signals from stop lamp switch under detecting condition, if the operation state of stop lamp switch does not change for more than 3 sec., ECM sets P0571. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• ECM detects stop lamp input signal when vehicle stops.	• Poor connection • Open or short to ground in signal circuit • Faulty ECM
Enable Conditions	• Engine works • Vehicle speed signal is normal. • Vehicle speed > 20kph (during 1sec or more)	
Threshold value	• Vehicle speed < 3kph • Vehicle acceleration < -6kph/s • Stop lamp "OFF" and not changing of stop lamp signal for more 3 sec.	
Diagnosis Time	• Continuous	
MIL On Condition	• NO MIL ON(DTC only)	

Diagnostic Circuit Diagram



Signal Waveform & Data

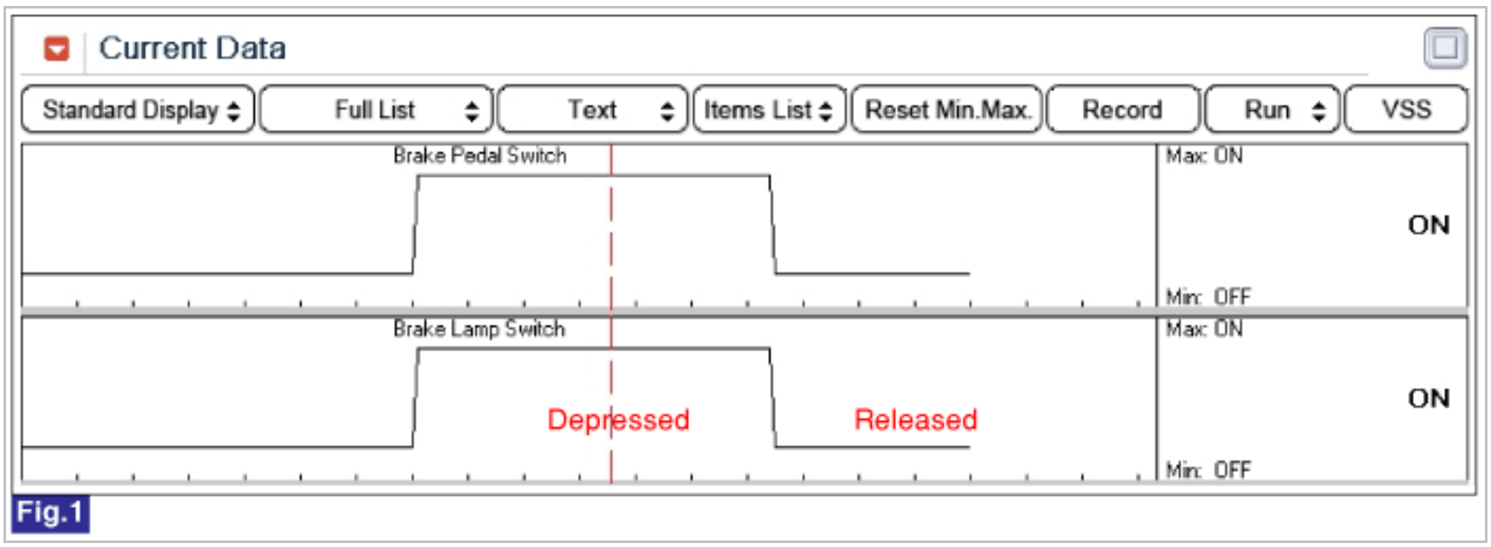
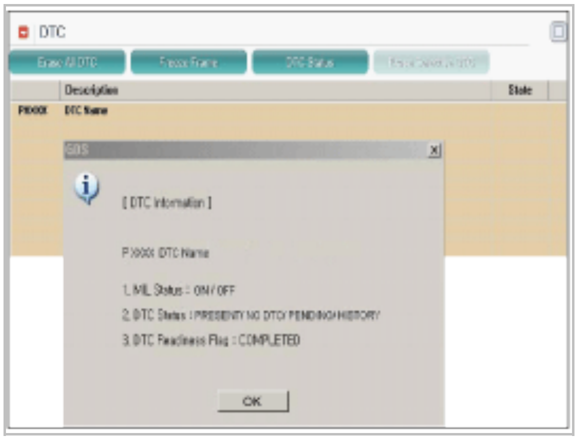


Fig.1) Normal data of Brake Switch during brake pedal released after depressed.

Monitor Scantool Data

1. Connect scantool to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect ECM connector.
2. IG "ON"
3. Brake 'OFF' : Measure the voltage between brake lamp signal terminal of ECM harness connector and chassis ground.(Measurement "A")
4. Brake 'ON' : Measure the voltage between brake lamp signal terminal of ECM harness connector and chassis ground.(Measurement "B")
Specification :

Item	Brake 'OFF'	Brake 'ON'
Brake Lamp side	0V	Battery voltage

5. Is the measured voltage within specification ?

YES	▶ Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair as necessary and go to "Verification of Vehicle

	Repair" procedure.
NO	▶ Go to "Check open in harness" as follows.

■ **Check open in harness**

1. IG "OFF" and disconnect stop lamp switch and ECM connector.
2. Measure the resistance between brake lamp signal terminal of ECM harness connector and brake lamp signal terminal of Stop lamp switch harness connector.

    Specification : Below 1Ω

3. Is the measured resistance within specification ?

YES	▶ Go to "Check Battery voltage" procedure.
NO	▶ Repair open in circuit and go to "Verification of Vehicle Repair" procedure.

■ **Check battery voltage**

1. IG "OFF" and disconnect stop lamp switch connector.
2. Measure the voltage between power supply terminals of stop lamp switch harness connector and chassis ground.
3. IG "ON"
4. Measure the voltage between power supply terminals of stop lamp switch harness connector and chassis ground.
    Specification :

Item	IG "OFF"	IG "ON"
Power supply to brake switch side	Battery voltage	Battery voltage
Power supply to brake lamp side	0V	Battery voltage

5. Is the measured voltage within specification ?

YES	▶ Substitute with a known - good stop lamp switch and check for proper operation. If the problem is corrected, replace stop lamp switch and go to "Verification of Vehicle Repair" procedure.
NO	▶ Check the fuse between battery and stop lamp switch. ▶ Repair open or short in power circuit of stop lamp switch and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

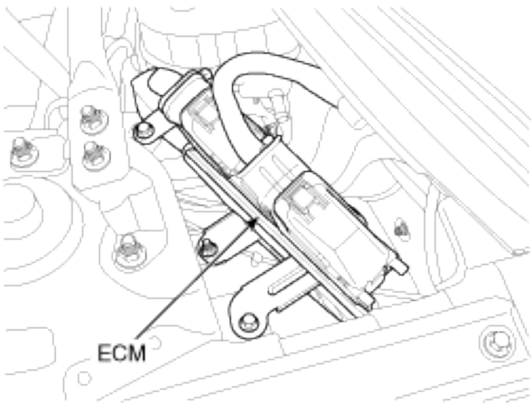
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0601 Internal Control Module Memory Check Sum Error

Component Location



General Description

A malfunction is detected by using a checksum technique for verifying data. The digital data is composed of zeros and ones. A checksum is the total of all ones in a string of data. By comparing the checksum value with a stored value, a malfunction can be detected.

DTC Description

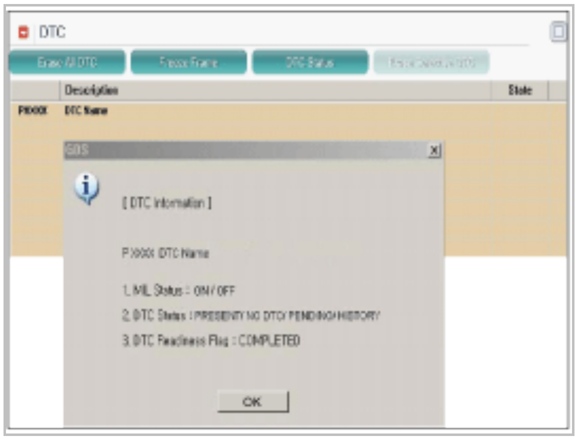
If real checksum does not accord with memory checksum, ECM sets P0601 and MIL(Malfunction Indication Lamp) turns on.

DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Checksum check	• Faulty ECM
Enable Conditions	• -	
Threshold value	• Discordance between the real checksum and the memorized checksum	
Diagnosis Time	• Continuous	
MIL On Condition	• 1 driving cycle	

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others

Verification of Vehicle Repair

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

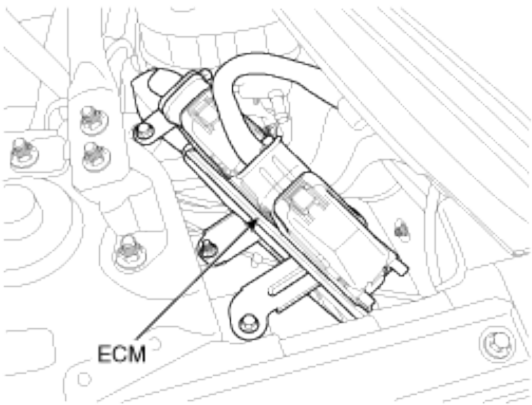
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.

NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0602 Control Module Programming Error

Component Location



General Description

A malfunction is detected by using a checksum technique for verifying data. The digital data is composed of zeros and ones. A checksum is the total of all ones in a string of data. By comparing the checksum value with a stored value, a malfunction can be detected.

DTC Description

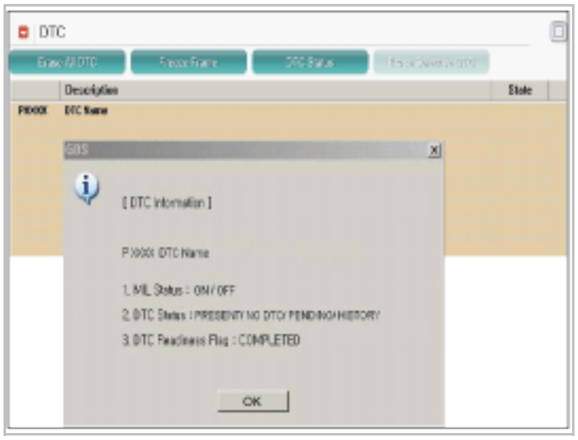
If CPU software version dose not accord with main CPU, ECM sets P0602.

DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Check internal CPU	• Faulty ECM
Enable Conditions	• -	
Threshold value	• The version discordance among PCU S/W or Calibration	
Diagnosis Time	• Continuous	
MIL On Condition	• 1 driving cycle	

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor’s and/or ECM’s connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others

Verification of Vehicle Repair

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

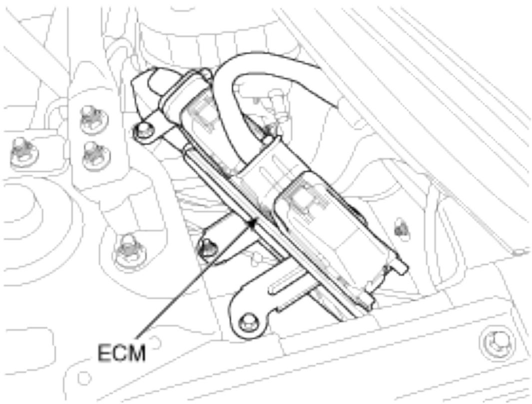
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.

NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0604 Internal Control Module Random Access Memory (RAM) Error

Component Location



General Description

A malfunction is detected by using a checksum technique for verifying data. The digital data is composed of zeros and ones. A checksum is the total of all ones in a string of data. By comparing the checksum value with a stored value, a malfunction can be detected.

DTC Description

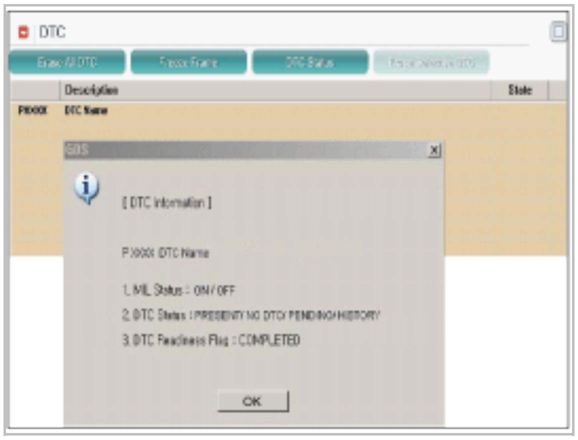
If the RAM in ECM has errors, ECM sets P0604 and MIL(Malfunction Indication Lamp) turns on.

DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Check internal CPU	• Faulty ECM
Enable Conditions	• -	
Threshold value	• RAM has errors	
Diagnosis Time	• Continuous	
MIL On Condition	• 1 driving cycle	

Monitor Scantool Data

1. Connect scantool to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others

Verification of Vehicle Repair

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

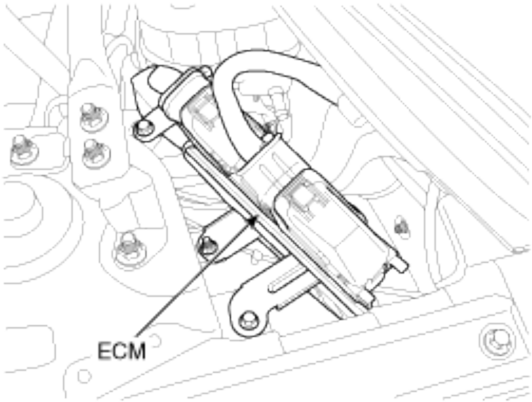
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.

NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0606 ECM/PCM Processor

Component Location



General Description

A malfunction is detected by using a checksum technique for verifying data. The digital data is composed of zeros and ones. A checksum is the total of all ones in a string of data. By comparing the checksum value with a stored value, a malfunction can be detected.

DTC Description

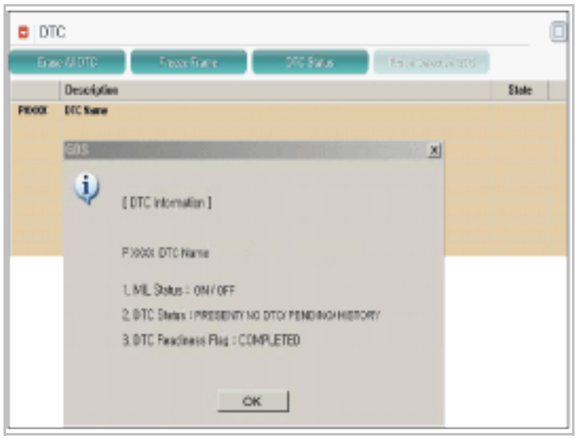
Checking ECM under detecting condition, if internal error is detected, ECM sets P0606. And MIL(Malfunction Indication Lamp) turns on.

DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Check ECM internal error	• Faulty ECM
Enable Conditions	• 7V < Battery voltage < 20V	
Threshold value	• ECM internal error (A/D unit error)	
Diagnosis Time	• Continuous	
MIL On Condition	• 1 driving cycle	

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others

Verification of Vehicle Repair

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

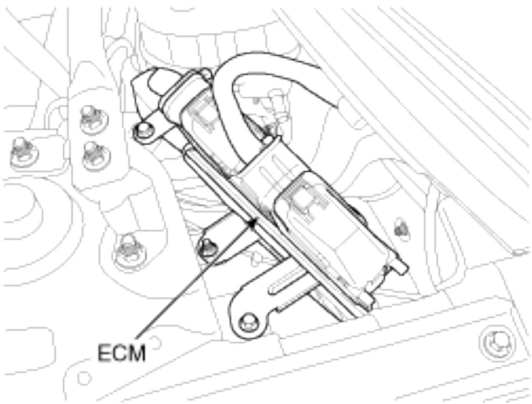
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.

NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P061B Internal Control Module Torque Calculation Performance

Component Location



General Description

A malfunction is detected by using a checksum technique for verifying data. The digital data is composed of zeros and ones. A checksum is the total of all ones in a string of data. By comparing the checksum value with a stored value, a malfunction can be detected.

DTC Description

If desired torque is calculated much higher than actual torque, ECM senses it and decreases desired torque. Also, ECM sets P061B. The causes of this error are abnormal operation of ECM (RAM,ROM, ALU errors) and hardware malfunction such that actual air flow enters the engine is more than the flow recognized by ECM.

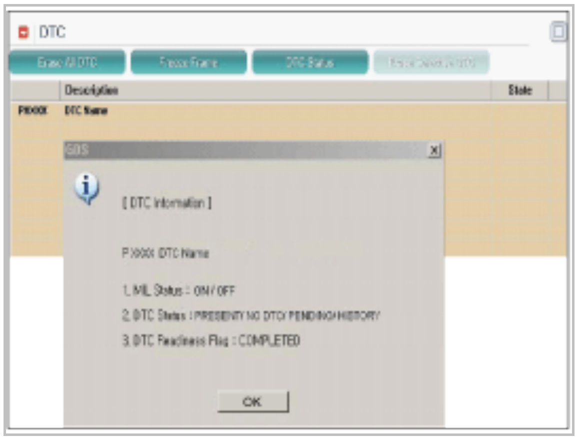
DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Monitor Desired torque and actual torque	• Poor Connection • Faulty ECM
Enable Conditions	• Engine works	
Threshold value	• Desired torque is much higher than actual torque.	
Diagnosis Time	• Continuous	
MIL On Condition	• DTC only(NO MIL ON)	

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.

4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure. (If different DTC showed up together, another DTC is repaired first.)
NO	▶ Fault is intermittent caused by ECM memory was not cleared after repair. Go to "Verification of Vehicle Repair Inspection" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.

NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0630 VIN Not Programmed or Incompatible-ECM/PCM

General Description

Regulations require that all 2005 and subsequent model year vehicles shall have the Vehicle Identification Number(VIN) available in a standardized format through the standardized data link connector in accordance with SAE J1979 specifications. Using a scan tool, PERFORM "VIN WRITING" procedure after replacing or reflashing a ECM.

DTC Description

The purpose of this logic is to prevent a vehicle from leaving the assembly plant or service station without a VIN in its EEPROM memory. If the VIN writing is not programmed or incompatible, the ECM determines that a fault exists and a DTC is stored.And the MIL(Malfunction Indication Lamp) turns on.

DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• VIN not programmed or incompatible	• VIN is not programmed. • Faulty ECM
Enable Conditions	• None	
Threshold value	• Error Code: "ON".	
Diagnosis Time	• Continuous	
MIL On Condition	• 1 driving cycle	

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Monitor the ECM status by VIN reading whether it is virgin or learnt
4. Is the ECM status Virgin ?

YES	▶ Perform VIN writing procedure according to the direction on the GDS screen and go to "Verification of Vehicle Reapair" procedure.
NO	▶ Fault is intermittent caused by poor contact in Sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by PCM. After testing PCM on the vehicle, use this function to reuse the PCM on the others.

Verification of Vehicle Repair

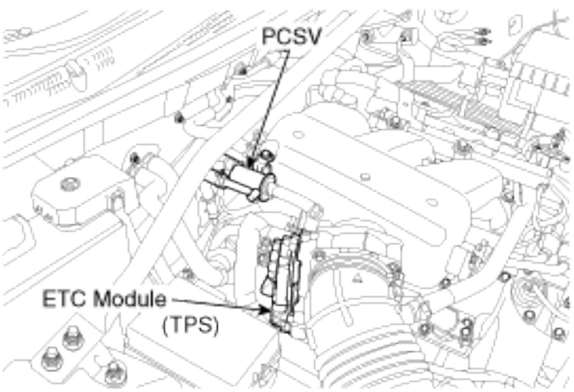
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0638 Throttle Actuator Control Range/Performance (Bank 1)

Component Location



General Description

The Electronic Throttle Control(ETC) system is made of the components throttle body, Throttle Position Sensor(TPS)1&2 and Accelerator Position Sensor(APS) 1&2. The throttle body contains the actuator, the throttle plate and the throttle position sensor (potentiometer), which are integrated in one housing. The actuator consists of a DC motor with a two-stage gear. The opening angle of the throttle valve is detected by the throttle position sensor which is mounted on the throttle body. And it provides feedback to the ECM to control the throttle motor in order to control the throttle valve opening angle properly in response to the driving condition.

DTC Description

Checking output signals from TPS under detecting condition, if the difference between real and target throttle position is above the specified value, ECM sets P0638 and then MIL(Malfunction Indication Lamp) turns on.

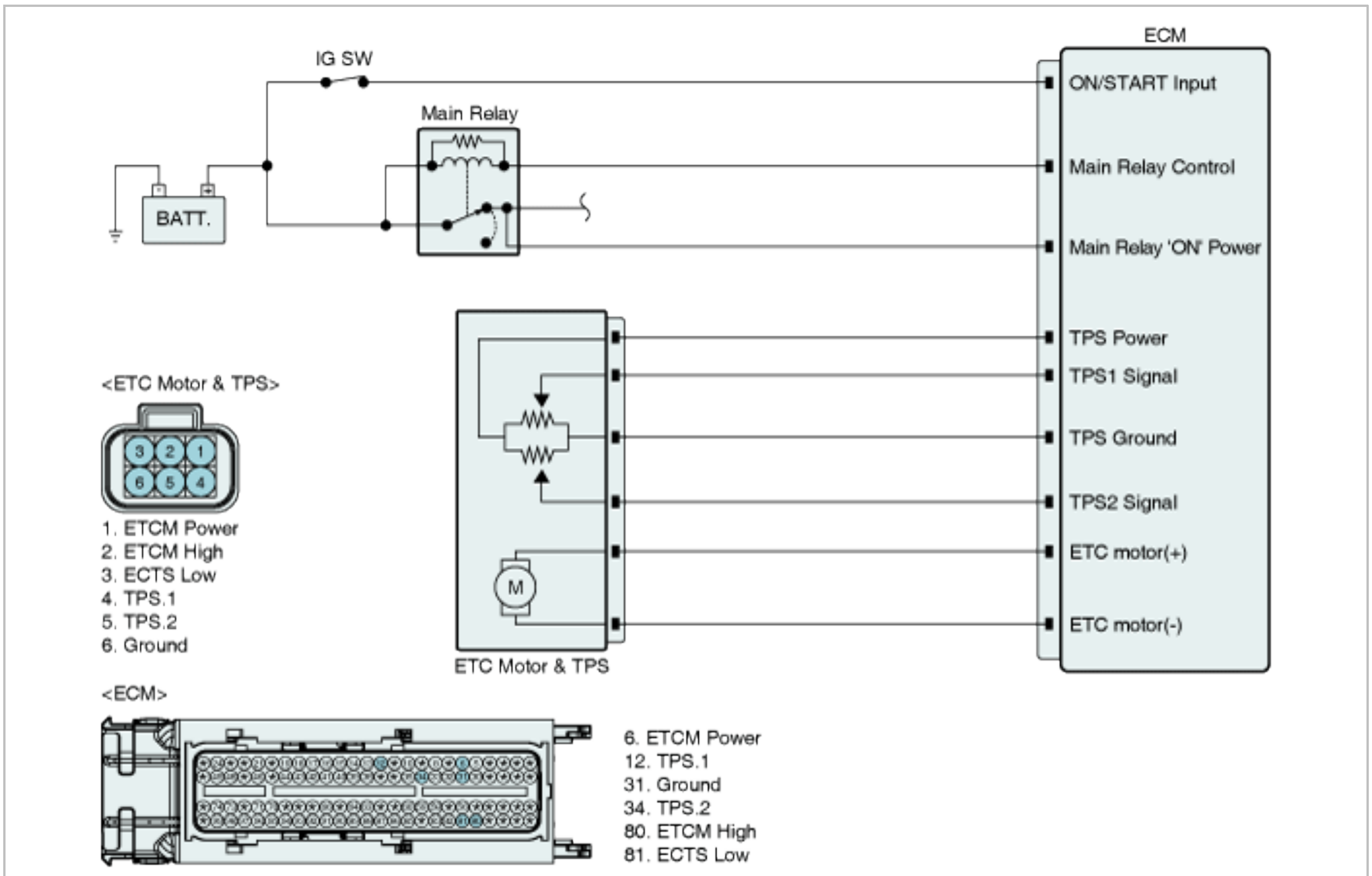
DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Monitor the throttle position	

Enable Conditions	• Engine works • Battery voltage > 5V	
Threshold value	• The difference between the real ETS motor & TPS value and the target ETS motor & TPS value is over 4.5°.	• Throttle stuck • Open in motor circuit • Faulty motor • Faulty ECM
	• When real Throttle position is below 36°, (the real throttle position - the target throttle position) < - 4.5°	
	• (the real throttle position - the target throttle position) < - 18°	
Diagnosis Time	• Continuous	
MIL On Condition	• 1 driving cycle	

※ If Main relay has a fault(ex. Open) under engine running, the DTCs,P0638/P0685/P1295/P2106, can happen at the same time.
<DTC Name>
- P0638 Throttle Actuator Control Range/Performance(Bank 1)
- P0685 ECM/ECM Power Relay Control Circuit /Open
- P1295 Throttle Actuator Control System - Power Management
- P2106 Throttle Actuator Control System - Forced Limited Power

Diagnostic Circuit Diagram



Signal Waveform & Data

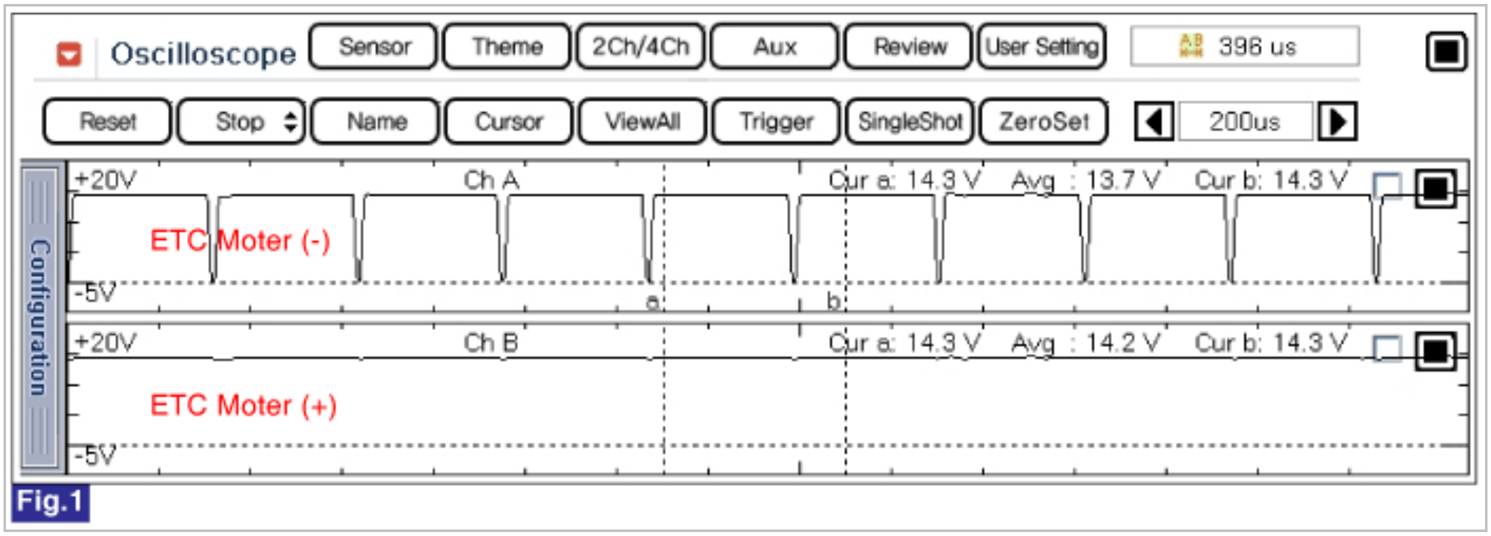


Fig.1

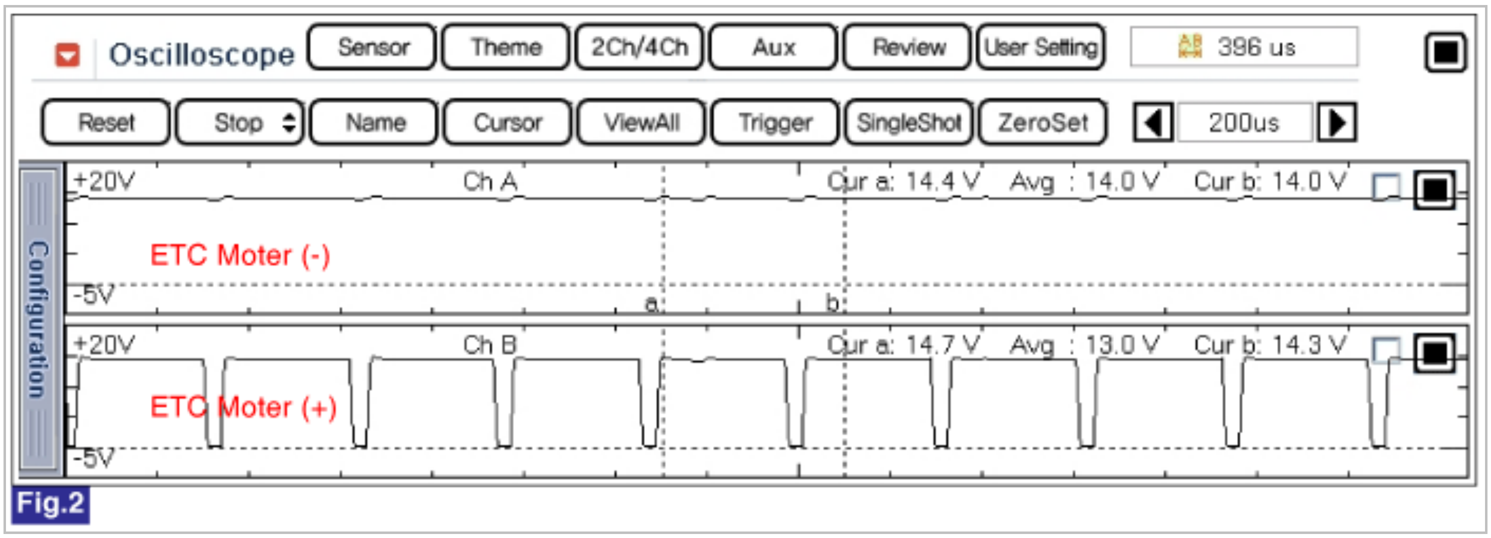
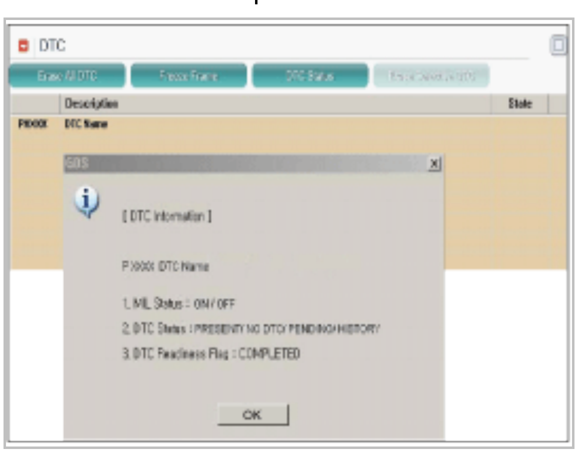


Fig.2

Fig.1) Normal waveform of ETC motor with acceleration
Fig.2) Normal waveform of ETC motor with deceleration

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to " Control Circuit Inspection " procedure.

Control Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect ETC Motor & TPS connector.
2. IG "ON"
3. Measure the voltage between ETC motor(+)/(-) of ETC Motor & TPS harness connector and chassis ground.

Specification : Approx. B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Go to "Check open in harness" as follows.

■ Check open in harness

1. IG "OFF" and disconnect ETC Motor & TPS connector and ECM connector.
2. Measure the resistance between ETC motor (+) terminal of ETC Motor & TPS harness connector and ETC motor (+) terminal of ECM harness connector.
3. Measure the resistance between ETC motor (-) terminal of ETC Motor & TPS harness connector and ETC motor (-) terminal of ECM harness connector.

Specification : Approx. below 1Ω

4. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in motor harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check throttle valve for stuck

1. IG "OFF" and disconnect the air hose between throttle body and air mass flow sensor.
2. Check stuck on throttle valve..
3. Is the throttle valve normal?

YES	▶ Go to "Check ETC motor resistance" as follows.
NO	▶ Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

■ Check ETC motor resistance

1. IG "OFF" and disconnect ETC Motor & TPS connector.
2. Measure the resistance between ETC motor(+) and (-) terminals of ETC Motor & TPS connector (component side).

Specification : Approx. 1.275 ~ 1.725Ω @ 23°C(73.4°F)

3. Is the throttle valve normal?

YES	▶ Is the measured resistance within specification ?
NO	▶ Substitute with a known - good ETC motor and check for proper operation. If the problem is corrected, replace ETC motor and go to "Verification of Vehicle Repair" procedure.

※ Procedure of ETS Initialization

A. Erase the trouble codes on ECM

B. Turn the ignition key off and keep this condition until the main relay is turned off.(It will take 10sec.)

C. Turn ignition key on more than 1second to record the throttle motor position on the EEPROM

■ ETC motor actuation test

1. IG "OFF" and connect ETC Motor & TPS connector.
2. After IG "ON", execute the "ETC motor actuation test" by GDS.

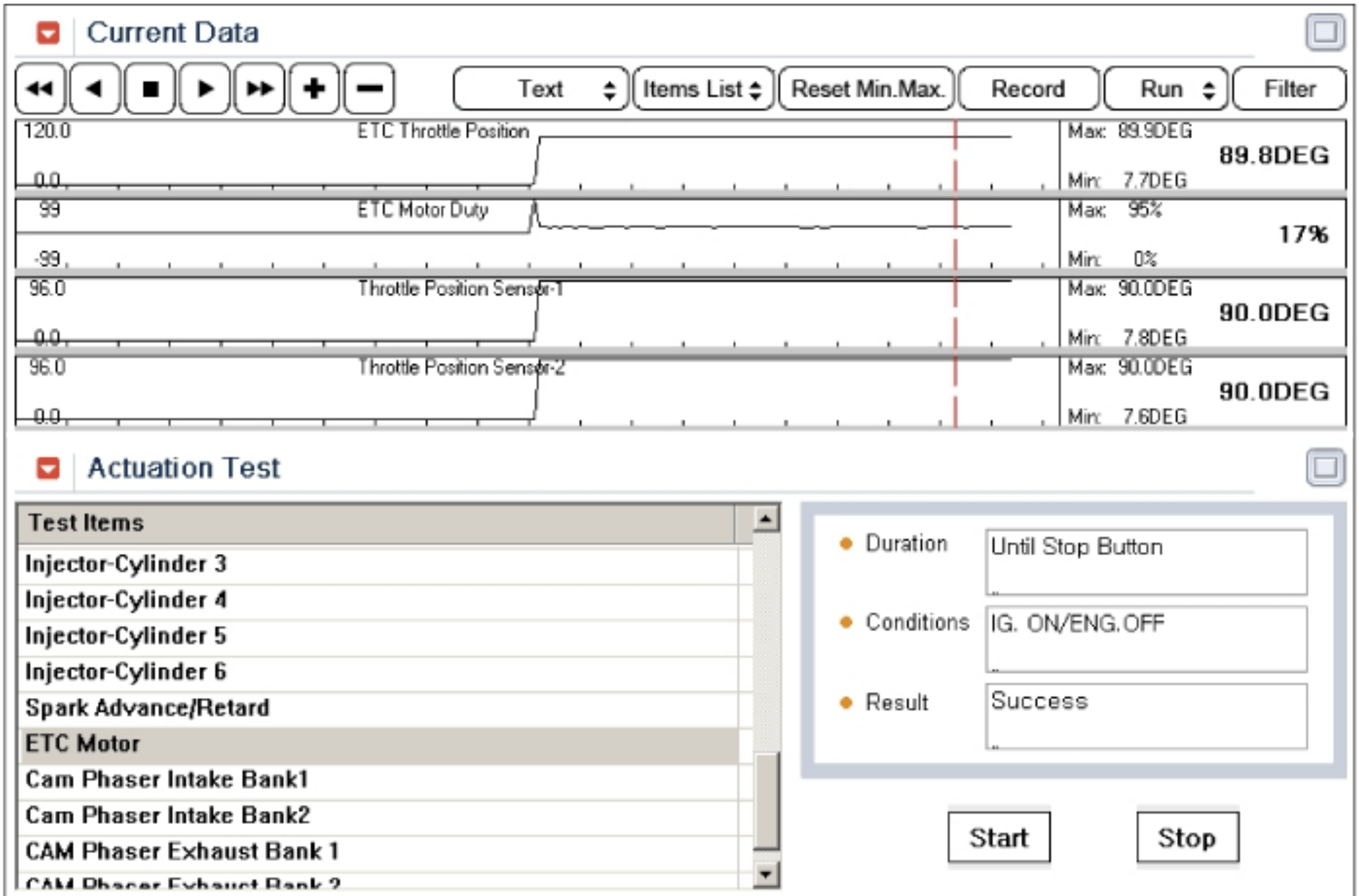


Fig.1

3. Does the ETC motor operate normally?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good ETC motor and check for proper operation. If the problem is corrected, replace ETC motor and go to "Verification of Vehicle Repair" procedure.

※ Procedure of ETS Initialization

A. Erase the trouble codes on ECM

B. Turn the ignition key off and keep this condition until the main relay is turned off.(It will take 10sec.)

C. Turn ignition key on more than 1second to record the throttle motor position on the EEPROM

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.

2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle

within conditions noted in the freeze frame data or enable conditions.

3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0641 Sensor Reference Voltage \'A\' Circuit/Open

General Description

The ECM provides a 5 volt reference voltage to Throttle Position Sensor 1(TPS1). The ECM monitors reference voltage deviation from the power supply circuit of the sensors.

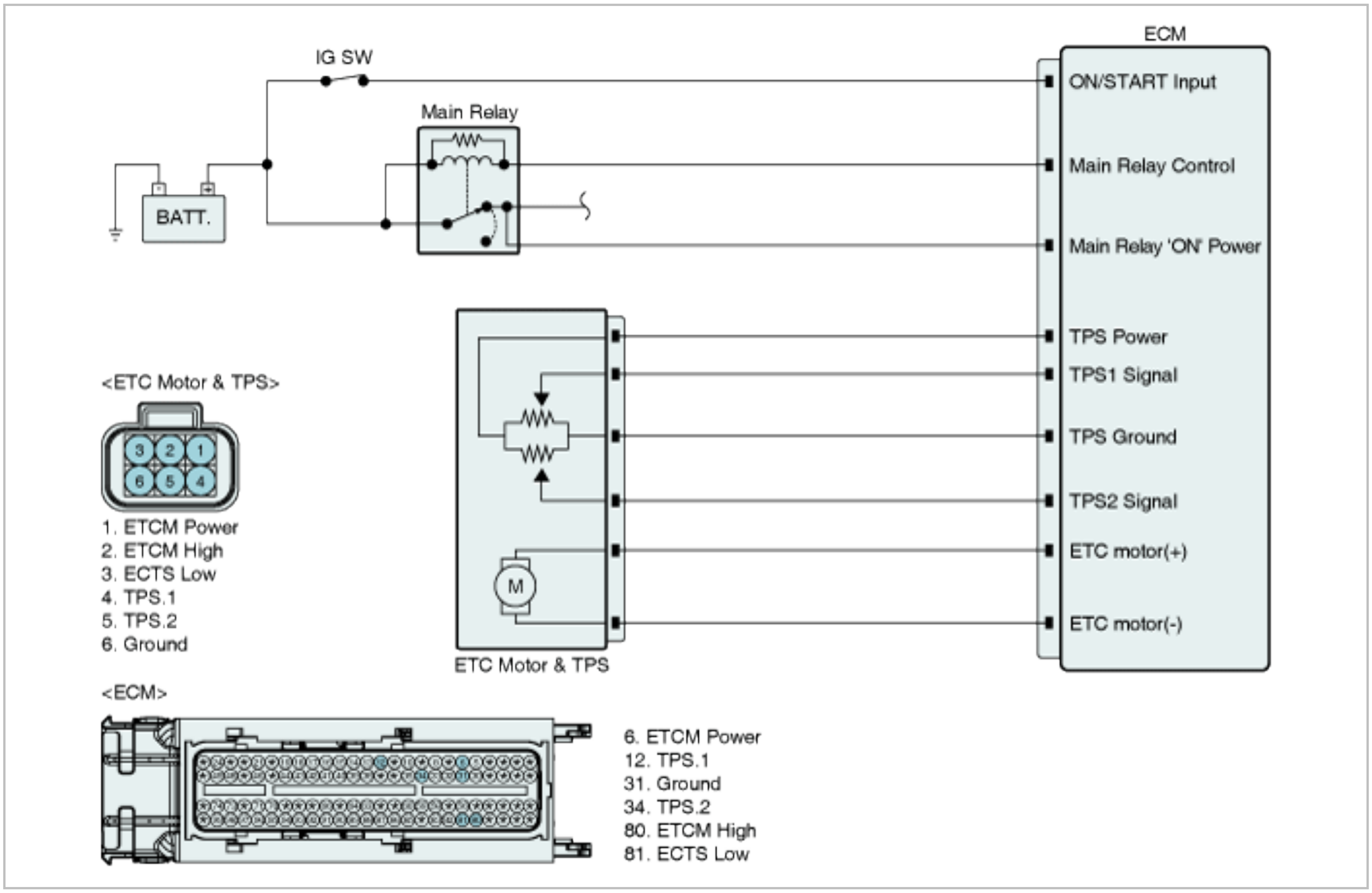
DTC Description

Checking the voltage from sensor power supply every 1.87 sec. under detecting condition, if the value within detecting condition lasts for more than 0.2 sec., ECM sets P0641. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

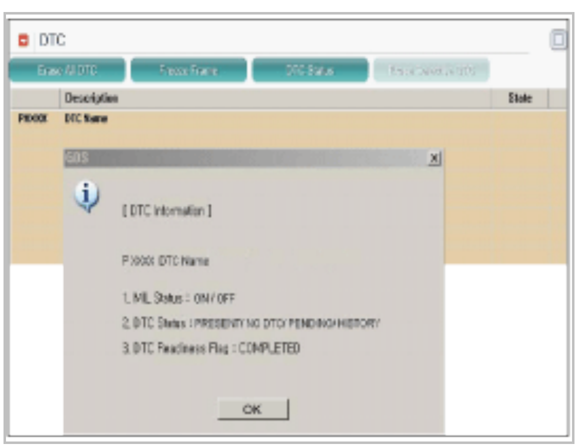
Item	Detecting Condition	Possible cause
DTC Strategy	• Sensor reference voltage check	• Short in sensor power supply line • Faulty ECM
Enable Conditions	• IG "ON"	
Threshold value	• Sensor supply power < 4.5V or > 5.5V	
Diagnosis Time	• Continuous (More than 0.2 seconds failure for every 1.87 seconds test)	
MIL On Condition	• 2 driving cycle	

Diagnostic Circuit Diagram



Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor’s and/or ECM’s connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as

	necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect ETC Motor & TPS connector.
2. IG "ON"
3. Measure voltage between TPS power terminal of ETC Motor & TPS harness connector and chassis ground.

Specification : Approx. 5V

4. Is the measured voltage within specification ?

YES	▶ Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check short in power harness" as follows.

■ Check short in power harness

1. IG "OFF" and disconnect ETC Motor & TPS connector and ECM connector.
2. Measure the resistance between TPS power and ETC motor (+) terminals of ETC Motor & TPS harness connector.(Measurement "A")
3. Measure the resistance between TPS power and ETC motor (-) terminals of ETC Motor & TPS harness connector.(Measurement "A")
4. Measure the resistance between TPS power and TPS ground terminals of ETC Motor & TPS harness connector.(Measurement "B")

Specification : Infinite

5. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically

	detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Repair short in power harness and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0646 A/C Clutch Relay Control Circuit Low

General Description

The A/C clutch relay is activated if the A/C switch is operated while the blower is running and system operation is enabled by the ECM. When A/C is requested, the Engine Control Module(ECM) provides a ground path to the A/C clutch relay control circuit. When the relay circuit is grounded, the A/C clutch relay is energized. The ECM delays grounding the relay circuit for a short time, so the ECM can adjust the engine idle speed for the additional load. The ECM will temporarily de-energized the A/C clutch relay for one or more of the following conditions:
- Full acceleration when the throttle is at WOT.(Wide Open Throttle)
- Risk of overheating: Engine coolant temp. exceeds threshold value
- A/C system pressure exceeds threshold value
- Engine starting

DTC Description

ECM monitors inputted voltage through A/C compressor relay. Checking voltage every 10 sec. under detecting condition, if the voltage lower than the specified value is detected for more than 5 sec., ECM sets P0646.

DTC Detecting Condition

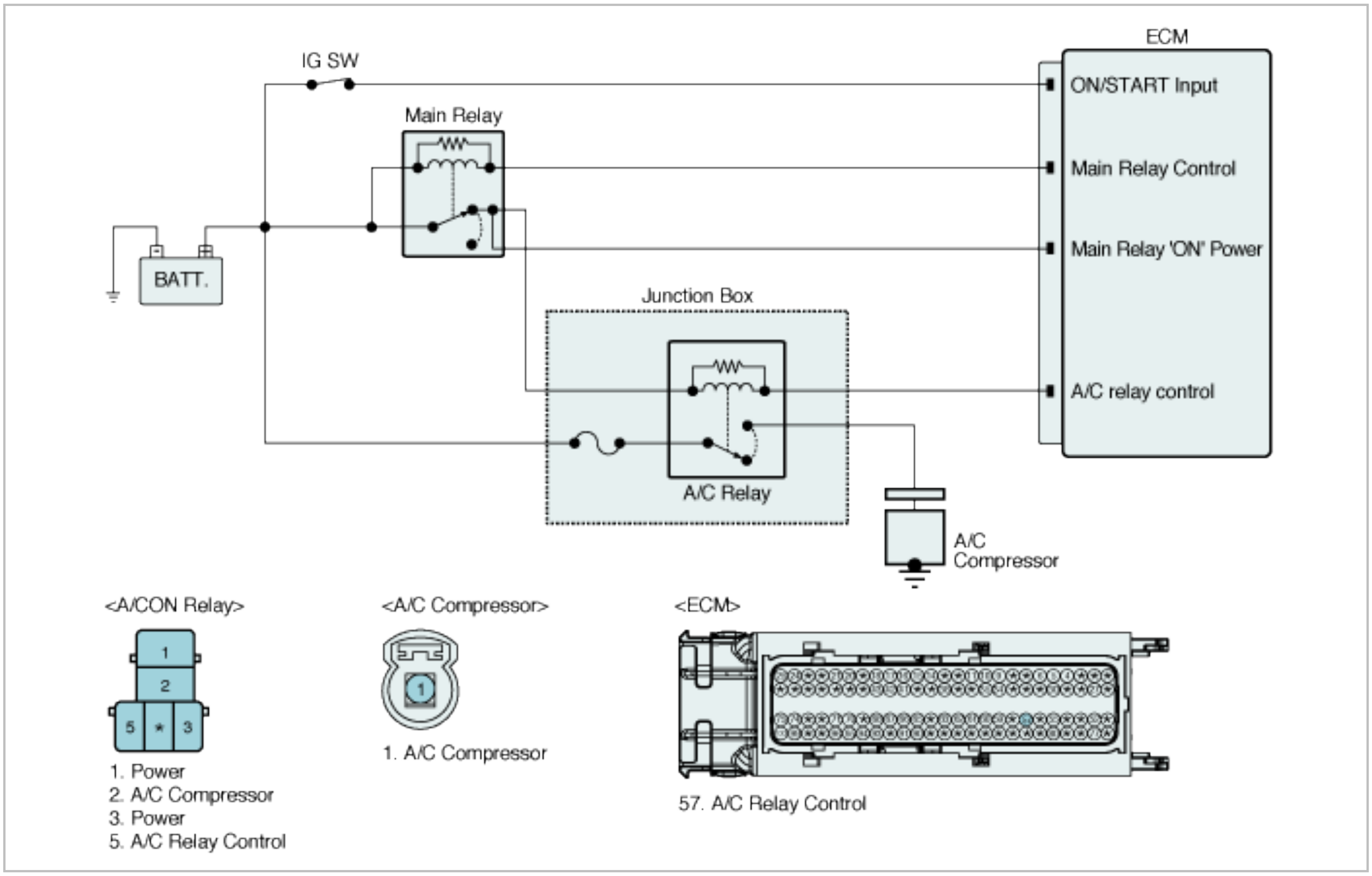
Item	Detecting Condition	Possible cause
DTC Strategy	• Detects circuit short to low voltage	• Poor connection • Open or short to ground in A/C relay circuit • Faulty ECM
Enable Conditions	• After 0.5 sec under conditions below • No DTC exists • Engine works • 11V ≤ Battery voltage ≤ 16V	
Threshold value	• Open or short to ground	
Diagnosis Time	• Continuous (More than 5 seconds failure for every 10	

Diagnosis Time	seconds test)	
MIL On Condition	• DTC only (NO MIL ON)	

Specification

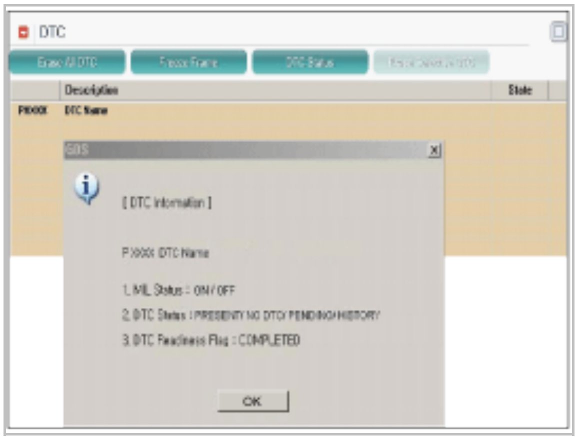
Coil Resistance	70Ω ~ 120Ω

Diagnostic Circuit Diagram



Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect A/C relay.
2. IG "ON"
3. Measure voltage between battery power supply terminals of A/C relay harness connector and chassis ground.

Specification : Approx. B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.
NO	▶ Check the fuse between Battery and A/C relay. ▶ Check Chassis ground for looseness. ▶ Repair open or short to ground in power harness and go to "Verification of Vehicle Repair" procedure.

Control Circuit Inspection

■ Check Short to Ground in harness

1. IG "OFF" and disconnect A/C Relay and ECM connector.
2. Measure the resistance between control terminal of A/C relay harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Check open in harness" as follows.
NO	▶ Repair short in coil control harness and go to "Verification of Vehicle Repair" procedure.

■ Check Open in harness

1. IG "OFF" and disconnect A/C relay and ECM connector.
2. Measure the resistance between control terminal of A/C relay harness connector and A/C relay control terminal of ECM harness connector.

Specification : Approx. below 1Ω

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in coil control harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check A/C relay

1. IG "OFF" and disconnect A/C relay
2. Measure resistance between battery power supply and power supply to A/C Compressor terminals of A/C relay. (Measurement "A")
3. Measure resistance between battery power supply and A/C relay control terminals of A/C relay. (Measurement "B")

Specification

Terminal	Continuity
Battery power supply - Power supply to A/C Compressor	NO
Battery power supply - A/C relay control	YES(Approx. 70Ω ~ 120Ω)

4. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this

	function to reuse the ECM on the others.
NO	▶ Substitute with a known - good A/C relay and check for proper operation. If the problem is corrected, replace A/C relay and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0647 A/C Clutch Relay Control Circuit High

General Description

The A/C clutch relay is activated if the A/C switch is operated while the blower is running and system operation is enabled by the ECM. When A/C is requested, the Engine Control Module(ECM) provides a ground path to the A/C clutch relay control circuit. When the relay circuit is grounded, the A/C clutch relay is energized. The ECM delays grounding the relay circuit for a short time, so the ECM can adjust the engine idle speed for the additional load. The ECM will temporarily de-energized the A/C clutch relay for one or more of the following conditions:
- Full acceleration when the throttle is at WOT.(Wide Open Throttle)
- Risk of overheating: Engine coolant temp. exceeds threshold value
- A/C system pressure exceeds threshold value
- Engine starting

DTC Description

ECM monitors inputted voltage through A/C compressor relay. Checking voltage every 10 sec. under detecting condition, if the voltage higher than the specified value is detected for more than 5 sec., ECM sets P0647.

DTC Detecting Condition

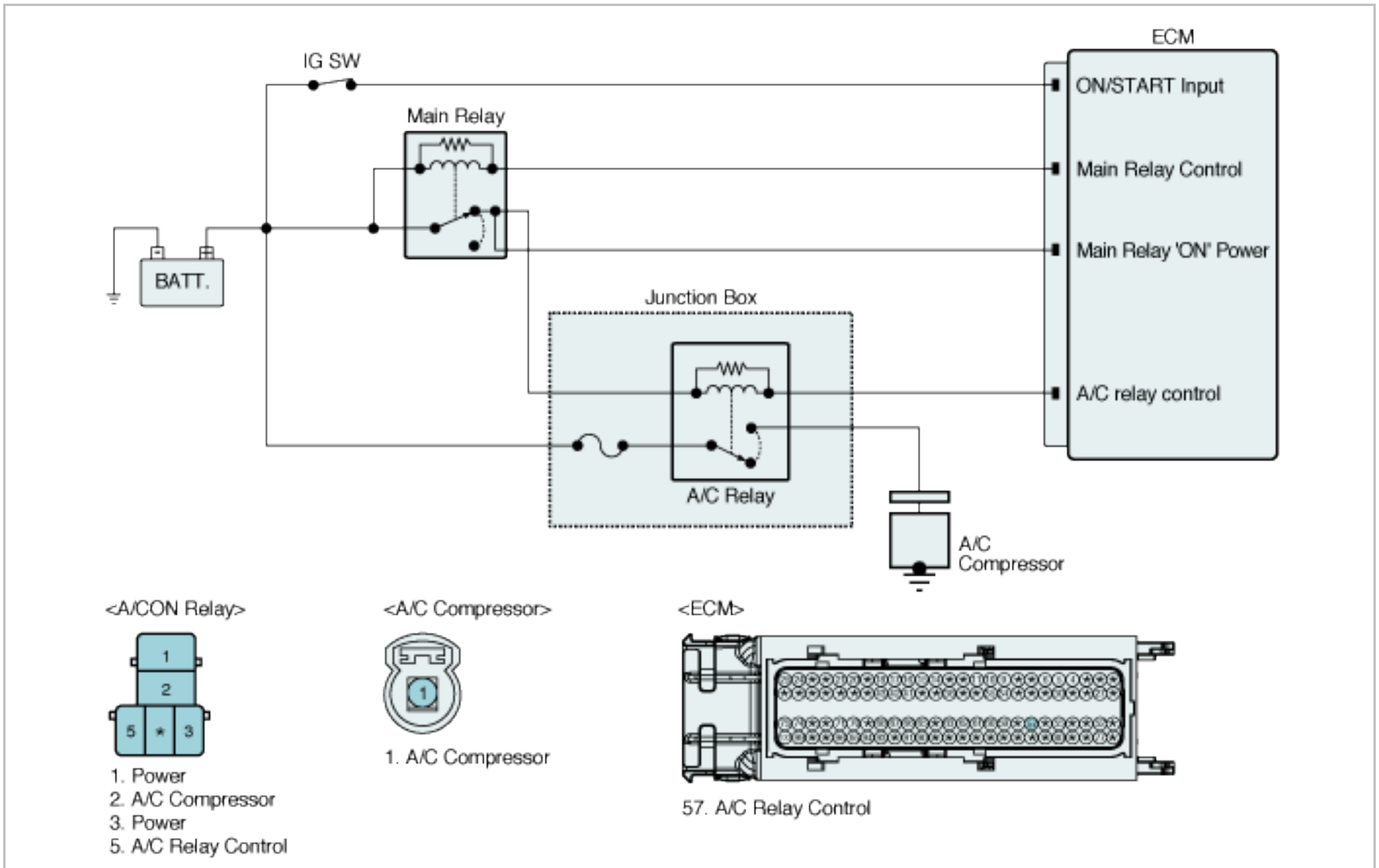
Item	Detecting Condition	Possible cause
DTC Strategy	• Detects circuit short to low voltage	• Poor connection • Short to power in A/C relay circuit • Faulty A/C relay • Faulty PCM
Enable Conditions	• After 0.5 sec under conditions below • No DTC exists • Engine works • 11V ≤ Battery voltage ≤ 16V	
Threshold value	• Short to power	
Diagnosis Time	• Continuous (More than 5 seconds failure for every 10 seconds test)	

MIL On Condition	• DTC only (NO MIL ON)	

Specification

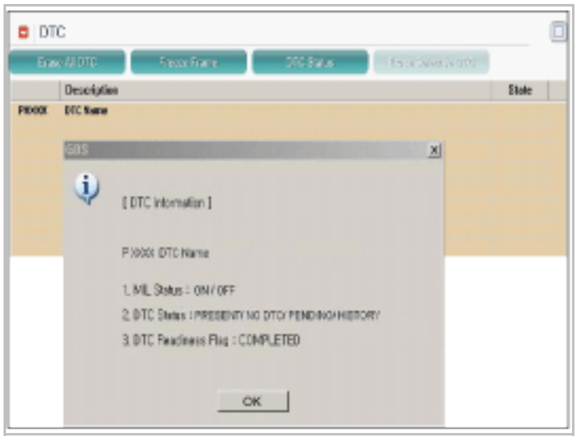
Coil Resistance	70Ω ~ 120Ω

Diagnostic Circuit Diagram



Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor’s and/or ECM’s connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect A/C relay.
2. IG "ON"
3. Measure voltage between battery power supply terminals of A/C relay harness connector and chassis ground.

Specification : Approx. B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.
NO	▶ Check the fuse between Battery and A/C relay. ▶ Check Chassis ground for looseness. ▶ Repair open or short to ground in power harness and go to "Verification of Vehicle Repair" procedure.

Control Circuit Inspection

■ **Check Short to Ground in harness**

1. IG "OFF" and disconnect A/C relay.
2. IG "ON"
3. Measure voltage between control terminal of A/C relay harness and chassis ground.

Specification : Approx.2.5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short in coil control harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ **Check A/C relay**

1. IG "OFF" and disconnect A/C relay.
2. Measure resistance between battery power supply and power supply to A/C Compressor terminals of A/C relay. (Measurement "A")
3. Measure resistance between battery power supply and A/C relay control terminals of A/C relay. (Measurement "B")

Specification

Terminal	Continuity
Battery power supply - Power supply to A/C Compressor	NO
Battery power supply - A/C relay control	YES(Approx. 70Ω ~ 120Ω)

4. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good A/C relay and check for proper operation. If the problem is corrected, replace A/C relay and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle

within conditions noted in the freeze frame data or enable conditions.

3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0650 Malfunction Indicator Lamp (MIL) Control Circuit

General Description

The Malfunction Indicator Lamp (MIL), which is located in the instrument cluster, comes on to notify the driver that there may be a problem with the vehicle and that service is needed. Immediately after the ignition switch turns on, the malfunction indicator lamp is lit to indicate that the MIL operates normally and goes off after starting

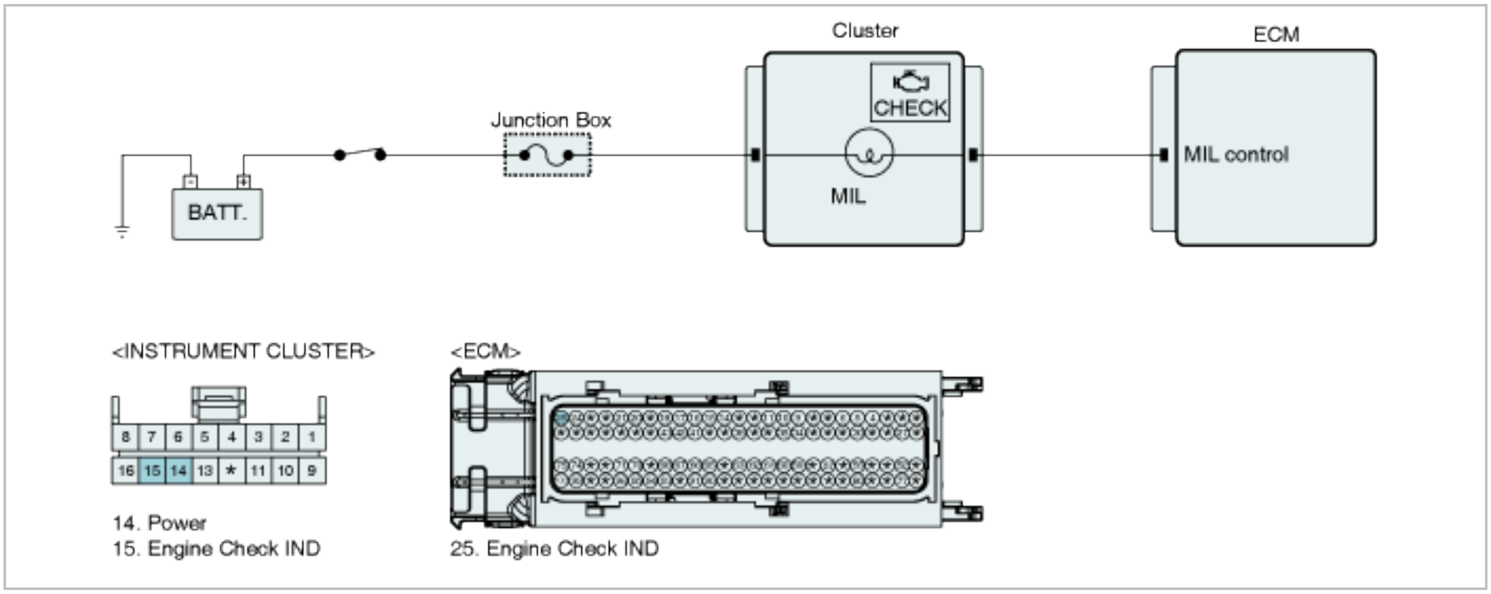
DTC Description

Checking input signal of engine check lamp every 10 sec. under detecting condition, if open, short to battery or ground is detected, ECM sets P0650.

DTC Detecting Condition

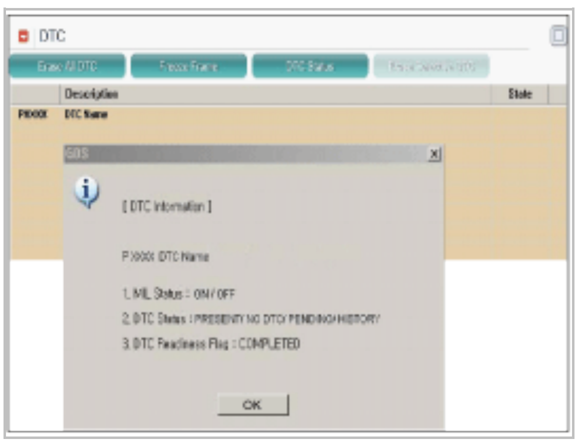
Item	Detecting Condition	Possible cause
DTC Strategy	• Check the MIL	• Poor connection • Open or short in MIL circuit • Faulty MIL • Faulty ECM
Enable Conditions	• After 0.5 sec under conditions below • Engine works • 11V ≤ Battery voltage ≤ 16V	
Threshold value	• Open or short	
Diagnosis Time	• Continuous	
MIL On Condition	• DTC only (NO MIL ON)	

Diagnostic Circuit Diagram



Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor’s and/or ECM’s connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.

3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect Instrument cluster connector.
2. IG "ON"
3. Measure voltage between power supply terminal of instrument cluster harness connector and chassis ground.

Specification : Approx. B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Control Circuit Inspection" procedure.
NO	▶ Check fuse between battery and instrument cluster for open or blown-off. ▶ Repair open or short to ground in harness, and go to "Verification of Vehicle Repair" procedure.

Control Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect ECM connector.
2. IG "ON"
3. Measure voltage between MIL termimal of ECM harness connector and chassis ground.

Specification : Approx. B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Check open in Engine warning lamp's filament. ▶ Repair open or short to ground in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check instrument cluster

1. IG "OFF"
2. Substitute with a known - good instrument cluster and check for proper operation.
3. Does it normally operate after replacement?

YES	▶ Replace instrument cluster and go to "Verification of Vehicle Repair" procedure.
NO	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

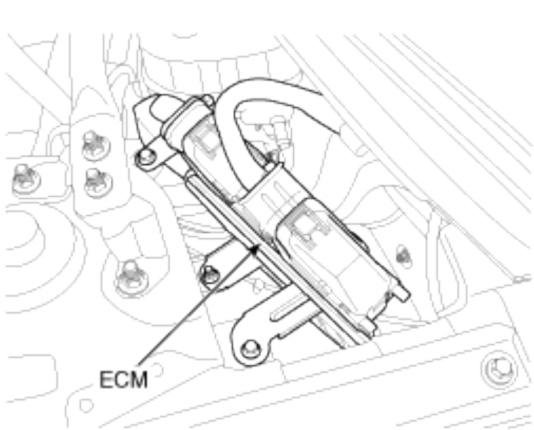
After a repair, it is essential to verify that the fault has been corrected.

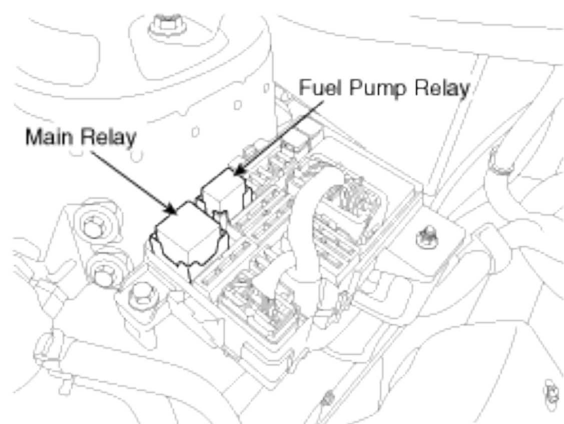
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0685 ECM/PCM Power Relay Control Circuit /Open

Component Location





General Description

The ECM provides ground to one side of the coil of the main relay and the other side is connected to the battery. The ECM monitors battery voltage and the voltage after the main relay.

DTC Description

Checking the contolling state of main relay every 10 sec. under detecting condition, if open or short in the circuit is detected for more than 5 sec., ECM sets P0685.

DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Detects a short to ground, to battery or open circuit on the main relay	• Poor Connection • Open or short in control circuit
Enable Conditions	• Engine Running • 11V ≤ Ignition Voltage ≤ 16V	

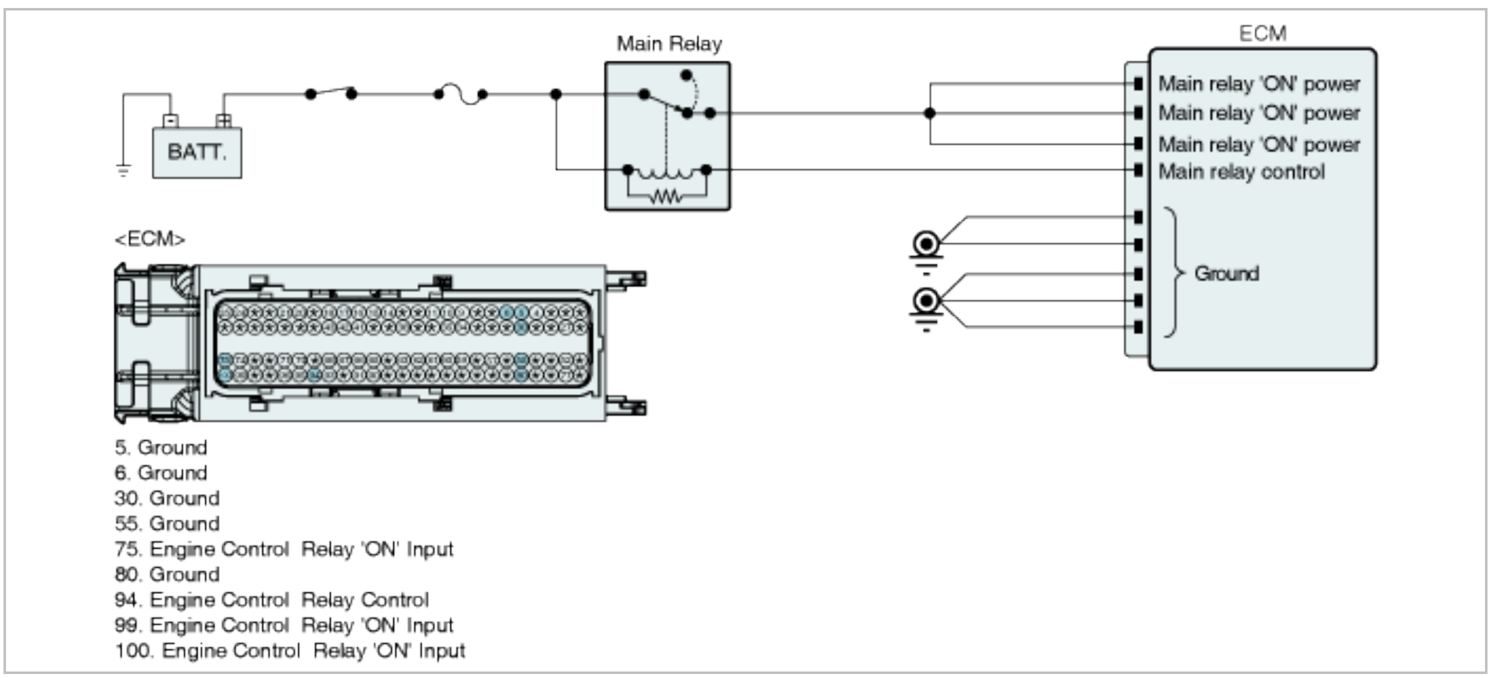
Threshold value	• Open or Short in circuit	• Faulty Main Relay • Faulty ECM
Diagnosis Time	• Contineous (More than 5sec. failure for every 10 sec. test)	
MIL On Condition	• DTC only (NO MIL ON)	

※ If Main relay has a fault(ex. Open) under engine running,
the DTCs,P0638/P0685/P1295/P2106, can happen at the same time.
<DTC Name>
- P0638 Throttle Actuator Control Range / Performance(Bank 1)
- P0685 ECM/ECM Power Relay Control Circuit /Open
- P1295 Throttle Actuator Control System - Power Management
- P2106 Throttle Actuator Control System - Forced Limited Power

Specification

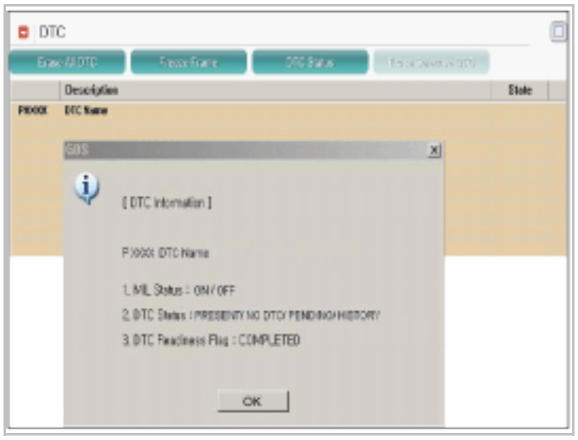
Coil Resistance	70Ω ~ 120Ω

Diagnostic Circuit Diagram



Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor’s and/or ECM’s connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect the main relay.
2. IG "ON"
3. Measure the voltage between power supply terminals of main relay harness connector and chassis ground.

Specification : Approx. B+

4. Is the measured voltage within specification ?

YES	▶ Go to "Control Circuit Inspecition" procedure.
NO	▶ Check the fuse between battery and main relay. ▶ Repair open or short to ground in power harness and go to "Verification of Vehicle Repair" procedure .

Control Circuit Inspection

■ **Check short in harness**

1. IG "OFF" and disconnect the main relay and ECM connector.
2. Measure the resistance between control terminal of main relay harness connector and chasses ground.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Check open in harness" procedure.
NO	▶ Repair short in control harness and go to "Verification of Vehicle Repair" procedure.

■ **Check open in harness**

1. IG "OFF" and disconnect the main relay and ECM connector.
2. Measure the resistance between control terminal of main relay harness connector and main relay control terminal of ECM harness connector.

Specification : Approx. below 1Ω

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in control harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ **Check Main relay**

1. IG "OFF" and disconnect main relay.
2. Measure the resistance between battery power supply and control terminals of main relay.(Measurement "A")
3. Measure the resistance between battery power supply and power supply to ECM terminals of main relay.(Measurement "B")
Specification :

Terminal	Continuity
Battery power supply - Power supply to ECM	NO
Battery power supply - Main relay control	YES(Approx. 70Ω ~ 120Ω)

4. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good Fuel Pump Relay and check for proper operation. If the

	problem is corrected, replace Fuel Pump Relay and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P0700 Transmission Control System (MIL Request)

General Description

The TCM can request activation of the MIL lamp Via a communication line to the ECM. This is only a request from TCM to ECM to turn the MIL on. The fault code is stored in the TCM. Select Transaxle system on the GDS and monitor DTC related automatic transaxle system.
DO ALL REPAIRS associated malfunction with A/T.

DTC Description

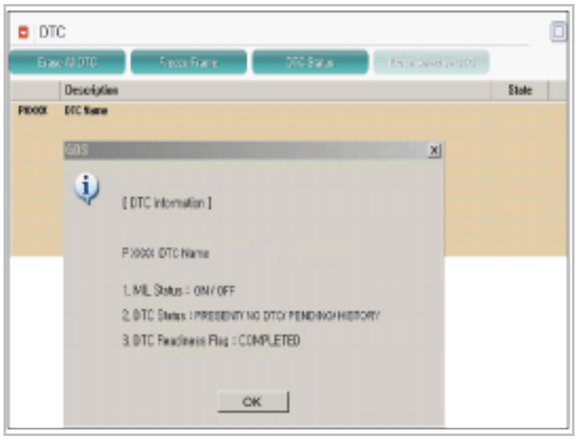
The ECM sets this code when it receives MIL ON request from TCM .

DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Freeze frame request via CAN	• Transaxle system
Enable Conditions	• Battery Voltage ≥ 10V	
Threshold value	• MIL is requested by TCM	
Diagnosis Time	• Contineous	
MIL On Condition	• 1 driving cycle	

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ This is only a request from TCM to ECM to turn the MIL on. The fault code is stored in the TCM. The Freeze Frame Data is stored in the ECM under the P0700 request code. Be sure to retrieve freeze frame data before clearing code P0700 from ECM. ▶ Check the transaxle system.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

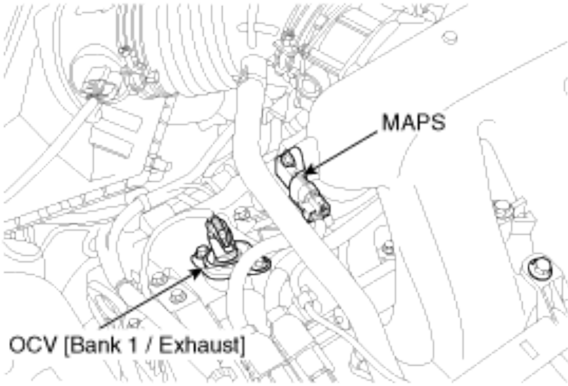
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P1106 Manifold Absolute Pressure Sensor Circuit Intermittent high

Component Location



General Description

The amount of intake air flow must be inputted to ECM in order to determine the fuel injection quantity. To measure the pressure inside of intake manifold, MAFS is used at idle and MAPS is required at accelerating. MAPS(Manifold Absolute Pressure) calculates the amount of air indirectly as measuring the pressure inside of intake manifold. This system is called a Speed-Density type.
MAPS transfers analog output signal which is proportional to the change of intake manifold pressure, then, with this signal and RPM, ECM calculates the amount of intake air flow.
The MAPS is mounted on surge tank to measure the pressure inside of intake manifold, and it consists of a piezo electric element and hybrid IC which amplifies output signal from the element. A piezo electric element is a sort of a diaphragm using piezo electric effect. One side of the diaphragm is surrounded with vacuum chamber while intake pressure is applied to the other side. Thus, signals are output by the transformation of diagphragm according to the change of pressure inside of intake manifold.

DTC Description

Checking output signals of MAPS under detecting condition, if an output signal is intermittently above 4.5V ., ECM sets P1106.

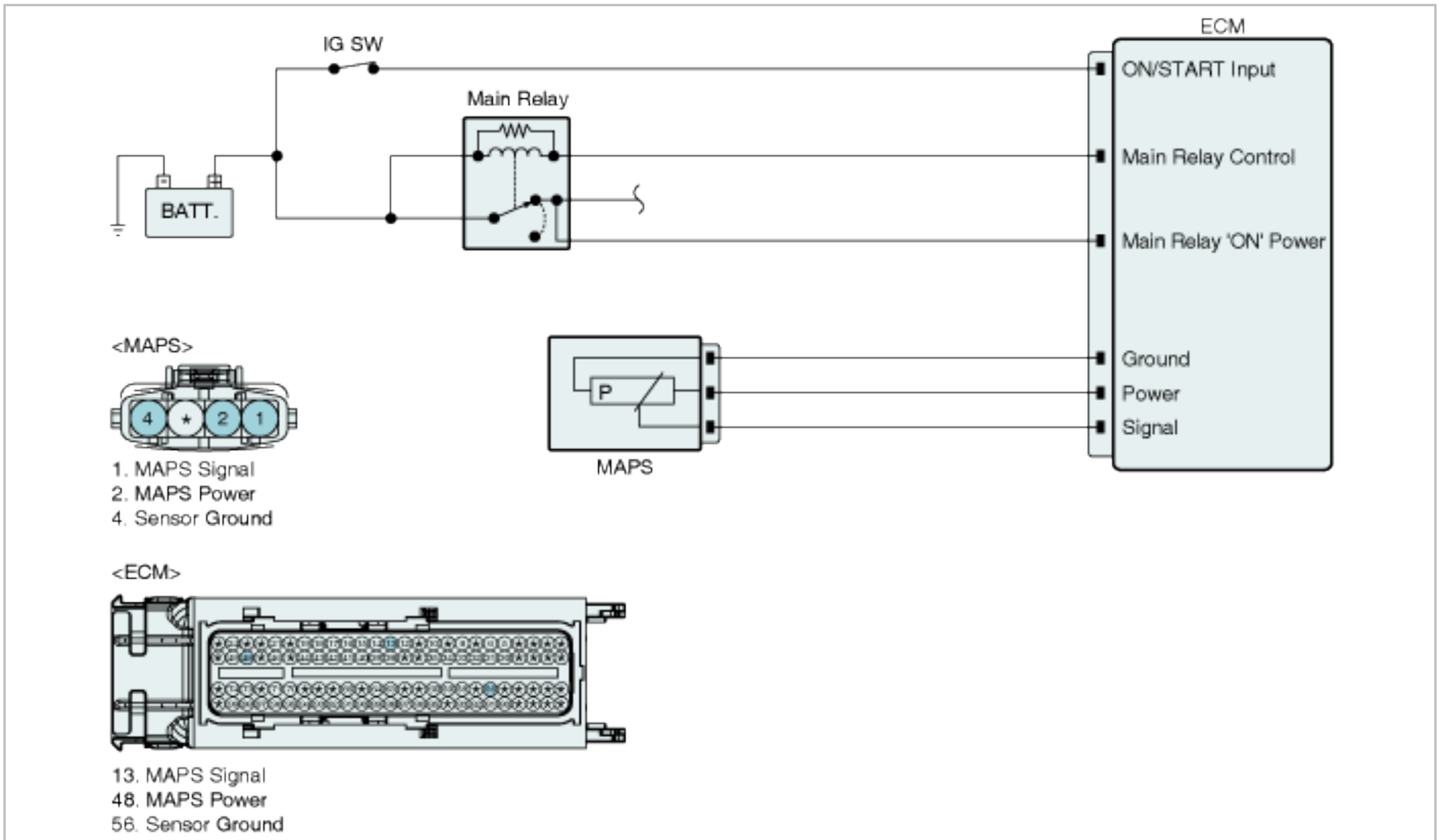
DTC Detecting Condition

Item		Detecting Condition	Possible cause
DTC Strategy		• Monitor the signal of MAP sensor	• Poor Connecting • Short to battery in signal circuit • Open in ground circuit • Faulty MAPS • Faulty ECM
Enable Conditions	Case 1	• No TPS Active Fault Present • Engine Running Time > 10sec. • Engine Speed ≤ 2500rpm • Throttle Position ≤ 30%	
	Case 2	• No TPS Active Fault Present • Engine Running Time > 10sec. • Engine Speed > 2500rpm • Throttle Position ≤ 40%	
Threshold value		• Intermittently MAP Signal > 4.5V	
Diagnosis Time		• Contineous (More than 2sec. failure for every 4 sec. test)	
MIL On Condition		• DTC only(NO MIL ON)	

Specification

Pressure(kPa)	Voltage(V)
20	0.79
46.66	1.84
101.32	4.0

Diagnostic Circuit Diagram



Signal Waveform & Data

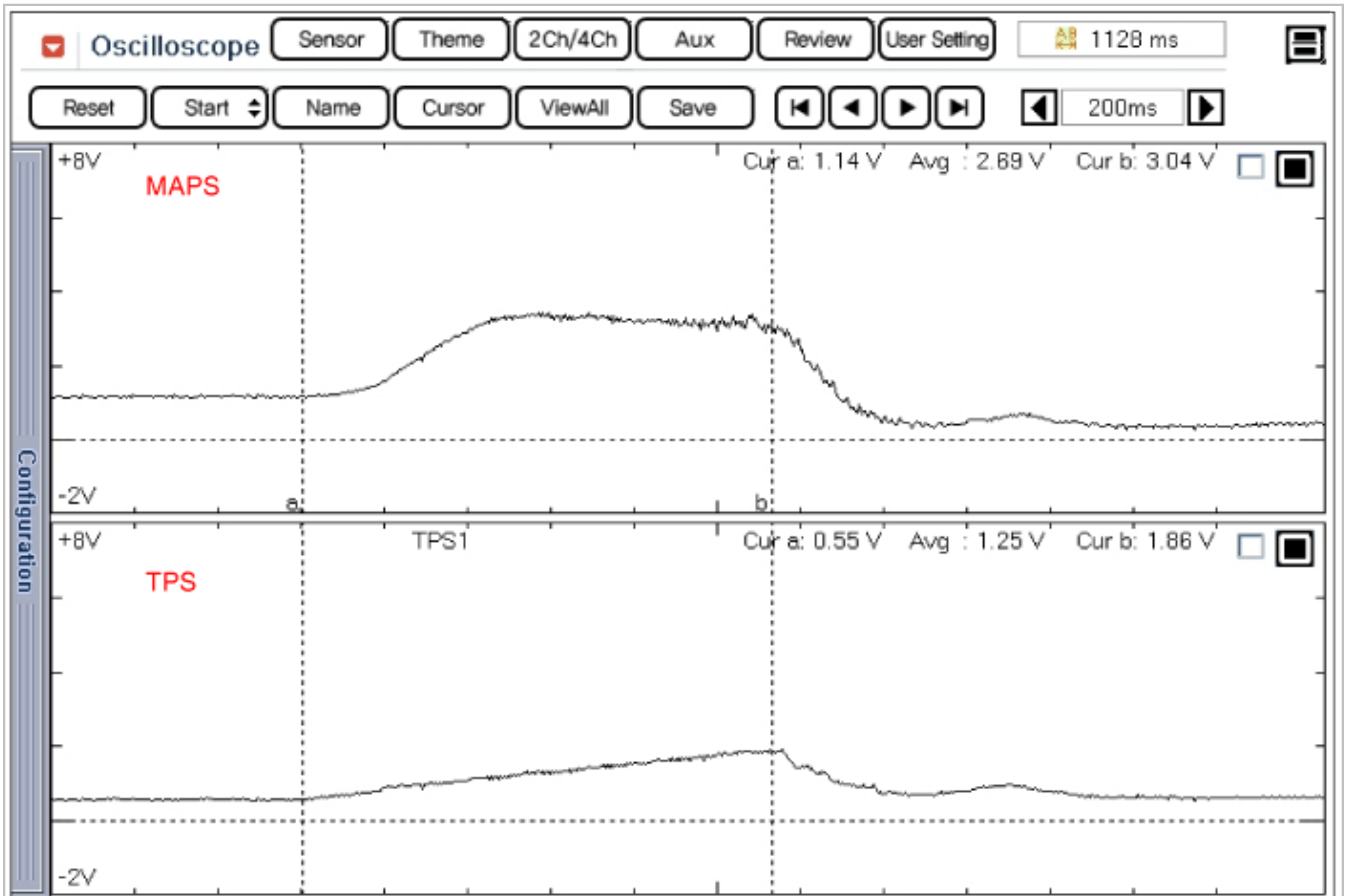


Fig.1

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | Filter

Sensor Name	Value	Unit
☑ Engine speed	560	RPM
☑ Air Flow Rate from Mass Air Flow Sensor	15	kg/h
☑ Manifold Absolute Pressure Sensor	347	hPa

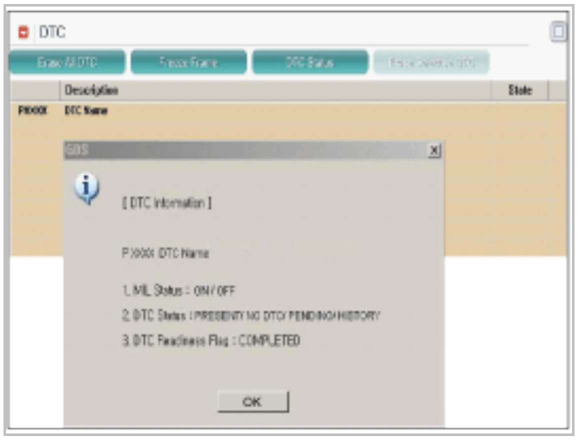
Fig.2

Fig.1) Normal waveform of MAPS & TPS with acceleration.
Fig.2) Normal data of MAPS at idle.
It is necessary that MAPS should be checked along with TPS. Because the MAP/TPS rationality diagnostic is comprised of two tests. A deceleration test is performed to provide a robust method for detection of an altitude compensated MAP value that is too high for the deceleration condition. The second test compares the altitude compensated MAP value to both high and low limits, dependent upon throttle position and engine speed. When the MAP value is out of the threshold range, the MAP/TPS system is determined to be failed.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.

4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and Disconnect MAPS connector.
2. IG "ON"
3. Measure the voltage between power terminal of MAPS harness connector and ground.

Specification : Approx. 5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Ground Circuit Inspection" Procedure.
NO	▶ Repair open or short in harness and go to "Verification of Vehicle Repair" procedure.

Ground Circuit Inspection

■ **Check voltage**

1. IG "OFF" and disconnect MAPS connector and then IG "ON".
2. Measure voltage between signal terminal of MAPS harness connector and chassis ground (Measurement "A")
3. Measure voltage between signal and ground terminals of MAPS harness connector (Measurement "B")

Specification : Voltage difference between Measurement "A" and "B" is below 200mV.

4. Is the measured voltage within specification ?

YES	▶ Go to "Signal Circuit Inspection" procedure.
NO	▶ Repair contact resistance or open in harnesss and then go to "Verification of Vehicle Repair" procedure.

Signal Circuit Inspection

■ **Check short to battery in harness**

1. IG "OFF".
2. Disconnect MAPS and ECM connector.
3. Measure resistance between signal and power terminals of MAPS harness connector.

Specification : Infinite

4. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" as follows.
NO	▶ Repair short in harnesss and then go to "Verification of Vehicle Repair" procedure.

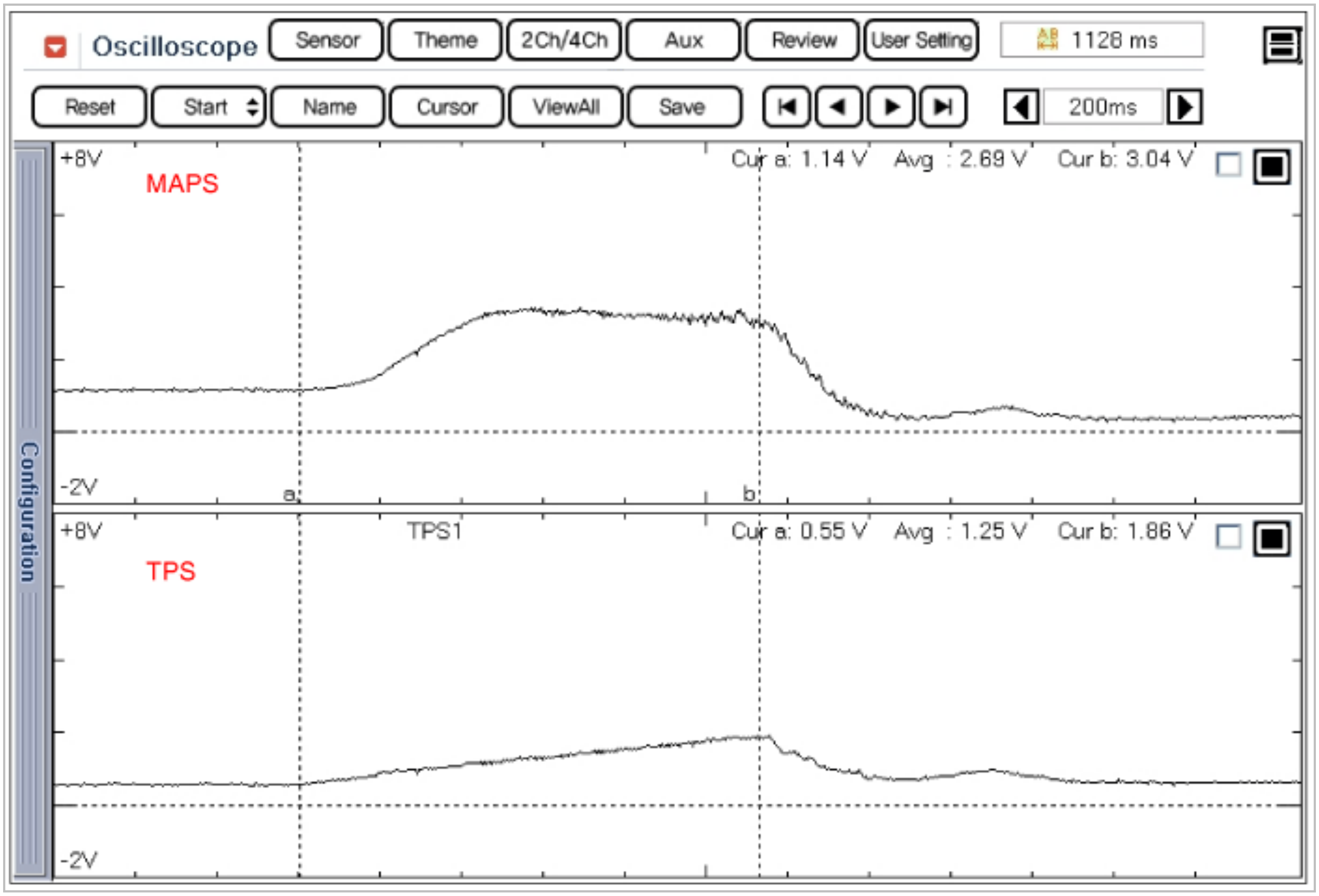
Component Inspection

■ **Check MAPS Performance**

1. IG "OFF" and install a GDS.
2. Connect probe to MAPS and TPS to check signal waveform by using oscilloscope function.
3. ENG "ON" and monitor signal waveform during accelleration and decelleration.

Specification : Signal waveform will be displayed as follows.

Pressure(kPa)	Voltage(V)
20	0.79
46.66	1.84
101.32	4.0



4. Is the relationship between the MAP and the TPS correct?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good MAPS and check for proper operation. If the problem is corrected, replace MAPS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

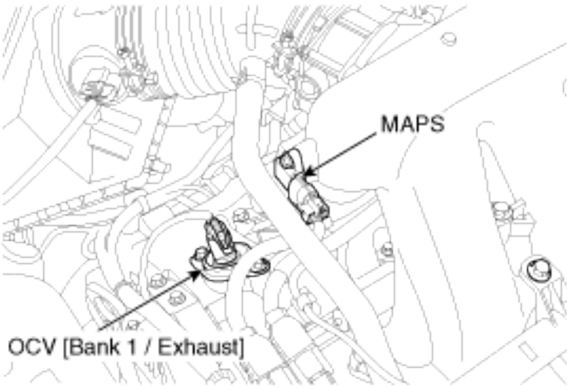
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.

NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P1107 Manifold Absolute Pressure Sensor Circuit Intermittent low

Component Location



General Description

The amount of intake air flow must be inputted to ECM in order to determine the fuel injection quantity. To measure the pressure inside of intake manifold, MAFS is used at idle and MAPS is required at accelerating. MAPS(Manifold Absolute Pressure) calculates the amount of air indirectly as measuring the pressure inside of intake manifold. This system is called a Speed-Density type.
MAPS transfers analog output signal which is proportional to the change of intake manifold pressure, then, with this signal and RPM, ECM calculates the amount of intake air flow. The MAPS is mounted on surge tank to measure the pressure inside of intake manifold, and it consists of a piezo electric element and hybrid IC which amplifies output signal from the element. A piezo electric element is a sort of a diaphragm using piezo electric effect. One side of the diaphragm is surrounded with vacuum chamber while intake pressure is applied to the other side. Thus, signals are output by the transformation of diagphragm according to the change of pressure inside of intake manifold.

DTC Description

Checking output signals of MAPS under detecting condition, if an output signal is intermittently below 0.25V, ECM sets P1107.

DTC Detecting Condition

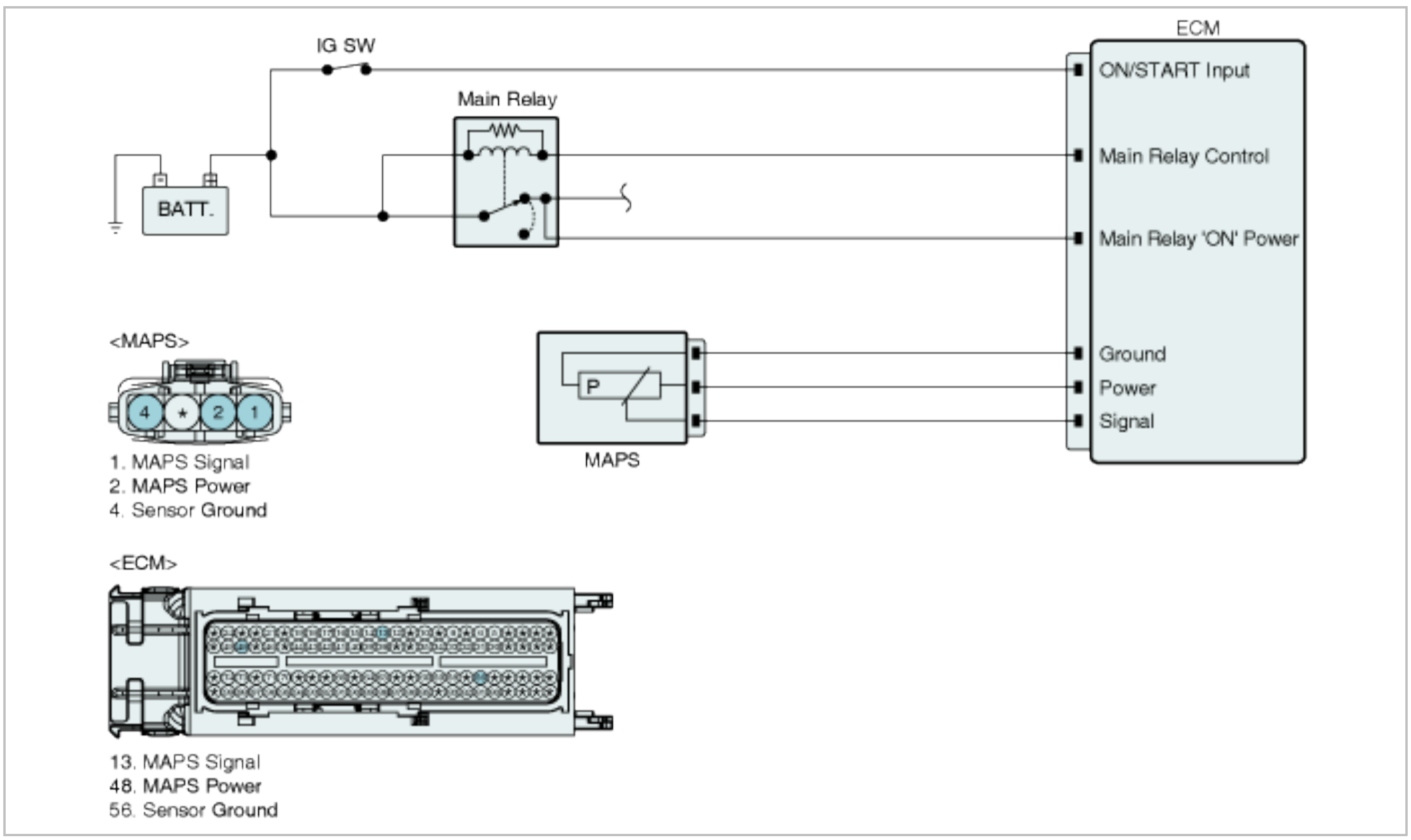
Item		Detecting Condition	Possible cause
DTC Strategy		• This code detects a continuous short to low or open in either the signal circuit or the MAP	• Connecting Condition • Open or short to ground in power circuit • Open or short to ground in
Enable Conditions	Case 1	• No TPS Active Fault Present • Ignition Voltage ≥ 11V • Engine Speed ≤ 1000rpm • Throttle Position ≥ 0%	
		• No TPS Active Fault Present	

	Case 2	• Ignition Voltage ≥ 11V • Engine Speed > 1000rpm • Throttle Position ≥ 30%	• Open or short to ground in signal circuit • MAPS • ECM
Threshold value		• MAP Signal < 0.25V	
Diagnosis Time		• Contineous (More than 2.5 seconds failure for every 5 seconds test)	
MIL On Condition		• NO MIL ON(DTC only)	

Specification

Pressure(kPa)	Voltage(V)
20	0.79
46.66	1.84
101.32	4.0

Diagnostic Circuit Diagram



Signal Waveform & Data

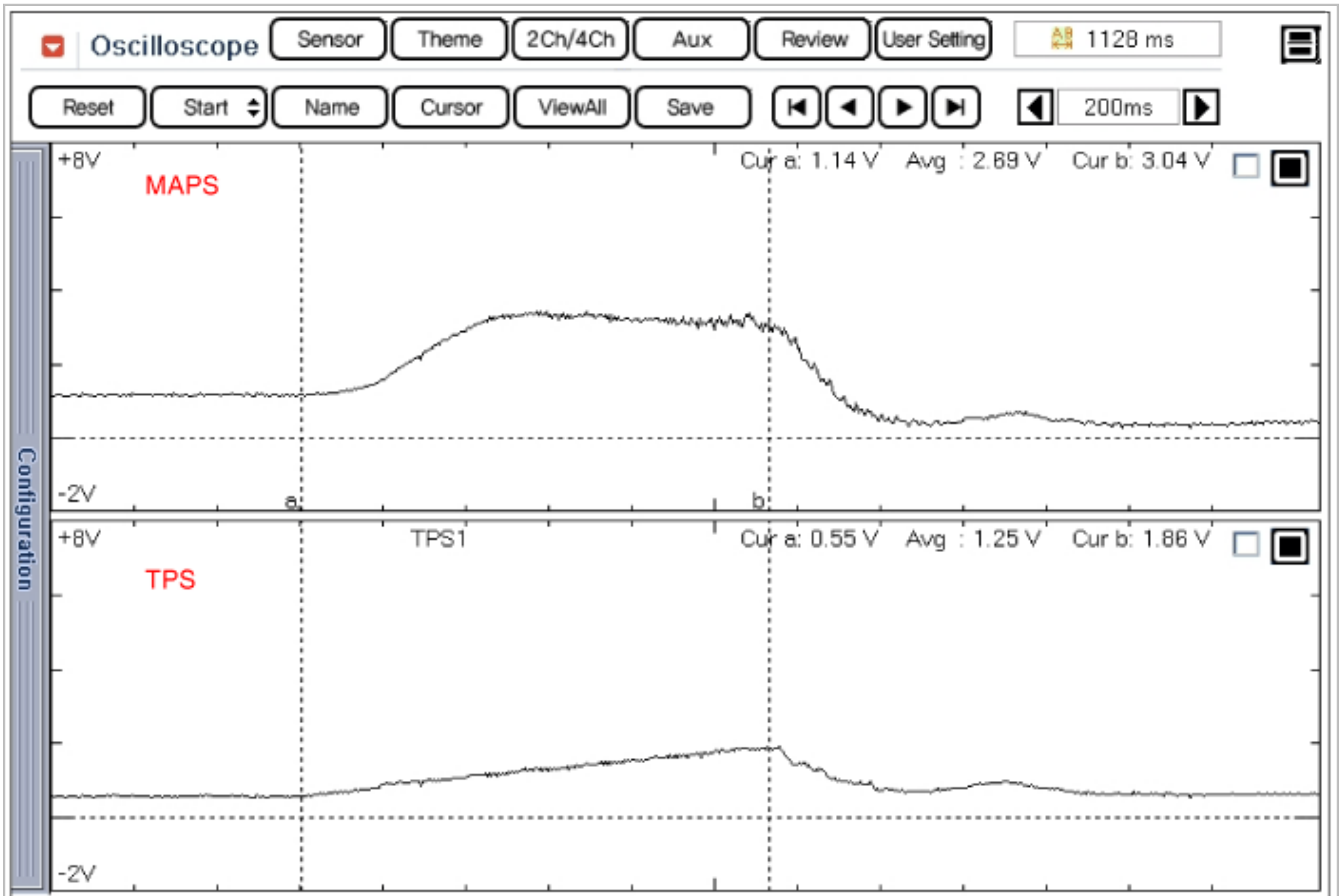
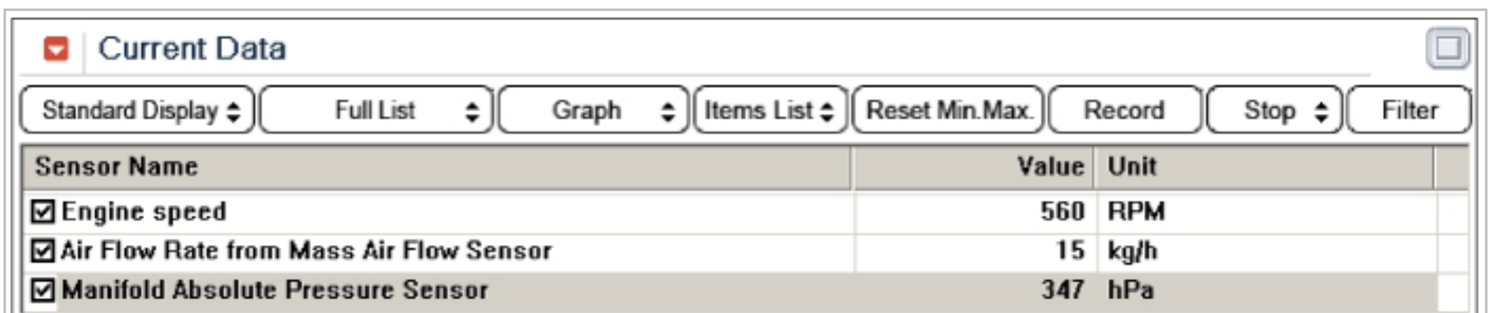


Fig.1



Sensor Name	Value	Unit
☑ Engine speed	560	RPM
☑ Air Flow Rate from Mass Air Flow Sensor	15	kg/h
☑ Manifold Absolute Pressure Sensor	347	hPa

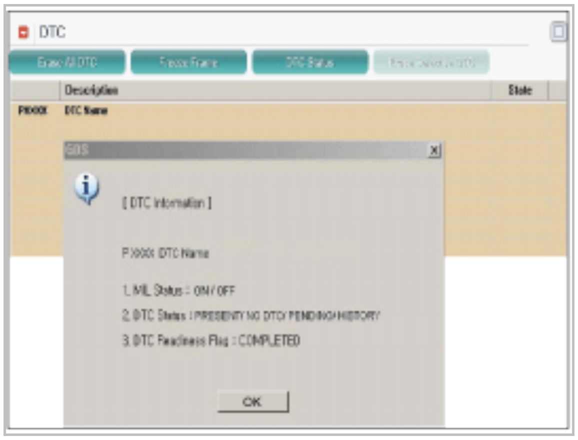
Fig.2

Fig.1) Normal waveform of MAPS & TPS with acceleration.
Fig.2) Normal data of MAPS at idle.
It is necessary that MAPS should be checked along with TPS. Because the MAP/TPS rationality diagnostic is comprised of two tests. A deceleration test is performed to provide a robust method for detection of an altitude compensated MAP value that is too high for the deceleration condition. The second test compares the altitude compensated MAP value to both high and low limits, dependent upon throttle position and engine speed. When the MAP value is out of the threshold range, the MAP/TPS system is determined to be failed.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.

4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor’s and/or ECM’s connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ **Check voltage**

1. IG "OFF" and Disconnect MAPS connector.
2. IG "ON"
3. Measure the voltage between power terminal of MAPS harness connector and ground.

Specification : Approx. 5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Signal Circuit Inspection" Procedure.
NO	▶ Repair open or short in harness and go to "Verification of Vehicle Repair" procedure.

Signal Circuit Inspection

■ **Check short to ground in harness**

1. IG "OFF".
2. Disconnect MAPS and ECM connector.
3. Measure the resistance between signal terminal of MAPS harness connector and ground.

Specification : Infinite

4. Is the measured resistance within specification ?

YES	▶ Go to "Check open in harness" as follows.
NO	▶ Repair short to ground in harness and go to "Verification of Vehicle Repair" procedure.

■ **Check open in harness**

1. IG "OFF" and disconnect MAPS and ECM connector.
2. Measure resistance between signal terminal of MAPS harness connector and MAPS signal terminal of ECM harness connector.

Specification : Approx. below 1Ω.

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in harness and go to "Verification of Vehicle Repair" procedure.

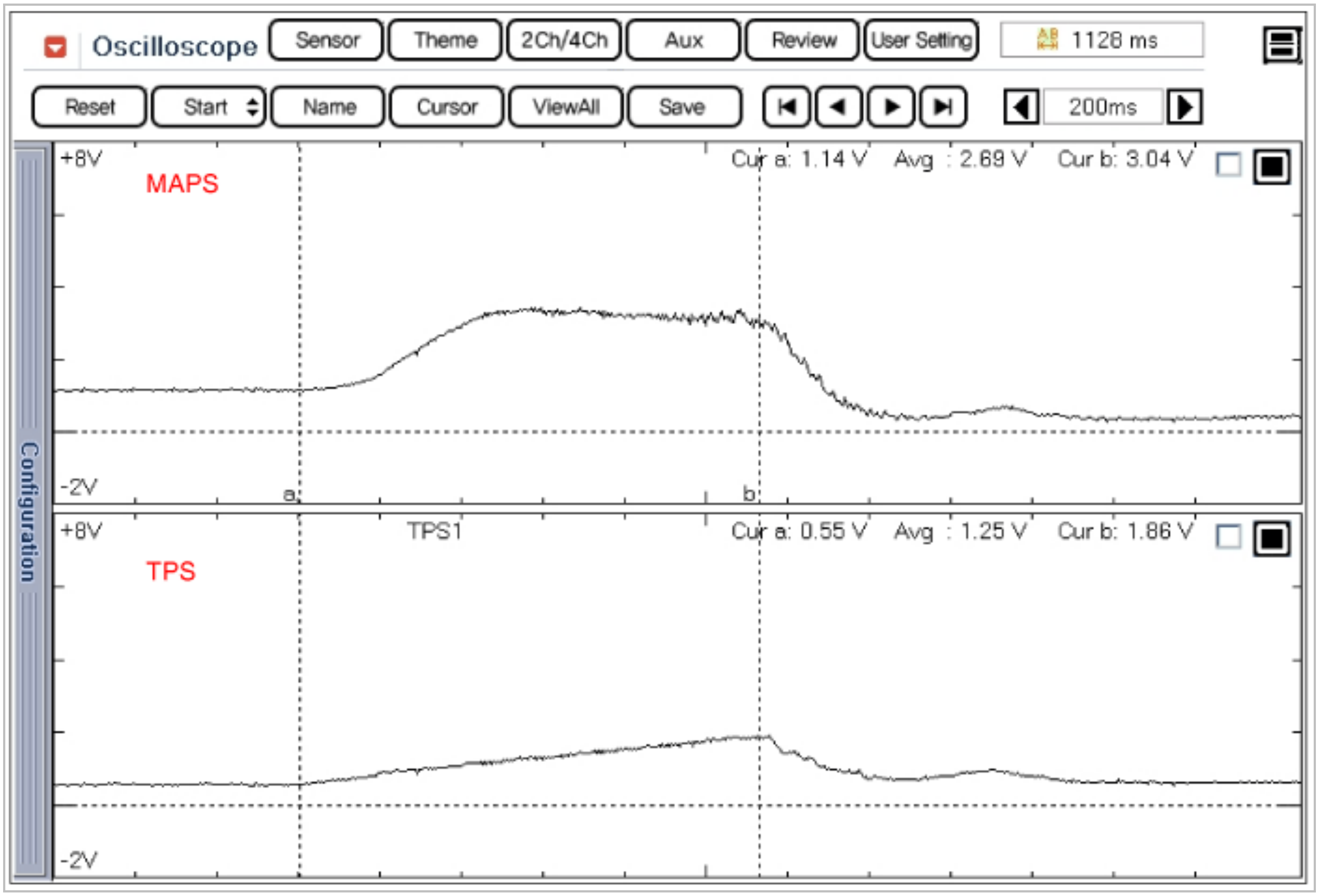
Component Inspection

■**Check MAPS Performance**

1. IG "OFF" and install a GDS.
2. Connect probe to MAPS and TPS to check signal waveform by using oscilloscope function.
3. ENG "ON" and monitor signal waveform during accelleration and decelleration.

Specification : Signal waveform will be displayed as follows.

Pressure(kPa)	Voltage(V)
20	0.79
46.66	1.84
101.32	4.0



4. Is the relationship between the MAP and the TPS correct?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good MAPS and check for proper operation. If the problem is corrected, replace MAPS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

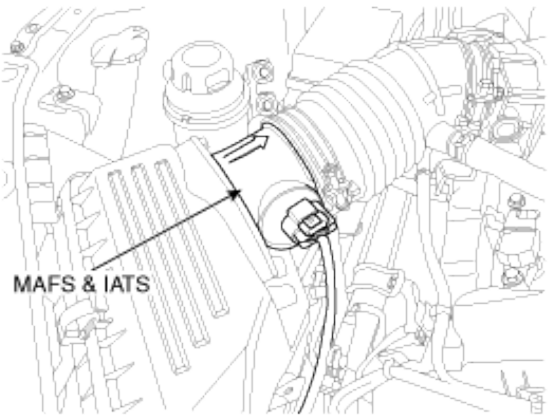
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.

NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P1111 Intake Air Temperature Sensor Circuit Intermittent high

Component Location



General Description

The Intake Air Temperature Sensor (IATS) is installed into the Mass Air Flow Sensor (MAFS). The IATS uses a thermistor whose resistance changes with the temperature. The electrical resistance of the IATS decreases as the temperature increases, and increases as the temperature decreases. The 5 V power source in the ECM is supplied to the IATS via a resistor in the ECM. That is, the resistor in the ECM and the thermistor in the IATS are connected in series. When the resistance value of the thermistor in IATS changes according to the intake air temperature, the signal voltage also changes. Using this signal, the information of the intake air temperature, the ECM corrects basic fuel injection duration and ignition timing.

DTC Description

Checking output signals of IATS under detecting condition, if an ouput signal is intermittently over 4.9V, ECM sets P1111.

DTC Detecting Condition

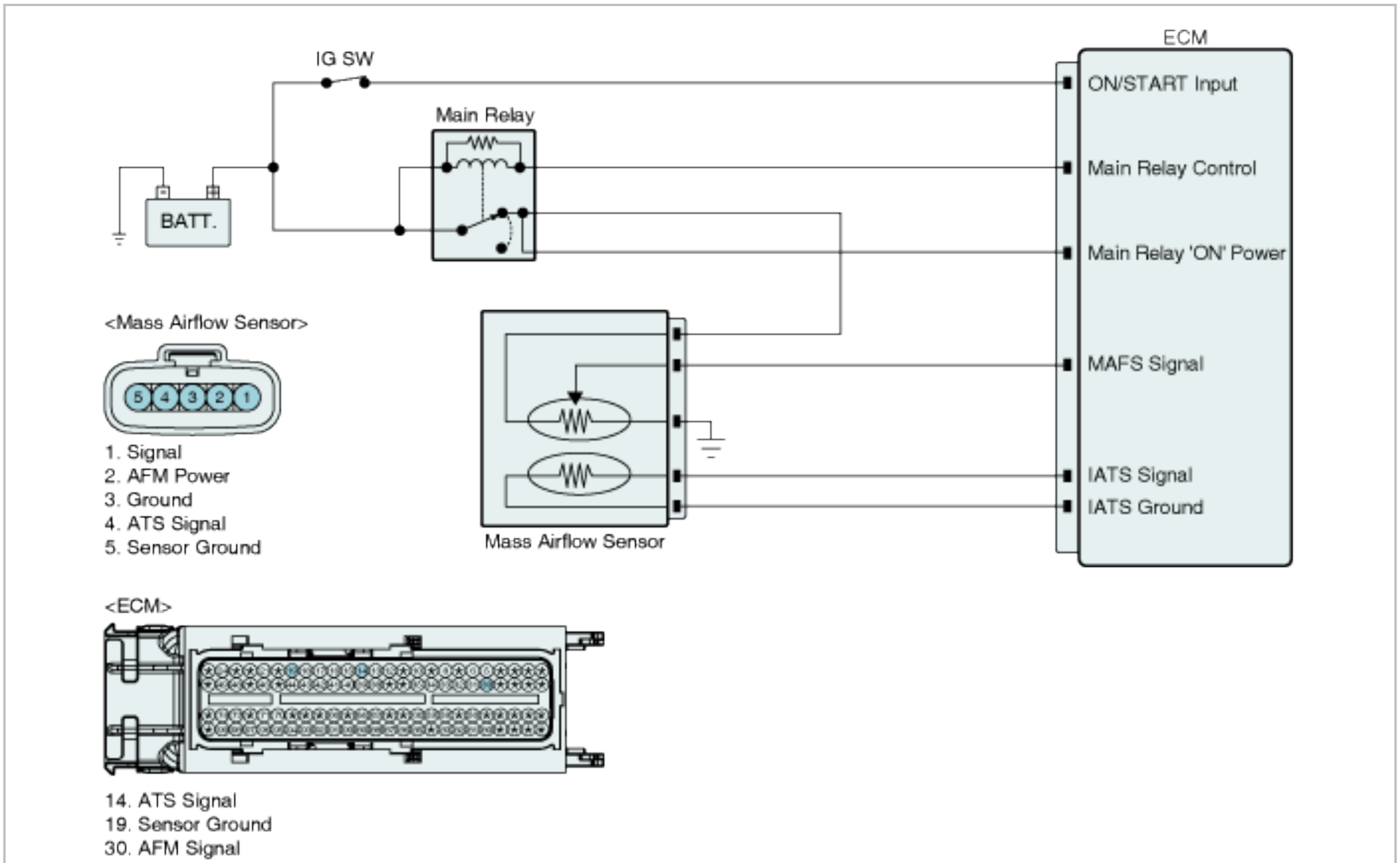
Item	Detecting Condition	Possible cause
DTC Strategy	• This code detects a continuous short to high in either the signal circuit or the sensor	• Poor connection • Open or short to battery in harness • Open in ground harness • IATS • ECM
Enable Conditions	• Engine running state • No Vehicle speed sensor fault • No ECTS fault • No MAFS fault • Intake airflow < 15 g/s • Vehicle speed < 25kph(9.3mph) • Engine coolant temperature > 50°C(122°F)	
Threshold value	• Intake air temperature sensor's voltage > 4.9V	

Diagnosis Time	• Continuous (More than 10 seconds failure for every 20 seconds test)	
MIL On Condition	• NO MIL ON(DTC only)	

Specification

Temp. (°C)	Resistance (kΩ)	Temp. (°C)	Resistance (kΩ)
-40 (-40°F)	95.95 ~ 105.78	20 (68°F)	3.42 ~ 3.61
-20 (-4°F)	27.4 ~ 29.77	40 (104°F)	1.43 ~ 1.5
0 (32°F)	9.08 ~ 9.72	60 (140°F)	0.66 ~ 0.69
10 (50°F)	5.49 ~ 5.83	80 (176°F)	0.33 ~ 0.34

Diagnostic Circuit Diagram



Signal Waveform & Data

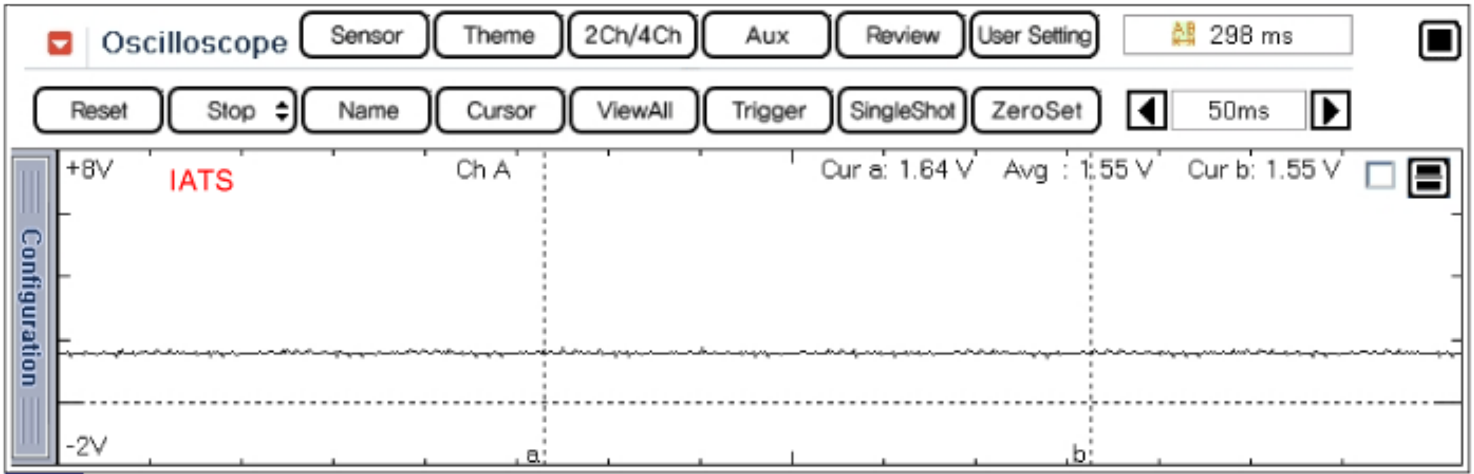


Fig.1

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | Filter

Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	80.6	'F
☑ Intake Air Temperature Sensor	86.0	'F
☑ Oil Temperature Sensor	83.3	'F

Fig.2

Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	194.0	'F
☑ Intake Air Temperature Sensor	106.3	'F
☑ Oil Temperature Sensor	194.0	'F

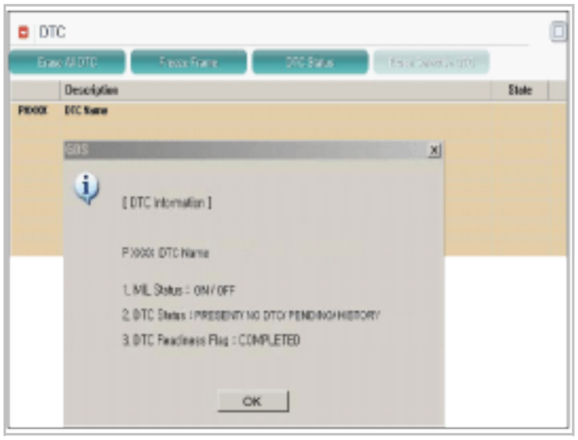
Fig.3

Fig.1) Normal waveform of IATS at 43°C (109°F)
Fig.2) Normal data of IATS & ECTS & EOTS at ig on
Fig.3) Normal data of IATS & ECTS & EOTS after warming up.
Fig.4) Abnormal data of IATS at open condition.

The output signals of IATS & ECTS change smoothly without any rapid changes. Those have almost same characteristic signal during the early period after start. It means that the temperatures of intake air and engine coolant are depended on the temperature of atmosphere. Meanwhile, during the warming up, the output signal of ECTS is going up increasingly. but, the output signal of IATS changes a little bit. even it may not change almost. It means that the heat of engine does not affect on the temperature of intake air.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure
NO	▶ Go to " Signal Circuit Inspection " procedure.

Signal Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect IATS connector.
2. IG "ON"
3. Measure voltage between signal terminal of IATS harness connector and chassis ground.

Specification : Approx. 3.2V

4. Is the measured voltage within specification ?

YES	▶ Go to "Ground Circuit Inspection" procedure.
NO	▶ If the voltage is 0V, go to "Check open in harness" as follows. If the voltage is more than 5.1V, go to "Check short to battery in harness" as follows.

■ Check short to battery in harness

1. IG "OFF" and disconnect IATS connector and ECM connector.

2. Measure resistance between signal terminal of IATS harness connector and power terminal of MAFS harness connector.
3. Measure resistance between signal terminal of IATS harness connector and signal terminal of MAFS harness connector.

Specification : Infinite

4. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to battery in harness and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect IATS connector and ECM connector.
2. Measure resistance between signal terminal of IATS harness connector and IATS signal terminal of ECM harness connector.

Specification : below 1Ω

3. Is the measured resistance within specification ?

YES	▶ Go to "Ground Circuit Inspection" procedure.
NO	▶ Repair open in harness and go to "Verification of Vehicle Repair" procedure.

Ground Circuit Inspection

■ Check open in harness

1. IG "OFF" and disconnect IATS connector and then IG "ON".
2. Measure voltage between signal terminal of IATS harness connector and chassis ground.(Measurement "A")
3. Measure voltage between signal and ground terminals of IATS harness connector.(Measurement "B")

Specification : Voltage difference between measurement "A" and "B" is below 200mV.

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair contact resistance or open in harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check IATS resistance

1. IG "OFF" and disconnect IATS connector.
2. Measure resistance between signal and ground terminals of IATS connector after checking out the temperature of IATS with GDS(Component Side)
Specification :

Temp. (°C)	Resistance (kΩ)
-40(-40°F)	95.95 ~ 105.78
-20(-4°F)	27.4 ~ 29.77
0 (32°F)	9.08 ~ 9.72
10 (50°F)	5.49 ~ 5.83
20 (68°F)	3.42 ~ 3.61
40 (104°F)	1.43 ~ 1.5
60 (140°F)	0.66 ~ 0.69
80 (176°F)	0.33 ~ 0.34

3. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good IATS and check for proper operation. If the problem is corrected, replace IATS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

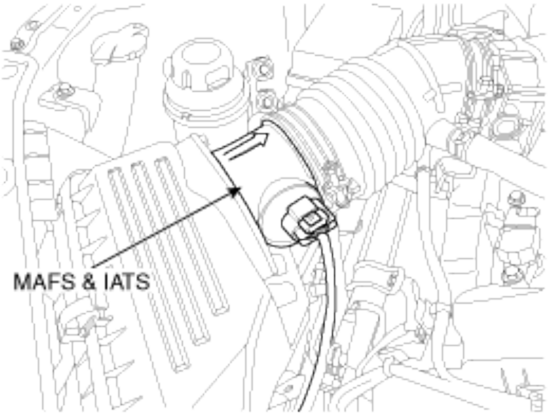
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P1112 Intak Air Temperature Sensor Circuit Intermittent low

Component Location



General Description

The Intake Air Temperature Sensor (IATS) is installed into the Mass Air Flow Sensor (MAFS). The IATS uses a thermistor whose resistance changes with the temperature. The electrical resistance of the IATS decreases as the temperature increases, and increases as the temperature decreases. The 5 V power source in the ECM is supplied to the IATS via a resistor in the ECM. That is, the resistor in the ECM and the thermistor in the IATS are connected in series. When the resistance value of the thermistor in IATS changes according to the intake air temperature, the signal voltage also changes. Using this signal, the information of the intake air temperature, the ECM corrects basic fuel injection duration and ignition timing.

DTC Description

Checking output signals of IATS under detecting condition, if an ouput signal is intermittently below 0.1V, ECM sets P1112.

DTC Detecting Condition

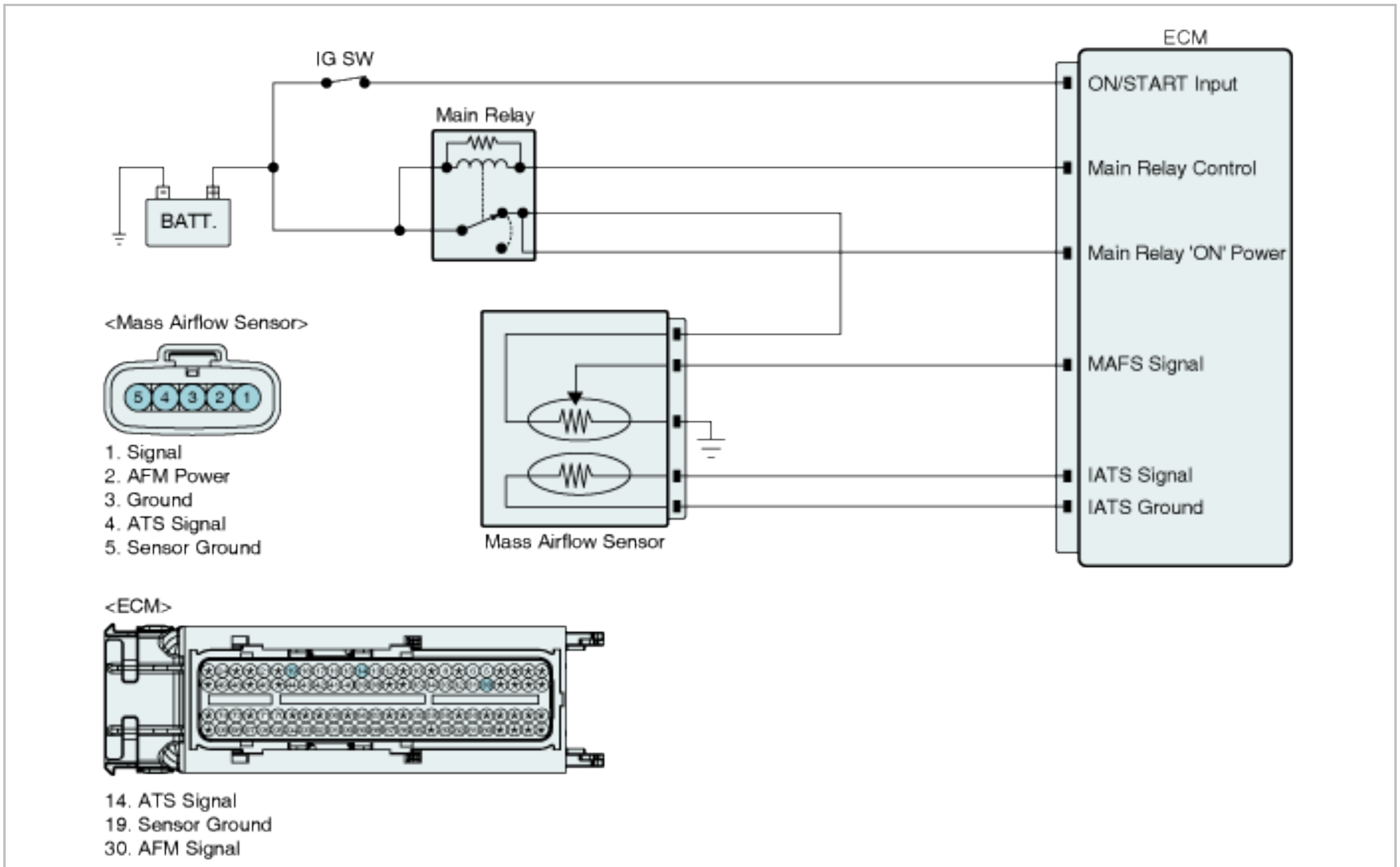
<table>
<tr><th colspan="2">Item</th><th>Detecting Condition</th><th>Possible cause</th></tr>
<tr><td colspan="2">DTC Strategy</td><td>• This code detects a continuous short to ground in either the signal circuit or the sensor</td><td rowspan="7">• Poor connection
• Short to ground in harness
• IATS
• ECM</td></tr>
<tr><td rowspan="2">Enable Conditions</td><td>Case 1</td><td>• Engine running state
• No Vehicle speed sensor fault
• Vehicle speed > 50kph(30mph)</td></tr>
<tr><td>Case 2</td><td>• Engine running time >120 sec.
• Time from IG "OFF" to IG "ON" > 360 min.</td></tr>
<tr><td colspan="2">Threshold value</td><td>• Intake air temperature sensor's voltage < 0.1V</td></tr>
<tr><td colspan="2">Diagnosis Time</td><td>• Continuous (More than 10 seconds failure for every 20 seconds test)</td></tr>
<tr><td colspan="2">MIL On Condition</td><td>• NO MIL ON(DTC only)</td></tr>
</table>

Specification

Temp. (°C)	Resistance (kΩ)	Temp. (°C)	Resistance (kΩ)

-40 (-40°F)	95.95 ~ 105.78	20 (68°F)	3.42 ~ 3.61
-20 (-4°F)	27.4 ~ 29.77	40 (104°F)	1.43 ~ 1.5
0 (32°F)	9.08 ~ 9.72	60 (140°F)	0.66 ~ 0.69
10 (50°F)	5.49 ~ 5.83	80 (176°F)	0.33 ~ 0.34

Diagnostic Circuit Diagram



Signal Waveform & Data

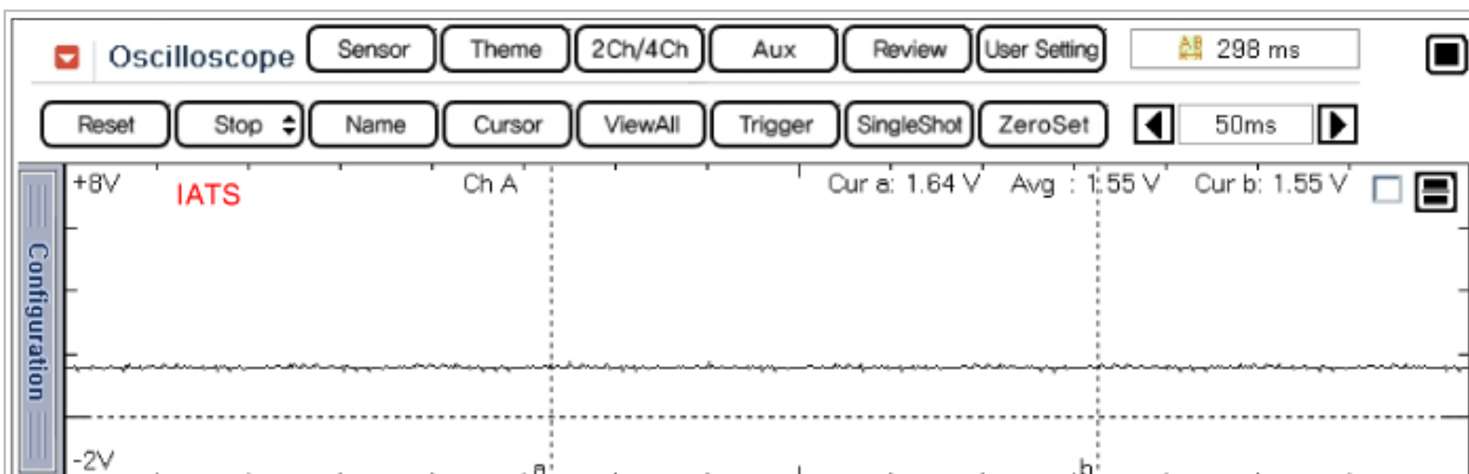


Fig.1

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | Filter

Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	80.6	'F
☑ Intake Air Temperature Sensor	86.0	'F
☑ Oil Temperature Sensor	83.3	'F

Fig.2

Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	194.0	'F
☑ Intake Air Temperature Sensor	106.3	'F
☑ Oil Temperature Sensor	194.0	'F

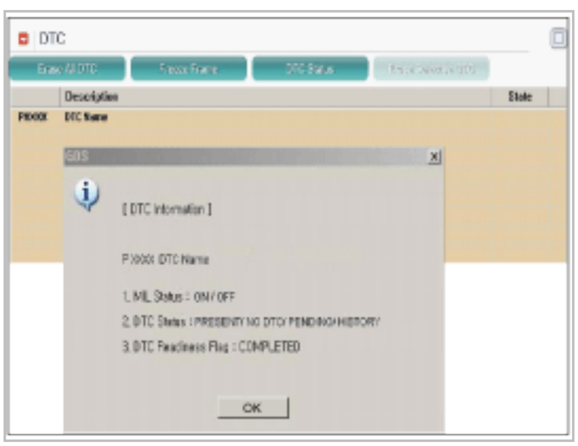
Fig.3

Fig.1) Normal waveform of IATS at 43°C (109°F)
Fig.2) Normal data of IATS & ECTS & EOTS at ig on
Fig.3) Normal data of IATS & ECTS & EOTS after warming up.
Fig.4) Abnormal data of IATS at open condition.

The output signals of IATS & ECTS change smoothly without any rapid changes. Those have almost same characteristic signal during the early period after start. It means that the temperatures of intake air and engine coolant are depended on the temperature of atmosphere. Meanwhile, during the warming up, the output signal of ECTS is going up increasingly. but, the output signal of IATS changes a little bit. even it may not change almost. It means that the heat of engine does not affect on the temperature of intake air.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as

	necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to " Signal Circuit Inspection " procedure.

Signal Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect IATS connector.
2. IG "ON"
3. Measure voltage between signal terminal of IATS harness connector and chassis ground.

Specification : Approx. 3.2V

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Go to "Check short to ground in harness" procedure.

■ Check short to ground in harness

1. IG "OFF" and disconnect IATS connector and ECM connector.
2. Measure resistance between signal terminal of IATS harness connector and chassis ground.(Measurement "A")
3. Measure resistance between signal and ground terminals of IATS harness connector.(Measurement "B")
4. Measure resistance between signal terminal of IATS harness connector and ground terminal of MAFS harness connector.(Measurement "B")

Specification : Infinite

5. Is the measured resistance within specification ?

YES	▶ Go to "Component inspection" procedure.
NO	▶ Repair short to ground in harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check IATS resistance

1. IG "OFF" and disconnect IATS connector.
2. Measure resistance between signal and ground terminals of IATS connector after checking out the temperature of IATS with GDS (Component Side)
   Specification :

Temp. (°C)	Resistance (kΩ)
-40(-40°F)	95.95 ~ 105.78
-20(-4°F)	27.4 ~ 29.77
0 (32°F)	9.08 ~ 9.72
10 (50°F)	5.49 ~ 5.83
20 (68°F)	3.42 ~ 3.61
40 (104°F)	1.43 ~ 1.5
60 (140°F)	0.66 ~ 0.69
80 (176°F)	0.33 ~ 0.34

3. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good IATS and check for proper operation. If the problem is corrected, replace IATS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

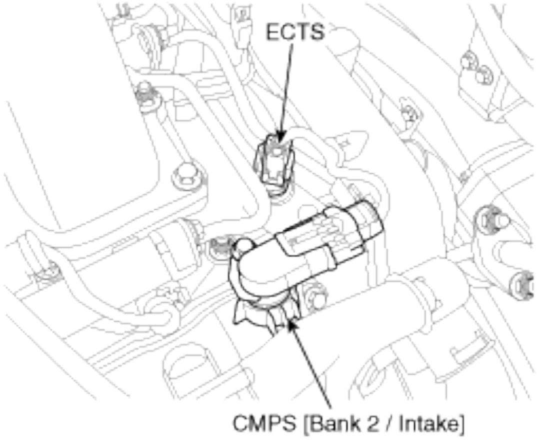
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P1114 Engine Coolant Temperature Sensor Circuit Intermittent low

Component Location



General Description

The Engine Coolant Temperature Sensor (ECTS) is located in the engine coolant passage of the cylinder head for detecting the engine coolant temperature. The ECTS uses a thermistor whose resistance changes with the temperature. The electrical resistance of the ECTS decreases as the temperature increases, and increases as the temperature decreases. The reference 5 V in the ECM is supplied to the ECTS via a resistor in the ECM. That is, the resistor in the ECM and the thermistor in the ECTS are connected in series. When the resistance value of the thermistor in the ECTS changes according to the engine coolant temperature, the output voltage also changes. During cold engine operation the ECM increases the fuel injection duration and controls the ignition timing using the information of engine coolant temperature to avoid engine stalling and improve drivability.

DTC Description

Checking output signals from ECTS under detecting condition, if an output signal is intermittently below 0.1V, ECM sets P1114.

DTC Detecting Condition

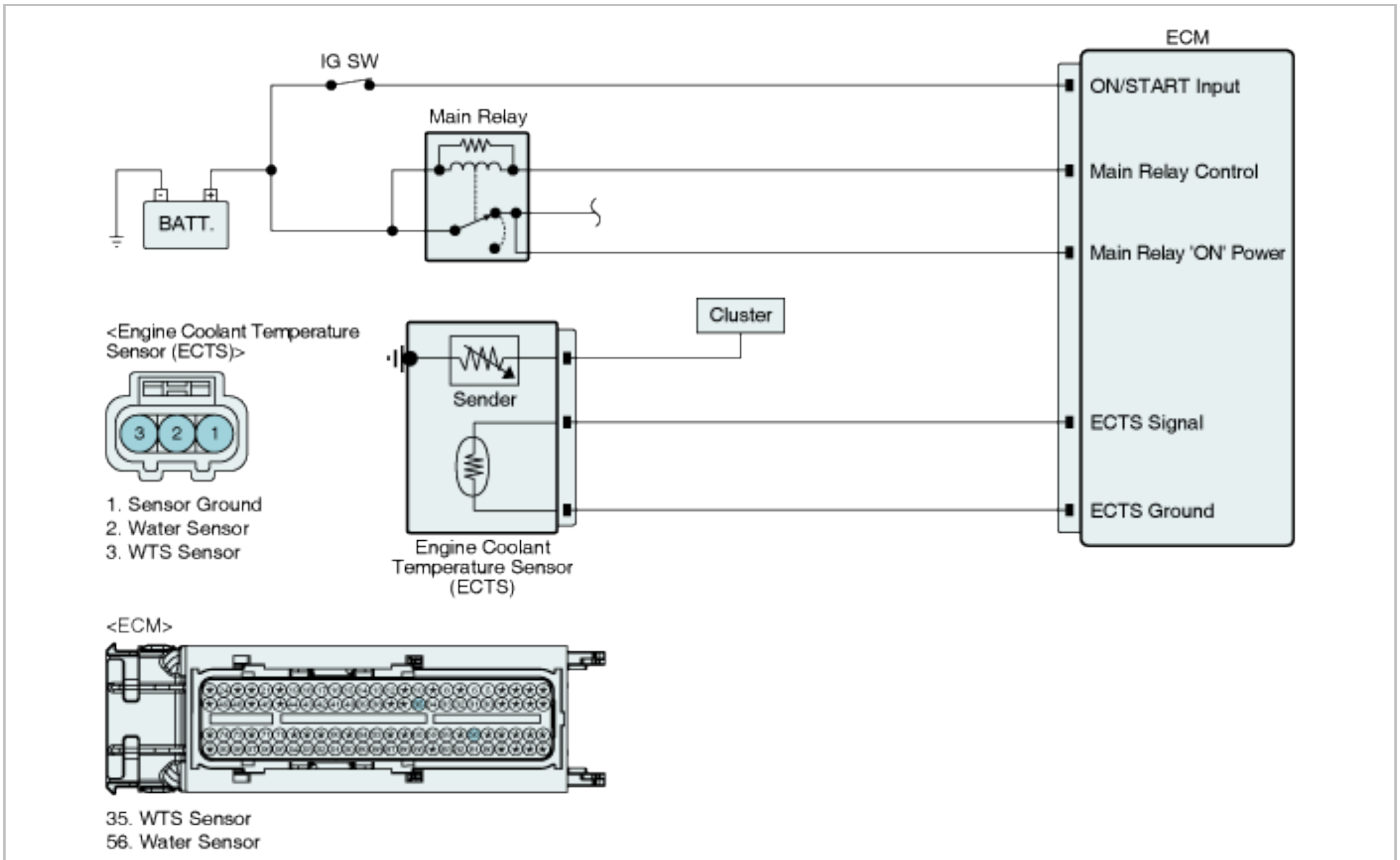
<table>
<tr><th colspan="2">Item</th><th>Detecting Condition</th><th>Possible cause</th></tr>
<tr><td colspan="2">DTC Strategy</td><td>• Signal low</td><td rowspan="7">• Poor connection
• Short to ground in harness
• ECTS
• ECM</td></tr>
<tr><td rowspan="2">Enable Conditions</td><td>Case 1</td><td>• Time after start-up > 120 sec.</td></tr>
<tr><td>Case 2</td><td>• Time from IG "OFF" to IG "ON" > 360 min.
• Engine running state</td></tr>
<tr><td colspan="2">Threshold value</td><td>• Engine coolant temperature sensor's voltage < 0.1V</td></tr>
<tr><td colspan="2">Diagnosis Time</td><td>• Continuous (More than 40 seconds failure for every 80 second test)</td></tr>
<tr><td colspan="2">MIL On Condition</td><td>• NO MIL ON(DTC only)</td></tr>
</table>

Specification

Temp. (°C)	Resistance (kΩ)	Temp. (°C)	Resistance (kΩ)
-40 (-40°F)	48.14	40 (104°F)	1.15
-20 (-4°F)	14.13 ~ 16.83	60 (140°F)	0.59

0 (32°F)	5.79	80 (176°F)	0.32
20 (68°F)	2.31 ~ 2.59		

Diagnostic Circuit Diagram



Signal Waveform & Data

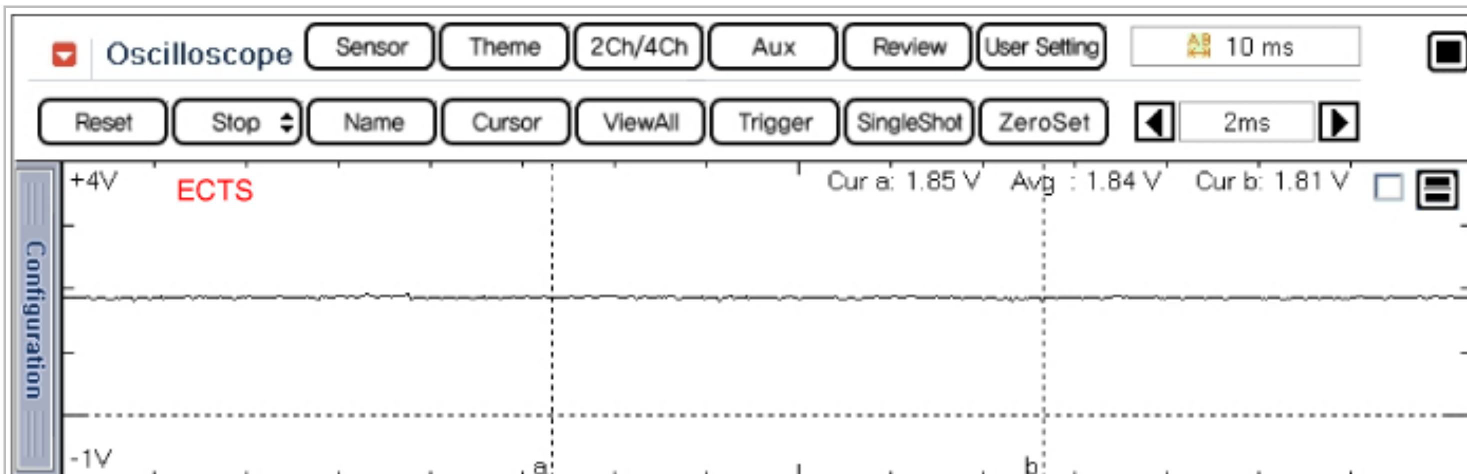


Fig.1

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | Filter

Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	80.6	'F
☑ Intake Air Temperature Sensor	86.0	'F
☑ Oil Temperature Sensor	83.3	'F

Fig.2

Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	194.0	'F
☑ Intake Air Temperature Sensor	106.3	'F
☑ Oil Temperature Sensor	194.0	'F

Fig.3

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | Filter

Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	230.4	'F
☑ Intake Air Temperature Sensor	113.0	'F
☑ Oil Temperature Sensor	194.0	'F
☑ Engine Cooling Fan-High	ON	-
☑ Engine Cooling Fan-Low	ON	-
☐ Ignition Timing Advance for 1 Cylinder	7.5	DEG
☐ Ignition Timing Advance for 2 Cylinder	7.5	DEG
☐ Ignition Timing Advance for 3 Cylinder	7.5	DEG

DTC

Erase All DTC | Freeze Frame | DTC Status | Erase Selective DTC

	Description	State
P0118	Engine Coolant Temperature Circuit High Input	
P1115	Engine Coolant Temperature Sensor Circuit Intermittent high	

Fig.4

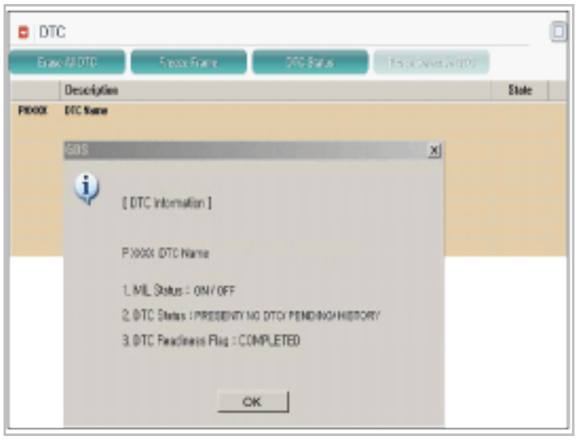
Fig.1) Normal waveform of ECTS at 90°C (194°F)
Fig.2) Normal data of IATS & ECTS & EOTS at ig on
Fig 3) Normal data of IATS & ECTS & EOTS after warming up.
Fig.4) Abnormal data of ECTS at open condition.

The output signals of IATS & ECTS change smoothly without any rapid changes. Those have almost same characteristic signal during the early period after start. It means that the temperatures of intake air and engine coolant are depended on the temperature of atmosphere. Meanwhile, during the warming up, the output signal of ECTS is going up increasingly. but, the output signal of IATS changes a little bit. even it may not change almost. It means that the heat of engine does not affect on the temperature of intake air.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".

3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to " Signal Circuit Inspection " procedure.

Signal Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect ECTS connector.
2. IG "ON"
3. Measure voltage between signal terminal of ECTS harness connector and chassis ground.

Specification : Approx. 3.3V

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Go to "Check short to ground in harness" as follows.

■ **Check short to ground in harness**

1. IG "OFF" and disconnect ECTS connector and ECM connector.
2. Measure resistance between signal terminal of ECTS harness connector and chassis ground.(Measurement "A")
3. Measure resistance between signal and ground terminals of ECTS harness connector.(Measurement "B")

   Specification : Infinite

4. Is the measured resistance within specification ?

YES	▶ Go to "Component inspection" procedure.
NO	▶ Repair short to ground in harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ **Check ECTS resistance**

1. IG "OFF" and disconnect ECTS connector.
2. Measure resistance between signal and ground terminals of ECTS connector after checking out the temperature of ECTS with GDS (Component Side)
   Specification :

Temp. (°C)	Resistance (kΩ)
-40	48.14
-20	14.13 ~ 16.83
0	5.79
20	2.31 ~ 2.59
40	1.15
60	0.59
80	0.32
100	0.19

3. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good EOTS and check for proper operation. If the problem is corrected, replace EOTS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

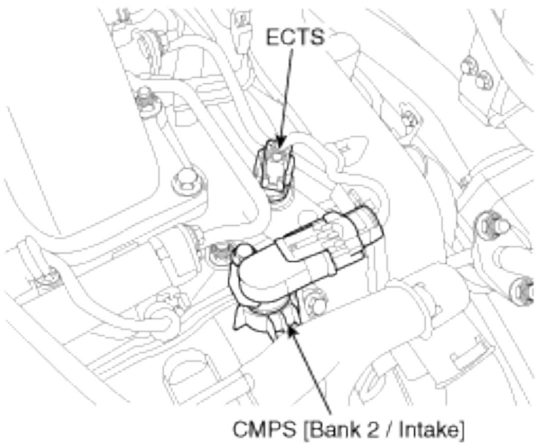
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P1115 Engine Coolant Temperature Sensor Circuit Intermittent high

Component Location



General Description

The Engine Coolant Temperature Sensor (ECTS) is located in the engine coolant passage of the cylinder head for detecting the engine coolant temperature. The ECTS uses a thermistor whose resistance changes with the temperature. The electrical resistance of the ECTS decreases as the temperature increases, and increases as the temperature decreases. The reference 5 V in the ECM is supplied to the ECTS via a resistor in the ECM. That is, the resistor in the ECM and the thermistor in the ECTS are connected in series. When the resistance value of the thermistor in the ECTS changes according to the engine coolant temperature, the output voltage also changes. During cold engine operation the ECM increases the fuel injection duration and controls the ignition timing using the information of engine coolant temperature to avoid engine stalling and improve drivability.

DTC Description

Checking output signals from ECTS under detecting condition, if an output signal is intermittently above 4.9V, ECM sets P1115.

DTC Detecting Condition

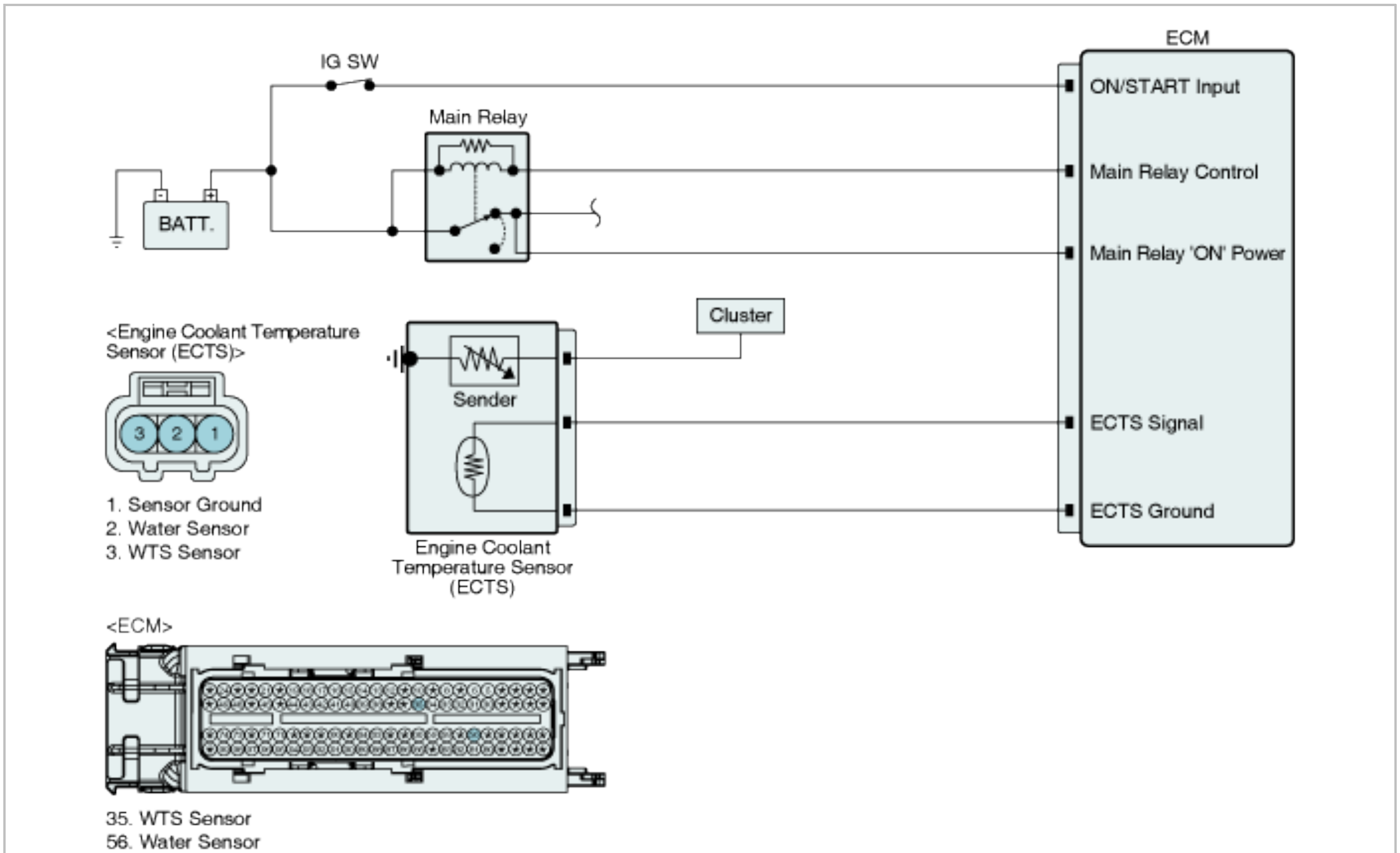
Item	Detecting Condition	Possible cause
DTC Strategy	• Open, Signal high	

Enable Conditions	Case 1	• Time after start-up > 120 sec.	• Poor connection • Open or short to battery in signal harness • Open in ground harness • ECTS • ECM
	Case 2	• Time from IG "OFF" to IG "ON" > 360 min. • Intake air temperature ≥ -10°C(14°F) • Engine running state	
Threshold value		• Engine coolant temperature sensor's voltage > 4.9V	
Diagnosis Time		• Continuous (More than 10 sec. failure for every 20 sec. test)	
MIL On Condition		• NO MIL ON(DTC only)	

Specification

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

Diagnostic Circuit Diagram



Signal Waveform & Data

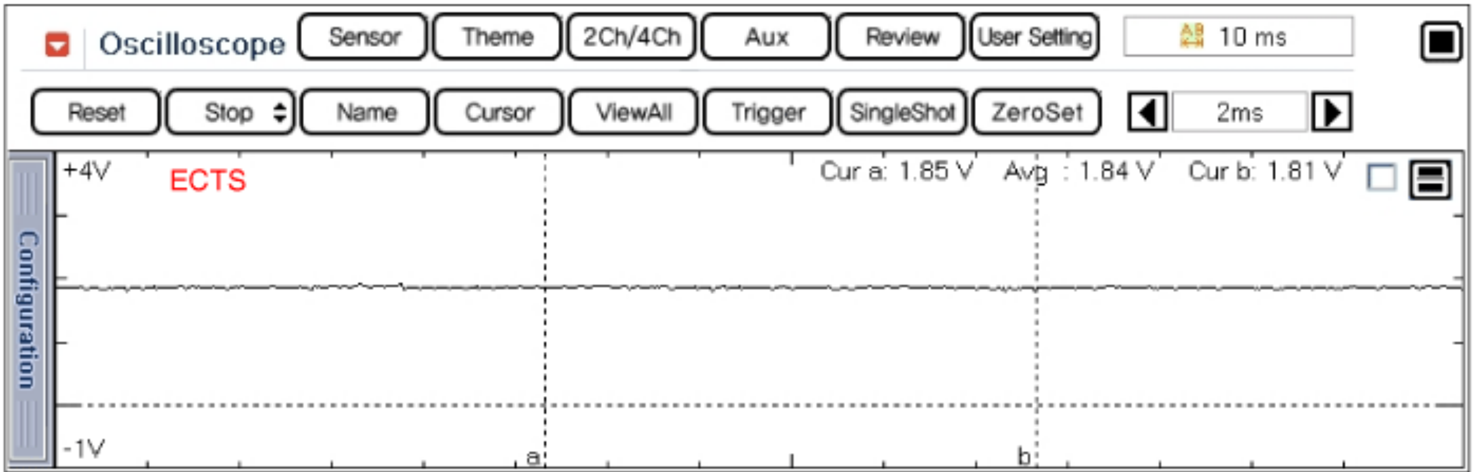
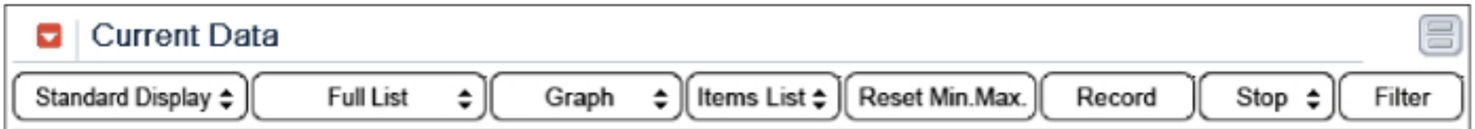


Fig.1



Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	80.6	'F
☑ Intake Air Temperature Sensor	86.0	'F
☑ Oil Temperature Sensor	83.3	'F

Fig.2

Sensor Name	Value	Unit
☑ Engine Coolant Temperature Sensor	194.0	'F
☑ Intake Air Temperature Sensor	106.3	'F
☑ Oil Temperature Sensor	194.0	'F

Fig.3

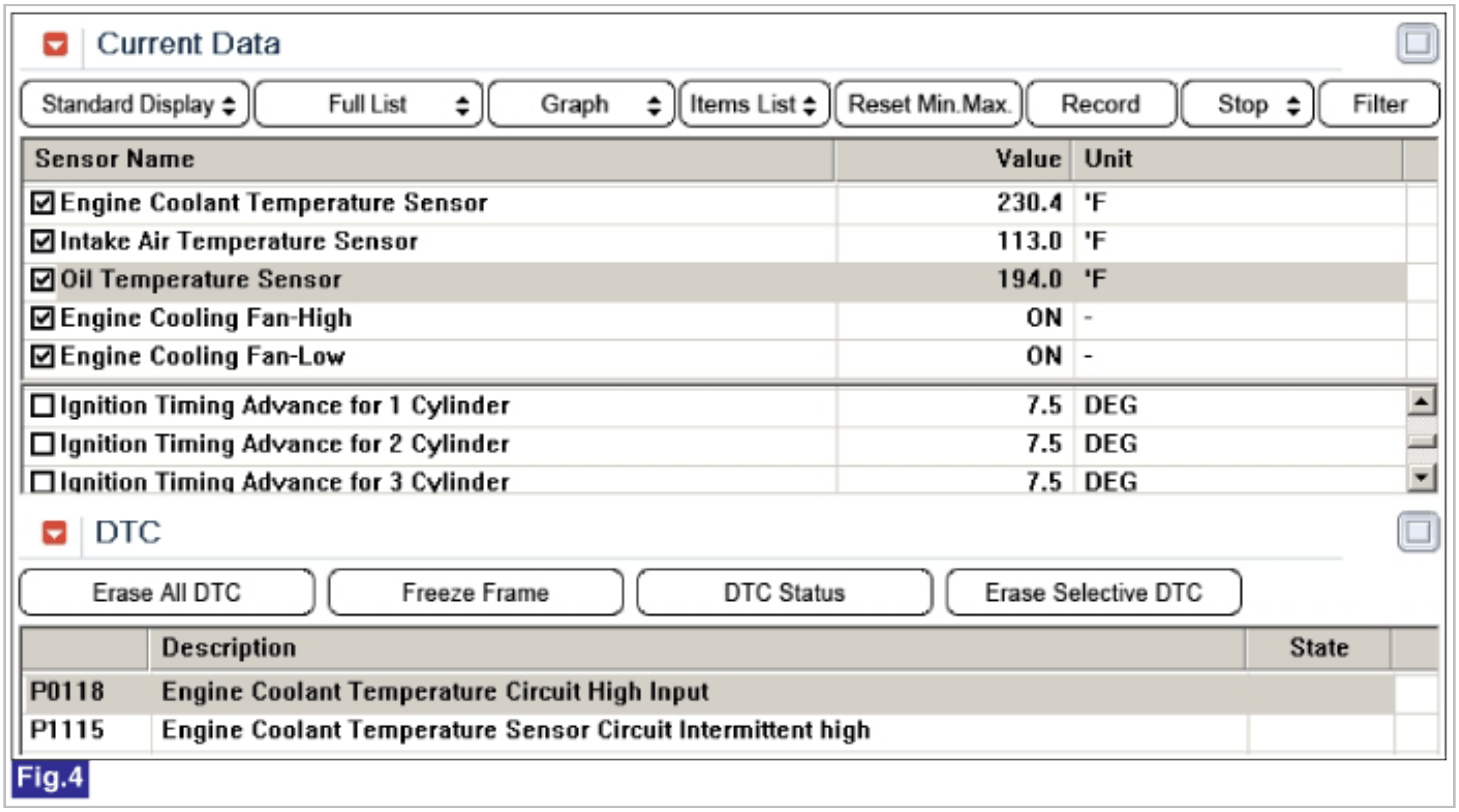
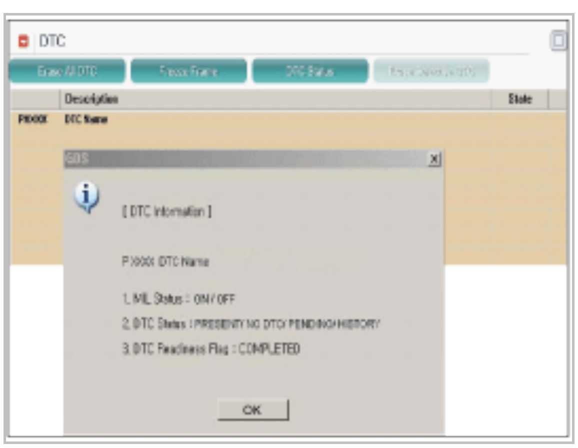


Fig.4

Fig.1) Normal waveform of ECTS at 90°C (194°F)
Fig.2) Normal data of IATS & ECTS & EOTS at ig on
Fig 3) Normal data of IATS & ECTS & EOTS after warming up.
Fig.4) Abnormal data of ECTS at open condition.
The output signals of IATS & ECTS change smoothly without any rapid changes. Those have almost same characteristic signal during the early period after start. It means that the temperatures of intake air and engine coolant are depended on the temperature of atmosphere. Meanwhile, during the warming up, the output signal of ECTS is going up increasingly. but, the output signal of IATS changes a little bit. even it may not change almost. It means that the heat of engine does not affect on the temperature of intake air.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to " Signal Circuit Inspection " procedure.

Signal Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect EOTS connector.
2. IG "ON"
3. Measure voltage between signal terminal of EOTS harness connector and chassis ground.

Specification : Approx. 3.3V

4. Is the measured voltage within specification ?

YES	▶ Go to "Ground Circuit Inspection" procedure.
NO	▶ If the voltage is 0V, go to "Check open in harness" as follows. If the voltage is more than 5.1V, repair short to battery in harness and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect ECTS connector and ECM connector.
2. Measure resistance between signal terminal of ECTS harness connector and ECTS signal terminal of ECM harness connector.

Specification : Below 1Ω

3. Is the measured resistance within specification ?

YES	▶ Go to "Ground Circuit Inspection" procedure.
NO	▶ Repair open in harness and go to "Verification of Vehicle Repair" procedure.

Ground Circuit Inspection

■ **Check open in harness**

1. IG "OFF" and disconnect ECTS connector and then IG "ON".
2. Measure voltage between signal terminal of ECTS harness connector and chassis ground.(Measurement "A")
3. Measure voltage between signal and ground terminals of ECTS harness connector.(Measurement "B")

Specification : Voltage difference between measurement "A" and "B" is below 200mV.

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair contact resistance or open in harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ **Check ECTS resistance**

1. IG "OFF" and disconnect ECTS connector.
2. Measure resistance between signal and ground terminals of ECTS connector after checking out the temperature of ECTS with GDS (Component Side)
   Specification :

Temp. (°C)	Resistance (kΩ)
-40	48.14
-20	14.13 ~ 16.83
0	5.79
20	2.31 ~ 2.59
40	1.15
60	0.59
80	0.32
100	0.19

3. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good EOTS and check for proper operation. If the problem is corrected, replace EOTS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P1295 Throttle Actuator Control System - Power Management

General Description

The Electronic Throttle Control(ETC) system is made of the components throttle body, Throttle Position Sensor(TPS)1&2 and Accelerator Position Sensor(APS) 1&2. The throttle body contains the actuator, the throttle plate and the throttle position sensor (potentiometer), which are integrated in one housing. The actuator consists of a DC motor with a two-stage gear. The opening angle of the throttle valve is detected by the throttle position sensor which is mounted on the throttle body. And it provides feedback to the ECM to control the throttle motor in order to control the throttle valve opening angle properly in response to the driving condition.

DTC Description

If power management mode is recognized under detecting condition, ECM sets P1295. And MIL(Malfunction Indication Lamp) turns on.

DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• This code detects if the system is in Power Management Mode	• TPS Malfunction • TPS Malfunction + MAFSMalfunction • MAP Malfunction + TPS Malfunction • Faulty ECM
Enable Conditions	• Ignition On	
Threshold value	• Power Management Mode is active	
Diagnosis Time	• -	
MIL On Condition	• 1 driving Cycle	

※ If Main relay has a fault(ex. Open) under engine running, the DTCs,P0638/P0685/P1295/P2106, can happen at the same time.
<DTC Name>
- P0638 Throttle Actuator Control Range/Performance(Bank 1)
- P0685 ECM/ECM Power Relay Control Circuit /Open
- P1295 Throttle Actuator Control System - Power Management
- P2106 Throttle Actuator Control System - Forced Limited Power

Monitor GDS Data

1. Connect GDS to DLC(Data Link Connector)
2. IG "ON" & Monitor that any different DTC(Diagnostic Trouble Code) is existed.
   (There will be at least one more DTC which causes this DTC P1295 to retrieve)
3. Repair the DTCs cause DTC P1295 first according to the designated trouble shooting guide.
   (After repairing the DTCs cause DTC P1295, don't forget to do "ETC Initialization" as follows.)
4. Is the same DTC occurred ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Go to "Verification of Vehicle Repair" procedure.

※ Procedure of ETS Initialization
1. Erase the trouble codes on ECM
2. Turn the ignition key off and keep this condition until the main relay is turned off.(It will take 10sec.)
3. Turn ignition key on more than 1second to record the throttle motor position on the EEPROM

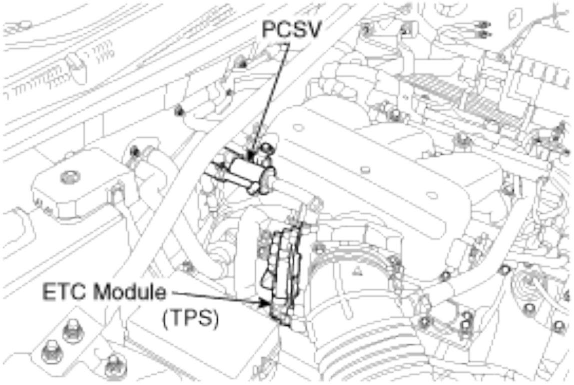
Verification of Vehicle Repair

After a repair, it is essential to verify that the fault has been corrected.
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P1523 Throttle Actuator Control System - Throttle Valve Stuck

Component Location



General Description

The Electronic Throttle Control(ETC) system is made of the components throttle body, Throttle Position Sensor(TPS)1&2 and Accelerator Position Sensor(APS) 1&2. The throttle body contains the actuator, the throttle plate and the throttle position sensor (potentiometer), which are integrated in one housing. The actuator consists of a DC motor with a two-stage gear. The opening angle of the throttle valve is detected by the throttle position sensor which is mounted on the throttle body. And it provides feedback to the ECM to control the throttle motor in order to control the throttle valve opening angle properly in response to the driving condition.

DTC Description

Checking throttle valve return state under detecting condition, if an output signal is within the threshold value for more than designated time, ECM sets P1523.

DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Monitor throttle valve return state	• Carbon in throttle • Broken Throttle return spring • throttle sticky • throttle icy
Enable Conditions	• ETC Power Control Mode • TPS 1 & 2 = normal • Sensor Supply voltage = Normal	
Threshold value	• The throttle did not return to default range within 1 to 4 seconds of turning off. That is, (TPS1's signal > 0.9V AND TPS1's signal < 1.85V) or (TPS2's signal < 1.85V AND TPS2's signal > 0.9V) when the power to the ETC motor is turned off.	
Diagnosis Time	• Continuous	
MIL On Condition	• DTC only (NO MIL ON)	

Specification

Throttle Opening (°)	Output Voltage (V) [Vref=5.0]	
	TPS1	TPS2
0°	0.0V	5.0V

10°	0.5V	4.5V
20°	0.9V	4.1V
30°	1.4V	3.6V
40°	1.8V	3.2V
50°	2.3V	2.7V
60°	2.7V	2.3V
70°	3.2V	1.8V
80°	3.6V	1.4V
90°	4.1V	0.9V
100°	4.5V	0.5V
110°	5.0V	0.0V

Signal Waveform & Data

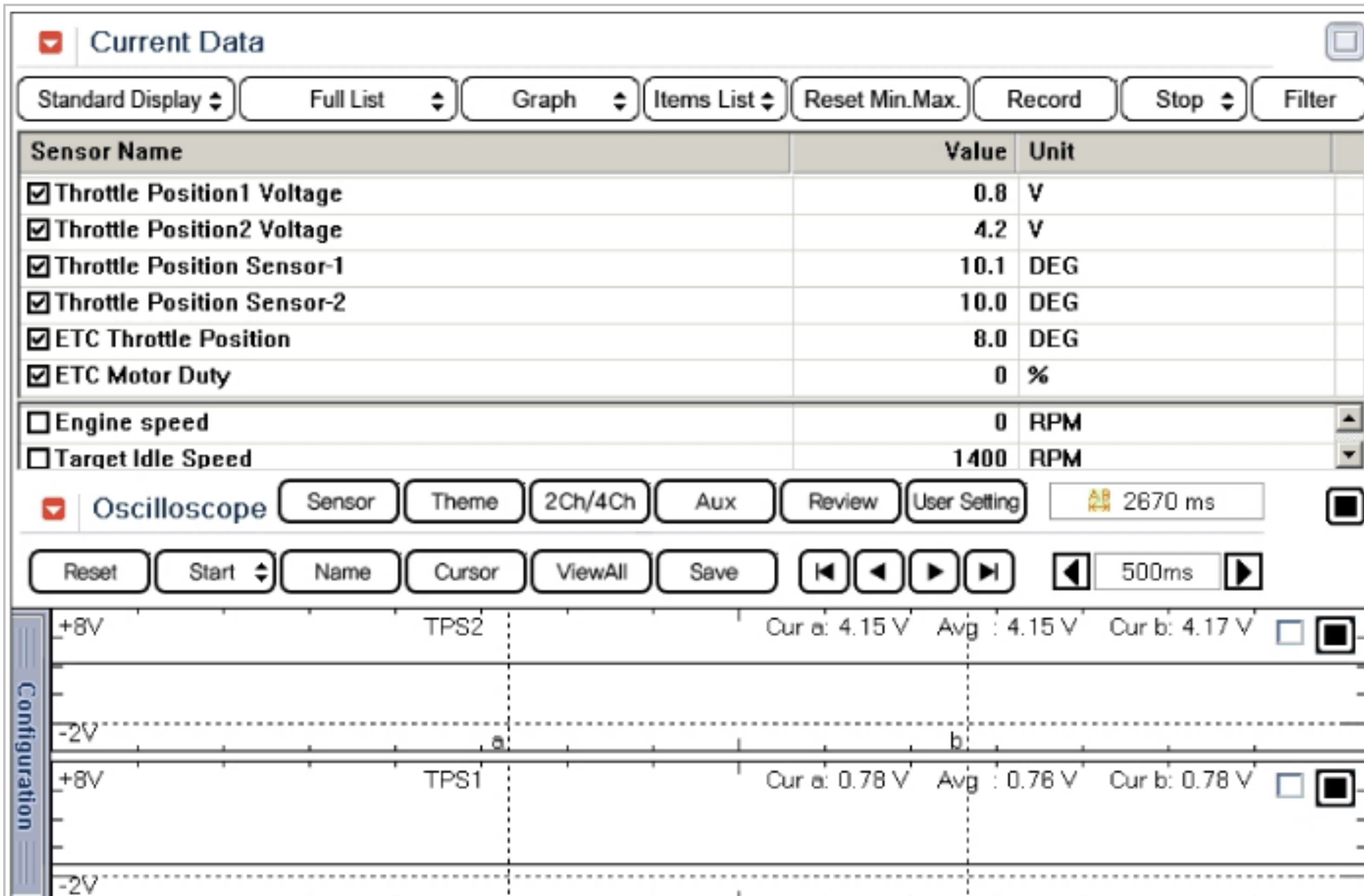


Fig.1

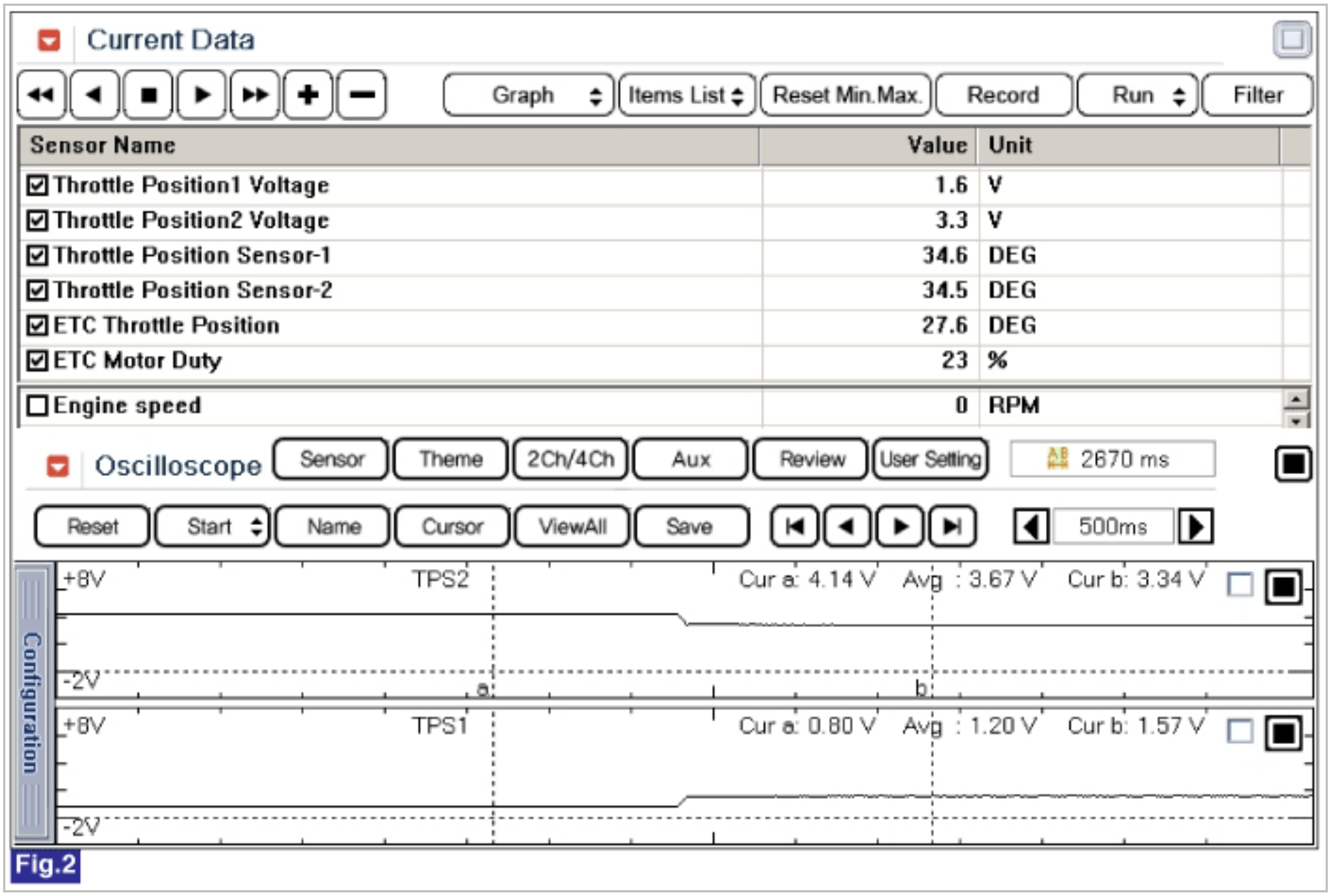
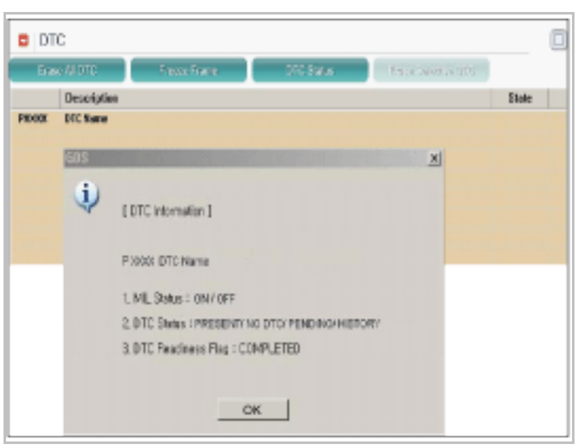


Fig.2

Fig.1) Normal data & waveform of TPS1 & TPS2 with no accel padal depressed under IG ON condition
Fig.2) Normal data & waveform of TPS1 & TPS2 with accel padal depressed under IG ON condition

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "System Inspection" procedure.

NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

System Inspection

■ Visual Inspection

1. IG "OFF".
2. Check throttle valve after removing air duct.
   - ▶ Carbon deposit.
   - ▶ Throttle icy
   - ▶ Broken return spring.
   - ▶ Throttle sticky
3. Is the throttle valve return O.K ?

YES	▶ Thoroughly check that something interferes throttle movement and perform ETS Initialization as follows and then, go to "Verification of Vehicle Repair" procedure.
NO	▶ Repair or replace as necessary and then, do ETS Initialization" as follows. then, go to "Verification of Vehicle Repair" procedure.

※ Procedure of ETS Initialization

A. Erase the trouble codes on ECM

B. Turn the ignition key off and keep this condition until the main relay is turned off.(It will take 10sec.)

C. Turn ignition key on more than 1second to record the throttle motor position on the EEPROM

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P161B ECM Torque Calculation Performance

General Description

Comparing actual torque and desired torque, ECM diagnoses calculated torque state. Actual torque keeps lower than desired torque, ECM checks if actual torque is higher than desired torque. deviding condition into two state, dynamic and steady states, ECM applies different diagnosis logic. Because the responses due to this code is similar to that of MAF control error, checking MAF at first.

DTC Description

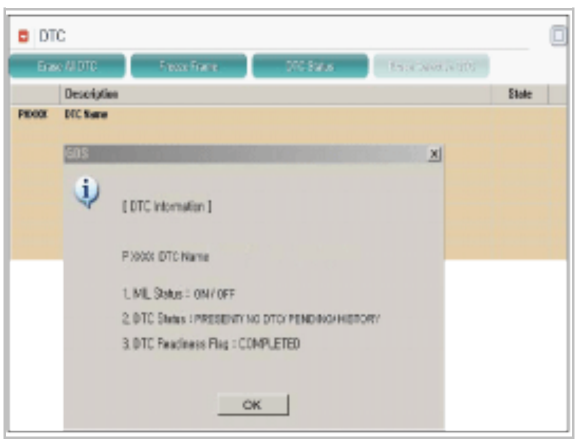
If the actual torque is higher than the desired torque, an error is recognized. And ECM sets P161B and MIL(Malfunction Indication Lamp) turns on.

DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Determines if actual torque is grossly different from desired torque	• Intake air leakage • Faulty ETS System • Clogged exhaust system • Faulty ECM
Enable Conditions	• No faults present • Engine Running state • Engine Speed > 600rpm • Driving(idle to maximum speed)	
Threshold value	• Actual Torque > Desired Torque	
Diagnosis Time	• Continuous (Within 20sec.)	
MIL On Condition	• 1 Driving Cycle	

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure
NO	▶ Go to " System Inspection " procedure.

System Inspection

■ Check air leakage

1. Check contamination or installation of Gasket
   ▶ Check throttle body gasket
   ▶ Check gasket between intake manifold and surge tank.
   ▶ Check contamination or clog by foreign material of gasket between intake manifold and injector.
   ▶ Check contamination or open stuck resulting from foreign material between surge tank and PCSV.
2. Is there any air leakage ?

YES	▶ Repair or replace as necessary and then, go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to " Check exhaust system for clogging" as follows.

■ Check exhaust system for clogging

1. Check exhaust system.
   ▶ Clogged or broken muffler
   ▶ Broken catalyst
2. Is the exhaust system colgged ?

YES	▶ Go to "Check throttle valve for stuck" as follows.
NO	▶ Repair or repalce as necessary and then, go to "Verification of Vehicle Repair" procedure.

■ Check exhaust system for clogging

1. IG "OFF".
2. Remove air hose between throttle body and airflow sensor.
3. Check if throttle valve is sutck by foreign material.
4. Is the throttle valve normal ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ After getting rid of foreign material, check that throttle valve is normal. And check for proper operation. If the problem is corrected, replace ETC and then go to "Verification of Vehicle Repair" procedure.

※ Procedure of ETS Initialization
A. Erase the trouble codes on ECM
B. Turn the ignition key off and keep this condition until the main relay is turned off.(It will take 10sec.)

C. Turn ignition key on more than 1second to record the throttle motor position on the EEPROM

Verification of Vehicle Repair

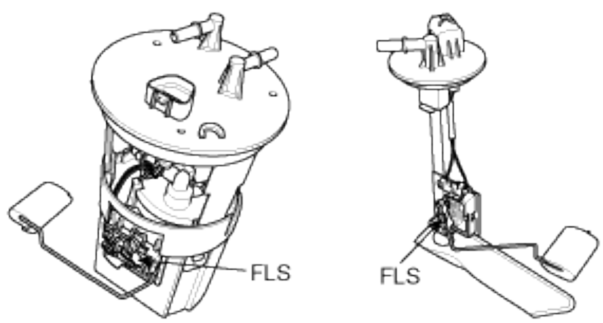
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2065 Fuel Level Sensor \'B\' Circuit

Component Location



General Description

The Fuel Level Sensor(FLS) measures the fuel level in fuel tank and its information is used to supply the ECM with information regarding the monitoring condition of the EVAP canister purge system for leak detection. If the fuel level sensor is monitored for high or low stuck or difference between voltage of fuel level sensor and voltage deviation of fuel level sensor is exceeds limited value while driving, this is interpreted by the ECM as a fault.

DTC Description

Checking output signals of fuel sender under detecting condition, if the difference between the fuel level of fuel sender and fuel sub sendor is too small, ECM sets P2065. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

DTC Detecting Condition

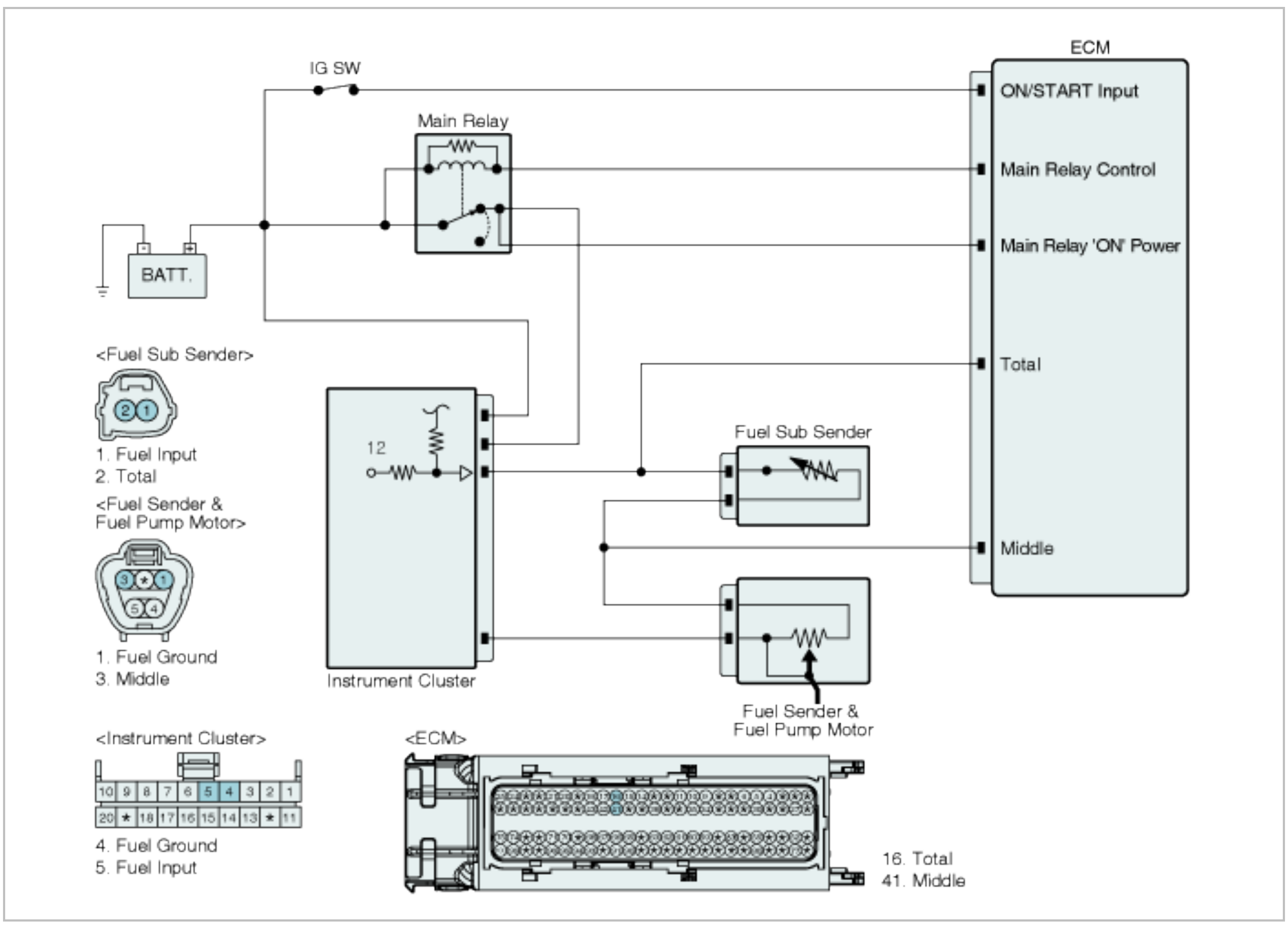
Item	Detecting Condition	Possible cause
DTC Strategy	• Monitoring fuel sender and fuel sub sender	

Enable Conditions	• Engine Running • Ignition Voltage > 11V	• Poor connection • Shorted signal circuits • Short in signal circuit • Faulty Fuel Sub Sender • Faulty ECM
Threshold value	• The difference between fuel sender and fuel sub sender < 2%	
Diagnosis Time	• Continuous (More than 5 sec.failure for every 10 sec.test)	
MIL On Condition	• 2 Driving Cycle	

Specification

FLS	Normal Parameter					
Float position	8/8	6/8	1/2	3/8	1/8	Warning Lamp ON
Sender-Resistance(Ω)	6.4±1	9.3±1	9.3±1	16.4±1	61.1±1	71.8±1
Sub Sender-Resistance(Ω)	7.1±1	50.5±1	95±1	110.0±1	110.0±1	-
Fuel volume(ℓ)	61.5	47.5	34.0	27.25	13.75	9.0

Diagnostic Circuit Diagram



Signal Waveform & Data

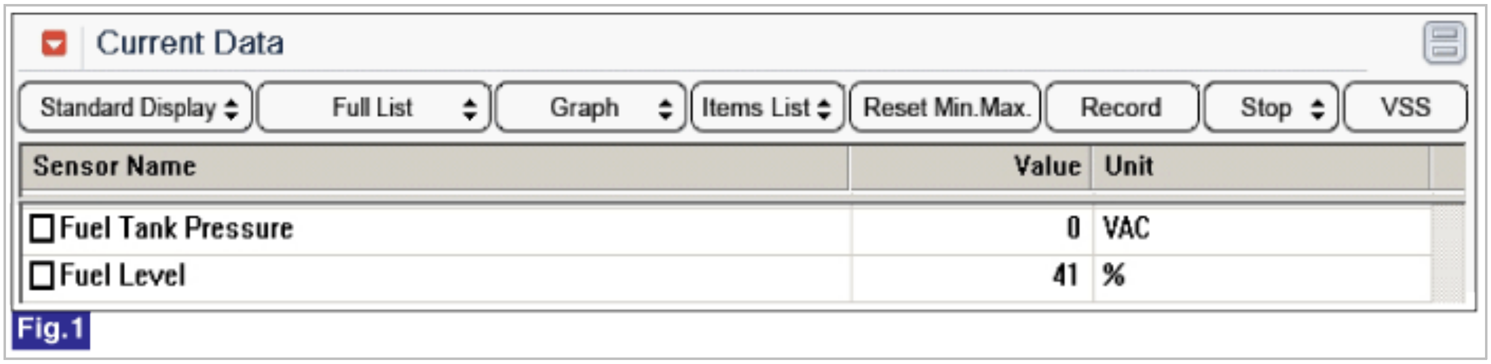
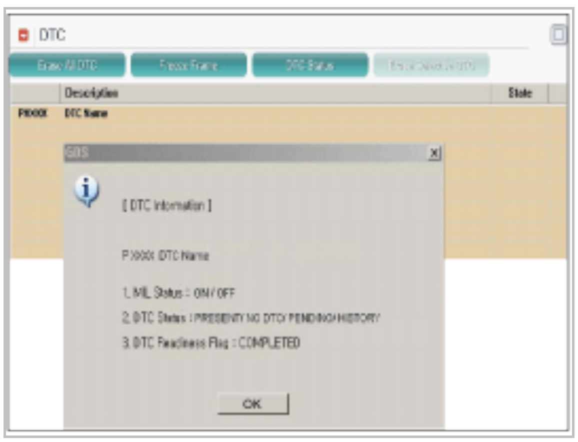


Fig.1) Normal data of Fuel Level at idle (41%).

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by ECM memory was not cleared after repair.Erase DTC and drive the vehicle to satisfy the enable codition then, go to "Component Inspection" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to " Signal Circuit Inspection " procedure.

Signal Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect Fuel Sub Sender connector and ECM connector.
2. IG "ON".
3. Measure voltage between Fuel level signal B terminal of ECM harness connector and chassis ground.

Specification : Approx. 11 ~ 12V

4. Is the measured voltage within specification ?

YES	▶ Go to "Check shorted in harness" procedure.
NO	▶ Repair short to ground or open in harness and go to "Verification of Vehicle Repair" procedure.

■ Check shorted in harness

1. IG "OFF" and disconnect Instrument cluster connector, Fuel Sender & Fuel Pump Motor connector, Fuel Sub Sender connector, and ECM connector.
2. Measure resistance between total and middle signal terminals of ECM harness connector.

Specification : Below 1Ω

3. Is the measured resistance within specification ?

YES	▶ Go to "Check short to battery in harness" procedure.
NO	▶ Repair shorted in harness and go to "Verification of Vehicle Repair" procedure.

■ Check short to battery in harness

1. IG "OFF" and disconnect Instrument cluster connector, Fuel Sender & Fuel Pump Motor connector, Fuel Sub Sender connector, and ECM connector.
2. IG "ON".
3. Measure voltage between middle signal terminal of ECM harness connector and chassis ground.

Specification : Approx. 0V

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to battery in harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check FLS resistance

1. IG "OFF" and Disconnect Fuel Sender & Fuel Pump Motor connector and Fuel Sub Sender connector.
2. Remove these senders from fuel tank and measure the reistance of Fuel sender while lifting up and down the fuel level float.

3. Does the resistance of FLS change as lifting up and down the fuel level float ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good Fuel Sender and check for proper operation. If the problem is corrected, replace Fuel Sender or and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

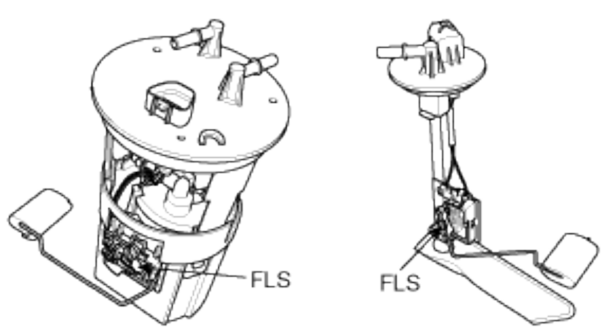
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2066 Fuel Level Sensor \'B\' Performance

Component Location



General Description

The Fuel Level Sensor(FLS) measures the fuel level in fuel tank and its information is used to supply the ECM with information regarding the monitoring condition of the EVAP canister purge system for leak detection. If the fuel level sensor is monitored for high or low stuck or difference between voltage of fuel level sensor and voltage deviation of fuel level sensor is exceeds limited value while driving, this is interpreted by the ECM as a fault.

DTC Description

Checking fuel level change under detecting condition, if the fuel level difference between current and previous is lower than 10% while odometer difference between present and previous is higher than 170km, ECM sets P2066.
MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

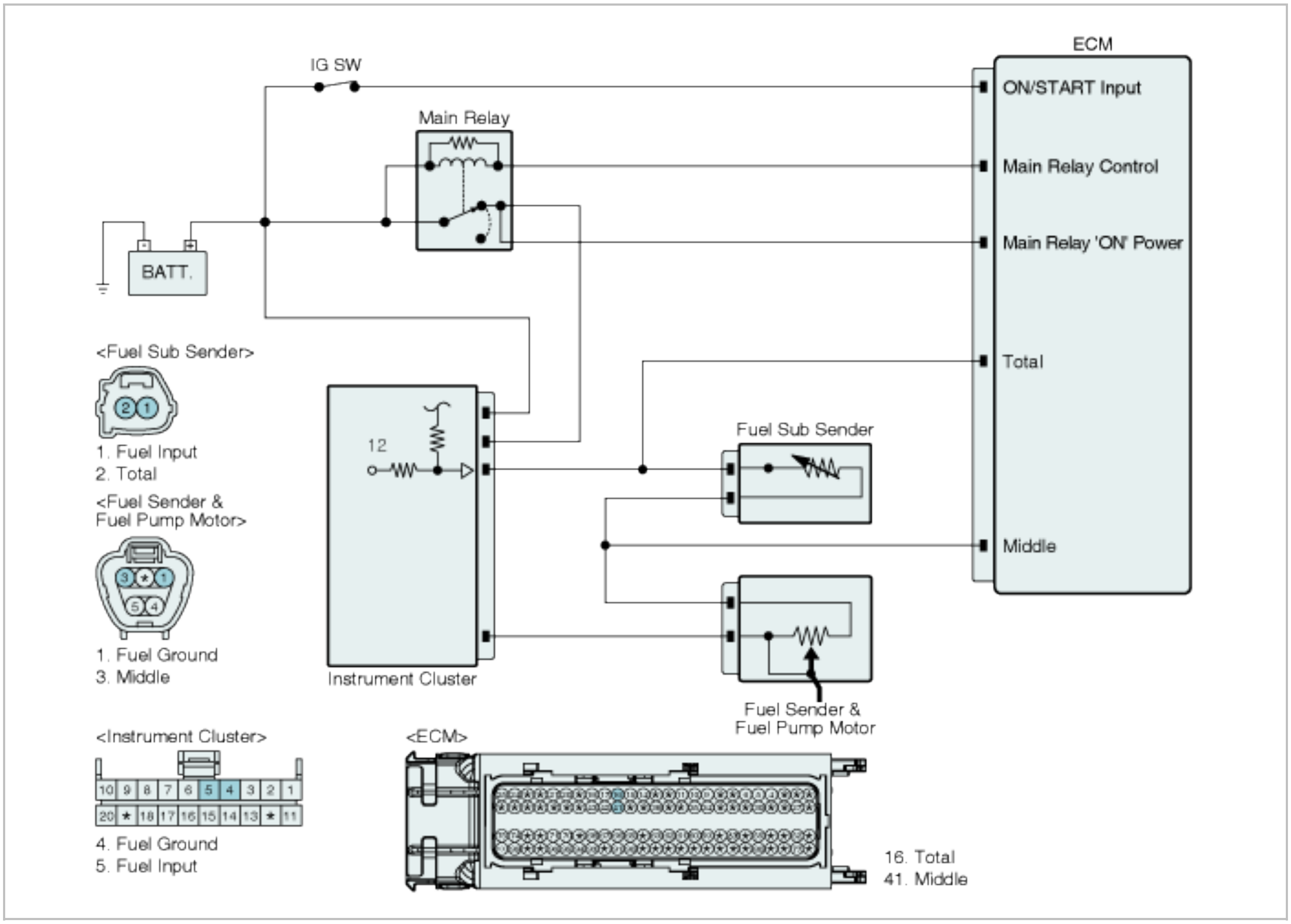
DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Detects a stuck fuel sub sender	• Poor connection • Faulty Fuel Sub Sender Stuck
Enable Conditions	• Engine Running • Fuel Level Fault Not Present • Ignition Voltage > 11V	
Threshold value	• Current fuel level sender's signal - Previous fuel level sender's signal ≤ 10% (After Present Odometer - Previous Odometer ≥ 170 km(105.6 mile))	
Diagnosis Time	• -	
MIL On Condition	• 2 Driving Cycle	

Specification

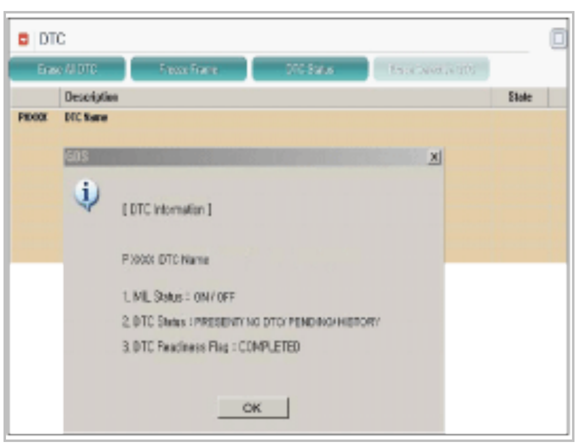
FLS	Normal Parameter					
Float position	8/8	6/8	1/2	3/8	1/8	Warning Lamp ON
Sender-Resistance(Ω)	6.4±1	9.3±1	9.3±1	16.4±1	61.1±1	71.8±1
Sub Sender-Resistance(Ω)	7.1±1	50.5±1	95±1	110.0±1	110.0±1	-
Fuel volume(ℓ)	61.5	47.5	34.0	27.25	13.75	9.0

Diagnostic Circuit Diagram



Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.

NO	▶ Fault is intermittent caused by ECM memory was not cleared after repair.Erase DTC and drive the vehicle to satisfy the enable codition then, go to "Component Inspection" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Component Inspection" procedure.

Component Inspection

■ Check FLS resistance

1. IG "OFF" and Disconnect Fuel Sender & Fuel Pump Motor connector and Fuel Sub Sender connector.
2. Remove these senders from fuel tank and measure the reistance of Fuel sender while lifting up and down the fuel level float.
3. Does the resistance of FLS change as lifting up and down the fuel level float ?

YES	▶ Fault is intermittent such as Float was stuck by something. Thoroughly check that any foreign material intrupts float moment. Erase DTC and drive the vehicle to satisfy the enable codition then, go to "Verification of Vehicle Repair " procedure.
NO	▶ Substitute with a known - good Fuel Sender and check for proper operation. If the problem is corrected, replace Fuel Sender or and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

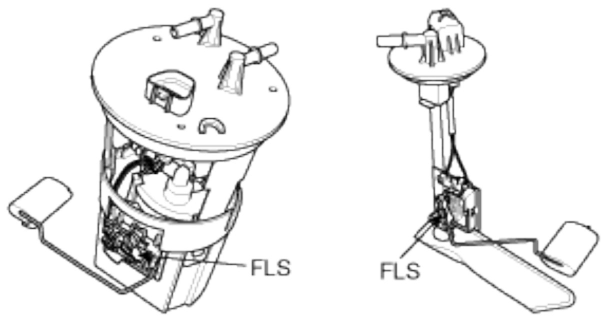
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2067 Fuel Level Sensor \'B\' Circuit Low

Component Location



General Description

The Fuel Level Sensor(FLS) measures the fuel level in fuel tank and its information is used to supply the ECM with information regarding the monitoring condition of the EVAP canister purge system for leak detection. If the fuel level sensor is monitored for high or low stuck or difference between voltage of fuel level sensor and voltage deviation of fuel level sensor is exceeds limited value while driving, this is interpreted by the ECM as a fault.

DTC Description

Checking output signals of fuel sub sender under detecting condition, if the fuel level is too low, ECM sets P2067. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

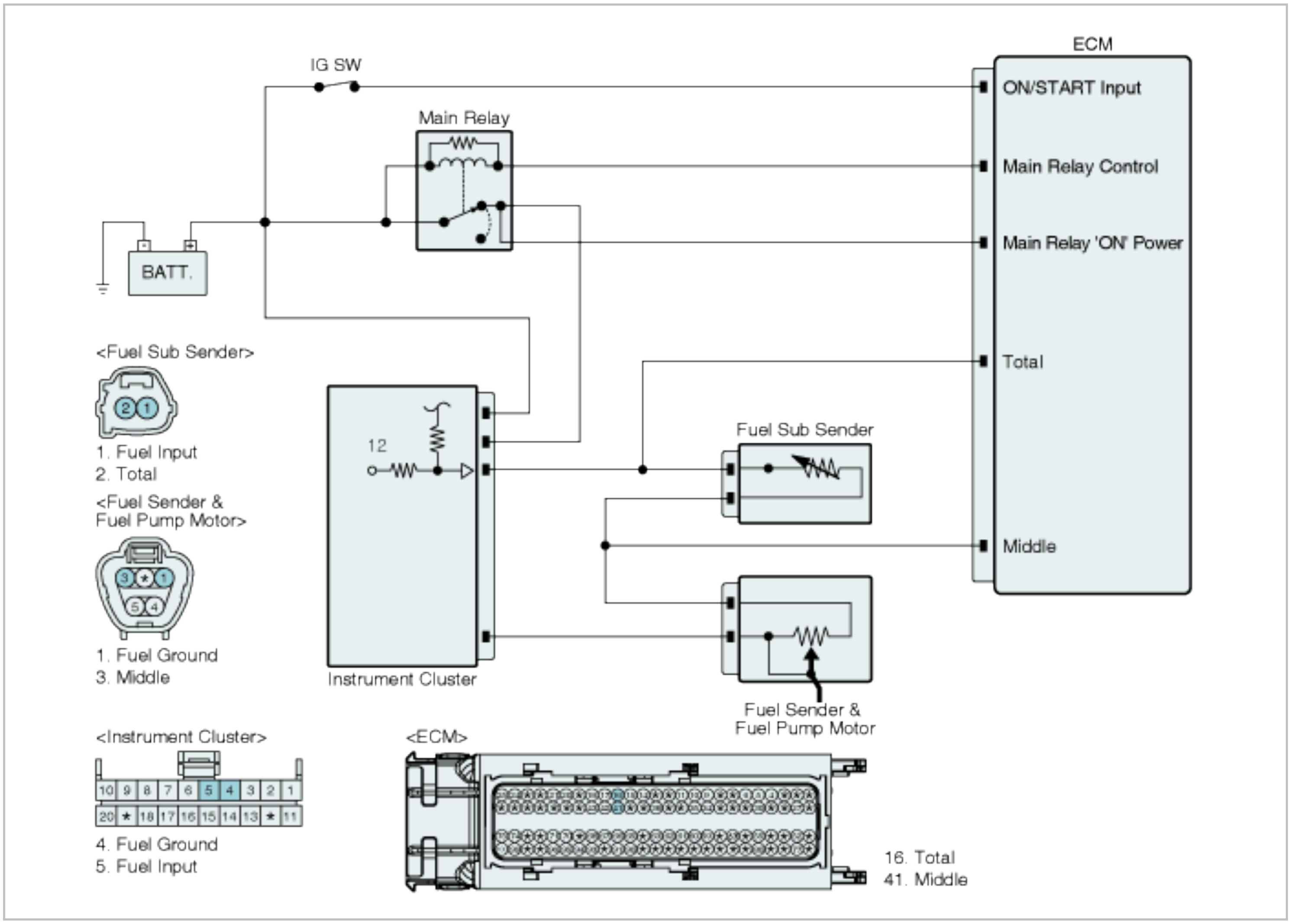
DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Monitoring the fuel level sender A	• Poor connection • Open or short to ground in signal circuit • Faulty Fuel Sub Sender • Faulty ECM
Enable Conditions	• Engine Running • Ignition Voltage > 11V	
Threshold value	• Raw fuel sub sender signal < 0.9 %	
Diagnosis Time	• Continuous (More than 5 sec.failure for every 10 sec.test)	
MIL On Condition	• 2 Driving Cycle	

Specification

FLS	Normal Parameter					
Float position	8/8	6/8	1/2	3/8	1/8	Warning Lamp ON
Sender-Resistance(Ω)	6.4±1	9.3±1	9.3±1	16.4±1	61.1±1	71.8±1
Sub Sender-Resistance(Ω)	7.1±1	50.5±1	95±1	110.0±1	110.0±1	-
Fuel volume(ℓ)	61.5	47.5	34.0	27.25	13.75	9.0

Diagnostic Circuit Diagram



Signal Waveform & Data

Current Data

Standard Display | Full List | Graph | Items List | Reset Min.Max. | Record | Stop | VSS

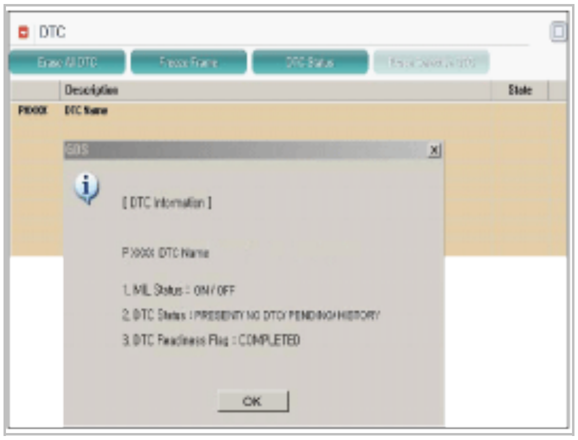
Sensor Name	Value	Unit
Fuel Tank Pressure	0	VAC
Fuel Level	41	%

Fig.1

Fig.1) Normal data of Fuel Level at idle (41%).

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor’s and/or ECM’s connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to " Signal Circuit Inspection " procedure.

Signal Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect Fuel Sender B connector.
2. IG "ON".
3. Measure voltage between total signal terminal of Fuel Sub Sender harness connector and chassis ground.

Specification : Approx. 11 ~ 12V

4. Is the measured voltage within specification ?

YES	▶ Go to "Check short to ground in harness" procedure.
NO	▶ Repair open in harness and go to "Verification of Vehicle Repair" procedure.

■ Check shorted in harness

1. IG "OFF" and disconnect Fuel Sender A & Fuel Pump Motor connector, Fuel Sub Sender B connector and ECM connector.

2. Measure resistance between middle signal terminal of ECM harness connector and chassis ground.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Check open in harness" as follows.
NO	▶ Repair short to ground in harness, and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect Fuel Sender A & Fuel Pump Motor connector and ECM connector.
2. Measure resistance between total signal terminal of Fuel Sender and middle signal terminal of ECM harness connector.

Specification : Below 1Ω

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check FLS resistance

1. IG "OFF" and Disconnect Fuel Sender & Fuel Pump Motor connector and Fuel Sub Sender connector.
2. Remove these senders from fuel tank and measure the reistance of Fuel sender while lifting up and down the fuel level float.
3. Does the resistance of FLS change as lifting up and down the fuel level float ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good Fuel Sub Sender and check for proper operation. If the problem is corrected, replace Fuel Sub Sender and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle

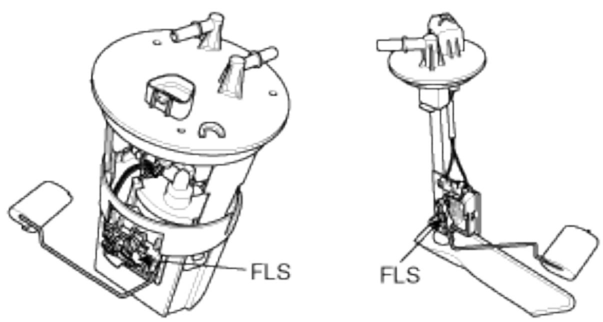
within conditions noted in the freeze frame data or enable conditions.

3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2068 Fuel Level Sensor \'B\' Circuit High

Component Location



General Description

The Fuel Level Sensor(FLS) measures the fuel level in fuel tank and its information is used to supply the ECM with information regarding the monitoring condition of the EVAP canister purge system for leak detection. If the fuel level sensor is monitored for high or low stuck or difference between voltage of fuel level sensor and voltage deviation of fuel level sensor is exceeds limited value while driving, this is interpreted by the ECM as a fault.

DTC Description

Checking output signals of fuel level sender under detecting condition, if the fuel level is too high, ECM sets P2068. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycle.

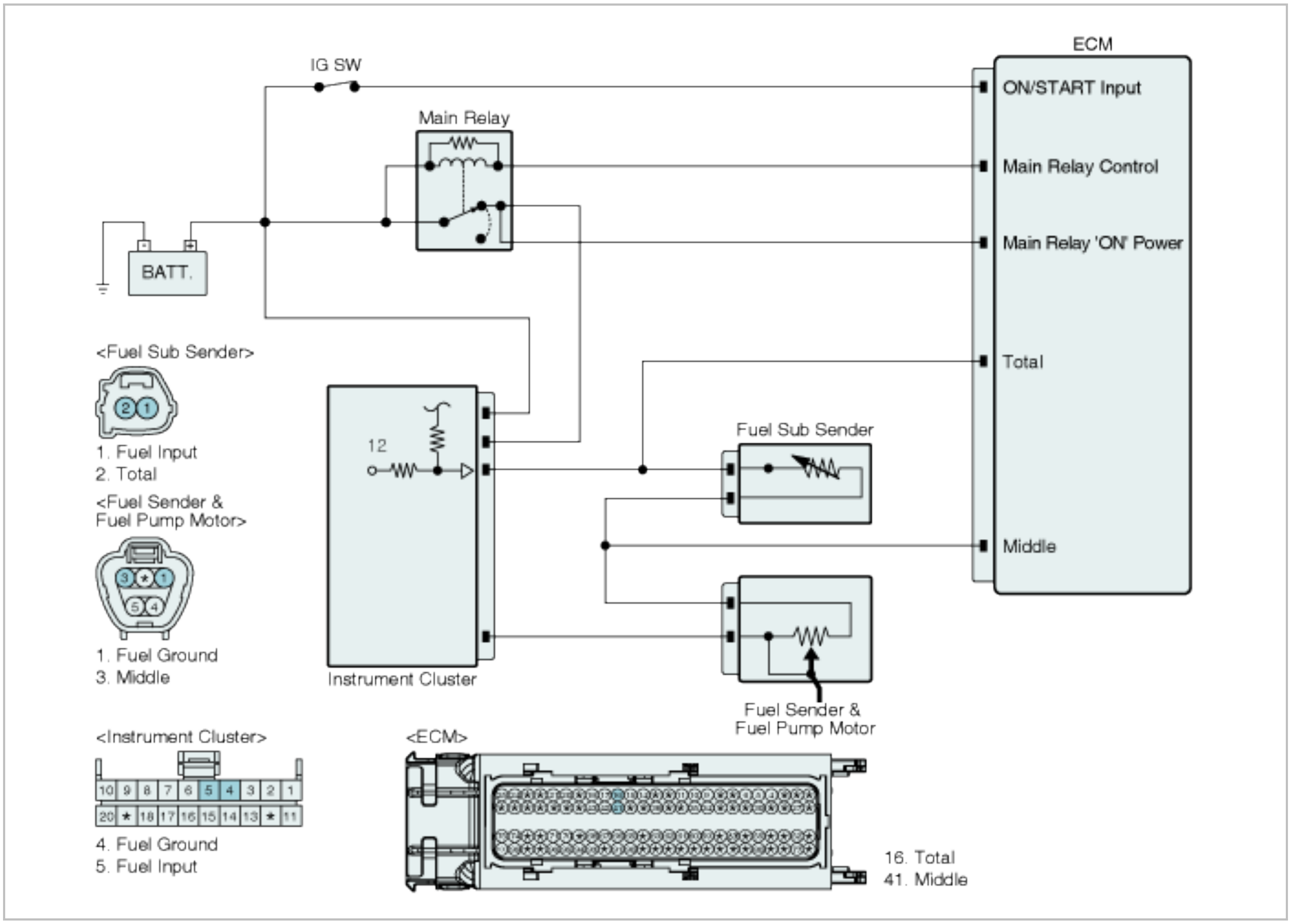
DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Monitoring the fuel level sender A	• Poor connection • Short to battery in signal Circuit • Faulty Fuel Sender • Faulty ECM
Enable Conditions	• Engine Running • Ignition Voltage > 11V	
Threshold value	• Raw fuel level sensor signal > 43 %	
Diagnosis Time	• Continuous (More than 5 sec.failure for every 10 sec.test)	
MIL On Condition	• 2 Driving Cycle	

Specification

FLS	Normal Parameter					
Float position	8/8	6/8	1/2	3/8	1/8	Warning Lamp ON
Sender-Resistance(Ω)	6.4±1	9.3±1	9.3±1	16.4±1	61.1±1	71.8±1
Sub Sender-Resistance(Ω)	7.1±1	50.5±1	95±1	110.0±1	110.0±1	-
Fuel volume(ℓ)	61.5	47.5	34.0	27.25	13.75	9.0

Diagnostic Circuit Diagram



Signal Waveform & Data

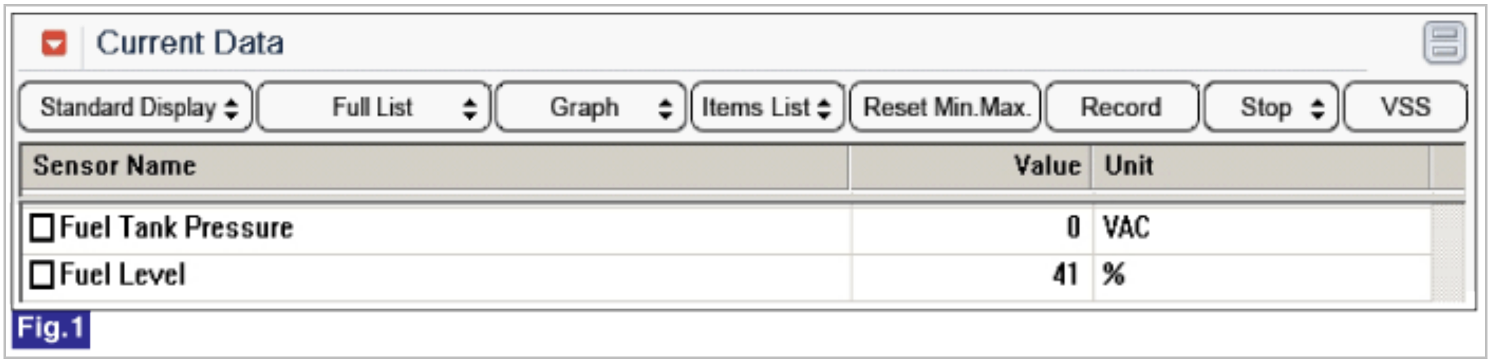
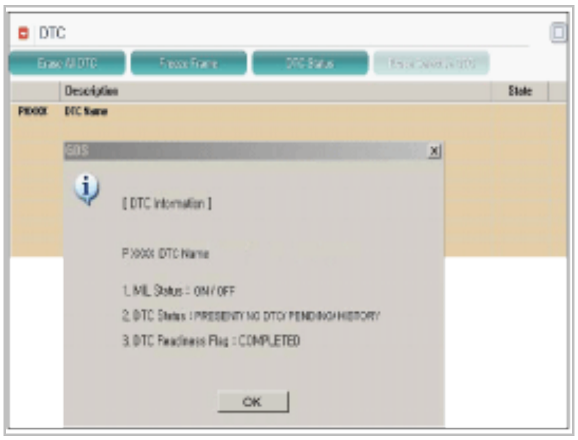


Fig.1) Normal data of Fuel Level at idle (41%).

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure
NO	▶ Go to " Signal Circuit Inspection " procedure.

Signal Circuit Inspection

■ Check short to battery in harness

1. IG "OFF" and disconnect Instrument cluster connector, Fuel Sender A & Fuel Pump Motor connector, and Fuel Sub Sender connector.
2. IG "ON".
3. Measure voltage between total signal terminal of Fuel Sub Sender harness connector and chassis ground.
4. Measure voltage between middle signal terminal of Fuel Sender A & Fuel Pump Motor harness connector and chassis ground.

Specification : Approx. 0V

5. Is the measured voltage within specification ?

YES	▶ Go to "Ground Circuit Inspection" procedure.
NO	▶ Repair short to battery in harness and go to "Verification of Vehicle Repair" procedure.

Ground Circuit Inspection

■ Check open in harness

1. IG "OFF" and disconnect Instrument cluster connector and Fuel Sender A & Fuel Pump Motor connector.
2. Measure resistance between ground terminal of Fuel Sender harness connector and Fuel ground terminal of Instrument cluster harness connector.

Specification : Below 1Ω

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in harness, and go to "Verification of Vehicle Repair" procedure.

Ground Circuit Inspection

■ Check FLS resistance

1. IG "OFF" and Disconnect Fuel Sender & Fuel Pump Motor connector and Fuel Sub Sender connector.
2. Remove these senders from fuel tank and measure the reistance of Fuel sender while lifting up and down the fuel level float.
3. Does the resistance of FLS change as lifting up and down the fuel level float ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
	▶ Substitute with a known - good Fuel Sender and check for proper operation. If the problem is

NO	▶ Substitute with a known - good Fuel Sender and check for proper operation. If the problem is corrected, replace Fuel Sender or and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2096 Post Catalyst Fuel Trim System too Lean (Bank 1)

General Description

In order to provide the best possible combination of drivability, fuel economy and emission control, the ECM uses a closed loop air/fuel metering system. The ECM monitors the HO2S signal voltage and adjusts fuel delivery based it in closed loop fuel control. Changes in fuel delivery will be indicated by the long-term and the short-term fuel trim values. The ideal fuel trim value is around 0%. The ECM will add fuel when the HO2S signal is indicating a lean condition. Additional fuel is indicated by fuel trim values that are above 0%. The ECM will reduce fuel when the HO2S signal is indicating a rich condition. Reduction in fuel is indicated by fuel trim values that are below 0%. The DTC relevant to fuel trim will be set when the amount reaches excessive levels because of a lean or rich condition.

DTC Description

If the lambda controller reaches the maximum or minimum threshold, then feedback control is no longer possible and emissions will be increased. The ECM sets DTC P2096 if no proportional post catalyst fuel trim adaptation occurs for a defined time after the lambda controller has reached its maximum threshold.

DTC Detecting Condition

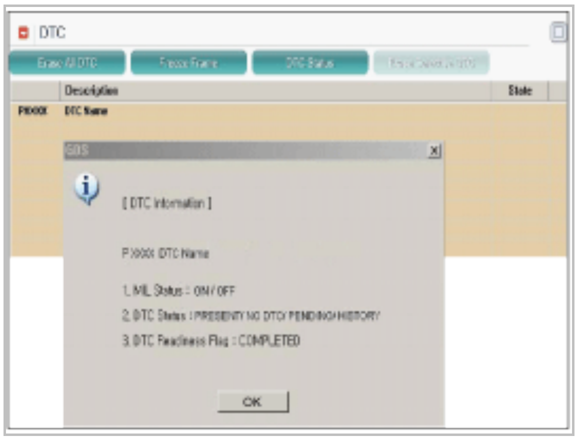
Item	Detecting Condition	Possible cause
DTC Strategy	• Fuel Trim Rear Sensor Control Limits Exceeded	• Air leakage in exhaust System • HO2S • TWC
Enable Conditions	• Cell Enabled • Barometric Pressure ≥ 74 kPa • Intake Air Temperature ≥ -10 °C • System Voltage ≥ 10.9936 V • Closed Loop Active • BLM learn Allowed • Disabling Fault not present	
Threshold value	• Front O2 Sensor switch point ≥ 0.6V Rear O2 Sensor Voltage < 0.25V	

Diagnosis Time	• Fail count > 60 within 80 samples 250ms continuous loop	
MIL On Condition	• 2 Driving Cycles	

Monitor GDS Data

> **NOTE**
>
> If any codes relating to Rear HO2S or TWC(ThreeWay Catalyst Converter) are stored, do ALL REPAIRS associated with those codes before proceeding with this troubleshooting tree.

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check Exhaust system

1. Visually/physically inspect the following conditions:
   - ▶ Exhaust system between HO2S and Three way catalyst for air leakage, restriction and damage
   - ▶ Damage, and for loose or missing hardware
2. Was a problem found in any of the above areas?

YES	▶ Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to next step as below

■ **Check TWC**

1. Visually/physically inspect the three-way catalyst(TWC) converter for the following damage:
   ▶ Severe discoloration caused by excessive temperature
   ▶ Dents and holes
   ▶ Internal rattle caused by a damaged catalyst
2. Also, ensure that the TWC is a proper original equipment manufacturer part.
3. Was a problem found in any of the above areas?

YES	▶ Replace TWC and go to "Verification of Vehicle Repair" procedure
NO	▶ Go to next step as below

■ **Check HO2S**

1. Visually/physically inspect the HO2S for the following conditions:
   ▶ Ensure that the HO2S is securely installed.(Pigtail and wiring harness not making contact with the exhaust pipe)
   ▶ Check for corrosion on terminals and terminal tension (at the HO2S and at the ECM)
   ▶ Front HO2S for silicon contamination. This contamination will be indicated by a white powdery coating on the portion of the sensor exposed to the exhaust stream and this will result in a but false(high) voltage signal
   ▶ Fuel, engine coolant or oil contamination
   ▶ Use of improper sealant
   ▶ If contamination is evident on the HO2S, Fix the source of the sensor contamination before replacingthe sensor to prevent future contamination. Go to "Verification of Vehicle Repair" procedure.
2. Warm up the engine to normal operating temperature and let it idle.
3. Connect GDS and monitor the "O2 SNSR VOL.-B1/S1" and "O2 SNSR VOL.-B1/S2" parameters on the GDS data list.

Specification :
- Front HO2S(O2 SNSR VOL.-B1/S1) : Approx. 0~1V with idle after warm up
Sensor voltage increase during engine acceleration and decrease during engine deceleration
Approx. 0V ~ 0.4 V when fuel cut
- Rear HO2S(O2 SNSR VOL.-B1/S2) : Above 0.4V at idle

---

4. Was a problem found in any of the above areas?

YES	▶ Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure
NO	▶ Check for poor connection between ECM and component: backed out terminal, improper mating, broken locks or poor terminal to wire connection. Repair as necessary and go to "Verification of Vehicle Repair" procedure

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.

NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2097 Post Catalyst Fuel Trim System too Rich (Bank 1)

General Description

In order to provide the best possible combination of drivability, fuel economy and emission control, the ECM uses a closed loop air/fuel metering system. The ECM monitors the HO2S signal voltage and adjusts fuel delivery based it in closed loop fuel control. Changes in fuel delivery will be indicated by the long-term and the short-term fuel trim values. The ideal fuel trim value is around 0%. The ECM will add fuel when the HO2S signal is indicating a lean condition. Additional fuel is indicated by fuel trim values that are above 0%. The ECM will reduce fuel when the HO2S signal is indicating a rich condition. Reduction in fuel is indicated by fuel trim values that are below 0%. The DTC relevant to fuel trim will be set when the amount reaches excessive levels because of a lean or rich condition.

DTC Description

If the lambda controller reaches the maximum or minimum threshold, then feedback control is no longer possible and emissions will be increased. The ECM sets DTC P2097 if no proportional post catalyst fuel trim adaptation occurs for a defined time after the lambda controller has reached its minimum threshold.

DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Fuel Trim Rear Sensor Control Limits Exceeded	• Air leakage in exhaust System • HO2S • TWC
Enable Conditions	• Cell Enabled • Barometric Pressure ≥ 74 kPa • Intake Air Temperature ≥ -10 °C • System Voltage ≥ 10.9936 V • Closed Loop Active • BLM learn Allowed • Disabling Fault not present	
Threshold value	• Front O2 Sensor switch point ≤ 0.4V Rear O2 Sensor Voltage > 0.82V	
Diagnosis Time	• Fail count > 30 within 80 samples 250ms continuous loop	
MIL On Condition	• 2 Driving Cycles	

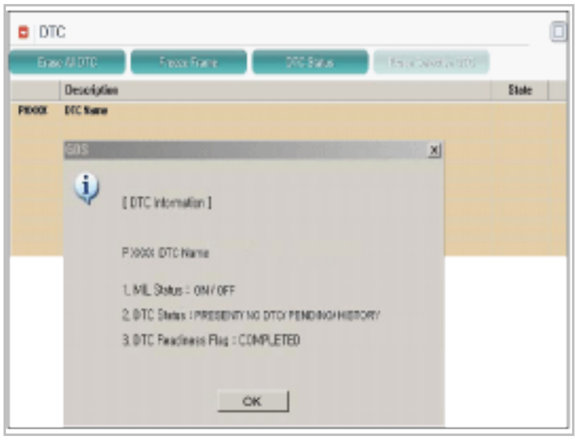
Monitor GDS Data

> **NOTE**
>
> If any codes relating to Rear HO2S or TWC(ThreeWay Catalyst Converter) are stored, do ALL REPAIRS associated with those codes before proceeding with this troubleshooting tree.

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".

3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.

4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check Exhaust system

1. Visually/physically inspect the following conditions:
   - ▶ Exhaust system between HO2S and Three way catalyst for air leakage, restriction and damage
   - ▶ Damage, and for loose or missing hardware
2. Was a problem found in any of the above areas?

YES	▶ Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure
NO	▶ Go to next step as below

■ Check TWC

1. Visually/physically inspect the three-way catalyst(TWC) converter for the following damage:
   - ▶ Severe discoloration caused by excessive temperature
   - ▶ Dents and holes
   - ▶ Internal rattle caused by a damaged catalyst
2. Also, ensure that the TWC is a proper original equipment manufacturer part.
3. Was a problem found in any of the above areas?

YES	▶ Replace TWC and go to "Verification of Vehicle Repair" procedure
NO	▶ Go to next step as below

■ Check HO2S

1. Visually/physically inspect the HO2S for the following conditions:
   - ▶ Ensure that the HO2S is securely installed.(Pigtail and wiring harness not making contact with the exhaust pipe)

▶ Check for corrosion on terminals and terminal tension (at the HO2S and at the ECM)
▶ Front HO2S for silicon contamination. This contamination will be indicated by a white powdery coating on the portion of the sensor exposed to the exhaust stream and this will result in a but false(high) voltage signal
▶ Fuel, engine coolant or oil contamination
▶ Use of improper sealant
▶ If contamination is evident on the HO2S, Fix the source of the sensor contamination before replacingthe sensor to prevent future contamination. Go to "Verification of Vehicle Repair" procedure.

2. Warm up the engine to normal operating temperature and let it idle.
3. Connect GDS and monitor the "O2 SNSR VOL.-B1/S1" and "O2 SNSR VOL.-B1/S2" parameters on the GDS data list.

Specification :
- Front HO2S(O2 SNSR VOL.-B1/S1) : Approx. 0~1V with idle after warm up
Sensor voltage increase during engine acceleration and decrease during engine deceleration
Approx. 0V ~ 0.4 V when fuel cut
- Rear HO2S(O2 SNSR VOL.-B1/S2) : Above 0.4V at idle

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4. Was a problem found in any of the above areas?

YES	▶ Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure
NO	▶ Check for poor connection between ECM and component: backed out terminal, improper mating, broken locks or poor terminal to wire connection. Repair as necessary and go to "Verification of Vehicle Repair" procedure

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2098 Post Catalyst Fuel Trim System Too Lean (Bank 2)

General Description

In order to provide the best possible combination of drivability, fuel economy and emission control, the ECM uses a closed loop air/fuel metering system. The ECM monitors the HO2S signal voltage and adjusts fuel delivery based it in closed loop fuel control. Changes in fuel delivery will be indicated by the long-term and the short-term fuel trim values. The ideal fuel trim value is around 0%. The ECM will add fuel when the HO2S signal is indicating a lean condition. Additional fuel is indicated by fuel trim values that are above 0%. The ECM will reduce fuel when the HO2S signal is indicating a rich condition. Reduction in fuel is indicated by fuel trim values that are below 0%. The DTC relevant to fuel trim will be set when the amount reaches excessive levels because of a lean or rich condition.

DTC Description

If the lambda controller reaches the maximum or minimum threshold, then feedback control is no longer possible and emissions will be increased. The ECM sets DTC P2098 if no proportional post catalyst fuel trim adaptation occurs for a defined time after the lambda controller has reached its maximum threshold.

DTC Detecting Condition

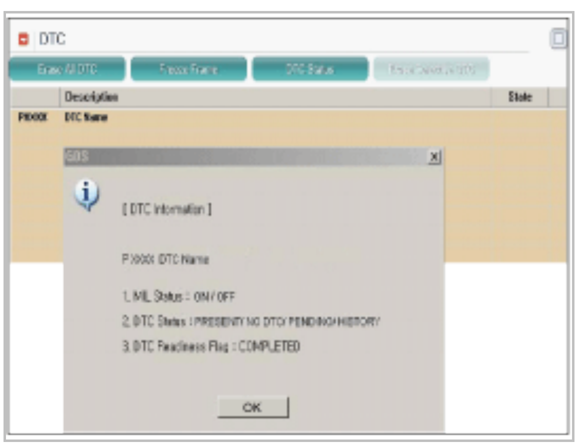
Item	Detecting Condition	Possible cause
DTC Strategy	• Fuel Trim Rear Sensor Control Limits Exceeded	• Air leakage in exhaust System • HO2S • TWC
Enable Conditions	• Cell Enabled • Barometric Pressure ≥ 74 kPa • Intake Air Temperature ≥ -10 °C • System Voltage ≥ 10.9936 V • Closed Loop Active • BLM learn Allowed • Disabling Fault not present	
Threshold value	• Front O2 Sensor switch point ≥ 0.6V Rear O2 Sensor Voltage < 0.25V	
Diagnosis Time	• Fail count > 60 within 80 samples 250ms continuous loop	
MIL On Condition	• 2 Driving Cycles	

Monitor GDS Data

NOTE

If any codes relating to Rear HO2S or TWC(ThreeWay Catalyst Converter) are stored, do ALL REPAIRS associated with those codes before proceeding with this troubleshooting tree.

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check Exhaust system

1. Visually/physically inspect the following conditions:
   ▶ Exhaust system between HO2S and Three way catalyst for air leakage, restriction and damage.
   ▶ Damage, and for loose or missing hardware
2. Was a problem found in any of the above areas?

YES	▶ Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure
NO	▶ Go to next step as below

■ Check TWC

1. Visually/physically inspect the three-way catalyst(TWC) converter for the following damage:
   ▶ Severe discoloration caused by excessive temperature
   ▶ Dents and holes
   ▶ Internal rattle caused by a damaged catalyst
2. Also, ensure that the TWC is a proper original equipment manufacturer part.
3. Was a problem found in any of the above areas?

YES	▶ Replace TWC and go to "Verification of Vehicle Repair" procedure
NO	▶ Go to next step as below

■ Check HO2S

1. Visually/physically inspect the HO2S for the following conditions:
   ▶ Ensure that the HO2S is securely installed.(Pigtail and wiring harness not making contact with the exhaust pipe)
   ▶ Check for corrosion on terminals and terminal tension (at the HO2S and at the ECM)
   ▶ Front HO2S for silicon contamination. This contamination will be indicated by a white powdery coating on the portion of the sensor exposed to the exhaust stream and this will result in a but false(high) voltage signal
   ▶ Fuel, engine coolant or oil contamination
   ▶ Use of improper sealant
   ▶ If contamination is evident on the HO2S, Fix the source of the sensor contamination before replacingthe sensor to prevent future contamination. Go to "Verification of Vehicle Repair" procedure.
2. Warm up the engine to normal operating temperature and let it idle.
3. Connect GDS and monitor the "O2 SNSR VOL.-B1/S1" and "O2 SNSR VOL.-B1/S2" parameters on the GDS data list.

Specification :
- Front HO2S(O2 SNSR VOL.-B1/S1) : Approx. 0~1V with idle after warm up
Sensor voltage increase during engine acceleration and decrease during engine deceleration
Approx. 0V ~ 0.4 V when fuel cut
- Rear HO2S(O2 SNSR VOL.-B1/S2) : Above 0.4V at idle

4. Was a problem found in any of the above areas?

YES	▶ Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure
NO	▶ Check for poor connection between ECM and component: backed out terminal, improper mating, broken locks or poor terminal to wire connection. Repair as necessary and go to "Verification of Vehicle Repair" procedure

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2099 Post Catalyst Fuel Trim System Too Rich (Bank 2)

General Description

In order to provide the best possible combination of drivability, fuel economy and emission control, the ECM uses a closed loop air/fuel metering system. The ECM monitors the HO2S signal voltage and adjusts fuel delivery based it in closed loop fuel control. Changes in fuel delivery will be indicated by the long-term and the short-term fuel trim values. The ideal fuel trim value is around 0%. The ECM will add fuel when the HO2S signal is indicating a lean condition. Additional fuel is indicated by fuel trim values that are above 0%. The ECM will reduce fuel when the HO2S signal is indicating a rich condition. Reduction in fuel is indicated by fuel trim values that are below 0%. The DTC relevant to fuel trim will be set when the amount reaches excessive levels because of a lean or rich condition.

DTC Description

If the lambda controller reaches the maximum or minimum threshold, then feedback control is no longer possible and emissions will be increased. The ECM sets DTC P2099 if no proportional post catalyst fuel trim adaptation occurs for a defined time after the lambda controller has reached its minimum threshold.

DTC Detecting Condition

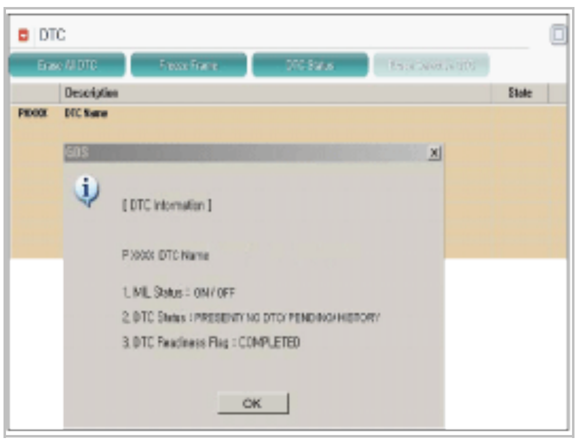
Item	Detecting Condition	Possible cause
DTC Strategy	• Fuel Trim Rear Sensor Control Limits Exceeded	
Enable Conditions	• Cell Enabled • Barometric Pressure ≥ 74 kPa • Intake Air Temperature ≥ -10 °C • System Voltage ≥ 10.9936 V	

	• Closed Loop Active • BLM learn Allowed • Disabling Fault not present	• Air leakage in exhaust System • HO2S • TWC
Threshold value	• Front O2 Sensor switch point ≤ 0.4V Rear O2 Sensor Voltage > 0.82V	
Diagnosis Time	• Fail count > 30 within 80 samples 250ms continuous loop	
MIL On Condition	• 2 Driving Cycles	

Monitor GDS Data

> **NOTE**
>
> If any codes relating to Rear HO2S or TWC(ThreeWay Catalyst Converter) are stored, do ALL REPAIRS associated with those codes before proceeding with this troubleshooting tree.

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor’s and/or ECM’s connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check Exhaust system

1. Visually/physically inspect the following conditions:
   ▶ Exhaust system between HO2S and Three way catalyst for air leakage, restriction and damage.
   ▶ Damage, and for loose or missing hardware

2. Was a problem found in any of the above areas?

YES	▶ Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure
NO	▶ Go to next step as below

■ **Check TWC**

1. Visually/physically inspect the three-way catalyst(TWC) converter for the following damage:
   ▶ Severe discoloration caused by excessive temperature
   ▶ Dents and holes
   ▶ Internal rattle caused by a damaged catalyst
2. Also, ensure that the TWC is a proper original equipment manufacturer part.
3. Was a problem found in any of the above areas?

YES	▶ Replace TWC and go to "Verification of Vehicle Repair" procedure
NO	▶ Go to next step as below

■ **Check HO2S**

1. Visually/physically inspect the HO2S for the following conditions:
   ▶ Ensure that the HO2S is securely installed.(Pigtail and wiring harness not making contact with the exhaust pipe)
   ▶ Check for corrosion on terminals and terminal tension (at the HO2S and at the ECM)
   ▶ Front HO2S for silicon contamination. This contamination will be indicated by a white powdery coating on the portion of the sensor exposed to the exhaust stream and this will result in a but false(high) voltage signal
   ▶ Fuel, engine coolant or oil contamination
   ▶ Use of improper sealant
   ▶ If contamination is evident on the HO2S, Fix the source of the sensor contamination before replacingthe sensor to prevent future contamination. Go to "Verification of Vehicle Repair" procedure.
2. Warm up the engine to normal operating temperature and let it idle.
3. Connect GDS and monitor the "O2 SNSR VOL.-B1/S1" and "O2 SNSR VOL.-B1/S2" parameters on the GDS data list.

Specification :
- Front HO2S(O2 SNSR VOL.-B1/S1) : Approx. 0~1V with idle after warm up
Sensor voltage increase during engine acceleration and decrease during engine deceleration
Approx. 0V ~ 0.4 V when fuel cut
- Rear HO2S(O2 SNSR VOL.-B1/S2) : Above 0.4V at idle

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4. Was a problem found in any of the above areas?

YES	▶ Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure
NO	▶ Check for poor connection between ECM and component: backed out terminal, improper mating, broken locks or poor terminal to wire connection. Repair as necessary and go to "Verification of Vehicle Repair" procedure

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle

within conditions noted in the freeze frame data or enable conditions.

3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2104 Limp Home Mode - Forced Idle

General Description

The Electronic Throttle Control(ETC) system is made of the components throttle body, Throttle Position Sensor(TPS)1&2 and Accelerator Position Sensor(APS) 1&2. The throttle body contains the actuator, the throttle plate and the throttle position sensor (potentiometer), which are integrated in one housing. The actuator consists of a DC motor with a two-stage gear. The opening angle of the throttle valve is detected by the throttle position sensor which is mounted on the throttle body. And it provides feedback to the ECM to control the throttle motor in order to control the throttle valve opening angle properly in response to the driving condition.

DTC Description

If ECM recognizes vehicle state as forced idle under detecting condition, it sets P2104 and MIL(Malfunction Indication Lamp) turns on.

DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• This code detects if the system is in Forced Idle Mode	• Faulty APS • Faulty APS+Brake • Faulty APS + Vehicle speed sensor • Faulty APS + Vehicle speed sensor + Brake • Faulty ECM
Enable Conditions	• Ignition "ON"	
Threshold value	• Forced Idle Mode is active	
Diagnosis Time	• -	
MIL On Condition	• 1 Driving Cycle	

Monitor GDS Data

1. Connect GDS to DLC(Data Link Connector)
2. IG "ON" & Monitor that any different DTC(Diagnostic Trouble Code) is existed.
   (There will be at least one more DTC which causes this DTC P2104 to retrieve)
3. Repair the DTCs cause DTC P2104 first according to the designated trouble shooting guide.
   (After repairing the DTCs cause DTC P2104 , don't forget to do "ETC Initialization" as follows.)
4. Is the same DTC occurred ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE

	There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Go to "Verification of Vehicle Repair" procedure.

※ Procedure of ETS Initialization

A. Erase the trouble codes on ECM

B. Turn the ignition key off and keep this condition until the main relay is turned off.(It will take 10sec.)

C. Turn ignition key on more than 1second to record the throttle motor position on the EEPROM

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2105 Limp Home Mode - Force Engine Shutdown

General Description

The Electronic Throttle Control(ETC) system is made of the components throttle body, Throttle Position Sensor(TPS)1&2 and Accelerator Position Sensor(APS) 1&2. The throttle body contains the actuator, the throttle plate and the throttle position sensor (potentiometer), which are integrated in one housing. The actuator consists of a DC motor with a two-stage gear. The opening angle of the throttle valve is detected by the throttle position sensor which is mounted on the throttle body. And it provides feedback to the ECM to control the throttle motor in order to control the throttle valve opening angle properly in response to the driving condition.

DTC Description

If ECM recognizes vehicle state as forced engine shutdown under detecting condition, it sets P2105 and then MIL(Malfunction Indication Lamp) turns on.

DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• This code detects if the system is in Forced Engine Shutdown Mode	• Faulty AFS+MAPS+ETS • Faulty ECM
Enable Conditions	• Ignition "ON"	
Threshold value	• Forced Engine Shutdown Mode Active	
Diagnosis Time	• -	

MIL On Condition	• 1 Driving Cycle	

Monitor GDS Data

1. Connect GDS to DLC(Data Link Connector)
2. IG "ON" & Monitor that any different DTC(Diagnostic Trouble Code) is existed.
   (There will be at least one more DTC which causes this DTC P2105 to retrieve)
3. Repair the DTCs cause DTC P2105 first according to the designated trouble shooting guide.
   (After repairing the DTCs cause DTC P2105 , don't forget to do "ETC Initialization" as follows.)
4. Is the same DTC occurred ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Go to "Verification of Vehicle Repair" procedure.

※ Procedure of ETS Initialization

A. Erase the trouble codes on ECM
B. Turn the ignition key off and keep this condition until the main relay is turned off.(It will take 10sec.)
C. Turn ignition key on more than 1second to record the throttle motor position on the EEPROM

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2106 Limp Home Mode - Force Limited Power

General Description

The Electronic Throttle Control(ETC) system is made of the components throttle body, Throttle Position Sensor(TPS)1&2 and Accelerator Position Sensor(APS) 1&2. The throttle body contains the actuator, the throttle plate and the throttle position sensor (potentiometer), which are integrated in one housing. The actuator consists of a DC motor with a two-stage gear. The opening angle of the throttle valve is detected by the throttle position sensor which is mounted on the throttle body. And it provides feedback to the ECM to control the throttle motor in order to control the throttle valve opening angle properly in response to the driving condition.

DTC Description

If ECM recognizes vehicle state as forced limited power mode under detecting condition, it sets P2106 and then MIL(Malfunction Indication Lamp) turns on.

DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• This code detects if the system is in Limit Performance Mode	• Faulty APS • Faulty APS+Brake • Faulty APS + Vehicle speed sensor • Faulty APS + Vehicle speed sensor + Brake • Faulty ECM
Enable Conditions	• Ignition "ON"	
Threshold value	• Limit Performance Mode is active	
Diagnosis Time	• -	
MIL On Condition	• 1 Driving Cycle	

※ If Main relay has a fault(ex. Open) under engine running, the DTCs,P0638/P0685/P1295/P2106, can happen at the same time.
<DTC Name>
- P0638 Throttle Actuator Control Range/Performance(Bank 1)
- P0685 ECM/ECM Power Relay Control Circuit /Open
- P1295 Throttle Actuator Control System - Power Management
- P2106 Throttle Actuator Control System - Forced Limited Power

Monitor GDS Data

1. Connect GDS to DLC(Data Link Connector)
2. IG "ON" & Monitor that any different DTC(Diagnostic Trouble Code) is existed.
   (There will be at least one more DTC which causes this DTC P2106 to retrieve)
3. Repair the DTCs cause DTC P2106 first according to the designated trouble shooting guide.
   (After repairing the DTCs cause DTC P2106 , don't forget to do "ETC Initialization" as follows.)
4. Is the same DTC occurred ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Go to "Verification of Vehicle Repair" procedure.

※ Procedure of ETS Initialization
A. Erase the trouble codes on ECM
B. Turn the ignition key off and keep this condition until the main relay is turned off.(It will take 10sec.)
C. Turn ignition key on more than 1second to record the throttle motor position on the EEPROM

Verification of Vehicle Repair

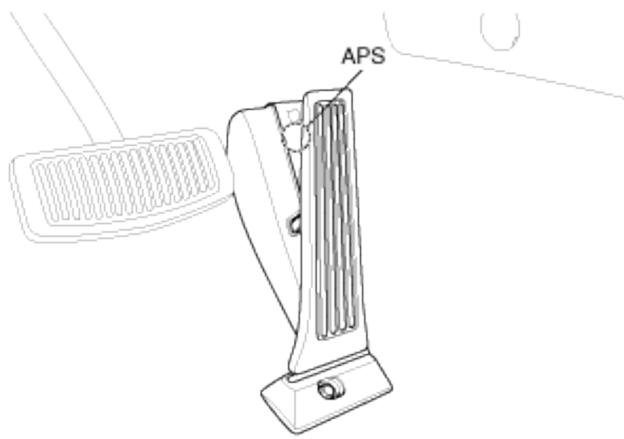
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2122 Accelerator Position Sensor 1 Signal Circuit Low Input

Component Location



General Description

The Electronic Throttle Control(ETC) system is made of the components throttle body, Throttle Position Sensor(TPS) 1&2 and Accelerator Position Sensor(APS) 1&2. The APS is mounted in the accelerator pedal to detect the opening angle of the accelerator pedal. It has 2 sensors to detect the accelerator position and a malfunction of the accelerator position sensor. The ECM judges the current opening angle of the accelerator pedal from APS1&2, and the ECM controls the throttle motor based on these signals.

DTC Description

Checking output signals from APS 1 under detecting condition, if output signals are below the threshold, ECM sets P2122. And then MIL(Malfunction Indication Lamp) turns on.

DTC Detecting Condition

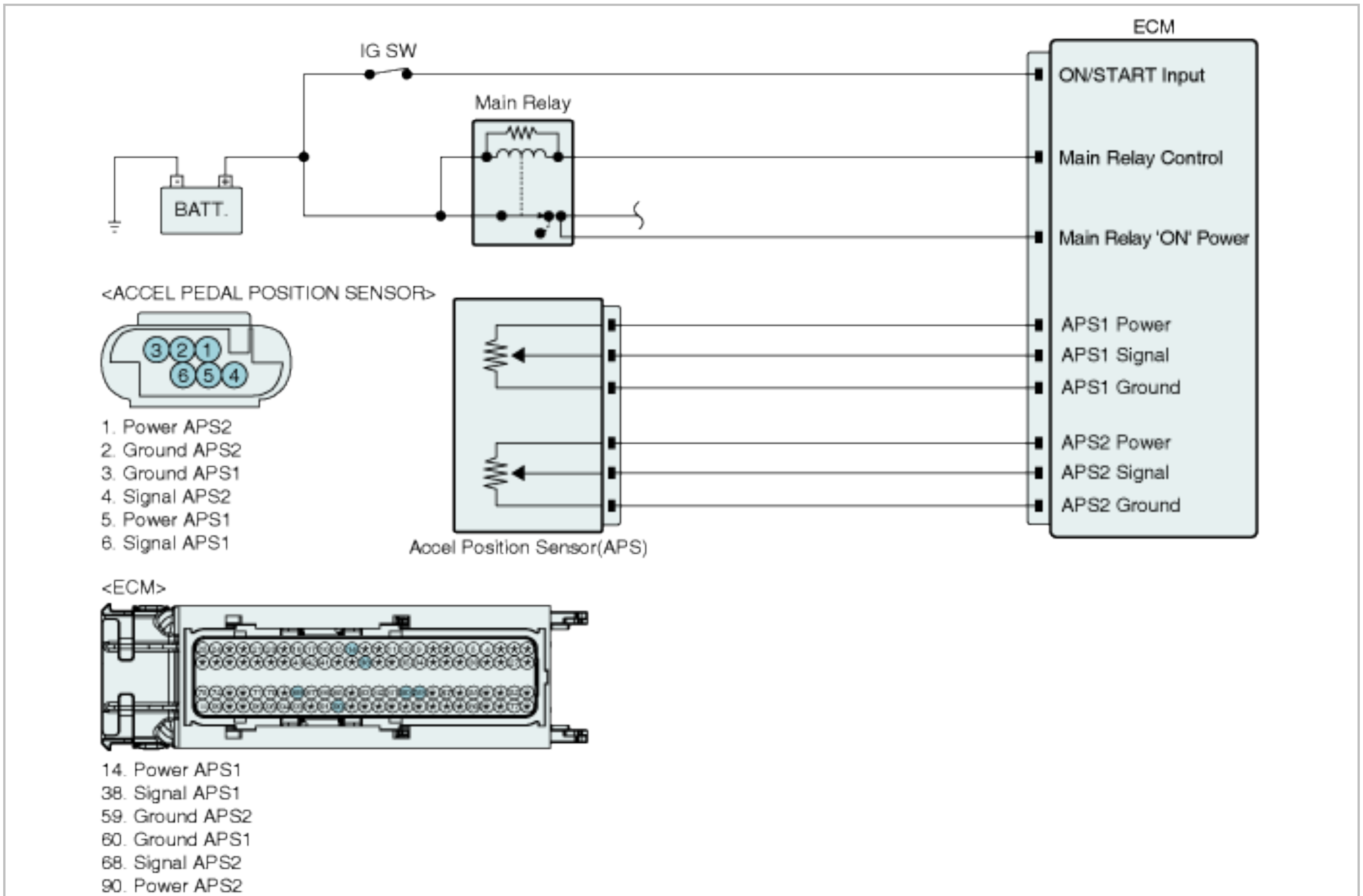
Item	Detecting Condition	Possible Cause
DTC Strategy	• This code detects a continuous short to ground or open in either the circuit or the sensor (0-100%)	• Poor connection

	open in either the circuit or the sensor (0-100%)	• Open or short to ground in power circuit • Open or short to ground in signal circuit • Faulty APS • Faulty ECM
Enable Conditions	• Ignition "ON"	
Threshold value	• APS1 < 0.125V	
Diagnosis Time	• Continuous	
MIL On Condition	• 1 Driving Cycle	

Specification

Pedal Position	Output Voltage(V) [Vref = 5.0V]	
	APS1	**APS2**
C.T	0.7 ~ 0.8V	0.29 ~ 0.46V
W.O.T	3.85 ~ 4.35V	1.93 ~ 2.18V

Diagnostic Circuit Diagram



Signal Waveform & Data

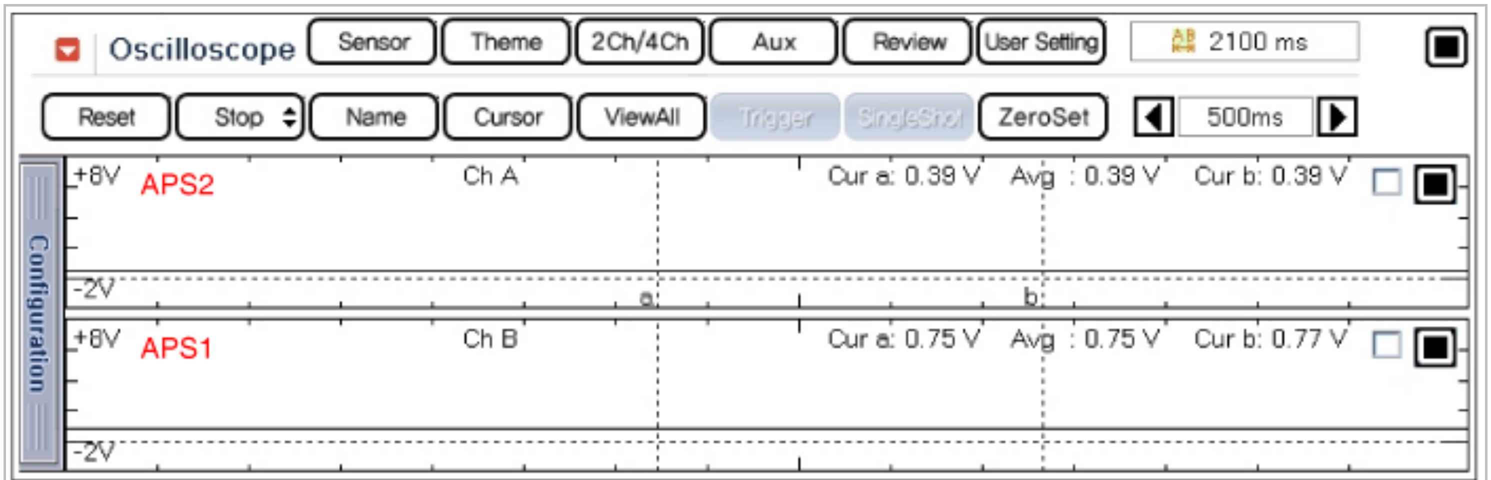


Fig.1

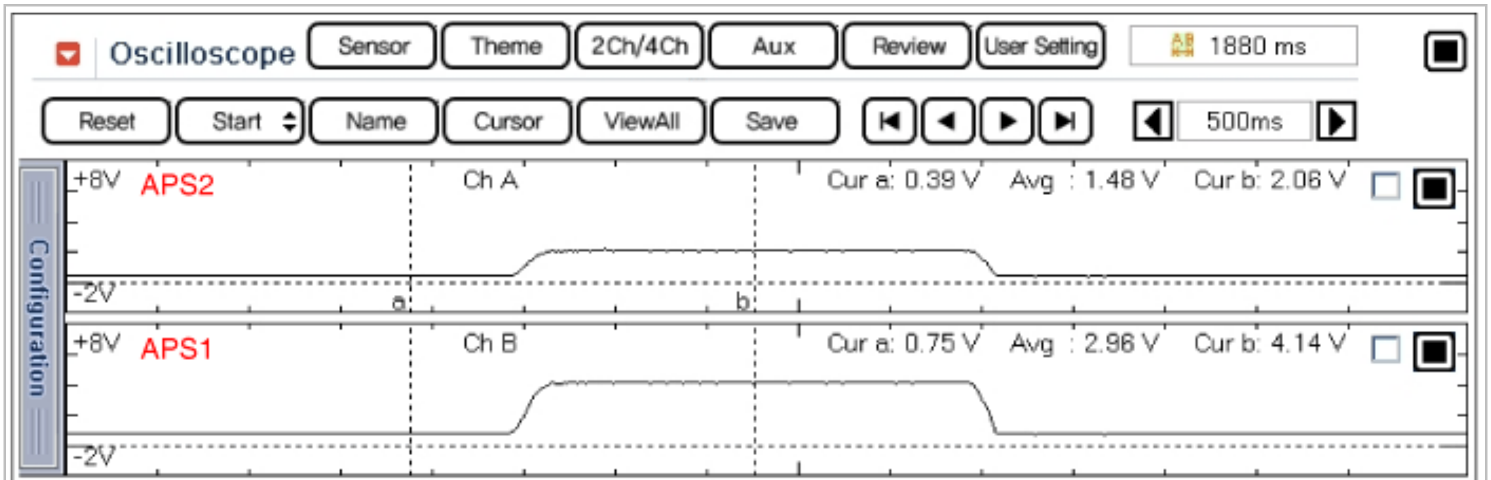


Fig.2

Sensor Name	Value	Unit
☑ Accelerator Pedal Position Sensor-1	0.7	V
☑ Accelerator Pedal Position Sensor-2	0.4	V
☑ Accelerator Pedal Position Sensor-1	15	%
☑ Accelerator Pedal Position Sensor-2	15	%
☑ Engine Speed	0	RPM

Fig.3

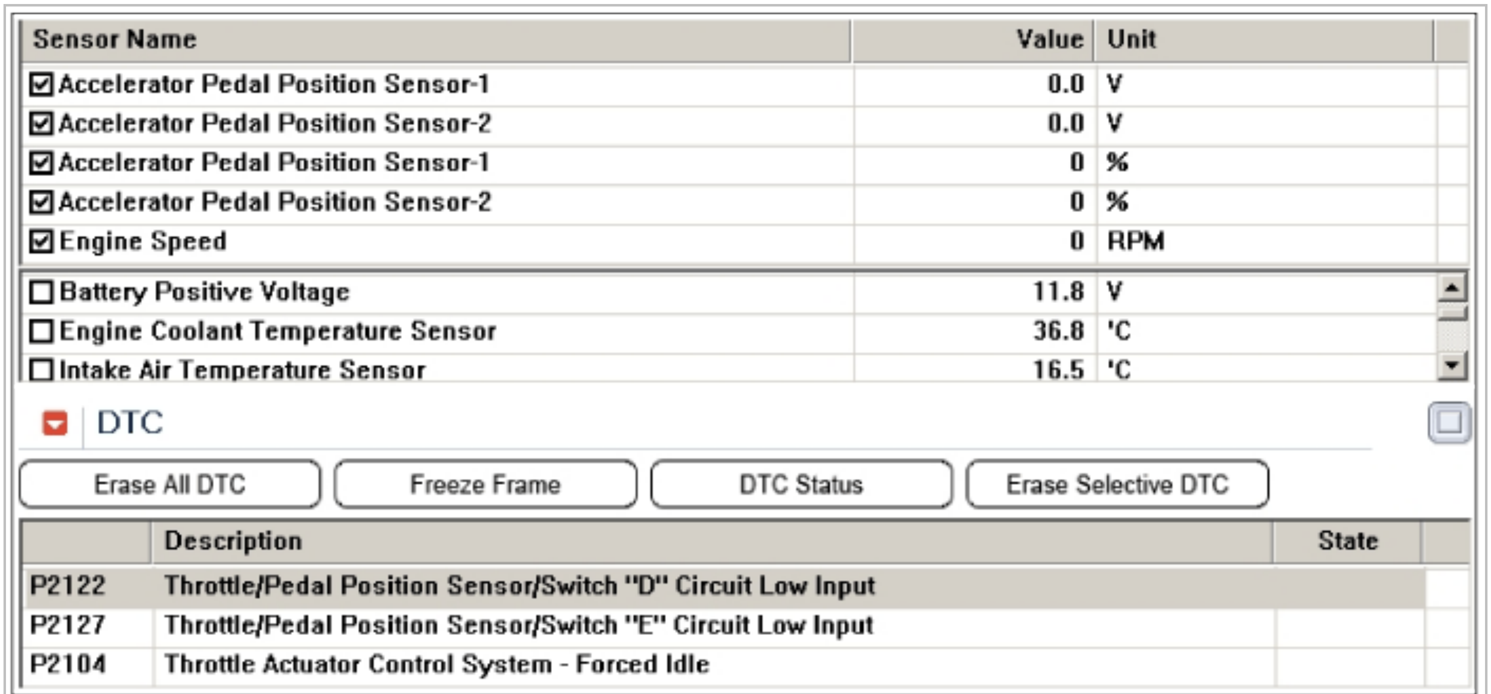
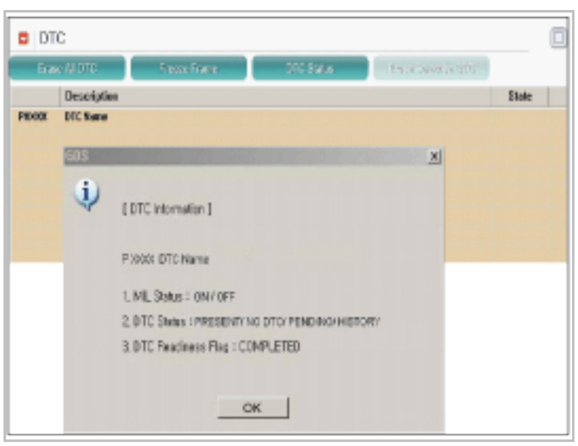


Fig.4

Fig.1) Normal waveform of APS1 & APS2 with no acceleration
Fig.2) Normal waveform of APS1 & APS2 with acceleration
Fig.3) Normal data of APS1 & APS2 at ig on.
Fig.4) Abormal data of APS1 & APS2 when APS1 & APS2 circuit open
Signal waveform of APS 1 & 2 shows that APS 2 increases voltage just half of APS 1 voltage increase when accelerating.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as

	necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect APS connector.
2. IG "ON"
3. Measure voltage between APS1 power terminal of APS harness connector and chassis ground.

Specification : Approx. 5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Signal Circuit Inspection" Procedure.
NO	▶ Repair open or short in harness and go to "Verification of Vehicle Repair" procedure.

Signal Circuit Inspection

■ Check short to ground in harness

1. IG "OFF".
2. Disconnect APS connector and ECM connector.
3. Measure resistance between APS1 signal terminal of APS harness connector and chassis ground.(Measurement "A")
4. Measure resistance between APS1 signal and APS1(2) ground terminals of APS harness connector.(Measurement "B")

Specification : Infinite

5. Is the measured resistance within specification ?

YES	▶ Go to "Check open in harness" as follows.
NO	▶ Repair short to ground in harness and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect APS connector and ECM connector.

2. Measure resistance between APS1 signal terminal of APS harness connector and APS1 signal terminal of ECM harness connector.

Specification : Approx. below 1Ω.

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check APS

1. IG "OFF" and install a GDSI.
2. Connect probe to APS1 and APS2 to check signal waveform by using oscilloscope function.
3. Measure signal waveform of APS by pressing and depressing accellerator pedal.

Specification : Signal waveform will be displayed as follows.

Pedal Position	Output Voltage(V) [Vref = 5.0V]	
	APS1	APS2
C.T	0.7 ~ 0.8V	0.29 ~ 0.46V
W.O.T	3.85 ~ 4.35V	1.93 ~ 2.18V

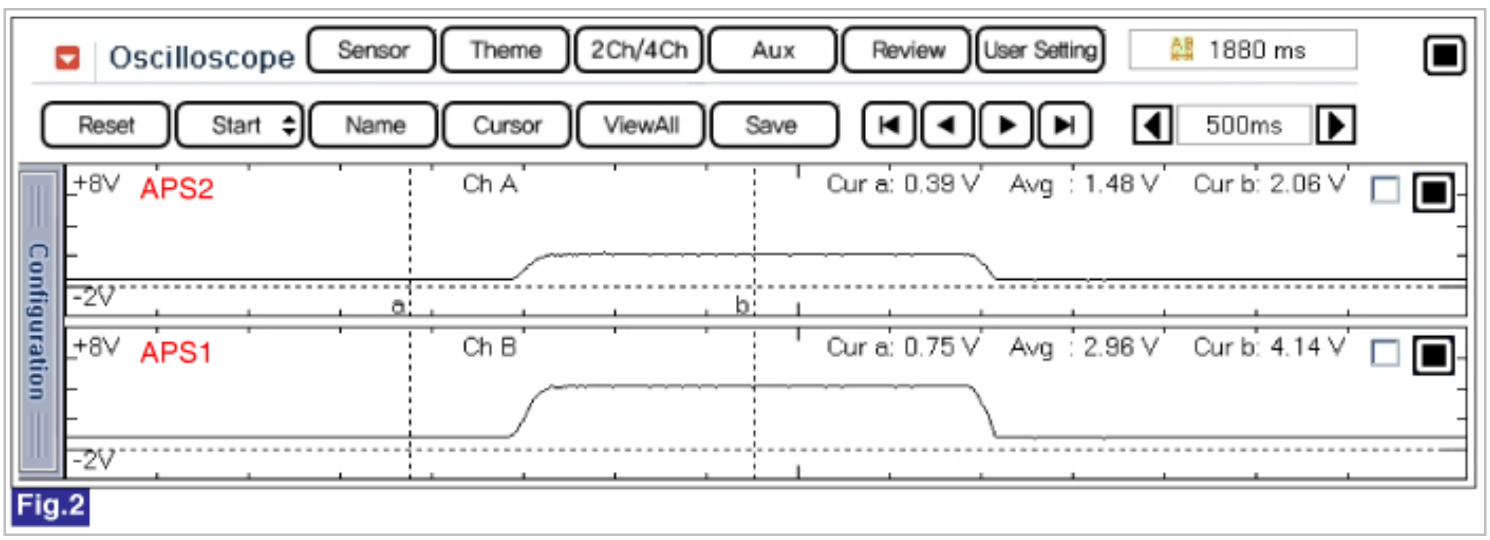


Fig.1) Normal waveform of APS1 & APS2 with acceleration

4. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this

	function to reuse the ECM on the others
NO	▶ Substitute with a known-good APS and check for proper operation. If the problem is corrected,replace APS and then go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

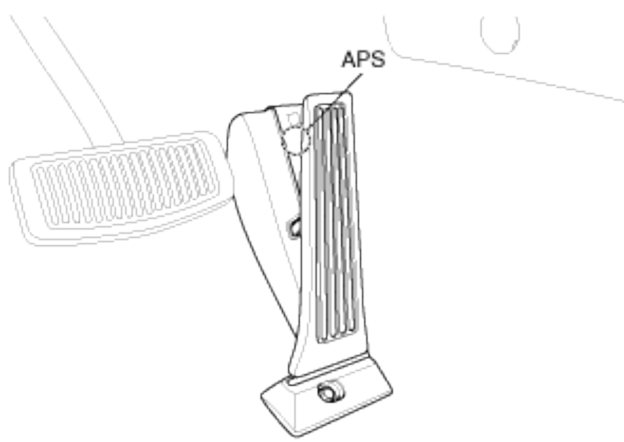
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2123 Accelerator Position Sensor 1 Signal Circuit High Input

Component Location



General Description

The Electronic Throttle Control(ETC) system is made of the components throttle body, Throttle Position Sensor(TPS) 1&2 and Accelerator Position Sensor(APS) 1&2. The APS is mounted in the accelerator pedal to detect the opening angle of the accelerator pedal. It has 2 sensors to detect the accelerator position and a malfunction of the accelerator position sensor. The ECM judges the current opening angle of the accelerator pedal from APS1&2, and the ECM controls the throttle motor based on these signals.

DTC Description

Checking output signals from APS 1 under detecting condition, if output signals are above the threshold, ECM sets P2123. And then MIL(Malfunction Indication Lamp) turns on.

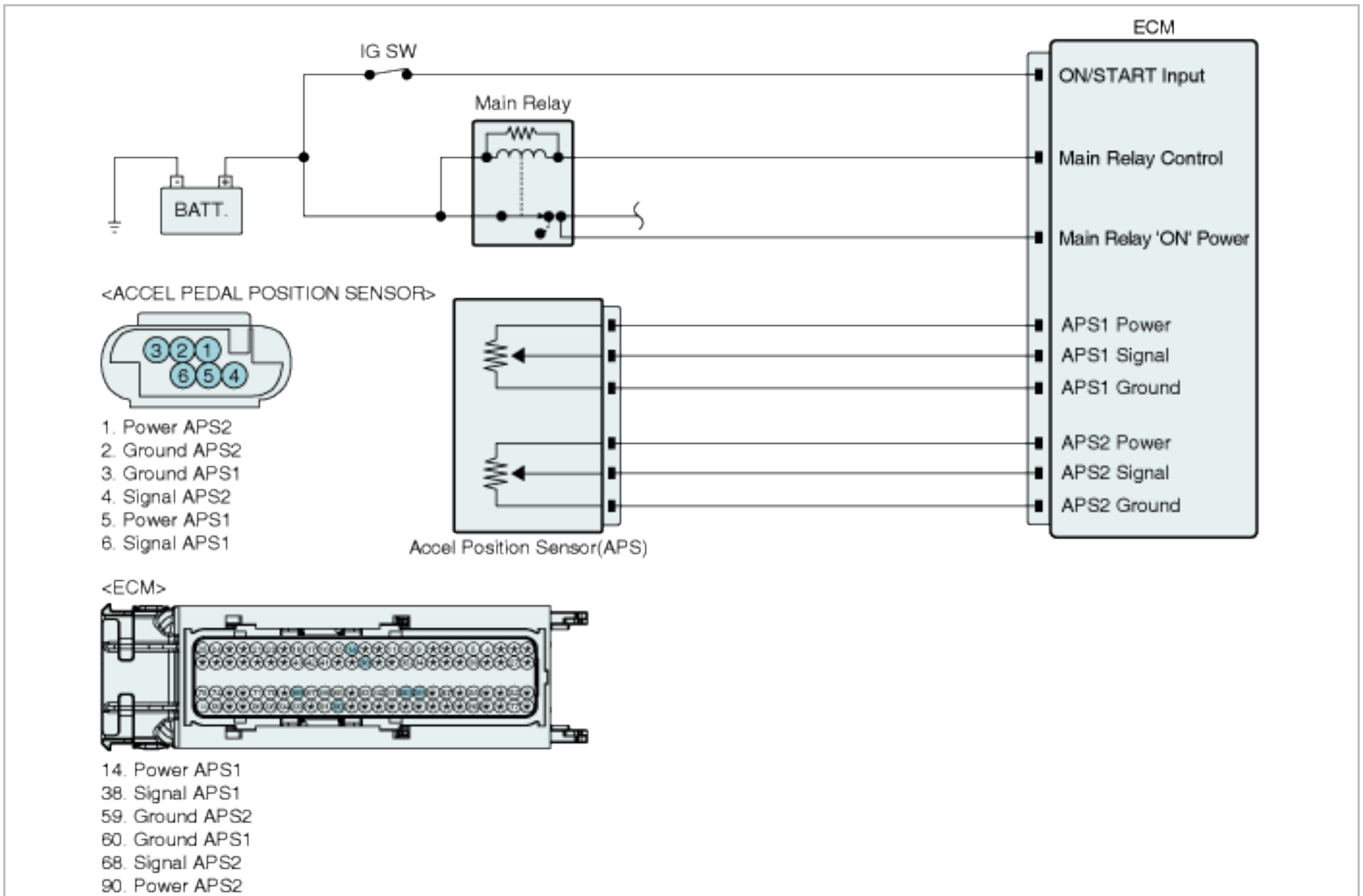
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• This code detects a short to high in either the circuit or the sensor (0-100%)	• Poor connection • Short to battery in signal circuit • Open in ground circuit • Faulty APS • Faulty ECM
Enable Conditions	• Ignition "ON"	
Threshold value	• APS1 > 4.5V	
Diagnosis Time	• Continuous	
MIL On Condition	• 1 Driving Cycle	

Specification

Pedal Position	Output Voltage(V) [Vref = 5.0V]	
	APS1	APS2
C.T	0.7 ~ 0.8V	0.29 ~ 0.46V
W.O.T	3.85 ~ 4.35V	1.93 ~ 2.18V

Diagnostic Circuit Diagram



Signal Waveform & Data

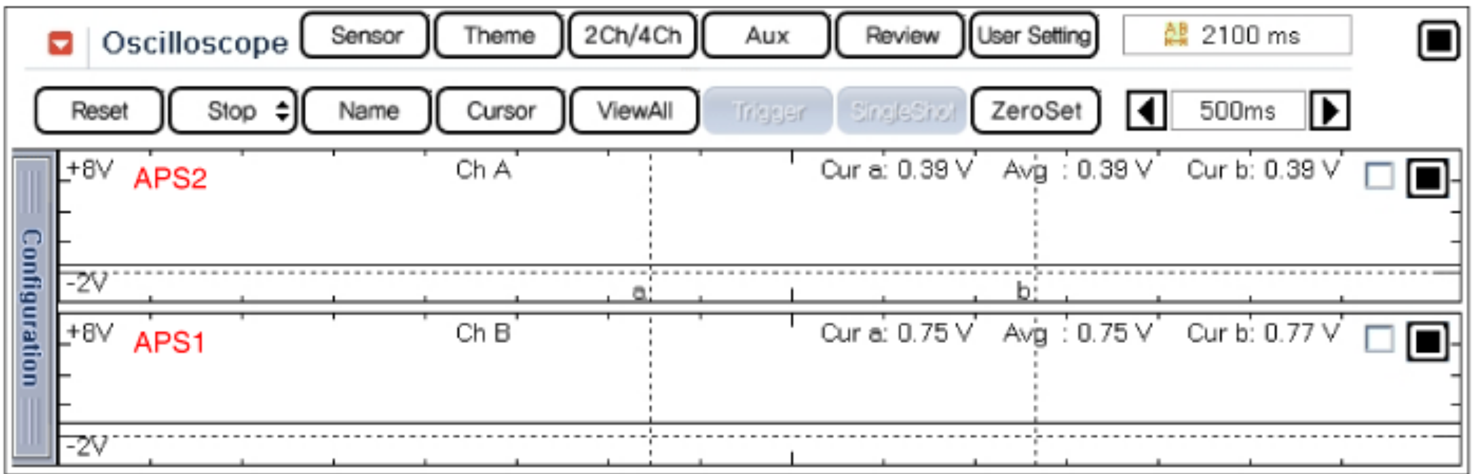


Fig.1

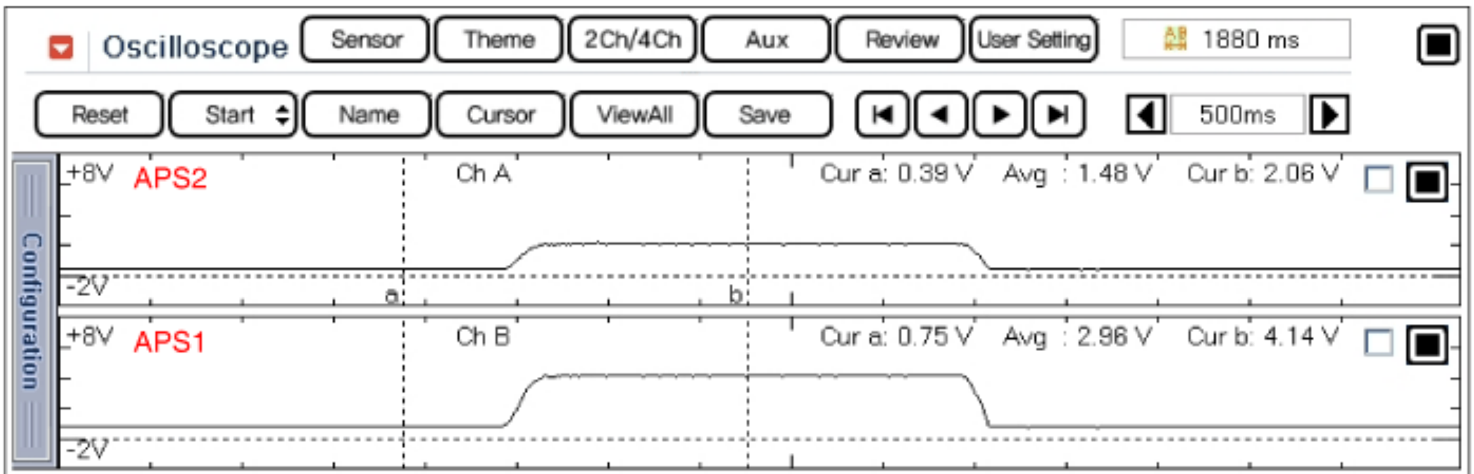
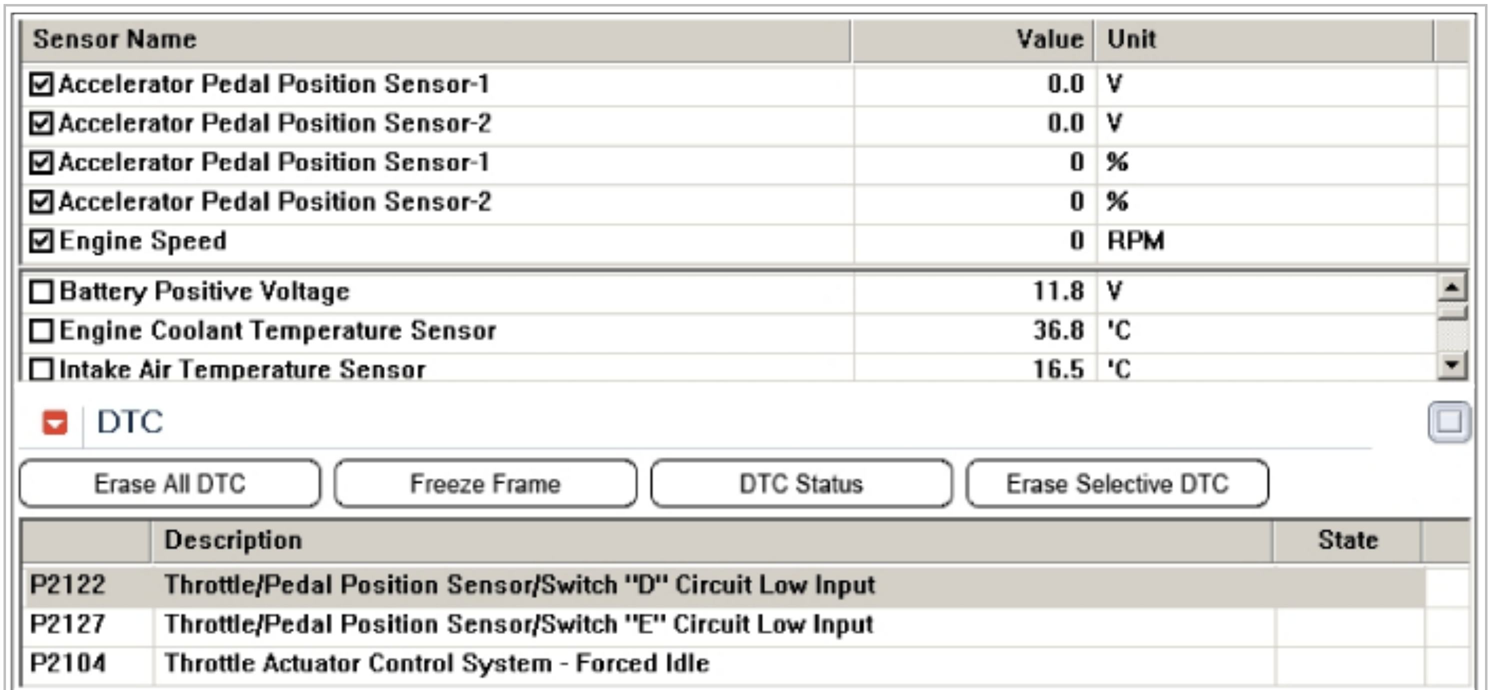


Fig.2

Sensor Name	Value	Unit
☑ Accelerator Pedal Position Sensor-1	0.7	V
☑ Accelerator Pedal Position Sensor-2	0.4	V
☑ Accelerator Pedal Position Sensor-1	15	%
☑ Accelerator Pedal Position Sensor-2	15	%
☑ Engine Speed	0	RPM

Fig.3



Sensor Name	Value	Unit
☑ Accelerator Pedal Position Sensor-1	0.0	V
☑ Accelerator Pedal Position Sensor-2	0.0	V
☑ Accelerator Pedal Position Sensor-1	0	%
☑ Accelerator Pedal Position Sensor-2	0	%
☑ Engine Speed	0	RPM
☐ Battery Positive Voltage	11.8	V
☐ Engine Coolant Temperature Sensor	36.8	'C
☐ Intake Air Temperature Sensor	16.5	'C

DTC

Erase All DTC | Freeze Frame | DTC Status | Erase Selective DTC

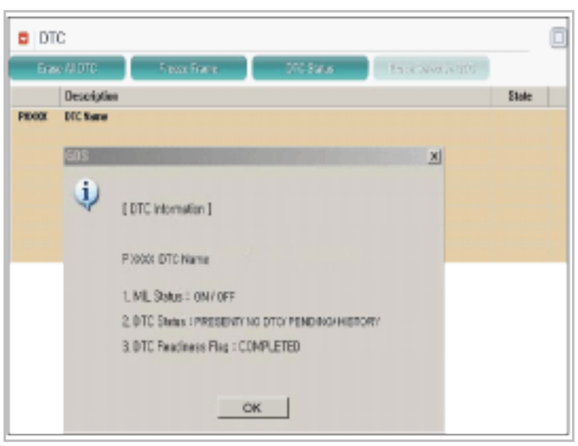
	Description	State
P2122	Throttle/Pedal Position Sensor/Switch "D" Circuit Low Input	
P2127	Throttle/Pedal Position Sensor/Switch "E" Circuit Low Input	
P2104	Throttle Actuator Control System - Forced Idle	

Fig.4

Fig.1) Normal waveform of APS1 & APS2 with no acceleration
Fig.2) Normal waveform of APS1 & APS2 with acceleration
Fig.3) Normal data of APS1 & APS2 at ig on.
Fig.4) Abormal data of APS1 & APS2 when APS1 & APS2 circuit open
Signal waveform of APS 1 & 2 shows that APS 2 increases voltage just half of APS 1 voltage increase when accelerating.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as

	necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to " Signal Circuit Inspection " procedure.

Signal Circuit Inspection

■ Check short to battery in harness

1. IG "OFF" and disconnect APS connector and ECM connector.
2. Measure resistance between APS1 signal and APS1 power terminals of APS harness connector.
3. Measure resistance between APS1 signal and APS2 power terminals of APS harness connector.

Specification : Infinite

4. Is the measured resistance within specification ?

YES	▶ Go to "Ground Circuit Inspection" procedure.
NO	▶ Repair short to battery in harness and go to "Verification of Vehicle Repair" procedure.

Ground Circuit Inspection

■ Check open in harness

1. IG "OFF" and disconnect APS connector.
2. Measure voltage between APS1 power terminal of APS harness connector and chassis ground.(Measurement "A")
3. Measure voltage between APS1 power and APS1 ground terminals of APS harness connector.(Measurement "B")

Specification : Voltage difference between measurement "A" and "B" is below 200mV.

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair contact resistance or open in harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check APS

1. IG "OFF" and install a GDS.
2. Connect probe to APS1 and APS2 to check signal waveform by using oscilloscope function.
3. Measure signal waveform of APS by pressing and depressing accellerator pedal.

Specification : Signal waveform will be displayed as follows.

Pedal Position	Output Voltage(V) [Vref = 5.0V]	
	APS1	APS2
C.T	0.7 ~ 0.8V	0.29 ~ 0.46V
W.O.T	3.85 ~ 4.35V	1.93 ~ 2.18V

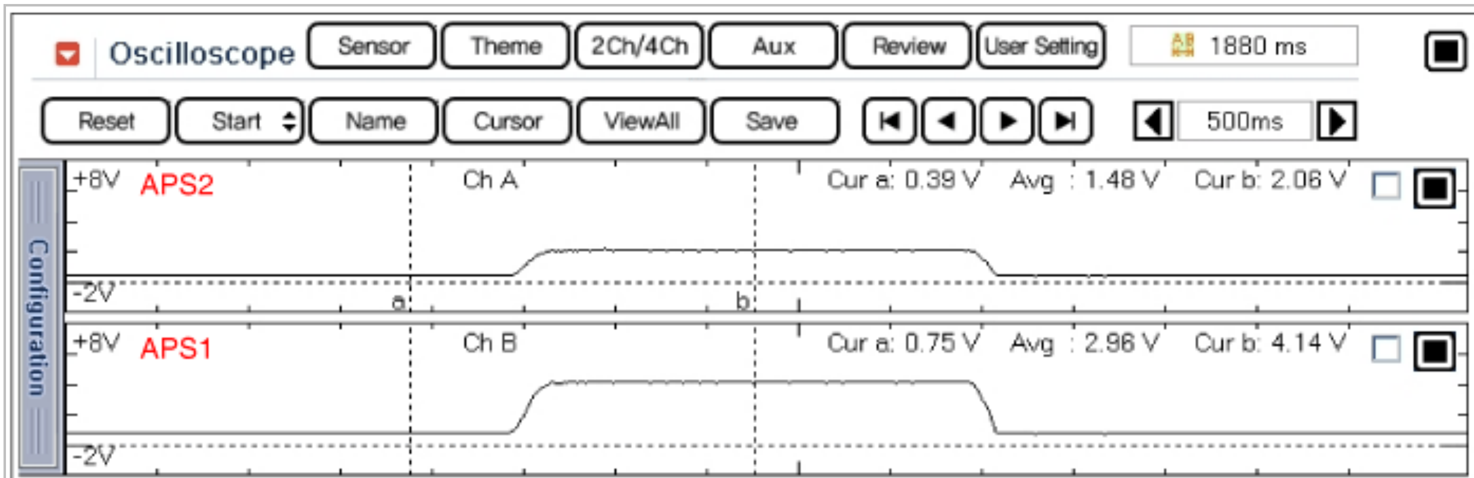


Fig.2

Fig.1) Normal waveform of APS1 & APS2 with acceleration

4. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known-good APS and check for proper operation. If the problem is corrected,replace APS and then go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

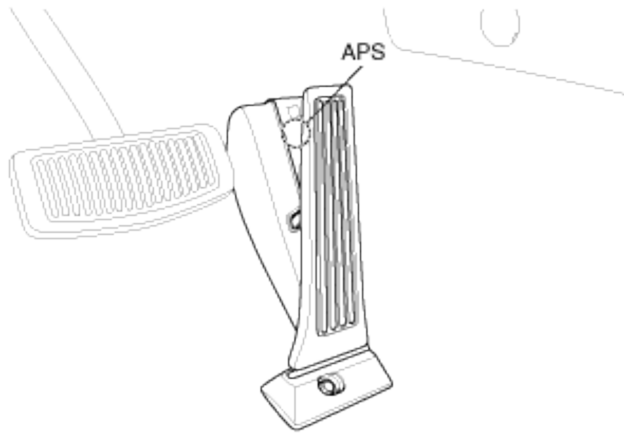
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2127 Accelerator Position Sensor 2 Signal Circuit Low Input

Component Location



General Description

The Electronic Throttle Control(ETC) system is made of the components throttle body, Throttle Position Sensor(TPS) 1&2 and Accelerator Position Sensor(APS) 1&2. The APS is mounted in the accelerator pedal to detect the opening angle of the accelerator pedal. It has 2 sensors to detect the accelerator position and a malfunction of the accelerator position sensor. The ECM judges the current opening angle of the accelerator pedal from APS1&2, and the ECM controls the throttle motor based on these signals.

DTC Description

Checking output signals from APS 2 under detecting condition, if output signals are below the threshold, ECM sets P2127. And then MIL(Malfunction Indication Lamp) turns on.

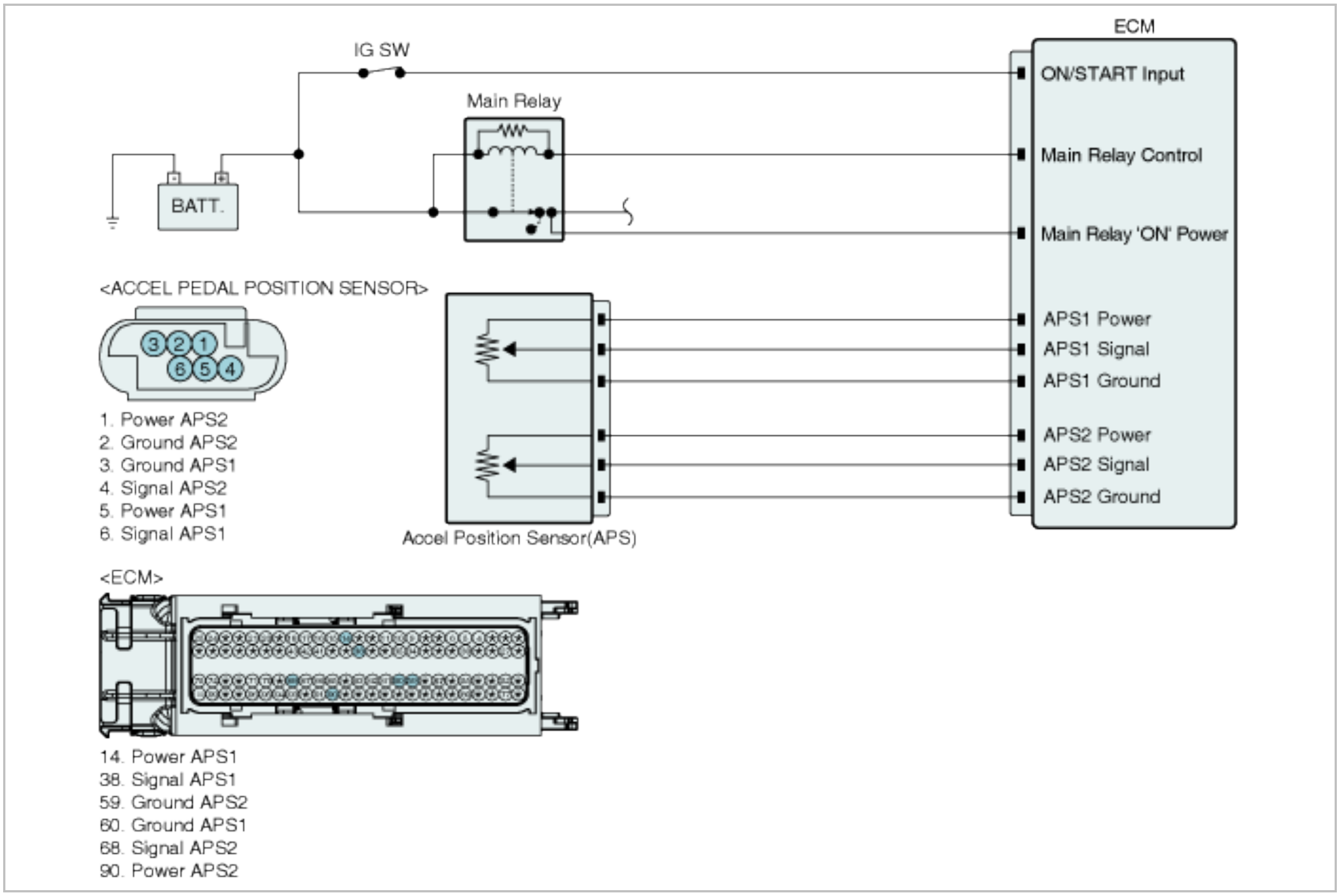
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• This code detects a continuous short to ground or open in either the circuit or the sensor (0-100%)	• Poor connection • Open or short to ground in power circuit • Open or short to ground in signal circuit • Faulty APS • Faulty ECM
Enable Conditions	• Ignition "ON"	
Threshold value	• APS2 < 0.125V	
Diagnosis Time	• Continuous	
MIL On Condition	• 1 Driving Cycle	

Specification

Pedal Position	Output Voltage(V) [Vref = 5.0V]	
	APS1	APS2
C.T	0.7 ~ 0.8V	0.29 ~ 0.46V
W.O.T	3.85 ~ 4.35V	1.93 ~ 2.18V

Diagnostic Circuit Diagram



Signal Waveform & Data

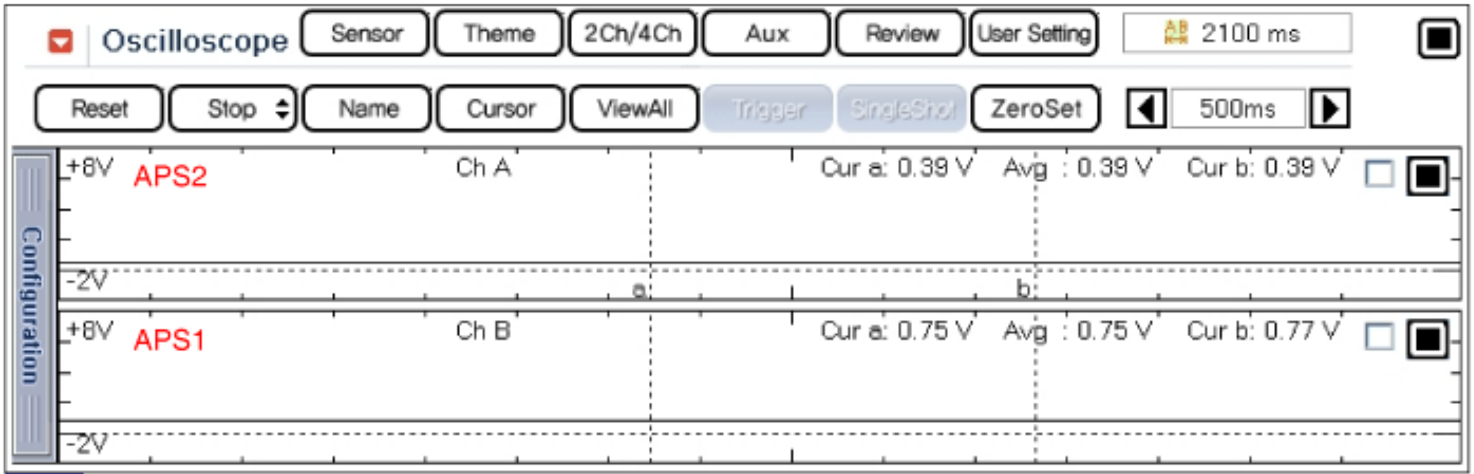


Fig.1

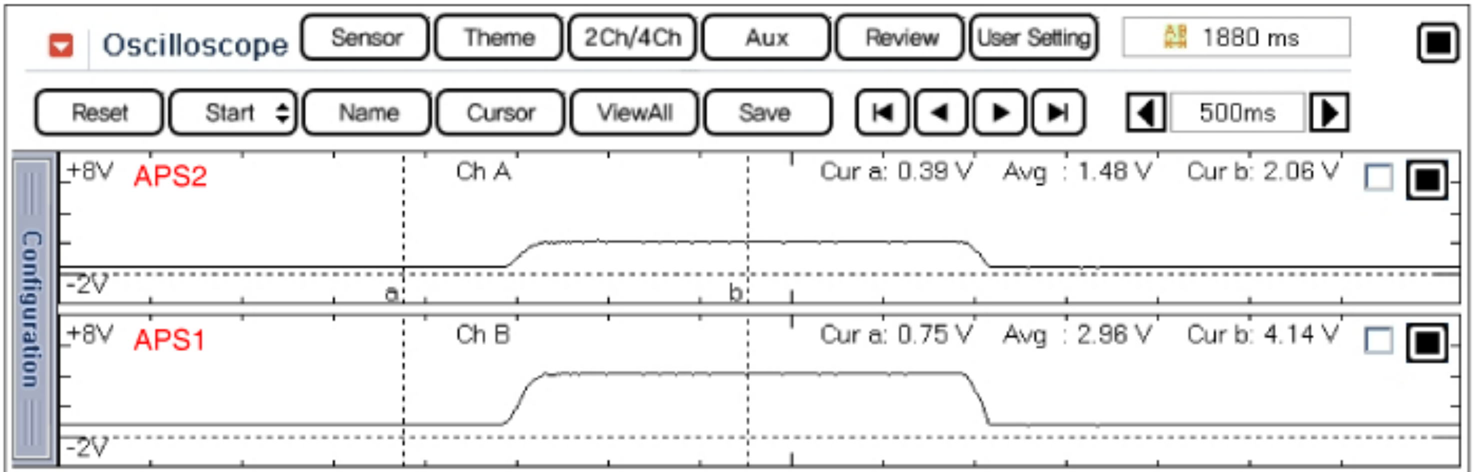
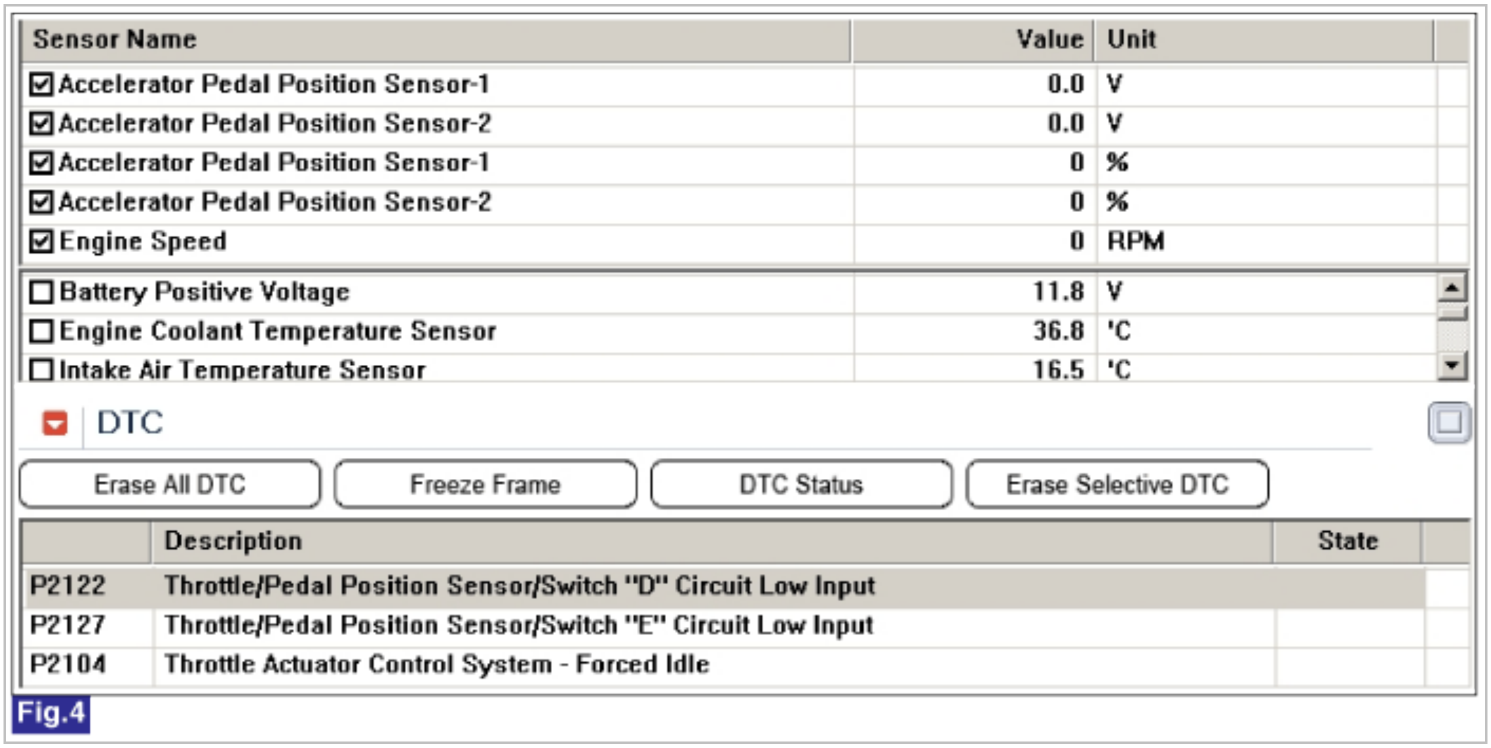


Fig.2

Sensor Name	Value	Unit
☑ Accelerator Pedal Position Sensor-1	0.7	V
☑ Accelerator Pedal Position Sensor-2	0.4	V
☑ Accelerator Pedal Position Sensor-1	15	%
☑ Accelerator Pedal Position Sensor-2	15	%
☑ Engine Speed	0	RPM

Fig.3



Sensor Name	Value	Unit
☑ Accelerator Pedal Position Sensor-1	0.0	V
☑ Accelerator Pedal Position Sensor-2	0.0	V
☑ Accelerator Pedal Position Sensor-1	0	%
☑ Accelerator Pedal Position Sensor-2	0	%
☑ Engine Speed	0	RPM
☐ Battery Positive Voltage	11.8	V
☐ Engine Coolant Temperature Sensor	36.8	'C
☐ Intake Air Temperature Sensor	16.5	'C

DTC

Erase All DTC | Freeze Frame | DTC Status | Erase Selective DTC

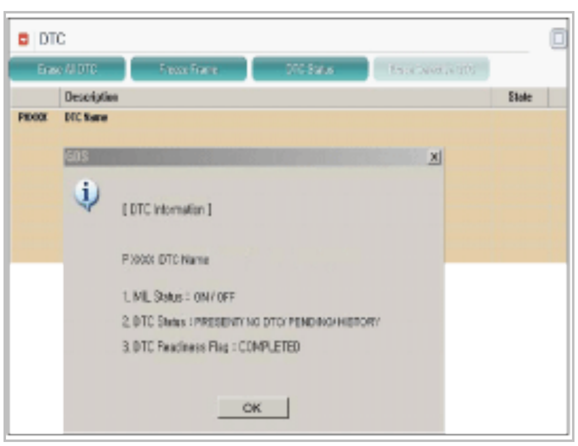
	Description	State
P2122	Throttle/Pedal Position Sensor/Switch "D" Circuit Low Input	
P2127	Throttle/Pedal Position Sensor/Switch "E" Circuit Low Input	
P2104	Throttle Actuator Control System - Forced Idle	

Fig.4

Fig.1) Normal waveform of APS1 & APS2 with no acceleration
Fig.2) Normal waveform of APS1 & APS2 with acceleration
Fig.3) Normal data of APS1 & APS2 at ig on.
Fig.4) Abormal data of APS1 & APS2 when APS1 & APS2 circuit open
Signal waveform of APS 1 & 2 shows that APS 2 increases voltage just half of APS 1 voltage increase when accelerating.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as

	necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect APS connector.
2. IG "ON"
3. Measure voltage between APS2 power terminal of APS harness connector and chassis ground.

Specification : Approx. 5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Signal Circuit Inspection" Procedure.
NO	▶ Repair open or short in harness and go to "Verification of Vehicle Repair" procedure.

Signal Circuit Inspection

■ Check short to ground in harness

1. IG "OFF".
2. Disconnect APS connector and ECM connector.
3. Measure resistance between APS2 signal terminal of APS harness connector and chassis ground.(Measurement "A")
4. Measure resistance between APS2 signal and APS1(2) ground terminals of APS harness connector.(Measurement "B")

Specification : Infinite

5. Is the measured resistance within specification ?

YES	▶ Go to "Check open in harness" as follows.
NO	▶ Repair short to ground in harness and go to "Verification of Vehicle Repair" procedure.

■ Check open in harness

1. IG "OFF" and disconnect APS connector and ECM connector.

2. Measure resistance between APS2 signal terminal of APS harness connector and APS2 signal terminal of ECM harness connector.

Specification : Approx. below 1Ω.

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair open in harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check APS

1. IG "OFF" and install a GDS.
2. Connect probe to APS1 and APS2 to check signal waveform by using oscilloscope function.
3. Measure signal waveform of APS by pressing and depressing accellerator pedal.

Specification : Signal waveform will be displayed as follows.

Pedal Position	Output Voltage(V) [Vref = 5.0V]	
	APS1	APS2
C.T	0.7 ~ 0.8V	0.29 ~ 0.46V
W.O.T	3.85 ~ 4.35V	1.93 ~ 2.18V

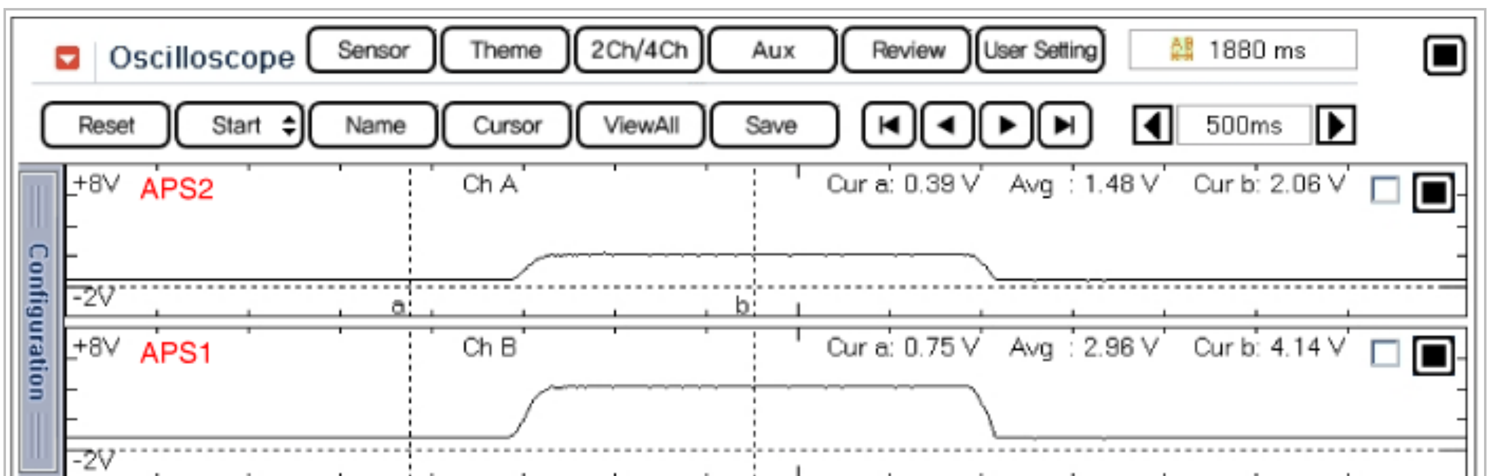


Fig.2

Fig.1) Normal waveform of APS1 & APS2 with acceleration

4. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this

	function to reuse the ECM on the others
NO	▶ Substitute with a known-good APS and check for proper operation. If the problem is corrected,replace APS and then go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

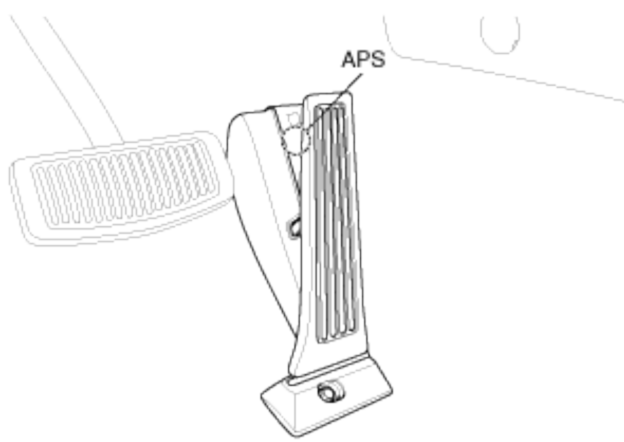
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2128 Accelerator Position Sensor 2 Signal Circuit-High Input

Component Location



General Description

The Electronic Throttle Control(ETC) system is made of the components throttle body, Throttle Position Sensor(TPS) 1&2 and Accelerator Position Sensor(APS) 1&2. The APS is mounted in the accelerator pedal to detect the opening angle of the accelerator pedal. It has 2 sensors to detect the accelerator position and a malfunction of the accelerator position sensor. The ECM judges the current opening angle of the accelerator pedal from APS1&2, and the ECM controls the throttle motor based on these signals.

DTC Description

Checking output signals from APS 2 under detecting condition, if output signals are above the threshold, ECM sets P2128. And then MIL(Malfunction Indication Lamp) turns on.

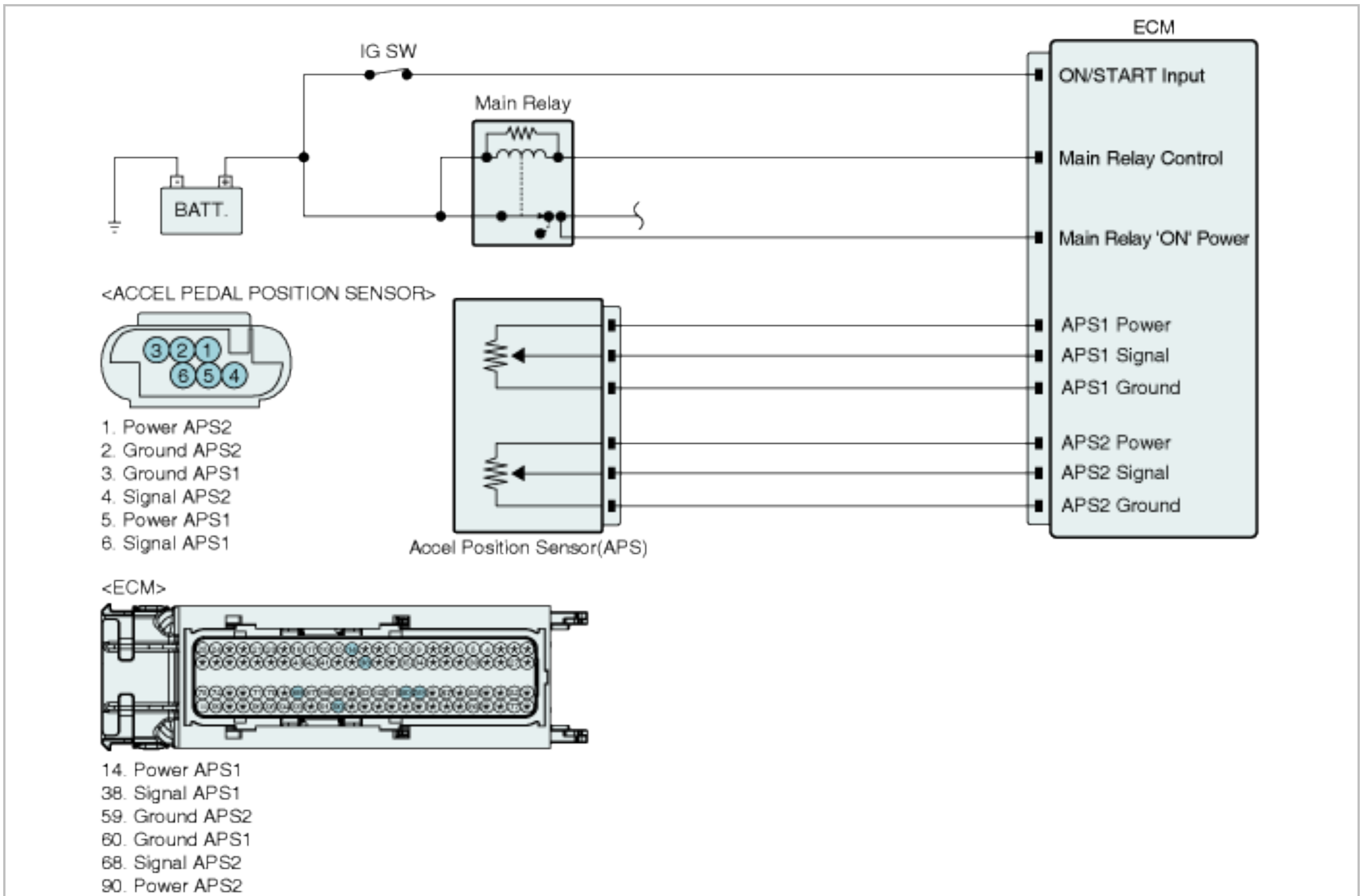
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• This code detects a short to high in either the circuit or the sensor (0-100%)	• Poor connection • Short to battery in Signal Circuit • Open in Ground Circuit • Faulty APS • Faulty ECM
Enable Conditions	• Ignition "ON"	
Threshold value	• APS2 > 3V	
Diagnosis Time	• Continuous	
MIL On Condition	• 1 Driving Cycle	

Specification

Pedal Position	Output Voltage(V) [Vref = 5.0V]	
	APS1	APS2
C.T	0.7 ~ 0.8V	0.29 ~ 0.46V
W.O.T	3.85 ~ 4.35V	1.93 ~ 2.18V

Diagnostic Circuit Diagram



Signal Waveform & Data

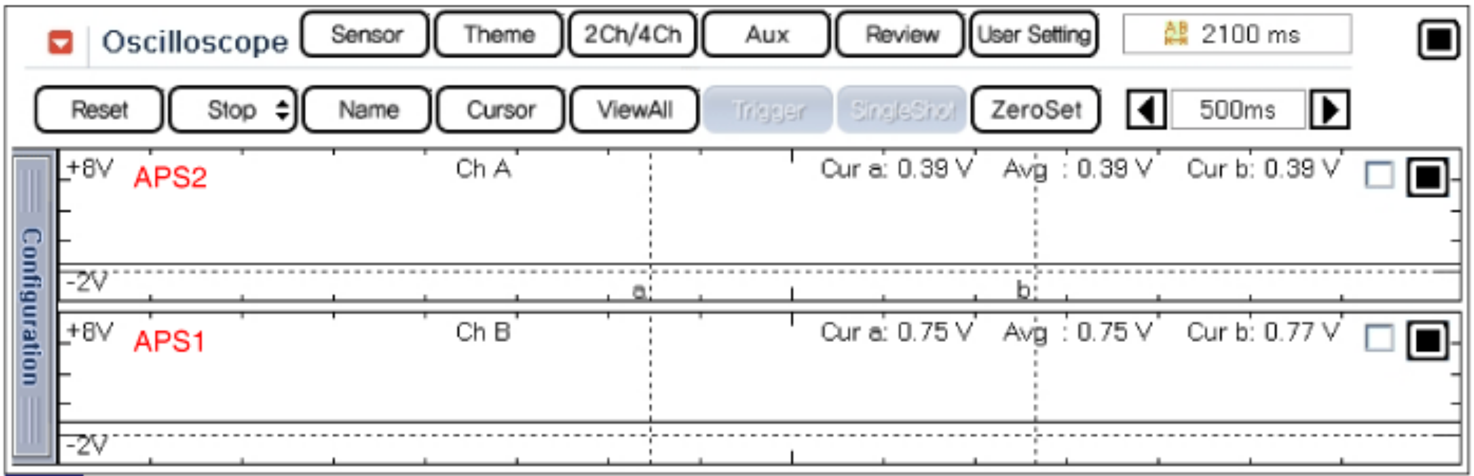


Fig.1

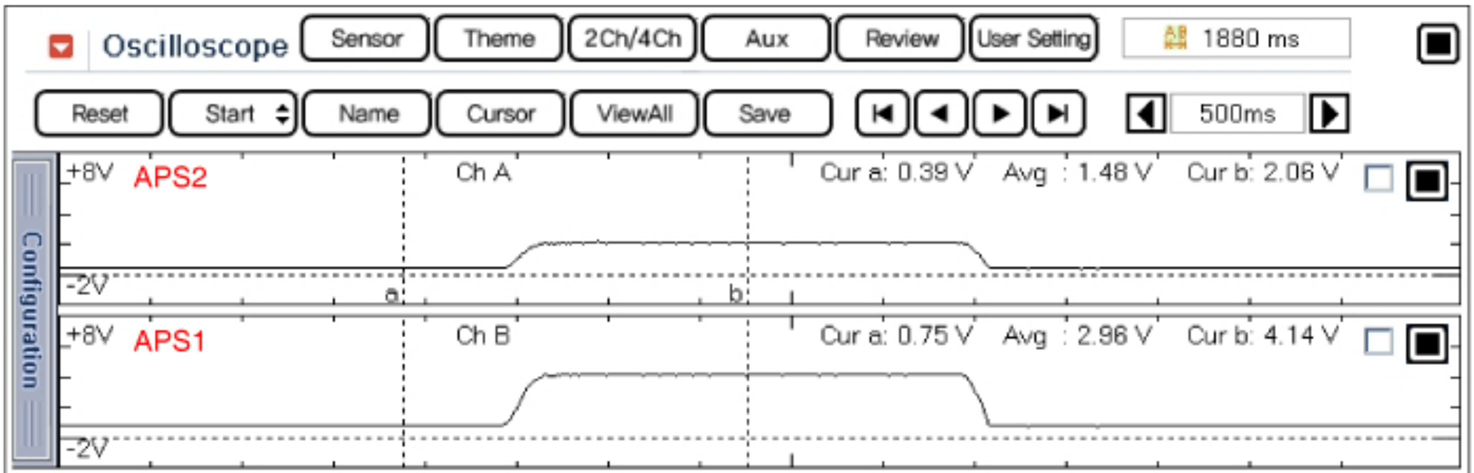
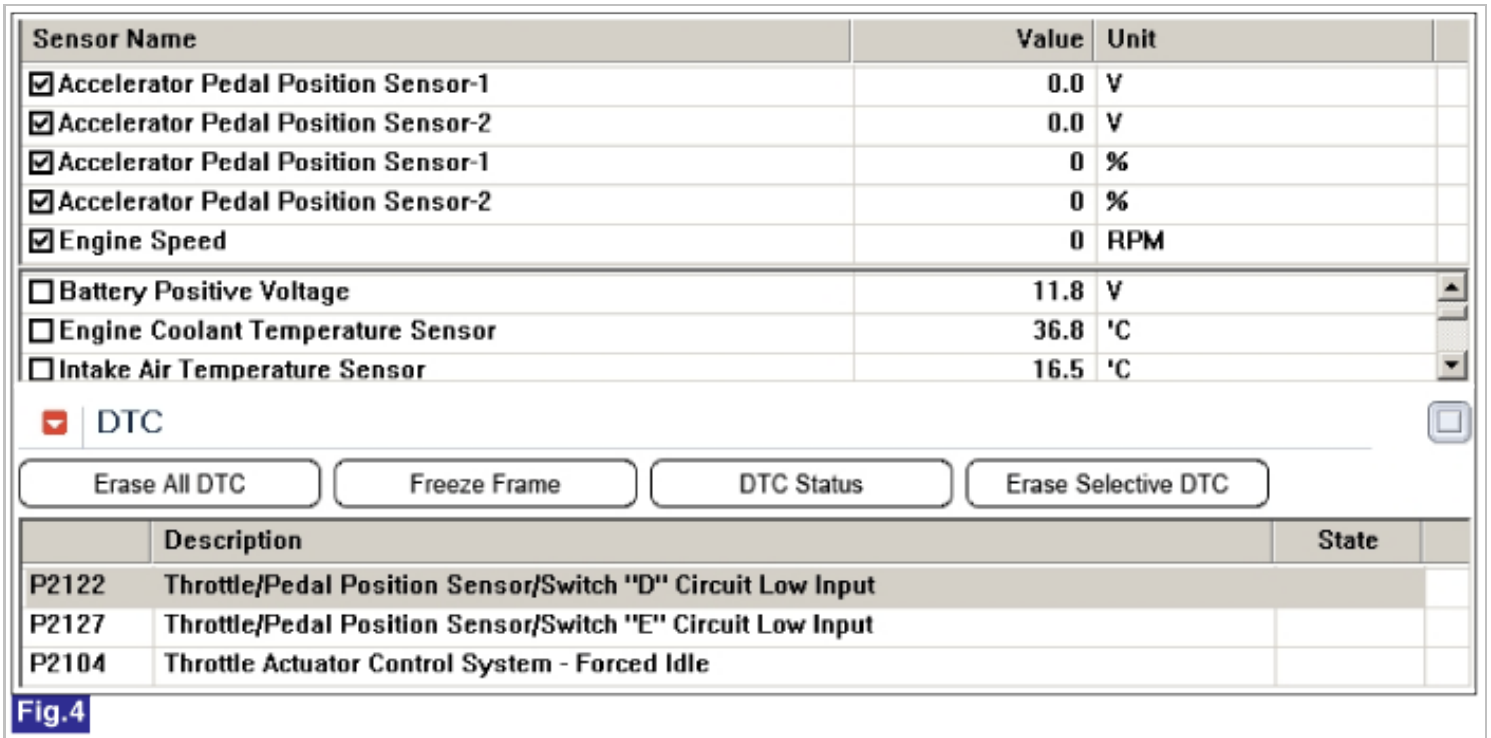


Fig.2

Sensor Name	Value	Unit
☑ Accelerator Pedal Position Sensor-1	0.7	V
☑ Accelerator Pedal Position Sensor-2	0.4	V
☑ Accelerator Pedal Position Sensor-1	15	%
☑ Accelerator Pedal Position Sensor-2	15	%
☑ Engine Speed	0	RPM

Fig.3



Sensor Name	Value	Unit
☑ Accelerator Pedal Position Sensor-1	0.0	V
☑ Accelerator Pedal Position Sensor-2	0.0	V
☑ Accelerator Pedal Position Sensor-1	0	%
☑ Accelerator Pedal Position Sensor-2	0	%
☑ Engine Speed	0	RPM
☐ Battery Positive Voltage	11.8	V
☐ Engine Coolant Temperature Sensor	36.8	'C
☐ Intake Air Temperature Sensor	16.5	'C

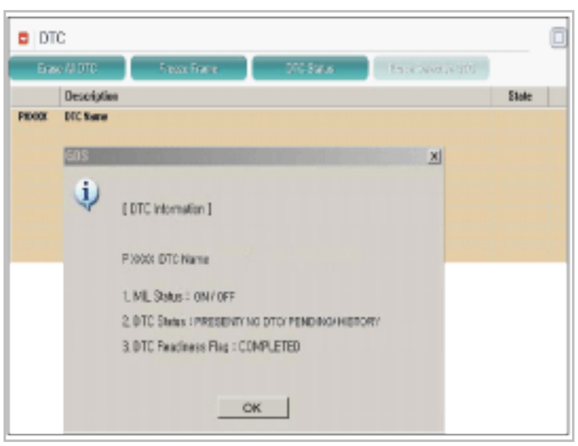
	Description	State
P2122	Throttle/Pedal Position Sensor/Switch "D" Circuit Low Input	
P2127	Throttle/Pedal Position Sensor/Switch "E" Circuit Low Input	
P2104	Throttle Actuator Control System - Forced Idle	

Fig.4

Fig.1) Normal waveform of APS1 & APS2 with no acceleration
Fig.2) Normal waveform of APS1 & APS2 with acceleration
Fig.3) Normal data of APS1 & APS2 at ig on.
Fig.4) Abormal data of APS1 & APS2 when APS1 & APS2 circuit open
Signal waveform of APS 1 & 2 shows that APS 2 increases voltage just half of APS 1 voltage increase when accelerating.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as

	necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure .
NO	▶ Go to " Signal Circuit Inspection " procedure.

Signal Circuit Inspection

■ Check short to battery in harness

1. IG "OFF" and disconnect APS connector and ECM connector.
2. Measure resistance between APS2 signal and APS1 power terminals of APS harness connector.
3. Measure resistance between APS2 signal and APS2 power terminals of APS harness connector.

Specification : Infinite

4. Is the measured resistance within specification ?

YES	▶ Go to "Ground Circuit Inspection" procedure.
NO	▶ Repair short to battery in harness and go to "Verification of Vehicle Repair" procedure.

Ground Circuit Inspection

■ Check open in harness

1. IG "OFF" and disconnect APS connector.
2. Measure voltage between APS2 power terminal of APS harness connector and chassis ground.(Measurement "A")
3. Measure voltage between APS2 power and APS2 ground terminals of APS harness connector.(Measurement "B")

Specification : Voltage difference between measurement "A" and "B" is below 200mV.

4. Is the measured voltage within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair contact resistance or open in harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check APS

1. IG "OFF" and install a GDS.
2. Connect probe to APS1 and APS2 to check signal waveform by using oscilloscope function.
3. Measure signal waveform of APS by pressing and depressing accellerator pedal.

Specification : Signal waveform will be displayed as follows.

Pedal Position	Output Voltage(V) [Vref = 5.0V]	
	APS1	APS2
C.T	0.7 ~ 0.8V	0.29 ~ 0.46V
W.O.T	3.85 ~ 4.35V	1.93 ~ 2.18V

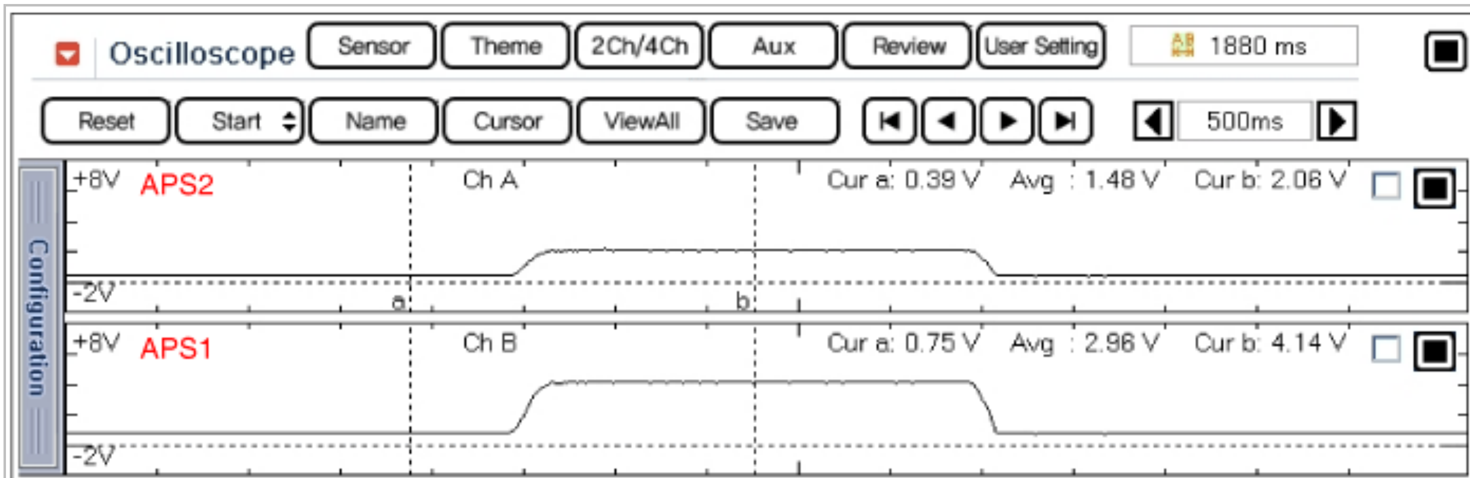


Fig.2

Fig.1) Normal waveform of APS1 & APS2 with acceleration

4. Is the measured resistance within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known-good APS and check for proper operation. If the problem is corrected,replace APS and then go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2135 Throttle Position Sensor 1 & 2 Signal Voltage Correlation

General Description

The Electronic Throttle Control(ETC) system is made of the components throttle body, Throttle Position Sensor(TPS)1&2 and Accelerator Position Sensor(APS) 1&2. TPS1&2 are sharing the same source voltage and ground.The throttle valve opening is control by throttle motor which is controlled by Engine Control Module(ECM).The opposite position indicator shows inverted signal characteristics.TPS1 output voltage increases smoothly in proportion with the throttle valve opening angle after starting. TPS2 output voltage decreases in inverse proportion with the throttle valve opening angle after starting. TPS provides feedback to the ECM to control the throttle motor in order to control the throttle valve opening angle properly in response to the driving condition.

DTC Description

Checking output signals from TPS 1 and 2 under detecting condition, if output signals difference between TPS1 and TPS2 are detected more than 8% for the specified number of times., ECM sets P2135. And then MIL(Malfunction Indication Lamp) turns on.

DTC Detecting Condition

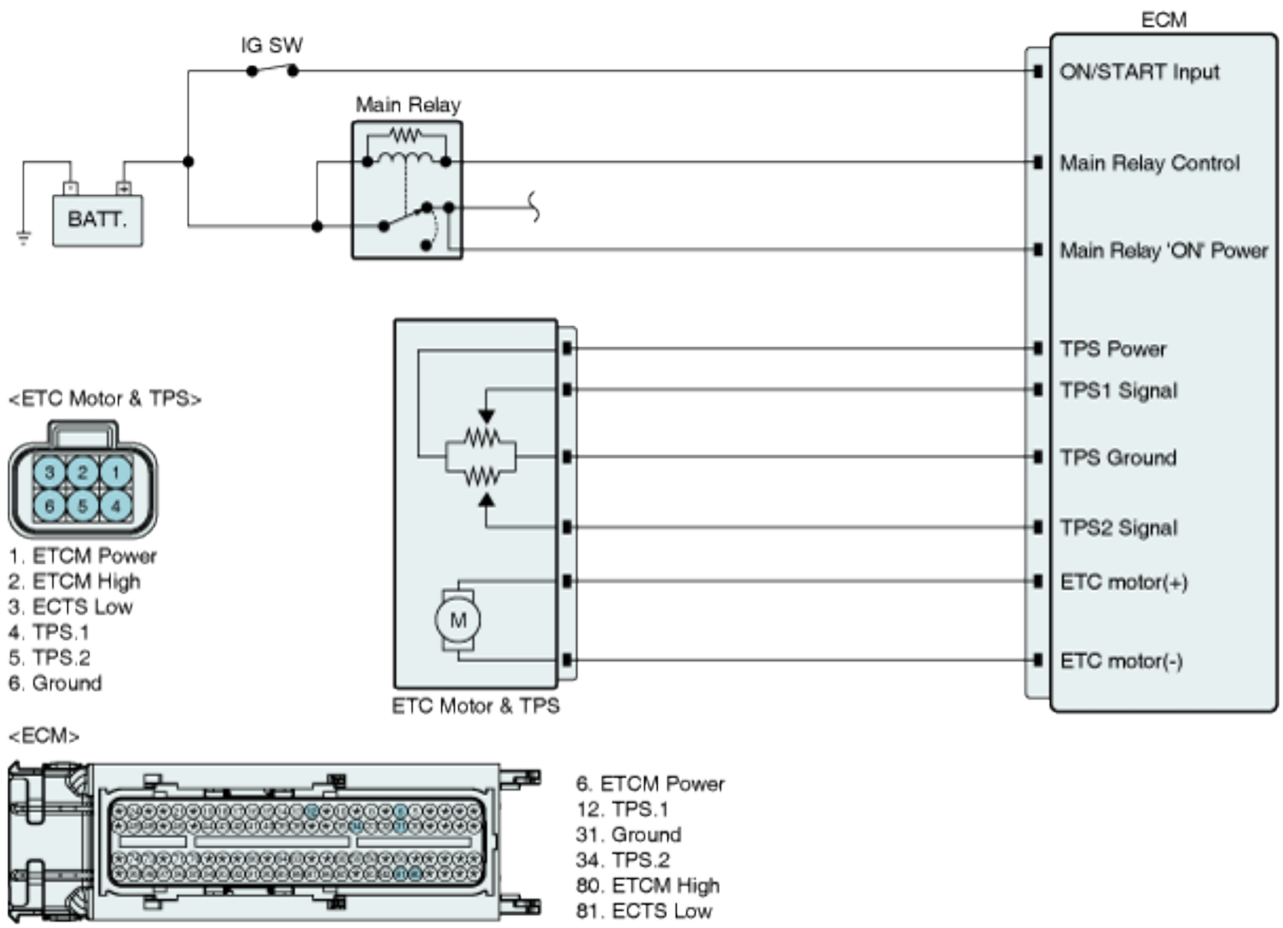
Item	Detecting Condition	Possible Cause
DTC Strategy	• Determines if TPS#1 disagrees with TPS#2	• Poor connection • Open or short in TPS circuit • Faulty TPS • Faulty ECM
Enable Conditions	• Ignition "ON"	
Threshold value	• Difference between average values of TPS1 and TPS2 > 8%	
Diagnosis Time	• Continuous	
MIL On Condition	• 1 driving cycles	

Specification

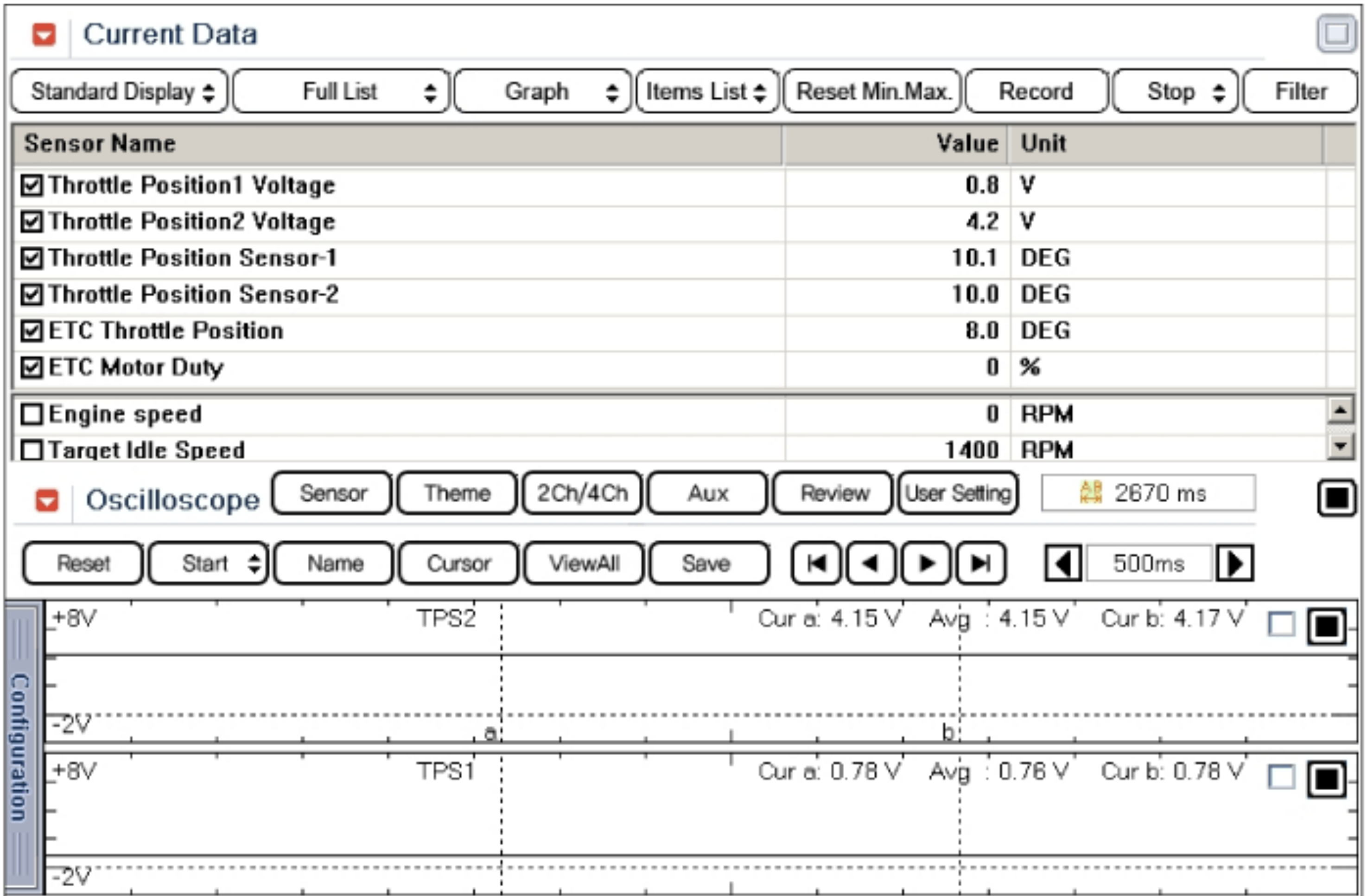
Throttle Opening (°)	Output Voltage (V) [Vref=5.0]	
	TPS1	TPS2
0°	0.0V	5.0V
10°	0.5V	4.5V
20°	0.9V	4.1V
30°	1.4V	3.6V
40°	1.8V	3.2V
50°	2.3V	2.7V
60°	2.7V	2.3V

70°	3.2V	1.8V
80°	3.6V	1.4V
90°	4.1V	0.9V
100°	4.5V	0.5V
110°	5.0V	0.0V

Diagnostic Circuit Diagram



Signal Waveform & Data



Current Data
Standard Display
Full List
Graph
Items List
Reset Min.Max.
Record
Stop
Filter
Sensor Name
Value
Unit
Throttle Position1 Voltage 0.8 V
Throttle Position2 Voltage 4.2 V
Throttle Position Sensor-1 10.1 DEG
Throttle Position Sensor-2 10.0 DEG
ETC Throttle Position 8.0 DEG
ETC Motor Duty 0 %
Engine speed 0 RPM
Target Idle Speed 1400 RPM
Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
2670 ms
Reset
Start
Name
Cursor
ViewAll
Save
500ms
Configuration
+8V
TPS2
Cur a: 4.15 V
Avg : 4.15 V
Cur b: 4.17 V
-2V
a
b
+8V
TPS1
Cur a: 0.78 V
Avg : 0.76 V
Cur b: 0.78 V
-2V

Fig.1

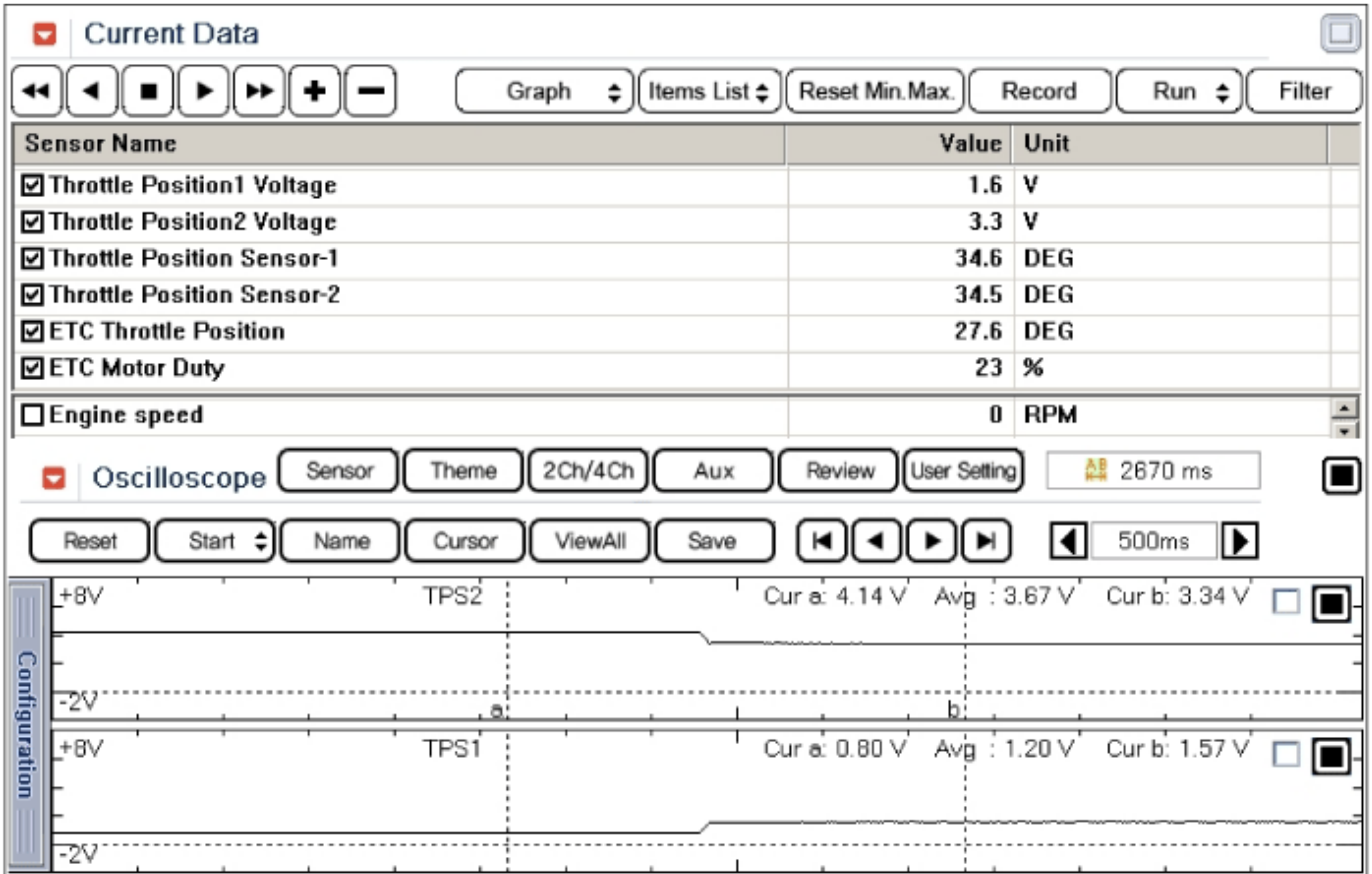


Fig.2

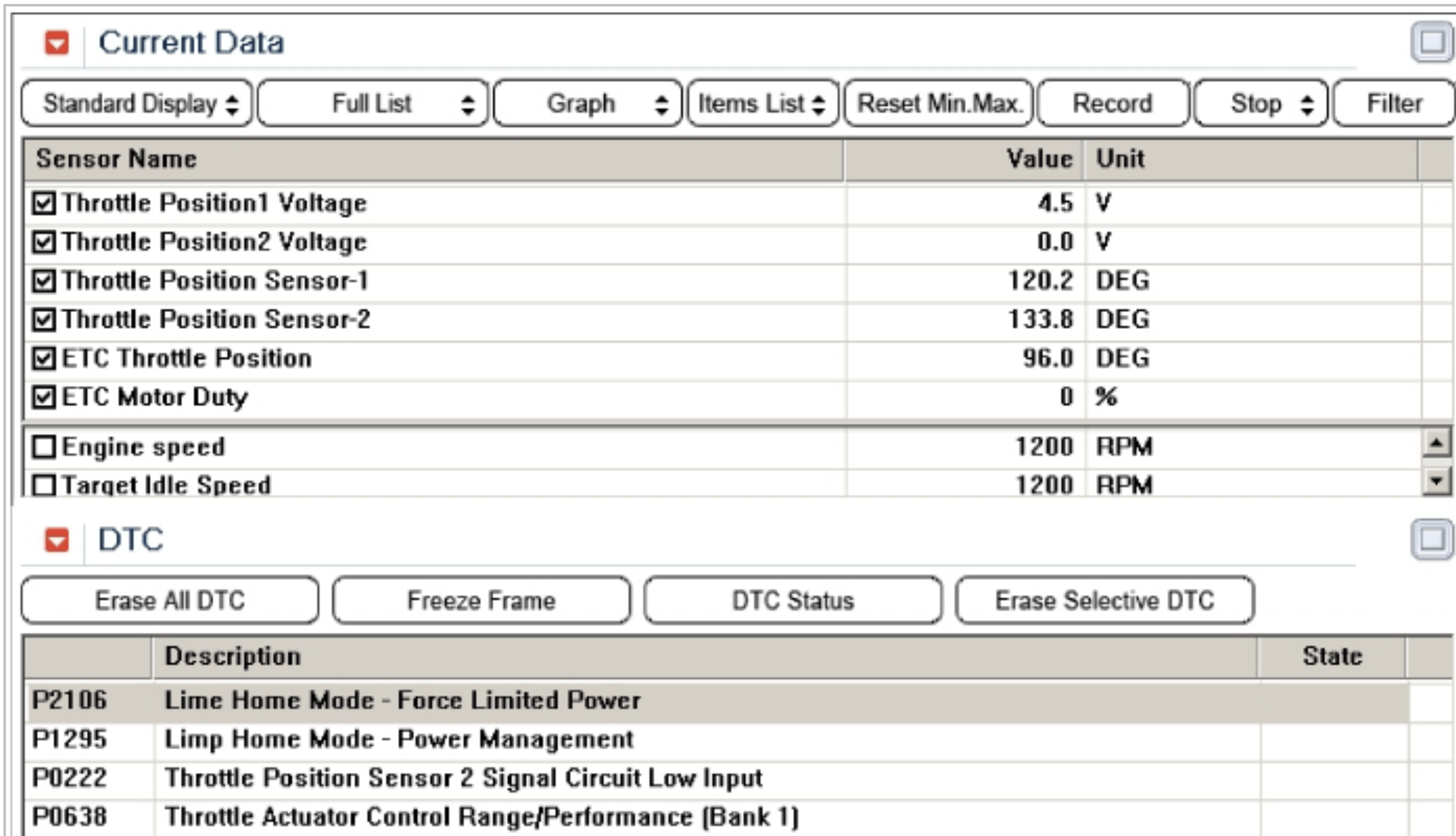


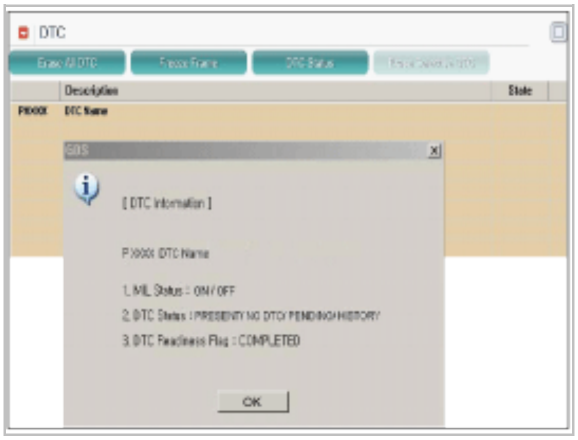
Fig.3

Fig.1) Normal data & waveform of TPS1 & TPS2 with no accel padal depressed under IG ON condition

Fig.2) Normal data & waveform of TPS1 & TPS2 with accel padal depressed under IG ON condition
Fig. 3) Abnormal data of TPS1 & TPS2 at open condition

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ **Check voltage**

1. IG "OFF" and disconnect ETC Motor & TPS connector.
2. IG "ON".
3. Measure voltage between TPS power terminal of ETC Motor & TPS harness connector and chassis ground.

Specification : Approx. 5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Signal circuit inspection" procedure.
NO	▶ Repair open or short in harness and go to "Verification of Vehicle Repair" procedure.

Signal Circuit Inspection

■ Check short in harness

1. IG "OFF" and disconnect ETC Motor & TPS connector and ECM connector.
2. Measure resistance between TPS1 signal and TPS2 signal terminals of ETC Motor & TPS harness connector.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair shorted in harnesses and go to "Verification of Vehicle Repair" procedure.

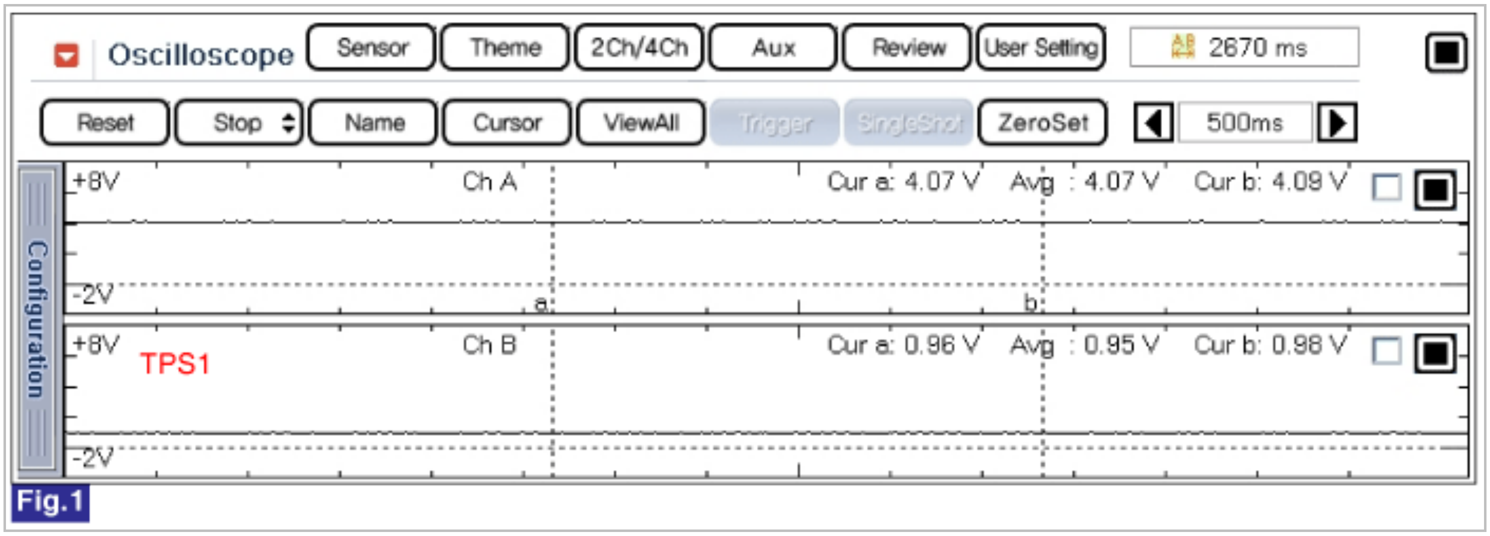
Component Inspection

■ Check TPS

1. IG "ON"
2. Monitor signal waveform of TPS by stepping on and off the accellerator padel on GDS.

Specification :

Throttle Opening (°)	Output Voltage (V) [Vref=5.0]	
	TPS1	**TPS2**
0°	0.0V	5.0V
10°	0.5V	4.5V
20°	0.9V	4.1V
30°	1.4V	3.6V
40°	1.8V	3.2V
50°	2.3V	2.7V
60°	2.7V	2.3V
70°	3.2V	1.8V
80°	3.6V	1.4V
90°	4.1V	0.9V
100°	4.5V	0.5V
110°	5.0V	0.0V



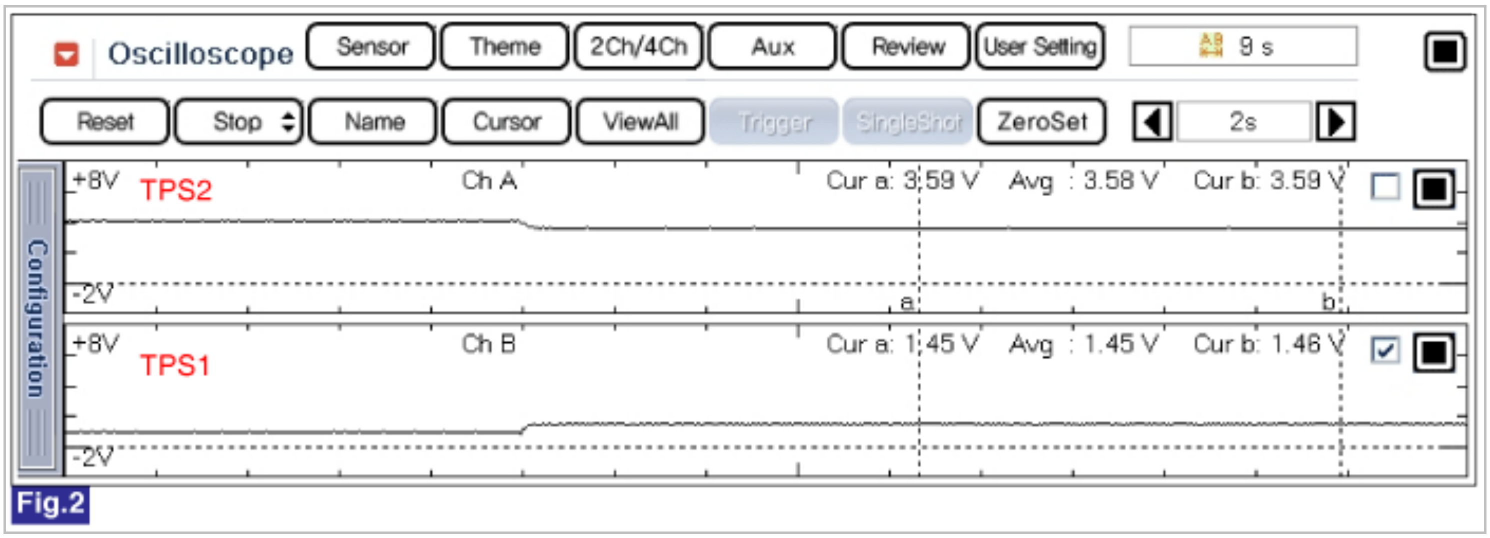


Fig.1) Normal waveform of TPS1 & TPS2 with no accel padal depressed under IG ON condition
Fig.2) Normal waveform of TPS1 & TPS2 with accel padal depressed under IG ON condition

3. Is the measured signal waveform O.K ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good ECT motor & TPS and check for proper operation. If the problem is corrected, replace ECT motor & TPS and go to "Verification of Vehicle Repair" procedure.

※ Procedure of ETS Initialization

A. Erase the trouble codes on ECM

B. Turn the ignition key off and keep this condition until the main relay is turned off.(It will take 10sec.)

C. Turn ignition key on more than 1second to record the throttle motor position on the EEPROM

Verification of Vehicle Repair

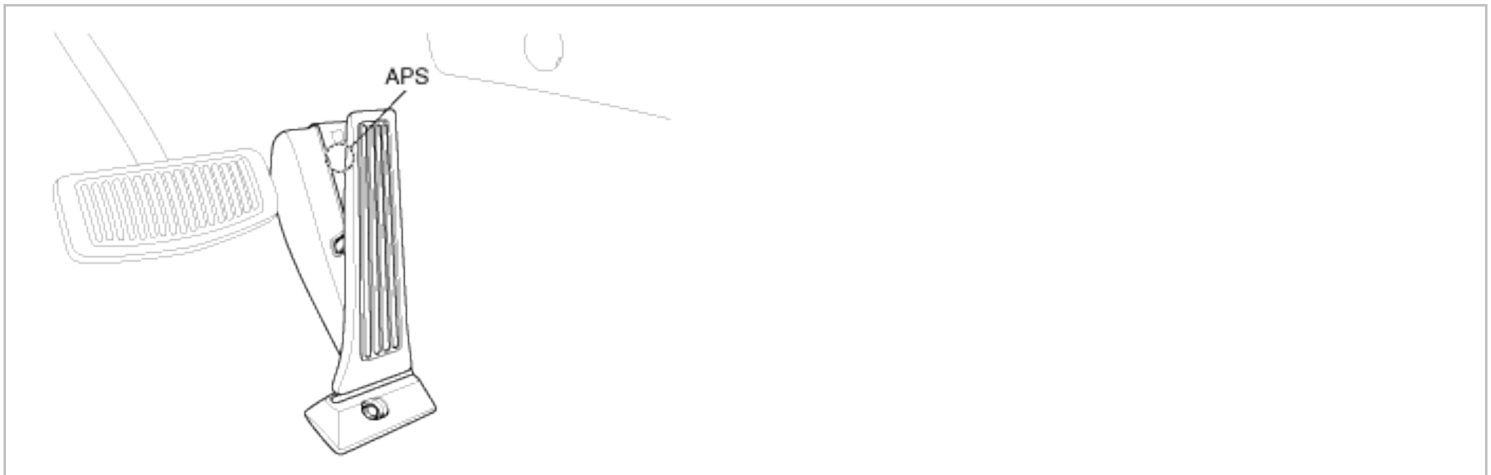
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2138 Accelerator Position Sensor 1 & 2 Signal Voltage Correlation

Component Location



General Description

The Electronic Throttle Control(ETC) system is made of the components throttle body, Throttle Position Sensor(TPS) 1&2 and Accelerator Position Sensor(APS) 1&2. The APS is mounted in the accelerator pedal to detect the opening angle of the accelerator pedal. It has 2 sensors to detect the accelerator position and a malfunction of the accelerator position sensor. The ECM judges the current opening angle of the accelerator pedal from APS1&2, and the ECM controls the throttle motor based on these signals.

DTC Description

Checking output signals from APS 1 and 2 under detecting condition, if output signals difference between APS 1 and 2 are detected more than 4.5% for the specified number of times., ECM sets P2138. And then MIL(Malfunction Indication Lamp) turns on.

DTC Detecting Condition

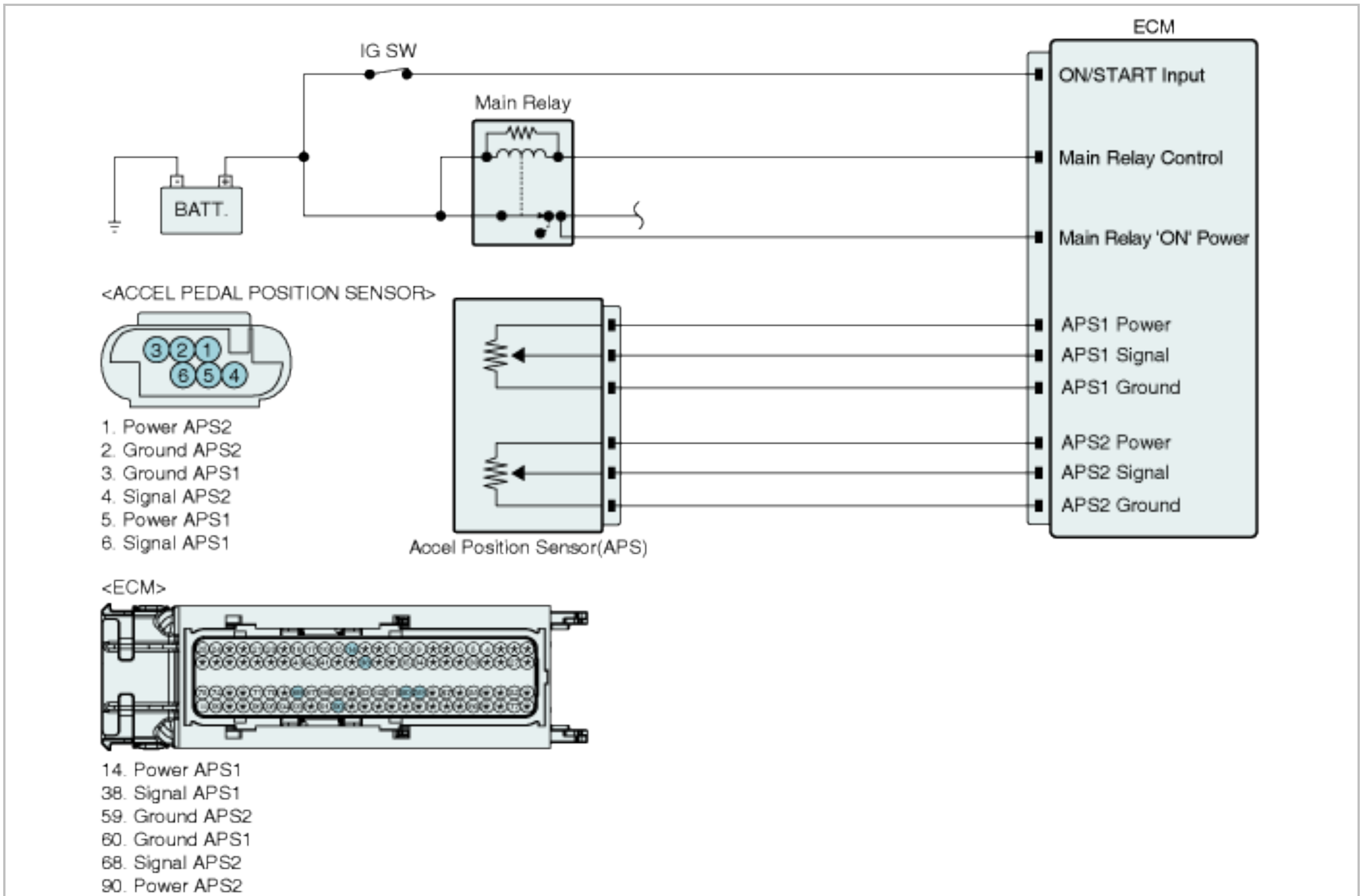
Item	Detecting Condition	Possible cause
DTC Strategy	• This code detects a correlation error between APS 1 and APS 2.	• Poor connection • Open or short in APS circuit
Enable Conditions	• Ignition "ON"	

Threshold value	• Difference between APS1 and APS2 Normalized values > 4.5%	• Open or short in APS circuit • Faulty APS • Faulty ECM
Diagnosis Time	• Continuous	
MIL On Condition	• 1 Driving Cycle	

Specification

Pedal Position	Output Voltage(V) [Vref = 5.0V]	
	APS1	APS2
C.T	0.7 ~ 0.8V	0.29 ~ 0.46V
W.O.T	3.85 ~ 4.35V	1.93 ~ 2.18V

Diagnostic Circuit Diagram



Signal Waveform & Data

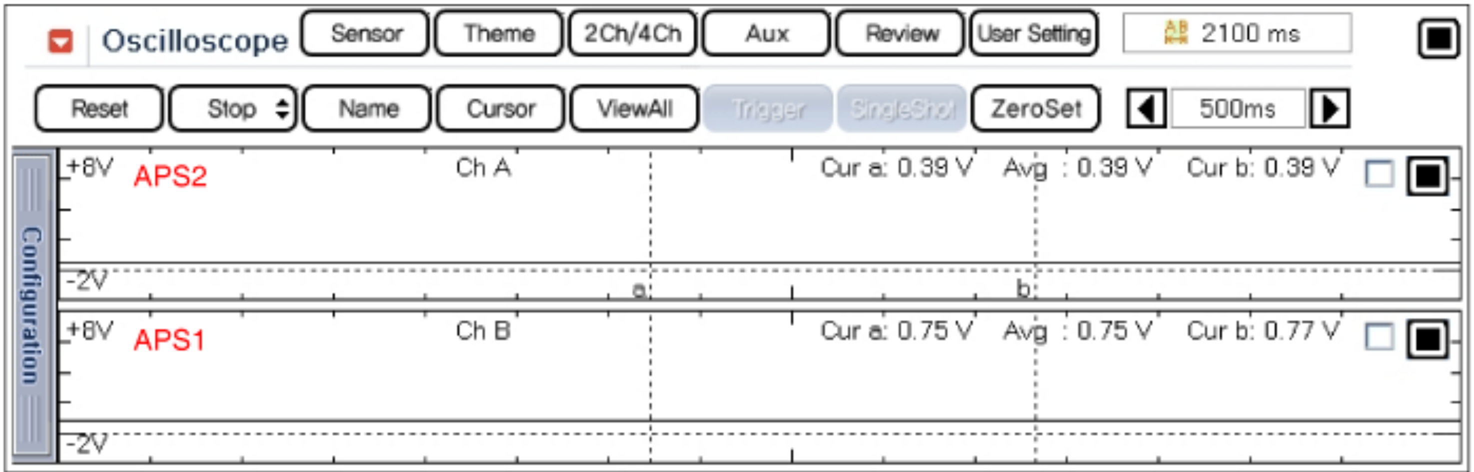


Fig.1

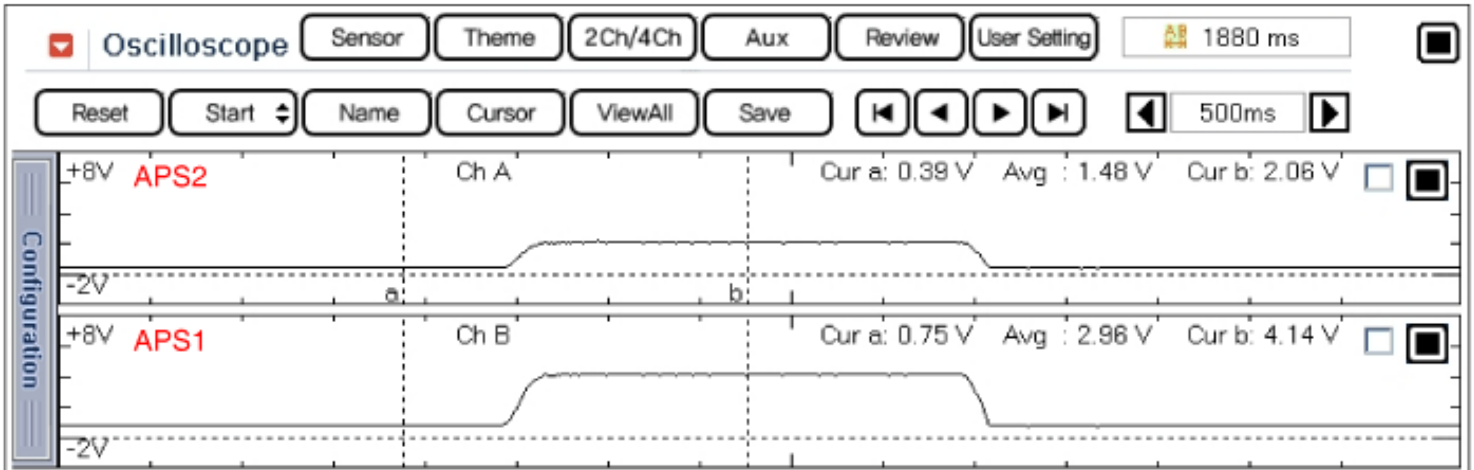


Fig.2

Sensor Name	Value	Unit
☑ Accelerator Pedal Position Sensor-1	0.7	V
☑ Accelerator Pedal Position Sensor-2	0.4	V
☑ Accelerator Pedal Position Sensor-1	15	%
☑ Accelerator Pedal Position Sensor-2	15	%
☑ Engine Speed	0	RPM

Fig.3

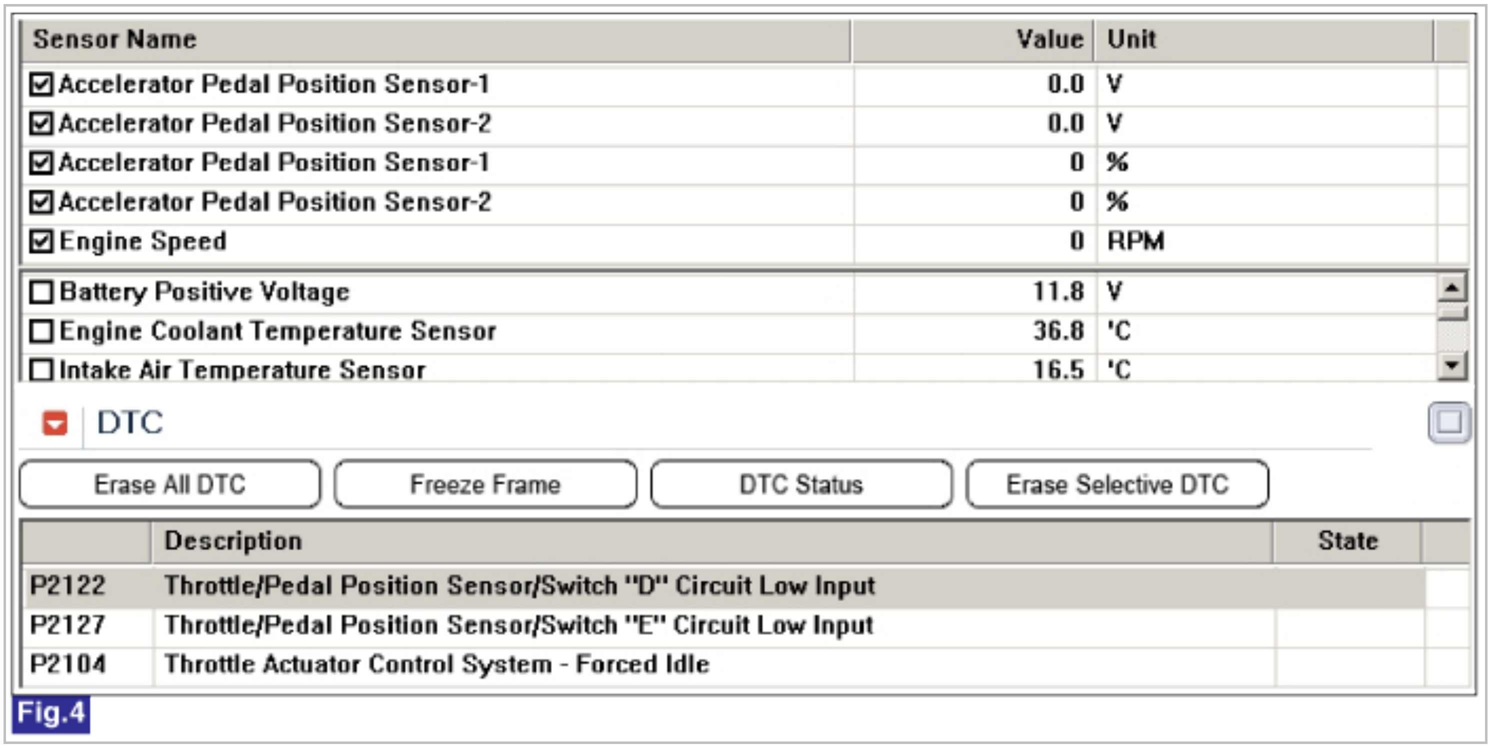
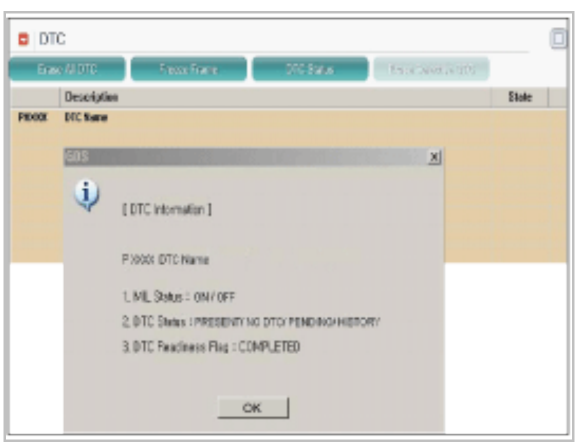


Fig.1) Normal waveform of APS1 & APS2 with no acceleration
Fig.2) Normal waveform of APS1 & APS2 with acceleration
Fig.3) Normal data of APS1 & APS2 at ig on.
Fig. 4) Abormal data of APS1 & APS2 when APS1 & APS2 circuit open
Signal waveform of APS 1 & 2 shows that APS 2 increases voltage just half of APS 1 voltage increase when accelerating.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as

	necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect APS connector.
2. IG "ON"
3. Measure voltage between APS1(2) power terminal of APS harness connector and chassis ground.

Specification : Approx. 5V

4. Is the measured voltage within specification ?

YES	▶ Go to "Signal Circuit Inspection" Procedure.
NO	▶ Repair open or short in harness and go to "Verification of Vehicle Repair" procedure.

Signal Circuit Inspection

■ Check short to ground in harness

1. IG "OFF", disconnect APS connector and ECM connector.
2. Measure resistance between APS1 signal and APS2 signal terminals of APS harness connector.

Specification : Infinite

3. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair short to ground in harness and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check APS

1. IG "OFF" and install a GDS.
2. Connect probe to APS1 and APS2 to check signal waveform by using oscilloscope function.

3. Measure signal waveform of APS by pressing and depressing accellerator pedal.

Specification : Signal waveform will be displayed as follows.

Pedal Position	Output Voltage(V) [Vref = 5.0V]	
	APS1	**APS2**
C.T	'0.7 ~ 0.8V	0.29 ~ 0.46V
W.O.T	'3.85 ~ 4.35V	1.93 ~ 2.18V

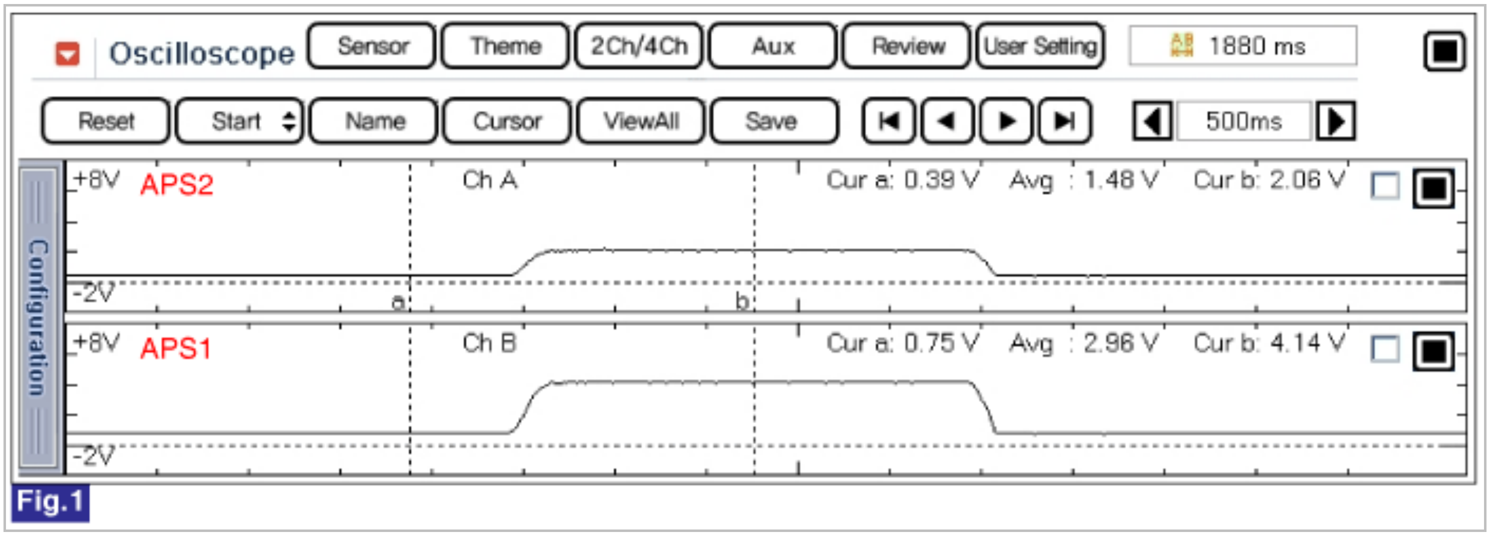


Fig.1) Normal waveform of APS1 & APS2 with acceleration

4. Is the measured signal waveform O.K ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known-good APS and check for proper operation. If the problem is corrected,replace APS and then go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

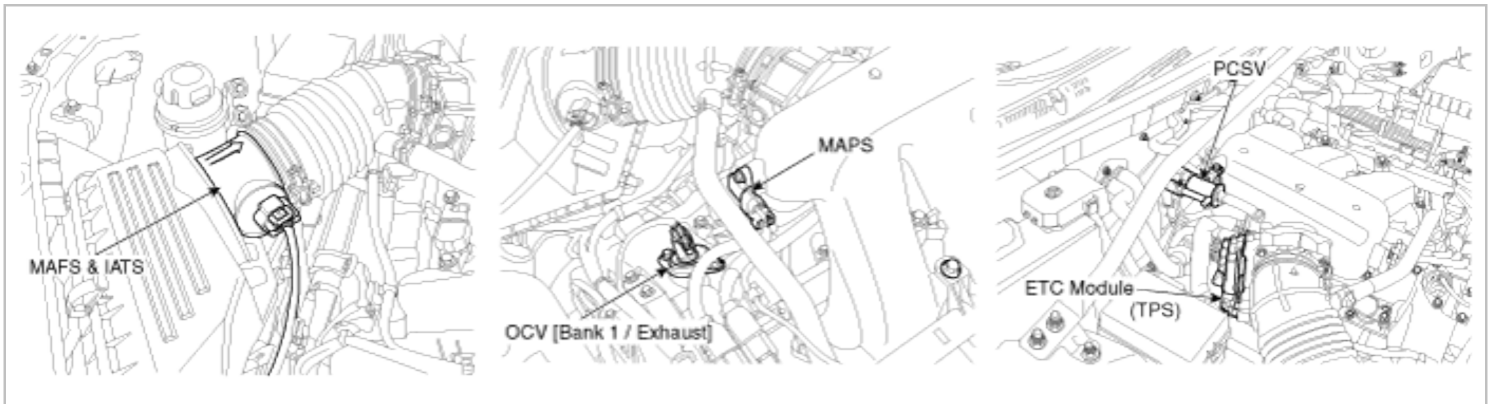
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2173 Throttle Actuator Control System- High Air Flow Detected.

Component Location



General Description

The Electronic Throttle Control(ETC) system is made of the components throttle body, Throttle Position Sensor(TPS)1&2 and Accelerator Position Sensor(APS) 1&2. The throttle body contains the actuator, the throttle plate and the throttle position sensor (potentiometer), which are integrated in one housing. The actuator consists of a DC motor with a two-stage gear. The opening angle of the throttle valve is detected by the throttle position sensor which is mounted on the throttle body. And it provides feedback to the ECM to control the throttle motor in order to control the throttle valve opening angle properly in response to the driving condition.

DTC Description

Comparing real intake air flow and the intake air flow calculated by ETS under detecting condition, if the air flow more than threshold value is detected for more than 19 sec., ECM sets P2173. And then MIL(Malfunction Indication Lamp) turns on.

DTC Detecting Condition

<table>
<tr><th colspan="2">Item</th><th>Detecting Condition</th><th>Possible cause</th></tr>
<tr><td colspan="2">DTC Strategy</td><td>• Monitor the measured engine airflow and the estimated airflow</td><td rowspan="6">• Air Leakage between TPS and MAFS
• Faulty throttle body or intake manifold
• Faulty MAFS</td></tr>
<tr><td colspan="2">EnableConditions</td><td>• Engine running
• No faults present</td></tr>
<tr><td rowspan="2">Threshold value</td><td>Case1</td><td>• MAPS reading - ETC estimated airflow > 9 g/s</td></tr>
<tr><td>Case2</td><td>• MAFS reading - ETC estimated airflow > 7g/s</td></tr>
<tr><td colspan="2">Diagnosis Time</td><td>• Continuous (Within 20 sec.)</td></tr>
<tr><td colspan="2">MIL On Condition</td><td>• 1 Driving Cycle</td></tr>
</table>

Specification

TPS		
Throttle Opening (°)	Output Voltage (V) [Vref=5.0]	
	TPS1	TPS2
0°	0.0V	5.0V
10°	0.5V	4.5V
20°	0.9V	4.1V
30°	1.4V	3.6V
40°	1.8V	3.2V
50°	2.3V	2.7V
60°	2.7V	2.3V
70°	3.2V	1.8V
80°	3.6V	1.4V
90°	4.1V	0.9V
100°	4.5V	0.5V
110°	5.0V	0.0V

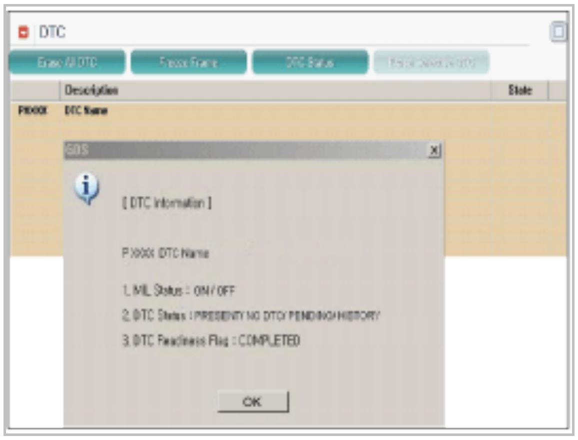
MAFS	
Air Flow(kg/h)	Frequency(Hz)
12.6	2320
18	2645
23.4	2903
32.4	3263
43.2	3622
57.6	3986
72	4288
108	4876
144	5380
198	5983
270	6636
360	7286
486	8002
666	8843
900	9699

MAP	
Pressure(kPa)	Voltage(V)
20	0.79
46.66	1.84

101.32	4.0

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "System Inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

System Inspection

■ Visual Inspection

1. Check the air hose between MAFS and throttle body is torn or installation.
2. Check deforamtion, crack or installation of throttle valve(body)
3. Has a problem been found ?

YES	▶ Substitute with a known-good Air hose or throttle body and check for proper operation. If the problem is corrected,replace air hose or throttle body and then go to "Verification of Vehicle Repair" proc
NO	▶ Go to "Check MAFS" as follows..

■ Check MAFS

1. IG "OFF" and install a GDS
2. ENG "ON" and monitor "MAFS" data on the service data.
3. Monitor signal waveform at signal terminal of MAFS with GDS.

Specification : Signal waveform will be displayed as follows. Frenquency will be increased during acceleration. (Be aware that the signal of MAFS is not voltage display but frequency display.)

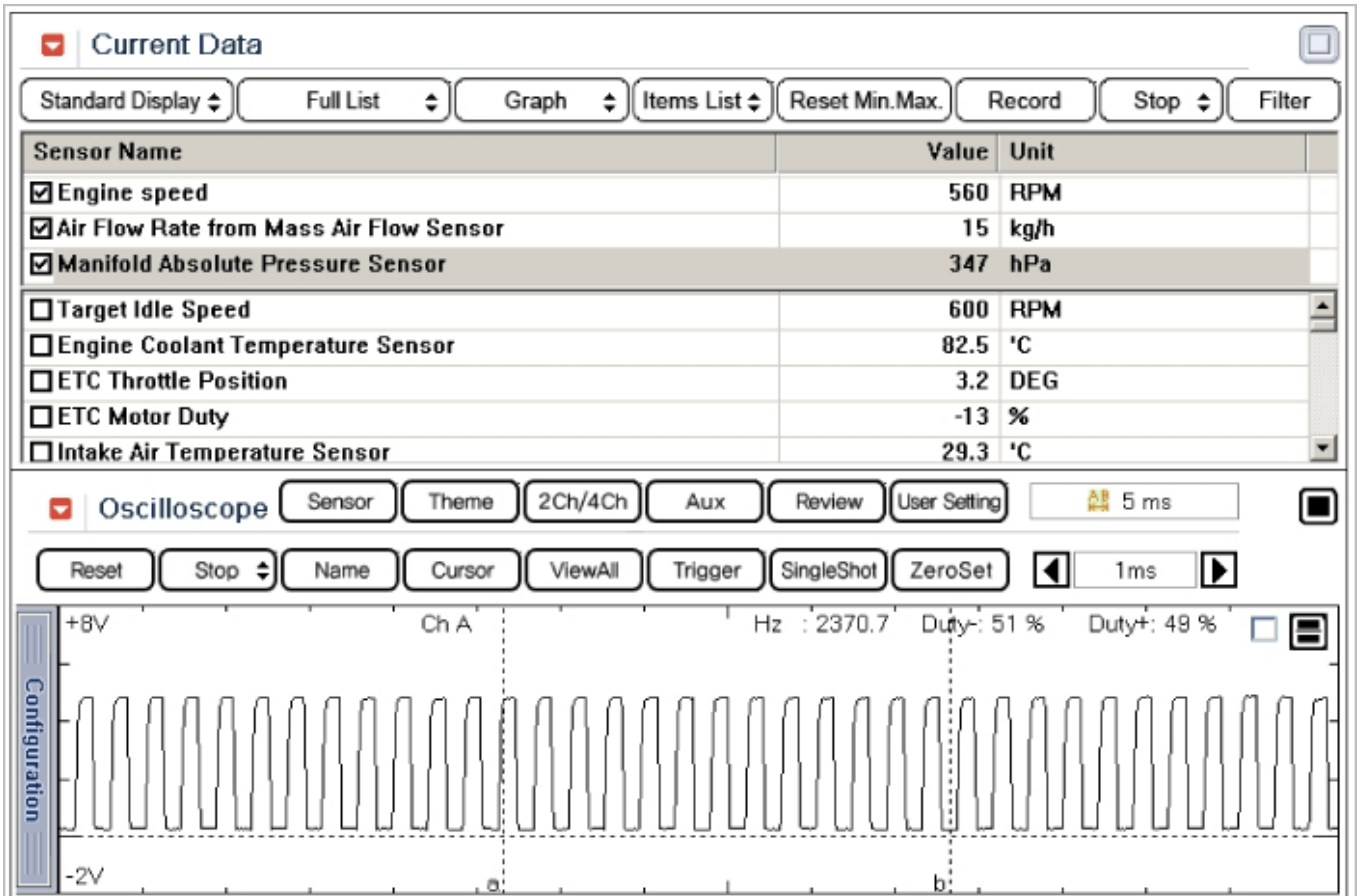


Fig.1

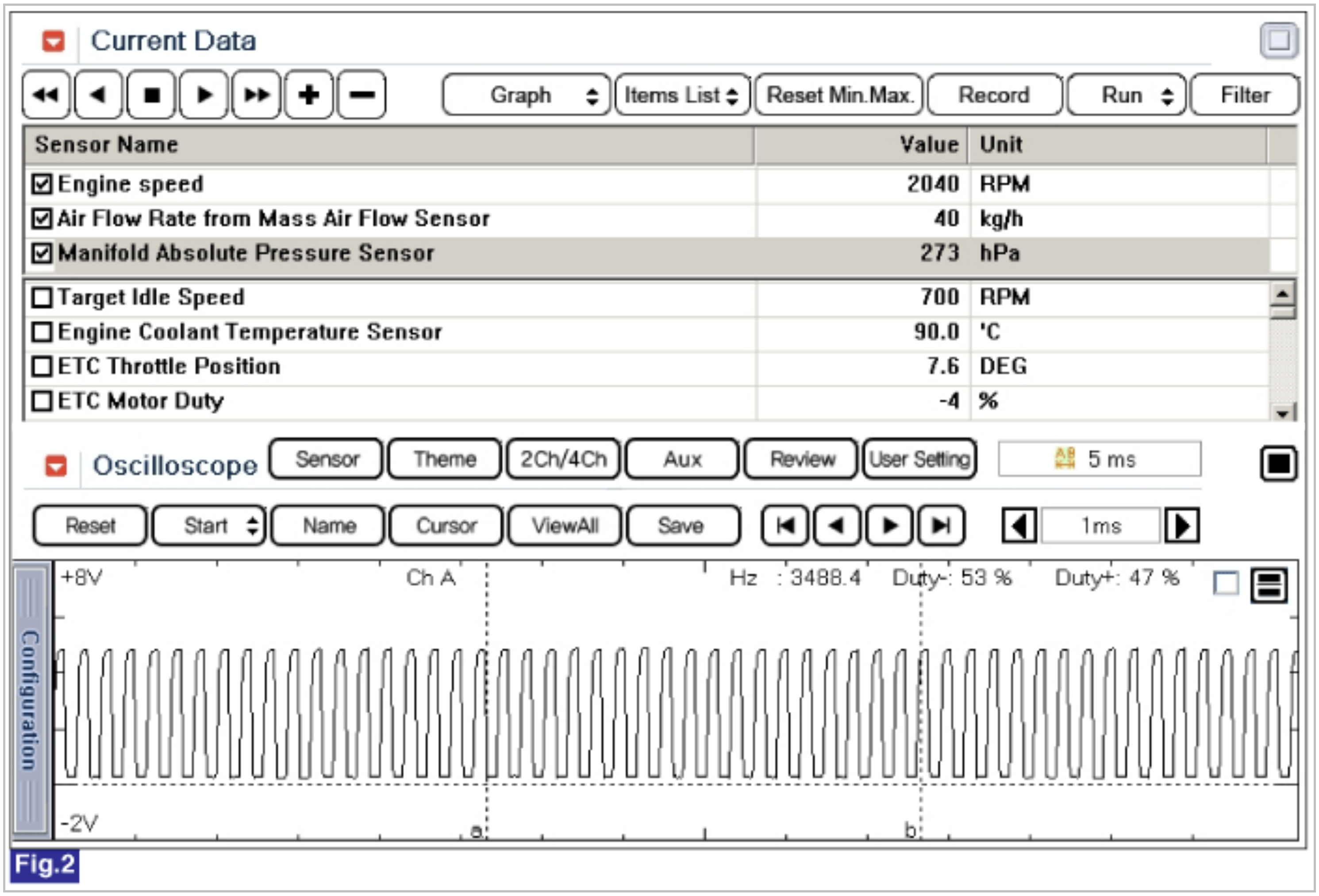


Fig.1) Normal data & waveform of MAFS at idle.
Fig.2) Normal data & waveform of MAFS at acceleration.

4. Are both service data and signalwave form dispayed correctly ?

YES	▶ Go to "Verification of Vehicle Repair" procedure.
NO	▶ Substitute with a known - good MAFS and check for proper operation. If the problem is corrected, replace MAFS and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2187 System too Lean at Idle (←Additive) (Bank 1)

General Description

In order to provide the best possible combination of drivability, fuel economy and emission control, the ECM uses a closed loop air/fuel metering system. The ECM monitors the HO2S signal voltage and adjusts fuel delivery based it in closed loop fuel control. Changes in fuel delivery will be indicated by the long-term and the short-term fuel trim values. The ideal fuel trim value is around 0%. The ECM will add fuel when the HO2S signal is indicating a lean condition. Additional fuel is indicated by fuel trim values that are above 0%. The ECM will reduce fuel when the HO2S signal is indicating a rich condition. Reduction in fuel is indicated by fuel trim values that are below 0%. The DTC relevant to fuel trim will be set when the amount reaches excessive levels because of a lean or rich condition.

DTC Description

Checking the fuel trime value at idle under detecting condition, if its average exceeds the limit over certain period, ECM sets P2187.
MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycles.

DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Monitor the fuel trim value at idle	• Air leakage • Improper fuel pressure • PCV valve stuck • Clogging of injector
Enable Conditions	• Engine warm-up sufficiently • Engine running under Idle state over 5 minutes • 60°C(140°F) ≤ Engine coolant temperature ≤ 115°C(239°F) • No disabling faults (DTCs related to HO2S, purge valve, catalyst)	
Threshold value	• Average of short term fuel trim > 0.8	
Diagnosis Time	• Continuous	
MIL On Condition	• 2 Driving Cycles	

Monitor GDS Data

1. Monitor DTCs related to HO2S, MAFS, MAPS, ECTS, PCSV, Injector or CVVT items with GDS.
2. Are there the DTCs above-mentioned?

YES	▶ Do all repairs associated with those codes before proceeding with this procedure.
NO	▶ Go to "System Inspection" procedure

System Inspection

■ Check air leakage

1. Visually/physically inspect the air leakage in intake/exhaust system for following items
   ▶ Vacuum hoses for splits, kinks and improper connections
   ▶ Throttle body gasket

- ▶ Gasket between intake manifold and cylinder head
- ▶ Seals between intake manifold and fuel injectors
- ▶ Exhaust system between HO2S and three way catalyst for air leakage

2. Has a problem found in this procedure?

YES	▶ Repair or replace it which has a problem, and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check the fuel line" as follows

■ Check the fuel line

1. Check the fuel line for following items
   - ▶ Connector connection state
   - ▶ Damage/ connection state for vacuum hoses connected to fuel line
   - ▶ Bent/ pressed/ twisted fuel line or fuel leakage
2. Has a problem found in this procedure?

YES	▶ Repair or replace it which has a problem, and go to " Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check fuel pressure" as follows

■ Check fuel pressure

> NOTE
>
> 1. Be cautious that Fuel is explosive and an empty fuel tank can still contain explosive gases. When working on fuel system make sure to supply adequate ventilation to the work area. Do not smoke, and keep sparks and open flames away.
> 2. The fuel system remains under pressure when the engine is not running. Release fuel system pressure before disconnecting any fuel line to reduce the chance of presonal injury or fire damage to vehicle components.

1. IG "OFF" and disconnect Fuel Pump Relay in Junction Box.
2. Start-up and wait until it stops itself.
3. IG "OFF" and connect Fuel Pump Relay.
4. Install the fuel pressure gauge to the delivery pipe with the fuel pressure gauge adaptor.
5. Activate the fuel pump, and with fuel pressure applied, check that there is no fuel leakage from the pressure gauge or connection part.
6. Measure the fuel pressure at idle.

Specification : 373.6 ~ 387.4 kPa(3.81 ~ 3.95 kg/cm², 54.2 ~ 56.1 psi)

7. Is the measured fuel pressure within specifications ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair or replace according to the below table. And then, go to " Verification of Vehicle Repair" procedure.

Condition	Possible Cause
Fuel Pressure is too low	Fuel filter,fuel pressure regulator, in-tank fuel hose or the fuel pump
Fuel Pressure is too high	Fuel pressure regulator, hose or pipe

Component Inspection

■ Check PCV

1. IG "OFF" and remove PCV valve from rocker cover.
2. Insert a thin stick into the PCV valve from the threaded side and verify that the plunger is moving.
3. Is the PCV valve normally moving?

YES	▶ Go to "Check injector for normal operation" as follows.
NO	▶ Replace it, and go to "Verification of Vehicle Repair" procedure.

■ Check injector for normal operation

1. Start engine.
2. Check its RPM decrease when doing the injector's actuation test.
3. Is there any cylinder with no change in RPM or only a small change in RPM?

YES	▶ Clear DTC and Test-drive under enable conditions above-mentioned. After the test, If this DTC is set, go to "Inspection & Repair" procedure. If not, troubleshooting is completed.
NO	▶ Replace injector, and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2188 System too Rich at Idle (Bank 1)

General Description

In order to provide the best possible combination of drivability, fuel economy and emission control, the ECM uses a closed loop air/fuel metering system. The ECM monitors the HO2S signal voltage and adjusts fuel delivery based it in closed loop fuel control. Changes in fuel delivery will be indicated by the long-term and the short-term fuel trim values. The ideal fuel trim value is around 0%. The ECM will add fuel when the HO2S signal is indicating a lean condition. Additional fuel is indicated by fuel trim values that are above 0%. The ECM will reduce fuel when the HO2S signal is indicating a rich condition. Reduction in fuel is indicated by fuel trim values that are below 0%. The DTC relevant to fuel trim will be set when the amount reaches excessive levels because of a lean or rich condition.

DTC Description

Checking the fuel trime value at idle under detecting condition, if its average exceeds the limit over certain period, ECM sets P2188. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycles.

DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Monitor the fuel trim value at idle	• Blocking of intake system • Fuel leakage in injector • Improper fuel pressure
Enable Conditions	• Engine warm-up sufficiently • Engine running under Idle state over 5 minutes • 60°C(140°F) ≤ Engine coolant temperature ≤ 115°C(239°F) • No disabling faults (DTCs related to HO2S, purge valve,catalyst)	
Threshold value	• Average of long term fuel trim < 0.75	
Diagnosis Time	• Continuous	
MIL On Condition	• 2 Driving Cycles	

Monitor GDS Data

1. Monitor DTCs related to HO2S, MAFS, MAPS, ECTS, PCSV, Injector or CVVT items with GDS.
2. Are there the DTCs above-mentioned?

YES	▶ Do all repairs associated with those codes before proceeding with this procedure.
NO	▶ Go to "System Inspection" procedure

System Inspection

■ Check blocking of intake system

1. Visually/physically inspect the blocking in intake system for following items
   ▶ Throttle body gasket and damage
   ▶ Blocking in intake manifold and injector caused by any foreign substance
2. Has a problem found in this procedure?

YES	▶ Repair or replace it which has a problem, and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to " Check fuel pressure" as follows.

■ Check fuel pressure

NOTE

1. Be cautious that Fuel is explosive and an empty fuel tank can still contain explosive gases. When working on fuel system make sure to supply adequate ventilation to the work area. Do not smoke, and keep sparks and open flames away.

2. The fuel system remains under pressure when the engine is not running. Release fuel system pressure before disconnecting any fuel line to reduce the chance of presonal injury or fire damage to vehicle components.

1. IG "OFF" and disconnect Fuel Pump Relay in Junction Box.
2. Start-up and wait until it stops itself.
3. IG "OFF" and connect Fuel Pump Relay.
4. Install the fuel pressure gauge to the delivery pipe with the fuel pressure gauge adaptor.
5. Activate the fuel pump, and with fuel pressure applied, check that there is no fuel leakage from the pressure gauge or connection part.
6. Measure the fuel pressure at idle.

Specification : 373.6 ~ 387.4 kPa(3.81 ~ 3.95 kg/cm², 54.2 ~ 56.1 psi)

7. Is the measured fuel pressure within specifications ?

YES	▶ Go to "Check fuel leakage in injector" as follow.
NO	▶ Repair or replace according to the below table. And then, go to " Verification of Vehicle Repair" procedure.

Condition	Possible Cause
Fuel Pressure is too low	Fuel filter,fuel pressure regulator, in-tank fuel hose or the fuel pump
Fuel Pressure is too high	Fuel pressure regulator, hose or pipe

■ **Check fuel leakage in injector**

1. IG "OFF" after checking the fuel pressure test..
2. Stop engine and check for a change in the fuel pressure gauge reading for 5 minutes.

Specification : After engine stops, fuel gauge reading is maintained for 5 minutes.

3. Is the fuel gauge reading maintained ?

YES	▶ Clear DTC and Test-drive under enable conditions above-mentioned. After the test, If this DTC is set, go to "Inspection & Repair" procedure. If not, troubleshooting is completed.
NO	▶ There is a fuel leakage in injector. Replace it, and go to " Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.

NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2189 System too Lean at Idle (- Additive) (Bank 2)

General Description

In order to provide the best possible combination of drivability, fuel economy and emission control, the ECM uses a closed loop air/fuel metering system. The ECM monitors the HO2S signal voltage and adjusts fuel delivery based it in closed loop fuel control. Changes in fuel delivery will be indicated by the long-term and the short-term fuel trim values. The ideal fuel trim value is around 0%. The ECM will add fuel when the HO2S signal is indicating a lean condition. Additional fuel is indicated by fuel trim values that are above 0%. The ECM will reduce fuel when the HO2S signal is indicating a rich condition. Reduction in fuel is indicated by fuel trim values that are below 0%. The DTC relevant to fuel trim will be set when the amount reaches excessive levels because of a lean or rich condition.

DTC Description

Checking the fuel trime value at idle under detecting condition, if its average exceeds the limit over certain period, ECM sets P2189. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycles.

DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Monitor the fuel trim value at idle	• Air leakage • Improper fuel pressure • PCV valve stuck • Clogging of injector
Enable Conditions	• Engine warm-up sufficiently • Engine running under Idle state over 5 minutes • 60°C(140°F) ≤ Engine coolant temperature ≤ 115°C(239°F) • No disabling faults (DTCs related to HO2S, purge valve,catalyst)	
Threshold value	• Average of long term fuel trim > 1.25	
Diagnosis Time	• Continuous	
MIL On Condition	• 2 Driving Cycles	

Monitor GDS Data

1. Monitor DTCs related to HO2S, MAFS, MAPS, ECTS, PCSV, Injector or CVVT items with GDSI.
2. Are there the DTCs above-mentioned?

YES	▶ Do all repairs associated with those codes before proceeding with this procedure.
NO	▶ Go to "System Inspection" procedure

System Inspection

■ **Check air leakage**

1. Visually/physically inspect the air leakage in intake/exhaust system for following items
   - ▶ Vacuum hoses for splits, kinks and improper connections.
   - ▶ Throttle body gasket
   - ▶ Gasket between intake manifold and cylinder head
   - ▶ Seals between intake manifold and fuel injectors
   - ▶ Exhaust system between HO2S and three way catalyst for air leakage
2. Has a problem found in this procedure?

YES	▶ Repair or replace it which has a problem, and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check the fuel line" as follows

■ Check the fuel line

1. Check the fuel line for following items
   - ▶ Connector connection state
   - ▶ Damage/ connection state for vacuum hoses connected to fuel line
   - ▶ Bent/ pressed/ twisted fuel line or fuel leakage
2. Has a problem found in this procedure?

YES	▶ Repair or replace it which has a problem, and go to " Verification of Vehicle Repair" procedure.
NO	▶ Go to "Check fuel pressure" as follows

■ Check fuel pressure

NOTE

1. Be cautious that Fuel is explosive and an empty fuel tank can still contain explosive gases. When working on fuel system make sure to supply adequate ventilation to the work area. Do not smoke, and keep sparks and open flames away.
2. The fuel system remains under pressure when the engine is not running. Release fuel system pressure before disconnecting any fuel line to reduce the chance of presonal injury or fire damage to vehicle components.

1. IG "OFF" and disconnect Fuel Pump Relay in Junction Box.
2. Start-up and wait until it stops itself.
3. IG "OFF" and connect Fuel Pump Relay.
4. Install the fuel pressure gauge to the delivery pipe with the fuel pressure gauge adaptor.
5. Activate the fuel pump, and with fuel pressure applied, check that there is no fuel leakage from the pressure gauge or connection part.
6. Measure the fuel pressure at idle.

Specification : 373.6 ~ 387.4 kPa(3.81 ~ 3.95 kg/cm², 54.2 ~ 56.1 psi)

7. Is the measured fuel pressure within specifications ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repair or replace according to the below table. And then, go to " Verification of Vehicle Repair" procedure.

Condition	Possible Cause

Fuel Pressure is too low	Fuel filter,fuel pressure regulator, in-tank fuel hose or the fuel pump
Fuel Pressure is too high	Fuel pressure regulator, hose or pipe

Component Inspection

■ Check PCV

1. IG "OFF" and remove PCV valve from rocker cover.
2. Insert a thin stick into the PCV valve from the threaded side and verify that the plunger is moving.
3. Is the PCV valve normally moving?

YES	▶ Go to "Check injector for normal operation" as follows.
NO	▶ Replace it, and go to "Verification of Vehicle Repair" procedure.

■ Check injector for normal operation

1. Start engine.
2. Check its RPM decrease when doing the injector's actuation test.
3. Is there any cylinder with no change in RPM or only a small change in RPM?

YES	▶ Clear DTC and Test-drive under enable conditions above-mentioned. After the test, If this DTC is set, go to "Inspection & Repair" procedure. If not, troubleshooting is completed.
NO	▶ Replace injector, and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2190 System too Rich at Idle (Bank 2)

General Description

In order to provide the best possible combination of drivability, fuel economy and emission control, the ECM uses a closed loop air/fuel metering system. The ECM monitors the HO2S signal voltage and adjusts fuel delivery based it in closed loop fuel control. Changes in fuel delivery will be indicated by the long-term and the short-term fuel trim values. The ideal fuel trim value is around 0%. The ECM will add fuel when the HO2S signal is indicating a lean condition. Additional fuel is indicated by fuel trim values that are above 0%. The ECM will reduce fuel when the HO2S signal is indicating a rich condition. Reduction in fuel is indicated by fuel trim values that are below 0%. The DTC relevant to fuel trim will be set when the amount reaches excessive levels because of a lean or rich condition.

DTC Description

Checking the fuel trime value at idle under detecting condition, if its average exceeds the limit over certain period, ECM sets P2190. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycles.

DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Monitor the fuel trim value at idle	• Blocking of intake system • Fuel leakage in injector • Improper fuel pressure
Enable Conditions	• Engine warm-up sufficiently • Engine running under Idle state over 5 minutes • 60°C(140°F) ≤ Engine coolant temperature ≤ 115°C(239°F) • No disabling faults (DTCs related to HO2S, purge valve,catalyst)	
Threshold value	• Average of long term fuel trim < 0.75	
Diagnosis Time	• Continuous	
MIL On Condition	• 2 Driving Cycles	

Monitor GDS Data

1. Monitor DTCs related to HO2S, MAFS, MAPS, ECTS, PCSV, Injector or CVVT items with GDS.
2. Are there the DTCs above-mentioned?

YES	▶ Do all repairs associated with those codes before proceeding with this procedure.
NO	▶ Go to "System Inspection" procedure

System Inspection

■ Check blocking of intake system

1. Visually/physically inspect the blocking in intake system for following items
   ▶ Throttle body gasket and damage
   ▶ Blocking in intake manifold and injector caused by any foreign substance
2. Has a problem found in this procedure?

YES	▶ Repair or replace it which has a problem, and go to "Verification of Vehicle Repair" procedure.
NO	▶ Go to " Check fuel pressure" as follows.

■ Check fuel pressure

NOTE

1. Be cautious that Fuel is explosive and an empty fuel tank can still contain explosive gases. When working on fuel system make sure to supply adequate ventilation to the work area. Do not smoke, and keep sparks and open flames away.
2. The fuel system remains under pressure when the engine is not running. Release fuel system pressure before disconnecting any fuel line to reduce the chance of presonal injury or fire damage to vehicle components.

1. IG "OFF" and disconnect Fuel Pump Relay in Junction Box.
2. Start-up and wait until it stops itself.
3. IG "OFF" and connect Fuel Pump Relay.
4. Install the fuel pressure gauge to the delivery pipe with the fuel pressure gauge adaptor.
5. Activate the fuel pump, and with fuel pressure applied, check that there is no fuel leakage from the pressure gauge or connection part.
6. Measure the fuel pressure at idle.

   Specification : 373.6 ~ 387.4 kPa(3.81 ~ 3.95 kg/cm², 54.2 ~ 56.1 psi)

7. Is the measured fuel pressure within specifications ?

YES	▶ Go to "Check fuel leakage in injector" as follow.
NO	▶ Repair or replace according to the below table. And then, go to " Verification of Vehicle Repair" procedure.

Condition	Possible Cause
Fuel Pressure is too low	Fuel filter,fuel pressure regulator, in-tank fuel hose or the fuel pump
Fuel Pressure is too high	Fuel pressure regulator, hose or pipe

■ Check fuel leakage in injector

1. IG "OFF" after checking the fuel pressure test.
2. Stop engine and check for a change in the fuel pressure gauge reading for 5 minutes.

   Specification : After engine stops, fuel gauge reading is maintained for 5 minutes.

3. Is the fuel gauge reading maintained ?

YES	▶ Clear DTC and Test-drive under enable conditions above-mentioned. After the test, If this DTC is set, go to "Inspection & Repair" procedure. If not, troubleshooting is completed.
NO	▶ There is a fuel leakage in injector. Replace it, and go to " Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

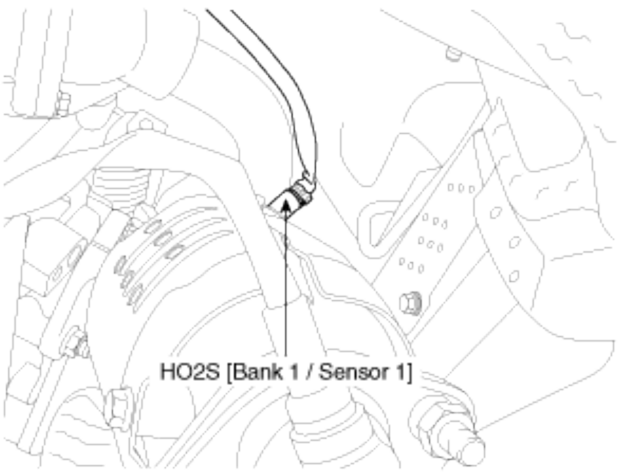
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.

4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2195 O2 Sensor Signal Stuck Lean (Bank 1 Sensor 1)

Component Location



General Description

In order to control emissions of the CO, HC and NOx components of the exhaust gas, heated oxygen sensor (HO2S), mounted on the front side and rear side of catalytic converter, detects the oxygen content in the exhaust gas. The front HO2S signal is used to control air/fuel ratio (closed loop fuel control) and the rear HO2S signal is used to monitor front HO2S and catalyst for proper operation. The HO2S requires a minimum temperature to operate properly and provide a closed loop fuel control system. The HO2S contains the heater element to reduce its warming-up time and ensure its performance during all driving conditions. The oxygen sensor generates a voltage that indicates the difference between the oxygen content of the exhaust stream and the oxygen content of ambient air. When the exhaust stream is “rich,” there is more oxygen in the ambient air than in the exhaust stream, so the voltage will be higher.

DTC Description

Checking output signals from HO2S under detecting condition, if HO2S's signal is lean during power enrichment conditions, ECM sets P2195. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycles.

DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Monitor HO2S's signal	
Enable Conditions	• Battery voltage ≥ 10V • Engine running ≥ 60sec. • Power Enrichment conditions • Engine warm-up state	• Poor Connection • Faulty HO2S

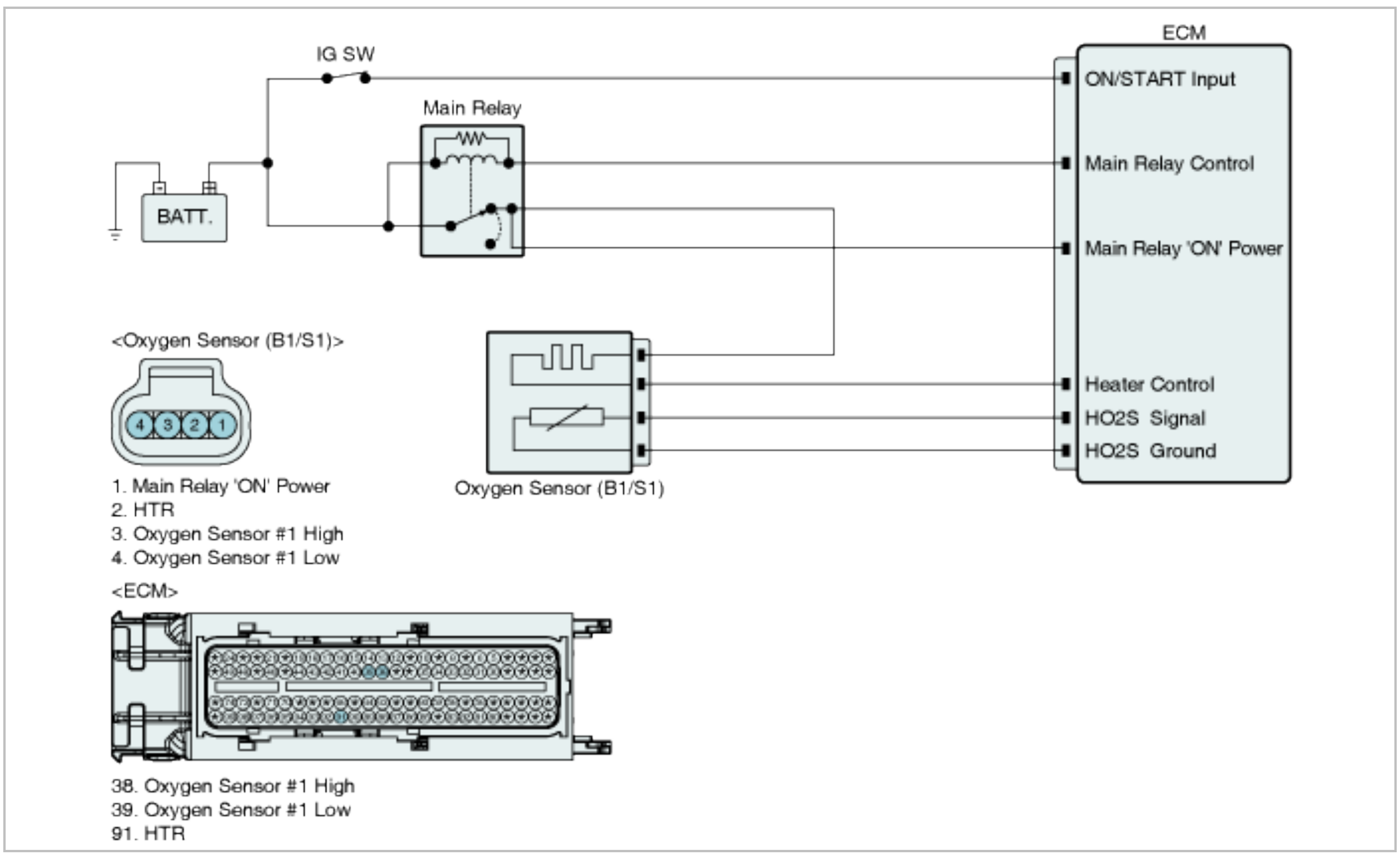
	• Not in Transient Conditions	• Clogging of fuel filter in fuel pump • Faulty ECM
Threshold value	• HO2S's signal < 0.35V and Air Fuel Ratio ≤ 13.5	
Diagnosis Time	• Continuous (More than 8 sec. failure for every 9 sec. Test)	
MIL On Condition	• 2 Driving Cycles	

Specification

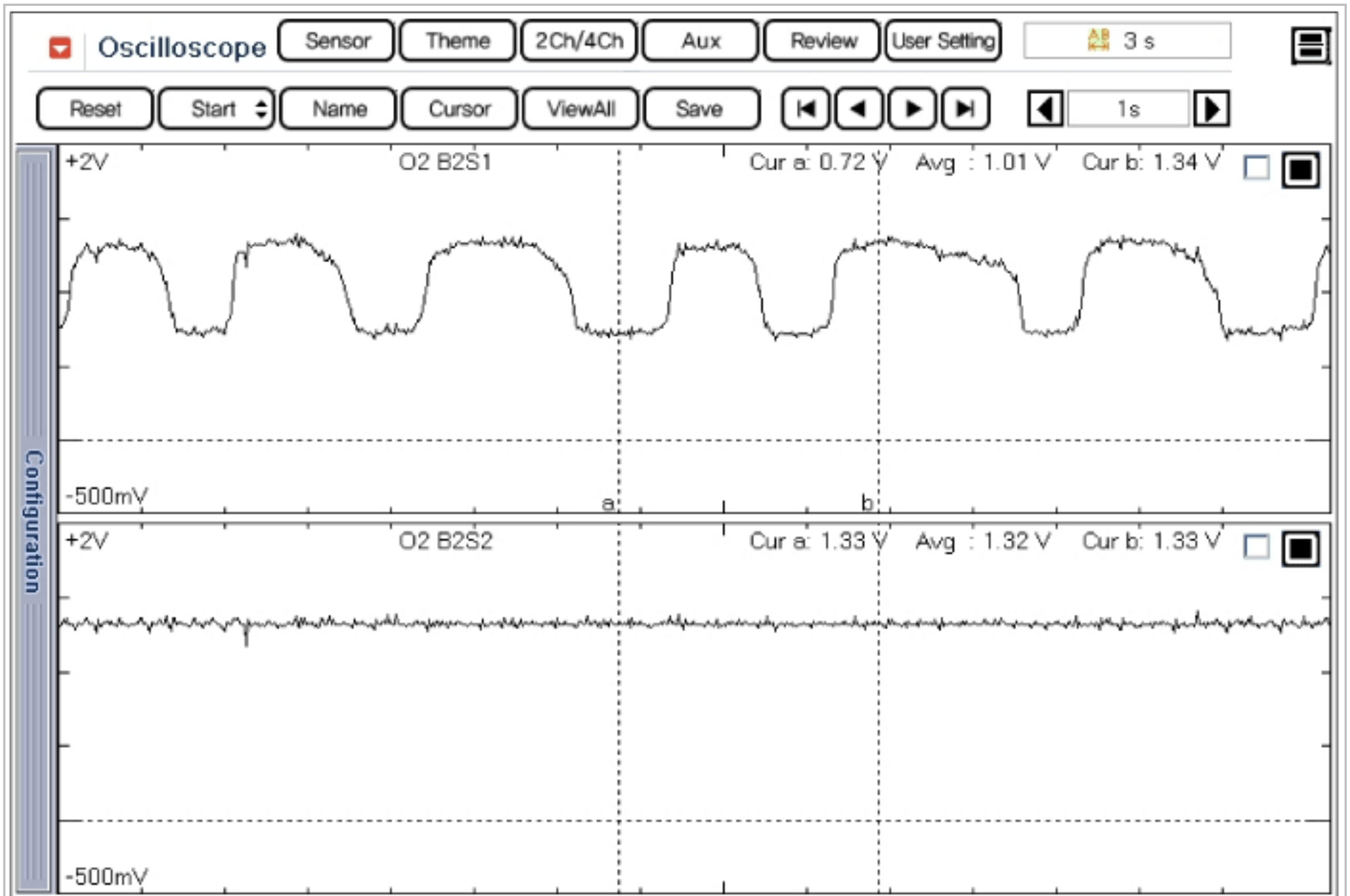
(Reference only)

Test Condition	HO2S Voltage(Sensor1)	HO2S Voltage(Sensor2)
HO2S Signal at idle after warm-up	Signal is commonly switching from rich to lean more than 3 times in 10 sec.	Signal is commonly above 0.6V.
HO2S signal at open circuit (Pumping current OFF)	Approx. 0.45V	
HO2S signal at open circuit (Pumping current ON)	Approx. 2.2V	

Diagnostic Circuit Diagram



Signal Waveform & Data


Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
3 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 0.72 V
Avg : 1.01 V
Cur b: 1.34 V
-500mV
a
b
+2V
O2 B2S2
Cur a: 1.33 V
Avg : 1.32 V
Cur b: 1.33 V
-500mV
Fig.1

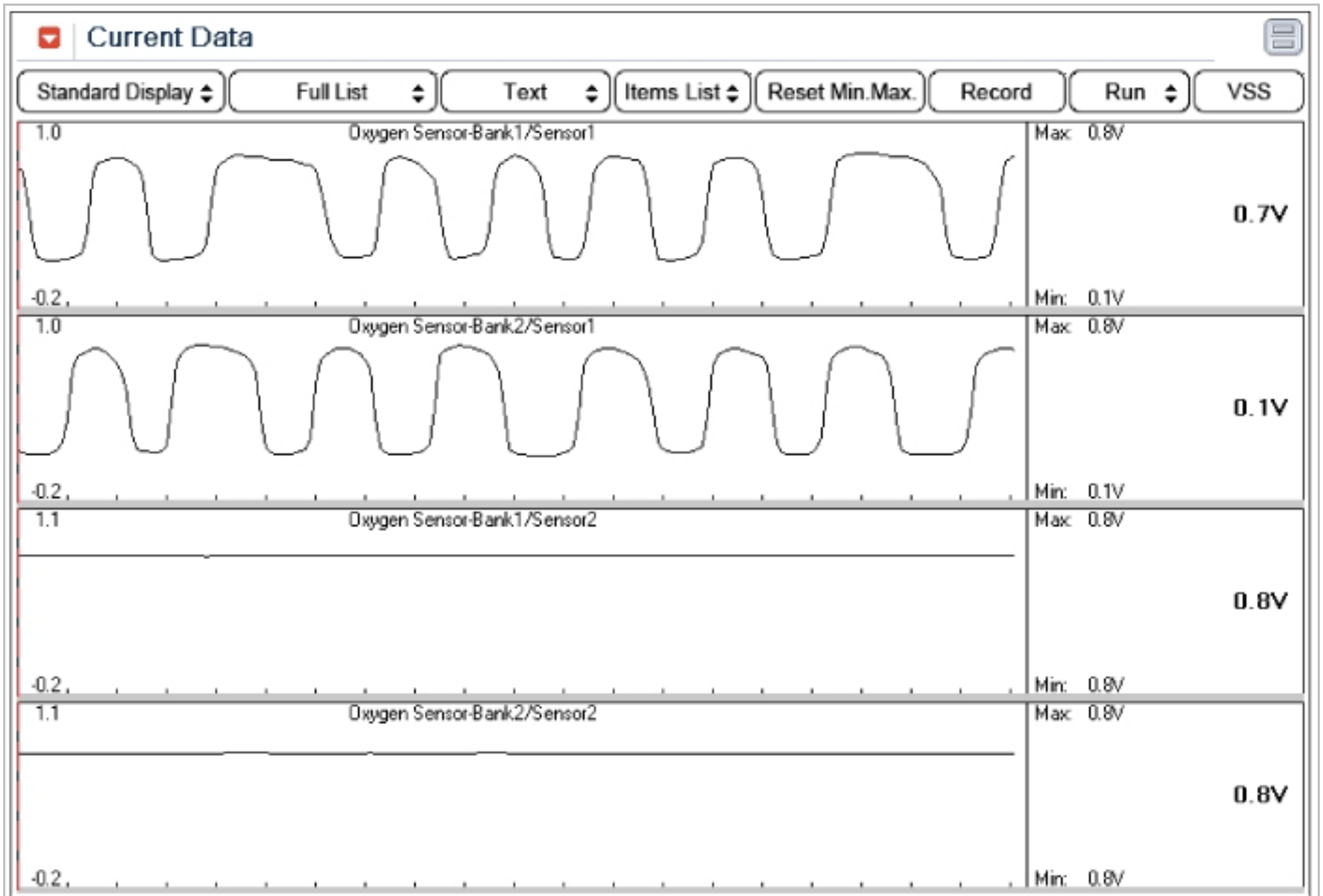
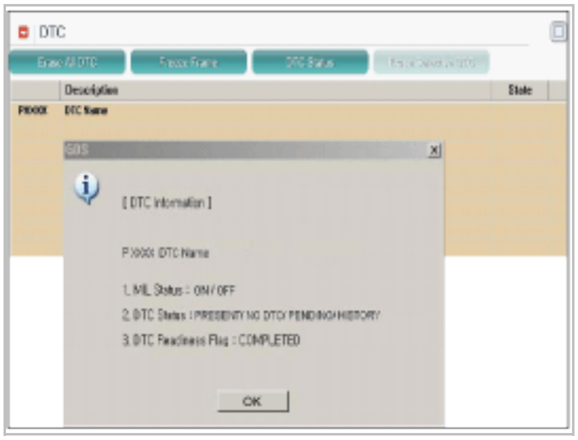


Fig.2

Fig.1) Normal waveforms of front HO2S(the upper) and rear HO2S(the lower)
Fig.2) Normal graph of front HO2S and rear HO2S at idle.
After warming-up, if accelerator pedal is released suddenly around 4000rpm, the HO2S signal reading will be lower than 200mV resulting from Fuel cut-off for the moment. Conversely, if suddenly accelerator pedal is depressed, HO2S signal reading will be around 0.6V ~1.0V. At idle, Normally HO2S signal will switch from lean to rich with 3 Hz. And as racing, Its frequency rises.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Component Inspection

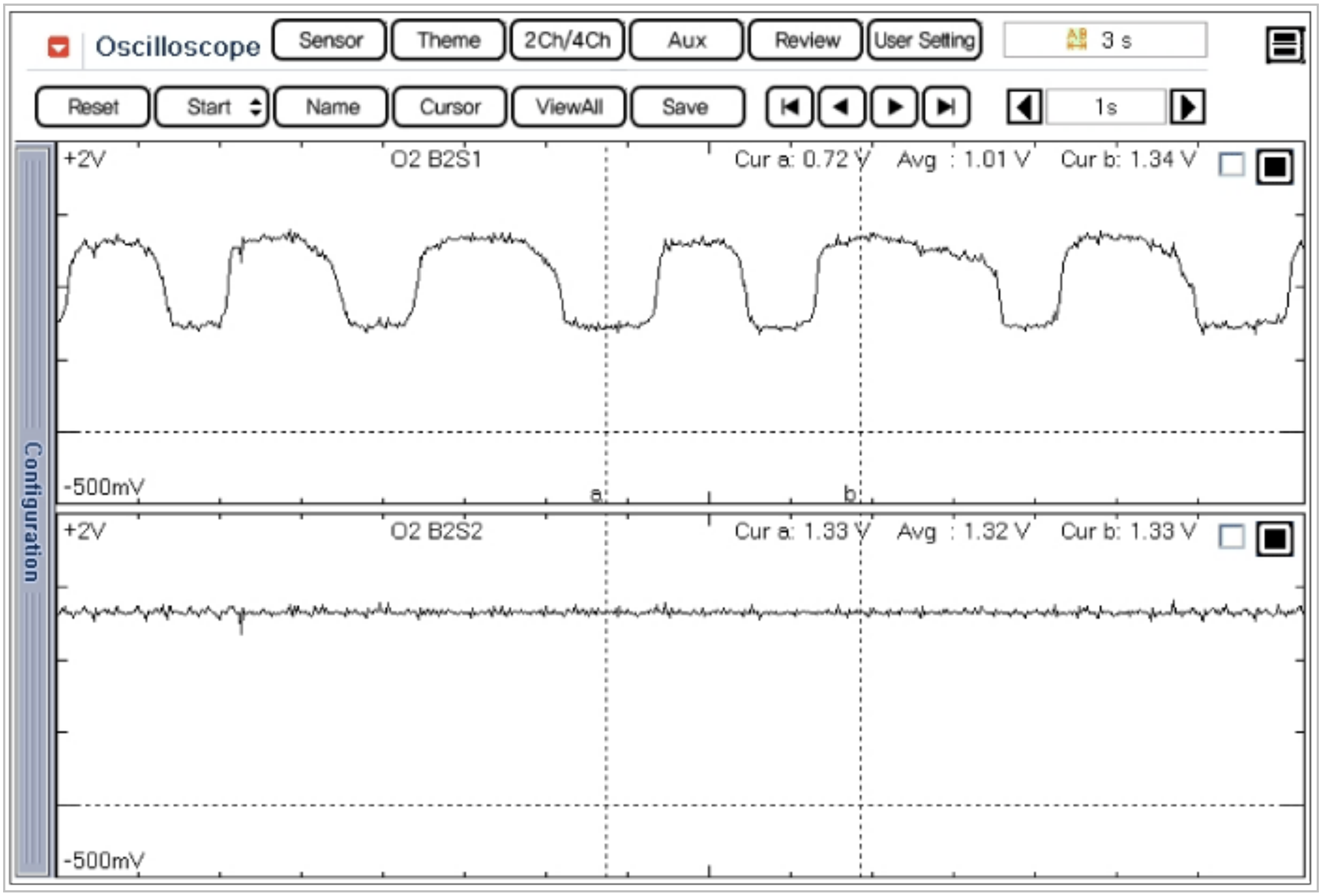
■ Check the condition of HO2S

1. Check HO2S for poor connection or loose terminal.
2. Check if HO2S is ensurely installed.
3. Is the conditions of HO2S normal ?

YES	▶ Go to "Check the Signal waveform of HO2S" as follows.
NO	▶ Repair it and then go to "Verification of Vehicle Repair" procedure.

■ Check the Signal waveform of HO2S

1. IG "OFF" and connect HO2S connector.
2. Engine start.
3. After warming-up, monitor signal waveform of HO2S with GDS.



4. Is the sensor switching properly?

YES	▶ Go to "Check fuel filter" as follows.
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

■ Check the fuel filter of fuel pump

1. IG "OFF" and disconnect the fuel pump connector.
2. Start the engine and wait until fuel in fuel line is exhausted. After the engine stalls, IG "OFF"
3. Remove the fuel pump assembly.
4. Check the fuel filter for clogging by dust, a foreign substance.
5. Is the fuel filter O.K.?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good fuel filter and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

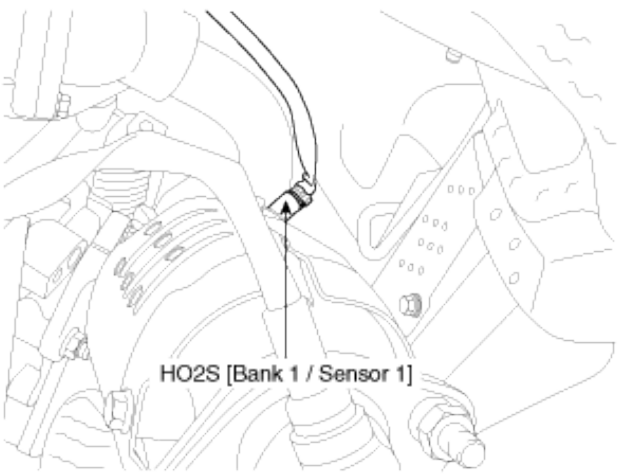
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2196 O2 Sensor Signal Stuck Rich (Bank 1 Sensor 1)

Component Location



General Description

In order to control emissions of the CO, HC and NOx components of the exhaust gas, heated oxygen sensor (HO2S), mounted on the front side and rear side of catalytic converter, detects the oxygen content in the exhaust gas. The front HO2S signal is used to control air/fuel ratio (closed loop fuel control) and the rear HO2S signal is used to monitor front HO2S and catalyst for proper operation. The HO2S requires a minimum temperature to operate properly and provide a closed loop fuel control system. The HO2S contains the heater element to reduce its warming-up time and ensure its performance during all driving conditions. The oxygen sensor generates a voltage that indicates the difference between the oxygen content of the exhaust stream and the oxygen content of ambient air. When the exhaust stream is “rich,” there is more oxygen in the ambient air than in the exhaust stream, so the voltage will be higher.

DTC Description

Checking output signals from HO2S under detecting condition, if HO2S's signal is rich during fuel cut-off conditions, ECM sets P2196. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycles.

DTC Detecting Condition

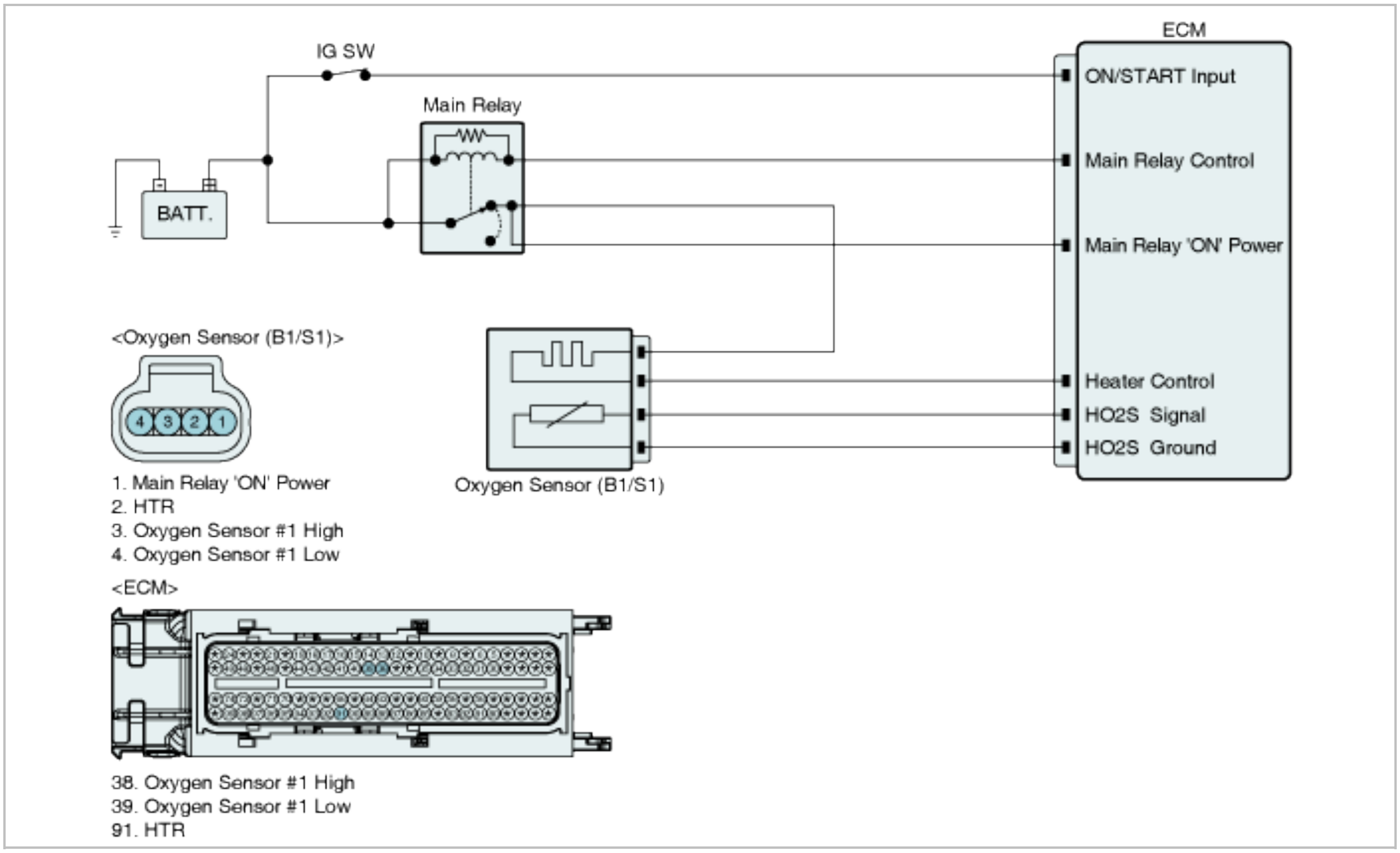
Item	Detecting Condition	Possible cause
DTC Strategy	• Monitor HO2S's signal	• Poor Connection • Faulty HO2S • Faulty ECM
Enable Conditions	• Battery voltage ≥ 10V • Engine running ≥ 60sec. • Fuel cut-off conditions • Engine warm-up state • Not in Transient Conditions	
Threshold value	• HO2S's signal > 0.42V	
Diagnosis Time	• Continuous (More than 8 sec. failure for every 9 sec. Test)	
MIL On Condition	• 2 Driving Cycles	

Specification

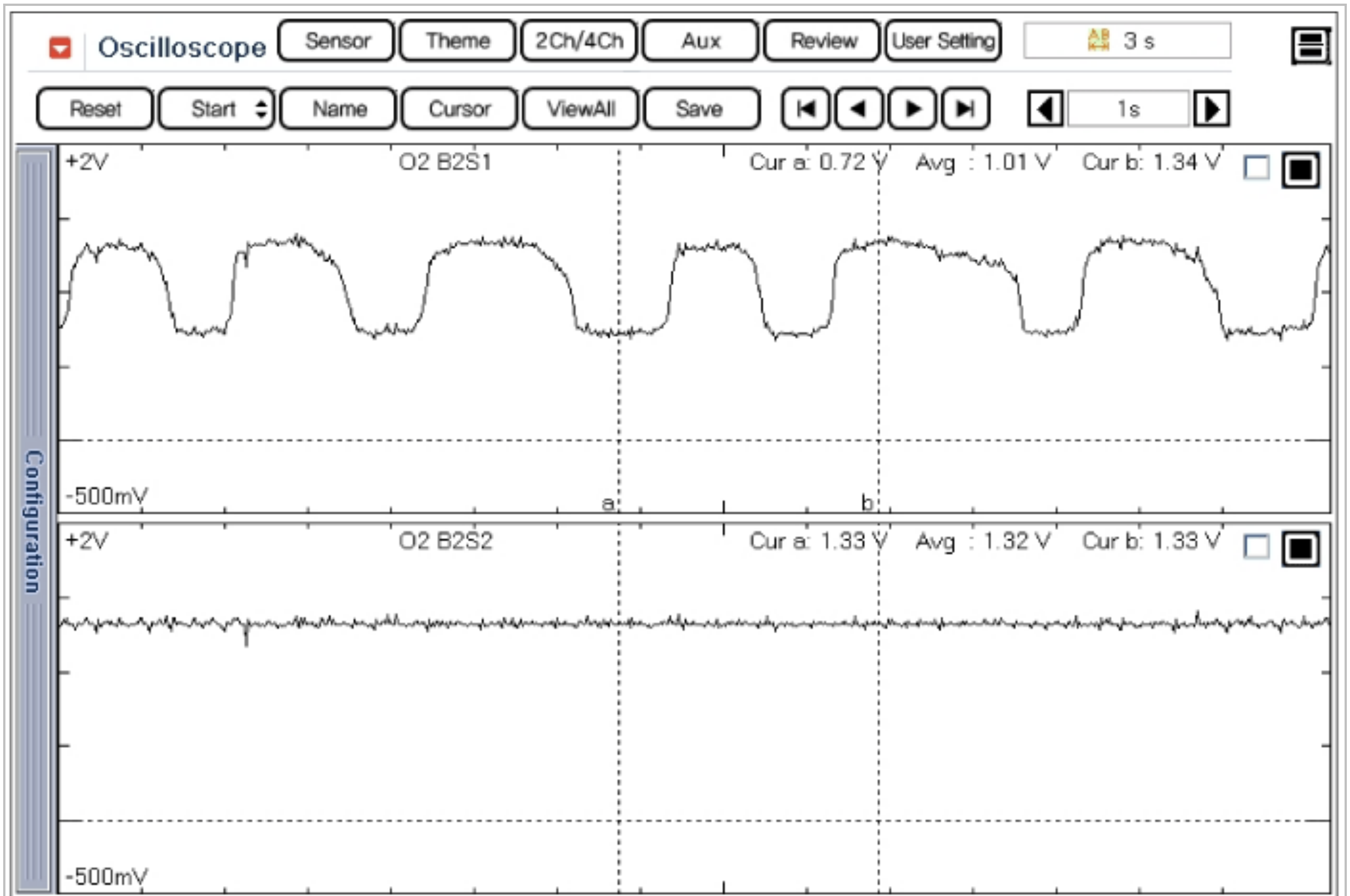
(Reference only)

Test Condition	HO2S Voltage(Sensor1)	HO2S Voltage(Sensor2)
HO2S Signal at idle after warm-up	Signal is commonly switching from rich to lean more than 3 times in 10 sec.	Signal is commonly above 0.6V.
HO2S signal at open circuit (Pumping current OFF)	Approx. 0.45V	
HO2S signal at open circuit (Pumping current ON)	Approx. 2.2V	

Diagnostic Circuit Diagram



Signal Waveform & Data


Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
3 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 0.72 V
Avg : 1.01 V
Cur b: 1.34 V
-500mV
a
b
+2V
O2 B2S2
Cur a: 1.33 V
Avg : 1.32 V
Cur b: 1.33 V
-500mV
Fig.1

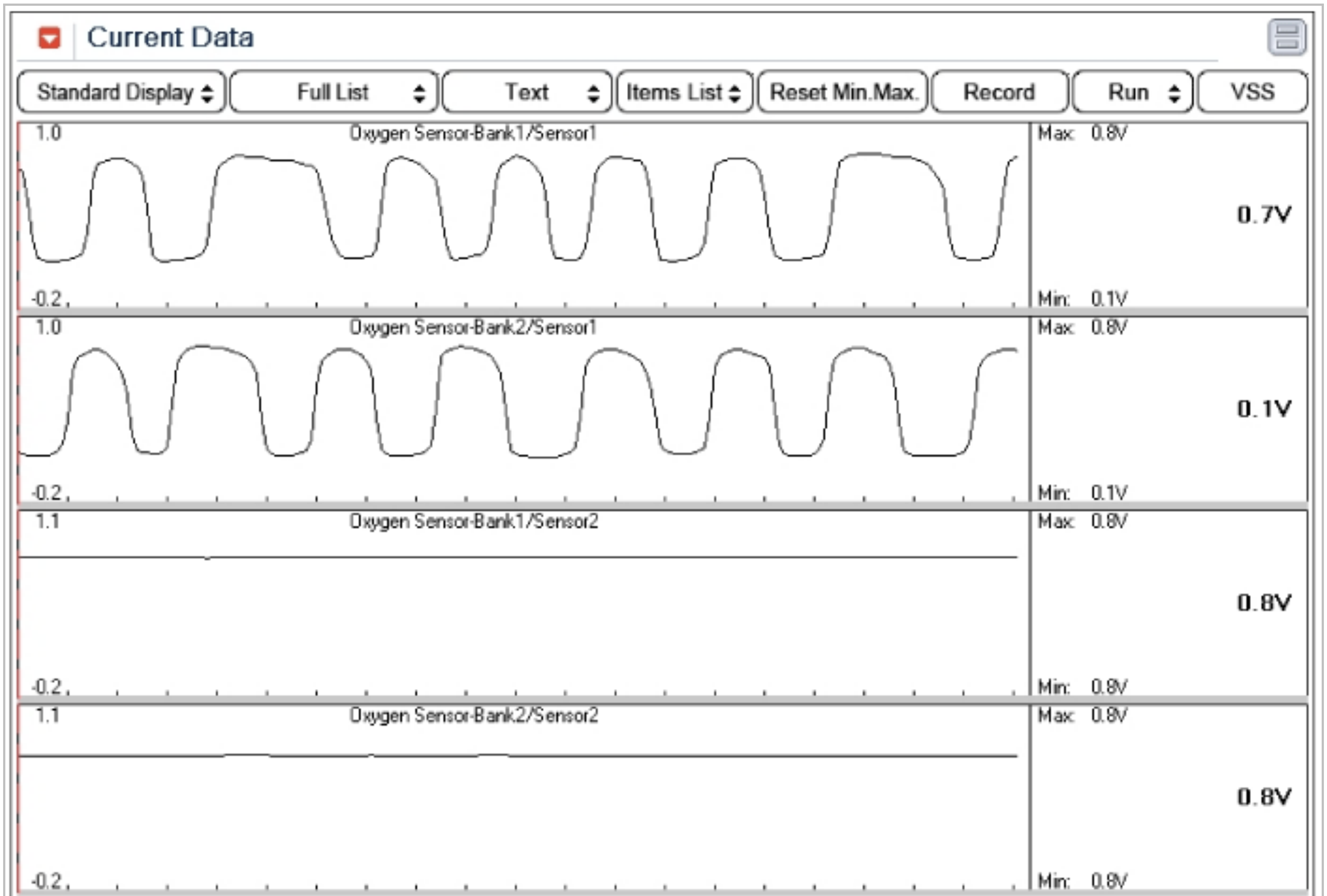
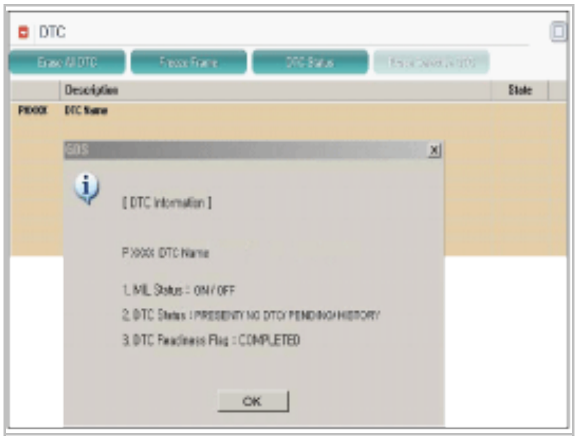


Fig.2

Fig.1) Normal waveforms of front HO2S(the upper) and rear HO2S(the lower)
Fig.2) Normal graph of front HO2S and rear HO2S at idle.
After warming-up, if accelerator pedal is released suddenly around 4000rpm, the HO2S signal reading will be lower than 200mV resulting from Fuel cut-off for the moment. Conversely, if suddenly accelerator pedal is depressed, HO2S signal reading will be around 0.6V ~1.0V. At idle, Normally HO2S signal will switch from lean to rich with 3 Hz. And as racing, Its frequency rises.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Component Inspection

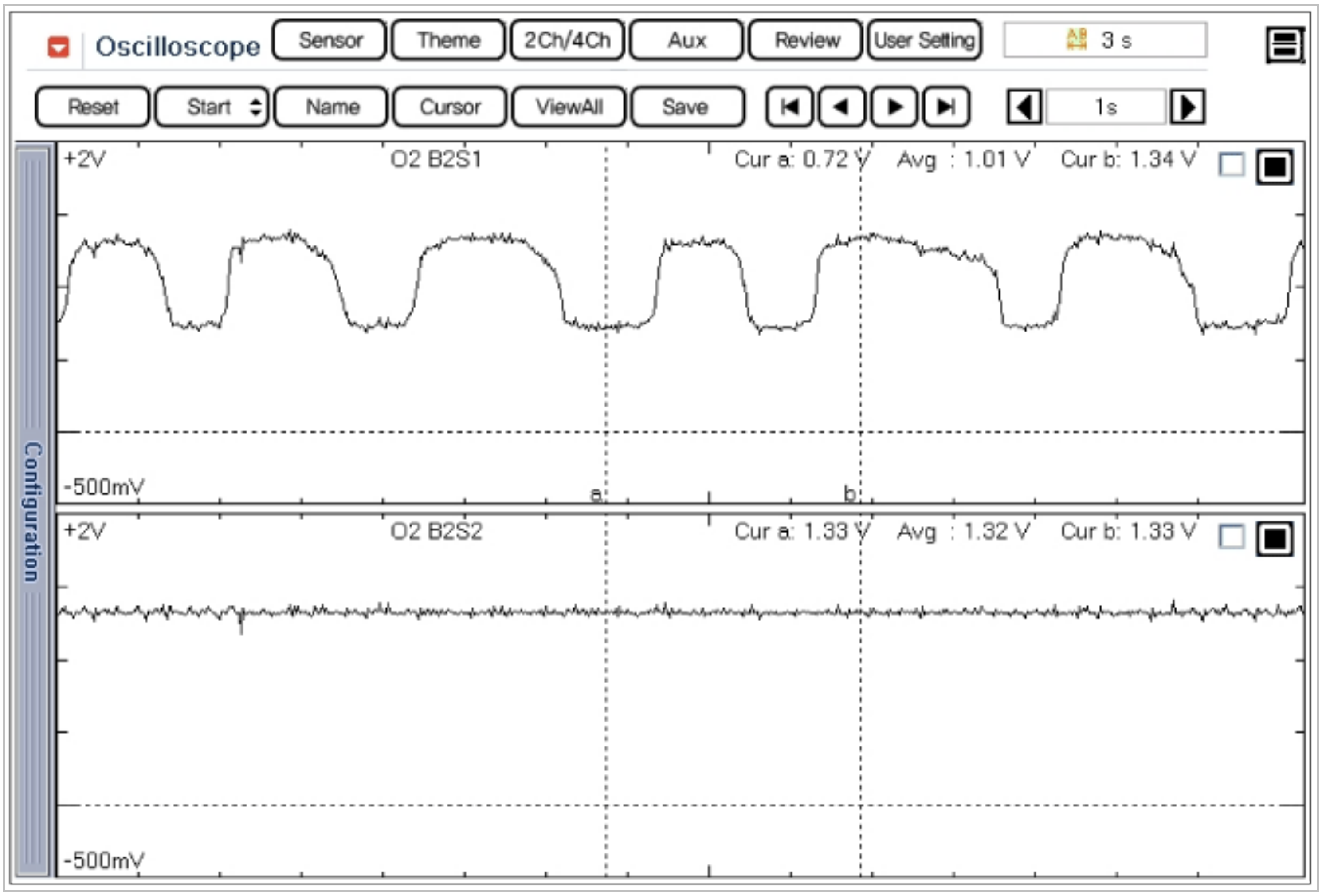
■ Check the condition of HO2S

1. Check HO2S for poor connection or loose terminal.
2. Check if HO2S is ensurely installed.
3. Is the conditions of HO2S normal ?

YES	▶ Go to "Check the Signal waveform of HO2S" as follows.
NO	▶ Repair it and then go to "Verification of Vehicle Repair" procedure.

■ Check the Signal waveform of HO2S

1. IG "OFF" and connect HO2S connector.
2. Engine start.
3. After warming-up, monitor signal waveform of HO2S with GDS.



4. Is the sensor switching properly?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

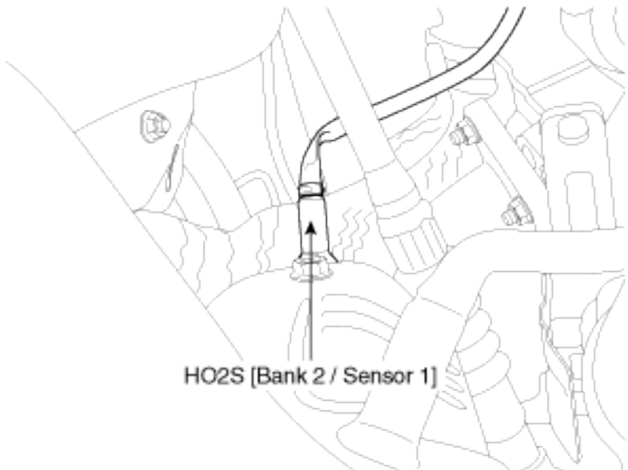
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.

NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2197 O2 Sensor Signal Stuck Lean (Bank 2 Sensor 1)

Component Location



General Description

In order to control emissions of the CO, HC and NOx components of the exhaust gas, heated oxygen sensor (HO2S), mounted on the front side and rear side of catalytic converter, detects the oxygen content in the exhaust gas. The front HO2S signal is used to control air/fuel ratio (closed loop fuel control) and the rear HO2S signal is used to monitor front HO2S and catalyst for proper operation. The HO2S requires a minimum temperature to operate properly and provide a closed loop fuel control system. The HO2S contains the heater element to reduce its warming-up time and ensure its performance during all driving conditions. The oxygen sensor generates a voltage that indicates the difference between the oxygen content of the exhaust stream and the oxygen content of ambient air. When the exhaust stream is “rich,” there is more oxygen in the ambient air than in the exhaust stream, so the voltage will be higher.

DTC Description

Checking output signals from HO2S under detecting condition, if HO2S's signal is lean during power enrichment conditions, ECM sets P2197. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycles.

DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Monitor HO2S's signal	• Poor Connection • Faulty HO2S • Clogging of fuel filter in fuel pump • Faulty ECM
Enable Conditions	• Battery voltage ≥ 10V • Engine running ≥ 60sec. • Power Enrichment conditions • Engine warm-up state • Not in Transient Conditions	
Threshold value	• HO2S's signal < 0.35V and Air Fuel Ratio ≤ 13.5	

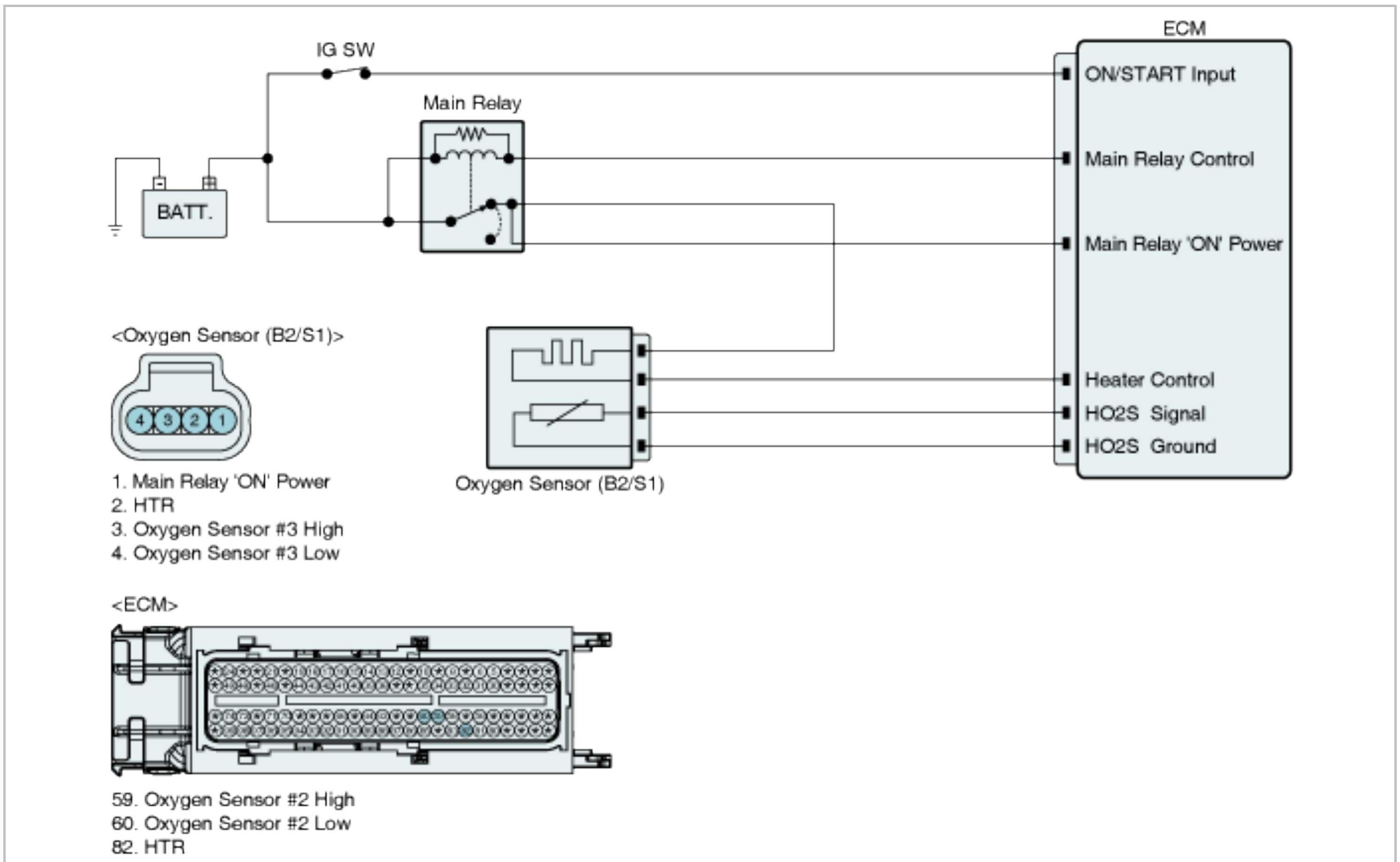
Diagnosis Time	• Continuous (More than 8 sec. failure for every 9 sec. Test)	
MIL On Condition	• 2 Driving Cycles	

Specification

(Reference only)

Test Condition	HO2S Voltage(Sensor1)	HO2S Voltage(Sensor2)
HO2S Signal at idle after warm-up	Signal is commonly switching from rich to lean more than 3 times in 10 sec.	Signal is commonly above 0.6V.
HO2S signal at open circuit (Pumping current OFF)	Approx. 0.45V	
HO2S signal at open circuit (Pumping current ON)	Approx. 2.2V	

Diagnostic Circuit Diagram



Signal Waveform & Data

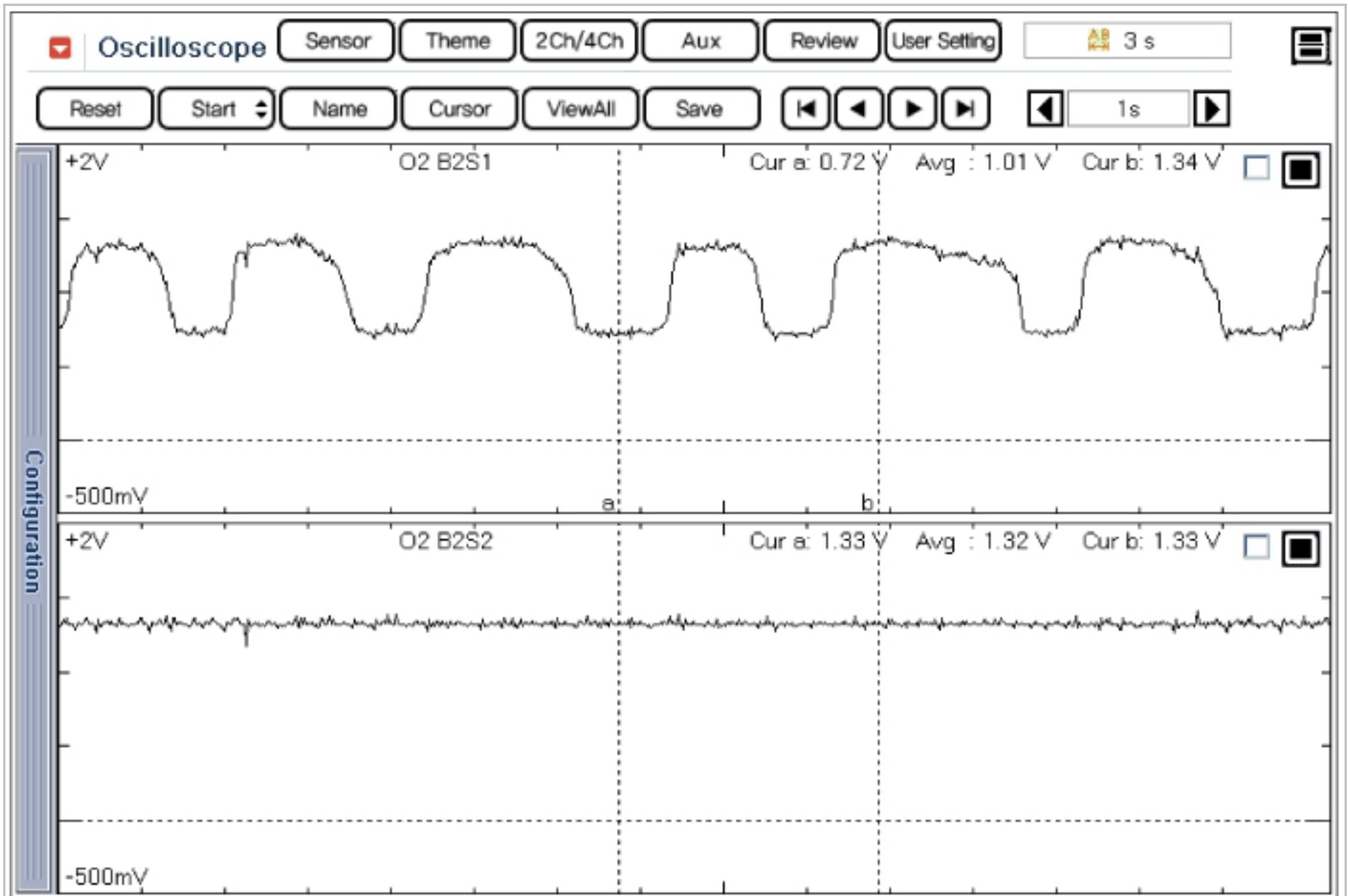

Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
3 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 0.72 V
Avg : 1.01 V
Cur b: 1.34 V
-500mV
a
b
+2V
O2 B2S2
Cur a: 1.33 V
Avg : 1.32 V
Cur b: 1.33 V
-500mV

Fig.1

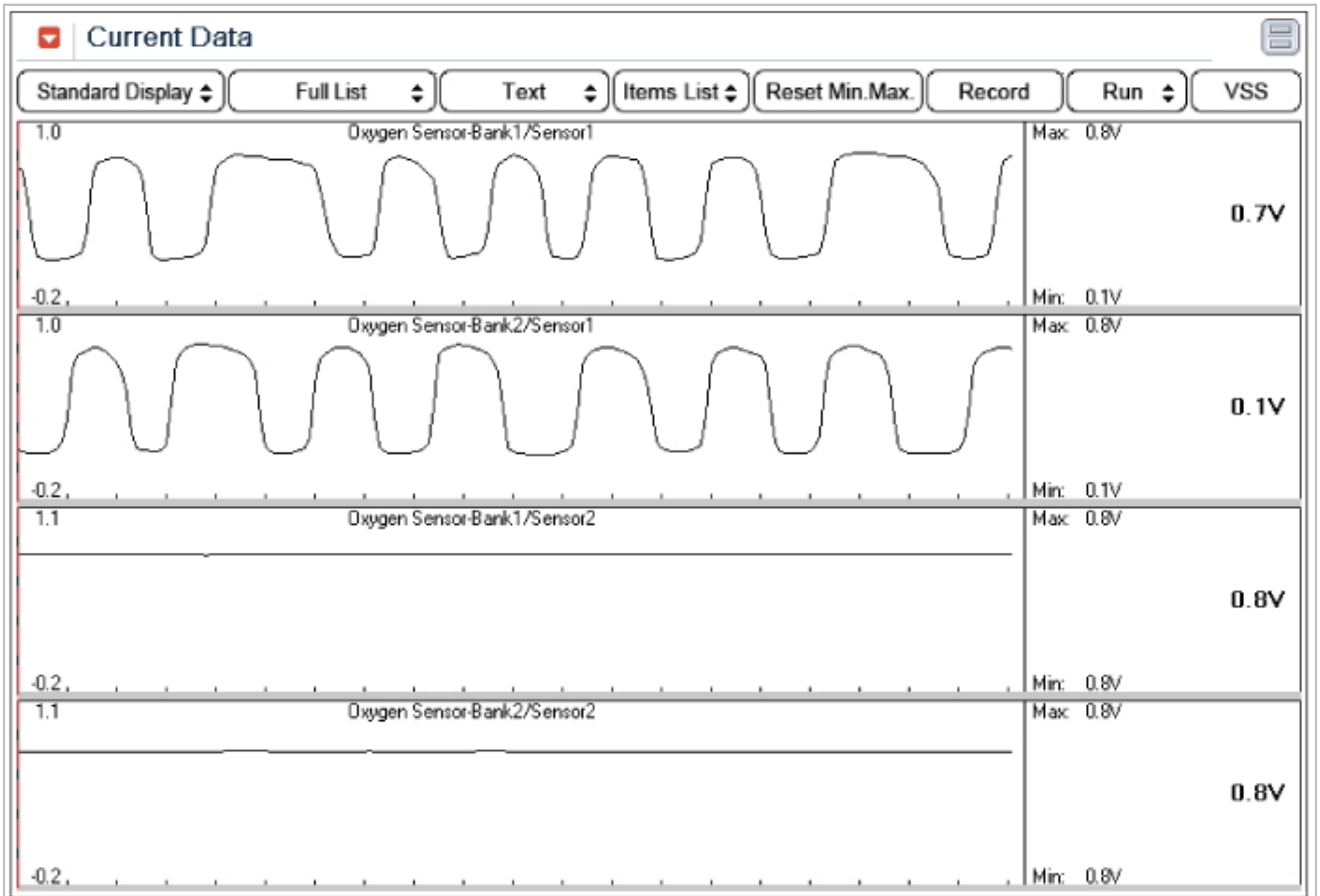


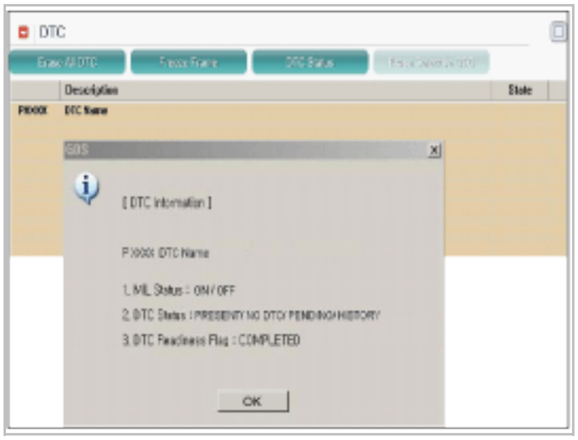
Fig.2

Fig.1) Normal waveforms of front HO2S(the upper) and rear HO2S(the lower)
Fig.2) Normal graph of front HO2S and rear HO2S at idle.

After warming-up, if accelerator pedal is released suddenly around 4000rpm, the HO2S signal reading will be lower than 200mV resulting from Fuel cut-off for the moment. Conversely, if suddenly accelerator pedal is depressed, HO2S signal reading will be around 0.6V ~1.0V. At idle, Normally HO2S signal will switch from lean to rich with 3 Hz. And as racing, Its frequency rises.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor’s and/or ECM’s connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Component Inspection

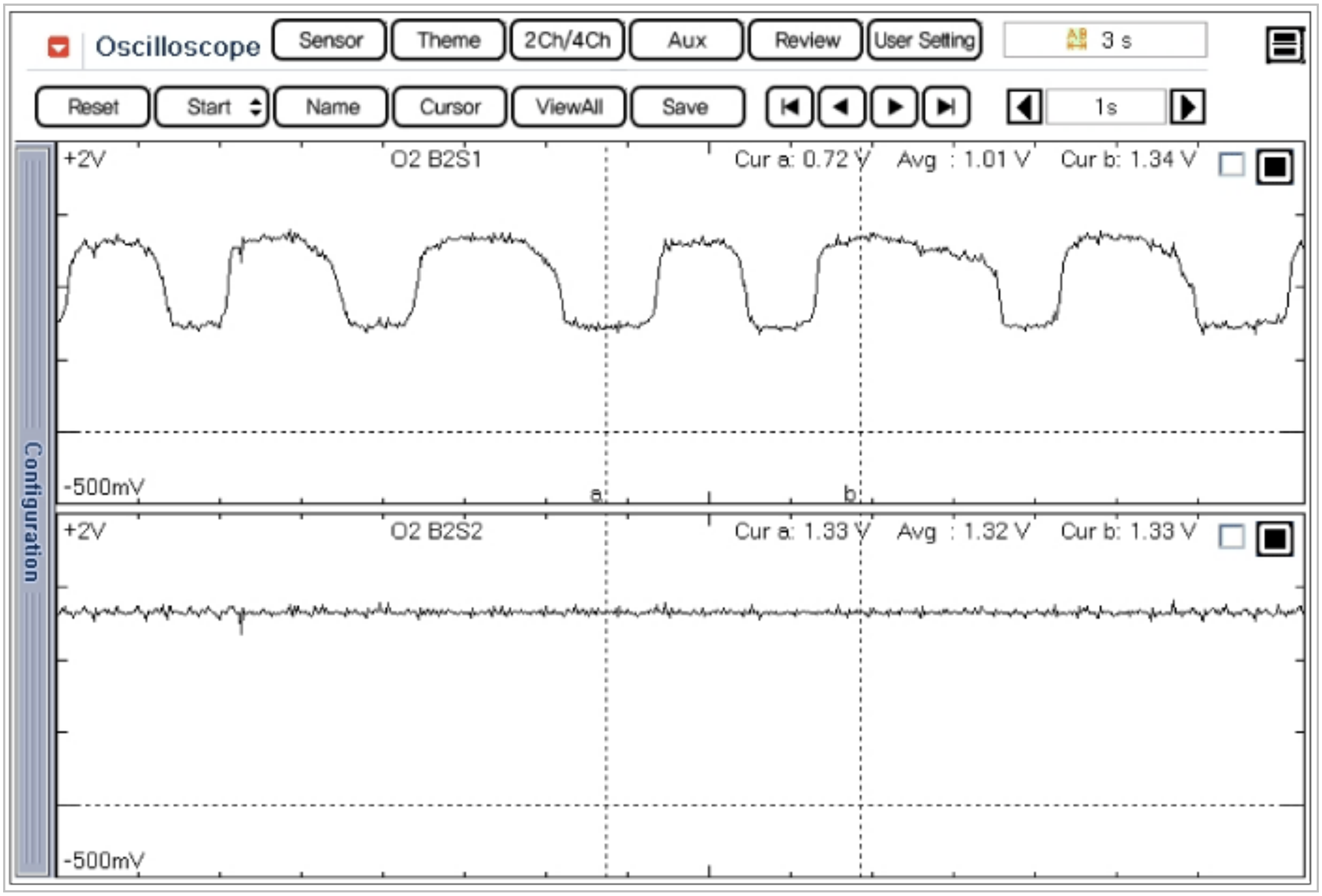
■ Check the condition of HO2S

1. Check HO2S for poor connection or loose terminal.
2. Check if HO2S is ensurely installed.
3. Is the conditions of HO2S normal ?

YES	▶ Go to "Check the Signal waveform of HO2S" as follows.
NO	▶ Repair it and then go to "Verification of Vehicle Repair" procedure.

■ Check the Signal waveform of HO2S

1. IG "OFF" and connect HO2S connector.
2. Engine start.
3. After warming-up, monitor signal waveform of HO2S with GDS.



4. Is the sensor switching properly?

YES	▶ Go to "Check fuel filter" as follows.
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

■ Check the fuel filter of fuel pump

1. IG "OFF" and disconnect the fuel pump connector.
2. Start the engine and wait until fuel in fuel line is exhausted. After the engine stalls, IG "OFF"
3. Remove the fuel pump assembly.
4. Check the fuel filter for clogging by dust, a foreign substance.
5. Is the fuel filter O.K.?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good fuel filter and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

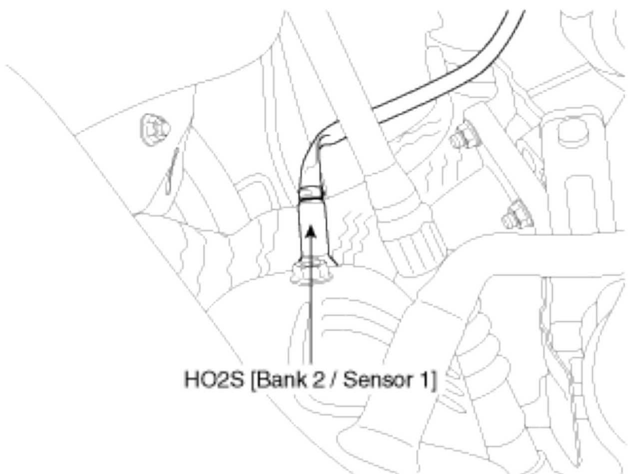
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2198 O2 Sensor Signal Stuck Rich (Bank 2 Sensor 1)

Component Location



General Description

In order to control emissions of the CO, HC and NOx components of the exhaust gas, heated oxygen sensor (HO2S), mounted on the front side and rear side of catalytic converter, detects the oxygen content in the exhaust gas. The front HO2S signal is used to control air/fuel ratio (closed loop fuel control) and the rear HO2S signal is used to monitor front HO2S and catalyst for proper operation. The HO2S requires a minimum temperature to operate properly and provide a closed loop fuel control system. The HO2S contains the heater element to reduce its warming-up time and ensure its performance during all driving conditions. The oxygen sensor generates a voltage that indicates the difference between the oxygen content of the exhaust stream and the oxygen content of ambient air. When the exhaust stream is “rich,” there is more oxygen in the ambient air than in the exhaust stream, so the voltage will be higher.

DTC Description

Checking output signals from HO2S under detecting condition, if HO2S's signal is rich during fuel cut-off conditions, ECM sets P2198. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycles.

DTC Detecting Condition

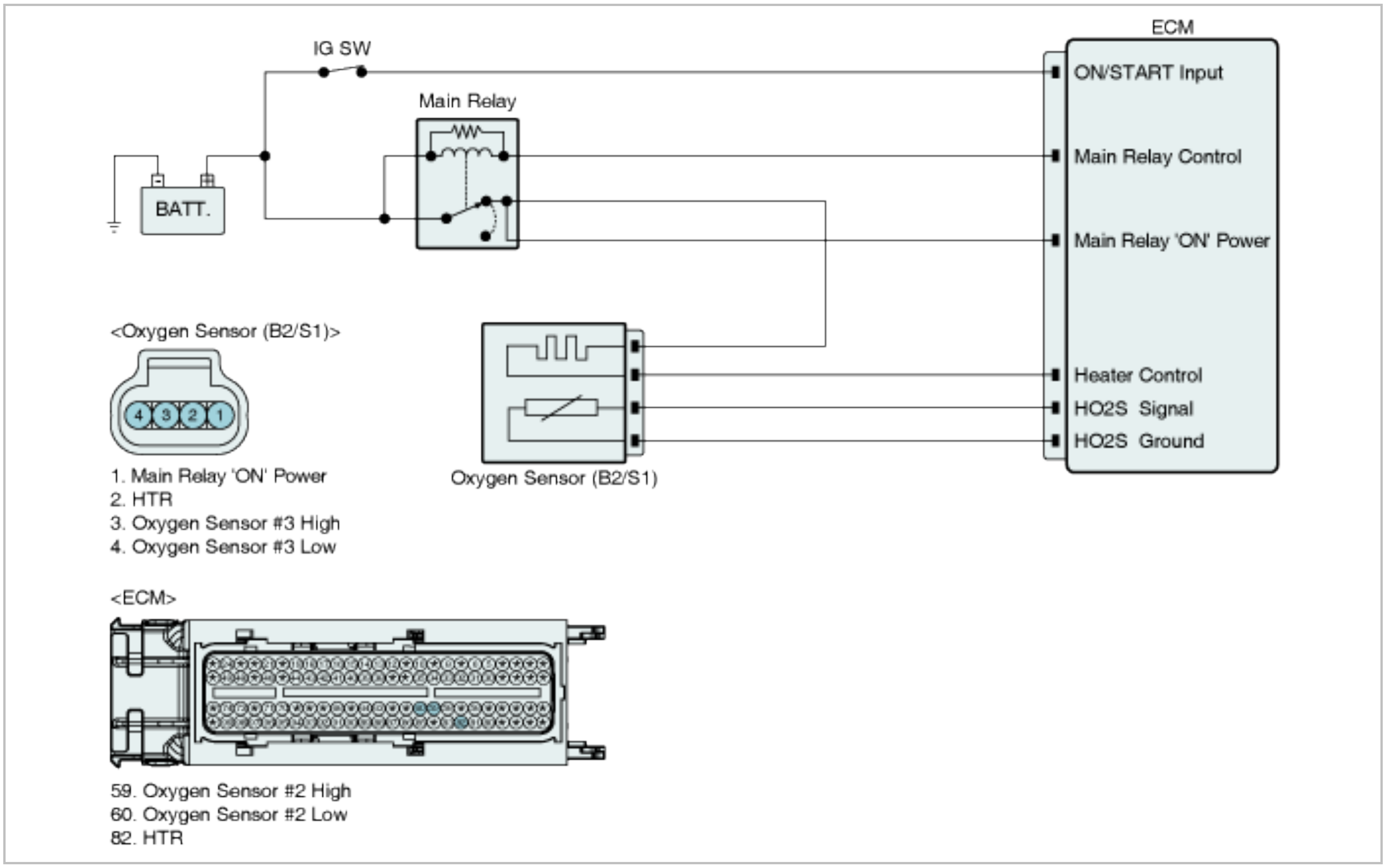
Item	Detecting Condition	Possible cause
DTC Strategy	• Monitor HO2S's signal	• Poor Connection • Faulty HO2S • Faulty ECM
Enable Conditions	• Battery voltage ≥ 10V • Engine running ≥ 60sec. • Fuel cut-off conditions • Engine warm-up state • Not in Transient Conditions	
Threshold value	• HO2S's signal > 0.42V	
Diagnosis Time	• Continuous (More than 8 sec. failure for every 9 sec. Test)	
MIL On Condition	• 2 Driving Cycles	

Specification

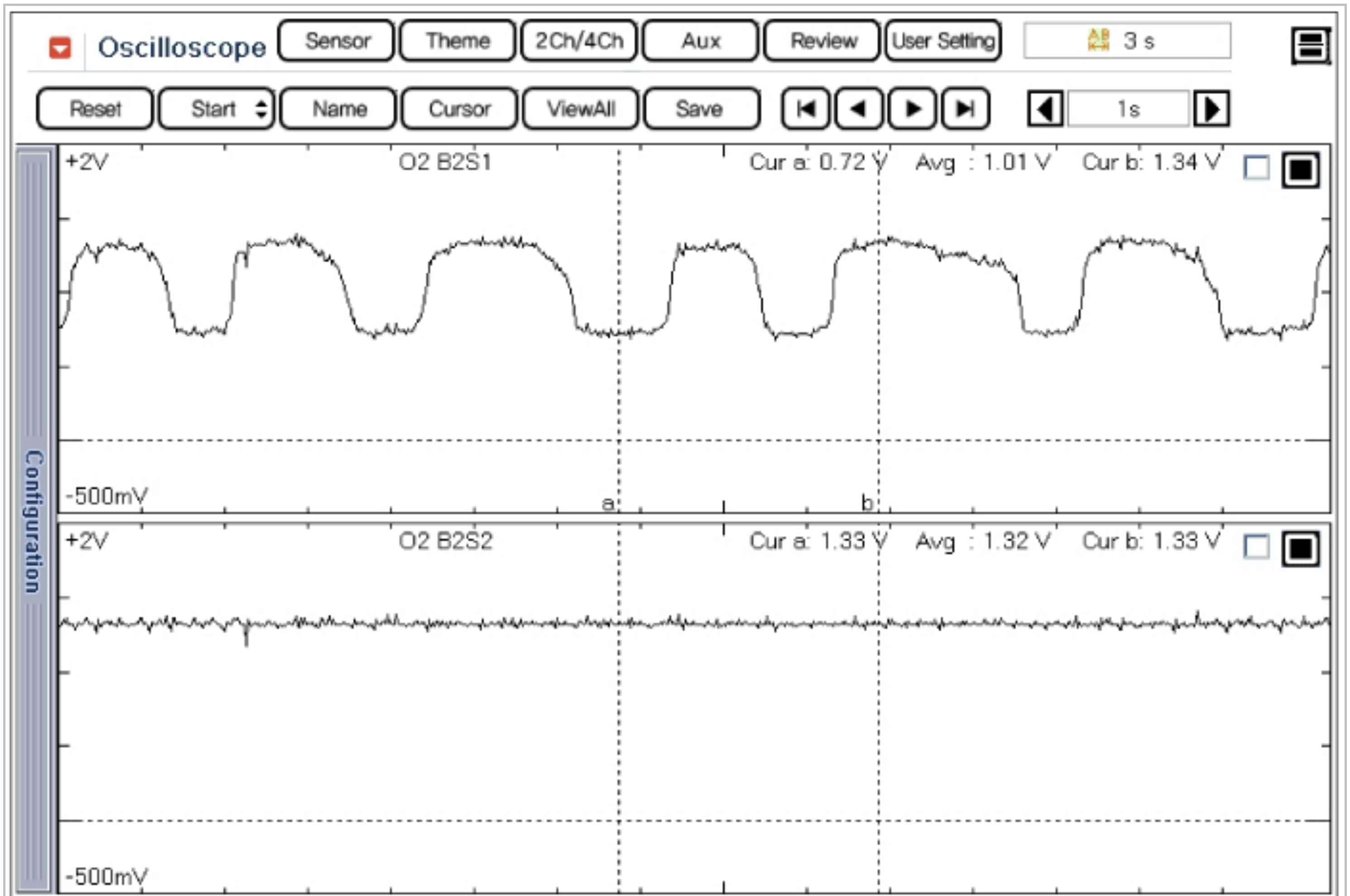
(Reference only)

Test Condition	HO2S Voltage(Sensor1)	HO2S Voltage(Sensor2)
HO2S Signal at idle after warm-up	Signal is commonly switching from rich to lean more than 3 times in 10 sec.	Signal is commonly above 0.6V.
HO2S signal at open circuit (Pumping current OFF)	Approx. 0.45V	
HO2S signal at open circuit (Pumping current ON)	Approx. 2.2V	

Diagnostic Circuit Diagram



Signal Waveform & Data



Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
3 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 0.72 V
Avg : 1.01 V
Cur b: 1.34 V
-500mV
a
b
+2V
O2 B2S2
Cur a: 1.33 V
Avg : 1.32 V
Cur b: 1.33 V
-500mV

Fig.1

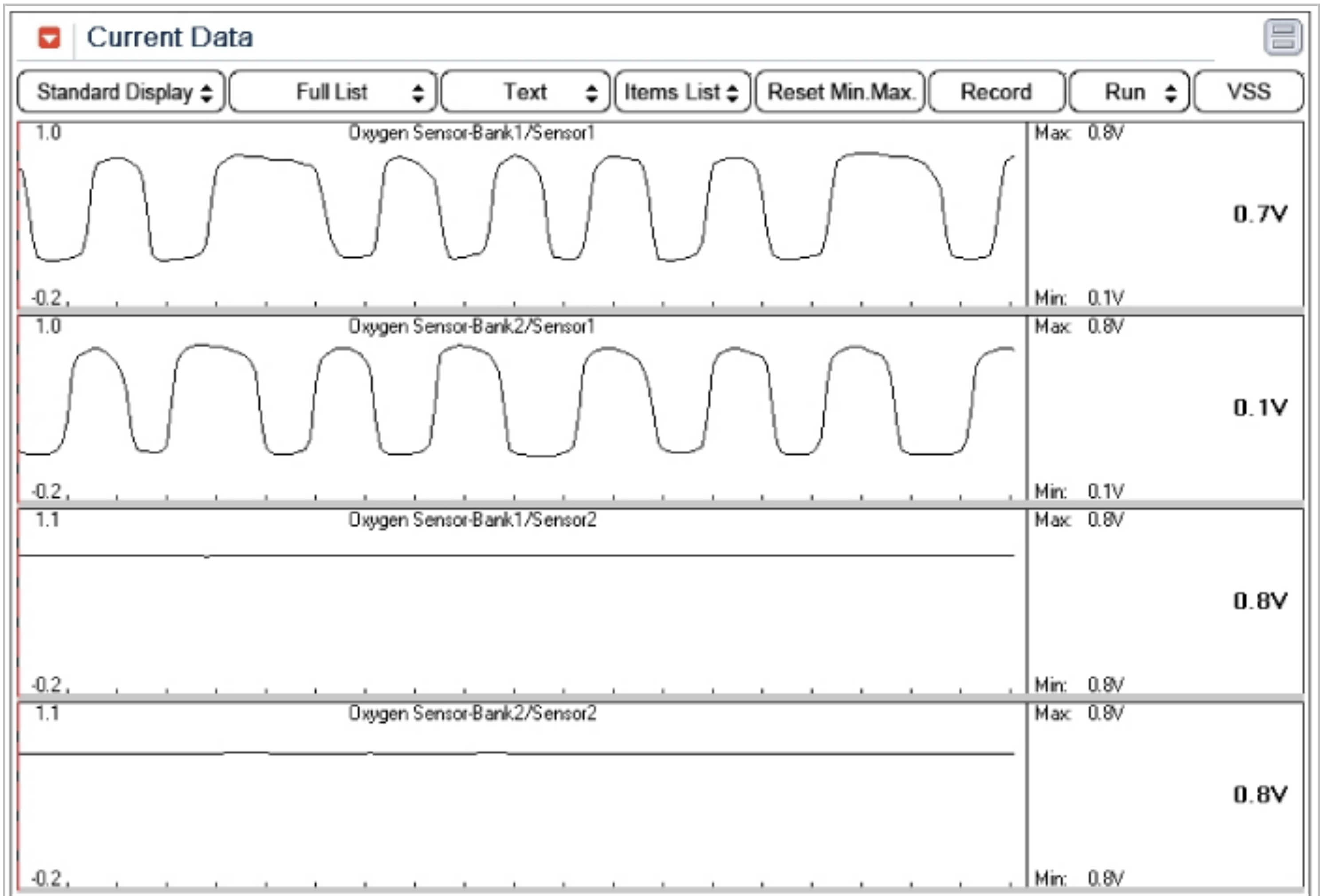
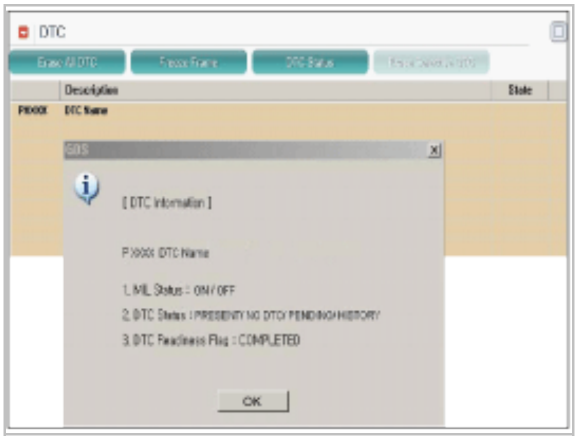


Fig.2

Fig.1) Normal waveforms of front HO2S(the upper) and rear HO2S(the lower)
Fig.2) Normal graph of front HO2S and rear HO2S at idle.
After warming-up, if accelerator pedal is released suddenly around 4000rpm, the HO2S signal reading will be lower than 200mV resulting from Fuel cut-off for the moment. Conversely, if suddenly accelerator pedal is depressed, HO2S signal reading will be around 0.6V ~1.0V. At idle, Normally HO2S signal will switch from lean to rich with 3 Hz. And as racing, Its frequency rises.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Component Inspection

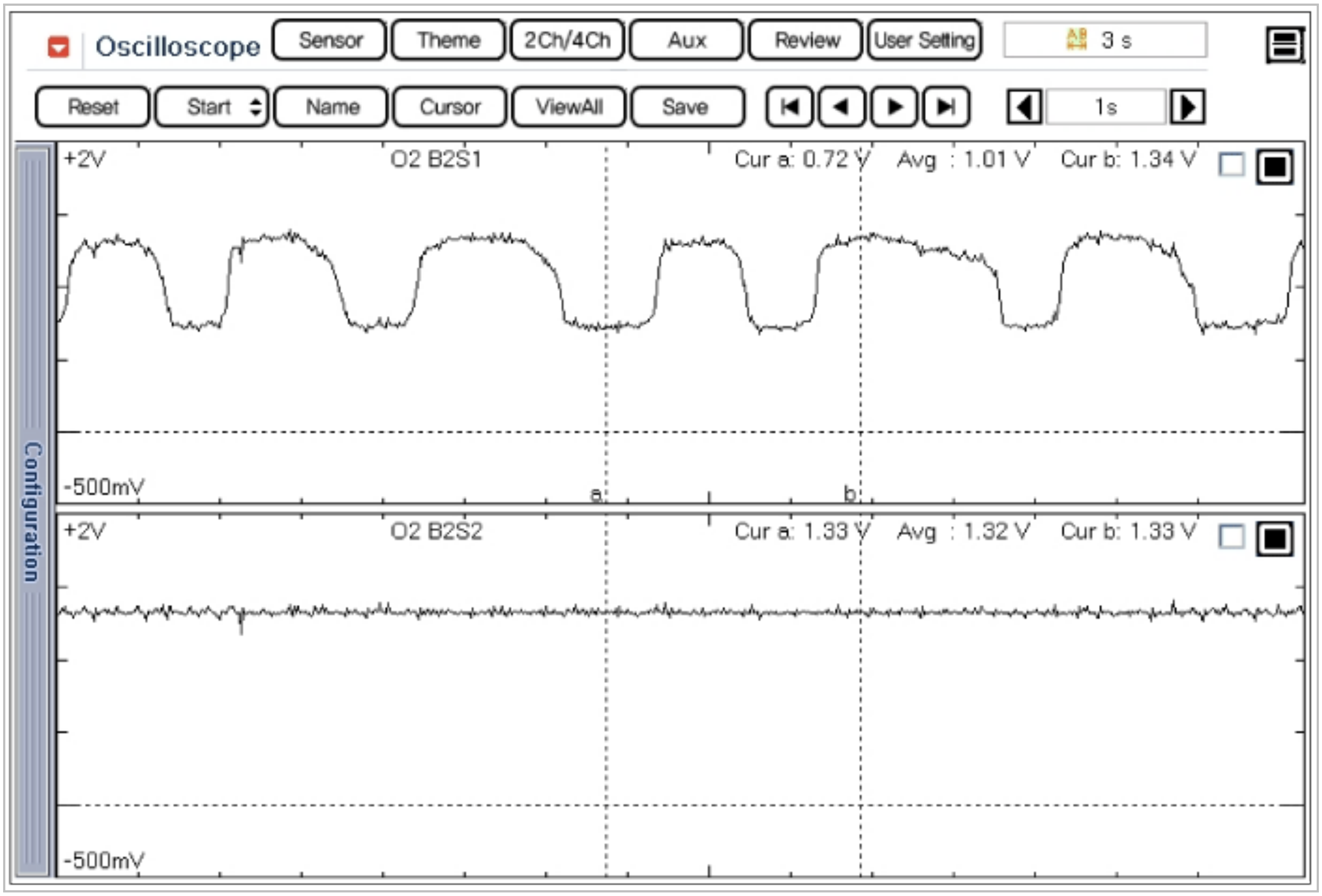
■ Check the condition of HO2S

1. Check HO2S for poor connection or loose terminal.
2. Check if HO2S is ensurely installed.
3. Is the conditions of HO2S normal ?

YES	▶ Go to "Check the Signal waveform of HO2S" as follows.
NO	▶ Repair it and then go to "Verification of Vehicle Repair" procedure.

■ Check the Signal waveform of HO2S

1. IG "OFF" and connect HO2S connector.
2. Engine start.
3. After warming-up, monitor signal waveform of HO2S with GDS.



4. Is the sensor switching properly?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

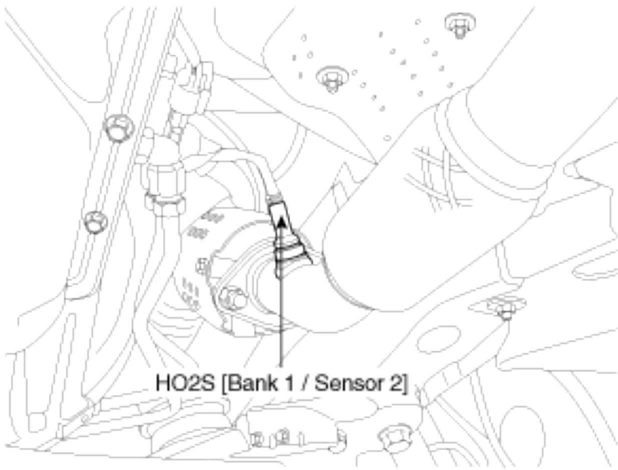
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.

NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2270 O2 Sensor Signal Stuck Lean (Bank 1 Sensor 2)

Component Location



General Description

The rear heated oxygen sensor is mounted on the rear side of the Catalytic Converter (warm-up catalytic converter) or in the rear exhaust pipe, which is able to detect catalyst efficiency. The rear heated oxygen sensor (HO2S) produces a voltage between 0V and 1V. This rear heated oxygen sensor is used to estimate the oxygen storage capability. If a catalyst has good conversion properties, the oxygen fluctuations are smoothed by the oxygen storage capacity of the catalyst. If the conversion provided by the catalyst is low due to aging, poisoning or misfiring, then the oxygen fluctuations are similar to signals from the front oxygen sensor.

DTC Description

Checking output signals from HO2S under detecting condition, if HO2S's signal is lean during power enrichment conditions, ECM sets P2270. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycles.

DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Monitor HO2S's signal	• Poor Connection • Faulty HO2S • Clogging of fuel filter in fuel pump • Faulty ECM
Enable Conditions	• Battery voltage ≥ 10V • Engine running ≥ 60sec. • Power Enrichment conditions • Engine warm-up state • Not in Transient Conditions	
Threshold value	• HO2S's signal < 0.35V and Air Fuel Ratio ≤ 13.5	
Diagnosis Time	• Continuous (More than 8 sec. failure for every 9 sec. Test)	

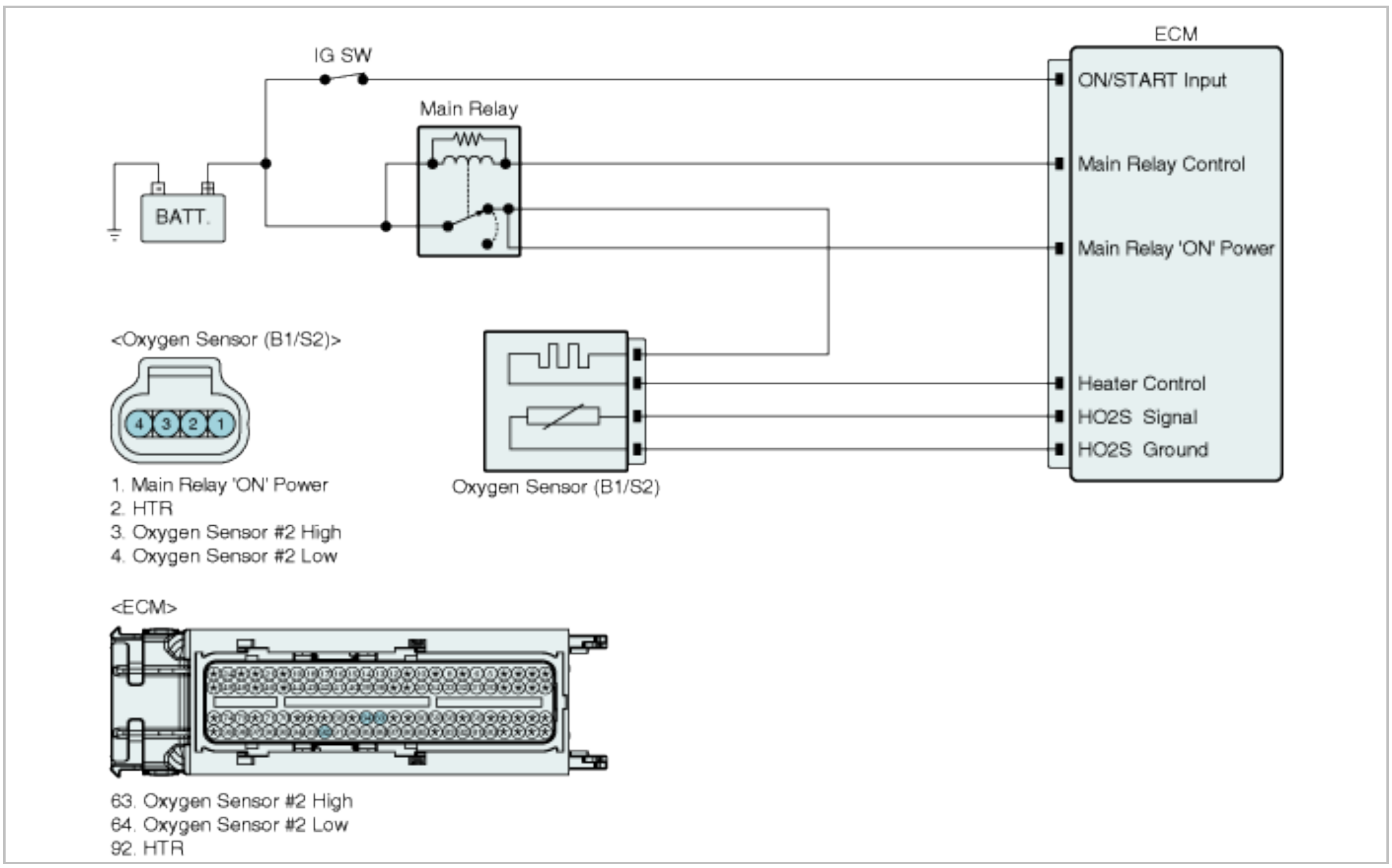
MIL On Condition	• 2 Driving Cycles	

Specification

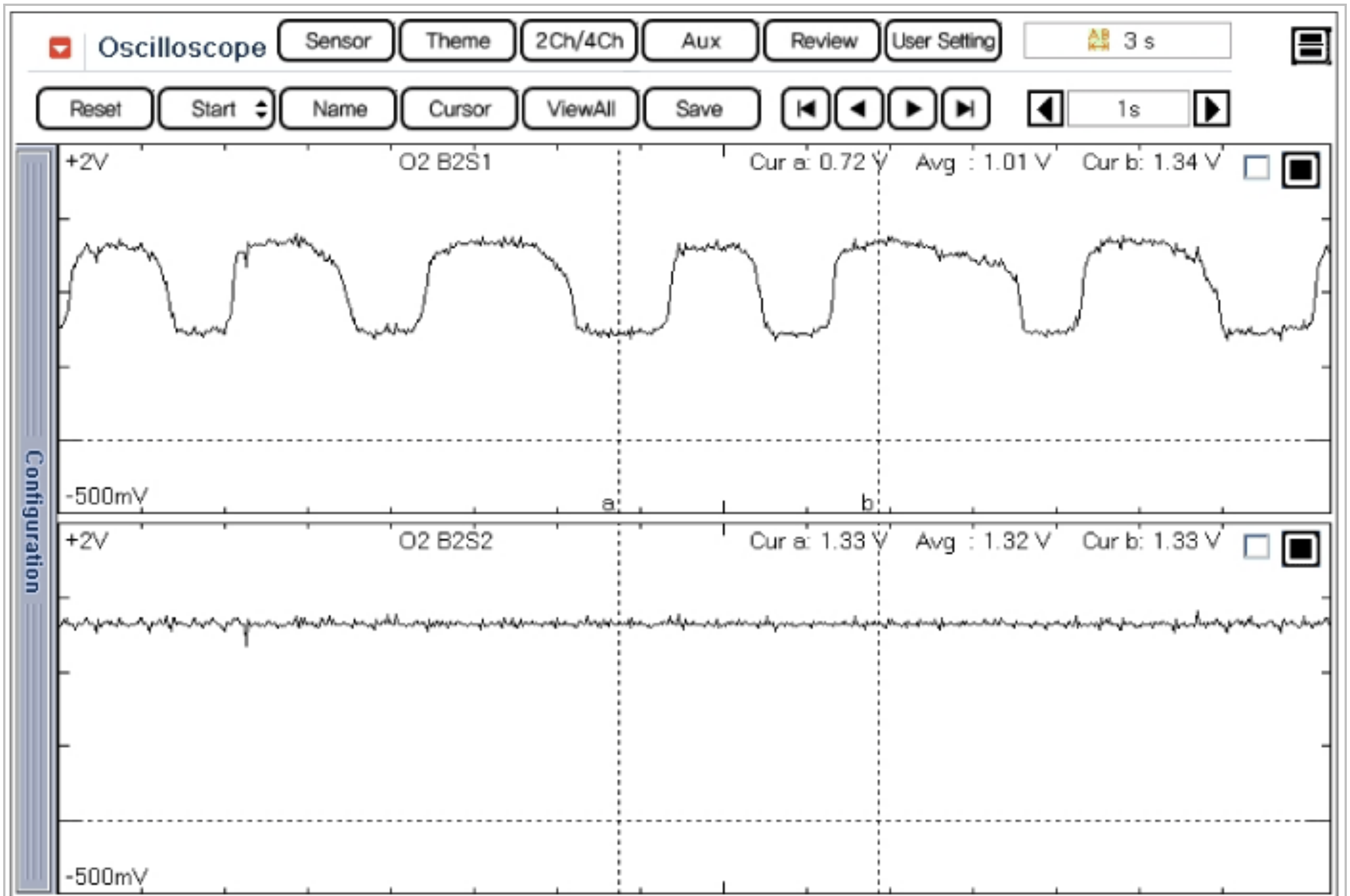
(Reference only)

Test Condition	HO2S Voltage(Sensor1)	HO2S Voltage(Sensor2)
HO2S Signal at idle after warm-up	Signal is commonly switching from rich to lean more than 3 times in 10 sec.	Signal is commonly above 0.6V.
HO2S signal at open circuit (Pumping current OFF)	Approx. 0.45V	
HO2S signal at open circuit (Pumping current ON)	Approx. 2.2V	

Diagnostic Circuit Diagram



Signal Waveform & Data



Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
3 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 0.72 V
Avg : 1.01 V
Cur b: 1.34 V
-500mV
a
b
+2V
O2 B2S2
Cur a: 1.33 V
Avg : 1.32 V
Cur b: 1.33 V
-500mV

Fig.1

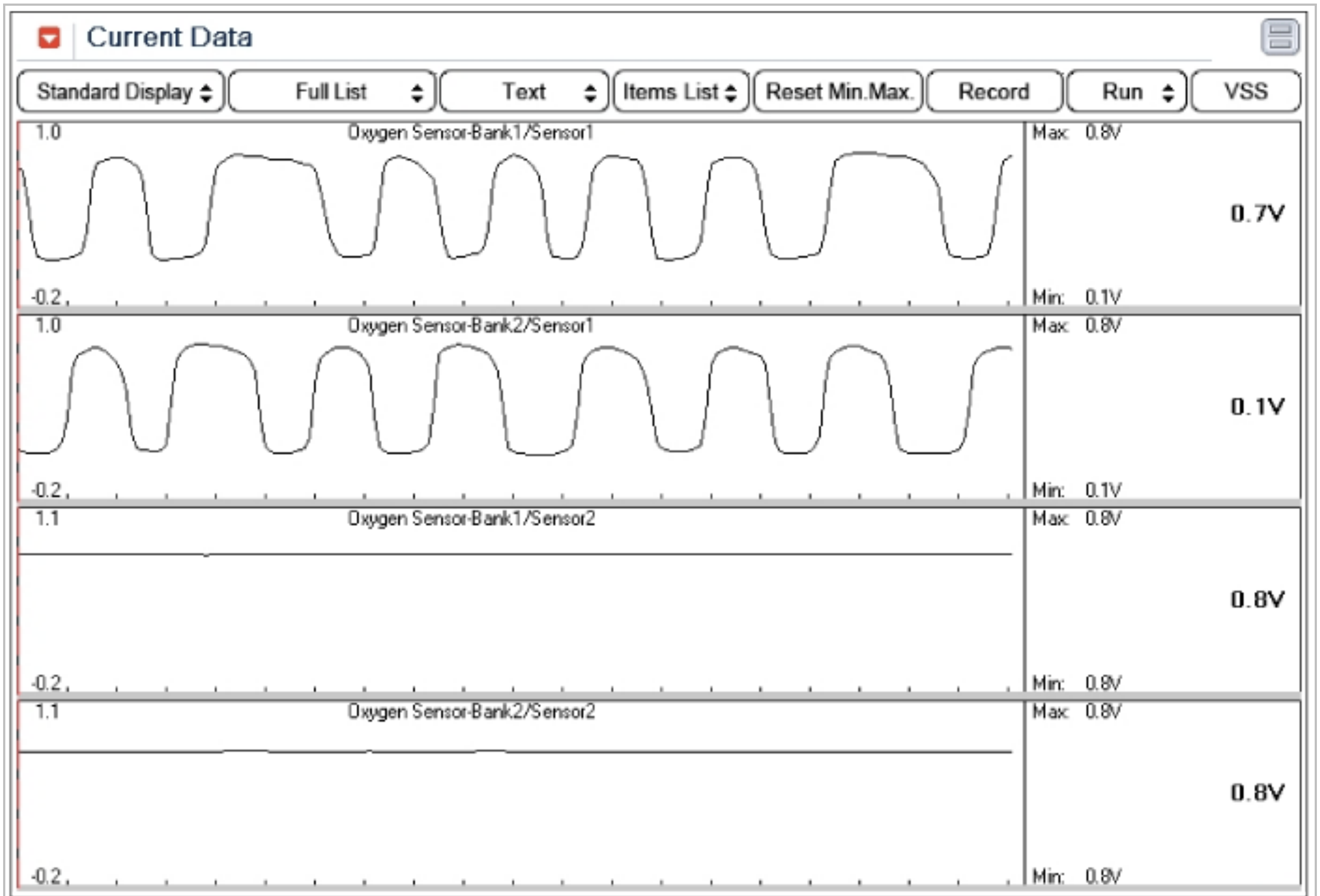
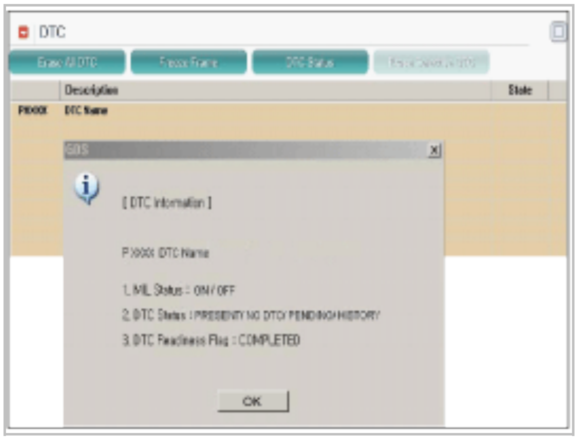


Fig.2

Fig.1) Normal waveforms of front HO2S(the upper) and rear HO2S(the lower)
Fig.2) Normal graph of front HO2S and rear HO2S at idle.
After warming-up, if accelerator pedal is released suddenly around 4000rpm, the HO2S signal reading will be lower than 200mV resulting from Fuel cut-off for the moment. Conversely, if suddenly accelerator pedal is depressed, HO2S signal reading will be around 0.6V ~1.0V. At idle, Normally HO2S signal will switch from lean to rich with 3 Hz. And as racing, Its frequency rises.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor’s and/or ECM’s connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Component Inspection

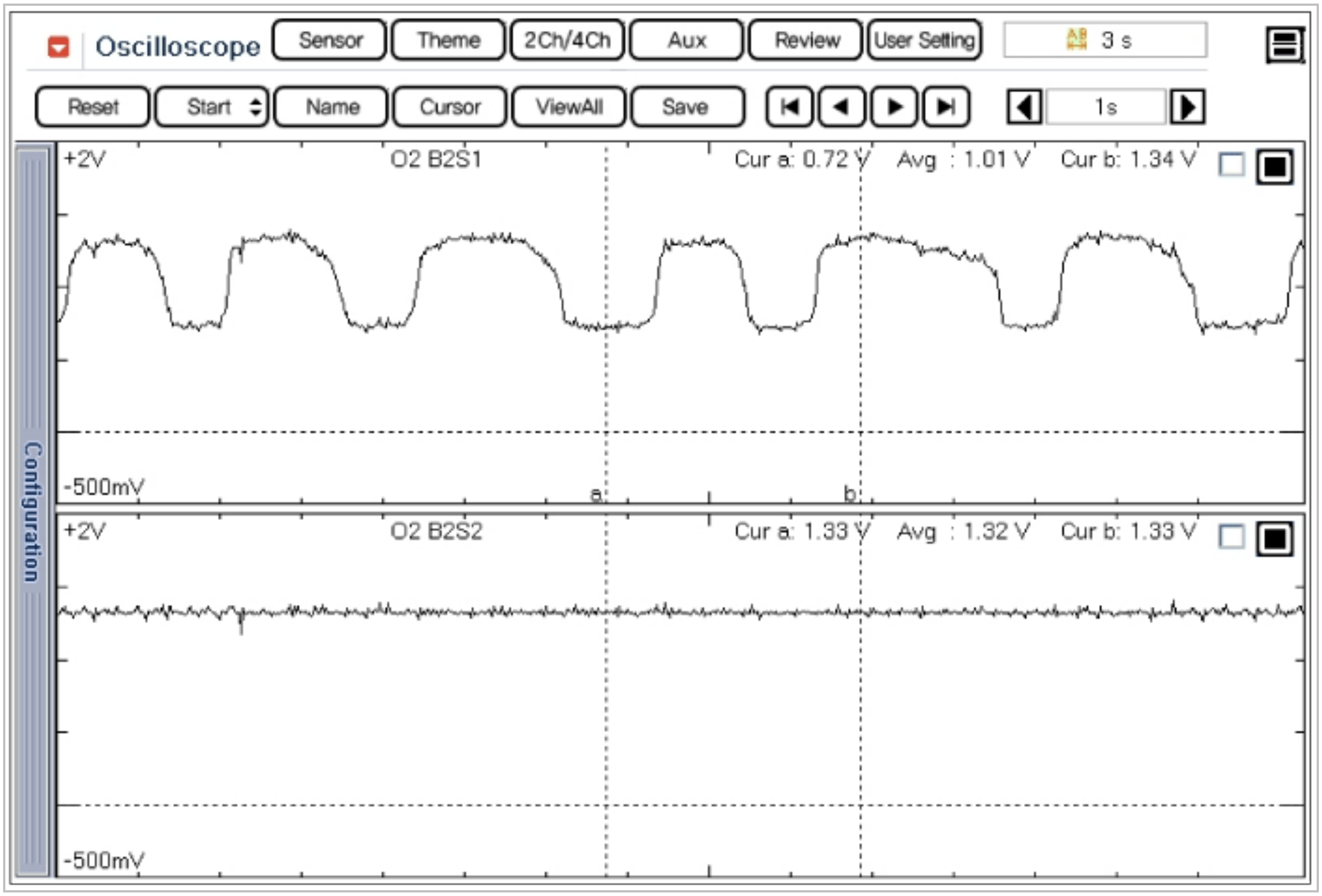
■ Check the condition of HO2S

1. Check HO2S for poor connection or loose terminal.
2. Check if HO2S is ensurely installed.
3. Is the conditions of HO2S normal ?

YES	▶ Go to "Check the Signal waveform of HO2S" as follows.
NO	▶ Repair it and then go to "Verification of Vehicle Repair" procedure.

■ Check the Signal waveform of HO2S

1. IG "OFF" and connect HO2S connector.
2. Engine start.
3. After warming-up, monitor signal waveform of HO2S with GDS.



4. Is the sensor switching properly?

YES	▶ Go to "Check fuel filter" as follows.
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

■ Check the fuel filter of fuel pump

1. IG "OFF" and disconnect the fuel pump connector.
2. Start the engine and wait until fuel in fuel line is exhausted. After the engine stalls, IG "OFF"
3. Remove the fuel pump assembly.
4. Check the fuel filter for clogging by dust, a foreign substance.
5. Is the fuel filter O.K.?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good fuel filter and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

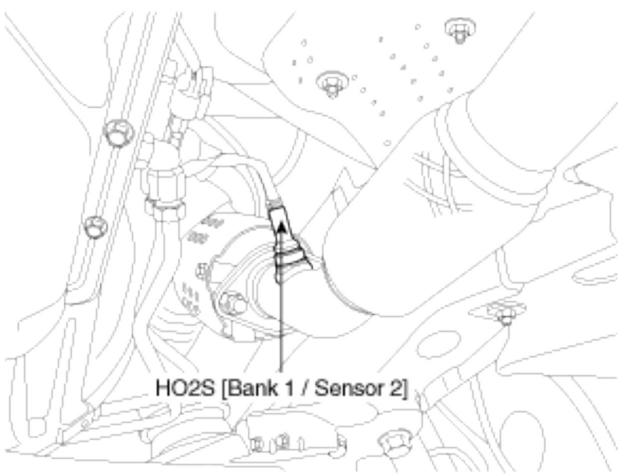
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2271 O2 Sensor Signal Stuck Rich (Bank 1 Sensor 2)

Component Location



General Description

The rear heated oxygen sensor is mounted on the rear side of the Catalytic Converter (warm-up catalytic converter) or in the rear exhaust pipe, which is able to detect catalyst efficiency. The rear heated oxygen sensor (HO2S) produces a voltage between 0V and 1V. This rear heated oxygen sensor is used to estimate the oxygen storage capability. If a catalyst has good conversion properties, the oxygen fluctuations are smoothed by the oxygen storage capacity of the catalyst. If the conversion provided by the catalyst is low due to aging, poisoning or misfiring, then the oxygen fluctuations are similar to signals from the front oxygen sensor.

DTC Description

Checking output signals from HO2S under detecting condition, if HO2S's signal is rich during fuel cut-off conditions, ECM sets P2271. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycles.

DTC Detecting Condition

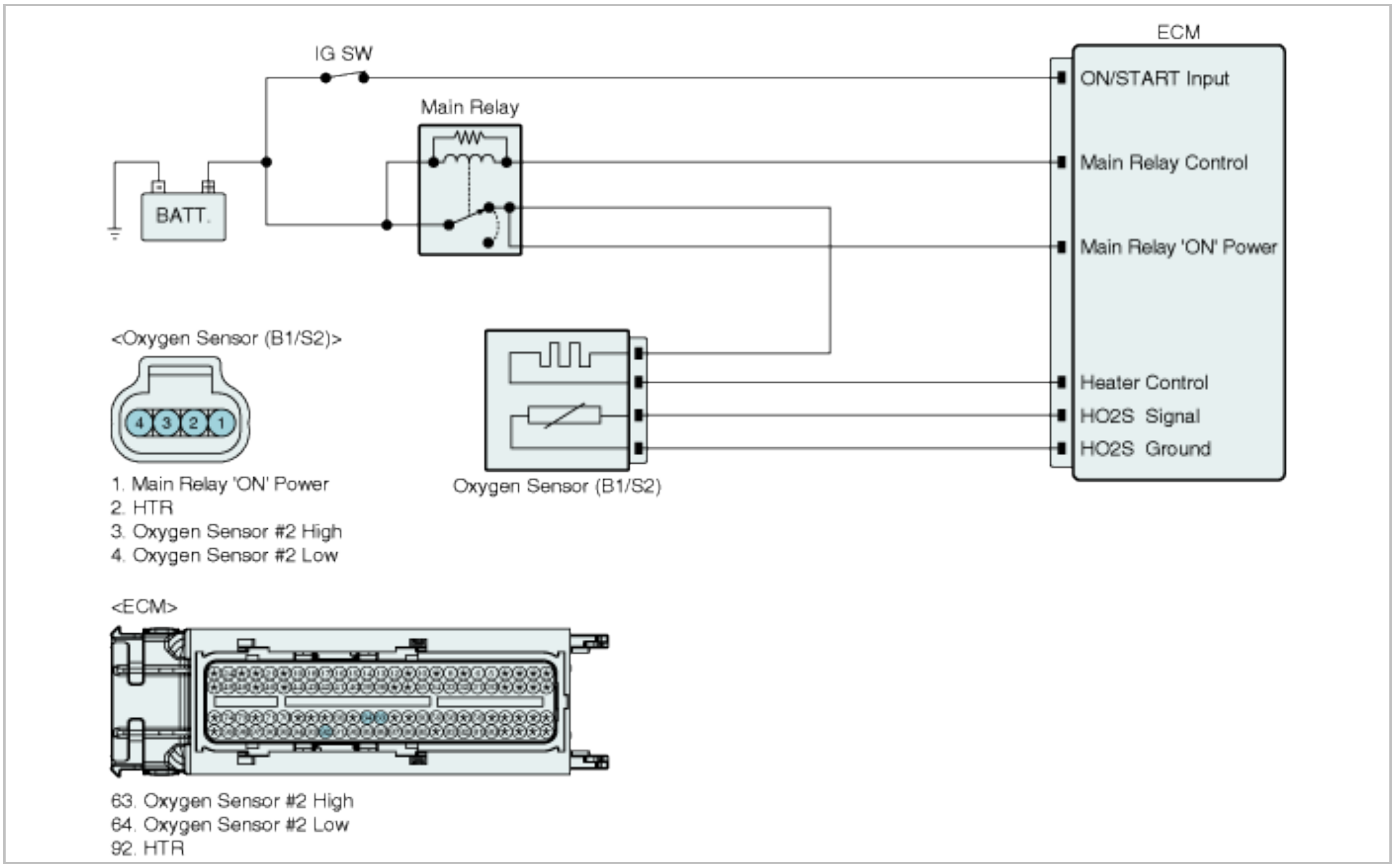
Item	Detecting Condition	Possible cause
DTC Strategy	• Monitor HO2S's signal	• Poor Connection • Faulty HO2S • Faulty ECM
Enable Conditions	• Battery voltage ≥ 10V • Engine running ≥ 60sec. • Fuel cut-off conditions • Engine warm-up state • Not in Transient Conditions	
Threshold value	• HO2S's signal > 0.42V	
Diagnosis Time	• Continuous (More than 8 sec. failure for every 9 sec. Test)	
MIL On Condition	• 2 Driving Cycles	

Specification

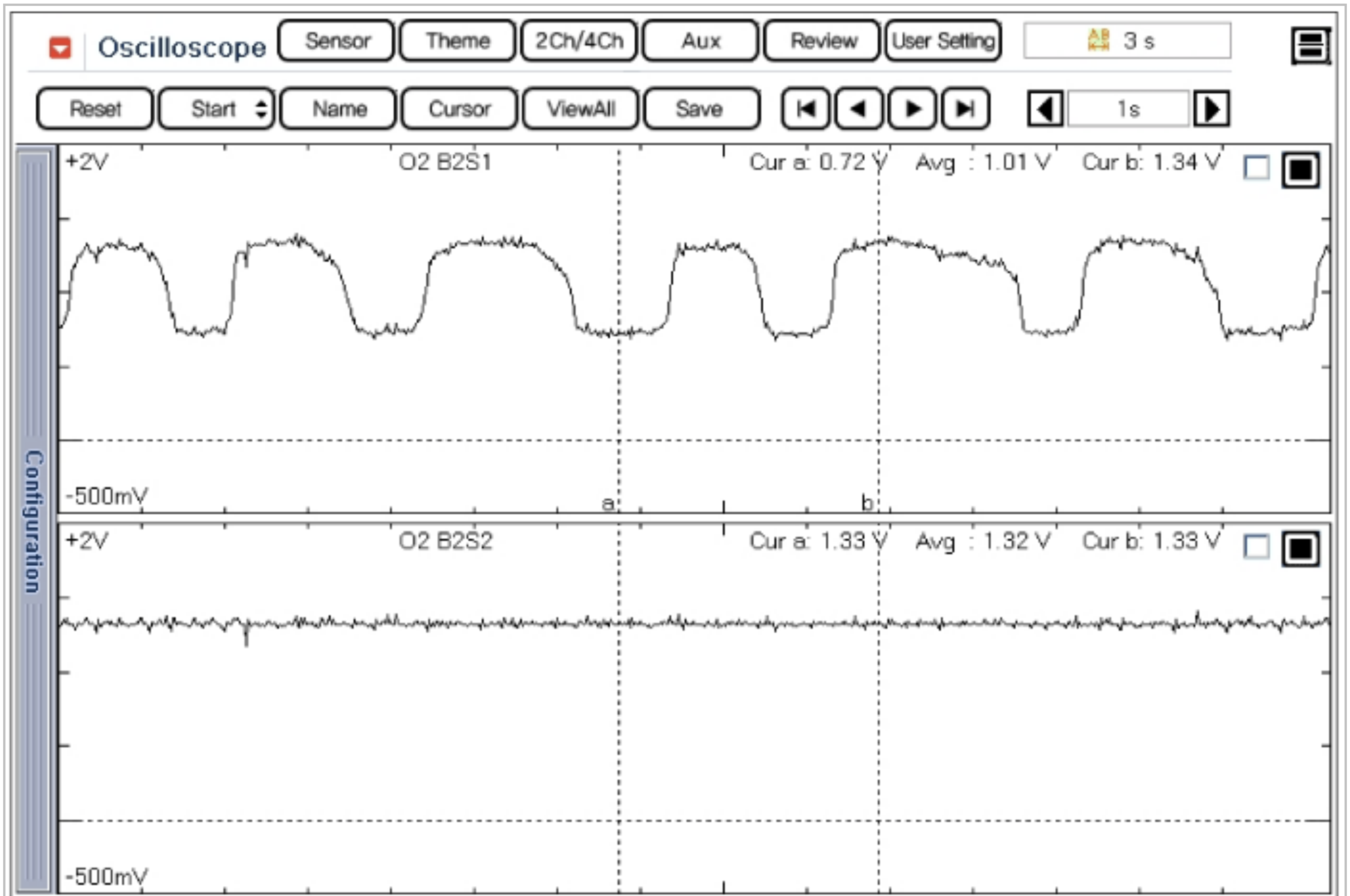
(Reference only)

Test Condition	HO2S Voltage(Sensor1)	HO2S Voltage(Sensor2)
HO2S Signal at idle after warm-up	Signal is commonly switching from rich to lean more than 3 times in 10 sec.	Signal is commonly above 0.6V.
HO2S signal at open circuit (Pumping current OFF)	Approx. 0.45V	
HO2S signal at open circuit (Pumping current ON)	Approx. 2.2V	

Diagnostic Circuit Diagram



Signal Waveform & Data


Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
3 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 0.72 V
Avg : 1.01 V
Cur b: 1.34 V
-500mV
a
b
+2V
O2 B2S2
Cur a: 1.33 V
Avg : 1.32 V
Cur b: 1.33 V
-500mV
Fig.1

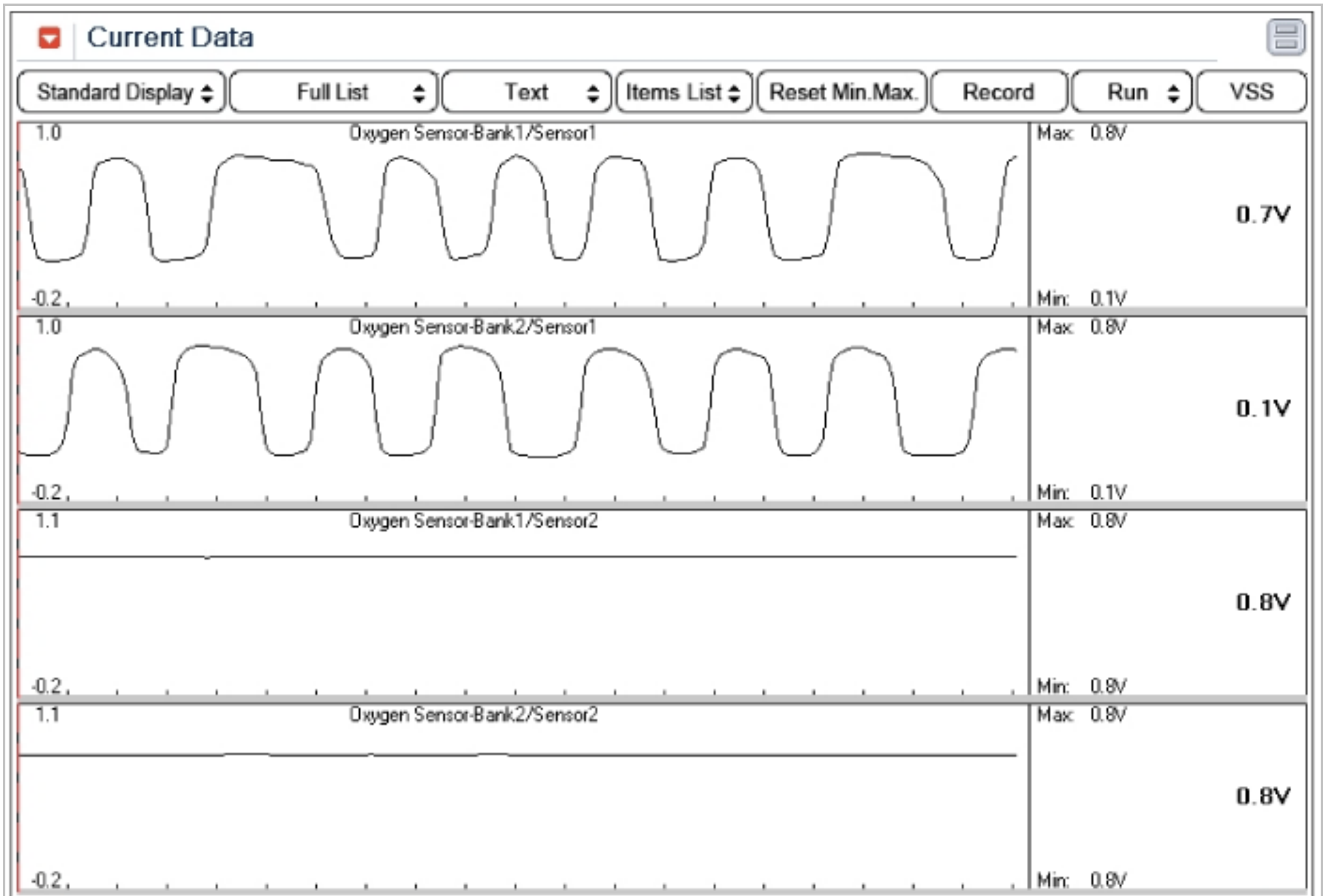


Fig.2

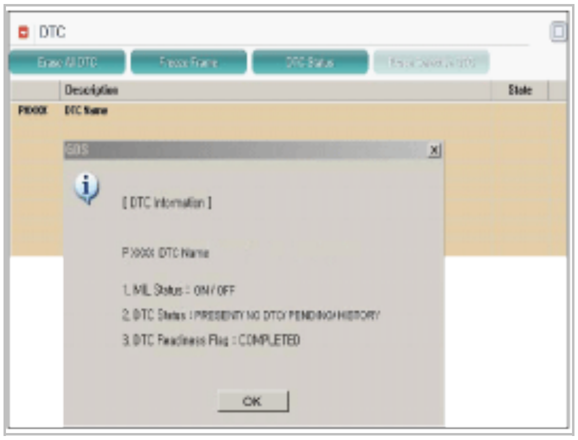
Fig.1) Normal waveforms of front HO2S(the upper) and rear HO2S(the lower)

Fig.2) Normal graph of front HO2S and rear HO2S at idle.

After warming-up, if accelerator pedal is released suddenly around 4000rpm, the HO2S signal reading will be lower than 200mV resulting from Fuel cut-off for the moment. Conversely, if suddenly accelerator pedal is depressed, HO2S signal reading will be around 0.6V ~1.0V. At idle, Normally HO2S signal will switch from lean to rich with 3 Hz. And as racing, Its frequency rises.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor’s and/or ECM’s connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Component Inspection

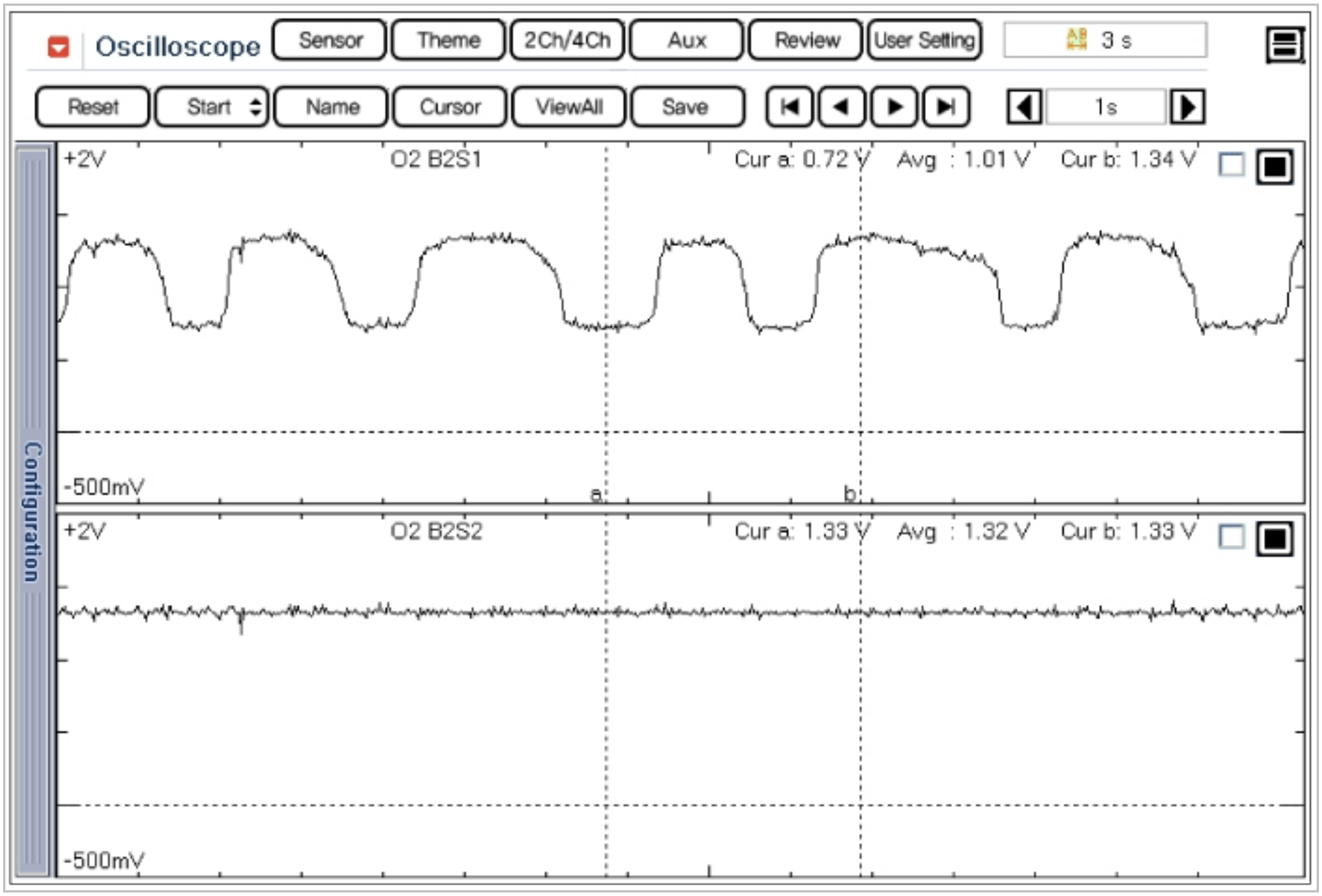
■ Check the condition of HO2S

1. Check HO2S for poor connection or loose terminal.
2. Check if HO2S is ensurely installed.
3. Is the conditions of HO2S normal ?

YES	▶ Go to "Check the Signal waveform of HO2S" as follows.
NO	▶ Repair it and then go to "Verification of Vehicle Repair" procedure.

■ Check the Signal waveform of HO2S

1. IG "OFF" and connect HO2S connector.
2. Engine start.
3. After warming-up, monitor signal waveform of HO2S with GDS.



4. Is the sensor switching properly?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

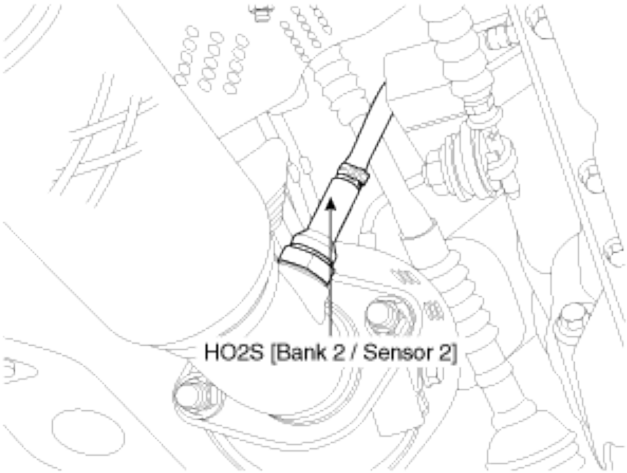
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.

NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2272 O2 Sensor Signal Stuck Lean (Bank 2 Sensor 2)

Component Location



General Description

The rear heated oxygen sensor is mounted on the rear side of the Catalytic Converter (warm-up catalytic converter) or in the rear exhaust pipe, which is able to detect catalyst efficiency. The rear heated oxygen sensor (HO2S) produces a voltage between 0V and 1V. This rear heated oxygen sensor is used to estimate the oxygen storage capability. If a catalyst has good conversion properties, the oxygen fluctuations are smoothed by the oxygen storage capacity of the catalyst. If the conversion provided by the catalyst is low due to aging, poisoning or misfiring, then the oxygen fluctuations are similar to signals from the front oxygen sensor.

DTC Description

Checking output signals from HO2S under detecting condition, if HO2S's signal is lean during power enrichment conditions, ECM sets P2272. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycles.

DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Monitor HO2S's signal	• Poor Connection • Faulty HO2S • Clogging of fuel filter in fuel pump • Faulty ECM
Enable Conditions	• Battery voltage ≥ 10V • Engine running ≥ 60sec. • Power Enrichment conditions • Engine warm-up state • Not in Transient Conditions	
Threshold value	• HO2S's signal < 0.35V and Air Fuel Ratio ≤ 13.5	
Diagnosis Time	• Continuous (More than 8 sec. failure for every 9 sec. Test)	

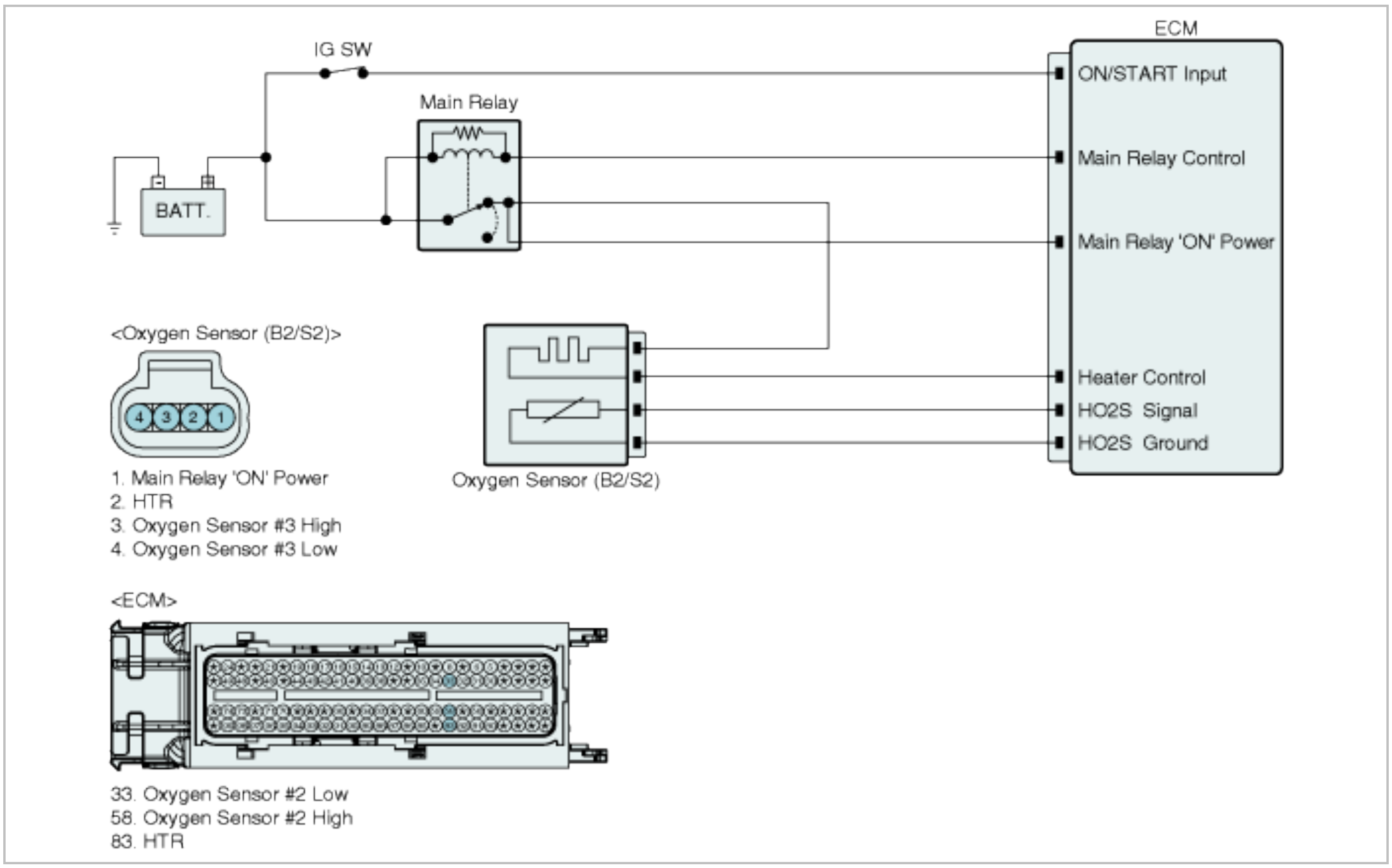
MIL On Condition	• 2 Driving Cycles	

Specification

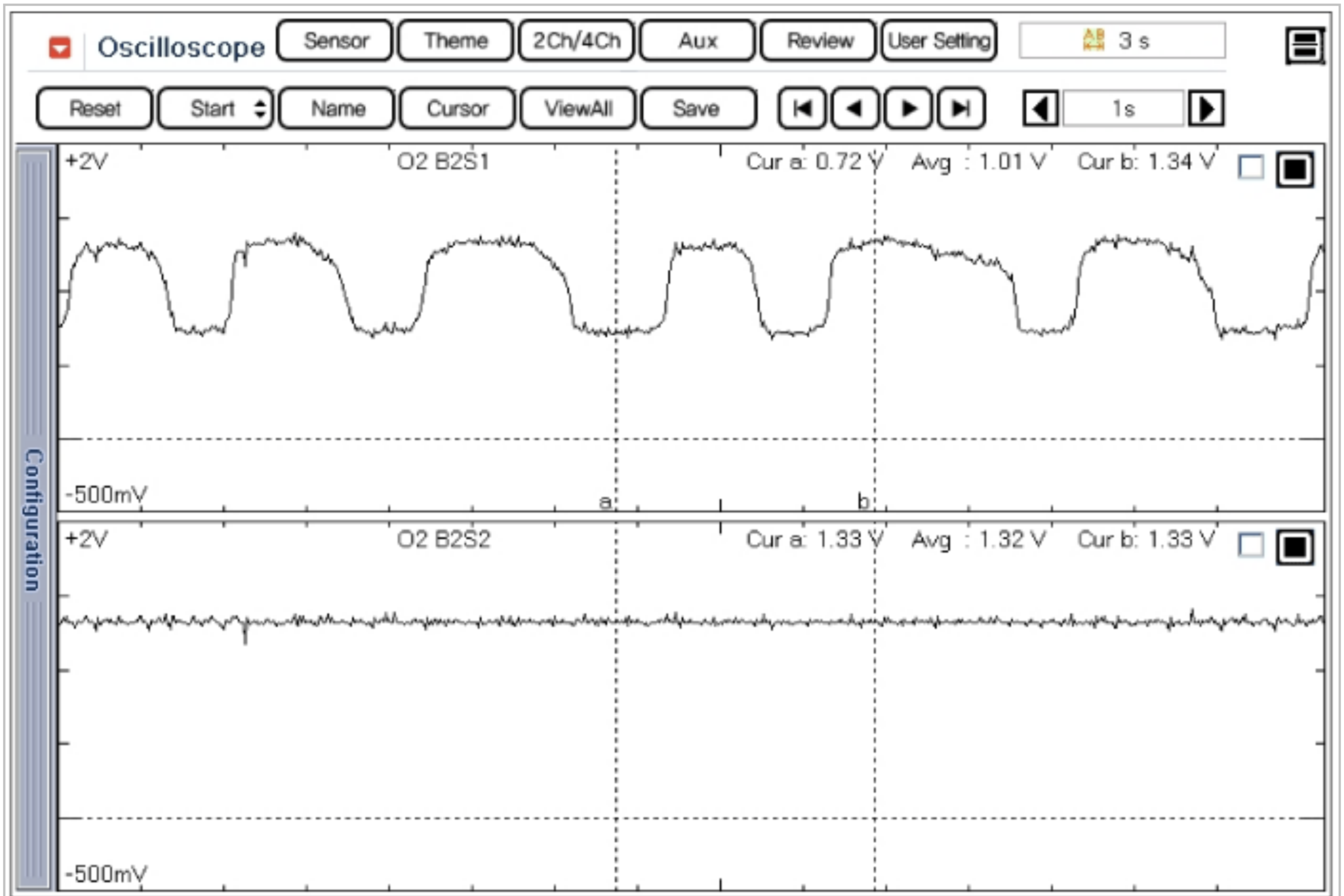
(Reference only)

Test Condition	HO2S Voltage(Sensor1)	HO2S Voltage(Sensor2)
HO2S Signal at idle after warm-up	Signal is commonly switching from rich to lean more than 3 times in 10 sec.	Signal is commonly above 0.6V.
HO2S signal at open circuit (Pumping current OFF)	Approx. 0.45V	
HO2S signal at open circuit (Pumping current ON)	Approx. 2.2V	

Diagnostic Circuit Diagram



Signal Waveform & Data


Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
3 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 0.72 V
Avg : 1.01 V
Cur b: 1.34 V
-500mV
a
b
+2V
O2 B2S2
Cur a: 1.33 V
Avg : 1.32 V
Cur b: 1.33 V
-500mV
Fig.1

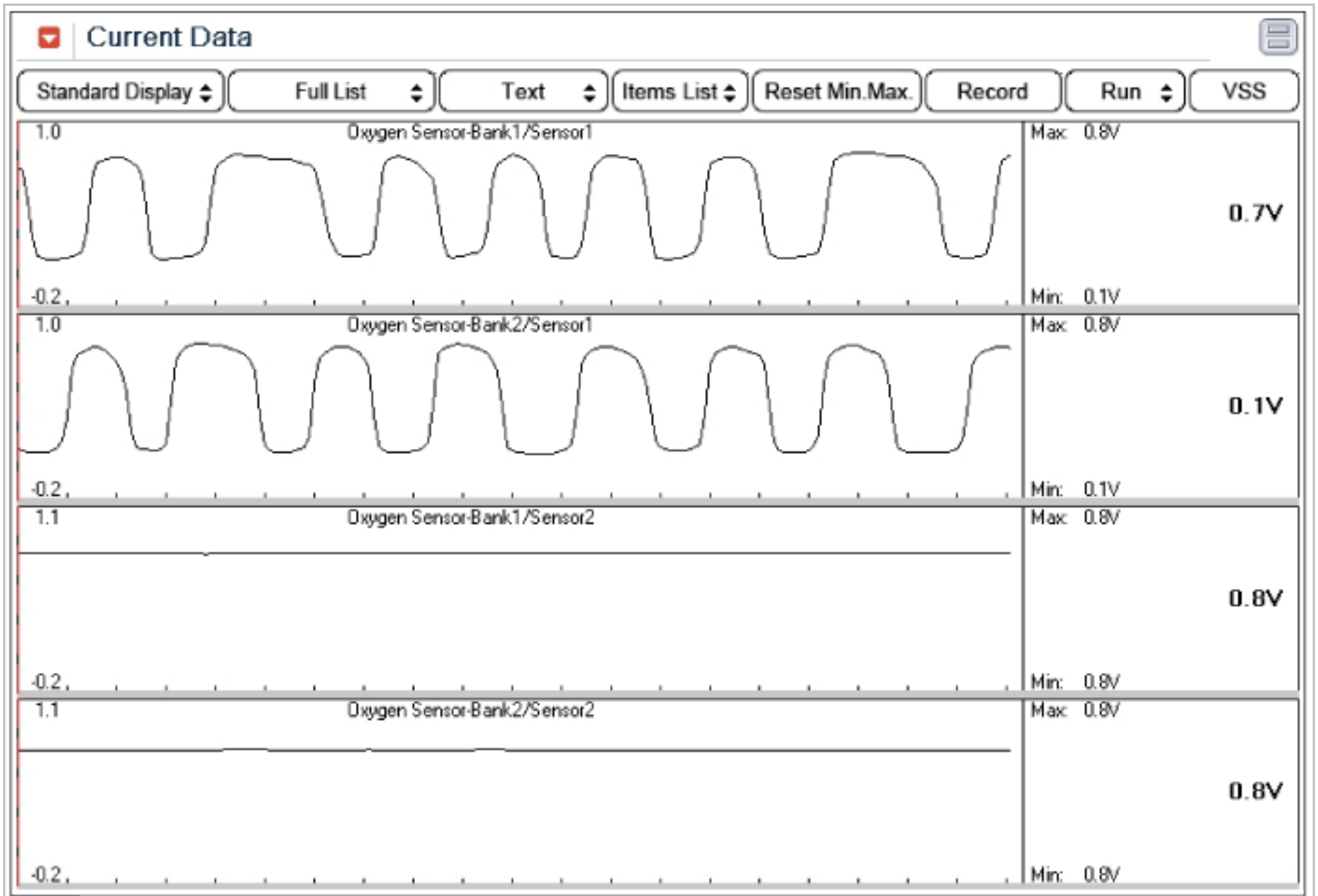


Fig.2

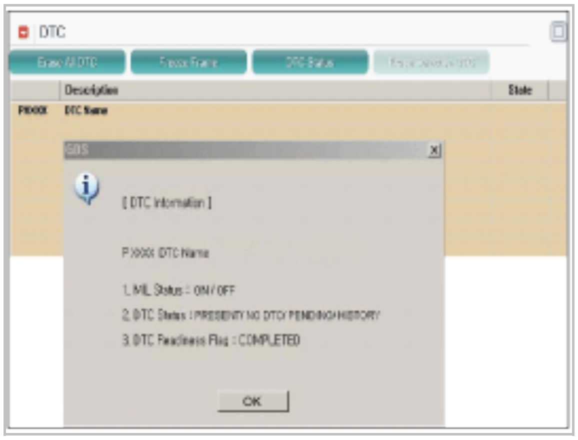
Fig.1) Normal waveforms of front HO2S(the upper) and rear HO2S(the lower)

Fig.2) Normal graph of front HO2S and rear HO2S at idle.

After warming-up, if accelerator pedal is released suddenly around 4000rpm, the HO2S signal reading will be lower than 200mV resulting from Fuel cut-off for the moment. Conversely, if suddenly accelerator pedal is depressed, HO2S signal reading will be around 0.6V ~1.0V. At idle, Normally HO2S signal will switch from lean to rich with 3 Hz. And as racing, Its frequency rises.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Component Inspection

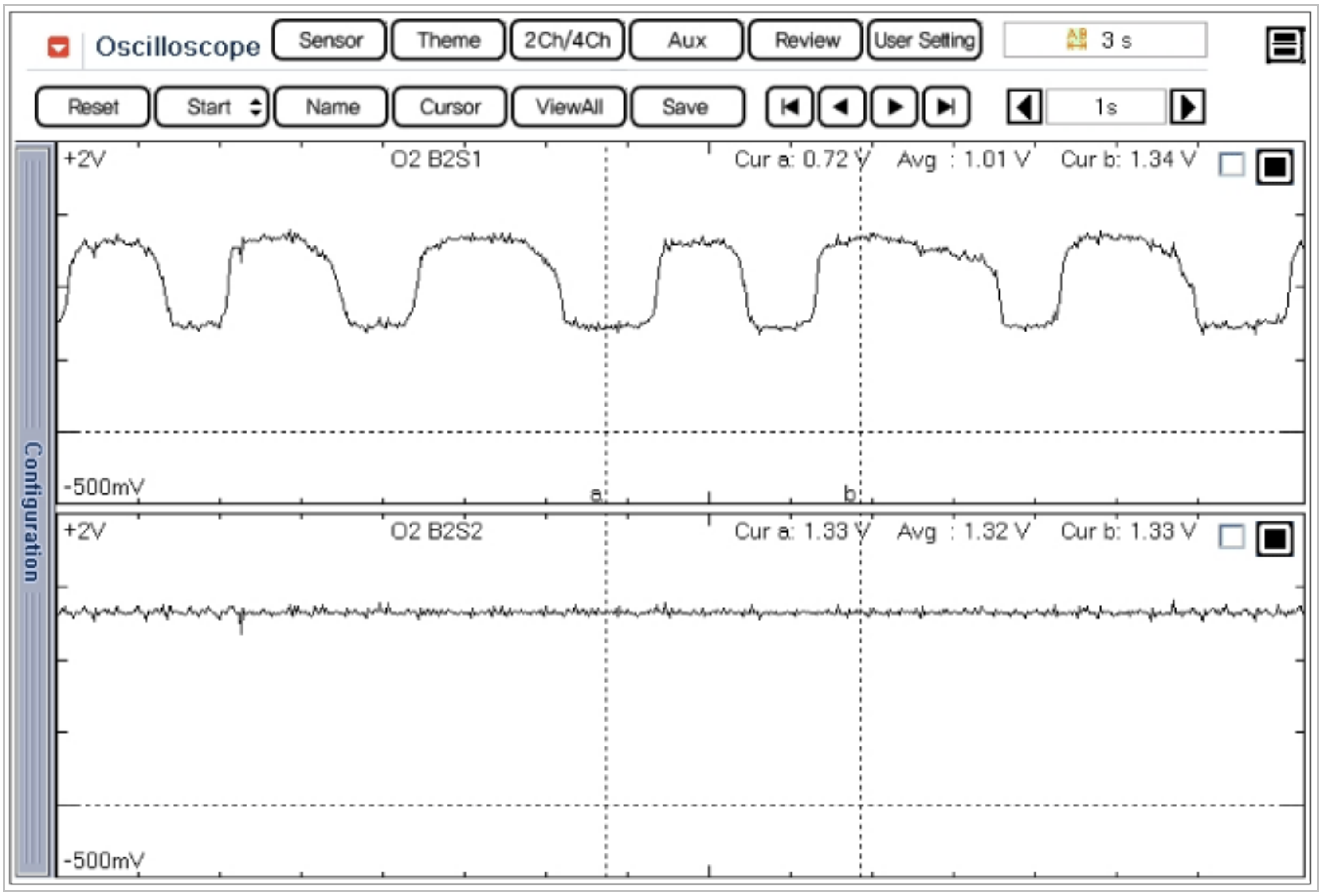
■ Check the condition of HO2S

1. Check HO2S for poor connection or loose terminal.
2. Check if HO2S is ensurely installed.
3. Is the conditions of HO2S normal ?

YES	▶ Go to "Check the Signal waveform of HO2S" as follows.
NO	▶ Repair it and then go to "Verification of Vehicle Repair" procedure.

■ Check the Signal waveform of HO2S

1. IG "OFF" and connect HO2S connector.
2. Engine start.
3. After warming-up, monitor signal waveform of HO2S with scantool.



4. Is the sensor switching properly?

YES	▶ Go to "Check fuel filter" as follows.
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

■ Check the fuel filter of fuel pump

1. IG "OFF" and disconnect the fuel pump connector.
2. Start the engine and wait until fuel in fuel line is exhausted. After the engine stalls, IG "OFF"
3. Remove the fuel pump assembly.
4. Check the fuel filter for clogging by dust, a foreign substance.
5. Is the fuel filter O.K.?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on scantool that can erase optional parts automaticallydetected and memorized by ECM.Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good fuel filter and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

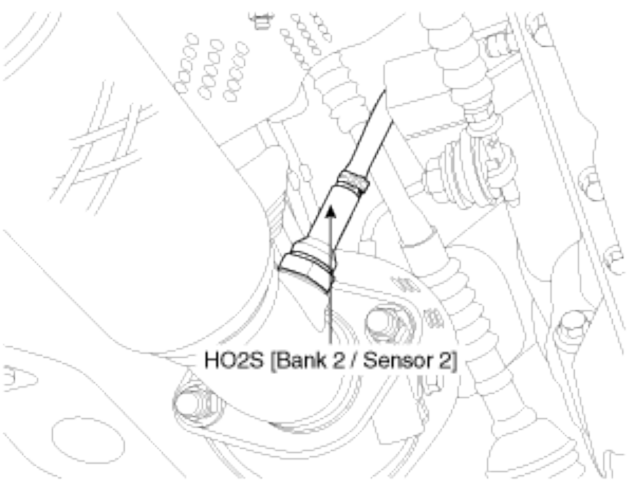
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2273 O2 Sensor Signal Stuck Rich (Bank 2 Sensor 2)

Component Location



General Description

The rear heated oxygen sensor is mounted on the rear side of the Catalytic Converter (warm-up catalytic converter) or in the rear exhaust pipe, which is able to detect catalyst efficiency. The rear heated oxygen sensor (HO2S) produces a voltage between 0V and 1V. This rear heated oxygen sensor is used to estimate the oxygen storage capability. If a catalyst has good conversion properties, the oxygen fluctuations are smoothed by the oxygen storage capacity of the catalyst. If the conversion provided by the catalyst is low due to aging, poisoning or misfiring, then the oxygen fluctuations are similar to signals from the front oxygen sensor.

DTC Description

Checking output signals from HO2S under detecting condition, if HO2S's signal is rich during fuel cut-off conditions, ECM sets P2273. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycles.

DTC Detecting Condition

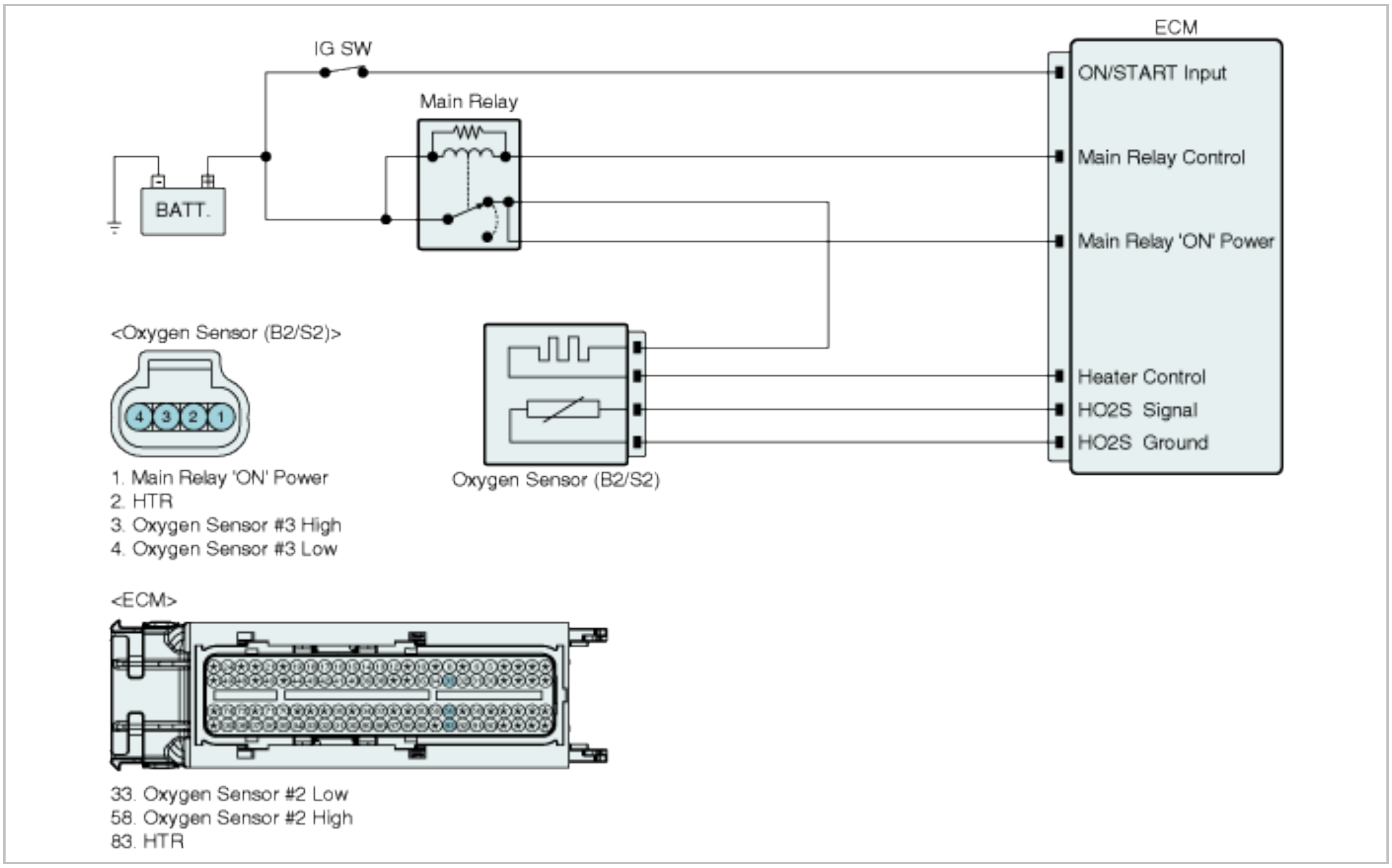
Item	Detecting Condition	Possible cause
DTC Strategy	• Monitor HO2S's signal	• Poor Connection • Faulty HO2S • Faulty ECM
Enable Conditions	• Battery voltage ≥ 10V • Engine running ≥ 60sec. • Fuel cut-off conditions • Engine warm-up state • Not in Transient Conditions	
Threshold value	• HO2S's signal > 0.42V	
Diagnosis Time	• Continuous (More than 8 sec. failure for every 9 sec. Test)	
MIL On Condition	• 2 Driving Cycles	

Specification

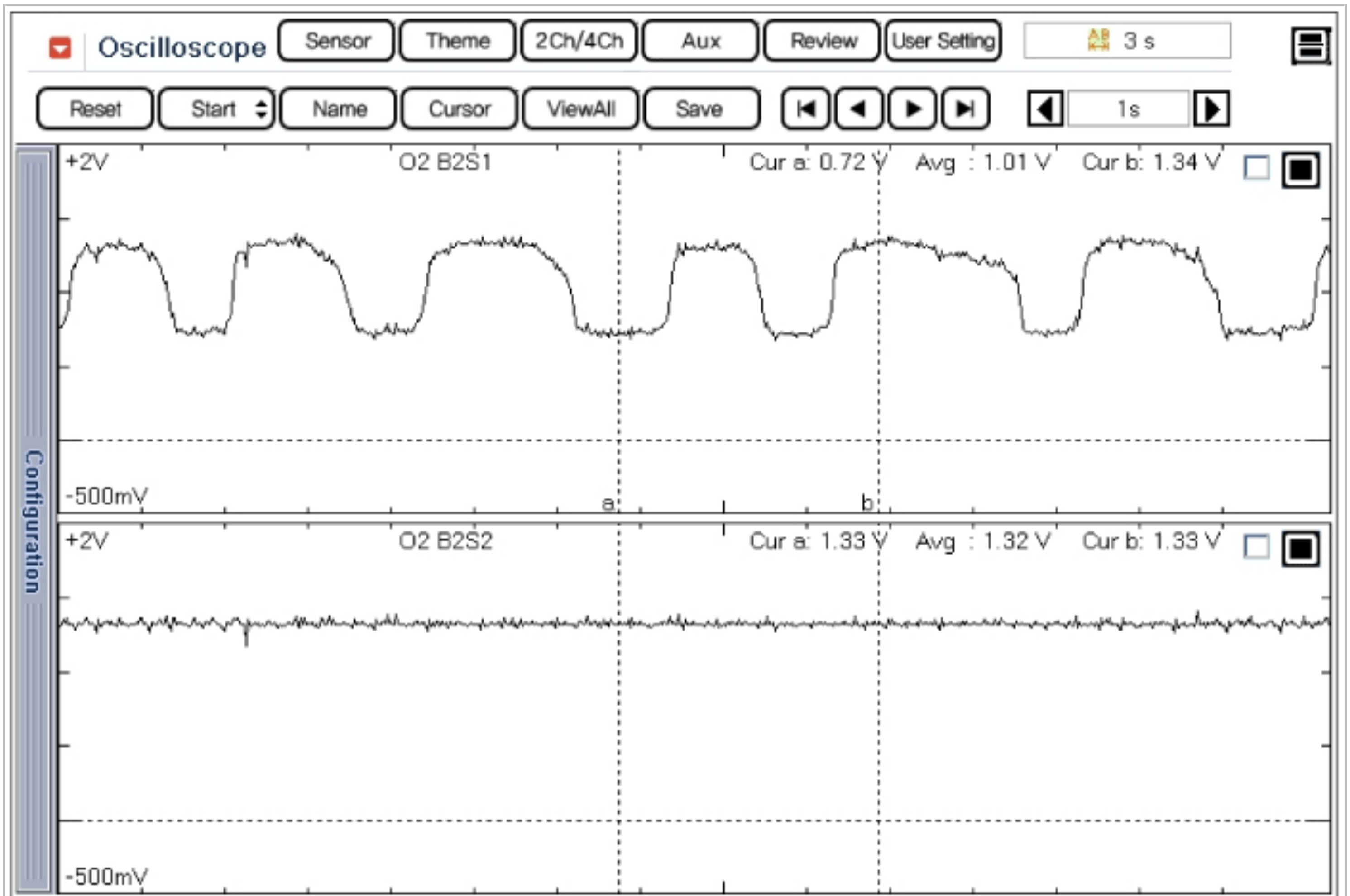
(Reference only)

Test Condition	HO2S Voltage(Sensor1)	HO2S Voltage(Sensor2)
HO2S Signal at idle after warm-up	Signal is commonly switching from rich to lean more than 3 times in 10 sec.	Signal is commonly above 0.6V.
HO2S signal at open circuit (Pumping current OFF)	Approx. 0.45V	
HO2S signal at open circuit (Pumping current ON)	Approx. 2.2V	

Diagnostic Circuit Diagram



Signal Waveform & Data


Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
3 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 0.72 V
Avg : 1.01 V
Cur b: 1.34 V
-500mV
a
b
+2V
O2 B2S2
Cur a: 1.33 V
Avg : 1.32 V
Cur b: 1.33 V
-500mV
Fig.1

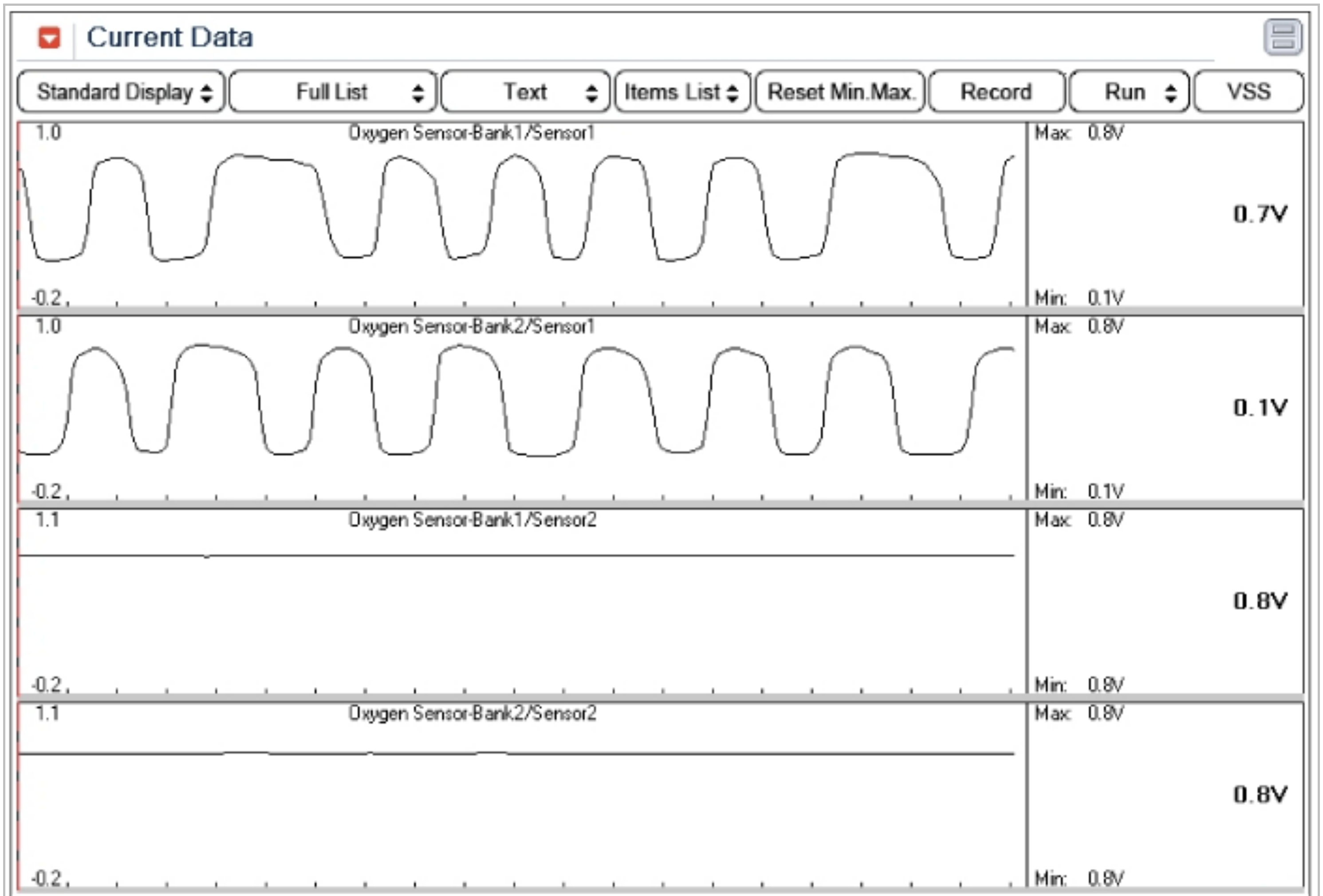
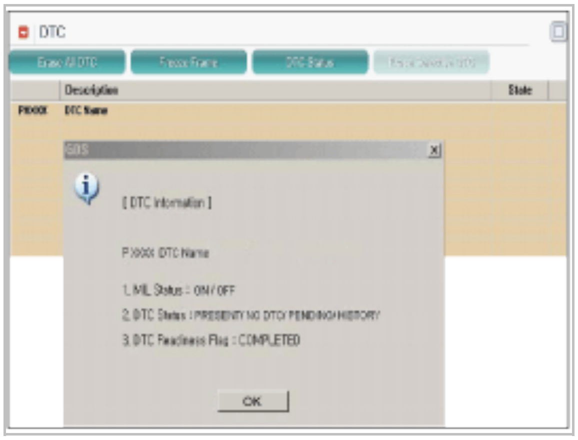


Fig.2

Fig.1) Normal waveforms of front HO2S(the upper) and rear HO2S(the lower)
Fig.2) Normal graph of front HO2S and rear HO2S at idle.
After warming-up, if accelerator pedal is released suddenly around 4000rpm, the HO2S signal reading will be lower than 200mV resulting from Fuel cut-off for the moment. Conversely, if suddenly accelerator pedal is depressed, HO2S signal reading will be around 0.6V ~1.0V. At idle, Normally HO2S signal will switch from lean to rich with 3 Hz. And as racing, Its frequency rises.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Component Inspection

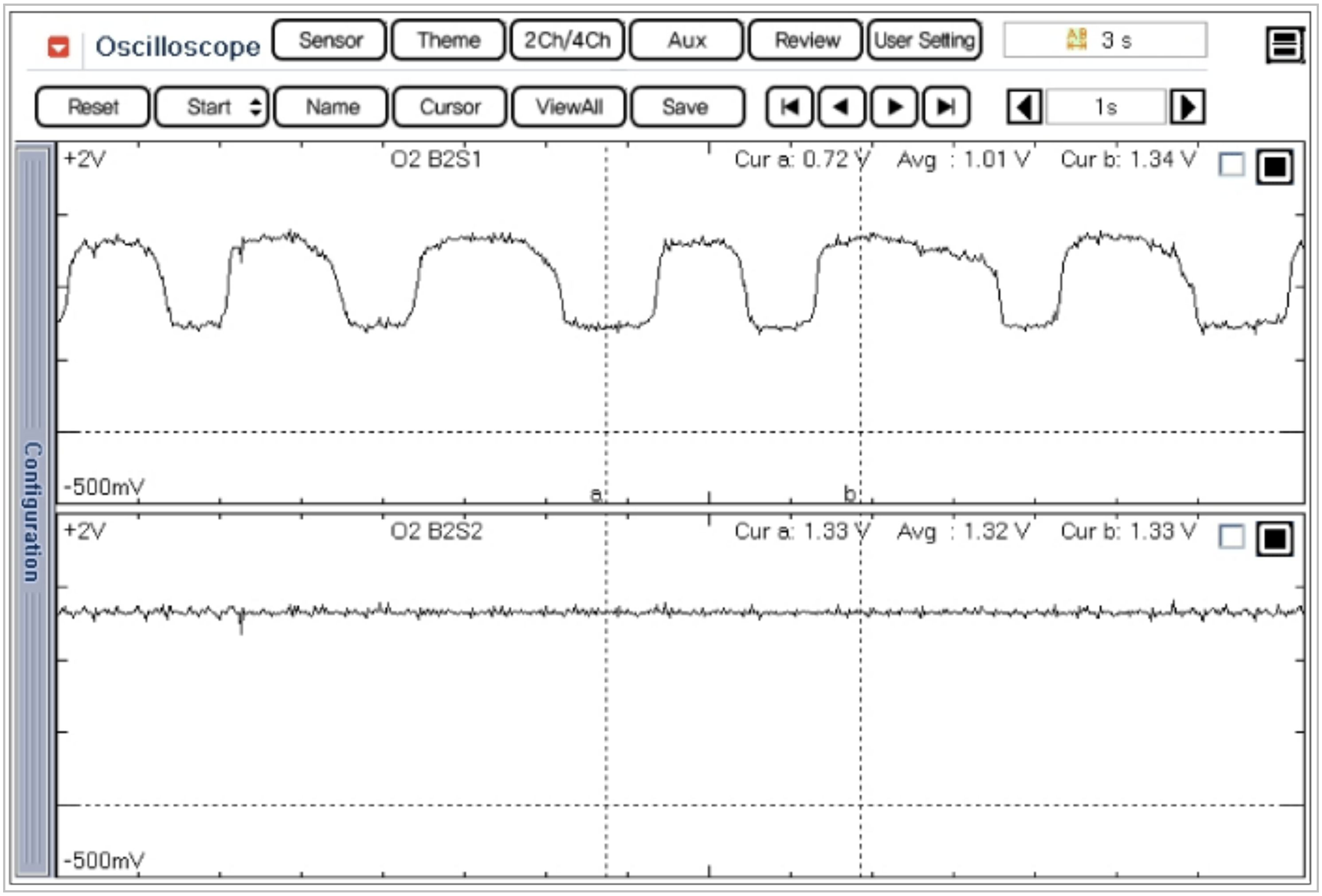
■ Check the condition of HO2S

1. Check HO2S for poor connection or loose terminal.
2. Check if HO2S is ensurely installed.
3. Is the conditions of HO2S normal ?

YES	▶ Go to "Check the Signal waveform of HO2S" as follows.
NO	▶ Repair it and then go to "Verification of Vehicle Repair" procedure.

■ Check the Signal waveform of HO2S

1. IG "OFF" and connect HO2S connector.
2. Engine start.
3. After warming-up, monitor signal waveform of HO2S with GDS.



4. Is the sensor switching properly?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

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

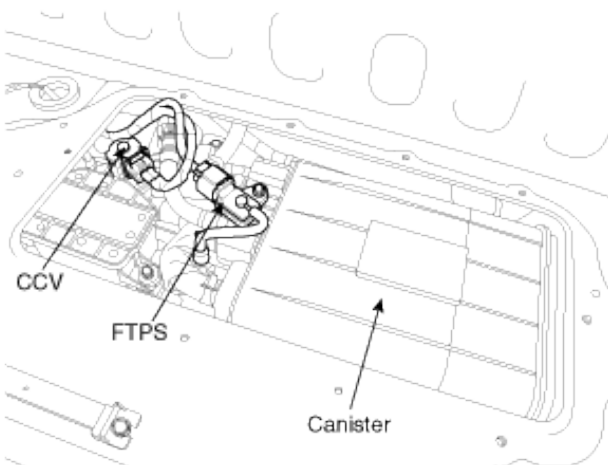
1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.

NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2422 Evaporative Emission System Vent Valve Stuck Closed

Component Location



General Description

The evaporative emission control system prevents hydrocarbon (HC) vapors from the fuel tank from escaping into the atmosphere where they could form photochemical smog. Gasoline vapors are collected in the charcoal canister. The ECM controls the Purge Control Solenoid Valve (PCSV) to purge any collected vapors from the canister back to the engine for combustion. This valve is actuated by the purge control signal from the ECM and controls fuel vapor flow from the canister to the intake manifold.

DTC Description

Checking output signals from fuel tank pressure sensor at purging, if fuel tank's vacuum is higher than prescribed threshold, ECM sets P2422.

DTC Detecting Condition

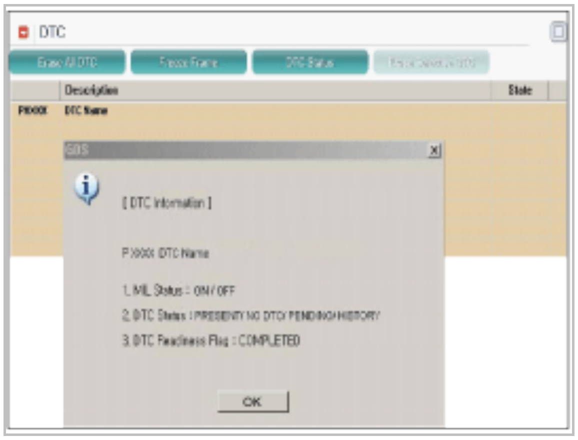
Item	Detecting Condition	Possible cause
DTC Strategy	• Monitor the fuel tank's vacuum	• Faulty Canister Close Valve • Clogging of canister air filter
Enable Conditions	• 10 V < Battery voltage < 16 V • Barometric pressure > 72 kPa (0.72 bar) • Engine coolant temperature at startup - Intake air temperature at startup < 6.7°C(12 °F) • Engine coolant temperature at startup: 4.5 ~ 35°C(40 ~ 95 °F) • Intake air temperature at startup: 4.5 ~ 35°C(40 ~ 95 °F) • Fuel level: 15 ~ 85 %	
Threshold value	• Fuel tank's vacuum at purging > a prescribed threshold	

Diagnosis Time	• Continuous	
MIL On Condition	• 2 Driving Cycles	

Monitor GDS Data

■ Check DTC Status

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Go to "Evap.Leakage Test" as below with GDS.

■ Evap. Leakage Test

1. Cool the vehicle down for about two hours to prevent misdiagnosis.
2. Install GDS and IG "ON" and then clear DTC.
3. Select and press "EVAP.LEAKAGE TEST" mode in the GDS.
4. Check if the vehicle is under test conditions as below [Fig 1].
5. If OK, Start engine and restart Evap.Leakage Test again[Fig 2].

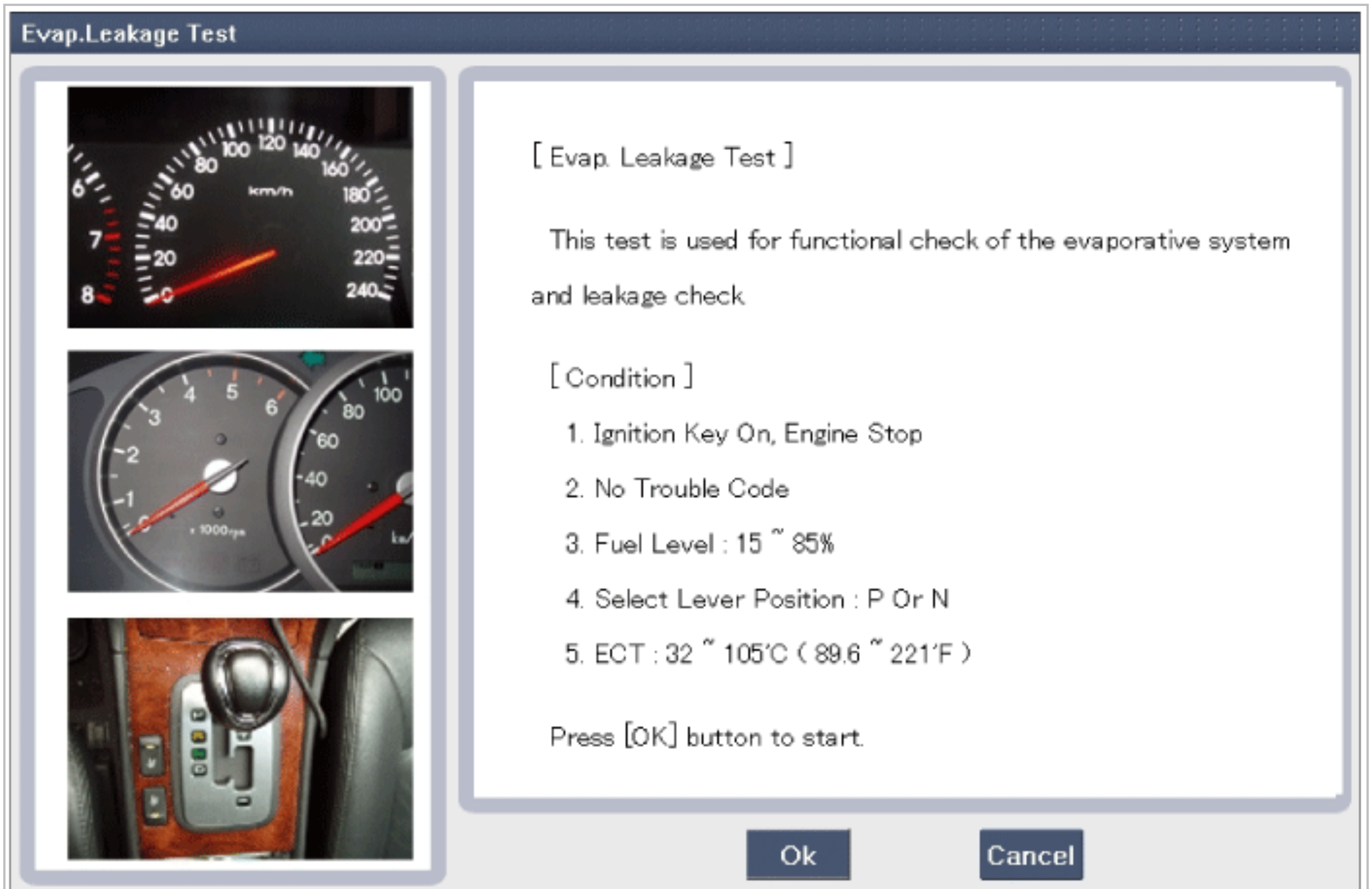


Fig.1

6. Is the same DTC set after the Evap.leakage test with GDS ?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Repeat "Evap.leakage test" with GDS after cool the vehicle down sufficiently. If the same DTC isn't displayed after the test, it was intermittent fault. Go to "Verification of vehicle Repair" procedure.

Component Inspection

■ Check Canister air filter and CCV

1. Visually inspect air filter is clogged.
2. Visually inspect duck between air filter and CCV is clogged.
3. Check that Canister is deformed or clogged by foreign materials.
4. Has a problem been found ?

YES	▶ Repair or replace as necessary and then go to "Verification of Vehicle Repair" procedure.
NO	▶ Carefully perform this troubleshooting procedures all over again from the beginning.

Verification of Vehicle Repair

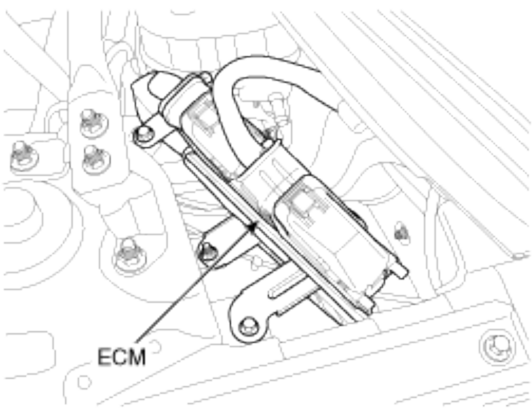
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2507 ECM/PCM power Input Signal Low

Component Location



General Description

When the ignition switch is turned "ON", battery voltage is applied from the battery to the ECM through the main relay. In case that the ignition switch is turned "OFF", the ECM is supplied with power through the battery power input line to control the basic operation of vehicle.

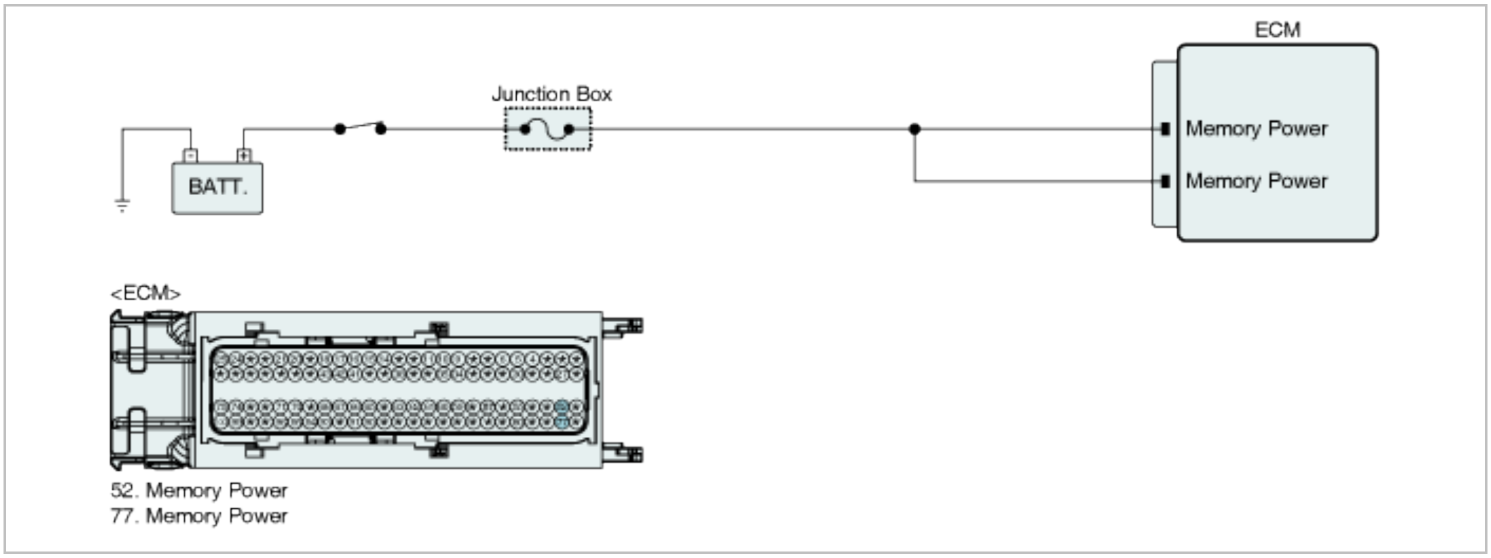
DTC Description

If the battery power input line has a problem, ECM sets P2507 and MIL(Malfunction Indication Lamp) turns on.

DTC Detecting Condition

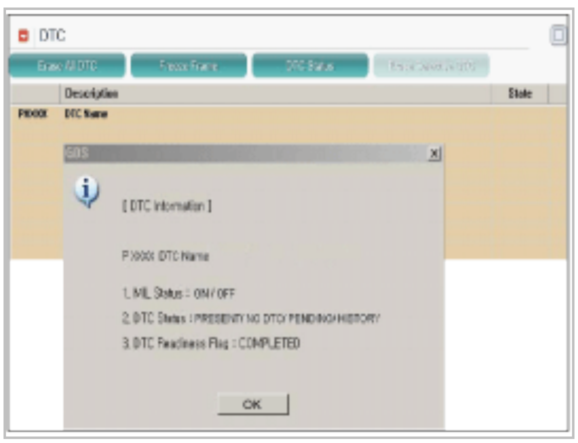
Item	Detecting Condition	Possible cause
DTC Strategy	• Monitor the battery power input line	• Poor connection • Open or short to ground in line • Faulty ECM
EnableConditions	• -	
Threshold value	• Open or short to ground in line	
Diagnosis Time	• Continuous (More than 5 sec. failure for every 10 sec.test)	
MIL On Condition	• 1 driving cycle	

Diagnostic Circuit Diagram



Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor’s and/or ECM’s connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.

2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure
NO	▶ Go to " Power Circuit Inspection " procedure.

Power Circuit Inspection

■ Check voltage

1. IG "OFF" and disconnect ECM connector
2. IG "ON"
3. Measure voltage between memory power terminal of ECM harness connector and chassis ground

Specification : Approx. B+

4. Is the measured voltage within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Check for open or short to ground in harness. ▶ Check whether fuse is installed or blown off. ▶ Repair or replace as necessary and then, go to "Verification of Vehicle Repair"procedure.

Verification of Vehicle Repair

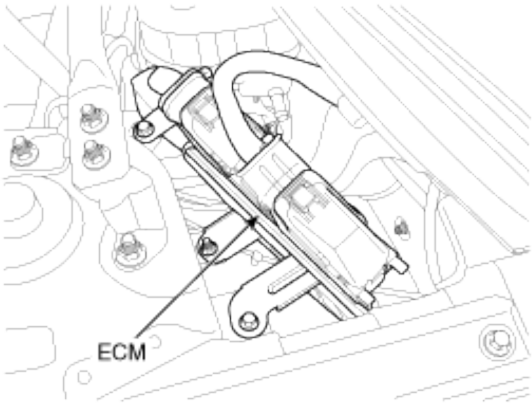
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2610 ECM / PCM-Engine Off Timer Performance

Component Location



General Description

Continuing to calculate data of several sensor despite turning ignition OFF, when ignition turns ON, ECM enables turning ignition ON to be easy using calculated data.

DTC Description

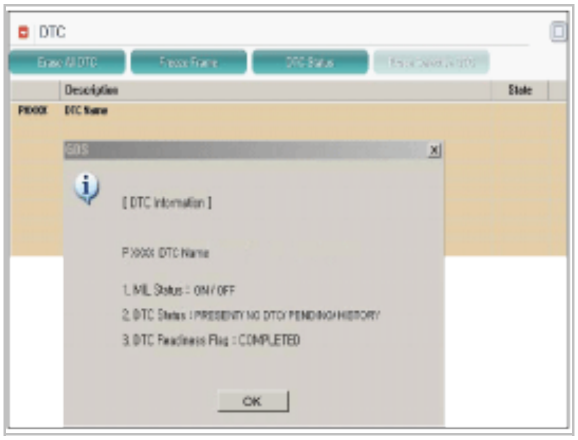
If abnormal counterdown is detected for a calibratable time, ECM sets P2610. And then MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycles.

DTC Detecting Condition

Item		Detecting Condition	Possible cause
DTC Strategy	Case1	• Compares the time elapsed recorded by the LPC(Low Power Counter) against that recorded by the test timer	• ECM • Poor Battery Condition • Connecting condition
	Case2	• Checks for abnormal resets of the LPC	
Enable Conditions	Case1	• Engine running > 10sec. • Battery voltage > 8V	
	Case2	• No Memory Failure Occurred	
Threshold value	Case1	• The difference between the counter the LPC and the calibration the test timer clocks up > 20sec.	
	Case2	• The LPC is reset to zero abnormally	
Diagnosis Time		• -	
MIL On Condition		• 2 Driving Cycles	

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor’s and/or ECM’s connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure
NO	▶ Go to "Component Inspection" procedure

Component Inspection

■ Battery Voltage Check

1. IG "ON"
2. Measure the voltage between + and - terminal of battery.

Specification : Above 11V

3. Is the measured voltage within specification ?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others

NO	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

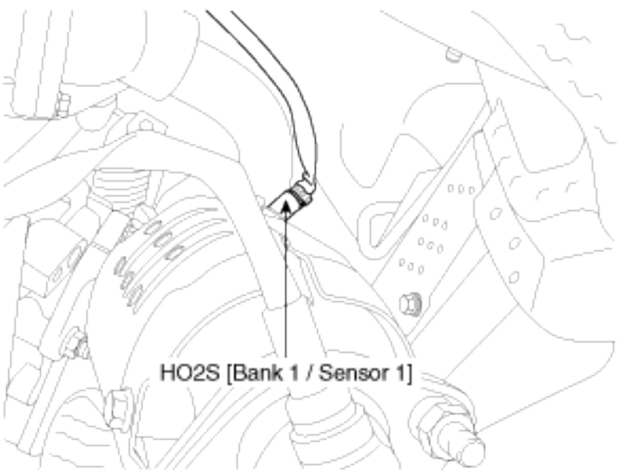
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2A00 HO2S Not Ready (Bank 1 / Sensor 1)

Component Location



General Description

In order to control emissions of the CO, HC and NOx components of the exhaust gas, heated oxygen sensor (HO2S), mounted on the front side and rear side of catalytic converter, detects the oxygen content in the exhaust gas. The front HO2S signal is used to control air/fuel ratio (closed loop fuel control) and the rear HO2S signal is used to monitor front HO2S and catalyst for proper operation. The HO2S requires a minimum temperature to operate properly and provide a closed loop fuel control system. The HO2S contains the heater element to reduce its warming-up time and ensure its performance during all driving conditions. The oxygen sensor generates a voltage that indicates the difference between the oxygen content of the exhaust stream and the oxygen content of ambient air. When the exhaust stream is “rich,” there is more oxygen in the ambient air than in the exhaust stream, so the voltage will be higher.

DTC Description

Checking output signals from HO2S under detecting condition, if HO2S is not ready, ECM sets P2A00.

DTC Detecting Condition

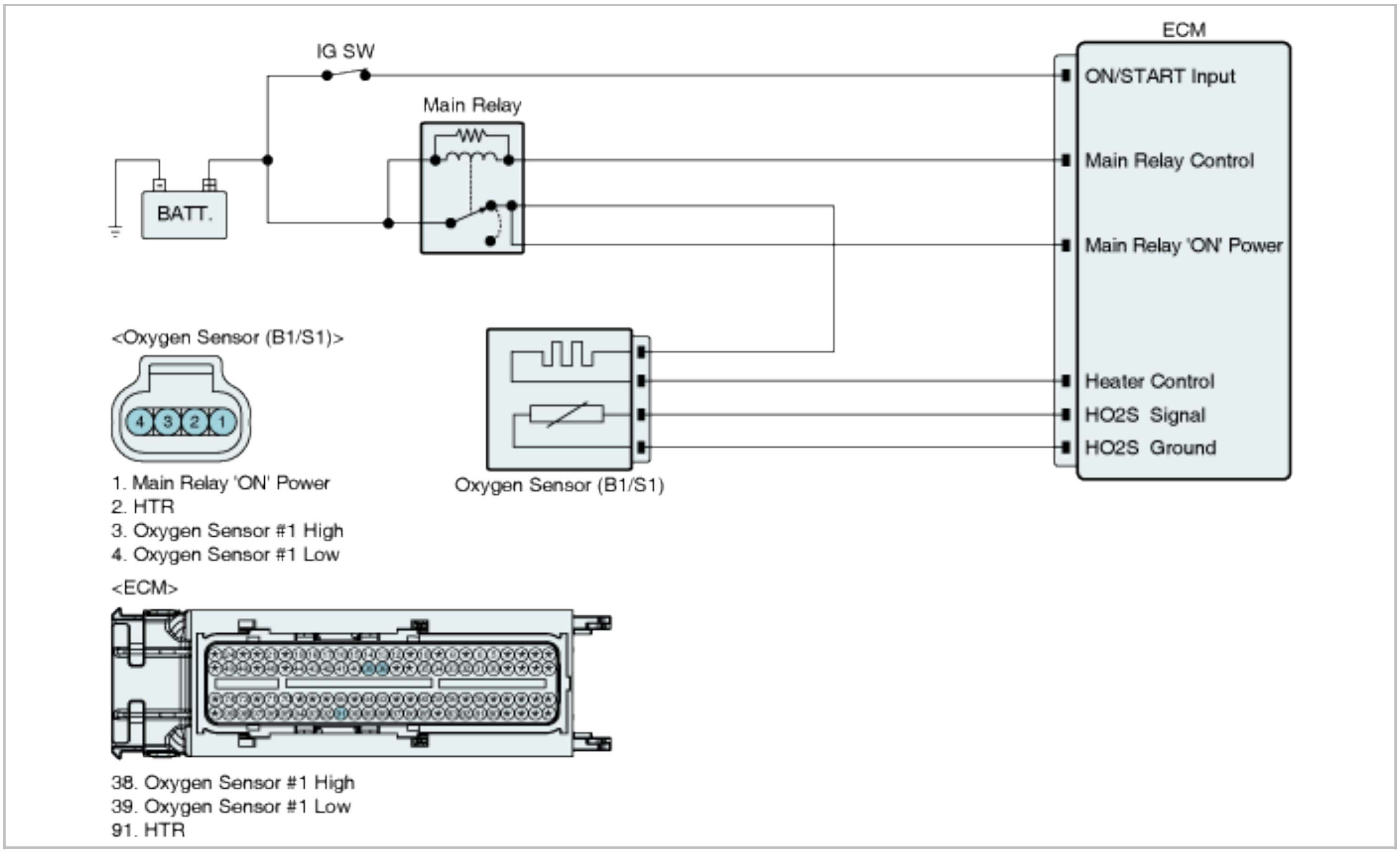
Item	Detecting Condition	Possible cause
DTC Strategy	• Monitor HO2S status	• Poor connection • Faulty HO2S • Faulty ECM
Enable Conditions	• Engine Running at idle > 20 sec.	
Threshold value	• HO2S is not ready	
Diagnosis Time	• Continuous (More than 10 second failure for every 12 second test .)	
MIL On Condition	• 2 driving cycle	

Specification

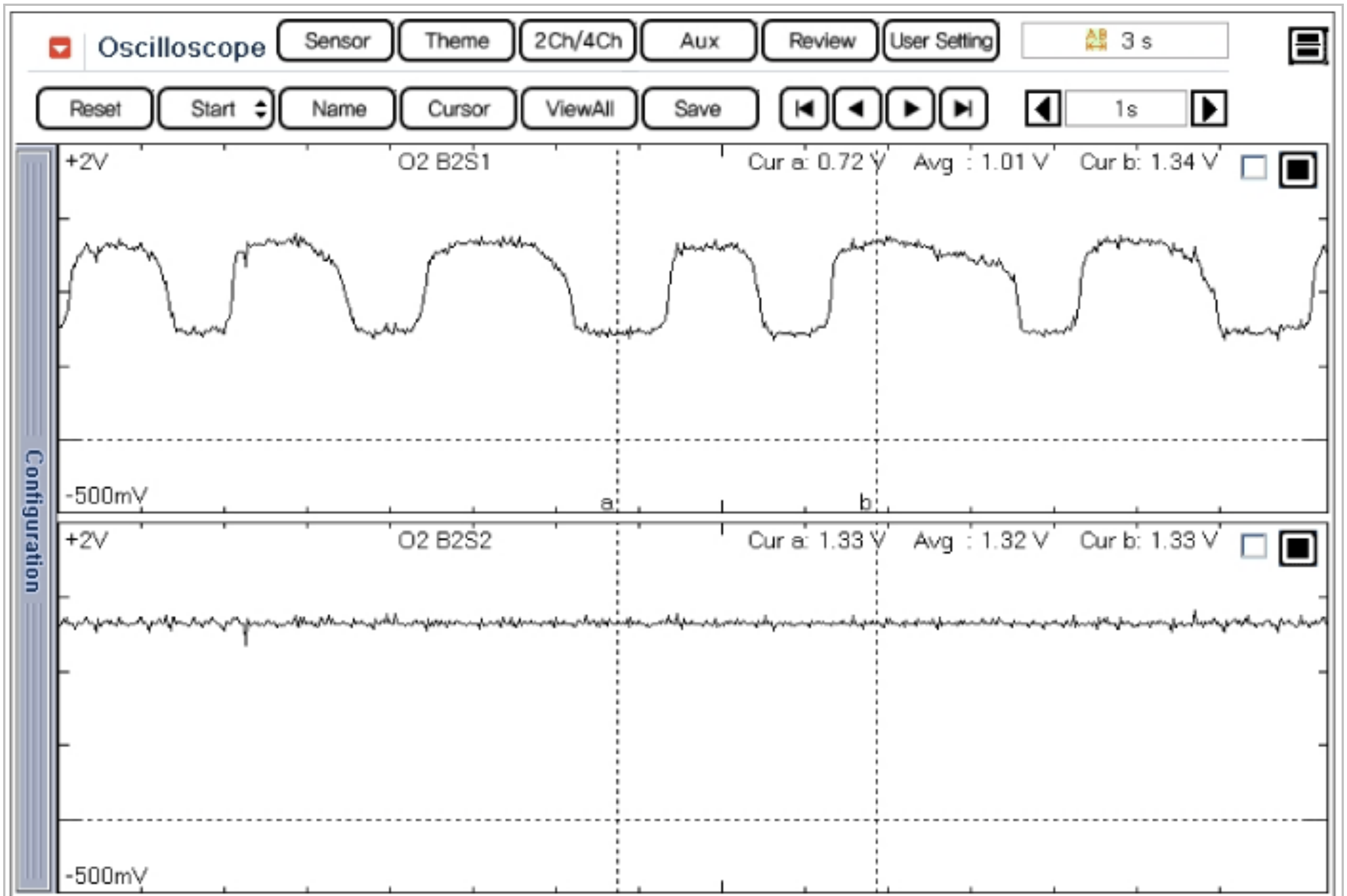
(Reference only)

Test Condition	HO2S Voltage(Sensor1)	HO2S Voltage(Sensor2)
HO2S Signal at idle after warm-up	Signal is commonly switching from rich to lean more than 3 times in 10 sec.	Signal is commonly above 0.6V.
HO2S signal at open circuit (Pumping current OFF)	Approx. 0.45V	
HO2S signal at open circuit (Pumping current ON)	Approx. 2.2V	

Diagnostic Circuit Diagram



Signal Waveform & Data



Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
3 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 0.72 V
Avg : 1.01 V
Cur b: 1.34 V
-500mV
a
b
+2V
O2 B2S2
Cur a: 1.33 V
Avg : 1.32 V
Cur b: 1.33 V
-500mV

Fig.1

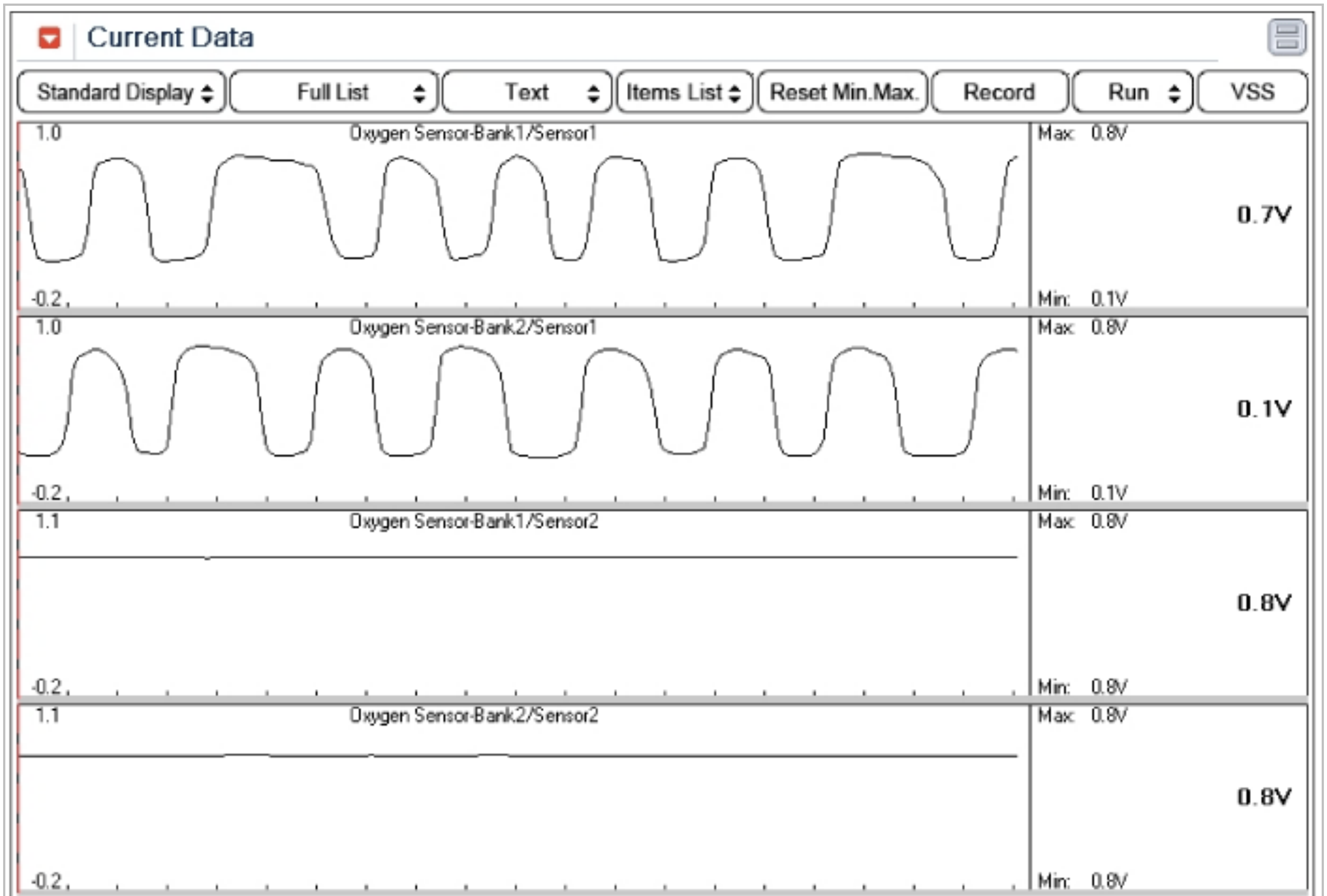
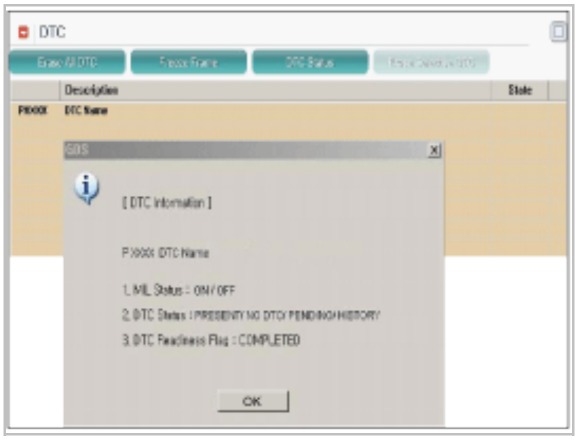


Fig.2

Fig.1) Normal waveforms of front HO2S(the upper) and rear HO2S(the lower)
Fig.2) Normal graph of front HO2S and rear HO2S at idle.
After warming-up, if accelerator pedal is released suddenly around 4000rpm, the HO2S signal reading will be lower than 200mV resulting from Fuel cut-off for the moment. Conversely, if suddenly accelerator pedal is depressed, HO2S signal reading will be around 0.6V ~1.0V. At idle, Normally HO2S signal will switch from lean to rich with 3 Hz. And as racing, Its frequency rises.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



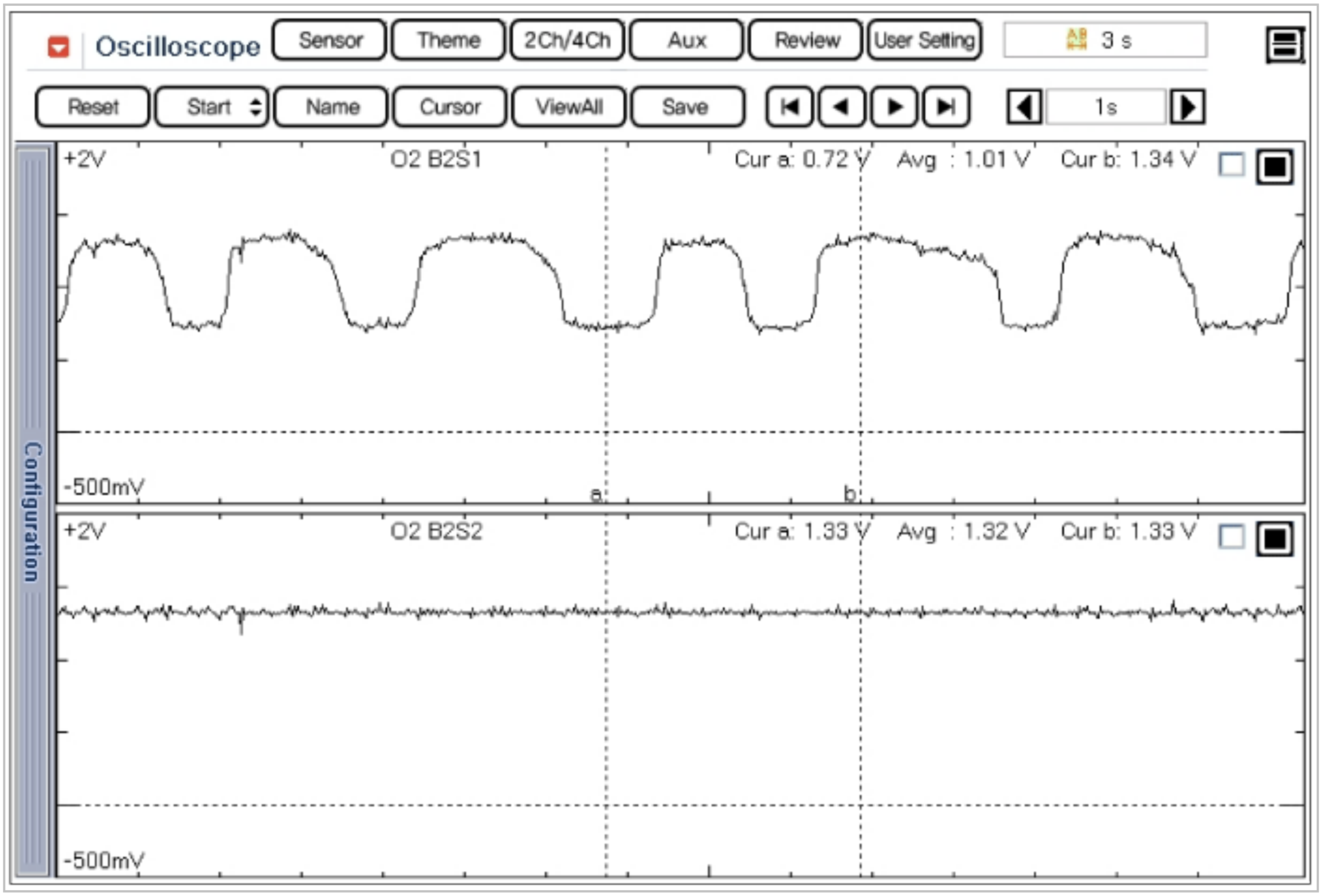
5. Is parameter displayed "Present fault"?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check the Signal waveform of HO2S

1. IG "OFF" and connect HO2S connector.
2. Engine start.
3. After warming-up, monitor signal waveform of HO2S with GDS.



4. Is the sensor switching properly?

YES	▶ Check HO2S for poor connection/ installation or damage. If O.K., Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others.
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

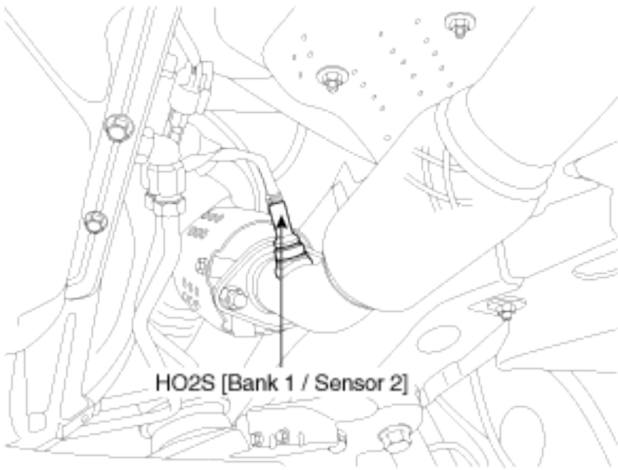
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2A01 HO2S Sensor Circuit Range/Performance(Bank1/Sensor2)

Component Location



General Description

The rear heated oxygen sensor is mounted on the rear side of the Catalytic Converter (warm-up catalytic converter) or in the rear exhaust pipe, which is able to detect catalyst efficiency. The rear heated oxygen sensor (HO2S) produces a voltage between 0V and 1V. This rear heated oxygen sensor is used to estimate the oxygen storage capability. If a catalyst has good conversion properties, the oxygen fluctuations are smoothed by the oxygen storage capacity of the catalyst. If the conversion provided by the catalyst is low due to aging, poisoning or misfiring, then the oxygen fluctuations are similar to signals from the front oxygen sensor.

DTC Description

Checking output signals from HO2S during deceleration fuel cut-off, if the HO2S's response time is too long, ECM sets P2A01. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycles.

DTC Detecting Condition

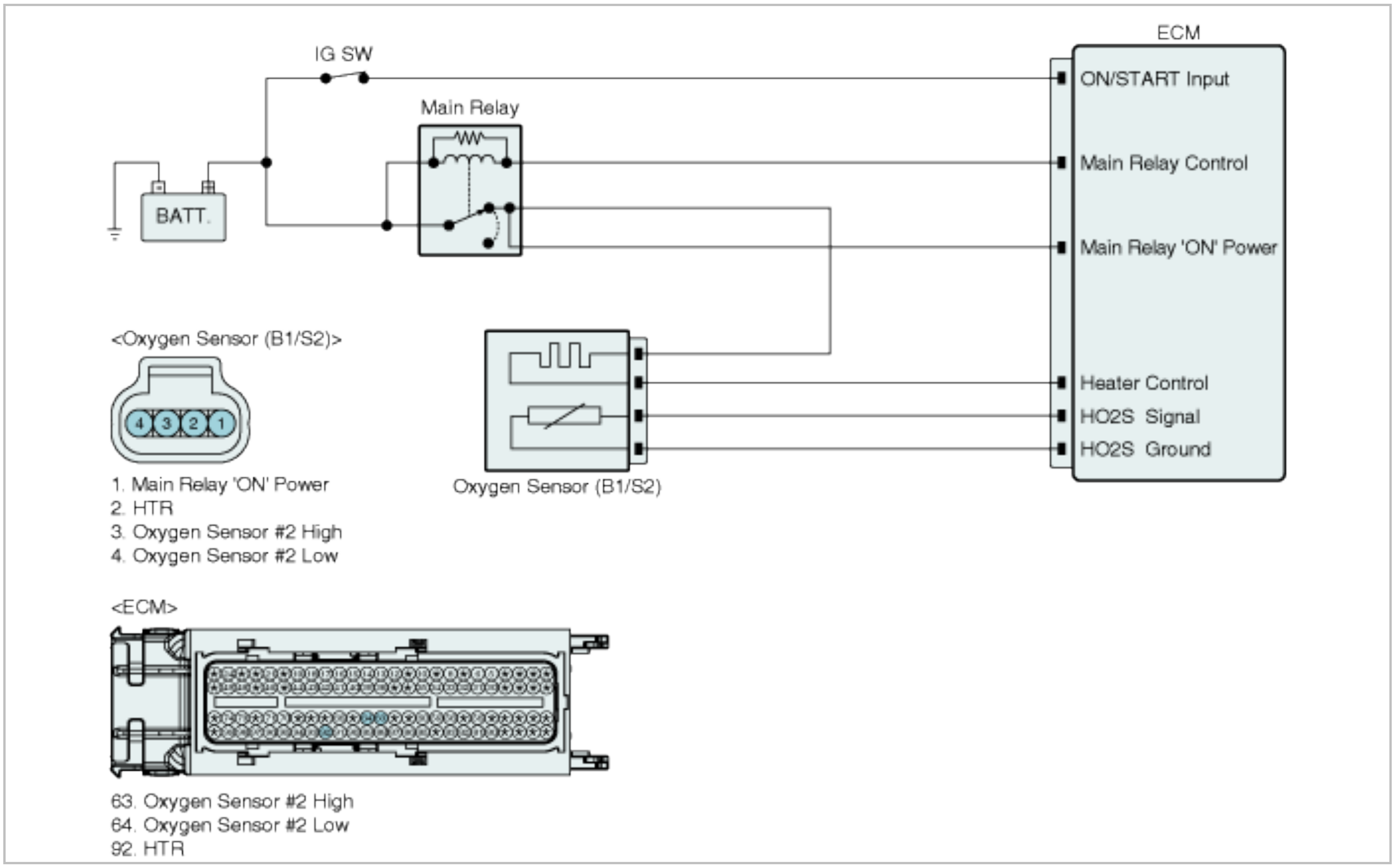
Item	Detecting Condition	Possible cause
DTC Strategy	• Monitor HO2S's response	• Poor connection • Faulty HO2S • Faulty ECM
Enable Conditions	• After engine warming-up • Deceleration fuel cut-off state • No other disabling faults	
Threshold value	• The average time for voltage drop > approx. 0.3 seconds	
Diagnosis Time	• During deceleration fuel cut-off	
MIL On Condition	• 2 driving cycle	

Specification

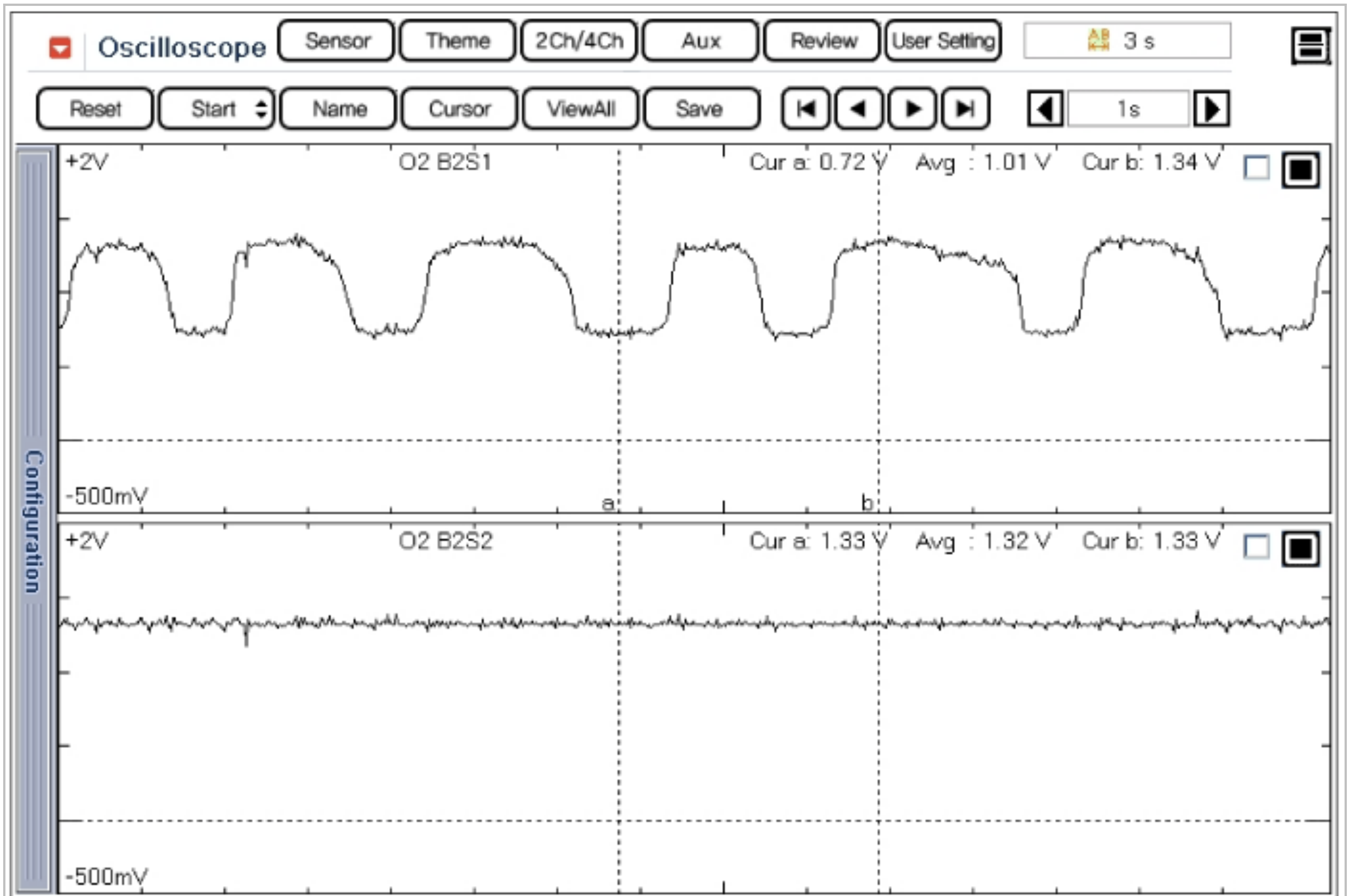
(Reference only)

Test Condition	HO2S Voltage(Sensor1)	HO2S Voltage(Sensor2)
HO2S Signal at idle after warm-up	Signal is commonly switching from rich to lean more than 3 times in 10 sec.	Signal is commonly above 0.6V.
HO2S signal at open circuit (Pumping current OFF)	Approx. 0.45V	
HO2S signal at open circuit (Pumping current ON)	Approx. 2.2V	

Diagnostic Circuit Diagram



Signal Waveform & Data


Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
3 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 0.72 V
Avg : 1.01 V
Cur b: 1.34 V
-500mV
a
b
+2V
O2 B2S2
Cur a: 1.33 V
Avg : 1.32 V
Cur b: 1.33 V
-500mV
Fig.1

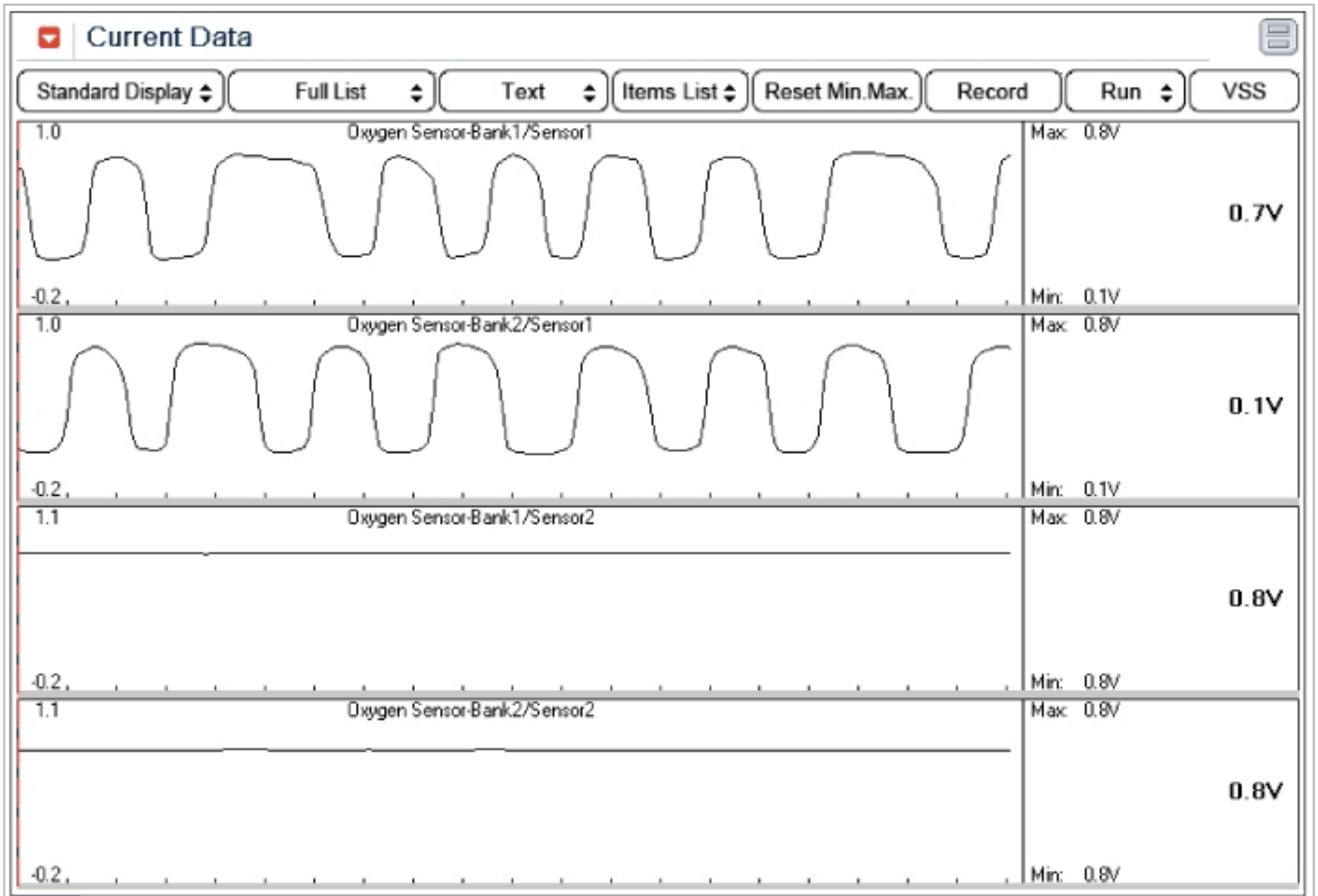
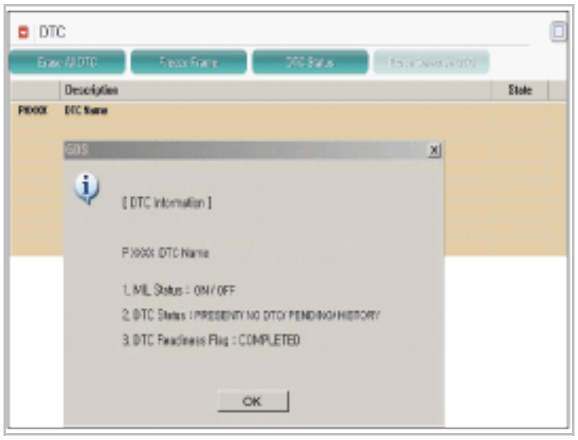


Fig.2

Fig.1) Normal waveforms of front HO2S(the upper) and rear HO2S(the lower)
Fig.2) Normal graph of front HO2S and rear HO2S at idle.
After warming-up, if accelerator pedal is released suddenly around 4000rpm, the HO2S signal reading will be lower than 200mV resulting from Fuel cut-off for the moment. Conversely, if suddenly accelerator pedal is depressed, HO2S signal reading will be around 0.6V ~1.0V. At idle, Normally HO2S signal will switch from lean to rich with 3 Hz. And as racing, Its frequency rises.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor’s and/or ECM’s connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Component Inspection

1. Replace the HO2S.
2. Clear DTC with GDS.
3. Start the engine and warm it up until the radiator fan comes on(more than at least 10 minutes).
4. Drive at a steady speed between 45-55 mph(72-88 km/h) and then release the accelerator(tip-out).
5. Repeat Step 4 to 5 more than 5 times.
6. Does the GDS show DTC?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. . **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others.
NO	▶ Troubleshooting is finished.

Verification of Vehicle Repair

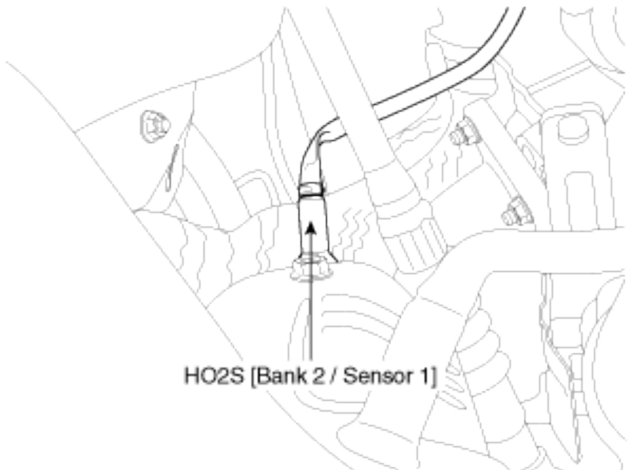
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2A03 HO2S Not Ready (Bank 2 / Sensor 1)

Component Location



General Description

In order to control emissions of the CO, HC and NOx components of the exhaust gas, heated oxygen sensor (HO2S), mounted on the front side and rear side of catalytic converter, detects the oxygen content in the exhaust gas. The front HO2S signal is used to control air/fuel ratio (closed loop fuel control) and the rear HO2S signal is used to monitor front HO2S and catalyst for proper operation. The HO2S requires a minimum temperature to operate properly and provide a closed loop fuel control system. The HO2S contains the heater element to reduce its warming-up time and ensure its performance during all driving conditions. The oxygen sensor generates a voltage that indicates the difference between the oxygen content of the exhaust stream and the oxygen content of ambient air. When the exhaust stream is “rich,” there is more oxygen in the ambient air than in the exhaust stream, so the voltage will be higher.

DTC Description

Checking output signals from HO2S under detecting condition, if HO2S is not ready, ECM sets P2A03.

DTC Detecting Condition

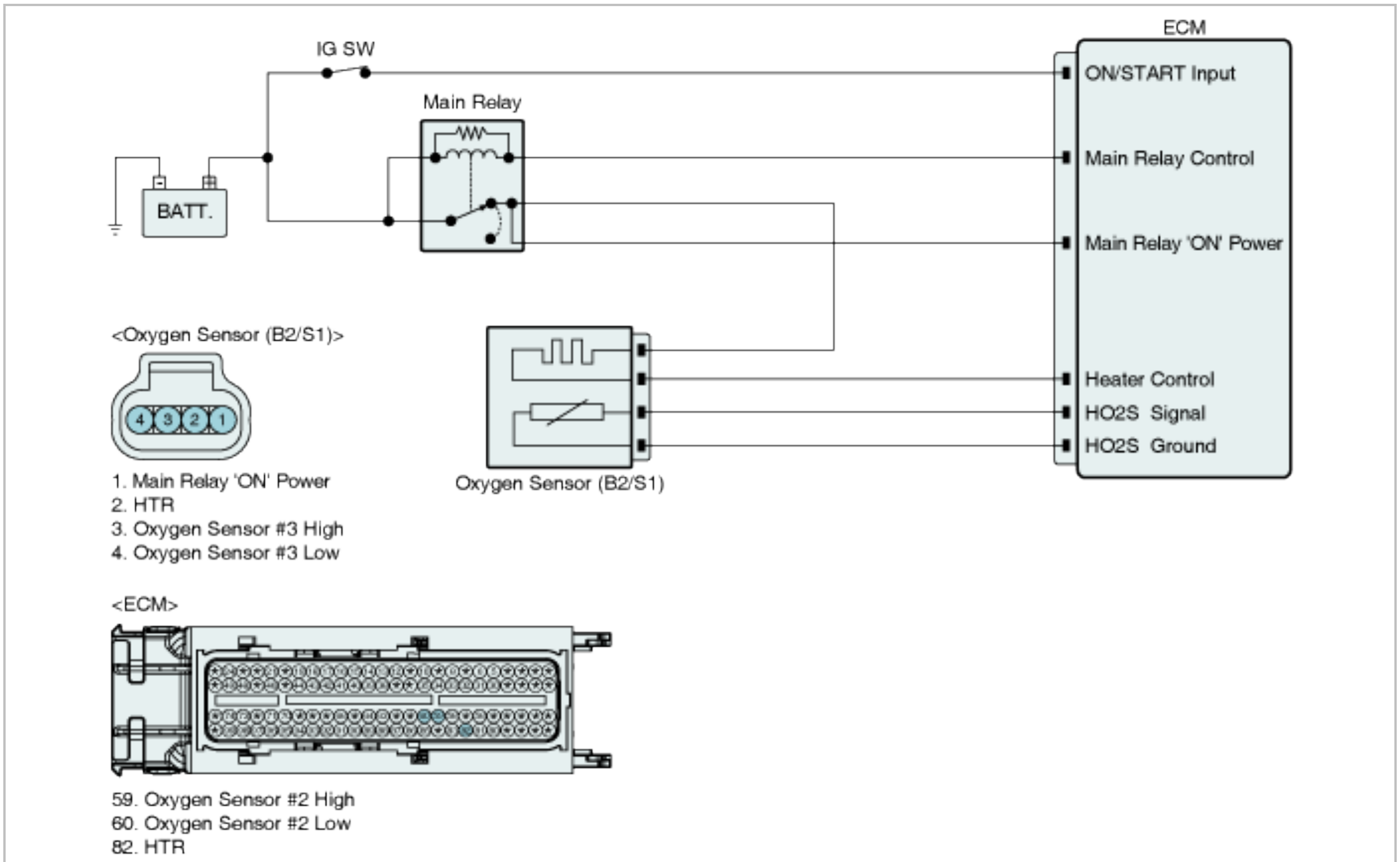
Item	Detecting Condition	Possible cause
DTC Strategy	• Monitor HO2S status	• Poor connection • Faulty HO2S • Faulty ECM
Enable Conditions	• Engine Running at idle > 20 sec.	
Threshold value	• HO2S is not ready	
Diagnosis Time	• Continuous (More than 10 second failure for every 12 second test .)	
MIL On Condition	• 2 driving cycle	

Specification

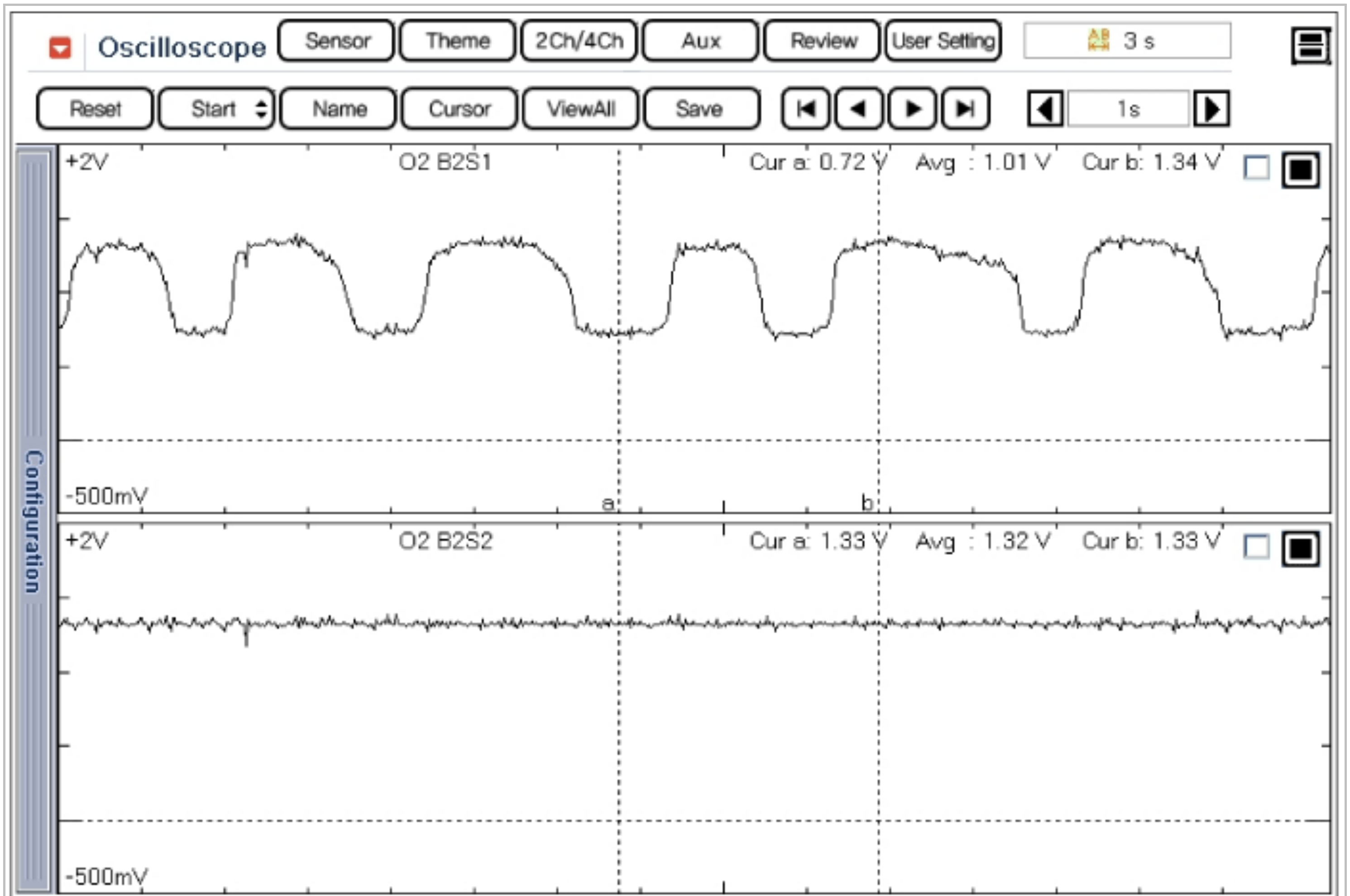
(Reference only)

Test Condition	HO2S Voltage(Sensor1)	HO2S Voltage(Sensor2)
HO2S Signal at idle after warm-up	Signal is commonly switching from rich to lean more than 3 times in 10 sec.	Signal is commonly above 0.6V.
HO2S signal at open circuit (Pumping current OFF)	Approx. 0.45V	
HO2S signal at open circuit (Pumping current ON)	Approx. 2.2V	

Diagnostic Circuit Diagram



Signal Waveform & Data



Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
3 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 0.72 V
Avg : 1.01 V
Cur b: 1.34 V
-500mV
a
b
+2V
O2 B2S2
Cur a: 1.33 V
Avg : 1.32 V
Cur b: 1.33 V
-500mV

Fig.1

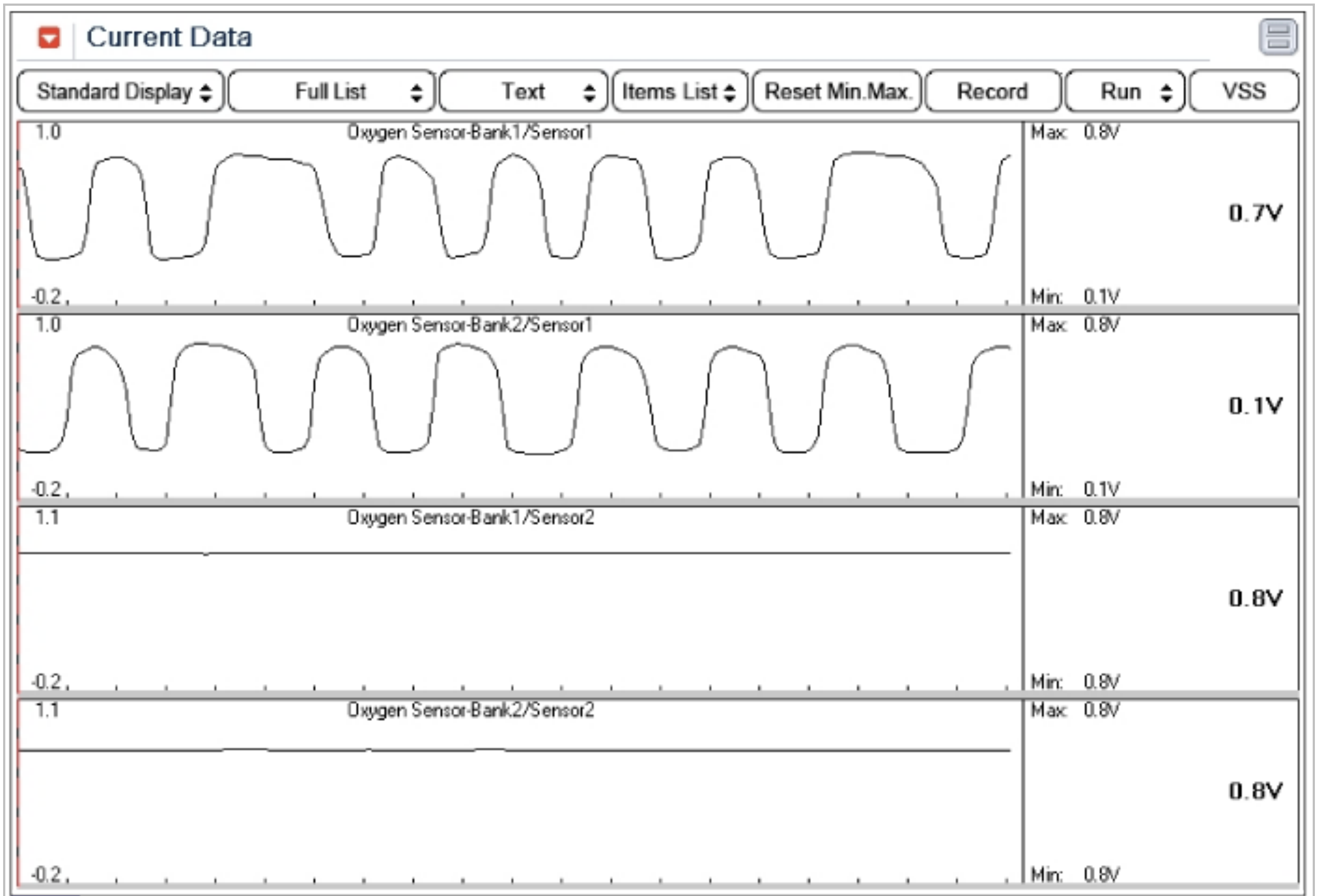


Fig.2

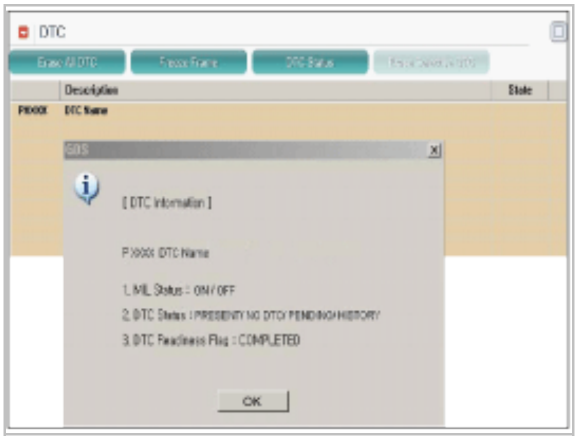
Fig.1) Normal waveforms of front HO2S(the upper) and rear HO2S(the lower)

Fig.2) Normal graph of front HO2S and rear HO2S at idle.

After warming-up, if accelerator pedal is released suddenly around 4000rpm, the HO2S signal reading will be lower than 200mV resulting from Fuel cut-off for the moment. Conversely, if suddenly accelerator pedal is depressed, HO2S signal reading will be around 0.6V ~1.0V. At idle, Normally HO2S signal will switch from lean to rich with 3 Hz. And as racing, Its frequency rises.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



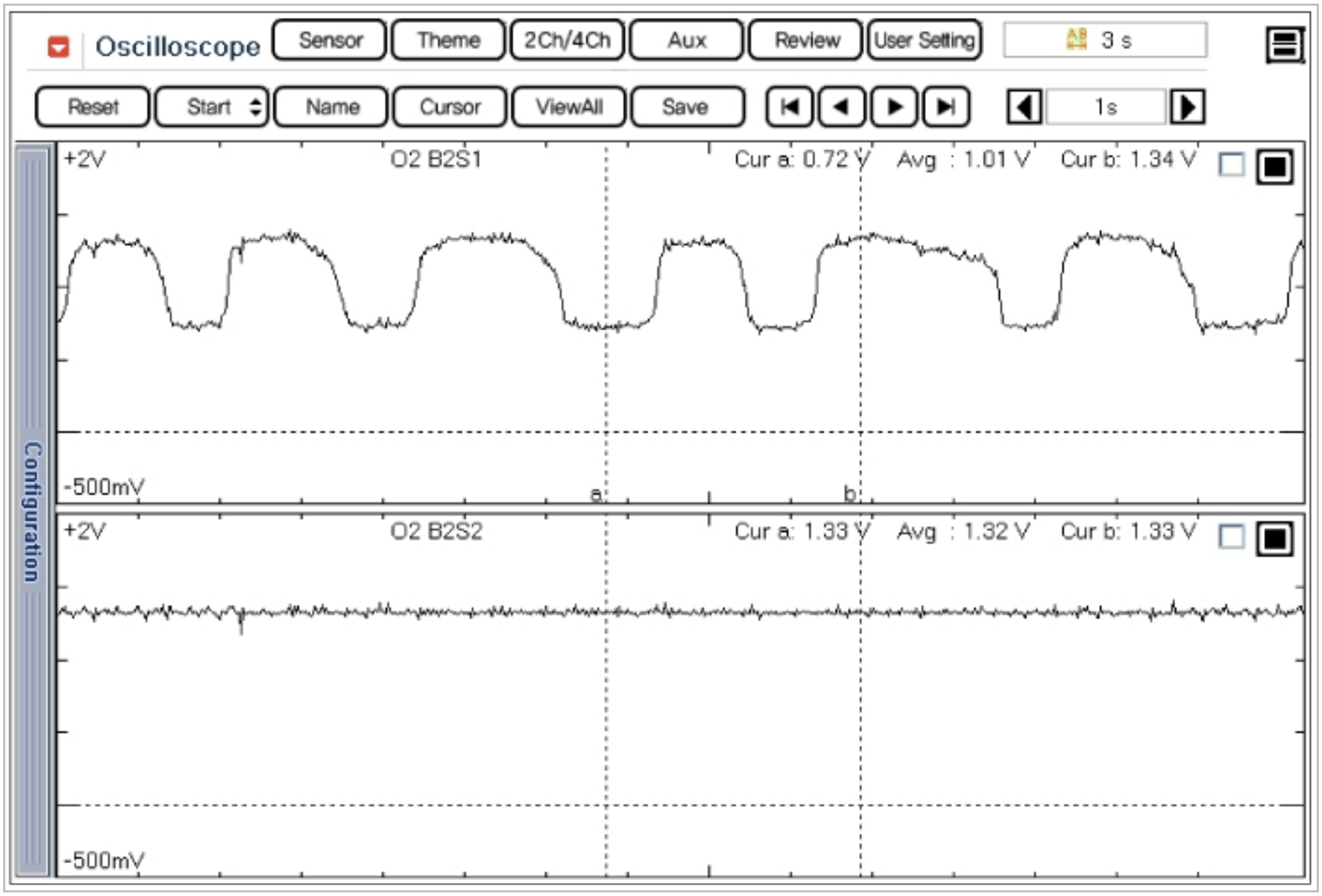
5. Is parameter displayed "Present fault"?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Component Inspection

■ Check the Signal waveform of HO2S

1. IG "OFF" and connect HO2S connector.
2. Engine start.
3. After warming-up, monitor signal waveform of HO2S with GDS.



4. Is the sensor switching properly?

YES	▶ Check HO2S for poor connection/ installation or damage. If O.K., Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Substitute with a known - good HO2S and check for proper operation. If the problem is corrected, go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

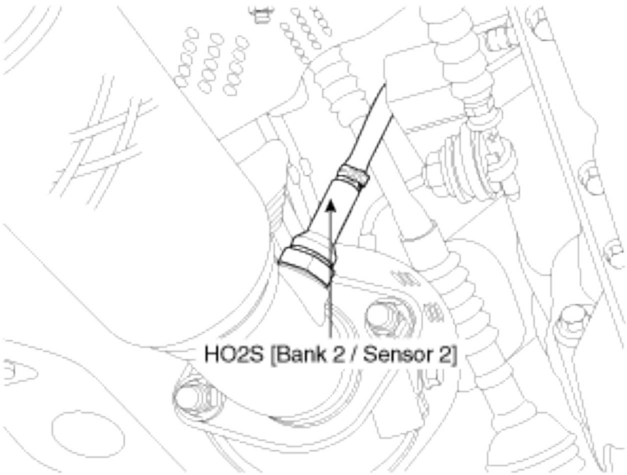
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > P2A04 HO2S Sensor Circuit Range/Performance(Bank2/Sensor2)

Component Location



General Description

The rear heated oxygen sensor is mounted on the rear side of the Catalytic Converter (warm-up catalytic converter) or in the rear exhaust pipe, which is able to detect catalyst efficiency. The rear heated oxygen sensor (HO2S) produces a voltage between 0V and 1V. This rear heated oxygen sensor is used to estimate the oxygen storage capability. If a catalyst has good conversion properties, the oxygen fluctuations are smoothed by the oxygen storage capacity of the catalyst. If the conversion provided by the catalyst is low due to aging, poisoning or misfiring, then the oxygen fluctuations are similar to signals from the front oxygen sensor.

DTC Description

Checking output signals from HO2S during deceleration fuel cut-off, if the HO2S's response time is too long, ECM sets P2A04. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycles.

DTC Detecting Condition

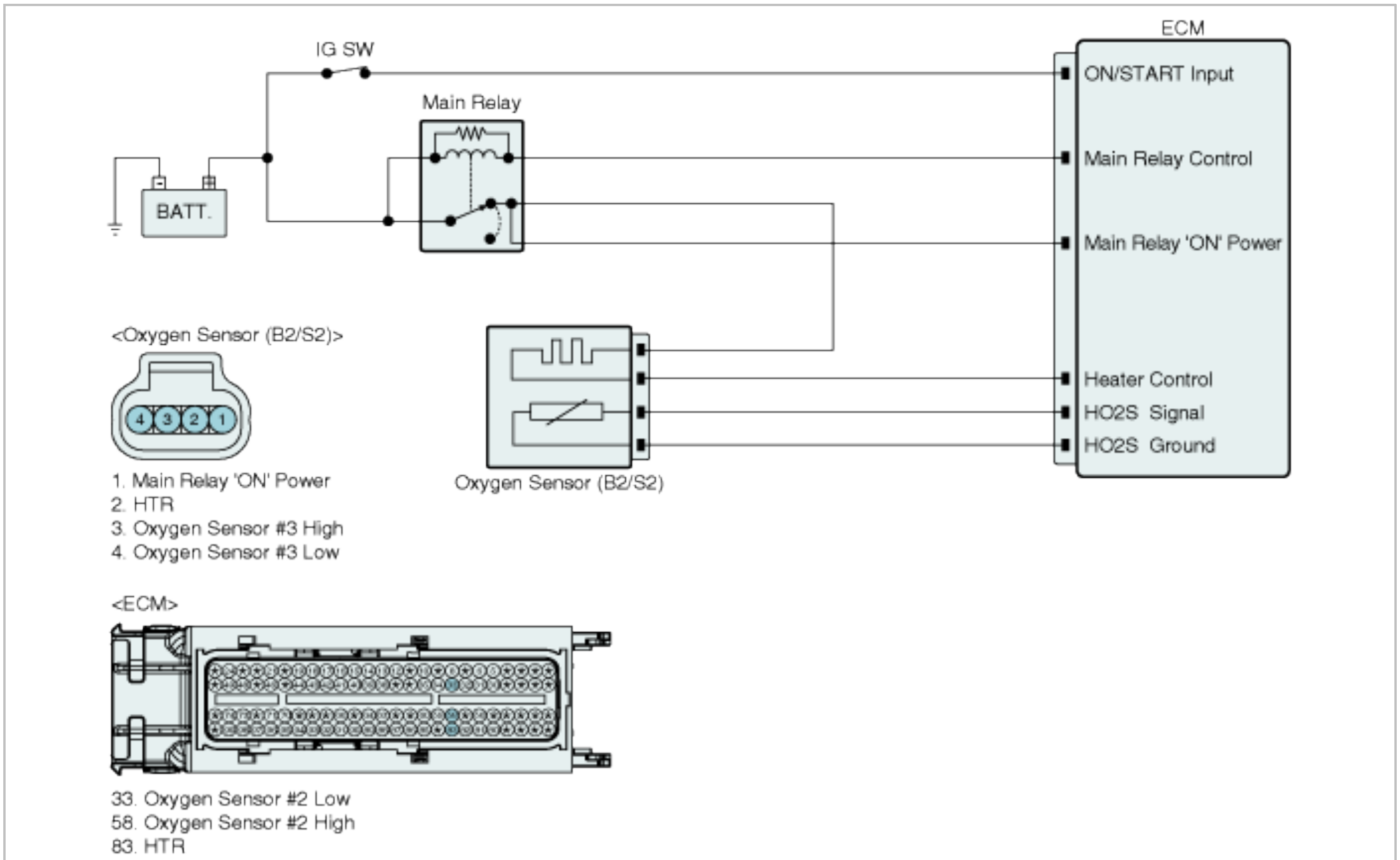
Item	Detecting Condition	Possible cause
DTC Strategy	• Monitor HO2S's response	• Poor connection • Faulty HO2S • Faulty ECM
Enable Conditions	• After engine warming-up • Deceleration fuel cut-off state • No other disabling faults	
Threshold value	• The average time for voltage drop > approx. 0.3 seconds	
Diagnosis Time	• During deceleration fuel cut-off	
MIL On Condition	• 2 driving cycle	

Specification

(Reference only)

Test Condition	HO2S Voltage(Sensor1)	HO2S Voltage(Sensor2)
HO2S Signal at idle after warm-up	Signal is commonly switching from rich to lean more than 3 times in 10 sec.	Signal is commonly above 0.6V.
HO2S signal at open circuit (Pumping current OFF)	Approx. 0.45V	
HO2S signal at open circuit (Pumping current ON)	Approx. 2.2V	

Diagnostic Circuit Diagram



Signal Waveform & Data

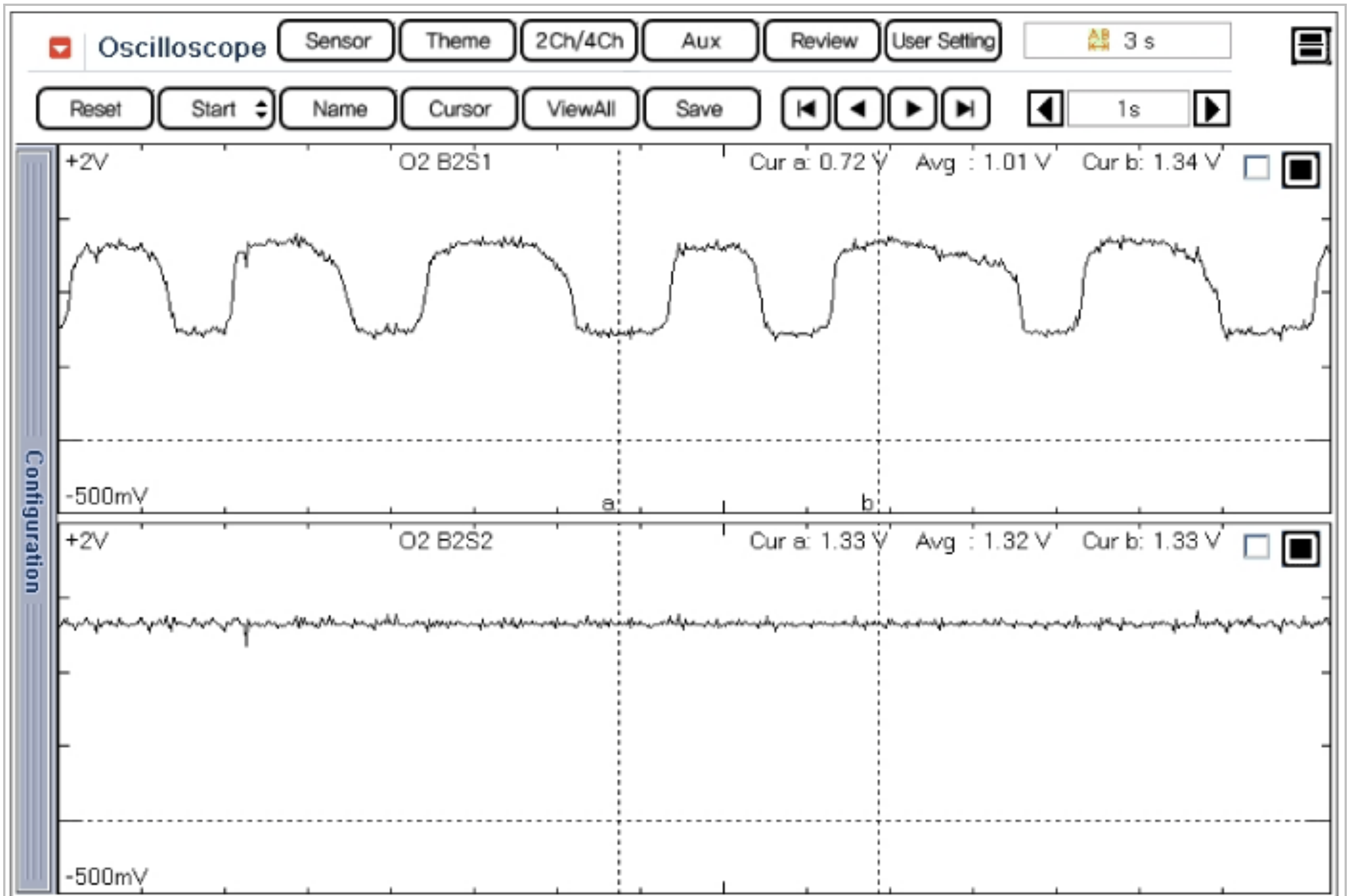

Oscilloscope
Sensor
Theme
2Ch/4Ch
Aux
Review
User Setting
3 s
Reset
Start
Name
Cursor
ViewAll
Save
1s
Configuration
+2V
O2 B2S1
Cur a: 0.72 V
Avg : 1.01 V
Cur b: 1.34 V
-500mV
a
b
+2V
O2 B2S2
Cur a: 1.33 V
Avg : 1.32 V
Cur b: 1.33 V
-500mV

Fig.1

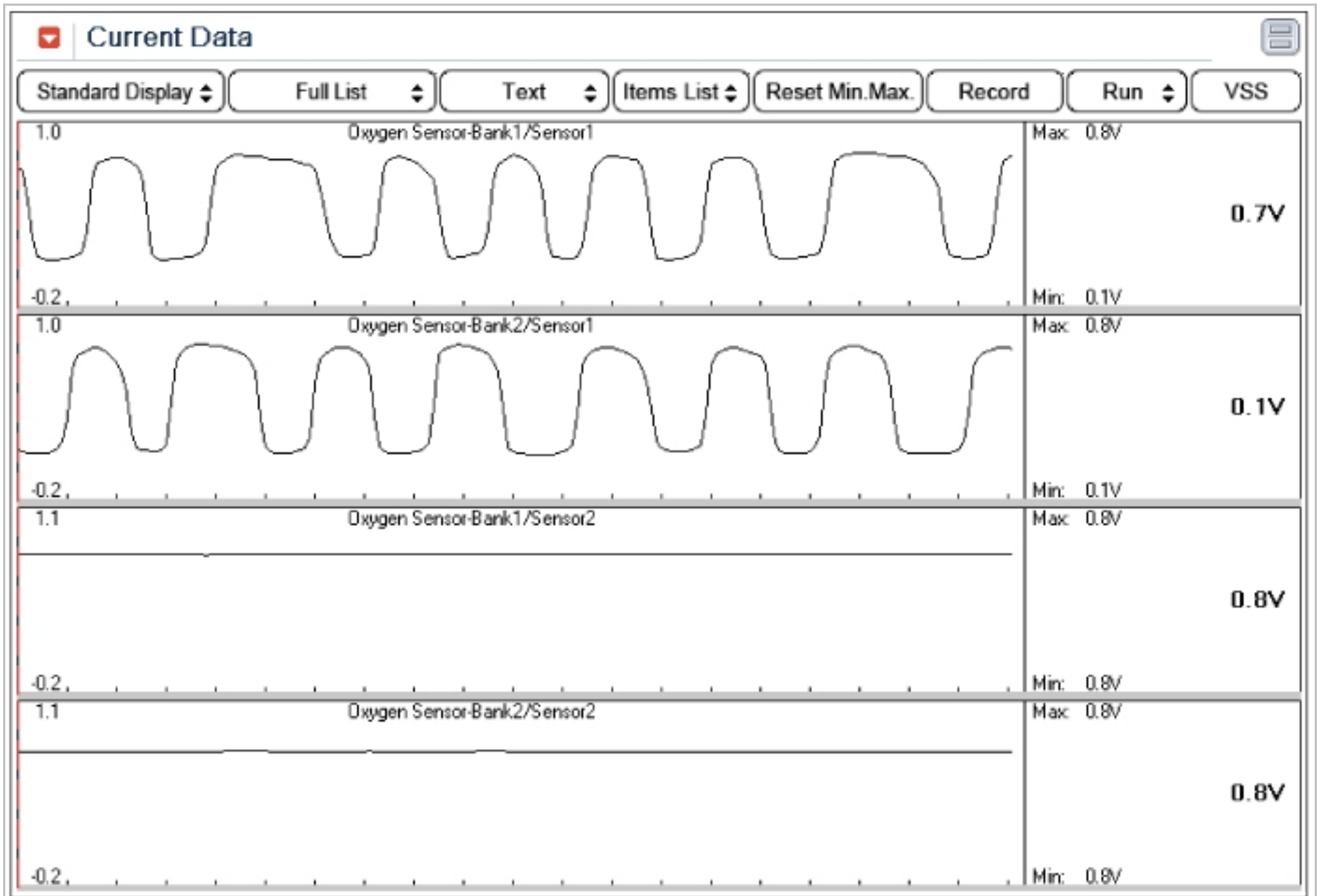
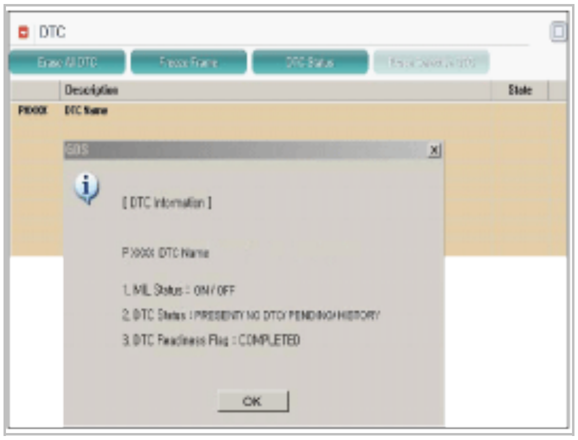


Fig.2

Fig.1) Normal waveforms of front HO2S(the upper) and rear HO2S(the lower)
Fig.2) Normal graph of front HO2S and rear HO2S at idle.
After warming-up, if accelerator pedal is released suddenly around 4000rpm, the HO2S signal reading will be lower than 200mV resulting from Fuel cut-off for the moment. Conversely, if suddenly accelerator pedal is depressed, HO2S signal reading will be around 0.6V ~1.0V. At idle, Normally HO2S signal will switch from lean to rich with 3 Hz. And as racing, Its frequency rises.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Component Inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Component Inspection

1. Replace the HO2S.
2. Clear DTC with GDS.
3. Start the engine and warm it up until the radiator fan comes on(more than at least 10 minutes).
4. Drive at a steady speed between 45-55 mph(72-88 km/h) and then release the accelerator(tip-out).
5. Repeat Step 4 to 5 more than 5 times.
6. Does the GDS show DTC?

YES	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. **NOTE** There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others
NO	▶ Troubleshooting is finished.

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > U0001 High Speed CAN Communication Bus off

General Description

Several control units are applied to electronically controlled vehicles. These units perform each control with informations from various sensors. Thus, sharing signal information from sensors is needed, so CAN communication type whose communication speed is high and insensitive to electrical noise by spark generation is adopted to controlling power-train(ECM, TCM,ESP ECM, ABS ECM)
As sharing signals of engine speed, APS, gear shifting, torque reduction in ESP and various modules, active control is performed.

DTC Description

Checking CAN communication, under detecting condition, if an error within the detecting condition is detected for more than 1.5 sec., ECM sets U0001. MIL(Malfunction Indication Lamp) turns on when the malfunction lasts till consecutive 2 driving cycles.

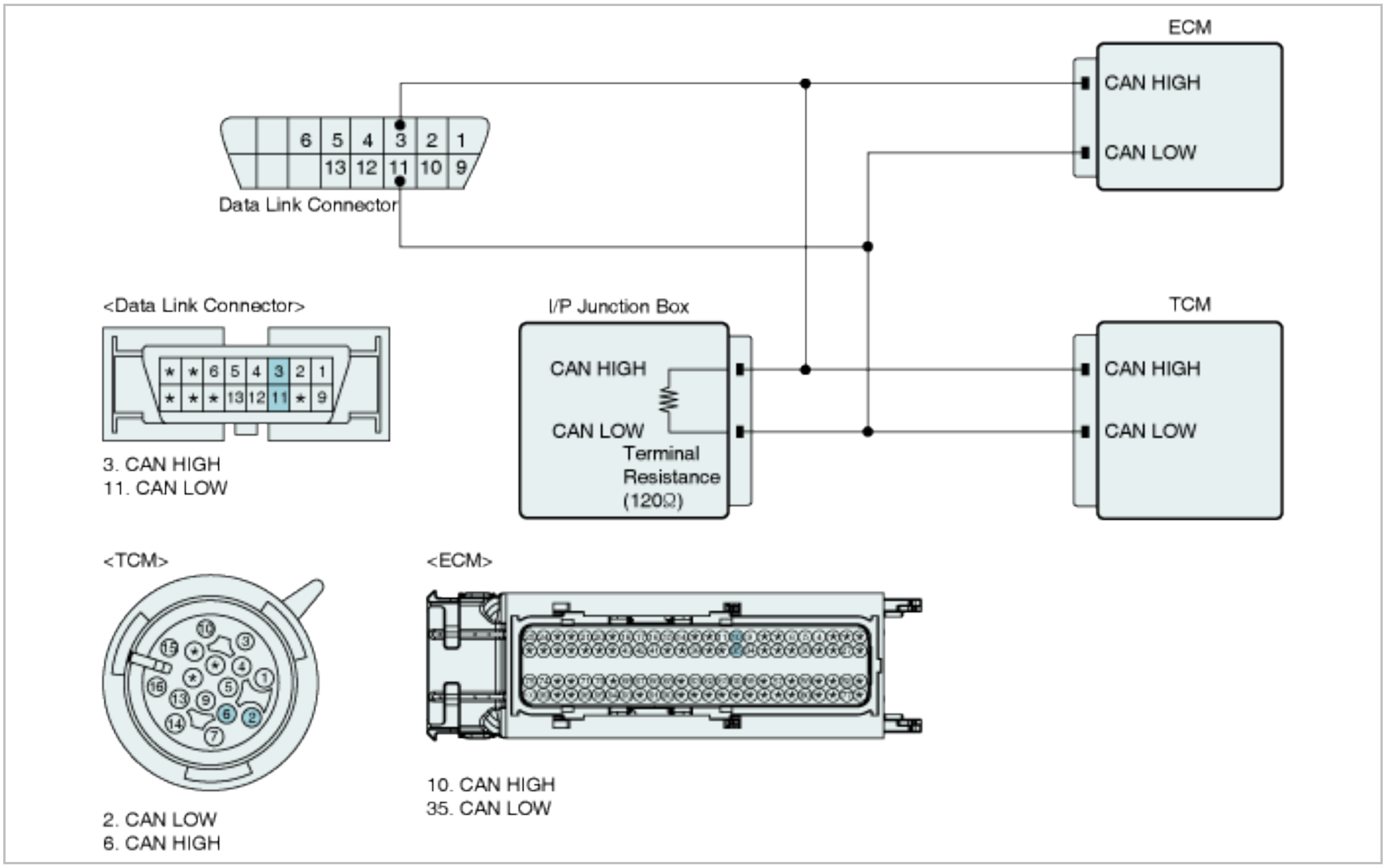
DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Detects failures in communication between the ECM and another or modules in the vehicle which are on the CAN serial bus.	• CAN BUS • CAN communication module component
EnableConditions	• Engine Run Time ≥ 2sec. • Ignition Voltage ≥ 11V	
Threshold value	• CAN communicatin error	
Diagnosis Time	• Continuous	
MIL On Condition	• 2 driving cycle	

Specification

Communication Format	DIGITAL "0"		DIGITAL "1"(BUS IDLE)		CAN Communication Line Resistance	
	HIGH	LOW	HIGH	LOW	ECM	Cluster
CAN 2.0B	3.5V	1.5V	2.5V	2.5V	120Ω (20°C)	120Ω (20°C)

Diagnostic Circuit Diagram



Signal Waveform & Data

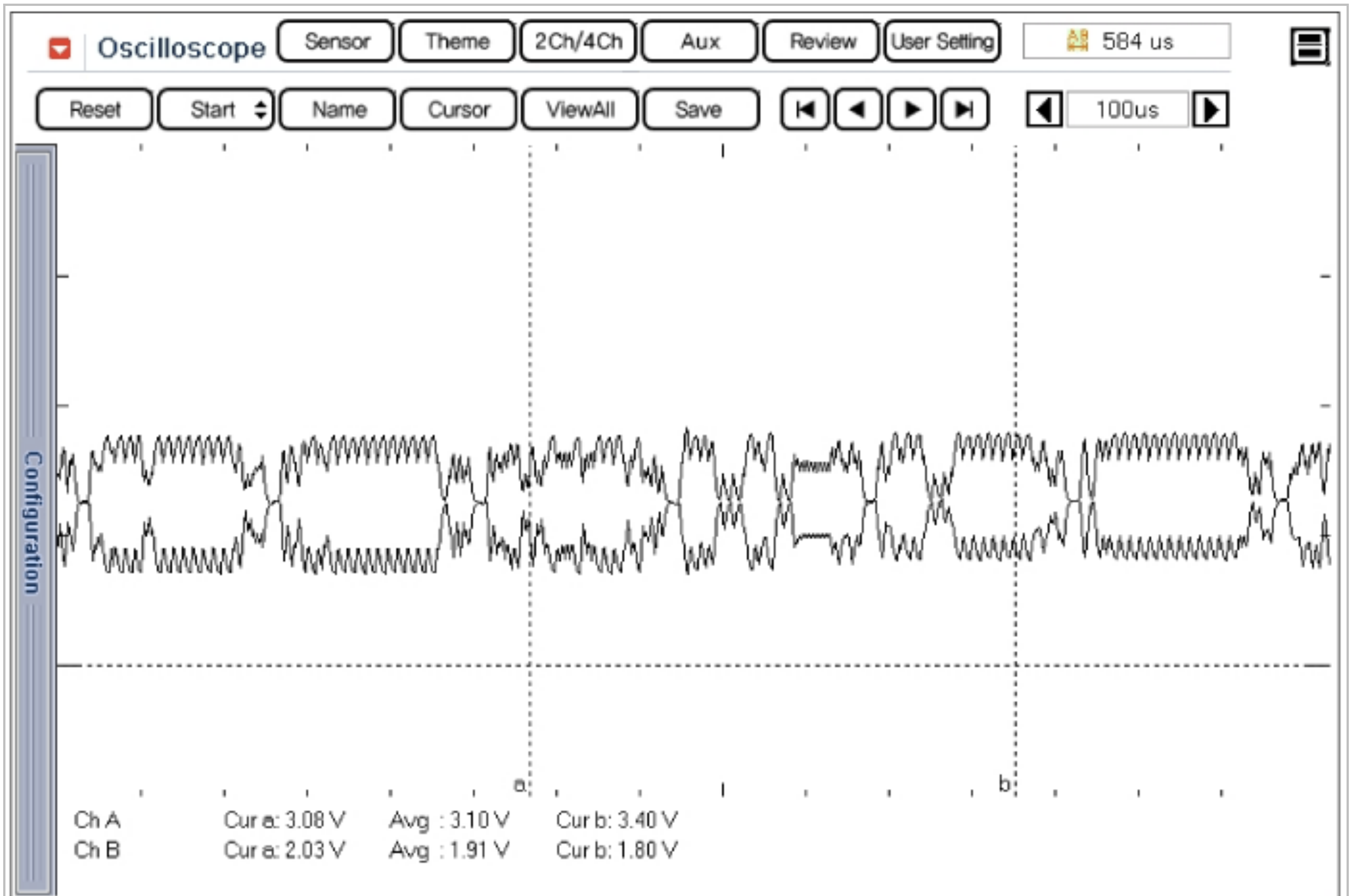


Fig.1

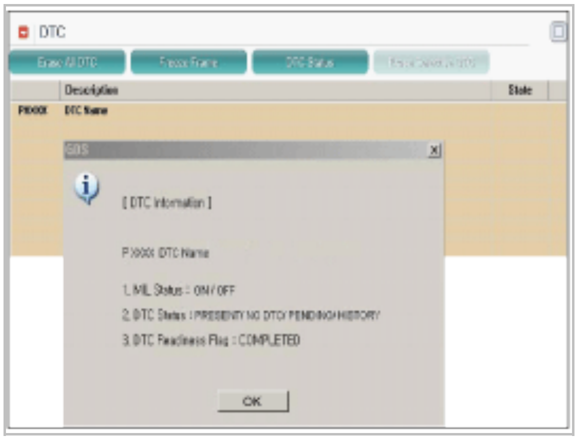
Fig.1) Can communication waveform at idle

Monitoring CAN HIGH and LOW simultaneously is important in monitoring CAN communication waveform. When CAN HIGH signal rise to 3.5V and LOW signal drops to 1.5V - voltage difference between HIGH and LOW signal is 2V - at BUS IDLE state(DIGITAL "1") whose reference voltage is 2.5V, "0" is recognized. Besides, comparing HIGH and LOW signal if opposite waveform is detected with the reference voltage of 2.5V, Check if current cam signal transfers correctly.

Continuous "0"signal above 6BIT means the occurence of error in CAN communication. 1BIT is easily distinguished as calculating the time when "SOF"(START OF FRAME) which notifies the start of frame occurs. Check if "0"signal above 6BIT is detected continuously when monitoring CAN communication waveform.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor’s and/or ECM’s connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure
NO	▶ Go to " Signal Circuit Inspection " procedure.

Signal Circuit Inspection

■ Check CAN BUS resistance in Data Link Connector

1. IG "OFF"
2. Measure the resistance between CAN-HIGH and CAN-LOW terminals of data link connector (Measurement "A")
3. Disconnect ECM connector.
4. Measure the resistance between CAN-HIGH and CAN-LOW terminals of data link connector (Measurement "B")

Specification : ECM connected : 60 ± 3Ω (Measurement "A"), ECM disconnected : 120 ± 3Ω (Measurement "B")

5. Is the measured resistance within specification ?

YES	▶ Go to "Check short to ground in CAN BUS" as follows.
NO	▶ Below 10Ω for both conditions(disconnected, connected) : Repair short between CAN BUS lines and go to "Verification of Vehicle Repair". ▶ 120Ω for both conditions(disconnected, connected) : Go to "Check CAN BUS continuity".

	▶ Infinite Ω for both conditions(disconnected, connected) :Repair open in CAN communication circuit between DLC terminal and In-pannel junction box.

■ **Check short to ground in CAN BUS**

1. IG "OFF" and disconnect ECM connector.
2. Check resistance between CAN-HIGH terminal of Data Link Connector and chassis ground. (CAN HIGH line)
3. Check resistance between CAN-LOW terminal of Data Link Connector and chassis ground. (CAN LOW line)

Specification : Infinite

4. Is the measured resistance within specification ?

YES	▶ Go to "Check short to battery in CAN BUS".
NO	▶ Repair short to ground in circuit and go to "Verification of Vehicle Repair".

■ **Check short to battery in CAN BUS**

1. IG "OFF" and disconnect ECM, TCM and ABS/ESC ECU connector.
2. IG "ON"
3. Measure the voltage between CAN-HIGH terminal of Data Link Connector and chassis ground. (CAN HIGH line)
4. Measure the voltage between CAN-LOW terminal of Data Link Connector and chassis ground. (CAN LOW line)

Specification : 0.0V~0.1V

5. Is the measured voltage within specification ?

YES	▶ Go to"Check CAN BUS continuity" as follows.
NO	▶ Repair short to battery and go to "Verification of Vehicle Repair".

■ **Check open in CAN BUS line**

1. IG "OFF" and disconnect ECM, Instrument Cluster and ABS/ESC ECU connector.
2. Check resistance between CAN-HIGH terminal of Data Link Connector and CAN-HIGH terminal of each module.(Measurement "A")
3. Check resistance between CAN-LOW terminal of Data Link Connector and CAN-LOW terminal of each module.(Measurement "B")

Specification : Below 1.0Ω

4. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection".
NO	▶ Repair open in CAN BUS line and go to "Verification of Vehicle Repair".

Component Inspection

■ **Check Resistance**

1. IG "OFF" and disconnect ECM connector.
2. Check resistance between CAN-LOW terminal and CAN-HIGH terminal of ECM.(Component Side)

Specification : Approx. 110~130 Ω

3. Is the measured resistance normal ?

YES	▶ Go to "Verification of Vehicle Repair".
NO	▶ Substitute with a known - good ECM and check for proper operation. If the problem is corrected, replace ECM and go to "Verification of Vehicle Repair" procedure. NOTE There is a memory reset function on GDS that can erase optional parts automatically detected and memorized by ECM. Before or after testing ECM on the vehicle, use this function to reuse the ECM on the others

Verification of Vehicle Repair

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

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Engine Control System > U0101 Lost Communication With TCM

General Description

Several control units are applied to electronically controlled vehicles. These units perform each control with informations from various sensors. Thus, sharing signal information from sensors is needed, so CAN communication type whose communication speed is high and insensitive to electrical noise by spark generation is adopted to controlling power-train(ECM, TCM,ESP ECM, ABS ECM)
As sharing signals of engine speed, APS, gear shifting, torque reduction in ESP and various modules, active control is performed.

DTC Description

Checking CAN communication, under detecting condition, if an CAN communication error between ECM and TCM is detected . ECM sets U0101.

DTC Detecting Condition

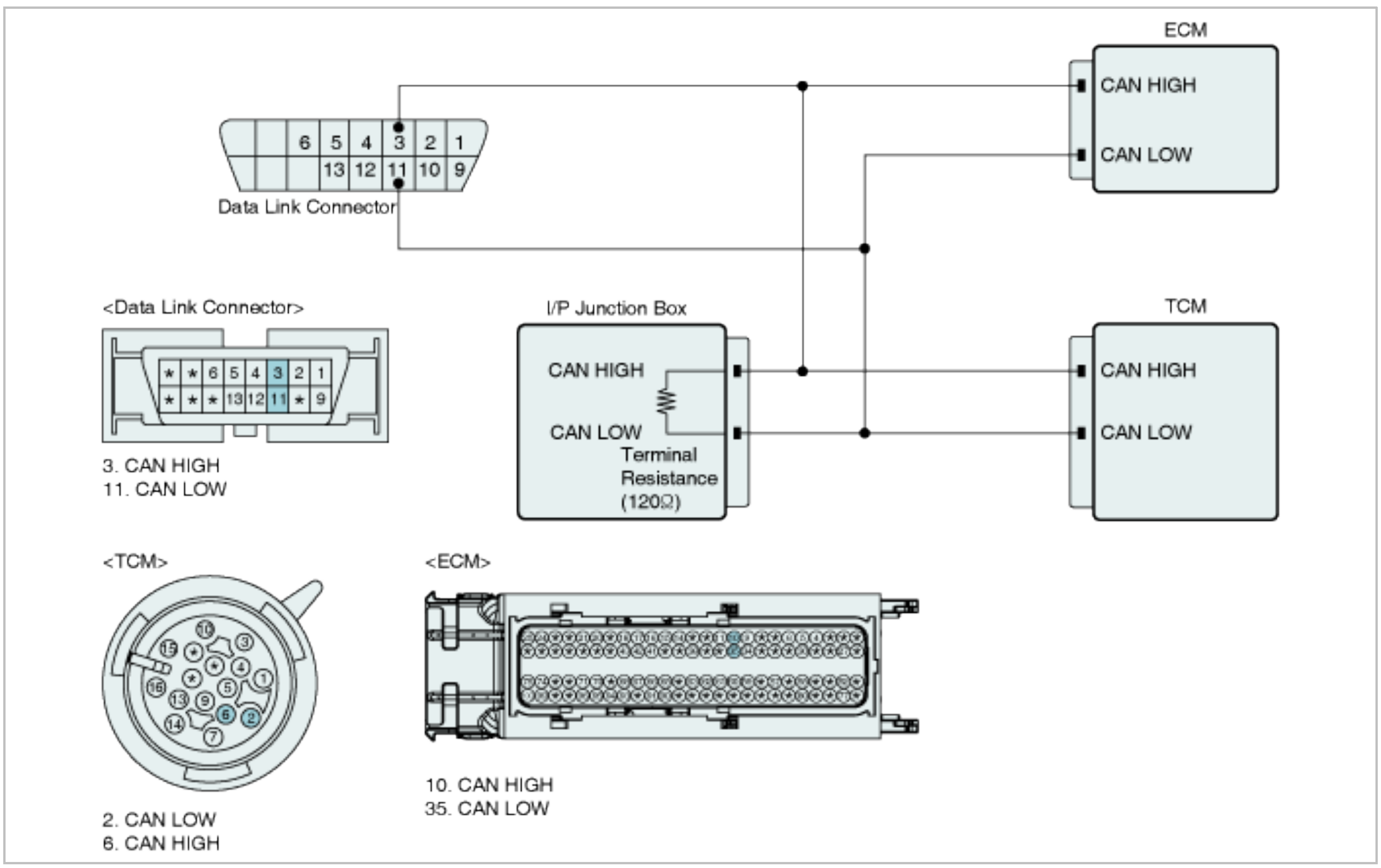
Item	Detecting Condition	Possible cause

DTC Strategy	• Check CAN message from TCM	• TCM faulty • CAN communication line between ECM and TCM
EnableConditions	• Engine Run Time ≥ 2sec. • Ignition Voltage ≥ 11V	
Threshold value	• CAN communicatin error with TCM	
Diagnosis Time	• Continuous	
MIL On Condition	• 2 driving cycle	

Specification

Communication Format	DIGITAL "0"		DIGITAL "1"(BUS IDLE)		CAN Communication Line Resistance	
	HIGH	LOW	HIGH	LOW	ECM	Cluster
CAN 2.0B	3.5V	1.5V	2.5V	2.5V	120Ω (20°C)	120Ω (20°C)

Diagnostic Circuit Diagram



Signal Waveform & Data

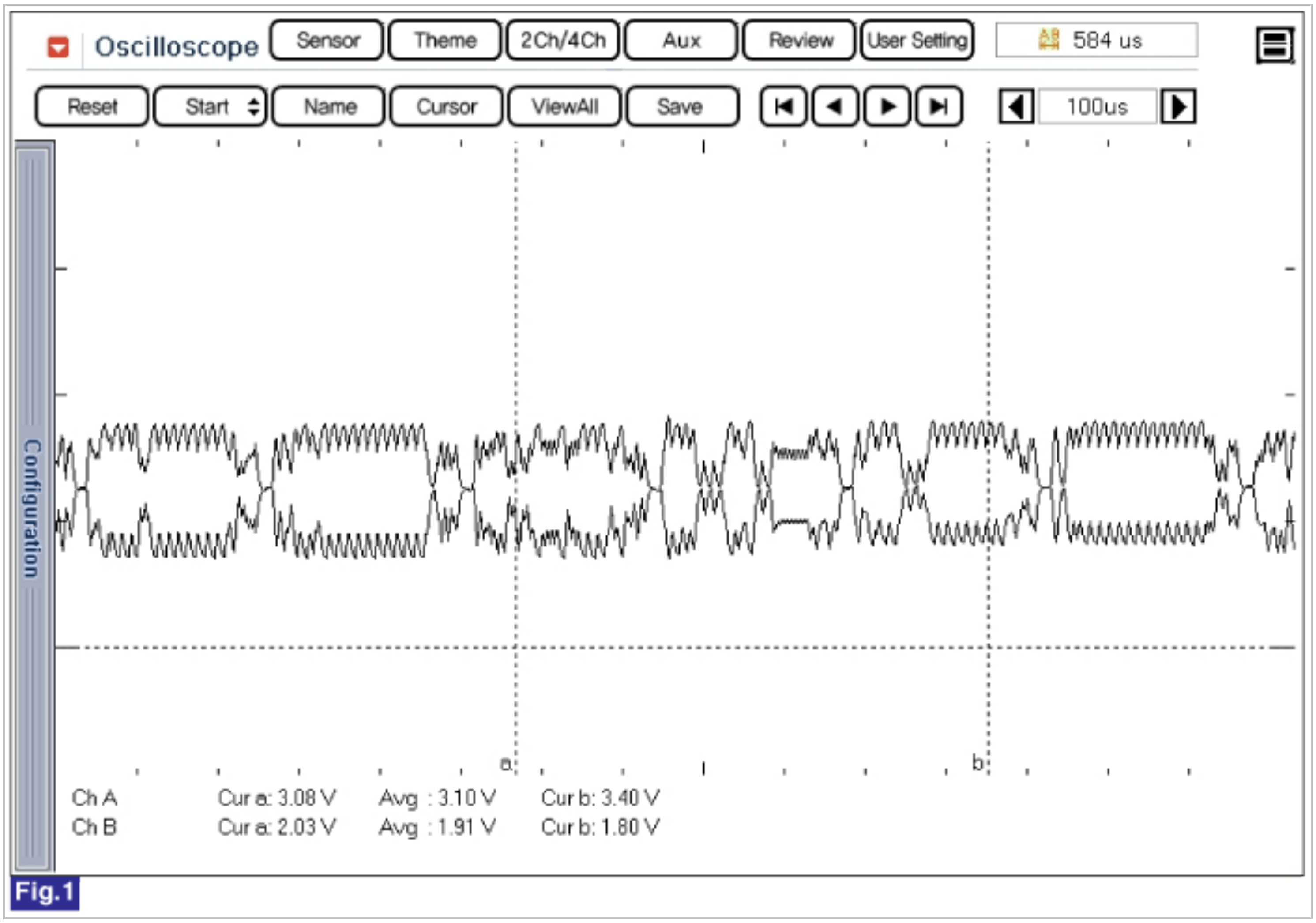


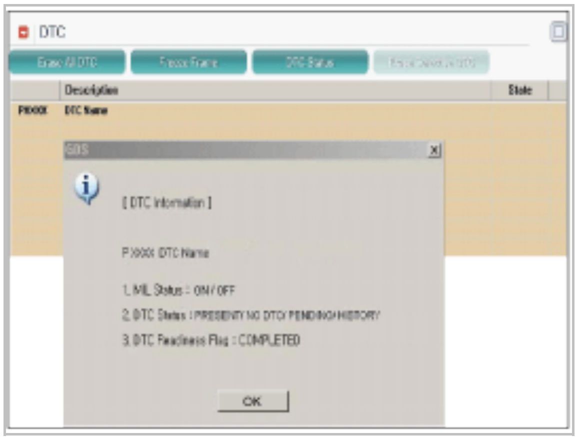
Fig.1) Can communication waveform at idle

Monitoring CAN HIGH and LOW simultaneously is important in monitoring CAN communication waveform. When CAN HIGH signal rise to 3.5V and LOW signal drops to 1.5V - voltage difference between HIGH and LOW signal is 2V - at BUS IDLE state(DIGITAL "1") whose reference voltage is 2.5V, "0" is recognized. Besides, comparing HIGH and LOW signal if opposite waveform is detected with the reference voltage of 2.5V, Check if current cam signal transfers correctly.

Continuous "0"signal above 6BIT means the occurence of error in CAN communication. 1BIT is easily distinguished as calculating the time when "SOF"(START OF FRAME) which notifies the start of frame occurs. Check if "0"signal above 6BIT is detected continuously when monitoring CAN communication waveform.

Monitor GDS Data

1. Connect GDS to Data Link Connector(DLC).
2. IG "ON".
3. Select "DTC" button, and then Press "DTC Status" to check DTC's information from the DTCs menu.
4. Read "DTC Status" parameter.



5. Is parameter displayed "Present fault"?

YES	▶ Go to "Terminal and Connector inspection" procedure.
NO	▶ Fault is intermittent caused by poor contact in the sensor's and/or ECM's connector or was repaired and ECM memory was not cleared. Thoroughly check connectors for looseness, poor connection, ending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Terminal and Connector inspection

1. Many malfunctions in the electrical system are caused by poor harness and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. .
3. Has a problem been found?

YES	▶ Repair as necessary and go to "Verification of Vehicle Repair" procedure
NO	▶ Go to " Signal Circuit Inspection " procedure.

Signal Circuit Inspection

■ Check open in harness

1. IG "OFF" and disconnect ECM and TCM connector.
2. Check resistance between CAN-HIGH terminal of ECM harness Connector and CAN-HIGH terminal of TCM harness connector.
3. Check resistance between CAN-LOW terminal of ECM harness Connector and CAN-LOW terminal of TCM harness connector.

Specification : Below 1.0Ω

4. Is the measured resistance within specification ?

YES	▶ Go to "Component Inspection".
NO	▶ Repair open in CAN BUS line and go to "Verification of Vehicle Repair".

Verification of Vehicle Repair

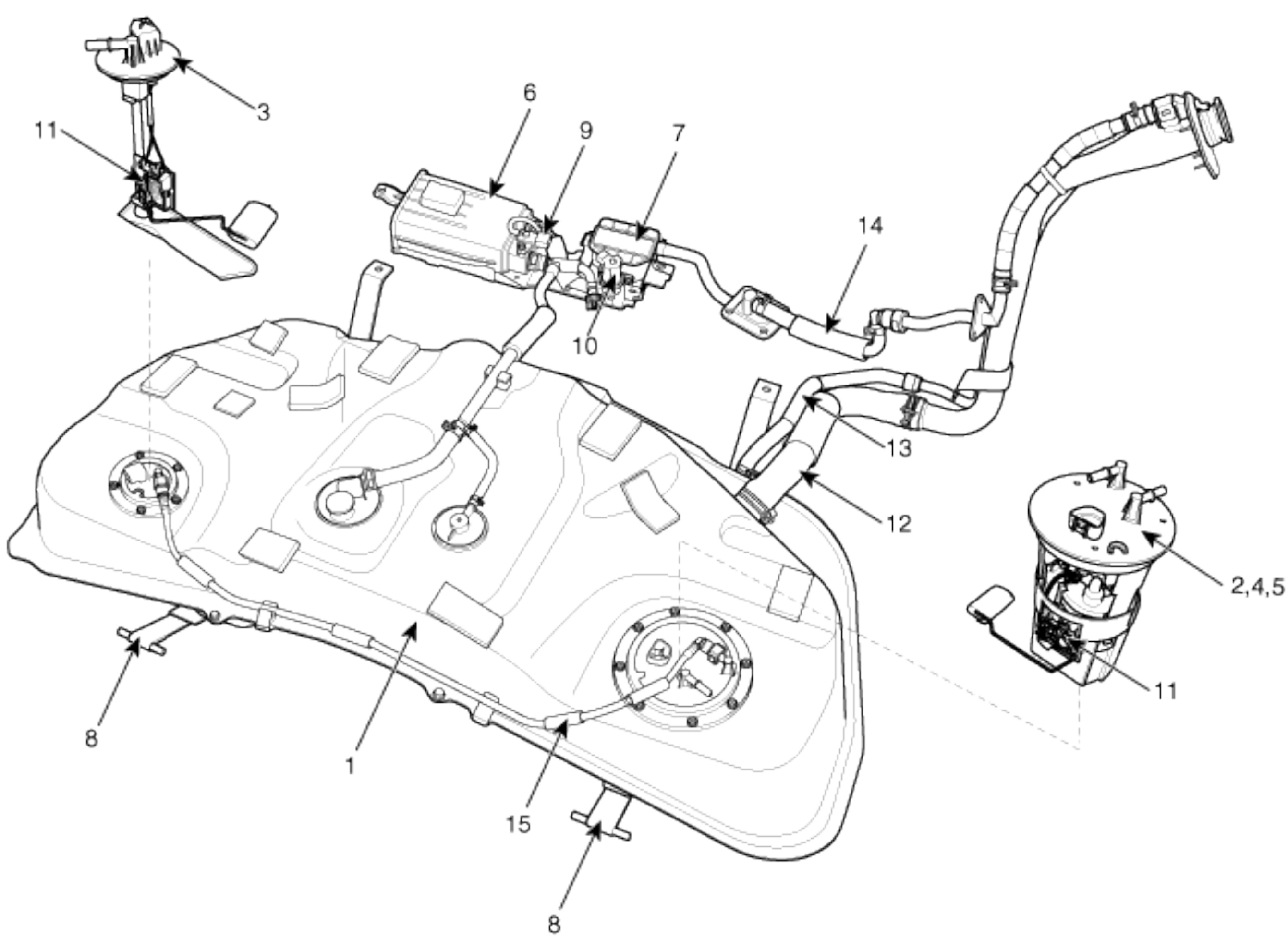
After a repair, it is essential to verify that the fault has been corrected.

1. Connect GDS and select "DTC" button.
2. Press "DTC Status" button and confirm that "DTC Readiness Flag" indicates "Completed". If not, drive the vehicle within conditions noted in the freeze frame data or enable conditions.
3. Read "DTC Status" parameter.
4. Is parameter displayed "History(Not Present) fault"?

YES	▶ System performing to specification at this time. Clear the DTC.
NO	▶ Go to the applicable troubleshooting procedure.

Fuel System > Fuel Delivery System > Components and Components Location

Components Location



1. Fuel Tank 2. Fuel Pump 3. Sub Fuel Sender	9. Fuel Tank Pressure Sensor (FTPS) 10. Canister Close Valve (CCV) 11. Fuel Level Sensor (FLS)

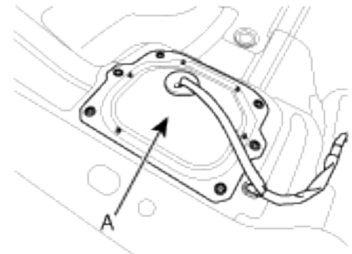
4. Fuel Filter 5. Fuel Pressure Regulator 6. Canister 7. Fuel Tank Air Filter 8. Fuel Tank Band	12. Fuel Filler Hose 13. Leveling Hose 14. Ventilation Hose 15. Suction Hose

Fuel System > Fuel Delivery System > Repair procedures

Fuel Pressure Test

1. PREPARING

1. Remove the rear seat cushion (Refer to "Seat" in BD group).
2. Remove the service cover of the fuel pump (A)

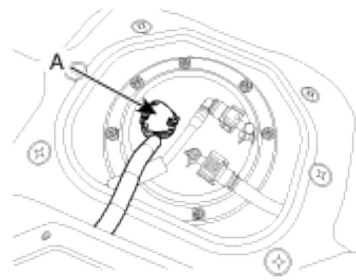


2. RELEASE THE INTERNAL PRESSURE

1. Disconnect the fuel pump connector (A).
2. Start the engine and wait until fuel in fuel line is exhausted.
3. After the engine stalls, turn the ignition switch to OFF position and disconnect the negative (-) terminal from the battery.

NOTE

Be sure to reduce the fuel pressure before disconnecting the fuel feed hose, otherwise fuel will spill out.



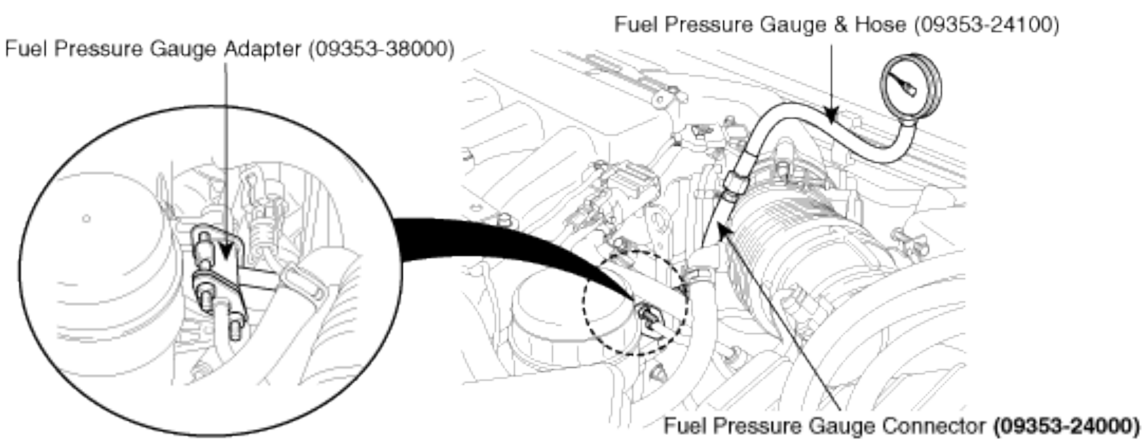
3. INSTALL THE SPECIAL SERVICE TOOL (SST) FOR MEASURING THE FUEL PRESSURE

1. Disconnect the fuel feed hose from the delivery pipe.

CAUTION

Cover the hose connection with a shop towel to prevent splashing of fuel caused by residual pressure in the fuel line.

2. Install the Fuel Pressure Gage Adapter (09353-38000) between the delivery pipe and the fuel feed hose.
3. Connect the Fuel Pressure Gage Connector (09353-24000) to the Fuel Pressure Gage Adapter (09353-38000).
4. Connect the Fuel Pressure Gage and Hose (09353-24100) to Fuel Pressure Gage Connector (09353-24000).
5. Connect the fuel feed hose to the Fuel Pressure Gage Adapter (09353-38000).



4. INSPECT FUEL LEAKAGE ON CONNECTION

1. Connect the battery negative (-) terminal.
2. Apply battery voltage to the fuel pump terminal and activate the fuel pump. With fuel pressure applied, check that there is no fuel leakage from the fuel pressure gauge or connection part.

5. FUEL PRESURE TEST

1. Diconnect the negative (-) terminal from the battery.
2. Connect the fuel pump connector.
3. Connect the battery negative (-) terminal.
4. Start the engine and measure the fuel pressure at idle.

Standard Value: 379.5kPa (3.87kgf/cm², 55.0psi)

- If the measured fuel pressure differs from the standard value, perform the necessary repairs using the table below.

Condition	Probable Cause	Suspected Area
Fuel Pressure too low	Clogged fuel filter	Fuel filter
	Fuel leak on the fuel-pressure regulator that is assembled on fuel pump because of poor seating of the fuel-pressure regulator.	Fuel Pressure Regulator
Fuel Pressure too High	Sticking fuel pressure regulator	Fuel Pressure Regulator

5. Stop the engine and check for a change in the fuel pressure gauge reading.

After engine stops, the gage reading should hold for about 5 minutes

- Observing the declination of the fuel pressure when the gage reading drops and perform the necessary repairs using the table below.

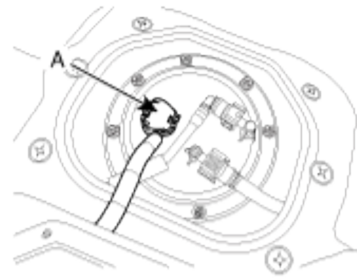
Condition	Probable Cause	Supected Area
Fuel pressure drops slowly after engine is stopped	Injector leak	Injector
Fuel pressure drops immediately after engine is stopped	The check valve within the fuel pump is open	Fuel Pump

6. RELEASE THE INTERNAL PRESSURE

1. Disconnect the fuel pump connector (A).
2. Start the engine and wait until fuel in fuel line is exhausted.
3. After the engine stalls, turn the ignition switch to OFF position and diconnect the negative (-) terminal from the battery.

NOTE

Be sure to reduce the fuel pressure before disconnecting the fuel feed hose, otherwise fuel will spill out.



7. REMOVE THE SPECIAL SERVICE TOOL (SST) AND CONNECT THE FUEL LINE

1. Disconnect the Fuel Pressure Gage and Hose (09353-24100) from the Fuel Pressure Gage Connector (09353-24000).
2. Disconnect the Fuel Pressure Gage Connector (09353-24000) from the Fuel Pressure Gage Adapter (09353-38000).
3. Disconnect the fuel feed hose from the Fuel Pressure Gage Adapter (09353-38000).
4. Disconnect the Fuel Pressure Gage Adapter (09353-38000) from the delivery pipe.

CAUTION

Cover the hose connection with a shop towel to prevent splashing of fuel caused by residual pressure in the fuel line.

5. Connect the fuel feed hose to the delivery pipe.

8. INSPECT FUEL LEAKAGE ON CONNECTION

1. Connect the battery negative (-) terminal.
2. Apply battery voltage to the fuel pump terminal and activate the fuel pump. With fuel pressure applied, check that there is no fuel leakage from the fuel pressure gauge or connection part.
3. If the vehicle is normal, connect the fuel pump connector.

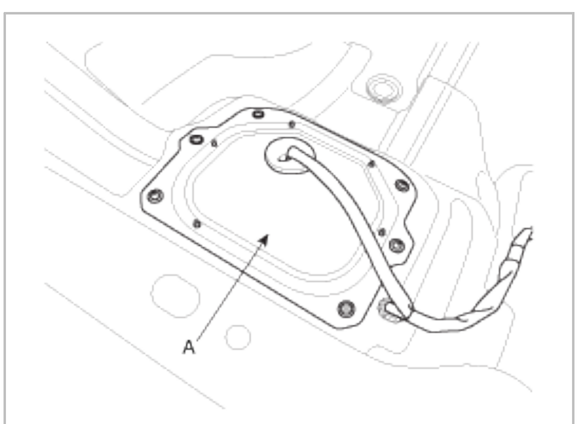
Fuel System > Fuel Delivery System > Fuel Tank > Repair procedures

Removal

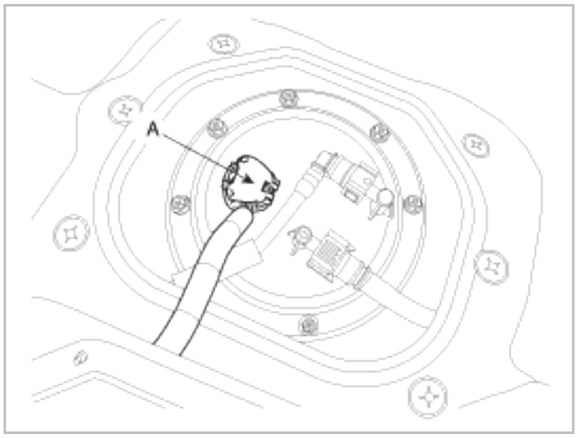
1. Preparation

(1) Remove the rear seat cushion (Refer to “Seat” in BD group).

(2) Remove the service cover of the fuel pump (A).



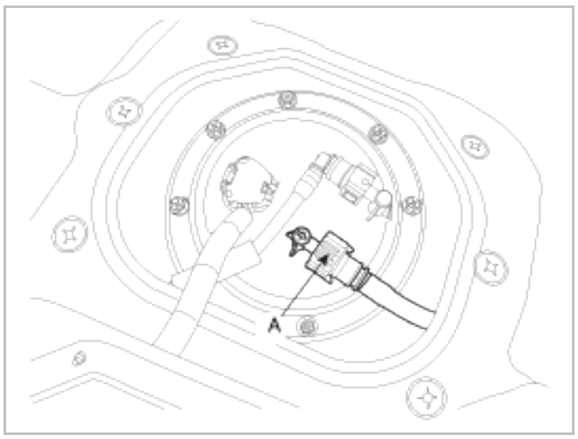
(3) Disconnect the fuel pump connector (A).



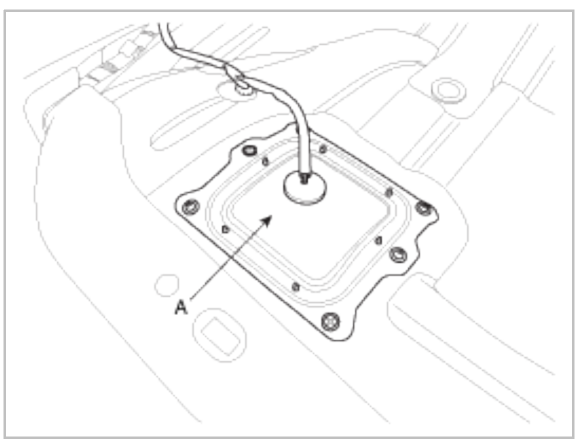
(4) Idle the engine and wait until fuel in feed line is exhausted.

(5) After engine stops, turn the ignition switch OFF.

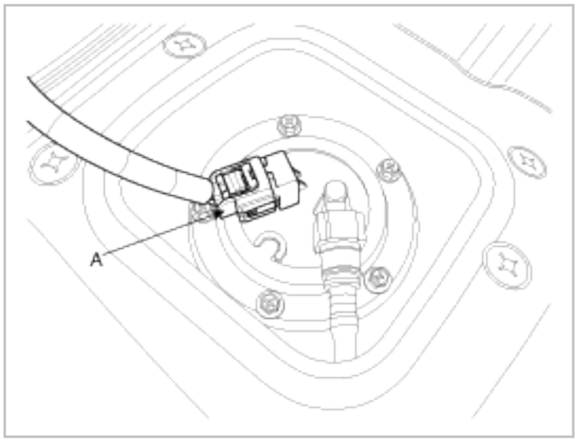
2. Disconnect the fuel feed tube quick-connector (A).



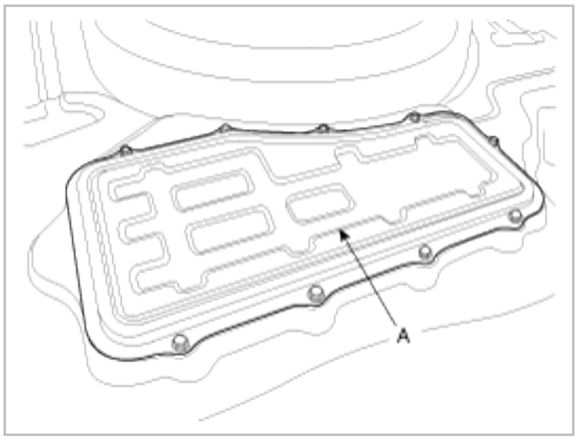
3. Remove the service cover of the sub fuel sender (A).



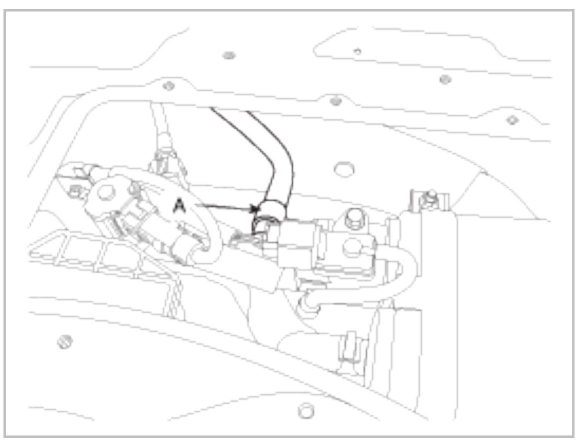
4. Disconnect the sub fuel sender connector (A).



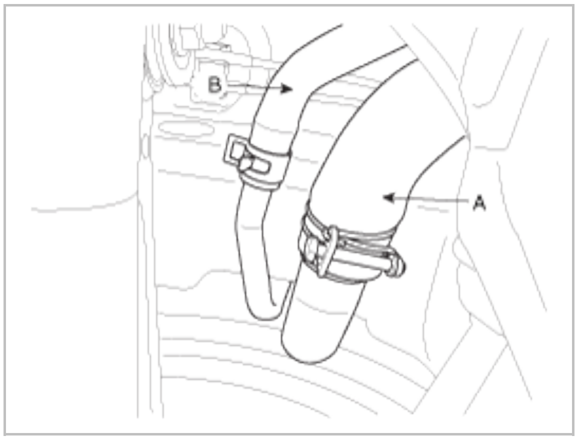
5. Remove the service cover of the canister (A) in trunk room.



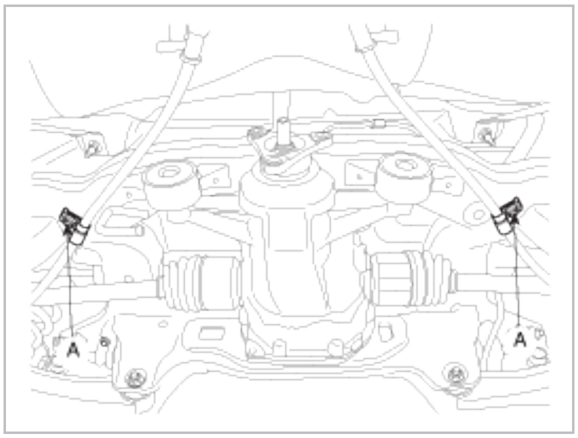
6. Disconnect the vapor tube quick-connector (A).



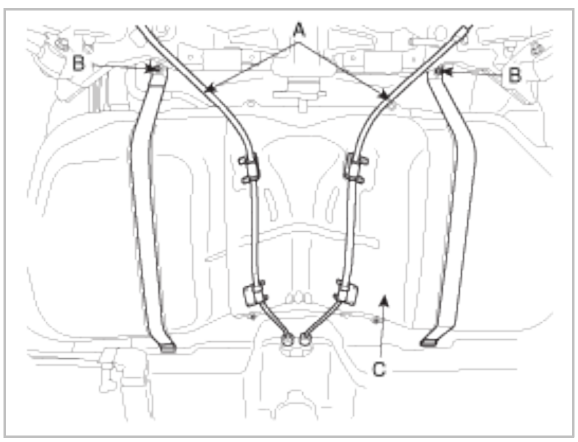
7. Lift the vehicle.
8. Remove the center muffler assembly (Refer to “Intake And Exhaust System” in EM group).
9. Remove the propeller shaft (Refer to “Propeller Shaft Assembly” in DS group).
10. Disconnect the fuel filler hose (A) and the leveling hose (B).



11. Remove the brake line bracket installation bolt (A).



12. Detach the parking brake cable (A) from the fuel tank.



13. Remove the fuel tank (C) from the vehicle after removing the mounting nuts (B).

Installation

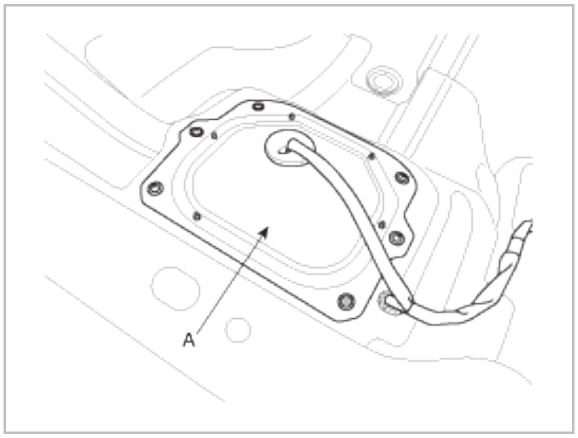
1. Installation is reverse of removal.

Fuel tank band installation nut:
39.2 ~ 54.0 N.m (4.0 ~ 5.5 kgf.m, 28.9 ~ 39.8 lb-ft)

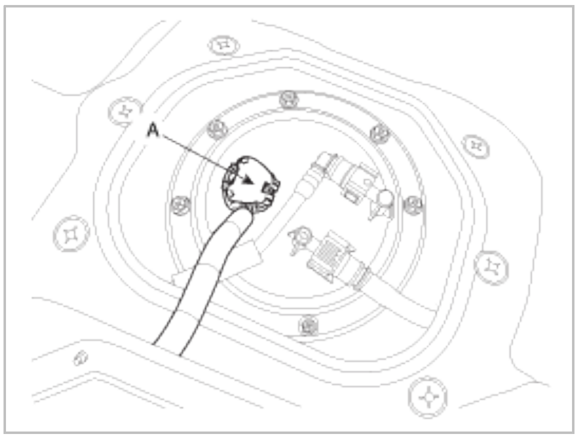
Fuel System > Fuel Delivery System > Fuel Pump > Repair procedures

Removal

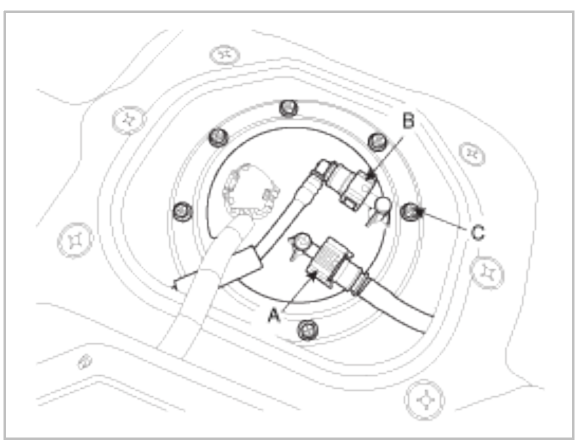
1. Preparation
   (1) Remove the rear seat cushion (Refer to “Seat” in BD group).
   (2) Remove the service cover of the fuel pump (A).



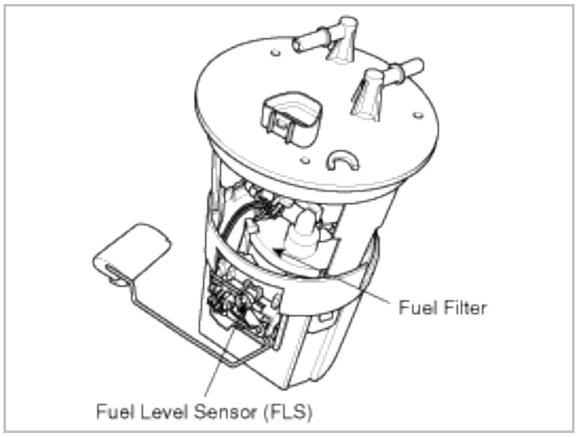
   (3) Disconnect the fuel pump connector (A).



   (4) Idle the engine and wait until fuel in feed line is exhausted.
   (5) After engine stops, turn the ignition switch OFF.
2. Disconnect the fuel feed tube quick-connector (A) and the suction tube quick-connector (B).



3. Remove the fuel pump from the fuel tank after removing the installation bolts (C).



Installation

1. Installation is reverse of removal.

Fuel pump installation bolt :
2.0 ~ 2.9 N.m (0.2 ~ 0.3 kgf.m, 1.4 ~ 2.2 lb-ft)

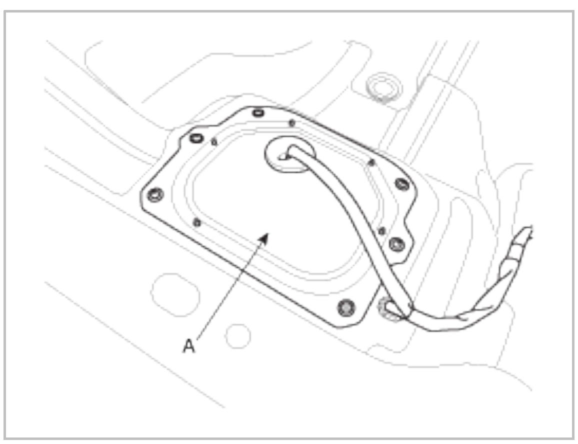
CAUTION

When installing the fuel pump module, be careful not to get the seal-ring entangled.

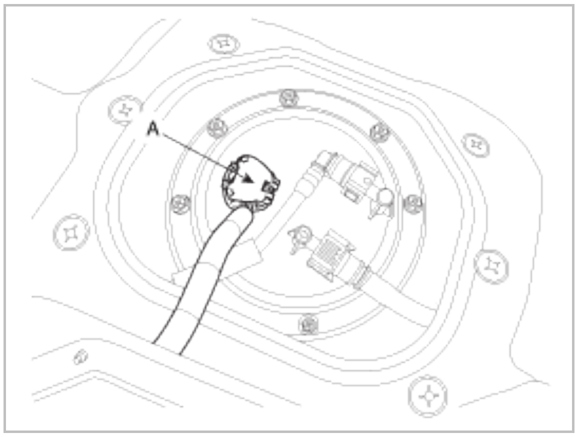
Fuel System > Fuel Delivery System > Sub Fuel Sender > Repair procedures

Removal

1. Preparation
   (1) Remove the rear seat cushion (Refer to “Seat” in BD group).
   (2) Remove the service cover of the fuel pump (A).



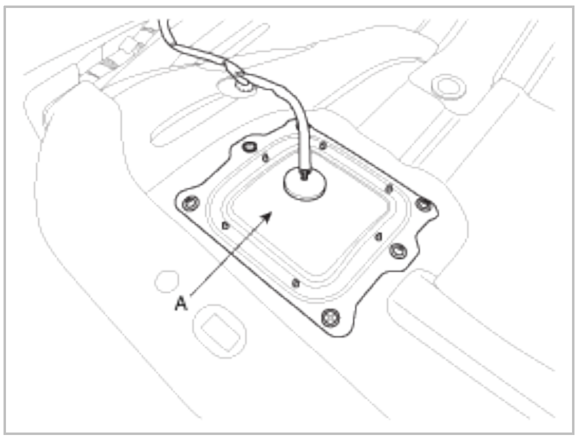
   (3) Disconnect the fuel pump connector (A).



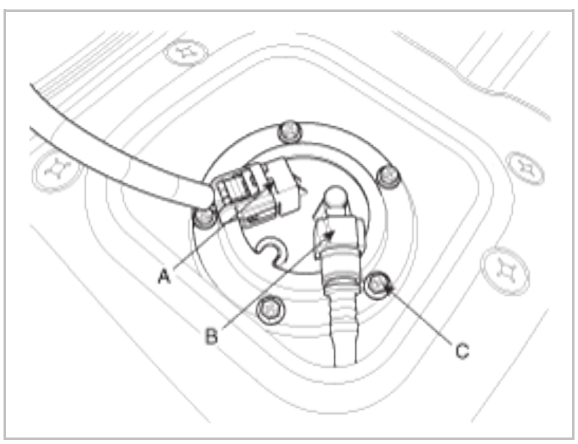
(4) Idle the engine and wait until fuel in feed line is exhausted.

(5) After engine stops, turn the ignition switch OFF.

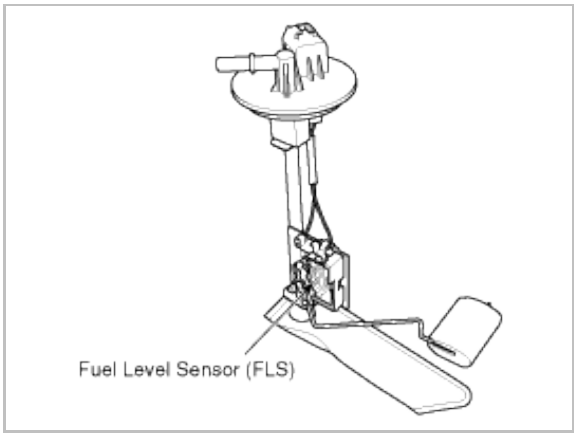
2. Remove the service cover of the sub fuel sender (A).



3. Disconnect the sub fuel sender connector (A).



4. Disconnect the suction tube quick-connector (B).
5. Remove the sub fuel sender from the fuel tank after removing the installation bolts (C).



Installation

1. Installation is reverse of removal.

Sub fuel sender installation bolt :
2.0 ~ 2.9 N.m (0.2 ~ 0.3 kgf.m, 1.4 ~ 2.2 lb-ft)

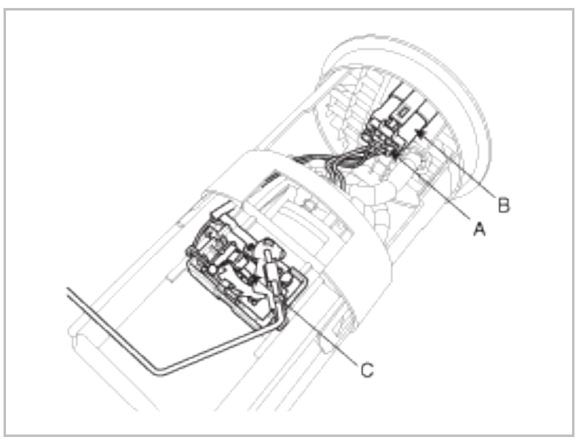
CAUTION

When installing the sub fuel sender, be careful not to get the seal-ring entangled.

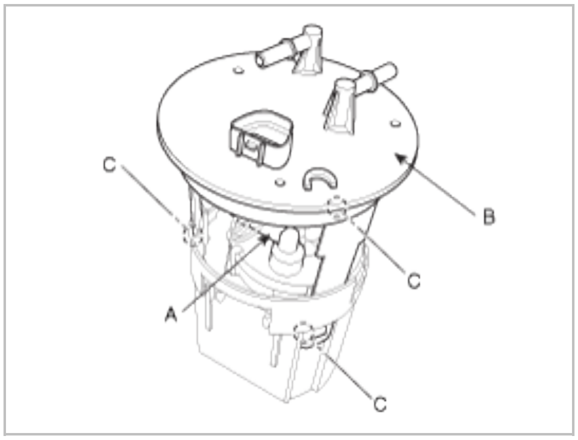
Fuel System > Fuel Delivery System > Fuel Filter > Repair procedures

Replacement

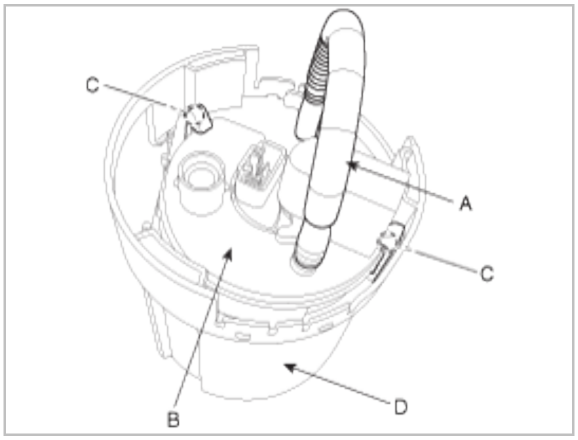
1. Remove the fuel pump (Refer to “Fuel Pump” in this group).
2. Disconnect the electric pump wiring connector (A) and the fuel sender connector (B).



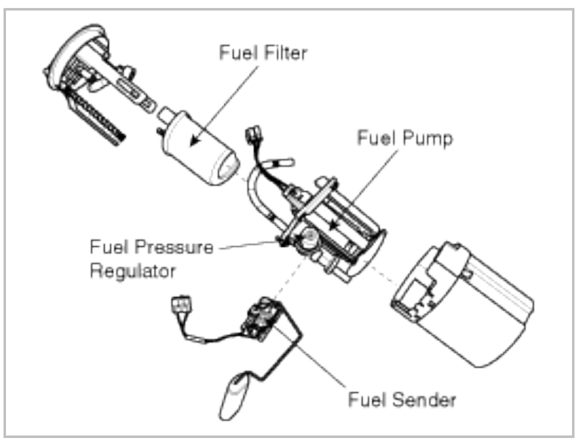
3. Remove the fuel sender (C).
4. Disconnect the fuel feed line (A) from the fuel filter.



5. Separate the head assembly (B) with the hooks (C) released.
6. Disconnect the regulator hose (A) from the fuel filter (B).



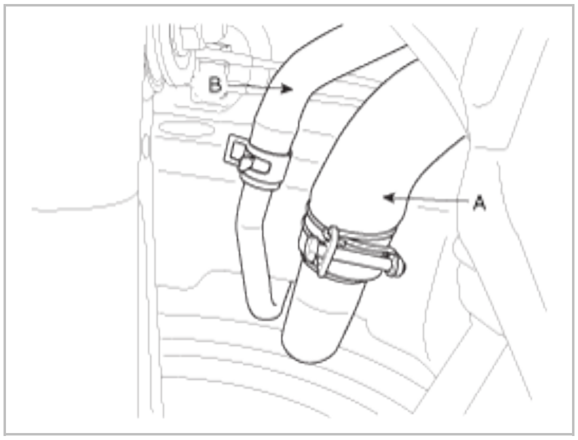
7. Separatate the fuel filter (B) from the reservior (D) with the hooks (C) released.



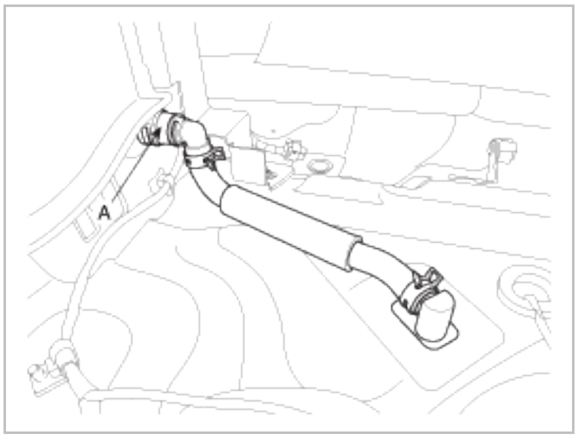
Fuel System > Fuel Delivery System > Filler-Neck Assembly > Repair procedures

Removal

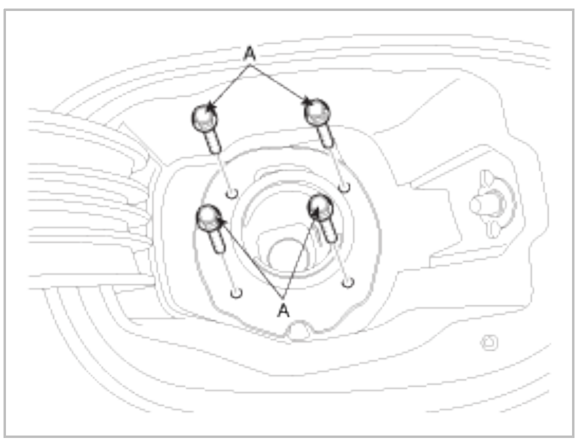
1. Disconnect the fuel filler hose (A) and the leveling hose (B).



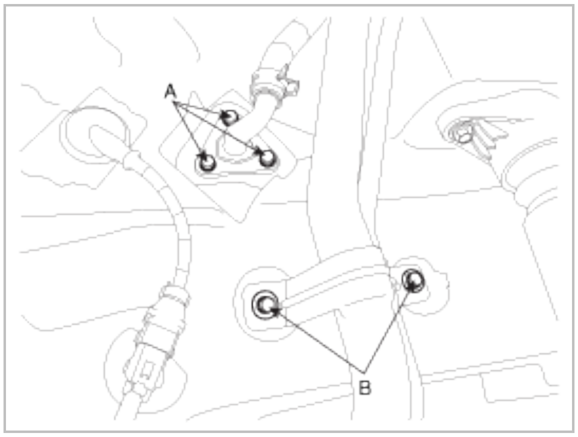
2. Disconnect the vapor hose quick-connector (A) after removing the trunk luggage trim.



3. Remove the rear-LH wheel, tire, and the inner wheel house.
4. Remove the filler-neck installation bolts (A).



5. Remove the filler-neck assembly from the vehicle after removing the vapor hose mounting bolts (A) and the bracket mounting bolts (B).



Installation

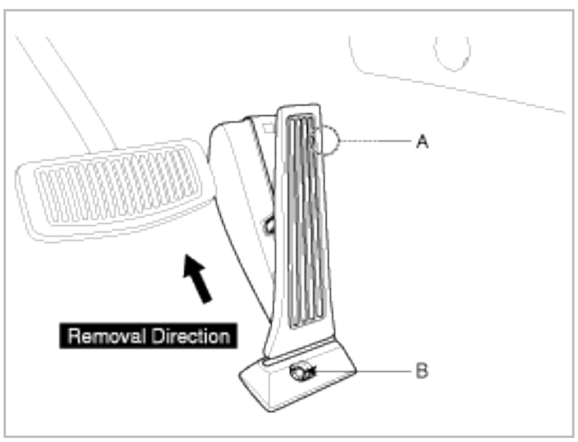
1. Installation is reverse of removal.

Filler-neck assembly installation bolt :
7.8 ~ 11.8 N.m (0.8 ~ 1.2 kgf.m, 5.8 ~ 8.7 lb-ft)
Filler-neck assembly installation nut :
3.9 ~ 5.9 N.m (0.4 ~ 0.6 kgf.m, 2.9 ~ 4.3 lb-ft)

Fuel System > Fuel Delivery System > Accelerator Pedal > Repair procedures

Removal

1. Turn the ignition switch OFF and disconnect the negative (-) battery cable.
2. Disconnect the accelerator position sensor connector (A).



3. Remove the accelerator pedal in the direction of "Remove Direction" in the figure after removing the mounting bolt (B).

Installation

1. Installation is reverse of removal.

Accelerator pedal module installation bolt :
3.9 ~ 5.9 N.m (0.4 ~ 0.6 kgf.m, 2.9 ~ 4.3 lb-ft)
