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Inside This Issue

Continuously Variable Valve Timing

At the present time, there are several Federal emissions standards that regulate motor vehicle emissions. These standards result in three emissions categories for vehicles: Low Emission Vehicle (LEV), Ultra Low Emission Vehicle (ULEV), and Super Ultra Low Emissions Vehicles (SULEV). The chart on page 2 shows the standard for each.

The 2003 Elantra is equipped with many new features to meet the rigorous Federal SULEV standards. Many modifications were made to the vehicle's Engine Management System (EMS) to meet these standards. The 2003 Elantra operates with a Siemens EMS. The Siemens system features a single Powertrain Control Module (PCM) rather than the separate ECM and TCM.

Several other changes are incorporated into the SULEV Elantra:

- Iridium spark plugs rather than platinum
- Mass Air Flow (MAF) sensor instead of a Manifold Pressure (MAP) sensor
- Wide range linear zirconium O2 sensor
- 12-hole injectors instead of 4-hole
- Front catalytic converter has increased capacity (900 CPSI vs. 400 CPSI)

continued on page 2

Continuously Variable Valve Timing

continued from page 1

- Continuously Variable Valve Timing (CVVT) Unit, Oil Control Valve (OCV) and Oil Temperature Sensor (OTS)
- Zero emissions evaporative emission system

All other components are the same as installed on the ULEV Elantra (CMP, CKP, TPS, rear O2 sensor, rear catalytic converter, knock sensor, FTPS, etc).

The CVVT unit is installed on the exhaust camshaft and controls the intake valve timing by advancing or retarding the intake cam in relation to the exhaust cam. The degree of advance or retard is controlled by the PCM depending on the engine load and speed. The crank angle may be varied up to 40°.

The three main advantages of the CVVT system are:

- Reduced Fuel consumption due to better cylinder charge achieved through increased valve overlap.
- Reduced NOx emissions due to the EGR effect created by valve overlap.
- Improved performance and increased torque at low speeds through increased volumetric and thermodynamic efficiencies created by varying the valve timing.

Volumetric efficiency (VE) is used to describe the amount of air in the cylinder in relation to regular atmospheric air. If the cylinder is filled with air at atmospheric pressure, then the engine is said to have 100% VE. On the other hand, super chargers and turbo chargers increase the pressure entering the cylinder, giving the engine a VE greater than 100%. However, if the cylinder is pulling in a vacuum, then the engine has less than 100% VE. Naturally aspirated engines typically run anywhere between 80% and 100% VE. So now, when you read that a certain manifold and cam combination tested out to have a 95% VE, you will know that the higher the number, the more power the engine can produce.

Thermodynamic Efficiency (TE) measures how much of the fuel gets converted to workable power. A typical street engine is only capable of using about one-fourth of its energy created by burning fuel. Racing engines get up to around one-third TE.

Category	Test Duration (in miles)	HC Emissions (g/miles)	NOx Emissions (g/miles)	CO Emissions (g/miles)
LEV	100,000	0.090	0.30	4.2
ULEV	100,000	0.055	0.30	2.1
SULEV	150,000	0.010	0.02	1.0

CVVT Component Functions

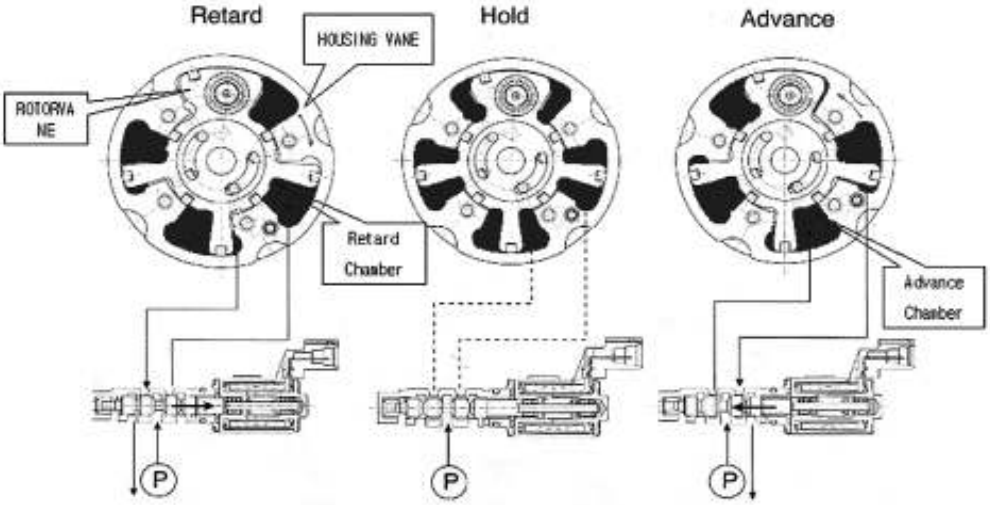
To accomplish its function, the CVVT unit must monitor the following sensors:

- Engine Coolant Temperature Sensor (ECT)
- Intake Air Temperature Sensor (IAT)
- MAF
- CKP
- OTS

After determining the engine load and speed, the PCM controls the CVVT unit indirectly through the OCV by duty cycling the ground side of the valve. During low engine load and speed (idle) the PCM will keep the CVVT unit in the fully retarded position. In high load/low speed conditions (hard acceleration at low speed) the PCM will fully advance the unit. Since the load on the engine is constantly changing, the degree of intake advance also changes constantly.

The OTS is a negative temperature coefficient resistor. That means its resistance drops as oil temperature increases. Its outputs allow the PCM to fine-tune the Oil Control Valve operations. As the oil temperature increases, the oil's viscosity decreases making it flow more readily. The PCM adjusts the OCV to compensate for these temperature induced changes in the oil's characteristics.

The OCV is basically an electromechanical spool valve (similar to spool valves in an automatic transaxle).



As the PCM increases the duty cycle on the valve the oil flow and pressure to the advance side of the CVVT increases advancing the cam.

During the Hold Mode the OCV is kept in a neutral position by equalizing the pressure to both chambers (some oil is allowed to flow past the OCV for cam bearing lubrication).

CVVT Operation

Driving Condition	Intake Valve Timing	Efficiency
Low Load (Idle)	Retard	Stable Combustion
High Load, High RPM	Retard	Improved Performance
High Load, Low RPM	Advance	Improved Torque
Low-to Medium Load, Low-to-Medium RPM (Cruise)	Advance	Improved Fuel Economy and Lower NOx Emissions

To prevent the OCV from becoming obstructed by small particles, an in-line filter is installed to ensure a supply of clean oil to the valve. The timing is tightly maintained between the intake and exhaust cams by a cam chain tensioner located between the cams. The tensioner is both spring loaded and hydraulically controlled.

NOTE: The cam chain and sprocket pitch is different than that of the non-CVVT equipped 2.0L engine. They are not interchangeable.

Front Oxygen Sensor

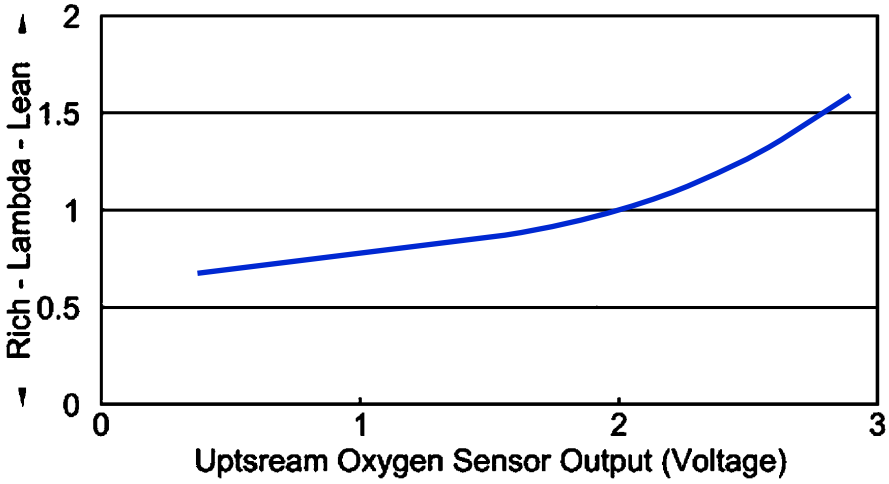
To maintain the air/fuel mixture at the optimum 14:1 ratio, a Wide Range Air/Fuel (WRAF) (or Linear) front oxygen sensor is employed. Although this heated sensor incorporates a Zirconium Dioxide active element, it acts more like a Titanium Dioxide sensor. The operating range of the sensor is 0-5V and the voltage output is as follows:

- High when the exhaust mixture is lean.
- Low when the mixture is rich (see illustration below).
- Normal output range of the sensor is approximately .32V – 2.8V
- Approximate voltage during fuel cut-off (deceleration) ~ 4.3V
- Approximate voltage at Lambda = 1 (Stoichiometric) ~ 2V.

There is **no reference voltage** to the sensor as it is self-generating. However, there is a 0.45V bias on the Signal Line. The WRAF heated O2 sensor has five wires instead of the customary four on other Hyundai heated O2 sensors.

The WRAF output cannot be read directly by an oscilloscope. There is a detection circuit built into the PCM that interprets current flow produced by the sensor and produces a voltage relative to the current flow, direction and strength. For example, a stoichiometric mixture will produce no current flow, and the detection circuit in the PCM will produce approximately 2V. For a lean exhaust mixture, the WRAF sensor outputs a positive current flow relative to the O2 content. The detection circuit generates more than 2V. Conversely, for a rich mixture a negative current flow is detected producing greater than 2V.

Another component upgraded in the SULEV Elantra is the front catalytic converter. As mentioned, it has 900 cells per square inch compared to 400 in the standard catalytic converters on other Hyundai vehicles. The increased surface area of the converter increases the efficiency in removing hydrocarbons, Carbon monoxide and nitrous oxides from the exhaust stream. The new converter has a round shape making it distinguishable from the earlier oval design. The main catalytic converter and the exhaust manifold are welded into a strengthen one-piece unit.



CVVT Service Tips

If a CVVT equipped vehicle experiences a condition of either poor performance or rough idle, the OCV may be malfunctioning or some foreign material may have stuck in the spool valve. In any case, there is an easy way to check the operation of the OCV. The procedure is as follows:

continued on page 4

Continuously Variable Valve Timing

continued from page 3

1. Start the vehicle and bring it up to normal operating temperatures (let the cooling fans cycle once).
2. With the engine idling, disconnect the connector from the OCV. You should not notice a change if the system is operating normally. If the OCV had a short, you may notice the idle smoothing out.
3. With the engine still idling, connect 12V to the OCV terminals (you should hear a click from the OCV). The engine should begin idling very rough or could even stall.

If nothing happened when 12V was applied to the OCV, stop the engine and remove the valve and verify the spool valve is moving back-and-forth when 12V is applied and removed. Replace the OCV if it will not operate during this test or has foreign material stuck in the spool valve.

NOTE: DO NOT TOUCH THE SLEEVE OR SPOOL! Handle the OCV by the coil body only.

If the OCV is operating normally, check the wiring between it and the PCM for any shorts or opens. Repair as necessary. If an OCV needs replacing due to foreign material in the spool valve, replace the OCV Filter (located on the end of the cylinder head on the exhaust side of the #4 cylinder), and check the operation of the system as follows:

1. Set up the Hi-Scan Pro for use as a 2-channel oscilloscope. Back probe the Orange wire at the CKP connector with a T-pin and back probe the Red/Black wire at the CMP connector with a T-pin (be careful not to damage the wire sealing ring or pierce the wire).
2. Connect the A-channel to the T-pin at the CMP sensor and connect the B-channel to the T-pin at the CKP sensor.
3. Set up the Hi-Scan Pro so the CMP sensor waveform overlaps the CKP sensor waveform.
4. Start the vehicle and bring it up to normal operating temperatures. (Let the cooling fans cycle once).
5. With the vehicle idling, the waveform should look like the example in illustration A below.
6. If the vehicle is an automatic, perform a short stall test while executing a flight record on the Hi-Scan Pro. If the vehicle is a manual, drive the vehicle and carefully and safely accelerate the vehicle at full throttle in 3rd gear from 1500 RPM while executing the flight record. The waveform (at full advance) should look like the example in illustration B.

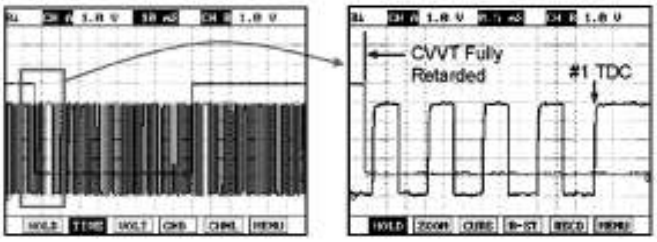


Illustration A

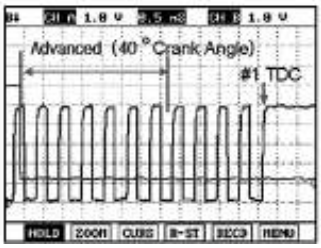


Illustration B

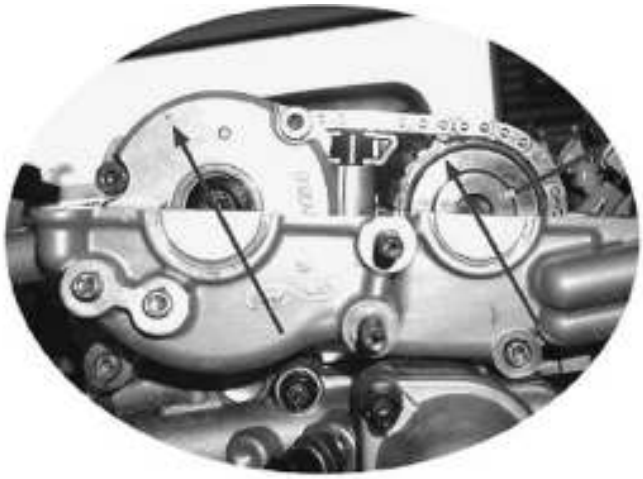
NOTE: The Hi-Scan Pro method can also be used to check for maximum retard and advance of the CVVT unit when disconnecting the OCV and applying 12V to the terminals.

If you determine with the Hi-Scan Pro method that the CVVT unit is not functioning correctly, but the OCV is working normally, check the cam timing by setting the engine so #1 cylinder is at TDC on its compression stroke. Note that the CVVT unit and cam timing marks do not line up with the head, but if imaginary lines are drawn through the center of the respective camshafts, they will be parallel. If the timing marks do line up, there may be a malfunction with the CVVT unit itself.

To check the operation of the CVVT unit, remove the exhaust cam bearing cap closest to the CVVT unit. Make sure the #1 cylinder is at TDC on the compression stroke.

While blocking the oil hole farthest from the CVVT unit, blow compressed air into the hole closest to the CVVT unit (Use a rubber-tipped nozzle and cover the area with a rag to capture any oil that may escape from the oil channels around the cam journal.) The compressed air (>125 PSI) will depress the retard lock pin in the CVVT unit and rotate the unit into the full-advance position. (See photo below.)

Note the left photo on the top of the next page: This is how the CVVT unit and intake cam timing marks line up with the #1 cylinder at TDC on the compression stroke and the CVVT unit fully retarded.



Note in the right photo below: This is how the CVVT unit and intake cam timing marks line up with the #1 cylinder at TDC on the compression stroke and the CVVT unit fully advanced.

Rotating the crankshaft counter-clockwise will retard the CVVT unit and the retard lock pin will lock into position. Replace the unit if it does not operate correctly.

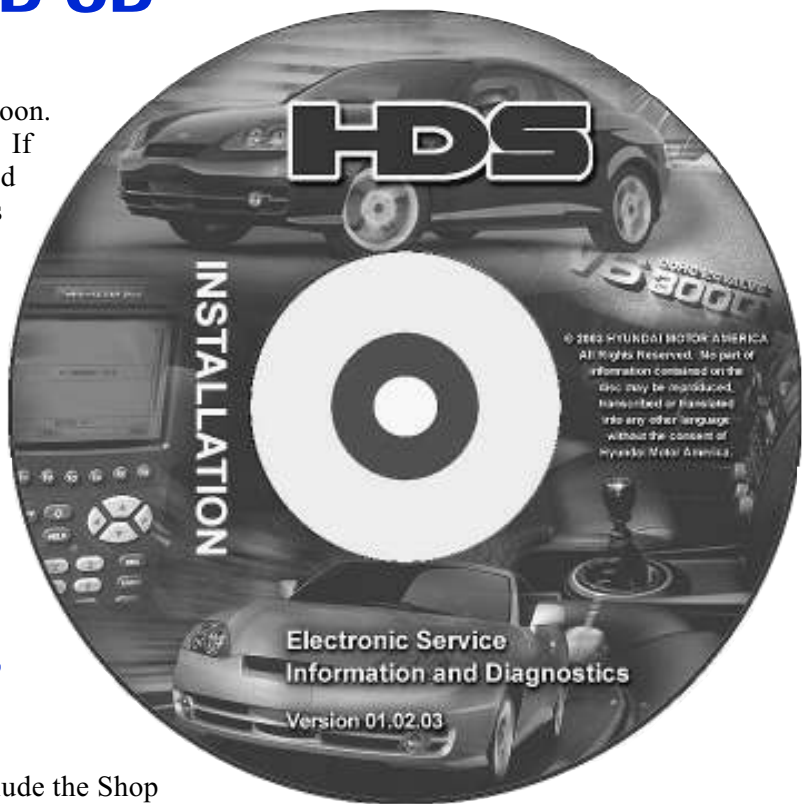
Note: Never attempt to overhaul the CVVT unit. It is assembled with special equipment and cannot be reassembled by hand.

This article serves as a basic introduction to the CVVT system and its components. Further service information will be included in an upcoming TSB.

HDS Update on RED CD

(Release 05.01.03)

The new HDS Update CDs are coming soon. Watch for yours towards the end of May. If your InfoTech screen doesn't display the Red menu bar, then you still need to run this Update. The single CD installation will start automatically when inserted in your HDS CD-Rom drive, and will prompt you through the update procedure. Be sure to run this Update on your HDS to get all the latest service information and SimuTech/InfoTech features onto your HDS, including the new SVG Viewer and the 2003 Tiburon Interactive Electrical Schematics.



2003 Shop Manuals and ETMs on WebTech

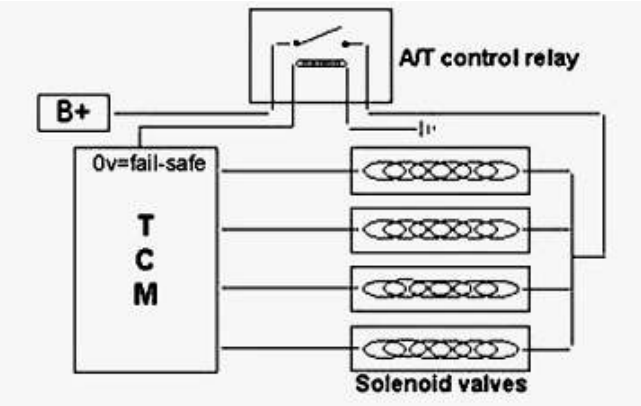
www.hmaservice.com has been updated to include the Shop Manuals and ETMs for all 2003 models – Accent, Elantra, Sante Fe, Sonata, XG350 and Tiburon. This includes the 2003 Tiburon Interactive Electrical Schematics. Also see the article in this issue for more information on SVG-based Interactive Schematics.

Third Gear Fail-Safe

The following models are equipped with a new generation transaxle (oil pan on side): 1999-2003 Sonata, 2001-03 Elantra, Santa Fe, XG, 2003 Tiburon. With this transaxle, the TCM continuously monitors all the sensors and solenoids on the transaxle when the vehicle is in operation. If the TCM detects a sensor or solenoid related condition, the TCM sets the transaxle in 3rd gear fail-safe to protect the transaxle and to provide a "limp-home" mode for the customer.

The TCM normally supplies 12 volts to the A/T control relay, which energizes the solenoids. If the TCM detects a condition that may prevent the correct operation of the transaxle, it turns off the current to the A/T relay, which cuts power to the solenoids. This causes the underdrive and overdrive clutches to be applied, providing 3rd gear fail-safe. The TCM then sets a DTC.

If you are servicing a vehicle with a customer comment of "stuck in gear" or "won't shift", check for DTC in both the "Engine" and "Automatic transaxle" menus. Refer to TSB 02-40-011 or 02-40-012 to find the applicable TSB.



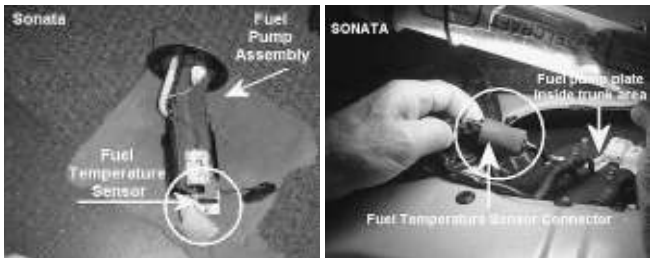
Relay Circuit Schematic

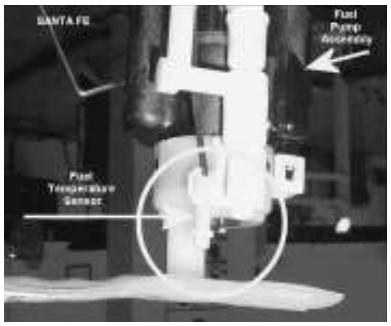
Fuel Temperature Sensor

A Fuel Temperature Sensor has been introduced in some 2003 models

The Fuel Temp Sensor (FTS) is installed in the Sonata, four-cylinder engine, Santa Fe four-cylinder engine, and the 2003 XG350. It may be installed in other models in the future as well.

The FTS is located inside the fuel tank, and is part of the fuel pump assembly. The sensor measures the fuel temperature and the ECM uses this information in monitoring the EVAP system. It's used by the ECM to compensate for the differential vapor pressure due to a temperature change. It enhances the ECM to correctly detect a leak in the EVAP system





Codes related to the FTS:

- **P0181:** Rationality check. Fuel temperature and coolant temperature differ by more than 60°F on start up.
- **P0182:** Sensor is shorted or signal voltage is low.
- **P0183:** Sensor is open or signal voltage is high. The most likely cause of a code, is a sensor connector not completely connected.

The FTS is a positive temperature coefficient thermistor type, changing resistance with temperature, thus causing the sensor voltage to increase or decrease with temperature.

To test the FTS, immerse the sensor in fluid at a specified temperature, and measure the resistance.

Resistance specs (k) ohms:

-20°C (-4° f) = 14.3 - 15.9
0° C (32°f) = 5.5 - 5.8
20° C (68°f) = 2.3 - 2.4
60° C (140°f) = 0.5 - 0.6

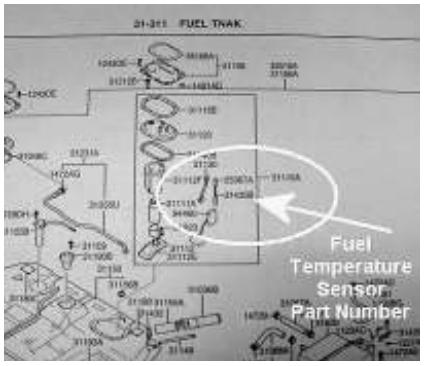
Part numbers for the FTS:

Santa Fe:
31435-26300

Sonata:
31435-38300

XG 350:
From 10/01/ 02 to 10/18/02
31435-3B500

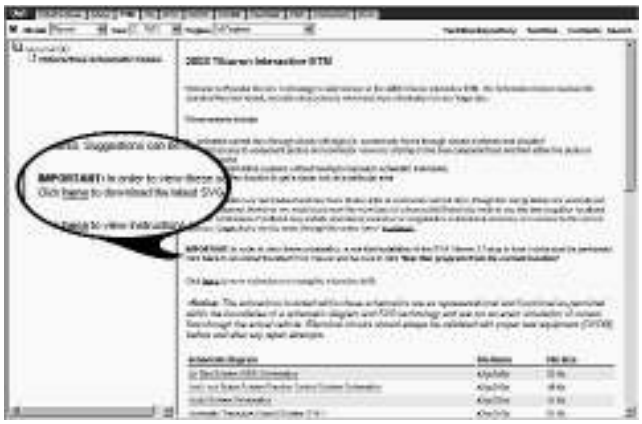
XG 350:
From 10/19/02 to present
31435-38300



Interactive Electrical Schematics Are Now Online for 2003 Tiburon

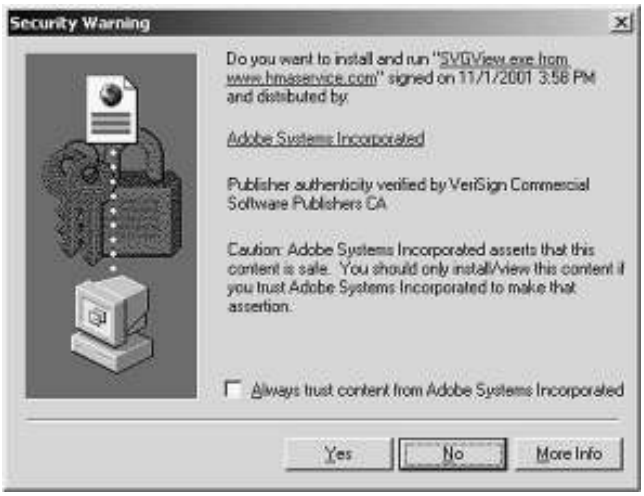
The 2003 Tiburon ETM is the first online publication in Hyundai's new high-tech format: SVG-based Interactive Electrical Schematics. SVG (Scalable Vector Graphic) is a new graphic format that allows functions such as zooming and panning, as well as adding some of the advanced features that Hyundai has designed for our wiring diagrams. These new schematics are available now at www.hmaservice.com, and will be added to your HDS hard-drive with the upcoming "Red" HDS Update CD.

If you have not yet updated your HDS, or are attempting to view SVG from the internet on a non-HDS computer, you may get a red "X" instead of your selected schematic. This means the computer does not have the SVG Viewer installed. Install the Viewer from the Schematic Index page, as follows:

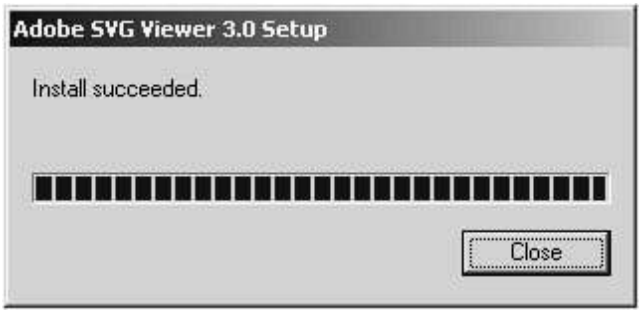


Click on the "here" link for the SVG Viewer software.

The window shown below left will pop-up. Click on "Run this program from its current location" and then click the "OK" button.



When downloading is complete, the above window may appear. Click the "Yes" button to run the installation.



The Setup window shown above will list files copying and installing, and when "Install succeeded." appears, the installation is complete. Click the "Close" button.

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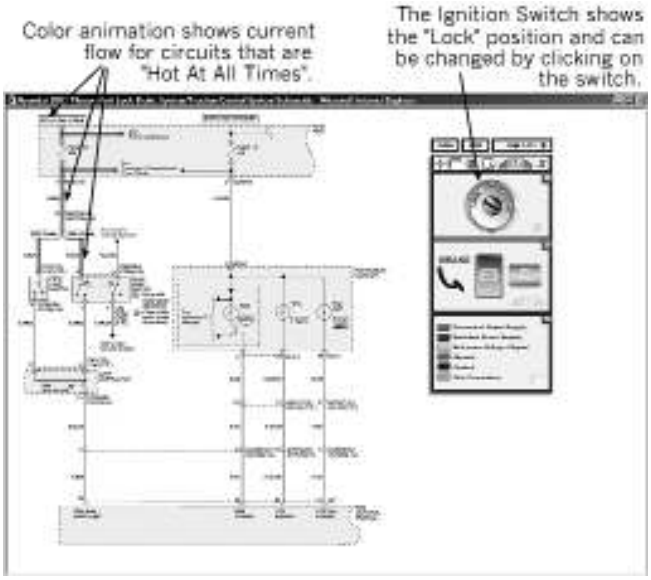
Interactive Electrical Schematics Are Now Online for 2003 Tiburon

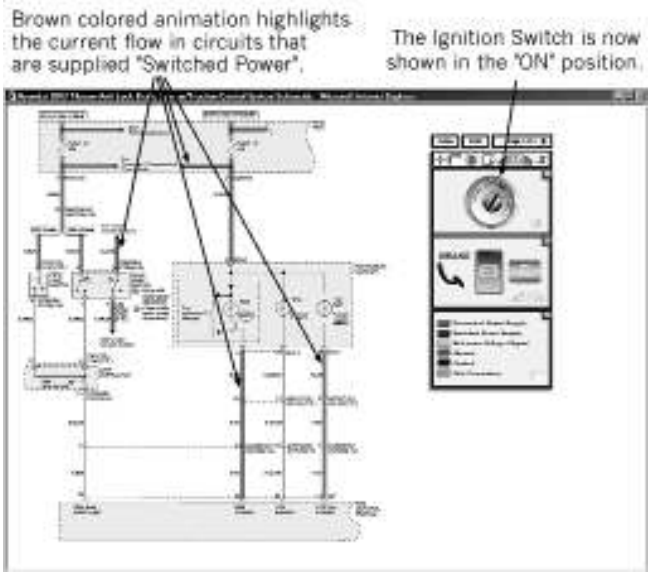
continued from page 7

You can now click on any schematic listed in the Interactive Schematic Index. The first time a diagram opens, you will see a copy of the SVG Viewer license agreement. Read the agreement and click "Accept".

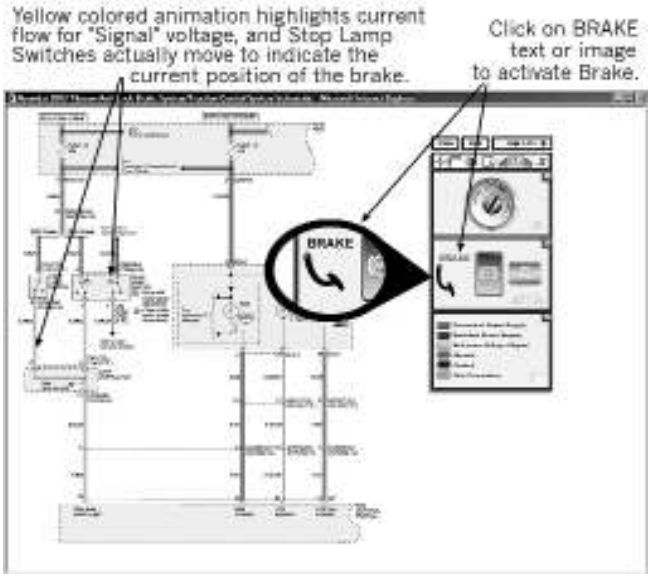
In the sample schematic shown below, for the ABS/TCS Wiring Diagrams, the schematic is shown in three switch states. First with the Ignition Switch in LOCK:



Second, with the Ignition Switch turned to ON:



And third, with the Ignition Switch in ON, the Brake Pedal is depressed:



The SVG-based Interactive Electrical Schematics simulate most of the switches on the car, so that you can recreate actual conditions and watch how the electrical circuits should be responding. Keep watching future newsletters for more hints on using these schematics.

Pre-Conditions for Readiness Monitors

A number of States have added a check of the "Readiness Monitor Status" as part of their state mandated emissions test requirements. Hyundai Motor America [HMA] has published TSB 02-36-030 – "OBD-II Readiness Test Drive Cycle For 1996-1998 Sonata," which contains detailed instructions on performing "Drive Cycles" for the sole purpose of setting "Readiness Monitors".

Pre-Condition #1:

Even if the Check Engine Light is OFF, Check for existing codes in the Engine and Trans Menus. If codes are present, make the necessary repairs before proceeding.

Pre-Condition #2:

Current Data Menu Item "Closed T. P. Switch" (Using the Hi-Scan Pro, under Trans Menu) must read 'ON' at Idle, and switch 'OFF' within 150 RPM when the throttle is applied. TSB 97-40-029 shown below contains detailed instructions on the idle switch adjustment procedure for 1996 to 1998MY vehicles equipped with Automatic Transaxles.

TSB# 97-40-029

Description:

Correct adjustment of the throttle position sensor (TPS) and idle switch is essential for proper driveability. A TPS or idle switch out of adjustment may cause one or more of the following driveablity conditions:

- Park to Reverse or Park to Drive engagement shock
- Engine speed fluctuation between 1000 - 1700 rpm during slow cruise at light throttle opening or during deceleration
- Harsh 4-3 downshift shock when decelerating to a stop
- Harsh 1-2 and 2-3 upshift
- Rough idle

The idle switch is incorporated in the TPS assembly on the 1996-97 2.0L and 1995-97 3.0L Sonata. To ensure proper adjustment, the idle switch is used to make the initial adjustment to the assembly. After adjustment, confirm that the TPS output voltage falls within the standard value range given in the Shop Manual and this TSB.

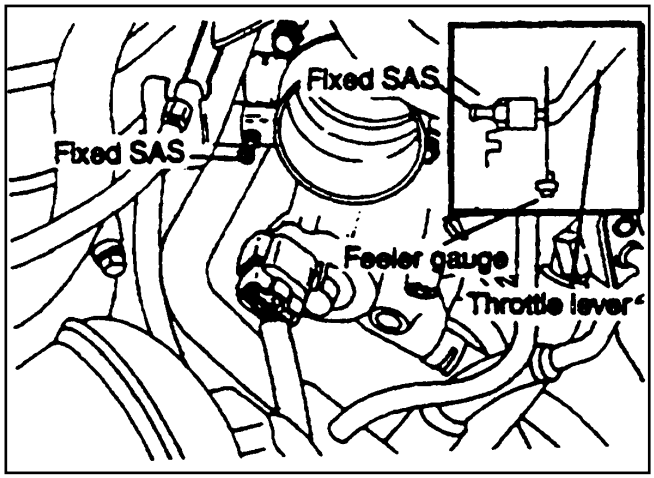
Service Procedure:

Ensure that the engine idle, throttle cable and cruise control cable (if equipped) are adjusted properly. Refer to the appropriate Shop Manual for the adjustment procedure.

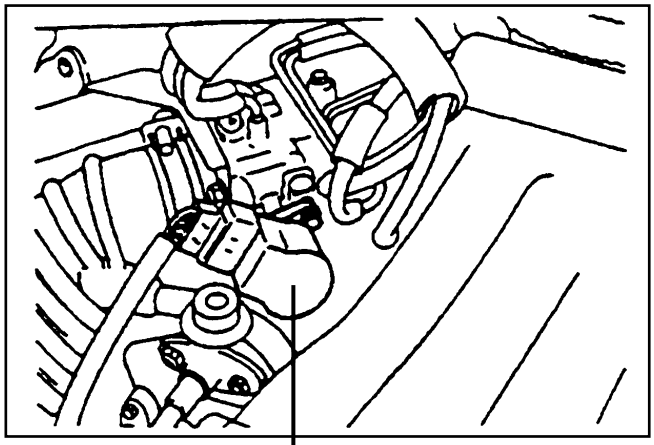
Connect the HDS scan tool to the data link connector and turn the ignition switch ON.

From the Menu, select "Transaxle," "Codes and Data Menu" and "Data" screen, then go to "IDLE SW."

Place a 0.025 in 0.65 mm thick feeler gauge between the fixed Speed Adjusting Screw (SAS) and throttle lever.



Loosen the TPS mounting bolts and turn the TPS body fully counterclockwise. Confirm that the idle switch readout shows "CLSD."



THROTTLE POSITION SENSOR

Slowly turn the TPS body clockwise until the idle switch readout shows "OPEN." Carefully tighten the TPS mounting bolts securely.

Remove the feeler gauge.

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Fix-It-Right

OXYGEN SENSOR LOCATION AND ENGINE BANK TERMINOLOGY – CLARIFICATION (TBS…)

MODEL: 1999-2003 MY V6

DESCRIPTION:
The illustration below explains the following terms:

- Engine BANK
- Up = Sensor 1 = Front = Closer to the exhaust manifold = Before the Catalyst
- Down = Sensor 2 = Rear = After the Catalyst

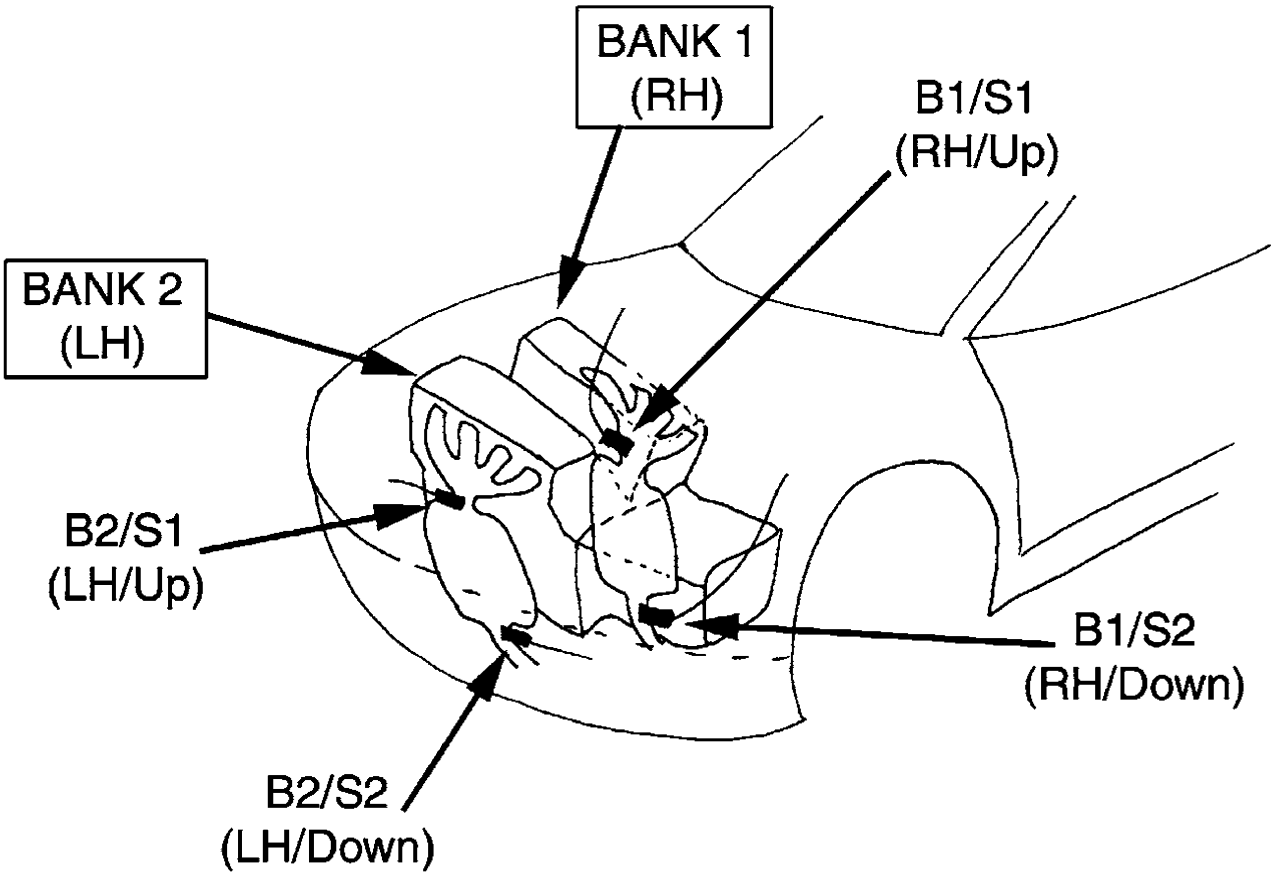
• Bank 1 is closer to the dash panel = RH (right hand)

• Bank 2 is closer to the Radiator = LH (left hand)

The following O2 Sensor EXAMPLES show how to interpret the terminology:

• B1/S1 = Bank 1/Sensor 1 = Dash Panel Side, BEFORE the catalyst

• B2/S2 = Bank 2/Sensor 2 = Radiator Side, AFTER the catalyst



2.7L V6 ENGINE OXYGEN SENSOR CHANGE (TBS…)

MODEL: 2003 SANTA FE V6, 2003 SONATA V6, 2003/4 TIBURON V6

This article supersedes TSB# 02-36-333 to correct part number descriptions.

DESCRIPTION:
The oxygen sensors on the 2.7L V6 (Delta) engine have been changed.

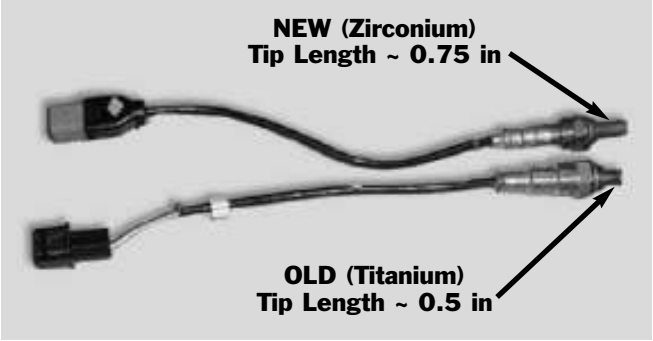
The table below explains the differences.

OXYGEN SENSOR PROPERTIES	PREVIOUS	NEW
Sensing Material	Titanium	Zirconium
Sensor Operating Range	0 - 5 V	0 - 1 V
Sensor Principle	Variable Resistance	Voltage Generating
Lean Mixture	5 V	0 V
Rich Mixture	0 V	1 V

NOTE: With this change, Oxygen Sensors on ALL Hyundai engines will be of the same basic design (Zirconium Type), except for SULEV.

Also note that this change to the O_2 Sensors results in changes to the related wiring harness and ECM. Refer to the Parts Catalog for related part numbers.

Old (Titanium) Versus New (Zirconium) O2 Sensors for the 2.7L V6 (Delta) Engine — Main Physical Difference



EFFECTIVE VEHICLE INFORMATION:

MODEL	EFFECTIVE PRODUCTION DATE
2003 Santa Fe V6	July 28, 2002 ~
2003 Sonata V6	August 9, 2002 ~
2003/4 Tiburon V6	January 1, 2003 ~

PARTS INFORMATION:

2003/4 TIBURON V6

SENSOR LOCATION	PREVIOUS	NEW
B1/S1	39210-37125	39210-37510
B1/S2	39210-37140	**39210-37525**
B2/S1	39210-37165	39210-37530
B2/S2	39210-37180	39210-37540

NOTE: New B2/S1 O_2 Sensor part number is unique to the Tiburon V6; otherwise, all other O_2 Sensor part numbers are the same as the 2003 Santa Fe V6 and 2003 Sonata V6.

PARTS INFORMATION:

2003 SANTA FE and 2003 SONATA V6

SENSOR LOCATION	PREVIOUS	NEW
B1/S1	39210-37125	39210-37510
B1/S2	39210-37140	39210-37520
B2/S1	39210-37165	39210-37530
B2/S2	39210-37180	39210-37540

B1/S1 = Bank 1, Sensor 1 (Front O_2)
B2/S1 = Bank 2, Sensor 1 (Front O_2)
B1/S2 = Bank 1, Sensor 2 (Rear O_2)
B2/S2 = Bank 2, Sensor 2 (Rear O_2)
Bank 1 = Dash Panel Side
Bank 2 = Radiator Side

INTERCHANGEABILITY:
The Previous and New O_2 sensors are **NOT** Interchangeable.

Pre-Conditions for Readiness Monitors

continued from page 9

Confirm that the idle switch changes from "CLSD" at idle to "OPEN" as the throttle is slightly opened.

Verify the TPS output voltage is within specification.

STANDARD VALUE: 0.4 - 1.0 V

NOTE: If the voltage is out of specification, check the TPS and associated harnesses for damage. Repair/replace TPS and associated harnesses if necessary.

If the vehicle is equipped with a Manual Transaxle, a voltmeter must be used to set the Idle Switch. Back-probe the Red/Yellow (Red/Blue for 1998) wire at pin 3 of the TPS connector (C16). Voltage values will be approximately 0.10 (remove the zero) volt when the switch is Closed, (ON) and 4.7 volt when the switch is Open, (Off). As mentioned above, the transition from On to OFF must occur within 150 RPM.

Pre-Condition #3:

Engine Coolant Temperature (ECT) Sensor value should not drop below 1800 F while the Drive Cycle is being performed. The vehicle should be driven at highway speeds with a co-driver to monitor the ECT value before an actual drive cycle is attempted. The CTS value at idle in a shop environment does not indicate accurately indicate the value when the vehicle is driven at highway speeds.

After all of the pre-conditions have been met you can move on to the Drive Cycle procedure. If the 1st drive cycle is successful, the O2 Sensor & O2 Sensor Heater monitors may set to "Completed" status. If not, recheck all of the pre-conditions.

TechNet Trivia

Trivia Question: What is the National Electric Drag Racing Association's quarter-mile speed record for a four-wheeled electric dragster?

Last issue's Trivia Answer: NEVRA stands for the National Electric Vehicle Racing Association which is comprised of several different "racing classes" with the intention of establishing rules that will "Showcase the Advancement and Potential of Electric Vehicles as a Viable Alternative Powered Vehicle."

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TechNet Times is published monthly by Hyundai Motor America's National Service Technology Department for Hyundai Dealership Technicians. The subjects covered in this publication are often one of a kind items, but they may help you to solve similar incidents. In all cases, the diagnostic procedures recommended in the Shop Manuals should always be performed first.

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