



HYUNDAI Technical Service Bulletin

Group	ENGINE ELECTRICAL
Number	06-36-006
Date	DECEMBER, 2006
Model	SONATA I4, XG300/350 & SANTA FE

Subject	EXHAUST GAS RECIRCULATION (EGR) SYSTEM DIAGNOSIS
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THIS BULLETIN SUPERSEDES TSB 01-36-021

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DESCRIPTION:

The models listed below are equipped with engines that utilize Exhaust Gas Recirculation (EGR) to reduce output of Oxides of Nitrogen (NOx).

The basic system described below has been in use on all Hyundai vehicles with external EGR Systems from the 1996 MY.

APPLICATON MODELS:

- 1996 to 1998 Sonata I4 and V6
- 1999 to 2005 Sonata I4
- 2001 - 2005 XG300/350
- 2001 - 2004 Santa Fe I4
- 2003 - 2006 Santa Fe 3.5L V6

HOW EGR WORKS:

When activated, the EGR Valve directs a metered amount of exhaust gas into the intake manifold and thereby into the combustion chamber.

The addition of the inert exhaust gas (does not chemically react during the combustion process) reduces peak combustion temperatures.

Lower peak combustion temperatures result in lower heat-related emissions of Nitrous-Oxides (NO_x).

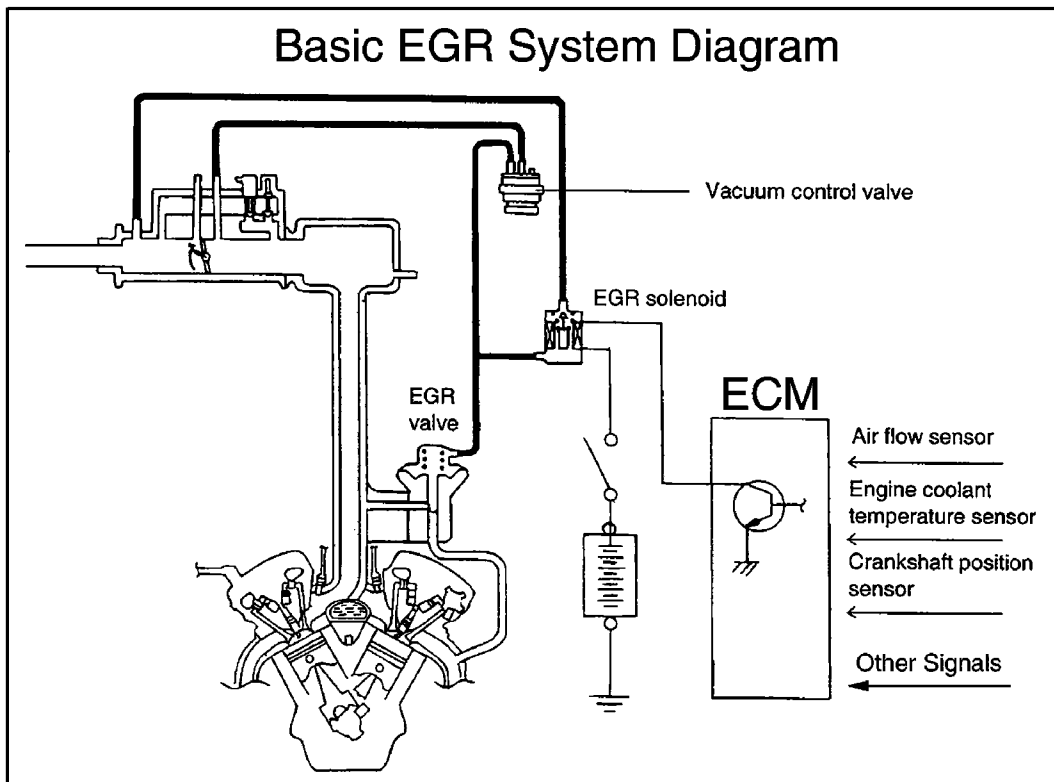
Some engines do not require a separate EGR System. They achieve an EGR effect by valve overlap.

This TSB concentrates on vehicles with “external” EGR systems.

NOTE: EGR is NOT activated when:

- The engine is idling.
- The engine speed is above 4,000 RPM.
- The engine coolant temperature is low (less than 113 °F).
- The vehicle is not moving.

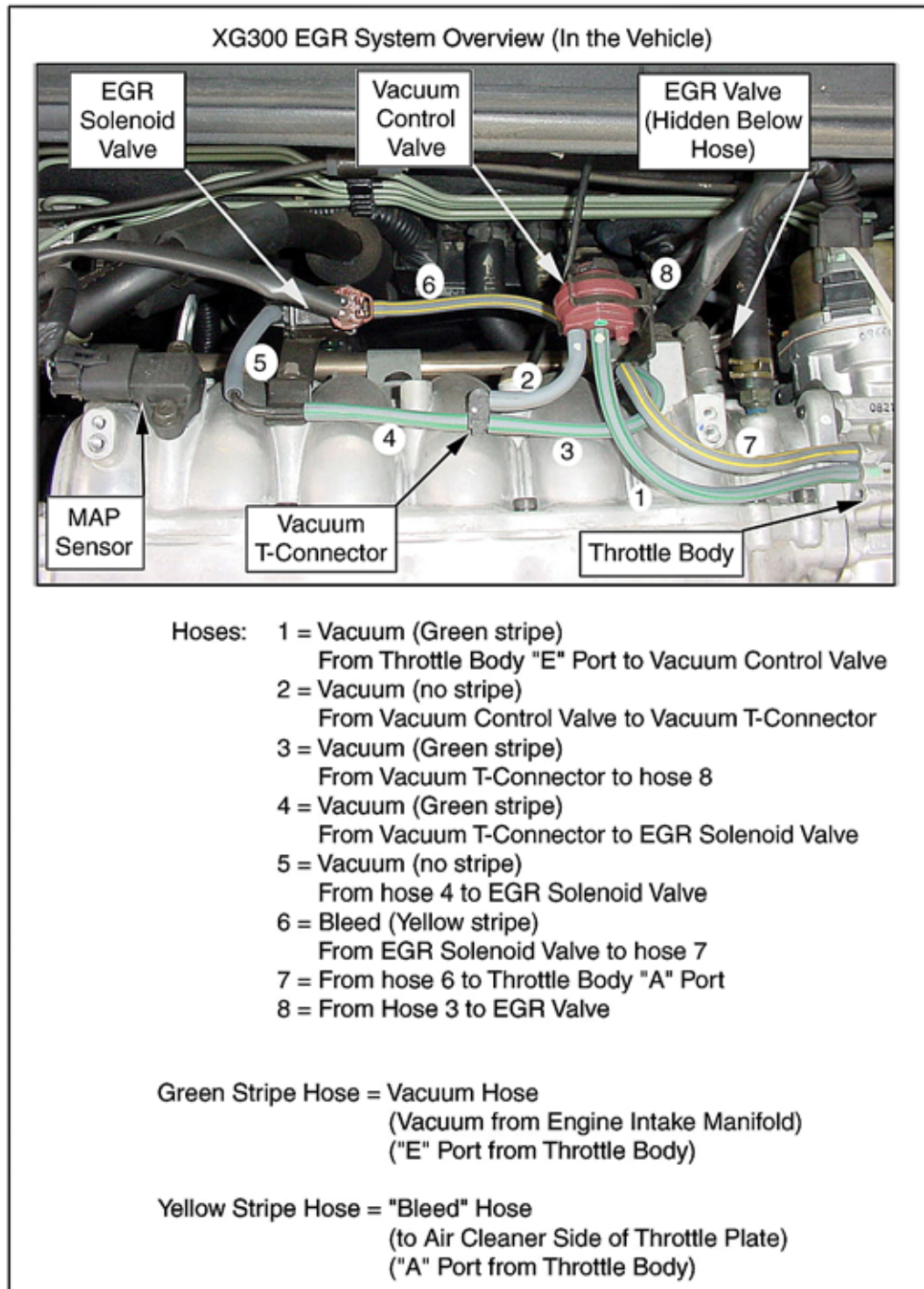
Schematic Diagram of the EGR System (XG300):



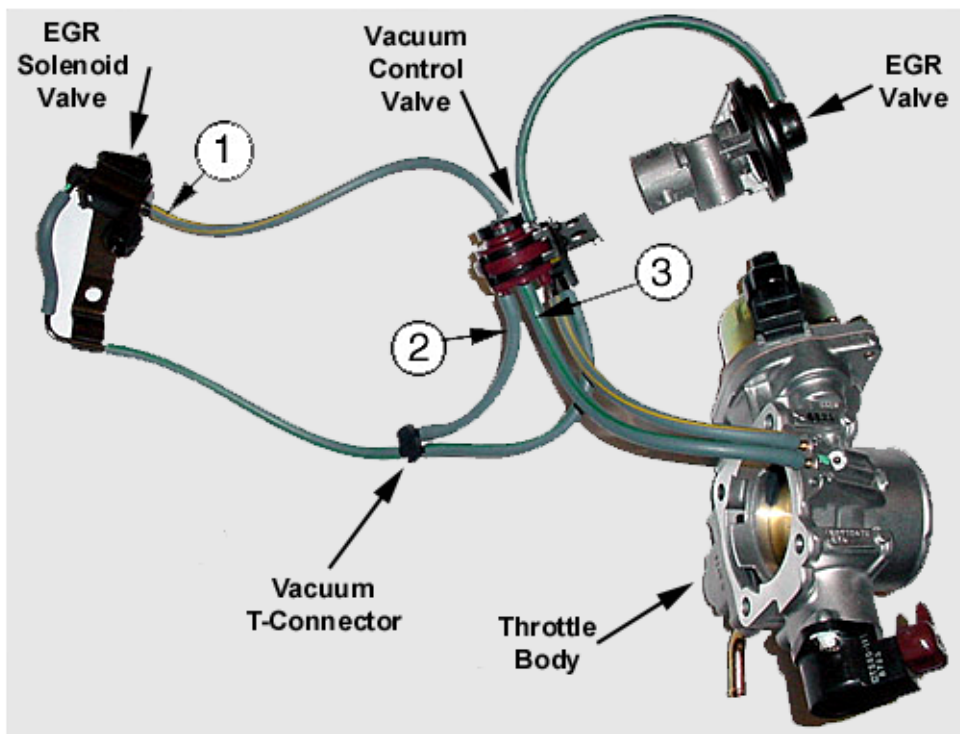


EGR SYSTEM COMPONENTS AND OVERVIEW:

- (1) EGR System photographs (The XG300 system is shown for illustration purposes. The systems in the Sonata I4 and Santa Fe I4 are very similar.)



XG300 EGR Components Out-of-Vehicle



① ② and ③ are the Location of the Orifices

In-Line Orifice



Orifice Integrated into the EGR Solenoid Valve



(Part # 39460-38750)



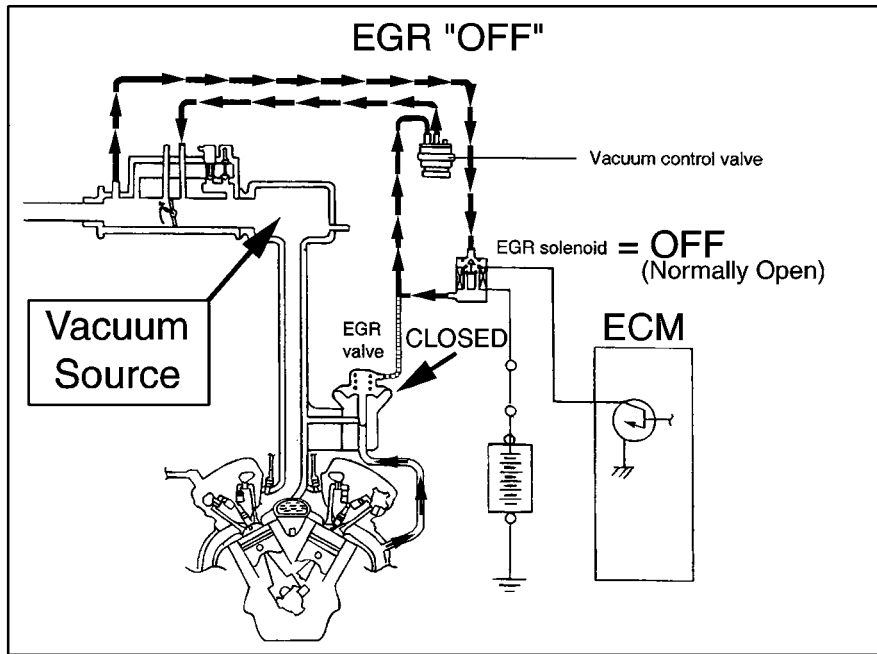
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(2) EGR System Components and their Function:

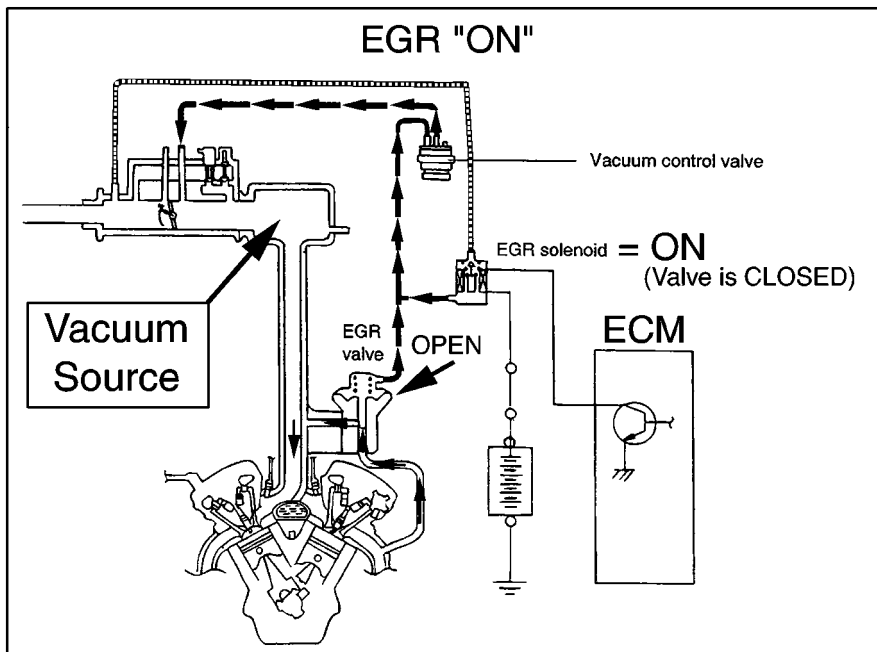
1. **EGR Valve:** This valve directly controls the flow of Exhaust Gases to the intake manifold. The EGR Valve is controlled by vacuum applied to a diaphragm. When vacuum is applied, the diaphragm moves and opens a pintle valve.
2. **Vacuum Control Valve:** To prevent excessive vacuum in the system, this valve regulates the vacuum. When the vacuum is greater than approximately 7 in-Hg (180 mm-Hg = 24 kPa = 3.5 psi), the Vacuum Control Valve opens to the atmosphere until the vacuum level decreases to 7 in-Hg. Regulating vacuum in the system results in improved EGR control and drivability.
3. **EGR Solenoid Valve:** The EGR Valve is controlled by the EGR Solenoid Valve which is normally an “open” valve. That is, when power is NOT applied to the EGR Solenoid Valve, the valve is open (can blow through the valve). When the EGR Solenoid Valve is energized (via a pulse-width signal from the ECM), the valve closes and allows the vacuum from the intake manifold to be applied to the EGR Valve (thus, activating the EGR).
4. **MAP Sensor:** The MAP sensor is used to detect pressure (or vacuum) changes in the intake manifold. When the EGR system is tested by activating the EGR under specific conditions (see the diagnostic logic in the next section), the MAP sensor signal change is what’s used to determine if the EGR system is working properly.
5. **Vacuum T-Connector:** This part allows the vacuum to bleed off through the EGR Solenoid Valve to the Air Intake side of the throttle body.
6. **Throttle Body:** The vacuum source and the Bleed-off back to the Air Intake side of the throttle plate is “plumbed” through the throttle body’s “E” Port (vacuum source) and the “A” Port (bleed-off side).
7. **Green Hoses:** The green striped hoses signify the “vacuum” side of the system.
8. **Yellow Hoses:** The yellow striped hoses signify the “bleed” side of the system.
9. **In-Line Orifices:** There are orifices in the system (three in the case of the XG300) to limit the “flow” in the system. Limiting the flow in the system limits the volume of air bypassing the throttle plate.
10. **ECM:** By processing a variety of input signals, the ECM determines when to activate EGR.

VACUUM "FLOW" DIAGRAMS:

EGR "OFF": Note that the EGR solenoid is "normally open" which allows the vacuum to "bleed off."



EGR "ON": The EGR solenoid is energized and the vacuum path back to the throttle body "A" port is cut off. Thus, the vacuum is APPLIED to the EGR valve's diaphragm.





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EGR SYSTEM DIAGNOSIS:

(1) PCM Diagnostic Trouble Code (DTC) Logic for P0401 (INSUFFICIENT EGR FLOW):

The PCM monitors the EGR system for proper function by conducting a test under the following conditions (this is also called EGR Monitoring):

- The engine is warming up (Engine Coolant Temperature > 113 °F)
- Engine Load is < 22%
- Engine Speed is between 968 and 1,875 RPM
- Idle Position Switch = ON (no throttle input)
- Battery Voltage > 10V
- Vehicle is decelerating

If the above conditions are met, the EGR Valve is closed for 1 second then is opened for about 1 second. During this later 1 second open period, the MAP sensor signal is monitored.

The PCM, using the Manifold Absolute Pressure (MAP) Sensor, measures the pressure change in the intake manifold during the above test. If the pressure changes less than 26mm-Hg -- millimeters of Mercury (equivalent to 0.5 psi = 3.5 kPa = 1 in-Hg), then a problem is detected and code P0401(INSUFFICIENT EGR FLOW) is set in the PCM.

After two consecutive trips of detecting the fault, the Check Engine Light is turned ON and the code & freeze frame data are available.

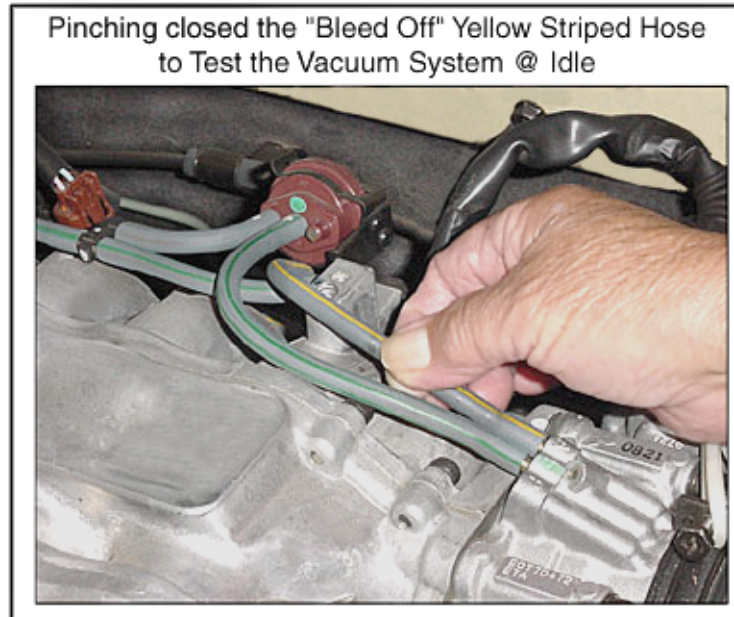
(2) Testing Procedures for P0401:

1. Visual Inspection:

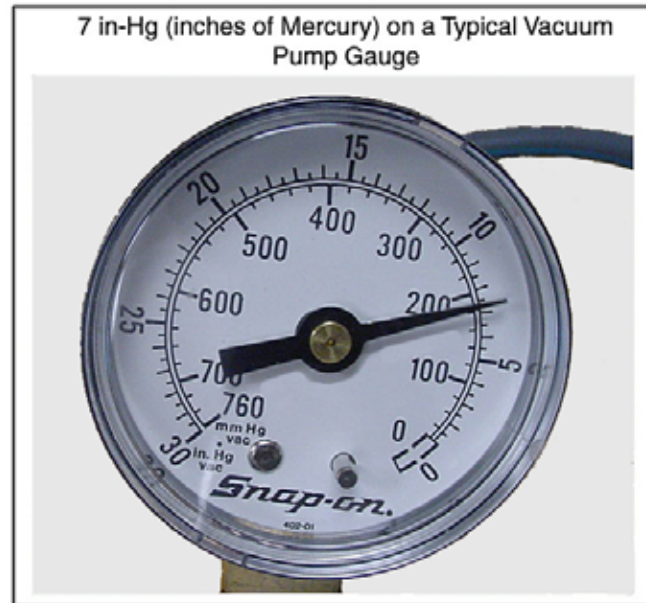
- Check that all hoses and the EGR Solenoid Connector are connected properly.
- Check for cracks or cuts in the hoses. Gently bend the hoses to reveal any cuts that may be difficult to see.
- Check the metal tubes and the EGR Solenoid body and tubes for any signs of cracks or damage.

2. Vacuum System Test:

- a. Engine is Idling in the stall.
- b. Activate the EGR Valve by pinching off the yellow striped hose.



- When the vacuum "bleed off" path is closed, the EGR Valve should open. This will cause the engine to stumble and stall.
- IF cutting-off the vacuum bleed-path does NOT cause the engine to run rough and stall, THEN there is a leak or blockage in the vacuum system.
- Check for leaks or blockages by starting at the throttle body "E" Port. Pull off the vacuum hose at the "E" Port, vacuum should be felt at the throttle body's "E" port tube.
- Then, check each hose and metal tube (working from the "E" port towards the EGR Solenoid Valve). Check each pathway using a vacuum pump with a built in gauge. Create about 7 in-Hg (23 kPa = 3.3 psi = 180 mm-Hg) of vacuum in each component/hose. This small amount of vacuum is enough to fully open the EGR Valve.



- Check the function of the Vacuum Control Valve. Remove the green striped hose at the throttle body and attach a vacuum pump. Plug the other port of the Vacuum Control Valve. Apply a vacuum greater than 7 in Hg (23 kPa = 3.3 psi = 180 mm Hg). The Vacuum Control Valve should regulate the vacuum down and hold vacuum at approximately 7 in Hg. If the vacuum does not hold, the Vacuum Control Valve needs to be replaced.

The Vacuum Control Valve is Regulating Vacuum to 7in-Hg.



- Connect a vacuum pump/gauge to the EGR Valve. Apply 7 in Hg (23 kPa = 3.3 psi) of vacuum; the valve should open fully and the vacuum should NOT bleed off. If the vacuum does not hold, then the EGR Valve needs to be replaced.



- Apply 1 in Hg (3.4 kPa = 0.5 psi) of vacuum directly to the EGR Valve; the valve should not open and air should not blow past the pintle valve.
- The EGR Solenoid Valve may be intermittently sticking closed when not energized. To test this condition, remove the EGR Solenoid Valve and repeatedly apply and remove 12V power to the Solenoid. Using a vacuum pump/gauge, check if the EGR Solenoid sticks in the closed position (vacuum is held when it should not be).
- Conversely, the EGR Solenoid Valve may not be closing properly when energized. Apply 12V to the EGR Solenoid Valve. Attach a vacuum pump/gauge and check if the valve is closed (holds vacuum). This condition may be intermittent and may require the test to be conducted repeatedly to reproduce the “sticking open” condition. An alternative test is to energize the EGR solenoid while the car is idling (apply 12V directly to solenoid). If the engine does not stumble and stall, then the EGR Solenoid is not closing properly and needs to be replaced.



The EGR Solenoid Valve Intermittently does not Close Internally (does not hold vacuum) When Turned ON



The EGR Solenoid Valve is Energized with a 12V Power Source.

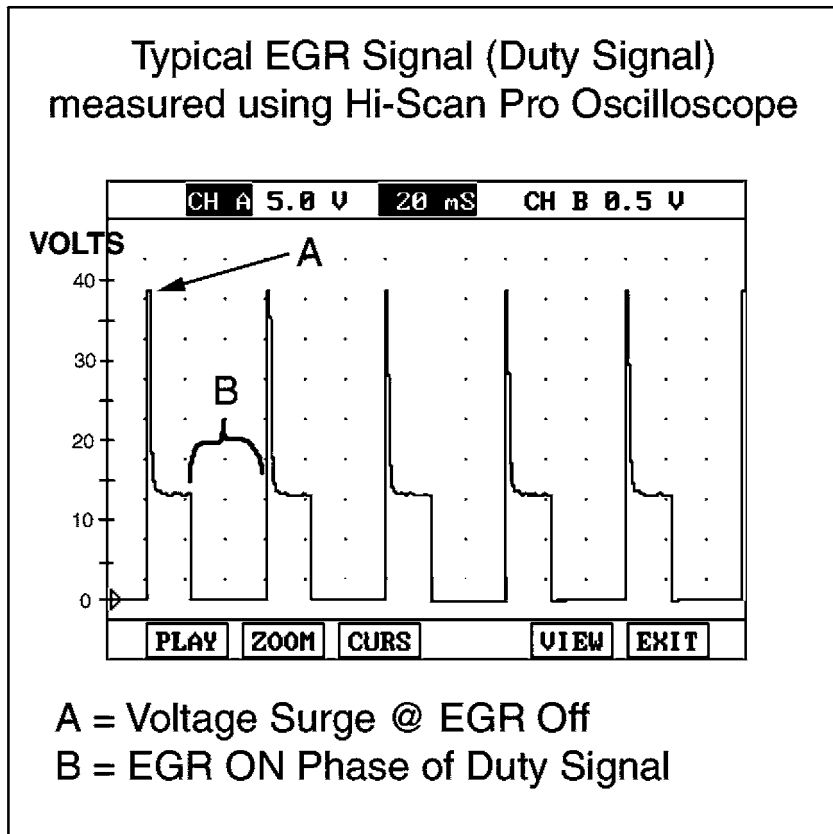
- An intermittent “leak” in the vacuum system is another possibility. This condition can be caused by a cut vacuum hose, which only leaks when flexed as a result of engine movement.
- Check the EGR Valve’s pintle for sticking, excessive carbon deposits, etc.

3. If the code P0401 is set and the engine is idling rough:

- Then, the EGR Valve is being held open at idle, when it should not be.
- This condition could be caused by an EGR Solenoid Valve which is sticking closed when NOT energized by the ECM. (Remember that this valve is “normally open.”)
- This condition could also be caused by a blockage of the “bleed path.” Check the yellow striped hoses for a blockage. Also check the EGR Solenoid Valve’s built-in orifice for blockage.

(3) PCM DTC Logic for P0403 (EGR Solenoid -- Malfunction):

- The ECM monitors the EGR electrical circuit for the presence of the proper EGR signal.
- A typical EGR duty signal is shown below (Hi-Scan Pro Recording).



- As can be seen, there is a voltage “surge” at the beginning of each pulse of the EGR signal. This surge voltage is monitored by the ECM.
- If the surge voltage is less than $[V_b \text{ (battery voltage)} + 2V]$ -- typically totalling about 16 Volts --, then the electrical system is considered to be malfunctioning and code P0403 is set in the ECM.
- After two consecutive trips of detecting the fault, the Check Engine Light is turned ON and the code & freeze frame are available.



(4) Testing Procedure for P0403:

- Check the integrity of the electrical system. Check that all electrical connectors (at the EGR Solenoid Valve and the ECM) are properly connected and that all pins are in good condition.
- Check the continuity of the wiring. Check for shorts or opens.
- Using GDS or the Hi-Scan Pro (in the oscilloscope mode), examine the EGR signal when the EGR is activated. (see the typical signal above). The conditions when the EGR is operating are:
 - Vehicle is moving
 - Engine is not idling
 - Idle switch is not “on” (that is, there is some throttle input)