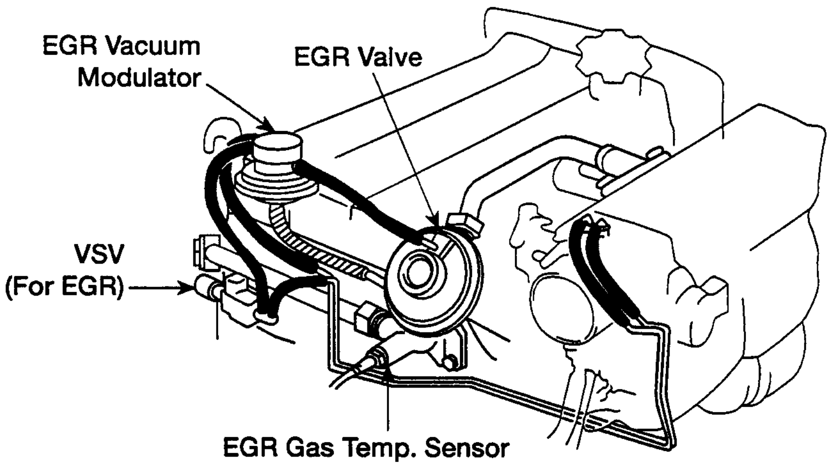
EGR System

The EGR System reduces NO_x output by recirculating exhaust gases in with the engine's normal A/F charge. By diluting the mixture, combustion temperature is lowered, and as a result, NO_x output is reduced.



Exhaust Gas Recirculation System

The Exhaust Gas Recirculation (EGR) system is designed to reduce the amount of Oxides of Nitrogen (NOx) created by the engine during operating periods that usually result in high combustion temperatures. NOx is formed in high concentrations whenever combustion temperatures exceed about 2500'F.

The EGR system reduces NOx production by recirculating small amounts of exhaust gases into the intake manifold where it mixes with the incoming air/fuel charge. By diluting the air/fuel mixture under these conditions, peak combustion temperatures and pressures are reduced, resulting in an overall reduction of NOx output. Generally speaking, EGR flow should match the following operating conditions:

- **High EGR flow** is necessary during cruising and mid-range acceleration, when combustion temperatures are typically very high
- **Low EGR** flow is needed during low speed and light load conditions
- **No EGR** flow should occur during conditions when EGR operation could adversely affect engine operating efficiency or vehicle driveability (engine warm up, idle, wide open throttle, etc.)

EGR Impact on the Engine Control System

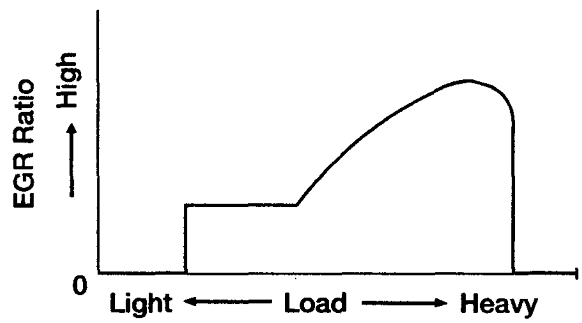
The ECM considers the EGR system an integral part of the entire Engine Control System (ECS). Therefore, the ECM is capable of neutralizing the negative performance aspects of EGR by programming additional spark advance and decreased fuel injection duration during periods of high EGR flow. By integrating fuel and spark control with the EGR metering system, engine performance and fuel economy can actually be enhanced when the EGR system is functioning as designed.

EGR Theory of Operation
The purpose of the EGR system is to precisely regulate EGR flow under different operating conditions, and to override flow under conditions which would compromise good engine performance. The precise amount of exhaust gas which must be metered into the intake manifold varies significantly as engine load changes. This results in the EGR system operating on a very fine line between good NOx control and good engine performance.

If too much exhaust gas is metered, engine performance will suffer. If too little EGR flows, the engine may knock and will not meet strict emissions standards. The theoretical volume of recirculated exhaust gas is referred to as EGR ratio. As the accompanying graph shows, the EGR ratio increases as engine load increases.

Relationship Between EGR Ratio and Load

The theoretical volume of EGR gas is referred to as EGR ratio. As shown on the graph, EGR ratio increases as engine load increases.

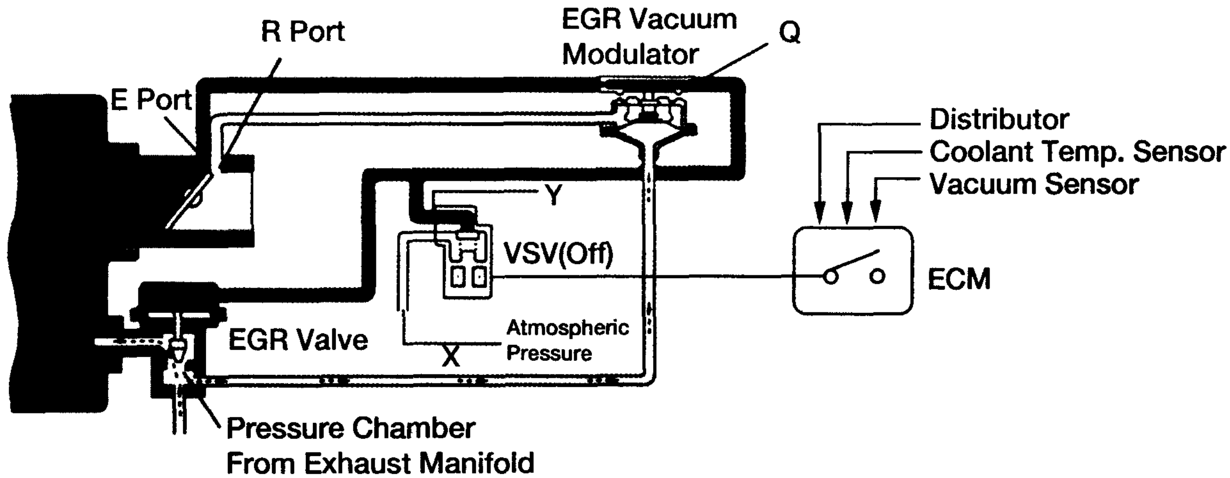


EGR System Components
To achieve this designed control of exhaust gas recirculation, the system uses the following components:

- Vacuum Actuated EGR Control Valve
- EGR Vacuum Modulator Assembly
- ECM Controlled Vacuum Switching Valve (VSV)

EGR Control Valve
The EGR control valve is used to regulate exhaust gas flow to the intake system by means of a pintle valve attached to the valve diaphragm. A ported vacuum signal and calibrated spring on one side of the diaphragm are balanced against atmospheric pressure acting on the other side of the diaphragm. As the vacuum signal applied to the valve increases, the valve is pulled further from ifs seat. The key to accurate EGR metering is the EGR vacuum modulator assembly which precisely controls the strength of the applied vacuum signal.

Typical EGR System Configuration

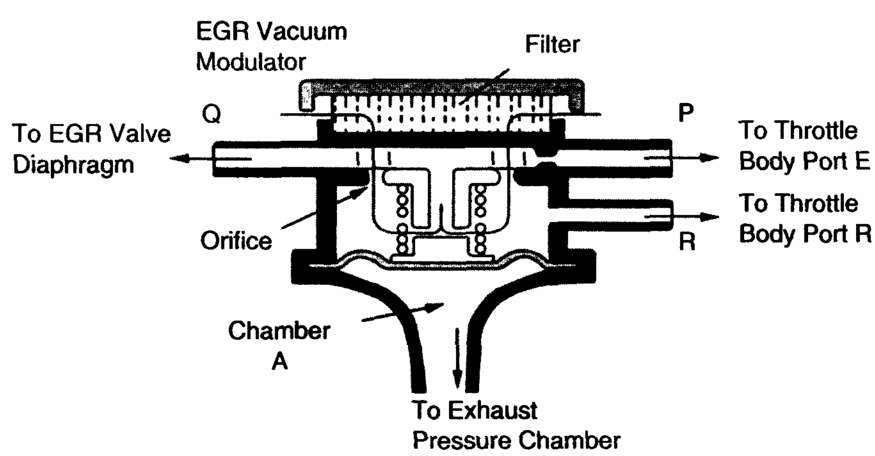


EGR Vacuum Modulator

Because exhaust backpressure increases proportionally with engine load, the EGR vacuum modulator uses this principle to precisely control the strength of the vacuum signal to the EGR valve. The typical EGR control system uses two ported vacuum signals from the throttle body. Port E is the first stage ported vacuum signal and Port R is the second stage ported vacuum signal uncovered by the opening throttle valve.

EGR Vacuum Modulator

The EGR Vacuum Modulator uses exhaust backpressure to precisely control the strength of the vacuum signal to the EGR valve.



When vacuum is applied from port E, the strength of the vacuum signal applied to the EGR valve will be dependent on the amount of exhaust backpressure acting on chamber A of the vacuum modulator. When vacuum is applied from port R, the strength of the vacuum signal applied to the EGR valve will no longer be dependent on the strength of the exhaust backpressure signal. During this mode, the EGR signal strength is determined solely by the strength of the vacuum signal from port E of the throttle body. The EGR vacuum modulator provides the ability to precisely match EGR flow rate to amount of load applied to the engine.

EGR Vacuum Signal Logic

Port	Throttle Valve Opening	Vacuum Signal
E	Position less than E port	No vacuum present
E	Position more than E port	Near manifold vacuum
R	Position less than R port	No vacuum present
R	Position more than R port	Near manifold vacuum

ECM Controlled Vacuum Switching Valve (VSV)
In addition to the EGR modulator, an ECM controlled VSV is used to inhibit EGR operation during conditions where it could adversely affect engine performance and vehicle driveability. The EGR VSV can be either normally open or closed and installed in series between the vacuum modulator and EGR valve or installed on a second port on the EGR valve. This VSV controls an atmospheric bleed which inhibits EGR operation any time a given set of ECM parameters are met.

ECM Override of EGR
As mentioned, the ECM is capable of inhibiting EGR flow through operation of the VSV bleed. When the ECM determines an inhibit condition, it de-energizes the VSV, blocking the vacuum signal to the EGR valve and opening the valve diaphragm to an atmospheric bleed. This causes the EGR valve to close. Typical EGR inhibit parameters are shown below.

Typical EGR Inhibit Parameters

The ECM is capable of inhibiting EGR flow through the operation of a VSV bleed. This chart lists typical EGR inhibit parameters.

Coolant Temperature	Engine RPM	Engine Load
EGR inhibit on all engines below specified coolant temperature (based on THW), typically around 130° F	EGR inhibit on some engines outside specified rpm range (based on Ne), typically around 4200 rpm	EGR inhibit on some engines below a given load factor (based on either Vs or PIM)

Variations on EGR VSV Placement
There are three basic variations of the EGR vacuum circuit depending on engine application. All three systems function similarly, the only difference being the placement of the VSV in the vacuum circuit and the logic of the VSV and ECM.

EGR Fault Detection System

An EGR malfunction detection system is incorporated into the TCCS system to warn the driver when the EGR system is not operating properly. The system uses an Exhaust Gas Temperature (THG) sensor on the intake side of the EGR valve where it is exposed to exhaust gas flow whenever the EGR valve opens.

The ECM compares the THG signal with parameters stored in memory. If EGR gas temperature is determined to be too cold when the ECM has the EGR valve enabled, the MIL will be illuminated, and a diagnostic code will be stored in ECM memory. This diagnostic configuration allows the ECM to monitor entire EGR system operation.

EGR Effect On Emissions & Driveability

- **Too little EGR flow** may cause detonation and IM240 emissions failure for excessive NOx. Because EGR tends to reduce the volatility of the air/fuel charge, loss of EGR typically causes detonation to occur. If EGR is commanded but doesn't flow (restricted passage in manifold, nonfunctional valve, etc.) severe detonation will occur.

- **Too much EGR flow** and/or excessive flow for driving conditions may cause stumble, flat spot, hesitation, and surging. Because EGR dilutes the air/fuel charge, too much EGR for a given engine demand can cause a misfire. It is not uncommon to see tip in hesitation, stumble and surging when too much EGR is metered.

EGR System Functional Tests

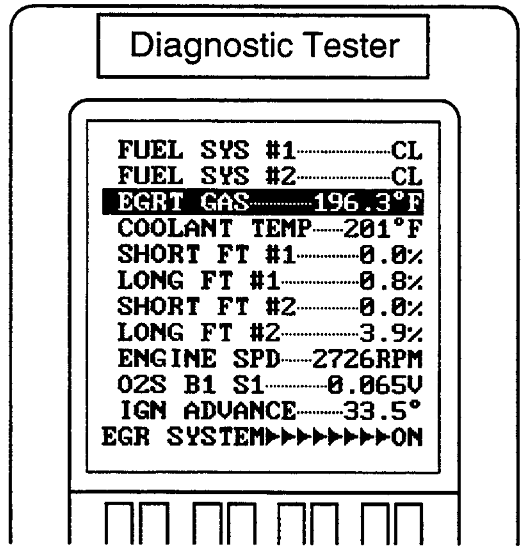
On some OBD-II vehicles, the EGR system can be controlled using the **active test** feature of the Diagnostic Tester. This is the easiest way to verify EGR system operation and can generally be performed as follows:

- Start the engine and allow it to reach operating temperature
- Using the Diagnostic Tester, access the Active Test menu
- Select "EGR System" from the Active Test menu
- Raise engine speed and maintain a steady 3000 rpm
- Activate the EGR VSV (turn EGR On)
- You should notice a slight drop in engine speed and a rise in EGRT gas temperature as EGR is activated

If engine speed and EGRT gas temperature does not change, the EGR system is not functioning and the problem may be mechanical or electrical. If the rpm drop is very slight, the problem may be a partially blocked or restricted EGR passage.

EGR Check Using Active Test

On OBD-II vehicles, the Diagnostic Tester may be used to perform an EGR system active test. This feature allows you to toggle the EGR VSV on/off, while observing changes to EGRT GAS, engine rpm, etc.

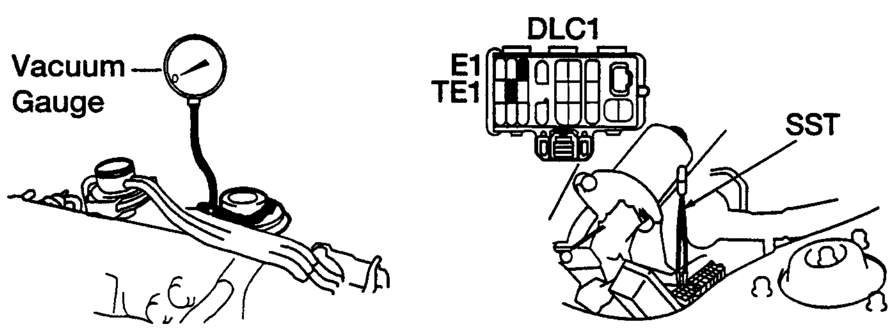


EGR System Inspection

On other vehicles, the only way to accurately check the operation of the EGR system is to perform a systematic inspection of the entire system. The following inspection procedures are for a 95 5S-FE Camry:

- First, inspect the EGR modulator filter and, if necessary, remove and clean the filter with compressed air.
- "Tee" a vacuum gauge into the vacuum line between the EGR valve and VSV.
- Start the engine and confirm that it does not run rough at idle. Note: This verifies that the EGR valve is closed.
- Next, connect terminals TE1 to E1 at DLC 1.

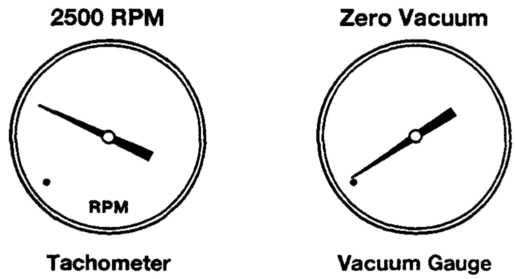
EGR System Inspection



- With coolant temperature cold (A/T: below 140' F, M/T: below 131' F) and engine at 2500 rpm, the vacuum gauge should indicate zero.

Note: This verifies that the VSV is inhibiting EGR flow during cold engine operations.

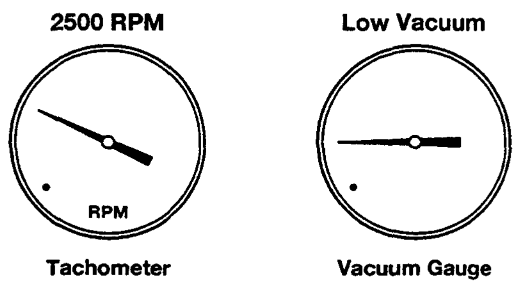
EGR System Inspection (cont.)



- Next, warm the engine to operating temperature and maintain 2500 rpm. The vacuum gauge should now indicate low vacuum (typically around 3")

Note: This verifies proper low vacuum signal to the EGR valve during light engine load conditions.

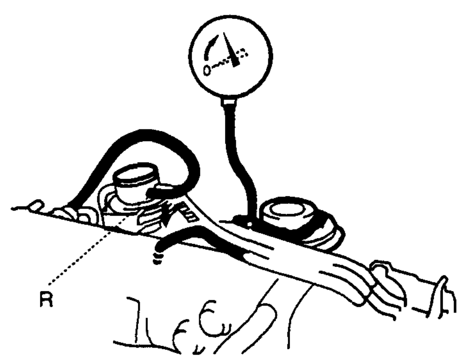
EGR System Inspection (cont.)



- Next, with engine speed at 2500 rpm, connect the R port of the EGR modulator directly to a manifold vacuum source. The vacuum gauge should now indicate high vacuum (typically around 13") and the engine should run rough.

Note: This verifies proper high signal vacuum to the EGR valve when R port vacuum overrides the backpressure modulator.

EGR System Inspection (cont.)

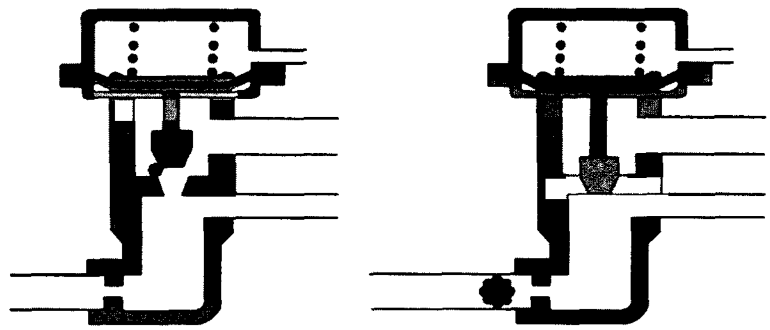


- Disconnect terminals TE1 and El at DLC1 and reattach the EGR hoses to their original location.

If the problem is related to the EGR valve itself, make sure heavy carbon deposits are not keeping the valve unseated or causing it to stick when opening. Also, if EGR valve control is OK remove the valve and check the EGR exhaust and intake passages for restrictions. Heavy carbon deposits can be removed by using a special carbon scrapping tool.

EGR Valve Inspection

When inspecting the EGR valve, look for common problems such as unseated or sticky valves and plugged exhaust/intake passages.



This inspection example systematically confirms the integrity of the EGR valve, VSV, backpressure modulator, system hoses, and EGR passages. Once the suspect part/component is identified, it should be individually tested and then repaired or replaced as necessary. Because slight model to model variations exist between EGR systems, refer to the Repair Manual for specific EGR system inspection procedures.

