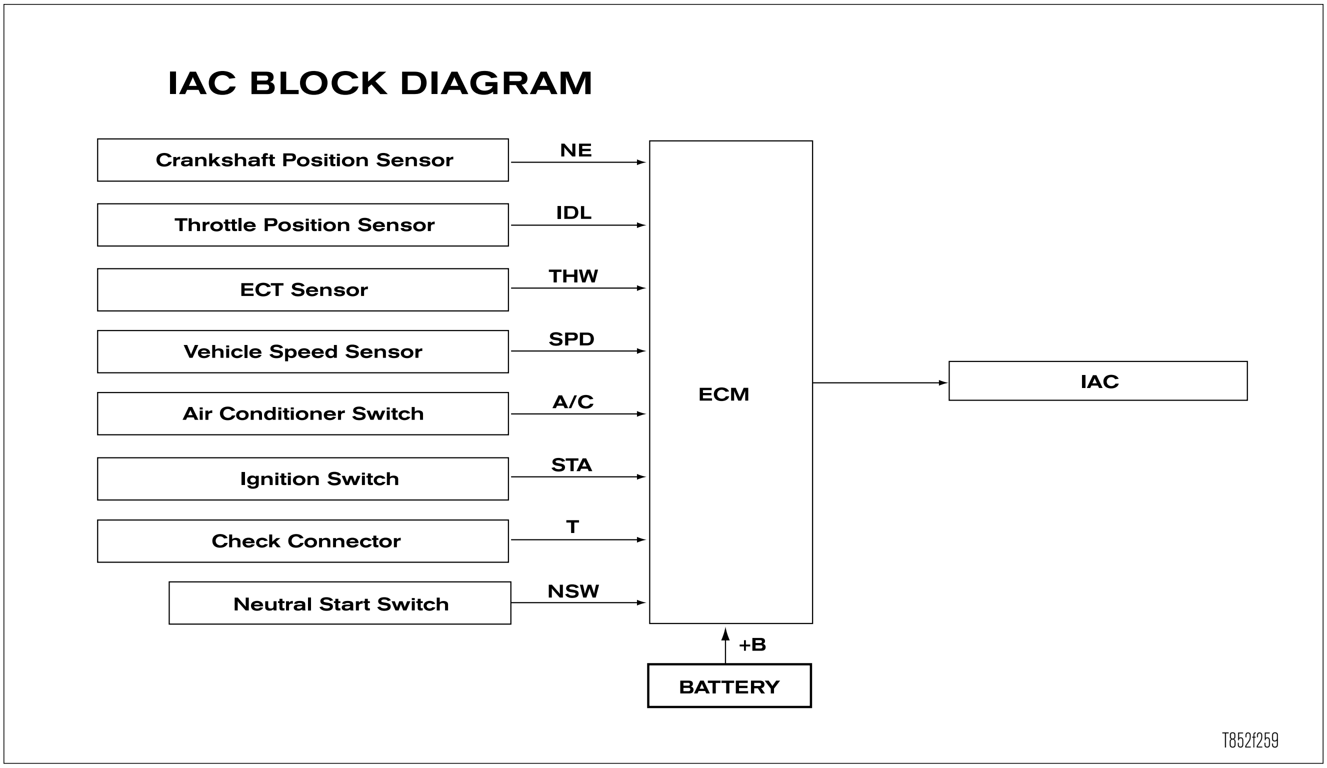
Section 6

Idle Air Control Systems



Lesson Objectives

1. Determine the condition of the IACV system based on engine data
2. Determine the root cause of a failure(s) in the IACV system using appropriate diagnostic procedures

Idle Air Control Systems

Idle Air Control System with Air Assist

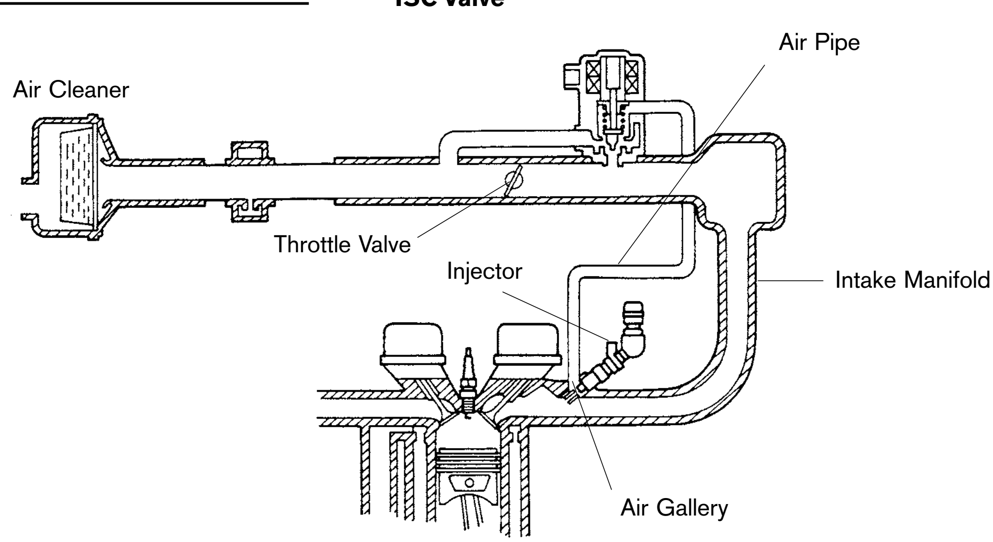


Fig. 6-01

T852f258

Idle Air Control Systems

The Idle Air Control (IAC) system regulates engine idle speed by adjusting the volume of air that is allowed to bypass the closed throttle valve. The ECM controls the Idle Air Control Valve (IACV) based on input signals received from various sensors. The system is necessary to provide stabilization of curb idle when loads are applied to the engine and to provide cold fast idle on some applications.

The idle air control system regulates idle speed under at least one or more of the following conditions, depending on application:

- Cold Fast Idle.
- Warm Curb Idle.
- Air Conditioner Load.
- Electrical Load.
- Automatic Transmission Load.
- Power Steering Idle Up.

The IAC system will also prevent engine stall on deceleration.

IAC System

IAC BLOCK DIAGRAM

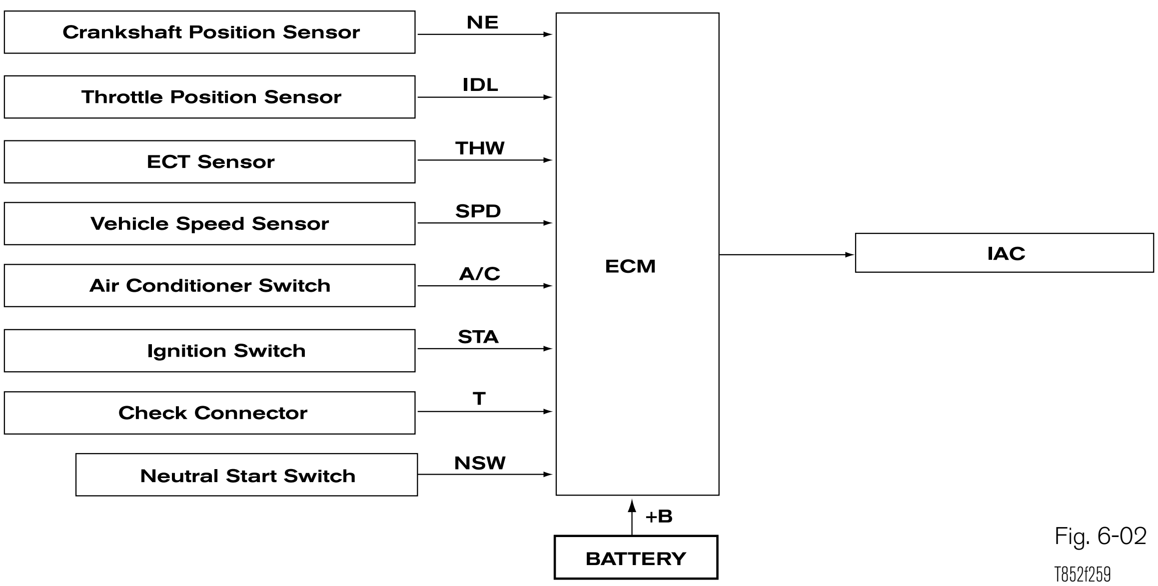


Fig. 6-02

T852f259

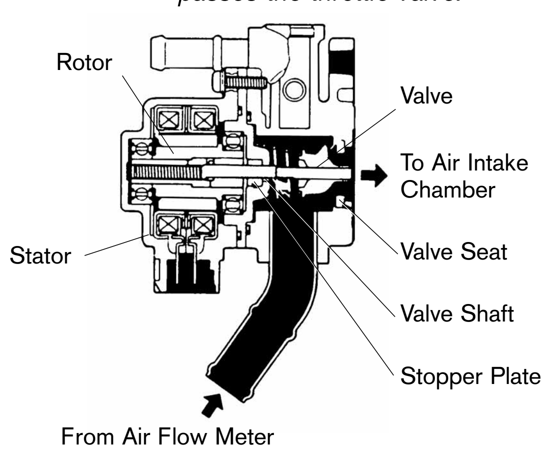
ECM Modulated Idle Air Control Systems (IAC)

There are four different types of ECM controlled IAC systems. These systems are referred to as:

- Stepper motor type.
- Rotary solenoid types.
- Duty control ACV type.
- On-off control VSV type.

Stepper Motor IACV

As the valve steps increase, more air by-passes the throttle valve.



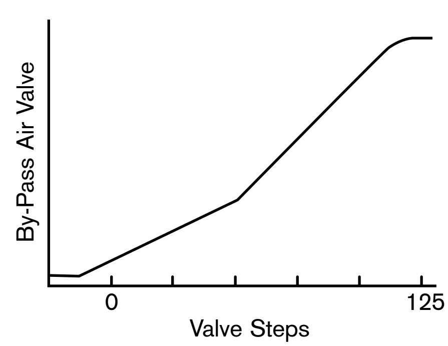


Fig. 6-03

T852f260/T852f261

Stepper Motor IAC Valve

The stepper motor IACV is located on the intake air chamber or throttle body. It regulates engine speed by means of a stepper motor and a pintle valve that controls the volume of air bypassing the closed throttle valve. The IACV throttle air bypass circuit routes intake air past the throttle valve directly to the intake manifold through an opening between the pintle valve and its seat. The size of this opening is determined by how far the pintle is from the seat.

The valve assembly consists of four electrical stator coils, a magnetic rotor, a valve and valve shaft. The valve shaft is screwed into the rotor so that as the rotor turns, the valve assembly will extend and retract.

Stepper Motor IAC Operation

The ECM commands a change in IAC position by sequentially turning on the stepper motor coils.

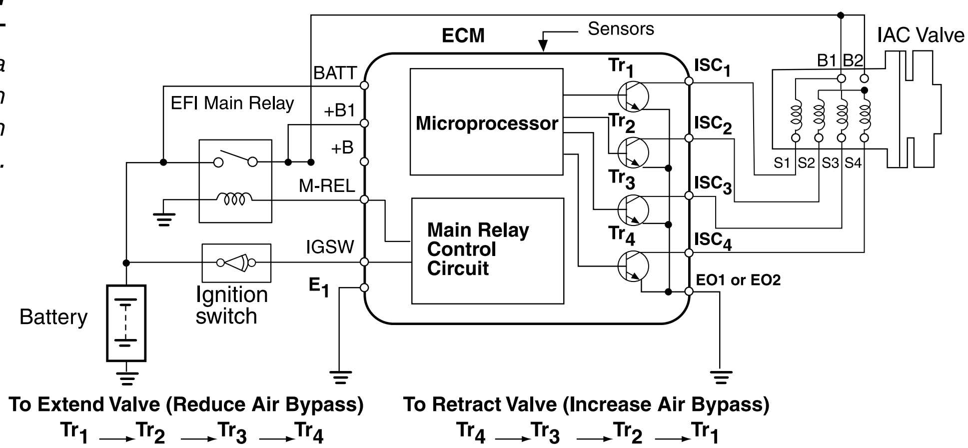


Fig. 6-04

T852f262

The ECM controls movement of the pintle valve by sequentially grounding the four electrical stator coils. Each time current is pulsed through one of the stator coils, the shaft moves one "step," either into or out of the air passage. The direction of valve movement depends on the sequence by which the ECM energizes the coils.

The ECM closes the air bypass by extending the valve through the following sequence:

ISC1 > ISC2 > ISC3 > ISC4

The ECM opens the air bypass by extending the valve through the following sequence:

ISC4 > ISC3 > ISC2 > ISC1

The pintle valve has 125 possible positions, from fully retracted (maximum air bypass) to fully extended (no air bypass). In the event that the IACV becomes disconnected or inoperative, its position will become fixed at the step count where it failed. Because the stepper idle air control motor is capable of controlling large volumes of air, it is used for cold fast idle control and is not used in combination with a mechanical air valve.

Initial Set-Up And After-Start Control

The IAC is opened to its 125th step immediately after the engine stops running. After engine start-up the ECM positions the IAC valve based on the current coolant temperature

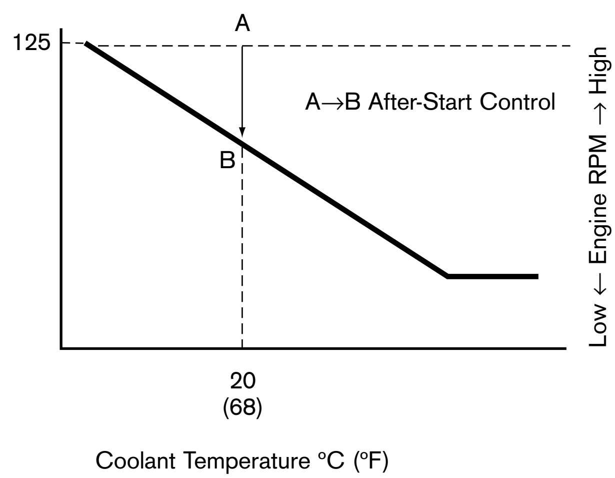


Fig. 6-05

T852f263

Primary Controlled Parameters
Initial Set-Up

Engines equipped with the stepper type IACV use an ECM controlled EFI main relay which delays system power down for about two seconds after the ignition is turned off. During these two seconds, the ECM fully opens the IACV to 125 steps from seat, improving engine stability when it is started. This reset also allows the ECM to keep track of the IACV position after each engine restart.

After-Start Control

Once the engine has started and reached approximately 500 RPM, the ECM drives the IACV to a precise number of steps from seat based on the coolant temperature at time of start-up. This information is stored in a look up table in the ECM memory and is represented by point B on the graph.

Warm-up Control

The IAC valve position adjusted to match the actual idle speed to calculated target speed.

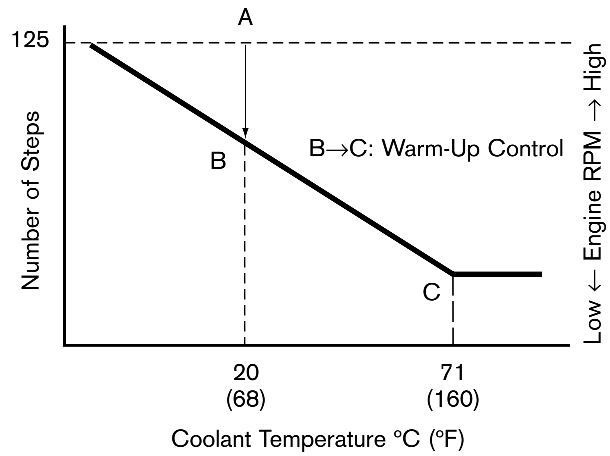


Fig. 6-06

T852f264

Engine Warm-up Control As the engine coolant approaches normal operating temperature, the need for cold fast idle is gradually eliminated. The ECM gradually steps the IACV toward its seat during warm-up. The warm curb idle position is represented by point C on the graph. When the coolant temperature is approximately 71°C (160°F), the cold fast idle program has ended.

Feedback Control

The IAC valve position adjusted to match the actual idle speed to calculated target speed.

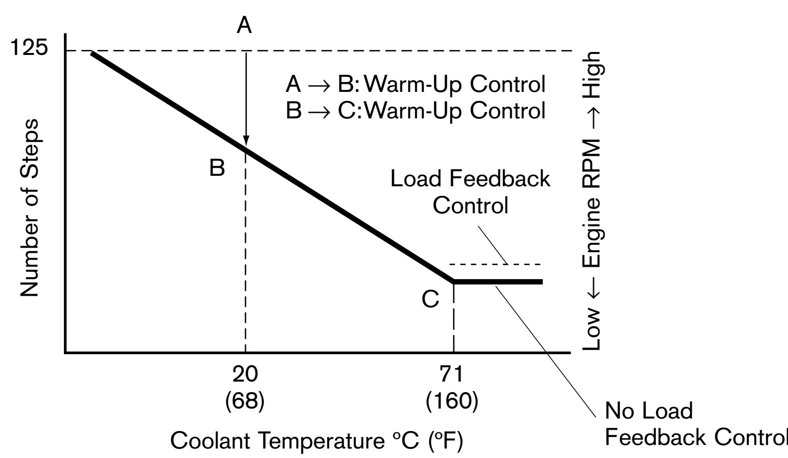


Fig. 6-07

T852f265

Feedback (Closed Loop) Idle Air Control The ECM has a preprogrammed target idle speed that is maintained by the IACV based on feedback from the NE signal. Feedback idle air control occurs any time the throttle is closed and the engine is at normal operating temperature. The target idle speed is programmed in an ECM look up table and varies depending on inputs from the A/C and NSW signals. Any time actual speed varies by greater than 20 RPM from target idle speed, the ECM will adjust the IAC valve position to bring idle speed back on target.

Target Idle Speed

Note the change in target speed as the A/C or NSW are on or off.

Air Conditioner Switch	Neutral Start Switch	Engine Speed
ON	ON	900 RPM
	OFF	750 RPM
OFF	ON	650 RPM
	OFF	580 RPM

Fig. 6-08

Engine Load/Speed Change Estimate Control

To prevent major loads from changing engine speed significantly, the ECM monitors signals from the Neutral Start Switch (NSW), the Air Conditioner switch (A/C), and models equipped with Power Steering Oil Pressure Switch (PS). By monitoring these inputs, the ECM reestablishes target idle speeds accordingly and adjusts IACV position.

Before a change in engine speed can occur, the ECM has moved the IACV to compensate for the change in engine load. This feature helps to maintain a stable idle speed under changing load conditions.

These speed specifications can be useful when troubleshooting suspected operational problems in the step type idle air control system or related input sensor circuits.

Other Controlled Parameters

Electrical Load Idle-up - Whenever a drop in voltage is sensed at the ECM +B or IG terminals, the ECM responds by increasing engine idle speed. This strategy ensures adequate alternator rpm to maintain system voltage at safe operational levels.

Deceleration Control - Some ECMs use a deceleration function to allow the engine to gradually return to idle. This strategy helps improve emissions control by allowing more air into the intake manifold on deceleration. This extra air is available to mix with any fuel that may have evaporated during the low manifold pressure conditions of deceleration.

Learned Idle Air Control - The idle air control program is based on an ECM stored look up table, which lists pintle step positions in relation to specific engine rpm values. Over time, engine wear and other variations tend to change these relationships. Because this system is capable of feedback control, it is also capable of memorizing changes in the relationship of step position and engine rpm. The ECM periodically updates its memory to provide more rapid and accurate response to changes in engine rpm.

NOTE If the battery is disconnected, the ECM must relearn target step positions.

Rotary Solenoid IAC System

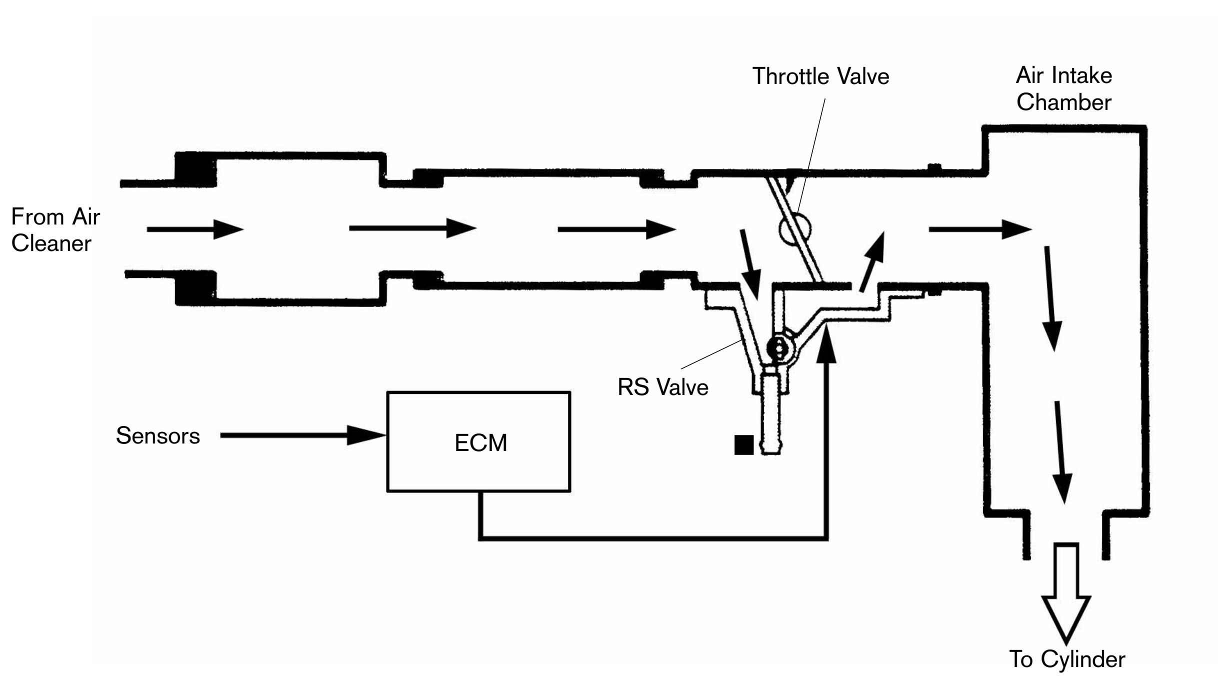


Fig. 6-09

T852f266

Rotary Solenoid

The RS IACV is mounted on the throttle body and intake air bypassing the throttle valve passes through it. According to the signals sent from the ECM, the IACV controls the flow rate of air bypassing the throttle valve during idle. The air flow rate determines the idle speed. The IACV receives its power from the EFI relay and ground through the ECM.

Rotary Solenoid Circuit

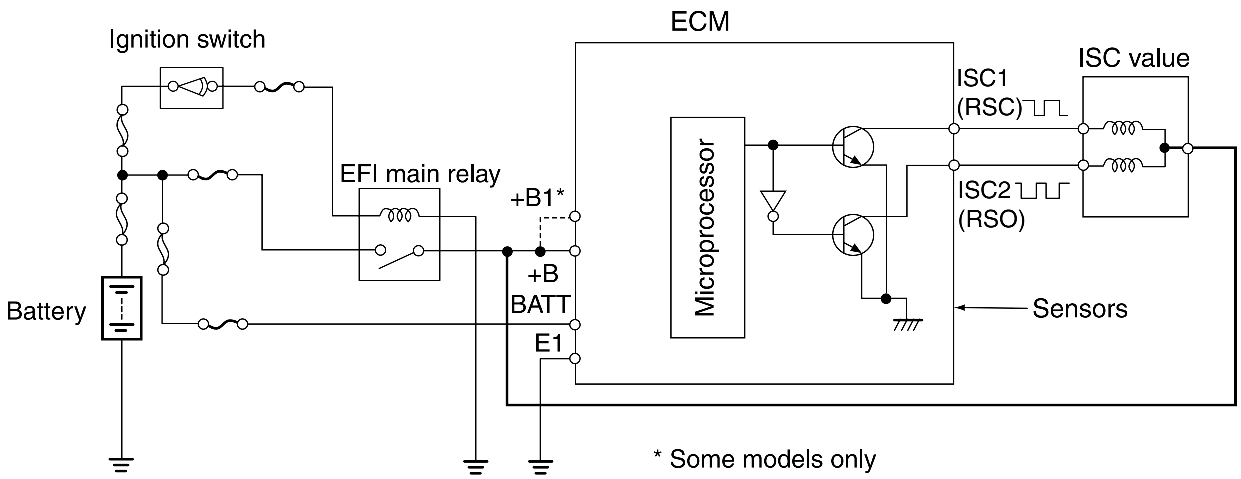
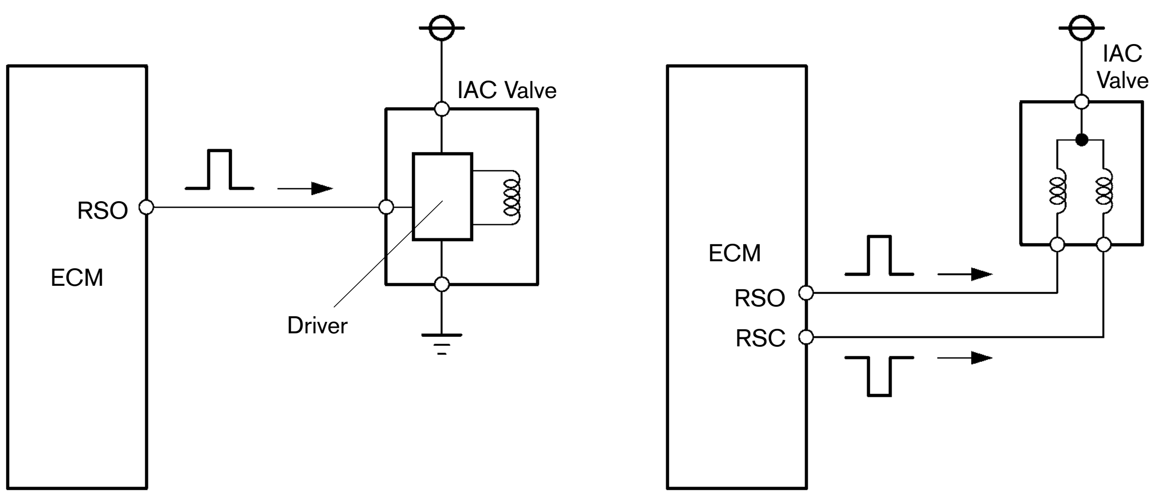


Fig. 6-10

T852f267

Types of Rotary Solenoid IACV



Single Driver Circuit

Dual Driver Circuits

Fig. 6-11

T852f268

There are two styles of rotary solenoid IACVs. The older style uses two driver circuits, one driver for each coil. The newer style uses a single driver circuit, one coil is controlled by the ECM while the other coil is always grounded. They are not interchangeable. An easy way to tell which type of rotary solenoid is to use the wiring schematic. The older style has two wires connected to the ECM while the newer type has one connected to the ECM and the other wire connected to ground.

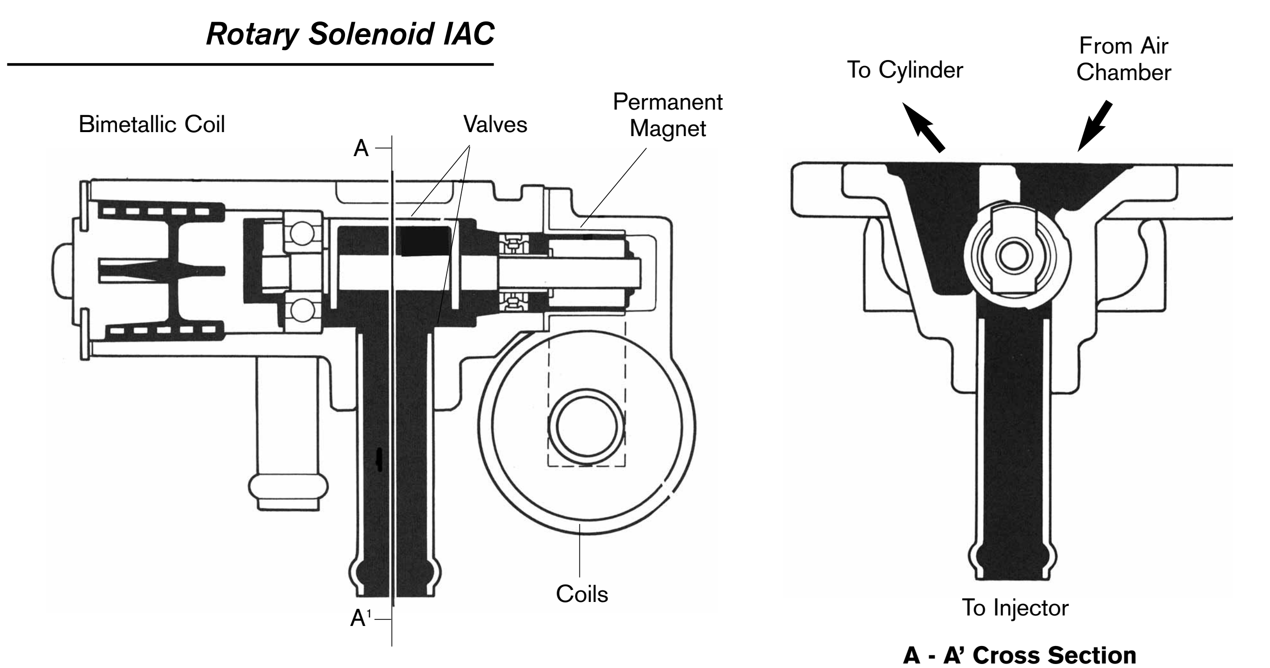


Fig. 6-12

T852f269/T852f270

Rotary IACV Operation

The valve assembly consists of two electrical coils, a permanent magnet mounted on the valve shaft, and a valve. A fail-safe bimetallic strip is fitted to the end of the shaft to operate the valve in the event of electrical failure in the IACV system.

Located at the end of the valve shaft, the cylindrical permanent magnet rotates when its two poles are repelled by the magnetism exerted by coils T1 and T2.

Anchored to the midsection of the valve shaft, the valve controls the amount of air passing through the bypass port. The valve, valve shaft, and permanent magnet all rotate together.

IACV Components

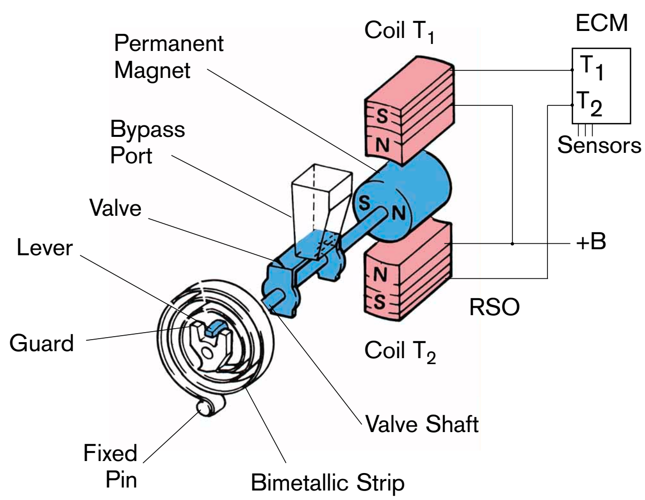


Fig. 6-13
T852f271

As shown, each coil is connected to a transistor, T1 and T2 located in the ECM. When transistor T1 turns on, current flows through that coil. The magnetic field of the coil and the magnetic field of the permanent magnet cause the valve to rotate clockwise. When T2 is turned on, the valve rotates counterclockwise.

The ECM varies the on time (duty ratio) for each coil. The difference in strength between the two magnetic fields determines the position of the valve. The frequency is very high, 250Hz. This high frequency helps the valve maintain the correct position for proper air flow.

Single Driver Rotary IACV Operation

The difference with this type of IACV is that the ECM sends a duty cycle signal to one coil inside the IACV; the other coil is always on. To change the IACV position, ECM changes the duty ratio in the controlled coil.

IACV Movement

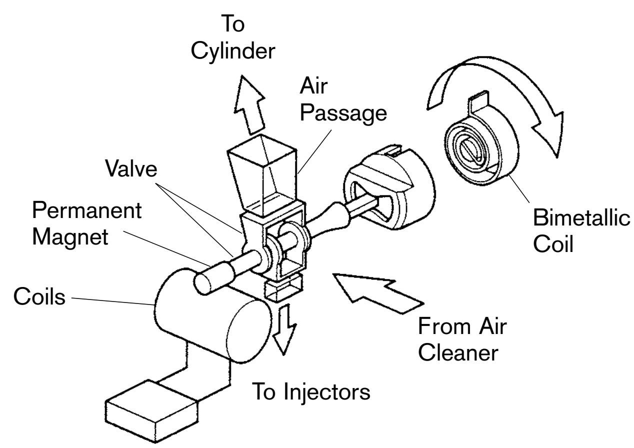


Fig. 6-14

T852f272

Bimetallic Spring Operation

If the electrical connector is disconnected or the valve fails electrically, the shaft will rotate to a position determined by the balancing of the permanent magnet with the iron core of the coils and the bi-metal strip.

The cold idle will not be as fast as normal and the warm idle will be higher than normal.

Using a bimetallic strip allows the IACV to change airflow rate with the change in temperature. The default rpm is approximately 1000 to 1200 RPM once the engine has reached normal operating temperature.

Rotary IACV Controlled Parameters

Engine Starting

As the engine is started, the ECM opens the IACV to a preprogrammed position based on coolant temperature and sensed rpm.

Warm-up

Once the engine has started, the ECM controls the fast idle based on coolant temperature. As the engine approaches normal operating temperature, engine speed is gradually reduced. At this time the ECM is comparing actual idle rpm to the target rpm.

Feedback Control

The ECM utilizes a feedback idle air control strategy (which functions very much like the stepper motor IAC system). That is, when the actual engine speed is lower than the target idling speed, the ECM signals the IACV to open. Conversely, when the actual idle speed is higher than the target idle speed, the ECM signal the IACV to close.

Engine Load/Speed Change Estimate Control

To prevent major loads from changing engine speed significantly, the ECM monitors signals from the neutral start switch (NSW), the air conditioner switch (A/C), headlights or rear window defogger (ELS), and in models equipped with power steering, an oil pressure switch (PS). By monitoring these inputs, the ECM reestablishes target idle speeds accordingly, and adjusts IACV position.

Before a change in engine speed can occur, the ECM has moved the IACV to compensate for the change in engine load. This feature helps to maintain a stable idle speed under changing load conditions.

These speed specifications can be useful when troubleshooting suspected operational problems in the IAC system or related input sensor circuits.

The Rotary Solenoid IAC system utilizes a learned idle air control strategy. The ECM memorizes the relationship between engine rpm and duty cycle ratio and periodically updates its memory. Over time, engine wear and other variations tend to change these relationships. Because this system is capable of feedback control, it is also capable of memorizing changes in the relationship of duty ratio and engine rpm. The ECM periodically updates its memory to provide more rapid and accurate response to changes in engine rpm.

NOTE

If the battery is disconnected, the ECM must relearn target step positions.

A/C Idle-Up

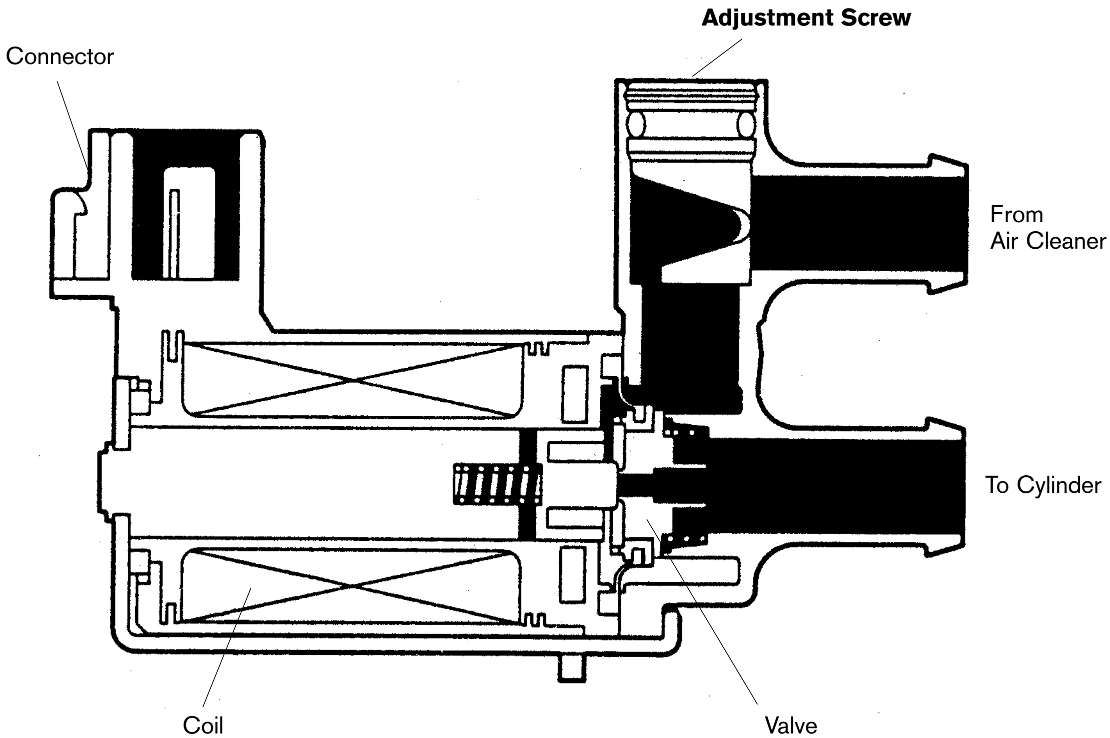


Fig. 6-15
T852f273

Air Conditioning Idle-Up

The air conditioning idle-up system is used in some models equipped with the rotary solenoid to increase engine idle rpm any time the air conditioning compressor is in operation. This system maintains engine idle stability during periods of A/C compressor operation. Additionally, it keeps compressor speed sufficiently high to ensure adequate cooling capacity at idle speed. The air control VSV is turned on or off by the air conditioning ECU.

Power Steering Idle-Up

Non-ECM Controlled System.

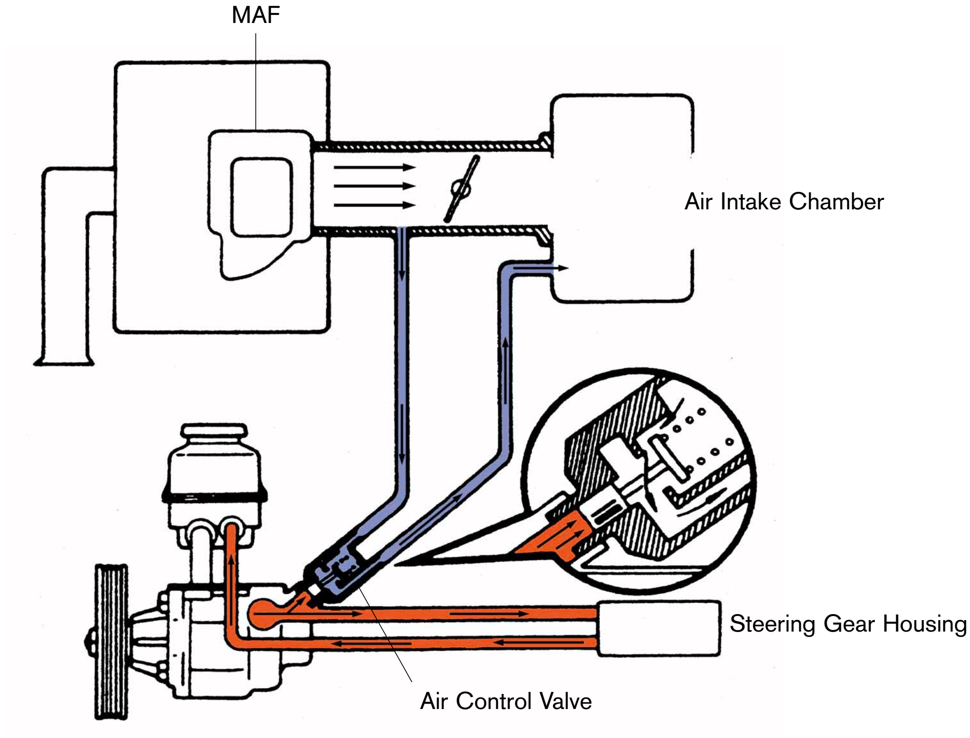


Fig. 6-16

T852f274

Power Steering Idle-Up

The power steering system draws a significant amount of horsepower from the engine when the steering wheel is turned to either stop. This can have an adverse effect on idle quality. To address this potential problem, many engines equipped with power steering use a power steering idle-up system that activates whenever the steering wheel is turned to a stop. There are two types:

- Non-ECM controlled.
- ECM controlled.

Non-ECM Controlled

The Non-ECM controlled power steering idle-up system consists of a hydraulically operated air control valve and a vacuum circuit which bypasses the throttle valve. Whenever power steering pressure exceeds the calibration point of the control valve, the valve opens, allowing a calibrated volume of air to bypass the closed throttle valve.

The system is only functional during very low speed maneuvering and at idle. The system can be tested by turning the steering wheel and listening for an RPM increase.

ECM Controlled

The ECM controlled power steering idle-up uses a pressure switch or sensor in place of the air control valve. Receiving a change in voltage signal from the sensor, the ECM will command the IACV to open, increasing engine RPMs.

Notes

WORKSHEET 6–1
Rotary Solenoid IACV System

Vehicle	Year/Prod. Date	Engine	Transmission

Technician Objectives

With this worksheet, you will learn to test rotary solenoid IACV circuits using the required tools and equipment, retrieve and apply the needed service information, retrieve and interpret service data information.

Tools and Equipment

- Vehicle Repair Manual
- Vehicle EWD
- Diagnostic Tester
- DVOM
- Hand Tool Set

Section 1

1. Setup the Diagnostic Tester, go to Data List. Connect the DVOM to either IACV terminal.
2. Start the engine and note IACV percentage and voltage.
3. With the engine warmed up, increase engine RPM to 2500. What happened to IACV percentage and voltage?

   ____

4. With engine at idle, create an intake manifold leak that will cause the engine to run rough but not stall.
5. What happened to IACV percentage?

   ____

Section 2

1. Using the RM, inspect IACV operation by connecting TE1 and E1 terminals in DLC1 (if applicable). What happened to the idle?

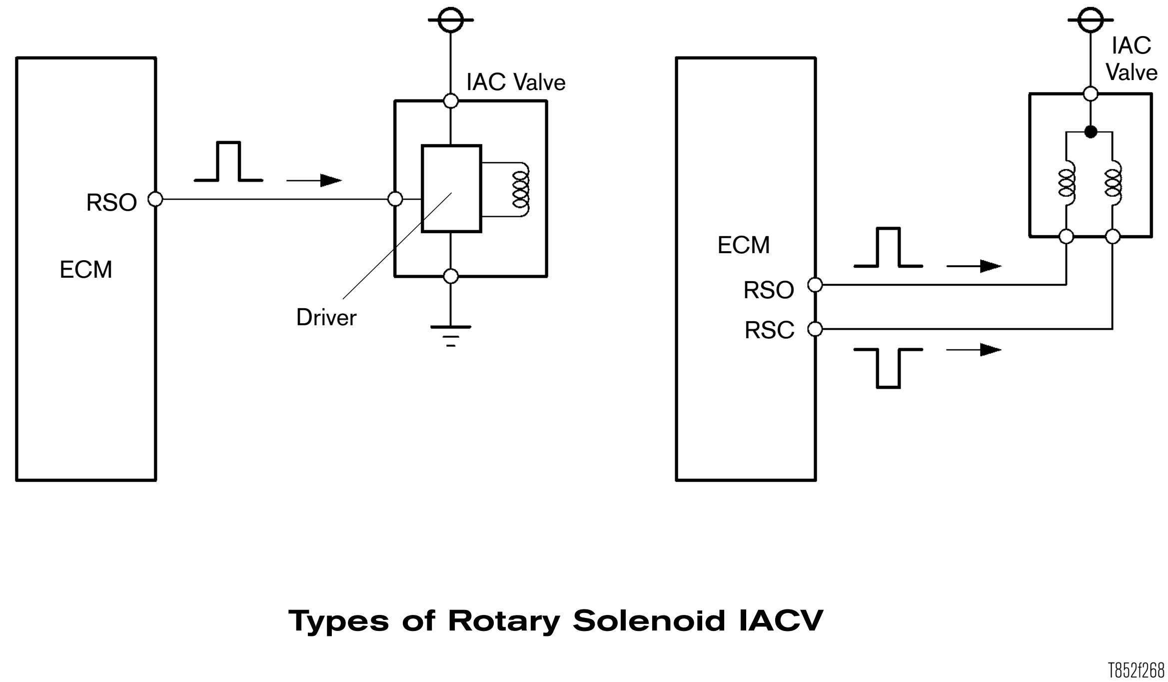
   ____

2. Go to Active Test for the IACV system. Increase the IACV percentage. What happened to engine RPM?

   ____

3. Decrease IACV percentage. What happened to engine RPM?

   ____



Types of Rotary Solenoid IACV

Section 3

Using the Repair Manual, complete the following statements.

1. For the rotary solenoid with two driver circuits:

   Applying battery voltage to terminal +B and grounding the RSC terminal will cause the valve to

   ____

   Applying battery voltage to terminal +B and grounding the RSO terminal will cause the valve to

   ____

2. For the rotary solenoid with a single driver circuit:

   ____

   Applying battery voltage to terminal +B and grounding the RSO terminal will cause the valve to

   ____

Rotary Solenoid IACV System

Name ____ Date ______________________

Review this sheet as you are doing the worksheet. Check each category after completing the worksheet and instructor presentation. Ask the instructor if you have questions. The comments section is for you to write where to find the information, questions, etc.

Topic	*I have questions*	*I know I can*	Comment
Locate components in the IACV system using the EWD and RM			
Find wire colors, pin numbers in the fuel delivery electrical circuits using the EWD and RM			
Locate the IACV status in the Data List and compare to specifications to determine condition			
Activate RS IACV with Active Test			
Determine effect on IACV operation when there are engine problems			
Test RS IACV operation			
Check and retrieve relevant DTCs			
Locate in the RM two sections related to IACV system concerns			