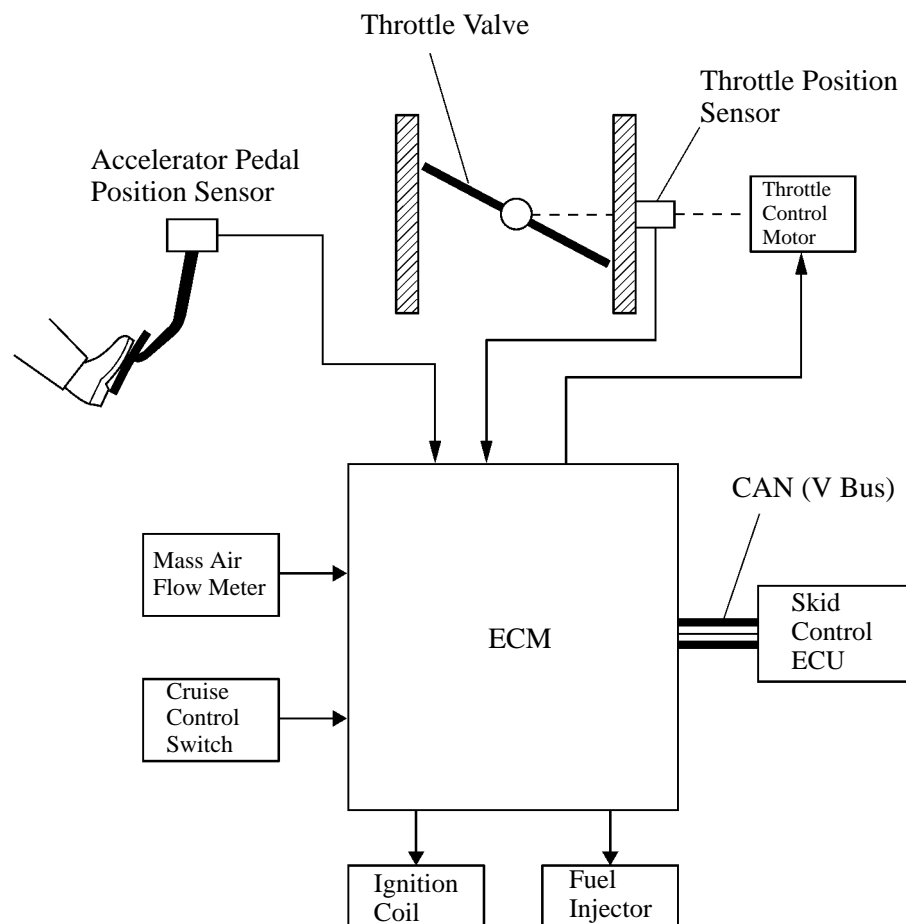## 6. ETCS-i (Electronic Throttle Control System-intelligent)
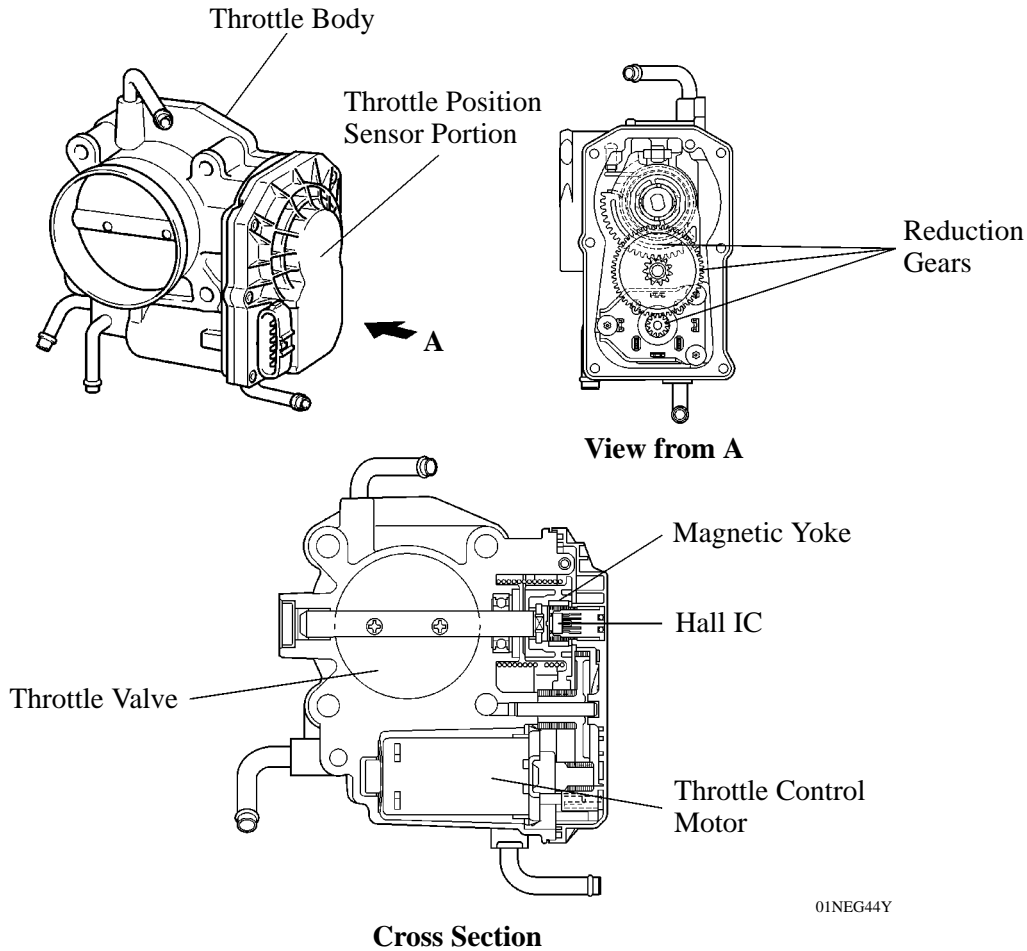
General

- The ETCS-i is used, providing excellent throttle control in all the operating ranges. In the 2AZ-FE engine, the accelerator cable has been discontinued, and an accelerator pedal position sensor has been provided on the accelerator pedal.

- In the conventional throttle body, the throttle valve opening angle is determined by the amount of the accelerator pedal effort. In contrast, the ETCS-i uses the ECM to calculate the optimal throttle valve opening angle that is appropriate for the respective driving condition and uses a throttle control motor to control the opening angle.

- The ETCS-i controls the ISC (Idle Speed Control) system, the TRAC (Traction Control), VSC (Vehicle Stability Control) system and cruise control system.

- In case of an abnormal condition, this system switches to the limp mode.

▶ **System Diagram** ◀

08SEG21Y

Construction

Throttle Body

Throttle Position
Sensor Portion

Reduction
Gears

View from A

Magnetic Yoke

Hall IC

Throttle Valve

Throttle Control
Motor

01NEG44Y

Cross Section

1) Throttle Position Sensor

The throttle position sensor is mounted on the throttle body, to detect the opening angle of the throttle valve.

2) Throttle Control Motor

A DC motor with excellent response and minimal power consumption is used for the throttle control motor. The ECM performs the duty ratio control of the direction and the amperage of the current that flows to the throttle control motor in order to regulate the opening angle of the throttle valve.

Operation

1) General

The ECM drives the throttle control motor by determining the target throttle valve opening angle in accordance with the respective operating condition.

- Non-linear Control
- Idle Speed Control
- TRAC Throttle Control
- VSC Coordination Control
- Cruise Control

2) Normal Throttle Control (Non-linear Control)

It controls the throttle to an optimal throttle valve opening angle that is appropriate for the driving condition such as the amount of the accelerator pedal effort and the engine speed in order to realize excellent throttle control and comfort in all operating ranges.

▶ **Control Examples During Acceleration and Deceleration** ◀

——— : With Control
- - - - - : Without Control
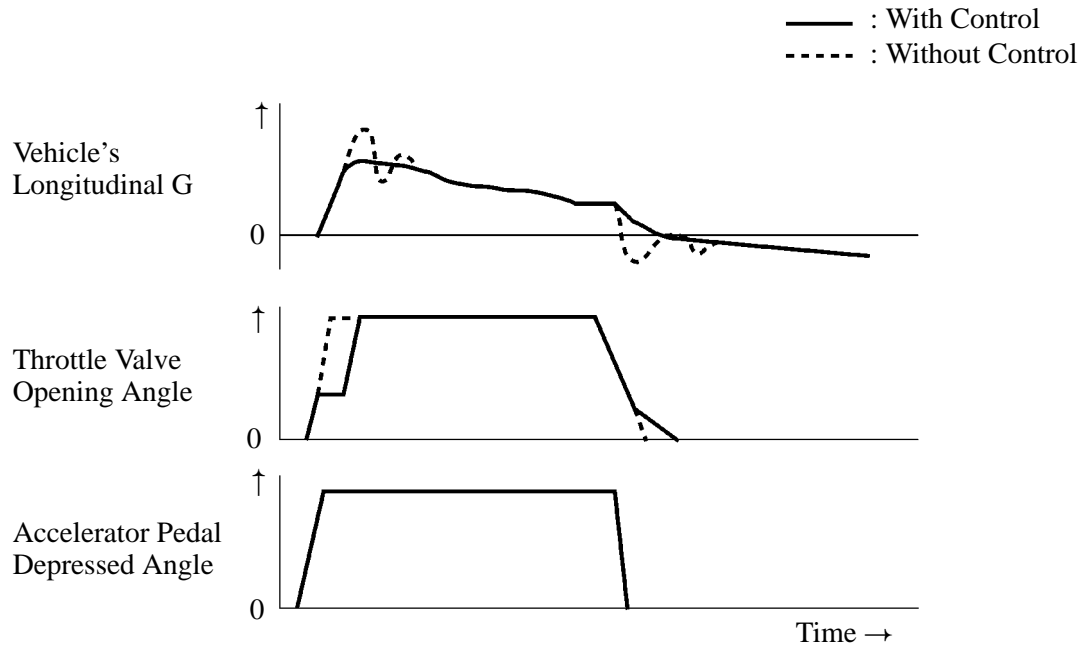
005EG13Y

3) Idle Speed Control

The ECM controls the throttle valve in order to constantly maintain an ideal idle speed.

4) TRAC Throttle Control

As part of the TRAC system, the throttle valve is closed by a demand signal from the skid control ECU if an excessive amount of slippage is created at a driving wheel, thus facilitating the vehicle in providing excellent stability and driving force.

5) VSC Coordination Control

In order to bring the effectiveness of the VSC system control into full play, the throttle valve opening angle is controlled by effecting a coordination control with the skid control ECU.

6) Cruise Control

An ECM with an integrated cruise control ECU directly actuates the throttle valve for operation of the cruise control.

Fail-safe of Accelerator Pedal Position Sensor

● The accelerator pedal position sensor is comprised of two (main, sub) sensor circuits. If a malfunction occurs in either one of the sensor circuits, the ECM detects the abnormal signal voltage difference between these two sensor circuits and switches to the limp mode. In the limp mode, the remaining circuit is used to calculate the accelerator pedal depressed angle, in order to operate the vehicle under the limp mode control.
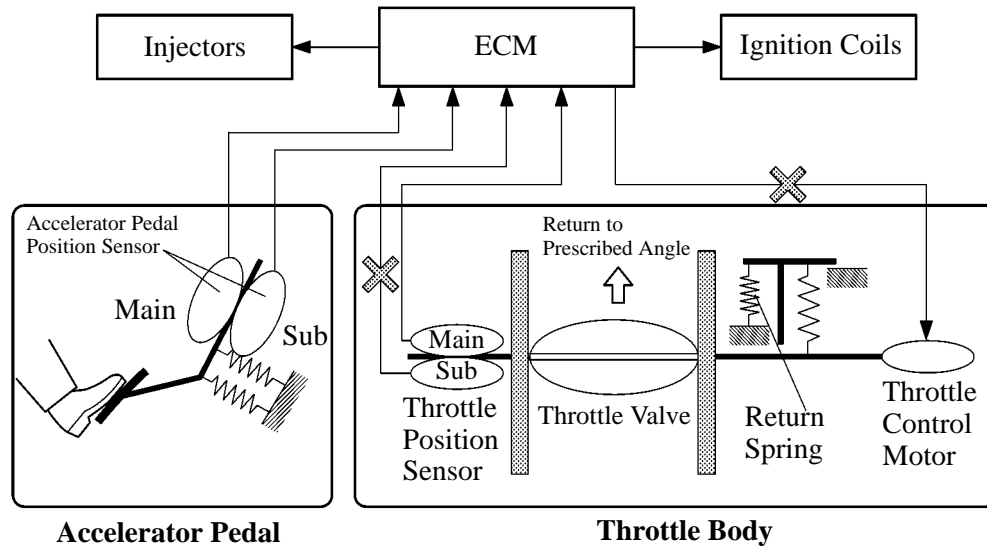

199EG45
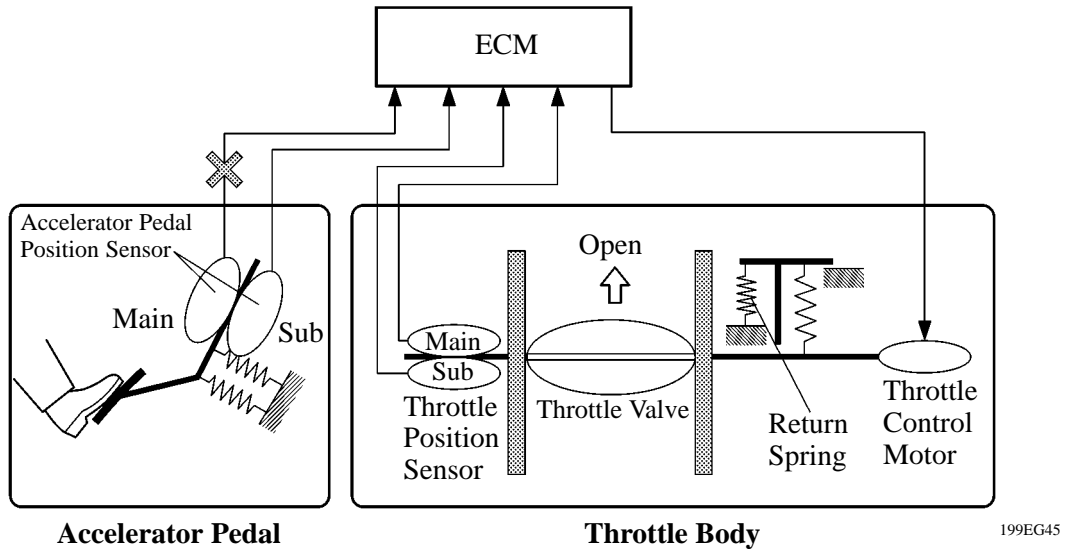
● If both circuits have malfunctions, the ECM detects the abnormal signal voltage from these two sensor circuits and stops the throttle control. At this time, the vehicle can be driven within its idling range.

199EG46
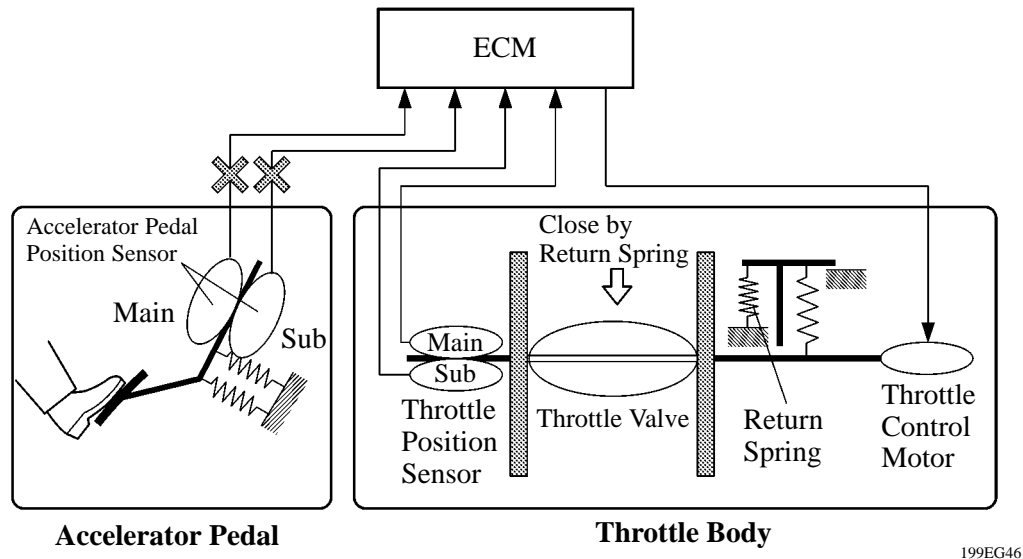
Fail-safe of Throttle Position Sensor

- The throttle position sensor is comprised of two (main, sub) sensor circuits. If a malfunction occurs in either one or both of the sensor circuits, the ECM detects the abnormal signal voltage difference between these two sensor circuits, cuts off the current to the throttle control motor, and switches to the limp mode. Then, the force of the return spring causes the throttle valve to return and stay at the prescribed opening angle. At this time, the vehicle can be driven in the limp mode while the engine output is regulated through the control of the fuel injection (intermittent fuel-cut) and ignition timing in accordance with the accelerator opening.

- The same control as above is effected if the ECM detects a malfunction in the throttle control motor system.


Accelerator Pedal   **Throttle Body**

199EG47

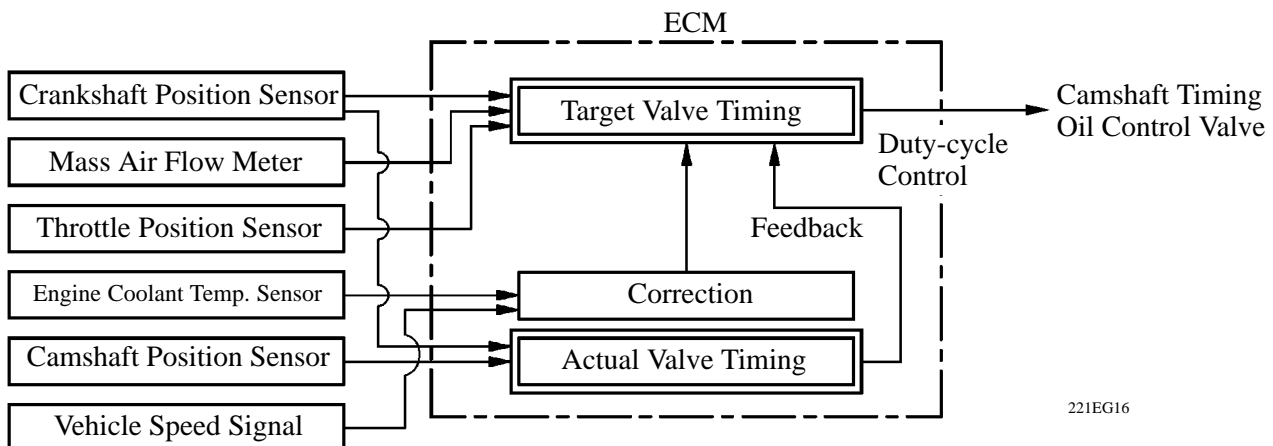## 7. VVT-i (Variable Valve Timing-intelligent) System

General

- The VVT-i system is designed to control the intake camshaft within a range of 40° (of Crankshaft Angle) to provide valve timing that is optimally suited to the engine condition. This realizes proper torque in all the speed ranges as well as realizing excellent fuel economy, and reducing exhaust emissions.
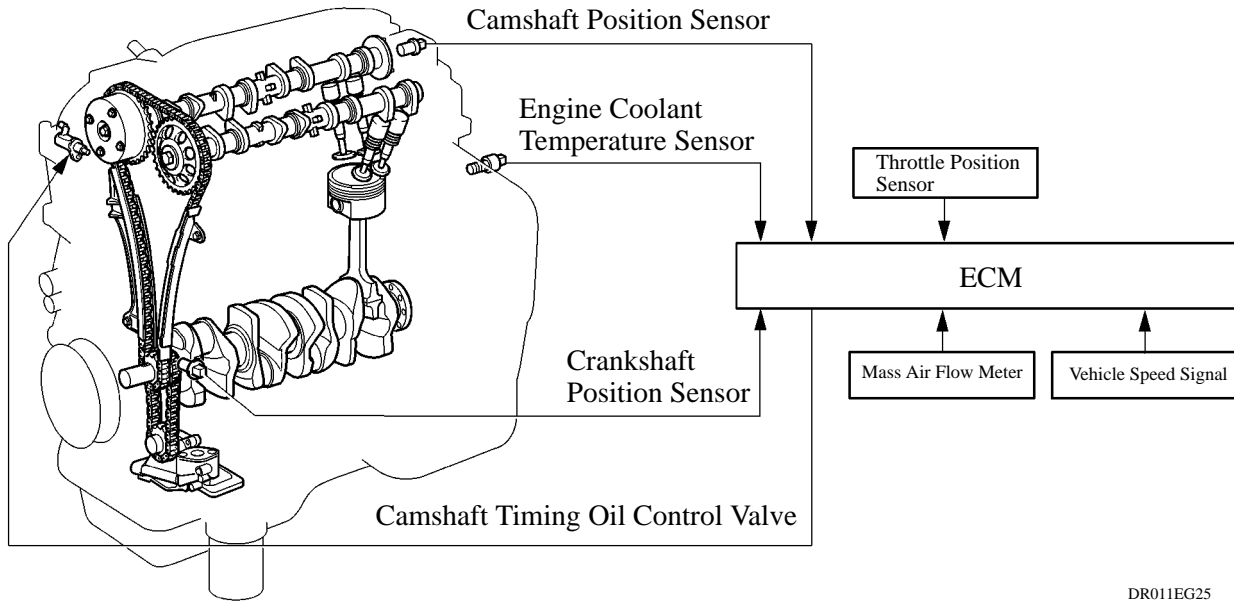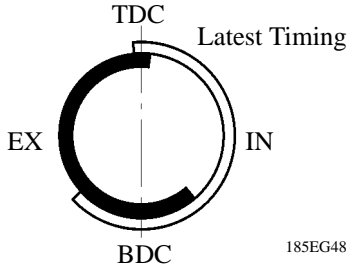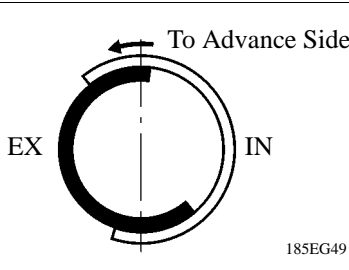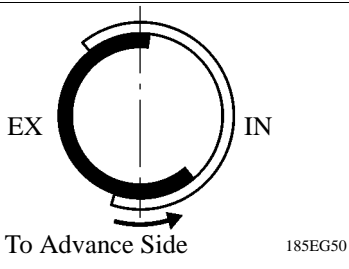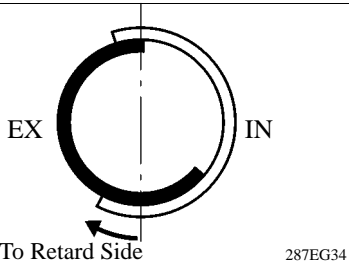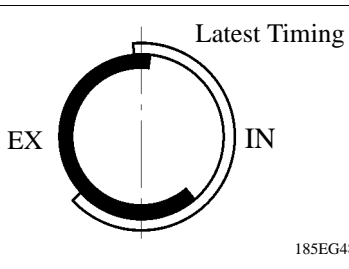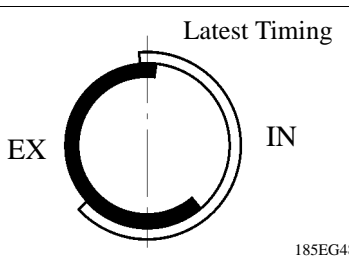

DR011EG25

- Using the engine speed signal, vehicle speed signal, and the signals from mass air flow meter, throttle position sensor and engine coolant temperature sensor, the ECM can calculate optimal valve timing for each driving condition and controls the camshaft timing oil control valve. In addition, the ECM uses signals from the camshaft position sensor and crankshaft position sensor to detect the actual valve timing, thus providing feedback control to achieve the target valve timing.

221EG16

Effectiveness of the VVT-i System

| Operation State	Objective	Effect
• During Idling • At Light Load	Minimizing overlap to reduce blowback to the intake side	• Stabilized idle speed • Better fuel economy
At Medium Load	Increasing overlap increases internal EGR, reducing pumping loss	• Better fuel economy • Improved emission control
In Low to Medium Speed Range with Heavy Load	Advancing the intake valve close timing for volumetric efficiency improvement	Improved torque in low to medium speed range
In High Speed Range with Heavy Load	Retarding the intake valve close timing for volumetric efficiency improvement	Improved output
At Low Temperature	Minimizing overlap to prevent blowback to the intake side leads to the lean burning condition, and stabilizes the idling speed at fast idle	• Stabilized fast idle speed • Better fuel economy
• Upon Starting • Stopping the Engine	Minimizing overlap to minimize blowback to the intake side	Improved startability

Construction

1) VVT-i Controller

This controller consists of the housing driven by the timing chain and the vane fixed on the intake camshaft.

The oil pressure sent from the advance or retard side path at the intake camshaft causes rotation in the VVT-i controller vane circumferential direction to vary the intake valve timing continuously.

When the engine is stopped, the intake camshaft will be in the most retarded state to ensure startability. When hydraulic pressure is not applied to the VVT-i controller immediately after the engine has been started, the lock pin locks the movement of the VVT-i controller to prevent a knocking noise.

Lock Pin

Housing

Intake Camshaft

Vane (Fixed on Intake Camshaft)

Oil Pressure

At a Stop   In Operation   169EG36

Lock Pin
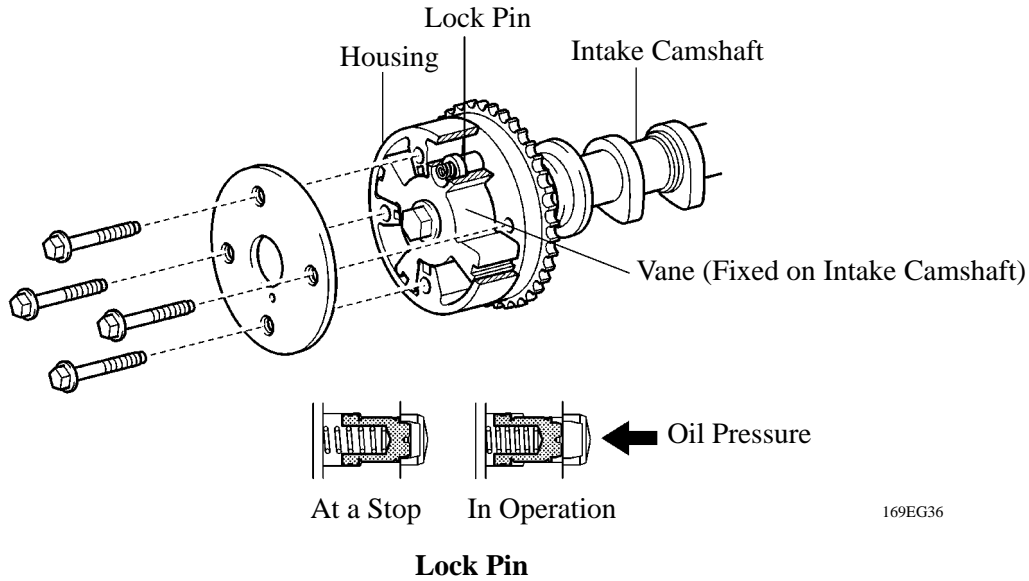
2) Camshaft Timing Oil Control Valve

This camshaft timing oil control valve controls the spool valve position in accordance with the duty-cycle control from the ECM. This allows hydraulic pressure to be applied to the VVT-i controller advance or retard sides. When the engine is stopped, the camshaft timing oil control valve is in the most retarded state.

To VVT-i Controller (Advance Side)

To VVT-i Controller (Retard Side)

Sleeve

Spring

Drain   Drain

Oil Pressure   Spool Valve

Coil   Plunger
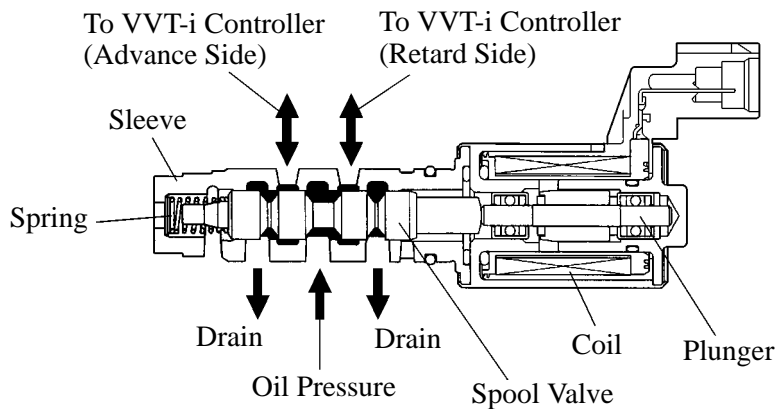
221EG17

Operation

1) Advance

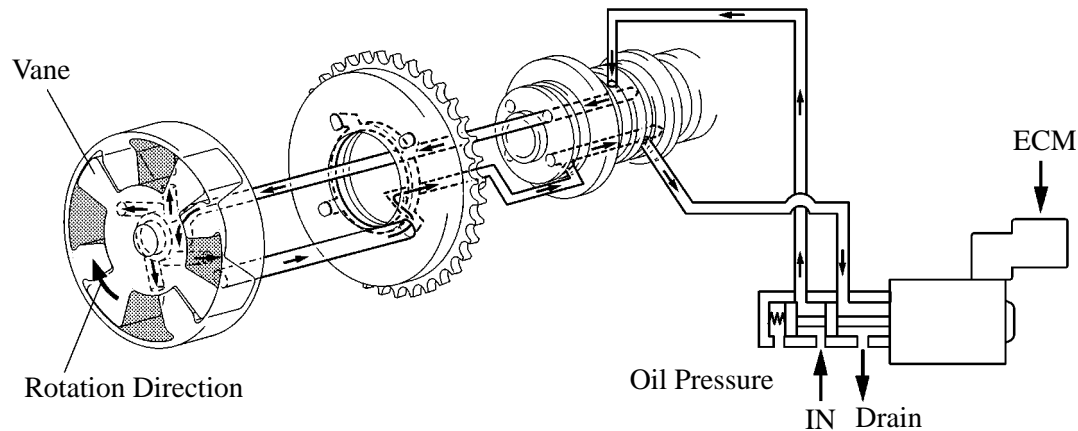When the camshaft timing oil control valve is operated as illustrated below by the advance signals from the ECM, the resultant oil pressure is applied to the advance side vane chamber to rotate the camshaft in the advance direction.

Vane

ECM

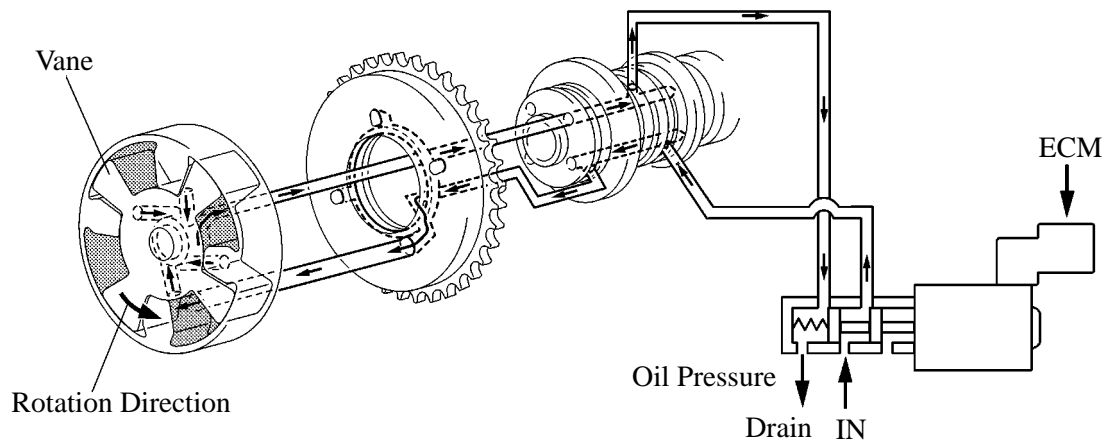Rotation Direction

Oil Pressure

IN Drain

198EG35

2) Retard

When the camshaft timing oil control valve is operated as illustrated below by the retard signals from the ECM, the resultant oil pressure is applied to the retard side vane chamber to rotate the camshaft in the retard direction.

Vane

ECM

Rotation Direction

Oil Pressure

Drain IN

198EG36

3) Hold

After reaching the target timing, the valve timing is held by keeping the camshaft timing oil control valve in the neutral position unless the traveling state changes.
This adjusts the valve timing at the desired target position and prevents the engine oil from running out when it is unnecessary.

8. Cooling Fan Control

The ECM controls the operation of the cooling fan in 2 speeds (low and high) based on the engine coolant temperature sensor signal, engine speed signal, vehicle speed signal, and air conditioning amplifier signal. This control is accomplished by operating the 2 fan motors in 2 stages through low speed (series connection) and high speed (parallel connection).

▶ **Wiring Diagram** ◀
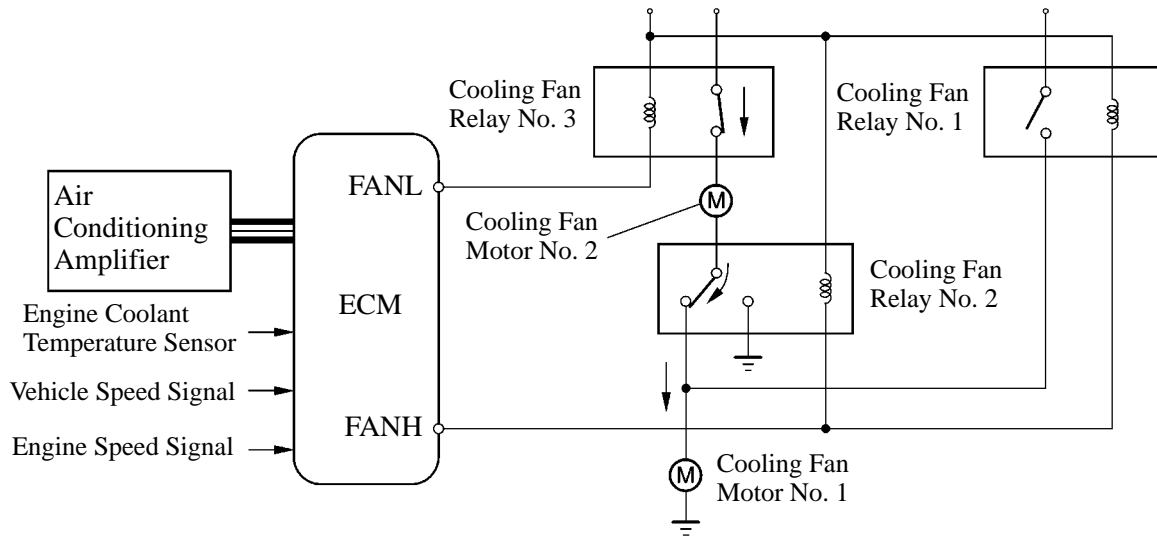
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Low Speed (Series Connection)
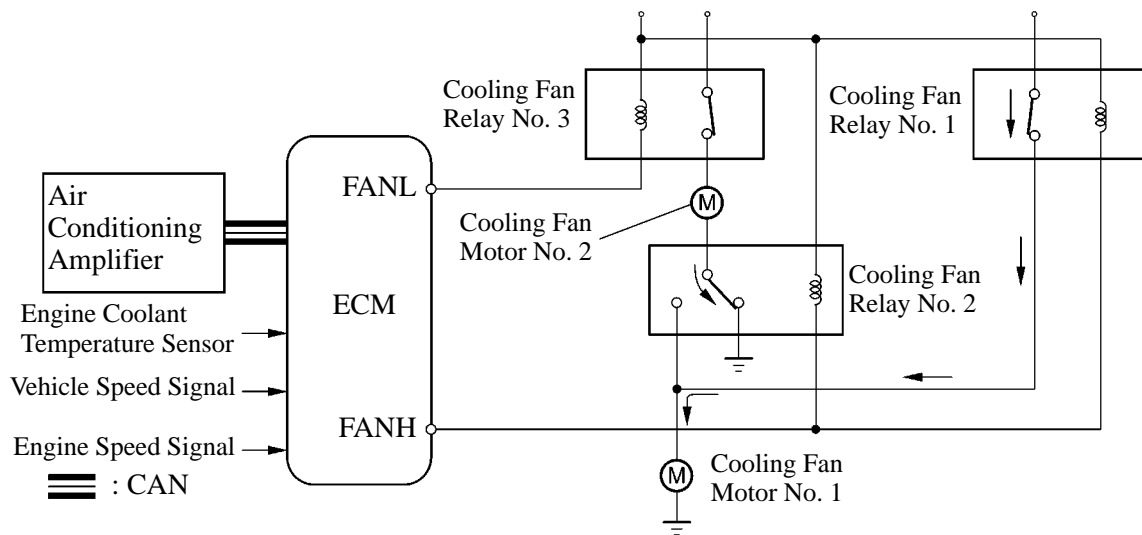
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High Speed (Parallel Connection)

9. Fuel Pump Control

A fuel cut control is used to stop the fuel pump when any of the SRS airbag is deployed. In this system, the airbag deployment signal from the airbag sensor is detected by the ECM, which turns OFF the circuit opening relay.

After the fuel cut control has been activated, turning the ignition switch from OFF to ON cancels the fuel cut control, and the engine can be restarted.

```
┌──────────────┐     ┌──────────┐          ┌──────────┐                    ┌──────┐ Circuit
│ Front Airbag │     │          │          │          │                    │ 8  o │ Opening
│ Sensor       │────▶│ Airbag   │═══       │   ECM    │────────────────────│    o │ Relay
│ (RH and LH)  │     │ Sensor   │          │          │                    └──────┘
└──────────────┘     └──────────┘          └──────────┘
                         ▲  ▲                                                 ┌──┐  Fuel
┌──────────────┐     ┌──────────────┐                                        │M │  Pump
│ Curtain Shield│    │ Side Airbag  │                                        └──┘  Motor
│ Airbag Sensor │    │ Sensor       │
│ (RH and LH)  │─ ─ ─│ (RH or LH)   │                                         777
└──────────────┘     └──────────────┘
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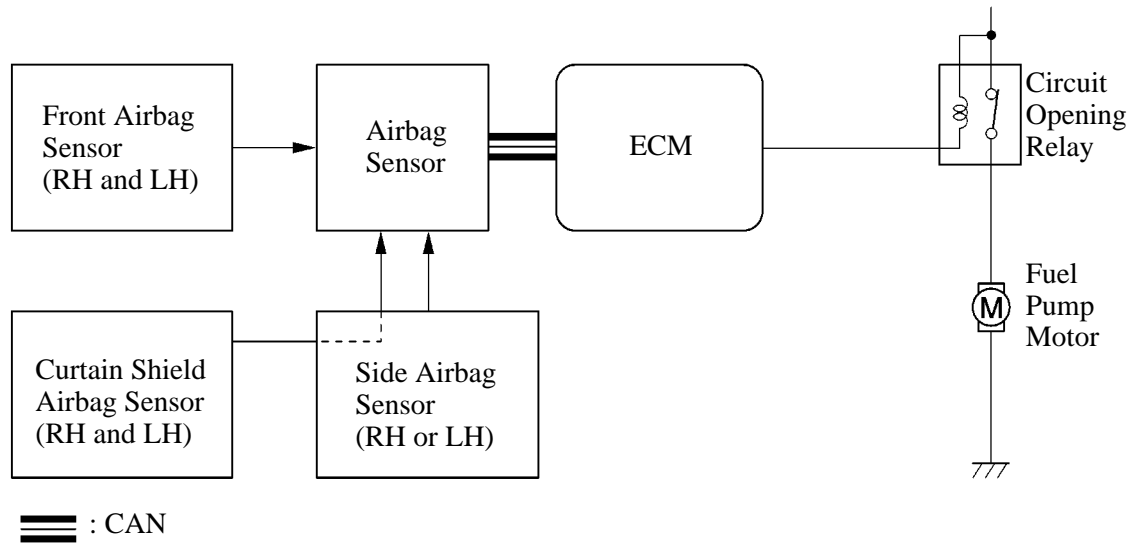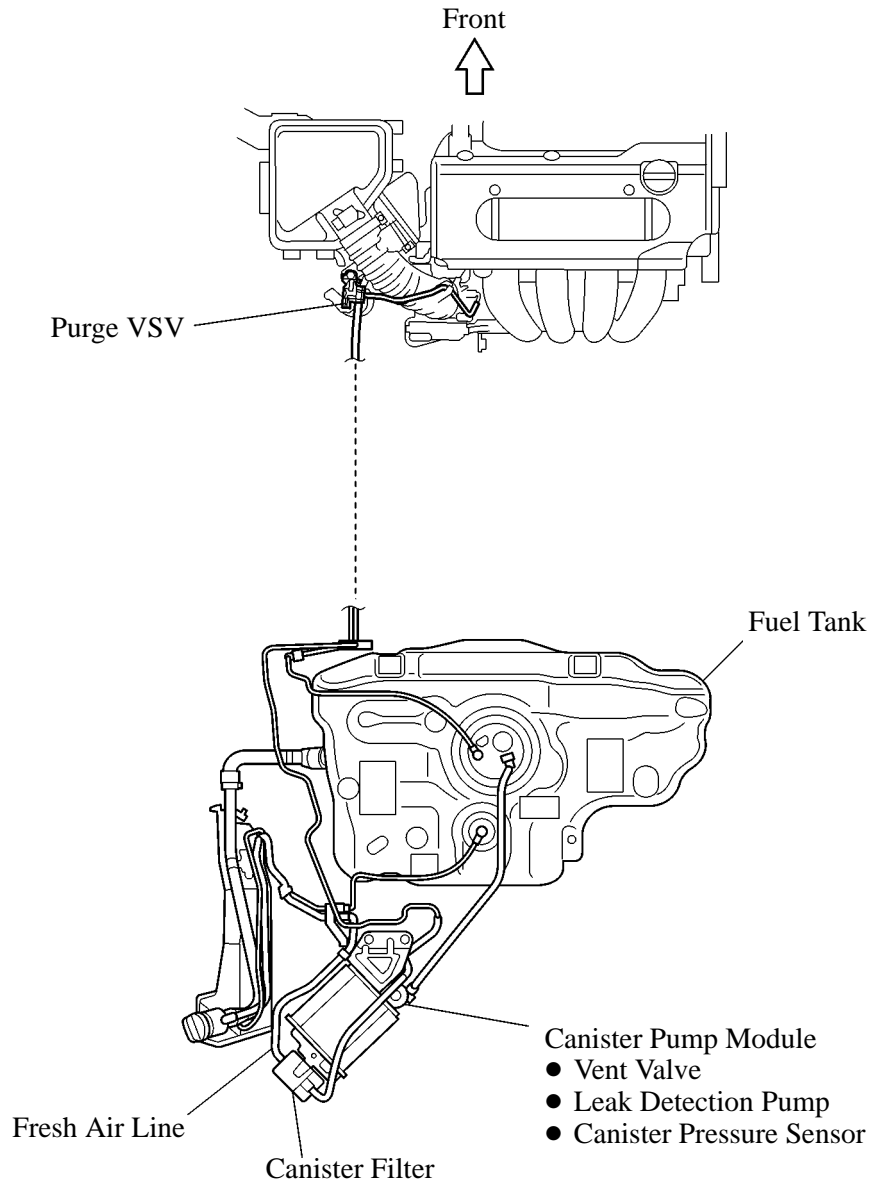
≡ : CAN

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10. EVAP (Evaporative Emission) Control System

General

The basic construction and operation of this system are the same as the 2ZR-FE engine. For details, see page EG-56.

Layout of Main Components

Front

Purge VSV

Fuel Tank

Canister Pump Module
● Vent Valve
● Leak Detection Pump
● Canister Pressure Sensor

Fresh Air Line

Canister Filter

08MEG10Y

11. Diagnosis

- When the ECM detects a malfunction, the ECM makes a diagnosis and memorizes the failed section. Furthermore, the MIL in the combination meter illuminates or blinks to inform the driver.

- The ECM will also store the DTCs of the malfunctions. The DTCs can be accessed by the use of the Techstream.

- For details, refer to the 2009 Corolla Repair Manual (Pub. No. RM08M0U).

Service Tip

To clear the DTC that is stored in the ECM, use a Techstream or disconnect the battery terminal or remove the EFI fuse for 1 minute or longer.

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12. Fail-safe

When a malfunction is detected at any of the sensors, there is a possibility of an engine or other malfunction occurring if the ECM were to continue to control the engine control system in the normal way. To prevent such a problem, the fail-safe function of the ECM either relies on the data stored in memory to allow the engine control system to continue operating, or stops the engine if a hazard is anticipated. For details, refer to the 2009 Corolla Repair Manual (Pub. No. RM08M0U).

– MEMO –