

■ ENGINE CONTROL SYSTEM

1. General

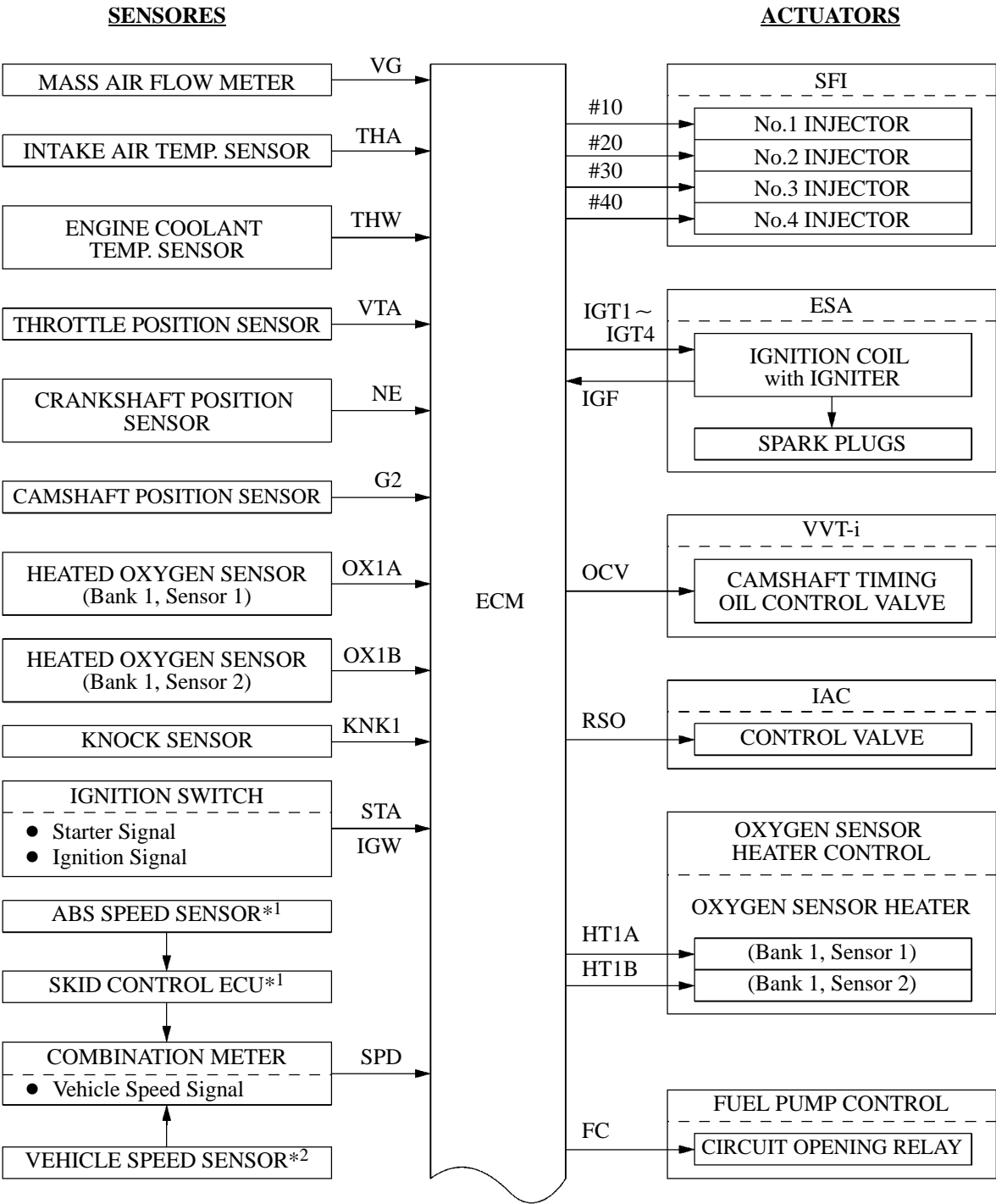
The engine control system for the 1ZZ-FE in the '03 Corolla Matrix and '02 Corolla are compared below.

System	Outline	'03 Corolla Matrix	'02 Corolla
SFI (Sequential Multiport Fuel Injection) [See page EG-35]	An L-type SFI system detects the intake air volume with a hot-wire type air flow meter.	○	○
ESA (Electronic Spark Advance)	Ignition timing is determined by the ECM based on signals from various sensors. The ECM corrects ignition timing in response to engine knocking.	○	○
IAC (Idle Air Control)	A rotary solenoid type IAC valve controls the fast idle and idle speeds.	○	○
VVT-i (Variable Valve Timing-intelligent) [See page EG-36]	Controls the intake camshaft to an optimal valve timing in accordance with the engine condition.	○	○
Fuel Pump Control [See page EG-40]	<ul style="list-style-type: none"> Fuel pump operation is controlled by signals from the ECM. The fuel pump is stopped when the SRS airbag is deployed in a front or side collision. 	○	○
Oxygen Sensor Heater Control	Maintains the temperature of the oxygen sensors at an appropriate level to increase accuracy of detection of the oxygen concentration in the exhaust gas.	○	○
Evaporative Emission Control [See page EG-41]	<ul style="list-style-type: none"> The ECM controls the purge flow of evaporative emissions (HC) in the charcoal canister in accordance with engine conditions. Using 3 VSVs and a vapor pressure sensor, the ECM detects any evaporative emission leakage occurring between the fuel tank and charcoal canister through changes in the fuel tank pressure. 	○	○
Air Conditioning Cut-off Control*	By turning the air conditioning compressor ON or OFF in accordance with the engine condition, drivability is maintained.	○	○
Cooling Fan Control [See page EG-46]	Cooling fan operation is controlled by signals from the ECM based on the engine coolant temperature sensor signal and the condition of the air conditioner operation.	○	—
Diagnosis [See page EG-47]	When the ECM detects a malfunction, the ECM diagnoses and memorizes the failed section.	○	○
Fail-Safe [See page EG-47]	When the ECM detects a malfunction, the ECM stops or controls the engine according to the data already stored in memory.	○	○

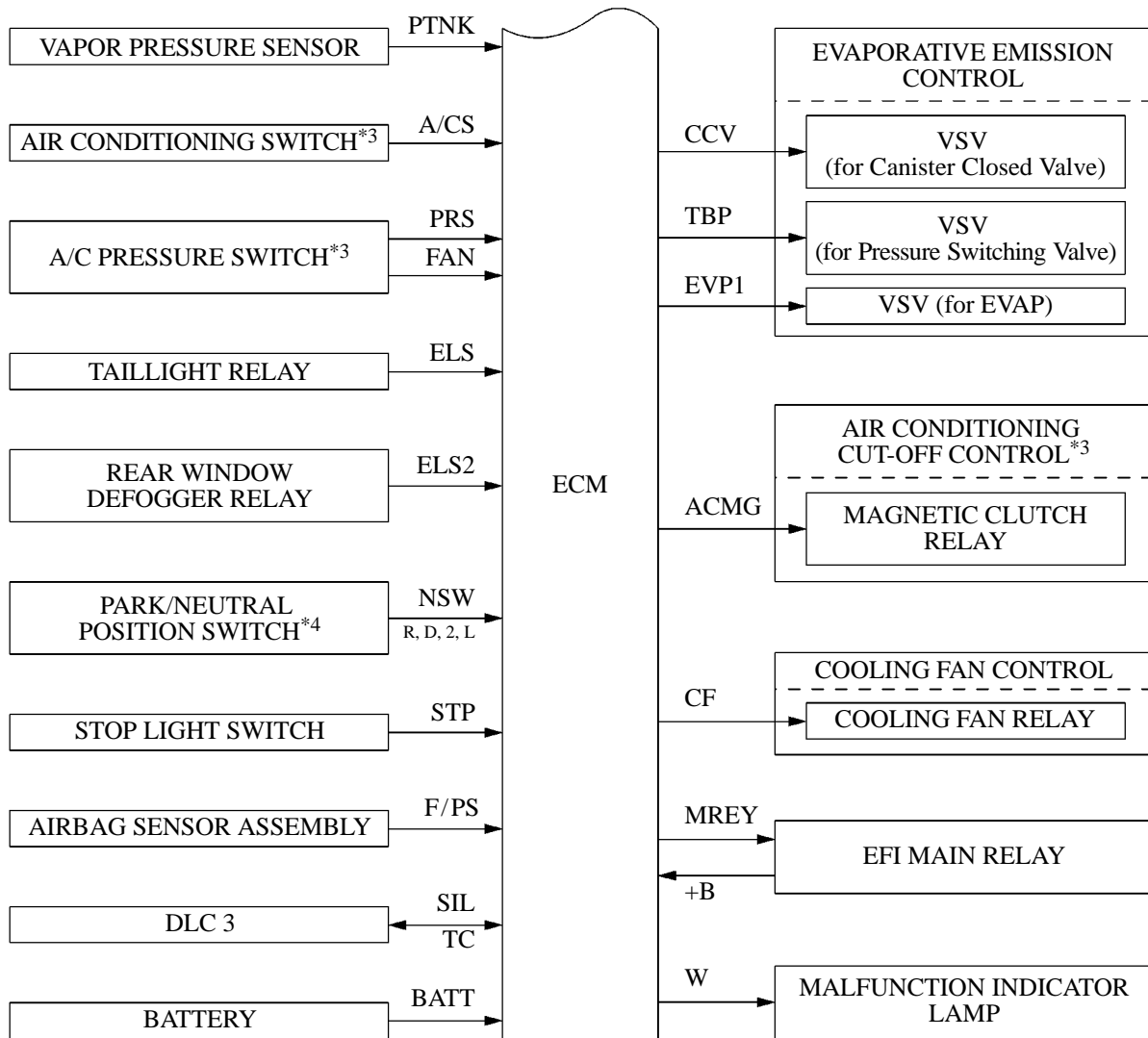
*: with Air Conditioning Model

2. Construction

The configuration of the engine control system in the 1ZZ-FE engines in the '03 Corolla Matrix is as shown in the following chart.



(Continued)



*1: with ABS Model

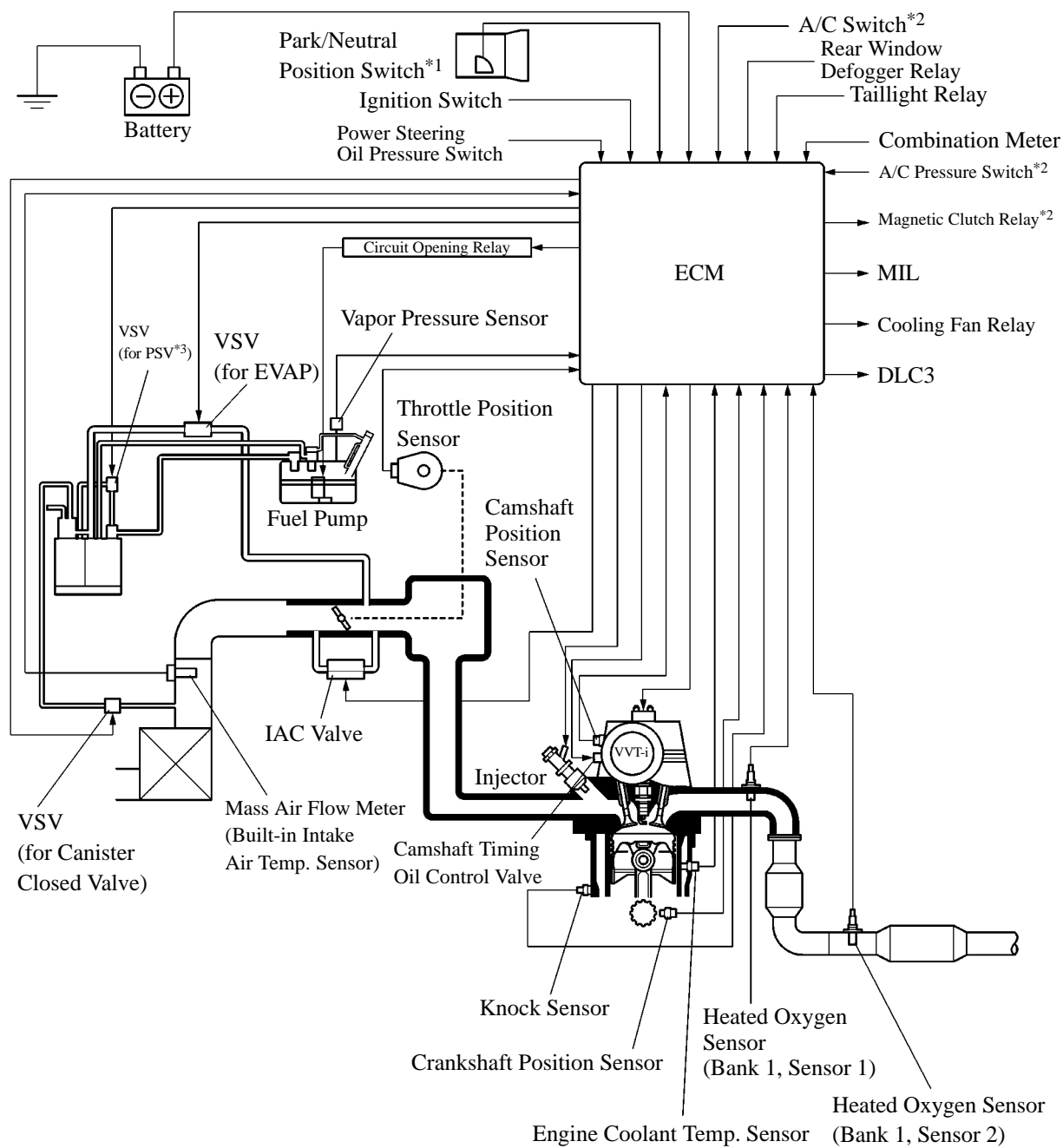
*2: without ABS Model

*3: with A/C Model

*4: Only for Automatic Transaxle Model

221EG05

3. Engine Control System Diagram

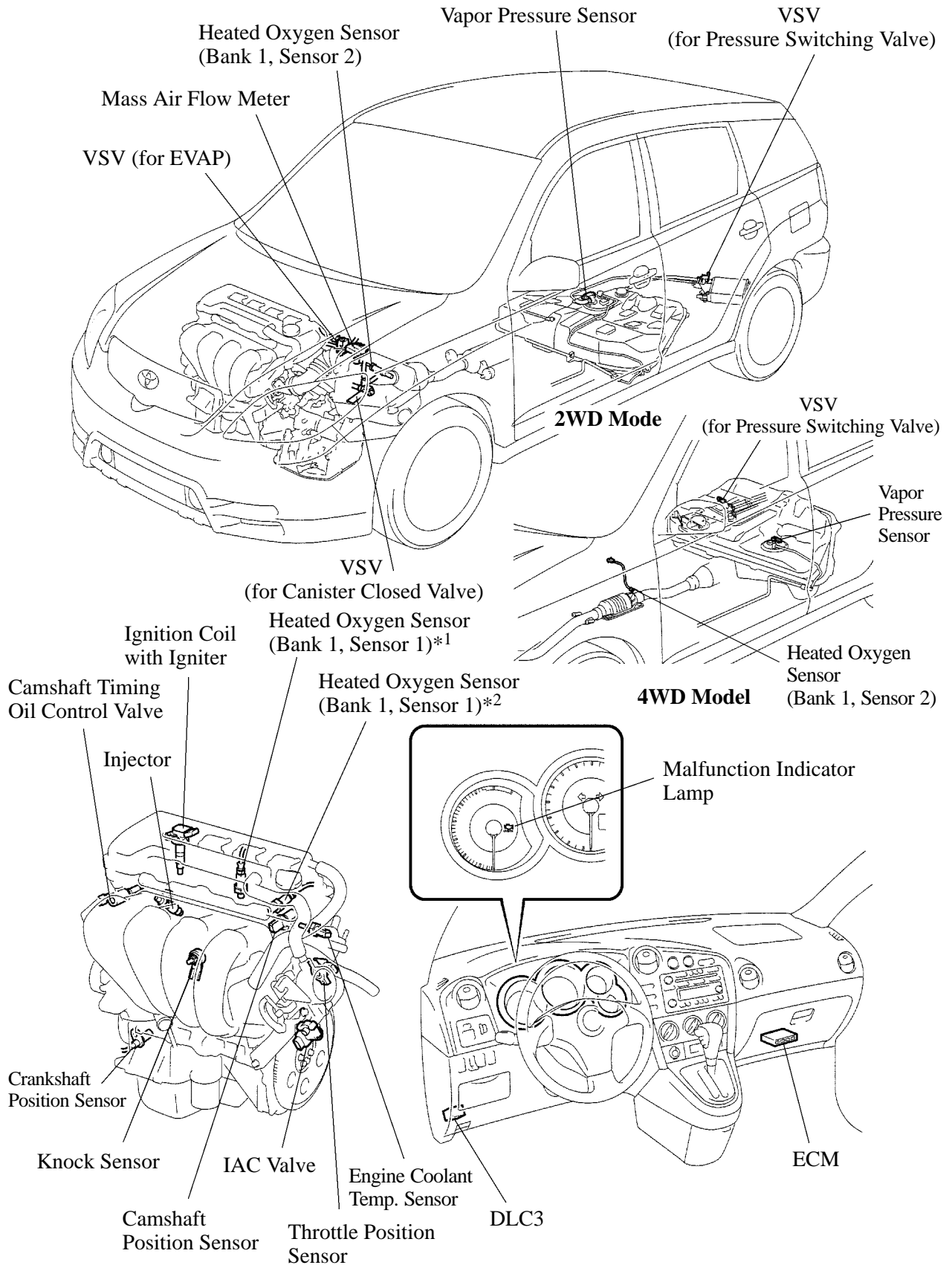


*1: Only for Automatic Transaxle Model

*2: with Air Conditioning Model

*3: PSV (Pressure Switching Valve)

4. Layout of Main Component



*1: for 2WD Model

*2: for 4WD Model

5. Main Component of Engine Control System

General

The main components of the 1ZZ-FE engine control system are as follows:

☐ : Change

Components	Outline	Quantity
ECM	32-bit	1
Mass Air Flow Meter	Hot-Wire Type	1
Crankshaft Position Sensor (Rotor Teeth)	Pick-Up Coil Type (36 - 2)	1
Camshaft Position Sensor (Rotor Teeth)	Pick-Up Coil Type (3)	1
Throttle Position Sensor	Linear Type	1
Knock Sensor	Built-in Piezoelectric Element Type (Flat Type)	1
Oxygen Sensor (Bank 1, Sensor 1 and 2)	with Heater	2
Injector	12-Hole Type	4
IAC Valve	Rotary Solenoid Type (1-coil Type)	1

ECM

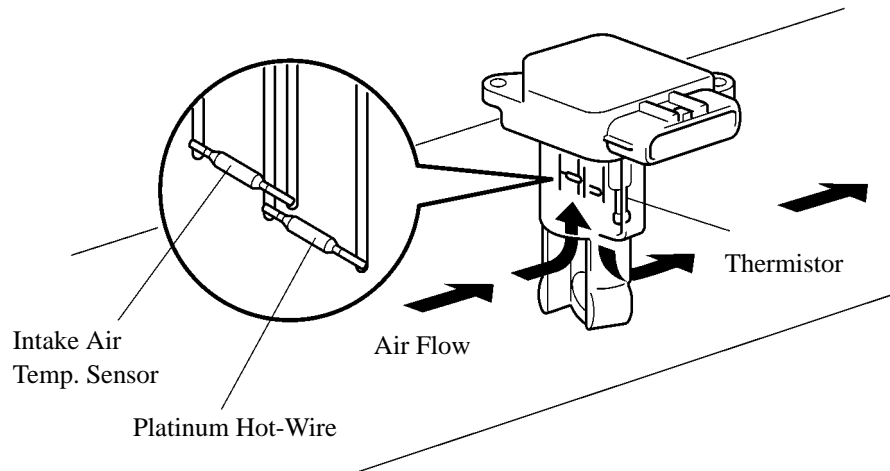
- The 32-bit CPU of the ECM has been changed from the 16-bit CPU to increase the speed for processing the signals.
- This ECM has a built-in air conditioning amplifier.

Service Tip

The length of time to clear the DTC via the battery terminal has been changed from the previous 10 seconds to 1 minute.

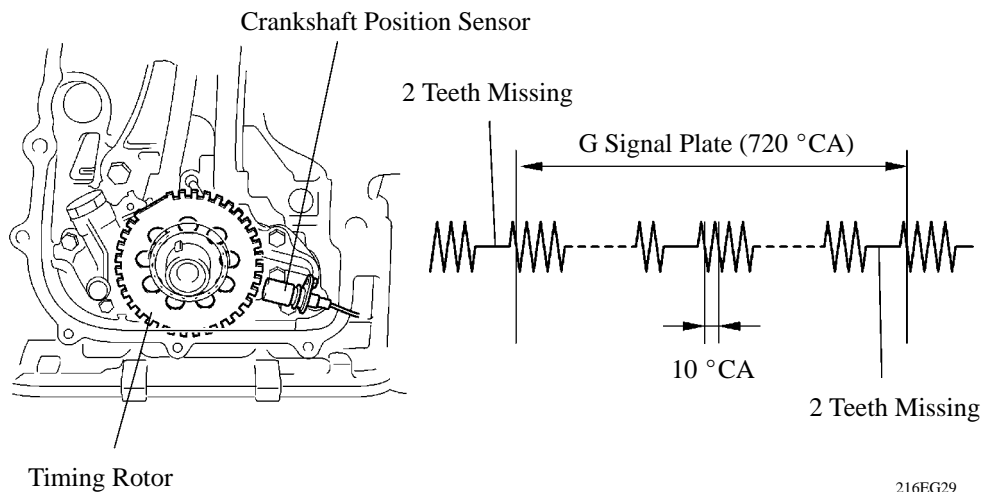
Mass Air Flow Meter

- This compact and lightweight mass air flow meter, which is a plug-in type, allows a portion of the intake air to flow through the detection area. By directly measuring the mass and the flow rate of the intake air, the detection precision is improved and the intake air resistance has been reduced.
- This mass air flow meter has a built-in intake air temperature sensor.



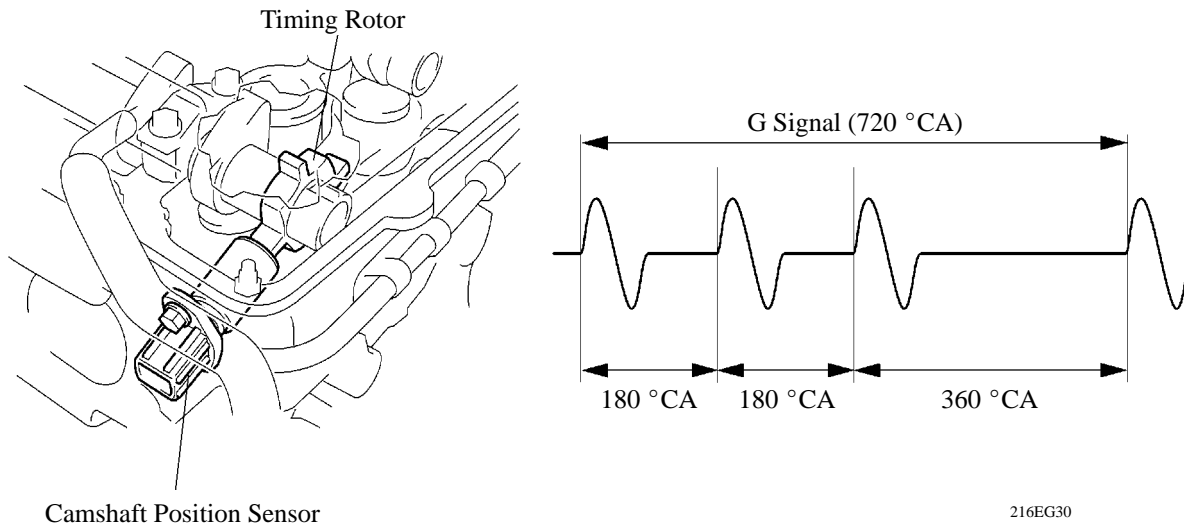
Crankshaft Position Sensor

The timing rotor of the crankshaft consists of 34 teeth, with 2 teeth missing. The crankshaft position sensor outputs the crankshaft rotation signals every 10°, and the missing teeth are used to determine the top-dead-center.



Camshaft Position Sensor

To detect the camshaft position, a timing rotor on the intake camshaft is used to generate 3 pulses for every 2 revolutions of the crankshaft.



Knock Sensor (Flat Type)

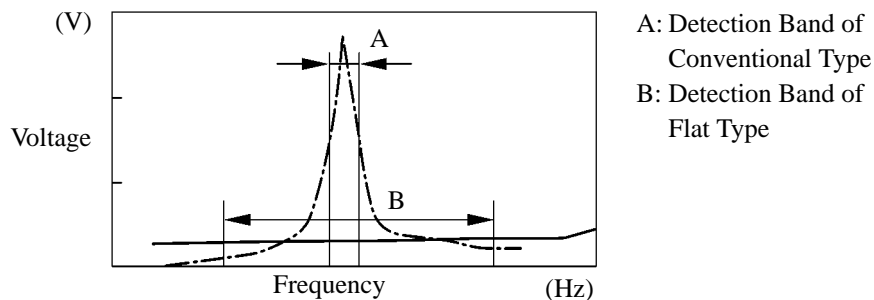
1) General

In the conventional type knock sensor (resonant type), a vibration plate which has the same resonance point as the knocking frequency of the engine is built in and can detect the vibration in this frequency band.

On the other hand, a flat type knock sensor (non-resonant type) has the ability to detect vibration in a wider frequency band from about 6 kHz to 15 kHz, and has the following features.

- The engine knocking frequency will change a bit depending on the engine speed. The flat type knock sensor can detect the vibration even when the engine knocking frequency is changed. Thus the vibration detection ability is increased compared to the conventional type knock sensor, and a more precise ignition timing control is possible.

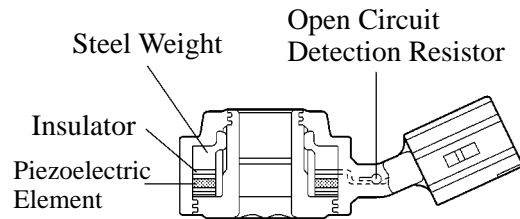
--- : Resonance Characteristic of Conventional Type
 — : Resonance Characteristic of Flat Type



Characteristic of Knock Sensor

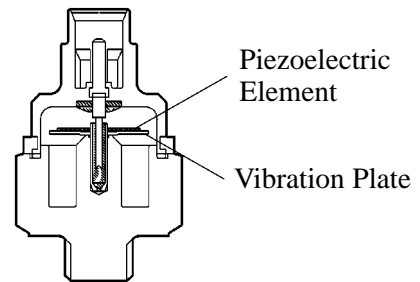
2) Construction

- The flat type knock sensor is installed on the engine through the stud bolt installed on the cylinder block. For this reason, a hole for the stud bolt is running through in the center of the sensor.
- Inside of the sensor, a steel weight is located on the upper portion and a piezoelectric element is located under the weight through the insulator.
- The open/short circuit detection resistor is integrated.



**Flat Type Knock Sensor
(Non-Resonant Type)**

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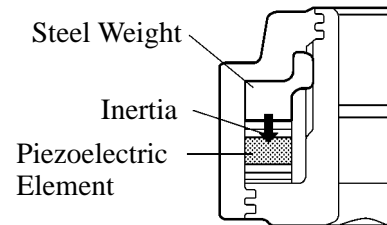


**Conventional Type Knock Sensor
(Resonant Type)**

214CE02

3) Operation

The knocking vibration is transmitted to the steel weight and its inertia applies pressure to the piezoelectric element. The action generates electromotive force.

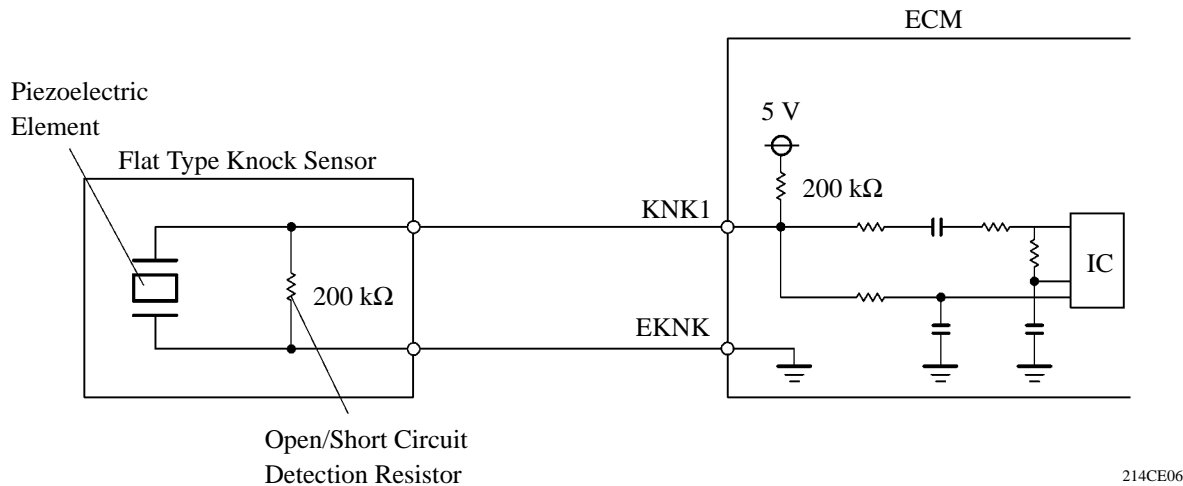


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4) Open/Short Circuit Detection Resistor

During the ignition is ON, the open/short circuit detection resistor in the knock sensor and the resistor in the ECM keep the voltage at the terminal KNK1 of engine constant.

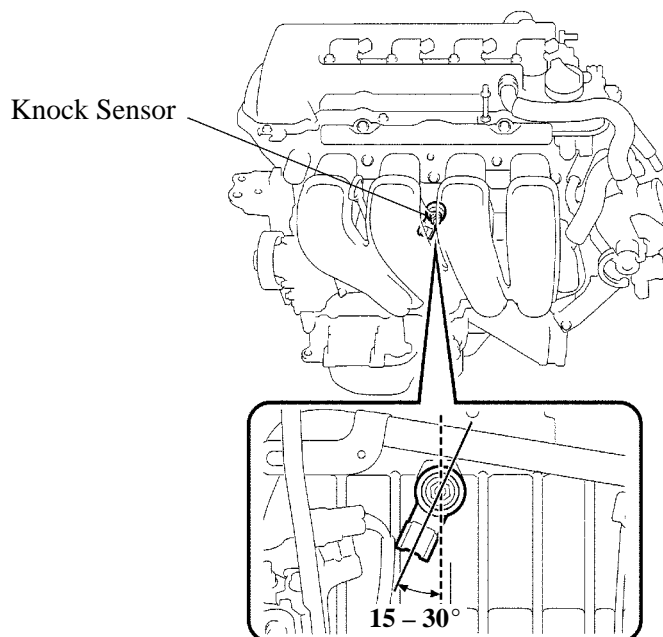
An IC (Integrated Circuit) in the ECM is always monitoring the voltage of the terminal KNK1. If the open/short circuit occurs between the knock sensor and the ECM, the voltage of the terminal KNK1 will change and the ECM detects the open/short circuit and stores DTC (Diagnostic Trouble Code) P0325.



214CE06

Service Tip

- In accordance with the adoption of an open/short circuit detection resistor, the inspection method for the sensor has been changed. For details, refer to 2003 Corolla Repair Manual (Pub. No. RM938U).
- To prevent the water accumulation in the connector, make sure to install the flat type knock sensor in the position as shown in the following illustration.

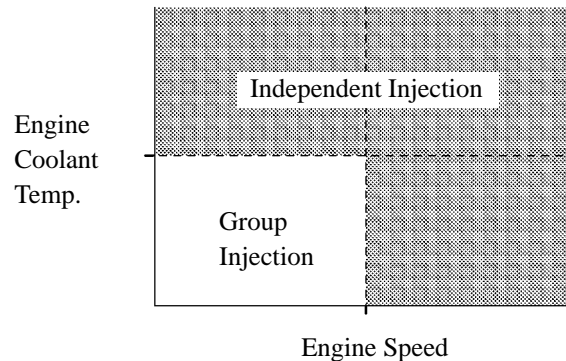


222EG13

6. SFI (Sequential Multiport Fuel Injection) System

- An L-type SFI system directly detects the intake air mass with a hot wire type mass air flow meter.
- An independent injection system (in which fuel is injected once into each cylinder for each two revolutions of the crankshaft) has been adopted.

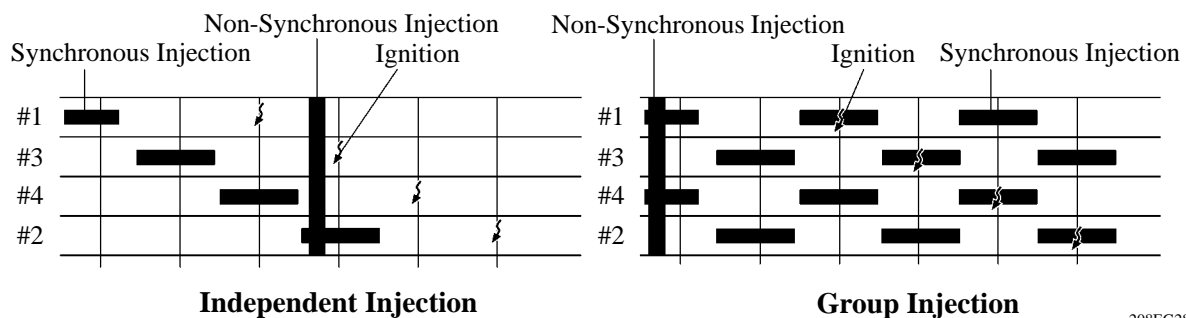
Also, when the engine is starting, a group injection (in which fuel is injected once into two cylinders for each one revolution of the crankshaft) is used. This changes to an independent injection when the engine speed or the engine coolant temperature become higher than a prescribed value.



208EG29

- There are two (synchronous and non-synchronous) injections:
 - a) The synchronous injection in which corrections based on the signals from the sensors are added to the basic injection time so that injection occurs always at the same position.
 - b) The non-synchronous injection in which injection is effected by detecting the requests from the signals of the sensors regardless of the crankshaft angle.

Furthermore, to protect the engine and achieve lower fuel consumption, the system use a fuel cutoff in which the injection of fuel is stopped temporarily in accordance with the driving conditions.

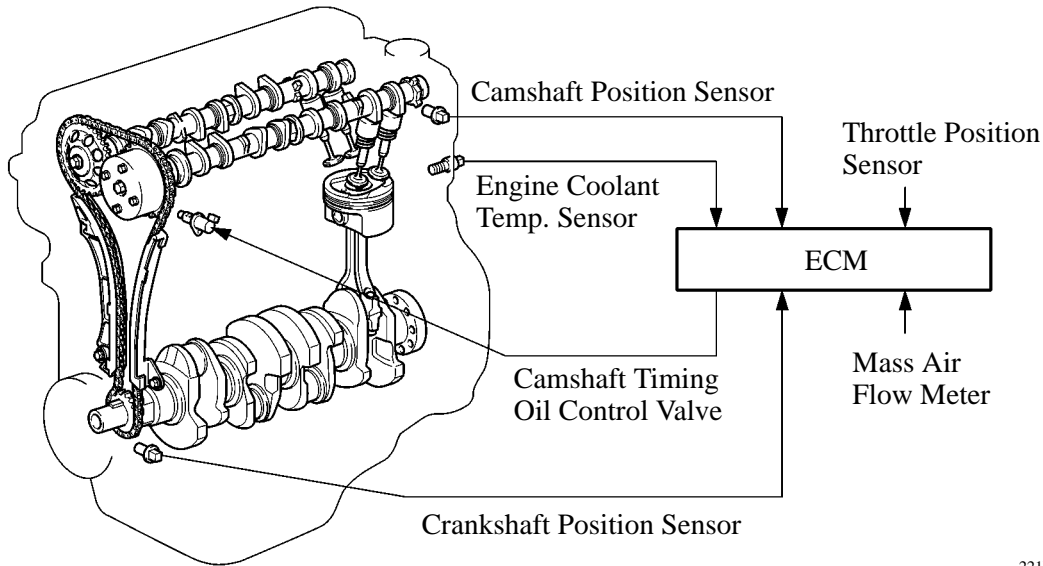


208EG28

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

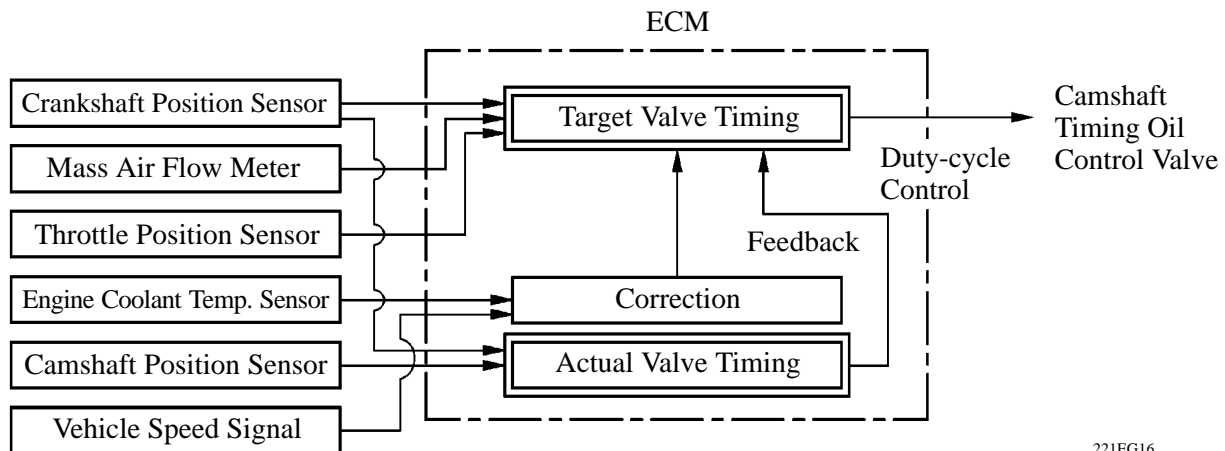
General

- 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 improves torque in all the speed ranges as well as increasing fuel economy, and reducing exhaust emissions.



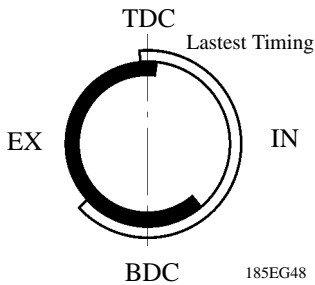
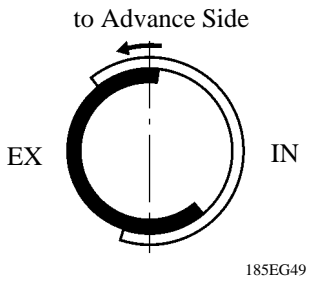
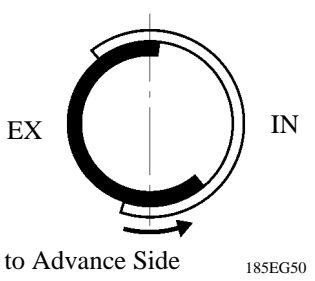
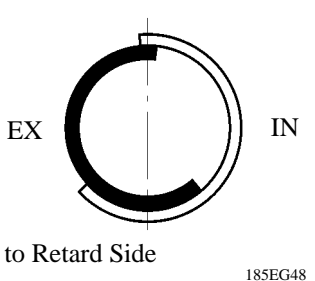
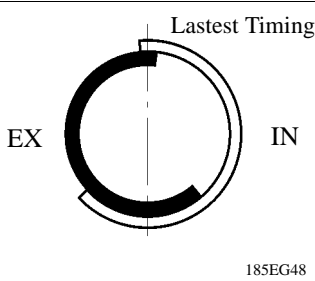
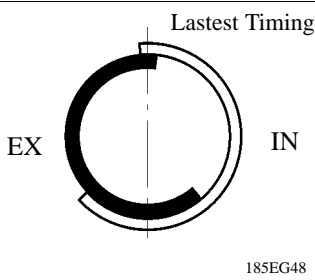
221EG15

- Using the engine speed, intake air volume, throttle position and engine coolant temperature, 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 the 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
<ul style="list-style-type: none"> • During Idling • At Light Load 	 <p>Minimizing overlap to reduce blow back to the intake side</p>	<ul style="list-style-type: none"> • Stabilized idling rpm • Better fuel economy
At Medium Load	 <p>Increasing overlap to increase internal EGR to reduce pumping loss</p>	<ul style="list-style-type: none"> • Better fuel economy • Improved emission control
In Low to Medium Speed Range with Heavy Load	 <p>Advancing the intake valve close timing for volumetric efficiency improvement</p>	Improved torque in low to medium speed range
In High Speed Range with Heavy Load	 <p>Retarding the intake valve close timing for volumetric efficiency improvement</p>	Improved output
At Low Temp.	 <p>Minimizing overlap to prevent blow back to the intake side leads to the lean burning condition, and stabilizes the idling speed at fast idle</p>	<ul style="list-style-type: none"> • Stabilized fast idle rpm • Better fuel economy
<ul style="list-style-type: none"> • Upon Starting • Stopping the Engine 	 <p>Minimizing overlap to minimize blow back to the intake side</p>	Improved starability

Construction

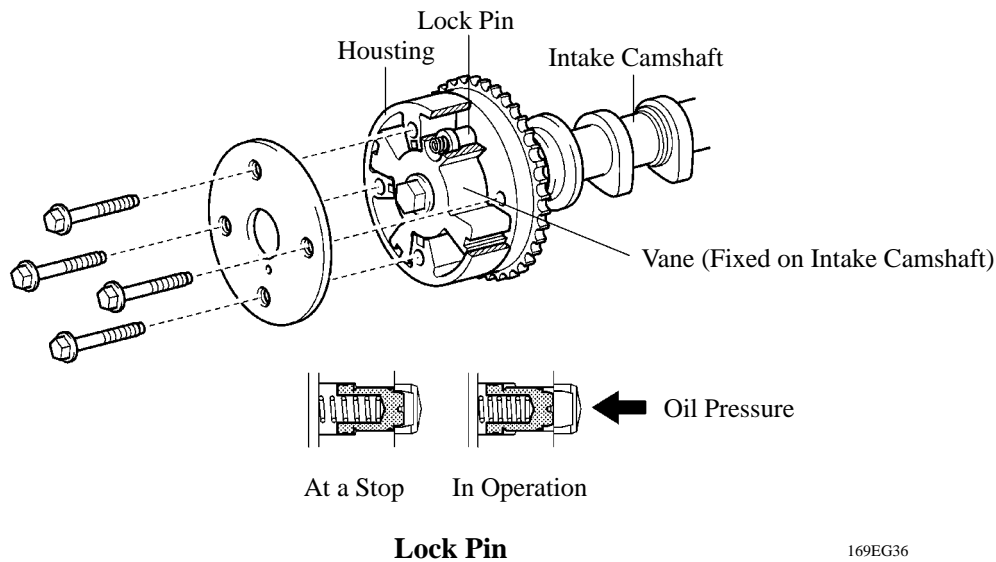
1) VVT-i Controller

This controller consists of the housing driven from the timing chain and the vane coupled with 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.

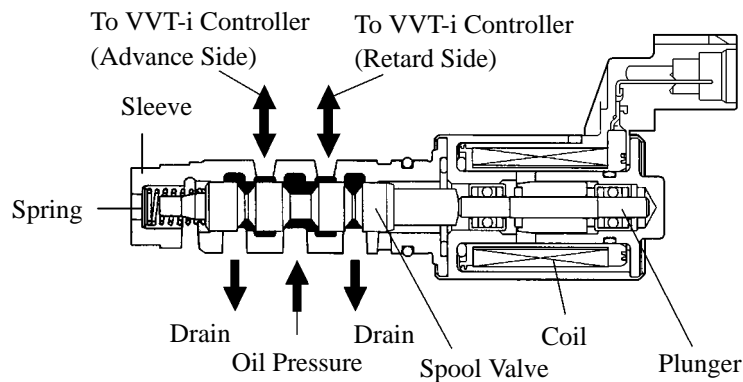
When hydraulic pressure is not applied to the VVT-i controller immediately after the engine has been started, the lock pin locks the movement of the VVT-i controller to prevent a knocking noise.



169EG36

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 side. When the engine is stopped, the camshaft timing oil control valve is in the most retard state.

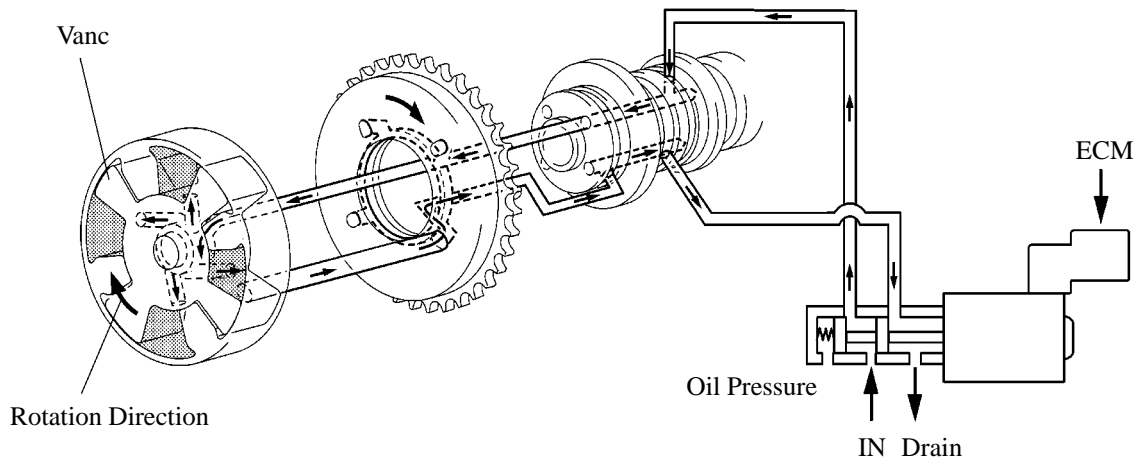


221EG17

Operation

1) Advance

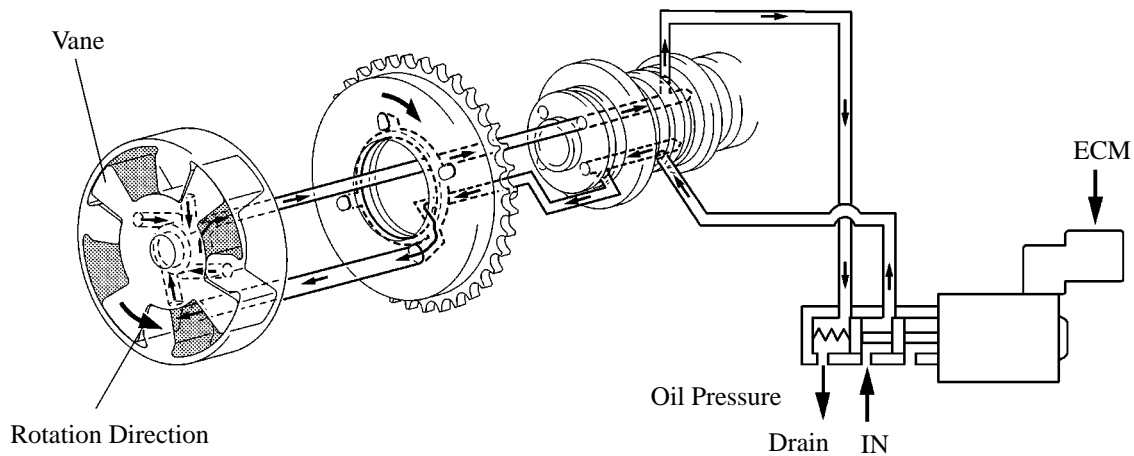
When the camshaft timing oil control valve is positioned as illustrated below by the advance signals from the ECM, the resultant oil pressure is applied to the timing advance side vane chamber to rotate the camshaft in the timing advance direction.



221EG19

2) Retard

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



221EG20

3) Hold

After reaching at 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.

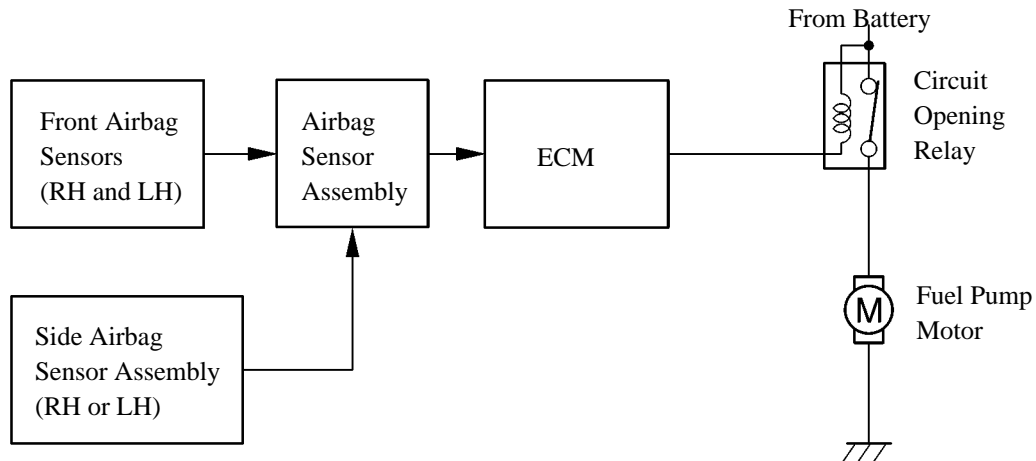
This adjusts the valve timing at the desired target position and prevents the engine oil from running out when it is unnecessary.

8. Fuel Pump Control

A fuel cut control is adopted to stop the fuel pump once when the SRS airbag is deployed in a front or side collision.

In this system, the airbag deployment signal from the airbag assembly is detected by the ECM, and it 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.



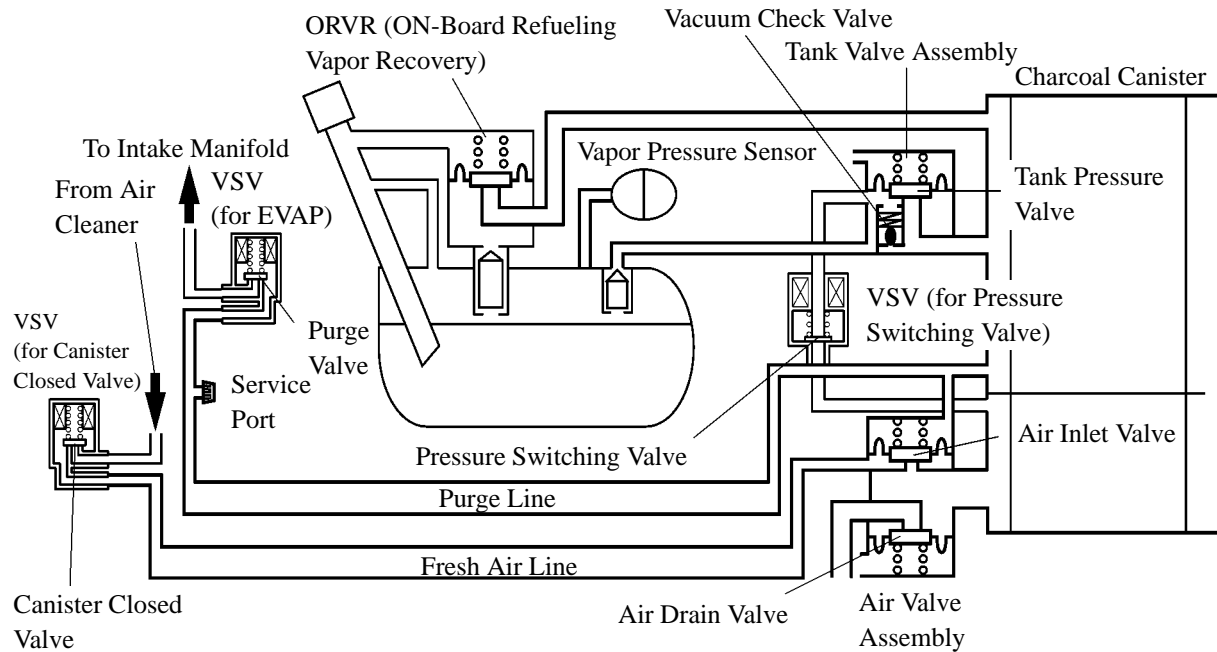
216EG31

9. Evaporative Emission Control System

General

The '03 Corolla Matrix uses the same vacuum type system used on the '02 Corolla to detect leaks in the evaporative emission control system. It forcefully introduces the purge vacuum into the entire system and monitors the changes in the pressure to detect leaks. It consists of the following main components:

- A VSV (for canister closed valve) that closes the fresh air line from the air cleaner to the charcoal canister has been adopted.
- A VSV (for pressure switching valve) that opens the evaporative line between the fuel tank and the charcoal canister
- A function to close the purge line from the air intake chamber to the charcoal canister for this system is added to the original functions of VSV (for EVAP).
- A vapor pressure sensor that measures the pressure in the fuel tank while checking for evaporative emission leaks and sends signals to the ECM

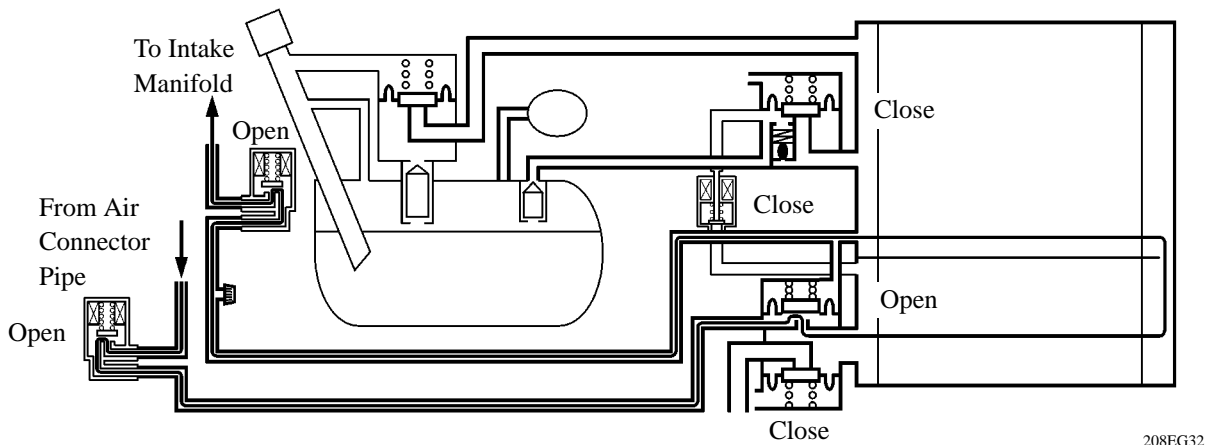


Operation

1) Purge Flow

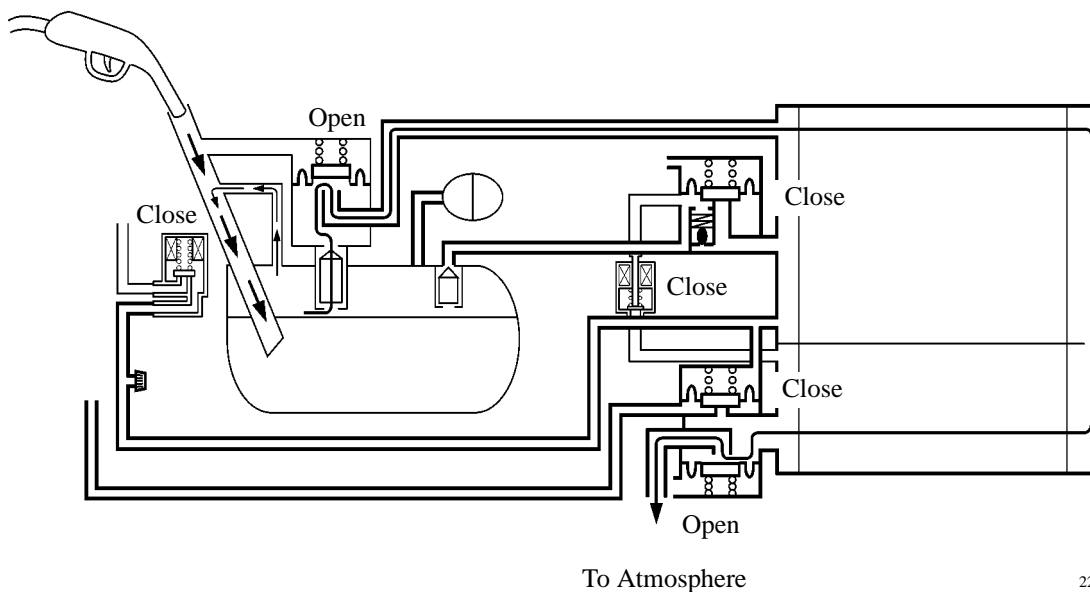
When the engine has reached the predetermined parameters (closed loop, engine coolant temp. above 74 °C (165 °F), etc.), stored fuel vapors are purged from the charcoal canister when the purge valve is opened by the ECM. At the appropriate time, the ECM will turn on the VSV (for EVAP).

The ECM will change the duty ratio cycle of the VSV (for EVAP) thus controlling purge flow volume. Purge flow volume is determined by manifold pressure and the duty ratio cycle of the VSV (for EVAP). Atmospheric pressure is allowed into the canister to ensure that purge flow is constantly maintained whenever purge vacuum is applied to the canister.



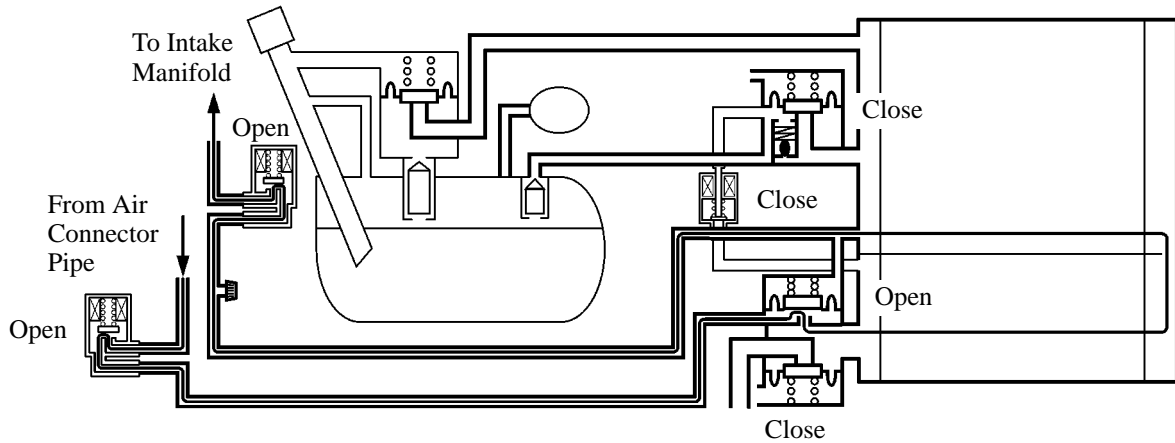
2) ORVR (On-Board Refueling Vapor Recovery)

During refueling, low pressure above the diaphragm in the on-board recovery valve lifts allowing fuel vapors into the charcoal canister. At the same time, the air drain valve opens and the charcoal absorbs the fuel vapors.

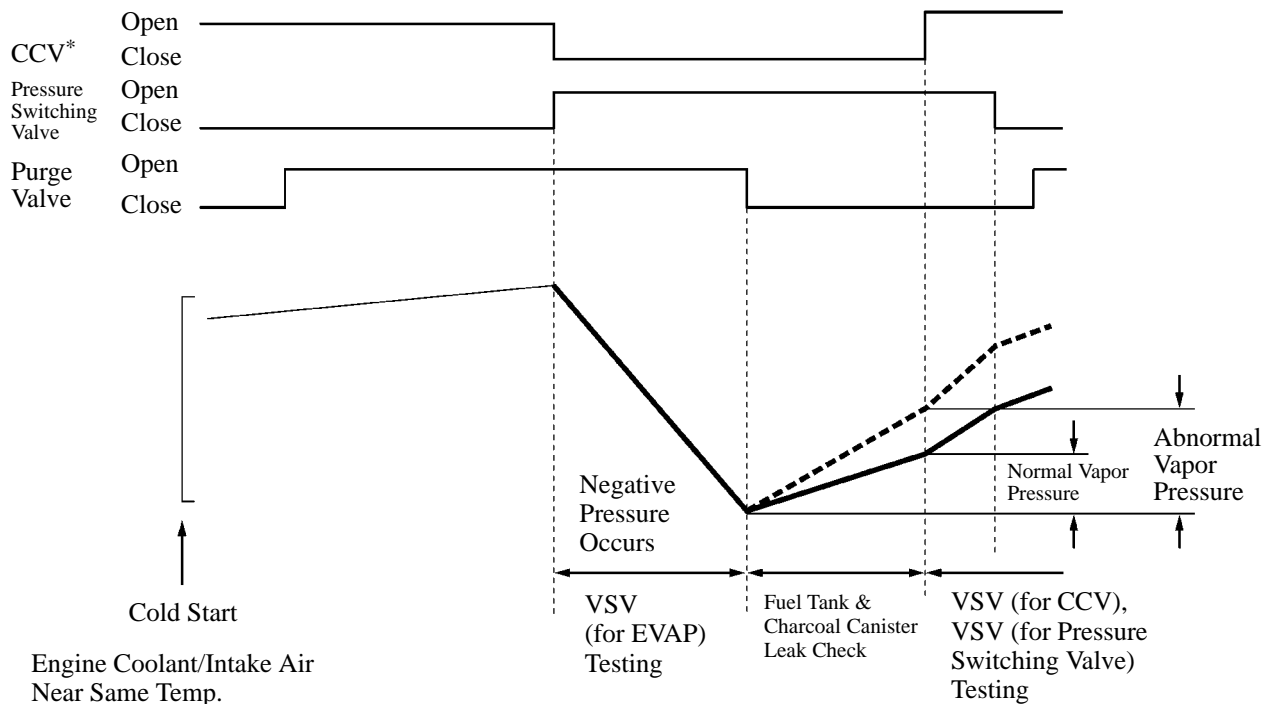


3) Monitor

The monitor sequence begins with a cold engine start. The intake air temp. and engine coolant temp. sensors must have approximately the same temperature reading. The ECM is constantly monitoring fuel tank pressure. As the temperature of the fuel increases, pressure slowly rises. The ECM will purge the charcoal canister at the appropriate time. With VSV (for pressure switching valve) closed, pressure will continue to rise in fuel tank.



208EG34



221EG23

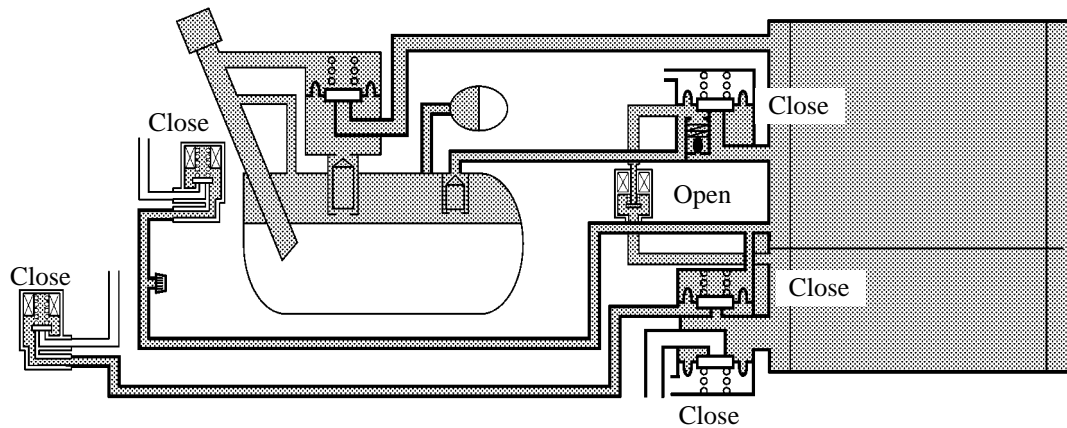
CCV: Canister Closed Valve

4) DTC P0440, P0442 (Evaporative Emission Control System Malfunction)

Initially, when the canister closed valve is closed, and the pressure switching valve and the purge valve are opened, a vacuum is applied to the purge line from the air intake to the charcoal canister and to the evaporative line from the charcoal canister to the fuel tank. Next, the purge valve is closed in order to maintain a vacuum from the VSV (for EVAP) to the inside of the fuel tank. Then, any subsequent changes in the pressure are monitored by the vapor pressure sensor in order to check for evaporative emission leaks.

If a leak is detected, the MIL (Malfunction Indicator Lamp) illuminates to inform the driver. Also, the DTC (Diagnostic Trouble Code) can be accessed through the use of a hand-held tester.

For details on the DTCs, refer to the 2003 Corolla Matrix Repair Manual (Pub. No. RM940U).

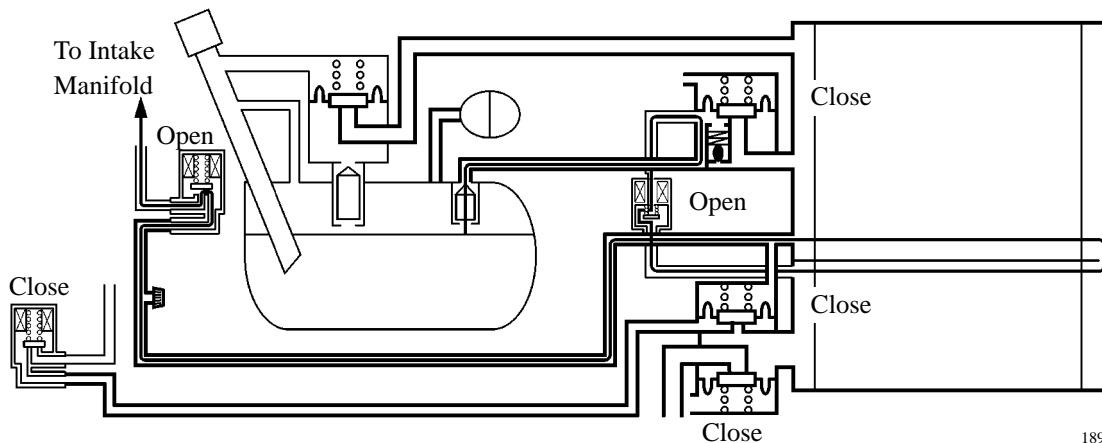


221EG24

5) DTC P0441 (Evaporative Emission Control System Incorrect Purge Flow)

At a predetermined point, the ECM closed the canister closed valve and opens the pressure switching valve causing a pressure drop in the entire EVAP system. The ECM continues to operate the VSV (for EVAP) until the pressure is lowered to a specified point at which time the ECM closed the purge valve. If the pressure did not drop, or if the drop in pressure increase beyond the specified limit, the ECM judges the VSV (for EVAP) and related components to be faulty and the MIL illuminates to inform the driver. Also, the DTC can be accessed through the use of a hand-held tester.

For details on the DTCs, refer to the 2003 Corolla Matrix Repair Manual (Pub. No. RM940U).

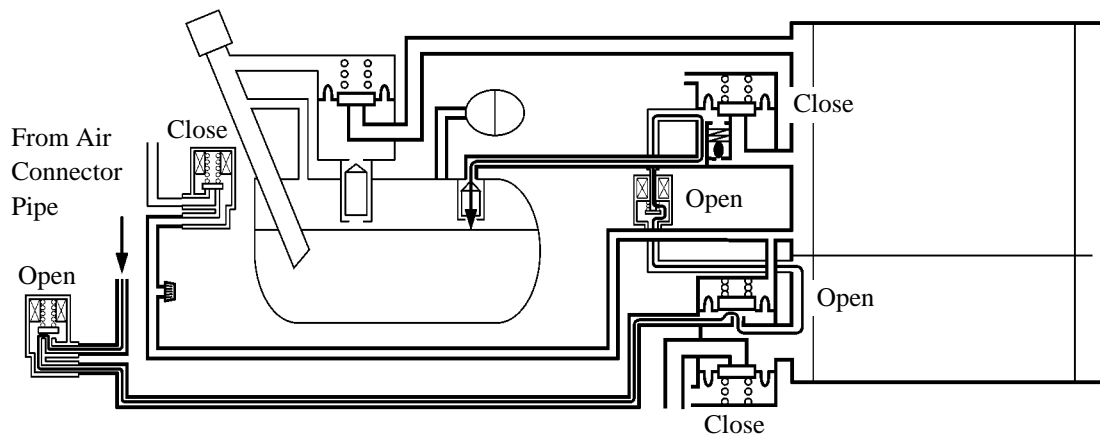


189EG35

6) DTC P0446 (Evaporative Emission Control System Vent Control Malfunction)

a. Canister Closed Valve

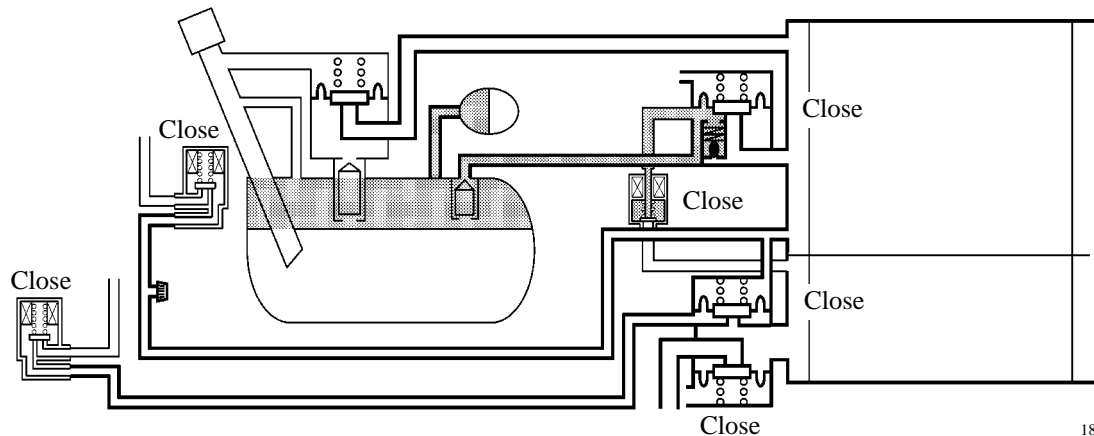
This stage checks the VSV (for canister closed valve) and vent (air inlet side) operation. When the vapor pressure rises to a specified point, the ECM opens the canister closed valve. Pressure will increase rapidly because of the air allowed into the system. No increase or an increase below specified rate of pressure increase indicates a restriction on the air inlet side. If a malfunction is detected, the MIL illuminates to inform the driver. Also, the DTC can be accessed through the use of a hand-held tester. For details on the DTCs, refer to the 2003 Corolla Matrix Repair Manual (Pub. No. RM940U).



221EG25

b. Pressure Switching Valve

The ECM closes the pressure switching valve. This action blocks air entering the tank side of the system. The pressure rise is no longer as great. If there was no change in pressure, the ECM will conclude the pressure switching valve did not close. If a malfunction is detected, the MIL illuminates to inform the driver. Also, the DTC can be accessed through the use of a hand-held tester. For details on the DTCs, refer to the 2003 Corolla Matrix Repair Manual (Pub. No. RM940U).

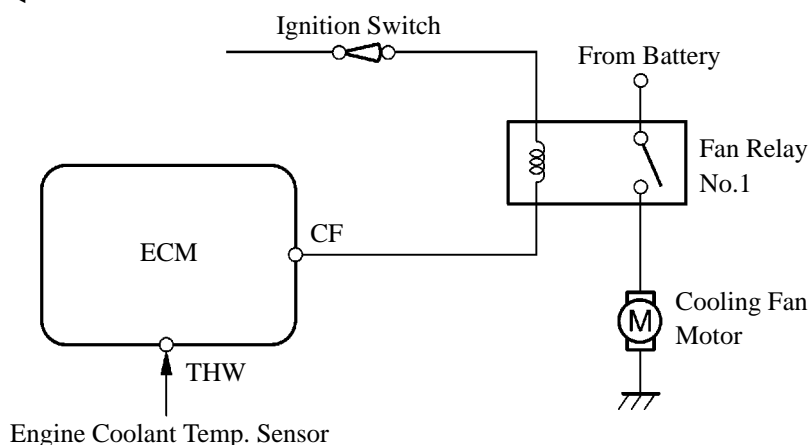


189EG37

10. Cooling Fan Control

- On the models without air conditioning, the ECM controls the operation of the cooling fan based on the engine coolant temp. sensor signal.

► Wiring Diagram ◀

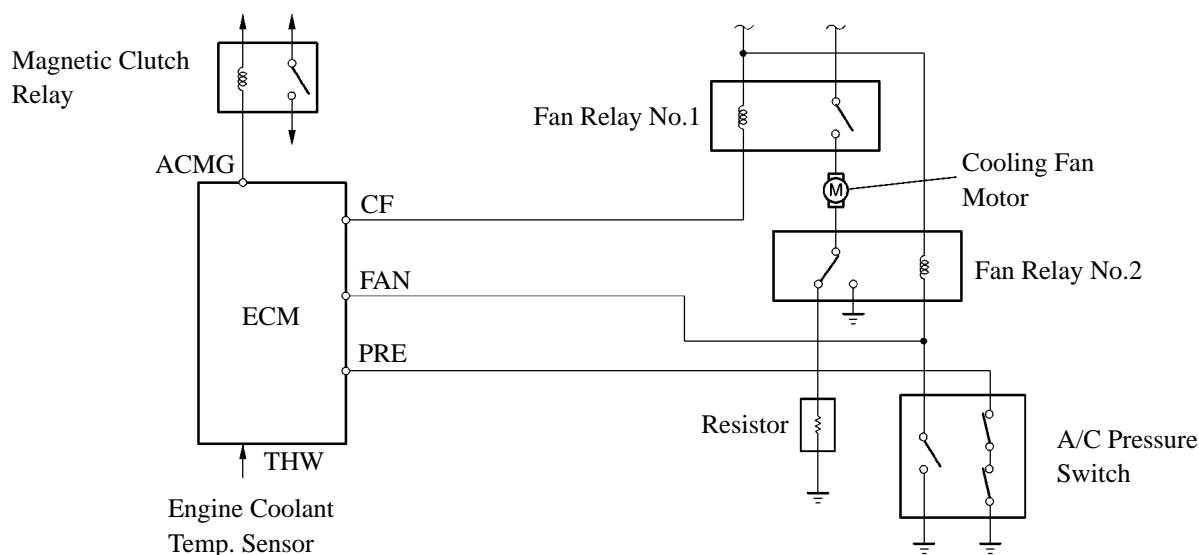


216EG32

Cooling Fan Operation		OFF	ON
Engine Coolant Temp.	°C (°F)	94.5 (202.1) or lower	96 (204.8) or higher

- On the models with air conditioning, the ECM controls the operation of the cooling fan in two speeds (Lo and Hi) based on the engine coolant temp. sensor signal and the A/C pressure switch signal. The Lo speed operation is accomplished by applying the current through a resistor, which reduces the speed of the cooling fan.

► Wiring Diagram ◀



221EG18

► Cooling Fan Operation ◀

Air Conditioning Condition		Engine Coolant Temp °C (°F)	
Compressor	Refrigerant Pressure MPa (kgf/cm ² , PSI)	94.5 (202.1) or lower	96 (204.8) or higher
OFF	1.2 (12.5, 178) or lower	OFF	High
ON	1.2 (12.5, 178) or lower	Low	High
	1.5 (15.5, 220) or higher	High	High

11. Diagnosis

- When the ECM detects a malfunction, the ECM makes a diagnosis and memorizes the failed section. Furthermore, the MIL (Malfunction Indicator Lamp) in the combination meter illuminates or blinks to inform the driver.
- At the same time, the DTCs (Diagnostic Trouble Codes) are stored in memory. The DTCs can be read by connecting a hand-held tester.
- For details, see the 2003 Corolla Matrix Repair Manual (Pub. No. RM940U).

12. Fail-Safe

When the ECM detects a malfunction, the ECM stops or controls the engine according to the data already stored in the memory.

► Fail-Safe Control List ◀

Location of Malfunction	Description of Control
Mass Air Flow Meter	In case of a signal malfunction, the engine could operate poorly or the catalyst could overheat if the engine continues to be controlled with the signals from the sensors. Therefore, the ECM effects control by using the values in the ECM or stops the engine.
Throttle Position Sensor	In case of a signal malfunction, the ECM effects control by rendering the throttle valve opening angle as being fully closed.
Engine Coolant Temp. Sensor and Intake Air Temp. Sensor	In case of a signals malfunction, the use of the values from the sensors will make the air-fuel ratio become too rich or too lean, which could cause the engine to stall or to run poorly during cold operation. Therefore, the ECM fixes the air-fuel ratio to the stoichiometric ratio and uses the constant values of 80 °C engine coolant temperature and 20 °C intake air temperature to perform the calculation.
Knock Sensor	In case of a malfunction in the knock sensor or in the knocking signal system (open or short circuit), the engine could become damaged if the timing is advanced despite the presence of knocking. Therefore, if a malfunction is detected in the knock sensor system, the ECM turns the timing retard correction of the knock sensor into the maximum retard value.
Ignition Coil (with Igniter)	In case of a malfunction in the ignition system, such as an open circuit in the ignition coil, the catalyst could become overheated due to engine misfire. Therefore, if the (IGF) ignition signal is not input twice or more in a row, the ECM determines that a malfunction occurred in the ignition system and stops only the injection of fuel into the cylinder with malfunction.
Camshaft Position Sensor	In case of a signal malfunction (open or short circuit) or a mechanical malfunction, the ECM stops the VVT-i control.