

ENGINE – 1ZZ-FE AND 2ZZ-GE ENGINES

■ ENGINE CONTROL SYSTEM

1. General

The engine control system for the 1ZZ-FE and 2ZZ-GE engines have following system.

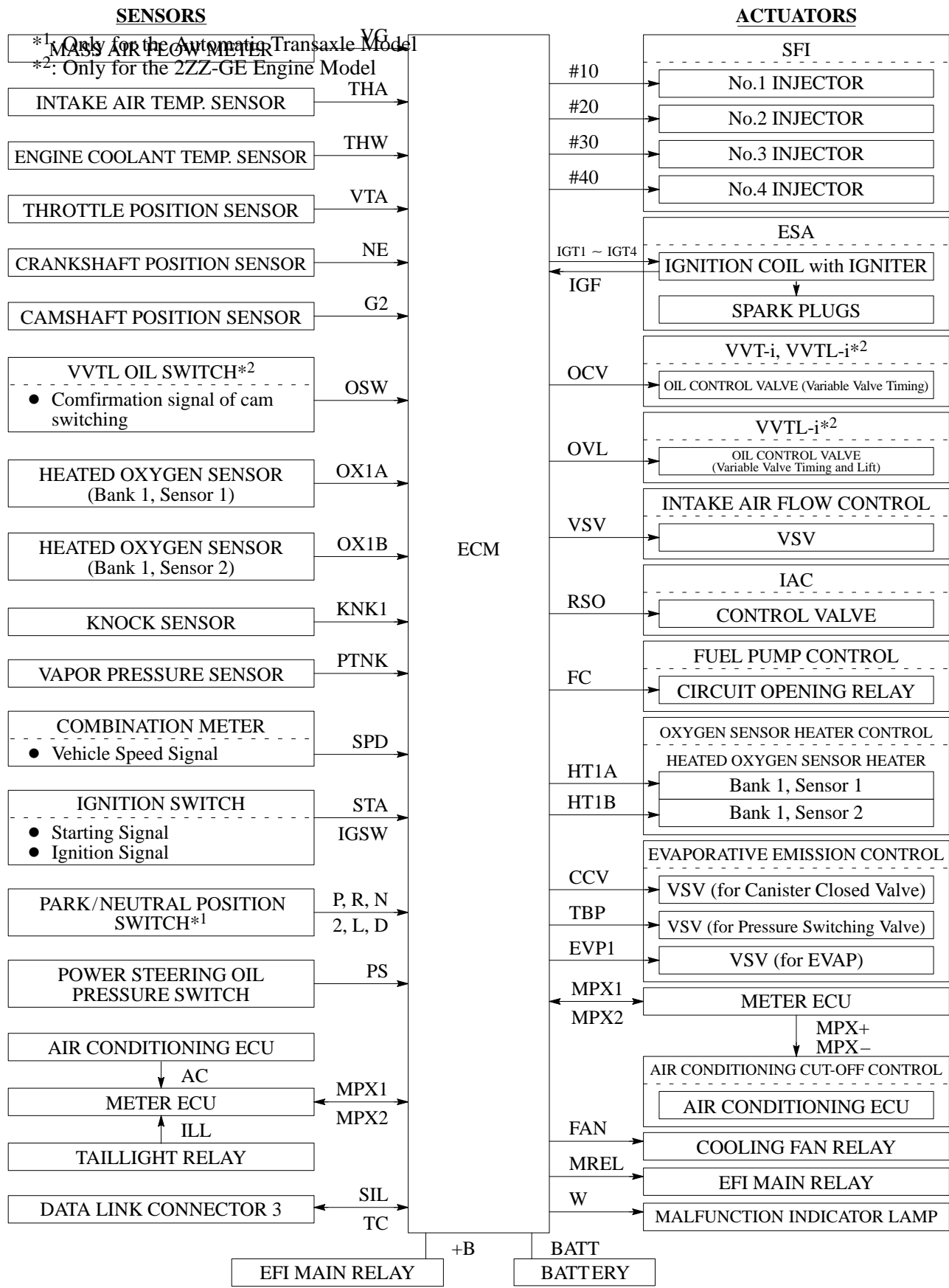
System	Outline	1ZZ-FE Engine	2ZZ-GE Engine
SFI (Sequential Multiport Fuel Injection)	<ul style="list-style-type: none"> An L-type SFI system directly detects the intake air volume with a hot-wire type mass air flow meter. The fuel injection system is a sequential multiport fuel injection system. 	○	○
ESA (Electronic Spark Advance)	<ul style="list-style-type: none"> Ignition timing is determined by the ECM based on signals from various sensors. The ECM corrects ignition timing in response to engine knocking. The torque control correction during gear shifting has been used to minimize the shift shock.* 	○	○
IAC (Idle Air Control)	A rotary solenoid type IAC valve controls the fast idle and idle speeds.	○	○
Intake Air Flow Control	The intake air duct is divided into two areas, and the ECM controls the variable intake valve and the actuator that are provided in one of the areas to reduce the amount of engine noise.	○	○
VVT-i (Variable Valve Timing-intelligent)	Controls the intake camshaft to an optimal valve timing in accordance with the engine condition.	○	—
VVTL-i (Variable Valve Timing and Lift-intelligent)	Controls the intake and exhaust camshafts and the cam changeover mechanism to realize an optimal valve timing and valve lift in accordance with the engine conditions.	—	○
Fuel Pump Control	<ul style="list-style-type: none"> Fuel pump operation is controlled by signal from the ECM. To stop the fuel pump during operation of the SRS airbag. For details, see page 58. 	○	○
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	<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 the charcoal canister through the changes in the 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.	○	○
Diagnosis	When the ECM detects a malfunction, the ECM diagnoses and memorizes the failed section.	○	○
Fail-Safe	When the ECM detects a malfunction, the ECM stops or controls the engine according to the data already stored in memory.	○	○

* Only for the Automatic Transaxle Model

ENGINE – 1ZZ-FE AND 2ZZ-GE ENGINES

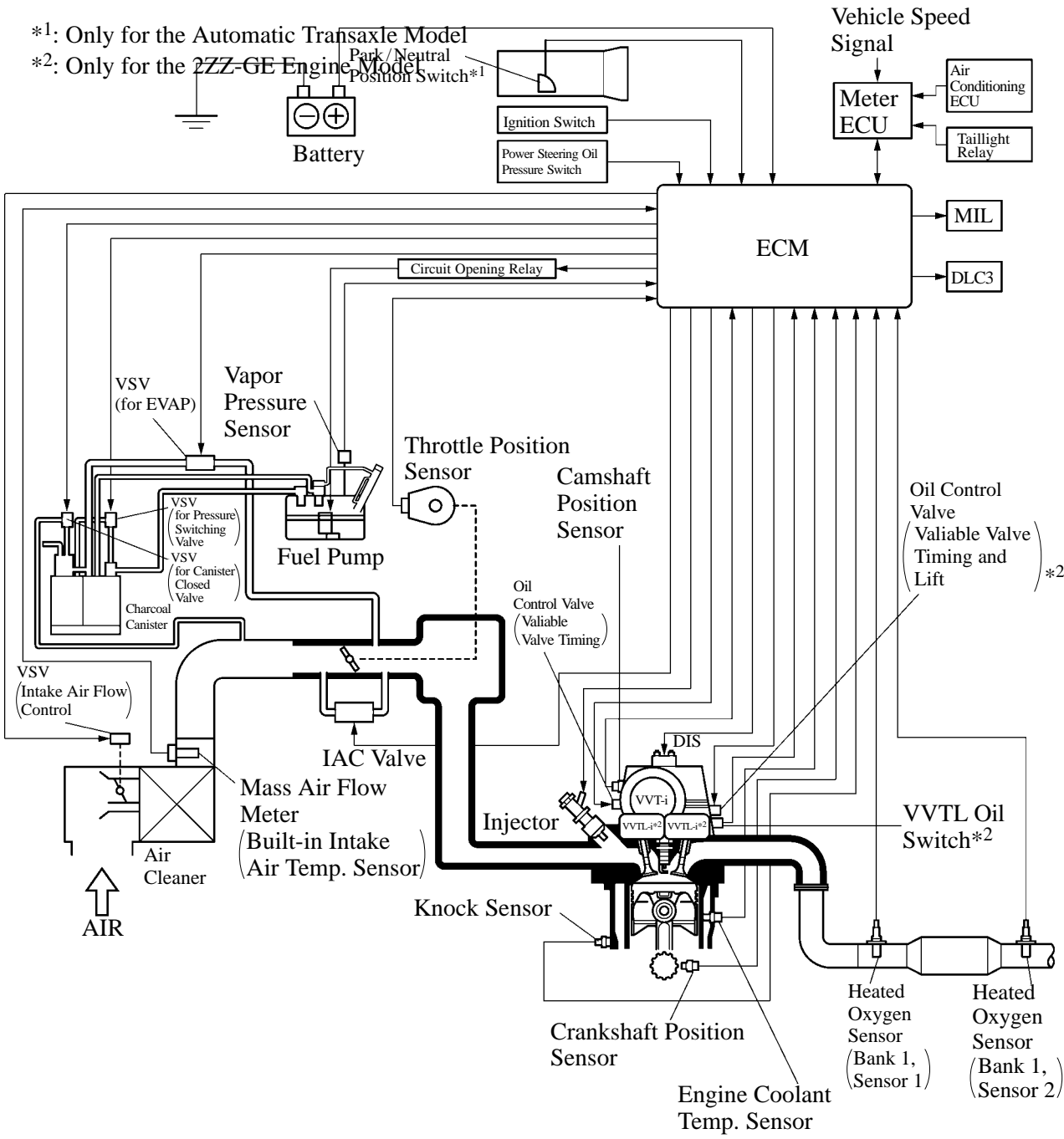
2. Construction

The configuration of the engine control system in the 1ZZ-FE and 2ZZ-GE engines in the new CELICA is as shown in the following chart.



ENGINE – 1ZZ-FE AND 2ZZ-GE ENGINES

3. Engine Control System Diagram

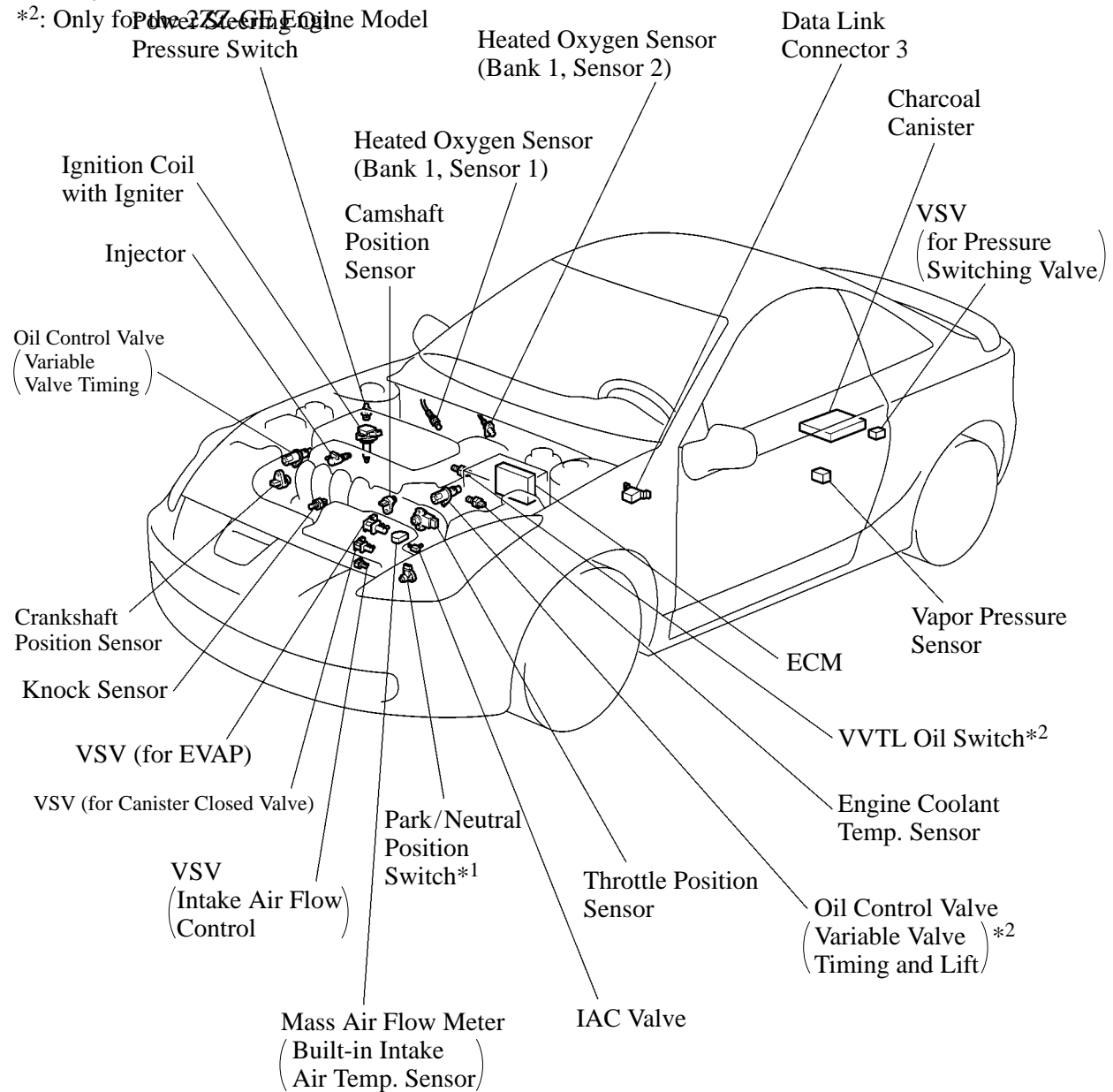


ENGINE – 1ZZ-FE AND 2ZZ-GE ENGINES

4. Layout of Main Components

*1: Only for the Automatic Transaxle Model

*2: Only for the Power Steering Engine Model



ENGINE – 1ZZ-FE AND 2ZZ-GE ENGINES

5. Main Components of Engine Control System

General

The main components of the 1ZZ-FE and 2ZZ-GE engines control system are as follows:

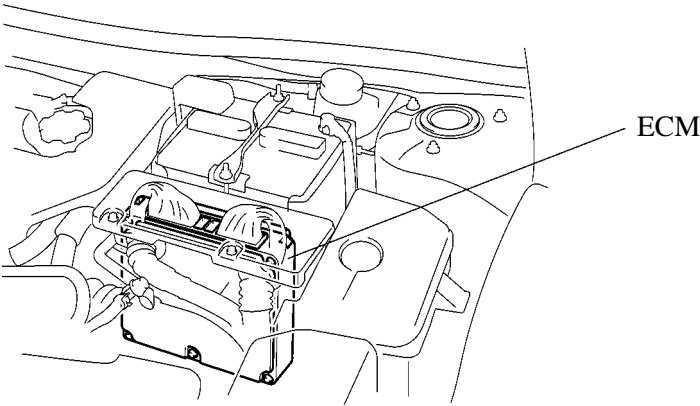
Components	Outline	Quantity
Mass Air Flow Meter	Hot-Wire Type	1
Crankshaft Position Sensor (Rotor Teeth)	Pick-Up Coil Type (36-2)	1
Camshaft Position Sensor (Rotor Teeth)	Pick-Up Coil Type (3)	1
Throttle Position Sensor	Linear Type	1
Knock Sensor	Built-In Piezoelectric Element Type	1
Oxygen Sensor	Heated Oxygen Sensor (Bank 1, Sensor 1) (Bank 1, Sensor 2)	2
Injector	12-Hole Type* ¹ , 4-Hole Type* ²	4
IAC Valve	Rotary Solenoid Type (1-Coil Type)	1

*¹: Only for the 1ZZ-FE Engine Model

*²: Only for the 2ZZ-GE Engine Model

ECM

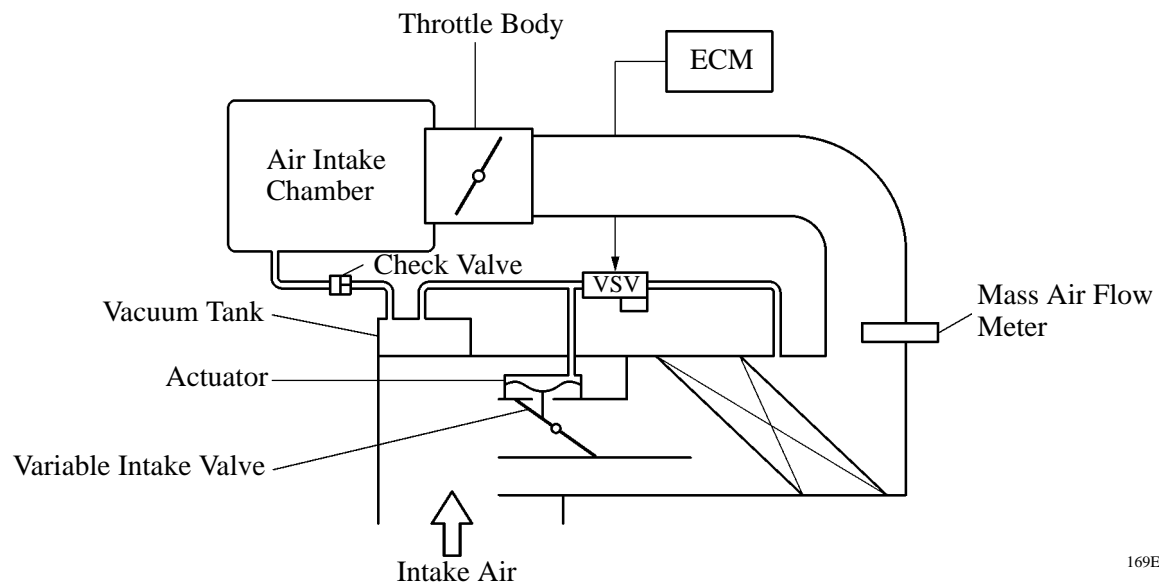
The ECM is installed in the ECM box in the engine compartment. As result, the wiring harness has been shorted, thus realizing weight reduction.



ENGINE – 1ZZ-FE AND 2ZZ-GE ENGINES

6. Intake Air Flow Control

The intake air duct is divided into two areas, and a variable intake valve and an actuator have been provided in one of the areas. When the engine is operating in the low-to mid-speed range, this control operates the variable intake valve to close one side of the intake air duct. When the engine is operating in the high-speed range, it turns OFF the variable intake valve, allowing both sides of the intake air duct to effect the intake of air. Accordingly, the level of engine noise has been reduced without using an intake resonator.



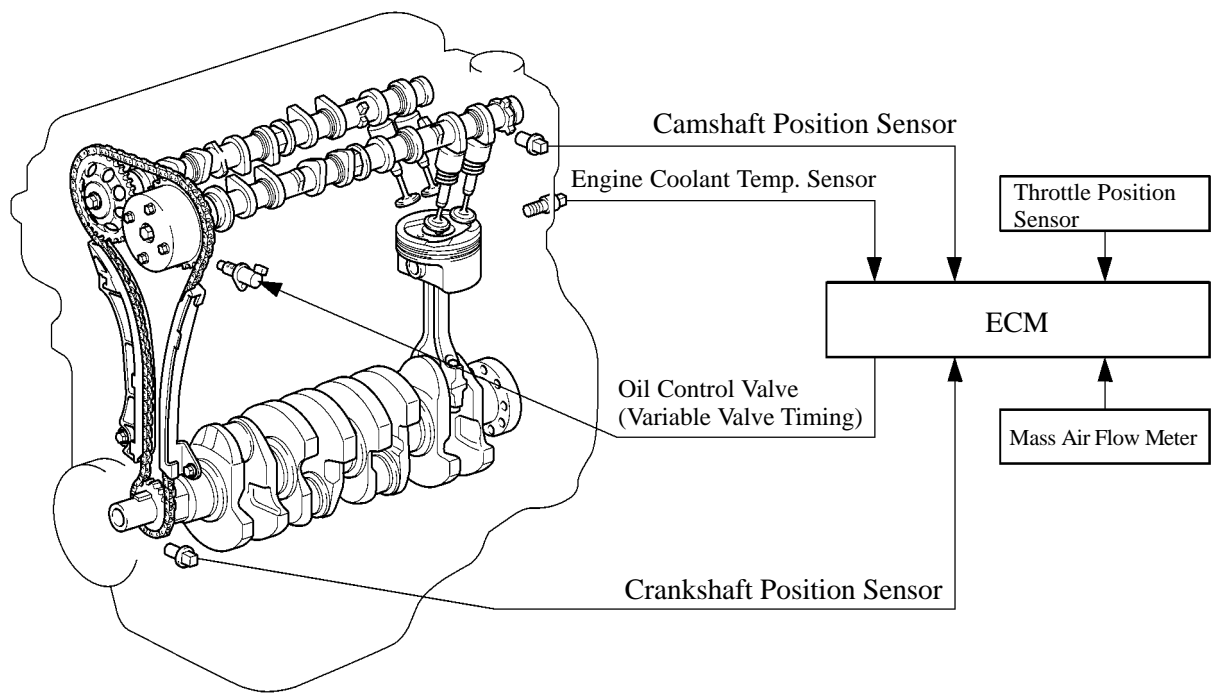
169EG34

ENGINE – 1ZZ-FE AND 2ZZ-GE ENGINES

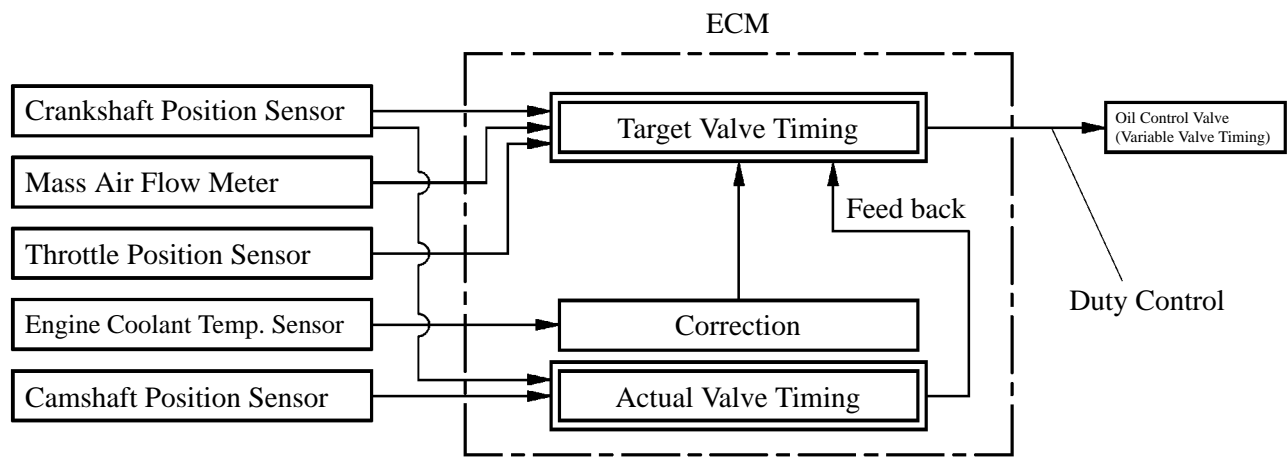
7. VVT-i (Variable Valve Timing-intelligent) System

General

This system controls the intake camshaft valve timing so as to obtain balance between the engine output, fuel consumption and emission control performance. The actual intake side valve timing is feed back by means of the camshaft position sensor for constant control to the target valve timing.



169EG35



157EG23

ENGINE – 1ZZ-FE AND 2ZZ-GE ENGINES

Construction

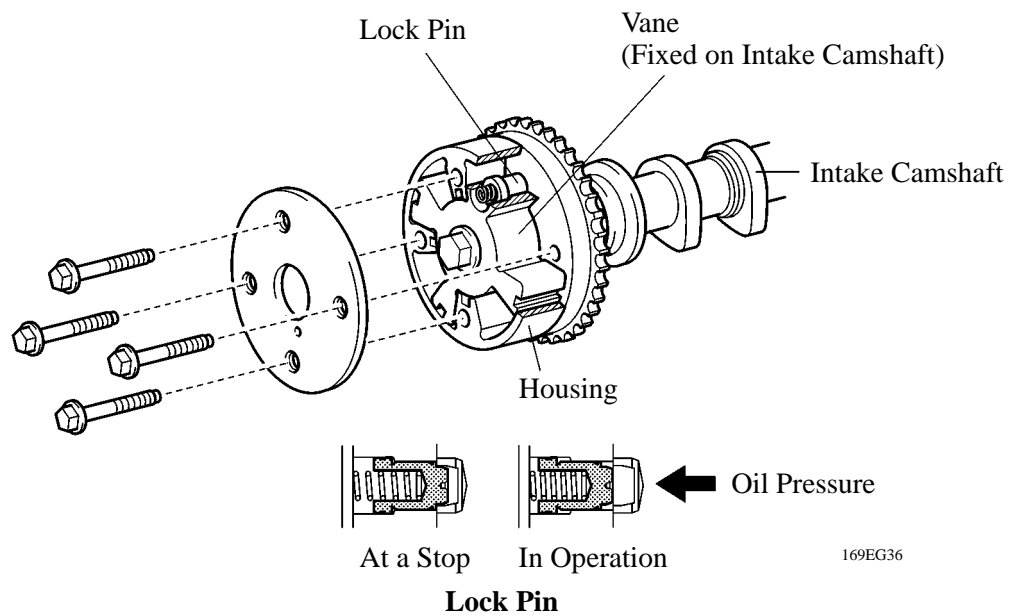
1) VVT-i Controller

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.

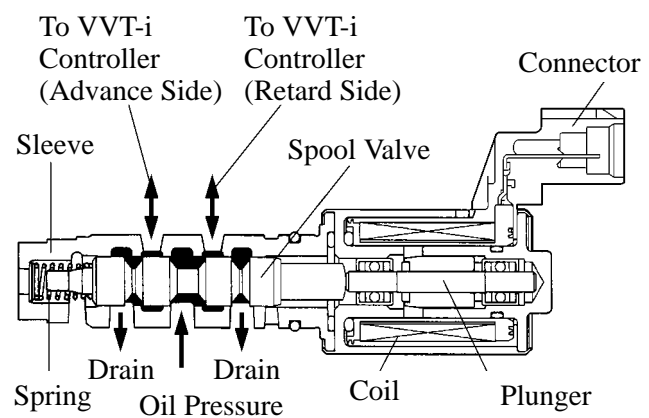
When the engine is stopped, the intake camshaft will be in the most retarded state to ensure startability.

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



2) Oil Control Valve (Variable Valve Timing)

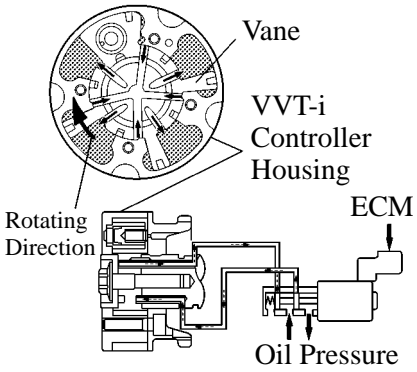
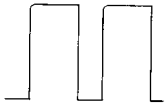
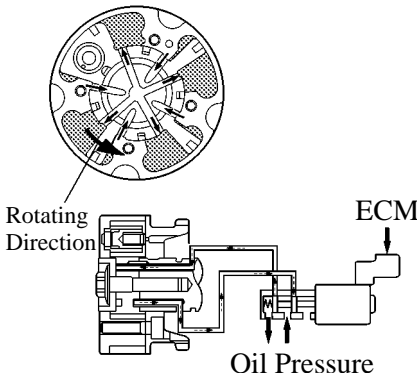
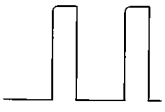
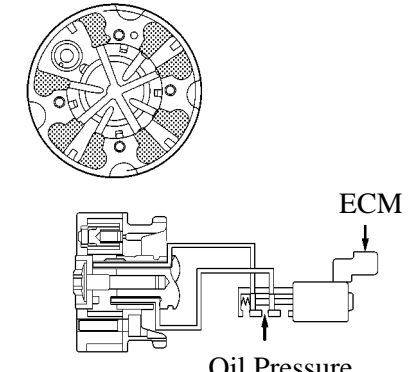
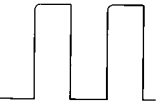
The oil control valve (variable valve timing) controls the spool valve position in accordance with the duty control from the ECM thus allocating the hydraulic pressure that is applied to the VVT-i controller to the advance and the retard side. When the engine is stopped, the oil control valve (variable valve timing) is in the most retarded state.



ENGINE – 1ZZ-FE AND 2ZZ-GE ENGINES

Operation

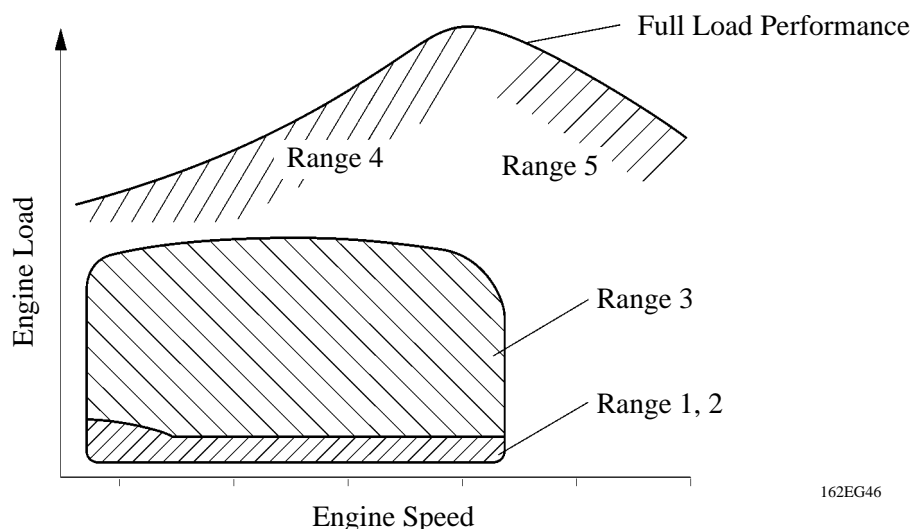
- The oil control valve (variable valve timing) selects the path to the VVT-i controller according to the advance, retard or hold signal from the ECM. The VVT-i controller rotates the intake camshaft in the timing advance or retard position or holds it according to the position where the oil pressure is applied.

	Operation	Oil Control Valve Drive Signal	Description
Advance	 169EG37	<p>Advance Signal</p>  <p>Duty Ratio</p> 157EG35	When the oil control valve (variable valve timing) is positioned as illustrated at left by the advance signal 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.
Retard	 169EG38	<p>Retard Signal</p>  <p>Duty Ratio</p> 157EG36	When the oil control valve (variable valve timing) is positioned as illustrated at left by the retard signal 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.
Hold	 169EG39	<p>Hold Signal</p>  <p>Duty Ratio</p> 157EG37	The ECM calculates the target timing angle according to the traveling state to perform control as described above. After setting at the target timing, the valve timing is held by keeping the oil control valve (variable valve timing) 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.

ENGINE – 1ZZ-FE ENGINE AND 2ZZ-GE ENGINES

- In proportion to the engine speed, intake air volume, throttle position and water temperature, the ECM calculates an optimal valve timing under each driving condition and control the oil control valve (variable valve timing). In addition, ECM uses signal from the camshaft position sensor and the crankshaft position sensor to detect the actual valve timing, thus performing feed back control to achieve the target valve timing.

► Operation During Various Driving Conditions (Conceptual Diagram) ◀



162EG46

Operation state	Range	Valve timing	Objective	Effect
During idling	1	<div style="text-align: center;"> <p>TDC</p> <p>IN</p> <p>EX Latest timing</p> </div>	Minimizing overlap to reduce blow back to the intake side	Stabilized idling rpm Better fuel economy
At light load	2	<div style="text-align: center;"> <p>IN</p> <p>EX To retard side</p> </div>	Decreasing overlap to eliminate blow back to the intake side	Ensured engine stability
At medium load	3	<div style="text-align: center;"> <p>IN</p> <p>EX To advance side</p> </div>	Increasing overlap to increase internal EGR for pumping loss elimination	Better fuel economy Improved emission control
In low to medium speed range with heavy load	4	<div style="text-align: center;"> <p>IN</p> <p>EX To advance side</p> <p>BDC</p> </div>	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	5	<div style="text-align: center;"> <p>IN</p> <p>EX To retard side</p> </div>	Retarding the intake valve close timing for volumetric efficiency improvement	Improved output
At low temperatures	—	<div style="text-align: center;"> <p>IN</p> <p>EX Latest timing</p> </div>	Minimizing overlap to prevent blow back to the intake side for reduction of fuel increase at low temperatures, and stabilizing the idling rpm for decreasing fast idle rotation	Stabilized fast idle rpm Better fuel economy
Upon starting/ stopping the engine	—	<div style="text-align: center;"> <p>IN</p> <p>EX Latest timing</p> </div>	Minimizing overlap to minimize blow back to the intake side	Improved startability

ENGINE – 1ZZ-FE AND 2ZZ-GE ENGINES

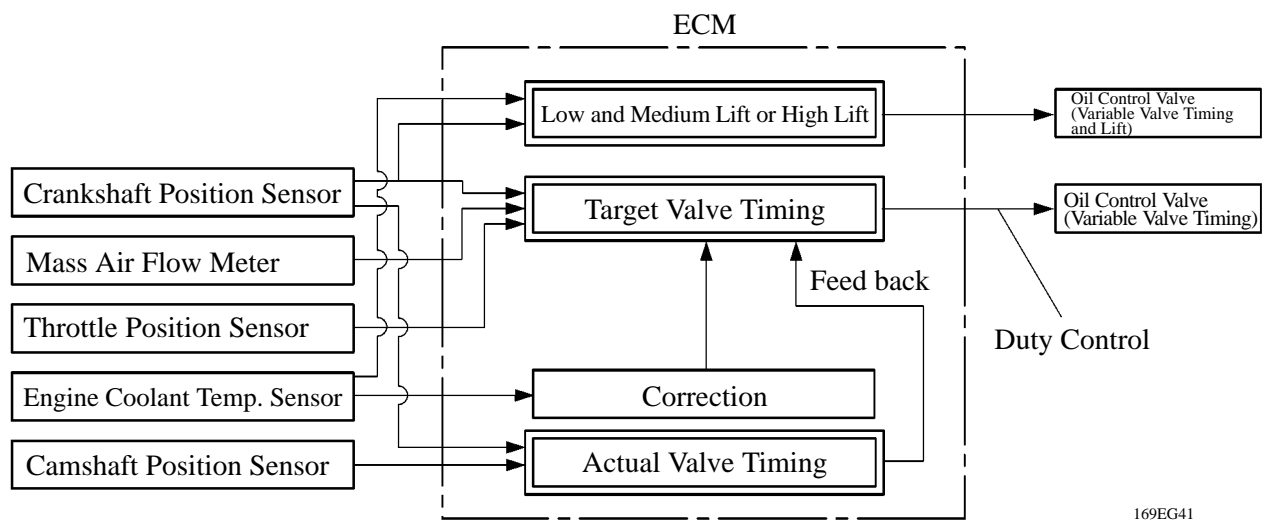
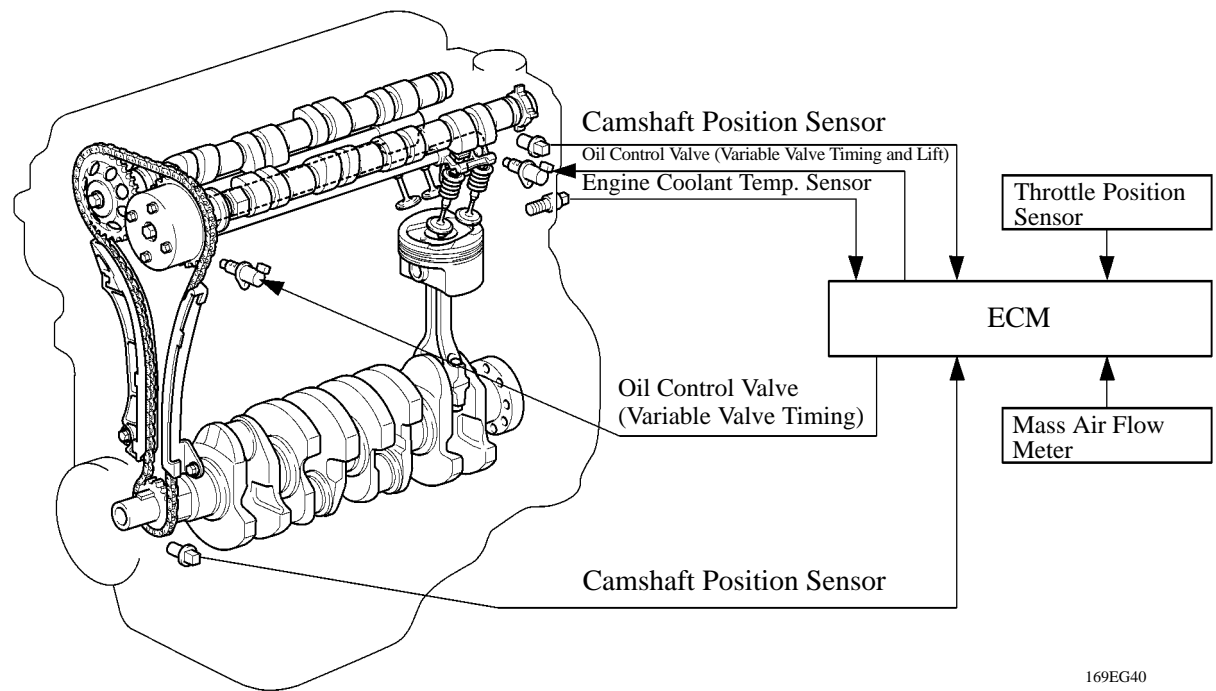
8. VVTL-i (Variable Valve Timing and Lift-intelligent) system (2ZZ-GE Engine)

General

Based on the VVT-i system, the VVTL-i system has adopted a cam changeover mechanism that varies the amount of lift of the intake and exhaust valves while the engine is operating at high speeds. In addition to achieving higher engine speeds and higher outputs, this system enables the valve timing to be optimally set, resulting in improved fuel economy.

When the engine is operating in the low-to mid-speed range, the low-and medium-speed cams of the camshafts operate to move the two valves via the rocker arms. Then, when the engine is operating in the high-speed range, the signals from the sensors cause the ECM to change the hydraulic passage of the oil control valve (for variable valve timing and lift), thus changing to the operation of the high-speed cams. Thus, the lift of the intake and exhaust valves increases, allowing the introduction of a greater volume of air-fuel mixture, and the discharge of a greater volume of exhaust gases. As a result, the engine operates at higher speeds and higher outputs.

The construction and the operation of the valve timing control are basically the same as in the VVT-i system.



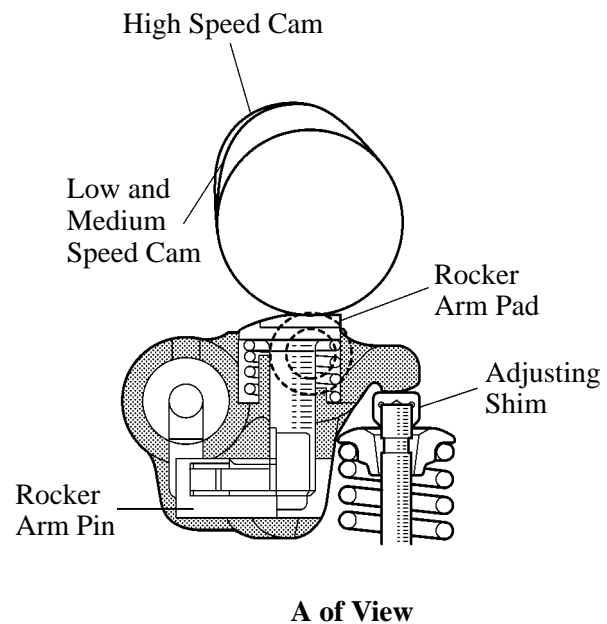
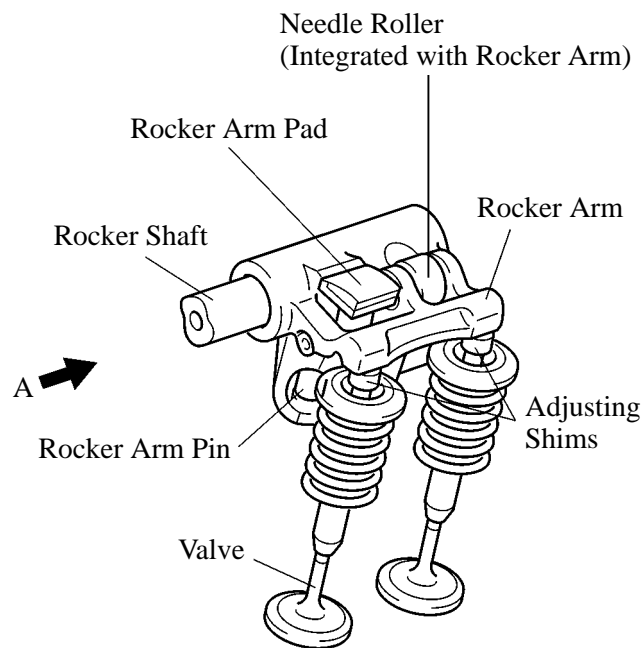
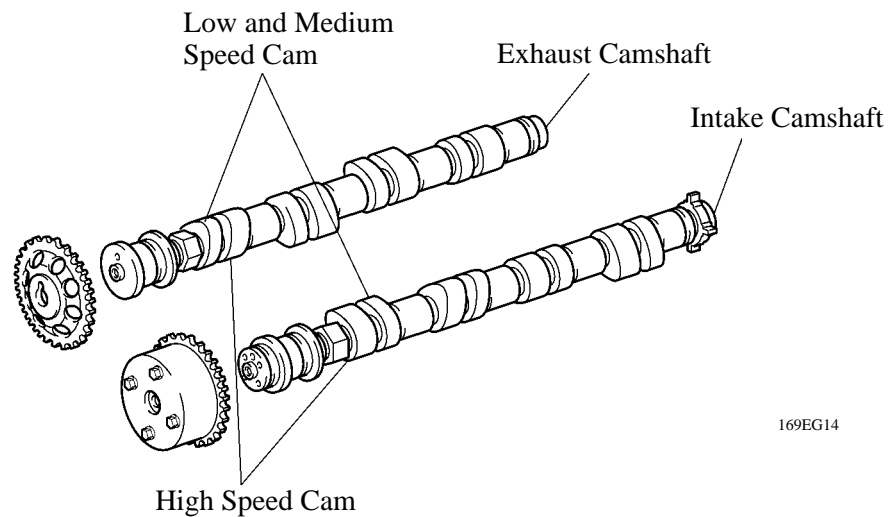
ENGINE – 1ZZ-FE AND 2ZZ-GE ENGINES

Construction and Operation

1) Cam Changeover Mechanism (Rocker Arm Type)

a. Construction

- A rocker arm type cam changeover mechanism has been adopted. The main components of the rocker arm type are the rocker arm, rocker arm pad, rocker arm pin, and the rocker shaft. This mechanism is provided for both the intake and exhaust camshafts, with each connected to its respective rocker arm shaft.
- Both the intake and exhaust camshafts contain low-and medium-speed cams and high-speed cams.



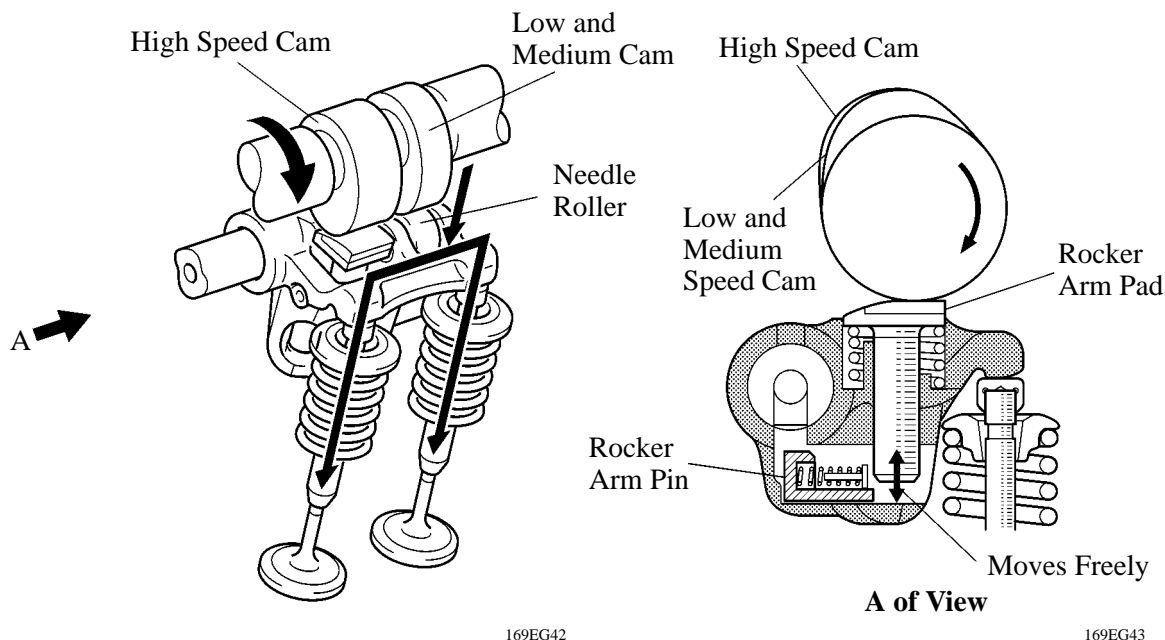
ENGINE – 1ZZ-FE AND 2ZZ-GE ENGINES

b. Operation

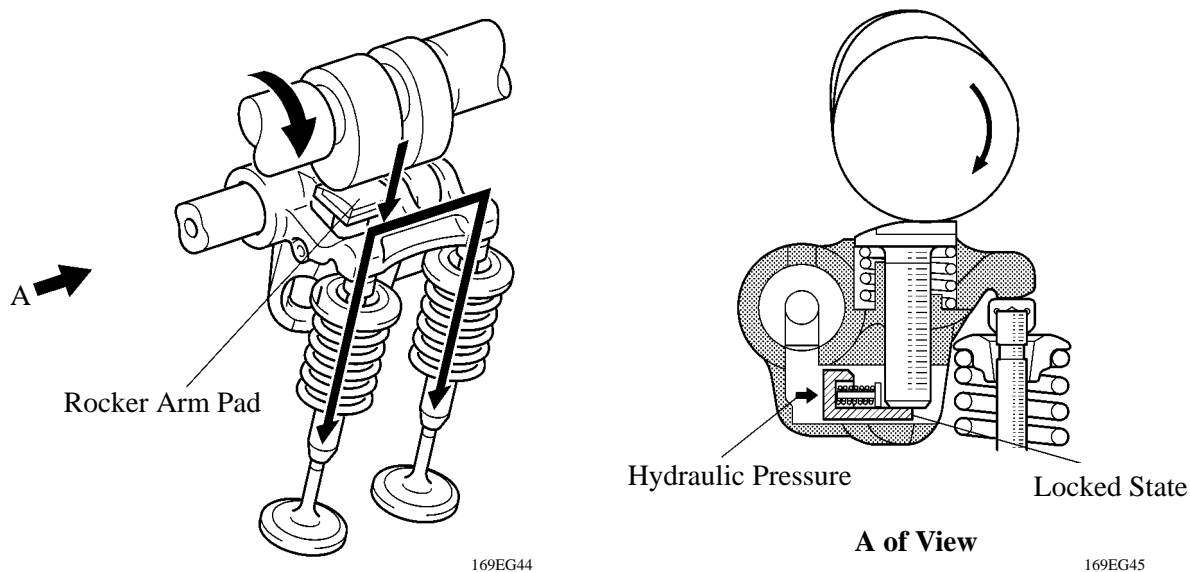
- When the engine coolant temperature is higher than 60°C and the engine speed is higher than 6000 rpm, this system changes the operation of the low-and medium-speed cams on the camshafts to the high-speed cams.

When the engine is operating in the low-to mid-speed range (below 6000 rpm), the low-and medium-speed cam pushes the needle roller of the rocker arm down to operate the two valves. At this time, the high-speed cam is also pushing down on the rocker arm pad, but because the rocker arm pad moves freely, this movement does not cause the rocker arm and the valves to move. Thereafter, when the engine reaches a high speed (over 6000 rpm), the hydraulic pressure pushes the rocker arm pin out to lock the bottom of the rocker arm pad. Because the high-speed cam has a greater cam lift than the low-and medium-speed cam, this time, the high-speed cam operates the two valves via the rocker arm pad and the rocker arm.

► Low and Medium Speed ◀



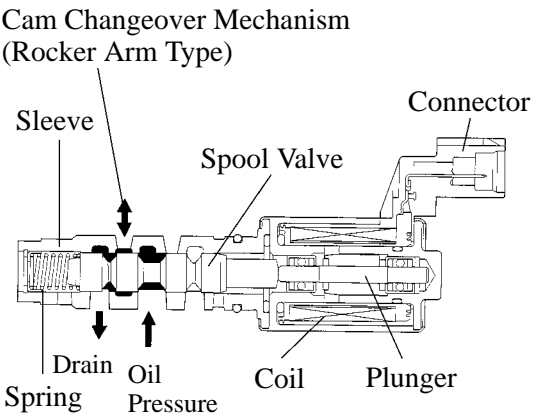
► High Speed ◀



ENGINE – 1ZZ-FE AND 2ZZ-GE ENGINES

2) Oil Control Valve (Variable Valve Timing and Lift)

The oil control valve (for the variable valve timing and lift) controls the spool valve position in accordance with the duty control from the ECM, thus allocating the hydraulic pressure that is applied to the high-speed cam side of the cam changeover mechanism.

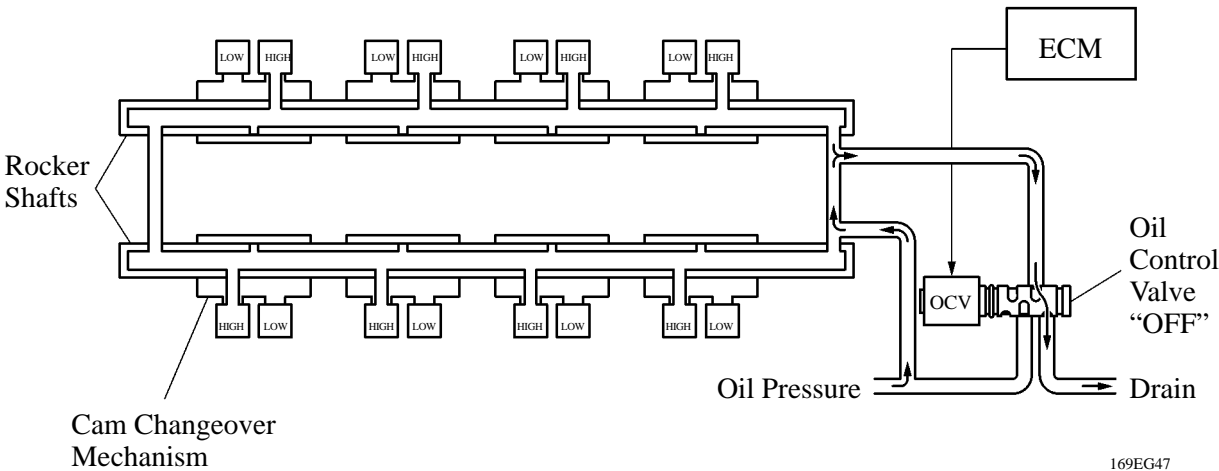


169EG46

3) Oil Pressure Control

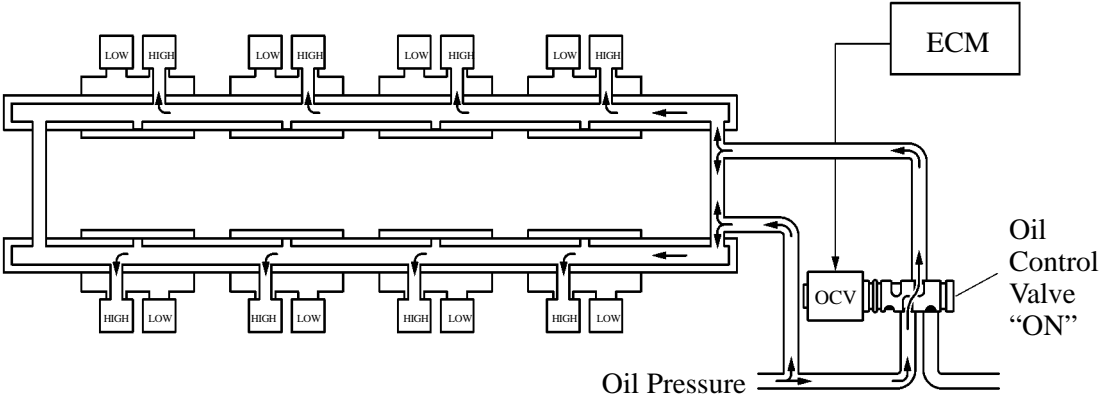
When the engine is operating in the low-to mid-speed range, the oil control valve opens on the drain side so that the oil pressure will not be applied to the cam changeover mechanism. Then, when the engine reaches a high speed, the oil control valve closes on the drain side in order to apply the oil pressure to the high-speed cam of the cam changeover mechanism.

► Low and Medium Speed ◀



169EG47

► High Speed ◀



169EG48

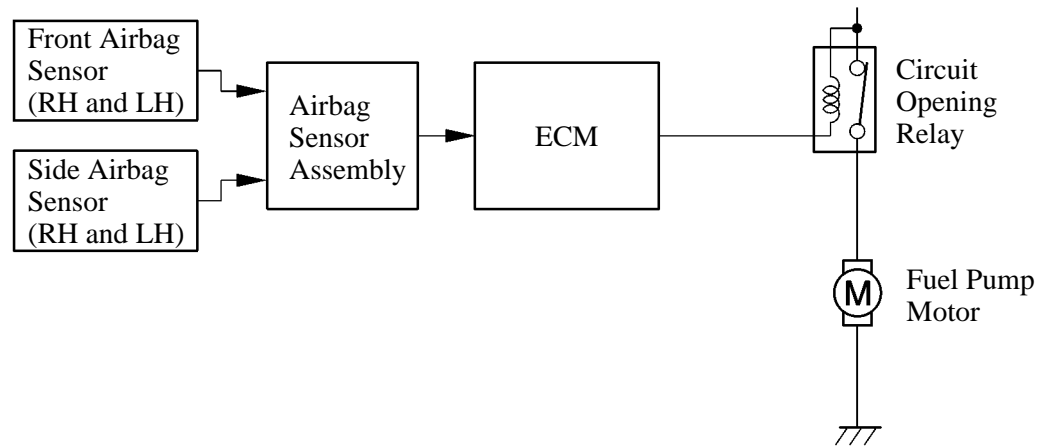
ENGINE – 1ZZ-FE AND 2ZZ-GE ENGINES

9. Fuel Pump Control

A fuel cut control has been adopted to stop the fuel pump when the SRS airbag is deployed, thus helping reduce fuel leakage.

In this system, the ECM detects the airbag deployment signal from the airbag sensor assembly and 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, thus engine can be restarted.



169EG28

ENGINE – 1ZZ-FE AND 2ZZ-GE ENGINES

10. Evaporative Emission Control System

The method for detecting evaporative emission leaks has been changed from the previous internal pressure monitor type to the vacuum type. The vacuum type forcefully introduces the purge vacuum into the entire system and a leak is detected by monitoring the transitions in pressure. The changes associated with this system are as follows:

- A VSV for canister closed valve has been added to the fresh air introduction line.
- The 3-way VSV for vapor pressure sensor has been discontinued, and a VSV for pressure switching valve has been added.
- The installed position of the vapor pressure sensor has been changed from the charcoal canister to the fuel tank in order to enhance the precision of the vapor pressure sensor.
- The fresh air valve characteristics of the charcoal canister have been changed.
- DTCs (Diagnostic Trouble Codes) have been added. For details on the DTCs, refer to the '00 CELICA Repair Manual (Pub. No. RM744U).

