■ENGINE CONTROL SYSTEM

1. General

The engine control system for the 1NZ-FE and 2NZ-FE engines have following features.

System	Outline	1NZ-FE	2NZ-FE	
			Unleaded	Leaded
EFI (Electronic Fuel Injection)	● An L-type EFI system directly detects the intake air mass with a hot-wire type air flow meter. ● The fuel injection system is a sequential multiport fuel injection system.	○	○	○
ESA (Electronic Spark Advance)	Ignition timing is determined by the engine ECU based on signals from various sensors. The engine ECU corrects ignition timing in response to engine knocking.	○	○	○
ETCS-i (Electronic Throttle Control System-intelligent) See page EG-133	Optimally controls the throttle valve opening angle in accordance with the amount of accelerator pedal effort and the condition of the engine and the vehicle.	○	○	○
	● A linkless-type is used without an accelerator. ● An accelerator pedal position sensor is provided on the accelerator pedal. ● A non-contact type throttle position sensor and accelerator pedal position sensor are used.	○	○	○
VVT-i (Variable Valve Timing-intelligent) See page EG-138	Controls the intake camshaft to an optimal valve timing in accordance with the engine condition.	○	○	–
Air Conditioner Cut-off Control*1	By turning the air conditioner compressor ON or OFF in accordance with the engine condition, drivability is maintained.	○	○	○
Cooling Fan Control See page EG-54	Cooling fan operation is controlled by signals from the engine ECU based on the water temperature sensor signal (THW) and the condition of the air conditioner operation.	○	○	–
Fuel Pump Control See page EG-55	● Fuel pump operation is controlled by signal from the engine ECU. ● The fuel pump is stopped when the SRS driver's and front passenger's airbags are deployed.	○	○	○
Heated Oxygen Sensor Heater Control	Maintains the temperature of the heated oxygen sensor at an appropriate level to increase accuracy of the oxygen concentration in the exhaust gas.	○	○	○
Evaporative Emission Control	The engine ECU controls the purge flow of evaporative emissions (HC) in the charcoal canister in accordance with engine conditions.	○	○	○
Starter Control (Cranking Hold Function) See page EG-56	Once the ignition switch is turned to the START position, this control continues to operate the starter until the engine is started	○	○	○

*1: Models with Air Conditioner

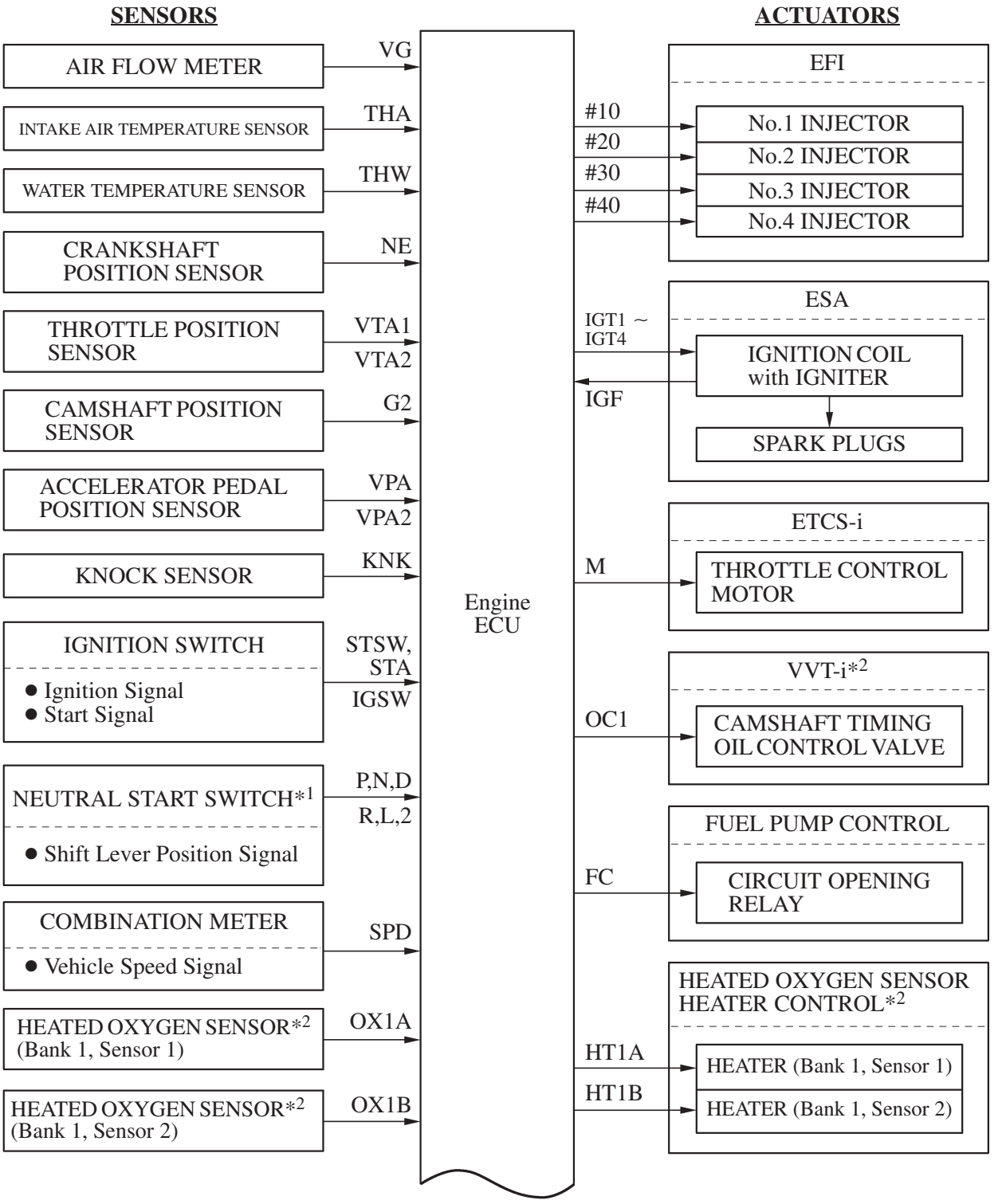
(Continued)

System	Outline	1NZ-FE	2NZ-FE	
			Unleaded	Leaded
Engine Immobilizer*2	Prohibits fuel delivery and ignition if an attempt is made to start the engine with an invalid ignition key.	○	○	○
Diagnosis See page EG-142	When the engine ECU detects a malfunction, the engine ECU diagnoses and memorizes the failed section.	○	○	○
Fail-safe See page EG-142	When the engine ECU detects a malfunction, the engine ECU stops or controls the engine according to the data already stored in memory.	○	○	○

*2: Models with Engine Immobilizer System

2. Construction

The configuration of the engine control system in the 1NZ-FE and 2NZ-FE engines is shown in the following chart.

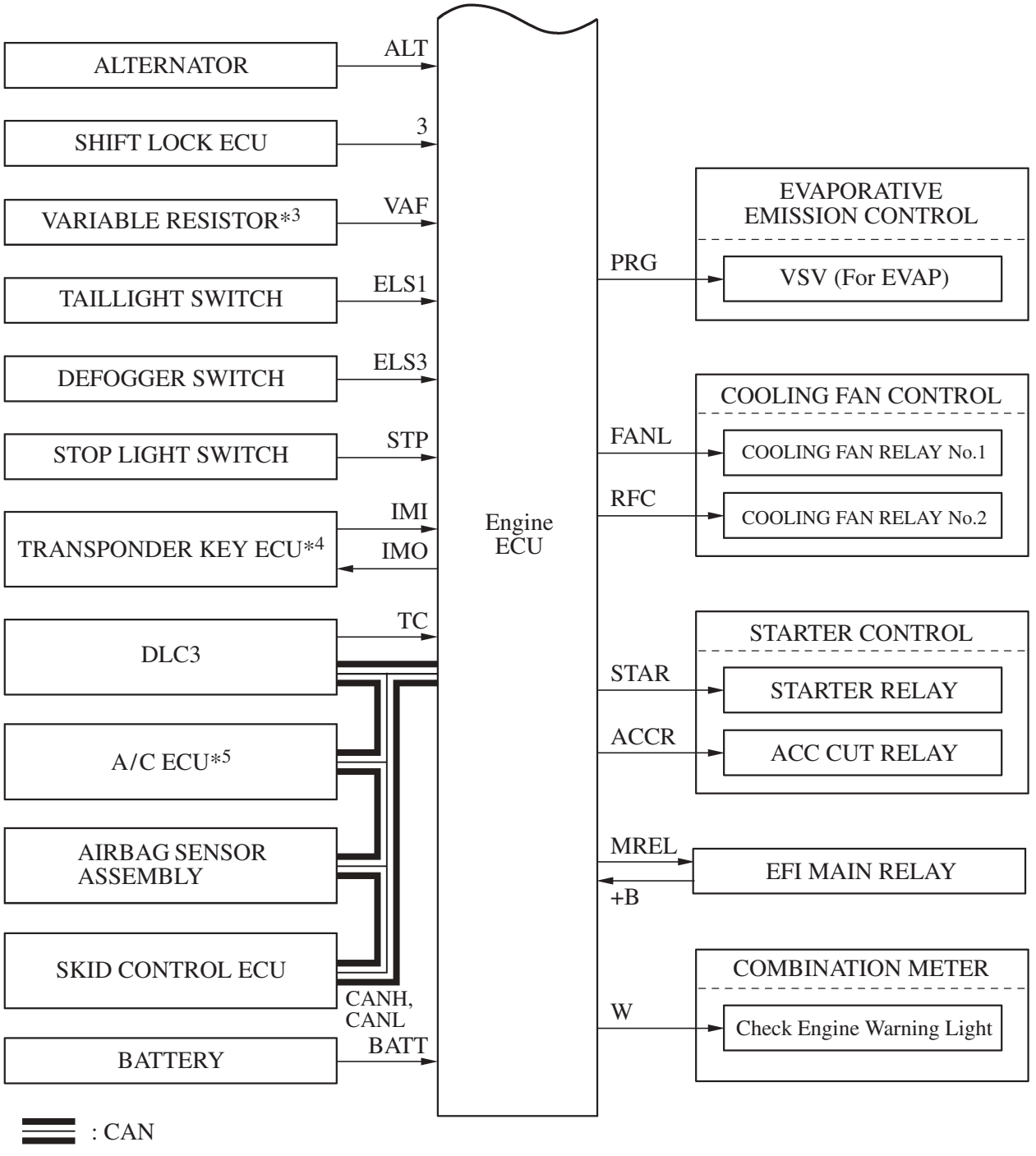


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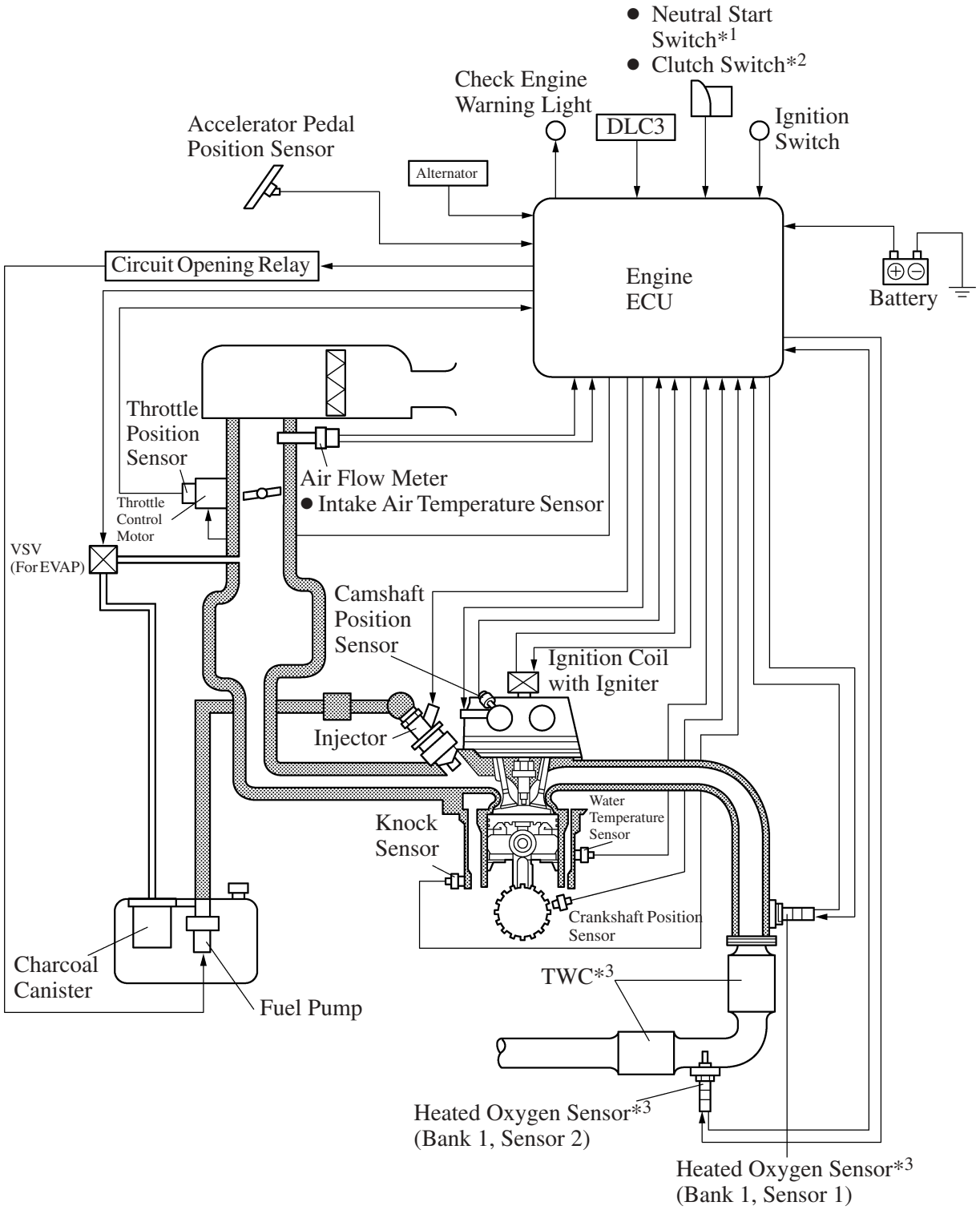
*1: A/T Models

*2: Unleaded Gasoline Models



*3: Leaded Gasoline Models
*4: Models with Engine Immobilizer System
*5: Models with Air Conditioner

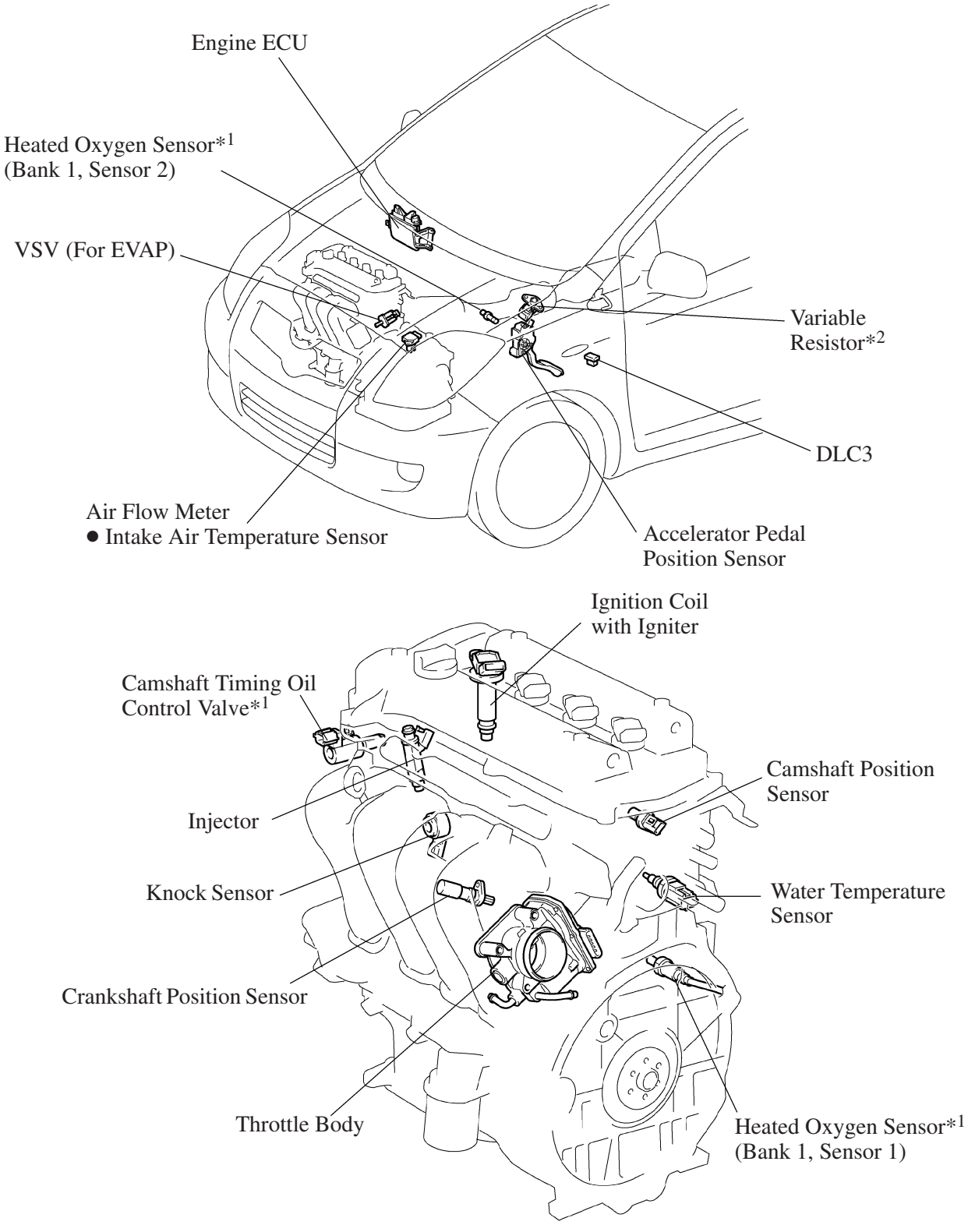
3. Engine Control System Diagram



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*1: A/T Models
*2: M/T Models
*3: Unleaded Gasoline Models

4. Layout of Main Components



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*1: Unleaded Gasoline Models
*2: Leaded Gasoline Models

5. Main Components of Engine Control System

General

The main components of the 1NZ-FE and 2NZ-FE engine control system are as follows:

Component	Outline	Quantity
Engine ECU	32-bit CPU	1
Air Flow Meter	Hot-wire Type	1
Crankshaft Position Sensor (Rotor Teeth)	Pickup Coil Type (36-2)	1
Camshaft Position Sensor (Rotor Teeth)	Pickup Coil Type (3)	1
Knock Sensor	Non-resonant Flat Type	1
Oxygen Sensor*1	with Heater	2
Throttle Position Sensor	Non-contact Type	1
Accelerator Pedal Position Sensor	Non-contact Type	1
Injector	12-hole Type*1 4-hole Type*2	4

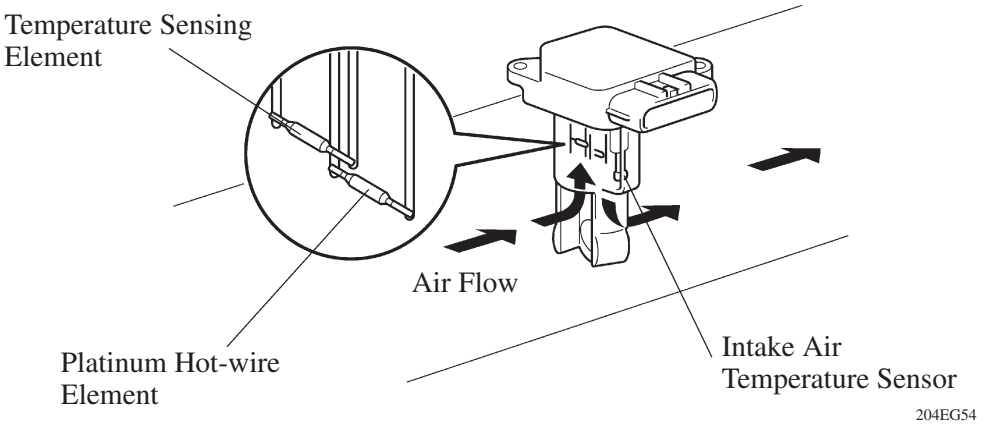
*1: Unleaded Gasoline Models
*2: Leaded Gasoline Models

Engine ECU

The 32-bit CPU of the engine ECU is used to increase the speed for processing the signals.

Air Flow Meter

- The compact and lightweight 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 high detection precision is achieved and the intake air resistance is reduced.
- This air flow meter has a built-in intake air temperature sensor.

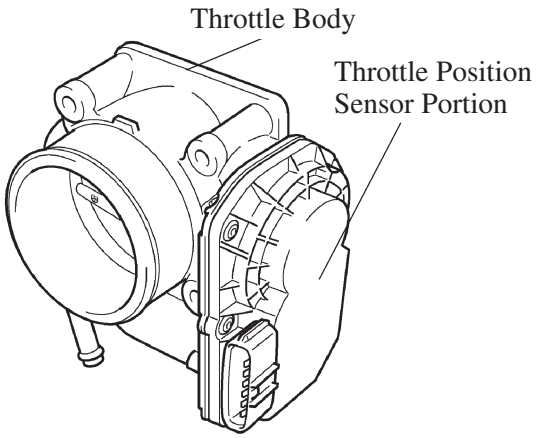


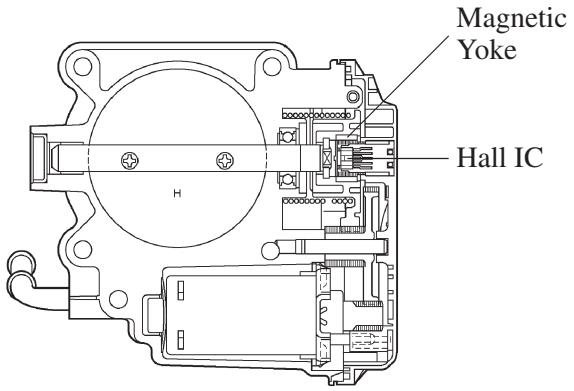
Accelerator Pedal Position Sensor

For details, see page EG-42 in the 1KR-FE engine section.

Throttle Position Sensor

The throttle position sensor is mounted on the throttle body to detect the opening angle of the throttle valve. The throttle position sensor converts the magnetic flux density that changes when the magnetic yoke (located on the same axis as the throttle shaft) rotates around the Hall IC into electric signals to operate the throttle control motor.

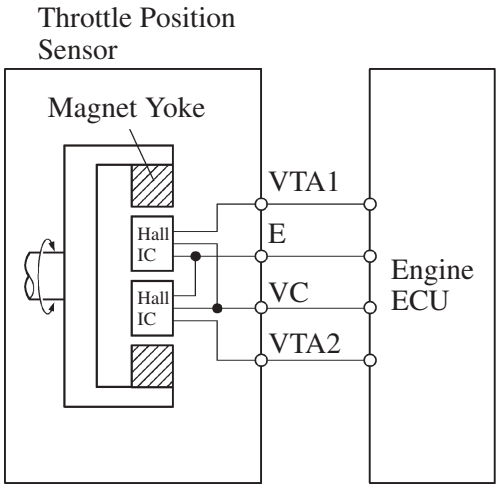




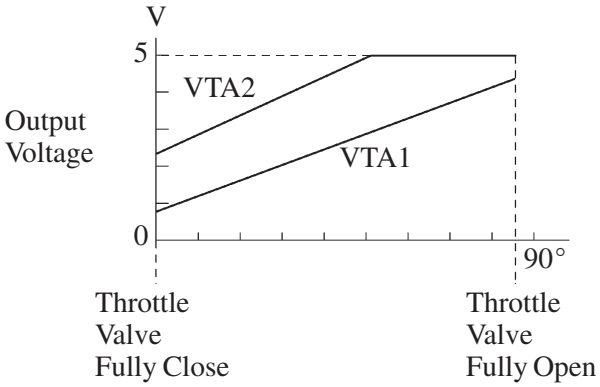
Cross Section

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▶ Characteristic of Throttle Position Sensor ◀



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Service Tip

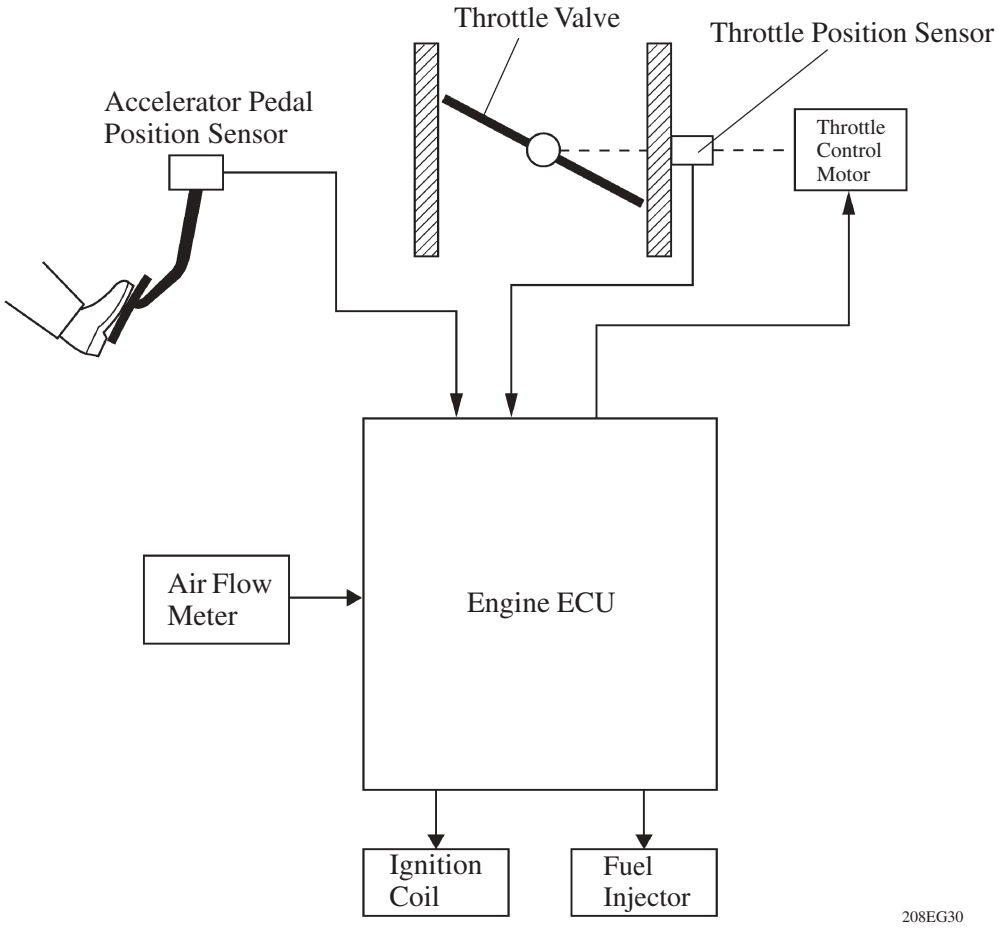
The inspection method differs from the conventional contact type throttle position sensor because this non-contact type sensor uses a Hall IC.
For details, refer to the Yaris Repair Manual (Pub. No. RM00S1E).

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

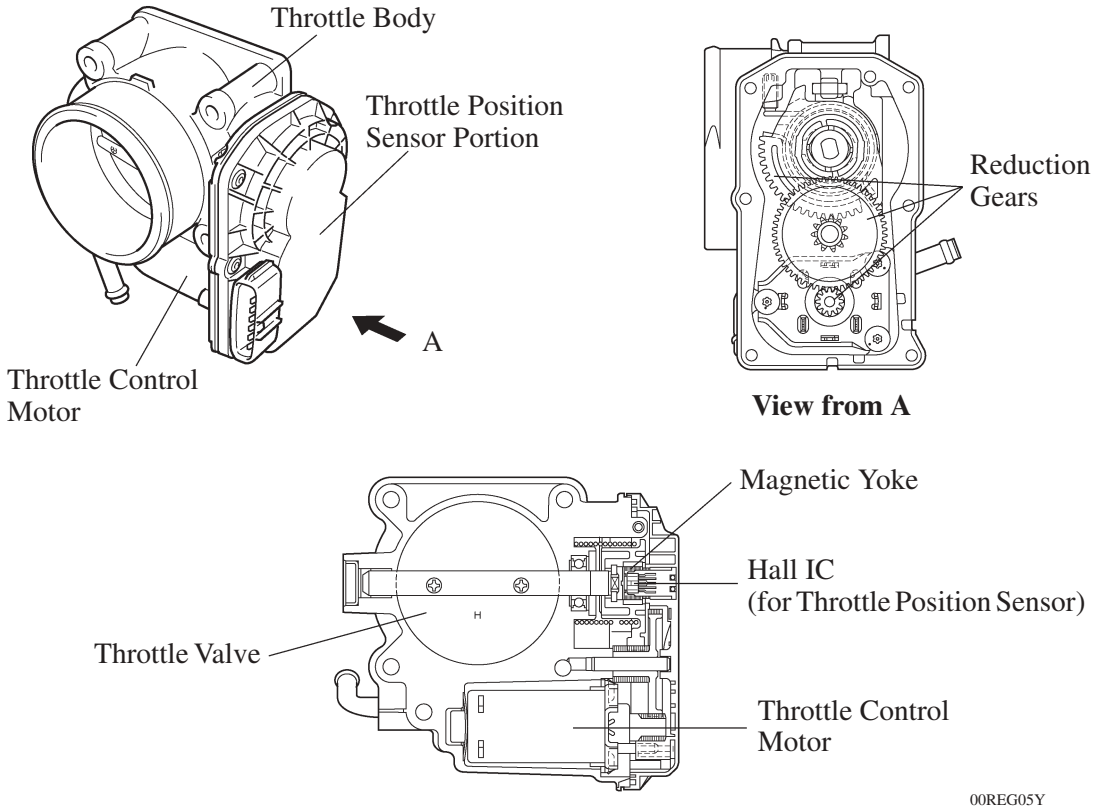
General

- The ETCS-i is used, providing excellent throttle control in all the operating ranges.
- 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 invariably by the amount of the accelerator pedal effort. In contrast, the ETCS-i uses the engine ECU 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.
- In case of an abnormal condition, this system switches to the limp mode.

▶ System Diagram ◀



Construction



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 engine ECU 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

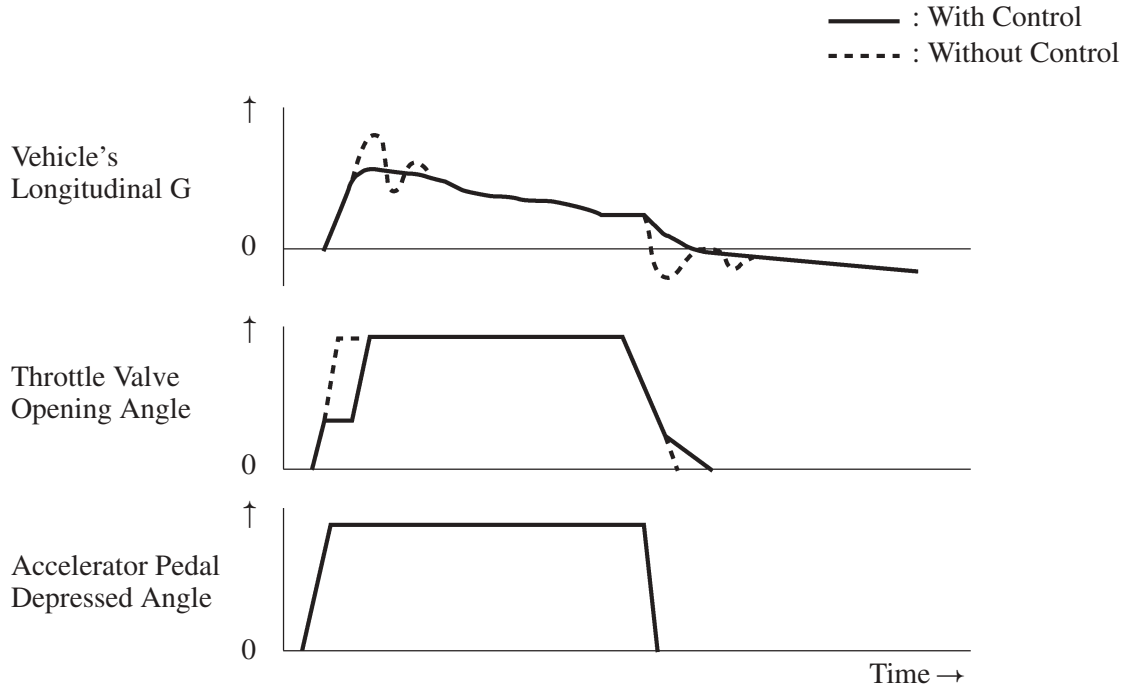
The engine ECU drives the throttle control motor by determining the target throttle valve opening angle in accordance with the respective operating condition.

- Non-linear Control
- Idle Speed Control

2) Non-linear Control

The enigne ECU controls the throttle valve to an optimal 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 ◀



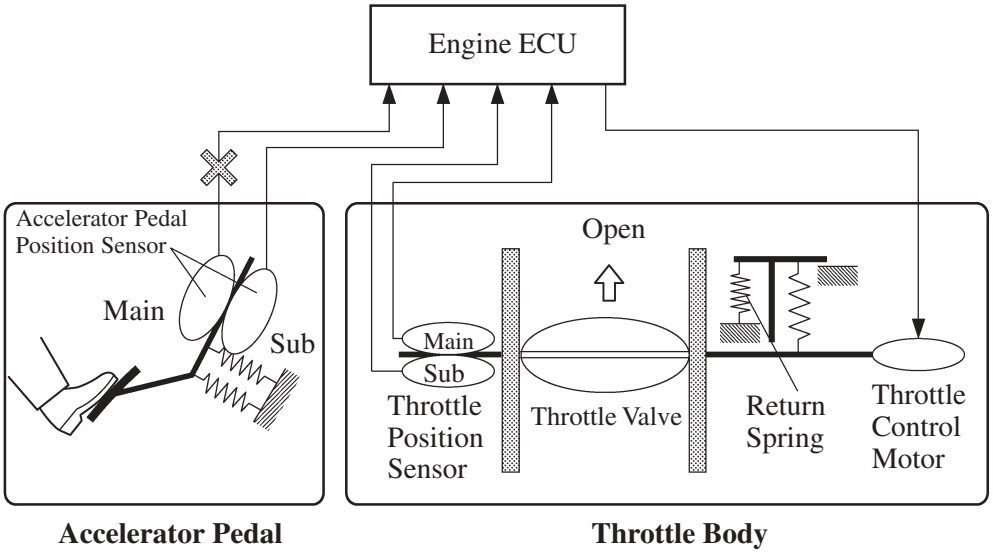
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3) Idle Speed Control

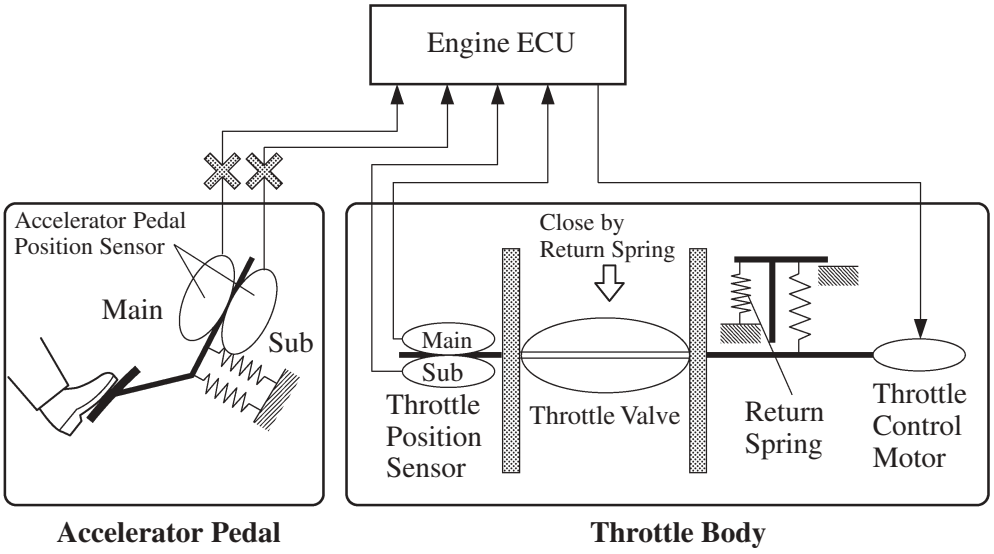
The engine ECU controls the throttle valve in order to constantly maintain an ideal idle speed.

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 engine ECU detects the abnormal signal by 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 limp mode control.

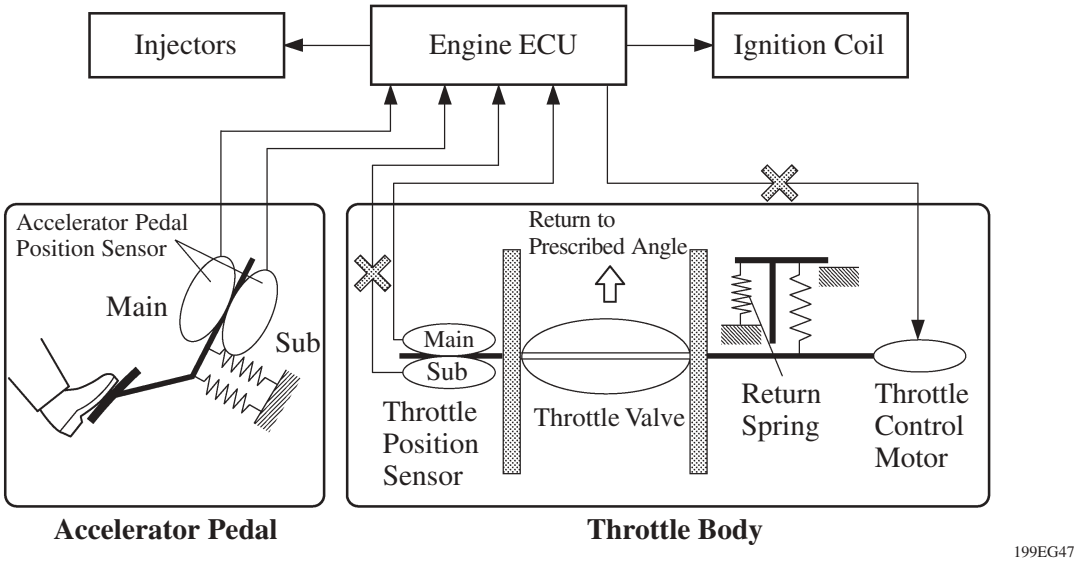


- If both circuits have a malfunction, the engine ECU detects the abnormal signal by voltage from these two sensor circuits and discontinues the throttle control. At this time, the vehicle can be driven within its idling range.



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 engine ECU detects the abnormal signal by 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 engine ECU detects a malfunction in the throttle control motor system.

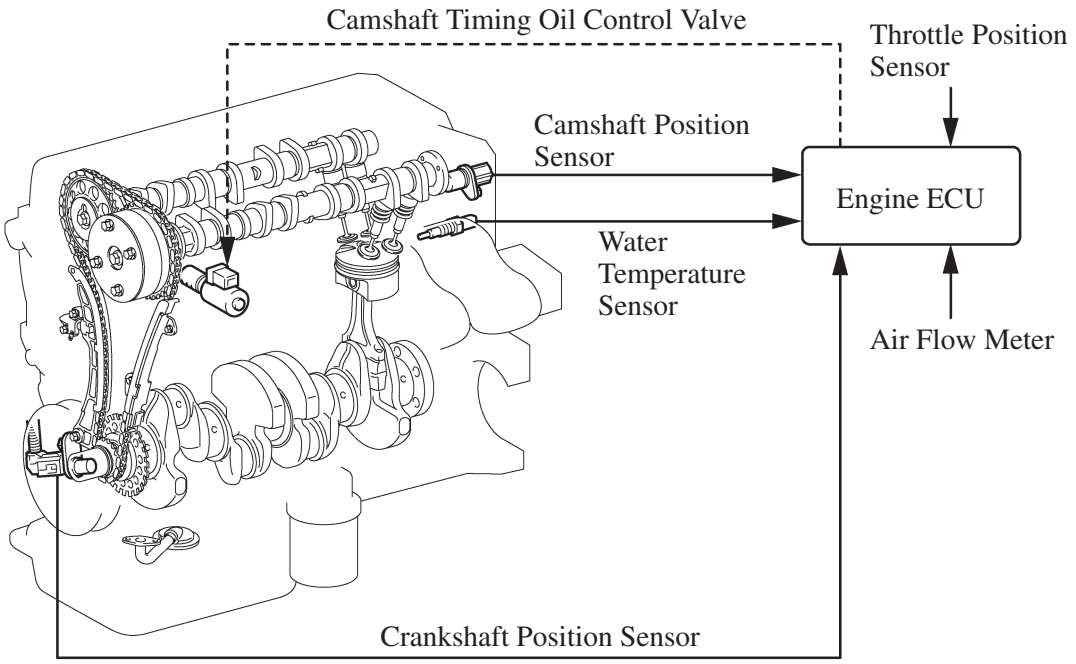


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7. VVT-i (Variable Valve Timing-intelligent) System

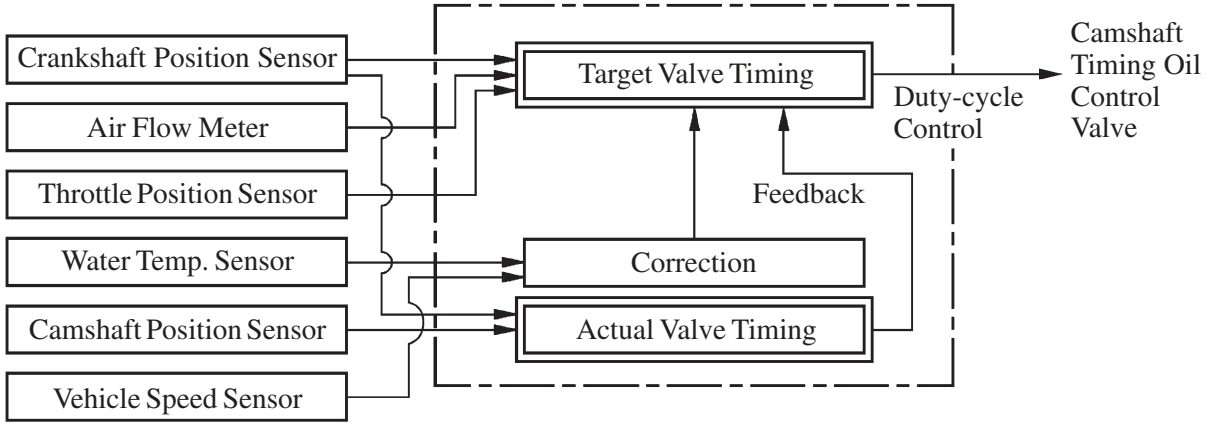
General

- 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 increasing fuel economy, and reducing exhaust emissions.



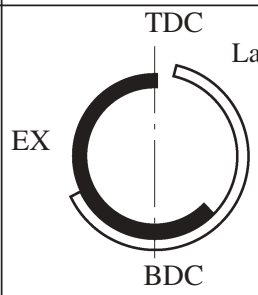
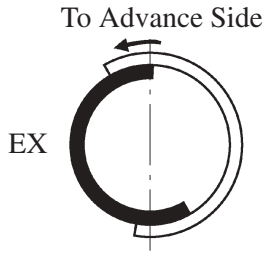
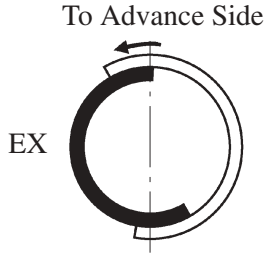
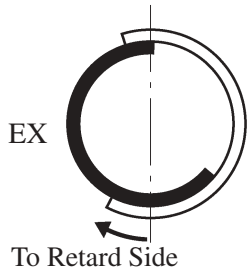
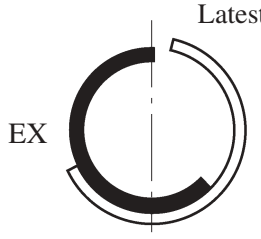
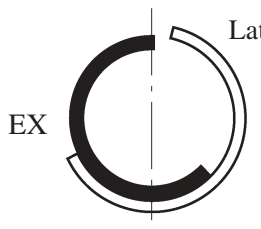
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- Using the engine speed signal, vehicle speed signal, and the signals from air flow meter, throttle position sensor and water temperature sensor, the engine ECU can calculate optimal valve timing for each driving condition and controls the camshaft timing oil control valve. In addition, the engine ECU 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.



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Effectiveness of the VVT-i System

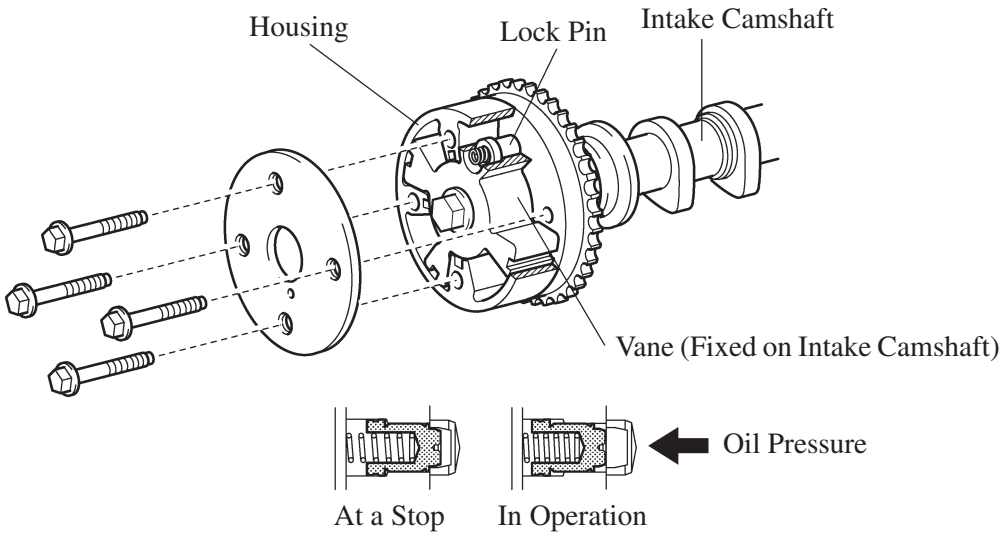
Operation State	Objective	Effect
● During Idling ● At Light Load	 Eliminating overlap to reduce blow back to the intake side.	● Stabilized idling rpm ● Better fuel economy
At Medium Load	 Increasing overlap to increase internal EGR to reduce pumping loss.	● Better fuel economy ● Improved emission control
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 Temperatures	 Eliminating overlap to prevent blow back to the intake side leads to the lean burning condition, and stabilizes the idling speed at fast idle.	● Stabilized fast idle rpm ● Better fuel economy
● Upon Starting ● Stopping the Engine	 Eliminating overlap to reduce blow back to the intake side.	Improved startability

EG

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.

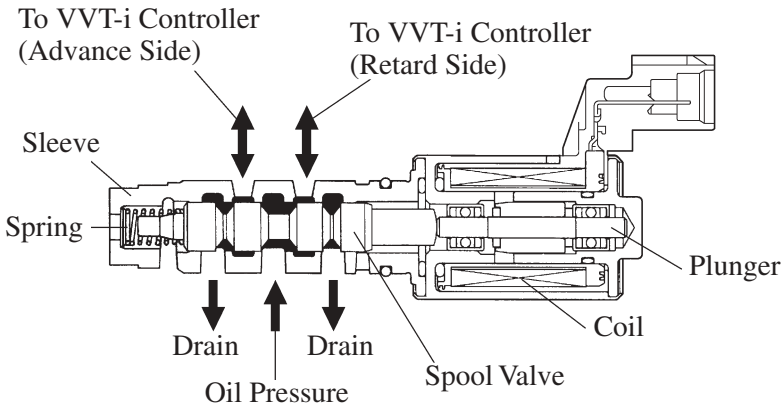


Lock Pin

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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 engine ECU. 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 retarded state.

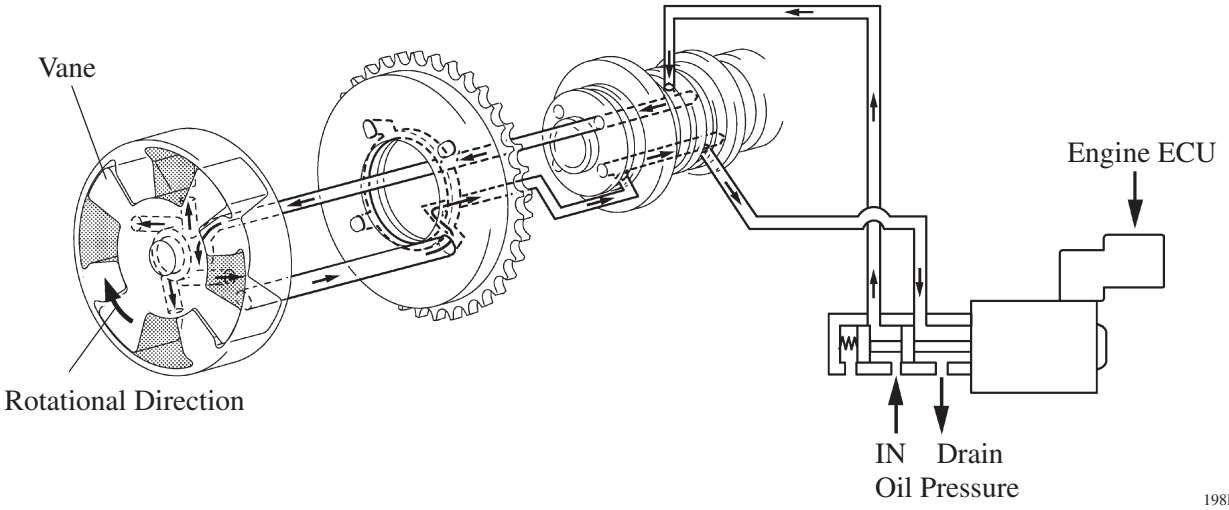


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Operation

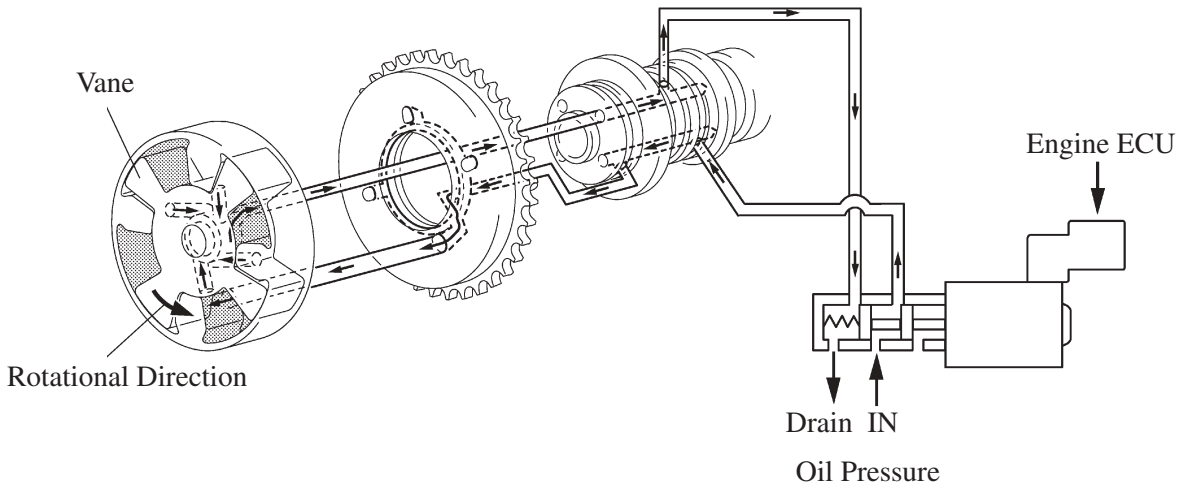
1) Advance

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



2) Retard

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



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. Diagnosis

- When the engine ECU detects a malfunction, the engine ECU makes a diagnosis and memorizes the failed section. Furthermore, the check engine warning light in the combination meter illuminates or blinks to inform the driver.
- By using the intelligent tester II, the 5-digit DTCs (Diagnostic Trouble Codes) and ECU data can be read out. Moreover, the ACTIVE TEST can be used to drive the actuator by means of the intelligent tester II.
- The engine ECU can output freeze-frame data to the intelligent tester II. This data is stored in the engine ECU at the very moment when the engine ECU detects its last data of malfunction.
- All the DTCs have been made to correspond to the SAE controlled codes. Some of the DTCs have been further divided into smaller detection areas than in the past, and new DTCs have been assigned to them. For details, refer to the Yaris Repair Manual (Pub. No. RM00S1E).

Service Tip

To clear the DTC that is stored in the engine ECU, use the intelligent tester II, and disconnect the battery terminal or remove the EFI fuse for 1 minute or longer.

9. Fail-safe

When a malfunction is detected by any of the sensors, there is a possibility of an engine or another malfunction occurring if the ECU were to continue to control the engine control system in the normal way. To prevent such a problem, the fail-safe function of the ECU 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 Yaris Repair Manual (Pub. No. RM00S1E).