## ■ENGINE CONTROL SYSTEM

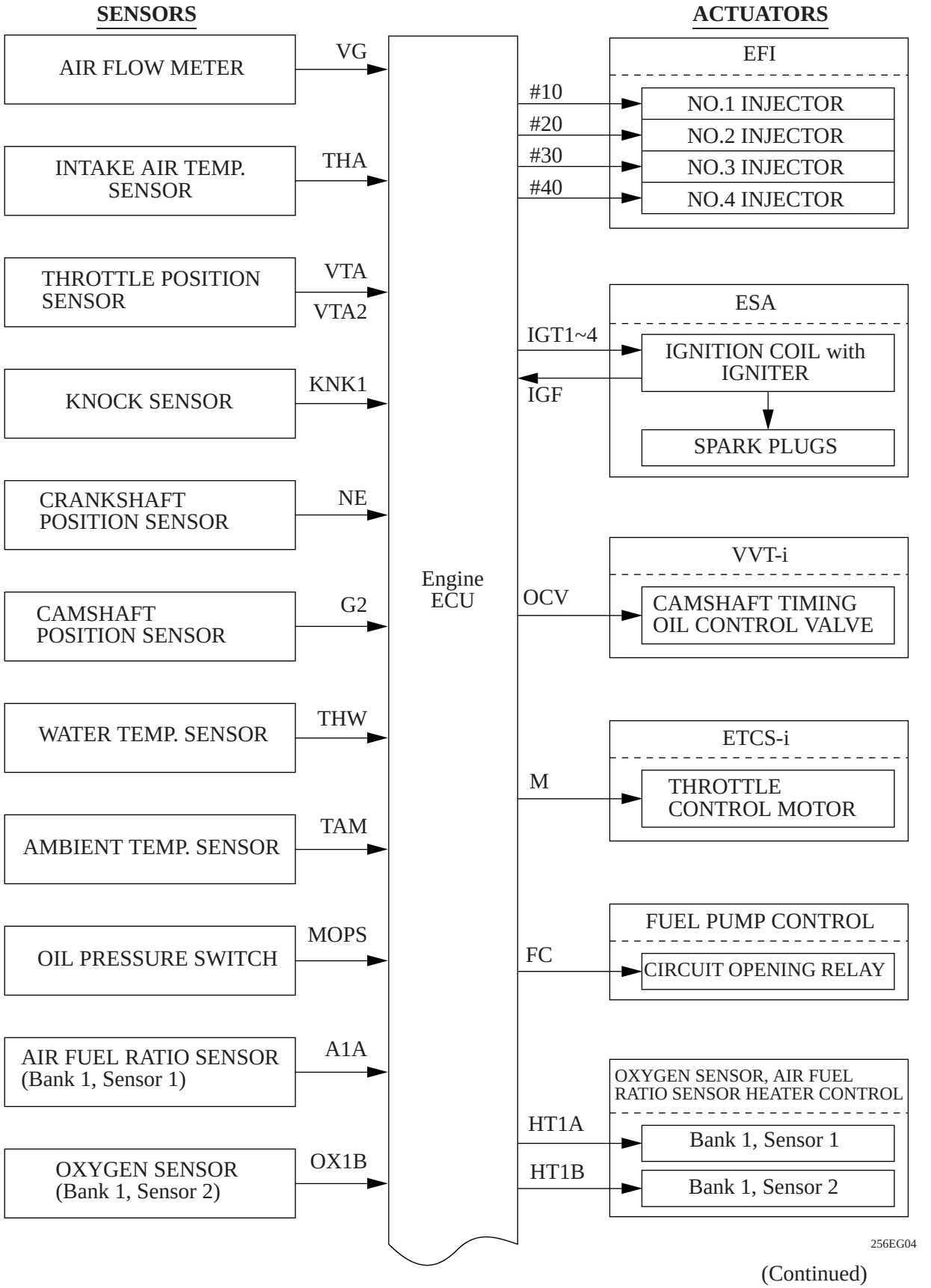
### 1. General

The engine control system of the 1NZ-FXE engine on the new Prius has following system.

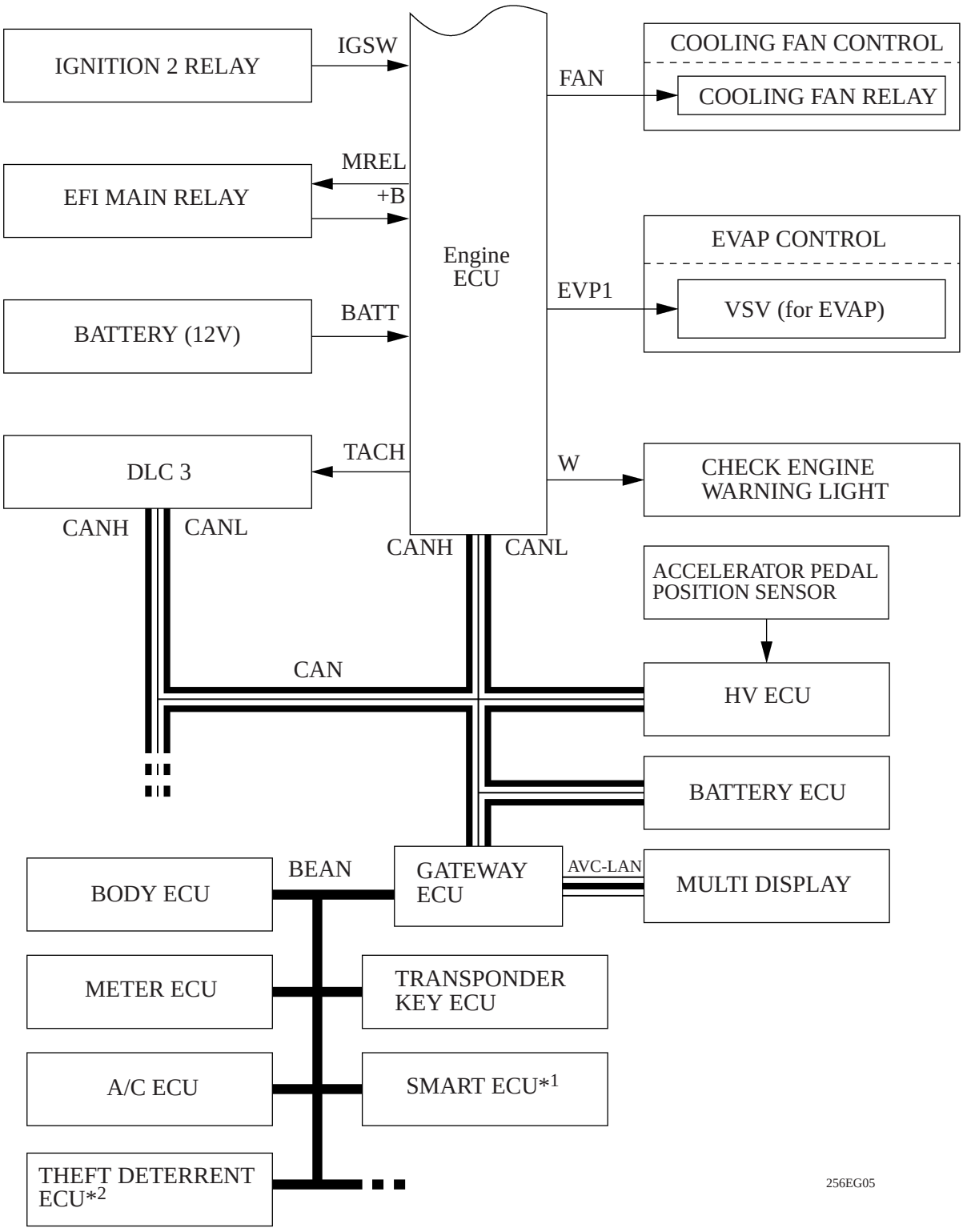
| System | Outline | New | Previous |
|---|---|---|---|
| EFI (Sequential Multiport Fuel Injection) | An L-type EFI system directly detects the intake air mass with a hot wire type mass air flow meter. | ○ | ○ |
| ESA (Electronic Spark Advance) | Ignition timing is determined by the engine ECU based on signals from various sensors. The engine ECU corrects ignition timing in response to engine knocking. | ○ | ○ |
| ETCS-i (Electronic Throttle Control System-intelligent) | The engine ECU optimally controls the throttle valve opening in accordance with the engine conditions and the ETCS-i control request received from the HV ECU. | ○ | ○ |
| VVT-i (Variable Valve Timing-intelligent) | Controls the intake camshaft to an optimal valve timing in accordance with the engine conditions and the control request received from the HV ECU. | ○ | ○ |
| | The maximum retard closing timing of the intake valve has been changed from 115° to 105° ABDC (After Bottom-Dead-Center). As a result, the cold-starting performance of the engine has been improved. | ○ | — |
| Air Fuel Ratio Sensor, Oxygen Sensor Heater Control | Maintains the temperature of the air fuel ratio sensor or oxygen sensor at an appropriate level to increase accuracy of detection of the oxygen concentration in the exhaust gas. | ○ | ○ |
| Fuel Pump Control | • Fuel pump operation is controlled by signal from the engine ECU.<br>• A fuel cut control is adopted to stop the fuel pump when the airbag is deployed during front or side collision. | ○ | ○ |
| Air Conditioner Cut-off Control | By turning the air conditioner compressor ON or OFF in accordance with the engine condition, drivability is maintained. | — | ○ |
| Cooling Fan Control | The engine ECU steplessly controls the speed of the fans in accordance with the engine coolant temperature, vehicle speed, engine speed, and air conditioning operating conditions. As a result, the cooling performance has been improved. | ○ | ○ |
| Evaporative Emission Control | The engine ECU controls the purge flow of evaporative emission (HC) in the charcoal canister in accordance with engine conditions. | ○ | ○ |
| HV Immobiliser | Prohibits fuel delivery, ignition, and starting the hybrid system if an attempt is made to start the hybrid system with an invalid card key (ignition key). | ○ | ○ |
| Diagnosis (See page EG-20) | When the engine ECU detects a malfunction, the engine ECU diagnoses and memorizes the failed section. | ○ | ○ |
| | All the DTCs (Diagnostic Trouble Codes) have been made to correspond to the SAE controlled codes. | ○ | — |
| Fail-Safe (See page EG-20) | When the engine ECU detects a malfunction, the engine ECU stops or controls the engine according to the data already stored in the memory. | ○ | ○ |

## 2. Construction

The configuration of the engine control system in the 1NZ-FXE engine is shown in the following chart.




(Continued)

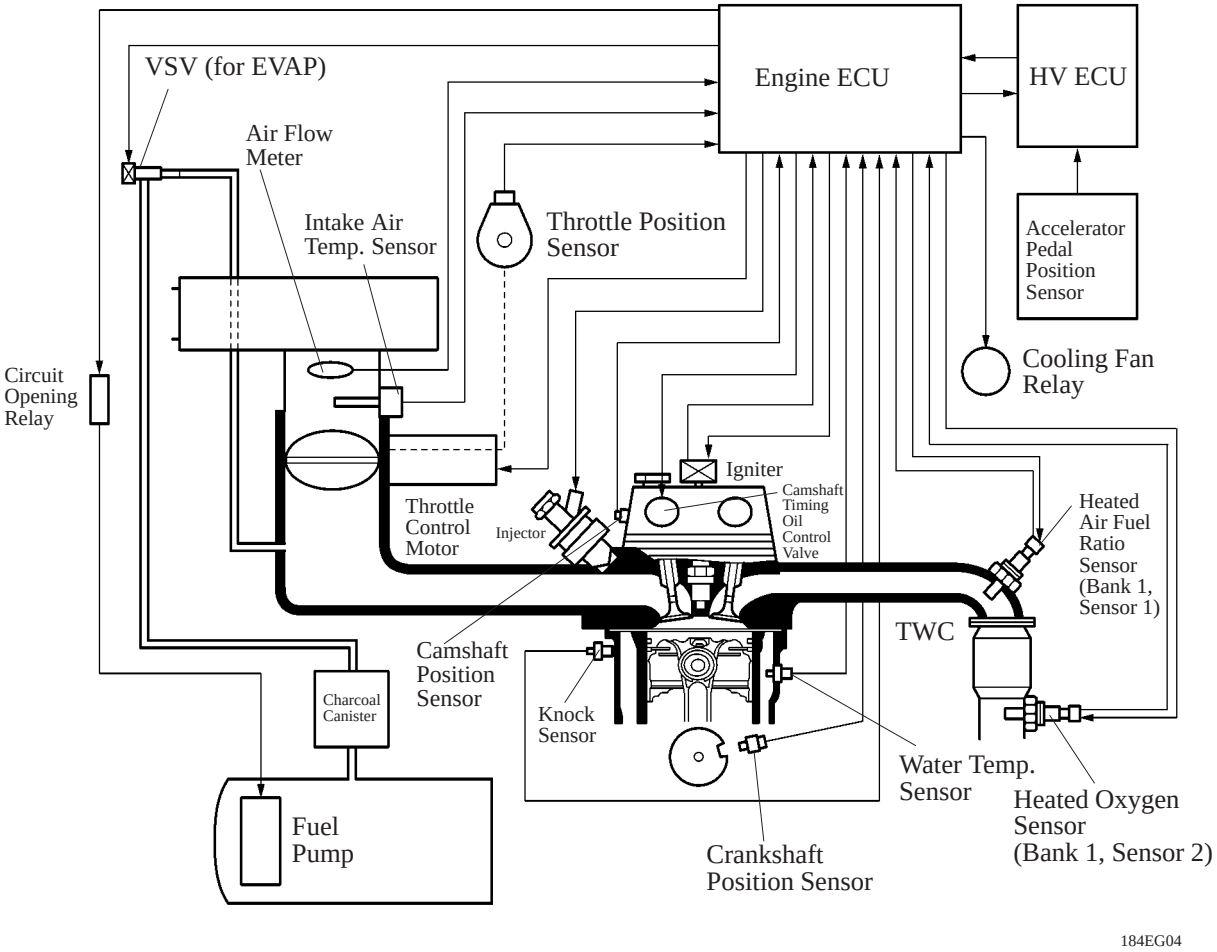



*1: Models with Smart Entry & Start System
*2: Only for European RHD Model

**▶ MPX Communication ◀**

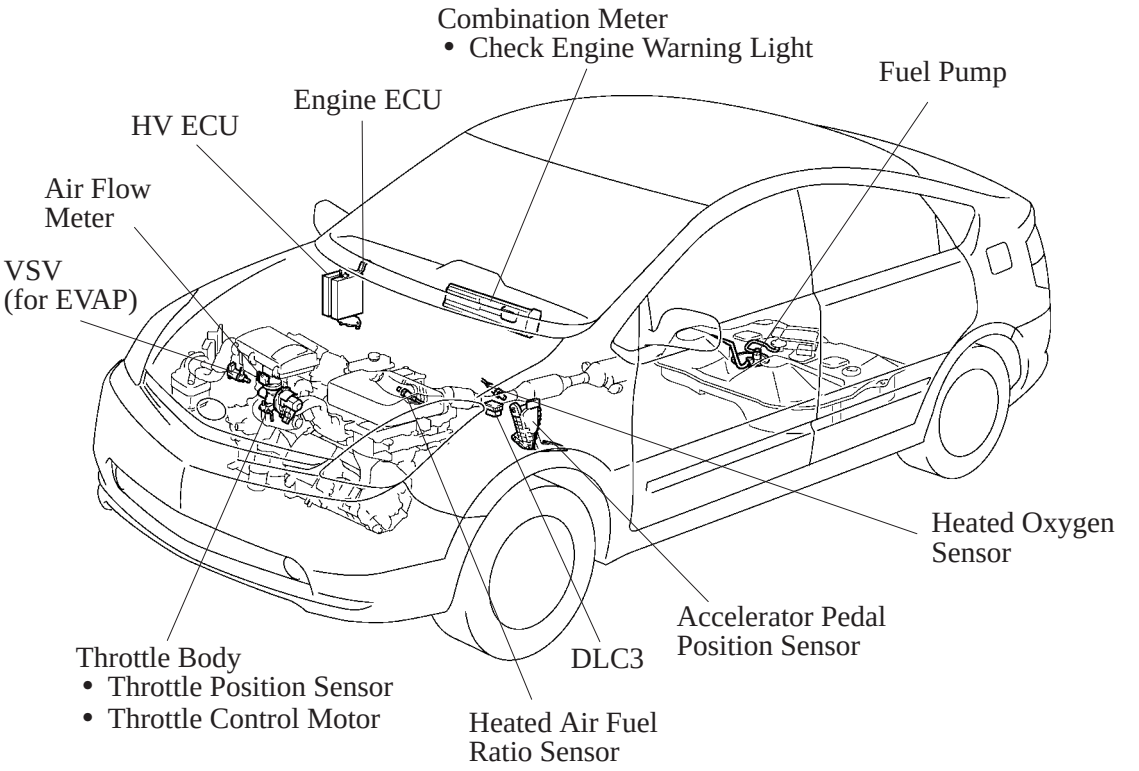
| Type | ECU | Signals Exchanged with Engine ECU | |
|---|---|---|---|
| | | Transmission Signals | Reception Signals |
| CAN | HV ECU | • Inspection mode<br>• Required engine motive force<br>• Fuel cut request<br>• Target engine speed<br>• Forced cranking request<br>• Forced A/F (Air Fuel Ratio) learning authorization<br>• MIL illumination request<br>• Radiator fan actuation request<br>• Shift condition<br>• READY condition<br>• Engine start request | • Inspection mode<br>• Engine brake request<br>• Fuel cut request<br>• Target engine speed<br>• Forced cranking request<br>• Forced A/F (Air Fuel Ratio) learning authorization<br>• MIL illumination request<br>• Radiator fan actuation request<br>• Shift condition<br>• READY condition<br>• Engine start request |
| | Battery ECU | — | • Crankshaft position sensor failure<br>• Water temperature sensor failure<br>• TWC warm-up request<br>• Engine speed |
| BEAN | Body ECU | — | • Engine speed<br>• Test mode |
| | Meter ECU | • Fuel Sender Gauge Level | • Water temperature sensor<br>• Engine speed<br>• Fuel injection volume<br>• Engine oil pressure switch<br>• Test mode |
| | A/C ECU | — | • Water temperature sensor<br>• Engine speed<br>• Ambient temperature sensor |
| | Transponder Key ECU | — | • Engine speed |
| | Smart ECU | — | • Engine speed |
| | Theft Deterrent ECU | — | • Engine speed |
| AVC-LAN | Multi Display | — | • Water temperature sensor<br>• Engine oil pressure switch<br>• Test mode |

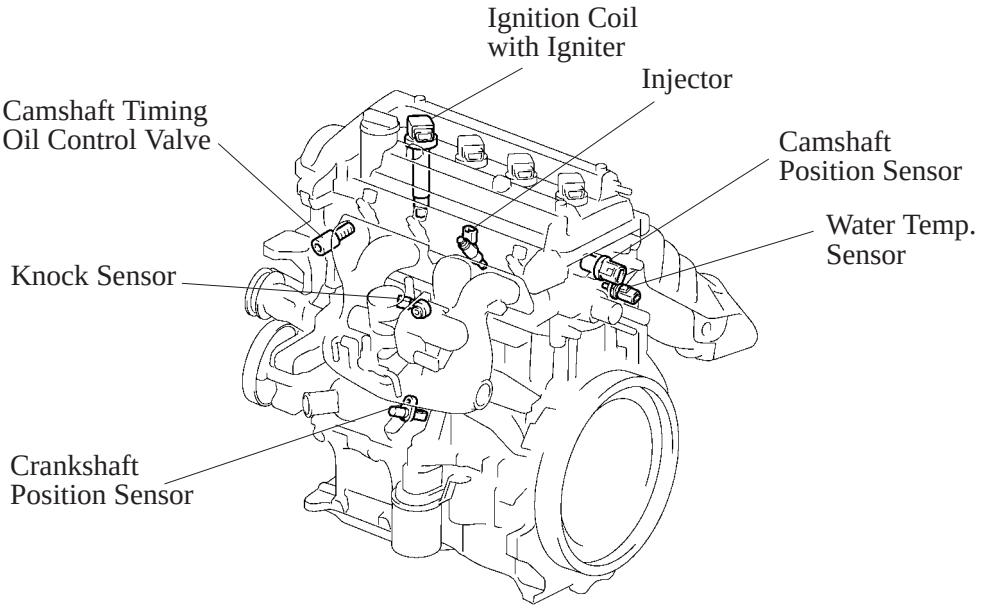
## 3. Engine Control System Diagram




EG

## 4. Layout of Main Components




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**LHD Model**

## 5. Main Components of Engine Control System

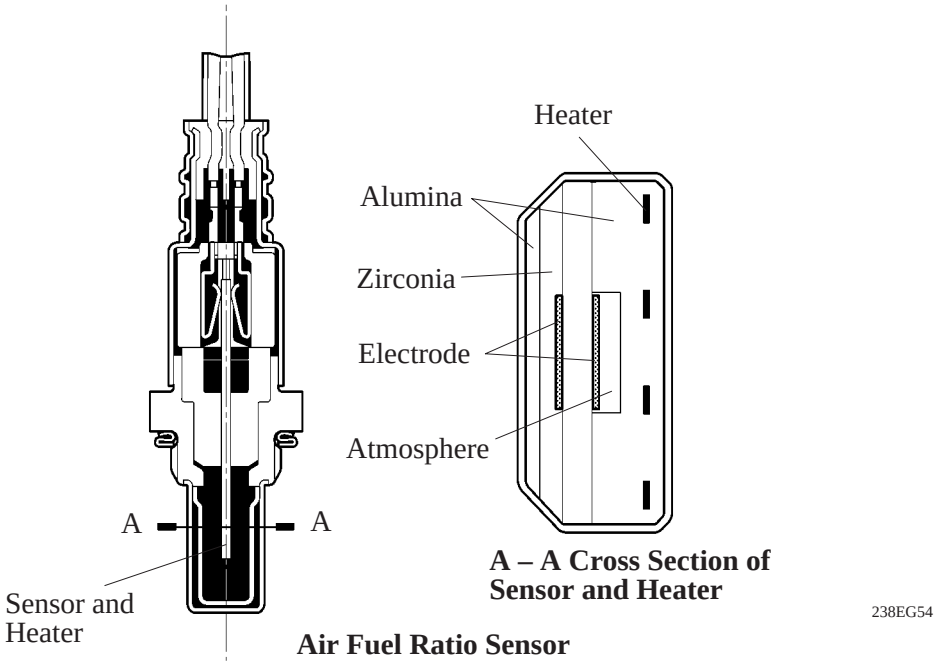
### General

The following table compares the main components.

| Components | New Prius | | Previous Prius | |
|---|---|---|---|---|
| | Outline | Quantity | Outline | Quantity |
| Engine ECU | 32-bit CPU | 1 | 16-bit CPU | 1 |
| Air Fuel Ratio Sensor | with Heater Type (Planar Type) | 1 | — | |
| Oxygen Sensor | with Heater Type (Cup Type) | 1 | with Heater Type (Cup Type) | 2 |
| 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) | 2 | ← | |
| Knock Sensor | Built-in Piezoelectric Type (Flat Type) | 1 | Built-in Piezoelectric Type (Conventional Type) | 1 |
| Throttle Position Sensor | Linear Type | 1 | ← | |
| Injector | 12-Hole Type | 4 | ← | |

### Air Fuel Ratio Sensor

The air-fuel ratio sensor is the planar type. Compared to the conventional type (cup type), the sensor and heater portions of the planar type are narrower overall. Because the heat of the heater acts directly on the alumina and zirconia (of the sensor portion) it accelerates the activation of the sensor.




**Air Fuel Ratio Sensor**

EG

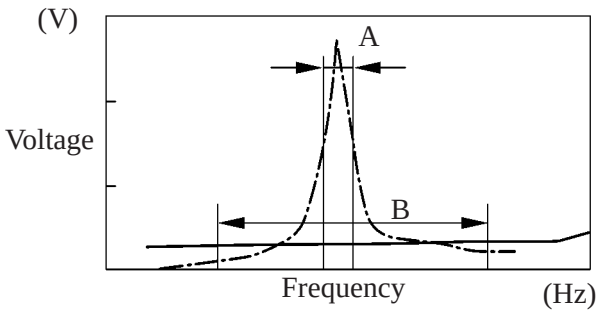
## Knock Sensor (Flat Type)

### 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



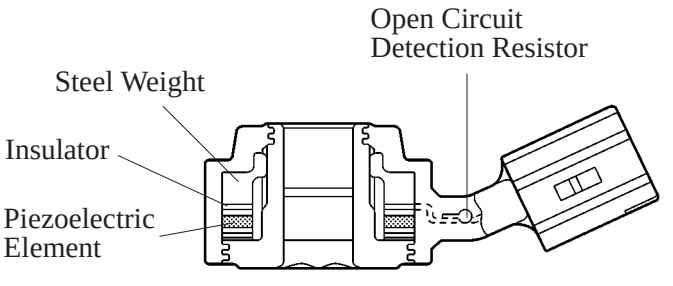

A: Detection Band of Conventional Type
B: Detection Band of Flat Type

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**Characteristic of Knock Sensor**

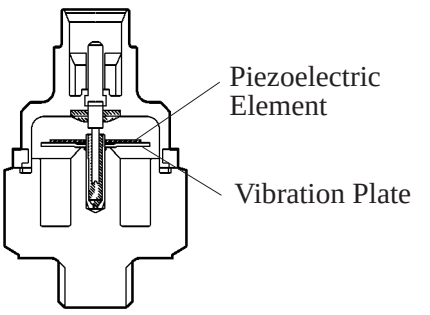
### 2) Construction

- 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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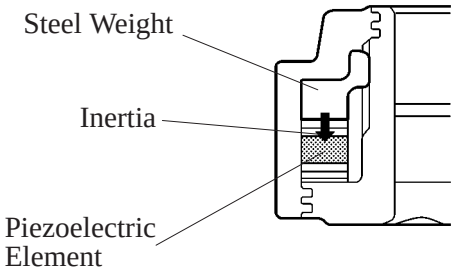



**Conventional Type Knock Sensor (Resonant Type)**

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### 3) Operation

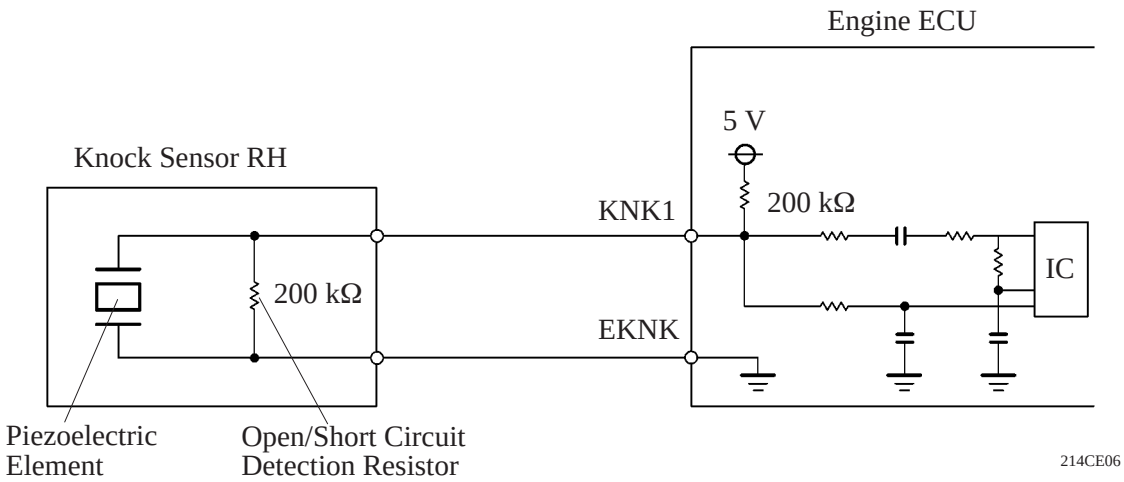
The knocking vibration is transmitted to the steel weight and its inertia applies pressure to the piezoelectric element. The action generates electromotive force.




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### 4) Open/Short Circuit Detection Resistor

When the ignition is ON, the open/short circuit detection resistor in the knock sensor and the resistor in the engine ECU keep the voltage at the terminal KNK1 of engine constant.
An IC (Integrated Circuit) in the engine ECU is always monitoring the voltage of the terminal KNK1. If the open/short circuit occurs between the knock sensor and the engine ECU, the voltage of the terminal KNK1 will change and the engine ECU detects the open/short circuit and stores DTC (Diagnostic Trouble Code).




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**Service Tip**

In accordance with the adoption of open/short circuit detection resistor, the inspection method for the sensor has been changed. For details, refer to Prius Repair Manual (Pub. No. RM1076E).

EG

## 6. 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.
- The engine ECU will also store the DTCs of the malfunctions.
- The diagnosis communication has been changed from serial communication (ISO9141) to CAN communication. Accordingly, a newly adopted Intelligent Tester II is required for reading the DTCs of the engine ECU. For details, see the Prius Repair Manual (Pub. No. RM1076E).
- All the DTCs (Diagnostic Trouble Codes) 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 Prius Repair Manual (Pub. No. RM1076E).

**Service Tip**

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

## 7. Fail-Safe

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

**▶ Fail-Safe Chart ◀**

| DTC No. | Fail-Safe Operation | Fail-Safe Deactivation Conditions |
|---|---|---|
| P0031, P0032, P0037, P0038 | The heater circuit in which the abnormality is detected is turned off | Power switch OFF |
| P0100, P0102, P0103 | Ignition timing is calculated from engine speed and a throttle angle | “Pass” condition detected |
| P0110, P0112, P0113 | Intake air temp. is fixed at 20°C (68°F) | “Pass” condition detected |
| P0115, P0117, P0118 | Engine coolant temp. is fixed at 80°C (176°F) | “Pass” condition detected |
| P0120, P0122, P0123 | Fuel cut intermittently | Power switch OFF |
| P0121 | Fuel cut intermittently | “Pass” condition detected and power switch OFF |
| P0325 | Max. ignition timing retardation | Power switch OFF |
| P0351, P0352, P0353, P0354 | Fuel cut | “Pass” condition detected |
| P2102, P2103 | VTA is fixed at about 16% and fuel cut intermittently | Power switch OFF |
| P2119 | VTA is fixed at about 16% and fuel cut intermittently | “Pass” condition detected and power switch OFF |