■ENGINE CONTROL SYSTEM

1. General

- In addition to the EFI (Electronic Fuel Injection) system and the ESA (Electronic Spark Advance) system, the engine control system has adopted the ETCS-i (Electronic Throttle Control System-intelligent) to ensure excellent controllability of the vehicle and improve its comfort.
- The M-OBD (Multiplex On-Board Diagnostic) system has been adopted to improve serviceability.
- The cruise control system and engine immobiliser system have been integrated with engine ECU.

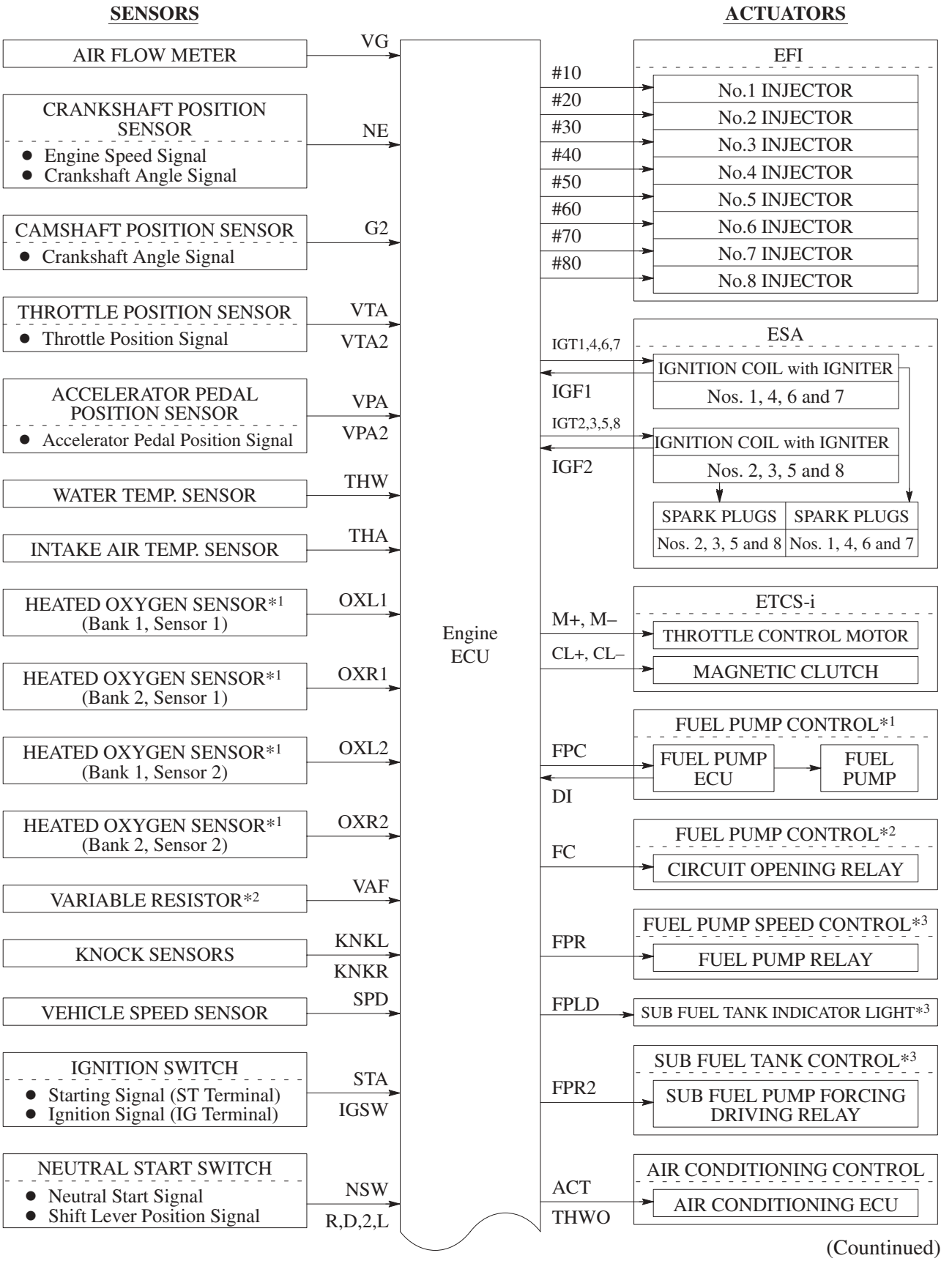
The engine control system for the 2UZ-FE engine has following system.

System	Outline
EFI (Electronic Fuel Injection)	● A L-type EFI system directly detects the intake air volume 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. Corrects ignition timing in response to engine knocking. ● The torque control correction during gear shifting has been used to minimize the shift shock. ● 2 knock sensors are used to further improve knock detection.
ETCS-i (Electronic Throttle Control System-intelligent)	Optimally controls the throttle valve opening in accordance with the amount of the accelerator pedal effort, and the conditions of the engine and the vehicle, and comprehensively controls the ISC, and cruise control.
Fuel Pump Control	Under light engine loads, pump speed is low to reduce electric power loss.
Oxygen Sensor Heater Control*1	Maintains the temperature of the oxygen sensor at an appropriate level to increase accuracy of detection of the oxygen concentration in the exhaust gas.
Air Conditioning Cut-Off Control	By controlling the air conditioning compressor ON or OFF in accordance with the engine condition, drivability is maintained.
Evaporative Emission Control	The engine ECU controls the purge flow of evaporative emissions (HC) in the charcoal canister in accordance with engine conditions.
Sub Fuel Tank Control*2	Drivers use the fuel tank changeover switch to select the fuel tank (main or sub) they wish to use.
Engine Immobiliser*3	Prohibits fuel delivery and ignition if an attempt is made to start the engine with an invalid ignition key.
Diagnosis	● When the engine ECU detects a malfunction, the engine ECU diagnoses and memorizes the failed section. ● A newly developed diagnostic system which utilizes a high speed bi-directional communication line to provide extended diagnostic capabilities and features.
Fail-Safe	When the engine ECU detects a malfunction, the engine ECU stops or controls the engine according to the data already stored in memory.

*1: Only for Europe Model
*2: Only on models equipped with sub tank system.
*3: Only on models equipped with the engine immobiliser system.

2. Construction

The configuration of the engine control system in the 2UZ-FE engine is as shown in the following chart.



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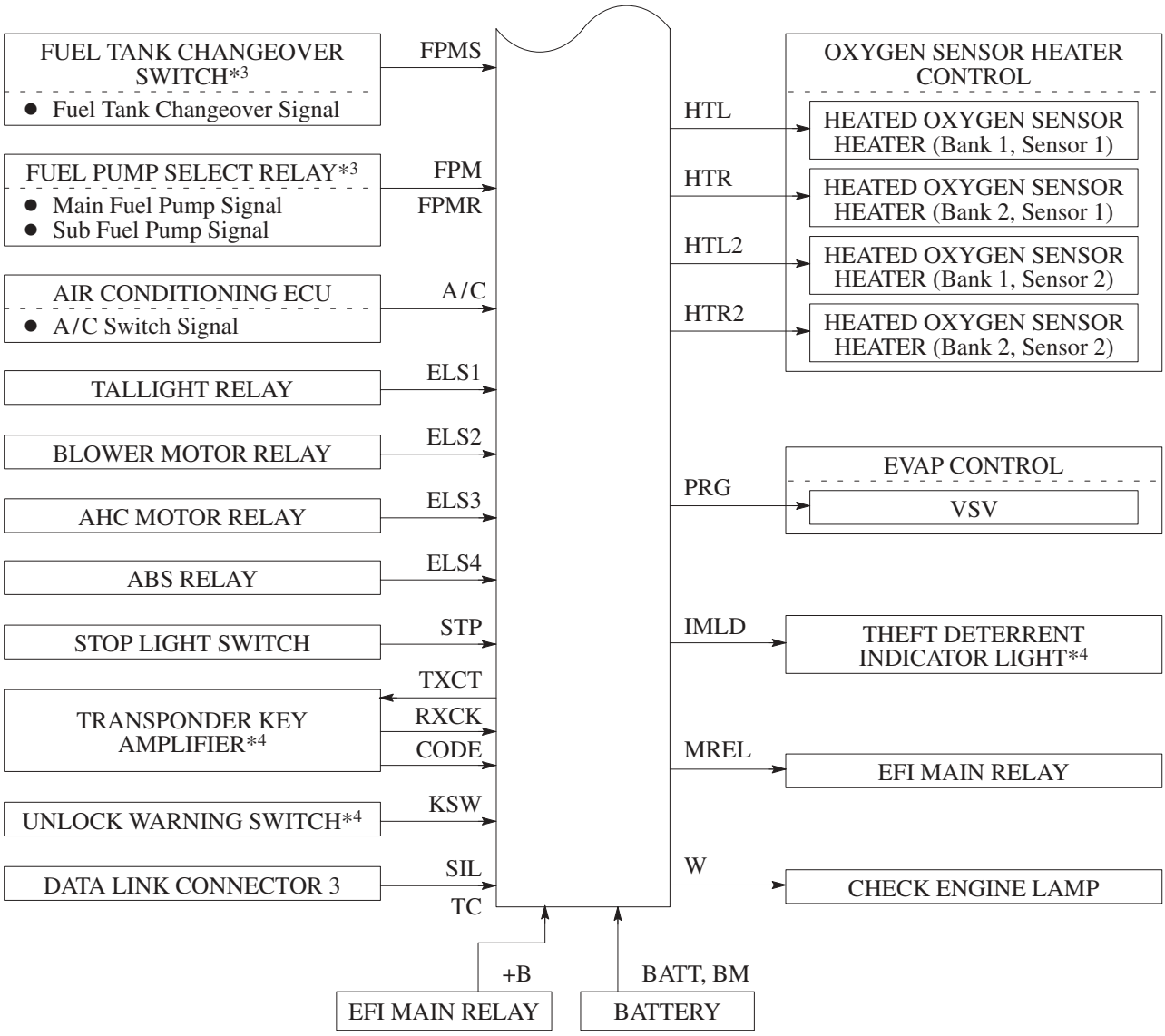

*1: Only for Europe
*2: Except for Europe
*3: Only on models equipped with sub fuel tank system.
*4: Only on models equipped with the engine immobiliser system.

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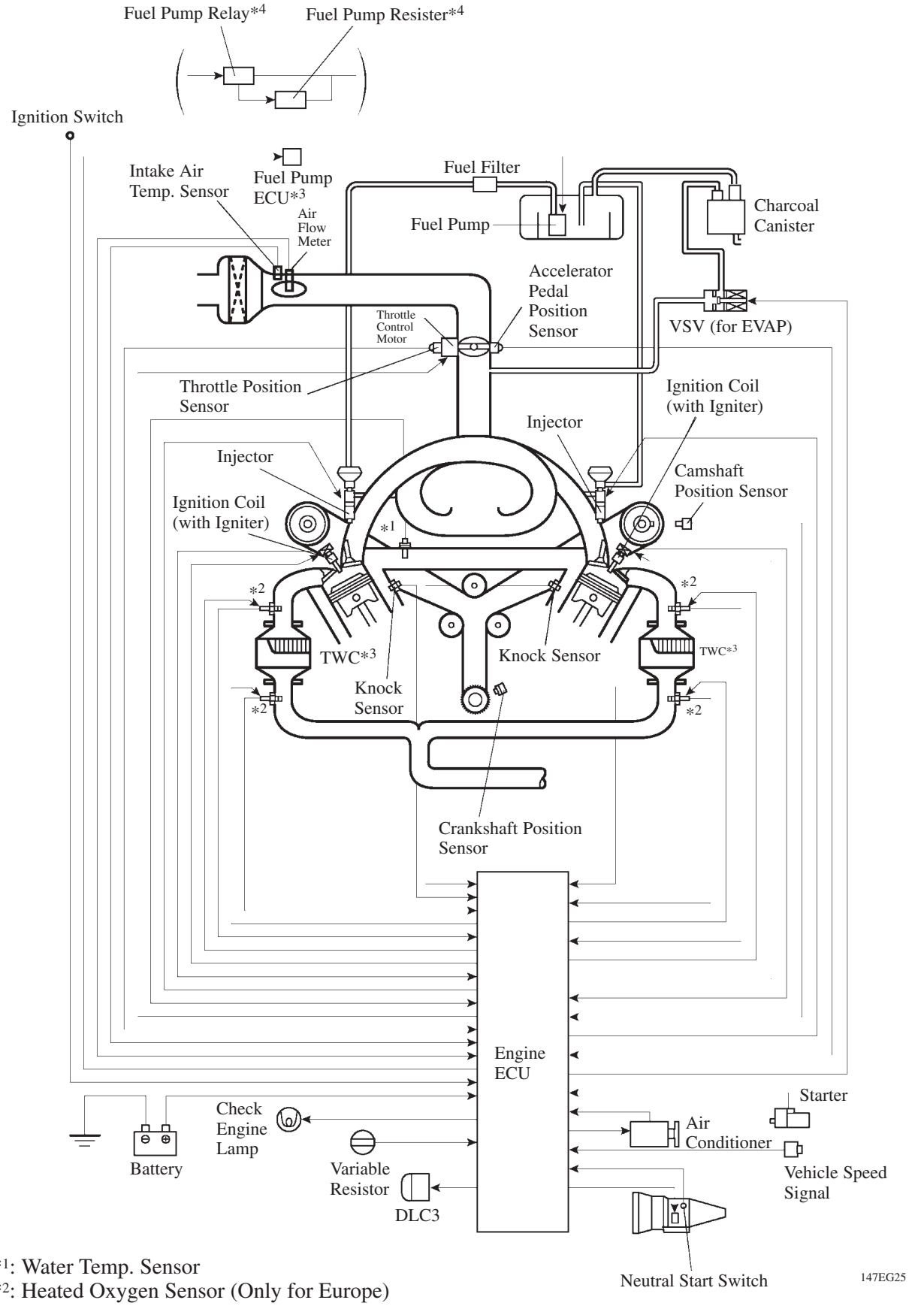
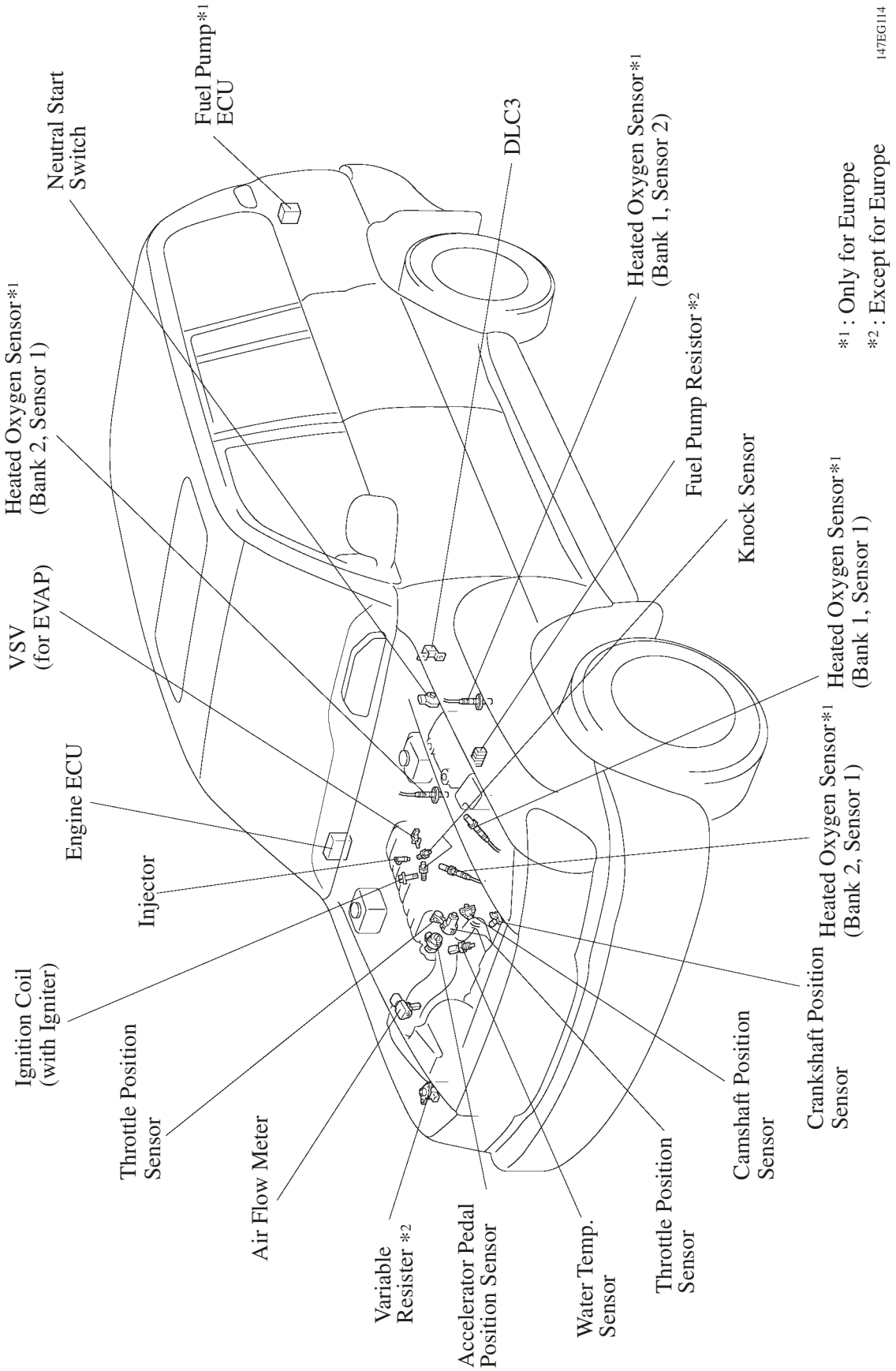
3. Engine Control System Diagram



*1: Water Temp. Sensor
*2: Heated Oxygen Sensor (Only for Europe)
*3: Only for Europe
*4: Except for Europe

4. Layout of Components



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5. Main Components of Engine Control System

General

The main components of the 2UZ-FE engine control system are as follows:

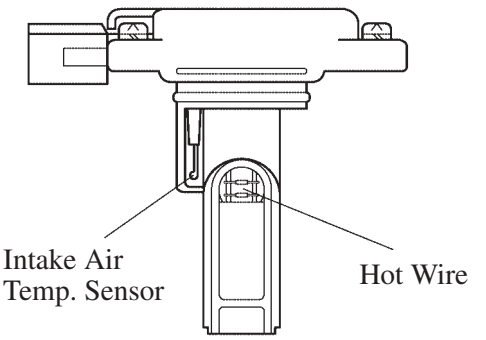
Components	Outline
Air Flow Meter	Hot-Wire Type
Crankshaft Position Sensor	Pick-Up Coil Type, 1
Camshaft Position Sensor	Pick-Up Coil Type, 1
Throttle Position Sensor	Linear Type, 2
Accelerator Pedal Position Sensor	Linear Type, 2
Knock Sensor	Built-In Piezoelectric Type, 2
Oxygen Sensor*	Heated Oxygen Sensor (Bank 1, Sensor 1) (Bank 2, Sensor 1) (Bank 1, Sensor 2) (Bank 2, Sensor 2)
Injector	4-Hole Type

*: Only for Europe Model

Air Flow Meter

The 2UZ-FE engine adopts the hot-wire type air flow meter designed for direct electrical measurement of the intake air mass flow.
This air flow meter offers superior measuring precision and its plastic housing is shaped for minimal flow resistance. It has the following features:

- Compact and lightweight
  The pressure loss caused by this sensor is small and offers only slight intake air flow resistance.
- Superior response and measuring accuracy
- Ability to measure a wide airflow range
- Having no mechanical functions, it offers a superior durability.



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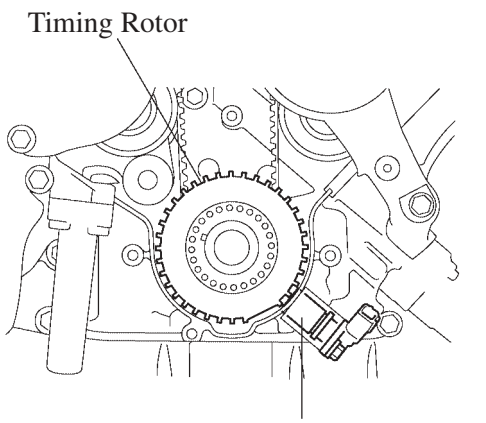
Crankshaft Position Sensor

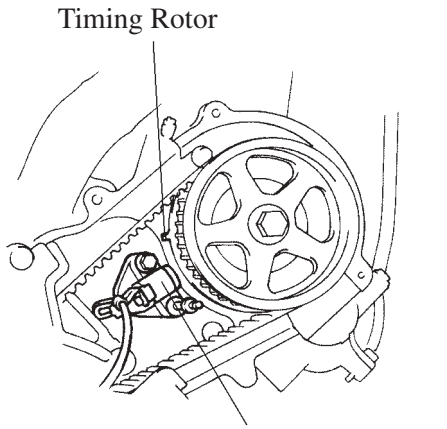
The crankshaft position sensor is mounted on the oil pump body as illustrated.
The timing rotor is integrated with the crankshaft pulley. The rotor's teeth are spaced 10° apart, according to crankshaft angle, but since there are 2 teeth missing, as illustrated below, there is a total of 34 teeth.
Accordingly, the engine ECU can detect the crankshaft angle in addition to the crankshaft speed.



151EG18

Camshaft Position Sensor

The camshaft position sensor is mounted on the left bank cylinder head. To detect the camshaft position, a protrusion that is provided on the timing pulley is used to generate 1 pulse for every 2 revolutions of the crankshaft.



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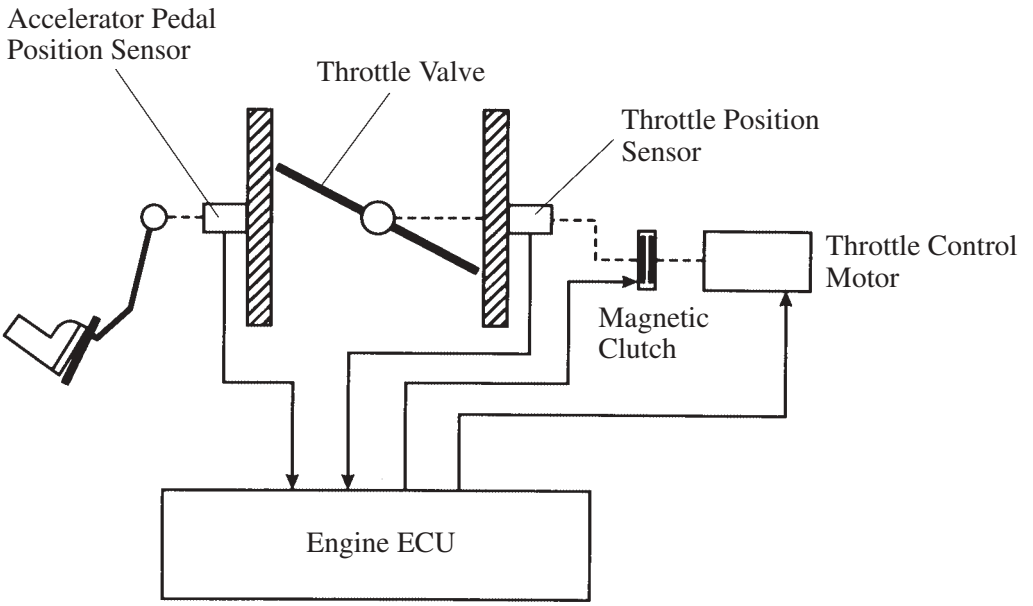
6. ETCS-i (Electronic Throttle Control System-intelligent)

General

- The ETCS-i system, which realizes excellent throttle control in all the operating ranges, has been adopted.
- In the conventional throttle body, the throttle valve opening 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 that is appropriate for the respective driving condition and uses a throttle control motor to control the opening.
- The ETCS-i controls the ISC (Idle Speed Control) system and the cruise control system.
- A duplicate system is provided to ensure a high level of reliability, and the system shuts off in case of an abnormal condition. Even when the system is shut off, the accelerator pedal can be used to operate the vehicle in the limp mode.



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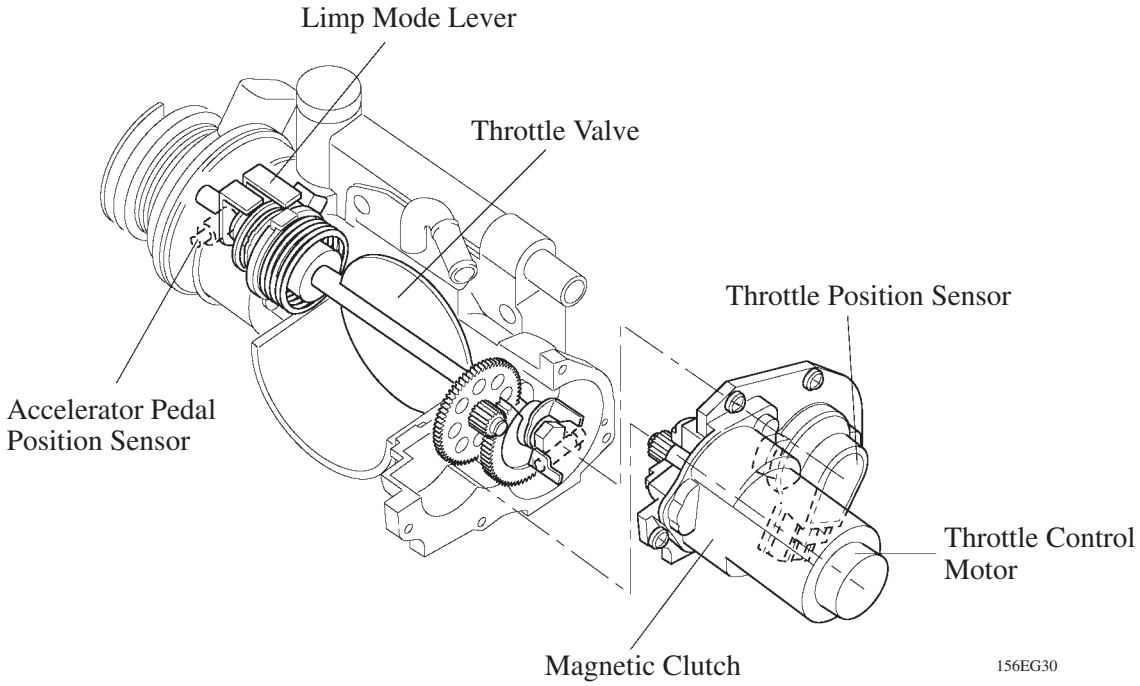
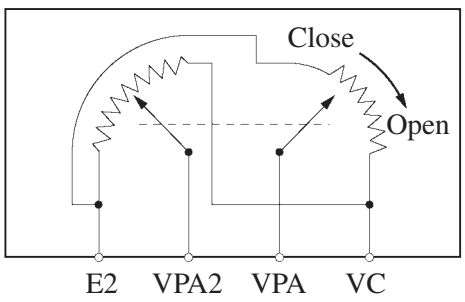
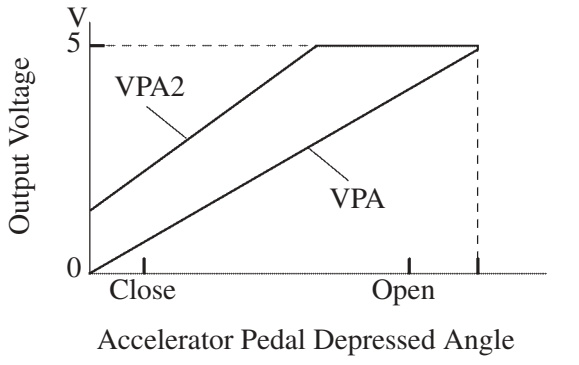
Construction



1) Accelerator Pedal Position Sensor

The accelerator pedal position sensor, which is mounted on the throttle body, is integrated with the throttle lever, which is connected to the cable that extends from the accelerator pedal.
The accelerator pedal position sensor converts the amount of accelerator pedal effort into two types of electrical signals with distinct output characteristics. The signals are then input into the engine ECU.





2) Throttle Position Sensor

The throttle position sensor converts the throttle valve opening into an electrical signal and inputs into the engine ECU. The output characteristics are the same as those of the accelerator pedal position sensor.

3) 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 of the throttle valve.

4) Magnetic Crutch

Ordinarily, the magnetic clutch engages the clutch to enable the throttle control motor to open and close the throttle valve. In case that a malfunction occurs in the system, this clutch is disengaged to prevent the throttle control motor to open and close the throttle valve.

Operation

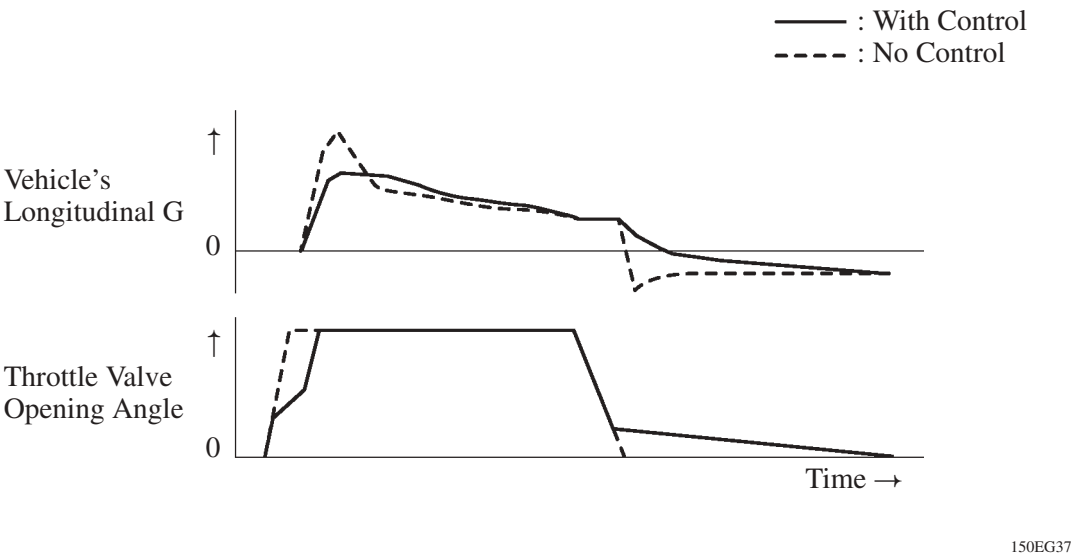
The engine ECU drives the throttle control motor by determining the target throttle valve opening in accordance with the respective operating condition.

1) Non-Linear Control
2) Idle Speed Control
3) Cruise Control

1) Non-Linear Control

Controls the throttle to an optimal throttle valve opening 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 ◀



2) Idle Speed Control

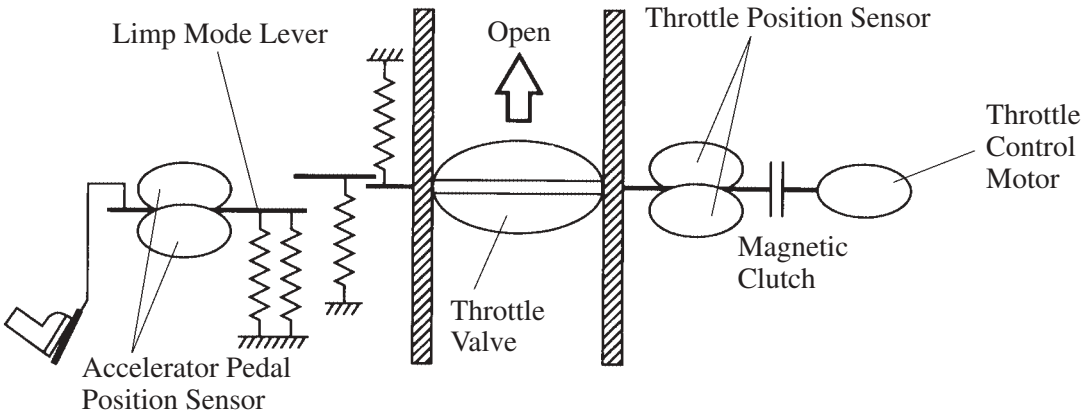
Previously, ISC valve was used to perform idle speed control such as fast idle during cold operating conditions and idle-up. In conjunction with the adoption of the ETCS-i, idle speed control is now performed by the throttle control motor, which controls the throttle valve opening.

3) Cruise Control

Previously, the vehicle speed was controlled by the cruise control actuator, which opened and closed the throttle valve. Along with the adoption of the ETCS-i, the vehicle speed is now controlled by the throttle control motor, which controls the throttle valve.

Fail-Safe

If an abnormal condition occurs with the ETCS-i, the CHECK ENGINE lamp illuminates to alert the driver. At the same time, the current to the throttle control motor and magnetic clutch are cut off in order not to operate the ETCS-i. This enables the return spring to close the throttle valve.
Even in this situation, the accelerator pedal can be used to operate the limp mode lever, which operates the throttle valve to enable the vehicle to be driven in the limp mode.



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Diagnosis

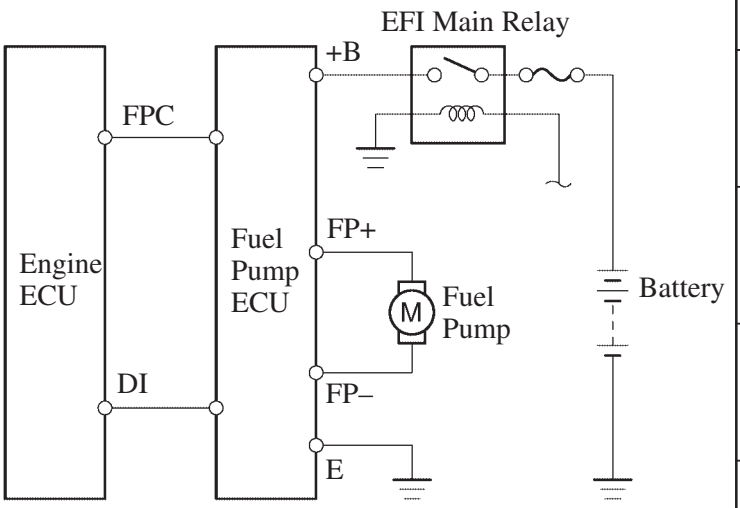
If the diagnostic trouble code 89 is being output to the CHECK ENGINE lamp, it means that the engine ECU has detected a malfunction in the ETCS-i, and outputs the diagnostic trouble code of the ETCS-i to the "ETCS"*1 (or "2nd STRT"*2) indicator light.
Also, the diagnostic trouble code can be output to a hand-held tester via the data link connector 3.
For details, refer to the 2UZ-FE Engine Repair Manual (Pub. No RM630E).

*1: For Manual Transmission Model
*2: For Automatic Transmission Model

7. Fuel Pump Control (Only for Europe Model)

The fuel pump speed control has adopted a fuel pump ECU to execute 3-step fuel pump speed control.

▶ System Diagram ◀



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FPC Signal	Fuel Pump Speed
5V / 0V	Hi
8.2 ms, 5V / 0V	Mid
4.1 ms, 5V / 0V	Low
5V / 0V	Stop

152EG12

8. Sub Fuel Tank Control

By activating the fuel pump of the fuel tank (main or sub) that was selected by the fuel tank changeover switch, and by changing over the fuel return valve, fuel is supplied to the engine from the fuel tank selected by the driver.
The construction and operation of the sub fuel tank control system is basically the same as the 1FZ-FE engine.
For detail, see page 58.

9. Engine Immobiliser System

The engine immobiliser system has been designed to prevent the vehicle from being stolen. This system uses a engine ECU that stores the ID code of the authorized ignition key. If an attempt is made to start the engine using an unauthorized key, the engine ECU prohibit fuel delivery and ignition, effectively disabling the engine. For details see page 277 in the Engine Immobiliser System section.

10. Diagnosis

An M-OBD (Multiplex On-Board Diagnostic) system has been adopted to improve serviceability.
The operation of the M-OBD system is basically the same as the 1FZ-FE engine.
For details, see page 60.