5. Engine Control System

General

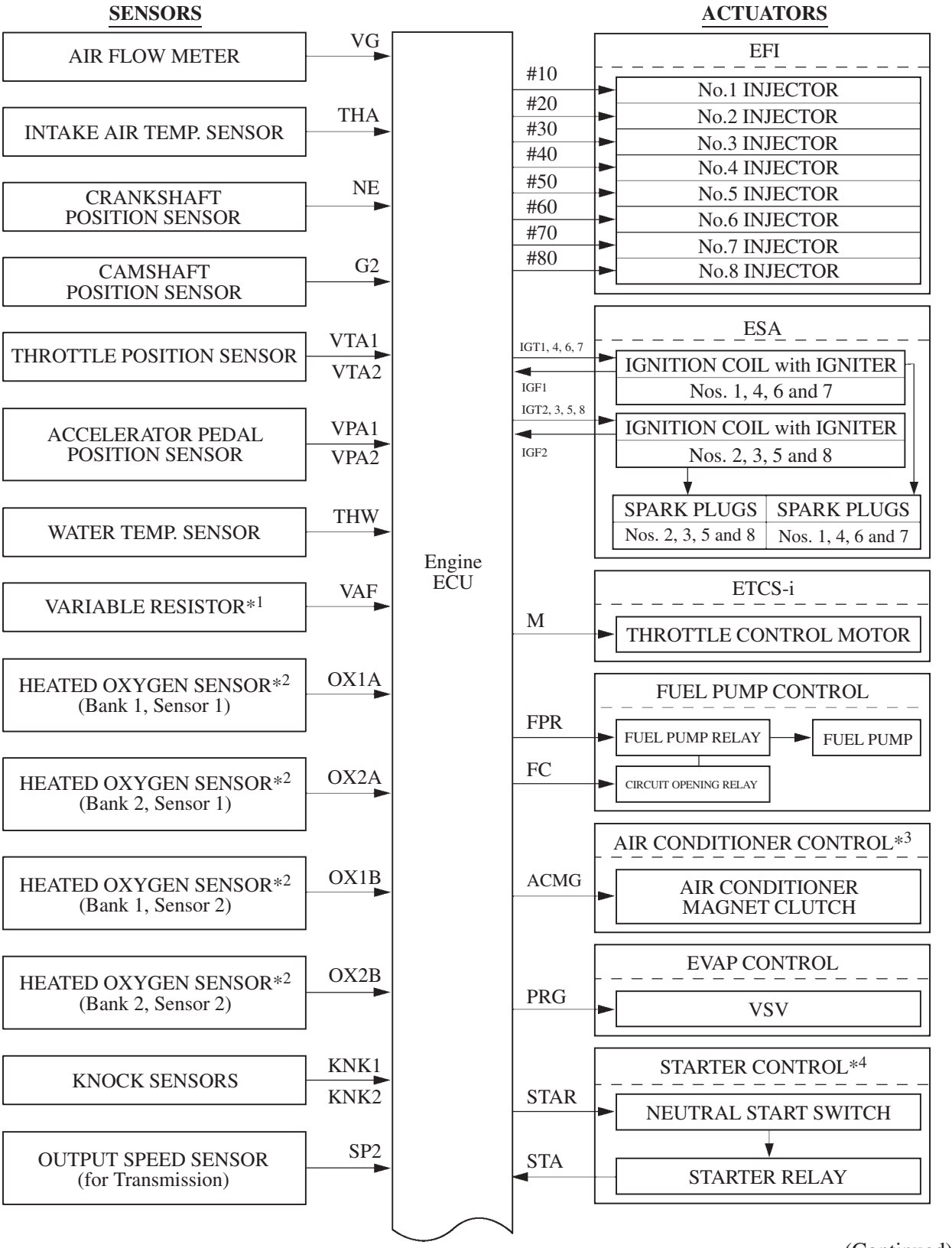
The engine control system of the 2UZ-FE engine on the new Land Cruiser (100 series) and 2UZ-FE engine on the previous model are compared below.

System	Outline	New	Previous
EFI (Electronic 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) (See page 157)	Optimally controls the throttle valve opening in accordance with the amount of accelerator pedal effort and the condition of the engine and the vehicle	○	○
	● A link less type is used, without an accelerator cable. ● An accelerator pedal position sensor is provided on the accelerator pedal. ● No-contact type throttle position sensor has been adopted.	○	—
Fuel Pump Control (See page 158)	The fuel pump ECU has been used to execute 3-step fuel pump speed control.	—	○*1
	The fuel pump speed is controlled by the fuel pump relay and the fuel pump resistor.	○	○*2
	A fuel cut control is adopted to stop the fuel pump when the airbag is deployed.	○	—
Oxygen Sensor Heater Control	Maintains the temperature of the oxygen sensor at an appropriate level to increase accuracy of detection of the oxygen concentration in the exhaust gas.	○*5	○*3 —*4
Evaporative Emission Control	The engine ECU controls the purge flow of evaporative emission (HC) in the charcoal canister in accordance with engine conditions.	○	○
Air Conditioner Cut-off Control	By turning the air conditioning compressor ON or OFF in accordance with the engine condition, drivability is maintained.	○	○
Engine Immobiliser	Prohibits fuel delivery and ignition if an attempt is made to start the engine with an invalid ignition key.	○	○
Starting System*6 (See page 159)	Once the ignition switch is turned to the START position, this control continues to operate the starter until the engine starts.	○	—
Diagnosis (See page 161)	When the engine ECU detects a malfunction, the engine ECU diagnoses and memorizes the failed section.	○	○
	All the DTC (Diagnostic Trouble Code) have been made to correspond to the SAE controlled codes.	○	—
Fail-Safe (See page 161)	When the engine ECU detects a malfunction, the engine ECU stops or controls the engine according to the data already stored in the memory.	○	○

*1: Europe Model
*2: except Europe Model
*3: Europe and G.C.C. Countries Model (for Saudi Arabia)
*4: Australia and General Countries Model
*5: except General Countries Model and G.C.C. Countries Model (except Saudi Arabia)
*6: Models with Automatic Transmission

Construction

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



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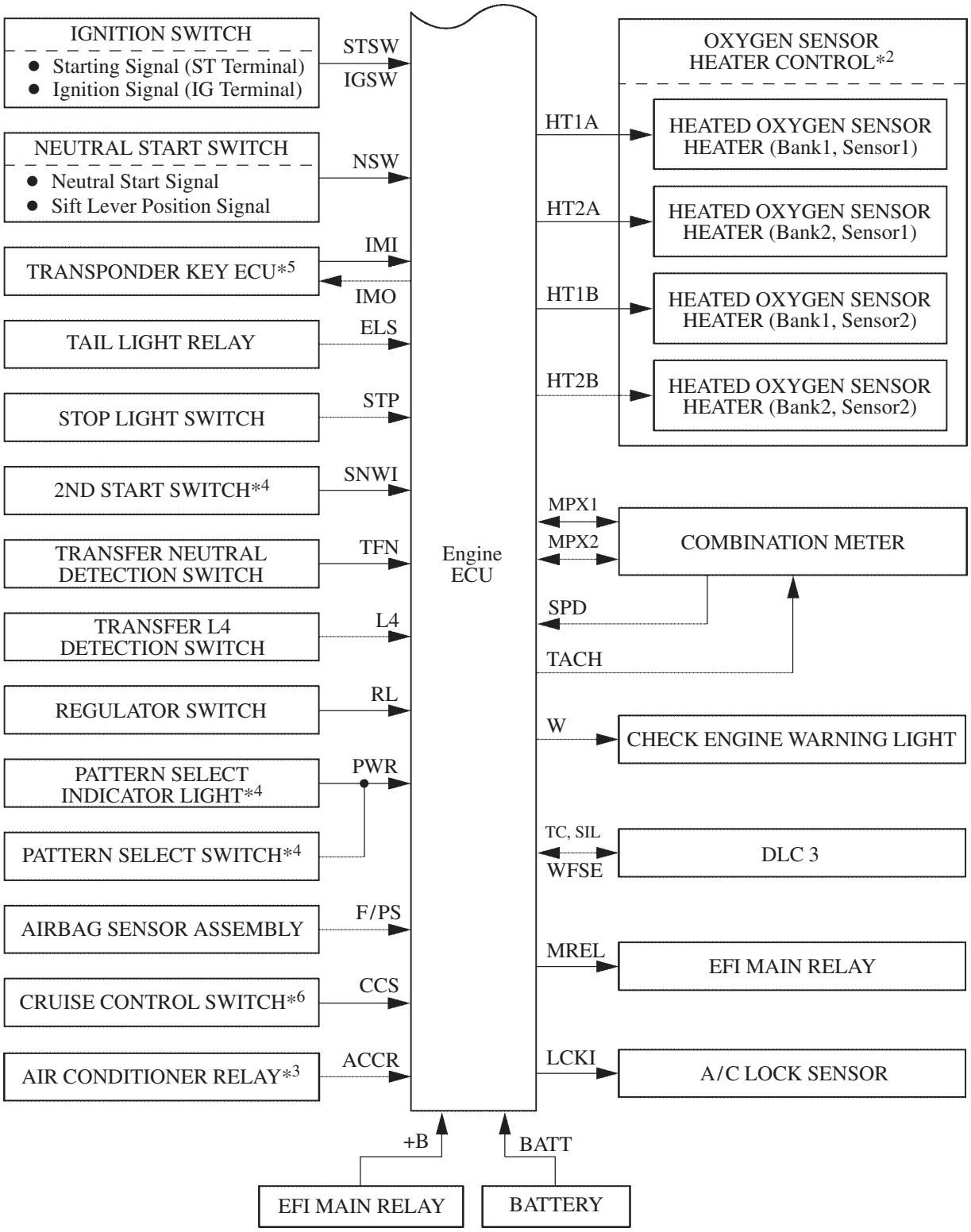

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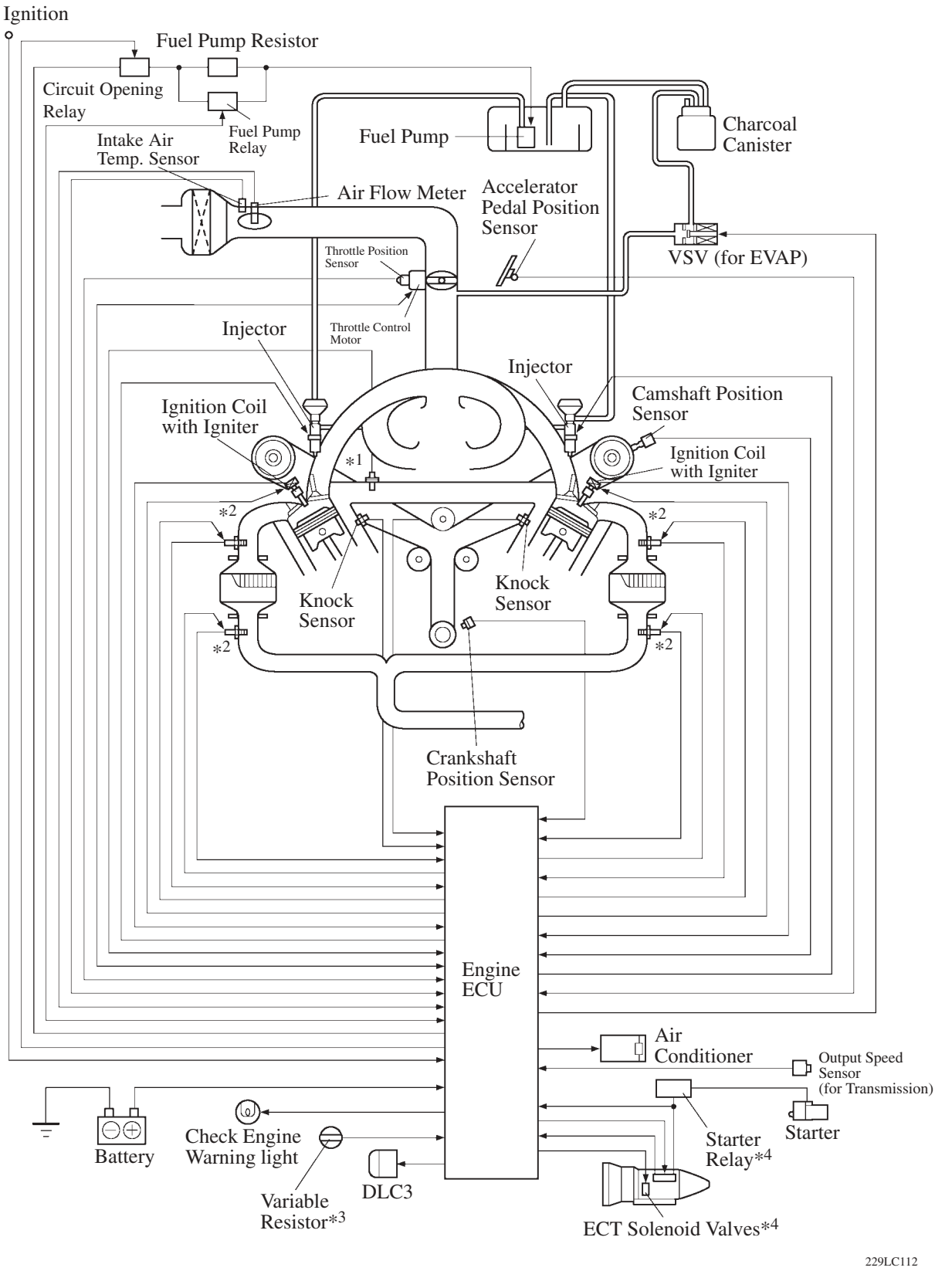
*1: for General Countries Model and G.C.C. Countries Model (except Saudi Arabia)
*2: except General Countries Model and G.C.C. Countries Model (for Saudi Arabia)
*3: Models with Air Conditioner
*4: Models with Automatic Transmission
*5: Models with Engine Immobiliser System
*6: Models with Cruise Control System

6

Engine Control System Diagram



*1: Water Temp. Sensor
*2: Heated Oxygen Sensor
*3: for Models without Heated Oxygen Sensor
*4: for Models with Automatic Transmission

Main Component of Engine Control System

1) General

The following table compares the main components.

Model Type	New		Previous	
Component	Outline	Quantity	Outline	Quantity
Engine ECU	32-bit CPU	1	←*2 16-bit CPU*3	
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 (1)	1	←	
Accelerator Pedal Position Sensor	Linear Type (Mounted on accelerator pedal)	1	Linear Type (Mounted on throttle body)	1
Throttle Position Sensor	No-contact Type	1	Linear Type	1
Knock Sensor	Built-in Piezoelectric Type	2	←	
Oxygen Sensor (Bank 1, Sensor 1) (Bank 1, Sensor 2) (Bank 2, Sensor 1) (Bank 2, Sensor 2)	with Heater*1	4	←*4 —*5	
Injector	4-Hole Type	8	←	

*1: except General Countries Model and G.C.C. Countries Model (except Saudi Arabia)
*2: Europe Model
*3: except Europe Model
*4: Europe and G.C.C. Countries Model (for Saudi Arabia)
*5: Australia, General Countries Models and G.C.C. Countries Model (except Saudi Arabia)

2) Engine ECU

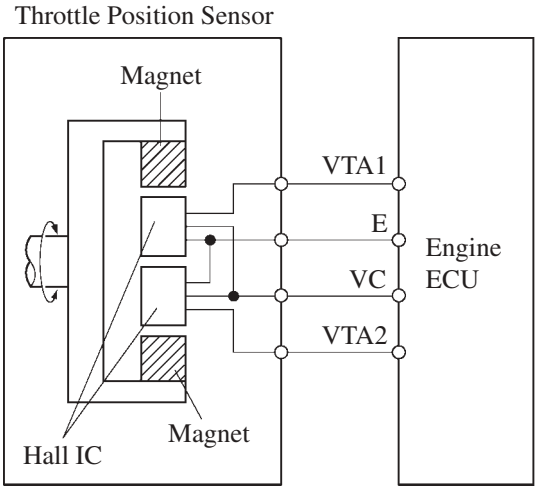
The 32-bit CPU of the engine ECU is used to increase the speed for processing the signals.

Service Tip

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

3) Throttle Position Sensor (No-Contact Type)

To detect the opening angle of the throttle valve, the throttle position sensor converts the magnetic flux density into electric signals that change when the magnetic yoke (located on the same axis as the throttle shaft) rotates around the hall IC.



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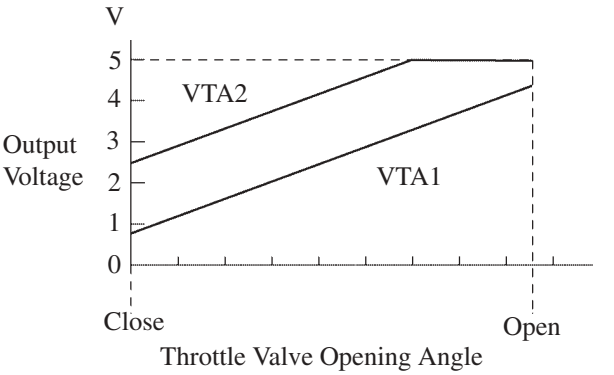

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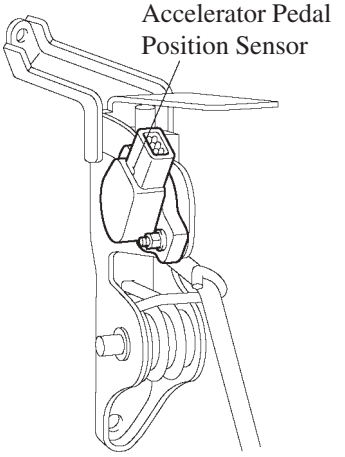
4) Accelerator Pedal Position Sensor

- This sensor converts the accelerator pedal depressed angles into electric signals with two differing characteristics and outputs them to the engine ECU. One is the VPA signal that linearly outputs the voltage along the entire range of the accelerator pedal depressed angle. The other is the VPA2 signal that outputs on offset voltage.
- The accelerator pedal position sensor is attached to the accelerator pedal.



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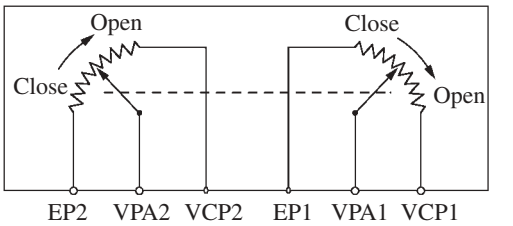

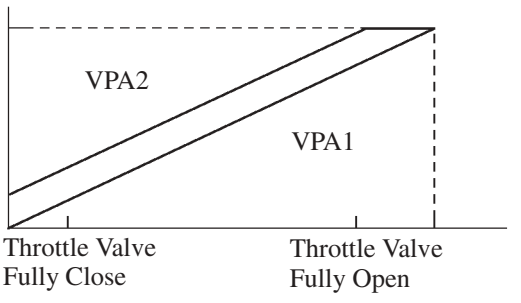

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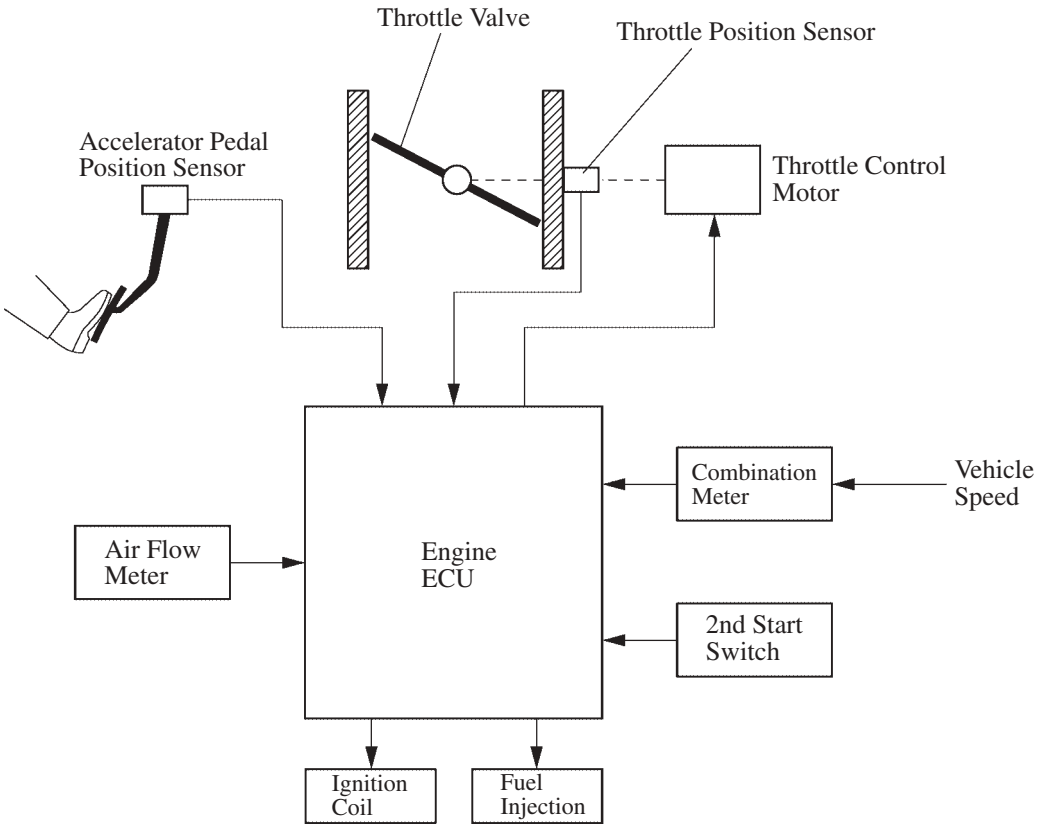
ETCS-i (Electronic Throttle Control System-intelligent)

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.

In contrast to the ETCS-i on the previous model, the following items have been changed on the new model:

- The accelerator cable and link have been discontinued, and an accelerator position sensor has been provided on the accelerator pedal.
- No-contact type throttle position sensor has been adopted.
- Accordingly, the limp-mode control, in the fail-safe mode has been changed.

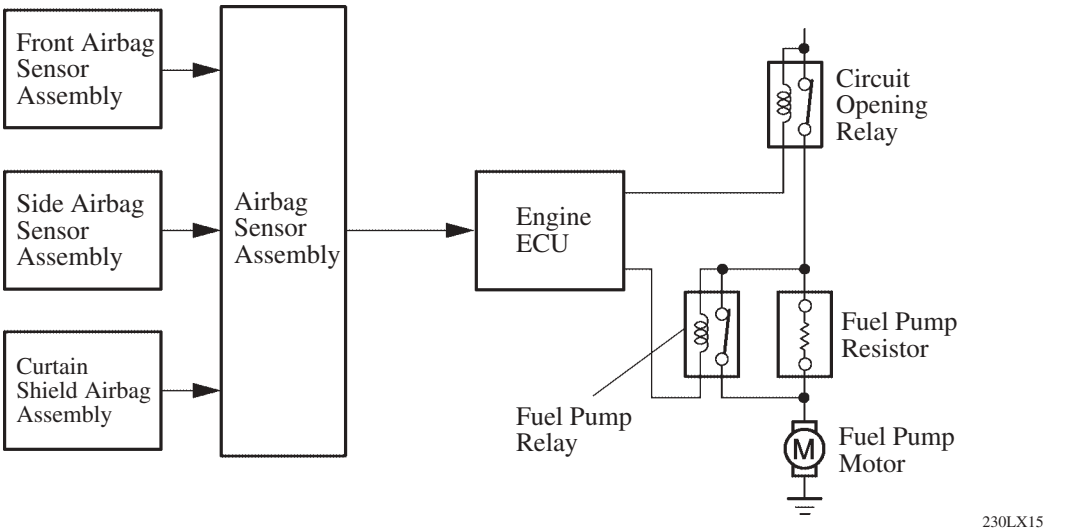
▶ System Diagram ◀



Fuel Pump Control

- On the previous model for Europe, the fuel pump ECU effected 3-step fuel pump speed control. However, on all the new models, the control has been changed to 2-step fuel pump speed control, which is effected by the fuel pump relay and the fuel pump resistors.
- This control system increases the fuel pump output by switching the fuel pump speed to high if a large volume of fuel is required by the engine ECU. In normal operations where the engine speeds are low, the fuel pump rotates at low speed to reduce unnecessary consumption of electric power and to maintain fuel pump durability.
- A fuel cut control is adopted to stop the fuel pump when the airbag is deployed. In this system, the airbag deployment signal from the airbag sensor assembly is detected by the engine ECU, which 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.

▶ System Diagram ◀

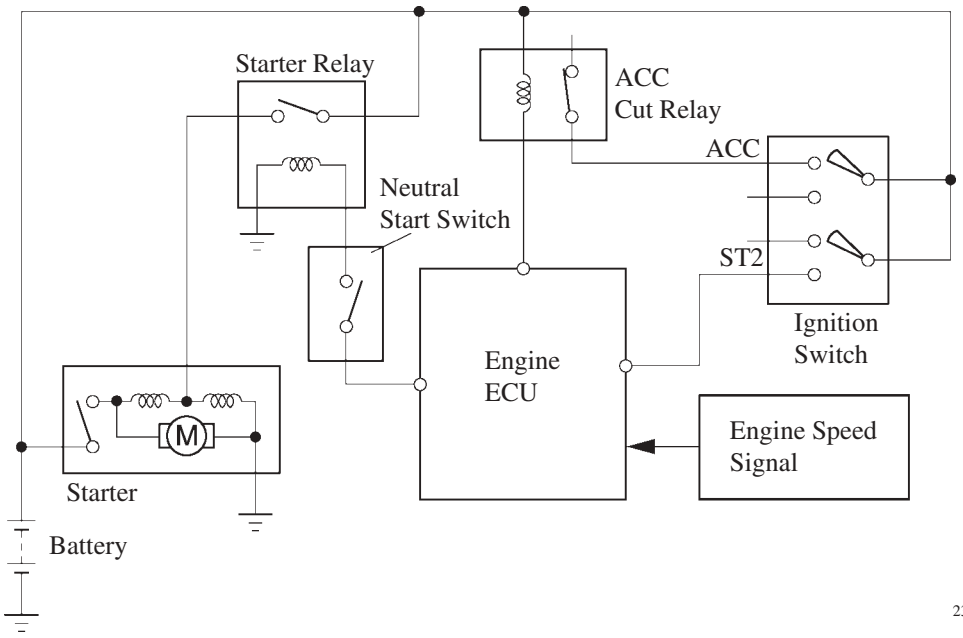


Cranking Hold Function

1) General

- The new Land Cruiser (100 series) with automatic transmission has adopted a cranking hold function. Once the ignition switch is turned to the START position, this control continues to operate the starter until the engine starts, without having to hold the ignition switch in the START position. This prevents starting failures and the engine from being cranked after it has started.
- When the engine ECU detects a start signal from the ignition switch, this system monitors the engine speed (NE) signal and continues to operate the starter until it has determined that the engine has started. Furthermore, even if the engine ECU detects a start signal from the ignition switch, it will not operate the starter if it has determined that the engine has already started.

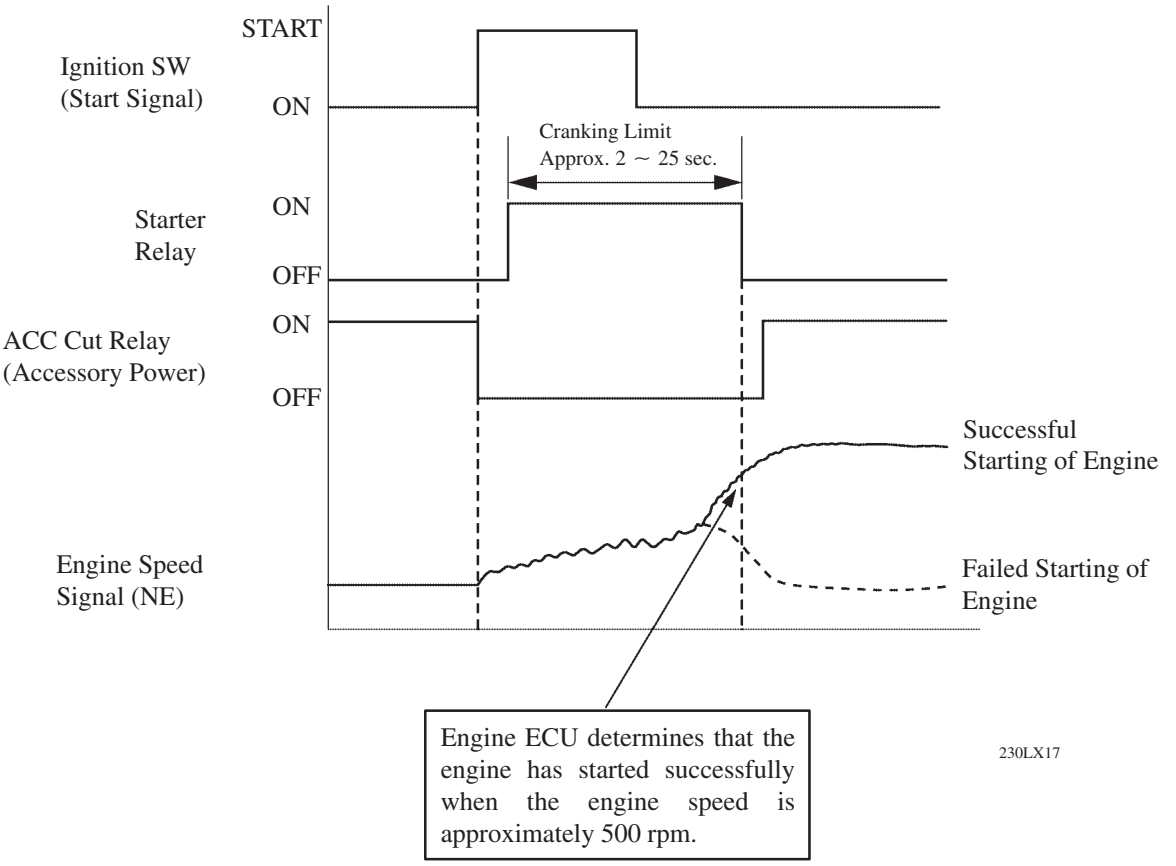
▶ System Diagram ◀



2) Operation

- As indicated in the timing chart shown below, when the engine ECU detects a start signal from the ignition switch, it energizes the starter relay to operate the starter. If the engine is already running, the engine ECU will not energize the starter relay.
- After the starter operates and the engine speed becomes higher than approximately 500 rpm, the engine ECU determines that the engine has started and stops the operation of the starter.
- If the engine has any failure and will not work, the starter operates as long as its maximum continuous operation time and stops automatically. The maximum continuous operation time is approximately 2 seconds through 25 seconds depending on the engine coolant temperature condition. When the engine coolant temperature is extremely low, it is approximately 25 seconds and when the engine is warmed up sufficiently, it is approximately 2 seconds.
- This system cuts off the current that powers the accessories while the engine is cranking to prevent the accessory illumination from operating intermittently due to the unstable voltage that is associated with the cranking of the engine.

▶ Timing Chart ◀



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 DTC (Diagnostic Trouble Code) of the malfunctions. The DTC can be accessed the use of the hand-held tester or SST (09843-18040).
- All the DTC have been made to correspond to the SAE controlled codes. Some of the DTC have been further divided into smaller detection areas than in the past, and new DTC have been assigned to them. For details, see the General Features Section.

Fail-Safe

1) General

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

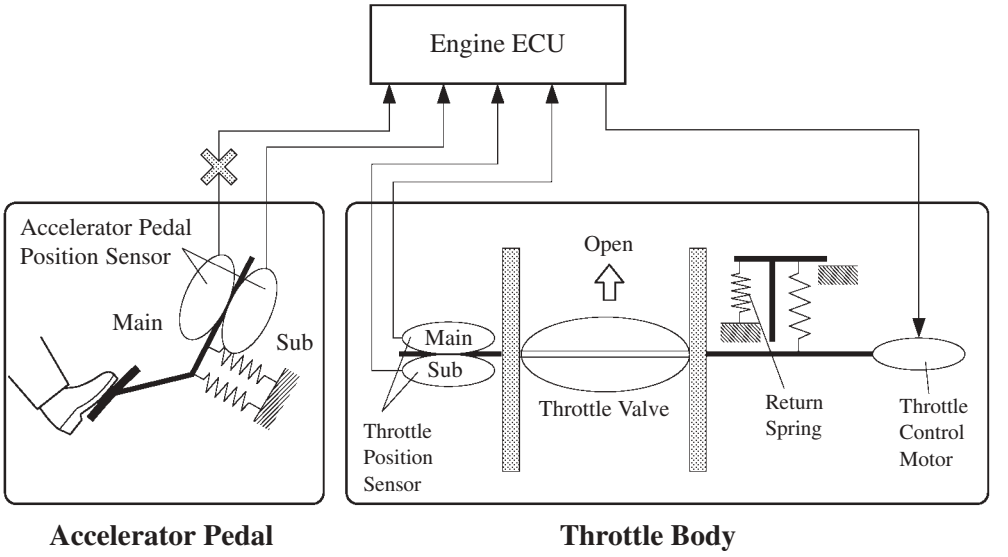
▶ Fail-Safe Control List ◀

□: New

Location on Malfunction	Description Control
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 engine ECU effects control by using the values in the engine ECU or stops the engine.
Accelerator Pedal Position Sensor (For details, see page 162)	In case of a signal malfunction, the engine ECU calculates the accelerator pedal opening angle that is limited by the dual circuits sensor value and continues effecting throttle valve control. If both circuits malfunction, the engine ECU considers that the accelerator pedal is fully closed.
Throttle Position Sensor (For details, see page 163)	In case of a signal malfunction, the engine ECU cuts off the current to the throttle control motor. The throttle valve returns to the prescribed opening by the force of the return spring. The engine ECU then adjusts the engine output by controlling the fuel injection and ignition timing in accordance with the accelerator pedal opening angle to enable the vehicle to continue driving.
Water Temp. Sensor and Intake Air Temp. Sensor	In case of a signal malfunction, the use of the values from the sensors will make the air-fuel ratio become too rich or too lean, which could causes the engine to stall or to run poorly during cold operation. Therefore, the engine ECU fixes the air-fuel ratio to the stoichiometric ratio and uses the constant values of 80°C water 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 engine ECU 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 be become overheated due to engine misfire. Therefore, if the (IGF) ignition signal is not input twice or more in a row, the engine ECU determines that a malfunction occurred in the ignition system and stops only the injection of fuel into the cylinder with the malfunction.

2) Fail-Safe of Accelerator Pedal Position Sensor

- The accelerator pedal position sensor comprises two (main, sub) sensor circuits. If a malfunction occurs in either one of the sensor circuits, the engine ECU detects the abnormal signal 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 opening, in order to operate the vehicle under limp mode control.



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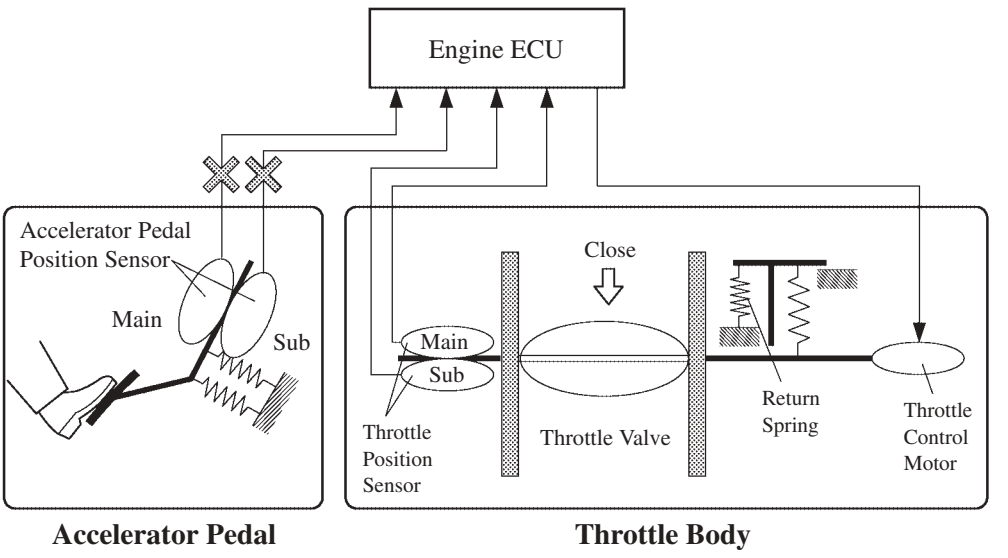
- If both circuits malfunction, the engine ECU detects the abnormal signal voltage between these two sensor circuits and regards that the opening angle of the accelerator pedal is fully opened and then continues the throttle control. At this time, the vehicle can be driven within its idling range.



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3) Fail-Safe of Throttle Position Sensor

- The throttle position sensor comprises two (main, sub) sensor circuits. If a malfunction occurs in either one of the sensor circuits, the engine ECU detects the abnormal signal 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. 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 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.