■ENGINE CONTROL SYSTEM

1. General

The engine control system has been changed to the D-type EFI system and the 3-grope type fuel injection system. In addition, the sub fuel tank control system, engine immobiliser system, and M-OBD (Multiplex On-Board Diagnosis) system have been newly adopted.
The engine control system of the new 1FZ-FE engine and previous 1FZ-FE engine are compered below.

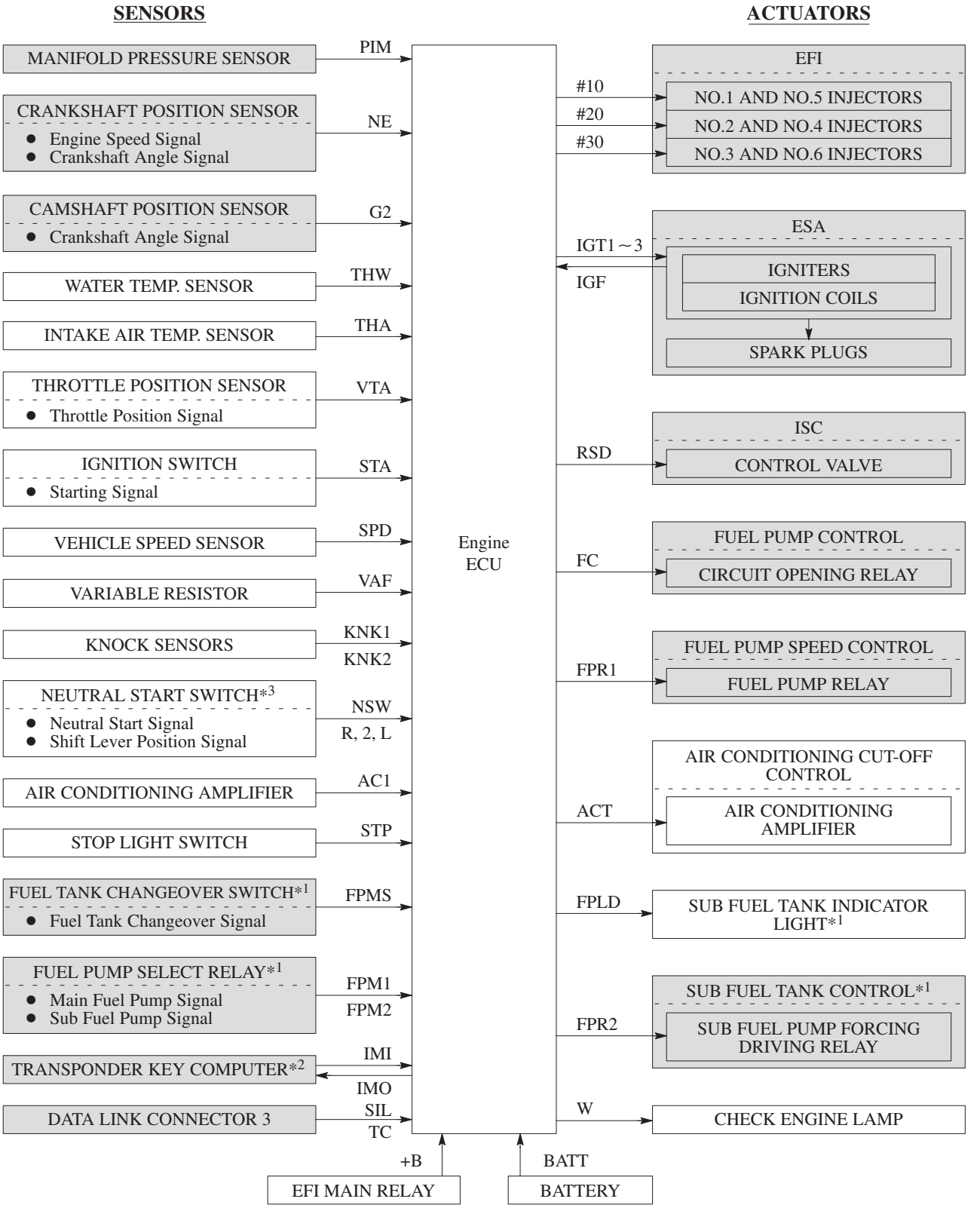
System	Outline	New	Previous
EFI (Electronic Fuel Injection)	A D-type EFI system is used, which indirectly detects intake air volume by manifold pressure sensor signal.	○	—
	An L-type EFI system is used, which directly detects the intake air mass with a hot-wire type air flow meter.	—	○
	The fuel injection system is a 3-group type, each of which injects 2 cylinders simultaneously.	○	—
	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.	○	○
	It retards ignition timing to suppress knocking when it occurs.	○	○
	In vehicles equipped with automatic transaxle, torque control correction during gear shifting has been used to minimize the shift shock.	○	○
ISC (Idle Speed Control)	A rotary solenoid type ISC system is used to control the fast idle and idle speeds.	○	—
	A step motor type ISC system controls the fast idle and idle speeds.	—	○
Fuel Pump Control	Under light engine loads, pump speed is low to reduce electric power loss.	○	—
Air Conditioner Cut-Off Control	By controlling the air conditioner compressor in accordance with the throttle valve opening angle and the vehicle speed, driveability is maintained.	○	—
Sub Fuel Tank Control	Drivers use the fuel tank changeover switch to select the fuel tank (main or sub) they wish to use.	○*1	—
Engine Immobiliser	Prohibits fuel delivery and ignition if an attempt is made to start the engine with an invalid ignition key.	○*2	—
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 on models equipped with sub tank system.
*2: Only on models equipped with the engine immobiliser system.

EG

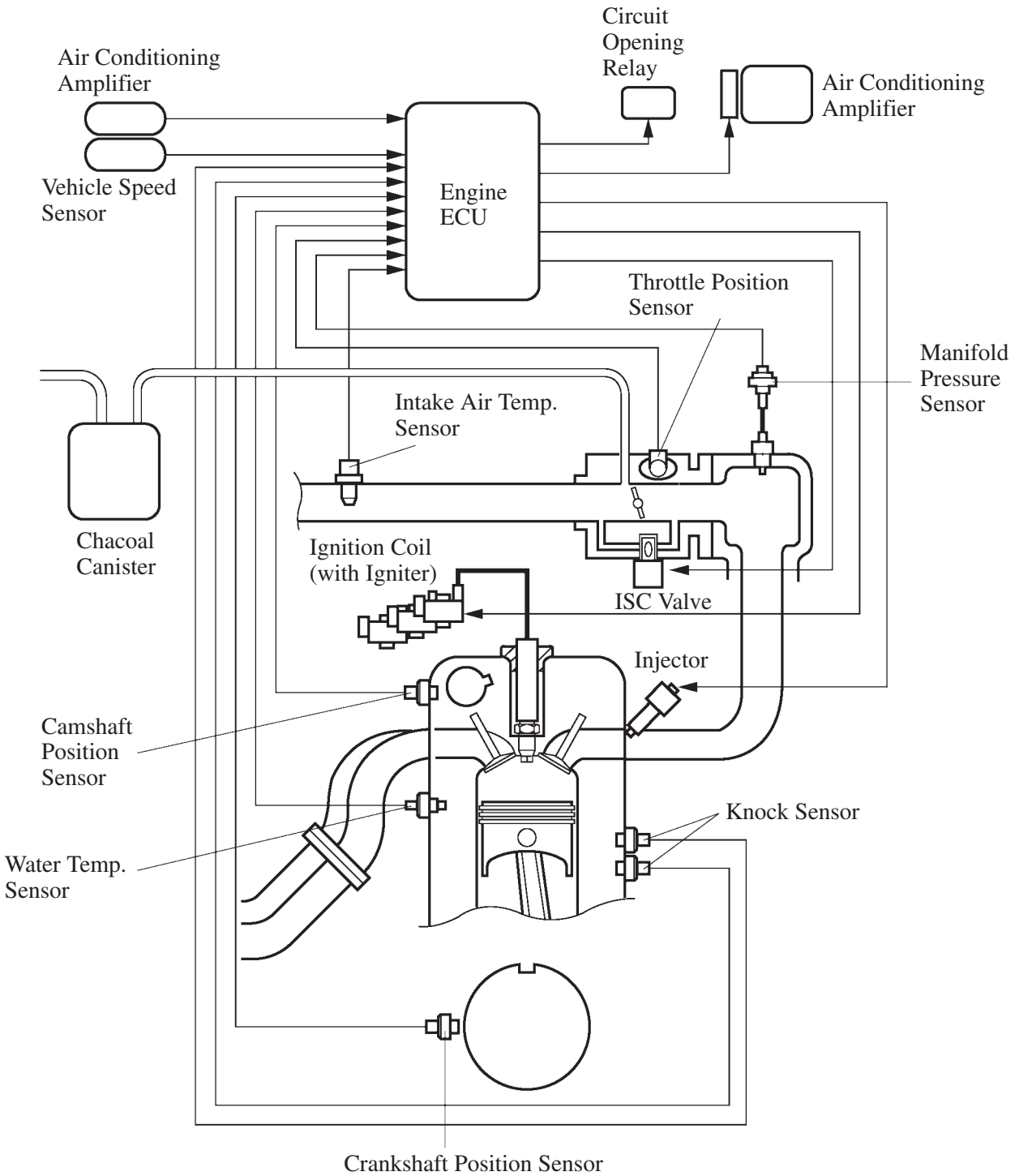
2. Construction

The configuration of the engine control system in the new 1FZ-FE engine is as shown in the following chart. Shaded portions [ ] differ from the previous 1FZ-FE engine.



*1: Only on models sub fuel tank system.
*2: Only on models with the engine immobiliser system.
*3: Applicable only to automatic transmission model.

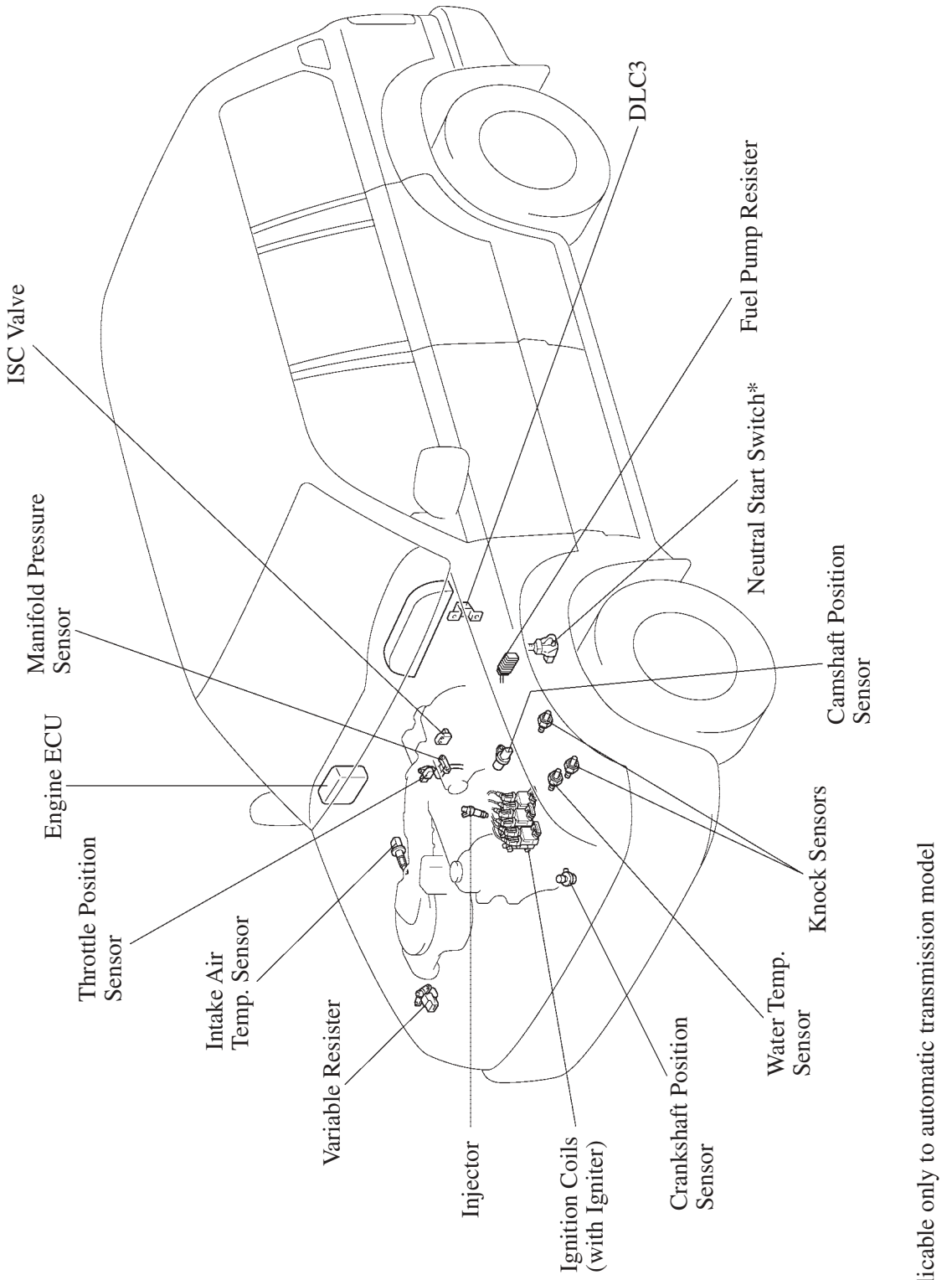
3. Engine Control System Diagram



147EG12

EG

4. Layout of Components



*: Applicable only to automatic transmission model

4. Main Components of Engine Control System

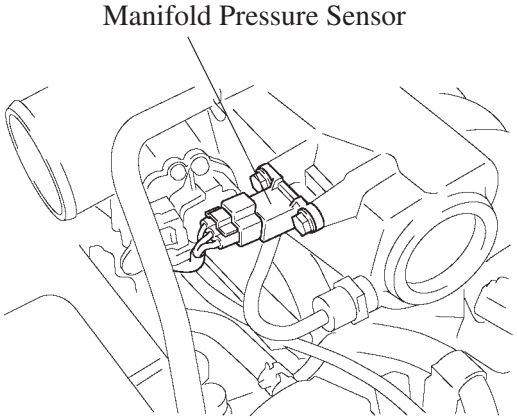
General

The following table compares the main components of the new 1FZ-FE engine and previous 1FZ-FE engine.

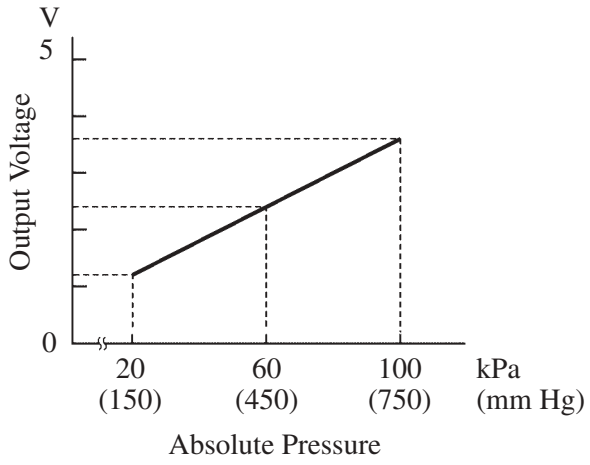
1FZ-FE Engine / Components		New	Previous
Manifold Pressure Sensor		Semiconductor Type	—
Air Flow Meter		—	Hot-Wire Type
Crankshaft Position Sensor		Pick-Up Coil Type, 1	—
Camshaft Position Sensor		Pick-Up Coil Type, 1	—
Distributor	Crankshaft Angle Sensor and Engine Speed Sensor	—	3 Pick-Up Coil (G1, G2, NE)
Throttle Position Sensor		Linear Type	←
Knock Sensor		Built-In Piezoelectric Type, 2	←
Injector		4-Hole Type	2-Hole Type
ISC Valve		Rotary Solenoid Type	Step Motor Type

Manifold Pressure Sensor

The manifold pressure sensor consists of a semiconductor which utilizes the characteristic of a silicon chip that changes its electrical resistance when pressure is applied to it. The sensor converts the manifold pressure into an electrical signal, and sends it to the engine ECU in an amplified form.



147EG32



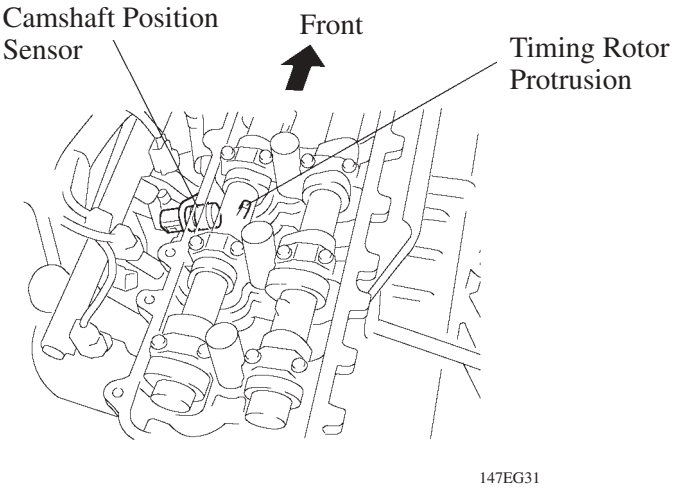
147EG23

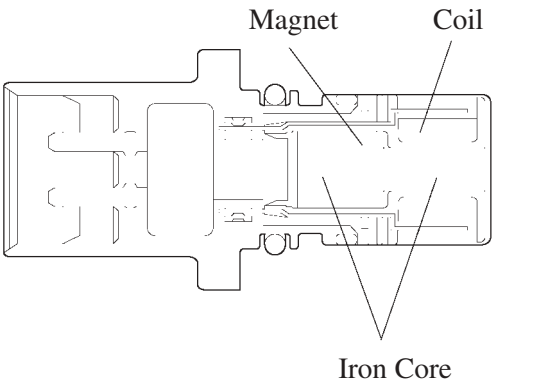
Manifold Pressure Sensor Output Characteristics

EG

Camshaft Position Sensor

The camshaft position sensor consists of a magnet, coil and iron core, and mounted onto the intake side of the cylinder head. The timing rotor is integrated with the intake camshaft.
Each time when the camshaft rotates, the air gap between the camshaft position sensor and the protrusion integrated onto the camshaft is varied. This causes the magnetic flux passing through the pickup coil to increase and decrease, generating an electromotive force. Since the voltage generated when the camshaft protrusion approaches the pickup coil is the opposite of when it departs, an alternating electrical current is produced.

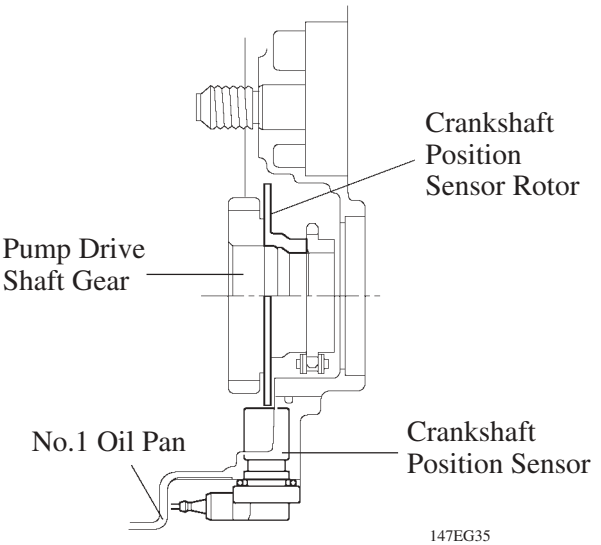


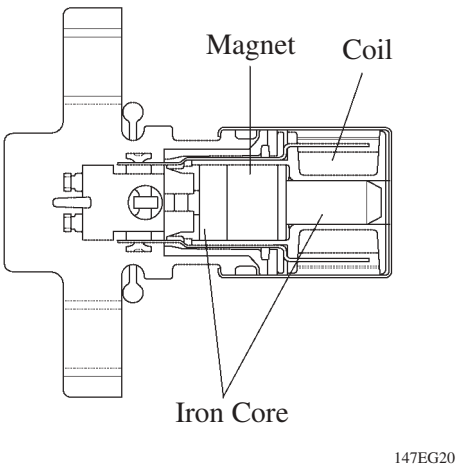


Camshaft Position Sensor Cross Section

Crankshaft Position Sensor

The crankshaft position sensor also consists of a magnet, coil and iron core, and is mounted on the No.1 oil pan as illustrated below.
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.

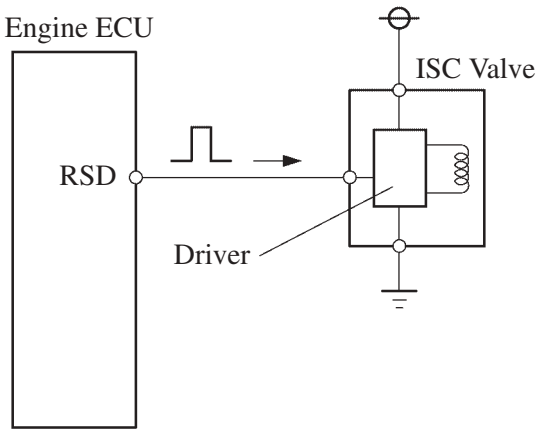




Crankshaft Position Sensor Cross Section

ISC Valve

A lightweight and compact rotary solenoid type ISC valve has been adopted. Also, a 1-coil type ISC valve with a built-in driver has been adopted to simplify the system.

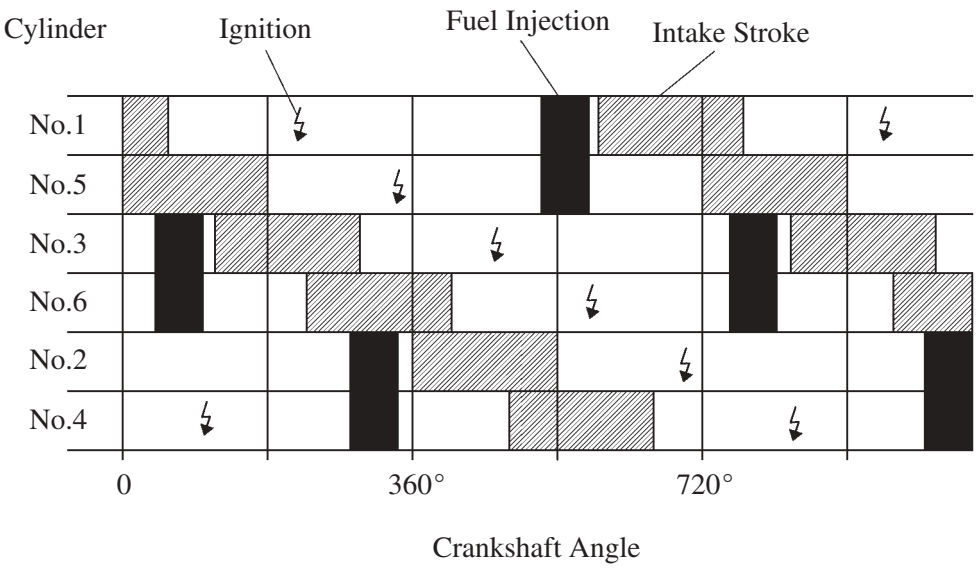


141EG30

6. EFI (Electronic Fuel Injection)

1) Fuel Injection Pattern

The previous sequential multiport fuel injection system has been changed to the 3-group injection system in which fuel is injected simultaneously into 2 cylinder each time the engine makes 2 revolutions.

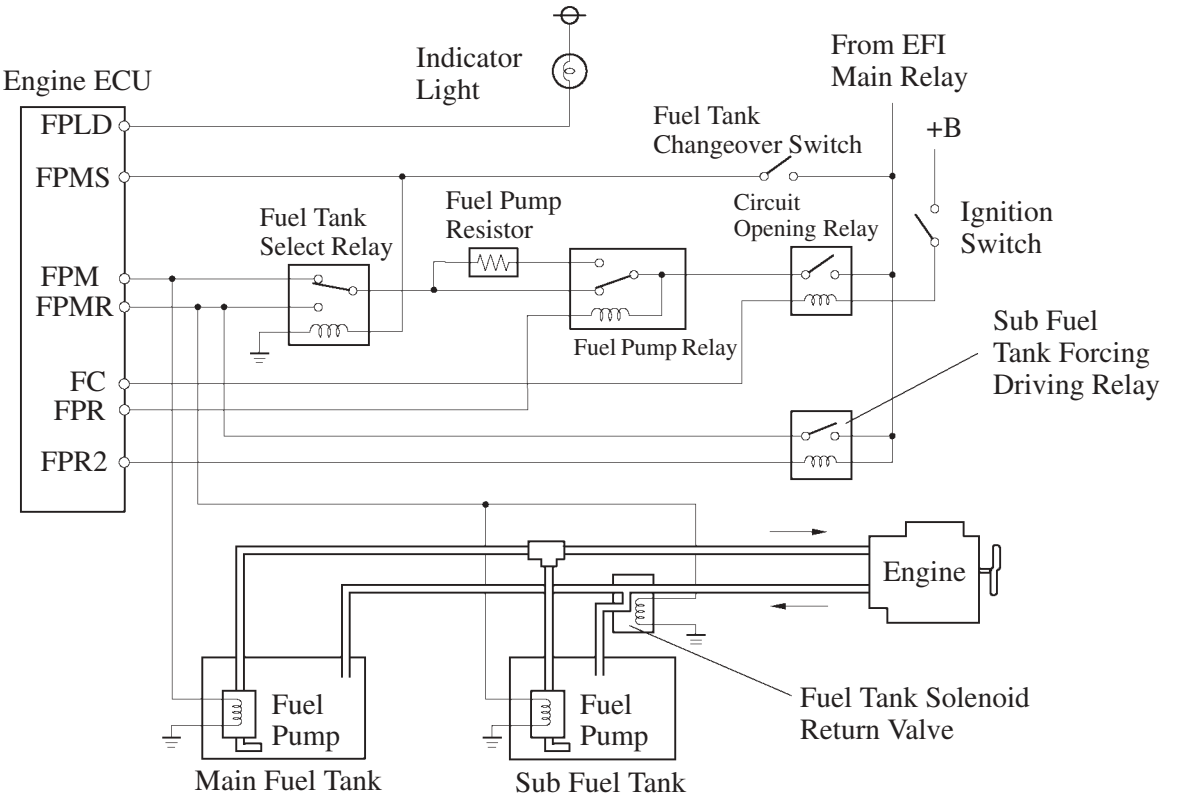


147EG13

7. Sub Fuel Tank Control

General

- 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.
- If a problem occurs in the electrical circuitry, the indicator light flashes to inform the driver.
- A diagnosis function is included for this system.



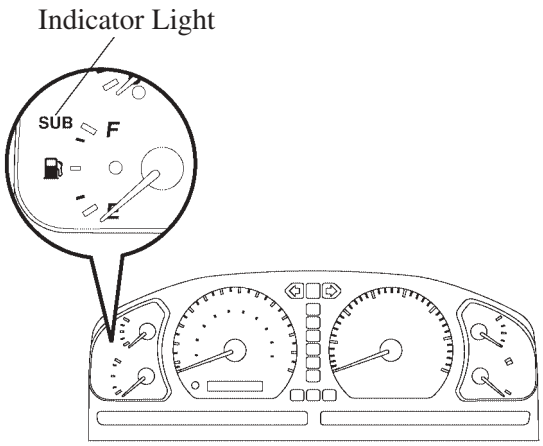
147EG16

Operation

- Turning the fuel tank changeover switch ON causes the fuel tank select relay to turn ON. This causes the fuel pump for the sub fuel tank to operate and supply the fuel in the sub fuel tank to the engine. At the same time, the fuel tank solenoid return valve turns ON to return the fuel to the sub fuel tank.
  In addition, the engine ECU turns on the indicator light to inform the driver that fuel is being supplied from the sub fuel tank.
- After the engine has started, if the engine coolant temperature is below a specified value, the engine ECU turns ON the sub fuel pump. This forces the driving relay to operate the sub fuel pump for a given time, thus preventing the sub fuel pump from seizure.
  Because the fuel tank solenoid return valve is also turned ON at this time, the return fuel is supplied to the sub fuel tank.

Diagnosis

If malfunction occurs in electrical circuity, the indicator light will blinks and alert the driver that a malfunction has occurred. The ECU will also store the codes of the malfunctions. For the diagnostic code check method, diagnostic code and diagnostic code clearance, see the 1FZ-FE Engine Repair Manual Supplement (Pub. No. RM619E).



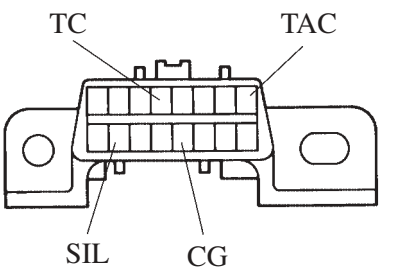
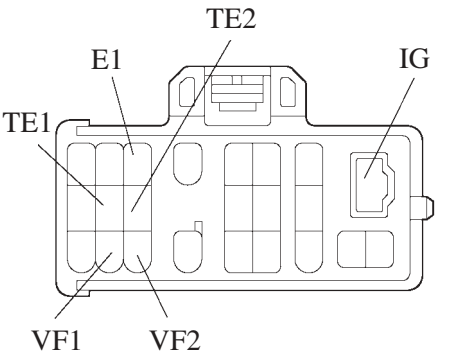
147EG34

8. Engine Immobiliser System

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

9. Diagnosis System

The M-OBD (Multiplex On-Board Diagnostic) system that has been adopted in the 1FZ-FE engine is the system that has been improved upon the previous diagnostic system in order to perform troubleshooting in a more efficient and accurate manner.
The functions of the M-OBD system can be fully utilized through the use of a hand-held tester.
The following table compares the M-OBD system and previous diagnostic system.

System / Item	M-OBD	Previous Diagnostic
Check Connector and Data Link Connector	The DLC3 (Data Lilnk Connector 3) has been newly provided. In addition, the check connector terminals TE1, TE2, and IG have been discontinued. **▶ DLC3 ◀**  140EG127 CG: Chassis Ground SIL: Provides communication between the engine ECU and the hand-held tester. TAC: Outputs the engine speed signal. TC: Provides the same function as the previous TE1 terminal.	The check connector is provided. **▶ Check Connector ◀**  140EG39
Diagnostic Trouble Code Check Method	After connecting terminals TC and CG of the DLC3, displays the code on CHECK Engine Lamp in the combination meter.	After connecting terminals TE1 and E1 of the check connector, displays the code on CHECK Engine Lamp in the combination meter.
Output Engine ECU Date	The engine ECU's control data can be output by connecting the hand-held tester to the DLC3. Output Date Speed: 9.6 kbps	The engine ECU's control data can be output by connecting the hand-held tester to the check connector. Output Date speed: 125 bps

Furthermore, on the M-OBD system, the functions listed below can be utilized by connecting the hand-held tester to the DLC3.

Function	Details
Diagnostic Trouble Code	The system can output 5-digit diagnostic trouble codes to the tester, which are more detailed than the previous 2-digit diagnostic trouble codes, thus making it easier to identify the location of the problem. Example: Code 28 (Oxygen Sensor) → P0130 (Oxygen Sensor) → P0135 (Oxygen Sensor Heater)
Freeze-Frame Data	The system can output freeze-frame data to the tester. This data (which depicts the condition of the engine control system and the vehicle) is stored in the engine ECU at the very moment when the engine ECU has detected its last data of malfunction.
Active Test	Through the use of the tester, the actuators (VSV, fuel pump, ISC valve, etc.) can be activated to a desired state.
Trouble Code Clear	Through the use of the tester, trouble codes stored in the engine ECU can be cleared.

- For details of the diagnostic trouble codes, active test, etc. described above, refer to the 1FZ-FE Engine Repair Manual Supplement (Pub. No. RM619E).
- For details of the hand-held tester, refer to the Hand-Held Tester Operator's Manual.