■ENGINE CONTROL SYSTEM

1. General

The engine control system of the 1ND-TV engine has the following systems.

System	Outline	New	Previous
Fuel Injection Volume Control (See page EG-178)	Based on the signals received from the sensors, the engine ECU determines the fuel injection volume in accordance with the engine condition.	○	○
Fuel Injection Timing Control (See page EG-179)	Based on the signals received from the sensors, the engine ECU determines the fuel injection timing in accordance with the engine condition.	○	○
During Starting Control (See page EG-180)	To facilitate startability, the engine ECU optimally controls the injection volume and injection timing during starting.	○	○
Idle Speed Control (See page EG-181)	The engine ECU determines the idle speed in accordance with the engine condition, and controls the fuel injection volume in order to maintain the target idle speed.	○	○
Fuel Pressure Control (See page EG-182)	Based on the signals received from the sensors, the engine ECU determines the fuel pressure via the MPROP and fuel pressure regulator in accordance with the engine condition.	○	○
Pilot Injection Control (See page EG-184)	Based on the signals received from the sensors, the engine ECU determines pilot injection volume/timing, and interval (between pilot injection and main injection) in accordance with the engine condition.	○	○
Glow Plug Control	Controls the length of time when current is applied to the glow plugs in accordance with water temperature.	○	○
EGR Control (See page EG-185)	Based on the signals received from the sensors, the engine ECU determines the EGR volume via the EGR valve in accordance with the engine condition.	○	○
Turbo Pressure Control (See page EG-186)	Based on the signals received from the sensors, the engine ECU controls the actuator via VRV in accordance with the engine condition.	○	—
Intake Throttle Control	The engine ECU determines the throttle valve opening angle via the E-VRV in accordance with the engine condition.	—	○
	Based on the signals received from sensors, the engine ECU determines the throttle valve opening angle via the torque motor in accordance with the engine condition.	○	—
	Fully closes the throttle valve in order to reduce the vibration when the engine is stopped.	○	○
Cooling Fan Control (See page EG-54)	Radiator cooling fan operation is controlled by the water temperature sensor signal (THW) and condition of the air conditioner operation.	○	○

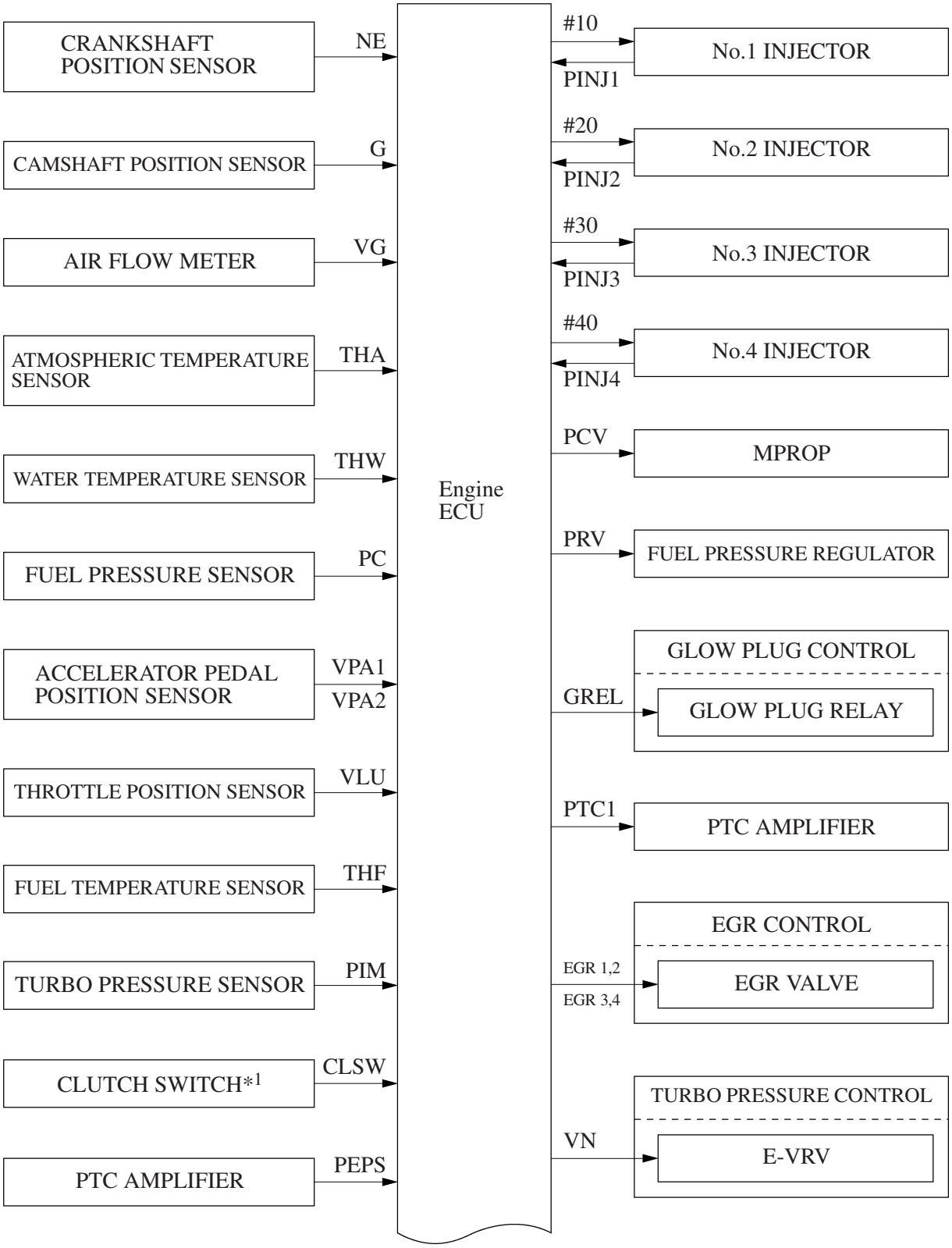
(Continued)

System	Outline	New	Previous
Air conditioner Cut-off Control*1	By turning the air conditioner compressor ON or OFF in accordance with the engine condition, drivability is maintained.	○	○
Cranking Hold Function (See page EG-187)	● Once the ignition switch is turned to the START position, this control continues to operate the starter until the engine is started.*2 ● Once the engine switch is pushed, this control continues to operate the starter until the engine is started.*3	○	—
Oil Maintenance Management System (See page EG-191)	An oil maintenance management system illuminates an oil change reminder light to inform the driver when the engine oil and oil filter must be changed.	○	—
Diagnosis (See page EG-193)	When the engine ECU detects a malfunction, the engine ECU diagnoses and memorizes the failed section.	○	○
Fail-safe (See page EG-193)	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: Models with Air Conditioner
*2: Models without Smart Entry & Start System
*3: Models with Smart Entry & Start System

2. Construction

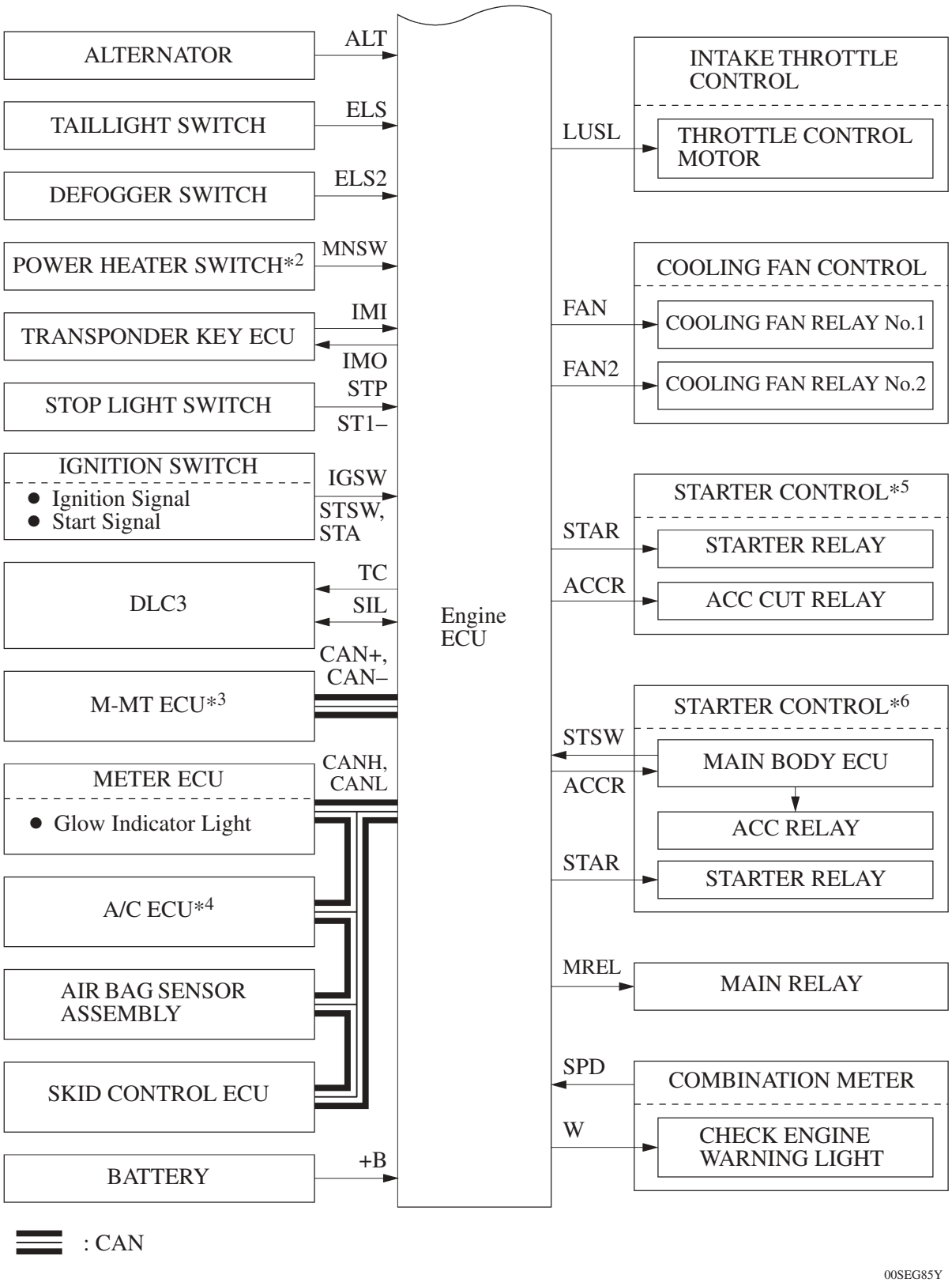
The configuration of the engine control system in the 1ND-TV engine is as shown in the following chart.



(Continued)

*1: M/T Models

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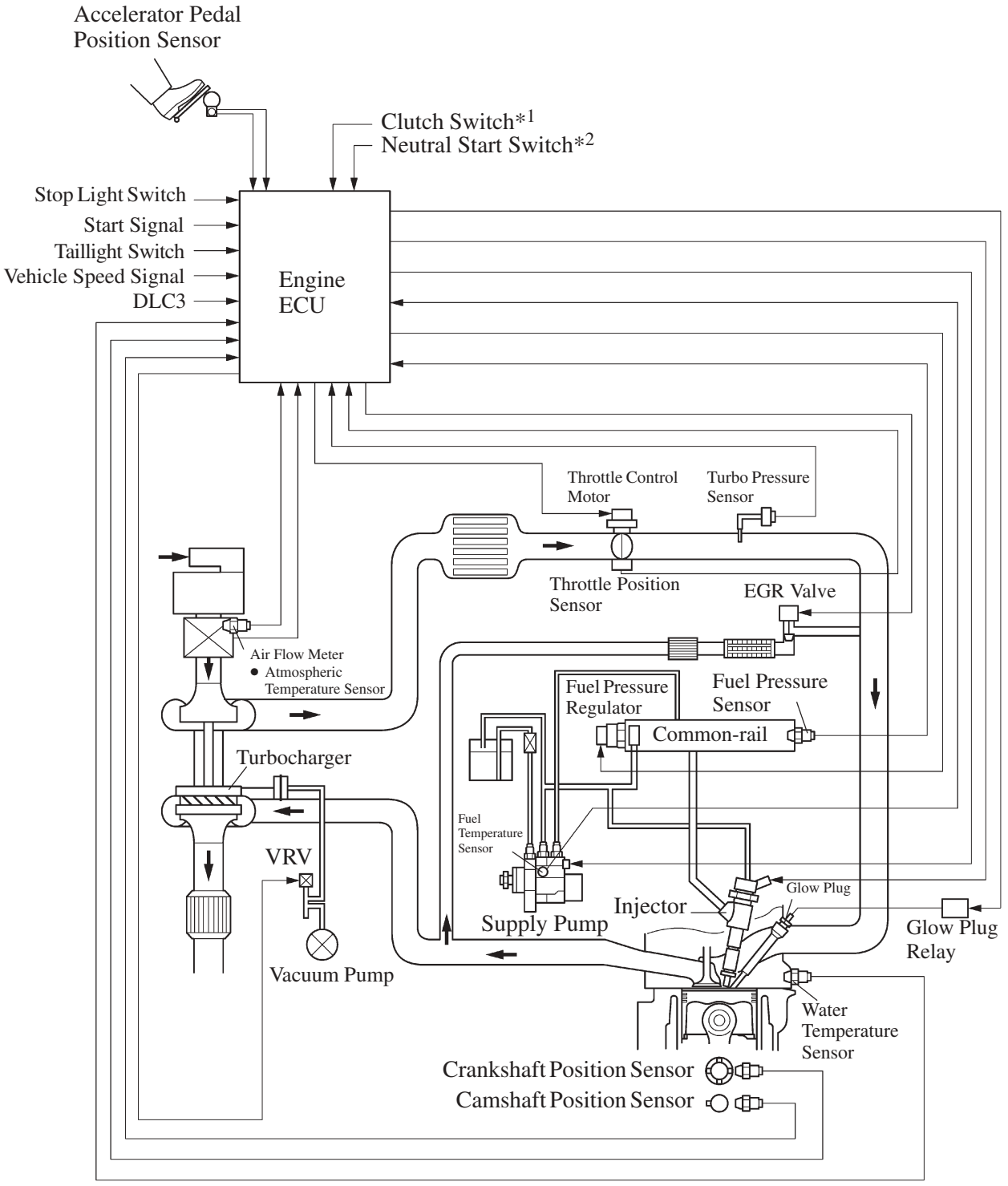


00SEG85Y

*2: Models with Combustion Type Power Heater
*3: Multi-mode Manual Transmission Models
*4: Models with Air Conditioner
*5: Models without Smart Entry & Start System
*6: Models with Smart Entry & Start System

EG

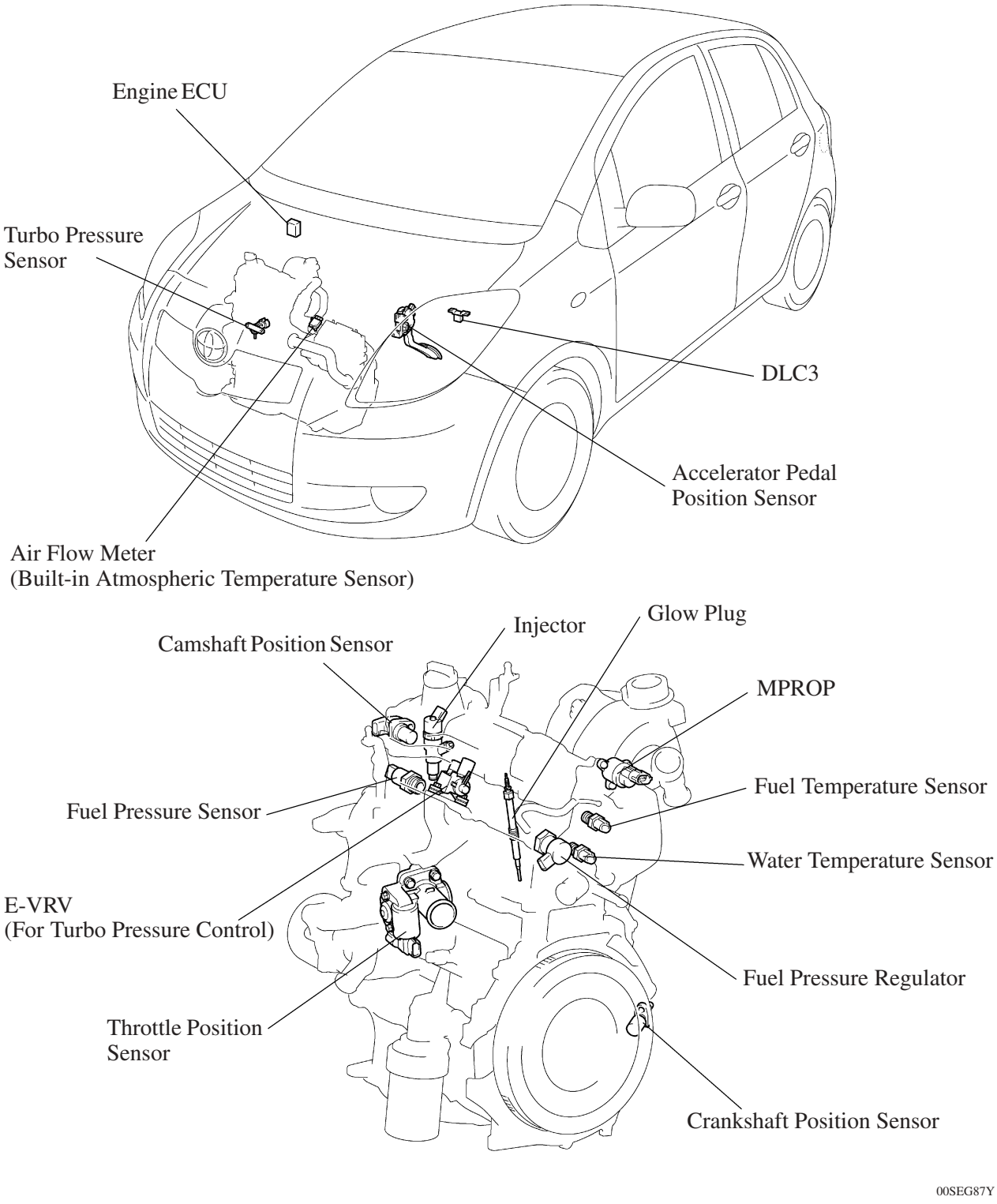
3. Engine Control System Diagram



00SEG86Y

*1: M/T Models
*2: M-MT Models

4. Layout of Main Component



5. Main Components and Engine Control System

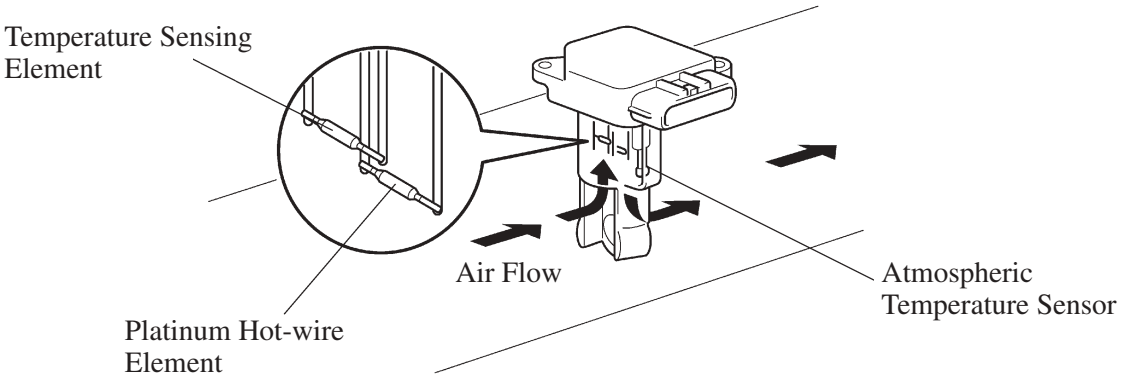
General

The following table compares the main components.

Component	Outline	Quantity
Engine ECU	32-bit ECU	1
Air Flow Meter	Hot-wire Type	1
Crankshaft Position Sensor (Rotor Teeth)	Magnet Pick-up coil Type (60-2)	1
Camshaft Position Sensor (Rotor Teeth)	Hall Element Type (1)	1
Throttle Position Sensor	Non-contact Type	1
Accelerator Pedal Position Sensor	Non-contact Type	1
Injector	6-hole Type	4

Air Flow Meter

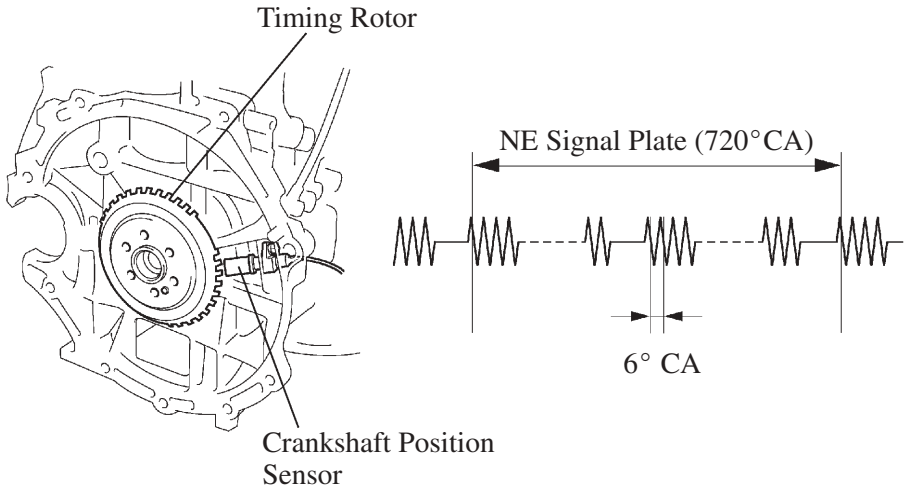
- The air flow meter of diesel engine uses precise fuel injection volume control and EGR volume control to realize excellent clean emission
- This air flow meter, which is a plug-in type, allows a portion of the intake air flow through the detection area. By directly measuring the mass and the flow rate of the intake air, the detection precision has been ensured and the intake air resistance has been reduced.
- This air flow meter has a built-in atmospheric temperature sensor.



204EG54

Crankshaft Position Sensor

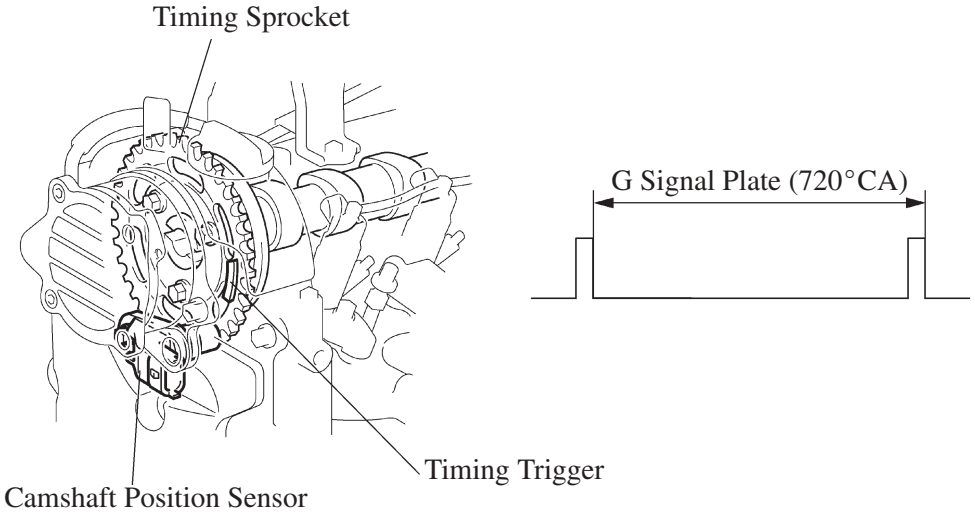
The timing rotor of the crankshaft consists of 58 teeth with 2 teeth missing. The crankshaft position sensor outputs the crankshaft rotation signals every 6°, and the missing teeth are used to determine the top-dead-center.



217EG46

Camshaft Position Sensor

- The hall element type camshaft position sensor is used.
- To detect the camshaft position, a protrusion that is provided on the timing sprocket is used to generate 1 signal for every 2 revolution of the crankshaft.



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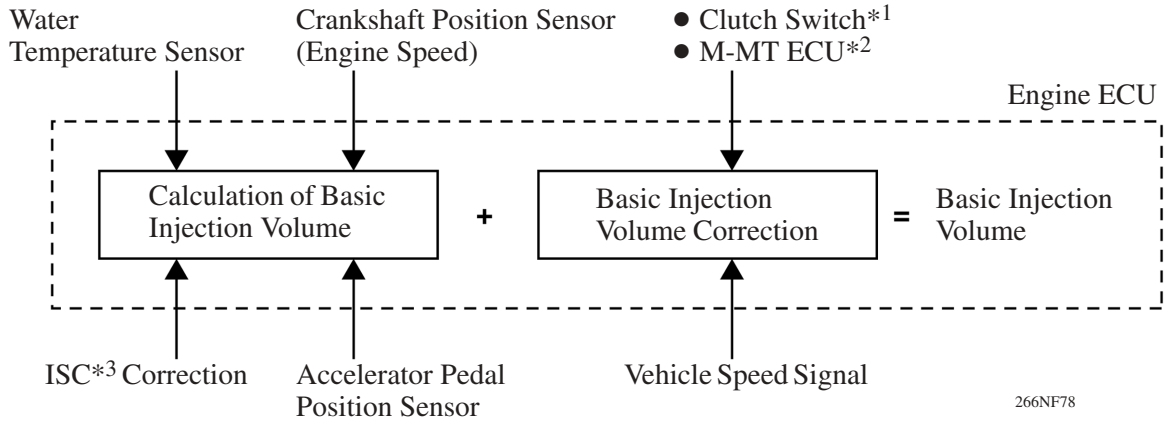
Accelerator Pedal Position Sensor

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

6. Fuel Injection Volume Control

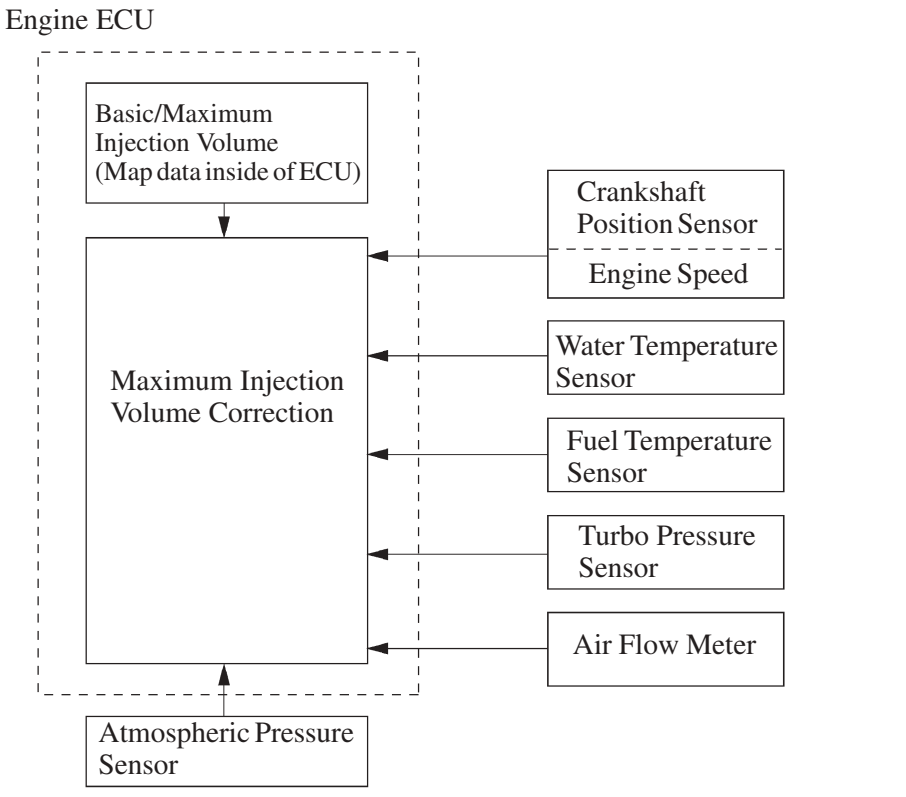
The engine ECU calculates two types of values: the basic injection volume and the maximum injection volume. Then the engine ECU compares the basic injection volume with the maximum injection volume, and determines a smaller calculated value to be the final injection volume.

▶ Basic Injection Volume ◀

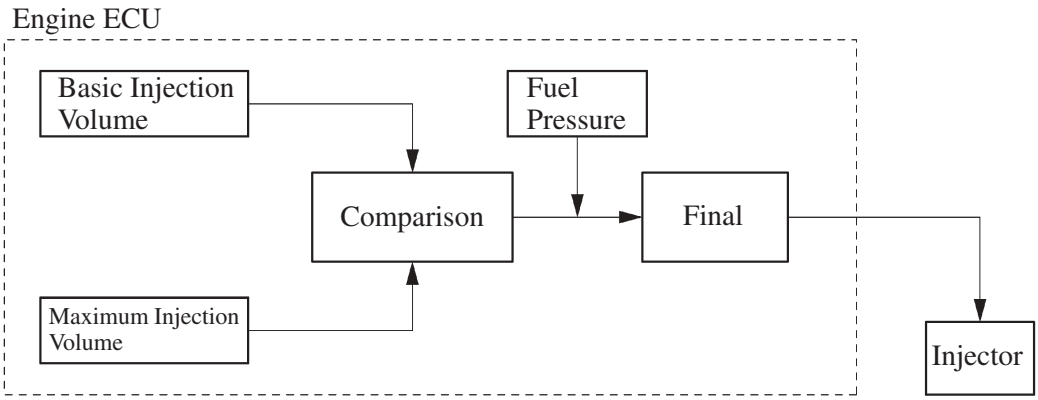


*1: M/T Models
*2: M-MT Models
*3: Idle Speed Control

▶ Maximum Injection Volume ◀



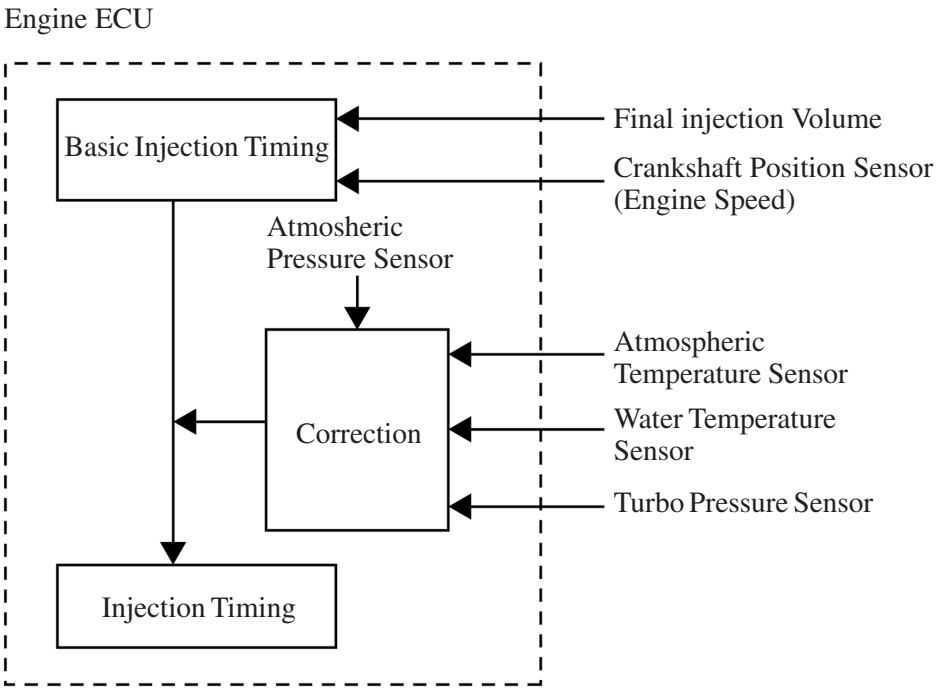
▶ Final Injection Volume Decision ◀



217EG50

7. Fuel Injection Timing Control

Fuel injection timing is controlled as shown below.

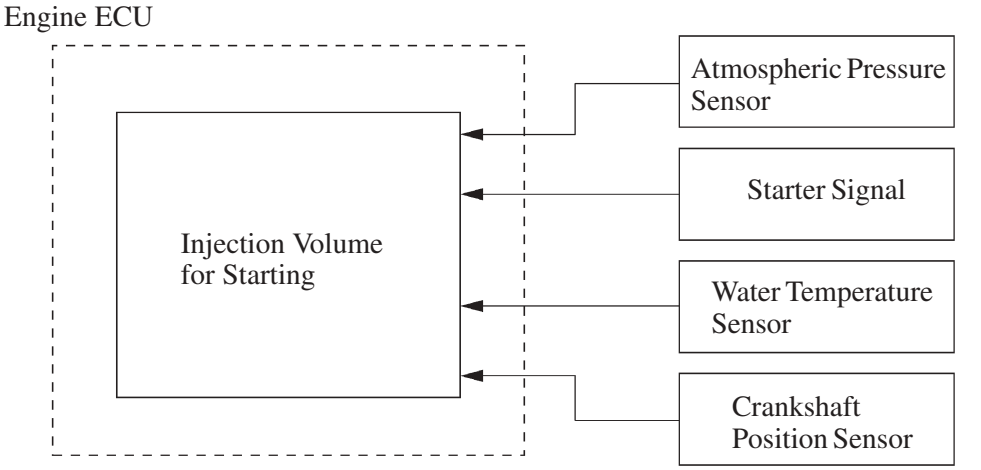


266NF81

8. During Starting Control

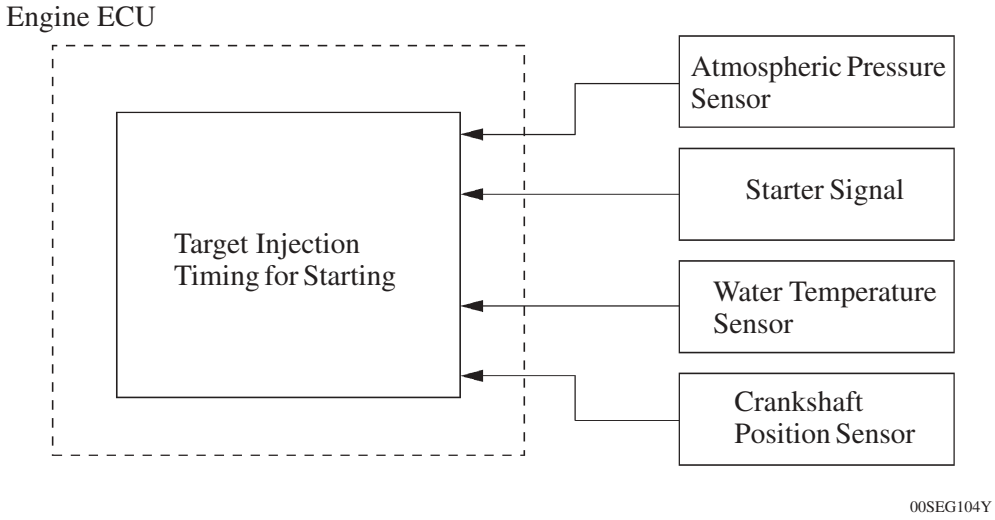
Injection Volume Control

The starting injection volume is determined independent from the basic injection volume in accordance with the starter ON signals (ON time), water temperature sensor signals and engine speed signals. When the engine is cold, the water temperature will be lower and the injection volume will be greater.



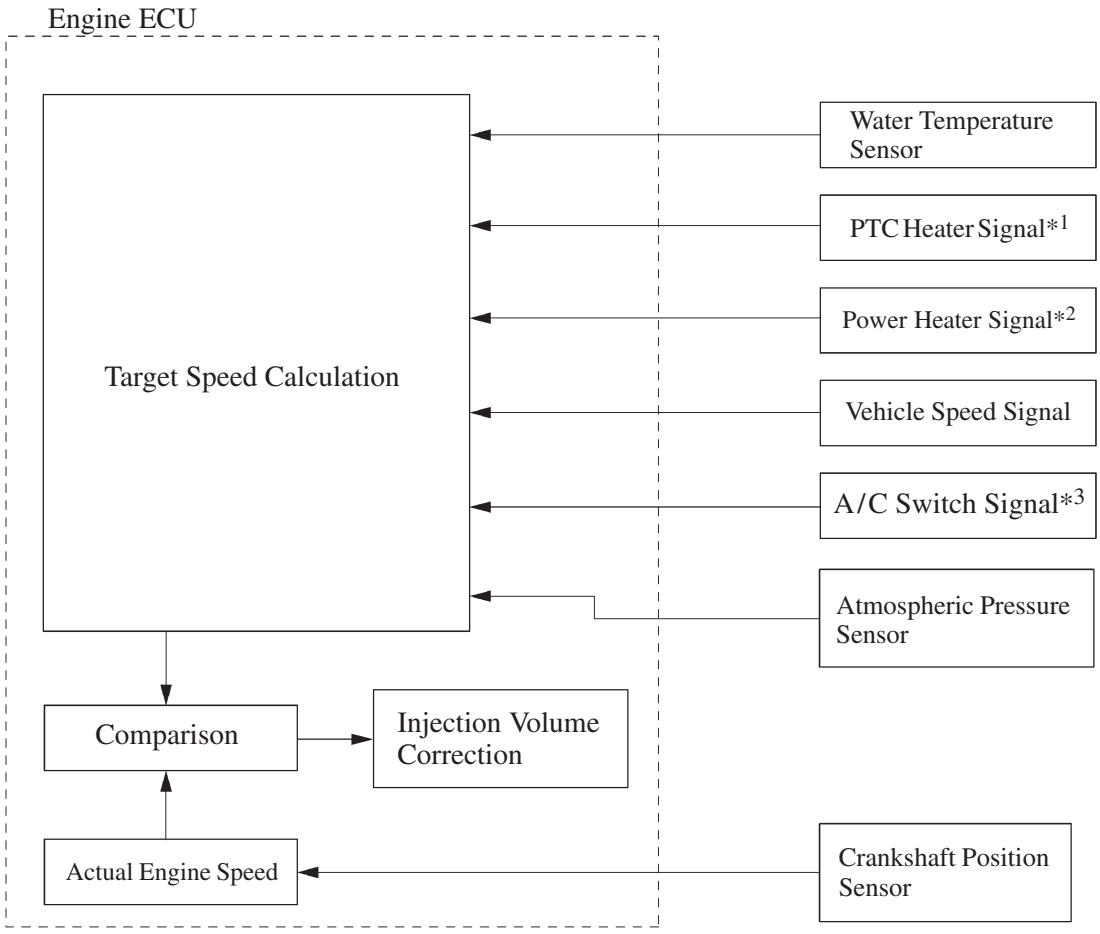
Injection Timing Control

The starting injection timing is determined independently from the basic injection timing in accordance with the starter signal, water temperature signal, and engine speed signal.



9. Idle Speed Control

ISC (Idle Speed Control) correction is controlled as shown below.



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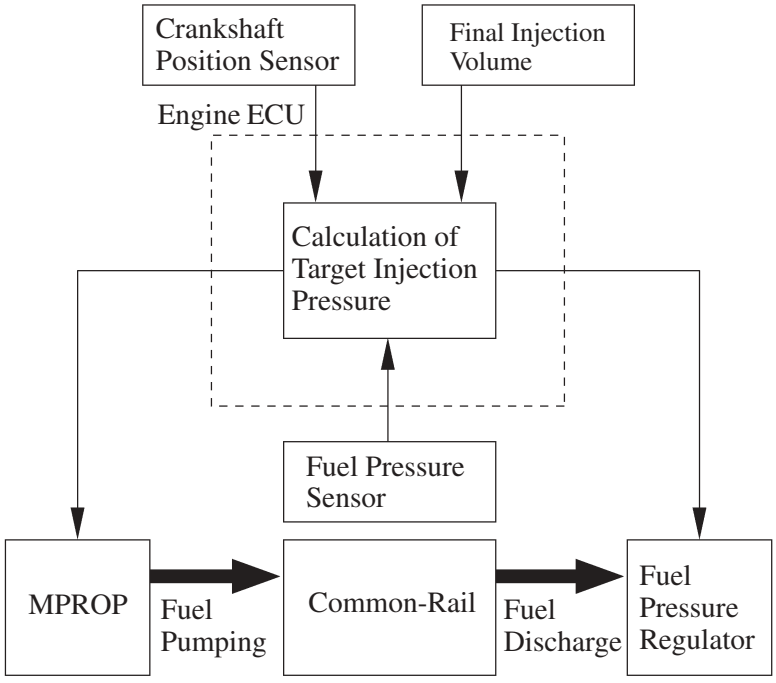
*1: Models with PTC Heater
*2: Models with Combustion Type Power Heater
*3: Models with Air Consitioner

EG

10. Fuel Pressure Control

General

The engine ECU calculates the target injection pressure (30 – 160 MPa) based on the engine conditions, which are the final injection volume and the signal from the crankshaft position sensor.
To control fuel pressure, signals sent to MPROP of the supply pump regulate the pumping volume and signals sent to fuel pressure regulator of the common-rail regulate the discharge volume, so that the pressure detected by the fuel pressure sensor matches the target injection pressure.



224EG52

System Operation

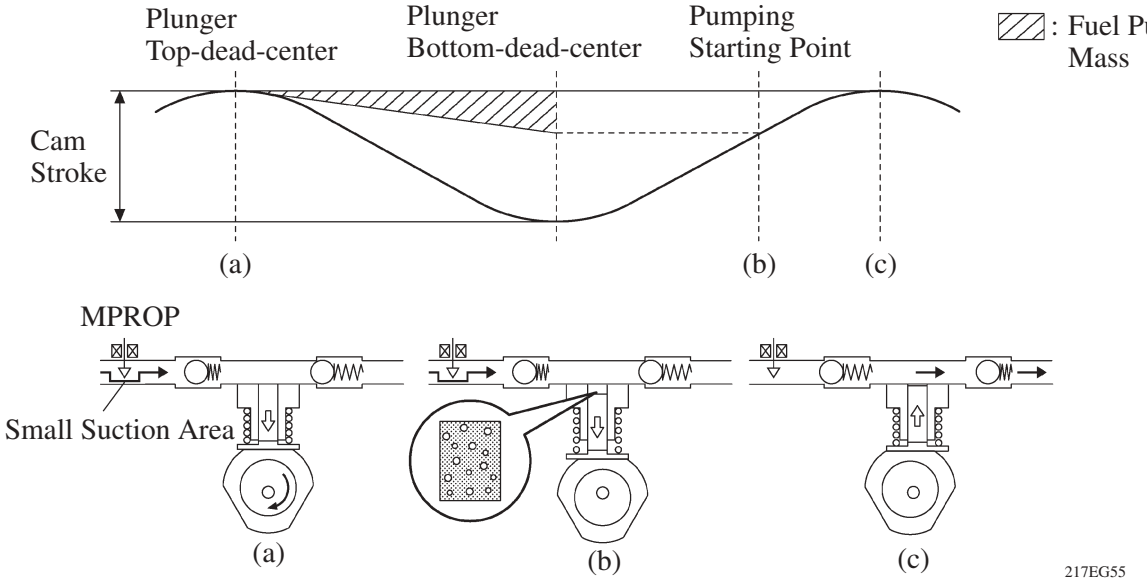
The engine ECU controls the opening of the MPROP in order to regulate the volume of fuel that is pumped by the supply pump to the common-rail. Consequently the fuel pressure in the common-rail is controlled to the target injection pressure.

▶ MPROP Opening Small ◀

(a) When the opening of the MPROP is small, the fuel suction area is kept small, which decreases the transferable fuel quantity.

(b) The plunger strokes fully, however, the suction volume becomes small due to the small suction area. Therefore, the difference of the volume between the geometry volume and suction volume is in vacuum condition.

(c) Pumping will start at the time when the fuel pressure has become higher than the common-rail pressure.

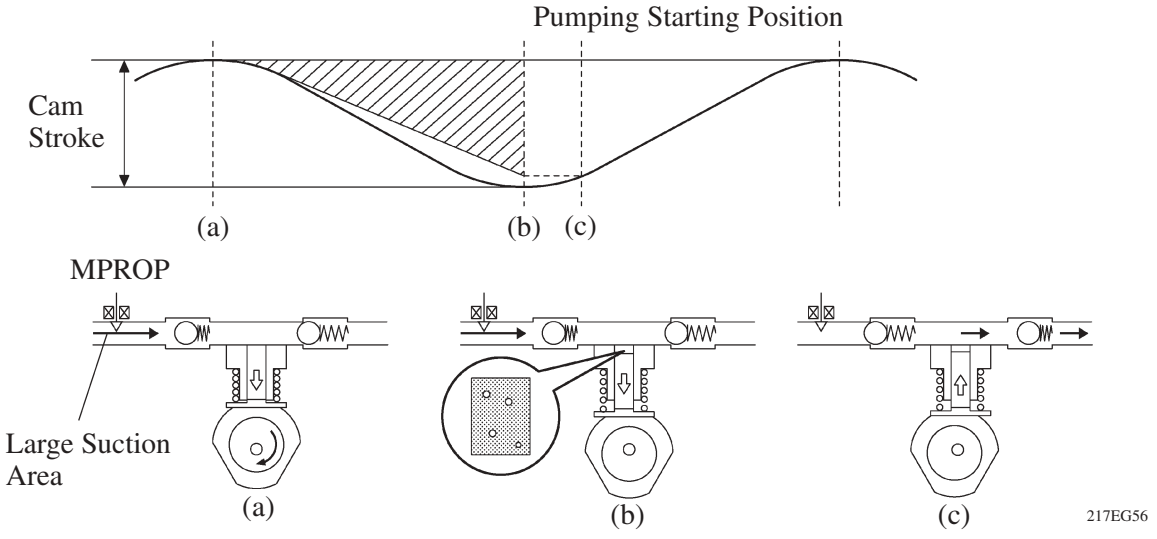


▶ MPROP Opening Large ◀

(a) When the opening of the MPROP is large, the fuel suction area is kept large, which increases the transferable fuel quantity.

(b) If the plunger strokes fully, the suction volume will increase because the suction area is large.

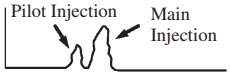
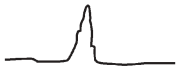
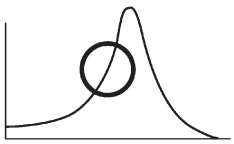
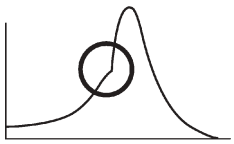
(c) Pumping will start at the time when the fuel pressure has become higher than the common-rail pressure.



EG

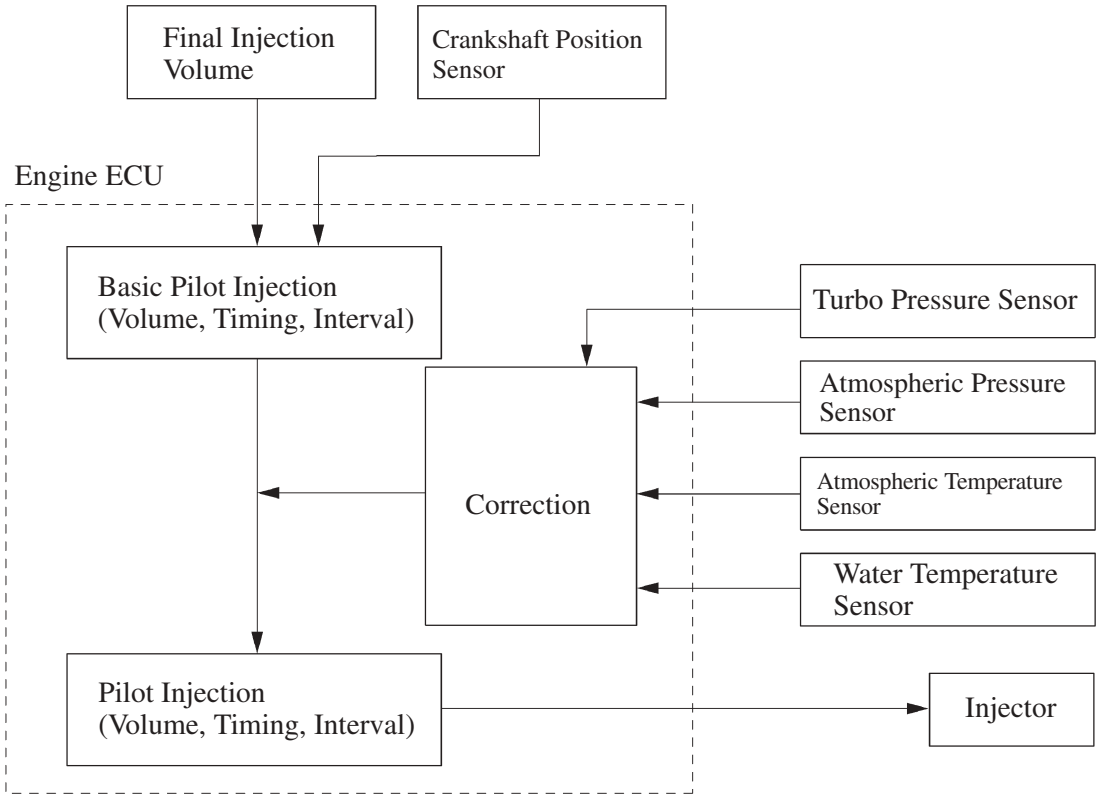
11. Pilot Injection Control

- Pilot injection is a method that provides an auxiliary fuel injection before the main fuel injection takes place. The purpose of pilot injection is to gently start the combustion of the fuel of the main injection in order to reduce combustion noise.

Start	Pilot Injection	Ordinarily Injection
Fuel Injection		
Combustion Pressure		

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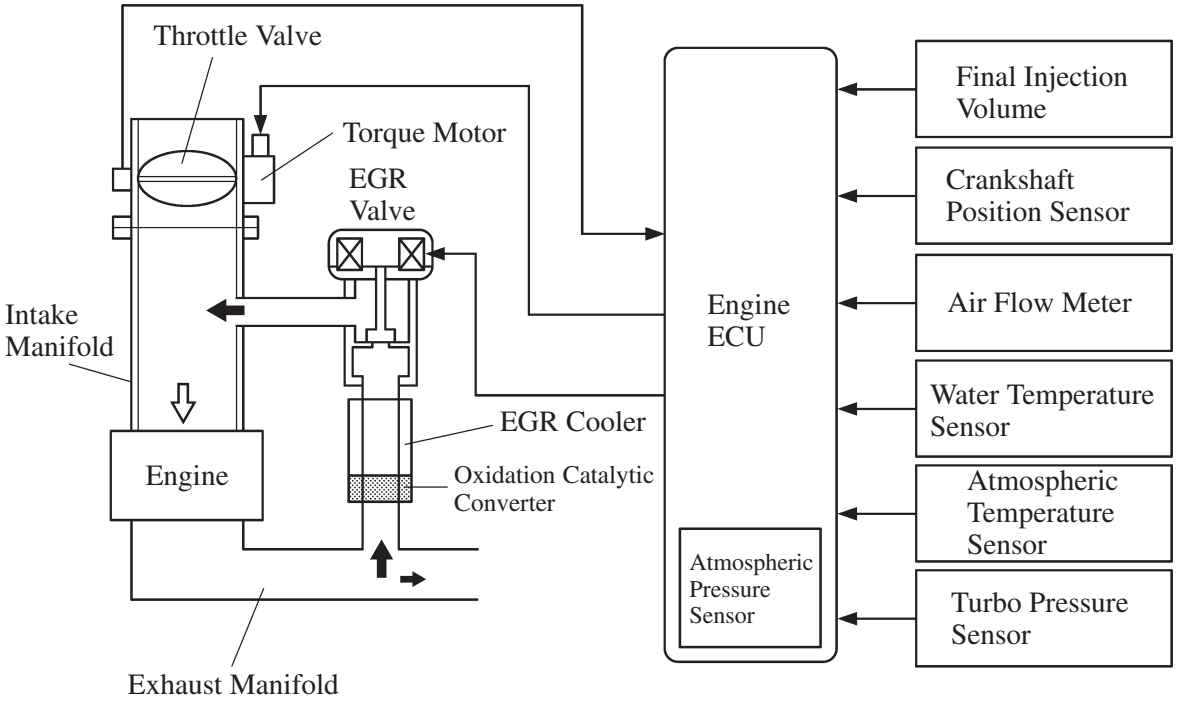
- During pilot injection, the pilot injection volume, timing, and interval (between pilot injection and main injection) are controlled as shown below.



00SEG106Y

12. EGR Control

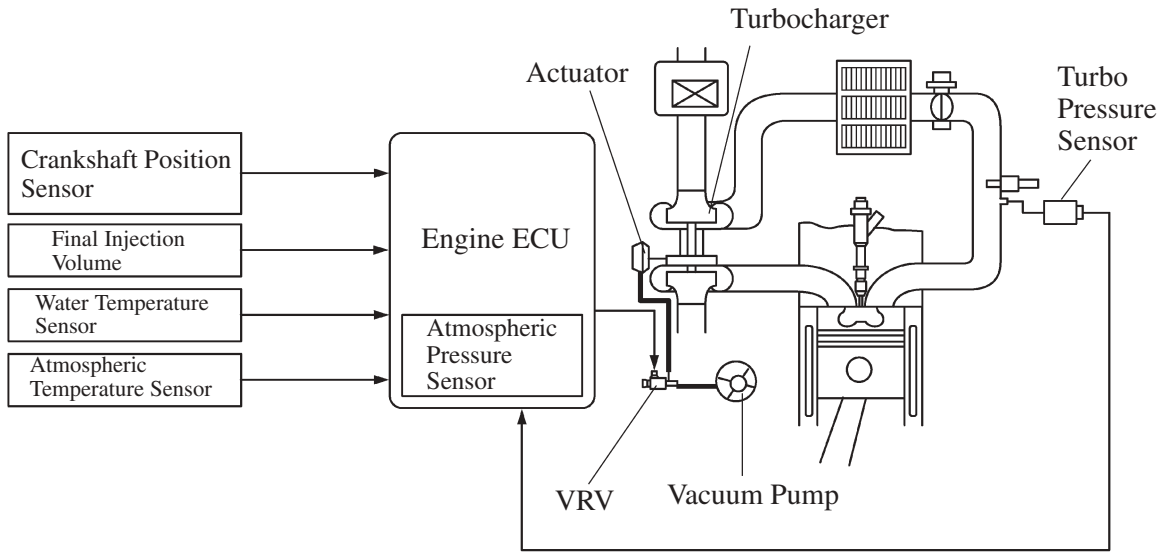
By sensing the engine driving conditions, the control unit electrically operates EGR valve of step motor operation type and throttle valve of torque motor operation type, and regulates the amount of recirculating exhaust gas.



00SEG46Y

13. Turbo Pressure Control

- The turbo pressure (intake manifold pressure) is controlled by the variable nozzle vane located in the turbine area. This nozzle is actuated by the actuator that is directly connected to it. This actuator is actuated by the vacuum pressure that has been regulated by the VRV (Vacuum Regulating Valve) in accordance with the signals from the engine ECU.
- The engine ECU calculates an optimal turbo pressure in accordance with the driving conditions (engine speed, injection volume, atmospheric pressure, and water temperature). It controls the variable nozzle so that the turbo pressure detected by the turbo pressure sensor matches the calculated turbo pressure.



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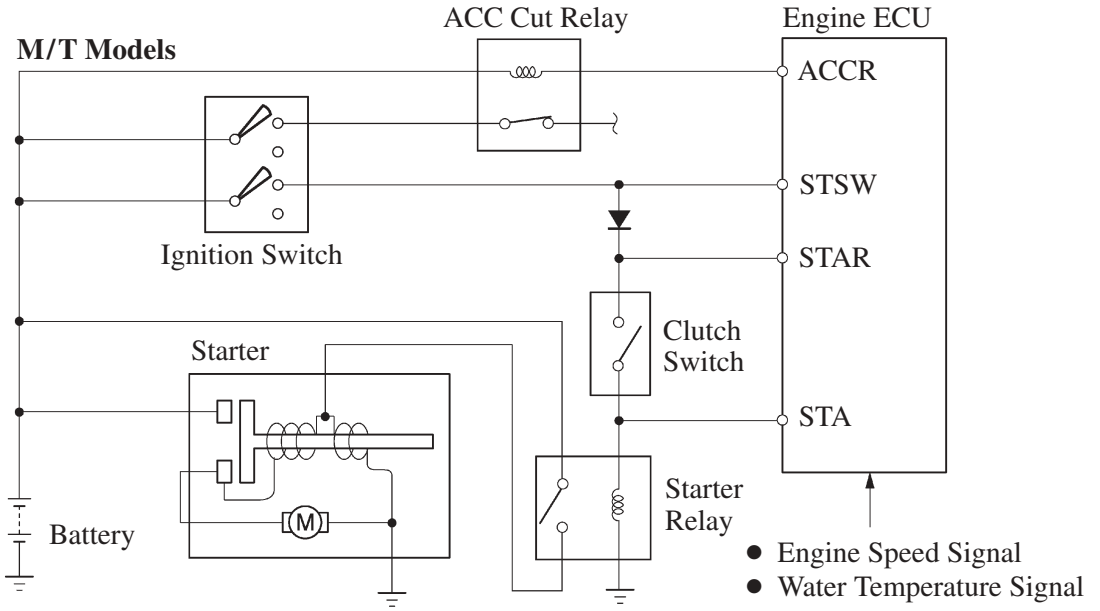
14. Cranking Hold Function

General

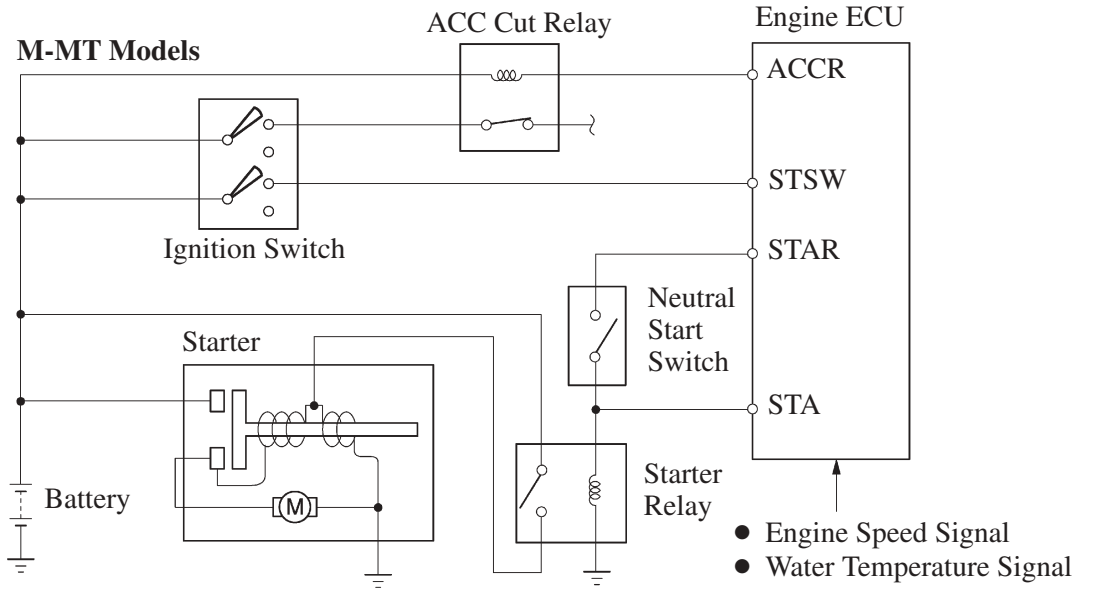
1) For Model without Smart Entry & Start System

- Once the ignition switch is turned to the START position, this control continues to operate the starter without having to hold the ignition switch in the START position, and stops the starter when the engine starts. This prevents starting failures. However, on the manual transaxle models, if the ignition switch is held in the START position, the starter continues to operate.
- 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.
- On the M-MT models, 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 ◀



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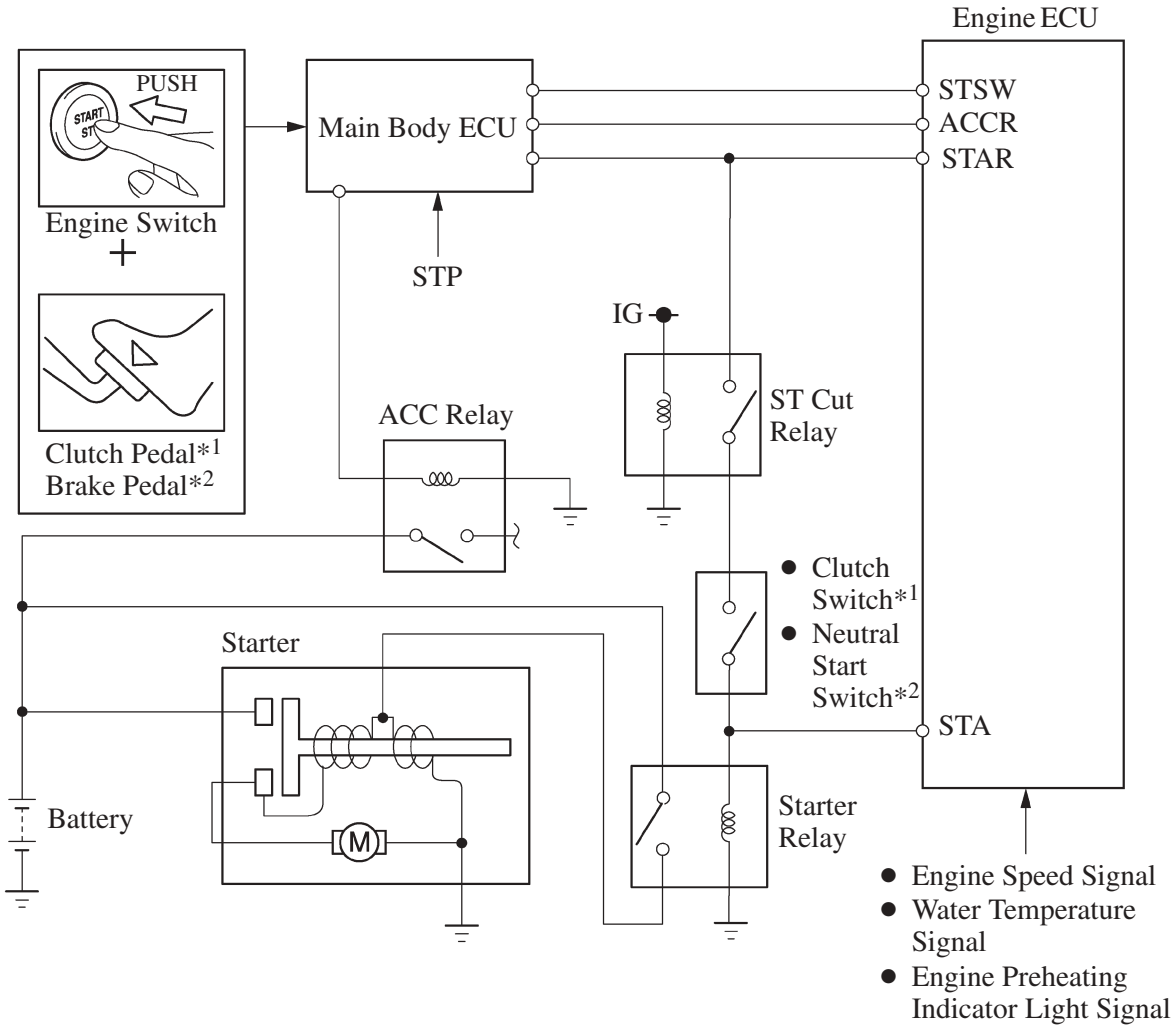


00SEG107Y

2) For Model with Smart Entry & Start System

- Once the engine switch is pushed, this function continues to operate the starter until the engine has started, provided that the brake pedal on the M-MT models or clutch pedal on the M/T models is pressed. This prevents starting failures and the engine from being cranked after the engine has started.
- When the engine ECU detects a start signal from the main body ECU, 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 main body ECU, this system will not operate if the engine ECU has determined that the engine has already started.

▶ System Diagram ◀



*1: M/T Models
*2: M-MT Models

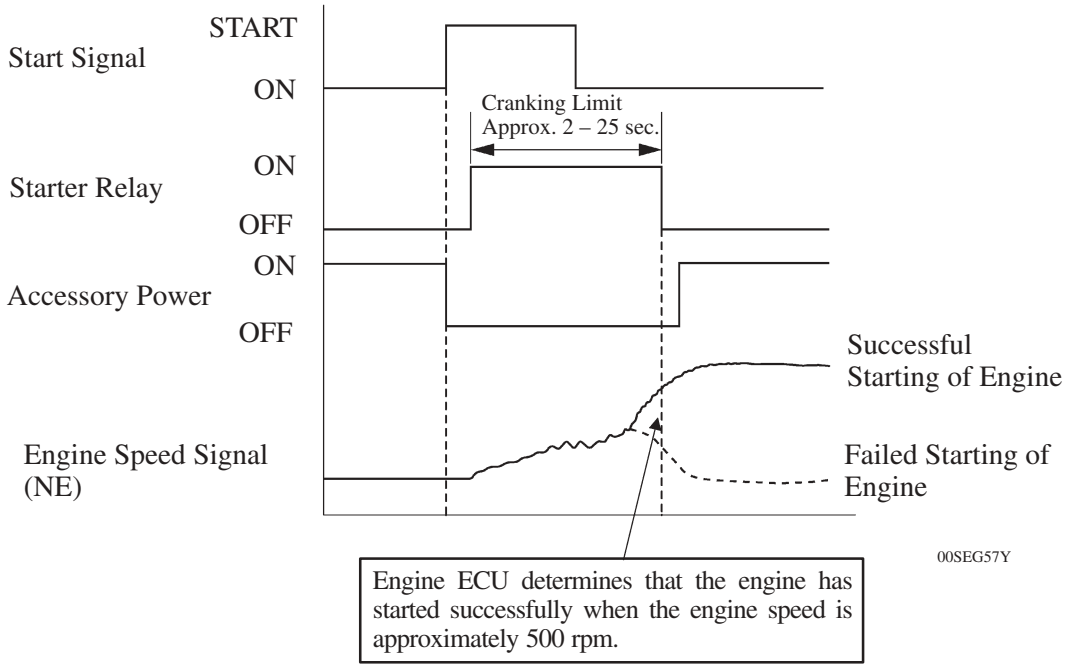
00SEG56Y

Operation

1) For Models without Smart Entry & Start System

- As indicated in the following timing chart, 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 does 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 water temperature condition. When the water 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.
- This system has the following protections.
  - On the M-MT models, while the engine is running normally, even if turning the ignition switch to START position, the starter will not operate.
  - On the M-MT models, in case that the driver keeps holding the ignition switch in START position and the engine starts half way, the engine ECU will stop the starter operation when the engine speed has becomes between 900 and 1,000 rpm, which varies according to the water temperature.
  - On the M-MT models, in case that the driver keeps holding the ignition switch in START position and the engine will not start, the engine ECU will stop the starter operation when approximately 30 seconds have been passed.
  - In case that the starter begins to operate, but cannot detect the engine speed signal, the engine ECU will stop the starter operation. However, on the manual transaxle models, if the ignition switch is held in the START position, the starter continues to operate.

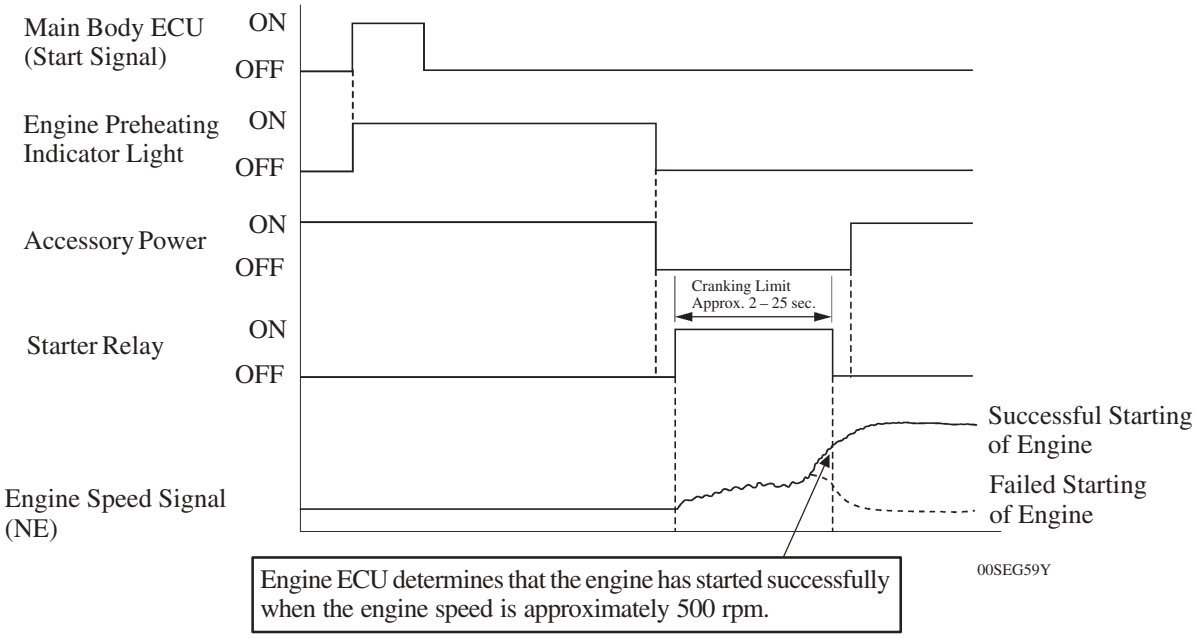
▶ Timing Chart ◀



2) For Models with Smart Entry & Start System

- As indicated in the following timing chart, when the engine ECU detects a start signal (STSW) from the main body ECU, the engine ECU outputs STAR and ACCR signals to the main body ECU at the same time that the engine preheating indicator light turns OFF. Upon detecting the STAR and ACCR signals from the engine ECU, the main body ECU energizes the starter relay to operate the starter. If the engine is already running, the engine ECU stops the output of the STAR and ACCR signals to the main body ECU. Thus, the main body ECU will not energize the starter relay.
  However, if the engine ECU detects a start signal again while the engine preheating indicator light is on, the engine ECU outputs STAR and ACCR signals and main body ECU energizes the starter relay to operate the starter.
- 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 output of the STAR and ACCR signals to the main body ECU. Thus, the main body ECU will stop the operation of the starter.
- If the engine has any failure and does 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 water temperature condition. When the water 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.
- This system has following protections.
  - While the engine is running normally, the starter does not operate.
  - In case the driver keeps pressing the engine switch and the engine starts half way, the engine ECU stops the output of the STAR and ACCR signals when the engine speed becomes higher than between 900 and 1,000 rpm, which varies according to the water temperature. Thus, the main body ECU will stop the operation of the starter.
  - In case the driver keeps pressing the engine switch and the engine does not start, the engine ECU stops the output of the STAR and ACCR signals after 30 seconds have elapsed. Thus, the main body ECU will stop the operation of the starter.
  - In case the engine ECU cannot detect an engine speed signal while the starter is operating, the engine ECU will stop the output of the STAR and ACCR signals. Thus, the main body ECU will stop the operation of the starter.

▶ Timing Chart ◀

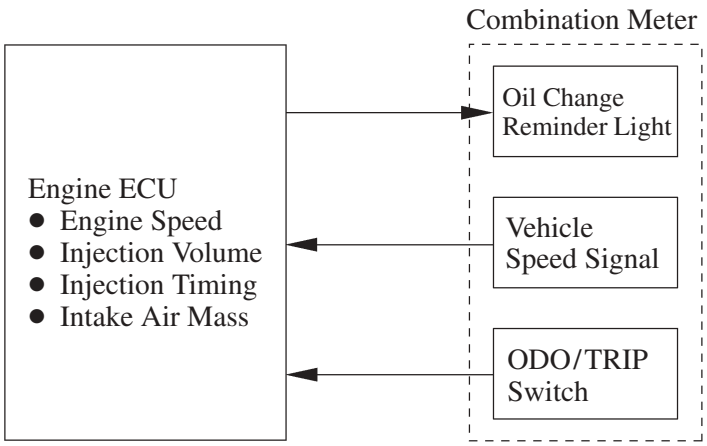


15. Oil Maintenance Management System

General

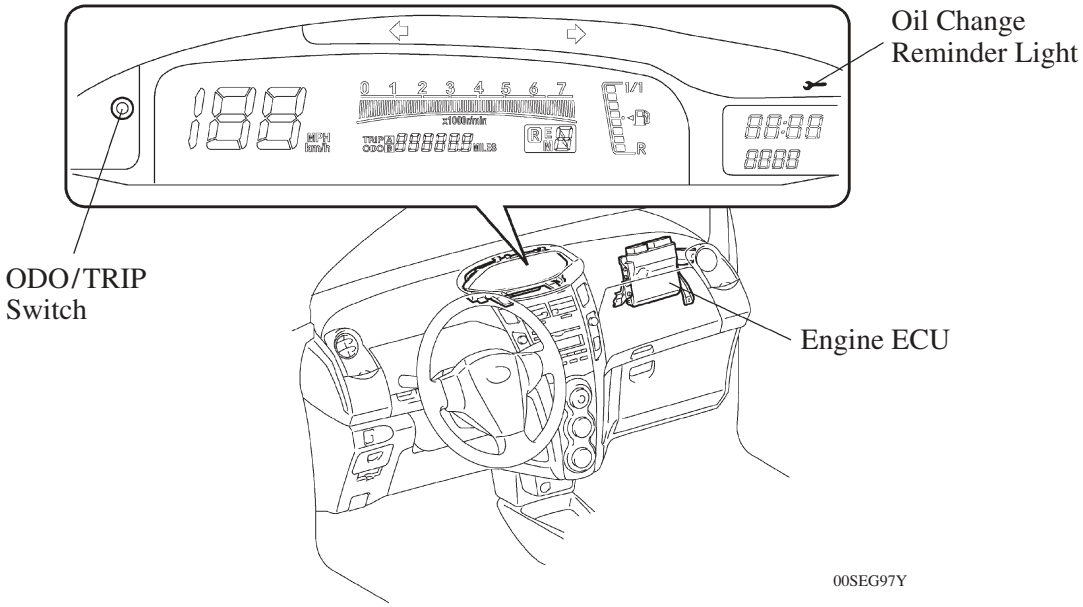
- An oil maintenance management system is newly used. This system determines the deterioration conditions of the engine oil and illuminates an oil change reminder light to inform the driver when the engine oil and oil filter must be changed. Accordingly, the maintenance intervals (40,000 km maximum) that correspond to the actual deterioration conditions of the engine oil have been realized.
- This system indirectly determines the deterioration of the engine oil based on the information provided by the engine ECU.

System Diagram



263EG19

Layout of Components

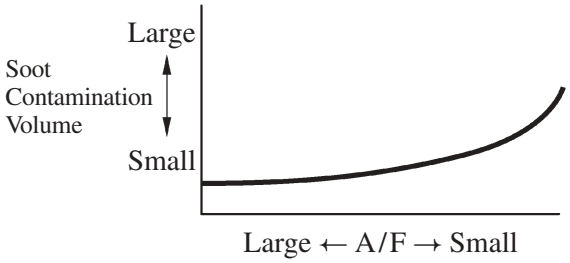


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System Operation

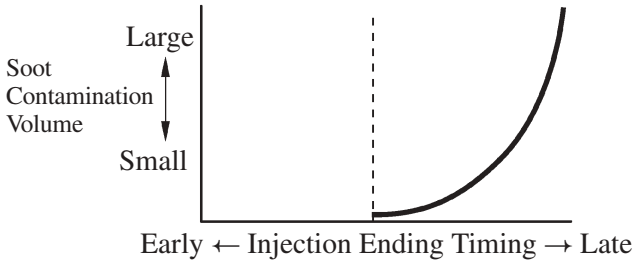
- This system determines the deterioration of the engine oil in accordance with the soot volume in the engine oil. The engine ECU calculates the soot volume in the engine oil in accordance with engine speed, injection timing, injection volume, and intake air mass. The engine ECU blinks the oil change reminder light when the calculated value of the soot volume approaches the predetermined value, and illuminates the light when the calculated value exceeds the predetermined value. Thus, this system informs the driver that the engine oil and oil filter must be changed.

▶ Soot Generation Conditions ◀



Relationship to Air-fuel Ratio

224EG35



Relationship to Injection Ending Timing

224EG36

- In addition to controlling the blinking and illumination of the oil change reminder light by counting the soot volume, the engine ECU blinks the oil change reminder light when the vehicle's driven distance exceeds 35,000 km, and illuminates the light when the distance exceeds 40,000 km. Thus, this function realizes the excellent reliability of the system.

NOTICE:

This system does not determine the deterioration of the engine oil based on the elapsed time. Even if the oil change reminder light does not illuminate, the engine oil and oil filter should be changed at 2-year intervals at the maximum.

Counter Reset

The accumulated mileage/kilometrage memorized in the engine ECU can be reset by the following procedures.

For Model without Smart Entry & Start System

- Turn the ignition key to the IG-ON position.
- Check that the LCD display screen has changed to the ODO mode.
  (The reset procedure will not function in TRIP mode.)
- Turn the ignition key to the OFF position.
- While pressing the ODO/TRIP switch, turn the ignition key to the IG-ON position. Do not depress the clutch pedal or brake pedal during this operation. After turning the ignition key to the IG-ON position, press and hold the ODO/TRIP switch for 5 seconds or more. When the LCD display screen shows no display, release the ODO/TRIP switch.
- The oil change reminder light goes OFF and then the LCD display indicates "000000" for about 1 sec.
- The LCD display should change to the ODO mode.
- This completes the reset procedure.

For Model with Smart Entry & Start System

- Push the engine switch and set the start system to the IG-ON mode.
- Make sure that the LCD display screen is the ODO mode.
  (Reset procedure will not work in the TRIP mode)
- Push the engine switch and set the start system to the OFF mode.
- While pressing the ODO/TRIP switch, push the engine switch to set the system to the IG-ON mode without depressing the clutch pedal. After setting the system to the IG-ON mode, hold down the ODO/TRIP switch for more than 5 seconds. When the LCD display screen shows no display, release the ODO/TRIP switch.
- The oil change reminder light goes OFF and then the LCD display indicates "000000" for about 1 sec.
- The LCD display should change to the ODO mode.
- This completes the reset procedure.

16. Diagnosis

- The diagnosis system of the 1ND-TV engine uses the EURO-OBD (Europe On-Board Diagnosis).
- When the engine ECU detects a malfunction, the engine ECU makes a diagnosis of 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 engine 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 has detected 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 small detection areas, 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, disconnect the battery terminal or remove the EFI fuse for 1 minute or longer.

17. 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 engine 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 engine 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).