

8. Engine Control System

General

The engine control system for the new model is compared to that for the previous model in the following table.

System	Outline	New	Previous
Fuel Injection Volume Control	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	Based on the signals received from the sensors, the engine ECU determines the fuel injection timing in accordance with the engine condition.	○	○
Fuel Pressure Control (See page EG-178)	Based on the signals received from the sensors, the engine ECU determines the fuel pressure via SCV (Suction Control Valve) in accordance with the engine condition.	—	○
	Based on the signals received from the sensors, the engine ECU determines the fuel pressure via SCV (Suction Control Valve) and pressure discharge valve in accordance with the engine condition.	○	—
Pilot Injection Control	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.	○	○
Idle Speed Control	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.	○	○
Glow Plug Control	Controls the length of time when the current is applied to the glow plugs, in accordance with engine coolant temperature.	○	○
Intake Restrictor Control	<ul style="list-style-type: none"> Controls the intake restrictor valve opening angle in accordance with the engine condition. Fully closes the intake restrictor valve in order to reduce the vibration when the engine is stopped. 	○	○
Swirl Control Valve Control (See page EG-181)	Based on the signals received from the sensors, the engine ECU controls the vacuum that is directed to the actuator via the VSV, in order to open and close the valve.	○	—
Turbocharger Control (See page EG-182)	Based on the signals received from the sensors, the engine ECU controls the actuator in accordance with the engine condition.	○	○
EGR Control (See page EG-186)	Based on the signals received from the sensors, the engine ECU determines the EGR volume via the EGR valve and intake restrictor valve in accordance with the engine condition.	○	○
Air Conditioner Cut-off Control*1	By controlling the air conditioner compressor ON or OFF in accordance with the engine condition, drivability is maintained.	○	○
Engine Immobilizer*2	Prohibits fuel injection if an attempt is made to start the engine with an invalid ignition key.	○	○
	The ID code stored in the transponder key ECU is compared with that of the transponder tip in the ignition key.	○	○

*1: Models with Air Conditioner

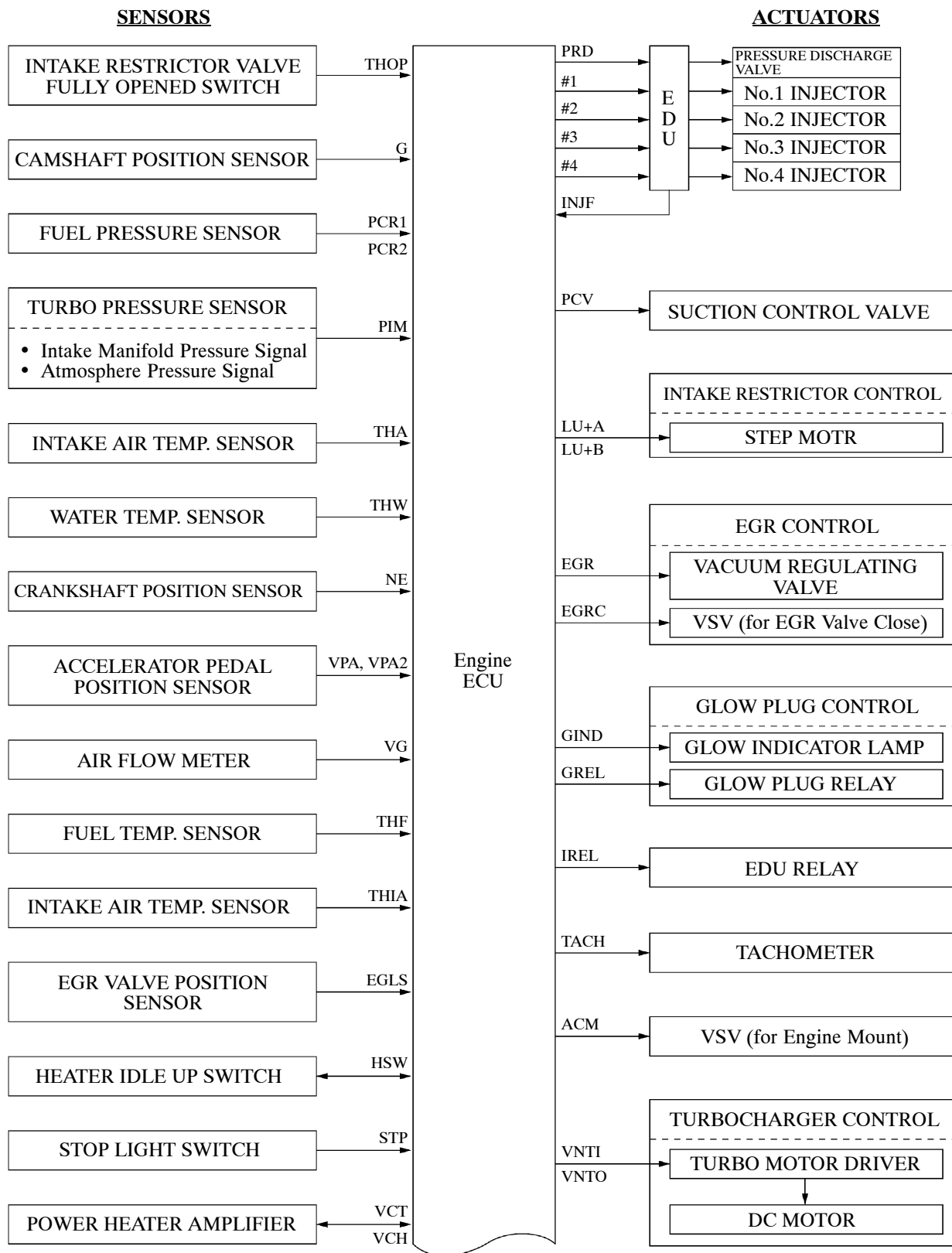
*2: Models with Immobilizer System

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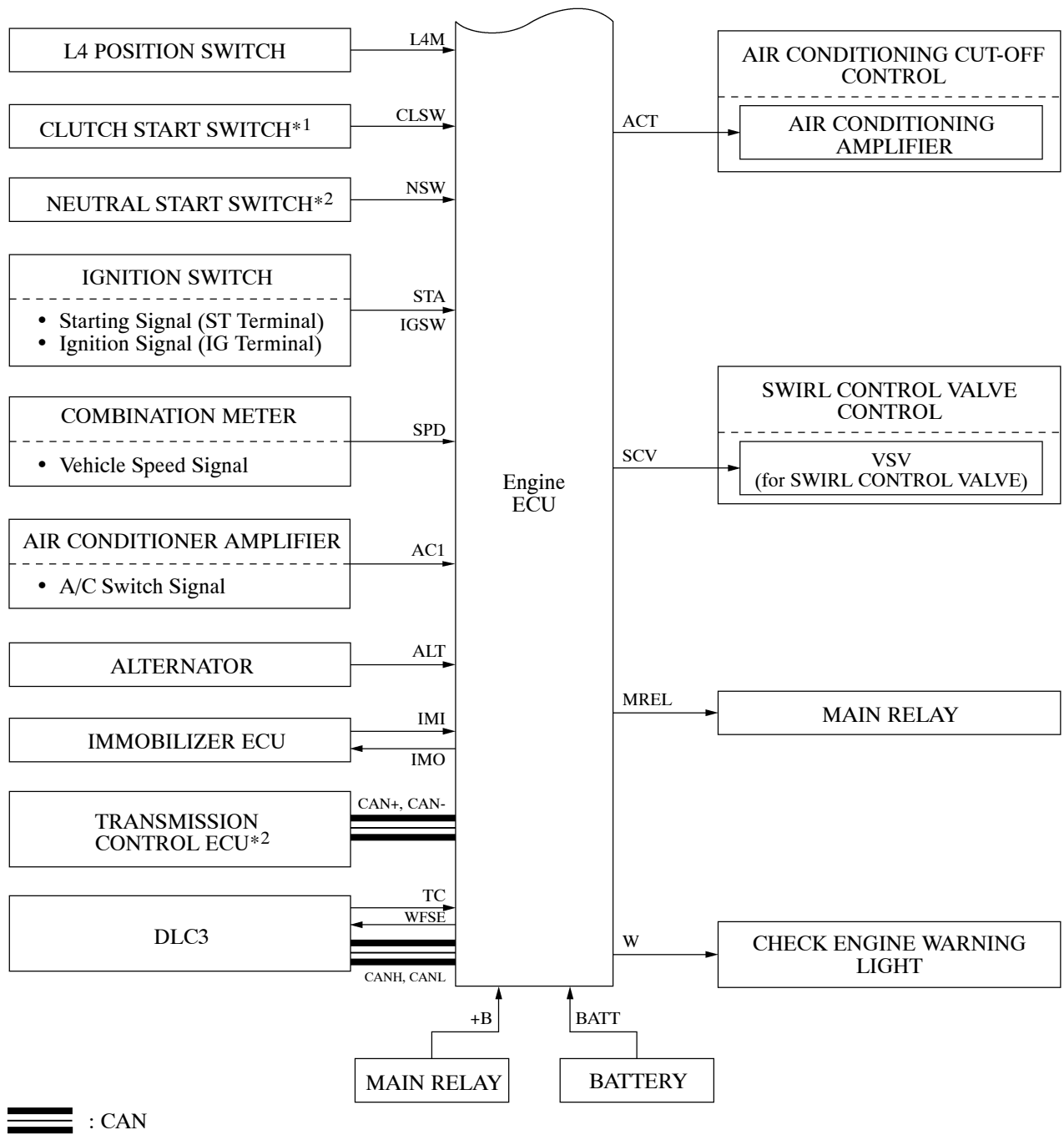
System	Outline	New	Previous
Engine Mount Control	When the engine speed is low and the vehicle is operating at low speeds, this control utilizes vacuum to soften the engine mount characteristics in order to restrain the engine vibration at idle.	<input type="radio"/>	<input type="radio"/>
Power Heater Control	Controls the power heater magnetic clutch ON or OFF in accordance with the engine condition.	<input type="radio"/>	<input type="radio"/>
Diagnosis	When the engine ECU detects a malfunction, the engine ECU diagnoses and memorizes the failed section.	<input type="radio"/>	<input type="radio"/>
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.	<input type="radio"/>	<input type="radio"/>

Construction

The configuration of the engine control system in the 1KD-FTV engine is shown in the following chart.



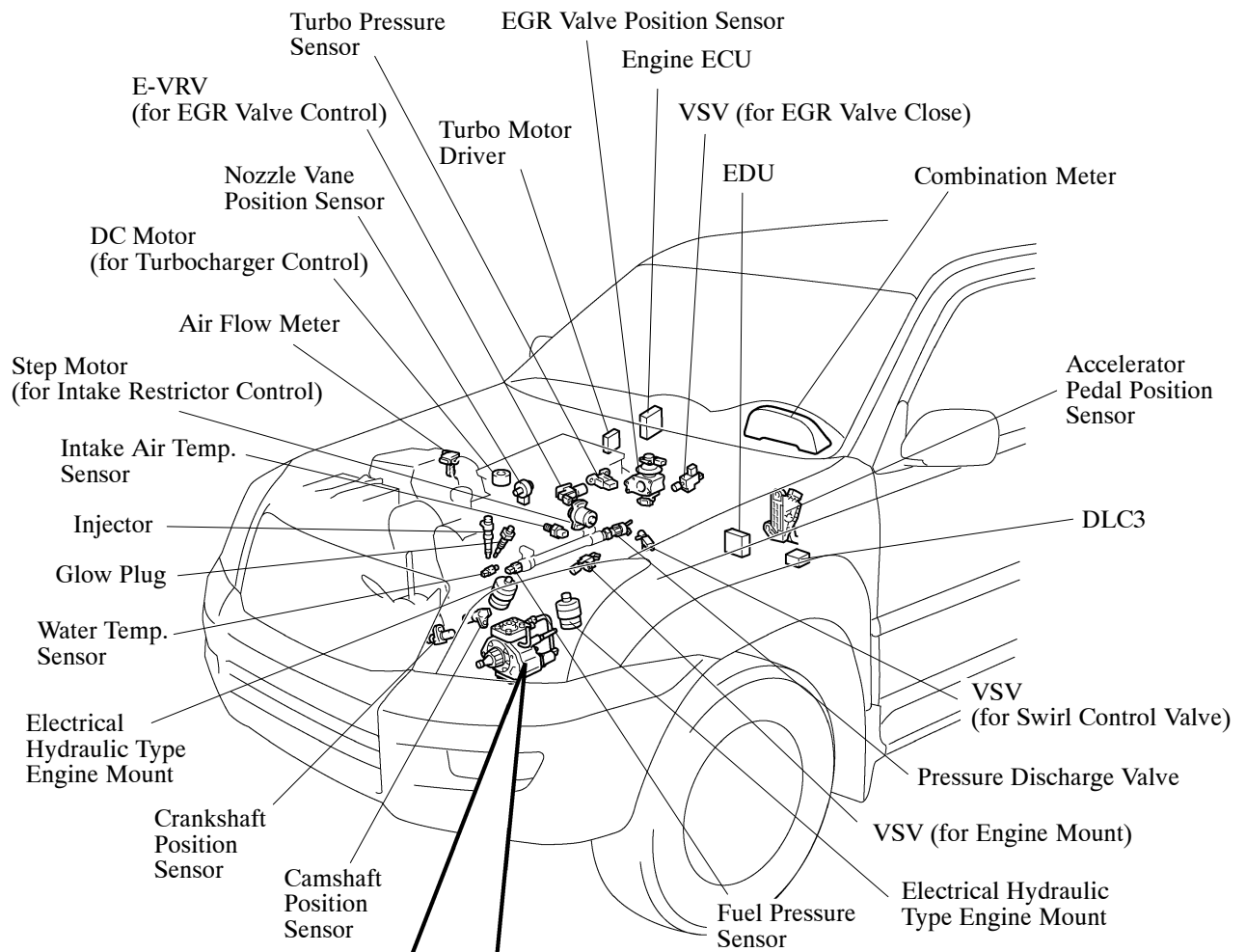
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*1: Only for Models with Manual Transmission

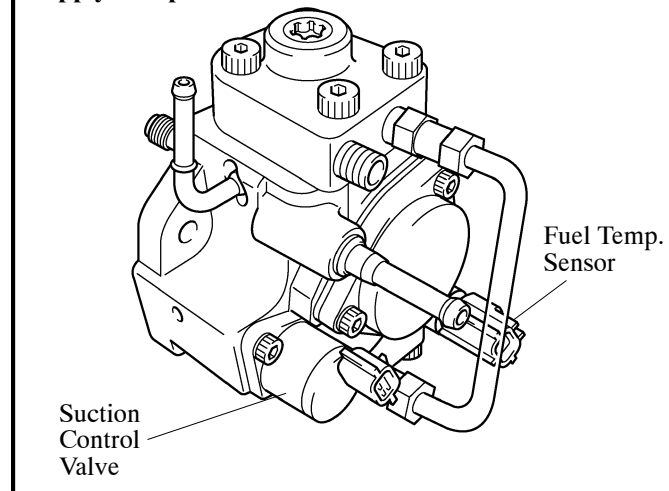
*2: Only for Models with Automatic Transmission

Layout of Main Component



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Supply Pump



Main Components of Engine Control System

1) General

The main components of the 1KD-FTV engine control system are as follows:

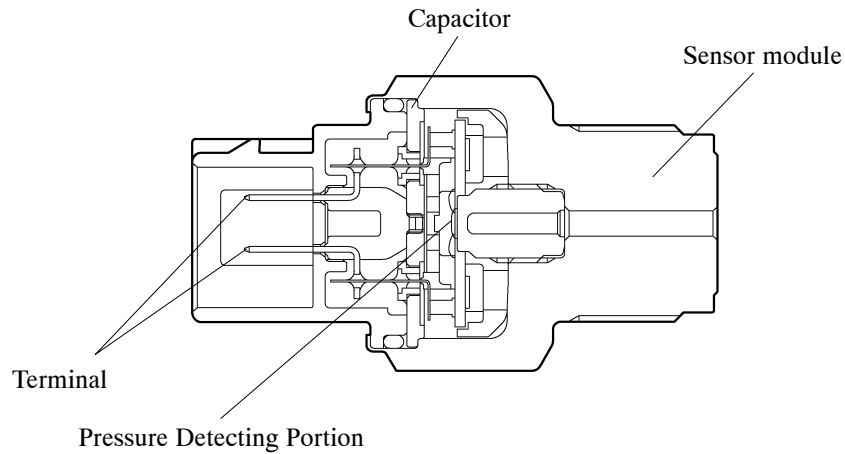
Model	New		Previous	
Components	Outline	Quantity	Outline	Quantity
Engine ECU	32-bit	1	16-bit	1
Air Flow Meter	Hot-wire Type	1	←	←
Crankshaft Position Sensor (Rotor Teeth)	Pick-up Coil Type (36-2)	1	←	←
Camshaft Position Sensor (Rotor Teeth)	Pick-up Coil Type (5)	1	←	←
Accelerator Pedal Position Sensor	Linear Type	1	←	←
Fuel Pressure Sensor	Semiconductor Strain Gauge Type (Two Circuits)	1	Semiconductor Strain Gauge Type (Single Circuit)	1
EDU	DC/DC Converter	1	←	←

2) Engine ECU

The 32-bit CPU of the engine ECU has been adopted.

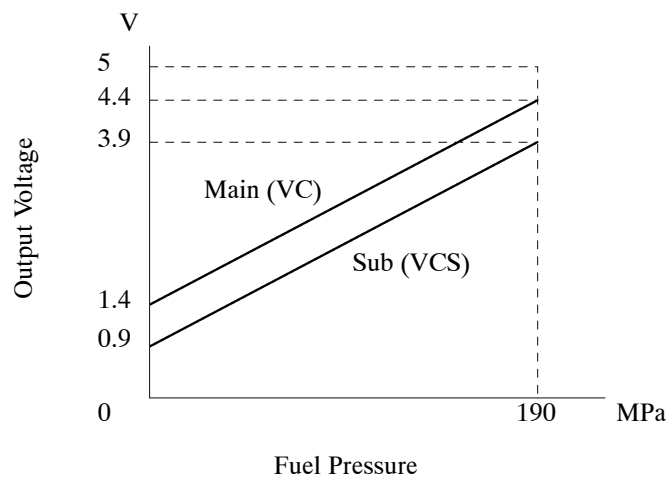
3) Fuel Pressure Sensor

- The fuel pressure sensor, which is mounted on the common-rail, outputs a signal that represents the fuel pressure in the common-rail to the engine ECU in order to constantly regulate the fuel at an optimal pressure.
- The fuel pressure sensor contains two circuits (main and sub), which enable the engine ECU to constantly compare the values detected by the two circuits. As a result, highly precise values can be detected, which also enable a higher level of fail-safe control.



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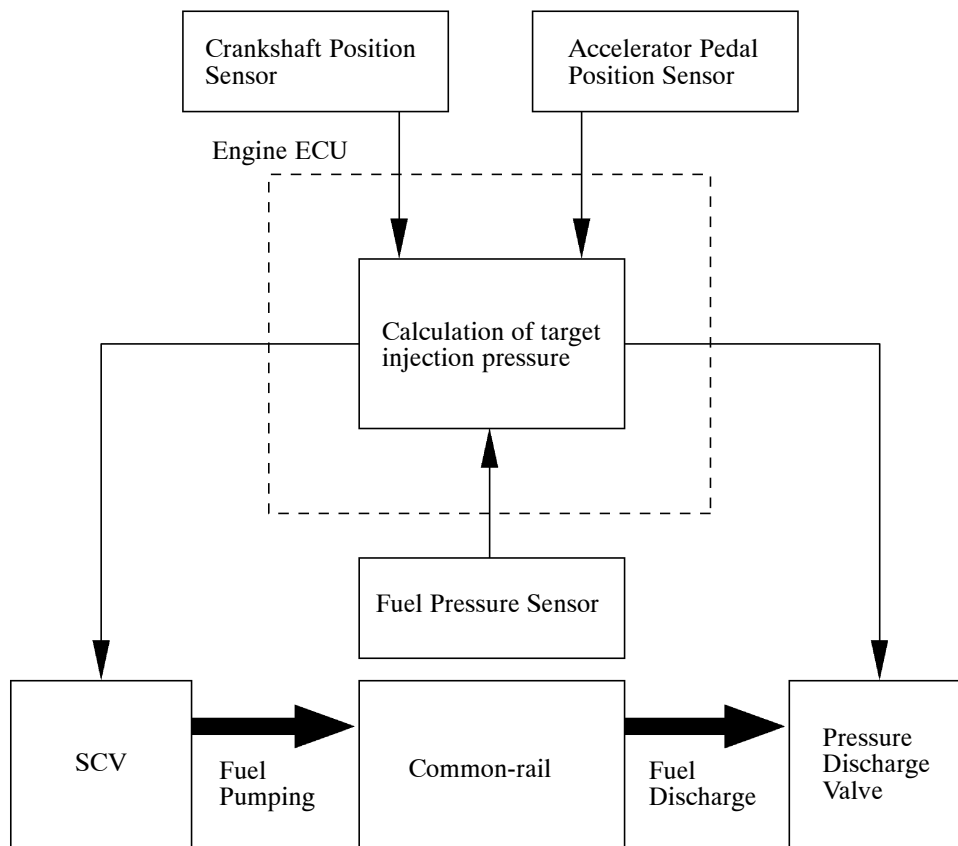
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Fuel Pressure Control

1) General

Engine ECU calculates the target injection pressure (30 - 160 MPa) based on the engine conditions, that are the signals from the accelerator pedal position sensor and the crankshaft position sensor.

To control fuel pressure, signals sent to SCV (Suction Control Valve) of the supply pump regulate the pumping volume and signals sent to pressure discharge valve of the common-rail regulate the discharge volume, so that the pressure detected by the fuel pressure sensor matches the target injection pressure.



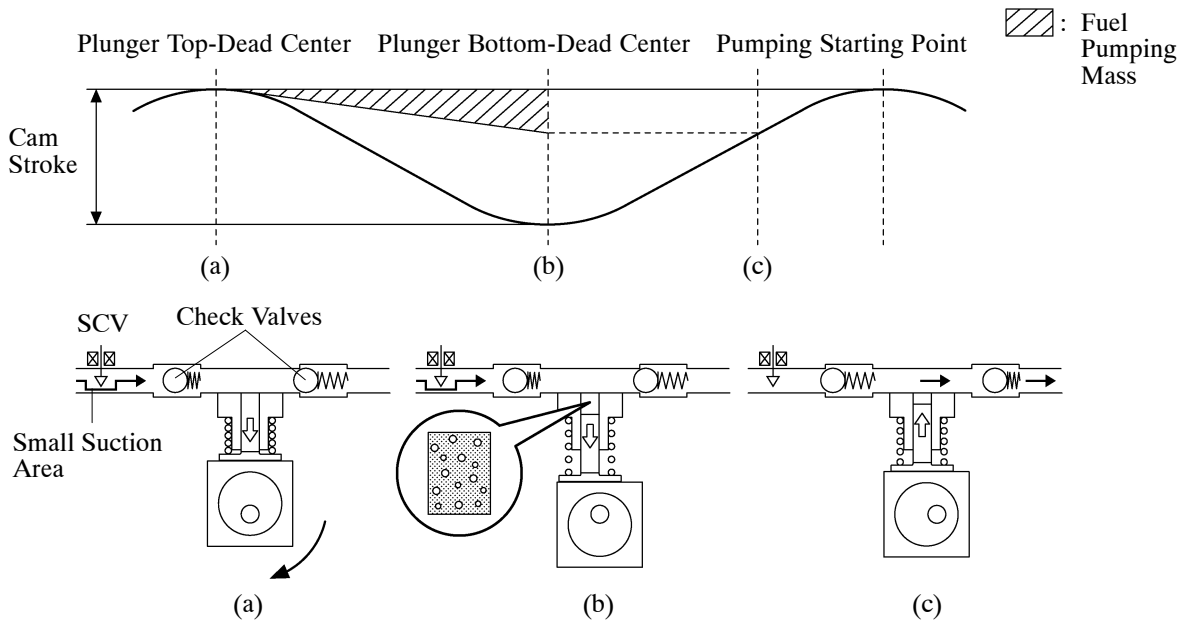
2) System Operation

a. Fuel Pumping

The engine ECU controls the opening of the SCV 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.

i) SCV Opening Small

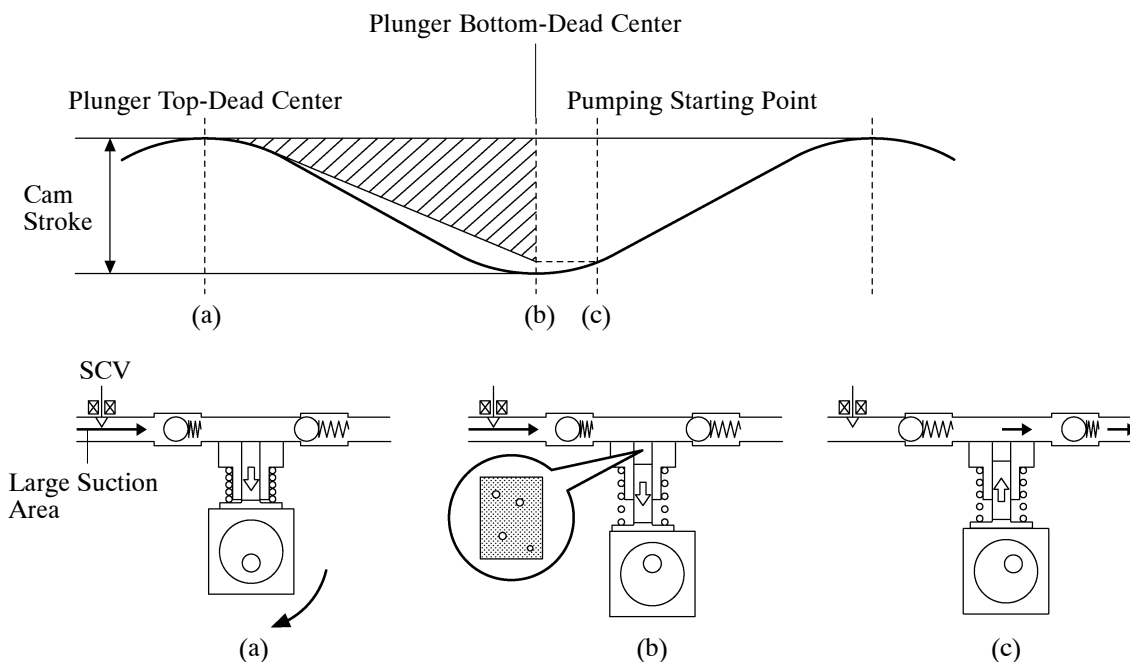
- When the opening of the SCV is small, the fuel suction area is kept small, which decrease the transferable fuel quantity.
- The plunger strokes fully, however, the suction volume becomes small due to the small suction area.
- Pumping will start at the time when the fuel pressure has become higher than the common-rail pressure.



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ii) SCV Opening Large

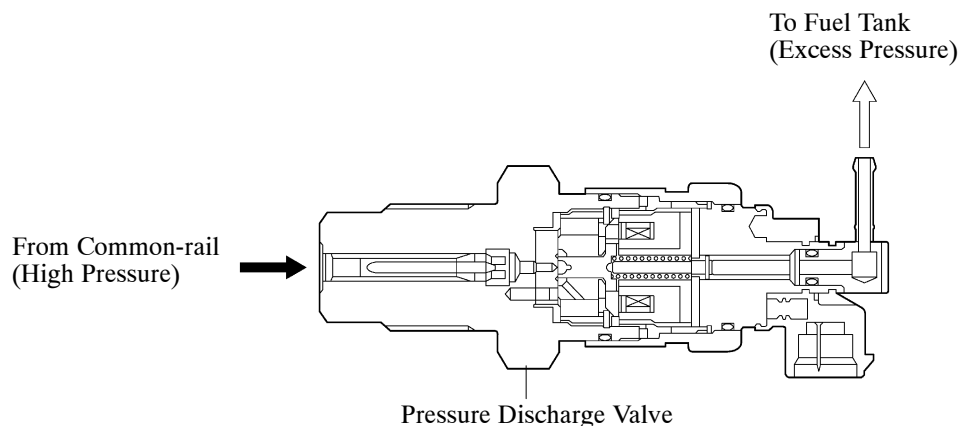
- When the opening of the SCV is large, the fuel suction area is kept large, which increases the transferable fuel quantity.
- When the plunger strokes fully, the suction volume will increase because the suction area is large.
- Pumping will start at the time when the fuel pressure becomes higher than the common-rail pressure.



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b. Fuel Discharge

When the fuel pressure in the common-rail becomes higher than the target injection pressure, the engine ECU discharges the fuel by the way of the pressure discharge valve in order to control the fuel pressure to the target injection pressure.

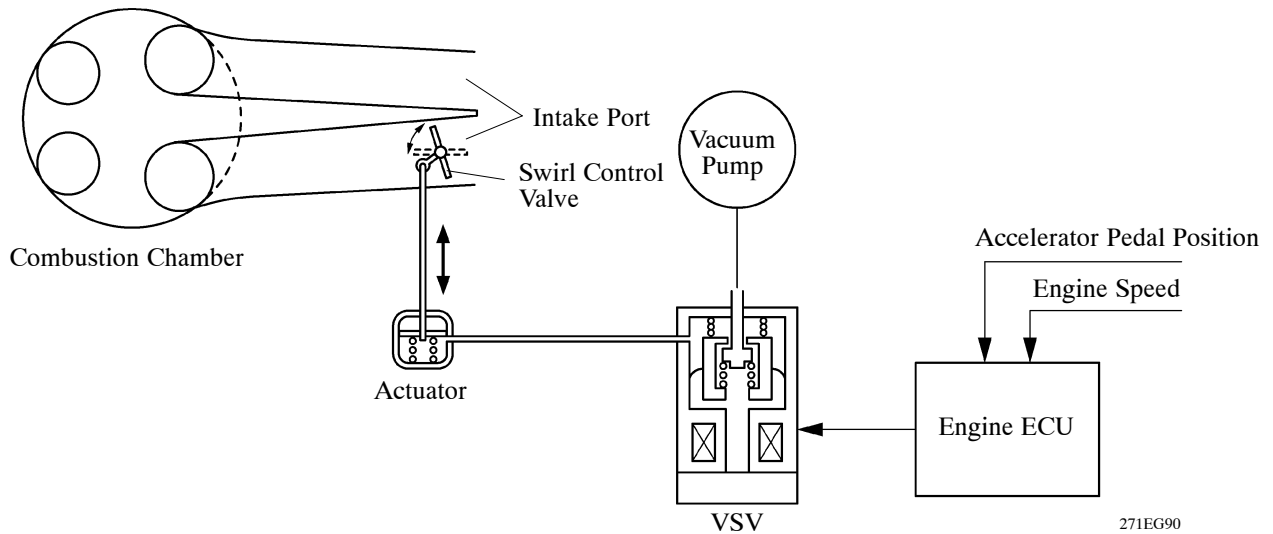


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Swirl Control Valve Control

The engine ECU determines the swirl control valve position (open or closed) based on the engine conditions (engine speed and accelerator pedal effort). Then, it switches the vacuum that is applied to the actuator diaphragm via the VSV, in order to open and close the swirl control valve.

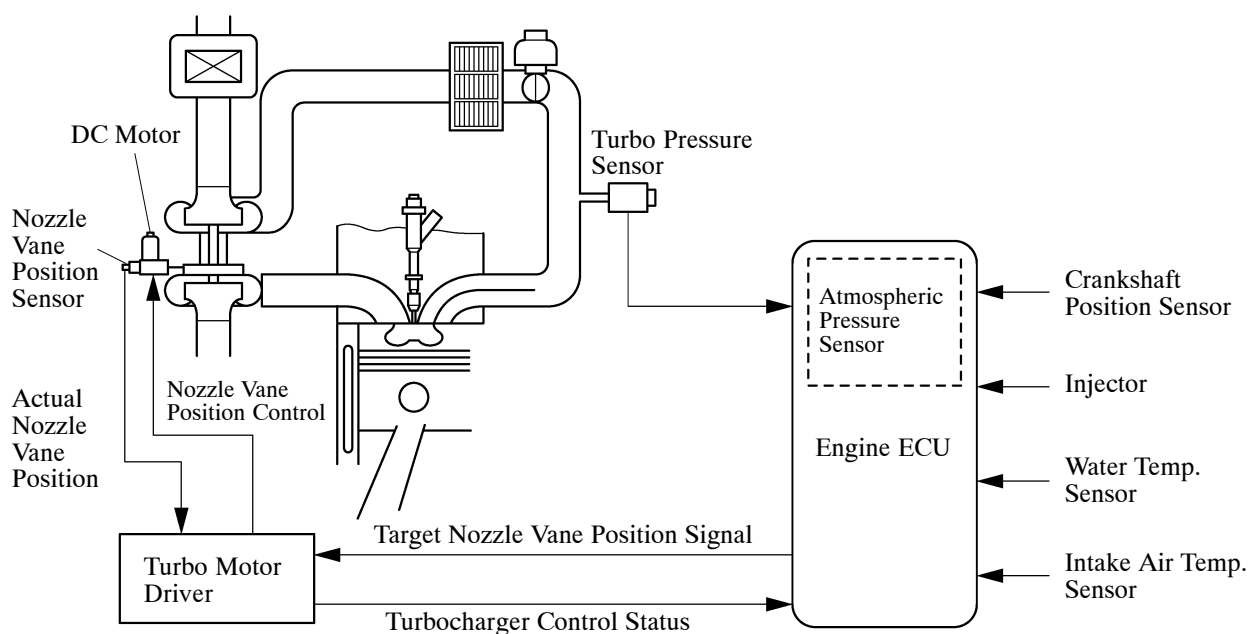
In the low engine speed range, the engine ECU closes the swirl control valve to strengthen the swirl in the combustion chamber, thus promoting the mixture of fuel and air and stabilizing combustion. When the engine speed increases to the medium or high-speed range, the engine ECU fully opens the swirl control valve. On a cold engine, the engine ECU fully closes the swirl control valve to reduce the amount of white smoke emissions.



Turbo Charger Control

1) General

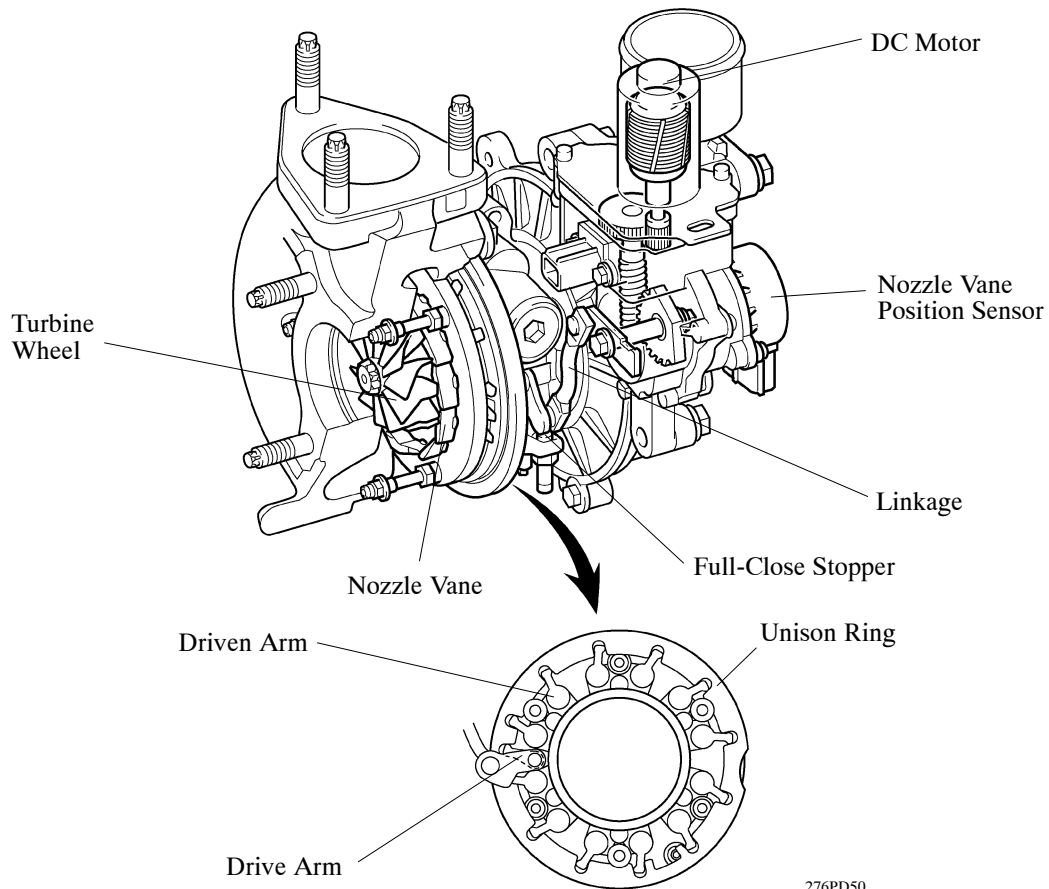
- The engine ECU controls the nozzle vane position using the turbo motor driver, in order to obtain the calculated target turbo pressure appropriate to the engine operating condition.
- The engine ECU calculates the optimal nozzle vane position in accordance with the driving conditions (engine speed, injection volume, atmospheric pressure, and water temperature etc), and sends a target nozzle vane position signal to the turbo motor driver. The turbo motor driver controls the nozzle vane position in accordance with this signal and the actual nozzle vane position signal provided by the nozzle vane position sensor.



2) Construction

a. General

Variable nozzle vane device is established on the turbine (exhaust) side, and consisted of a DC motor, nozzle vane position sensor, linkage, drive arm unison ring, driven arms and nozzle vanes.

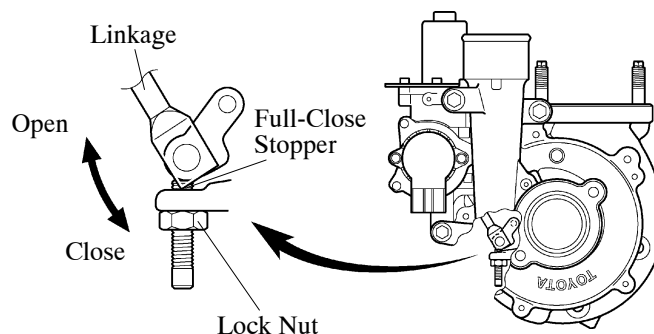


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Service Tip

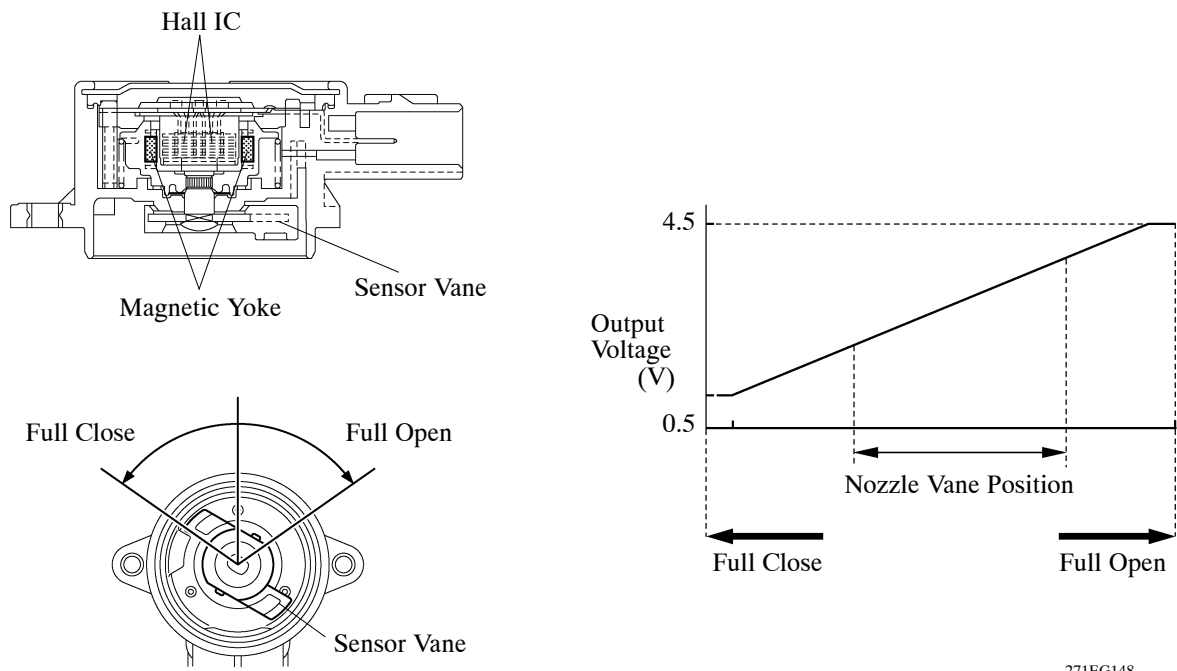
- To control the nozzle vane position, the turbo motor driver renders the contact position of the linkage with the full-close stopper (thus fully closing the nozzle vane) as the zero point for the nozzle vane position sensor.
- If the turbocharger has been reinstalled or replaced, turn the ignition switch from ON to OFF once, and make sure that the linkage comes in contact with the full-close stopper.
- The full-close stopper position, which is adjusted at the factory at the time of shipment, is not serviceable in the field. For this reason, if the linkage does not come in contact with the full-close stopper during an inspection, the turbocharger assembly must be replaced. Never attempt to loosen or tighten the locknut of the full-close stopper because it will adversely affect the performance of the engine.
- For details, refer to the Land Cruiser/ Land Cruiser Prado Repair Manual Supplement (Pub. No. RM1151E).



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b. Nozzle Vane Position Sensor

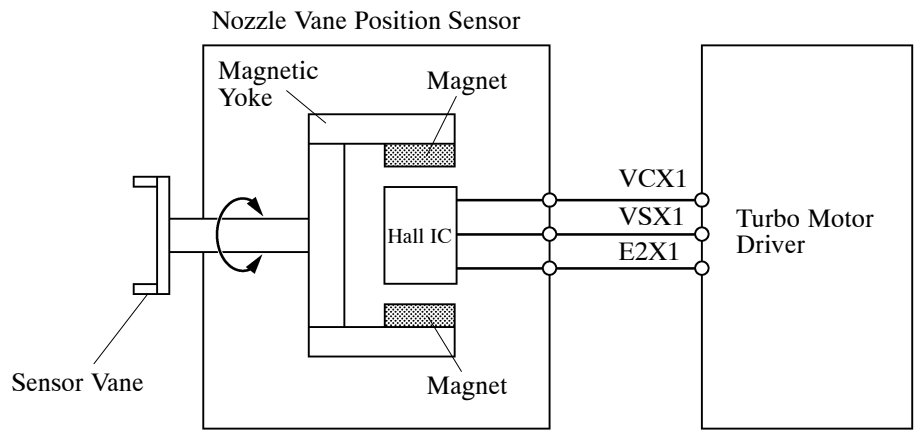
The nozzle vane position sensor consists of a Hall IC and a magnetic yoke that rotates in unison with the movement of the linkage that actuates the nozzle vane. The nozzle vane position sensor converts the changes in the magnetic flux that are caused by the rotation of the DC motor (hence, the rotation of the magnetic yoke) into electric signals, and outputs them to the turbo motor driver. The turbo motor driver determines the actual nozzle vane position from the electric signals in order to calculate the target nozzle vane position.



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► System Diagram ◀



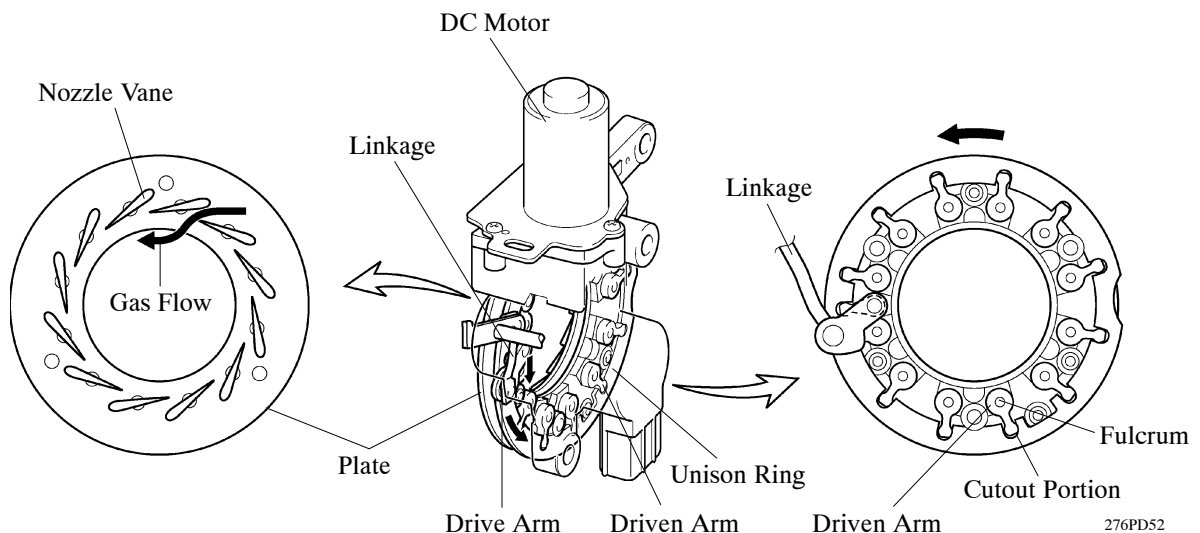
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3) Operation

a. At Engine Low Speed Range

When the engine is running in a low speed range, the DC motor presses down the linkage by a signal from the turbo motor driver. The tip of the linkage rotates the unison ring counterclockwise through a drive arm.

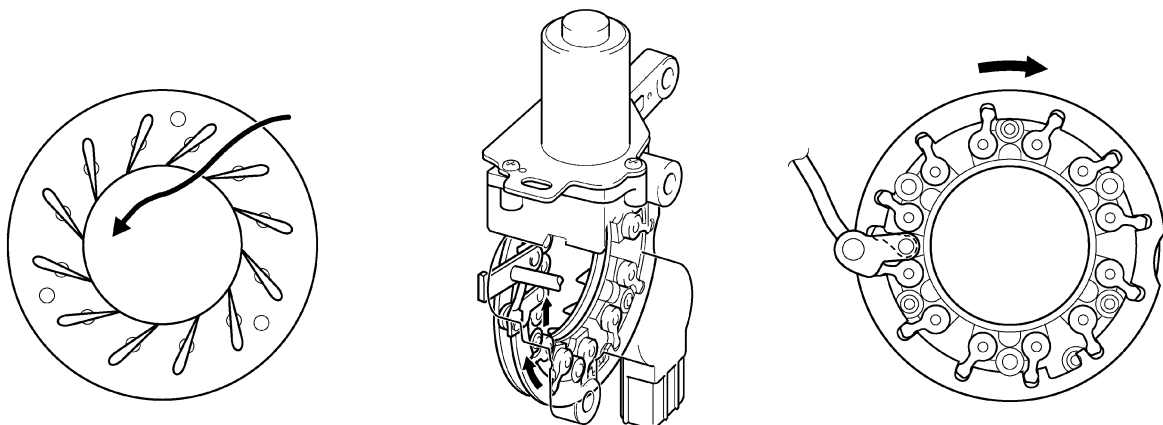
The unison ring contains a driven arm, which is placed through the cutout portion of the unison ring. This driven arm also moves in the direction of the rotation of the unison ring. The fulcrum of the driven arm is an axis that is integrated with the nozzle vane behind the plate. When the driven arm moves counterclockwise, the nozzle vane moves toward the closing direction. This results in increasing the velocity of the exhaust gas flowing to the turbine, as well as the speed of the turbine. As a result, torque is improved when the engine is running at low speeds.



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b. At Engine Medium-to-High Speed Range

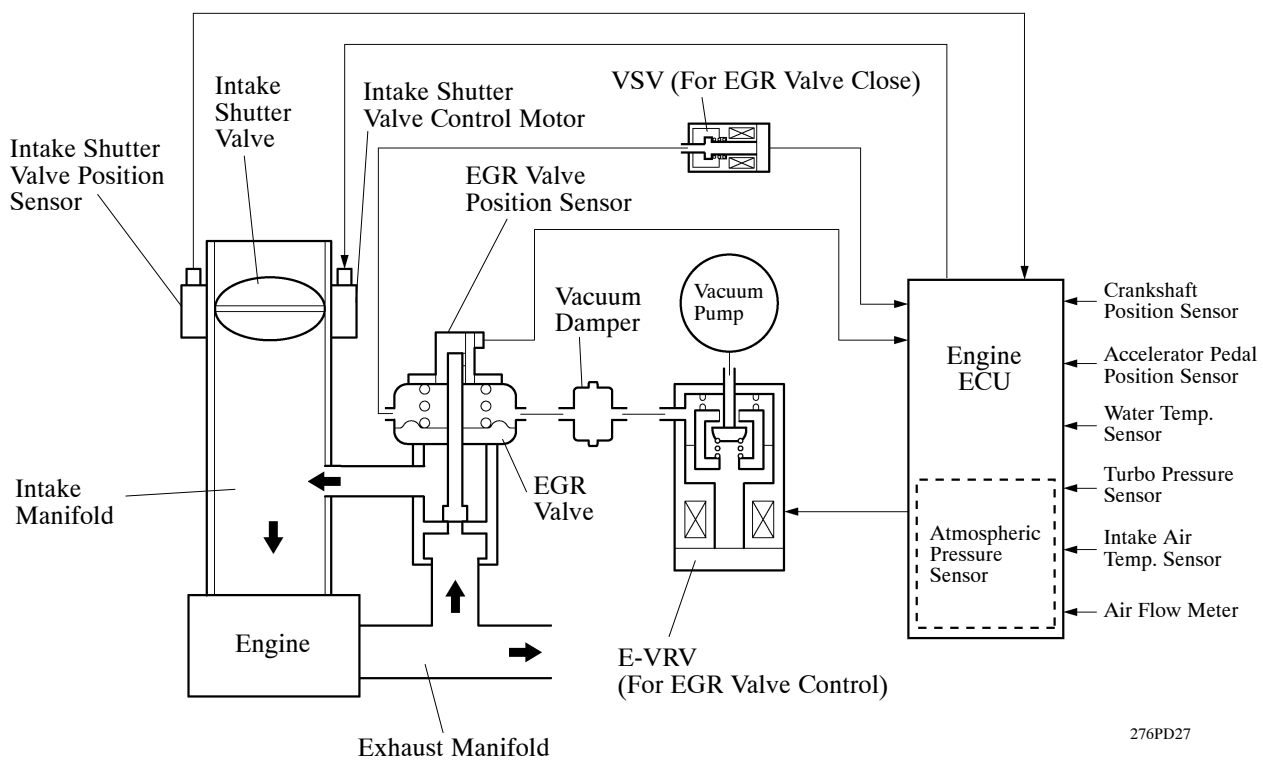
When the engine is running in a medium-to-high speed range, the DC motor pulls up the linkage by a signal from the turbo motor driver. With this, the driven arm moves clockwise and this opens the nozzle vane and holds the specified supercharging pressure. Thus, lowering the back pressure and improving the output and fuel consumption.



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EGR Control System

- By sensing the engine driving conditions and actual amount of EGR valve opening, the engine ECU electrically operates both the E-VRV (for EGR valve control) and VSV (for EGR valve close), which controls the magnitude of vacuum introduced into diaphragm of EGR valve, and intake shutter valve (throttle valve) opening position with intake shutter valve control motor and the amount of recirculating exhaust gas is regulated. EGR valve opening lift is controlled by modulated negative pressure.
- The VSV (for EGR valve close) is activated when the EGR control is stopped, in order to introduce the atmospheric pressure to the EGR valve diaphragm and improve EGR valve closure response to maintain driveability.



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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 also stores the DTCs (Diagnostic Trouble Codes) of the malfunctions. The DTCs can be read by connecting the SST (09843-18040) between the Tc and CG terminals of the DLC3, and observing the blinking of the check engine warning light (2-digit code), or by connecting the intelligent tester II to the DLC3 (5-digit code).
- For details, refer to the Land Cruiser/ Land Cruiser Prado Repair Manual Supplement (Pub. No. RM1151E).

Service Tip

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