■ENGINE CONTROL SYSTEM

1. General

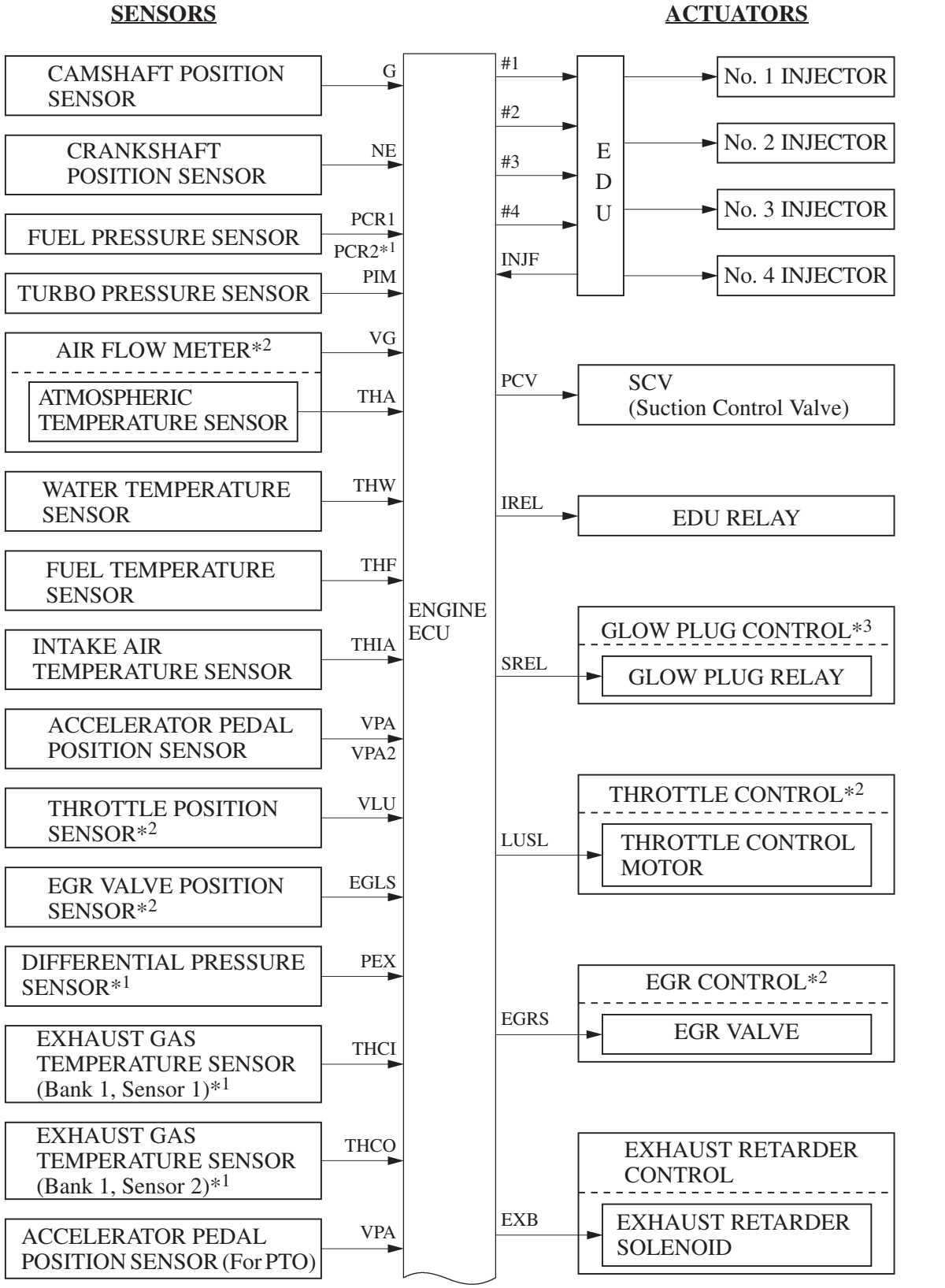
The engine control systems for the N04C-TQ, N04C-TT and N04C-TU engines have the following systems.

System	Outline
Fuel Injection Volume Control	Controls the injection volume by calculating an optimal level in accordance with the conditions of the engine.
Engine Torque Control	Controls the engine torque when driving in the 1st or reverse gear.
Pilot Injection Control	Pilot injection is method that provides an auxiliary fuel injection.
Fuel Injection Timing Control	Controls the injection timing by calculating optimal fuel injection timing in accordance with the conditions of the engine.
Fuel Pressure Control	Controls the fuel pressure by sending signals to the suction control valve of the supply pump in accordance with the operating conditions of the engine.
Throttle Control*1	Controls the extent of the opening of the throttle valve in accordance with the engine conditions.
	Controls the intake throttle mechanism, which is provided upstream of the EGR valve, to an opening that is suited to the driving conditions.
Glow Plug Relay Control*2	Controls the duration of the time the glow plug relay is energized in accordance with the water temperature, while the engine is being started.
Idle Speed Control	Controls the idle speed by calculating the target speed in accordance with the conditions of the engine.
Idle Speed Fluctuation Stabilization Control	Detects the fluctuations of the engine speed for each cylinder and makes injection volume corrections.
Air Conditioner Cut-off Control*3	Cuts off the air conditioner during acceleration to ensure proper drivability.
EGR Control*1	Controls the volume of exhaust gas recirculation in accordance with the driving conditions.
Exhaust Retarder Control	Closes the exhaust retarder valve in order to apply the engine brake.
	Closes the exhaust retarder valve when the engine is idling for a long time, in order to reduce the HC in the DPF catalytic converter.*4
DPF Control*4	Based on the signals received from various sensors, the engine ECU controls the common-rail system in order to burn the PM that is captured in the filter with catalyst.
Diagnosis	If a malfunction occurs in the system, this function illuminates an indicator light to alert the driver. Also, it is possible to diagnose the area of the malfunction by shorting the terminals.
Fail-safe	If a failure occurs in the sensor signals, this function continues control through the use of the standard values stored in the engine ECU, or causes the engine to stop.

*1: N04C-TQ and N04C-TU Engines
*2: N04C-TU Engine
*3: Models with Air Conditioner
*4: N04C-TQ Engine

2. Construction

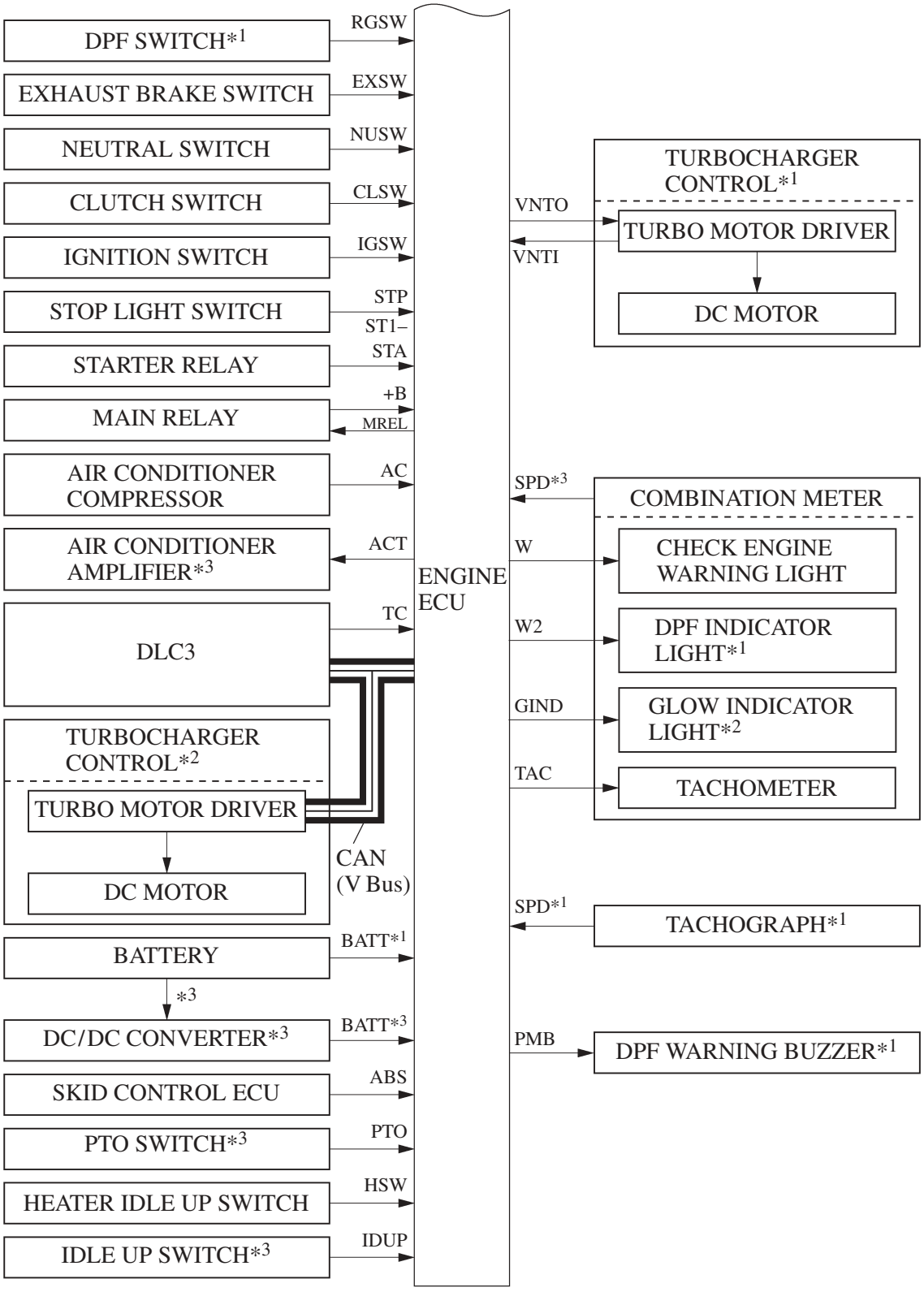
The configuration of the engine control system in the N04C-TQ, N04C-TT and N04C-TU engines is as shown in the following chart.



(Continued)

*1: N04C-TQ Engine
*2: N04C-TQ and N04C-TU Engines
*3: N04C-TU Engine

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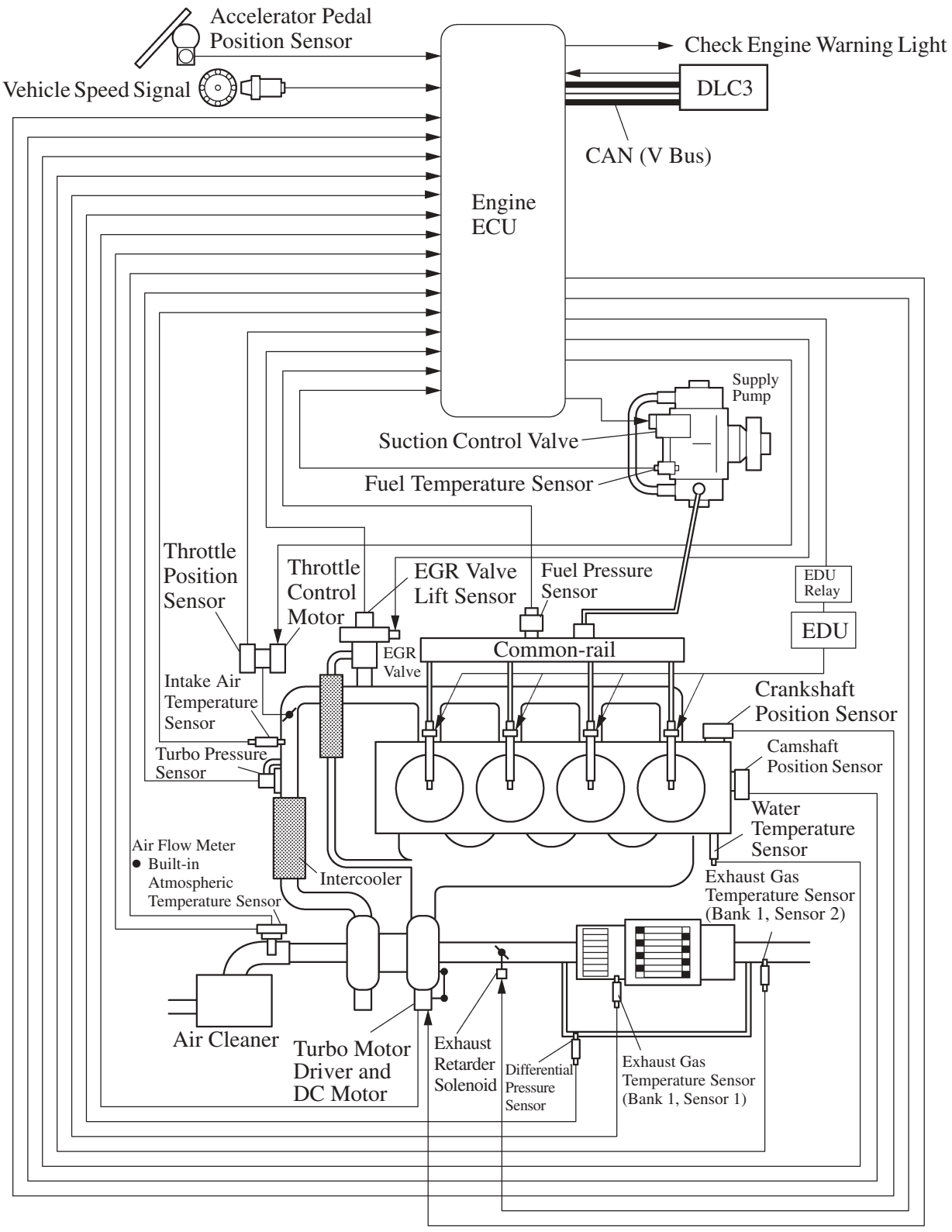
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*1: N04C-TQ Engine
*2: N04C-TU Engine
*3: N04C-TT and N04C-TU Engines

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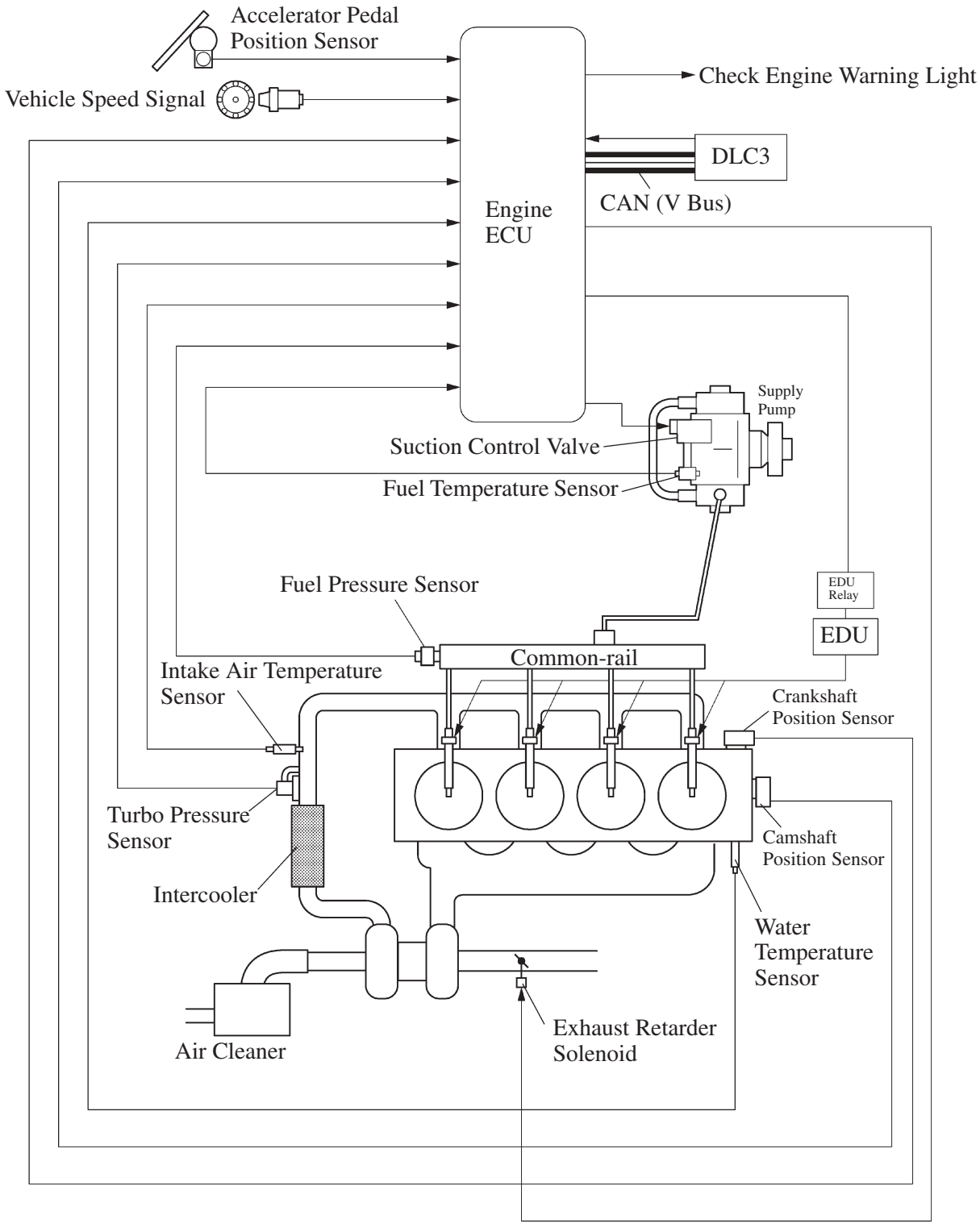
3. System Diagram

▶ N04C-TQ Engine ◀



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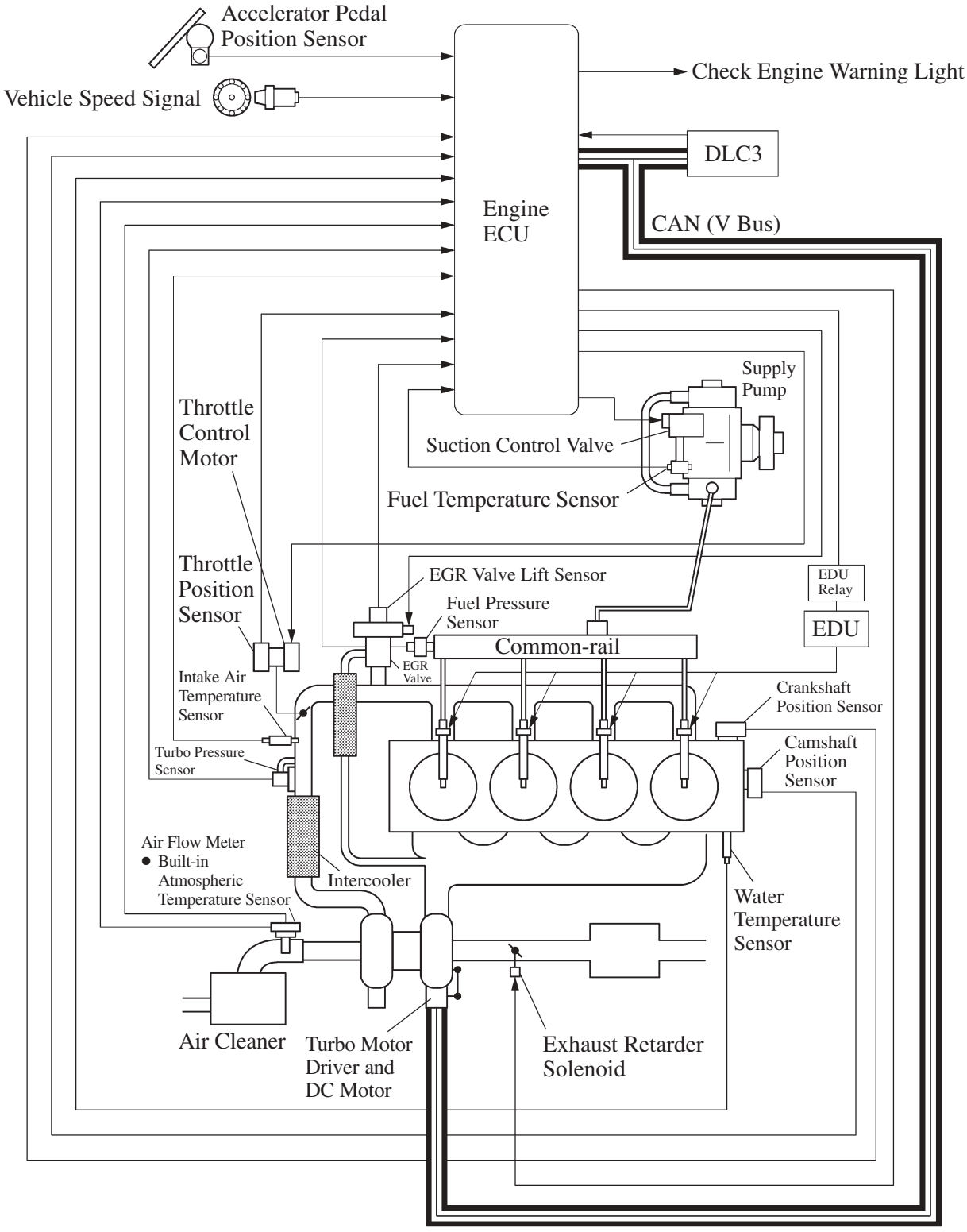
▶ N04C-TT Engine ◀



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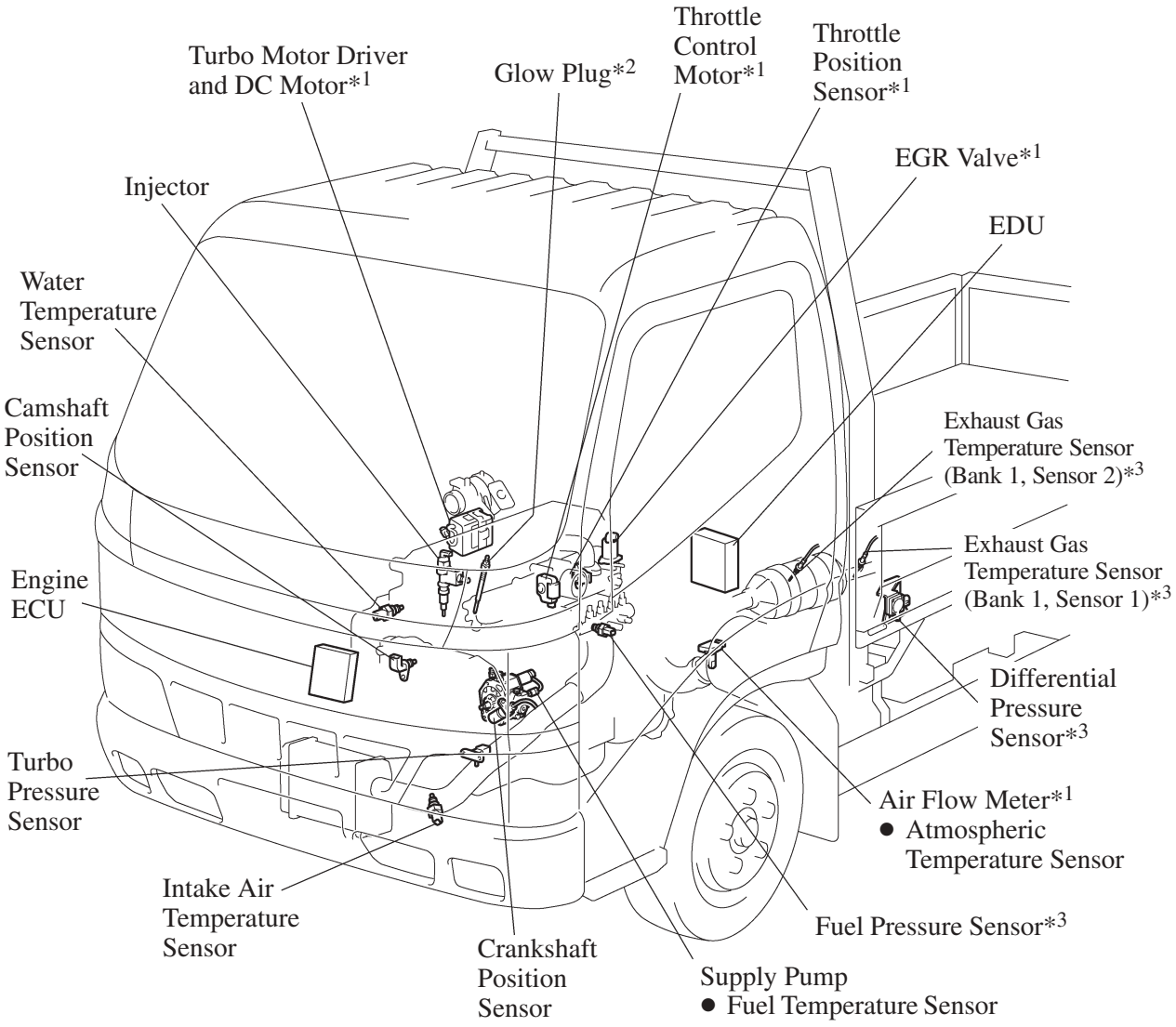
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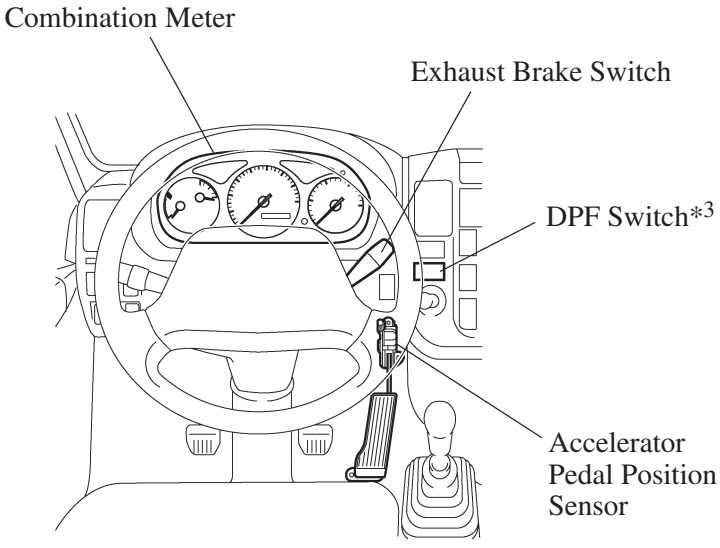
▶ N04C-TU Engine ◀

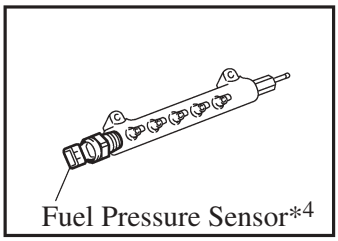


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4. Layout of Main Components







*1: N04C-TQ and N04C-TU Engines
*2: N04C-TU Engine
*3: N04C-TQ Engine
*4: N04C-TT and N04C-TU Engines

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5. Main Components of Engine Control System

General

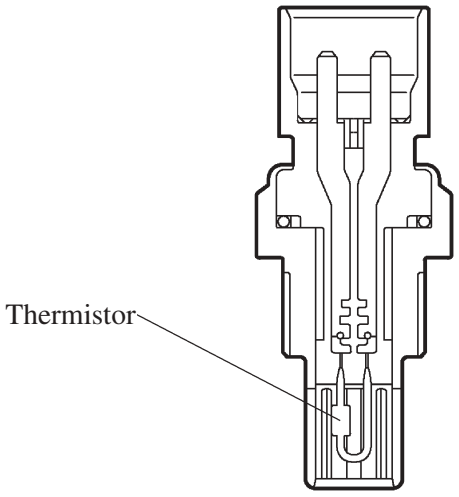
The following table compares the main components.

Function	Outline
Intake Air Temperature Sensor (Behind Intercooler)	Detects the intake air temperature at the intercooler outlet (secondary side).
Water Temperature Sensor	Detects the water temperature.
Fuel Pressure Sensor	Detects the fuel pressure in the common-rail.
Fuel Temperature Sensor	Detects the fuel temperature in the supply pump.
Turbo Pressure Sensor	Detects the intake air pressure in the intake manifold.
Crankshaft Position Sensor	Detects the engine speed by way of the crankshaft position.
Camshaft Position Sensor	Identifies the cylinder by way of the rotation of the rotor.
Air Flow Meter*1 (Includes Atmospheric Temperature Sensor)	Uses a hot wire to detect the intake air flow mass.
Starter Signal	Detects the starter voltage signal at the time the engine is started.
Vehicle Speed Sensor	Detects the vehicle speed.
Throttle Position Sensor*1	Detects the entire opening of the throtle valve.
Accelerator Pedal Position Sensor	Mounted on the accelerator pedal, it detects the position of the accelerator pedal.
Differential Pressure Sensor*2	Measures the pressure differences between before and after the DPF catalytic converter.
Exhaust Gas Temperature Sensors*2	Detect the temperature of the exhaust gas before and after the DPF catalytic converter.
Injector	Precisely injects fuel.
Suction Control Valve	Controls the volume of fuel to be supplied to the supply pump.
Exhaust Retarder Solenoid	Opens and closes the exhaust retarder.
Throttle Control Motor	Uses a step motor to restrict the intake passage.
EDU Relay	Controls the volume of fuel injected by the injectors.

*1: N04C-TQ and N04C-TU Engines
*2: N04C-TQ Engine

Intake Air Temperature Sensor (Behind Intercooler)

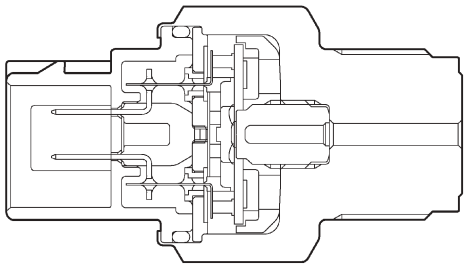
- Along with the adoption of the turbo engine with an intercooler, a thermistor type intake air temperature sensor has been provided.
- Immediately before the air is drawn to the cylinder, the intake air temperature sensor measures the air temperature and sends the signal to the engine ECU for the fuel injection control.
- A slit has been added to the cover around the detection portion in order to realize high response.



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Fuel Pressure Sensor

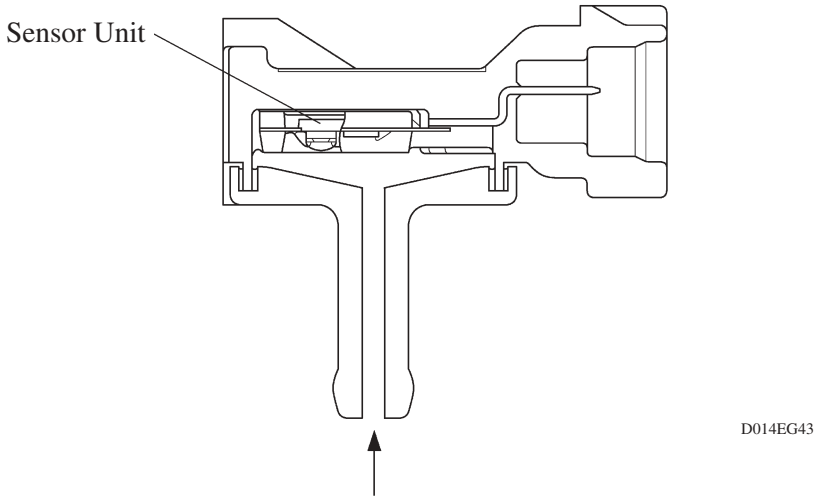
- The fuel pressure sensor, which is mounted on the common-rail, outputs a signal that represents the fuel pressure in the common-rail to the engine ECU in order to constantly regulate the fuel at an optimal pressure.
- On the N04C-TT and N04C-TU engines, the fuel pressure sensor contains two circuits (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 high level of fail-safe control.



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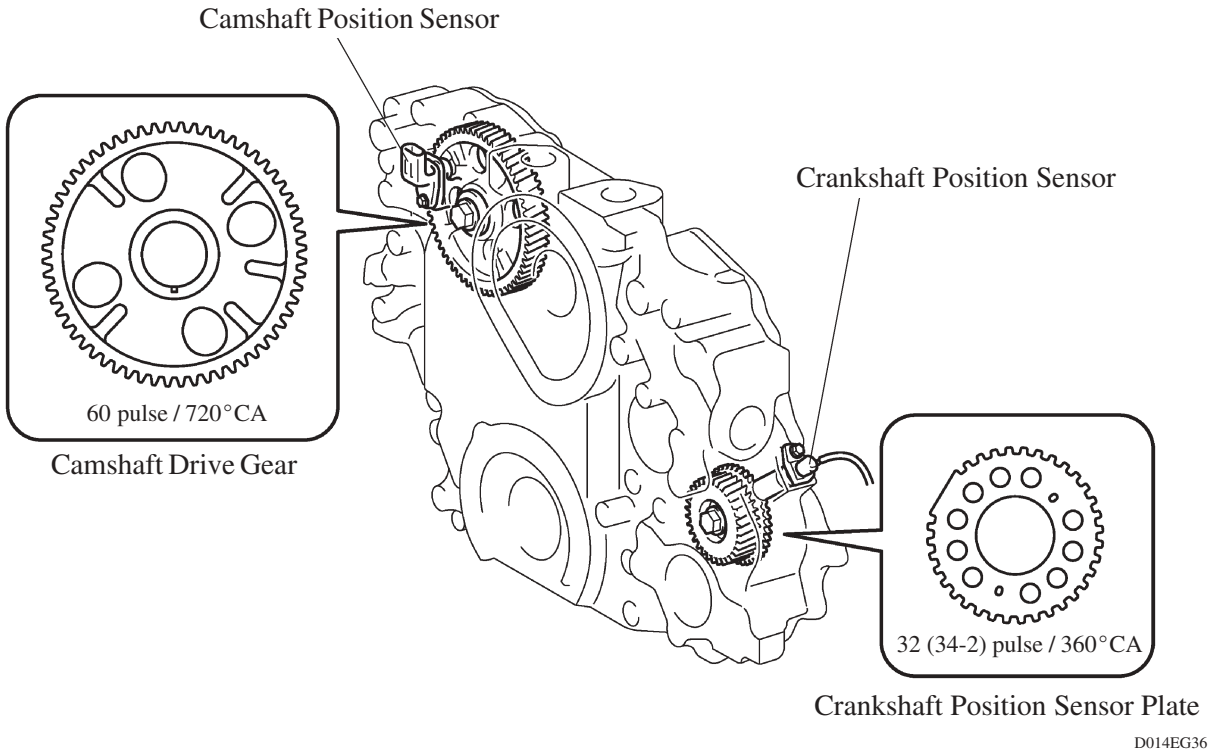
Turbo Pressure Sensor

The turbo pressure sensor detects the intake pressure in the intake manifold, which is used for calculating the maximum injection volume during the transient stage.
The sensor contains an internal amplification circuit to stabilize the output voltage.



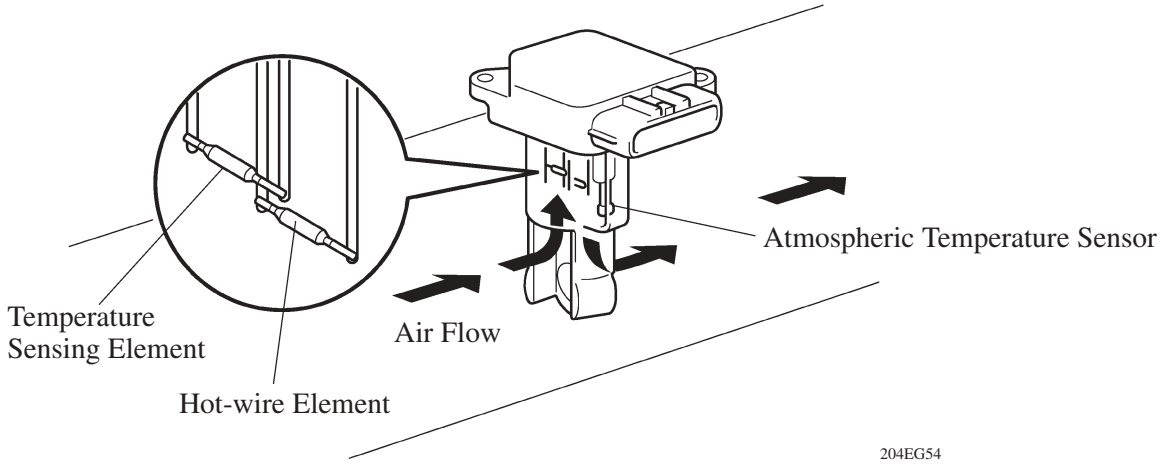
Crankshaft Position Sensor and Camshaft Position Sensor

A crankshaft position sensor is mounted on the crankshaft position sensor plate and a camshaft position sensor is mounted on the camshaft drive gear in order to detect the engine speed and identify the cylinders.



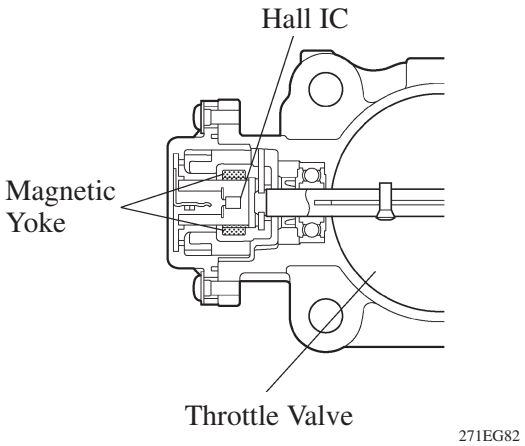
Air Flow Meter (N04C-TQ and N04C-TU Engines)

- This compact and lightweight air flow meter, which is a plug-in type, allows a portion of the intake air to flow through the detection area. By directly measuring the mass and the flow rate of the intake air, the detection precision is achieved and low intake air resistance is realized.
- This mass air flow meter has a built-in atmospheric temperature sensor.
- The atmospheric temperature sensor detects the air temperature around the air flow meter to control the fuel injection volume.

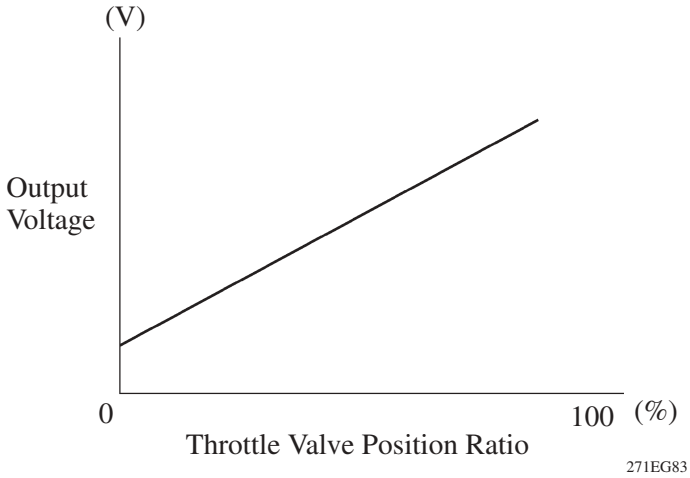


Throttle Position Sensor (N04C-TQ and N04C-TU Engines)

The throttle position sensor is mounted on the throttle body, to detect the opening angle of the throttle valve. The throttle position sensor converts the magnetic flux density that changes when the magnetic yoke (located on the same axis as that of the throttle valve shaft) rotates around the Hall IC into electric signals to operate the throttle control motor.

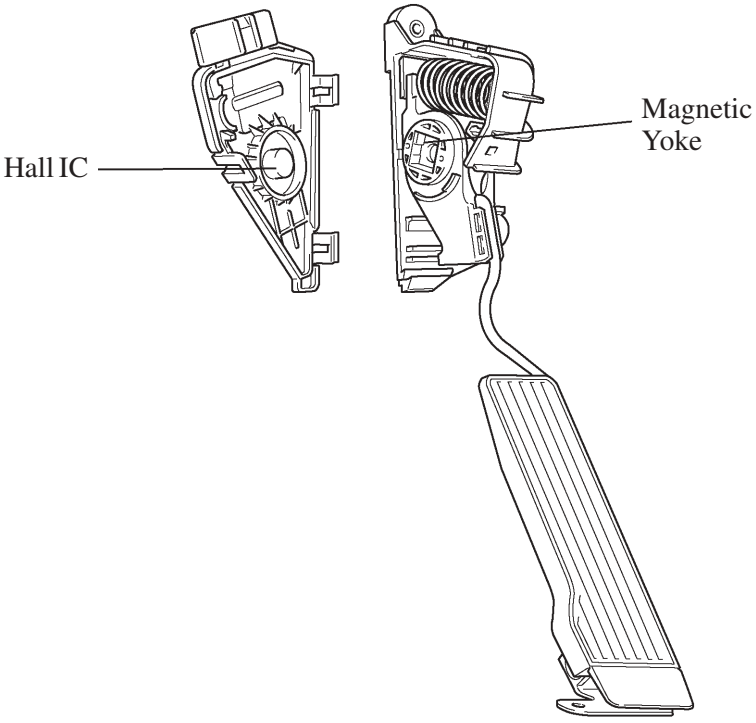


▶ Output Characteristic ◀

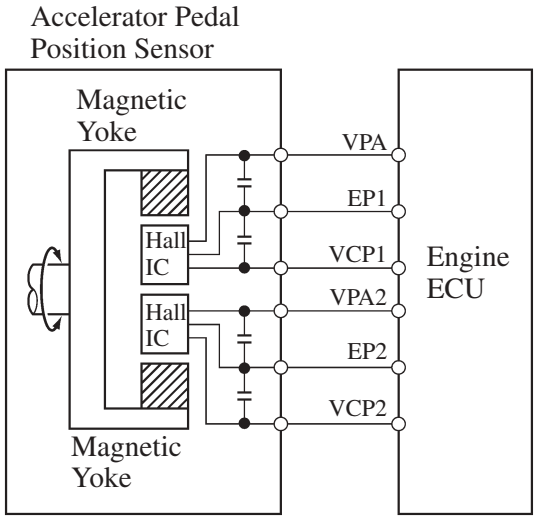


Accelerator Pedal Position Sensor

The magnetic yoke that is mounted at the base of the accelerator pedal arm rotates around the Hall IC in accordance with the amount of effort that is applied to the accelerator pedal. The Hall IC converts the changes in the magnetic flux that occur at that time into electrical signals, and outputs them in the form of accelerator pedal effort to the engine ECU.

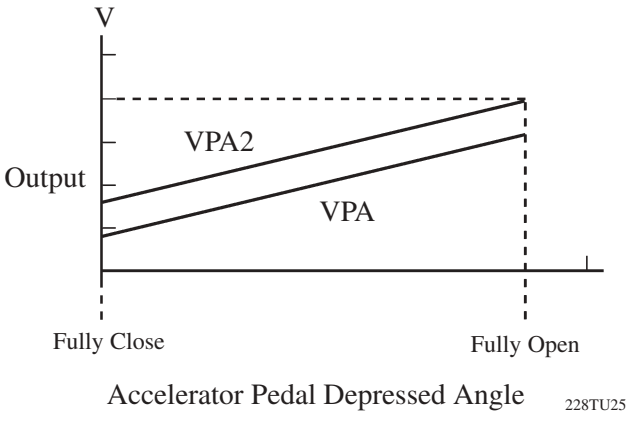


LHD Models 04VEG25Y



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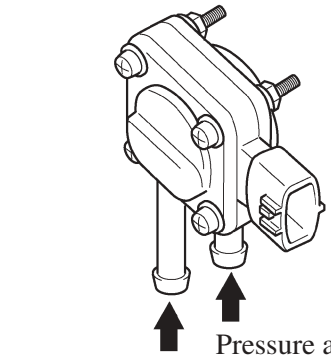
▶ Output Characteristic ◀

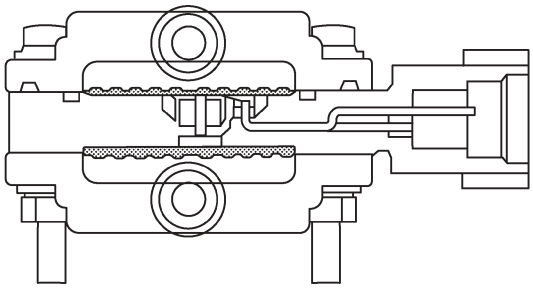


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Differential Pressure Sensor (N04C-TQ Engine)

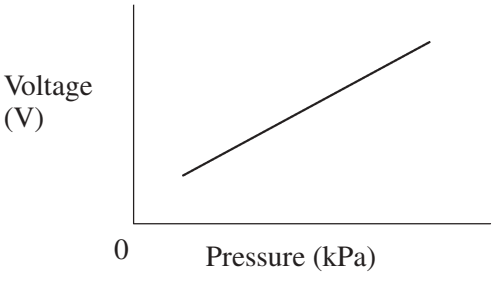
- The differential pressure sensor measures the pressure differences between before and after the DPF catalytic converter in order to detect the clogging.
- The DPF catalytic converter and the sensor are connected with pipes and hoses.





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▶ Output Characteristic ◀

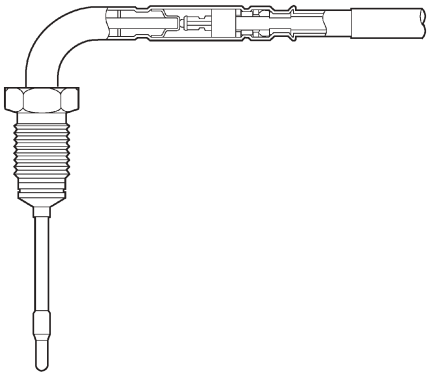


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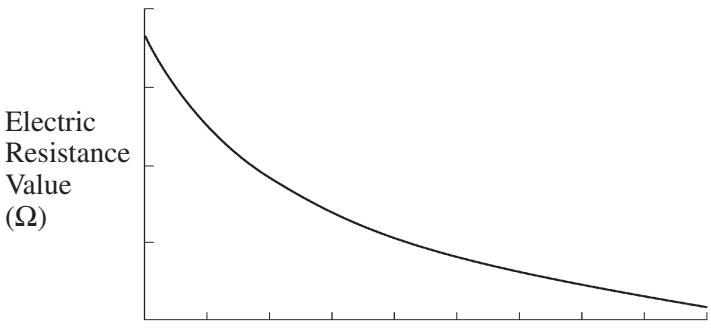
Exhaust Gas Temperature Sensor (N04C-TQ Engine)

The exhaust gas temperature sensors, which are thermistor types, are installed before and after the filter with catalyst of the DPF catalytic converter, in order to detect the temperature of the exhaust gas.

▶ Output Characteristic ◀



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6. Fuel Injection Control

General

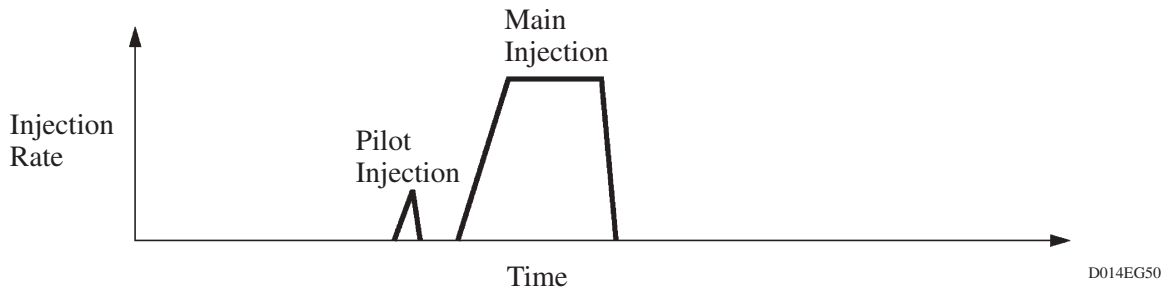
- The engine ECU transmits signals to the injector via the EDU (Electronic Driver Unit) in order to control the fuel injection timing and injection volume.
- A constant fuel pressure that is required by the injectors to properly inject fuel is maintained by optimally controlling the fuel pressure.
- The fuel pressure sensor detects the pressure in the common-rail and the supply pump delivers fuel in order to attain the target pressure in the common-rail.
- The system divides the injection of fuel into two stages and provides a supplementary pilot injection before the main injection. This enables the main combustion to start gradually in order to achieve low NOx emission and low noise.

Fuel Pressure Control

The engine ECU calculates the target injection pressure in accordance with the throttle valve position and the engine speed. Based on the value of the fuel pressure sensor, the engine ECU controls the fuel delivery volume of the suction control valve in the supply pump in order to attain a target pressure in the common-rail.

Multiple Injection Control

- EDU (Electronic Driver Unit) which makes a high-voltage, quick-charging system using a DC-DC converter is used to actuate the pressurized fuel injectors at high speeds and deliver high-precision multiple injections.
- This control divides the injection of fuel into the following stages: pilot injection and main injection. This enhances combustion efficiency and fuel economy, and achieves low noise and low NOx emission.



Injection Type	Control	Result
Pilot Injection	Injects fuel slightly advanced from the main injection.	Achieves low NOx emission and low noise
Main Injection	Injects fuel for normal combustion.	Achieves high torque

Idle Speed Control

This control regulates the fuel injection volume in order to attain an optimal engine speed during idle.

Correction

The system corrects the injection timing and injection volume of the main injection and the pilot injection in accordance with the signals provided by the sensors.

Correction Items	Correction
Intake Air Temperature Correction	When the intake air temperature is low, this correction increases the fuel volume to compensate for the high air density.
Post-warm-up Fuel Increase Correction	When the water temperature is low, this correction increases the fuel volume to ensure the proper drivability while the engine is cold.
Intake Air Pressure Correction	When the intake air mass is low, this correction reduces the fuel volume.

Fuel Cut-off

1) Deceleration Fuel Cut-off

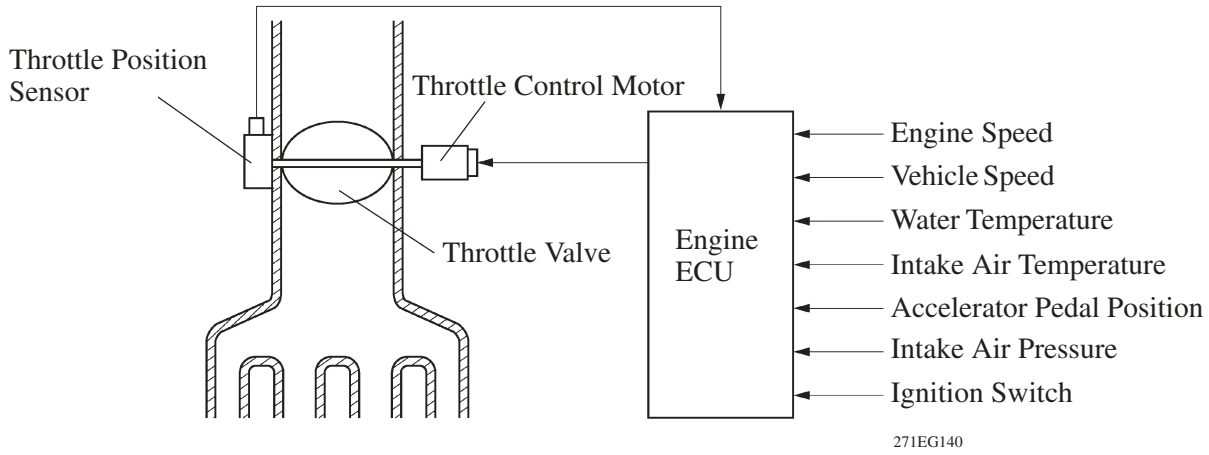
When the vehicle is decelerating and the engine speed is 900 rpm or higher, this control stops the injection of fuel in order to achieve fuel economy. The engine speed for fuel cut-off and restoration will be high when the water temperature is low.

2) Fuel Cut-off According to Engine Speed

When the engine speed is 3,650 rpm or higher, this control stops the injection of fuel to prevent the engine from over-revving.

7. Throttle Control (N04C-TQ and N04C-TU Engines)

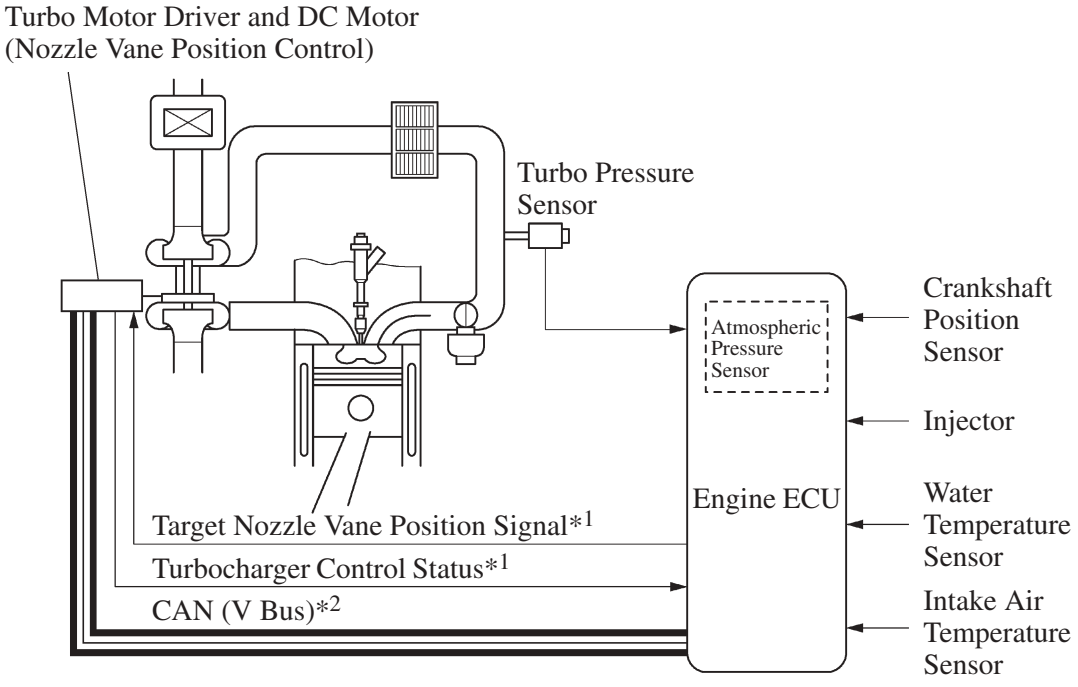
The opening of the throttle valve is controlled by the engine ECU in accordance with engine conditions. As a result, the noise that is generated during idling and deceleration, as well as the noise and vibration that are generated when the engine is stopped, has been reduced.



8. Turbocharger Control (N04C-TQ and N04C-TU Engines)

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 turbo motor driver detects the actual nozzle vane position and provides feedback to the engine ECU. 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.

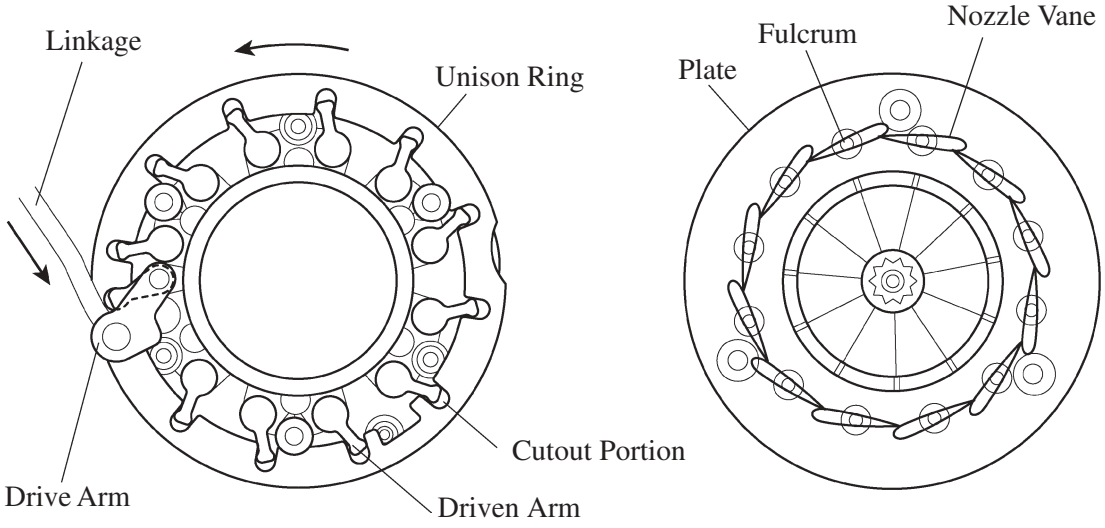


*1: N04C-TQ Engine
*2: N04C-TU Engine

Operation

1) At Low Speed Range

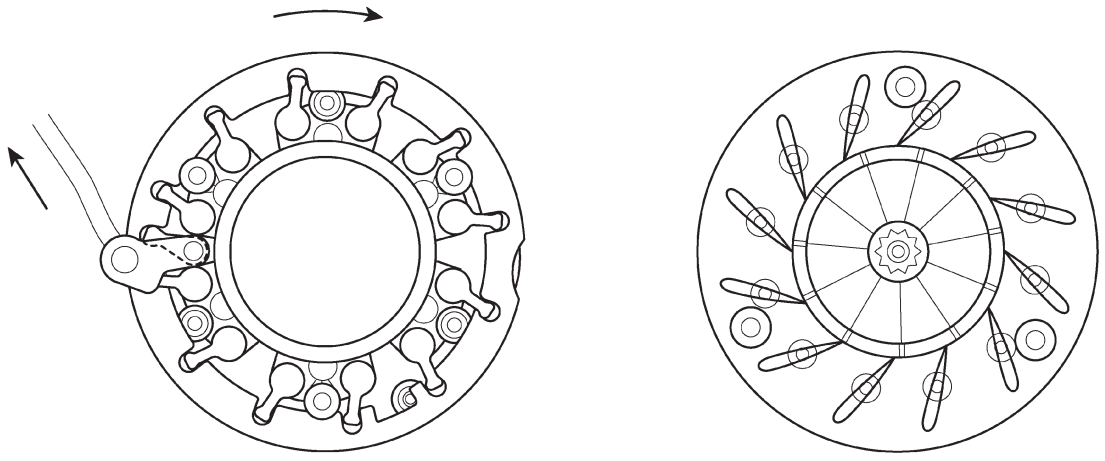
When the engine is running in a low speed range, the DC motor presses down the linkage by a signal from the turbo motor driver. The tip of the linkage rotates the unison ring counterclockwise through a drive arm.
The unison ring contains a driven arm, which is placed through the cutout portion of the 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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2) At Medium-to-High Speed Range

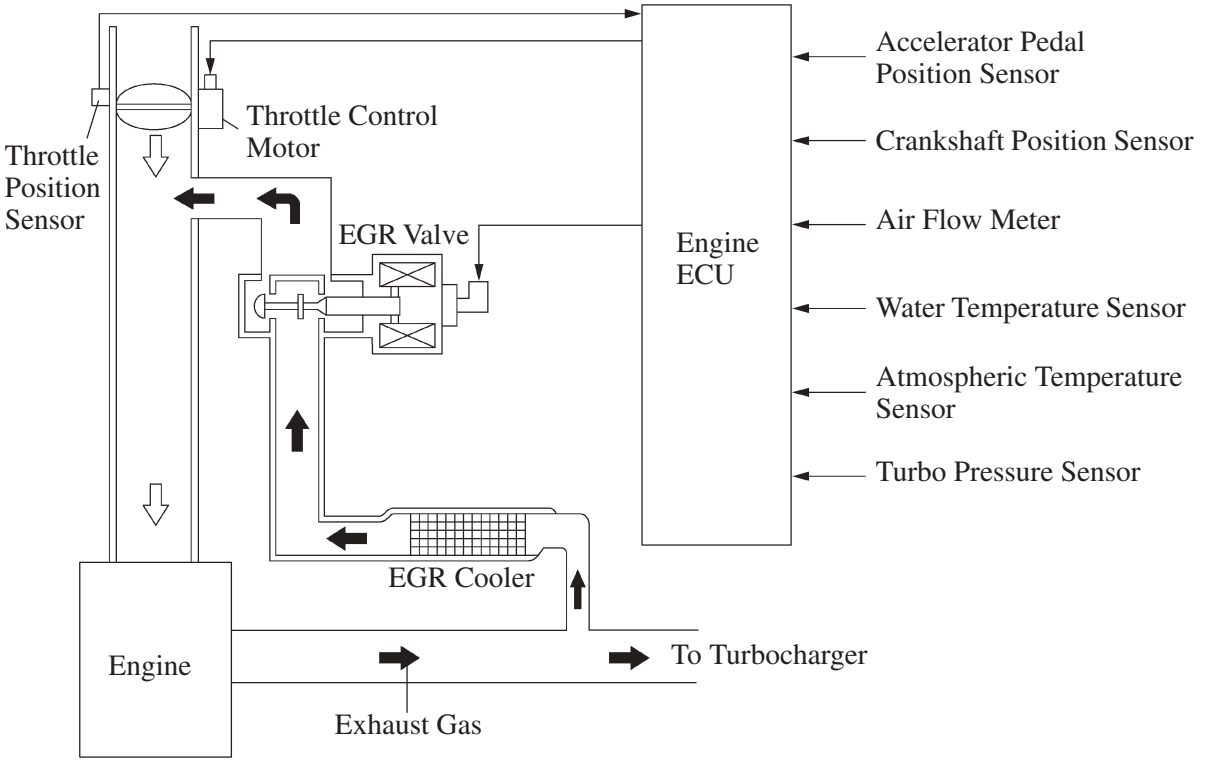
When the engine is running in a medium-to-high speed range, the DC motor pulls up the linkage by a signal from the turbo motor driver. With this, the driven arm moves clockwise and this opens the nozzle vane and holds the specified supercharging pressure. Thus, the back pressure is lowered and the output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



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9. EGR Control (N04C-TQ and N04C-TU Engines)

- This system is designed to reduce and control NOx formation due to a slight reduction of peak temperature in the engine combustion chamber, which is accomplished by introducing a small amount of inert gas into intake manifold.
- By sensing the engine driving conditions, the engine ECU operates the EGR valve and throttle control motor, and regulates the amount of exhaust gas.



10. DPF Control (N04C-TQ Engine)

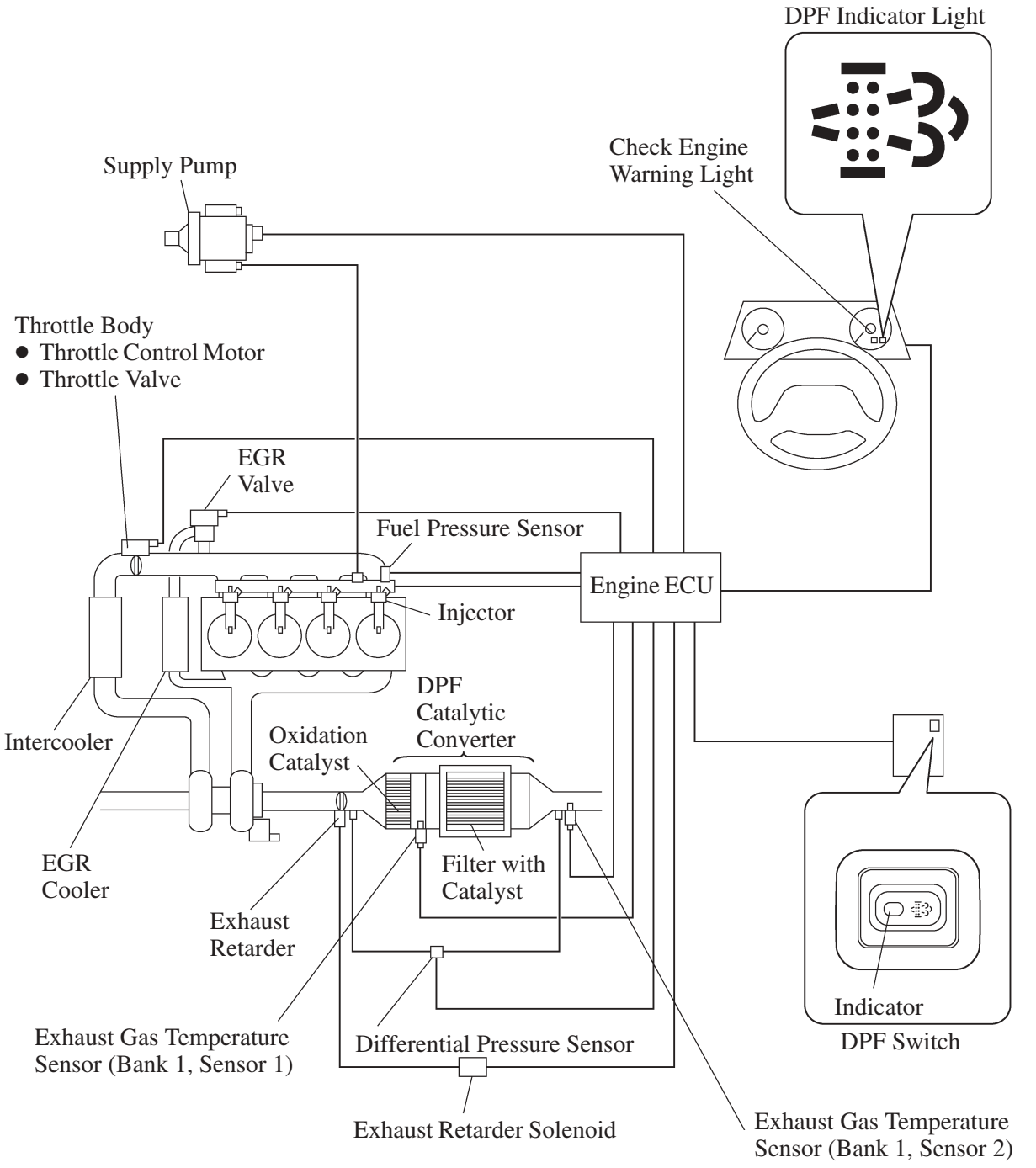
General

The engine ECU judges DPF catalytic converter condition based on injection volume, injection timing, and signals from the air flow meter, water temperature sensor, two exhaust gas temperature sensors and differential pressure sensor. When the filter in the DPF catalytic converter captures a predetermined amount of PM, it automatically burns the captured PM. This prevents an abnormal accumulation of PM, allowing the DPF catalytic converter to operate normally.

Operation

- When the exhaust gas temperature is high, such as when driving at high speeds, the filter in the DPF catalytic converter reaches a temperature that burns the PM, allowing the PM to burn naturally.
- When the exhaust gas temperature is low, it has become possible to raise the temperature of the filter in the DPF catalytic converter by injecting fuel during the exhaust stroke of the cylinder. Thus, even when the exhaust gas temperature is low, this function raises the temperature of the filter to a temperature (approximately 600°C) that burns the PM, effectively burning the accumulated PM.
- During normal driving, this function transfers automatically to the cleaning mode approximately every 200 km*. The cleaning mode does not affect driving. If the cleaning mode operates while the engine is idling, the idle speed increases, causing the exhaust retarder to operate. Thus, the cleaning of the filter might not be completed, depending on the driving conditions. The indicator in the DPF switch and the DPF indicator light in the combination meter will flash to indicate that the cleaning is not completed. When this happens, the driver must press the DPF switch to effect forced cleaning. If the driver does not attend to it even if the indicator in the DPF switch and the DPF indicator light in the combination meter flash, the amount of PM accumulated in the DPF catalytic converter will increase. Then, the engine ECU will inform the driver by illuminating the check engine warning light and sounding the buzzer.
  *: This distance varies depending on the driving conditions.

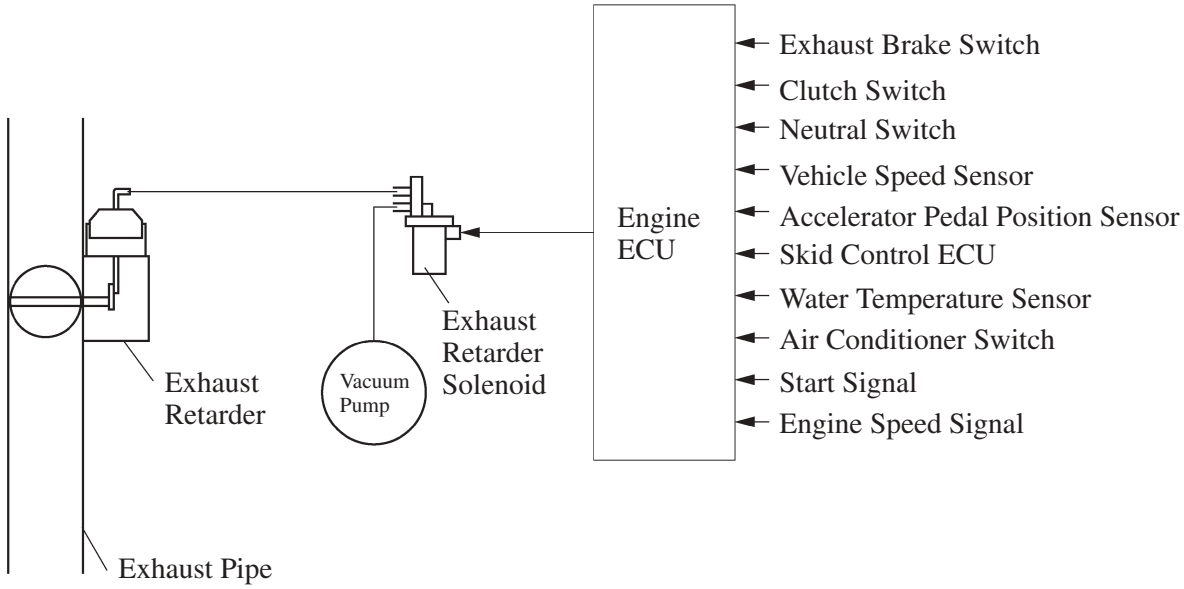
▶ System Diagram ◀



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11. Exhaust Retarder Control

- The engine braking effect is boosted by closing a valve provided in the exhaust pipe and narrowing the exhaust gas passage. The stop lights illuminate when this function operates.
- On the N04C-TQ engine, when the engine idles for a long period of time, unburned HC accumulates in the DPF catalytic converter. This causes white smoke to be emitted when the vehicle starts off. For this reason, the system effects longtime idling control to reduce HC. This control raises the idle speed and closes the exhaust retarder valve when the engine idles for a long time.



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▶ System Components and Specifications ◀

Component	Function
Exhaust Retarder Solenoid	Switch between atmospheric pressure and negative pressure applied to the vacuum cylinder, opening and closing the exhaust retarder valve.
Exhaust Brake Switch	Pulling the exhaust brake switch (incorporated in the wiper control switch) toward the driver activates the exhaust retarder and causes the indicator light in the combination meter to illuminate.
Clutch Switch	Detects clutch engagement according to clutch pedal operation; depressing the clutch pedal turns off current to exhaust retarder solenoid.
Neutral Switch	Detects engagement of neutral or any other gear.
Vehicle Speed Sensor	Built into speedometer; detects vehicle speed and sends it to the engine ECU.

▶ Objective and Operating Condition for Exhaust Retarder ◀

Objective	Operating Condition
Exhaust Brake	● Exhaust brake switch is ON. ● Clutch is not operating. ● Accelerator pedal is not operating. ● Vehicle speed is more than predetermined value. ● Transmission is not neutral. ● ABS is not operating.
Longtime Idling Control (Only for N04C-TQ Engine)	● Vehicle is stopped. ● Engine is idling for long time. ● Clutch is not operating. ● Accelerator pedal is not operating. ● Transmission is neutral.
DPF Control (Only for N04C-TQ Engine)	Vehicle is stopped with idling during DPF catalytic converter cleaning mode (see page 71).

12. Diagnosis

- When the engine ECU detects a malfunction, the engine ECU makes DTCs (Diagnosis Trouble Codes) and memorizes the failed section. Furthermore, the check engine warning light in the combination meter illuminates to inform the driver.
- At the same time, the DTCs are stored in memory. The DTCs can be read by connecting an intelligent tester II.
- For details, refer to the DYNA Repair Manual Supplement (Pub. No. RM04V0E).

Service Tip

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

13. 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. For details, refer to the DYNA Repair Manual Supplement (Pub. No. RM04V0E).