NEW FEATURES

■ N04C-UH ENGINE

1. General

- The N04C-UH engine is a newly developed engine, which is based on the N04C-TQ engine (EURO IV), but has undergone various modifications in order to comply with the EURO V emission regulations.
- The N04C-UH engine is an in-line 4-cylinder, 4.0-liter, 16-valve OHV engine. A common-rail system and variable nozzle vane type turbocharger with intercooler are used to realize high output and good fuel economy.
- For the N04C-UH engine, a DPF (Diesel Particulate Filter) system is used to realize clean exhaust emissions.

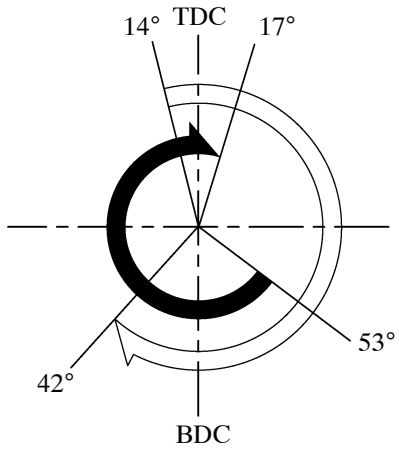
▶ Engine Specifications ◀

No. of Cyls. & Arrangement			4-cylinder, In-line
Valve Mechanism			16-valve, OHV, Gear Drive
Combustion Chamber			Direct Injection
Manifolds			Cross-flow
Fuel System			Common-rail Type
Displacement cm^3 (cu. In.)			4009 (244.6)
Bore × Stroke mm (in.)			104.0 × 118.0 (4.09 × 4.65)
Compression Ratio			18.0 : 1
Max. Output [EEC]			110 kW @ 2700 rpm
Max. Torque [EEC]			397 N·m @ 1800 rpm
Valve Timing	Intake	Open	14° BTDC
		Close	42° ABDC
	Exhaust	Open	53° BBDC
		Close	17° ATDC
Turbocharger			Variable Nozzle Vane Type
Fuel Cetane Number			48 or more
Firing Order			1 - 3 - 4 - 2
Emission Regulations			EURO V
Engine Service Mass (Reference)* kg (lb)			382 (842) :Manual Transmission Models
			362 (798) :Automatic Transmission Models

*: Weight shows the figure with oil and water fully filled.

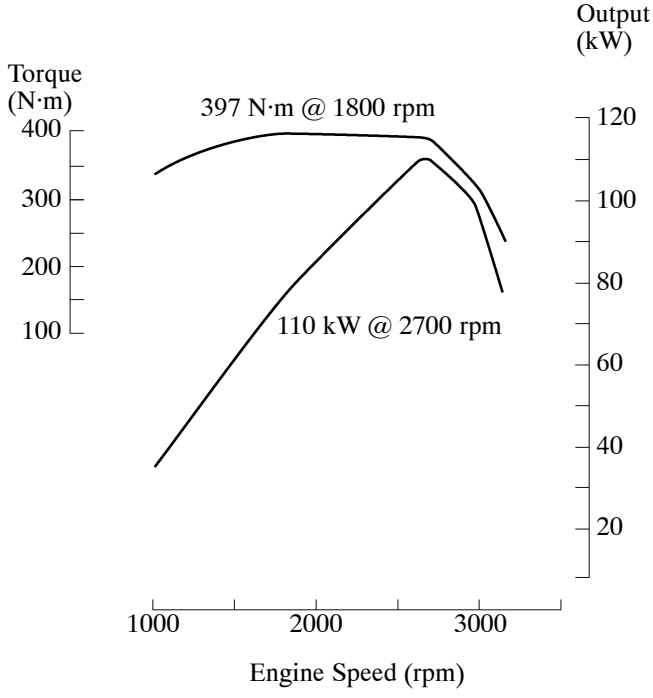
▶ Valve Timing ◀

: Intake Valve Opening Angle
: Exhaust Valve Opening Angle



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▶ Performance Curve ◀



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2. Major Differences (from N04C-TQ Engine)

The major differences between the N04C-UH engine and the N04C-TQ engine are listed in the table below.

System	Outline
Engine Specifications	In accordance with various changes, the following specifications have been changed. • The engine complies with EURO V with regards to emission regulations.
Cooling System	• The cooling performance target value (target engine coolant temperature, etc.) has been reviewed to improve the efficiency of the engine. • The installation position of the radiator has been changed to the rear of the vehicle (approx. 25.5 mm), due to the use of a large-size intercooler. In accordance with this change, the shape of the drain sections and the water hoses, etc. have been changed.
Intake System	• The turbocharger has been changed. • The size of the EGR cooler has been increased. • A large-size intercooler is used. • The intake manifold has been changed.
Exhaust System	• A new type of DPF catalytic converter which improves the purification performance is used.
Fuel System	• A new type of injector is used. • An air-cooled type fuel cooler is provided.
Blowby Gas Recirculation System	• The oil separator Assembly has been changed.
Charging System	• An alternator with a rated voltage of 12 V is used. (Models Other Than Europe Models)
Starting System	• A starter with a rated voltage of 12 V and a rated output of 2.7 kW is used. (Models Other Than Europe Models)
Engine Control System	• The engine control voltage has been set to 12V. • In accordance with the setting of the engine control voltage to 12V, a DC/DC converter which converts the vehicle power supply voltage (24V) to the engine control voltage (12V) is used. (Models for Europe) • Also with the setting of the engine control voltage to 12V, components of engine control system such as the accelerator pedal position sensor have been changed to 12V-compatible parts. • The installation position of the intake air temperature sensor has been changed. • The EDU has been changed. • In accordance with the changes to the cooling, intake, exhaust and fuel systems, the specifications for engine ECU control have been changed and optimized for the N04C-UH engine.

3. Features of N04C-UH Engine

The N04C-UH engine has been able to achieve the following.

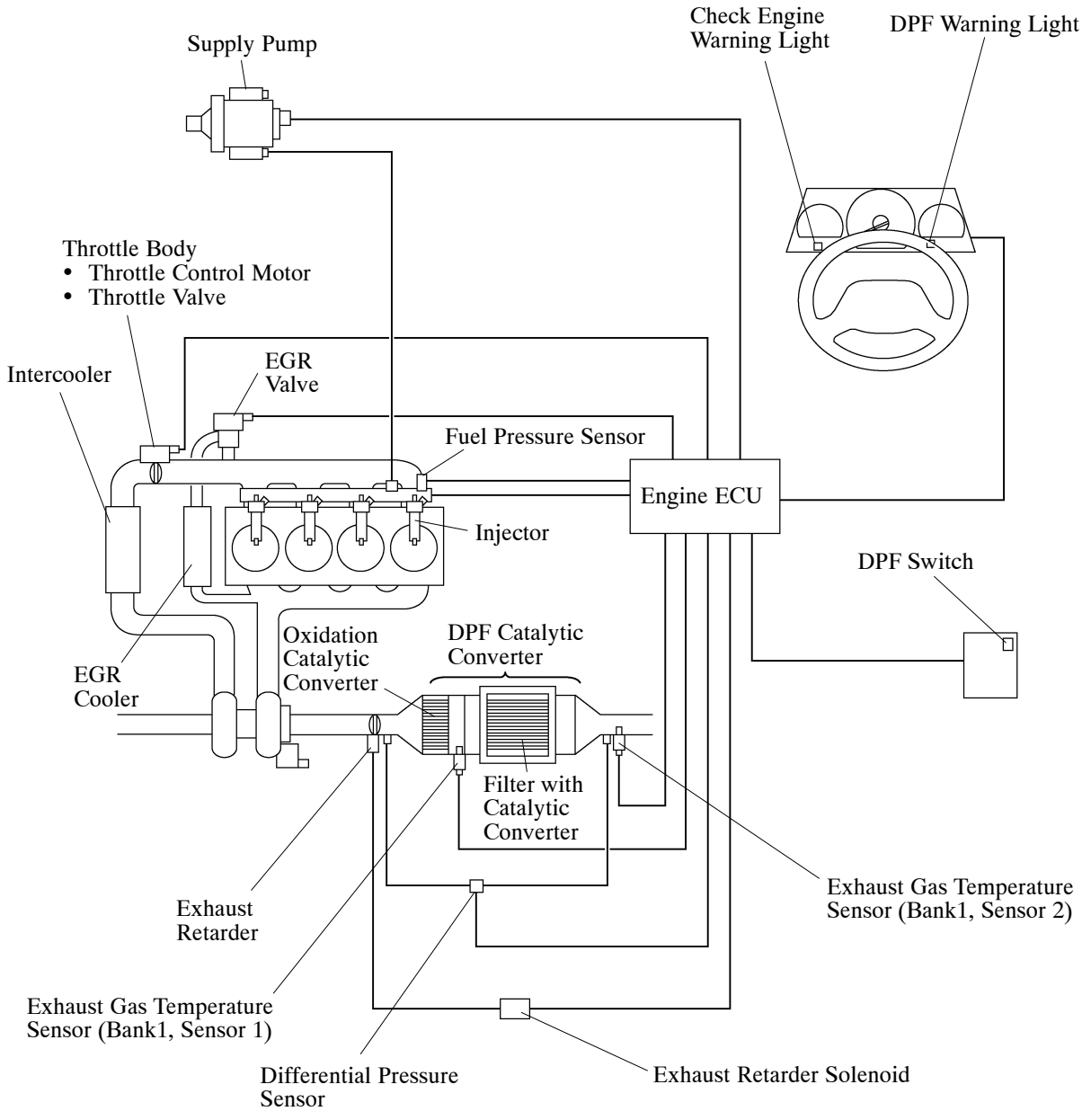
(1) High Output
(2) Good Fuel Economy
(3) Clean Exhaust Gases
(4) Low Noise and Low Vibration
(5) Weight Reduction

Features	(1)	(2)	(3)	(4)	(5)
DPF System			○		
No. 2 Cylinder Head Cover				○	
Full Jacket Type Water Jacket	○	○	○		
High-precision Timing Gear Train				○	
Highly Rigid Push Rod	○				
Lightweight and Highly Rigid Piston	○	○	○	○	○
Optimal Combustion Chamber Shape	○	○	○		
Highly Rigid Crankshaft	○			○	
Piston Skirt Coating				○	
Throttle Body		○	○	○	
Air-cooled Type Intercooler	○	○	○		
Variable Nozzle Vane Type Turbocharger	○	○	○		
Common-rail System	○	○	○	○	○
DPF Catalytic Converter			○		
Multiple-orifice, Small-diameter Injector	○	○	○		
EGR System		○	○		
Water-cooled Type EGR Cooler		○	○		
Blowby Gas Recirculation System			○		

4. DPF (Diesel Particulate Filter) System

- A DPF (Diesel Particulate Filter) catalytic converter, which contains a filter with catalyst for capturing PM (Particulate Matter), is used in the center pipe in order to comply with the EURO V emission regulations.
- In the DPF system, the engine ECU precisely controls the common-rail system, and effects DPF control to burn the PM that is captured in the filter. As a result, this system realizes a stable PM reduction performance even when the exhaust gas temperature is low. For details, see page 64.

▶ System Diagram ◀

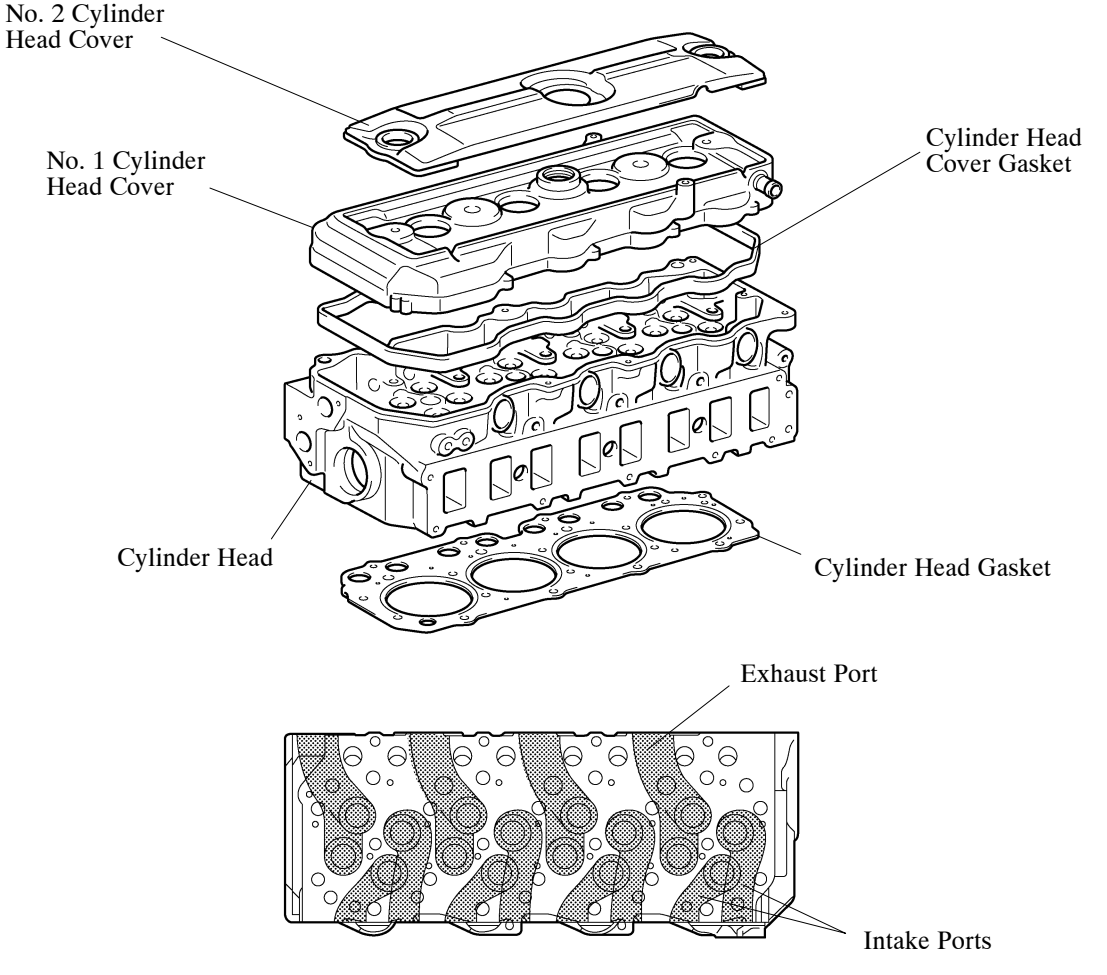


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5. Engine Proper

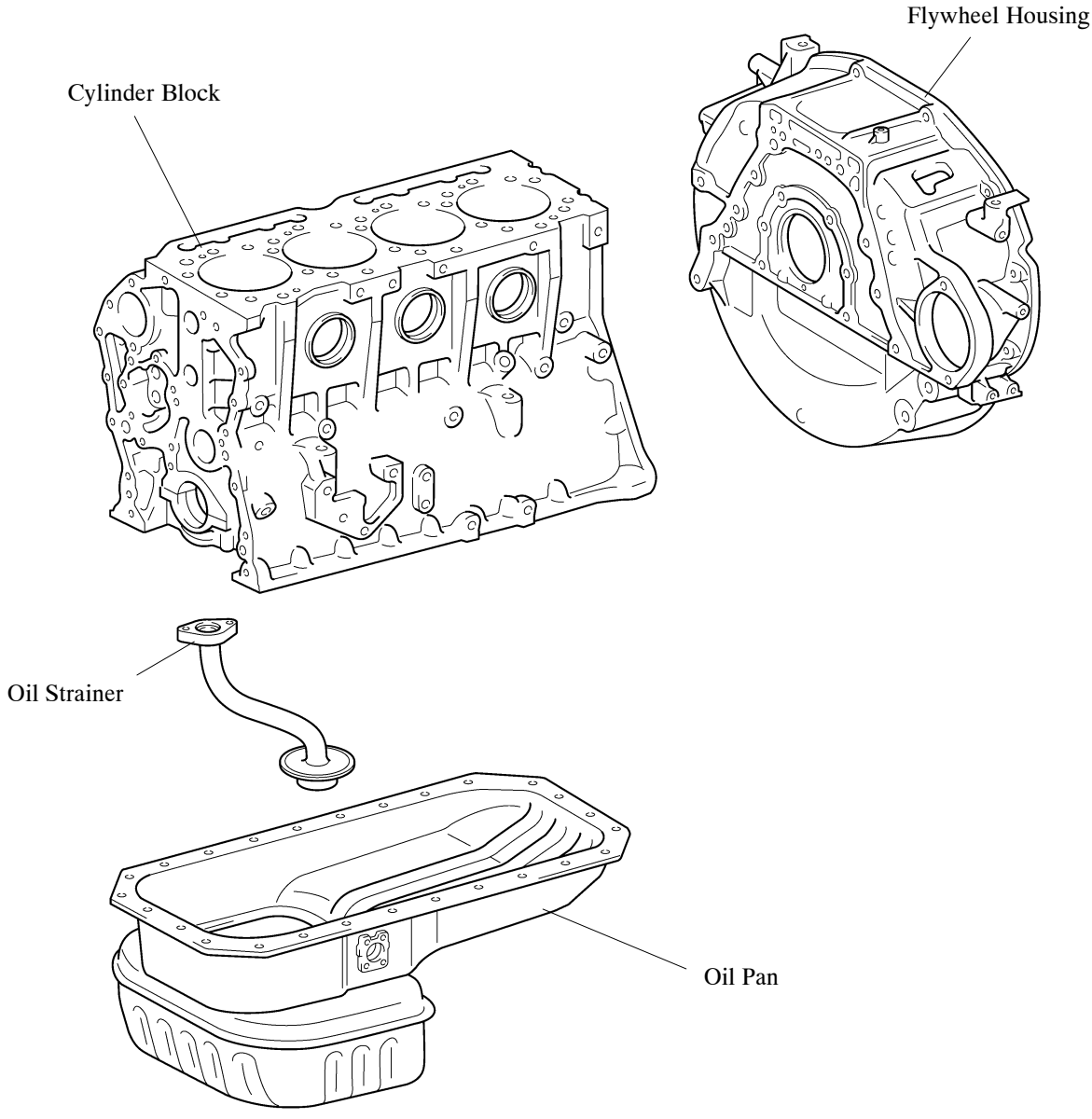
Cylinder Head

- A cylinder head made of high-strength cast iron is used. The thickness of the walls and the layout of the water jacket have been optimized to achieve well-balanced rigidity and cooling performance. Two intake valves and two exhaust valves have been provided for each cylinder, and the shape of the ports has been optimized.
- Cross-flow type intake ports that consist of two different shapes are used to produce an optimal swirl in order to achieve high charging efficiency and exhaust efficiency.
- Valve guides made of a sintered material that provides good oil retention are used in order to ensure seizure resistance and wear resistance. Furthermore, the amount of oil leakage through the valve stem oil seal has been minimized to achieve low oil consumption and exhaust emissions.
- A steel laminate type cylinder head gasket is used to achieve high sealing performance and heat resistance.
- A No. 1 cylinder head cover made of aluminum alloy is used for weight reduction.
- A cylinder head cover gasket made of a highly heat-resistant and oil-resistant acrylic rubber is used to ensure reliability.
- The No. 2 cylinder head cover is bolted in two locations in the center to achieve a reduced number of parts and high serviceability.



Cylinder Block and Oil Pan

- The cylinder block is made of cast iron alloy and contains dry type cylinder liners that are highly rigid. A full jacket type water jacket is used to ensure strength and durability.
- The casting thickness of the walls of the cylinder block has been optimized to ensure strength and weight reduction.
- An FIPG (Formed-In-Place Gasket), which excels in sealing performance, is used along the outer flange of the oil pan.
- A flywheel housing made of lightweight and highly rigid aluminum alloy is used.

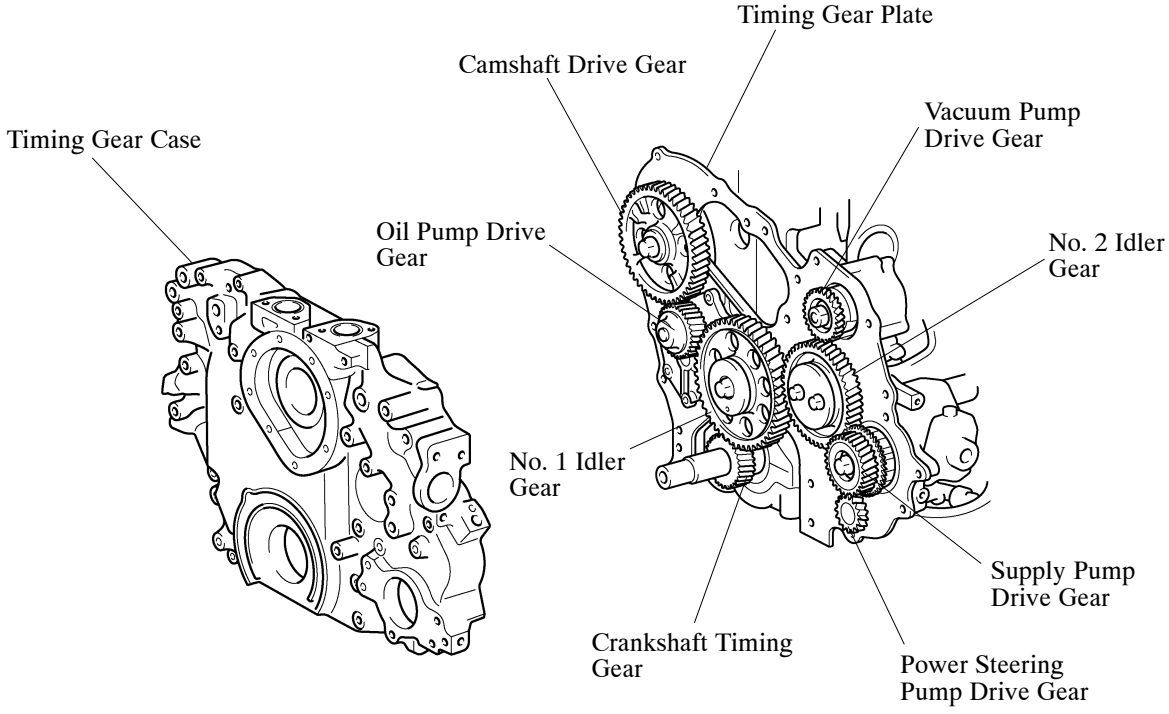


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Timing Gear Train

The timing gear train drives the supply pump, oil pump, vacuum pump, camshaft, and power steering pump.

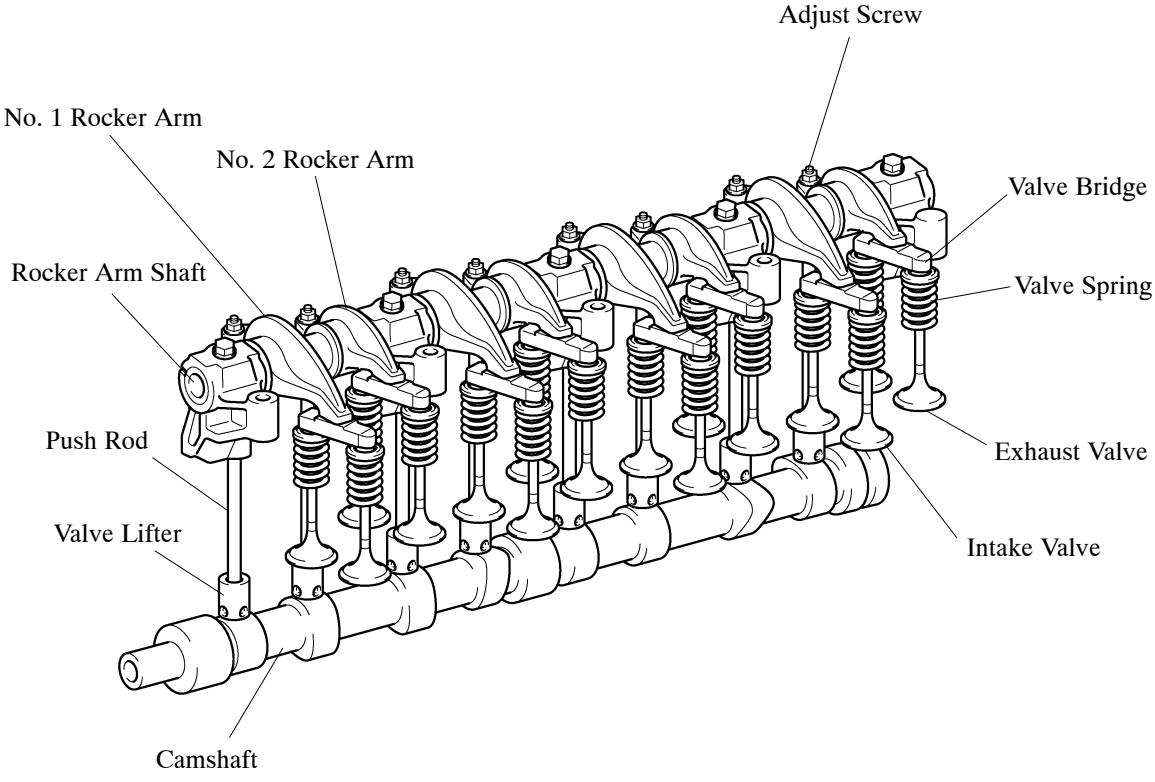
- A timing gear case made of aluminum alloy is used.
- The power of the crankshaft timing gear is transmitted to the No. 1 idler gear to drive the oil pump drive gear and the No. 2 idler gear.
- The No. 2 idler gear drives the supply pump drive gear, which also drives the power steering pump drive gear.
- The oil pump drive gear drives the camshaft drive gear.
- The No. 2 idler gear drives the vacuum pump drive gear.



Valve Mechanism

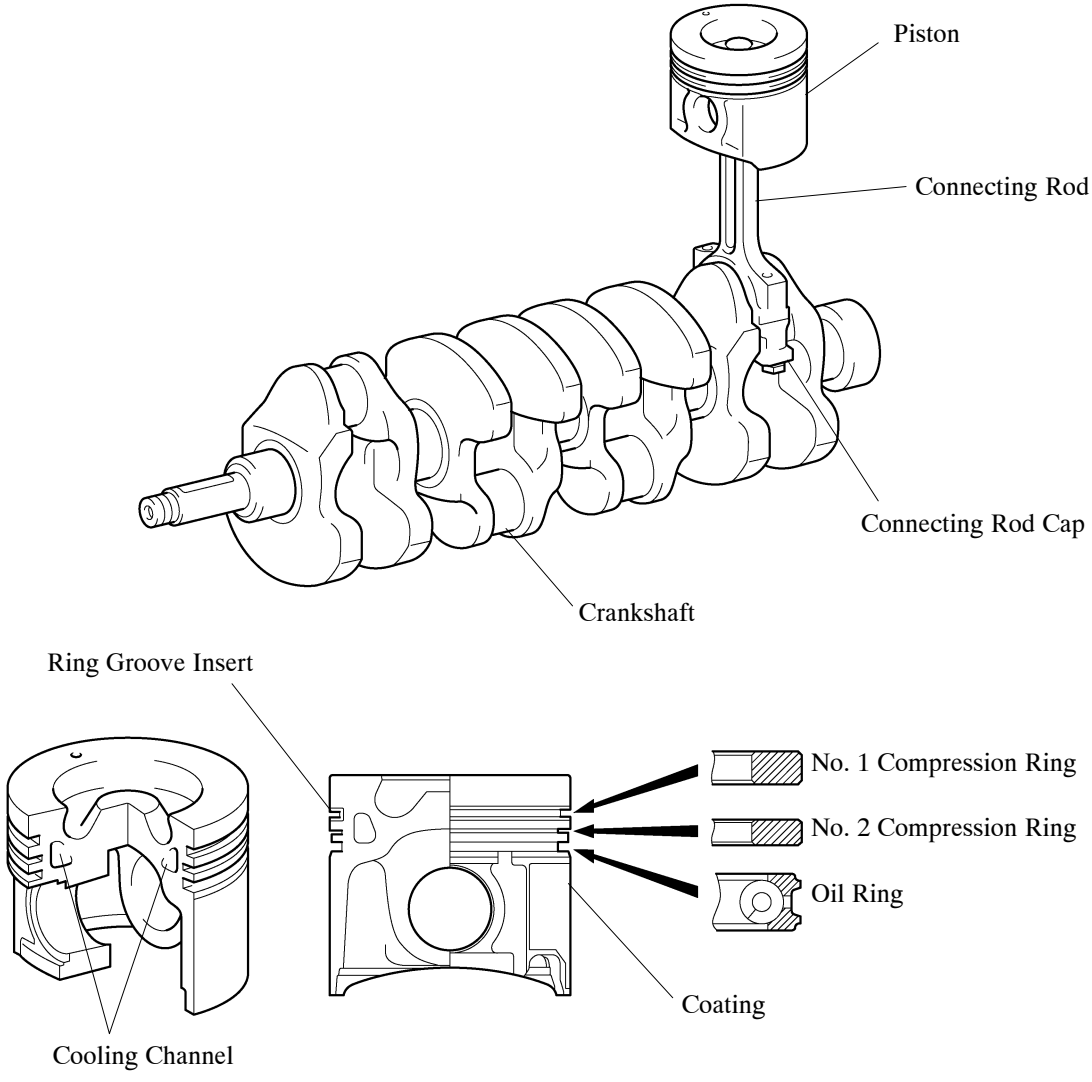
A 16-valve OHV system is used. The camshaft drives the push rods, rocker arms, and valve bridges in order to open and close the valves.

- Push rods made of highly rigid carbon steel are used to achieve a high speed threshold. The portion of the push rods that comes in contact with the rocker arms has been hardened to ensure proper wear resistance.
- Intake and exhaust valves made of heat-resistant steel are used. The stems and the ends have been nitrocarburized to ensure proper wear resistance.
- Cast iron valve lifters are used.



Pistons, Connecting Rods and Crankshaft

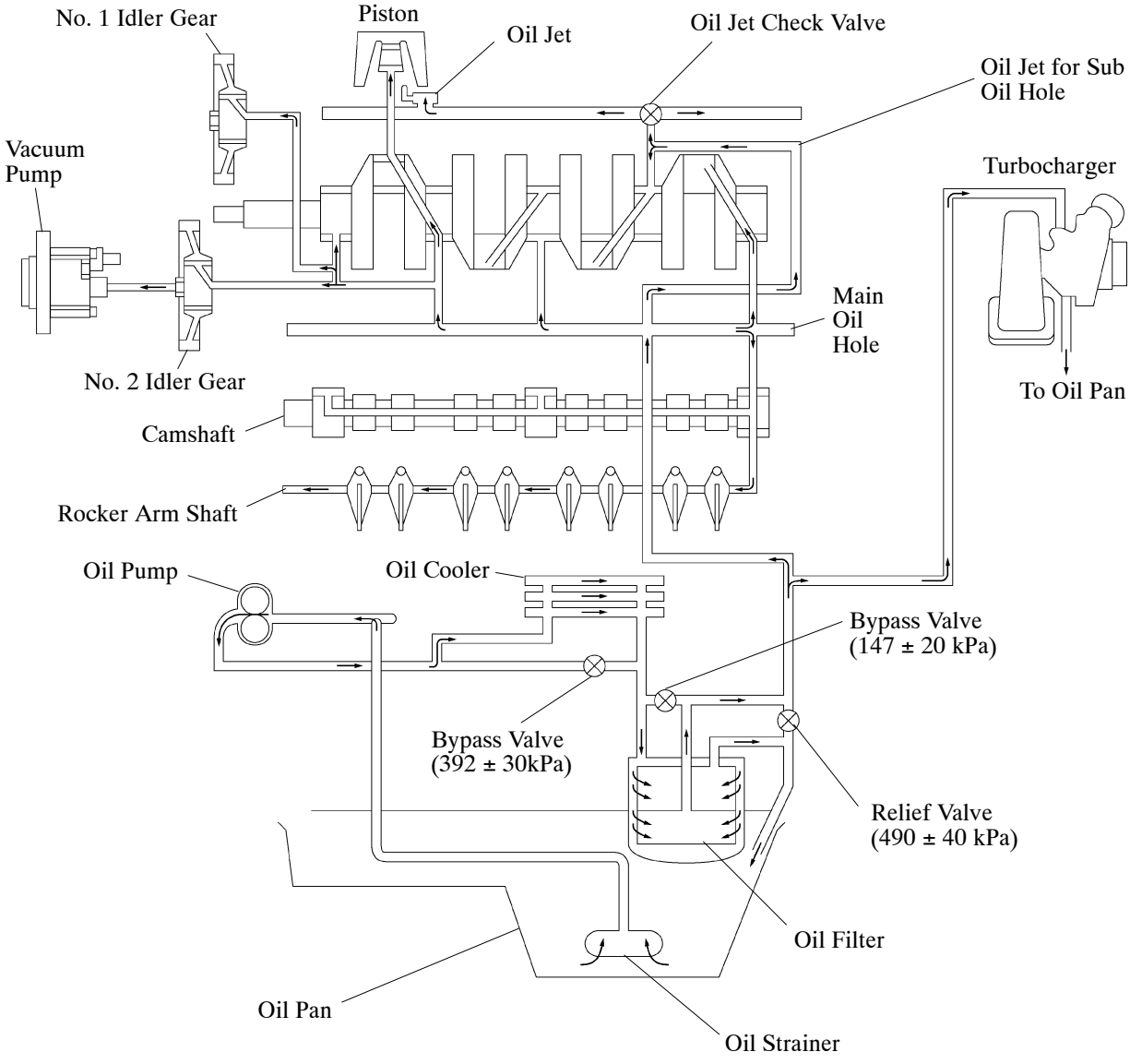
- Pistons made of lightweight and high-temperature resistant aluminum alloy are used, and the combustion chambers are a reentrant shape in order to achieve high power output, good fuel economy, and low exhaust emissions.
- Full-floating type piston pins are used. Their overall length and wall thickness have been optimized to accommodate the high power output of the engine.
- Connecting rods made of cast carbon steel are used.
- The crankshaft is made of high-strength forged special steel.
- A cooling channel has been provided inside each piston ring groove in order to cool the piston with oil, thus improving reliability.
- A ring groove insert has been provided in the top ring groove to ensure wear resistance, and the skirt has been coated to achieve high scuffing resistance.



6. Lubrication System

General

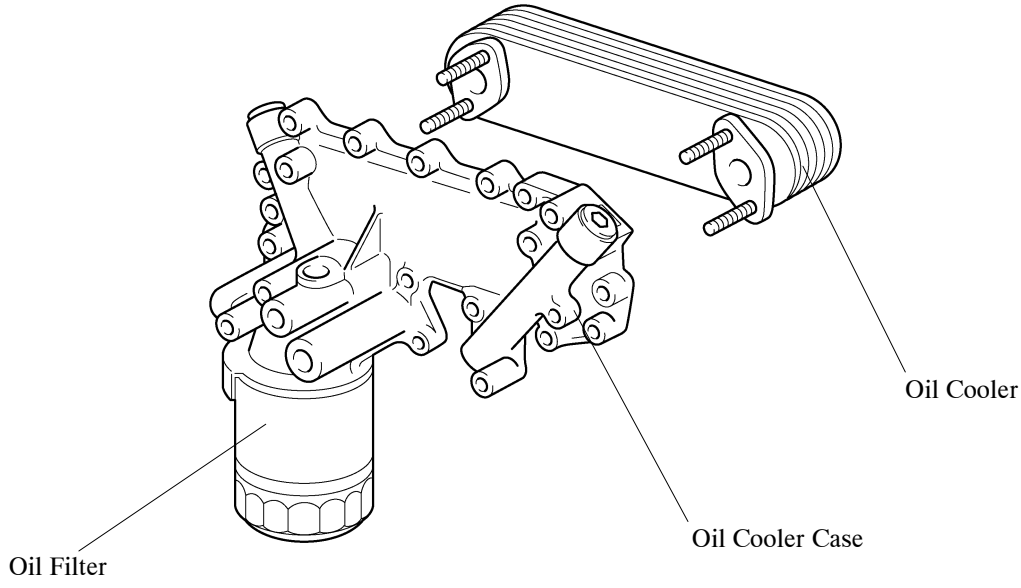
- A full-flow, full-filter lubrication system is used.
- A highly efficient oil cooler is provided upstream of the oil filter.
- Oil jets for cooling and lubricating the pistons are used.



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Oil Cooler and Oil Filter

- A water-cooled, multiplate, 6-element type oil cooler, which is built into the cylinder block, is used.
- A full-flow single type oil filter is used.



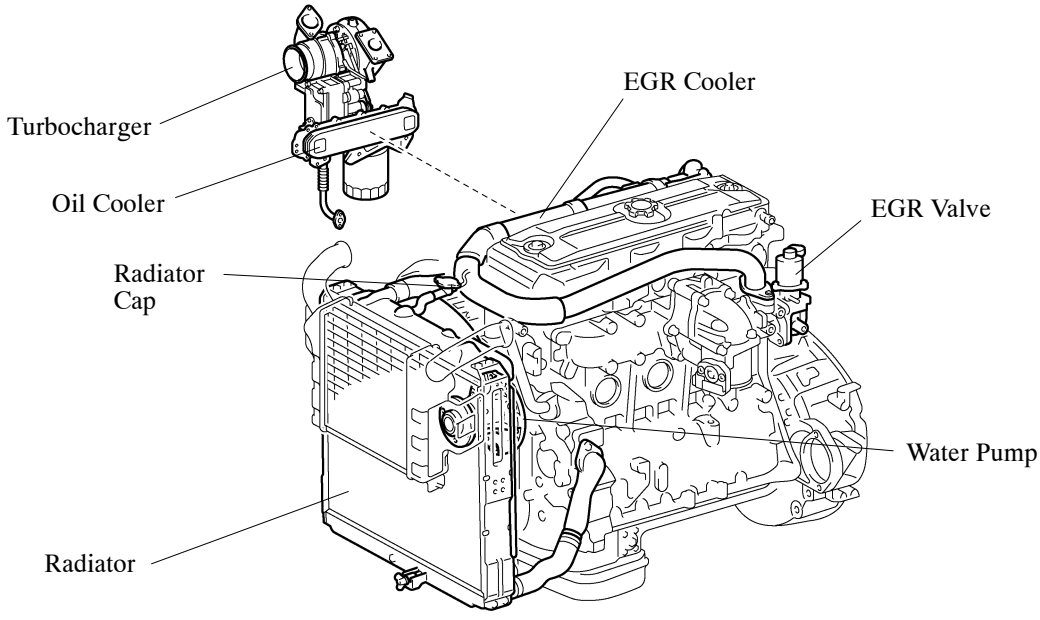
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7. Cooling System

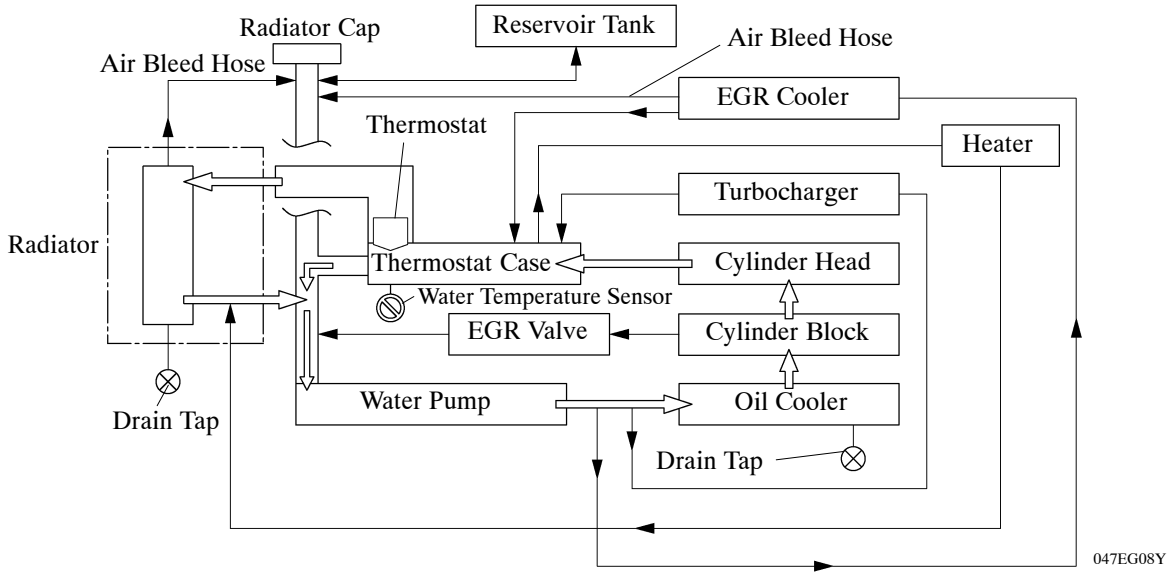
General

An outlet thermostat type, water-cooled, pressurized circulation cooling system that uses a thermostat with a bypass valve at the water outlet is used.

- The valve opening temperature of the thermostat is set to 82°C.
- The water pump is mounted in front of the cylinder block and is driven by the V-belt.
- A radiator with an aluminum core is used for weight reduction and high recyclability. An air bleed hose has been provided between the radiator tank and the radiator cap to facilitate the bleeding of air from the cooling circuit.
- The cooling performance target value (target engine coolant temperature, etc.) has been reviewed to improve the efficiency of the engine.
- The system also circulates coolant through the turbocharger and the oil cooler in order to cool them.
- TOYOTA genuine SLLC (Super Long Life Coolant) is used.



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▶ Specifications ◀

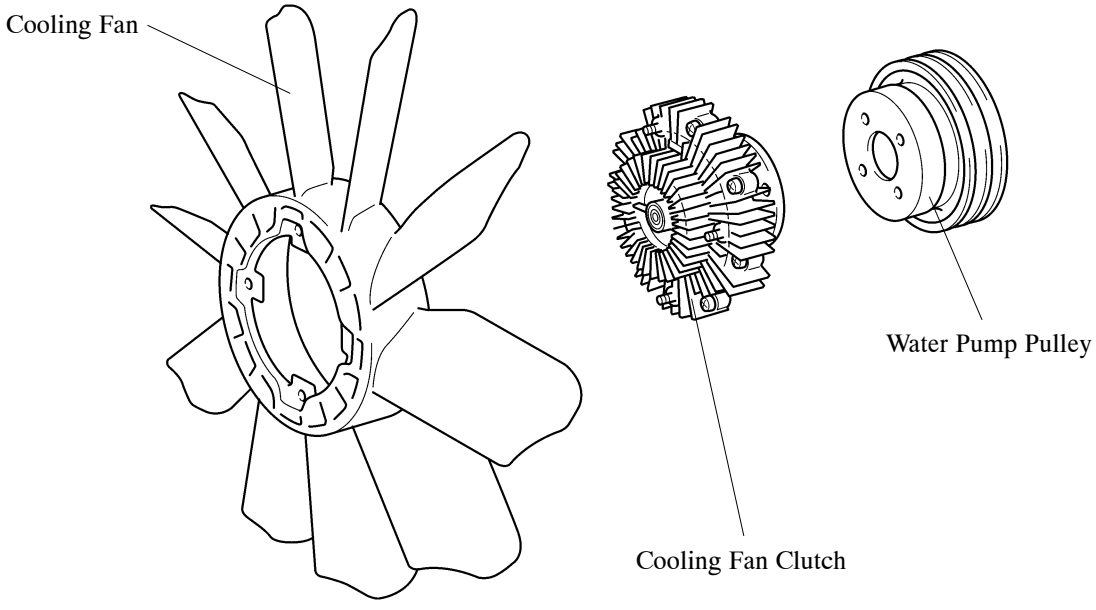
Capacity liters (US qts, Imp. qts)		14.35 (15.17, 12.63)
Type		TOYOTA Genuine SLLC or equivalent as shown as below*
Color		Pink
Maintenance Interval	First Time	160,000 km (100,000 miles)
	Subsequent	Every 80,000 km (50,000 miles)

- SLLC is pre-mixed (50% coolant and 50% deionized water). Therefore, no dilution is needed when SLLC is added or replaced.
- If LLC is mixed with SLLC, the interval for LLC (every 40,000 km/25,000 miles or 24 months (whichever comes first) should be used.

*: Similar high quality ethylene glycol based non-silicate, non-amine, non-nitrite, and non-borate coolant with long-life hybrid organic acid technology (coolant with hybrid organic acid technology consists is a combination of low phosphates and organic acids)

Cooling Fan

- A cooling fan with an outer diameter of 450 mm and 10 blades is used.
- A large-diameter cooling fan clutch is used to improve the transmission of torque to the cooling fan.



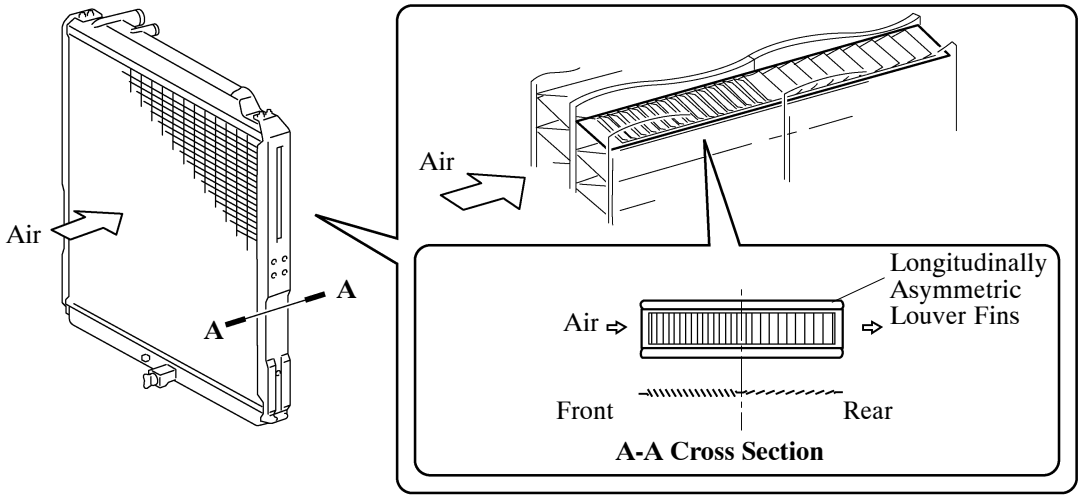
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▶ Specifications ◀

Engine Type	N04C-UH
Fan diameter	450 mm (17.72 in.)
Number of blades	10
Blade width	55 mm (2.2 in.)
Cooling fan clutch diameter	193 mm (7.6 in.)

Radiator

- Longitudinally asymmetric louver fins are used in the radiator core. This achieves a large tube heat dissipation surface area and ensures a high amount of heat dissipation.
- A radiator with an aluminum core is used for weight reduction and high recyclability.



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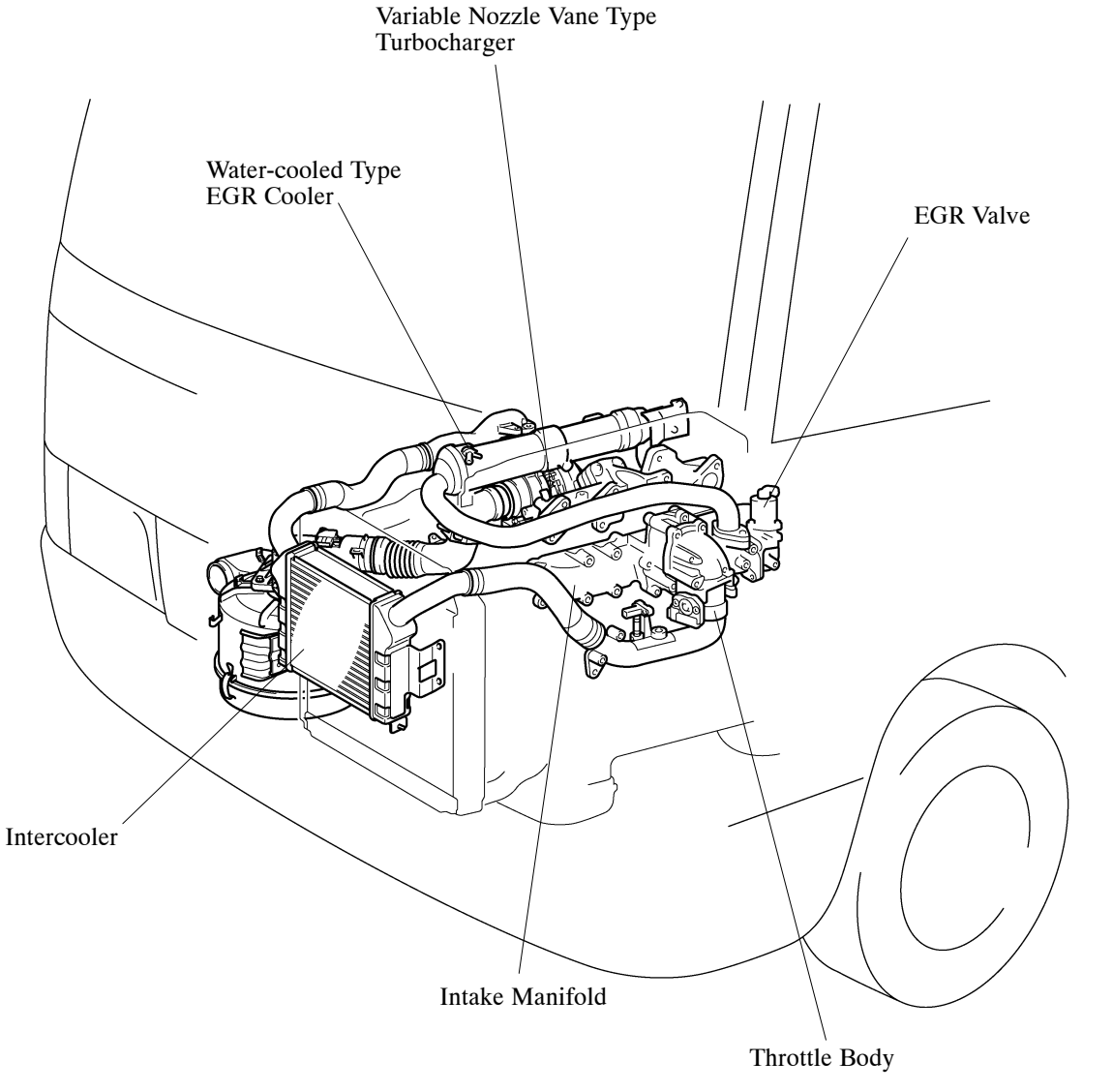
▶ Specifications ◀

Core Dimensions	Width	583.2 mm (23.0 in.)
	Height	490 mm (19.3 in.)
	Depth	48 mm (1.9 in.)
Fin Pitch		4.0/2 mm (0.16 in.)

8. Intake System

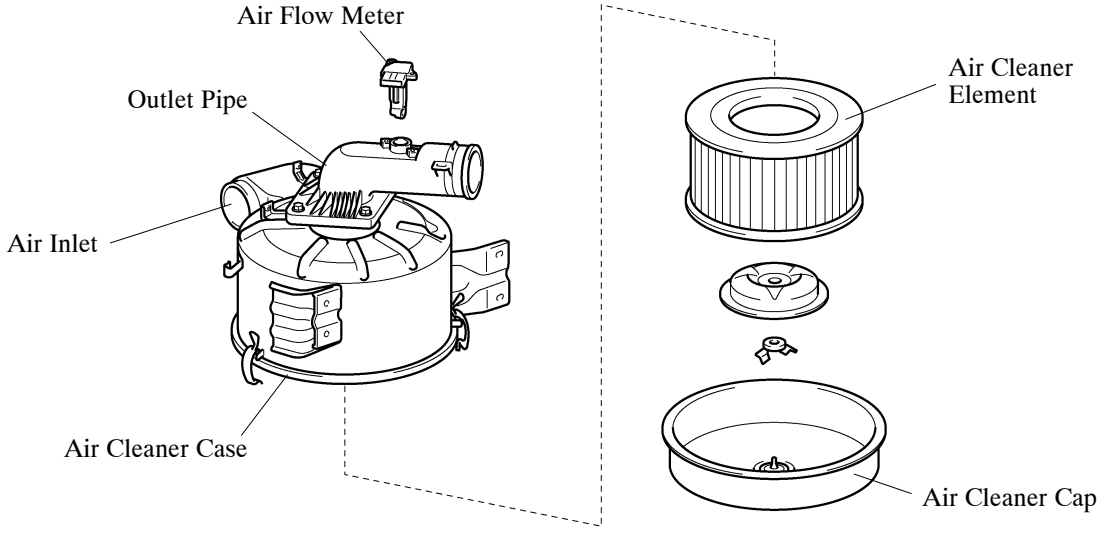
General

- A new variable nozzle vane type turbocharger made by Honeywell (Garrett brand) is used.
- A large-size intercooler with a fin type core is used.
- A long core water-cooled type EGR cooler is used.
- An intake manifold made of lightweight aluminum alloy is used.
- The throttle body is located in front of the intake manifold.
- A dual-valve mechanism EGR valve is used.
- The air pipes in the vicinity of the intercooler, and part of the hose band have been newly designed to suit material changes and increased supercharging pressure.



Air Cleaner

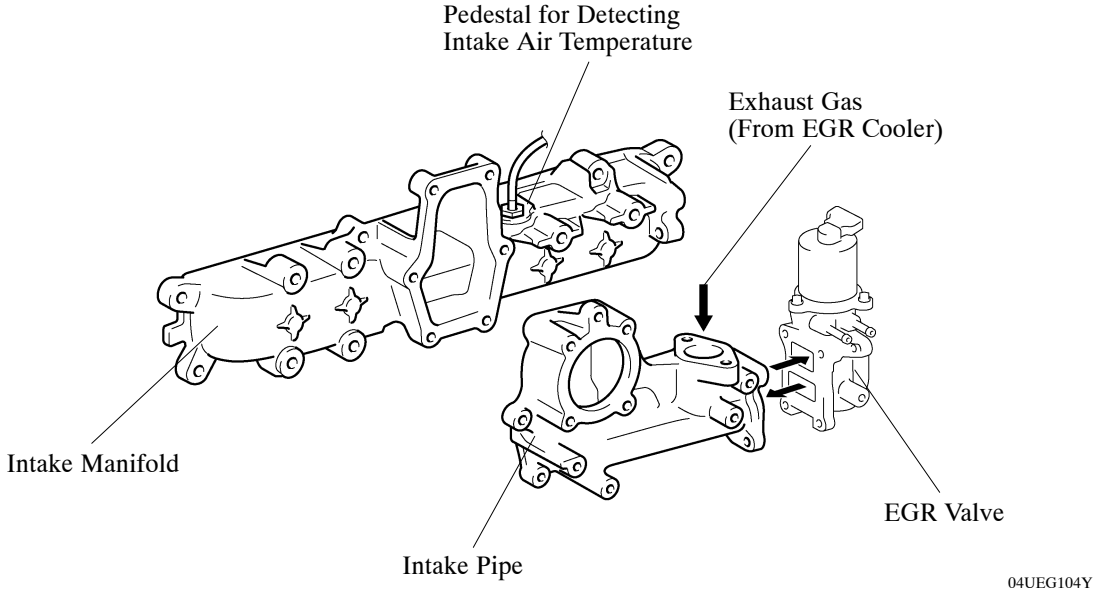
- An air inlet, air cleaner case and air cleaner cap made of steel are used.
- An air flow meter is provided on the outlet pipe.



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Intake Manifold and Intake Pipe

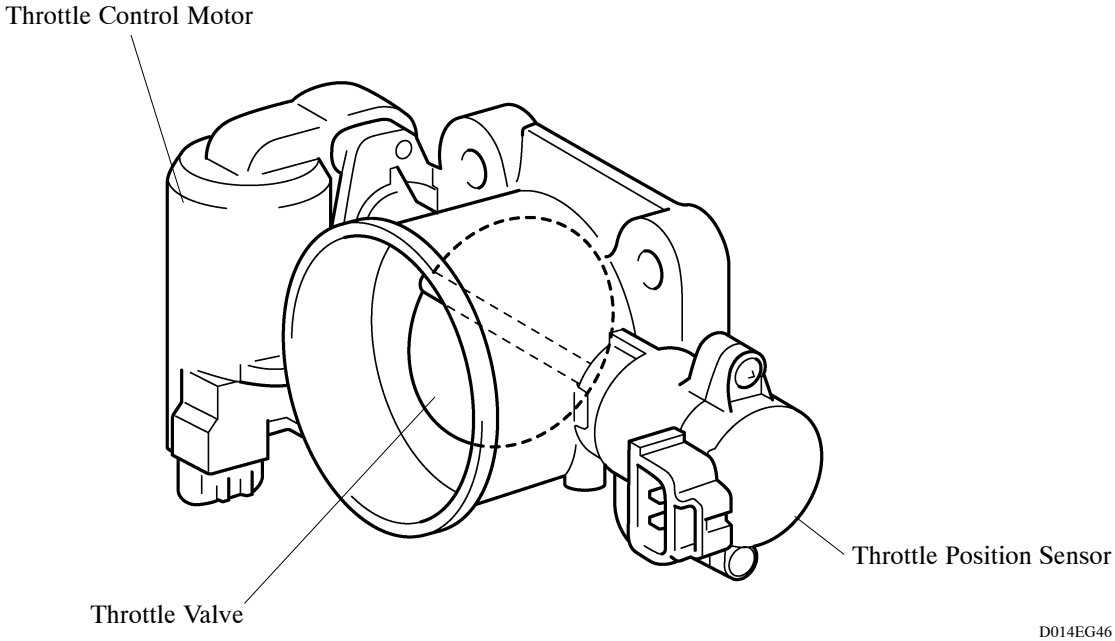
- An intake manifold made of lightweight aluminum alloy is used. The shape of the ports has been optimized in order to ensure the proper intake air volume throughout all operating ranges, ensure better combustion efficiency, and minimize exhaust emissions.
- The intake pipe is located in front of the intake manifold.
- In the intake pipe, an EGR passage is provided between the EGR cooler and EGR valve, and between the EGR valve and the intake manifold.
- A pedestal for detecting the intake air temperature is provided on the intake manifold.



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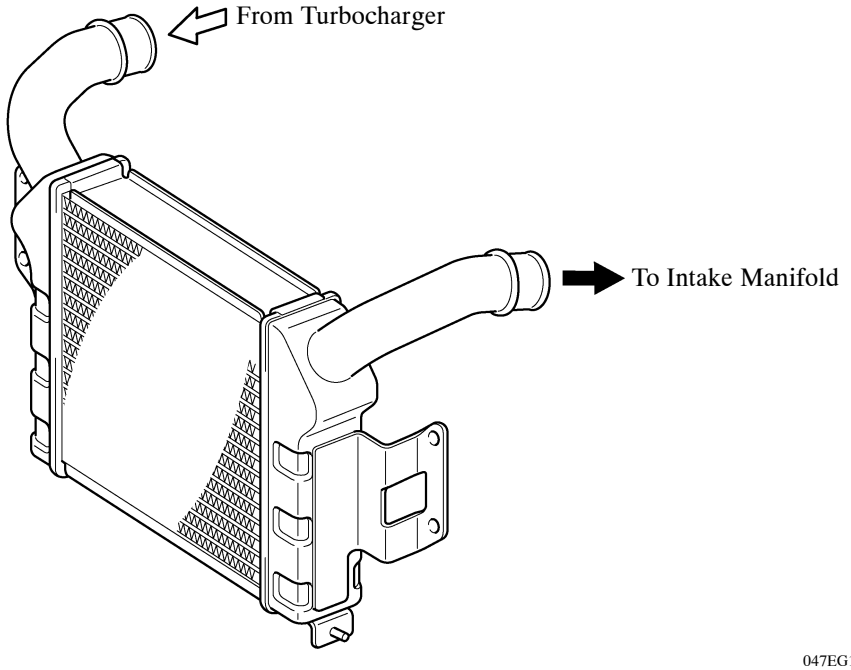
Throttle Body

- A throttle body equipped with a rotary solenoid type throttle control motor is used.
- The signals provided by the engine ECU open and close the throttle valve by actuating the throttle control motor, in order to control the intake air mass.
- A non-contact type throttle position sensor is used in the throttle body.
- When the engine stops or the exhaust retarder is operating, the throttle valve is entirely closed, in order to minimize noise.



Intercooler

- A large-capacity fin type intercooler is used to improve the intake air cooling performance.
- An air-cooled intercooler is used to lower the intake air temperature in order to minimize exhaust emissions and produce high power output. In addition, a stamped tank has been brazed onto the intercooler to ensure reliability.
- A large core is provided in front of the radiator to maximize cooling performance. Ample distance is provided between the intercooler and the engine to minimize the pressure loss from the cooling air.



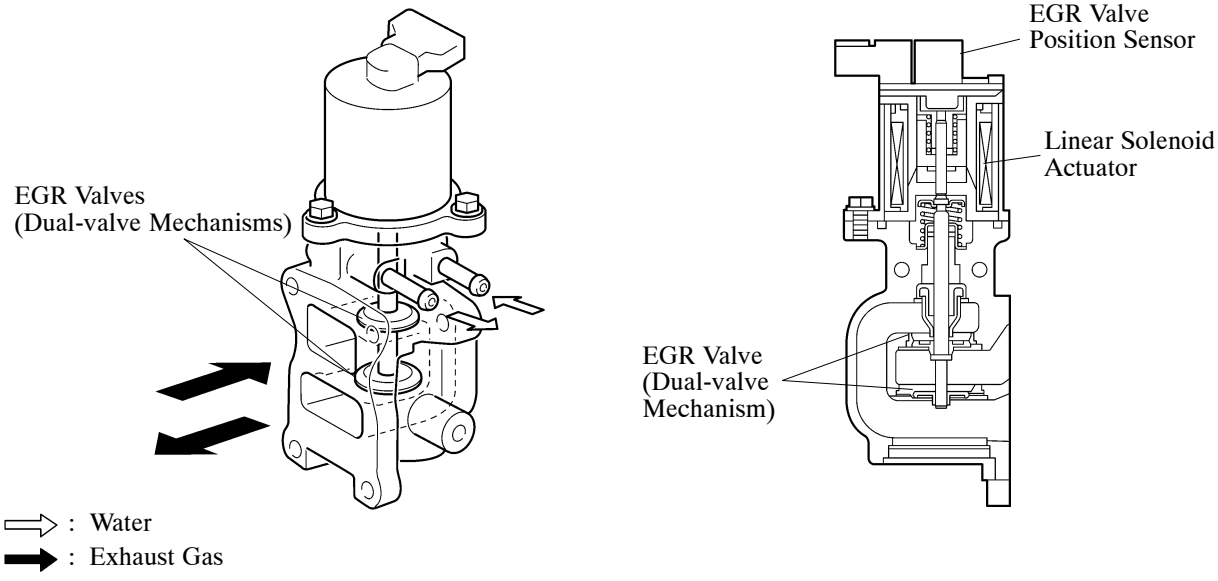
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▶ Specifications ◀

		Intercooler for N04C-UH	Intercooler for N04C-TQ
Cooling System		Air-cooled	Air-cooled
Core Type		Fin Type	Drawn Cap Type
Core Size	Width	278.2 mm (11.0 in.)	369.1 mm (14.5 in.)
	Height	302.0 mm (11.9 in.)	175.0 mm (6.9 in.)
	Depth	65.0 mm (2.6 in.)	65.0 mm (2.6 in.)
Fin Pitch		3.5 mm (0.14 in.)	3.5 mm (0.14 in.)

EGR Valve

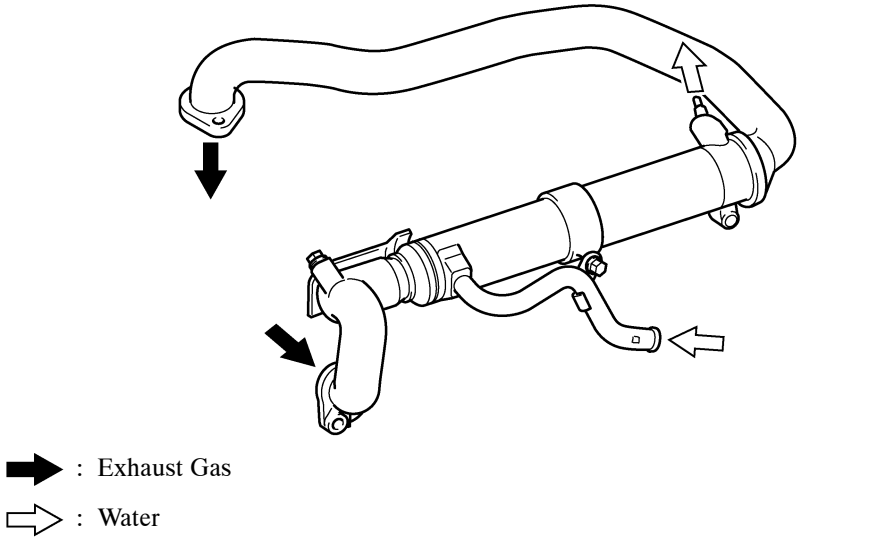
- A linear solenoid type EGR valve is used. Also, a dual-valve mechanism is used to cancel the effects of the exhaust pressure during actuation in order to realize quick response.
- An EGR valve position sensor is provided in the EGR valve. This sensor enables EGR valve control at a higher level of precision by detecting the amount of lift of the EGR valve.



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EGR Cooler

- A long core (387 mm) water-cooled type EGR cooler is used. This improves the exhaust gas cooling performance, making recirculation control for large volumes of emissions possible, and realizes better NOx emission volume control.
- There are 40 heat exchanger tubes in the EGR cooler, and exhaust gas goes through each tube. The water runs around the heat exchanger tubes and absorbs the heat of the exhaust gas through the tubes.



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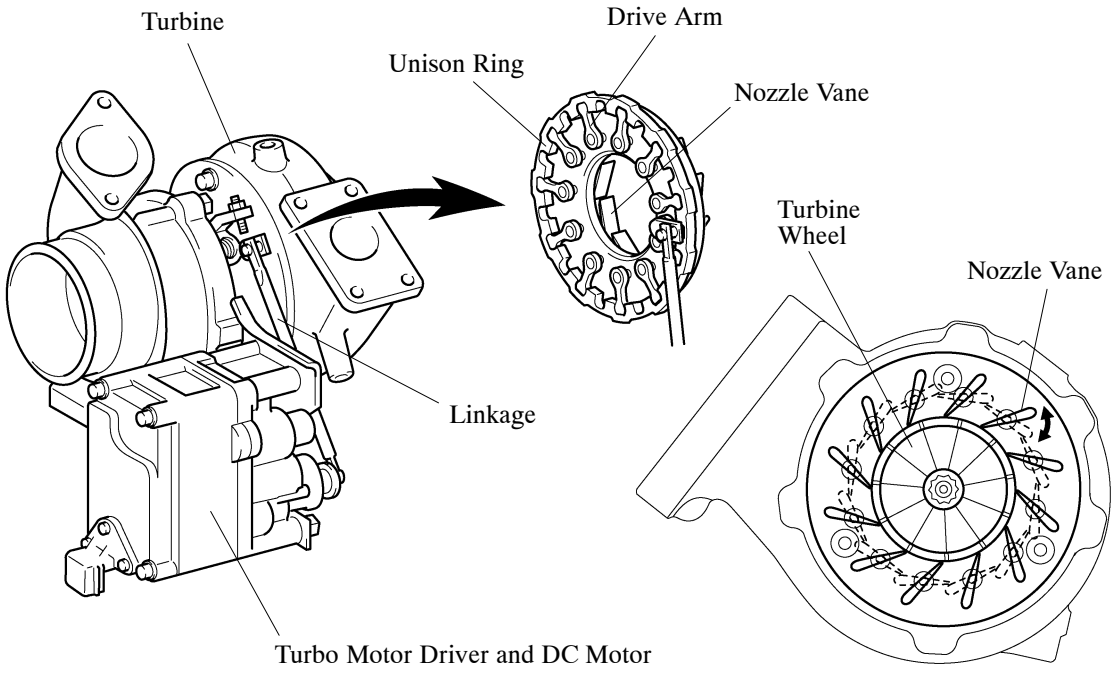
Turbocharger

1) General

A variable nozzle vane type turbocharger, which has a small-diameter turbine and which is made by Honeywell (Garrett brand), is used to improve the efficiency of the system.

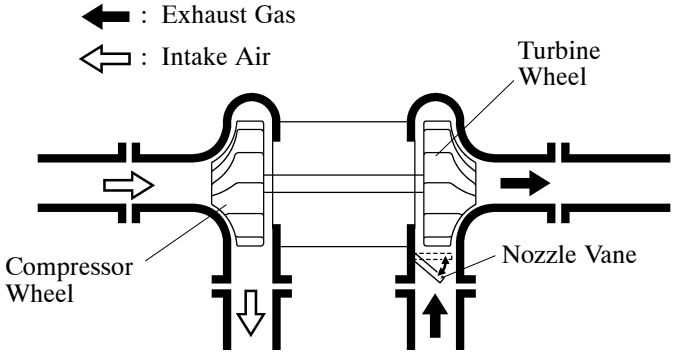
2) Variable Nozzle Vane Type Turbocharger

- The variable nozzle vane type turbocharger consists primarily of a turbine wheel, compressor wheel, nozzle vane, unison ring, linkage, DC motor and turbo motor driver. The DC motor and turbo motor driver are integrated.
- This turbocharger has realized great improvements in low-speed torque, maximum output, fuel consumption, and emission reduction. These improvements have been accomplished through variable control of the nozzle vane position, and an optimal velocity for the exhaust gas inflow to the turbine wheel at all times in response to the engine condition.
- The engine ECU outputs a signal to the turbo motor driver, which actuates the DC motor, to control the nozzle vane position. Also, the turbo motor driver detects the position of the nozzle vane. For details, see page 61.



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- The exhaust gas from the exhaust manifold goes through the nozzle vane inside the turbocharger housing, and flows to the exhaust pipe through the turbine wheel. The speed of the turbine wheel (supercharging pressure) differs depending on the flow velocity of the exhaust gas going through the turbine wheel and the flow velocity of the exhaust gas is controlled by the opening angle of the nozzle vane. At times like during idling, when the exhaust gas is reduced, the nozzle vanes are almost fully closed, but as there is a slight clearance between the nozzle vanes, the exhaust gas flows through this clearance to the exhaust pipe. As the nozzle vanes of this type of turbocharger can move in this way, there is no need for bypassing as with the conventional type turbocharger.

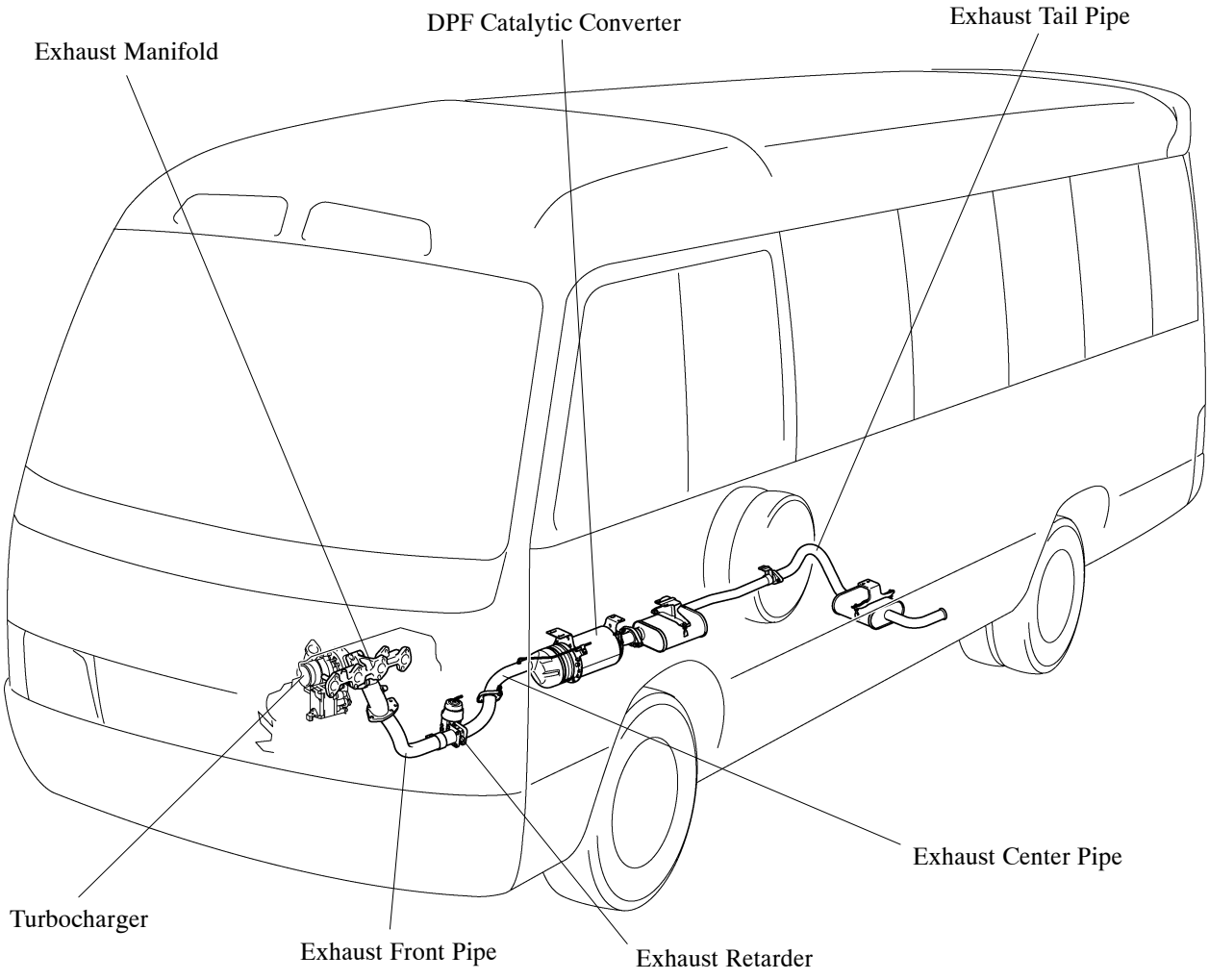


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9. Exhaust System

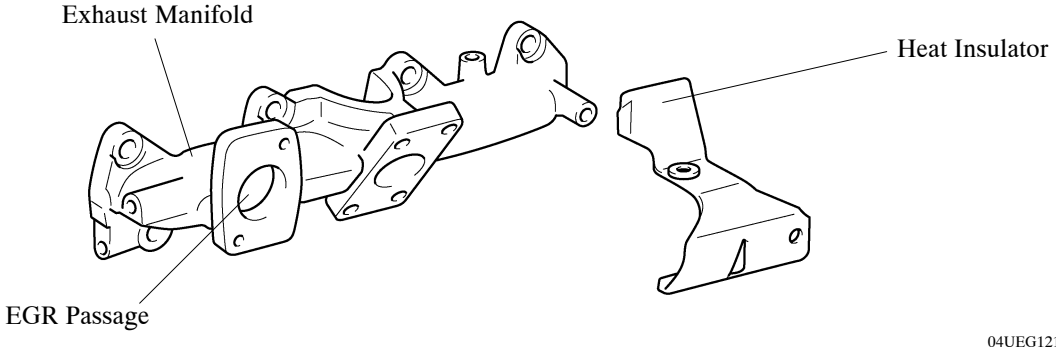
General

- A DPF catalytic converter which reduces the exhaust gas pressure drop is used to realize clean exhaust emissions and improved performance.
- An exhaust pipe made of stainless steel is used.



Exhaust Manifold

- An exhaust manifold made of cast iron with special additive elements is used to ensure durability.
- A triple-layer stainless steel type exhaust manifold gasket is used for every port.

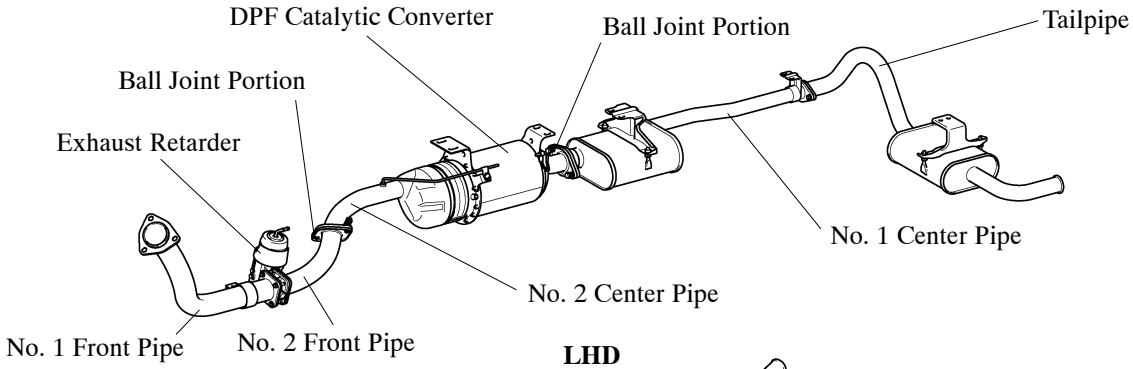


Exhaust Pipe

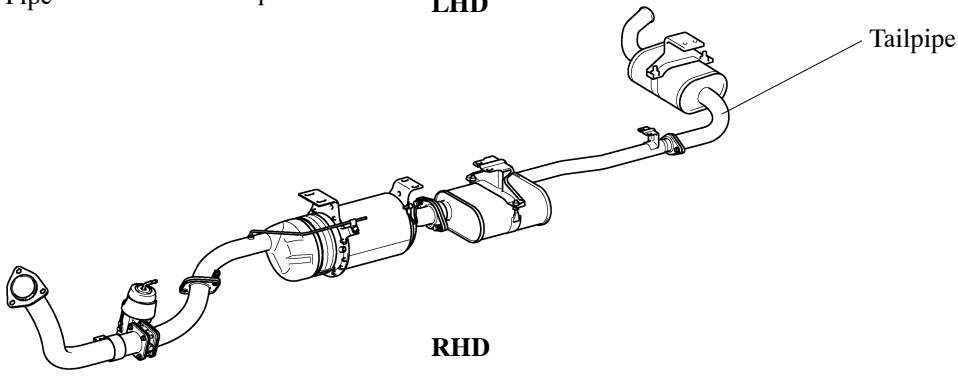
1) General

- An exhaust pipe made of stainless steel is used to reduce the weight and improve corrosion resistance.
- A DPF catalytic converter is used in the center pipe to realize clean emissions.
- Two ball joints are used to join the No. 2 front pipe and No. 2 center pipe, and the No. 2 center pipe and No. 1 center pipe. As a result, a simple construction and reliability are realized.
- An exhaust retarder is used. The engine braking effect is boosted by closing a valve provided in the exhaust pipe and narrowing the exhaust gas passage. For details, see page 66.

▶ Long Wheel Base Models ◀

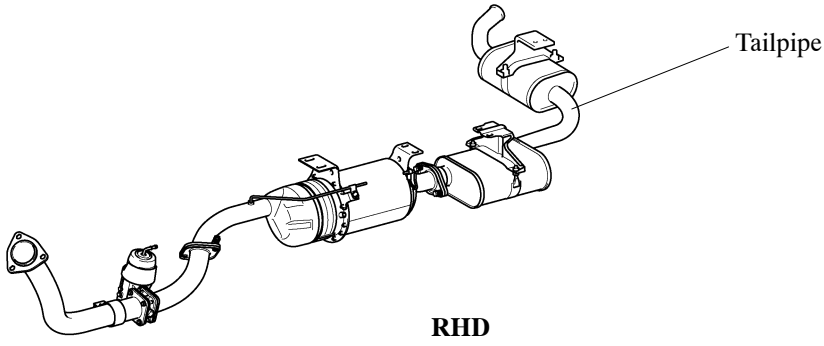


LHD



RHD

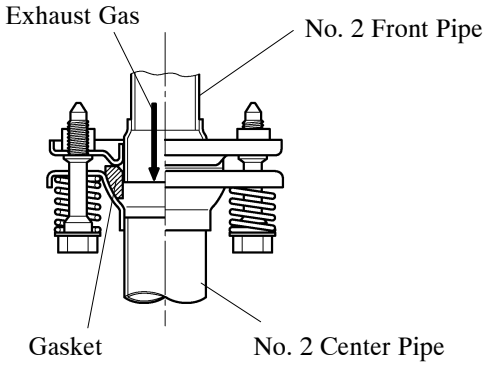
▶ Standard Wheel Base Model ◀



RHD

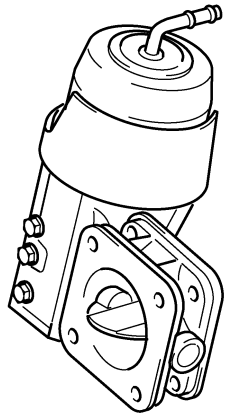
047EG158Y

▶ Ball Joint ◀



032EG12Y

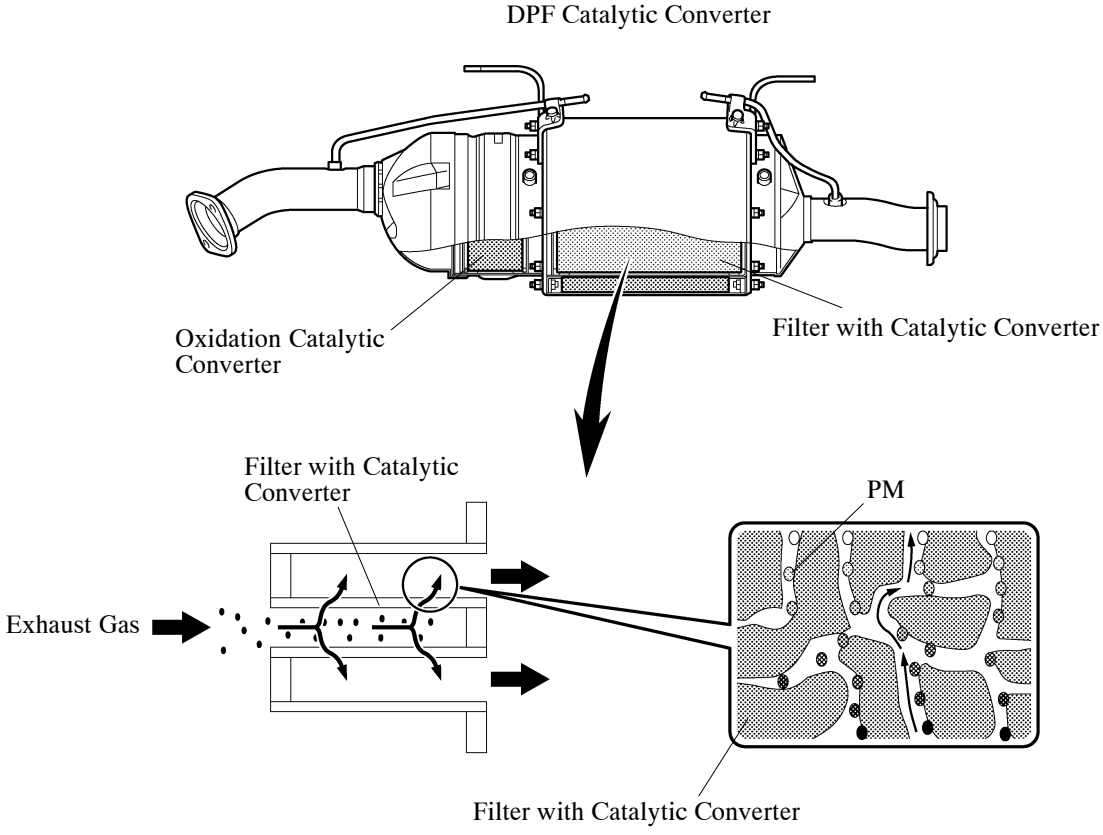
▶ Exhaust Retarder ◀



047EG30Y

2) DPF Catalytic Converter

The DPF catalytic converter consists of an oxidation catalyst and filter with catalyst. It contains a micropore ceramic filter, which cleans the exhaust gas by capturing the PM (Particulate Matter) in it.

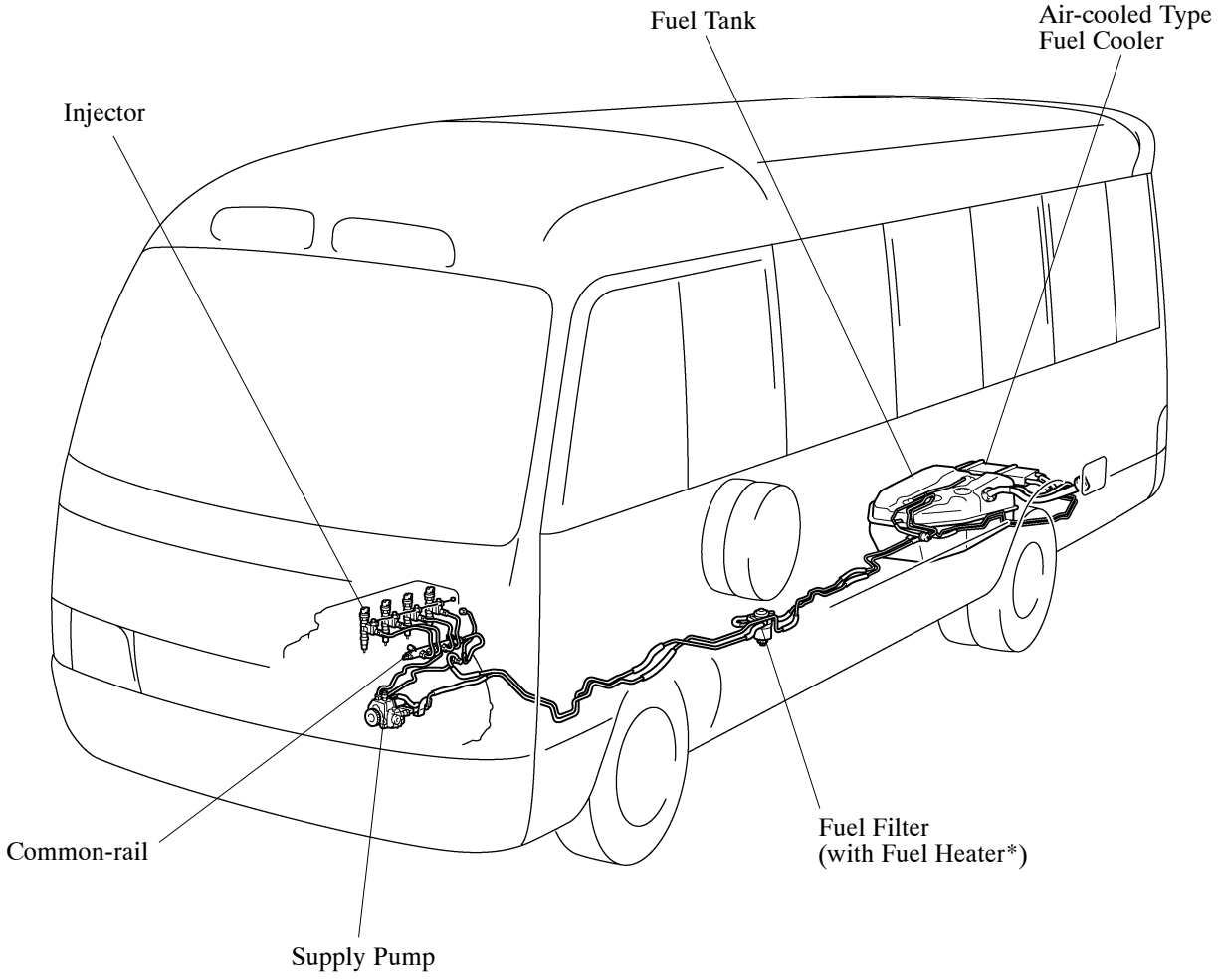


047EG159Y

10. Fuel System

General

- A common-rail system is used.
- A supply pump that produces super high pressure (max. 180 MPa) and low drive torque is used.
- A new type of solenoid-valve-controlled injector which is suited to high injection pressurization is used.
- An air-cooled type fuel cooler which cools the return fuel, and a fuel heater integrated with the fuel filter in cold area specification models are used to ensure the durability and reliability of the fuel system.



*: Cold Area Specification Models

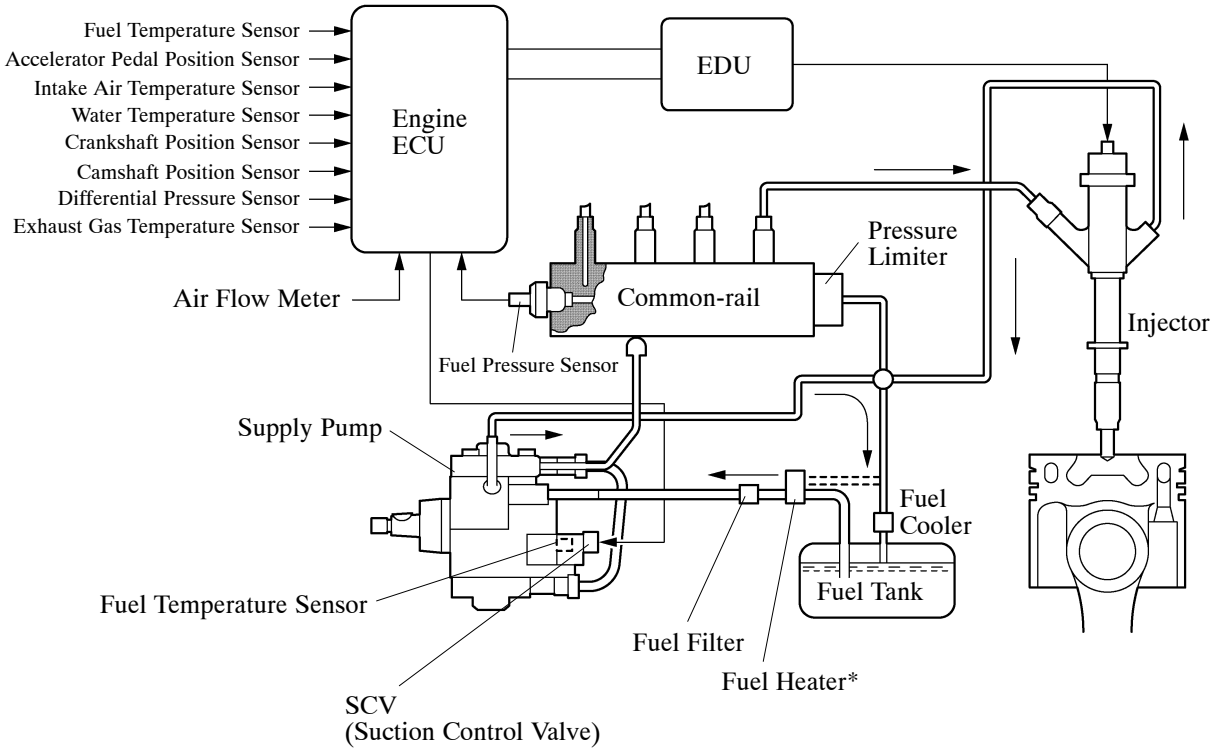
047EG160Y

Common-rail System

1) General

- In the common-rail system, the pressurized fuel provided by the supply pump is stored in the common-rail and injected by the solenoid injectors.
- The common-rail system stores the fuel, which has been pressurized by the pump, in the common-rail. Because the common-rail constantly accumulates a stable injection pressure without being affected by engine speed or load, this system is able to constantly provide a stable injection pressure, even when the engine is operating at low speeds.
- The engine ECU transmits signals to the injector solenoid valves via the EDU (Electronic Driver Unit) in order to precisely control the fuel injection timing and injection volume.

▶ System Diagram ◀



*: Cold Area Specification Models

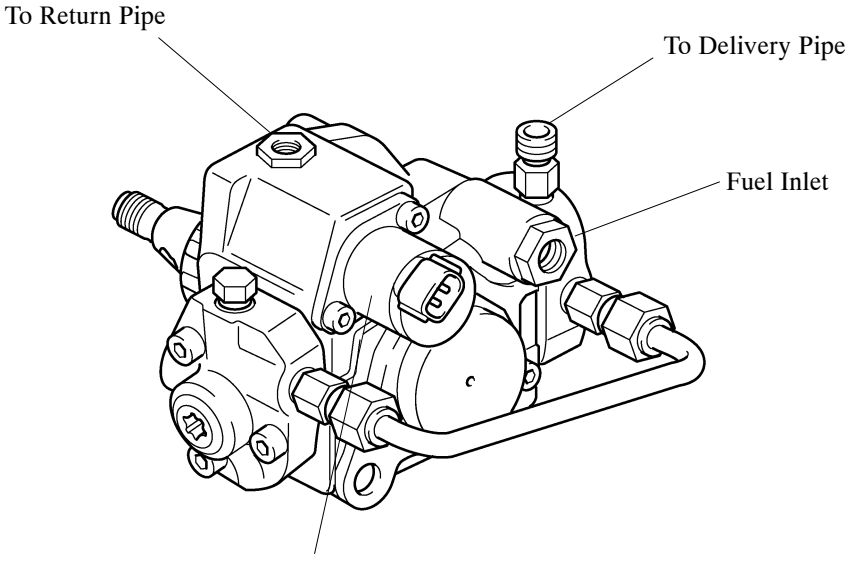
047EG162

2) Main Components of Common-rail System

a. Supply Pump

i) General

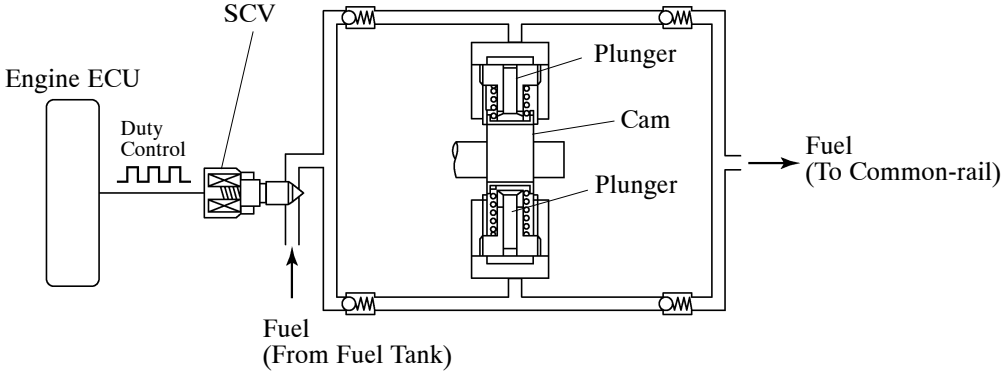
- The supply pump, which is driven by the crankshaft, pumps fuel to the common-rail.
- The suction and pumping of fuel have been divided into two systems in order to stabilize the fuel supply.



04UEG13Y

ii) SCV (Suction Control Valve)

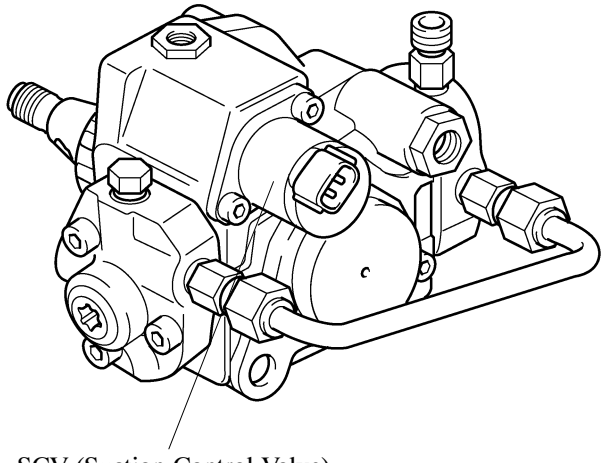
- The engine ECU determines the target fuel pressure based on the load condition.
- The engine ECU adjusts the SCV opening angle by the duty control function to reach the target fuel pressure.
- The suction control valve adjusts the fuel pressure in the range of 30 MPa to 180 MPa.



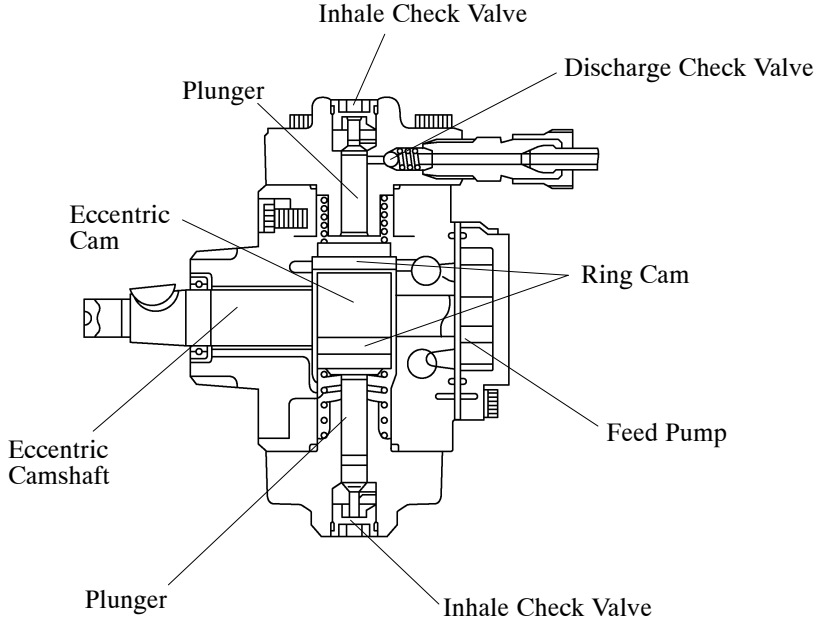
D014EG55

iii) Construction

- The drive force of the pump outputs in the following order: the crankshaft, the idle gears, the gear that is attached to the front of the pump, and the ring cam.
- The supply pump consists of four portions: a pump body to pump pressurized fuel, a discharge check valve to regulate the fuel flow rate, a suction control valve to regulate the fuel pressure at the inlet to the inhale check valve, and a feed pump to supply fuel to the pump body. The supply pump draws an appropriate amount of fuel and feeds pressurized fuel into the common-rail.
- The eccentric cam alternately moves two plungers via the ring cam.
- The two plungers are horizontally opposed, so when one plunger is in a suction stroke, the other is in a pumping stroke. The two plungers repeat these strokes in order to ensure a constant and stable delivery of fuel.



04UEG13Y

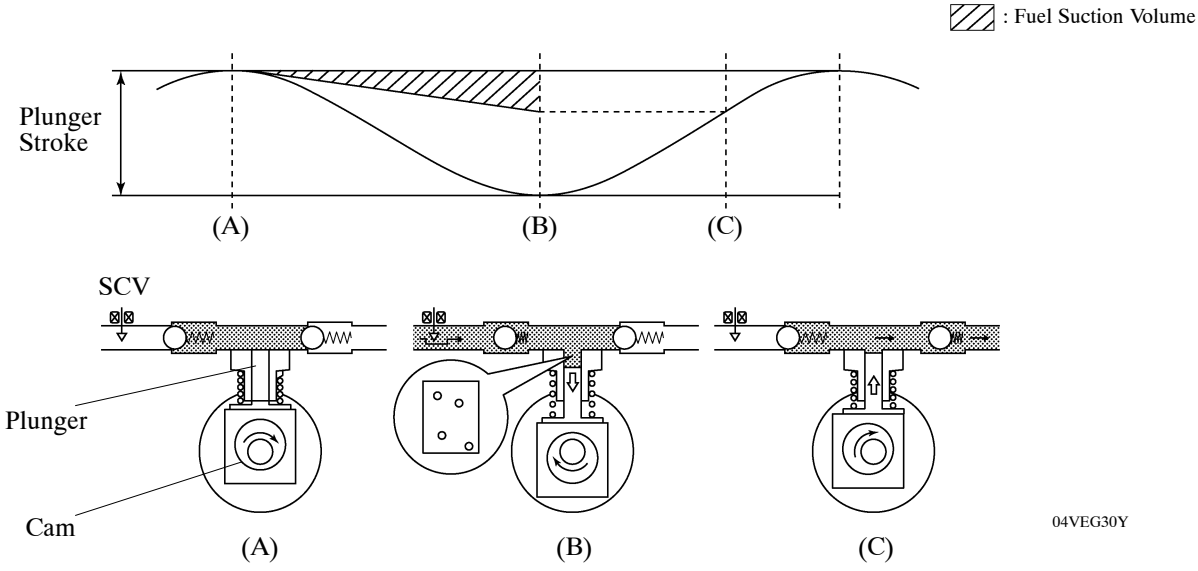


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iv) Operation

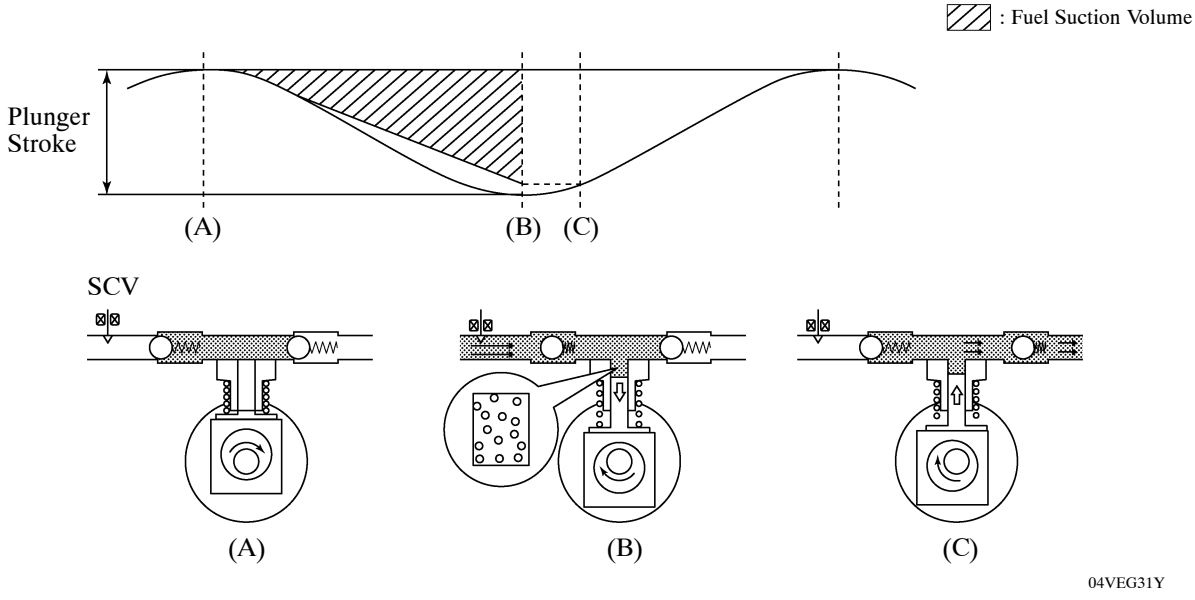
- **Small Opening of Suction Control Valve**

  - When the opening of the suction control valve is small, the fuel suction passage narrows and slows down the fuel flow.
  - Even if the plunger reaches its maximum stroke, the volume of fuel drawn in by the plunger becomes restricted because the fuel suction passage is restricted. (See “B” in the diagram.)
  - The supply pump discharges fuel when the cam pushes the plunger upward and the fuel discharge pressure becomes higher than the fuel pressure in the common-rail. (See “C” in the diagram.)



(A) Plunger Top-Dead-Center
(B) Plunger Bottom-Dead-Center
(C) Compression Starting Point

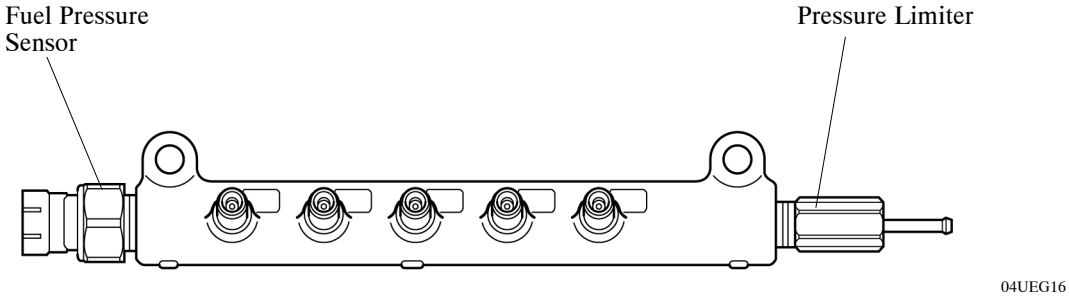
- **Large Opening of Suction Control Valve**
  - When the opening of the suction control valve is large, the fuel suction passage widens and facilitates the fuel flow.
  - When the plunger reaches its maximum stroke, the plunger draws an ample volume of fuel because the fuel suction passage is not restricted. (See “B” in the diagram.)
  - The supply pump discharges fuel when the cam pushes the plunger upward and the fuel discharge pressure becomes higher than the fuel pressure in the common-rail. (See “C” in the diagram.)



(A) Plunger Top-Dead-Center
(B) Plunger Bottom-Dead-Center
(C) Compression Starting Point

b. Common-rail

- The function of the common-rail is to store the fuel that has been pressurized by the supply pump. The common-rail is provided with a fuel pressure sensor that detects the fuel pressure in the common-rail, and a pressure limiter that mechanically relieves the pressure in case the internal pressure of the common-rail rises abnormally.
- An orifice is provided at the outlet of the common-rail to each injector in order to minimize fuel pressure pulsations.
- The fuel pressure sensor 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 valve opening pressure of the pressure limiter has been optimized in accordance with the increase in the supply pump pressure.



Service Tip

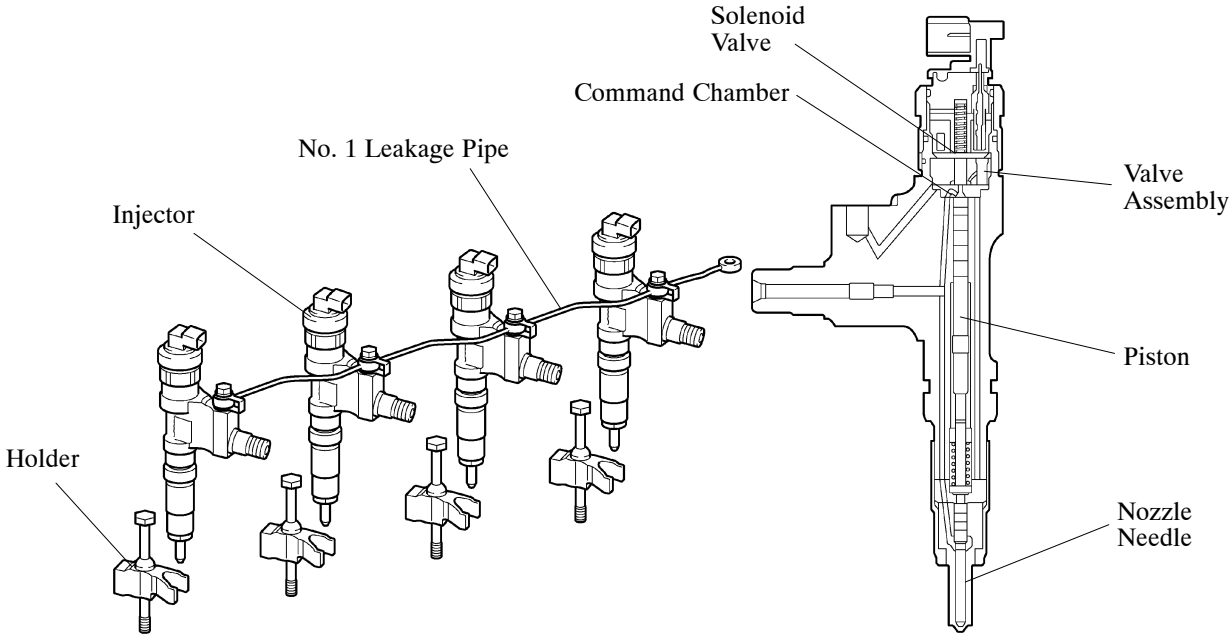
- The fuel pressure sensor has its sealing portion plastic-deformed in order to maintain the sealing performance, For this reason, do not reuse it after disassembling.
- The fuel pressure sensor and pressure limiter are supplied as a set with the common-rail.
- Do not disassemble the pressure limiter and fuel pressure sensor.
- If parts that affect the alignment have been changed, be sure to replace the pipe with a new one as well. The parts that require the replacement of a pipe are listed below.
  Injection Pipe: Injector, Common-rail, Cylinder Head and Intake Manifold
  Fuel Inlet Pipe: Supply Pump, Common-rail, Cylinder Head and Intake Manifold

For details, refer to the COASTER Repair Manual (Pub. No. RM0474E).

c. Injector

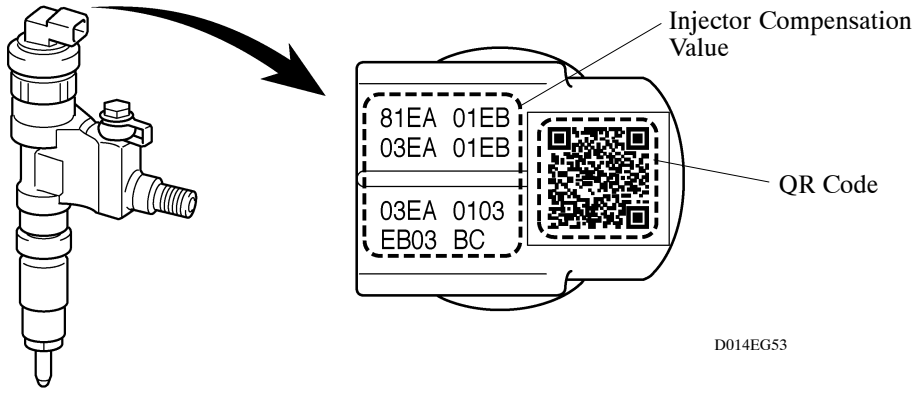
i) General

- Because this system uses solenoid injectors in which solenoid valves open and close the fuel passages, the engine ECU can precisely control the fuel injection volume and injection timing. Thus, this system minimizes the generation of black smoke, which is peculiar to diesel engines.
- Each injector consists of a nozzle needle, piston, and solenoid valve.
- An injector compensation value and QR (Quick Response) code containing encoded characteristics of the injector are printed on each injector.
- The injector compensation value and QR code contain various pieces of information regarding the injector, such as model code and injection volume values.



Service Tip

- If the engine ECU is replaced, use the intelligent tester II and input the injector compensation values of all 4 injectors. If an injector is replaced, input the injector compensation value of the replaced injector. Then, the proper compensation will be made so that the injection volume precision prior to the replacement will remain unchanged. For details, refer to the COASTER Repair Manual.
- The QR code, which requires a special scan tool, is not used at TOYOTA dealers.



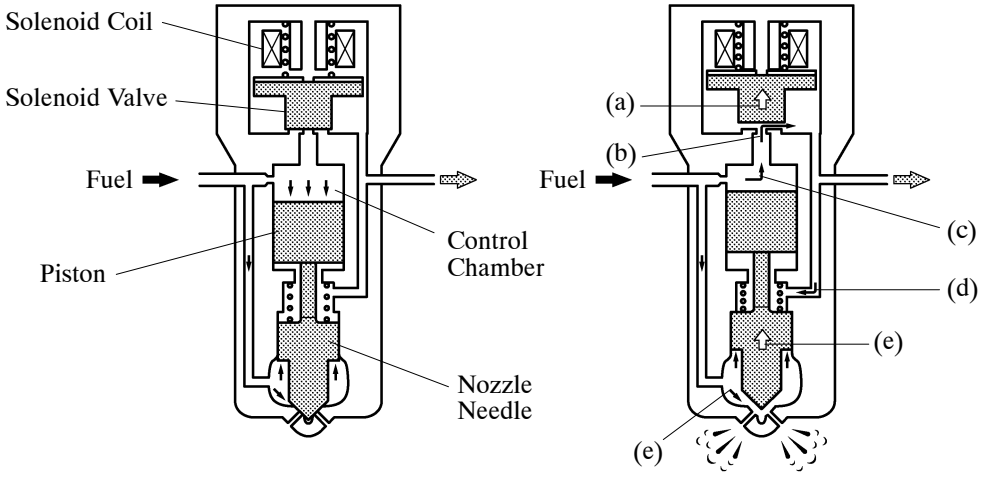
— REFERENCE —

What is QR (Quick Response) Code?

- *QR code, a matrix symbology consisting of an array of nominally square cells, allows omni-directional, high-speed reading of large amounts of data.*
- *QR code encodes many types of data such as numeric, alphanumeric, kanji, kana and binary code. A maximum of 7,089 characters (numeric) can be encoded.*
- *QR code (2D code) contains information in the vertical and horizontal directions, whereas a bar code contains data in one direction only. QR code (2D code) holds a considerably greater volume of information than a bar code.*

ii) Operation

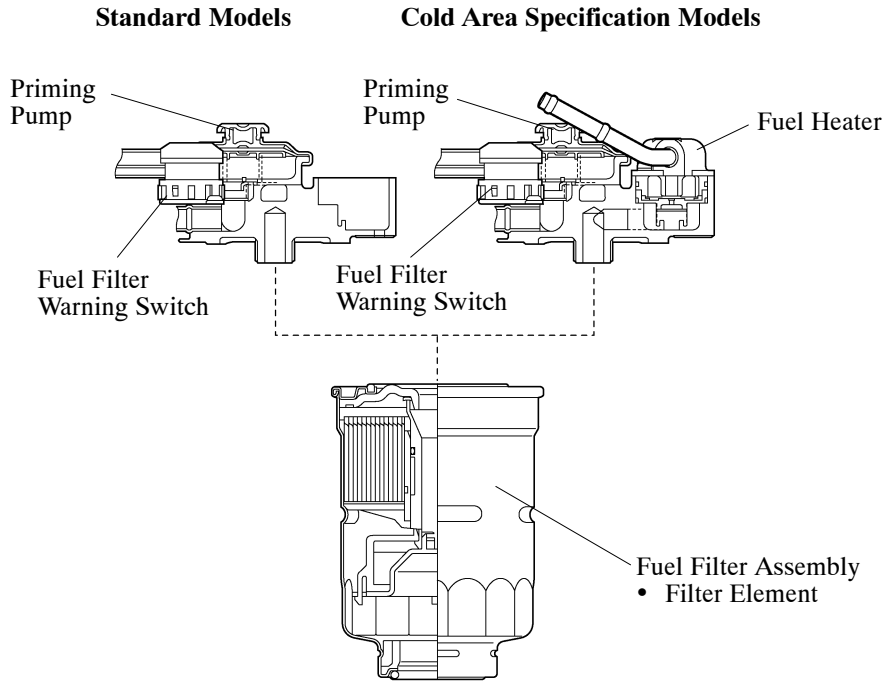
(a) When electrical current is applied to the solenoid coil, it pulls the solenoid valve up.
(b) The orifice of the control chamber opens, allowing the fuel to flow out.
(c) The fuel pressure in the control chamber drops.
(d) Simultaneously, fuel flows from the orifice to the bottom of the piston, which raises the piston.
(e) As a result, the piston raises the nozzle needle to inject fuel.



Fuel Filter

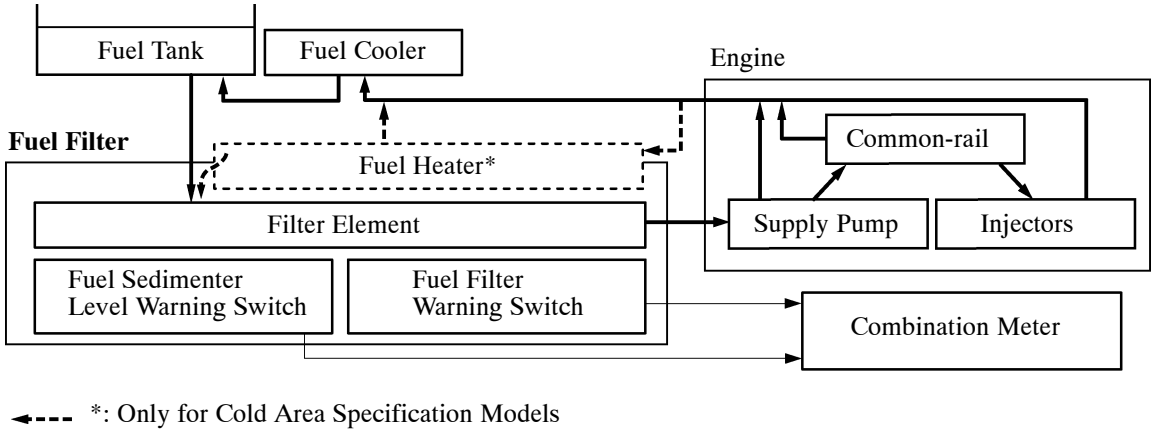
1) General

- The fuel filter consists of a fuel filter element integrated with the fuel filter housing.
- A fuel filter with a built-in sedimenter is used.
- A fuel sedimenter level warning switch, which detects when water, etc. has accumulated beyond a specific level, is provided in the sedimenter section. When the fuel sedimenter level warning switch turns ON, the warning indicator light of the combination meter illuminates to alert the driver.
- A fuel filter warning switch is provided in the fuel filter.
- A recirculation type fuel heater is used in cold area specification models. This limits the precipitation of the wax component of light oil fuel at low temperatures, thus inhibiting the clogging of the filter element.



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▶ System Diagram ◀

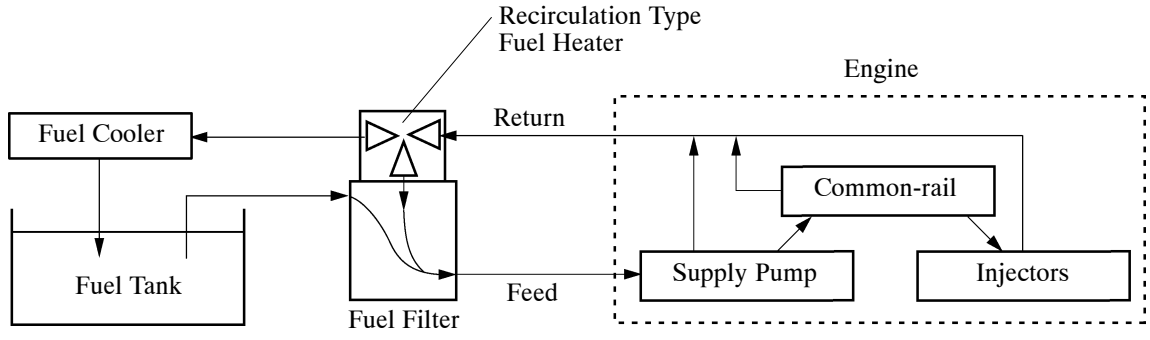


047EG163

2) Fuel Heater

a. General

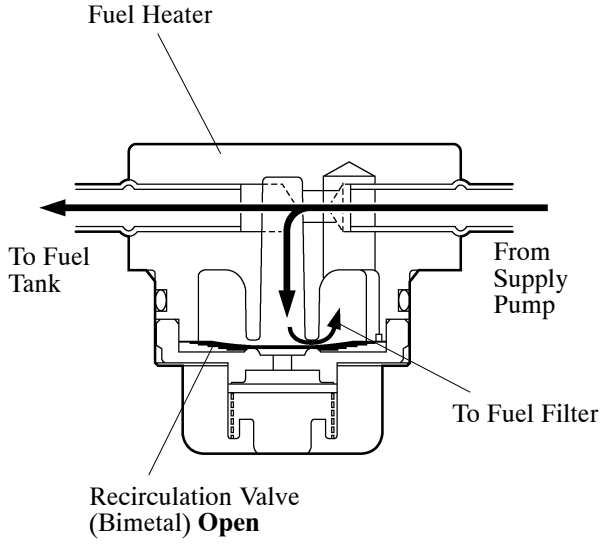
A recirculation type fuel heater is used in cold area specification models. This heater heats the fuel by recirculating the return fuel, which that has reached a high temperature as a result of the pumping of the supply pump, to the fuel filter.



047EG166

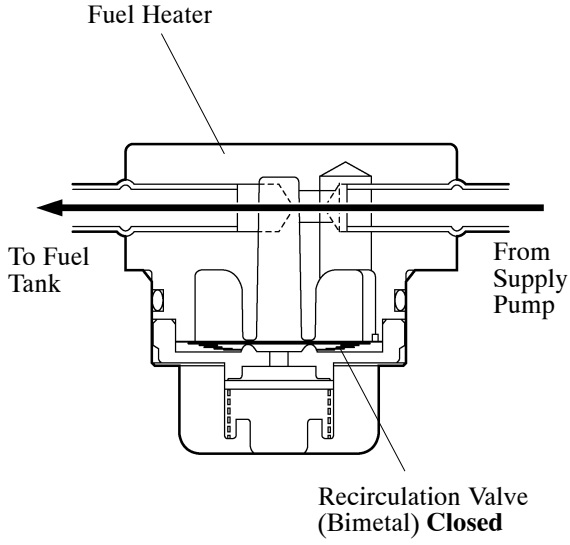
b. Operation

- While the engine is cold, the recirculation valve inside the fuel heater will be open due to the bimetal action, so the return fuel will return to the fuel filter and the fuel tank.
- While the engine is warm, the recirculation valve will be closed due to the bimetal action, so all the return fuel will return to the fuel tank.



Cold Engine

047EG35Y

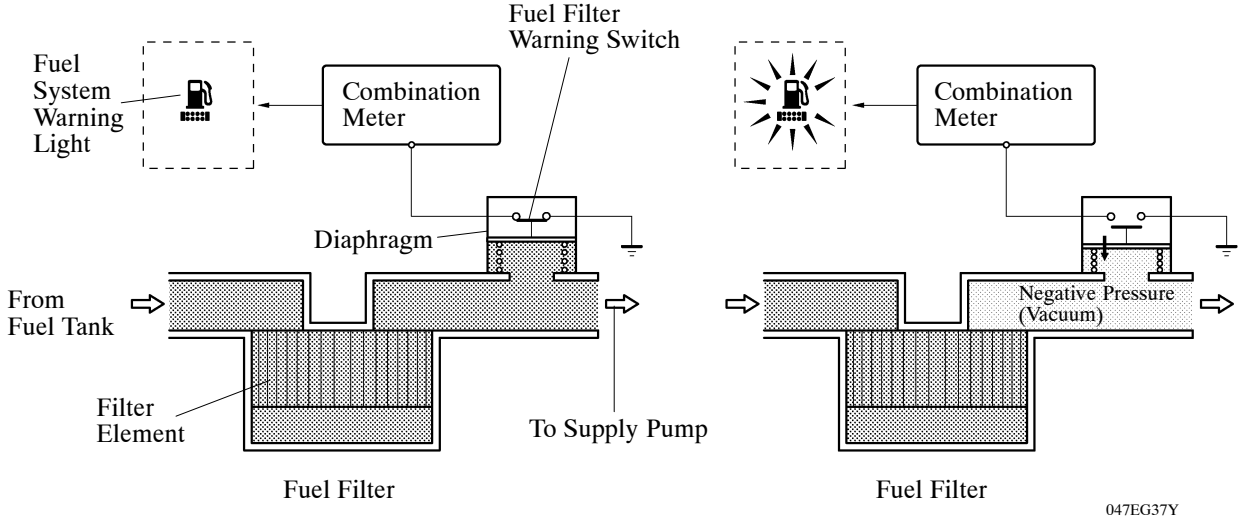


Warm Engine

047EG36Y

3) Fuel Filter Warning Switch

- A fuel filter warning switch, which turns ON/OFF when the internal vacuum of the filter increases, is provided in the fuel filter. This switch, which turns OFF when the internal vacuum of the fuel filter increases to a predetermined level, is connected by a wire to the combination meter.
- When the fuel filter warning switch detects that the internal vacuum of the fuel filter has increased (by way of the fuel filter warning switch OFF signal), it determines that the fuel filter has become clogged. Then, it illuminates the fuel system warning light on the combination meter to urge the driver to replace the fuel filter.

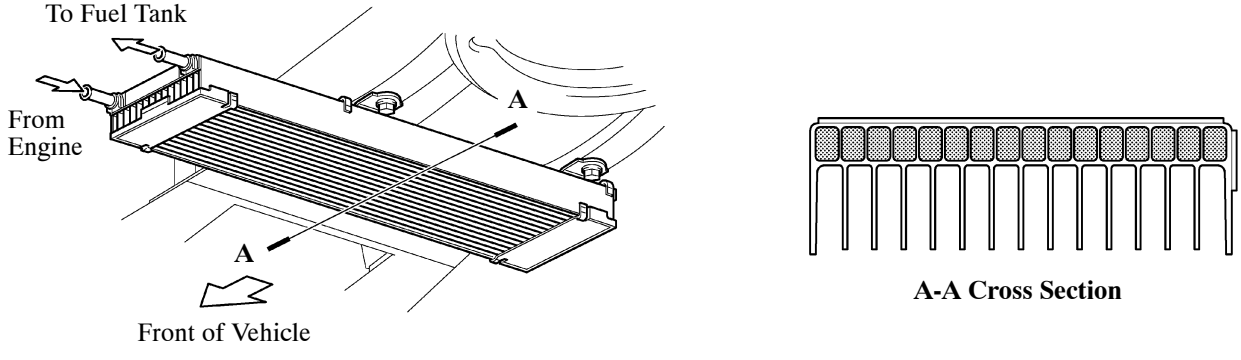


Normal Fuel Filter **Fuel Filter Clogged Up**

Fuel Cooler

- An air-cooled type fuel cooler is provided. The fuel cooler, which is located in the fuel return path, cools the return fuel that has reached a high temperature as a result of the pumping of the supply pump. This prevents the reduction in fuel viscosity that is caused by the rise in fuel temperature, and improves the reliability of the fuel system.
- The fuel passage and cooling fins in the cooling core of the fuel cooler have been molded together in order to reduce both the number of parts and the weight.

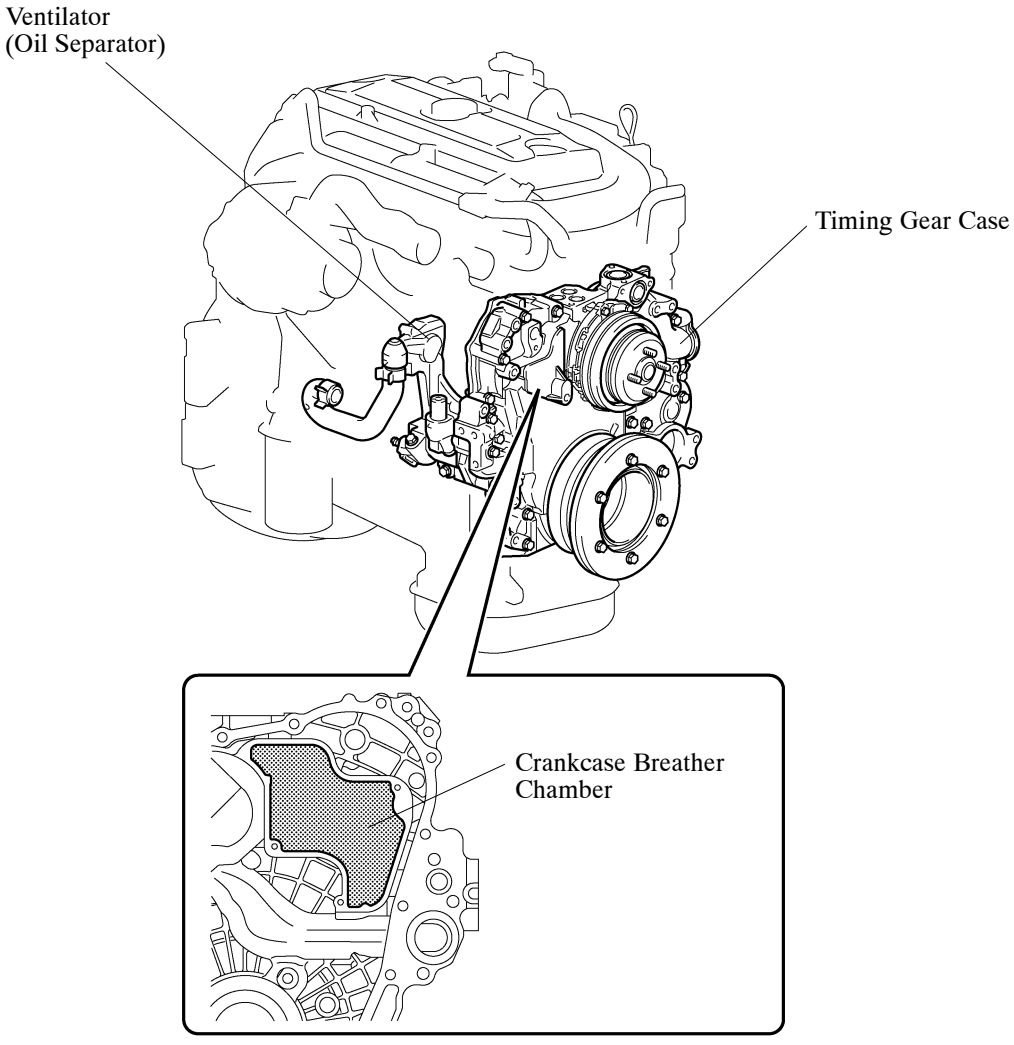
▶ Air-cooled Type Fuel Cooler ◀



11. BLOWBY GAS RECIRCULATION SYSTEM

A closed breather type blowby gas recirculation system is used. This system returns the blowby gas into the intake without releasing it into the atmosphere, thus achieving low exhaust emissions.

- The filter-less type blowby gas recirculation system is used in order to realize the maintenance-free construction.



047EG174Y

12. Charging System

General

- In accordance with the setting of the vehicle power supply voltage to 12 V, a segment conductor type alternator with a rated voltage of 12 V is used. (Models Other Than Europe Models)
- For Europe models with a vehicle power supply voltage of 24 V, a segment conductor type alternator with a rated voltage of 24 V is used.

▶ Specifications ◀

Models	Models Other Than Europe Models	Europe Models
Rated Voltage	12 V	24 V
Rated Output	130 A	80 A
Initial Output Starting Speed	1300 rpm max.	1500 rpm max.

13. Starting System

General

- In accordance with the setting of the vehicle power supply voltage to 12 V, a starter with a rated voltage of 12 V and a rated output of 2.7 kW is used. (Models Other Than Europe Models)
- For Europe models with a vehicle power supply voltage of 24 V, a starter with a rated voltage of 24 V and a rated output of 5.0 kW is used.

▶ Specifications ◀

Models	Models Other Than Europe Models	Europe Models
Rated Output	2.7 kW	5.0 kW
Rated Voltage	12 V	24 V
Length*1	240.1 mm (9.5 in.)	232.2 mm (9.1 in.)
Weight	7450 g (16.4 lb)	7200 g (15.8 lb)
Rotational Direction*2	Clockwise	Clockwise

*1: Distance from the mounted area to the rear end of the starter
*2: Viewed from pinion side

14. Engine Control System

General

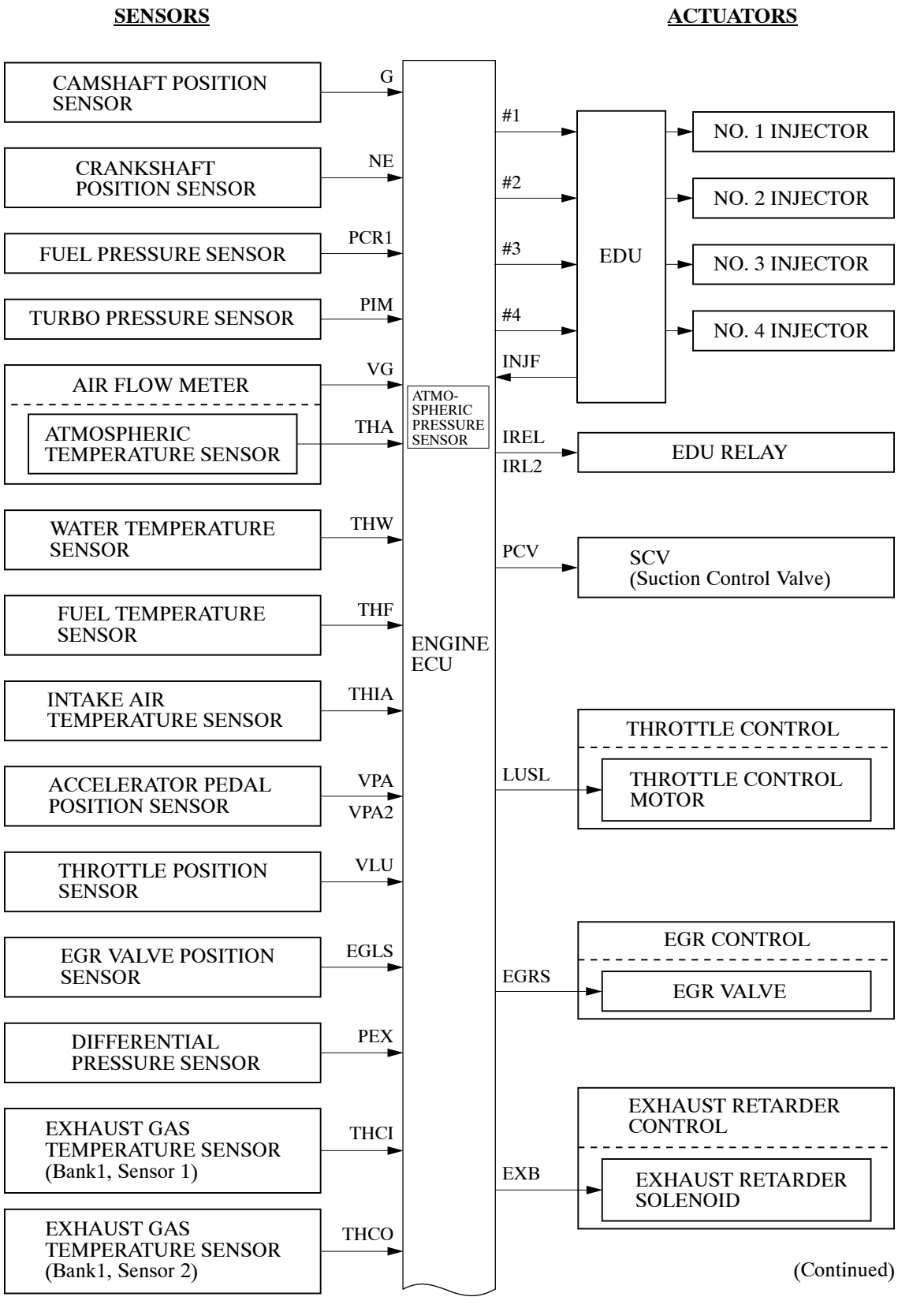
The engine control system of the N04C-UH engine consists of the following systems.

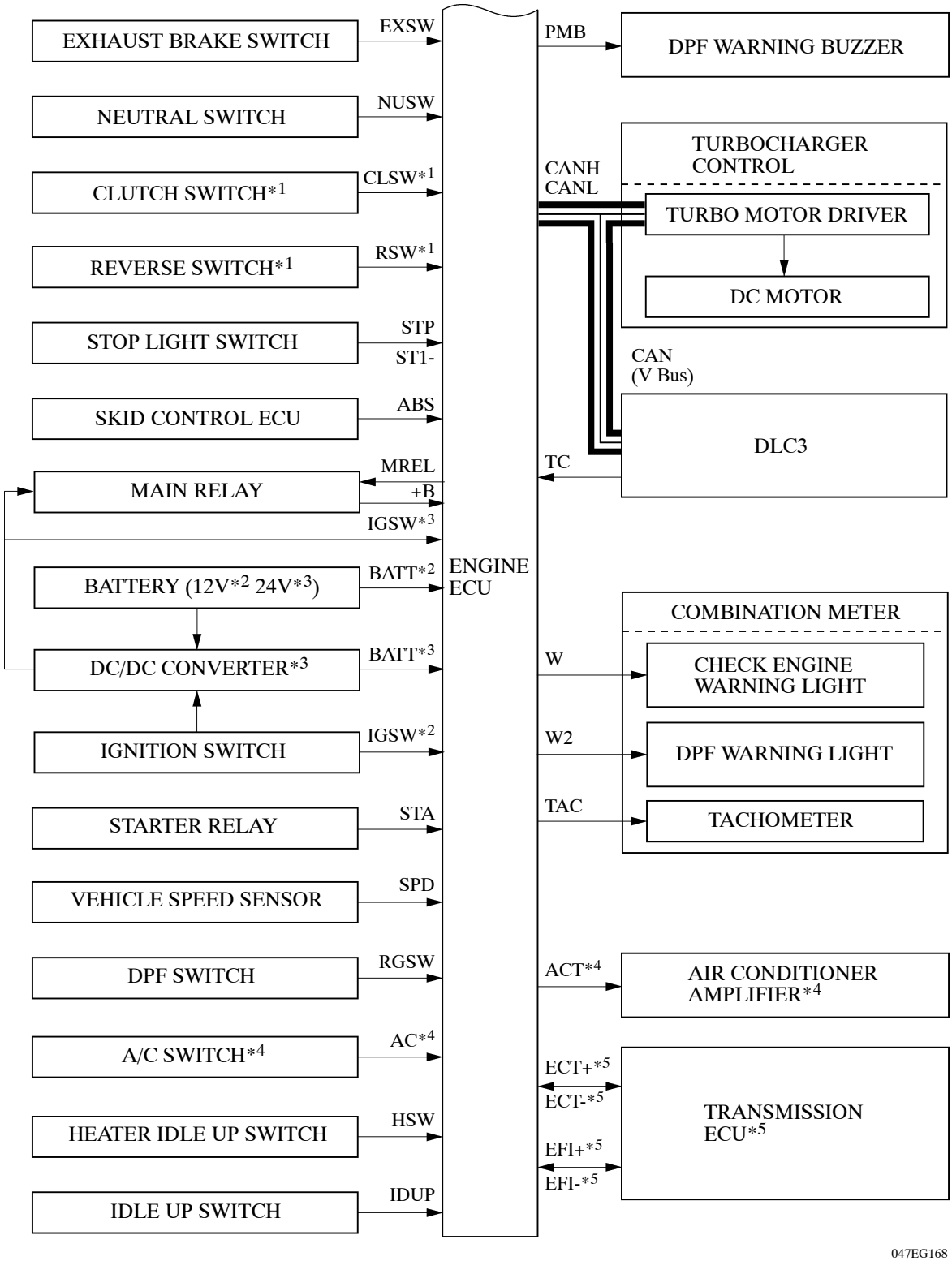
System	Outline
Fuel Injection Volume Control	Controls the injection volume by calculating an optimal level in accordance with the conditions of the engine.
Pilot Injection Control	Pilot injection is a method that provides auxiliary fuel injection.
Fuel Injection Timing Control	Controls the injection timing by calculating the 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	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 a degree of opening that is suited to the driving conditions.
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 in the engine speed for each cylinder and makes injection volume corrections.
Air Conditioning Cut-off Control*	Cuts off the air conditioning during acceleration to ensure proper drivability.
EGR Control	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.
DPF Control	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.

*: Models with Air Conditioner

Construction

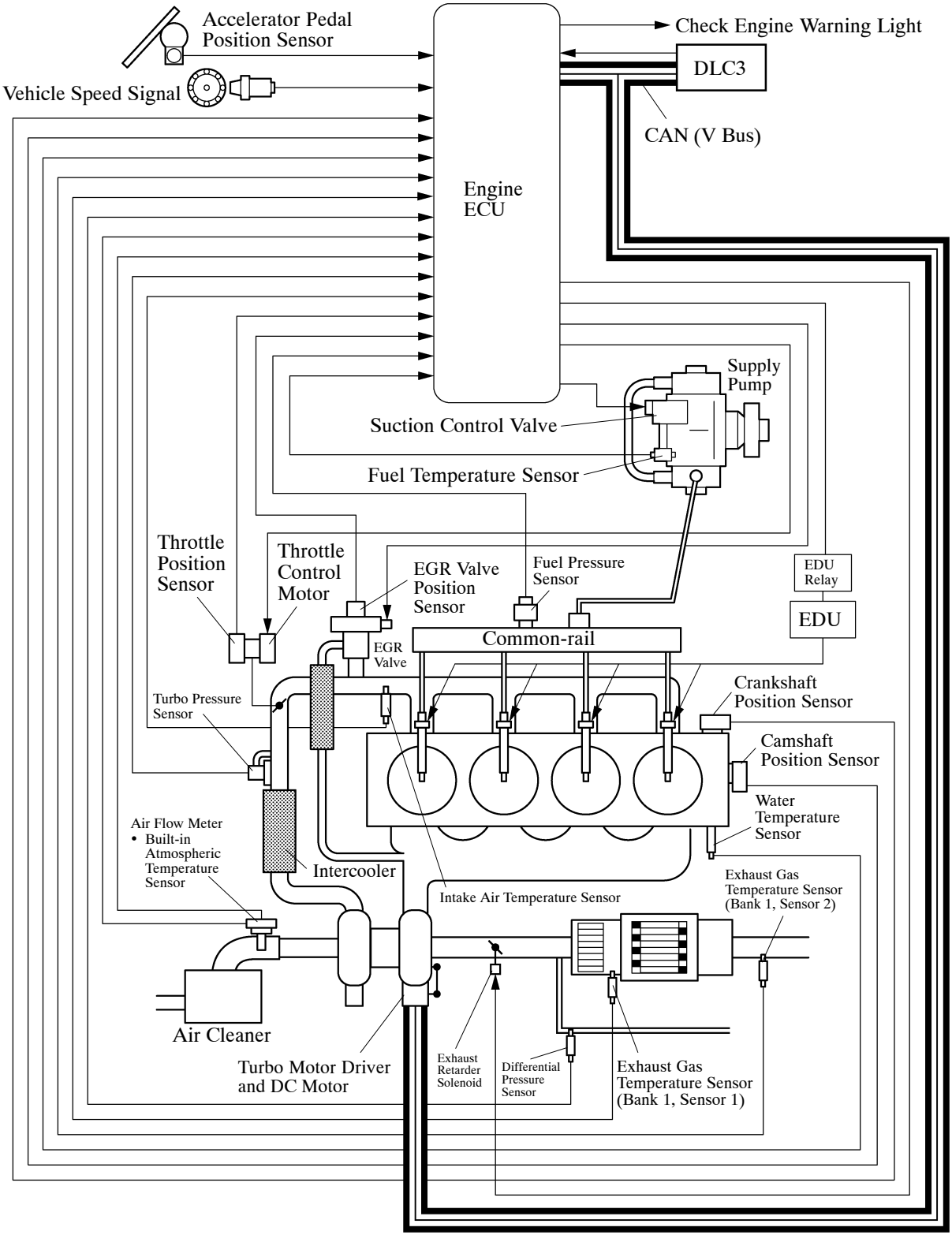
The configuration of the engine control system of the N04C-UH engine is as shown in the following chart.





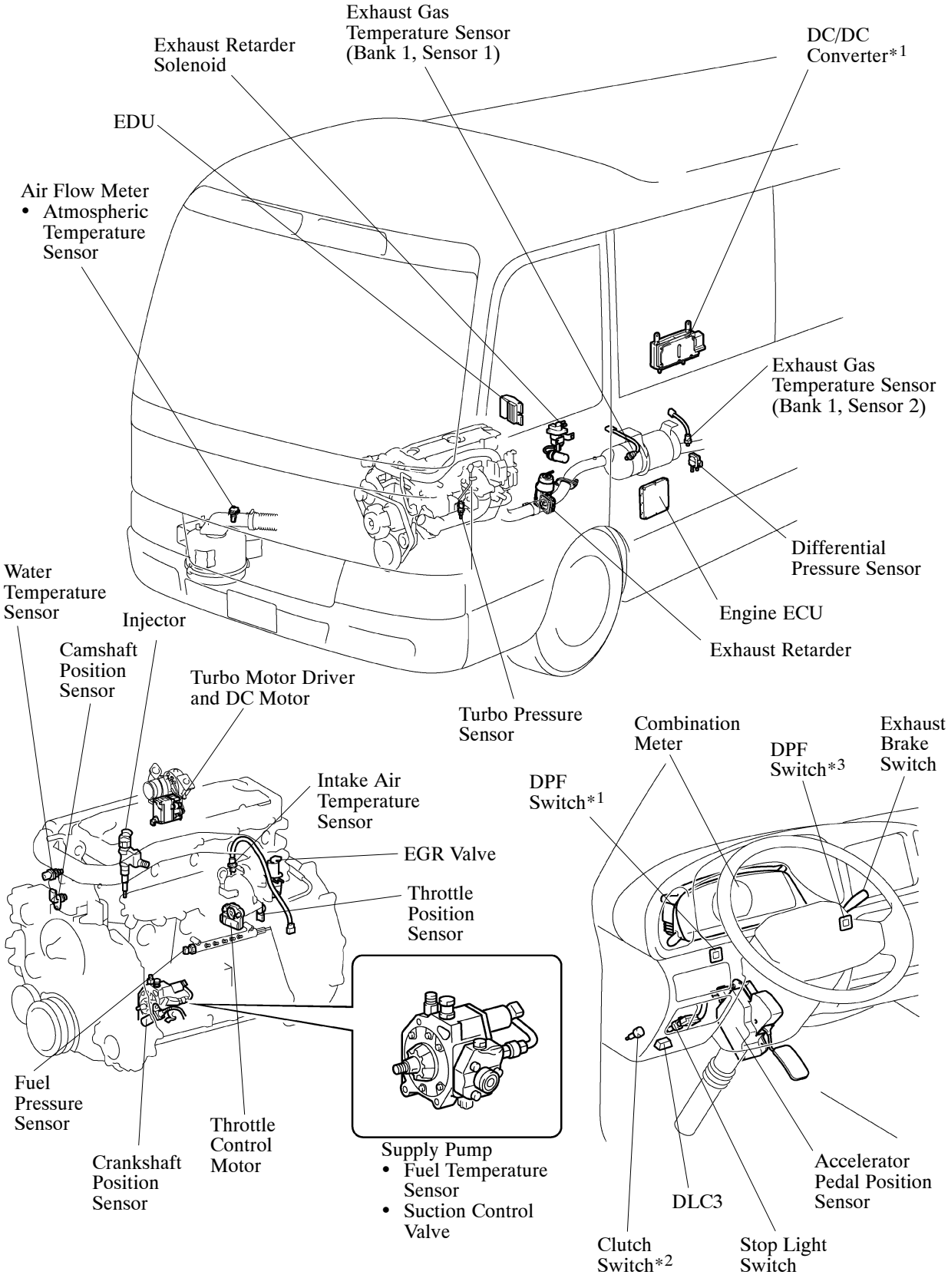
*1: Manual Transmission Models
*2: Models Other Than Europe Models (Vehicles with 12V vehicle power supply)
*3: Europe Models (Vehicles with 24V vehicle power supply)
*4: Models with Air Conditioner
*5: Automatic Transmission Models

System Diagram



04UEG114Y

Layout of Main Components



*1: Europe Models (Vehicles with 24V vehicle power supply)
*2: Manual Transmission Models
*3: Taiwan Models

047EG165Y

Main Components of Engine Control System

1) General

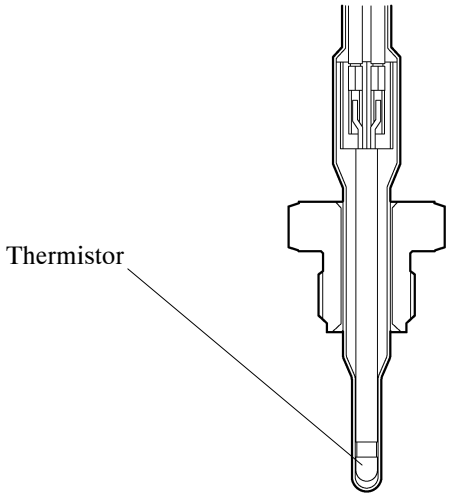
- The following table compares the main components.
- The control voltage for each component of the engine control system, including the engine ECU, has been set to 12 V.
- In Europe models with a vehicle power supply voltage of 24 V, the DC/DC converter supplies 12 V power to the engine ECU and each component of the engine control system. For details of the DC/DC converter, see page 77.

Component	Outline
Intake Air Temperature Sensor (Behind Intercooler)	Detects the intake air temperature in the intake manifold.
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 from the crankshaft position.
Camshaft Position Sensor	Identifies the cylinder from the rotation of the rotor.
Air Flow Meter (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	Detects the opening angle of the throttle valve.
Accelerator Pedal Position Sensor	Mounted on the accelerator pedal. Detects the position of the accelerator pedal.
Differential Pressure Sensor	Measures the pressure differences in positions in front of and behind the DPF catalytic converter.
Exhaust Gas Temperature Sensors	Detect the temperature of the exhaust gas in positions in front of and behind 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	Controls the volume of fuel injected by the injectors.
DC/DC Converter*	Converts the supply voltage from 24 V to 12 V, and supplies it to the engine control system.

*: Europe Models (Vehicles with 24V vehicle power supply)

2) Intake Air Temperature Sensor (Intake Manifold)

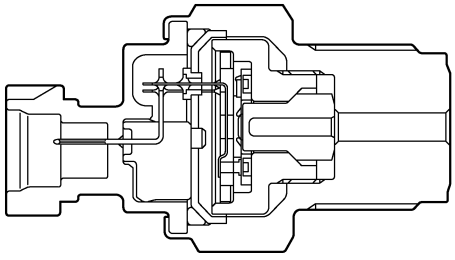
- The thermistor type intake air temperature sensor detects the temperature of the air within the intake manifold after it has passed through the intercooler and the EGR cooler.
- Immediately before the air is drawn into the cylinder, the intake air temperature sensor measures the air temperature and sends a signal to the engine ECU for 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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3) Fuel Pressure Sensor

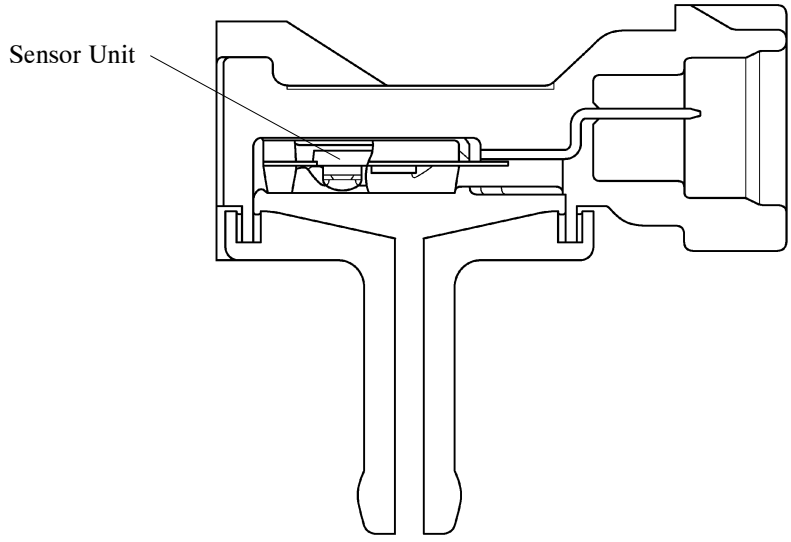
The fuel pressure sensor, which is mounted on the common-rail, outputs a signal that represents the fuel pressure in the common-rail to the engine ECU in order to constantly regulate the fuel at an optimal pressure.



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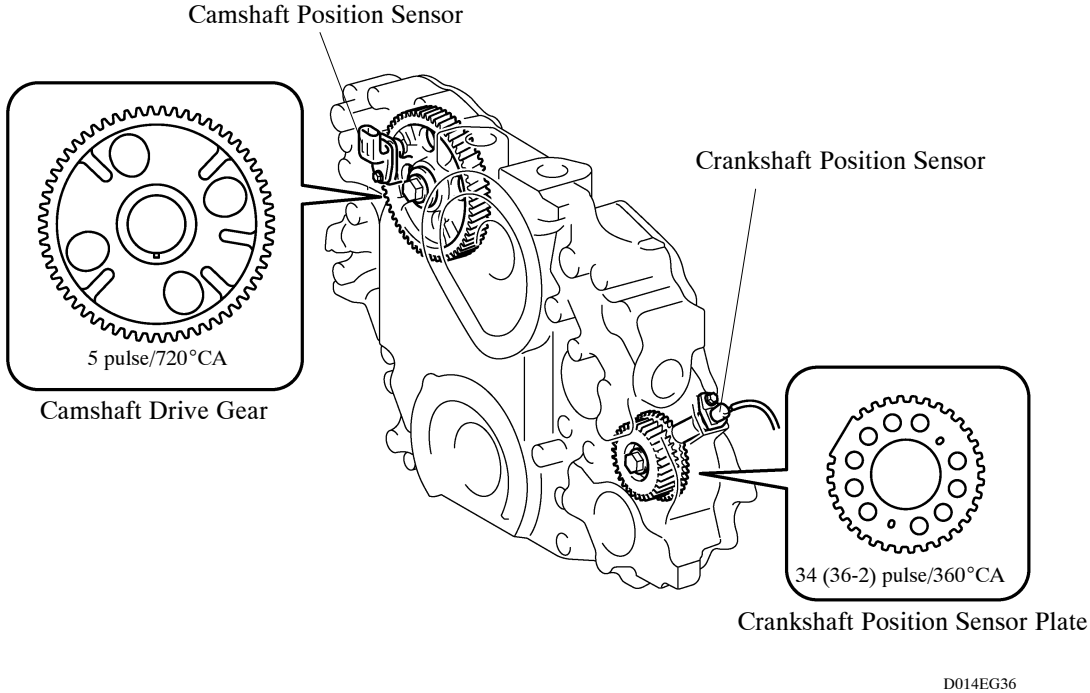
4) Turbo Pressure Sensor

The turbo pressure sensor detects the intake air 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.



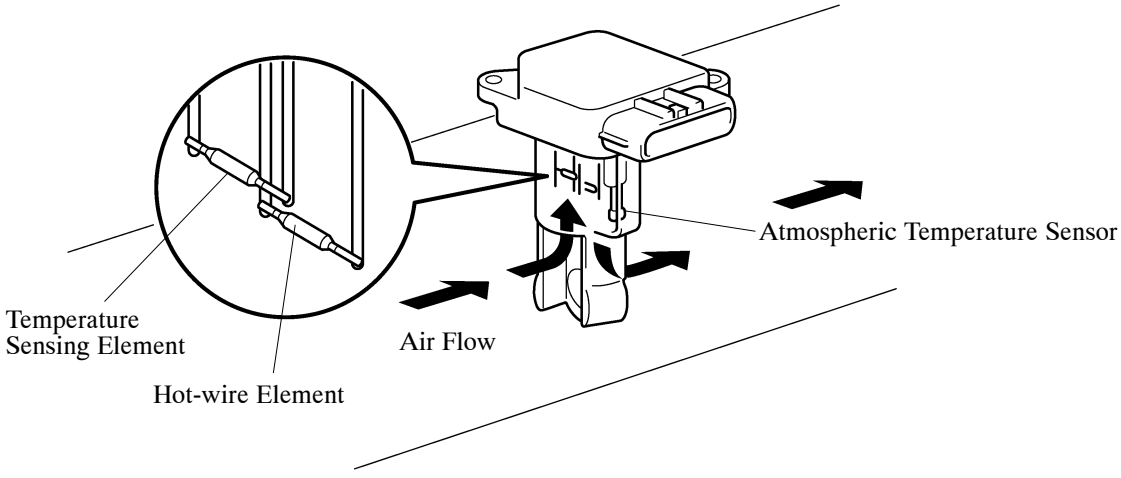
5) Crankshaft Position Sensor and Camshaft Position Sensor

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, respectively.



6) Air Flow Meter

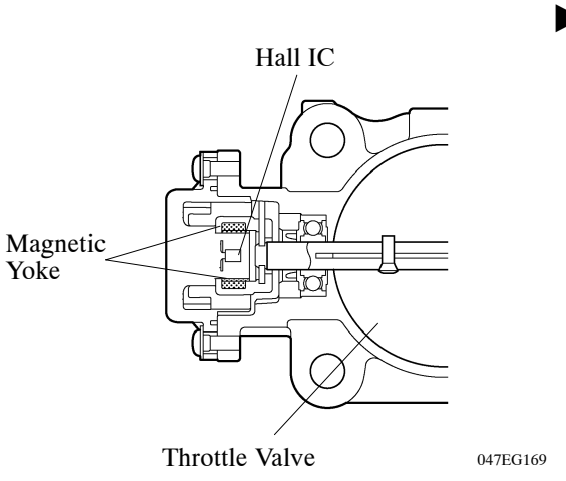
- The compact and lightweight air flow meter, which is a plug-in type, allows a portion of the intake air to flow through the detection area. By directly measuring the mass and the flow rate of the intake air, detection precision is achieved and low intake air resistance is realized.
- The air flow meter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



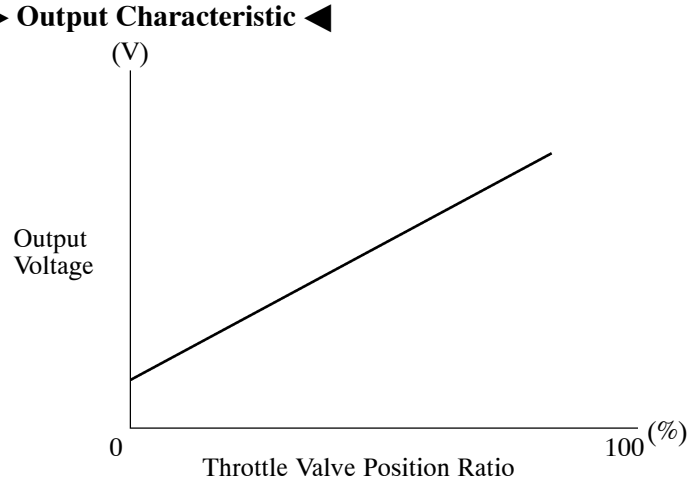
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7) Throttle Position Sensor

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 the throttle valve shaft) rotates around the Hall IC into electric signals to operate the throttle control motor.



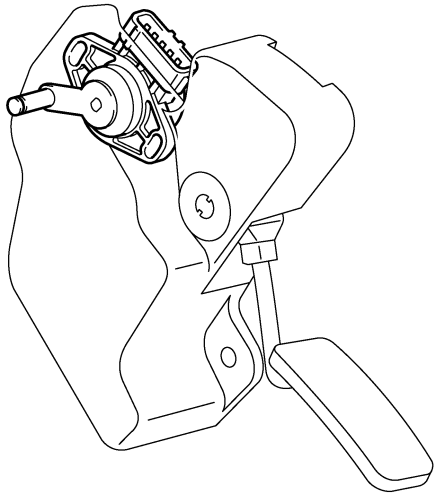
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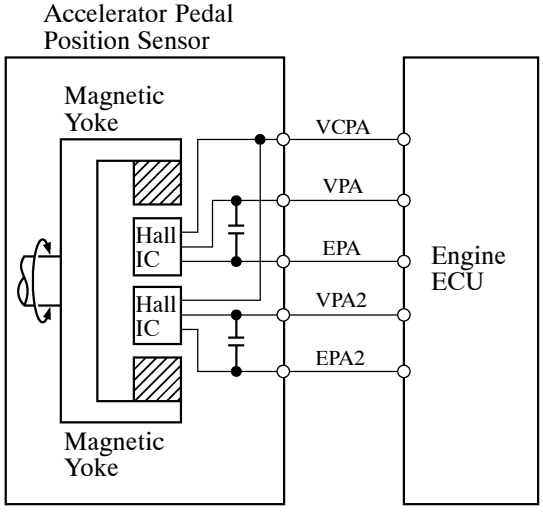
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8) Accelerator Pedal Position Sensor

- 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 offset voltage.

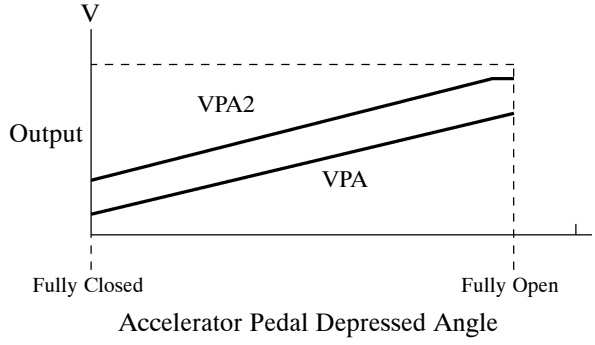


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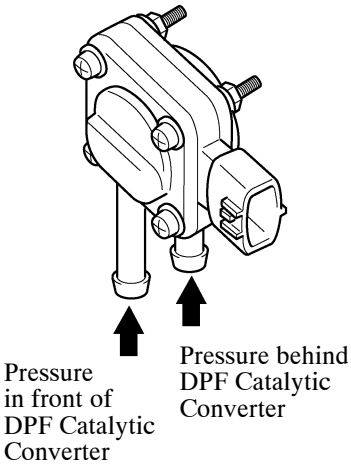
▶ Output Characteristic ◀

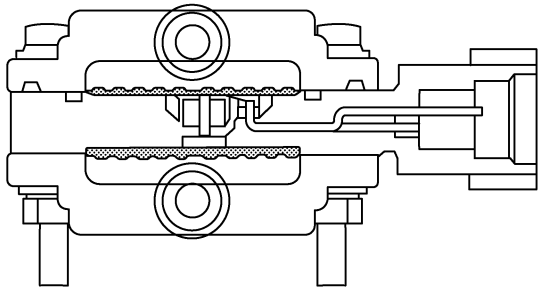


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9) Differential Pressure Sensor

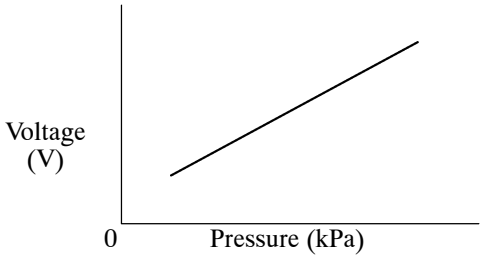
- The differential pressure sensor measures the pressure differences in positions in front of and behind the DPF catalytic converter in order to detect clogging.
- The DPF catalytic converter and the sensor are connected with pipes and hoses.





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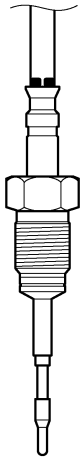
▶ Output Characteristic ◀



047EG23Y

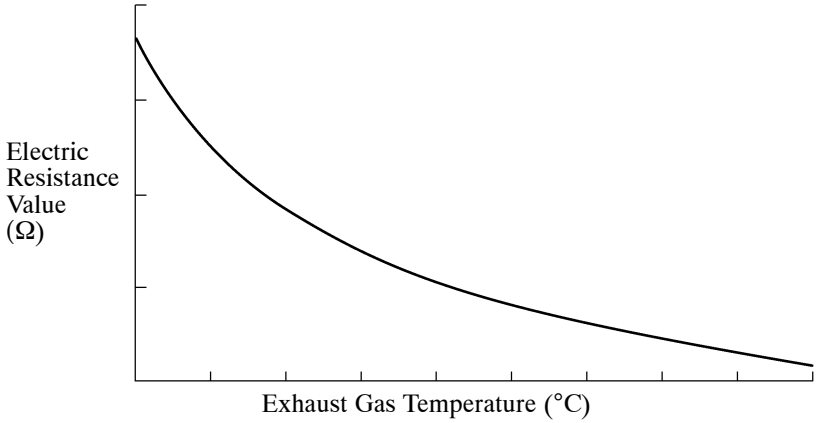
10) Exhaust Gas Temperature Sensor

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



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▶ Output Characteristic ◀



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Fuel Injection Control

1) General

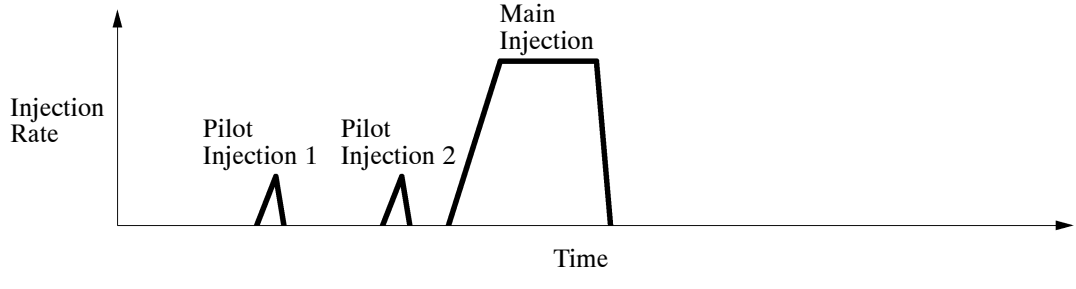
- The engine ECU transmits signals to the injector via the EDU (Electronic Driver Unit) in order to control the fuel injection timing and injection volume.
- A constant fuel pressure, which is required by the injectors to properly inject fuel, is maintained by optimally controlling the fuel pressure.
- 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 1 and pilot injection 2 before the main injection. This enables the main combustion to start gradually in order to achieve low NOx emission rates and low noise.

2) 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 the target pressure in the common-rail.

3) Multiple Injection Control

- The EDU (Electronic Driver Unit), which is capable of generating a high voltage and charging quickly, is used to actuate the pressurized fuel injectors at high speeds and deliver high-precision multiple injections.
- Multiple injection 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 rates.



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Injection Type	Control	Result
Pilot Injection 1 Pilot Injection 2	Injects fuel slightly ahead of the main injection.	Achieves low NOx emission rates and low noise
Main Injection	Injects fuel for normal combustion.	Achieves high torque

4) Idle Speed Control

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

5) 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 type of 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 type of correction increases the fuel volume to ensure proper drivability while the engine is cold.
Intake Air Pressure Correction	When the intake air mass is low, this type of correction reduces the fuel volume.

6) Fuel Cut-off

a. Deceleration Fuel Cut-off

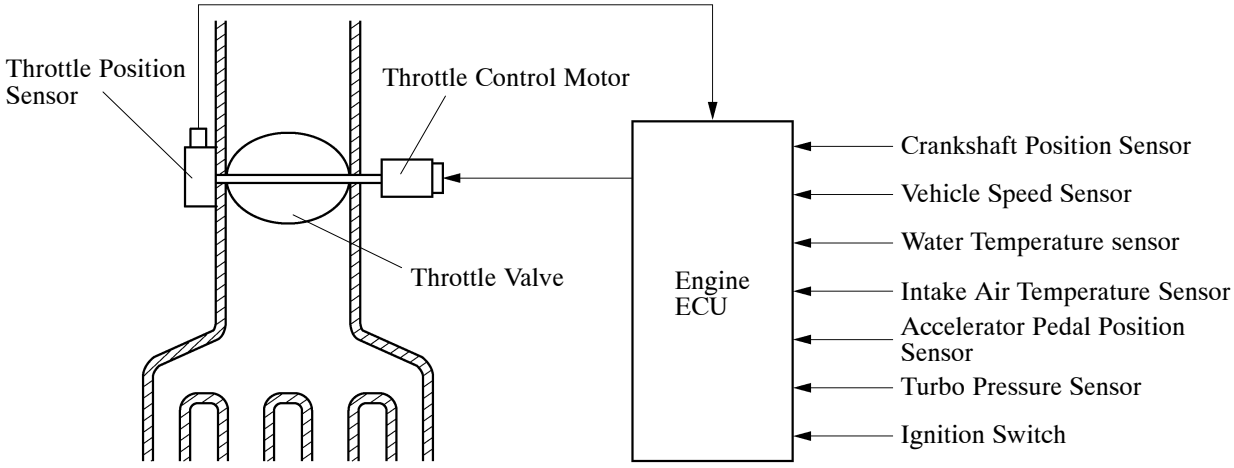
When the vehicle is decelerating and the engine speed is idle engine speed or higher, this control stops the injection of fuel in order to achieve better fuel economy. The engine speed for fuel cut-off and restoration will be high when the water temperature is low.

b. Fuel Cut-off According to Engine Speed

When the engine speed is 3650 rpm or higher, this control stops the injection of fuel to prevent the engine from over-revving.

Throttle Control

The opening of the throttle valve is controlled by the engine ECU in accordance with the 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.

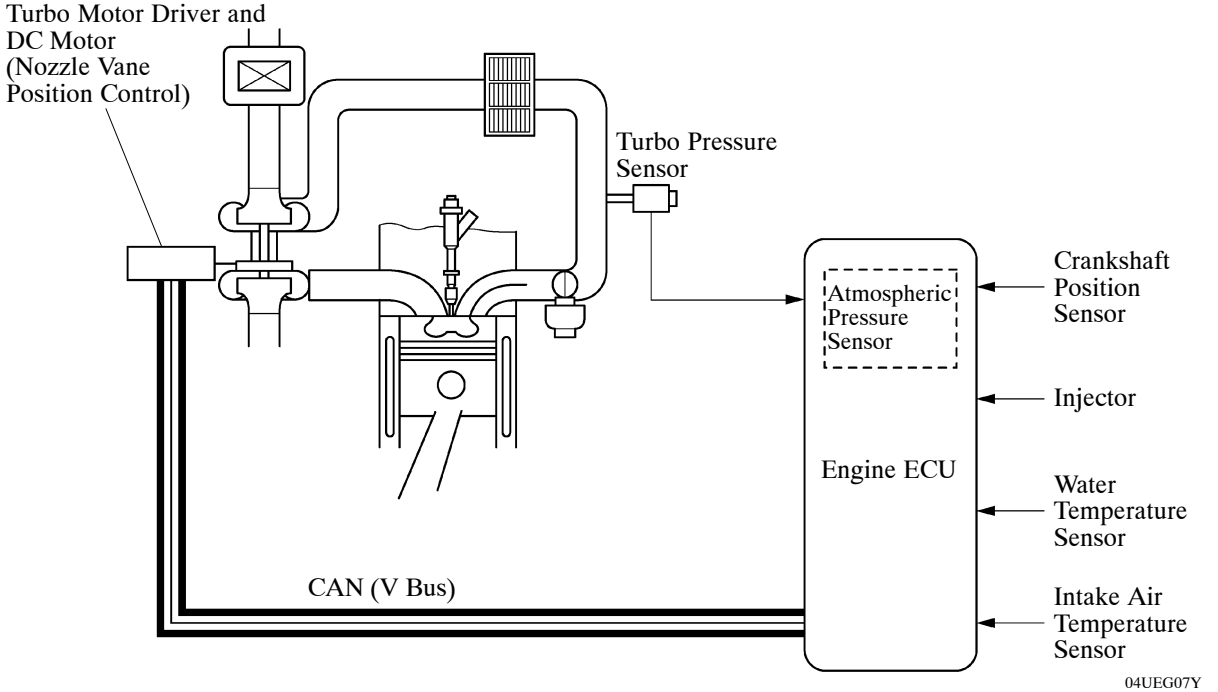


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Turbocharger Control

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 conditions.
- 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.

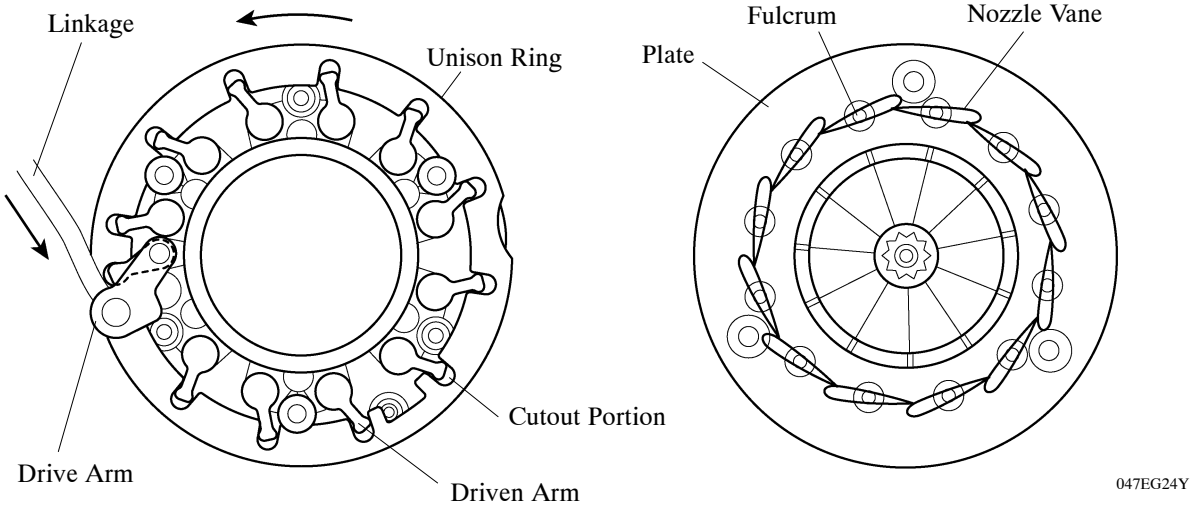


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2) Operation

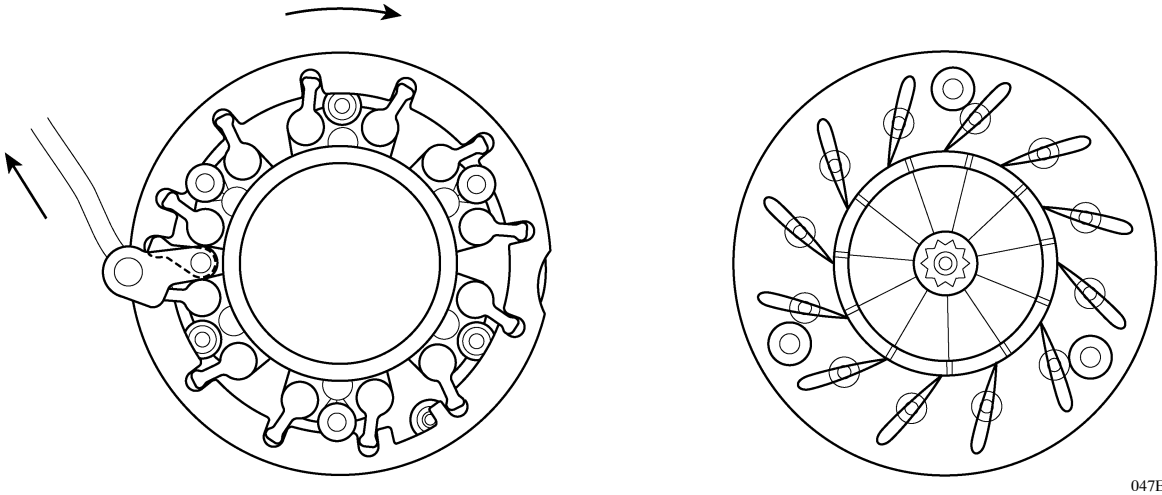
a. In Low Speed Range

When the engine is running in a low speed range, the DC motor presses down the linkage with 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 an increasing in 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.



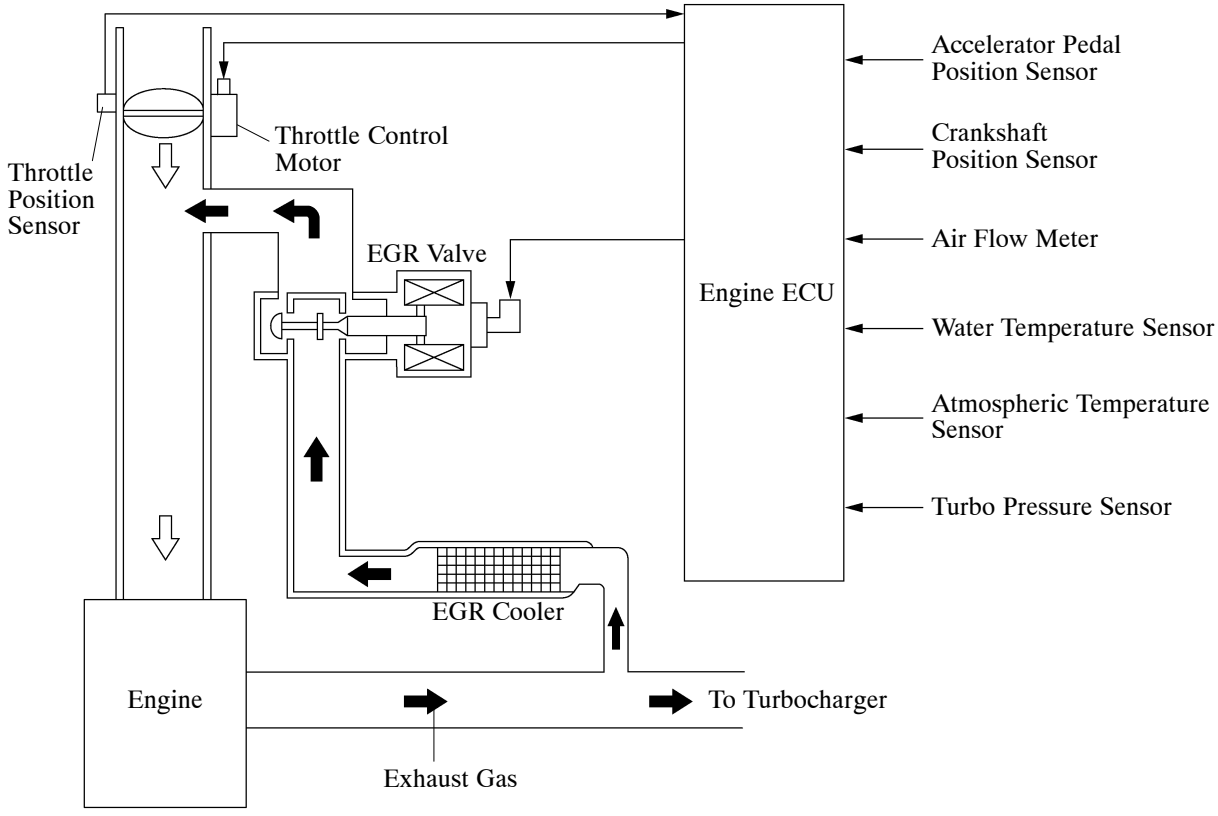
b. In Medium-to-High Speed Range

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



EGR Control

- 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 the 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.



DPF Control

1) General

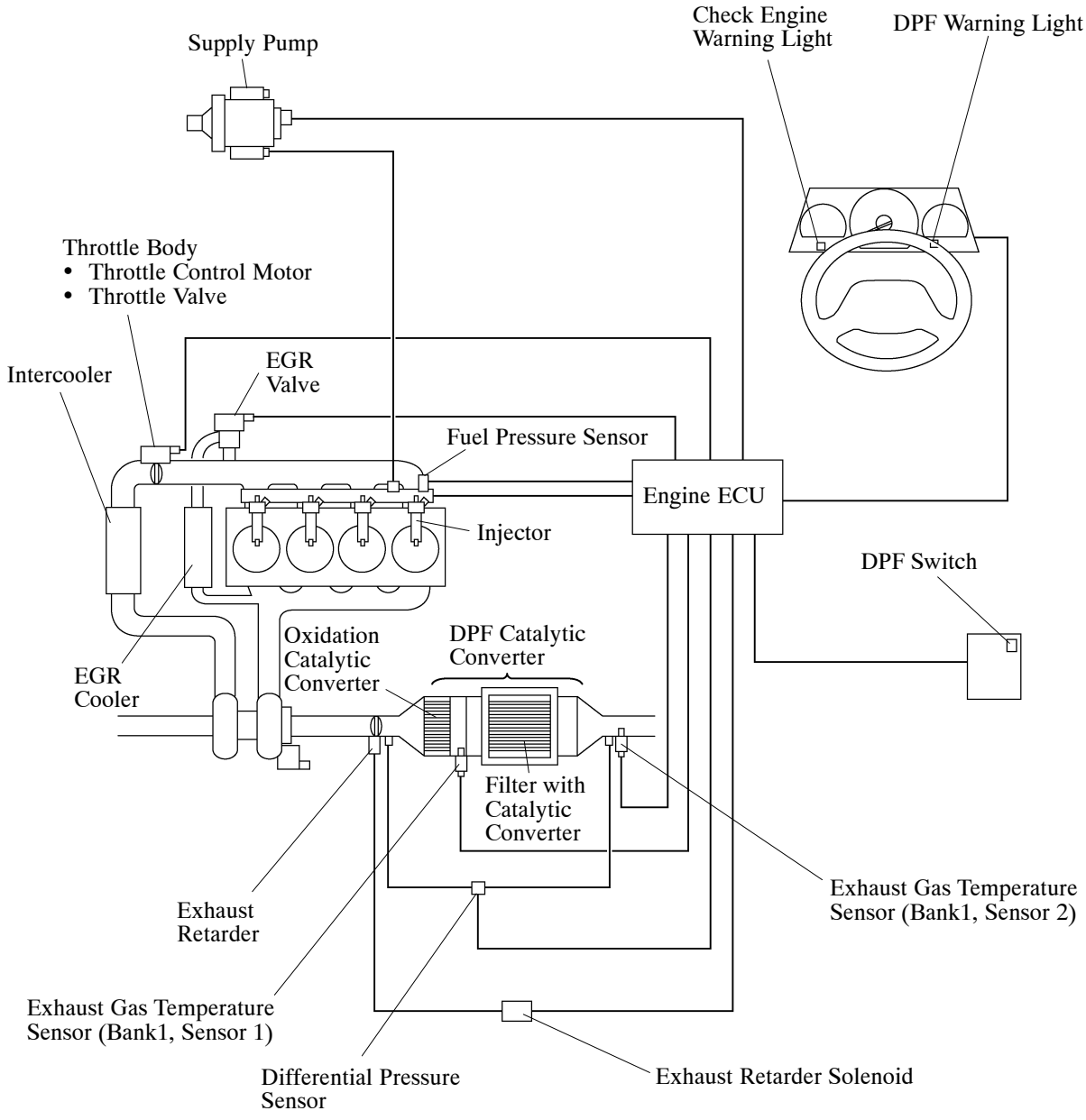
The engine ECU judges the DPF catalytic converter condition based on injection volume, injection timing, and signals from the air flow meter, water temperature sensor, two exhaust gas temperature sensors and differential pressure sensor. When the filter in the DPF catalytic converter captures a predetermined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

2) 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 becomes 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 (approx. 600°C) that effectively burns the accumulated PM.
- During normal driving, this function switches 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 has not been 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.

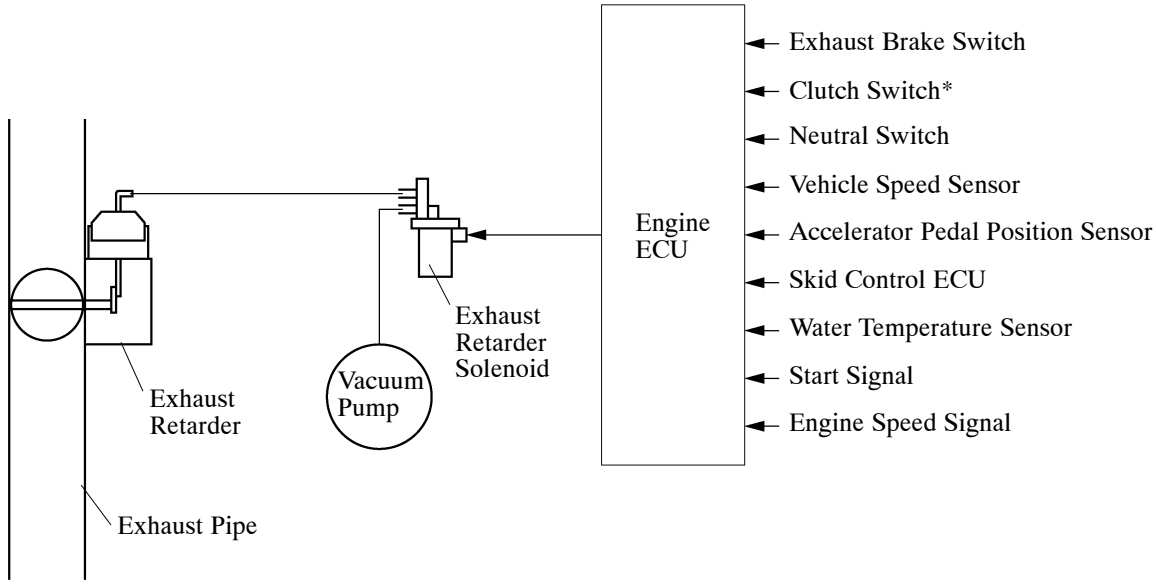
*: This distance varies depending on the driving conditions.

▶ System Diagram ◀



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.
- 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.



*: Manual Transmission Models

▶ System Components and Functions ◀

Component	Function
Exhaust Retarder Solenoid	Switches 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 the exhaust retarder solenoid.
Neutral Switch	Detects engagement of neutral or any other gear.
Vehicle Speed Sensor	Built into speedometer; detect vehicle speed and send it to the engine ECU.

*: Manual Transmission Models

▶ Objectives and Operating Conditions for Exhaust Retarder ◀

Objective	Operating Conditions
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 in neutral. • ABS is not operating.
Long Time Idling Control	• Vehicle is stopped. • Engine is idling for a long time. • Clutch is not operating.* • Accelerator pedal is not operating. • Transmission is in neutral.
DPF Control	Vehicle is stopped and the engine is idling during DPF catalytic converter cleaning mode (see page 64).

*: Manual Transmission Models

Diagnosis

- When the engine ECU detects a malfunction, it outputs 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 COASTER Repair Manual (Pub. No. RM0474E).

Service Tip

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

Fail Safe

When the engine ECU detects a malfunction, it stops or controls the engine according to the data already stored in the memory. For details, refer to the COASTER Repair Manual (Pub. No. RM0474E).