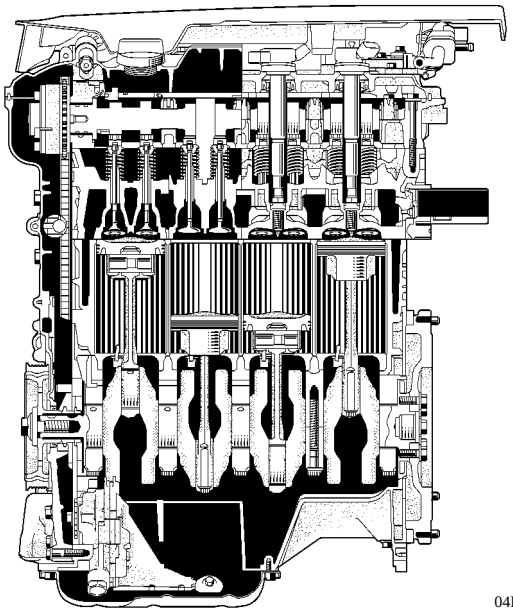
ENGINE

2ZR-FE ENGINE

■DESCRIPTION

- The newly developed 2ZR-FE engine is an in-line 4-cylinder, 1.8-liters, 16-valve DOHC engine.
- This engine uses the Dual VVT-i (Variable Valve Timing-intelligent) system, DIS (Direct Ignition System) and ETCS-i (Electronic Throttle Control System-intelligent). They have been developed to realize high performance and fuel economy, and reduce exhaust emission.



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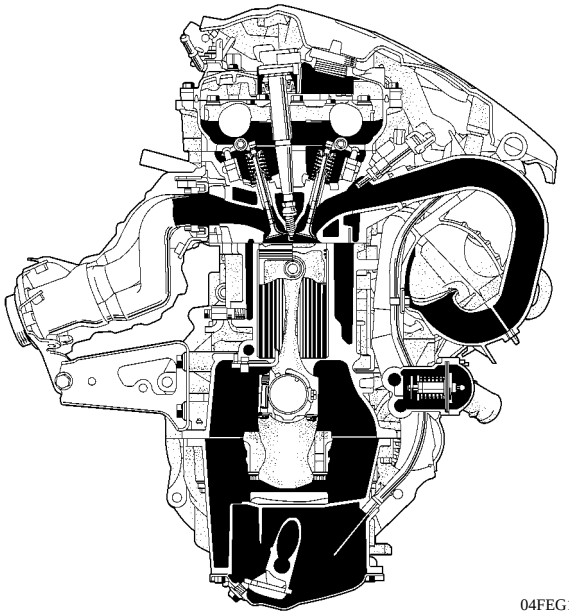

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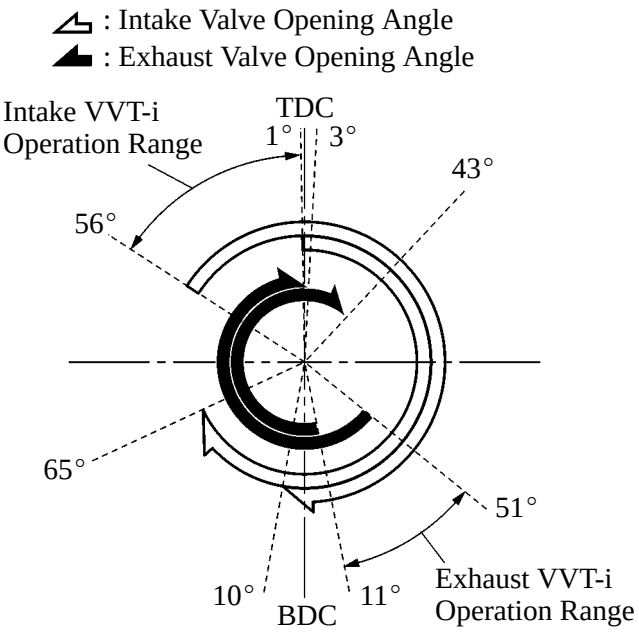
▶ Engine Specifications ◀

No. of Cyls. & Arrangement			4-cylinder, In-line
Valve Mechanism			16-valve DOHC, Chain Drive (with Dual VVT-i)
Combustion Chamber			Pentroof Type
Manifolds			Cross-flow
Fuel System			SFI
Displacement cm^3 (cu. in.)			1798 (109.7)
Bore × Stroke mm (in.)			80.5 × 88.3 (3.17 × 3.48)
Compression Ratio			10.0 : 1
Max. Output*1 (SAE-NET)			98 kW @ 6000 rpm (132 HP @ 6000 rpm)
Max. Torque*1 (SAE-NET)			174 N·m @ 4400 rpm (128 ft·lbf @ 4400 rpm)
Valve Timing	Intake	Open	1° – 56° BTDC
		Close	65° – 10° ABDC
	Exhaust	Open	51° – 11° BBDC
		Close	3° – 43° ATDC
Firing Order			1 – 3 – 4 – 2
Octane Rating			87 or higher
Oil Grade			ILSAC
Tailpipe Emission Regulation			ULEV-II, SFTP
Evaporative Emission Regulation			LEV-II, ORVR
Engine Service Mass*2 (Reference)			117 kg (257.9 lb)

*1: Maximum output and torque ratings are determined by revised SAE J1349 standard.

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

▶ Valve Timing ◀



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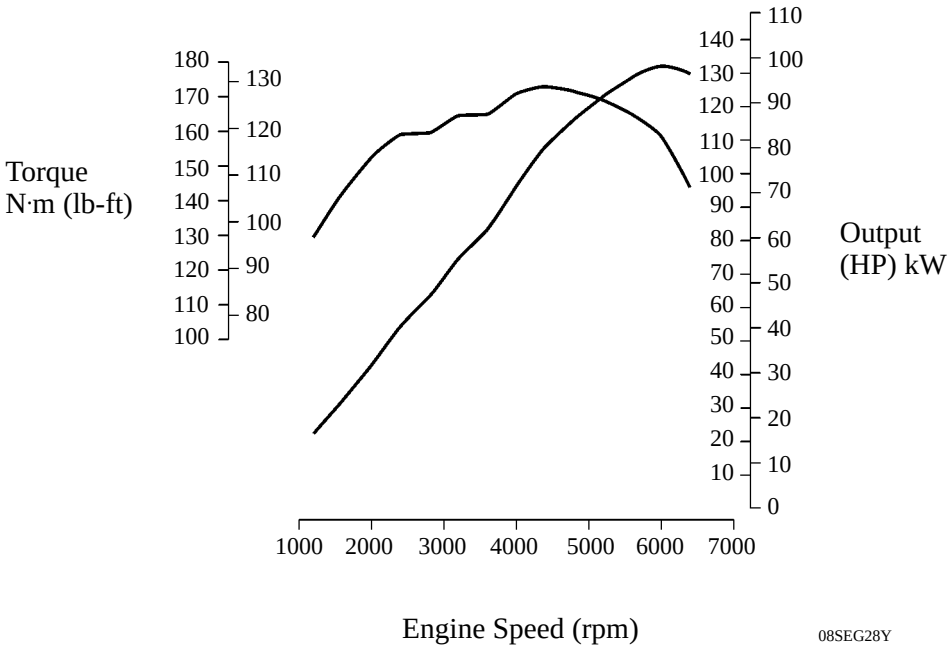
▶ Performance Curve ◀



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■FEATURES OF 2ZR-FE ENGINE

The 2ZR-FE engine has been able to achieve the following performance through the use of the items listed below.

(1) High performance and fuel economy

(2) Low noise and vibration

(3) Lightweight and compact design

(4) Good serviceability

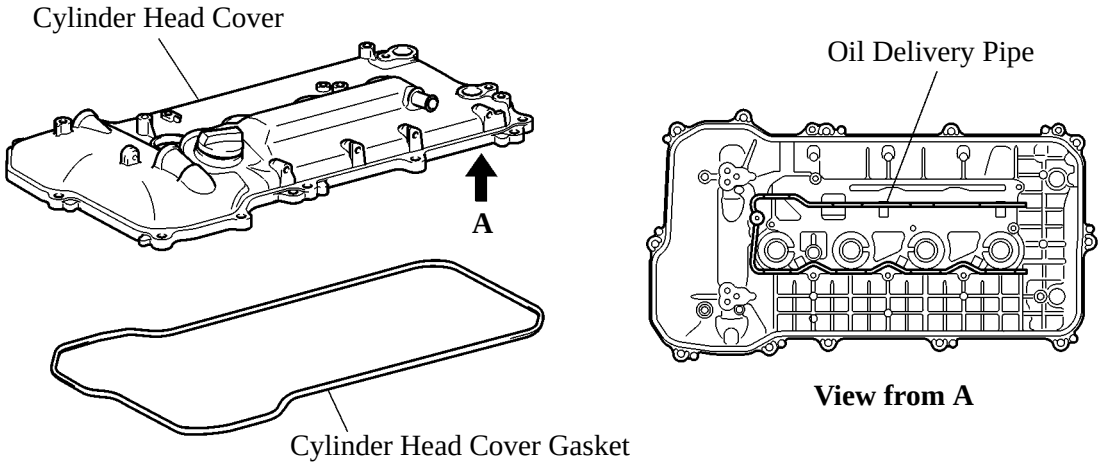
(5) Clean emission

Item		(1)	(2)	(3)	(4)	(5)
Engine Proper	A cylinder block made of aluminum alloy is used.			○		
	Spiny liners are used.	○				
	The skirt portion of the piston has a resin coating applied to reduce friction.	○	○			○
	Low tension piston rings are used.	○				○
Valve Mechanism	A timing chain and a chain tensioner are used.		○		○	
	Hydraulic lash adjusters are used.		○		○	
	Roller rocker arms are used.	○	○		○	
Cooling System	TOYOTA Genuine SLLC (Super Long Life Coolant) is used.				○	
Intake and Exhaust System	A charcoal filter is used in the air cleaner cap.					○
	An intake manifold made of plastic is used.			○		
	An upright intake port is used.	○				
	A stainless steel exhaust manifold is used.			○		○
	The TWCs (Three-Way Catalytic converters) are used on the exhaust pipe.					○
Fuel System	A fuel returnless system is used.			○	○	○
	Quick connectors are used to connect the fuel hose with the fuel pipe.				○	
Ignition System	The DIS (Direct Ignition System) makes ignition timing adjustment unnecessary.	○			○	○
	Long-reach, thin-electrode type iridium tipped spark plugs are used.	○			○	○
Charging System	A segment conductor type generator is used.	○		○		
Serpentine Belt Drive System	A serpentine belt drive system is used.	○		○	○	
Engine Control System	MRE (Magnetic Resistance Element) type camshaft position sensors are used.					○
	The ETCS-i (Electronic Throttle Control System-intelligent) is used.	○				
	The Dual VVT-i (Variable Valve Timing-intelligent) is used.	○				○
	The starter control (cranking hold function) is used.	○				

■ENGINE PROPER

1. Cylinder Head Cover

- Lightweight and high-strength aluminum die-cast cylinder head cover is used.
- An oil delivery pipe is installed inside the cylinder head cover. This ensures lubrication to the sliding parts of the roller rocker arm, improving reliability.



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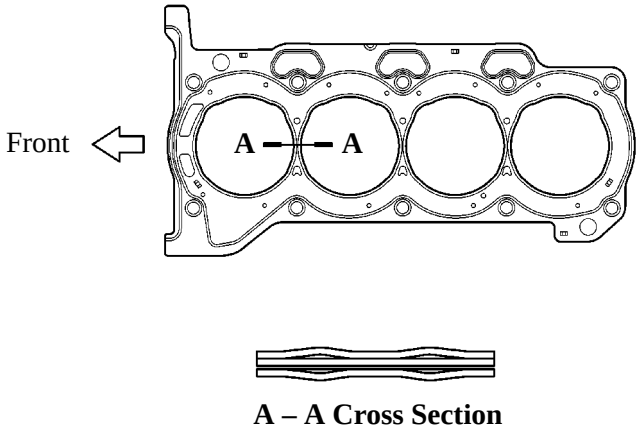
2. Cylinder Head Gasket

A triple-layer metal type cylinder head gasket is used.



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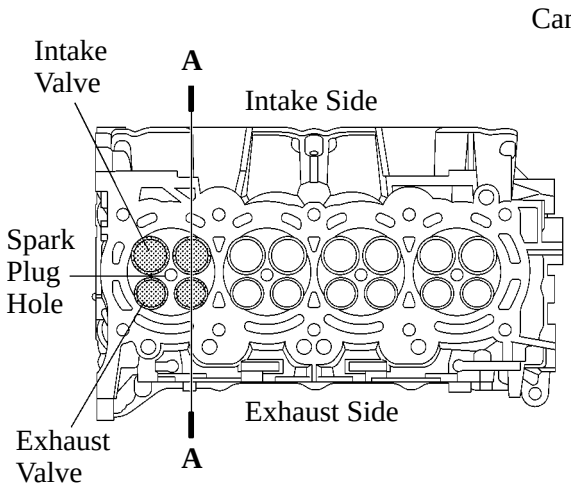
3. Cylinder Head and Camshaft Housing

- The cylinder head structure has been simplified by separating the camshaft housing (cam journal portion) from the cylinder head.
- The cylinder head, which is made of aluminum, contains a pentroof type combustion chamber. The spark plug is located in the center of the combustion chamber in order to improve the engine's anti-knocking performance.
- The angle of the intake and exhaust valves is narrowed and set at 29° to permit a compact cylinder head.
- Spark plugs with an M12 thread size are used in order to increase the diameter of the intake and exhaust valves. As a result, improved intake and exhaust efficiency has been realized.
- Upright intake ports are used to realize intake efficiency.
- A taper squish combustion chamber is used to improve anti-knocking performance and intake efficiency. In addition, engine performance and fuel economy have been improved.
- Long nozzle type fuel injectors are installed in the cylinder head to reduce the distance from the fuel injector to intake valve, thus it prevents the fuel from adhering to the intake port walls, and reduces HC exhaust emissions.
- The siamese type intake port is used to reduce the overall surface area of the intake port walls. This prevents the fuel from adhering onto the intake port walls, thus reducing HC exhaust emissions.



View from Bottom Side

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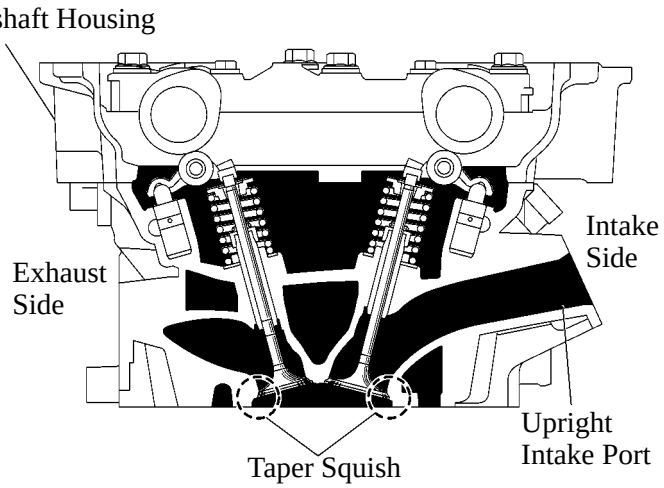

A – A Cross Section

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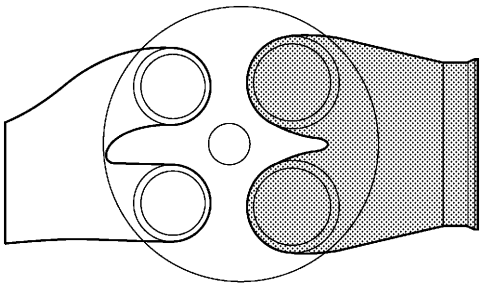
— REFERENCE —

Siamese Type



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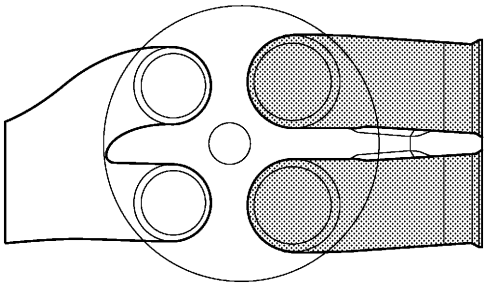
Independent Type



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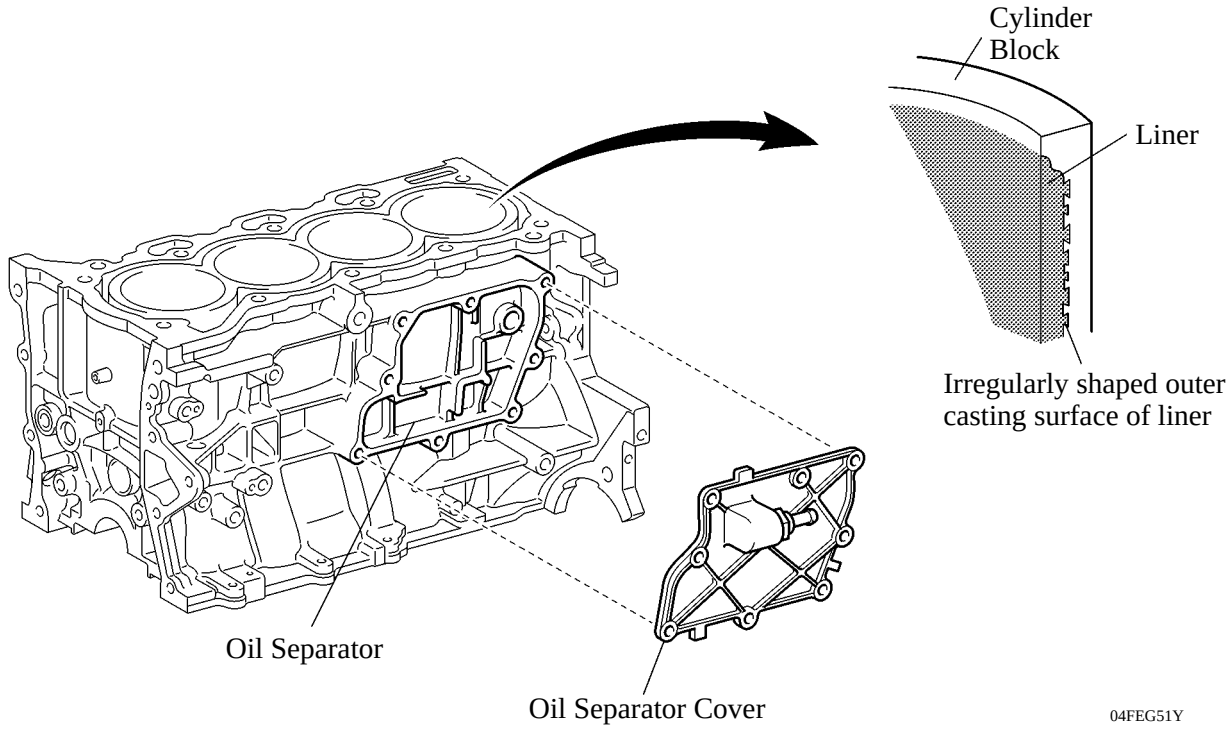
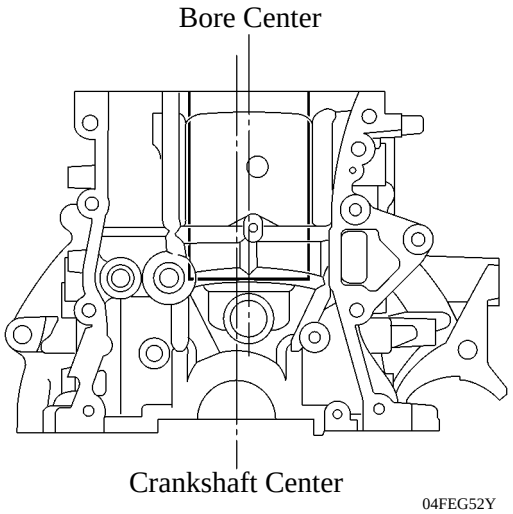
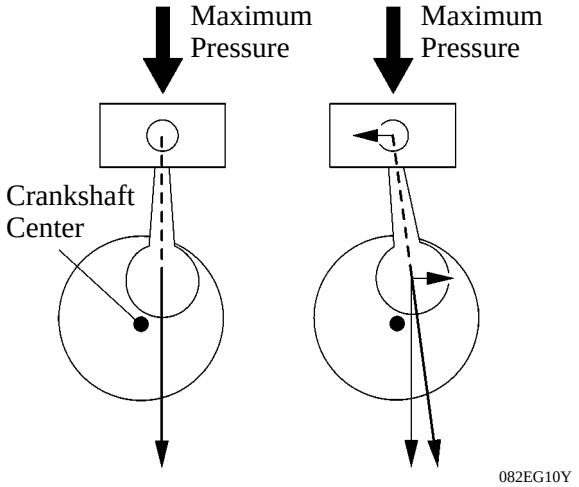
4. Cylinder Block

- An aluminum cylinder block with a 7 mm (0.28 in.) distance between the cylinder bores is used to realize a compact and lightweight configuration.
- An oil separator is provided in the blowby gas passage inside the cylinder block. This separates the engine oil from the blowby gas in order to reduce the degradation and consumption of volume of the engine oil.
- It is not possible to bore the block with this liner. The liners are the spiny type, which have been manufactured so that their casting exterior form a large irregular surface in order to enhance the adhesion between the liners and the aluminum cylinder block. The enhanced adhesion helps heat dissipation, resulting in a lower overall temperature and reduced heat deformation of the cylinder bores.
- Through the use of the offset crankshaft, the bore center is shifted 8 mm (0.31 in.) towards the intake, in relation to the crankshaft center. Thus, the side force to cylinder wall is reduced when the maximum pressure is applied, which contributes to fuel economy.



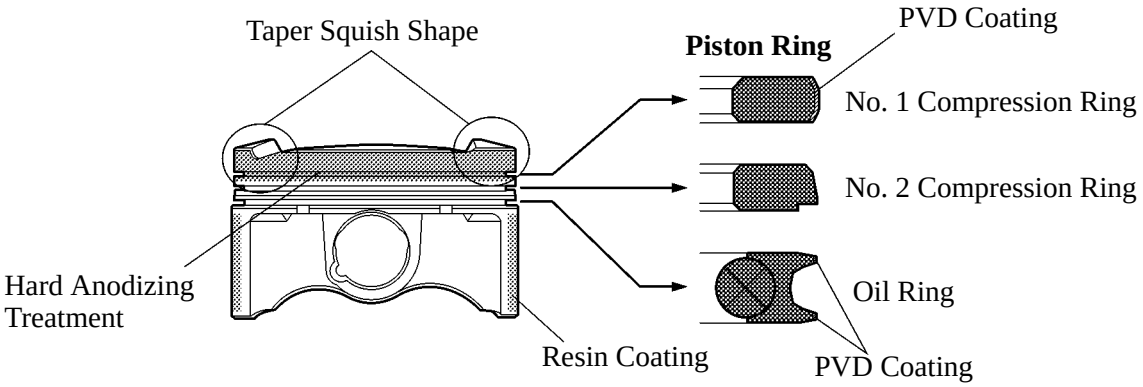




Offset Crankshaft **Center Crankshaft**

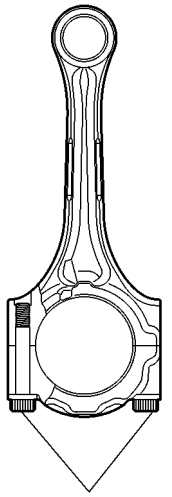
5. Piston

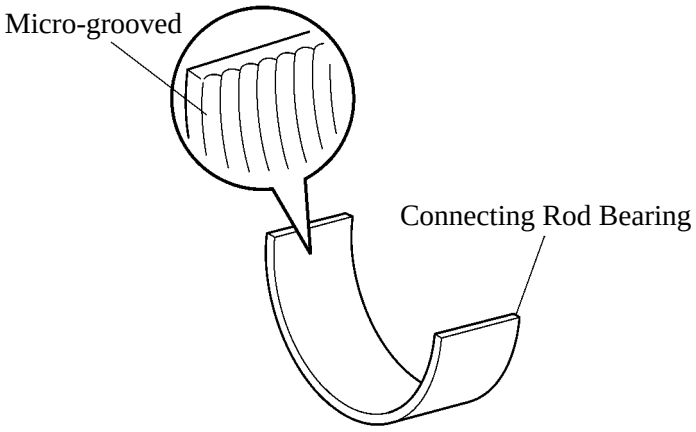
- The piston is made of aluminum alloy to be compact and lightweight.
- The piston head portion is a taper squish shape and accomplishes fuel combustion efficiency.
- Full floating type piston pins are used.
- The groove of the top ring is applied with hard anodizing treatment to ensure abrasion resistance.
- Low-tension piston rings are used to reduce friction and achieve excellent fuel economy.
- Narrow-width piston rings are used to reduce weight and friction.
- A No. 1 compression ring with an inside bevel shape is used to reduce blowby gas.
- A PVD (Physical Vapor Deposition) coating has been applied to the surface of the No. 1 compression ring and oil ring, in order to improve its wear resistance.
- The piston skirt is coated with resin to reduce the friction loss.



6. Connecting Rod and Connecting Rod Bearing

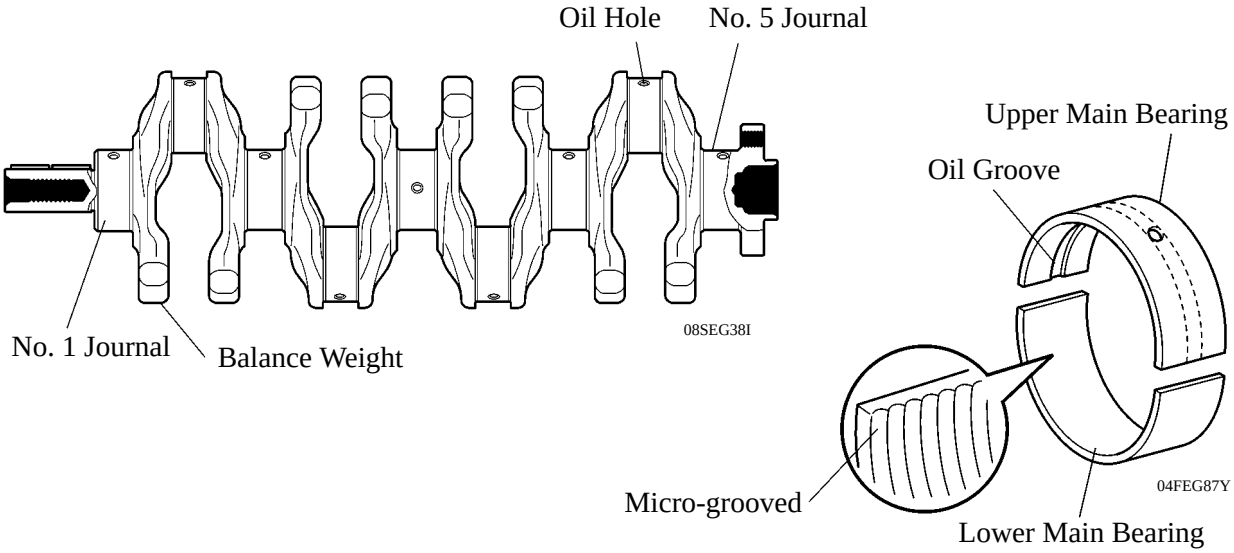
- The connecting rods are made of high-strength steel weight reduction.
- Plastic region tightening bolts are used for a light design.
- The connecting rod bearings have been optimized in width to reduce friction.
- The lining surface of the connecting rod bearing has been micro-grooved to realize an optimal amount of oil clearance. As a result, cold-engine cranking performance has been improved and engine vibrations have been reduced.





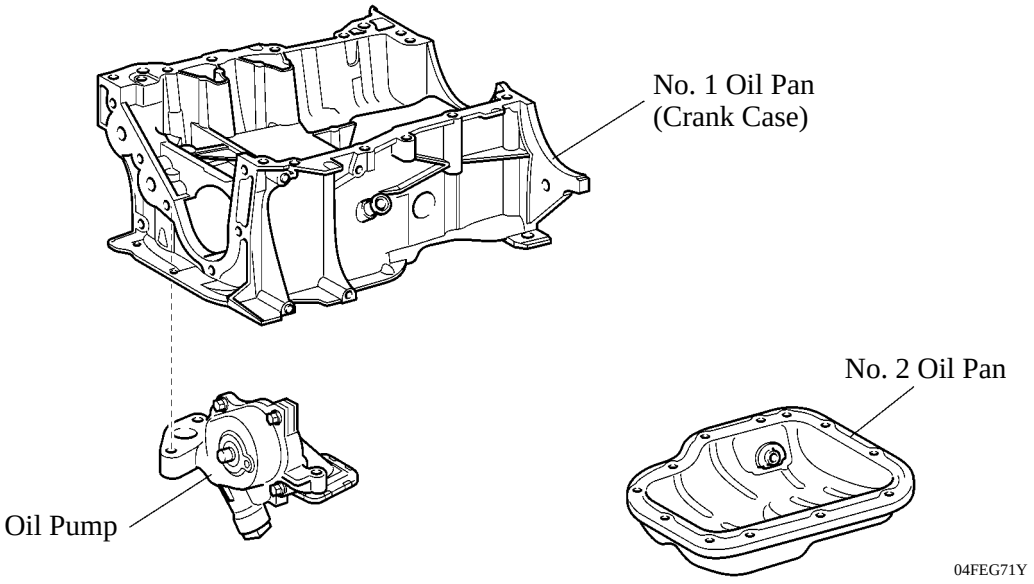
7. Crankshaft and Crankshaft Bearing

- The crankshaft has 5 journals and 8 balance weights.
- The crankshaft bearings have been optimized in width to reduce friction.
- The pins and journals have been machined with increased precision and the surface roughness is minimized to reduce friction.
- The lining surface of the crankshaft bearing has been micro-grooved to realize an optimal amount of oil clearance. As a result, cold-engine cranking performance has been improved and engine vibrations have been reduced.



8. Oil Pan

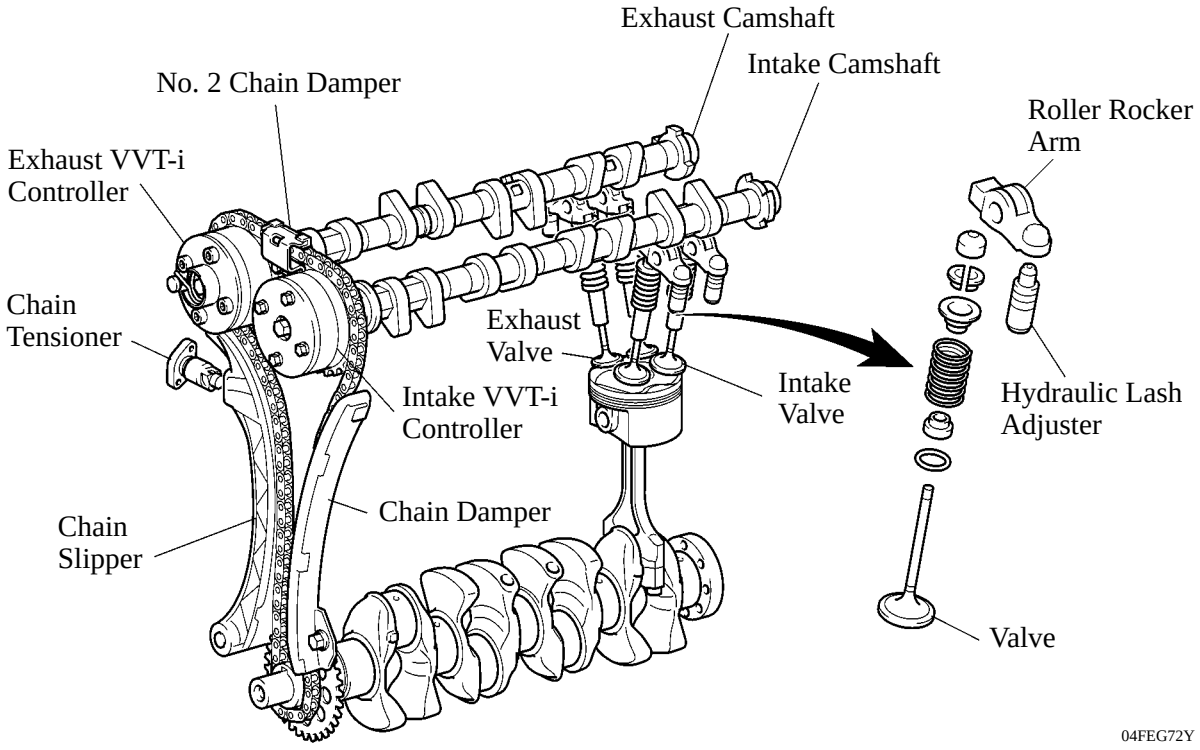
- The No. 1 oil pan (crank case) is made of aluminum alloy.
- The No. 2 oil pan is made of steel.
- The oil pump is installed in the No. 1 oil pan to make the engine compact.
- To improve serviceability, the No. 1 oil pan has been designed so that it can be removed without removing the No. 2 oil pan and the oil pump.
- The air conditioning compressor brackets are integrated into the No. 1 oil pan.



■VALVE MECHANISM

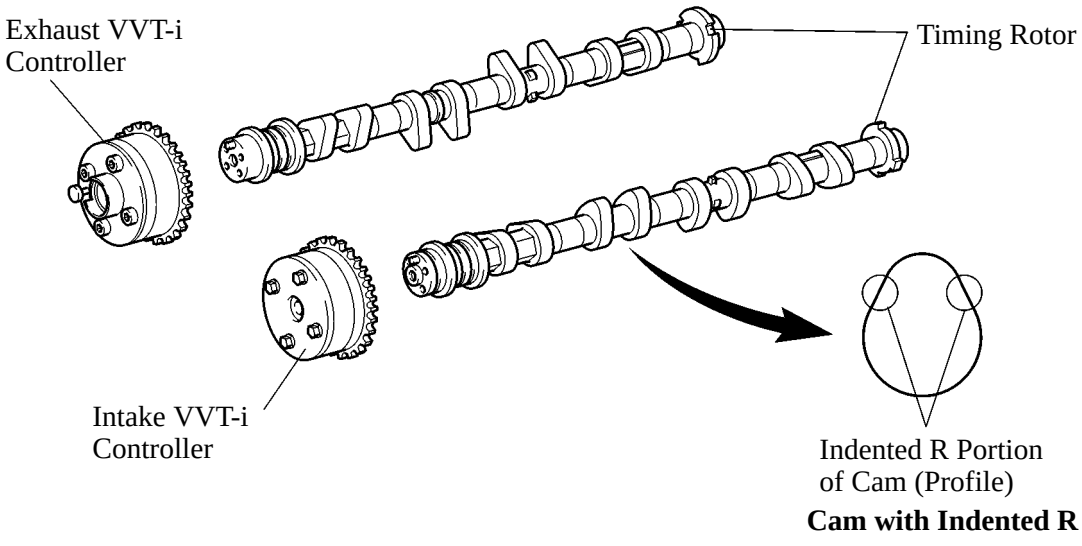
1. General

- Intake and exhaust efficiency has been increased due to the larger total port areas.
- The 2ZR-FE engine uses roller rocker arms with built-in needle bearings. This reduces the friction that occurs between the cams and the areas (roller rocker arms) that push the valves down, thus improving fuel economy.
- The hydraulic lash adjusters, which maintain a constant zero valve clearance through the use of oil pressure and spring force, are used.
- The intake and exhaust camshafts are driven by a timing chain.
- The 2ZR-FE engine uses a Dual VVT-i (Variable Valve Timing-intelligent) system which controls the intake and exhaust camshafts to provide optimal valve timing according to driving conditions. With this, lower fuel consumption, higher engine performance, and fewer exhaust emissions have been achieved. For details of Dual VVT-i control, see page EG-49.



2. Camshaft

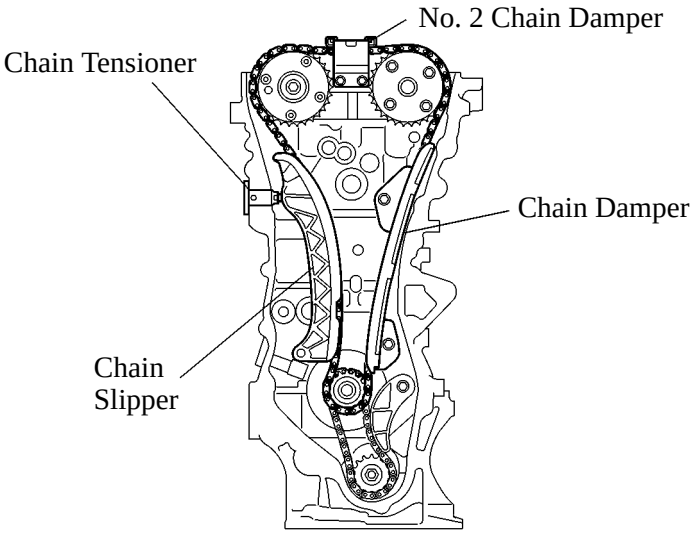
- The intake and exhaust camshafts are made of cast iron alloy.
- An oil passage is provided in the intake and exhaust camshafts in order to supply engine oil to the VVT-i system.
- A VVT-i controller has been installed on each front of the intake and exhaust camshafts to vary the timing of the intake and exhaust valves.
- Together with the use of the roller rocker arm, the cam profile has been designed with an indented R (radius). This results in increased valve lift when the valve begins to open and finishes closing, helping to achieve enhanced output performance.
- A timing rotor for the camshaft position sensor is provided at each back end of the intake and exhaust camshafts.



Cam with Indented R 04FEG54Y

3. Timing Chain and Chain Tensioner

- A roller chain with an 8 mm pitch is used to make the engine more compact.
- The timing chain is lubricated by a timing chain oil jet. See page EG-13 for the location of the timing chain oil jet.
- The chain tensioner uses a spring and oil pressure to maintain proper chain tension at all times. The chain tensioner suppresses noise generated by the timing chain.
- The chain tensioner is ratchet type with a non-return mechanism.
- To achieve excellent serviceability, the chain tensioner is constructed so that it can be removed and installed from the outside of the timing chain cover.



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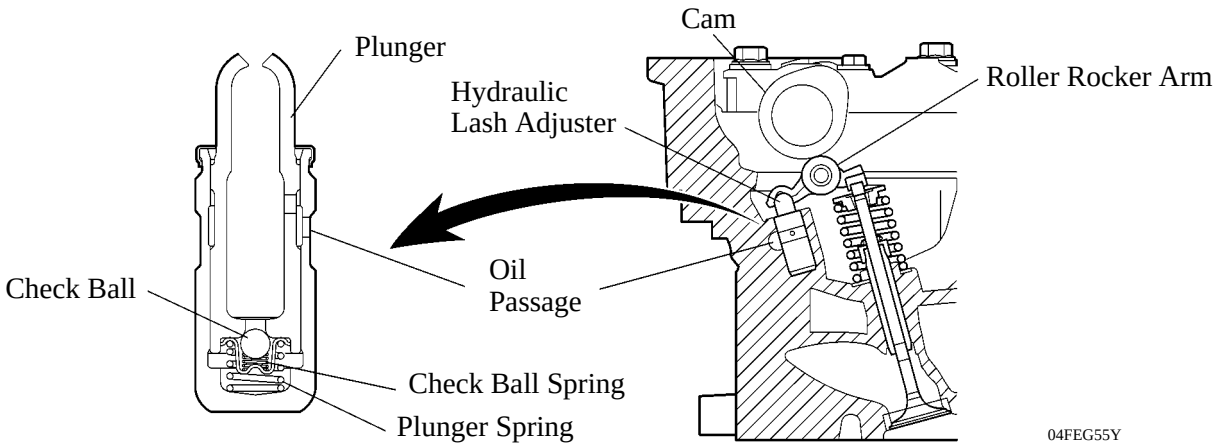
4. Hydraulic Lash Adjuster

- The hydraulic lash adjuster, which is located at the fulcrum of the roller rocker arm, consists primarily of a plunger, plunger spring, check ball, and check ball spring.
- The engine oil that is supplied by the cylinder head and the built-in spring actuates the hydraulic lash adjuster. The oil pressure and the spring force that act on the plunger push the roller rocker arm against the cam, in order to adjust the valve clearance that is created during the opening and closing of the valve. As a result, engine noise is reduced.

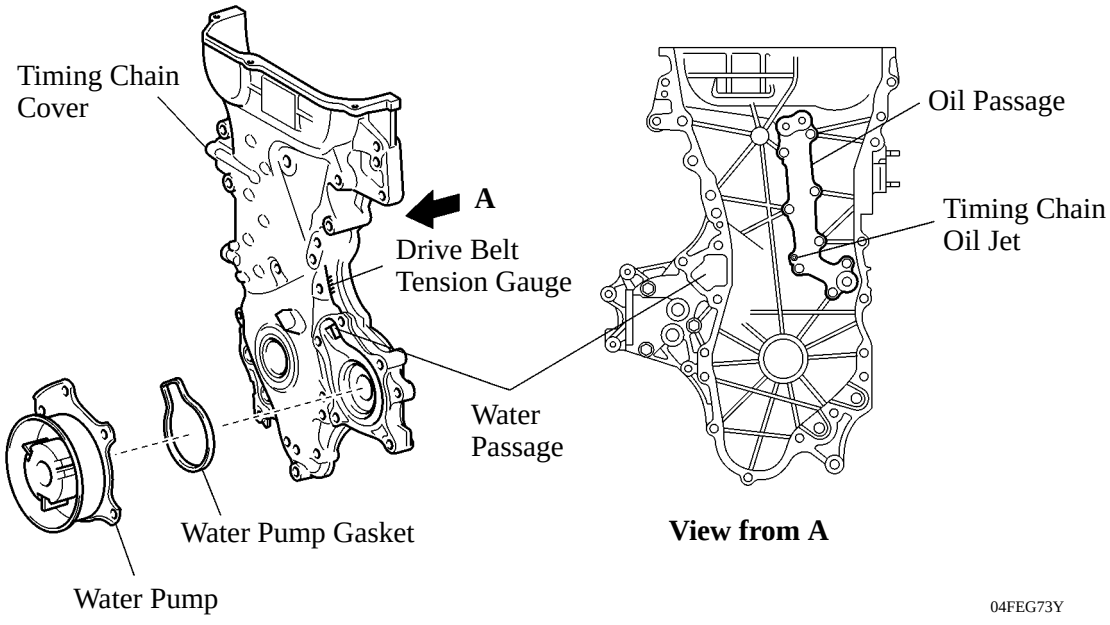


Service Tip

Valve clearance adjustment is not necessary because a hydraulic lash adjuster is used.

5. Timing Chain Cover

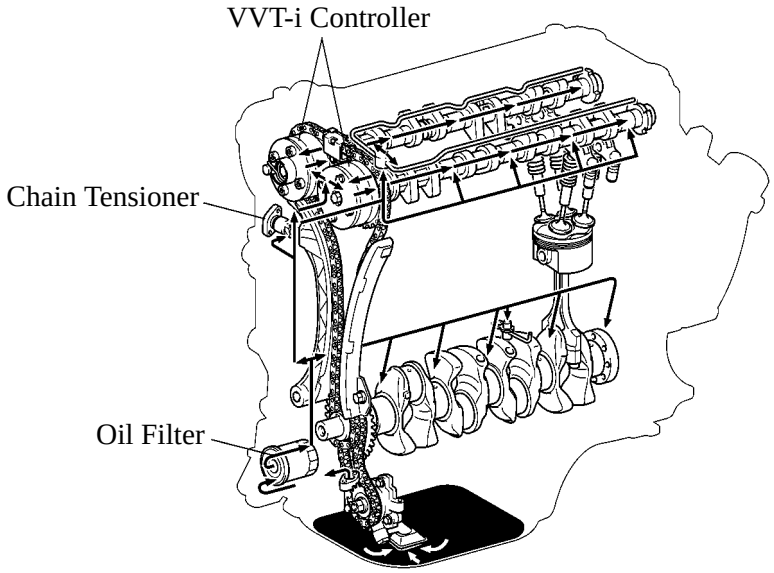
- An aluminum die-cast timing chain cover is used.
- The timing chain cover has an integrated construction consisting of the cooling system (water pump and water passage). Thus, the number of parts has been reduced for weight reduction.
- The oil passage is provided on the timing chain cover to simplify the oil passage.
- The timing chain oil jet is provided in the timing chain cover.
- A drive belt tension gauge is provided on the timing chain cover.



■LUBRICATION SYSTEM

1. General

- The lubrication circuit is fully pressurized and oil passes through an oil filter.
- The trochoid gear type oil pump is chain-driven by the crankshaft.
- The 2ZR-FE engine has an oil return system in which the oil is force-fed to the upper cylinder head and returns to the oil pan through the oil return hole in the cylinder head.
- The 2ZR-FE engine uses the Dual VVT-i system. This system is operated by the engine oil.



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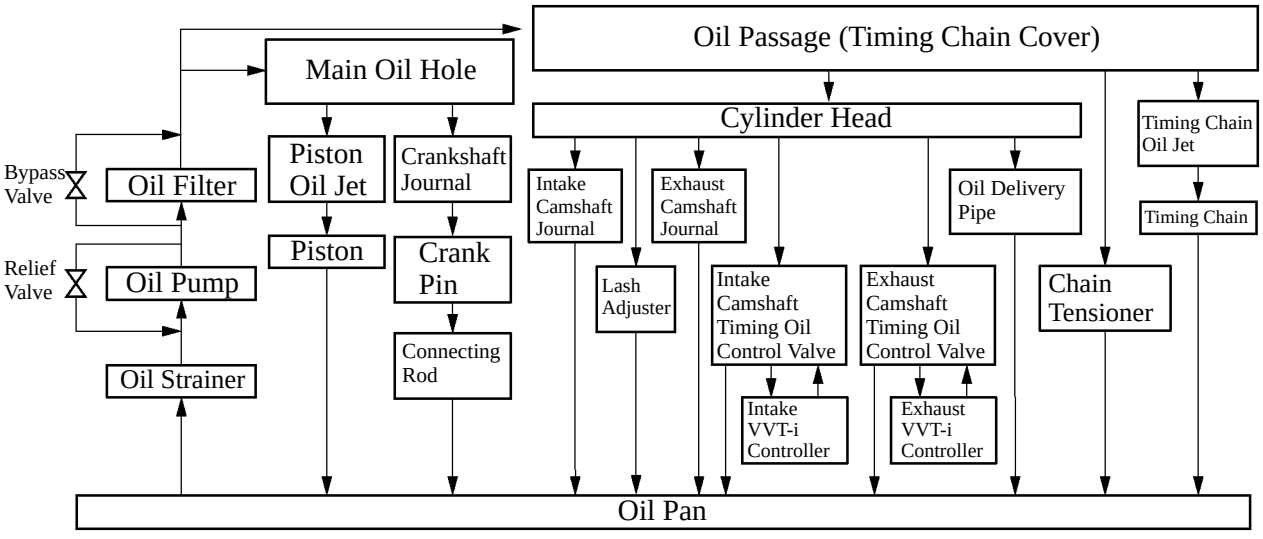
▶ Oil Capacity ◀

Dry	4.7 Liters (5.0 US qts, 4.1 Imp. qts)
With Oil Filter	4.2 Liters (4.4 US qts, 3.7 Imp. qts)
Without Oil Filter	3.9 Liters (4.1 US qts, 3.4 Imp. qts)

▶ Oil Circuit ◀



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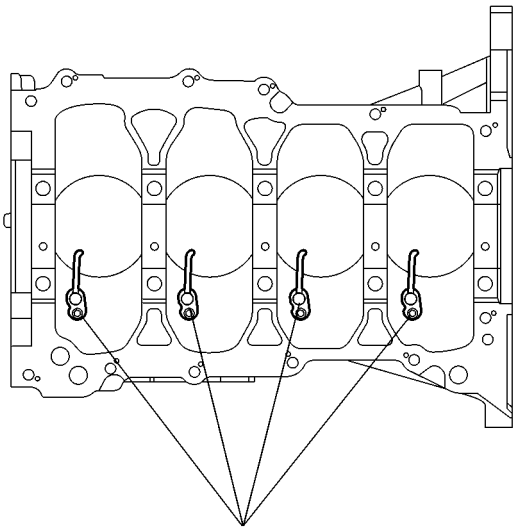
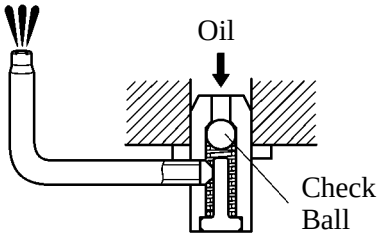
2. Piston Oil Jet

- Piston oil jets for cooling and lubricating the pistons have been provided in the cylinder block.
- These oil jets contain a check ball to prevent oil from being fed when the oil pressure is low. This prevents the overall oil pressure in the engine from dropping.



Piston Oil Jets

Bottom Side View



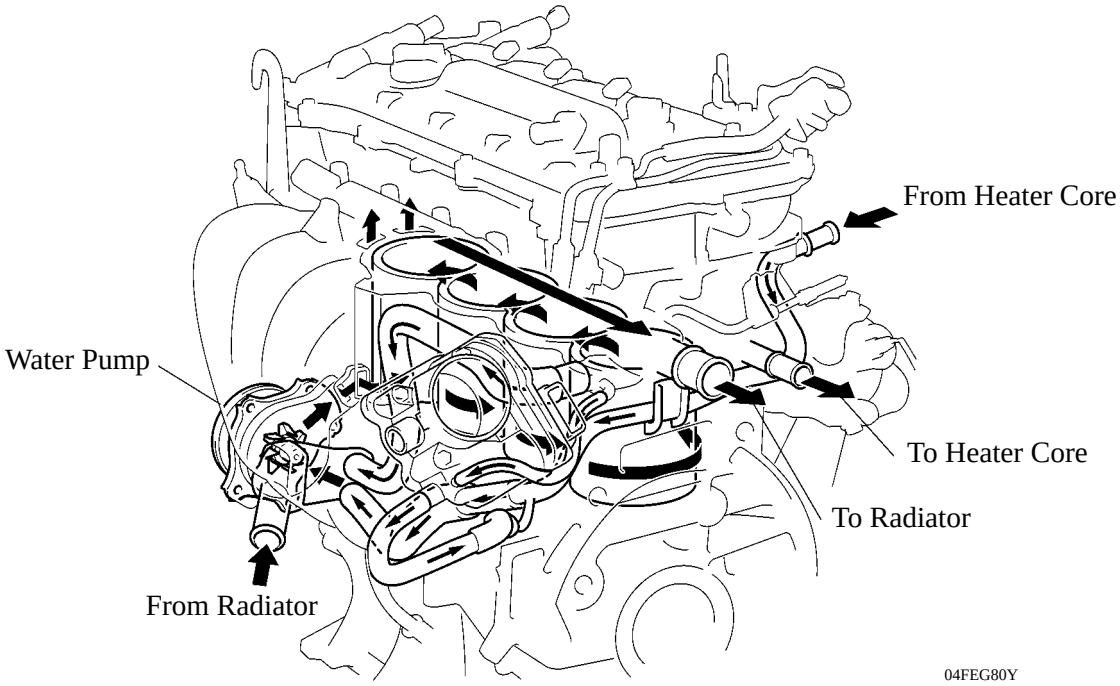
Oil Jet Cross Section

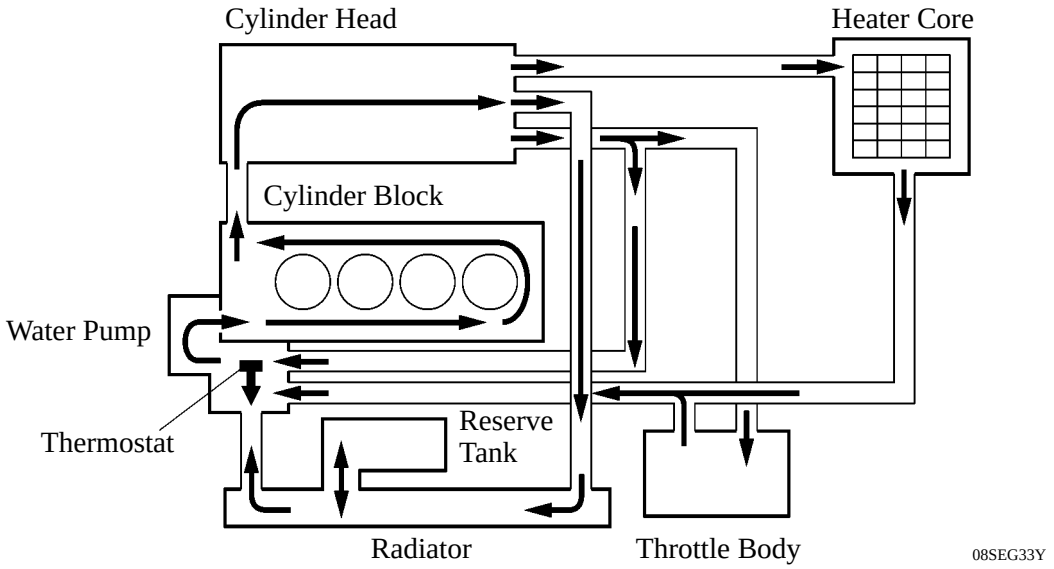
04FEG74Y

■COOLING SYSTEM

- The cooling system is a pressurized, forced-circulation system with simple-closing reserve tank.
- A thermostat with a bypass valve is located in the water inlet housing to maintain a suitable temperature in the cooling system.
- The flow of the engine coolant makes a U-turn in the cylinder block to ensure a smooth flow. In addition, a bypass passage is enclosed in the cylinder head and the cylinder block.
- Warm water from the cylinder head is sent to the throttle body to prevent freeze-up.
- The TOYOTA Genuine Super Long Life Coolant (SLLC) is used.

▶ Water Circuit ◀





▶ Specifications ◀

Engine Coolant	Type		TOYOTA Genuine Super Long Life Coolant (SLLC) or 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 long-life hybrid organic acid technology is a combination of low phosphates and organic acids). Do not use plain water alone.
	Capacity		5.5 Liters (5.8 US qts, 4.8 Imp. qts)
	Color		Pink
	Maintenance Intervals	First time	100,000 mile (160,000 km)
		Subsequent	Every 50,000 mile (80,000 km)
Thermostat	Opening Temperature °C (°F)		80 – 84 (176 – 183)

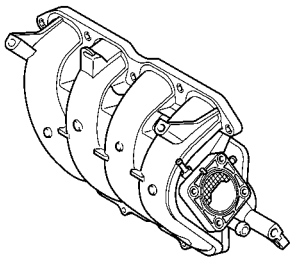
SLLC is pre-mixed (the U.S.A. models: 50% coolant and 50% deionized water, the Canada models: 55% coolant and 45% deionized water). Therefore, no dilution is needed when SLLC in the vehicle is added or replaced.

■INTAKE AND EXHAUST SYSTEM

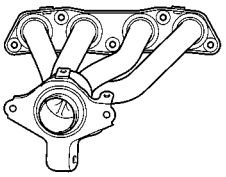
1. General

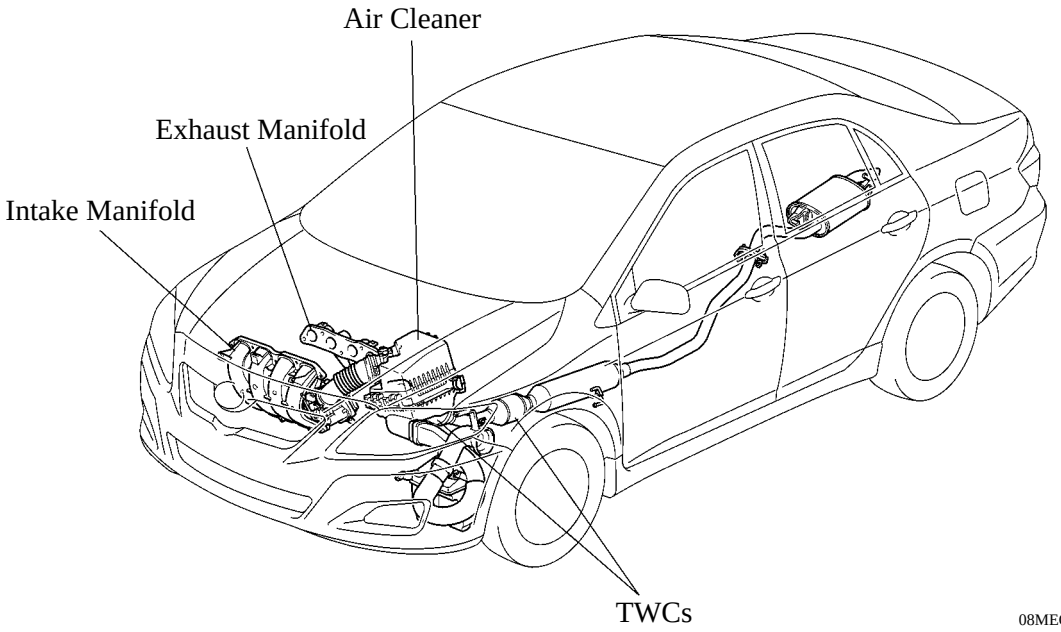
- The intake manifold has been made of plastic to reduce the weight and the amount of heat transferred from the cylinder head. As a result, it has become possible to reduce the intake air temperature and improve the intake volumetric efficiency.
- A stainless steel exhaust manifold is used for weight reduction.
- A throttle body mesh is used between the throttle body and the intake manifold to improve the flow of air within the intake manifold.
- Two TWCs (Three-Way Catalytic converters) are used in the exhaust pipe.

▶ Intake Manifold ◀



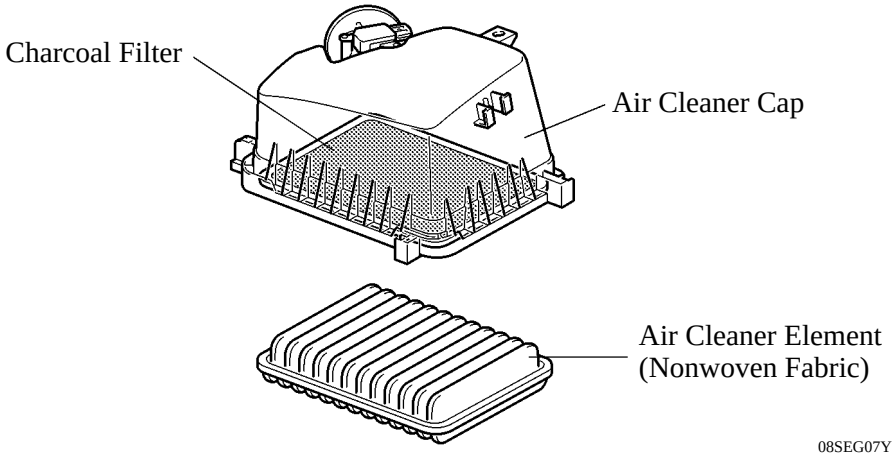
▶ Exhaust Manifold ◀





2. Air Cleaner

- A nonwoven, full-fabric type air cleaner element is used.
- A charcoal filter, which adsorbs the HC that accumulates in the intake system when the engine is stopped, is used in the air cleaner cap in order to reduce evaporative emissions.

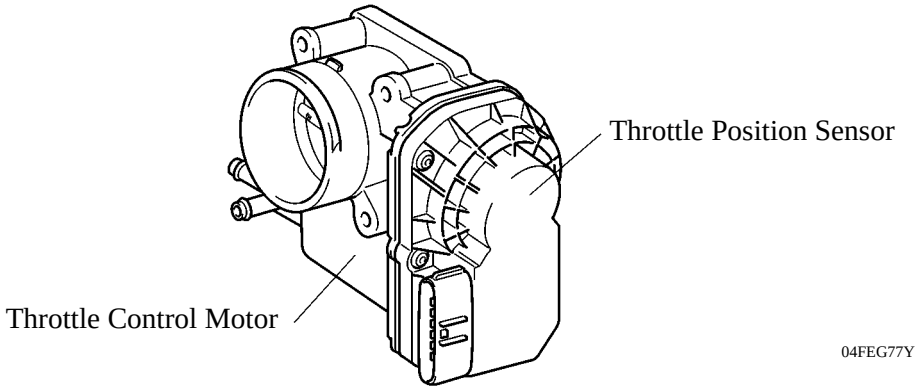


Service Tip

The charcoal filter, which is maintenance-free, cannot be removed from the air cleaner cap.

3. Throttle Body

- The linkless-type throttle body is used and it realizes excellent throttle control.
- A DC motor with excellent response and minimal power consumption is used for the throttle control motor. The ECM performs the duty cycle control of the direction and the amperage of the current that flows to the throttle control motor in order to regulate the opening angle of the throttle valve.



4. Exhaust Pipe

- 2 ball joints are used to joint the exhaust manifold to the front pipe, and the front pipe to the tailpipe. As a result, a simple construction and improved reliability have been realized.
- The TWC can improve exhaust emission by optimizing the cell density and the wall thickness.