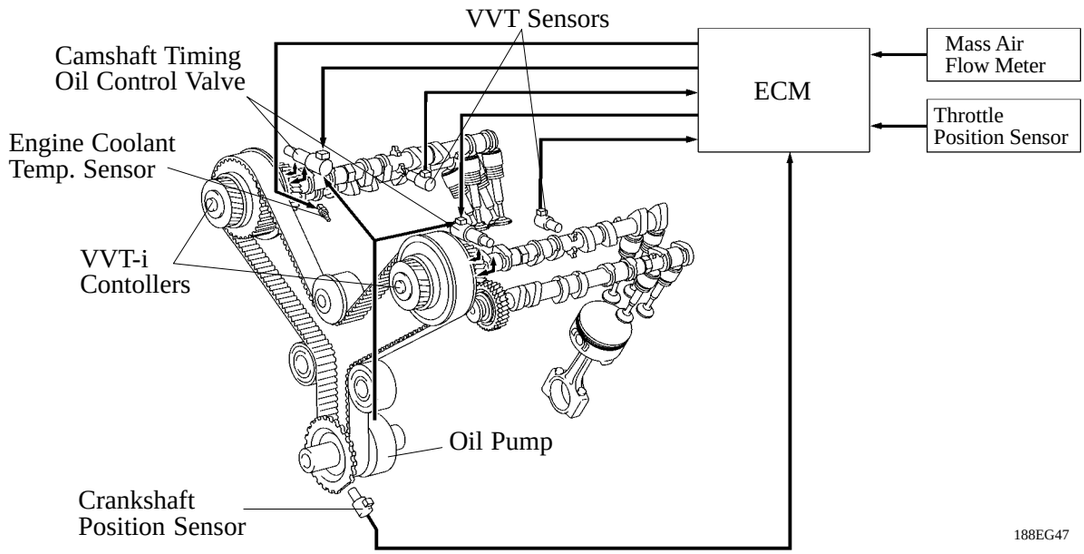
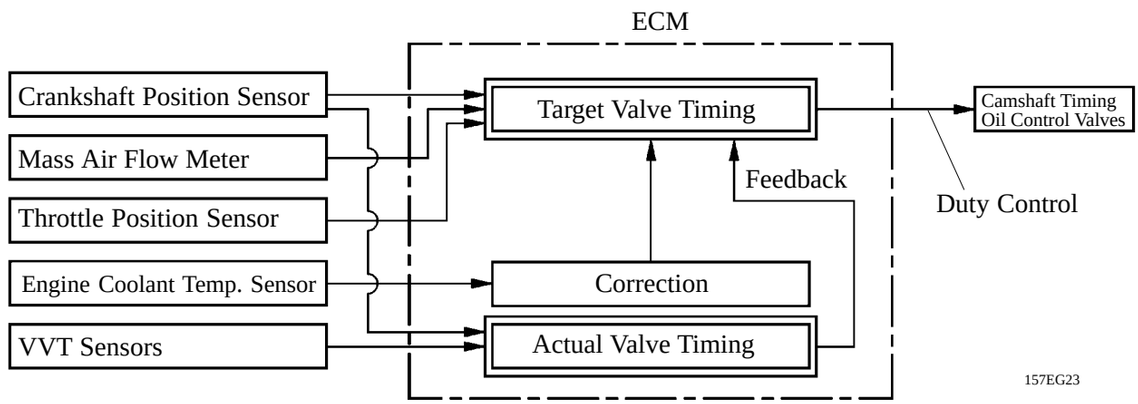
VVT-i (Variable Valve Timing-intelligent) System

1) General

The VVT-i system is designed to control the intake camshaft within a wide range of 45° (of crankshaft angle) to provide a valve timing that is optimally suited to the engine condition, thus realizing improved torque in all the speed ranges and fuel economy, and reduce exhaust emissions.

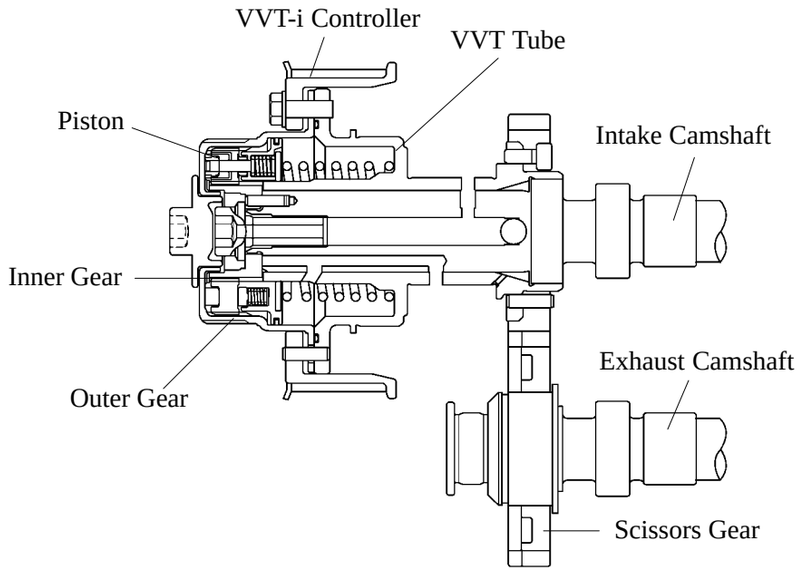




2) Construction and Operation

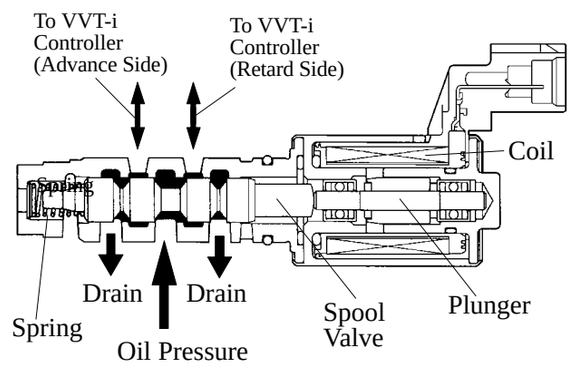
a. VVT-i Controller

The VVT-i controller comprises the outer gear that is driven by the timing belt, the inner gear that is affixed to the camshaft and a movable piston that is placed between the outer gear and inner gear. Having helical splines (twisted, vertical grooves) on its inner and outer periphery, the piston moves in the axial direction to shift the phase of the outer gear and inner gear, thus causing the valve timing to change continuously.
The VVT tube drives the exhaust camshaft via the scissors gear that is installed on the back.



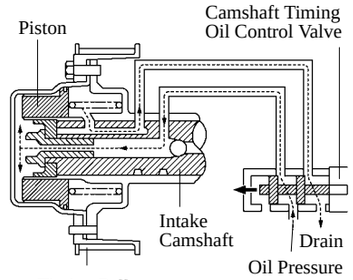
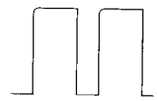
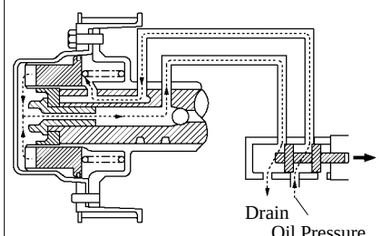
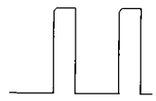
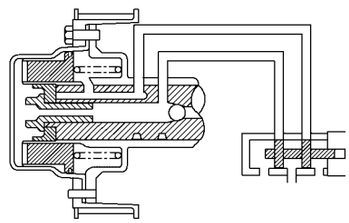
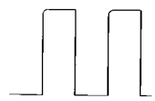
b. Camshaft Timing Oil Control Valve

The camshaft timing oil control valve controls the spool valve position in accordance with the duty control from the ECM thus allocating the hydraulic pressure that is applied to the VVT-i controller to the advance and the retard side. When the engine is stopped, the camshaft timing oil control valve is in the most retarded state.



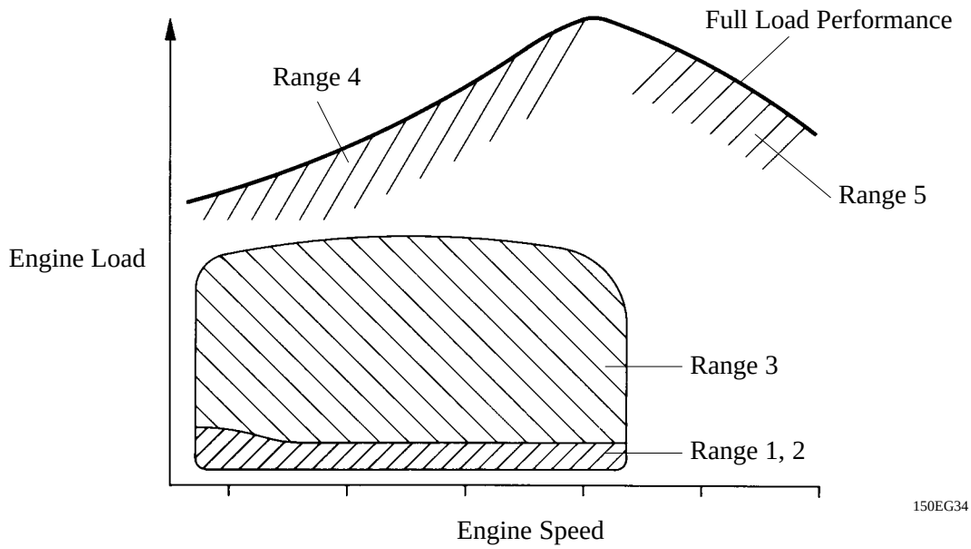
3) Operation

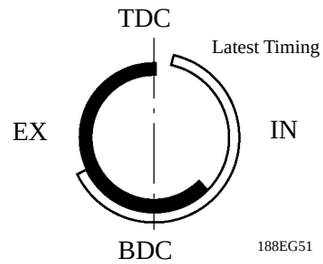
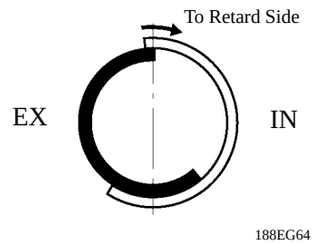
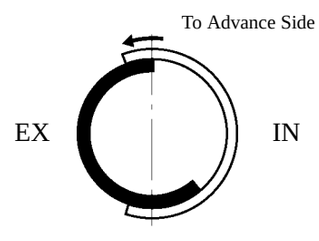
- The camshaft timing oil control valve selects the path to the VVT-i controller according to the advance, retard or hold signal from the ECM. The VVT-i controller rotates the intake camshaft in the timing advance or retard position or holds it according to the position where the oil pressure is applied.

	Operation	Camshaft Timing Oil Control Valve Drive Signal	Description
Advance	 188EG48	Advance Signal  Duty Ratio 157EG35	When the camshaft timing oil control valve is positioned as illustrated in accordance with the advance signal from the ECM, the oil pressure is applied to the chamber at the advance side. Then, the twist of the helical spline causes the camshaft to rotate in the direction of timing advance.
Retard	 188EG49	Retard Signal  Duty Ratio 157EG36	When the camshaft timing oil control valve is positioned as illustrated in accordance with the retard signal from the ECM, the oil pressure is applied to the chamber at the retard side. Then, the twist of the helical spline causes the camshaft to rotate in the direction of timing retard.
Hold	 188EG50	Hold Signal  Duty Ratio 157EG37	The ECM calculates the target timing angle according to the traveling state to perform control as described above. After setting at the target timing, the valve timing is held by keeping the camshaft timing oil control valve in the neutral position unless the traveling state changes. This adjusts the valve timing at the desired target position and prevents the engine oil from running out when it is unnecessary.

- In proportion to the engine speed, intake air volume, throttle position and water temperature, the ECM calculates an optimal valve timing under each driving condition and control the camshaft timing oil control valve. In addition, ECM uses signal from the VVT sensors and the crankshaft position sensor to detect the actual valve timing, thus performing feed back control to achieve the target valve timing.

▶ Operation During Various Driving Condition (Conceptual Diagram) ◀



Operation State	Range	Valve Timing	Objective	Effect
During Idling	1		Eliminating overlap to reduce blow back to the intake side	Stabilized idling rpm Better fuel economy
At Light Load	2		Decreasing overlap to eliminate blow back to the intake side	Ensured engine stability
At Medium load	3		Increasing overlap to increase internal EGR for pumping loss elimination	Better fuel economy Improved emission control

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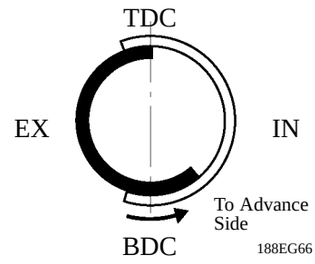
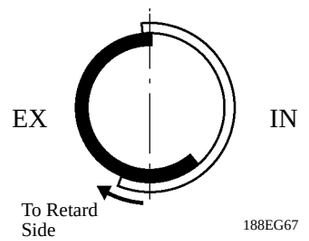
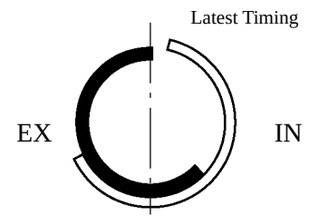
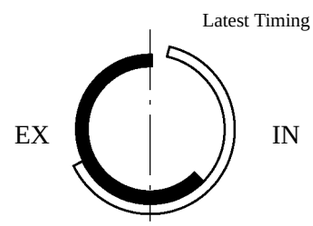
Operation State	Range	Valve Timing	Objective	Effect
In Low to Medium Speed Range with Heavy Load	4		Advancing the intake valve close timing for volumetric efficiency improvement	Improved torque in low to medium speed range
In High Speed Range with Heavy Load	5		Retarding the intake valve close timing for volumetric efficiency improvement	Improved output
At Low Temperatures	—		Eliminating overlap to prevent blow back to the intake side leads to the lean burning condition, and stabilizes the idling speed at fast idling.	Stabilized fast idle rpm Better fuel economy
Upon Starting/ Stopping the Engine	—		Eliminating overlap to minimize blow back to the intake side	Improved startability