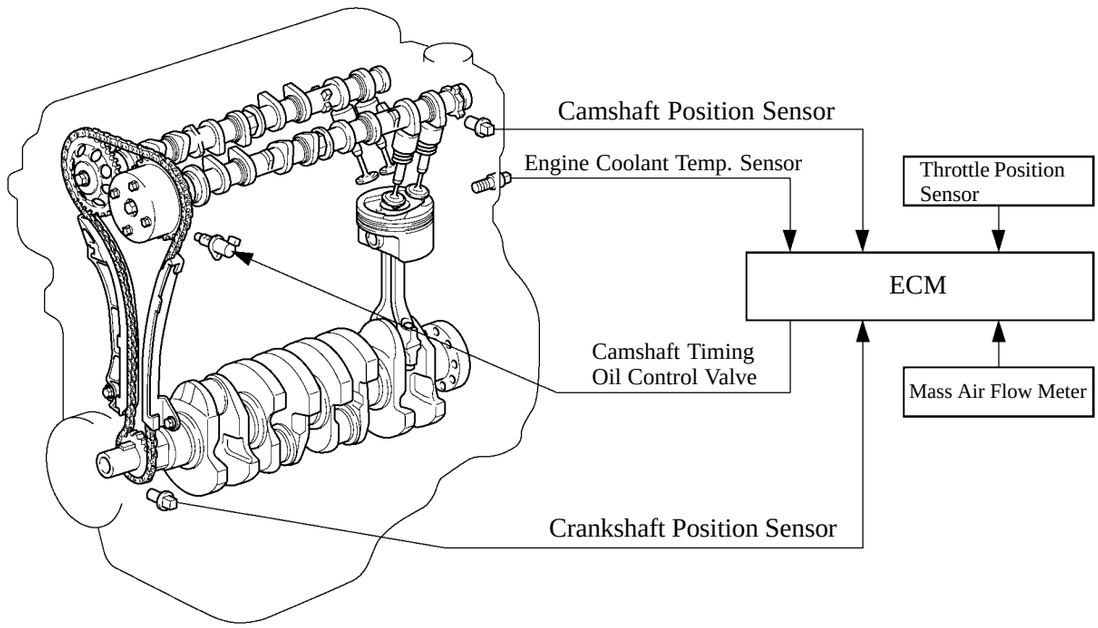
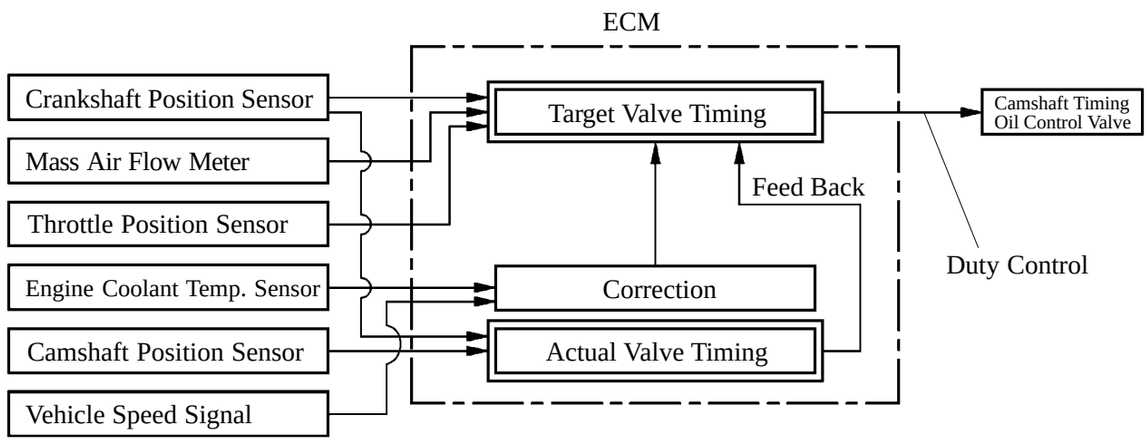
6. VVT-i (Variable Valve Timing-intelligent) System

General

This system controls the intake camshaft valve timing so as to obtain balance between the engine output, fuel consumption and emission control performance. The actual intake side valve timing is feed back by means of the camshaft position sensor for constant control to the target valve timing.



169EG35

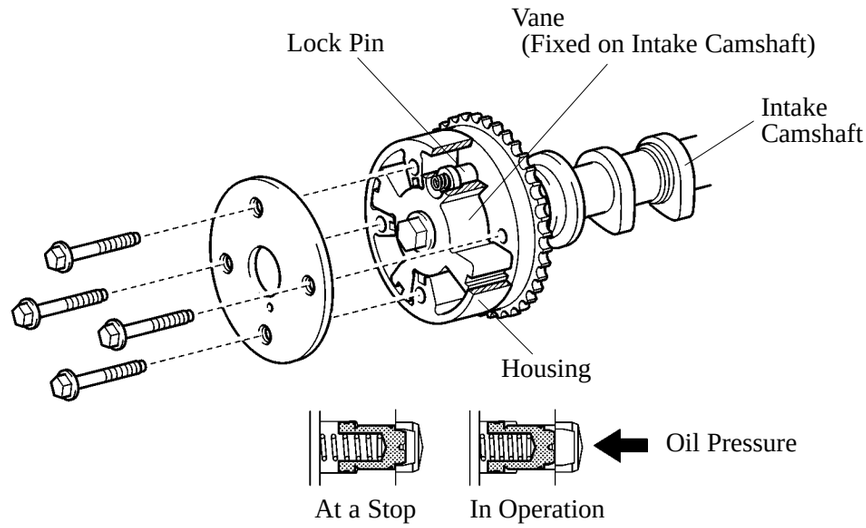


172CR07

Construction

1) VVT-i Controller

This controller consists of the housing driven from the timing chain and the vane coupled with the intake camshaft.
The oil pressure sent from the advance or retard side path at the intake camshaft causes rotation in the VVT-i controller vane circumferential direction to vary the intake valve timing continuously.
When the engine is stopped, the intake camshaft will be in the most retarded state to ensure startability.
When hydraulic pressure is not applied to the VVT-i controller immediately after the engine has been started, the lock pin locks the movement of the VVT-i controller to prevent a knocking noise.

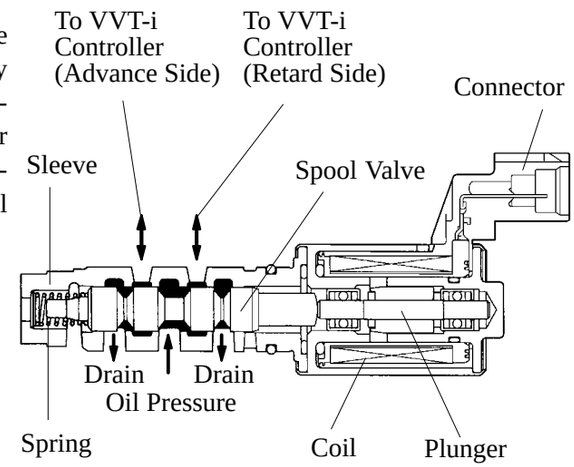


Lock Pin

169EG36

2) Camshaft Timing Oil Control Valve

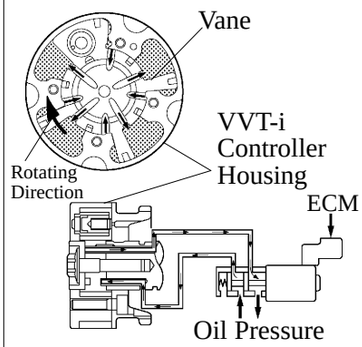
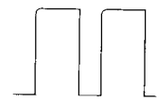
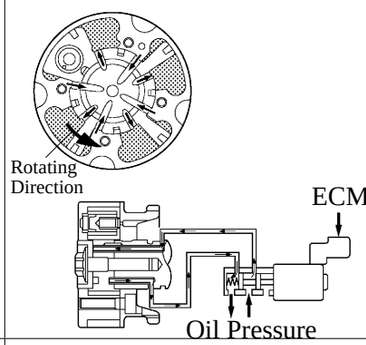
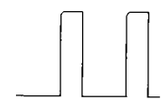
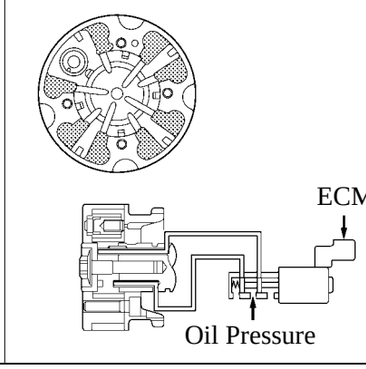
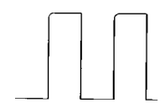
The camshaft timing oil control valve controls the spool valve position in accordance with the duty control from the ECM thus allocating the hydraulic pressure that is applied to the VVT-i controller to the advance and the retard side. When the engine is stopped, the camshaft timing oil control valve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



165EG34

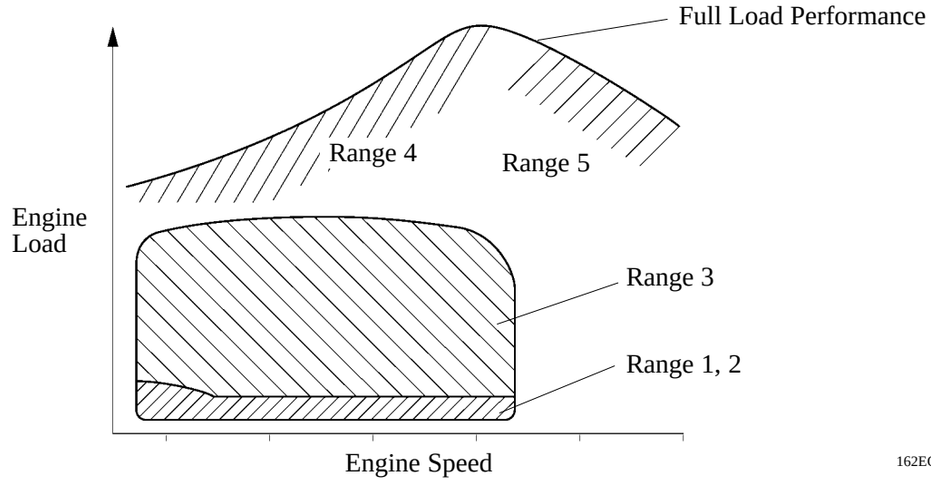
Operation

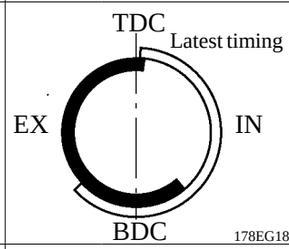
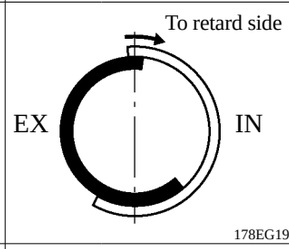
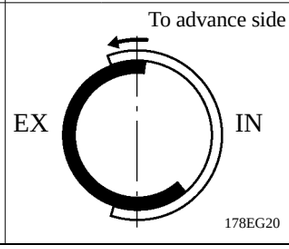
- The camshaft timing oil control valve selects the path to the VVT-i controller according to the advance, retard or hold signal from the ECM. The VVT-i controller rotates the intake camshaft in the timing advance or retard position or holds it according to the position where the oil pressure is applied.

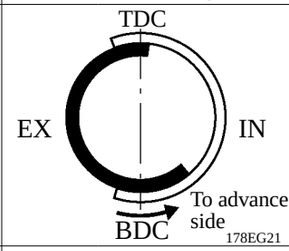
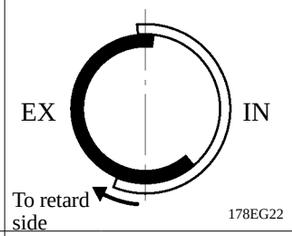
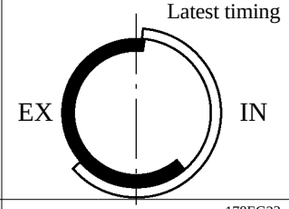
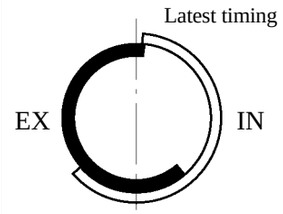
	Operation	Camshaft Timing Oil Control Valve Drive Signal	Description
Advance	 178EG15	Advance Signal  Duty Ratio 157EG35	When the camshaft timing oil control valve is positioned as illustration by the advance signal from the ECM, the resultant oil pressure is applied to the timing advance side vane chamber to rotate the camshaft in the timing advance direction.
Retard	 178EG16	Retard Signal  Duty Ratio 157EG36	When the camshaft timing oil control valve is positioned as illustration by the retard signal from the ECM, the resultant oil pressure is applied to the timing retard side vane chamber to rotate the camshaft in the timing retard direction.
Hold	 178EG17	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 camshaft position sensor 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		Minimizing 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

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	—		Minimizing overlap to prevent blow back to the intake side for reduction of fuel increase at low temperatures, and stabilizing the idling rpm for decreasing fast idle rotation	Stabilized fast idle rpm Better fuel economy
Upon Starting/ Stopping the Engine	—		Minimizing overlap to minimize blow back to the intake side	Improved startability