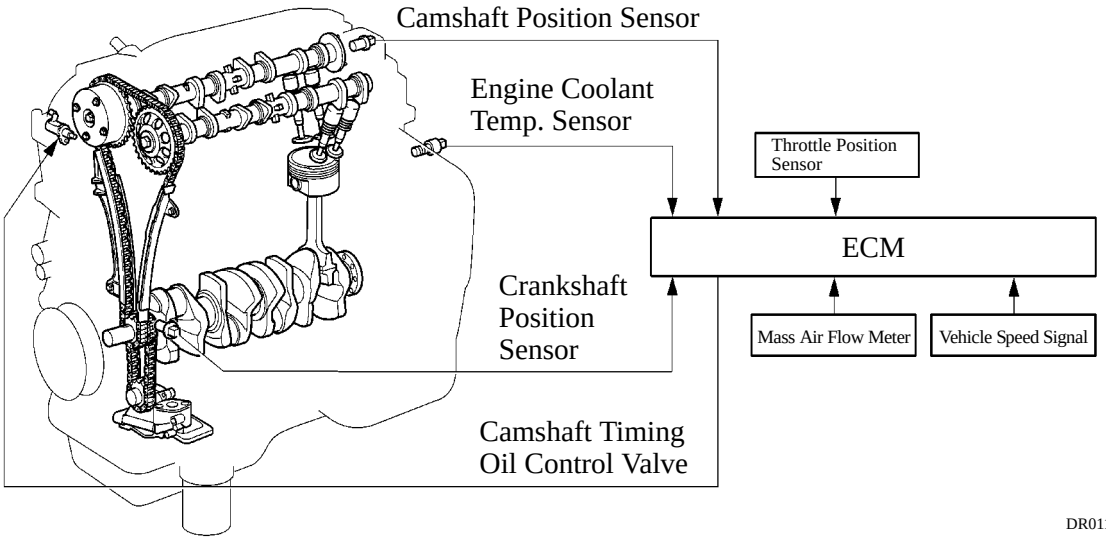
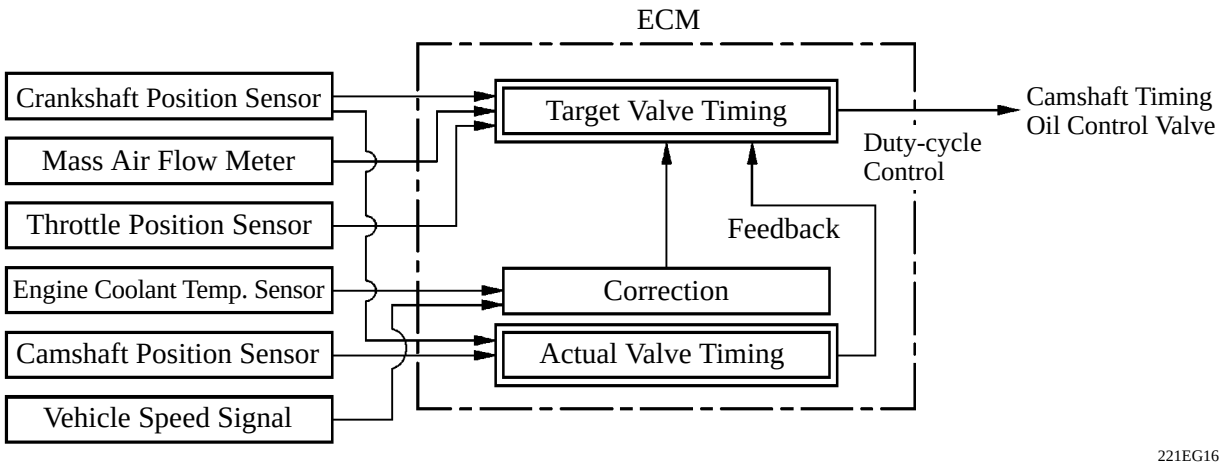
## 7. VVT-i (Variable Valve Timing-intelligent) System

### General

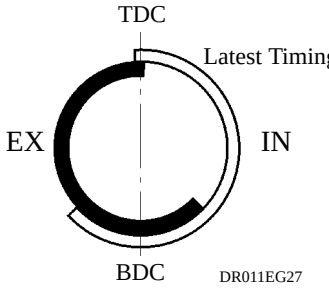
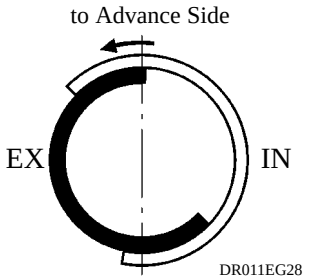
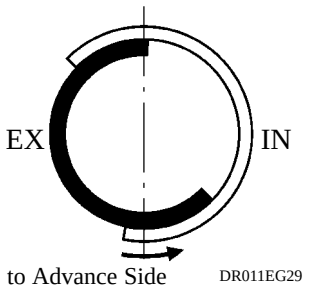
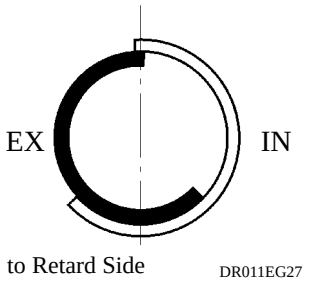
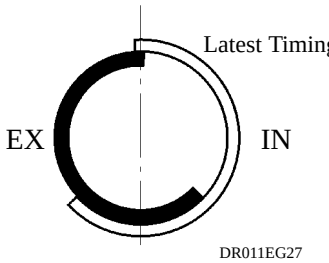
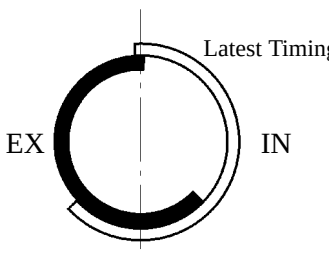
- The VVT-i system is designed to control the intake camshaft within a range of 40° (of Crankshaft Angle) to provide valve timing that is optimally suited to the engine condition. This improves torque in all the speed ranges as well as increasing fuel economy, and reducing exhaust emissions.




- Using the engine speed, intake air volume, throttle position and water temperature, the ECM can calculate optimal valve timing for each driving condition and controls the camshaft timing oil control valve. In addition, the ECM uses signals from the camshaft position sensor and the crankshaft position sensor to detect the actual valve timing, thus providing feedback control to achieve the target valve timing.



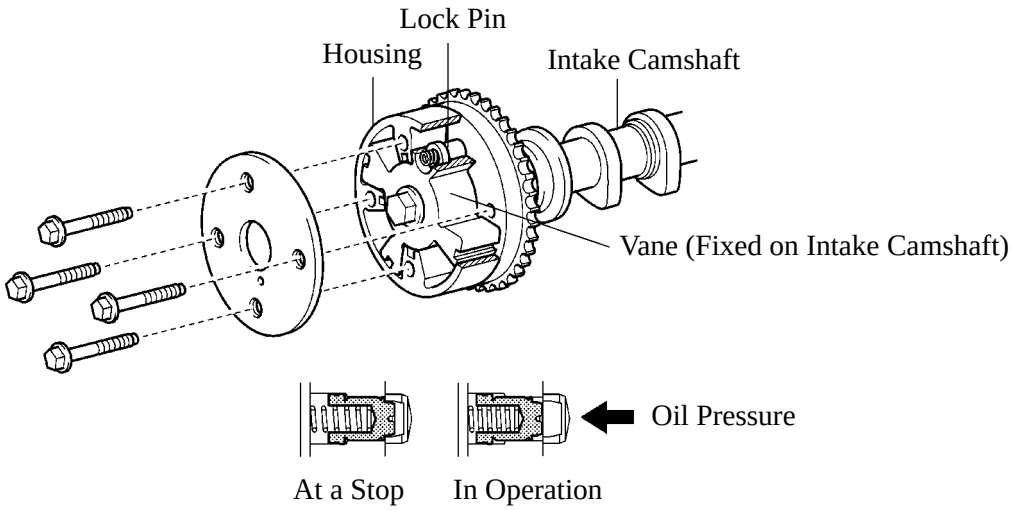
**Effectiveness of the VVT-i System**

| Operation State | Objective | Effect |
|---|---|---|
| ● During Idling<br>● At Light Load |  Minimizing overlap to prevent blow back to the intake side | ● Stabilized idling rpm<br>● Better fuel economy |
| At Medium Load |  Increasing overlap to increase internal EGR to reduce pumping loss | ● Better fuel economy<br>● Improved emission control |
| In Low to Medium Speed Range with Heavy Load |  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 |  Retarding the intake valve close timing for volumetric efficiency improvement | Improved output |
| At Low Temp. |  Minimizing overlap to prevent blow back to the intake side | ● Stabilized fast idle rpm<br>● Better fuel economy |
| ● Upon Starting<br>● Stopping the Engine |  Minimizing overlap to prevent blow back to the intake side | Improved startability |

**Construction**

**1) VVT-i Controller**

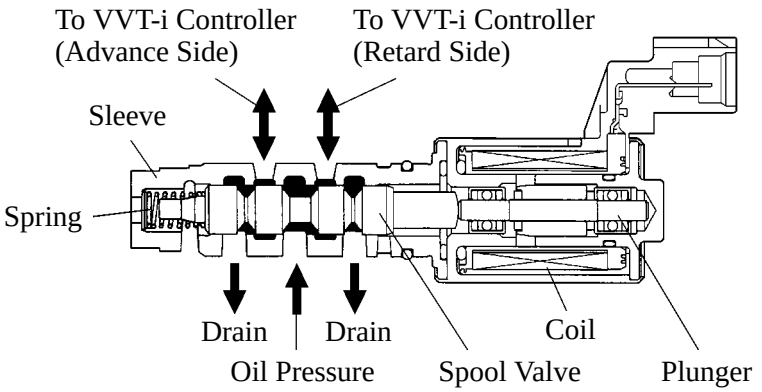
- This controller consists of the housing driven from the timing chain and the vane coupled with the intake camshaft.
- The oil pressure sent from the advance or retard side path at the intake camshaft causes rotation in the VVT-i- controller vane circumferential direction to vary the intake valve timing 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**

**2) Camshaft Timing Oil Control Valve**

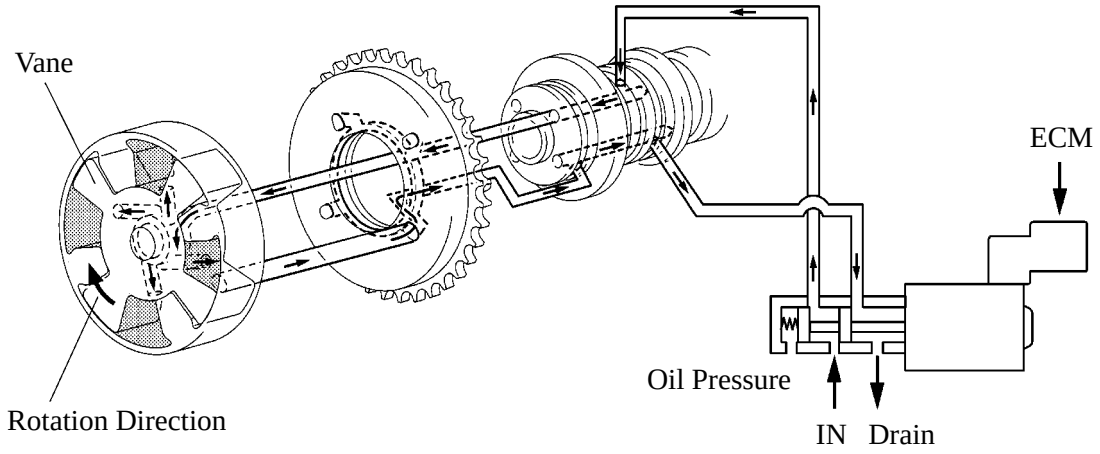
The camshaft timing oil control valve controls the spool valve position in accordance with the duty control from the ECM thus allocating the hydraulic pressure that is applied to the VVT-i controller to the advance and the retard side. When the engine is stopped, the camshaft timing oil control valve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



**Operation**

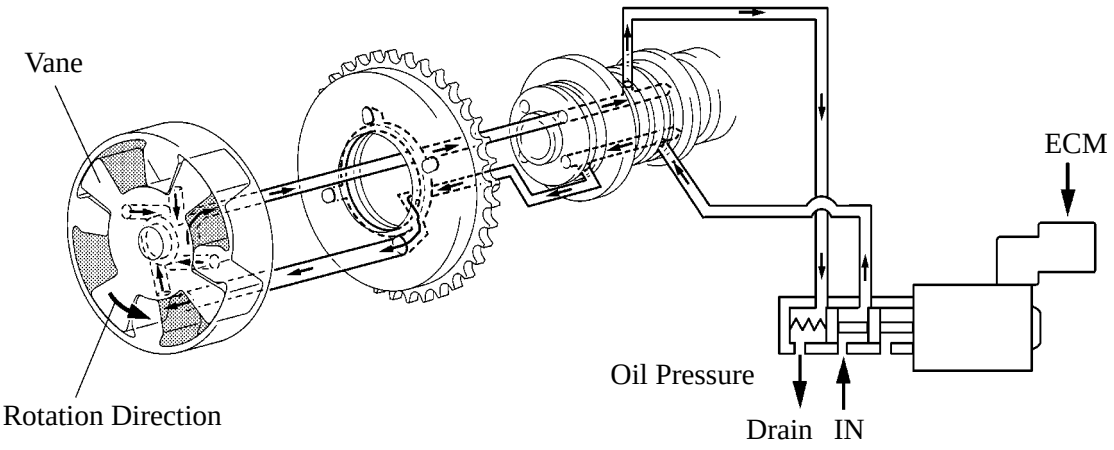
**1) Advance**

When the camshaft timing oil control valve is positioned as illustrated below 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.




**2) Retard**

When the camshaft timing oil control valve is positioned as illustrated below 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.




**3) Hold**

After reaching 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.