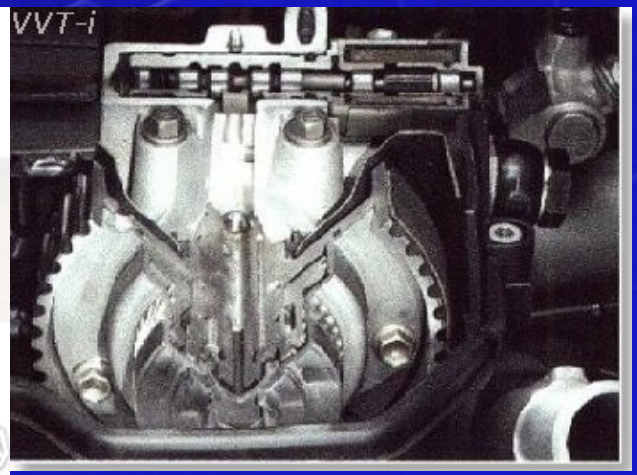
VARIABLE VALVE TIMING INTELLIGENT SYSTEM



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WHAT IS VVT ?

- Variable Valve Timing (VVT) ,is a generic term for an automobile piston engine technology
- VVT allows the lift or duration or timing (some or all) of the intake or exhaust valves (or both) to be changed while the engine is in operation
- Two stroke engines use a power valve system to get similar results to VVT.

HISTORY

- The earliest variable valve timing systems came into existence in the nineteenth century on steam engines. Stephenson valve gear, as used on early steam locomotives supported variable cutoff, that is, changes to the time at which the admission of steam to the cylinders is cut off during the power stroke. Early approaches to variable cutoff coupled variations in admission cutoff with variations in exhaust cutoff. Admission and exhaust cutoff were decoupled with the development of the Corliss valve. These were widely used in constant speed variable load stationary engines, with admission cutoff, and therefore torque, mechanically controlled by a centrifugal governor. As poppet valves came into use, simplified valve gear using a camshaft came into use. With such engines, variable cutoff could be achieved with variable profile cams that were shifted along the camshaft by the governor.
- The earliest Variable valve timing systems on internal combustion engines were on the Lycoming R-7755 hyper engine, which had cam profiles that were selectable by the pilot. This allowed the pilot to choose full take off and pursuit power or economical cruising speed, depending on what was needed.

WHAT IS VVT-i

- The VVT-i system is designed to control the intake camshaft with in a range of 50°(of Crankshaft Angle) to provide valve timing i.e. optimally suited to the engine condition .This improves the torque in all the speed ranges as well as fuel economy ,and reducing exhaust emissions.
- This system controls the intake camshaft valve timing so as to obtain balance between the engine output, fuel consumption & 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.

CONSTRUCTION

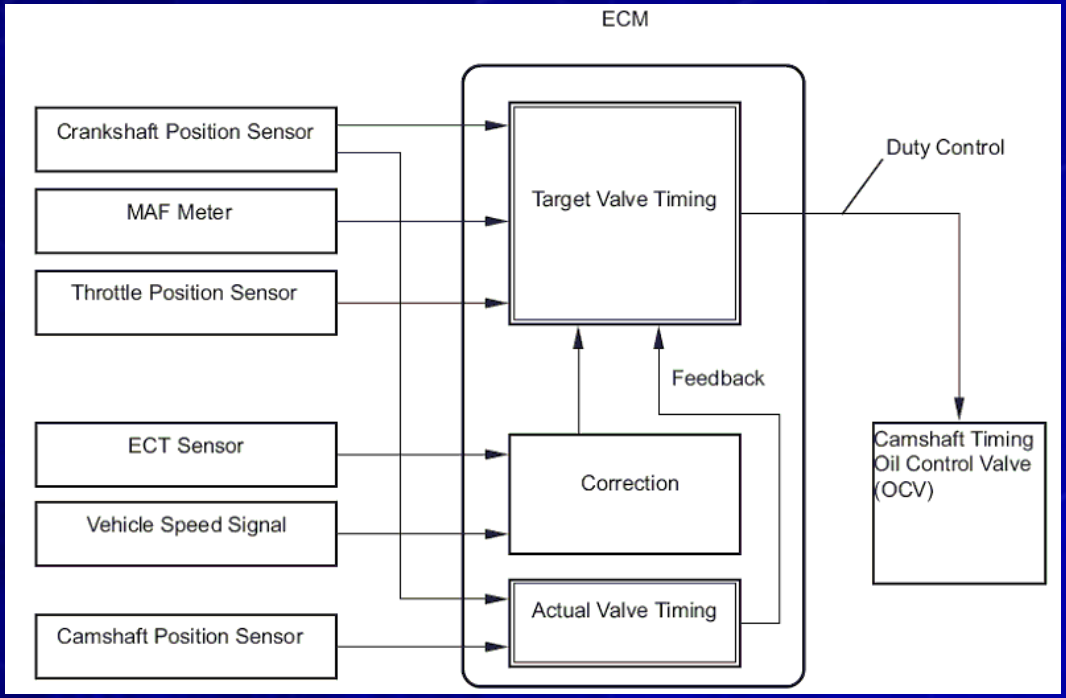
The Variable Valve Timing (VVT) system includes

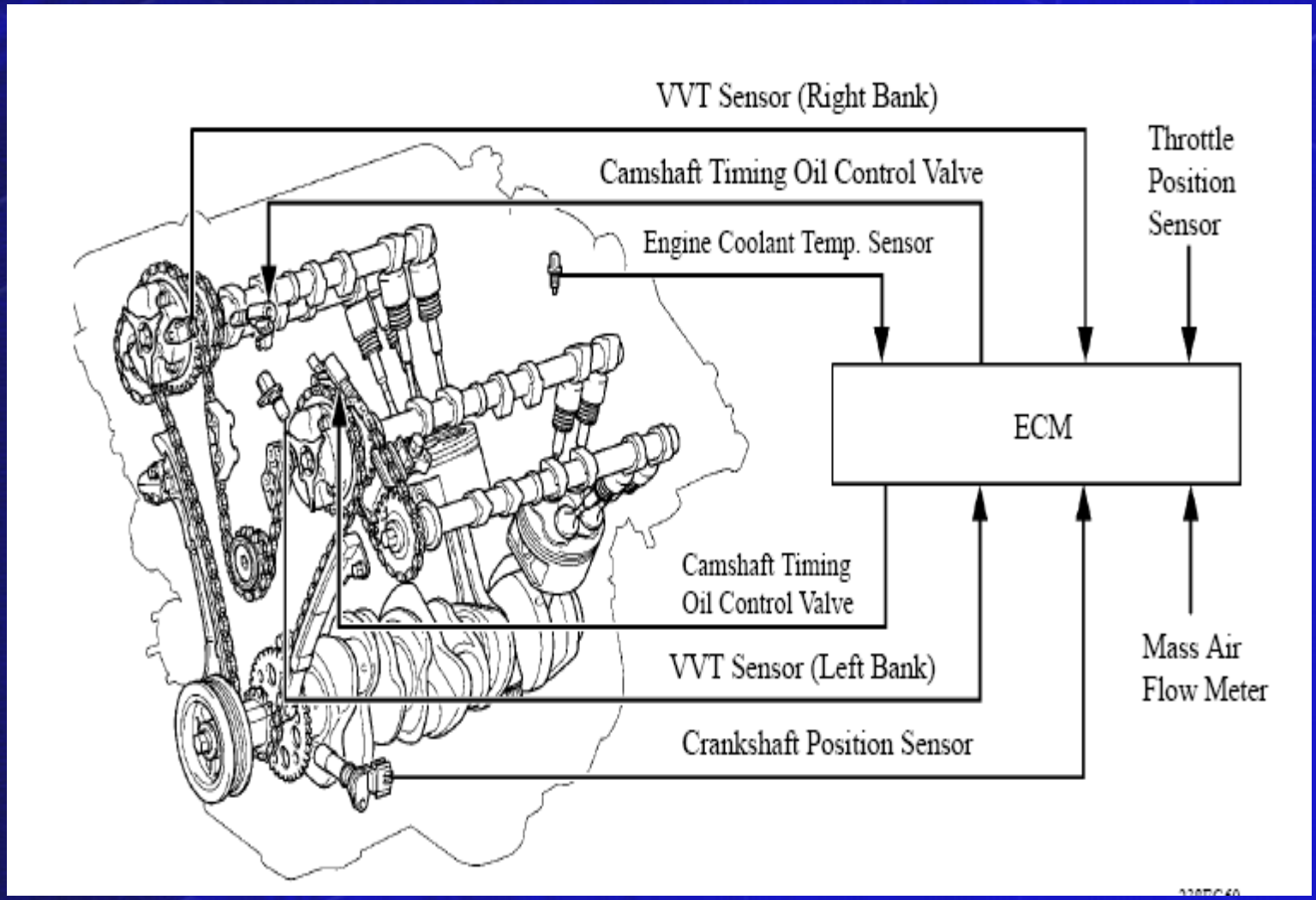
- ECM
- OCV
- VVT controller

- The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. Camshaft timing control is performed according to engine operating conditions such as the intake air volume, throttle valve position and engine coolant temperature.

- The ECM controls the OCV, based on the signals transmitted by several sensors. The VVT controller regulates the intake camshaft angle using oil pressure through the OCV. As a result, the relative positions of the camshaft and crankshaft are optimized, the engine torque and fuel economy improve, and the exhaust emissions decrease under overall driving conditions. The ECM detects the actual intake valve timing using signals from the camshaft and crankshaft position sensors, and performs feedback control. This is how the target intake valve timing is verified by the ECM.

•The ECM optimizes the valve timing using the VVT system to control the intake camshaft. The VVT system includes the ECM, the OCV and the VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. The VVT controller can advance or retard the intake camshaft.

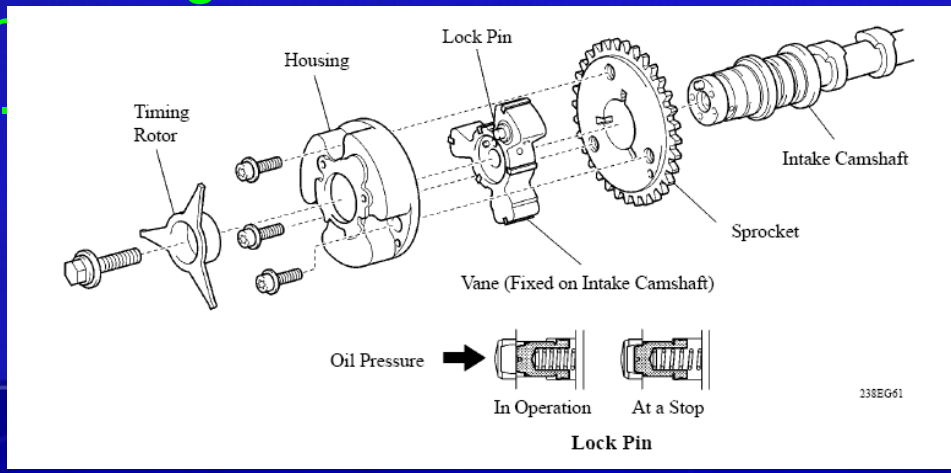



VVT Sensor (Right Bank)
Throttle Position Sensor
Camshaft Timing Oil Control Valve
Engine Coolant Temp. Sensor
ECM
Camshaft Timing Oil Control Valve
VVT Sensor (Left Bank)
Mass Air Flow Meter
Crankshaft Position Sensor

1.VVT-i Controller

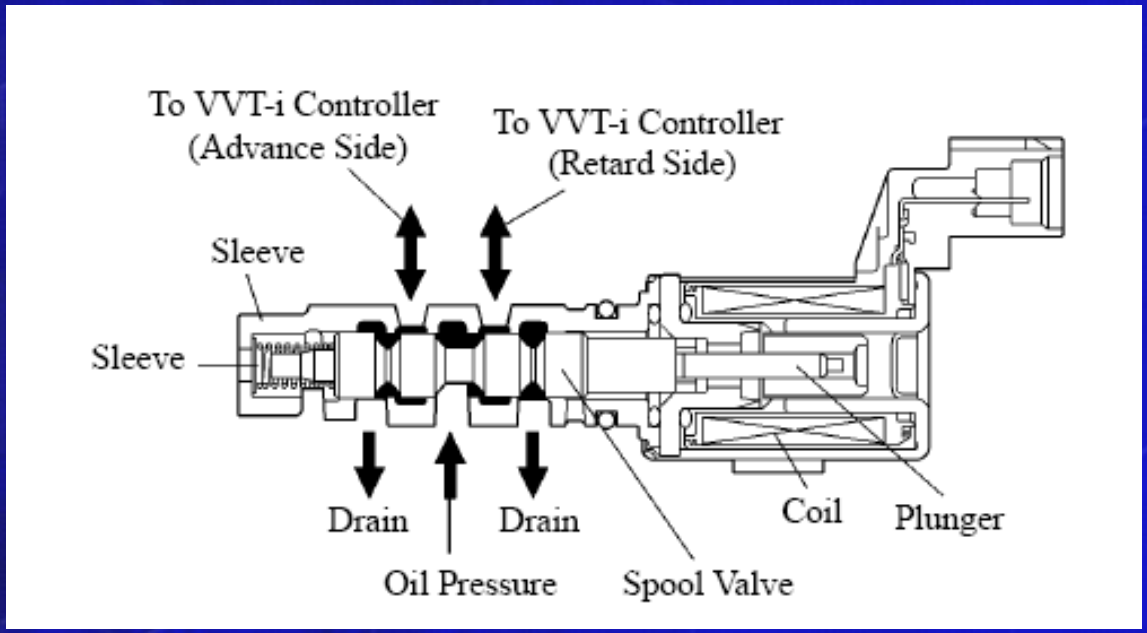
- It consist of the housing driven from the timing chain & the vane coupled with the intake camshaft.
- The oil pressure sent from the advance or retard side path at the intake camshaft causes rotation in the VVT-i controller vane circumferential direction to vary the intake valve timing continuously.

- When the engine is stopped the intake camshaft will be in the most retard state to ensure start ability.
- When hydraulic pressure is not applied to the VVT-i controller immediately after the engine has been started, the lock pin locks the mover
ng noise.



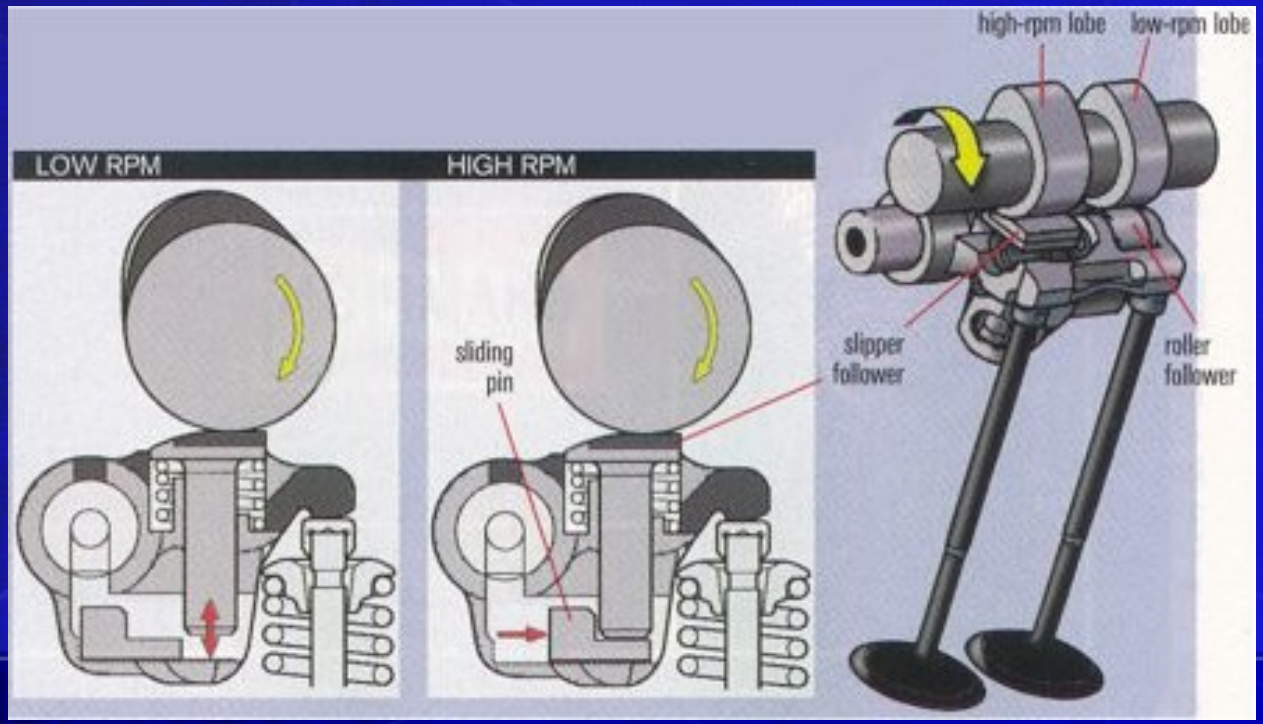
2.Camshaft Timing Oil Control valve

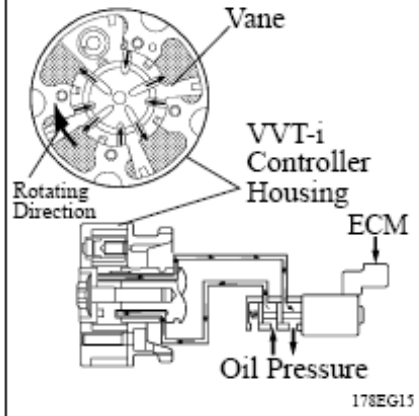
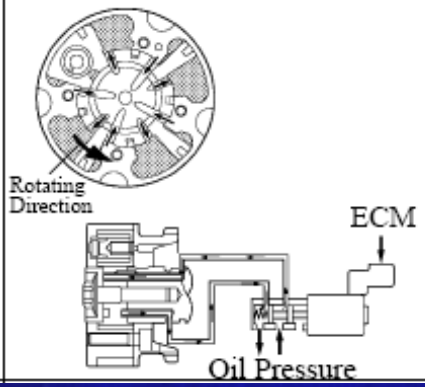
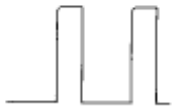
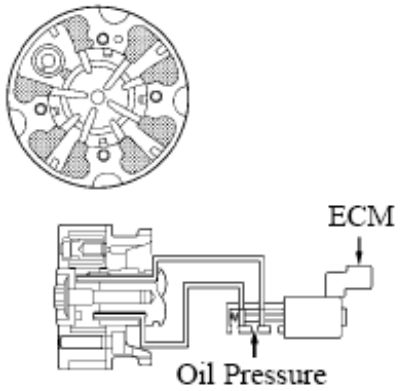
- The camshaft timing oil control valve controls the spool valve position in accordance with the duty-cycle control from the ECM.This allows the hydraulic pressure to be applied to the VVT-i controller advance or retard side



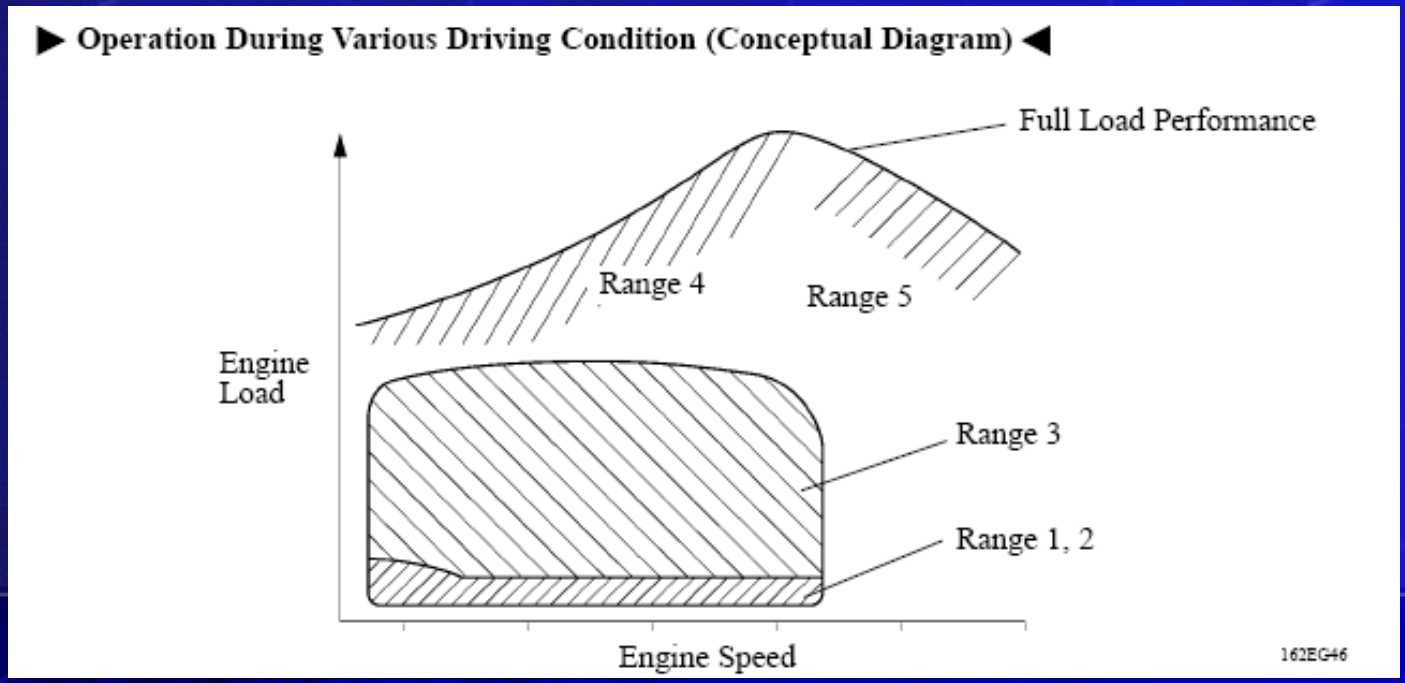
OPERATION

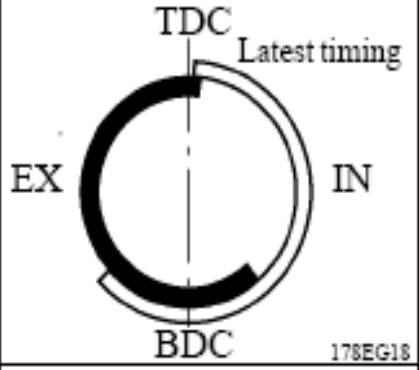
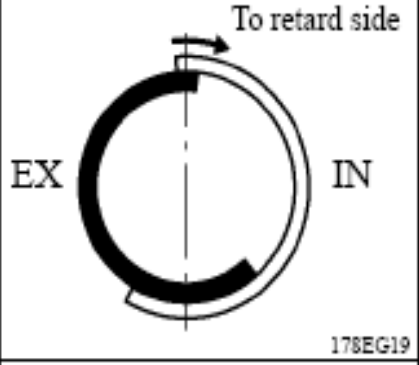
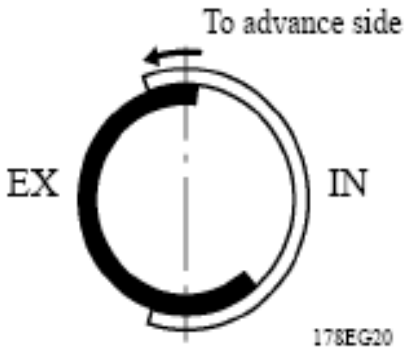
- The camshaft timing oil control valve selects the path according to the advance, retard or hold signal from the ECM.The VVT-i controller rotates the intake camshaft in the timing advance or retard position or holds it according to the position where the oil pressure is applied.

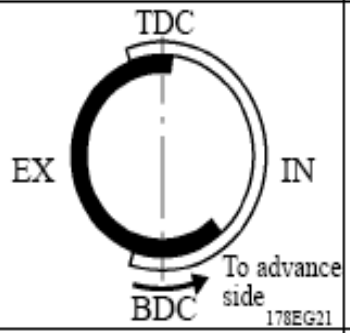
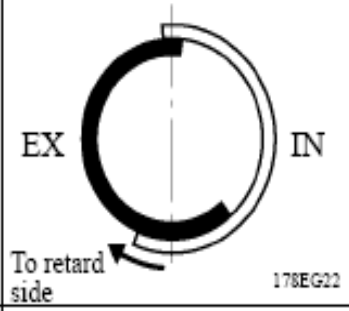
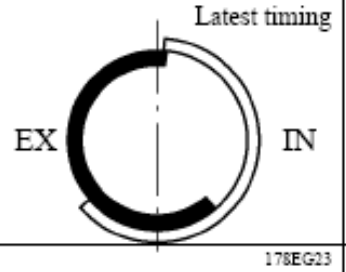
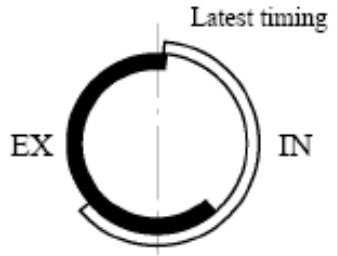


	Operation	Camshaft Timing Oil Control Valve Drive Signal	Description
Advance		Advance Signal  Duty Ratio 157EG35	When the camshaft timing oil control valve is positioned as illustration by the advance signal from the ECM, the resultant oil pressure is applied to the timing advance side vane chamber to rotate the camshaft in the timing advance direction.
Retard		Retard Signal  Duty Ratio	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	178EG16 	157EG36 Hold Signal  Duty Ratio	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 optimal valve timing under each driving condition & controls the camshaft timing oil control valve. In addition ECM uses signal from the camshaft position sensor & the crankshaft position sensor to detect the actual valve timing, thus performing feedback control to achieve the target valve timing



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

ADVANTAGES of vvt-i

- Improved torque & output
- Battery & fuel economy
- Reduced nitrogen oxide & hydrocarbon emissions

Applications of VVT-i

Toyota

VVT - Toyota 4A-GE 20-Valve engine introduced VVT in the 1992 Corolla GT-versions.

VVT-i - Continuously varies the timing of the intake camshaft, or both the intake and exhaust camshafts (depending on application).

VVTL-i - Continuously varies the timing of the intake valves. Varies duration, timing and lift of the intake and exhaust valves by switching between two different sets of cam lobes

THANK YOU