

Variable Camshaft Timing (VCT) System**Overview**

The VCT system enables rotation of the camshafts relative to the crankshaft rotation as a function of engine operating conditions. There are 4 types of VCT systems.

- Exhaust phase shifting (EPS) - the exhaust cam is the active cam being retarded.
- Intake phase shifting (IPS) - the intake cam is the active cam being advanced.
- Dual equal phase shifting (DEPS) - both intake and exhaust cams are phase shifted and equally advanced or retarded.
- Twin independent phase shifting - where both the intake and exhaust cams are shifted independently.

All systems have 4 operational modes: idle, part throttle, wide open throttle (WOT), and default mode. At idle and low engine speeds with closed throttle, the powertrain control module (PCM) determines the phase angle based on airflow, engine oil temperature and engine coolant temperature. At part and wide open throttle the PCM determines the phase angle based on engine RPM, load, and throttle position. VCT systems provide reduced emissions and enhanced engine power, fuel economy and idle quality. IPS systems also have the added benefit of improved torque. In addition, some VCT system applications can eliminate the need for an external exhaust gas recirculation (EGR) system. The elimination of the EGR system is accomplished by controlling the overlap time between the intake valve opening and exhaust valve closing.

The VCT system knocking and noise concerns are diagnosed in the Workshop Manual. For additional information, refer to the Workshop Manual Section 303-00, Engine System — General Information. Verification of incorrect VCT phasing on a warm engine operating below 1500 RPM can be isolated using a stethoscope and by monitoring the PIDs using a scan tool. If the VCT phaser does not maintain correct valve timing, low oil pressure or oil flow restrictions are primary possible causes. Verify correct oil pressure and flow, refer to the Workshop Manual Section 303-00, Engine System — General Information.

PID	Description
VCTADV, VCTADV2, VCT_INT_ACT1, VCT_EXH_ACT1, VCT_INT_ACT2 and VCT_EXH_ACT2	Monitors the VCT advance and displays the advance angle in degrees. The actual camshaft position is measured using the camshaft position (CMP) sensor.
VCT1_F, VCT2_F, VCT1_INTK_F, VCT1_EXH_F, VCT2_INTK_F and VCT2_EXH_F	Displays FAULT or NO FAULT to indicate a VCT related concern is detected. The CMP circuit DTCs cause the VCT advance to default to 0. Correct any CMP DTCs prior to diagnosing engine timing or VCT DTCs.
VCTADVERR, VCTADVERR2, VCT_INTK_DIFF1, VCT_EXH_DIFF1, VCT_INTK_DIFF2 and VCT_EXH_DIFF2	Displays the error in VCT advance. The CMP signal is used to determine the difference between the actual camshaft position and the camshaft advance requested. The difference is displayed as a percentage that ranges from -5 to +5%. When the accelerator pedal is cycled this may range as high as 20%.
VCTDC, VCTDC2, VCT_INTK_DC1, VCT_EXH_DC1, VCT_INTK_DC2 and VCT_EXH_DC2	Variable camshaft timing duty cycle ranges from 0 to 100%. The PCM controls the VCT solenoid operation through the duty cycled ground.
VCTSUS	Variable camshaft timing system displays whether the engine is in open or closed loop. In open loop, the PCM defaults the VCT system to OFF (0% duty cycle). In closed loop, the PCM turns the VCT system to ON (varies the VCT duty cycle). If a VCT DTC is detected, the VCT system defaults to open loop operation.

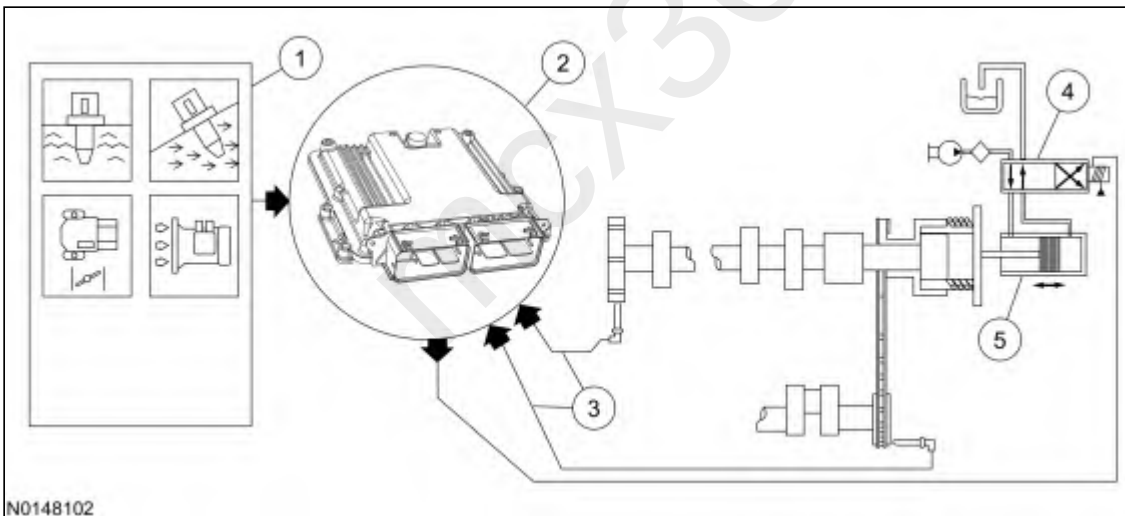
VCT System

The VCT system consists of an electric hydraulic positioning control solenoid, a camshaft position (CMP) sensor, and a trigger wheel. The CMP sensor trigger wheel indicates the camshaft position signal for that bank. A crankshaft position (CKP) sensor provides the PCM with crankshaft positioning information in 10 degree increments.

1. The PCM receives input signals from the intake air temperature (IAT), engine coolant temperature (ECT), CMP, throttle position (TP), mass airflow (MAF) (if equipped), and CKP sensors to determine the operating conditions of the engine. At idle and low engine speeds with closed throttle, the PCM controls the camshaft position based on engine coolant temperature, engine oil temperature, intake air temperature, and mass airflow. During part and wide open throttle, the camshaft position is determined by engine RPM, load and throttle position. The VCT system does not operate until the engine is at normal operating temperature.
2. The VCT system is enabled by the PCM when the correct conditions are met.
3. The CKP signal is used as a reference for camshaft positioning.
4. The VCT solenoid valve is an integral part of the VCT system. The solenoid valve controls the flow of engine oil in the VCT actuator assembly. As the PCM controls the duty cycle of the solenoid valve, oil pressure/flow advances or retards the cam timing. Duty cycles near 0% or 100% represent rapid movement of the camshaft. Retaining a fixed camshaft position is accomplished by dithering (oscillating) the solenoid valve duty cycle.

The PCM calculates and determines the desired camshaft position. It continually updates the VCT solenoid duty cycle until the desired position is achieved. A difference between the desired and actual camshaft position represents a position error in the PCM VCT control loop. The PCM disables the VCT and places the camshaft in a default position if a concern is detected. A related DTC also sets when the concern is detected.

5. When the VCT solenoid is energized, engine oil is allowed to flow to the VCT actuator assembly which advances or retards the camshaft timing. One half of the VCT actuator is coupled to the camshaft and the other half is connected to the timing chain. Oil chambers between the 2 halves couple the camshaft to the timing chain. When the flow of oil is shifted from one side of the chamber to the other, the differential change in oil pressure forces the camshaft to rotate in either an advance or retard position depending on the oil flow.



VCT System

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