DTC	P0011	Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 1)

DTC	P0012	Camshaft Position "A" - Timing Over-Retarded (Bank 1)

DTC	P0021	Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 2)

DTC	P0022	Camshaft Position "A" - Timing Over-Retarded (Bank 2)

HINT:
If DTC P0011, P0012, P0021 or P0022 is present, check the VVT (Variable Valve Timing) system.

DESCRIPTION

Refer to DTC P0010 (See page ES-66).

DTC No.	DTC Detection Conditions	Trouble Areas
P0011 P0021	Advanced cam timing: With warm engine and engine speed of between 500 rpm and 4,000 rpm, all conditions (a), (b) and (c) met (1 trip detection logic) (a) Difference between target and actual intake valve timings more than 5°CA (Crankshaft Angle) for 4.5 seconds (b) Current intake valve timing fixed (timing changes less than 5°CA in 5 seconds) (c) Variations in VVT controller timing more than 19°CA of maximum delayed timing (advanced)	• Valve timing • Oil control valve (OCV) • OCV filter • Camshaft timing gear assembly • ECM
P0012 P0022	Retarded cam timing: With warm engine and engine speed of between 500 rpm and 4,000 rpm, all conditions (a), (b) and (c) met (2 trip detection logic) (a) Difference between target and actual intake valve timings more than 5°CA (Crankshaft Angle) for 4.5 seconds (b) Current intake valve timing fixed (timing changes less than 5°CA in 5 seconds) (c) Variations in VVT controller timing 19°CA or less of maximum delayed timing (retarded)	

MONITOR DESCRIPTION

The ECM optimizes the intake valve timing using the VVT (Variable Valve Timing) system to control the intake camshaft. The VVT system includes the ECM, the Oil Control Valve (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. If the difference between the target and actual intake valve timings is large, and changes in actual intake valve timing are small, the ECM interprets this as the VVT controller stuck malfunction and sets a DTC.
Example:
A DTC is set when the following conditions 1), 2) and 3) are met:
1) The difference between the target and actual intake valve timings is more than 5°CA (Crankshaft Angle) and the condition continues for more than 4.5 seconds.
2) It takes 5 seconds or more to change the valve timing by 5°CA.
3) After above conditions 1) and 2) are met, the OCV is forcibly activated 63 times or more.
DTCs P0011 and P0021 (Advanced Cam Timing) are subject to 1 trip detection logic.

DTCs P0012 and P0022 (Retarded Cam Timing) are subject to 2 trip detection logic.
These DTCs indicate that the VVT controller cannot operate properly due to OCV malfunctions or the presence of foreign objects in the OCV.
The monitor will not run unless the following conditions are met:

- The engine is warm (the engine coolant temperature is 75°C [167°F] or more).
- The vehicle has been driven at more than 40 mph (64 km/h) for 3 minutes.
- The engine has idled for 3 minutes.

MONITOR STRATEGY

Related DTCs	P0011: Advanced camshaft timing (bank 1) P0012: Retard camshaft timing (bank 1) P0021: Advanced camshaft timing (bank 2) P0022: Retard camshaft timing (bank 2)
Required Sensors/Components (Main)	VVT OCV and VVT Actuator
Required Sensors/Components (Related)	Crankshaft position sensor, Camshaft position sensor and Engine coolant temperature sensor
Frequency of Operation	Once per driving cycle
Duration	Within 10 seconds
MIL Operation	P0011 and P0021: Immediate P0012 and P0022: 2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs not present	P0100 - P0103 (MAF sensor) P0115 - P0118 (ECT sensor) P0125 (Insufficient ECT for closed loop) P0335 (CKP sensor) P0340 (CMP sensor) P0351 - P0356 (igniter)
Battery voltage	11 V or more
Throttle position learning	Completed
Engine RPM	500 to 4,000 rpm
Engine coolant temperature	75 to 100°C (167 to 212°F)

TYPICAL MALFUNCTION THRESHOLDS

OCV activation	9.5 seconds or more
Response of valve timing	1 sec/°CA or more (valve timing does not change)

If the difference between the target and actual camshaft timings is greater than the specified value, the ECM operates the VVT actuator.
Then, the ECM monitors the camshaft timing change for 5 seconds.

WIRING DIAGRAM

Refer to DTC P0010 (See page ES-68).

HINT:

Abnormal bank	Advanced timing over (Valve timing is out of specified range)	Retarded timing over (Valve timing is out of specified range)
Bank 1	P0011	P0012
Bank 2	P0021	P0022

- If DTC P0011 or P0012 is displayed, check the bank 1 VVT system circuit.
- Bank 1 refers to the bank that includes cylinder No. 1.

- If DTC P0021 or P0022 is displayed, check the bank 2 VVT system circuit.
- Bank 2 refers to the bank that does not include cylinder No. 1.
- Read freeze frame data using an intelligent tester. Freeze frame data record the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data, from the time the malfunction occurred.

1	CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0011, P0012, P0021 OR P0022)

(a) Connect an intelligent tester to the DLC3.
(b) Turn the ignition switch ON and turn the tester ON.
(c) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(d) Read DTCs.

Result

Display (DTC Output)	Proceed to
P0011, P0012, P0021 or P0022	A
P0011, P0012, P0021 or P0022 and other DTCs	B

HINT:
If any DTCs other than P0011, P0012, P0021 or P0022 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART

A

2	PREFORM ACTIVE TEST USING INTELLIGENT TESTER (OPERATE OCV)

(a) Connect an intelligent tester to the DLC3.
(b) Start the engine and turn the tester ON.
(c) Warm up the engine.
(d) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / VVT CTRL B1.
(e) Check the engine speed while operating the Oil Control Valve (OCV) using the tester.

OK

Tester Operations	Specified Conditions
OCV OFF	Normal engine speed
OCV ON	Engine idles roughly or stalls (soon after OCV switched from OFF to ON)

NG → Go to step 4

OK

3	CHECK WHETHER DTC OUTPUT RECURS (DTC P0011, P0012, P0021 OR P0022)

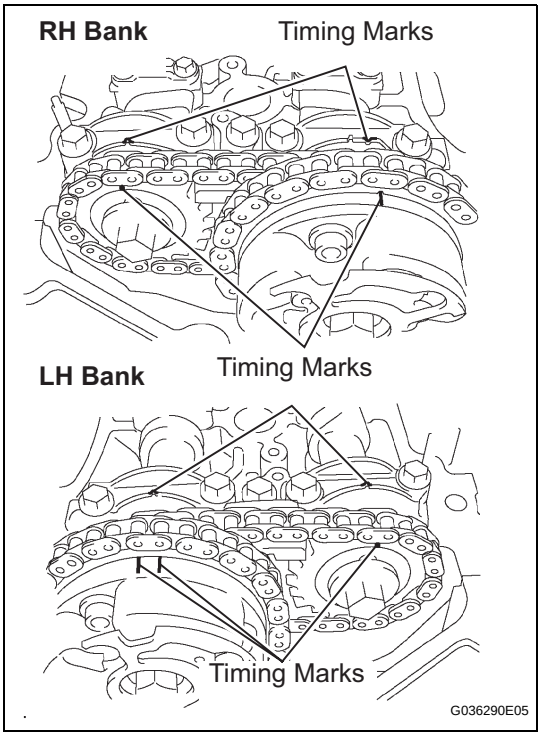
(a) Connect an intelligent tester to the DLC3.
(b) Turn the ignition switch ON and turn the tester ON.
(c) Clear DTCs (See page ES-38).
(d) Start the engine and warm it up.

(e) Switch the ECM from normal mode to check mode using the tester (See page ES-41).
(f) Drive the vehicle for more than 10 minutes.
(g) Read DTCs using the tester.
OK:
No DTC output.

OK → **END**

NG

4 CHECK VALVE TIMING (CHECK FOR LOOSE AND JUMPED TEETH ON TIMING CHAIN)

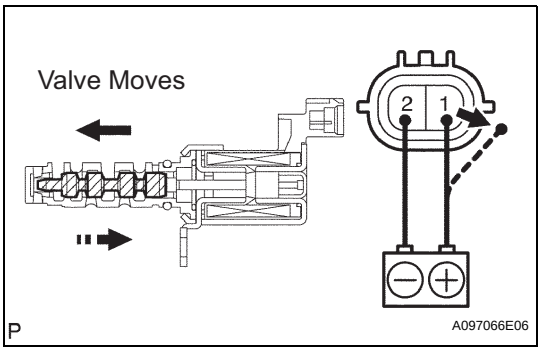


(a) Remove the cylinder head cover (See page EM-57 or EM-74).
(b) Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.
(c) Check that the timing marks of the camshaft timing gears are aligned with the timing marks of the bearing cap as shown in the illustration.
If not, turn the crankshaft 1 revolution (360°), then align the marks as above.
OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.
(d) Reinstall the cylinder head cover (See page EM-57 or EM-74).

NG → **ADJUST VALVE TIMING**

OK

5 INSPECT CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY (OCV)



(a) Remove the OCV.
(b) Measure the resistance between the terminals of the OCV.
Standard resistance:
6.9 to 7.9 Ω at 20°C (68°F)
(c) Apply the positive battery voltage to terminal 1 and negative battery voltage to terminal 2. Check the valve operation.
OK:
Valve moves quickly.
(d) Reinstall the OCV.

NG → **REPLACE CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY**

OK

6	INSPECT OIL CONTROL VALVE FILTER

OK:
Filter is not clogged.

NG → **CLEAN OIL CONTROL VALVE FILTER**

OK

7	REPLACE CAMSHAFT TIMING GEAR ASSEMBLY

ES

NEXT

8	CHECK IF DTC OUTPUT RECURS

(a) Connect an intelligent tester to the DLC3.
(b) Turn the ignition switch ON and turn the tester ON.
(c) Clear DTCs (See page ES-38).
(d) Start the engine and warm it up.
(e) Switch the ECM from normal mode to check mode using the tester (See page ES-41).
(f) Drive the vehicle for more than 10 minutes.
(g) Confirm that no DTC is set using the tester.
Standard:
No DTC output.
HINT:
DTC P0011, P0012, P0021 or P0022 is output when foreign objects in engine oil are caught in some parts of the system. These codes will stay registered even if the system returns to normal after a short time. These foreign objects are then captured by the oil filter, thus eliminating the source of the problem.

OK → **SYSTEM OK**

NG

REPLACE ECM