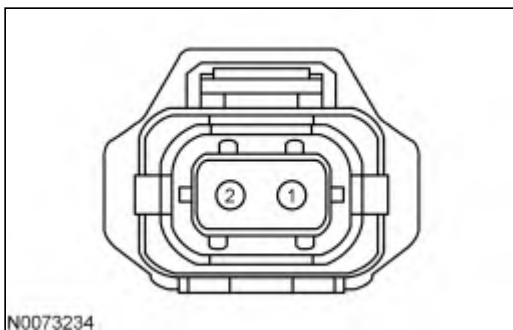
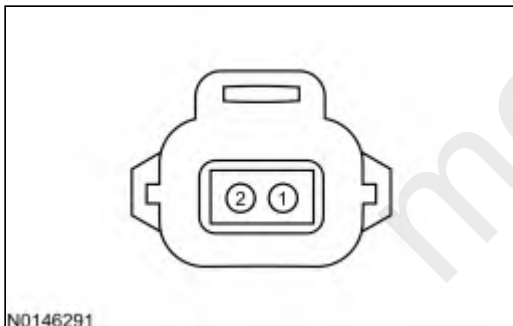
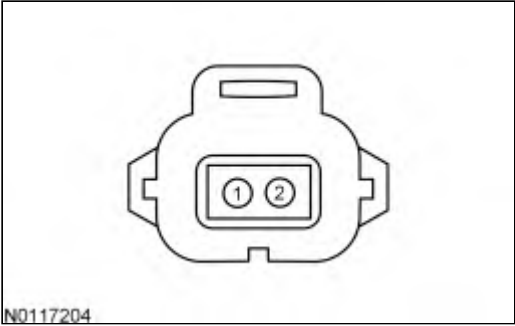


HK: Variable Camshaft Timing (VCT)

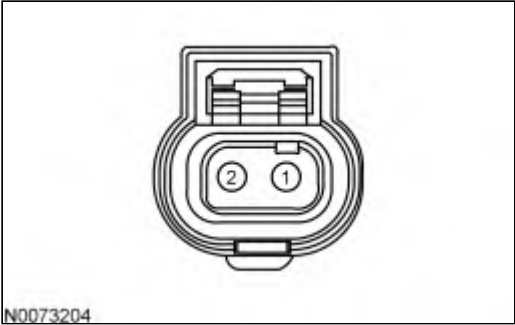
This pinpoint test is intended to diagnose the following:

- VCT solenoid (6L713) or (6B297)
- spider assembly right bank (6C260) or left bank (6C261)
- harness circuits: VPWR and VCT
- PCM (12A650)

Variable Camshaft Timing Bank 1 Solenoid 1 (VCT11) Solenoid Connector**A****B****C****D**



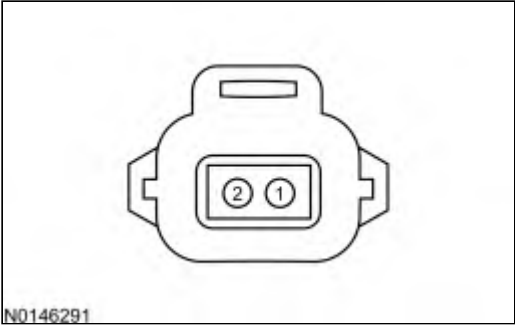
E



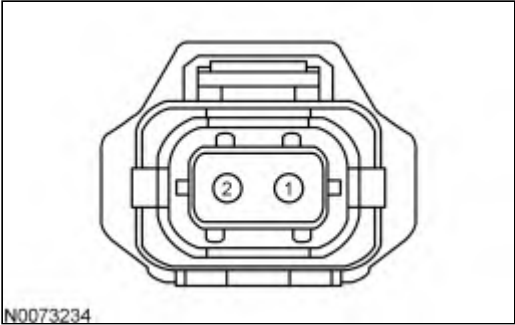
Vehicle	Connector	Pin	Circuit
E-Series, Escape/Kuga 1.5L, Expedition, F-150 5.0L, F-150 3.5L, F-Series Super Duty 6.2L, KA 1.2L, KA 1.5L, Mustang 5.2L, Mustang 5.0L, Navigator	A	1 2	VPWR VCT11
EcoSport 1.5L, Ford GT	B	1 2	VPWR VCT11
Flex GTDI 3.5L	C	1 2	VPWR VCT11
Fusion 1.5L	D	1 2	VPWR VCT11
All other vehicles	E	1 2	VPWR VCT11

Variable Camshaft Timing Bank 1 Solenoid 2 (VCT12) Solenoid Connector

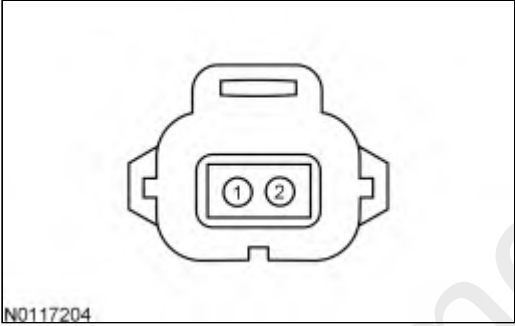
A



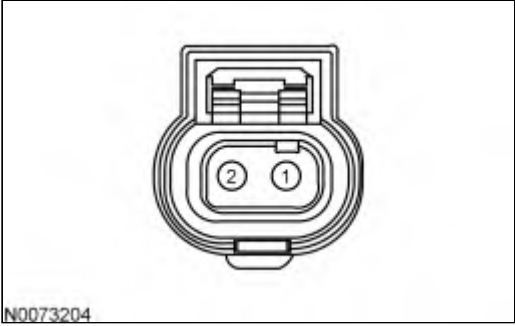
B



C



D

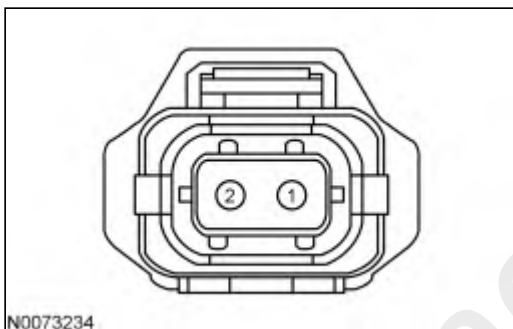


Vehicle	Connector	Pin	Circuit
EcoSport 1.5L, Ford GT	A	1 2	VPWR VCT12

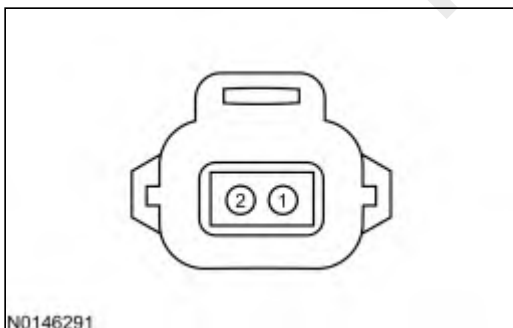
Vehicle	Connector	Pin	Circuit
Escape/Kuga 1.5L, Expedition, F-150 3.5L, F-150 5.0L, KA 1.2L, KA 1.5L, Mustang 5.2L, Mustang 5.0L, Navigator	B	1 2	VPWR VCT12
Fusion 1.5L	C	1 2	VPWR VCT12
All other vehicles	D	1 2	VPWR VCT12

Variable Camshaft Timing Bank 2 Solenoid 1 (VCT21) Solenoid Connector

A



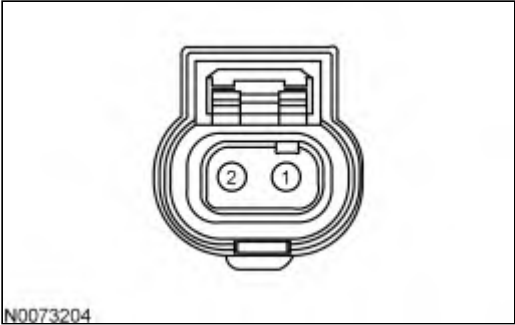
B



C



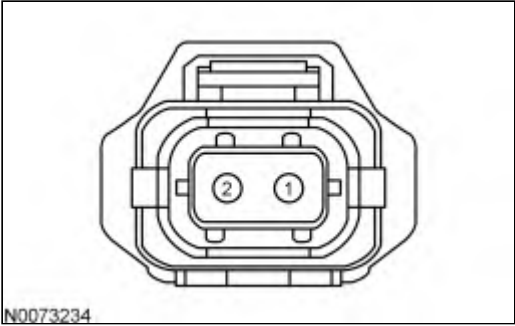
D



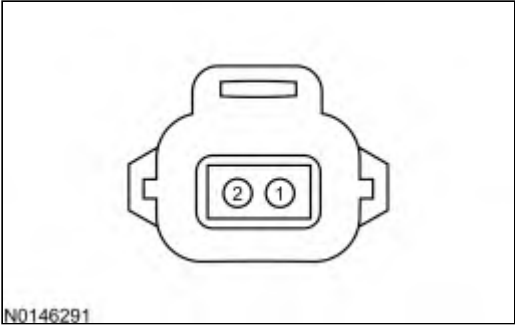
Vehicle	Connector	Pin	Circuit
E-Series, Expedition, F-150 3.5L, F-150 5.0L, F-Series Super Duty, Mustang, Navigator	A	1 2	VPWR VCT21
Ford GT	B	1 2	VPWR VCT21
Flex GTDI 3.5L	C	1 2	VPWR VCT21
All other vehicles	D	1 2	VPWR VCT21

Variable Camshaft Timing Bank 2 Solenoid 2 (VCT22) Solenoid Connector

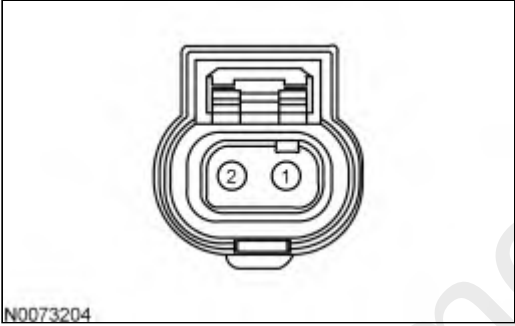
A



B



C



Vehicle	Connector	Pin	Circuit
Expedition, F-150 3.5L, F-150 5.0L, Mustang, Navigator	A	1 2	VPWR VCT22
Ford GT	B	1 2	VPWR VCT22
All other vehicles	C	1 2	VPWR VCT22

Powertrain Control Module (PCM) Connector

For PCM connector views or reference values, refer to Section 6, Reference Values.

Vehicle	Connector	Pin	Circuit
Aviator, Explorer 3.0L	306 PIN	E22 E25 E102 E4	VCT22 VCT21 VCT12 VCT11
Continental 2.0L, EcoSport 1.0L Automatic Transmission, EcoSport 2.0L, Fusion 1.5L, Fusion 2.0L, MKZ 2.0L	198 PIN	E29 E1	VCT12 VCT11
Continental 2.7L, Continental 3.0L, Ford GT	198 PIN	E17 E18 E29 E1	VCT22 VCT21 VCT12 VCT11
Continental 3.7L, Flex TiVCT 3.5L, Mustang TiVCT 5.2L	198 PIN	E6 E7 E4 E5	VCT22 VCT21 VCT12 VCT11
Corsair 2.5L, Escape/Kuga 2.5L, Fusion 2.5L, Transit Connect 2.5L	198 PIN	E1	VCT11
E-Series	198 PIN	E7 E5	VCT21 VCT11
EcoSport 1.0L Manual Transmission	198 PIN	E31 E16	VCT12 VCT11
EcoSport 1.5L Automatic Transmission, KA 1.5L Automatic Transmission	198 PIN	E2 E1	VCT12 VCT11
EcoSport 1.5L Manual Transmission, KA 1.2L, KA 1.5L Manual Transmission	112 PIN	E45 E51	VCT12 VCT11
Edge 2.7L, Explorer 3.3L, F-150 2.7L, F-150 3.3L, F-150 5.0L, F-150 3.5L, Mustang 5.0L, Mustang 5.2L Supercharged, Nautilus 2.7L, Transit	306 PIN	E111 E25 E102 E4	VCT22 VCT21 VCT12 VCT11

Vehicle	Connector	Pin	Circuit
Expedition, F-150 3.5L High Output, Navigator	198 PIN	E31 E61 E16 E46	VCT22 VCT21 VCT12 VCT11
F-Series Super Duty 6.2L	306 PIN	E25 E4	VCT21 VCT11
F-Series Super Duty 7.3L, Motorhome / Stripped Chassis / Step Van	306 PIN	E4	VCT11
Flex GTDI 3.5L	198 PIN	E18 E1	VCT21 VCT11
Fusion 2.7L, MKZ 3.0L	198 PIN	E17 E29 E18 E1	VCT22 VCT21 VCT12 VCT11
KA 1.0L	128 PIN	E46 E47	VCT12 VCT11
Ranger 2.5L	128 PIN	E43	VCT11
All other vehicles	198 PIN	E1 E5	VCT12 VCT11

HK1 CHECK FOR DTCS

Note: These DTCs may be accompanied by other DTCs. Diagnose all CMP sensor DTCs first. If no CMP sensor related DTCs are present, continue to follow diagnosis for the DTC. If any CMP DTCs are present, GO to Pinpoint Test [DR](#). If no CMP DTCs are present, continue to follow this test.

Are DTCs P000A, P000B, P0010, P0011, P0012, P0013, P0014, P0015, P0016, P0017, P0018, P0019, P0020, P0021, P0022, P0023, P0024, P0025, P052A, P052B, P052C, P052D, P054A, P054B, P054C, P054D, P2088, P2089, P2090 or P2091 present?

Yes	For DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090 and P2091, GO to HK2 . For all others, GO to HK10 .
No	For symptoms without DTCs, GO to HK10 . For all others, RETURN to Section 3, Symptom Charts for further direction.

HK2 CHECK FOR VCT DTCS

Note: The engine should be at operating temperature before running the self-test.

- Clear the PCM DTCs.
- Carry out the PCM self-test.

Are DTCs P0010, P0013, P0020, P0023, P2088, P2089, P2090 or P2091 present?

Yes	GO to HK4 .
No	GO to HK3 .

HK3 CARRY OUT A THOROUGH WIGGLE TEST ON THE VCT HARNESS

- Carry out a thorough wiggle test on the VCT harness.

- Carry out the PCM self-test.

Are DTCs P0010, P0013, P0020, P0023, P2088, P2089, P2090 or P2091 present?

Yes	GO to HK4 .
No	GO to Pinpoint Test Z .

HK4 CHECK THE VCT SOLENOID RESISTANCE

Note: Diagnose the suspect VCT solenoid indicated by the DTC.

- Ignition OFF.
- Disconnect the VCT solenoid related to the current DTC.
- Measure the resistance between:

(+) VCT Solenoid Connector, Component Side	(-) VCT Solenoid Connector, Component Side
VCT	VPWR

Is the resistance between 5 - 14 ohms?

Yes	GO to HK5 .
No	INSTALL a new VCT solenoid. REFER to the Workshop Manual Section 303-14, Electronic Engine Controls. Clear the PCM DTCs. REPEAT the self-test.

HK5 CHECK THE VCT SOLENOID FOR INTERNAL SHORTS

- Measure the resistance between:

(+) VCT Solenoid Connector, Component Side	(-)
VCT	Ground

Is the resistance greater than 10K ohms?

Yes	GO to HK6 .
No	INSTALL a new VCT solenoid. REFER to the Workshop Manual Section 303-14, Electronic Engine Controls. Clear the PCM DTCs. REPEAT the self-test.

HK6 CHECK THE VPWR CIRCUIT FOR AN OPEN

- Ignition ON, engine OFF.
- Measure the voltage between:

(+) VCT Solenoid Connector, Harness Side	(-)
VPWR	Ground

Is the voltage greater than 10.5 V?

Yes	GO to HK7 .
No	REPAIR the open circuit. Clear the PCM DTCs. REPEAT the self-test.

HK7 CHECK THE VCT CIRCUIT FOR AN OPEN

- Ignition OFF.
- PCM connector disconnected.
- Measure the resistance between:

(+) VCT Solenoid Connector, Harness Side	(-) PCM Connector, Harness Side
VCT	VCT

Is the resistance less than 5 ohms?

Yes	GO to HK8 .
No	REPAIR the open circuit. Clear the PCM DTCs. REPEAT the self-test.

HK8 CHECK THE VCT CIRCUIT FOR A SHORT TO GROUND

- Measure the resistance between:

(+) VCT Solenoid Connector, Harness Side	(-)
VCT	Ground

Is the resistance greater than 10K ohms?

Yes	GO to HK9 .
No	REPAIR the short circuit. Clear the PCM DTCs. REPEAT the self-test.

HK9 CHECK THE VCT CIRCUIT FOR A SHORT TO VOLTAGE

- Ignition OFF.
- Ignition ON, engine OFF.
- Measure the voltage between:

(+) VCT Solenoid Connector, Harness Side	(-)
VCT	Ground

Is any voltage present?

Yes	REPAIR the short circuit. Clear the PCM DTCs. REPEAT the self-test.
No	GO to HK15 .

HK10 CHECK THE OPERATION OF THE VCT SYSTEM

Note: Do not install a new component unless directed to install a new component in this pinpoint test.

Note: Some vehicles require higher RPMs and loads to actuate the VCT system than others. The VCTADVERR PID, VCT_INT_DIF PID or VCT_EXH_DIF PID should be close to zero whether actuating or not. During rapid VCT movements, the VCTADVERR PID, VCT_INT_DIF PID or VCT_EXH_DIF PID may momentarily deviate from zero.

Note: For a symptom based concern, monitor all applicable PIDs during this step.

- Ignition ON, engine OFF.
- Clear the PCM DTCs.
- Ignition ON, engine running.
- For E-Series, F-Series Super Duty, Fusion 2.5L, Ranger 2.5L and Transit Connect 2.5L:
- For DTCs P0011, P0012, P0016, P052A or P052B,
- Access the PCM and monitor the VCTADV (ANGL) and VCTADVERR (ANGL) PIDs.
- For DTCs P0018, P0021, P0022, P052C or P052D,
- Access the PCM and monitor the VCTADV2 (ANGL) and VCTADVERR2 (ANGL) PIDs.
- For all others:
- For DTCs P000A, P0011, P0012, P0016, P052A or P052B,
- Access the PCM and monitor the VCT_INT_ACT1 (ANGL) and VCT_INT_DIF1 (ANGL) PIDs.
- For DTCs P000B, P0014, P0015, P0017, P054A or P054B,
- Access the PCM and monitor the VCT_EXH_ACT1 (ANGL) and VCT_EXH_DIF1 (ANGL) PIDs.
- For DTCs P0018, P0021, P0022, P052C or P052D,
- Access the PCM and monitor the VCT_INT_ACT2 (ANGL) and VCT_INT_DIF2 (ANGL) PIDs.
- For DTCs P0019, P0024, P0025, P054C or P054D,
- Access the PCM and monitor the VCT_EXH_ACT2 (ANGL) and VCT_EXH_DIF2 (ANGL) PIDs.
- Drive the vehicle while exercising the throttle to generate VCT movement.

Does the VCTADV PID, VCT_INT_ACT PID or VCT_EXH_ACT PID indicate VCT movement while the VCTADVERR PID or VCT_INT_DIF PID or VCT_EXH_DIF PID maintain close to zero?

Yes	Unable to duplicate or identify the concern at this time. The concern may have been caused by an oil flow restriction which was removed by operating the VCT system. Clear the PCM DTCs. REPEAT the self-test.
No	If the engine runs rough at idle and KOER or continuous memory DTCs are present, GO to HK12 . For all others, GO to HK11 .

HK11 CHECK THE FUNCTIONALITY OF THE VCT SYSTEM

Note: Do not install a new component unless directed to install a new component in this pinpoint test.

Note: Diagnose the suspect VCT solenoid indicated by the DTC.

Note: For a symptom based concern, monitor all applicable PIDs during this step.

- For E-Series, F-Series Super Duty, Fusion 2.5L, Ranger 2.5L and Transit Connect 2.5L:
- For DTCs P0011, P0012, P0016, P052A or P052B,
- Access the PCM and monitor the VCTADV (ANGL) PID.
- For DTCs P0018, P0021, P0022, P052C or P052D,
- Access the PCM and monitor the VCTADV2 (ANGL) PID.
- For all others:
- For DTCs P000A, P0011, P0012, P0016, P052A or P052B,
- Access the PCM and monitor the VCT_INT_ACT1 (ANGL) PID.
- For DTCs P000B, P0014, P0015, P0017, P054A or P054B,
- Access the PCM and monitor the VCT_EXH_ACT1 (ANGL) PID.
- For DTCs P0018, P0021, P0022, P052C or P052D,
- Access the PCM and monitor the VCT_INT_ACT2 (ANGL) PID.
- For DTCs P0019, P0024, P0025, P054C or P054D,
- Access the PCM and monitor the VCT_EXH_ACT2 (ANGL) PID.
- Ignition OFF.
- Disconnect the VCT solenoid related to the current DTC.
- Ignition ON, engine running.
- Record the PID value at engine idle.

- Connect a 5 amp fused jumper wire between the following:

Point A VCT Solenoid Connector, Component Side	Point B Vehicle Battery
VPWR	Positive terminal

- Connect a 5 amp fused jumper wire between the following:

Point A VCT Solenoid Connector, Component Side	Point B Vehicle Battery
VCT	Negative terminal

- Record the PID value at engine idle.

Does the VCTADV PID, VCT_INT_ACT PID or VCT_EXH_ACT PID indicate VCT movement of 20 degrees or more?

Yes	The concern is not present at this time. The concern may have been caused by an oil flow restriction which was removed by operating the VCT system. Clear the PCM DTCs. REPEAT the self-test.
No	GO to HK12 .

HK12 ATTEMPT TO CLEAR ANY VCT SOLENOID DEBRIS

Note: Do not install a new component unless directed to install a new component in this pinpoint test.

Note: Diagnose the suspect VCT solenoid indicated by the DTC.

Note: For a symptom based concern, monitor all applicable PIDs during this step.

- For E-Series, F-Series Super Duty, Fusion 2.5L, Ranger 2.5L and Transit Connect 2.5L:
- For DTCs P0011, P0012, P0016, P052A or P052B,
- Access the PCM and monitor the VCTADV (ANGL) PID.
- For DTCs P0018, P0021, P0022, P052C or P052D,
- Access the PCM and monitor the VCTADV2 (ANGL) PID.
- For all others:
- For DTCs P000A, P0011, P0012, P0016, P052A or P052B,
- Access the PCM and monitor the VCT_INT_ACT1 (ANGL) PID.
- For DTCs P000B, P0014, P0015, P0017, P054A or P054B,
- Access the PCM and monitor the VCT_EXH_ACT1 (ANGL) PID.
- For DTCs P0018, P0021, P0022, P052C or P052D,
- Access the PCM and monitor the VCT_INT_ACT2 (ANGL) PID.
- For DTCs P0019, P0024, P0025, P054C or P054D,
- Access the PCM and monitor the VCT_EXH_ACT2 (ANGL) PID.
- Ignition ON, engine running.
- Record the PID value at engine idle.
- Connect a 5 amp fused jumper wire between the following:

Point A VCT Solenoid Connector, Component Side	Point B Vehicle Battery
VPWR	Positive terminal

- Connect a 5 amp fused jumper wire between the following:

Point A VCT Solenoid Connector, Component Side	Point B Vehicle Battery

Point A VCT Solenoid Connector, Component Side	Point B Vehicle Battery
VCT	Negative terminal

- Quickly connect and disconnect the jumper wire to the negative battery terminal at least 20 times within 20 seconds.
- Connect the jumper wire to the negative battery terminal and leave it connected.
- Record the PID value at engine idle.

Does the VCTADV PID, VCT_INT_ACT PID or VCT_EXH_ACT PID indicate VCT movement of 20 degrees or more?

Yes	The concern is not present at this time. The concern may have been caused by an oil flow restriction which was removed by operating the VCT system. Clear the PCM DTCs. REPEAT the self-test.
No	GO to HK13 .

HK13 CHECK THE BASE ENGINE OIL PRESSURE

- Ignition OFF.
- Connect the VCT solenoid related to the current DTC.
- Check the base engine oil pressure. Refer to the Workshop Manual Section 303-00, Engine System, Oil Pressure Test.

Are any concerns present?

Yes	REPAIR as necessary. Clear the PCM DTCs. REPEAT the self-test.
No	GO to HK14 .

HK14 CHECK THE FUNCTIONALITY OF THE VCT SOLENOID

Note: Do not install a new component unless directed to install a new component in this pinpoint test.

Note: Diagnose the suspect VCT solenoid indicated by the DTC.

- Ignition OFF.
- Disconnect the VCT solenoid related to the current DTC.
- Remove the VCT solenoid related to the current DTC. REFER to the Workshop Manual Section 303-14, Electronic Engine Controls.
- Connect a 5 amp fused jumper wire between the following:

Point A VCT Solenoid Connector, Component Side	Point B Vehicle Battery
VPWR	Positive terminal

- Connect a 5 amp fused jumper wire between the following:

Point A VCT Solenoid Connector, Component Side	Point B Vehicle Battery
VCT	Negative terminal

- While holding the VCT solenoid, quickly connect and disconnect the jumper wire to the negative battery terminal. The VCT solenoid plunger vibration can be felt by hand when connecting the jumper wires.
- Repeat as necessary to verify the VCT solenoid operation.

Does the VCT solenoid plunger activate when the jumpers are connected?

Yes	INSTALL a new VCT phaser as necessary. REFER to the Workshop Manual Section 303-01 Engine,
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	Timing Drive Components. Clear the PCM DTCs. REPEAT the self-test.
No	INSTALL a new VCT solenoid. REFER to the Workshop Manual Section 303-14, Electronic Engine Controls. Clear the PCM DTCs. REPEAT the self-test.

HK15 CHECK FOR CORRECT PCM OPERATION

- Disconnect all the PCM connectors.
- Visually inspect for:
 - pushed out pins
 - corrosion
- Connect all the PCM connectors and make sure they seat correctly.
- Carry out the PCM self-test.
- Verify the concern is still present.

Is the concern still present?

Yes	INSTALL a new PCM. REFER to Section 2, Flash Electrically Erasable Programmable Read Only Memory (EEPROM) , Programming the VID Block for a Replacement PCM.
No	The system is operating correctly at this time. The concern may have been caused by a loose or corroded connector.