



Service Information System

Previous Screen

Product: TRUCK ENGINE
Model: C-15 TRUCK ENGINE 6NZ
Configuration: C-15 Truck Engine 6NZ00001-UP

Troubleshooting

3406E, C-10, C-12, C-15, C-16 and C-18 On-highway Engines

Media Number -REN2238-16

Publication Date -01/07/2010

Date Updated -29/07/2010

Accelerator Pedal (Throttle) Position Sensor Circuit - Test

SMCS - 1913-038

System Operation Description:

Use this procedure to troubleshoot any suspect problems with the accelerator pedal position sensor.

This procedure covers the following diagnostic codes:

- 41-03 8 Volt Supply voltage high
- 41-04 8 Volt Supply voltage low
- 91-08 Throttle Position Invalid
- 91-13 Throttle Position out of calibration

The accelerator pedal position sensor is used to provide a throttle position signal to the Engine Control Module (ECM). Sensor output is a constant frequency signal with a pulse width that varies with the pedal position. This output signal is referred to as either a duty cycle or a pulse width modulated signal (PWM) and this output signal is expressed as a percentage between 3 and 100 percent.

The accelerator pedal position sensor is attached directly to the accelerator pedal assembly. The accelerator pedal position sensor requires no adjustment.

The accelerator pedal position sensor will produce a duty cycle of 10 to 22 percent at low idle and 75 to 90 percent when the accelerator pedal is fully depressed. The percent of duty cycle is translated in the ECM into an accelerator pedal position of 3 to 100 percent.

Note: When the ECM automatically calibrates new duty cycle values for the low idle throttle position and the high idle throttle position the ECM assumes 22 percent duty cycle at low idle and 75 percent duty cycle at high idle. As a result, you may notice that the throttle position status reaches 100 percent well before the accelerator pedal is fully depressed. This is normal. After some cycling of the accelerator pedal to the high idle position, the ECM will adjust the calibration automatically. The ECM will adjust the calibration automatically provided that the high idle stop position is within the 75 to 90 percent duty cycle range, and the low idle is in the 10 to 22 percent duty cycle range. During normal operation, you may also notice that more movement of the accelerator pedal is required for

the throttle position status to increase above 3 percent. You may also observe that the status reaches the 100 percent value prior to the limit of the high idle position. This is done in order to ensure that the throttle reaches these two critical points for engine operation.

The accelerator pedal position sensor is powered by the ECM supply voltage (+8 VDC) from connector P1-4 to terminal "A" of the accelerator pedal position sensor connector. The accelerator pedal position sensor can be replaced separately from the pedal assembly. An incorrectly calibrated pedal assembly can not be adjusted. The entire pedal assembly must be replaced.

If the vehicle is in PTO mode, the accelerator pedal position sensor will be ignored while the engine is in PTO mode and the "PTO Configuration" is programmed to one of the following options:

- Remote switches
- Remote throttle

Note: In the configuration for the cab switches, the vehicle's accelerator pedal can be used in order to control the engine rpm for the PTO operation. The accelerator pedal can also be ignored in the "Cab Switches" PTO configuration. Programming of customer parameters is required in order to ignore the accelerator pedal in the "Cab Switches" configuration.

The ECM is in PTO mode if the "PTO On/Off Switch" is on. This can be checked with the Caterpillar Electronic Technician (ET). Refer to Troubleshooting, "PTO Switch Circuit - Test" for testing if the PTO is being used.

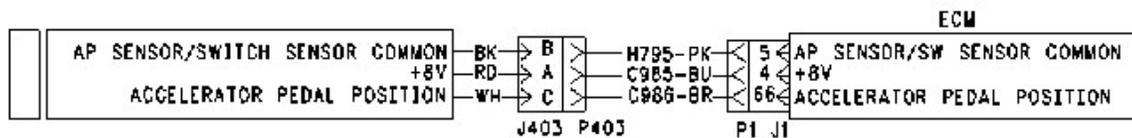


Illustration 1

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Schematic for the accelerator pedal position sensor

Test Step 1. Monitor the Status for the "Accelerator Pedal Position"

- A. Turn the keyswitch to the OFF position.
- B. Connect Cat ET to the service tool connector.
- C. Turn the keyswitch to the ON position.
- D. Access the status for the "Accelerator Pedal Position".
- E. While the status is monitored, depress the accelerator pedal and release the accelerator pedal.

The correct status for the "Accelerator Pedal Position" is 100 percent when the accelerator is fully depressed. The correct status for the "Accelerator Pedal Position" is less than 5 percent when the accelerator is fully released.

- F. Turn the keyswitch to the OFF position.

Expected Result:

The correct status for the "Accelerator Pedal Position" is being reported by Cat ET.

Results:

- **OK** - The correct status for the "Accelerator Pedal Position" is being reported by Cat ET.

Repair: The accelerator pedal position sensor is operating correctly. There may be an intermittent electrical problem in the circuit for the accelerator pedal position sensor. If an intermittent problem is suspected, refer to Troubleshooting, "Electrical Connectors - Inspect". Verify that the engine is not in PTO mode. PTO mode may cause the accelerator pedal position sensor to be ignored. Verify that all required parameters are programmed. Certain unprogrammed parameters may cause the engine to be limited to low idle. Refer to Troubleshooting, "System Configuration Parameters".

If a diagnostic code that is related to the accelerator pedal position sensor is still active, proceed to Test Step 2.

- **Not OK** - The correct status for the "Accelerator Pedal Position" is not being reported by Cat ET. The accelerator pedal position sensor is not operating correctly. Proceed to Test Step 2.

Test Step 2. Monitor the Duty Cycle

- Turn the keyswitch to the ON position.
- Access the following display screen in order:
 - "Service"
 - "Calibrations"
 - "Monitor Throttle Position Sensor"

- While the duty cycle is being monitored, depress the accelerator pedal and release the accelerator pedal.

The correct duty cycle is 10 percent to 22 percent when the accelerator pedal is released. The correct duty cycle is 75 percent to 90 percent when the accelerator pedal is depressed.

- Turn the keyswitch to the OFF position.

Expected Result:

Cat ET reports that the duty cycle is correct.

Results:

- **OK** - Cat ET is reporting the correct duty cycle for the sensor.

Repair: The duty cycle is within the specified range. There may be an intermittent electrical problem in the circuit for the accelerator pedal position sensor. If an intermittent problem is suspected, refer to Troubleshooting, "Electrical Connectors - Inspect". Verify that the engine is not in PTO mode. PTO mode may cause the accelerator pedal position sensor to be ignored. Verify that all required parameters are programmed. Certain unprogrammed parameters may cause the engine to be limited to low idle. Refer to Troubleshooting, "System Configuration Parameters".

STOP

- **Not OK** - Cat ET is not reporting the correct duty cycle for the sensor. The duty cycle is not within the range. Proceed to Test Step 3.

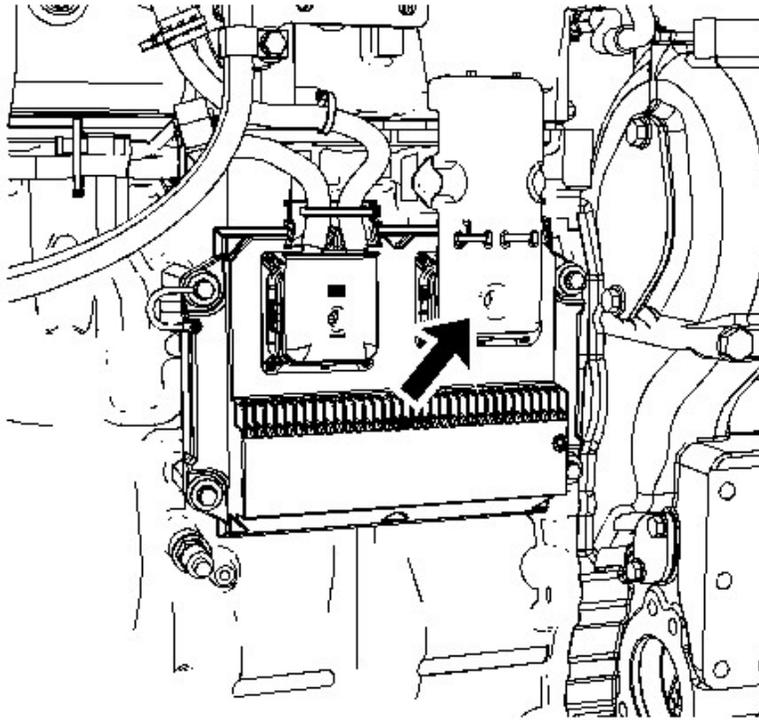
Test Step 3. Inspect the Electrical Connectors and the Wiring

Illustration 2

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Location of the J1/P1 ECM connectors (typical left side engine view)

- A. Thoroughly inspect the J1/P1 ECM connector, the firewall bulkhead connector and the accelerator pedal position sensor connector. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.
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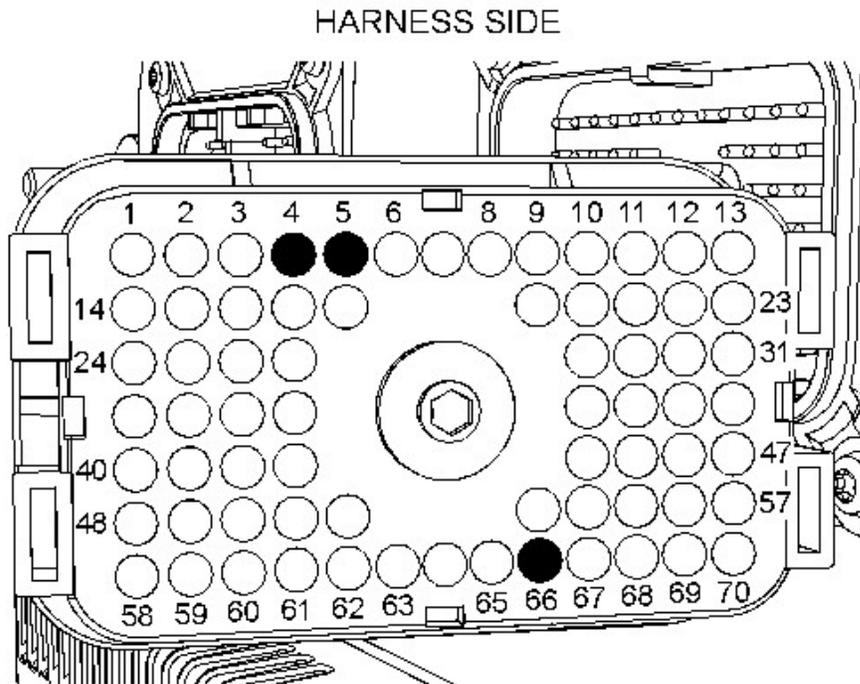
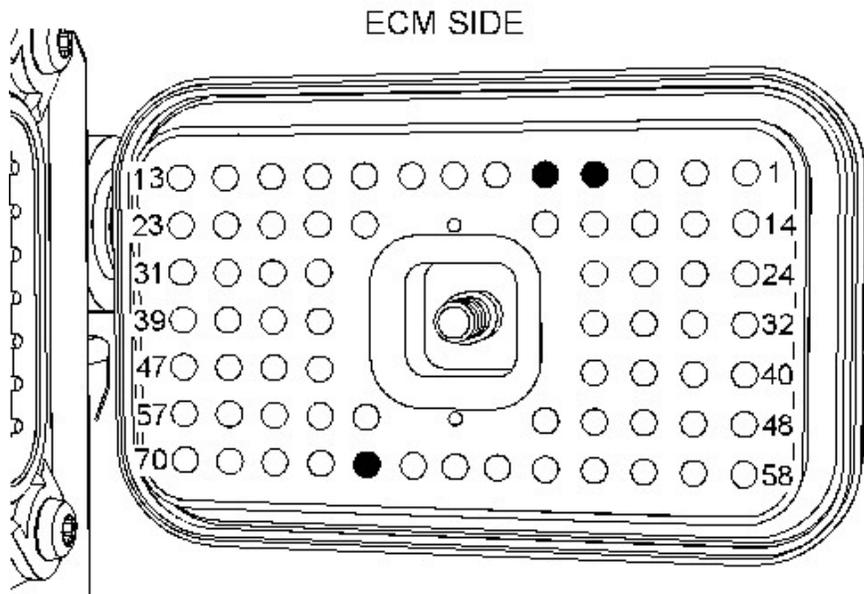


Illustration 3

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Terminal locations at the P1 ECM connector for the accelerator pedal position sensor

(P1-4) Sensor supply (8 VDC)

(P1-5) Sensor return

(P1-66) Accelerator pedal position sensor

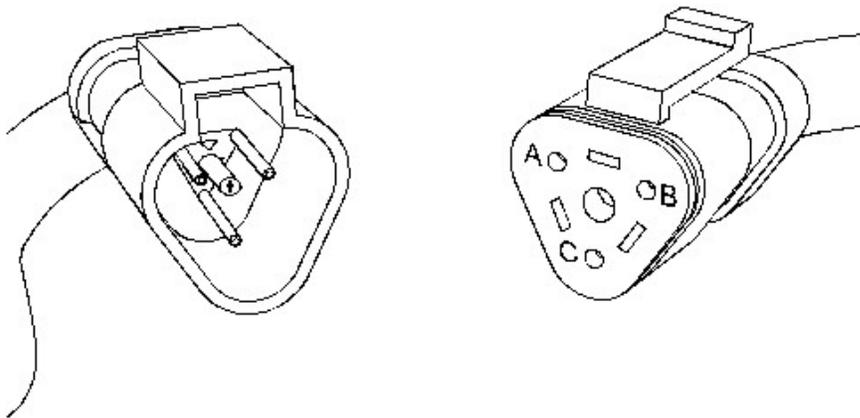


Illustration 4

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Sensor connector

(Terminal A) Sensor supply

(Terminal B) Sensor return

(Terminal C) Sensor signal

- B. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the accelerator pedal position sensor.
- C. Check the allen head screw for each of the ECM connectors for the proper torque. Refer to Troubleshooting, "Electrical Connectors - Inspect" for the correct torque values.
- D. Check the harness and wiring for abrasion and pinch points from the accelerator pedal position sensor to the ECM.

Expected Result:

All connectors, pins and sockets are completely coupled and/or inserted and the harness and wiring are free of corrosion, of abrasion or of pinch points.

Results:

- **OK** - The harness and connectors appear to be OK. Proceed to Test Step 4.
- **Not OK** - There is a problem with the connectors and/or wiring.

Repair: Perform the following repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled. Verify that the repair eliminates the problem.

STOP

Test Step 4. Check for Active Diagnostic Codes

- A. Turn the keyswitch to the ON position.

B. Check for the following active diagnostic codes on Cat ET:

Note: Wait at least 30 seconds in order for the diagnostic codes to become active.

- 41-03
- 41-04
- 91-08
- 91-13

C. Turn the keyswitch to the OFF position.

Expected Result:

One of the diagnostic codes that are listed above are active.

Results:

- **Active 91-08 or 91-13** - There is a problem with the throttle signal. Proceed to Test Step 5.
- **Active 41-03 or 41-04** - There is a problem with the supply circuit for the accelerator pedal position sensor. Proceed to Test Step 8.

Test Step 5. Check the Duty Cycle at the Sensor

- A. Remove the signal wire from terminal C at the harness side of the connector for the accelerator pedal position sensor.
- B. Install a **7X-6370** Adapter Cable As (3-PIN BREAKOUT) at the connector for the accelerator pedal position sensor.
- C. Turn the keyswitch to the ON position.
- D. Use a multimeter that can read a duty cycle to measure the signal between terminals C and B at the breakout t.
- E. While the duty cycle is being monitored on the multimeter, depress the accelerator pedal and release the accelerator pedal.

The correct measurement is a duty cycle that is between 10 percent and 22 percent when the accelerator pedal is fully released. The correct measurement is a duty cycle that is between 75 percent and 90 percent when the accelerator pedal is fully depressed.

F. Turn the keyswitch to the OFF position.

Expected Result:

The measurements agree with the duty cycles that are stated above.

Results:

- **OK** - The measurements agree with the results that are stated above. The accelerator pedal position sensor and the throttle pedal assembly are working correctly. Restore the wiring to the original configuration. Proceed to Test Step 6.

- **Not OK** - The measurements do not agree with the results that are stated above. There is a problem with the accelerator pedal position sensor. There may be a problem with the throttle pedal assembly. Leave the breakout T in the circuit. Proceed to Test Step 7.

Test Step 6. Check the Duty Cycle of the Sensor at the ECM

- A. Disconnect the J1/P1 ECM connectors.
- B. Remove the wire from terminal location P1-66 (accelerator pedal position sensor) at the ECM connector.
- C. Install a **208-0059** Adapter Cable As (70-PIN BREAKOUT) at the J1/P1 ECM connector. Connect the J1/P1 ECM connector.
- D. Turn the keyswitch to the ON position.
- E. Use a multimeter to measure the duty cycle between terminal locations 5 (sensor return) at the breakout T and the loose end of the signal wire that was removed from terminal location P1-66.
- F. While the duty cycle output of the accelerator pedal position sensor is being monitored on the multimeter, depress the accelerator pedal and release the accelerator pedal.

The correct measurement is a duty cycle that is between 10 percent and 22 percent when the accelerator pedal is fully released. The correct measurement is a duty cycle that is between 75 percent and 90 percent when the accelerator pedal is fully depressed.

- G. Turn the keyswitch to the OFF position. Restore the wiring to the original configuration.

Expected Result:

The measurements agree with the duty cycles that are stated above.

Results:

- **OK** - The measurements agree with the results that are stated above.

Repair: The correct signal is reaching the ECM. Verify that the ECM is receiving the proper battery voltage. If the ECM is receiving the proper battery voltage, there is a problem with the ECM.

1. Temporarily connect a test ECM.

Refer to Troubleshooting, "Replacing the ECM".

2. Perform this procedure again.

If the problem is resolved with the test ECM, install the suspect ECM. If the problem returns with the suspect ECM, replace the ECM. Verify that the problem is resolved.

If the problem is not resolved with the test ECM, install the original ECM. There is a problem in the wiring.

Send the vehicle to the OEM dealer for repair, if necessary.

STOP

- **Not OK** - The measurements do not agree with the duty cycles that are stated above. The signal is OK at the sensor connector, but the correct signal is not reaching the ECM. There is a problem with signal wire for the accelerator pedal position sensor that is in the vehicle wiring harness. Repair the signal wire in the harness or replace the signal wire in the harness. Verify that the repair corrects the original problem.

Test Step 7. Remove the Sensor from the Pedal Assembly

- A Mate sensor to accelerator pedal assembly. Key must match up with the sensor slot. Check the sensor housing for a flush fit to the pedal assembly mounting surface (This ensures slot on sensor has mated correctly with the pedal assembly key.)
- B Ensure the sensor is oriented the same as it was prior to removal to ensure sensor harness pigtail is routed correctly.
- C Line up screw holes and install mounting screws.

NOTE: Procedure is identical for the suspended accelerator pedal assembly.

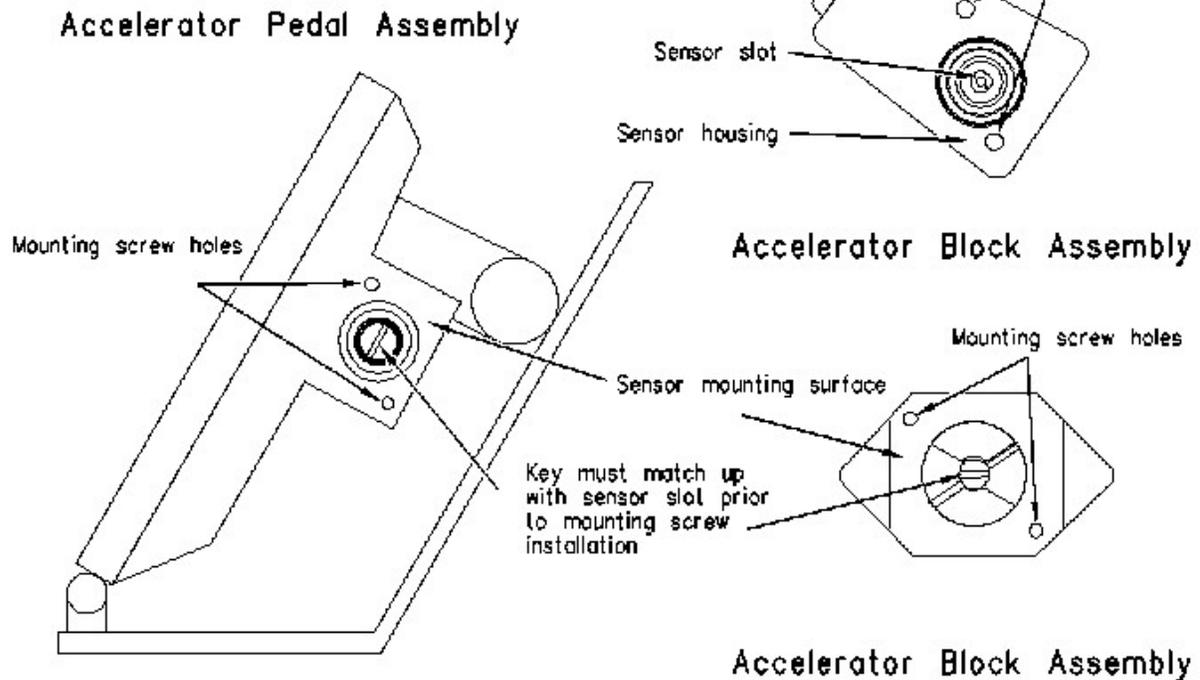


Illustration 5

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Accelerator pedal assembly

- A. Remove the accelerator pedal position sensor from the accelerator pedal assembly. Record the sensor's orientation in the accelerator pedal assembly. Also, note the routing of the sensor's pigtail prior to removal. Thoroughly inspect the pigtail for signs of abrasion and damage.

Note: When the sensor is removed from the accelerator pedal assembly, a 91-13 Throttle Sensor Calibration may be generated. This is normal. The diagnostic code should disappear when the sensor is properly assembled back into the accelerator pedal assembly.

- B. Connect the multimeter between terminal "C" (sensor signal) and terminal B (sensor return) at the breakout t.
- C. Turn the keyswitch to the ON position.

- D. Measure the duty cycle of the accelerator pedal position sensor while the slot is released. Use a screwdriver to advance the sensor slot to the maximum position. Again, measure the duty cycle of the sensor.

When the sensor is removed from the accelerator pedal assembly and the sensor slot is released, the correct duty cycle is 10 percent or less. When the sensor slot is moved to the maximum position, the correct duty cycle will become 90 percent or more.

- E. Turn the keyswitch to the OFF position.

Expected Result:

When the sensor is removed from the accelerator pedal assembly, the accelerator pedal position sensor generates the correct signal.

Results:

- **OK** - When the sensor is removed from the accelerator pedal assembly, the accelerator pedal position sensor generates the correct signal.

Repair: The accelerator pedal position sensor is operating correctly. There appears to be a problem with the accelerator pedal assembly. Clear any diagnostic codes that were caused by performing this test procedure. Refer to the OEM dealer for correct replacement of the accelerator pedal assembly.

STOP

- **Not OK** - When the sensor is removed from the accelerator pedal assembly, the accelerator pedal position sensor does not generate the correct signal.

Repair: The accelerator pedal position sensor is faulty. Check the accelerator pedal assembly in order to ensure that the accelerator pedal assembly is not causing damage to the sensor. If the accelerator pedal assembly is causing damage to the sensor, refer to the OEM dealer for correct replacement of the accelerator pedal assembly. If the accelerator pedal assembly appears OK, replace the accelerator pedal position sensor.

STOP

Test Step 8. Disconnect the 8 Volt Sensor while you Monitor the Active Diagnostic Codes

- A. Turn the keyswitch to the ON position.
- B. Monitor the active diagnostic code screen on Cat ET while you disconnect the accelerator pedal position sensor at the sensor connector. Check for an active 41-3 code or an active 41-4 code.

Note: Wait at least 30 seconds in order for the diagnostic codes to become active.

- C. Turn the keyswitch to the OFF position.

Expected Result:

The diagnostic code deactivates when the accelerator pedal position sensor is disconnected.

Results:

- **OK** - The 41-3 or 41-4 diagnostic code deactivates when the accelerator pedal position sensor is disconnected.

Repair: Connect the suspect sensor. If the code returns, replace the sensor. Connect all of the connectors. Verify that the problem is resolved.

STOP

- **Not OK** - The 41-3 or 41-4 diagnostic code remains active after the accelerator pedal position sensor is disconnected. The sensor is not the cause of the diagnostic code. Leave the sensor disconnected. Proceed to Test Step 9.

Test Step 9. Check the 8 Volt Supply Voltage at the ECM

- A. Ensure that the keyswitch is in the OFF position.
- B. Fabricate a jumper wire that is long enough to be used to create a test circuit at the ECM connector. Crimp a connector socket to one end of the jumper wire.
- C. Use a wire removal tool to remove the wire from terminal location P1-4 (sensor supply) at the ECM connector. Install the socket end of the jumper wire into this terminal location.
- D. Install a **7X-1709** Multimeter Probe (BLACK) into terminal location P1-5 (AP sensor/sw sensor common) at the ECM connector.

Note: Ensure that the multimeter probe is in good repair. A bent probe may contact other terminals inside the connector.
- E. Turn the keyswitch to the ON position.
- F. Measure the voltage between the jumper wire in P1-4 (8 V sensor supply) and the loose end of the multimeter probe.
- G. Turn the keyswitch to the OFF position. Restore the wiring to the original configuration.

Expected Result:

The voltage measurement is 8.0 ± 0.4 VDC.

Results:

- **OK** - The voltage measurement is 8.0 ± 0.4 VDC. The ECM is operating correctly.

Repair: The supply wire is shorted to another wire in the harness or the supply wire is shorted to engine ground. There may be an open circuit in the supply wire that is in the harness. Repair the supply wire.

STOP

- **Not OK** - The voltage measurement is not 8.0 ± 0.4 VDC.

Repair: There is a problem with the ECM. Perform the following procedure:

1. Temporarily connect a test ECM.

Refer to Troubleshooting, "ECM - Replace".
2. Recheck the circuit in order to ensure that the original problem has been resolved.

If the problem is resolved with the test ECM, install the suspect ECM. If the problem returns with the suspect ECM, replace the ECM. Verify that the problem is resolved.

If the problem is not resolved with the test ECM, install the original ECM. There is a problem in the wiring.

STOP

[C](#)