Product: POWER MODULE
Model: PM3516 POWER MODULE BPD
Configuration: PM3516 Power Module BPD00001-UP

Troubleshooting
3500B Engines For Caterpillar Built Power Modules
Media Number -RENR4929-00 **Publication Date -01/06/2000** **Date Updated -09/10/2001**

i01364760

Engine Sensor Open/Short Test

SMCS - 1901-038

System Operation Description:

Engine sensors provide various signals to the engine ECM. These sensors receive a regulated voltage from the ECM. Analog sensors receive 5.0 VDC and digital sensors receive 8.0 VDC.

The ECM performs an automatic calibration of these sensors whenever the ECM is powered and the engine is OFF for at least five seconds. During an automatic calibration, the ECM calibrates pressure sensors against the Atmospheric Pressure Sensor and an acceptable offset pressure range.

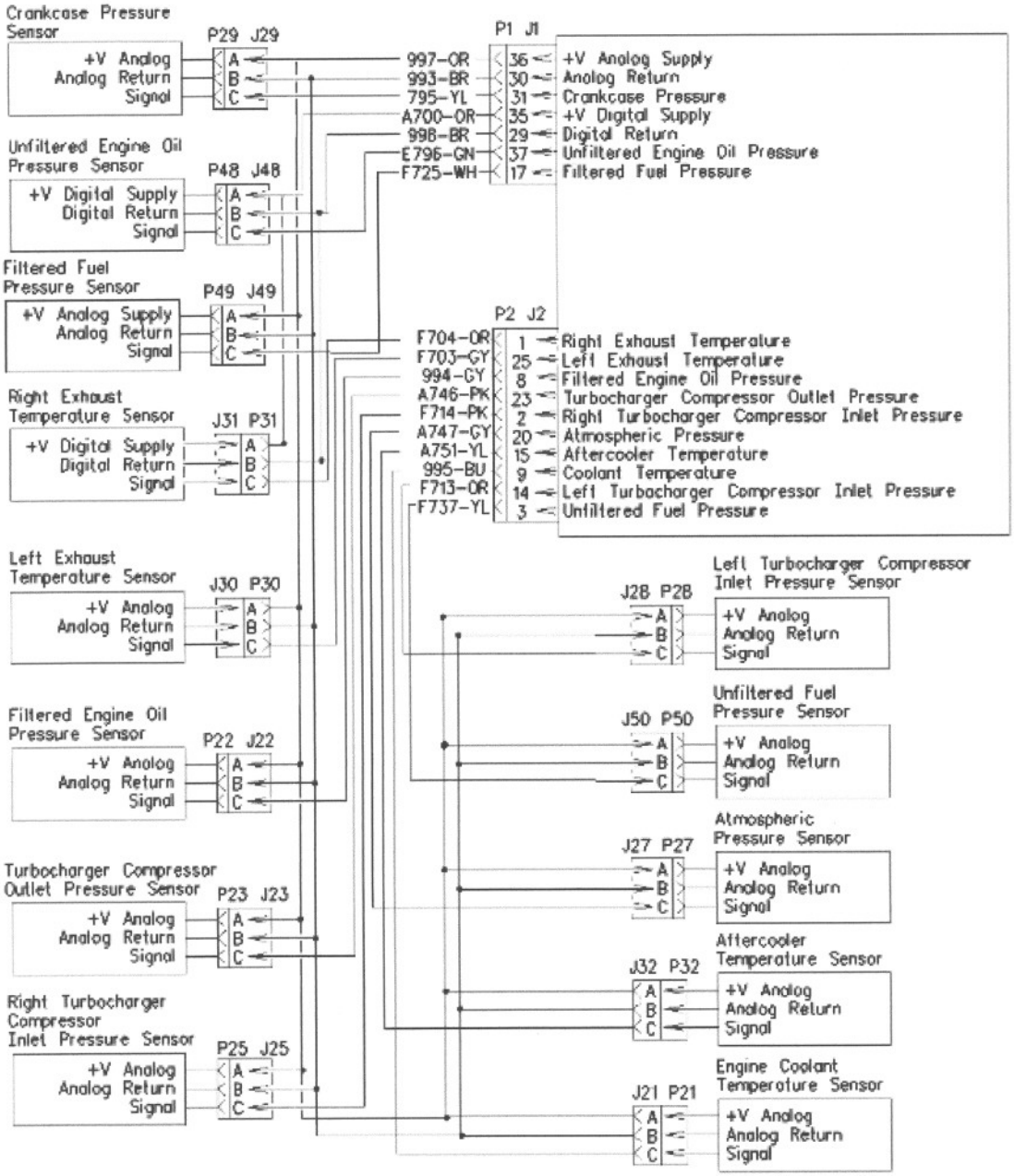

Illustration 1 g00719929

Test Step 1. Check for Connector Damage.

A. Turn the circuit breaker for the battery to the OFF position.

B. Turn the ECS to the OFF position.

C. Check the connectors and wiring for the following problems: damage, corrosion, abrasion and incorrect attachment.

Expected Result:

The connectors and wiring should be free of the following problems: damage, corrosion, abrasion and incorrect attachment.

Results:

- **OK** - Proceed to test step 2.
- **Not OK** -

  Repair: Repair the connectors and/or wiring or replace the connectors and/or wiring.

  Stop.

Test Step 2. Check for Active Diagnostic Codes.

A. Connect the ET.

B. Turn the ECS to the ON position. The engine should be OFF.

C. Wait for 15 seconds for the CID-FMI.

Expected Result:

Determine the failure mode identifier (FMI). Determine if diagnostic code 262-03 and/or diagnostic code 262-04 are present. Determine if diagnostic codes 263-03 and/or 263-04 are present.

Results:

- **FMI 03** - A diagnostic code with a FMI of 03 is present. Proceed to test step 3.
- **FMI 04** - A diagnostic code with a FMI of 04 is present. Proceed to test step 4.
- **FMI 00, 02 or 08** - A diagnostic code with a FMI of 00, 02 or 08 is present. Proceed to test step 5.
- **262-03 or 262-04 Active Code** - A diagnostic code of 263-03 or 263-04 is present. Proceed to test step 6.
- **263-03 or 263-04 Active Code** - A diagnostic code of 263-03 or 263-04 is present. Proceed to test step 7.

Test Step 3. Check the Voltage at the Connector.

A. Turn the ECS to the OFF/RESET position.

B. Measure the voltage on the sensor side of the wiring harness.

C. Measure the voltage between pin A and pin B for the suspect sensor.

Expected Result:

The supply voltage should reach 5.0 ± 0.5 VDC for all analog sensors and 8.0 ± 0.5 for all digital sensors.

Results:

- **OK -** The voltage is correct. Proceed to test step 8.
- **Not OK -** The voltage is out of range. Proceed to test step 9.

Test Step 4. Check the Voltage at the Sensor Connector.

A. Turn the ECS to the OFF/RESET position.

B. Measure the voltage on the ECM side of the wiring harness. Measure the voltage between pin A and pin B for the suspect sensor.

Expected Result:

The supply voltage should reach 5.0 ± 0.5 VDC for all analog sensors and 8.0 ± 0.5 for all digital sensors.

Results:

- **OK -** The voltage is correct. Proceed to test step 10.
- **Not OK -** The voltage is out of range. Proceed to test step 9.

Test Step 5. Check the Fluid Level.

A. Check the fuel level.

B. Check the engine oil level.

C. Check for any leaks.

Expected Result:

The fuel and oil level should be ok. There should not be any leaks.

Results:

- **OK -** Proceed to test step 11.
- **Not OK -**

  Repair: If the oil level is low add oil. If the fuel level is low add fuel. Repair the leaks. Reset the system and note any active diagnostic codes.

Stop.

Test Step 6. Perform the following test: Analog Sensor Supply

Results:

- **REPAIRED, OK - Stop.**

Test Step 7. Perform the following test: Digital Sensor Supply

Results:

- **REPAIRED, OK - Stop.**

Test Step 8. Install a Jumper Wire.

A. Turn the ECS to the OFF/RESET position.

B. Disconnect the suspect sensor.

C. Use a wire with socket terminals at each end. Connect pin B and pin C at the suspect sensor connector.

D. Turn the ECS to the ON position. The engine should be OFF.

E. Check if the CID-FMI has changed from 03 to 04.

F. Turn the ECS to the OFF/RESET position.

G. Remove the wire short.

Expected Result:

The CID-FMI should change from 03 to 04.

Results:

- **OK -** The circuit now indicates a short circuit diagnostic code. Proceed to test step B.
- **Not OK -** The circuit indicates a open circuit diagnostic code.

  Repair: Temporarily connect a new sensor. Verify that the new sensor solves the problem before you permanently install the new sensor. Calibrate the sensor.

  Stop.

Test Step 9. Check the Voltage at the ECM.

A. Turn the ECS to the OFF/RESET position.

B. Turn the ECS to the ON position. The engine should be OFF.

C. Use signal reading probes to measure the analog voltage between P1-36 (997-OR) and P1-30 (993-BR).

D. Use signal reading probes to measure the digital voltage between P1-35 (700-OR) and P1-29 (998-BR).

E. Turn the ECS to the OFF/RESET position.

Expected Result:

The analog supply voltage should be 5.0 ± 0.5 VDC. The digital supply voltage should be 8.0 ± 0.5 VDC.

Results:

- **OK - Stop.**
- **Not OK Analog -** Proceed to test step 6.
- **Not OK Digital -** Proceed to test step 7.

Test Step 10. Create an Open Circuit at the Sensor Connector.

A. Turn the ECS to the OFF/RESET position.

B. Disconnect the suspect sensor.

C. Turn the ECS to the ON position. The engine should be OFF.

D. The CID-FMI should change from 04 to 03.

Note: Disconnecting the Atmospheric Pressure Sensor will cause several sensor diagnostic codes to become active. Troubleshoot the original code. Reset the system. Delete the logged diagnostic codes when you are finished.

Expected Result:

The CID-FMI should change from 04 to 03 when the sensor is disconnected.

Results:

- **OK -**

Repair: Replace the suspect sensor. Verify that the repair eliminates the problem.

Stop.

- **Not OK -** Proceed to test step 13.

Test Step 11. Compare the Pressure or Temperature to the Actual Pressure or Temperature.

A. Turn the ECS to the OFF/RESET position.

B. If you are troubleshooting a temperature sensor, install a **6v-9130** Temperature Adapter near the sensor.

C. Observe the temperature reading for the suspect sensor. The ET should display the same temperature as the **6V-9130** Temperature Adapter .

Note: When the temperature is below 0 °C (32 °F), the temperature can vary 15 °C (59 °F).

D. If you are troubleshooting a pressure sensor, disconnect the sensor.

E. Remove the suspect sensor from the engine.

F. Connect the suspect sensor to the sensor connector.

G. Connect the vacuum pump test unit to the suspect sensor.

H. Connect the vacuum pump to the differential pressure gauge.

I. Turn the ECS to the ON position. The engine should be OFF.

J. Observe the pressure reading for the suspect sensor. The ET should display the barometric pressure in your area.

K. Use the vacuum pump to pull 5 kPa (0.7 psi) of vacuum on the differential pressure gauge.

Note: The pressure gauge reading should remain constant until the vacuum is released.

L. Compare the readings on the ET and the pressure test kit.

Expected Result:

The ET should show constant pressure. The ET should show a 5 ± 2 kPa (0.7 ± 0.3 psi) drop in pressure.

Results:

- **OK -** The sensor is working correctly. Reset the system and note any active diagnostic codes. **Stop.**
- **Not OK -** Proceed to test step 14.
- **Vacuum Leak -**

Repair: Check for leaks. If no leaks are found there is an internal leak in the suspect pressure

sensor. Replace the sensor and calibrate the sensor. Reset the system and note any active diagnostic codes.

Stop.

Test Step 12. Install a Jumper Wire.

A. Connect the suspect sensor.

B. Remove the suspect sensor signal wire from the ECM. Remove the suspect ground wire from the ECM.

C. Use a wire with socket terminals at each end. Connect the jumper wire at the ECM between the sensor signal and the ground.

D. Turn the ECS to the ON position. The engine should be OFF.

E. The CID-FMI should change from 03 to 04 when the jumper is in place.

Expected Result:

The diagnostic code should change from a FMI of 03 to an FMI of 04.

Results:

- **OK -** There is a problem with the wiring between the ECM and the suspect sensor.

  Repair: Repair the connectors and/or wiring or replace the connectors and/or wiring.

  Stop.

- **Not OK -** Replace the ECM.

  Repair: Refer to Troubleshooting, "Replacing the ECM".

  Stop.

Test Step 13. Create an Open at the ECM.

A. Turn the ECS to the OFF/RESET position.

B. Disconnect the suspect sensor signal wire from the ECM connector.

C. Turn the ECS to the ON position. The engine should be OFF.

D. Check if the CID-FMI has changed from 04 to 03.

Note: Disconnecting the Atmospheric Pressure Sensor will cause several sensor diagnostic codes to become active. Troubleshoot the original code. Reset the system. Delete the logged diagnostic

codes when you are finished.

Expected Result:

The CID-FMI should change from 04 to 03 when the sensor signal wire is disconnected.

Results:

- **OK** - The diagnostic code has changed from a FMI of 04 to an FMI of 03.

  Repair: Repair the connectors and/or wiring or replace the connectors and/or wiring.

  Stop.

- **Not OK** - Replace the ECM.

  Repair: Refer to Troubleshooting, "Replacing the ECM".

  Stop.

Test Step 14. Check the Voltage at the Sensor Connector.

A. Turn the ECS to the OFF/RESET position.

B. Measure the analog sensor voltage. Turn the ECS to the ON position. The engine should be OFF.

C. Measure the voltage between pin C and pin B.

D. Measure the digital sensor voltage. Turn the ECS to the OFF/RESET position.

E. Turn the ECS to the ON position. The engine should be OFF.

F. Measure the frequency and the duty cycle between pin C and pin B.

Expected Result:

The signal voltage should be 0.2 to 4.5 VDC for all analog sensors.

The frequency reading should be between 150 Hz and 1000 Hz for all digital sensors.

When the temperature is below 49 °C (120 °F), the duty cycle should be between 10% to 21%.

When the temperature is between 49 °C (120 °F), and 851 °C (1564 °F) the duty cycle should be between 22% to 88%.

When the temperature is above 851 °C (1564 °F), the duty cycle should be between 80% to 90%.

Results:

- **OK** - Proceed to test step 15.
- **Not OK** - Proceed to test step 16.

Test Step 15. Check for Shorts in the Wiring Harness.

A. Turn the ECS to the OFF/RESET position.

B. Disconnect ECM connector J1/P1, ECM connectorJ2/P2, and the suspect sensor.

C. Measure the resistance between the suspect sensor signal wire at the ECM connector and the supply voltage at the ECM connector.

D. Measure the resistance between the suspect sensor signal wire at the ECM connector and the sensor return line at the ECM connector.

E. Measure the resistance between the suspect sensor signal wire at the ECM connector and engine ground.

F. Reconnect all connectors.

Expected Result:

The resistance should be greater than 20,000 Ohms.

Results:

- **OK** - The resistance is greater than 20,000 Ohms. Proceed to test step 17.
- **Not OK** -

  Repair: Repair the connectors and/or wiring or replace the connectors and/or wiring.

  Stop.

Test Step 16. Check the Signal Frequency and the Duty Cycle at the Sensor Connector.

A. Turn the ECS to the OFF/RESET position.

B. Remove pin C from the sensor connector.

C. Connect the main power.

D. Measure the frequency and the duty cycle from pin C with reference to pin B.

E. Turn the ECS to the OFF/RESET position.

Expected Result:

The frequency reading should be between 150 Hz and 1000 Hz.

When the temperature is below 49 °C (120 °F), the duty cycle should be between 10% to 21%.

When the temperature is between 49 °C (120 °F), and 851 °C (1564 °F) the duty cycle should be between 22% to 88%.

When the temperature is above 851 °C (1564 °F), the duty cycle should be between 80% to 90%.

Results:

- **OK** - Proceed to test step 15.
- **Not OK** -

  Repair: Temporarily replace the sensor. Verify that the repair eliminates the problem.

  Stop.

Test Step 17. Check the Resistance through the Harness.

A. Disconnect ECM connector J1/P1, ECM connector J2/P2,and the suspect sensor connector.

B. Use a suitable piece of wire to connect pin A to pin C.

C. Measure the resistance between suspect sensor signal wire and the suspect sensor voltage supply at the ECM connector P1.

D. Use a suitable piece of wire to connect pin B to pin C.

E. Measure the resistance between the sensor signal wire and the sensor return line at the ECM connector P1.

F. Remove all wire shorts.

G. Reconnect all connectors.

Expected Result:

The resistance should be less than 10 Ohms through the harness.

Results:

- **OK** - Proceed to test step 18.
- **Not OK** -

  Repair: Repair the connectors and/or wiring or replace the connectors and/or wiring.

Stop.

Test Step 18. Check the Voltage at the ECM.

A. Turn the ECS to the OFF/RESET position.

B. Turn the ECS to the ON position. The engine should be OFF.

C. Measure the analog voltage between the suspect sensor signal voltage and the sensor return line at the ECM connector P1.

D. Observe the sensor reading on the status screen on the ET.

E. Turn the ECS to the OFF/RESET position.

Note: The status screen on the ET displays INVALID DATA when the ECM reads an signal that is out of range.

F. Turn the ECS to the OFF/RESET position.

G. Turn the ECS to the ON position. The engine should be OFF.

H. Measure the frequency and the duty cycle between the digital suspect sensor signal and the sensor return line at the ECM connector P1.

I. Start the engine.

J. Observe the sensor reading on the status screen on the ET.

Note: The status screen on the ET displays INVALID DATA when the ECM reads an signal that is out of range.

K. Turn the ECS to the OFF/RESET position.

Expected Result:

The signal voltage for the analog sensors should be 0.2 to 0.6 VDC for the suspect analog sensor.

The frequency reading should be between 150 Hz and 1000 Hz.

When the temperature is below 49 °C (120 °F), the duty cycle should be between 10% to 21%.

When the temperature is between 49 °C (120 °F), and 851 °C (1564 °F) the duty cycle should be between 22% to 88%.

When the temperature is above 851 °C (1564 °F), the duty cycle should be between 80% to 90%.

While the engine is cold, the ET should read 30 °C (86 °F). As the engine warms up the exhaust temperature reading should increase.

Results:

- **OK -** The sensor is working correctly. Reset the system and note any diagnostic codes. **Stop.**
- **NOT OK Analog -** Proceed to test step 6.
- **Not OK Digital -** Proceed to test step 7.
- **Intermittent Problem -** Proceed to test step 19.
- **Invalid Data -**

  Repair: Replace the ECM. Refer to Troubleshooting, "Replacing the ECM".

  Stop.

Test Step 19. Perform the following test: Inspecting Electrical Connectors

Results:

- **REPAIRED, OK - Stop.**
- **OK - Stop.**

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