10.16 EXHAUST GAS RECIRCULATION SYSTEM (EGR-1) – FAULT, SERIES 50 ENGINE

The following procedures will troubleshoot the Exhaust Gas Recirculation (EGR) system:

10.16.1 Exhaust Gas Recirculation System Troubleshooting

Perform the following steps for all EGR related issues.

NOTE:
EGR system related part numbers can be found in parts bulletin #2–PI-00.

1. Check ECM voltage via DDR. The system voltage must be 24V (not 12V).
2. Check bus air systems. Air pressure must be greater than 620 kPa (90 psi).
3. Check EGR solenoid assembly to ensure there is at least 90 psi air pressure to the solenoid.
   If the bus has 620 kPa (90 psi), but not at solenoid, check the air lines to the solenoid.
4. Check hot, cold and cooler tubes and V-band clamps for leakage.
5. Disconnect the air hoses from the EGR valve and VGT (Variable Geometry Turbocharger) actuator. See Figure 10-12.

![Figure 10-12 PWM Valve Assembly](image)

1. EGR Solenoid
2. PWM Valve air Line
3. EGR Solenoid Air Line
4. Air Supply air Line (hidden)
5. Electrical Connectors
6. Bolt
7. Bracket

**Figure 10-12    PWM Valve Assembly**

[a] Install the pressure gauges at the outlet of these hoses. (Use two gauges or test separately.)

[b] Use DDR/DDDL to activate output T3 and watch pressure at the EGR valve. Pressure should be 503–545 kPa (73–79 psi). Low or high pressure indicates PWM valve assembly fault.

[c] Use DDR/DDDL to cycle output S3 and watch the pressure gauge at the VGT actuator. Pressure should be 427–448 kPa (62–65 psi). Low or high pressure indicates PWM valve assembly fault.

**NOTE:**
The EGR solenoid and the PWM valve can be serviced separately.

6. Reconnect air hose and ensure bus air pressure is at least 620 kPa (90 psi).

[a] Activate output T3 and watch the EGR actuator rod for movement. If actuator rod does not move, replace EGR valve assembly.
[b] Toggle output S3 and watch the VGT actuator rod for movement. If the rod does not travel to set screw, adjust actuator rod length following the procedure outlined in the Series 50 Service Manual. If adjustment cannot be obtained, replace actuator assembly or inspect VGT vanes for damage.

NOTE:
Never adjust set screw.

7. Use the DDR/DDDL and check turbocharger speed at idle. The speed should be about 18,000 to 30,000 rpm. If speed is low, check inlet restriction. Also check the exhaust back pressure.

8. Check the Delta-P orifice pressure at idle. Pressure at idle should be less than 1 kPa (0.15 psi). If pressure differs, shut the engine off. Turn the key on.
   [a] If pressure is greater than 1 kPa (0.15 psi), viewed on the DDR/DDDL, replace the EGR pressure sensor.
   [b] If pressure is less than 1 kPa (0.15 psi), inspect the EGR valve, and replace if necessary.

9. Check the Delta-P orifice pressure at idle. Pressure at idle should be less than 1 kPa (0.15 psi). If pressure differs, shut the engine off. Turn the key on.
   [a] If pressure is greater than 1 kPa (0.15 psi), viewed on the DDR/DDDL, replace the EGR pressure sensor.
   [b] If pressure is less than 1 kPa (0.15 psi), inspect the EGR valve, and replace if necessary.

10. If corrections have been made as a result of these checks, verify the repair by checking the applicable flash code verification.
   [a] If all tests pass, and no DDEC codes are present, contact DDC Technical Service.
   [b] If all tests pass, but a problem still exists, view the DDEC codes for further troubleshooting. For a list of EGR fault codes, refer to section 10.16.2.

10.16.2 DDEC Codes for Exhaust Gas Recirculation

DDEC Codes for Exhaust Gas Recirculation are listed in Table 10-21.

<table>
<thead>
<tr>
<th>Flash Code</th>
<th>Refer To</th>
<th>J1587 Code</th>
<th>Description</th>
<th>Typical Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>31</td>
<td>section 31</td>
<td>s 51 3 or 4</td>
<td>PWM valve power open or short to ground</td>
<td>Open or shorted wire</td>
</tr>
<tr>
<td>31</td>
<td>section 31</td>
<td>s 52 3 or 4</td>
<td>EGR Solenoid power open or short to ground</td>
<td>Open or shorted wire</td>
</tr>
<tr>
<td>39</td>
<td>section 39</td>
<td>s 146 2</td>
<td>EGR leak — boost power</td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>section 39</td>
<td>s 146 12</td>
<td>EGR leak — boost Jake</td>
<td></td>
</tr>
<tr>
<td>Flash Code</td>
<td>Refer To</td>
<td>J1587 Code</td>
<td>Description</td>
<td>Typical Reason</td>
</tr>
<tr>
<td>------------</td>
<td>----------</td>
<td>------------</td>
<td>-------------</td>
<td>----------------</td>
</tr>
<tr>
<td>39</td>
<td>section 39</td>
<td>s 152 7 or 146 7</td>
<td>EGR Valve mechanism not responding</td>
<td>EGR valve or air supply fault, EGR Delta-Pressure sensor fault</td>
</tr>
<tr>
<td>39</td>
<td>section 39</td>
<td>s 147 2</td>
<td>VNT vanes not responding — boost power</td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>section 39</td>
<td>s 147 12</td>
<td>VNT vanes not responding — boost Jake</td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>section 39</td>
<td>s 147 14</td>
<td>EGR flow too low</td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>section 39</td>
<td>s 147 11</td>
<td>VNT vanes at max — Jake</td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>section 39</td>
<td>s 153 7 or 147 7</td>
<td>VNT Vane Mechanism Not Responding</td>
<td>Failed Turbo or air supply fault, EGR Delta-Pressure sensor fault</td>
</tr>
<tr>
<td>48</td>
<td>section 48</td>
<td>s 154 1 or 412 1</td>
<td>EGR Temperature Low</td>
<td>EGR valve not opening correctly</td>
</tr>
<tr>
<td>48</td>
<td>section 48</td>
<td>s 155 1 or 411 1</td>
<td>EGR Delta-Pressure Low</td>
<td>EGR valve not opening correctly</td>
</tr>
<tr>
<td>63</td>
<td>section 63</td>
<td>s 60 3</td>
<td>PWM (#4) above or below normal range</td>
<td>Open or shorted wire</td>
</tr>
<tr>
<td>64</td>
<td>section 64</td>
<td>p 103 0</td>
<td>Turbo Overspeed Code</td>
<td>Turbo or turbo speed sensor</td>
</tr>
<tr>
<td>81</td>
<td>section 81</td>
<td>s 154 3 or 412 3</td>
<td>EGR Temperature Circuit Failed High</td>
<td>Wiring/sensor fault</td>
</tr>
<tr>
<td>81</td>
<td>section 81</td>
<td>s 155 3 or 411 3</td>
<td>EGR Delta-Pressure Circuit Failed High</td>
<td>Wiring/sensor fault</td>
</tr>
<tr>
<td>82</td>
<td>section 82</td>
<td>s 154 4 or 412 4</td>
<td>EGR Temperature Circuit Failed Low</td>
<td>Wiring/sensor fault</td>
</tr>
<tr>
<td>82</td>
<td>section 82</td>
<td>s 155 4 or 411 4</td>
<td>EGR Delta-Pressure Circuit Failed Low</td>
<td>Wiring/sensor fault or crossed Delta-P hoses</td>
</tr>
<tr>
<td>83</td>
<td>section 83</td>
<td>s 154 0 or 412 0</td>
<td>EGR Temperature High</td>
<td>EGR valve stuck/partly open</td>
</tr>
<tr>
<td>83</td>
<td>section 83</td>
<td>s 155 0 or 411 0</td>
<td>EGR Delta-Pressure High</td>
<td>EGR valve stuck open</td>
</tr>
</tbody>
</table>

The DDEC Single ECM Troubleshooting Guide is organized by flash code. Refer to the corresponding section of the guide for troubleshooting that code.

Table 10-21  DDEC Codes for Exhaust Gas Recirculation
10.17 MAINTENANCE ALERT SYSTEM

The following procedures will troubleshoot the Maintenance Alert System (MAS).

10.17.1 Maintenance Alert System Troubleshooting

The following procedures will troubleshoot a Maintenance Alert System (MAS) display problem. Listed in Table 10-22 are typical faults.

<table>
<thead>
<tr>
<th>Fault</th>
<th>Typical Fault</th>
<th>Refer to</th>
</tr>
</thead>
<tbody>
<tr>
<td>No lights, blank display.</td>
<td>Loss of power to display module</td>
<td>Refer to section 10.17.2</td>
</tr>
<tr>
<td>All red LEDs flashing.</td>
<td>Data link wire fault</td>
<td>Refer to section 10.17.3</td>
</tr>
<tr>
<td>Single item LED blank.</td>
<td>Sensor fault Refer to sensor troubleshooting.</td>
<td>Refer to section 10.17.6</td>
</tr>
</tbody>
</table>

Table 10-22 Maintenance Alert System Faults

10.17.2 Checking for Power to Display

Perform the following steps to check for power to the display:

1. Unplug MAS display harness.
2. Check connectors for bent, corroded, or unseated pins.
   - If connectors are bent, corroded or otherwise damaged, replace them and test the operation.
   - If connectors are in good condition, continue the inspection.
3. Turn the ignition ON.
4. Measure the voltage between cavity A (#953) ground and cavity C (#439) ignition. See Figure 10-13.
   - If voltage is less than 10.5 volts, determine the reason for low voltage. Refer to OEM guidelines. One possibility is a battery fault.
10.17 MAINTENANCE ALERT SYSTEM

[b] If voltage is greater than 10.5 volts, refer to Step 5.

Figure 10-13 Maintenance Pro Display Harness

5. Measure voltage between cavity A (#953) ground and cavity B, battery (+).
   See Figure 10-13.
   
   [a] If the measured voltage is less than 10.5 volts, charge the batteries or check for bad 12 volt wire. Refer to section 10.17.7.
   
   [b] If the voltage is greater than 10.5 volts, replace the display; verify repair. Refer to section 10.17.7.

10.17.3 Check for Open Data Link Wires

Perform the following steps to check for open data link wires:

1. Unplug the MAS display harness connector at the display.
2. Insert a jumper wire between cavity E (#900) and cavity D (#901). See Figure 10-13.

3. Unplug the vehicle interface harness at the ECM.

4. Measure resistance between cavity C1 and C2 of the vehicle interface harness connector. See Figure 10-14.

---

**Figure 10-14 ECM Vehicle Harness Connector**

[a] If measured resistance is greater than 10 Ω, one of the data link wires are open. Locate the open and repair or replace the wire; then test. Refer to section 10.17.7.

[b] If measured resistance is less than 10 Ω, proceed with the troubleshooting. Refer to section 10.17.4.

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**10.17.4 Check for Shorted Data Link**

Perform the following steps to check for shorted data link wires:

1. Remove jumper wire.

2. Measure resistance between cavity C1 and C2 of the vehicle interface harness connector. See Figure 10-14.

[a] If the measured resistance is less than 10 Ω, the data link wires are shorted to each other. Replace wire or repair the short; test. Refer to section 10.17.7.

[b] If the measured resistance is greater than 10 Ω, proceed with the troubleshooting. Refer to section 10.17.5.
10.17.5 Check for Short to Ignition

Perform the following steps to check for a short to the ignition:

1. Measure resistance between cavity B3 and C2. Measure again between cavity B3 and C1. See Figure 10-14.
   [a] If any of the readings are less than 10 Ω, that wire is shorted to the ignition wire where the reading was recorded. Repair the short; replace the wire; then test. Refer to section 10.17.7.
   [b] If both readings are less than 10 Ω, replace the MAS display and test. Refer to section 10.17.7.

10.17.6 Information

A blank LED for an item indicates a fault in the sensor used for that display. If all lights (green and red) illuminate during the bulb check sequence, refer to the affected sensor troubleshooting section.

10.17.7 Verify Repairs

Perform the following steps to verify repairs.

☐ Turn ignition ON.
☐ Observe the MAS display.
   [a] If MAS display operates correctly, troubleshooting is complete.
   [b] If MAS display does not operate correctly, repeat the checks. Refer to section 10.17.2.
10.18 EXHAUST GAS RECIRCULATION SYSTEM BASIC CHECKS FOR SERIES 60 ENGINES

For all EGR related concerns (may include exhaust smoke complaints), perform the following steps. If any corrections are made as a result of these checks, test the unit again before proceeding further:

Basic checks for all Series 60 EGR engines require the following tools:

- 1,000 Ohm resistor (low watt)
- DDR suite 8 or DDDL version 4.2 of higher
- Volt Ohm Meter
- Pressure gage 0–200 psi
- Pressure gage 0–100 psi

10.18.1 Check Delta-P sensor

Follow these steps to check the Delta-P sensor:

1. Turn ignition ON.
2. Plug in DDR/DDDL.
3. Read Delta-P counts (EGR DPS)
   [a] If Delta-P counts read 82–122, verify that the EGR pipes and hoses are correctly assembled from the EGR tube to the Delta-P sensor. Reversed hoses or pipes will create black smoke and surging. Go to step 3[b].
   [b] Also inspect carefully for split or leaking pipes or hoses in the EGR mixer tube from the EGR cooler to the intake manifold. If hoses/pipes are correct, Refer to section 10.18.2.
   [c] If counts do not fall within the 82–122 range, replace Delta-P sensor; then go to Test.

10.18.2 Check Variable Output Pressure Device (VPOD) P/N and Supply Voltage

The following checks should be performed for the VPOD P/N and supply voltage:

1. Check VPOD label to determine if it is +12V or +24V compatible.
2. Unplug VPODs mating connector. A 1,000 Ohm resistor is needed for the next step. Insert the resistor between cavity 1 and 3 for ease of checking with the VOM.
   [a] Turn ignition switch ON.
   [b] Measure voltage from pin 3 to pin 1.
   [c] Plug in DDR and check ECM voltage.
3. Is the VPOD P/N and voltage, and ECM voltage correct?
   [a] If the VPOD P/N and voltage are correct, go to section 10.18.3.
10.18.3 Check VPOD Wiring

The following checks should be performed for the VPOD wiring.

**NOTE:**
VPOD power should have been verified under the P/N check. If not, refer to section 10.18.2.

1. Turn ignition switch ON.
2. Unplug the VPOD mating connector.
3. Insert a 1,000 ohm resistor between cavities #2 and #1 for the 12V version, or cavities #2 and #3 for the 24V version.
4. Connect a VOM to the VPOD connector between pin #2 and pin #3 for the 12V VPOD or pin #2 and pin #1 for the 24V VPOD.
5. Using a DDR/DDDL, activate the PWM #2 (EGR Valve) and PWM #4 (VNT), and ensure:
   
   [a] Activating 11% duty cycle: VDC = 90% of the VPOD supply voltage ± 1 volt
       (e.g. voltage to VPOD = 13.8V * 0.9 = 12.42V; therefore 11.42V to 13.42V at PWM is okay.)

   [b] Activating 90% duty cycle: VDC = 10% of the VPOD supply voltage ± 1 volt.
       (e.g. voltage to VPOD = 13.8V * 0.1 = 1.38V, therefore 0.38V to 2.38V at PWM is okay.)

6. Note any air leakage when PWMs are activated to 90% and correct the leaks as needed.

**NOTE:**
Both actuators operate their component with full travel of the linkage.

[a] If both of the PWM voltage measurements are correct, go to section 10.18.4.

[b] If the PWM voltage measurements are incorrect, and the wiring checks are okay, try a test ECM programmed for EGR, or contact DDC Technical Service.
10.18.4 Check VPOD Input Pressure

Follow these steps to check VPOD input pressure:

1. Measure VPOD input pressure to port 1; ensure it is between 703 – 1296 kPa (102 – 188 psi).
   
   [a] If the supply pressure is not between 703 – 1296 kPa (102 – 188 psi), troubleshoot the vehicle air system until that result is obtained.
   
   [b] If the supply pressure is between 703 – 1296 kPa (102 – 188 psi), go to section 10.18.5.

10.18.5 Check VPOD Output Pressure

Follow these steps to check VPOD output pressure:

1. Disconnect the air hoses from the EGR and VGT (Variable Geometry Turbocharger) actuators.

2. Install pressure gauges (accurate to within 1.4 kPa [0.2 psi]) at the outlet of the EGR and VGT hoses. (Use two gauges, or test separately.)

3. Using the DDR/DDDL, activate PWM #2 (EGR) and PWM #4 (VNT) duty cycles and monitor the output pressure from the VPOD.

4. Test: Activating 11 % duty cycle: Pressure = 120 ± 14 kPa (17.4 ± 2 psi). Go to steps 5[a] and 5[b].

5. Test: Activating 90 % duty cycle: VDC = 500 ± 14 kPa (72.5 ± 2 psi).
   
   [a] If the VPOD readings are as listed, go to section 10.18.6.

   [b] If the results in this step cannot be attained, replace the VPOD.
10.18.6 Check for Active Codes

Follow this procedure to check for active codes.

1. Turn ignition ON.
2. Plug in DDR/DDDL.
3. Read active codes.
4. Record or print codes. Ensure that PID, SID, and FMI are recorded. Refer to the proper code section of this guide to troubleshoot that code.

NOTE:
FMIs listed as 14 are diagnostic information codes and no troubleshooting is required. For example, an engine derates due to high TCO temperature; a 404/14 code will be stored. This would indicate that conditions warranted having the ECM derate the fueling to the engine. If the customer complaint was a power loss, it could be explained that loss of power was done by the ECM to protect other engine components.

5. If the issue is not related to the EGR system components, or assistance is needed, contact Detroit Diesel Technical Service.

10.18.7 Test

Follow these steps to test:

1. Reassemble connectors or components.
2. Start and run the engine.
3. Perform loaded road test if this is necessary to duplicate original complaint.
   [a] If symptoms/codes are gone, repairs are complete.
   [b] If any codes display, review this section again; contact Detroit Diesel Technical Service.