SMCS - 1401

i09557504

Use this procedure to troubleshoot the electrical system if a problem is suspected with the power to the engines Electronic Control Module (ECM). Use this procedure if any of the diagnostic codes in Table 1 are active or easily repeated.

Table 1

Diagnostic Trouble Codes for the Electrical Power Supply			
J1939 Code	**CDL Code**	**Code Description (code descriptions may vary)**	**Comments**
158-2	1834-2	Ignition Key Switch loss of signal	The ECM detects the following conditions: The signal from the keyswitch was erratic because the keyswitch was cycled at least three times within the last second. If equipped, the warning lamp will come on. The diagnostic code will be logged. The ECM will stop energizing the injector solenoids. The engine will shut down.
168-0	168-0	Electrical System Voltage High	The ECM detects the following conditions: For 24 Volt DC systems, the battery voltage to the ECM exceeds 32 Volts for more than 0.5 seconds. For 12 Volt DC systems, the battery voltage to the ECM exceeds 16 Volts for more than 0.5 seconds. The keyswitch is in the ON mode. The engine is not cranking. The engine is running for more than 30 seconds. The ECM will log the diagnostic code. If equipped, the warning lamp may come on.
168-1	168-1	Electrical System Voltage Low	The ECM detects the following conditions: The engine is running. The engine is not cranking. The diagnostic code will normally be logged. The check engine lamp and the warning lamp may come on.
168-2	168-2	Electrical System Voltage erratic,	The ECM detects the following conditions:

		intermittent, or incorrect	Three voltage readings that are below 6 Volts DC in a period of 7 seconds will be detected by the ECM. The voltage mustsubsequently increase to more than 9 Volts DC. The keyswitch is in the ON position. The engine is running. The engine is not cranking. The diagnostic code will normally be logged. The check engine lamp and the warning lamp may come on.
168-3	168-3	Electrical System Voltage High	The ECM detects the following conditions: The battery voltage to the ECM exceeds 32 VDC for more than 3 seconds. The keyswitch is in the ON position. The engine is not cranking. The engine is running for more than 30 seconds. The ECM will log the diagnostic code. A warning will appear on the control panel.
168-4	168-4	Electrical System Voltage Low	The ECM detects the following conditions: The battery voltage to the ECM is below 18 VDC for more than 3 seconds. The keyswitch is in the ON position. The engine is not cranking. The engine is running for more than 30 seconds. The ECM will log the diagnostic code. The engine will be derated. A warning will appear on the control panel.

The ECM receives electrical power (battery voltage) through the wiring that is supplied by the manufacturer of the application. Unswitched battery+ voltage is supplied through P1: 7, 8, 15 and 16. The battery- is supplied through P1: 1, 2, 3, 9 and 10. The ECM receives the input from the keyswitch at P1:40 when the keyswitch is in the ON position or in the START position. When the ECM detects battery voltage at this input, the ECM will power up. When battery voltage is removed from this input, the ECM will power down.

The cause of an intermittent power supply to the ECM can occur on either the positive side or on the negative side of the battery circuit. The connections for the unswitched battery+ may be routed through a dedicated protection device (circuit breaker).

Some applications may be equipped with an engine protection shutdown system or an idle timer shutdown system that interrupts electrical power to the keyswitch. The engine protection shutdown system can be an aftermarket device and the idle timer shutdown system can be external to the ECM. Some of these systems will not supply power to the ECM until one of the following conditions is met:

- The engine is cranked.
- The engine oil pressure achieves acceptable limits.
- An override button is pressed.

These devices may be the cause of intermittent power to the ECM. These devices may also shut down the engine.

Usually, battery power to the diagnostic connector is available and the battery power to the data link connector is independent of the keyswitch. Therefore, although it is possible to power up the electronic service tool, there may be no communication with the engine ECM. The engine ECM requires the keyswitch to be in the ON position in order to maintain communications. The ECM may power down a short time after connecting the electronic service tool if the keyswitch is in the OFF position. This is normal.

For intermittent faults such as intermittent shutdowns that could be caused by the application wiring, temporarily bypassing the application wiring may be an effective means of determining the root cause. If the symptoms disappear with the bypass wiring, the application wiring is the cause of the fault. A means of bypassing the application wiring is explained in this test procedure. This is especially important for applications that do not provide dedicated circuits for the unswitched battery and the connections for the keyswitch.

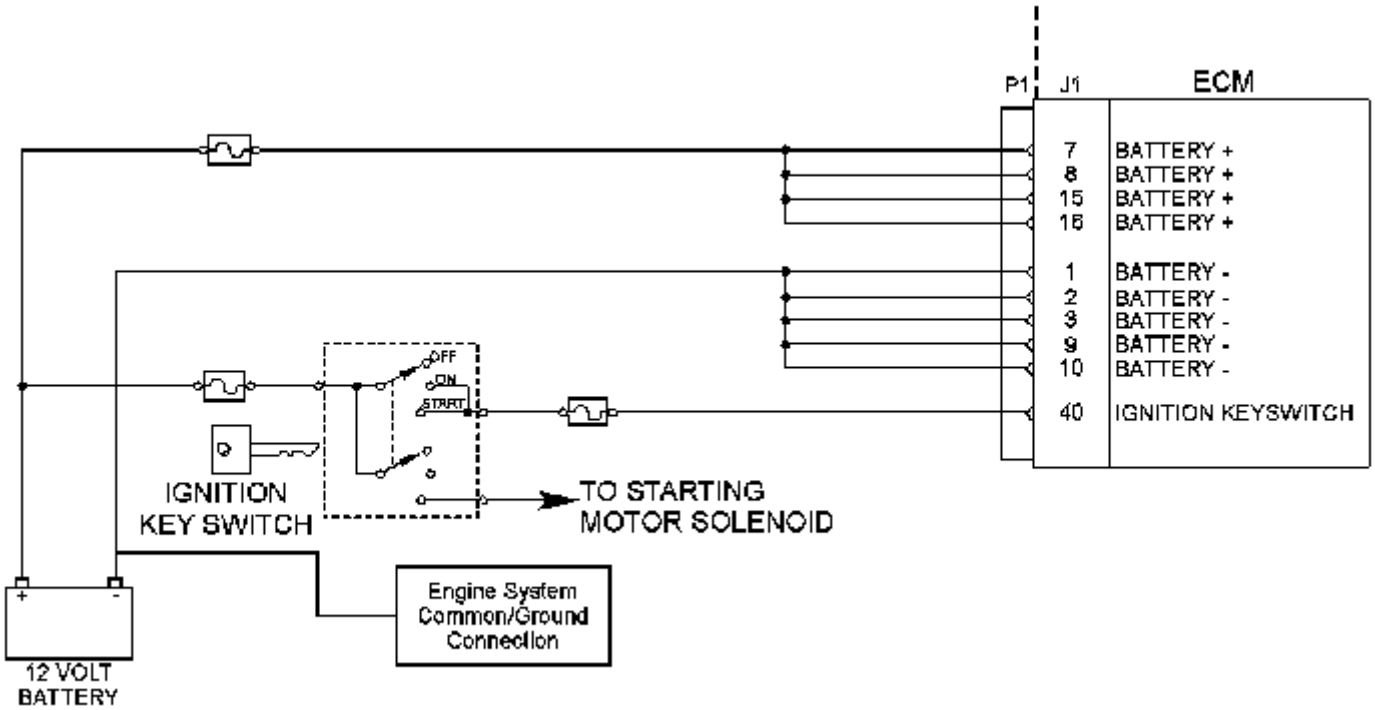

Illustration 1 g01803755
Schematic for the ignition keyswitch and battery supply circuit

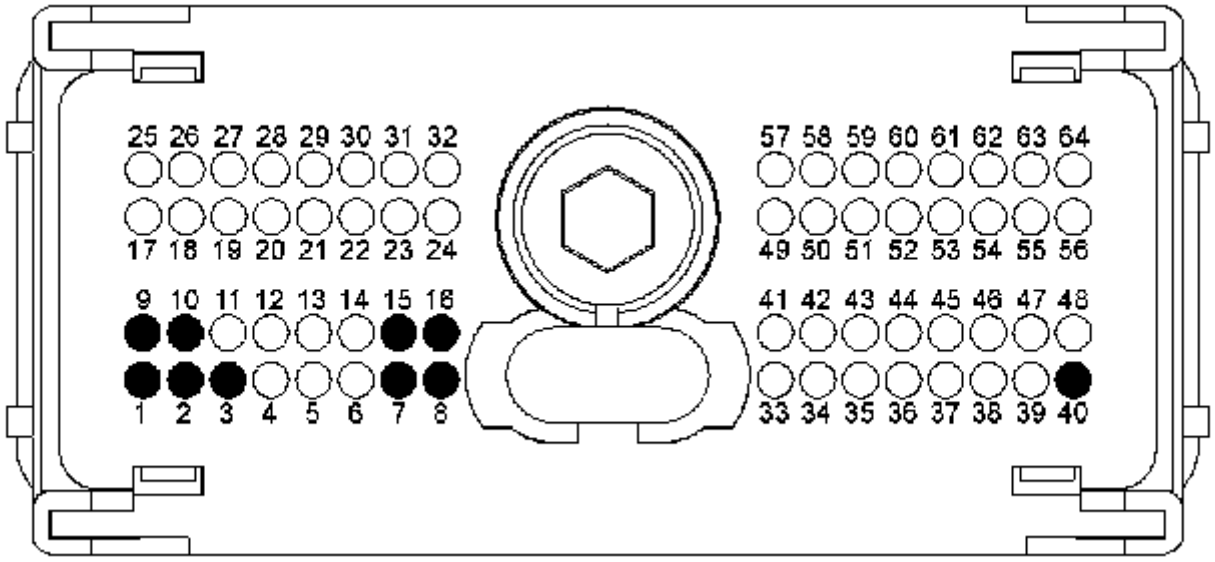

Illustration 2 g01803934
View of the pin locations on the P1 connector for the ignition keyswitch and battery supply circuit
(1) Battery ground (GND)
(2) Battery ground (GND)
(3) Battery ground (GND)
(7) Battery+
(8) Battery+
(9) Battery ground (GND)
(10) Battery ground (GND)
(15) Battery+
(16) Battery+
(40) Ignition key switch

Complete the procedure in the order in which the steps are listed.

Table 2

Troubleshooting Test Steps	Value	Results
1. Inspect Electrical Connectors and Wiring **A.** Thoroughly inspect the P1 connector, the battery connections and the connections to the keyswitch. Refer to Troubleshooting, Electrical Connectors - Inspect for details. **B.** Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the following connections: P1: 7, 8, 15, 16 (Unswitched Battery+) P1: 1, 2, 3, 9, 10 (Battery-) P1:40 (keyswitch)	Damaged wire or connector. Blown fuse.	**Result:** All connectors, pins and sockets are completely coupled and/or inserted and the harness is free of corrosion, of abrasion or of pinch points. The harness and connectors appear to be OK. Proceed to Test Step 2. **Result:** A damaged wire or damaged connector was found. **Repair:** Repair the connectors or the harness and/or replace the connectors or the harness. Ensure that all of the seals are correctly in place and ensure that the connectors are completely coupled. Use the electronic service tool to clear all logged diagnostic codes. Verify that the repair eliminates the fault.

C. Use the electronic service tool to perform a "Wiggle Test". Special attention must be paid to the following connections: P1: 7, 8, 15, 16 (Unswitched Battery+) P1: 1, 2, 3, 9, 10 (Battery-) P1:40 (keyswitch) **D.** Check the ECM connector for the correct torque of 5.0 N·m (44 lb in). **E.** Check the harness for abrasion and for pinch points from the battery to the ECM, and from the keyswitch to the ECM.		
2. Check for Active Diagnostic Codes or Logged Diagnostic Codes **A.** Connect the electronic service tool to the diagnostic connector. **B.** Turn the keyswitch to the ON position. **C.** Monitor the active diagnostic code screen on the electronic service tool. Check and record any active diagnostic codes or logged diagnostic codes. **Note:** Wait at least 30 seconds for the diagnostic codes to become active.	Diagnostic Codes	**Result:** Diagnostic code 168-0, 168-1, 168-3 or 168-4 is active. **Repair:** If the fault is intermittent, refer to Troubleshooting, "Battery Problem". **Result:** Diagnostic code 168-2 or diagnostic code 1834-2 is active or logged. **Note:** Diagnostic code 1834-2 can be generated by rapidly cycling the keyswitch. If diagnostic code 1834-2 is logged but not active, this may be the cause. Proceed to Test Step 3. **Result:** No diagnostic code is active. The fault is no longer present. **Repair:** If the fault is intermittent, refer to Troubleshooting, "Electrical Connectors - Inspect".
3. Check the Battery Voltage at the ECM Connector **A.** Disconnect the P1 connector from the ECM. **B.** Turn the keyswitch to the ON position.	For 12V Systems, 11.0 - 13.5 VDC For 24V Systems, 22.0 - 27.0	**Result:** The ECM is receiving the correct voltage. **Repair:** If an intermittent fault is suspected, refer to Troubleshooting, "Electrical Connectors - Inspect". **Result:** The ECM is not receiving the correct voltage.

C.Measure the voltage between P1:7 (Unswitched Battery+) and P1:1 (Battery-). **D.** Measure the voltage between P1:8 (Unswitched Battery+) and P1:2 (Battery-). **E.** Measure the voltage between P1:15 (Unswitched Battery+) and P1:9 (Battery-). **F.** Measure the voltage between P1:16 (keyswitch) and P1:10 (Battery-). **G.** Measure the voltage between P1:40 (keyswitch) and P1:3 (Battery-). **H.** Turn the keyswitch to the OFF position.	VDC	**Repair:** Check for continuity in the harness for the keyswitch from P1:40 through the keyswitch circuit to the batteries. Check the circuit protection for the circuit. For intermittent faults such as intermittent shutdowns that could be caused by the application wiring, temporarily bypassing the application wiring may be an effective means of determining the root cause. Proceed to Test Step 5. **Result:** No voltage is present on P1: 7, 8, 15, 16. **Repair:** Check for continuity in the harness for the unswitched Battery+ from the ECM to the batteries. Check the circuit protection for the circuit. Check for continuity in the harness for the Battery- from the ECM to the batteries. For intermittent faults such as intermittent shutdowns that could be caused by the application wiring, temporarily bypassing the application wiring may be an effective means of determining the root cause. Proceed to Test Step 5. **Result:** Battery voltage is out of range. Proceed to Test Step 4.
4. Check the Batteries **A.** Load test the batteries. Use a suitable battery load tester.	For 12V Systems, 11.0 VDC For 24V Systems, 22.0 VDC	**Result:** The batteries pass the load test. For 12 Volt systems, the measured voltage is at least 11.0 Volts DC. For 24 Volt systems, the measured voltage is at least 22.0 Volts DC. **Repair:** Refer to the service manual for the application for instructions on troubleshooting the application harness. Troubleshoot the application harness and repair the application harness, as required. Verify that the repairs eliminate the fault. **Result:** The batteries do not pass the load test. For 12 Volt systems, the measured voltage is less than 11.0 Volts DC. For 24 Volt systems, the measured voltage is less than 22.0 Volts DC.

		Repair: Recharge or replace the faulty batteries. Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair eliminates the fault.

WARNING

Batteries give off flammable fumes which can explode.

To avoid injury or death, do not strike a match, cause a spark, or smoke in the vicinity of a battery.

NOTICE

Do not connect the bypass harness to the battery until all of the in-line fuses have been removed from the Battery+ line. If the fuses are not removed before connection to the battery, a spark may result.

Note: This bypass harness is only for test applications. This bypass harness must be removed before the application is released to the customer. The bypass harness can be used to determine if the cause of the intermittent problem is interruptions in battery power to the ECM or to the keyswitch circuit.

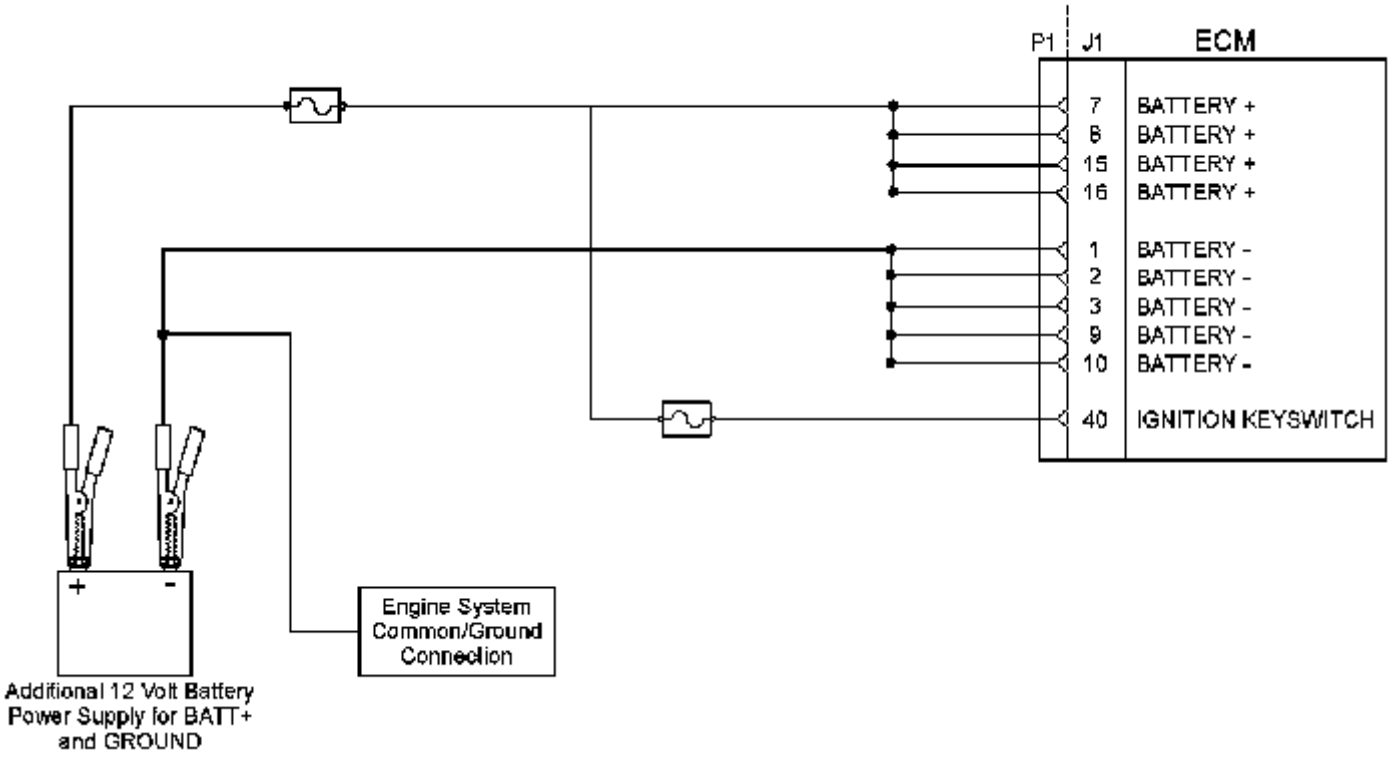

Illustration 3 g01803954
Schematic for the bypass application harness

Table 3

5. Bypass the Application Harness **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the P1 connector from the ECM. **C.** Connect a bypass harness to the ECM. **D.** Remove the fuses from the Battery+ wire of the bypass harness and connect the Battery+ and the Battery- wires directly to the battery terminals. **Note:** This bypass directly connects the circuit for the keyswitch to the ECM. The ECM will remain powered until the connection to the unswitched battery+ line is disconnected. Remove the fuses from the in-line fuse holder to power down the ECM. Do not connect the bypass to the battery terminals or do not remove the bypass from the battery terminals without first removing the in-line fuses. **E.** Use a multimeter to measure the voltage between P2:46 and ground. The voltage should be +5 Volts DC.	Bypass Application Harness	If the measured voltage between P2:46 and ground is +5 Volts DC, installing the bypass has eliminated the fault. **Result:** The symptoms disappear when the bypass harness is installed. Also, the symptoms return when the bypass harness is removed. **Repair:** The fault is in the wiring for the application that supplies power to the ECM. Check for aftermarket engine protection switches that interrupt power. Send the machine to the OEM dealer to repair. **Result:** The measured voltage is not +5 VDC **Repair:** Perform the following procedure: Connect the bypass to another

Note: Remove the bypass harness and restore all wiring to the original condition after testing.		battery and verify if the fault is resolved. If the fault is resolved, the fault is with the batteries on the application. If the fault still exists, make sure that the latest flash file for the application is installed in the ECM. Refer to Troubleshooting, "ECM Software - Install". Contact the Dealer Solutions Network (DSN). If the Technical Communicator recommends the use of a test ECM, install a test ECM. Refer to Troubleshooting, "ECM - Replace". Use the electronic service tool to recheck the system for active diagnostic codes. If the fault is resolved with the test ECM, reconnect the suspect ECM. If the fault returns with the suspect ECM, replace the ECM. Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair eliminates the fault.