[Previous Screen](#)

< Product: GENERATOR SET  
Model: 3456 GENERATOR SET C4G  
Configuration: 3456 Generator Set C4G00001-UP

## Troubleshooting

### 3406E and 3456 Generator Set Engines

Media Number -REN2227-04

Publication Date -01/07/2004

Date Updated -19/07/2004

i02090412

## Speed Control - Test

SMCS - 1913-038

### System Operation Description:

The speed control provides a throttle signal and a droop signal to the engine's Electronic Control Module (ECM). The output for rated speed is a pulse width modulated signal (PWM) at a constant frequency. The speed signal varies with the position of the speed adjust potentiometer. The output for droop is a PWM signal at a constant frequency. The droop signal varies with the position of the droop adjust potentiometer. The output signal is referred to as a duty cycle or as a PWM signal. The output signal is expressed as a percentage between 0 and 100 percent for the speed adjust and a percentage between 0 and 10 percent for the droop adjust.

The ECM calculates the desired engine rpm from the rated speed signal and the droop signal. The rated speed signal is valid when the duty cycle is in the range of 5 to 95 percent. If the ECM determines that the rated speed signal is invalid, the engine rpm will be set to the programmed low idle.

**Note:** Desired speed can be adjusted from 1369 to 1945 rpm for a 60 Hz system and from 1141 to 1621 rpm for a 50 Hz system.

The droop signal is valid when the duty cycle is in the range of 15 to 85 percent. If the ECM determines that the droop signal is invalid, the engine will run with no droop which is referred to as isochronous mode.

Some applications may choose not to use the speed control. Some applications may use a load sharing module. The load sharing module is configured to provide the engine control with a rated speed signal. The signal has the same characteristics as the above defined signal. Some of these load sharing modules can not provide a signal until the engine is running. In these cases, troubleshooting should be performed while the engine is running.

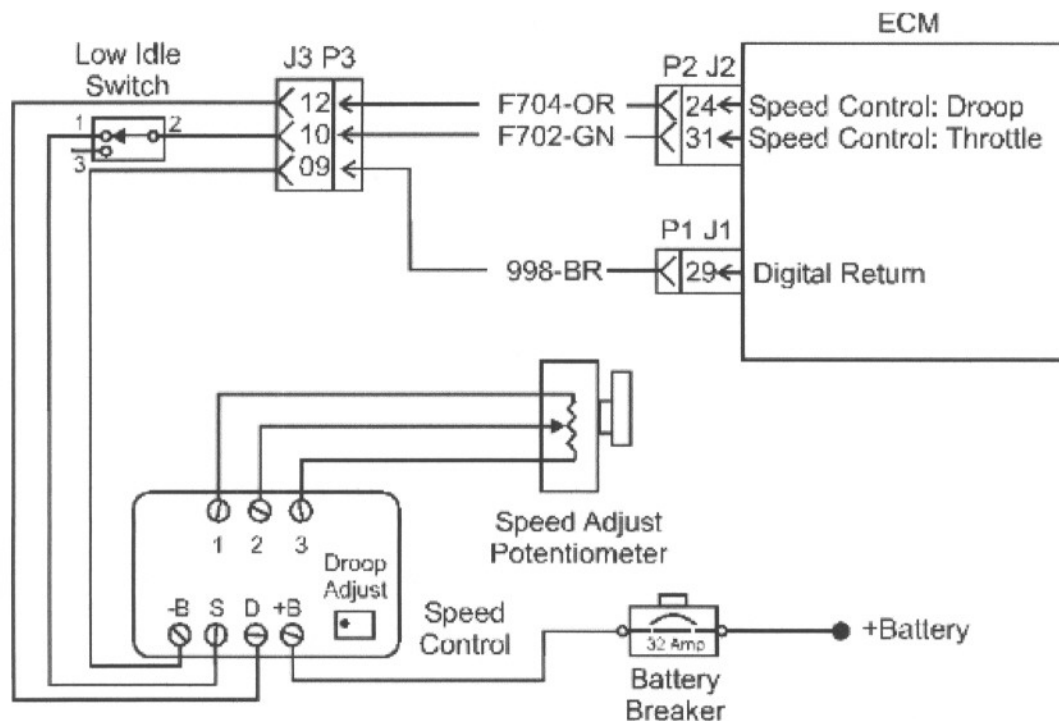


Illustration 1

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Schematic for the speed control circuit

### Test Step 1. Inspect Electrical Connectors and Wiring

- A. Turn the ECS to the OFF/RESET position.
- B. Thoroughly inspect the ECM connectors J1/P1 and J2/P2. Inspect all of the other connectors. Refer to the diagnostic functional test Troubleshooting, "Inspecting Electrical Connectors" for details.
- C. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the circuit.
- D. Check the ECM connector (allen head screw) for the proper torque of 6.0 N·m (55 lb in).
- E. Check the customer connector (allen head screw) for the proper torque of  $2.25 \pm 0.25$  N·m ( $20 \pm 2$  lb in).
- F. Check the harness and the wiring for abrasion and for pinch points.

**Expected Result:**

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

**Results:**

- **OK** - The connectors and wiring are okay. Proceed to Test Step 2.
- **Not OK** - The connectors and/or wiring are not okay.

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

**Stop.**

**Test Step 2. Check the Supply Voltage to the Speed Control.**

- A. Turn the circuit breaker at the battery to the ON position.
- B. Turn the ECS to the STOP position.
- C. Connect one probe of a voltage test lamp to the +Battery terminal of the speed control. Connect one probe of the voltage test lamp to the -Battery terminal of the speed control.

**Note:** Connect one probe of a voltage test lamp to the +Battery. Connect the other probe of the test lamp to the -Battery in order to verify that the voltage test lamp is functioning properly. The lamp bulb will illuminate if the voltage test lamp is functioning properly.

**Expected Result:**

The voltage test lamp is illuminated.

**Results:**

- **OK** - The voltage supply to the speed control is correct. Proceed to Test Step 3.
- **Not OK** - The test lamp did not illuminate.

**Repair:** Repair the supply circuit for the speed control.

**Stop.**

**Test Step 3. Determine the Component that has Failed.**

- A. Determine if the problem is with the input for the "Speed Control: Throttle" or with the "Speed Control: Droop".
- B. Select "UNSURE" if the source of the problem is unknown.

**Expected Result:**

The throttle position on the Caterpillar Electronic Technician (ET) varies with the turning of the speed adjust potentiometer. The droop on Cat ET varies with the turning of the droop adjust potentiometer.

**Results:**

- **"Rated Speed"** - The throttle position on Cat ET does not vary with the turning of the speed adjust potentiometer. Proceed to Test Step 4.
- **"Droop Speed"** - The droop on Cat ET does not vary with the turning of the droop adjust potentiometer. Proceed to Test Step 5.
- **Unsure** - The problem is not apparent. Proceed to Test Step 4.

**Test Step 4. Check the Throttle Position**

- A. Turn the ECS to the STOP position.
- B. Observe the position of the throttle on Cat ET.
- C. Turn the speed adjust potentiometer to the lowest setting.
  - 60 Hz equals 1369 rpm
  - 50 Hz equals 1141 rpm
- D. Start at the low idle position. Slowly turn the speed adjust potentiometer in the other direction. Monitor the position of the throttle on Cat ET.

**Expected Result:**

The throttle position on Cat ET reads 0 percent at the lowest setting and 0 to 100 percent as the speed adjust potentiometer is adjusted.

**Results:**

- **OK** - The speed control is operating correctly.

**Repair:** The problem may be intermittent. If the problem is intermittent, perform the diagnostic functional test Troubleshooting, "Inspecting Electrical Connectors".

**Stop.**

- **Not OK** - The throttle position on Cat ET does not vary as the speed adjust potentiometer is adjusted. Proceed to Test Step 6.

**Test Step 5. Check the "Speed Control: Droop Signal" on Cat ET.**

- A. Turn the ECS to the STOP position.
- B. Observe the droop on Cat ET.
- C. Slowly turn the droop adjust potentiometer in a clockwise direction. Monitor the droop on Cat ET.

**Note:** Do not overturn the droop adjust potentiometer in the clockwise direction. The signal will become erratic.

- D. Monitor the speed droop on Cat ET. Turn the droop adjust potentiometer in a counterclockwise direction.

### **Expected Result:**

The droop on Cat ET reads 0 percent at the lowest setting and 0 to 10 percent as the droop adjust potentiometer is adjusted.

### **Results:**

- **OK** - The droop is operating correctly.

**Repair:** The problem may be intermittent. If the problem is intermittent, perform the diagnostic functional test Troubleshooting, "Inspecting Electrical Connectors".

### **Stop.**

- **Not OK** - The droop on Cat ET does not vary as the droop adjust potentiometer is adjusted. Proceed to Test Step 7.

### **Test Step 6. Check the Speed Control.**

- A. Remove the wire from the S terminal at the speed control.
- B. Set the multimeter to "VDC". Press the "Hz" button twice so that the % symbol is displayed.
- C. Place one probe of the multimeter on the S terminal of the speed control. Place the other probe on the -Battery terminal of the speed control.
- D. Monitor the output of the percent duty cycle from the speed control on the multimeter. Turn the speed adjust potentiometer from the low setting to the high setting.

**Note:** The throttle position on Cat ET will not match the percent duty cycle on the multimeter.

### **Expected Result:**

The duty cycle is between 4 and 10 percent at the low setting and between 90 and 95 percent at the high setting.

### **Results:**

- **OK** - The speed control is supplying the correct duty cycle. Proceed to Test Step 8.
- **Not OK** - The duty cycle is not correct on the multimeter.

**Repair:** Temporarily install another speed control. Verify that the problem is no longer present. Reinstall the old speed control. If the problem returns, replace the speed control.

**Stop.**

#### **Test Step 7. Check the Droop Signal at the Speed Control.**

- A. Remove the wire from the D terminal of the speed control.
- B. Set the multimeter to "VDC". Press the "Hz" button twice so that the % symbol is displayed.
- C. Place one probe of the multimeter on the D terminal of the speed control. Place the other probe on the -Battery terminal of the speed control.
- D. Monitor the output of the percent duty cycle from the speed control on the multimeter. Turn the droop adjust potentiometer from the low setting to the high setting.

**Note:** The droop on Cat ET will not match the percent duty cycle on the multimeter.

#### **Expected Result:**

The duty cycle is between 15 and 85 percent. This range should be attainable.

#### **Results:**

- **OK** - The speed control is providing the correct droop signal. Proceed to Test Step 9.
- **Not OK** - The problem appears to be in the speed control.

**Repair:** Temporarily install another speed control. Verify that the problem is no longer present. Reinstall the old speed control. If the problem returns, replace the speed control.

**Stop.**

#### **Test Step 8. Check the "Speed Control: Throttle Signal" at the ECM Input.**

- A. Turn the ECS to the STOP position.
- B. Set the multimeter to "VDC". Press the "Hz" button twice so that the % symbol is displayed.
- C. Measure the voltage between pins P2:31 and P1:29 on the ECM connectors.
- D. Monitor the output of the percent duty cycle from the speed control on the multimeter. Monitor the percent throttle position on Cat ET. Turn the speed adjust potentiometer from the low setting to the high setting.

**Expected Result:**

The duty cycle is between 4 and 10 percent at the low setting and between 90 and 95 percent at the high setting. The percent throttle position is between 0 and 100 percent for the above settings of the speed adjust potentiometer.

**Results:**

- **OK** - The duty cycle is correct. Proceed to Test Step 9.
- **Not OK - Duty Cycle** - The duty cycle is not correct.

**Repair:** There is a problem in the wiring between P2:31 and the S terminal of the speed control. Verify that the low idle switch is functioning properly.

**Stop.**

- **Not OK - Throttle Position** - The duty cycle is correct but the throttle position is not correct. The ECM is not processing the correct signal.

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

**Stop.****Test Step 9. Check the Droop Signal at the ECM Input.**

- A. Turn the ECS to the STOP position.
- B. Measure the voltage between pins P2:24 and P1:29 on the ECM connector.
- C. Set the multimeter to "VDC". Press the "Hz" button twice so that the % symbol is displayed.
- D. Monitor the output of the percent duty cycle of the droop signal at the speed control with the multimeter. Monitor the droop on Cat ET. Turn the droop adjust potentiometer from the low setting to the high setting.

**Note:** Do not overturn the droop adjust potentiometer in the clockwise direction. The signal will become erratic.

**Expected Result:**

The duty cycle is between 1 and 15 percent at the fully clockwise setting and between 85 and 99 percent at the fully counterclockwise setting. The droop is between 0 and 10 percent for the above settings of the droop adjust potentiometer.

**Results:**

- **OK** - The duty cycle is correct.

**Repair:****Stop.**

- **Not OK - Duty Cycle** - The duty cycle is not correct.

**Repair:** There is a problem in the wiring between P2:24 and the D terminal of the speed control.

**Stop.**

- **Not OK - Droop** - The duty cycle is correct but the droop is not correct. The ECM is not processing the correct signal.

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

**Stop.**