Hazard Definitions
These terms are used to bring attention to presence of hazards of various risk levels or to important information concerning product life.

**CAUTION**
Indicates presence of hazards that will or can cause minor personal injury or property damage if ignored.

**NOTICE**
Indicates special instructions on installation, operation or maintenance that are important but not related to personal injury hazards.

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Battery Conditions
Until temperatures of electrical system components stabilize, these conditions may be observed during cold start voltage tests.

- **Maintenance/low maintenance battery:**
  - Immediately after engine starts, system volts are lower than regulator setpoint with medium amps.
  - 3-5 minutes into charge cycle, higher system volts and reduced amps.
  - 5-10 minutes into charge cycle, system volts are at, or nearly at, regulator setpoint, and amps are reduced to a minimum.
  - Low maintenance battery has same characteristics with slightly longer recharge times.

- **Maintenance-free battery:**
  - Immediately after engine start, system volts are lower than regulator setpoint with low charging amps.
  - 15-30 minutes into charge cycle, still low volts and low amps.
  - 15-30 minutes into charge cycle, volts increase several tenths. Amps increase gradually, then quickly to medium to high amps.
  - 20-35 minutes into charge cycle, volts increase to setpoint and amps decrease.

- **High-cycle maintenance-free battery:**
  - These batteries respond better than standard maintenance-free. Charge acceptance of these batteries may display characteristics similar to maintenance batteries.

Charge Volt and Amp Values
The volt and amp levels are a function of the battery state of charge. If batteries are in a state of discharge, as after extended cranking time to start the engine, the system volts, when measured after the engine is started, will be lower than the regulator setpoint and the system amps will be high. This is a normal condition for the charging system. The measured values of system volts and amps will depend on the level of battery discharge. In other words, the greater the battery discharge level, the lower the system volts and higher the system amps will be. The volt and amp readings will change, system volts reading will increase up to regulator setpoint and the system amps will decrease to low level (depending on other loads) as the batteries recover and become fully charged.

- **Low Amps:** A minimum or lowest charging system amp value required to maintain battery state of charge, obtained when testing the charging system with a fully charged battery and no other loads applied. This value will vary with battery type.

- **Medium Amps:** A system amps value which can cause the battery temperature to rise above the adequate charging temperature within 4-8 hours of charge time. To prevent battery damage, the charge amps should be reduced when battery temperature rises. Check battery manufacturer’s recommendations for proper rates of charge amps.

- **High Amps:** A system amps value which can cause the battery temperature to rise above adequate charging temperature within 2-3 hours. To prevent battery damage the charge amps should be reduced when the battery temperature rises. Check battery manufacturer’s recommendations for proper rates of charge amps.

- **Battery Voltage:** Steady-state voltage value as measured with battery in open circuit with no battery load. This value relates to battery state of charge.

- **Charge Voltage:** A voltage value obtained when the charging system is operating. This value will be higher than battery voltage and must never exceed the regulator voltage setpoint.

- **B+ Voltage:** A voltage value obtained when measuring voltage at battery positive terminal or alternator B+ terminal.

- **Surface Charge:** A higher than normal battery voltage occurring when the battery is removed from a battery charger. The surface charge must be removed to determine true battery voltage and state of charge.

- **Significant Magnetism:** A change in the strength or intensity of a magnetic field present in the alternator rotor shaft when the field coil is energized. The magnetic field strength when the field coil is energized should feel stronger than when the field is not energized.

- **Voltage Droop or Sag:** A normal condition which occurs when the load demand on the alternator is greater than rated alternator output at given rotor shaft RPM.
CEN N1509 and N1511 Dual Voltage Alternator Description and Operation

N1509 and N1511 100 A (28/14 V) dual voltage alternators are internally rectified. All windings and current-transmitting components are non-moving, so there are no brushes or slip rings to wear out. Energize switch (commonly an oil pressure switch) activates regulator. Field coil is then energized. Upper voltage (28 V) is rectified with standard diodes. Lower voltage (14 V) circuit output current is controlled by SCRs in the drive end housing. Alternator output current is self-limiting and will not exceed rated capacity of alternator.

N3207 regulator used with some units:
- maintains alternator output voltage at regulated settings as vehicle electrical loads are switched on and off.
- maintains equal voltage across battery terminals of series-connected batteries.

N2003 load and battery control device (LBCD) used with these units provides dual-voltage reverse polarity protection and independent control of battery-charging current.
A. Tools and Equipment for Job
- Digital Multimeter (DMM)
- Ammeter (digital, inductive)
- Jumper wires
If no tools are available, monitor LED code.

B. Identification Record
List the following for proper troubleshooting:
- Alternator model number ______________________
- Regulator model number ______________________
- Setpoint listed on regulator _________________
- LBCD model number _________________________

C. Preliminary Check-out
Check symptoms in Table 1 and correct if necessary.

<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Voltage Output</td>
<td>Check: loose drive belt; low battery state of charge. Check: current load on system is greater than alternator can produce. Check: defective wiring or poor ground path; low regulator setpoint. Check: defective alternator and/or regulator.</td>
</tr>
<tr>
<td>No Voltage Output</td>
<td>Check: presence of energize signal. Check: battery voltage at alternator output terminal. Check: defective alternator and/or regulator.</td>
</tr>
<tr>
<td>No 14 V Output</td>
<td>Go to “Flashing Amber” in Table 2, page 6.</td>
</tr>
</tbody>
</table>

D. Basic Troubleshooting
1. Inspect charging system components
Check connections at ground cables, positive cables, and regulator harness. Repair or replace any damaged component before troubleshooting.

2. Inspect load and battery control device connections
Connections must be in proper sequence and clean and tight. See Figure 5, page 7.

3. Inspect connections of vehicle batteries
Connections must be clean and tight.

4. Determine battery type, voltage and state of charge
Batteries must be all the same type for system operation. If batteries are discharged, recharge or replace batteries as necessary. Electrical system cannot be properly tested unless batteries are charged 95% or higher. See page 1 for details.

5. Connect meters to alternator
Connect red lead of DMM to alternator 28 V B+ terminal and black lead to alternator B– terminal. Clamp inductive ammeter on 28 V B+ cable.

6. Operate vehicle
Observe charge voltage.

   CAUTION
   If charge voltage is above 33 volts for 28 V system or 16 V for 14 V system, immediately shut down system. Electrical system damage may occur if charging system is allowed to operate at excessive voltage. Go to Table 1 at left.

   If voltage is at or below regulator setpoint, let charging system operate for several minutes to normalize operating temperature.

7. Observe charge volts and amps in each circuit
Charge voltage should increase and charge amps should decrease. If charge voltage does not increase within ten minutes, continue to next step.

8. Batteries are considered fully charged if charge voltage is at regulator setpoint and charge amps remain at lowest value for 10 minutes.

9. If charging system is not performing properly, go to Chart 1, page 5.
N3207 Regulator
DESCRIPTION AND OPERATION
N3207 Regulator with OVCO is attached directly to the outside of alternator. Regulator setpoint has negative temperature compensation. At 75ºF, the setting is 28.2 V for 28 V system and 14.1 V for 14 V system.

Main diagnostic feature of N3207 regulator consists of two tricolored (red, amber, green) LEDs located on the side of the regulator. One LED indicates 28 V system performance, the other LED indicates 14 V system performance. The two LEDs work independently of each other. See Table 2 for diagnostic features and LED explanations.

OVCO (overvoltage cutout) will trip at any of the following conditions:

- 14 V side trips at voltage **higher** than regulator setpoint that exists longer than 3 seconds of reading voltage above 16 V. OVCO feature detects overvoltage and reacts by signaling relay in F– alternator circuit to open. This turns off alternator (14 V LED is steady RED light). OVCO circuit will reset by either:
  - Restarting engine (regulator regains control of alternator output voltage) OR
  - System falling below 11 V. OVCO will automatically reset.

- 28 V side trips at voltage **higher** than regulator setpoint that exists longer than 2 seconds of reading voltage above 32 V. OVCO feature detects overvoltage and reacts by signaling relay in F– alternator circuit to open. This turns off alternator (28 V LED is steady RED light). OVCO circuit will reset by either:
  - Restarting engine (regulator regains control of alternator output voltage) OR
  - System falling below 22 V. OVCO will automatically reset.

TROUBLESHOOTING
Shut down vehicle and restart engine. If alternator functions normally after restart, a “no output condition” was normal response of voltage regulator to overvoltage condition. Inspect condition of electrical system, including loose battery cables, both positive and negative. If battery disconnects from system, it could cause overvoltage condition in electrical system, causing OVCO circuit to trip.

If you have reset alternator once, and electrical system returns to normal charge voltage condition, there may have been a one time, overvoltage spike that caused OVCO circuit to trip.

If OVCO circuit repeats cutout a second time in short succession and shuts off alternator F– circuit, try third restart. If OVCO circuit repeats cutout a third time, check color of LED while engine is running.

<table>
<thead>
<tr>
<th>LED COLOR</th>
<th>STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFF</td>
<td>Regulator is not energized. Measure E terminal voltage. If voltage above 21 V, regulator is defective.</td>
</tr>
<tr>
<td>FLASHING</td>
<td></td>
</tr>
<tr>
<td>Green</td>
<td>Respective system voltage is at regulated setting and operating under control.</td>
</tr>
<tr>
<td>Amber</td>
<td>Respective system voltage is below regulated setting. Alternator is not producing power or circuit is overloaded. See Chart 1 on page 5 for 28 V systems, Chart 2 for 14 V systems.</td>
</tr>
<tr>
<td>Red</td>
<td>Respective system voltage is above regulated setting. This may occur intermittently with voltage transients or with system faults.</td>
</tr>
<tr>
<td>STEADY</td>
<td></td>
</tr>
<tr>
<td>Red</td>
<td>Alternator is shut down and is not producing power for either voltage. 28 V side trips after 2 seconds of reading voltage above 32 V. 14 V side trips after 3 seconds of reading voltage above 16 V. Regulator remains in this mode until reset by restarting engine or if system voltage drops below 22 V or 11 V, respectively. See Chart 3 on page 6 for 28V systems, Chart 4 for 14 V systems.</td>
</tr>
</tbody>
</table>
Section 3: Advanced Troubleshooting (CONT’D)

Chart 1 – 28 V LED Flashing AMBER – No 28V Alternator Output – Test Charging Circuit

**STATIC TEST – MASTER SWITCH ON, KEY ON, ENGINE OFF**

Test for battery voltage at alternator 28 V B+ terminal. Does battery voltage exist?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Repair vehicle wiring as necessary. Continue test.

Jumper 28 V B+ terminal on alternator to E terminal on regulator. Wait 10 seconds. Run engine. Does alternator charge and is 28 V LED flashing GREEN?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Turn off engine, leave key on. Remove jumper wire. Go to E terminal on regulator. Test for battery voltage going into E terminal from battery. Does battery voltage exist?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Repair vehicle circuit to E terminal. Vehicle charging circuit test is complete.

Run engine and re-test charging circuit for operation.

Turn off engine, leave key on. Connect jumper wire from pin A in harness plug to B– terminal on alternator. Spark will occur. Touch steel tool to shaft to detect significant magnetism. Is shaft magnetized?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Alternator is defective.

Test for battery voltage at pin D in harness plug. Does battery voltage exist?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Alternator is defective.

Connect DMM red lead to pin C on harness plug. Connect black lead to alternator B– terminal. Does continuity exist?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Alternator is defective.

Set DMM to diode test. Connect DMM red lead to pin F on harness plug. Connect black lead to alternator B+ terminal. Reverse leads. Meter should read OL in one direction, and voltage drop in the other direction. Do tests prove out?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Regulator is defective.

Alternator is defective.
Section 3: Advanced Troubleshooting

Chart 2 – 14 V LED Flashing AMBER – No 14 V Alternator Output – Test Circuit

Run engine. Is 28 V LED on regulator flashing GREEN?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>Go to Chart 1.</th>
</tr>
</thead>
</table>

With engine off, is battery voltage present at alternator 14 V B+ terminal?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>Repair vehicle wiring as necessary. Continue test.</th>
</tr>
</thead>
</table>

Connect DMM red lead to pin E on alternator-to-regulator harness plug. Connect black lead to pin C on same plug. Does battery voltage exist?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>Alternator is defective.</th>
</tr>
</thead>
</table>

Substitute a known good regulator. Run engine. Is regulator setpoint voltage present and is 14 V LED flashing GREEN?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>Original regulator was defective. Alternator is defective.</th>
</tr>
</thead>
</table>

Chart 3 – 28 V LED Steady RED – No Alternator Output – Test OVCO Circuit

Remove 28 V and 14 V positive battery cables AT BATTERY PACK before proceeding.

Unplug alternator-to-regulator harness from regulator. Connect red lead from DMM to socket A in plug. Connect black lead to B– terminal. Does resistance read 2.2 ± 0.2 ohms?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>Alternator is defective.</th>
</tr>
</thead>
</table>

Set DMM to manual ohms scale. Connect red lead from DMM to socket A in plug. Connect black lead to B– terminal. Does meter read OL (out of limits)? Then connect red lead to socket D and black lead to B– terminal. Does meter read OL (out of limits)?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>Alternator is defective.</th>
</tr>
</thead>
</table>

Reconnect cables. Replace existing regulator with known good regulator. Run engine. Does OVCO trip?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>Alternator is defective. Original regulator is defective.</th>
</tr>
</thead>
</table>

Chart 4 – 14 V LED Steady RED – No Alternator Output – Test OVCO Circuit

Run engine. Is 28 V LED on regulator flashing GREEN?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>Go to Chart 3.</th>
</tr>
</thead>
</table>

Replace regulator with known good regulator. Run engine. Does OVCO trip?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>Alternator is defective. Original regulator is defective.</th>
</tr>
</thead>
</table>
N2003 Load & Battery Control Device
DESCRIPTION AND OPERATION
Main diagnostic feature of the LBCD is an LED display located on the side of the device. The LBCD monitors alternator output and vehicle electrical system and regulated voltage. If system voltage falls below 20.5 volts, N2003 will disconnect batteries and supply trickle charge. See Table 3 for diagnostic features and LED display explanations.

### TABLE 3 – N2003 Load & Battery Control Device Diagnostics

<table>
<thead>
<tr>
<th>CHARGING SYSTEM LED STATUS</th>
<th>N2003 LED COLOR</th>
<th>N2003 STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>Unlit (Clear)</td>
<td>Alternator not charging.</td>
</tr>
<tr>
<td>ON</td>
<td>Solid Amber</td>
<td>Alternator RPM below 1500 rpm.</td>
</tr>
<tr>
<td>OFF</td>
<td>Solid Green</td>
<td>System operating properly. Batteries are connected to system. Alternator charging.</td>
</tr>
<tr>
<td>OFF</td>
<td>Solid Red</td>
<td>Batteries are disconnected from system and battery voltage is less than 24.5 V. Alternator 28 V B+ output terminal is at regulated voltage.</td>
</tr>
</tbody>
</table>

![Figure 4 – N2003 Control Harness Receptacle](image)

![Figure 5 – N2003 Load & Battery Control Device](image)
Chart 5 – 28V Only – N2003 Sequence of Operation

DYNAMIC TEST — MASTER SWITCH ON, KEY ON, ENGINE ON

Start

Steady AMBER

Read RPM

Is RPM greater than 1500?
Yes | No

Charging system indicator LED is “OFF.”
Wait ten seconds.

Read System Voltage

Is System Voltage less than 20.5 V?
Yes | No

Steady GREEN.
System is operating properly.

Steady RED

Batteries are disconnected.

Read Alternator Voltage

Is Alternator Voltage less than 24 V?
Yes | No

Trickle charge “OFF.”
Trickle charge “ON.”

Read Battery Voltage

Is Battery Voltage more than 24.5 V for one time and one time only?
Yes | No

Batteries are reconnected.
Steady GREEN.
System is operating properly.

Are batteries disconnected?

Yes | No

Connect batteries and then go back to “Read System Voltage” above
LBCD is defective. Replace.