Hazard Definitions

CAUTION

NOTICE

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Battery Conditions

NOTICE

- **Maintenance/Low Maintenance Battery**
  - — Immediately after engine starts, system volts are lower than regulator setpoint, amps are medium.
  - — 3–5 minutes into charge cycle, system volts increase, amps decrease.
  - — 5–10 minutes into charge cycle, system volts increase to, or near, regulator setpoint and amps decrease to a minimum.
  - — Low maintenance battery has same characteristics with slightly longer recharge times.
- **Maintenance-free Battery**
  - — Immediately after engine starts, system volts are lower than regulator setpoint, low charging amps.
  - — Once charge cycle begins, low volts and low amps are still present.
  - — After alternator energizes, voltage will increase several tenths. Amps will increase gradually, then quickly, to medium to high amps.
  - — Finally, volts will increase to setpoint and amps will decrease.

  The time it takes to reach optimum voltage and amperage will vary with engine speed, load, and ambient temperature.
- **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.
- **AGM (Absorbed Glass Mat) Maintenance-free Battery**
  These dry-cell batteries respond better than standard maintenance-free. If battery state of charge drops to 75% or less, batteries should be recharged to 95% or higher separately from the engine's charging system to avoid damaging charging system components and to provide best overall performance. Charge acceptance of these batteries may display characteristics similar to maintenance batteries.

Battery Charge Volt and Amp Values

Volt and amp levels fluctuate depending on the battery state of charge. If batteries are in a state of discharge—as after extended cranking time to start the engine—system volts will measure lower than the regulator setpoint after the engine is restarted and system amps will measure higher. This is a normal condition for the charging system; the greater the battery discharge level, the lower the system volts and the higher the system amps. The volt and amp readings will change as batteries recover and become fully charged: system volts will increase to regulator setpoint and system amps will decrease to low level (depending on other loads).

- **Low Amps:** 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:** System amps value which can cause the battery temperature to rise above 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 charge amp rates.
- **High Amps:** System amps value which can cause the battery temperature to rise above adequate charging temperature within 2-3 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 charge amp rates.
- **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:** 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:** Voltage value obtained when measuring voltage at battery positive terminal or alternator B+ terminal.
- **Surface Charge:** Higher than normal battery voltage occurring when the battery is disconnected from battery charger. The surface charge must be removed to determine true battery voltage and state of charge.
- **Significant Magnetism:** Change in strength or intensity of a magnetic field present in 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:** Normal condition occurring when the load demand on alternator is greater than rated alternator output at given rotor shaft RPM.

CEN N1601, N1602, N1603, N1604
Alternator and Regulator Description and Operation

The alternators listed below are self-rectifying. All windings and current-transmitting components are non-moving, so there are no brushes or slip rings to wear out. Energize switch activates regulator. Field coil is then energized.

- **N1601** 28 V 400 A
- **N1602** 28 V 400 A with optional 28 V/ 14 V (50 A maximum on 14 V)
- **N1603** 28 V 450 A
- **N1604** 28 V 400 A

N3107 regulator used on some N1601, N1603, and N1604 alternators maintains alternator output voltage at regulated setting as vehicle electrical loads are switched on and off. Alternator output current is self-limiting and will not exceed rated capacity of alternator. The regulator has:

- an AC terminal to provide optional AC voltage output tap.
- overvoltage cutout (OVCO). Regulators with OVCO (overvoltage cutout) will trip at vehicle electrical system voltages 5.3641 0 TD T -2.32-6uiove)Tj41 0 TD2 l3.236 0 TD-0009 Tc0009 T 35(v3Tws)-.3.1(o)8.4(l)13.5(515.3.8

    - ar7(h)8.8(e)-13at.9(g)-3i.3(p)-v6.tem-1255 136.7(r)7r c2ueag:s 5l sit(g a)3-8.(CO)TJ.75 -1.1111-856(a)-40(r)6.216(06(8.13l)1.

Tools and Equipment for Job

- Digital Multimeter (DMM)
- Ammeter (digital, inductive)
- Jumper wires

Identification Record

List the following for proper troubleshooting:

❑ Alternator model number _____

❑ Regulator model number _____

❑ Setpoint listed on regulator _____

Preliminary Check-out

Check symptoms in Table 1 and correct if necessary.

TABLE 1 – System Conditions

SYMPTOM	ACTION
Low Voltage Output	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 or regulator. Check: wrong regulator.
High Voltage Output	Check: high regulator setpoint. Check: defective regulator. Check: alternator.
No 28 V Output	Check: broken drive belt. Check: battery voltage at alternator output terminal. Check: defective alternator or regulator.
No 14 V Output	Go to Chart 2, page 7.

Basic Troubleshooting

1. **Inspect charging system components for damage**
   Check connections at B– cables, B+ cables, B+ interconnect cable, B– interconnect cable, and alternator-to-regulator harness. Repair or replace any damaged component before troubleshooting.
2. **Inspect all vehicle battery connections**
   Connections must be clean and tight.
3. **Determine battery voltage and state of charge**
   If batteries are discharged, recharge or replace batteries as necessary. Electrical system cannot be properly tested unless batteries are charged 95% or higher. In addition, open circuit voltages must be within ± 0.2 V.
4. **Connect meters to alternator**
   Connect red lead of DMM to alternator anti-drive end B+ terminal and black lead to alternator anti-drive end B– terminal. Clamp inductive ammeter on anti-drive end B+ cable.
5. **Operate vehicle**
   Observe charge voltage at batteries with engine running (nom. 27-28 V or 13.5-14.0 V).

   CAUTION

   If voltage is at or below regulator setpoint, let charging system operate for several minutes to normalize operating temperature.
6. **Observe charge volts and amps**
   Charge voltage should increase and charge amps should decrease. If charge voltage does not increase within ten minutes, continue to next step.
7. **Batteries** are considered fully charged if charge voltage is at regulator setpoint and charge amps remain at lowest value for 10 minutes.
8. **If charging system** is not performing properly, go to:
   - N1601, N1602, N1603—Chart 1 on page 6
   - N1604—Chart 4 on page 9

Advanced 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.

N3223 only: If OVCO circuit repeats cutout a second time in short succession and shuts off alternator field circuit, try third restart. If OVCO circuit repeats cutout a third time, check color of LED while engine is running and go to Chart 3a or 3b, page 8.

Other regulators: 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, go to Chart 3 on page 8; or for N1604, go to chart 5 on page 10.

N3223 Regulator

DESCRIPTION AND OPERATION

N3223 regulator with OVCO is attached directly to the outside of alternator. Regulator setpoint has flat temperature compensation. Voltage setpoint is 28.0 ±1.0 V and 14.0 ±0.5.

Main diagnostic feature of regulators 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) operation:

- 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 disabling the alternator field circuit. This turns off alternator (14 V LED is steady RED light). OVCO circuit will reset automatically when:
  - — restarting engine
    OR
  - — system voltage falls below 11 V.
- 28 V side trips at voltage **higher** than regulator setpoint that exists longer than 3 seconds of reading voltage above 32 V. OVCO feature detects overvoltage and reacts by disabling the alternator field circuit. This turns off alternator (28 V LED is steady RED light). OVCO circuit will reset automatically when:
  - — restarting engine
    OR
  - — system voltage falls below 22 V.

TABLE 2 – N3223 Regulator LED Operation Modes

LED COLOR	STATUS
FLASHING	
Amber	No AC/rotation. See Chart 1 on page 6 for 28 V systems, Chart 2 on page 7 for 14 V systems.
Red	Alternator is shut down and is not producing power for either voltage. 28 V side trips after 3 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 3a or 3b on page 8.
STEADY	
Green	Respective system voltage is at regulated setting and operating under control.
Amber	Respective system voltage is below regulated setting. Alternator is not producing power or circuit is overloaded. See Chart 1 on page 6 for 28 V systems, Chart 2 on page 7 for 14 V systems.

Chart 1 – N3107, N3118, N3211, N3223, N3237, N3245 – No 28V Alternator Output – Test Charging Circuit

(N1604: start with Chart 4 on page 9)

STATIC TEST – KEY ON, ENGINE OFF

Shut down vehicle and restart engine. Does alternator function normally after restart?

- Yes → Regulator responded to overvoltage condition. Go to Chart 3 on page 8 to troubleshoot OVCO.
- No →

Shut off engine. With key off, engine off: Test for battery voltage at alternator 28 V B+ terminal. Does battery voltage exist?

- Yes →
- No → Repair vehicle ignition circuit wiring as necessary. Continue test.

With key on, engine running: Test for battery voltage between IGN terminal on regulator and alternator B– terminal. Does 28 V battery voltage exist?

- Yes →
- No → Repair vehicle ignition circuit wiring as necessary. Continue test.

With key off, engine off: Remove alternator-to-regulator 4-pin harness from regulator. Test for battery voltage across sockets D and C in harness plug. Does 28 V battery voltage exist?

- Yes →
- No → Alternator is defective.

With DMM, check resistance across field coil. Connect red lead of DMM to socket A in alternator-to-regulator harness plug. Connect black lead to B+ terminal on alternator. Does meter show 1.0 ± 0.2 ohms?

- Yes →
- No → Alternator is defective.

Connect jumper wire from socket A in regulator harness plug to B– terminal on alternator. Spark will occur. Touch steel tool to shaft to detect significant magnetism. Is shaft magnetized?

- Yes →
- No → Alternator is defective.

Test phase signal into regulator (AC). Set meter to diode tester:

Connect red lead of DMM to socket C of regulator harness and black lead to socket B. Meter should show voltage drop value.

Then reverse meter lead connections. Meter should show OL (blocking).

- Yes → Regulator is defective.
- No → Alternator is defective.

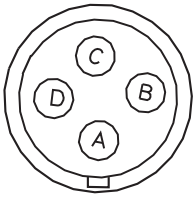

Figure 5 – Alternator-to-Regulator 4-Socket Harness Plug

Chart 3 – N3107, N3118, N3211, N3223, N3237, N3245 – OVCO Trip – Determine 28 V or 14 V (LEDs on N3223 will determine affected output)

With meter red lead on 28 V B+ at battery and black lead on chassis ground, start engine.
Watch meter dial: Does meter read charge voltage above 29 V?

Yes	No
28 V side tripped OVCO circuit. Go to Chart 3b.	14 V side tripped OVCO circuit. Go to Chart 3a.

Chart 3a – N3118, N3223 – No 14 V Alternator Output – Test OVCO Circuit (14 V LED on N3223 steady RED)

Yes	No

Chart 3b – N3107, N3118, N3211, N3223, N3237, N3245 – No 28 V Alternator Output – Test OVCO Circuit (28V LED on N3223 steady RED)

Unplug alternator-to-regulator 4-socket harness from regulator. Connect red lead from DMM to socket A in plug. Connect black lead to socket D in plug. Does resistance read 1.0 ± 0.2 ohms?

Yes	No
	Alternator is defective.

With red lead from DMM connected to socket A in plug, connect black lead to B– terminal. Does resistance read OL (out of limits)?

Yes	No
Replace existing regulator with known good regulator. Run engine. Does OVCO trip?	Alternator is defective.

Yes	No
Alternator is defective.	Original regulator is defective.

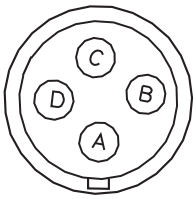

Figure 8 – Alternator-to-Regulator 4-Socket Harness Plug

Original regulato( )[][J] -1.1111 TD[]20

Chart 4 – N1604-all models – No Output

Test for battery voltage across and diagonally between both alternator B+ terminals and alternator B- terminals. Does battery voltage exist?

- **No** → Repair vehicle wiring as necessary. Continue test.
- **Yes** → Install a jumper from anti-drive end B+ terminal on alternator to IGN terminal on regulator. Touch shaft with steel tool to detect significant magnetism. Is shaft magnetized?
  - **Yes** → Repair vehicle circuit to IGN terminal. Vehicle charging circuit test is complete.
  - **No** → Unplug alternator-to-regulator wiring harness. Install a jumper from socket A in harness plug to anti-drive end B– terminal on alternator. Touch shaft with steel tool to detect significant magnetism. Is shaft magnetized?
    - **No** → Alternator is defective.
    - **Yes** → Connect DMM across socket D and socket C in harness plug. Does battery voltage exist?
      - **No** → Alternator is defective.
      - **Yes** → Using diode tester, attach red lead to alternator anti-drive end B– terminal and black lead to socket B in harness. Continuity should exist. Reverse leads. No continuity should exist.
        - **Yes** → Regulator is defective.
        - **No** → Alternator is defective.

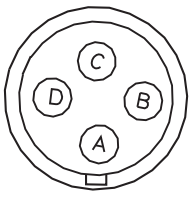

Figure 9 – Alternator-to-Regulator Harness Plug

Chart 5 – N1604-all models – No Alternator Output – Test OVCO Circuit

With engine off, unplug alternator-to-regulator harness. Connect DMM red lead to socket A on harness plug. Connect black lead to alternator anti-drive end B+ terminal. Does resistance measure about 1.0 ± 0.2 ohms?

- No → Alternator is defective.
- Yes → Connect DMM red lead to socket A on alternator-to-regulator harness plug. Connect black lead to alternator anti-drive end B– terminal. Does continuity exist?
  - Yes → Alternator is defective.
  - No → Connect DMM red lead to socket A on alternator-to-regulator harness plug. Connect black lead to alternator case. Does continuity exist?
    - No → Regulator is defective.
    - Yes → Alternator is defective.

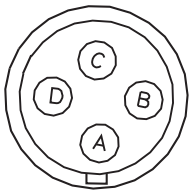

Figure 10 – Alternator-to-Regulator Harness Plug

If you have questions about your alternator or any of these test procedures, or if you need to locate a Factory Authorized Service Dealer, please contact us at:

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