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Battery Charging Conditions

The following conditions may be observed during cold-start voltage tests until temperatures of electrical system components stabilize. The time it takes to reach optimum voltage and amps will vary with engine speed, load, and ambient temperature.

Maintenance/Low Maintenance Lead-Acid Battery:

Traditional lead acid batteries require lowest charge voltage of all vehicle battery chemistries. Battery cells must be maintained by periodically topping off with distilled water as required.

Maintenance-free Lead-Acid Battery:

Maintenance-free batteries are similar to Maintenance/ Low Maintenance batteries, but may require slightly higher charge voltage.

Deep-cycle/Marine Maintenance-free Battery:

Charge acceptance of these batteries may display characteristics similar to maintenance-free batteries and may charge faster due to generally lower capacity relative to size.

AGM (Absorbed Glass Mat) Maintenance-free Battery:

These dry-cell batteries respond better than standard maintenance-free batteries. If battery state of charge (SOC) drops to 75% or less, batteries should be recharged to 95% or higher separately from engine 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, but may require higher charge voltage and will draw significant current (<100 amps) when under 50% SOC.

Lithium Battery:

Lithium batteries have unique charging characteristics that differ from lead acid. These batteries require charging systems configured specifically for lithium battery chemistries. Contact CEN for more information on lithium battery charging systems and components.

Testing Guidelines

Professional service technicians rely on the following guidelines when testing electrical components.

Voltage testing:

- Set meter to proper scale and type (AC or DC).
- Be sure to zero the meter scale or identify the meter burden by touching meter leads together. Meter burden must be subtracted from final reading obtained.
- Be sure the meter leads touch source area only. Prevent short circuit damage to test leads or source by not allowing meter leads to touch other pins or exposed wires in test area.
- Be sure to use CEN tools designed especially for troubleshooting CEN alternators when available.

Resistance (ohm) testing:

- Set meter to proper scale.
- Be sure to zero the meter scale or identify the meter burden by touching meter leads together. Meter burden must be subtracted from final reading obtained.
- Be sure meter leads touch source area only. Allowing fingers or body parts to touch meter leads or source during reading may alter reading.
- Be sure reading is taken when source is at 70°F. Readings taken at higher temperatures will increase the reading. Conversely, readings taken at lower temperatures will decrease the reading.
- Be sure to test directly at the source. Testing through extended harnesses or cable extensions may increase the reading.
- "OL" as referenced in this document refers to open circuit: "infinite" resistance, typically in very high kilo- or megaohm range depending on meter and settings.

Diode testing:

- Diodes allow current to flow in one direction only. Typical voltage drop in forward bias can range from 0.1-0.85V. Meter should read OL in reverse bias. Check meter user manual for meter-specific testing guidelines.

Voltage drop testing:

- Measure voltage between B+ on alternator or power source and B- (ground) on alternator or source. Record reading. Move to batteries or other power source and measure again between B+ and B- terminals on battery or other power source. The difference between the two readings represents voltage lost within circuit due to, but not limited to, inadequate cable gauge or faulty connections.
- Voltage drop measurements must be taken with all electrical loads or source operating.

Dynamic/Live testing (Connecting power and ground to component to test operation/function out of circuit):

- Connect jumper leads directly and securely to power source contacts of component being tested.
- Make any connection to power and ground at power supply or battery source terminals. Do not make connection at component source terminals, as that may create an arc and damage component source terminals.

CEN N1505-1, N1237-1, and N1225-1 Dual Voltage Alternators Description and Operation

N1505-1 28 V 100 A and **N1237-1/N1225-1** 28 V 200 A alternators all with optional 28 V/14 V (50 A maximum on 14 V) are internally rectified. All windings and current-transmitting components are non-moving, so there are no brushes or slip rings to wear out.

After engine is running, **N3135** regulator receives energize signal. Regulator monitors alternator rotation and provides field current only when it detects alernator shaft rotating at suitable speed.

After regulator detects alternator rotation, it gradually applies field current, preventing an abrupt mechanical load on accessory drive system. The soft start may take up to 10 seconds at full electrical load.

N3135 regulator used with these units also

- is negative temperature compensated. Setpoints are 28.0 ± 0.2 V and 14.0 ± 0.2 V at 75° F.
- provides overvoltage cutout (OVCO). Regulator will trip OVCO when system voltage rises above 32 V in a 28 V system (16 V in a 14 V system) for longer than 2 seconds. OVCO feature detects high voltage and reacts by signaling relay in F– alternator circuit to open, turning off alternator. Restarting engine resets OVCO circuit.
- maintains alternator output voltage at regulated settings as vehicle electrical loads are switched on and off.
- can be used in single or dual voltage with these alternators.
  - — Allows single-voltage operation (28 V only). 14 V is not available as a single voltage application with this regulator.
  - — Provides optional 28 V/14 V output only from the regulator when phase cable from alternator is connected to regulator.

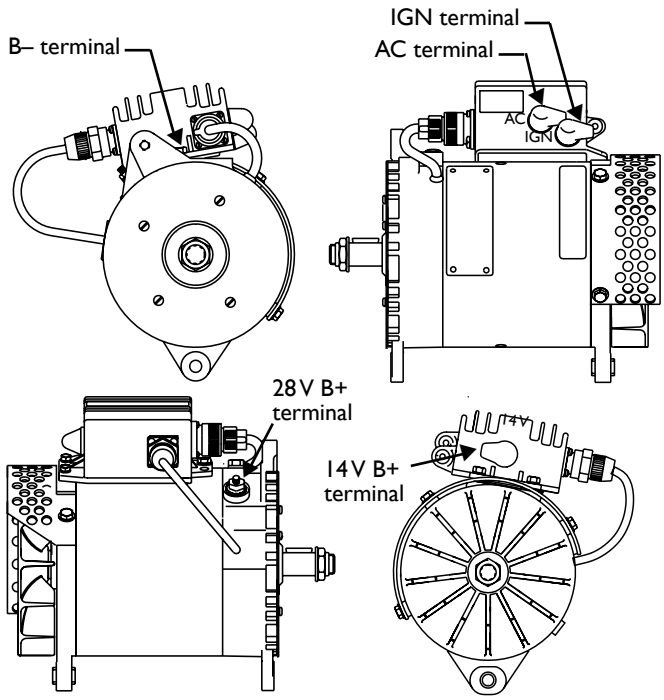


Figure 1 — N1505-1/N1237-1/N1225-1 Alternators and N3135 Regulator Terminals

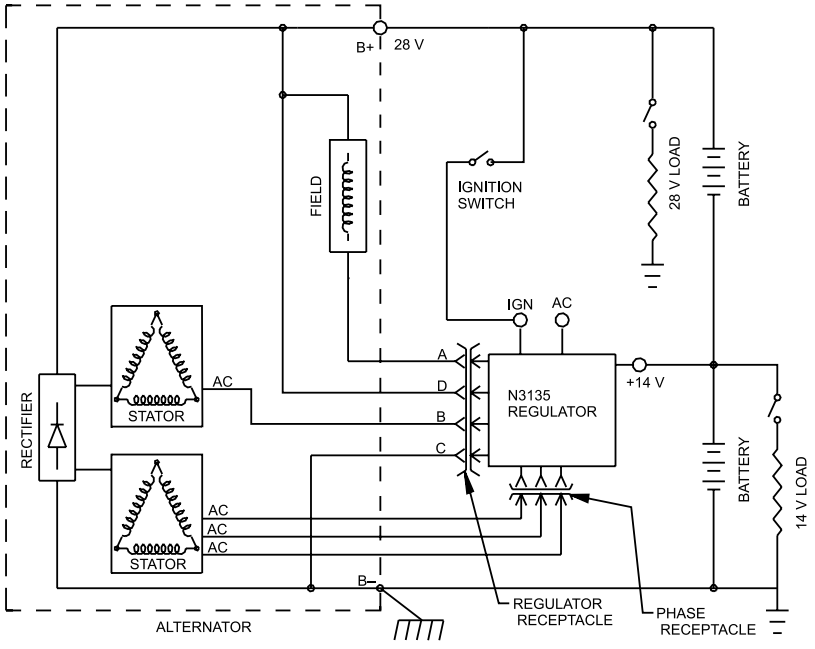


Figure 2 — N1505-1/N1237-1/N1225-1 Alternators with N3135 Regulator Wiring Diagram

A. Tools and Equipment for Job

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

B. Identification Record

List the following for proper troubleshooting:

❑ Alternator model number _____

❑ Regulator model number _____

❑ Setpoint listed on regulator_____

C. 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 alternator and/or regulator.
High Voltage Output	Check: wrong regulator. Check: defective regulator. Check: alternator.
No 28 V Output	Check: presence of energize signal. Check: battery voltage at alternator output terminal. Check: defective alternator and/or regulator.
No 14 V Output	Go to Chart 2, page 5.

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 connections of vehicle batteries**
   Connections must be clean and tight.

3. **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. Nominal battery voltage for 28 V systems is 25.2 ± 0.2 V; for 14 V systems is 12.6 ± 0.2 V. Less than 25 V or 12.4 V indicates no charge condition when engine is running.

4. **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.

5. **Operate vehicle**
   Observe charge voltage at batteries with engine running (nom. 27-28 V or 13.5-14.0 V).

CAUTION

If charge voltage is above 32 V 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.

6. **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.

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 Chart 1, page 4.

9. **Check OVCO (overvoltage cutout) circuit.**
   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 go to Chart 3, page 6.

Chart 1 – No 28V Alternator Output – Test Charging Circuit

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 6 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 1.8 to 2.2 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?

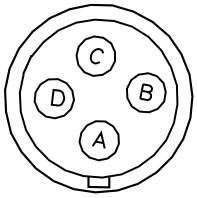
- **Yes** →
- **No** → Alternator is defective.

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.



SOCKET	CONNECTIONS
A	F–
B	Phase Signal AC
C	B–
D	28 V B+

Figure 3 – Alternator-to-Regulator 4-Socket Harness Plug

Chart 2 – No 14 V Alternator Output – Test Circuit

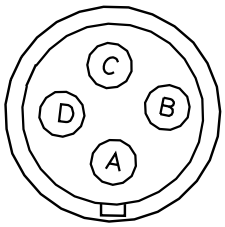
Shut off engine. With key off, engine off: Test for battery voltage of 14 V output terminal on regulator. Does +14 V battery voltage exist?

- Yes
- No → Repair vehicle wiring as necessary.

Set DMM to diode tester. Connect red lead of DMM to socket C of regulator harness plug and black lead to each phase pin in phase harness plug. Meter should show voltage drop value.

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

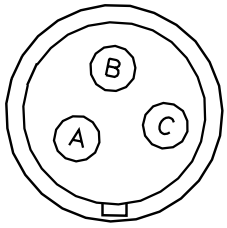
- Yes → Regulator is defective.
- No → Alternator is defective.



SOCKET CONNECTIONS

A	F–
B	Phase Signal AC
C	B–
D	28 V B+

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



PIN CONNECTIONS

A	Phase P1
B	Phase P2
C	Phase P3

Figure 5 – Phase Connection 3-Pin Harness Plug

Chart 3 – OVCO Trip – Determine 28 V or 14 V

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

Chart 3a – No 14 V Alternator Output – Test OVCO Circuit

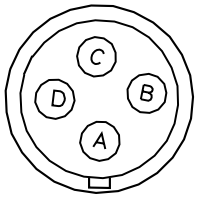
Unplug alternator-to-regulator 4-socket harness from regulator. At receptacle on regulator, connect red lead from DMM to pin C. Connect black lead to B– terminal. Does resistance read OL (out of limits)?

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

Chart 3b – No 28 V Alternator Output – Test OVCO Circuit

Unplug alternator-to-regulator 4-socket harness from regulator. Connect red lead from DMM to pin A in plug. Connect black lead to pin D in plug. Does resistance read 1.8 ± 2.2 ohms?

- Yes → With red lead from DMM connected to pin A in plug, connect black lead to B– terminal. Does resistance read OL (out of limits)?
  - Yes → Replace existing regulator with known good regulator. Run engine. Does OVCO trip?
    - Yes → Alternator is defective.
    - No → Original regulator is defective.
  - No → Alternator is defective.
- No → Alternator is defective.



SOCKET CONNECTIONS

A	F–
B	Phase Signal AC
C	B–
D	28 V B+

Figure 6 – Alternator-to-Regulator 4-Socket 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 Distributor, please contact us at:
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