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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 NI 128 Dual Voltage Alternator Description and Operation

**N1128** 28 V 100 A alternator with 28 V/14 V (60 A maximum on 14 V) is internally rectified. All windings and current-transmitting components are non-moving, so there are no brushes or slip rings to wear out.

After the **N3212** regulator receives energize signal, it monitors alternator rotation and provides field current only when it detects alternator 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 20 seconds.

**N3212** regulator used with these units also

- is negative temperature compensated. Setpoints are  $28.0 \pm 0.2$  V and  $14.0 \pm 0.2$  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 causes alternator field circuit to open, turning off alternator. Restarting engine resets OVCO circuit. If vehicle remains operating after OVCO trip, the OVCO will automatically reset when system voltage drops to 22 V (11 V on 14 V side). Regulator then resumes normal operation.
- maintains alternator output voltage at regulated settings as vehicle electrical loads are switched on and off.
- allows 28 V only voltage operation if 14 V loads are not used in the application and 14 V terminal on regulator is not terminated.
- provides optional 14 V output at the regulator 14 V terminal when phase cable from alternator is connected to regulator.
- maintains battery equalization between 28 V and 14 V if 14 V output is used.

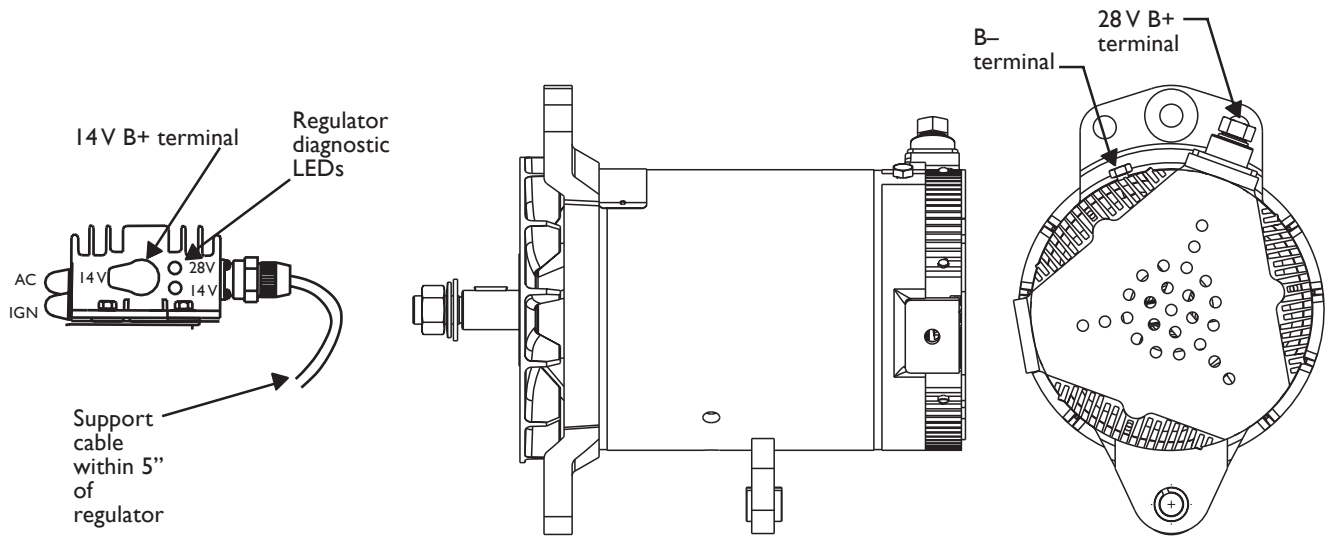


Figure 1 — N1128 Alternator and N3212 Regulator Terminals

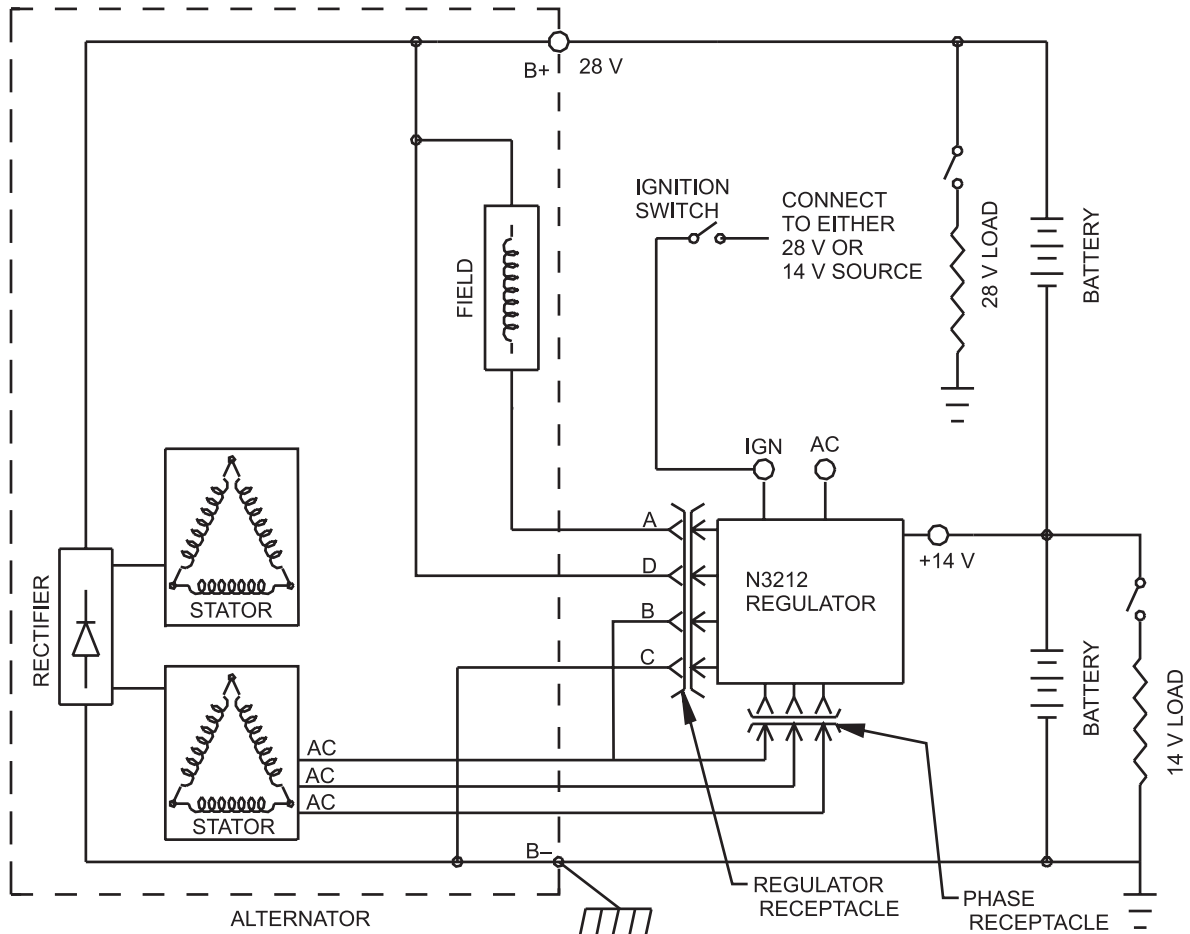


Figure 2 — N1128 Alternator with N3212 Regulator



## 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 \_\_\_\_\_

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 and/or regulator.
High Voltage Output	Check: wrong regulator. Check: high regulator setpoint. Check: defective regulator. Check: alternator.
No Voltage Output	Check: presence of energize signal. Check: battery voltage at alternator output terminal. Check: defective alternator and/or regulator.
No 14 V Output	Check: defective regulator.

## C. Basic Troubleshooting

- Inspect charging system components**  
 Check connections at ground cables, positive cables, and regulator harness. Repair or replace any damaged component before troubleshooting.
- Inspect connections of vehicle batteries**  
 Connections must be clean and tight.
- 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.
- 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.
- 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 page 8.  
  
 If voltage is at or below regulator setpoint, let charging system operate for several minutes to normalize operating temperature.
- 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.
- Batteries** are considered fully charged if charge voltage is at regulator setpoint and charge amps remain at lowest value for 10 minutes.
- If charging system** is not performing properly, go to Chart 1, page 6.



### N3212 Regulator

#### DESCRIPTION AND OPERATION

**N3212** Regulator with OVCO is remote-mounted no more than 12 inches from the alternator. Regulator setpoint has negative temperature compensation. At 75°F, the setting is 28.2 V for 28 V system and 14.1 V for 14 V system.

Main diagnostic feature of **N3212** regulator consists of two bicolored (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 2 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 flashing AMBER /28 V LED is off). OVCO circuit will reset by either:
  - Restarting engine (regulator regains control of alternator output voltage and resets OVCO) 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 flashing AMBER / 14 V LED is off). OVCO circuit will reset by either:
  - Restarting engine (regulator regains control of alternator output voltage and resets OVCO) 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.

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 LEDs while engine is running.

28 V LED flashing AMBER / 14 V LED off—go to Chart 4, page 8.

14 V LED flashing AMBER /28 V LED off—go to Chart 3, page 8.

**TABLE 2 – N3212 Regulator LED Diagnostics**

N3212 LED COLOR	N3212 STATUS
Off (Clear)	Regulator is not energized. Measure IGN terminal voltage. If voltage is above 21 V, regulator is defective.
Flashing AMBER (either 28 V or 14 V)	Respective system voltage is reading high voltage.
AMBER (either 28 V or 14 V with the other LED off)	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 2 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 8 of Troubleshooting Guide for 28V systems, Chart 4 for 14 V systems.
GREEN (both flashing once every 5 sec.)	Regulator is energized, but waiting for AC signal from alternator.
Steady AMBER	Respective system voltage is below regulated setting or is processing soft start (20-second delay).
GREEN	Normal operation (respective system voltage is at regulated setting)



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

Start engine. Wait 20 seconds. Is 28 V LED steady GREEN on regulator?

Yes No

Regulator responded to overvoltage condition. Go to Chart 4 on page 8 to troubleshoot OVCO.

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

Yes No

Check and repair wiring and battery cables 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

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

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 No

Regulator is defective.

Alternator is defective.

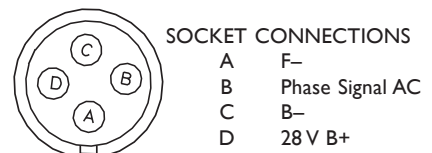


Figure 3 – Alternator-to-Regulator 4-Socket Harness Plug



## Section 4: Advanced Troubleshooting (cont.)

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

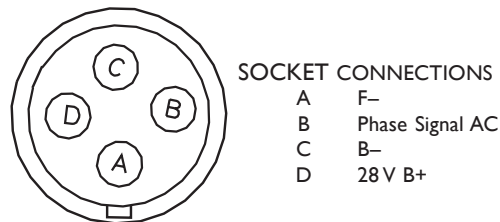
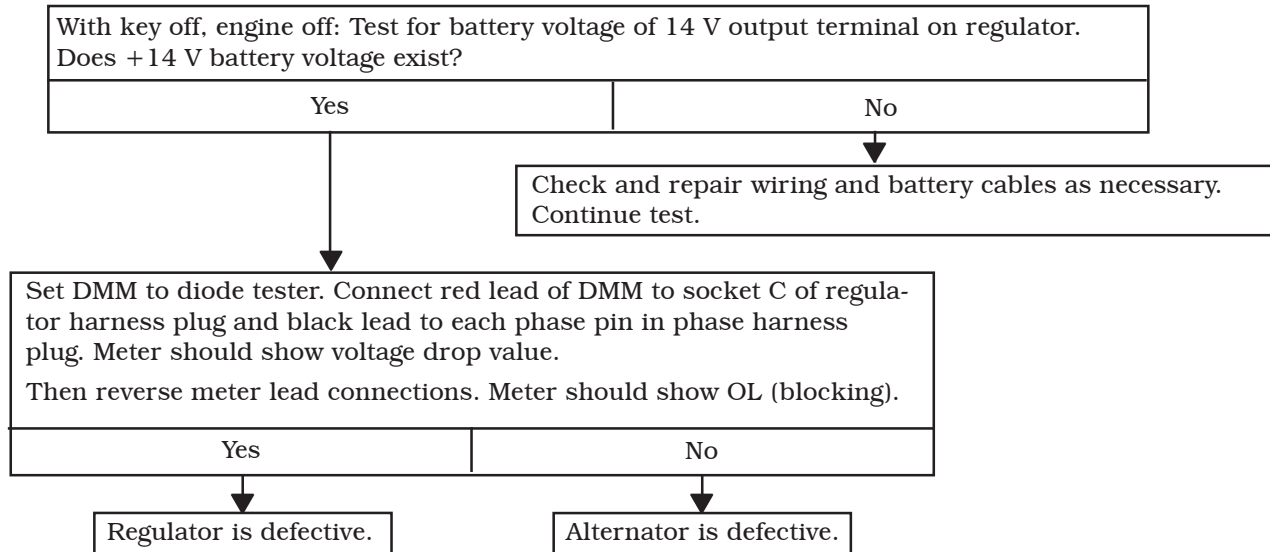


Figure 4 – Alternator-to-Regulator 4-Socket Harness Plug

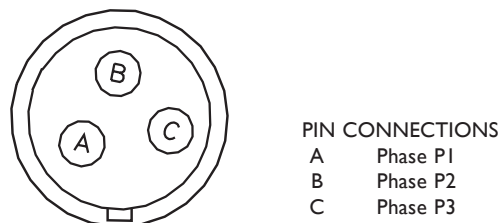


Figure 5 – Phase Connection 3-Pin Harness Plug



Chart 3 – 14 V LED Flashing AMBER/ 28V LED Off – No Alternator Output – Test OVCO Circuit

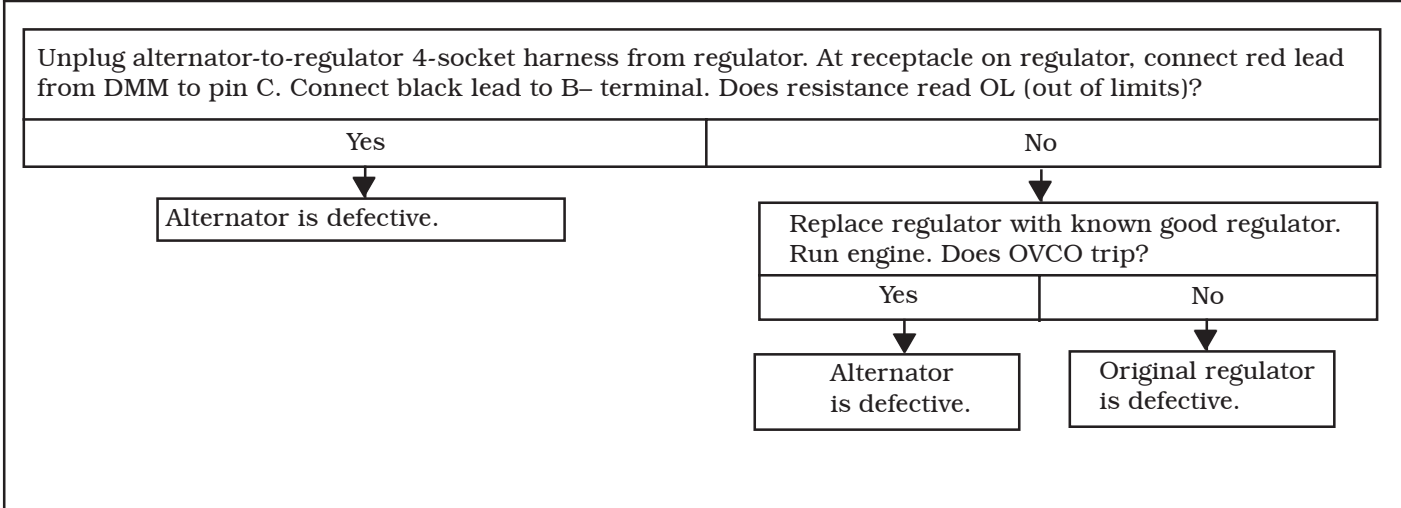


Chart 4 – 28 V LED Flashing AMBER/ 14V LED Off – NO Alternator Output – Test OVCO Circuit

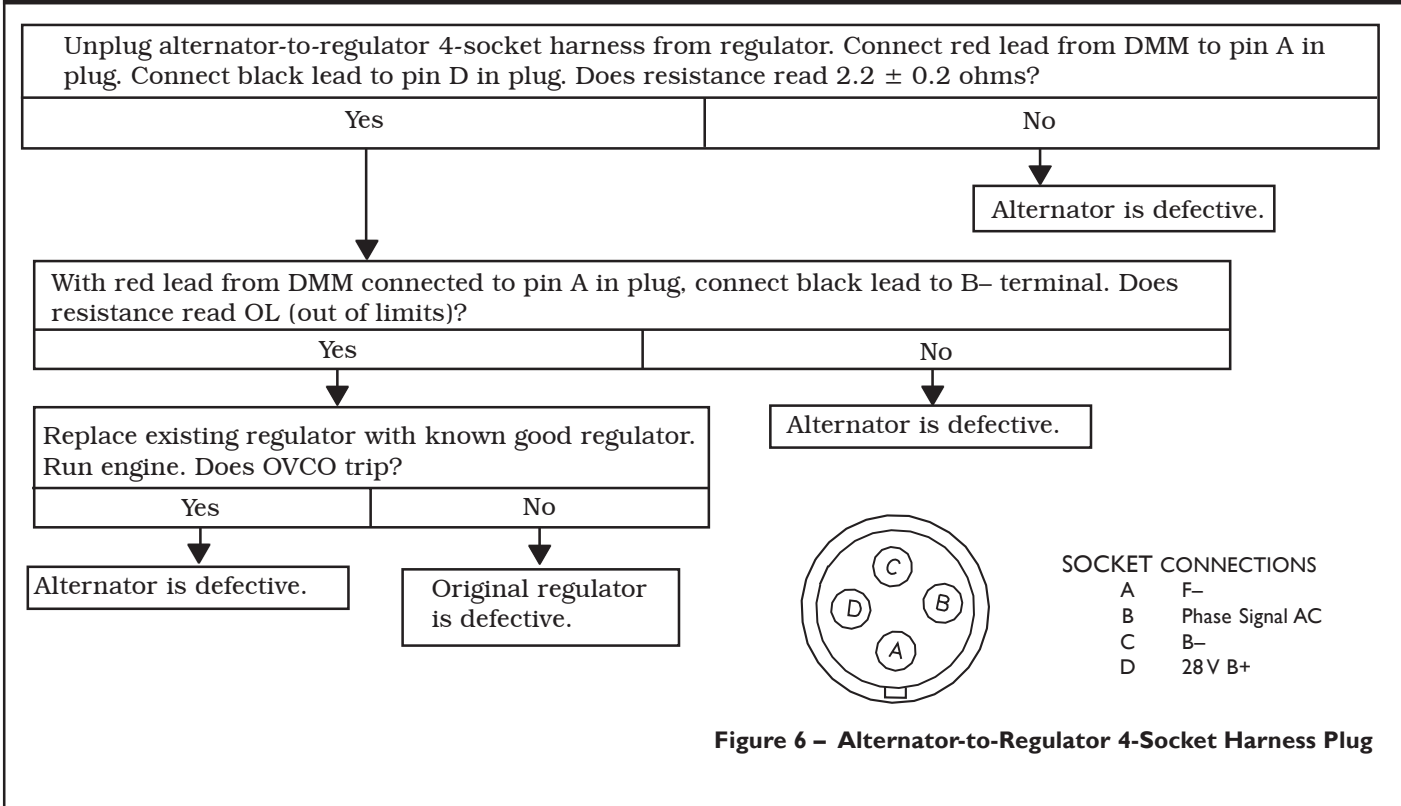


Figure 6 – Alternator-to-Regulator 4-Socket Harness Plug

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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 TEL: 800.643.4633 USA and Canada • TEL: 847.866.6030 outside USA and Canada • FAX: 847.492.1242  
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