



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 hazard(s) 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

NOTICE

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, 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 NI313 Dual Voltage Alternator Description and Operation

NI313 300 A (28 /14 V) dual voltage alternator is internally rectified. All windings and current-conducting components are non-moving, so there are no brushes or slip rings to wear out. Energize switch (commonly an oil pressure switch or ignition switch) activates regulator. Field coil is then energized when rotation is detected. Upper voltage (28 V) is rectified with standard diodes. Lower voltage (14 V) circuit output current is controlled by SCRs. Alternator output current is self-limiting and will not exceed rated capacity of alternator.

N3039 and **N3222** regulators used with these units also

- are flat temperature compensated. Setpoints are 28.0 ± 0.2 V and 14.0 ± 0.2 V.
- provide overvoltage cutout (OVCO). Regulator will trip above 32 V for 28 V system (16 V for 14 V system) 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. If vehicle is run in OVCO mode, OVCO will automatically reset when system voltage drops to 22 V. Regulator regains control of alternator below output voltage.
- maintain alternator output voltage at regulated settings as vehicle electrical loads are switched on and off.

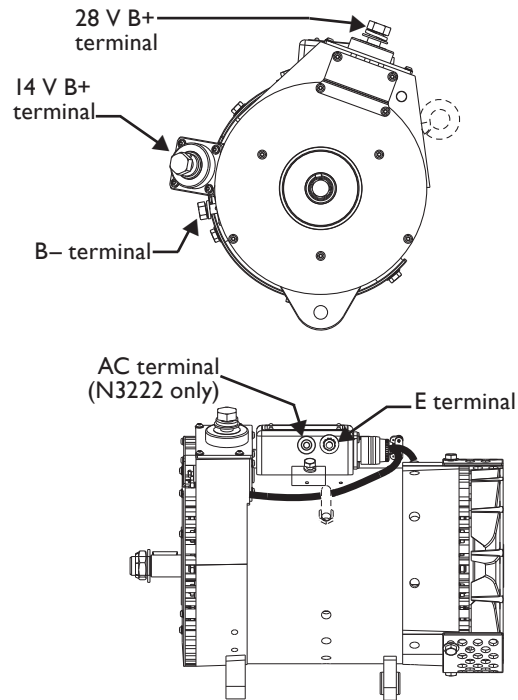


Figure 1 — NI313 Alternator and N3039 or N3222 Regulator Terminals

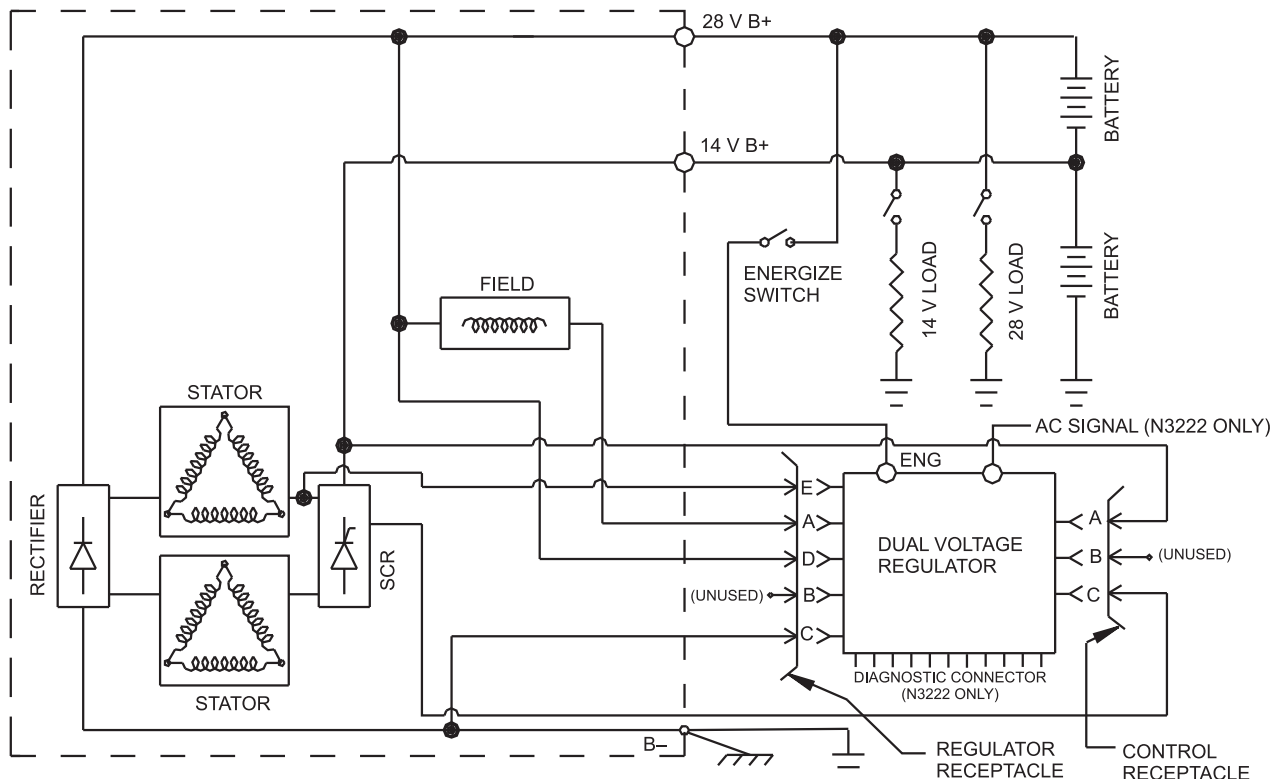


Figure 2 — NI313 Alternator with Regulator



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 alternator or regulator.
High Voltage Output	Check: wrong regulator. Check: defective regulator.
No Voltage Output	Check: alternator. Check: presence of energize signal. Check: battery voltage at alternator output terminal. Check: defective alternator or regulator.
No 14 V Output	Go to Chart 2, page 6.

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 28V system or 16V for 14V 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 5.



N3222 Regulator

DESCRIPTION AND OPERATION

N3222 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) 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 disabling the alternator field circuit. 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 voltage falling below 11 V. OVCO will automatically reset.
- 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 by either:
 - Restarting engine (regulator regains control of alternator output voltage) OR
 - System voltage falling below 22 V.

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.

N3039 only: 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 7.

N3222 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 7.

TABLE 2 – N3222 Regulator LED Operation Modes

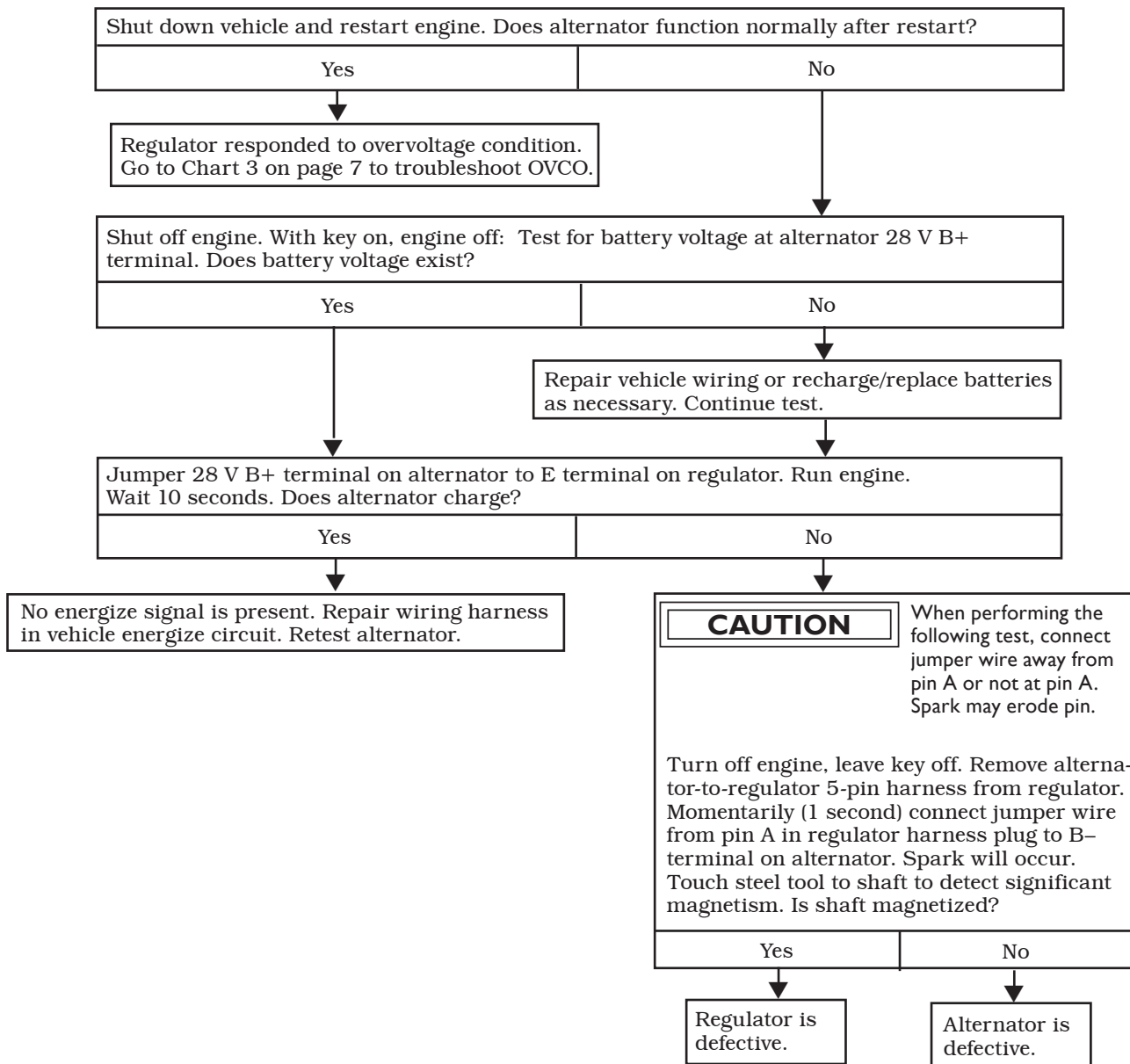
LED COLOR	STATUS
OFF	Regulator is not energized. Measure E terminal voltage. If voltage above 21 V, regulator is defective.
FLASHING Green	Respective system voltage is at regulated setting and operating under control.
Amber	Respective system voltage is below regulated setting. Alternator is not producing power or circuit is overloaded. See Chart 1 on page 5 for 28 V systems, Chart 2 on page 6 for 14 V systems.
Red	Respective system voltage is above regulated setting. This may occur intermittently with voltage transients or with system faults.
STEADY 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 7.



Section C: Advanced Troubleshooting (CONT'D)

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

STATIC TEST – KEY ON, ENGINE OFF



PIN CONNECTIONS

- A F-
- B unused
- C B-
- D 28 V B+
- E Phase

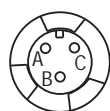
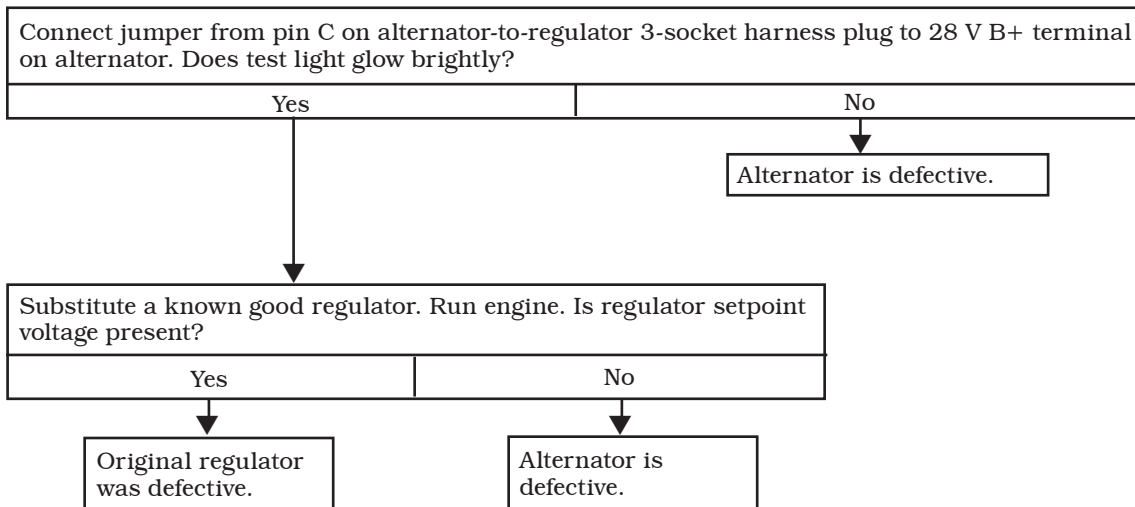
Figure 3 – Alternator-to-Regulator 5-Pin Harness Plug



Chart 2 – No 14 V Alternator Output – Test Circuit

Before starting test:

1. Remove 14 V B+ cable at alternator. Insulate cable to prevent arcing.
2. Connect test light across 14V B+ terminal on alternator and B-terminal on alternator.



SOCKET CONNECTIONS

- A 14 V B+
- B unused
- C 14 V Control

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



Section C: Advanced Troubleshooting (CONT'D)

Chart 3 – OVCO Trip N3039 only – Determine 28 V or 14 V (LEDs on N3222 will determine which output)

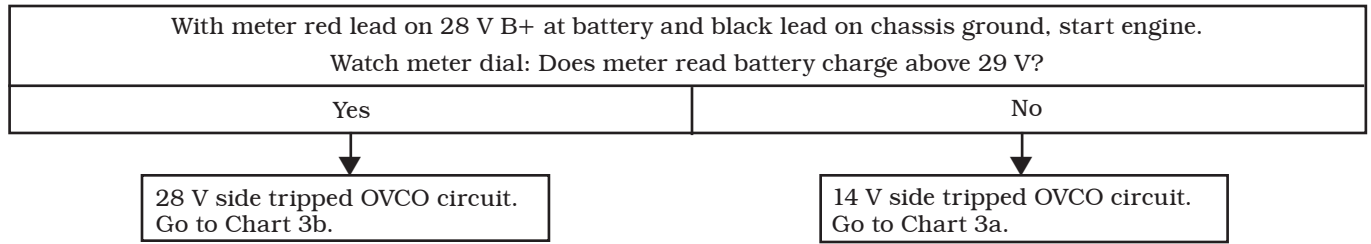


Chart 3a – No 14 V Alternator Output – Test OVCO Circuit (14 V LED on N3222 steady RED)

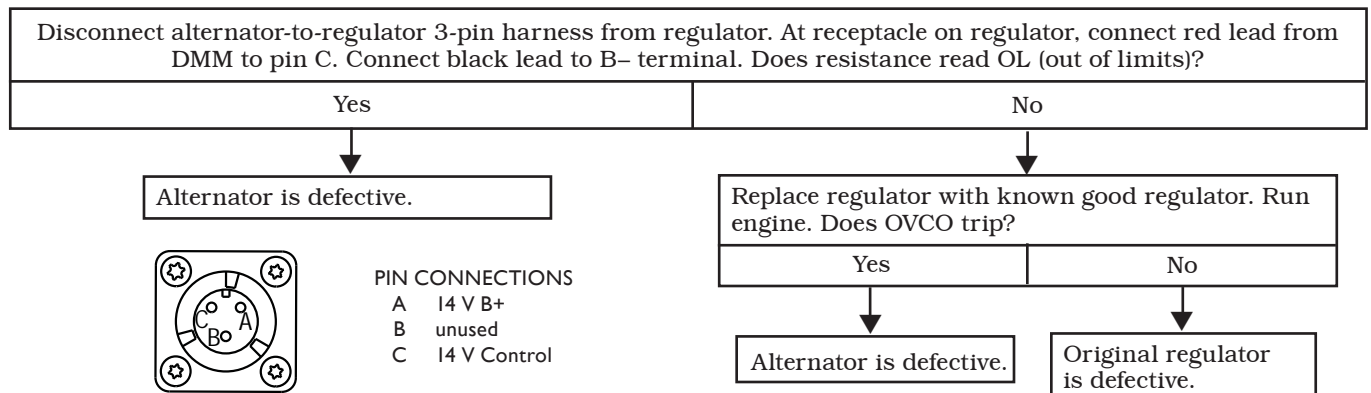


Figure 5 – Alternator-to-Regulator 3-Pin Harness Receptacle

Chart 3b – No 28 V Alternator Output – Test OVCO Circuit (28 V LED on N3222 steady RED)

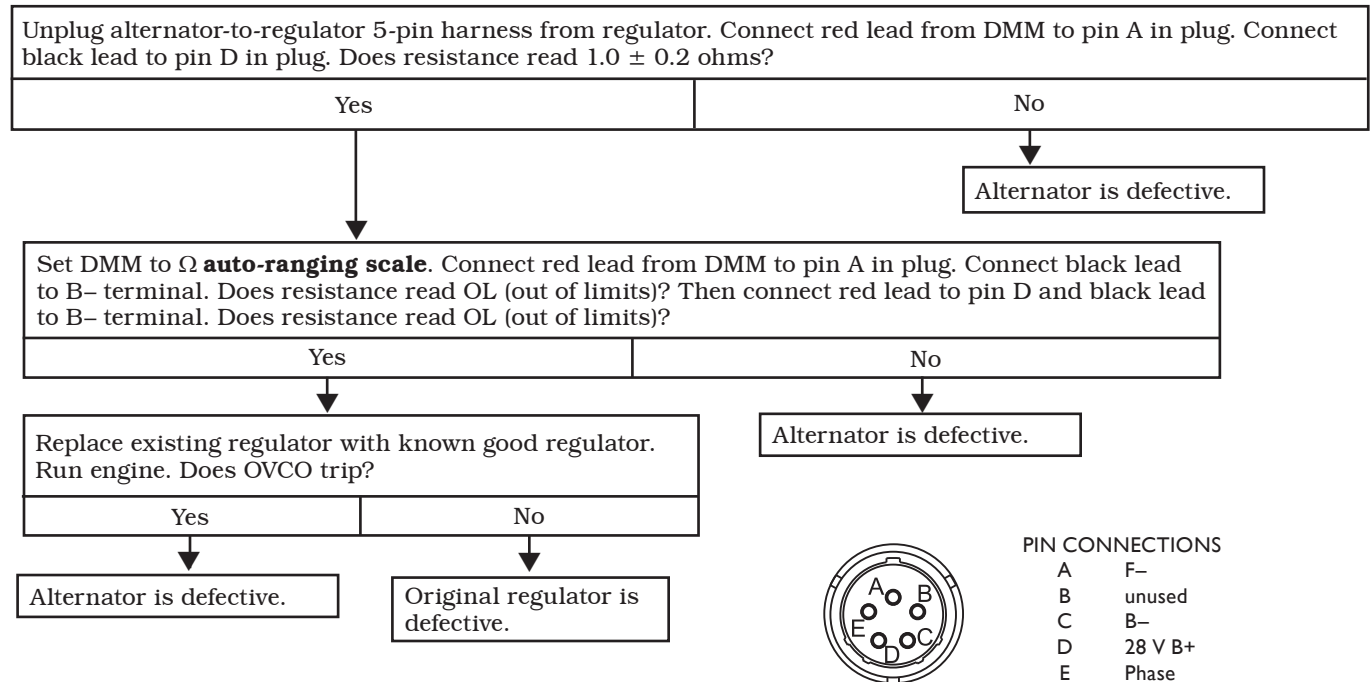


Figure 6 – Alternator-to-Regulator 5-Pin Harness Plug



14 V Functions		
Lead Connections from DMM	Normal Resistance Reading	Component Tested
red to pin C in 3-pin receptacle and black to socket C in 5-socket receptacle	OL*	14 V control signal
red to socket C in 3-socket plug and black to socket A in 3-socket plug	7-13Ω**	SCR gate in anti-drive end housing
28 V Functions		
Lead Connections from DMM to 5-socket Receptacle	Normal Reading	Component Tested
red to socket A and black to socket C	OL* (resistance)	Power transistor
red to socket A and black to socket D	Short tone on Diode Checker*	Supressor diode

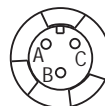
* If readings register other than those shown, regulator is defective.

** If readings register other than those shown, anti-drive end housing is defective.



5-PIN CONNECTIONS

- A F-
- B unused
- C B-
- D 28 V B+
- E Phase



3-SOCKET CONNECTIONS

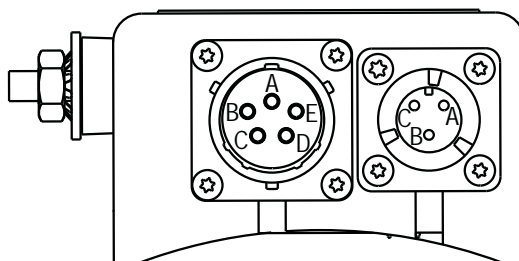
- A 14 V B+
- B unused
- C 14 V Control

Figure 7 – Alternator-to-Regulator 5-Pin Harness Plug

Figure 8 – Alternator-to-Regulator 3-Socket Harness Plug

5-SOCKET CONNECTIONS

- A F-
- B unused
- C B-
- D 28 V B+
- E Phase



3-PIN CONNECTIONS

- A 14 V B+
- B unused
- C 14 V Control

Figure 9 – Alternator-to-Regulator Harness Connections at Regulator – 5-Socket Receptacle and 3-Pin Receptacle

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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