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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 70ºF. 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 C622 Alternator
Description and Operation

C622 28 V 100 A/84 V 50 A alternator is internally rectified. All windings and current-transmitting components are non-moving, so there are no brushes or slip rings to wear out. This unit is externally energized through an energize switch (commonly an oil pressure switch), which activates regulator. Field coil is then energized. 84 V system is not energized until 28 V system is energized. 84 V and 28 V circuit output currents are controlled by separate SCRs in the drive end housing. Alternator output current is self-limiting and will not exceed rated capacity of alternator.

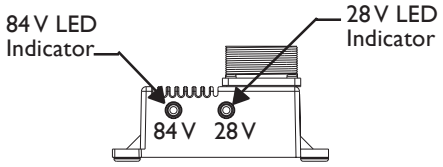
A2-307 regulator used with these units:

- maintains alternator output voltage at regulated settings as vehicle electrical loads are switched on and off.
- monitors 28 V and 84 V systems separately.

A2-604 battery charge equalizer and **A9-069** harness used with these units:

- equalizes six 12 V batteries connected in series.
- turns on when charge voltage is above 78 volts.

DANGER HIGH VOLTAGE. Use extreme caution when working around 84 V system. Severe personal injury or death will result from contact.



A2-307 Regulator LEDs

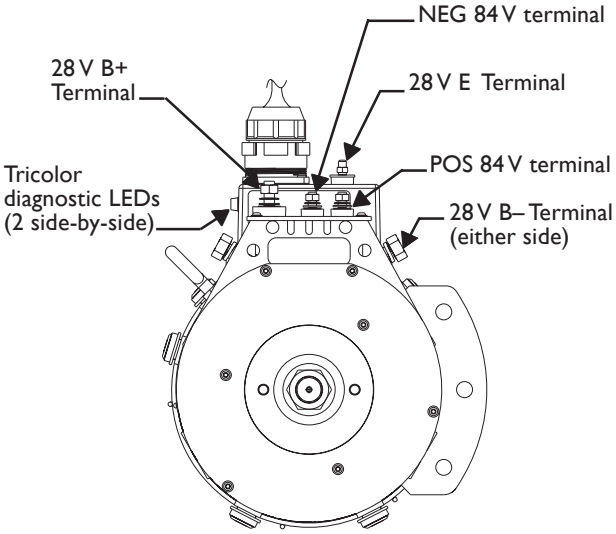


Figure 1 — C622 Alternator Terminals

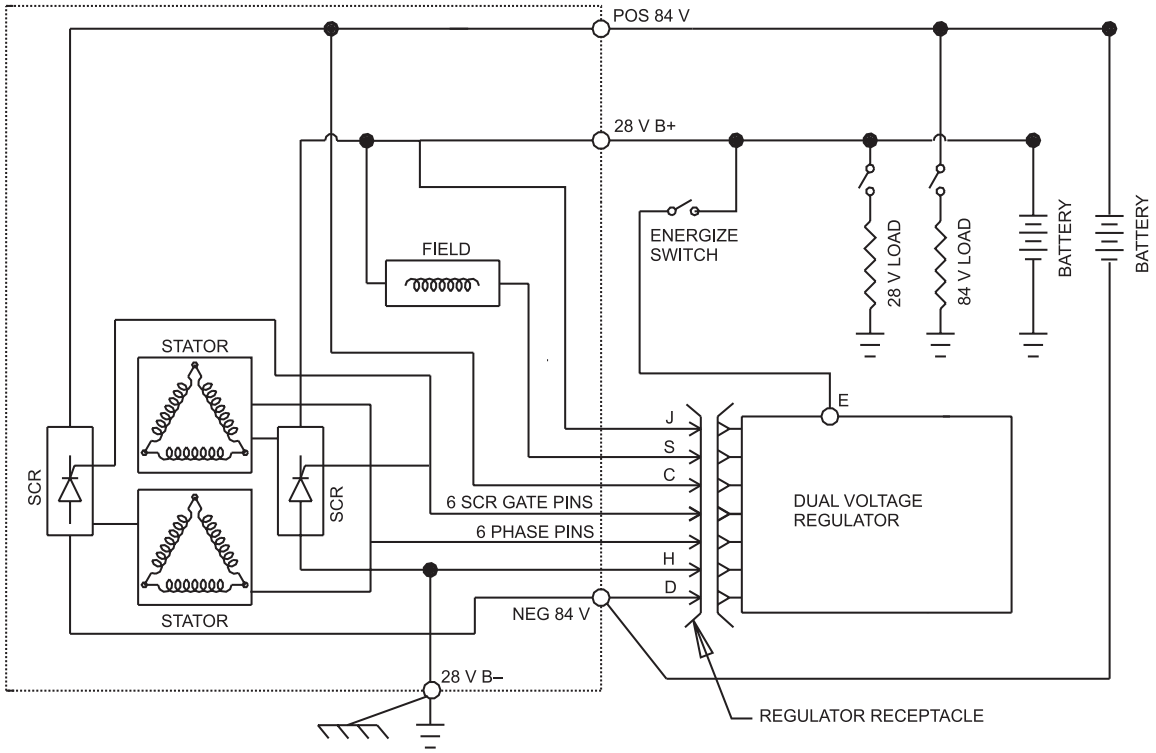


Figure 2 — C622 Alternator with Regulator

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 _____

❑ Battery charge equalizer model number _____

❑ Harness model number _____

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 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 84 V Output	Go to "Steady Amber" in Table 2, page 4.

D. Basic Troubleshooting

DANGER HIGH VOLTAGE. Use extreme caution when working around 84 V system. Severe personal injury or death will result from contact.

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 battery charge equalizer connections**
   Connections must be in proper sequence and clean and tight. See Figure 4, page 6.
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 28 V 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 85 V for 84 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 3, page 7.

A2-307 Regulator

DESCRIPTION AND OPERATION

A2-307 Regulator with OVCO is attached directly to the outside of alternator. Set point of temperature compensation regulator is 82.0 V.

Main diagnostic feature of A2-307 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 84 V system performance. The two LEDs work independently of each other, not in combination with each other. See Table 2 for diagnostic features and LED explanations.

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

- 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 high voltage and reacts by signaling relay in F+ alternator circuit to open. This turns off alternator (28 V LED is steady RED light). Restarting engine resets OVCO circuit. Regulator regains control of alternator output voltage.
- 84 V side trips at voltage **higher** than regulator setpoint that exists longer than 2 seconds of reading voltage above 85 V. OVCO feature detects high voltage and reacts by signaling relay in F+ alternator circuit to open. This turns off alternator (84 V LED is steady RED light). Restarting engine resets OVCO circuit. Regulator regains control of alternator output voltage.

TROUBLESHOOTING

DANGER HIGH VOLTAGE. Use extreme caution when working around 84 V system. Severe personal injury or death will result from contact.

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

28 V RED LED - go to Chart 1, page 5.

84 V RED LED - go to Chart 2, page 5.

TABLE 2 – A2-307 Regulator Diagnostics

LED COLOR	STATUS
OFF	Regulator is not energized. Measure E terminal voltage. If voltage above 21 V, regulator is defective.
FLASHING (*once per second for respective system voltage)*	
Green	Respective system voltage is at regulated setting and operating under control.
Amber	Respective system voltage is below regulated setting. Alernator is not producing power or circuit is overloaded.
Red	Respective system voltage is above regulated setting. This may occur intermittently with voltage transients or with system faults.
STEADY	
Amber (84 V LED Only)	Alternator is producing only 28 V output current. This will occur if 84 V batteries are disconnected. Regulator remains in this mode until reset by restarting engine.
Red	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. 84 V side trips after 2 seconds of reading voltage above 85 V. Regulator remains in this mode until reset by restarting engine.
FAST FLASHING RED *(at least two times per second for respective system voltage)*	Indicates regulator redundant control is lost. Service as soon as possible for alternator, regulator or wiring fault. High side voltage will continue to produce 84 V, but low voltage side will default to 26 V regulation to alert operator of control malfunction. Regulator remains in this mode until reset by restarting engine. See Chart 1, page 5.

Chart 1 – 28 V RED LED On Steady – No Alternator Output – Test OVCO Circuit

Make sure batteries are properly charged before proceeding.

Disconnect ground cable from 28 V battery pack. Unplug alternator-to-regulator harness from regulator. Connect red lead from DMM to socket S in plug. Connect black lead to alternator 28 V B+ terminal. Does resistance read 2.2 ± 0.2 ohms?

- No → Alternator is defective.
- Yes → Disconnect cable from alternator 28 V B+ terminal. Set DMM to ohms scale. Connect red lead from DMM to socket S in plug. Connect black lead to 28 V B– terminal. Does meter read OL (out of limits)?
  - No → Alternator is defective.
  - Yes → Reconnect cables. Replace existing regulator with known good regulator. Run engine. Does OVCO trip?
    - Yes → Alternator is defective.
    - No → Original regulator is defective.

Chart 2 – 84 V RED LED On Steady – No Alternator Output – Test OVCO Circuit

DANGER HIGH VOLTAGE . Use extreme caution when working around 84 V system. Severe personal injury or death will result from contact.

Make sure batteries are properly charged before proceeding.

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

- Yes → Alternator is defective.
- No → Original regulator is defective.

A2-604 Battery Charge Equalizer and A9-069 Harness

DESCRIPTION AND OPERATION

A2-604 Battery Charge Equalizer is attached directly to the battery compartment.

Main diagnostic feature of A2-604 equalizer is an LED display located on the front of the equalizer. The equalizer measures battery charge voltage and "equalizes" battery voltage to prevent overcharge. See Table 3 for diagnostic features and LED display explanations.

TABLE 3 – A2-604 Battery Charge Equalizer Diagnostics

DISPLAY	STATUS
0	All batteries are equalized.
1, 2, 3, 4, 5 or 6 in rotation	Number represents series location of battery that is at least 0.4 V higher than the others. Number will change frequently during operation.
Flashing one number (not "0")	Number represents series location of battery that is continuously overcharged. Perform battery tests to determine problem. Replace batteries as necessary.
C	Connections are in wrong position or at least one of the wires is disconnected.
(unlit)	Equalizer is off.

DANGER Do not allow batteries to overcharge. Battery can explode, resulting in severe personal injury, death or substantial property damage.

TABLE 4 – A9-069 Harness Plug Pin Functions

Pin	Function	Battery #
A	12 V	1
B	24 V	2
C	36 V	3
D	48 V	4
E	60 V	5
F	72 V	6
G	0.0 V	N/A

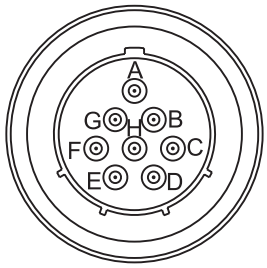


Figure 3 – A9-069 Harness Plug

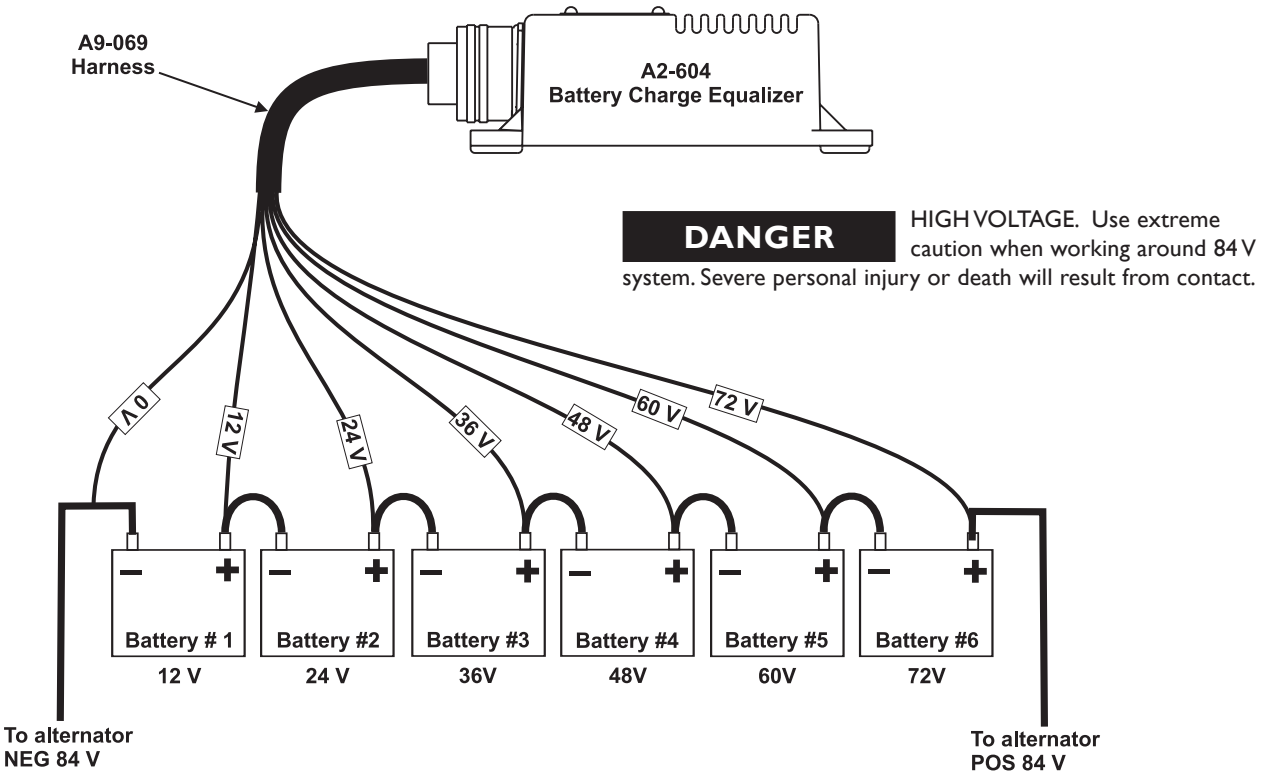


Figure 4 – A9-069 Harness Connections

Chart 3 – No Alternator Output – Test Charging Circuit

STATIC TEST – ENGINE OFF, BATTERY SWITCH ON, KEY ON

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

- **No** → Repair vehicle wiring as necessary. Continue test.
- **Yes** → Jumper 28 V B+ terminal on alternator to E terminal on regulator. Touch shaft with steel tool to detect significant magnetism. Is shaft magnetized?

  - **Yes** → Go to energize switch on engine in E circuit. Test for battery voltage going into energize switch from battery. Does battery voltage exist?

    - **No** → Repair vehicle circuit to energize switch. Continue test.
    - **Yes** → Make sure jumper wire from alternator 28 V B+ terminal to regulator E terminal is still attached.

      Test for battery voltage at energize switch E terminal connection. Does battery voltage exist at energize switch?

      - **No** → Repair vehicle circuit from E terminal on regulator to energize switch on engine.
      - **Yes** → E circuit from regulator to energize switch is good. Energize switch is defective.

      → Vehicle charging circuit test is complete. Remove jumper wire used in testing. Run engine and re-test charging circuit for operation.

  - **No** → Connect jumper wire from socket S in alternator-to-regulator harness plug to 28 V B– terminal on alternator. Spark will occur. Touch shaft with steel tool to detect significant magnetism. Is shaft magnetized?

    - **No** → Alternator is defective.
    - **Yes** → Disconnect jumper wire. Connect DMM red lead to socket J in alternator-to-regulator harness plug. Connect black lead to socket H in same plug. Does battery voltage exist?

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

SOCKET CONNECTIONS

Pin G, F, E	84 V Phase
Pin R, Q, P	84 V SCR Gate
Pin D	84 V NEG
Pin C	84 V POS
Pin S	F –
Pin J	28 V B+
Pin H	28 V B –
Pin B, A, K	28 V Phase
Pin M, L, T	28 V SCR Gate

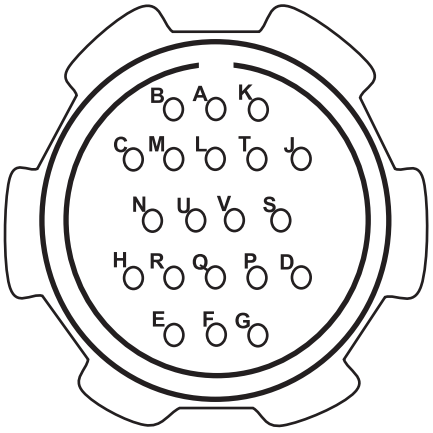


Figure 5 – Alternator-to-Regulator Harness Plug

If you have questions about your alternator or any of these test procedures, or if you need to locate a Factory Authorized Service 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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