CONTENTS

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 C701/C701A Alternators Description and Operation

C701/C701A 28 V, 300 A alternators are internally rectified. 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. Regulator 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.

A2-213 regulator furnished with most units has D+ terminal that can provide signal to vehicle electrical system, confirming alternator operation. Regulator also has a P terminal that can provide an optional AC voltage tap. Regulator also provides overvoltage cutout (OVCO). Regulator also has a green lens LED (see page 4).

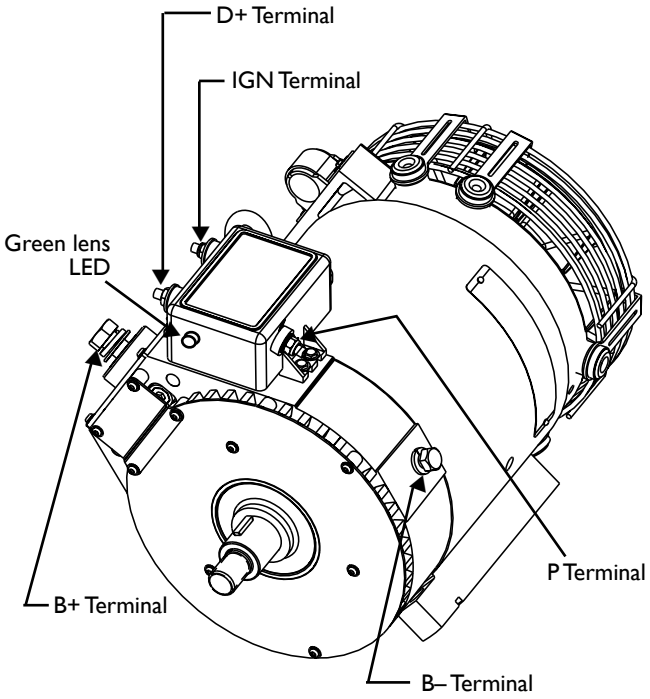

Figure 1 — C701 and C701A

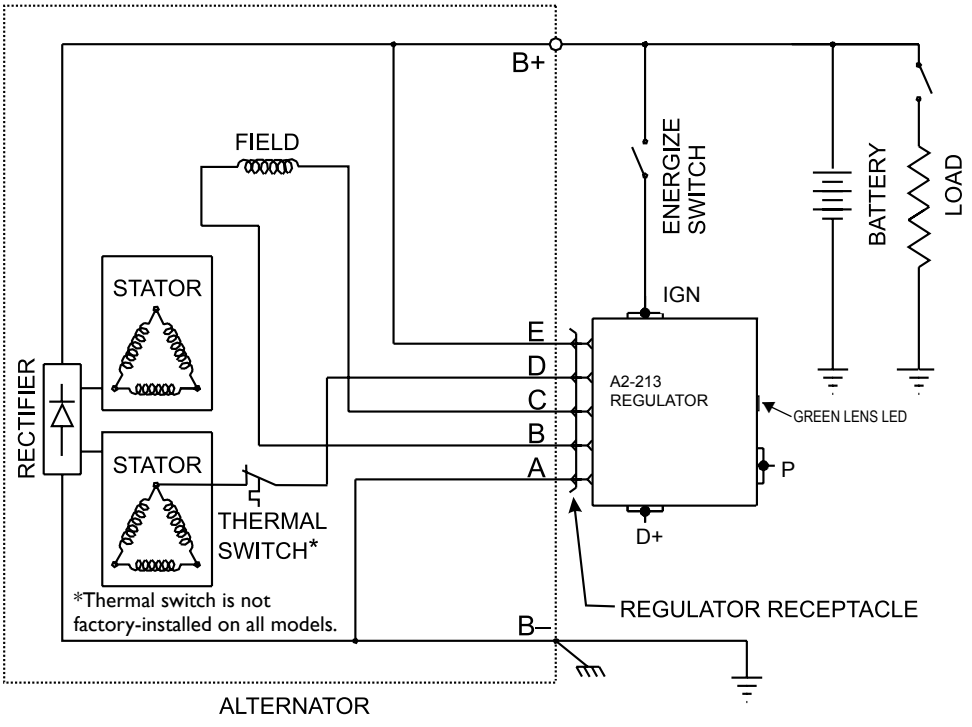

Figure 2 — C701 and C701A Alternator with Regulator

Tools and Equipment for Job

- Digital Multimeter (DMM)
- Ammeter (digital, inductive)
- CEN Regulator Bypass Adapter A10-129
- Jumper wire

Identification Record

List the following for proper troubleshooting:

❒ Alternator model number _____

❒ Regulator model number _____

❒ Setpoints 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 and/or regulator. Check: wrong regulator.
High Voltage Output	Check: high regulator setpoint. Check: defective regulator. Check: alternator.
No Voltage Output	Check: broken drive belt. Check: battery voltage at alternator output terminal. Check: defective alternator and/or regulator.
No Air-Conditioning/ Alternator Warning Light On	**CAUTION** If alternator warning light on vehicle is ON, do not operate vehicle until troubleshooting resolves the condition. Check: defective alternator or regulator. Go to Chart 2, page 6.

NOTICE

Failure to check for the following conditions will result in erroneous test results in the troubleshooting charts.

Basic Troubleshooting

1. **Inspect charging system components for damage**
   Check connections at B– cable, B+ cable, and regulator harness. Check IGN, D+, and P terminal wiring from regulator to vehicle components. Check ignition switch for proper operation. Repair or replace any damaged component before electrical troubleshooting.
2. **Inspect vehicle battery connections**
   Connections must be clean and tight.
3. **Check drive belt**
   Repair or replace as necessary.
4. **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.
5. **Connect meters to alternator**
   Connect red lead of DMM to alternator B+ terminal and black lead to alternator B– terminal. Clamp inductive ammeter on B+ cable.
6. **Operate vehicle**
   Observe charge voltage.

   CAUTION

   If charge voltage is above 32 volts, immediately shut down system. Electrical system damage may occur if charging system is allowed to operate at high 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**
   Charge voltage should increase and charge amps should decrease. If charge voltage does not increase within ten minutes, continue to next step.
8. **Battery** is 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.

A2-213 Regulator

DESCRIPTION AND OPERATION

A2-213 regulator is either attached directly to the outside of alternator or remote-mounted.

Main diagnostic feature of regulator is a green lens LED located on the front of the regulator. LED indicates whether regulator has been energized. See Table 2 for LED indication and status.

Regulators with OVCO (overvoltage cutout) will trip at vehicle electrical system voltages **above** 32 volts that exist longer than 3 seconds. OVCO feature detects high voltage and reacts by signaling the F+ alternator circuit to open. This turns off alternator. Restarting engine resets OVCO circuit. Regulator regains control of alternator output voltage.

TABLE 2—A2-213 Regulator LED Indications and Status

INDICATION	STATUS
ON steady	Normal regulator operation. Alternator is producing output.
FLASHING	Regulator is receiving energize signal. LED will flash until alternator produces output.
OFF	Regulator is not receiving energize signal or OVCO has tripped.

Troubleshooting

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, go to page 7.

REMOTE-MOUNTED REGULATORS: CHECK CONDITION OF FUSE IN WIRING HARNESS BEFORE TROUBLESHOOTING

Chart 1 – No Alternator Output – Quick Diagnostic

With engine running, does battery voltage exist at alternator B+ terminal and regulator IGN terminal?

- **No** → Repair vehicle harness circuit to IGN terminal on regulator or B+ terminal on alternator.
- **Yes** → With key off, engine off: Unplug alternator-to-regulator harness. Connect DMM on DC volt scale across sockets A and E in harness plug. Does battery voltage exist?
  - **No** → Alternator is defective.
  - **Yes** → With DMM on resistance scale, ensure that the field resistance measured between sockets B and C in harness plug is about 1.2 (±0.2) ohms.
    - **No** → Alternator is defective.
    - **Yes** → Install a jumper from socket B in harness plug to B+ terminal on alternator. Momentarily (1 sec.) jumper socket C in harness plug to alternator B– terminal. Touch shaft with steel tool to detect significant magnetism. Is shaft magnetized?
      - **Yes** → Regulator is defective.
      - **No** → Go to Chart 3, page 7.

SOCKET CONNECTIONS

Socket A	B–
Socket B	Field +
Socket C	Field –
Socket D	AC
Socket E	B+

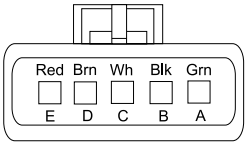

Figure 3 – Alternator-to-Regulator Harness Plug

Chart 2 – No Air-Conditioning/Alternator Warning Light On

With engine running, verify operation of charging system. Is regulator setpoint voltage present?

- Yes
- No → Go to Chart 3, page 7.

Connect DMM red lead to D+ (or P) terminal on regulator. Connect black lead to alternator B– terminal.

At D+ terminal – is regulator setpoint voltage present?

At P terminal – is 12 V to 18 V present?

- Yes → Stop engine. Alternator is good. Check vehicle wiring.
- No

Stop engine. Unplug alternator-to-regulator harness. Set DMM to Diode Test. Connect DMM red lead to socket D on alternator-to-regulator harness plug. Connect black lead to alternator B+ terminal. Does continuity exist?

- Yes → Regulator is defective.
- No → Go to Chart 4, page 8.

SOCKET CONNECTIONS

Socket A	B–
Socket B	Field +
Socket C	Field –
Socket D	AC
Socket E	B+

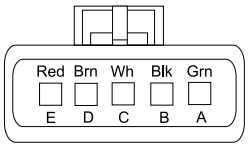

Figure 4 – Alternator-to-Regulator Harness Plug

Chart 3 – No Alternator Output – Test Charging Circuit

STATIC TEST – ENGINE OFF, BATTERY SWITCH ON, KEY ON.
REMOTE-MOUNTED REGULATORS: CHECK CONDITION OF FUSE IN WIRING HARNESS BEFORE TROUBLESHOOTING

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

- Yes → With engine running: Test for battery voltage at regulator IGN terminal. Does battery voltage exist?
  - Yes → Stop engine. Unplug alternator-to-regulator harness. Connect DMM red lead to socket E in harness plug. Connect black lead to socket A in same plug. Does battery voltage exist?
    - Yes → Connect DMM red lead to socket D in harness plug. Connect black lead to alternator B+ terminal. Does continuity exist?
      - Yes → Connect DMM red lead to socket B on alternator-to-regulator harness plug. Connect black lead to socket C on same plug. Does resistance measure about 1.2 ohms?
        - Yes → Unplug alternator-to-regulator harness. Plug CEN Regulator Bypass Adapter A10-129 into harness plug. Make sure black lead does not touch ground. Clip red lead to B+ terminal on alternator. (If Adapter is not available, connect jumper wire from pin B on harness to alternator B+ terminal.) Does spark occur at alternator B+ terminal?
          - Yes → Disconnect Adapter or jumper wire. Alternator is defective.
          - No → Momentarily (1 sec) touch black lead to ground on alternator case. [If Adapter is not available, momentarily (1 sec.) connect jumper wire from pin C on harness to ground.] Spark will occur at ground. Touch steel tool to shaft to detect significant magnetism. Is shaft magnetized?
            - Yes → Disconnect Adapter or jumper wire. Regulator is defective.
            - No → Disconnect Adapter or jumper wire. Alternator is defective.
        - No → Alternator is defective.
      - No → Go to Chart 4, page 8.
    - No → Alternator is defective.
  - No → Repair vehicle wiring as necessary. Continue test.
- No → Repair vehicle wiring as necessary. Continue test.

SOCKET CONNECTIONS

Socket A	B–
Socket B	Field +
Socket C	Field –
Socket D	AC
Socket E	B+

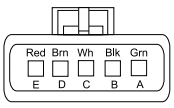

Figure 5 – Alternator-to-Regulator Harness Plug

Chart 4 – Continuation of Chart 2 or 3 as Noted

Set DMM to diode test. Connect black lead of DMM to B+ terminal on alternator. Connect red lead to socket D on harness plug. DMM should read voltage drop. Reverse leads. DMM should read OL.

Yes	No

Yes → Repair vehicle circuit to IGN terminal. Vehicle charging circuit test is complete.

No → Check continuity of thermal switch inside control unit: Remove drive end cover on alternator. With DMM, check continuity between socket D on harness plug and diode shown in Figure 7 below. Does continuity exist?

Yes	No
Alternator is defective.	Thermal switch in control unit is defective.

SOCKET CONNECTIONS

Socket A	B–
Socket B	Field +
Socket C	Field –
Socket D	AC
Socket E	B+

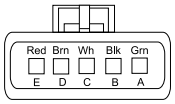

Figure 6 – Alternator-to-Regulator Harness Plug

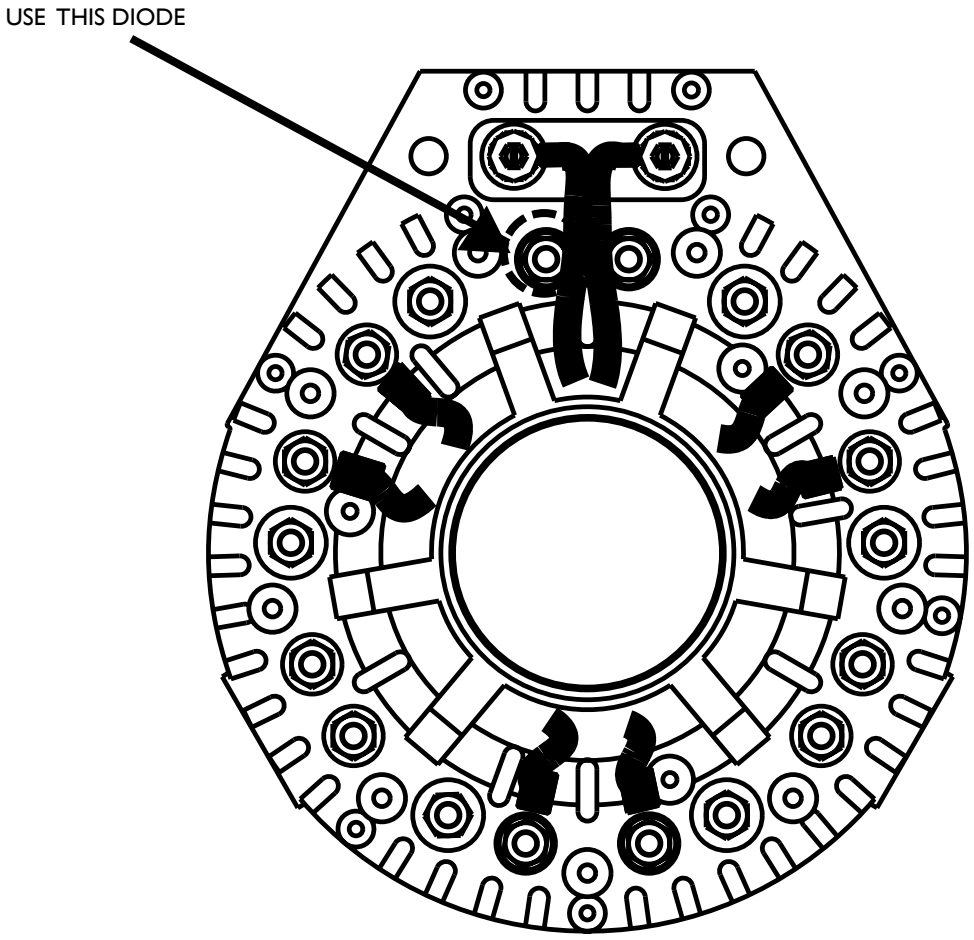

Figure 7 – Diode Arrangement inside Drive End Housing

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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