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 hazards that will or can cause minor personal injury or property damage.

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 C653/C653A and C625 Alternators
Description and Operation

C653/C653A and C625 28 V (260 A) alternators are self-rectifying. All windings and current-transmitting components are non-moving, so there are no brushes or slip rings to wear out.

When controlled by the A2-146 or A2-153 regulator, these alternators become self-energizing through internal diode trios. Residual magnetic field induces small voltage in stator and energizes field coil. Field coil continues receiving incremental voltage until full voltage is achieved. AC is rectified into DC output through diodes. Regulator controls voltage output. Regulator has:

- D+ terminal to provide a signal to vehicle electrical system, confirming alternator operation
- P terminal to provide an optional AC voltage tap.

When controlled by the A2-214 regulator, these alternators become externally energized through the IGN terminal, connected to a switched power source to turn on regulator. See wiring diagram, Figure 5 on page 3. Regulator has:

- D+ terminal that can provide signal to vehicle electrical system, confirming alternator operation.
- P terminal that can provide an optional AC voltage tap.

When C653 alternator is controlled by the A2-338 regulator, the alternator becomes self-energized through sensing of alternator rotation through AC circuit. Residual magnetic field induces small voltage in stator and energizes field coil. Field coil continues receiving incremental voltage until full voltage is achieved. Regulator controls voltage output. See wiring diagram, Figure 4 on page 3. A2-338 regulator has:

- P terminal that can provide optional AC voltage tap.
- D+ terminal that can provide DC voltage signal to vehicle electrical system, confirming alternator operation.
- Overvoltage cutout (OVCO) function. See page 10.
- Tricolored LED. See page 10.
- T terminal to connect optional A9-4011 temperature sense lead to adjust regulator setpoint to maintain charge voltage (or negative temperature compensation) by sensing ambient temperature within the battery box. If temperature sense lead is not connected, the regulator will operate at 27.5 V.
Figure 4 — C653/C653A Alternators with A2-146 or A2-153 or A2-338 Regulator

Figure 5 — C653/C653A and C625 Alternators with A2-214 Regulator

*Thermal switch is not factory-installed on all models.
Section B: Basic Troubleshooting

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 ______________________________
- Setpoints listed on regulator ________________________

Preliminary Check-out
Check symptoms in Table 1 and correct if necessary.

<table>
<thead>
<tr>
<th>TABLE 1 – System Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYMPTOM</td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td>Low Voltage Output</td>
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<td></td>
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<tr>
<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>High Voltage Output</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>No Voltage Output</td>
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<td></td>
</tr>
</tbody>
</table>

Basic Troubleshooting
1. Inspect charging system components for damage
   Check connections at B– cable, B+ cable, and regulator harness. Also check connections at regulator terminal wiring from regulator to vehicle components. 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.
   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.

   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
   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 1, page 5, for A2-146/A2-153
   - Chart 2, page 7, for A2-214
   - Chart 5, page 11, for A2-338

CAUTION
Failure to check for the following conditions will result in erroneous test results in the troubleshooting charts.
Self-energized alternator may have lost magnetism. Touch steel tool to shaft to detect any magnetism. Is shaft magnetized?

| Yes | No |

Momentarily (1 sec.) jumper D+ terminal on regulator to B+ terminal on alternator. Touch shaft with steel tool to detect significant magnetism. Is shaft magnetized?

| Yes | No |

Remove jumper from D+ to B+.

Install a jumper from B+ terminal on alternator to pin F in harness plug. Momentarily (1 sec.) jumper pin A to B– terminal on alternator. Touch shaft with steel tool to detect significant magnetism. Is shaft magnetized?

| Yes | No |

Alternator is defective.

Regulator is defective.

CAUTION When conducting this step, ensure that the probes do not touch other pins, as an arc may damage the wiring in the harness.

Unplug alternator-to-regulator harness. Connect DMM across pin D and pin C in harness plug. Does battery voltage exist?

| Yes | No |

Install a jumper from B+ terminal on alternator to pin F in harness plug. Momentarily (1 sec.) jumper pin A to B– terminal on alternator. Touch shaft with steel tool to detect significant magnetism. Is shaft magnetized?

| Yes | No |

Alternator is defective.

Regulator is defective.

Set DMM to diode test. Connect black lead of DMM to pin E in harness plug. Connect red lead to B+ terminal on alternator. DMM should read OL. Reverse leads. DMM should also read OL.

| Yes | No |

Install a jumper from B+ terminal on alternator to pin F in harness plug. Momentarily (1 sec.) jumper pin A to B– terminal on alternator. Touch shaft with steel tool to detect significant magnetism. Is shaft magnetized?

| Yes | No |

Alternator is defective.

Regulator is defective.
A2-214 Regulator

DESCRIPTION AND OPERATION

A2-214 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.

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 8.

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

<table>
<thead>
<tr>
<th>INDICATION</th>
<th>STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON steady</td>
<td>Normal regulator operation. Alternator is producing output.</td>
</tr>
<tr>
<td>FLASHING</td>
<td>Regulator is receiving energize signal. LED will flash until alternator produces output.</td>
</tr>
<tr>
<td>OFF</td>
<td>Regulator is not receiving energize signal or OVCO has tripped.</td>
</tr>
</tbody>
</table>
# Chart 2 – No Alternator Output – Quick Diagnostic

<table>
<thead>
<tr>
<th>Step</th>
<th>With engine running, does battery voltage exist at alternator B+ terminal and regulator IGN terminal?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Repair vehicle harness circuit to IGN terminal on regulator or B+ terminal on alternator.</td>
</tr>
<tr>
<td>No</td>
<td>CAUTION: When conducting this step, ensure that the probes do not touch other pins, as an arc may damage the wiring in the harness. Unplug alternator-to-regulator harness. Connect DMM across pin D and pin C in harness plug. Does battery voltage exist?</td>
</tr>
<tr>
<td>Yes</td>
<td>Alternator is defective.</td>
</tr>
<tr>
<td>No</td>
<td>With DMM on resistance scale, ensure that the field resistance measured between pins F and A in harness plug is about 1.2 (±0.2) ohms.</td>
</tr>
<tr>
<td>Yes</td>
<td>Alternator is defective.</td>
</tr>
<tr>
<td>No</td>
<td>Install a jumper from pin F in harness plug to B+ terminal on alternator. Momentarily (1 sec.) jumper pin A in harness plug to alternator B– terminal. Touch shaft with steel tool to detect significant magnetism. Is shaft magnetized?</td>
</tr>
<tr>
<td>Yes</td>
<td>Regulator is defective.</td>
</tr>
<tr>
<td>No</td>
<td>Go to Chart 3, page 8.</td>
</tr>
</tbody>
</table>

**PIN CONNECTIONS**
- Pin A: F–
- Pin B: Phase
- Pin C: B–
- Pin D: B+
- Pin E: D+
- Pin F: F+

**Figure 7 – Alternator-to-Regulator Harness Plug**
Chart 3 – No Alternator Output – Test Charging Circuit

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

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

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

With engine running: Test for battery voltage at regulator IGN terminal. Does battery voltage exist?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

Repair vehicle wiring as necessary. Continue test.

Repair vehicle wiring as necessary. Re-test.

CAUTION
When conducting this step, ensure that the probes do not touch other pins, as an arc may damage the wiring in the harness.

With engine off: Unplug alternator-to-regulator harness. Connect DMM across pin D and pin C in harness plug. Does battery voltage exist?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

Alternator is defective.

Turn off battery switch. Disconnect B+ battery cable from alternator. Connect black lead of DMM to pin E in harness plug. Connect red lead to B+ terminal on alternator. DMM should read OL. Reverse leads. DMM should also read OL.

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

Alternator is defective.

Reconnect B+ battery cable to alternator. Turn on battery switch. Set DMM to Diode Test. Connect red lead to pin B in harness plug. Connect black lead to B+ terminal on alternator. Does continuity exist?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

Regulator is defective.

Install a jumper from pin F in harness plug to B+ terminal on alternator. Momentarily (1 sec.) jumper pin A in harness plug to alternator B– terminal. Touch shaft with steel tool to detect significant magnetism. Is shaft magnetized?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

Regulator is defective.

**PIN CONNECTIONS**

<table>
<thead>
<tr>
<th>PIN CONNECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pin A</td>
</tr>
<tr>
<td>Pin B</td>
</tr>
<tr>
<td>Pin C</td>
</tr>
<tr>
<td>Pin D</td>
</tr>
<tr>
<td>Pin E</td>
</tr>
<tr>
<td>Pin F</td>
</tr>
</tbody>
</table>

**Figure 8 – Alternator-to-Regulator Harness Plug**
Set DMM to diode test. Connect black lead of DMM to B+ terminal on alternator. Connect red lead to pin B on harness plug. DMM should read voltage drop. Reverse leads. DMM should read OL.

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repair vehicle circuit to IGN terminal. Vehicle charging circuit test is complete.</td>
<td>Check continuity of thermal switch inside control unit: Remove drive end cover on alternator. With DMM, check continuity between pin B on harness plug and diode shown in Figure 9 below. Does continuity exist?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternator is defective.</td>
<td>Thermal switch in control unit is defective.</td>
</tr>
</tbody>
</table>

Figure 9 – Diode Arrangement inside C653 Drive End Housing
A2-338 Regulator
Description and Operation

A2-338 regulator is attached directly to the outside of alternator. A9-4011 temperature sense lead may or may not be used with this regulator. See below.

Main diagnostic feature of the regulator is a tricolored LED next to the harness receptacle on regulator. LED works like a voltmeter, measuring charging voltage. See Table 3 for diagnostic features and LED explanations.

This regulator has OVCO (overvoltage cutout) that will trip at vehicle electrical system voltage above 33 volts that exists longer than 3 seconds. OVCO feature detects high voltage and reacts by signaling field circuit to open. This turns off alternator (LED is flashing RED). OVCO circuit is reset when engine is restarted or when system voltage drops below 26.5 V.

When the A9-4011 temperature sense lead is not in use, the regulator will operate at 27.5 V.

When A9-4011 temperature sense lead is in use, the lead senses the ambient temperature within the battery box and regulator will adjust charge voltage based on battery temperature—the higher the battery temperature, the lower the charge voltage.

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 field circuit, try third restart. If OVCO circuit repeats cutout, go to Chart 5, page 11.

---

<table>
<thead>
<tr>
<th>LED COLOR</th>
<th>STATUS</th>
<th>ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>GREEN</td>
<td>Solid</td>
<td>Alternator and regulator operating normally. No action required.</td>
</tr>
<tr>
<td></td>
<td>Flashing</td>
<td>Regulator is in soft start mode. Wait 10 seconds until alternator achieves full rotation.</td>
</tr>
<tr>
<td>AMBER</td>
<td>Solid</td>
<td>Low system voltage — Electrical load exceeds alternator rating at present rotor speed. When loads decrease or speed increases, LED should be solid GREEN. If not, check drive belt and charging system connections.</td>
</tr>
<tr>
<td></td>
<td>Flashing</td>
<td>Alternator fault — No output. Replace alternator.</td>
</tr>
<tr>
<td>RED</td>
<td>Solid</td>
<td>High system voltage – May occur during normal load switching. If solid more than 3 seconds, OVCO will trip, disabling charging system. LED will flash RED.</td>
</tr>
</tbody>
</table>
Self-energized alternator may have lost magnetism. Touch steel tool to shaft to detect any magnetism. Is shaft magnetized?

Yes | No
--- | ---

| CAUTION | When conducting this step, ensure that the probes do not touch other pins, as an arc may damage the wiring in the harness. |
--- | ---

Momentarily (1 sec.) jumper D+ terminal on regulator to B+ terminal on alternator. Touch shaft with steel tool to detect significant magnetism. Is shaft magnetized?

Yes | No
--- | ---

Unplug alternator-to-regulator harness. Connect DMM across pin D and pin C in harness plug. Does battery voltage exist?

Yes | No
--- | ---

Install a jumper from B+ terminal on alternator to pin F in harness plug. Momentarily (1 sec.) jumper pin A to B– terminal on alternator. Touch shaft with steel tool to detect significant magnetism. Is shaft magnetized?

Yes | No
--- | ---

Set DMM to diode test. Connect black lead of DMM to pin E in harness plug. Connect red lead to B+ terminal on alternator. DMM should read OL. Reverse leads. DMM should also read OL.

Yes | No
--- | ---

Install a jumper from B+ terminal on alternator to pin F in harness plug. Momentarily (1 sec.) jumper pin A to B– terminal on alternator. Touch shaft with steel tool to detect significant magnetism. Is shaft magnetized?

Yes | No
--- | ---

Regulator is defective.

Figure 10 – Alternator-to-Regulator Harness Plug