500 Series Troubleshooting Guide for C510 Alternators

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 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 with medium amps.
  - — 3-5 minutes into charge cycle, higher system volts and reduced amps.
  - — 5-10 minutes into charge cycle, system volts are at, or nearly at, regulator setpoint, and amps are reduced to a minimum.
  - — Low maintenance battery has same characteristics with slightly longer recharge times.
- Maintenance-free battery:
  - — Immediately after engine start, system volts are lower than regulator setpoint with low amps.
  - — 15-30 minutes into charge cycle, still low volts and low amps.
  - — 15-30 minutes into charge cycle, volts increase several tenths. Amps increase gradually, then quickly to medium to high amps.
  - — 20-35 minutes into charge cycle, volts increase to setpoint and amps decrease.
- 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.

Charge Volt and Amp Values

The volt and amp levels are a function of the battery-state of charge. If batteries are in a state of discharge, as after extended cranking time to start the engine, the system volts, when measured after the engine is started will be lower than the regulator set point and the system amps will be high. This is a normal condition for the charging system. The measured values of system volts and amps will depend on the level of battery discharge, in other words, the greater the battery discharge level the lower the system volts and higher the system amps will be. The volt and amp readings will change and system volts reading will increase up to regulator set point and the system amps will decrease to low level (depending on other loads) as the batteries recover and become fully charged.

- **Low Amps:** A 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:** A system amps value which can cause the battery temperature to rise above the 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 amps rates.
- **High Amps:** A system amps value which can cause the battery temperature to rise above adequate charging temperature within 2-3 hours. To prevent battery damage the charge amps should be reduced when the 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:** A voltage value obtained when the charging system is operating. This value will be higher than battery voltage and must never exceed the regulator voltage set point.
- **B+ Voltage:** A voltage value obtained when measuring voltage at battery positive terminal or alternator B+ terminal.
- **Surface Charge:** A higher than normal battery voltage occurring when the battery is removed from a battery charger. The surface charge must be removed to determine true battery voltage and state of charge.
- **Significant Magnetism:** A change in the strength or intensity of a magnetic field present in the 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:** A normal condition which occurs when the load demand on the alternator is greater than rated alternator output at given rotor shaft RPM.

CEN C510 Alternator Description and Operation

The **C510** alternator is a 14 V, 280 A brushless alternator that uses an externally mounted rectifier and regulator. 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, which 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.

A2-136 external regulator furnished with all units has R terminal for optional AC voltage tap. Optional 15.5 V regulator setpoint is available for battery isolator applications.

A8-201 or A8-205 external rectifier allows for mounting in engine compartment. A8-205 rectifier suppresses electromagnetic interference (EMI) with internal filters to acceptable levels defined by the Society of Automotive Engineers (SAE) specification J1113/41. A8-205 rectifier will not reduce EMI from sources such as antennas, poor cable routing practice, or other electronic devices that cause EMI. If EMI continues, consult an electromagnetic compliance (EMC) specialist to determine EMI source.

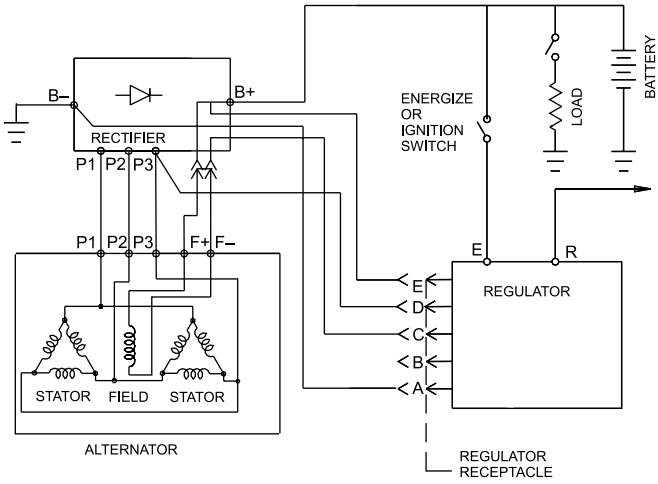

Figure 1 — C510 Alternator Wiring Diagram

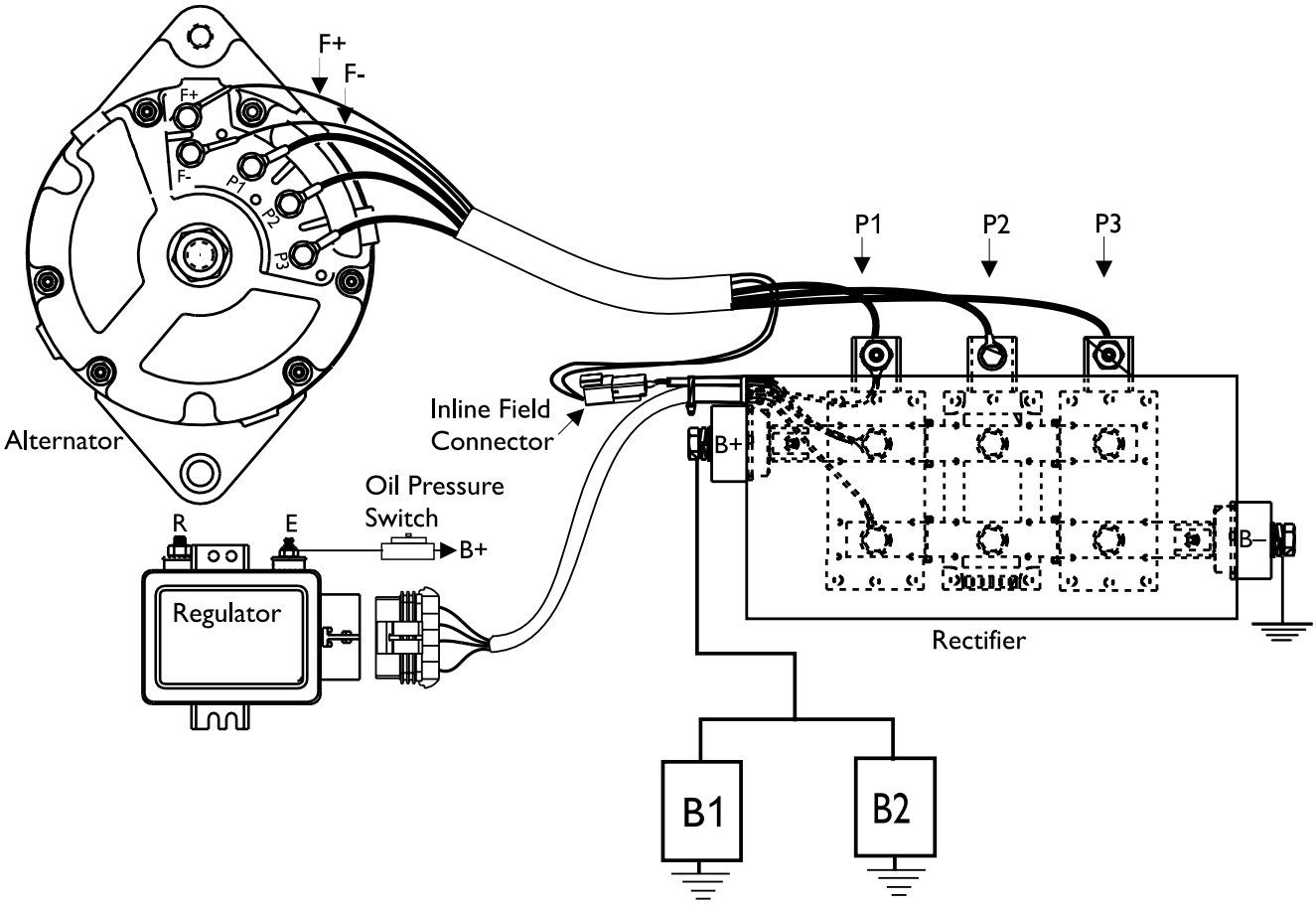

Figure 2 — C510 Terminal Locations

A. Tools and Equipment for Job

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

B. Identification Record

Complete the following for proper troubleshooting:

❑ Alternator model number _____

❑ Rectifier model number _____

❑ Regulator model number _____

❑ Setpoints listed on regulator _____

C. Preliminary Check-out

Check condition of items 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, rectifier and/or regulator. Check: loss of phase winding. See Chart 1, page 4.
High Voltage Output	Check: wrong regulator. Check: high regulator set-point. Check: defective regulator. Check: alternator.
No Voltage Output	Check: broken drive belt. Check: battery voltage at alternator output terminal. Check: defective alternator, rectifier and/or regulator.

D. Basic Troubleshooting

1. **Inspect charging system components for damage**
   Check connections at B– cable, B+ cable, rectifier harness and regulator harness. Repair or replace any damaged component before electrical troubleshooting.

2. **Inspect vehicle battery connections**
   Connections must be clean and tight.

3. **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.

4. **Determine if battery isolator is used in charging circuit**
   Check vehicle wiring diagram. If so, you must jumper out isolator before troubleshooting. See Chart 1 for details.

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 16.5 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 1, page 4.

START HERE

Chart 1 – System Circuit

Is there a battery isolator in the system?

Yes	No

Yes:

Install temporary jumper between one battery terminal and alternator terminal on isolator. Use minimum 12 AWG wire.

CAUTION Do not operate charging system more than two minutes with jumper installed. Charging system voltage will be abnormally high and damage other components.

For "low voltage output" condition: go to Chart 2 below.

For "no voltage output" condition:
- with **energize switch**, go to Chart 3, page 6.
- with **ignition switch**, go to Chart 4, page 7.

Chart 2 – Low Voltage Output – Alternator Not Keeping Up with Load

Operate engine at idle, battery as sole load, no other loads applied. Measure charge voltage at battery posts (B+ to B-) and output voltage at rectifier B+ and B– terminals. Measure charge amps entering battery and charge amps out of alternator at rectifier B+ terminal.
Is difference in voltages greater than 0.2 V and amp difference less than 20 A?

Yes	No

Yes:

Inspect harnesses and connections for corrosion. Repair/replace as necessary. Repeat test. Voltage value should be less than 0.1 V.

Increase engine speed to 1200 rpm, battery as sole load, no other loads applied, meters attached as in box above. Increase load to 75, 150 and 280 A.
Does voltage remain steady?

Yes	No

Yes: Re-test charging system.

No:

Measure AC voltage from terminals: P1 to P2, P2 to P3, and P3 to P1 on rectifier.
Are voltages within 5% of each other?

Yes	No

Yes: Re-test charging system.

No: Start test at top of page 5.

Chart 2 – Low Voltage Output – Alternator Not Keeping Up with Load (cont'd)

RECTIFIER TEST

The following will test modules inside rectifier:

1. Disconnect all battery cables.
2. Disconnect harness leads to rectifier terminals P1, P2 and P3.
3. Disconnect B+ and B– cables from rectifier.
4. Unplug rectifier-to-regulator harness.
5. Unplug alternator field circuit harness connector.
6. Use DMM set to diode tester. Meter readings should not vary more than 10%, test to test.
7. If expected reading is not obtained, diode inside module is most likely defective. Diode modules are individually replaceable. Consult CEN authorized service distributor for more information.
8. If tests indicate rectifier is good, alternator is defective. Consult CEN authorized service distributor for more information.

TABLE 2 – Diode Test

Positive (Red) Meter Lead on	Negative (Black) Meter Lead on	Correct Result on Meter	What You Are Measuring
P1, P2, P3 terminals on rectifier, one at a time.	B+ terminal on rectifier.	Uniform voltage drop across each positive diode.	Positive side diode is conducting.
B+ terminal on rectifier.	P1, P2, P3 terminals on rectifier, one at a time.	DMM will read OL (out of limits).	Positive side diode is blocking.
P1, P2, P3 terminals on rectifier, one at a time.	B– terminal on rectifier.	DMM will read OL (out of limits).	Negative side diode is blocking.
B– terminal on rectifier.	P1, P2, P3 terminals on rectifier, one at a time.	Uniform voltage drop across each negative diode.	Negative side diode is conducting.

Chart 3 – No Alternator Output – **Energize Switch** – Test Charging Circuit

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

Test for battery voltage at B+ terminal on rectifier. Does battery voltage exist?
- Yes
- No → Repair vehicle wiring as necessary. Continue test.

Jumper B+ terminal on rectifier to E terminal on regulator. Touch shaft with steel tool to detect significant magnetism. Is shaft magnetized?
- Yes
- No → Unplug rectifier-to-regulator harness. Plug CEN Regulator Bypass Adapter A10-129 into harness plug and touch black lead to ground on alternator case. (If no Adapter is available, connect jumper wire from pin C on the harness to ground). Spark will occur at ground. Touch steel tool to shaft to detect significant magnetism. Is shaft magnetized?
  - Yes → Disconnect Regulator Bypass Adapter or jumper wire. Connect DMM red lead to socket E in rectifier-to-regulator plug. Connect black lead to socket A in same plug. Does battery voltage exist?
    - Yes → Regulator is defective.
    - No → Check wiring and connections in rectifier. Run engine and re-test charging circuit for operation.
  - No → Unplug inline field connector. Check resistance across two sockets on alternator side of connector. Does resistance measure 0.9 to 1.1 ohms?
    - Yes → Field coil is okay. Disconnect Regulator Bypass Adapter or jumper wire. Check wiring and connections in rectifier. Reconnect wiring. Run engine and re-test charging circuit for operation.
    - No → Check resistance across F+ and F– terminals on alternator. Does resistance measure 0.9 to 1.1 ohms?
      - Yes → Wiring harness is defective.
      - No → Alternator is defective.

Go to energize switch on engine in E circuit. Test for battery voltage going into energize switch from battery. Does battery voltage exist?
- Yes
- No → Repair vehicle circuit to energize switch. Continue test.

Make sure jumper wire from rectifier 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?
- Yes → E circuit from regulator to energize switch is good. Energize switch is defective.
- No → Repair vehicle circuit from E teminal on regulator to energize switch on engine.

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

SOCKET CONNECTIONS

Socket A	B–
Socket B	Not Used
Socket C	Field –
Socket D	Phase AC
Socket E	B+

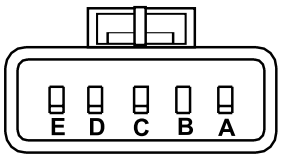

Figure 3 – Rectifier-to-Regulator Harness Plug

Chart 4 – No Alternator Output – **Ignition Switch** – Test Charging Circuit

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

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

- Yes → Jumper B+ terminal on rectifier to E terminal on regulator. Touch shaft with steel tool to detect significant magnetism. Is shaft magnetized?
  - Yes → Disconnect jumper. Apply 12 V test light to regulator E terminal and ground. Does light glow brightly?
    - Yes → Run vehicle. Does charge voltage exist?
      - Yes → System operating normally.
      - No → Jumper B+ terminal on rectifier to regulator E terminal. Does charge voltage exist?
        - Yes → Repair wiring or ignition switch.
        - No → Contact CEN Service Department for assistance.
    - No → Repair wiring or ignition switch.
  - No → Unplug rectifier-to-regulator harness. Plug CEN Regulator Bypass Adapter A10-129 into harness plug; touch black lead to ground on alternator case. (If no Adapter is available, connect jumper wire from pin C on the harness to ground.) Spark will occur at ground. Touch steel tool to shaft to detect significant magnetism. Is shaft magnetized?
    - Yes → Unplug inline field connector. Check resistance across two sockets on alternator side of connector. Does resistance measure 0.9 to 1.1 ohms?
      - Yes → Field coil is okay. Disconnect Regulator Bypass Adapter or jumper wire. Check wiring and connections in rectifier. Reconnect wiring. Run engine and re-test charging circuit for operation.
      - No → Check resistance across F+ and F– terminals on alternator. Does resistance measure 0.9 to 1.1 ohms?
        - Yes → Wiring harness is defective.
        - No → Alternator is defective.
    - No → Disconnect Regulator Bypass Adapter or jumper wire. Connect DMM red lead to socket E in rectifier-to-regulator plug. Connect black lead to socket A in same plug. Does battery voltage exist?
      - Yes → Regulator is defective.
      - No → Check wiring and connections in rectifier. Run engine and re-test charging circuit for operation.
- No → Repair vehicle wiring as necessary. Continue test.

SOCKET CONNECTIONS
Socket A B–
Socket B Not Used
Socket C Field –
Socket D Phase AC
Socket E B+

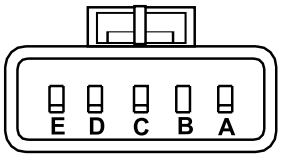

Figure 3 – Rectifier-to-Regulator Harness Plug

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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