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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 Battery:

- Immediately after engine starts, system volts are lower than regulator setpoint and amp output is medium.
- After alternator energizes, voltage will increase by several tenths. Amps increase gradually to medium-to-high levels.
- 3–5 minutes into charge cycle, system voltage increase and amps decrease.
- 5–10 minutes into charge cycle, system volts increase to or near regulator set point. Amps decrease to a minimum.
- Has same characteristics as maintenance battery, but has slightly longer recharge time.

Maintenance-free 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 70°F. 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.

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 gage 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.



C640L Alternator
Description and Operation

The C640L 28 V alternator is self-rectifying and self-energized. All windings and current-carrying components are stationary, so there are no brushes or slip rings to wear out. When controlled by a smart regulator, the C640L alternator becomes self-energized through sensing of alternator rotation through AC circuit. A residual magnetic field induces a small voltage in each stator and energizes the field coil. The AC voltage is then rectified to DC. The field coil continues receiving incremental voltage until setpoint voltage is reached. Voltage output is controlled by the regulator. See wiring diagram below.

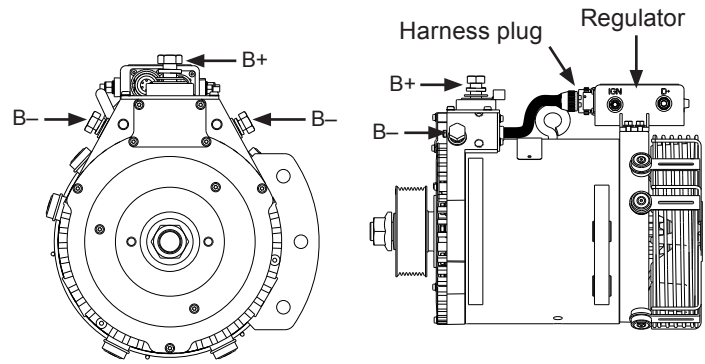
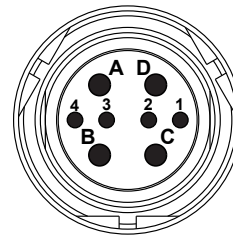
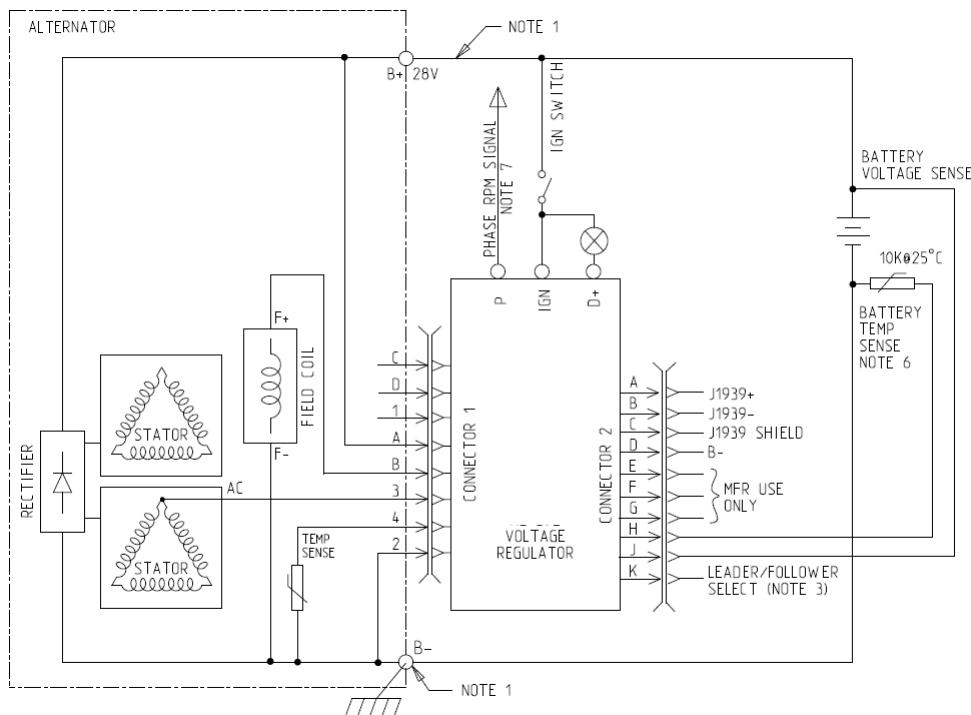


Figure 1: C640L Alternator



- Socket A = B+
- Socket B = F+
- Socket C = Not used
- Socket D = Not used
- Socket 1 = Not used
- Socket 2 = B-
- Socket 3 = Phase
- Socket 4 = Temp sense

Figure 2: Alternator-to-Regulator Harness Plug Sockets



NOTES:

1. Voltage drop at 260 amperes between alternator B+ terminal and battery B+ terminal shall not exceed 0.4 volts. Ground cable should follow the same rule.
2. Connections to terminals "P," "D+," "IGN" and to connector 2 are optional.
3. For leader regulator configuration, leave pin K on connector 2 unconnected. For follower regulator configuration, connect pin K to pin D on connector 2.

Figure 3: C640L Alternator Wiring Diagram



Regulator Description and Operation

Smart regulators furnished with some units include:

- IGN terminal on regulator is connected to vehicle ignition to provide battery voltage when engine is running. Circuit should be off (no voltage present) when vehicle ignition is off or engine is not running.
- P terminal that can provide optional AC voltage tap. P terminal signal frequency (Hz) x 10 = alternator shaft rpm.
- D+ terminal that can provide DC voltage signal to vehicle electrical system, confirming alternator operation.
- Overvoltage cutout (OVCO) circuit. See Table 2 below.
- Tricolored status indicator LED. See page 4.
- J1939 connector to be used with optional A9-4036 harness. When A9-4036 temperature/voltage sense harness is connected, regulator will automatically optimize the charge voltage for battery type based on temperature. Also, vehicle manufacturer-requested functions of 1939 interface are available through connector.

NOTICE When optional A9-4036 temperature/voltage sense harness is not connected, regulator will operate in fixed voltage setting determined by the select switch position on the bottom of the regulator. See Column 2 in Table 1.

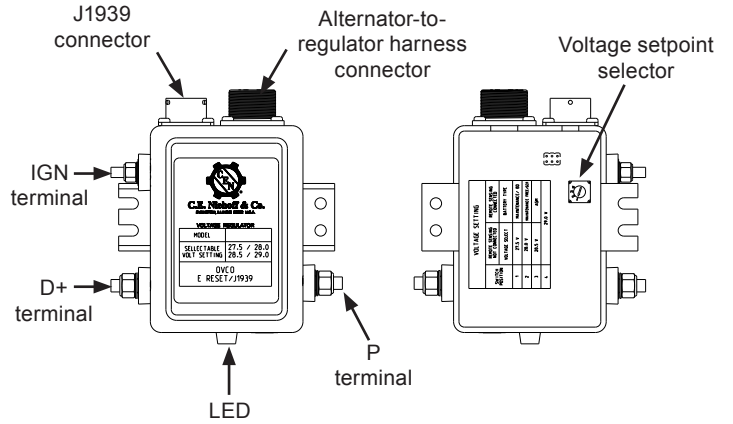


Figure 4: Regulator External Features

Setting	Harness Not Connected (Voltage Select)	Harness Connected (Battery Select)
1	27.5 V	Maintenance (D Category)
2	28.0 V	Maintenance-free (Group 31)
3	28.5 V	AGM
4	29.0 V	

LED COLOR	ALTERNATOR / REGULATOR STATUS	REQUIRED ACTION
GREEN (Solid)	Alternator and regulator operating normally.	No action required.
GREEN (Flashing)	Surge suppression circuit disabled; alternator still charging battery.	No action required.
AMBER (Solid)	Voltage is below 25.0 V	If voltage is at or below regulator setpoint, allow charging system to operate for several minutes to normalize operating temperature. If charge voltage does not increase within 10 minutes, perform troubleshooting procedures on page 5.
AMBER (Flashing)	No rotation detected.	Power down and restart alternator. If LED remains flashing amber, perform troubleshooting procedures on page 5.
RED (Solid)	Field coil out of specification	Power down and restart alternator. If LED remains solid red, perform troubleshooting procedures on page 5.
RED (Flashing)	OVCO condition detected.	Power down and restart alternator. If LED remains flashing red, refer to basic OVCO troubleshooting procedure on page 6.

NOTE: LED off = No power/output.



Required Tools and Equipment

- Digital Multimeter (DMM)
- Ammeter (digital, inductive)
- Jumper wires

Identification Record

Enter the following information in the spaces provided for identification records.

- Alternator model number _____
- Regulator model number _____
- Voltage setpoints listed on regulator _____

Preliminary Check-out

Check charging system for conditions listed in Table 1 below.

TABLE 1: Preliminary Charging System Check-Out	
PROBLEM:	CHECK FOR:
Low Voltage Output	Loose drive belt. Low battery state of charge. Load on system exceeds rated output of alternator. Low regulator setpoint. Faulty wiring or poor ground path. Faulty alternator or regulator. Wrong regulator installed.
High Voltage Output	High regulator setpoint. Faulty regulator. Faulty alternator.
No Voltage Output	Broken drive belt. Faulty alternator or regulator. Lost residual magnetism in self-energizing alternator. Go to Chart 1 on page 5.

Basic Troubleshooting

1. Inspect charging system components for damage. Check connections at B– cable, B+ cable, and regulator harness. Check 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 belt as necessary.
4. Determine battery voltage and state of charge. If batteries are discharged, recharge or replace batteries. Electrical system cannot be properly tested unless batteries are charged 95% or higher.
5. Connect meters to alternator:
 - a. Connect DMM red lead to alternator B+ terminal.
 - b. Connect DMM black lead to alternator B– terminal.
 - c. Clamp inductive ammeter onto B+ cable.
6. Operate vehicle and observe charge voltage. Charge voltage should increase and charge amps should decrease. Battery is considered fully charged when charge voltage is at regulator setpoint and charge amps remain at lowest value for 10 minutes.
 - a. If voltage is at or below regulator setpoint, allow charging system to operate for several minutes to normalize operating temperature.
 - b. If charge voltage exceeds 32 V, shut down system immediately.

CAUTION

Damage to electrical system may occur if charging system is allowed to operate above 32V for more than 3 seconds.

7. If charge voltage does not increase within 10 minutes, go to Chart 1 on page 5.

Check for OVCO Condition

1. 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.
2. 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.
3. 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.



Chart 1: No Alternator Output – Test Charging Circuit

CAUTION

When performing the following steps, make sure probes do not touch other sockets, as this may create an arc and damage plug.

- TEST MEASUREMENTS ARE TAKEN AT ALTERNATOR HARNESS PLUG. Taking measurements from an extended harness plug may affect results.
- CHECK CONDITION OF FUSES IN REMOTE MOUNTED REGULATOR HARNESS BEFORE TESTING.
- IF AVAILABLE, CONNECT A CEN A10-151 IN-LINE TEST TOOL TO HARNESS PLUG AND CONDUCT TESTS FROM A10-151 SOCKETS. Otherwise perform all tests directly from harness plug sockets.
- BEFORE TESTING, VERIFY THE FOLLOWING AND REPAIR/REPLACE IF NOT TO SPECIFICATION:
 - Batteries for state-of-charge (25.0-28.0 V), condition, and secure connections.
 - Master battery switch for function.

MASTER BATTERY SWITCH ON, KEY ON, ENGINE ON: Test for battery voltage at B+ terminal on alternator to ground, then at IGN terminal on regulator to ground. Does battery voltage exist at both locations?

Yes

No

Disconnect 8-pin alternator-to-regulator harness plug at regulator and connect CEN A10-151 in-line test tool to harness plug end only. Make sure connections are secure.

Repair vehicle wiring as necessary. Run engine and re-test charging circuit. Is charging system performing properly?

No

Yes

System is operative.

MASTER BATTERY SWITCH ON, KEY OFF, ENGINE OFF: Readings of all four tests must pass.

1. Battery voltage test: Connect DMM red lead to socket A in test tool. Connect DMM black lead to socket 2 in A10-151 in-line test tool. Battery voltage should exist.
2. Field coil resistance test: Set DMM to ohms test. Resistance between sockets B and 2 in test tool should measure nominal $1.0-1.5 \pm 0.5$ ohms. Field coil is faulty if reading is less than 0.5 ohms or greater than 3 ohms.
3. Phase signal test: Set DMM to diode test. Connect DMM black lead to socket 3 in test tool. Connect red lead to alternator B+ terminal. DMM should read OL in this direction. Reverse leads. DMM should read diode voltage drop in this direction. Repeat for socket 3 and alternator B- terminal. Tests should read diode voltage drop in one direction and OL in the other direction.
4. Temperature sensor test: Set DMM to Ohms test. Measure resistance between alternator B- terminal and socket 4. Resistance should read between 60k and 130k ohms at room temperature.

Yes

No

Regulator is faulty.

Alternator is faulty.

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- Socket 3 = Phase
- Socket 4 = Temp sense

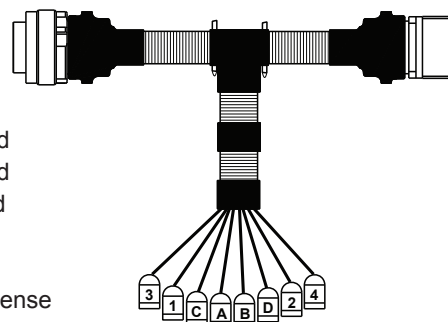
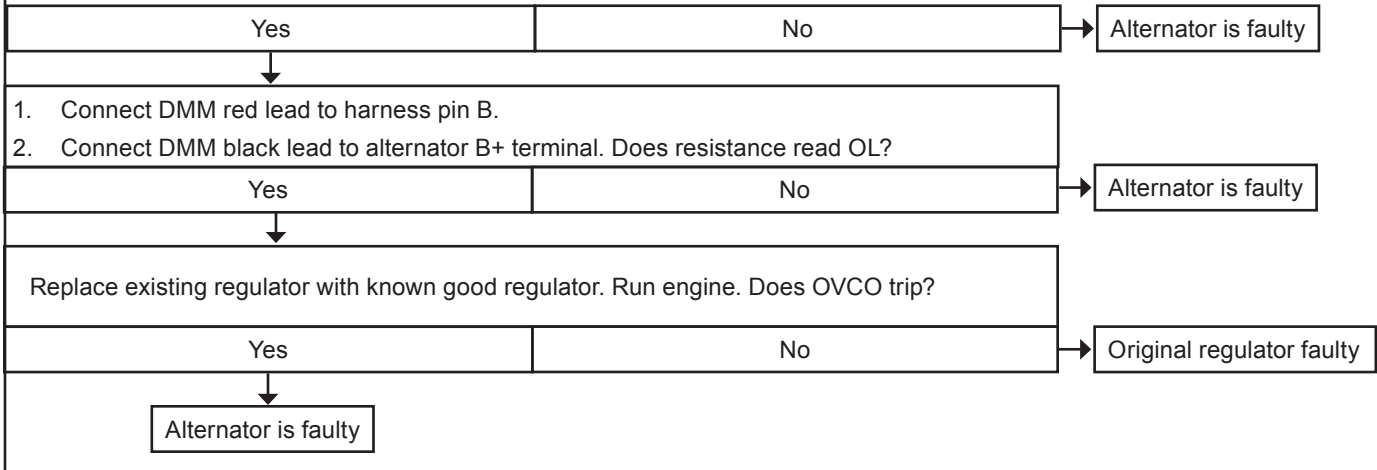


Figure 5: CEN 8-pin A10-151 In-line Harness Tool Socket Connections



Chart 2: Test OVCO Circuit

1. Unplug alternator-to-regulator harness from regulator. Set DMM to ohms test.
2. Connect DMM red lead to harness pin B.
3. Connect DMM black lead to alternator B-. Does resistance read $1.0-1.5 \pm 0.2$ ohms?



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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