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 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.
- "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 N1387-1 Dual Voltage Alternator Description and Operation

N1387-1 28 V 210 A alternator with optional 28 V/14 V (50 A maximum on 14 V) is internally rectified. All windings and current-transmitting components are non-moving, so there are no brushes or slip rings to wear out.

After engine is running, **N3225** regulator receives energize signal. Regulator monitors alternator rotation and provides field current only when it detects alernator shaft rotating at suitable speed.

After regulator detects alternator rotation, it gradually applies field current, preventing an abrupt mechanical load on accessory drive system. The soft start may take up to 20 seconds.

N3225 regulator used with these units also

- is negative temperature compensated. Setpoints are 28.0 ± 0.2 V and 14.0 ± 0.2 V at 75° F.
- provides overvoltage cutout (OVCO). Regulator will trip OVCO when system voltage rises above 32 V in a 28 V system (16 V in a 14 V system) for longer than 2 seconds. OVCO feature detects high voltage and reacts by signaling relay in F– alternator circuit to open, turning off alternator. Restarting engine resets OVCO circuit. If vehicle is run in OVCO mode OVCO will automatically reset when system voltage drops to 22 V (11 V on 14 V side). Regulator regains control of alternator below output voltage.
- maintains alternator output voltage at regulated settings as vehicle electrical loads are switched on and off.
- can be used in single or dual voltage with this alternator.
  - — Allows single-voltage operation (28 V only). 14 V is not available as a single voltage application.
  - — Provides optional 28 V/14 V output only from the regulator when phase cable from alternator is connected to regulator.
- works with the EPM to provide dual voltage output during batteryless operation. When operating in batteryless mode, the system will have higher ripple. LEDs might change color more rapidly depending on loads.

EPM Electric Power Manager used with these units

- is rated for continuous current at 200 A on 28 V side. The 14 V side is rated for continuous current at 100 A.
- manually connects batteries after battery-connect button on vehicle is pressed.
- automatically disconnects batteries from vehicle loads 3 minutes after engine shuts down.
- provides 28 V auxillary output power for up to four 20 A channels and 14 V auxillary output power for one 20 A channel, protected by an internal, resettable, electronic circuit breaker.
- keeps batteries connected to system when emergency flashers are used.

Normal Start-Up Procedure

1. Press the vehicle battery-connect button to connect batteries.
2. Turn START-RUN switch to RUN.
3. Wait until glow plug light goes off.
4. Turn START-RUN switch to START and crank engine.
5. Return switch to RUN when engine starts.
6. If engine fails to crank, turn START-RUN switch to OFF, repeat steps 1-5 above.
7. If engine still fails to start, the EPM could be damaged.

WARNING Do not leave vehicle cabling connected as described in steps 7a-b. Diagnostic and repair must be performed as soon as possible.

   a. Remove cables from “Load” side of EPM and temporarily attach to “Battery” side of EPM.
   b. Follow steps 2-5 above.

Emergency Start-Up Procedure

WARNING This procedure will bypass EPM and batteries in system. Use this procedure ONLY when vehicle must be removed immediately from location in an EMERGENCY.

1. Connect slave vehicle Nato connector to vehicle.
2. Follow steps 2-5 above.
3. Disconnect slave NATO connector after engine is running.

Shutdown Procedure

1. Place gear shift in park or neutral and set parking brake.
2. Turn start-run switch to OFF to stop engine.
3. Batteries will be disconnected from vehicle in 3 min. unless emergency flashers are on, then batteries will stay connected until flashers are turned off or battery is discharged.

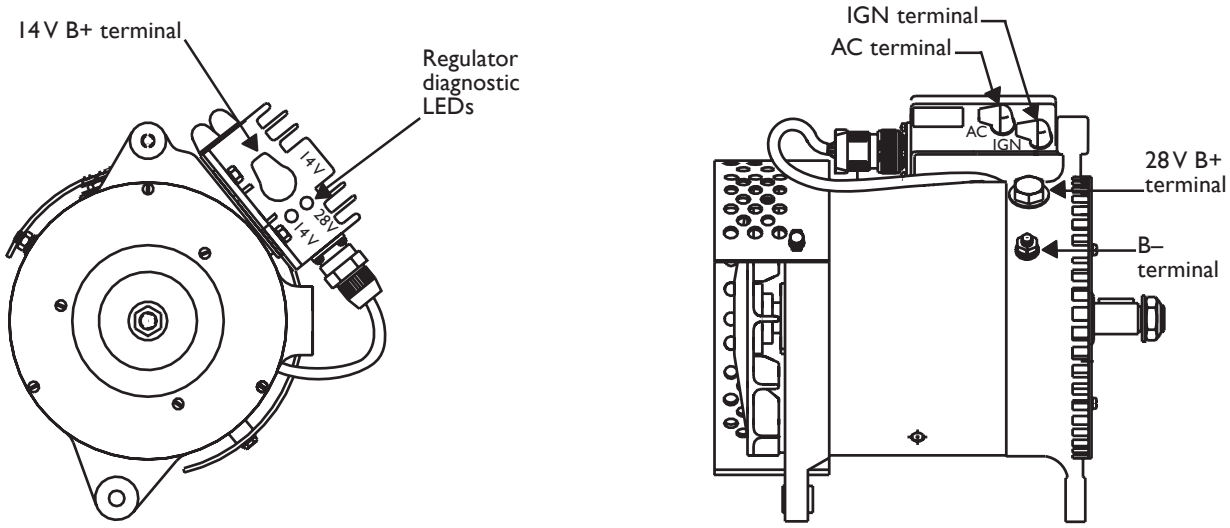


Figure 1 — N1387-1 Alternator and N3225 Regulator Terminals

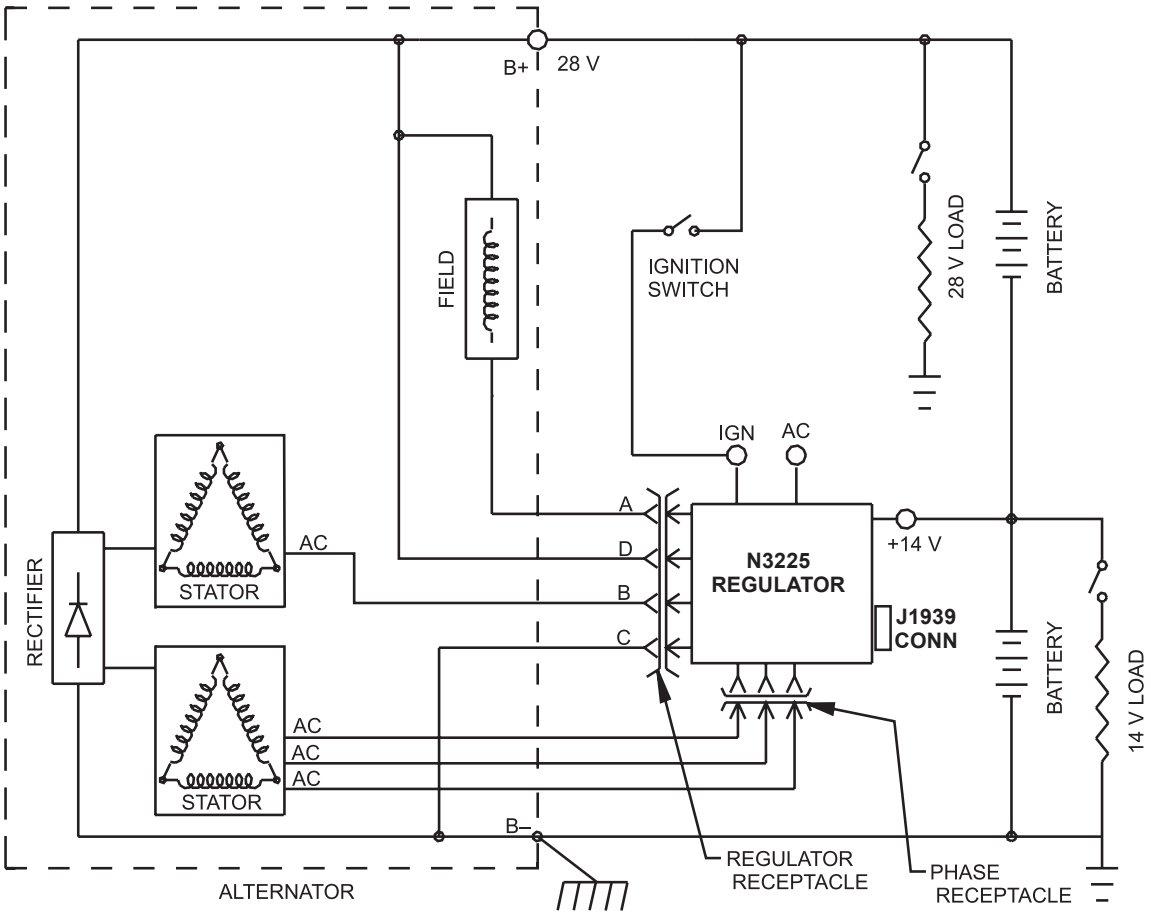


Figure 2 — N1387-1 Alternator with N3225 Regulator

CAN/J1939 Interface

DESCRIPTION AND OPERATION

The EPM and the CEN N3225 digital regulator are compatible with the SAE J1939 communications standard for vehicle networking.

CEN uses MIL-STD connector MS3112E12-10P to interface between the EPM/N3225 and the DPA adapter used to monitor the broadcast messages on the CAN bus line. The readouts of these messages are shown in Table 2 for the EPM and Table 3 for the regulator.

TABLE 1 – J1939 Connector Circuit Identification	
Pin	**Identification**
A	CAN High
B	CAN Low
C	CAN Shield
D	Ground
E	Restricted use
F	Restricted use
G	Restricted use
H	unused
J	unused
K	+28V power

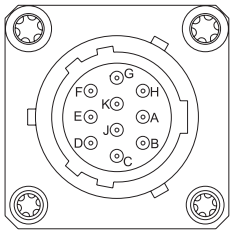


Figure 3 – J1939 Connector Pins

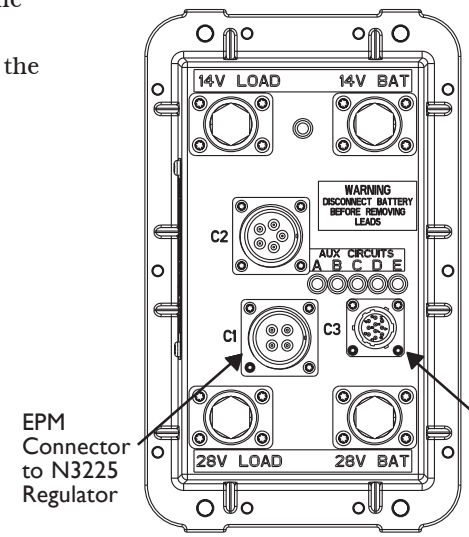


Figure 4 – EPM Electric Power Manager

TABLE 2 – EPM/J1939 Readout Diagnostics (With Engine Running)		
EPM Readout	**Expected Reading**	**Action If Expected Reading Not Achieved**
Load Voltage 28 V System	27–29 V	See Chart 1, page 7.
Load Voltage 14 V System	13.5–14.5 V	See Chart 2, page 8.
Alternator Speed	1200 to 6000 RPM	Check drive belt and charging system connection.
Battery Voltage 28 V System	27–29 V	See Chart 1, page 7.
Battery Voltage 14 V System	13.5–14.5 V	See Chart 2, page 8.
EPM Temperature	–50°F (–46°C) to 200°F (93°C)	Check connections to EPM.
Charging and Discharging Current of 28 V Battery	10 A (varies according to battery condition)	Observe current charges with battery and ignition on and then off.
Batt Charging 28 V LED	OK	See Chart 1, page 7.
Batt Charging 14 V LED	OK	See Chart 2, page 8.
Main Switches On	OK	Verify "Battery Connect" indicator is lit AMBER.
Cranking Detected	OK	See Chart 5, page 11.
Emergency Flasher Detected	OK	Check bulbs on flashers or ICC to battery.

TABLE 3 – N3225 Regulator/J1939 Readout Diagnostics		
Regulator Readout	**Expected Reading**	**Action If Expected Reading Not Achieved**
Alternator Output Voltage 28 V System	27–29 V	See Chart 1, page 7.
Alternator Output Voltage 14 V System	13.5–14.5 V	See Chart 2, page 8.
Alternator Speed	1200 to 6000 RPM	Check drive belt and chg system connection.
Alternator Temperature	Less than 260° F/127°C	Decrease load on alternator. See Chart 4, page 9.
Battery Voltage 28 V System	27–29 V	See Chart 1, page 7.
Battery Voltage 14 V System	13.5–14.5 V	See Chart 2, page 8.
Alternator Output Capacity	0–100%	Varies with load.
Charging System Status	OK	See Chart 1, page 7, or Chart 2, page 8.

A. Tools and Equipment for Job

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

If no tools are available, monitor LED code.

B. Identification Record

List the following for proper troubleshooting:

❑ Alternator model number _____

❑ Regulator model number _____

❑ Setpoint listed on regulator _____

❑ EPM model number _____

TABLE 4 – 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. Check: defective alternator and/or regulator.
High Voltage Output	Check: defective regulator. Check: alternator.
No Voltage Output	Check: presence of energize signal to IGN terminal on regulator. Check: battery voltage at alternator output terminal. Check: defective alternator and/or regulator.
No 14 V Output	Check:defective regulator. Check:cable from 14 V regulator terminal to battery.

C. Basic Troubleshooting

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 EPM connections**
Connections must be in proper sequence and clean and tight. See Figure 9, page 10.

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 B– terminal. Clamp inductive ammeter on 28 V B+ cable.

6. **Operate vehicle**
Follow start-up procedure on Page 2. Observe charge voltage.

CAUTION If charge voltage is above 33 volts for 28 V system or 16 V for 14 V system, immediately shut down system. Electrical system damage may occur if charging system is allowed to operate at excessive voltage. Go to page 9.

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 1, page 7.

N3225 Regulator

DESCRIPTION AND OPERATION

N3225 Regulator with OVCO is attached directly to the outside of the alternator. Regulator setpoint has negative temperature compensation. At 75ºF, the setting is 28.2 V for 28 V system and 14.1 V for 14 V system.

Main diagnostic feature of **N3225** regulator consists of two bicolored (amber, green) LEDs located on the side of the regulator. One LED indicates 28 V system performance, the other LED indicates 14 V system performance. The two LEDs work independently of each other. See Table 5 for diagnostic features and LED explanations.

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

- 14 V side trips at voltage **higher** than regulator setpoint that exists longer than 2 seconds of reading voltage above 16 V. OVCO feature detects overvoltage and reacts by signaling relay in F– alternator circuit to open. This turns off alternator (14 V LED is flashing AMBER /28 V LED is off). OVCO circuit will reset by restarting engine (regulator regains control ofalternator output voltage and resets OVCO).
- 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 overvoltage and reacts by signaling relay in F– alternator circuit to open. This turns off alternator (28 V LED is flashing AMBER / 14 V LED is off). OVCO circuit will reset by restarting engine (regulator regains control of alternator output voltage and resets OVCO).

TROUBLESHOOTING

Shut down vehicle and restart engine per start-up procedure on page 2. If alternator functions normally after restart, a “no output condition” was normal response of voltage regulator to overvoltage condition. Inspect condition of electrical system.

If you have reset alternator once, and electrical system returns to normal charge voltage condition, there may have been a one time, overvoltage spike that caused 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 LEDs while engine is running.

28 V LED flashing AMBER / 14 V LED off—go to Chart 4, page 9.

14 V LED flashing AMBER /28 V LED off—go to Chart 3, page 9.

TABLE 5 – N3225 Regulator LEDs Diagnostics

N3225 LEDs COLOR	N3225 STATUS
Off (Clear)	Regulator is not energized. Measure IGN terminal voltage. If voltage is above 21 V, regulator is defective.
Flashing AMBER (either 28 V or 14 V)	Respective system voltage is reading high voltage.
AMBER (either 28 V or 14 V with the other LED off)	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. 14 V side trips after 2 seconds of reading voltage above 16 V. Regulator remains in this mode until reset by restarting engine or if system voltage drops below 22 V or 11 V, respectively. See Chart 3 on page 9 of Troubleshooting Guide for 28V systems, Chart 4 for 14 V systems.
GREEN (both flashing once every 5 sec.)	Regulator is energized, but waiting for AC signal from alternator.
Steady AMBER	Respective system voltage is below regulated setting or is processing soft start (20-second delay).
GREEN	Normal operation (respective system voltage is at regulated setting)

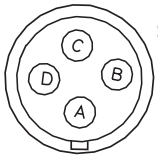
Chart 1 – 28 V LED Steady AMBER – No 28V Alternator Output – Test Charging Circuit

CAUTION

Troubleshooting sequences must be performed during 3-minute delay after battery-connect button on vehicle is pressed. If main LED on EPM is not flashing GREEN, press button to reactivate system. LED on EPM must be flashing GREEN while performing tests.

Start engine. Wait 20 seconds. Is 28 V LED steady GREEN on regulator?

- Yes → Regulator responded to overvoltage condition. Go to Chart 4 on page 9 to troubleshoot OVCO.
- No → Shut off engine. With key off, engine off: Test for battery voltage at alternator 28 V B+ terminal. Does battery voltage exist?
  - No → Check and repair EPM wiring and battery cables as necessary. Continue test.
  - Yes → With key on, engine running: Test for battery voltage between IGN terminal on regulator and alternator B– terminal. Does 28 V battery voltage exist?
    - No → Repair vehicle ignition circuit wiring as necessary.
    - Yes → With key off, engine off: Remove alternator-to-regulator 4-pin harness from regulator. Test for battery voltage across sockets D and C in harness plug. Does 28 V battery voltage exist?
      - No → Alternator is defective.
      - Yes → With DMM, check resistance across field coil. Connect red lead of DMM to socket A in alternator-to-regulator harness plug. Connect black lead to B+ terminal on alternator. Does meter show 2.0 ± 0.2 ohms?
        - No → Alternator is defective.
        - Yes → Connect jumper wire from socket A in regulator harness plug to B– terminal on alternator. Spark will occur. Touch steel tool to shaft to detect significant magnetism. Is shaft magnetized?
          - No → Alternator is defective.
          - Yes → Test phase signal into regulator (AC). Set meter to diode tester:
            Connect red lead of DMM to socket C of regulator harness and black lead to socket B. Meter should show voltage drop value.
            Then reverse meter lead connections. Meter should show OL (blocking).
            - Yes → Regulator is defective.
            - No → Alternator is defective.



SOCKET CONNECTIONS

A	F–
B	Phase Signal AC
C	B–
D	28 V B+

Figure 5 – Alternator-to-Regulator 4-Socket Harness Plug

Chart 2 – 14 V LED Solid AMBER – No 14 V Alternator Output – Test Circuit

CAUTION

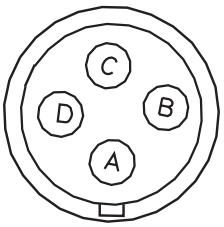
Troubleshooting sequences must be performed during 3-minute delay after battery-connect button on vehicle is pressed. If main LED on EPM is not flashing GREEN, press switch to reactivate system. LED on EPM must be flashing GREEN while performing tests.

With key off, engine off: Test for battery voltage of 14 V output terminal on regulator. Does +14 V battery voltage exist?

- **No** → Check and repair EPM wiring and battery cables as necessary. Continue test.
- **Yes** → Set DMM to diode tester. Connect red lead of DMM to socket C of regulator harness plug and black lead to each phase pin in phase harness plug. Meter should show voltage drop value.

  Then reverse meter lead connections. Meter should show OL (blocking).

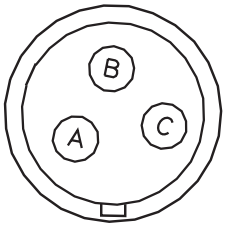
  - **Yes** → Regulator is defective.
  - **No** → Alternator is defective.



SOCKET CONNECTIONS

A	F–
B	Phase Signal AC
C	B–
D	28 V B+

Figure 6 – Alternator-to-Regulator 4-Socket Harness Plug



PIN CONNECTIONS

A	Phase P1
B	Phase P2
C	Phase P3

Figure 7 – Phase Connection 3-Pin Harness Plug

CAUTION

Troubleshooting sequences must be performed during 3-minute delay after push-button switch on vehicle is pressed. If main LED on EPM is not flashing GREEN, press switch to reactivate system. LED on EPM must be flashing GREEN while performing tests.

Chart 3 – 14 V LED Flashing AMBER/ 28V LED Off – No Alternator Output – Test OVCO Circuit

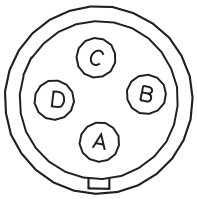
Unplug alternator-to-regulator 4-socket harness from regulator. At receptacle on regulator, connect red lead from DMM to pin C. Connect black lead to B– terminal. Does resistance read OL (out of limits)?

- Yes → Alternator is defective.
- No → Replace regulator with known good regulator. Run engine. Does OVCO trip?
  - Yes → Alternator is defective.
  - No → Original regulator is defective.

Chart 4 – 28 V LED Flashing AMBER/ 14V LED Off – No Alternator Output – Test OVCO Circuit

Unplug alternator-to-regulator 4-socket harness from regulator. Connect red lead from DMM to pin A in plug. Connect black lead to pin D in plug. Does resistance read 2.0 ± 0.2 ohms?

- Yes → With red lead from DMM connected to pin A in plug, connect black lead to B– terminal. Does resistance read OL (out of limits)?
  - Yes → Replace existing regulator with known good regulator. Run engine. Does OVCO trip?
    - Yes → Alternator is defective.
    - No → Original regulator is defective.
  - No → Alternator is defective.
- No → Alternator is defective.



SOCKET CONNECTIONS

A	F–
B	Phase Signal AC
C	B–
D	28 V B+

Figure 8 – Alternator-to-Regulator 4-Socket Harness Plug

EPM Electric Power Manager
DESCRIPTION AND OPERATION

Main diagnostic feature of the EPM is a bicolored (amber, green) LED located on the side of the device. The EPM manually connects and automatically disconnects batteries after 3 minutes unless emergency flashers are on.

EPM also allows batteryless operation until vehicle is shut off.

TABLE 6 – EPM LED Diagnostics

EPM LED COLOR	EPM STATUS
Off (Clear)	EPM is not energized or EPM is defective.
Flashing GREEN	EPM has connected the batteries during start-up and has prevented automatic disconnection for 3 minutes after vehicle shuts down when only vehicle battery-connect button is pressed.
Steady GREEN	Normal operation (batteries are connected to the system and engine is running)

TABLE 7 – EPM Harness Plug Socket Functions

Pin	Function
A	Battery Ground
B	Alternator Phase In Signal
C	Energize (Active Low) Signal
D	Ignition Signal

TABLE 8 – AUX Circuit and LED Functions

Pin	Function (Max. 30 A)	LED Color Normally On	If LED OFF:
A	14 V	GREEN	A short or overcurrent may have occurred. Check AUX load wiring and reset EPM by pressing Low Battery Indicator.
B	28 V	GREEN	
C	28 V	GREEN	
D	28 V	GREEN	
E	28 V	GREEN	

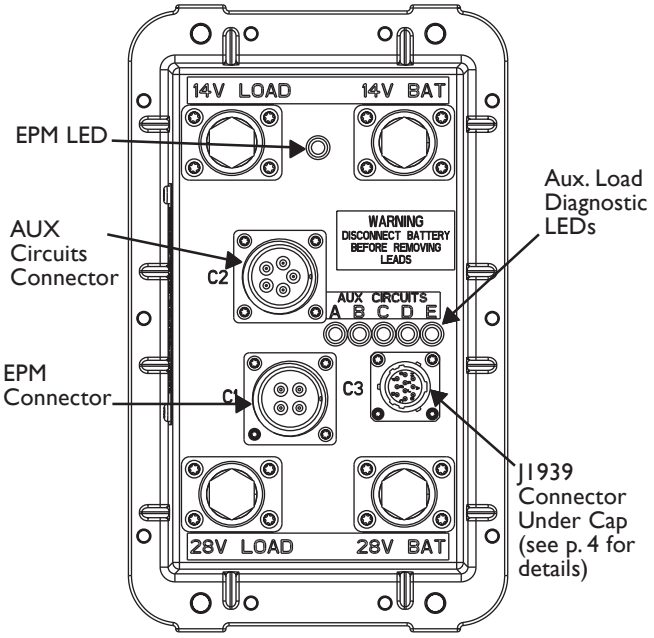


Figure 9 – EPM Electric Power Manager

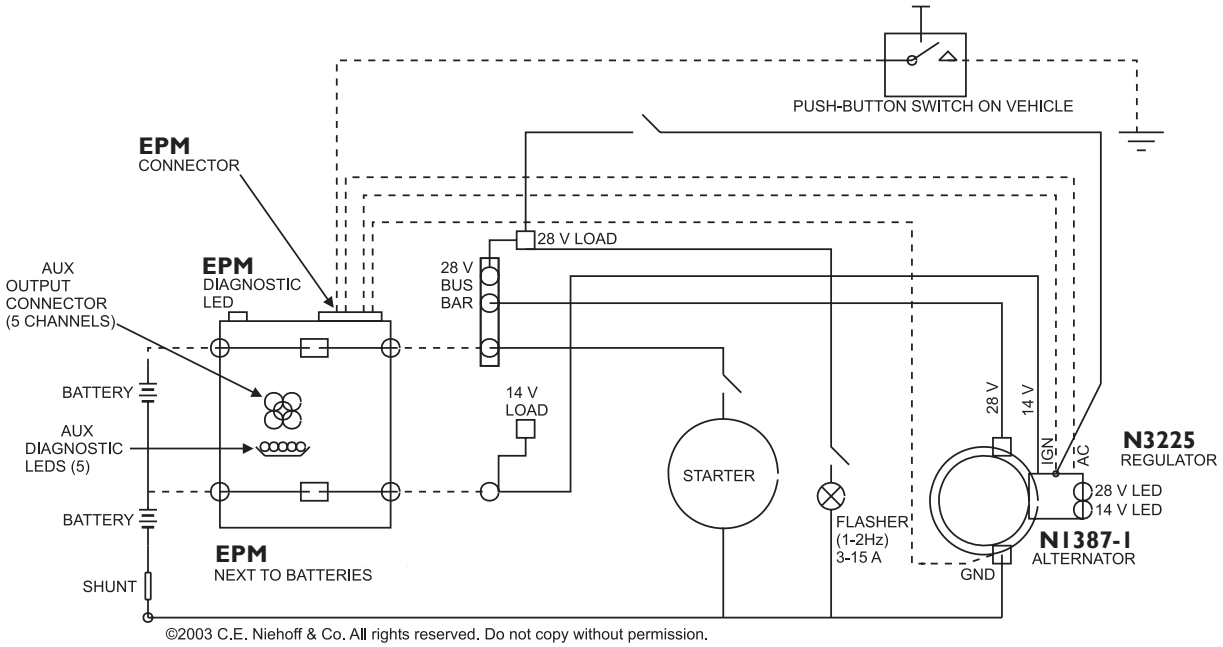


Figure 10 – EPM System Schematic

CAUTION

Troubleshooting sequences must be performed during 3-minute delay after battery-connect button on vehicle is pressed. If main LED on EPM is not flashing GREEN, press switch to reactivate system. LED on EPM must be flashing GREEN while performing tests.

Chart 5 – Engine Will Not Crank at Start-Up

Before Troubleshooting, Check Batteries for Proper Charge Voltage. See Page 1.

Turn START-RUN switch to OFF. Press vehicle battery-connect button. Check LED on EPM. Is LED flashing GREEN?

- **Yes** → Check for continuity across 28 V and 14 V terminals on EPM. Does continuity exist?
  - **Yes** → Check and repair starter and starter wiring as necessary. Re-test.
  - **No** → EPM is defective.
- **No** → Disconnect 4-socket harness at EPM. While pressing vehicle battery-connect button, check for continuity between socket C on EPM harness plug and ground. Does continuity exist?
  - **Yes** → EPM is defective.
  - **No** → Check and repair vehicle battery-connect button and wiring as necessary. Re-test.

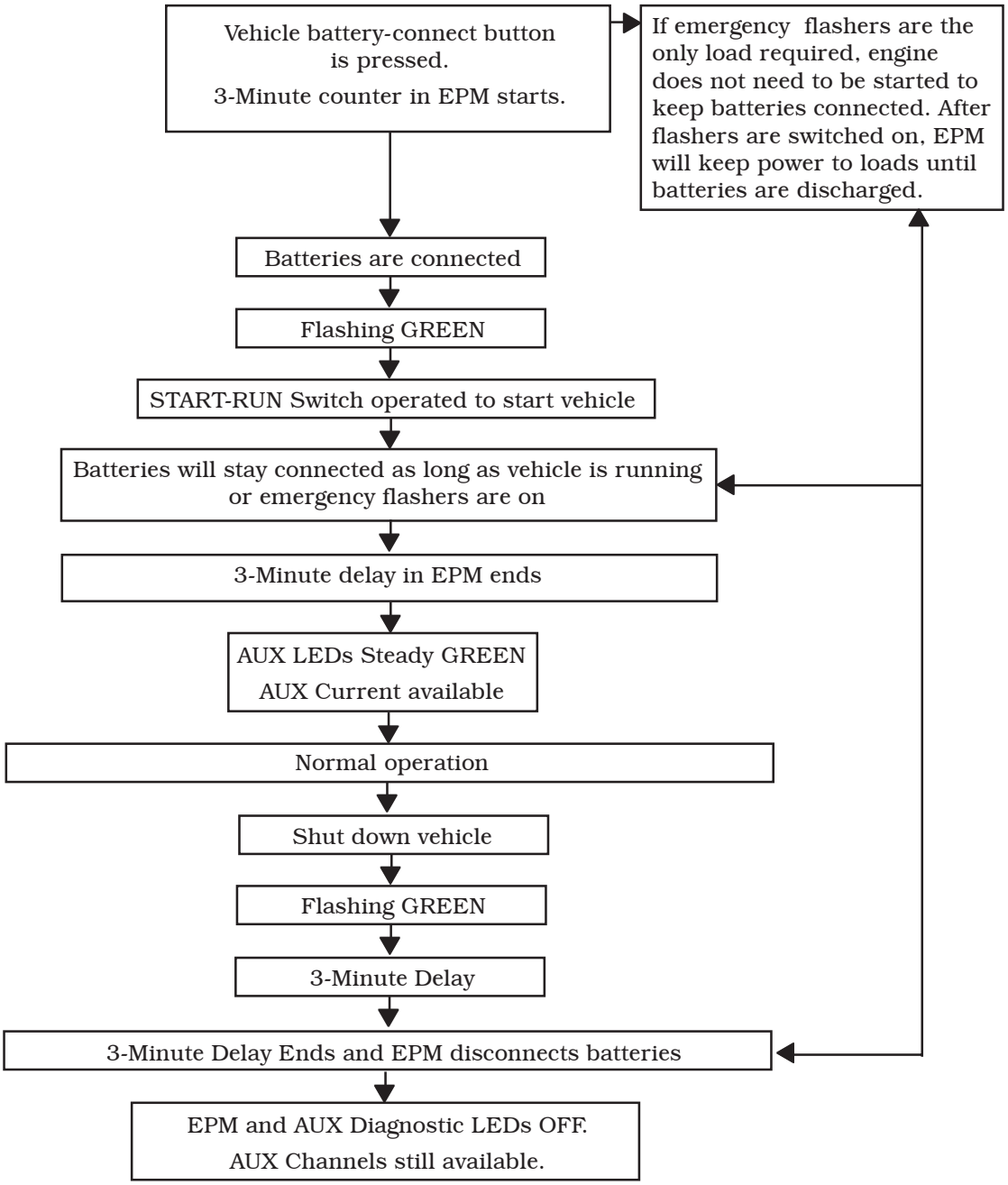
Chart 6 – No Power to Aux. Loads –One or More LEDs are OFF

Before Troubleshooting, Check Batteries for Proper Charge Voltage. See Page 1.

Disconnect Aux. Load harness from EPM. Turn start-run switch to OFF. Press vehicle battery-connect button. Is LED on EPM flashing GREEN?

- **Yes** → Are all five Aux diagnostic LEDs lit on EPM?
  - **Yes** → Check and repair load and load wiring as necessary. Re-test.
  - **No** → EPM is defective.
- **No** → EPM is defective.

Chart 7 – 28V Only – EPM Sequence of Operation



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:
C. E. Niehoff & Co.• 2021 Lee Street • Evanston, IL 60202 USA
TEL: 800.643.4633 USA and Canada • TEL: 847.866.6030 outside USA and Canada • FAX: 847.492.1242
E-mail us at service@CENiehoff.com