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Alternator, Delco Remy CS–130 Series 15.00

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General Information

The CS-130 alternator features a high ampere output per pound of weight, and a totally new and different regulator. A diode trio is not used. A delta stator, a rectifier bridge, and a rotor with slip rings and brushes are electrically similar to earlier models of alternators (**Fig. 1** and **Fig. 2**).

The CS stands for Charging System, and 130 denotes the outside diameter in millimeters of the stator laminations. The CS-130 features sealed bearings with lifetime lubrication in both end frames. A conventional fan mounted next to the pulley pulls air through the assembly for cooling. An internal fan mounted on the rotor pulls air through the slip ring end frame to cool the rectifier bridge and regulator. The air is expelled through openings in the end frame. No periodic maintenance on the alternator is required.

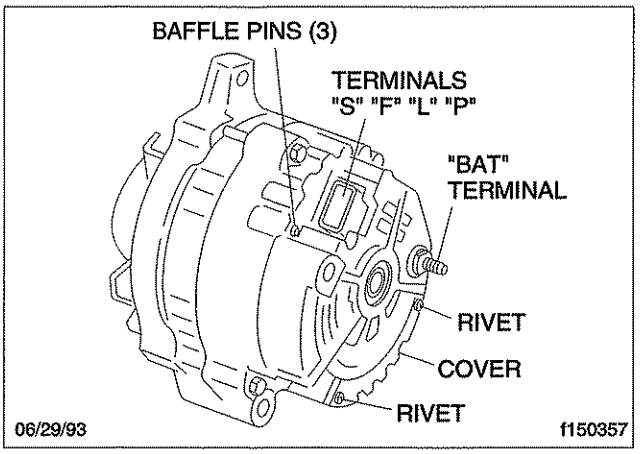
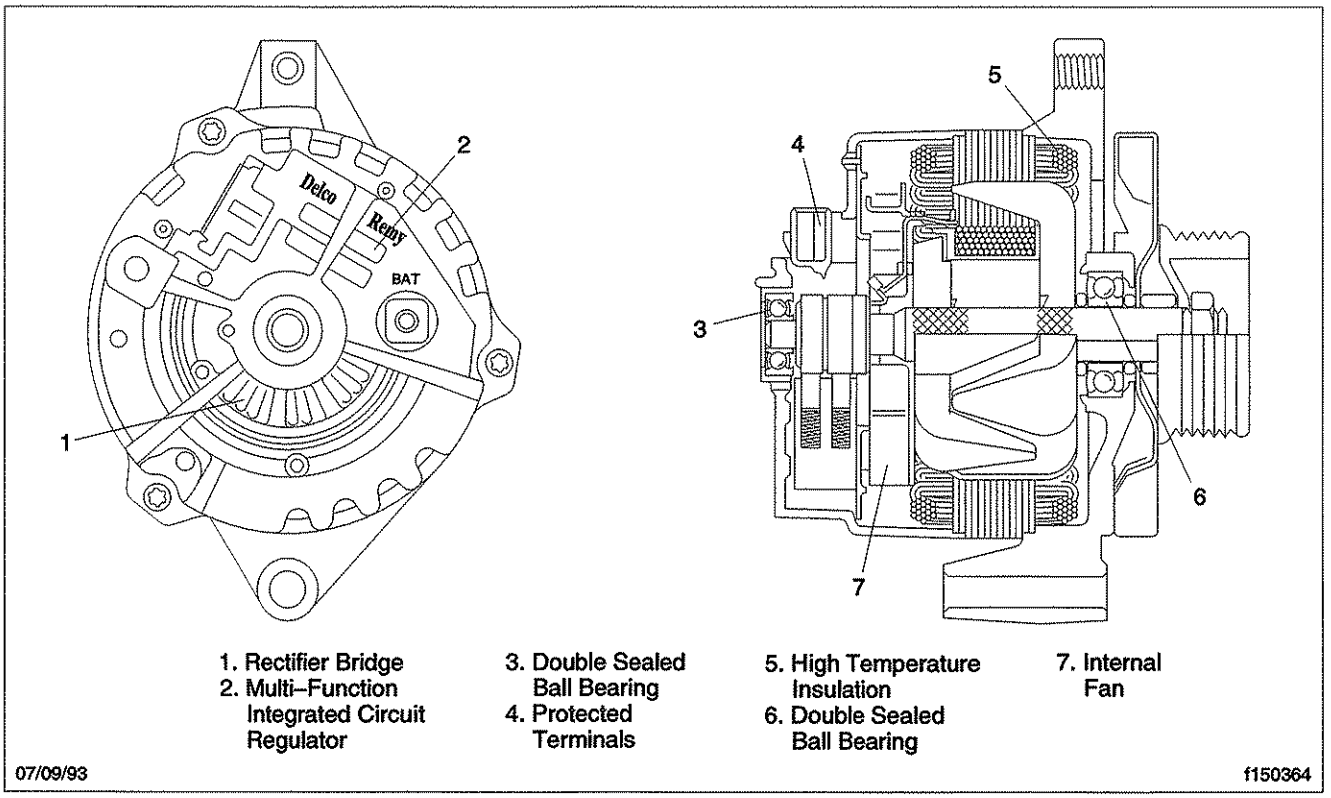


Fig. 1



1. Rectifier Bridge
2. Multi–Function Integrated Circuit Regulator
3. Double Sealed Ball Bearing
4. Protected Terminals
5. High Temperature Insulation
6. Double Sealed Ball Bearing
7. Internal Fan

Fig. 2, Typical Cross-Sectional View

General Information and Principles of Operation

Principles of Operation

The CS-130 used on Freightliner trucks is wired with three wires connected to the alternator. The charge indicator works in much the same way as on other charging systems— the indicator light comes on when the switch is closed, and then goes out when the engine is running. If the charge indicator is on with the engine running, a charging system problem is indicated. Regardless of the problem, the indicator will glow at full brilliance. A new feature of this regulator is that it will cause the charge indicator to be on with the engine running if the system voltage is too high or too low. The regulator is temperature-compensated; that is, its voltage setting varies with temperature.

As in other alternators, the regulator limits the system voltage by controlling the rotor field current. Unlike other regulators, this regulator switches the field current on and off at a fixed frequency of about 400 cycles per second. By varying the on-off time, the correct average field current for proper system voltage control is obtained. At high speeds, the on-time may be 10%, and the off-time 90%. At low speeds with high electrical loads the on-off time may be 90% and 10% respectively.

The use of the "P" and "S" terminals is optional. The "P" terminal is connected to the stator, and may be connected externally to a tachometer or other device. The "S" terminal may be connected externally to a voltage, such as battery voltage, to sense the voltage to be controlled. For the complete circuit, see the wiring diagrams.

Where the regulator is identified with an "I" marking on the regulator case, the circuit in **Fig. 3** applies. In this circuit, both the "L" and "I" terminals serve to turn on the regulator and allow field current to flow when the switch is closed. The "I" terminal may be connected directly to the switch, or through a resistor. Both are illustrated. The "I" circuit may be used with or without the "L" circuit; that is, with or without anything connected to the "L" circuit.

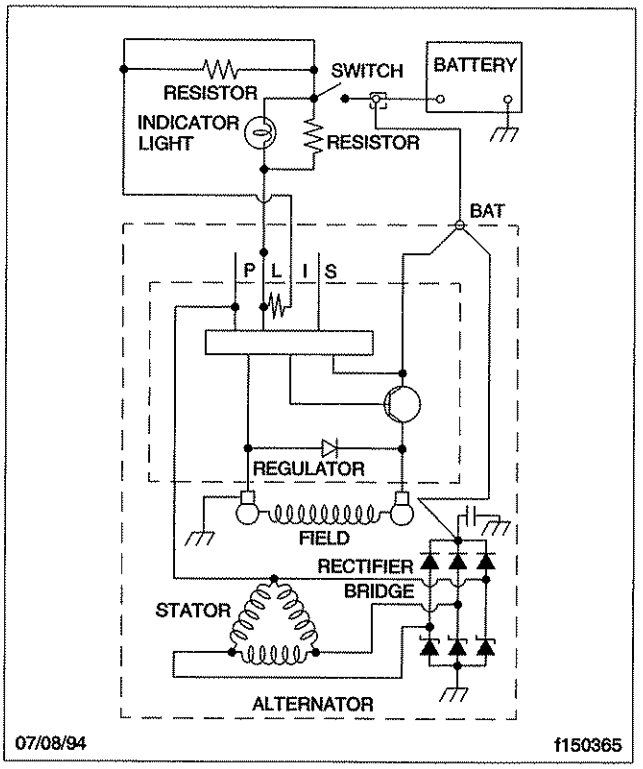


Fig. 3, Basic Circuit Using L and I Terminals, I Terminal Connected to Switch Either Directly or Through Resistor

Alternator Removal and Installation, Cummins B Series Engines

Removal

1. Disconnect the batteries, negative lead.
2. Disconnect and mark the battery lead wire on the alternator.
3. Disconnect the alternator wiring harness.
4. Gripping the wrench handle firmly, lift the tensioner arm and pulley; then remove the belt from the alternator pulley. **See Fig. 1.**
5. Remove the alternator mounting bolts. Remove the alternator.

Installation

1. Check the tightness of the alternator-bracket fasteners **(Fig. 2**, Ref. 1). Tighten them 24 N·m (18 lbf·ft).

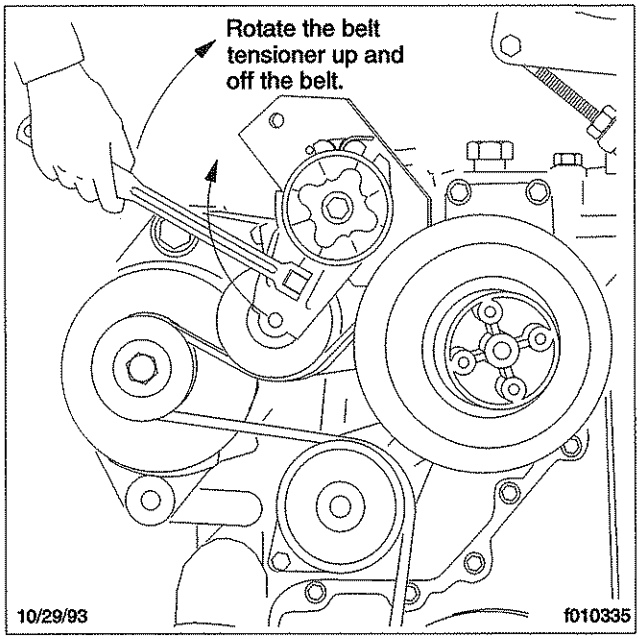


Fig. 1

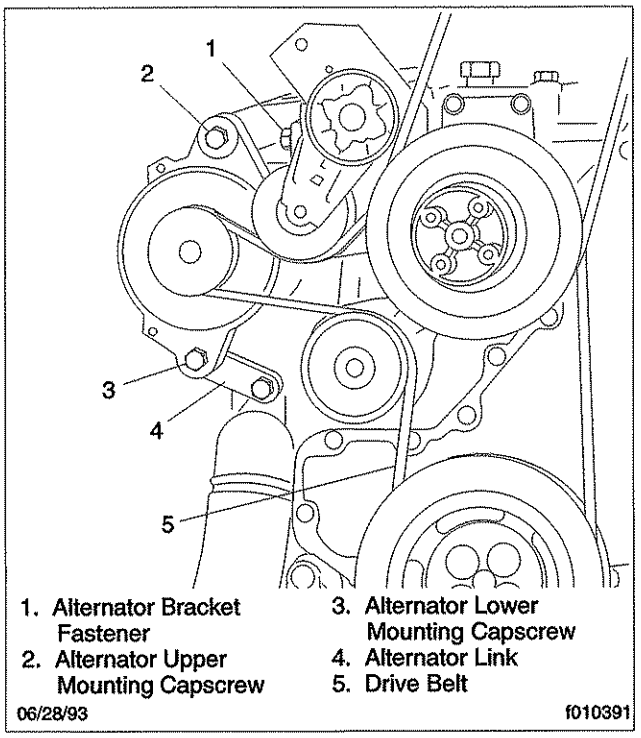


Fig. 2, Alternator and Drive Belt Installation

2. Position the alternator on the mounting bracket, then install the mounting bolts finger-tight.
3. Connect the alternator link **(Fig. 2,** Ref. 4) to the alternator, finger-tight.

NOTE: Make sure the alternator link is properly positioned for correct belt alignment.

4. Tighten the alternator mounting capscrews as follows:
   - 8 mm: 16 N·m (12 lbf·ft)
   - 3/8-inch: 38 N·m (28 lbf·ft)
5. Lift the tensioner arm; then install the drive belt on the pulleys **(see Fig. 2).**
6. Connect the alternator wiring harness.
7. Connect the battery lead wire to the back of the alternator as previously marked. Tighten the output terminal nut maximum 8 N·m (6 lbf·ft) when attaching the cable.
8. Connect the batteries.

Disassembly (Refer to Fig. 1)

NOTE: If spare parts are not available, malfunctioning alternators must be replaced.

1. Remove the alternator from the vehicle. For instructions, **refer to "Removal and Installation, 100."**
2. Remove the long frame assembly bolts, and separate the drive-end frame assembly from the slip-ring end frame assembly.
3. Remove the drive-end frame from the rotor: place the rotor in a vise tightened only enough to permit removal of the shaft nut, or hold the rotor with a hex wrench in the end of the shaft when removing the nut.
4. Disassemble the slip ring end frame **(Fig. 1)** as follows:
   - 4.1 Punch out the cover rivets or pins and discard the cover.
   - 4.2 Separate the stator from the end frame assembly by cutting off the stator leads at the rectifier bridge terminals just long enough to leave adequate wire for connecting these parts if they are to be re-used.
   - 4.3 Remove the stator.
   - 4.4 Punch out the baffle pins and remove the baffle.

   NOTE: To ensure correct assembly, carefully note the arrangement of parts; crimped, soldered, or welded connections; and location of mechanical fasteners. **See Fig. 2.**
   - 4.5 Remove the fasteners; then lift the brush holder, regulator, and rectifier bridge from the end frame.
   - 4.6 Unsolder and uncrimp the connector to disconnect the regulator from the rectifier bridge and from the brush holder.

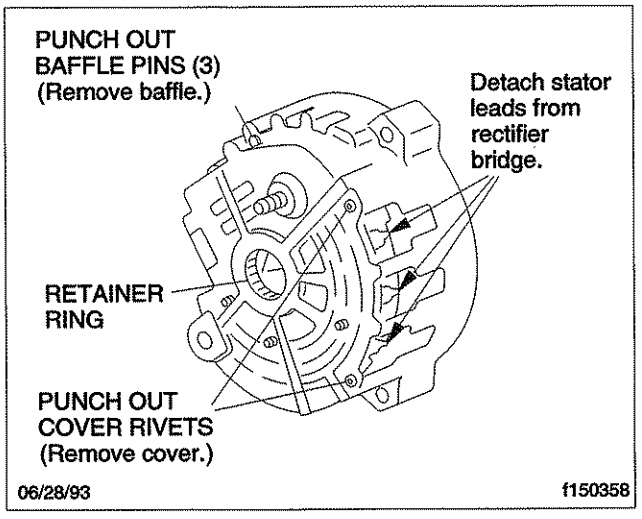


Fig. 1, Slip Ring End Frame Partially Disassembled, Bearing Removed

Checking

ROTOR FIELD WINDING CHECKS

1. Connect an ohmmeter between one slip ring and the rotor. If the reading is less than one ohm, the rotor is grounded. **See Fig. 3.**
2. Check for opens by connecting the ohmmeter between the two slip rings. If the ohmmeter reading is high (infinite), the winding is open.

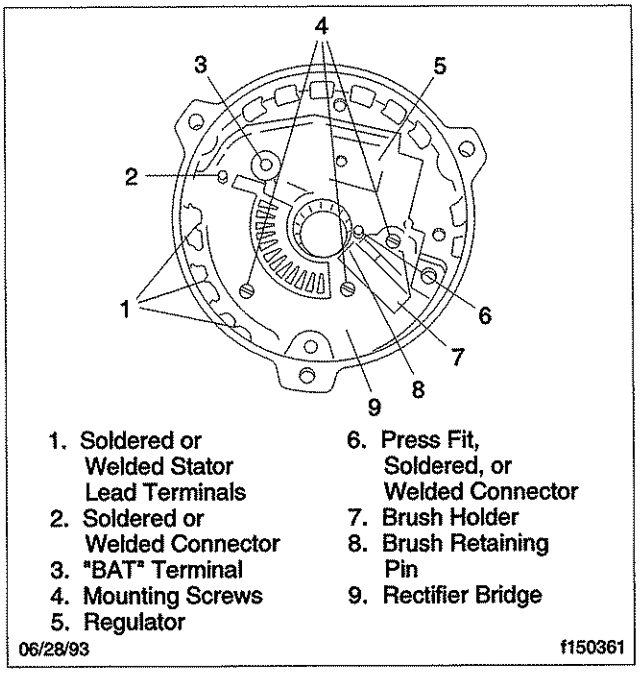


Fig. 2, View Inside the Slip Ring End Frame

Disassembly, Checking, and Assembly

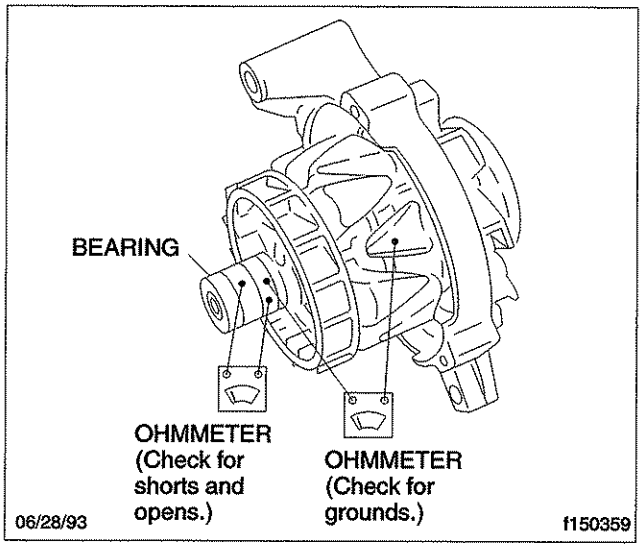


Fig. 3, Checking the Rotor

3. Check the winding for short circuits or excessive resistance by connecting a battery and ammeter in series between the two slip rings. Note the ammeter reading and refer to Delco Remy Service Bulletin 1G-188 for specifications. An ammeter reading above the specified value indicates shorted windings.

   An alternate method is to check the resistance of the field by connecting an ohmmeter between the two slip rings. If the resistance reading is below the specified value, the winding is shorted; if it is above the specified value, the winding has excessive resistance.

NOTE: The winding resistance or ammeter readings will vary slightly with winding temperature changes. If the rotor checks out okay, but the alternator fails to supply rated output, the problem is in the rectifier bridge, stator, or regulator.

STATOR CHECKS

Connect an ohmmeter between each of the stator leads and bare metal on the stator laminations. If any reading is less than 1000 ohms, the stator is grounded. **See Fig. 4.**

NOTE: An ohmmeter cannot be used to test the delta stator for shorts or opens. However, noticeable discoloration any place on the assembly usually indicates damaged stator windings.

RECTIFIER BRIDGE CHECK **(See Fig. 5)**

1. To check the rectifier bridge, connect an ohmmeter (using a low scale) from the bridge terminal to the heat sink; then reverse the connections. If both readings are the same, replace the rectifier bridge.
2. Connect the ohmmeter between each of the other two terminals to the heat sink in the same manner, in order to check the other two diodes.
3. Connect the ohmmeter between each of the other three terminals and the base plate, in order to check the remaining three diodes in the rectifier bridge.

NOTE: Some digital ohmmeters cannot be used to check the diodes in the rectifier bridge. Consult the ohmmeter manufacturer's instructions to determine the ohmmeter's capabilities.

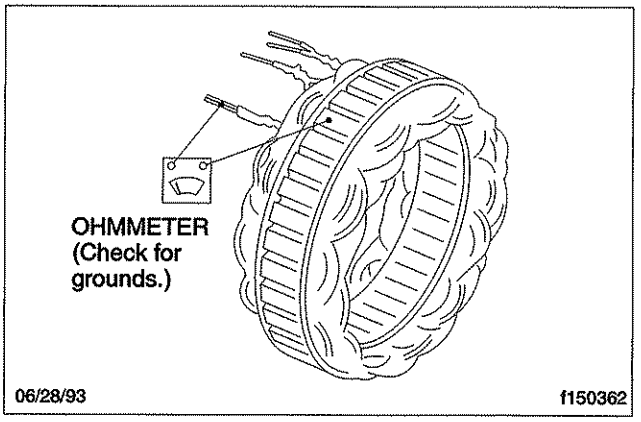


Fig. 4, Checking the Stator

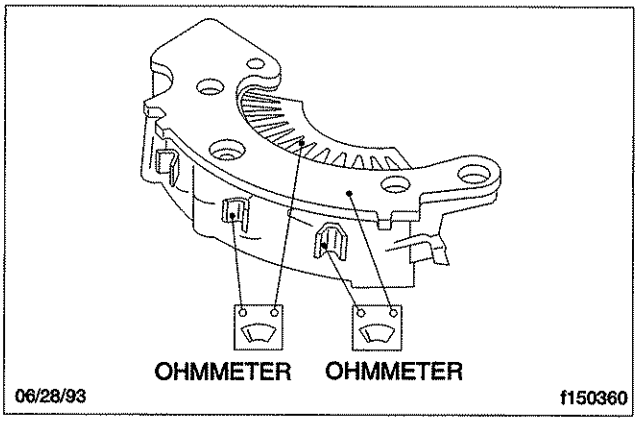


Fig. 5, Checking the Rectifier Bridge

REGULATOR

The regulator cannot be checked with an ohmmeter. Use only an approved tester to test regulators of this type.

BRUSH HOLDER

If the brushes are to be re-used, clean them with a soft, dry cloth. Replace the brush holder assembly if the brushes are excessively worn.

SLIP RING SERVICING

1. If the slip rings are rough or out-of-round, turn them on a lathe to 0.05 mm (0.002 inch) maximum indicator reading. Remove only enough material to make the rings smooth and round.
2. After the slip rings are trued, or if they are only dirty, they may be cleaned and finished with 400 grain or finer polishing cloth. Spin the rotor, and hold the polishing cloth against the slip rings until they are clean. Blow away all the dust.

IMPORTANT: Turn the rotor in order to clean the slip rings evenly. Cleaning the slip rings by hand without spinning the rotor may result in flat spots on the slip rings, causing brush noise.

Assembly

1. Discard the bearing retainer ring. **See Fig. 1.**
2. Install a new ring.
3. Install a new bearing outer race; push on it until the bearing bottoms in the end frame.

NOTE: This procedure is not yet completed: See the step for installing the inner and outer races after the alternator is completely assembled.

4. Position the regulator, rectifier bridge, and brush holder on the work bench flat surface; then solder or crimp the connectors as in the original assembly. Hold the brushes in the holder with a pin.
5. To improve heat dissipation, place silicone grease 1974984 on the end frame casting under the rectifier bridge.
6. Position the assembly in the slip ring end frame; then assemble the fasteners.
7. Assemble the baffle, using a punch to drive the pins down flush with the baffle.
8. Seat the stator securely against the end frame; then solder the three stator leads to the rectifier bridge terminals.
9. Install the cover; then use a punch to drive the pins flush with the cover.
10. Push on both the inner and outer races of the slip ring end bearing to assemble the end frames together.
11. Install the long frame assembly bolts. Remove the brush holder pin.
12. With the alternator assembled, push on both the inner and outer races so the slip ring end bearing outer race is recessed 1.9 to 2.2 mm (0.07 to 0.09 inch) into the casting. **See Fig. 6.**

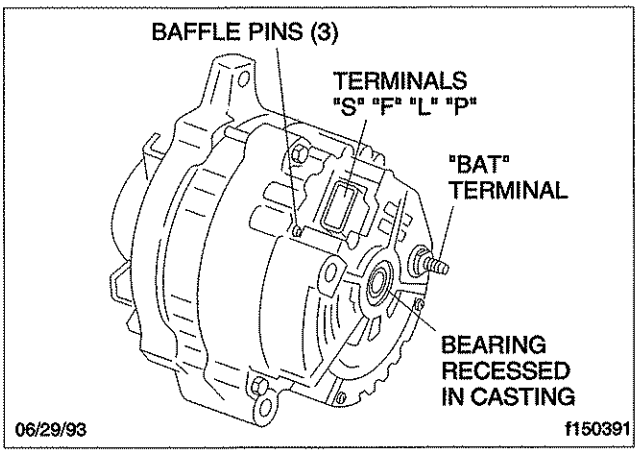


Fig. 6, Slip Ring End Bearing Assembled in the End Frame

Troubleshooting

Many alternators have been replaced that later investigation reveals were working properly. This may be due to incorrectly diagnosing the problem.

IMPORTANT: Before testing, make sure:

- All belts are correctly tightened;
- The wiring and terminals are clean and in good condition;
- All terminal nuts are torqued and properly protected.

Delco Remy has an alternator testing tool called the Intelli-Check Alternator Analyzer. See **Fig. 1**. This tool (DR 10457848, a single tester, or DR 10457865, a four-pack of testers) is to be used as a quick check of the alternator to see if it is working correctly.

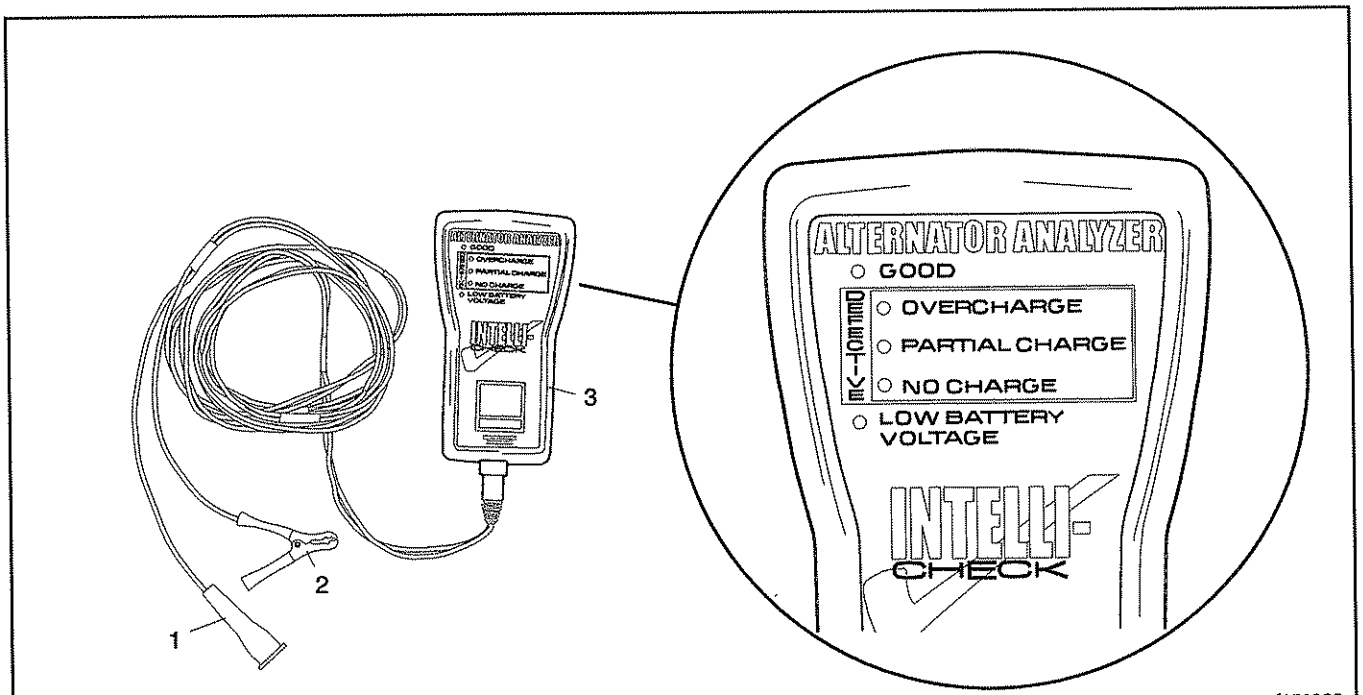
NOTE: If you do not have the Delco Intelli-Check Tester, or if the alternator rated output is above 145 amps, or if a total vehicle charging system analysis is required, see "Alternator/Charging System Testing."

Intelli-Check Alternator Analyzer

The following information includes a pre-test procedure and operating instructions for the Delco Intelli-Check Tester, and is similar to the procedures provided by Delco with the Intelli-Check Tester.

Pre-Test Procedure (Engine Off)

1. Inspect the alternator connections to verify that all terminals are secured and tight. Verify that the sense wire is connected to the sense terminal on vehicles equipped with remote-sense alternators.
2. With the engine off, connect the red alligator clip to the output terminal of the alternator. Connect the black alligator clip to the alternator ground. An optional ground connection is to the body of the alternator. The tester LEDs will illuminate and then go off as it performs a self-test.



1. Red Alligator Clip
2. Black Alligator Clip
3. Hand-Held Alternator Analyzer

Fig. 1, Delco Remy Intelli-Check Alternator Analyzer

Troubleshooting

3. After 4 seconds the tester will activate. The following LEDs may illuminate depending on the condition of the batteries:
    - **GOOD** (green) LED indicates the battery voltage is above 12.8 and has a surface charge. The surface charge must be removed before proceeding with the alternator test. To remove the surface charge, do the following:
        A. Turn on the headlights and blower motor for 2 minutes without restarting the engine.
        B. Reset the tester by disconnecting, then reconnecting the tester alligator clips. The analyzer will again perform its self-test.
        C. Repeat the applicable steps of the Pre-Test Procedure.
    - **NO CHARGE** (red) LED indicates the battery voltage is below 12.8. This LED should illuminate for most tests. Proceed with the alternator test.
    - **LOW BATTERY VOLTAGE** (blue) LED indicates the battery voltage is below 12.35. If the batteries will start the vehicle, proceed with the alternator test. However, after completing the Intelli-Check alternator test, perform the procedures under "Alternator/Charging System Testing" to determine the condition of the rest of the charging system.

Tester Operating Instructions (Engine Running)

1. Start the engine using onboard batteries only. If the batteries will not start the engine, they must be charged for 2 hours. Start the test again after charging the batteries.
2. Verify the engine is at idle and all electrical loads are off.
3. Depress the accelerator to governed speed, hold for 10 seconds, then return to idle.
    - If the **GOOD** (green) LED illuminates, proceed to the next step.
    - If any LEDs illuminate indicating overcharge, partial charge or no charge (the three red lights in the **DEFECTIVE** section), replace the alternator and run the complete test again.
    - If the **LOW BATTERY VOLTAGE** (blue) LED illuminates, evaluate the charging system using the instructions in "Alternator/Charging System Testing."
4. With the engine running, turn on all electrical loads.
5. Depress the accelerator to governed speed, hold for 10 seconds, then return to idle.
6. If the **GOOD** (green) LED illuminates, the alternator is OK and the test is complete.

NOTE: If the alternator tests OK in the above tests, and the customer's complaint is reduced battery or headlight life, see "Alternator/Charging System Testing" to completely analyze the charging system.

7. If any LEDs illuminate indicating overcharge, partial charge or no charge (the three red lights in the **DEFECTIVE** section), replace the alternator and run the complete test again.
8. If the **LOW BATTERY VOLTAGE** (blue) LED illuminates, evaluate the charging system using the instructions in "Alternator/Charging System Testing".

Alternator/Charging System Testing

Battery Open Circuit Voltage Test, Alternator Output Voltage Test and Alternator Amperage Output Test

1. Use a digital volt-ohmmeter (VOM) set on the 2-20VDC (or similar) scale to test the battery open circuit voltage (OCV). With the engine shut down and the voltmeter set up as shown in **Fig. 2**, check for voltage of 12.4 volts or more.

    If the OCV is 12.4 volts or more, turn on the vehicle headlights for approximately 3 minutes.

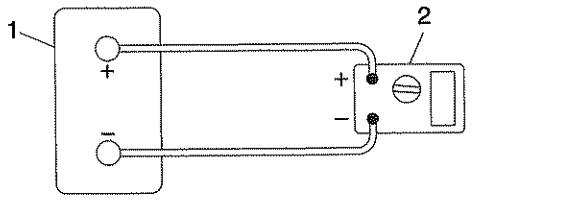
    If the OCV is less than 12.4 volts, charge the batteries properly. For instructions, see **Group 54**.

IMPORTANT: Be sure to disconnect the batteries or remove them from the vehicle before charging.

2. Check the alternator output without a load. See **Fig. 3**.

2.1 Start the engine and run it at 1500 rpm for 3 to 5 minutes to stabilize the system before proceeding to the next step.

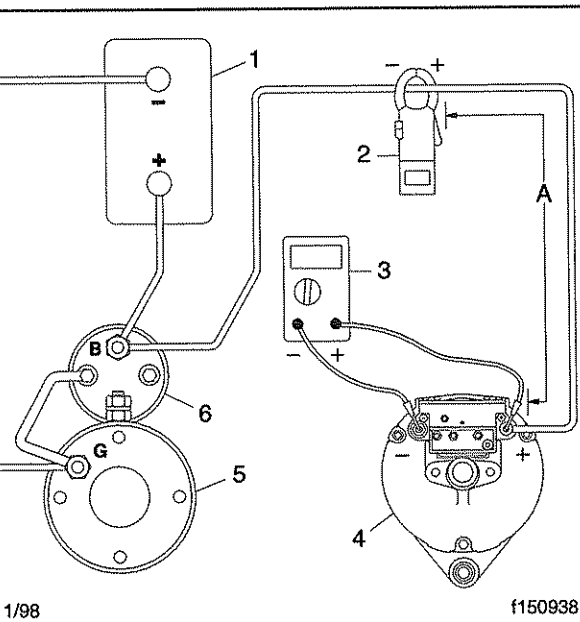
2.2 Connect the positive (+) lead of the digital voltmeter (still set on the 2-20VDC or similar scale) to the alternator (battery) terminal. Connect the negative (–) lead of the voltmeter to the alternator negative (–) ground terminal. See **Fig. 3.**



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1. Battery
2. Digital Voltmeter

Fig. 2, Setup 1: Battery Open Circuit Voltage (and alternator amperage output)



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A. Locate the ammeter at least 6 inches (15 cm) away from the alternator.

1. Battery
2. Ammeter
3. Digital Voltmeter
4. Alternator
5. Cranking Motor
6. Solenoid

Fig. 3, Setup 2: Alternator Output Test

2.3 If the voltmeter reads from 13.8 to 14.2 volts, record this reading (V1) and go to the next step. If the alternator reads less than 13.8 volts and is adjustable, try to adjust the voltage regulator to 13.8 to 14.2 volts. If unable to obtain acceptable output, replace the alternator.

3. Check the alternator output under load. See **Fig. 3.**

3.1 Attach a clamp-on induction ammeter around the positive (+) wire. See **Fig. 3.**

NOTE: Locate the ammeter at least 6 inches (15 cm) away from the alternator.

3.2 With the engine still running at 1500 rpm, turn on the following electrical accessories to load the alternator until the ammeter reads 60 to 75 amps.

- Both front and rear heater blowers (on HIGH)
- Headlights (high beams)
- Road lights
- Interior lights

NOTE: As an alternate method of putting load on the alternator, connect a carbon pile tester and set it to 60 to 75 amps.

3.3 Keep the voltmeter connected as in the previous step; positive (+) lead connected to the alternator positive (+) terminal; negative (–) lead connected to the alternator negative (–) terminal.

3.4 If the voltmeter reads from 13.6 to 14.2 volts, record this reading (V2) and go to the next step.

If the voltmeter reads less than 13.6 volts, replace the alternator.

4. Perform an alternator amperage output test.

4.1 Connect a carbon pile tester across the vehicle batteries as shown in **Fig. 2.**

NOTE: **Figure 2** shows a voltmeter, but the connections for the carbon pile tester are the same.

4.2 Attach a clamp-on induction ammeter around the alternator output wire. See **Fig. 3.**

Troubleshooting

NOTE: Locate the ammeter at least 6 inches (15 cm) away from the alternator.

4.3 Start the engine and make sure all vehicle electrical accessories are turned off. Run it at fast speed and adjust the tester to the alternator maximum current output. Record this output value.

NOTE: Ensure that the alternator is turning at maximum available rpms and keep adjusting the tester dial until the ammeter reads its highest value.

4.4 Turn off the tester and shut down the engine.

4.5 If the output value recorded is less than 85 percent of the rated amperage output, repeat the test. If the output value recorded is still less than 85 percent of the rated amperage output, replace the alternator.

4.6 Make sure that all test instruments are removed and that the vehicle wiring is returned to its operational state.

5. To identify other problem areas within the vehicle, check the operation of the charging system. Set up the voltmeter as shown in **Fig. 2** and **Fig. 3.**

NOTE: For any load at 1500 rpm or more, battery voltage must be within 0.5 volts of the alternator voltage.

5.1 If readings at the batteries are within 0.5 volts of the readings at the alternator, the charging system is working correctly. Check other areas of the vehicle to locate the problem.

5.2 If the reading at the batteries is more than 0.5 volts lower than the reading at the alternator, do the next step.

6. Check charging system connections, cables and terminals.

6.1 Check all connections between the battery, starter and alternator for tightness and signs of corrosion. Tighten and clean as necessary.

6.2 Check all cables for breaks or partial breaks. Repair or replace as necessary.

6.3 Check each ring terminal for breakage at the point where it attaches to its wire or cable.

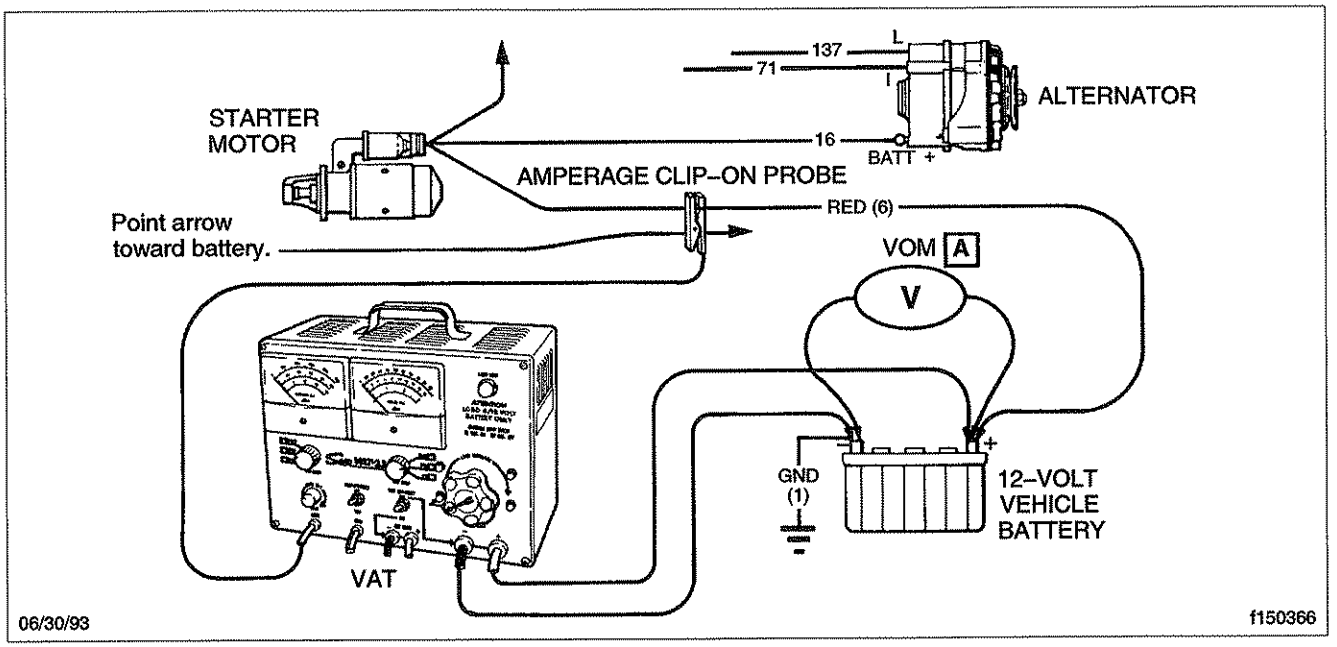


Fig. 5, Alternator In-Vehicle Check

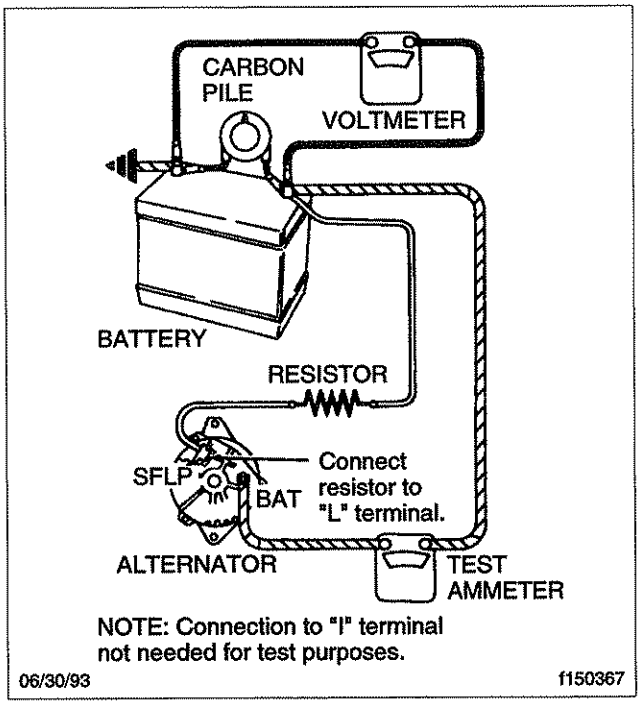


Fig. 6, Bench Test Circuit

See **Fig. 1** for a schematic of the charging system.

Description	Size	Torque	
		lbf·in (N·cm)	lbf·ft (N·m)
Alternator Bracket Fasteners	—	—	18 (24)
Alternator Mounting Capscrews:			
Lower	M8	—	12 (16)
Upper	3/8	—	28 (38)
Alternator Output Terminal Bolt	—	72 (810)	—
Alternator Adjustment Outer Jam Nut	—	—	155 (210)
Alternator Shaft Nut	—	—	60–80 (80–110)

Table 1

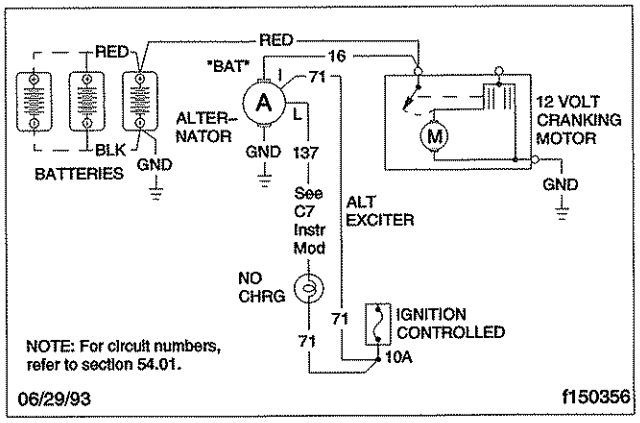


Fig. 1, Charging System

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General Description

The Delco Remy 21–SI series alternator (see **Fig. 1**) features a solid-state regulator that is mounted inside the end frame. The only moving part in the assembly is the rotor, which is mounted on a ball bearing at the drive end, and a roller bearing at the rectifier end. See **Fig. 2**.

All bearings are sealed so that no periodic maintenance is required. All current-carrying conductors are stationary, as are the field-winding stator components. The regulator and diodes are enclosed in a sealed compartment. A fan located on the drive end provides air flow for cooling.

Only one wire connects the alternator to the battery at the starter, along with a ground return. Since the vehicle's system is a negative ground, the output terminal connects to the starter's positive terminal.

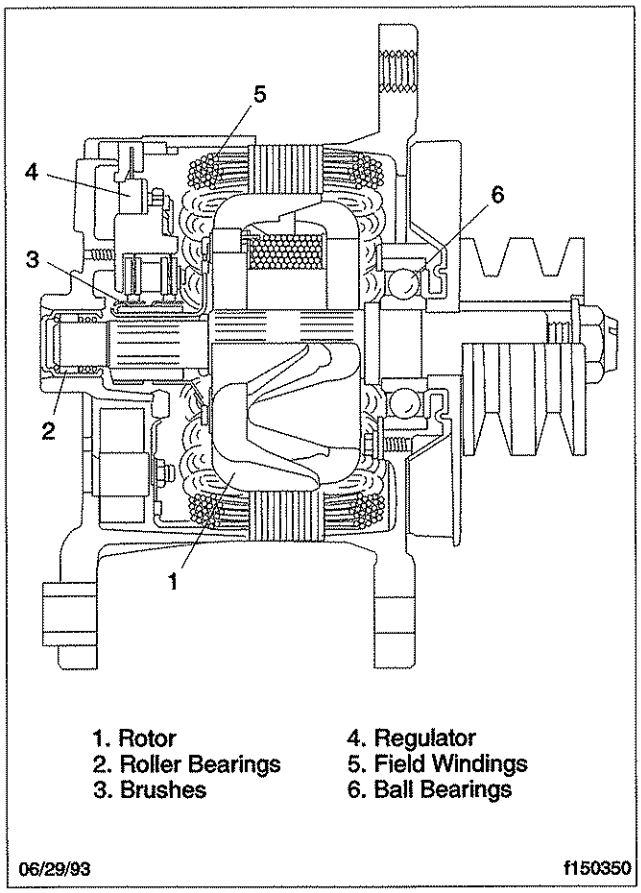


Fig. 1, 21-SI Alternator Components

As the rotor begins to turn, the permanent magnetism within it induces voltages in the stator windings. The voltages across the diodes cause current to flow, charging the battery.

General Description

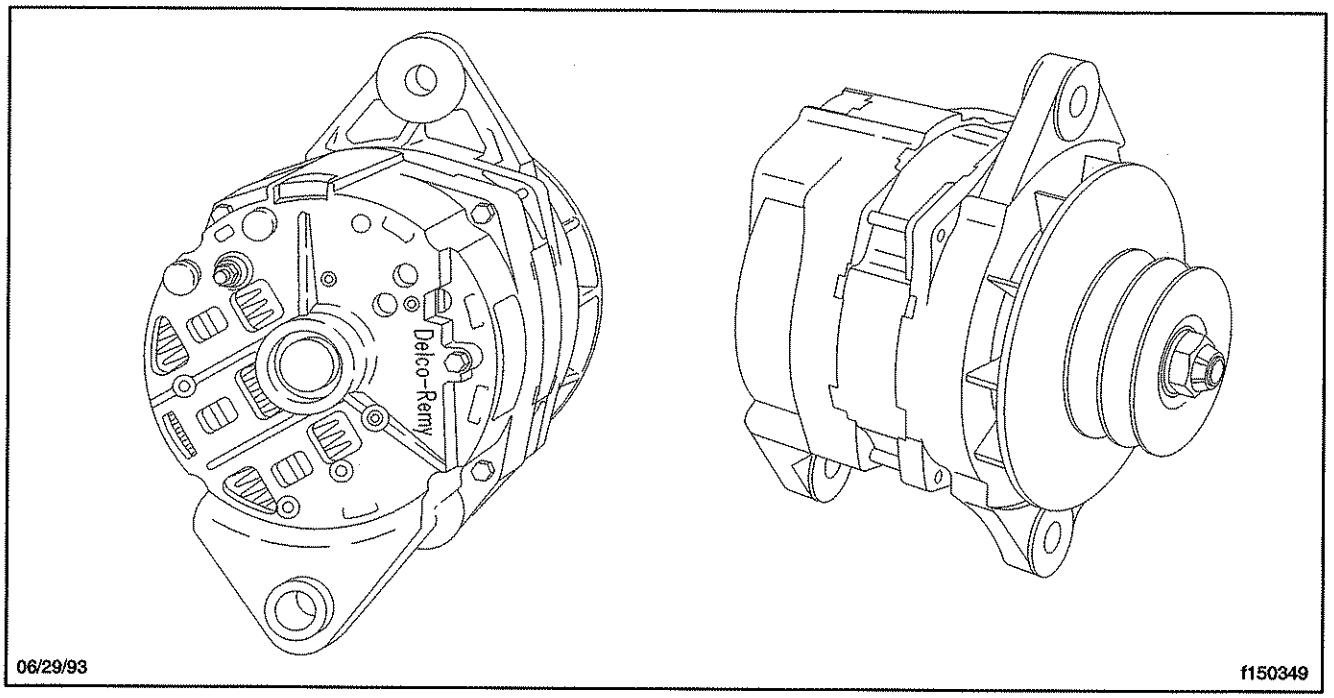


Fig. 2, Delco Remy 21-SI Alternator

Removal and Installation from Cummins B Series Engine

Removal

1. Apply the parking brakes, chock the tires, and tilt the hood.
2. Disconnect the batteries or, if equipped, turn off the battery shutoff switch.
3. Disconnect the wires from the alternator terminals, and label them for reassembly.
4. Remove the alternator belt.
   - 4.1 Insert a 3/8-inch breaker bar in the belt tensioner **(see Fig. 1),** and rotate the tensioner up and off the belt.
   - 4.2 Holding the tensioner up, remove the belt from the alternator pulley.
   - 4.3 Slowly release the belt tensioner, and remove the breaker bar.
5. Remove the alternator. **Refer to Fig. 2.**
   - 5.1 Remove the capscrew (Ref. 8) that secures the lower alternator mount to the link (Ref. 7).
   - 5.2 Remove the nut and washer (Refs. 5 and 4) from the pivot bolt (Ref. 1).

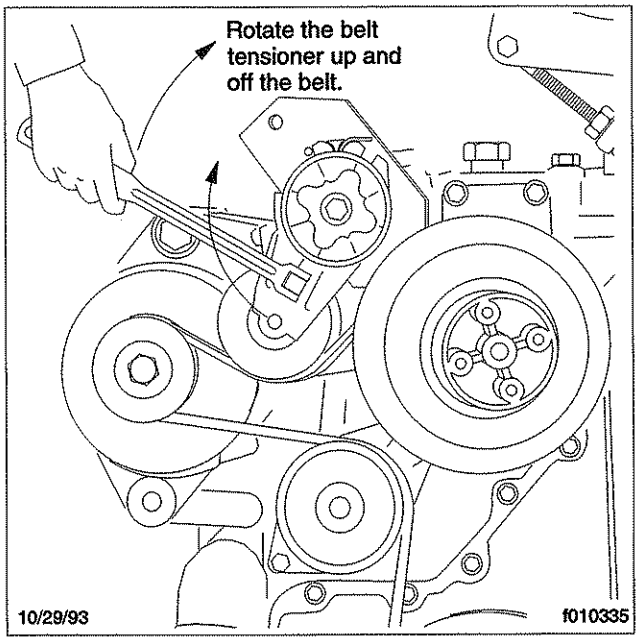


Fig. 1

   - 5.3 Securely hold the alternator to prevent it from falling, and remove the pivot bolt.
   - 5.4 Remove the alternator from the vehicle.

Installation

1. Install the alternator on the alternator mount. **Refer to Fig. 2.**
   - 1.1 Position the alternator on the mount.
   - 1.2 Insert the pivot bolt (Ref. 1) through the alternator and mount.
   - 1.3 Install the washer and nut (Refs. 4 and 5) on the end of the pivot bolt.
2. Install the capscrew **(Fig. 2,** Ref. 8) to secure the lower alternator mount to the alternator link **(Fig. 2,** Ref. 7), and tighten it 21 N·m (16 lbf·ft). Tighten the nut on the end of the pivot bolt 54 N·m (40 lbf·ft).
3. Install the belt on the alternator.
   - 3.1 Insert a 3/8-inch breaker bar in the belt tensioner **(see Fig. 1),** and rotate the tensioner up while installing the belt on the alternator pulley. Make sure the belt is aligned on all pulleys.
   - 3.2 Slowly release the tensioner assembly onto the belt. The tensioner automatically tightens the belt to the correct tension.
   - 3.3 Remove the breaker bar from the tensioner.
4. Connect the wires to the alternator terminals. If the wires are not labeled, refer to the wiring diagram in **"Specifications, 400."**
5. Connect the batteries or, if equipped, turn on the battery shutoff switch.
6. Lower the hood, and remove the chocks from the tires.

Removal and Installation from Cummins B Series Engine

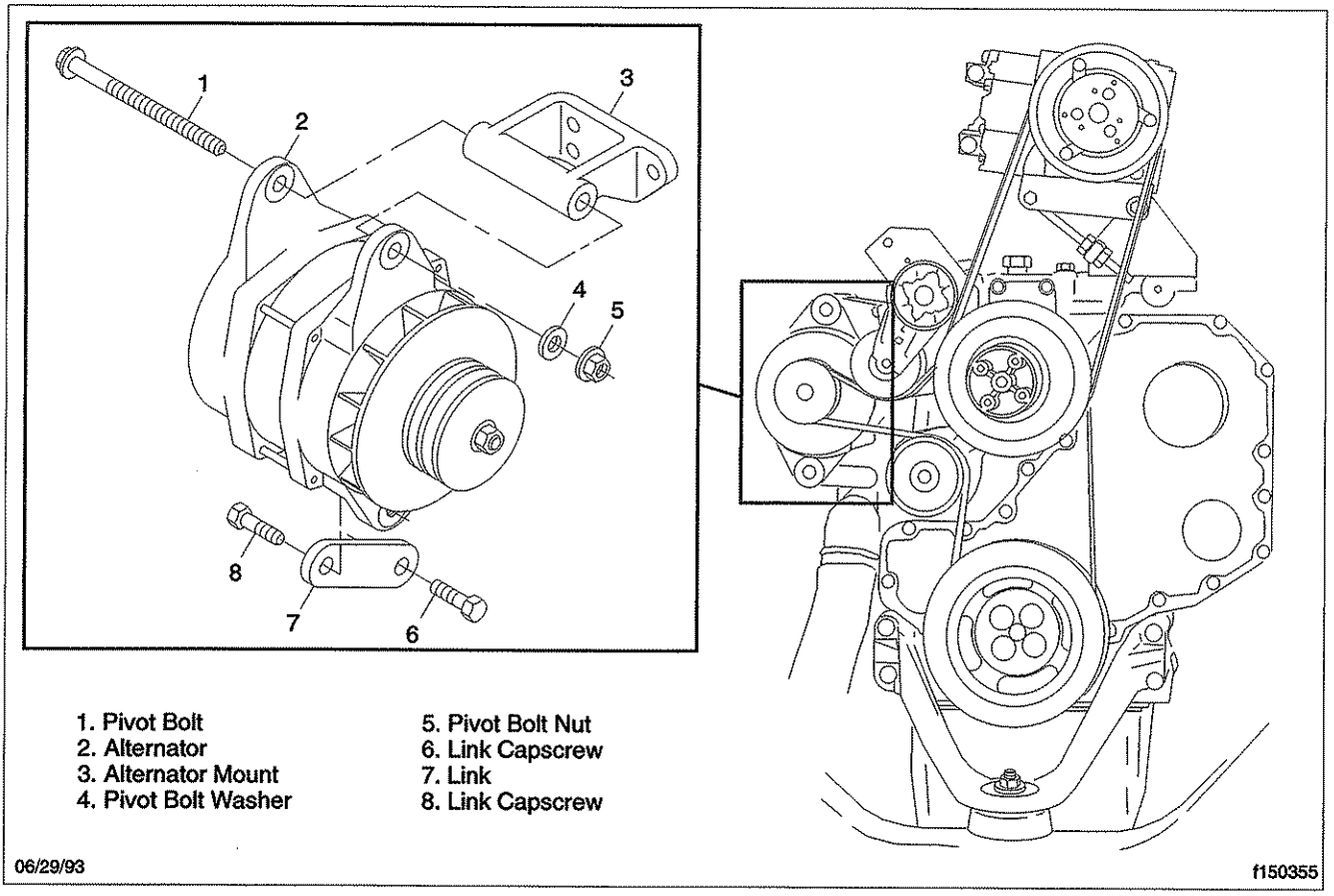


Fig. 2, Alternator Installation, Cummins B Series Engine

Removal and Installation from Mercedes-Benz OM 366LA Engine

Removal (Refer to Fig. 1)

1. Apply the parking brakes, chock the tires, and tilt the hood.
2. Disconnect the batteries or, if equipped, turn off the battery shutoff switch.
3. Disconnect the wires from the alternator terminals, and label them for reassembly.
4. Remove the alternator belt.
   - 4.1 Turn the adjusting rod nut (Ref. 2) clockwise to allow the adjusting rod guide (Ref. 3) to slide inward along the adjusting rod (Ref. 1).
   - 4.2 Loosen the capscrew (Ref. 4) in the adjusting rod guide.
   - 4.3 Loosen the nut (Ref. 13) on the pivot bolt (Ref. 6).
   - 4.4 Rotate the alternator inward along the adjusting rod, and remove the belt.
5. Remove the alternator.
   - 5.1 Rotate the alternator outward until the adjusting rod guide (Ref. 3) is off the adjusting rod.
   - 5.2 Remove the nut (Ref. 13) from the pivot bolt.
   - 5.3 Securely hold the alternator to prevent it from falling, and remove the pivot bolt.
   - 5.4 Remove the alternator from the vehicle.

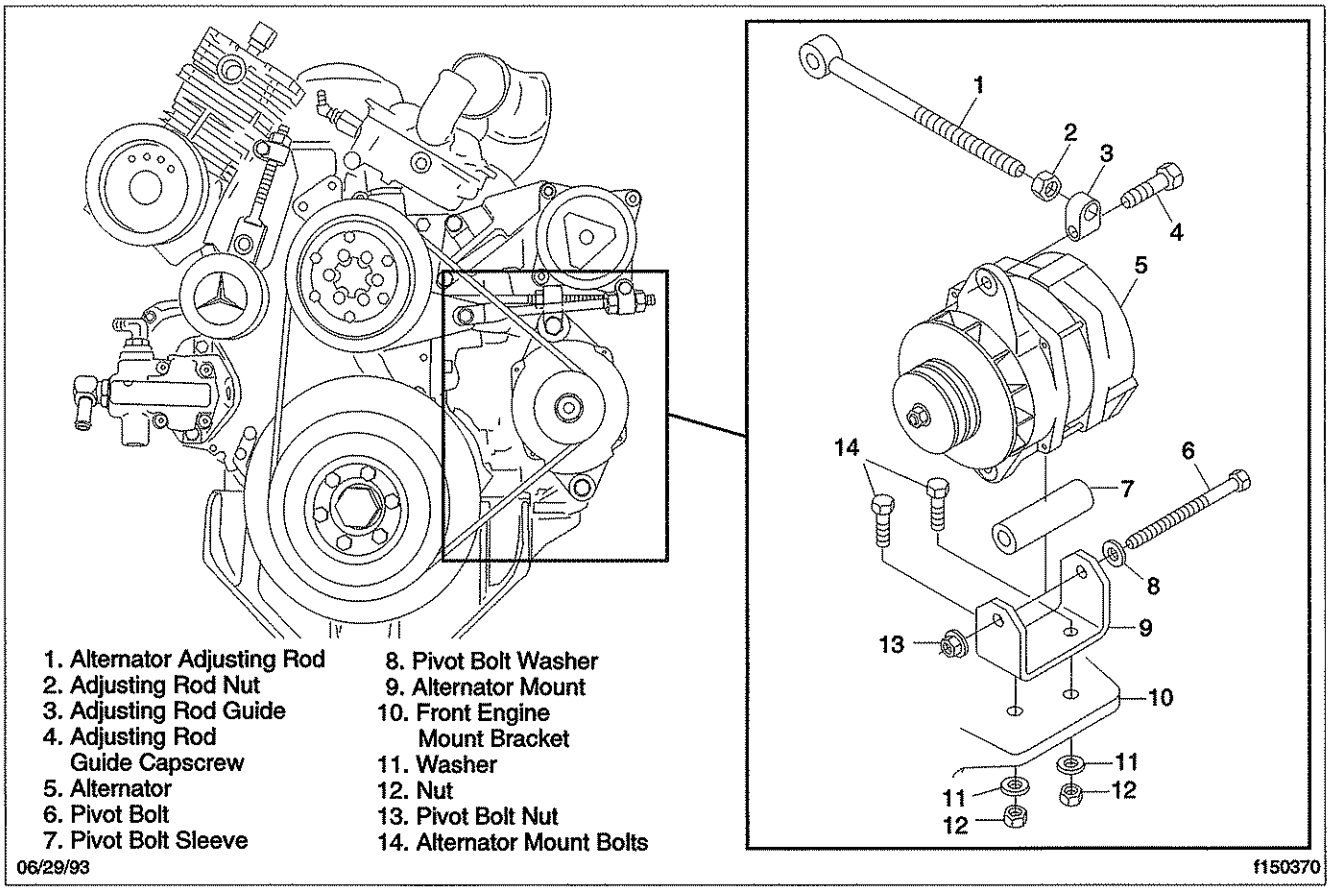


Fig. 1, Alternator Installation, Mercedes-Benz OM 366LA Engine

Removal and Installation from Mercedes-Benz OM 366LA Engine

Installation (Refer to Fig. 1)

1. Install the alternator on the alternator mount (Ref. 9).
   - 1.1 Position the alternator on the mount.
   - 1.2 Hold the pivot bolt sleeve (Ref. 7) in place between the two flanges of the mount, and insert the pivot bolt (Ref. 6) through the alternator, mount, and sleeve.
   - 1.3 Install the nut (Ref. 13) on the end of the pivot bolt, and tighten the nut finger-tight.
2. Install the belt on the alternator.
   - 2.1 Rotate the alternator upward, and insert the adjusting rod (Ref. 1) through the adjusting rod guide (Ref. 3).
   - 2.2 Loop the belt on the alternator pulley, and make sure it is still aligned on the fan and vibration damper pulleys.
   - 2.3 Tighten the belt by turning the adjusting rod nut (Ref. 2) counterclockwise until the alternator rotates outward against the belt.

     Check the tension while turning the nut, use your thumb to apply about 11 kg (25 lbs) of force at the center of the longest belt free-span until the belt deflection equals one belt thickness per 305 mm (1 ft) of pulley center distance.
   - 2.4 Install a belt tension gauge at the center of the belt's longest free-span.
   - 2.5 Turn the adjusting rod nut against the adjusting rod guide to move the alternator outward until the belt tension is 75 kg (160 lbs).

IMPORTANT: Do not overtighten the belt; too much tension shortens belt and bearing life.

3. Tighten the capscrew on the adjusting rod guide (Ref. 3) 81 N·m (60 lbf·ft).
4. Tighten the nut (Ref. 13) on the pivot bolt 81 N·m (60 lbf·ft).
5. Check the belt tension again, and adjust if needed.
6. If installing a new belt, operate the engine for about 20 minutes, then check the belt tension.

   All new belts will lose tension after 20 minutes of operation.

   If necessary, adjust the belt to 75 kg (160 lbs).
7. Connect the wires to the alternator terminals. If the wires are not labeled, refer to the wiring diagram in **"Specifications, 400".**
8. Connect the batteries or, if equipped, turn on the battery shutoff switch.
9. Lower the hood, and remove the chocks from the tires.

Troubleshooting

Many alternators have been replaced that later investigation reveals were working properly. This may be due to incorrectly diagnosing the problem.

IMPORTANT: Before testing, make sure:

- All belts are correctly tightened;
- The wiring and terminals are clean and in good condition;
- All terminal nuts are torqued and properly protected.

Delco Remy has an alternator testing tool called the Intelli-Check Alternator Analyzer. See **Fig. 1**. This tool (DR 10457848, a single tester, or DR 10457865, a four-pack of testers) is to be used as a quick check of the alternator to see if it is working correctly.

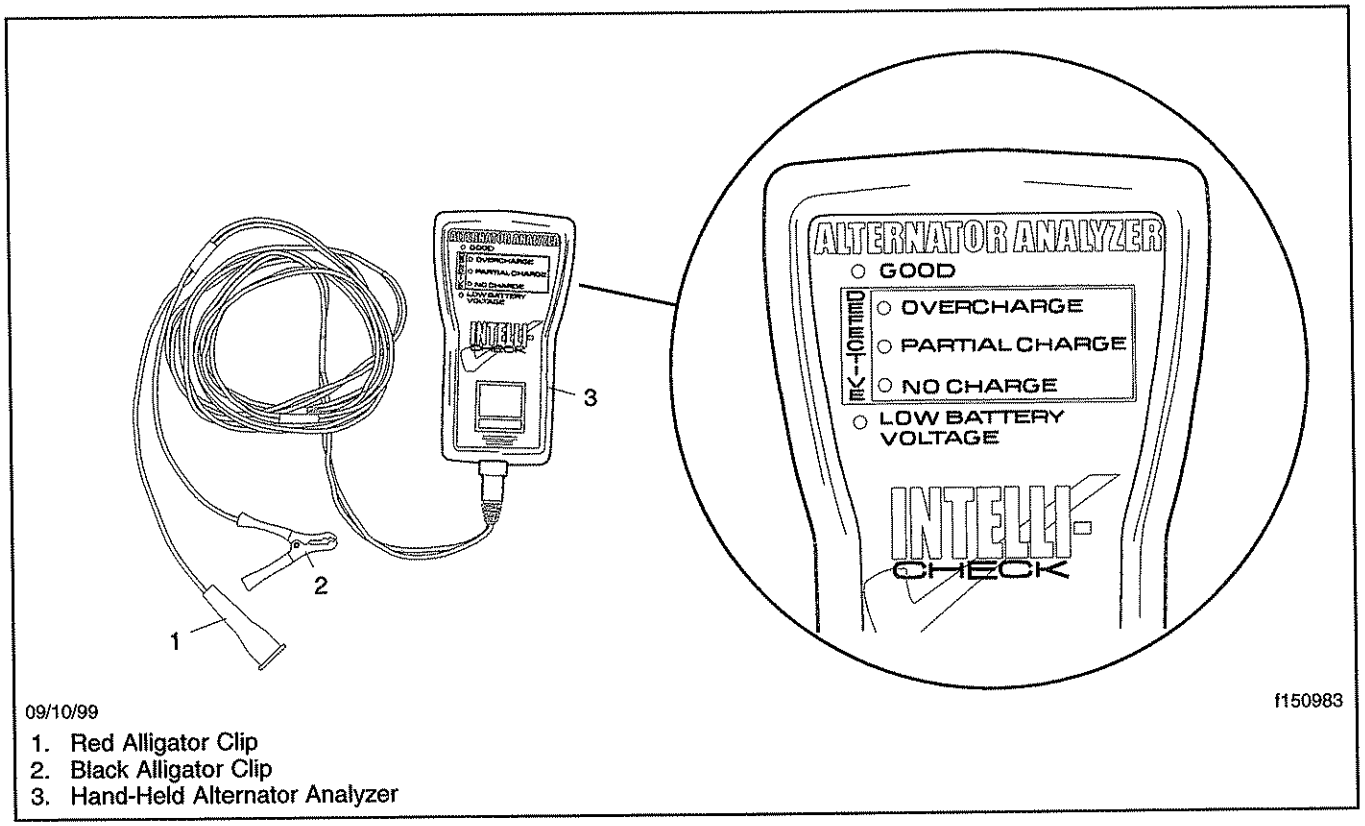
NOTE: If you do not have the Delco Intelli-Check Tester, or if the alternator rated output is above 145 amps, or if a total vehicle charging system analysis is required, see "Alternator/Charging System Testing."

Intelli-Check Alternator Analyzer

The following information includes a pre-test procedure and operating instructions for the Delco Intelli-Check Tester, and is similar to the procedures provided by Delco with the Intelli-Check Tester.

Pre-Test Procedure (Engine Off)

1. Inspect the alternator connections to verify that all terminals are secured and tight. Verify that the sense wire is connected to the sense terminal on vehicles equipped with remote-sense alternators.
2. With the engine off, connect the red alligator clip to the output terminal of the alternator. Connect the black alligator clip to the alternator ground. An optional ground connection is to the body of the alternator. The tester LEDs will illuminate and then go off as it performs a self-test.



1. Red Alligator Clip
2. Black Alligator Clip
3. Hand-Held Alternator Analyzer

Fig. 1, Delco Remy Intelli-Check Alternator Analyzer

Troubleshooting

3. After 4 seconds the tester will activate. The following LEDs may illuminate depending on the condition of the batteries:
    - **GOOD** (green) LED indicates the battery voltage is above 12.8 and has a surface charge. The surface charge must be removed before proceeding with the alternator test. To remove the surface charge, do the following:
        A. Turn on the headlights and blower motor for 2 minutes without restarting the engine.
        B. Reset the tester by disconnecting, then reconnecting the tester alligator clips. The analyzer will again perform its self-test.
        C. Repeat the applicable steps of the Pre-Test Procedure.
    - **NO CHARGE** (red) LED indicates the battery voltage is below 12.8. This LED should illuminate for most tests. Proceed with the alternator test.
    - **LOW BATTERY VOLTAGE** (blue) LED indicates the battery voltage is below 12.35. If the batteries will start the vehicle, proceed with the alternator test. However, after completing the Intelli-Check alternator test, perform the procedures under "Alternator/Charging System Testing" to determine the condition of the rest of the charging system.

Tester Operating Instructions (Engine Running)

1. Start the engine using onboard batteries only. If the batteries will not start the engine, they must be charged for 2 hours. Start the test again after charging the batteries.
2. Verify the engine is at idle and all electrical loads are off.
3. Depress the accelerator to governed speed, hold for 10 seconds, then return to idle.
    - If the **GOOD** (green) LED illuminates, proceed to the next step.
    - If any LEDs illuminate indicating overcharge, partial charge or no charge (the three red lights in the **DEFECTIVE** section), replace the alternator and run the complete test again.
    - If the **LOW BATTERY VOLTAGE** (blue) LED illuminates, evaluate the charging system using the instructions in "Alternator/Charging System Testing."
4. With the engine running, turn on all electrical loads.
5. Depress the accelerator to governed speed, hold for 10 seconds, then return to idle.
6. If the **GOOD** (green) LED illuminates, the alternator is OK and the test is complete.

NOTE: If the alternator tests OK in the above tests, and the customer's complaint is reduced battery or headlight life, see "Alternator/Charging System Testing" to completely analyze the charging system.

7. If any LEDs illuminate indicating overcharge, partial charge or no charge (the three red lights in the **DEFECTIVE** section), replace the alternator and run the complete test again.
8. If the **LOW BATTERY VOLTAGE** (blue) LED illuminates, evaluate the charging system using the instructions in "Alternator/Charging System Testing".

Alternator/Charging System Testing

Battery Open Circuit Voltage Test, Alternator Output Voltage Test and Alternator Amperage Output Test

1. Use a digital volt-ohmmeter (VOM) set on the 2-20VDC (or similar) scale to test the battery open circuit voltage (OCV). With the engine shut down and the voltmeter set up as shown in **Fig. 2**, check for voltage of 12.4 volts or more.

    If the OCV is 12.4 volts or more, turn on the vehicle headlights for approximately 3 minutes.

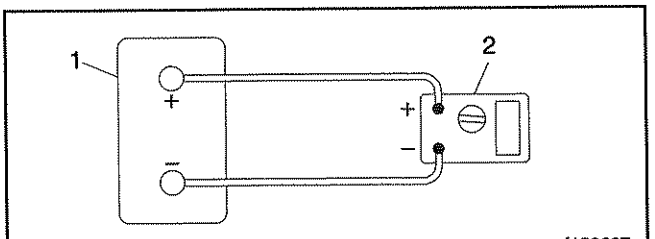
    If the OCV is less than 12.4 volts, charge the batteries properly. For instructions, see **Group 54**.

IMPORTANT: Be sure to disconnect the batteries or remove them from the vehicle before charging.

2. Check the alternator output without a load. See **Fig. 3**.

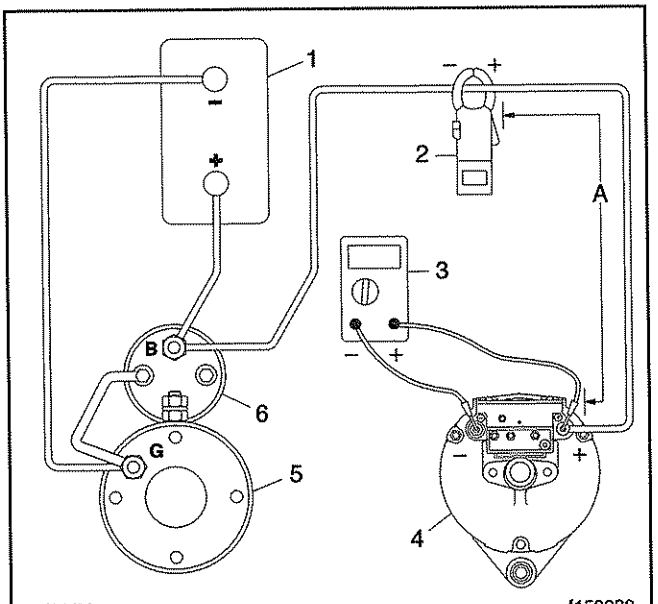
2.1 Start the engine and run it at 1500 rpm for 3 to 5 minutes to stabilize the system before proceeding to the next step.

2.2 Connect the positive (+) lead of the digital voltmeter (still set on the 2-20VDC or similar scale) to the alternator (battery) terminal. Connect the negative (–) lead of the voltmeter to the alternator negative (–) ground terminal. See **Fig. 3.**



1. Battery
2. Digital Voltmeter

Fig. 2, Setup 1: Battery Open Circuit Voltage (and alternator amperage output)



A. Locate the ammeter at least 6 inches (15 cm) away from the alternator.

1. Battery
2. Ammeter
3. Digital Voltmeter
4. Alternator
5. Cranking Motor
6. Solenoid

Fig. 3, Setup 2: Alternator Output Test

2.3 If the voltmeter reads from 13.8 to 14.2 volts, record this reading (V1) and go to the next step. If the alternator reads less than 13.8 volts and is adjustable, try to adjust the voltage regulator to 13.8 to 14.2 volts. If unable to obtain acceptable output, replace the alternator.

3. Check the alternator output under load. See **Fig. 3.**

3.1 Attach a clamp-on induction ammeter around the positive (+) wire. See **Fig. 3.**

NOTE: Locate the ammeter at least 6 inches (15 cm) away from the alternator.

3.2 With the engine still running at 1500 rpm, turn on the following electrical accessories to load the alternator until the ammeter reads 60 to 75 amps.

- Both front and rear heater blowers (on HIGH)
- Headlights (high beams)
- Road lights
- Interior lights

NOTE: As an alternate method of putting load on the alternator, connect a carbon pile tester and set it to 60 to 75 amps.

3.3 Keep the voltmeter connected as in the previous step; positive (+) lead connected to the alternator positive (+) terminal; negative (–) lead connected to the alternator negative (–) terminal.

3.4 If the voltmeter reads from 13.6 to 14.2 volts, record this reading (V2) and go to the next step.

If the voltmeter reads less than 13.6 volts, replace the alternator.

4. Perform an alternator amperage output test.

4.1 Connect a carbon pile tester across the vehicle batteries as shown in **Fig. 2.**

NOTE: **Figure 2** shows a voltmeter, but the connections for the carbon pile tester are the same.

4.2 Attach a clamp-on induction ammeter around the alternator output wire. See **Fig. 3.**

Troubleshooting

NOTE: Locate the ammeter at least 6 inches (15 cm) away from the alternator.

4.3 Start the engine and make sure all vehicle electrical accessories are turned off. Run it at fast speed and adjust the tester to the alternator maximum current output. Record this output value.

NOTE: Ensure that the alternator is turning at maximum available rpms and keep adjusting the tester dial until the ammeter reads its highest value.

4.4 Turn off the tester and shut down the engine.

4.5 If the output value recorded is less than 85 percent of the rated amperage output, repeat the test. If the output value recorded is still less than 85 percent of the rated amperage output, replace the alternator.

4.6 Make sure that all test instruments are removed and that the vehicle wiring is returned to its operational state.

5. To identify other problem areas within the vehicle, check the operation of the charging system. Set up the voltmeter as shown in **Fig. 2** and **Fig. 3**.

NOTE: For any load at 1500 rpm or more, battery voltage must be within 0.5 volts of the alternator voltage.

5.1 If readings at the batteries are within 0.5 volts of the readings at the alternator, the charging system is working correctly. Check other areas of the vehicle to locate the problem.

5.2 If the reading at the batteries is more than 0.5 volts lower than the reading at the alternator, do the next step.

6. Check charging system connections, cables and terminals.

6.1 Check all connections between the battery, starter and alternator for tightness and signs of corrosion. Tighten and clean as necessary.

6.2 Check all cables for breaks or partial breaks. Repair or replace as necessary.

6.3 Check each ring terminal for breakage at the point where it attaches to its wire or cable.

Specifications

This subject contains the following tables:

- Fastener Torques
- Drive Belt Tension, Mercedes-Benz OM 366LA Engine

See Fig. 1 for a Delco Remy 21-SI Alternator wiring diagram.

Description	Grade	Size	Torque N.m (lbf.ft)
Mercedes-Benz OM 366LA Engine Alternator Pivot Bolt Nut	8	1/2-13	81 (60)
Mercedes-Benz OM 366LA Engine Alternator Pivot Bolt Nut	8	1/2-13	81 (60)
Cummins B Series Engine Alternator Adjusting Rod Guide Capscrew	8	3/8-16	54 (40)
Cummins B Series Engine Alternator Link Capscrew	8.8	M8	21 (16)

Table 1, Fastener Torque

Description	Tension kg (lbs)
Fan/Alternator Belt	75 (160)

Table 2, Drive Belt Tension, Mercedes-Benz OM 366LA Engine

Specifications

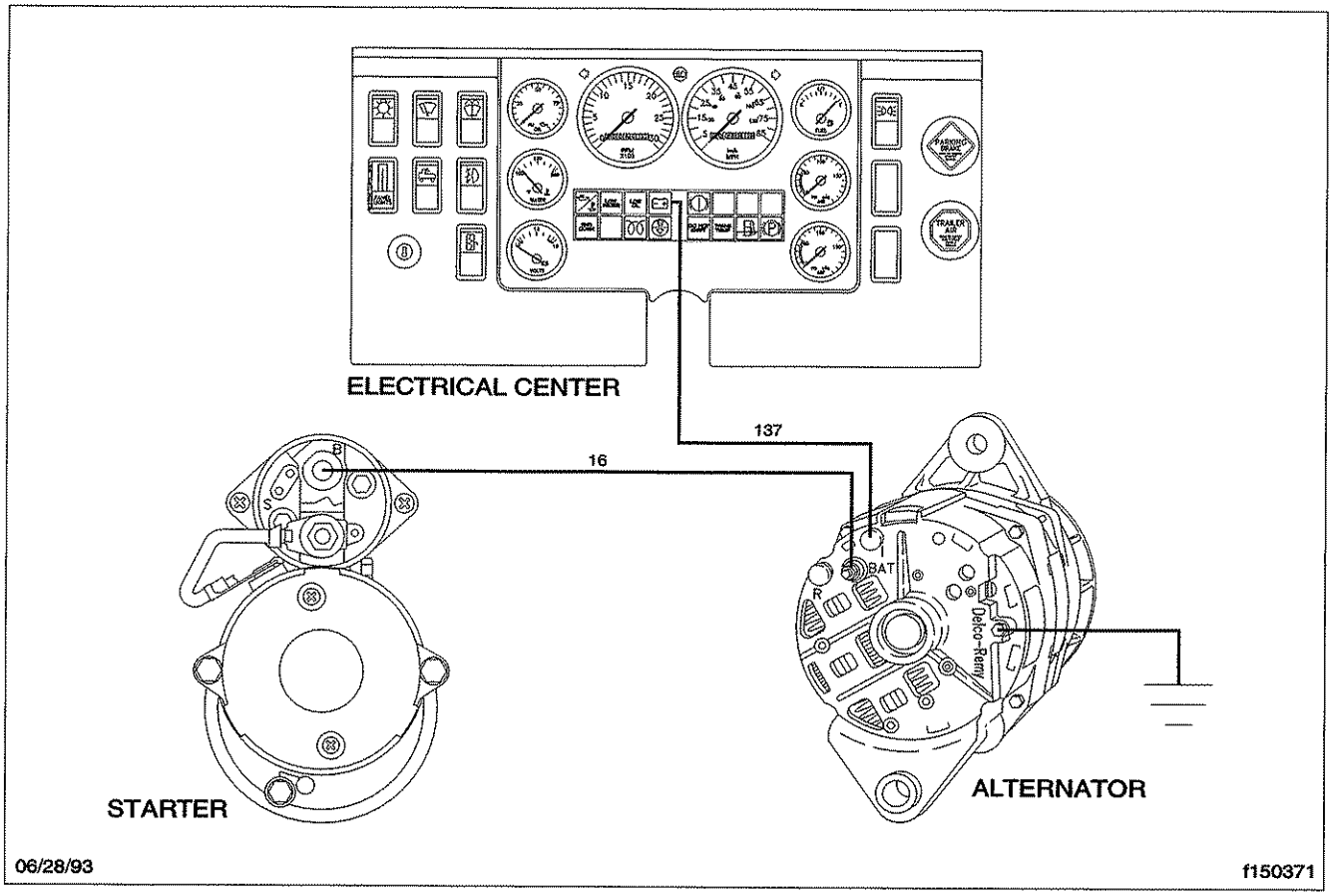


Fig. 1, Delco Remy Alternator 21-SI Wiring Diagram

Starter, Delco Remy 28–MT Series 15.02

Contents

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General Information

The Delco Remy 28-MT starter **(Fig. 1)** mounts at the forward face of the flywheel bell housing. On Cummins B Series engines, the starter mounts on the right side of the engine. On Mercedes-Benz OM 366LA engines, it mounts on the left.

The starter assembly **(Fig. 2)** consists of two basic parts: the solenoid and the starter motor. The shift lever and wiring connect the two parts, and the lever, motor, and solenoid are completely enclosed for protection from dirt, ice, and splash. The 28-MT starter features sealed bearings with lifetime lubrication.

The solenoid is wired to the starter relay, the alternator, and the batteries. Turning the key switch to start supplies power to the starter relay, and the relay activates the solenoid. Once activated, the solenoid plunger slides forward, moving the shift lever to engage the starter drive gear with the engine flywheel ring gear, and connecting the solenoid's battery terminal to the motor terminal.

The motor terminal is wired to the starter motor so power from the batteries activates the starter motor after the starter drive gear engages the engine flywheel.

Once the engine starts, and the ignition stops supplying power to the starter relay, the solenoid plunger retracts, disengaging the starter motor from the engine flywheel, and cutting battery power to the starter motor.

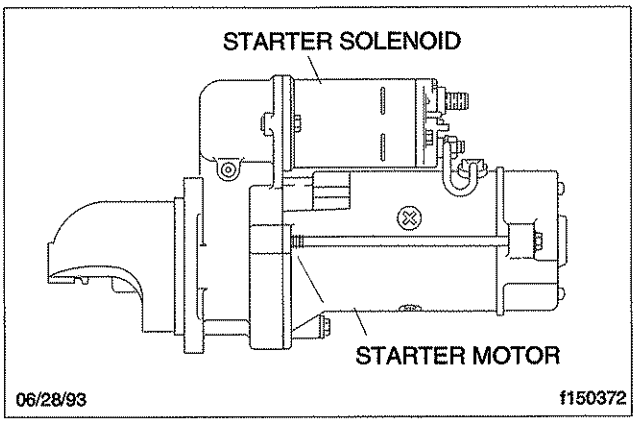


Fig. 1, Delco Remy 28-MT Starter

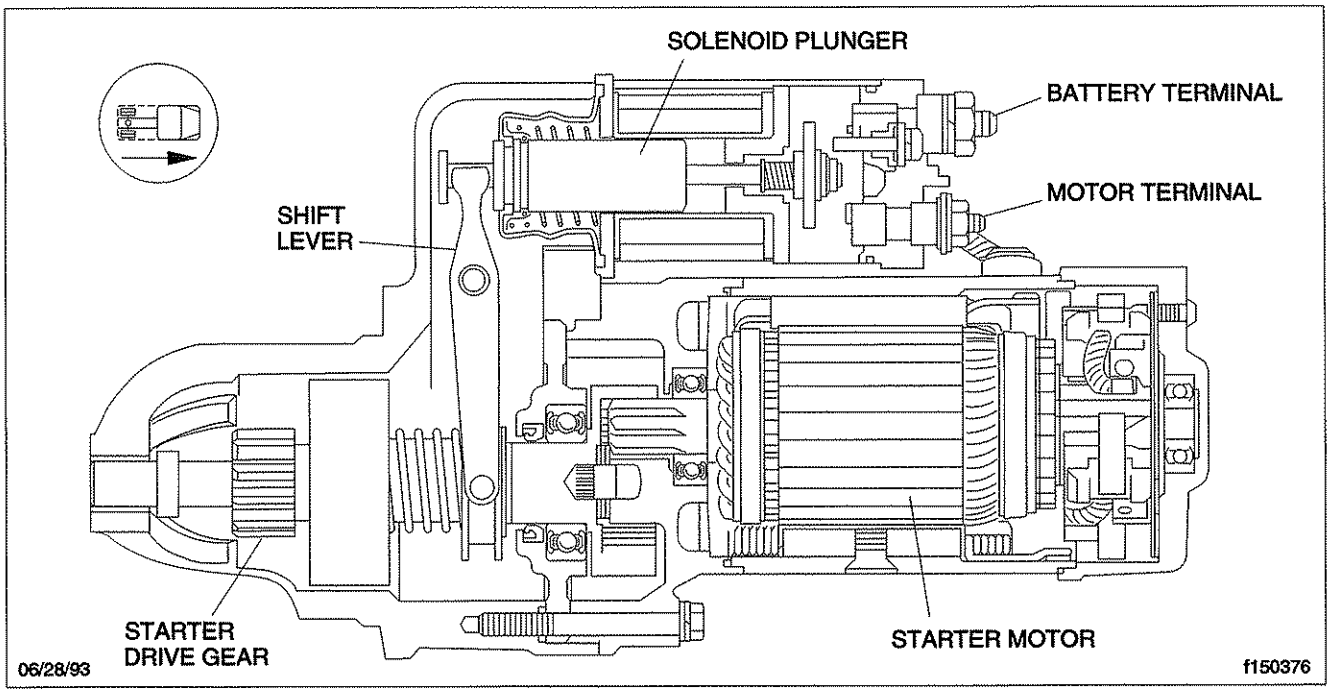


Fig. 2, Starter Components

Removal and Installation

Removal

1. Apply the parking brakes, chock the tires, and tilt the hood.
2. Disconnect the batteries or, if equipped, turn off the battery shutoff switch.
   - 2.1 Disconnect the battery ground cable at the vehicle frame.
   - 2.2 Disconnect the positive battery cable from the batteries.
3. Disconnect the wires from the starter solenoid terminals, and label them for reassembly.
4. Remove the starter from the engine.

   On Cummins B Series engines, remove the three capscrews that secure the starter to the engine. **Refer to Fig. 1.**

   On Mercedes-Benz OM 366LA engines, remove the oil return pipe from the bottom of the turbocharger by removing the two bolts that hold the top of the pipe and the

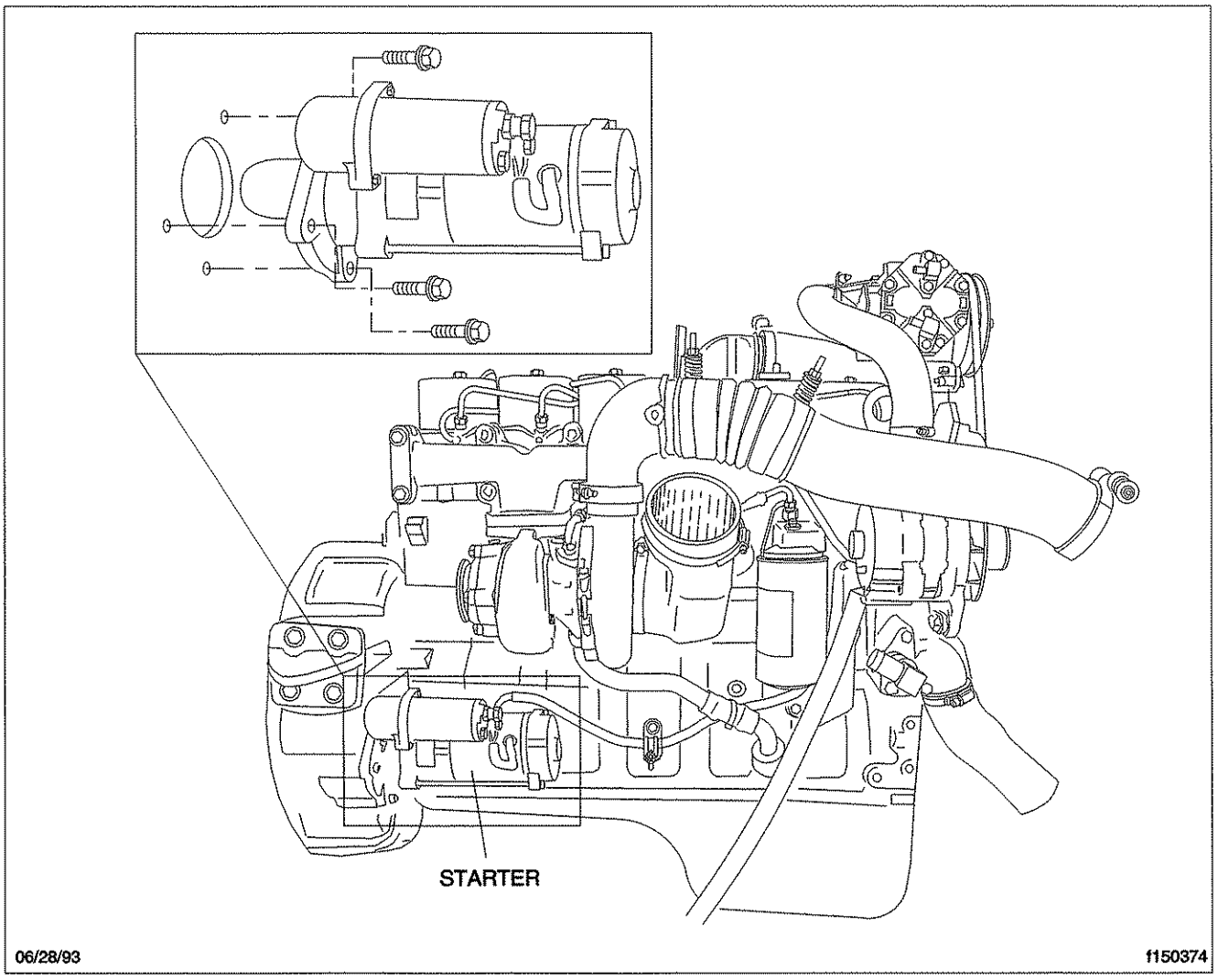


Fig. 1, Cummins B Series Engine

Removal and Installation

5. pipe clamp that holds the base. **Refer to Fig. 2.** Remove the three nuts that secure the starter to the engine.

Installation

1. Install the starter on the engine.

   On Cummins B Series engines, position the starter and secure it with the three capscrews. **Refer to Fig. 1.** Tighten the capscrews 43 N·m (32 lbf·ft).

   On Mercedes-Benz OM 366LA engines, position the starter and secure it with the three nuts. **Refer to Fig. 2.** Tighten the nuts 43 N·m (32 lbf·ft). To install the oil return pipe on the bottom of the turbocharger, tighten the bolts at the top of the pipe 40 N·m (30 lbf·ft), and tighten the clamp at the base of the pipe.

2. Connect the wires to the starter terminals. If the wires were not labeled for reassembly, refer to the starter wiring diagram in **"Specifications, 400."**

3. Connect the batteries or, if equipped, turn on the battery shutoff switch.

   3.1 Connect the positive battery cable to the batteries.

   3.2 Connect the battery ground cable to the vehicle frame.

4. Lower the hood, and remove the chocks from the tires.

5. Start the engine to test the starter.

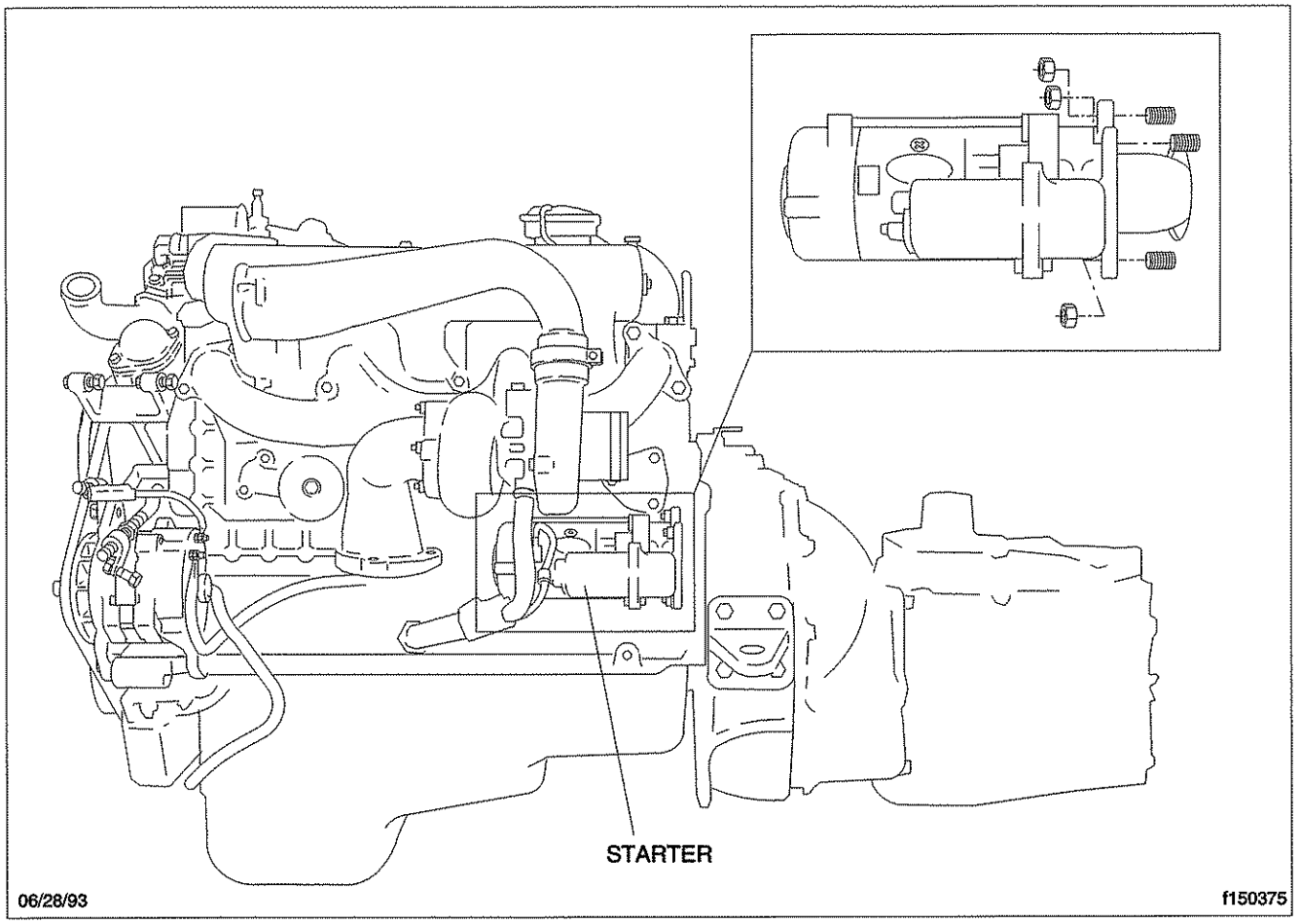


Fig. 2, Mercedes-Benz OM 366LA Engine

Specifications

This subject contains the following table:

See Fig. 1 for a starter wiring diagram.

•Fastener Torques

Description	Grade	Size	Torque N·m (lbf·ft)
Starter Mounting Capscrews, Cummins B Series Engines	8.8	M10 x 1.5	43 (32)
Starter Mounting Nuts, Mercedes-Benz OM 366LA Engine	10.9	M10 x 1.5	43 (32)
Turbocharger Oil Return Pipe Mounting Bolts	10.9	M8 x 1.25	40 (30)

Table 1, Fastener Torques

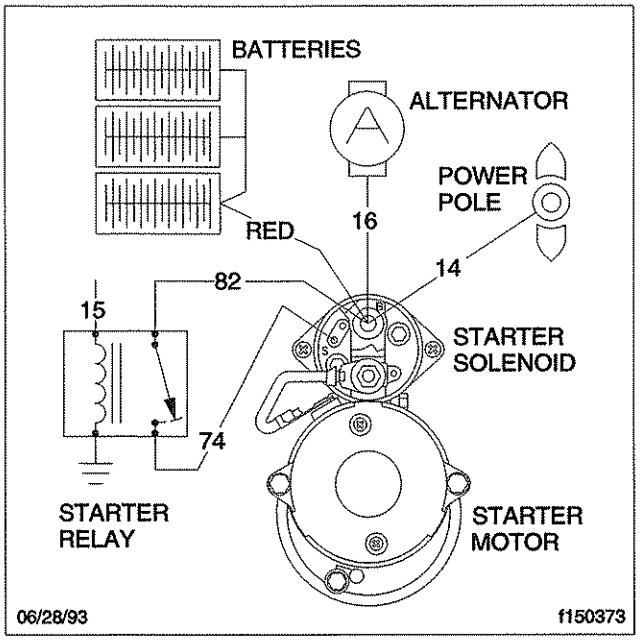


Fig. 1, Starter Wiring Diagram

Starter, Nippondenso 15.03

Contents

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General Information

The Nippondenso starter mounts on the left-hand side of the engine directly into the transmission, through a hole in the torque converter access cover.

The starter motor incorporates a planetary gear system between the electric motor and pinion gear. This feature allows the armature to rotate at a higher speed and delivers increased torque to the drive plate ring gear or flywheel. At the same time, it reduces the size and weight of the starter.

The starter motor is activated by a solenoid mounted to the overrunning clutch housing. The starter motor and solenoid are serviced as a complete unit only. If either component fails, replace the entire assembly.

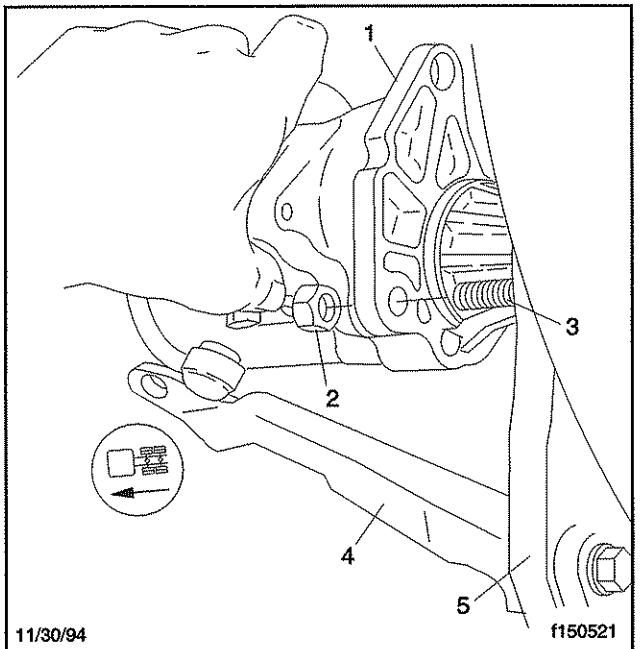
Starter Removal and Installation

Removal

1. Apply the parking brakes, chock the tires, and tilt the hood.
2. Disconnect the batteries.
3. Raise and support the vehicle.
4. Remove the starter from the bell housing.
   - 4.1 Remove the battery cable standoff bracket. Remove the battery cable bolt and bracket. Do not remove the clamp from the battery cable.
   - 4.2 Mark and disconnect the battery and solenoid cable leads. Remove the two starter mounting bolts and the mounting stud nut.
   - 4.3 Move the starter forward until the nose of the starter gear housing clears the hole in the torque converter access cover and the mounting flange clears the mounting stud. **See Fig. 1.**

Installation

1. Install the starter. **See Fig. 1.**
   - 1.1 Attach the battery cable leads to the starter, as previously marked. Tighten the connector on the battery lead 800 to 1240 N·cm (70 to 110 lbf·in). Tighten the connector on the solenoid lead 500 to 740 N·cm (45 to 65 lbf·in).
   - 1.2 Insert the starter gear housing into the hole in the torque converter access cover. Slip the starter into place over the starter mounting stud.
   - 1.3 Install the two starter mounting bolts and tighten them 68 N·m (50 lbf·ft). Install the starter mounting nut on the stud and tighten it 27 N·m (20 lbf·ft).
   - 1.4 Install the battery cable standoff bracket.
2. Connect the batteries.
3. Lower the vehicle and remove the supports.
4. Lower the hood and remove the chocks from the tires.
5. Start the engine to test the starter.



1. Starter
2. Mounting Stud Nut
3. Mounting Stud
4. Engine-to-Transmission Strut
5. Bell Housing

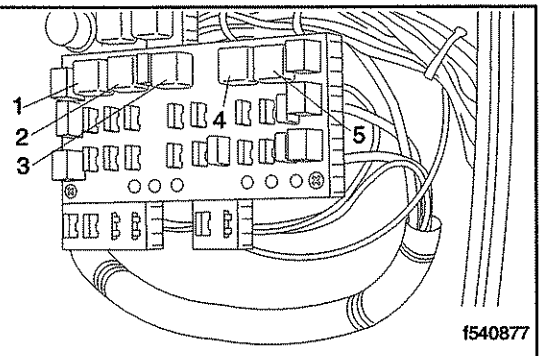
Fig. 1, Starter Removal and Installation

Starter Relay Replacement

Replacement

The starter relay is located inside the Electrical Power Center (EPC). The EPC is underneath the dash panel on the passenger side.

1. Disconnect the batteries.
2. Remove the starter relay from the EPC.
   - 2.1 Remove the fasteners holding the EPC cover. Look for the starter relay on the top row of the EPC. For a typical installation, **see Fig. 1**. The exact location of the starter relay will vary depending on options installed.
   - 2.2 Unplug the old starter relay unit from the EPC.
3. Plug in the new starter relay. Make sure the relay is firmly seated on its mounting plate and that the electrical connections behind the panel are tight.
4. Replace the EPC cover and install the fasteners.
5. Connect the batteries.
6. Start the engine to test the starter relay.



This is a typical installation. The exact location of the starter relay will vary depending on options installed.

1. Fuel Pump Relay
2. Engine Shutdown Relay
3. Starter Relay
4. Stop Lamp Relay
5. Air Conditioning Ground Signal Relay

Fig. 1, Electrical Power Center (EPC)

Specifications

Description	Torque N·m (lbf·ft)	Torque N·cm (lbf·in)
Starter Mounting Bolts	68 (50)	—
Starter Mounting Nut	27 (20)	—
Starter Battery Lead Connector	—	800–1240 (70–110)
Starter Solenoid Lead Connector	—	500–740 (45–65)

Table 1, Fastener Torques

Alternator, Nippondenso 15.04

Contents

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General Information

The Nippondenso alternator is driven by the engine through the serpentine accessory drive belt. It mounts directly onto the engine, on the right-hand side.

The alternator is serviced as a complete unit only. If the alternator fails for any reason, replace the entire unit.

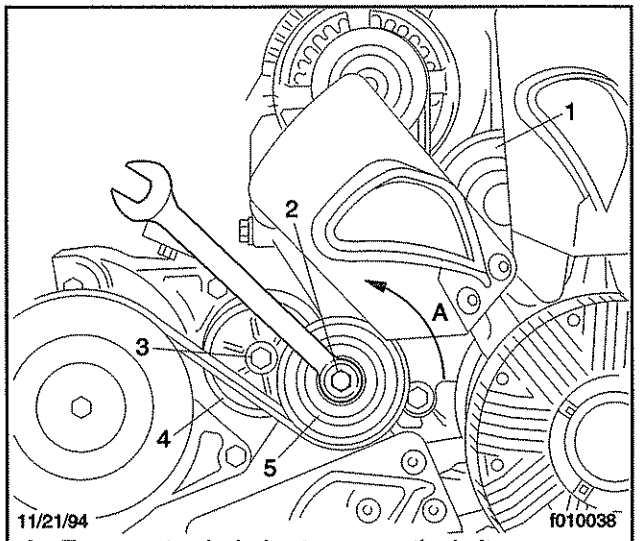
Removal

1. Apply the parking brakes, chock the tires, and tilt the hood.

⚠ WARNING

WARNING: Disconnect the negative cable from the batteries before removing the battery output wire from the alternator. Failure to do so could cause personal injury.

2. Disconnect the batteries.
3. Remove the engine accessory drive belt.
   - 3.1 Place a 5/8-inch wrench over the pulley bolt on the automatic belt tensioner, and turn the wrench counterclockwise to relax the belt tensioner. **See Fig. 1.**
   - 3.2 When the belt tension is fully relaxed, remove the engine accessory drive belt. Remove the belt first from the belt tensioner, then from the other pulleys.
4. Remove the alternator from the vehicle.
   - 4.1 Remove the alternator mounting bolts. **See Fig. 2.**
   - 4.2 From the rear (rectifier) end of the alternator, remove the nuts from the battery (positive) terminal, ground (negative) terminal, the wire harness hold-down, and the two field terminals. **See Fig. 3.**
   - 4.3 Remove the alternator.



A. Turn counterclockwise to remove the belt.
1. Idler Pulley
2. Tensioner Pulley Bolt
3. Tensioner Mounting Bolt
4. Belt Tensioner
5. Tensioner Pulley

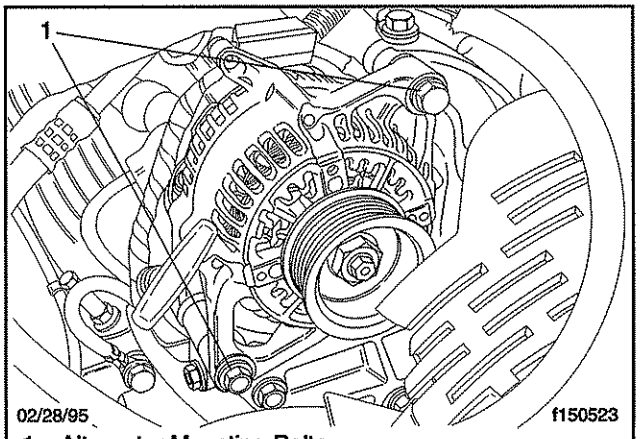
Fig. 1, Relaxing the Belt Tension

Installation

1. Install the alternator.
   - 1.1 Attach the alternator electrical connectors to the alternator. Tighten the nuts on the field terminals 280 N·cm (25 lbf·in). Tighten all the other nuts 840 N·cm (75 lbf·in). **See Fig. 3.**
   - 1.2 Install the alternator mounting bolts. Tighten each one 41 N·m (30 lbf·ft).
2. Install the engine accessory drive belt.

⚠ CAUTION

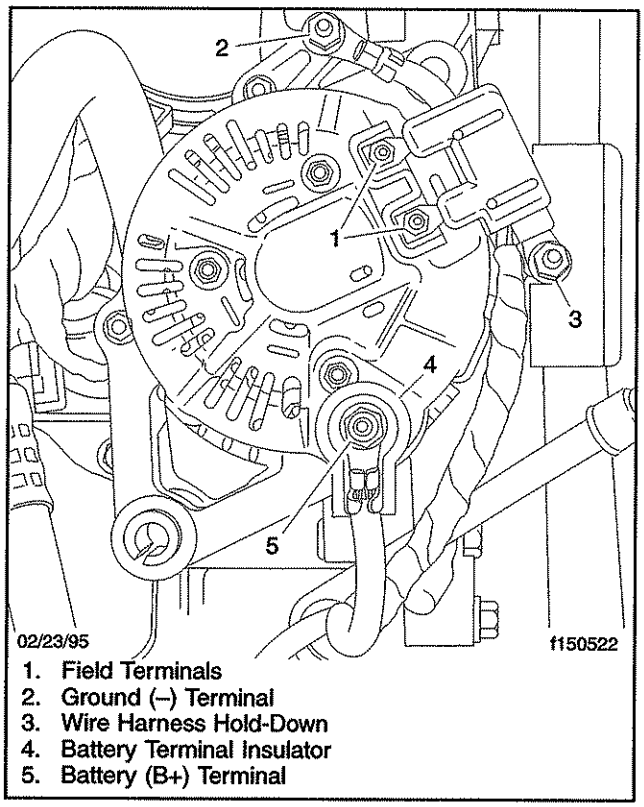
CAUTION: When installing the serpentine accessory drive belt, route the belt correctly. If the belt is not routed correctly, the water pump pulley may rotate in the wrong direction, allowing the engine to overheat.



1. Alternator Mounting Bolts

Fig. 2, Alternator Mounting Bolts

Removal and Installation



1. Field Terminals
2. Ground (–) Terminal
3. Wire Harness Hold-Down
4. Battery Terminal Insulator
5. Battery (B+) Terminal

Fig. 3, Alternator Electrical Connectors

NOTE: If the pulley must be removed from the automatic belt tensioner, note that the pulley bolt has left-hand threads.

2.1 Position the drive belt over all the pulleys *except the drive belt tensioner.* For the correct belt routing, **see Fig. 4** or **Fig. 5.**

2.2 Place a 5/8-inch wrench over the pulley bolt on the automatic belt tensioner, and turn the wrench counterclockwise to relax the belt tensioner. **See Fig. 1.**

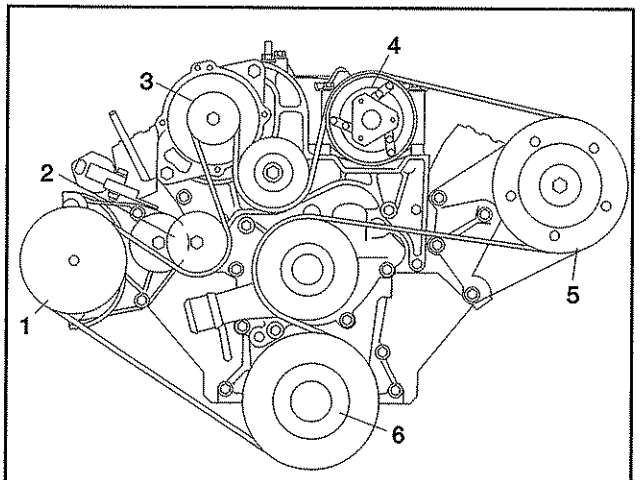
⚠ CAUTION

CAUTION: Never use a screwdriver to force the belt over a pulley rim. This can damage the synthetic fiber of the belt.

2.3 When the belt tension is fully relaxed, install the belt over the tensioner pulley. Allow the tensioner to move the belt back into place.

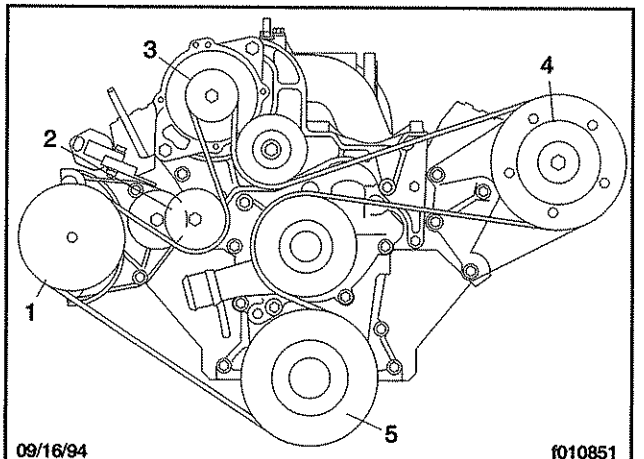
2.4 Remove the wrench and be sure the belt is correctly seated on each pulley.

3. Connect the batteries.



1. Air Injection Pump
2. Automatic Belt Tensioner
3. Alternator
4. Refrigerant Compressor
5. Power Steering Fluid Pump
6. Vibration Damper

Fig. 4, Drive Belt Routing (with a Refrigerant Compressor)



1. Air Injection Pump
2. Automatic Belt Tensioner
3. Alternator
4. Power Steering Fluid Pump
5. Vibration Damper

Fig. 5, Drive Belt Routing (without a Refrigerant Compressor)

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Troubleshooting

Many alternators have been replaced that later investigation reveals were working properly. This may be due to incorrectly diagnosing the problem.

IMPORTANT: Before testing, make sure:

- All belts are correctly tightened;
- The wiring and terminals are clean and in good condition;
- All terminal nuts are torqued and properly protected.

Delco Remy has an alternator testing tool called the Intelli-Check Alternator Analyzer. See **Fig. 1**. This tool (DR 10457848, a single tester, or DR 10457865, a four-pack of testers) is to be used as a quick check of the alternator to see if it is working correctly.

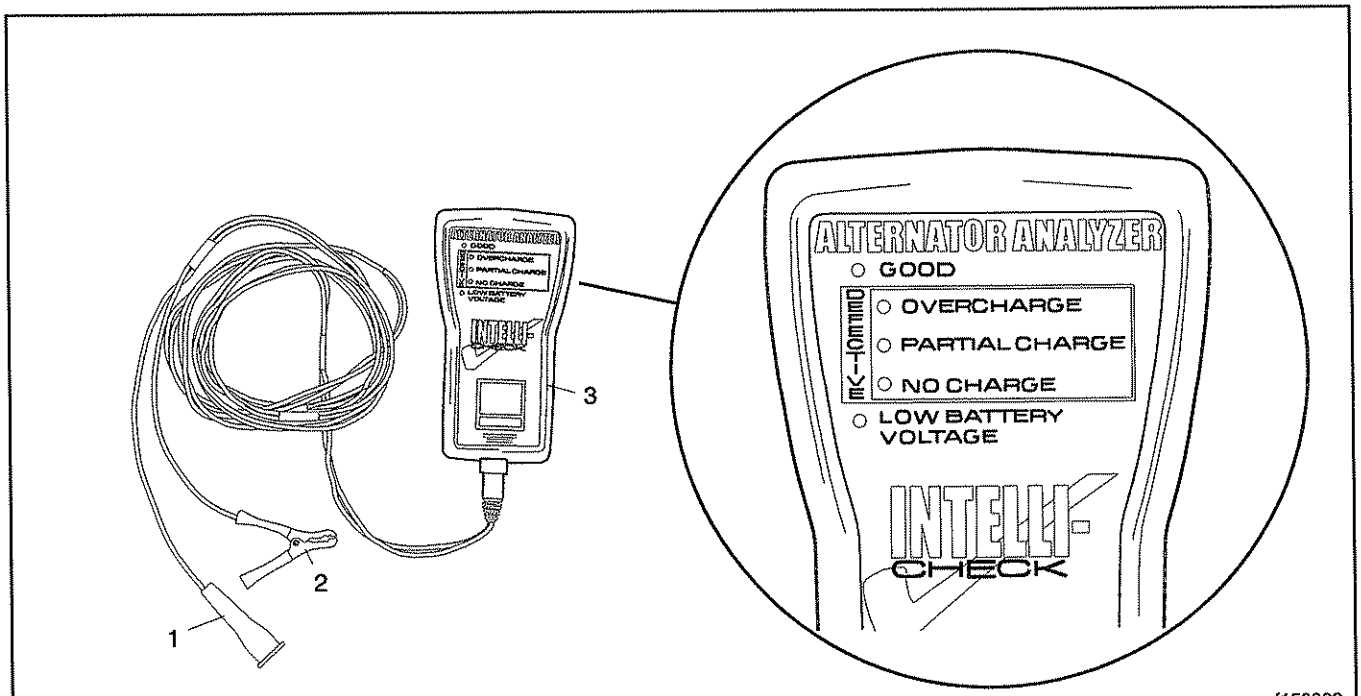
NOTE: If you do not have the Delco Intelli-Check Tester, or if the alternator rated output is above 145 amps, or if a total vehicle charging system analysis is required, see "Alternator/Charging System Testing."

Intelli-Check Alternator Analyzer

The following information includes a pre-test procedure and operating instructions for the Delco Intelli-Check Tester, and is similar to the procedures provided by Delco with the Intelli-Check Tester.

Pre-Test Procedure (Engine Off)

1. Inspect the alternator connections to verify that all terminals are secured and tight. Verify that the sense wire is connected to the sense terminal on vehicles equipped with remote-sense alternators.
2. With the engine off, connect the red alligator clip to the output terminal of the alternator. Connect the black alligator clip to the alternator ground. An optional ground connection is to the body of the alternator. The tester LEDs will illuminate and then go off as it performs a self-test.



1. Red Alligator Clip
2. Black Alligator Clip
3. Hand-Held Alternator Analyzer

Fig. 1, Delco Remy Intelli-Check Alternator Analyzer

Troubleshooting

3. After 4 seconds the tester will activate. The following LEDs may illuminate depending on the condition of the batteries:
    - **GOOD** (green) LED indicates the battery voltage is above 12.8 and has a surface charge. The surface charge must be removed before proceeding with the alternator test. To remove the surface charge, do the following:
        A. Turn on the headlights and blower motor for 2 minutes without restarting the engine.
        B. Reset the tester by disconnecting, then reconnecting the tester alligator clips. The analyzer will again perform its self-test.
        C. Repeat the applicable steps of the Pre-Test Procedure.
    - **NO CHARGE** (red) LED indicates the battery voltage is below 12.8. This LED should illuminate for most tests. Proceed with the alternator test.
    - **LOW BATTERY VOLTAGE** (blue) LED indicates the battery voltage is below 12.35. If the batteries will start the vehicle, proceed with the alternator test. However, after completing the Intelli-Check alternator test, perform the procedures under "Alternator/Charging System Testing" to determine the condition of the rest of the charging system.

Tester Operating Instructions (Engine Running)

1. Start the engine using onboard batteries only. If the batteries will not start the engine, they must be charged for 2 hours. Start the test again after charging the batteries.
2. Verify the engine is at idle and all electrical loads are off.
3. Depress the accelerator to governed speed, hold for 10 seconds, then return to idle.
    - If the **GOOD** (green) LED illuminates, proceed to the next step.
    - If any LEDs illuminate indicating overcharge, partial charge or no charge (the three red lights in the **DEFECTIVE** section), replace the alternator and run the complete test again.
    - If the **LOW BATTERY VOLTAGE** (blue) LED illuminates, evaluate the charging system using the instructions in "Alternator/Charging System Testing."
4. With the engine running, turn on all electrical loads.
5. Depress the accelerator to governed speed, hold for 10 seconds, then return to idle.
6. If the **GOOD** (green) LED illuminates, the alternator is OK and the test is complete.

NOTE: If the alternator tests OK in the above tests, and the customer's complaint is reduced battery or headlight life, see "Alternator/Charging System Testing" to completely analyze the charging system.

7. If any LEDs illuminate indicating overcharge, partial charge or no charge (the three red lights in the **DEFECTIVE** section), replace the alternator and run the complete test again.
8. If the **LOW BATTERY VOLTAGE** (blue) LED illuminates, evaluate the charging system using the instructions in "Alternator/Charging System Testing".

Alternator/Charging System Testing

Battery Open Circuit Voltage Test, Alternator Output Voltage Test and Alternator Amperage Output Test

1. Use a digital volt-ohmmeter (VOM) set on the 2-20VDC (or similar) scale to test the battery open circuit voltage (OCV). With the engine shut down and the voltmeter set up as shown in **Fig. 2**, check for voltage of 12.4 volts or more.

    If the OCV is 12.4 volts or more, turn on the vehicle headlights for approximately 3 minutes.

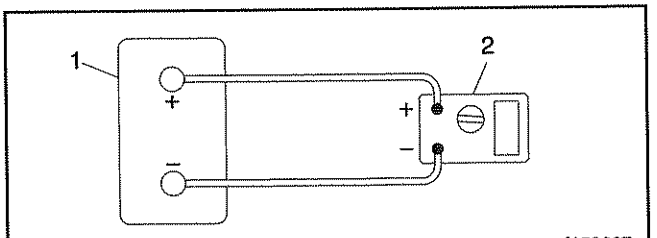
    If the OCV is less than 12.4 volts, charge the batteries properly. For instructions, see **Group 54**.

IMPORTANT: Be sure to disconnect the batteries or remove them from the vehicle before charging.

2. Check the alternator output without a load. See **Fig. 3**.

2.1 Start the engine and run it at 1500 rpm for 3 to 5 minutes to stabilize the system before proceeding to the next step.

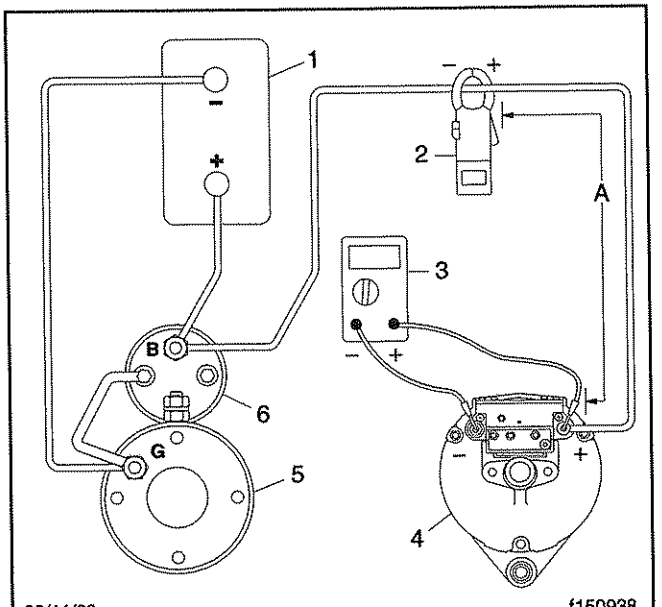
2.2 Connect the positive (+) lead of the digital voltmeter (still set on the 2-20VDC or similar scale) to the alternator (battery) terminal. Connect the negative (–) lead of the voltmeter to the alternator negative (–) ground terminal. See **Fig. 3.**



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1. Battery
2. Digital Voltmeter

Fig. 2, Setup 1: Battery Open Circuit Voltage (and alternator amperage output)



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A. Locate the ammeter at least 6 inches (15 cm) away from the alternator.

1. Battery
2. Ammeter
3. Digital Voltmeter
4. Alternator
5. Cranking Motor
6. Solenoid

Fig. 3, Setup 2: Alternator Output Test

2.3 If the voltmeter reads from 13.8 to 14.2 volts, record this reading (V1) and go to the next step. If the alternator reads less than 13.8 volts and is adjustable, try to adjust the voltage regulator to 13.8 to 14.2 volts. If unable to obtain acceptable output, replace the alternator.

3. Check the alternator output under load. See **Fig. 3.**

3.1 Attach a clamp-on induction ammeter around the positive (+) wire. See **Fig. 3.**

NOTE: Locate the ammeter at least 6 inches (15 cm) away from the alternator.

3.2 With the engine still running at 1500 rpm, turn on the following electrical accessories to load the alternator until the ammeter reads 60 to 75 amps.

- Both front and rear heater blowers (on HIGH)
- Headlights (high beams)
- Road lights
- Interior lights

NOTE: As an alternate method of putting load on the alternator, connect a carbon pile tester and set it to 60 to 75 amps.

3.3 Keep the voltmeter connected as in the previous step; positive (+) lead connected to the alternator positive (+) terminal; negative (–) lead connected to the alternator negative (–) terminal.

3.4 If the voltmeter reads from 13.6 to 14.2 volts, record this reading (V2) and go to the next step.

If the voltmeter reads less than 13.6 volts, replace the alternator.

4. Perform an alternator amperage output test.

4.1 Connect a carbon pile tester across the vehicle batteries as shown in **Fig. 2.**

NOTE: **Figure 2** shows a voltmeter, but the connections for the carbon pile tester are the same.

4.2 Attach a clamp-on induction ammeter around the alternator output wire. See **Fig. 3.**

Troubleshooting

NOTE: Locate the ammeter at least 6 inches (15 cm) away from the alternator.

4.3 Start the engine and make sure all vehicle electrical accessories are turned off. Run it at fast speed and adjust the tester to the alternator maximum current output. Record this output value.

NOTE: Ensure that the alternator is turning at maximum available rpms and keep adjusting the tester dial until the ammeter reads its highest value.

4.4 Turn off the tester and shut down the engine.

4.5 If the output value recorded is less than 85 percent of the rated amperage output, repeat the test. If the output value recorded is still less than 85 percent of the rated amperage output, replace the alternator.

4.6 Make sure that all test instruments are removed and that the vehicle wiring is returned to its operational state.

5. To identify other problem areas within the vehicle, check the operation of the charging system. Set up the voltmeter as shown in **Fig. 2** and **Fig. 3**.

NOTE: For any load at 1500 rpm or more, battery voltage must be within 0.5 volts of the alternator voltage.

5.1 If readings at the batteries are within 0.5 volts of the readings at the alternator, the charging system is working correctly. Check other areas of the vehicle to locate the problem.

5.2 If the reading at the batteries is more than 0.5 volts lower than the reading at the alternator, do the next step.

6. Check charging system connections, cables and terminals.

6.1 Check all connections between the battery, starter and alternator for tightness and signs of corrosion. Tighten and clean as necessary.

6.2 Check all cables for breaks or partial breaks. Repair or replace as necessary.

6.3 Check each ring terminal for breakage at the point where it attaches to its wire or cable.

Specifications

Description	Torque N·m (lbf·ft)	Torque N·cm (lbf·in)
Alternator Mounting Bolts	41 (30)	—
Battery Terminal Nut	—	840 (75)
Ground Terminal Nut	—	840 (75)
Harness Hold-Down Nut	—	840 (75)
Field Terminal Nuts	—	280 (25)

Table 1, Fastener Torques

Alternator, Lestek Brute

15.09

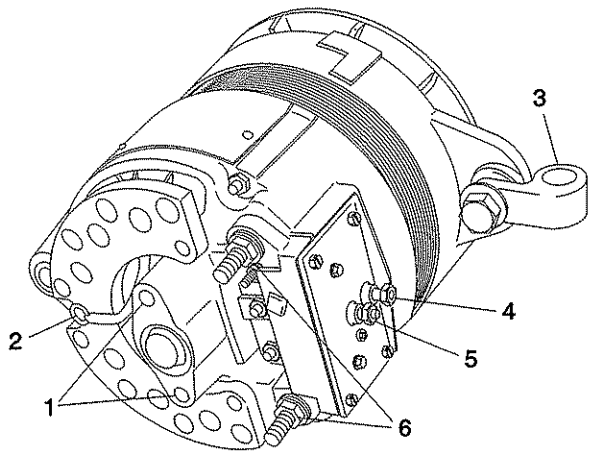
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General Information

The Lestek alternator is an electromechanical device that converts mechanical force from the engine crankshaft or accessory drive, into pulsed DC electrical energy. See **Fig. 1**. A multi-poled magnet, referred to as a rotor, is spun inside a multiphased coil called a stator, that induces AC current flow in the stator coils. This AC current is then rectified using positive and negative diodes, producing a pulsed DC output which can then be used to drive electrical devices, motors, lights, etc., and charge the system batteries.

The Lestek Brute 190 alternator is rated for 150 amps at engine idle and the Lestek Brute 200 is rated at 140 at engine idle. They contain a patented hand-wound Dual Delta stator. Eighteen 50-amp press-fit diodes combine for a 450-amp rectifier manufactured of high grade milled aluminum. The rotors utilize special high-flux density coils that are precision balanced for long bearing life. They use an SAE standard J180 mount, and an external regulator.



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1. Optional Negative Ground
2. Negative Ground
3. End Link
4. Field to Regulator
5. Ground to Regulator
6. Positive Terminals

Fig. 1, Lestek Brute 190 (and 200) Alternator

Alternator Removal and Installation

Removal

1. Park the vehicle on a level surface and apply the parking brake. Shut down the engine. Chock the rear tires.
2. Tilt the hood.

⚠ WARNING

Before disconnecting the batteries, read the instructions and Danger and Warning notices in Section 54.02. Keep sparks, flames, burning cigarettes, etc. away from batteries. Batteries generate explosive gases, which could cause a battery to explode, causing serious personal injury, including blindness.

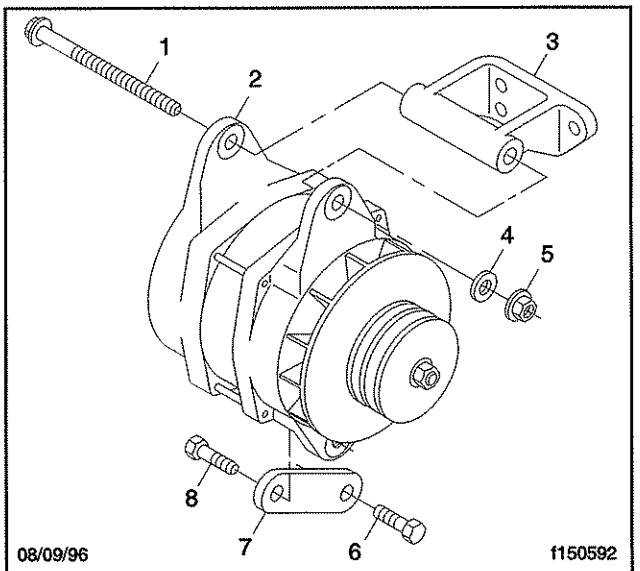
3. Disconnect the batteries.
4. Mark all electrical leads and disconnect them from the alternator.
5. Remove the drive belts and note the routing. For instructions, see **Section 01.00**.
6. Remove the alternator. See **Fig. 1**.
   - 6.1 Remove the alternator mounting capscrew (Ref. 8) from the link (Ref. 7).
   - 6.2 Remove the nut and washer (Refs. 5 and 4) from the pivot bolt (Ref. 1).
   - 6.3 Securely hold the alternator to prevent it from falling, and remove the pivot bolt.
   - 6.4 Remove the alternator from the vehicle.
7. Inspect the drive belts. For instructions, see **Section 01.00**.

Installation

1. Install a new pulley, if applicable, and tighten the shaft nut to 75 lbf·ft (102 N·m).
2. Install the alternator on the pivot bracket. See **Fig. 1**.
   - 2.1 Position the alternator on the bracket.
   - 2.2 Insert the pivot bolt (Ref. 1) through the alternator and the bracket.
   - 2.3 Install the washer and nut (Refs. 4 and 5) on the end of the pivot bolt.
3. Check the torque of the alternator bracket fasteners. If necessary, tighten, see **Specifications 400**.
4. Install the alternator mounting capscrew, and tighten it 65 lbf·ft (88 N·m). Tighten the pivot nut 65 lbf·ft (88 N·m).
5. Install the drive belt on the pulley as removed. For instructions, see **Section 01.00**.

NOTE: The belt tensioner automatically adjusts the drive belt to the correct tension. If the belt slips, repair or replace the tensioner. For instructions, see the engine manufacturer's service literature.

6. Connect all leads to the back of the alternator as previously marked and tighten. See **Specifications 400**.



1. Pivot Capscrew
2. Mounting Lug
3. Pivot Bracket
4. Washer
5. Pivot Nut
6. Alternator Link Fastener
7. Alternator Link
8. Alternator Mounting Capscrew

Fig. 1, Mounting Hardware (Cummins engine mounting shown)

Alternator Removal and Installation

7. Spray any exposed terminal connectors with dielectric red enamel. See **Table 1** for approved brands.

Protectant Material	Approved Brand
Dielectric Red Enamel Spray	MMM 1602 IVI–Spray Sealer, Red Electric Grade (Spray-On B–6–665)

Table 1, Approved Dielectric Red Enamel

8. Connect the batteries.
9. Before returning the vehicle to operation, test the alternator DC output voltage. For instructions, see "Alternator Voltage Output Test" in **Section 15.09, Troubleshooting 300.**
10. Lower the hood.
11. Remove the tire chocks.

Troubleshooting

Many alternators have been replaced that later investigation reveals were working properly. This may be due to incorrectly diagnosing the problem.

IMPORTANT: Before testing, make sure:

- All belts are correctly tightened;
- The wiring and terminals are clean and in good condition;
- All terminal nuts are torqued and properly protected.

Delco Remy has an alternator testing tool called the Intelli-Check Alternator Analyzer. See **Fig. 1**. This tool (DR 10457848, a single tester, or DR 10457865, a four-pack of testers) is to be used as a quick check of the alternator to see if it is working correctly.

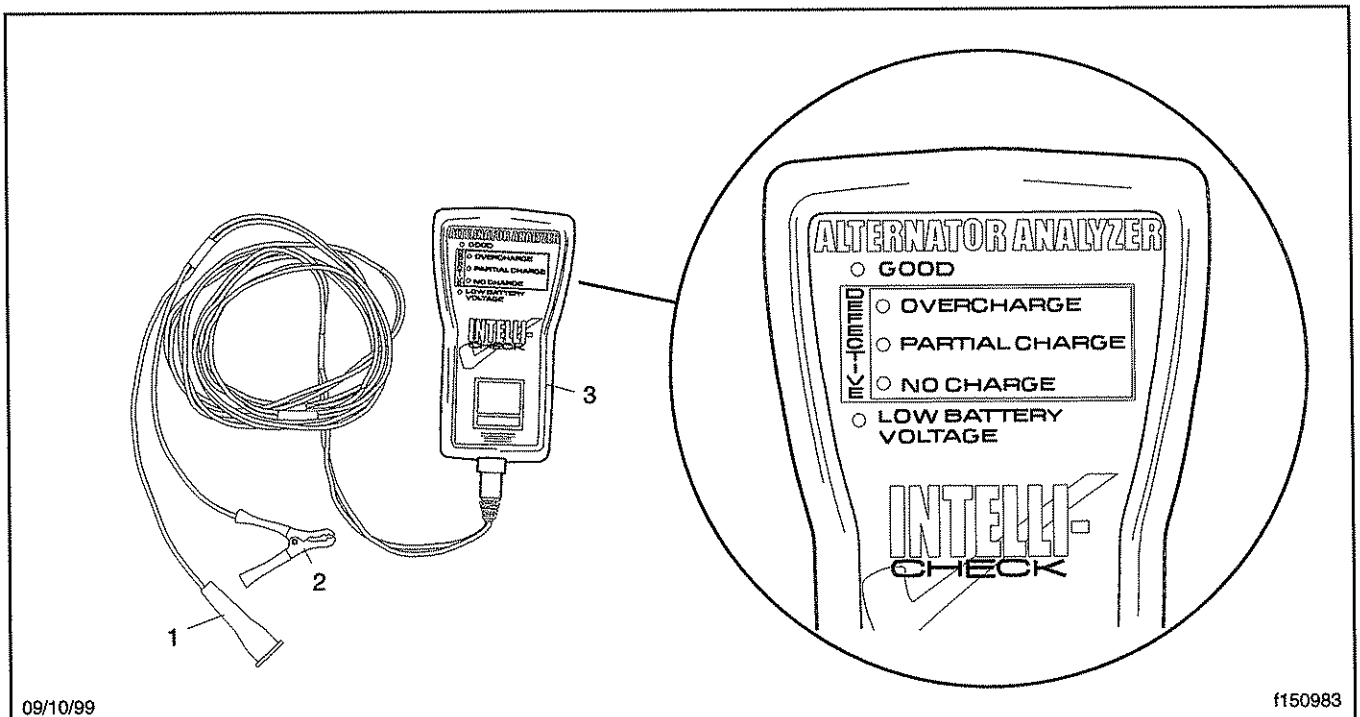
NOTE: If you do not have the Delco Intelli-Check Tester, or if the alternator rated output is above 145 amps, or if a total vehicle charging system analysis is required, see "Alternator/Charging System Testing."

Intelli-Check Alternator Analyzer

The following information includes a pre-test procedure and operating instructions for the Delco Intelli-Check Tester, and is similar to the procedures provided by Delco with the Intelli-Check Tester.

Pre-Test Procedure (Engine Off)

1. Inspect the alternator connections to verify that all terminals are secured and tight. Verify that the sense wire is connected to the sense terminal on vehicles equipped with remote-sense alternators.
2. With the engine off, connect the red alligator clip to the output terminal of the alternator. Connect the black alligator clip to the alternator ground. An optional ground connection is to the body of the alternator. The tester LEDs will illuminate and then go off as it performs a self-test.



1. Red Alligator Clip
2. Black Alligator Clip
3. Hand-Held Alternator Analyzer

Fig. 1, Delco Remy Intelli-Check Alternator Analyzer

Troubleshooting

3. After 4 seconds the tester will activate. The following LEDs may illuminate depending on the condition of the batteries:
    - **GOOD** (green) LED indicates the battery voltage is above 12.8 and has a surface charge. The surface charge must be removed before proceeding with the alternator test. To remove the surface charge, do the following:
        A. Turn on the headlights and blower motor for 2 minutes without restarting the engine.
        B. Reset the tester by disconnecting, then reconnecting the tester alligator clips. The analyzer will again perform its self-test.
        C. Repeat the applicable steps of the Pre-Test Procedure.
    - **NO CHARGE** (red) LED indicates the battery voltage is below 12.8. This LED should illuminate for most tests. Proceed with the alternator test.
    - **LOW BATTERY VOLTAGE** (blue) LED indicates the battery voltage is below 12.35. If the batteries will start the vehicle, proceed with the alternator test. However, after completing the Intelli-Check alternator test, perform the procedures under "Alternator/Charging System Testing" to determine the condition of the rest of the charging system.

Tester Operating Instructions (Engine Running)

1. Start the engine using onboard batteries only. If the batteries will not start the engine, they must be charged for 2 hours. Start the test again after charging the batteries.
2. Verify the engine is at idle and all electrical loads are off.
3. Depress the accelerator to governed speed, hold for 10 seconds, then return to idle.
    - If the **GOOD** (green) LED illuminates, proceed to the next step.
    - If any LEDs illuminate indicating overcharge, partial charge or no charge (the three red lights in the **DEFECTIVE** section), replace the alternator and run the complete test again.
    - If the **LOW BATTERY VOLTAGE** (blue) LED illuminates, evaluate the charging system using the instructions in "Alternator/Charging System Testing."
4. With the engine running, turn on all electrical loads.
5. Depress the accelerator to governed speed, hold for 10 seconds, then return to idle.
6. If the **GOOD** (green) LED illuminates, the alternator is OK and the test is complete.

NOTE: If the alternator tests OK in the above tests, and the customer's complaint is reduced battery or headlight life, see "Alternator/Charging System Testing" to completely analyze the charging system.

7. If any LEDs illuminate indicating overcharge, partial charge or no charge (the three red lights in the **DEFECTIVE** section), replace the alternator and run the complete test again.
8. If the **LOW BATTERY VOLTAGE** (blue) LED illuminates, evaluate the charging system using the instructions in "Alternator/Charging System Testing".

Alternator/Charging System Testing

Battery Open Circuit Voltage Test, Alternator Output Voltage Test and Alternator Amperage Output Test

1. Use a digital volt-ohmmeter (VOM) set on the 2-20VDC (or similar) scale to test the battery open circuit voltage (OCV). With the engine shut down and the voltmeter set up as shown in **Fig. 2**, check for voltage of 12.4 volts or more.

    If the OCV is 12.4 volts or more, turn on the vehicle headlights for approximately 3 minutes.

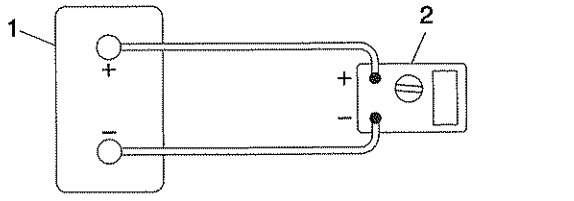
    If the OCV is less than 12.4 volts, charge the batteries properly. For instructions, see **Group 54**.

IMPORTANT: Be sure to disconnect the batteries or remove them from the vehicle before charging.

2. Check the alternator output without a load. See **Fig. 3**.

2.1 Start the engine and run it at 1500 rpm for 3 to 5 minutes to stabilize the system before proceeding to the next step.

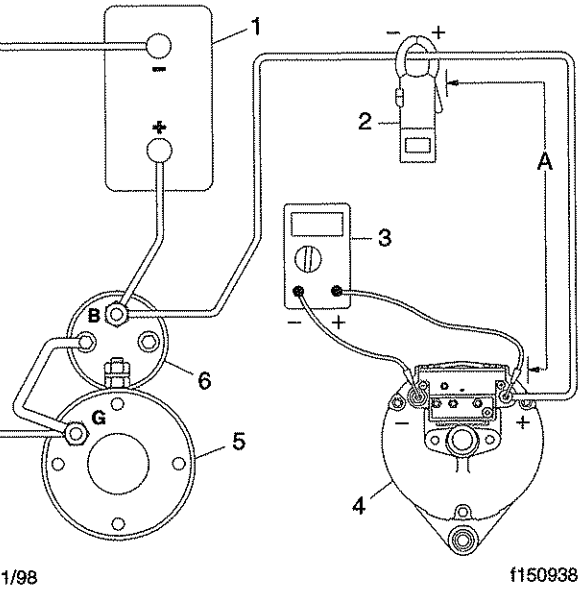
2.2 Connect the positive (+) lead of the digital voltmeter (still set on the 2-20VDC or similar scale) to the alternator (battery) terminal. Connect the negative (–) lead of the voltmeter to the alternator negative (–) ground terminal. See **Fig. 3.**



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1. Battery
2. Digital Voltmeter

Fig. 2, Setup 1: Battery Open Circuit Voltage (and alternator amperage output)



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A. Locate the ammeter at least 6 inches (15 cm) away from the alternator.

1. Battery
2. Ammeter
3. Digital Voltmeter
4. Alternator
5. Cranking Motor
6. Solenoid

Fig. 3, Setup 2: Alternator Output Test

2.3 If the voltmeter reads from 13.8 to 14.2 volts, record this reading (V1) and go to the next step. If the alternator reads less than 13.8 volts and is adjustable, try to adjust the voltage regulator to 13.8 to 14.2 volts. If unable to obtain acceptable output, replace the alternator.

3. Check the alternator output under load. See **Fig. 3.**

3.1 Attach a clamp-on induction ammeter around the positive (+) wire. See **Fig. 3.**

NOTE: Locate the ammeter at least 6 inches (15 cm) away from the alternator.

3.2 With the engine still running at 1500 rpm, turn on the following electrical accessories to load the alternator until the ammeter reads 60 to 75 amps.

- Both front and rear heater blowers (on HIGH)
- Headlights (high beams)
- Road lights
- Interior lights

NOTE: As an alternate method of putting load on the alternator, connect a carbon pile tester and set it to 60 to 75 amps.

3.3 Keep the voltmeter connected as in the previous step; positive (+) lead connected to the alternator positive (+) terminal; negative (–) lead connected to the alternator negative (–) terminal.

3.4 If the voltmeter reads from 13.6 to 14.2 volts, record this reading (V2) and go to the next step.

If the voltmeter reads less than 13.6 volts, replace the alternator.

4. Perform an alternator amperage output test.

4.1 Connect a carbon pile tester across the vehicle batteries as shown in **Fig. 2.**

NOTE: **Figure 2** shows a voltmeter, but the connections for the carbon pile tester are the same.

4.2 Attach a clamp-on induction ammeter around the alternator output wire. See **Fig. 3.**

Troubleshooting

NOTE: Locate the ammeter at least 6 inches (15 cm) away from the alternator.

4.3 Start the engine and make sure all vehicle electrical accessories are turned off. Run it at fast speed and adjust the tester to the alternator maximum current output. Record this output value.

NOTE: Ensure that the alternator is turning at maximum available rpms and keep adjusting the tester dial until the ammeter reads its highest value.

4.4 Turn off the tester and shut down the engine.

4.5 If the output value recorded is less than 85 percent of the rated amperage output, repeat the test. If the output value recorded is still less than 85 percent of the rated amperage output, replace the alternator.

4.6 Make sure that all test instruments are removed and that the vehicle wiring is returned to its operational state.

5. To identify other problem areas within the vehicle, check the operation of the charging system. Set up the voltmeter as shown in **Fig. 2** and **Fig. 3**.

NOTE: For any load at 1500 rpm or more, battery voltage must be within 0.5 volts of the alternator voltage.

5.1 If readings at the batteries are within 0.5 volts of the readings at the alternator, the charging system is working correctly. Check other areas of the vehicle to locate the problem.

5.2 If the reading at the batteries is more than 0.5 volts lower than the reading at the alternator, do the next step.

6. Check charging system connections, cables and terminals.

6.1 Check all connections between the battery, starter and alternator for tightness and signs of corrosion. Tighten and clean as necessary.

6.2 Check all cables for breaks or partial breaks. Repair or replace as necessary.

6.3 Check each ring terminal for breakage at the point where it attaches to its wire or cable.

Specifications

Mounting Fastener Torques, Caterpillar Engines			
Description	**Grade**	**Size**	**Torque: lbf·ft (N·m)**
End Link Mounting Capscrew	8PO	1/2–13	68 (92)
Alternator Mounting Capscrew	8PO	1/2–13	68 (92)
Adjusting Rod Mounting Capscrew	8PO	1/2–13	68 (92)
Adjusting Rod Jam Nut	5	5/8	95 (130)
Alternator Bracket Fasteners	5PO	3/8–16	34 (46)

Table 1, Mounting Fastener Torques, Caterpillar Engines

Mounting Fastener Torques			
Description	**Grade**	**Size**	**Torque: lbf·ft (N·m)**
Alternator Mounting Capscrews	8PO	1/2–13	65 (88)
Adjusting Strap Mounting Capscrew	8PO	1/2–13	65 (88)

Table 2, Mounting Fastener Torques, Cummins Engines

Terminal Fastener Torques			
Description	**Grade**	**Size**	**Torque: lbf·in (N·cm)**
Alternator Output ("BAT") Terminal Nut	5	5/16–18	100 (1140)
Alternator Ground ("G") Terminal Nut	5	1/4–20	65 (740)
Alternator Instrument ("I") Terminal Nut	8.8	#10, M4	20 (220)

Table 3, Terminal Fastener Torques

Pulley Nut Torque			
Description	**Grade**	**Size**	**Torque: lbf·ft (N·m)**
Pulley Nut	8PO	5/8	75 (102)

Table 4, Pulley Nut Torque