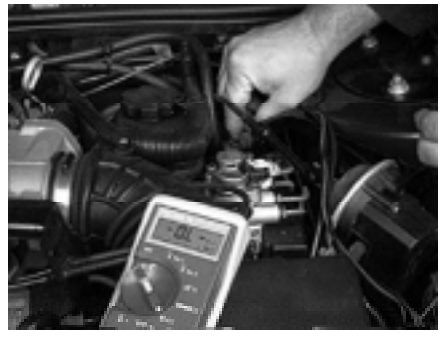
Uniform Procedures For Collision Repair

EL11–Troubleshooting

 v.2.3

1. Description

This procedure describes methods for troubleshooting electrical circuits and restoring normal operation. Inspection and evaluation requirements are also included.



2. Purpose

The purpose of this procedure is to provide industry-accepted requirements for performing electrical troubleshooting to assess damage and restore individual electrical circuits to their normal operating condition. This procedure is intended for use by professionals who are qualified through training and experience.

3. Referenced Documents

The following documents are considered part of this procedure by reference.

3.1 Procedures

EL01 Wire Repair
EL21 Self-Diagnostics
HM01 Hazardous Materials
LA31 Switches And Controls
PS01 Personnel Safety

3.2 Other Information

Equipment-specific information
Vehicle-specific repair information

4. Equipment And Material Requirements

4.1 Electrical Test Equipment

The following equipment is used in this procedure:

- ❑ fused jumper wires
- ❑ digital volt-ohmmeter (DVOM)
- ❑ volt-amp tester (VAT)
- ❑ battery load tester
- ❑ electro-static discharge (ESD) strap
- ❑ generic and vehicle-specific breakout boxes and test harnesses

5. Damage Analysis

5.1 Visual Inspection

Look for visible damage to these parts:

- ❑ battery
- ❑ alternator or generator
- ❑ starter
- ❑ starter solenoid
- ❑ belts
- ❑ wiring harnesses and connectors
- ❑ switches
- ❑ fuses, fusible links, and circuit breakers
- ❑ electrical parts, such as bulbs, sockets, motors, solenoids, relays, and sensors
- ❑ ground connections

See **LA31** for ignition switch replacement procedures.

Check electrical parts for these indicators of possible damage:

- ❑ blown fuses, fusible links, open circuit breakers
- ❑ burned or melted wiring and connectors
- ❑ crushed wiring harnesses
- ❑ wires with damaged insulation
- ❑ damaged connectors
- ❑ corroded terminals
- ❑ signs of previous damage or improper repairs
- ❑ improper warning lamp operation (see **EL21**)

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5. Damage Analysis (cont'd)

- ❏ improper continuity (short) between circuits
- ❏ failed voltage drop test
- ❏ loose connections
- ❏ moisture inside connectors

See **EL21** for troubleshooting circuits having self-diagnostic capability.

If possible, start the vehicle and perform a road-test. See **11.2**.

6. Personnel Safety

6.1 General Safety

General safety information is in **PS01**.

Before working around battery acid spills or leakage, clean the area with baking soda and water, followed by soap and water.

7. Environmental Safety

7.1 Battery Disposal

Properly dispose of used lead-acid batteries.

Hazardous material safety information is in **HM01**.

7.2 Mercury Disposal

Some switches, and certain electronic modules used in airbag systems, contain mercury. Follow the vehicle maker's recommendations for properly disposing of any part containing mercury.

8. Vehicle Protection

8.1 Electronic Parts

To protect computers and other sensitive electronic parts from damage during testing and repair:

- ❏ Follow the vehicle maker's recommendations for recording and resetting electronic memories.
- ❏ Disarm the passive restraint system, if working in the area of the airbag sensors, modules, or wiring. Follow the vehicle maker's recommendations.
- ❏ Do not repair airbag harness wiring, unless recommended by the vehicle maker.
- ❏ Protect computer modules, connectors, and wiring from dirt, heat, static electricity, and moisture. Use an ESD strap when handling computers and other sensitive parts.
- ❏ Loosen or remove any wiring harnesses or electrical parts that could be damaged during the repair process.
- ❏ Use a DVOM with at least a 10 megohm internal impedance.
- ❏ Avoid touching electrical terminals.
- ❏ Do not store computers and other sensitive electronic parts near electric welders or other high-energy electrical equipment.
- ❏ Do not test a computer module unless directed by a service manual procedure.
- ❏ Do not unpack a replacement module until it is to be installed on the vehicle.

9. Repair Procedure

9.1 Basic Troubleshooting Steps

To perform basic electrical troubleshooting and repair:

- ❏ 1. Define the problem as completely as possible. Operate all switches and loads that may be related to the non-working circuit. Isolate the problem or group of problems as much as possible.
- ❏ 2. Locate and trace the power source, fuses, switches, wires, connectors, and the circuit load on the problem circuit wiring diagram. See **9.2**. Use power and ground distribution diagrams to help isolate the problem to an individual circuit.

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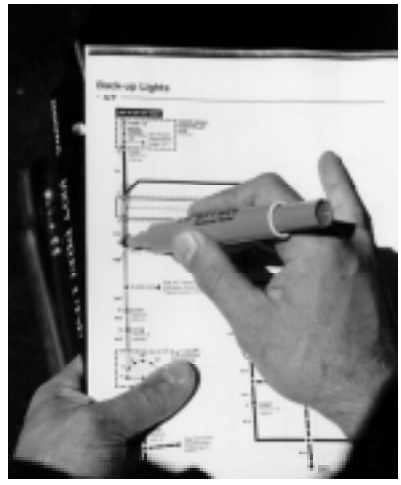
9. Repair Procedure (cont'd)

❑ 3. Find the cause of the problem by using test equipment and part locator diagrams to do systematic resistance, voltage, and current testing of the circuit power source, wiring and connectors, fuses, switches, and load. Use service manual procedures, flowcharts, service bulletins, or develop your own plan to find the circuit defect.
❑ 4. Repair or replace the wiring or electrical parts, as required, to restore normal circuit operation.
❑ 5. Test the circuit and related circuits for normal operation.

Note: A vehicle-specific test harness or breakout box may be required to perform electrical testing.

9.2 Wiring Diagrams



Use electrical wiring diagrams and highlight pens to trace the current path. To trace and understand the current path on a wiring diagram:

❑ 1. Read the circuit description section of the vehicle maker's service manual.
❑ 2. Identify where and how the circuit operating voltage is applied.
❑ 3. Determine the rating and type of circuit protection.
❑ 4. Locate the circuit control devices.
❑ 5. Locate the circuit loads.
❑ 6. Identify all wires on the current path and the wire colors.
❑ 7. Locate the circuit ground.

Use power and ground distribution diagrams to locate related circuits.

9.3 Resistance Testing

To test a wire or circuit part for proper resistance using a DVOM:

❑ 1. Turn the circuit power off.
❑ 2. Remove or isolate the wire or part to be measured.
❑ 3. Use a DVOM to measure the resistance of the wire or part. Do not short either end of the wire or part being measured to ground or another circuit.
❑ 4. Compare the reading to the specification for the wire or part.

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9. Repair Procedure (cont'd)

9.4 Measuring Voltage

To measure source voltage or voltage drop using a DVOM:

❑ 1. Check the test specifications and set the DVOM to the correct voltage range for the circuit location being measured.
❑ 2. Turn on power to the circuit.
❑ 3. Use the DVOM to read the voltage.
❑ 4. Compare the reading to the test specification.

9.5 Measuring Current

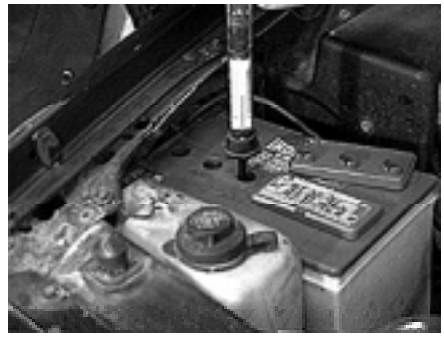
To measure circuit current with a DVOM:

❑ 1. Check the test specifications and set the DVOM to the correct amperage range for the circuit being measured.
❑ 2. Turn on power to the circuit.
❑ 3. Use the DVOM to read the current.
❑ 4. Compare the reading to the test specification.

Caution: To prevent equipment damage when making a series-type current reading, make sure that the normal current range of the circuit does not exceed the current rating of the DVOM. DVOM damage could result if an over-current condition exits.

9.6 Battery Testing

To test for proper battery operation:



❑ 1. Use a DVOM to perform a battery leakage test. If the meter reads voltage, use a baking soda and water solution to clean the top of the battery.
❑ 2. Use a hydrometer to perform a specific gravity test. If the corrected hydrometer reading is below 1.265, recharge or replace the battery, as required. This procedure should not be used on maintenance-free batteries.
❑ 3. Use a DVOM to measure the open-circuit (no load) terminal voltage. Batteries with voltage readings of less than 12.4 volts must be recharged or replaced, as required.
❑ 4. Use an ammeter to perform a battery drain test. If the current draw exceeds the vehicle maker's specifications, repair or replace the defective circuit.

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❑ 5. Use a battery load tester to perform a capacity test. If the temperature-corrected voltage is below the vehicle maker's specification, recharge or replace the battery, as required.

❑ 6. Use a DVOM to perform voltage-drop testing of the battery cables. If any voltage drop exceeds 0.2 volt, repair or replace the defective circuit.

9.7 Alternator Testing

To test for proper alternator operation:

❑ 1. Use a VAT to perform alternator voltage and current output tests. Alternators that do not meet the vehicle maker's voltage and current output specifications must be repaired or replaced, as required.

❑ 2. Use a VAT and jumper wires to perform an alternator full-field test. Alternators that cannot generate 90% of the vehicle maker's rated current and voltage output must be repaired or replaced, as required.

❑ 3. Use a DVOM to perform voltage-drop testing of the alternator wiring. If any voltage drop exceeds 0.1 volt, repair or replace the defective circuit.

❑ 4. Use a DVOM to check the alternator output for AC voltage ripple. If AC voltage exceeds 0.5 volt, repair or replace the alternator.

9.8 Starter Testing

To test for proper starter operation:

❑ 1. Use a VAT to do starter current-draw tests. Current draw is dependent on engine size. If the current is higher or lower than the vehicle maker's specifications range, repair or replace the starter, as required.

❑ 2. Use a DVOM to perform voltage-drop tests of the starter cables. If any voltage drop exceeds 0.2 volt, repair or replace the defective circuit.

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9. Repair Procedure (cont'd)

9.9 DC Motor Testing

To test for proper DC motor operation:

❏ 1. Use a DVOM to verify that the motor-control circuit maintains the proper voltage at the motor leads while the motor is under load. If not, use the DVOM to check the motor-control circuit for high resistance.
❏ 2. Disconnect the shaft from the load, if required.
❏ 3. Spin the motor shaft with no voltage applied, to check for binding.
❏ 4. Verify that the motor develops torque, in the proper direction, with 12-volts applied across the leads, or between each lead and ground. For bi-directional motors, reverse the voltage polarity and verify that the torque reverses.
❏ 5. If the motor runs too slowly, or develops insufficient torque, check the load for binding, and measure the field resistance between the leads. Verify that the field winding is not shorted internally to ground. Note: Some bi-directional motors have two windings, which may be connected to ground internally.
❏ 6. Compare the results to the vehicle maker's specifications or measurements from a similar motor.
❏ 7. Troubleshoot the motor-control circuit, and make any required repairs.
❏ 8. Replace the motor, if required.

10. Use Of Recycled (Salvage) Parts

10.1 Inspection Of Salvage Parts

Do not use salvage electrical parts having any of these defects:

❏ visible damage
❏ improper electrical measurements compared to the vehicle maker's specifications
❏ corrosion

Do not use salvage electrical parts from flood-damaged vehicles.

11. Inspection And Testing

11.1 Inspection After Electrical Testing And Repair

After electrical testing and repair, inspect the vehicle for these conditions:

- ❏ proper operation of all electrical circuits
- ❏ proper routing of electrical wiring
- ❏ proper installation of all mounting fasteners and retaining clips
- ❏ proper connection of all electrical connectors
- ❏ properly sealed wire splices
- ❏ no damaged insulation
- ❏ no corrosion on wiring or electrical parts
- ❏ electronic memories properly restored

Correct any defects.

11.2 Road-Test

Road-test the vehicle, following the vehicle maker's recommendations. Check for any of these conditions:

- ❏ improper operation of interior and exterior lamps
- ❏ improper operation of motors
- ❏ improper operation of accessory circuits
- ❏ improper operation of warning lamps
- ❏ driveability problems
- ❏ transmission shifting problems
- ❏ improper braking

Correct any defects.