Typical problems:
Most automotive electrical problems can be traced to a bad connection or a failed component. High resistance ground connections can be one of the most frustrating of electrical problems. They can produce bizarre symptoms that don’t seem to have anything to do with the cause, once you finally find it. The symptoms include lights that glow dimly, lights that come on when others should, gauges that change when the headlights are turned on, or lights that don’t come on at all. A failed alternator, a bad battery, or a blown fuse can all result in things just not working at all.

Task summary:
This booklet will help you diagnose and fix common electrical problems in your car. When troubleshooting electrical systems, it’s important to use a logical process of deductive reasoning to solve the problem. This process is most important since, unlike mechanical devices, you can’t see inside or dismantle the majority of electrical components to tell whether they’re functioning. We’ll start with the battery and charging circuit, then look at bad grounds and other electrical connections, then finish by checking for failed components.

Recommended tools:
You will need a DMM that measures DC volts, AC volts, resistance, and continuity. You will also need a current clamp accessory that measures DC current. As an alternative, use a clamp-on multimeter that combines all the above measurement capabilities. It is assumed you have basic knowledge of how to make electrical measurements and how to operate a DMM or clamp meter. If not, you should start by reading “Basic DMM Measurements” and your DMM or clamp meter owner’s manual.

Step by step troubleshooting:
1. Measuring Battery Voltage:
If your battery becomes discharged it will be unable to provide sufficient voltage or current to the starter, hence the engine won’t crank. The first step is to test the battery and charge it if necessary. Verify that the connections to the battery look clean and are tight. With the engine off, bleed the surface charge from the battery by turning on the headlights for a minute. Now with the lights off, set your DMM to the DC voltage function, 20 volt range, and measure the voltage across the battery terminals by touching the red probe tip to the “+” terminal and the black probe tip to the “−” terminal. (see figure 1) Use the chart below to determine the approximate percent charge on the battery. If the battery voltage reads low, the battery may be damaged or worn out, or the charging system is not working correctly. See below for how to verify the alternator is working. A more complete load test should be done to indicate battery performance under load and determine if the battery is damaged.

2. Verifying a Good Alternator:
To perform this test, the battery must be fully charged (see step 1). Run the engine at idle and verify that no-load voltage is 13.8 - 15.3 volts DC (check as in step 1). Next, load the alternator to rated output current by turning on as many accessories as possible (e.g. headlights, brake lights, heater fan, rear window defogger and lighter). Run the engine at a fast idle, about 2000 RPM. Check the output current of the alternator with a DC current clamp (see figure 2) to see if it is at or near the rated output current. Now check the alternator output voltage. (see figure 3) The alternator must maintain at least 12.6 volts DC output at rated alternator current output.

3. Checking Ripple Voltage:
The alternator generates AC voltage which is converted to DC voltage. The output of a properly functioning alternator will show a small amount of AC voltage called “ripple”. A good alternator should measure less than 0.5 volts AC ripple with the engine running and loads applied.

Run the engine at fast idle and turn on accessories to load the alternator. Measure the ripple voltage by switching your DMM to the AC voltage function, 2 volt range, and connecting the black lead to a good ground (such as the engine block) and the red lead to the “BAT” terminal on the back of the alternator (not at the battery). (see figure 4) A reading higher than 0.5 volts AC may indicate damaged alternator diodes.

To rule out the wiring as the source of the trouble, check all the wire connections between the alternator and the battery terminals. Refer to Step 5.
“Testing for Bad Connections” for details on performing a voltage drop test. A resulting voltage drop of 200 mV (0.2 V) or greater means that the wiring connectors need cleaning and tightening, or replacement.

If the wiring is OK, have the engine’s charging circuit serviced.

4. Testing for Circuit Integrity:
Electrical devices need good, solid connections in order to operate properly. This is particularly true in automobiles since the power source is a battery. Vibration, temperature extremes, and corrosion from salt and rain can cause good connections to go bad in your car. Loose connectors, build-up of rust and corrosion, broken wires, and damaged switches are all examples of bad connections.

If a device is not working properly, first check to make sure it is getting power. Set your DMM to the DC voltage function, 20 volt range. Connect the black lead to a good ground and probe with the red lead on the “+” input of the device. (Make sure the ignition switch is turned ON. Many accessories do not operate with the ignition turned off.) If the reading is zero, there is no power to the device. This could be an indication of a blown fuse.

To check for a blown fuse, first locate the fuse holder. This is usually a block about the size of a pack of cigarettes with a plastic cover located either under the dashboard or in the engine compartment. Remove the cover. Use the diagram on the cover to locate the fuse that supplies power to the accessory or device you are testing.

To test the fuse, set the DMM to the DC voltage function and connect the black lead to a good ground, then probe both sides of the fuse for 12 volts DC. (see figure 5) A good fuse will show 12 volts on both sides. A blown fuse will show 12 volts on one side only. If you cannot easily probe both sides of the fuse, as an alternative you can remove the fuse and check it for continuity. Set the DMM to the continuity function and probe one side with the black lead and the other side with the red lead. A good fuse will sound the continuity beeper and show almost zero ohms of resistance. A bad fuse will not sound the beeper and will show “OL” for resistance. Replace any blown fuse only with one of the same type and current rating.

5. Testing for Bad Connections:
A bad, or high resistance, ground connection robs some of the voltage needed by the device you want to run. If a device is not operating properly, check all the connections leading up to the device, and back to the battery. Suspect connections include terminal posts, crimp connectors, bulb sockets, switches, and even the wiring itself.

To check for a bad connection, you need to measure the voltage drop across the connection. The higher the voltage drop, the worse the connection. Current must be flowing for the meter to register the voltage drop found. Turn ON the device (and the ignition, if necessary). Set your multimeter to the DC voltage function, 3 volt range. Connect the red lead to the side of the connection nearer the battery positive (+) terminal and the black lead to the side nearer the battery negative (-) terminal or ground. (see figure 6)

If you find a higher voltage reading than indicated in the table above, you have a bad connection. Try cleaning the contacts by removing any rust or corrosion, scraping the metal or wires to expose clean metal, reseating the connectors, and securely tightening all screws or nuts. Any wiring or switches that show a high voltage drop should be replaced.

6. Testing Switch Operation:
Use the resistance or continuity function to find a bad switch. With power removed from the circuit, set your meter to measure resistance and probe both sides of the switch. Operate the switch and watch for a change on the meter display. If the display doesn’t change, the switch is defective.

7. Where to Go From Here:
With the help of the tips and techniques in this booklet, you should be able to troubleshoot most of the common electrical problems. If not, it may be time to replace the component completely. If you suspect a more serious problem, call a qualified certified automotive technician for help.

(continued on page 3)
Diagnosing common automotive electrical problems

figure 1

figure 2

figure 3

figure 4

figure 5

figure 6

Diagnosing common automotive electrical problems

- figure 1: A multimeter connected to a battery and a fuse.
- figure 2: A multimeter with a clamp probe.
- figure 3: A multimeter with a test lead connected to a light bulb.
- figure 4: A multimeter measuring voltage across a resistor.
- figure 5: A multimeter with a test lead connected to a solenoid.
- figure 6: A multimeter with a test lead connected to a relay.