Electrical Troubleshooting

Follow all safety rules when working around electricity. Electrocution burns, and physical injury can result from not being careful enough.

Troubleshooting skills apply to many occupations. Automotive, appliance repair, construction electrician, and industrial maintenance electrician are just a few examples.

Most electrical problems fall into one of three categories;

1. Opens – No electrical connection
2. Shorts – Unwanted connections
3. High or Low Resistance – Abnormal values

An open is a complete break in a system or component increasing circuit resistance. This will reduce total circuit current. A short is the opposite of an open and will reduce resistance and increase current. Usually they are caused by bad or broken insulation. They can often occur in components with windings. An ohmmeter connected across a short will read lower than normal resistance. A short may cause a device to operate despite being turned off. A short will typically show up with a blown fuse or circuit breaker.

High or low resistance is often more difficult to diagnose as it is only partial. With a higher than normal resistance a motor may run slowly or a bulb may burn dimly.

Circuit testing may involve using meters, jumpers, or test lights. Jumpers are good for testing non-resistive devices like switches, solenoids, wires, and relays. A test light is often the fastest way to check for power. A multimeter or VOM (voltmeter, ohmmeter, and ammeter) is usually connected across or in parallel with the component. Readings can be compared to manufacturer’s specs to see if there is a problem. An ammeter will be connected in series with the device and you must make sure it is set to a high enough value. (Many newer meters have an auto-range function) An inductive or clip-on (clump-on) ammeter is faster to use as it clamps around the wire and measures the magnetic field. (No need to disconnect the wire)

Troubleshooting tips;

1. Observe the symptoms (What is working right and what is not)
2. Use all your senses (Touch, smell, look) (OK maybe not taste)
3. Isolate the problem (Narrow it down)
4. Test the circuit (Use the meter)
5. Make the repair
6. Verify the repair (Use the meter)

Refer to the service manual when troubleshooting a piece of equipment. You will find the theory of operation, wiring diagrams, wire color codes, part numbers, specifications and parts list.

Disconnected wires and loose or corroded connections are often the cause of electrical problems. You can move the wires around a bit to try to get the circuit working again. If you move a wire and it affects circuit operation you have found the source of the problem. Vibration or contraction and expansion can cause a problem with a connection. A voltage drop across a connection indicates a problem. A wire can be disconnected and the resistance can be measured with an ohmmeter. Wire resistance depends on the gauge and length (also temperature, etc.) of the wire.

If a newly replaced fuse blows or a circuit breaker trips again after being reset a circuit problem exists. A short circuit will cause the overcurrent device to blow immediately but an overload may cause it to blow after a short period of time. A voltmeter is a good way to check a fuse. If it is good it will have voltage on both sides when tested to ground. There should be no voltage across a good fuse. If it is blown it will have no voltage to ground on the circuit side. If you remove the fuse and test it with an ohmmeter it should have almost no resistance if it is good and infinite resistance if it is bad. Circuit breakers and fuses can weaken with age. An ammeter will tell you if the breaker or fuse is tripping at less than the rated current. Look for burns or marks on the wires and terminals. You may be able to isolate (disconnect) parts of the circuit until the problem goes away so you can narrow the problem down to a smaller area. Always replace a fuse or circuit breaker with one of the same current and voltage rating.

A failed resistor will typically overheat, short, and burn open. To test a resistor it will likely require removing it from the circuit. (Other components may affect the reading) The resistance reading should be compared to the specifications. A variable resistor can develop shorted or dead spots where it touches the windings. A good reading should be a gradual change in resistance value throughout the range and match the specs.

Switches are subject to mechanical wear and burned contacts. A bad switch will typically burn open. (Infinite resistance when on) Voltage drop measured across a switch should read circuit voltage if open and almost no drop if closed. If a closed switch shows a significant voltage drop there is a problem. If the power is removed from the circuit an ohmmeter can be used to test the switch. With the switch open the resistance reading should be infinity and closed it should read zero or very close. All poles of a multi-pole switch must be checked for proper operation.

Windings in coils, motors, transformers, etc. are prone to shorts and opens as they are made from a very fine wire. Typically they should have a very low ohm reading. Infinite resistance indicates an open in the winding and zero ohms indicates a short. Relays can have pitted, burned, or worn contacts creating a high resistance point in the circuit.
When testing a capacitor with an ohmmeter the reading should show low ohms at first then move to high ohms as the capacitor fills with an electric charge. If you want to test again you must switch the leads so it will charge in the opposite direction. If there is an “open” in the capacitor it will show high ohms. If there is a “short” in the capacitor it will show low ohms. After testing you should use a resistor to discharge the capacitor. Large capacitors typically have a discharge capacitor in the circuitry.

Motor problems are often caused by dry worn bearings. This causes the motor to work too hard and overheat. Motor brushes can also wear developing opens or shorts. Excessive sparking can also occur if the brushes are not properly seated or have too little tension. Brushes should be replaced at about ¼ of their original length. Testing of bearings can be done with temperature or vibration measuring devices. Motor windings can be tested with an ohmmeter (Out of service) or with an ammeter. (In service) Many single-phase motors have an end switch that removes windings or capacitors from the circuit at 75% of rated speed. The contacts in the end switch are often the source of motor problems. If they are slightly pitted they can often be sanded with a fine emery cloth or special material. If they are burned too badly they will need to be replaced.