

Electrical Troubleshooting



⚠ DANGER

Before using a voltmeter on electrical components, do the following:

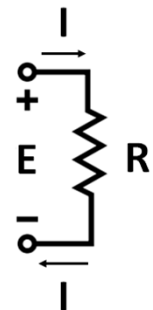
- Conduct a hazard assessment and follow approved safe work practices.
- Wear appropriate protective clothing and equipment.
- Use insulated gloves, tools, blankets, and barriers if required.

For more information, refer to the HOLT CAT Electrical Safety Policy and Procedures or your Company's Safety Policy.

Ohm's Law Fundamentals



E, I, and R, the parameters of Ohm's law.



E (Volts) = Electromotive Force. The potential difference measured across the conductor in units of volts.

I (Amperage) = Intensity. The current through the conductor in units of amperes.

R (Ohm) = Resistance. The resistance of the load in units of ohms.

Electrical Troubleshooting



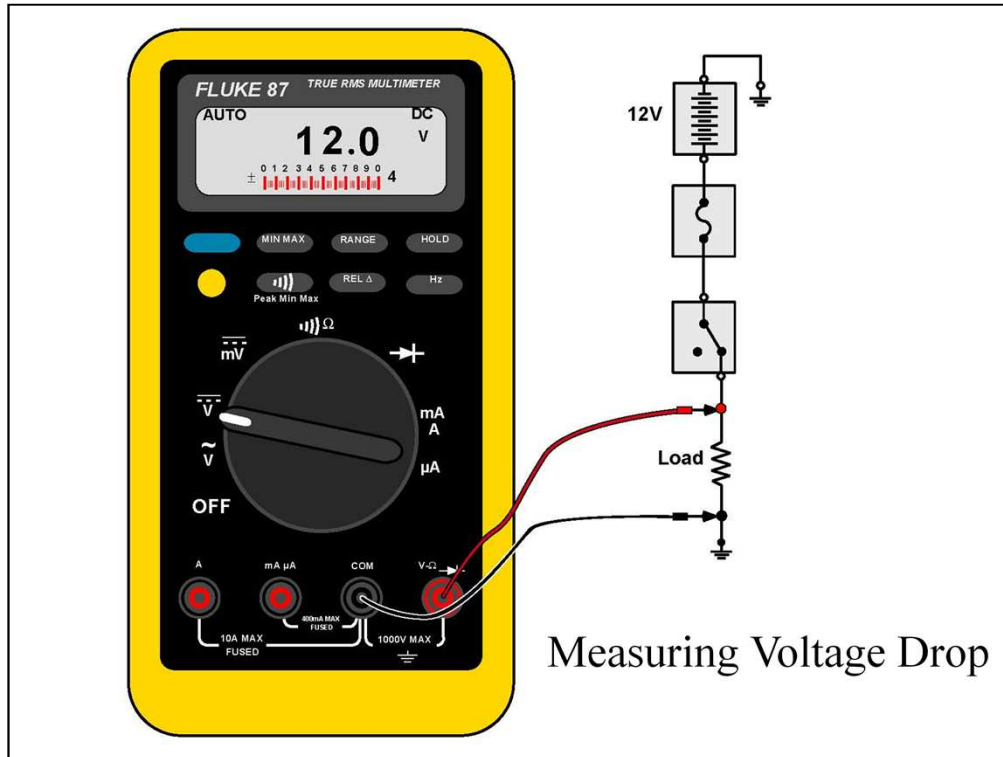
When using the multimeter to make voltage measurements it is important to remember that the voltmeter must always be connected in parallel with the load or circuit under test. The accuracy of the multimeter is approximately $\pm 0.01\%$ in the five ac/dc voltage ranges with an input impedance of approximately $10\text{ M}\Omega$ when connected in parallel.

To measure voltage perform the following tasks:

- Make sure the circuit is turned ON.
- Place the black meter lead in the COM input port on the meter and the red lead in the VOLT/OHM input port.
- Place the rotary switch in the desired position AC or DC.
- Place the black meter lead in the on the low side or the ground side of the component or circuit being measured.
- Place the red meter lead in the on the high side or the positive side of the component or circuit being measured.

NOTE: The **Fluke 87** illustrated in these pages is used with permission from the Fluke Corporation.

Electrical Troubleshooting



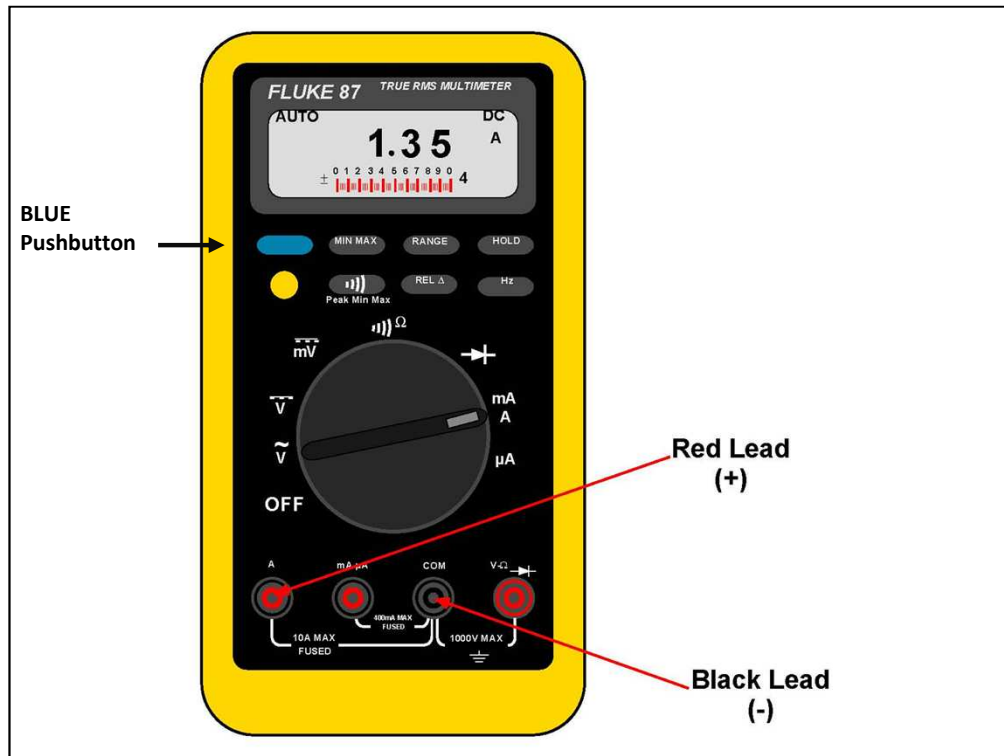
Measuring Voltage Drop

Observe the circuit above. The test leads are connected in parallel across the circuit load. With a 12 volt power source connected to the load, the meter should read a voltage drop equal to the source voltage or 12 volts.

If the meter reads a voltage drop less than 12 volts, it would indicate that an unwanted resistance was present in the circuit. A logical process would be to measure the voltage drop across the closed switch contacts. If a voltage reading was present it would indicate that the switch contacts were corroded, requiring the switch to be replaced.

The digital multimeter is a high impedance meter. This means the meter will not significantly increase the current flow in the circuit being measured. Voltage measurements should always be made with the circuit under power. The digital multimeter is ideal for use in circuits controlled by solid state devices such as, electronic components and computers.

Electrical Troubleshooting

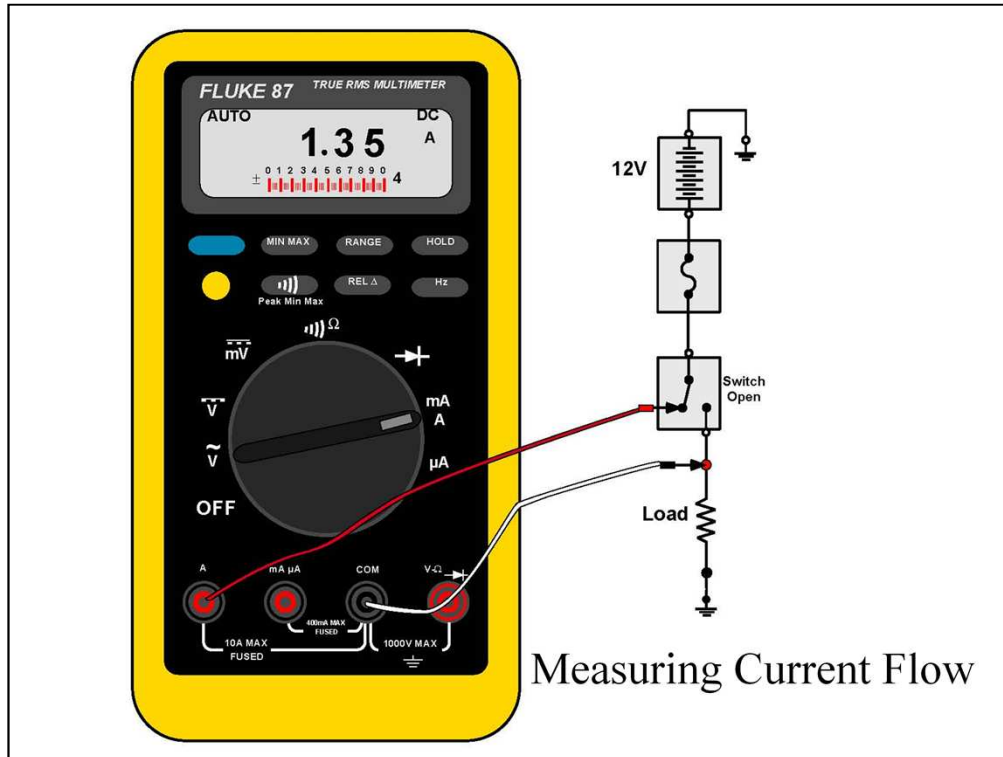


When using the multimeter to make current measurements it is necessary that the meter probes must be connected in **SERIES** with the load or circuit under test. To toggle between alternating and direct current measurements, use the **BLUE** pushbutton.

When measuring current, the meter's internal shunt resistors develop a voltage across the meter's terminals called "burden voltage." The burden voltage is very low, but could possibly affect precision measurements. When measuring current flow, the Fluke 87 multimeter is designed with low resistance to not affect the current flow in the circuit. When measuring current in a circuit, always start with the red lead of the multimeter in the Amp input (10 A fused) of the meter. Only move the red lead into the mA/μA input after you have determined the current is below the mA/μA input maximum current rating (400 mA).

The meter has a "buffer" which allows it to momentarily measure current flows higher than 10A. This buffer is designed to handle the "surge" current when a circuit is first turned on. As stated earlier, the meter is capable of reading 20 amps for a period not to exceed 30 seconds.

Electrical Troubleshooting



Measuring Current Flow

To measure current, perform the following tasks:

- Place the black multimeter input lead in the COM port and the red input lead in the A (amp) port.
- Create an open in the circuit, preferably by "pulling" the fuse, or by "opening" the switch.
- Place the leads in SERIES with the circuit, so that the circuit amperage is flowing through the meter.
- Apply power to the circuit.

Caution: If the current flow exceeds the rating of the fuse in the meter, the fuse will "open."

Electrical Troubleshooting

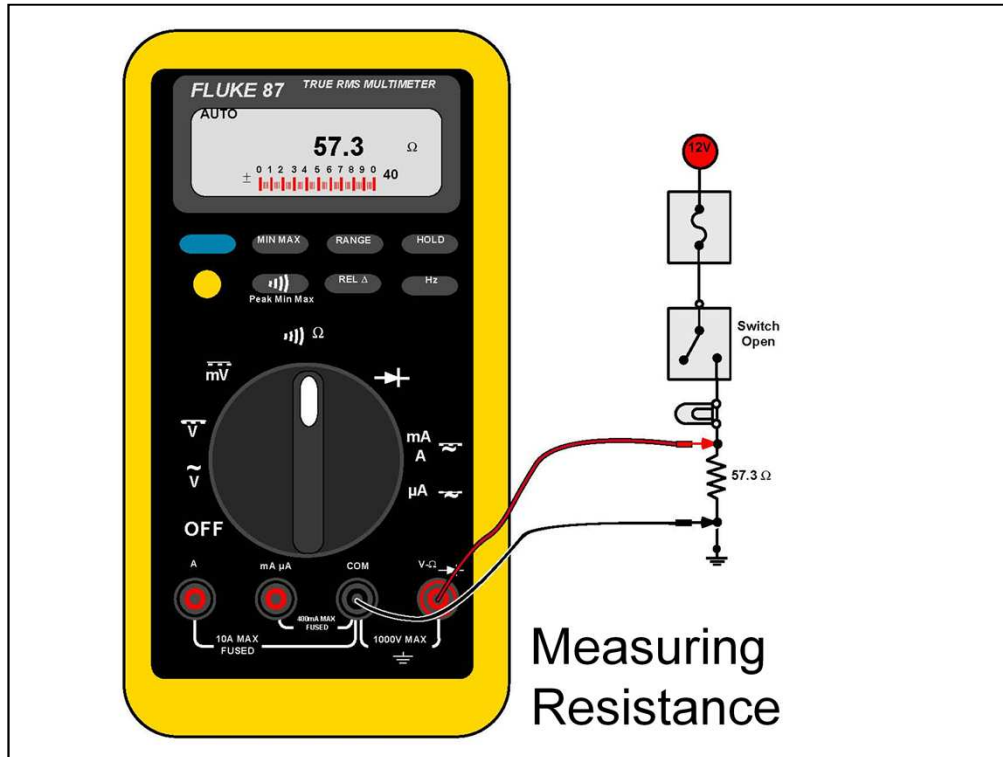


Measuring Resistance

When using the multimeter to make resistance measurements it is necessary to turn off the circuit power and discharge all capacitors before attempting in-circuit measurements. If an external voltage is present across the component being tested, it will be impossible to record an accurate measurement. The digital multimeter measures resistance by passing a known current through the external circuit or component and measures the respective voltage drop. The meter then internally calculates the resistance using the Ohm's Law equation $R = E/I$. It is important to remember, the resistance displayed by the meter is the total resistance through all possible paths between the two meter probes.

To accurately measure most circuits or components it is therefore necessary to isolate the circuit or component from other paths. Additionally, the resistance of the test leads can affect the accuracy when the meter is in its lowest (400 ohm) range. The expected error is approximately 0.1 to 0.2 ohms for a standard pair of test leads. To determine the actual error, short the test leads together and read the value displayed on the meter. Use the (REL) mode on the digital multimeter to automatically subtract the lead resistance from the actual measurements.

Electrical Troubleshooting



Measuring Resistance

To accurately measure resistance, perform the following tasks:

- Make sure the circuit or component power is turned OFF.
- Place the red lead in the jack marked Volt/Ohms and the black lead in the jack marked COM.
- Place the rotary selector in the Ω position.
- Place the meter leads ACROSS the component or circuit being measured.

IMPORTANT: It is important that your fingers are not touching the tips of the meter leads when performing resistance measurements. Internal body resistance can affect the measurement

NOTE: In the circuit shown, the power source is isolated from the circuit by "opening" the switch. It also, isolates the resistor from any other path that may affect the accuracy of the measurement.

Electrical Troubleshooting



Measuring Equipment

This picture shows the equipment and test leads often used to perform effective troubleshooting.

Want to Learn More?

HOLT ProTech offers a **Fundamentals of Electricity (TG01)** and an **Electronic Troubleshooting (DE205)** course where attendees learn how to troubleshoot electronics effectively and reduce the time needed to troubleshoot by half-the-time. Find out more at www.HoltProTech.com today.