Introduction to Electronics

LaACES, Lecture 02.01

Electric Potential

1 volt = 1 joule of energy per coulomb of charge

Some examples:

- flashlight battery – 1.5 V (DC)
- car battery – 12 V (DC)
- wall socket – 120 V (AC)
- overhead power lines – 6,000 to 250,000 V (AC)

Electric Current

1 ampere = movement of 1 coulomb of charge per time interval of 1 second

Some examples:

- Flashlight – 300 milliamps (DC)
- Toaster – 10 amperes (AC)
- Automobile starter – 150 amperes (DC)
- Quartz wristwatch – a few microamps (10^{-6} ampere)
- Enough to "shock" – a few milliamps (10^{-3} ampere)

Electric Resistance

1 ohm (Ω) of resistance allows a potential of 1 volt to cause a current of 1 ampere to flow in a circuit

Ohms's Law $V = I R$

V = potential in volts

I = current in amperes

R = resistance in oms

Electric Power

1 watt of power is produced when a potential of 1 volt causes a current of 1 ampere to flow in a circuit

$$P = I\,V$$

V = potential in volts

I = current in amperes

R = resistance in ohms

P = power in watts

Using Ohm's Law and $P = I\,V$, then $P = I^2\,R = V^2 / R$

Electric Power

Some examples…

- Quartz wristwatch – 0.000001 watt (1 microwatt)
- Flashlight – 1 watt
- Balloon radio beacon – 5 watts
- Table lamp – 60 watts
- 27” television set – 130 watts
- Hair dryer – 1100 watts
- Clothes dryer – 5000 watts (5 kilowatts)
- State of Louisiana – 8,000,000,000 watts (8000 megawatts)

How To Use a Digital Multimeter

Digital MultiMeter (DMM)

Measures voltage, current, resistance, sometimes other parameters

This one cost less than $5
- AC and DC voltage
- DC current
- Resistance
- Diode and Transistor properties
- Battery tester

Taking Measurements (Setup)

BLACK test lead is plugged Into the **COM** (common) terminal

Select the proper MEASUREMENT and RANGE if required

Some DMMs are *autoranging* and automatically adjust the range

Taking Measurements (Voltage)

RED test lead is plugged into the **VΩmA** terminal for measuring voltage and resistance

Taking Measurements (Current)

Some meters have a common plug for voltage and current, others it is seperate

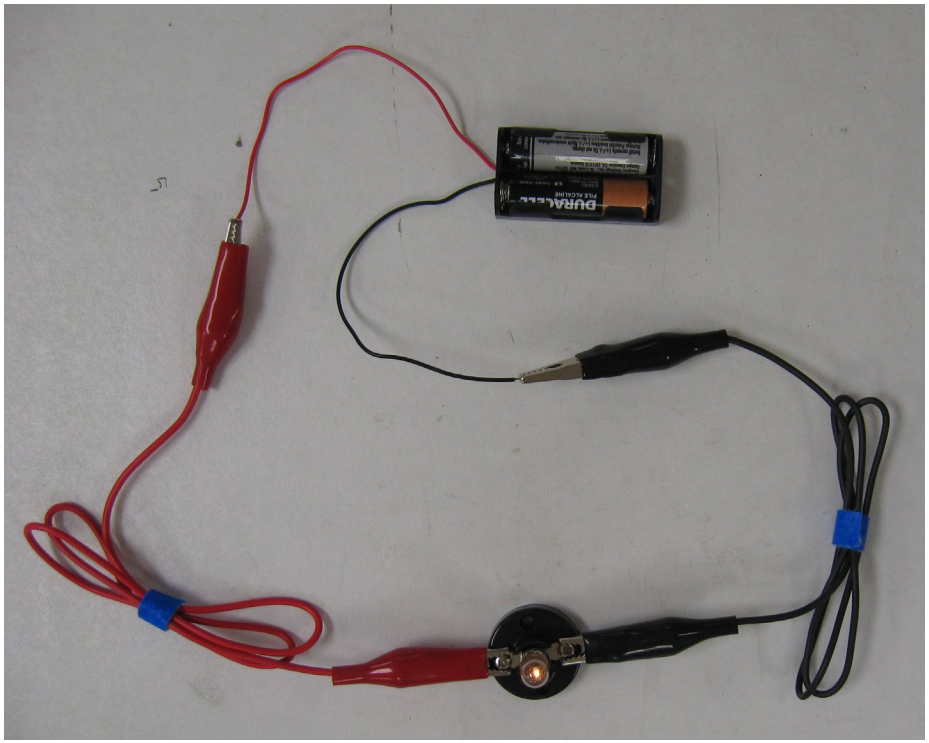
For large DC currents (up to 10 amperes) RED test lead is connected To the **10ADC** terminal

Current plugs are fused (fuses can be blown)

Voltage Measurement

Here's a simple battery and lamp circuit

Let's measure the voltage across the lamp

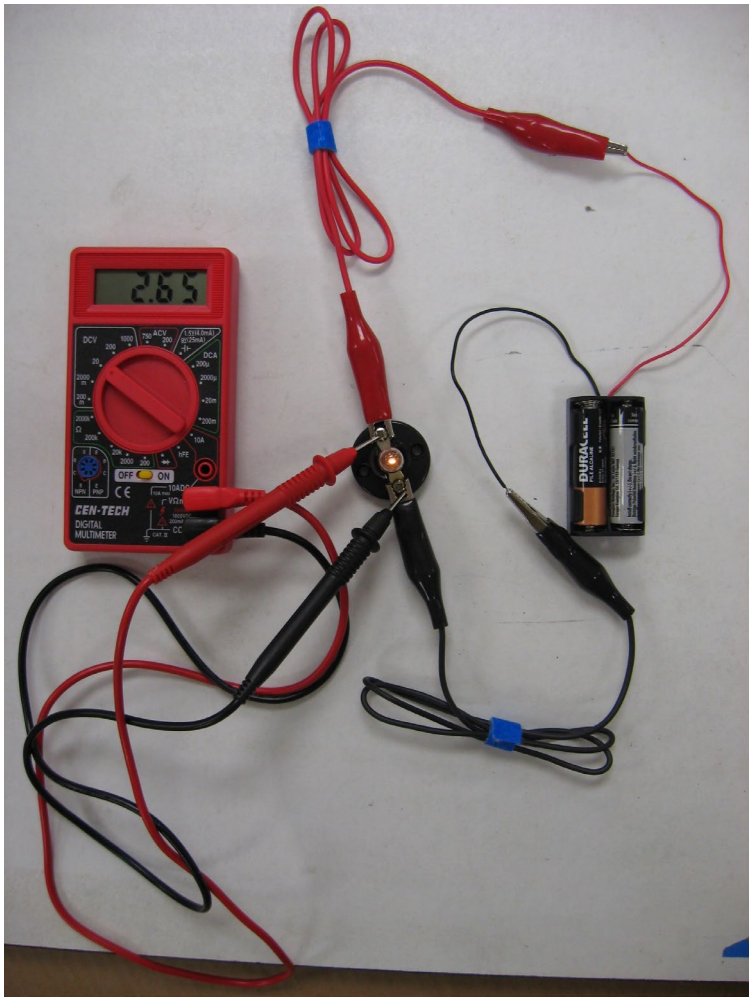


Voltage Measurement

Voltage measurements require the DMM to be connected in ***parallel*** (*i.e.*, ***across***) the circuit element whose voltage is being measured

Note there is a parallel path around the lamp through the multimeter

In this case the multimeter has a very large resistance so no extra current flows through it

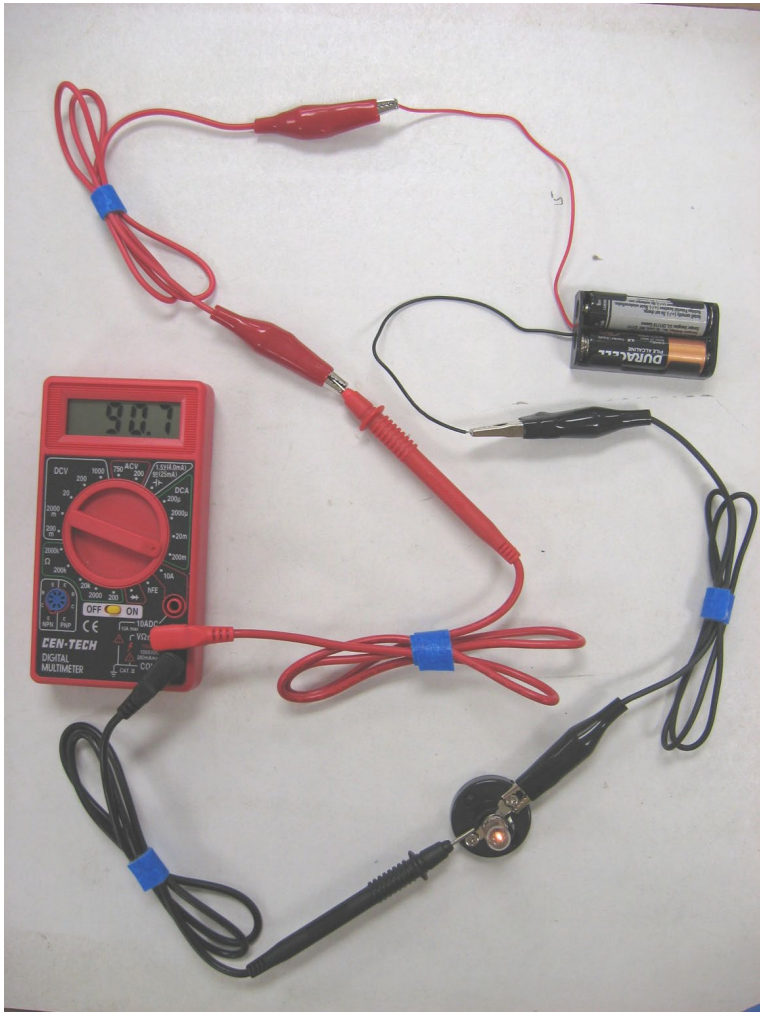


Current Measurement

To measure current, the DMM must be connected ***in series*** (*i.e.*, ***in line with***) the circuit element whose current is being Measured

The current in the circuit must flow through the meter before getting to the lamp

The meter has a very low resistance in order not to decrease the current flow

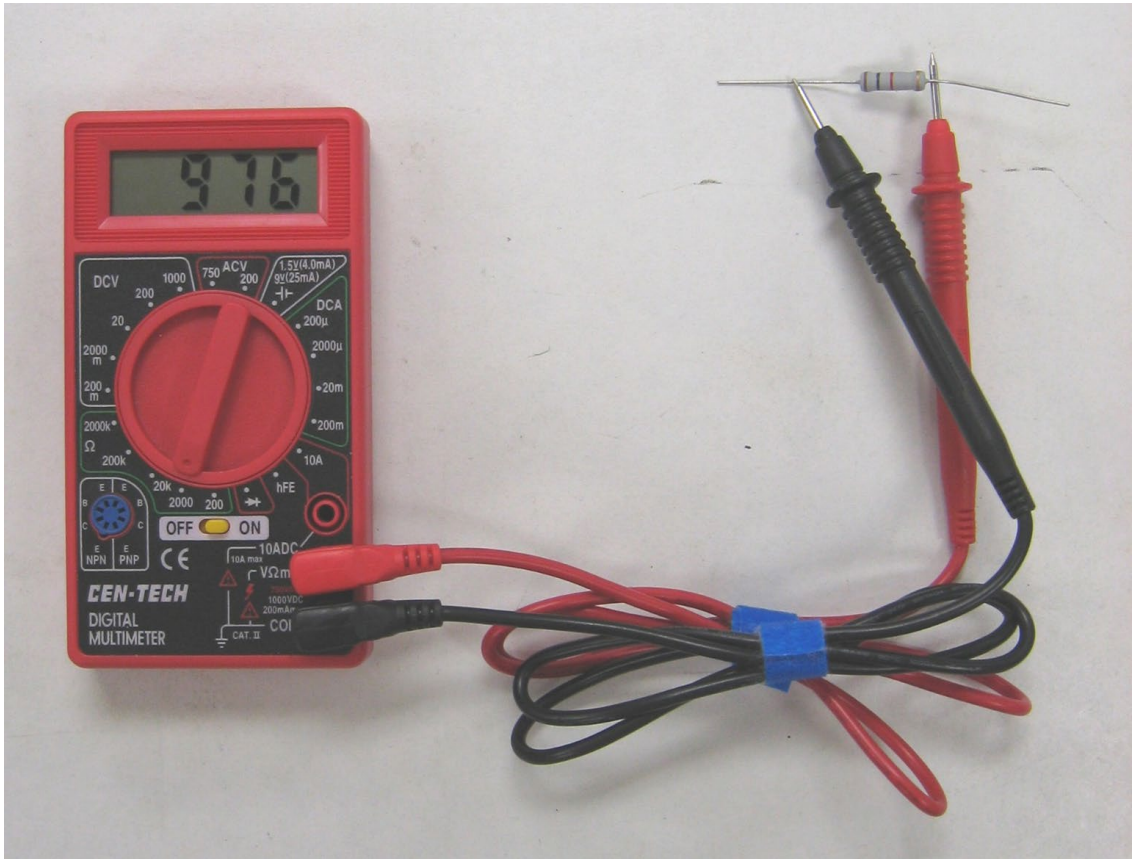


Resistance Measurement

Here's how to measure the resistance of an element

Note: the element is removed from its circuit

If the resistor has power the meter will not be able to accurately measure



Resistance Measurement

The RANGE is 0-2000 Ω So the reading is interpreted as 976 Ω, or 0.976 K Ω

If the meter was on the 20k setting the meter would read 0.976 instead

*****WARNING*****

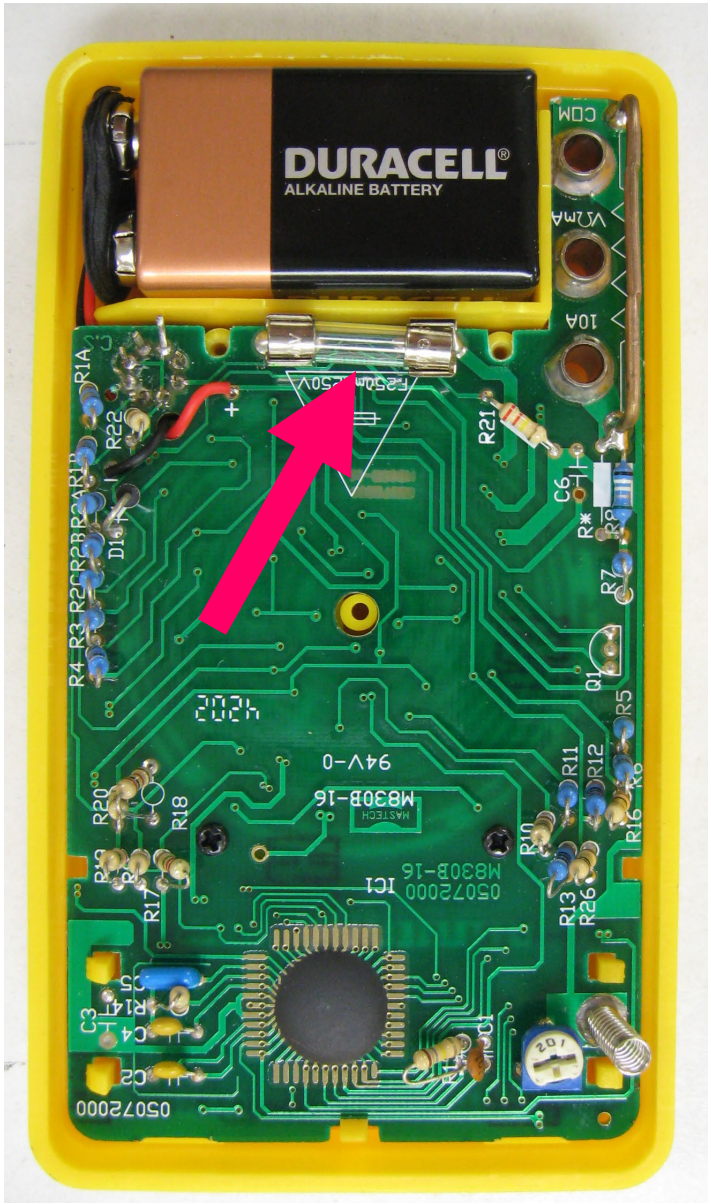
Don’t try this at home.

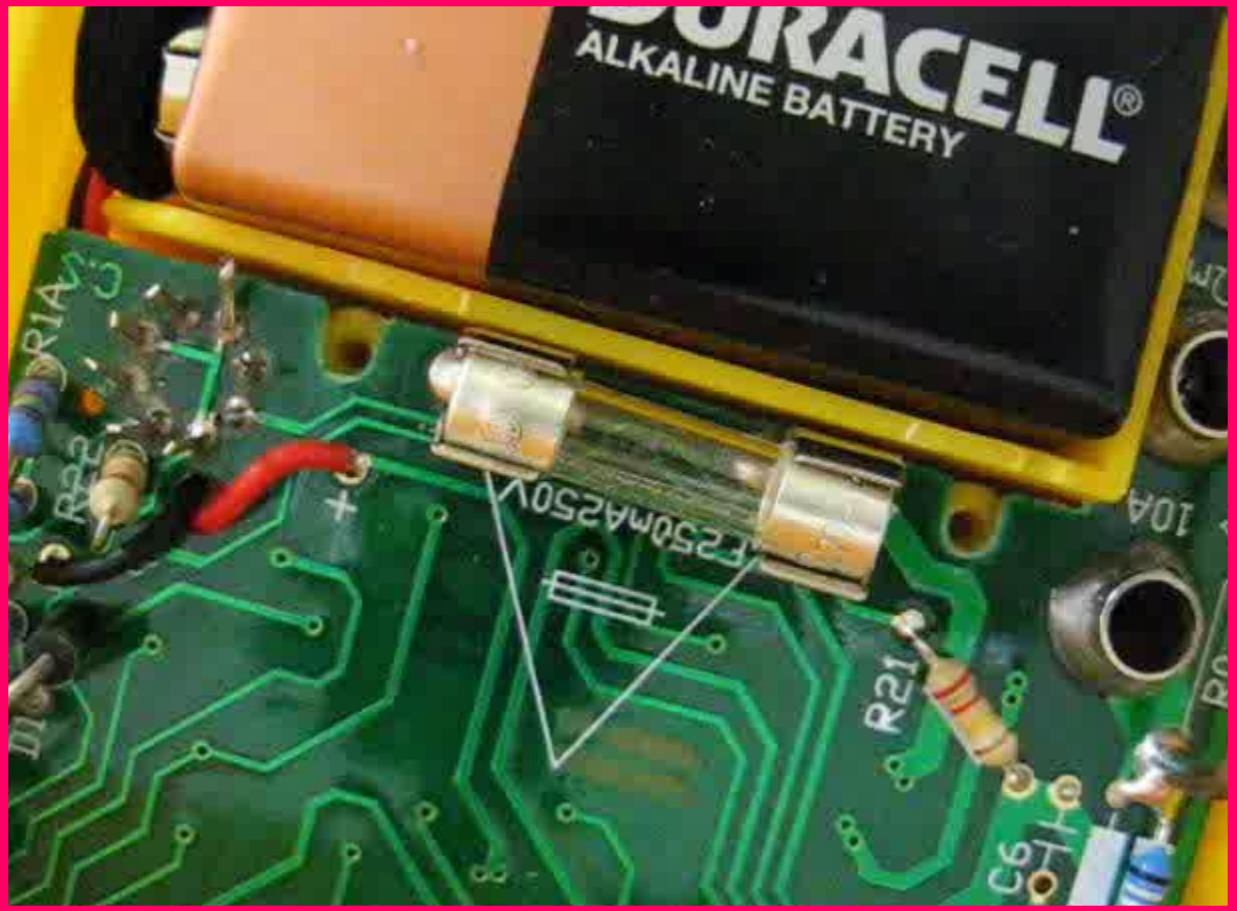
What happens if you connect a DMM, ***set to read current***,in parallel with a voltage source, such as a battery?

Some V small R means large I

Some of the magic smoke may Escape from your DMM. (You may damage your circuit or meter)

Fortunately, even this inexpensive DMM includes a protective fuse.
So your DMM **might** not be destroyed.

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