Series Parallel Circuits

Equipment

1	Modular Circuits	EM-3536-KIT
1	Modular Current Sensor	EM-3534
1	Voltage Sensor	UI-5100
1	4mm Banana Plug Cords-Red Set of 5	SE-9750
Required but not included:		
1	550 Universal Interface	UI-5001

Introduction

Series/Parallel circuits are reduced to an equivalent resistance and that resistance is verified by measuring the total current and total voltage.

In a second stand-alone experiment, the behavior of lamps in series, parallel, and series/parallel is qualitatively examined.

Theory

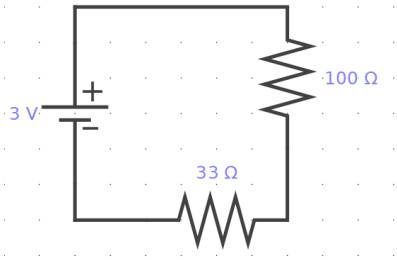
A resistor generally means a device that obeys Ohm's Law (many devices do not) and has a resistance R. Two (or more) resistors can be connected in series (as in Figure 1), or in parallel (as in Figure 2). Resistors could also be connected in a series/parallel circuit as shown in Figures 3 and 4. An equivalent resistor is a single resistor that could replace a more complex circuit and produce the same total current when the same total voltage is applied. For a series circuit, the resistances are additive:

$$R_{eq} = R_1 + R_2 \qquad (2)$$

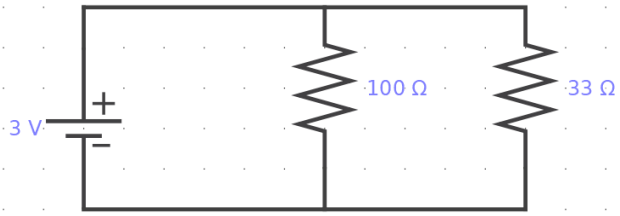
where R_{eq} is the equivalent resistance. For a parallel circuit, the resistances add as reciprocals

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} \qquad (3)$$

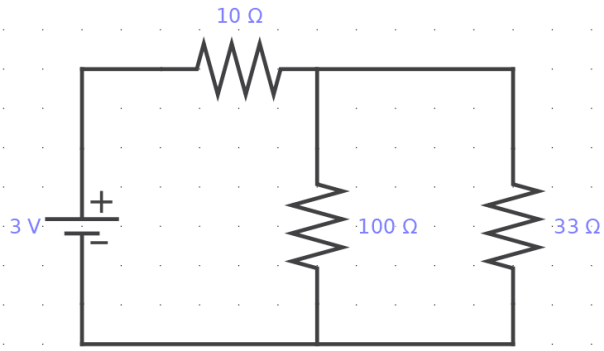
A more complex circuit like that in Circuit Diagram 3 can be handled by noting that R_1 and R_2 are in parallel and can be reduced to an equivalent resistance using Equation 3. That equivalent resistance is then in series with R_3 and can be treated using Equation 2 to find the equivalent resistance of the entire series/parallel circuit.



Circuit Diagram 1: Series



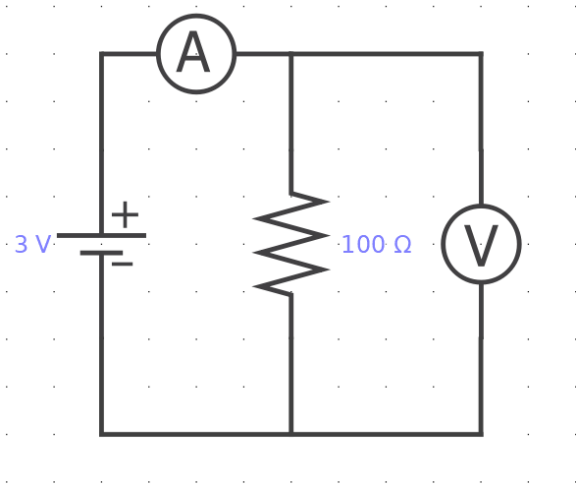
Circuit Diagram 2: Parallel



Circuit Diagram 3: Series and Parallel

Checking the Resistance

1. Plug a Voltage Sensor into Channel A of the 550 Interface.
2. Assemble the circuit for a single resistor as shown in Circuit Diagram 4.



Circuit Diagram 4

3. Turn on the Wireless Current Module and connect it in the software.
4. Set the common sample rate for 500 Hz.

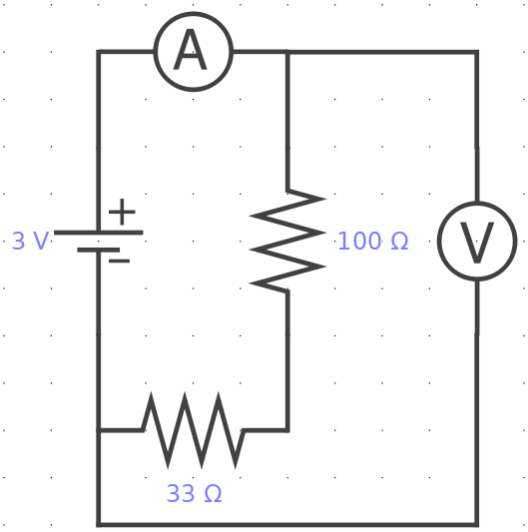
5. Create a graph of Voltage vs. Current.
6. Click open the Signal Generator at the left of the page. Set Waveform for a Triangle wave at 0.1 Hz with an amplitude of 3 V. Click Auto. Click Signal Generator to close the panel.
7. Set a stop condition of 9 seconds.
8. Click Record.
9. On the graph, select a linear fit.
10. The slope of the line is the measured resistance. Record the value of the resistance.
11. Repeat for each of the three resistor modules (100 Ω, 33 Ω, and 10 Ω).

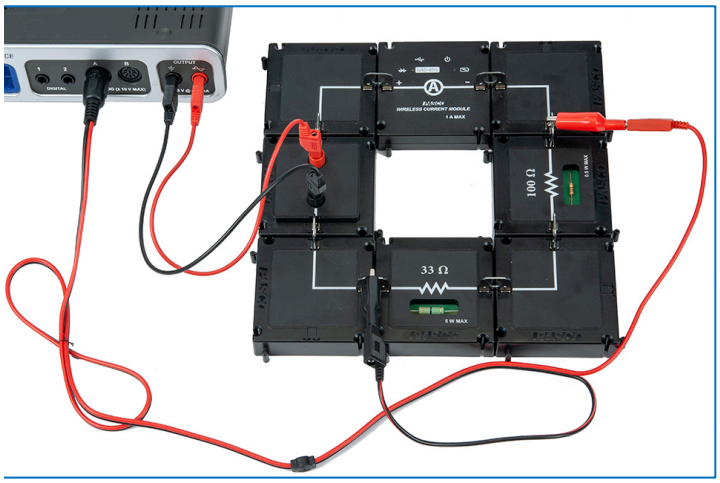
Equivalent Resistance

Using the calibrated values for the resistors, calculate the equivalent resistance for each of the three circuit diagrams shown in the Theory Section. Record these equivalent resistances.

Setup

Construct the circuit shown in the Circuit Diagram 1 and Figure 1.



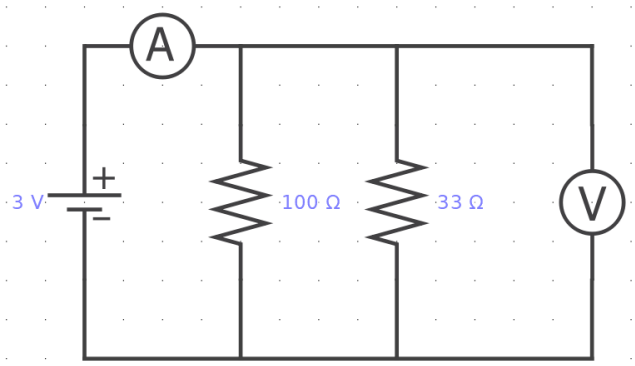


Circuit Diagram 1: Series with Meters Figure 1: Series Circuit

Procedure

1. Use the same signal generator settings and Voltage vs. Current graph as before.
2. Start recording for the Series Circuit Diagram.
3. On the graph, select a linear fit.

4. The slope of the line is the measured equivalent resistance. Record the value of the resistance.
5. Repeat for each of the circuits shown below.



Circuit Diagram 2 with Meters

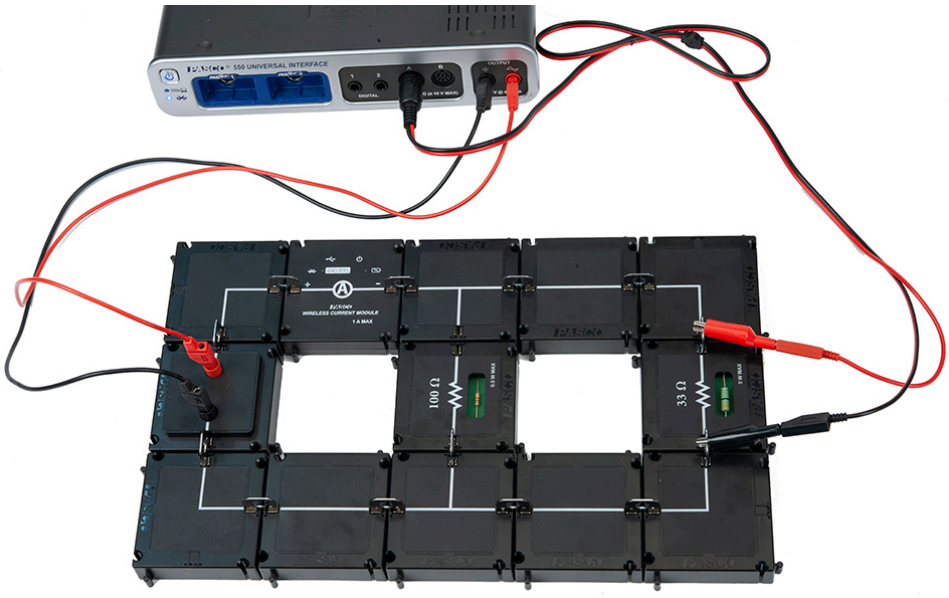
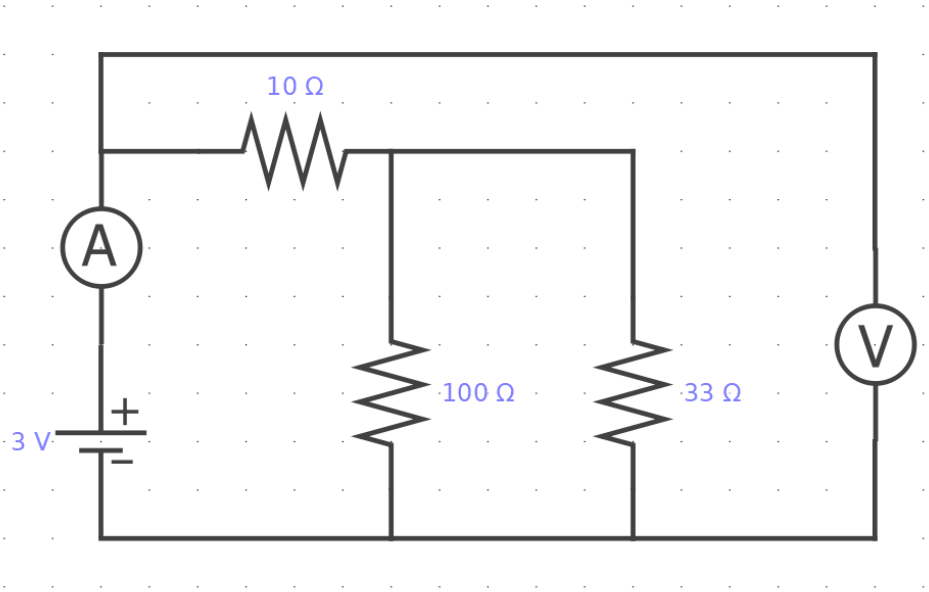


Figure 2: Parallel Resistors with Meters



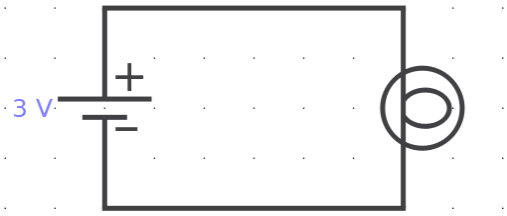
Circuit Diagram 3: Series and Parallel Resistors with Meters

Conclusions

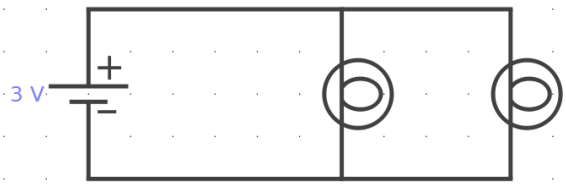
How well did the experiment work? What does it show?

Lamp Setups

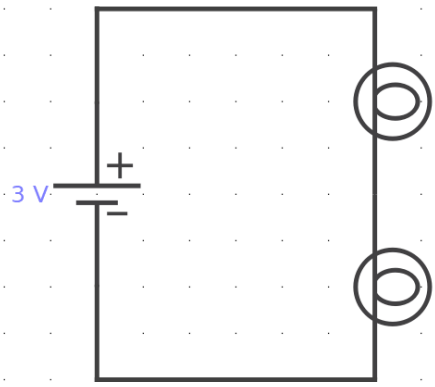
Setup as in Circuit Diagram 5 with only lamp A in the circuit.



Circuit Diagram 5: Single Lamp



Circuit Diagram 6: Lamps in Parallel



Circuit Diagram 7: Lamps in Series

Lamp Procedure

1. Turn on the signal generator to 3 VDC. Observe the brightness of the single lamp.

2. Construct Circuit Diagram 6 with two lamps in parallel.

3. Turn on the signal generator to 3 VDC. Observe the brightness of the two lamps. How does the brightness of these lamps compare to the brightness of one bulb? Why?

4. Construct Circuit Diagram 7 with two lamps in series.

5. Turn on the signal generator to 3 VDC. Observe the brightness of the two lamps. How does the brightness of these lamps compare to the brightness of one bulb? Why?