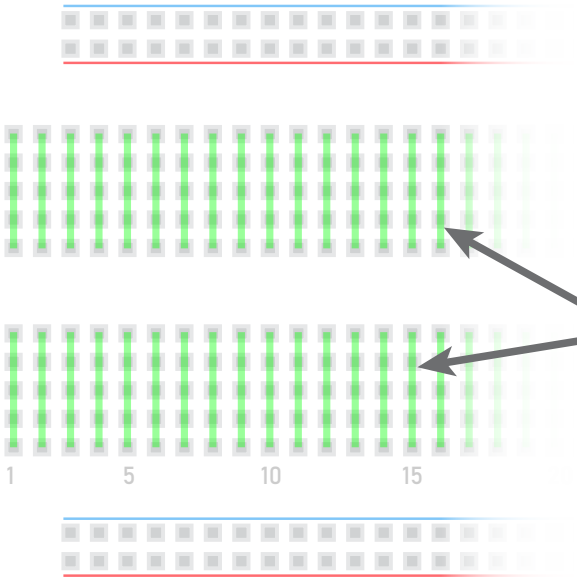
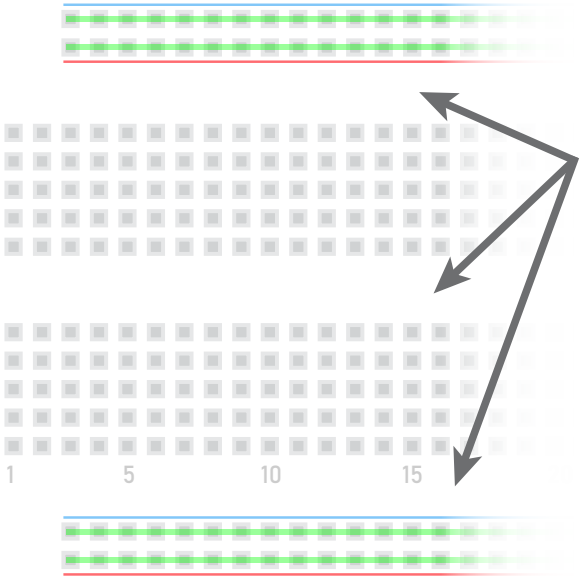


Breadboards make it easy to assemble and change electronic circuits.

The holes on a breadboard are connected in two different ways.

The vertical columns on either side of the central gap are connected in groups of five. If you put a part or wire in one hole it will be connected to whatever is below or above it in that column.

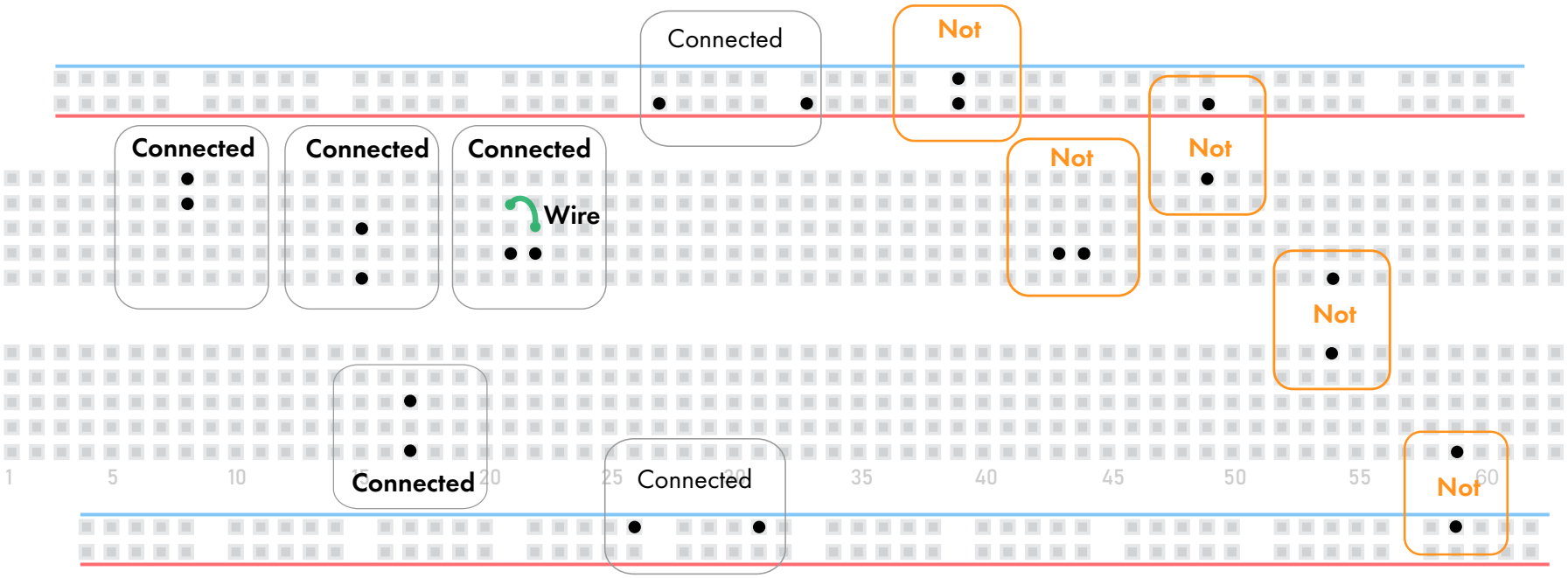


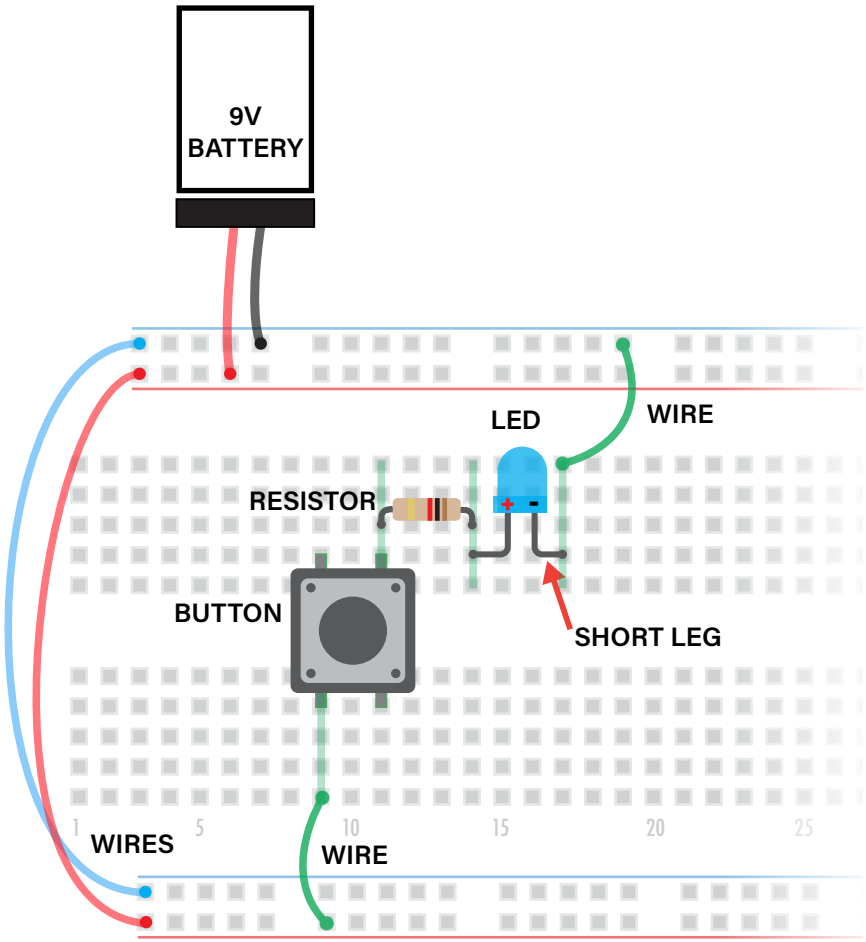
The red and blue lines are connected all the way across the board. We'll call the red strip "9 Volts" and blue strip "ground"

The horizontal gaps separate the different areas.

These dots could be any electronics part. An LED, a wire, a chip, or anything else.

Making a circuit is all about having the correct things connected. If something is connected that shouldn't be, the device won't work and something could break.





Step 1

Here we will use the button to turn the LED (Light Emitting Diode) on.

The button and resistor can be put in either direction.

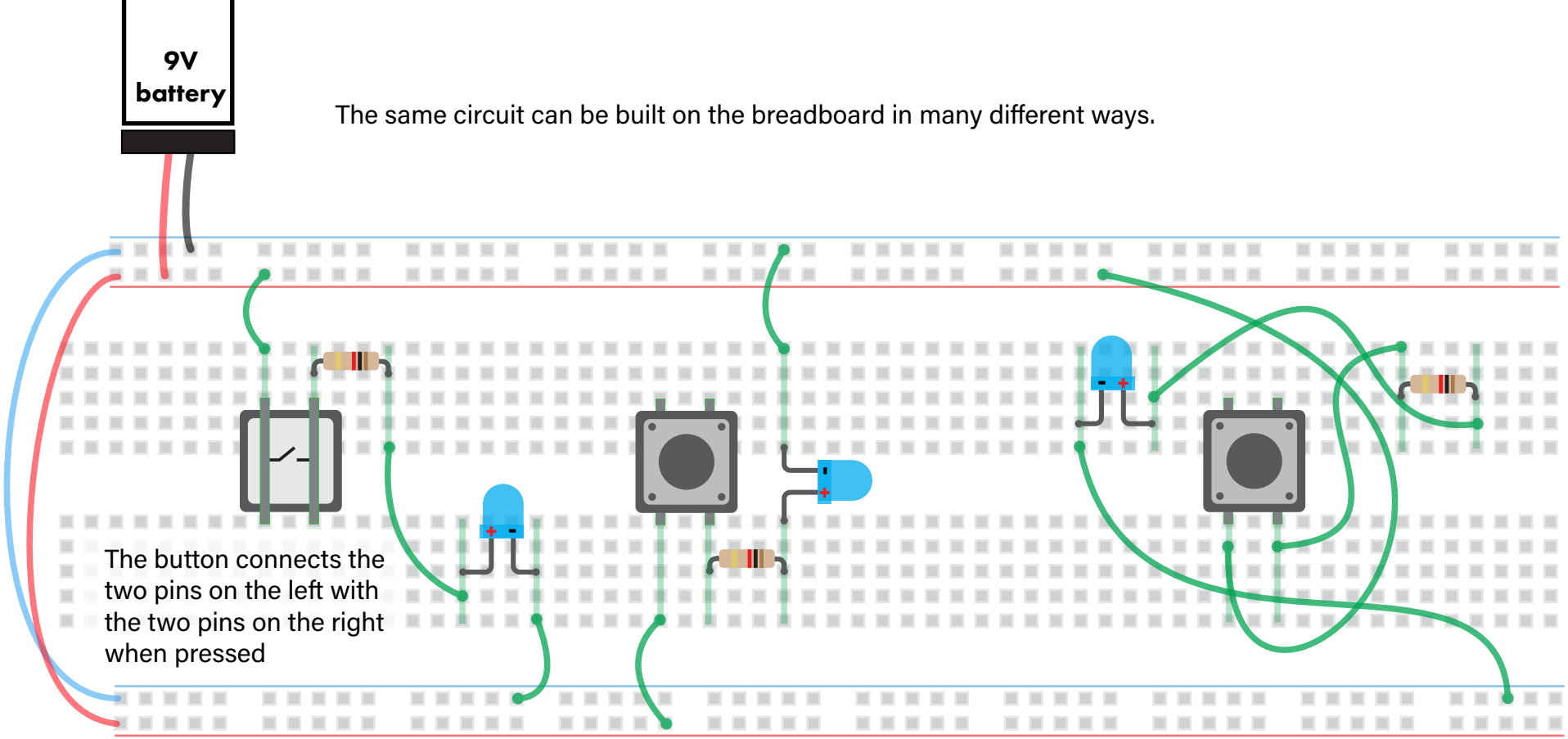
The LED needs to go in a specific direction.
The short leg needs to connect to the wire on the right.

When you push the button the circuit will be complete so electricity can flow through the resistor to the LED. The resistor keeps the LED from getting too much electricity and burning out.

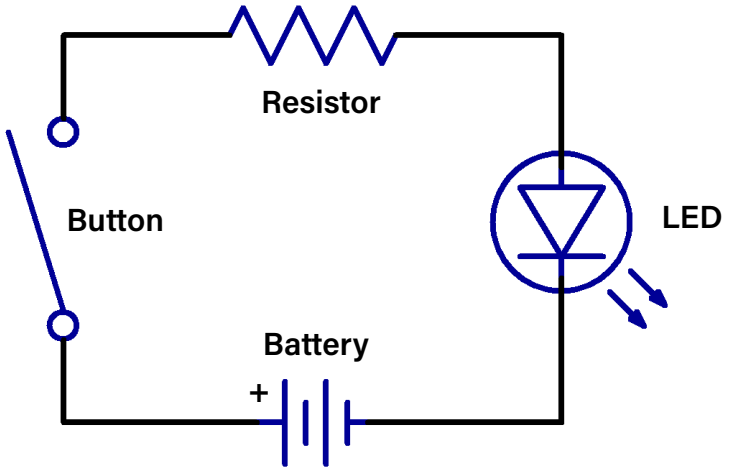
We don't have to worry about being shocked or electrocuted by the circuits we will make today because a 9V battery can't put out enough electricity to hurt us. But, take care to never "short out" the battery by connecting the black and red wires together.
This will make the battery get hot and damage it.

The large resistor is 1k while the small one is 100k
Brown Black Red Gold = 1kΩ = 1000 Ohms of resistance
Brown Black Yellow Gold = 100kΩ = 100,000 Ohms of resistance

The same circuit can be built on the breadboard in many different ways.



All of these different ways of making the circuit can be shown with the same schematic.

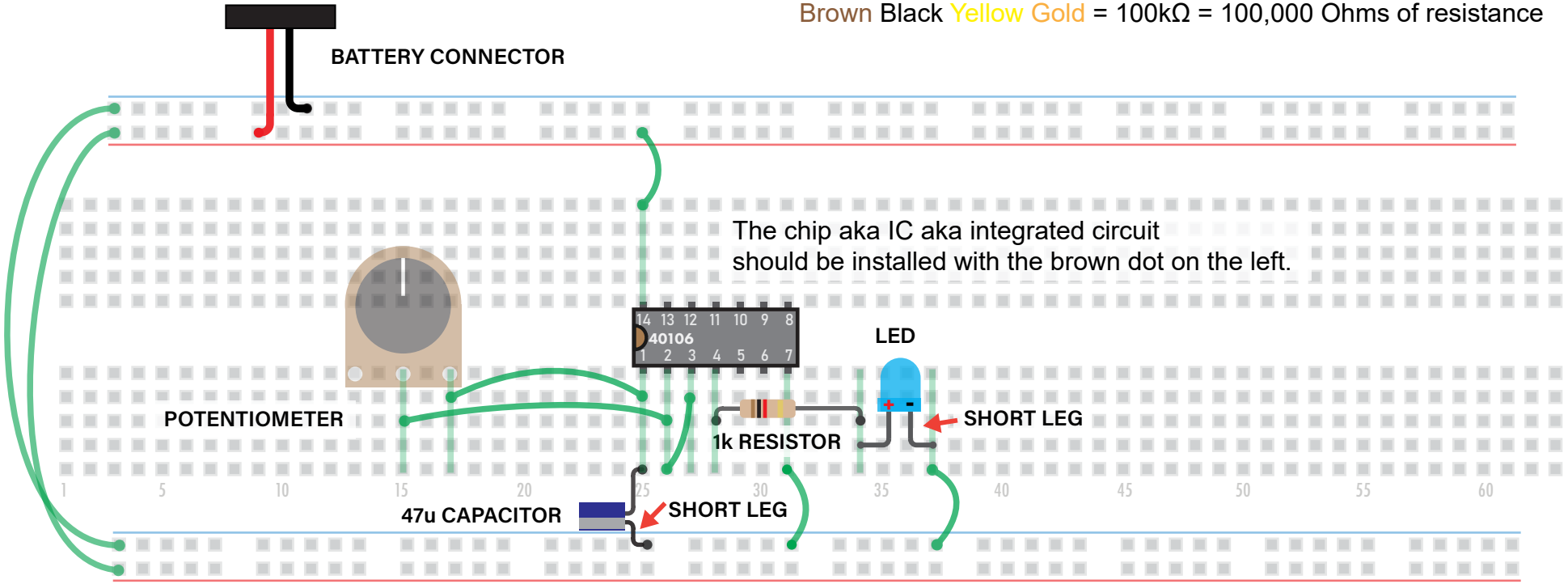


2 - Blinking

Don’t attach the battery until you are sure all the parts are in the correct places

The large resistor is 1k while the small one is 100k

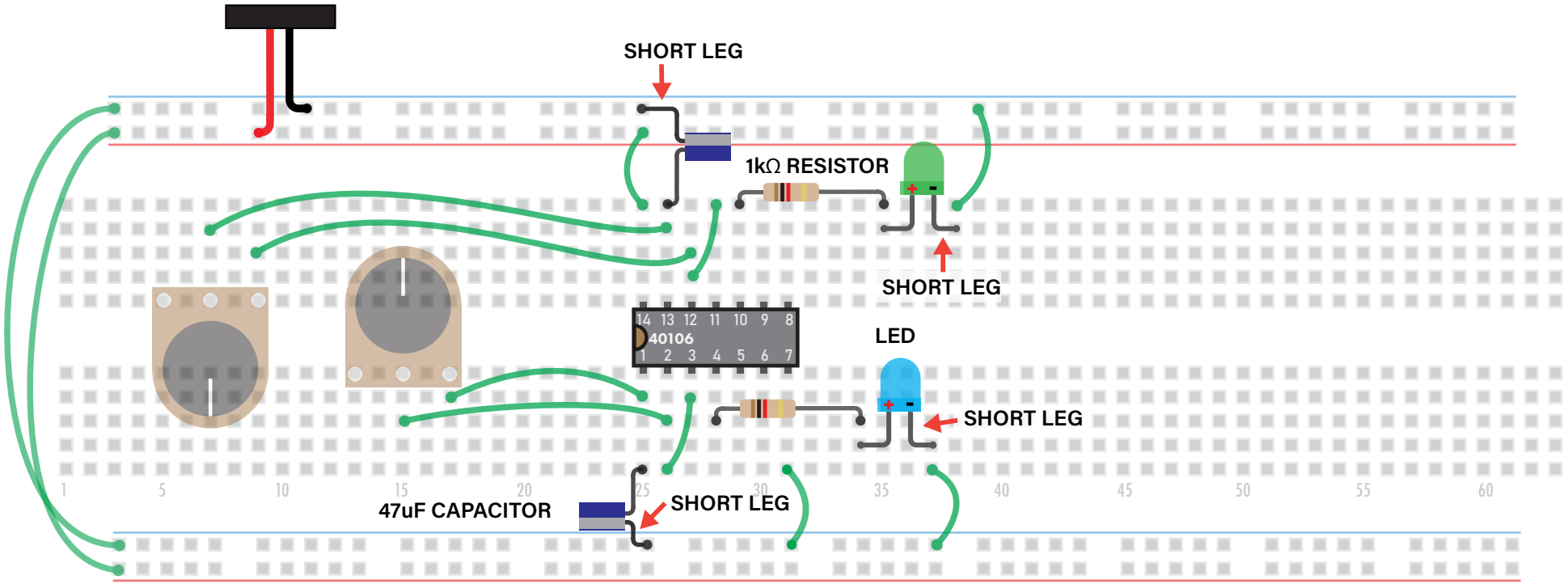
Brown Black Red Gold = 1kΩ = 1000 Ohms of resistance
Brown Black Yellow Gold = 100kΩ = 100,000 Ohms of resistance



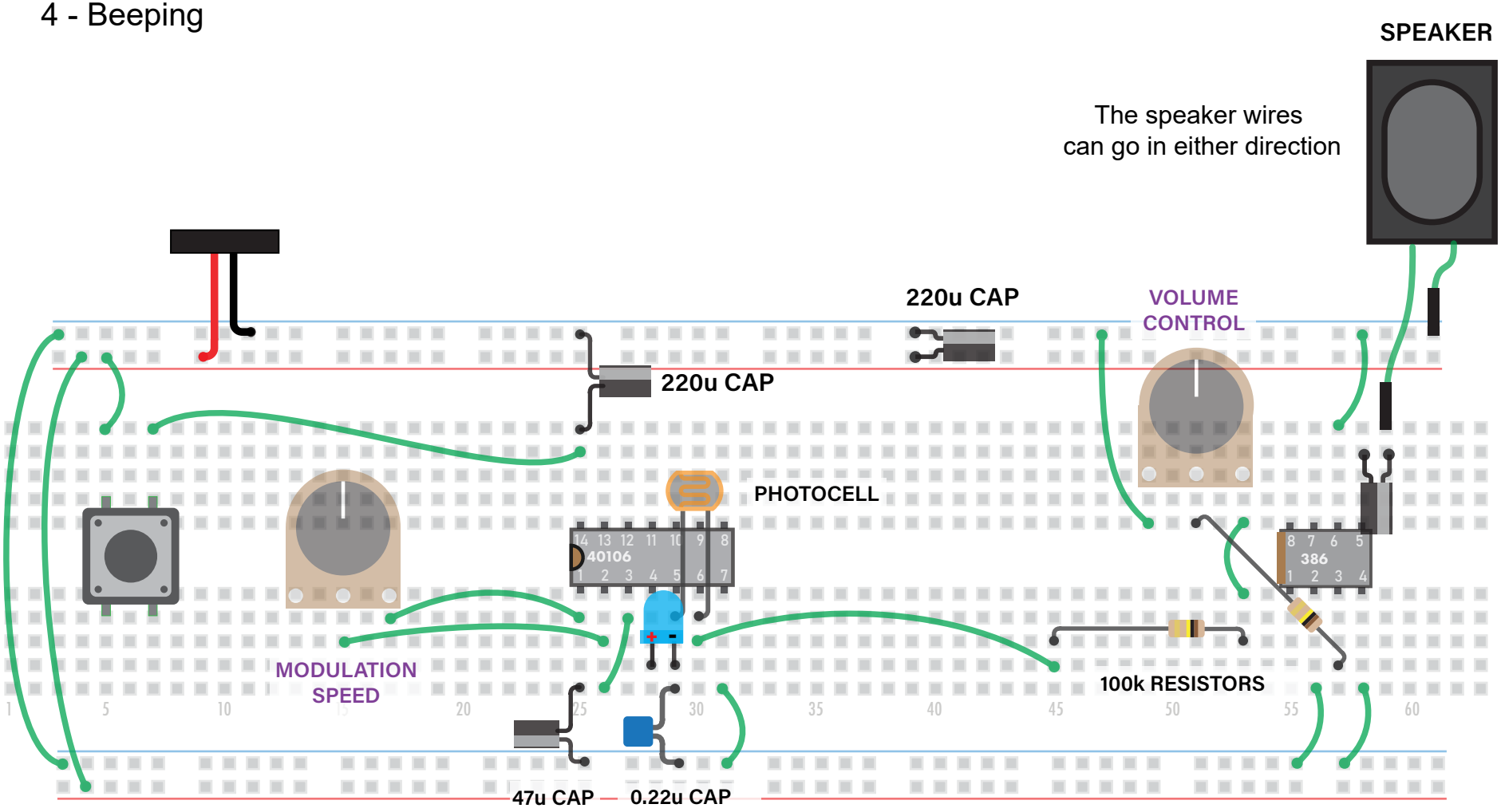
A “Pot” or “Knob” is a variable resistor

The large “Caps” have a short leg that needs to go in the correct place, like the LEDs do. Here the short side is shown with the grey stripe.

3 - Multiple Oscillators Blinking



4 - Beeping

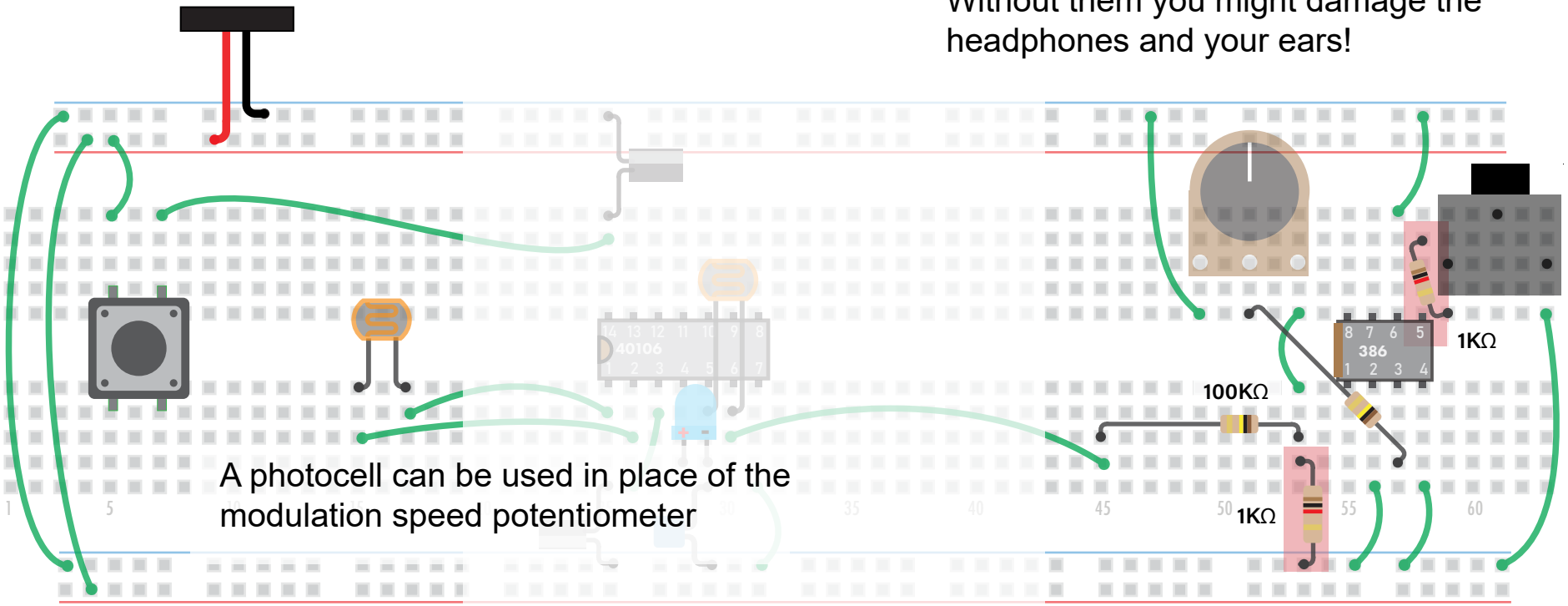


Remove the 1k resistor and move the LED.
The short leg of the LED goes on the right.

The tiny .22 uF capacitor and the photocell can go in either direction.

4B - Mods

To use headphones, the 200uF capacitor is removed and two 1k resistors are added. Without them you might damage the headphones and your ears!

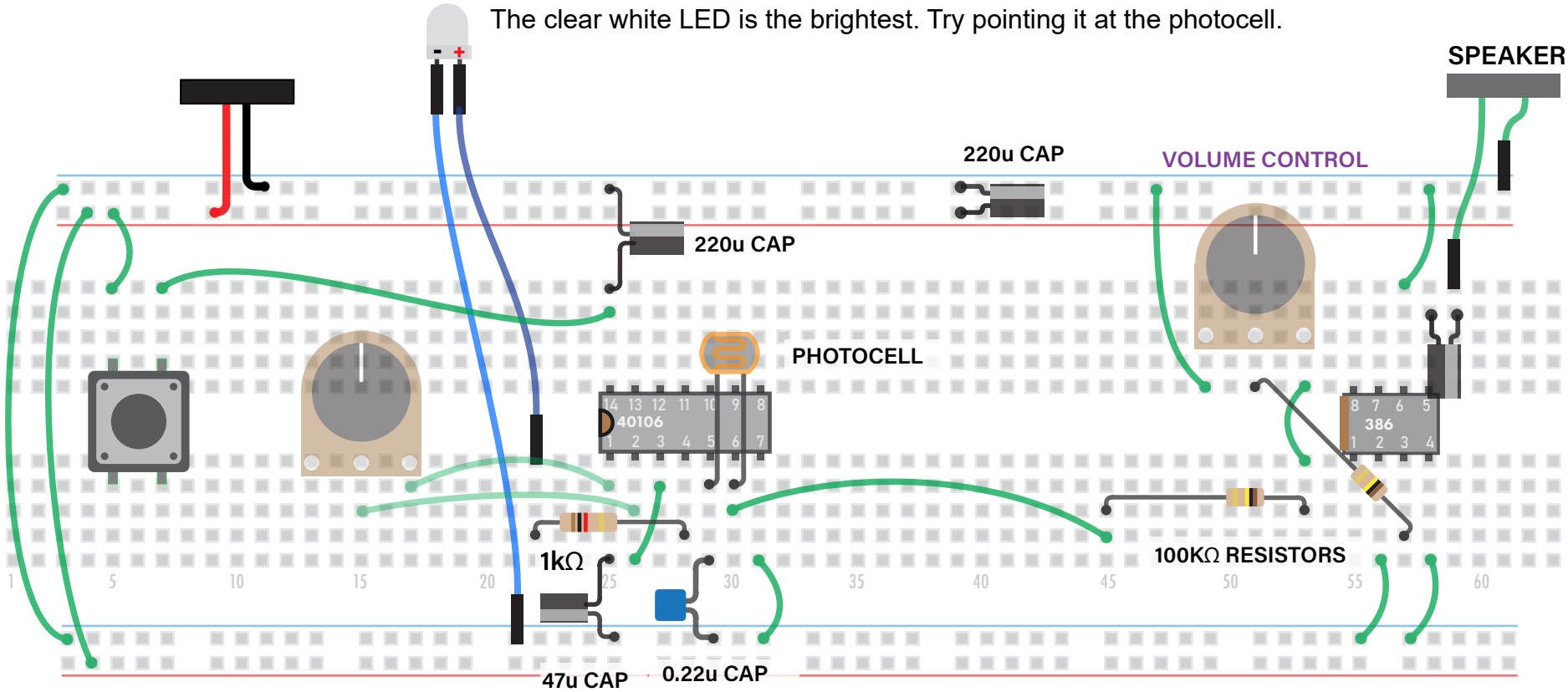


A photocell can be used in place of the modulation speed potentiometer

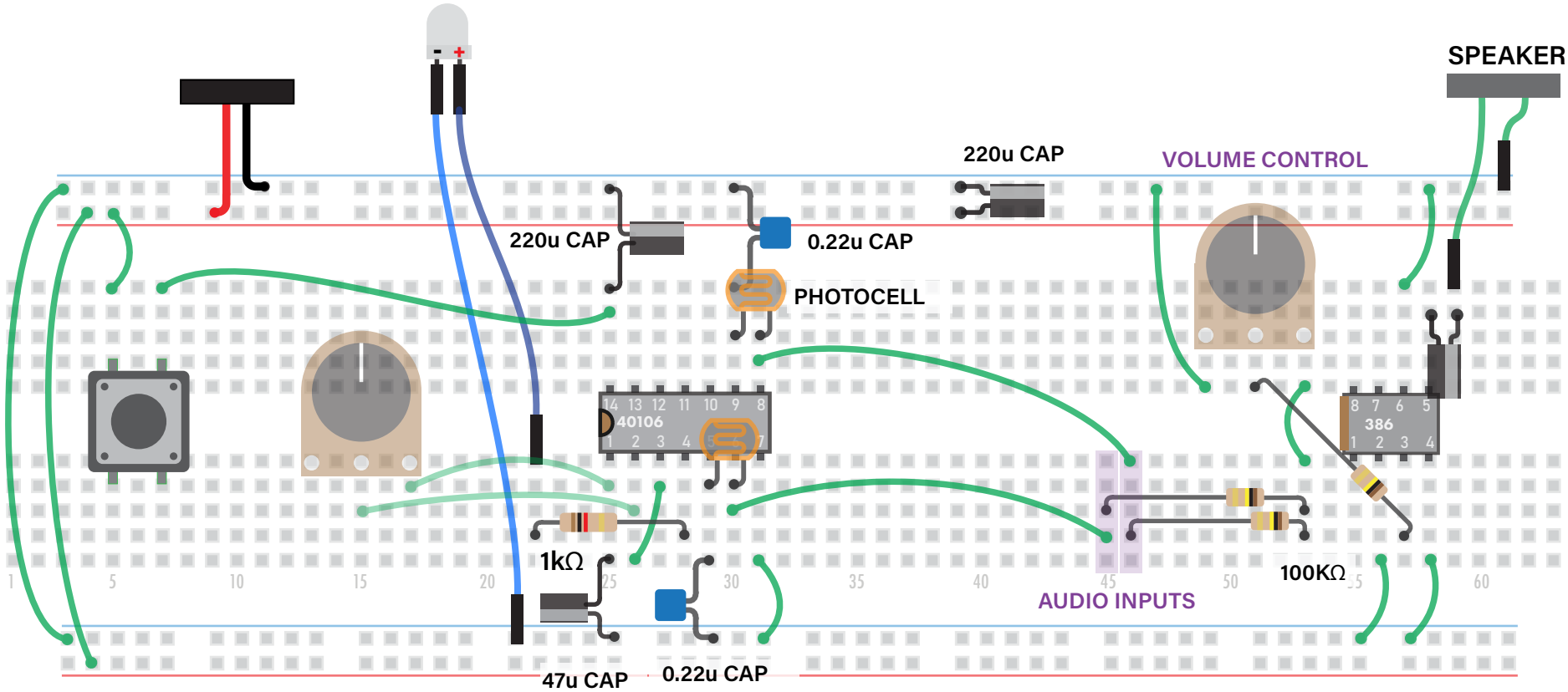
5 - Different ways to modulate

Short leg goes to the blue line, aka ground, aka battery negative

The clear white LED is the brightest. Try pointing it at the photocell.

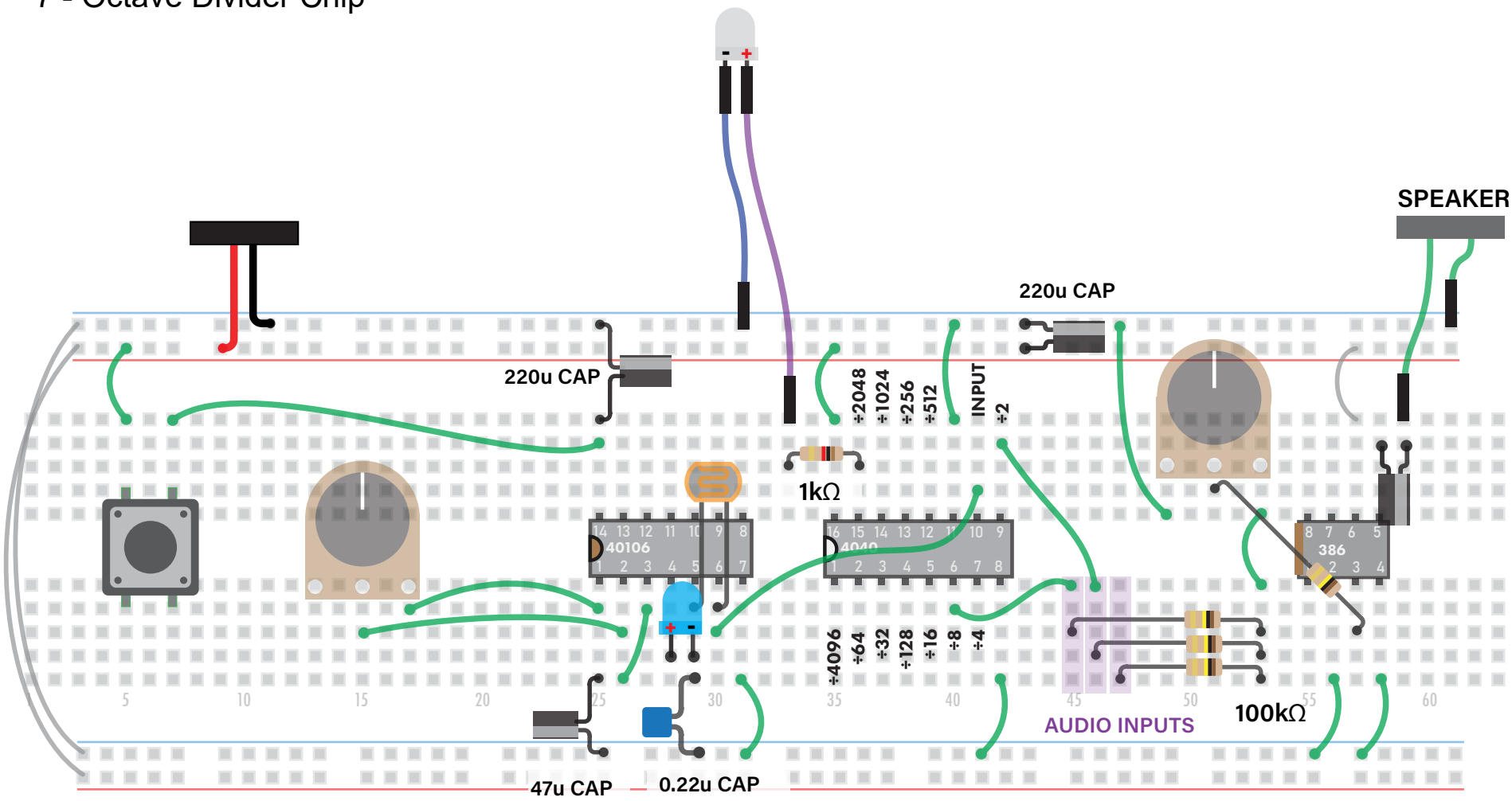


6 - Multiple audio oscillators



7 - Octave Divider Chip

Bleeplabs.com/summer26



The 4040 chip with a white dot is a divider. It takes an incoming square wave signal and puts out tweleve slower signals. Divide by 2 will be an octve down. Divide by 4 will be two octaves down. 4096 is twelve octaves.