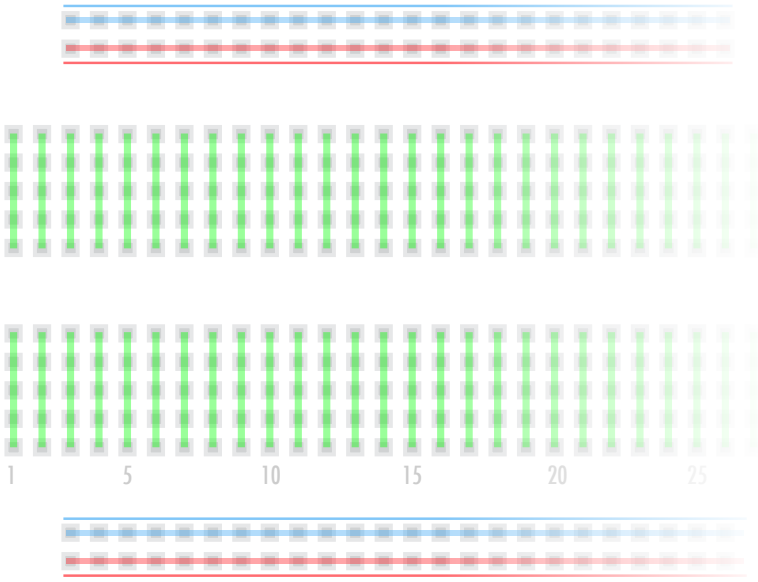
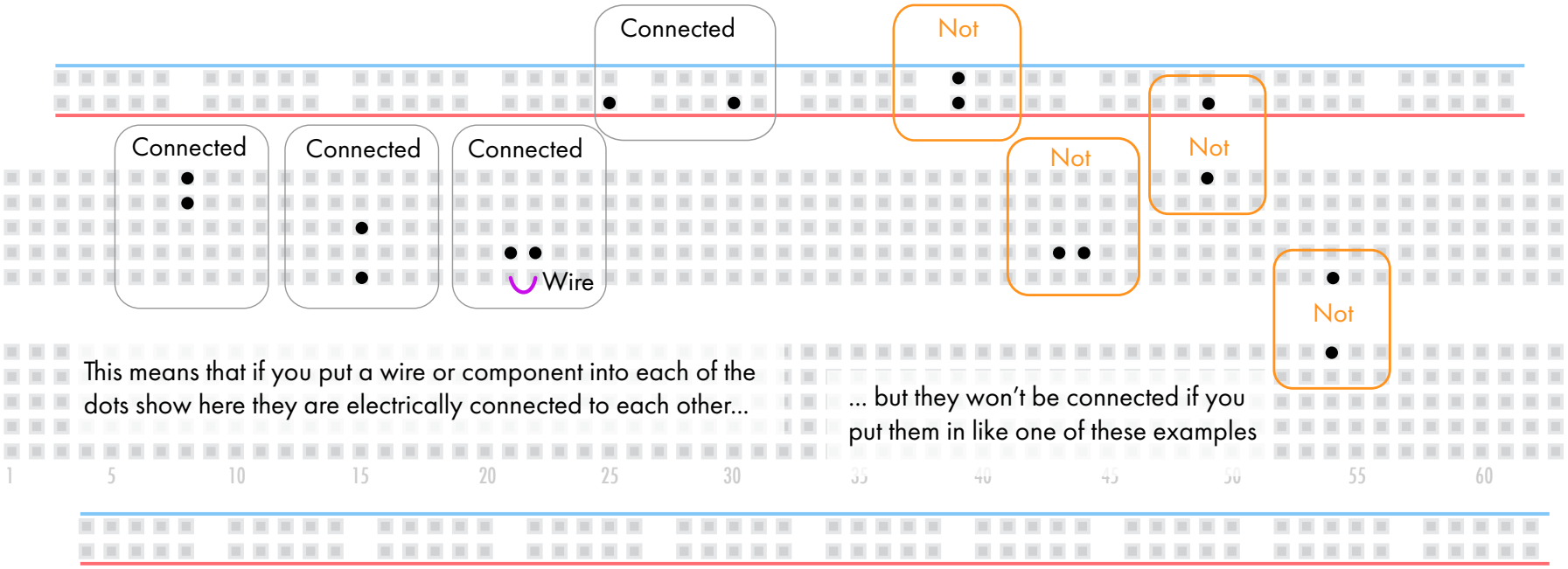
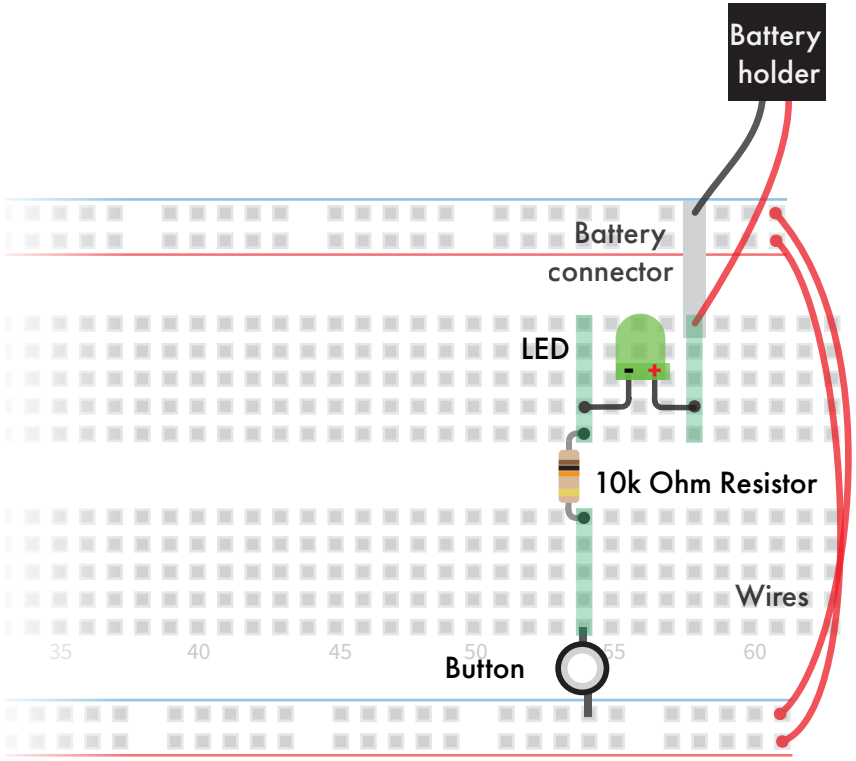
Making Music and Movement With Electronics
More info at github.com/BleepLabs/Laguna-Gloria-workshop



Breadboards make it easy to assemble electronic circuits without soldering

The holes on a breadboard are connected as show with the colored lines.
The vertical strips on either side of the central gap are connected in groups of five.
The horizontal red and blue “bus” lines are connected all the way across the board.

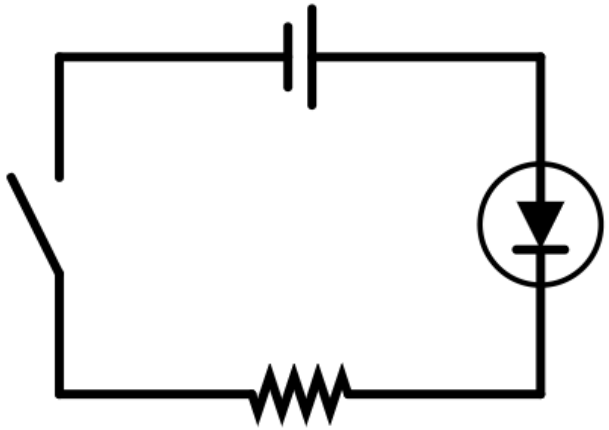




Your first circuit

Here we use a button to turn on an LED.
The battery and LED need to be installed in the correct direction. The battery should have the black wire side in the top blue buss line. The LED needs to have its shorter leg on the left side. Resistors and buttons don't have a polarity and can go in either direction.

The wires connect the top and bottom buses so you can easily access power and ground anywhere on the board. We're not using the red bus just yet, though.



Here's the schematic for what we just made.
On the top the positive wire from the battery goes to the anode, the positive side of the LED. The cathode of the LED goes to the resistor and then the other side of the resistor goes to a switch. When the switch is not being pressed, the circuit is open meaning that electricity is not flowing. Pressing the button completes the circuit, connecting the resistor to the negative side of the battery and allowing electricity to flow. The battery takes those electrons and puts them back out the positive side, continuing the cycle.

Without the resistor the LED will consume too much current and burn out quickly.
The four AA batteries put out about 5 Volts. We can think of voltage as the amount of electrons or how much water is in the battery/bucket. Current is the speed of the water. How fast is it flowing. How much oomf does it have.
Electrons want to go from high potential to low potential as quickly as possible. The electrons leaving the red, positive wire want to get to the battery's negative aka ground wire immediately. If we hooked the wires together they would do just that and damage the batteries pretty quickly. We use resistors to restrict the flow of current so a device like an LED doesn't have to deal with the fire hose of current available from the battery.

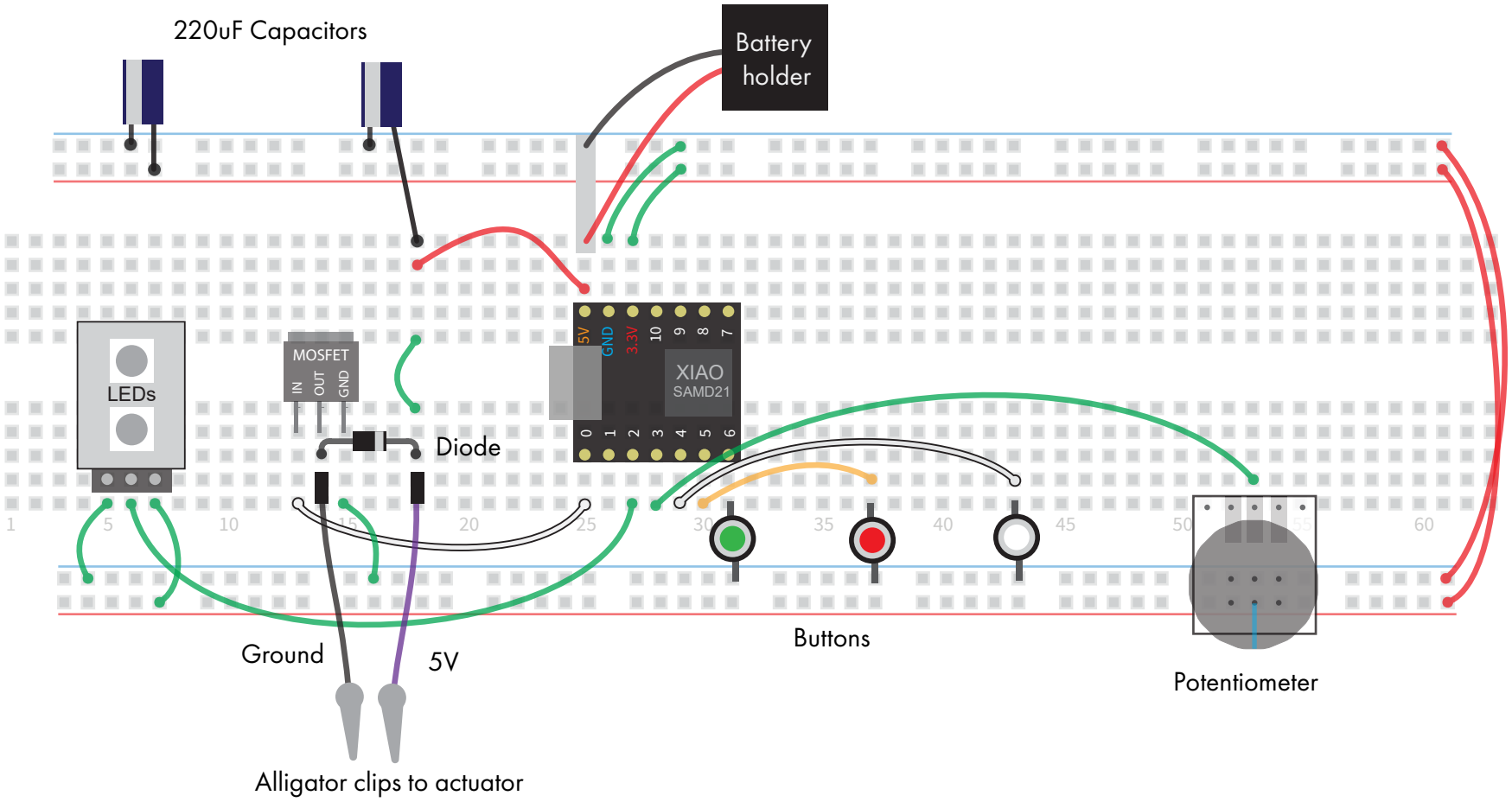
Current is the speed of the water flowing in a circuit. It's also what is depleted from a battery. This is what the mAh, milliamp hour rating is.
Voltage is how much water there is.
Power is the voltage multiplied by the current, resulting in Watts. So we can think of it as the force of the water. A river of water moving slowly or a tiny stream flowing quickly might generate the same force that is, move the same amount of water.

First channel

There are five sizes of wire in the kit.
1″ Green
1.5″ Orange
2″ White, shown here outlined in black
2.5″ Red
3.5″ Green

Install the parts in the breadboard as shown. They don't have to go in the exact spaces shown but they do have to make the correct connections. For example, a wire going into the red or blue buses at the top and bottom can go in anywhere as it's all connected.

The capacitors, diodes, and MOSFETs need to be installed in the direction shown.
The buttons don't have a polarity and can go in either way.



Using the device

Each side of the device acts about the same.

Hold record and press action to record a sequence. Let go of record and it will being to loop that sequence. The sequence can be up to 2 minutes long but the length is determined by how long you hold down record.

Press play to start and stop the sequence.

Pressing action when the device isn't playing closees the MOSFET, allowing the actuator to turn on.

Press record again to erase the current sequence and start making another.

The top and bottom LEDs correspond to the top and bottom channels.

Blue is not playing

Red is recording in the regular mode.

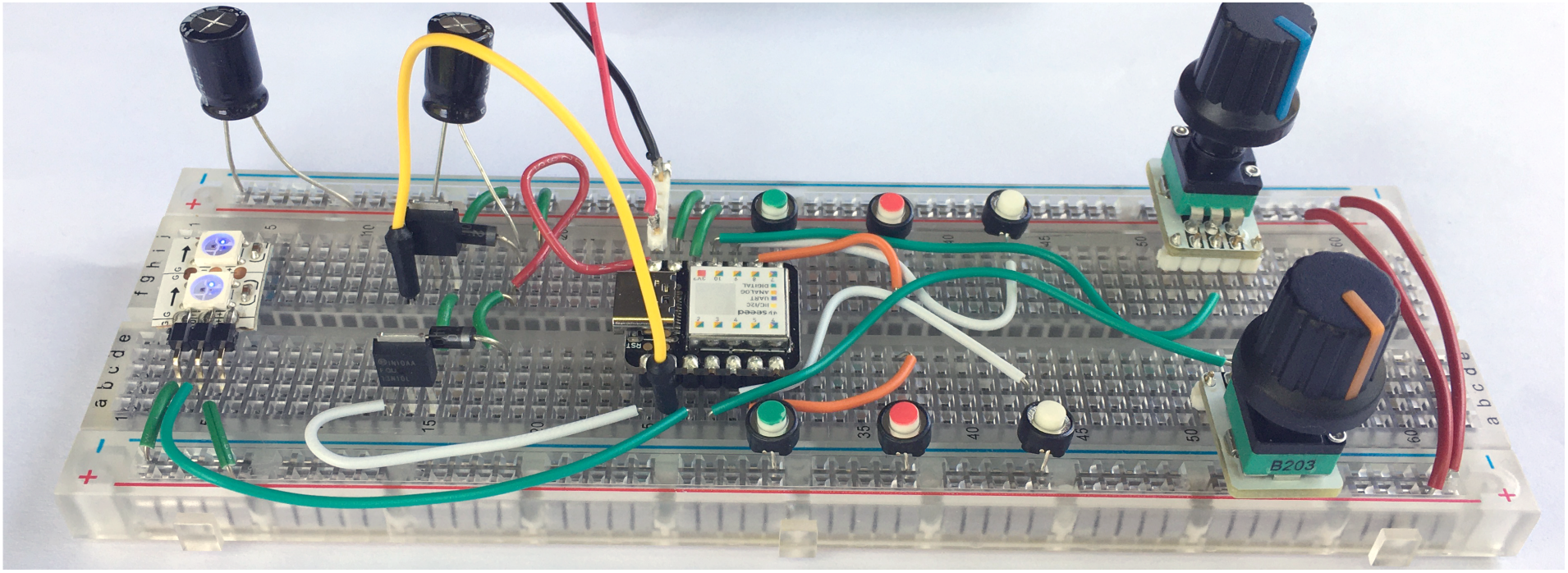
Green is playing.

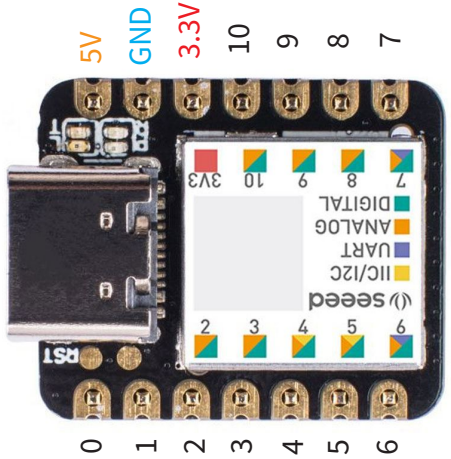
It blinks white when it is outputting an "on" signal.

It will blink a dimmer green when there is a action recorded but due to the probability knob it won't output it.

The green light in the top left corner of the Xiao means it is getting power.

The knobs change the probability of the output. When it's all the way to the right it will output exactly what you recorded. In the middle there are 50% odds that it will play it. Turn it all the way to the right an there is only 1% chance.

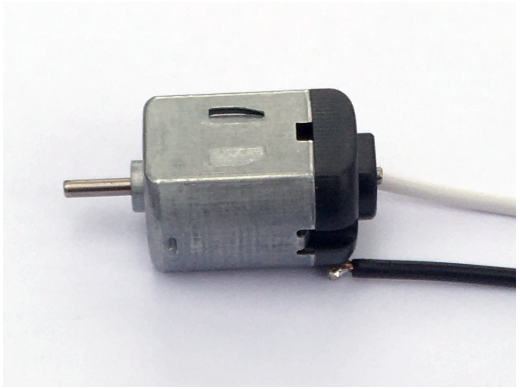




The Arduino device we're using is the Seeeduino XIAO SAMD21. It runs off of 3.3 Volts rather than 5V so it has an internal regulator to convert the Voltage to something it can use. The pin in the top left is the power input which is the only pin that can be connected to 5V. We need to make sure not to connect any other pin to the 5V coming from the battery it as it'll damage the Xiao.
The actuators we'll be using do connect to 5V.
The Xiao can't create very much current on each of it's pins so we use special types of transistors called MOSFETs to drive the actuators. In general transistors are switches. You give them a tiny bit of power and they can switch on and off something using a much bigger power source.
Here the MOSFET is told to connect and disconnect the output and ground pins. If one wire of the actuator is connected to 5V and the other is connected to the output pin, the MOSFET acts just like the button in the first breadboard example. Unlike the button the MOSFET can handle several Amps of current.
The diode is there to prevent current from trying to go the wrong direction when the actuator turns off because magnetism and electricity are weird dudes.

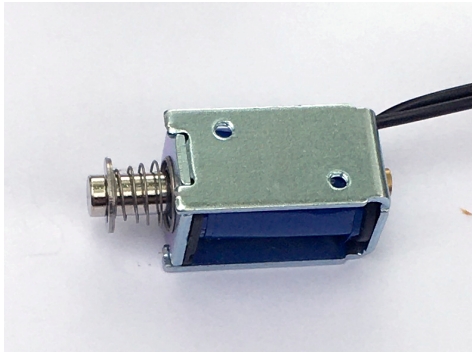
Safety

There's no risk of getting shocked by what we're working with but there are some things we need to be aware of.
Don't connect the blue and red or the 5V and blue connections. This will break the batteries or Xiao.
If anything gets hot remove the battery connector from the breadboard.
This device prioritizes simplicity over doing things the right way. This means the actuators are pushed a little past their limits and will heat up over time. It's nothing that should cause a issue though.
Don't try and use the device when it's powered by USB rather than batteries. USB power is usually used for Arduino devices but it can't supply enough current to work the actuators.

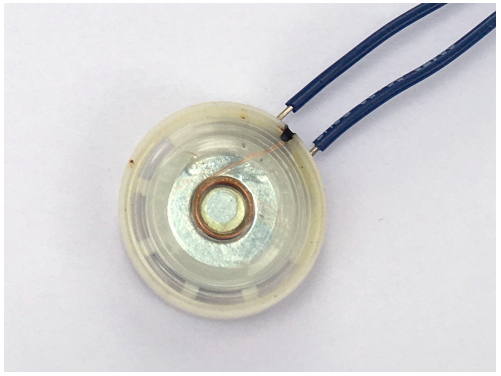


Actuators

Motor
Rotates when switched on. Direction of rotation can be changed by flipping the wires connecting to it.

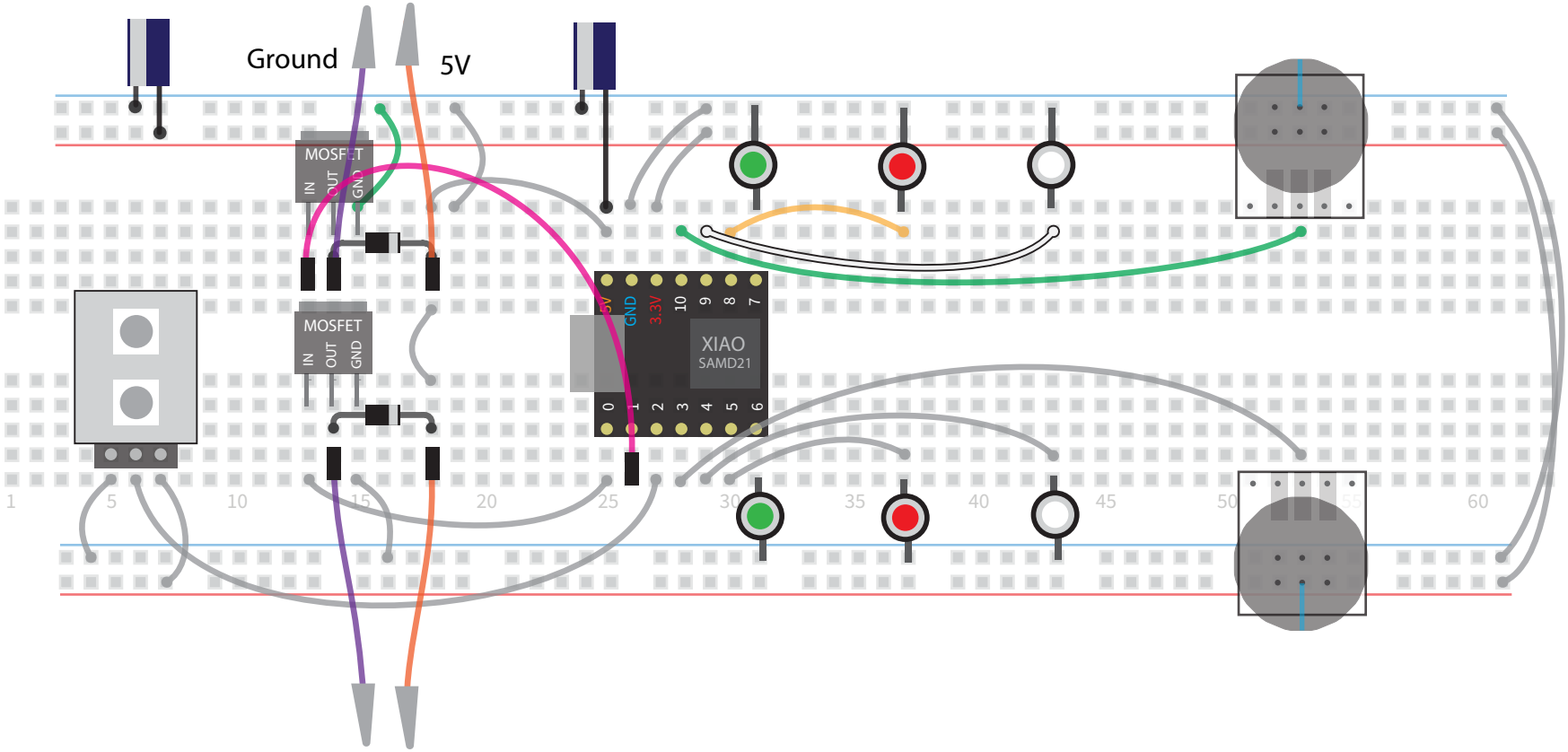


Solenoid
Moves a small piston one direction when powered and then returns when powered off. It's non-polar so the wires can be attached either way for the same result.



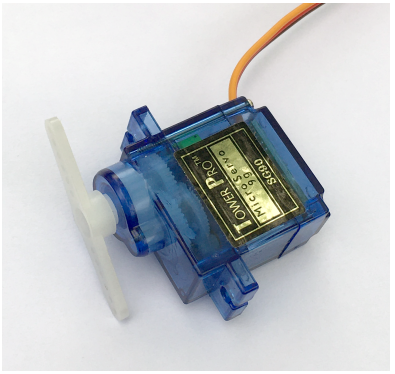
Speaker
Makes a nice little pop when turned on. Technically polar but doesn't matter in this situation.

The top channel is very similar.
Wires in gray are already installed
The pink wire has pins with black cylinders on both ends. It might be several different colors.
This wire gets moved to use the servo so this kind of wire makes it easier



Servo

Can be moved to a specific angle in it's 180° range based on the data it receives.
To use it, move the wire connecting pin 1 of the Xiao so it connects to the yellow wire of the servo.
The red wire will go to 5V and the brown to ground.



To use it, hold play then record. The light will be yellow instead of red. Now it's recording the knob's position. When playing in knob mode the light will be pinkish and change with the position.
The act button will move the servo all the way to one side when recording.
Note that servos are mildly possessed and will wiggle on their own sometimes when connected but not playing.

Pressing record without holding play will record the action button sequence jut like the bottom channel.