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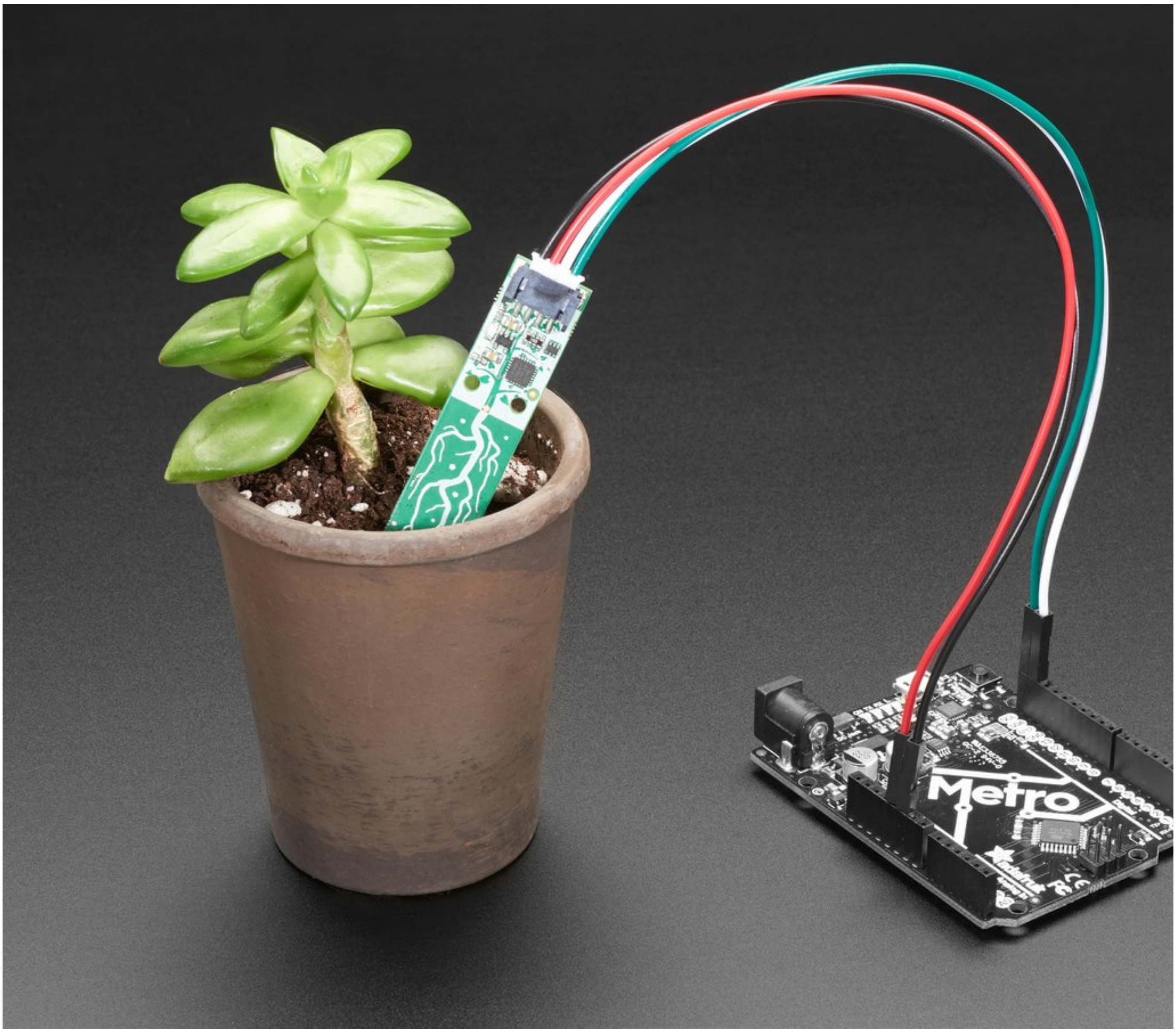

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[CircuitPython Essentials](https://learn.adafruit.com/circuitpython-essentials) CircuitPython PWM

CircuitPython Essentials

By Kattni Rembor
The next step in learning CircuitPython.

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CircuitPython PWM

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Your board has `pwmio` support, which means you can PWM LEDs, control servos, beep piezos, and manage "pulse train" type devices like DHT22 and Infrared.

Nearly every pin has PWM support! For example, all ATSAMD21 board have an **A0** pin which is 'true' analog out and *does not* have PWM support.

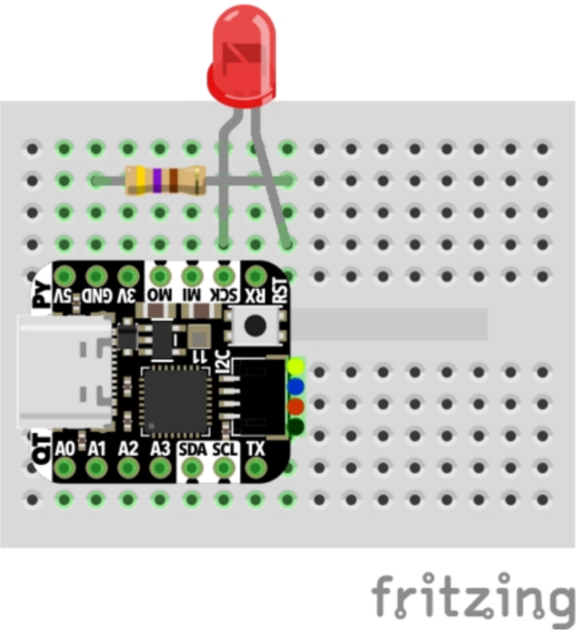
PWM with Fixed Frequency

This example will show you how to use PWM to fade the little red LED on your board.

The QT Py M0 does not have a little red LED. Therefore, you must connect an external LED and edit this example for it to work. Follow the wiring diagram and steps below to run this example on QT Py M0.

The following illustrates how to connect an external LED to a QT Py M0.

- **LED +** to **QT Py SCK**
- **LED -** to **470Ω resistor**
- **470Ω resistor** to **QT Py GND**

- 

Copy and paste the code into **code.py** using your favorite editor, and save the file.

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```
"""CircuitPython Essentials: PWM with Fixed Frequency example."""
import time
import board
import pwmio

# LED setup for most CircuitPython boards:
led = pwmio.PWMOut(board.LED, frequency=5000, duty_cycle=0)
# LED setup for QT Py M0:
# led = pwmio.PWMOut(board.SCK, frequency=5000, duty_cycle=0)

while True:
    for i in range(100):
        # PWM LED up and down
        if i < 50:
            led.duty_cycle = int(i * 2 * 65535 / 100)  # Up
        else:
            led.duty_cycle = 65535 - int((i - 50) * 2 * 65535 / 100)  # Down
        time.sleep(0.01)
```

View on GitHub
Remember: To "comment out" a line, put a # and a space before it. To "uncomment" a line, remove the # + space from the beginning of the line.

To use with QT Py M0, you must comment out `led = pwmio.PWMOut(board.LED, frequency=5000, duty_cycle=0)` and uncomment `led = pwmio.PWMOut(board.SCK, frequency=5000, duty_cycle=0)`. Your setup lines should look like this for the example to work with QT Py M0:

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```
# LED setup for most CircuitPython boards:
# led = pwmio.PWMOut(board.LED, frequency=5000, duty_cycle=0)
# LED setup for QT Py M0:
led = pwmio.PWMOut(board.SCK, frequency=5000, duty_cycle=0)
```

Create a PWM Output

```
led = pwmio.PWMOut(board.LED, frequency=5000, duty_cycle=0)
```

Since we're using the onboard LED, we'll call the object `led`, use `pwmio.PWMOut` to create the output and pass in the `D13` LED pin to use.

Main Loop

The main loop uses `range()` to cycle through the loop. When the range is below 50, it PWMs the LED brightness up, and when the range is above 50, it PWMs the brightness down. This is how it fades the LED brighter and dimmer!

The `time.sleep()` is needed to allow the PWM process to occur over a period of time. Otherwise it happens too quickly for you to see!

PWM Output with Variable Frequency

Fixed frequency outputs are great for pulsing LEDs or controlling servos. But if you want to make some beeps with a piezo, you'll need to vary the frequency.

The following example uses `pwmio` to make a series of tones on a piezo.

To use with any of the M0 boards, no changes to the following code are needed.

Remember: To "comment out" a line, put a # and a space before it. To "uncomment" a line, remove the # + space from the beginning of the line.

To use with the Metro M4 Express, ItsyBitsy M4 Express or the Feather M4 Express, you must comment out the `piezo = pwmio.PWMOut(board.A2, duty_cycle=0, frequency=440, variable_frequency=True)` **line and uncomment the** `piezo = pwmio.PWMOut(board.A1, duty_cycle=0, frequency=440, variable_frequency=True)` **line. A2 is not a supported PWM pin on the M4 boards!**

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```
"""CircuitPython Essentials PWM with variable frequency piezo example"""
import time
import board
import pwmio

# For the M0 boards:
piezo = pwmio.PWMOut(board.A2, duty_cycle=0, frequency=440, variable_frequency=True)

# For the M4 boards:
# piezo = pwmio.PWMOut(board.A1, duty_cycle=0, frequency=440, variable_frequency=True)

while True:
    for f in (262, 294, 330, 349, 392, 440, 494, 523):
        piezo.frequency = f
        piezo.duty_cycle = 65535 // 2  # On 50%
        time.sleep(0.25)  # On for 1/4 second
        piezo.duty_cycle = 0  # Off
        time.sleep(0.05)  # Pause between notes
    time.sleep(0.5)
```

View on GitHub

If you have `simpleio` library loaded into your /lib folder on your board, we have a nice little helper that makes a tone for you on a piezo with a single command.

To use with any of the M0 boards, no changes to the following code are needed.

To use with the Metro M4 Express, ItsyBitsy M4 Express or the Feather M4 Express, you must comment out the `simpleio.tone(board.A2, f, 0.25)` **line and uncomment the** `simpleio.tone(board.A1, f, 0.25)` **line. A2 is not a supported PWM pin on the M4 boards!**

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```
"""CircuitPython Essentials PWM piezo simpleio example"""
import time
import board
import simpleio

while True:
    for f in (262, 294, 330, 349, 392, 440, 494, 523):
        # For the M0 boards:
        simpleio.tone(board.A2, f, 0.25)  # on for 1/4 second
        # For the M4 boards:
        # simpleio.tone(board.A1, f, 0.25)  # on for 1/4 second
        time.sleep(0.05)  # pause between notes
    time.sleep(0.5)
```

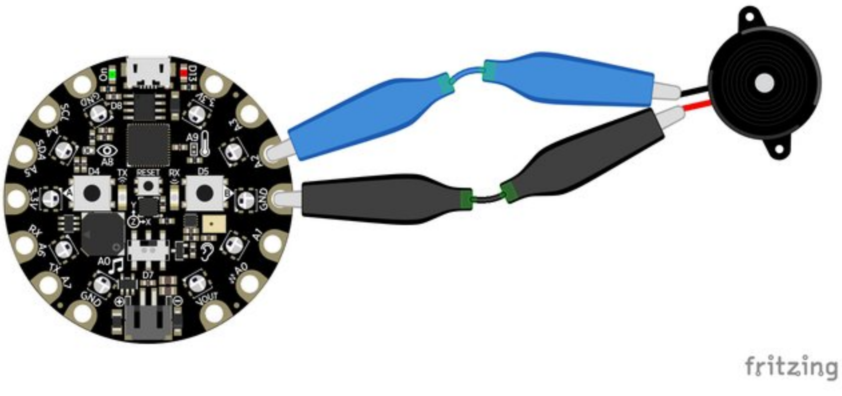
View on GitHub

As you can see, it's much simpler!

Wire it up

Use the diagrams below to help you wire up your piezo. Attach one leg of the piezo to pin **A2** on the M0 boards or **A1** on the M4 boards, and the other leg to **ground**. It doesn't matter which leg is connected to which pin. They're interchangeable!

Circuit Playground Express



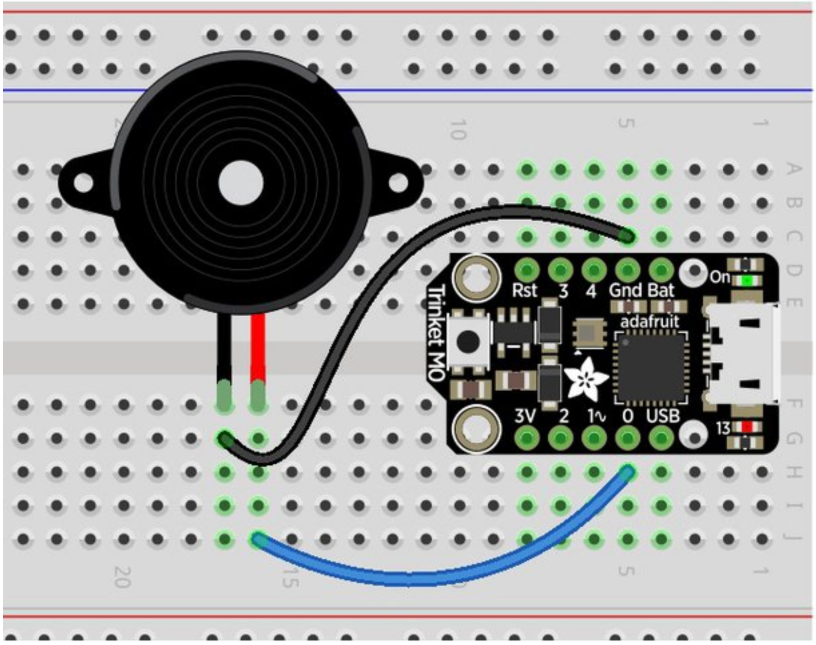
Use alligator clips to attach **A2** and any one of the **GND** to different legs of the piezo.

CPX has PWM on the following pins: A1, A2, A3, A6, RX, LIGHT, A8, TEMPERATURE, A9, BUTTON_B, D5, SLIDE_SWITCH, D7, D13, REMOTEIN, IR_RX, REMOTEOUT, IR_TX, IR_PROXIMITY, MICROPHONE_CLOCK, MICROPHONE_DATA, ACCELEROMETER_INTERRUPT, ACCELEROMETER_SDA, ACCELEROMETER_SCL, SPEAKER_ENABLE.

There is NO PWM on: A0, SPEAKER, A4, SCL, A5, SDA, A7, TX, BUTTON_A, D4, NEOPIXEL, D8, SCK, MOSI, MISO, FLASH_CS.

-

Trinket M0

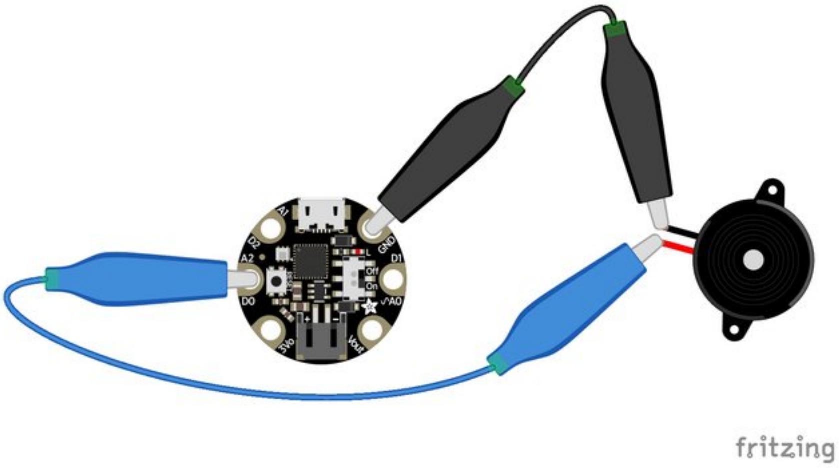
- 

Note: A2 on Trinket is also labeled Digital "0"!

Use jumper wires to connect **GND** and **D0** to different legs of the piezo.

Trinket has PWM available on the following pins: D0, A2, SDA, D2, A1, SCL, MISO, D4, A4, TX, MOSI, D3, A3, RX, SCK, D13, APA102_MOSI, APA102_SCK.

There is NO PWM on: A0, D1.

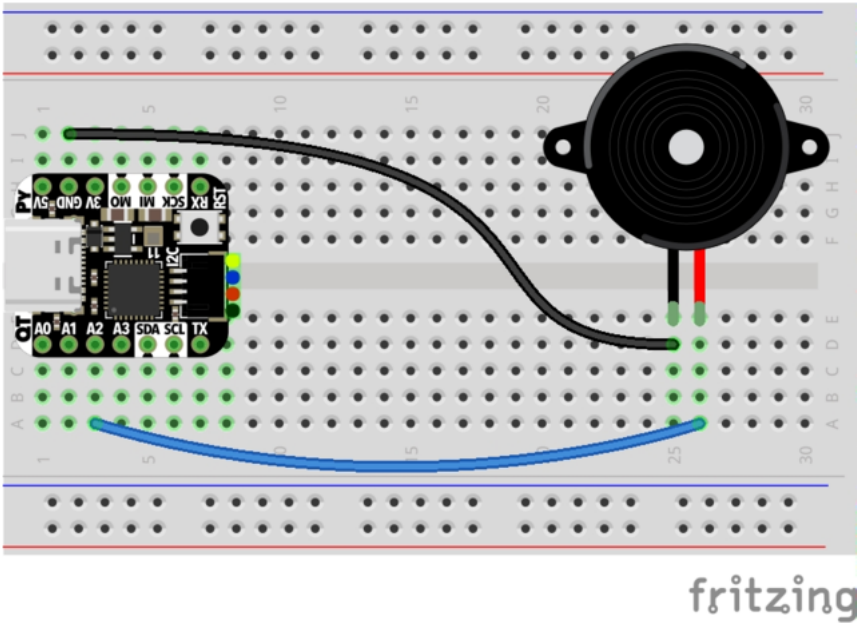
- 

Gemma M0

Use alligator clips to attach **A2** and **GND** to different legs on the piezo.

Gemma has PWM available on the following pins: A1, D2, RX, SCL, A2, D0, TX, SDA, L, D13, APA102_MOSI, APA102_SCK.

There is NO PWM on: A0, D1.

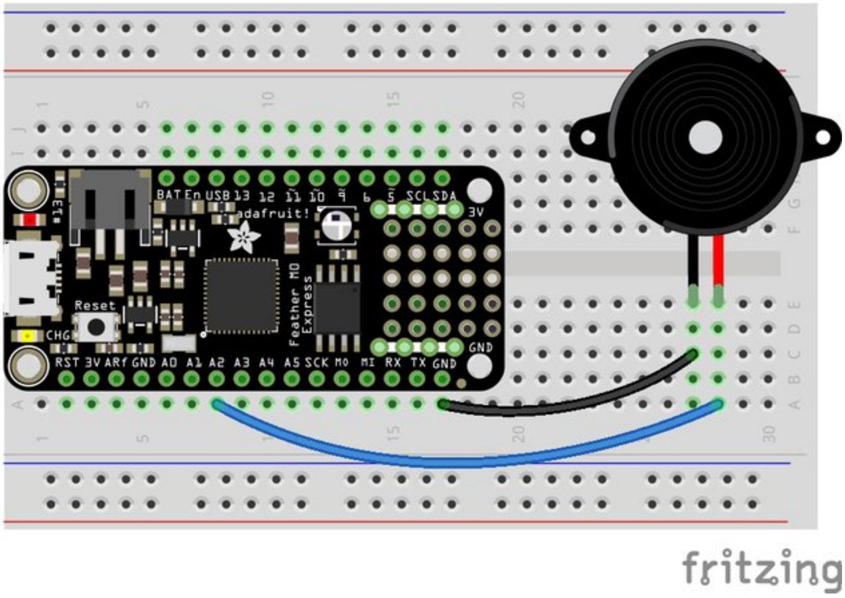
- 

QT Py M0

Use jumper wires to attach **A2** and **GND** to different legs of the piezo.

The QT Py M0 has PWM on the following pins: A2, A3, A6, A7, A8, A9, A10, D2, D3, D4, D5, D6, D7, D8, D9, D10, SCK, MISO, MOSI, NEOPIXEL, RX, TX, SCL, SDA.

There is NO A0, A1, D0, D1, NEOPIXEL_POWER.

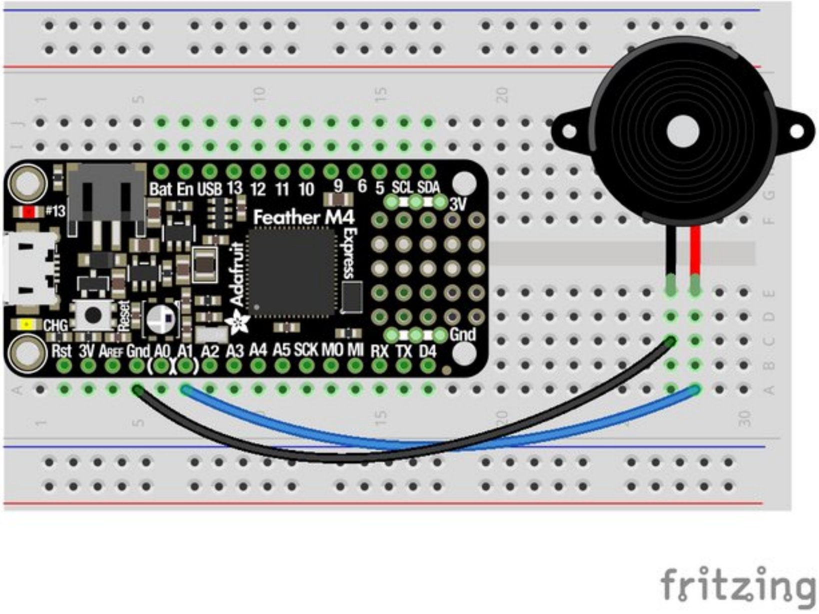
- 
BAT En USB 13 12 11 10 9 6 5 SCL SDA
3V
adafruit!
Feather M0 Express
Reset
CHG
#13
GND
RST 3V ARf GND A0 A1 A2 A3 A4 A5 SCK MO MI RX TX GND
fritzing

  Feather M0 Express

  Use jumper wires to attach **A2** and one of the two **GND** to different legs of the piezo.

  Feather M0 Express has PWM on the following pins: A2, A3, A4, SCK, MOSI, MISO, D0, RX, D1, TX, SDA, SCL, D5, D6, D9, D10, D11, D12, D13, NEOPIXEL.

  There is NO PWM on: A0, A1, A5.

- 
Bat En USB 13 12 11 10 9 6 5 SCL SDA
3V
Feather M4
Express
Adafruit
#13
CHG
Reset
Gnd
Rst 3V Aref Gnd A0 A1 A2 A3 A4 A5 SCK MO MI RX TX D4
fritzing

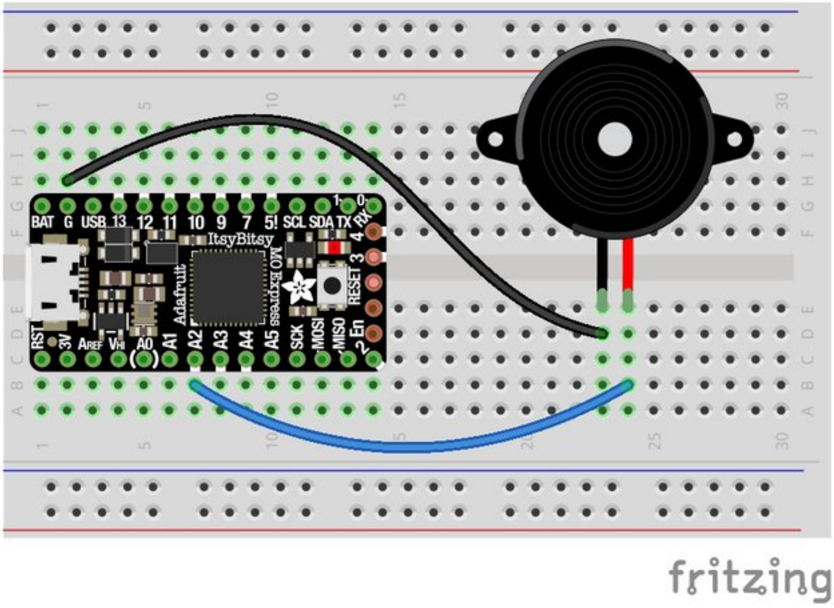
  Feather M4 Express

  Use jumper wires to attach **A1** and one of the two **GND** to different legs of the piezo.

  To use A1, comment out the current pin setup line, and uncomment the line labeled for the M4 boards. See the details above!

  Feather M4 Express has PWM on the following pins: A1, A3, SCK, D0, RX, D1, TX, SDA, SCL, D4, D5, D6, D9, D10, D11, D12, D13.

  There is NO PWM on: A0, A2, A4, A5, MOSI, MISO.

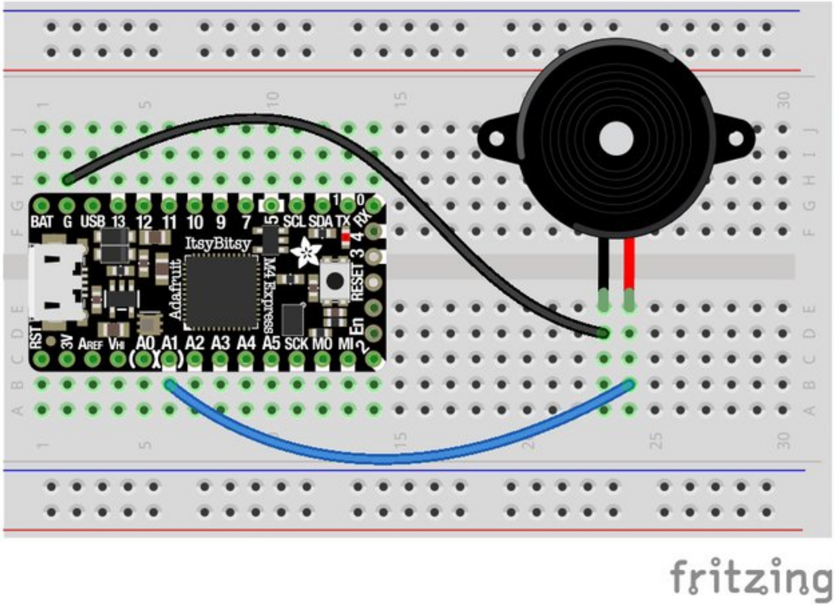
- 
BAT G USB 13 12 11 10 9 7 5! SCL SDA TX RX
ItsyBitsy
M0 Express
Adafruit
RST 3V Aref Vhi A0 A1 A2 A3 A4 A5 SCK MOSI MISO En
RESET
fritzing

  ItsyBitsy M0 Express

  Use jumper wires to attach **A2** and **G** to different legs of the piezo.

  ItsyBitsy M0 Express has PWM on the following pins: D0, RX, D1, TX, D2, D3, D4, D5, D6, D7, D8, D9, D10, D11, D12, D13, L, A2, A3, A4, MOSI, MISO, SCK, SCL, SDA, APA102_MOSI, APA102_SCK.

  There is NO PWM on: A0, A1, A5.

- 
BAT G USB 13 12 11 10 9 7 5 SCL SDA TX RX
ItsyBitsy
Adafruit
M4 Express
RESET 3 4
RST 3V AREF VHI A0 A1 A2 A3 A4 A5 SCK MO MI 2 En
fritzing

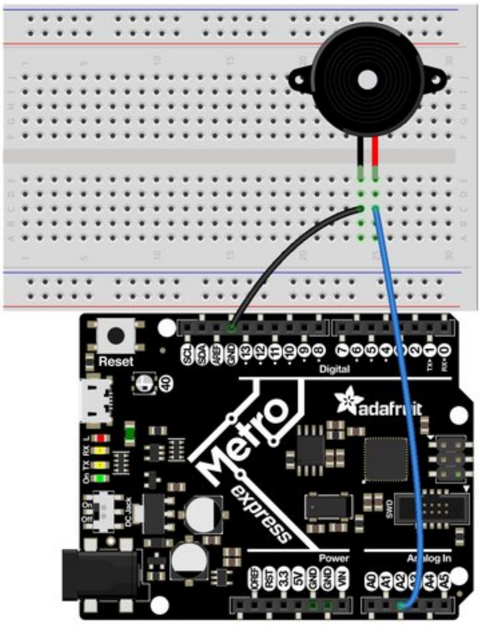
  ItsyBitsy M4 Express

  Use jumper wires to attach **A1** and **G** to different legs of the piezo.

  To use A1, comment out the current pin setup line, and uncomment the line labeled for the M4 boards. See the details above!

  ItsyBitsy M4 Express has PWM on the following pins: A1, D0, RX, D1, TX, D2, D4, D5, D7, D9, D10, D11, D12, D13, SDA, SCL.

  There is NO PWM on: A2, A3, A4, A5, D3, SCK, MOSI, MISO.

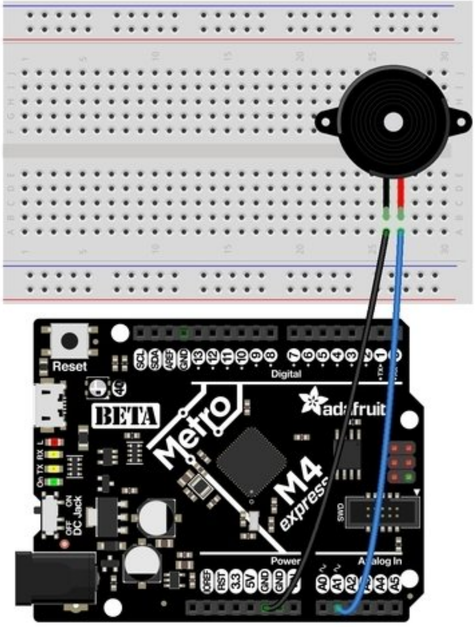
- 

  Metro M0 Express

  Use jumper wires to connect **A2** and any one of the **GND** to different legs on the piezo.

  Metro M0 Express has PWM on the following pins: A2, A3, A4, D0, RX, D1, TX, D2, D3, D4, D5, D6, D7, D8, D9, D10, D11, D12, D13, SDA, SCL, NEOPIXEL, SCK, MOSI, MISO.

  There is NO PWM on: A0, A1, A5, FLASH_CS.

- 

  Metro M4 Express

  Use jumper wires to connect **A1** and any one of the **GND** to different legs on the piezo.

  To use A1, comment out the current pin setup line, and uncomment the line labeled for the M4 boards. See the details above!

  Metro M4 Express has PWM on: A1, A5, D0, RX, D1, TX, D2, D3, D4, D5, D6, D7, D8, D9, D10, D11, D12, D13, SDA, SCK, MOSI, MISO

  There is No PWM on: A0, A2, A3, A4, SCL, AREF, NEOPIXEL, LED_RX, LED_TX.

Where's My PWM?

Want to check to see which pins have PWM yourself? We've written this handy script! It attempts to setup PWM on every pin available, and lets you know which ones work and which ones don't. Check it out!

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Copy Code

```
"""CircuitPython Essentials PWM pin identifying script"""
import board
import pwmio

for pin_name in dir(board):
    pin = getattr(board, pin_name)
    try:
        p = pwmio.PWMOut(pin)
        p.deinit()
        print("PWM on:", pin_name)  # Prints the valid, PWM-capable pins!
    except ValueError:  # This is the error returned when the pin is invalid.
        print("No PWM on:", pin_name)  # Prints the invalid pins.
    except RuntimeError:  # Timer conflict error.
        print("Timers in use:", pin_name)  # Prints the timer conflict pins.
    except TypeError:  # Error returned when checking a non-pin object in dir(board).
        pass  # Passes over non-pin objects in dir(board).
```

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CircuitPython MP3 Audio CircuitPython Servo

This guide was first published on Apr 02, 2018. It was last updated on 2021-04-07 13:36:38 -0400.

This page (CircuitPython PWM) was last updated on Feb 05, 2022.

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Difficulty: Beginner
Guide Type: Tutorial
Contributors: Kattni Rembor, Jeff Epler, Carter Nelson, lady ada
Categories: LEDs
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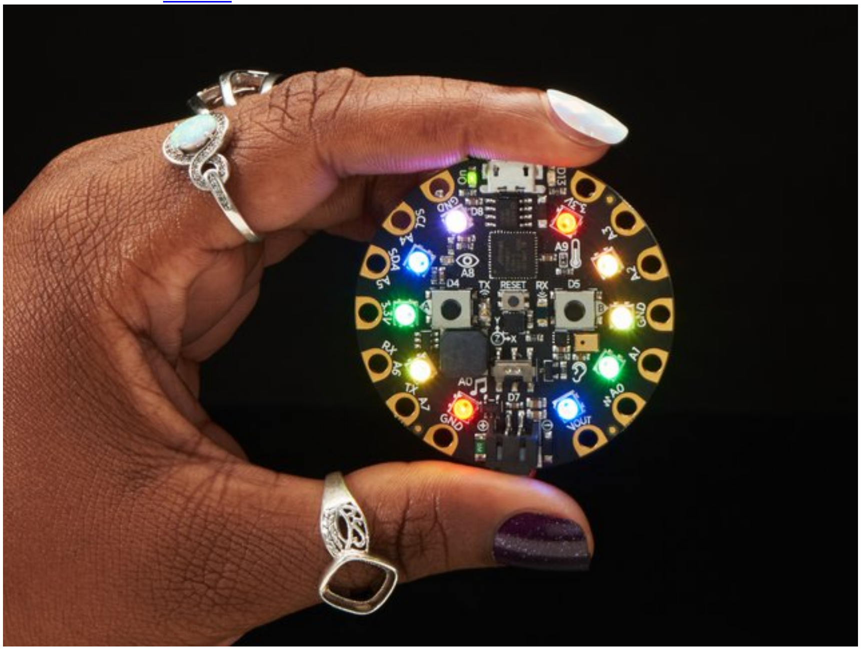

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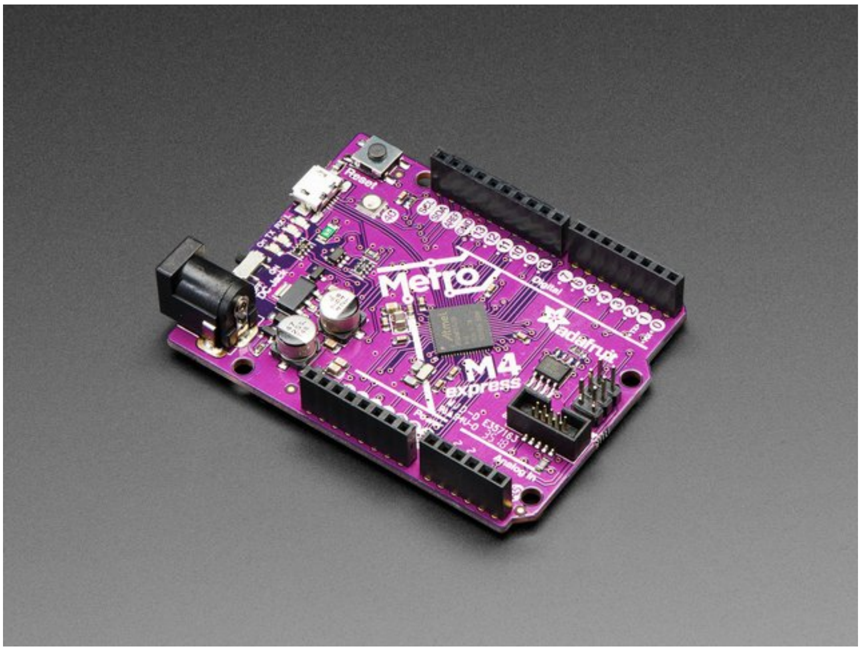

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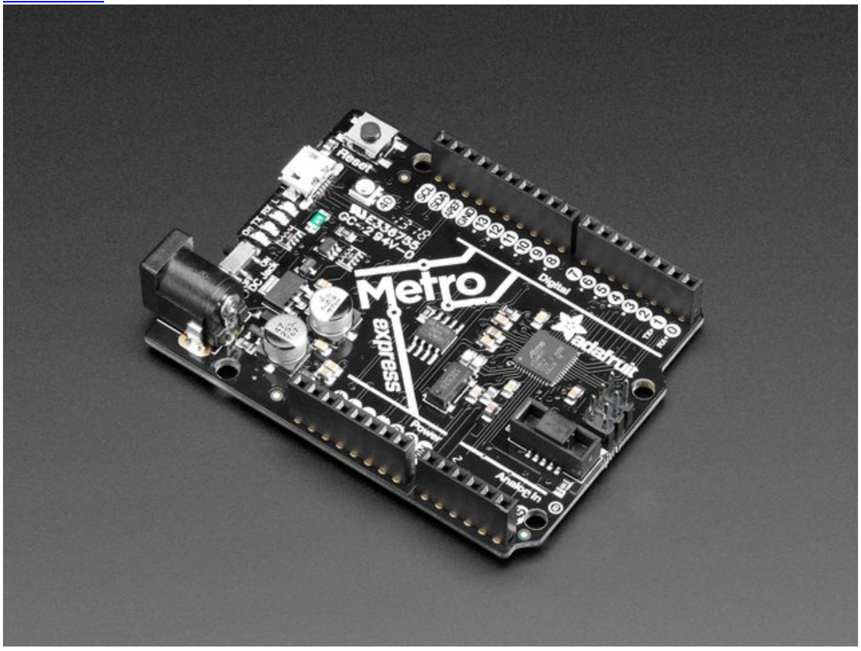

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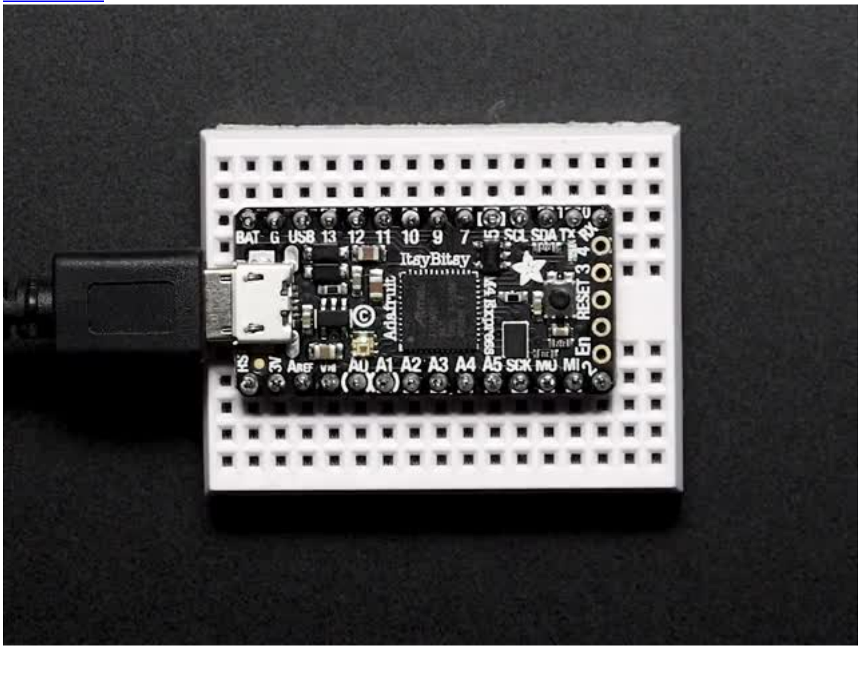

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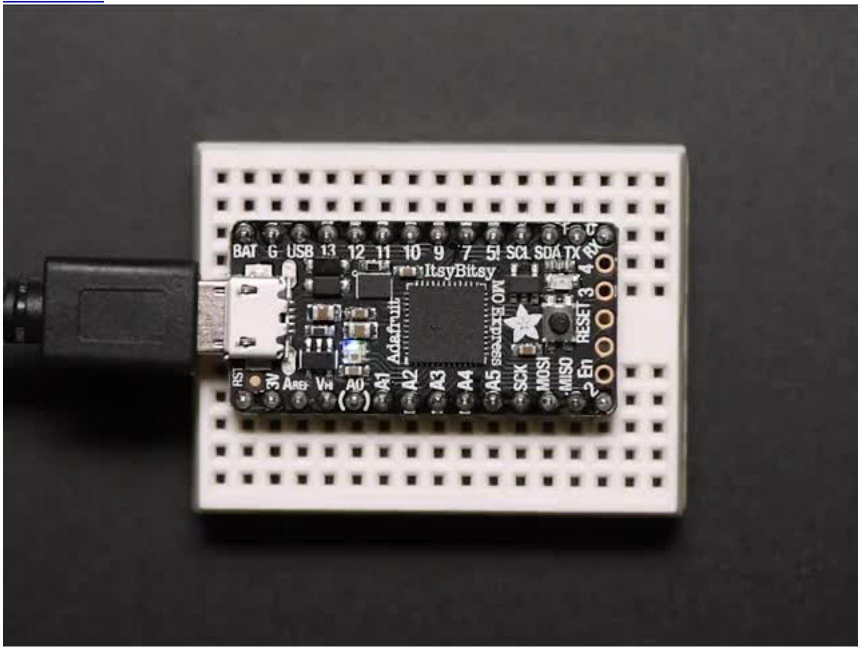

Adafruit ItsyBitsy M0 Express - for CircuitPython & Arduino IDE

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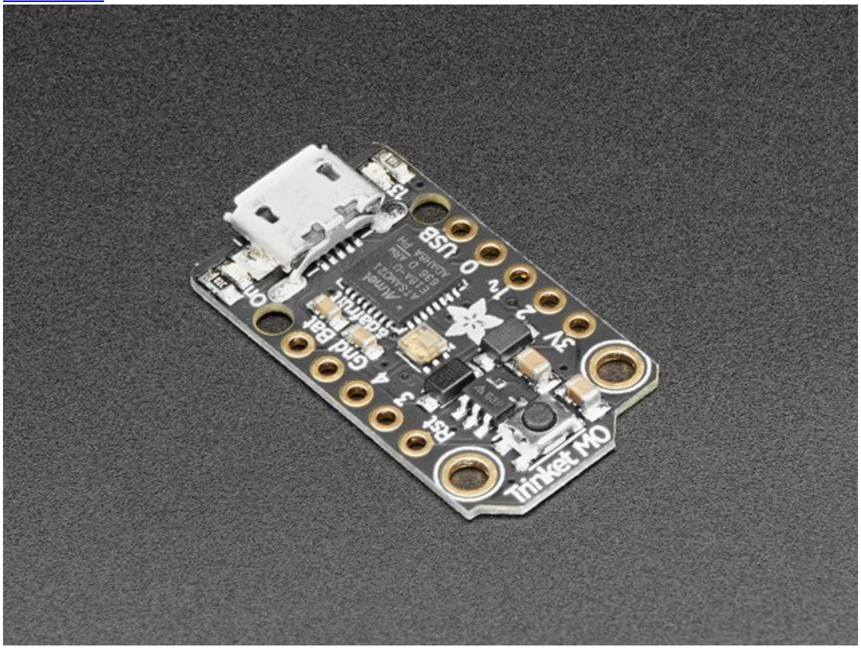

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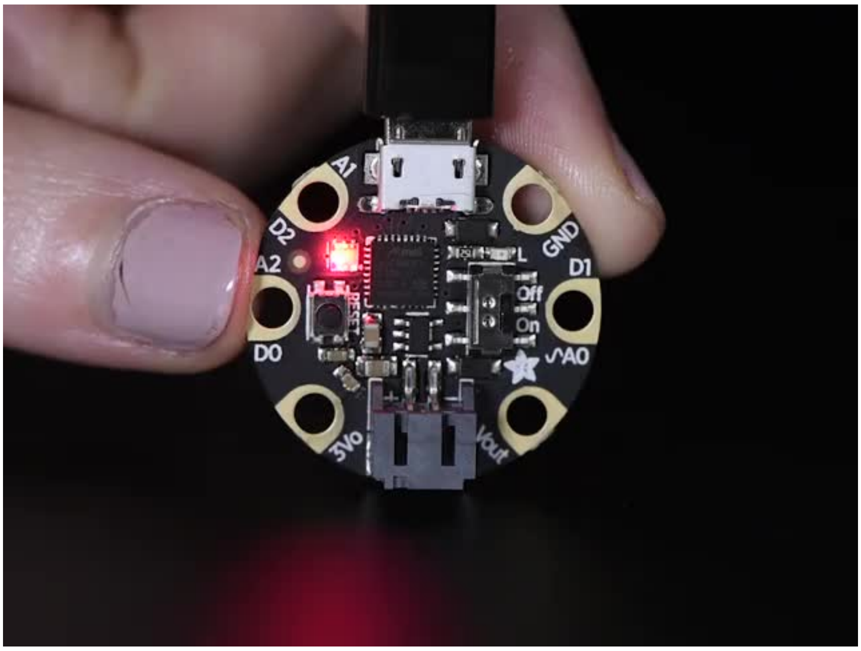

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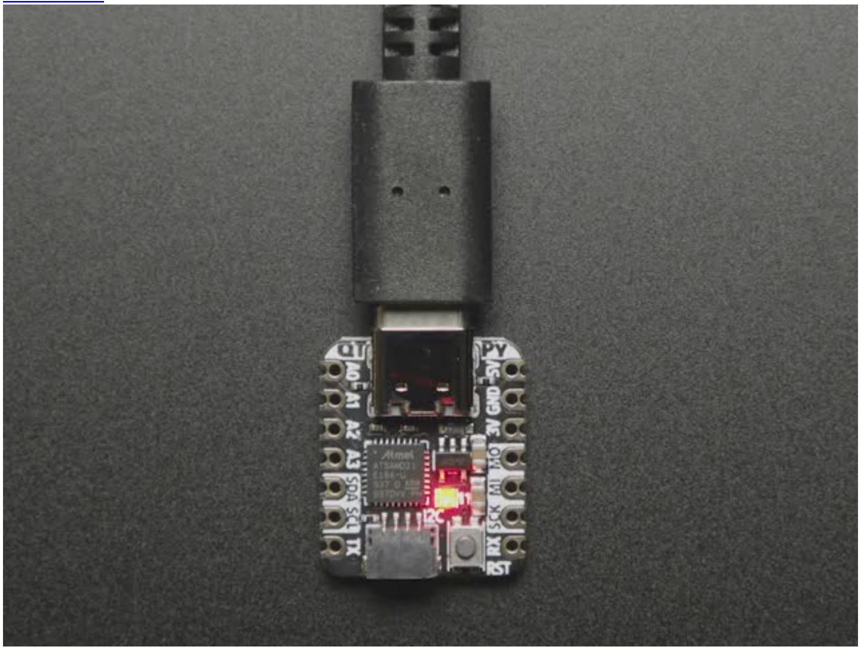

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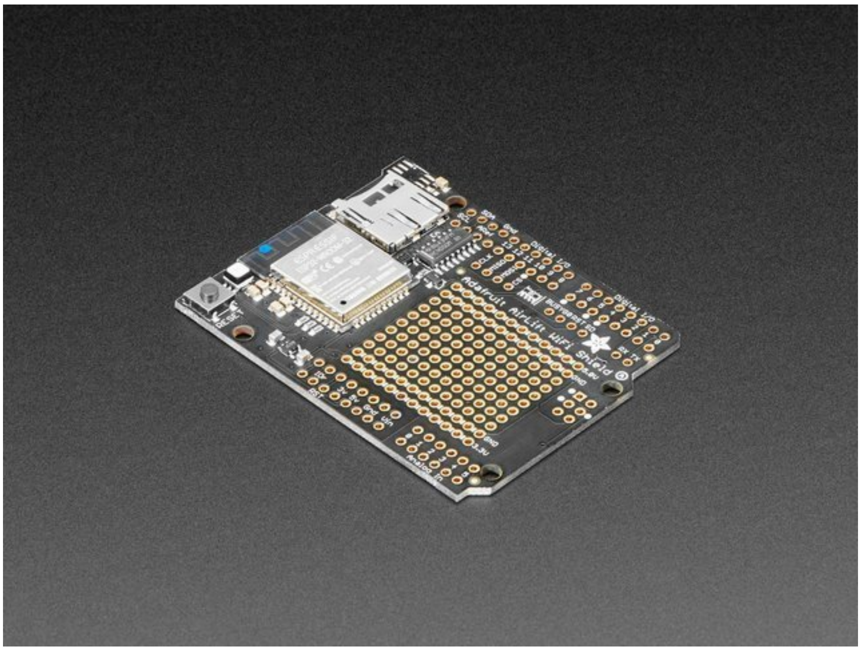

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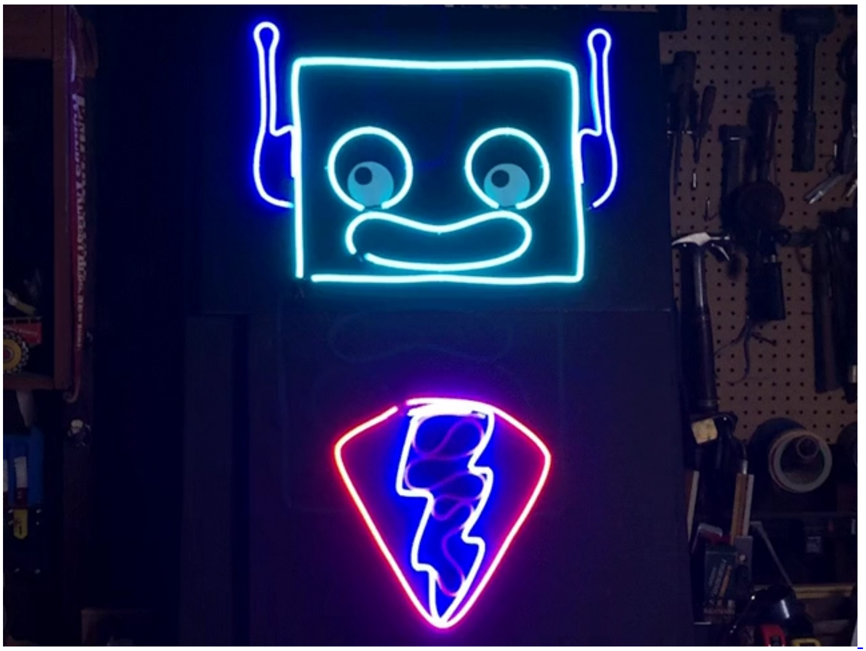

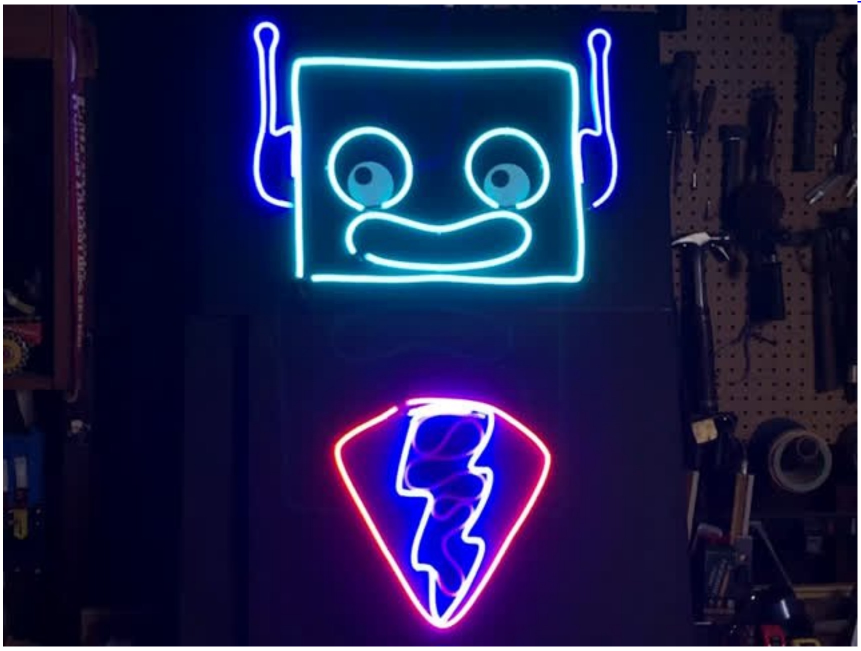

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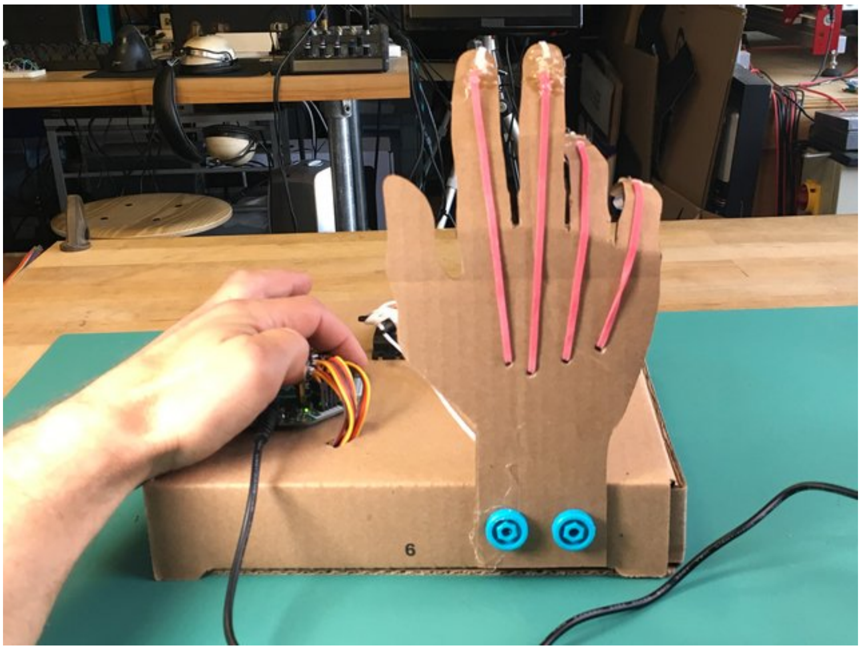

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