MicroPython Introduction (cont.)

MCHE 201 – Spring 2019

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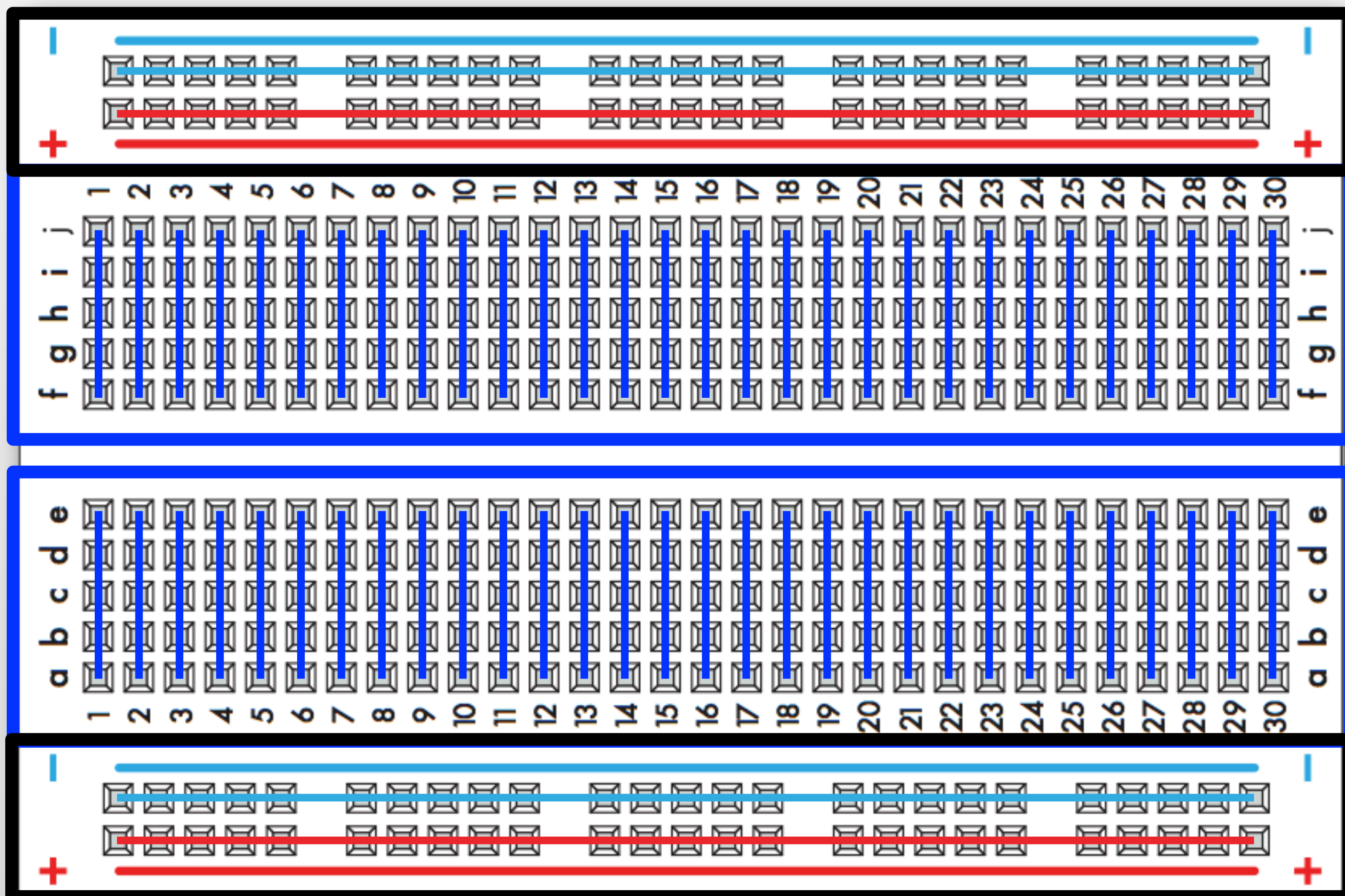
GitHub

All of the code contained in these lectures is available at the MCHE201 Class Repository on GitHub:

```
https://github.com/DocVaughan/MCHE201---Intro-to-Eng-Design
```

Breadboard Setup Review

Internally connected by column



Internally connected by row

Break in connection

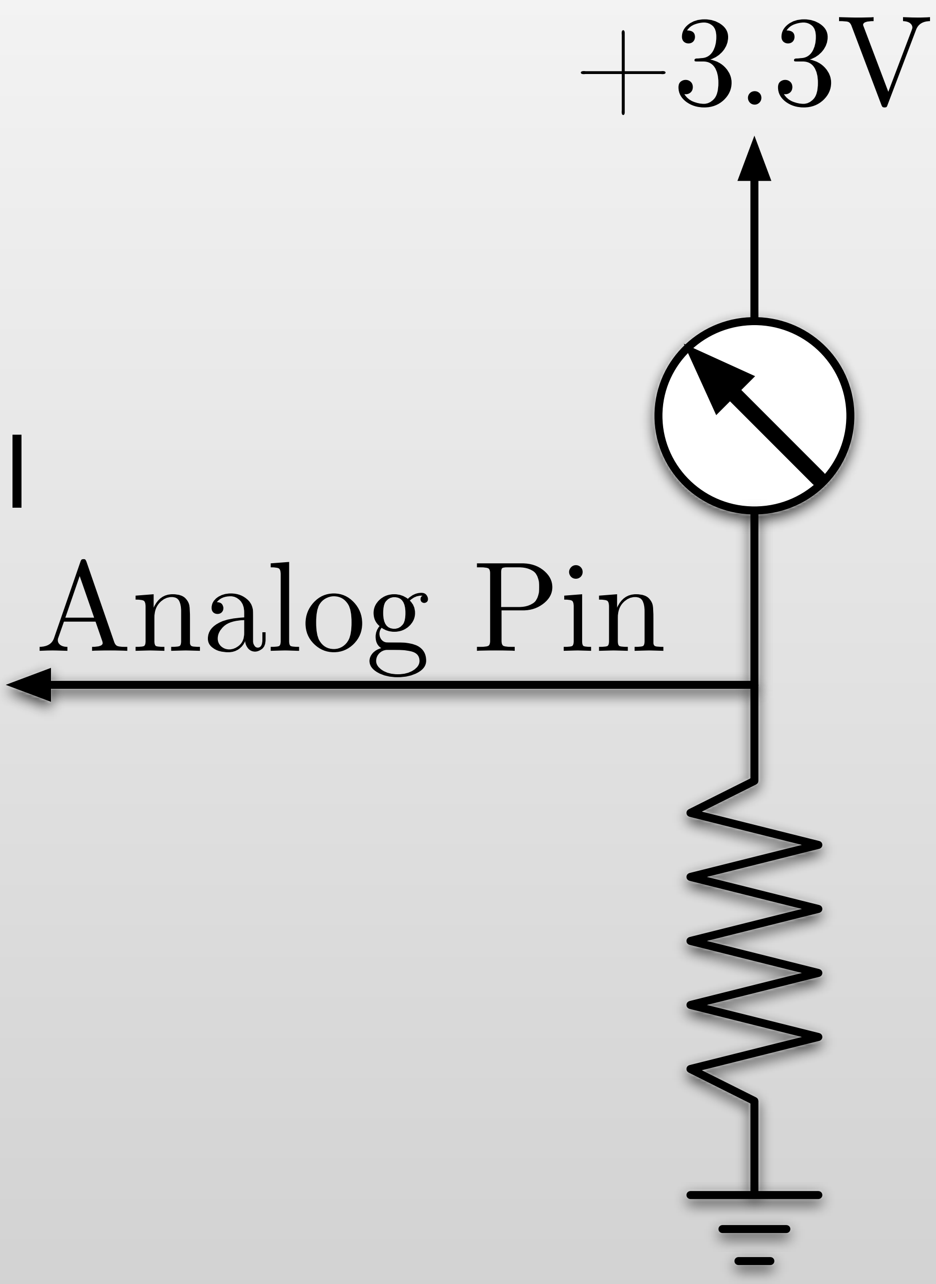
In your kit…

- **Potentiometer** - changes resistance based on rotation
- **Soft Potentiometer** - changes resistance based on where it's squeezed
- **Flex Sensor** - changes resistance based on how far it's bent
- **Force Sensitive Resistor (FSR)** - changes resistance based on how hard it's squeezed

All of these are *analog* sensors.

Measuring Changes in Resistance

- Make the component part of a voltage divider
- Measure voltage change resulting from resistance change
- To measure an analog signal, we'll need an Analog-to-Digital Converter (ADC)
- The pyboard ADCs are 12 bit, meaning that a value of 4095 for 3.3V and a value of 0 for 0V



On the pyboard

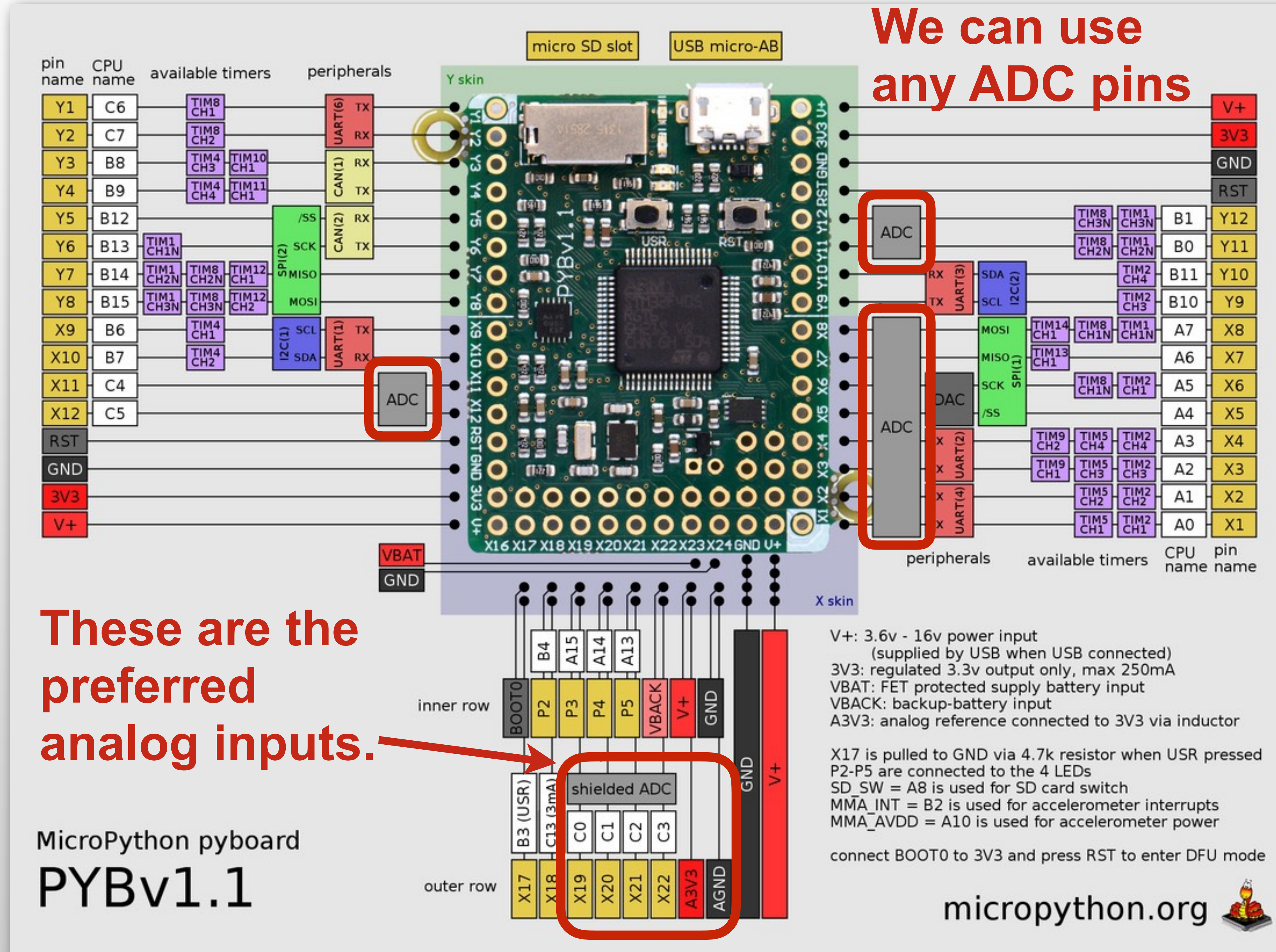


Image via `micropython.org`

In-class Exercise 4

- When the external pushbutton is pressed, turn on one of the onboard LEDs. When it is not pressed, the LED should be off.

- *Hint:* The logic will be identical to In-class Exercise 3. Only the setup and method to read the button need to change.

In-class Exercise 4 Setup

```python
import pyb  # import the pyboard module
import time # import the time module

# Assign the 1st LED to variable RED_LED
RED_LED = pyb.LED(1)

# Assign the input pin to input_pin
input_pin = pyb.Pin("X6",
                    pyb.Pin.IN,
                    pull=pyb.Pin.PULL_DOWN)
```

In-class Exercise 4 Algorithm

```
# Loop forever, checking the button every 100ms
while (True):
    # read the state of the input
    input_state = input_pin.value()

    if (input_state):
        print("The input is high (on).")
        RED_LED.on()

    else:
        print("The input is low (off).")
        RED_LED.off()

    # Sleep 100 milliseconds (0.1s)
    time.sleep_ms(100)
```

In-Class Exercise 5

- Divide the flex sensor range into four
- Turn on the same number LEDs as the “range number” of the current state of the flex sensor.
- In other words, when the sensor is not bent, no LEDs should be on. When it’s bent a little, one LED should turn on. When it’s bent to its maximum, all 4 LEDs should be on.

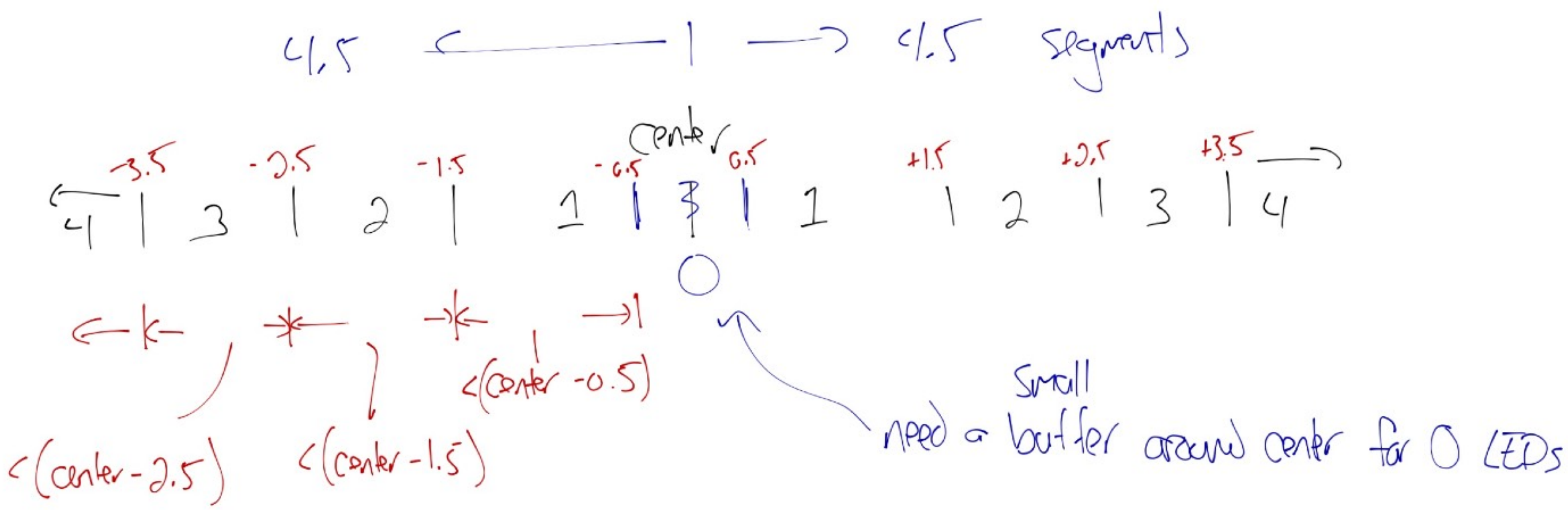
In-class Exercise 5 Setup

```python
import pyb          # import the pyboard module
import time         # import the time module

# Set up the analog-to-digital converter
flex_adc = pyb.ADC(pyb.Pin("X22"))

# Assign the names to the onboard LEDs
RED_LED = pyb.LED(1)
GREEN_LED = pyb.LED(2)
YELLOW_LED = pyb.LED(3)
BLUE_LED = pyb.LED(4)
```

Wait… What's the *algorithm*?



- Define center
- Define limits in each direction
- Calculate ranges for each LED #
  - 1 segment around 0
  - 4 other ranges on each side
- If in range:
  light N LEDs
  turn off others

Setting up the Ranges

```
# These numbers will likely vary for your particular system.
# So, they should be determined experimentally.
MIN_ADC = 2875
CENTER = 3275
MAX_ADC = 3850

# Using the analysis above, we can define the size of each division
LOW_ADC_DIVIDER = (CENTER - MIN_ADC) / 4.5
HIGH_ADC_DIVIDER = (MAX_ADC - CENTER) / 4.5

# We'll create ranges both above and below the center
# This will account for the flex sensor being bent in either direction
ONE_ZONE_LOW = CENTER - LOW_ADC_DIVIDER * 0.5
TWO_LED_LOW = CENTER - LOW_ADC_DIVIDER * 1.5
THREE_LED_LOW = CENTER - LOW_ADC_DIVIDER * 2.5
FOUR_LED_LOW = CENTER - LOW_ADC_DIVIDER * 3.5

ONE_ZONE_HIGH = CENTER + HIGH_ADC_DIVIDER * 0.5
TWO_LED_HIGH = CENTER + HIGH_ADC_DIVIDER * 1.5
THREE_LED_HIGH = CENTER + HIGH_ADC_DIVIDER * 2.5
FOUR_LED_HIGH = CENTER + HIGH_ADC_DIVIDER * 3.5
```

The Reading and Check

```
# Now read the pot every 500ms, forever
while (True):
    # Read the value of the flex sensor. Should be in the range 0-4095
    flex_value = flex_adc.read()

    # print out the values, nicely formatted
    print("\nADC:     {:5d}".format(flex_value))

    # Check ADC value to determine to which of the ranges it belongs
    if flex_value < FOUR_LED_LOW or flex_value > FOUR_LED_HIGH:
        print("All LEDs on.")
        RED_LED.on()
        GREEN_LED.on()
        YELLOW_LED.on()
        BLUE_LED.on()
```

(several elif statements)

```
    else:
        print("No LEDs on.")
        RED_LED.off()
        GREEN_LED.off()
        YELLOW_LED.off()
        BLUE_LED.off()

    time.sleep_ms(500)
```

In-class Exercise 6

- Vary the intensity of the onboard blue LED based on how hard you are pressing on the FSR
- Pressing harder should make the light brighter

In-class Exercise 6 Setup

```
import pyb        # import the pyboard module
import time       # import the time module

# Assign the 4th LED to variable BLUE_LED
BLUE_LED = pyb.LED(4)

# Set up the analog-to-digital converter
# Remember the pin can be any with ADC func.
fsr_adc = pyb.ADC(pyb.Pin("Y12"))
```

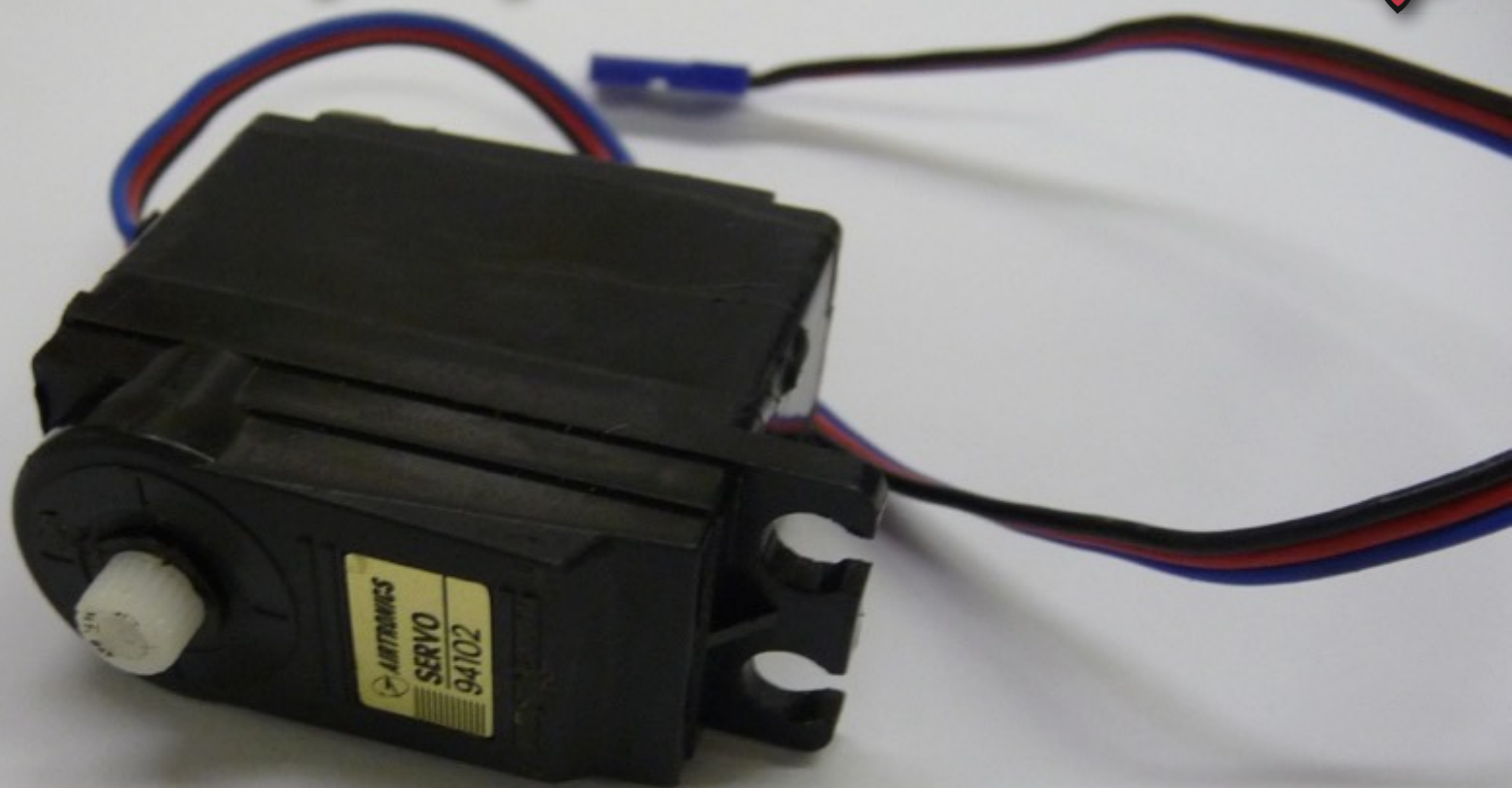
Wait… what's the *algorithm*?

- Have linear range of ADC in ~0-4095
- LED.intensity() expects integer from 0-255
- Define a function to map
  - Linear is good place to start (y = mx + b)
  - *Note:* Our eyes don't process light this way
- Based on that mapping, set LED intensity

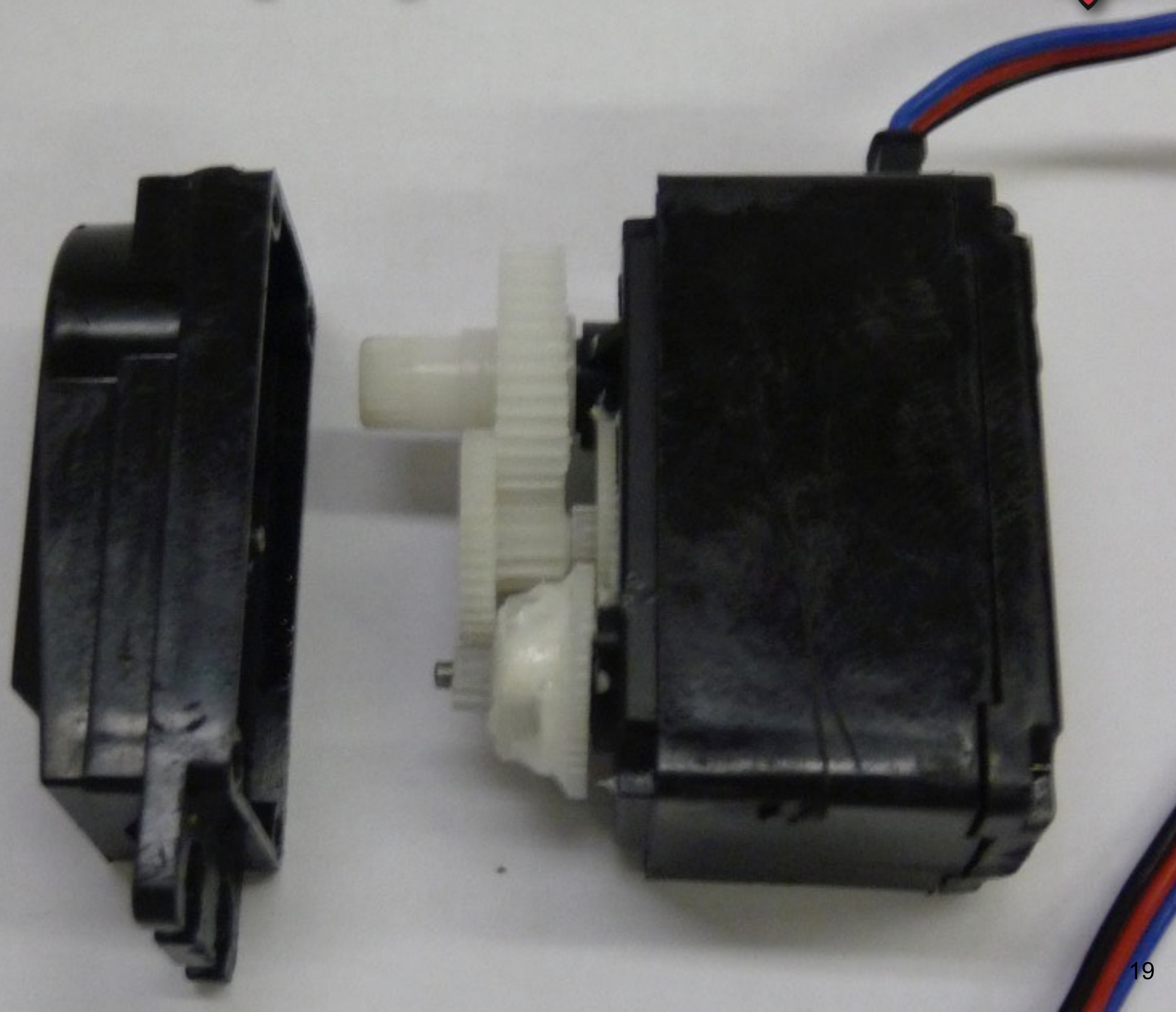
One solution: `https://github.com/DocVaughan/MCHE201---Intro-to-Eng-Design/tree/Spring-2019/MicroPython/MCHE201%20-%20In-class%20Exercise%206%20-%2003:14:19`

Hobby-style Servomotor

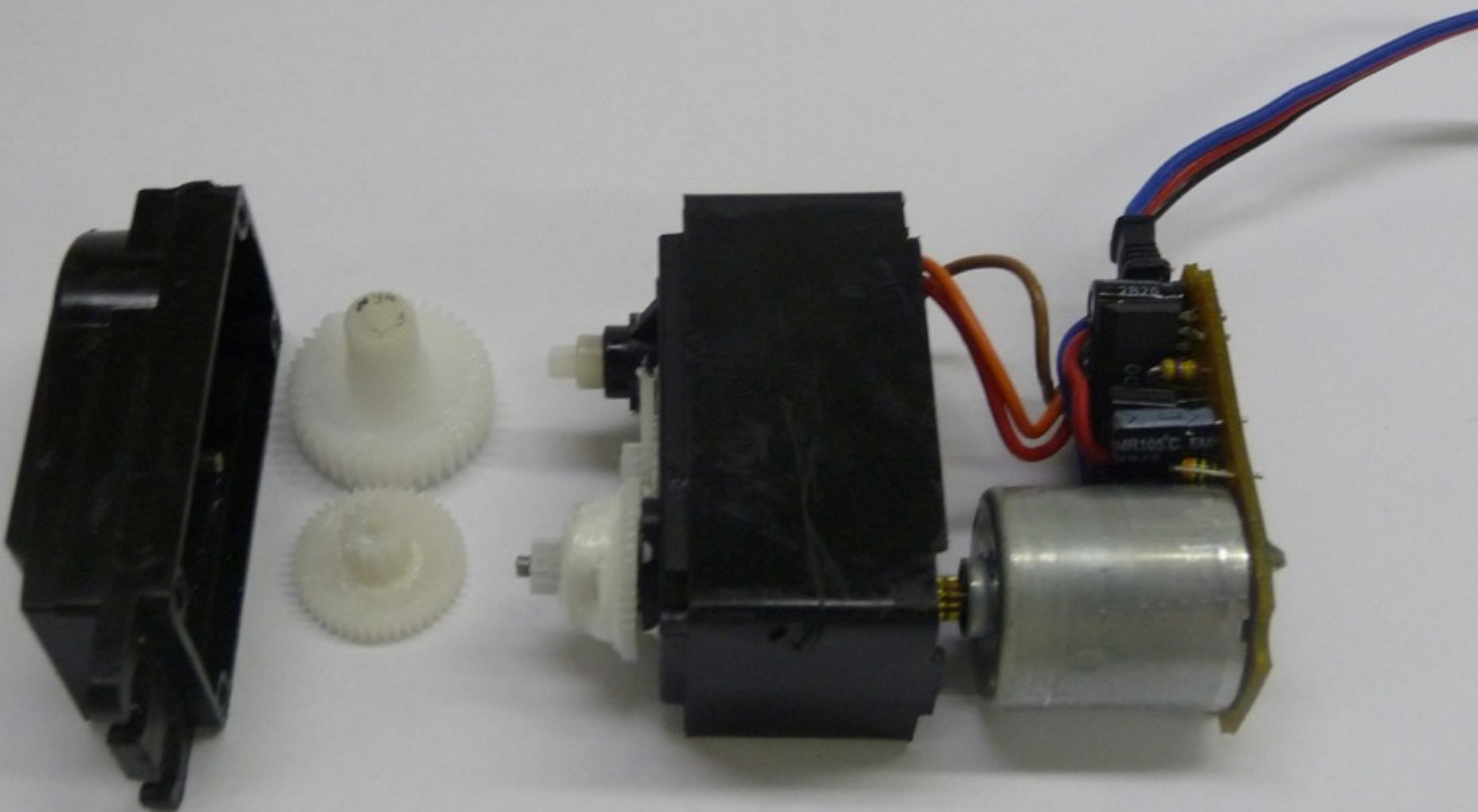
Inside a Hobby-style Servomotor



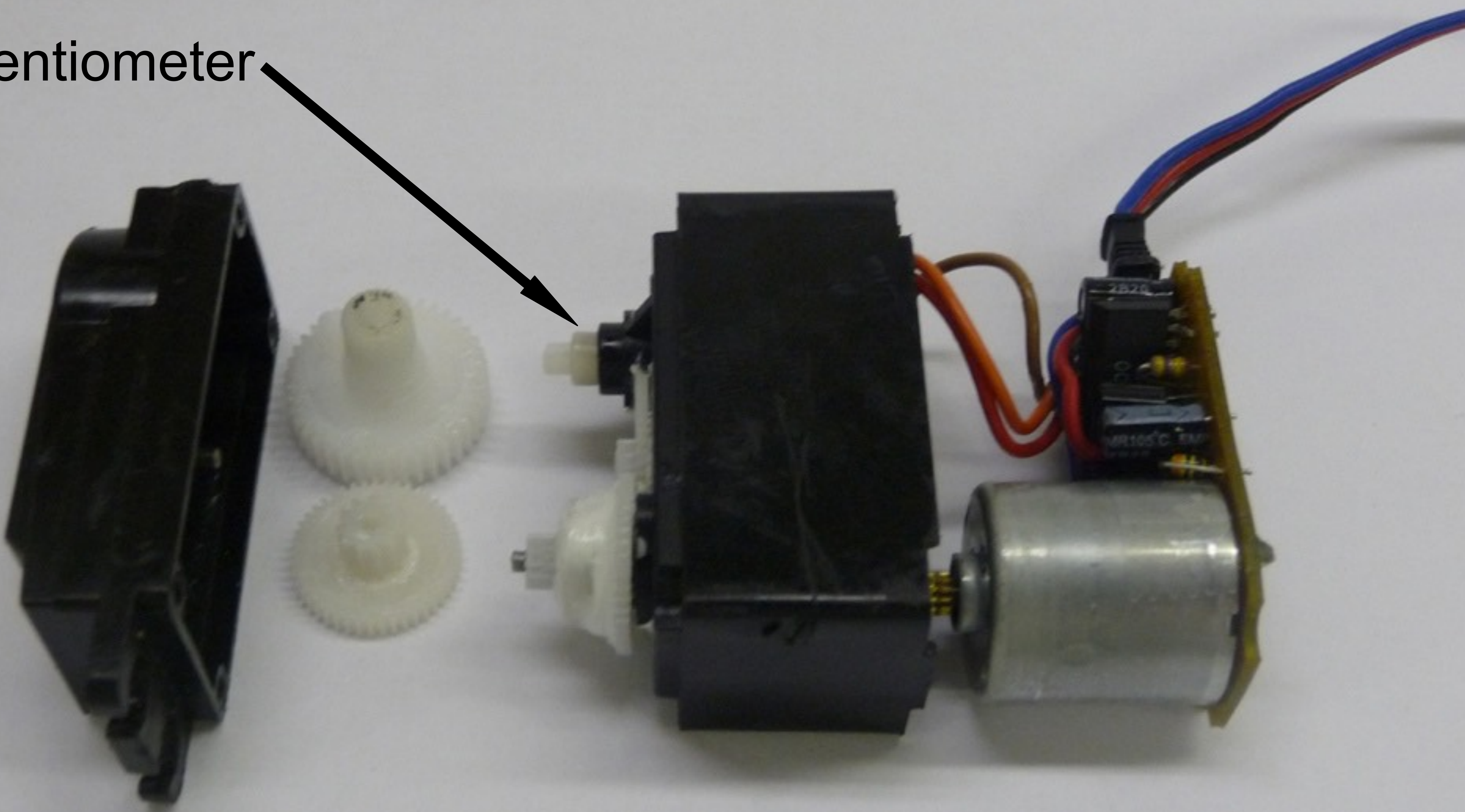
Inside a Hobby-style Servomotor



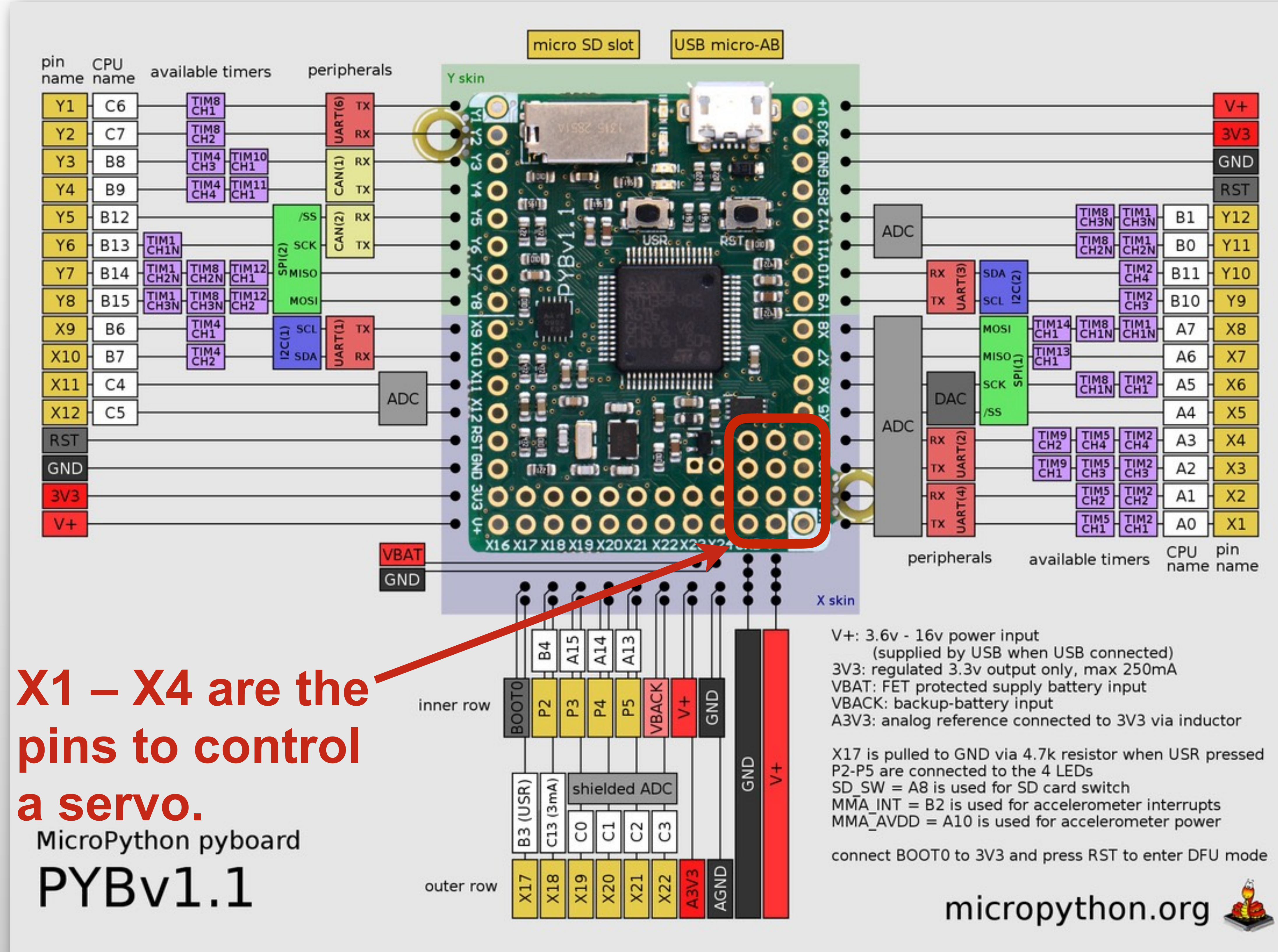
Inside a Hobby-style Servomotor



Inside a Hobby-style Servomotor



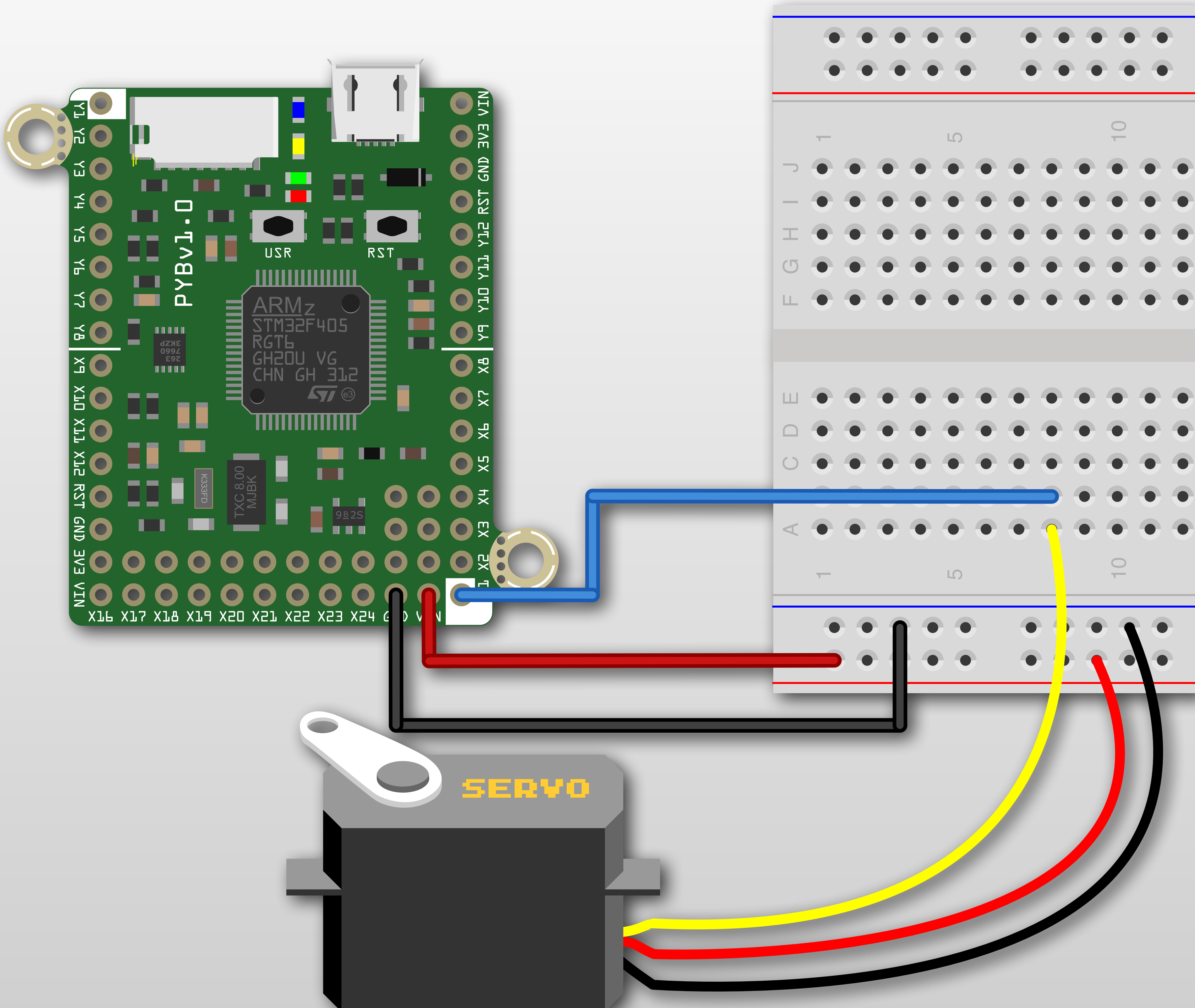
Servo Pins on the pyboard



X1 – X4 are the pins to control a servo.

Image via `micropython.org`

Servomotor Hardware Setup



Servomotor Core Functions

```
# Define the servo object.
# Servo 1 is connected to X1, Servo 2 to X2,
# Servo 3 to X3, and Servo 4 to X4
servo1 = pyb.Servo(1)

# Now, we can control the angle of the servo
# The range of possible angles is -90 < angle < 90,
# but many servos can not move over that entire range. -45 to 45 is safer
servo1.angle(45)

# Sleep 1s to let it move to that angle
time.sleep(1)

# Move to -45 degrees
servo1.angle(-45)

# To get the angle, call the .angle() method without an argument
current_angle = servo1.angle()

# Move to 45 degrees, taking 2seconds to get there
servo1.angle(45, 2000)
```

Reading User Input

- We can ask for user input from the REPL using `input()`

```
# Now, we'll ask the user for their input
print("Enter the desired angle in
degrees, then press return.")
desired_angle_input = input()
```

Reading User Input

- We can ask for user input from the REPL using `input()`

```
# Now, we'll ask the user for their input
print("Enter the desired angle in
degrees, then press return.")
desired_angle_input = input()
```

No guarantee the user will input a reasonable number… or a number at all.

MUST Check Input

Is it a number?

```
# We can use a try...except block to make sure
# the user actually input a number. If not,
# we'll use the current angle as the desired.

try:
    # convert to an integer
    desired_angle = int(desired_angle_input)

except ValueError:
    print("Please enter a valid number.")
    print("Remaining at current angle.")
    desired_angle = current_angle
```

MUST Check Inputs

Is is an *acceptable* number?

```
# Check that desired angle is within the bounds of the servo
if desired_angle > SERVO_MAX_ANGLE:
    desired_angle = SERVO_MAX_ANGLE
    print("The servo cannot move to that angle.")
    print("Moving to max. angle instead\n".format(desired_angle))

elif desired_angle < SERVO_MIN_ANGLE:
    desired_angle = SERVO_MIN_ANGLE
    print("The servo cannot move to that angle.")
    print("Moving to min. angle instead\n".format(desired_angle))

else:
    print("Moving to desired angle".format(desired_angle))

servo1.angle(desired_angle)
```

In-class Exercise 7

- Attach a potentiometer
- Have the servo angle track the angle of the potentiometer