MicroPython Introduction (cont.)

MCHE 201 – Spring 2019

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In-class Exercise 8

- Connect a pushbutton
- Turn on the green LED
- When the pushbutton is pressed
  - Turn on the red LED
  - Turn off the green LED
- When the button is pressed again
  - Turn off the red LED
  - Turn on the green LED
  - Print the time elapsed between button presses to the REPL

In-class Exercise 8 Setup

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

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

```
# Assign the input pin to variable input_pin
# We set it up as an input with a pulldown resistor
input_pin = pyb.Pin("X6", pyb.Pin.IN,
                           pull=pyb.Pin.PULL_DOWN)

# Turn on the green LED
GREEN_LED.on()
```

In-class Exercise 8 Core Logic

See: https://github.com/DocVaughan/MCHE201---Intro-to-Eng-Design/tree/Spring-2019/MicroPython/MCHE201%20-%20In-class%20Exercise%208%20-%2003:26:19

In-class Exercise 9

- Connect a pushbutton
- Turn on the green LED
- Once the button is pressed the first time, turn off all LEDs.
- Then, turn on 1 LED every 1s until the button is pressed again
- When the button is pressed again, print the time elapsed between button pressed to the REPL
- If more than 5s elapses:
  - Print "You took too long!!!" to the REPL
  - Turn on only the green LED again

In-class Exercise 9 Setup

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

# 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)

# Assign the input pin to variable input_pin
# We set it up as an input with a pulldown resistor
input_pin = pyb.Pin("X6", pyb.Pin.IN,
                    pull=pyb.Pin.PULL_DOWN)

# Turn on the green LED
GREEN_LED.on()
```

In-class Exercise 9 – First Press

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

    if (input_state):
        start_time = time.ticks_ms() # save the current time
        GREEN_LED.off()
        print("Button pressed to start.")

        # We could also have another delay here, to force a
        # longer separation between the pressing of the button to
        # start the timer and pressing it to end the timer.
        time.sleep_ms(200)

        # If true, we are waiting for the second button
        button_timing = True
```

In-class Exercise 9 – Second Press

```
if (input_state):
    CODE TO RESET LED PATTERN
    print("Elapsed time = {}ms".format(time_elapsed))

    # Set button_timing to False because we are no longer in a
    # timing part of the algorithm.
    button_timing = False

    # We could also have another delay here, …
    time.sleep_ms(200)
else:
    if time_elapsed > 5000: # >5000ms
        print("You took too long!!!")

    # We no longer want to look for the "timing" button press
    button_timing = False

    # Turn off the LEDs
    CODE TO TURN OFF ALL LEDS

elif time_elapsed > 4000: # >4000ms
    BLUE_LED.on()
elif time_elapsed > 3000: # >3000ms
    YELLOW_LED.on()
elif time_elapsed > 2000: # > 2000ms
    GREEN_LED.on()
elif time_elapsed > 1000: # > 1000ms
    RED_LED.on()
```

In-class Exercise 10

- Connect
  - a pushbutton
  - the servomotor

- Start the servo at 0 degrees

- When the pushbutton is pressed:
  - move the servo to 30 degrees
  - pause 1 second
  - move the servo back to 0 degrees

- Only allow this to happen once per 30 seconds

In-class Exercise 10 Setup

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

# Assign the input pin to variable input_pin
# We set it up as an input with a pulldown resistor
input_pin = pyb.Pin("X6", pyb.Pin.IN,
                    pull=pyb.Pin.PULL_DOWN)
```

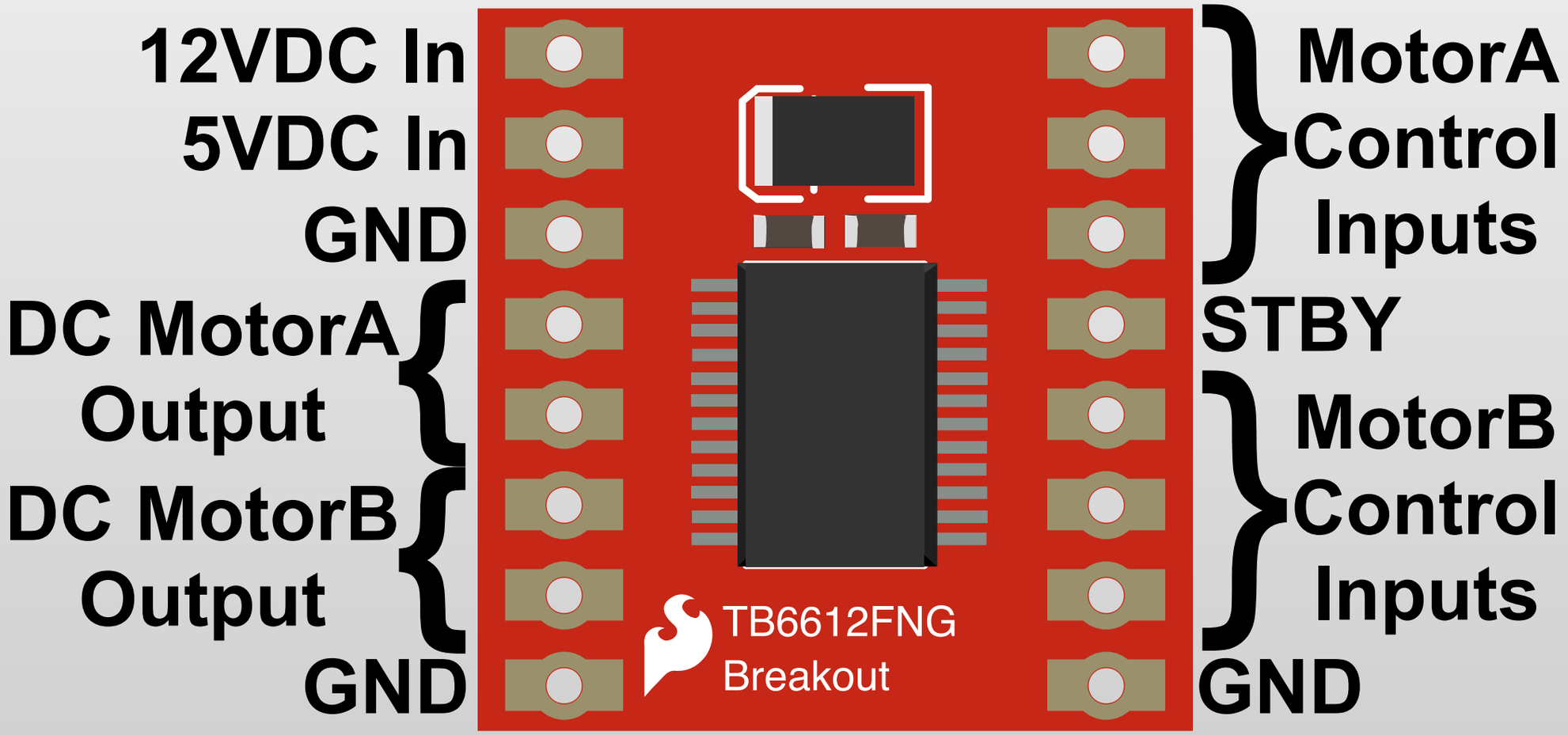
```
# For the pyboard Servo 1 is connected to X1, Servo 2
# to X2, Servo 3 to X3, and Servo 2 to X4
servo1 = pyb.Servo(1)

# Set the initial angle to 0
servo1.angle(0)
```

In-class Exercise 10 Main Loop

```
# This will loop forever, checking the button every 10ms
while (True):
    input_state = input_pin.value() # Check the button state

    if (input_state):
        print("The button was pressed. Moving the servo now.")

        # Move the servo to 30 deg
        servo1.angle(30)

        # sleep for 1 second
        time.sleep(1)

        # Now, move back to 0 deg
        servo1.angle(0)

        # sleep for 29 seconds to disallow any other action
        # during this time.
        time.sleep(29)
    else:
        print("Button not pressed. Wait, then check again.")

    time.sleep_ms(10)           # Sleep 10 milliseconds (0.01s)
```

Your Motor Driver

- Same chip as the one driving stepper motors on the MCHE201 board, but…
- We have to control it manually, rather than over i2c



Pulse Width Modulation (PWM)

Method to control speed of Brushed DC motors

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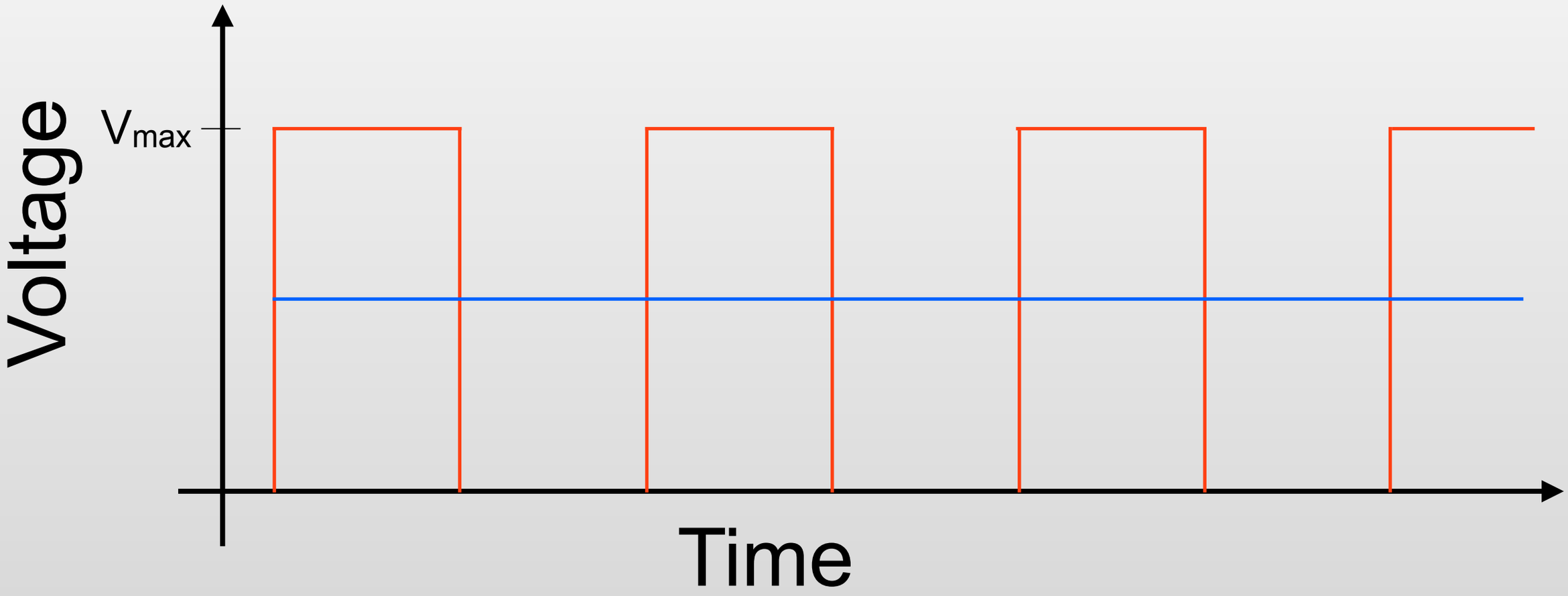
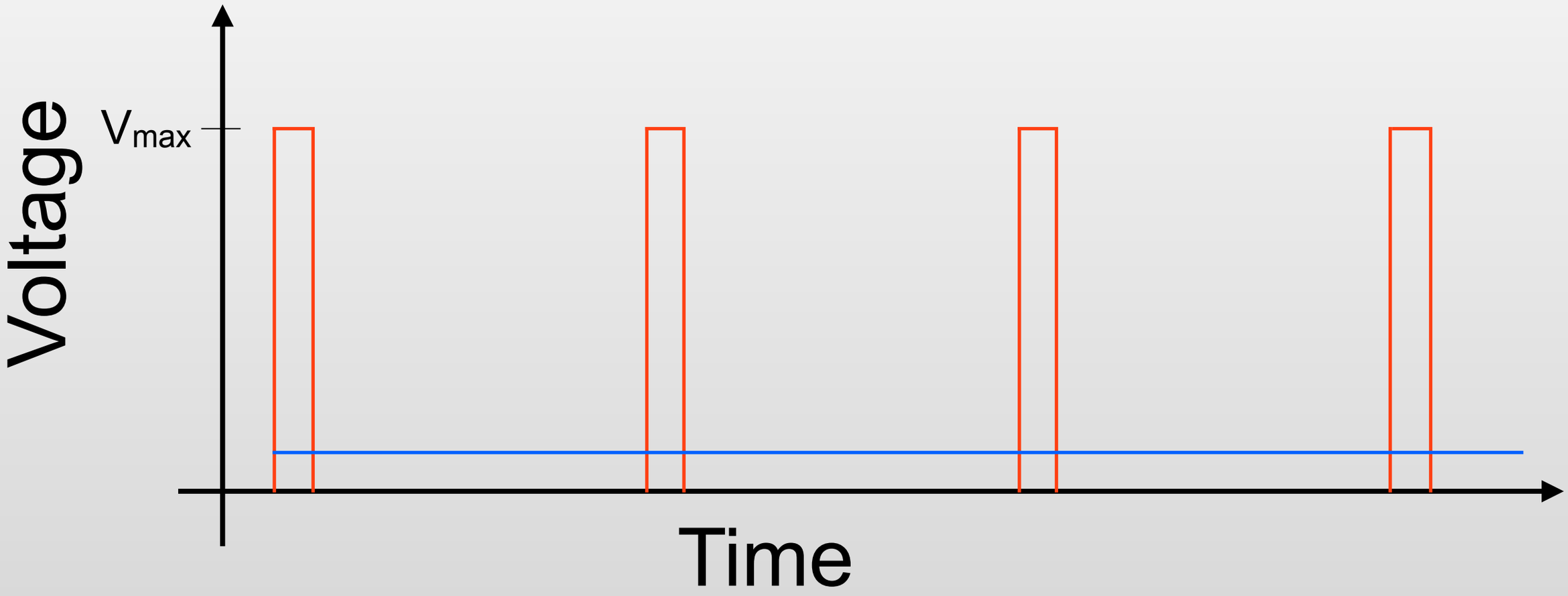
Method to control speed of Brushed DC motors



Full voltage 1/2 of the time = 50% duty cycle

Pulse Width Modulation (PWM)

Method to control speed of Brushed DC motors



Full voltage 1/10 of the time = 10% duty cycle

The pyboard – Timers for PWM

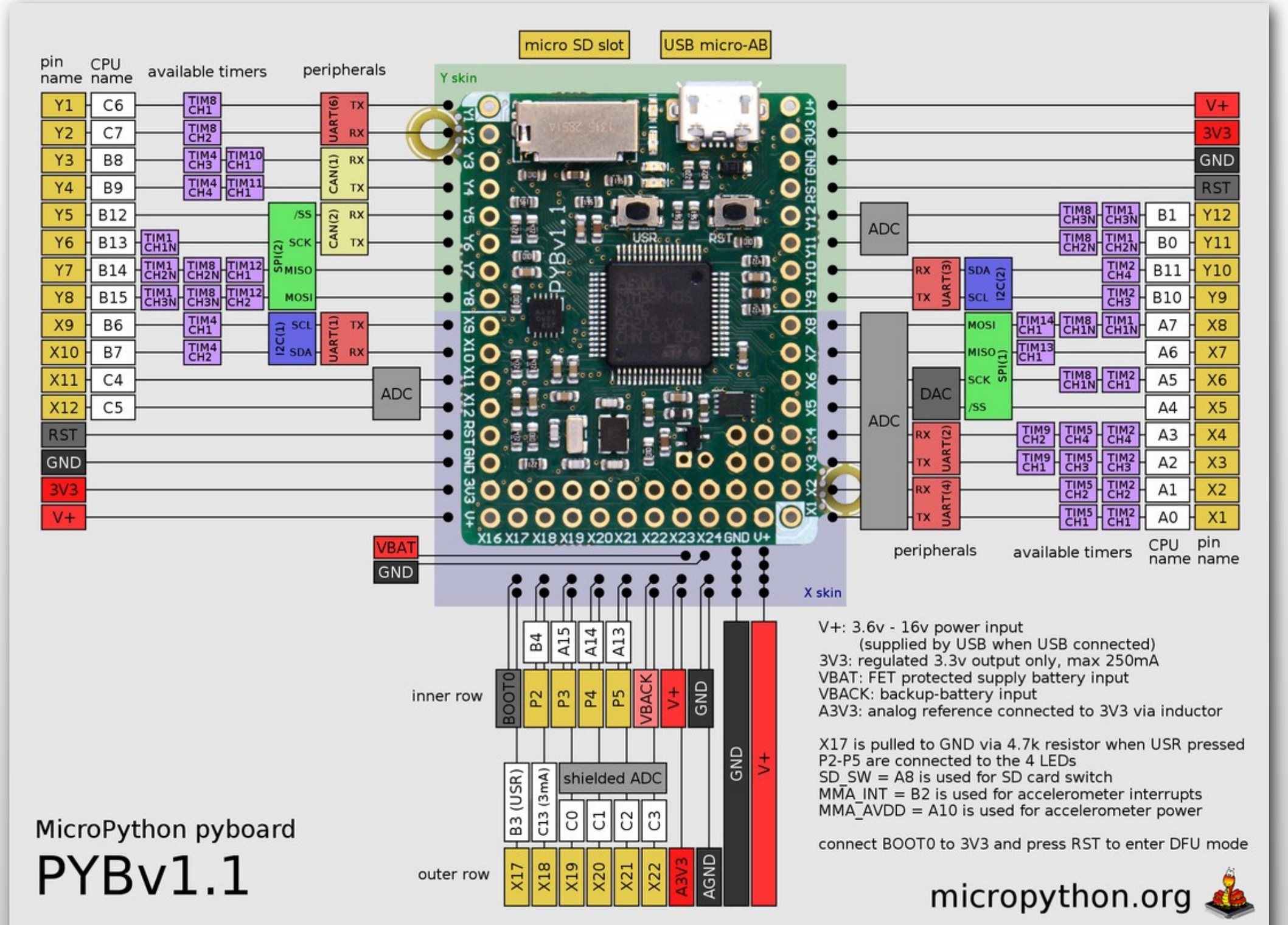
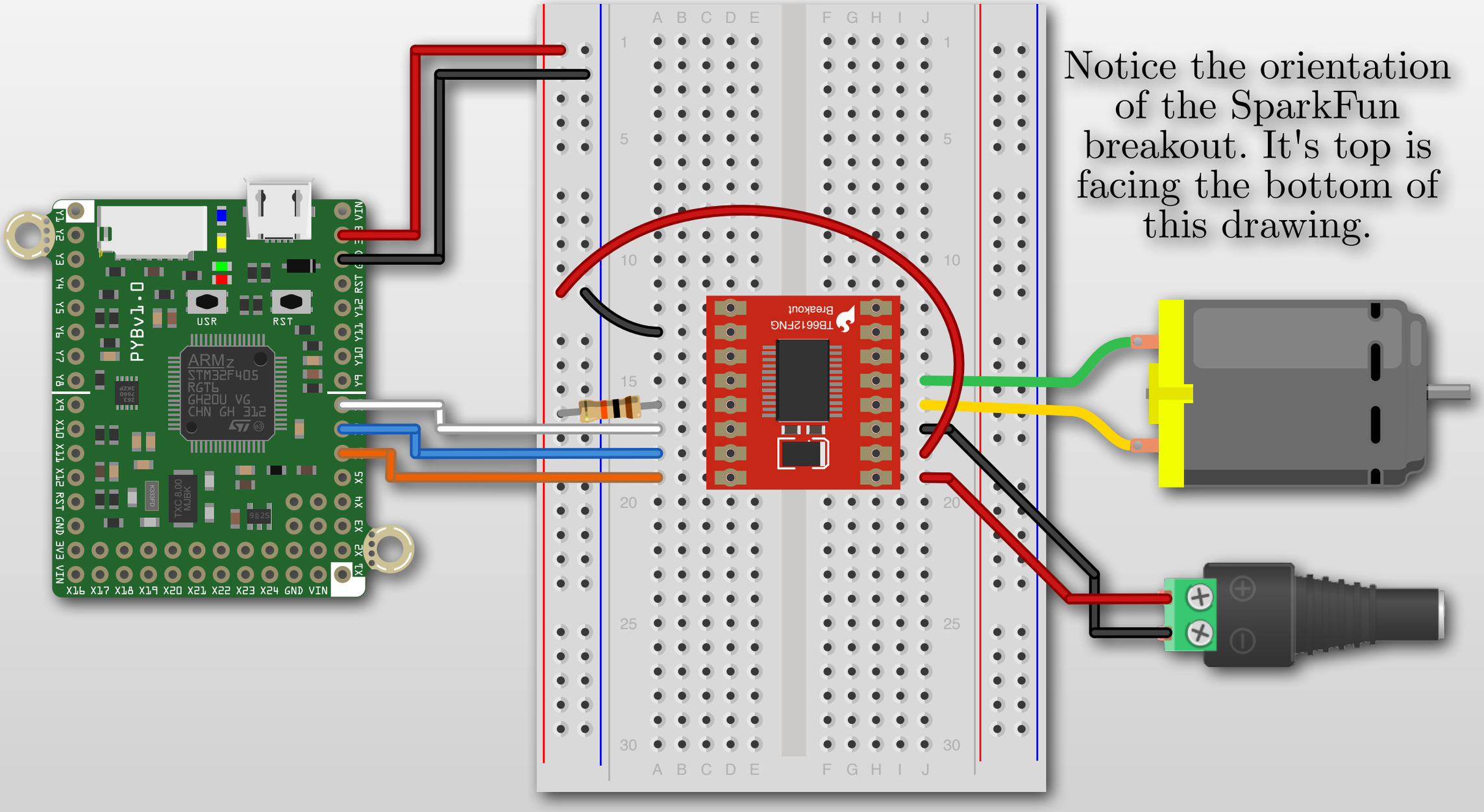


Image via `micropython.org`

Hardware Setup – MotorA



Notice the orientation of the SparkFun breakout. It's top is facing the bottom of this drawing.

From the TB6612 Spec Sheet

Input				Output		
IN1	IN2	PWM	STBY	OUT1	OUT2	Mode
H	H	H/L	H	L	L	Short brake
L	H	H	H	L	H	CCW
		L	H	L	L	Short brake
H	L	H	H	H	L	CW
		L	H	L	L	Short brake
L	L	H	H	OFF (High impedance)		Stop
H/L	H/L	H/L	L	OFF (High impedance)		Standby

Table from TB6612 Specification Sheet

MotorA Pin Setup

```
# We need to set up two digital outputs that we will
# use to control the direction of the motor.
A1_pin = pyb.Pin("X8", pyb.Pin.OUT_PP,
                       pull=pyb.Pin.PULL_DOWN)

A2_pin = pyb.Pin("X7", pyb.Pin.OUT_PP,
                       pull=pyb.Pin.PULL_DOWN)
```

```
# We also need to set up a third pin to control the
# speed of the motor. This output needs to have PWM
# capabilities, so it should be connected to a pin
# that has an associated timer on the pyboard
PWM_pin = pyb.Pin("X6")
PWM_TIMER = pyb.Timer(2, freq=20000)
PWM_CHANNEL = PWM_TIMER.channel(1, pyb.Timer.PWM,
                                   pin=PWM_pin)
```

MotorA Basic Control

```
# to turn the motor in one direction,
# A1 should be high and A2 low
#
# To move in the other direction,
# A1 should be low and A2 high
A1_pin.value(1)
A2_pin.value(0)
```

```
# We set the speed by setting the duty cycle of the PWM
# command in the range 0-100. 0 means stop
PWM_CHANNEL.pulse_width_percent(50)
```

What's a better way to do this?

Using the `TB6612.py` File

- Place `TB6612.py` on your pyboard
- Add `import TB6612` to your `main.py`

Setup Using TB6612.py

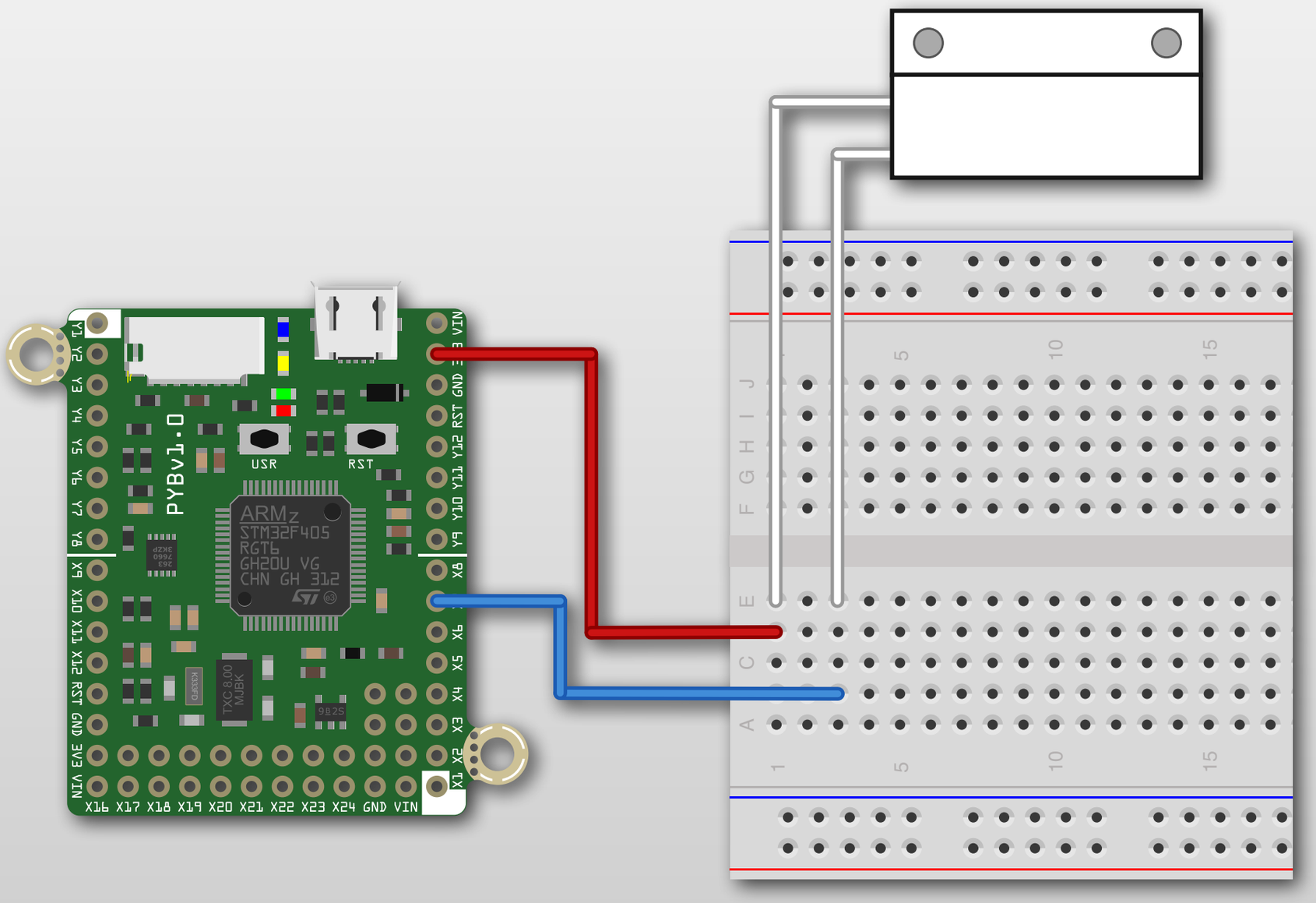
```
import TB6612 # import the file containing our TB6612 motor code

# We need to set up two digital outputs that we will use to
# control the direction of the motor. In this case, the TB6612
# class file will handle the low-level settings for the pins
A1_PIN = "X8"
A2_PIN = “X7"

# We also need to set up a third pin to control the speed of the
# motor. This output needs to have PWM capabilities. If these
# are defined correctly here, then the TB6612 class file will
# handle the low-level set up
PWM_PIN = “X6"
PWM_TIMER = 2
PWM_CHANNEL = 1

# Now, create a motor instance, calling upon the TB6612 class
motorA = TB6612.motor(PWM_PIN, A1_PIN, A2_PIN, PWM_TIMER,
                      PWM_CHANNEL)
```

Basic Use with TB6612.py

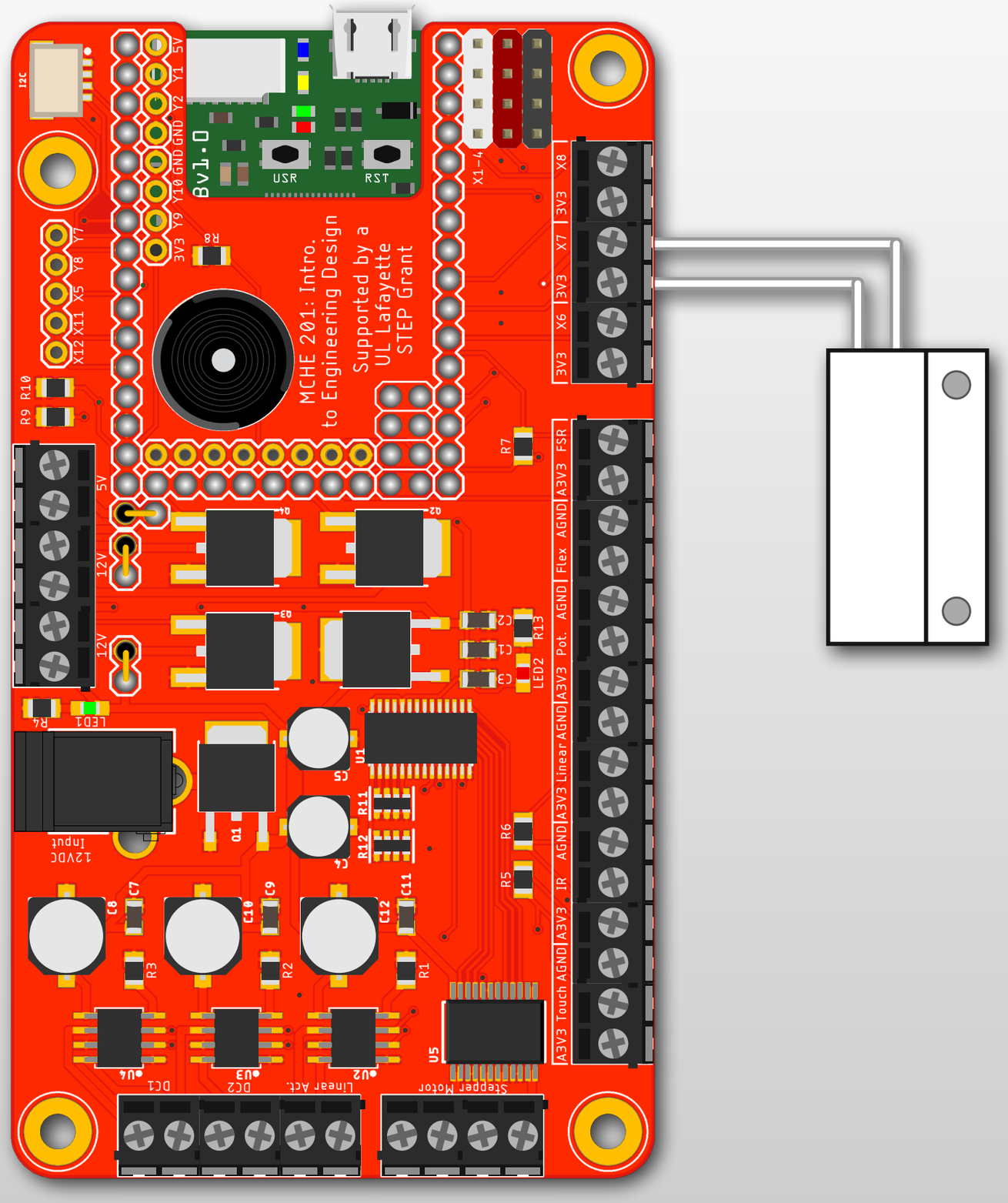
```
# To start the motor, issue
# the .set_speed() command with a speed
# between -100 and 100
motorA.set_speed(50)

# To stop the motor, set its speed to 0
motorA.set_speed(0)

# Or, use the .stop() method
motorA.stop()
```

MCHE201 Magnetic Switch

- Switch closes when the magnet gets close
- Wire and process just like a pushbutton



MCHE201 Magnetic Switch



Magnetic Switch Code

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

# Assign the input pin to variable input_pin
# We set it up as an input with a pulldown resistor
input_pin = pyb.Pin("X7", pyb.Pin.IN, pull=pyb.Pin.PULL_DOWN)

# This will 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 magnet is close by.")
    else:
        print("The magnet is not close by.")

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

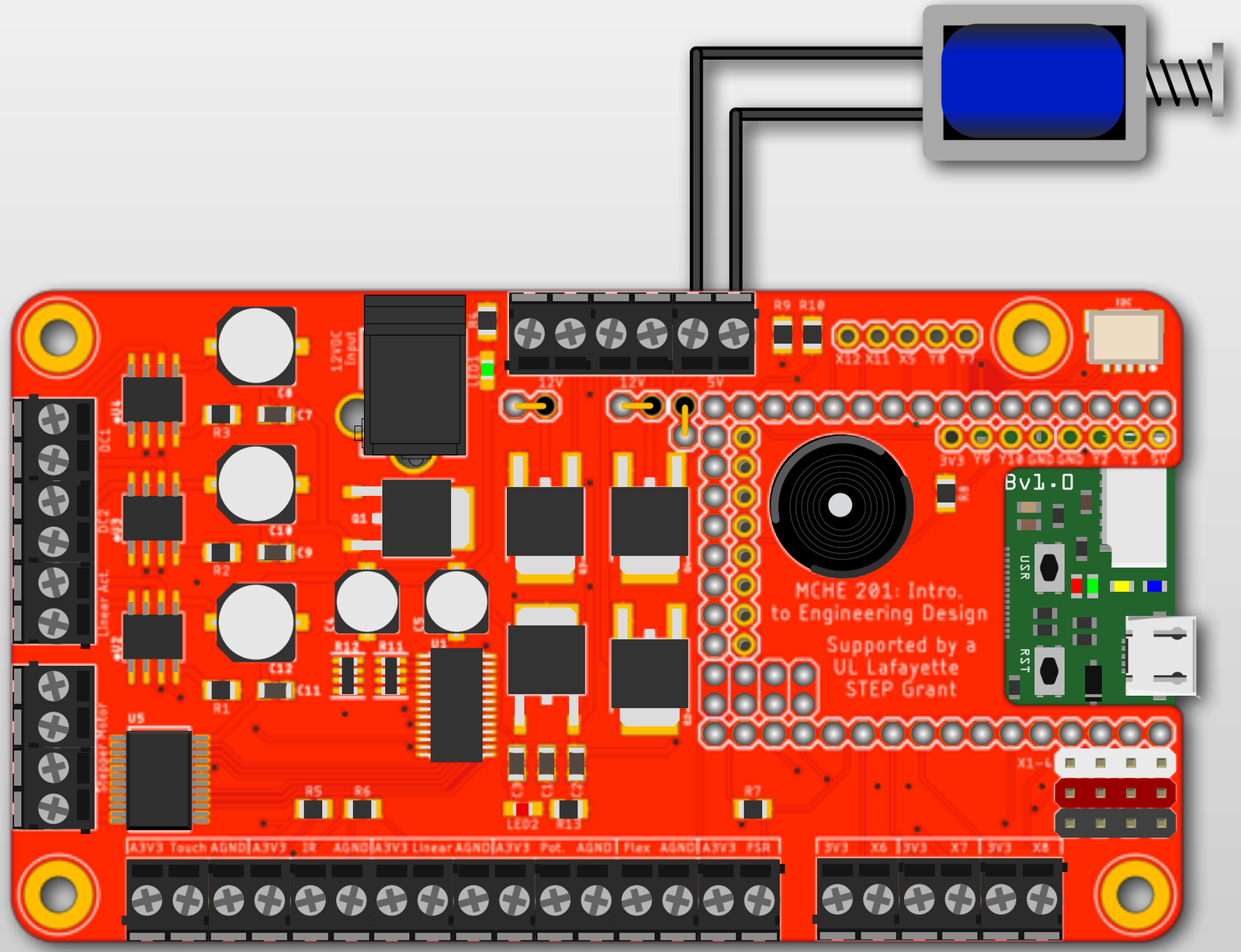
MCHE201 Small Solenoid

- Retracts when coils are energized
- Spring return when not
- Use a MOSFET to control it and pyboard to control the MOSFET (http://bildr.org/2012/03/rfp30n06le-arduino/)

Image from: https://www.sparkfun.com/products/11015

Small Solenoid Hardware Setup

- Do ***NOT*** leave the solenoid powered
- Connect to "upper" screw terminal labeled 5V



Small Solenoid Control

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

# Assign the output pin to variable mosfet_pin
# We set it up as an output with a pulldown resistor
solenoid = pyb.Pin("Y3", pyb.Pin.OUT_PP, pull=pyb.Pin.PULL_DOWN)

# This loop will run 5 times
for counter in range(5):
    print("MOSFET on. Solenoid should retract.")
    solenoid.high()
    time.sleep_ms(100)          # Sleep 100ms

    print("MOSFET off. Solenoid should extend via spring.")
    solenoid.low()
    time.sleep(1)               # Sleep 1 second
```

GitHub

All of the code contained in this lecture is available at the MCHE201 Class Repository on GitHub:

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