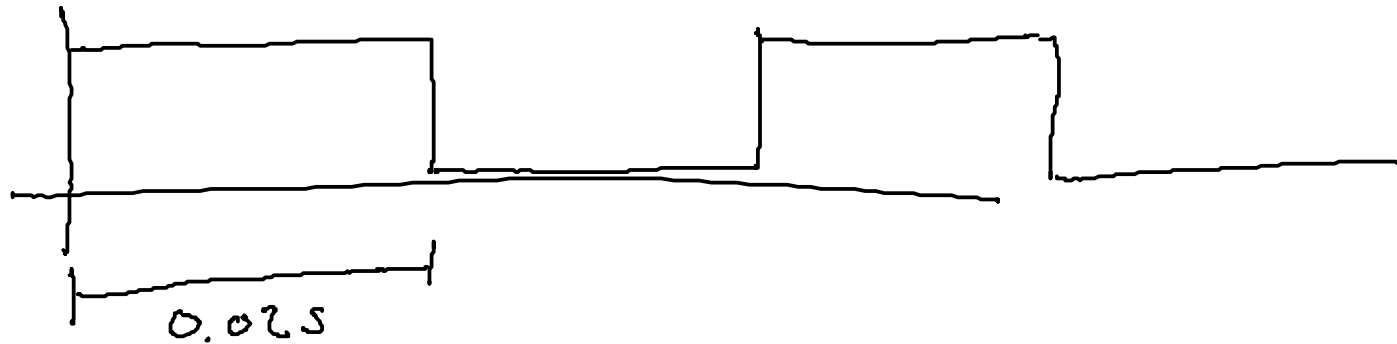


# Warmup

Write (or re-run) code to blink an LED with your ESP32

How fast can you blink the LED before it doesn't appear to your eyes to be blinking anymore?



Challenge: figure out a way to measure (or at least estimate) the fastest you can possibly blink an LED with the ESP32.

# EN 1-24: Engineering in the Kitchen

Steven Bell

19 October 2021



# Project 3

[nolop.org/haunted-house/](http://nolop.org/haunted-house/)

Build an interactive pumpkin exhibit

# Project 3 schedule

Today: Controlling outputs

Thursday: Controlling outputs with feedback

Next Tuesday: Making sound

Next Thursday: Pumpkin carving / project assembly

Next Friday: set up ~4pm (or earlier), clean up ~5:30

# How fast can we blink?

Let's try!

Use `sleep_us()` for microsecond sleeps.

**What's wrong with this?**

# Introducing PWM

Built-in hardware to turn pins on and off

(Take ES 4 if you wanna learn how this works!)

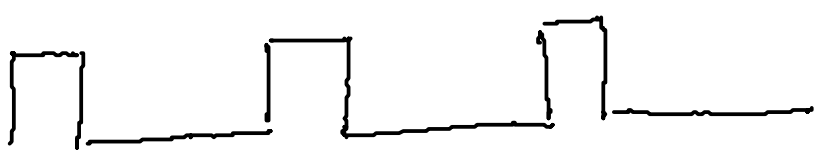
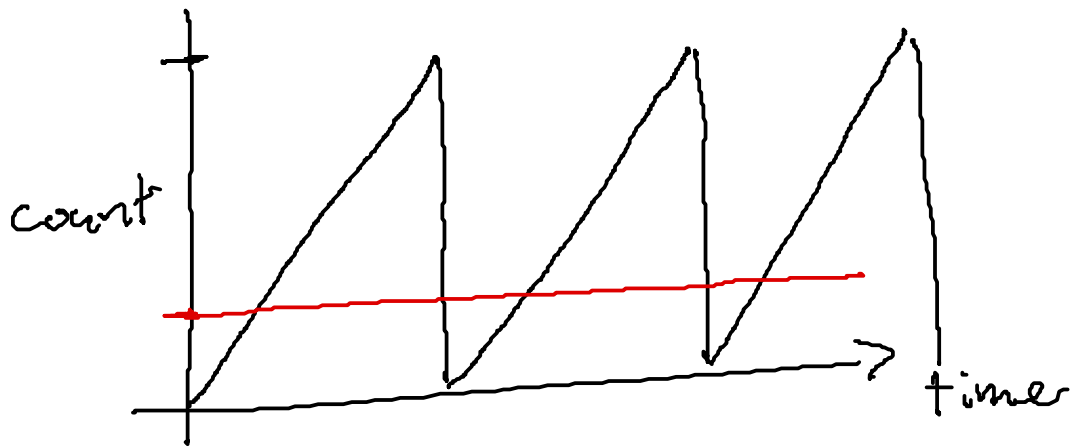
```
from machine import Pin, PWM
```

```
led = PWM(Pin(13))
```



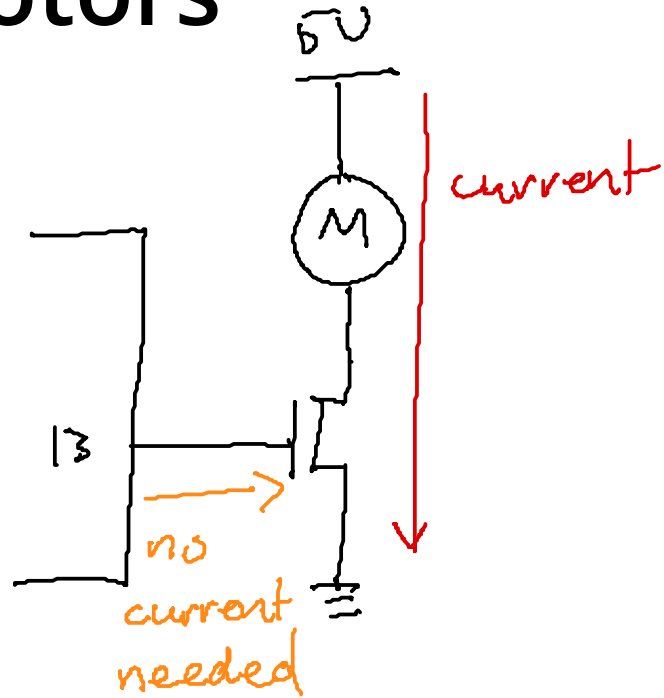
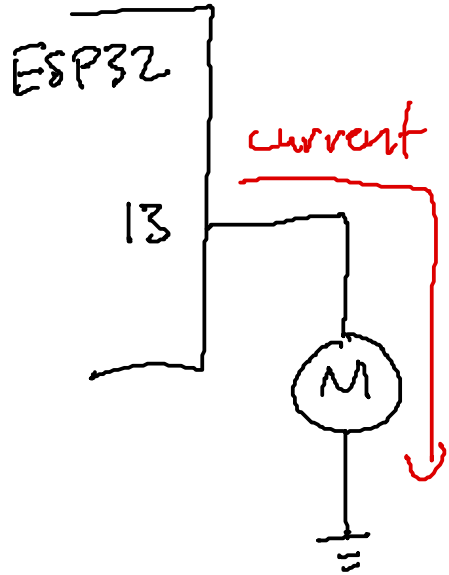
```
led.freq(1000) # Hz, ranges from 1Hz to 40MHz
```

```
led.duty(512) # Fraction, ranges from 0-1023  
               % of time high
```



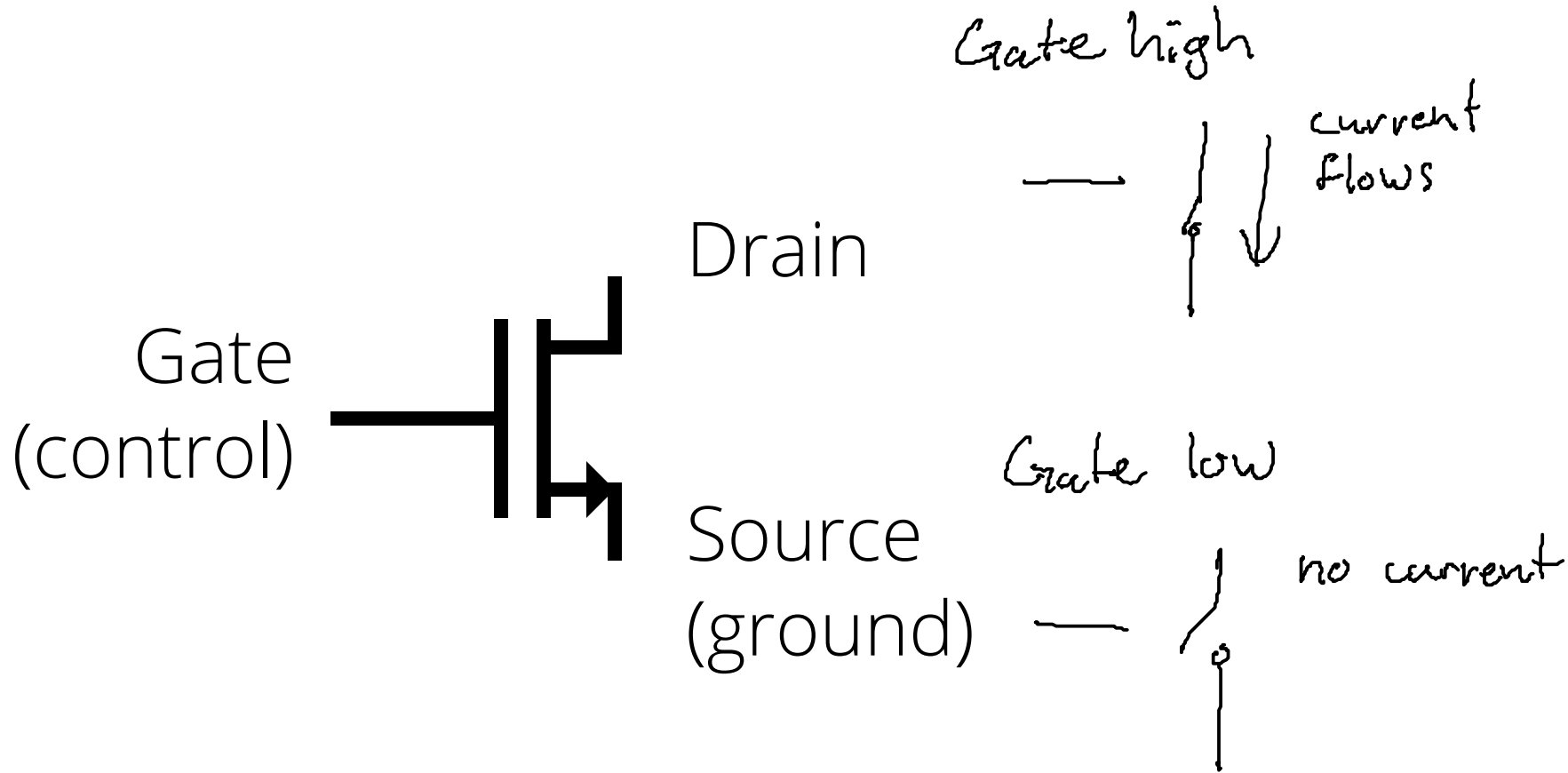


# Brushed DC motors



# Transistors

A transistor is a voltage controlled switch:



# Controlling "big" stuff with transistors

# Making motors go both ways