

IOT SESSIONS #05

OUTPUTS | FUN & GAMES

18:30 for 19:00 | 25 July | Newmedialabs
Tickets from R150 via Quicket

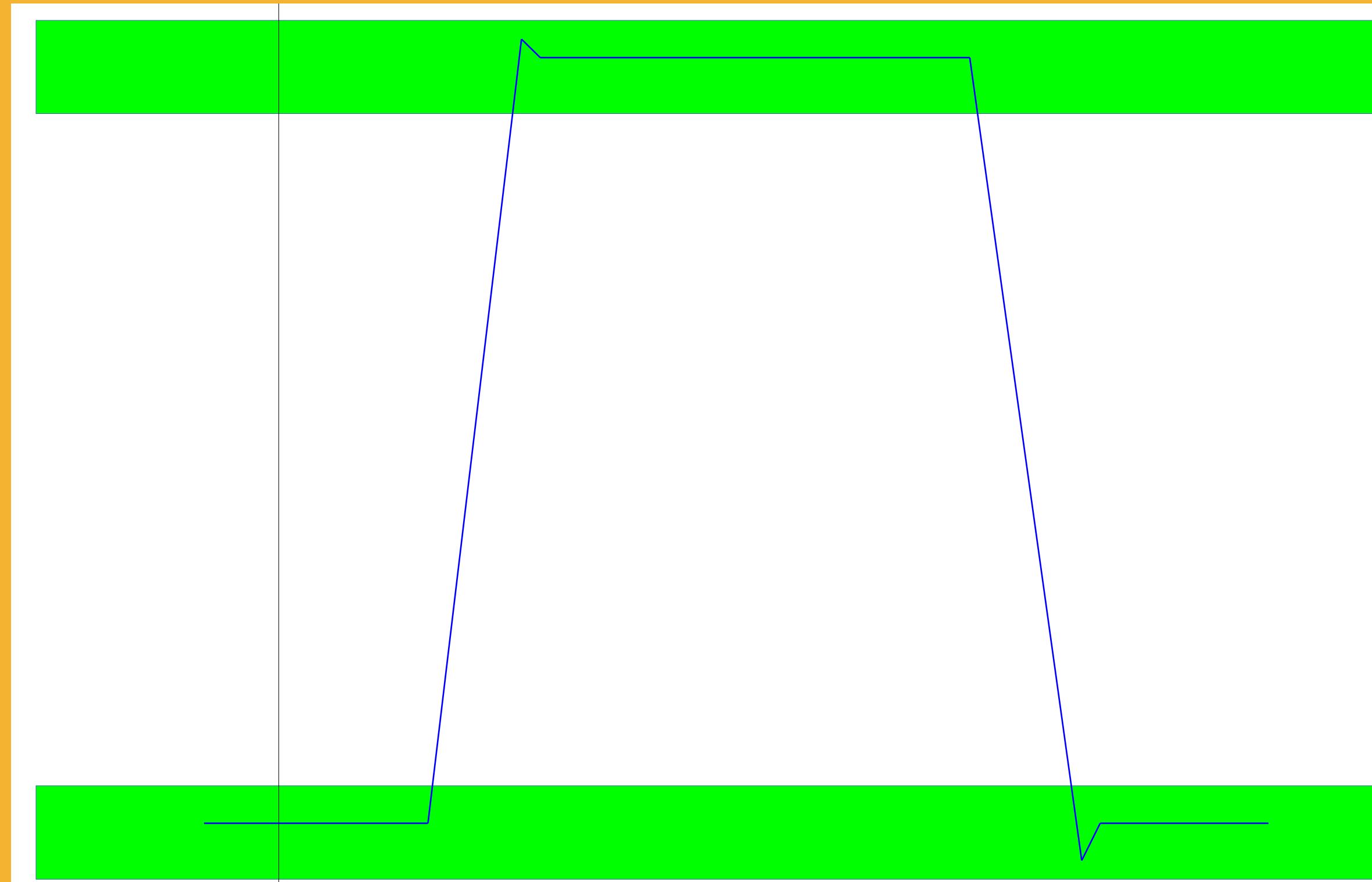


OUTPUTS: A THEORETICAL OVERVIEW

WE WILL COVER:

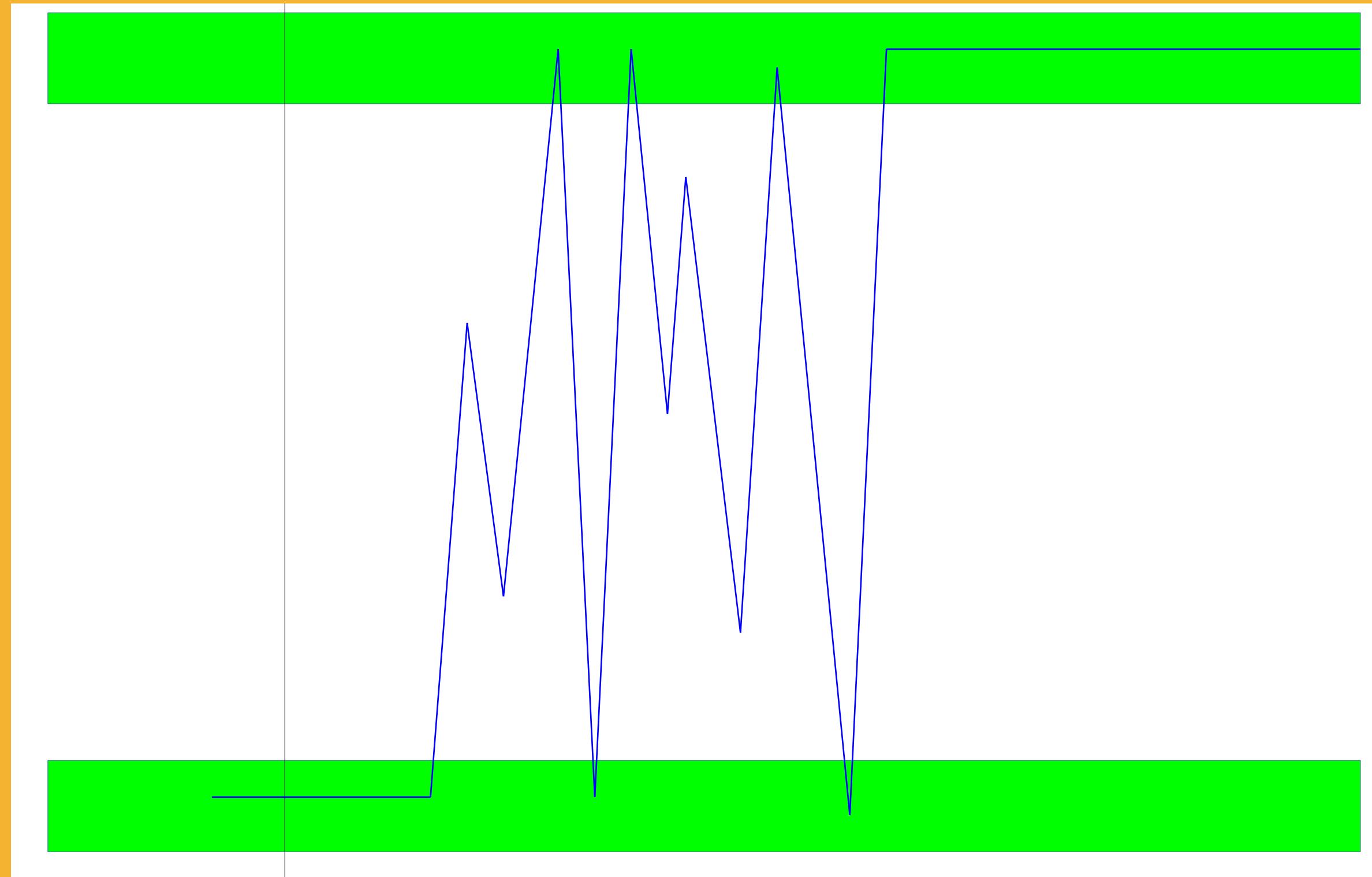
- Digital outputs
- Pulse width modulation (PWM)
- Driving external hardware
- Using LEDs as output
- Handling more output than you have pins for

THEORETICALLY PERFECT OUTPUT



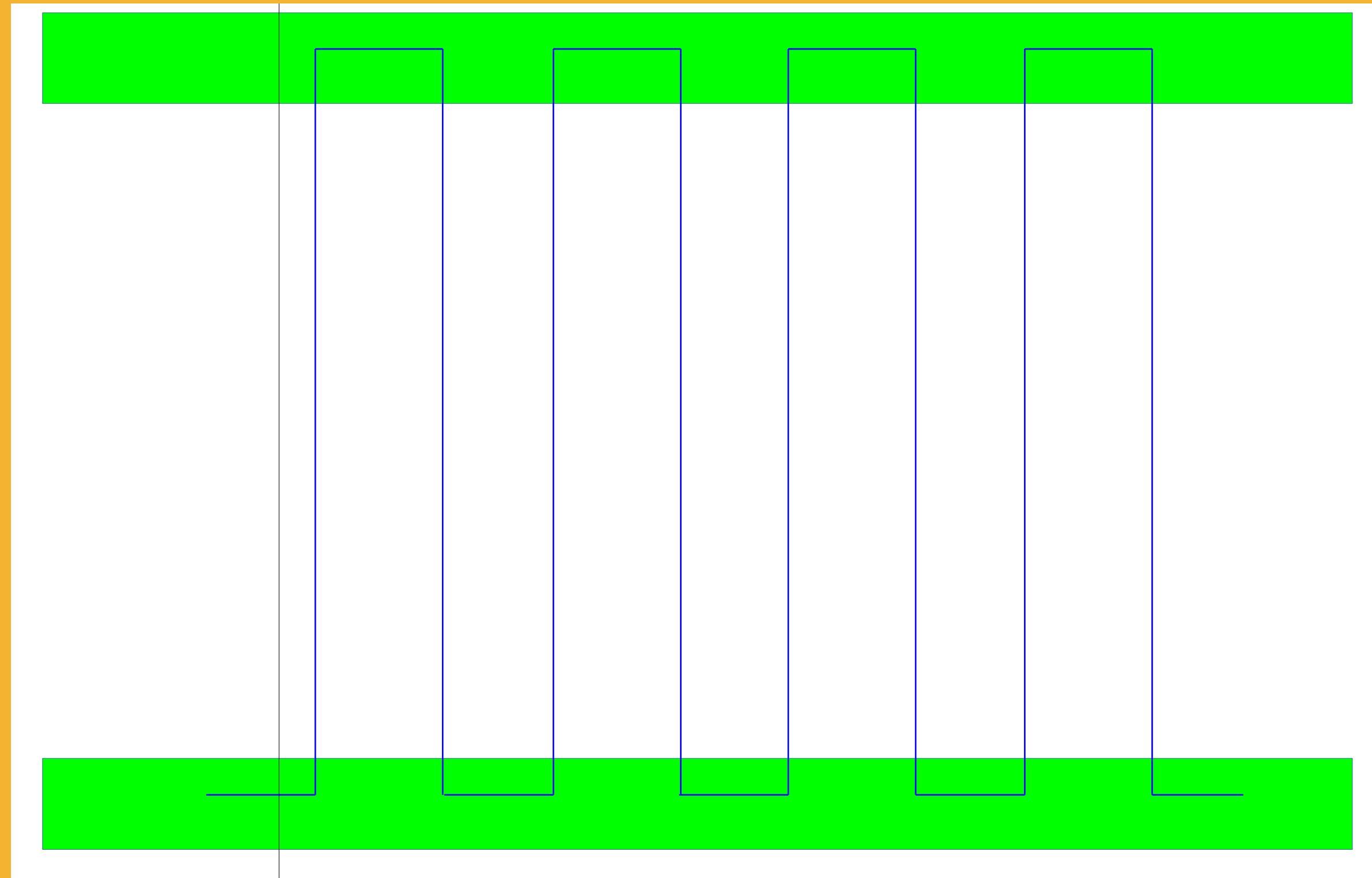
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HUMAN PRESSING A SWITCH



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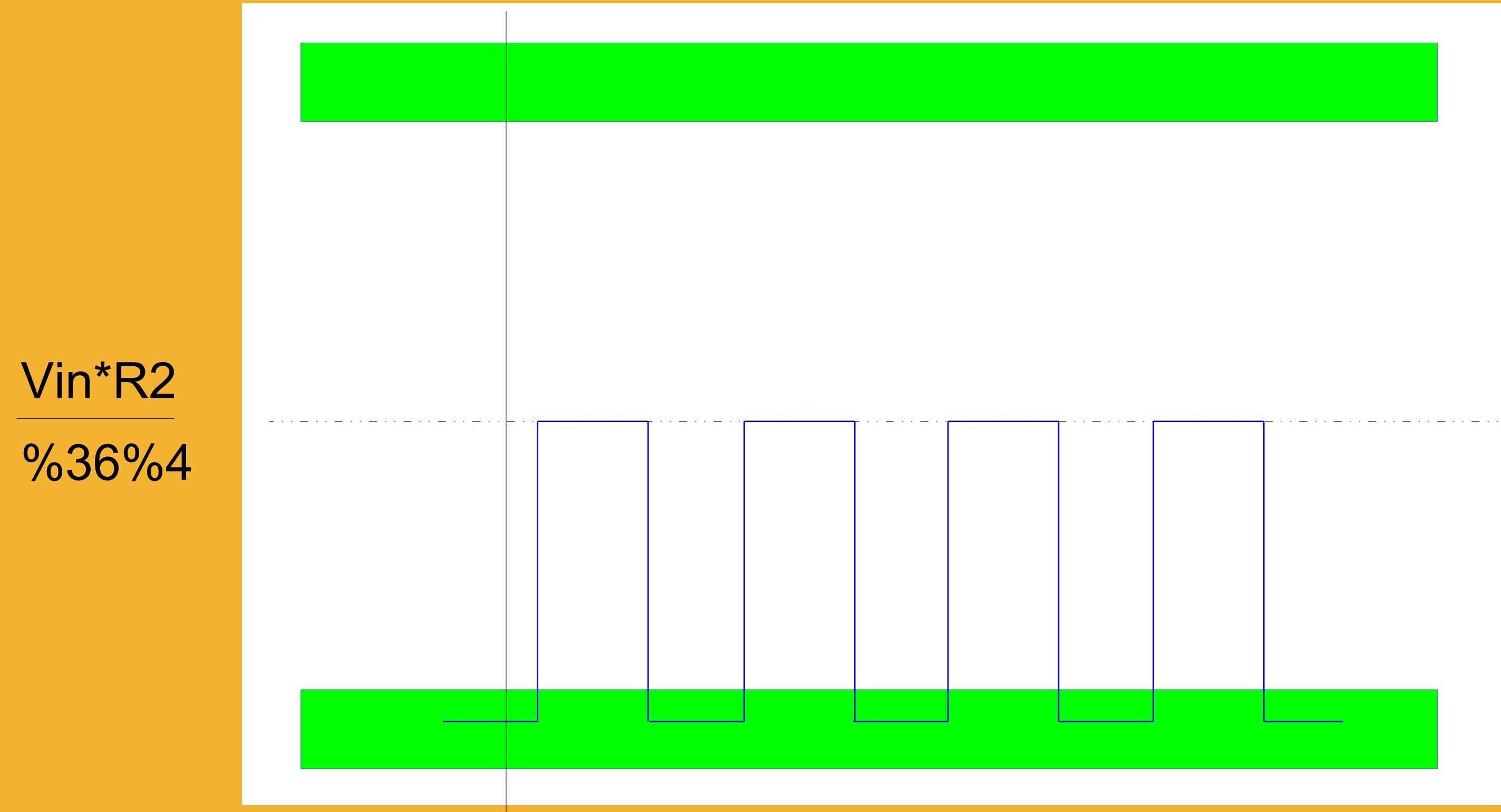
PULSE WIDTH MODULATION



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VOLTAGE DIVIDER OUTPUT



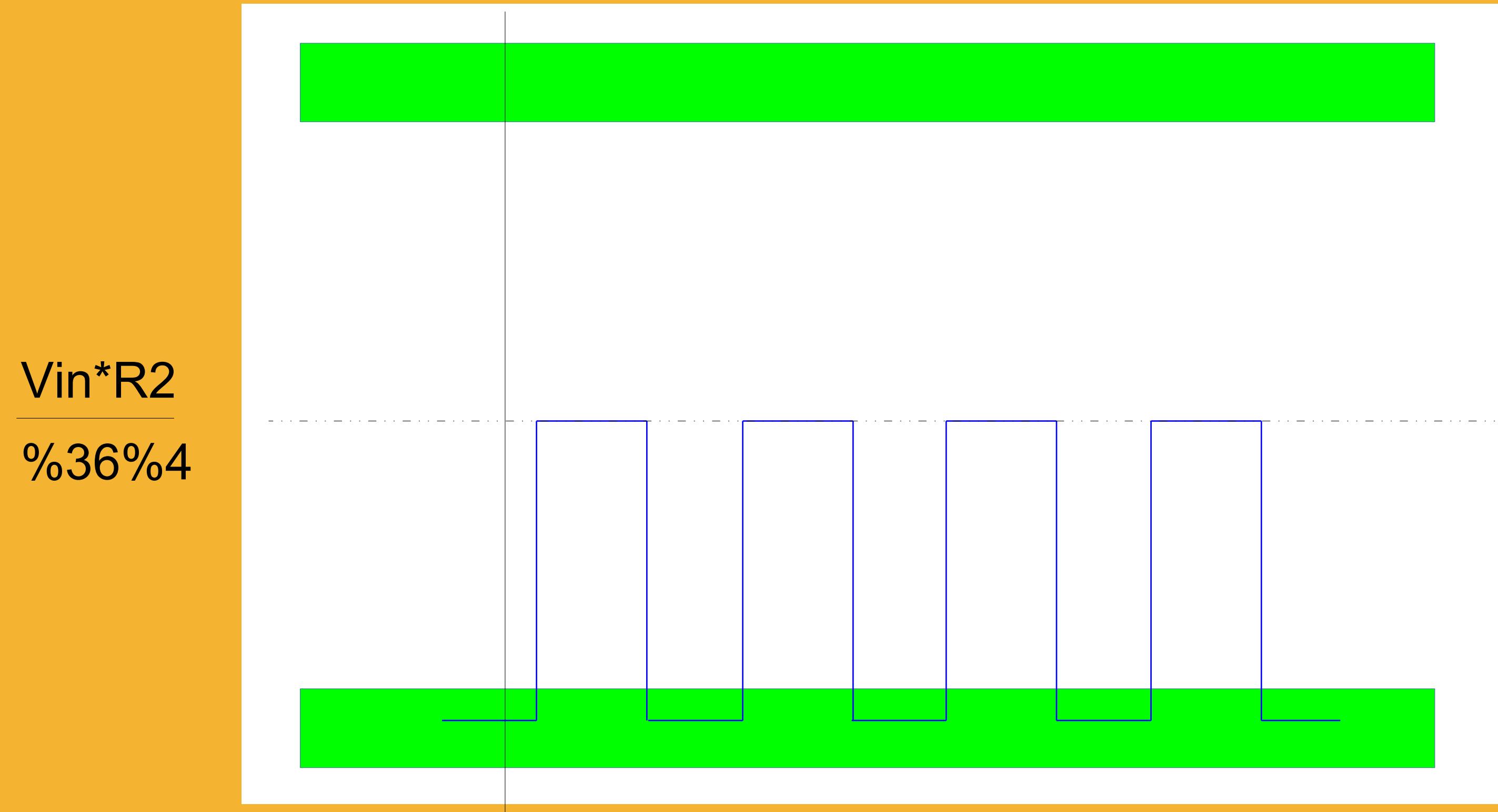
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PULSE WIDTH MODULATION

- Rapidly switches between high and low voltages
- Remains in a high state a given percentage of the time
- Can be used to vary the brightness of an LED or the speed of a motor
- Rapid switching can be a problem for some hardware (e.g. relays)
- Can be converted into a voltage with a low-pass filter

VOLTAGE DIVIDER OUTPUT



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VOLTAGE DIVIDER

- Output is proportional to input
- Output resistance can be affected by the load.

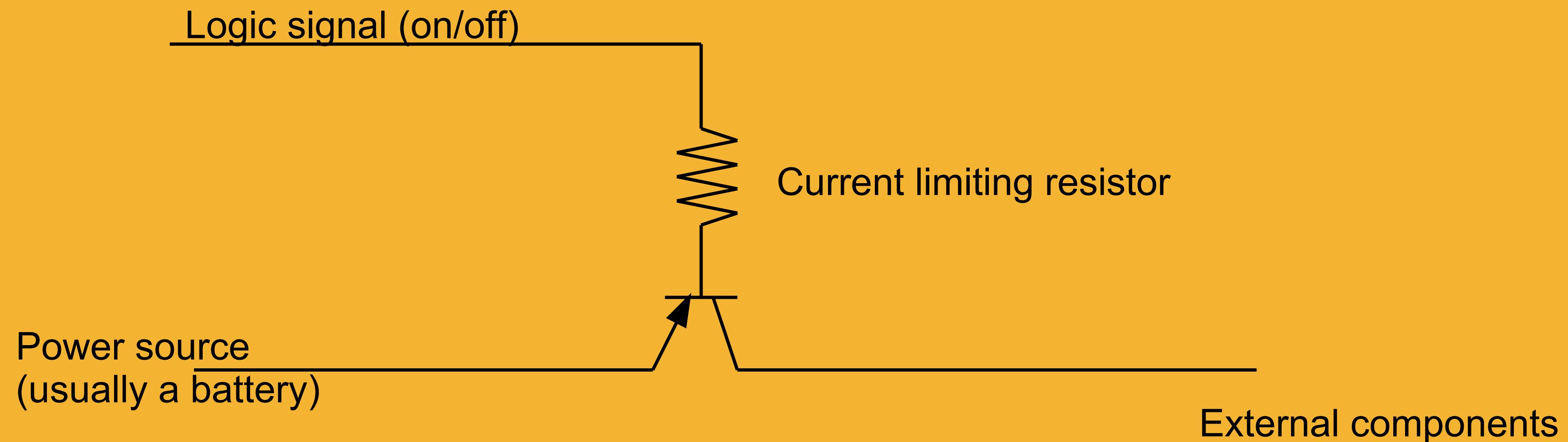
Choosing large resistor values will reduce this effect

- Can only reduce output voltage, never increase it
- Needs to be powered by the input source

DRIVING EXTERNAL HARDWARE

- Most logic chips provide very little output current
(the shift register can provide about 6mA at 5V. The NodeMCU provides less than 5V)
- This is enough to drive an LED or logic chip, but not much else
- How to turn on and off more power-hungry components?

FIRST SOLUTION: TRANSISTOR



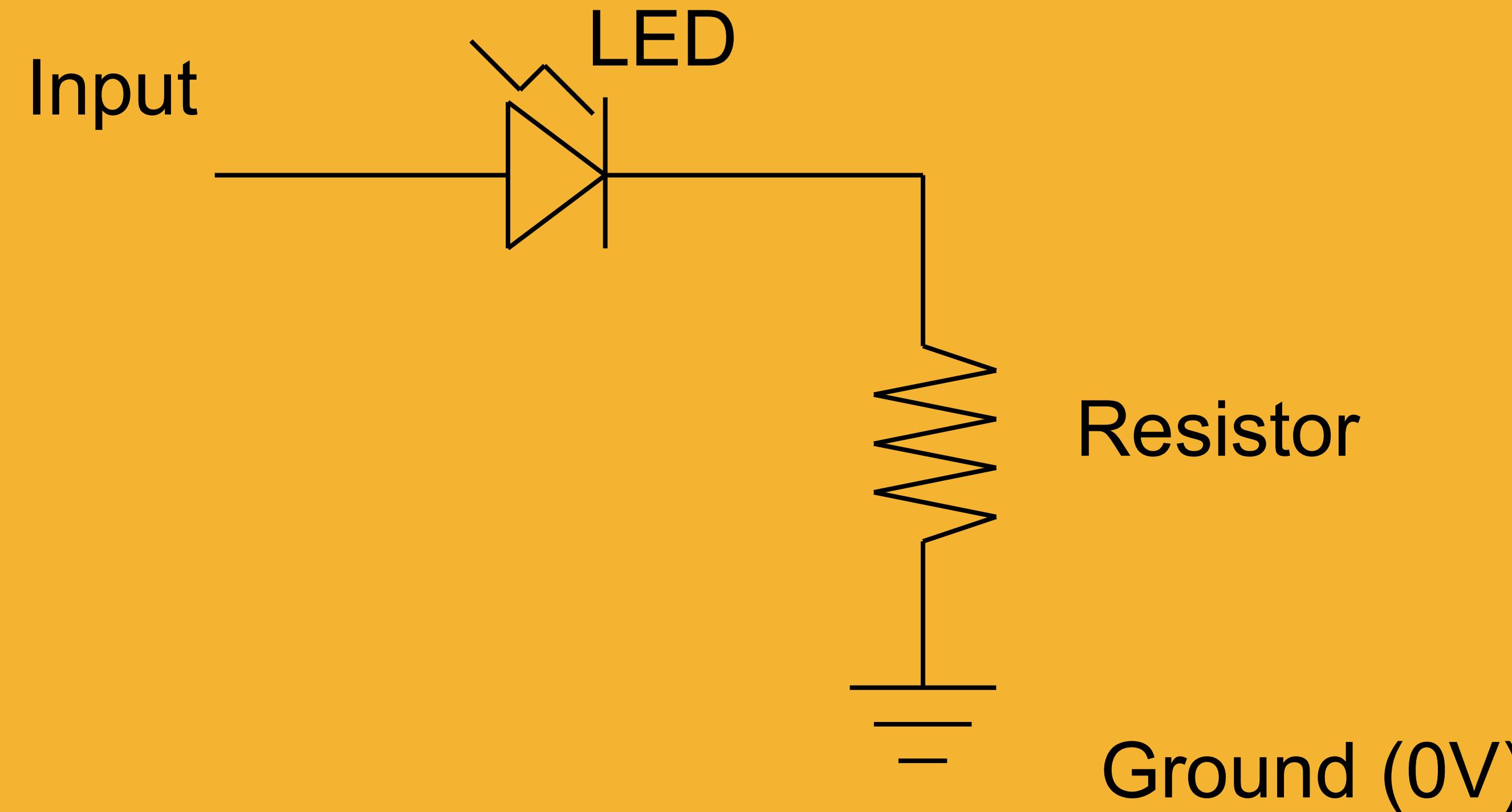
TRANSISTOR

- Small input current in the base allows a large input current through the emitter and out the collector
- Can handle rapid switching with ease (you can use pwm with it)
- Completely silent
- Excellent choice for most hobby projects
- Microchips are basically collections of transistors

RELAYS

- Completely isolate control and load lines
(you can use a DC circuit to switch on an AC circuit)
- Slow to switch (can take as long as 50ms)
- Makes an audible click on switching
- Will wear off after enough(tens of thousands) clicks
- Use only if you need to provide full AC power to something
- Consider use for heavy-duty power applications

LED AS OUTPUT



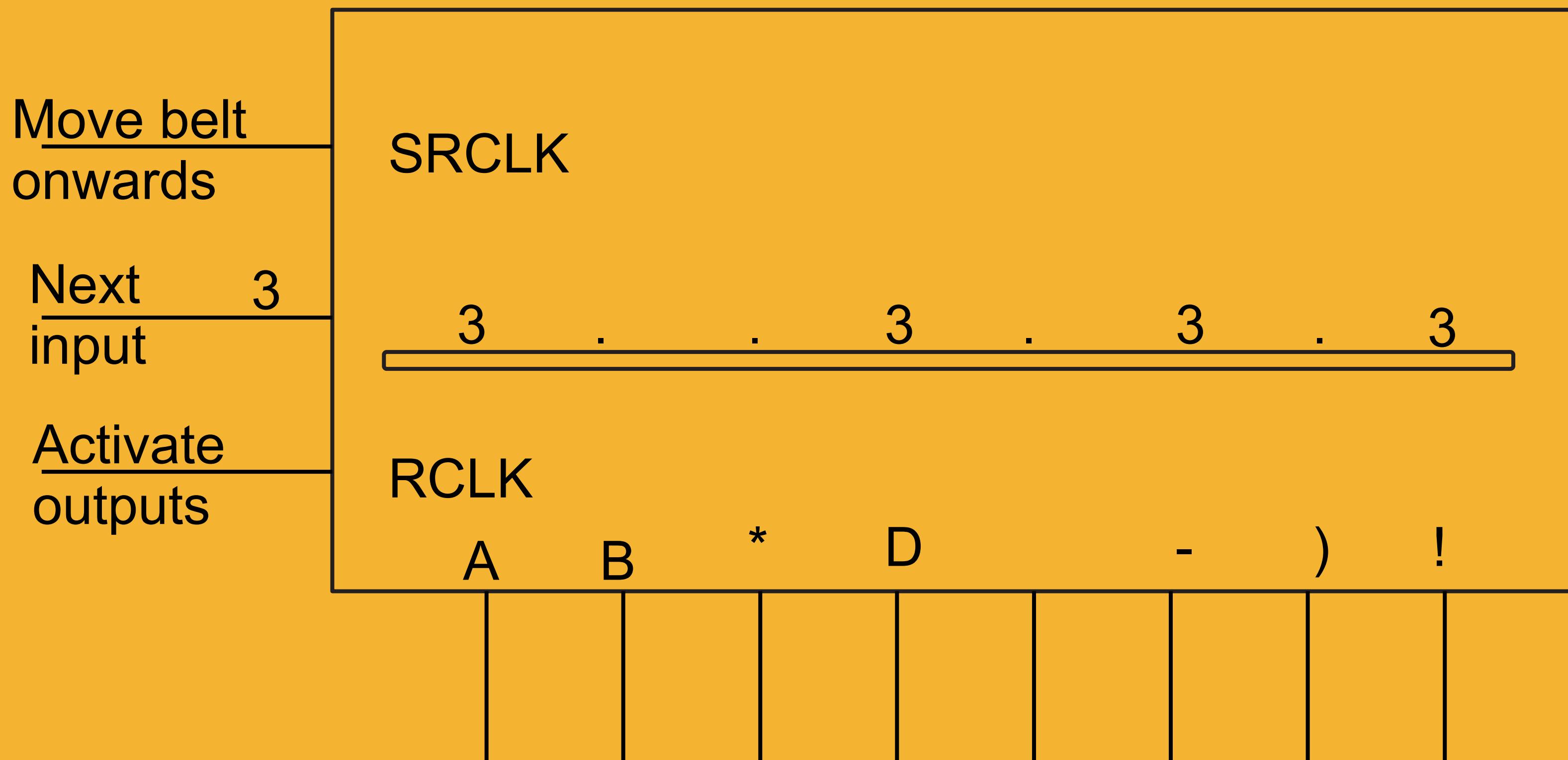
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LED

- Stands for Light Emitting Diode
- Will light up if connected properly to power, very easy to see if it's working
- Will not light up (or permit current through) if connected in reverse - like any diode
- Must always be connected through a resistor to limit input current
- Multiple diodes can be connected through a single resistor,
though each requires a certain voltage.
- When accompanied by a 220ohm resistor, requires very little current

SHIFT REGISTER



LIMITED OUTPUT PINS

- The NodeMCU only has so many outputs
- A tictactoe board has nine spots. Three LEDS are used for the score.
Each bicolour LED has two inputs. This requires 24 inputs
- The nodeMCU only has 16 GPIO pins. Some of these are required for inputs.

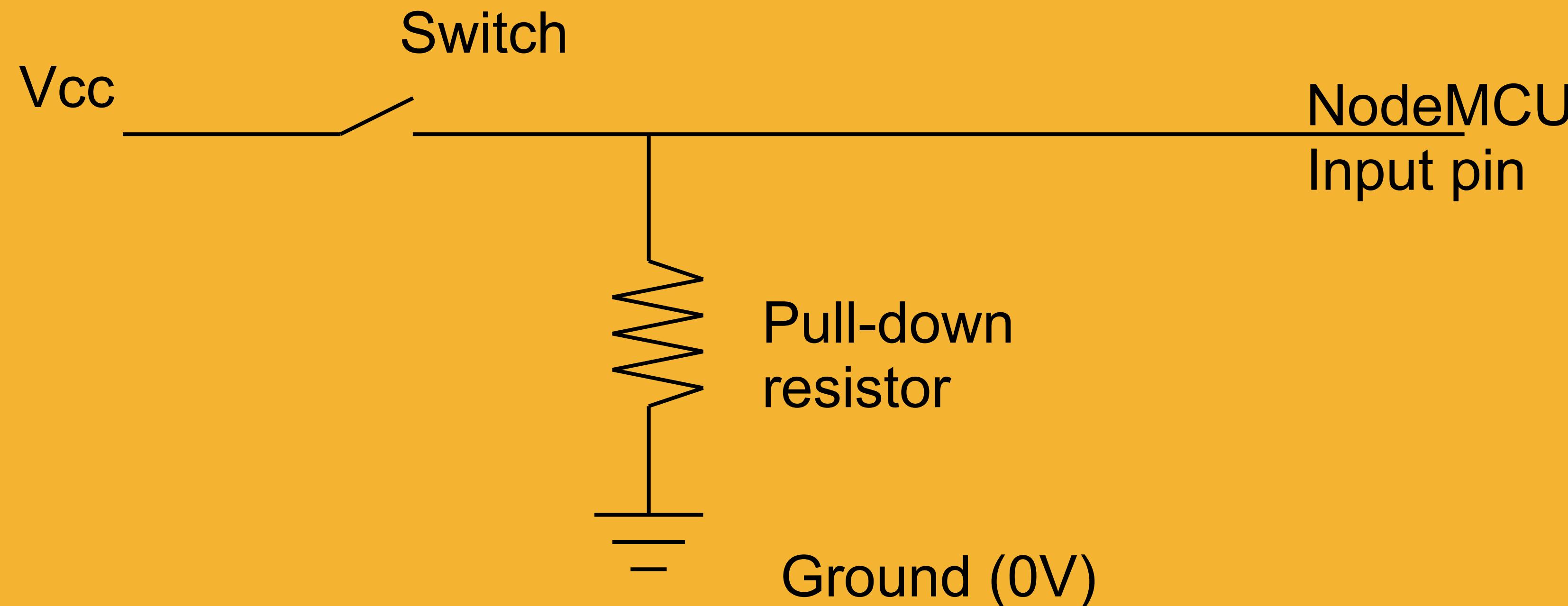
SHIFT REGISTER

- SRCLK and RCLK can be shared between multiple chips
- Thus, $(n+2)$ outputs can be converted into $9 \times n$ outputs.

24 LED outputs require only 5 NodeMCU outputs.

- Switching speed of the final outputs is drastically reduced (perhaps 20 times)
- Cannot use PWM through a shift register
- Can use multiple layers of shift registers,
if you don't mind the slowdown and complexity

SWITCHES AS INPUTS



SWITCHES AS INPUTS

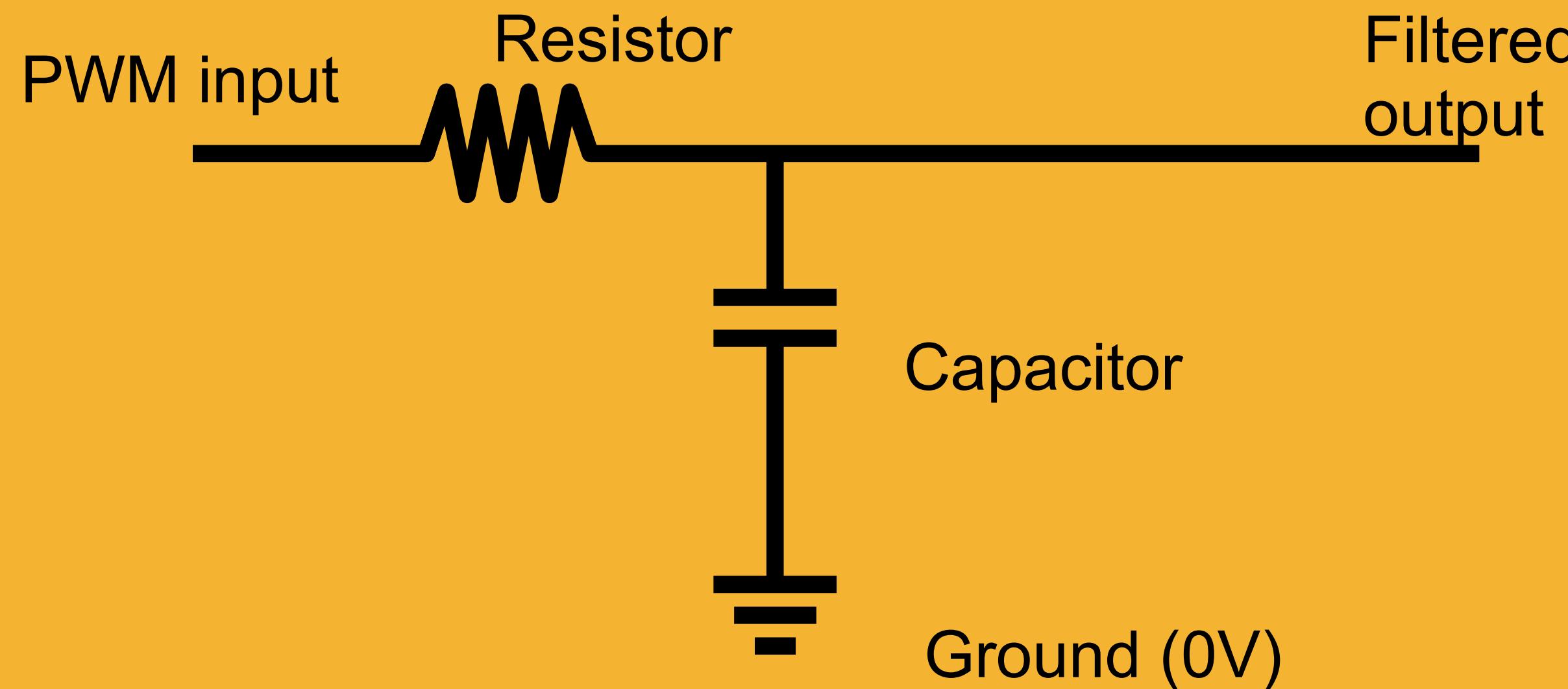
- The pull-down resistor pulls the input voltage to zero when not using the switch
- Leaving out the pull-down resistor means that your input is floating.
A floating input can be anything. This tends to lead to strange behaviour.
- The switch will need to be debounced in software

QUESTIONS?

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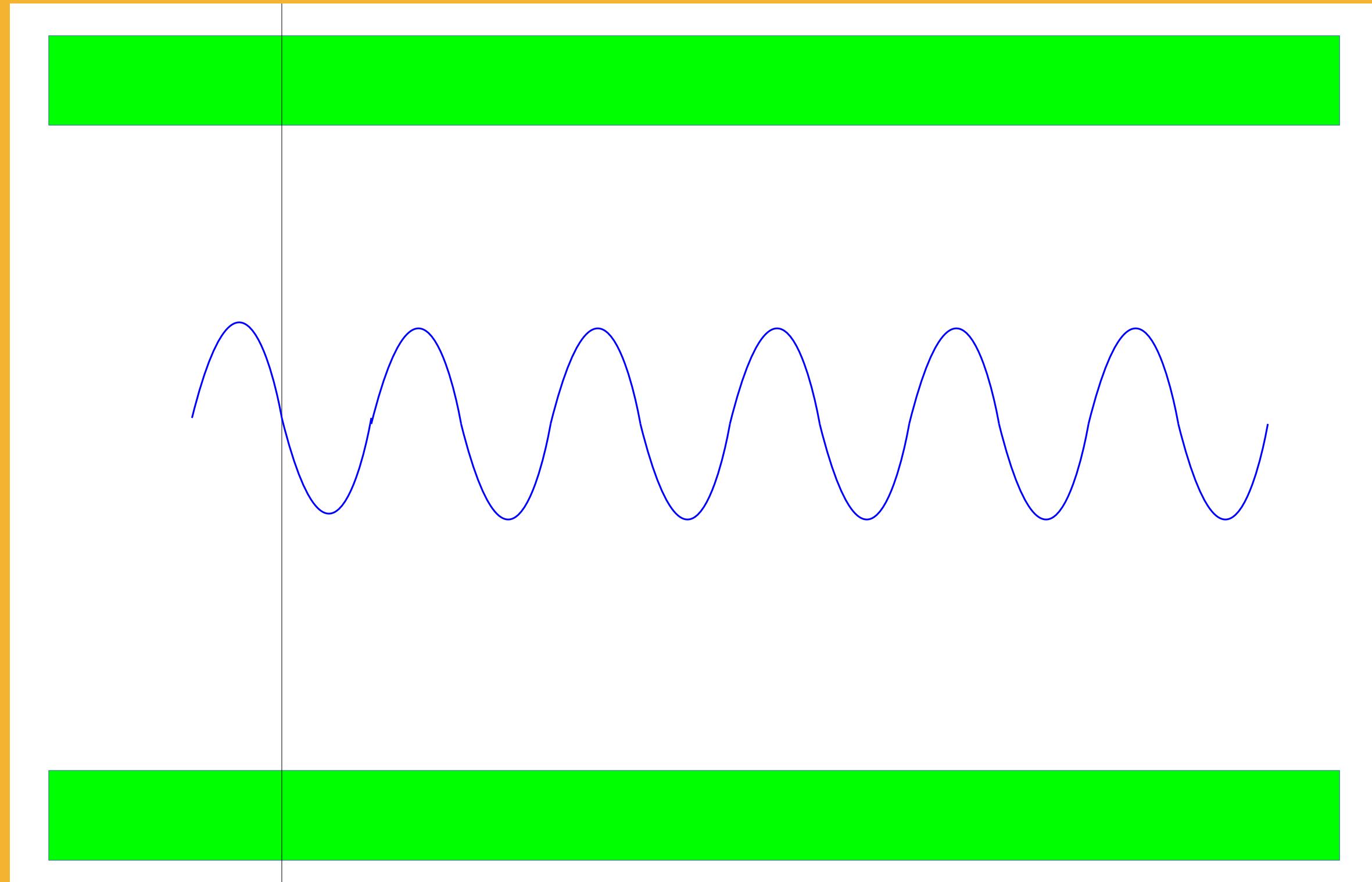
LOW-PASS FILTER



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LOW-PASS FILTER OUTPUT



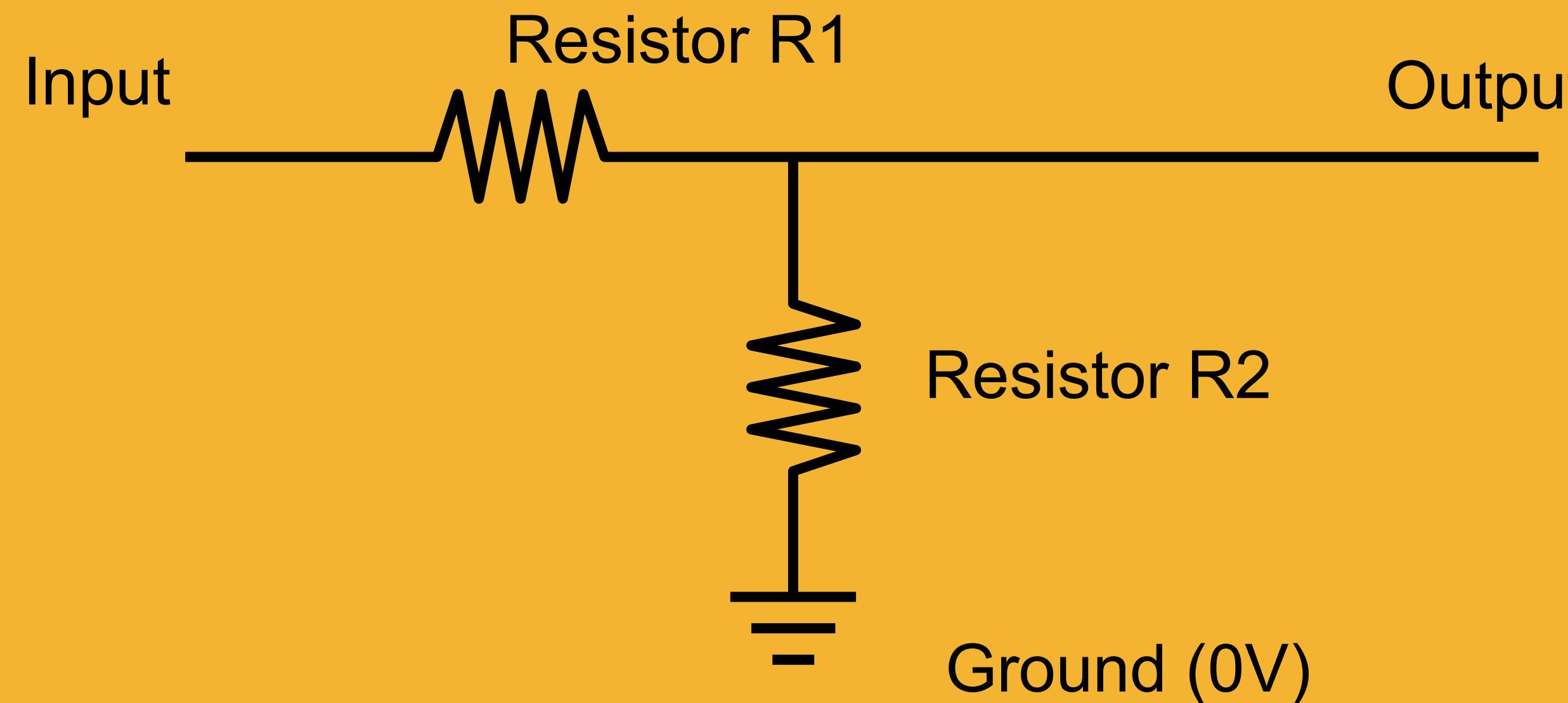
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PWM WITH LOW-PASS FILTER

- More output switching provides a flatter, smoother output curve
- Good for a system that must be able to produce a variety of voltages
- Fiddling around with the sizes of the resistor and capacitor has a lot of effects on the output
- A full discussion is well beyond the scope of this presentation
- If you'll only need one output voltage, a voltage divider is a better choice

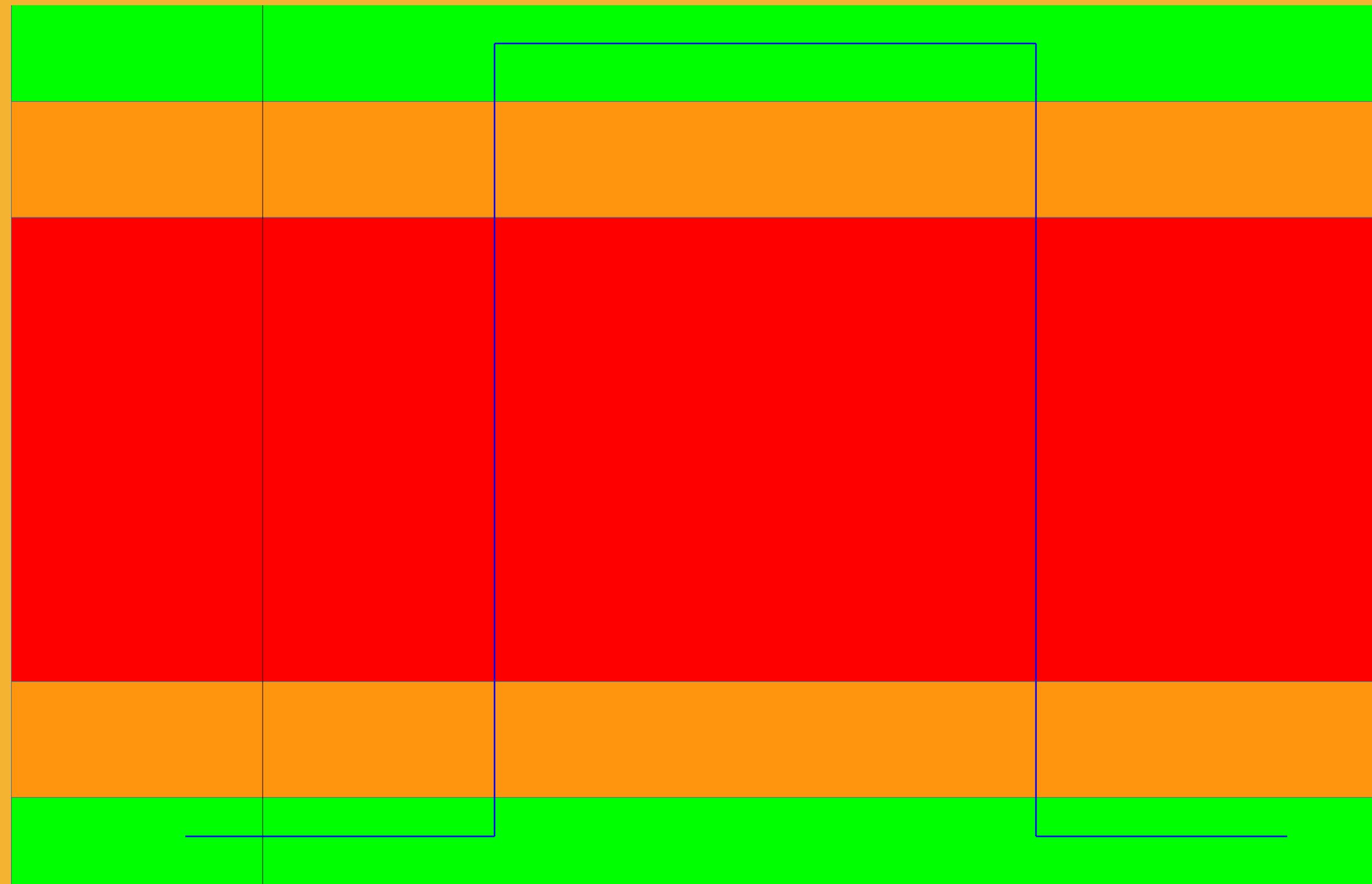
VOLTAGE DIVIDER



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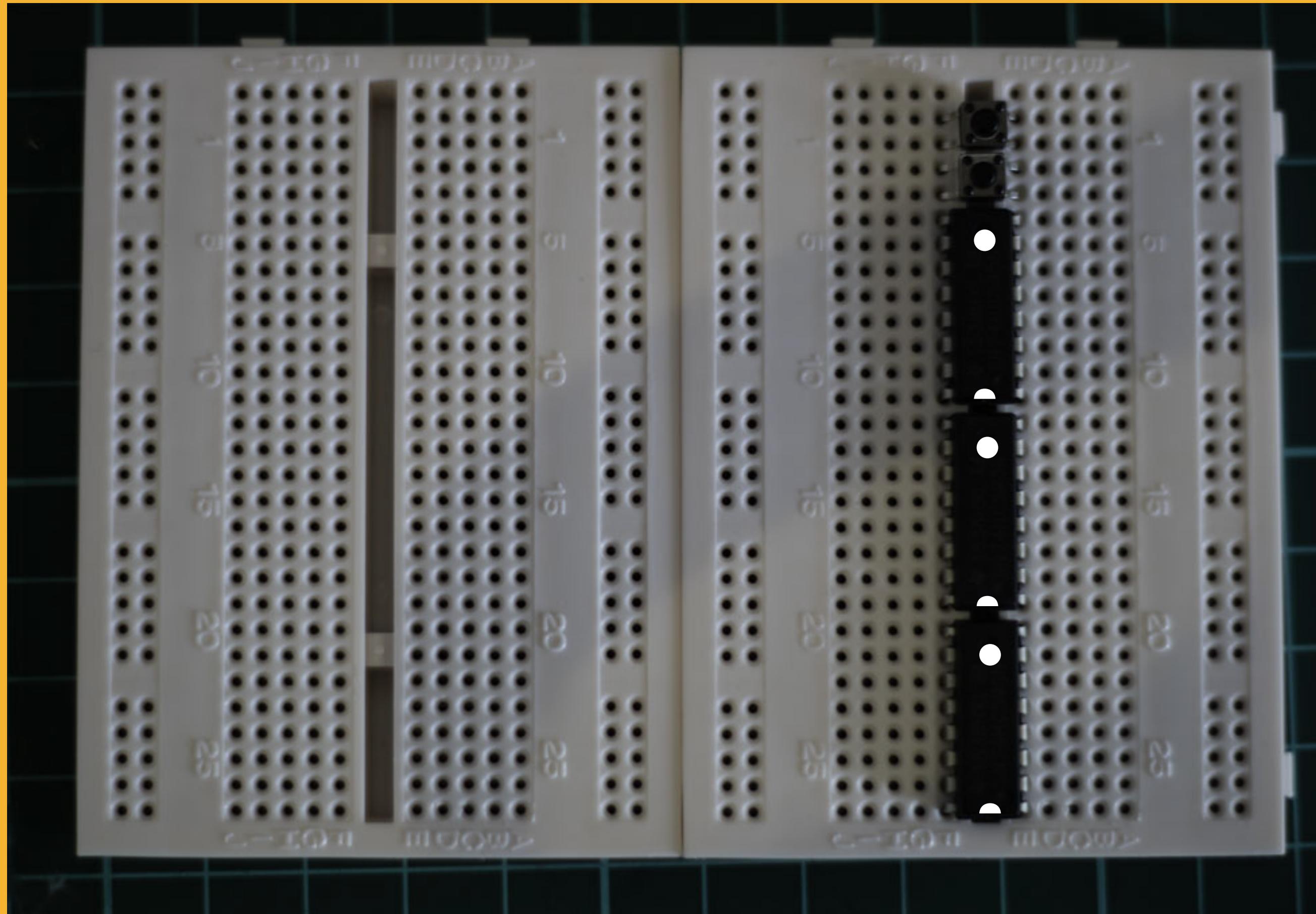
THEORETICALLY PERFECT OUTPUT



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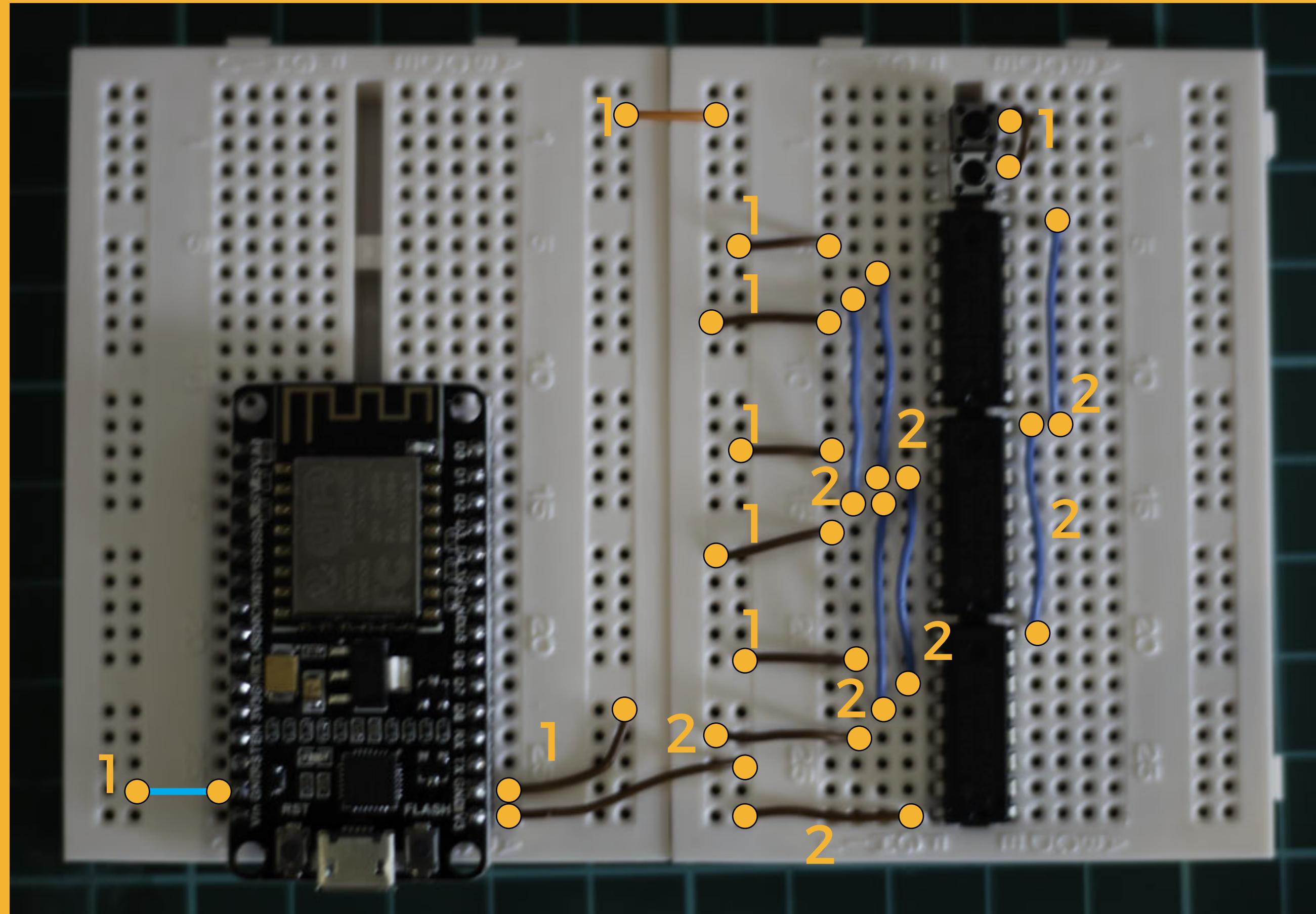
WIRE IT UP



1. Add shift registers
2. Add buttons

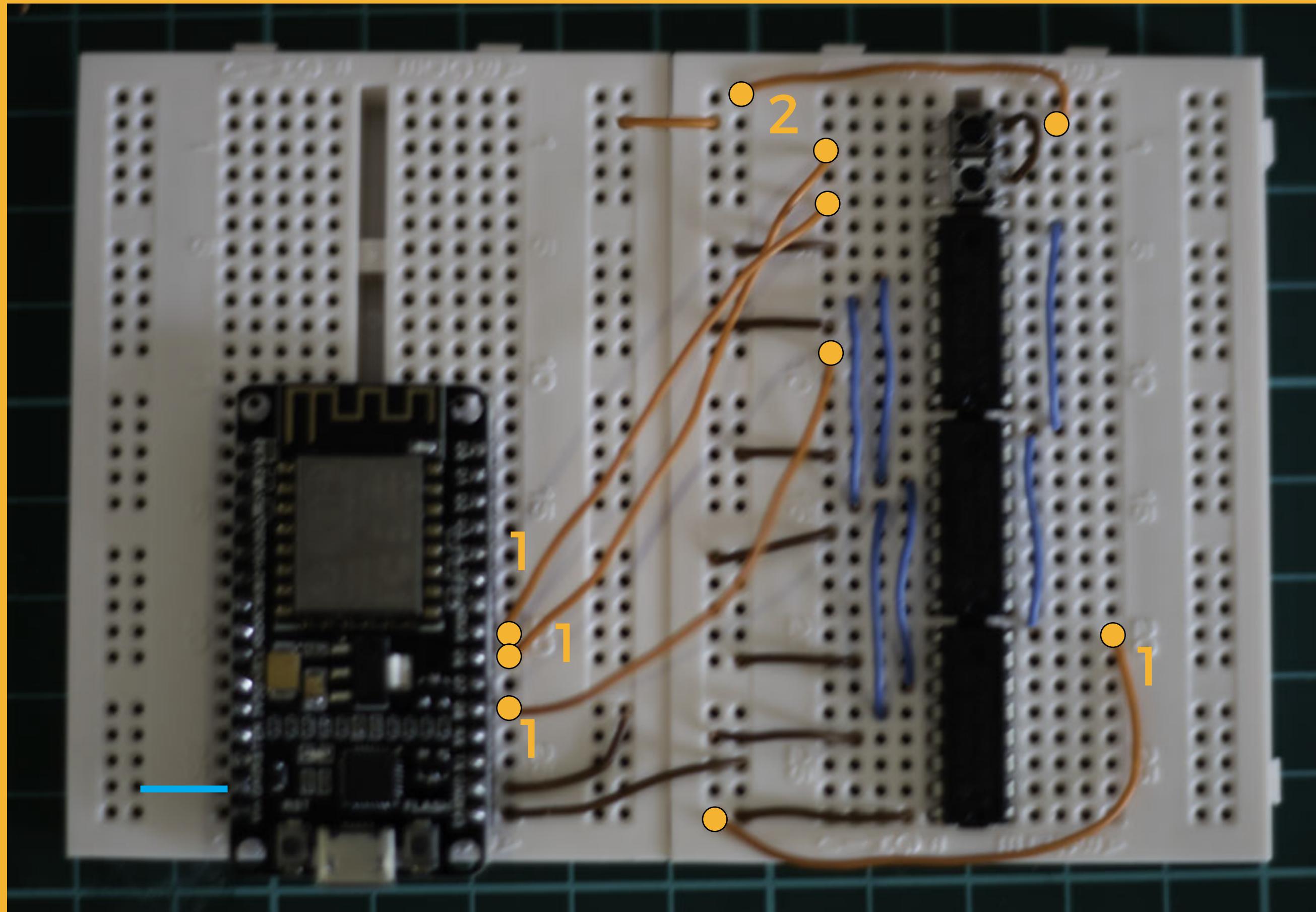
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WIRE IT UP



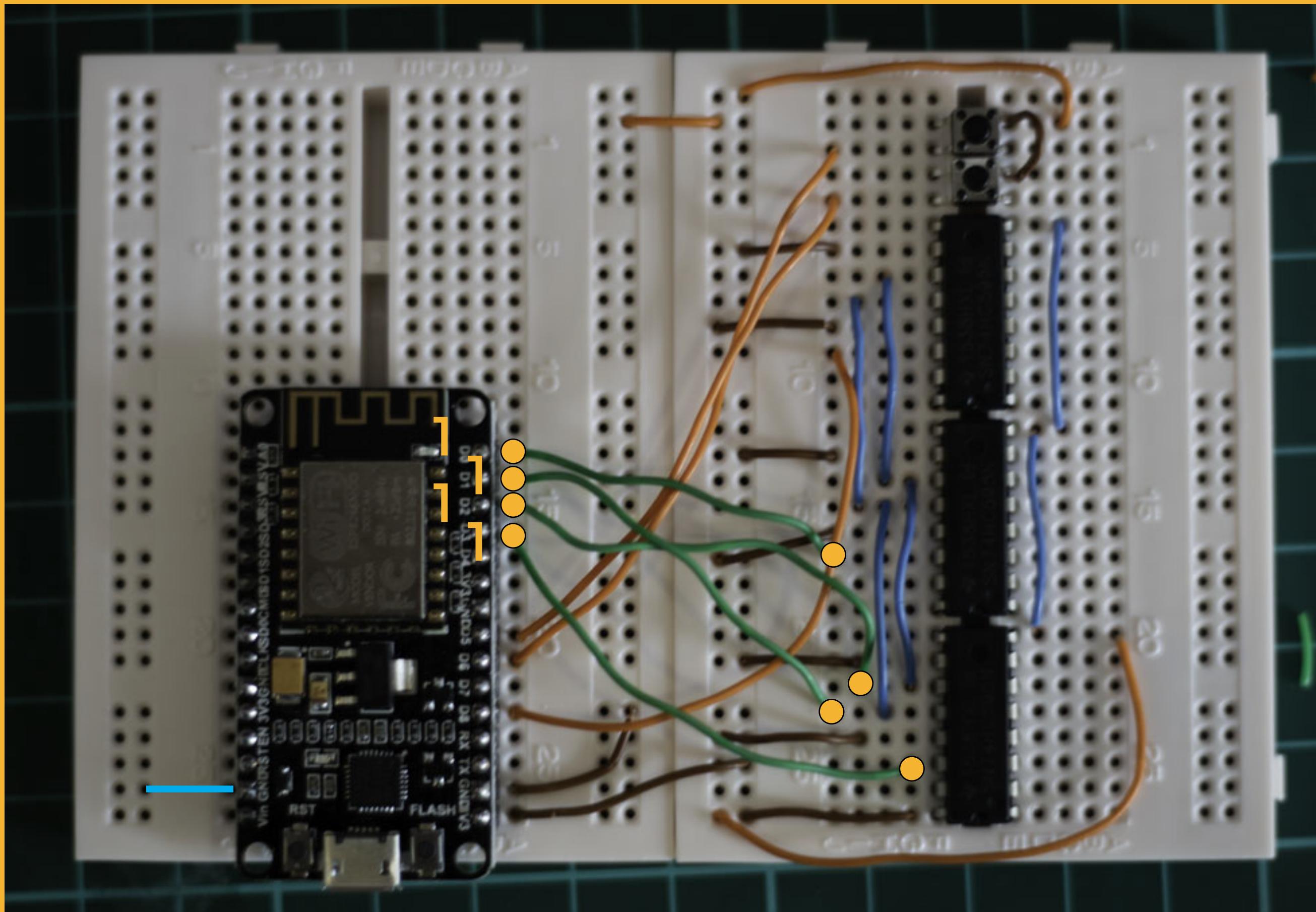
1. 8x 20mm jumper
2. 7x 30mm jumper

WIRE IT UP



1. 4x 70mm jumper
2. 1x60mm jumper

WIRE IT UP

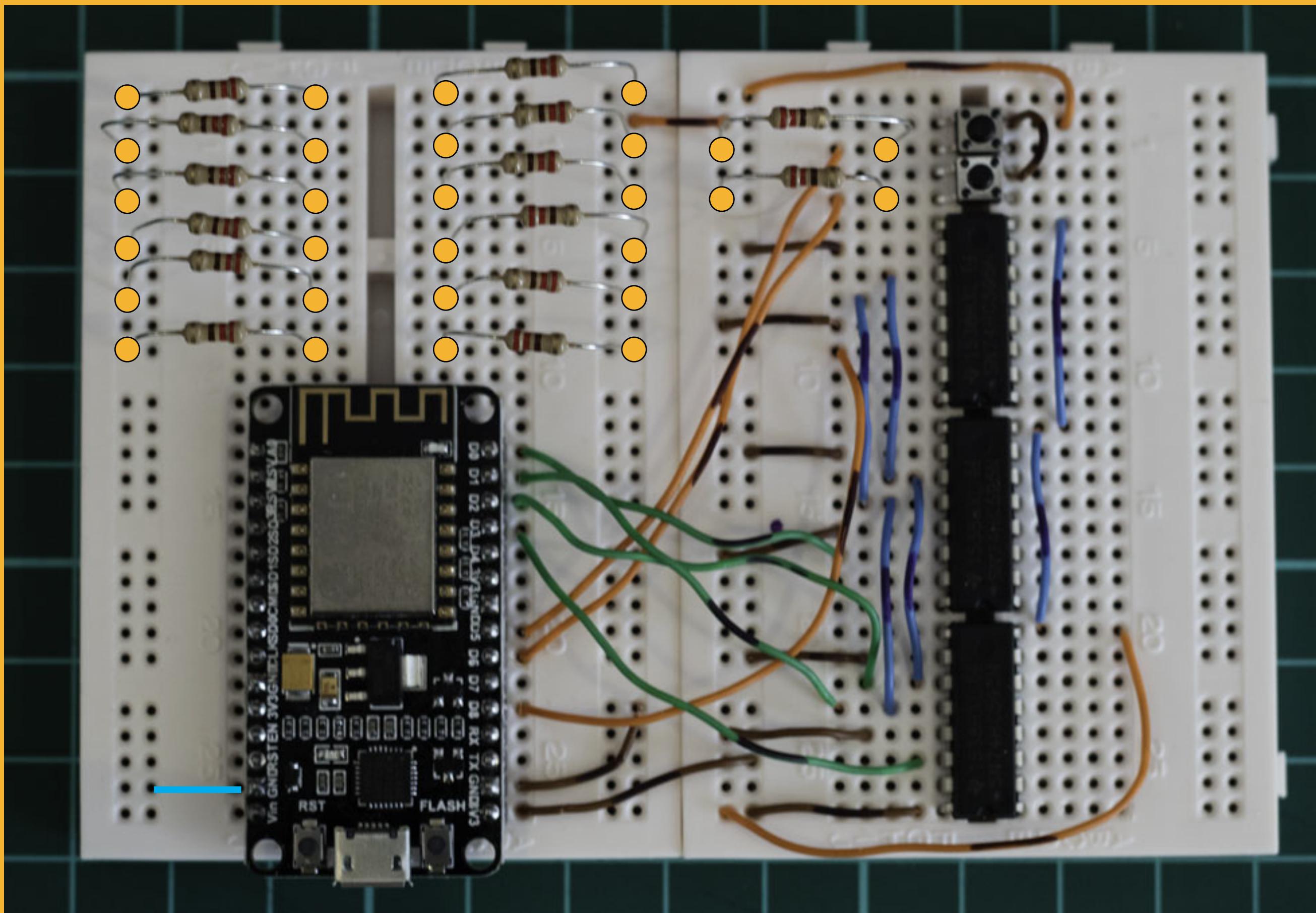


1. 4x 60mm jumper

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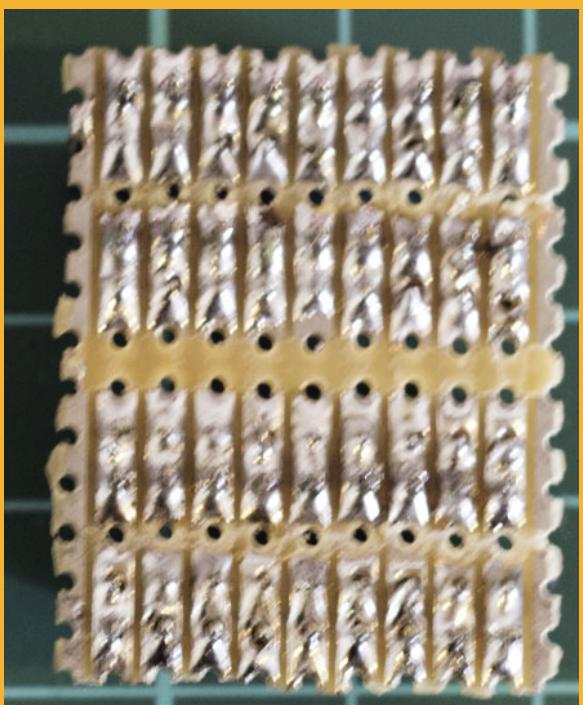
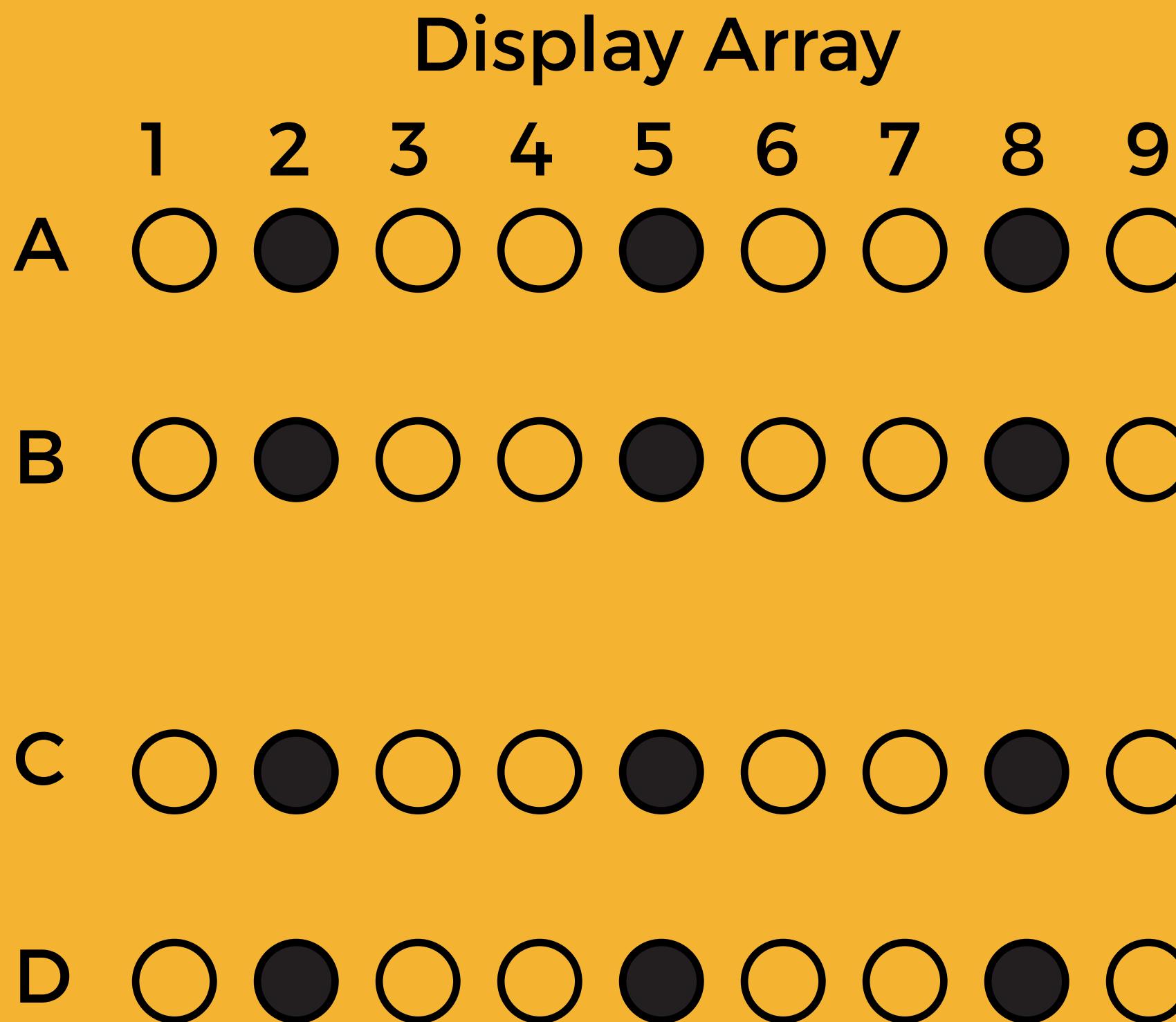


1. 14 x 220 Ohm Resistors

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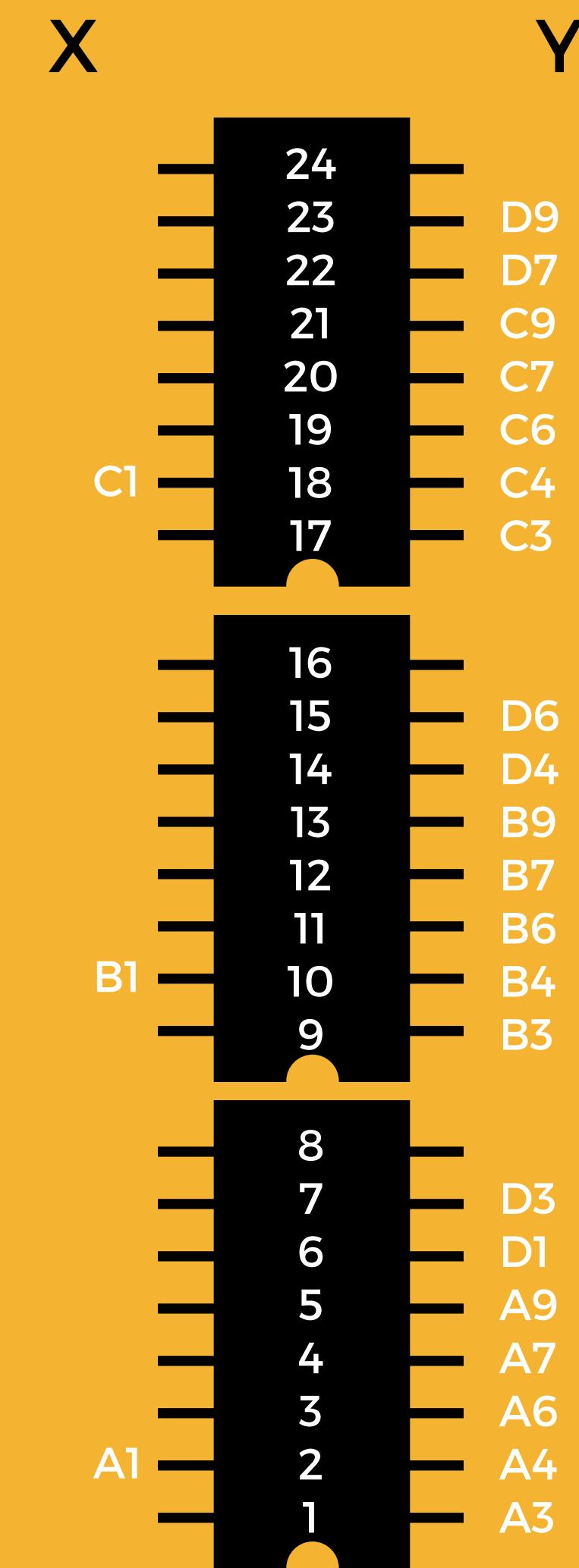
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WIRE IT UP | LED

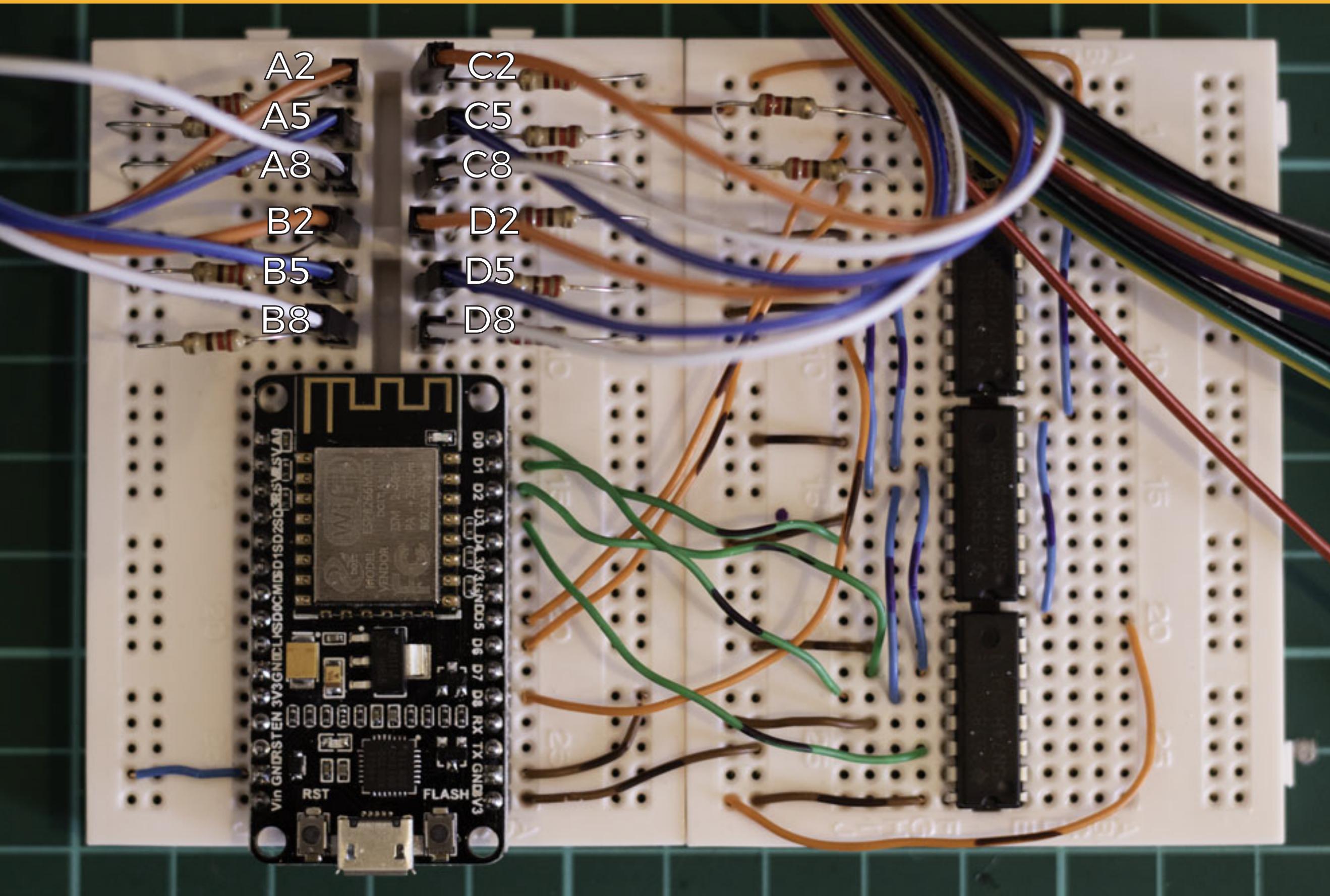


* solid dots represent LED grounds,
these will be connected to resistors on board

Shift register connections

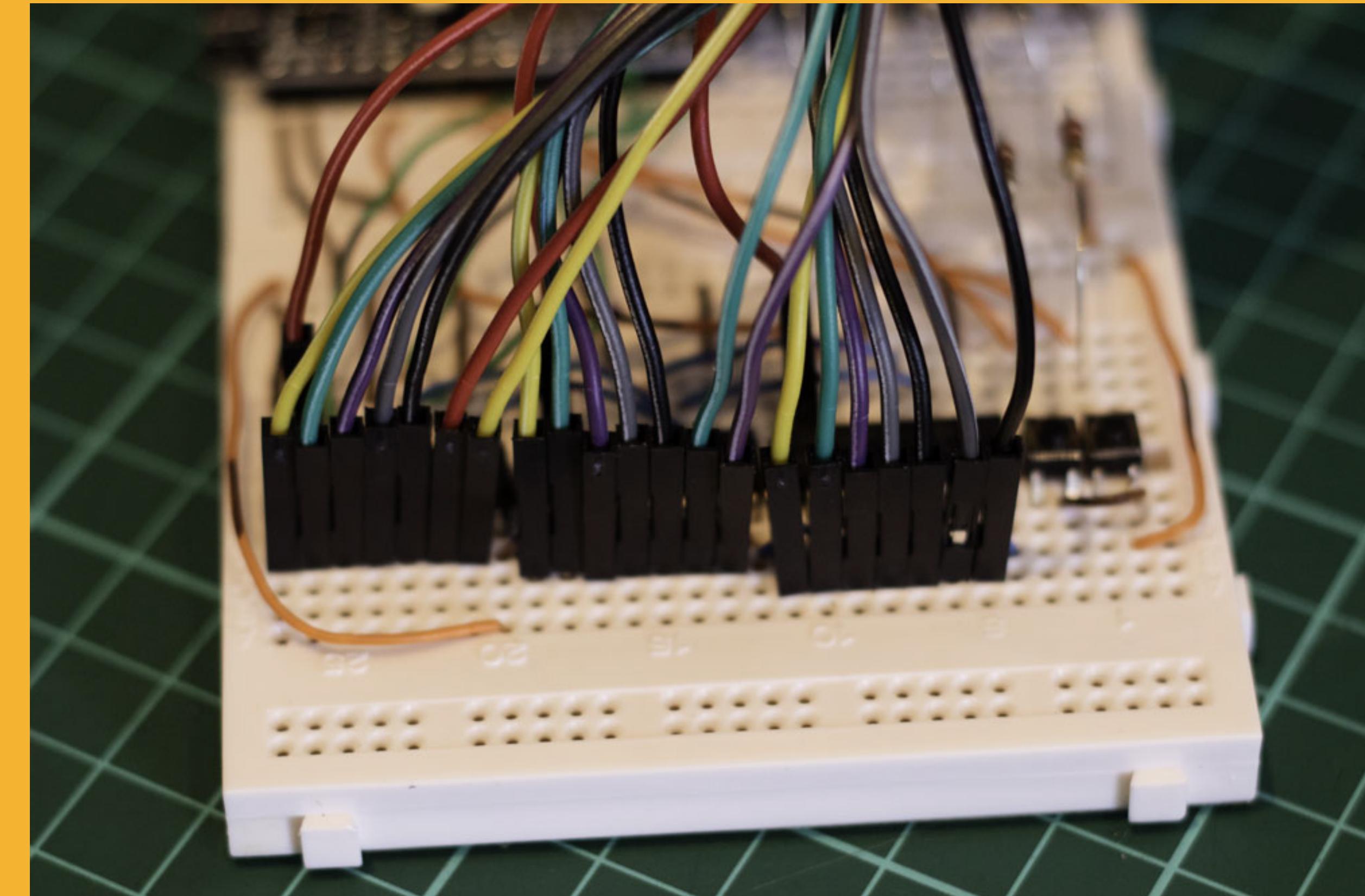
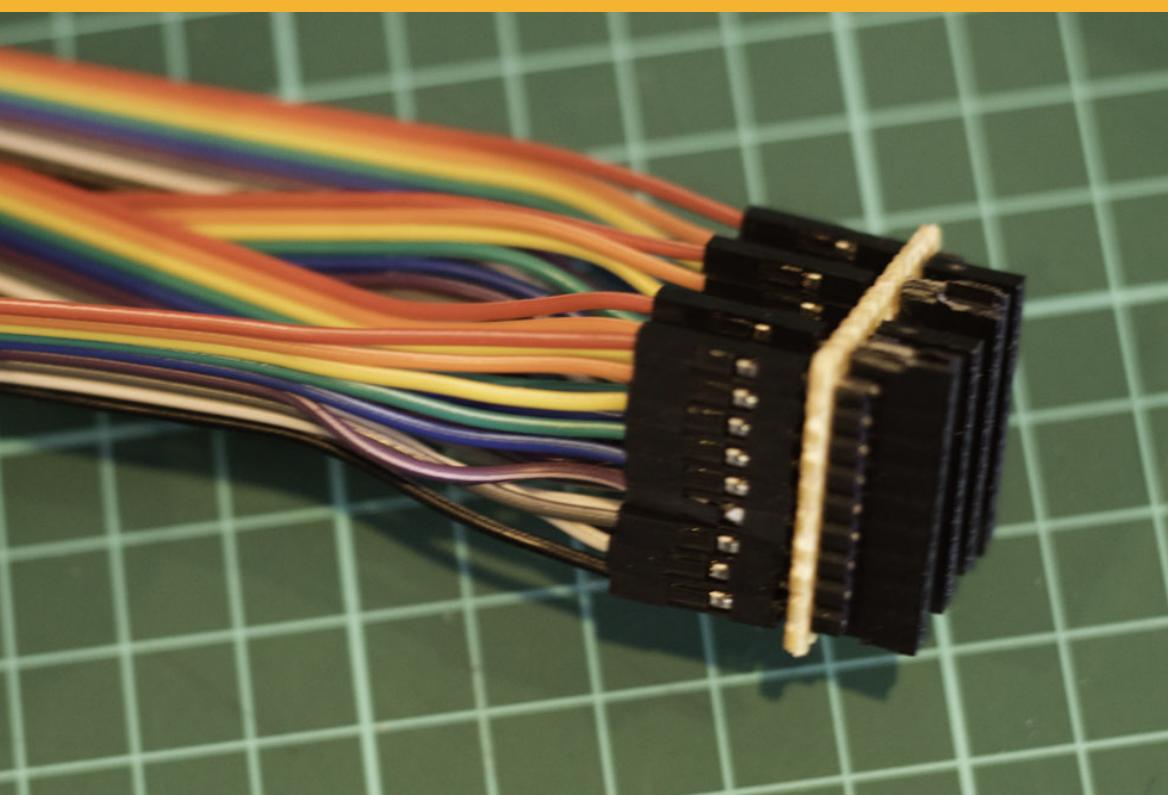
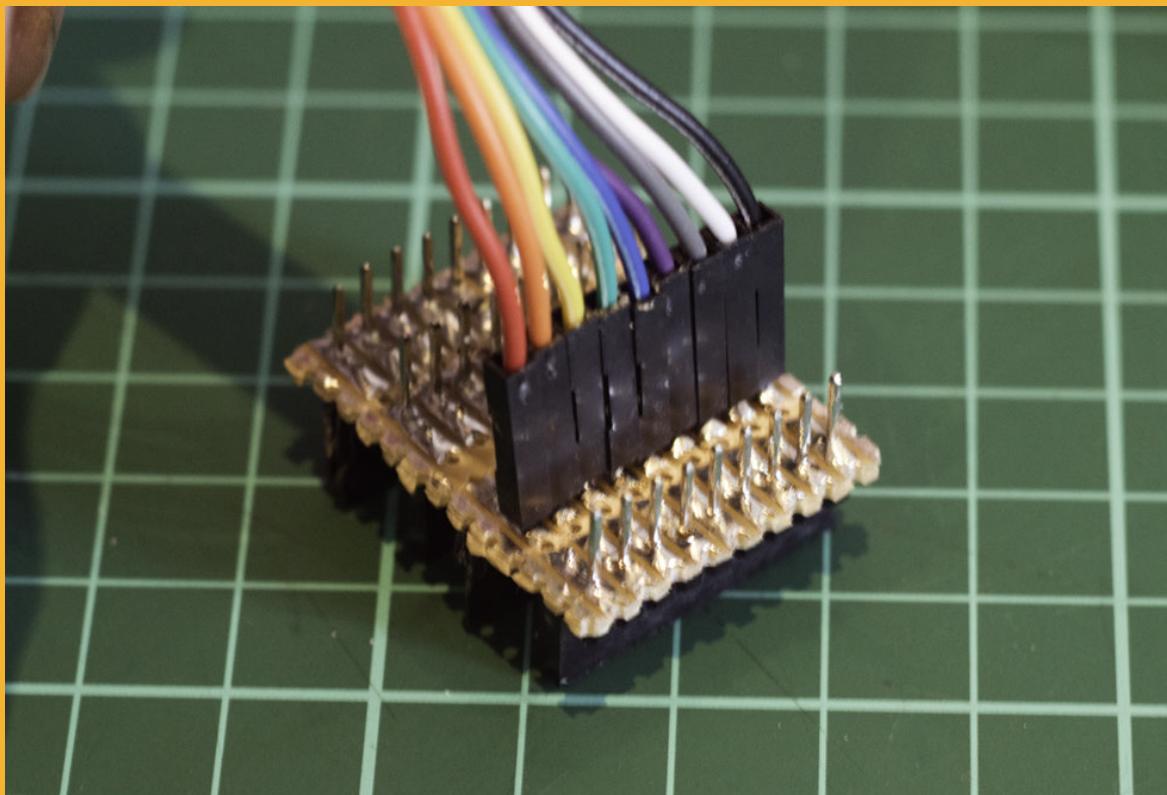


WIRE IT UP | LED GROUND CONNECTIONS



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WIRE IT UP | LED REFERENCE

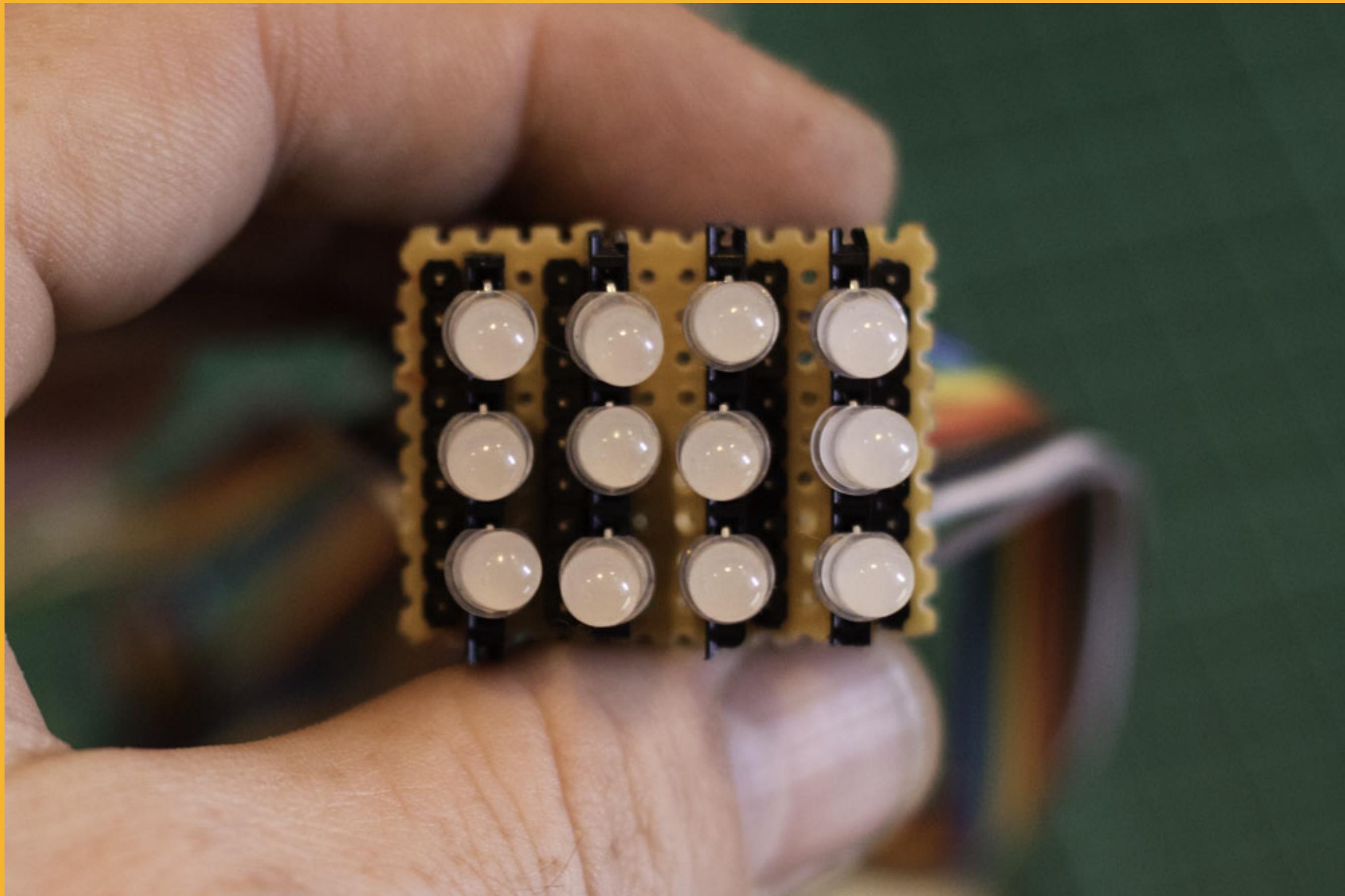


Ensure secure seating for jumper wires but pushing the connection all the way to the base of the board

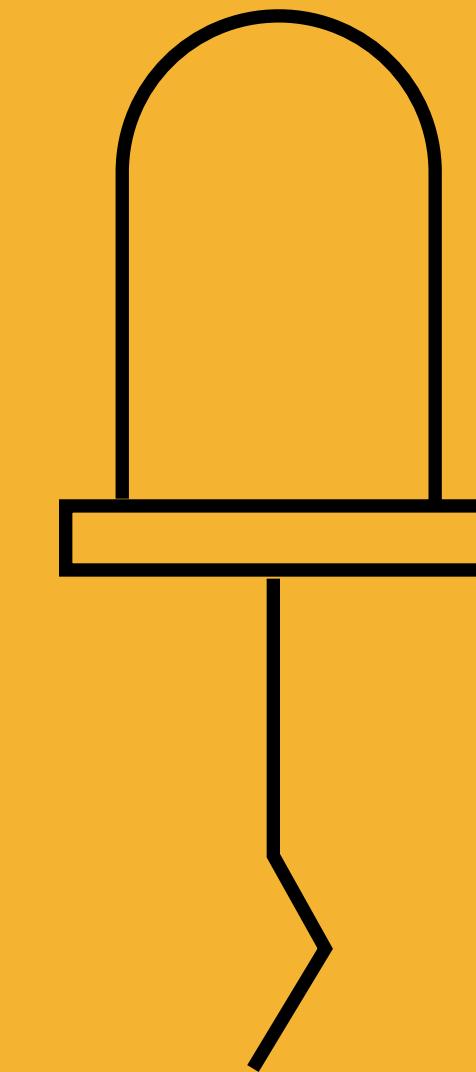
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WIRE IT UP | LED CONNECTIONS



Ensure LEDs all face the same direction: One side is flattened



Protip: slightly kink LED legs
with a needlenose plier
to ensure secure fitment

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FLASH NODEMCU

- Open tictactoe.ino with Arduino IDE
- Select board and port from tools menu
- click Upload

CODE REVIEW

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QUESTIONS

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