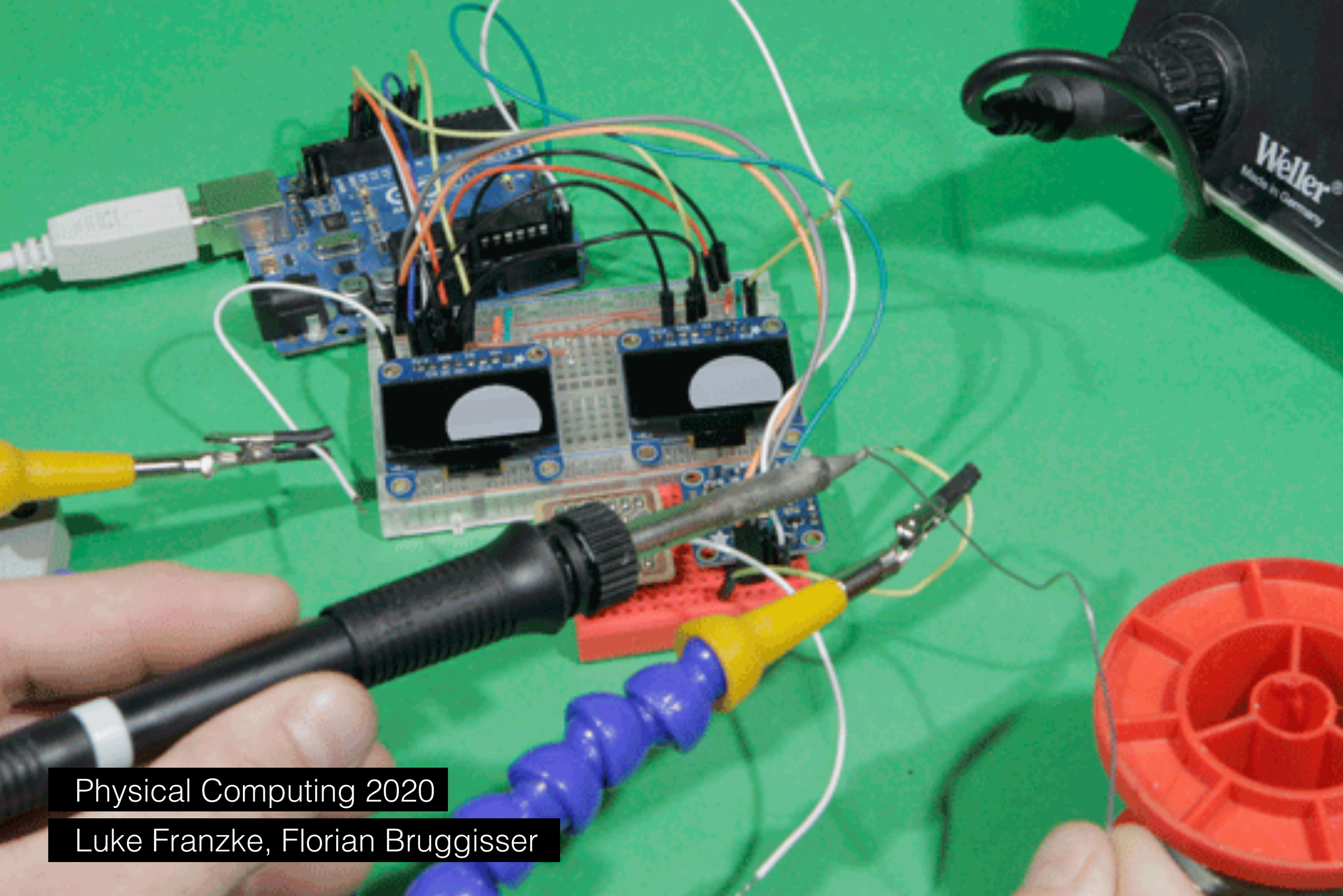
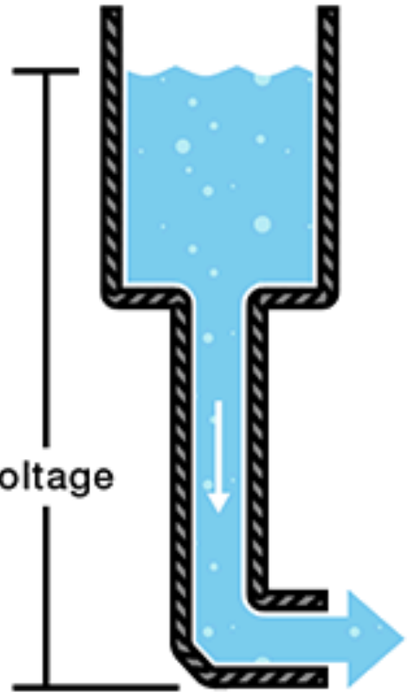
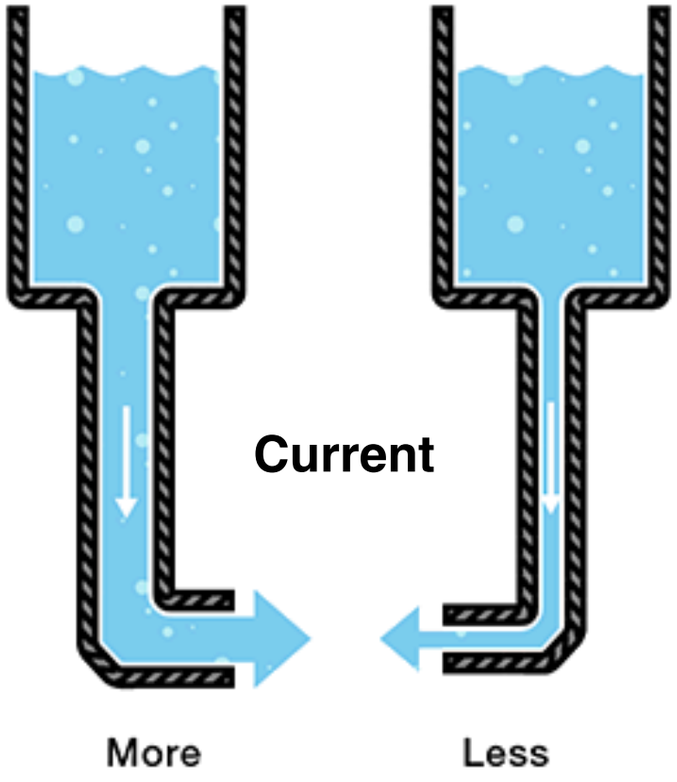


Physical Computing 2020

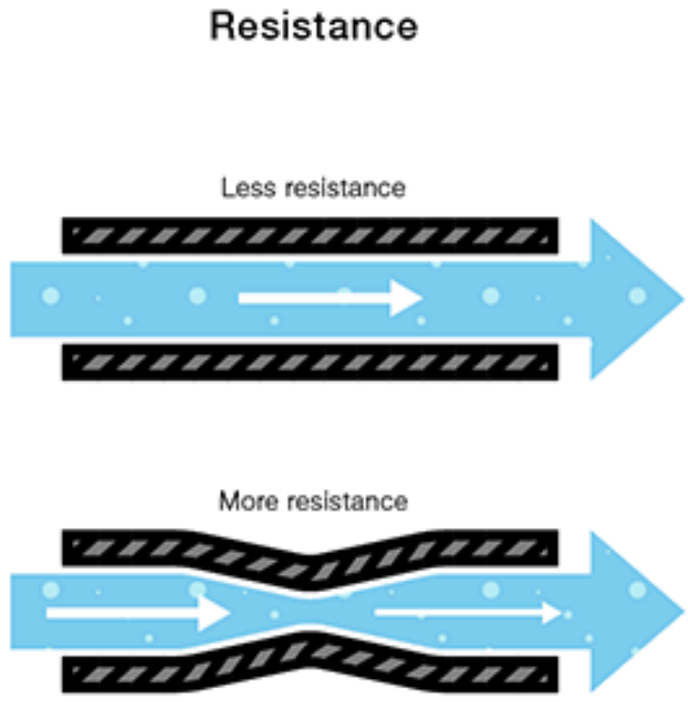
Luke Franzke, Florian Bruggisser



Spannung



Strom

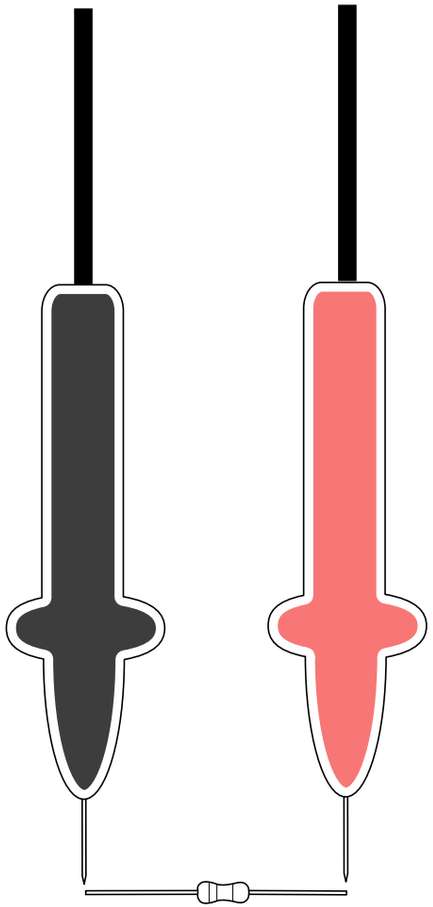


Wiederstand

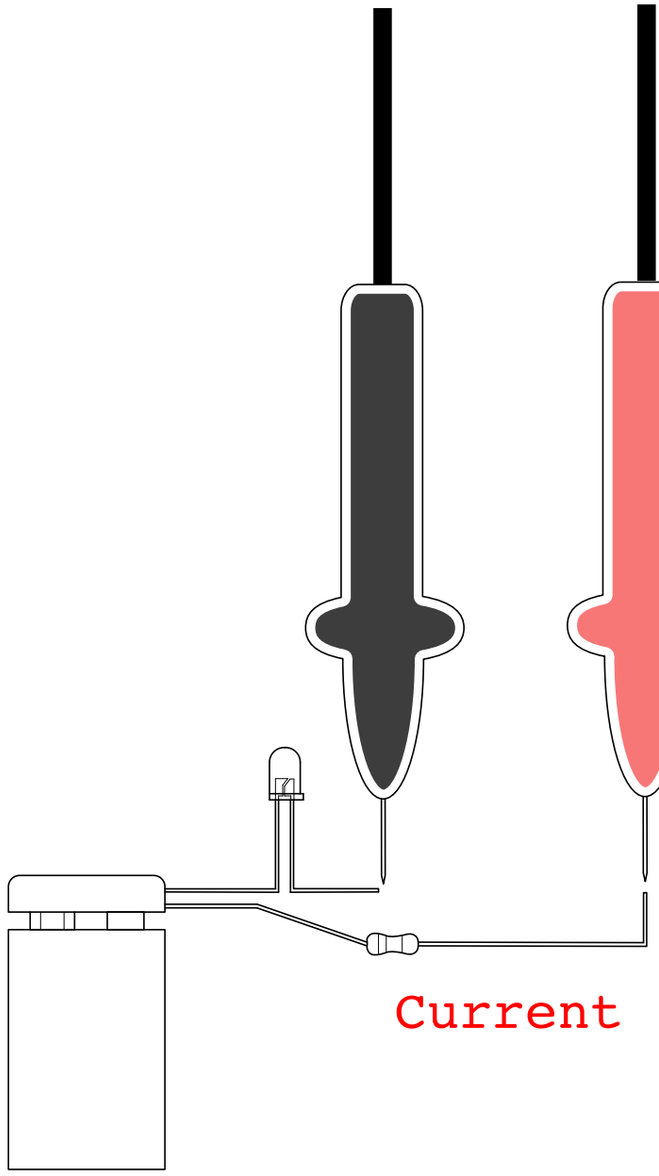
Measures of Electricity

The multimeter is an essential tool for problem solving in electronics!

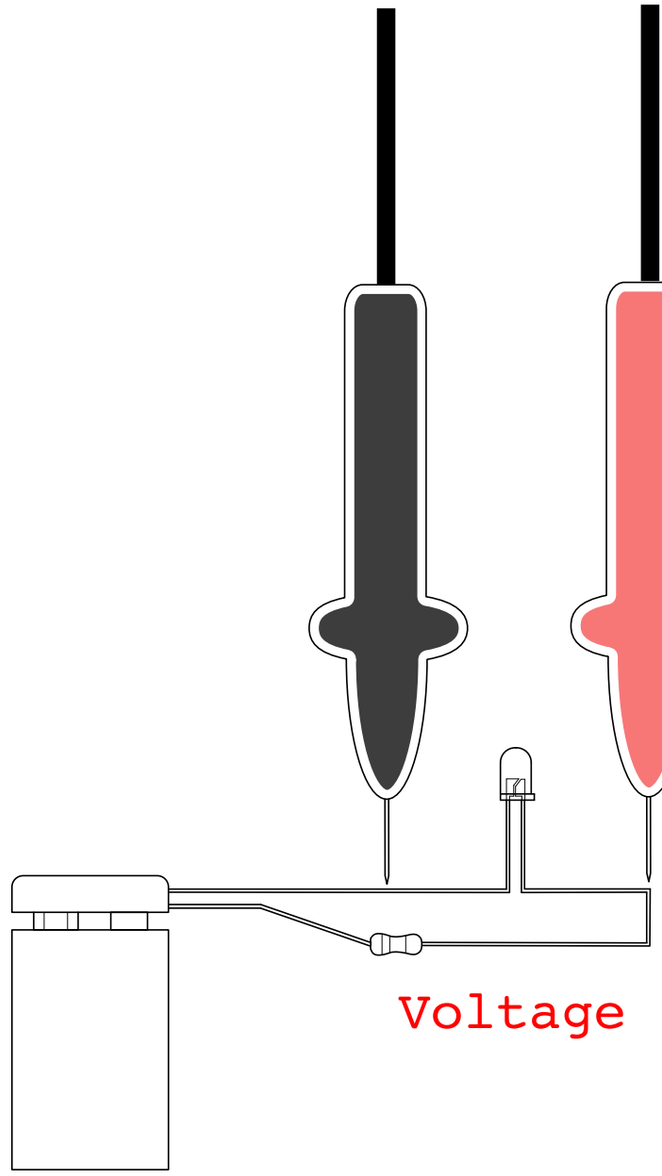
The Multimeter



Resistance



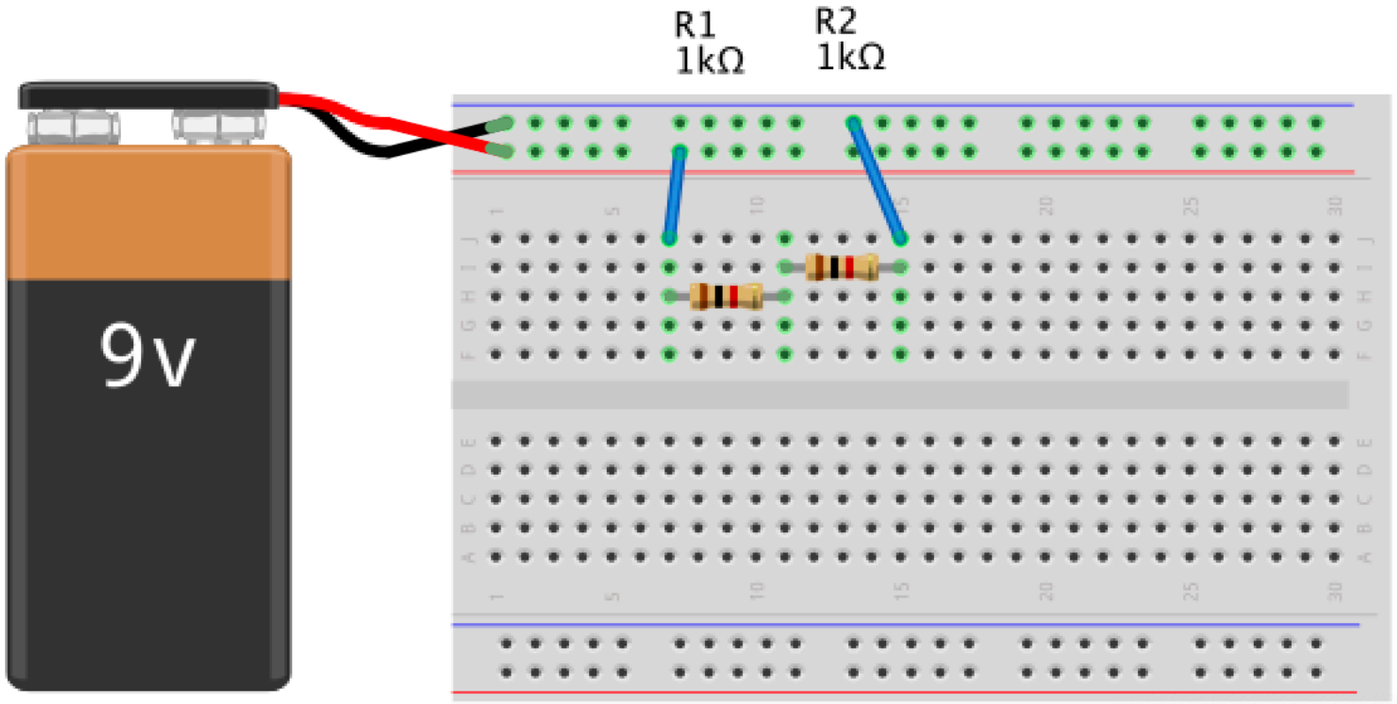
Current

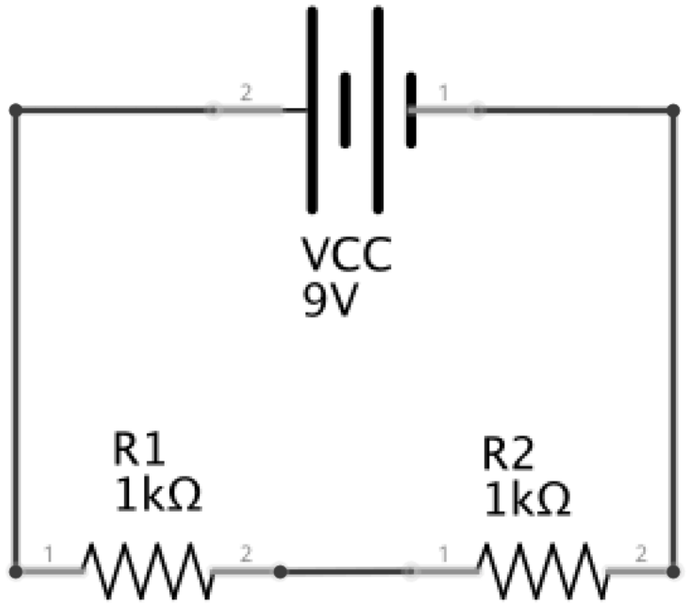


Voltage

The way we use the probes on a multimeter depends on what we are testing! Resistance of components should (ideally) be tested outside its circuit. For current we have to break the circuit, and insert the probes to close it again. Voltage, however, can be measure between any two points.

The Multimeter



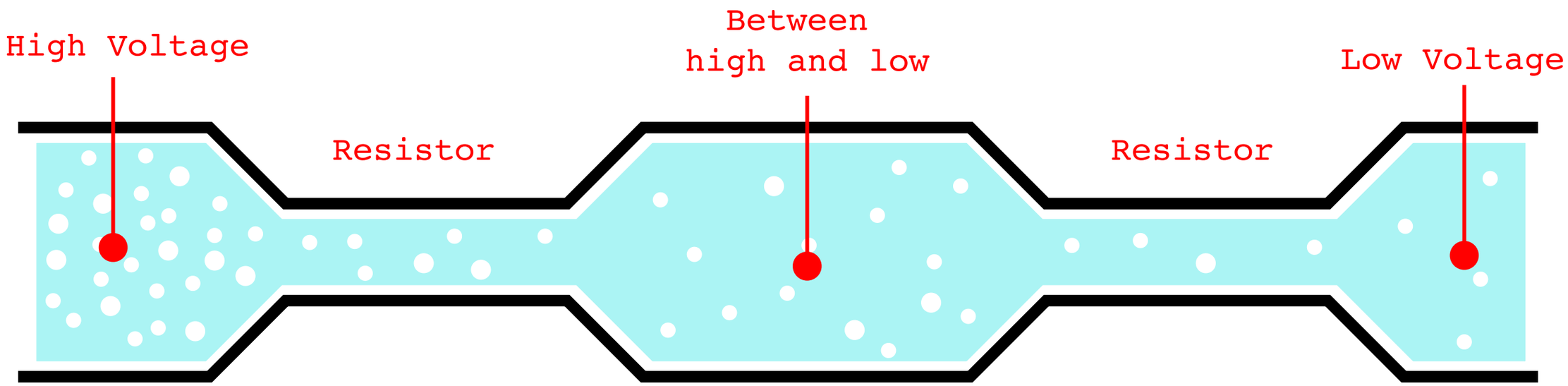


Exercise 3.1: Voltage Divider

Assembly the circuit with resistors of two different values. Try calculating the voltage between your resistors, and check with the multimeter if it's correct.

$$\mathbf{Vres = Vcc \times \frac{R2}{(R1 + R2)}}$$

Vres = resulting voltage
Vcc = applied voltage (9V)
R1 = first resistor (1000 ohm)
R2 = second resistor (1000 ohm)

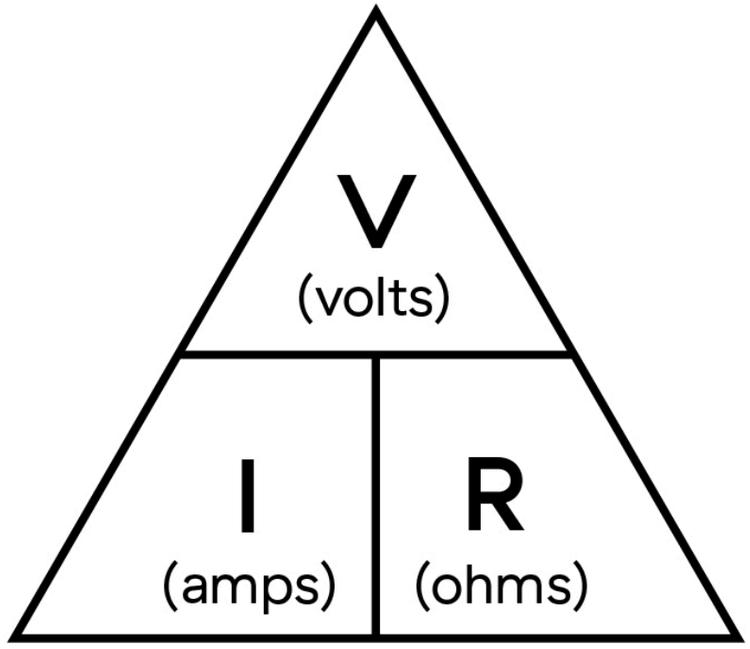


Voltage will drop when current flow though any component that converts electricity to some other form of energy.

Voltage Divider

Ohms LAW

There is an intrinsic relationship between voltage, current and resistance, expressed as ohms Law. We can use this formula to deduct the values in many situations

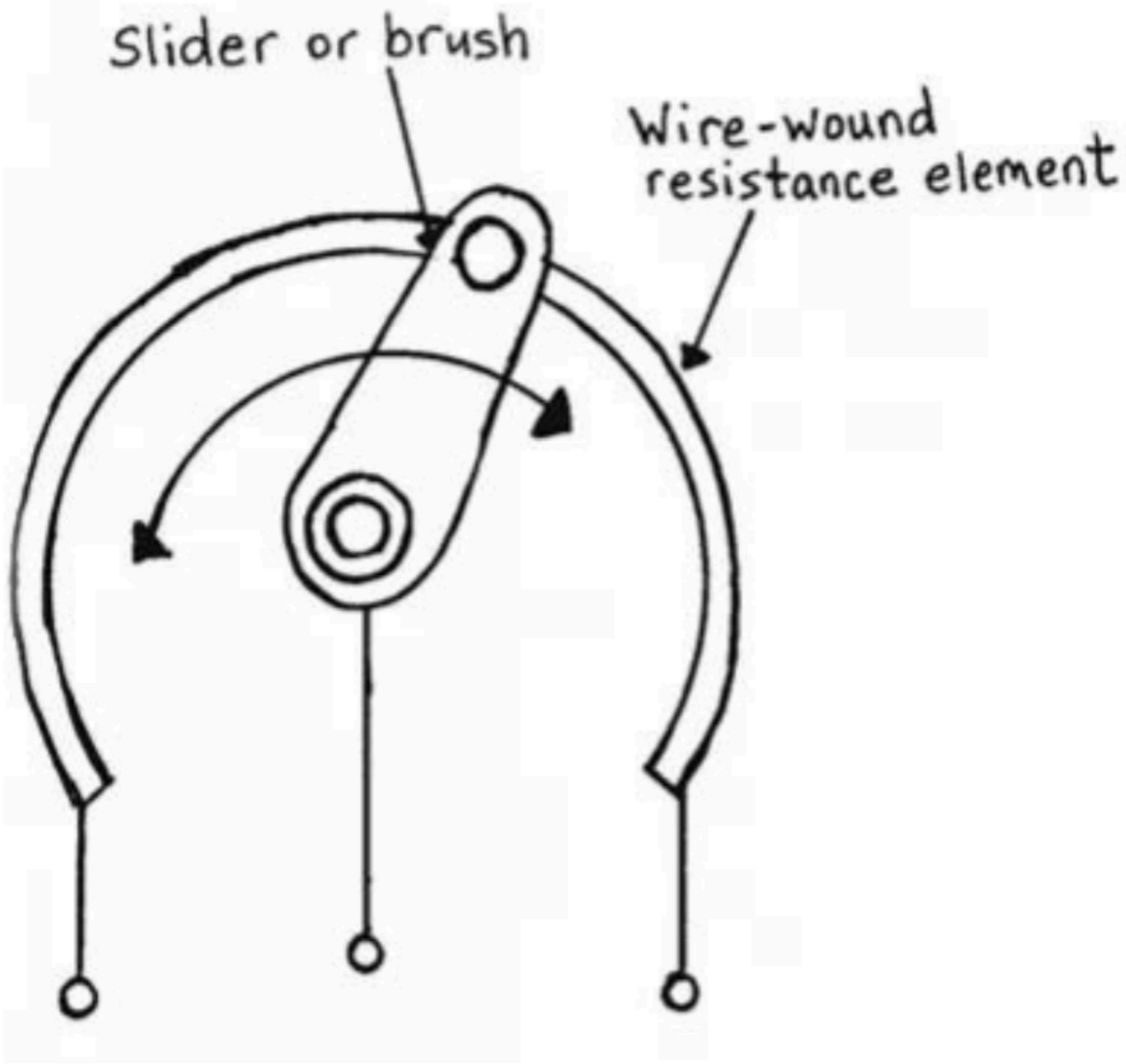


$$V = I \times R$$

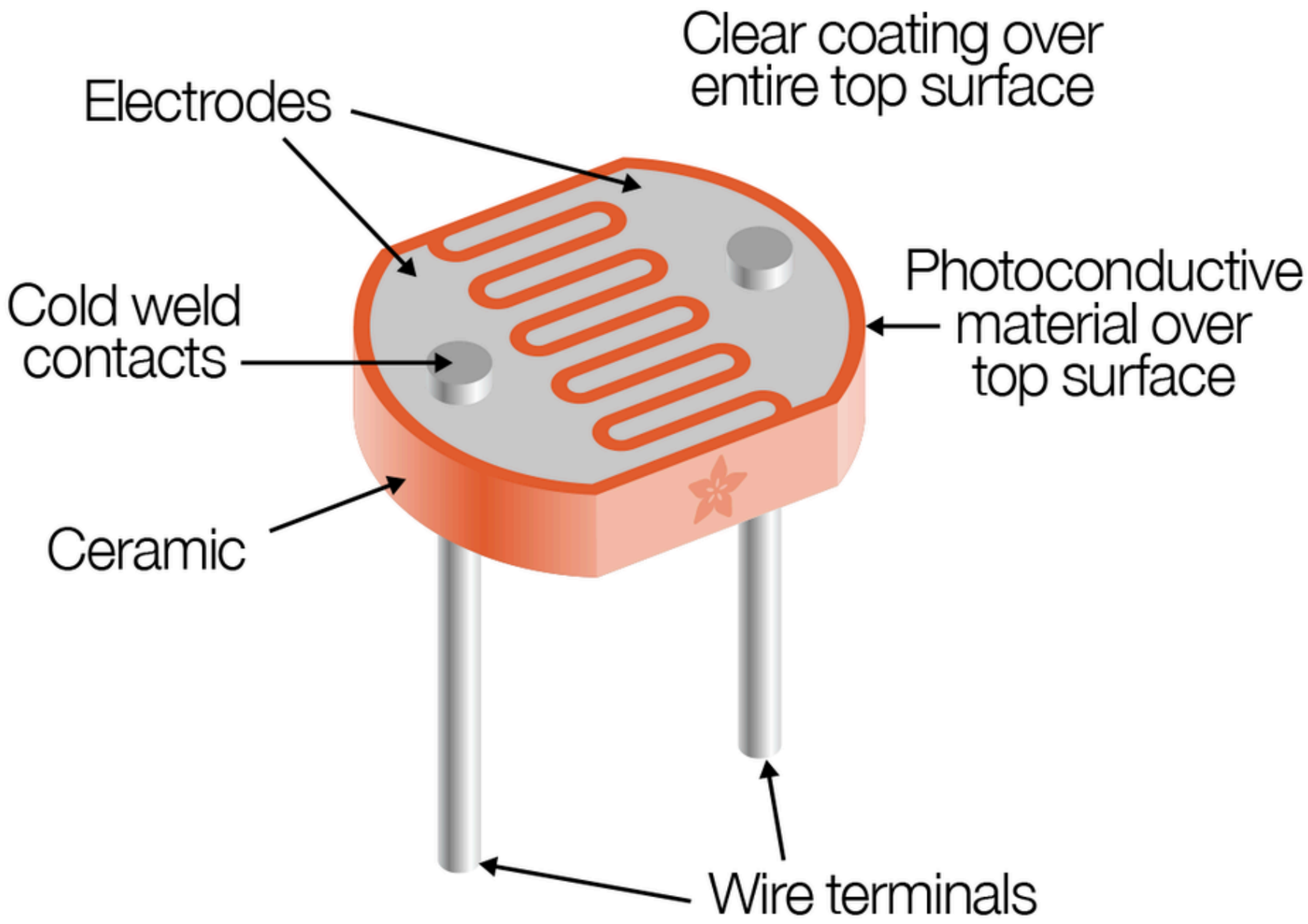
$$I = \frac{V}{R}$$

$$R = \frac{V}{I}$$

A Potentiometer is also a voltage divider!



Potentiometer

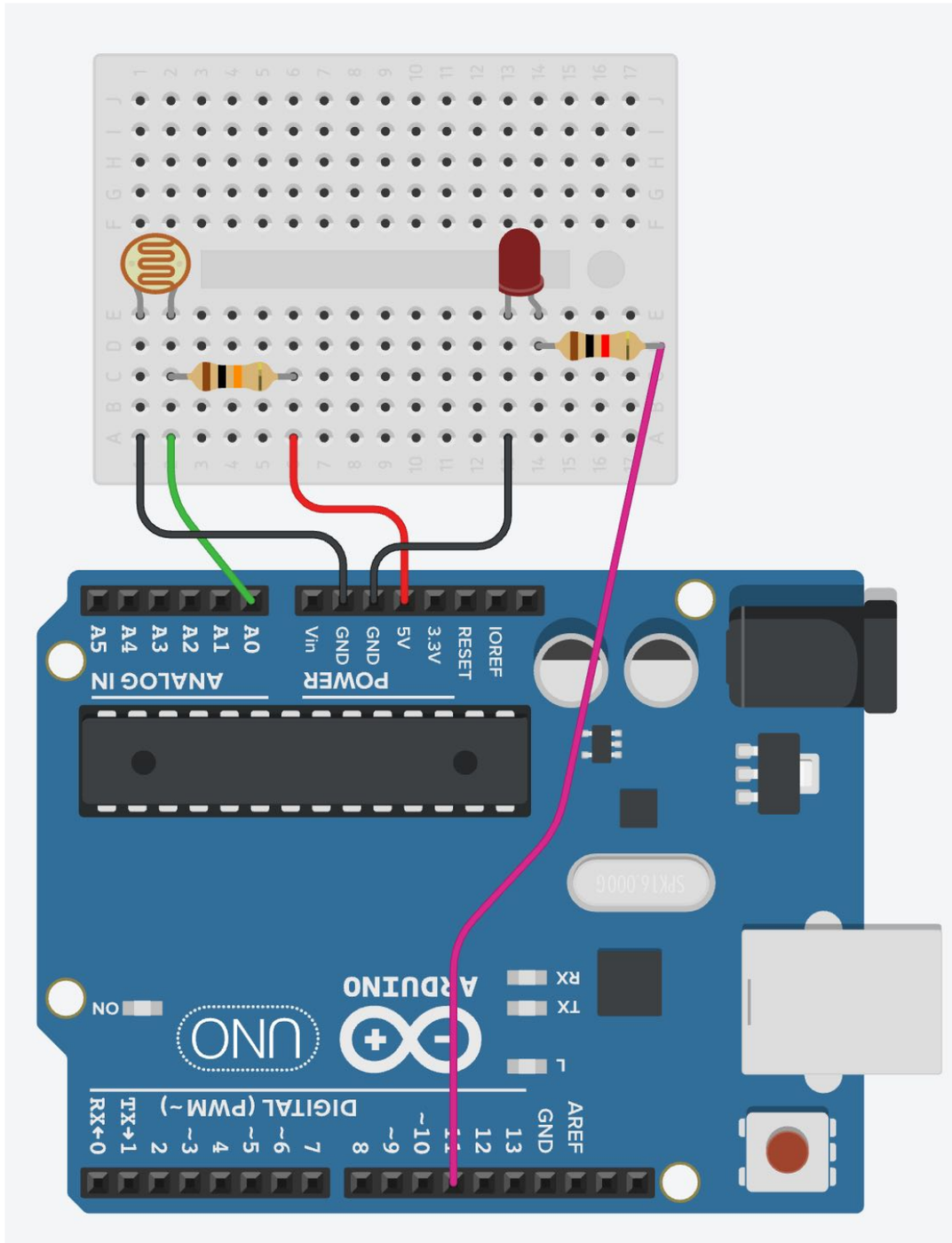


Analog Sensors

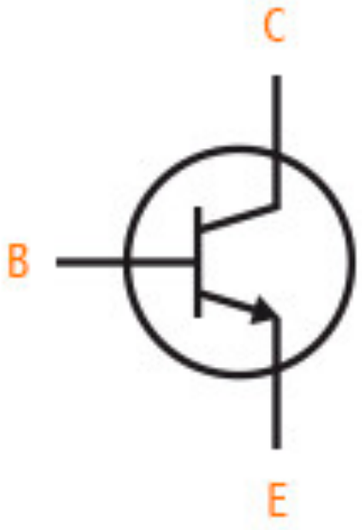
Exercise 3.2: Light Sensor

Build a circuit and code it to turn on an LED when it gets dark using a Photoresistor.

Optional: cod it so the LED fades smoothly between Dark and light states.

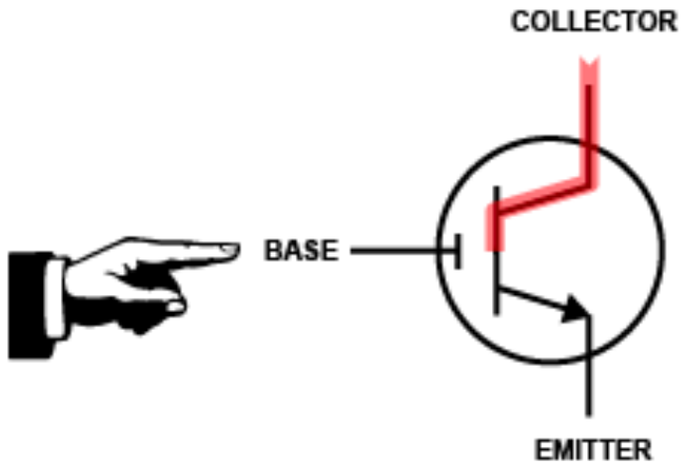


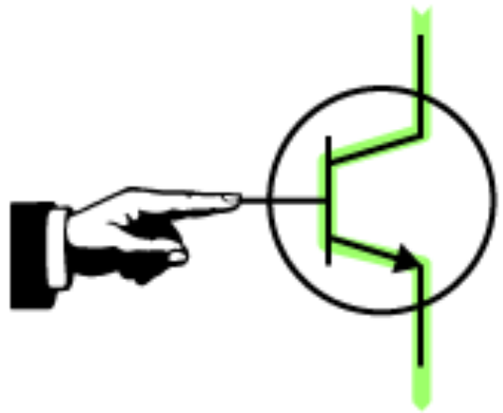
To power loads greater than the 40mA our Arduino digital pins can provide, we need to use a transistor.



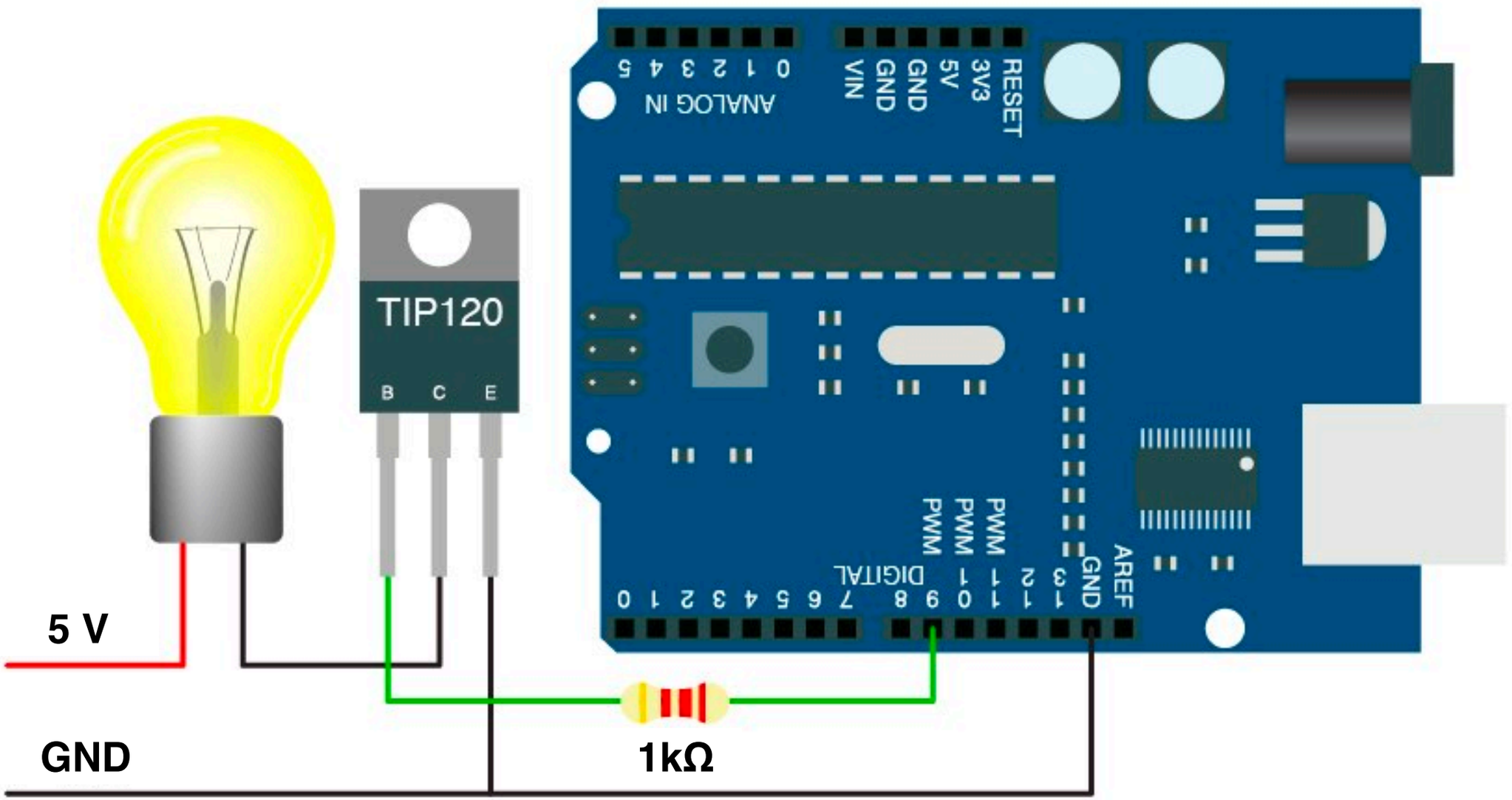
Transistors

Transistors work like buttons, with a very small current on the base pin, allowing a larger current to flow between collector and emitter.



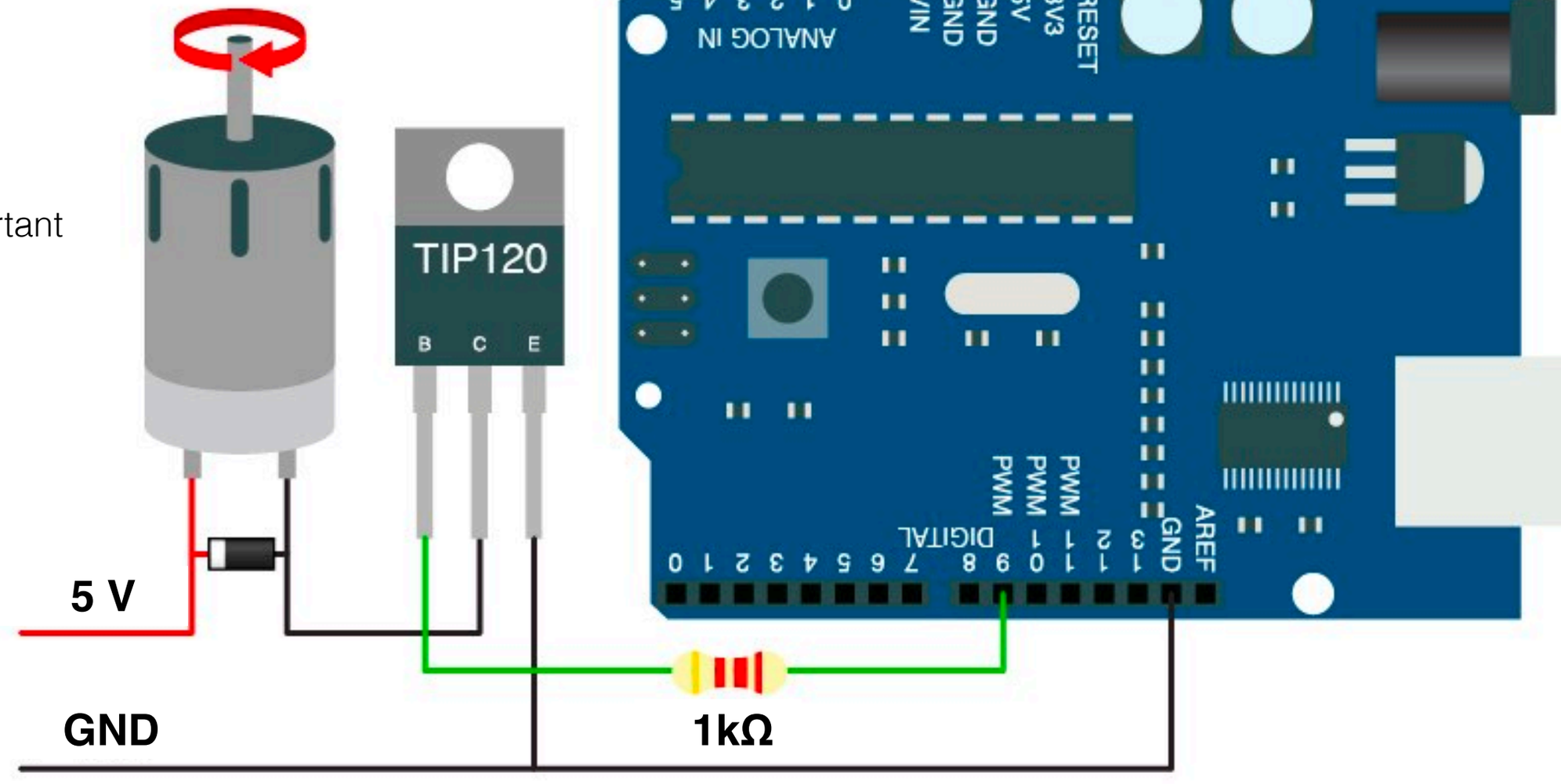


Transistors



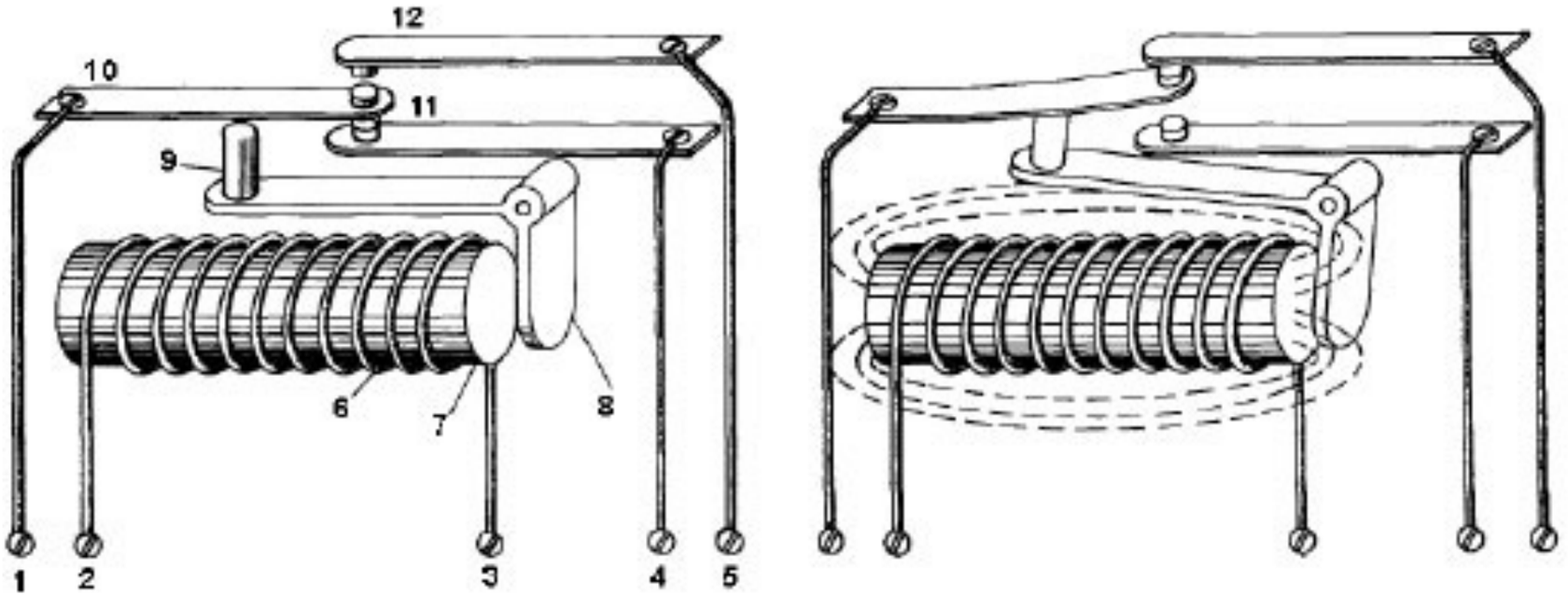
Transistors

Adding diode is important
for inductive loads
(motors for example)

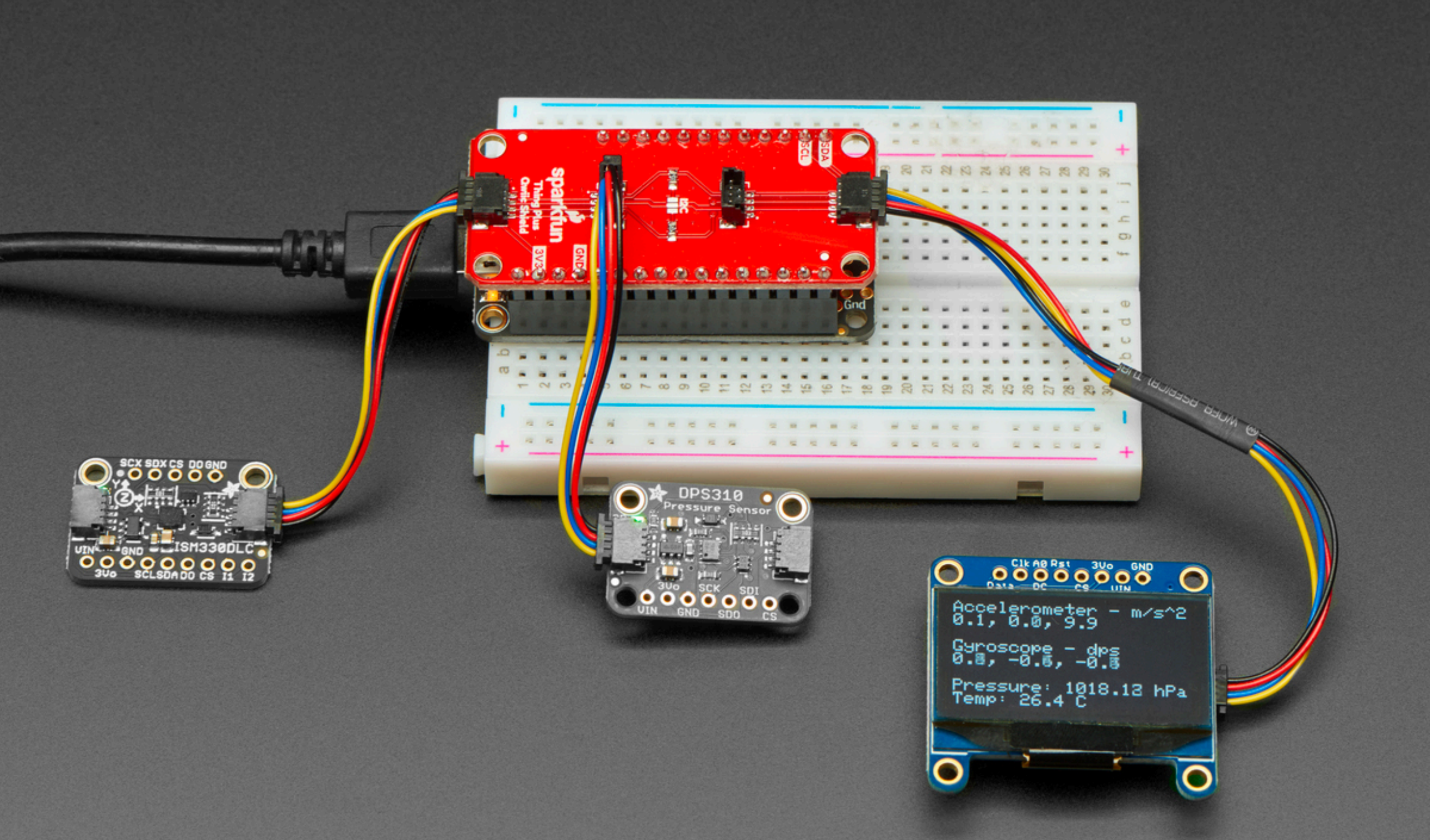


Transistors

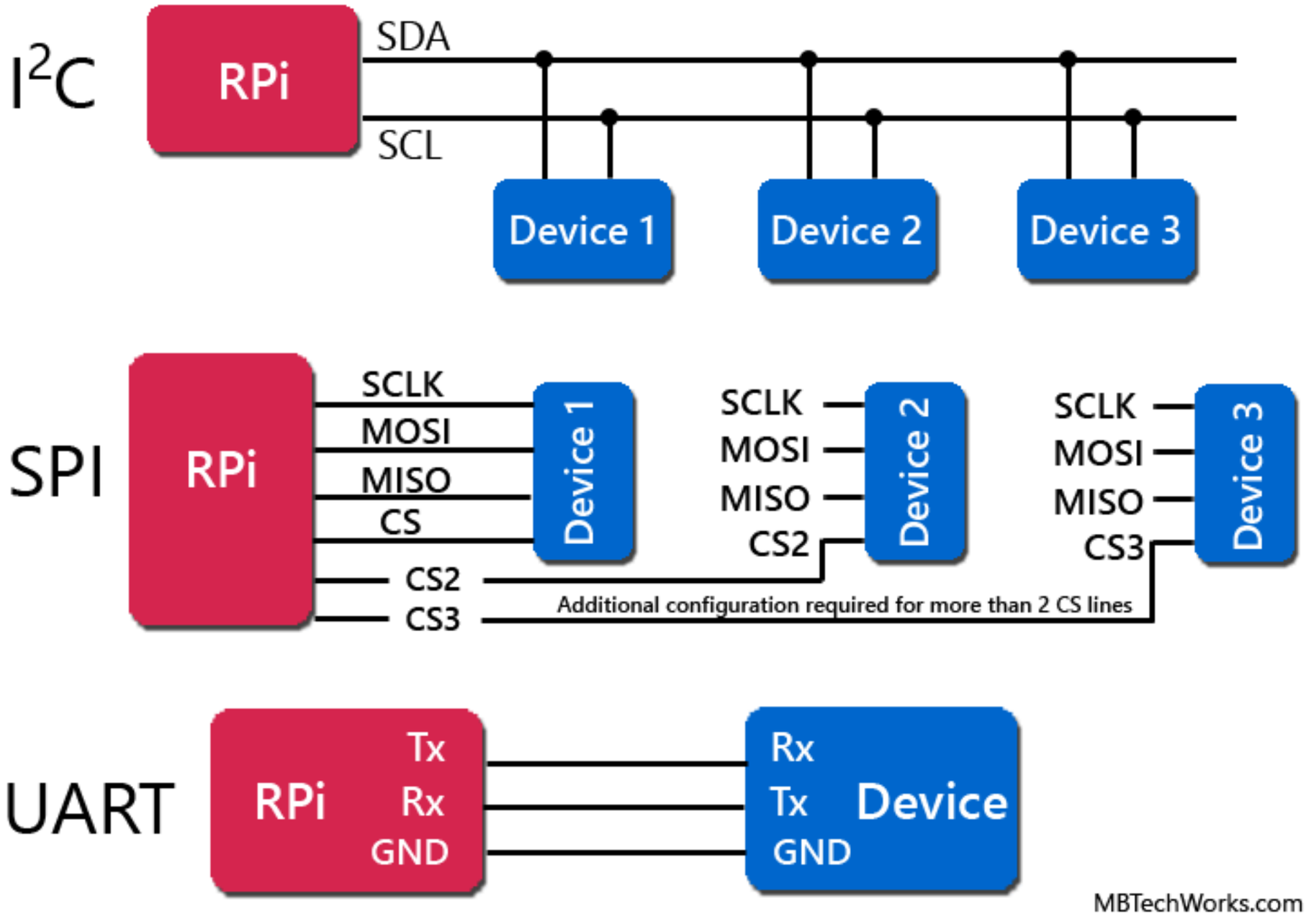
Relays can sometimes be used instead of transistors (for controlling very high loads, or when the HV circuits need to be completely isolated. But, they are loud and slow!



Relays



Digital Peripherals and Protocols

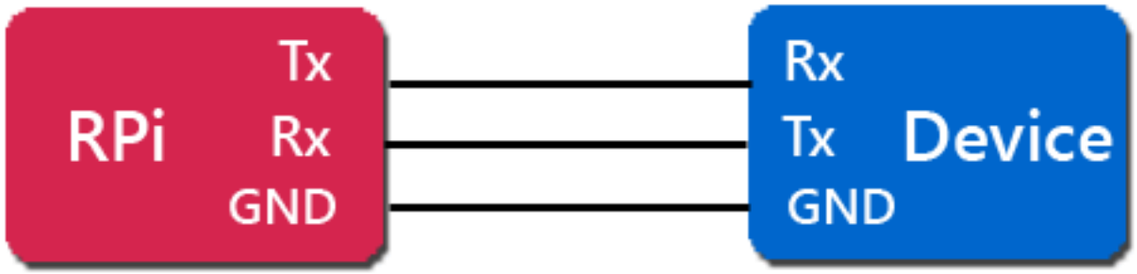


Digital Devices and Protocols

UART - Universal Asynchronous Receiver/Transmitter

UART is useful for:

- Communicating between Arduino and a Computer
- Communicating between two Arduino
- Communicating over longer distances



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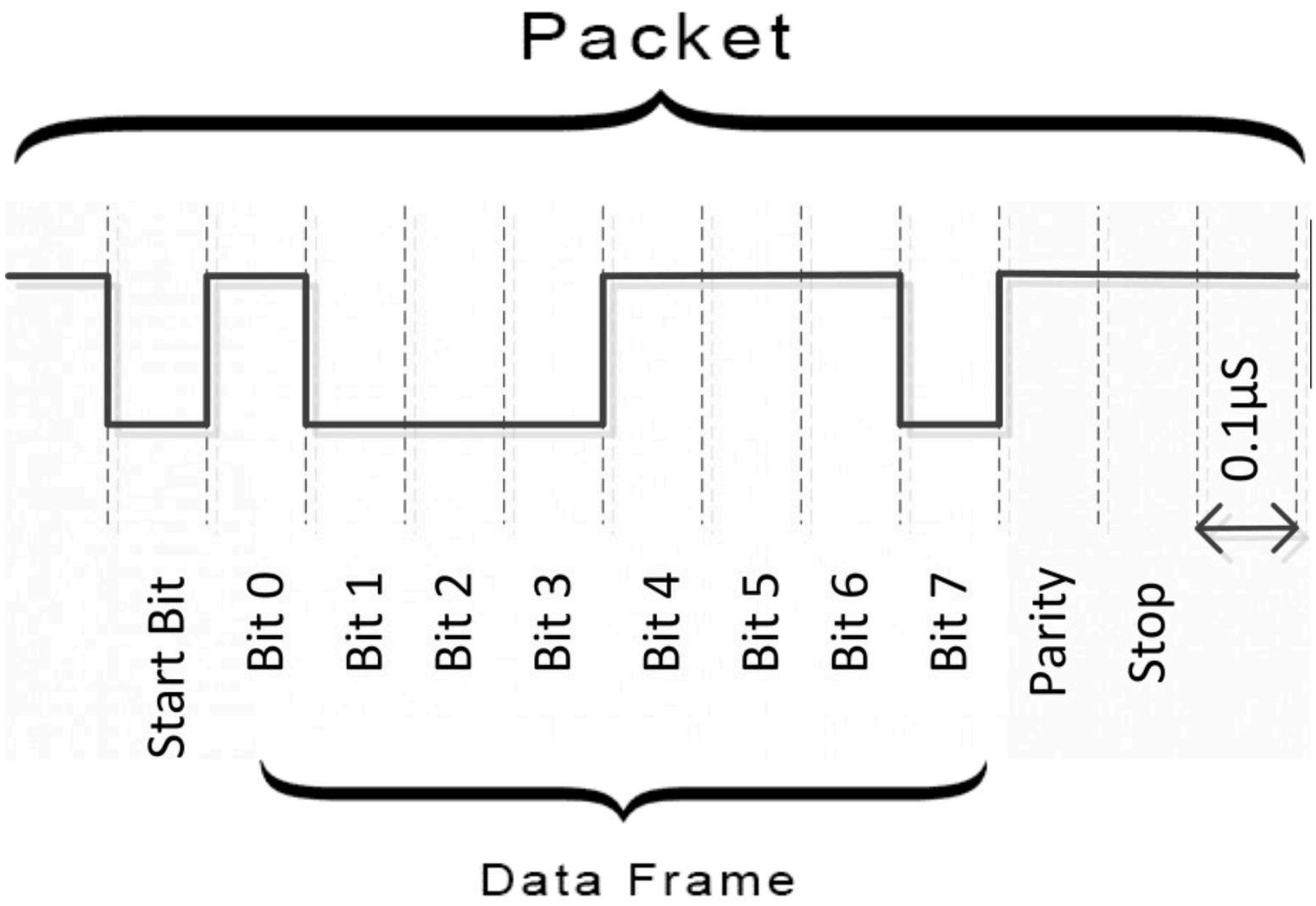
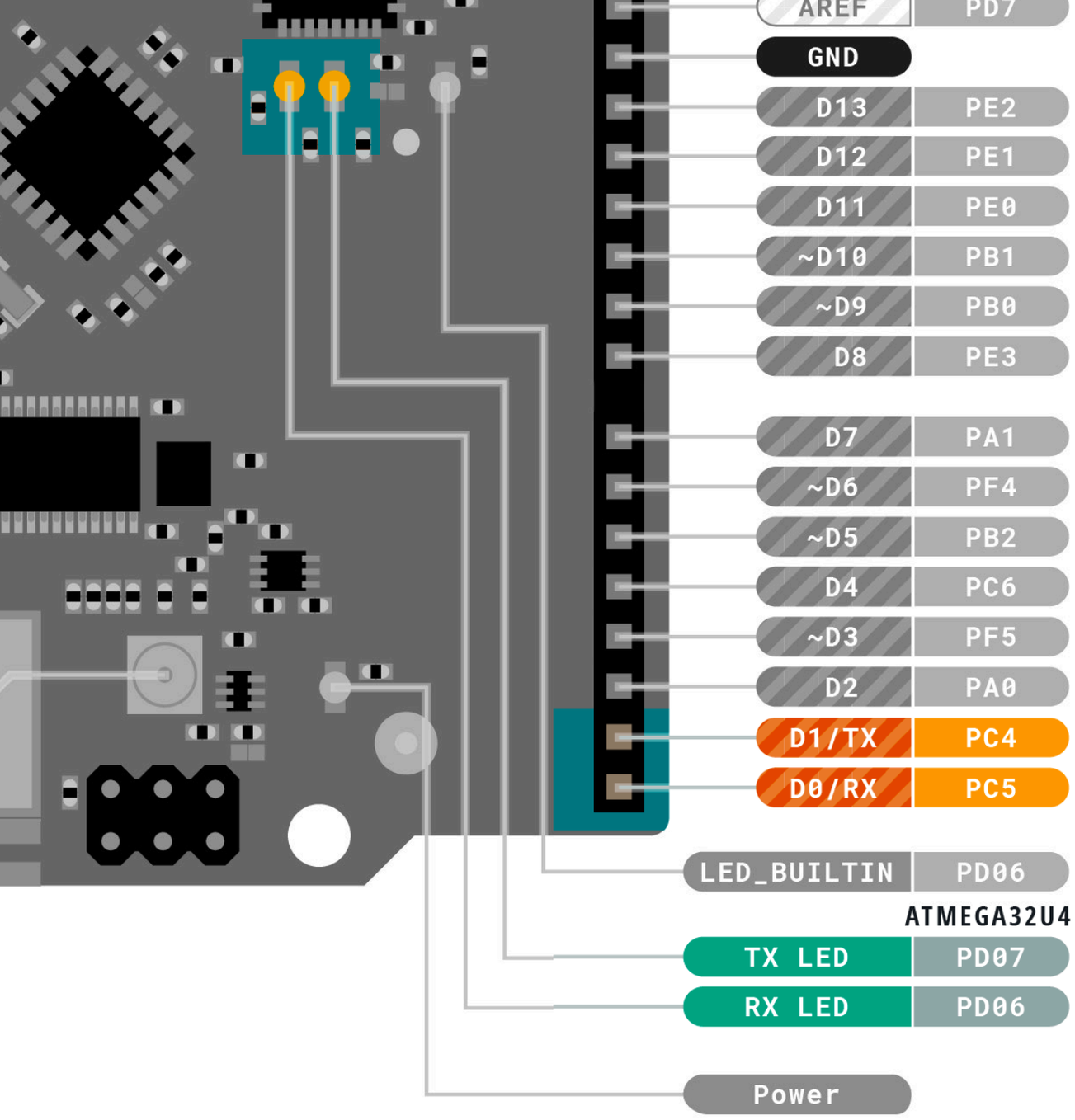


Universal Asynchronous Receiver/Transmitter.

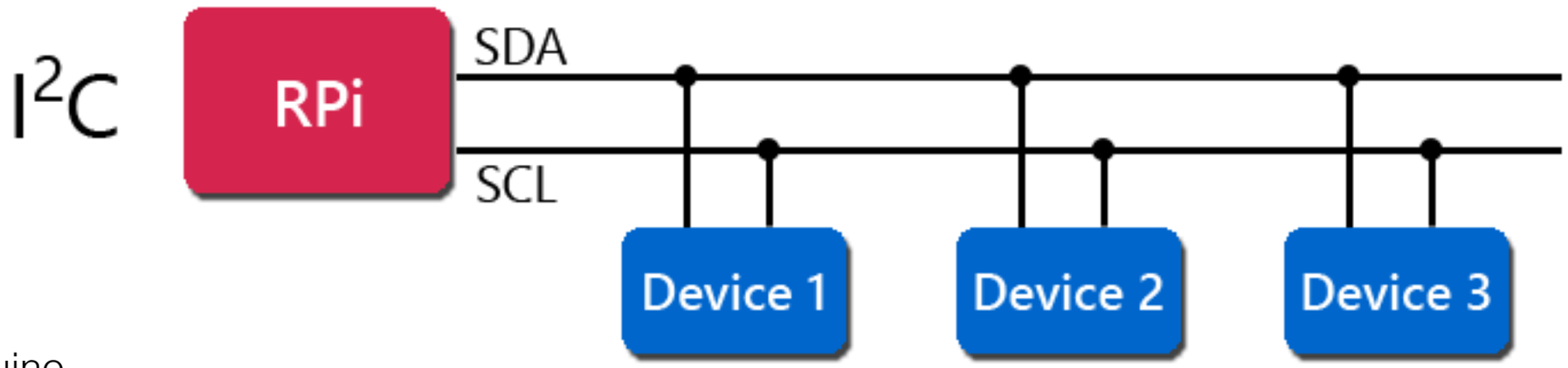



```
Serial.begin(9600);

Serial.println(“Hello World”);
```

UART - Universal Asynchronous Receiver/Transmitter

I²C (Inter Integrated Circuit)

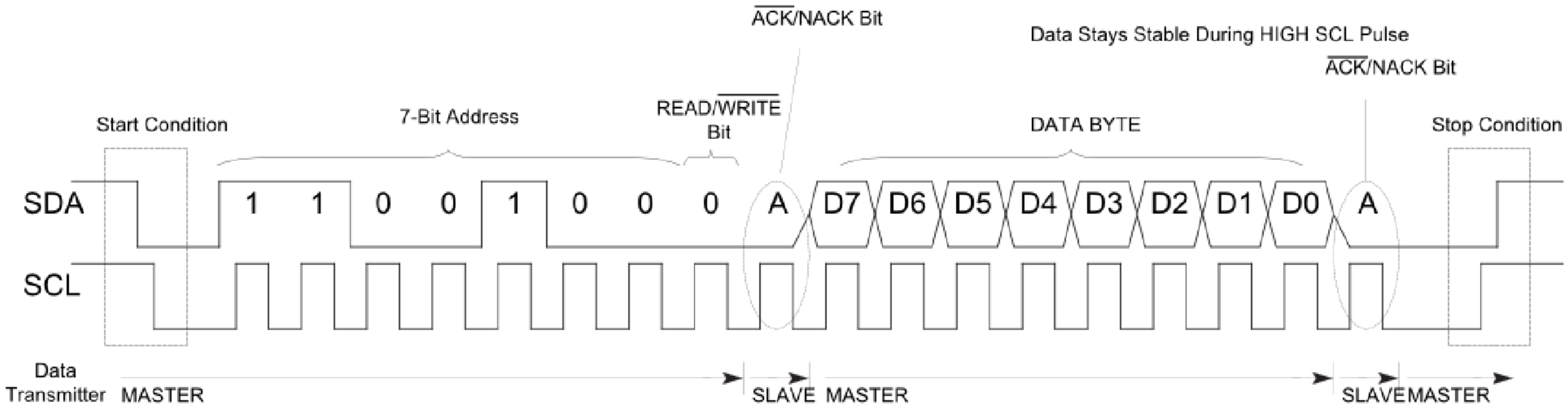


Uses:

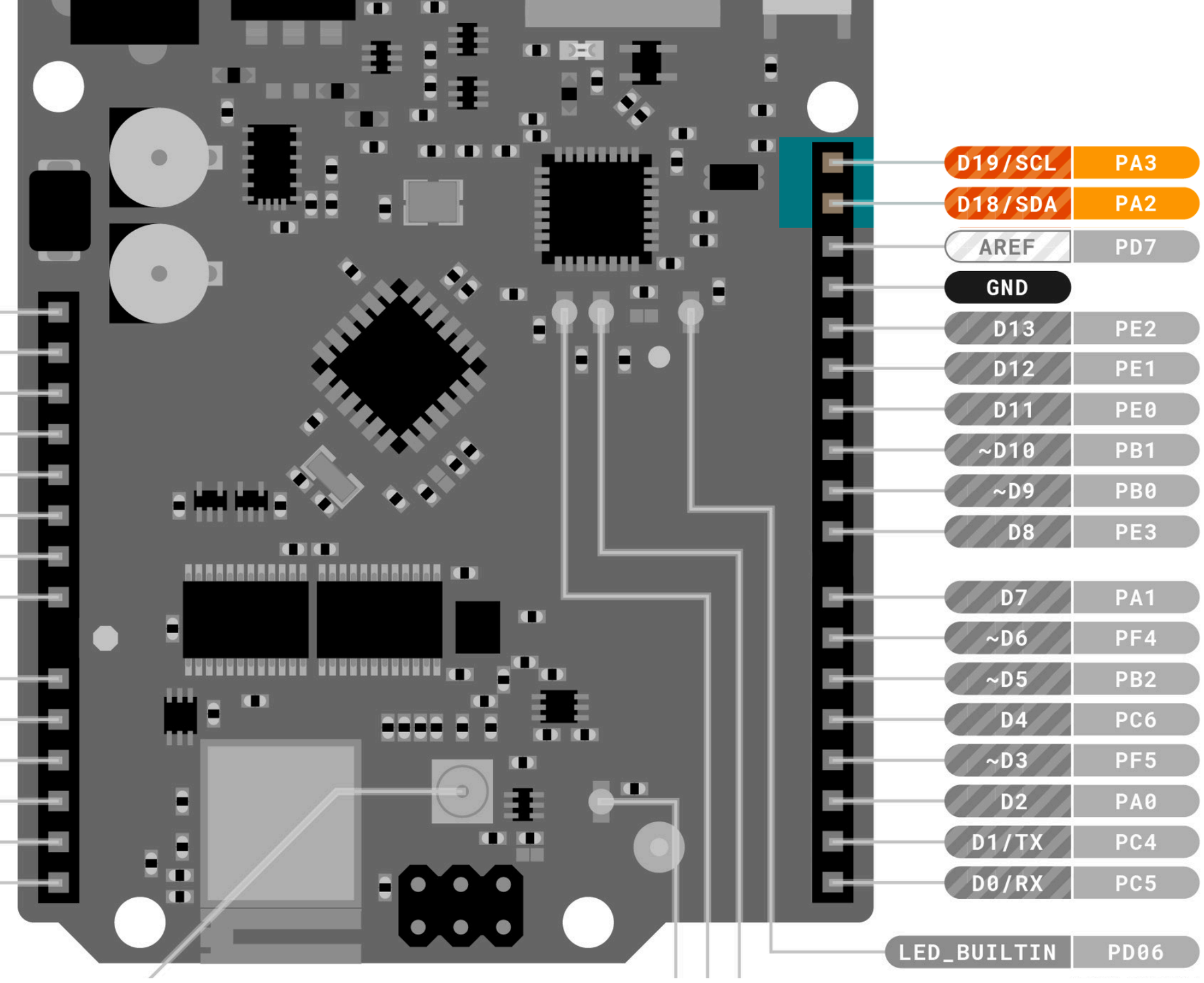
- Communicating between Arduino and other chips (sensors or displays for example)
- Communicating between several Arduino boards on a small network

Limits:

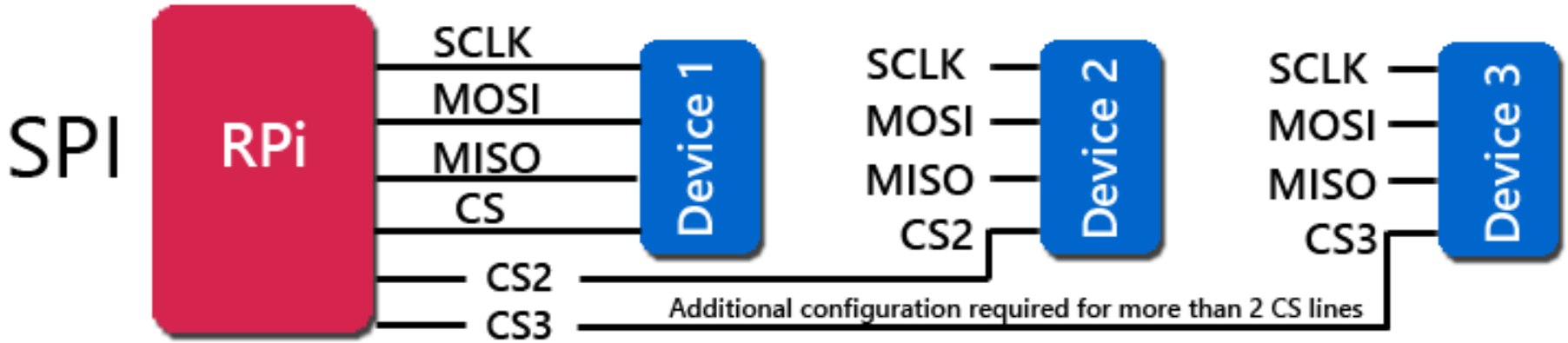
- Fairly slow (probably doesn't matter for our project)
- IC2 only works over short distances.



I²C (Inter Integrated Circuit)



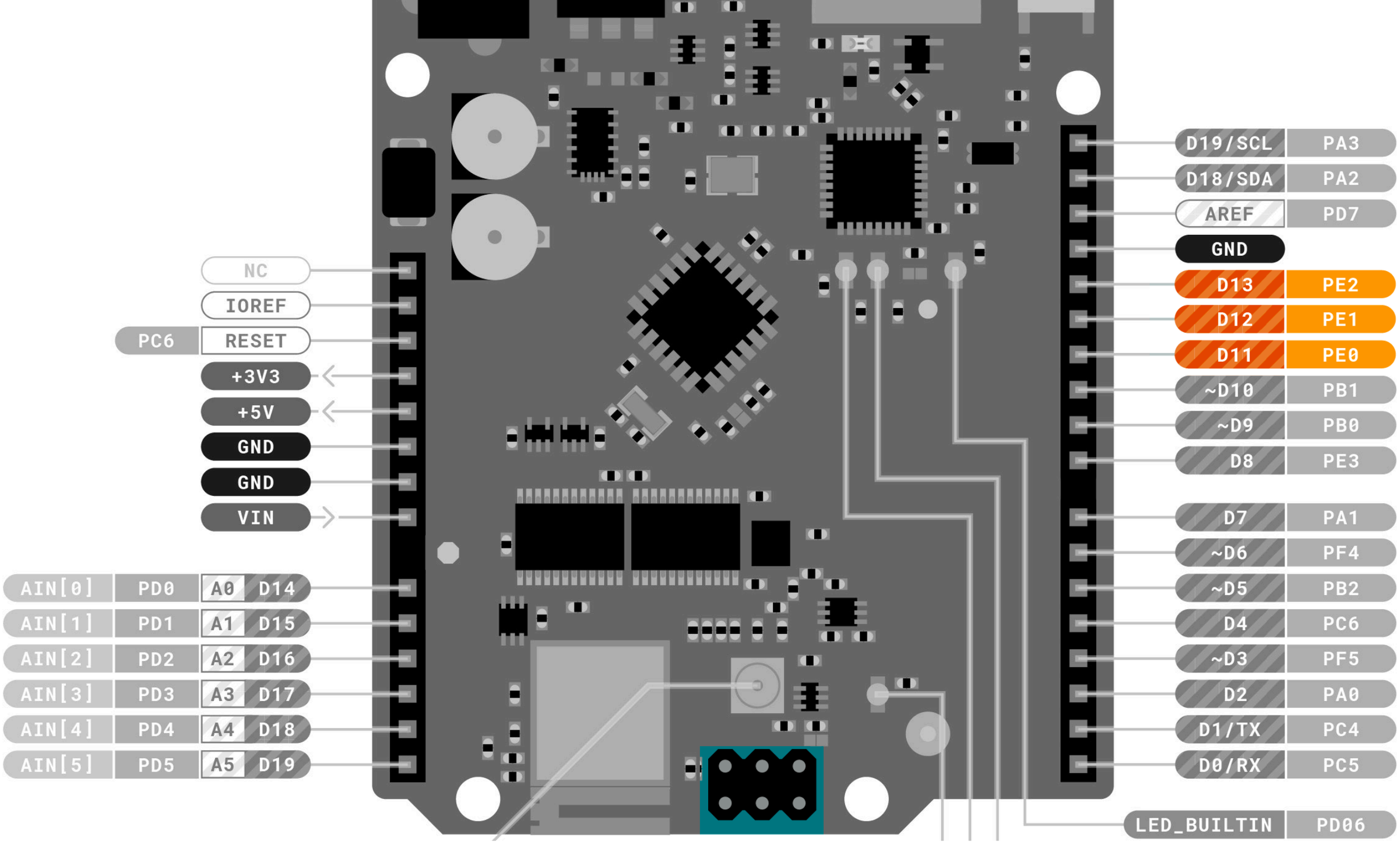
I²C (Inter Integrated Circuit)



Much faster than I2c

Picking which device is in use is very simple, but wiring gets complicated if you have many slave devices.

SPI (Serial Peripheral Interface)



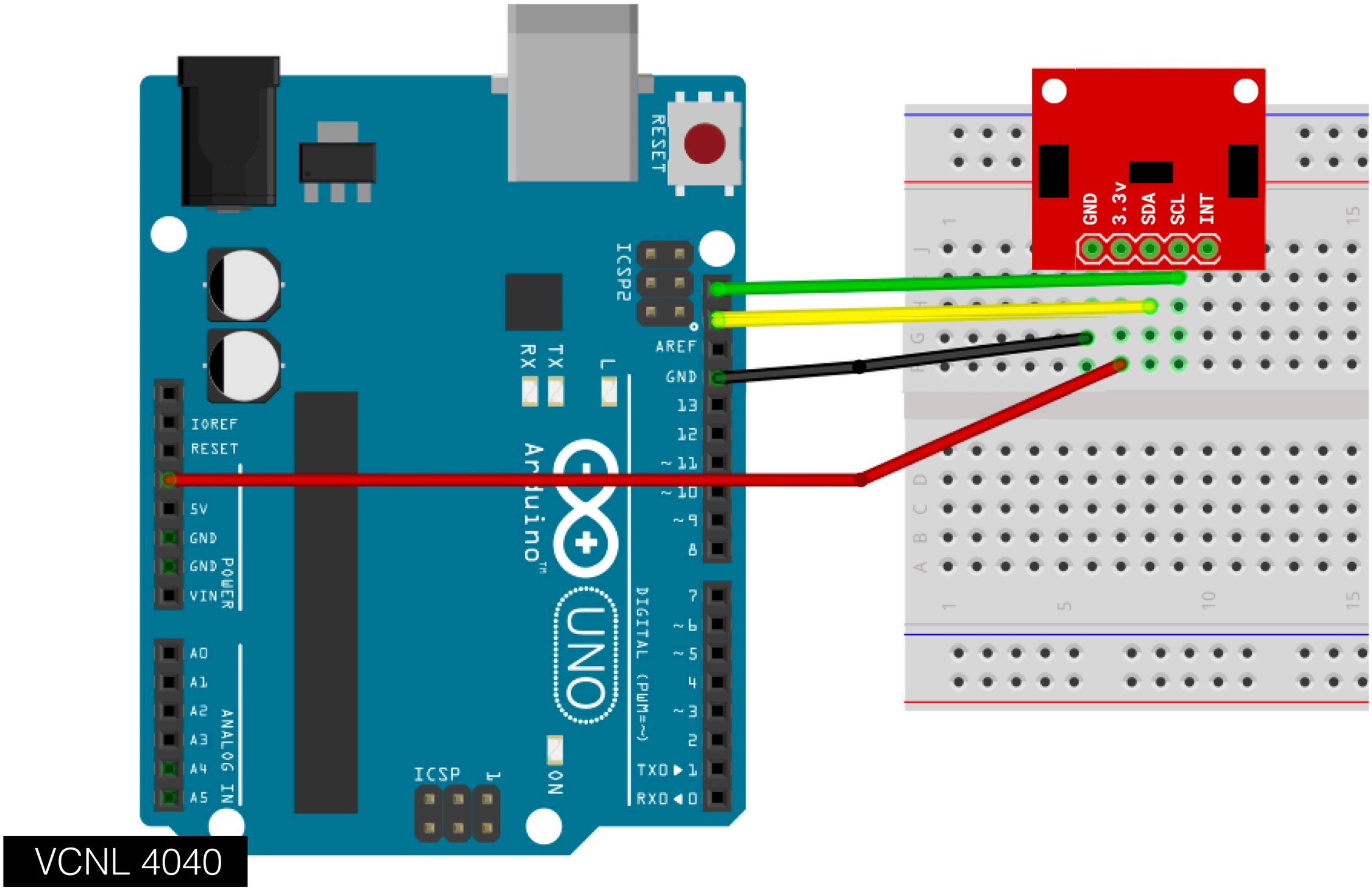
SPI (Serial Peripheral Interface)

Exercise 3.3: Reverse Parking helper

Using the VCNL 4040, build a circuit with at least 3 led's and code it show proximity level (i.e as an object moves closer, more led's turn on)

Alternative: Operate a motor so it "reverses" itself until it is too close to an object.

VCNL 4040


RESET
ICSP2
AREF
GND
13
12
~ 11
~ 10
~ 9
8
7
~ 6
~ 5
4
~ 3
2
TXD ▶ 1
RXD ◀ 0
DIGITAL (PWM=~)
RX
TX
L
ON
ICSP
1
IOREF
RESET
3V3
5V
GND
GND
VIN
POWER
A0
A1
A2
A3
A4
A5
ANALOG IN
UNO
Arduino™
GND
3.3v
SDA
SCL
INT

VCNL 4040