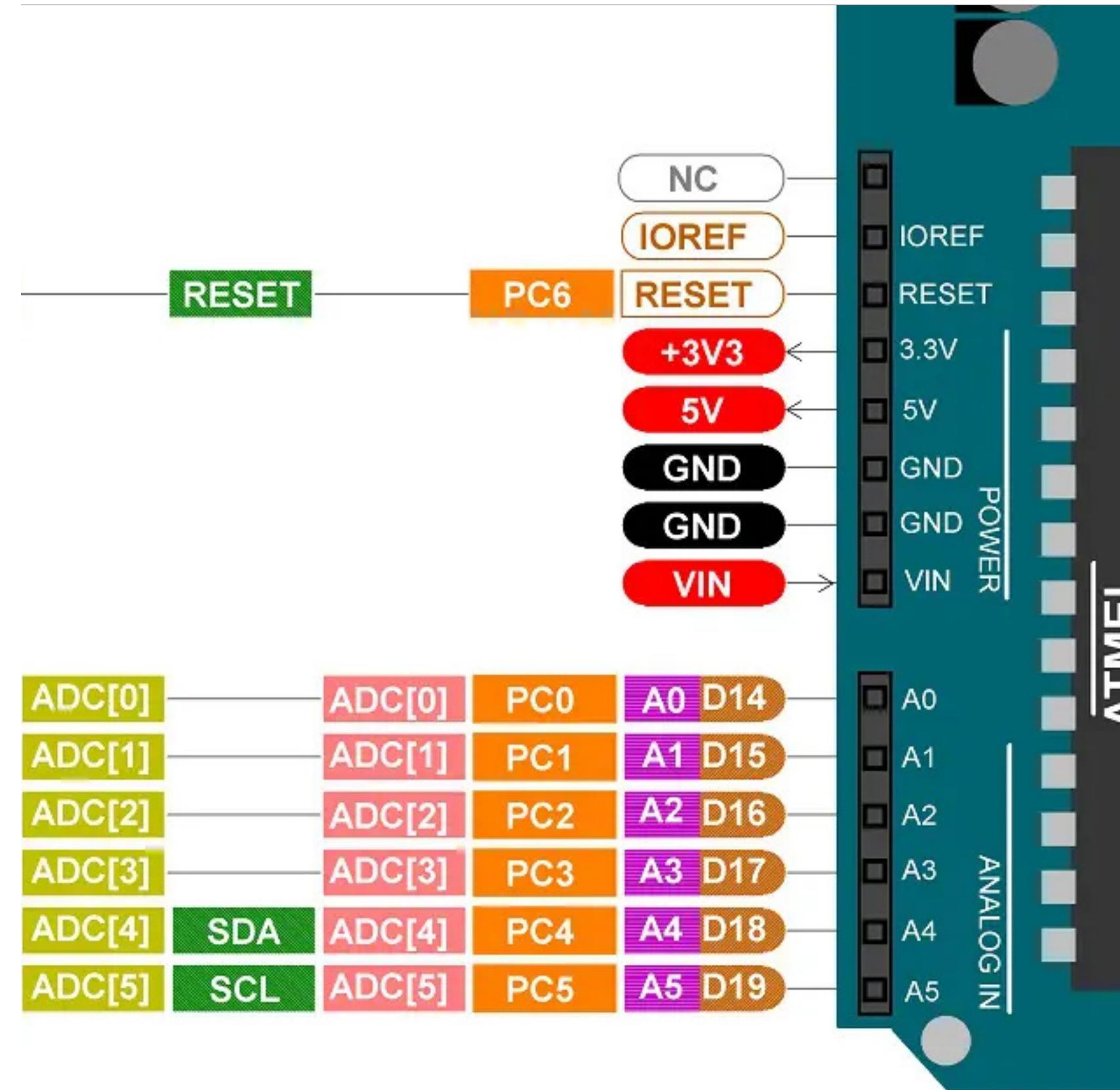
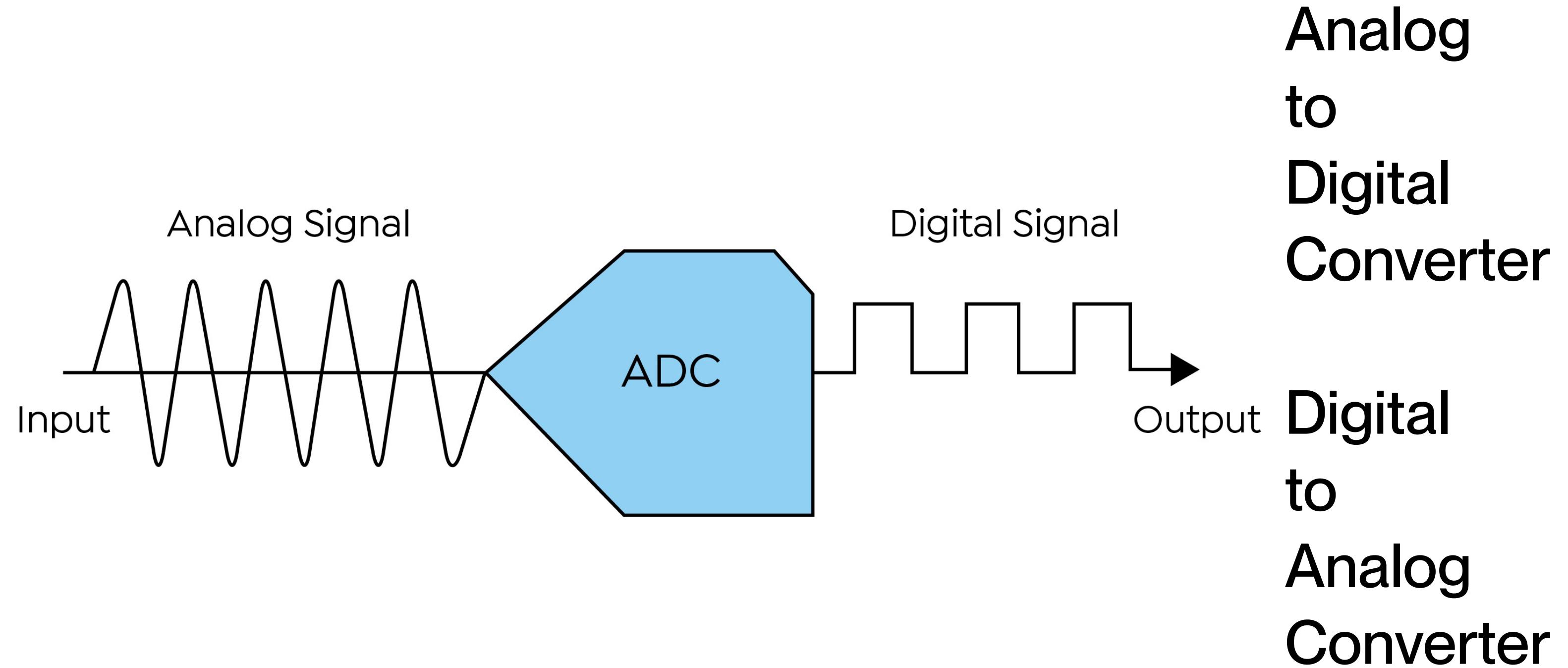


# Physical Computing

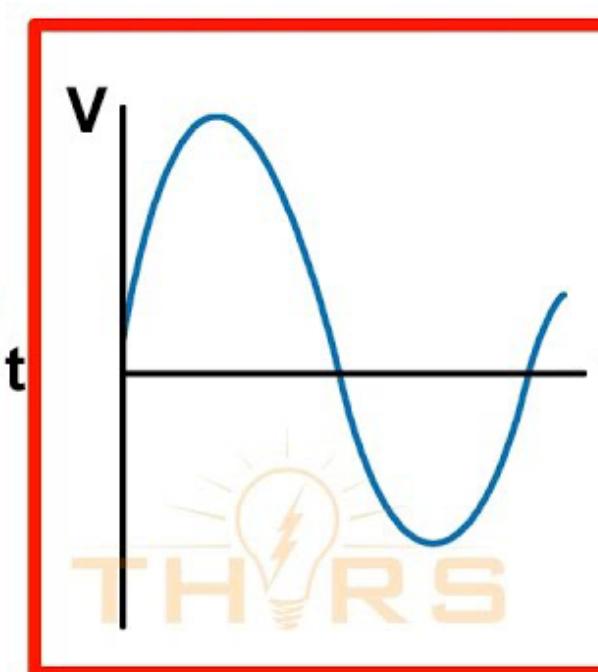
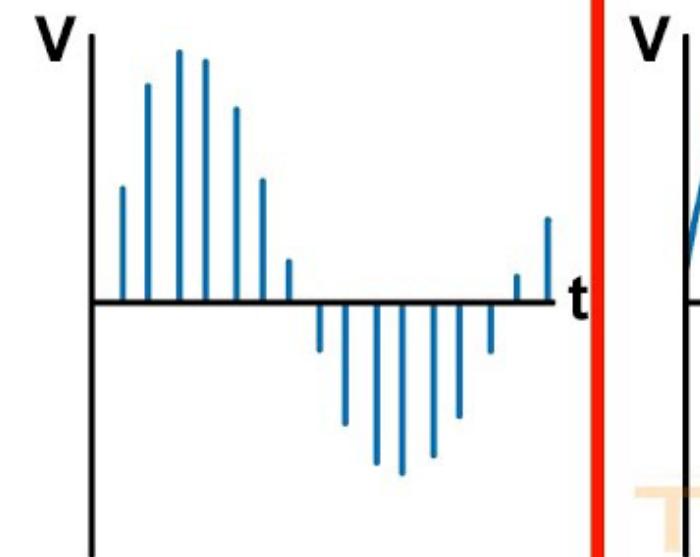
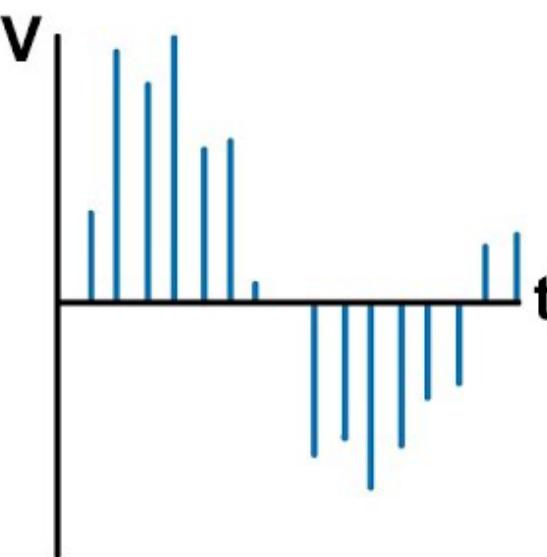
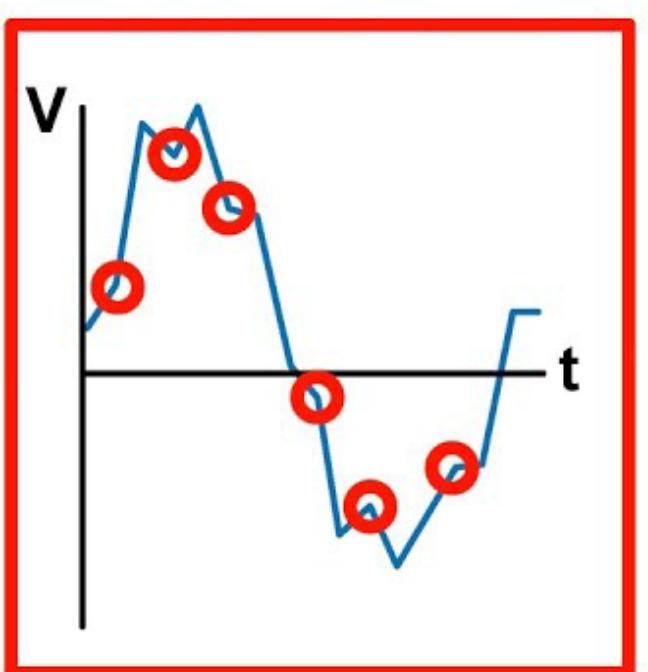
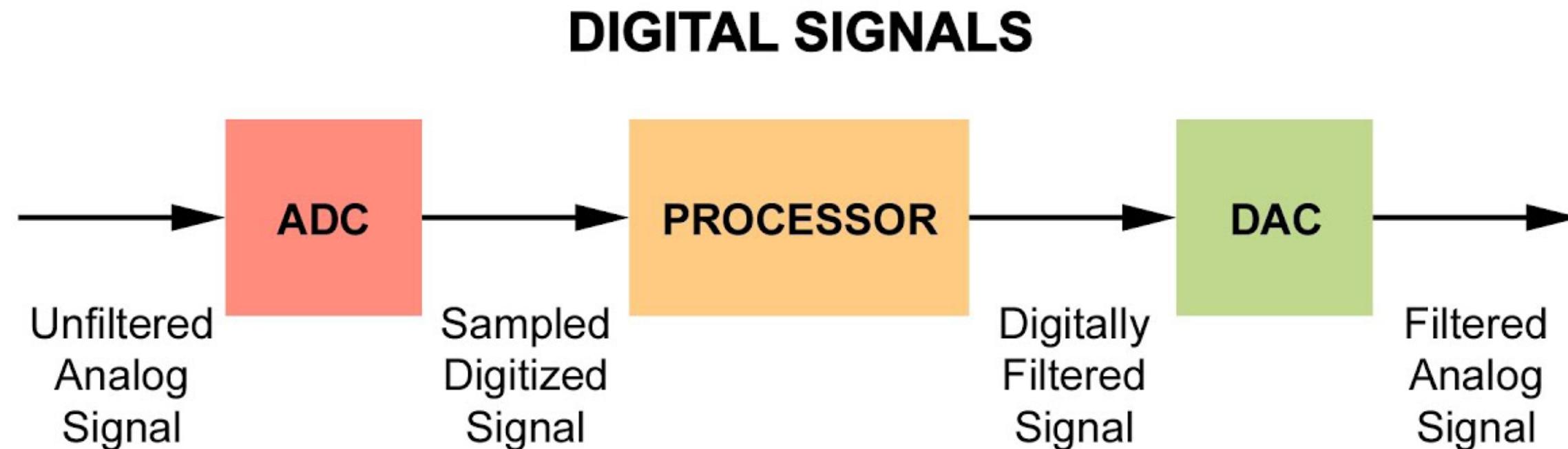
# Analog Inputs



# Analog Pins



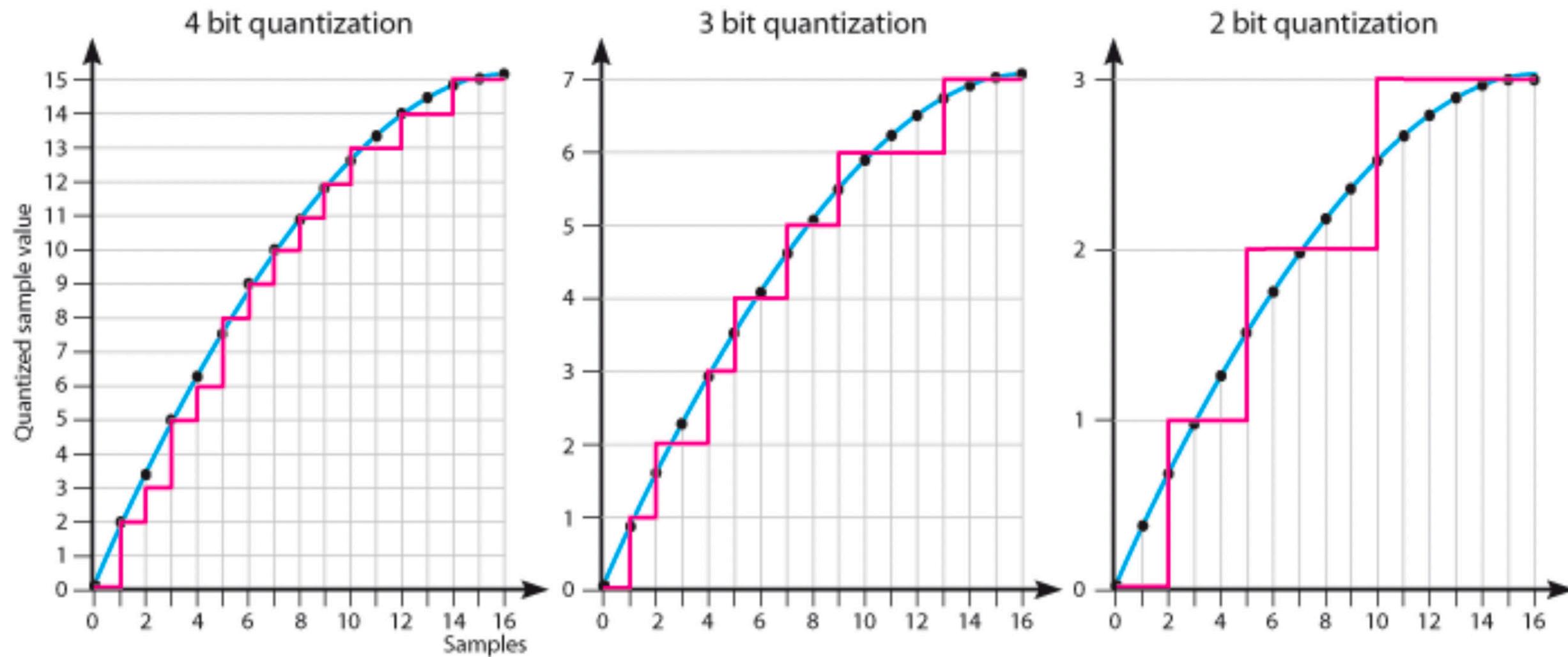
# Analog to Digital Converter



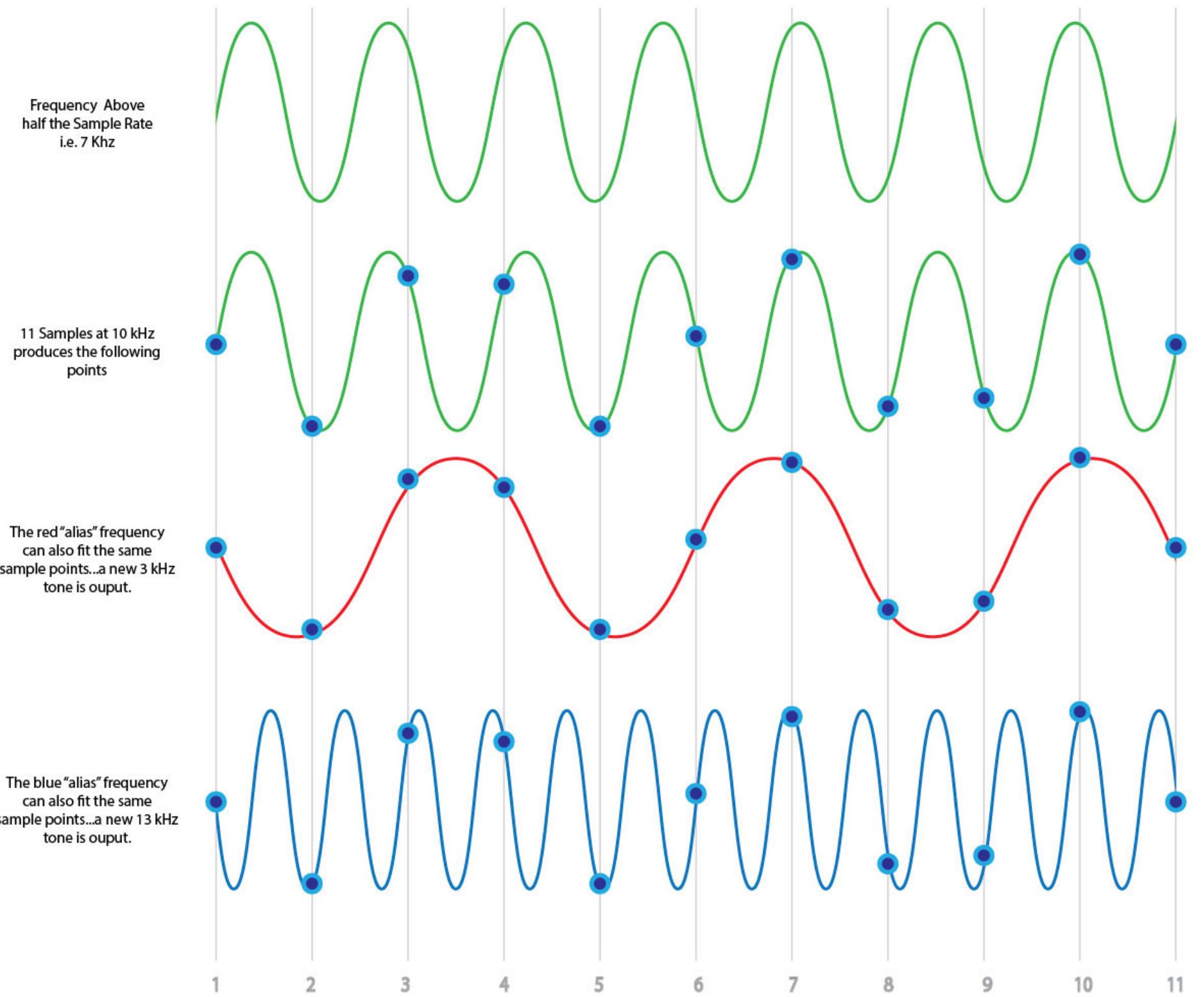
# Digital to Analog Converter

# Analog to Digital Converter

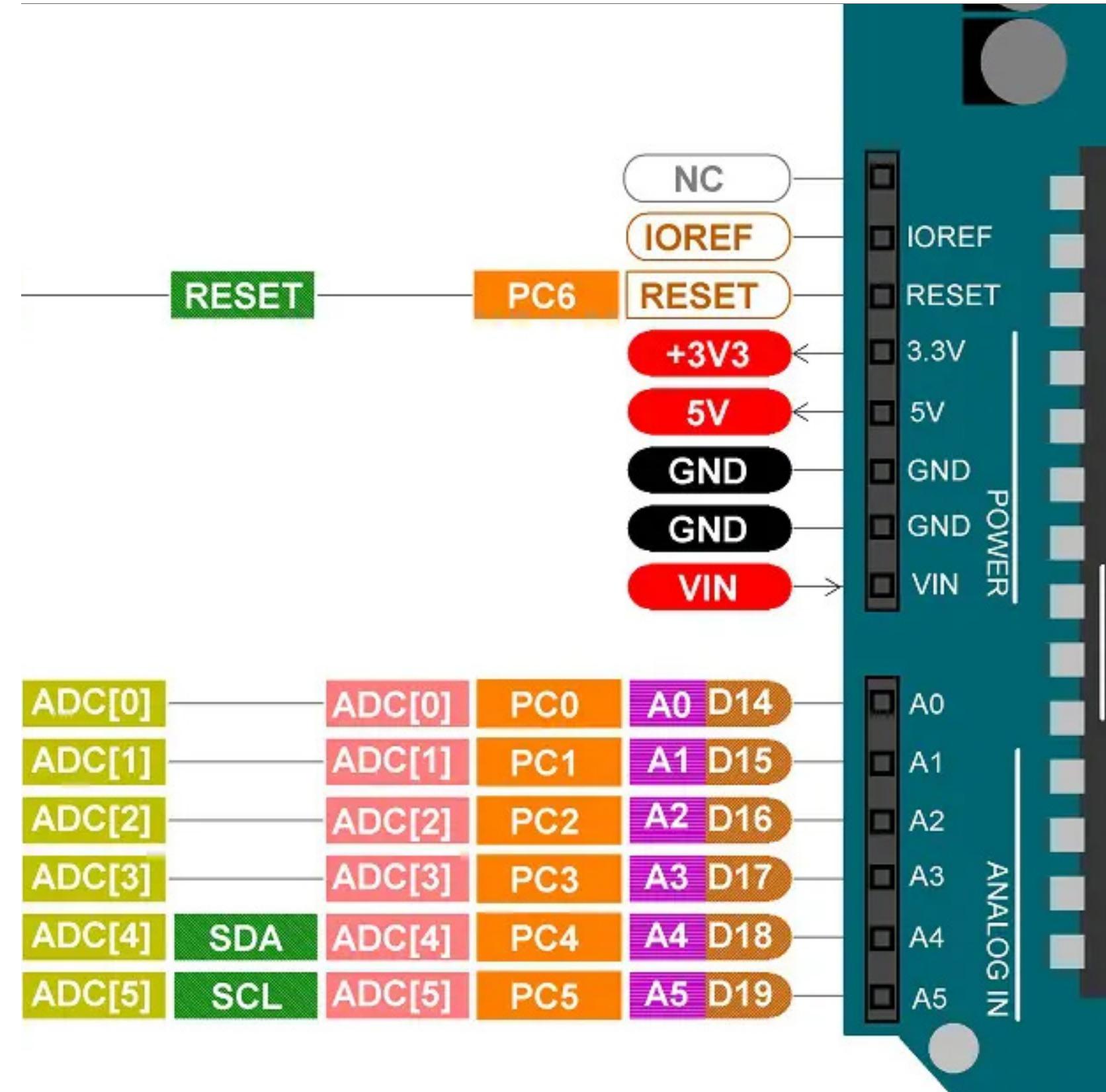
# Digital to Analog Converter



# Aliasing



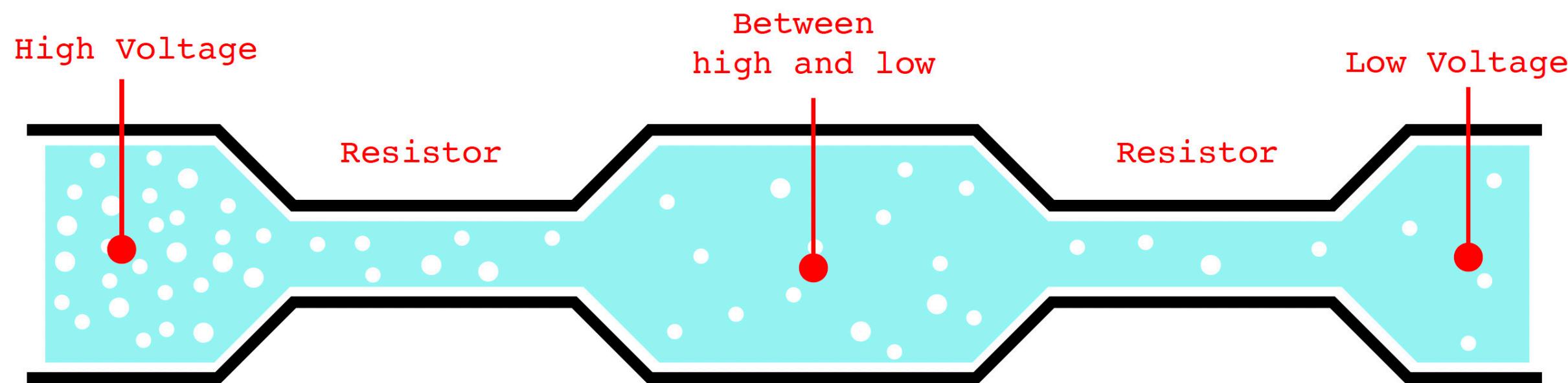
# Aliasing

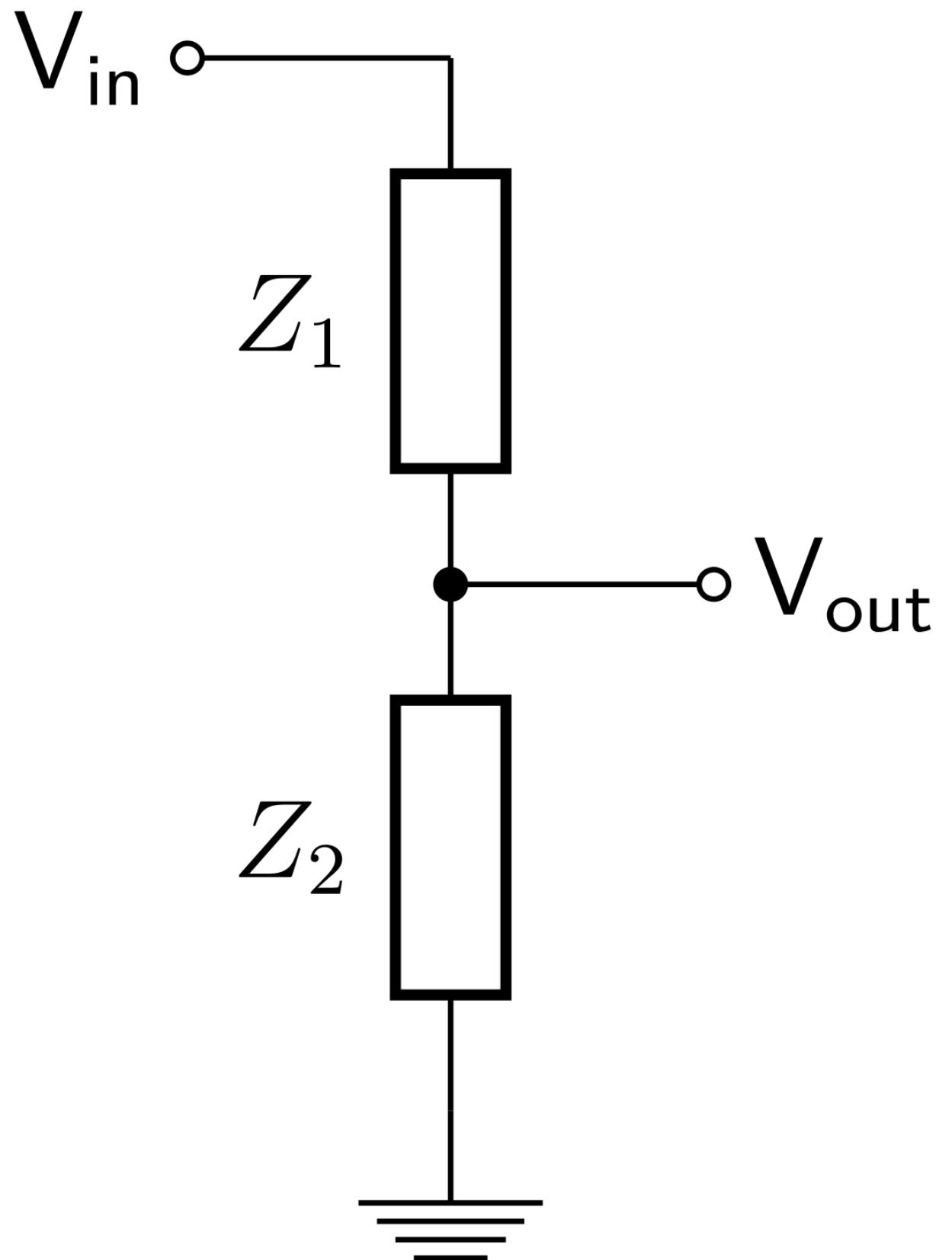


# Analog Pins

- 6 Channel
- 10-Bit:  
0 - 5 V / 1024 Steps
- `pinMode(Pin_Number, Mode)`
- `analogRead(Pin_Number)`
- `analogWrite(Pin_Number, Value)`
- Modes:  
OUTPUT, INPUT, INPUT\_PULLUP

# Voltage Divider



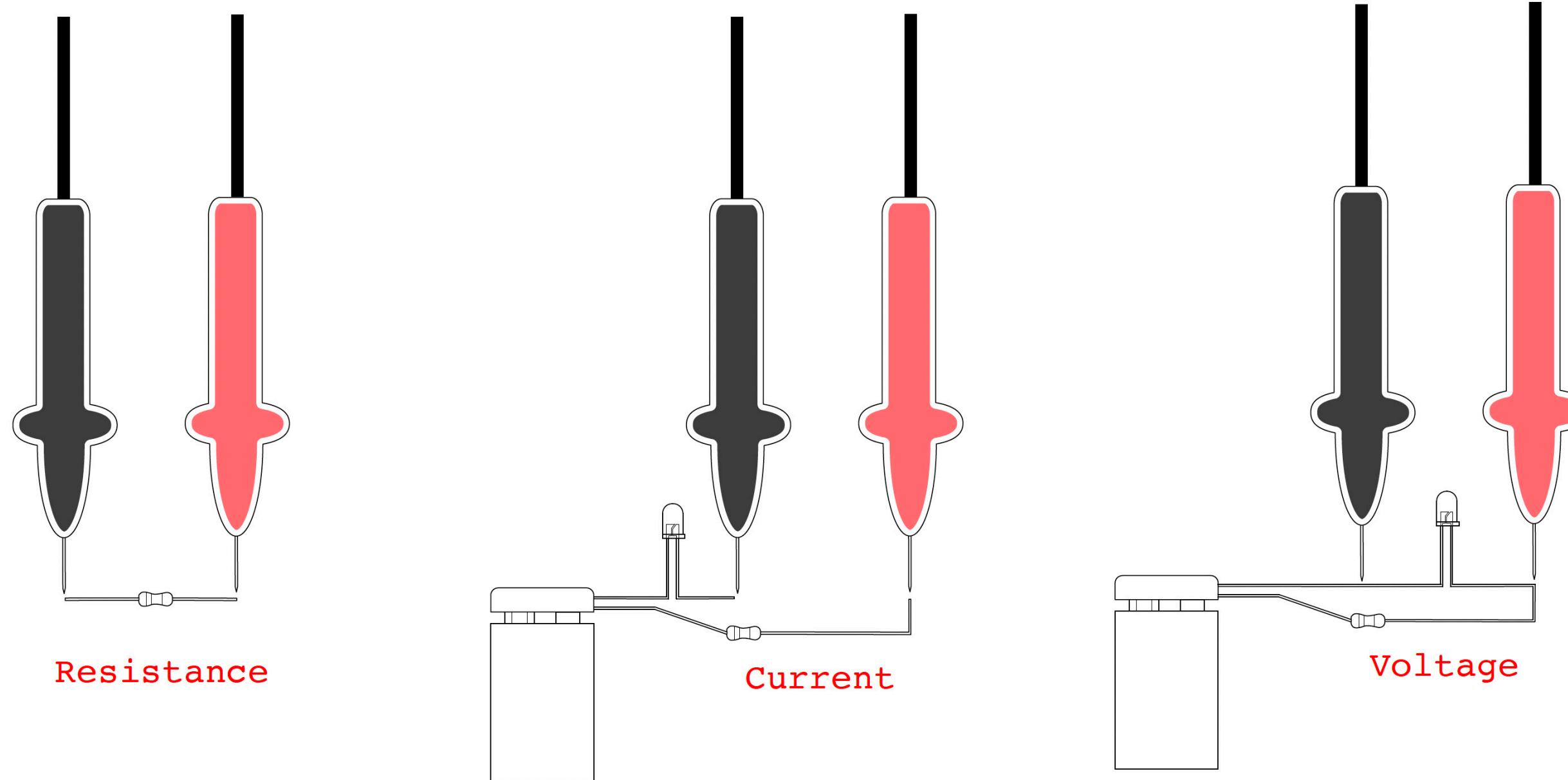


# Voltage Divider

# Multimeter



# Multimeter

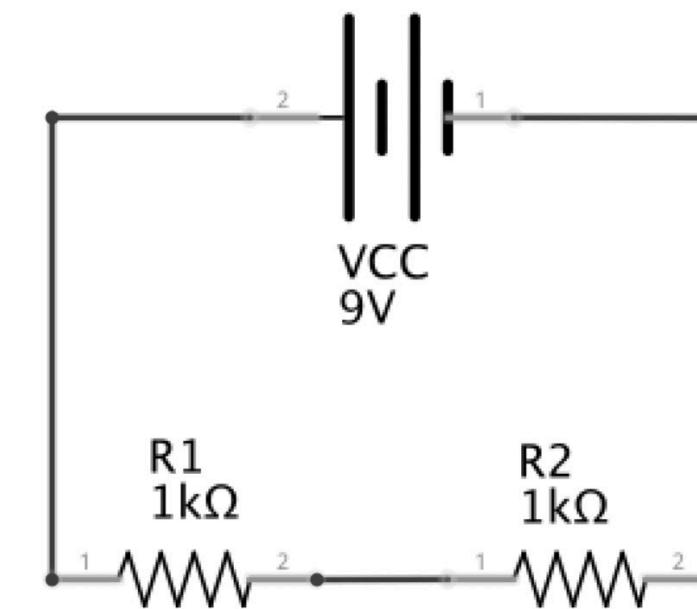
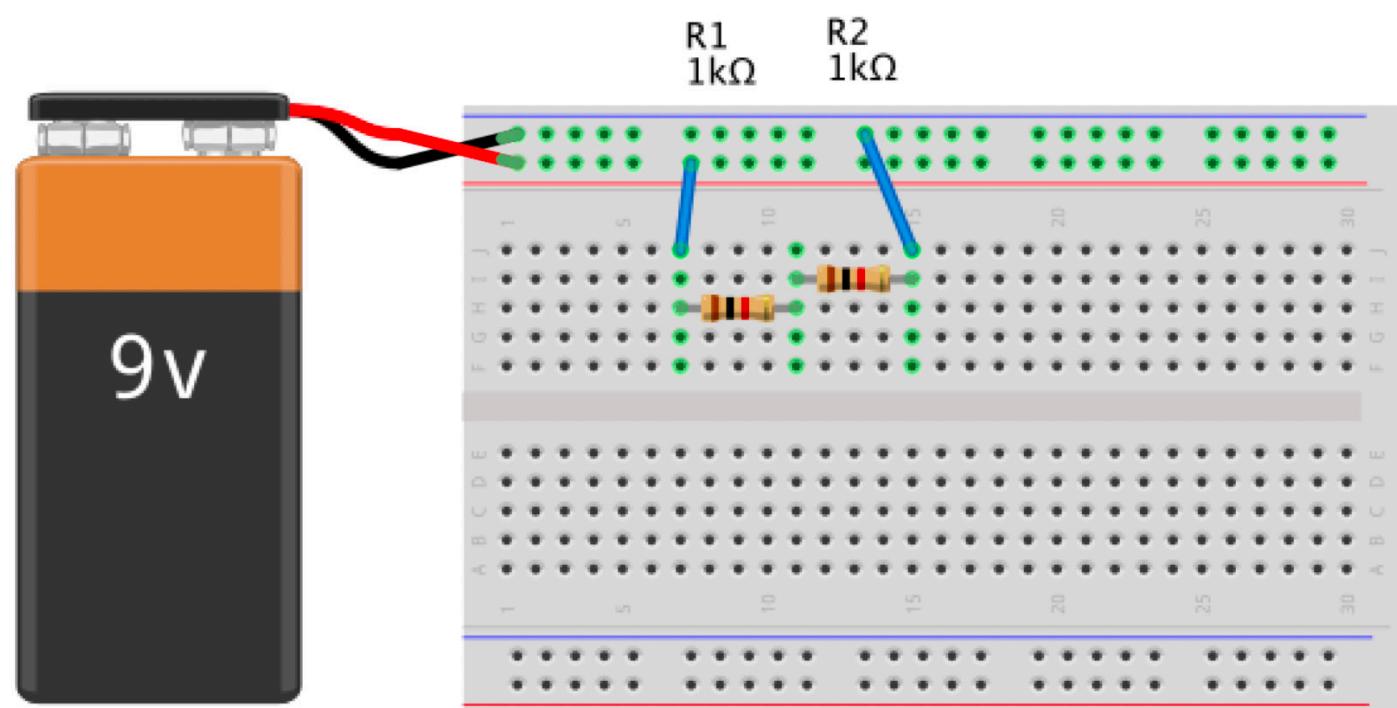


Resistance

Current

Voltage

# Resistance



$$V_{res} = V_{cc} \times \frac{R_2}{(R_1 + R_2)}$$

**V<sub>res</sub>** = resulting voltage

**V<sub>cc</sub>** = applied voltage (9V)

**R<sub>1</sub>** = first resistor (1000 ohm)

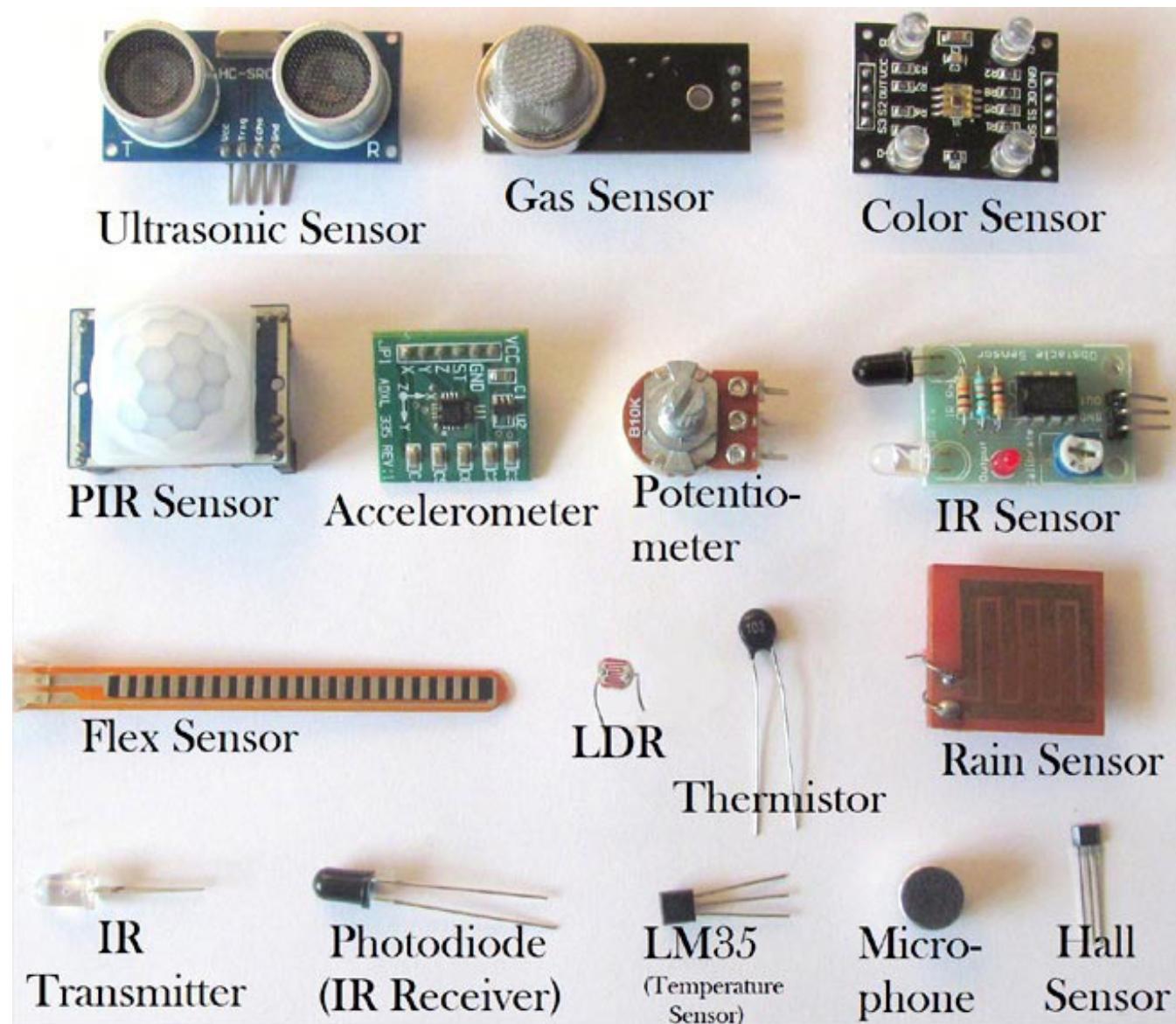
**R<sub>2</sub>** = second resistor (1000 ohm)

# Analog Sensors

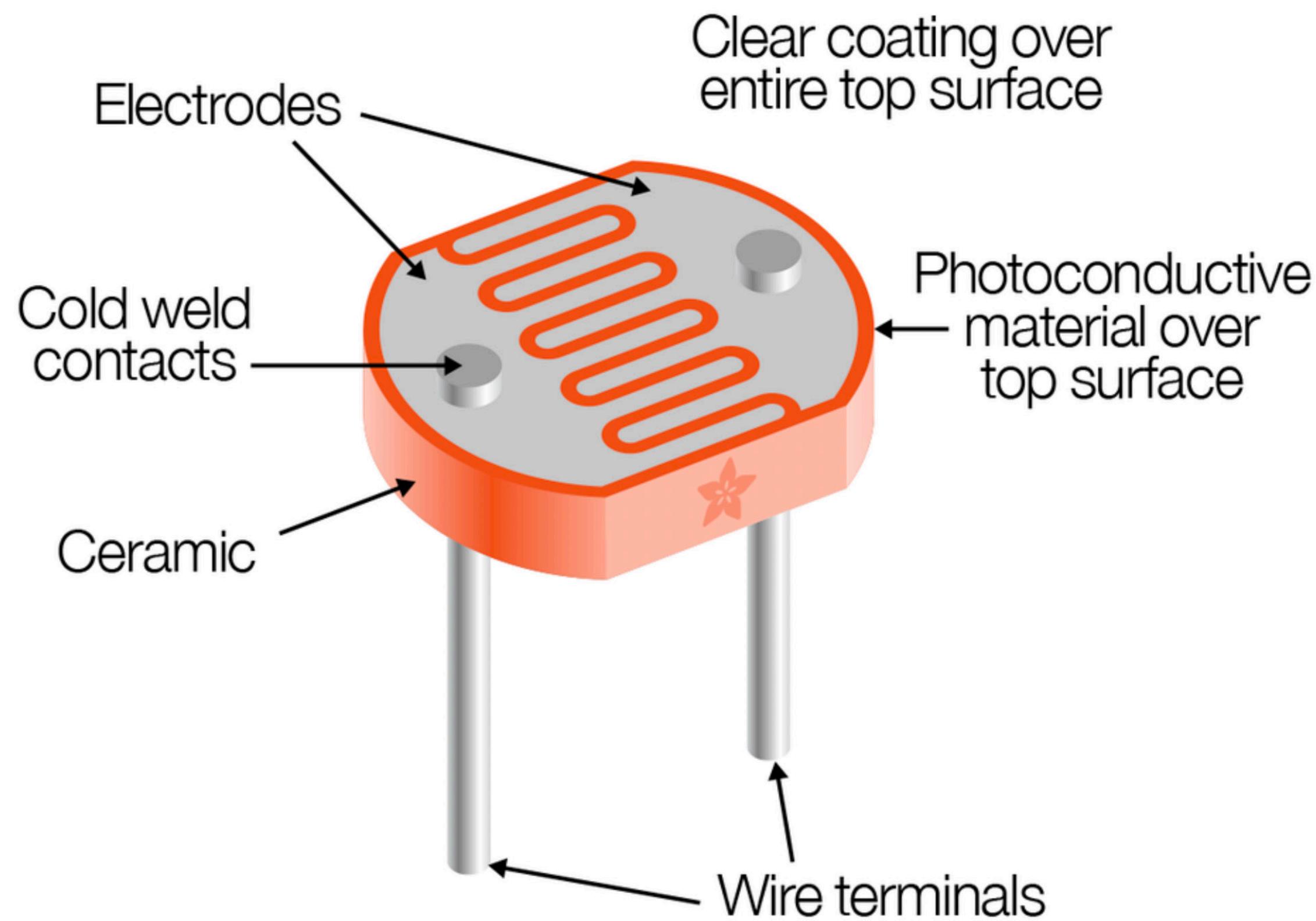


# Analog Computers

# Analog Sensors



# Photodiode

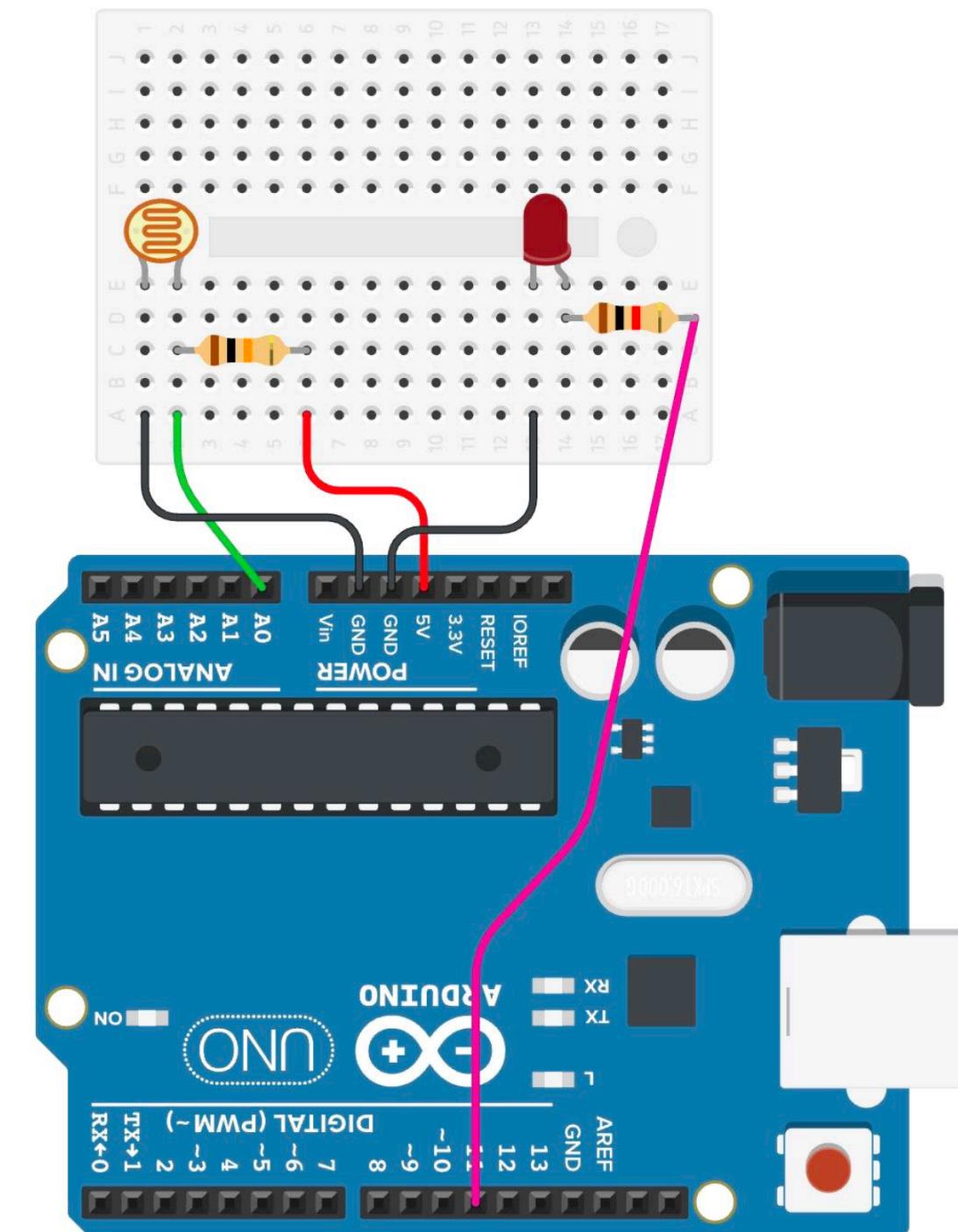


# Exercise 2.2

## Exercise 2.2: Light Sensor

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

Optional: code it so the LED fades smoothly between dark and light states.



# Potentiometer



# Neopixel

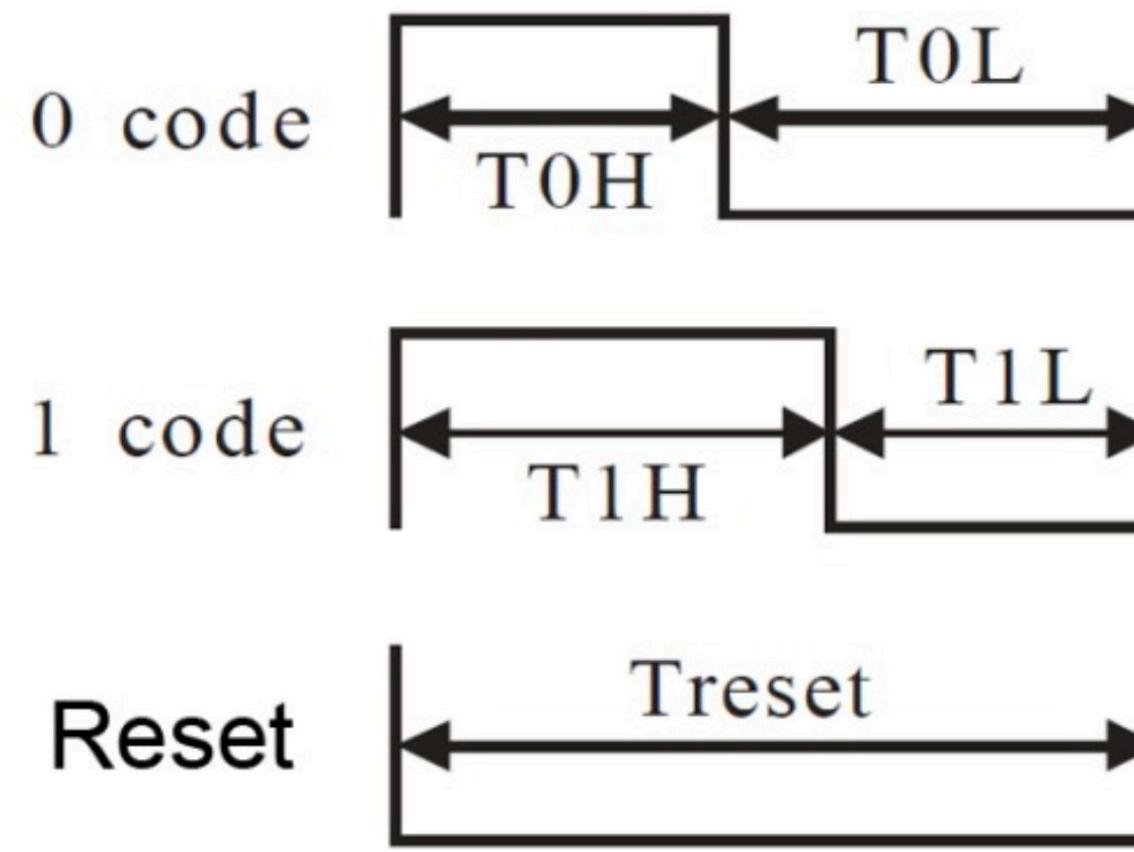


Strip Type	Voltage	Compatible Libraries	Price (As Tested)	Pros	Cons
WS2811	12	FastLED, Neopixel, WS2812FX	\$15.83	<ul style="list-style-type: none"> <li>Inexpensive</li> <li>Compatible with most libraries</li> <li>Resistant to voltage drop</li> </ul>	<ul style="list-style-type: none"> <li><b>Control groups of 3 LEDs instead of individual LEDs</b></li> <li>12 volts means separate power will be required for your microcontroller</li> </ul>
WS2812B	5	FastLED, Neopixel, WS2812FX	\$17.08	<ul style="list-style-type: none"> <li>Inexpensive</li> <li>Compatible with most libraries</li> <li>5 volts means your LEDs and microcontroller can share power</li> </ul>	<ul style="list-style-type: none"> <li>Power injection required every 5m to keep color accuracy</li> </ul>
WS2812B Eco	5	FastLED, Neopixel, WS2812FX	\$13.15	<ul style="list-style-type: none"> <li><b>Least expensive</b></li> <li>Lowest idle power consumption</li> <li>Compatible with most libraries</li> <li>5 volts means your LEDs and microcontroller can share power</li> </ul>	<ul style="list-style-type: none"> <li>Power injection required every 5m to keep color accuracy</li> </ul>
WS2813	5	FastLED, Neopixel, WS2812FX	\$22.98	<ul style="list-style-type: none"> <li>Compatible with most libraries</li> <li>5 volts means your LEDs and microcontroller can share power</li> <li><b>Backup data channel to prevent strip outage</b></li> </ul>	<ul style="list-style-type: none"> <li>Expensive</li> <li>Power injection required every 2.5m to keep color accuracy</li> </ul>
WS2815	12	FastLED, Neopixel, WS2812FX	\$23.86	<ul style="list-style-type: none"> <li>Compatible with most libraries</li> <li><b>Backup data channel to prevent strip outage</b></li> <li><b>Resistant to voltage drop</b></li> </ul>	<ul style="list-style-type: none"> <li>Expensive</li> <li>12 volts means separate power will be required for your microcontroller</li> </ul>
SK9822	5	FastLED	\$28.45	<ul style="list-style-type: none"> <li><b>Clock pin allows for total control of frames per second and accurate animations.</b></li> <li>5 volts means your LEDs and microcontroller can share power</li> </ul>	<ul style="list-style-type: none"> <li>Expensive</li> <li>Power injection required every 2.5m to keep color accuracy</li> <li><b>Library must include a clock pin (FastLED)</b></li> </ul>
SK6812	5	Neopixel	\$26	<ul style="list-style-type: none"> <li><b>Dedicated “white” LED channel allows for the most accurate white colors</b></li> <li>Lowest power consumption when producing white light</li> <li>5 volts means your LEDs and microcontroller can share power</li> </ul>	<ul style="list-style-type: none"> <li>Expensive</li> <li>Power injection required every 2.5m to keep color accuracy (only when using RGB for white).</li> <li><b>Library must include a white channel (Neopixel)</b></li> </ul>

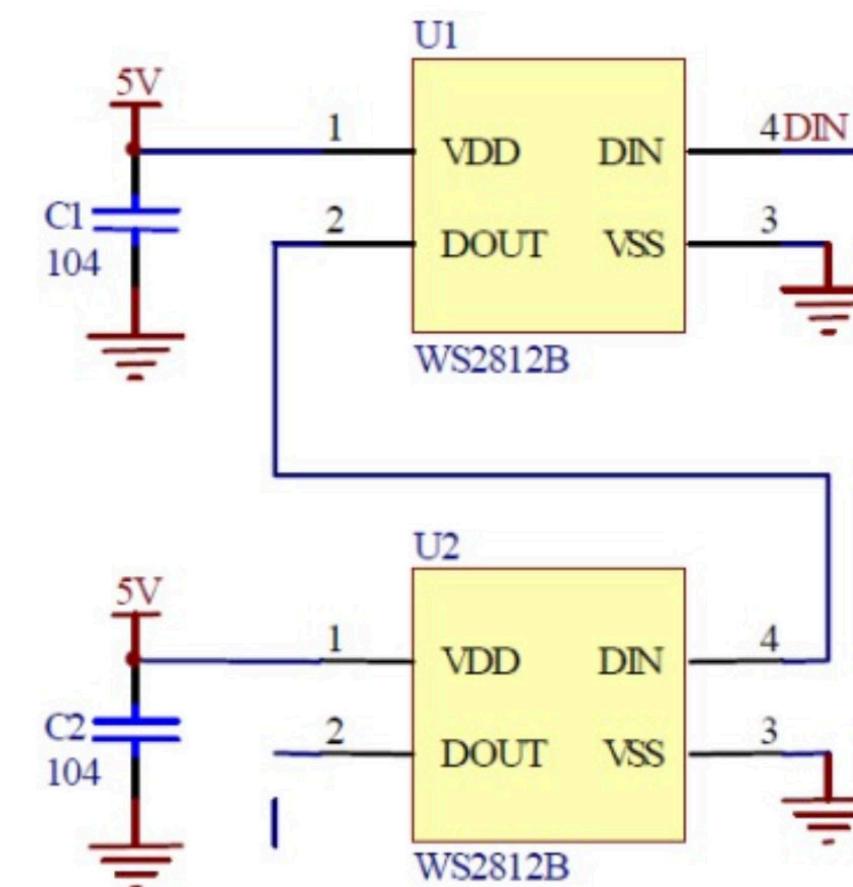
# Overview LED's

# Protocol

## WS2812 Protocol



## LED-Chain



## AVR-BASED ARDUINO:

# Memory

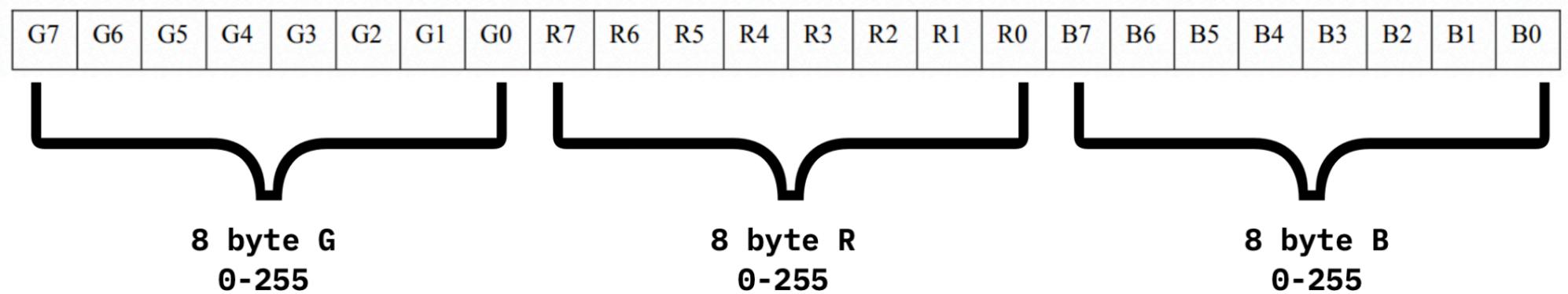
**Flash (program space) : 32k bytes (of which 0.5k is used for the bootloader). This is where the Arduino sketch is stored.**

**SRAM (static random access memory) : 2k bytes Where the sketch creates and manipulates variables during runtime.**

**EEPROM 1k byte Used to store long-term information**

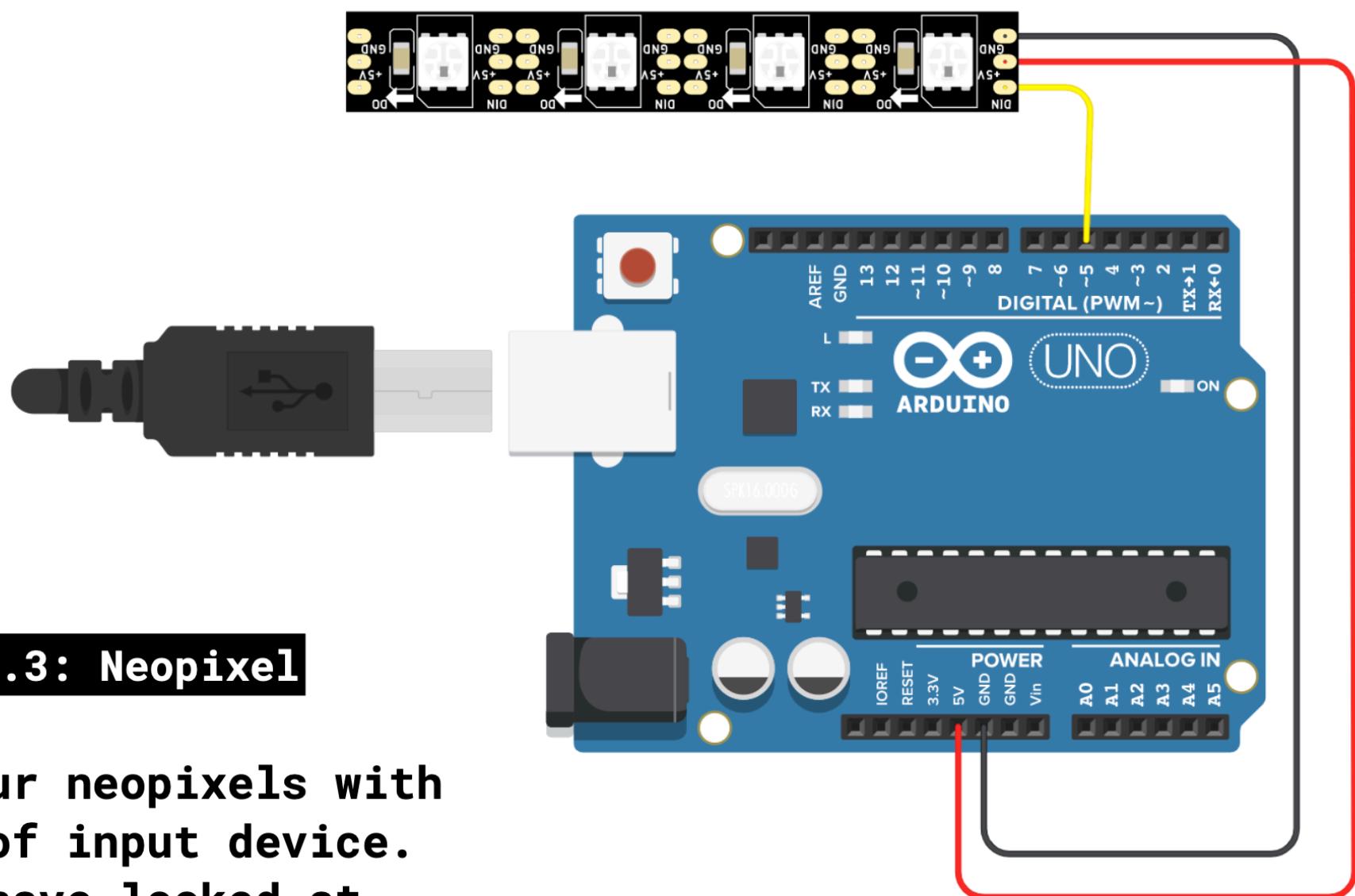
**Each NeoPixel requires 3 bytes of RAM. This means that you will need to add another Arduino after  $\approx 600$  LEDs ( $\approx 10m$ )**

# Color



$256^3 = 16777216$  colors per pixel

# Exercise 2.3



## Exercise 2.3: Neopixel

**Control your neopixels with some kind of input device. So far we have looked at buttons, the light sensor and the potentiometer.**

# Libraries

# Boards

# Ressources / Know-How