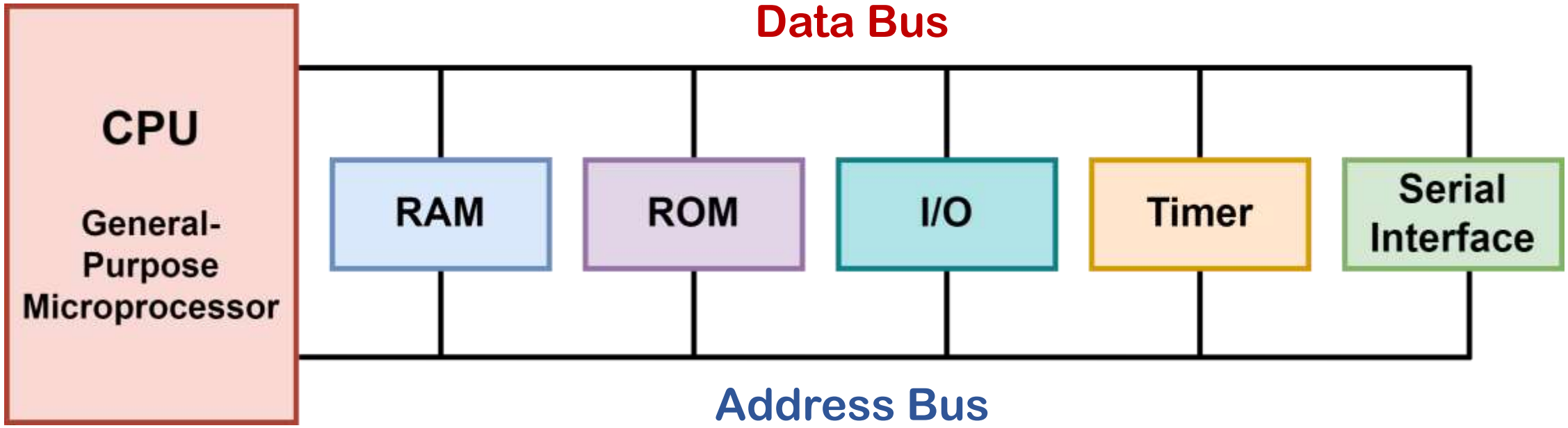
Embedded Systems

Intro to Embedded Systems

Embedded Team, BFCAI

General-Purpose Microprocessor System

- By microprocessor is meant the general-purpose microprocessors.
- These microprocessors contain no RAM, no ROM, and no I/O ports on the chip itself.

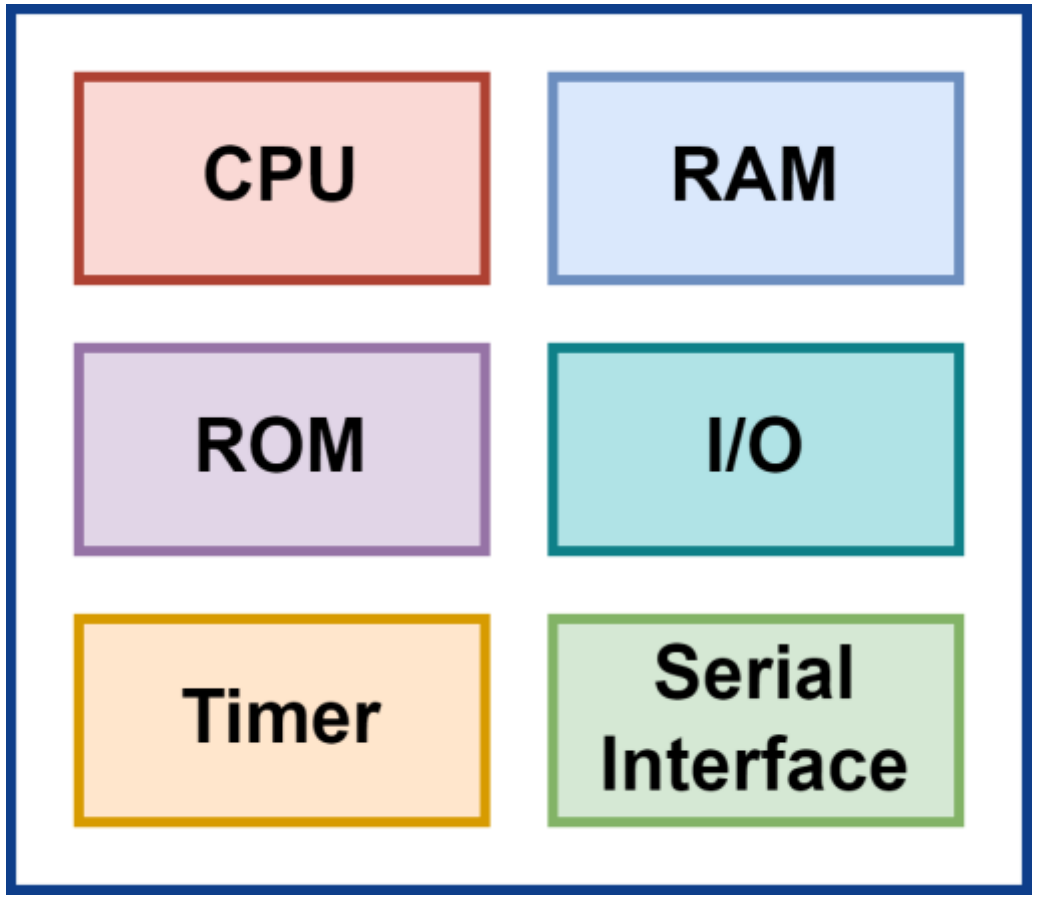


General-Purpose Microprocessor System

- Programming
- Games
- Watching Movies
- Playing Music
- Internet
- Work
- Home Automation
- Storage
- Security
- Anything!

Microcontroller

- A microcontroller is an integrated circuit consisting of a complete computer on a single chip and used for specified control functions.



Microprocessor vs. Microcontroller

- A system designer using a general-purpose microprocessor such as must add RAM, ROM, I/O ports, and timers externally.
- This is not the case with microcontrollers.
- A microcontroller has a CPU in addition to a fixed amount of RAM, ROM, I/O ports, and a timer, all on a single chip.
- In other words, the processor, RAM, ROM, I/O ports, and timer are all embedded together on one chip.
- The fixed amount of on-chip ROM, RAM, and number of I/O ports in microcontrollers makes them ideal for many applications.

Embedded Systems

- To understand the expression "embedded system", consider each word separately.
- In this context, the word embedded means "a computer is hidden inside so one can't see it."
- The word "system" refers to the fact that there are many components which act in concert achieving the common goal.
- An embedded system is an electronic system that includes a one or more microcontrollers that is configured to perform a specific dedicated application.

Embedded Systems Examples: Washing Machine

- Embedded systems in a washing machine, for example, would include controlling the water and spin cycles, saving water.
- These processes are controlled by microcontrollers.

Embedded Systems Examples: Microwave Oven

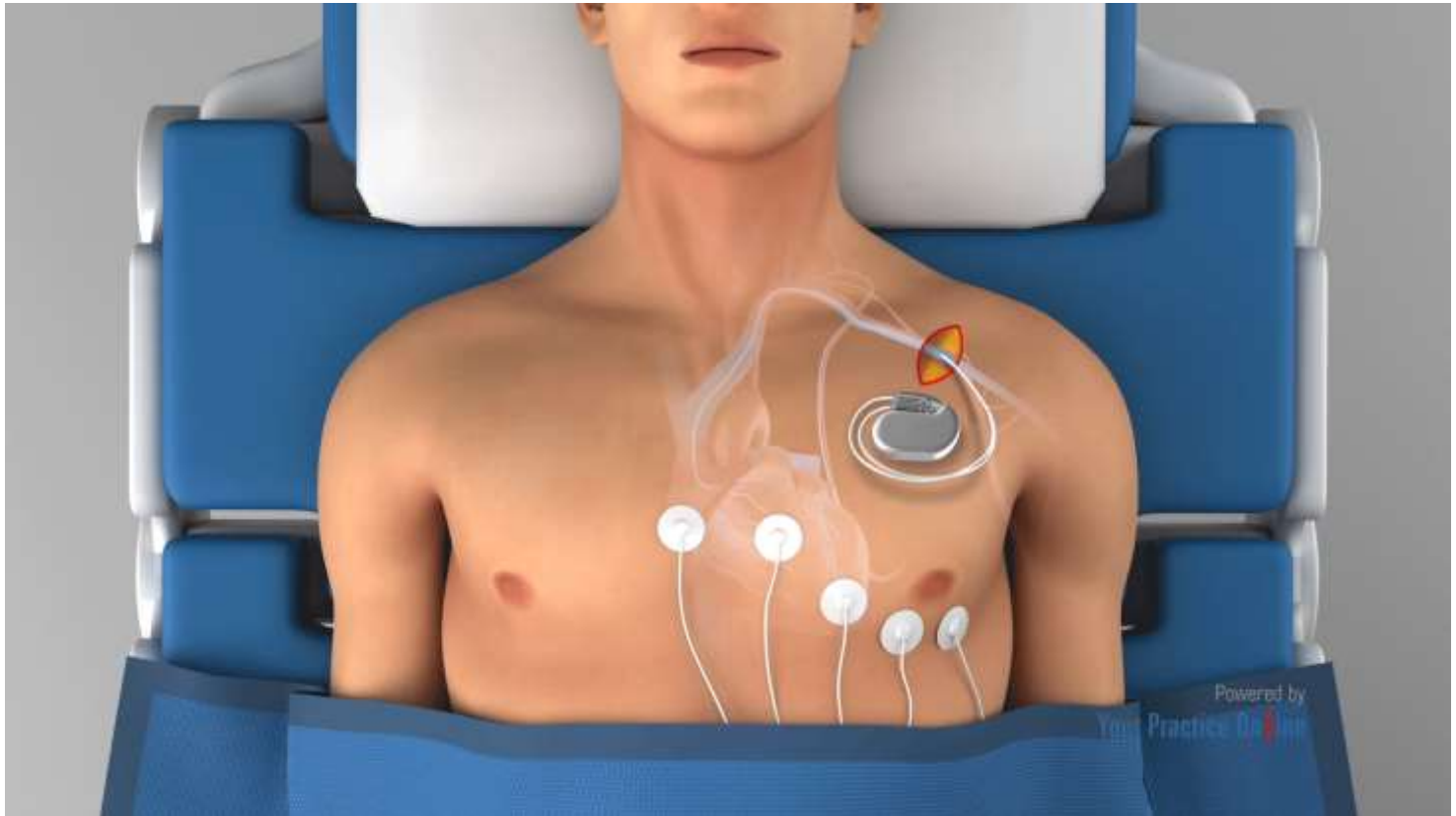
- Embedded systems typically perform a single function.
- For example, the embedded system in a microwave oven may be reconfigured to control different versions of the oven.
- But, a microwave oven will always be a microwave oven, and you can't reprogram it to be a dishwasher!

Embedded Systems Examples: Microwave Oven

- A printer is an example of an embedded system because the processor inside it performs one task only; namely, getting the data and printing it.

Embedded Systems Examples: Pacemaker

- The goal of a pacemaker is to regulate and improve heart function.
- Its inputs are sensors on the heart to detect electrical activity, and its outputs can deliver electrical pulses to stimulate the heart.



Embedded Systems Examples: Smoke Detector

- The goal of a smoke detector is to warn people in the event of a fire.
- It has a sensor that detects the presence of smoke.
- There are also two outputs: an LED and the alarm.

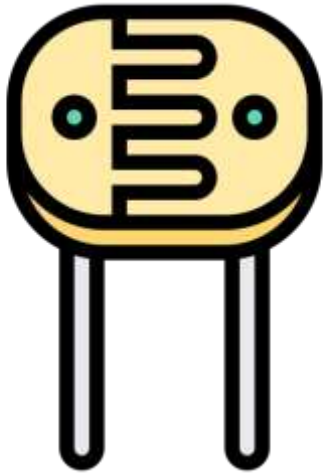
Embedded Systems Everywhere!

- We live in a world stuffed with embedded systems.
- In fact, much of our technology is based on them.
- That digital watch on your wrist, the microwave that you use for heating food, and the car that you drive every day.

Sensors

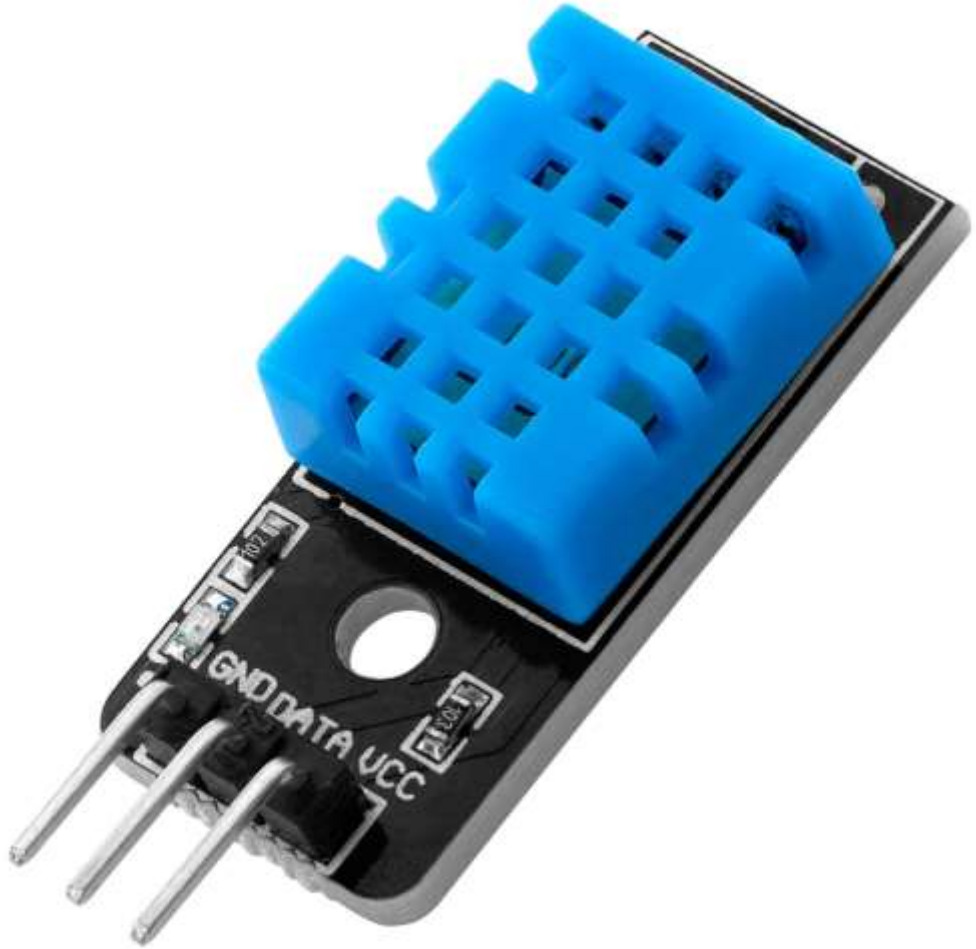
- A sensor is a device that detects some type of input from the physical environment.
- The input can be light, heat, motion, pressure or any number of other environmental phenomena.



Sensors: Temperature/Humidity Sensor (DHT11)

- The DHT11 sensor measures temperature and humidity.



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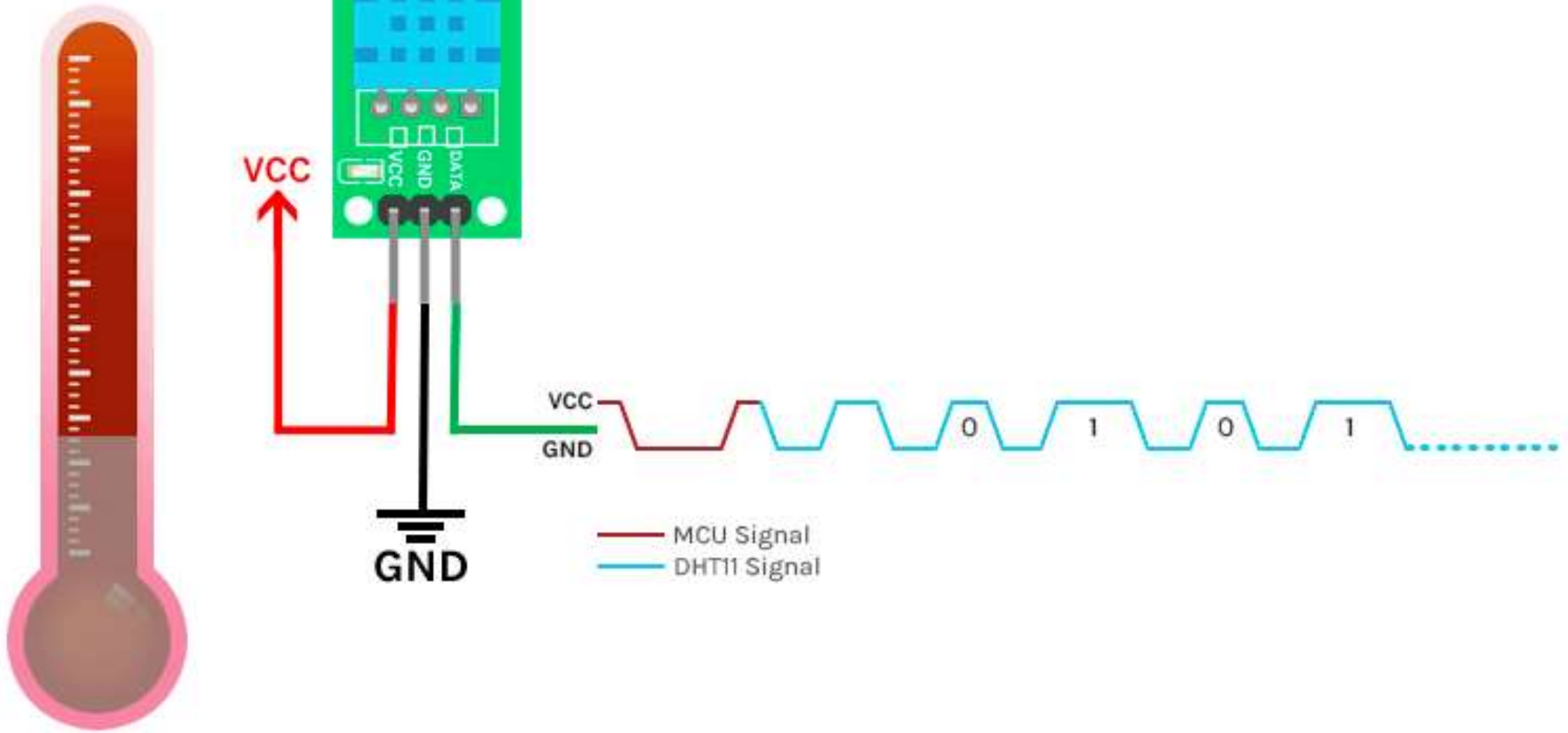

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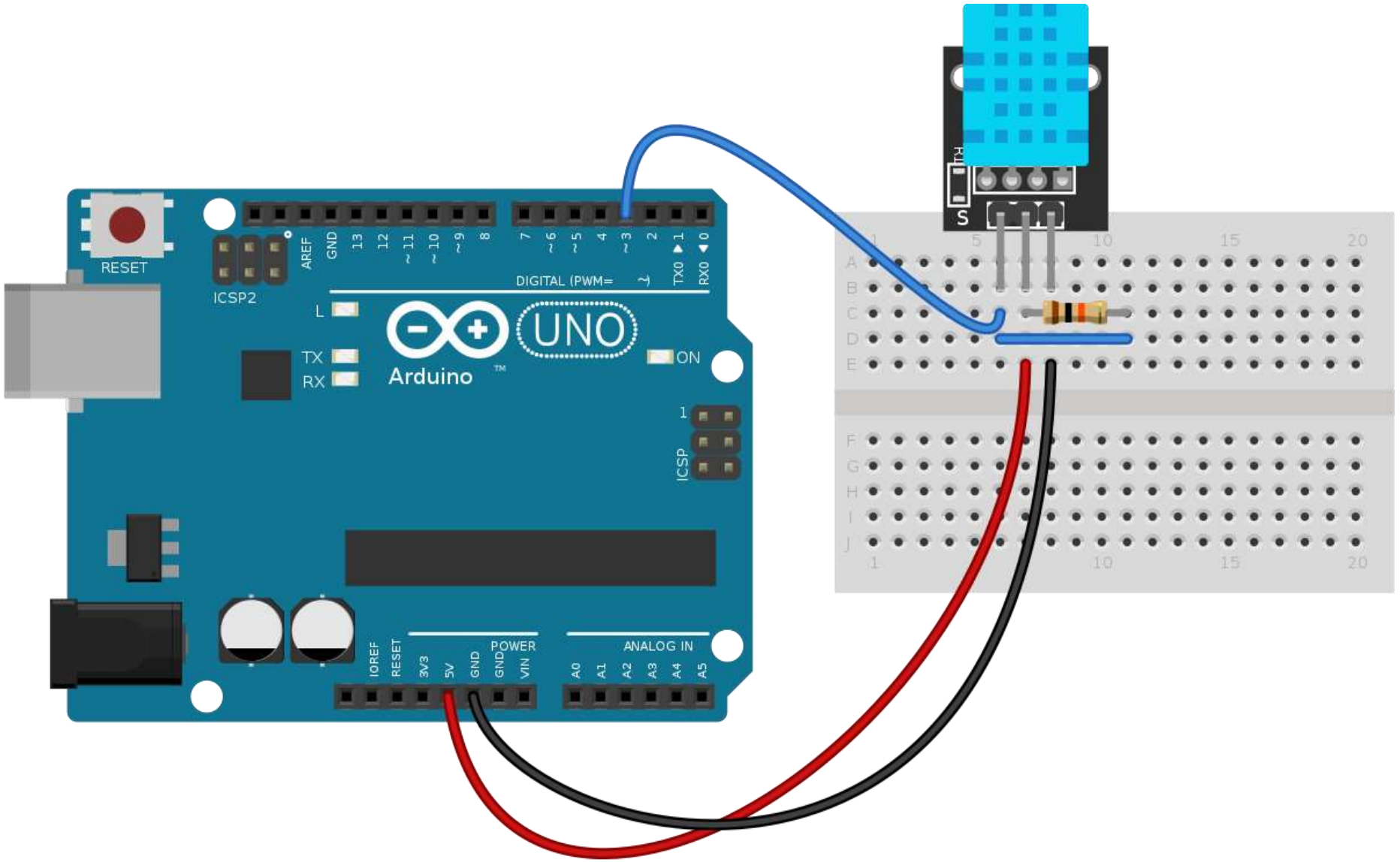
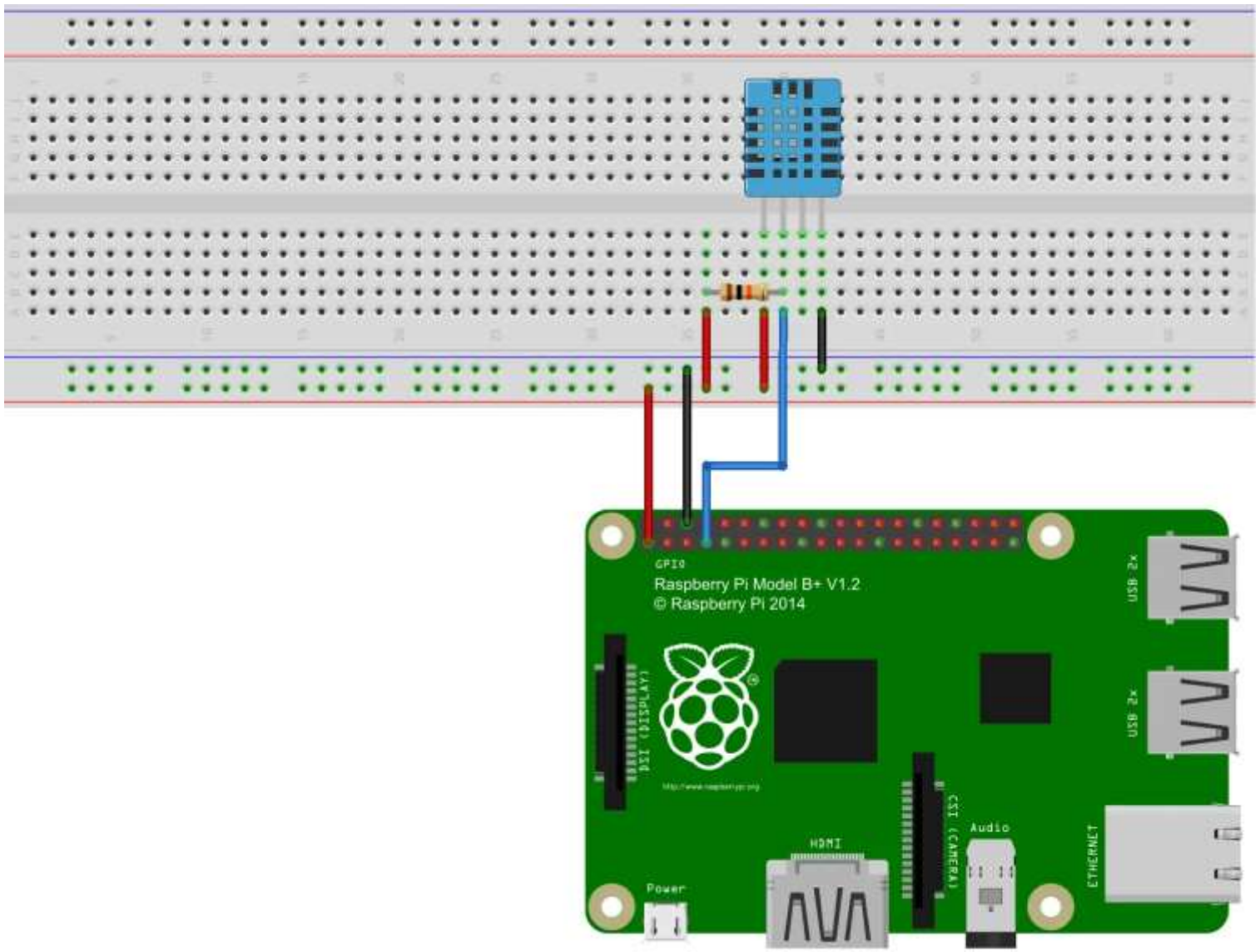


Sensors: Temperature/Humidity Sensor (DHT11)



Sensors: Temperature/Humidity Sensor (DHT22)

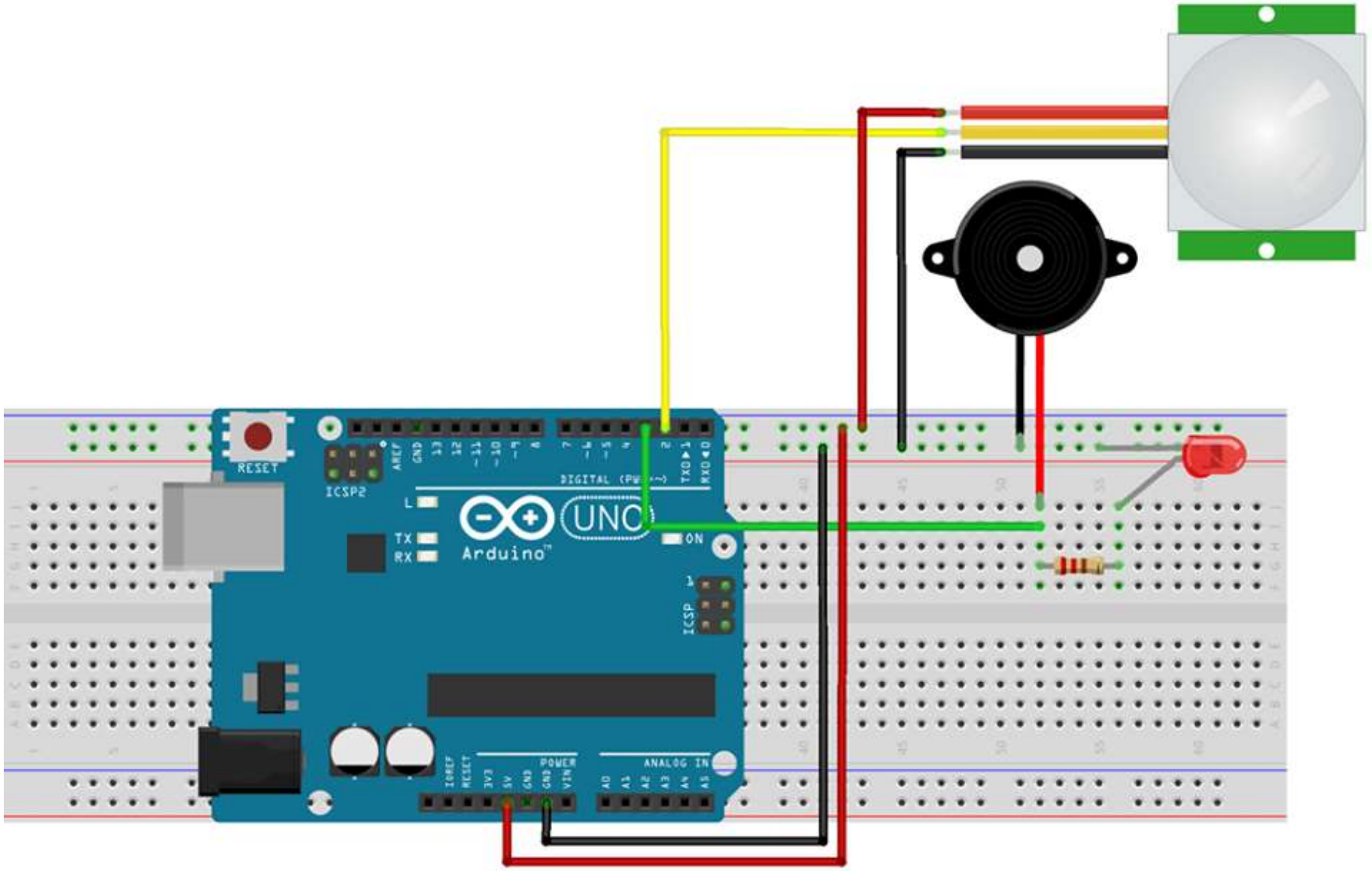
- The DHT22 sensor has better specifications than DHT11.

Sensors: PIR Motion Detection Sensor

- The PIR (Passive Infrared) sensor allows you to sense motion.
- PIR is used to detect whether a human has moved in or out of the sensor's range.

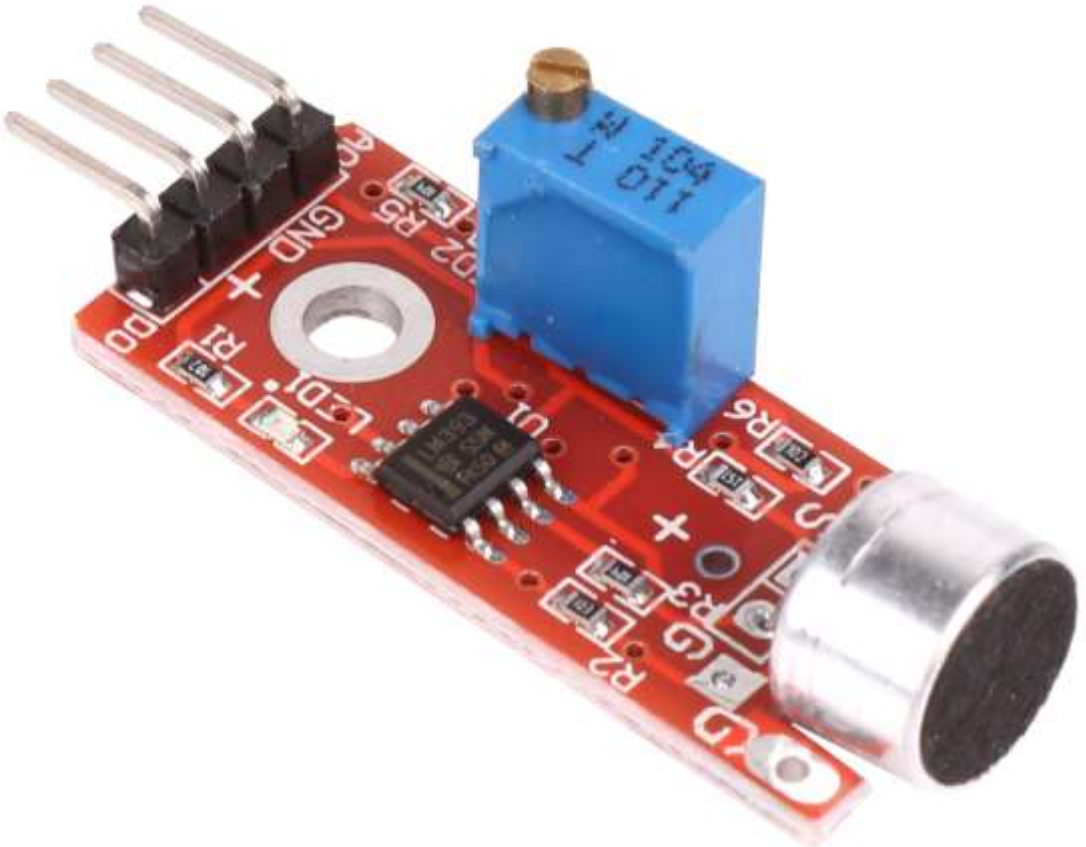
Sensors: PIR Motion Detection Sensor

Sensors: PIR Motion Detection Sensor



Sensors: Microphone Sound Detection Sensor

- The microphone sound sensor, as the name says, detects sound.
- It gives a measurement of how loud a sound is.



Sensors: Microphone Sound Detection Sensor

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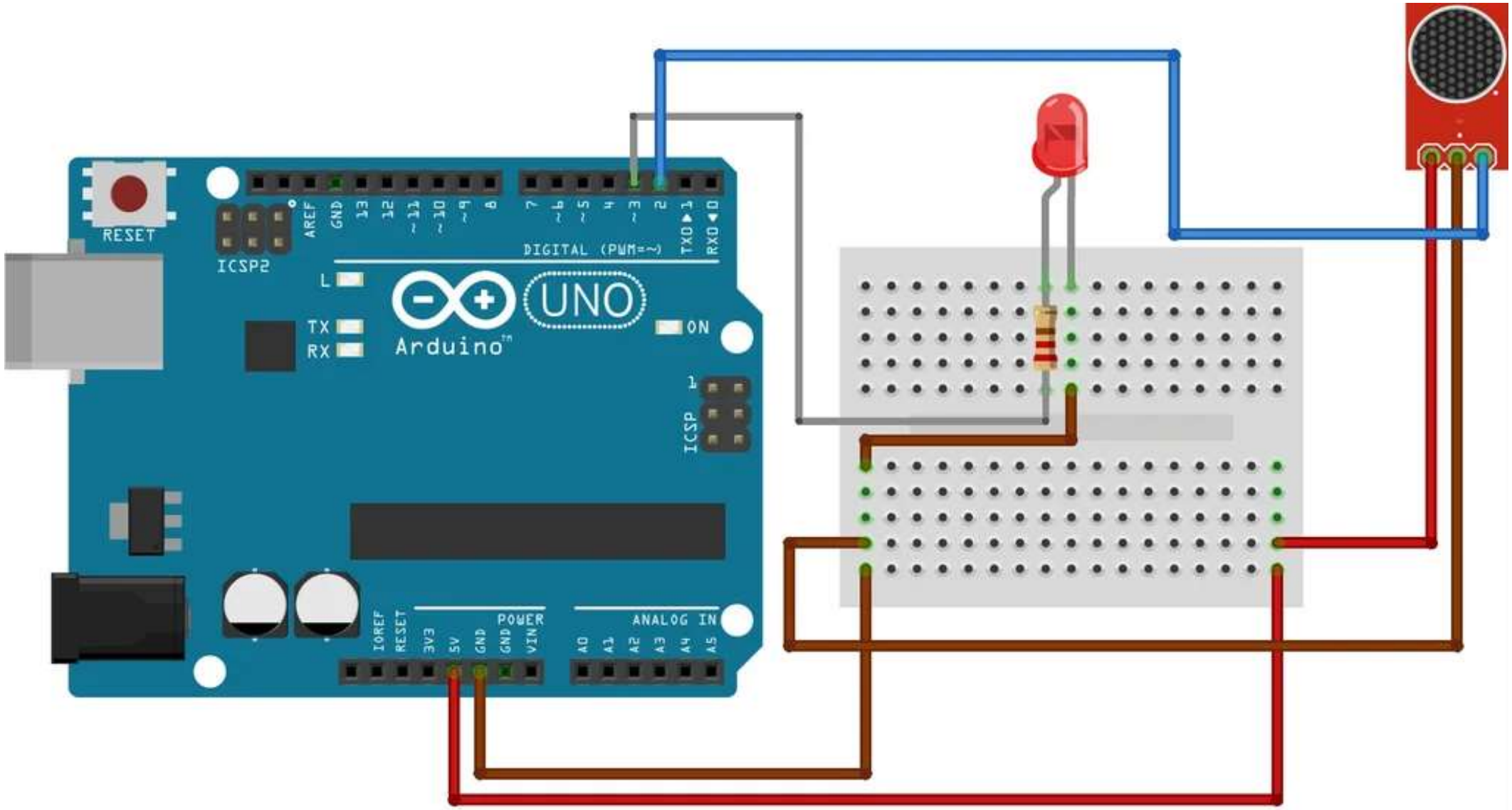
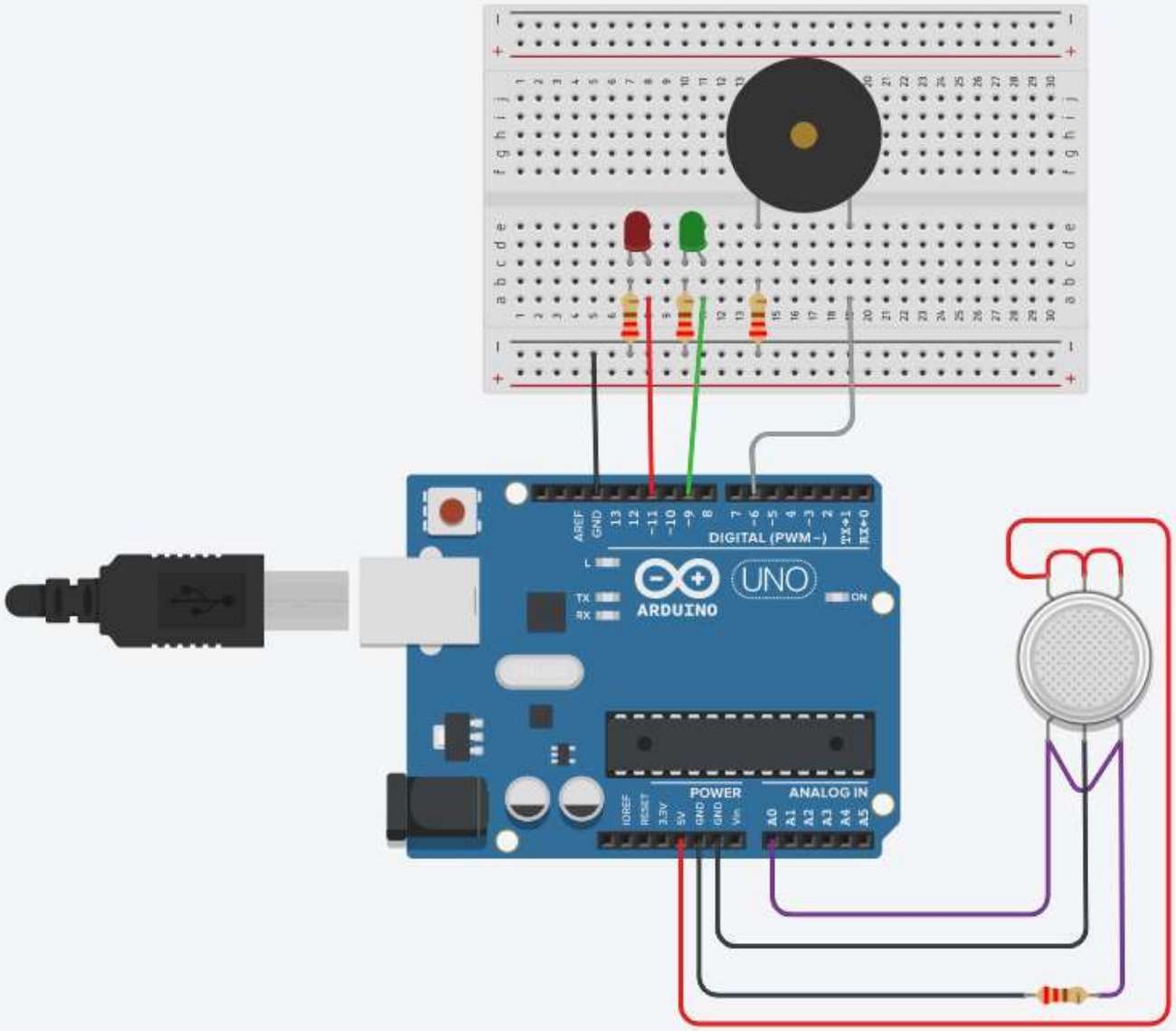


Sensors: Gas Sensor (MQ-2)

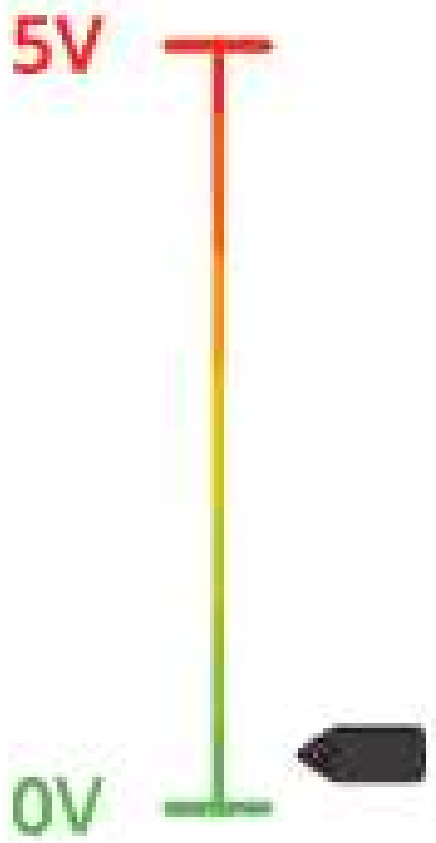
- The MQ-2 gas sensor module is useful for gas leakage detecting.
- The module measures gas such as butane.

Sensors: Gas Sensor (MQ-2)



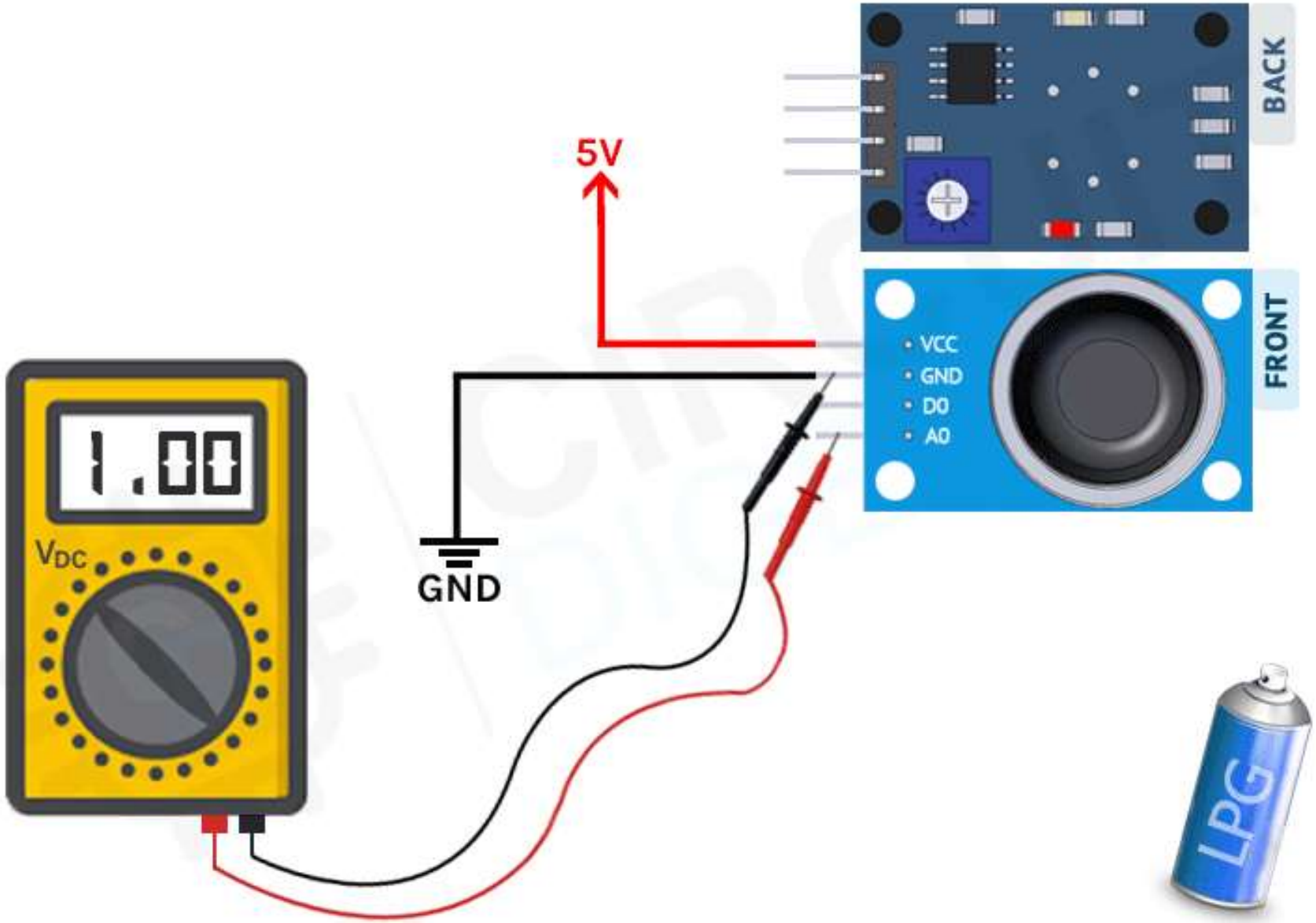
Sensors: Gas Sensor (MQ-2)

Clean Air



Output Voltage

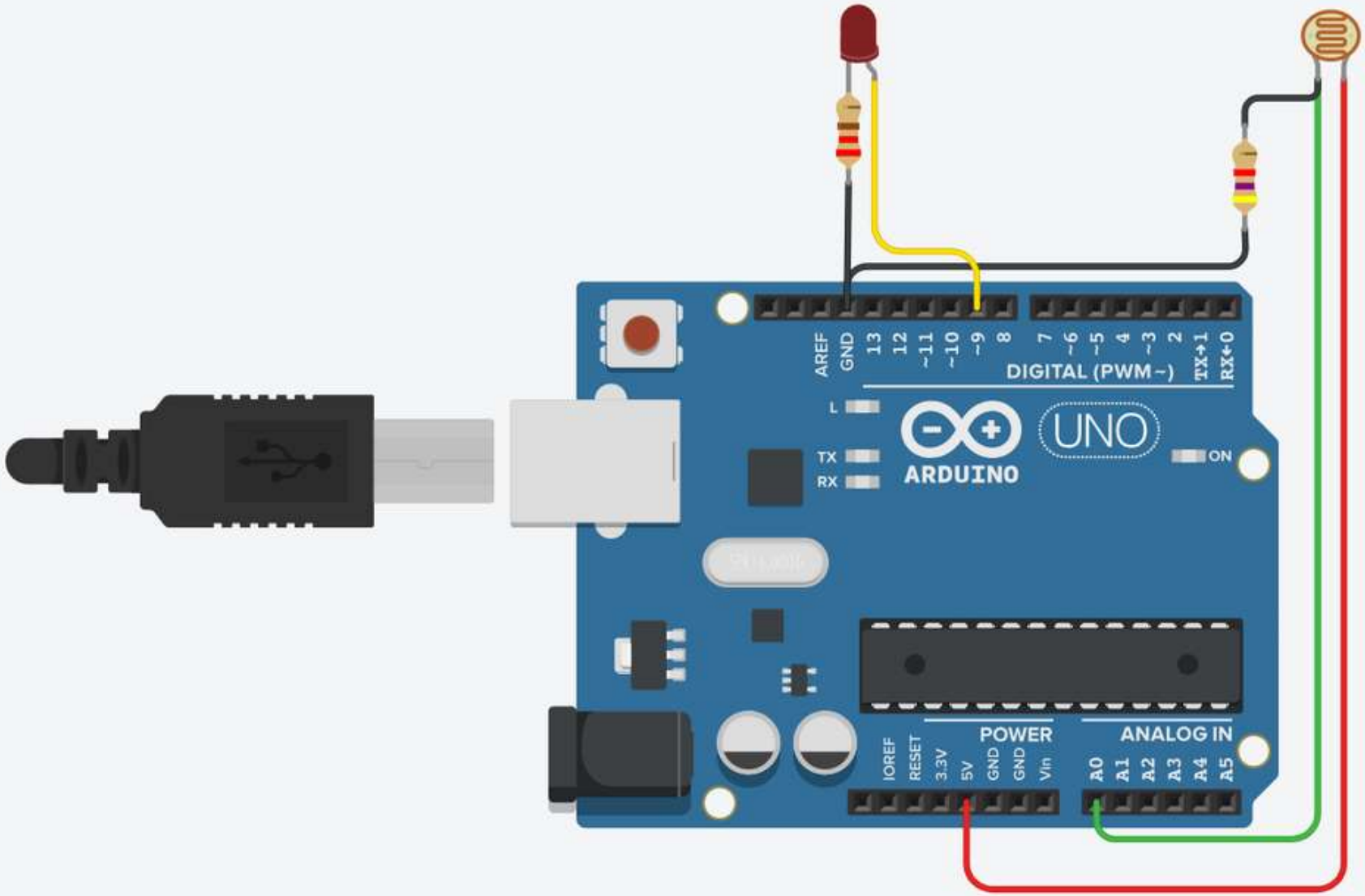
Sensors: Gas Sensor (MQ-2)



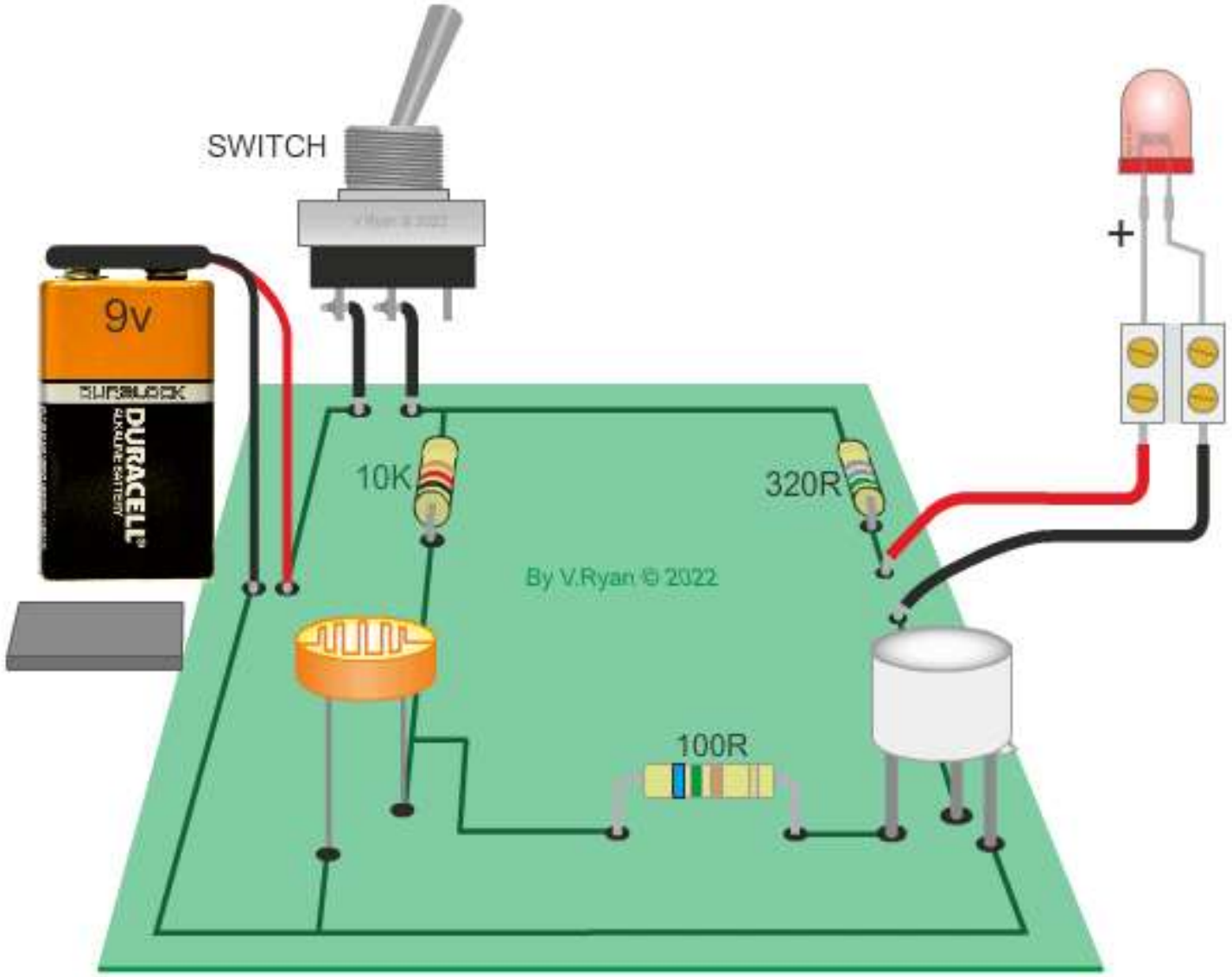
Sensors: CdS Sensor

- A CdS photocell or Light Dependent Resistor (LDR) is a resistor where the resistance changes based on the amount of light.

Sensors: CdS Sensor



Sensors: CdS Sensor

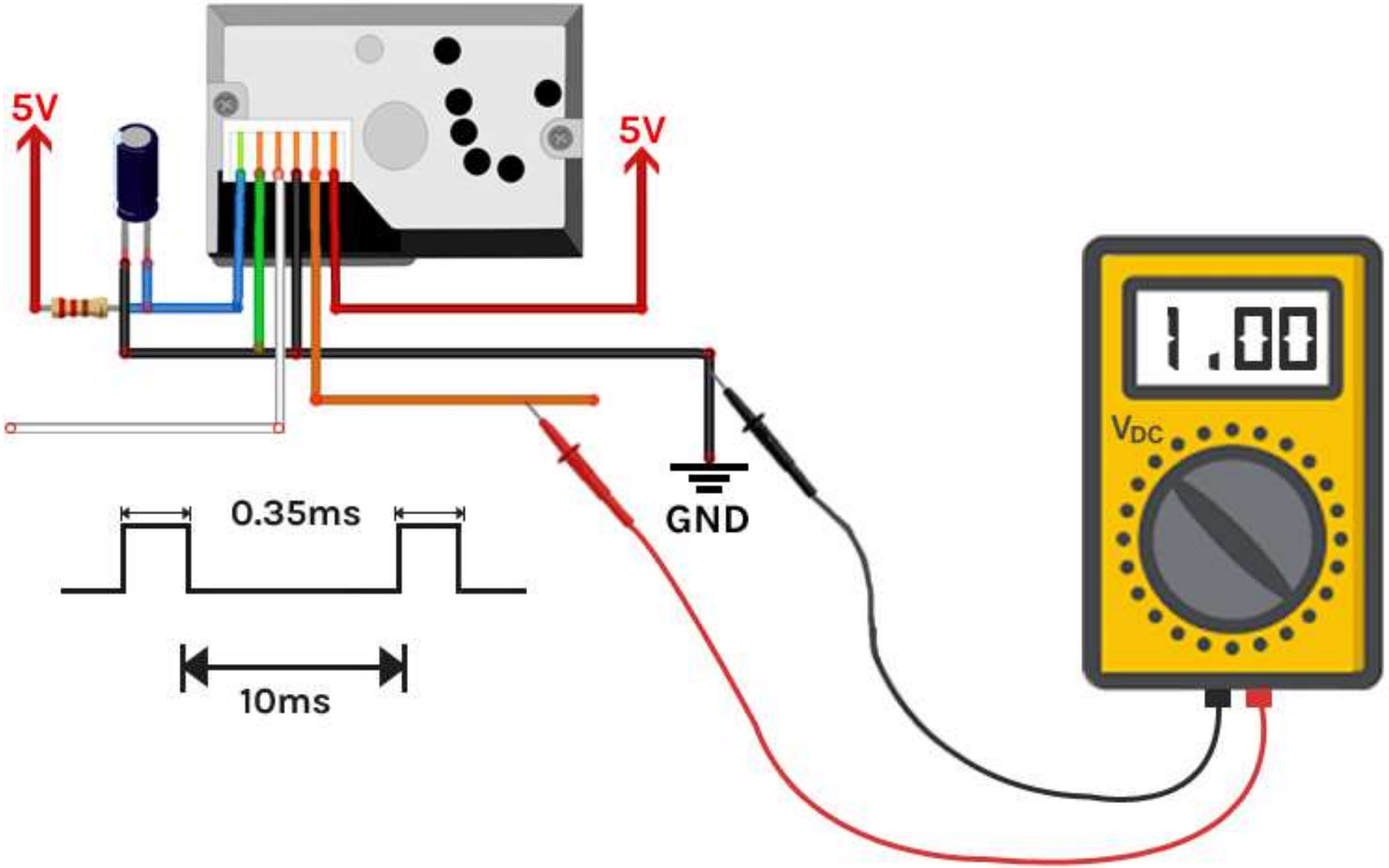


Sensors: CdS Sensor

Sensors: Dust Sensor

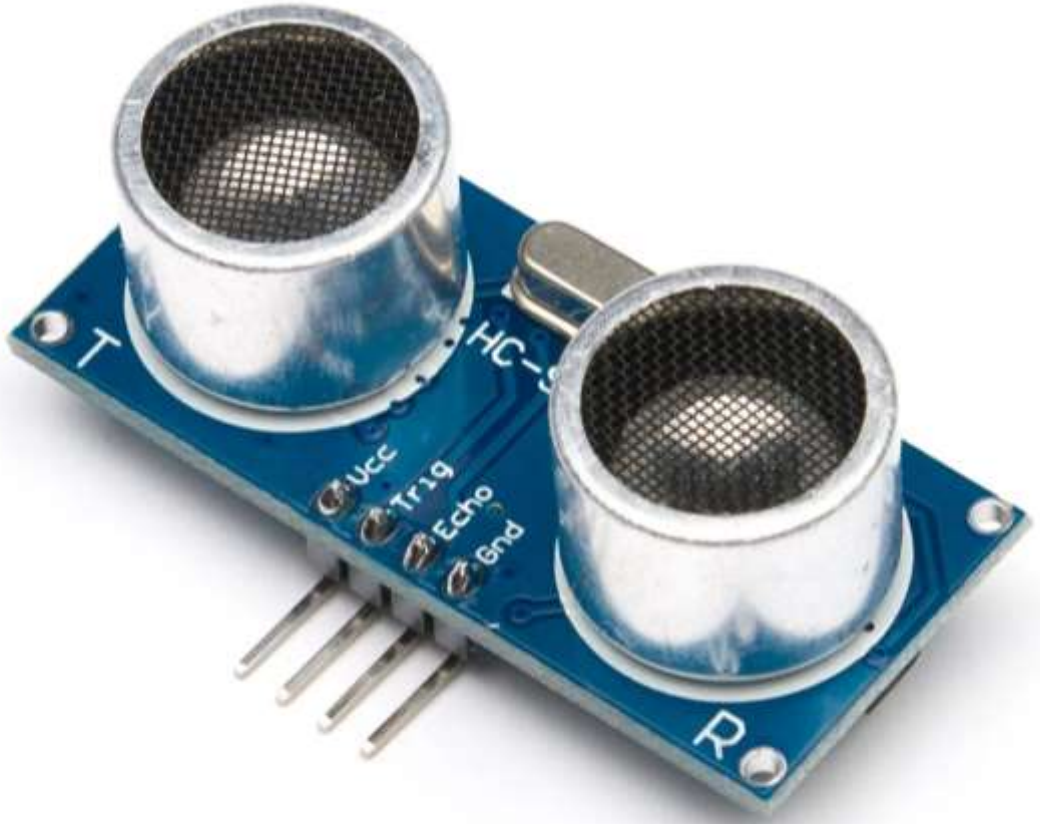
- The dust sensor is a simple air monitoring module.

Sensors: Dust Sensor



Sensors: Ultrasonic Sensor (HC-SR04)

- As the name indicates, ultrasonic sensors measure distance by using ultrasonic waves.



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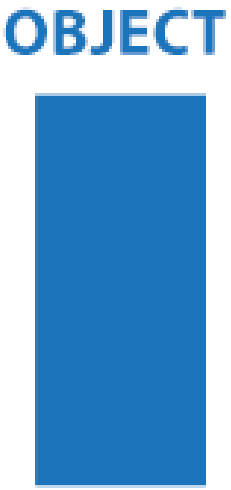
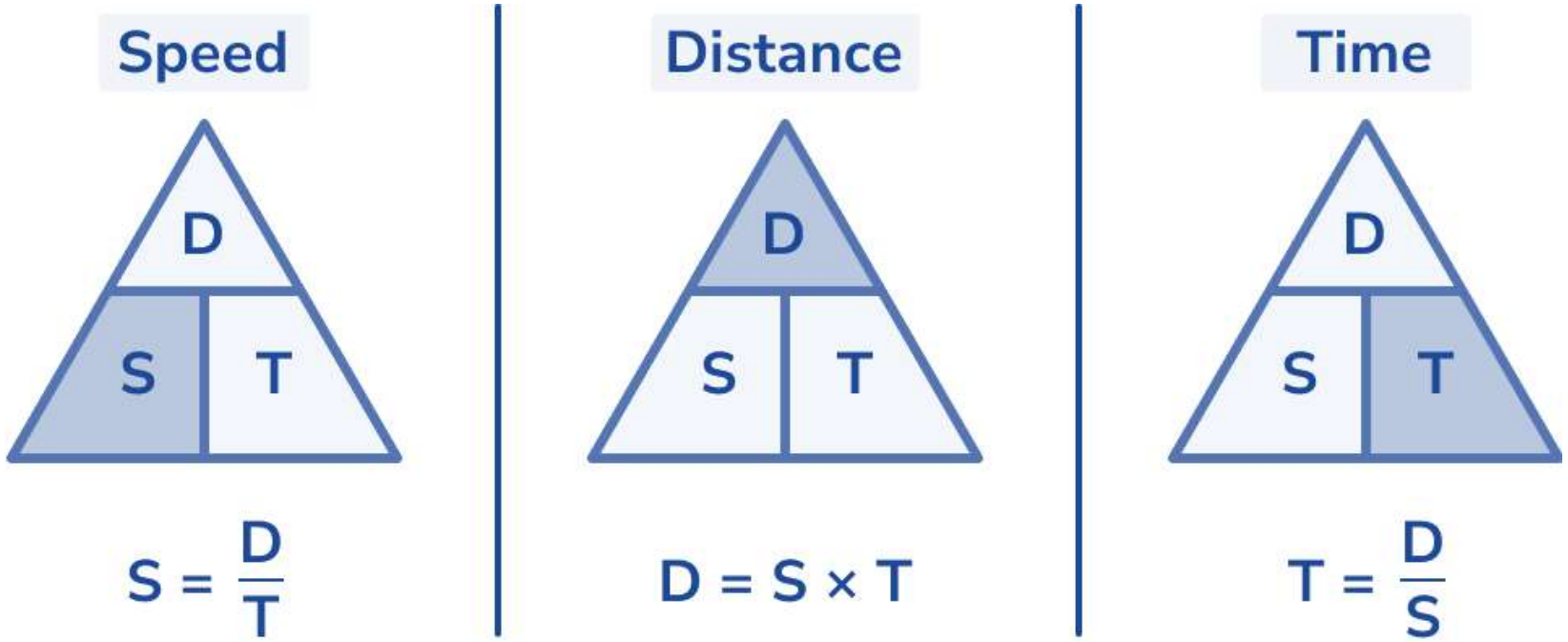


Sensors: Ultrasonic Sensor (HC-SR04)

- The width of the received pulse is used to calculate the distance from the reflected object.
- This can be worked out using the simple distance-speed-time equation we learned in high school.



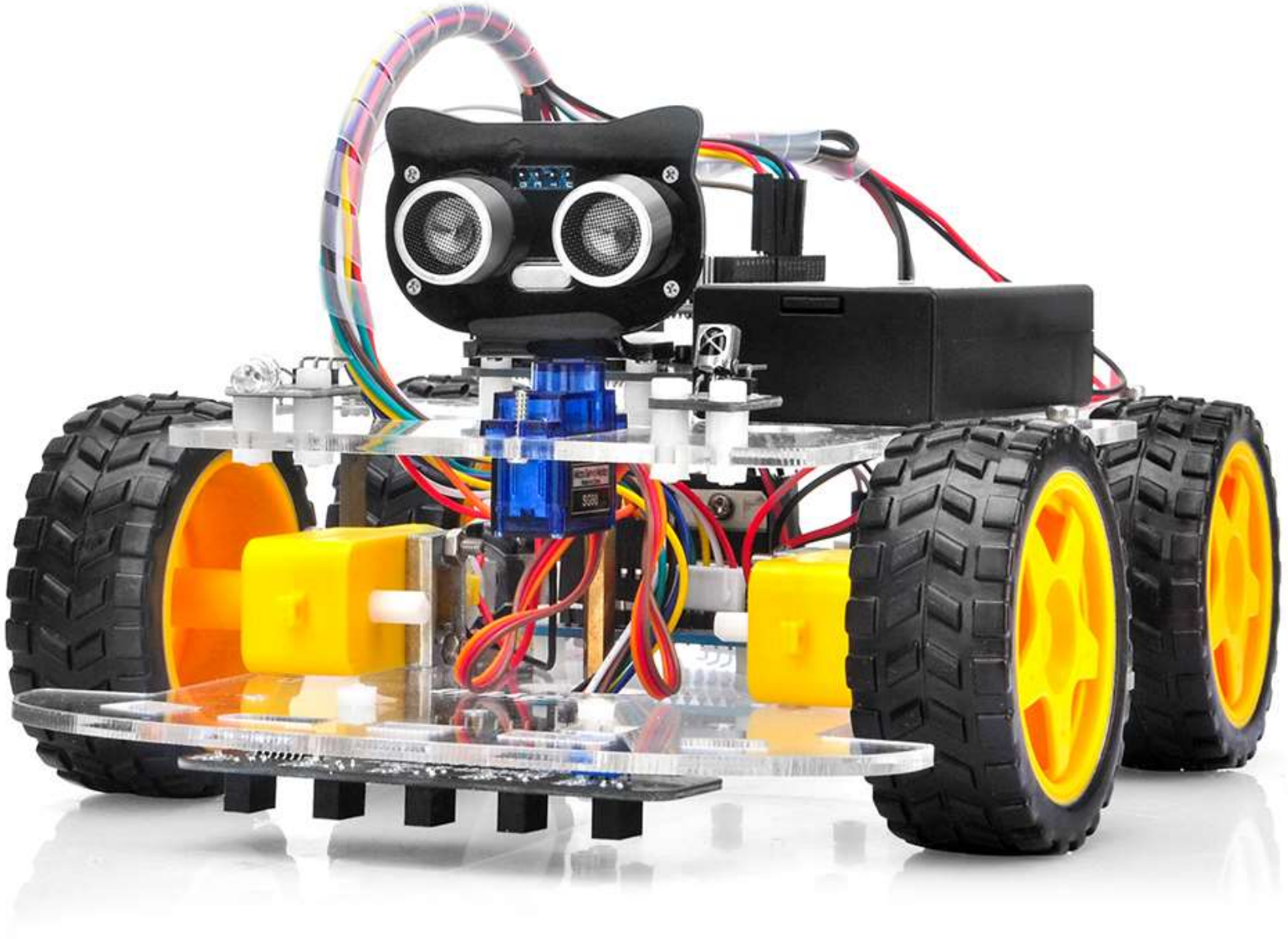
Sensors: Ultrasonic Sensor (HC-SR04)

- For the calculation of the object distance, the sensor measures the time taken by the signal to travel between the transmission of the sound by the transmitter to the reflecting back towards the receiver.

$$\text{Distance} = \frac{1}{2}\text{Time} \times \text{Speed}$$

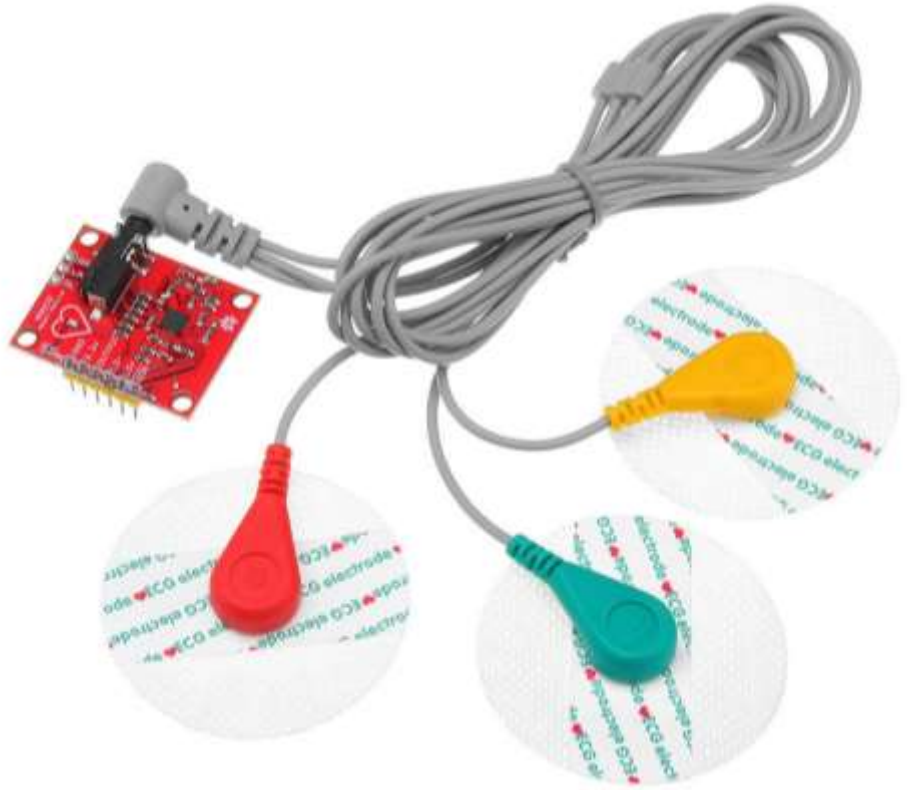
- The speed of sound in the air at 20ºC is 343 m/s.

Sensors: Ultrasonic Sensor (HC-SR04)

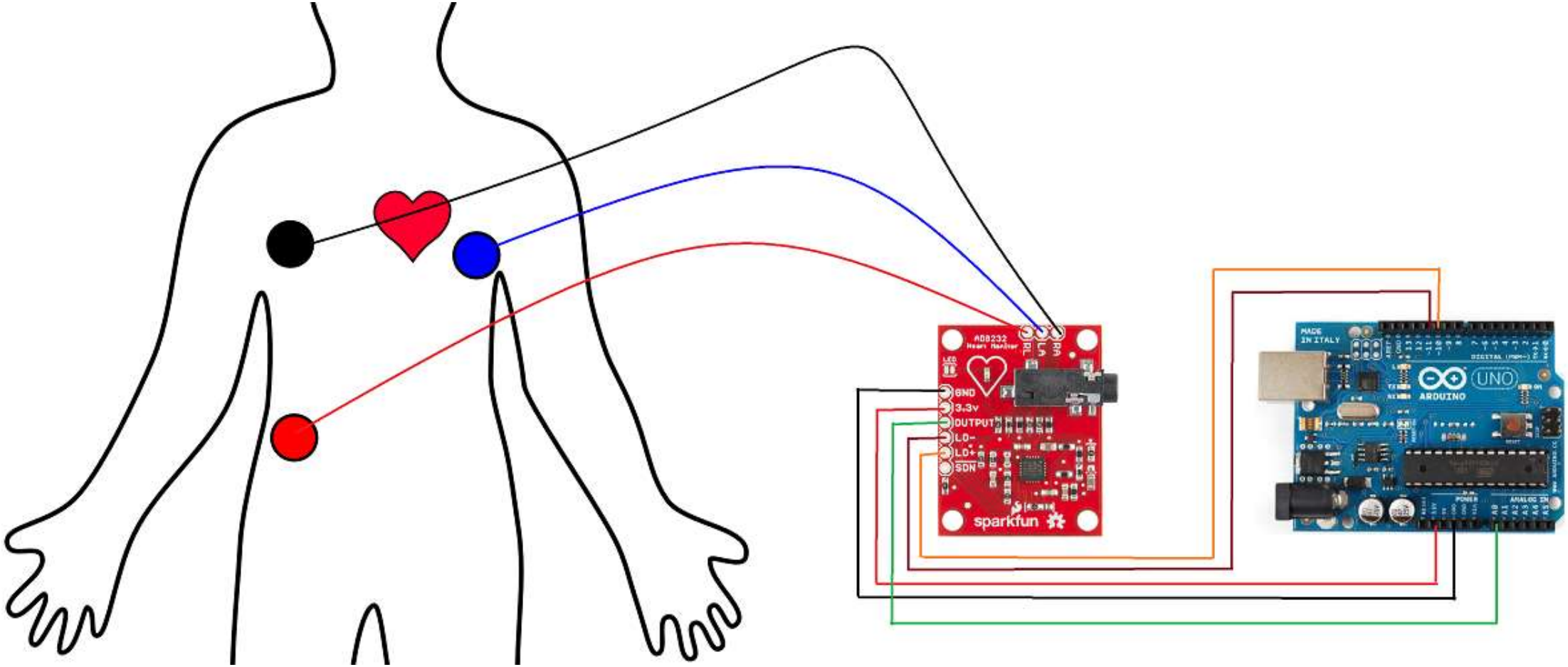


Sensors: ECG AD8232 Heart Rate Sensor

- The heart rate module with the AD8232 is a device which is capable of measuring electrical activity of the heart.
- The activity can be displayed using an ECG type graphic.



Sensors: ECG AD8232 Heart Rate Sensor

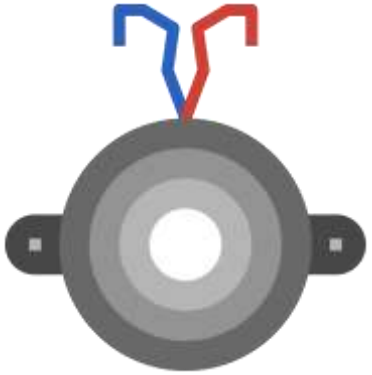


Sensors: ECG AD8232 Heart Rate Sensor

Actuators

- Sensors turn a physical input into an electrical output, while actuators do the opposite.
- Actuators take electrical signals from control modules and turn them into physical outputs.

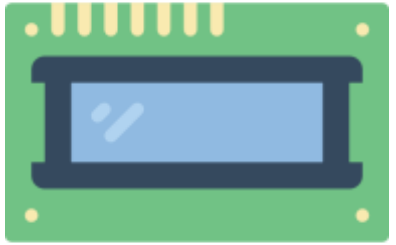
LEDs



Buzzer

DC Fan

Servo Motor



LCD

Actuators: Servo Motor

- A servo motor is an electrical device which can push or rotate an object with great precision.

Actuators: Servo Motor

- The HBE-ROBONOVA AI 3 is an intelligent robot with an MR-C3024 controller board capable of controlling 32 servo motors simultaneously.

Hardware Per Team

No.	Item	Price	Quantity	Subtotal
1	Arduino Uno	360	1	360
2	Arduino Uno Cable	15	1	15
3	Breadboard	33	1	33
4	LED (Red)	0.35	10	3.5
5	LED (Green)	0.35	5	1.75
6	LED (Yellow)	0.35	5	1.75
7	Resistor (330 Ohm)	0.25	20	5
8	Resistor (1K Ohm)	0.25	10	2.5
9	Resistor (10K Ohm)	0.25	10	2.5
10	Jumper Wire (Male to Male)	0.75	40	30
11	Jumper Wire (Male to Female)	0.75	20	15
12	7-Segment Display Common Cathode	4.5	1	4.5
13	Push Button 2-Pin	0.75	2	1.5
14	Rotry POT 1K	4	1	4
15	Character LCD 2×16	50	1	50
16	Male Pin Header	3.5	1	3.5

Hardware Per Team

No.	Item	Price	Quantity	Subtotal
17	Universal IR Infrared Receiver	4.5	1	4.5
18	IR Remote Control	15	1	15
19	RGB LED Common Cathode	2.5	2	5
20	Ultrasonic Sensor (HC-SR04)	40	1	40
21	Ultrasonic Sensor Holder	10	1	10
22	Micro Servo Motor (180 Degree)	120	1	120
23	IR Obstacle Avoidance Sensor	25	1	25
24	Motor Driver L298N Module	65	1	65
25	Robot Smart Car 4WD	310	1	310
26	Li-ion Battery Cell 3.7v (18650)	65	3	195
27	Battery Holder (3×18650)	17	1	17
28	Battery Charger Li-ion (18650)	70	1	70
29	Bluetooth Module (HC-05)	190	1	190
Total				**1600**

Electronics Stores in Egypt

- **Lampatronics**
- **RAM Electronics**
- **Micro Ohm Electronics**
- **Makers Electronics**

Tutorials

- Arafa Microsys - Arabic Hardware Channel
- Mohamed Yousef - Arabic Hardware Channel
- Khaled Magdy - Arabic Hardware Channel
- Walid Issa - Arabic Hardware Channel
- Hossam Magdy - Arabic Hardware Channel
- Ayman Elkfrawy - Arabic Hardware Channel

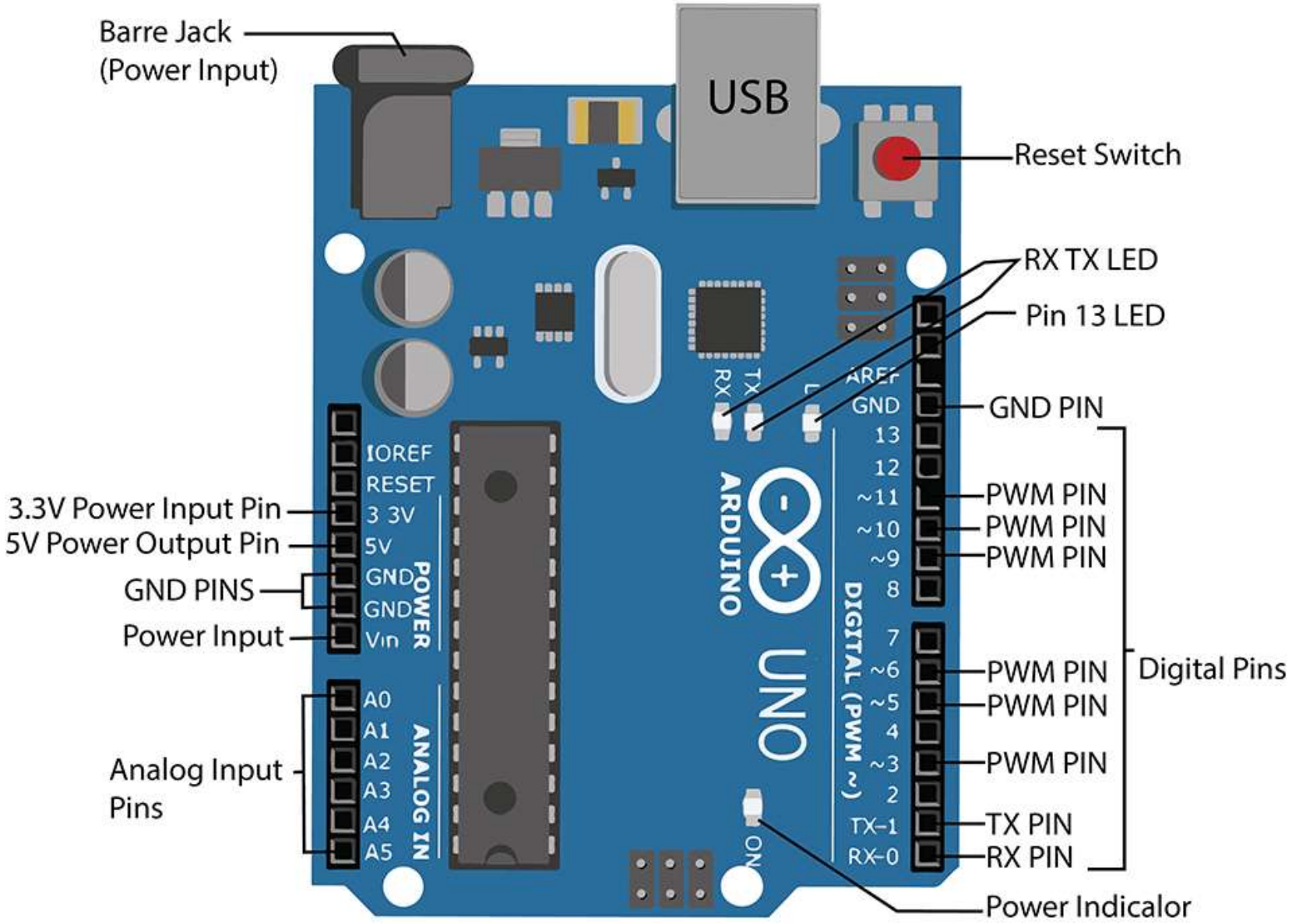
Arduino

- Arduino is open-source hardware that can be used to develop embedded systems with open-source software.
- Arduino has gained massive popularity among students for making a working model.
- The reasons behind the popularity of Arduino are its low cost, availability of software, and easy- to-interface possibility.
- The Arduino environment has been designed to be easy to use for beginners who have no software or electronics experience.

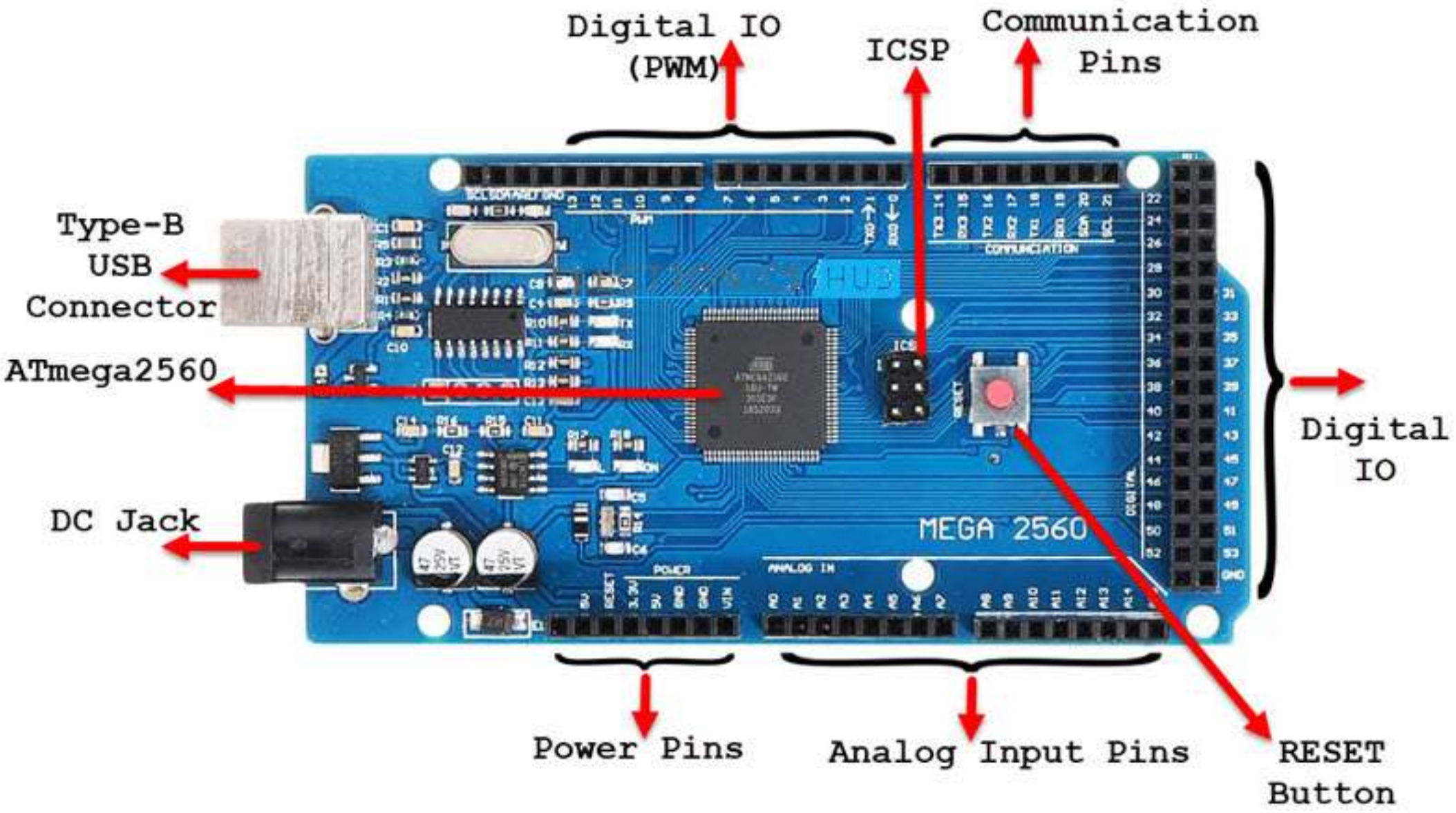
Arduino

- Arduino is used in many educational programs around the world, particularly by designers who want to easily create prototypes but do not need a deep understanding of the technical details.
- Because it is designed to be used by nontechnical people, the software includes plenty of example code to demonstrate how to use the Arduino board.
- People already working with microcontrollers are also attracted to Arduino because of its facility for quick implementation of ideas.

Arduino Uno Board

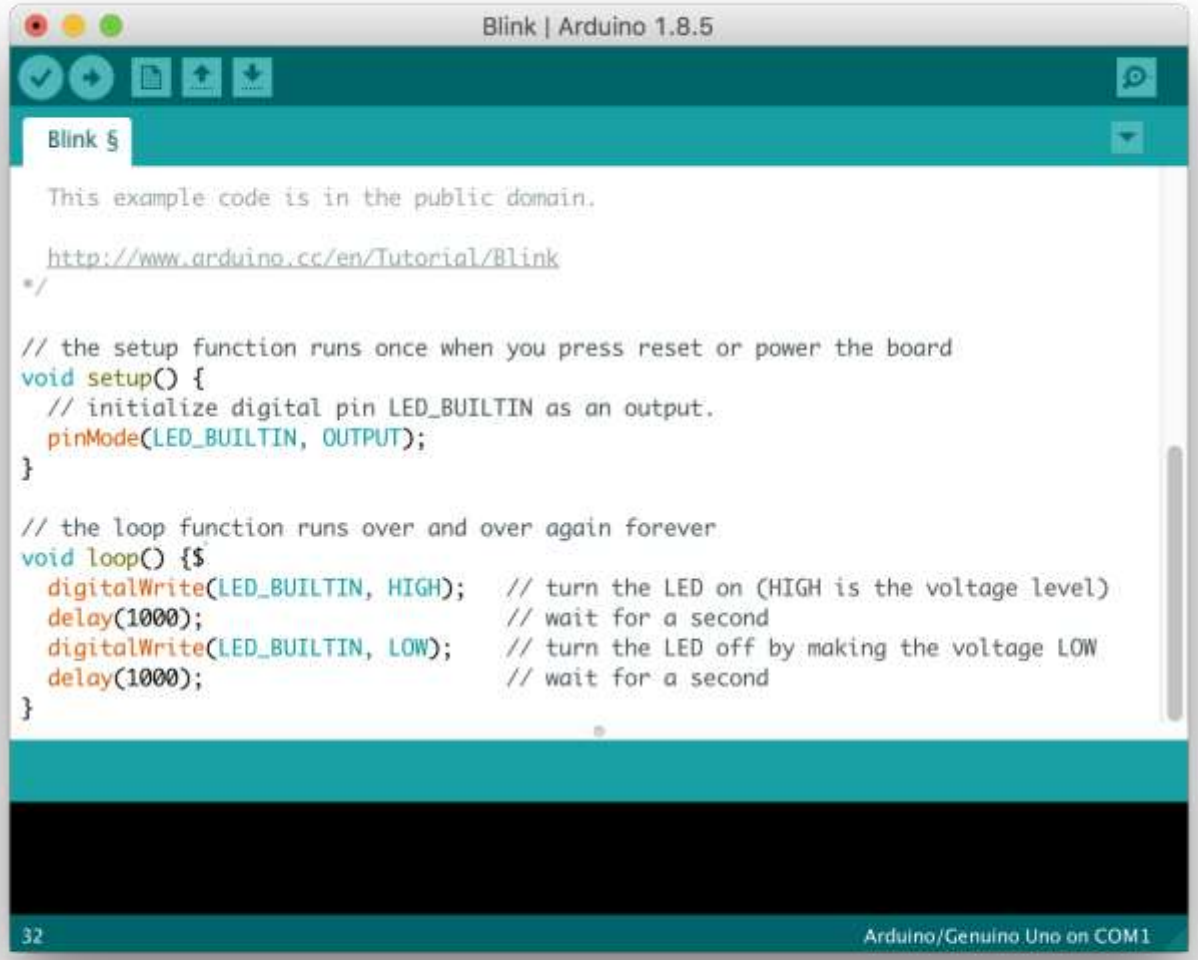


Arduino Mega Board



Arduino IDE

- The Arduino IDE enables you to write and edit code and convert this code into instructions that Arduino hardware understands.

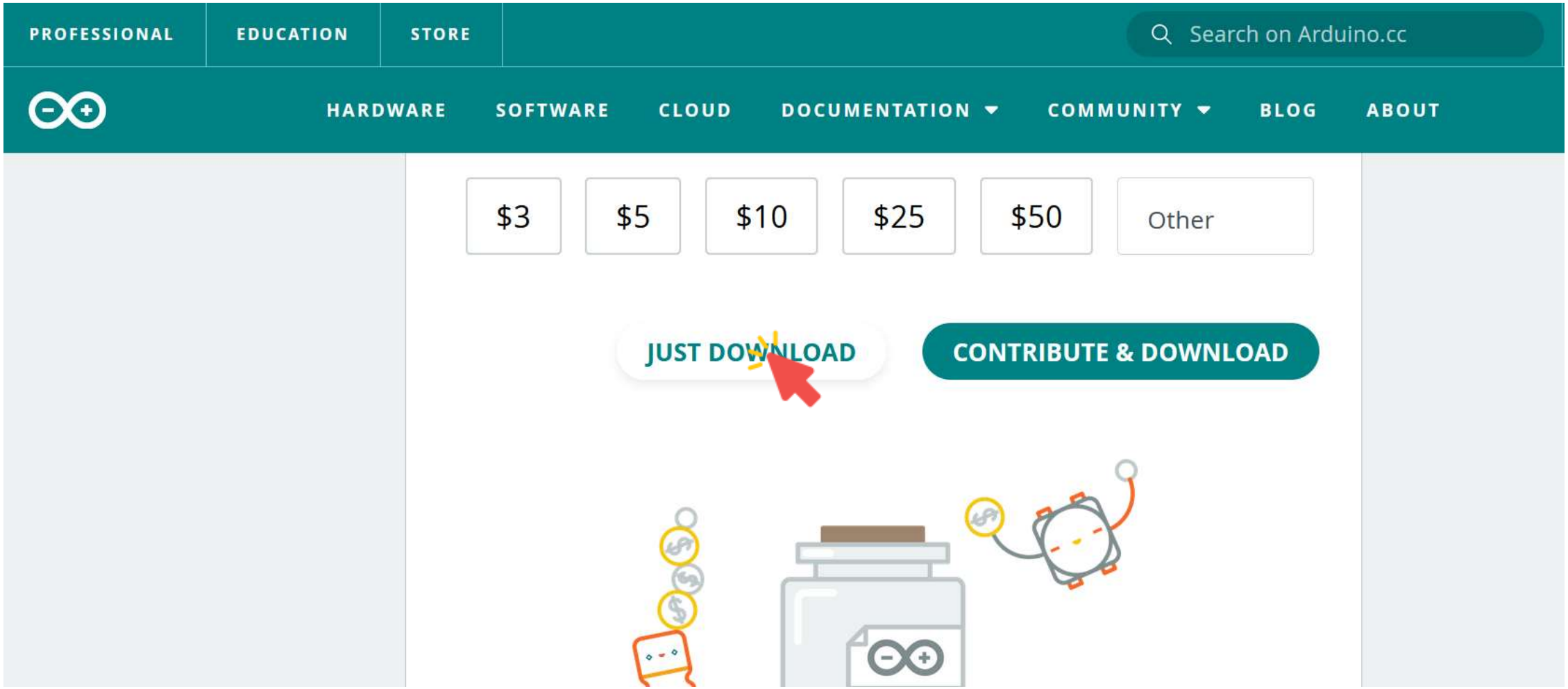


Downloading Arduino IDE

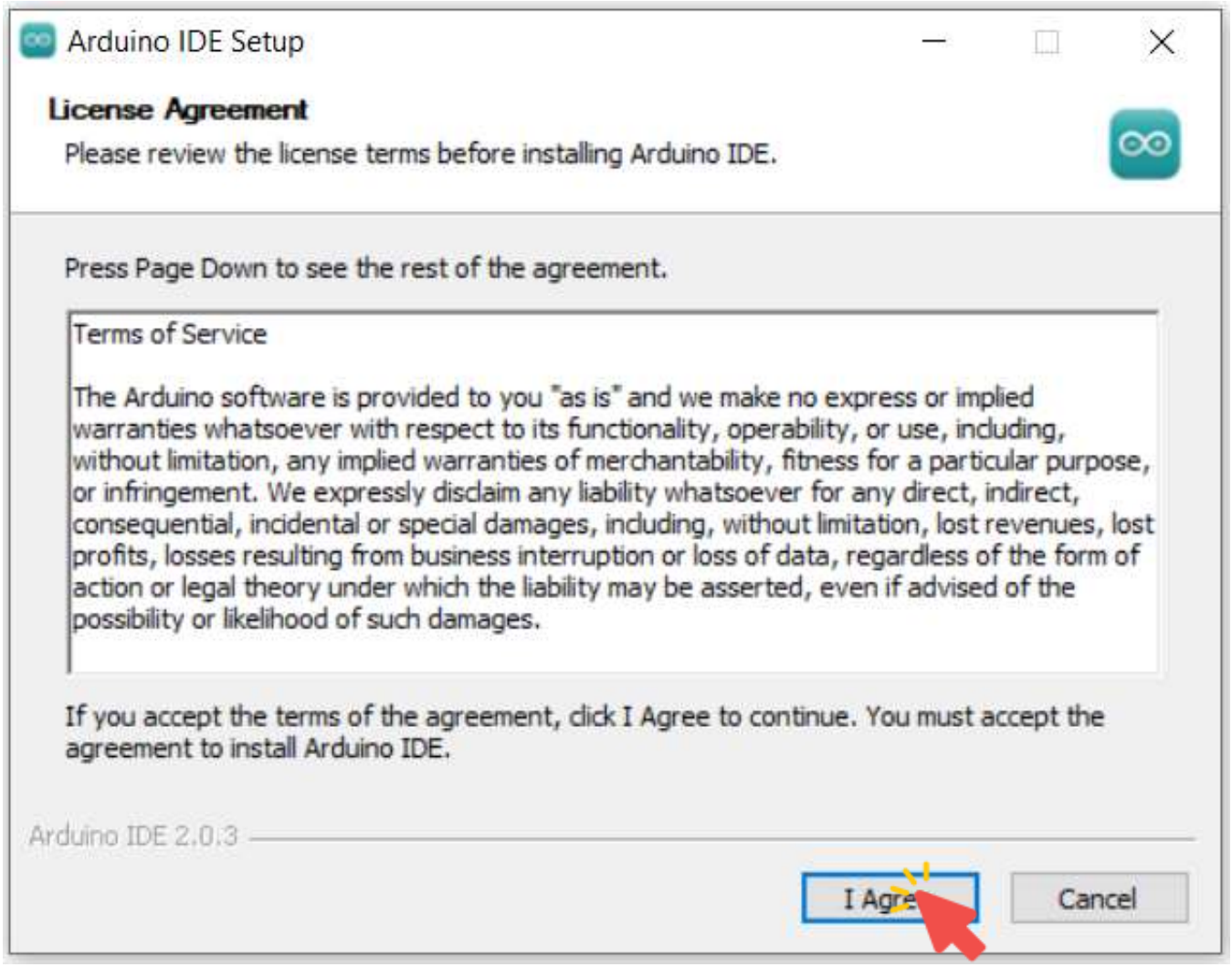
- Go to https://www.arduino.cc/en/software website.

Downloading Arduino IDE

- Click the "Just Download" option.



Installing Arduino IDE



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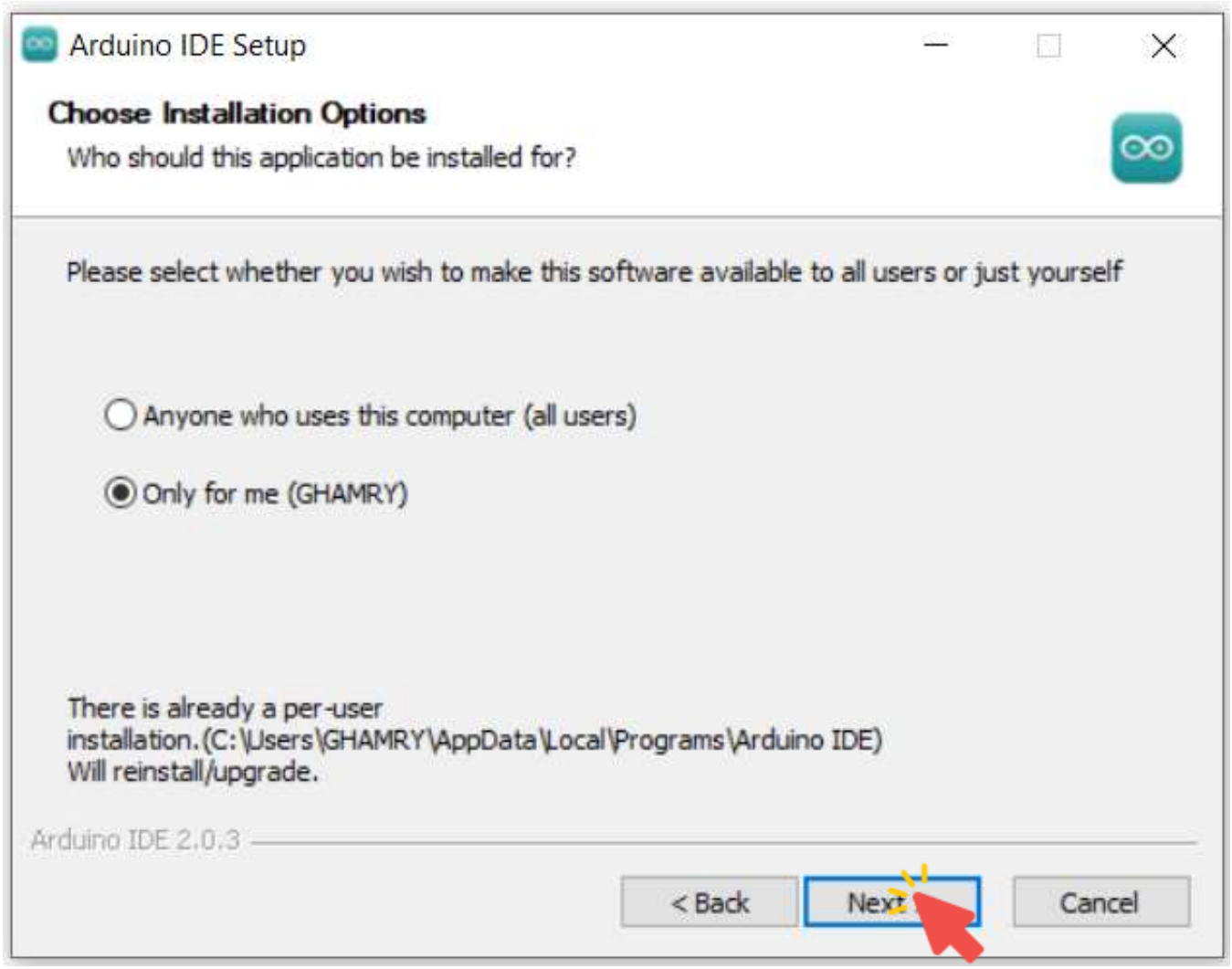

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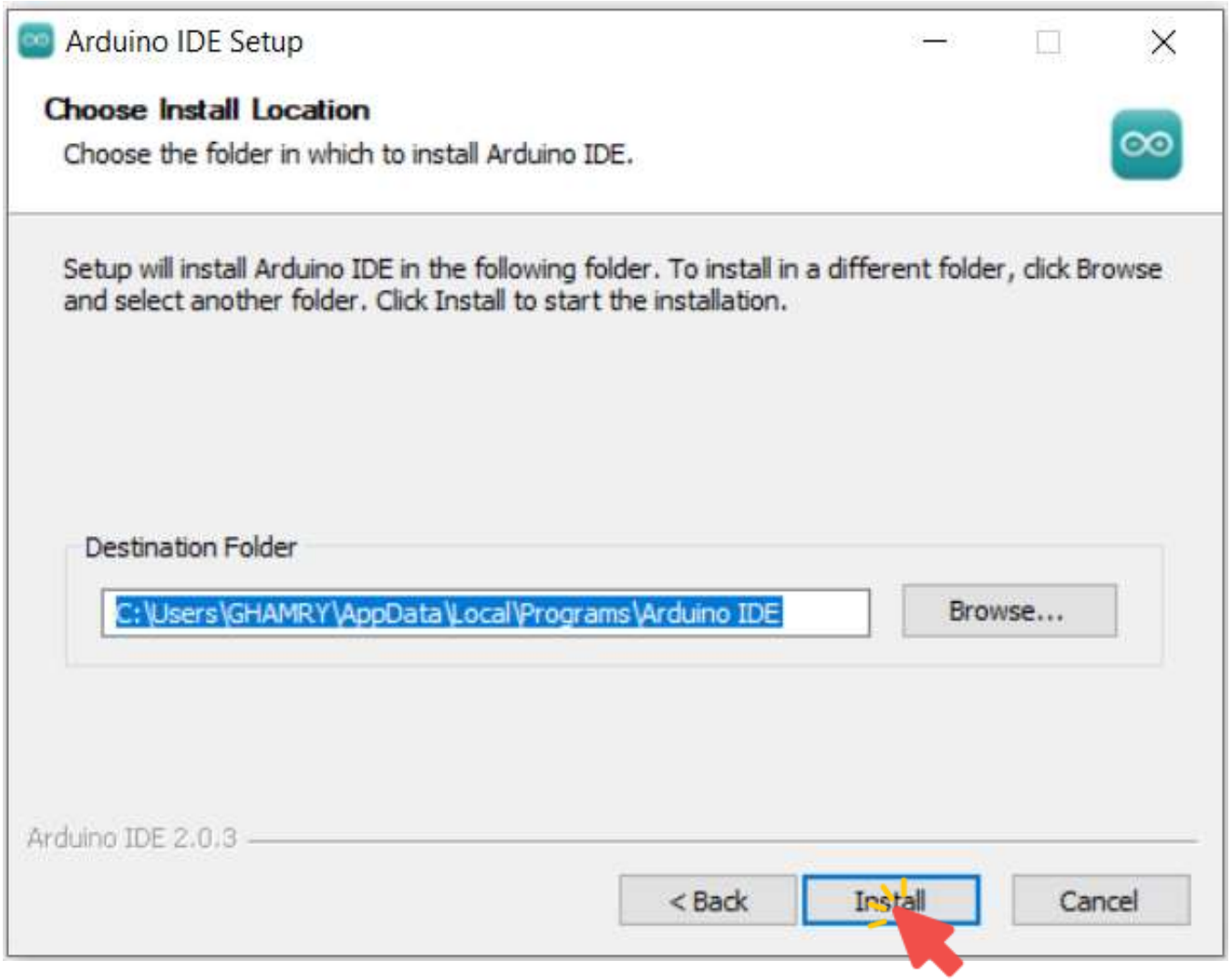

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