Armstrong

School Program 2023-2024

Lesson 5

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Lesson Content

Digital signals

Analog signals

PWM

Serial monitor

Potentiometer

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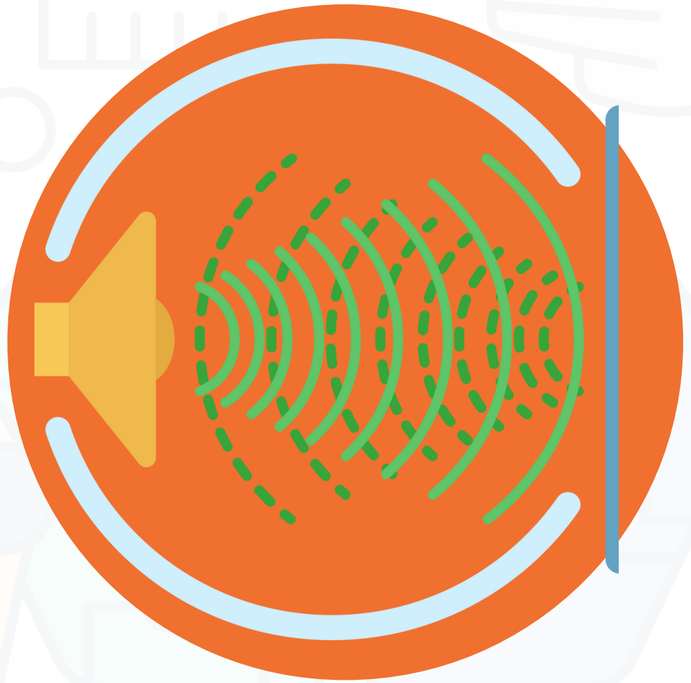
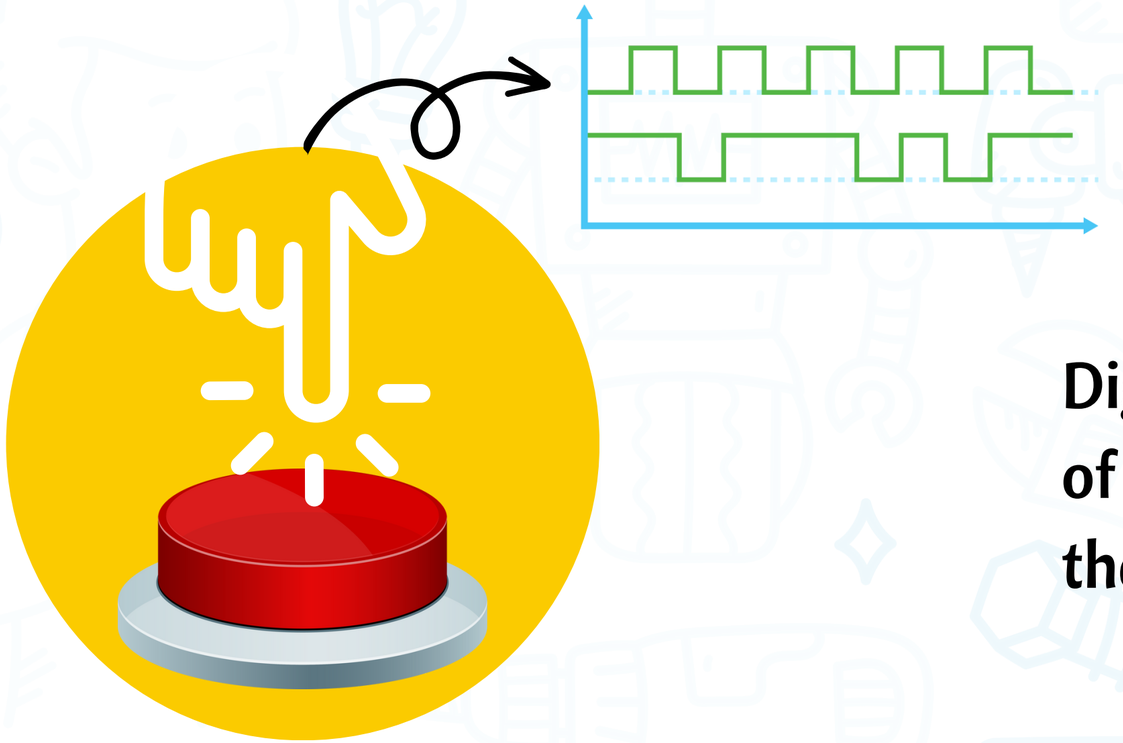
Remember

Digital vs Analog :



signals

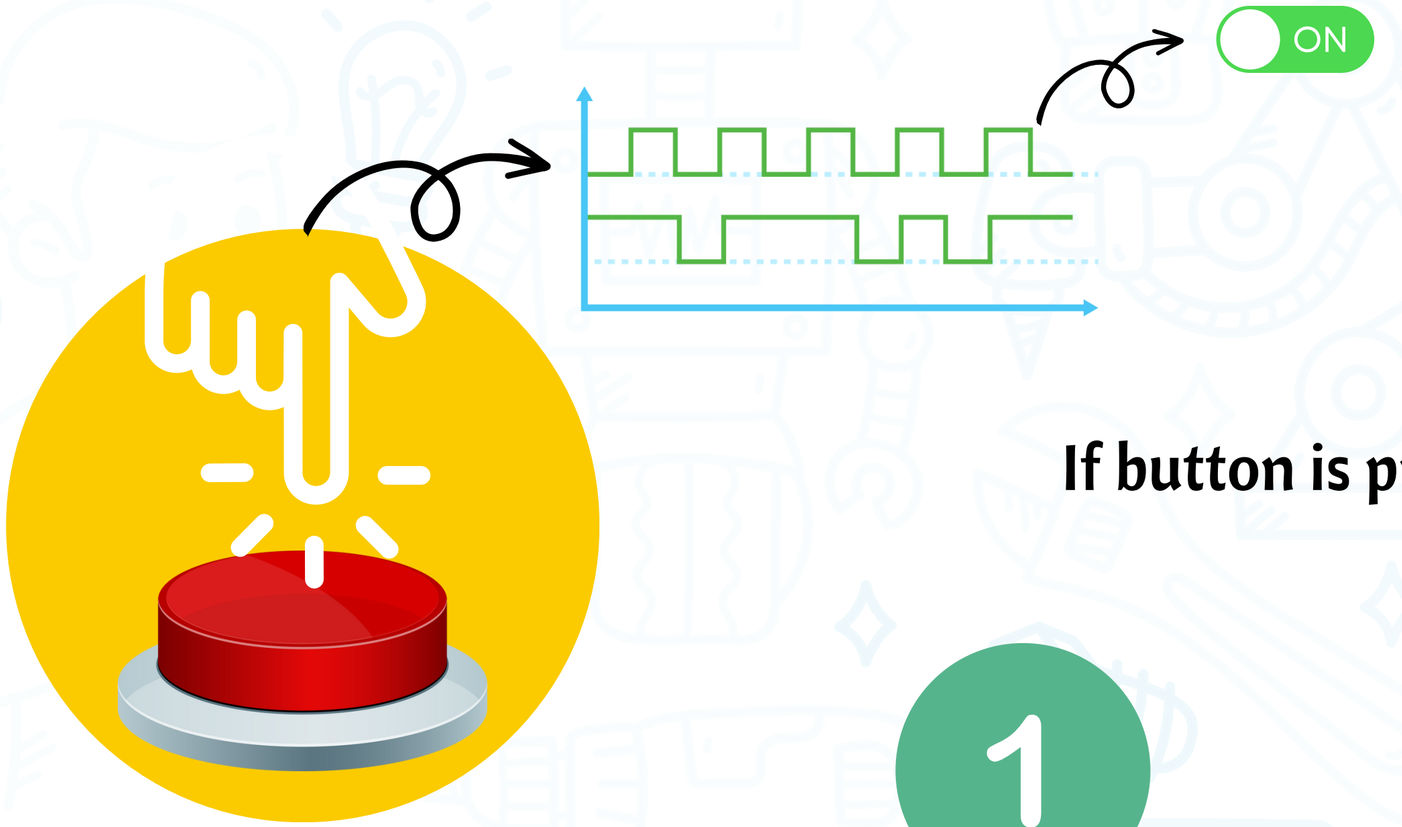
Digital input :



Digital signals are transmitted in the form of 1s and 0s, and it is entirely on or off there is no in-between.

signals

Digital input :

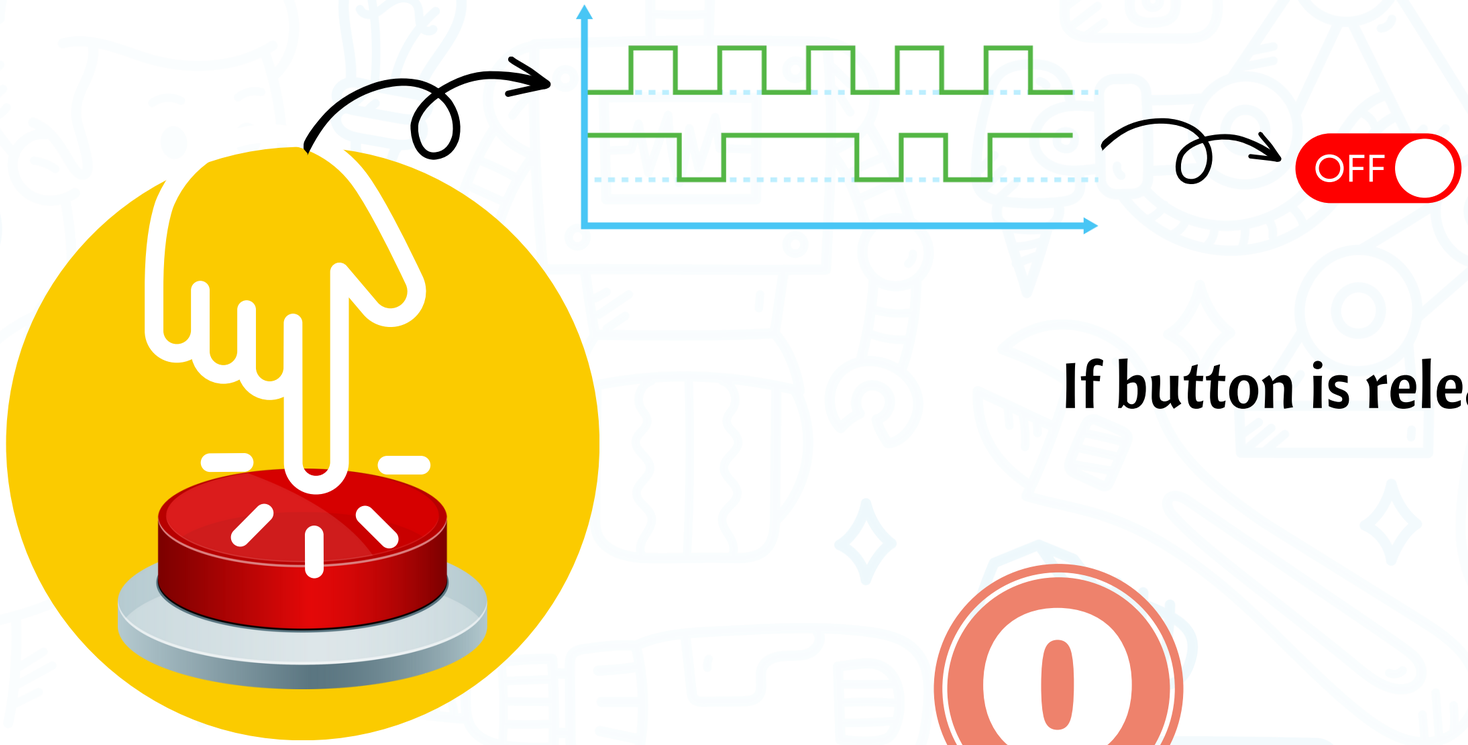


If button is pressed then its "high".

1

signals

Digital input :



If button is released then its "low".

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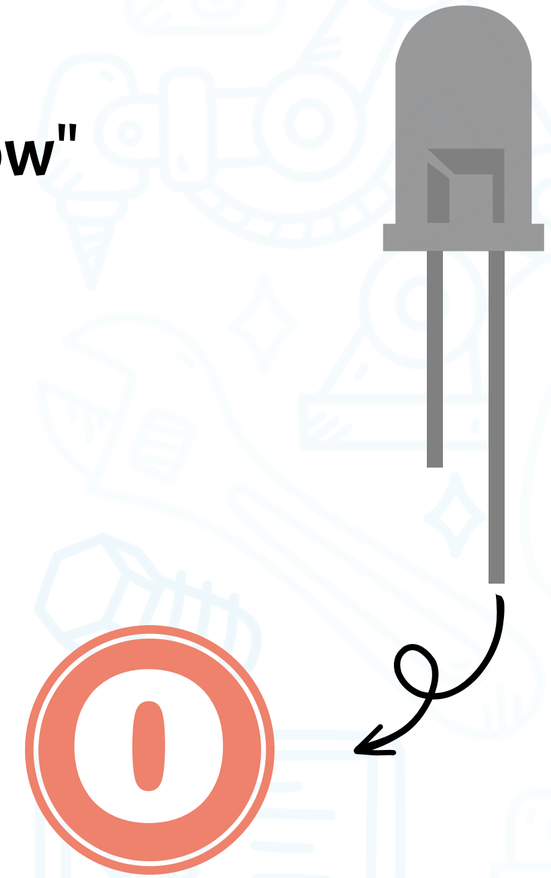
signals

Digital output :

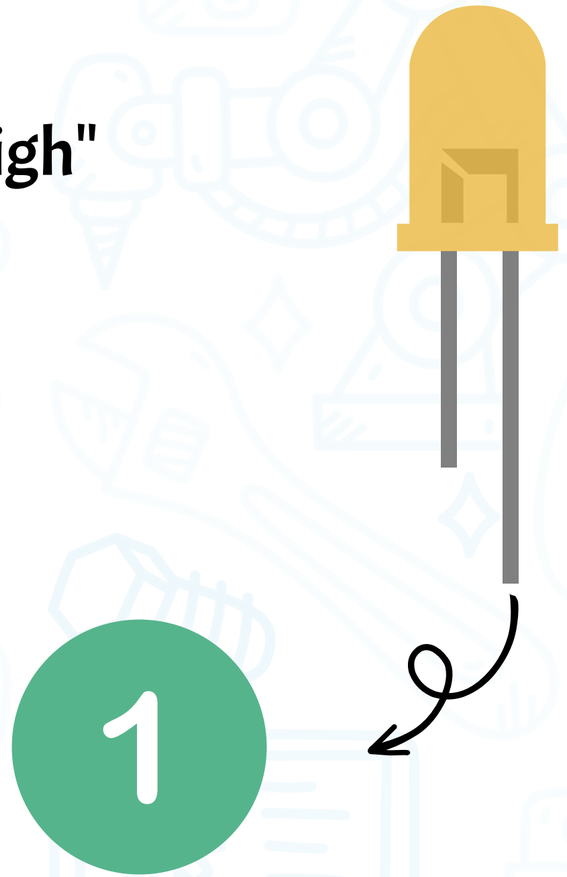
when the led light is off its digital "low"



signals

Digital output :

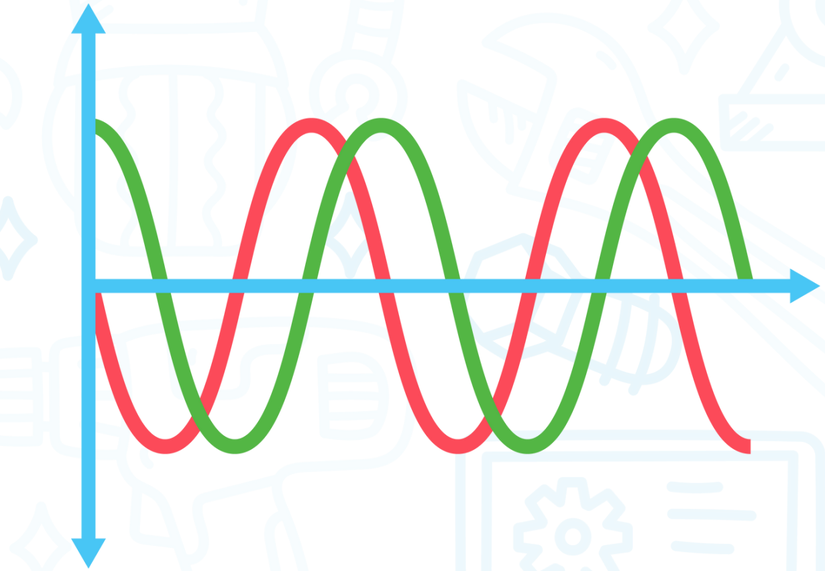
when the led light is on its digital "high"



Signals

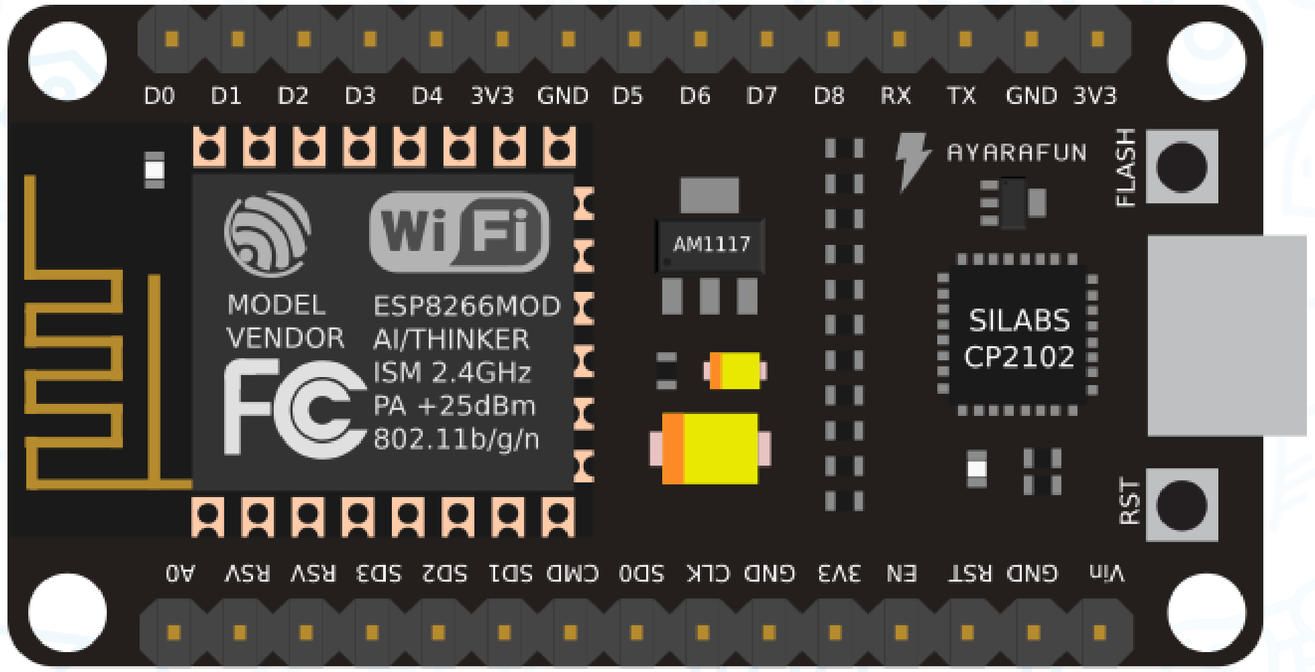
Digital vs Analog :

Analog signals are waves with a range of values and have gradual changes by time.



Remember

ESP8266: :



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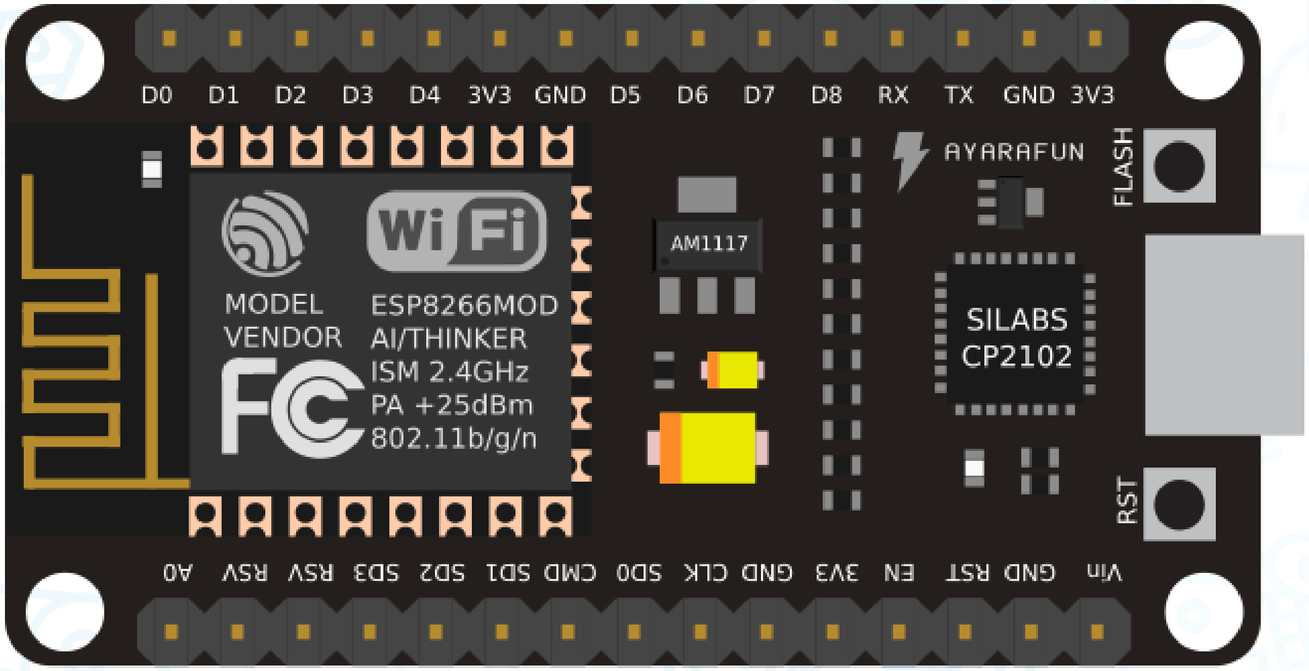
ESP8266

Analog signal :

It has only one analog input pin (A0)



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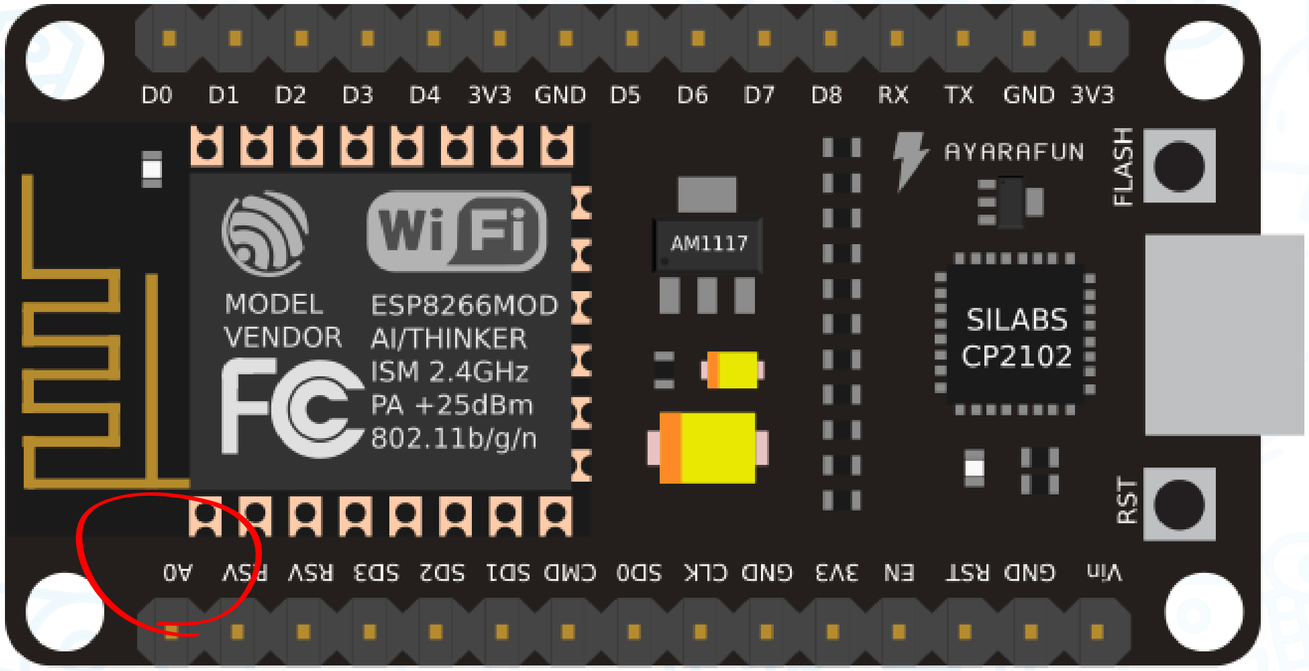
ESP8266

Analog signal :

It has only one analog input pin (A0)



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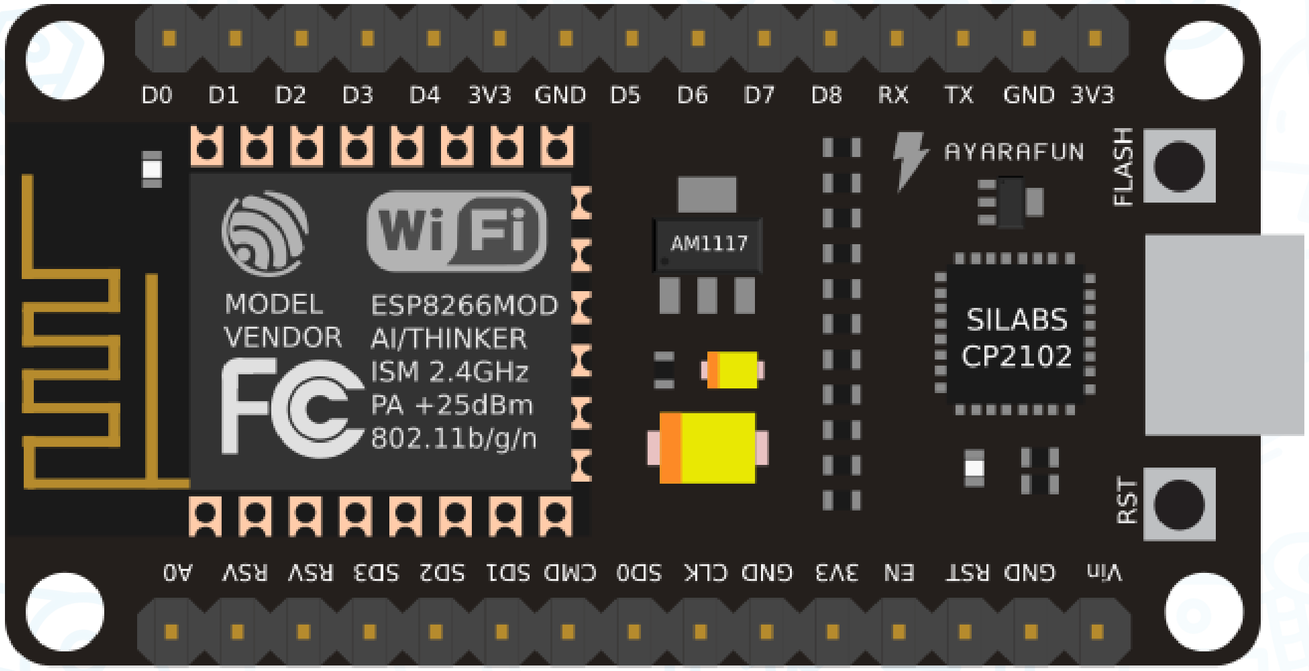
ESP8266

Analog signal :

It has 9 analog output pins (D0-D8)



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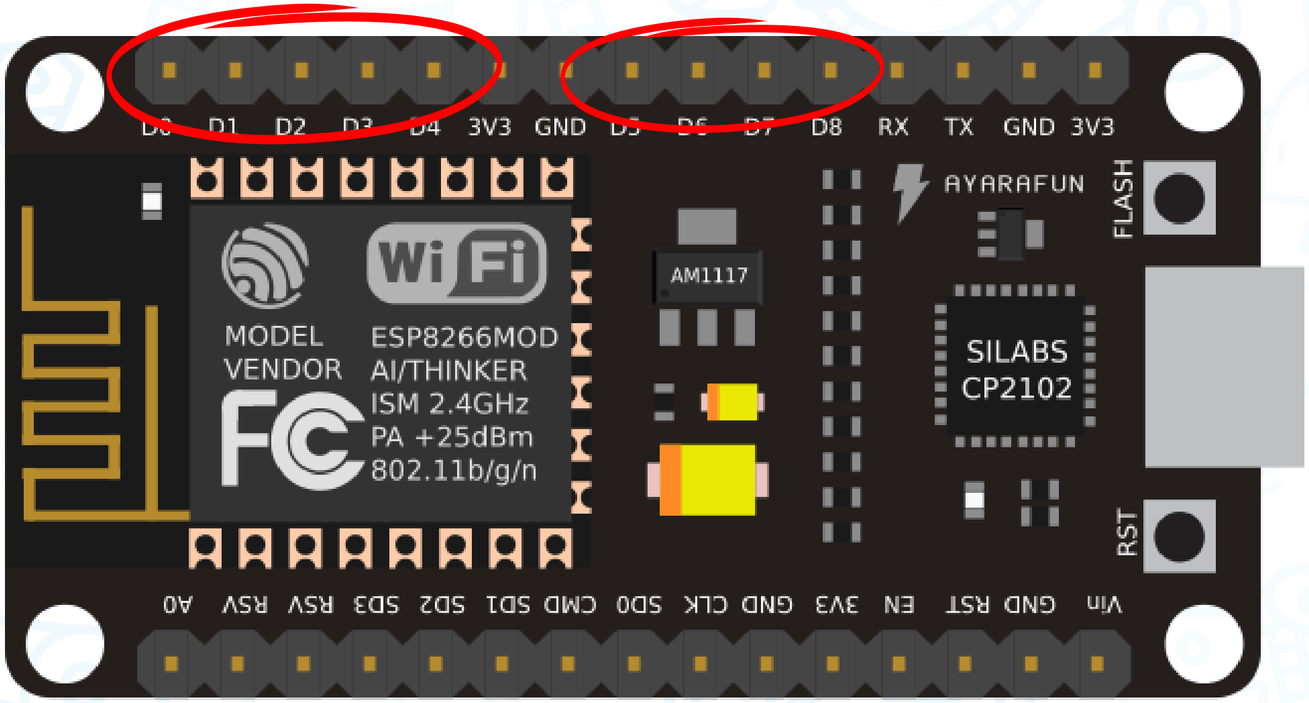
ESP8266

Analog signal :

It has 9 analog output pins (D0-D8)



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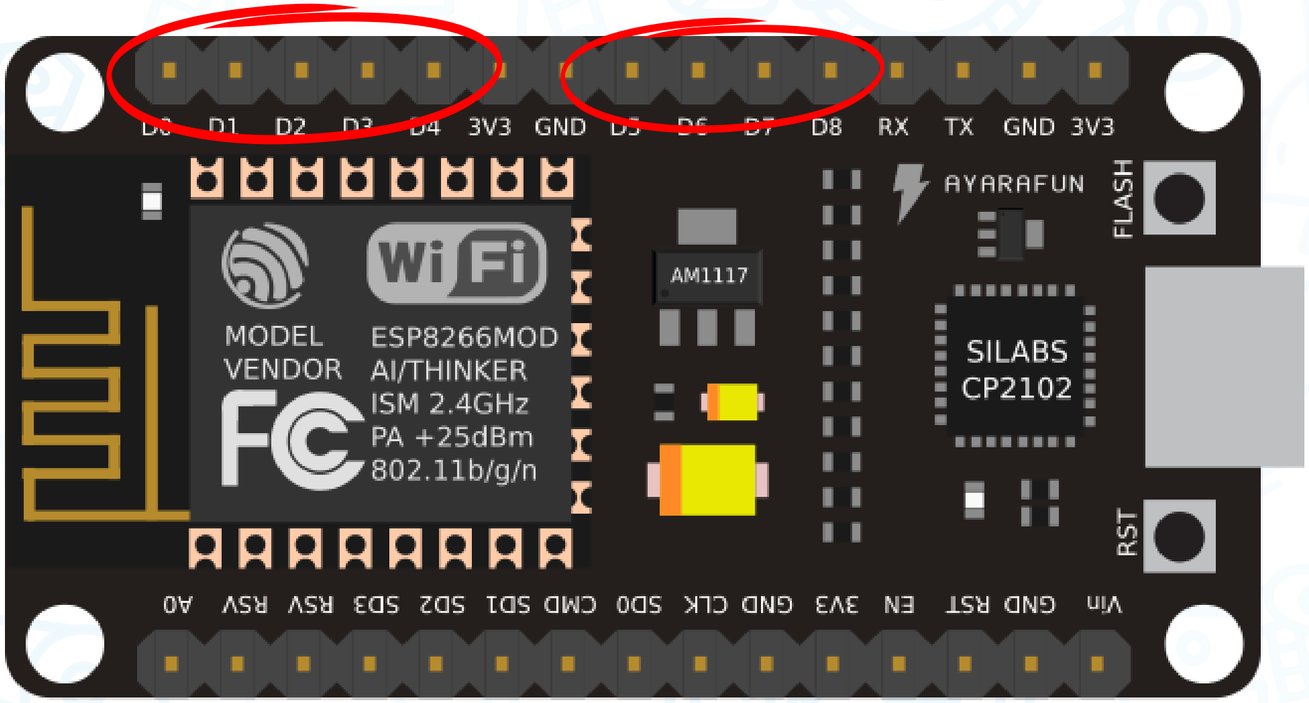
ESP8266

pins:

Those pins can be used as digital input ,digital output

and also analog output



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Think

How can we use the digital pins as analog output?

Analogy ≈

Imagine you have a faucet that can only be fully open or fully closed.

How can you control how much water comes out?

By turning the faucet on and off very quickly.

Analogy ≈

If you have to fill a bucket by turning the faucet on and off:

How can you get a small amount of water?

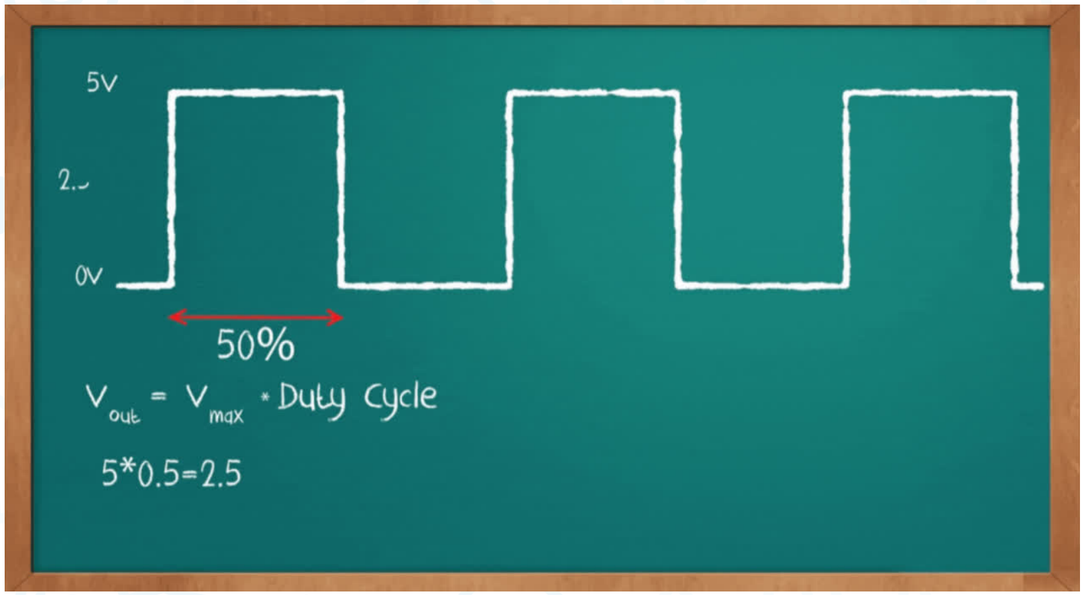
if you turn it on for a short time and then off for a long time.

How can you get a bigger amount?

If you turn the faucet on for a long time and then off for a short time, you will get more water.

Analogy ≈

The amount of water that comes out depends on how long the faucet is on compared to how long it is off. This is called the **duty cycle**.



Duty cycle

The duty cycle is like the brightness of an LED. If the LED is on for a long time and then off for a short time, it will be brighter than if it is on for a short time and then off for a long time.

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Think

If the switch is on for a long time and then off for a short time, the light bulb will be bright. If the switch is on for a short time and then off for a long time, the light bulb will be dim.

Can you see the flickering of the light?

Think

If the switch is on for a long time and then off for a short time, the light bulb will be bright. If the switch is on for a short time and then off for a long time, the light bulb will be dim.

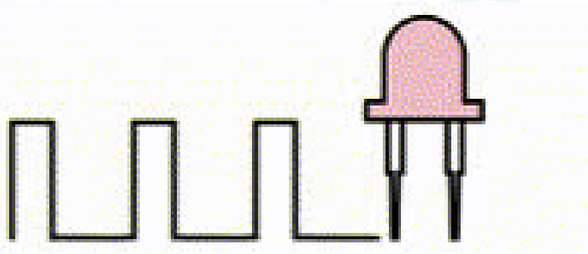
Can you see the flickering of the light?

The human eye cannot see the flickering of the light, but it can perceive the average brightness.

PWM

What does PWM stands for?

Pulse width modulation.



What is PWM?

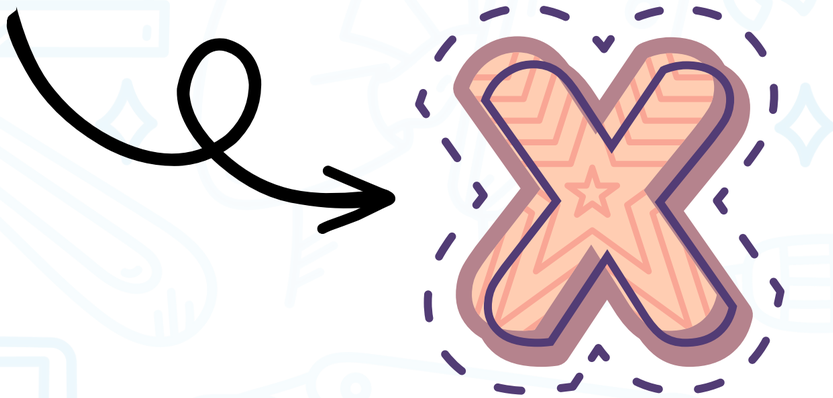
PWM is a way to control the amount of electricity that goes to a device by turning it on and off very quickly, like a water faucet.

Analog reading

code :

```
int x= analogRead(A0);
```

The value of the analog signal will be saved in the variable x



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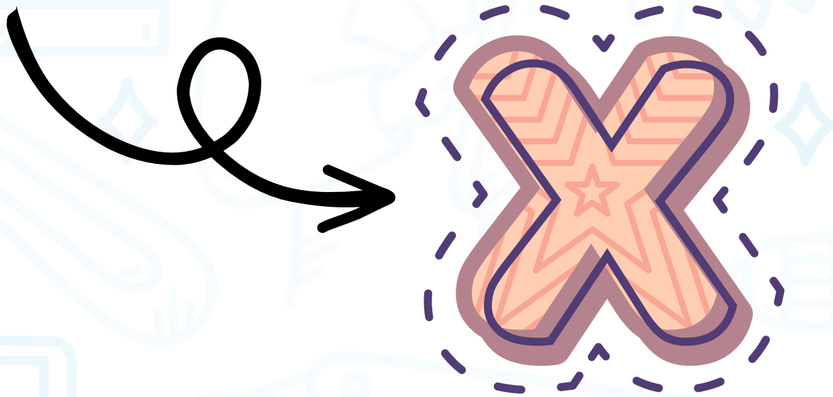
Analog reading

code :

```
int x= analogRead(A0);
```

The value of the analog signal will be saved in the variable x

The range of the values is between (0-1023)



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Analog reading

The maximum value for x is 1023:

If voltage is 3.3 v in ESP8266

If voltage is 5 v in arduino nano

The minimum value for x is 0:

If voltage is 0 v in ESP8266 and arduino nano

Think

what is the voltage in arduino and ESP8266 if x = 512?

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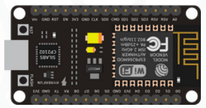
Think

what is the voltage in arduino and ESP8266 if x = 512?

If voltage is 3.3 v in ESP8266



If voltage is 5 v in arduino nano

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$\frac{1}{2}$ the max

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Serial monitor

what is a serial monitor?

Its the partition on the screen where you display and print outputs or send inputs

For example we can print a simple message:

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Serial monitor

Step 1:open the serial port:

```
void setup() {
Serial.begin(9600);
}
```

Data rate

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Serial monitor

Step 1:open the serial port:

```
void setup() {
Serial.begin(9600);
}
```

Data rate

Step 2:use Serial.print() to print a simple message:

```
void setup() {
Serial.begin(9600);
Serial.println("Hello world!");
}
```

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Serial monitor

Step 3:upload sketch:

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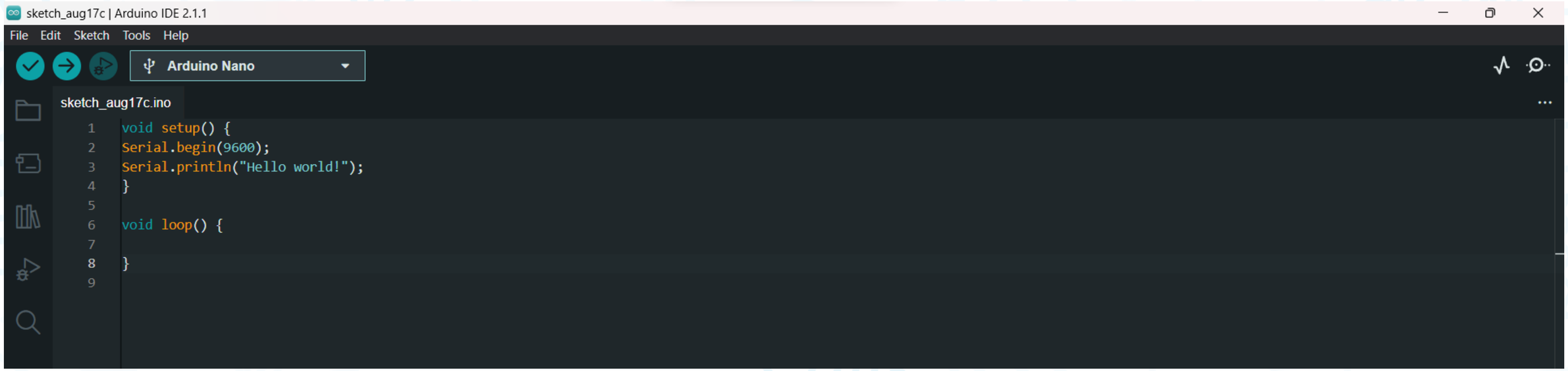
Serial monitor

Step 4:open the serial monitor:



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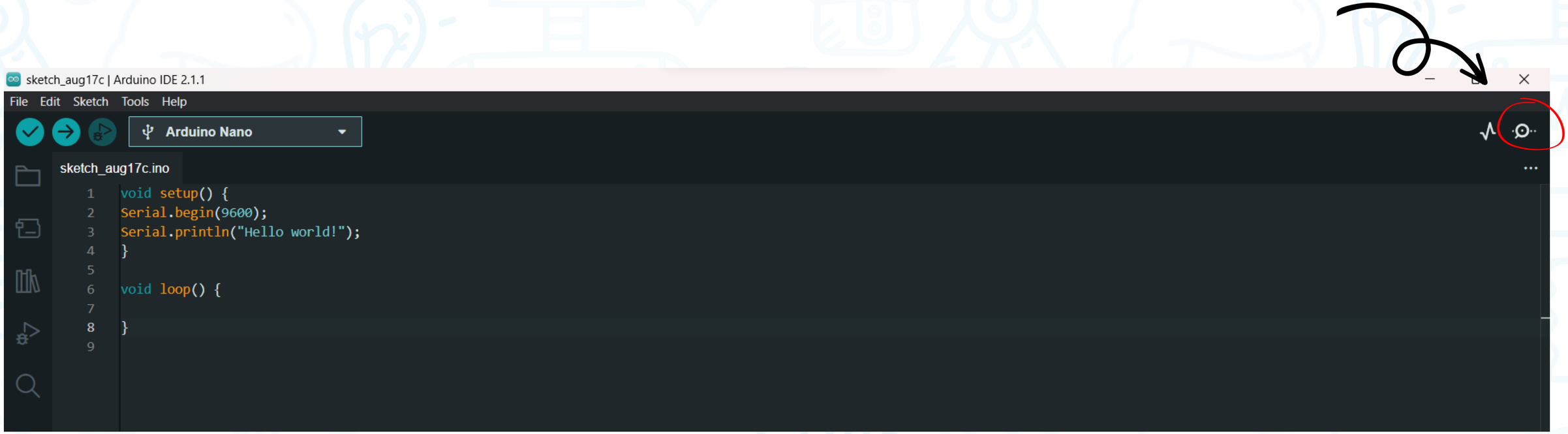
Serial monitor

Step 4:open the serial monitor:



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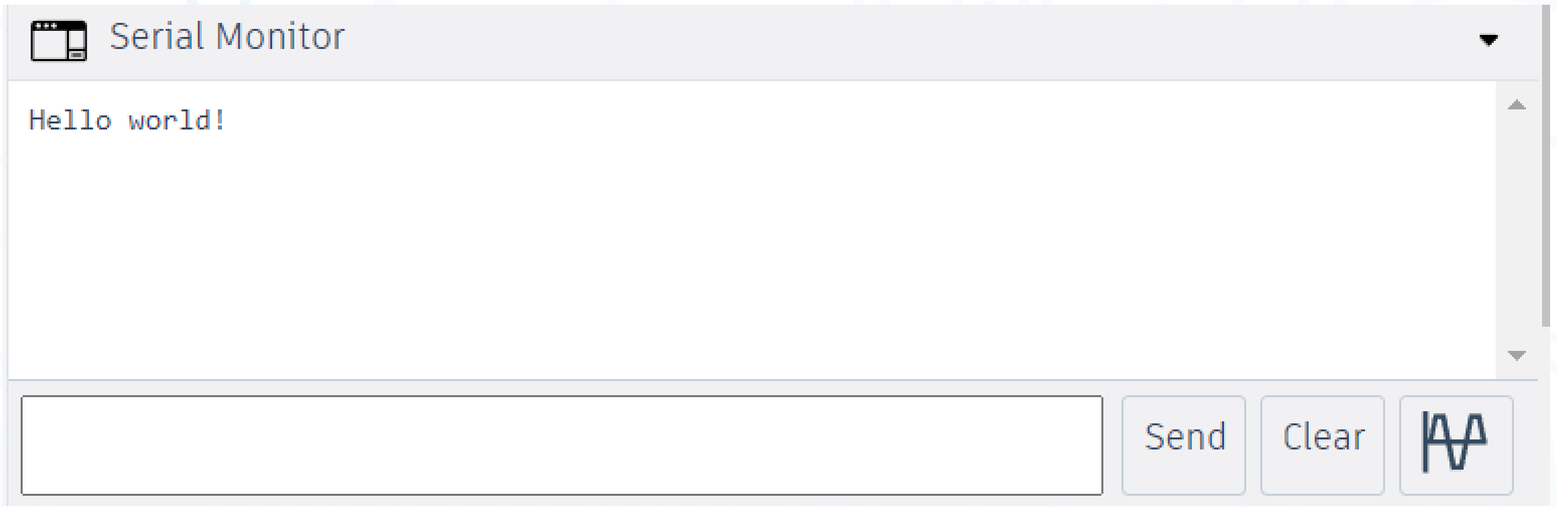
Serial monitor

Output:



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Serial monitor

Serial.print() vs Serial.println():

Try the 2 codes:

```
void setup() {
Serial.begin(9600);
}
void loop() {
Serial.print("Hello world!");
delay(1000);
}
```

VS

```
void setup() {
Serial.begin(9600);
}
void loop() {
Serial.println("Hello world!");
delay(1000);
}
```

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Observe

What did you notice?

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Serial monitor

Serial.print() vs Serial.println():

Try the 2 codes:

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VS

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void setup() {
Serial.begin(9600);
}
void loop() {
Serial.println("Hello world!");
delay(1000);
}
```

Serial Monitor

```
Hello world!Hello world!Hello world!Hello world!Hello world
```

Serial Monitor

```
Hello world!
Hello world!
Hello world!
Hello world!
Hello world!
Hello world!
```

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Serial monitor

Serial.print() vs Serial.println():

Try the 2 codes:

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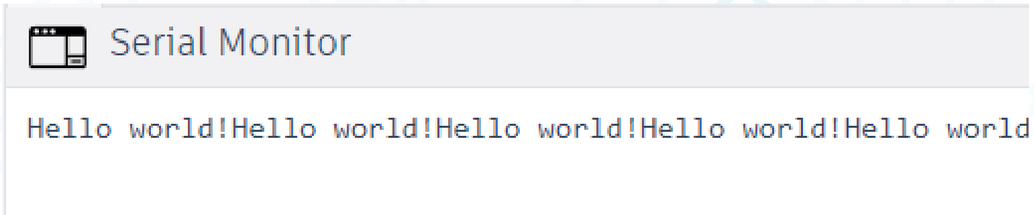

It prints output without starting a new line

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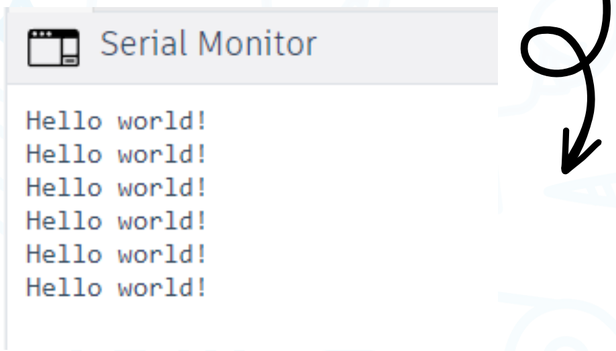
Serial monitor

Serial.print() vs Serial.println():

Try the 2 codes:

```
void setup() {
Serial.begin(9600);
}
void loop() {
Serial.println("Hello world!");
delay(1000);
}
```

It prints output and starts a new line



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Serial monitor

you can print variables:

```
void setup() {
Serial.begin(9600);
int x=45;
Serial.print(x);
}
void loop() {

}
```

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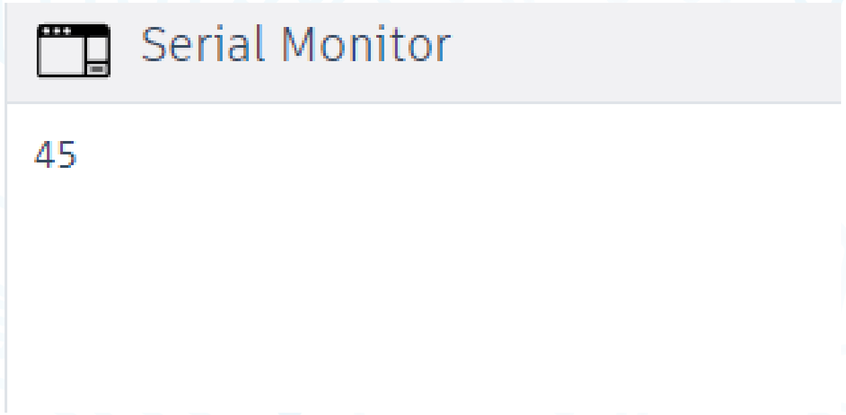
Serial monitor

you can print variables:

```
void setup() {
Serial.begin(9600);
int x=45;
Serial.print(x);
}
void loop() {

}
```



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Serial monitor

Exercise: Try to print numbers from 0 to 9 and then resets and starts over at 9:

Serial monitor

Exercise: Try to print numbers from 0 to 9 and then resets and starts over at 9:

Step 1: setup the serial monitor and initialize a variable to print in the loop:

```
void setup() {
Serial.begin(9600);
}

int x=0;
```

Serial monitor

Exercise: Try to print numbers from 0 to 9 and then resets and starts over at 9:

Step 2: In the loop print the variable and then increase it by one:

```
void setup() {
Serial.begin(9600);
}

int x=0;

void loop() {
Serial.println(x);
x+=1;
```

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Serial monitor

Exercise: Try to print numbers from 0 to 9 and then resets and starts over at 9:

Step 3: If the variable exceeds 9 we reset it to zero

```
void setup() {
Serial.begin(9600);
}

int x=0;

void loop() {
Serial.println(x);
x+=1;

if (x==10){
    x=0;}
```

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Serial monitor

Exercise: Try to print numbers from 0 to 9 and then resets and starts over at 9:

Step 4: we add a 1 second delay to observe easily:

```
void setup() {
Serial.begin(9600);
}

int x=0;

void loop() {
Serial.println(x);
x+=1;

if (x==10){
    x=0;}

delay(1000);
}
```

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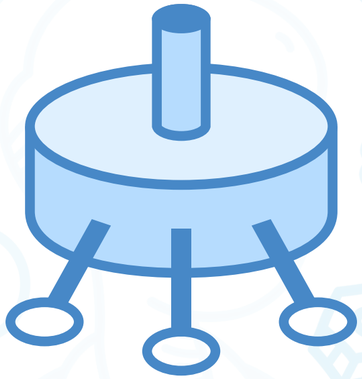
potentiometer

what is the potentiometer?

Its a variable resistance that can be changed manually,it has no polarity and is a good example for analog input



potentiometer

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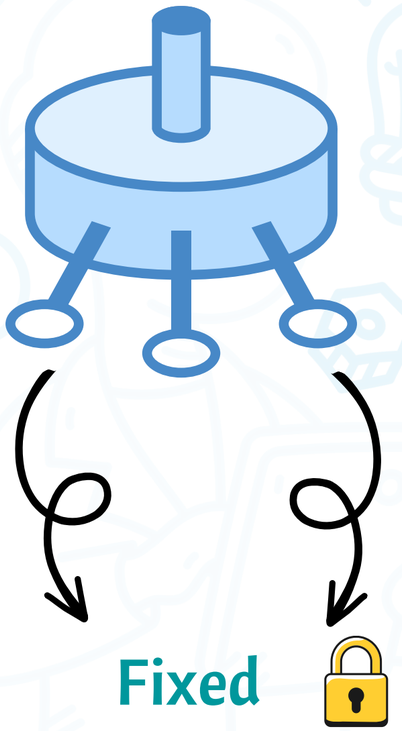
How does it work?

It has three terminals, the first and third resistances are fixed



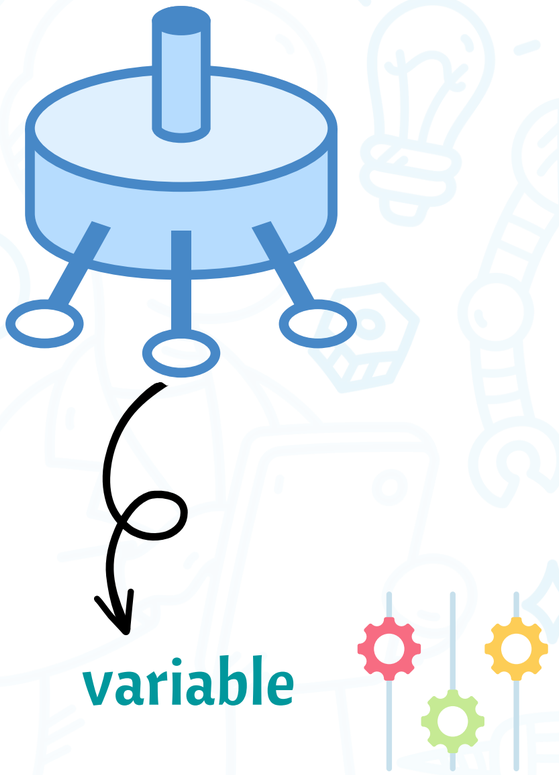
potentiometer

what is the potentiometer?

Its a variable resistance that can be changed manually,it has no polarity and is a good example for analog input

How does it work?

It has three terminals, the first and third resistances are fixed and the middle one is variable



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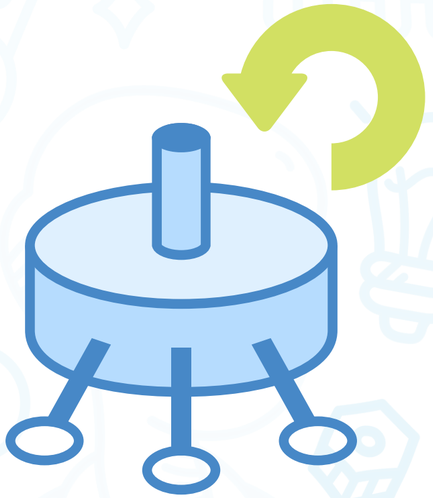


How does it work?

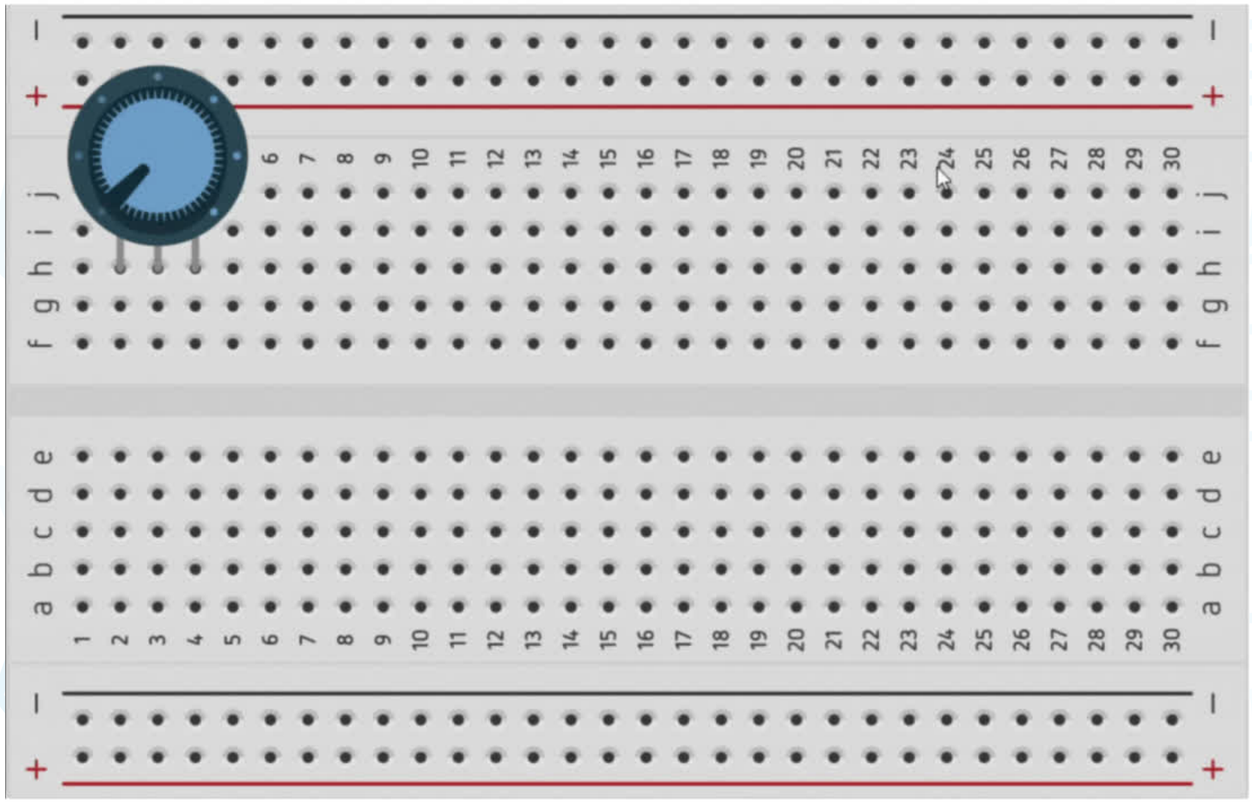
It has three terminals, the first and third resistances are fixed and the middle one is variable

when the knob is turned the resistance between the middle terminal and the other two terminals changes it decreases in the direction of rotation

potentiometer

Use it as a voltage divider:

Connect the left pin to -ve and
connect the right in to +ve the middle pin
will be variable



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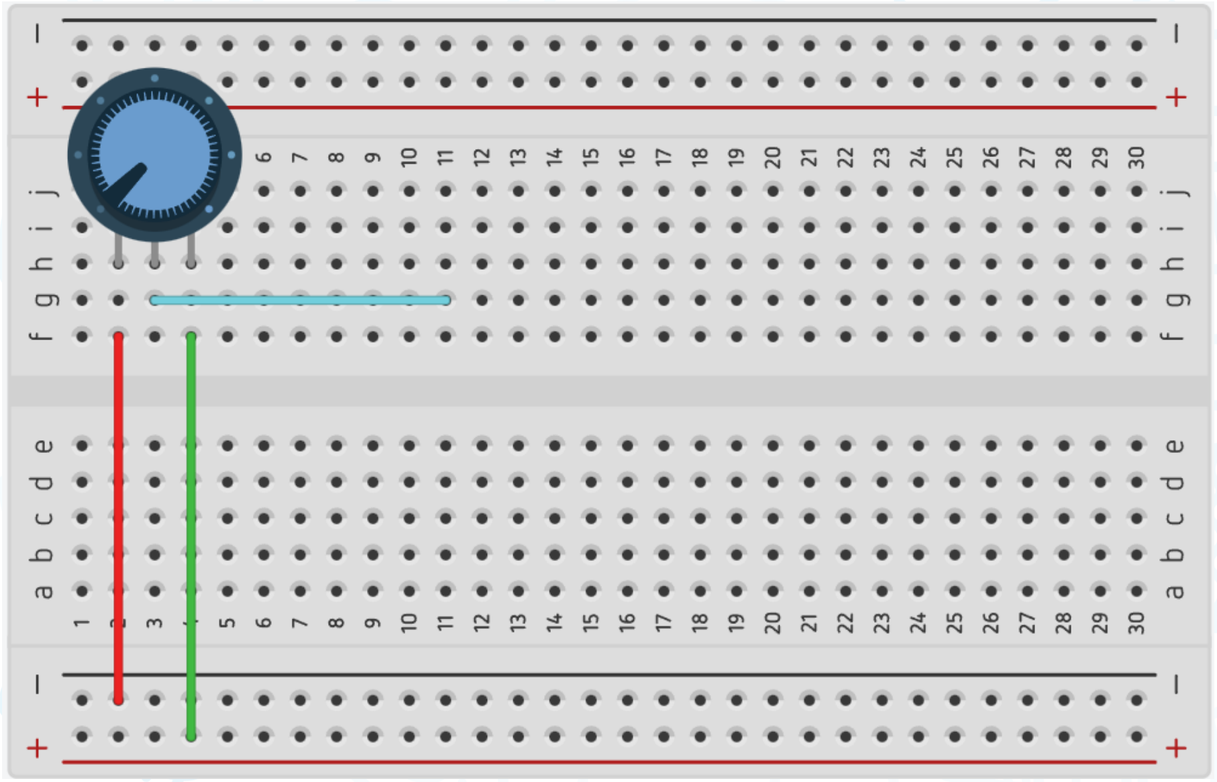
potentiometer

Use it as a voltage divider:

Connect the left pin to -ve and
connect the right in to +ve the middle pin
will be variable

When you turn the knob towards
the +ve pin the middle pin voltage will increase



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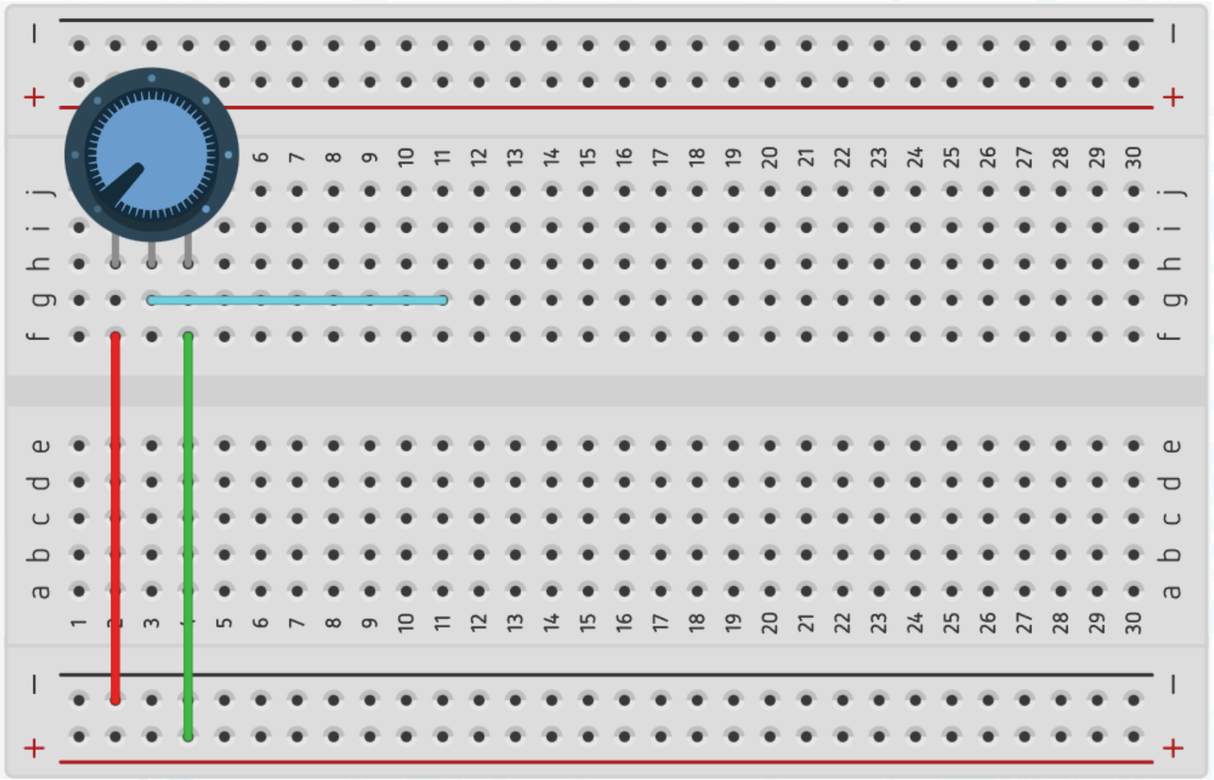
potentiometer

Use it as a voltage divider:

Connect the left pin to -ve and
connect the right in to +ve the middle pin
will be variable

When you turn the knob towards
the +ve pin the middle pin voltage will increase

If you turn the knob toward the -ve pin
the middle pin voltage will decrease



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Let's display Analog reading from the potentiometer

START

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potentiometer

Step 1: setup the serial monitor and get the analog reading :

```
void setup() {
  Serial.begin(9600);
}

void loop() {
  int analogValue = analogRead(potentiometerPin);
```

potentiometer

Step 2: print it using Serial.print() :

```
void setup() {
  Serial.begin(9600);
}

void loop() {
  int analogValue = analogRead(potentiometerPin);

  Serial.print("Analog Reading: ");
  Serial.println(analogValue);
  delay(100);
}
```

0.1 second delay to observe easily

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ENTERTAINMENT MEETS EDUCATION

Let's do the same but display it in ranges HIGH,MEDIUM,LOW

START

potentiometer

Step 3: put an if conditional to print the correct range according to the value:

```
void setup() {
  Serial.begin(9600);
}

void loop() {

  int analogValue = analogRead(potentiometerPin);

  Serial.print("Analog Reading: ");
  Serial.println(analogValue);

  if (analogValue < 350) {
    Serial.println("State: LOW");
  } else if (analogValue >= 350 && analogValue <= 800) {
    Serial.println("State: MEDIUM");
  } else {
    Serial.println("State: HIGH");
  }

  delay(100);
}
```