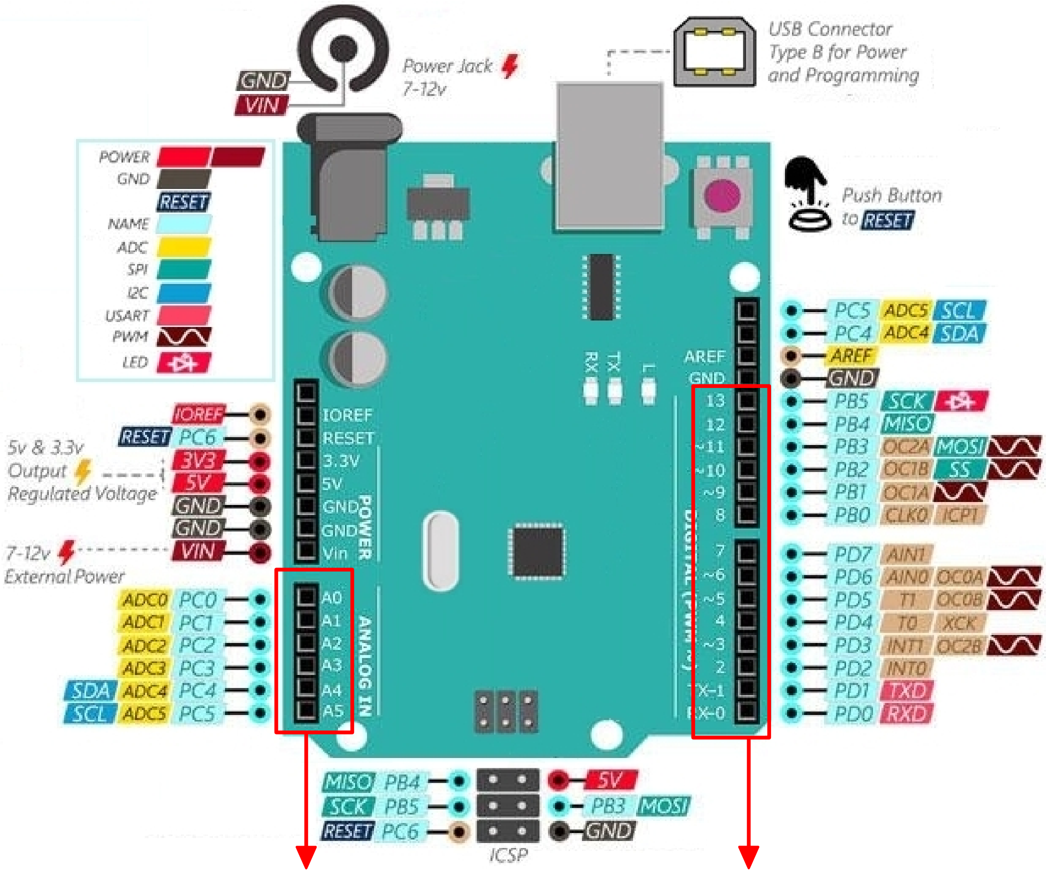
STEMKRAF - TUTORIAL - PARTS - INPUT/OUPUT PINS

https://github.com/teaksoon/stemkraf



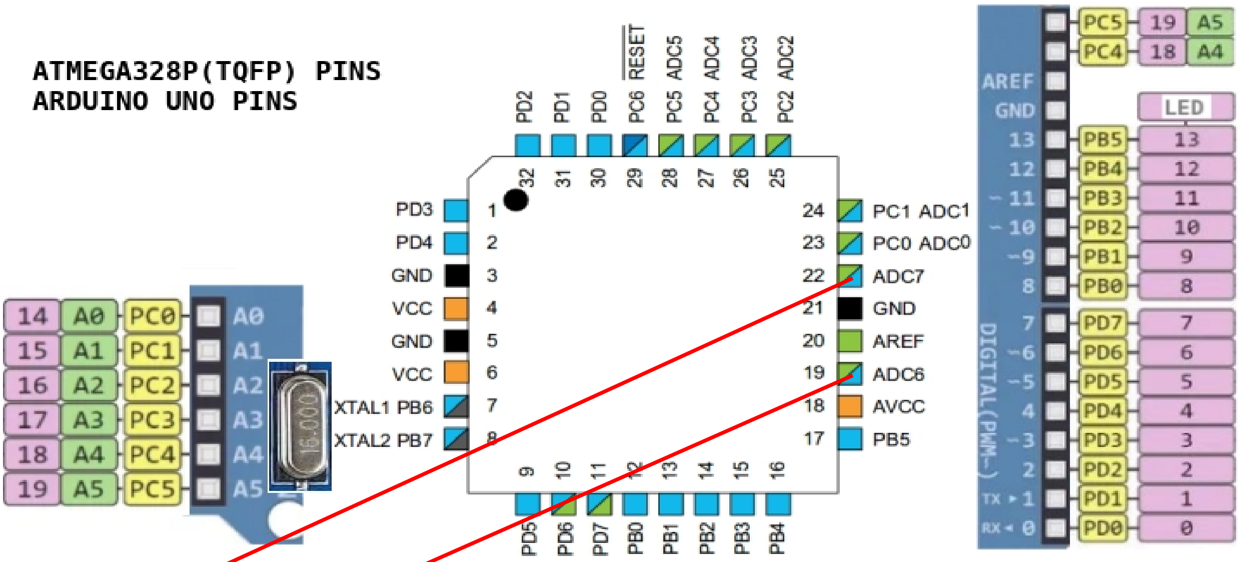
Pin 0 to 13, Pin A0 to A5 are also dealing with Voltage. Unlike the Vin, 5V, 3.3V Pin fixed behaviour, the behaviour of Pin 0 to 13, Pin A0 to A5 can be programmed and controlled by us.

- **The I/O Pins can Receive Power from External Source (INPUT PIN)**

- **The I/O Pins can Supply Power to External Device (OUTPUT PIN)**

Bulk of the micro-controller programming is about
- Reading the Voltage on the INPUT
- Changing the Voltage on OUTPUT pins

ATMEGA328P(TQFP) PINS
ARDUINO UNO PINS



There are another 2 Analog Pin from the atmega328 that is not used in Arduino Uno board, ADC7 and ADC6 (they are available on the Arduino Nano board). If you must use them from the Arduino Uno board, you can physically solder a connection to those pin

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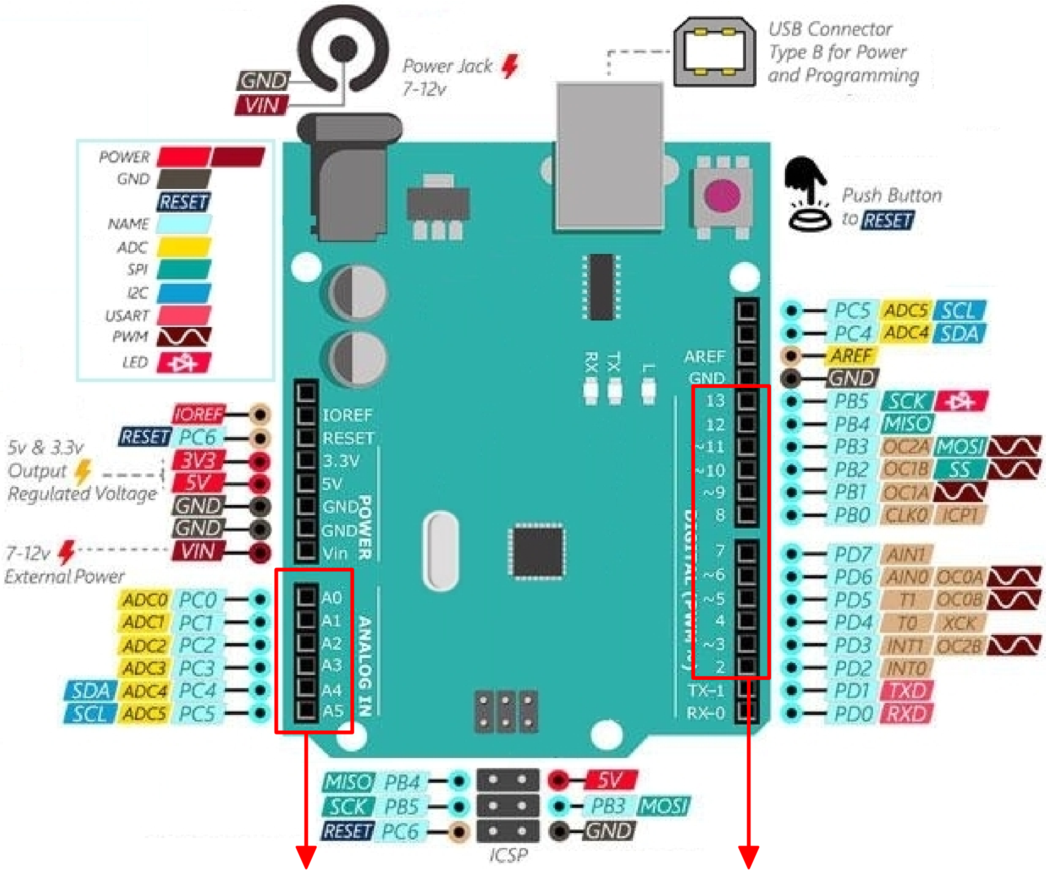

INPUT PIN (receive power from connected device)

We can make pin INPUT PIN, we need to programm the following code into our micro-controller

pinMode(pin, INPUT);

Note: however this is optional because INPUT is the default for all the Pins.

When the pin is set as INPUT PIN, we can use 2 Arduino functions to read the Voltage that is currently received by this Pin

- digitalRead() function
- analogRead() function

- digitalRead() function

This function only works with all the Pins (1 to 13, A0 to A5)

When we code **digitalRead(pin);**
- if the Voltage on the pin is 5V or very near to 5V, the function will give us the value of HIGH or 1
- if the Voltage on the pin is 0V or very near to 0V, the function will give us the value of LOW or 0

- analogRead() function

This function only works with the Analog Pins (A0 to A5)

When we code **analogRead(pin);**
- We will get the actual Voltage on the pin, represented by a 10-bit numbering system (0 to 1023), meaning

- if the voltage on the pin is 5V, we will get 1023
- if the voltage on the pin is 0V, we will get 0

if the voltage is nV, we will get (n/5) x 1023

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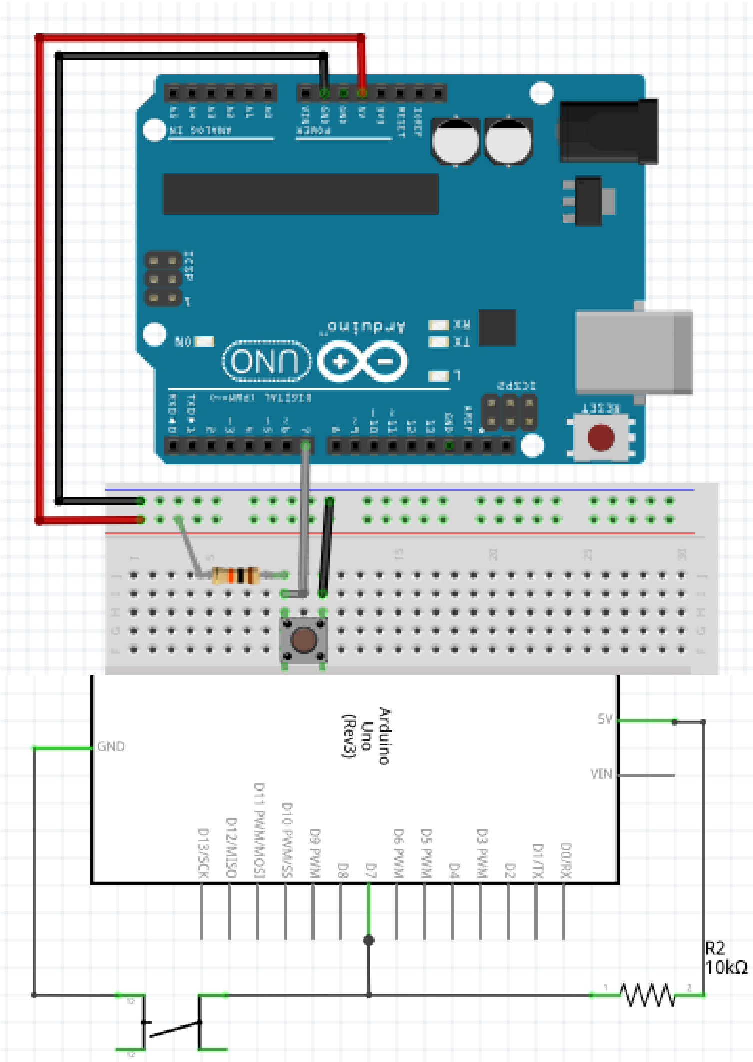
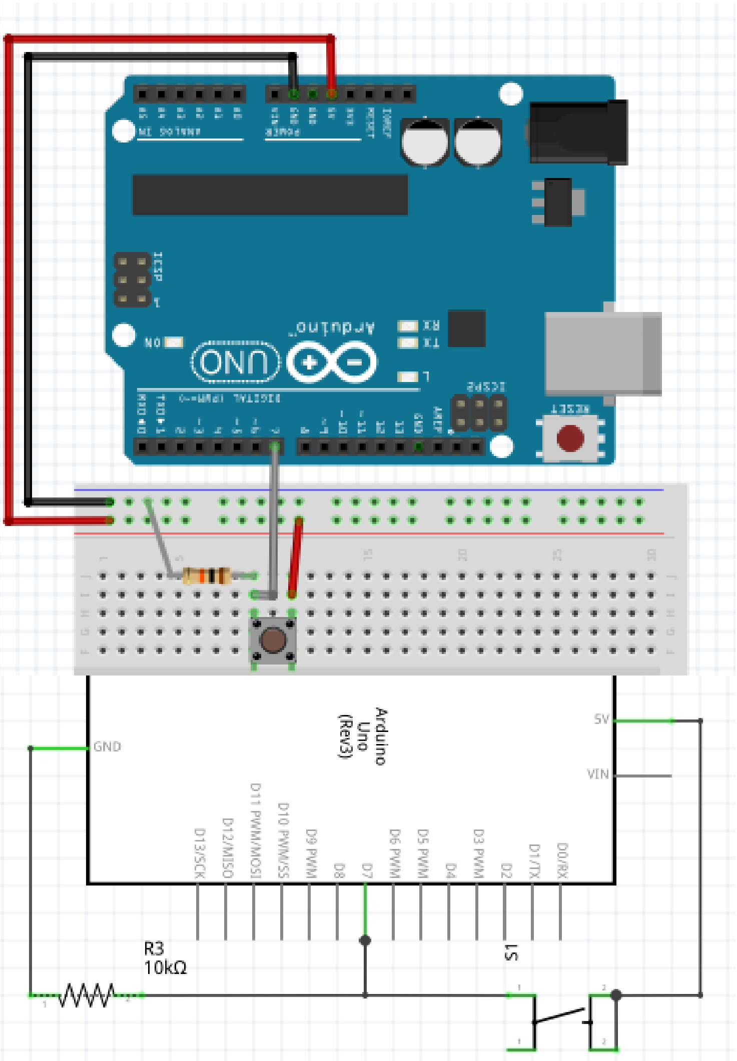


Circuit Type 1:

Tactile Button is **RELEASED**
– 5V going to Pin 7

Button is **PRESSED/HELD-DOWN**
– 0V going to Pin 7



Circuit Type 2:

Tactile Button is **RELEASED**
– 0V going to Pin 7

Button is **PRESSED/HELD DOWN**
– 5V going to Pin 7

These are physical electrical circuit, connecting and disconnecting 5V from the Arduino Uno board to the digital Pin 7.

The digitalRead() function will tell us whether digital Pin 7 has HIGH(5V) or LOW(0V). This reading will tell us whether the Button is pressed or released. digitalRead() can work for all the Pins (Pin 0 to 13, A0 to A5)

The analogRead() function however, can only read from the Analog Pins(A0 to A5). Usage is similar to digitalRead() where it will read a Pin for Voltage. Instead of HIGH and LOW, analogRead() gives us a range of values (0 to 1023)

Why do we need a Resistor ?

Without a resistor, we will get alot of “electrical noise” on the pin, we may get wierd results when reading Voltage from the Pin. Any resistor above 1Kohm should be enough to filter the noise for the tactile switch

STEMKRAF – TUTORIAL PARTS

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```
Program: tp04A_inputpin_digitalread_7
   (1/1): input pin, digitalread Pin 7
        :
        : by TeakSoon Ding for STEMKRAF (OCT-2021)
```

```
void setup() {
  pinMode(7, INPUT);
  Serial.begin(9600);
}
void loop() {
  Serial.print("\ndigitalRead(7) = "); Serial.print(digitalRead(7));
}
```

- Upload the program above with the Arduino IDE Software
- Open up the Serial Monitor from the Arduino IDE Software
- Press and hold-down the tactile button and see the Serial Monitor Screen
- Release the tactile button and see the Serial Monitor Screen

STEMKRAF – TUTORIAL PARTS

https://github.com/teaksoon/stemkraf

```
Program: tp04B_inputpin_digitalread_A0
   (1/1): input pin, digitalread Pin A0
        :
        : by TeakSoon Ding for STEMKRAF (OCT-2021)
```

```
void setup() {
  pinMode(A0, INPUT);
  Serial.begin(9600);
}
void loop() {
  Serial.print("\ndigitalRead(A0) = "); Serial.print(digitalRead(A0));
}
```

- Upload the program above with the Arduino IDE Software
- Open up the Serial Monitor from the Arduino IDE Software
- Press and hold-down the tactile button and see the Serial Monitor Screen
- Release the tactile button and see the Serial Monitor Screen

STEMKRAF – TUTORIAL PARTS

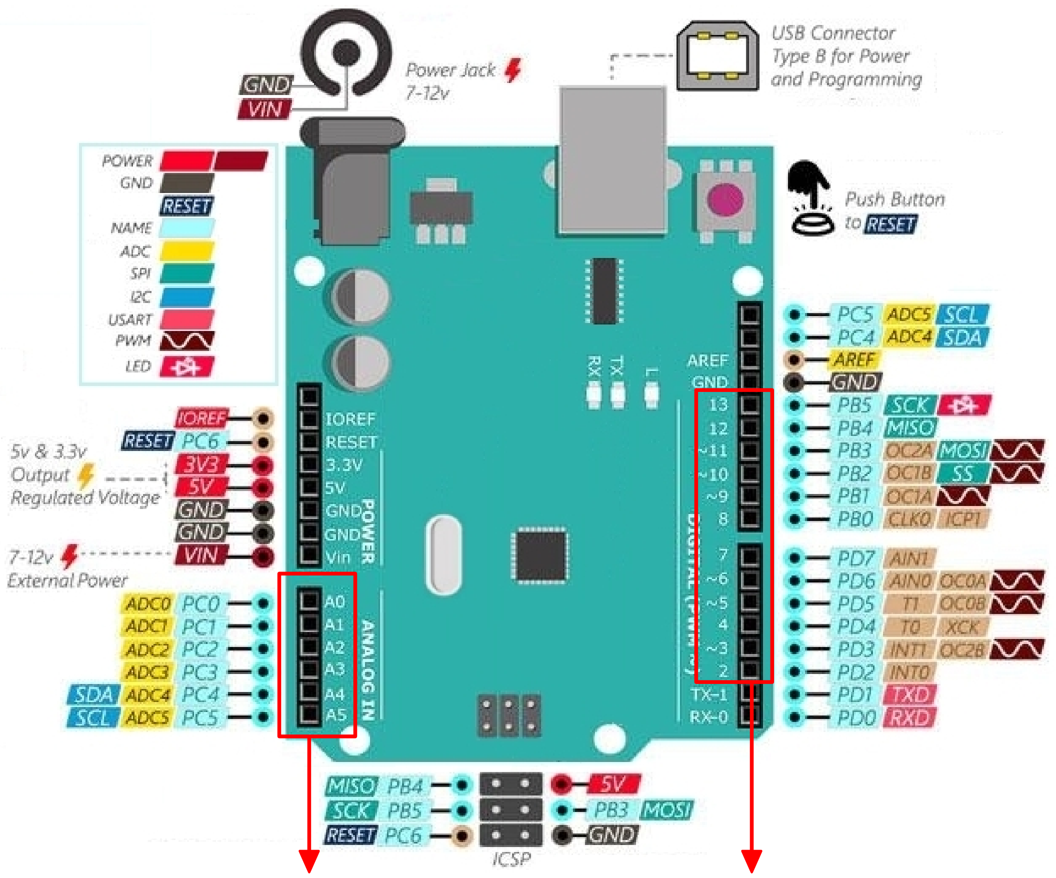
https://github.com/teaksoon/stemkraf

```
Program: tp04C_inputpin_analogread_A0
   (1/1): input pin, analogread Pin A0
        :
        : by TeakSoon Ding for STEMKRAF (OCT-2021)
```

```
void setup() {
  pinMode(A0, INPUT);
  Serial.begin(9600);
}
void loop() {
  Serial.print("\nanalogRead(A0) = "); Serial.print(analogRead(A0));
}
```

- Upload the program above with the Arduino IDE Software
- Open up the Serial Monitor from the Arduino IDE Software
- Press and hold-down the tactile button and see the Serial Monitor Screen
- Release the tactile button and see the Serial Monitor Screen

STEMKRAF - TUTORIAL - PARTS - OUTPUT PINS
https://github.com/teaksoon/stemkraf



OUTPUT PIN (supply power to connected device)

We can make pin INPUT PIN, we need to programm the following code into our micro-controller

```
pinMode(pin, OUTPUT);
```

When the pin set as OUTPUT PIN, we can use 2 Arduino functions to control how much Voltage this pin will supply to the connected device.

- **digitalWrite() function**
- **analogWrite() function**

- digitalWrite() function

1. When we code digitalWrite(pin, HIGH), pin will supply 5V to whatever device connected to it.

2. When we code digitalWrite(pin, LOW), pin will supply 0V to whatever device connected to it.

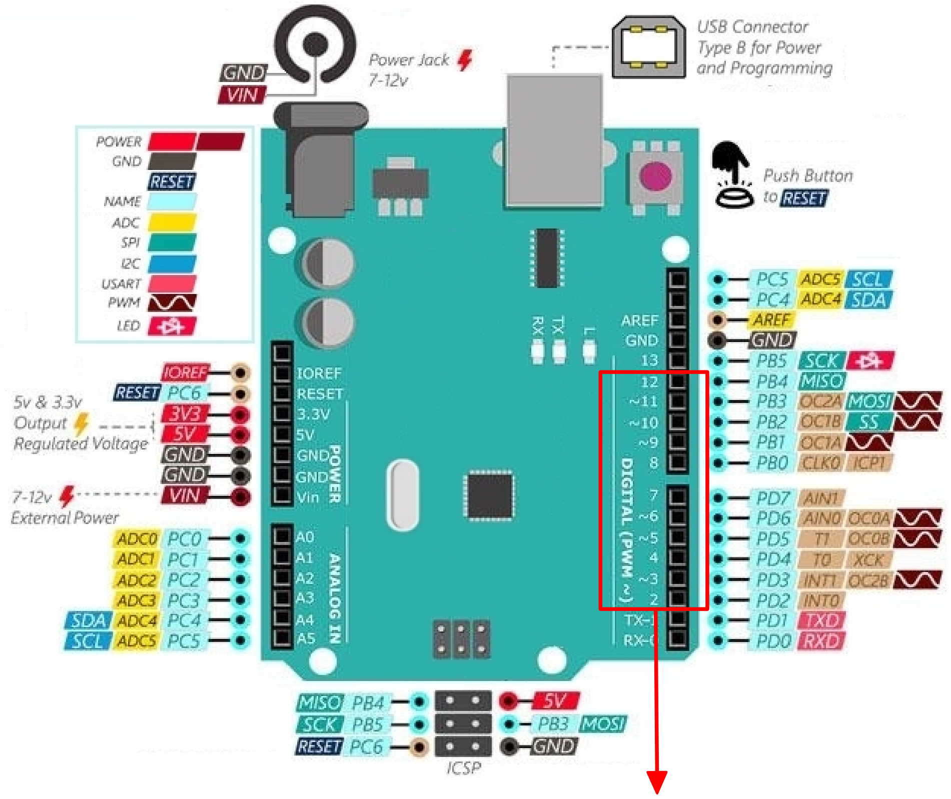
- analogWrite() function

This function only works with the PWM Digital pins, on Arduino board they are labeled with the **~** symbol, on Arduino pin 3,5,6,9,10 and 11.

NOTE:
analogWrite() function has nothing to do with the physical Arduino Analog Pins, A0 to A5. This function should be called “pwmWrite” instead.

What analogWrite(pin,value) does is, based on the specified value, it runs a series of digitalWrite(pin,HIGH) and digitalWrite(pin,LOW) in various combinatons to create a PWM voltage effect on the connected Device (more on PWM-Pulse Wave Modulation in the next slide)

STEMKRAF - TUTORIAL - PARTS - OUTPUT PINS - PWM
https://github.com/teaksoon/stemkraf



PWM - Pulse Wave Modulation

PWM is the process of alternating between HIGH and LOW. It is actually a series of “digitalWrite()”. On Arduino Uno, PWM pins are labelled with ~ symbol, Arduino pin 3,5,6,9,10 and 11.

PWM Pins will only work when set as OUTPUT mode.

pinMode(pin, OUTPUT);

analogWrite(pin,value);
value = 0 to 255 (Binary 00000000 to 11111111 since it is stored in an 8-bit memory). Although the name is “analogWrite”, it has nothing to do with Analog Pins. It is actually for digital PWM Pins, it cannot work on Arduino Analog Pins

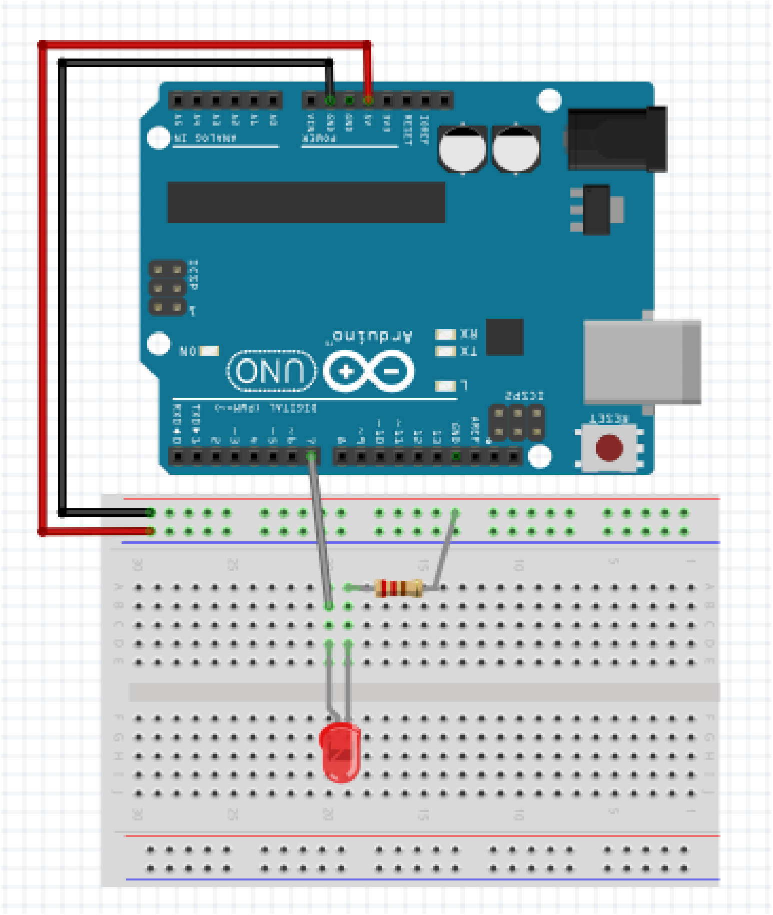
1. analogWrite(pin,255);
We make the pin HIGH, continue making it HIGH, it is called 100% duty cycle Meaning, the pin provide 5V,5V,5V,... to the device connected to this pin. The connected device will get a “constant 5V” power supply

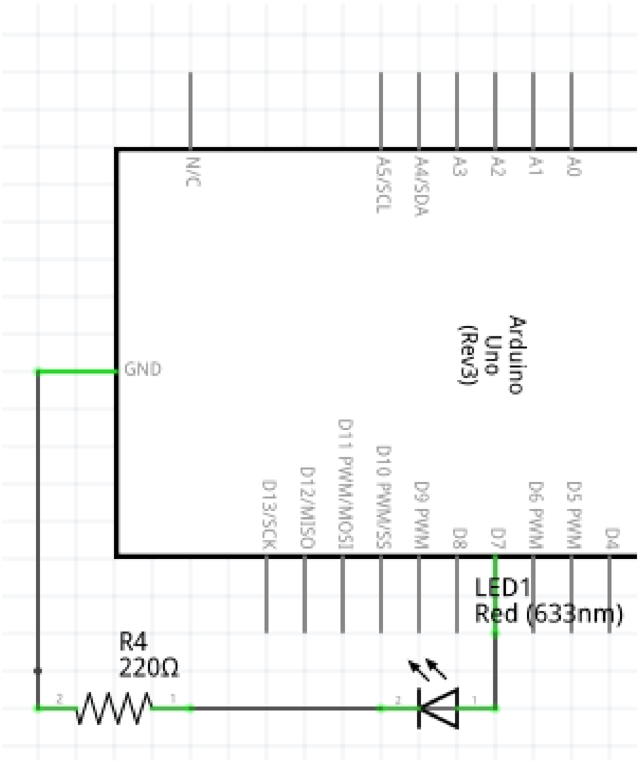
2. analogWrite(pin,0);
We make the pin LOW, continue making it LOW, it is called 0% duty cycle Meaning, the pin provide 0V,0V,0V,... to the device connected to this pin. The connected device will get a “constant 0V” power supply

3. analogWrite(pin,127); // this is between 0 and 255
We issue “HIGH, LOW”, and repeats that combination, it is called 50% duty cycle. Meaning, the pin provide 5V,0V,5V,0V,... to the device connected to this pin. This is not a constant Voltage, it repeats sets of “5V,0V”. The connected device will react accordingly

4. analogWrite(pin,191); // this is between 127 and 255
We issue “HIGH, HIGH, LOW”, and repeats that combination, it is called 75% duty cycle. Meaning, this pin provide 5V,5V,0V,5V,5V,0V,... to the device connected to this pin. This is not a constant Voltage, it repeats the set of “5V,5V,0V”. The connected device will react accordingly

5. and so on... The “value” used in analogWrite() can be changed to achieve different PWM effect voltage for the connected device.





After setting the Pin 7 to OUTPUT Pin,

```
pinMode(7, OUTPUT);
```

Immediately after that, Pin 7 has 0V.

LED will only light up when there is a minimum amount of Voltage (usually minimum 1.3V, varies from one LED to another). At this point of time, Pin 7 has 0V, so the connected LED will not light up

When we code **digitalWrite(7,HIGH);**
The Micro-controller will make 5V flow to Pin 7, providing 5V to the LED and that will cause LED to turn ON

When we code **digitalWrite(7,LOW);**
The micro-controller will make 0V flow to Pin 7, providing 0V to the LED and that will cause LED to turn OFF

We can use digitalWrite() function on the Analog Pins (A0 to A5) the same way like we use on the digital Pins (0 to 13)

Why do we need a Resistor ?

A direct 5V from Arduino Uno Board will destroy the LED, that is why we have the 220 ohm resistor there to prevent the LED from being damaged.

STEMKRAF – TUTORIAL PARTS
https://github.com/teaksoon/stemkraf

```
Program: tp04D_outputpin_digitalwrite_7
   (1/1): output pin, digitalwrite Pin 7
        :
        : by TeakSoon Ding for STEMKRAF (OCT-2021)
```

```
void setup() {
  pinMode(7,OUTPUT);
  digitalWrite(7,HIGH);
}
void loop(){ }
```

- Upload the above programs with the Arduino IDE Software
- watch the LED
- try change HIGH to LOW, upload again to test

STEMKRAF – TUTORIAL PARTS
https://github.com/teaksoon/stemkraf

```
Program: tp04E_outputpin_digitalwrite_A0
   (1/1): output pin, digitalwrite Pin A0
        :
        : by TeakSoon Ding for STEMKRAF (OCT-2021)
```

```
void setup() {
  pinMode(A0, OUTPUT);
  digitalWrite(A0, HIGH);
}
void loop() { }
```

- Upload the above programs with the Arduino IDE Software
- watch the LED
- try change HIGH to LOW, upload again to test

STEMKRAF – TUTORIAL PARTS
https://github.com/teaksoon/stemkraf

```
Program: tp04F_outputpin_analogwrite_9
   (1/1): input pin, analogwrite Pin 9
        :
        : by TeakSoon Ding for STEMKRAF (OCT-2021)
```

```
void setup() {
  pinMode(9, OUTPUT);
  analogWrite(9, 15);
}
void loop() { }
```

- Upload the above programs with the Arduino IDE Software
- watch the LED
- try change 15 to some other number (0 to 255), upload again to test