스마트시스템입문

2018년 1학기

공지

- 중간고사 문의:
  - 수업 직후, 363호
  - 금요일 4-5시, 363호

부품 구매 공지

- 부품 신청 요령
  - 현재 조의 프로젝트에 대한 소개와 부품이 필요한 이유를 간략히 설명하여 이메일로 신청 (swbyun@inu.ac.kr)
  - 마감: **5월 20일(일)**까지 신청. 21일에 학과에 구매 요청 예정
  - 부품을 구매할 수 있는 **링크를 같이 첨부**해야함.
  - 단, 우선적으로 http://www.devicemart.co.kr/ 와 http://www.eleparts.co.kr/ 에서 검색해서 부품이 있는 경우에는 위 사이트의 링크를 첨부하고, 부품이 없는 경우 다른 링크를 첨부.

보유품

- 현재 보유품

제품명	모델	수량
쿨링팬	아두이노 쿨링팬	4
펌프키트	DC다이아프램펌프 키트	4
nfc 태그	NFC태그스티커	다수
캐패시터	세라믹 캐패시터 0.1uF	200
다이오드	1N4001 다이오드 (Diode Rectifier - 1A 50V)	200
트랜지스터	2N2222 트랜지스터 (Transistor - NPN)	200

보유품 신청 요령:

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발표일정

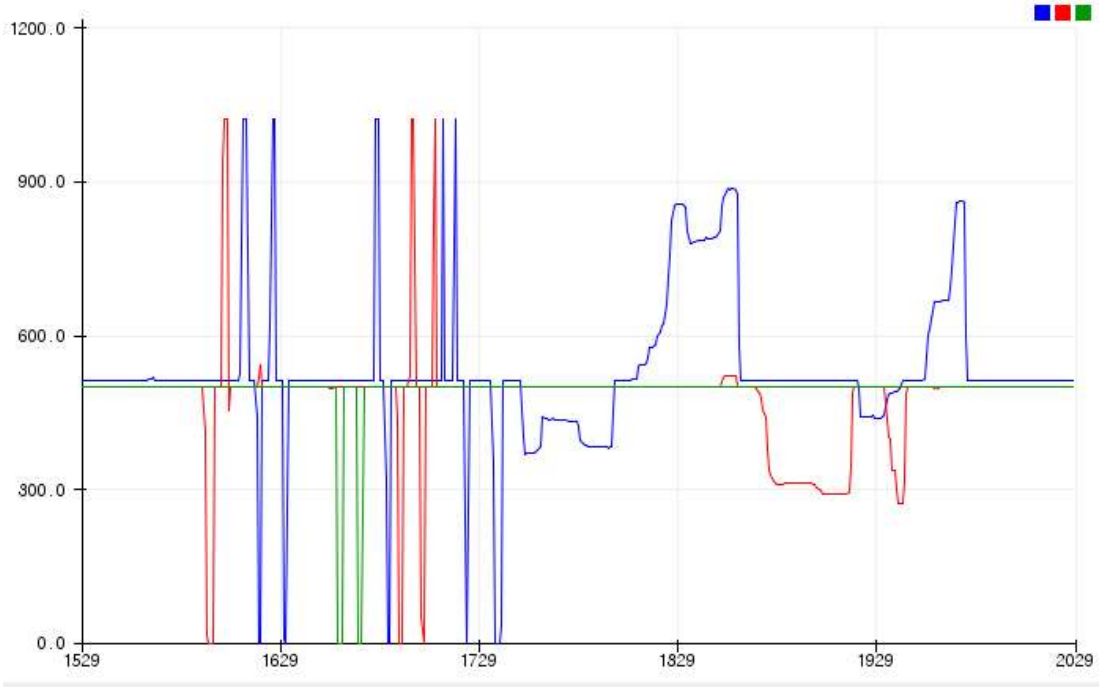
- 5월 30일: 중간발표 여부 결정
- 6월 6일: 정상 수업 (불가 시 다른 요일 보강)
- 최종발표: 6월 13일, 14일, 15일 저녁 보강일 결정
- 기말고사: 6월 20일

Joystick

```
int X = A4;
int Y = A5;
int Z = 5;

void setup() {
  pinMode(X, INPUT);
  pinMode(Y, INPUT);
  pinMode(Z, INPUT);
  Serial.begin(9600);
  }
 void loop()  {
    int x,y,z;
    x=analogRead(X);
    y=analogRead(Y);
    z=digitalRead(Z);
    Serial.print(x);
    Serial.print(",");
    Serial.print(y);
    Serial.print(",");
    Serial.println(z*500);
    delay(50);
   }
```

- Use plotter to see the result



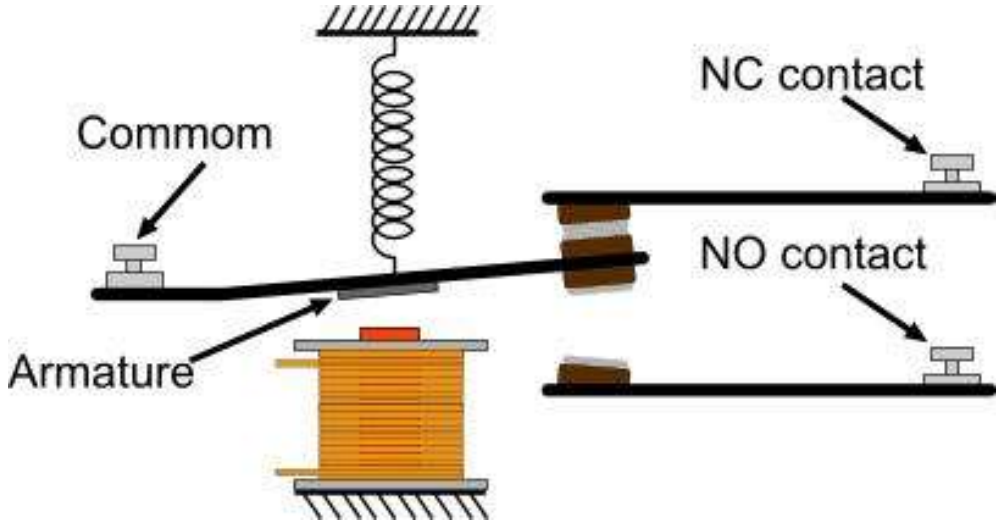
Relay module

- Output voltage of Arduino board is limited. Usually, 5V.
- We cannot control devices which require high voltage supply, such as motors, lights, and etc.

- Relay module
  - Is a switch
  - Provides isolation of two circuits
  - Controls high voltage devices

Relay module

- **Relay module**
  - Is a switch
  - Provides isolation of two circuits
  - Controls high voltage devices
  - 3 terminals: common, NO (normal open) and NC (normal close)
  - Switch between NO and NC (전자석을 이용)



http://www.pcbheaven.com/wikipages/How_Relays_Work/

Relay module

- **Relay module**
  - 3 terminals: common, NO (normal open) and NC (normal close)
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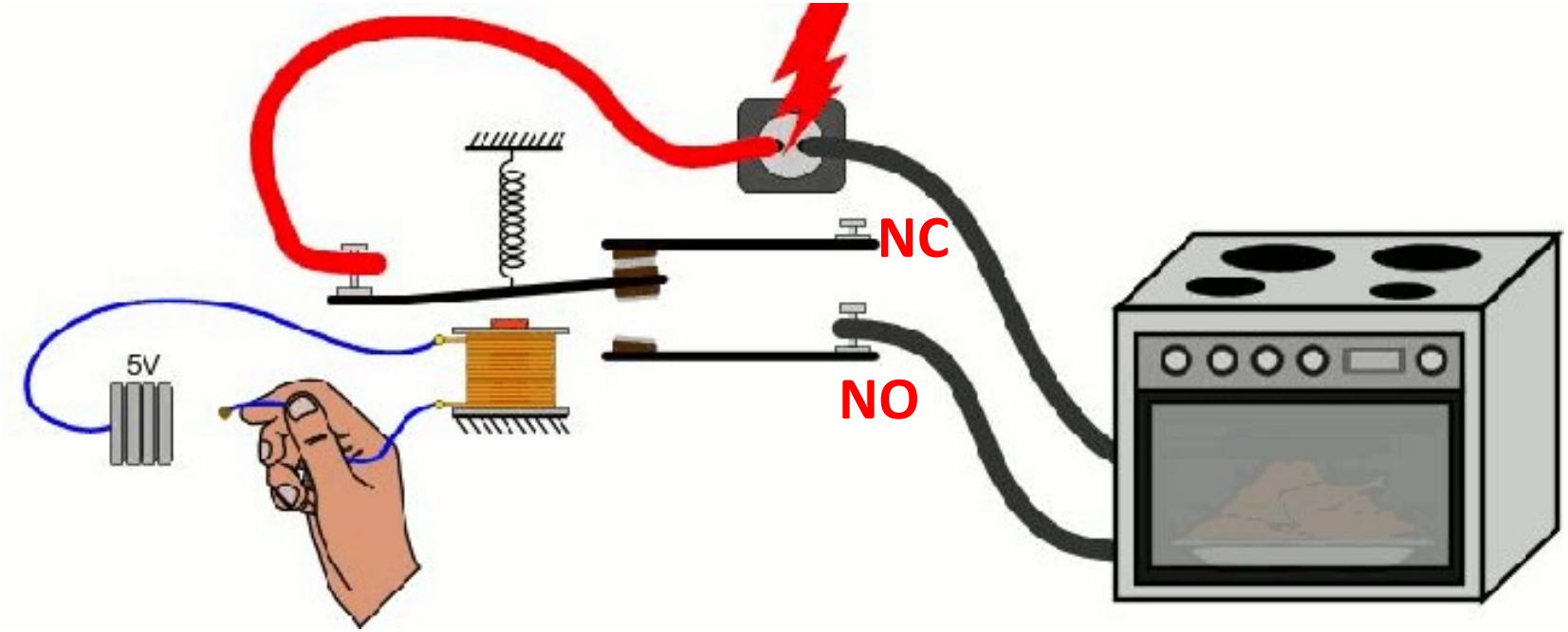
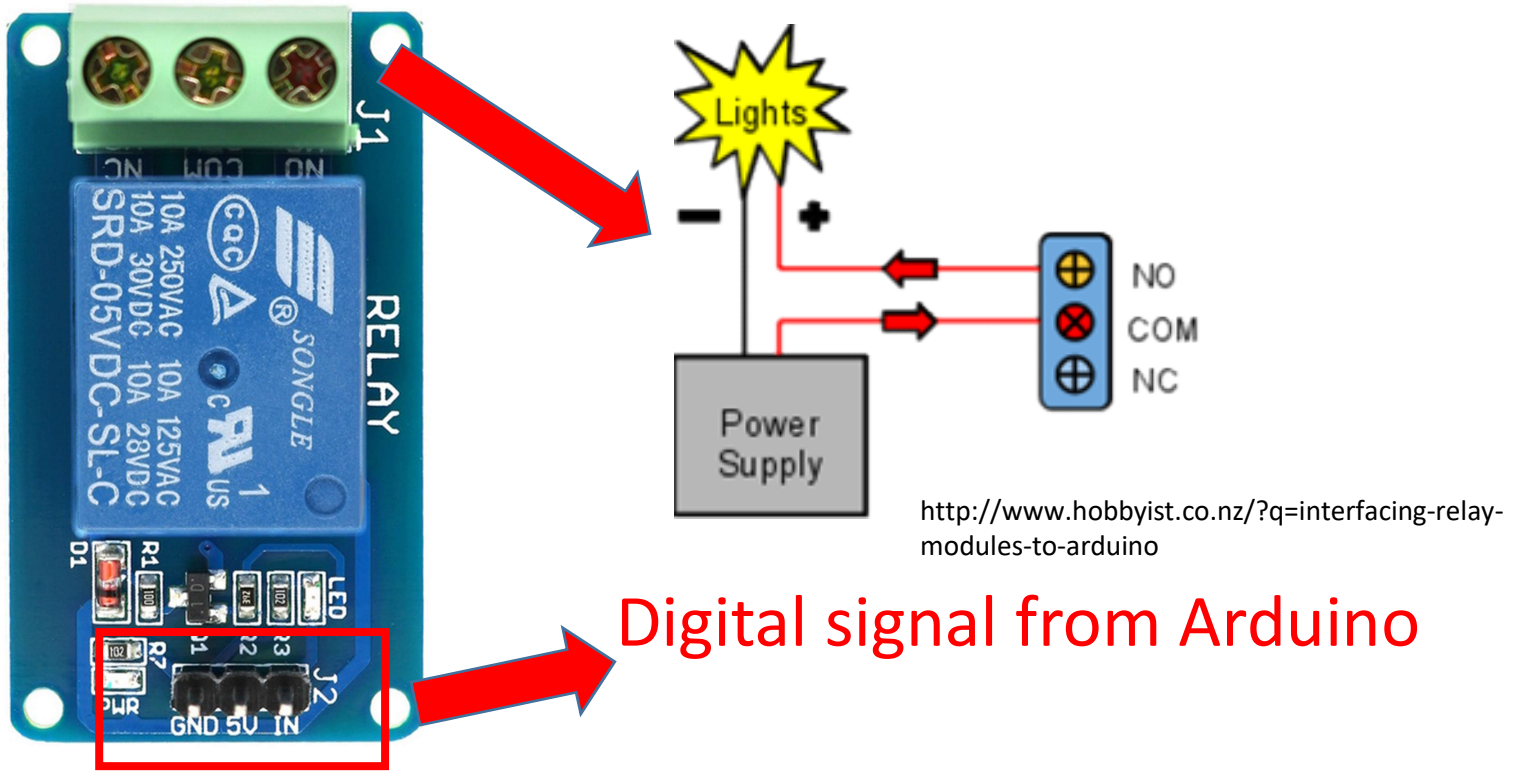


http://www.pcbheaven.com/wikipages/How_Relays_Work/

Relay module



http://www.hobbyist.co.nz/?q=interfacing-relay-modules-to-arduino

- 아두이노에서 3개의 입력이 연결된다.
  - VCC, GND, digital signal (NC or NO)
  - NO → on, NC → off

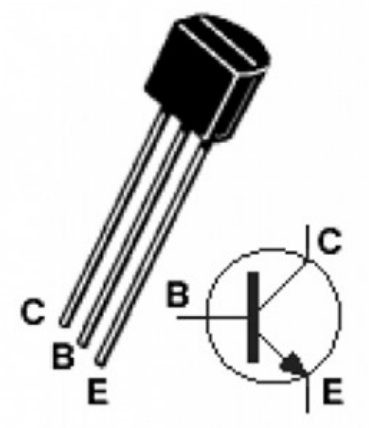
Relay module

```
int RL = 5;

void setup() {
pinMode(RL, OUTPUT);
}

void loop() {
digitalWrite(RL, HIGH);
delay(1000);
digitalWrite(RL, LOW);
delay(300);
}
```

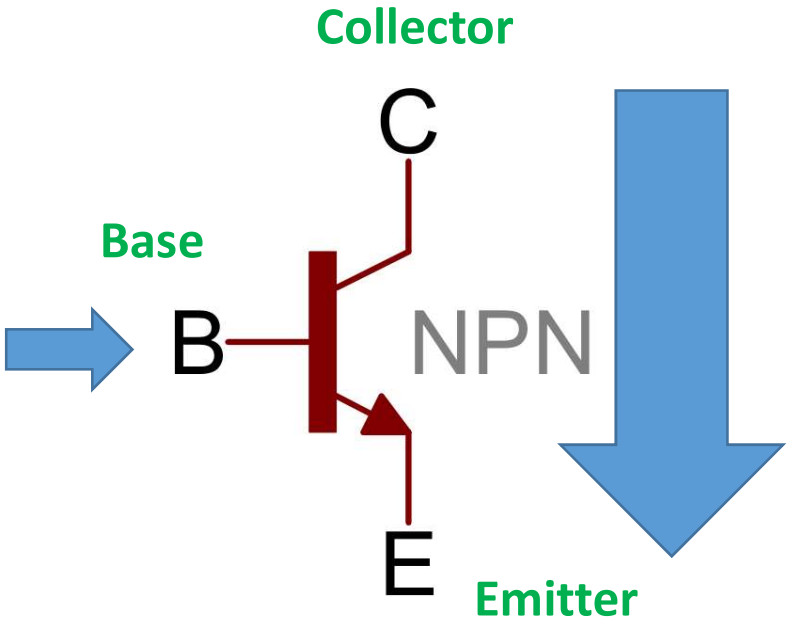
Transistor

Transistor

- Controls large voltage with small voltage signals
- Can be used for amplification or switching



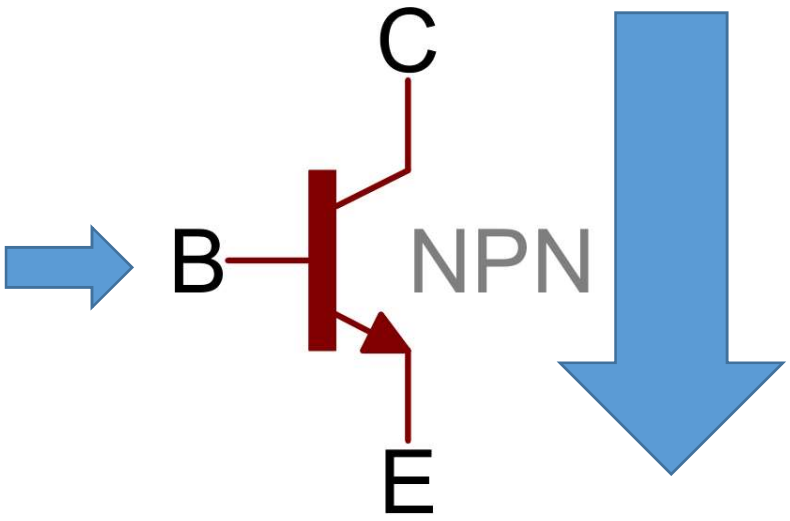
http://www.hobbytronics.co.za/p/607/npn-transistorp2n2222a-06a-ic-10vce



https://learn.sparkfun.com/tutorials/transistors

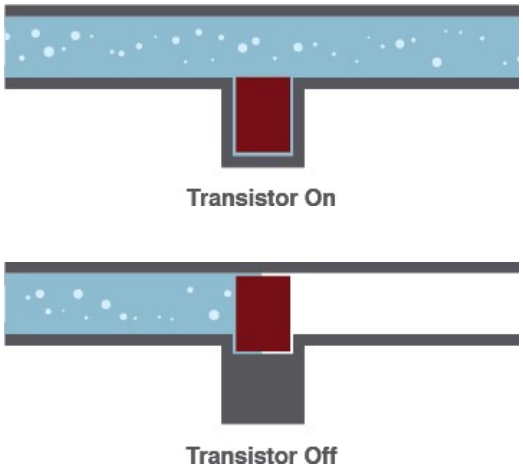
Transistor

npn transistor

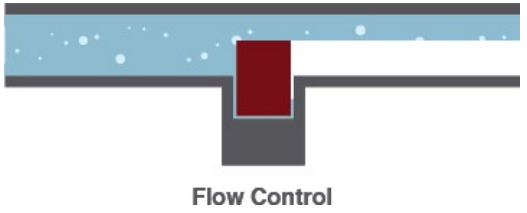


- Amount of current from E to C depends on the state of B
- npn transistor: transistor is on when the base is on

ON / OFF

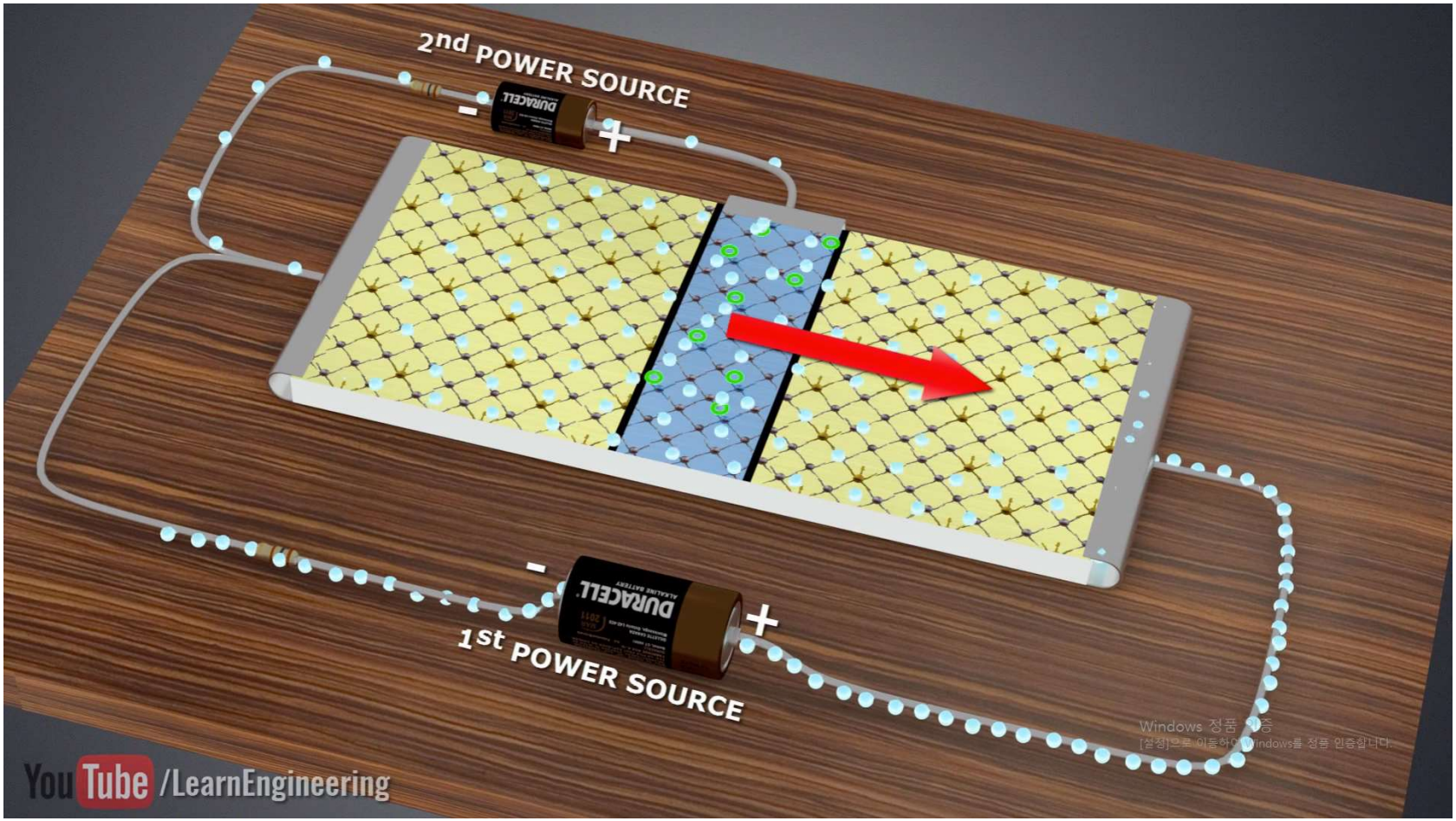


Flow control



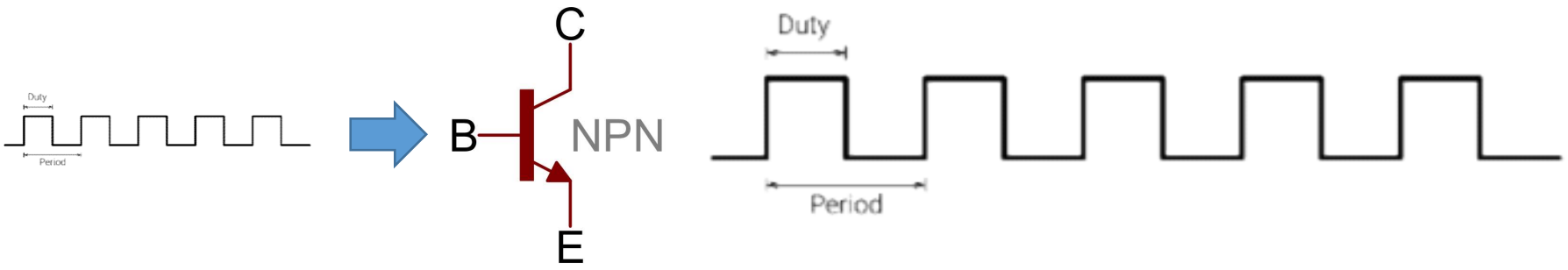
https://learn.sparkfun.com/tutorials/transistors

Transistor

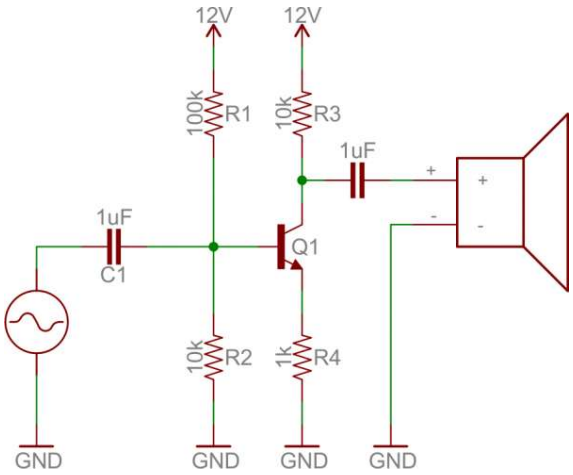


https://www.youtube.com/watch?v=7ukDKVHnac4

Transistor and PWM



- PWM signals can be amplified by a transistor
- Amplified signal can be used control other devices require high voltage supply

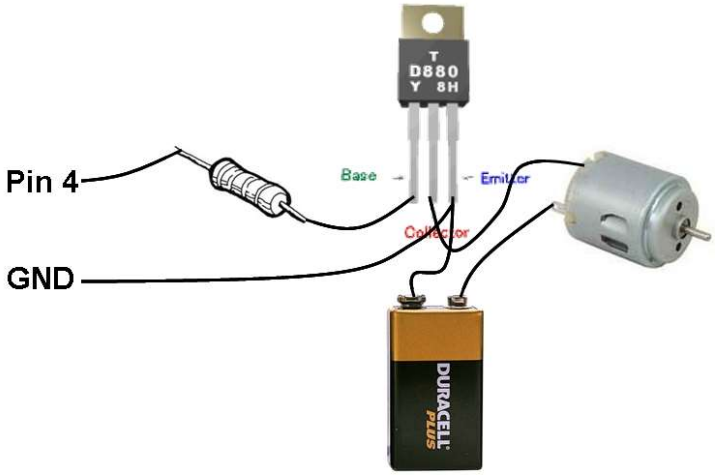


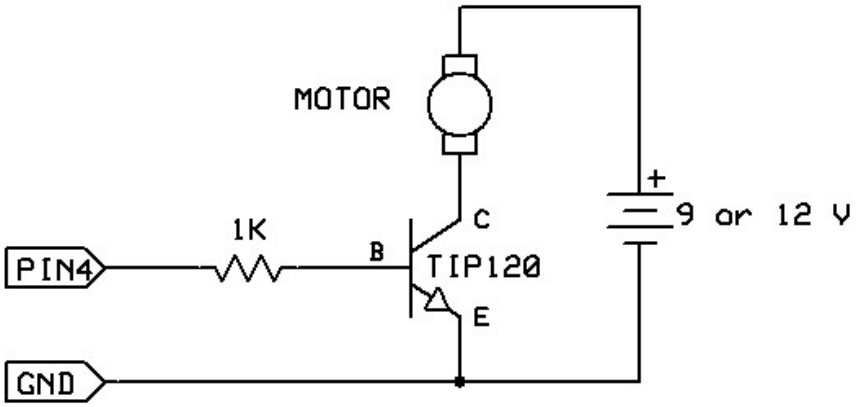
Example: microphone

https://learn.sparkfun.com/tutorials/transistors

Transistor, PWM, and motor

- Amplified signal can be used control other devices require high voltage supply
- **Transistor needs additional voltage supply**





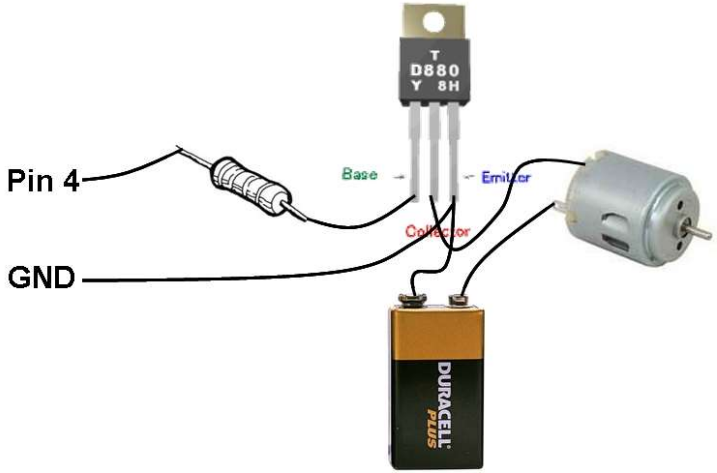
Do not use pin 4 for PWM. This is an example just for circuit diagram.

http://www.me.umn.edu/courses/me2011/arduino/technotes/motorswitchled/arduino-motor.jpg

Transistor, PWM, and motor

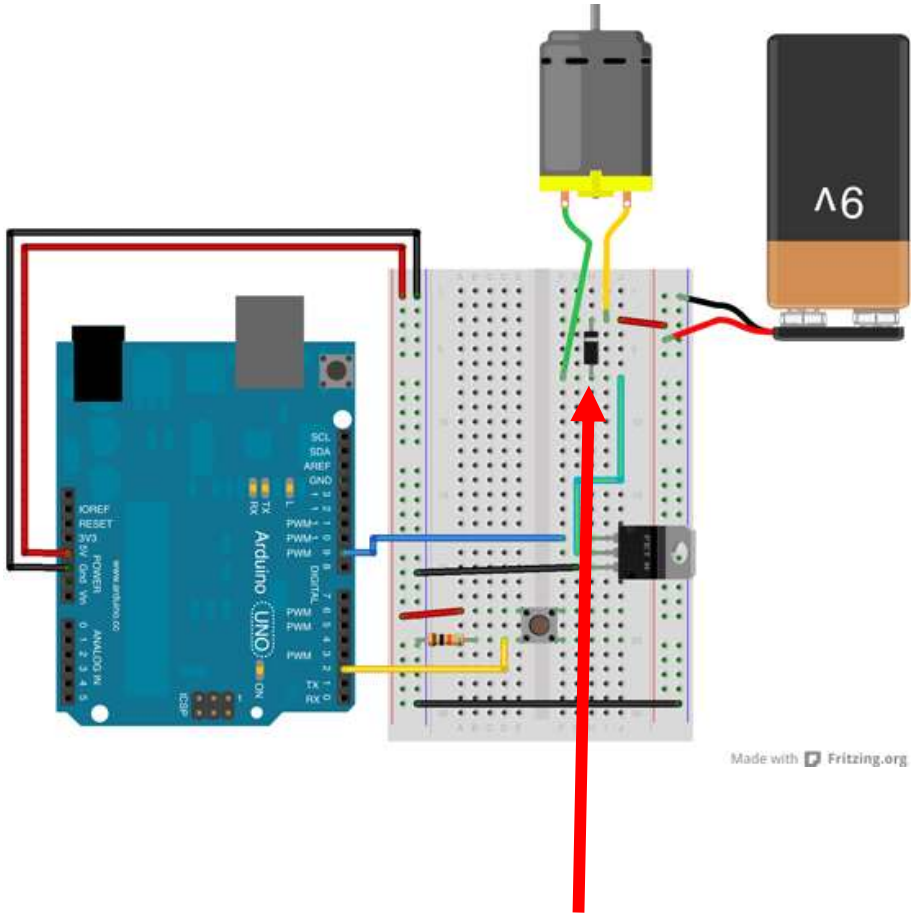
```
int pin = 11;

void setup() {
pinMode(pin, OUTPUT);
}

void loop() {
 for (int i=0;i<=255;i++){
 analogWrite(pin,i);
 delay(10);}


 for (int i=255;i>=0;i--){
 analogWrite(pin,i);
 delay(10);}

}
```

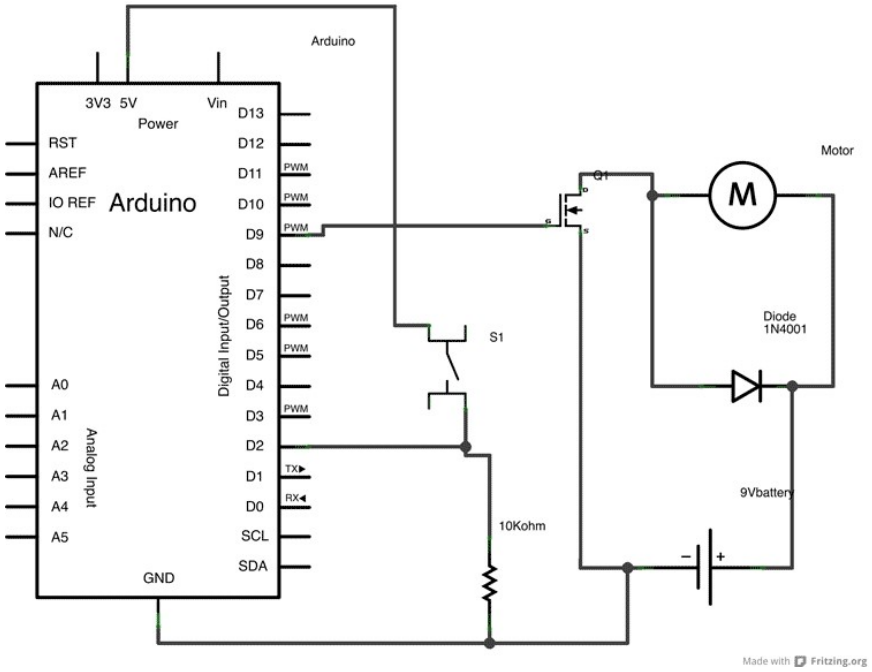
- This code changes brightness of a LED
- The same code can also control speed of a motor



http://www.me.umn.edu/courses/me2011/arduino/technotes/motorswitchled/arduino-motor.jpg

Protecting the circuit with a diode



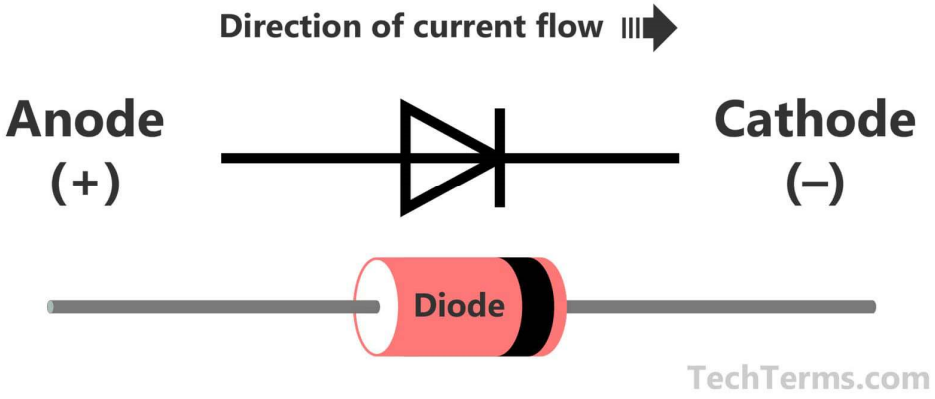


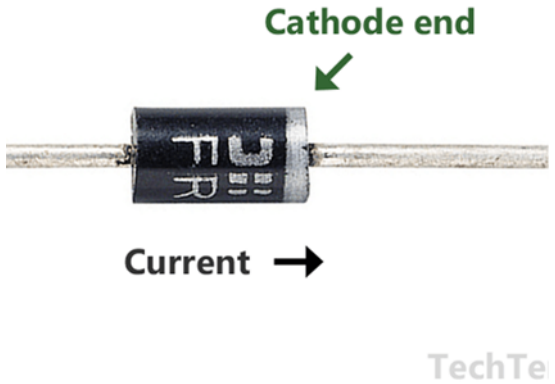
- What is the role of a diode?

https://www.arduino.cc/en/Tutorial/TransistorMotorControl

Protecting the circuit with a diode

- **A Diode** is a device that only allows for the flow of electricity to pass in **one direction**.
- These components are often used to isolate the effect of one component from another.



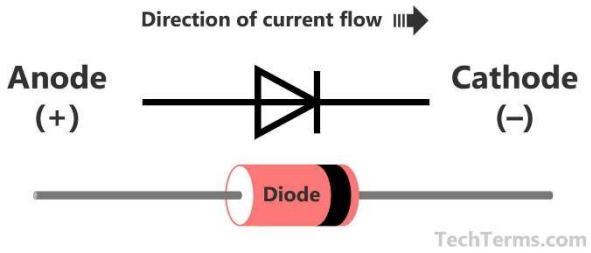


https://techterms.com/definition/diode

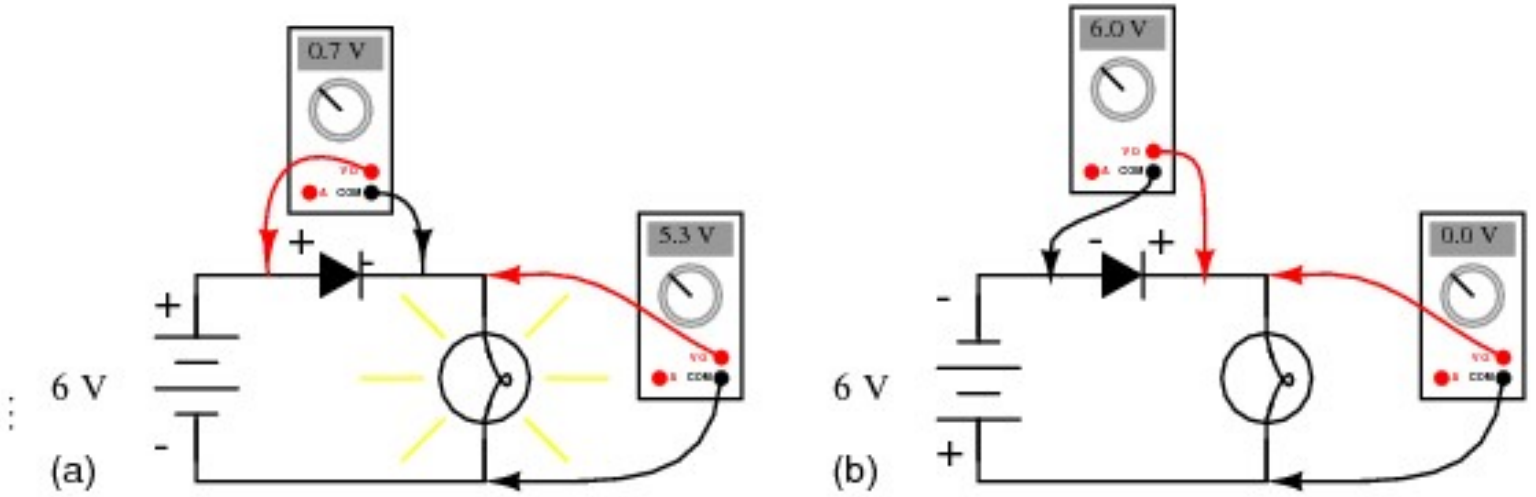
https://playground.arduino.cc/Main/Components

Protecting the circuit with a diode

- **A Diode** is a device that only allows for the flow of electricity to pass in **one direction**.

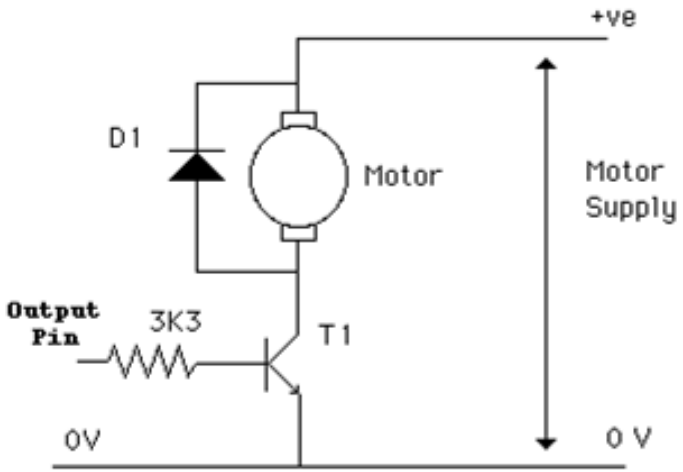


https://cdn.techterms.com/img/lg/diode_1244.jpg



https://sub.allaboutcircuits.com/images/03249.png

Protecting the circuit with a diode



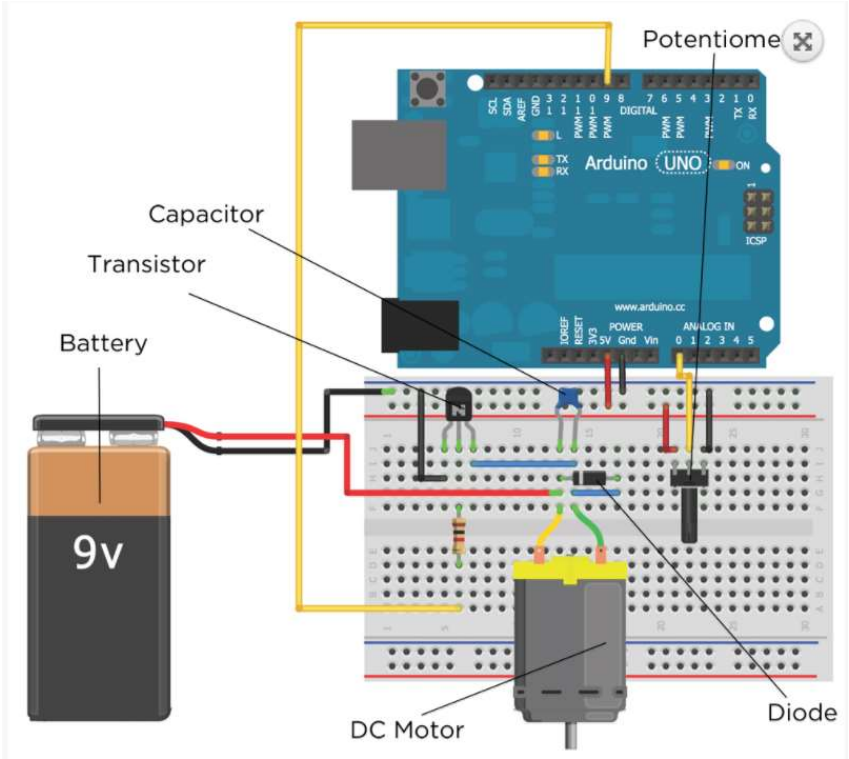
https://arduino-info.wikispaces.com/DC-Motors

- **Kickback diode**
- **Flyback diode**
- **Rectifier diode**
- **방향에 주의! (반대의 경우 다이오드가 손상을 입음)**

- Motor is a **inductive** load
- A sudden change in current will produce a large voltage spikes (“kickback”)
- Inductive energy가 motor에 모여 있을 때 순간적인 off가 되면 그 에너지가 spike voltage 를 형성한다.
- Purpose of a diode is to absorb the voltage that is produced when the transistor is turned on and off.
- Use a kickback diode with a bipolar transistor

Use potentiometer to control the motor

An example from “Exploring Arduino”




```
//Motor Speed Control with a Pot

const int MOTOR=9;  //Motor on Digital Pin 9
const int POT=0;    //POT on Analog Pin 0

int val = 0;

void setup()
{
    pinMode (MOTOR, OUTPUT);
}

void loop()
{
    val = analogRead(POT);
    val = map(val, 0, 1023, 0, 255);
    analogWrite(MOTOR, val);
}
```

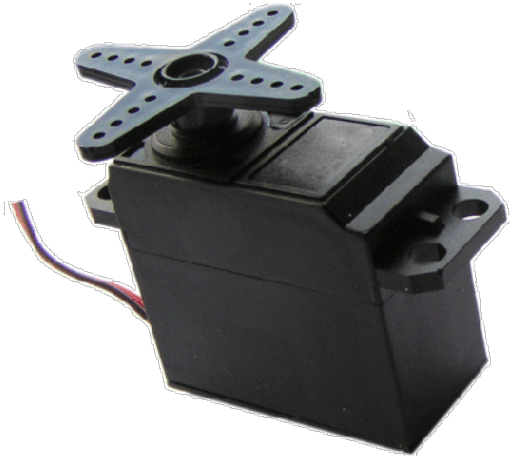
https://www.exploringarduino.com/content/ch4/

Code by Jeremy Blum

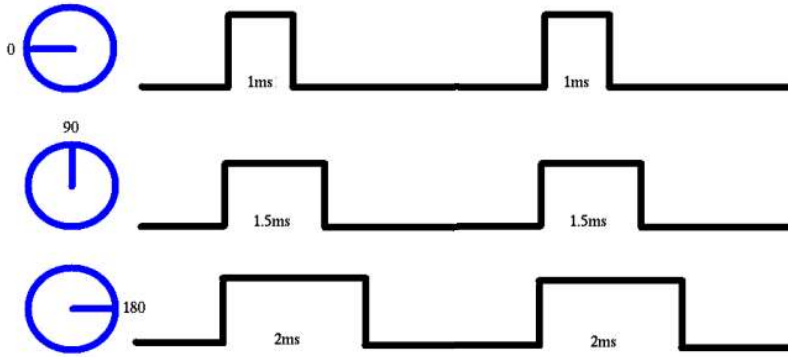
Servo motor

- Servo motor can control position of rotor

https://www.youtube.com/watch?v=BfMfysmfoNM #t=05m00s



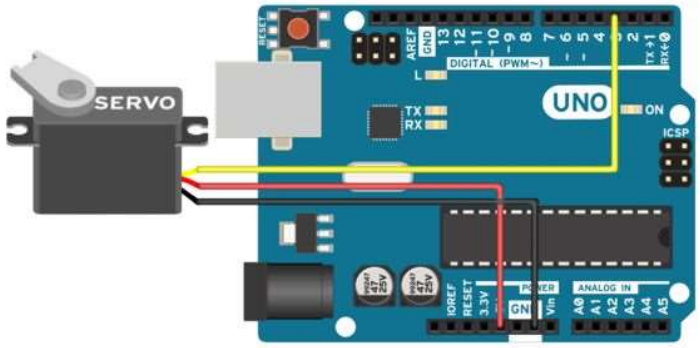
https://electrosome.com/wp-content/uploads/2012/06/Servo-Motor.gif



http://www.lirtex.com/images/electronics/ServoMotors/ServoMotorControl.png

Servo with Arduino

- Reference: http://www.instructables.com/id/Arduino-Servo-Motors/
- Use servo library




```
#include <Servo.h>

// Declare the Servo pin
int servoPin = 3;
// Create a servo object
Servo Servo1;

void setup() {
Servo1.attach(servoPin);
}

void loop(){
Servo1.write(0);
  delay(1000);
Servo1.write(90);
  delay(1000);
}
```

초음파 센서

HC-SR04

초음파를 발생하여 장애물에 의해
반사되어 다시 돌아오기까지의
시간을 거리로 계산

https://howtomechatronics.com/tutorials/arduino/ultrasonic-sensor-hc-sr04/

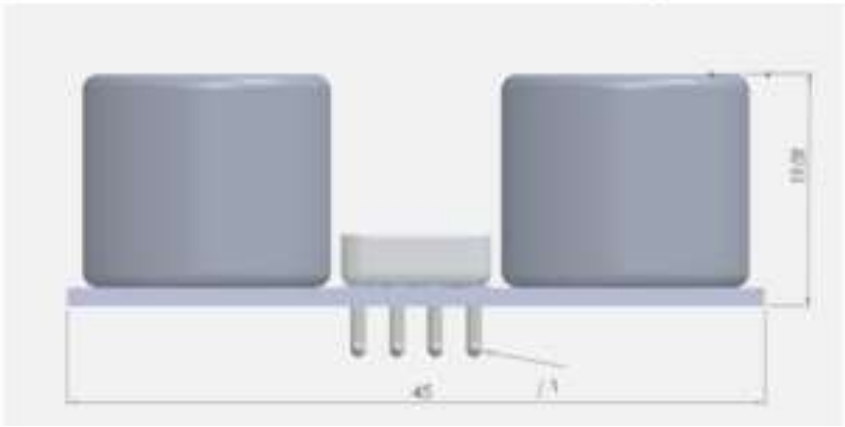
초음파 센서

- HC-SR04 초음파 센서
  - Operating voltage: +5V
  - Theoretical Measuring Distance: 2cm to 450cm
  - Practical Measuring Distance: 2cm to 80cm
  - Accuracy: 3mm
  - Measuring angle covered: <15°

- 감지할 수 없는 장애물
  - 철사, 줄과 같은 초음파가 반사될 수 없는 가는 물체
  - 스펀지, 섬유, 눈 등과 같이 전파를 흡수하는 물체

https://components101.com/ultrasonic-sensor-working-pinout-datasheet

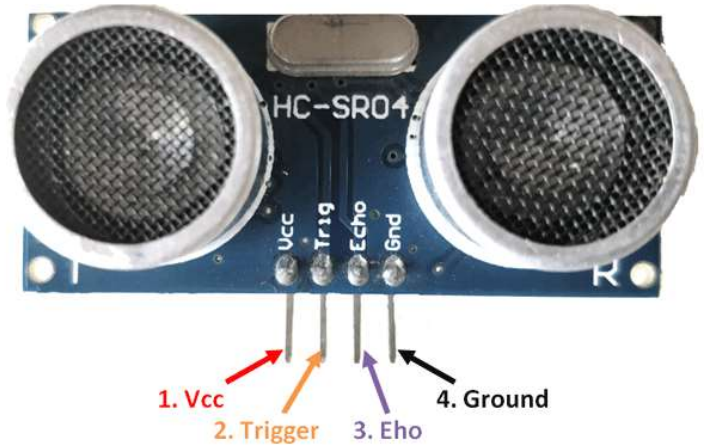
초음파 센서



송신부 (T)
수신부 (R)

https://components101.com/ultrasonic-sensor-working-pinout-datasheet

초음파 센서



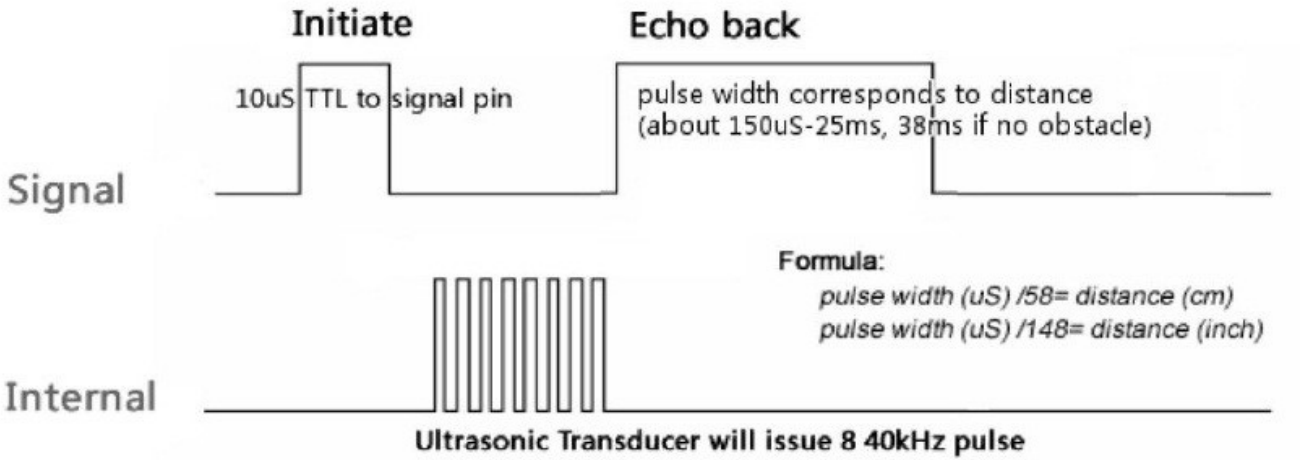
https://components101.com/ultrasonic-sensor-working-pinout-datasheet

Pin Number	Pin Name	Description
1	Vcc	The Vcc pin powers the sensor, typically with +5V
2	Trigger	Trigger pin is an Input pin. This pin has to be kept high for 10us to initialize measurement by sending US wave.
3	Echo	Echo pin is an Output pin. This pin goes high for a period of time which will be equal to the time taken for the US wave to return back to the sensor.
4	Ground	This pin is connected to the Ground of the system.

초음파 센서

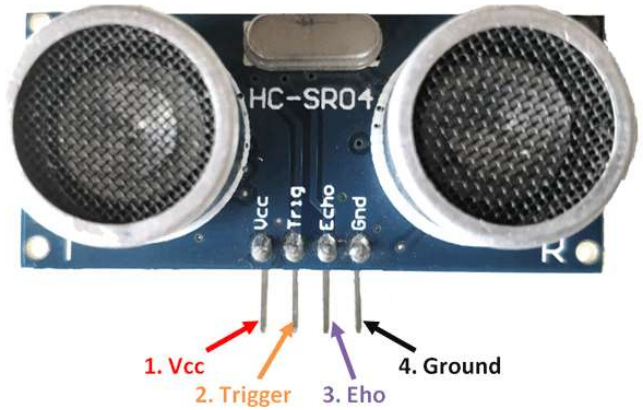
The timing diagram of HC-SR04 is shown. To start measurement, Trig of SR04 must receive a pulse of **high (5V) for at least 10us**, this will initiate the sensor will transmit out **8 cycle of ultrasonic burst at 40kHz** and **wait for the reflected ultrasonic burst**. When the sensor detected ultrasonic from receiver, it will set the Echo pin to high (5V) and delay for a period (width) which proportion to distance. To obtain the distance, measure the width (Ton) of Echo pin.

Time = Width of Echo pulse, in uS (micro second)
•Distance in centimeters = Time / 58
•Or you can utilize the speed of sound, which is 340m/s



https://docs.google.com/document/d/1Y-yZnNhMYy7rwhAgyL_pfa39RsB-x2qR4vP8saG73rE/edit

초음파 센서



- Vcc: D13 VCC
- GND: D13 GND
- Trig: D13 Signal
- Echo: D12 Signal

```
int trig=13;
int echo=12;
void setup() {
  Serial.begin (9600);
  pinMode(trig, OUTPUT);
  pinMode(echo, INPUT);
}
void loop() {
  long duration, distance;
  digitalWrite(trig, LOW);
  delayMicroseconds(2);
  digitalWrite(trig, HIGH);
  delayMicroseconds(10);
  digitalWrite(trig, LOW);
  duration = pulseIn(echo, HIGH);
  distance = (duration/2) / 29.1;
  Serial.print(distance);
  Serial.println(" cm");
  delay(200);
}
```

초음파 센서

```
int trig=13;
int echo=12;
void setup() {
  Serial.begin (9600);
  pinMode(trig, OUTPUT);
  pinMode(echo, INPUT);
}
void loop() {
  long duration, distance;
  digitalWrite(trig, LOW);
  delayMicroseconds(2);
  digitalWrite(trig, HIGH);
  delayMicroseconds(10);
  digitalWrite(trig, LOW);
  duration = pulseIn(echo, HIGH);
  distance = (duration/2) / 29.1;
  Serial.print(distance);
  Serial.println(" cm");
  delay(200);
}
```

Low로 초기화

Trig 신호를 10 us 동안 유지

Echo pulse의 신호 폭을 측정

거리계산

초음파 센서

- **pulseIn(pin, value)**
  - pin : pulse를 읽는 핀 번호 (*int*)
  - value : 읽은 pulse의 type : HIGH 또는 LOW (*int*)

- **(Returns)** pulse 길이 (*μs*)
  - timeout 시간 이내에 pulse가 완료되지 않으면 0 값을 return

- value 가 HIGH 경우, 해당 핀이 HIGH가 되면서부터 LOW로 될 때까지의 시간을 *μs* 단위로 측정

초음파 센서

- 거리계산
  - 음파속도: 343 m/s (기온 20도)
  - 1 cm 이동 소요 시간 = 29.15 us

- Pulse의 길이는 왕복에 필요한 시간이므로 pulse 길이의 절반에 해당하는 시간을 29.1로 나눠주면 이동 길이기 cm로 나온다.