

1. analogWrite & analogRead

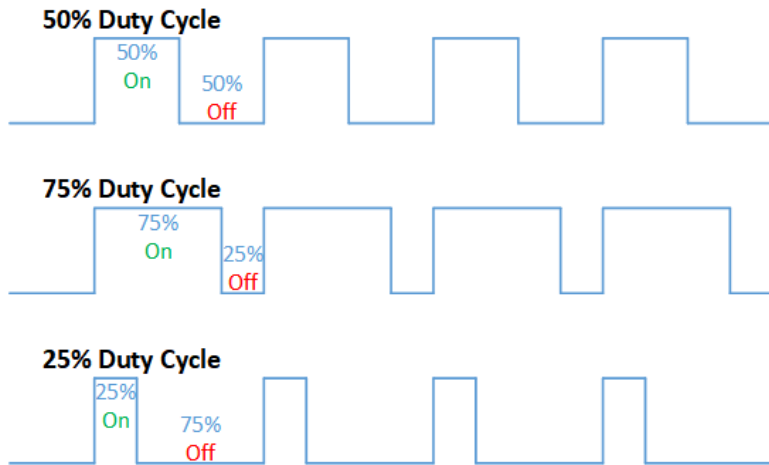
2. 외부 인터럽트(External Interrupt)

마이크로프로세서 종합 설계. 10주차.

목표

- 고속 PWM과 PWM 신호의 이해
 - analogWrite
 - RC서보모터
- analogRead
- 외부 인터럽트의 이해와 실험

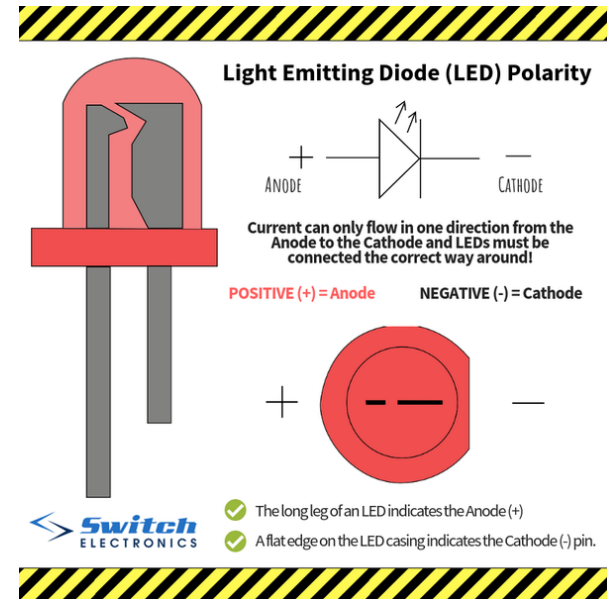
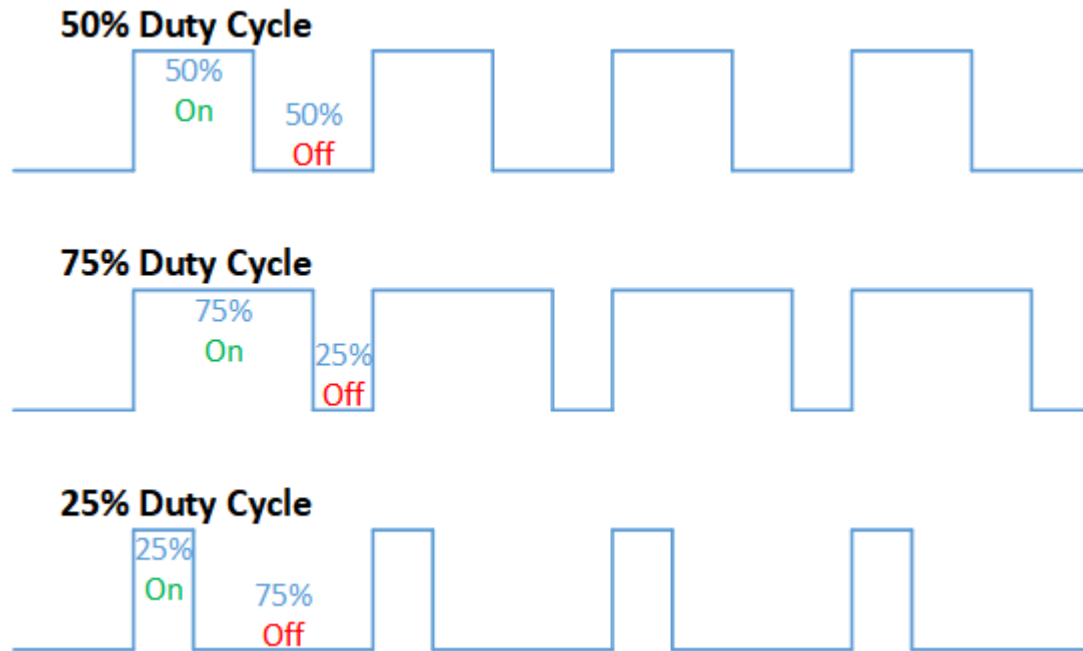
PWM(Pulse Width Modulation)



고속 PWM : analogWrite

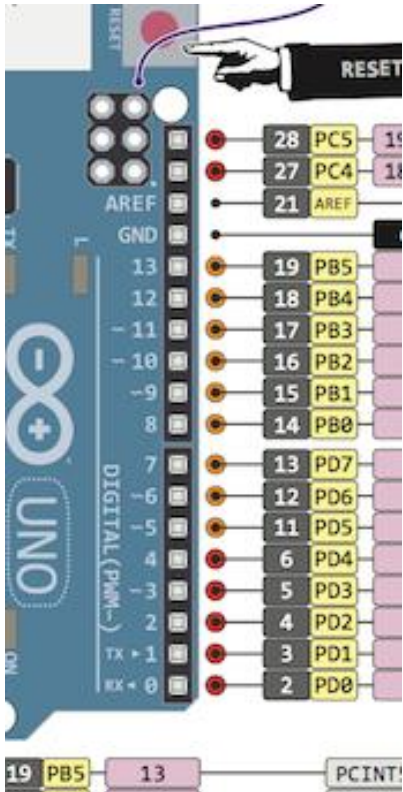
PWM 신호 : RC 서보모터

PWM을 이용한 LED 밝기 제어



디지털 입출력 관련 API

- PWM(디지털 출력) 관련 명령

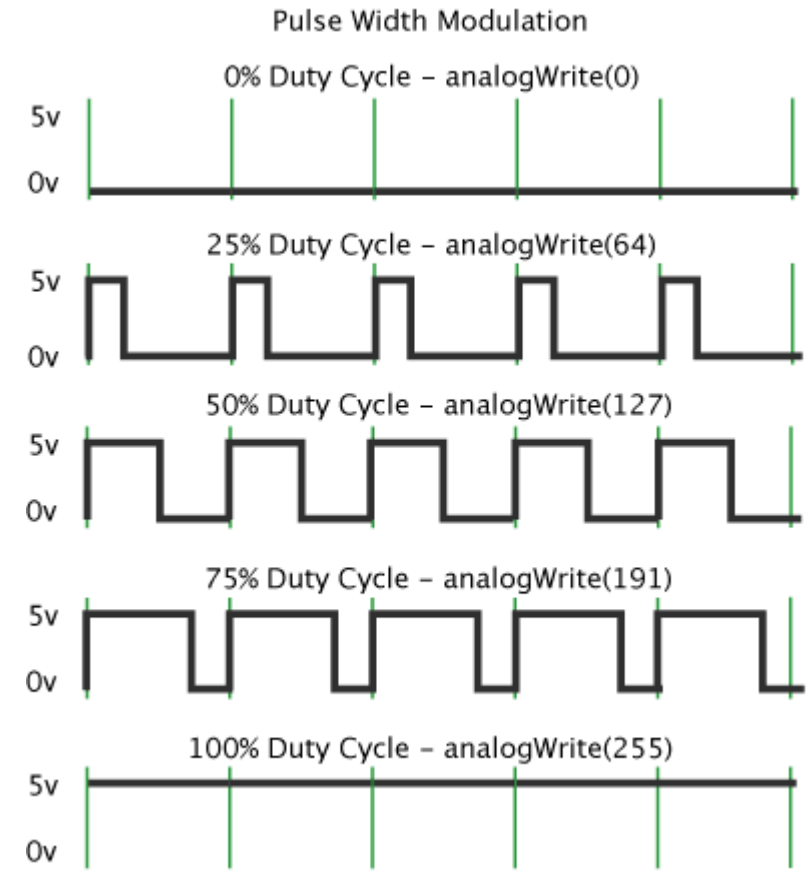
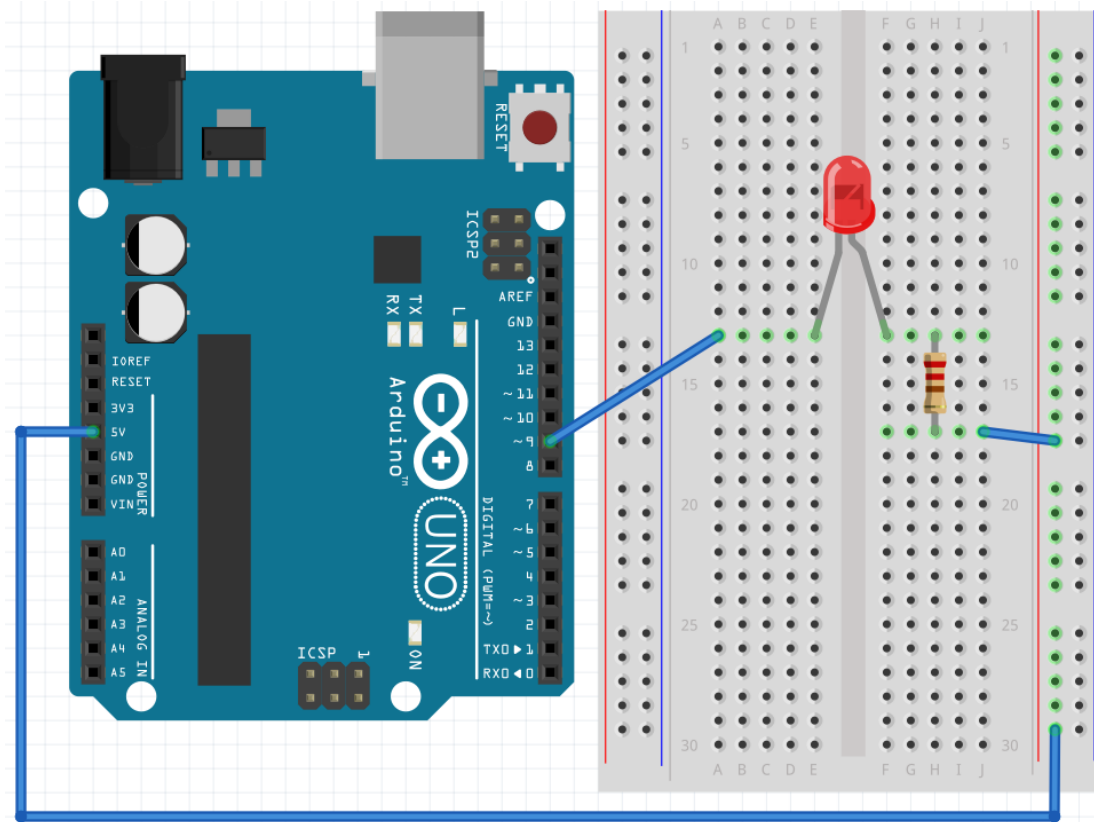


analogWrite(핀번호, Duty Cycle) ;

- `analogWrite(9, 0) ;`
- `analogWrite(9, 128) ;`
- `analogWrite(9, 255) ;`

아두이노를 이용한 LED 밝기 제어 예제

- 함수 : `analogWrite(핀번호, duty cycle)`



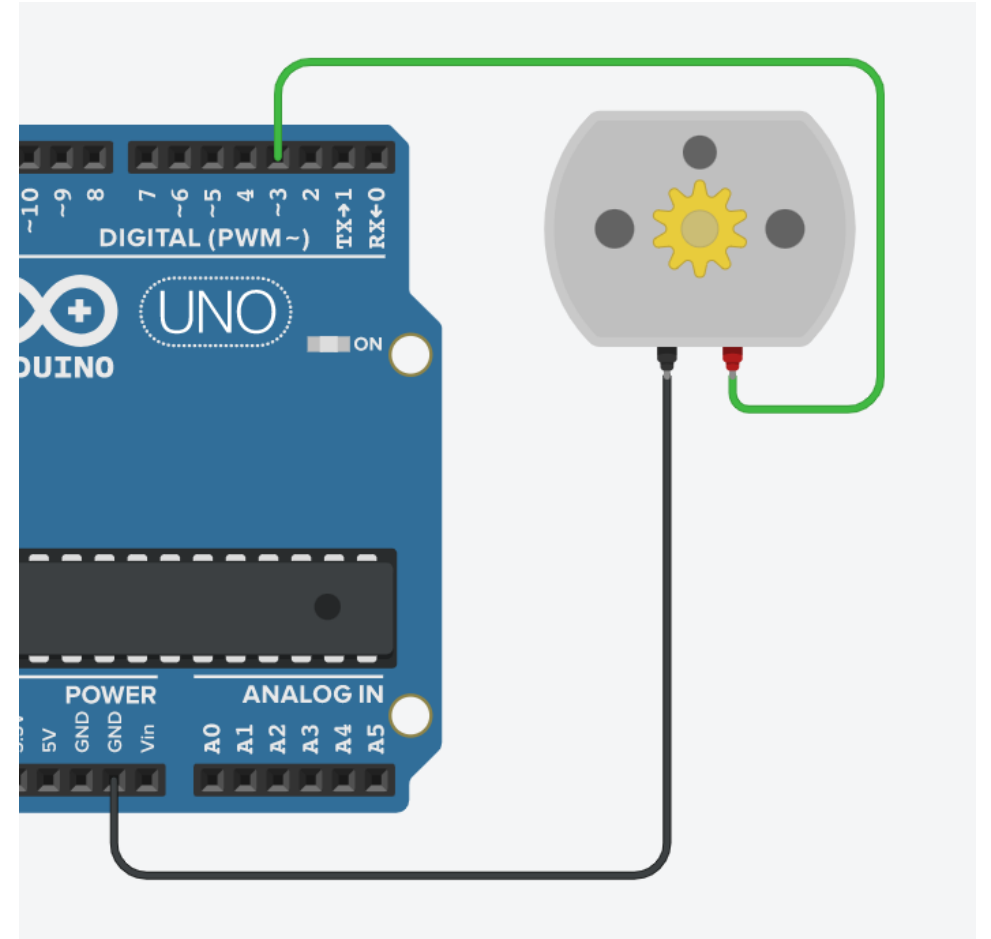
analogWrite(PWM)을 이용한 DC모터 제어

```
void setup()
{
  pinMode(3, OUTPUT); // 핀을 출력으로 설정
}

void loop()
{
  analogWrite(3, 255); //analogWrite 값은 0 부터 255까지
}
```

```
void setup()
{
  pinMode(3, OUTPUT); // 핀을 출력으로 설정
}

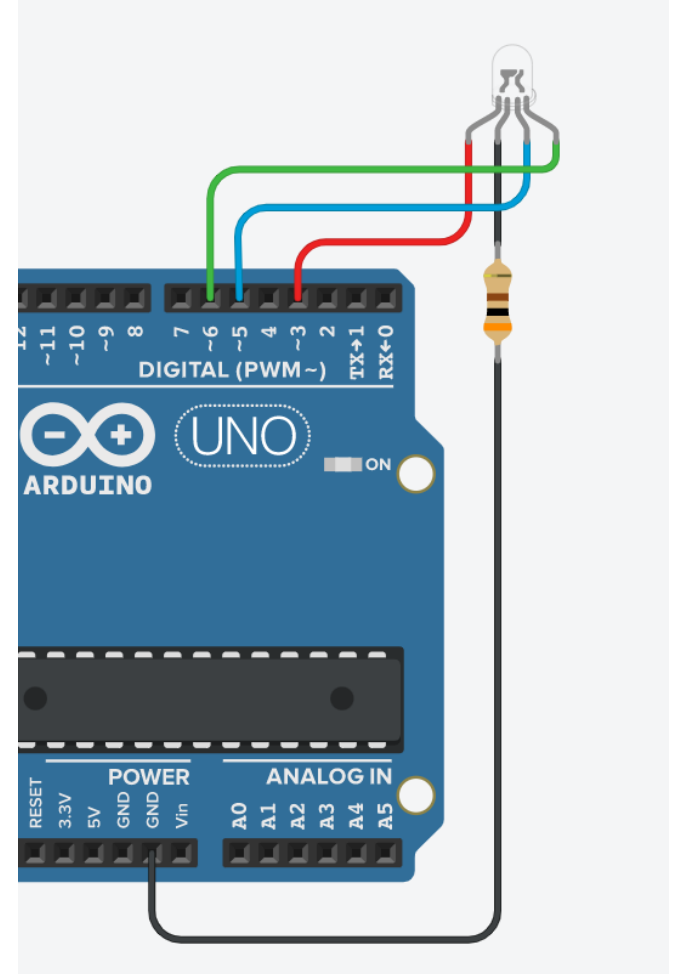
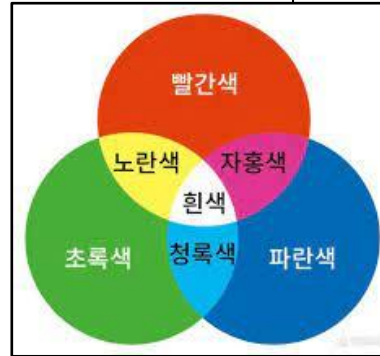
void loop()
{
  analogWrite(3, 128); //analogWrite 값은 0 부터 255까지
}
```



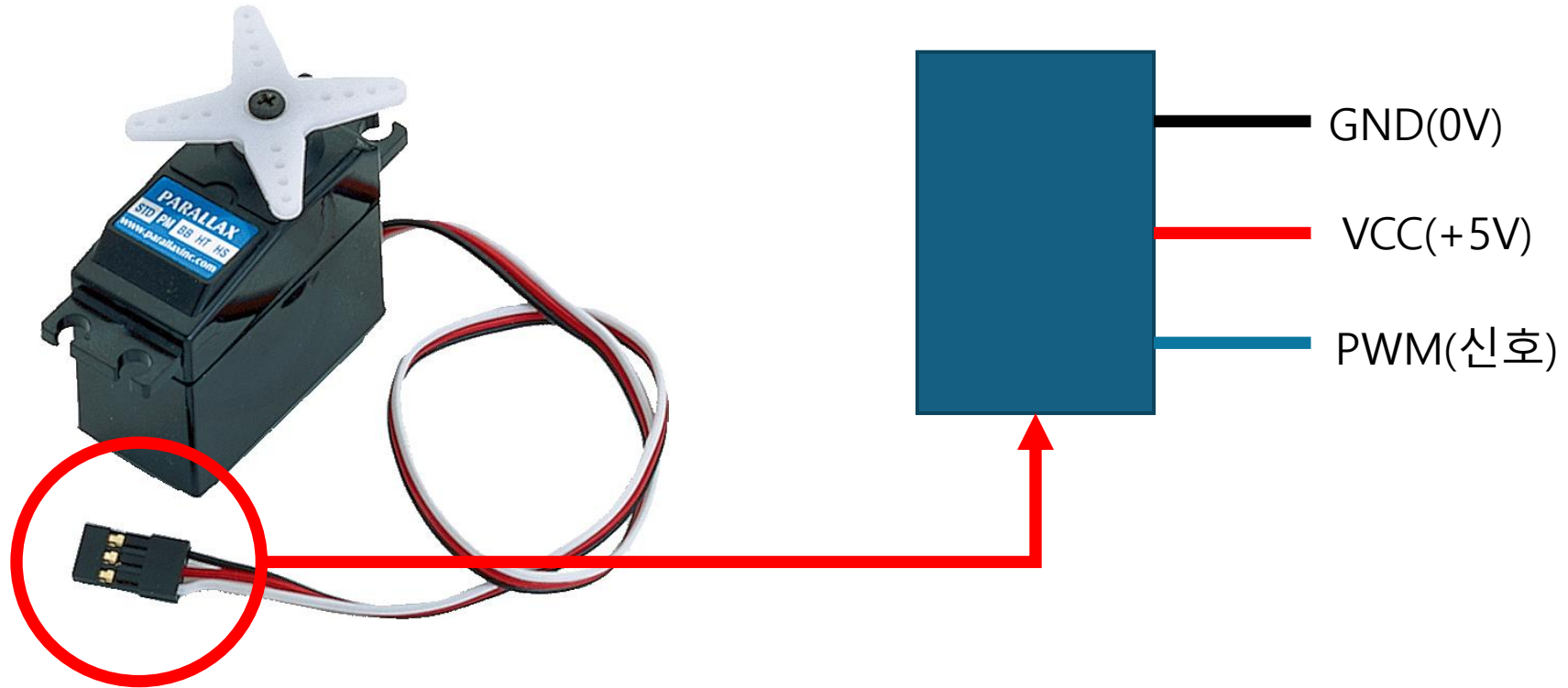
analogWrite(PWM)을 이용한 RGB LED제어

```
void setup()
{
  pinMode(3, OUTPUT); // 핀을 출력으로 설정
  pinMode(5, OUTPUT); // 핀을 출력으로 설정
  pinMode(6, OUTPUT); // 핀을 출력으로 설정
}
```

```
void loop()
{
  analogWrite(3, 255); //analogWrite 값은 0 부터 255까지
  analogWrite(5, 255); //analogWrite 값은 0 부터 255까지
  analogWrite(6, 0); //analogWrite 값은 0 부터 255까지
}
```

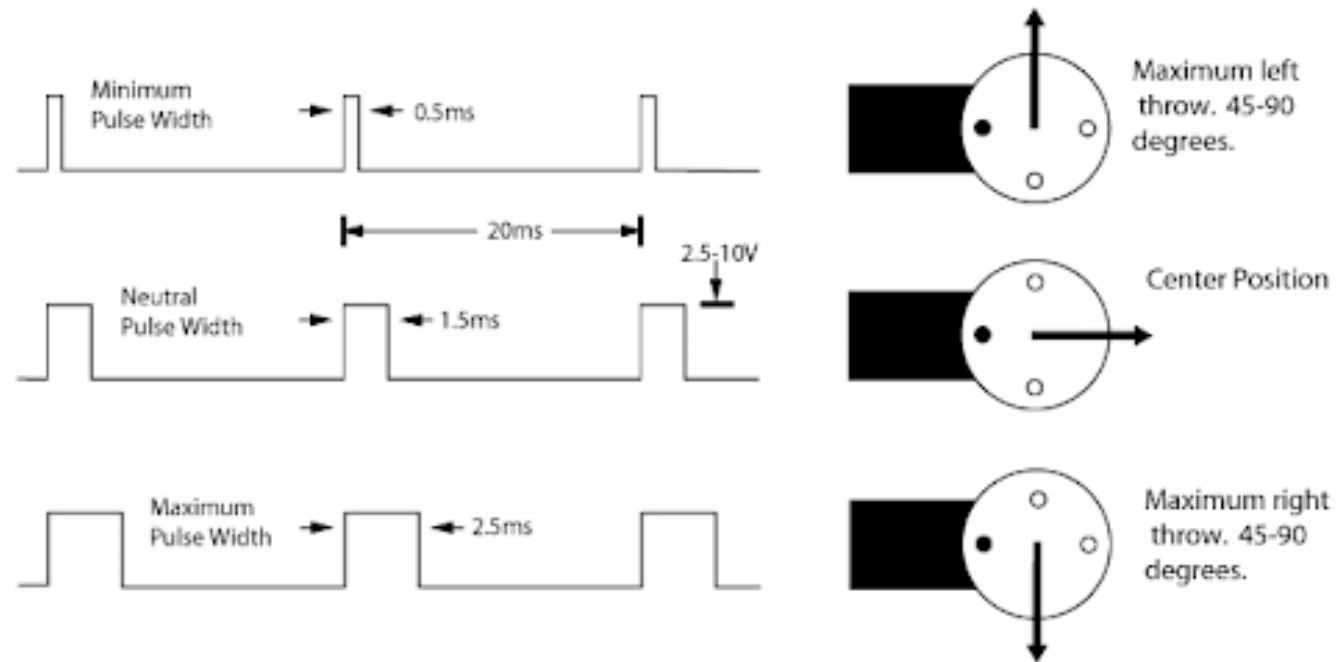


RC 서보모터



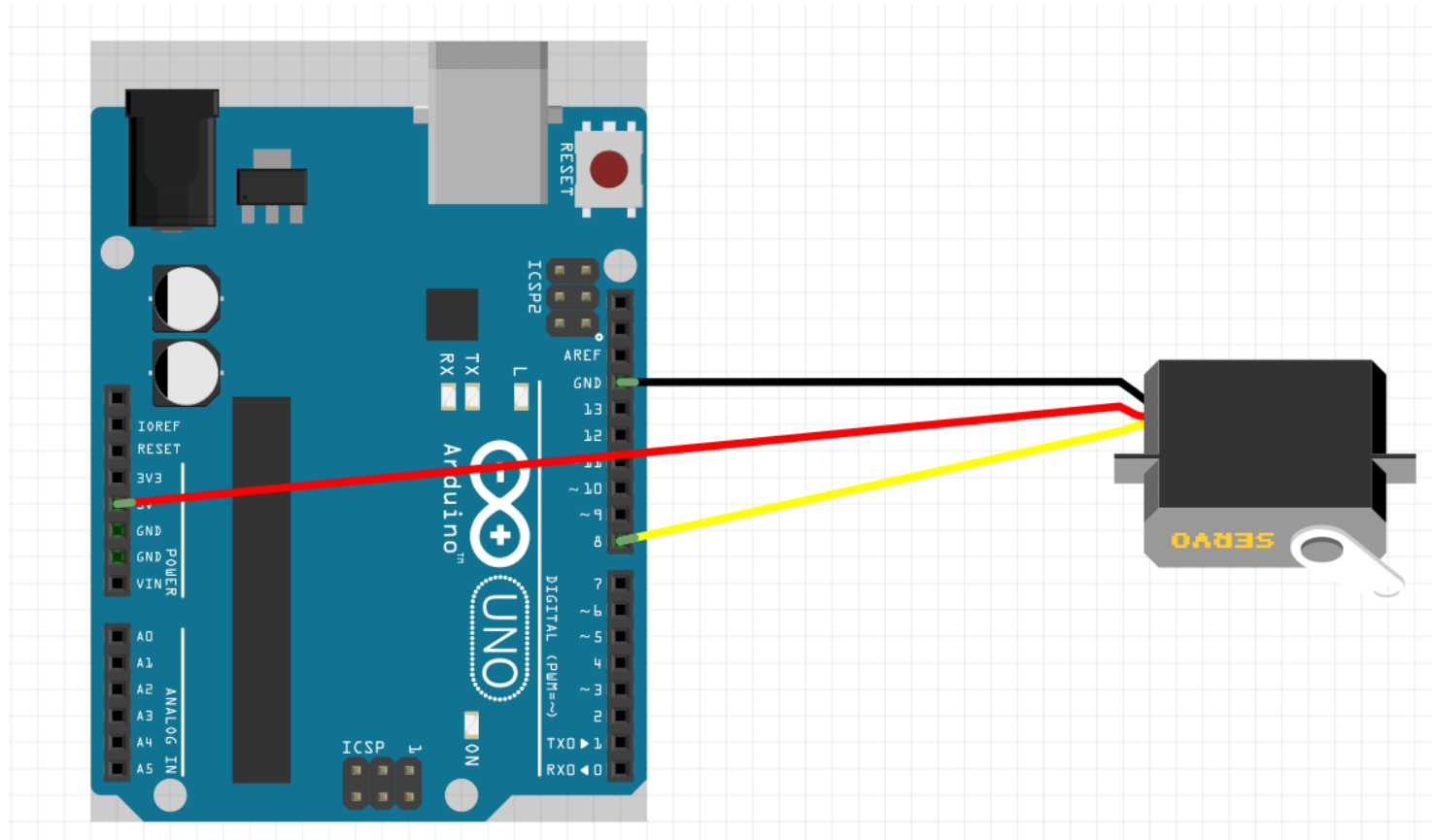
PWM을 이용한 RC 서보모터 제어

R/C Control Signal Theory



아두이노를 이용한 서보모터 제어

- 테스트 회로 구성



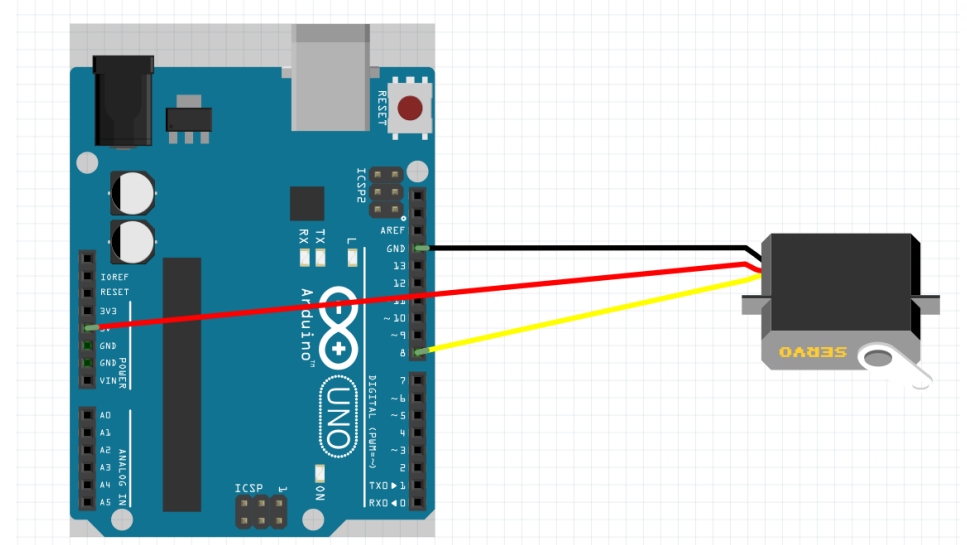
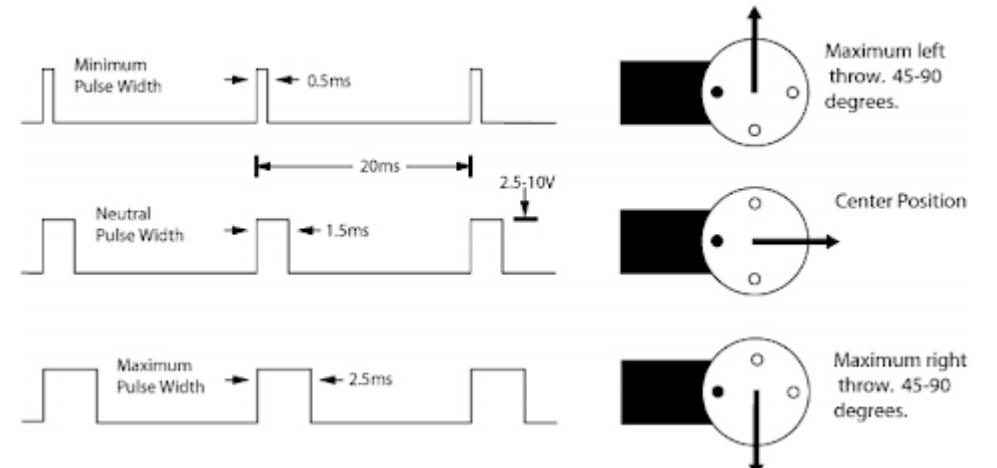
아두이노를 이용한 서보모터 제어

```
void setup()
{
  pinMode(8, OUTPUT) ;
}

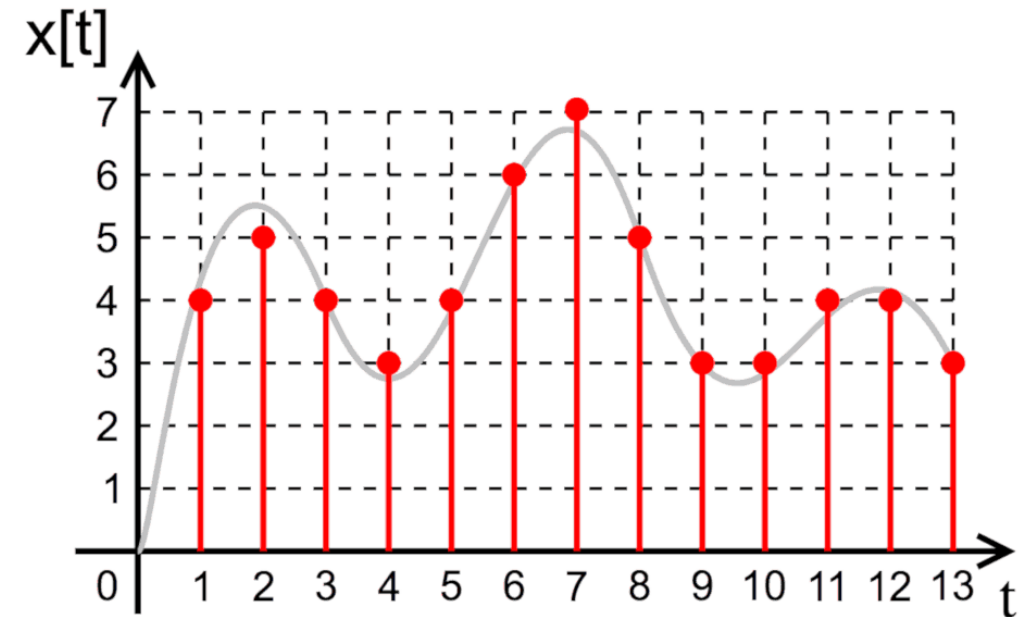
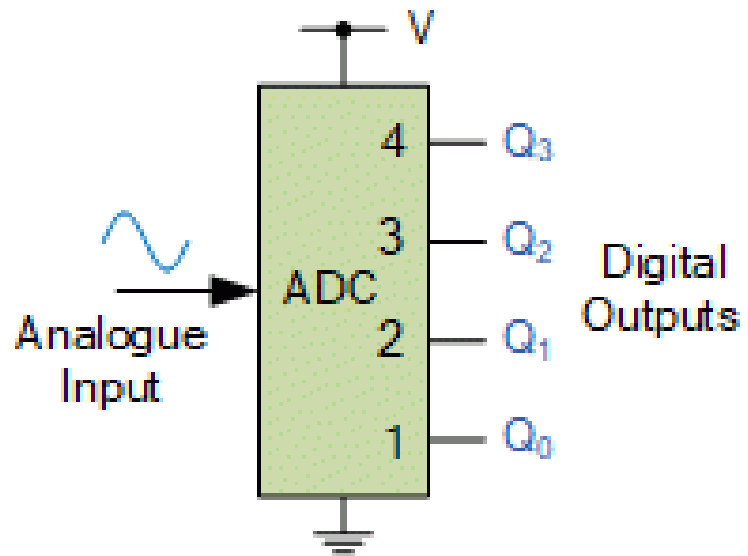
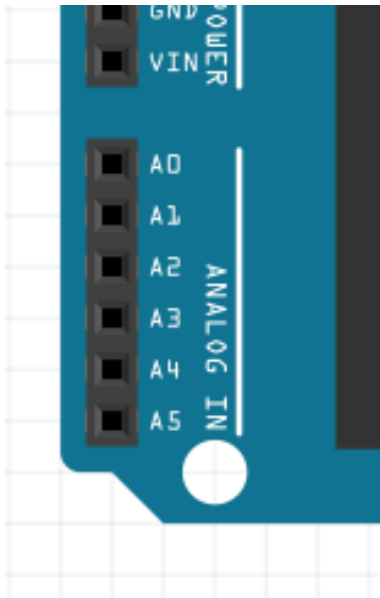
void loop()
{
  digitalWrite(8, HIGH);
  delayMicroseconds(1400);

  digitalWrite(8, LOW);
  delayMicroseconds(20000-1400);
}
```

R/C Control Signal Theory

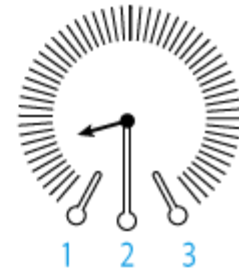
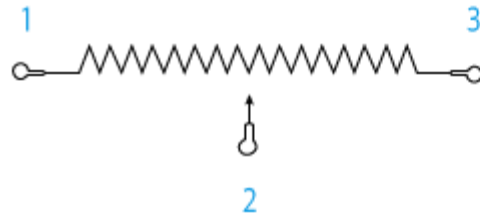


아날로그 입력(ADC)



가변저항(Potentiometer, 볼륨)

- 저항값을 변경

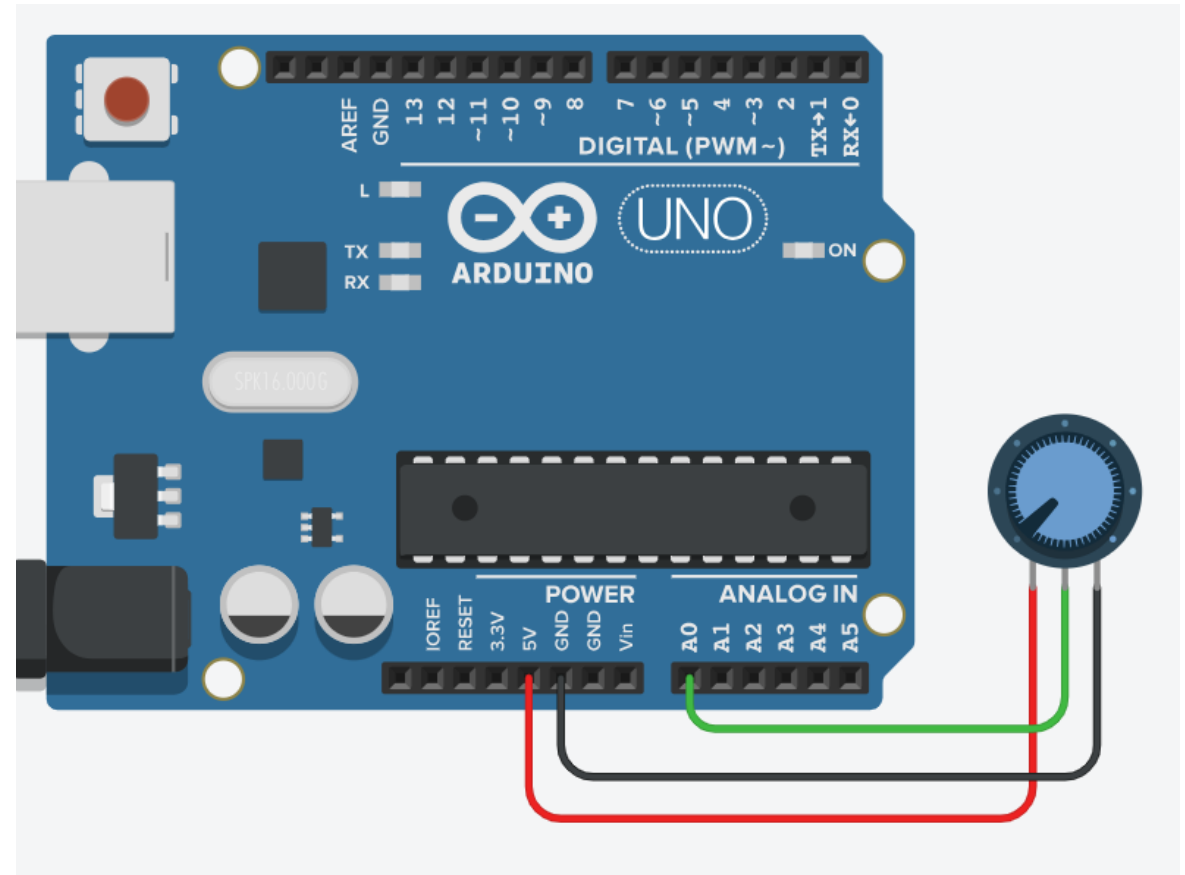


가변저항의 동작방식

가변저항(Potentiometer, 볼륨)

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

void loop()
{
  int val = analogRead(A0);
  Serial.print("Analog : ");
  Serial.println(val);
}
```



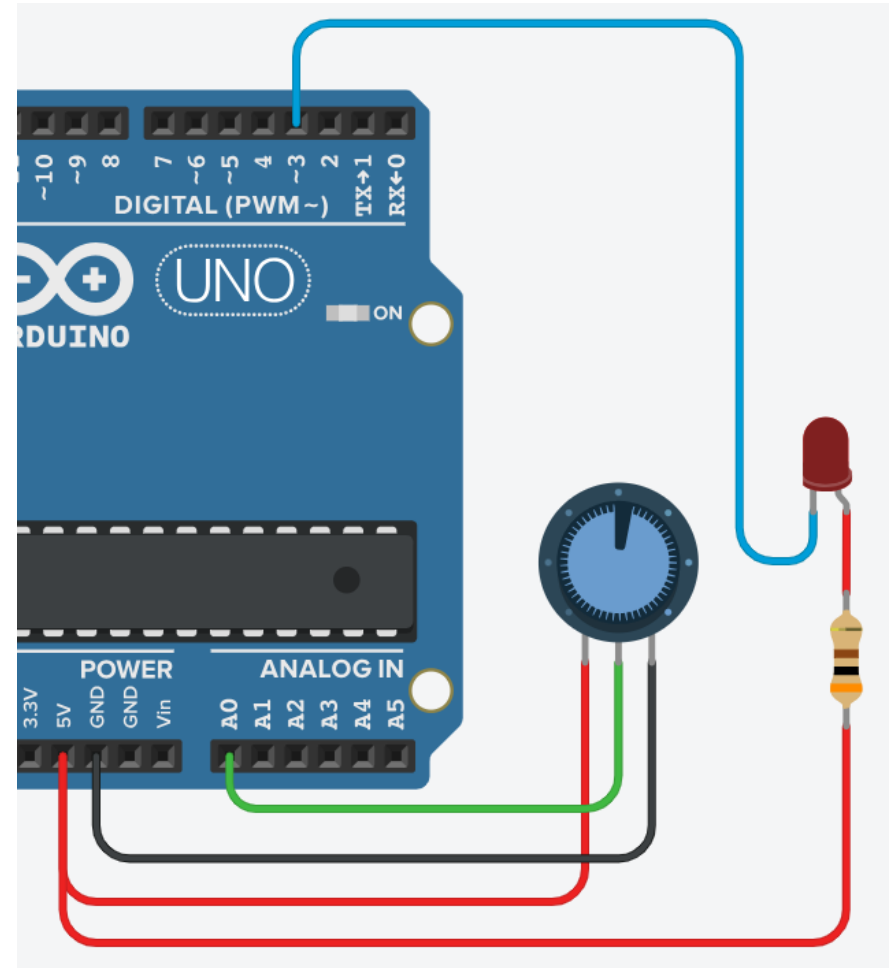
analogWrite / analogRead 실험

```
void setup ()
{
  Serial.begin(9600);
  pinMode(3, OUTPUT);
}

void loop()
{
  int val = analogRead(A0);
  Serial.print("Analog : ");
  Serial.println(val);

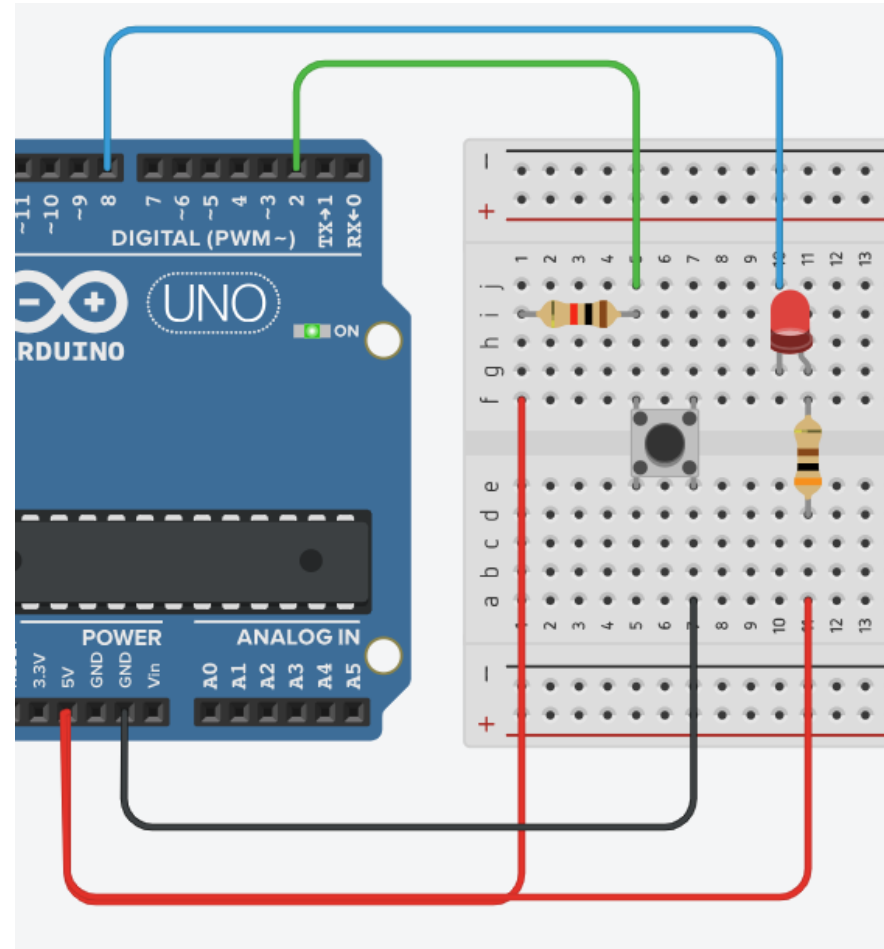
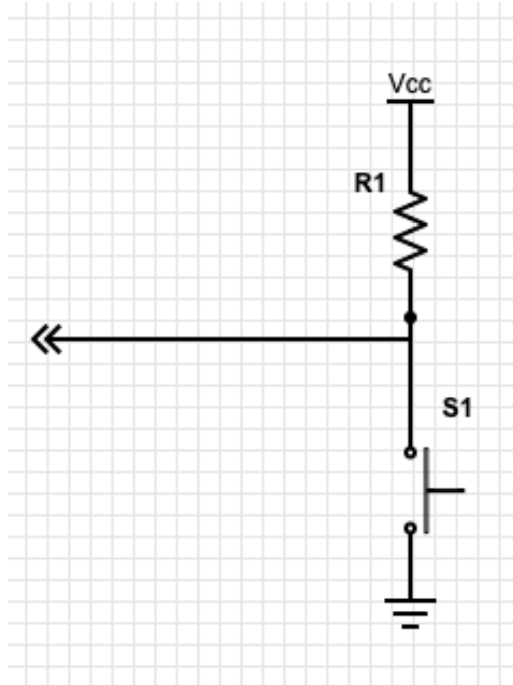
  val = val / 4 ;

  analogWrite(3, val);
}
```



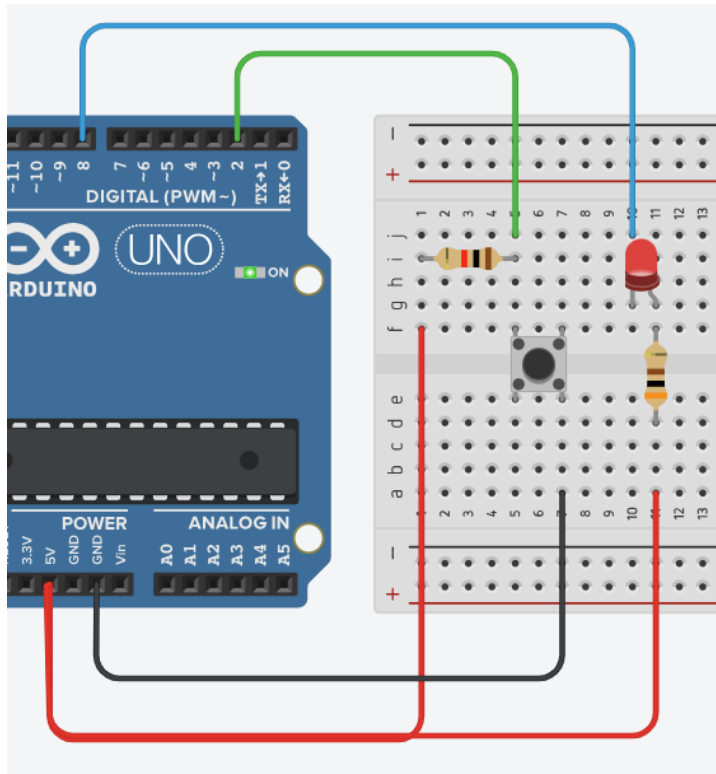
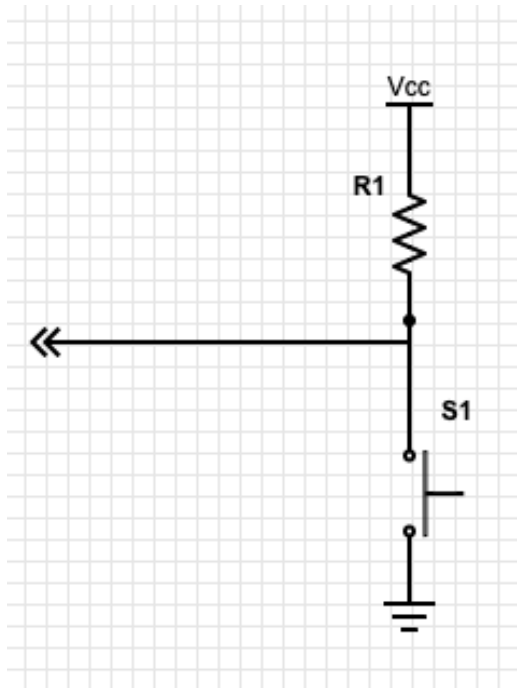
외부 인터럽트(External Interrupt)

- 펄싱 vs 인터럽트



외부 인터럽트(External Interrupt)

- 풀링 vs 인터럽트



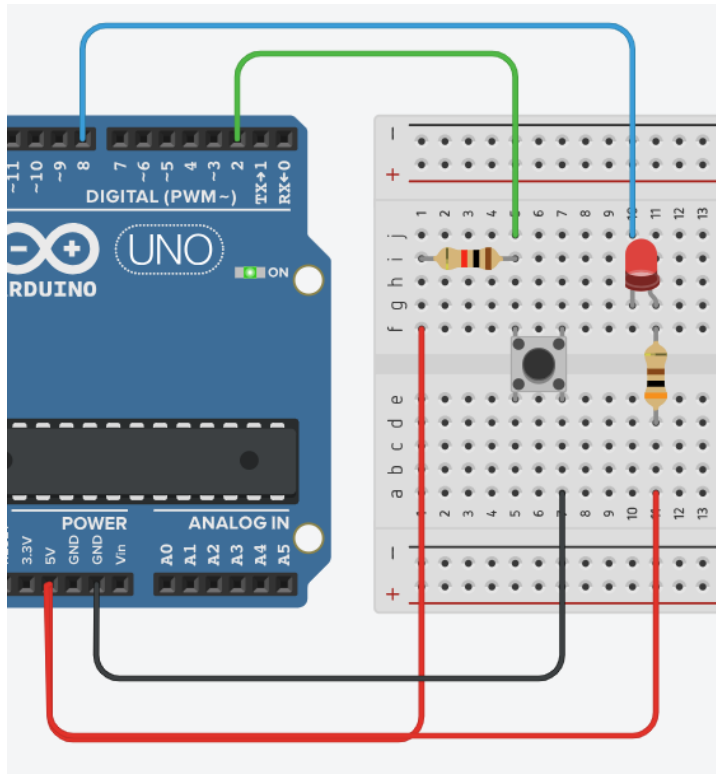
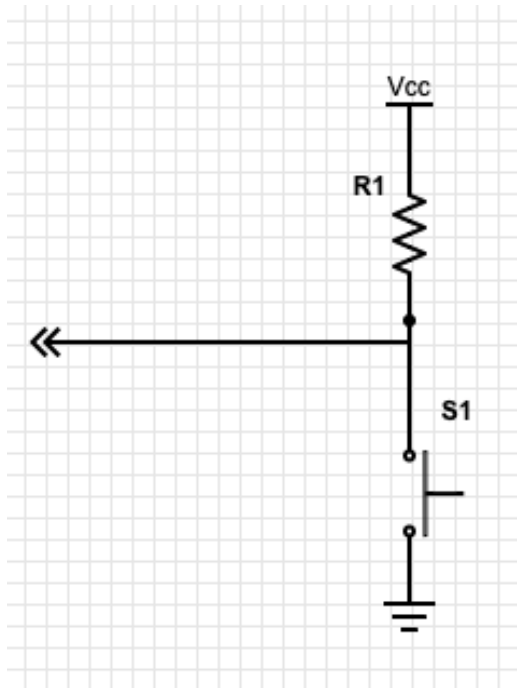
```
void setup()
{
  pinMode(2, INPUT) ;
  pinMode(8, OUTPUT) ;
}

void loop()
{
  int input = digitalRead(2) ;

  if( input == 0 )
  {
    digitalWrite(8, 0) ;
  }
  else
  {
    digitalWrite(8, 1) ;
  }
}
```

외부 인터럽트(External Interrupt)

- 풀링 vs 인터럽트



```
void setup()
{
  pinMode(2, INPUT) ;
  pinMode(8, OUTPUT) ;

  Serial.begin(9600) ;
}

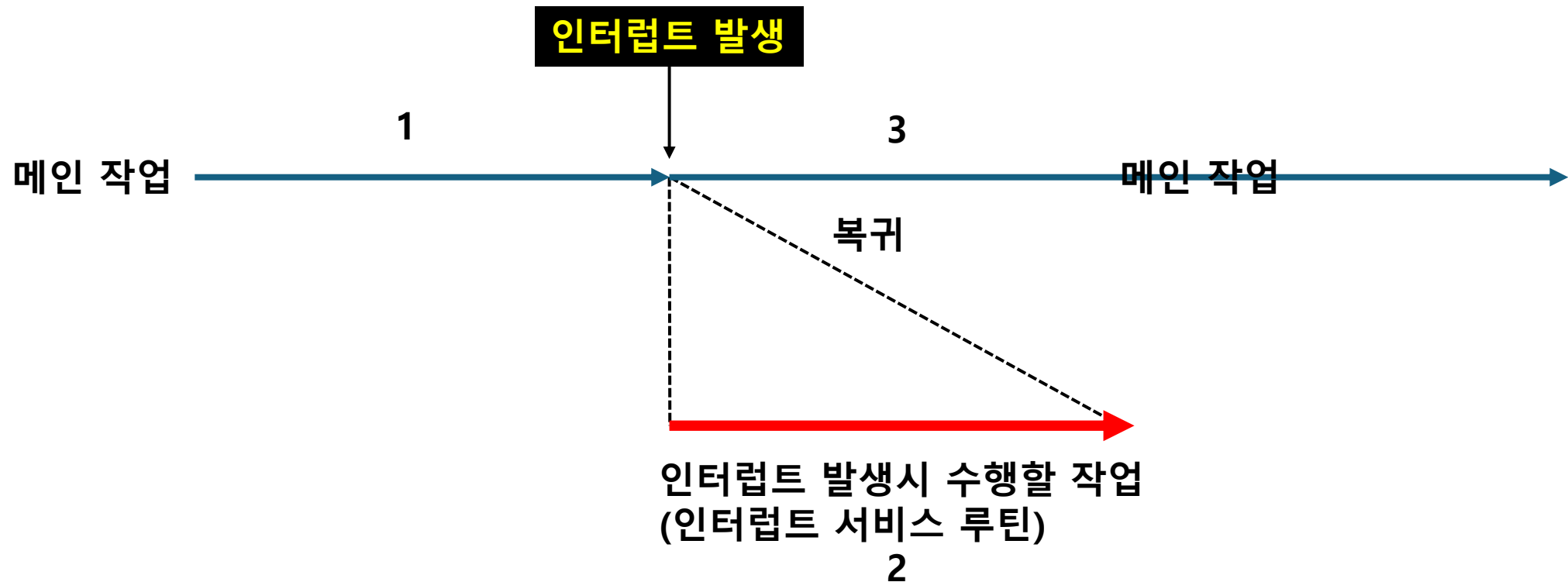
void loop()
{
  digitalWrite(8, 0) ;
  delay(1000) ;

  digitalWrite(8, 1) ;
  delay(1000) ;

  int input = digitalRead(2) ;
  if( input == 0 )
  {
    Serial.println("key") ;
  }
}
```

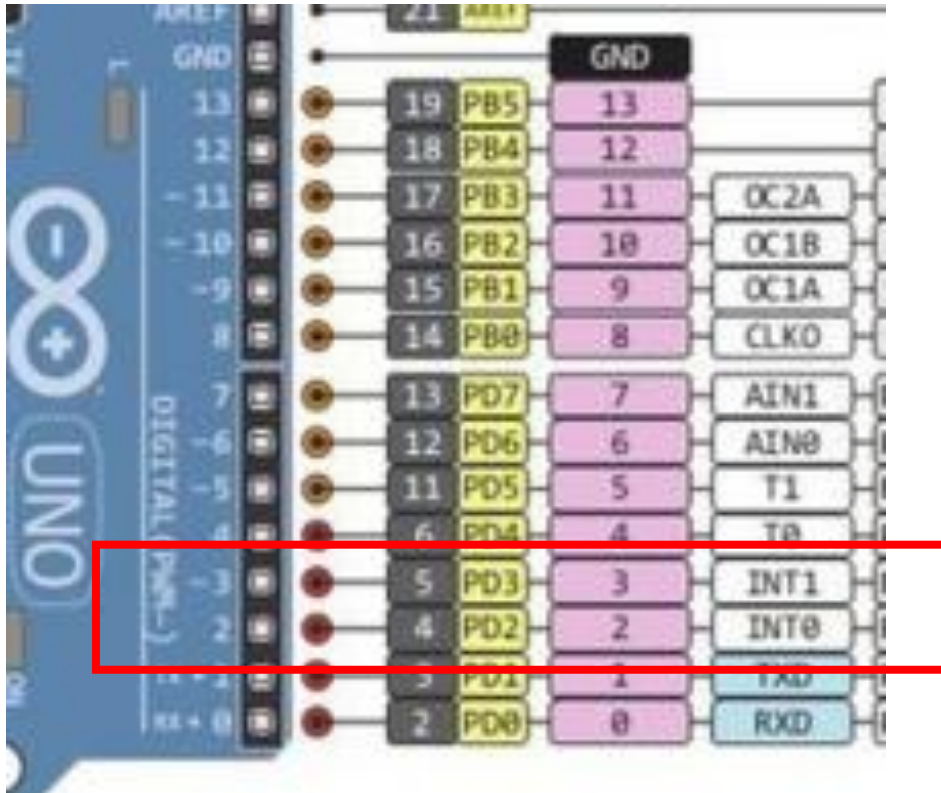
외부 인터럽트(External Interrupt)

- 폴링 vs 인터럽트



외부 인터럽트(External Interrupt)

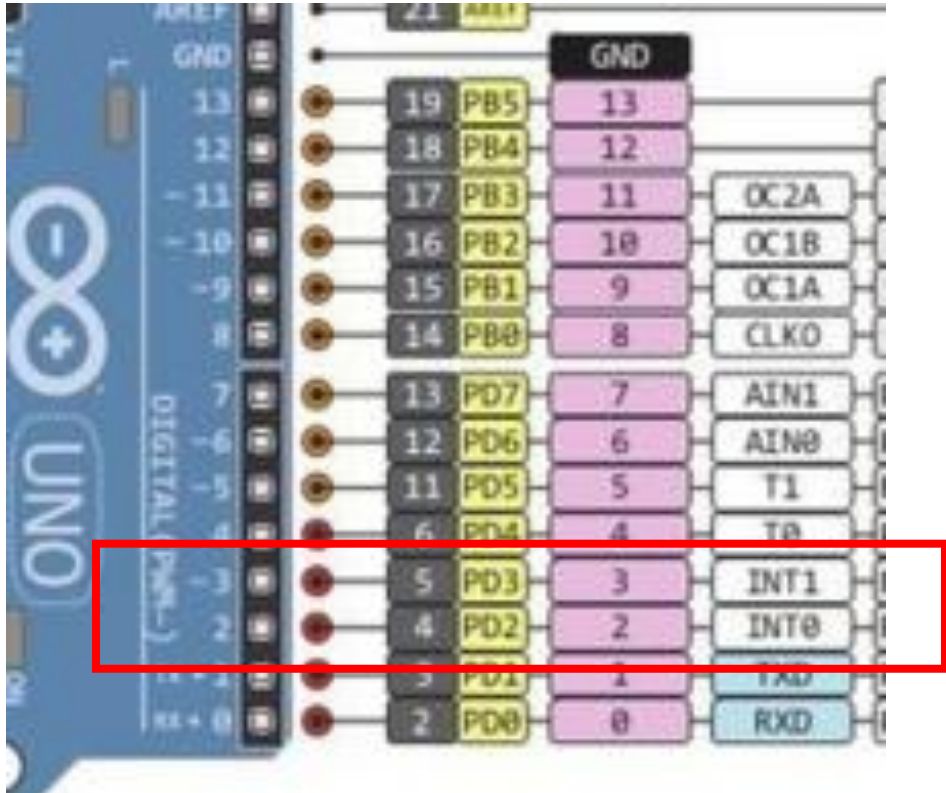
- 폴링 vs 인터럽트



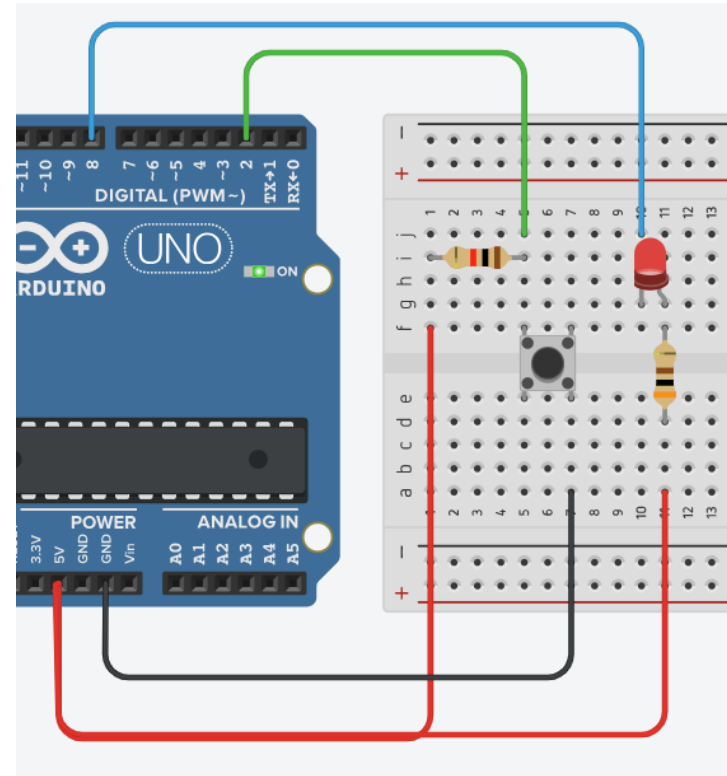
- INT1 : Interrupt #1
- INT0 : Interrupt #0

외부 인터럽트(External Interrupt)

- 폴링 vs 인터럽트



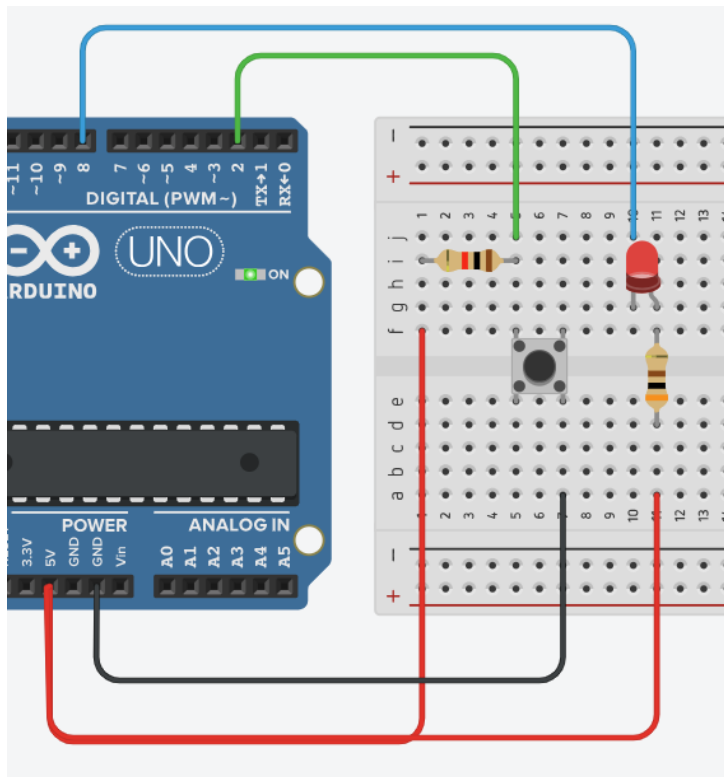
2 → INT0 : Interrupt #0



외부 인터럽트(External Interrupt)

- 폴링 vs 인터럽트

2 → INT0 : Interrupt #0



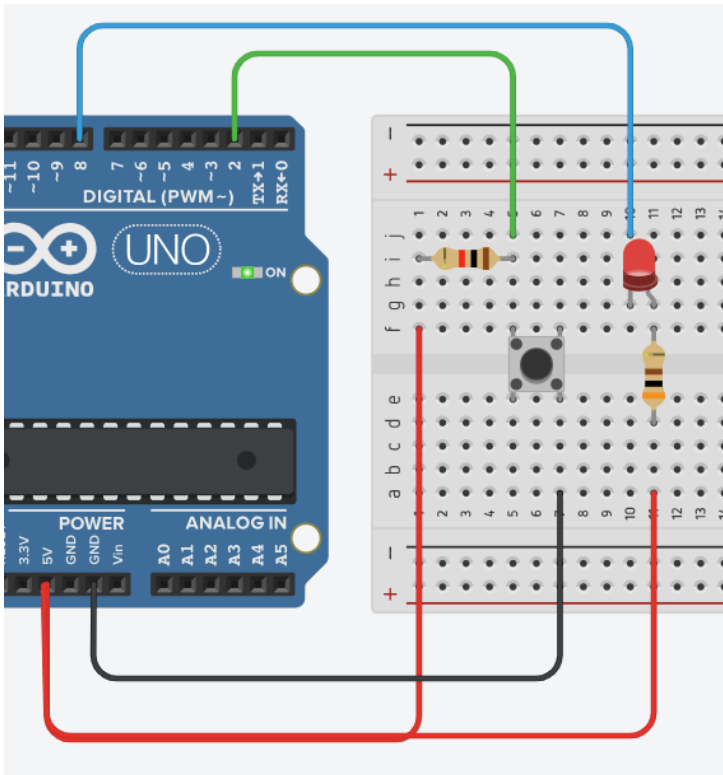
인터럽트 발동 조건 (mode)

모드	상태
LOW	핀이 LOW일때
CHANGE	LOW->HIGH or HIGH->LOW로 변할 때
RISING	LOW ->HIGH일때
FALLING	HIGH -> LOW일때
HIGH	핀이 HIGH일때

외부 인터럽트(External Interrupt)

- 폴링 vs 인터럽트

2 → INT0 : Interrupt #0



```
attachInterrupt( digitalPinToInterrupt(핀번호), 서비스루틴함수명, 모드 );
```

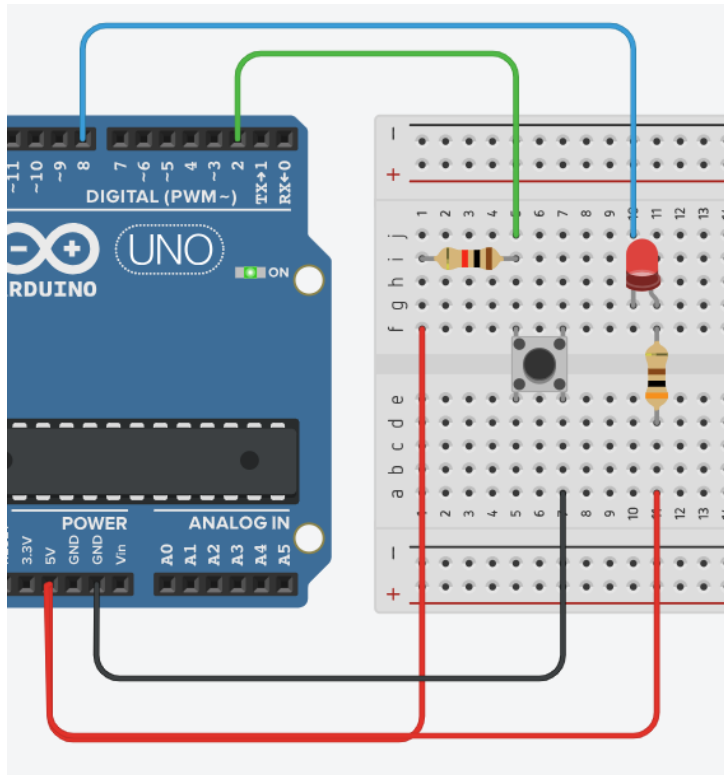
인터럽트 발동 조건 (mode)

모드	상태
LOW	핀이 LOW일때
CHANGE	LOW->HIGH or HIGH->LOW로 변할 때
RISING	LOW ->HIGH일때
FALLING	HIGH -> LOW일때
HIGH	핀이 HIGH일때

외부 인터럽트(External Interrupt)

• 폴링 vs 인터럽트

2 → INT0 : Interrupt #0



```
attachInterrupt( digitalPinToInterrupt(2), ExINT, FALLING );
```

```
attachInterrupt( digitalPinToInterrupt(핀번호), 서비스루틴함수명, 모드 );
```

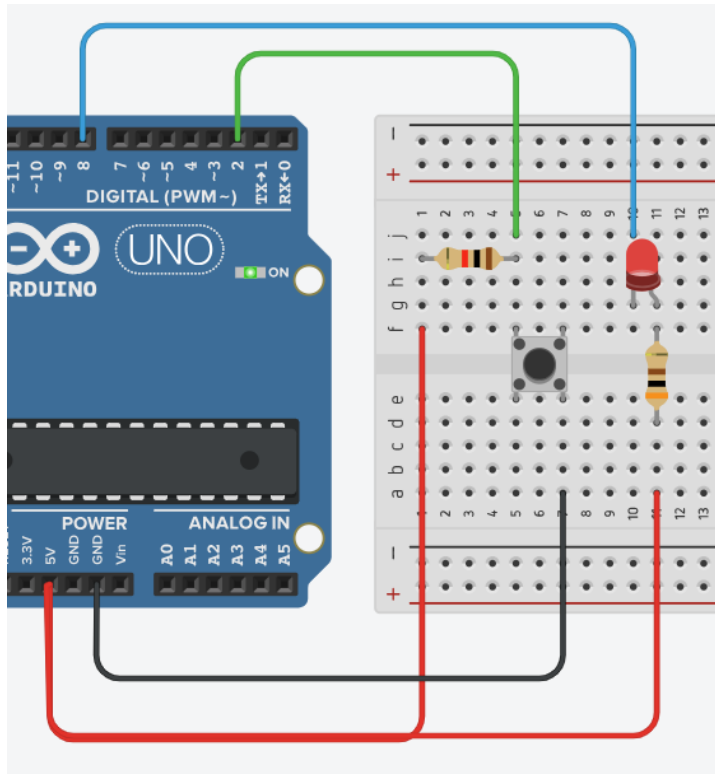
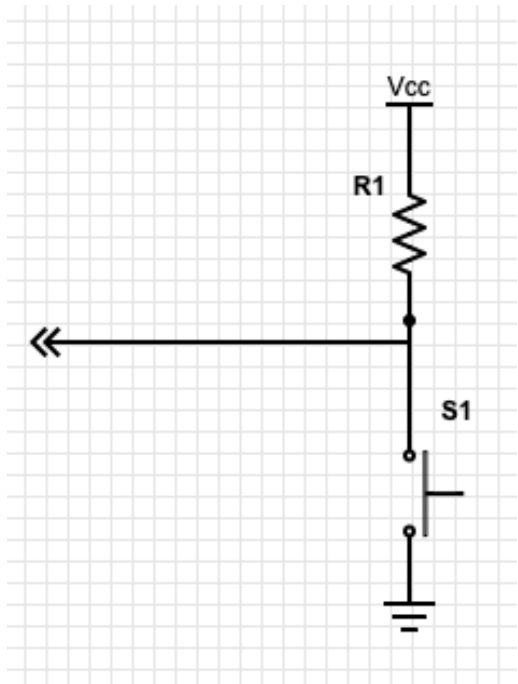
인터럽트 발동 조건 (mode)

모드	상태
LOW	핀이 LOW일때
CHANGE	LOW->HIGH or HIGH->LOW로 변할 때
RISING	LOW ->HIGH일때
FALLING	HIGH -> LOW일때
HIGH	핀이 HIGH일때

외부 인터럽트(External Interrupt)

- 폴링 vs 인터럽트

`attachInterrupt(digitalPinToInterrupt(2), ExINT, FALLING);`



```
void setup()
{
  pinMode(8, INPUT) ;
  pinMode(2, OUTPUT) ;

  attachInterrupt( digitalPinToInterrupt(2), ExINT, FALLING );

  Serial.begin(9600) ;
}

void loop()
{
  digitalWrite(2, 0) ;
  delay(1000) ;

  digitalWrite(2, 1) ;
  delay(1000) ;
}

void ExINT()
{
  Serial.println("ExINT") ;
}
```