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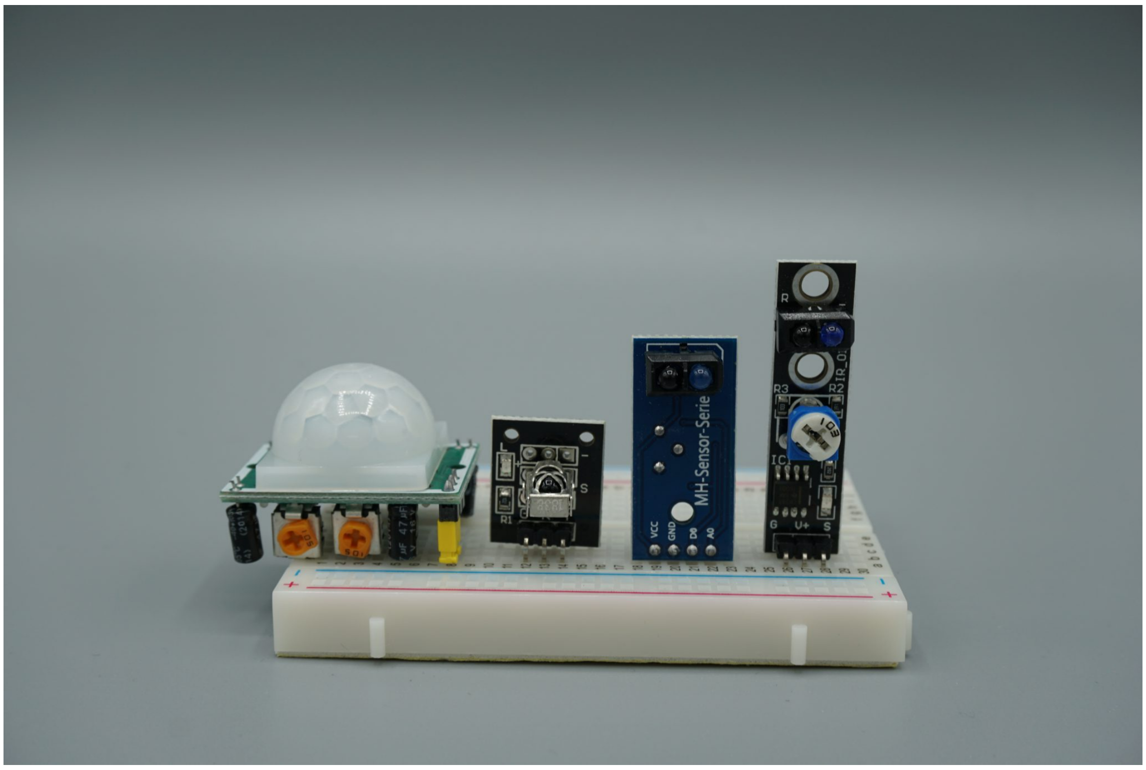
Infrared Sensor Tutorial for Arduino, ESP8266 and ESP32 - DIYI0T

Daan 5. June 2020 at 20:11

12-15 minutes

In this tutorial we will see how to use an infrared sensor. We take a look at three different types of infrared modules.

- Infrared sensor for object detection.
- Passive infrared sensor to detect a person in front of a device like a monitor.
- Infrared distance module which can be used in robotic use cases where a car follows a line.

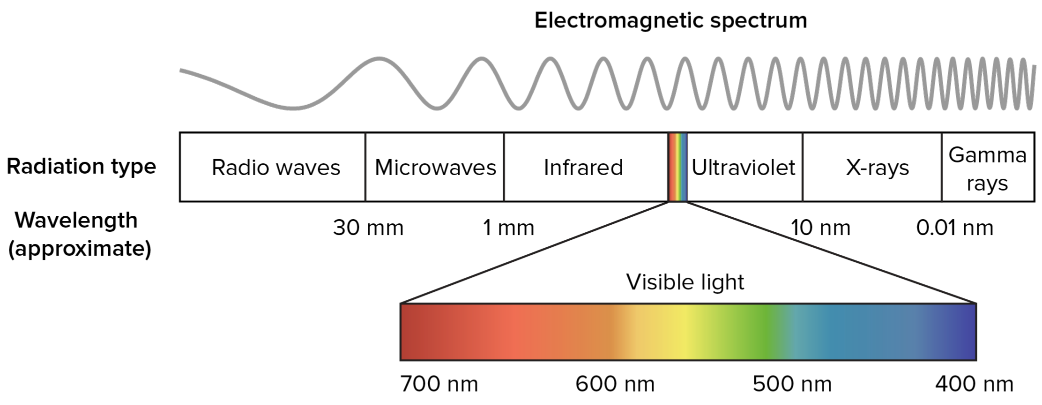


Infrared radiation (IR) or infrared light is an electromagnetic

radiation (EMR) and carries radiant energy like all EMR. Although IR behaves both like a wave and like its quantum particle, the photon.
Infrared light is not visible for humans because of longer wavelength as the human eye is capable to see:

- Wavelength infrared: 700nm to 1000nm
- Human visible wavelength: 400nm to 700nm

The following pictures gives you an overview about the electromagnetic spectrum.



But there is a possibility to see the infrared light. You can see the light via your mobile phone, because the camera of you mobile phone see the light emitted by the infrared diode. You will see that the light is flickering because the infrared diode will turn on an off very fast. There is a rhythm behind this behavior which is necessary to encode the information sent from the diode.

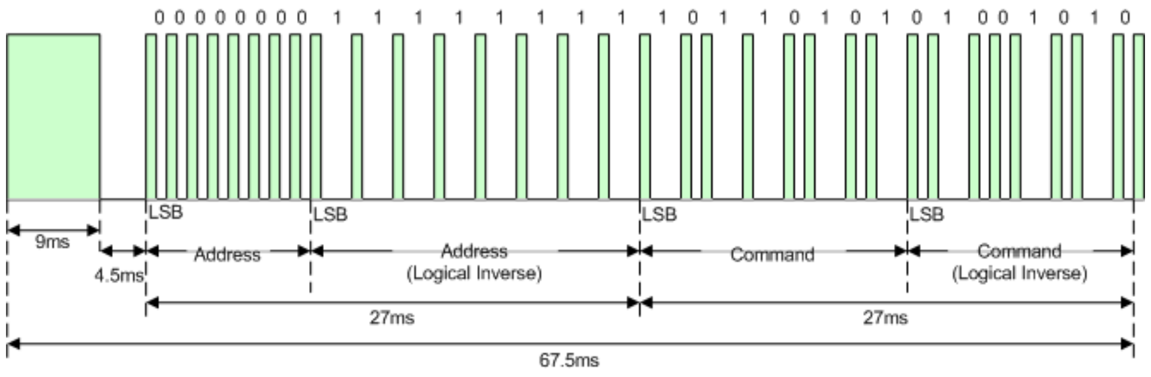
Therefore we can use the IR by sending information as analog signals and encode these signals with a sensor. The following chapters describe normal infrared sensors and passive infrared sensors. Moreover we will discuss the use of infrared distance modules.

NEC Infrared Transmission Protocol

The NEC IR transmission protocol uses pulse distance encoding of the message bits. Each pulse burst (mark – RC transmitter ON) is 562.5µs in length, at a carrier frequency of 38kHz (26.3µs). Logical bits are transmitted as follows:

- Logical ‘0’ – a 562.5µs pulse burst followed by a 562.5µs space, with a total transmit time of 1.125ms
- Logical ‘1’ – a 562.5µs pulse burst followed by a 1.6875ms space, with a total transmit time of 2.25ms

When a key is pressed on the remote controller, the message transmitted consists of the following, in order:



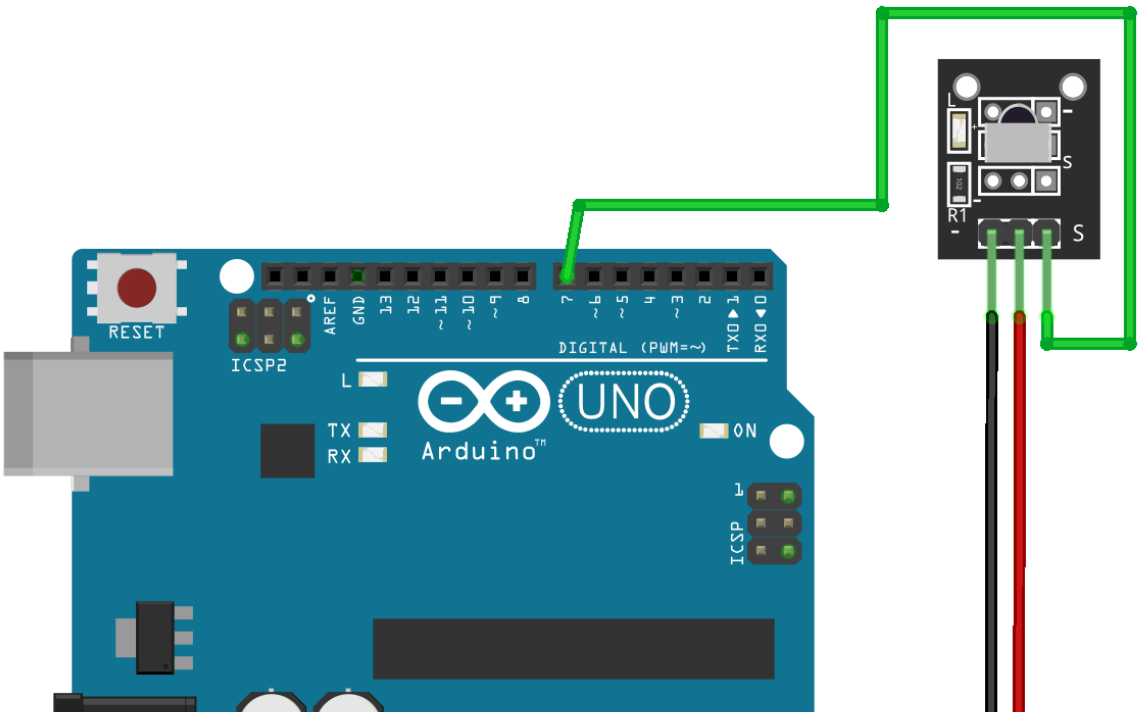
1. a 9ms leading pulse burst (16 times the pulse burst length used for a logical data bit)
2. a 4.5ms space
3. the 8-bit address for the receiving device
4. the 8-bit logical inverse of the address
5. the 8-bit command
6. the 8-bit logical inverse of the command
7. a final 562.5µs pulse burst to signify the end of message transmission

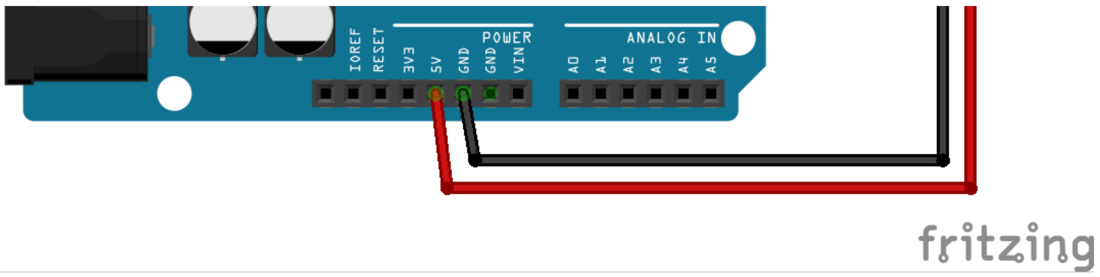
The following table gives you an overview of all components and parts that I used for this tutorial. I get commissions for purchases made through links in this table.

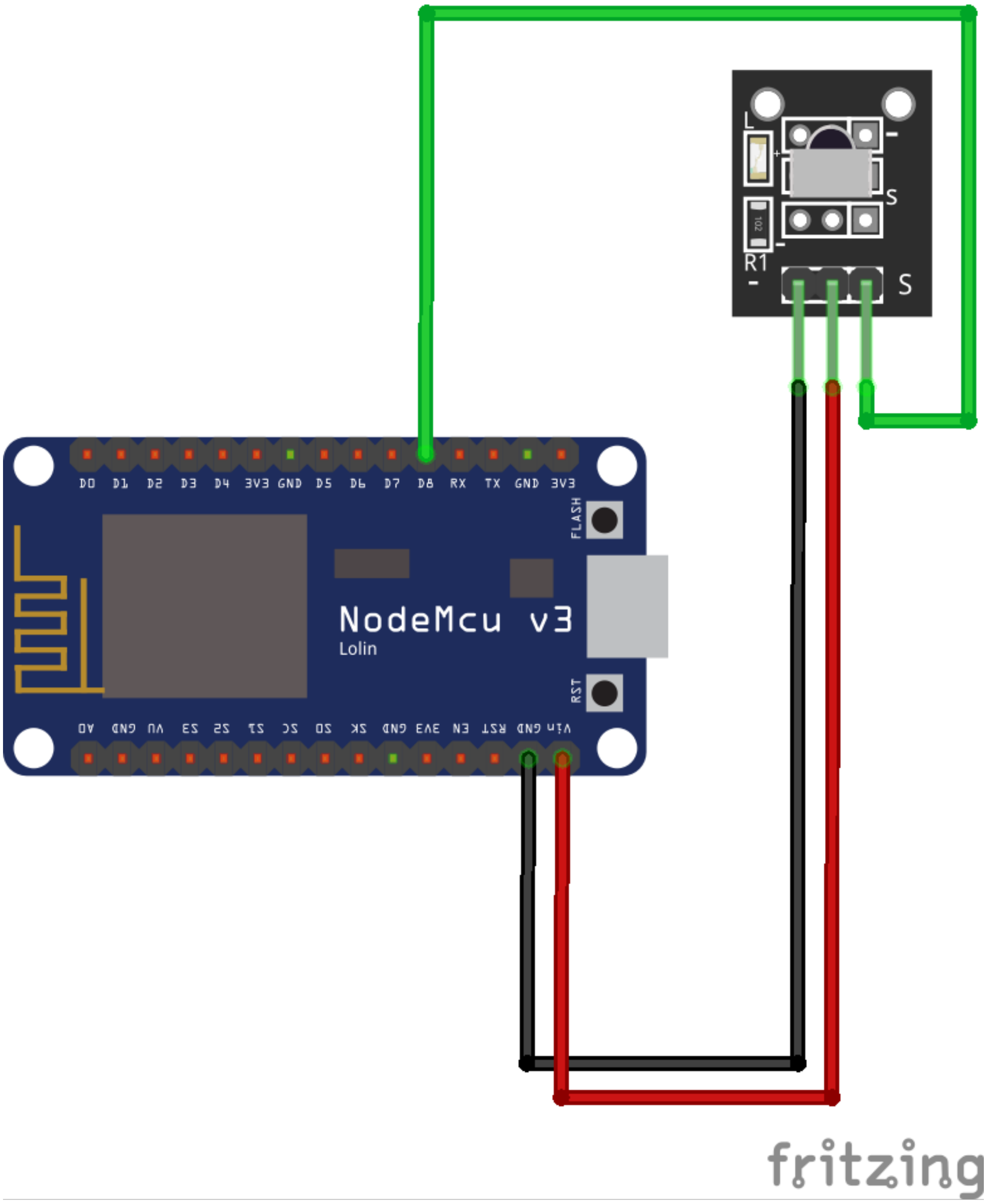
With the help of an infrared sensor the Arduino board is able to receive information from an infrared remote and take action based on the button you pushed on the infrared remote. Therefore the sensor scans specific frequency ranges, defined by standards, and convert these signals to the output pins of the sensor. The most basic infrared sensor is the VS1838B.

For operation the sensor receives and IR signal which have to be encoded.
There is the library “IRremote” from Ken Shirriff which encode the light pulse and will output a HEX code depending on the information sent by the infrared diode. I suggest to use the library because the decoding of the different manufacturer is quite difficult. You find here the article how to install a library in your Arduino IDE. You find the regarding library in the search field with the keyword “irremote”.
Sadly the library “IRremote” does not support boars based on the ESP8266 like the NodeMCU. But there is another library called “IRremoteESP8266” you have to use.

The following picture shows the connections between the infrared sensors and the Arduino Uno and the NodeMCU.



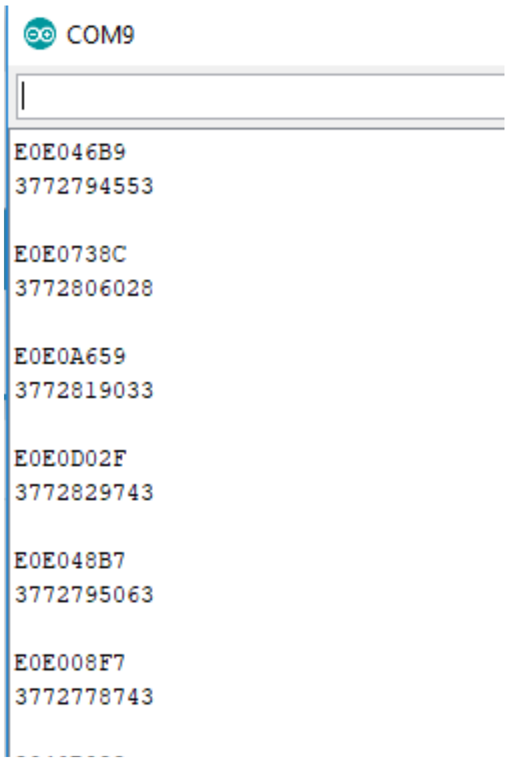




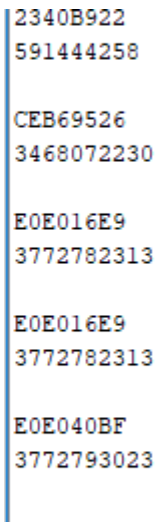
After we connect our devices we will go into the code. Our objective is to print out the code in HEX and Decimal (DEZ) when we push different buttons on the infrared remote control. In this example I use my TV remote control.

```
#include "IRremote.h"
```

```
const int RECV_PIN = 7;
IRrecv irrecv(RECV_PIN);
decode_results results;

void setup(){
  Serial.begin(9600);
  irrecv.enableIRIn();
  irrecv.blink13(true);
}

void loop(){
  if (irrecv.decode(&results)){
        Serial.println(results.value, HEX);
        Serial.println(results.value, DEC);
        irrecv.resume();
        Serial.println();
  }
}
```



```
E0E046B9
3772794553

E0E0738C
3772806028

E0E0A659
3772819033

E0E0D02F
3772829743

E0E048B7
3772795063

E0E008F7
3772778743
```



```
2340B922
591444258

CEB69526
3468072230

E0E016E9
3772782313

E0E016E9
3772782313

E0E040BF
3772793023
```

With the help of this example you can identify all key codes of the remote control. After the identification you are able to react to different buttons on the remote control. On example could be that you want to turn on a red LED when you press volume up and you turn on a green LED when you press volume down on you remote control. Feel free to think about different use cases and try to program the corresponding sketch.

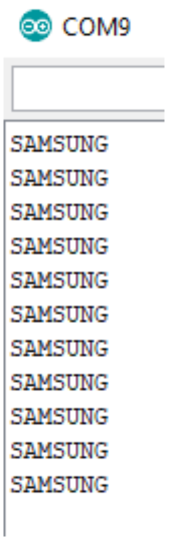
What if I do not know which protocol to use?

If you do not know which protocol to use, you can use the following sketch to find out what protocol to use.

```
#include "IRremote.h"

const int RECV_PIN = 7;
IRrecv irrecv(RECV_PIN);
decode_results results;

void setup(){
  Serial.begin(9600);
  irrecv.enableIRIn();
  irrecv.blink13(true);
}
```

```
void loop(){
  if (irrecv.decode(&results)){
        switch (results.decode_type){
            case NEC: Serial.println("NEC");
break ;
            case SONY: Serial.println("SONY");
break ;
            case RC5: Serial.println("RC5");
break ;
            case RC6: Serial.println("RC6");
break ;
            case DISH: Serial.println("DISH");
break ;
            case SHARP:
Serial.println("SHARP"); break ;
            case JVC: Serial.println("JVC");
break ;
            case SANYO:
Serial.println("SANYO"); break ;
            case MITSUBISHI:
Serial.println("MITSUBISHI"); break ;
            case SAMSUNG:
Serial.println("SAMSUNG"); break ;
            case LG: Serial.println("LG");
break ;
            case WHYNTER:
Serial.println("WHYNTER"); break ;
            case AIWA_RC_T501:
Serial.println("AIWA_RC_T501"); break ;
            case PANASONIC:
Serial.println("PANASONIC"); break ;
            case DENON:
```

```
Serial.println("DENON"); break ;
          default:
            case UNKNOWN:
Serial.println("UNKNOWN"); break ;
          }
        irrecv.resume();
 }
}
```



```
SAMSUNG
SAMSUNG
SAMSUNG
SAMSUNG
SAMSUNG
SAMSUNG
SAMSUNG
SAMSUNG
SAMSUNG
SAMSUNG
SAMSUNG
```

Because I used for my example the TV remote control, you see that I have a Samsung TV.

The HC-SR501 has a build in voltage regulator on the PCB. Because the HC-SR501 is designed for Arduino boards, the sensor requires an operation voltage of 5V. However there is a possibility to get the HC-SR501 running for NodeMCU. You have to connect the Power Pin with the middle pin of the voltage regulator.

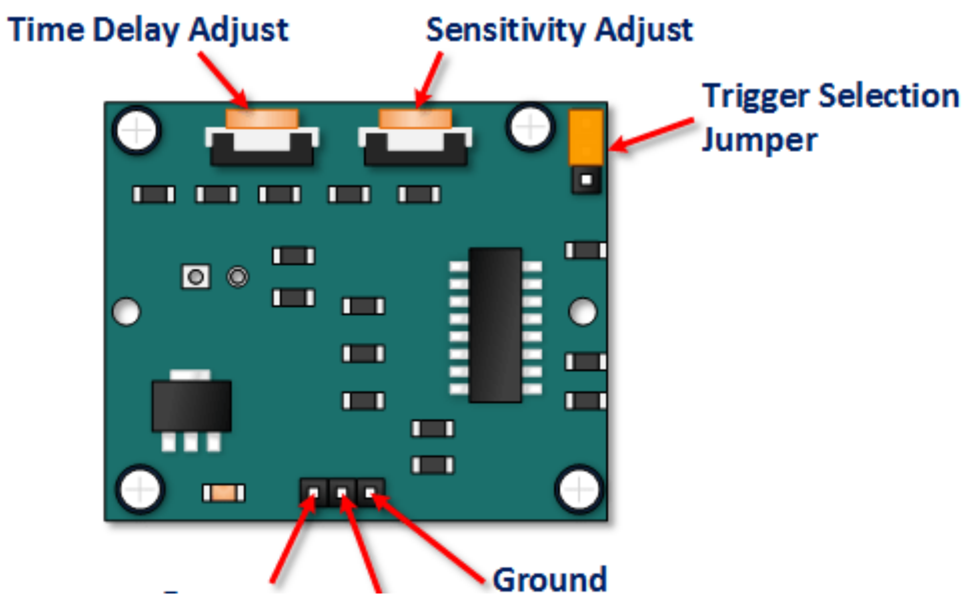
Passive infrared sensors are often used in systems when a device like a monitor should come back from energy save mode. Also these kind of sensors are used in motion alarm detectors.

All objects above a temperature of absolute zero emit heat energy in form of infrared radiation. Passive infrared (PIR) sensors like the HC-SR501 convert these infrared radiation into output voltage. Therefore the movement of an object results in a change in the infrared radiation level is detected by the PIR sensor.

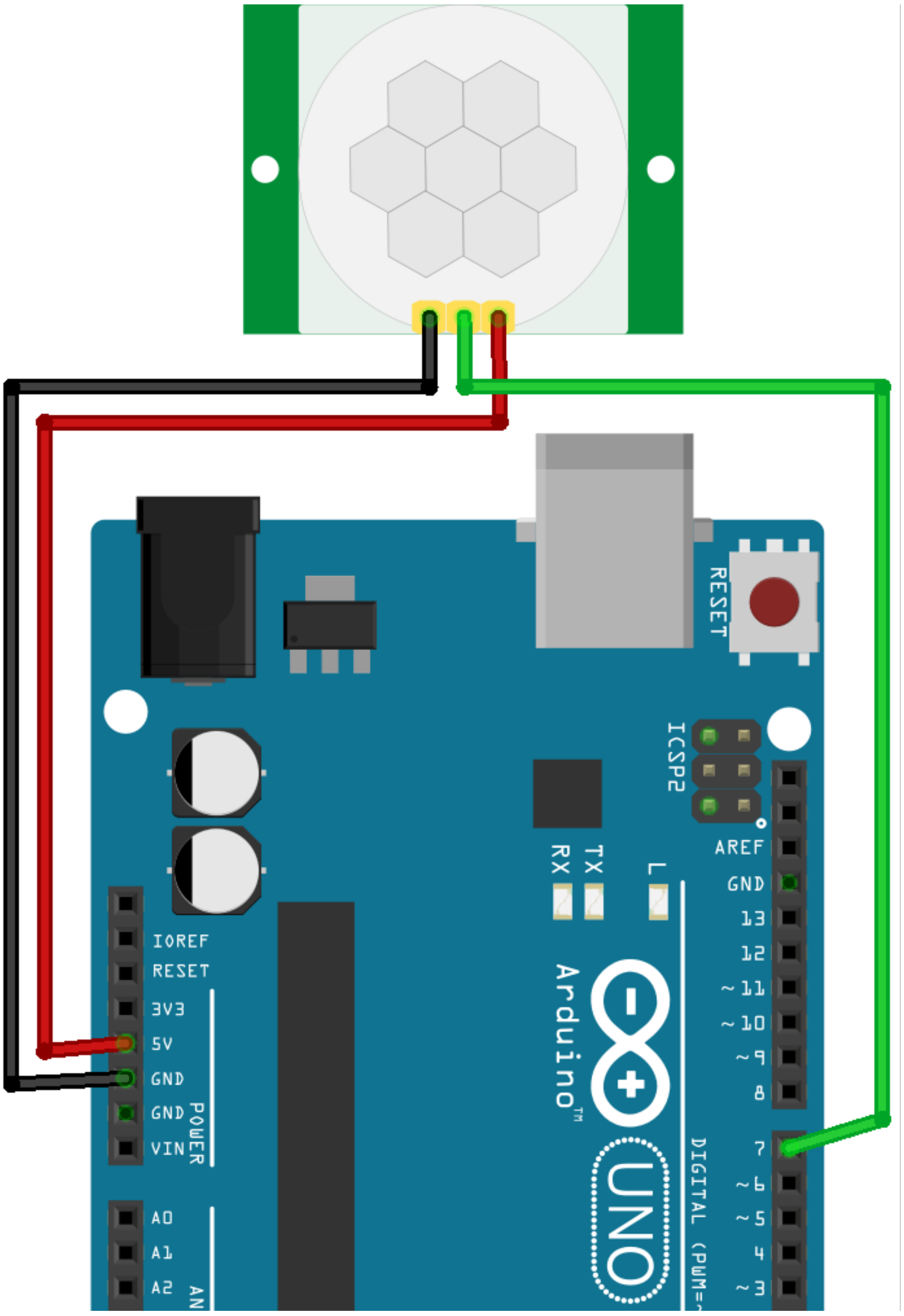
After switching the sensor on, the PIR sensor requires 60 seconds to stabilize the current level of radiation. The HC-SR501 sensor has a 110 degree field of view and an operating range of 6 meters because of the Fresnel lenses. After a movement is detected the output is HIGH for 2.5 seconds after the movement is detected and switches back to LOW after the time.

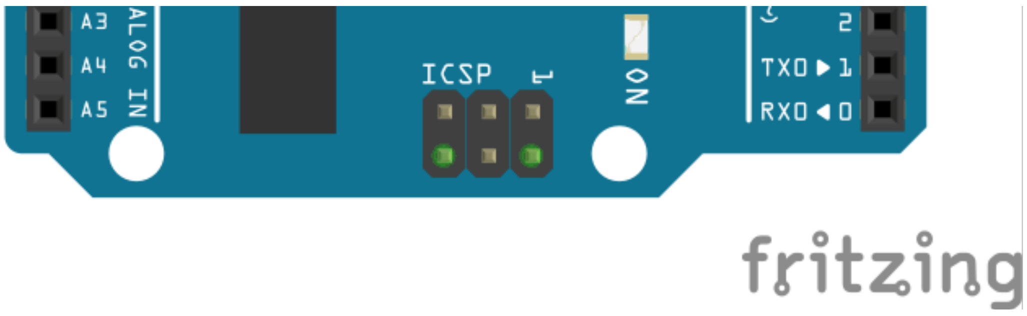
With the use of the build in potentiometer you can adjust the time delay and the sensitivity of the sensor. The following table shows both maximum position of the potentiometer and the resulting settings.

Position of potentiometer	Degree of sensitivity	Time delay	Distance range
Most counterclockwise	High sensitivity	2.5 seconds	3 meters
Less counterclockwise	Low sensitivity	5 minutes	7 meters



After we connect our devices we will go into the code. Our objective is to detect if someone stays in front of the sensor. Therefore the sensitivity has to be high and the position of the potentiometer most counterclockwise.





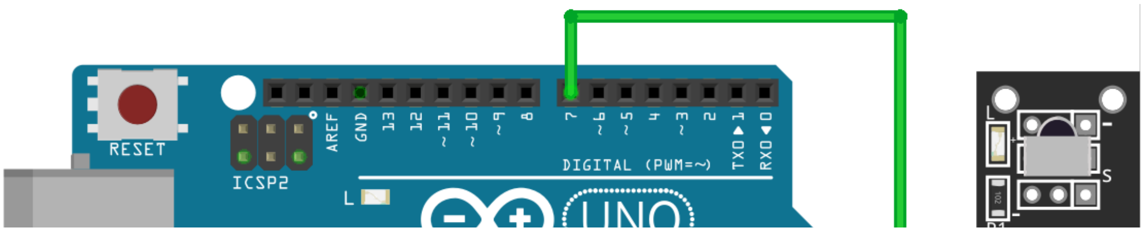
```
int inputPin = 7;               // input pin
(for PIR sensor)
int pirState = LOW;             // we start,
assuming no motion detected
int val = 0;                    // variable for
reading the pin status

void setup() {
  pinMode(inputPin, INPUT);     // declare
sensor as input
  Serial.begin(9600);
}

void loop(){
  val = digitalRead(inputPin);  // read input
value
  if (val == HIGH) {            // check if the
input is HIGH
    if (pirState == LOW) {
      // we have just turned on
      Serial.println("Motion detected!");
      // We only want to print on the output
change, not state
      pirState = HIGH;
    }
  } else {
    if (pirState == HIGH){
      // we have just turned of
      Serial.println("Motion ended!");
      // We only want to print on the output
change, not state
      pirState = LOW;
    }
  }
}
```

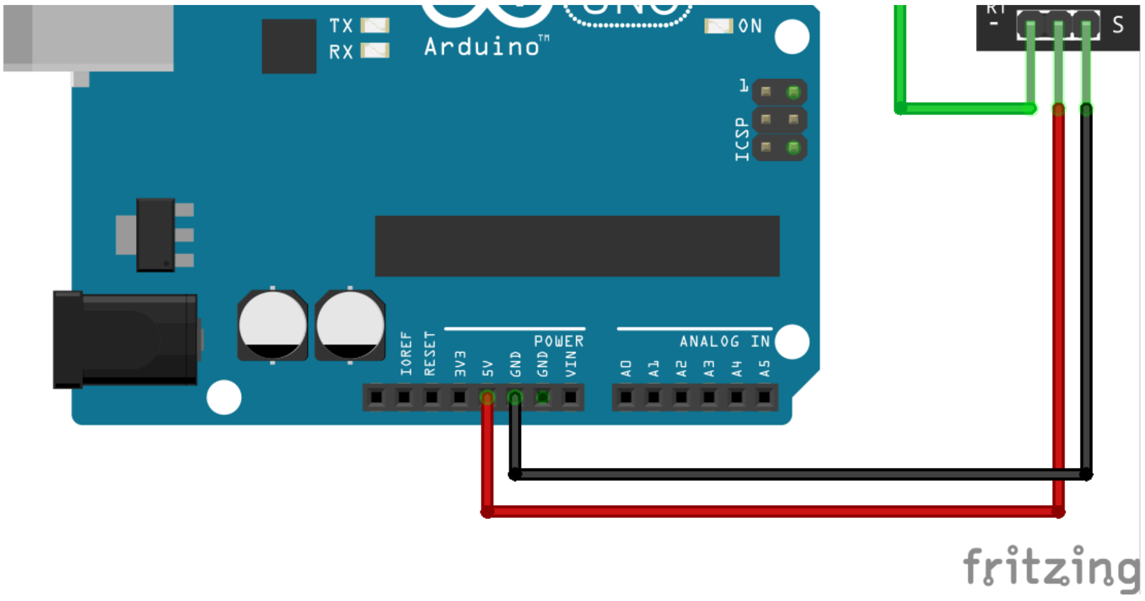
The ultrasonic distance sensor is not the only sensor to detect if an object is in a predefined range in front of a sensor. There is also the infrared distance module. As sensor the TCRT5000 infrared distance module includes an infrared emitter and receiver and a potentiometer and is most often used. The module has also a potentiometer to define the threshold when an object is detected.

If the sensor is connected to the power source, the infrared diode is emitting the infrared light continuously. The distance measured by the sensor depends on the color of the surface. Different colors are measured by the reflecting factor because a black surfaces reflects less light than a white surface. Therefor the sensor is often used in follow the line robot projects. In our example we will investigate the impact of different colors on the sensors measurement.

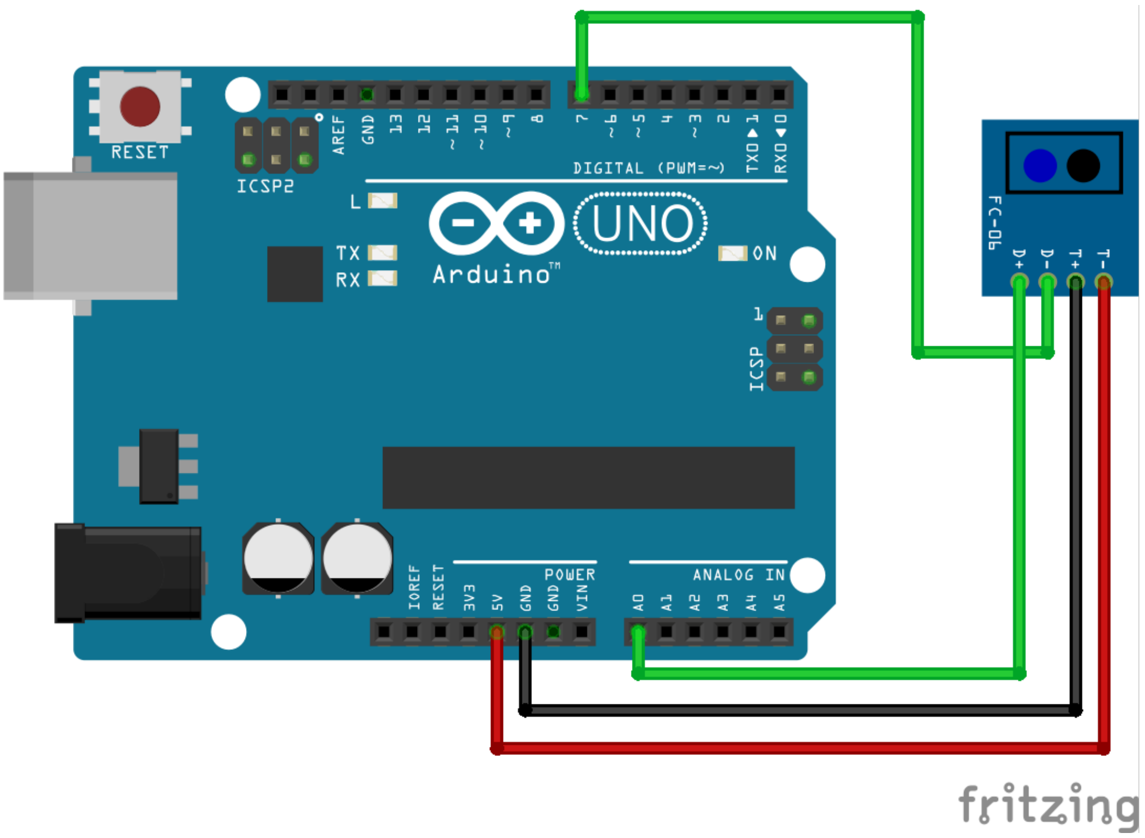
If the received signal is greater than the threshold then the TRCT500 D0 pin state changes from LOW to HIGH and the onboard LED shows that an object is located.

Infrared Distance Module without analog output





Infrared Distance Module with analog output



TCRT5000 infrared distance module with analog output	TCRT5000 infrared distance module without analog output	Arduino Uno / NodeMCU
VCC	VCC	5V / VIN
GND	GND	GND

D0	D0	Digital I/O
A0		A0

After we connect our devices we will go into the code. Our objective is to measure different distances the sensor is able to receive and we will test the influence of different colors.

Infrared Distance Module without analog output

The distance module without analog output can not measure the distance because therefore the sensor needs the analog values. But the sensor has the digital output to detect an object.

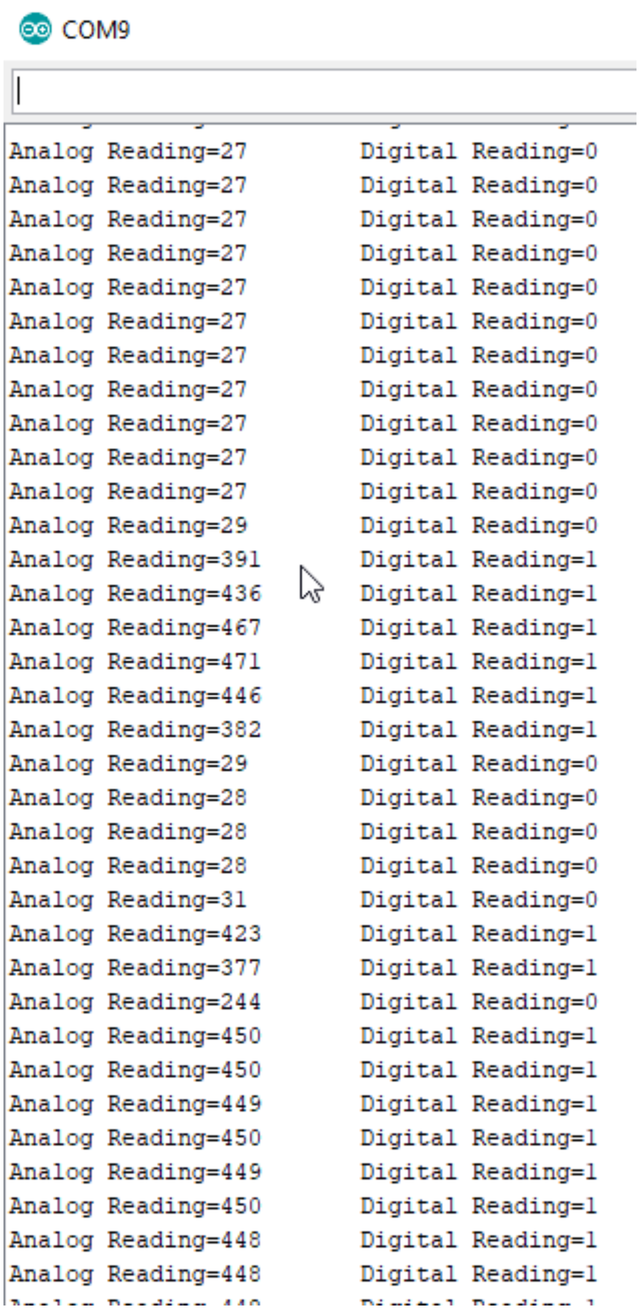
```
const int trackingPin = 7;
const int ledPin = 13; //pin13 built-in led
void setup()
{
  pinMode(trackingPin, INPUT); // set 
trackingPin as INPUT
  pinMode(ledPin, OUTPUT); //set ledPin as 
OUTPUT
}
void loop()
{
  boolean val = digitalRead(trackingPin); // 
read the value of tracking module
  if(val == HIGH) //if it is HiGH
  {
    digitalWrite(ledPin, LOW); //turn off the 
led
  }
  else
  {
    digitalWrite(ledPin, HIGH); //turn on the
led
  }
}
```

Infrared Distance Sensor 2

Infrared Distance Module with analog output

The infrared sensor with analog output can measure the distance to the target object and also the color of the target object.

```
const int pinIRd = 7;
const int pinIRa = A0;
int IRvalueA = 0;
int IRvalueD = 0;

void setup()
{
  Serial.begin(9600);
  pinMode(pinIRd,INPUT);
  pinMode(pinIRa,INPUT);

}

void loop()
{
  IRvalueA = analogRead(pinIRa);
  IRvalueD = digitalRead(pinIRd);

  Serial.print("Analog Reading=");
  Serial.print(IRvalueA);
  Serial.print("\t Digital Reading=");
  Serial.println(IRvalueD);
  delay(1000);

}
```



```
Analog Reading=27        Digital Reading=0
Analog Reading=27        Digital Reading=0
Analog Reading=27        Digital Reading=0
Analog Reading=27        Digital Reading=0
Analog Reading=27        Digital Reading=0
Analog Reading=27        Digital Reading=0
Analog Reading=27        Digital Reading=0
Analog Reading=27        Digital Reading=0
Analog Reading=27        Digital Reading=0
Analog Reading=27        Digital Reading=0
Analog Reading=27        Digital Reading=0
Analog Reading=29        Digital Reading=0
Analog Reading=391       Digital Reading=1
Analog Reading=436       Digital Reading=1
Analog Reading=467       Digital Reading=1
Analog Reading=471       Digital Reading=1
Analog Reading=446       Digital Reading=1
Analog Reading=382       Digital Reading=1
Analog Reading=29        Digital Reading=0
Analog Reading=28        Digital Reading=0
Analog Reading=28        Digital Reading=0
Analog Reading=28        Digital Reading=0
Analog Reading=31        Digital Reading=0
Analog Reading=423       Digital Reading=1
Analog Reading=377       Digital Reading=1
Analog Reading=244       Digital Reading=0
Analog Reading=450       Digital Reading=1
Analog Reading=450       Digital Reading=1
Analog Reading=449       Digital Reading=1
Analog Reading=450       Digital Reading=1
Analog Reading=449       Digital Reading=1
Analog Reading=450       Digital Reading=1
Analog Reading=448       Digital Reading=1
Analog Reading=448       Digital Reading=1
```

Conclusion

In this article we took a look at three different types of infrared modules. First we saw how we can detect an object with an infrared sensor. With the help of a passive infrared sensor we build a sketch how we can detect a person in front of a device like a monitor. The last sensor was the infrared distance module which can be used in robotic use cases where a car follows a line.

Do you have any further questions about the different infrared modules? Use the comment section below to ask your questions. And what are projects you would like to use the sensors in this article? If you plan to use a distance sensor for a DIY project, check out the article about the ultrasonic distance sensor.