LAMPIRAN

DATASHEET ARDUINO

Product Reference Manual
SKU: A000066

Description

The Arduino UNO R3 is the perfect board to get familiar with electronics and coding. This versatile development board is equipped with the well-known ATmega328P and the ATMega 16U2 Processor.

This board will give you a great first experience within the world of Arduino.

Target areas:

Maker, introduction, industries

Features

- **ATMega328P** Processor
  - **Memory**
    - AVR CPU at up to 16 MHz
    - 32KB Flash
    - 2KB SRAM
    - 1KB EEPROM
  - **Security**
    - Power On Reset (POR)
    - Brown Out Detection (BOD)
  - **Peripherals**
    - 2x 8-bit Timer/Counter with a dedicated period register and compare channels
    - 1x 16-bit Timer/Counter with a dedicated period register, input capture and compare channels
    - 1x USART with fractional baud rate generator and start-of-frame detection
    - 1x controller/peripheral Serial Peripheral Interface (SPI)
    - 1x Dual mode controller/peripheral I2C
    - 1x Analog Comparator (AC) with a scalable reference input
    - Watchdog Timer with separate on-chip oscillator

Six PWM channels

Interrupt and wake-up on pin change

ATMega16U2 Processor

8-bit AVR® RISC-based microcontroller

Memory

16 KB ISP Flash

512B EEPROM

512B SRAM

debugWIRE interface for on-chip debugging and programming

Power

2.7-5.5 volts

CONTENTS

1 The Board

1.1 Application Examples

The UNO board is the flagship product of Arduino. Regardless if you are new to the world of electronics or will use the UNO as a tool for education purposes or industry-related tasks, the UNO is likely to meet your needs.

First entry to electronics: If this is your first project within coding and electronics, get started with our most used and documented board; Arduino UNO. It is equipped with the well-known ATmega328P processor, 14 digital input/output pins, 6 analog inputs, USB connections, ICSP header and reset button. This board includes everything you will need for a great first experience with Arduino.

Industry-standard development board: Using the Arduino UNO R3 board in industries, there are a range of companies using the UNO board as the brain for their PLC's.

Education purposes: Although the UNO R3 board has been with us for about ten years, it is still widely used for various education purposes and scientific projects. The board's high standard and top quality performance makes it a great resource to capture real time from sensors and to trigger complex laboratory equipment to mention a few examples.

1.2 Related Products

- Starter Kit
-
- Arduino UNO R4 Minima
-

Arduino UNO R4 WiFi

Tinkerkit Braccio Robot

2 Ratings

2.1 Recommended Operating Conditions

Symbol	Description	Min	Max
	Conservative thermal limits for the whole board:	-40 °C (-40°F)	85 °C (185°F)

NOTE: In extreme temperatures, EEPROM, voltage regulator, and the crystal oscillator, might not work as expected.

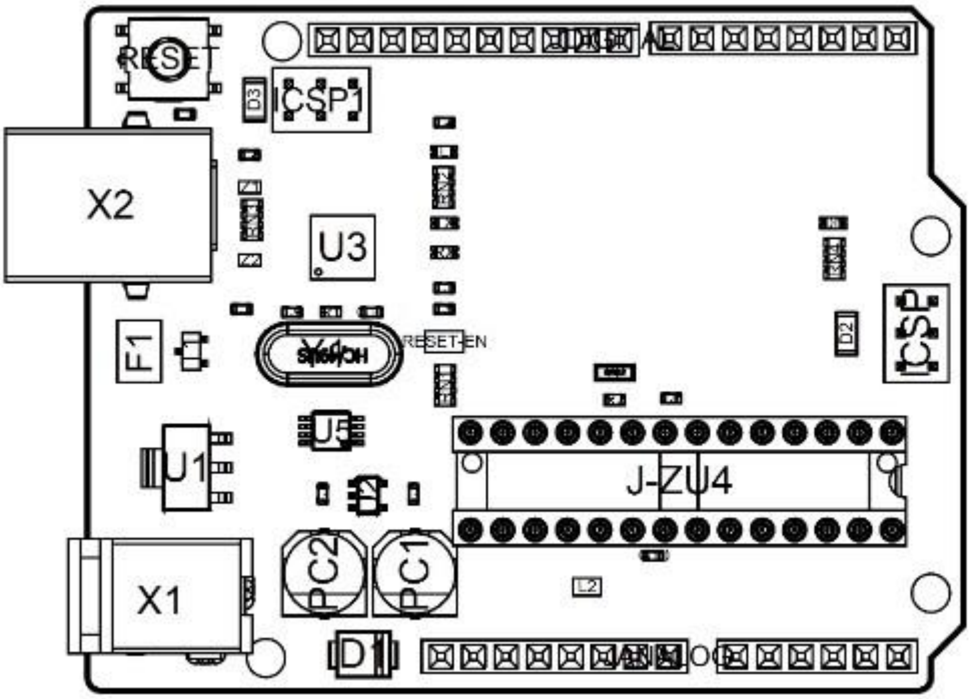
2.2 Power Consumption

Symbol	Description	Min	Typ	Max	Unit
VINMax	Maximum input voltage from VIN pad	6	-	20	V
VUSBMax	Maximum input voltage from USB connector		-	5.5	V
PMax	Maximum Power Consumption	-	-	xx	mA

3 Functional Overview

3.1 Board Topology

Top view



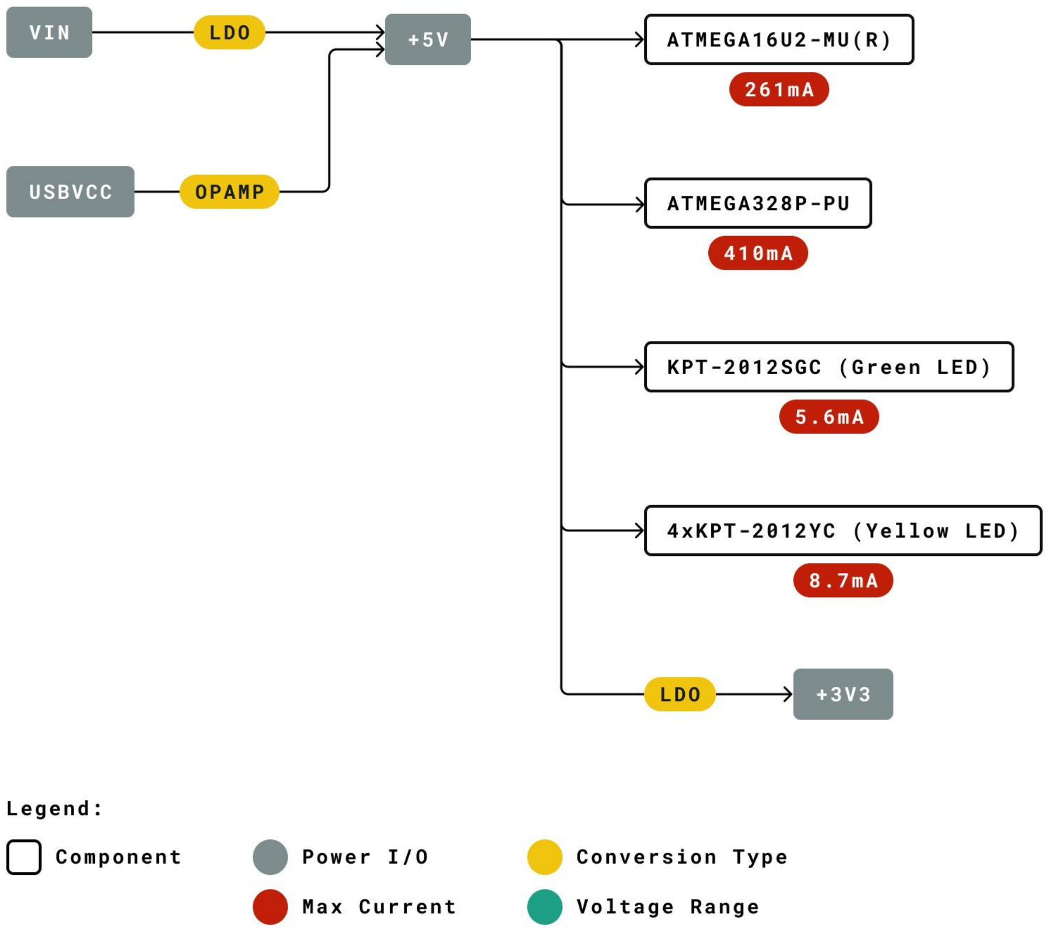
Board topology

Ref.	Description	Ref.	Description
X1	Power jack 2.1x5.5mm	U1	SPX1117M3-L-5 Regulator
X2	USB B Connector	U3	ATMEGA16U2 Module
PC1	EEE-1EA470WP 25V SMD Capacitor	U5	LMV358LIST-A.9 IC
PC2	EEE-1EA470WP 25V SMD Capacitor	F1	Chip Capacitor, High Density
D1	CGRA4007-G Rectifier	ICSP	Pin header connector (through hole 6)
J-ZU4	ATMEGA328P Module	ICSP1	Pin header connector (through hole 6)
Y1	ECS-160-20-4X-DU Oscillator		

3.2 Processor

The Main Processor is a ATmega328P running at up to 20 MHz. Most of its pins are connected to the external headers, however some are reserved for internal communication with the USB Bridge coprocessor.

3.3 Power Tree



Power tree

4 Board Operation

4.1 Getting Started - IDE

If you want to program your Arduino UNO R3 while offline you need to install the Arduino Desktop IDE [1] To connect the Arduino UNO to your computer, you'll need a USB-B cable. This also provides power to the board, as indicated by the LED.

4.2 Getting Started - Arduino Web Editor

All Arduino boards, including this one, work out-of-the-box on the Arduino Web Editor [2], by just installing a simple plugin.

The Arduino Web Editor is hosted online, therefore it will always be up-to-date with the latest features and support for all boards. Follow **[3]** to start coding on the browser and upload your sketches onto your board.

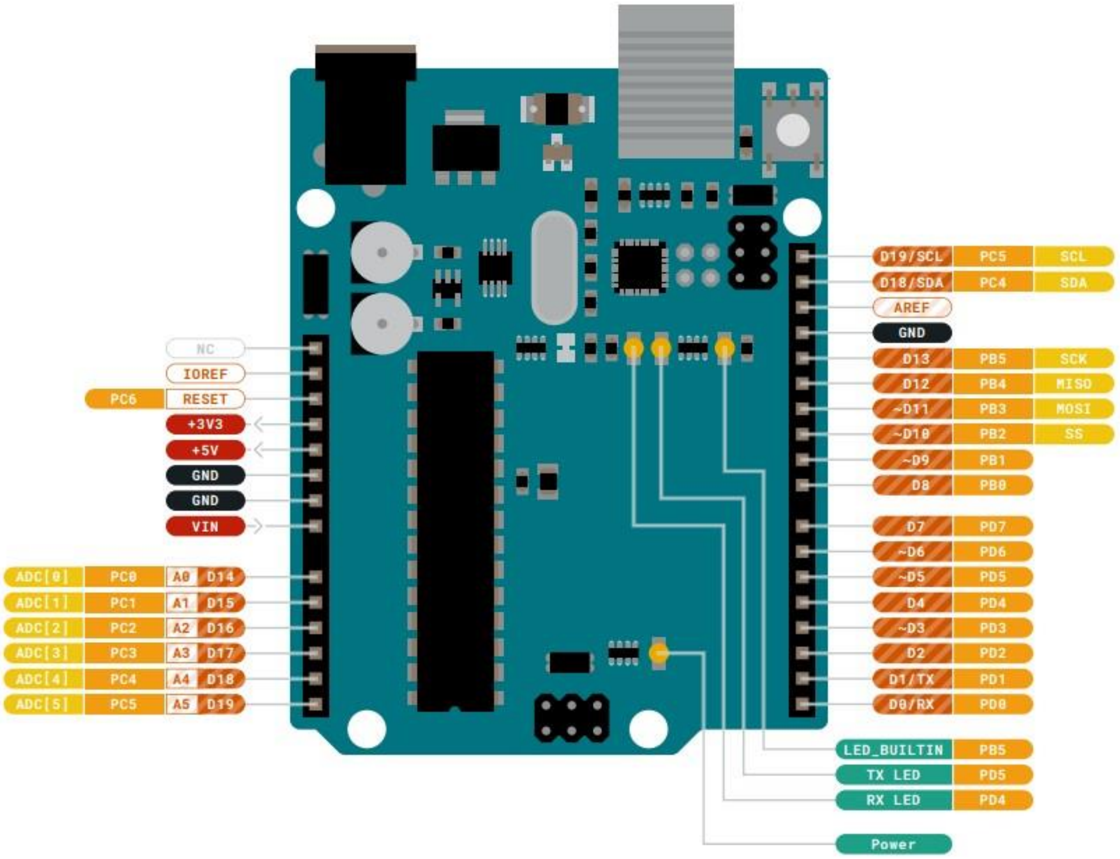
4.3 Sample Sketches

Sample sketches for the Arduino UNO R3 can be found either in the "Examples" menu in the Arduino IDE or in the "Documentation" section of the Arduino website [4]

4.4 Online Resources

Now that you have gone through the basics of what you can do with the board you can explore the endless possibilities it provides by checking exciting projects on Arduino Project Hub **[5]**, the Arduino Library Reference **[6]** and the online Arduino store **[7]** where you will be able to complement your board with sensors, actuators and more.

5 Connector Pinouts



Pinout

5.1 JANALOG

Pin	Function	Type	Description
1	NC	NC	Not connected
2	IOREF	IOREF	Reference for digital logic V - connected to 5V
3	Reset	Reset	Reset
4	+3V3	Power	+3V3 Power Rail
5	+5V	Power	+5V Power Rail
6	GND	Power	Ground
7	GND	Power	Ground
8	VIN	Power	Voltage Input
9	A0	Analog/GPIO	Analog input 0 /GPIO
10	A1	Analog/GPIO	Analog input 1 /GPIO
11	A2	Analog/GPIO	Analog input 2 /GPIO
12	A3	Analog/GPIO	Analog input 3 /GPIO
13	A4/SDA	Analog input/I2C	Analog input 4/I2C Data line
14	A5/SCL	Analog input/I2C	Analog input 5/I2C Clock line

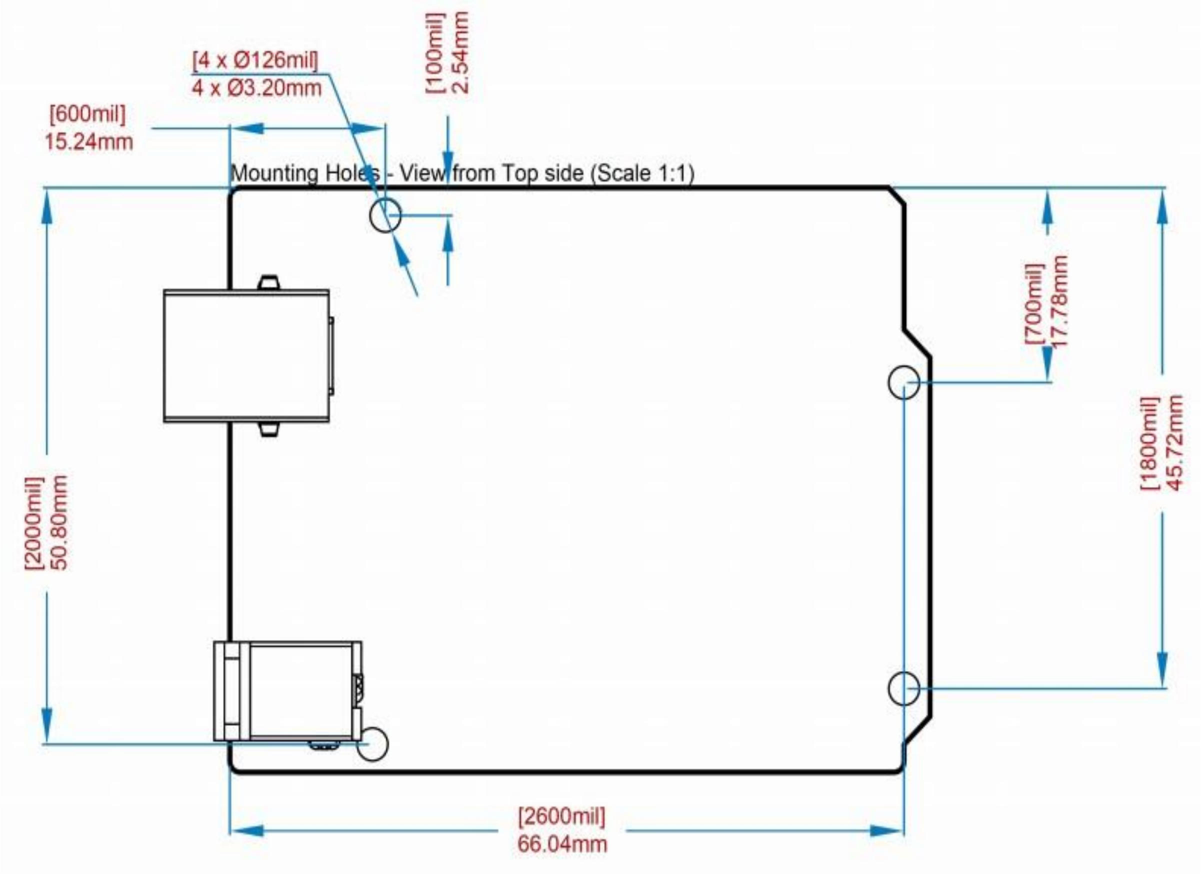
5.2 JDIGITAL

Pin	Function	Type	Description
1	D0	Digital/GPIO	Digital pin 0/GPIO
2	D1	Digital/GPIO	Digital pin 1/GPIO
3	D2	Digital/GPIO	Digital pin 2/GPIO
4	D3	Digital/GPIO	Digital pin 3/GPIO
5	D4	Digital/GPIO	Digital pin 4/GPIO
6	D5	Digital/GPIO	Digital pin 5/GPIO
7	D6	Digital/GPIO	Digital pin 6/GPIO
8	D7	Digital/GPIO	Digital pin 7/GPIO
9	D8	Digital/GPIO	Digital pin 8/GPIO
10	D9	Digital/GPIO	Digital pin 9/GPIO
11	SS	Digital	SPI Chip Select
12	MOSI	Digital	SPI1 Main Out Secondary In
13	MISO	Digital	SPI Main In Secondary Out
14	SCK	Digital	SPI serial clock output
15	GND	Power	Ground
16	AREF	Digital	Analog reference voltage

17	A4/SD4	Digital	Analog input 4/I2C Data line (duplicated)
18	A5/SD5	Digital	Analog input 5/I2C Clock line (duplicated)

5.3 Mechanical Information

5.4 Board Outline & Mounting Holes



Board outline

6 Certifications

6.1 Declaration of Conformity CE DoC (EU)

We declare under our sole responsibility that the products above are in conformity with the essential requirements of the following EU Directives and therefore qualify for free movement within markets comprising the European Union (EU) and European Economic Area (EEA).

ROHS 2 Directive 2011/65/EU	
Conforms to:	EN50581:2012
Directive 2014/35/EU. (LVD)	
Conforms to:	EN 60950-1:2006/A11:2009/A1:2010/A12:2011/AC:2011

Directive 2004/40/EC & 2008/46/EC & 2013/35/EU, EMF	
Conforms to:	EN 62311:2008

6.2 Declaration of Conformity to EU RoHS & REACH 211 01/19/2021

Arduino boards are in compliance with RoHS 2 Directive 2011/65/EU of the European Parliament and RoHS 3 Directive 2015/863/EU of the Council of 4 June 2015 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

Substance	Maximum limit (ppm)
Lead (Pb)	1000
Cadmium (Cd)	100
Mercury (Hg)	1000
Hexavalent Chromium (Cr6+)	1000
Poly Brominated Biphenyls (PBB)	1000
Poly Brominated Diphenyl ethers (PBDE)	1000
Bis(2-Ethylhexyl} phthalate (DEHP)	1000
Benzyl butyl phthalate (BBP)	1000
Dibutyl phthalate (DBP)	1000
Diisobutyl phthalate (DIBP)	1000

Exemptions: No exemptions are claimed.

Arduino Boards are fully compliant with the related requirements of European Union Regulation (EC) 1907 /2006 concerning the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH). We declare none of the SVHCs (https://echa.europa.eu/web/guest/candidate-list-table), the Candidate List of Substances of Very High Concern for authorization currently released by ECHA, is present in all products (and also package) in quantities totaling in a concentration equal or above 0.1%. To the best of our knowledge, we also declare that our products do not contain any of the substances listed on the "Authorization List" (Annex XIV of the REACH regulations) and Substances of Very High Concern (SVHC) in any significant amounts as specified by the Annex XVII of Candidate list published by ECHA (European Chemical Agency) 1907 /2006/EC.

6.3 Conflict Minerals Declaration

As a global supplier of electronic and electrical components, Arduino is aware of our obligations with regards to laws and regulations regarding Conflict Minerals, specifically the

Dodd-Frank Wall Street Reform and Consumer Protection Act, Section 1502. Arduino does not directly source or process conflict minerals such as Tin, Tantalum, Tungsten, or Gold. Conflict minerals are contained in our products in the form of solder, or as a component in metal alloys. As part of our reasonable due diligence Arduino has contacted component suppliers within our supply chain to verify their continued compliance with the regulations. Based on the information received thus far we declare that our products contain Conflict Minerals sourced from conflict-free areas.

7 FCC Caution

Any Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference

(2) this device must accept any interference received, including interference that may cause undesired operation.

FCC RF Radiation Exposure Statement:

1. This Transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.
2. This equipment complies with RF radiation exposure limits set forth for an uncontrolled environment.
3. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

English: User manuals for license-exempt radio apparatus shall contain the following or equivalent notice in a conspicuous location in the user manual or alternatively on the device or both. This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions:

(1) this device may not cause interference

(2) this device must accept any interference, including interference that may cause undesired operation of thedevice.

French: Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

(1) l' appareil nedoit pas produire de brouillage

(2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

IC SAR Warning:

English This equipment should be installed and operated with minimum distance 20 cm between the radiator and your body.

French: Lors de l' installation et de l' exploitation de ce dispositif, la distance entre le radiateur et le corps est d 'au moins 20 cm.

Important: The operating temperature of the EUT can't exceed 85℃ and shouldn't be lower than -40℃.

Hereby, Arduino S.r.l. declares that this product is in compliance with essential requirements and other relevant provisions of Directive 2014/53/EU. This product is allowed to be used in all EU member states.

8 Company Information

Company name	Arduino S.r.l
Company Address	Via Andrea Appiani 25 20900 MONZA Italy

9 Reference Documentation

Reference	Link
Arduino IDE (Desktop)	https://www.arduino.cc/en/Main/Software
Arduino IDE (Cloud)	https://create.arduino.cc/editor
Cloud IDE Getting Started	https://create.arduino.cc/projecthub/Arduino_Genuino/getting-started-with-arduino-webeditor-4b3e4a
Arduino Website	https://www.arduino.cc/
Project Hub	https://create.arduino.cc/projecthub?by=part&part_id=11332&sort=trending
Library Reference	https://www.arduino.cc/reference/en/

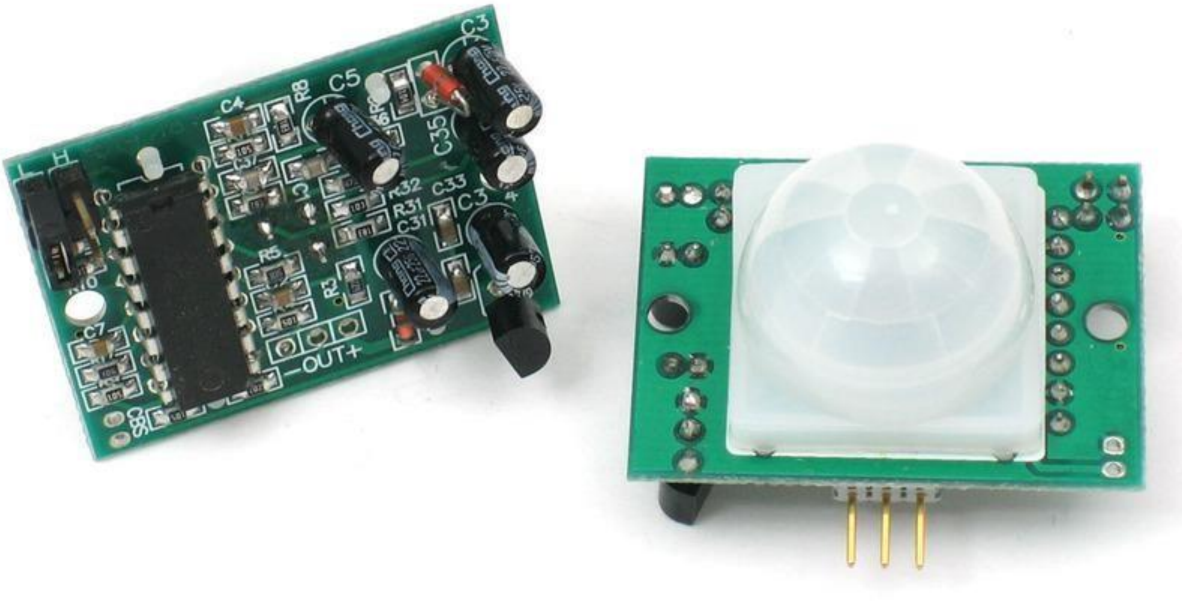
Online Store	https://store.arduino.cc/

10 Revision History

Date	Revision	Changes
26/07/2023	2	General Update
06/2021	1	Datasheet release

PIR Motion Sensor

Created by lady ada



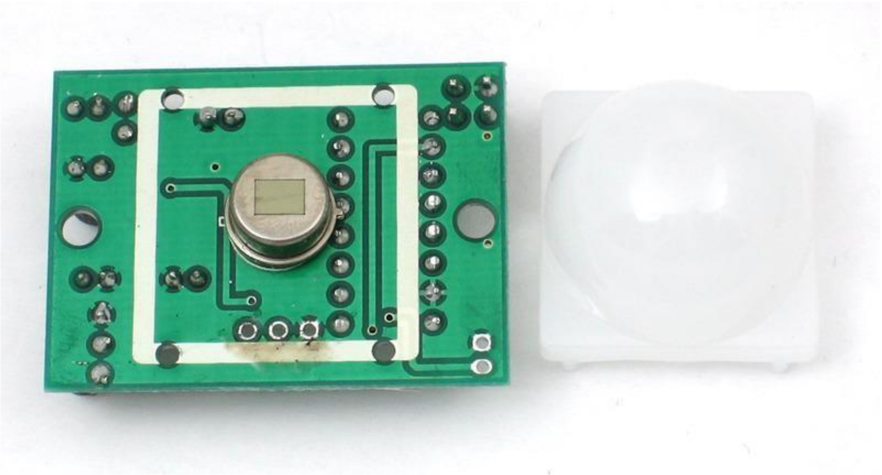
https://learn.adafruit.com/pir-passive-infrared-proximity-motion-sensor

Last updated on 2023-09-27 10:59:11 AM EDT

Overview

PIR sensors allow you to sense motion, almost always used to detect whether a human has moved in or out of the sensors range. They are small, inexpensive, lowpower, easy to use and don't wear out. For that reason they are commonly found in appliances and gadgets used in homes or businesses. They are often referred to as PIR, "Passive Infrared", "Pyroelectric", or "IR motion" sensors.

PIRs are basically made of a pyroelectric sensor () (which you can see below as the round metal can with a rectangular crystal in the center), which can detect levels of infrared radiation. Everything emits some low level radiation, and the hotter something is, the more radiation is emitted. The sensor in a motion detector is actually split in two halves. The reason for that is that we are looking to detect motion (change) not average IR levels. The two halves are wired up so that they cancel each other out. If one half sees more or less IR radiation than the other, the output will swing high or low.

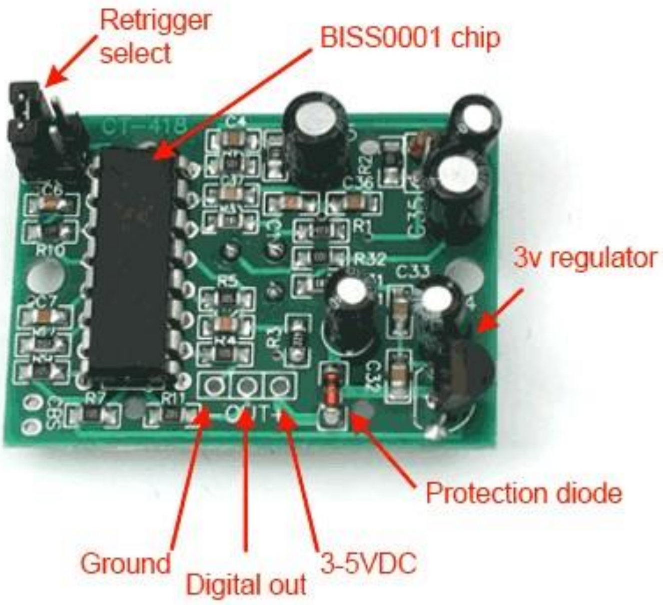


Along with the pyroelectic sensor is a bunch of supporting circuitry, resistors and capacitors. It seems that most small hobbyist sensors use the BISS0001 ("Micro Power

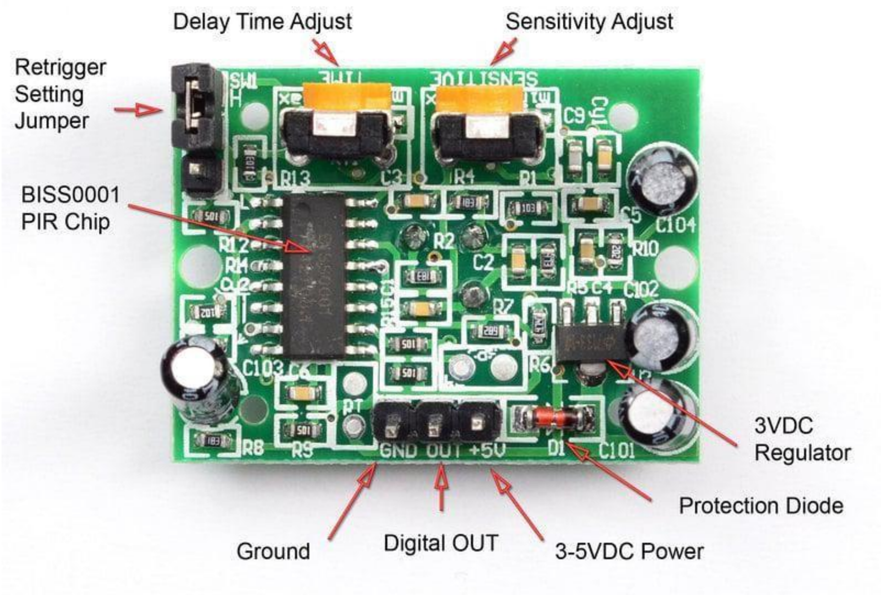
PIR Motion Detector IC") (), undoubtedly a very inexpensive chip. This chip takes the

output of the sensor and does some minor processing on it to emit a digital output pulse from the analog sensor.

Our older PIRs looked like this:



Our new PIRs have more adjustable settings and have a header installed in the 3-pin ground/out/power pads



For many basic projects or products that need to detect when a person has left or entered the area, or has approached, PIR sensors are great. They are low power and low cost, pretty rugged, have a wide lens range, and are easy to interface with. Note that PIRs won't tell you how many people are around or how close they are to the sensor, the lens is often fixed to a certain sweep and distance (although it can be hacked somewhere) and they are also sometimes set off by housepets. Experimentation is key!

Some Basic Stats

These stats are for the PIR sensor in the Adafruit shop which is very much like the Parallax one () . Nearly all PIRs will have slightly different specifications, although they all pretty much work the same. If there's a datasheet, you'll want to refer to it

- Size: Rectangular
- Price: $10.00 at the Adafruit shop ()
- Output: Digital pulse high (3V) when triggered (motion detected) digital low when idle (no motion detected). Pulse lengths are determined by resistors and capacitors on the PCB and differ from sensor to sensor.
- Sensitivity range: up to 20 feet (6 meters) 110° x 70° detection range

- Power supply: 5V-12V input voltage for most modules (they have a 3.3V regulator), but 5V is ideal in case the regulator has different specs
- BIS0001 Datasheet () (the decoder chip used)
- RE200B datasheet () (most likely the PIR sensing element used)
- NL11NH datasheet () (equivalent lens used)
- Parallax Datasheet on their version of the sensor ()

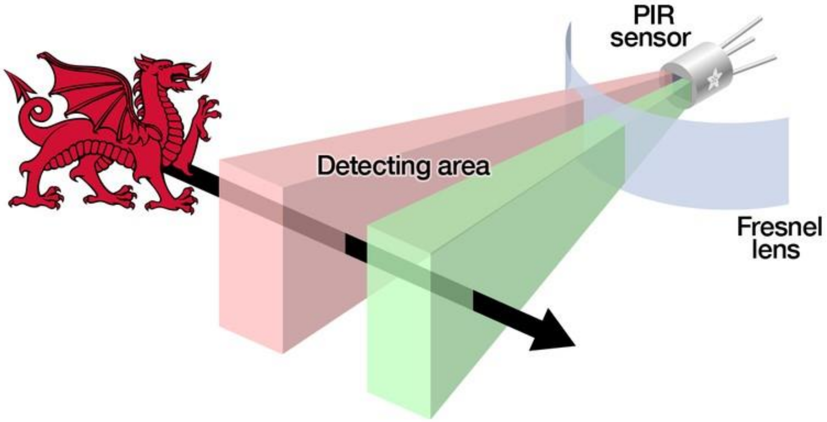
More links!

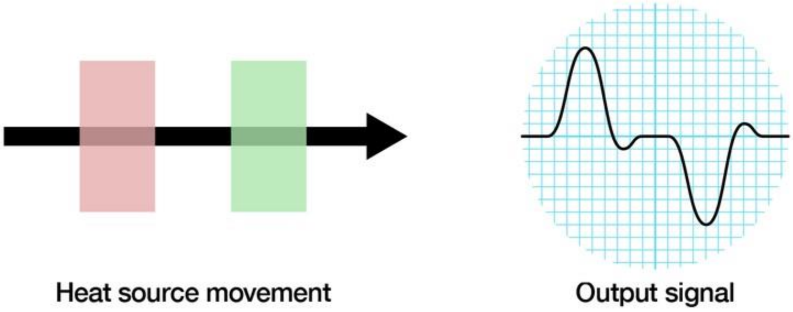
- A great page on PIR sensors from GLOLAB \\ ()

How PIRs Work

PIR sensors are more complicated than many of the other sensors explained in these tutorials (like photocells, FSRs and tilt switches) because there are multiple variables that affect the sensors input and output. To begin explaining how a basic sensor works, we'll use this rather nice diagram

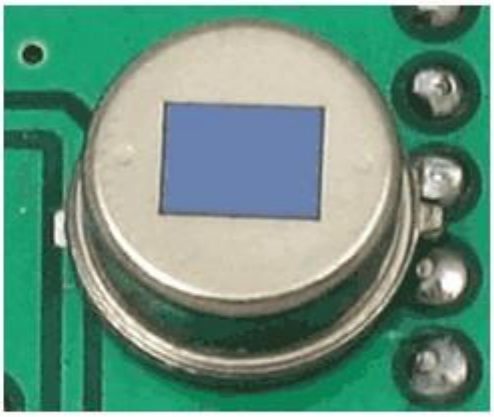
The passive infrared (PIR) sensor itself has two slots in it, each slot is made of a special material that is sensitive to IR. The lens used here is not really doing much and so we see that the two slots can 'see' out past some distance (basically the sensitivity of the sensor). When the sensor is idle, both slots detect the same amount of IR, the ambient amount radiated from the room or walls or outdoors. When a warm body like a human or animal passes by, it first intercepts one half of the PIR sensor, which causes a positive differential change between the two halves. When the warm body leaves the sensing area, the reverse happens, whereby the sensor generates a negative differential change. These change pulses are what is detected.





The PIR Sensor

The IR sensor itself is housed in a hermetically sealed metal can to improve noise/temperature/humidity immunity. There is a window made of IR-transmissive material (typically coated silicon since that is very easy to come by) that protects the sensing element. Behind the window are the two balanced sensors.



Left image from Murata datasheet ()

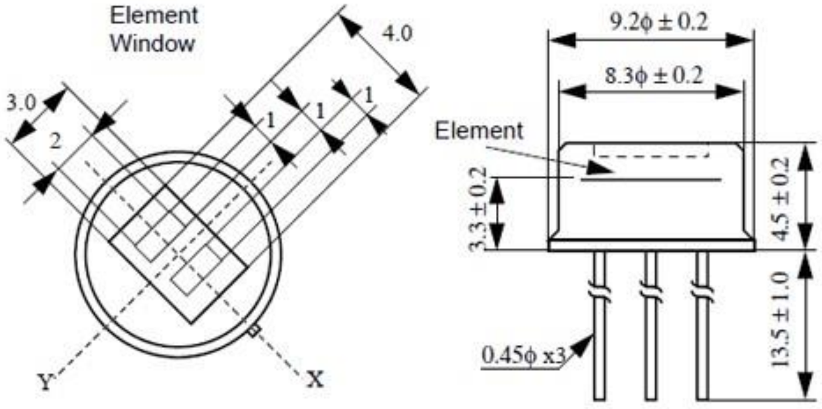


Image from RE200B datasheet ()

You can see above the diagram showing the element window, the two pieces of sensing material

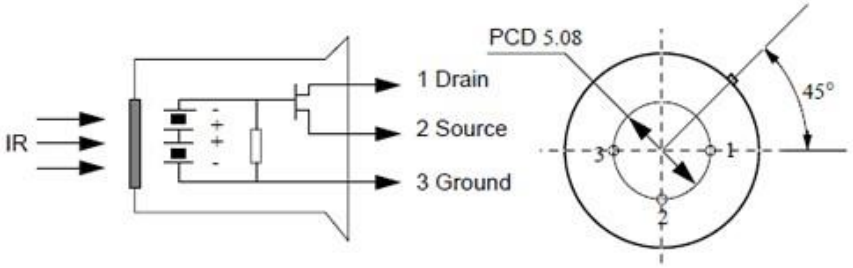


Image from RE200B datasheet ()

This image shows the internal schematic. There is actually a JFET inside (a type of transistor) which is very low-noise and buffers the extremely high impedence of the sensors into something a low-cost chip (like the BIS0001) can sense.

Lenses

PIR sensors are rather generic and for the most part vary only in price and sensitivity. Most of the real magic happens with the optics. This is a pretty good idea for manufacturing: the PIR sensor and circuitry is fixed and costs a few dollars. The lens costs only a few cents and can change the breadth, range, sensing pattern, very easily.

In the diagram up top, the lens is just a piece of plastic, but that means that the detection area is just two rectangles. Usually we'd like to have a detection area that is much larger. To do that, we use a simple lens () such as those found in a camera: they

condenses a large area (such as a landscape) into a small one (on film or a CCD sensor). For reasons that will be apparent soon, we would like to make the PIR lenses small and thin and moldable from cheap plastic, even though it may add distortion. For this reason the sensors are actually Fresnel lenses ():

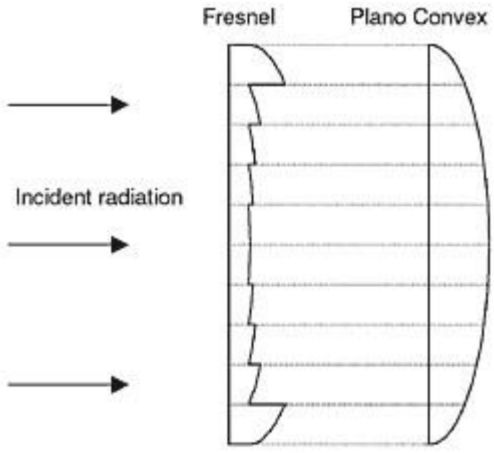


Image from Sensors Magazine ()

The Fresnel lens condenses light, providing a larger range of IR to the sensor.

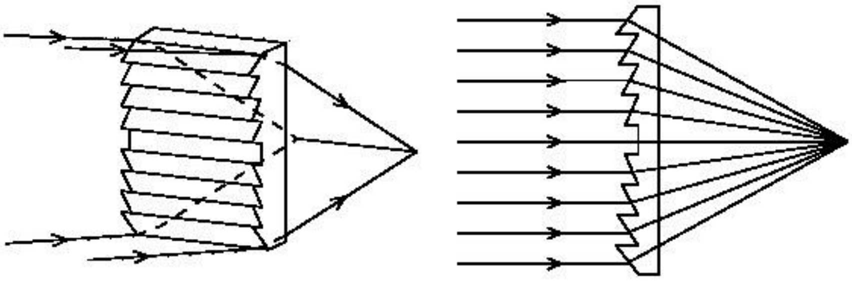


Image from BHlens.com ()

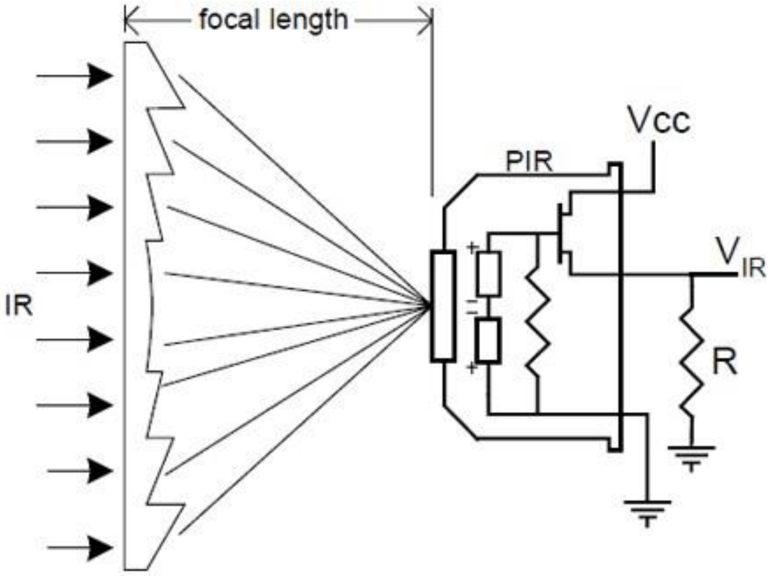
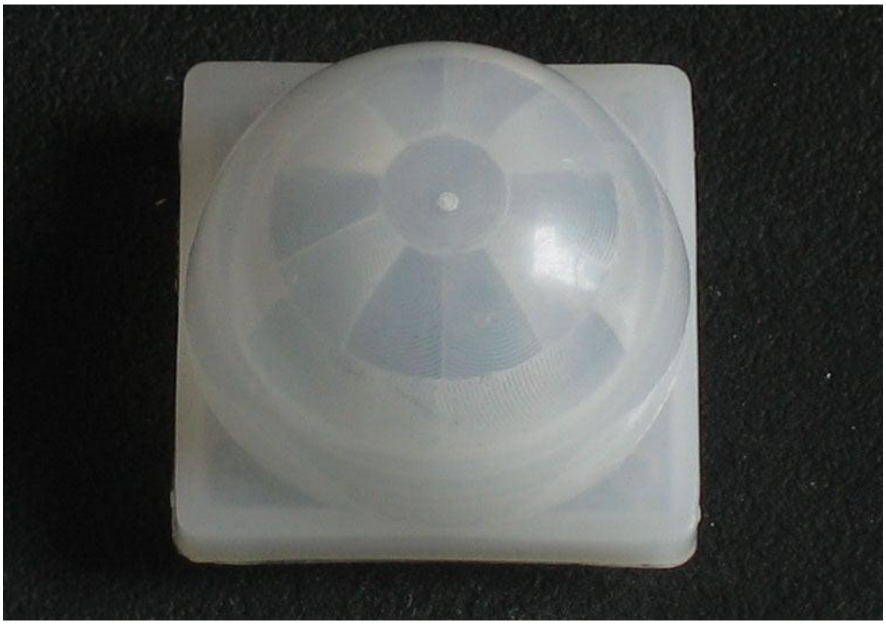
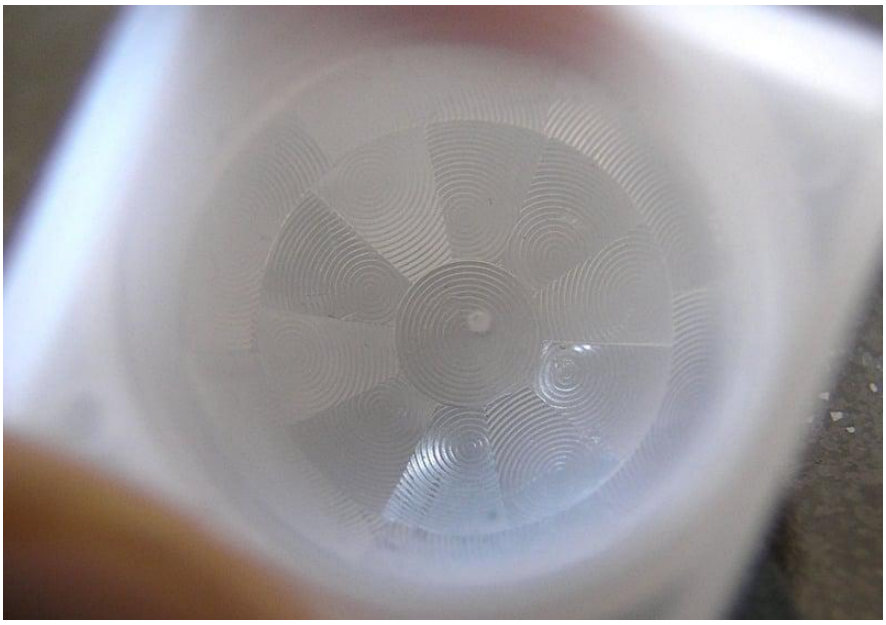


Image from Cypress appnote 2105 ()

OK, so now we have a much larger range. However, remember that we actually have two sensors, and more importantly we dont want two really big sensing-area rectangles, but rather a scattering of multiple small areas. So what we do is split up the lens into multiple section, each section of which is a fresnel lens.

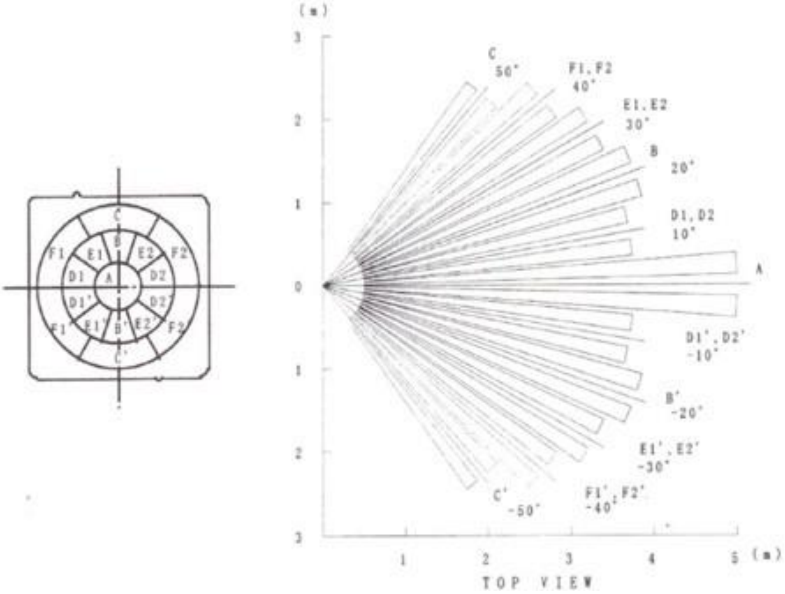


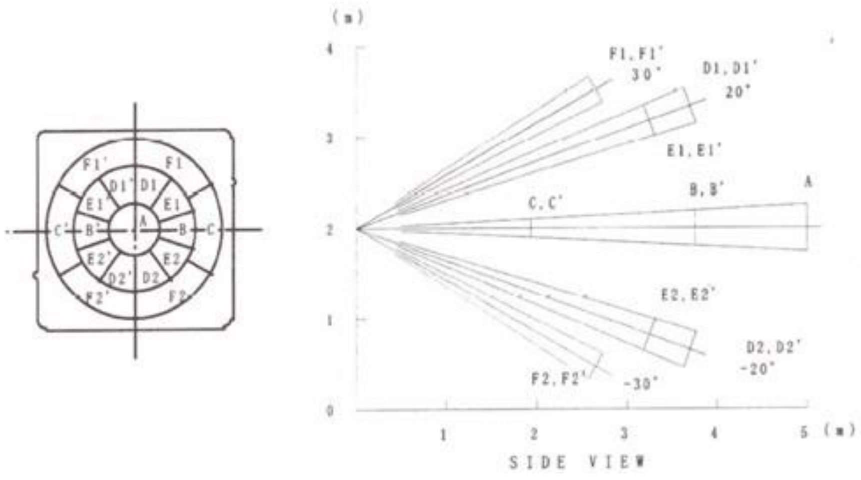
Here you can see the multiple facet-sections



This macro shot shows the different Fresnel lenses in each facet!

The different faceting and sub-lenses create a range of detection areas, interleaved with each other. That's why the lens centers in the facets above are 'inconsistent' every other one points to a different half of the PIR sensing element





Images from NL11NH datasheet ()

Here is another image, more qualitative but not as quantitative. (Note that the sensor in the Adafruit shop is 110° not 90°)

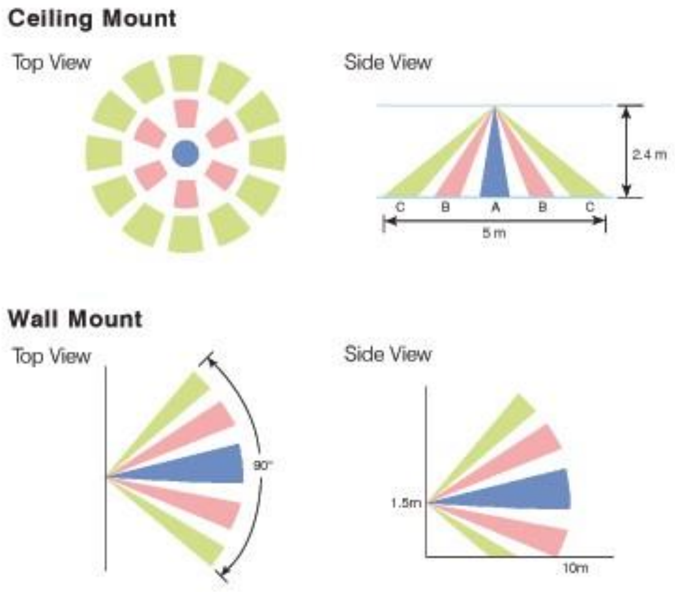
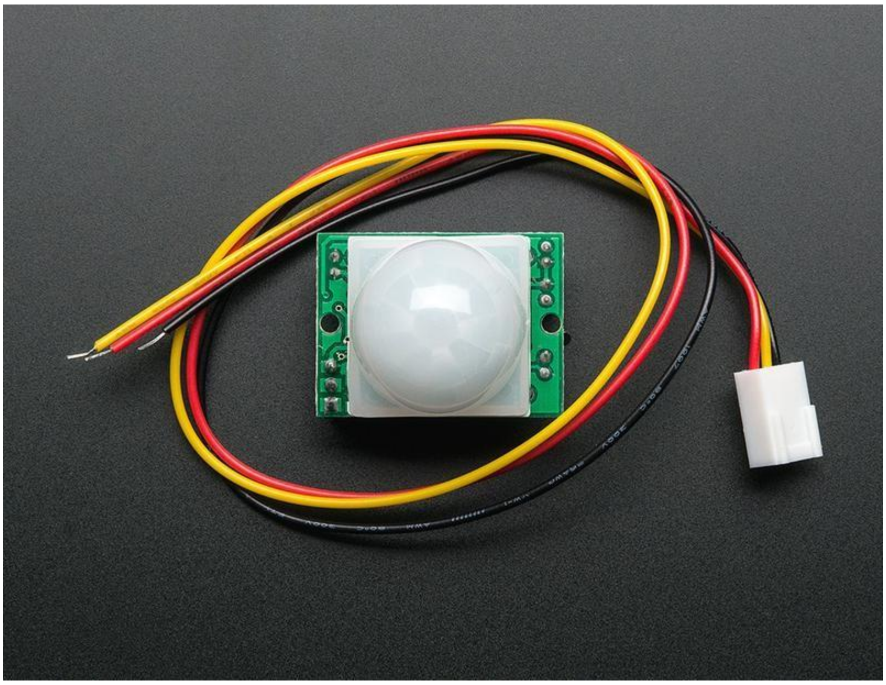


Image from IR-TEC ()

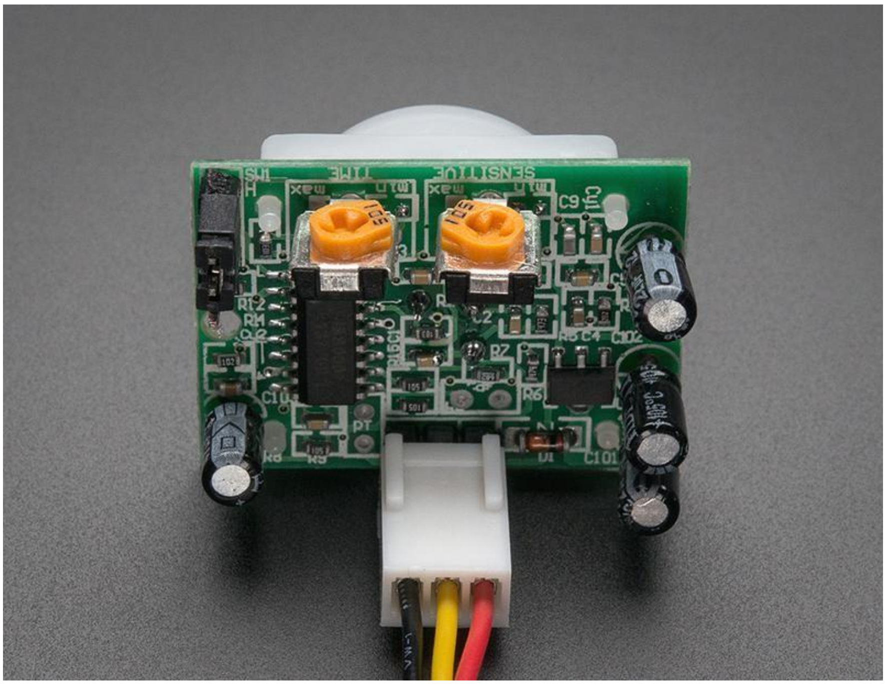
Connecting to a PIR



Most PIR modules have a 3-pin connection at the side or bottom. The pinout may vary between modules so triple-check the pinout! It's often silkscreened on right next to the connection (at least, ours is!) One pin will be ground, another will be signal and the final one will be power. Power is usually 3-5VDC input but may be as high as 12V. Sometimes larger modules don't have direct output and instead just operate a relay in which case there is ground, power and the two switch connections.

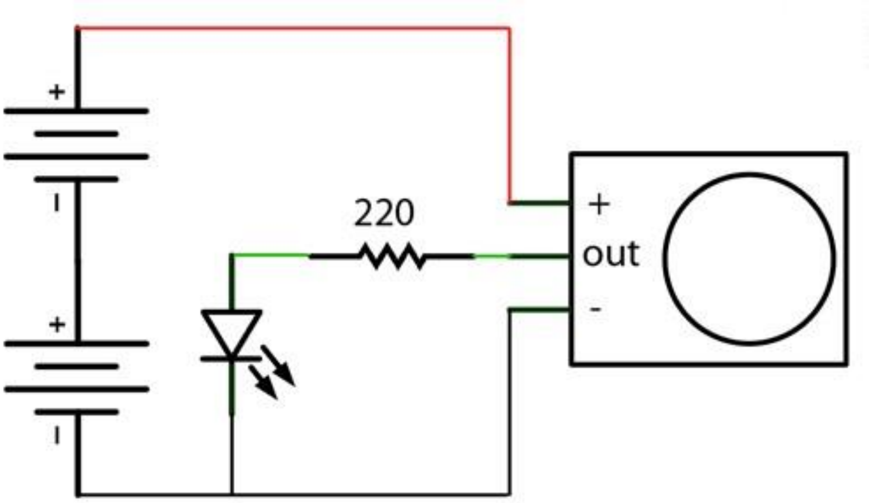
The output of some relays may be 'open collector' - that means it requires a pullup resistor. If you're not getting a variable output be sure to try attaching a 10K pullup between the signal and power pins.

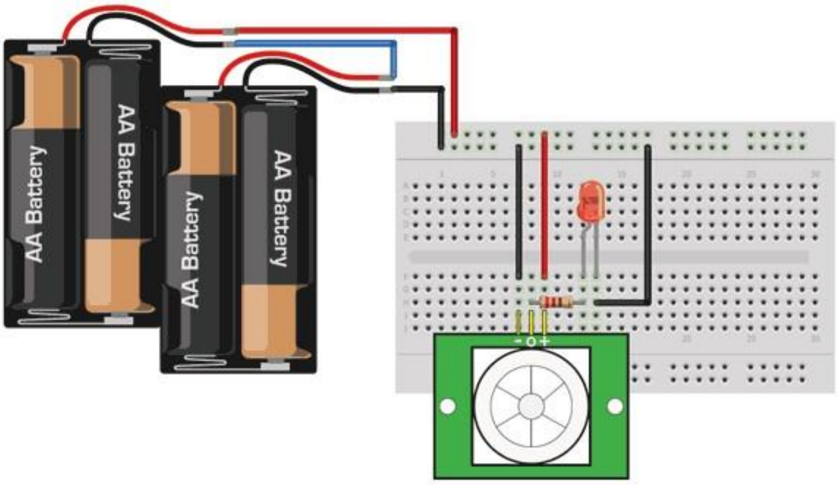
An easy way of prototyping with PIR sensors is to connect it to a breadboard since the connection port is 0.1" spacing. Some PIRs come with header on them already, the one's from adafruit have a straight 3-pin header on them for connecting a cable



For our PIR's the red cable is + voltage power, black cable is - ground power and yellow is the signal out. Just make sure you plug the cable in as shown above! If you get it backwards you won't damage the PIR but it won't work.

Testing a PIR





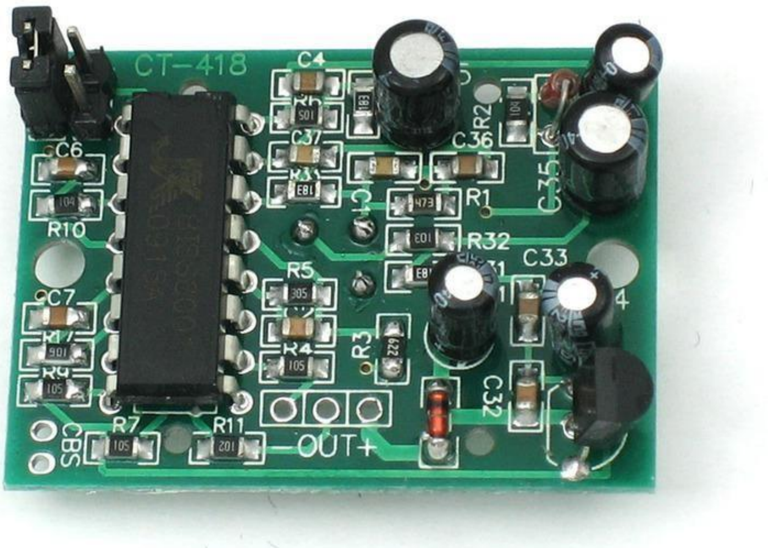
Now when the PIR detects motion, the output pin will go "high" to 3.3V and light up the LED!

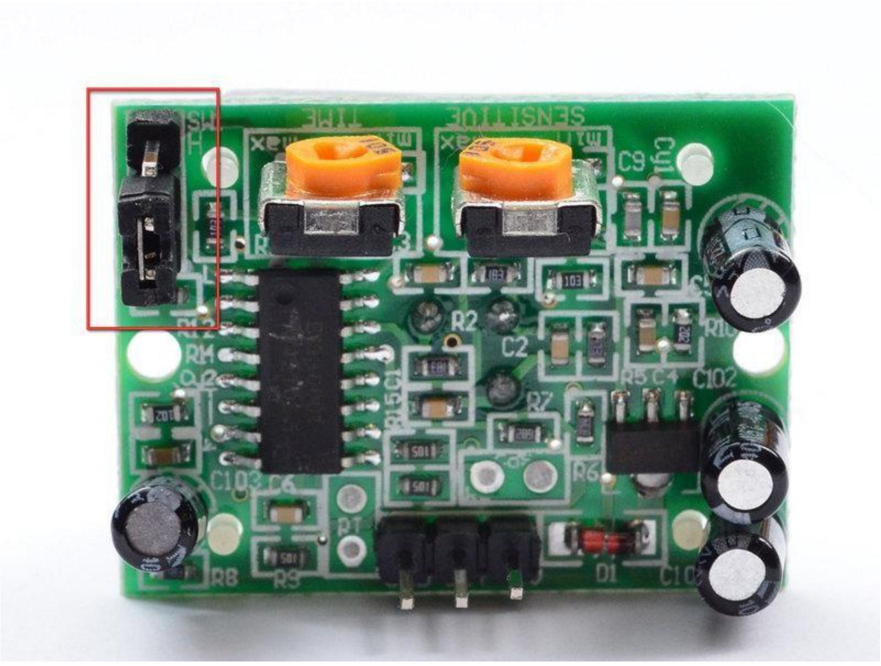
Once you have the breadboard wired up, insert batteries and wait 30-60 seconds for the PIR to 'stabilize'. During that time the LED may blink a little. Wait until the LED is off and then move around in front of it, waving a hand, etc, to see the LED light up!

Retriggering

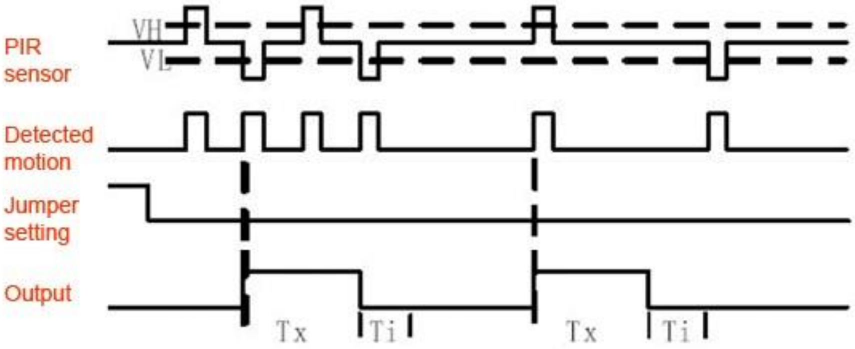
There's a couple options you may have with your PIR. First up we'll explore the 'Retriggering' option.

Once you have the LED blinking, look on the back of the PIR sensor and make sure that the jumper is placed in the L position as shown below.

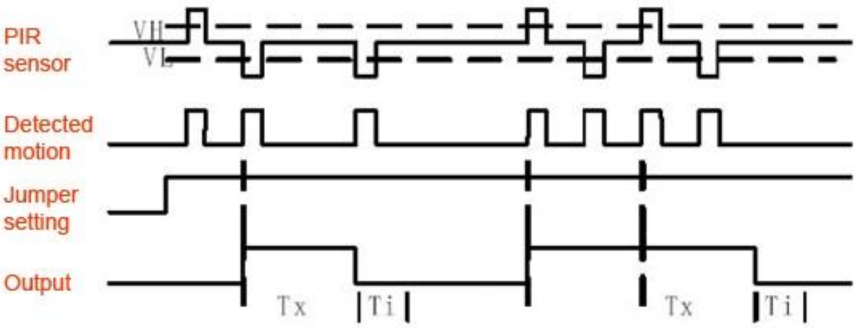




Now set up the testing board again. You may notice that when connecting up the PIR sensor as above, the LED does not stay on when moving in front of it but actually turns on and off every second or so. That is called "non-retriggering".

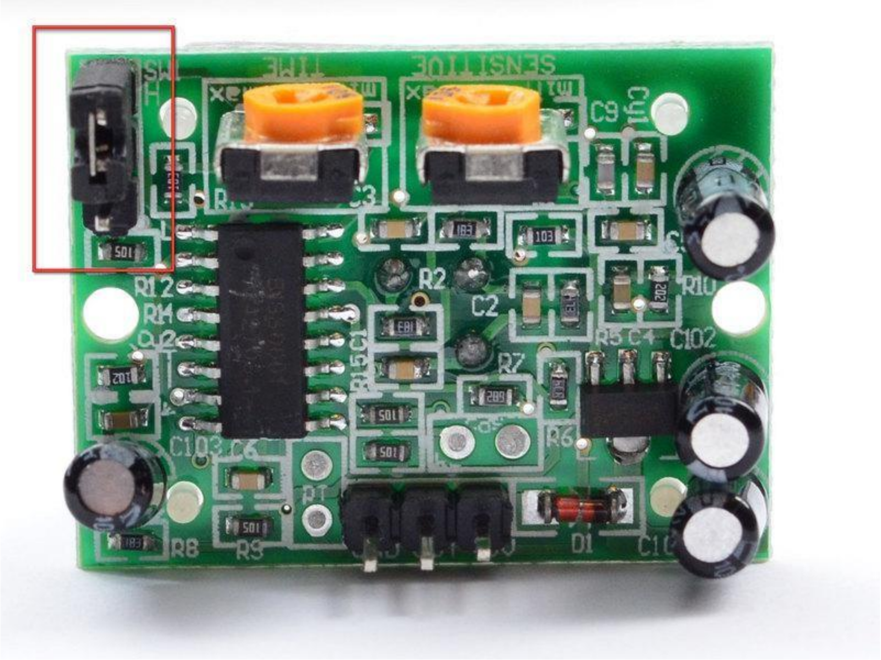


Now change the jumper so that it is in the H position. If you set up the test, you will notice that now the LED does stay on the entire time that something is moving. That is called "retriggering".



(The graphs above are from the BISS0001 datasheet, they kinda suck)

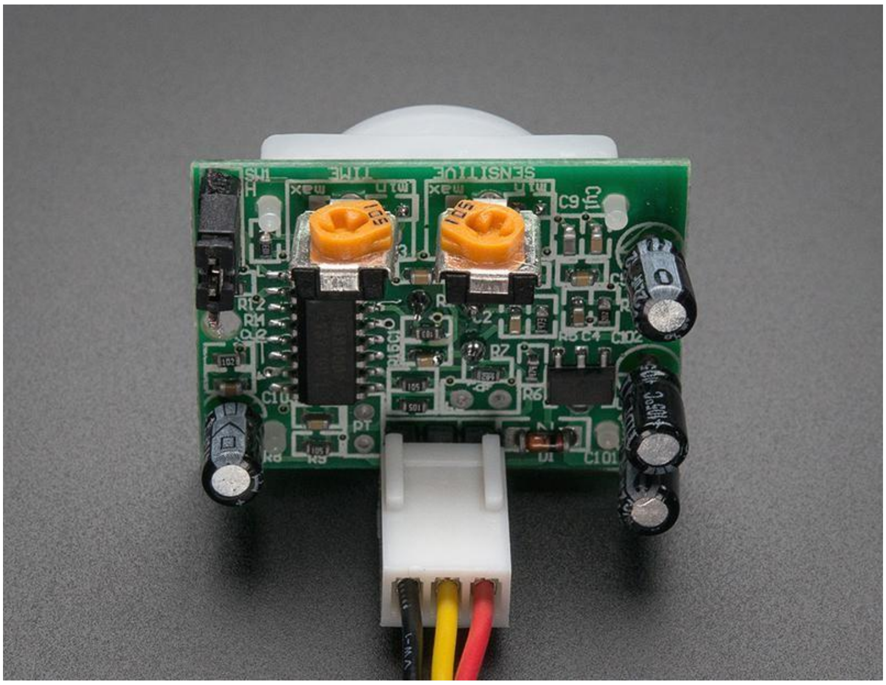
For most applications, "retriggering" (jumper in H position as shown below) mode is a little nicer.



If you need to connect the sensor to something edge-triggered, you'll want to set it to "non-retriggering" (jumper in L position).

Changing sensitivity

The Adafruit PIR has a trimpot on the back for adjusting sensitivity. You can adjust this if your PIR is too sensitive or not sensitive enough - clockwise makes it more sensitive.

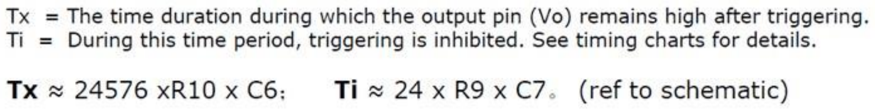


Changing Pulse Time and Timeout Length

There are two 'timeouts' associated with the PIR sensor. One is the "Tx" timeout: how long the LED is lit after it detects movement - this is easy to adjust on Adafruit PIR's because there's a potentiometer.

The second is the "Ti" timeout which is how long the LED is guaranteed to be off when there is no movement. This one is not easily changed but if you're handy with a soldering iron it is within reason.

First, lets take a look at the BISS datasheet again



Tx = The time duration during which the output pin (Vo) remains high after triggering.
Ti = During this time period, triggering is inhibited. See timing charts for details.

Tx ≈ 24576 xR10 x C6; **Ti** ≈ 24 x R9 x C7。 (ref to schematic)

On Adafruit PIR sensors, there's a little trim potentiometer labeled TIME. This is a 1 Megaohm adjustable resistor which is added to a 10K series resistor. And C6 is 0.01uF so

Tx = 24576 x (10K + Rtime) x 0.01uF

If the Rtime potentiometer is turned all the way down counter-clockwise (to 0 ohms) then

Tx = 24576 x (10K) x 0.01uF = 2.5 seconds (approx)

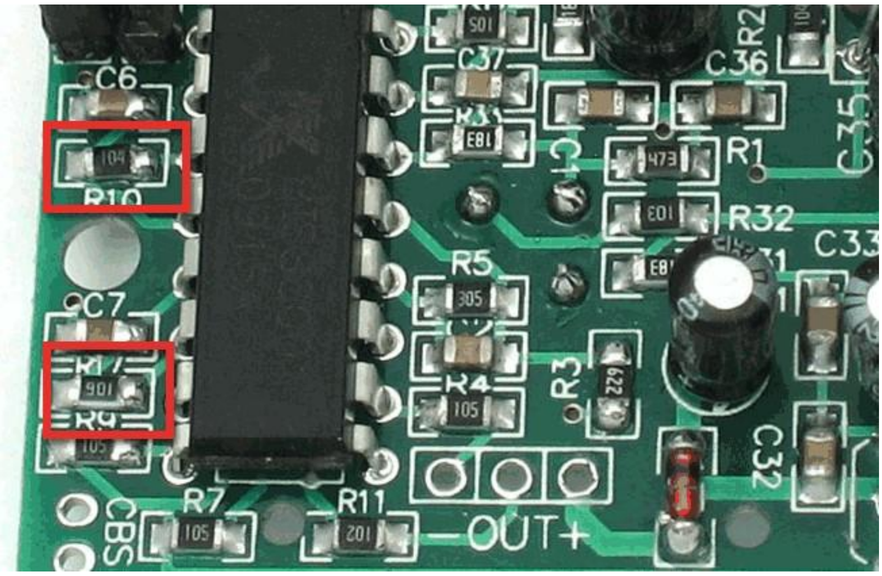
If the Rtime potentiometer is turned all the way up clockwise to 1 Megaohm then

Tx = 24576 x (1010K) x 0.01uF = 250 seconds (approx)

If RTime is in the middle, that'd be about 120 seconds (two minutes) so you can tweak it as necessary. For example if you want motion from someone to turn on a fan for a minimum of 1 minute, set the Rtime potentiometer to about 1/4 the way around.

For older/other PIR sensors

If you have a PIR sensor from somewhere else that does not have a potentiometer adjust, you can trace out the adjustment resistors this way:



Determining R10 and R9 isnt too tough. Unfortunately this PIR sensor is mislabeled (it looks like they swapped R9 R17). You can trace the pins by looking at the BISS001 datasheet and figuring out what pins they are - R10 connects to pin 3 and R9 connects to pin 7. the capacitors are a little tougher to determine, but you can 'reverse engineer' them from timing the sensor and solving!

For example:

Tx is = 24576 * R10 * C6 = ~1.2 seconds

R10 = 4.7K and C6 = 10nF

Likewise,

Ti = 24 * R9 * C7 = ~1.2 seconds

R9 = 470K and C7 = 0.1uF

You can change the timing by swapping different resistors or capacitors. For a nice tutorial on this, see Keith's PIR hacking page ().

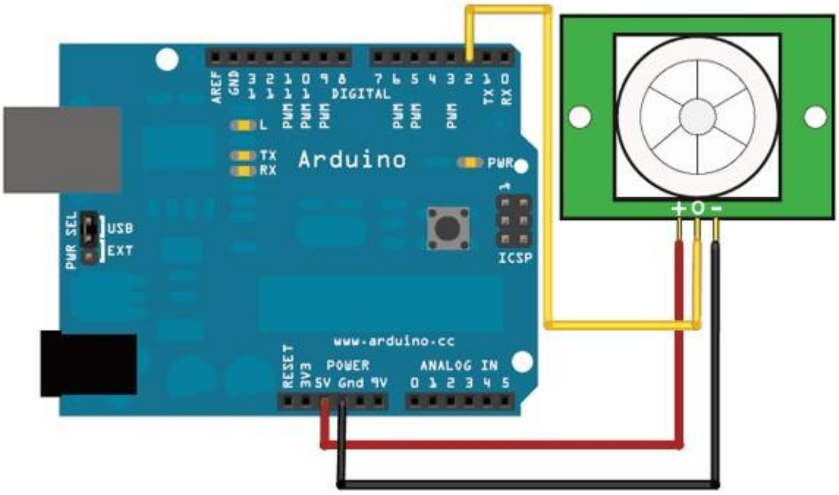
Using a PIR w/Arduino

Reading PIR Sensors

Connecting PIR sensors to a microcontroller is really simple. The PIR acts as a digital output, it can be high voltage or low voltage, so all you need to do is listen for the pin to flip high (detected) or low (not detected) by listening on a digital input on your Arduino

Its likely that you'll want retriggering, so be sure to put the jumper in the H position!

Power the PIR with 5V and connect ground to ground. Then connect the output to a digital pin. In this example we'll use pin 2.



The code is very simple, and is basically just keeps track of whether the input to pin 2 is high or low. It also tracks the state of the pin, so that it prints out a message when motion has started and stopped.

```
/*
 * PIR sensor tester
 */

int ledPin = 13;                // choose the pin for the LED
int inputPin = 2;               // choose the 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(ledPin, OUTPUT);      // declare LED as output
  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
    digitalWrite(ledPin, HIGH);  // turn LED ON
    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 {
    digitalWrite(ledPin, LOW); // turn LED OFF
    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;
    }
  }
}
```

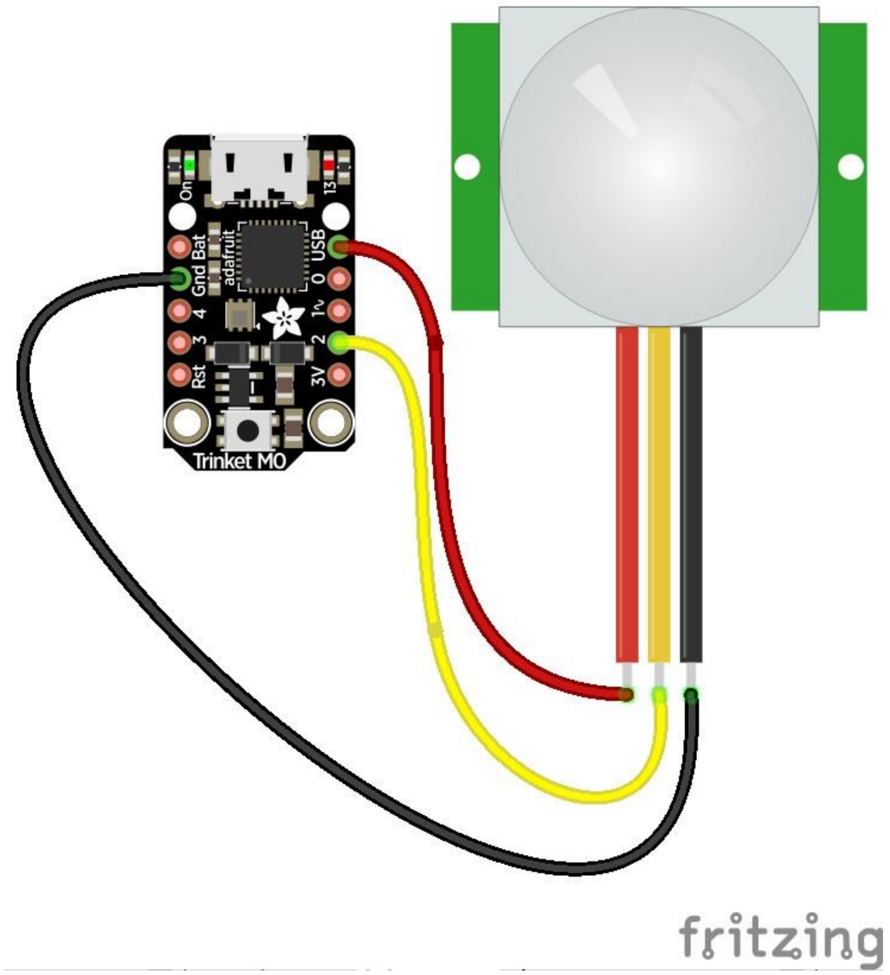
Don't forget that there are some times when you don't need a microcontroller. A PIR sensor can be connected to a relay (perhaps with a transistor buffer) without a micro!

CircuitPython Code

It's easy to use a PIR sensor with CircuitPython using simple digital inputs. The PIR sensor looks and acts kind of like a button or switch, i.e. it's only ever a high or low logic level, so you don't need any special libraries or other code to read one from Python. It will help to familiarize yourself with CircuitPython digital inputs and outputs

() before continuing though!

First make sure your PIR sensor is wired to your board as shown in the previous page. There's no difference wiring a PIR sensor to an Arduino vs. CircuitPython board. You must connect the power, ground, and sensor output to your board. The sensor output should be connected to any digital I/O line on your board. In this example we'll use pin D2 on a Trinket M0.



Fritzing Source

Next connect to the board's serial REPL ()so you are at the CircuitPython >>> prompt.

Run the following code to import the board and digitalio modules which lets you read digital inputs:

```
import board
import digitalio
```

Then create a simple digital input for the PIR. Remember to use the right board pin for how you've wired your sensor to your board. This example is using pin D2 on a Trinket M0:

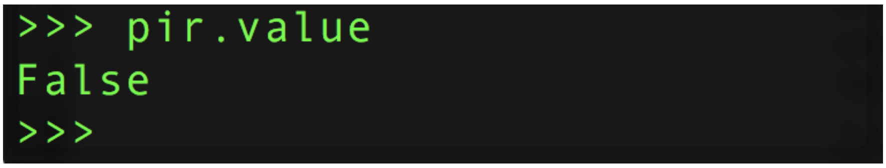
```
pir = digitalio.DigitalInOut(board.D2)
pir.direction = digitalio.Direction.INPUT
```

At this point you can read the state of the sensor by reading the value property. If the value is at a low logic level, or False, the sensor sees no movement. If it's at a high logic level, or True, the sensor is detecting movement!

Note you'll likely want the sensor's jumper in the H position for retriggering mode as mentioned on the previous page.

For example with no movement in front of the sensor you might see:

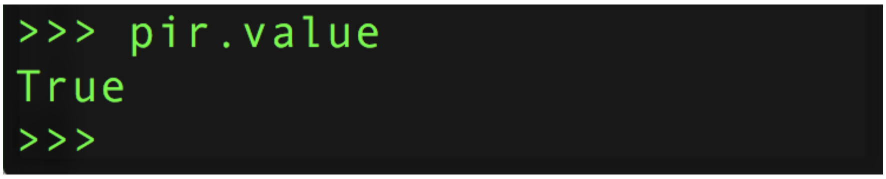
```
pir.value
```



```
>>> pir.value
False
>>>
```

Then wave your hand in front of the sensor, and as you wave it run the same command again. Notice you get a True result!

```
pir.value
```



```
>>> pir.value
True
>>>
```

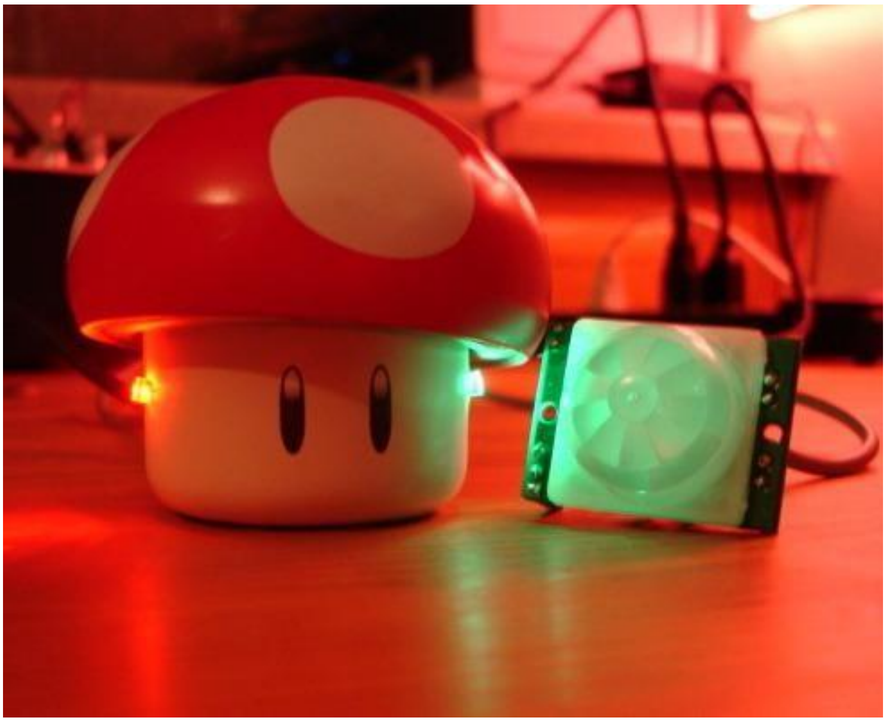
That's all there is to using a PIR sensor with CircuitPython!

Here's a complete example just like from the previous page where movement from the PIR sensor will turn on the board's LED and print a message. This is a direct port of the previous page's Arduino example to CircuitPython. Try saving it as a main.py on your board and connecting to the serial terminal to see the output as it runs! (be sure to change the board pin numbers to your sensor and LED wiring!)

```
import board
import digitalio

LED_PIN = board.D13  # Pin number for the board's built in LED.
PIR_PIN = board.D2   # Pin number connected to PIR sensor output wire.

# Setup digital input for PIR sensor:
pir = digitalio.DigitalInOut(PIR_PIN)
pir.direction = digitalio.Direction.INPUT

# Setup digital output for LED:
led = digitalio.DigitalInOut(LED_PIN)
led.direction = digitalio.Direction.OUTPUT

# Main loop that will run forever:
old_value = pir.value
while True:
    pir_value = pir.value
    if pir_value:
        # PIR is detecting movement! Turn on LED.
        led.value = True
        # Check if this is the first time movement was
        # detected and print a message!
        if not old_value:
            print('Motion detected!')
    else:
        # PIR is not detecting movement. Turn off LED.
        led.value = False
        # Again check if this is the first time movement
        # stopped and print a message.
        if old_value:
            print('Motion ended!')
    old_value = pir_value
```

Example Projects

A simple room greeter that plays the super mario brothers theme music when triggered by a PIR in a hacked airwick freshener unit.

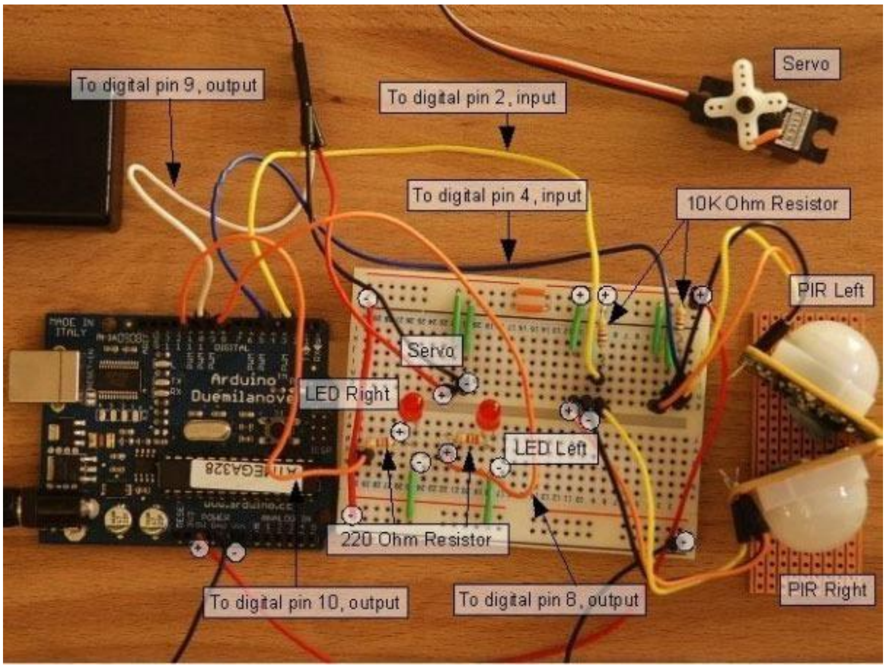


A USB-powered singing and blinking Mario mushroom (there's a video on the site!) ()

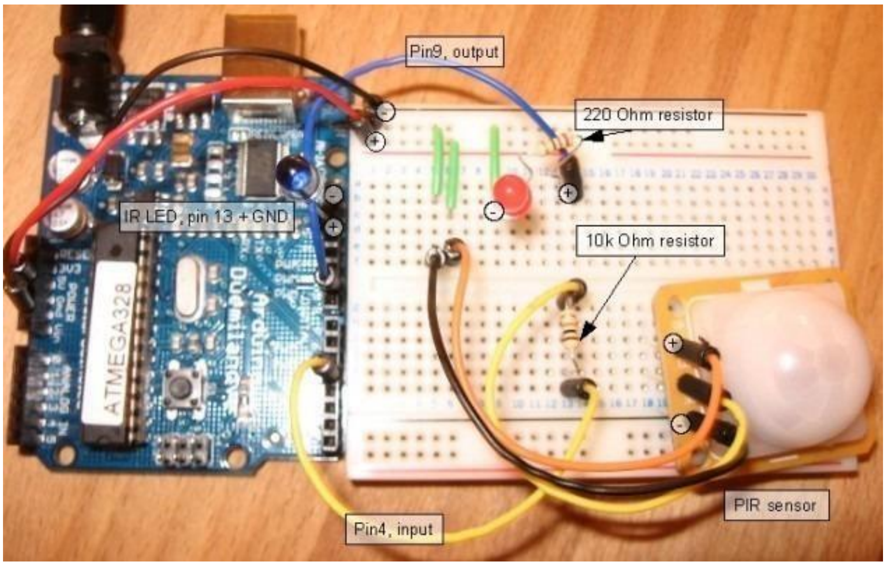
Rain Umbrellas ()

A home-made security system using PIR sensors (which is built into a Start Trek panel!)

PIR sensor + Arduino + Servo = automatic cat door!



A 2-PIR motion tracker () by Lucky Larry



A PIR-based remote camera trigger (also by Lucky Larry!) ()

An interesting hack whereby the PIR sensor is used 'raw' to track movement.

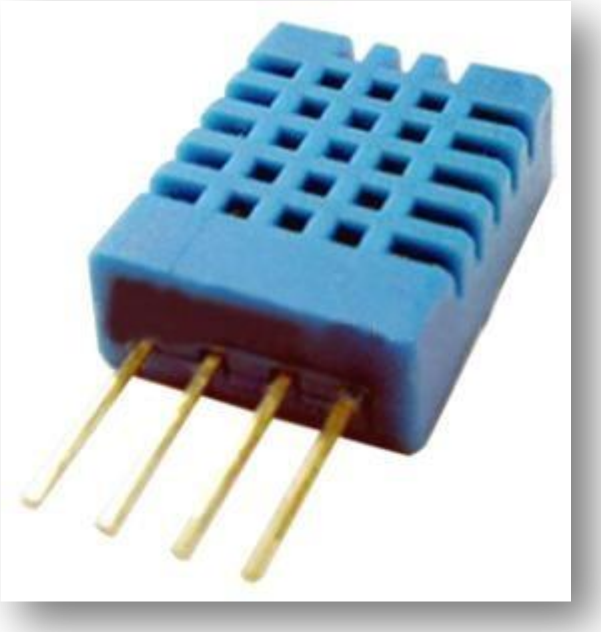
DHT11 Humidity & Temperature Sensor

DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output.

DHT 11 Humidity & Temperature Sensor

1. Introduction

DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a highperformance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness.



Each DHT11 element is strictly calibrated in the laboratory that is extremely accurate on humidity calibration. The calibration coefficients are stored as programmes in the OTP memory, which are used by the sensor's internal signal detecting process. The single-wire serial interface makes system integration quick and easy. Its small size, low power consumption and up-to-20 meter signal transmission making it the best choice for various applications, including those most demanding ones. The component is 4-pin single row pin package. It is convenient to connect and special packages can be provided according to users' request.

2. Technical Specifications:

Overview:

Item	Measurement Range	Humidity Accuracy	Temperature Accuracy	Resolution	Package
DHT11	20-90%RH 0-50 °C	±5%RH	±2°C	1	4 Pin Single Row

Detailed Specifications:

Parameters	**Conditions**	**Minimum**	**Typical**	**Maximum**
Humidity				
Resolution		1%RH	1%RH	1%RH
			8 Bit	
Repeatability			±1%RH	
Accuracy	25°C		±4%RH	
	0-50°C			±5%RH
Interchangeability	Fully Interchangeable			
Measurement Range	0°C	30%RH		90%RH
	25°C	20%RH		90%RH
	50°C	20%RH		80%RH
Response Time (Seconds)	1/e(63%)25°C, 1m/s Air	6 S	10 S	15 S
Hysteresis			±1%RH	
Long-Term Stability	Typical		±1%RH/year	
Temperature				
Resolution		1°C	1°C	1°C
		8 Bit	8 Bit	8 Bit
Repeatability			±1°C	
Accuracy		±1°C		±2°C

Measurement Range		0℃		50℃
Response Time (Seconds)	1/e(63%)	6 S		30 S

3. Typical Application (Figure 1)

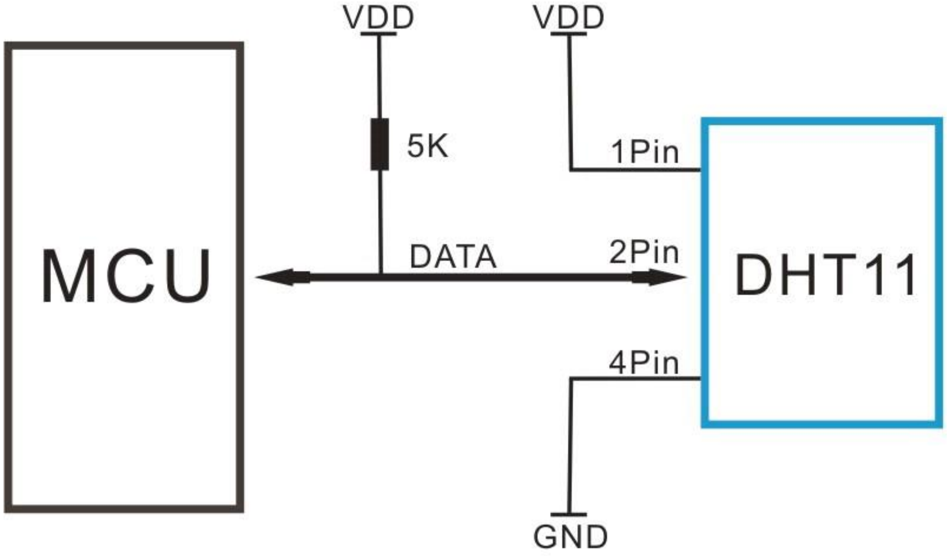


Figure 1 Typical Application

Note: 3Pin – Null; MCU = Micro-computer Unite or single chip Computer

When the connecting cable is shorter than 20 metres, a 5K pull-up resistor is recommended; when the connecting cable is longer than 20 metres, choose a appropriate pull-up resistor as needed.

4. Power and Pin

DHT11's power supply is 3-5.5V DC. When power is supplied to the sensor, do not send any instruction to the sensor in within one second in order to pass the unstable status. One capacitor valued 100nF can be added between VDD and GND for power filtering.

5. Communication Process: Serial Interface (Single-Wire Two-Way)

Single-bus data format is used for communication and synchronization between MCU and DHT11 sensor. One communication process is about 4ms.

Data consists of decimal and integral parts. A complete data transmission is **40bit**, and the sensor sends **higher data bit** first.

Data format: 8bit integral RH data + 8bit decimal RH data + 8bit integral T data + 8bit decimal T data + 8bit check sum. If the data transmission is right, the check-sum should be the last 8bit of "8bit integral RH data + 8bit decimal RH data + 8bit integral T data + 8bit decimal T data".

5.1 Overall Communication Process (Figure 2, below)

When MCU sends a start signal, DHT11 changes from the low-power-consumption mode to the running-mode, waiting for MCU completing the start signal. Once it is completed, DHT11 sends a response signal of 40-bit data that include the relative humidity and temperature information to MCU. Users can choose to collect (read) some data. Without the start signal from MCU, DHT11 will not give the response signal to MCU. Once data is collected, DHT11 will change to the lowpower-consumption mode until it receives a start signal from MCU again.

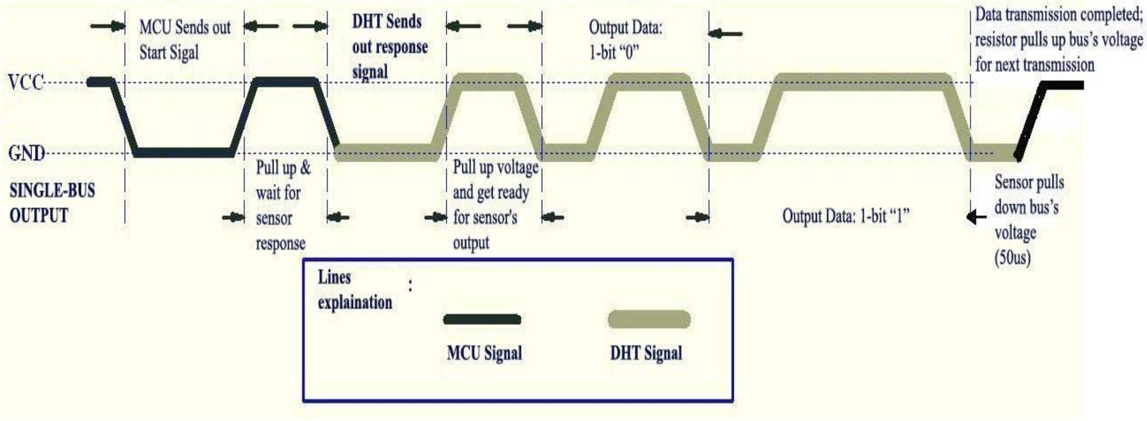

MCU Sends out Start Sigal
DHT Sends out response signal
Output Data: 1-bit "0"
Data transmission completed; resistor pulls up bus's voltage for next transmission
VCC
GND
SINGLE-BUS OUTPUT
Pull up & wait for sensor response
Pull up voltage and get ready for sensor's output
Output Data: 1-bit "1"
Sensor pulls down bus's voltage (50us)
Lines explaination :
MCU Signal
DHT Signal

Figure 2 Overall Communication Process

5.2 MCU Sends out Start Signal to DHT (Figure 3, below)

Data Single-bus free status is at high voltage level. When the communication between MCU and DHT11 begins, the programme of MCU will set Data Single-bus voltage level from high to low and this process must take at least 18ms to ensure DHT's detection of MCU's signal, then MCU will pull up voltage and wait 20-40us for DHT's response.

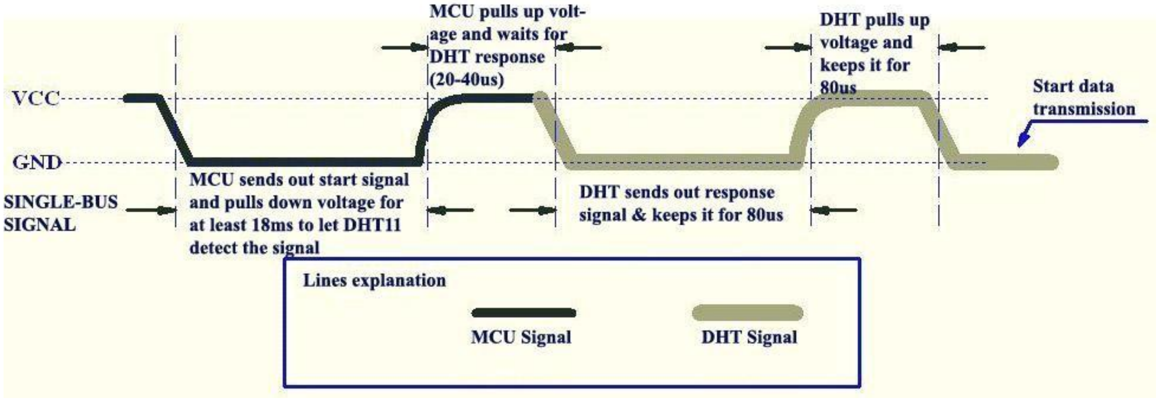

MCU pulls up voltage and waits for DHT response (20-40us)
DHT pulls up voltage and keeps it for 80us
VCC
GND
Start data transmission
SINGLE-BUS SIGNAL
MCU sends out start signal and pulls down voltage for at least 18ms to let DHT11 detect the signal
DHT sends out response signal & keeps it for 80us
Lines explanation
MCU Signal
DHT Signal

Figure 3 MCU Sends out Start Signal & DHT Responses

5.3 DHT Responses to MCU (Figure 3, above)

Once DHT detects the start signal, it will send out a low-voltage-level response signal, which lasts 80us. Then the programme of DHT sets Data Single-bus voltage level from low to high and keeps it for 80us for DHT's preparation for sending data.

When DATA Single-Bus is at the low voltage level, this means that DHT is sending the response signal. Once DHT sent out the response signal, it pulls up voltage and keeps it for 80us and prepares for data transmission.

When DHT is sending data to MCU, every bit of data begins with the 50us low-voltage-level and the length of the following high-voltage-level signal determines whether data bit is "0" or "1" (see Figures 4 and 5 below).

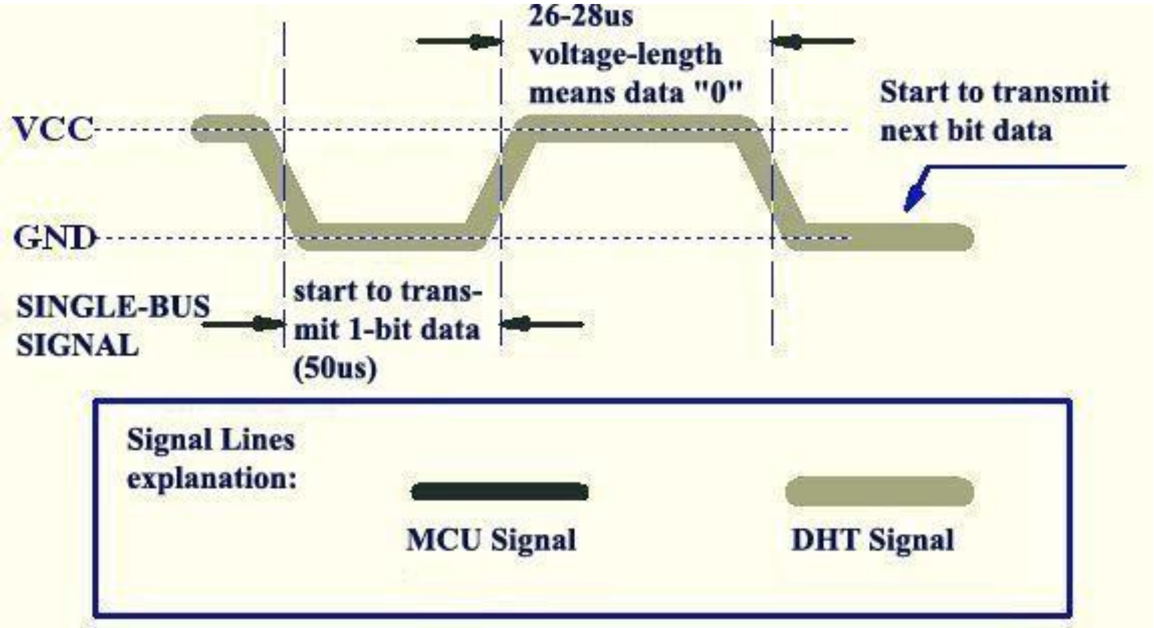


Figure 4 Data "0" Indication

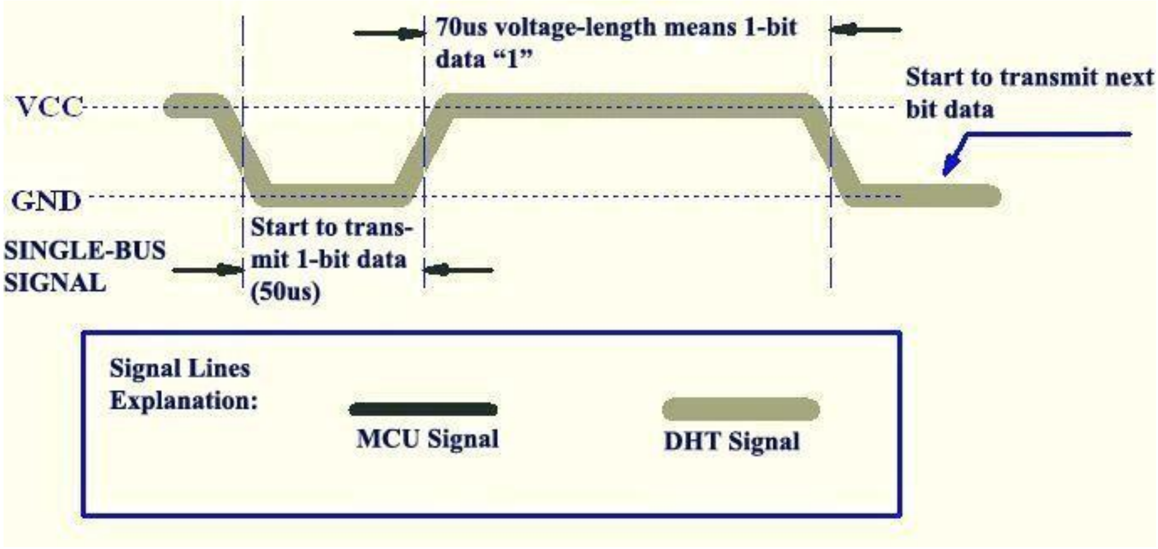

70us voltage-length means 1-bit data "1"
Start to transmit next bit data
VCC
GND
SINGLE-BUS SIGNAL
Start to trans-mit 1-bit data (50us)
Signal Lines Explanation:
MCU Signal
DHT Signal

Figure 5 Data "1" Indication

If the response signal from DHT is always at high-voltage-level, it suggests that DHT is not responding properly and please check the connection. When the last bit data is transmitted, DHT11 pulls down the voltage level and keeps it for 50us. Then the Single-Bus voltage will be pulled up by the resistor to set it back to the free status.

6. Electrical Characteristics

VDD=5V, T = 25℃ (unless otherwise stated)

	Conditions	Minimum	Typical	Maximum
Power Supply	DC	3V	5V	5.5V
Current Supply	Measuring	0.5mA		2.5mA
	Average	0.2mA		1mA
	Standby	100uA		150uA
Sampling period	Second	1		

Note: Sampling period at intervals should be no less than 1 second.

7. Attentions of application

(1) Operating conditions

Applying the DHT11 sensor beyond its working range stated in this datasheet can result in 3%RH signal shift/discrepancy. The DHT11 sensor can recover to the calibrated status gradually when it gets back to the normal operating condition and works within its range. Please refer to (3) of this section to accelerate its recovery. Please be aware that operating the DHT11 sensor in the non-normal working conditions will accelerate sensor's aging process.

(2) Attention to chemical materials

Vapor from chemical materials may interfere with DHT's sensitive-elements and debase its sensitivity. A high degree of chemical contamination can permanently damage the sensor.

(3) Restoration process when (1) & (2) happen

Step one: Keep the DHT sensor at the condition of Temperature 50~60Celsius, humidity <10%RH for 2 hours;
Step two:K keep the DHT sensor at the condition of Temperature 20~30Celsius, humidity >70%RH for 5 hours.

(4) Temperature Affect

Relative humidity largely depends on temperature. Although temperature compensation technology is used to ensure accurate measurement of RH, it is still strongly advised to keep the humidity and temperature sensors working under the same temperature. DHT11 should be mounted at the place as far as possible from parts that may generate heat.

(5) Ligh tAffect

Long time exposure to strong sunlight and ultraviolet may debase DHT's performance.

(6) Connection wires

The quality of connection wires will affect the quality and distance of communication and high quality shielding-wire is recommended.

(7) Other attentions

* Welding temperature should be bellow 260Celsius and contact should take less than 10 seconds.
* Avoid using the sensor under dew condition.
* Do not use this product in safety or emergency stop devices or any other occasion that failure of DHT11 may cause personal injury.
* Storage: Keep the sensor at temperature 10-40℃, humidity <60%RH.

Disclaimer

This is a translated version of the manufacturer's data sheet. OSEPP is not responsible for the accuracy of the translated information.

4 channel 12V Relay Module

Introduction:

The 4 channel Relay Board can be used to turn lights, fans and other devices on/off while keeping them isolated from your microcontroller.

Relay's coil voltage is 12V, so you can use directly with any 12V regulator. (We suggest separate regulators between your Arduino and Relay board).
This Relay Board allows you to control high-power devices (up to 10 A) via the on-board relay.
Control of the relay is provided via a 1 x 3 header – friendly to servo cables and convenient to connect to many development boards.

Key Features:

Control high-power devices up to 10 A with a simple high/low signal Provides isolation between the microcontroller and device being controlled Screw terminals for relay connections 3-pin servo-style header for power/signal interface LED indicator provides visual feedback

Specification:

Control signal: TTL voltage

Active at HIGH level

Rated load: 10 A 250VAC / 10A 30DC