

Preface

About SunFounder

SunFounder is a technology company focused on Raspberry Pi and Arduino open source community development. Committed to the promotion of open source culture, we strive to bring the fun of electronics making to people all around the world and enable everyone to be a maker. Our products include learning kits, development boards, robots, sensor modules and development tools. In addition to high quality products, SunFounder also offers video tutorials to help you make your own project. If you have interest in open source or making something cool, welcome to join us!

About This Kit

The kit is suitable for SunFounder Uno, Mega 2560, Duemilanove and Nano and also fully compatible with the corresponding Arduino boards. It includes 37 various modules for you to learn and we provide corresponding lessons which are simple and useful for better understanding. Hope you can learn their applications quickly and use them in your own projects!

In this book, we will show you circuits with both realistic illustrations and schematic diagrams. You can go to our official website www.sunfounder.com to download related materials (code, Fritzing figures and document in PDF) by clicking [LEARN -> Get Tutorials](#).

Free Support



If you have any **TECHNICAL questions**, add a topic under **FORUM** section on our website and we'll reply as soon as possible.



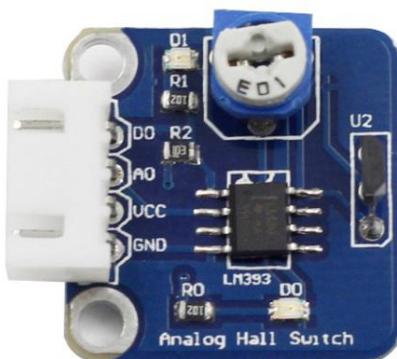
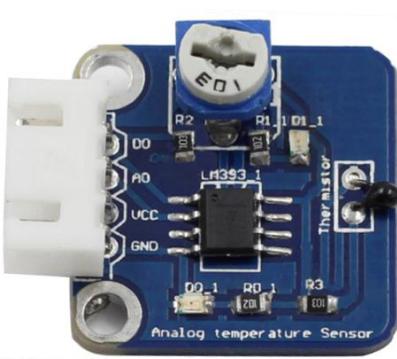
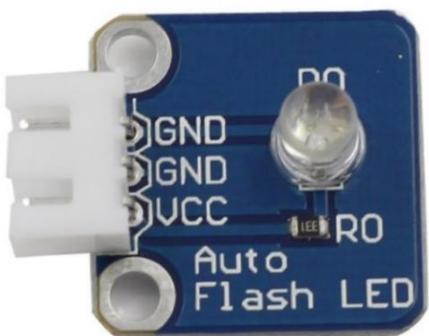
For **NON-TECH questions** like order and shipment issues, please **send an email to service@sunfounder.com**. You're also welcomed to share your projects on FORUM.

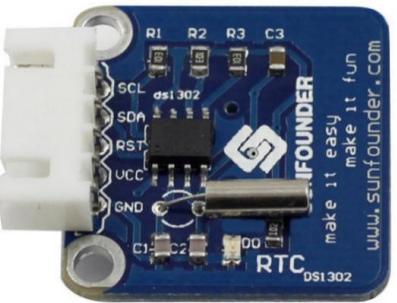
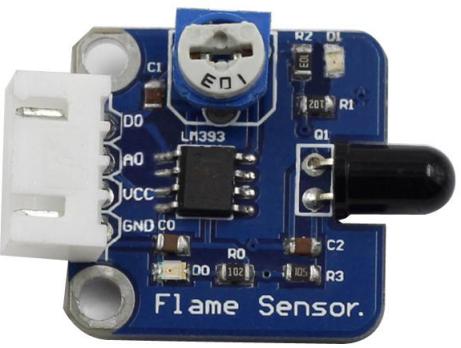
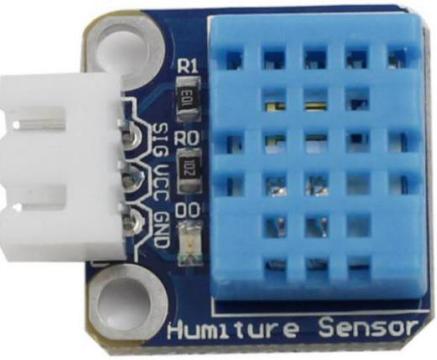
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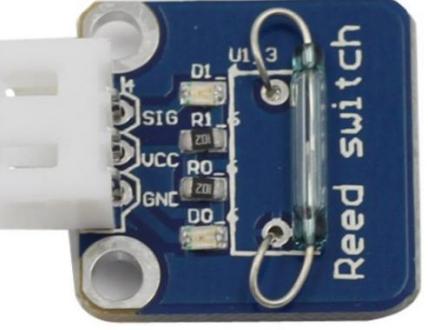
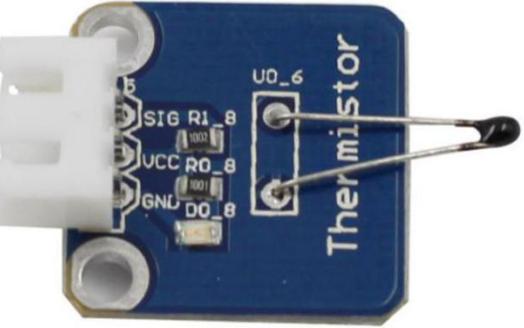
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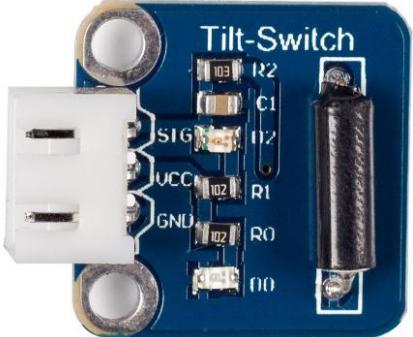
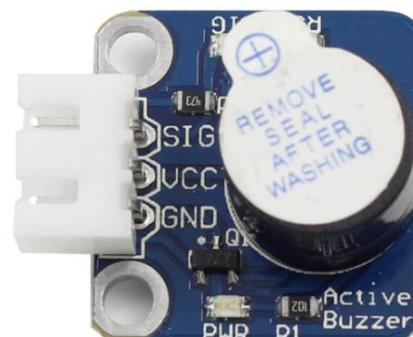
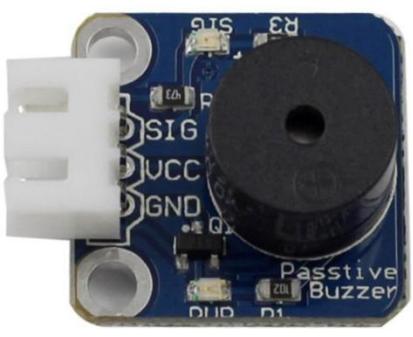
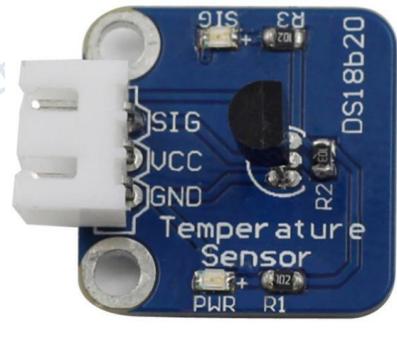
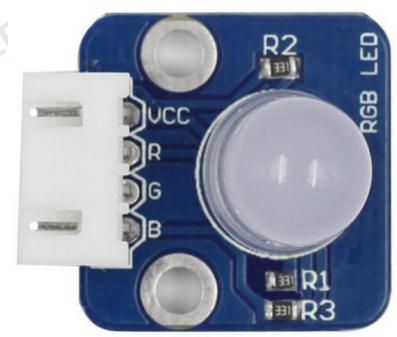
Components List

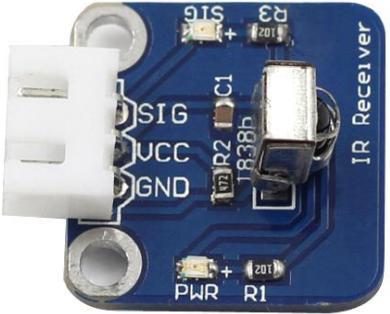
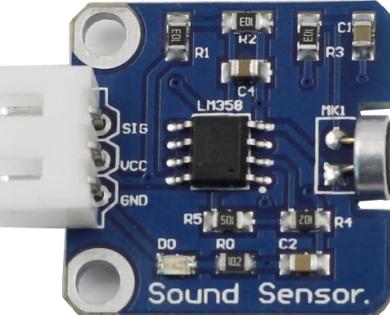
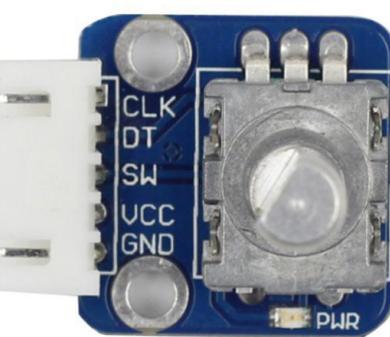
No.	Name	Qty.	Component
1	Analog Hall Sensor	1	 Analog Hall Sensor module featuring an LM393 op-amp and a Hall effect sensor. It includes pins for VCC, GND, AO, DO, and a digital output pin labeled U2.
2	Hall Switch Sensor	1	 Hall Switch Sensor module featuring an LM393 op-amp and a Hall effect sensor. It includes pins for VCC, GND, and a digital output pin labeled U2.
3	Analog Temperature Sensor	1	 Analog temperature sensor module featuring an LM393 op-amp and a thermistor. It includes pins for VCC, GND, AO, DO, and a digital output pin labeled U2.
4	Auto Flash LED	1	 Auto Flash LED module featuring an LM393 op-amp and a light-emitting diode (LED). It includes pins for VCC, GND, and a digital output pin labeled U2.

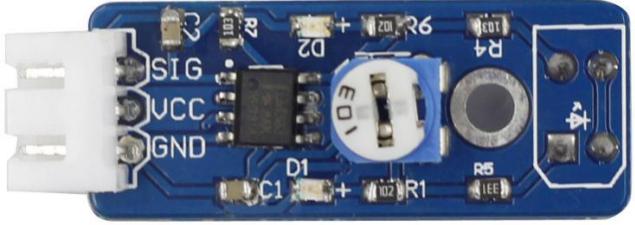
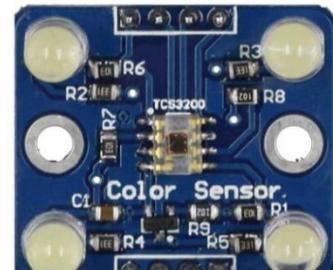
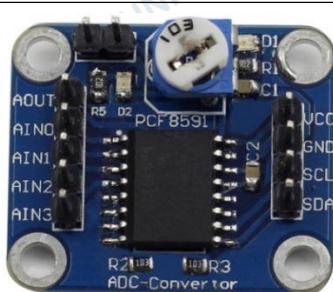
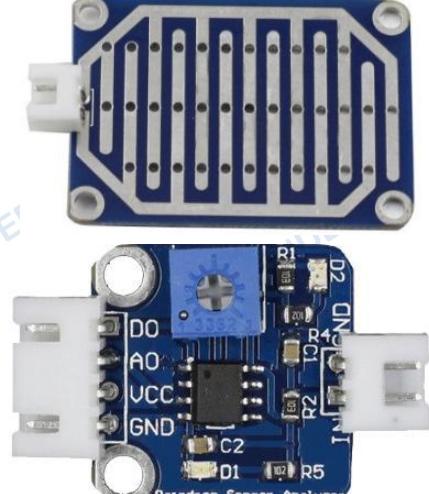
5	Barometer-BMP280	1	 A blue printed circuit board labeled "Barometer" featuring a BMP280 pressure sensor chip. It has several pins labeled VCC, GND, SCK, SDO, SCL, and CS.
6	RTC-DS1302	1	 A blue printed circuit board labeled "RTC DS1302" featuring a DS1302 real-time clock chip. It has pins labeled SCL, SDA, RST, UCC, and GND.
7	Flame Sensor	1	 A blue printed circuit board labeled "Flame Sensor." featuring a flame detection module with a black cylindrical sensor and various resistors and capacitors.
8	Gas Sensor	1	 A blue printed circuit board labeled "Gas Sensor" featuring a gas detection module with a circular metal detector element and associated electronic components.
9	Humiture Sensor	1	 A blue printed circuit board labeled "Humiture Sensor" featuring a digital temperature and humidity sensor module with a blue plastic housing and a metal detector element.

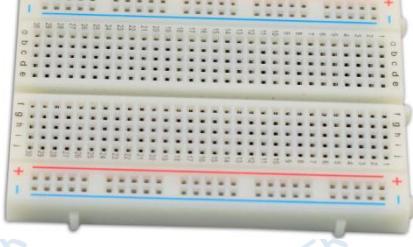
10	Joystick PS2	1	A blue printed circuit board (PCB) labeled "Joystick". It features a central analog joystick with two small black caps on top. Surrounding the joystick are several pins and a small microcontroller chip. A black circular cap is shown separately.
11	Button	1	A blue printed circuit board (PCB) labeled "Button". It features a central square push-button switch with four pins. The PCB also includes a small microcontroller chip and some resistors.
12	Mercury Switch	1	A blue printed circuit board (PCB) labeled "Mercury Switch". It features a small cylindrical glass tube containing a metal ball (mercury). The tube is connected to the PCB via wires. The PCB has several pins and a small microcontroller chip.
13	Touch Switch	1	A blue printed circuit board (PCB) labeled "Touch Switch". It features a small circular metal disc with concentric rings, which is the touch-sensitive component. The PCB has several pins and a small microcontroller chip.
14	Photo-interrupter	1	A blue printed circuit board (PCB) labeled "Photo-interrupter". It features a small black rectangular component, likely a photodiode or LED, and a metal clip for mounting. The PCB has several pins and a small microcontroller chip.

15	Photoresistor	1	 A blue printed circuit board labeled "Photoresistor". It features a white plastic housing with two metal pins extending from it. On the board, there is a small LED diode, a resistor, and a photoresistor component. Pin connections are labeled SIG, R1, UCC, RO, GND, and DO.
16	Reed Switch	1	 A blue printed circuit board labeled "Reed switch". It has a white plastic housing with two metal pins. The board contains a Reed switch, a diode (D1), and some resistors. Pin connections are labeled SIG, R1, UCC, RO, GND, and DO.
17	Potentiometer	1	 A blue printed circuit board labeled "Potentiometer". It includes a blue cylindrical potentiometer with a dial. The board has three pins labeled SIG, UCC, and GND, along with two output pins labeled DO and RO.
18	Relay Module	1	 A blue printed circuit board labeled "Relay module". It features a relay component with two sets of contacts. The board is labeled with technical specifications: 10A 250VAC 10A 125VDC 10A 30VDC 10A 28VDC SRD-05VDC-SL-C. Pin connections are labeled SIG, R1, UCC, R2, Q1, GND, R3, Q2, RO, and DO.
19	Thermistor	1	 A blue printed circuit board labeled "Thermistor". It has a white plastic housing with two metal pins. The board contains a thermistor and some resistors. Pin connections are labeled SIG, R1, UCC, RO, GND, and DO.

20	Tilt-Switch	1	 A blue printed circuit board (PCB) featuring a white plastic housing. On the left side, there is a white header with pins labeled SIG, UCC, GND, and GND. On the right side, there is a small cylindrical component labeled R2, a capacitor labeled C1, and a resistor labeled R1. A red LED is visible at the bottom right.
21	Active Buzzer	1	 A blue printed circuit board (PCB) featuring a white plastic housing. On the left side, there is a white header with pins labeled SIG, UCC, GND, and PWR. On the right side, there is a large circular component labeled R1, a capacitor labeled C1, and a resistor labeled R2. A blue label on the housing reads "REMOVE SEAL AFTER WASHING".
22	Passive Buzzer	1	 A blue printed circuit board (PCB) featuring a white plastic housing. On the left side, there is a white header with pins labeled SIG, UCC, GND, and PWR. On the right side, there is a large circular component labeled R1, a capacitor labeled C1, and a resistor labeled R2. A blue label on the housing reads "Passtive Buzzer".
23	Temperature Sensor DS18B20	1	 A blue printed circuit board (PCB) featuring a white plastic housing. On the left side, there is a white header with pins labeled SIG, UCC, GND, and PWR. On the right side, there is a small black component labeled DS18B20, a capacitor labeled C1, and a resistor labeled R2. A blue label on the housing reads "Temperature Sensor DS18B20".
24	RGB LED	1	 A blue printed circuit board (PCB) featuring a white plastic housing. On the left side, there is a white header with pins labeled UCC, R, G, and B. On the right side, there is a large circular component labeled RGB LED, a resistor labeled R1, and a resistor labeled R3.

25	IR Receiver	1	 A blue printed circuit board labeled "IR Receiver". It features a white plastic housing with a clear lens on top. On the left side, there are four pins labeled DSIG, UCC, GND, and PWR. On the right side, there is a small component labeled "T838B" and two resistors labeled R1 and R2.
26	Dual-Color LED	1	 A blue printed circuit board labeled "Dual-Color LED". It features a white plastic housing with a clear lens on top. On the left side, there are four pins labeled R, G, UCC, and GND. On the right side, there is a single white LED.
27	Sound Sensor	1	 A blue printed circuit board labeled "Sound Sensor.". It features a white plastic housing with a clear lens on top. On the left side, there are four pins labeled SIG, UCC, GND, and PWR. On the right side, there is a small component labeled "LM356" and several resistors labeled R1 through R5.
28	Rotary Encoder	1	 A blue printed circuit board labeled "Rotary Encoder". It features a white plastic housing with a clear lens on top. On the left side, there are five pins labeled CLK, DT, SW, UCC, and GND. On the right side, there is a small component labeled "TLLR".
29	Laser Emitter	1	 A blue printed circuit board labeled "Laser Emitter". It features a white plastic housing with a clear lens on top. On the left side, there are two pins labeled UCC and SIG. On the right side, there is a gold-colored cylindrical component labeled "Laser Emitter".

30	Tracking Sensor	1	
31	IR Obstacle Sensor	1	
32	Color Sensor	1	
33	AD/DA Converter PCF8591	1	
34	Raindrop Sensor	1	

35	Ultrasonic	1	
36	Remote Controller	1	
37	I2C LCD1602	1	
38	Breadboard	1	
39	USB Cable	1	
40	5-Pin Anti-reverse Cable	5	

41	3-Pin Anti-reverse Cable	5	A cable with a grey 3-pin male header connector on one end and three wires (red, yellow, black) with alligator clips on the other end.
42	4-Pin Anti-reverse Cable	5	A cable with a grey 4-pin male header connector on one end and four wires (red, black, white, black) with alligator clips on the other end.
43	2-Pin Anti-reverse Cable	2	A cable with a grey 2-pin male header connector on one end and two red wires with alligator clips on the other end.
44	2-Pin Ribbon Cable (F to F)	1	A short grey ribbon cable with two grey female connectors at both ends.
45	Dupont Wire (M to F)	10	A yellow Dupont wire with a grey male header connector on one end and a grey female header connector on the other end.
46	Dupont Wire (M to M)	10	A purple Dupont wire with two grey male header connectors at both ends.
47	Dupont Wire (F to F)	10	A teal Dupont wire with two grey female header connectors at both ends.

Get Started

Note:

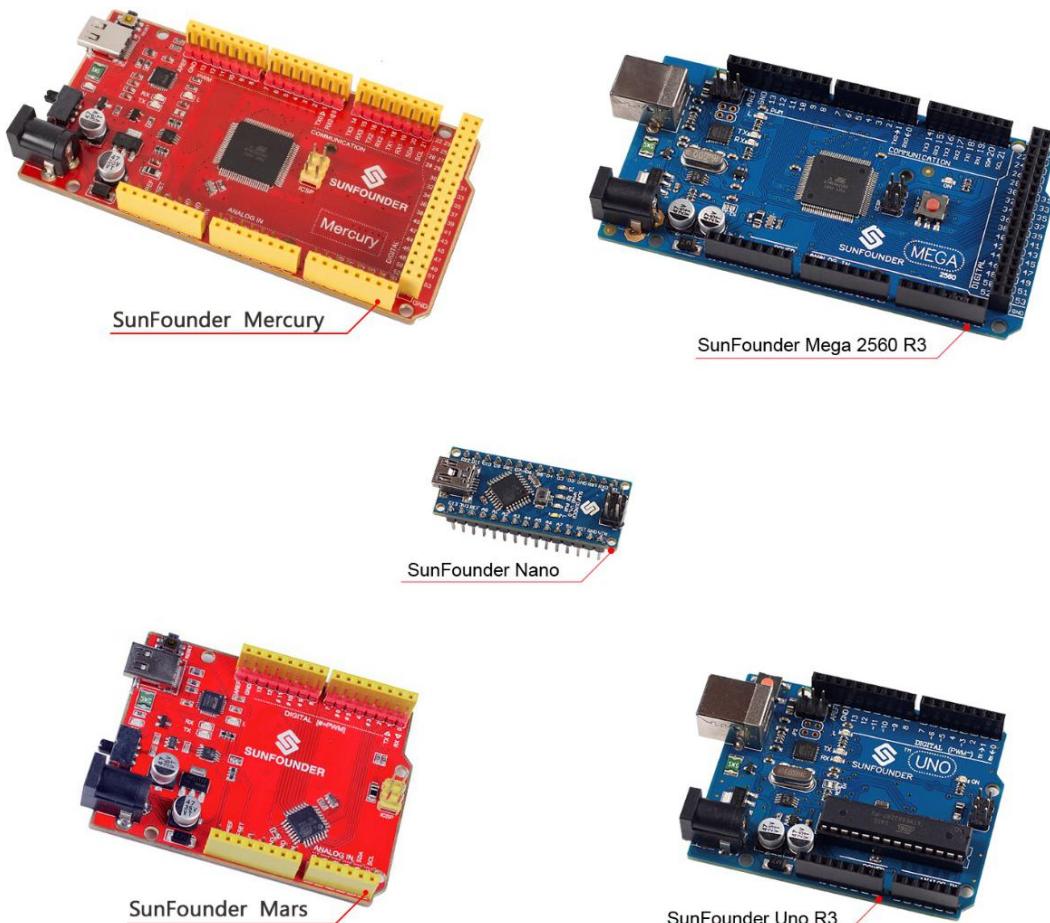
Before starting your own project, you must download the file **Sensor Kit V2.0 for Arduino.zip** on our official website by visiting **LEARN -> Get Tutorials -> Sensor Kit V2.0 for Arduino** and unzip it.

Arduino

Description

Arduino is an open source platform with simple software and hardware. You can pick it up in short time even if you are a beginner. It provides an integrated development environment (IDE) for code compiling, compatible with multiple control boards. So you can just download the Arduino IDE, upload the sketches (i.e. the code files) to the board, and then you can see relative experimental phenomena. For more information, refer to <http://www.arduino.cc>.

SunFounder Arduino Board



Now, SunFounder has five Arduino boards: SunFounder Uno R3 Board, Mega 2560 Board,

Nano Board, SunFounder Mars Board and SunFounder Mercury Board. The Uno Board and the Mars Board share the same kind of pins at the same position. And the pins of the first half part on the Mega 2560 are the same as those on the Uno. The difference lies in that on the Mega 2560 board, the I2C pin (SDA) and pin SCL don't correspond to pin A4 and A5 but to pin 20 and 21. On the other hand, the Nano and the Uno also share the same kind of pins at the same position. Though the Nano is in a smaller size, making it applicable for projects.

The following is the parameters of the four boards:

Board Parameters	Uno R3	Mars	Nano	Mega 2560	Mercury
Microcontroller	ATmega328P	ATmega328P	ATmega328P	ATmega2560	ATmega2560
USB connection	Type B	Type C	Mini-B	Type B	Type C
USB-to-Serial Chip	MEGA16U2	FT232R	PL2303	MEGA16U2	FT232R
Power jack?	Y	Y	N	Y	Y
Operating Voltage	5V	5V	5V	5V	5V
Input Voltage	7-12V	7-12V	7-12V	7-12V	7-12V
Digital I/O Pins	14 (of which 6 provide PWM output)	14 (of which 6 provide PWM output)	14 (of which 6 provide PWM output)	54 (of which 15 provide PWM output)	54 (of which 15 provide PWM output)
Analog Input Pins	6	6	8	16	16
DC Current per I/O Pin	20 mA	20mA	20 mA	20 mA	20 mA

Install Arduino IDE

The code in this kit is written based on Arduino, so you need to install the IDE first. Skip it if you have done this.

Now go to arduino.cc and click **DOWNLOAD**. On the page, check the software list on the right side under **Download the Arduino Software**.

DOWNLOAD

ENGLISH

Download the Arduino Software



The screenshot shows the Arduino Software (IDE) download page. On the left, there's a large teal circular icon with a white infinity symbol containing a minus sign on the left and a plus sign on the right. To its right, the text "ARDUINO 1.6.8" is displayed in bold. Below it is a detailed description of the software: "The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software. This software can be used with any Arduino board. Refer to the [Getting Started](#) page for Installation instructions." To the right of this text block is a teal sidebar with links: "Windows Installer", "Windows ZIP file for non admin install", "Mac OS X 10.7 Lion or newer", "Linux 32 bits", "Linux 64 bits", "Release Notes", "Source Code", and "Checksums".

Find the one that suits your operation system and click to download. There are two versions of Arduino for Windows: Installer or ZIP file. You're recommended to download the former. Just download the package, and run the executable file to start installation. It will download the driver needed to run Arduino IDE. After downloading, follow the prompts to install. For the details of installing steps, you can refer to the guide on [Learning->Getting Started with Arduino](#), scroll down and see [Install the Arduino Software](#).

After installing, you will see Arduino icon on your desktop and double click to open it.



Plug in the Board

Connect the control board to your computer with a USB cable. If you use Uno, Mega2560 or Mars as the control board, the system will automatically install the driver when you plug it in. After a while, a prompt will show up at the bottom right corner telling you which port the board locates at.

Add libraries

What is Library?

A library, gathering some function definitions and header files, usually contains two files: .h (header file, including function statement, Macro definition, constructor definition, etc.) and .cpp (execution file, with function implementation, variable definition, and so on). When you need to use a function in some library, you just need to add a header file (e.g. #include <LiquidCrystal_I2C.h>), and then call that function. This can make your code more

concise. If you don't want to use the library, you can also write that function definition directly. Though as a result, the code will be long and inconvenient to read.

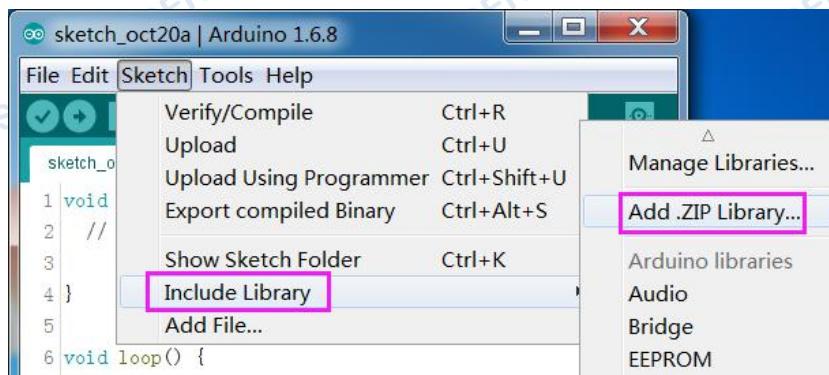
Add libraries

Some libraries are already built in the Arduino IDE, when some others may need to be added. So now let's see how to add one. There are two methods for that.

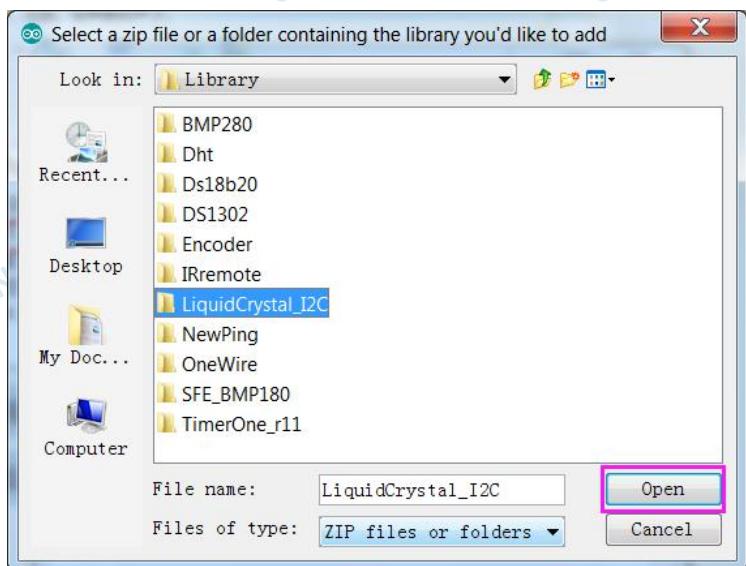
Method 1

Directly import the library in Arduino IDE (take LiquidCrystal_I2C as an example below). The advantage of this method is easy to understand and operate, but on the other hand, only one library can be imported at a time. So it is inconvenient when you need to add quite a lot of libraries.

Step 1: Select Sketch -> Include Library -> Add ZIP Library.



Step 2: Find Sensor Kit V2.0 for Arduino\Library\LiquidCrystal_I2C, Click Open.



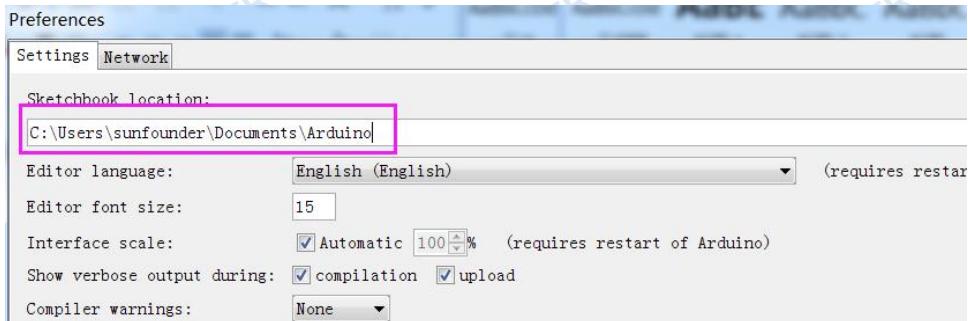
Step 3: When you see "Library added to your libraries. Check "Include library" menu", it means you have added the library successfully. Please use the same method to add other libraries then.



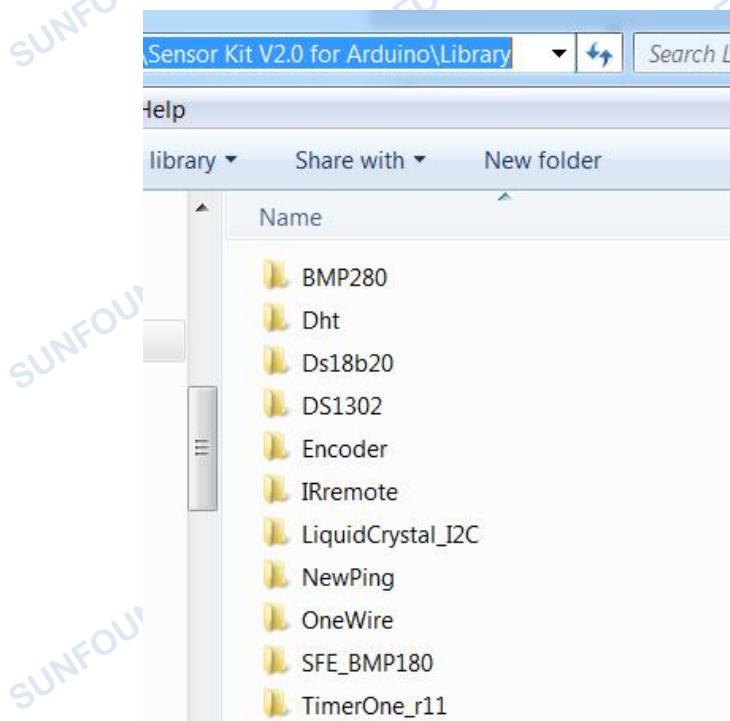
Method 2

Directly copy the library to libraries/Arduino path. This method can copy all libraries and add them at a time, but the drawback is that it is difficult to find libraries/Arduino.

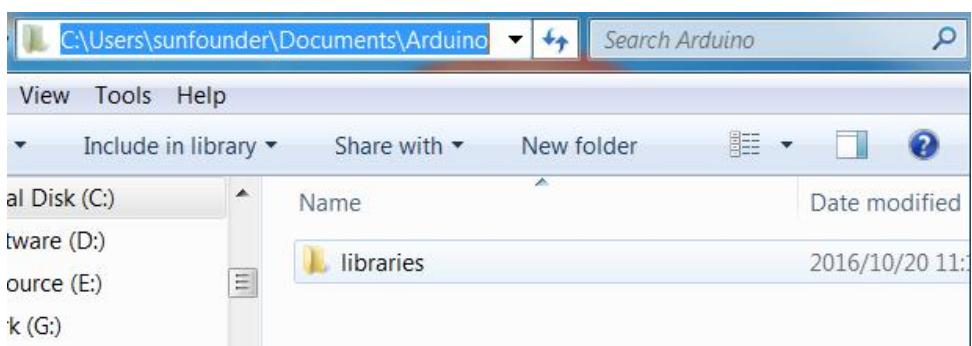
Step 1: Click **File -> Preferences** and on the pop-up window you can see the path of the libraries folder in the textbox as shown below.



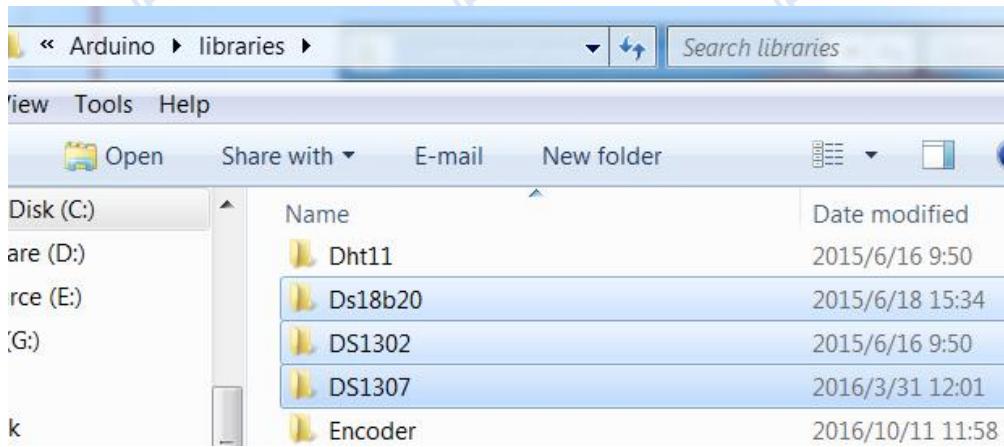
Step 3: Copy all Libraries in the path Sensor Kit V2.0 for Arduino\Library\.



Step 4: Go to the path above and you will see there is a *Libraries* folder, click to open it.



Step 5: Paste the libraries copied to the folder. Then you can see them in libraries.



For more details about Arduino IDE, go to **Learning->Getting started->Foundation** on the arduino.cc and click **Arduino Software (IDE)** on the page:

<http://www.arduino.cc/en/Guide/Environment>.

If your sketch fails the upload, on the same page click **Troubleshooting**

<http://www.arduino.cc/en/Guide/Troubleshooting>.

Notes:

- If your computer is running on the Windows XP system, the new version IDE will prompt errors when running the code. You are recommended to download the Arduino 1.0.5 or Arduino 1.0.6. Or you can also upgrade your Window system.
- All the experiments in this kit are done with SunFounder Uno R3 board, but they are also compatible with SunFounder Mega 2560, SunFounder Mars, SunFounder Nano and all official Arduino Boards. All the code included in this kit works with these boards.

So what does COMPATIBLE mean here? It means you can use any of the three boards to do the same experiment with the same wiring. Simply put, if the wire is connected to Pin 12 of Uno in the user manual, likewise, you can connect it to Pin 12 on any other official Arduino boards you are using. Then open the corresponding sketch and upload them.

Now let's begin!

Lesson 1 Display by I2C LCD1602

Introduction

As we all know, though LCD and some other displays greatly enrich the man-machine interaction, they share a common weakness. When they are connected to a controller, multiple IOs will be occupied of the controller which has no so many outer ports. Also it restricts other functions of the controller. Therefore, LCD1602 with an I2C bus is developed to solve the problem.

I2C bus is a type of serial bus invented by PHILIPS. It is a high performance serial bus which has bus ruling and high or low speed device synchronization function required by multiple-host system. The blue potentiometer on the I2C LCD1602 (see the figure below) is used to adjust the backlight for better display. I²C uses only two bidirectional open-drain lines, Serial Data Line (SDA) and Serial Clock Line (SCL), pulled up with resistors. Typical voltages used are +5 V or +3.3 V although systems with other voltages are permitted.



Components

- 1 * SunFounder Uno board
- 1 * I2C LCD1602 module
- 1 * USB cable
- 1 * 4-Pin Dupont wire (M to F)

Principle

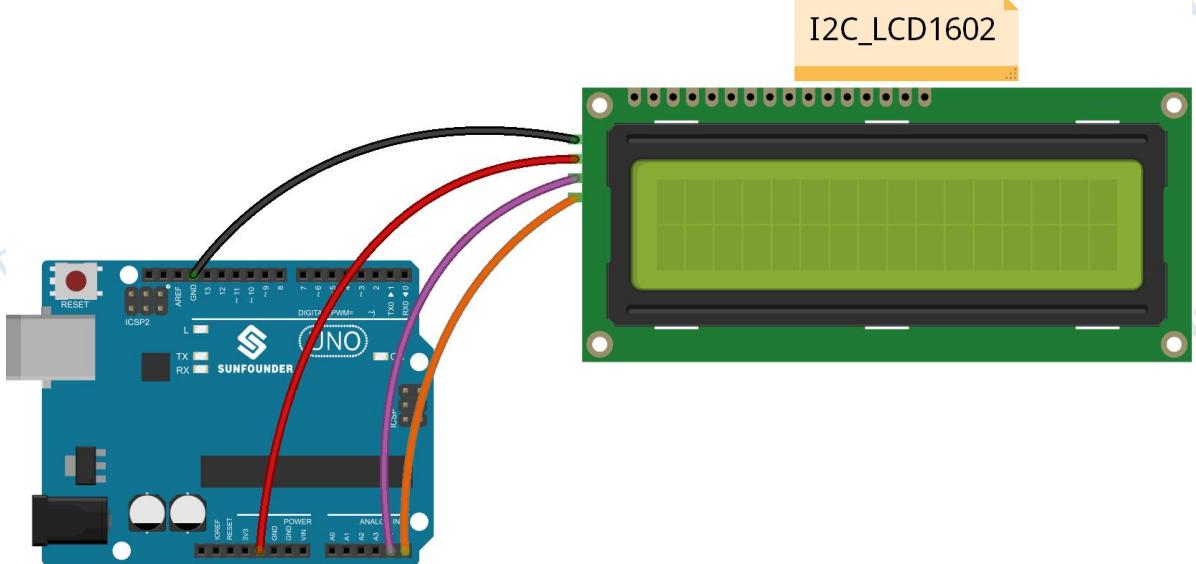
In this experiment, we will let I2C LCD1602 display "SunFounder" and "hello, world" by programming.

Experimental Procedures

Step 1: Build the circuit

I2C LCD1602	SunFounder Uno/ Mega2560
GND	GND
VCC	5V
SDA	A4 (Uno)/Pin 20 (Mega2560)
SCL	A5 (Uno)/Pin 21 (Mega2560)

Note: The I2C LCD1602 is connected to Mega2560 differently compared with being done to Uno. PLEASE follow the wiring above.



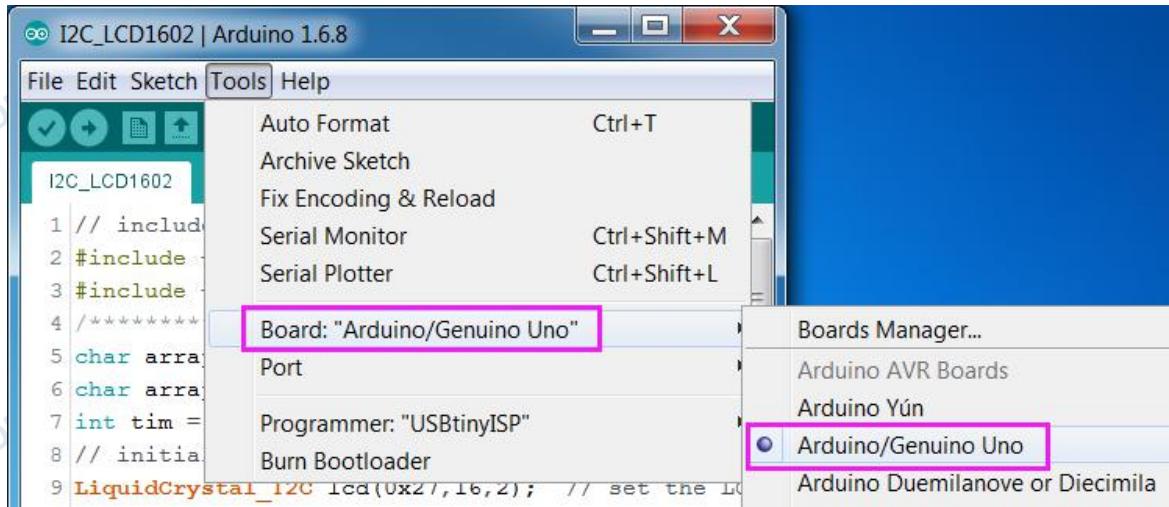
Step 2: Open the code file

In the folder **Sensor Kit V2.0 for Arduino** you just downloaded and unzipped, you can see the folder for the corresponding lesson which includes two folders: **code** (the sketch) and **circuit** (Fritzing file). Go to the **code** folder and find the **.ino** file (**.ino** is the format of the sketch). Then double click to open it. You can also open an empty **.ino** file and type in the code we provide.

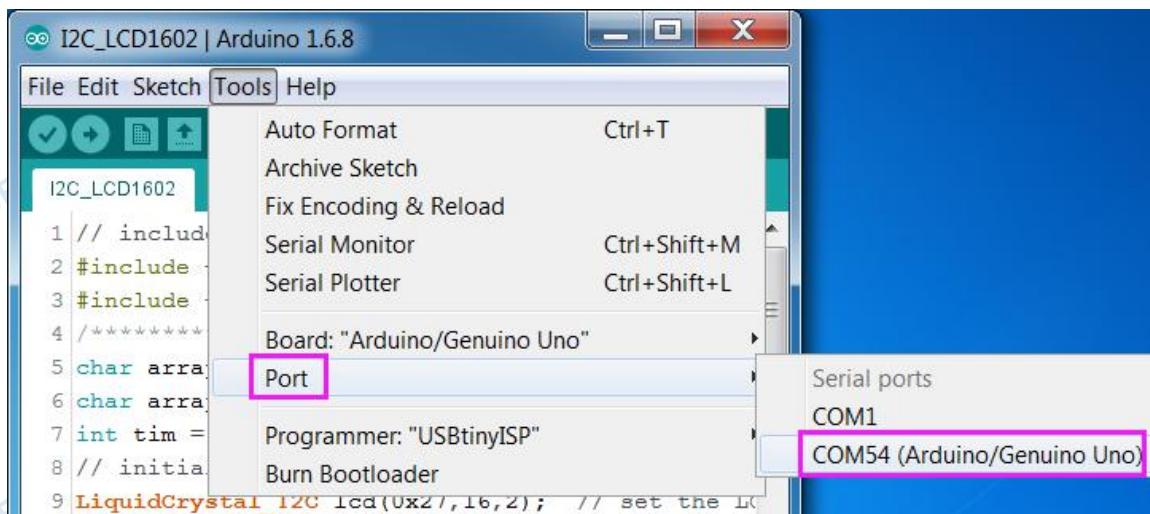
Step 3: Select the Board and Port

Before uploading the code, you need to select the **Board** and **Port**.

Click **Tools ->Board** and select **Arduino/Genuino Uno**. If your board is Mega2560, then select **Arduino/Genuino Uno Mega** or **Mega2560**.

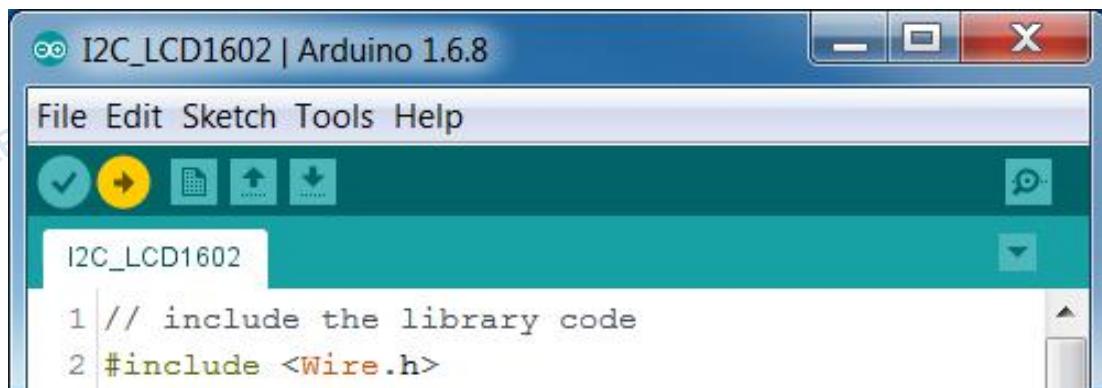


Then select **Tools ->Port**. Your port should be different from mine.



Step 4: Upload the sketch to the SunFounder Uno board

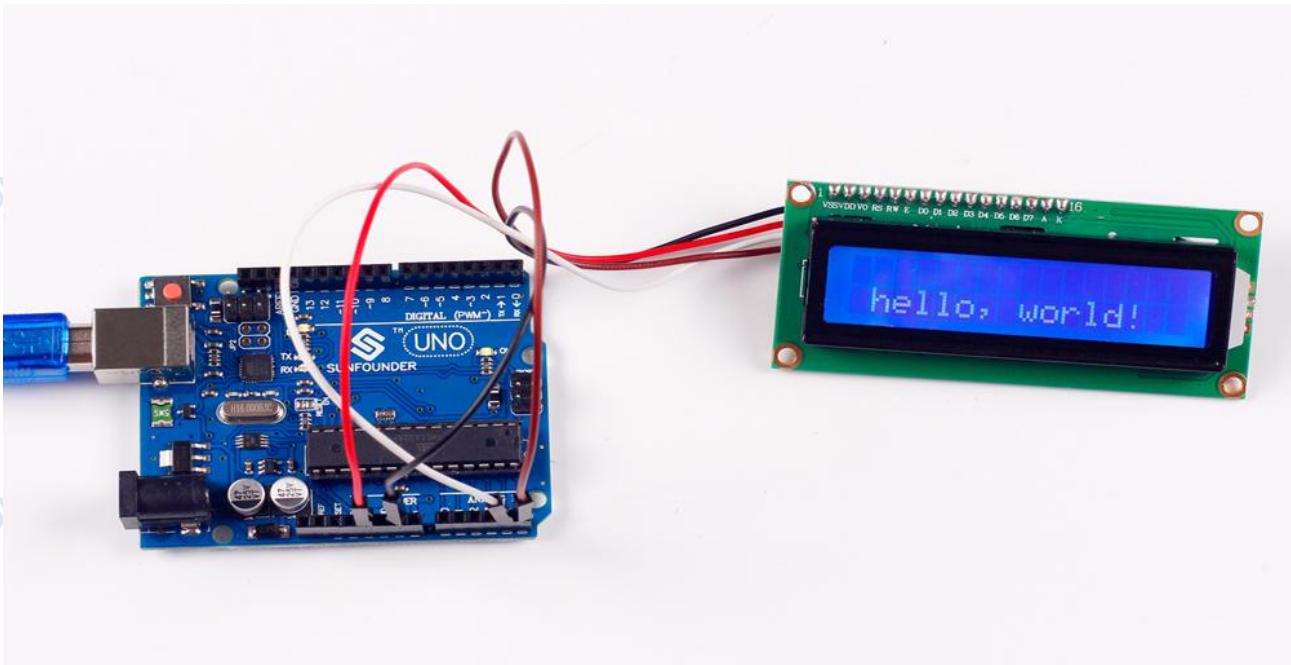
Click the **Upload** icon to upload the code to the control board.



If "Done uploading" appears at the bottom of the window, it means the sketch has been successfully uploaded.



You should now see your I2C LCD1602 display the flowing characters: "SunFounder" and "hello, world".



Lesson 2 Analog Hall Sensor

Introduction

Based on the Hall Effect, a Hall sensor is a one that varies its output voltage in response to a magnetic field. Hall sensors are used for proximity switching, positioning, speed detection, and current sensing applications.

Hall sensors can be categorized into linear (analog) Hall sensors and switch Hall sensors. A switch Hall sensor consists of voltage regulator, Hall element, differential amplifier, Schmitt trigger, and output terminal and it outputs Boolean value (0/1). A linear Hall sensor consists of Hall element, linear amplifier, and emitter follower and it outputs analog values. If a comparator is added to a linear (analog) Hall sensor, it can output both analog and digital signals.



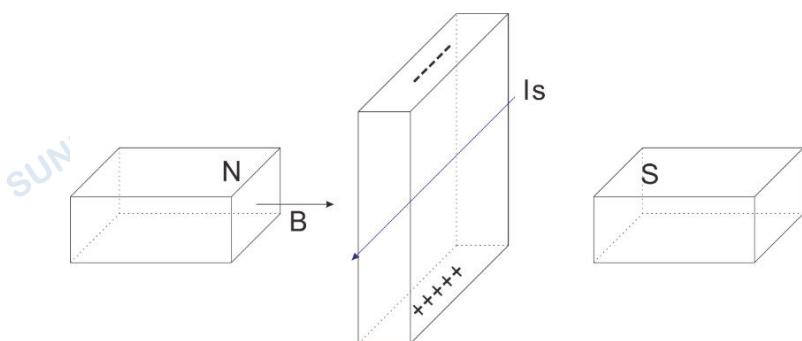
Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * Analog Hall sensor module
- 1 * 4-Pin anti-reverse cable
- 1 * Magnet

Experimental Principles

Hall Effect

Hall Effect is a kind of electromagnetic effect. It was discovered by Edwin Hall in 1879 when he was researching conductive mechanism about metals. The effect is seen when a conductor is passed through a uniform magnetic field. The natural electron drift of the charge carriers causes the magnetic field to apply a Lorentz force (the force exerted on a charged particle in an electromagnetic field) to these charge carriers. The result is what is seen as a charge separation, with a buildup of either positive or negative charges on the bottom or on the top of the plate.

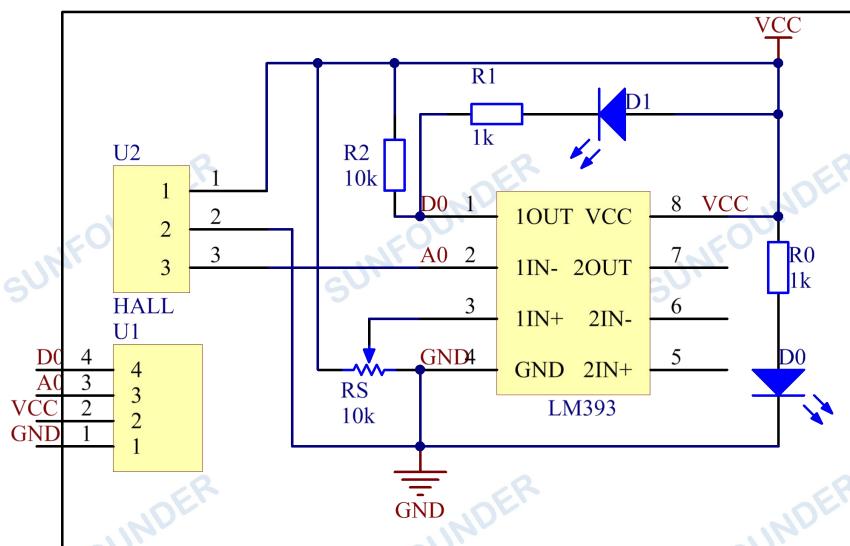


A Hall sensor is a magnetic field sensor based on it.

Electricity carried through a conductor will produce a magnetic field that varies with current, and a Hall sensor can be used to measure the current without interrupting the circuit. Typically, the sensor is integrated with a wound core or permanent magnet that surrounds the conductor to be measured.

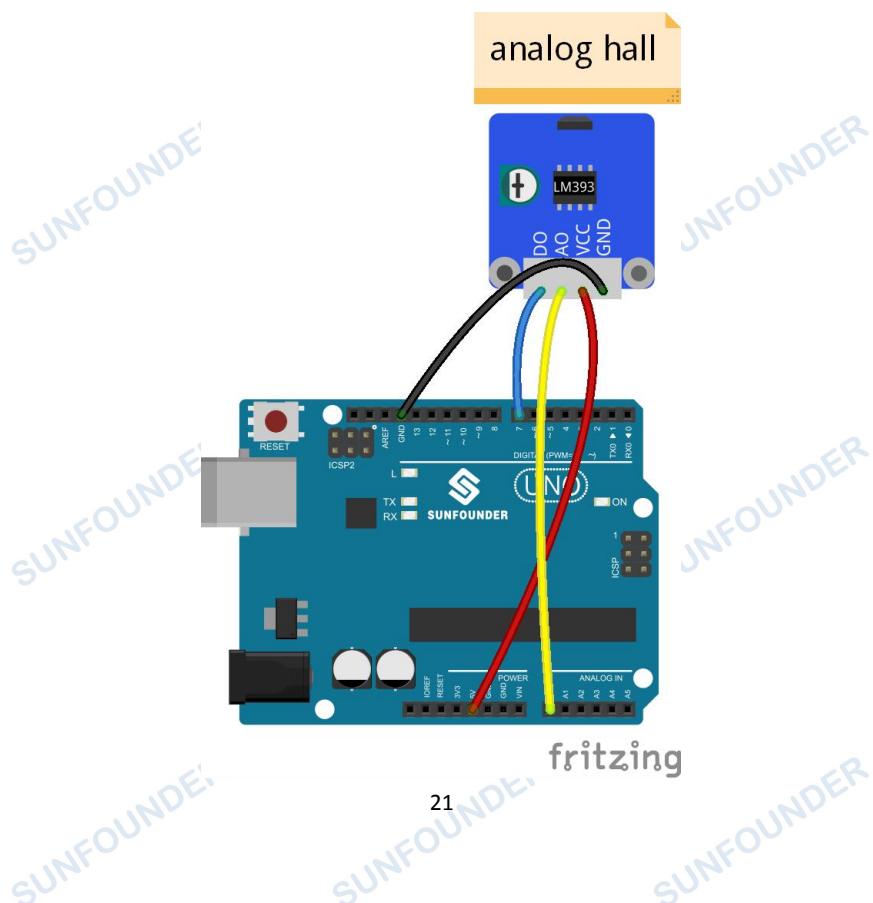
In this experiment, when the sensor approaches the magnet, the value of pin A0 will change. When the value exceeds the threshold set by the potentiometer before, D0 will output low level and the corresponding LED lights up.

The schematic diagram of the analog Hall sensor module:



Experimental Procedures

Step 1: Build the circuit

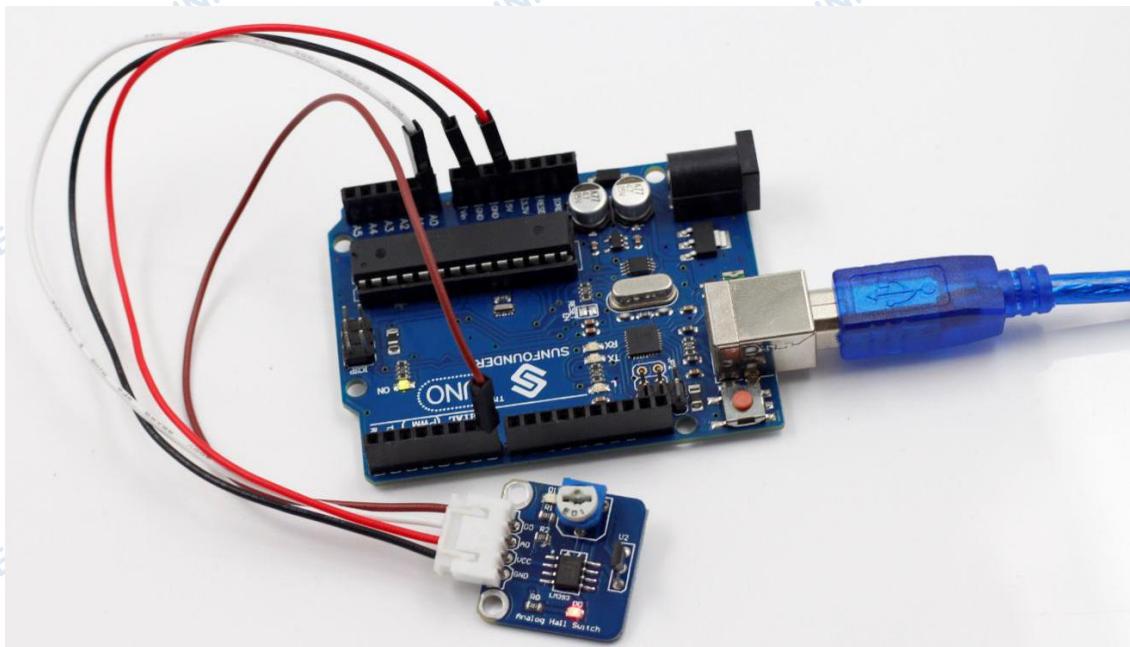


Step 2: Open the code file

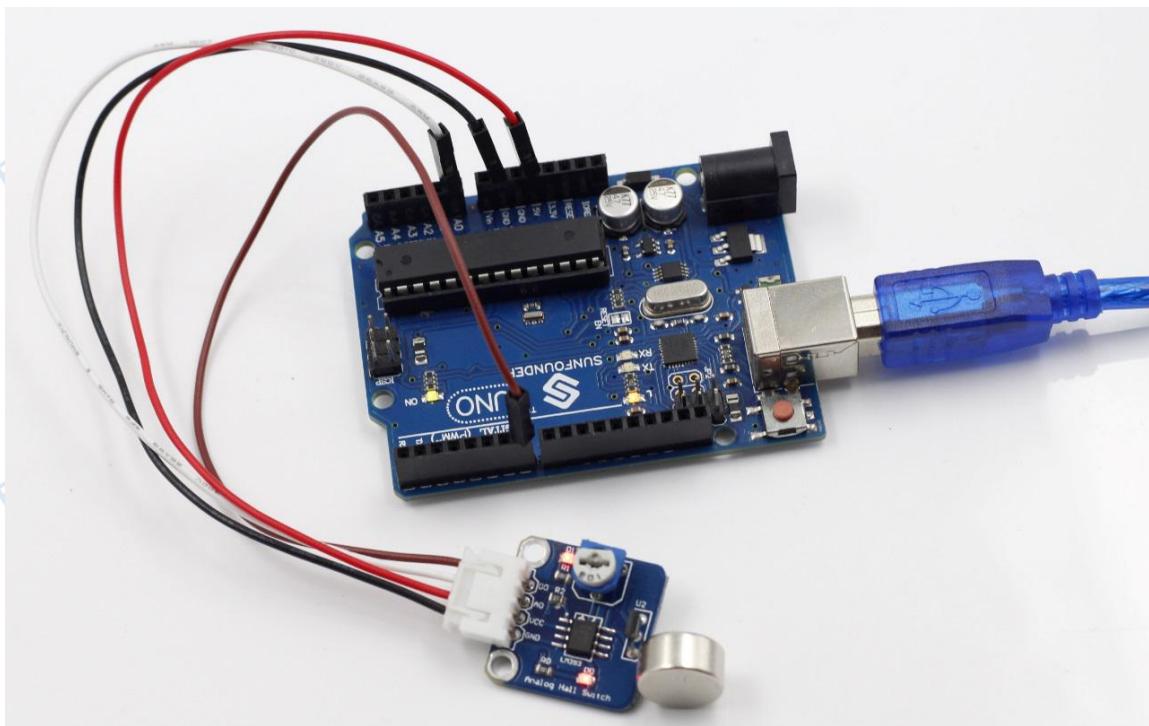
Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

Now, put a magnet close to the Hall sensor. The voltage of D0 changes from high to low, and then the LED on the sensor and that attached to pin 13 of the SunFounder Uno light up. You can see the value of A0 and D0 on Serial Monitor.



Before the experiment



After the experiment

Lesson 3 Switch Hall Sensor

Introduction

A switch Hall sensor consists of voltage regulator, Hall element, differential amplifier, Schmitt trigger, and output terminal. It outputs digital values.

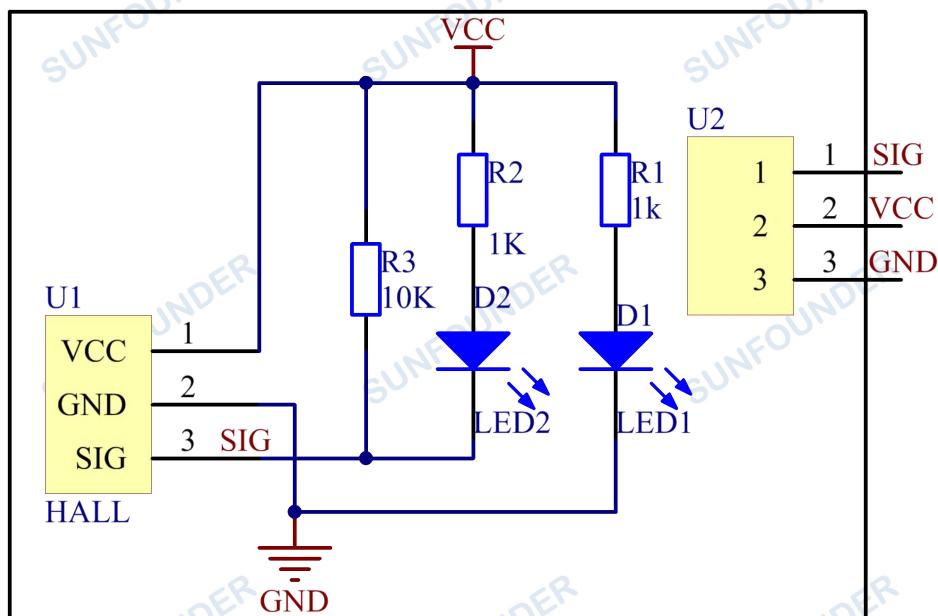


Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * Switch Hall sensor module
- 2 * 3-Pin anti-reverse cable
- 1 * Passive buzzer
- 1 * Magnet

Experimental Principles

Hook up the switch Hall sensor module with pin 8 of the SunFounder Uno, and the buzzer to pin 7. When an energized conductor approaches the module, the output terminal SIG outputs low level; the buzzer beeps and at the same time the corresponding LED lights up.



Experimental Procedures

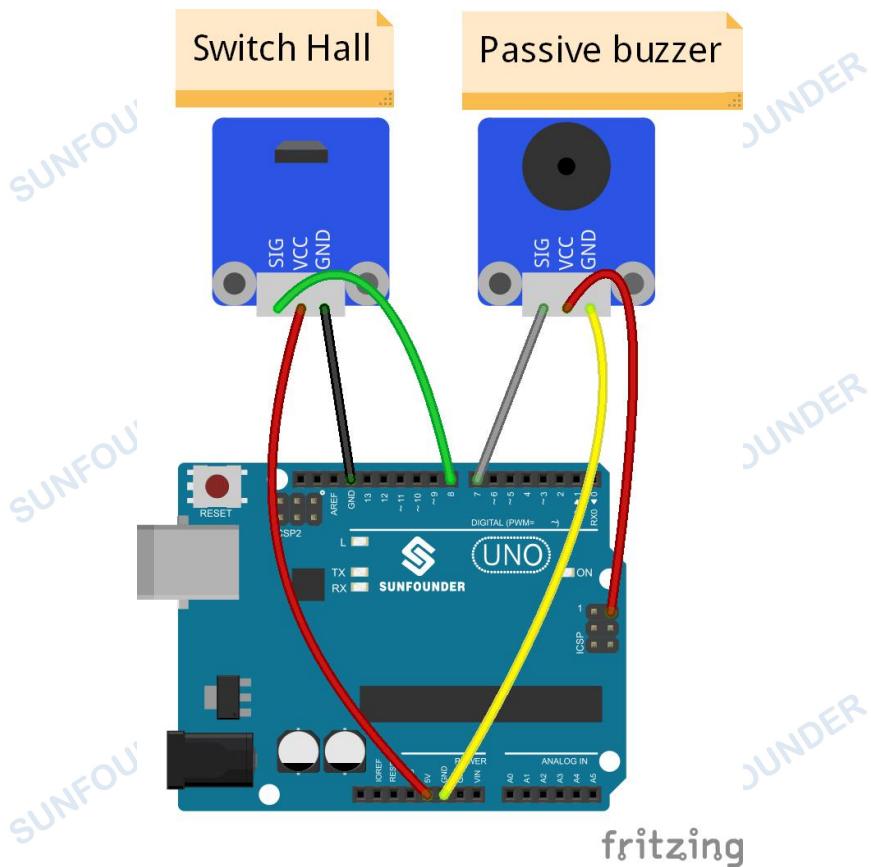
Step 1: Build the circuit

The wiring between the switch Hall sensor and SunFounder Uno board:

Switch Hall Sensor	SunFounder Uno
SIG	8
VCC	5V
GND	GND

The wiring between the passive buzzer and SunFounder Uno board:

Passive Buzzer	SunFounder Uno
SIG	7
VCC	5V
GND	GND

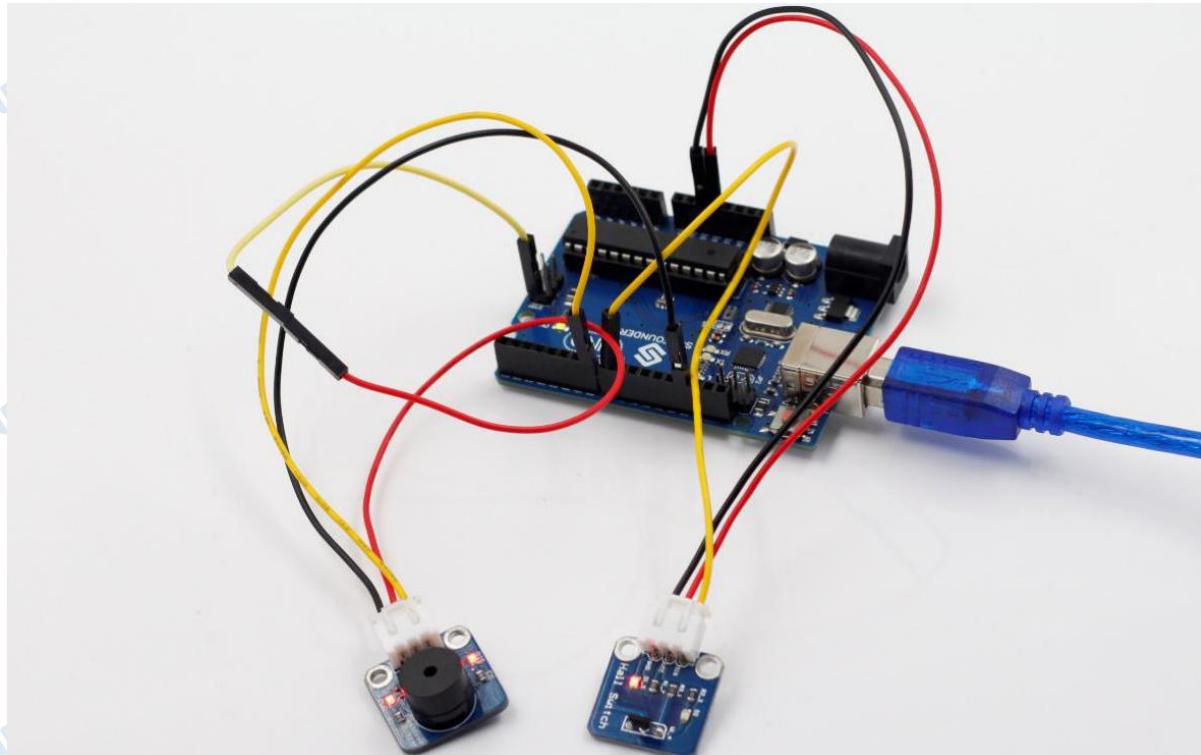


Step 2: Open the code file

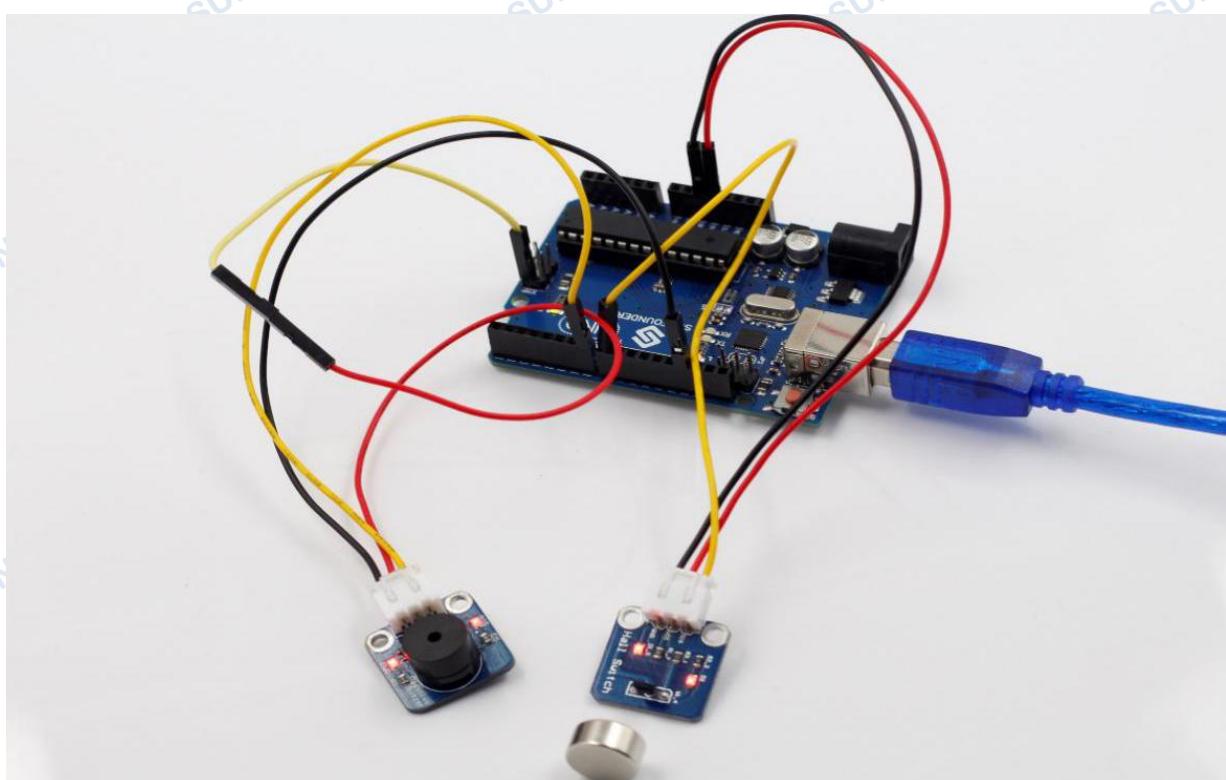
Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

Now, if a magnet approaches the switch Hall sensor, the indicator light on the sensor will light up and the buzzer will beep. At the same time, the LED attached to pin 13 on the SunFounder Uno board will also light up.



Before

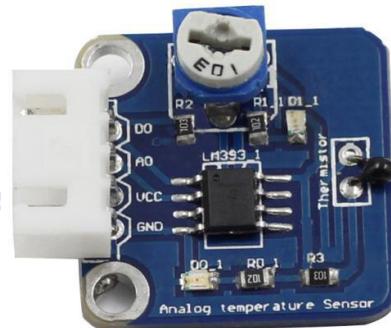


After

Lesson 4 Analog Temperature Sensor

Introduction

A temperature sensor is a component that senses temperature and converts it into output signals. By material and component features, temperature sensors can be divided into two types: thermal resistor and thermocouple. Thermistor is one kind of the former type. It is made of semiconductor materials; most thermistors are negative temperature coefficient (NTC) ones, the resistance of which decreases with rising temperature. Since their resistance changes acutely with temperature changes, thermistors are the most sensitive temperature sensors.



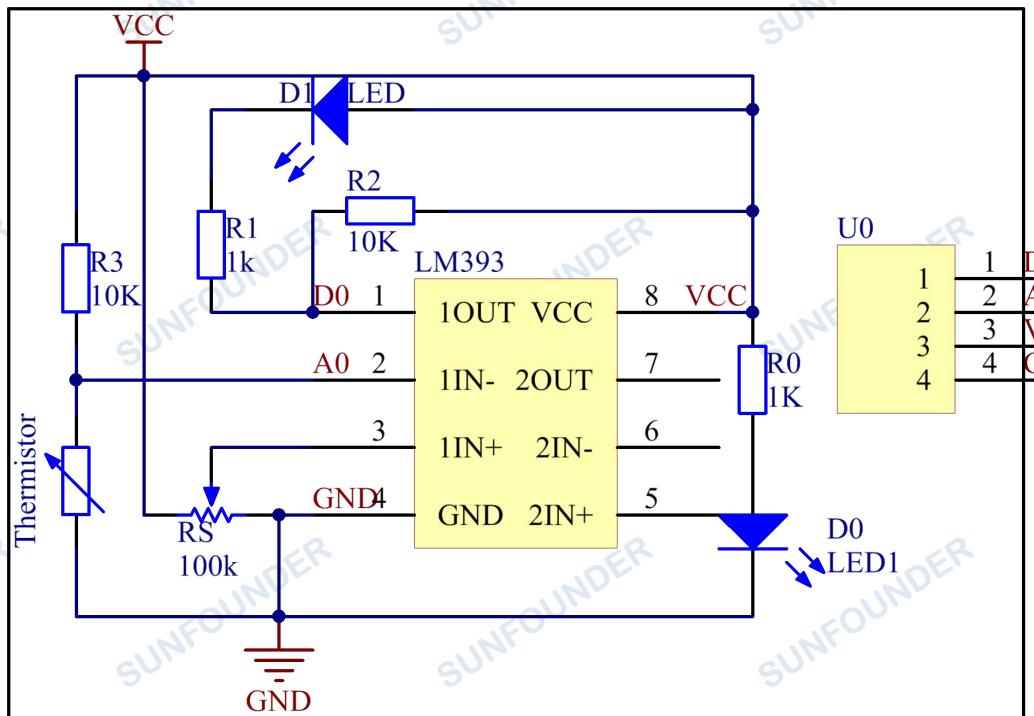
The Analog Temperature Sensor module uses an NTC thermistor, thus measuring temperature sensitively. It also has a built-in comparator LM393 which enables the module to output both digital and analog signals at the same time. The module can be used for temperature alarm and temperature measurement.

Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * Analog temperature sensor module
- 1 * 4-Pin anti-reverse cable

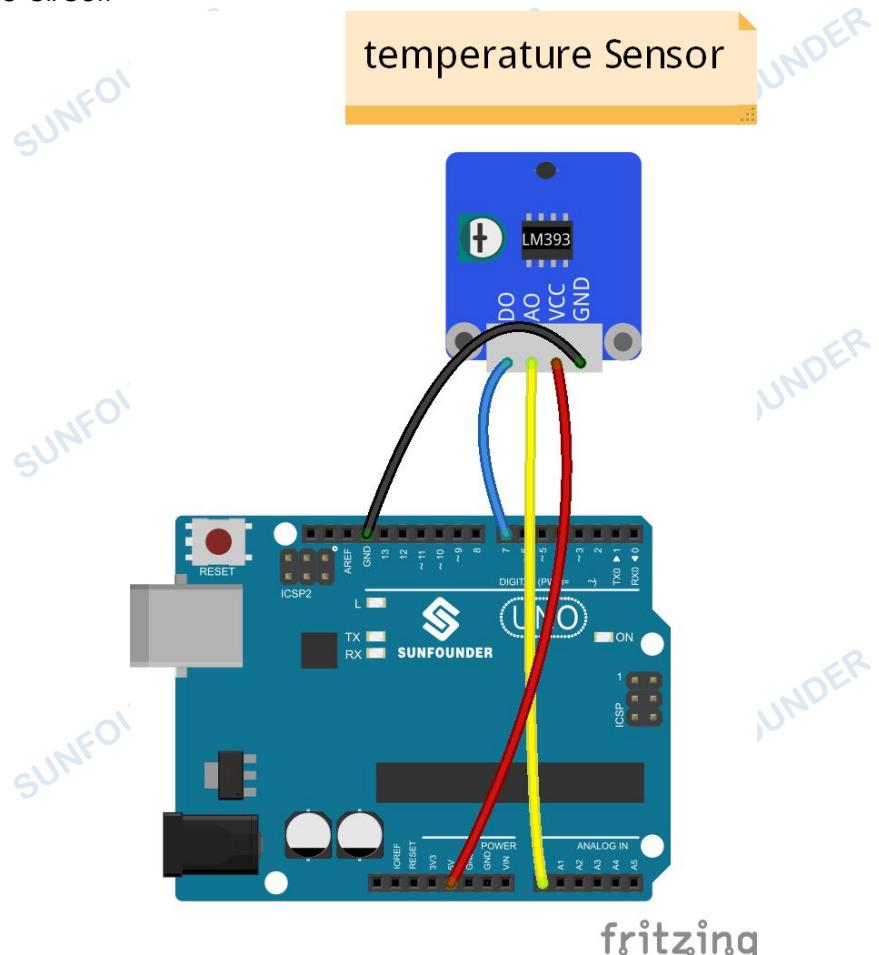
Experimental Principle

There is a comparator LM393 on the analog temperature sensor module. You may set a threshold by the potentiometer on it. When you touch the thermistor, the value of A0 decreases. Once the value is lower than the threshold, D0 will output high level and the indicator LED on the analog temperature sensor module and that attached to pin 13 of the SunFounder Uno will go out. You can check the value of A0 and D0 on Serial Monitor. The schematic diagram of the module:



Experimental Procedures

Step 1: Build the circuit

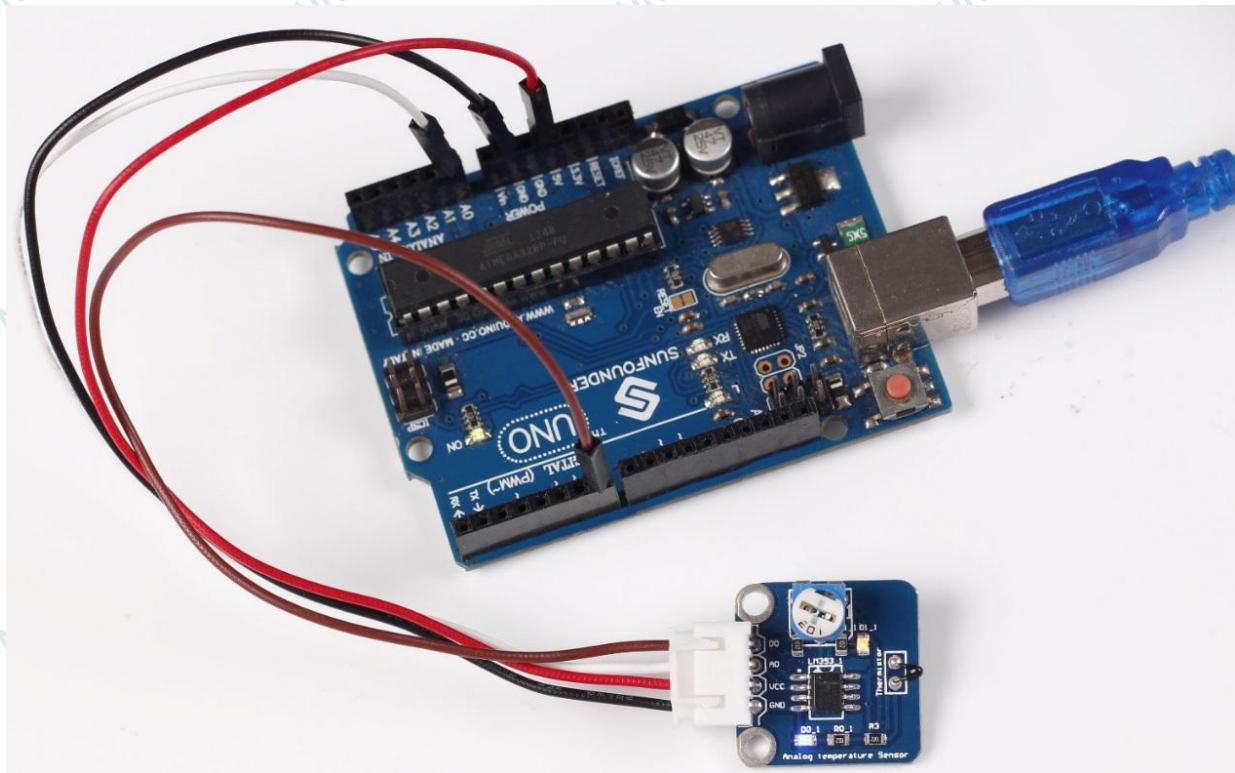


Step 2: Open the code file

Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

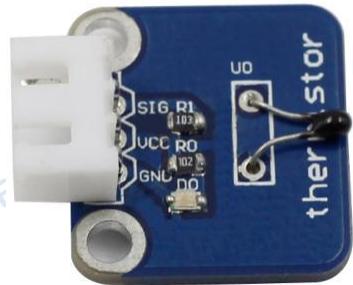
Now, touch the thermistor, and the LED on the analog temperature sensor module and that attached to pin 13 of the SunFounder Uno will go out.



Lesson 5 Temperature Detection by Thermistor

Introduction

As mentioned in Lesson 4, thermistors are the most sensitive temperature sensors because their resistance changes acutely with temperature changes. Therefore, the thermistor sensor module measures temperature sensitively though it can output only analog signals. The module is often used to detect the temperature changes in ambient environment.



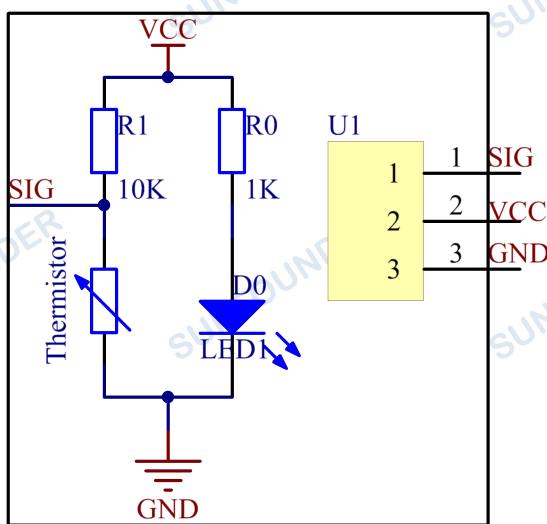
Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * Thermistor module
- 1 * I2C LCD1602 module
- 1 * 3-Pin anti-reverse cable
- 1 * 4-Pin anti-reverse cable
- 1 * Dupont wire (F to F)

Experimental Principle

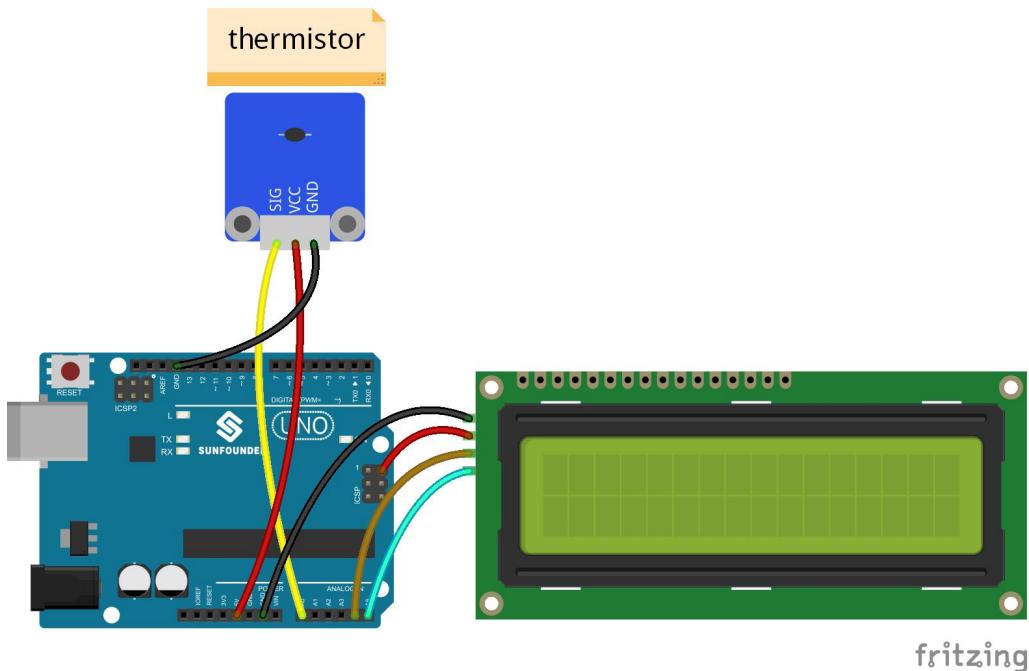
How a thermistor works: its resistance varies significantly with the ambient temperature. It can detect surrounding temperature changes in a real-time manner and send the temperature data to analog I/O port of the SunFounder board. What you need to do is convert the output to Celsius temperatures by simple programming and then display it on an LCD.

The schematic diagram of the module:



Experimental Procedures

Step 1: Build the circuit

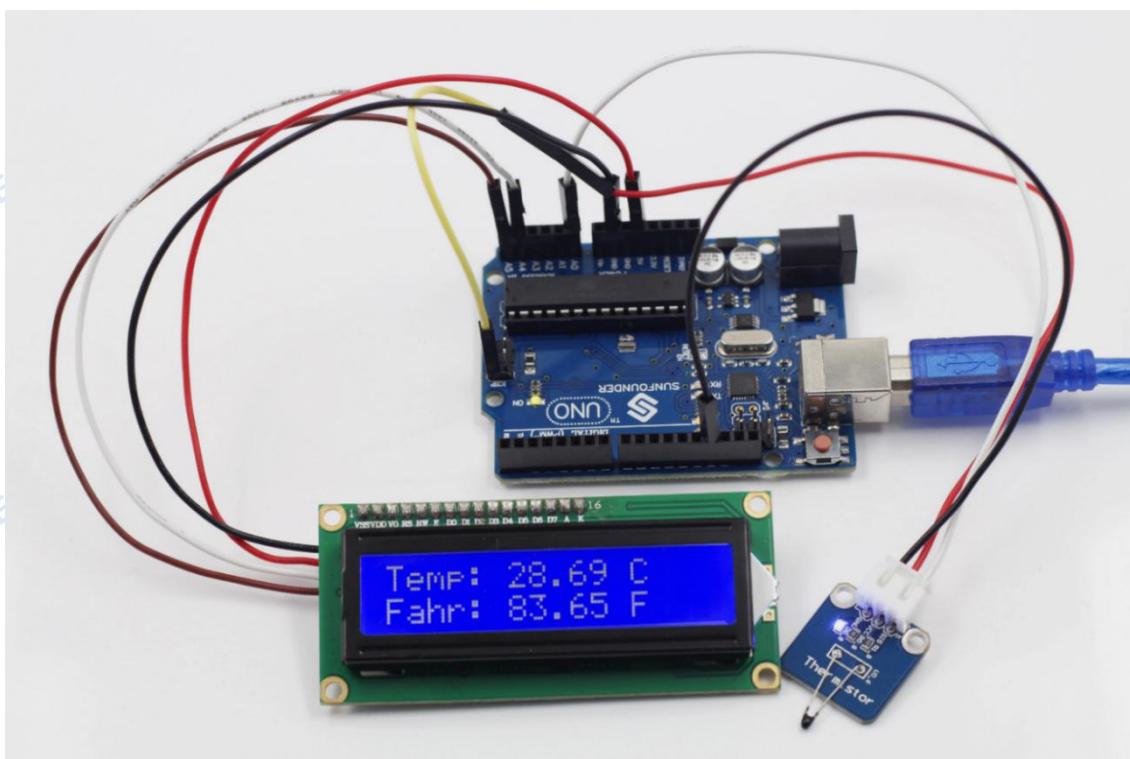


Step 2: Open the code file

Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

Now, you can see the current value of temperature displayed on the LCD, in both Celsius and Fahrenheit degrees.



Lesson 6 Auto-flash LED

Introduction

The 7-color auto-flash LED module can automatically flash built-in colors after power on. It can be used to make quite fascinating light effects.

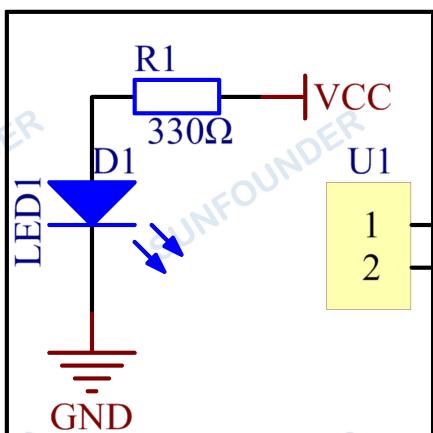


Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * 7-color auto-flash LED module
- 1 * 3-Pin anti-reverse cable

Experimental Principle

When it is power on, the 7-color auto flash LED will flash built-in colors. The schematic diagram of the module:

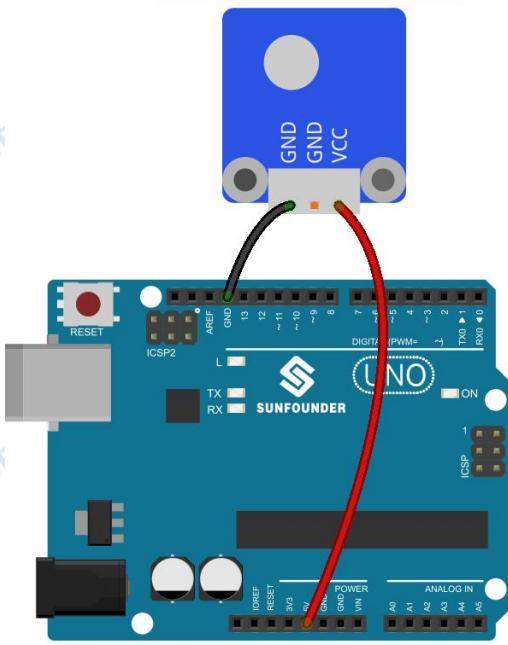


Experimental Procedures

Just connect pin VCC of the module to 5V of the SunFounder Uno board and pin GND to GND.

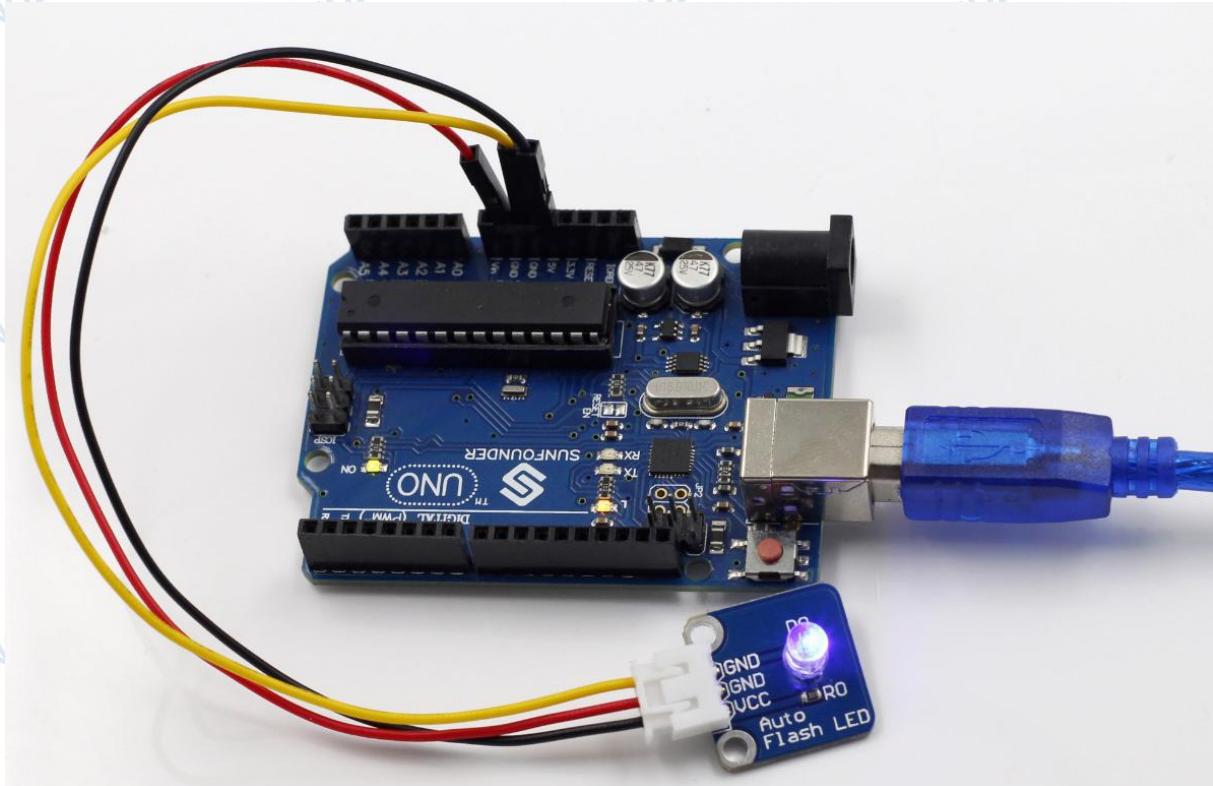
Note: There are two GND pins on the module. You only need to connect one of them.

Auto-flash LED



fritzing

Now, you should see the LED flashing seven colors.

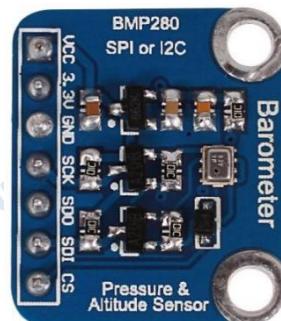


Lesson 7 Barometer BMP280

Introduction

The BMP280 Digital Barometer is developed by Bosch Sensortec. Compared with the previous BMP085, BMP180, and BMP183, this BMP280 barometer comes with a higher performance and the smallest size in the industry.

The BMP280 is an absolute barometric pressure sensor especially designed for mobile applications. The sensor module is housed in an extremely compact 8-pin metal-lid LGA package with a footprint of only $2.0 \times 2.5\text{mm}^2$ and 0.95mm package height. Its small dimensions and low power consumption of $2.7\mu\text{A}@1\text{Hz}$ allow the implementation in battery-driven devices such as mobile phones, GPS modules or watches. It supports two types of communication: I2C and SPI.

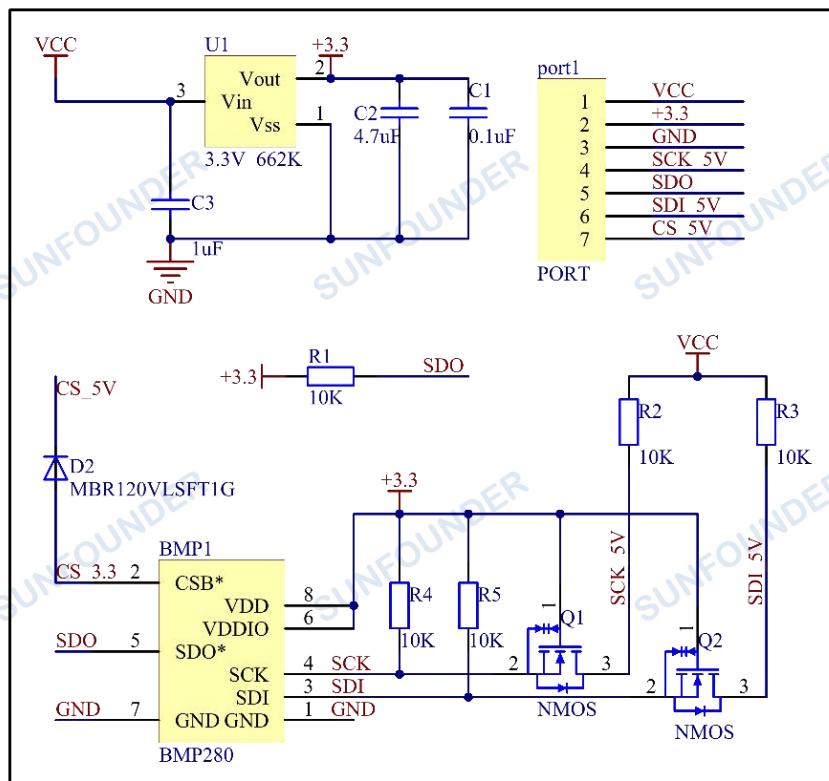


Components

- 1 * SunFounder Uno Board
- 1 * USB Cable
- 1 * BMP280 Module
- Several Jump Wires
- 1* Breadboard

Principle

The schematic diagram of the module:



- Power

- VCC: power pin. The working voltage for the chip is 1.71-3.6V. Since the module integrates a 3.3V voltage regulator, the power supply can be either 3.3V or 5V. If you are using an Arduino board, you're recommended to use a 5V power supply.
- 3.3V: the output of the voltage regulator, meaning you can provide the chip with a 3.3V for power here.
- GND: common ground for power and logic

BMP280 supports I2C and SPI communication and the module keeps both ports. If you want to make the circuit simple, you can use the I2C port; to connect multiple sensors, you can use the SPI port free of I2C address collisions.

- I2C interface

The I2C interface uses the following pins:

- SCK: serial clock (SCL)
- SDI: data (SDA)
- SDO: The I2C address decides the pin. If SDO connects to GND (0), the address is 0x76, if it connects to VDDIO (1), the address is 0x77. In this module, we have connected it to VDDIO, so the address should be 0x77.
- CSB: Must be connected to VDDIO to select I2C interface.

- SPI interface

The SPI interface uses the following pins:

- CSB: chip select, active low and has an integrated pull-up resistor
- SCK: serial clock
- SDI: serial data input; data input/output in 3-wire mode
- SDO: serial data output; hi-Z in 3-wire mode

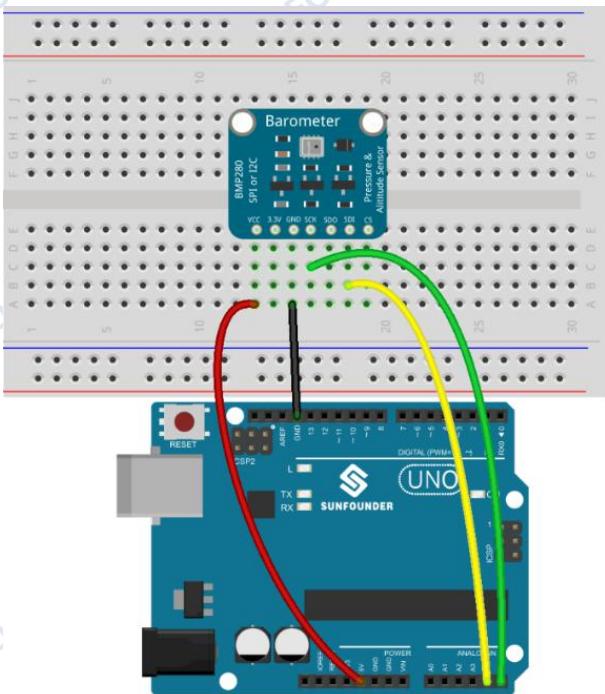
Experimental Procedures

Step 1: Build the circuit

You can connect the components in the two ways: I2C and SPI. These two ways will be a little different on the Uno R3 and the Mega2560 (as shown below). Here take Uno R3 as an example. You can use just either way and connect devices correctly.

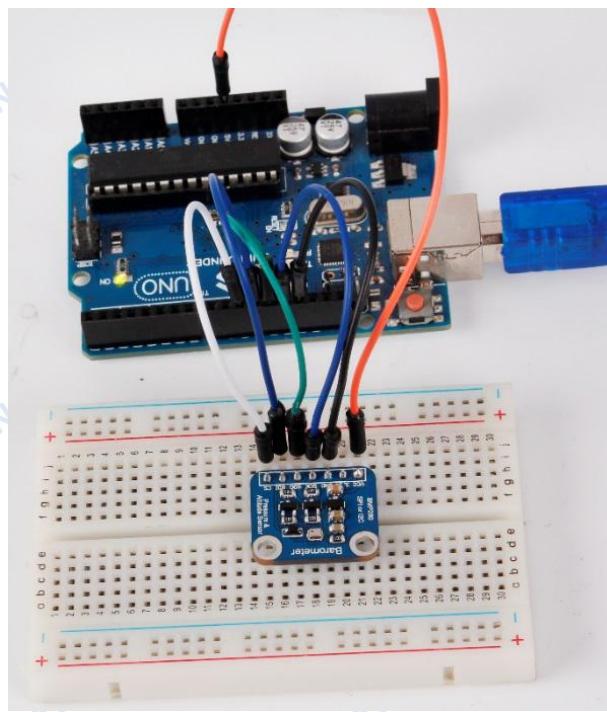
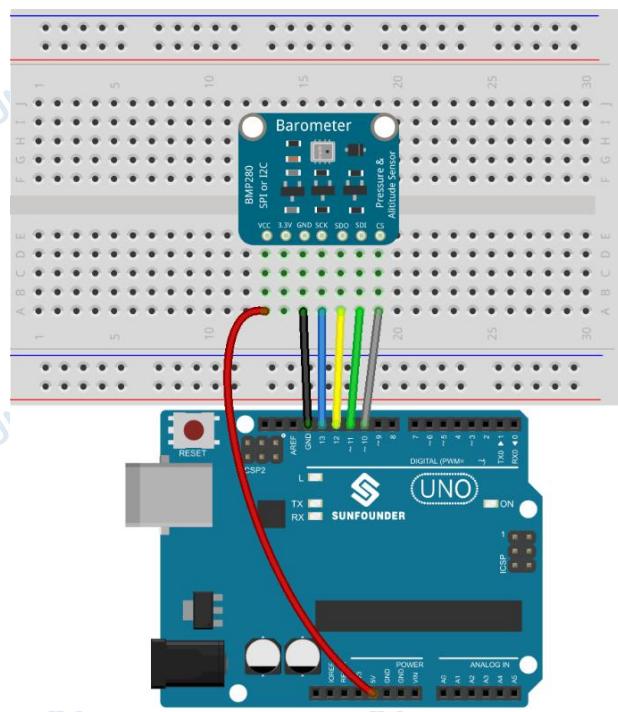
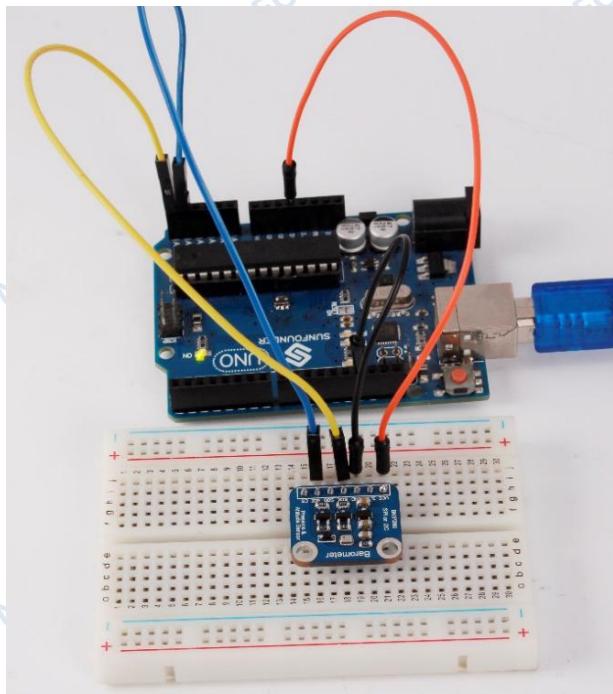
I2C Wiring

BMP280	SunFounder Uno/Mega2560
VCC	5V
GND	GND
SCK	A5/Pin 21 Mega2560
SDI	A4/Pin 20 Mega2560



SPI Wiring

BMP280	Uno/Mega2560
VCC	5V
GND	GND
SCK	13 /Pin 52
SDO	12/Pin 50
SDI	11 / Pin 51
CS	10 /Pin 53



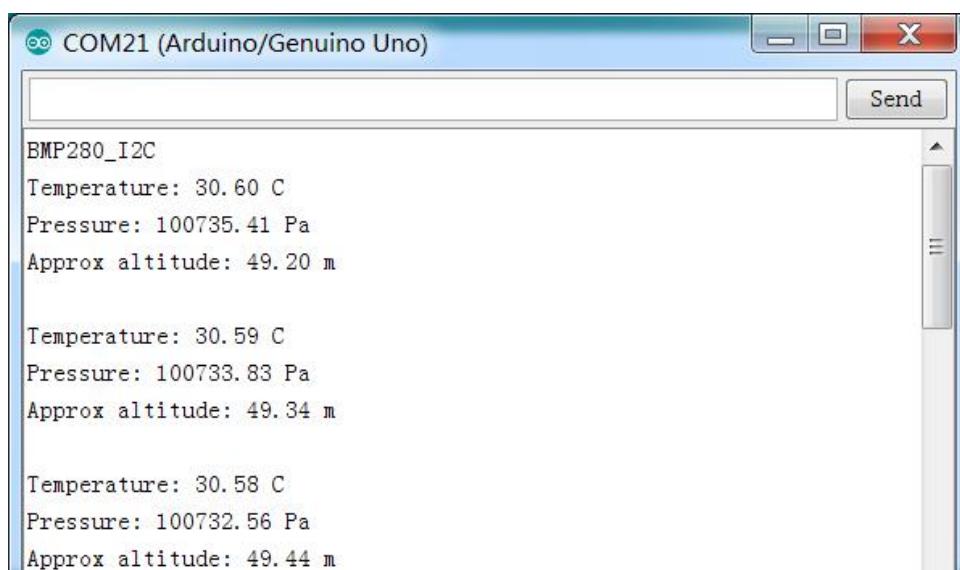
Step 2: Open the code file

If you adopt the **I2C** way for connecting, double-click *BMP280_I2C.ino* under Sensor Kit V2.0 for Arduino\Lesson 7 Barometer\BMP280\Code \BMP280_I2C to open it; for the **SPI** way, double-click *BMP280_SPI.ino* under Sensor Kit V2.0 for Arduino\Lesson 7 Barometer\BMP280\Code\BMP280_SPI.

Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

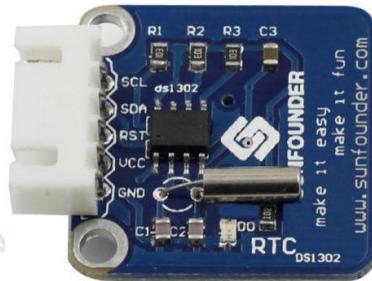
Open the serial monitor, and you will see the figures of the temperature, the air pressure and the sea-level altitude.



Lesson 8 Real-time Clock Module

Introduction

Nowadays there are many popular serial clock circuits such as DS1302, DS1307, PCF8485, etc. They are widely used for simple interface, low cost, and ease of use. In this lesson, we will use the DS1302 real-time clock (RTC) module to obtain current date and time.



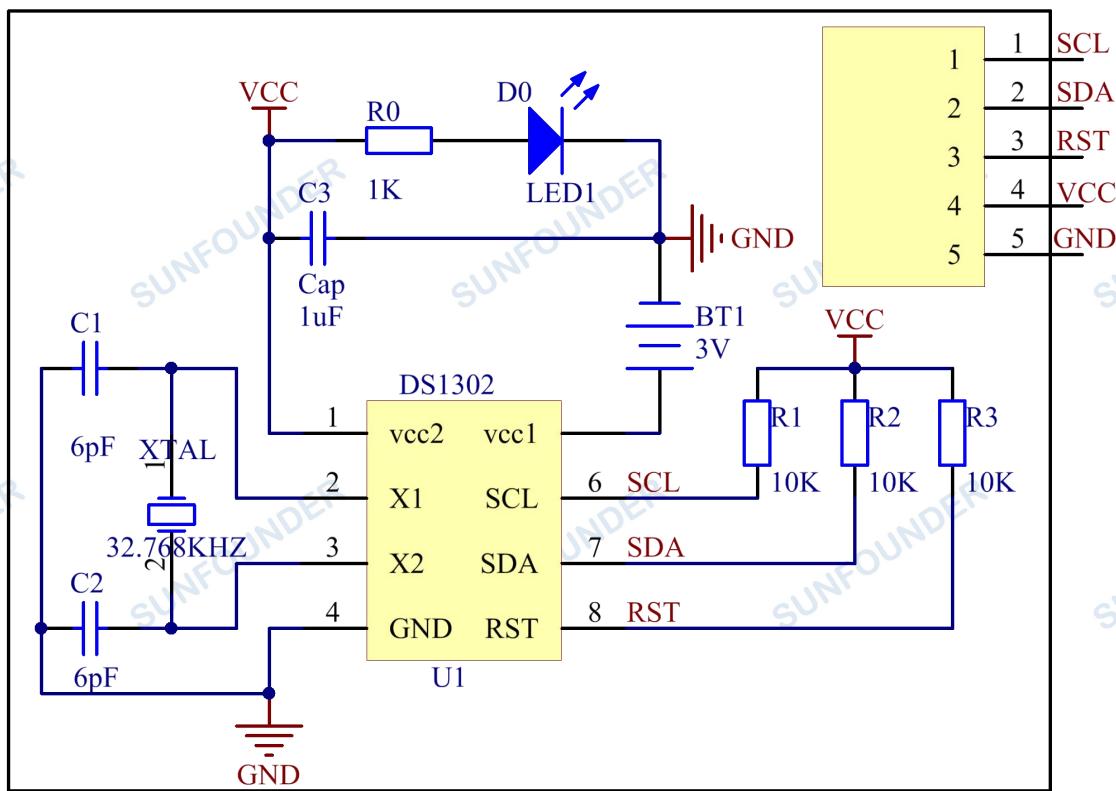
Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * RTC-DS1302 module
- 1 * I2C LCD1602 module
- 1 * 5-Pin anti-reverse cable
- 1 * 4-Pin anti-reverse cable
- 1 * Dupont wire (F to F)

Experimental Principle

DS1302 is a trickle charging clock chip, launched by DALLAS in America. With a built-in real-time clock/calendar and a 31-byte static RAM, it can communicate with MCU through simple serial ports. The real-time clock/calendar circuit provides information about second, minute, hour, day, week, month, and year. DS1302 can automatically adjust the number of days per month and days in leap year. You can determine to use a 24-hour or 12-hour system by AM/PM selection. It can simply communicate with MCU in synchronous serial way and only needs to use three port cables: Reset (RST) cable, I/O data (SDA) cable and serial clock (SCL) cable.

The schematic diagram of the module:

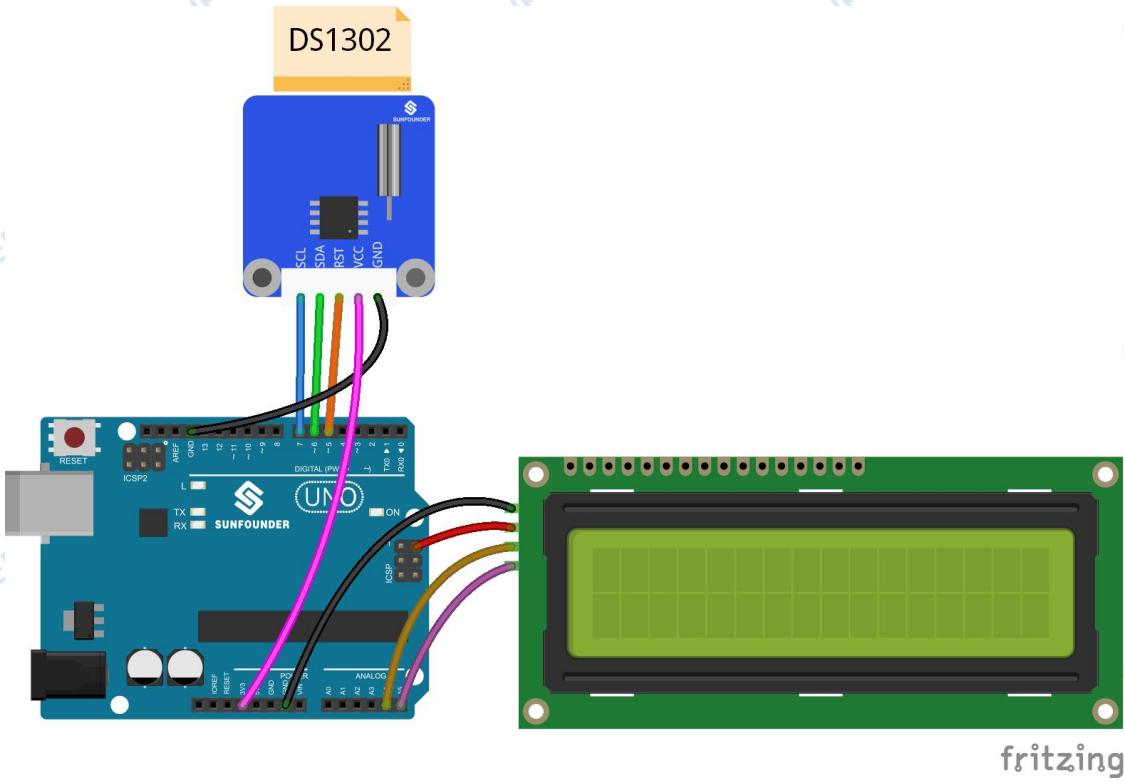


Experimental Procedures

Step 1: Build the circuit

The wiring between DS1302 and SunFounder Uno board is as shown below:

DS1302	SunFounder Uno
SCL	7
SDA	6
RST	5
VCC	3.3V
GND	GND

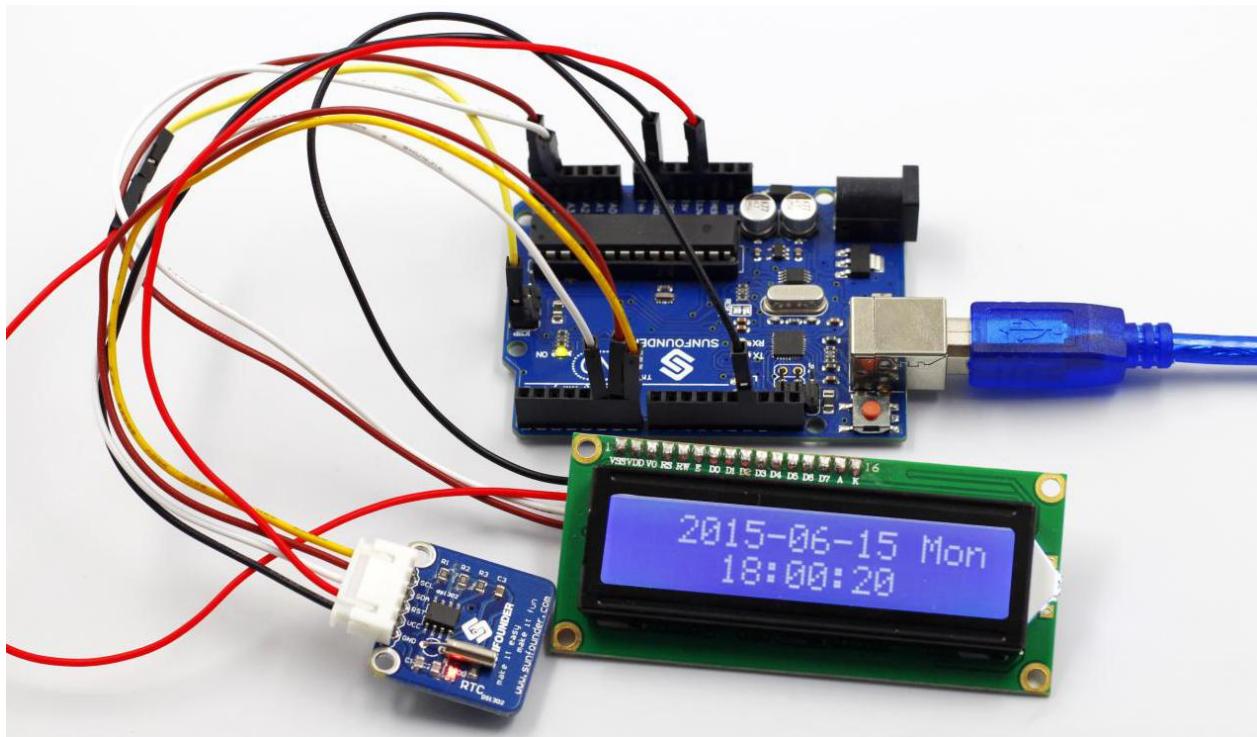


Step 2: Open the code file

Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

Now, you can see the current date and time information displayed on the I2C LCD1602.



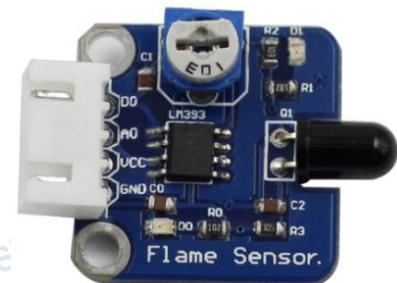
Lesson 9 Flame Alarm

Introduction

A flame sensor module performs detection by capturing infrared wavelengths from flame. It can be used to detect and warn of flames.

Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * Flame sensor module
- 1 * Passive buzzer module
- 1 * 4-Pin anti-reverse cable
- 1 * 3-Pin anti-reverse cable

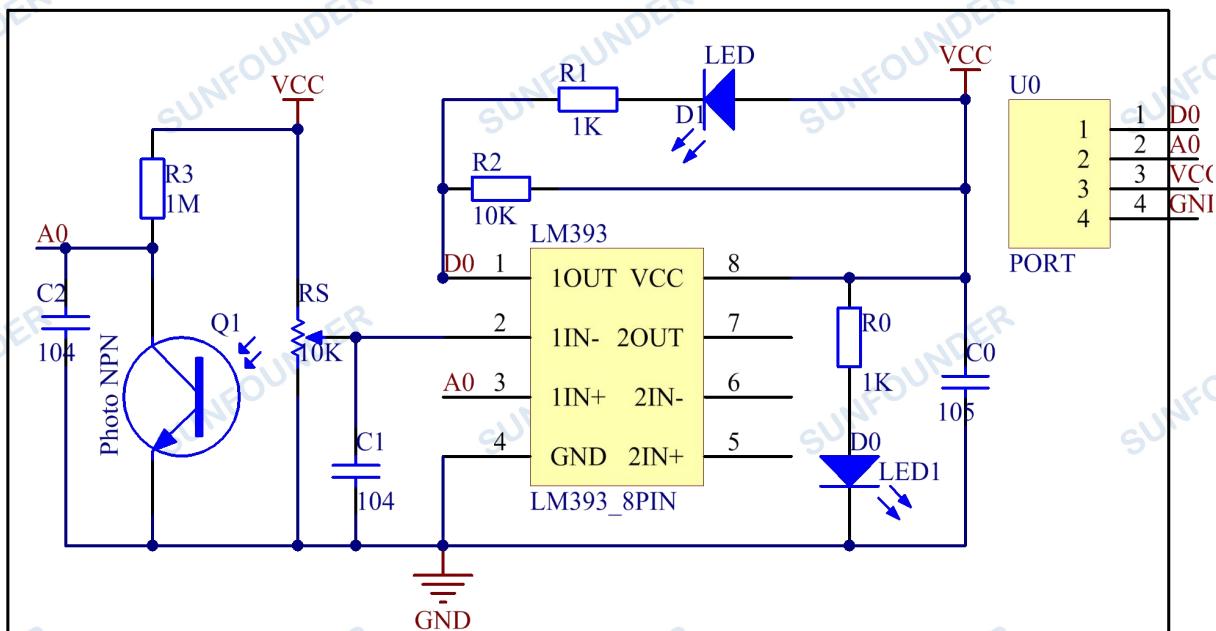


Experimental Principle

There are several types of flame sensors. In this experiment, we will use a far-infrared flame sensor. It can detect infrared light with a wavelength ranging from 700nm to 1000nm. A far-infrared flame probe converts the strength changes of the external infrared light into current changes. And then it converts analog quantities into digital ones.

In this experiment, connect pin D0 to the digital port 8 of the SunFounder board. Then when the flame sensor detects flame signals, the buzzer beeps and the corresponding LED lights up. When it detects no flame signals, the buzzer stops and the LED goes out.

The schematic diagram of the module:



Experimental Procedures

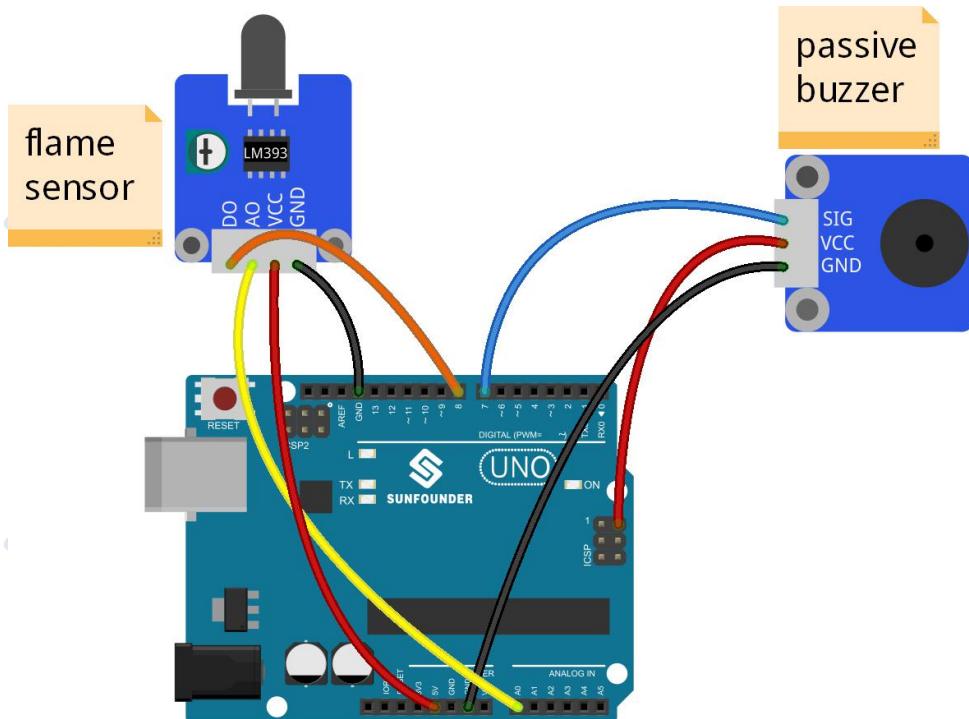
Step 1: Build the circuit

The wiring between the flame sensor and SunFounder Uno board:

Flame Sensor	SunFounder Uno
D0	8
A0	A0
VCC	5V
GND	GND

The wiring between the passive buzzer and SunFounder Uno board:

Passive Buzzer	SunFounder Uno
SIG	7
VCC	5V
GND	GND

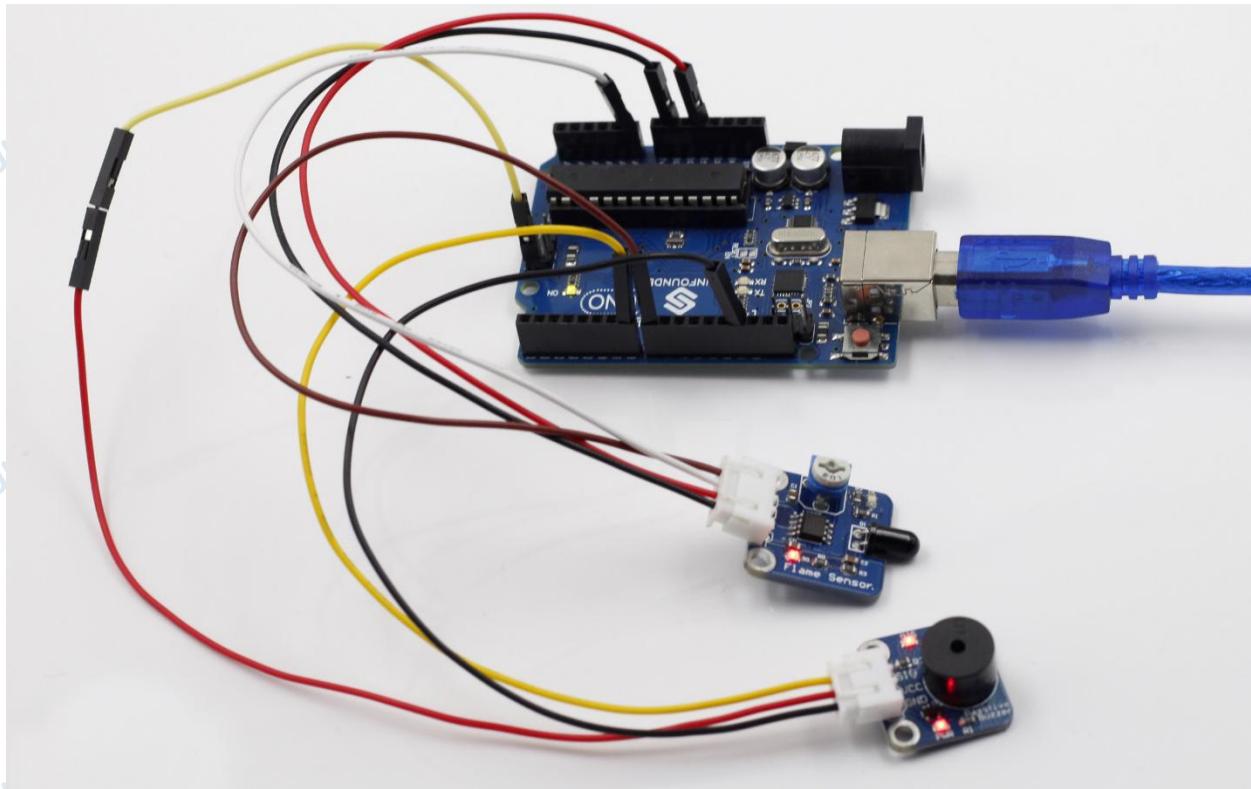


Step 2: Open the code file

Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

Now, ignite a lighter near the flame sensor. Then the buzzer will beep, and the LED on the flame sensor module and that attached to pin 13 of the SunFounder board will light up.



Lesson 10 Flammable Gas Detection

Introduction

Gas Sensor MQ-2 is a sensor for flammable gas and smoke by detecting the concentration of combustible gas in the air. They are often used in gas detecting equipment for smoke and flammable gasses such as LPG, i-butane, propane, methane and alcohol in household, industry or automobile.



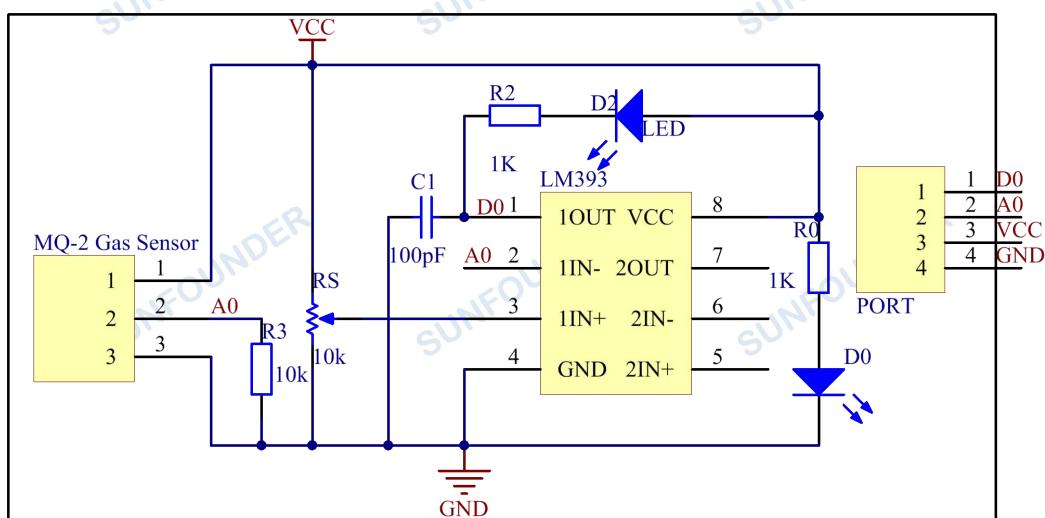
Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * MQ-2 gas sensor module
- 1 * 4-Pin anti-reverse cable

Experimental Principle

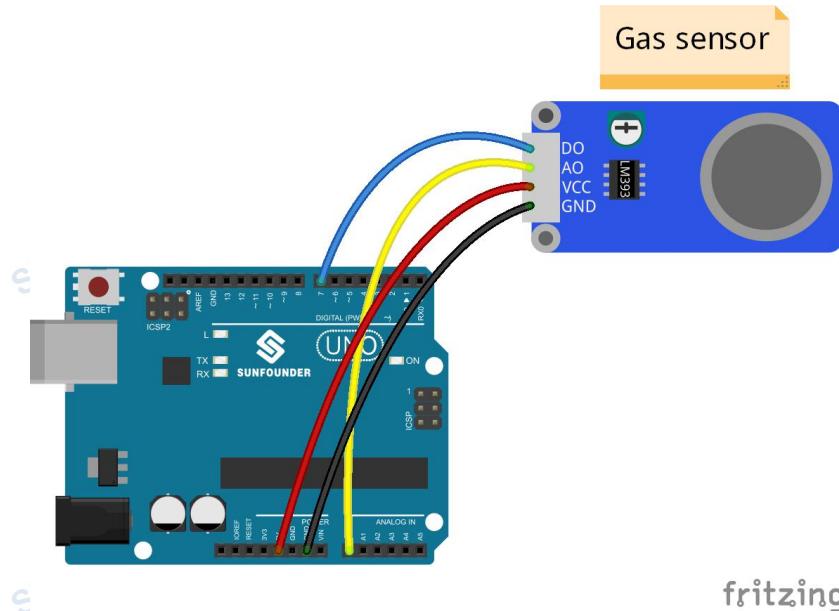
MQ-2 gas sensor applies SnO₂ (an oxygen-deficient n-type semiconductor) which has a lower conductivity in the clear air as a gas-sensing material. In an atmosphere where there may be inflammable gases, the conductivity of the gas sensor raises along with the inflammable gas concentration increases. MQ-2 performs a good detection to different inflammable gases such as natural gas, especially sensitive to liquefied gas, propane and hydrogen.

In this experiment, release some combustible gas around the sensor and the value at A0 increases. Once the concentration of the gas exceeds a limit, D0 outputs low level and the corresponding LED will light up. Please note that the sensor needs burn-in time so the readings can be more consistent and reliable.



Experimental Procedures

Step 1: Build the circuit



fritzing

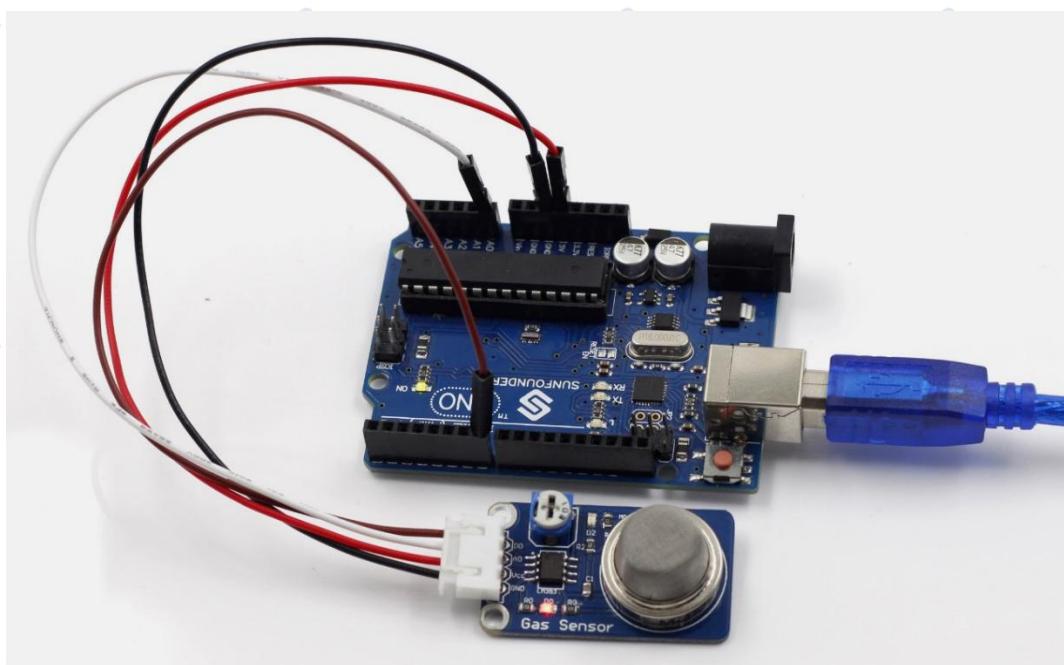
Step 2: Open the code file

Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

Now, ignite a lighter. Then the sensor detects the gas emitted. Thus, the LED on the gas sensor and that attached to pin 13 on the SunFounder Uno board will light up. Also you can see the value at A0 and D0 printed on Serial Monitor.

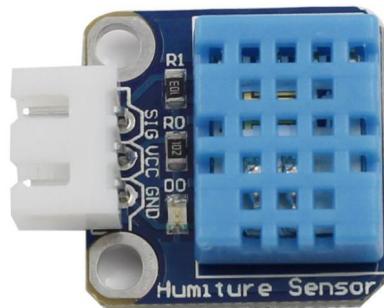
Note: It is normal that the gas sensor generates heat. Actually, the higher the temperature is, the sensor is more sensitive.



Lesson 11 Humiture Detection

Introduction

The digital temperature and humidity sensor DHT11 is a composite sensor that contains a calibrated digital signal output of temperature and humidity. The technology of a dedicated digital modules collection and the temperature and humidity sensing technology are applied to ensure that the product has high reliability and excellent long-term stability.



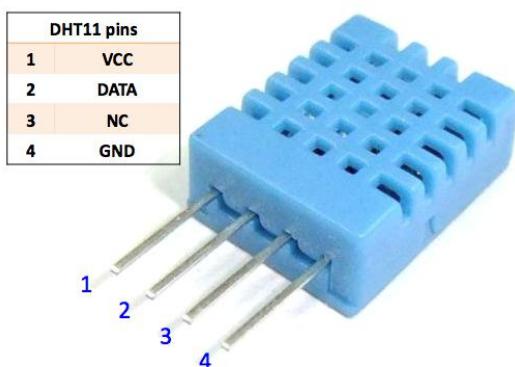
The sensor includes a resistive sense of wet component and an NTC temperature measurement device, and is connected with a high-performance 8-bit microcontroller.

Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * Humiture sensor module
- 1 * I2C LCD1602
- 1 * 3-Pin anti-reverse cable
- 1 * 4-Pin anti-reverse cable
- 1 * Dupont wire (F to F)

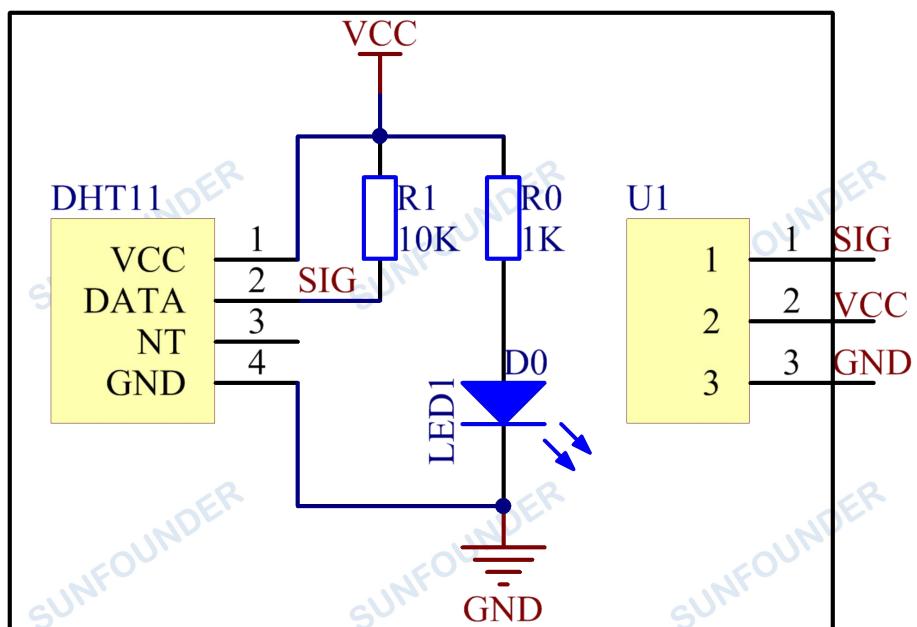
Experimental Principle

Only three pins are available for use: VCC, GND, and DATA. The communication process begins with the DATA line sending start signals to DHT11, and DHT11 receives the signals and returns an answer signal. Then the host receives the answer signal and begins to receive 40-bit humiture data (8-bit humidity integer + 8-bit humidity decimal + 8-bit temperature integer + 8-bit temperature decimal + 8-bit checksum).



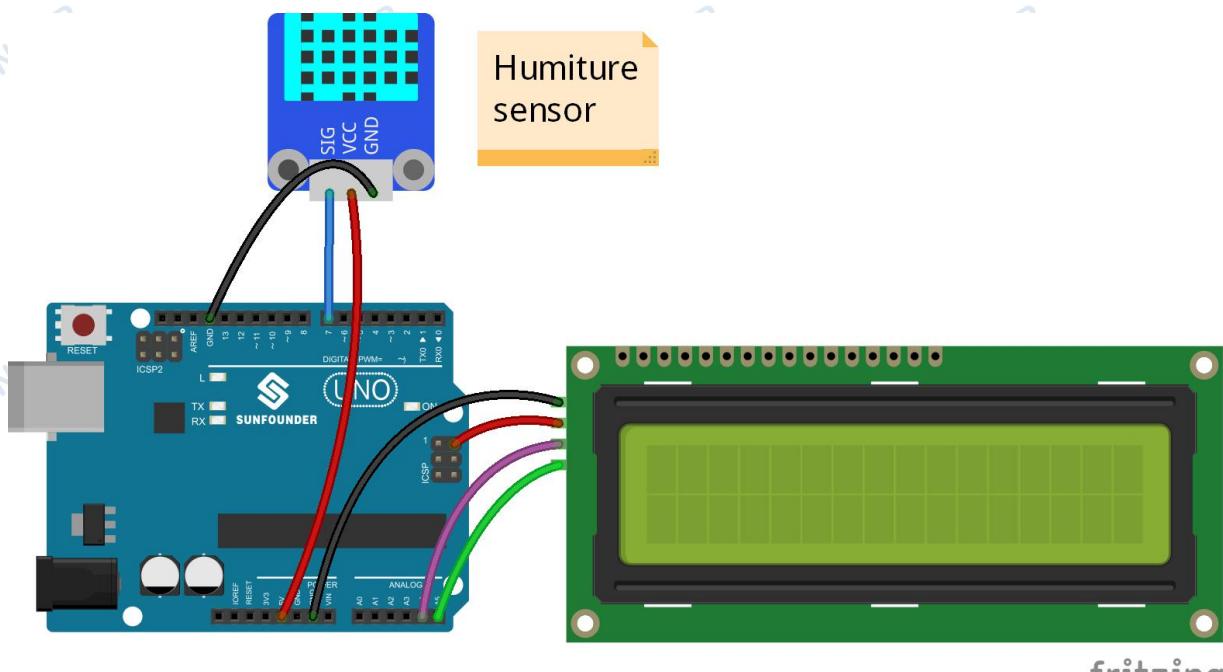
For more information, please refer to the datasheet of DHT11.

The schematic diagram



Experimental Procedures

Step 1: Build the circuit

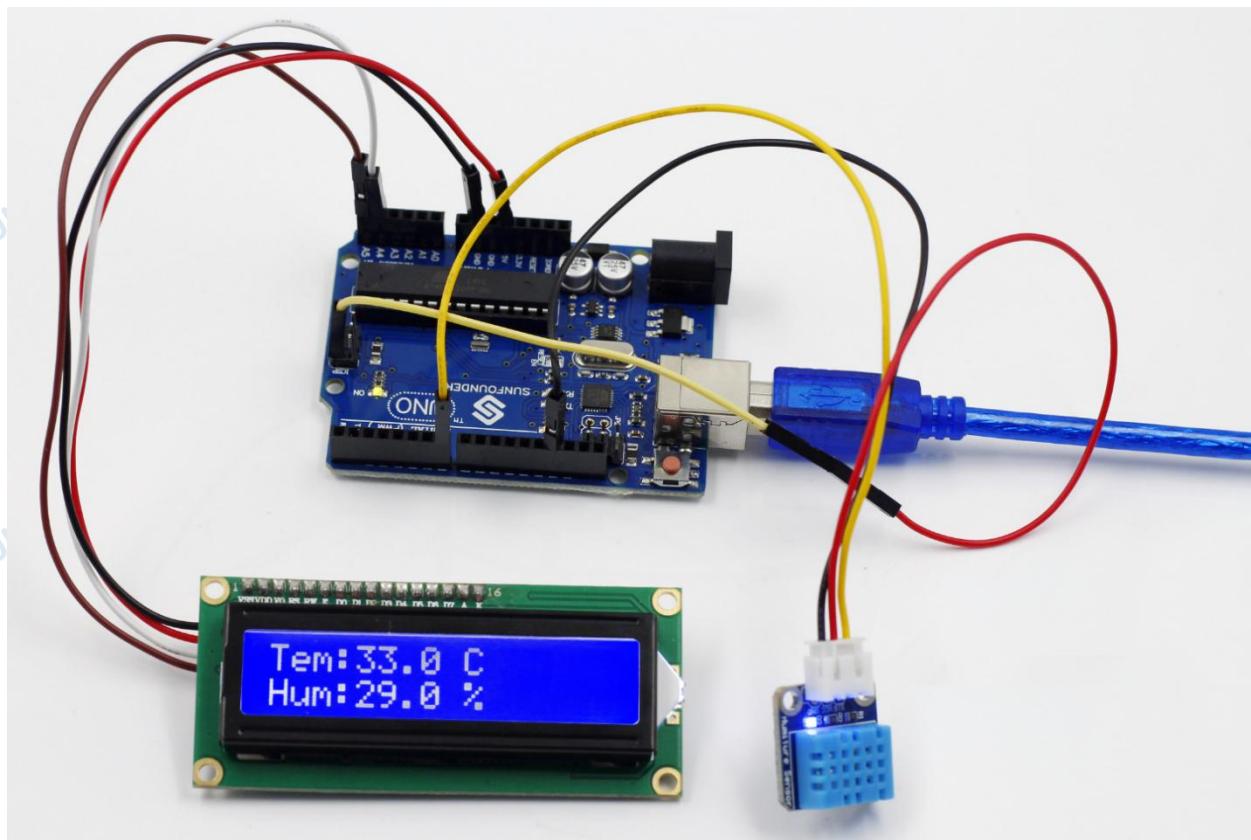


Step 2: Open the code file

Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

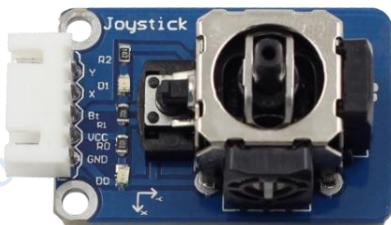
Now, you can see the value of current humidity and temperature displayed on the LCD.



Lesson 12 Joystick PS2

Introduction

A joystick is an input device consisting of a stick that pivots on a base and reports its angle or direction to the device it is controlling. Joysticks are often used to control video games and robots. A Joystick PS2 is used here.

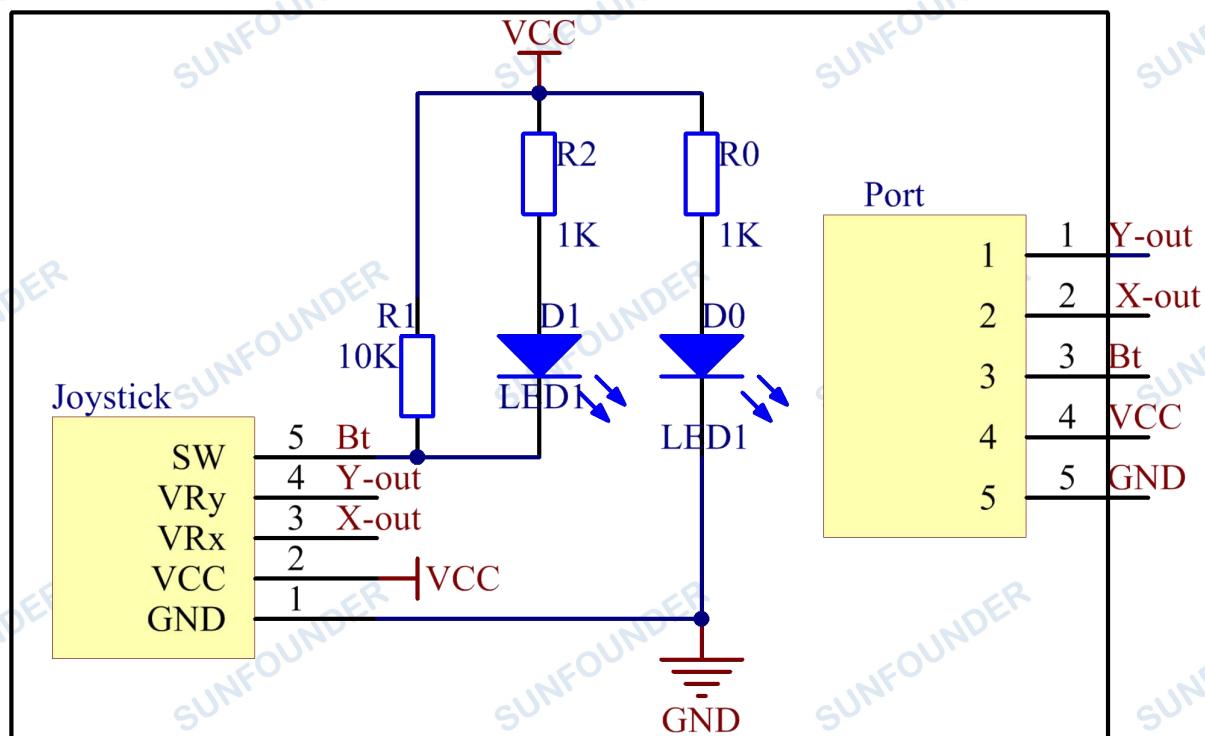


Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * Joystick PS2 module
- 1 * 5-Pin anti-reverse cable

Experimental Principle

This module has two analog outputs (corresponding to X and Y coordinates) and one digital output representing whether it is pressed on Z axis.

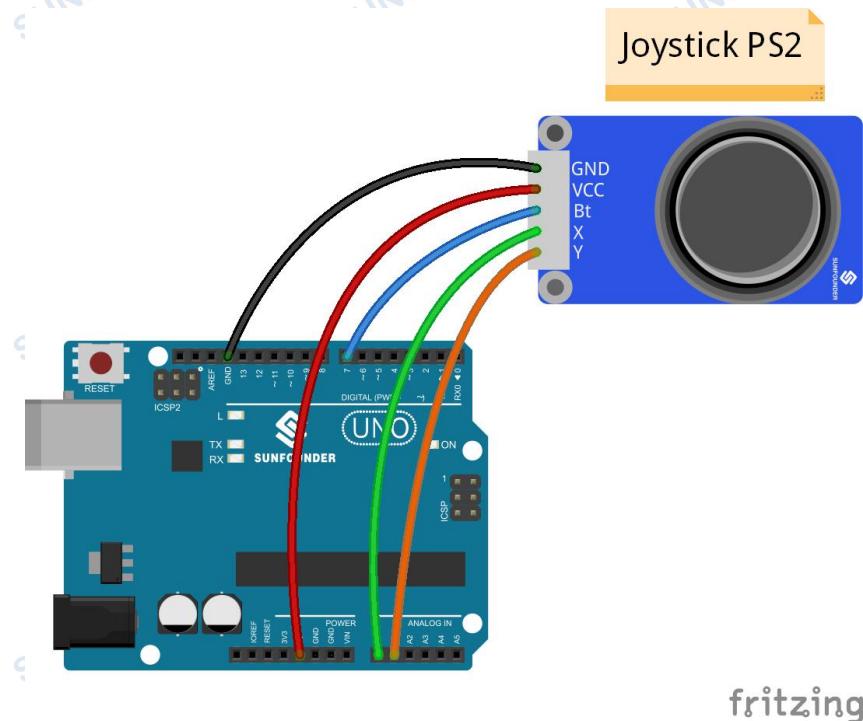


Experimental Procedures

Step 1: Build the circuit

The wiring between the Joystick PS2 and SunFounder Uno board:

Joystick PS2	SunFounder Uno
GND	GND
VCC	5V
Bt	7
X	A0
Y	A1

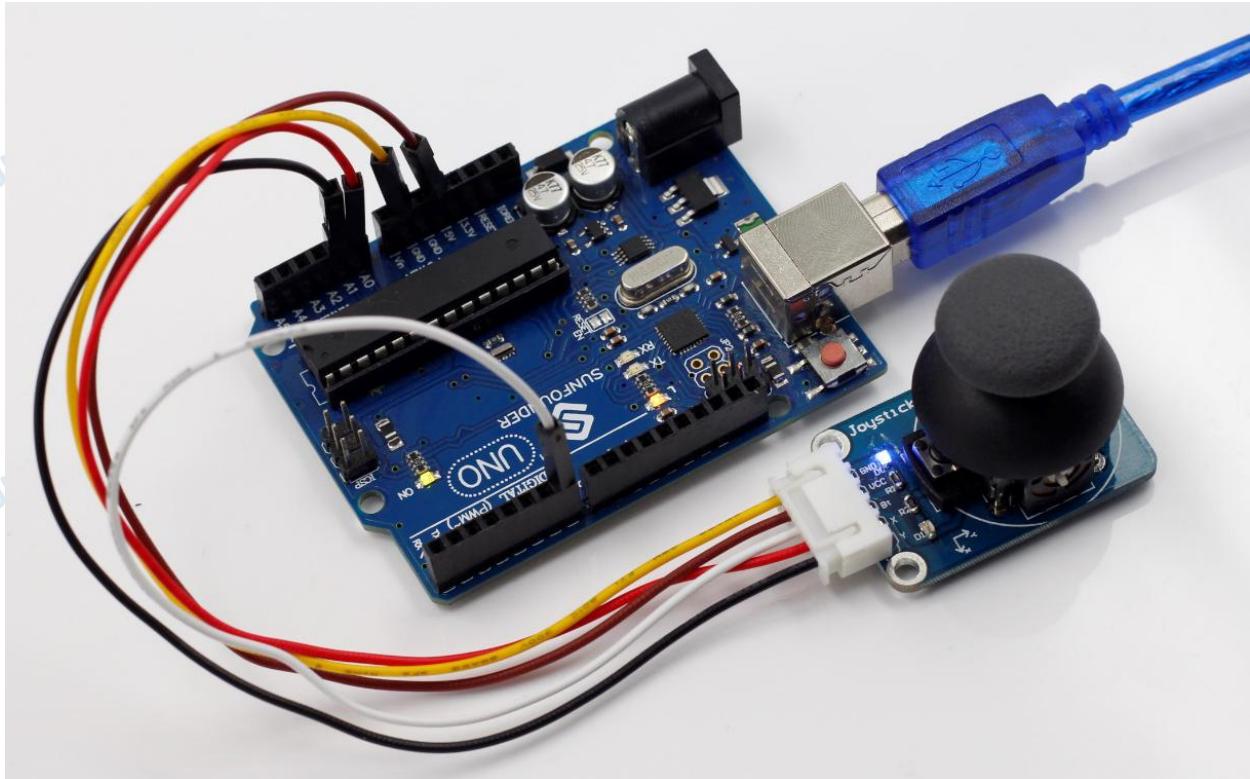


Step 2: Open the code file

Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

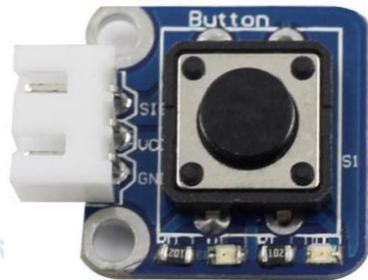
Now, push the rocker and the coordinates of X and Y axes displayed on Serial Monitor will change accordingly; press the button, and the coordinate of Z=0 will also be displayed.



Lesson 13 Controlling an LED by Button

Introduction

As you can see, an LED has been attached to pin 13 on most of the SunFounder boards already. So just a button module can be used to build a simple circuit to make the LED light up.

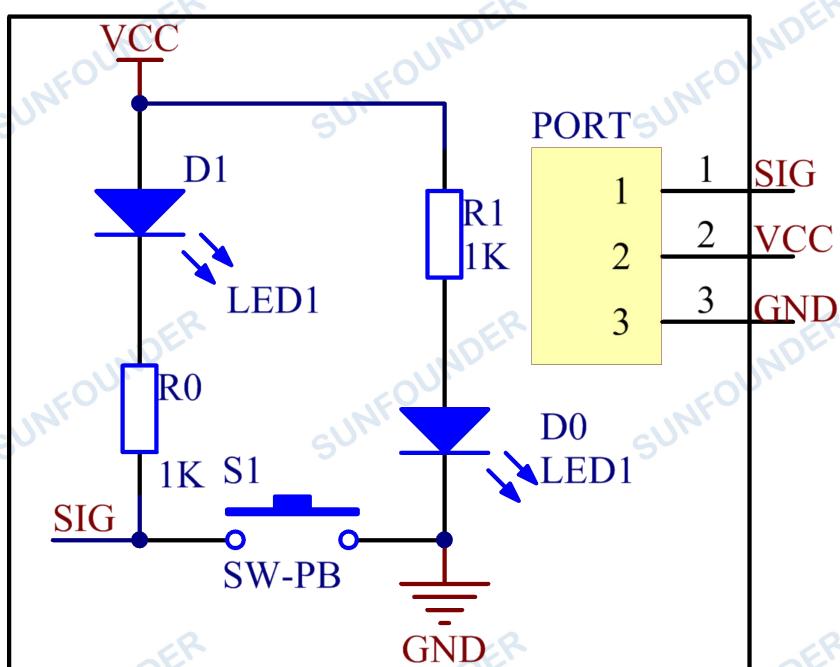


Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * Button module
- 1 * 3-Pin anti-reverse cable

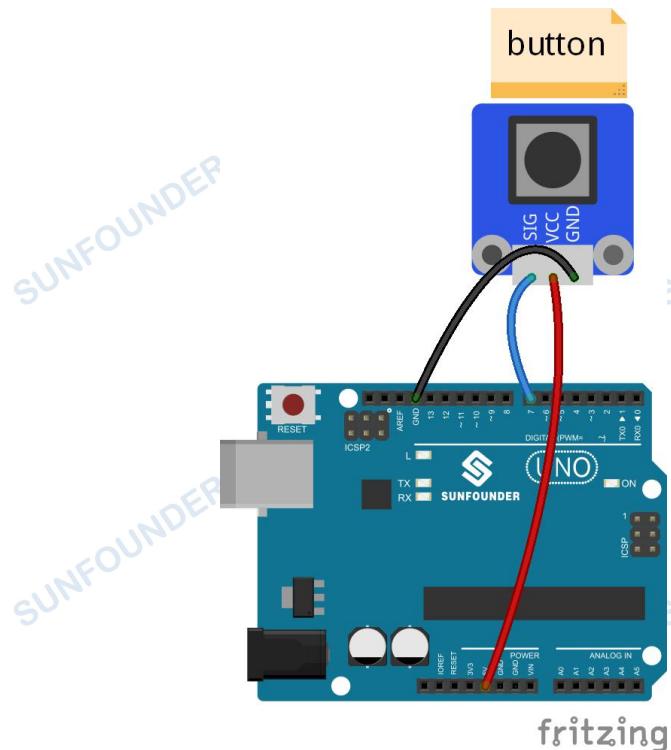
Experimental Principle

Since the LED has been attached to pin 13, just connect the button module to digital pin 7. When the button module identifies inductive button-pressing signals, the LED will be on. Otherwise it will be off.



Experimental Procedures

Step 1: Build the circuit

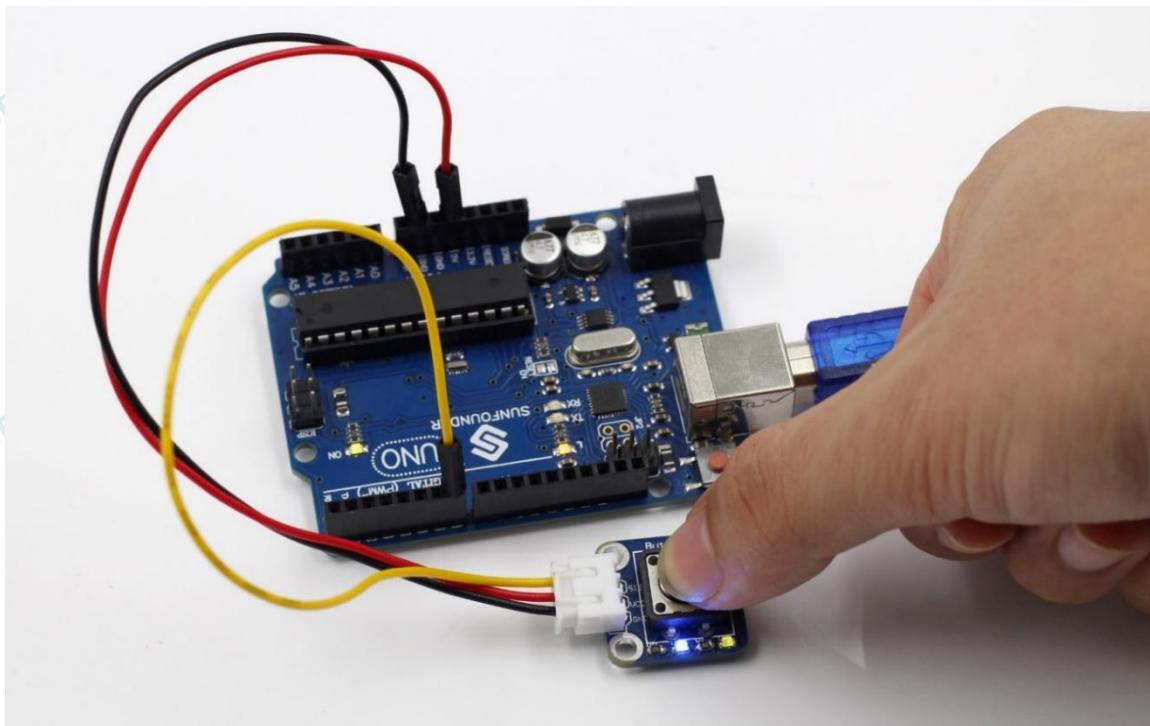


Step 2: Open the code file

Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

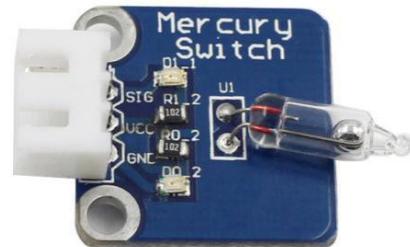
Now, press the button, and then the LED on the button module and that hooked up with pin 13 of the SunFounder Uno board will light up.



Lesson 14 Mercury Switch

Introduction

Similar to a tilt switch, a mercury switch is used to detect slight inclinations of a large angle. A mercury switch (also known as a mercury tilt switch) is a switch which opens and closes an electrical circuit through a small amount of liquid mercury.



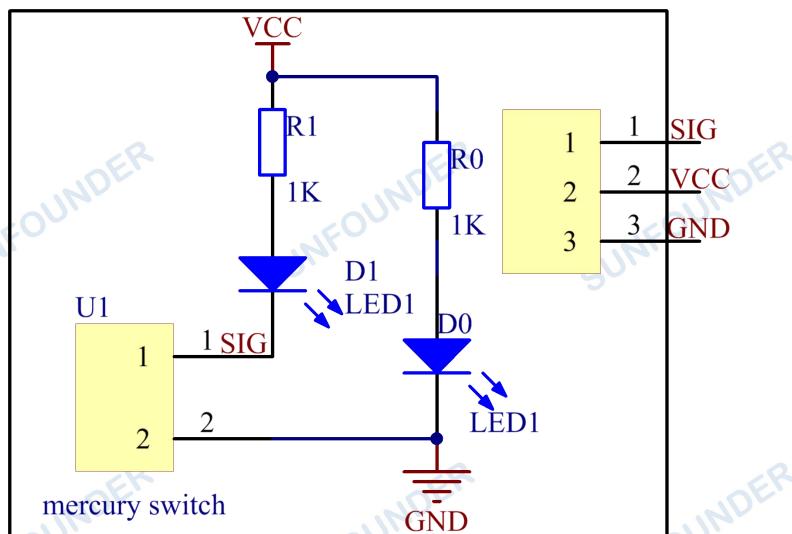
Mercury switches have one or more sets of electrical contacts in a sealed glass envelope which contains a bead of mercury. The envelope may also contain air or inert gas, or is just vacuum. Gravity is constantly pulling the drop of mercury to the lowest point in the envelope. When the switch is tilted in the appropriate direction, the mercury will touch the set of contacts, thus completing the electrical circuit through those contacts. Tilting the switch in the opposite direction causes the mercury to move away from that set of contacts, thus breaking that circuit.

Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * Mercury switch module
- 1 * 3-Pin anti-reverse cable

Experimental Principle

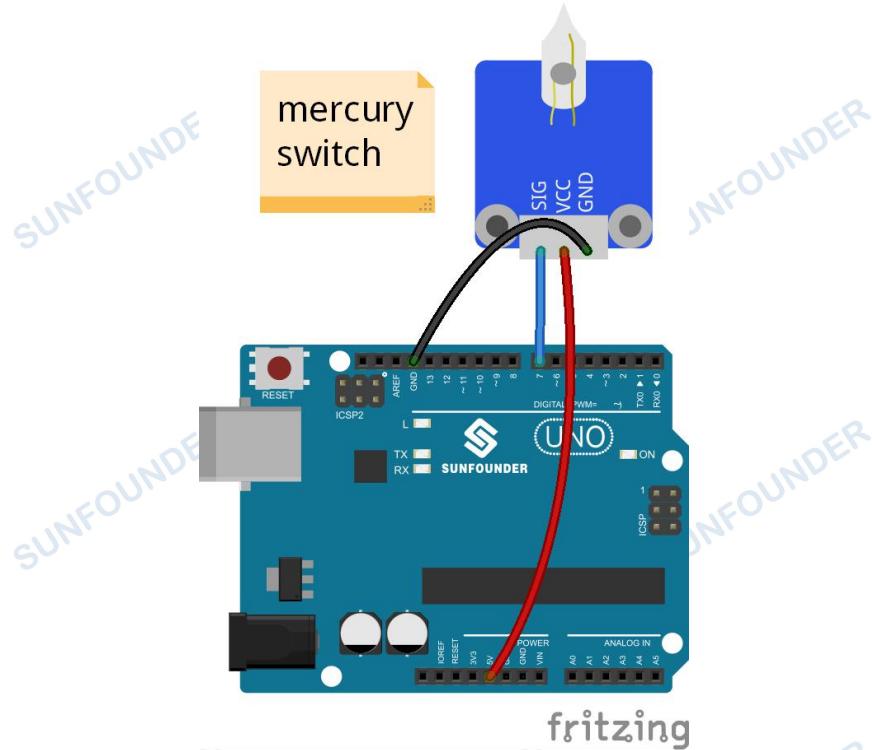
Since the LED has been attached to pin 13, just connect pin S to digital pin 7 of the SunFounder Uno board. When the mercury switch identifies inductive tilt signals, the LED will be on. Otherwise it will be off.



Note: Mercury is harmful to human body and environment. Thus, please BE CAREFUL when using a mercury switch in case of glass breaking. It should also be properly handled if it's no longer used.

Experimental Procedures

Step 1: Build the circuit

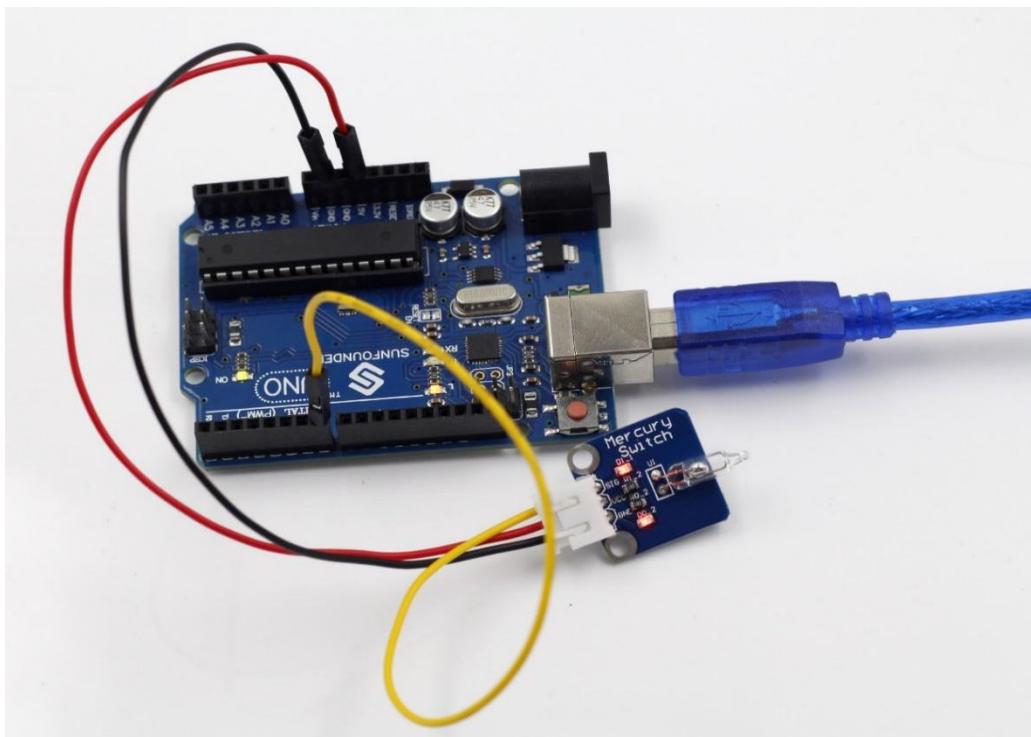


Step 2: Program (Please refer to the example code in [LEARN -> Get Tutorial](#) on our [website](#))

Step 3: Compile

Step 4: Upload the sketch to SunFounder Uno board

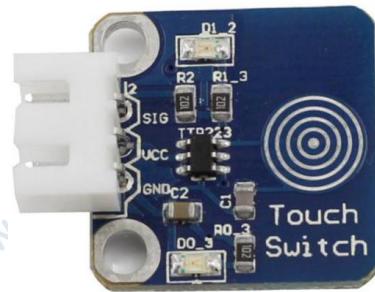
Now, tilt the switch. Then the indicators on the switch and the LED attached to pin 13 on the SunFounder Uno board will light up.



Lesson 15 Touch Switch

Introduction

A metal touch sensor is a type of switch that only operates when it's touched by a charged body. It has a high-frequency transistor which is energized when receiving electromagnetic signals.

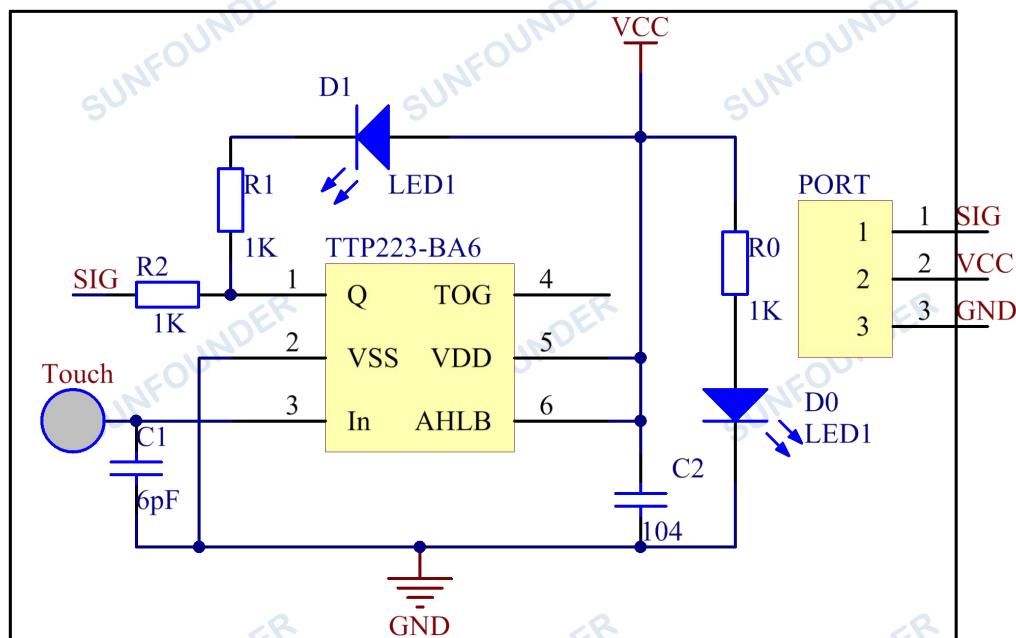


Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * Touch Switch module
- 1 * 3-Pin anti-reverse cable

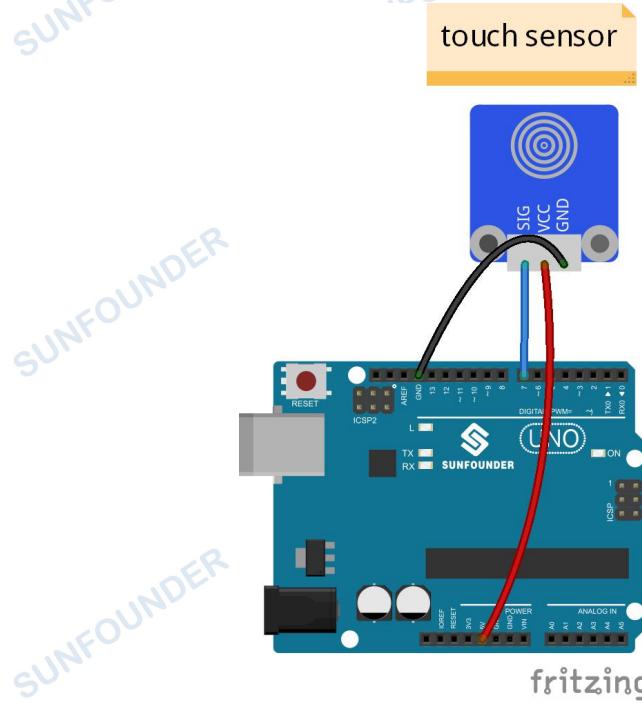
Experimental Principle

In this experiment, touch the base electrode of the transistor to make it conduct electricity, for human body itself is a kind of conductor and an antenna that can receive electromagnetic waves in the air.



Experimental Procedures

Step 1: Build the circuit

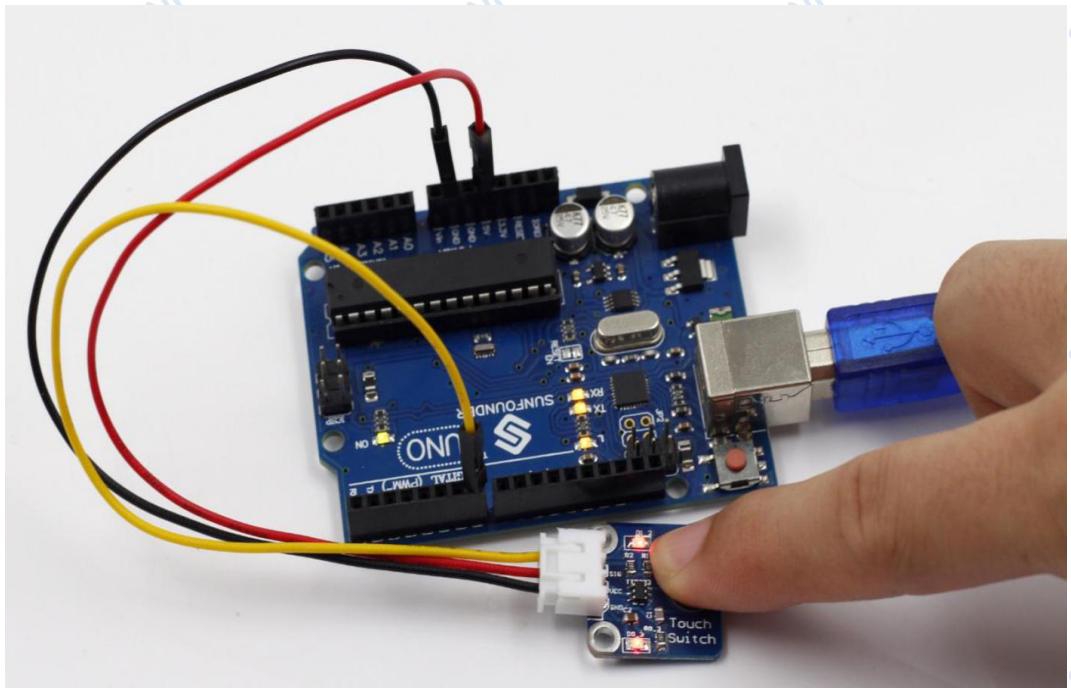


Step 2: Open the code file

Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

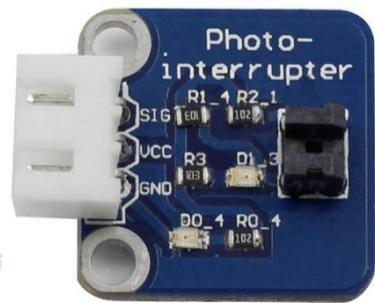
When the module is electrified, the original state of pin SIG is low and the LED on it is on. Now, touch the electrode with your finger. Then it outputs high and the LED on it and that attached to pin 13 on the SunFounder Uno board will go out. Move away and touch it again, and it'll output low with the LEDs turned on, and so forth. Thus, the output level changes between high and low with each touch, together with LEDs brightening and dimming.



Lesson 16 Photo-interrupter

Introduction

A photo-interrupter is a sensor with a light-emitting component and light-receiving component packaged face to face. It applies the principle that light is interrupted when an object passes through the sensor. Therefore, photo-interrupters are widely used in speed measurement.

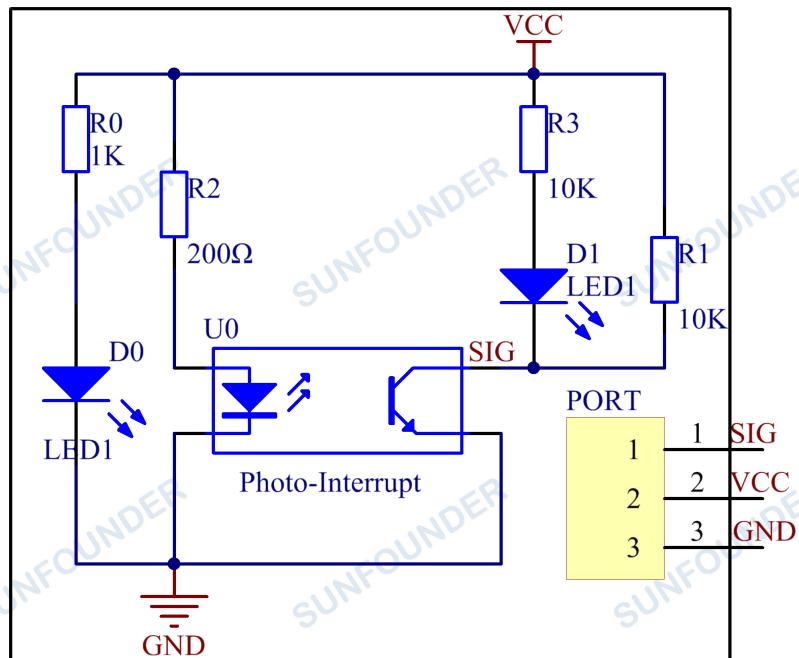


Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * Photo-interrupter module
- 1 * 3-Pin anti-reverse cable

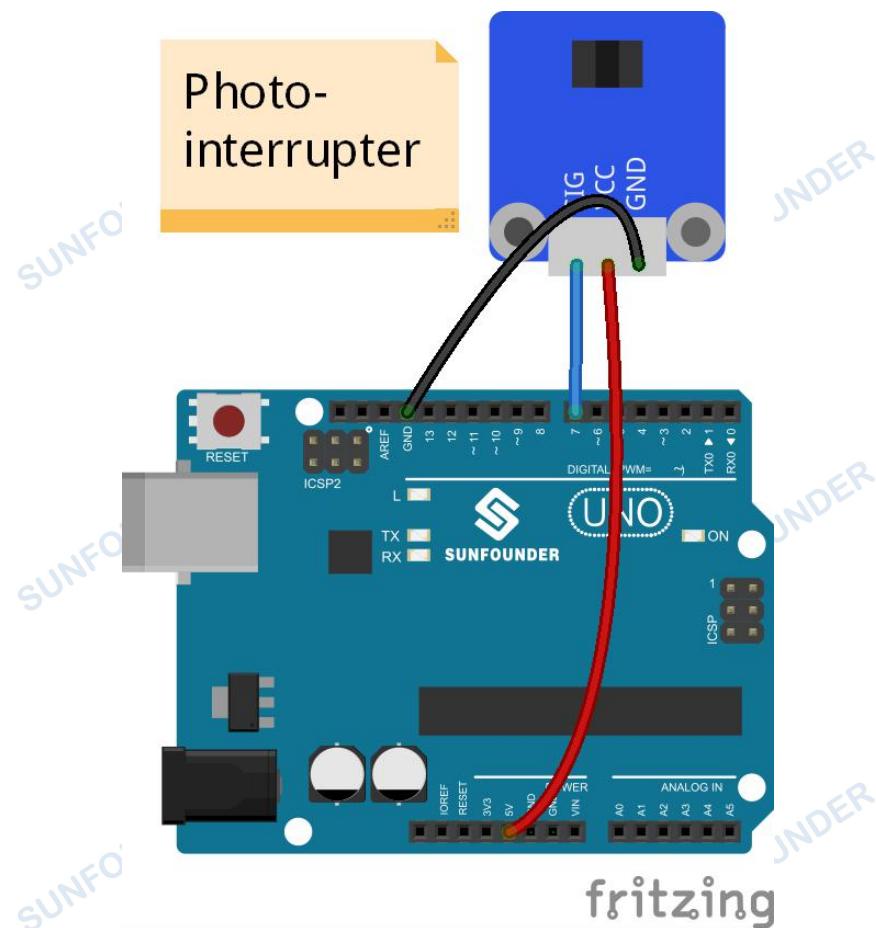
Experimental Principle

Basically a photo-interrupter consists of two parts: transmitter and receiver. The transmitter (e.g., an LED or a laser) emits light and then the light goes to the receiver. If the light beam between the transmitter and receiver is interrupted by an obstacle, the receiver will detect no incident light even for a moment and the output level will change. In this experiment, we will turn an LED on or off by using this change.



Experimental Procedures

Step 1: Build the circuit

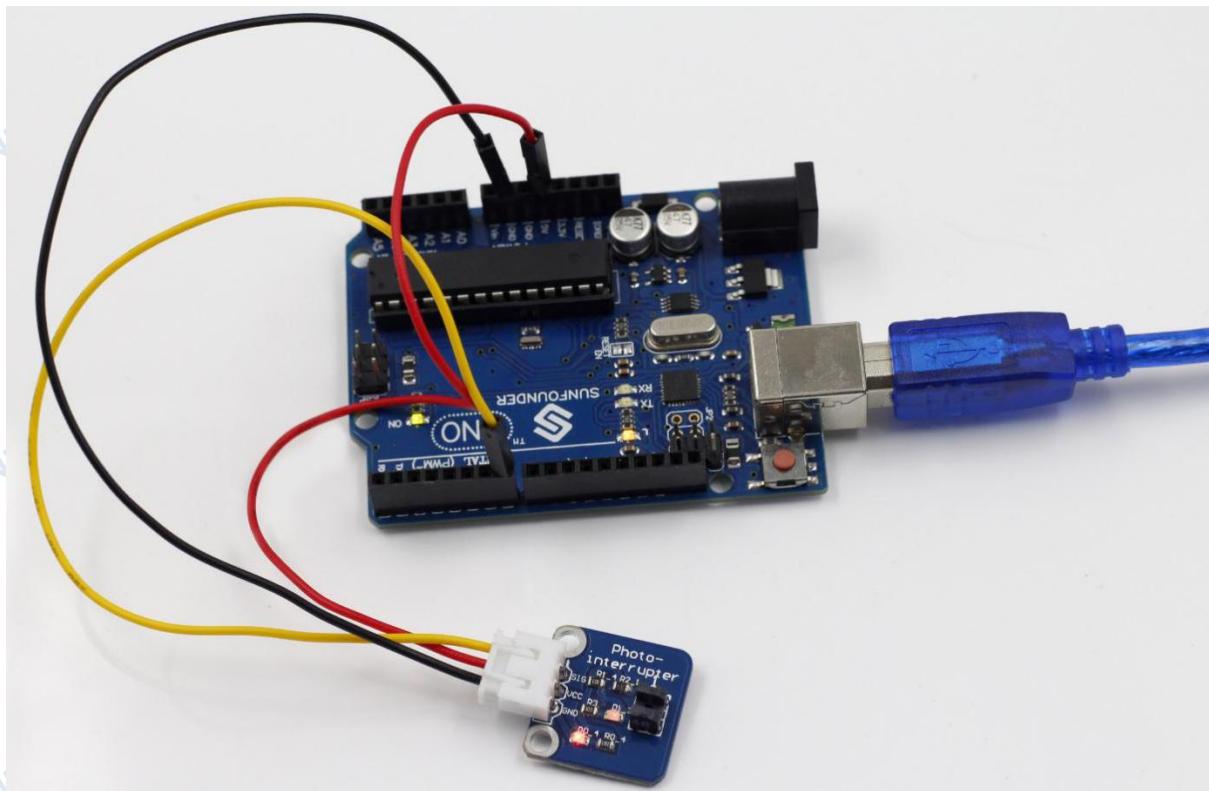


Step 2: Open the code file

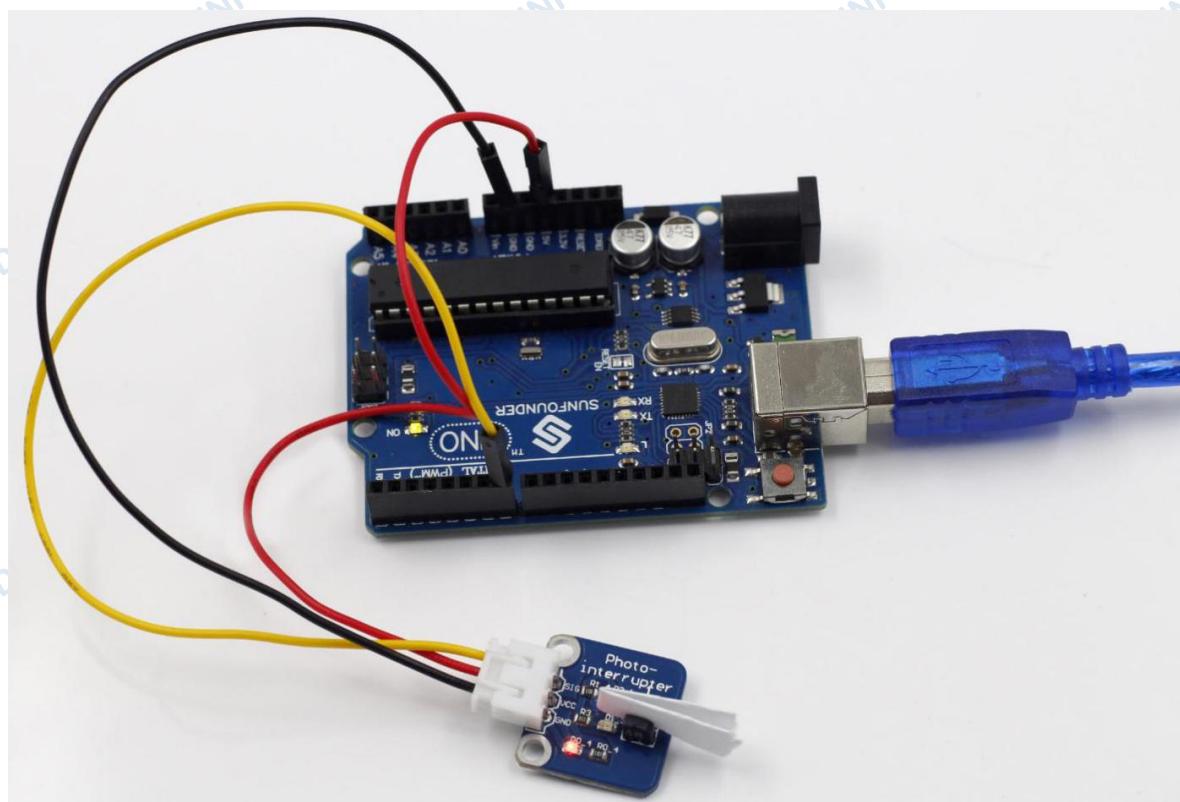
Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

Now, stick a piece of paper in the gap of the sensor, and the LED attached to pin 13 on the SunFounder Uno will go out; remove the paper, and then the LED will light up again.



Before

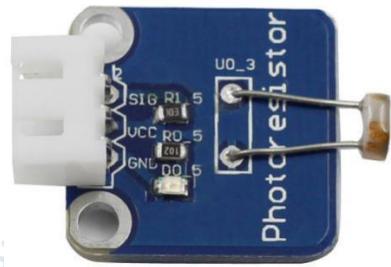


With paper interrupting

Lesson 17 Photoswitch

Introduction

The sensor is in fact a photoresistor which changes its resistance with varying light intensity. It can be used to make a photoswitch.

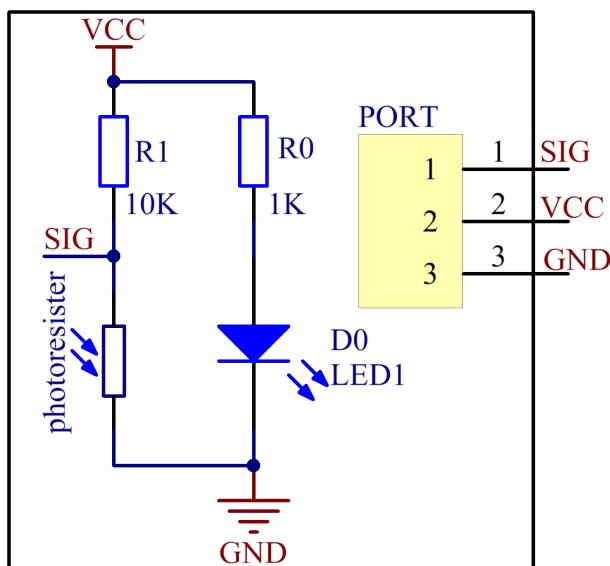


Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * Relay module
- 1 * Photoresistor sensor module
- 2 * 3-Pin anti-reverse cable
- 1 * Dupont wire (F to F)

Experimental Principle

A photoresistor or light-dependent resistor (LDR) or photocell is a light-controlled variable resistor. The resistance of a photoresistor decreases with increasing incident light intensity; in other words, it exhibits photoconductivity. A photoresistor can be applied in light-sensitive detector circuits, and light- and dark-activated switching circuits. In this experiment, hook up the photoresistor to A0 of the SunFounder board, and relay to pin 8. When the value reaches or even exceeds 400, the normally open contact of the relay is closed and the LED at pin 13 on the SunFounder Uno board will light up; otherwise, it will be off. In this way you can make a photoswitch.



Experimental Procedures

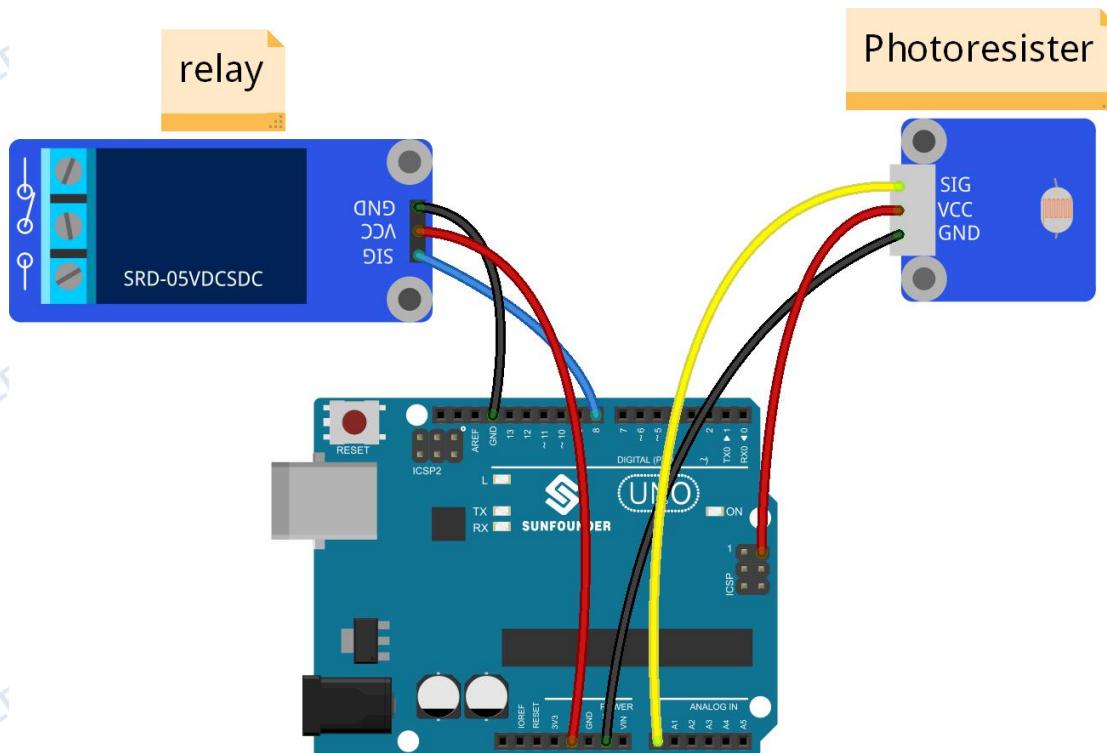
Step 1: Build the circuit

The wiring between the relay and SunFounder Uno board:

Relay	SunFounder Uno
GND	GND
VCC	5V
SIG	8

The wiring between the photoresistor and SunFounder Uno board:

Photoresistor	SunFounder Uno
SIG	A0
VCC	5V
SIG	A0

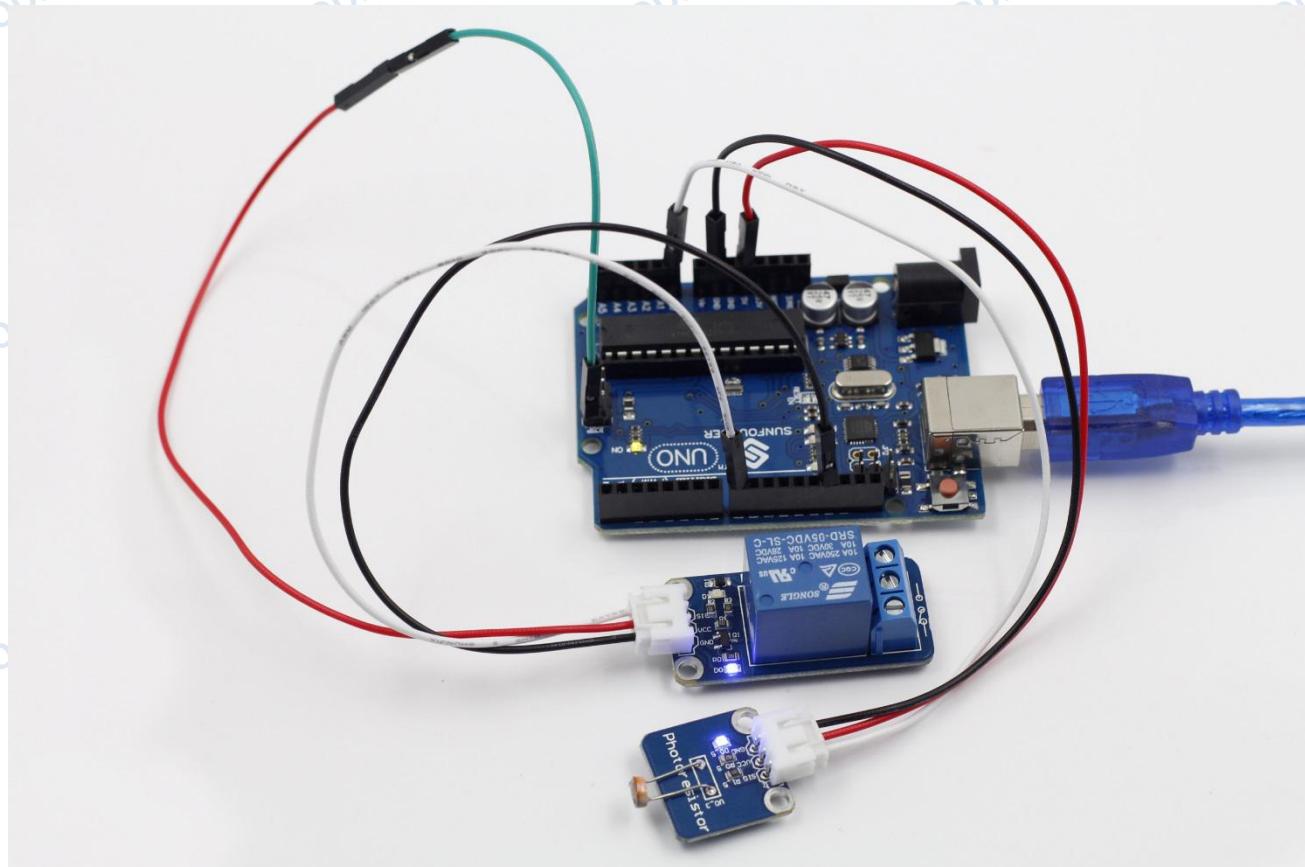


Step 2: Open the code file

Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

Now hold the photoresistor with your fingers and check the value at A0 on Serial Monitor. You can see when the resistance is up to 400ohm, the normally open contact of the relay is closed and the LED connected to pin 13 on the SunFounder Uno board lights up; or else, it keeps out.



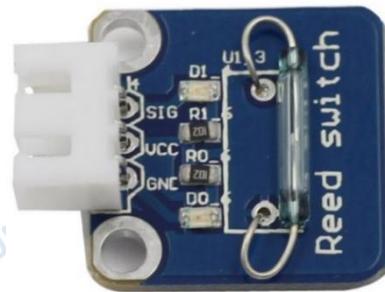
Summary

In this experiment we've use the sensor making a photoswitch. You may try other applications. For instance, connect a bulb to the relay module based on the circuit. Then when it gets dimmer, the normally open contact of the relay is closed and the bulb will light up. The same way applies to the street light.

Lesson 18 Reed Switch

Introduction

A reed switch is also a sensor used to detect the magnetic field. Hall sensors are generally used to measure the speed of intelligent vehicles and count assembly lines, while reed switches are often used to detect the existence of a magnetic field.



Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * Reed Switch module
- 1 * 3-Pin anti-reverse cable
- 1 * Magnet

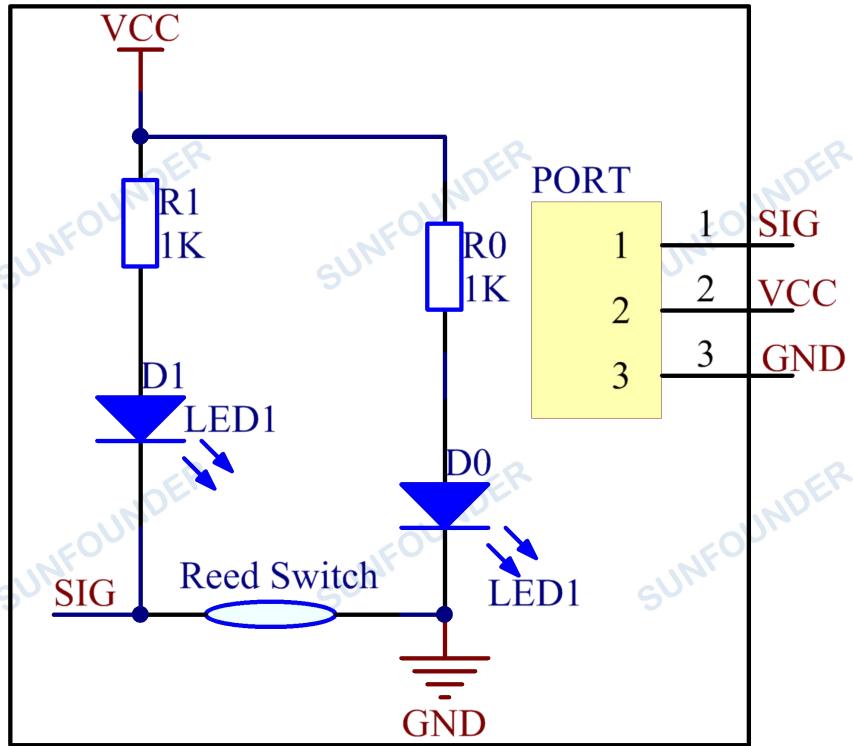
Experimental Principle

A reed switch is a type of line switch component that realizes control by magnetic signals. It induces by a magnet. The "switch" here means dry reed pipe, which is a kind of contact passive electronic switch component with the advantage of simple structure, small size, and convenient control. The shell of a reed switch is commonly a sealed glass pipe in which two iron elastic reed electroplates are equipped and inert gases are filled. Normally, the two reeds made of special materials in the glass tube are separated. However, when a magnetic substance approaches the glass tube, the two reeds in the glass tube are magnetized to attract each other and contact under the function of magnetic field lines. As a result, the two reeds will pull together to connect the circuit connected with the nodes.

After external magnetic force disappears, the two reeds will be separated with each other because they have the same magnetism, so the circuit is also disconnected. Therefore, as a line switch component controlling by magnetic signals, the dry reed pipe can be used as a sensor to count, limit positions and so on. At the same time, it is widely used in a variety of communication devices.

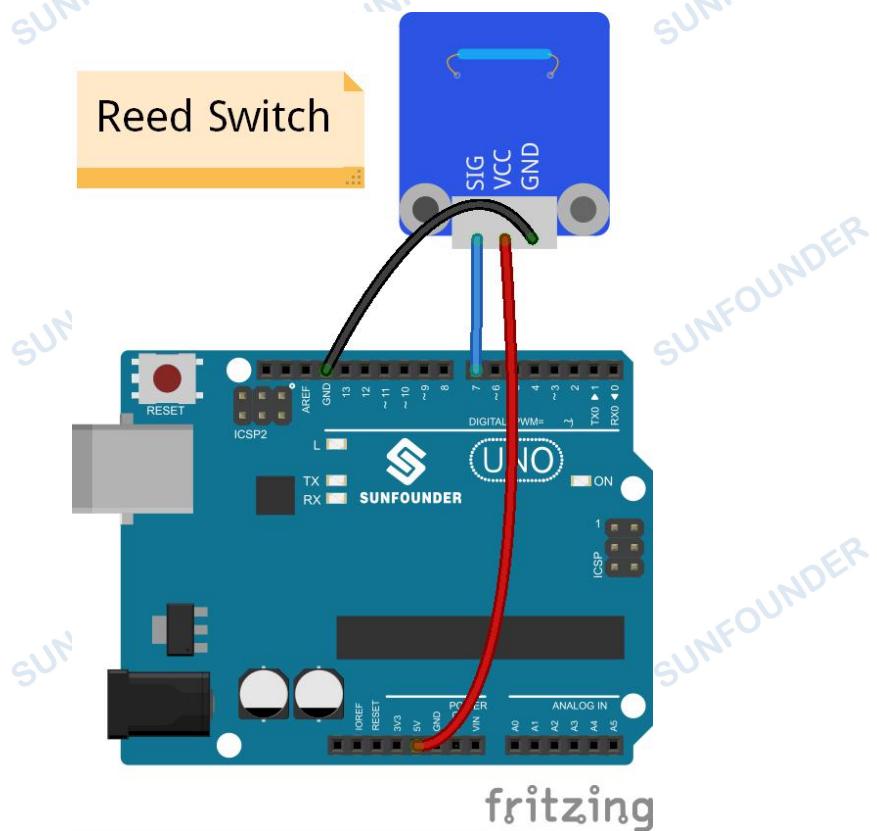
In this experiment, since an LED has been attached to pin 13, just connect pin SIG of the reed switch to digital pin 7 of SunFounder Uno board. When the reed switch identifies magnetic field signals, the LED will be on. Otherwise it will be off.

The schematic diagram



Experimental Procedures

Step 1: Build the circuit

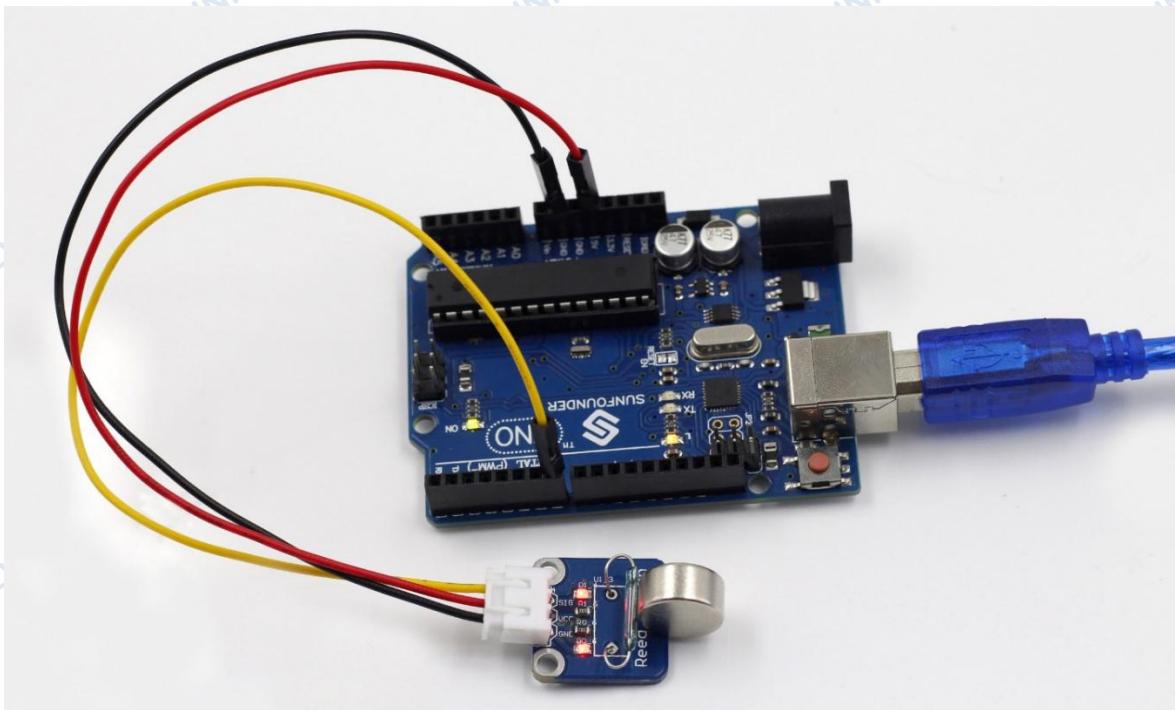


Step 2: Open the code file

Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

Now, use a magnet to approach the reed switch, and the LED on the reed switch module and that on the SunFounder board light up. Move the magnet farther and the LED will go out.



Lesson 19 Relay

Introduction

As we know relay is a device which is used to provide connection between two or more points or device in response to the input signal applied. In another words relay provide isolation between the controller and the device as we know devices may work on AC as well as on DC. However, they receive signals from microcontroller which works on DC hence we require a relay to bridge the gap. Relay is extremely useful when you need to control a large amount of current or voltage with small electrical signal.



Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * Relay module
- 1 * 3-Pin anti-reverse cable

Experimental Principle

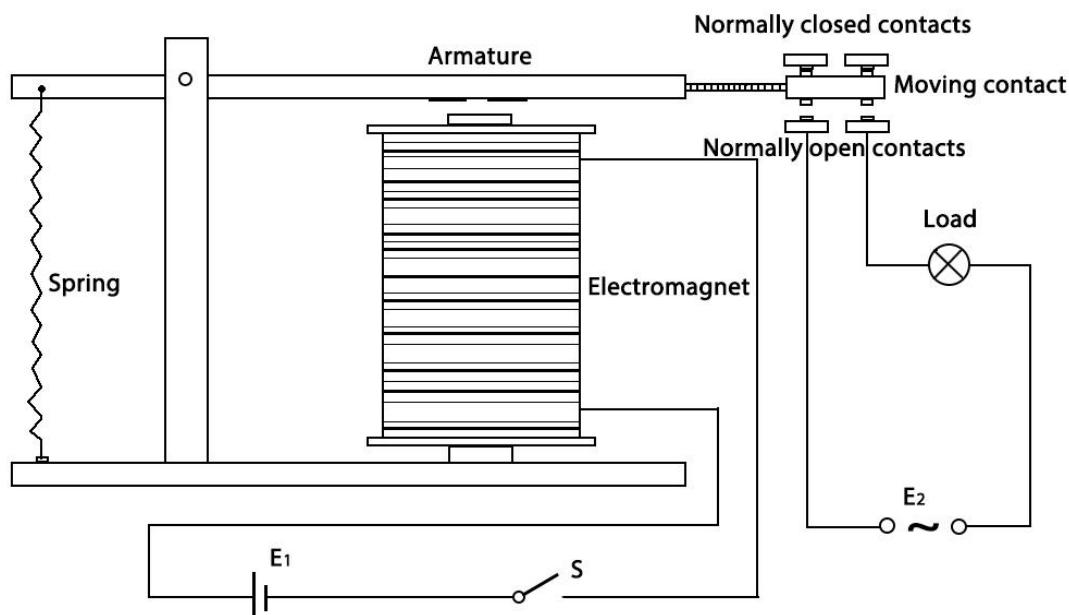
Relay – There are 5 parts in every relay:

1. **Electromagnet** – It consists of an iron core wounded by coil of wires. When electricity is passed through, it becomes magnetic. Therefore, it is called electromagnet.
2. **Armature** – The movable magnetic strip is known as armature. When current flows through them, the coil is energized thus producing a magnetic field which is used to make or break the normally open (N/O) or normally close (N/C) points. And the armature can be moved with direct current (DC) as well as alternating current (AC).
3. **Spring** – When no currents flow through the coil on the electromagnet, the spring pulls the armature away so the circuit cannot be completed.
4. Set of electrical **contacts** – There are two contact points:
 - Normally open - connected when the relay is activated, and disconnected when it is inactive.
 - Normally close – not connected when the relay is activated, and connected when it is inactive.
5. Molded frame – Relays are covered with plastic for protection.

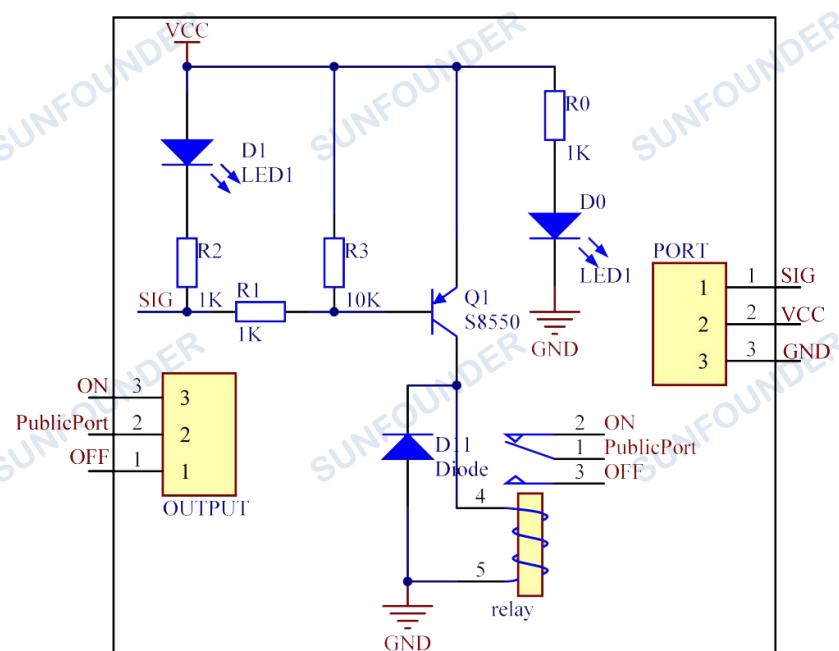
Working of Relay

The working principle of relay is simple. When power is supplied to the relay, currents start flowing through the control coil; as a result, the electromagnet starts energizing. Then the

armature is attracted to the coil, pulling down the moving contact together thus connecting with the normally open contacts. So the circuit with the load is energized. Then breaking the circuit would a similar case, as the moving contact will be pulled up to the normally closed contacts under the force of the spring. In this way, the switching on and off of the relay can control the state of a load circuit.

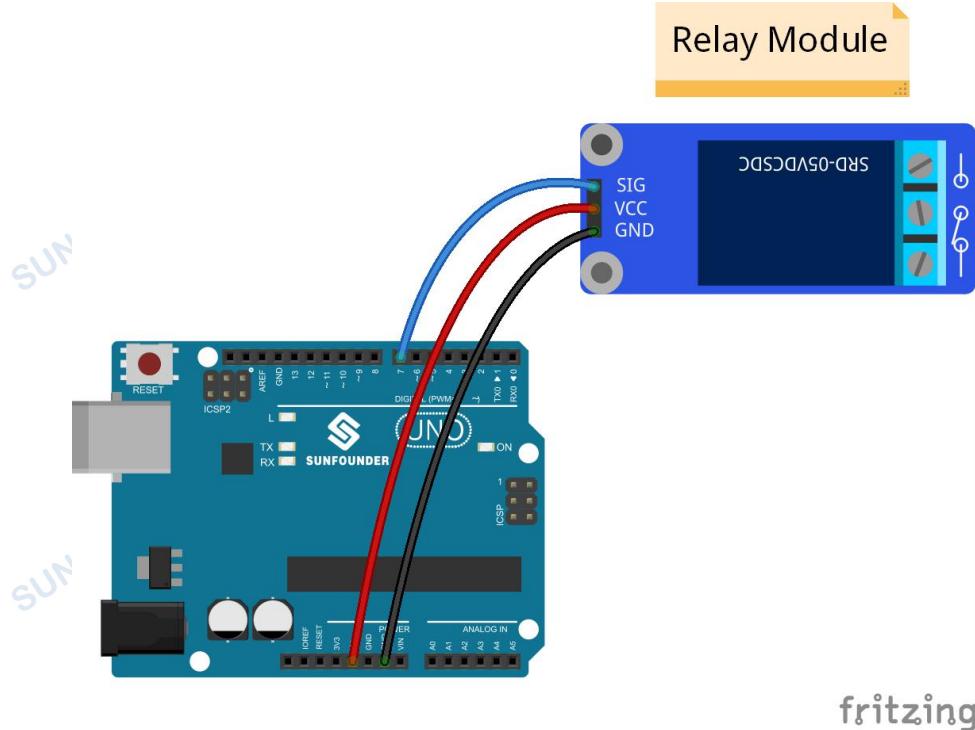


So in this experiment, hook the SIG to the SunFounder Uno board. Send a low level to SIG; the PNP transistor is energized and the coil of the relay is electrified. Thus, the normally open contact of the relay is closed, while the normally closed contact of the relay will be off the public port. Send a high level to SIG; the transistor will be de-energized and the relay will restore to the initial state.



Experimental Procedures

Step 1: Build the circuit



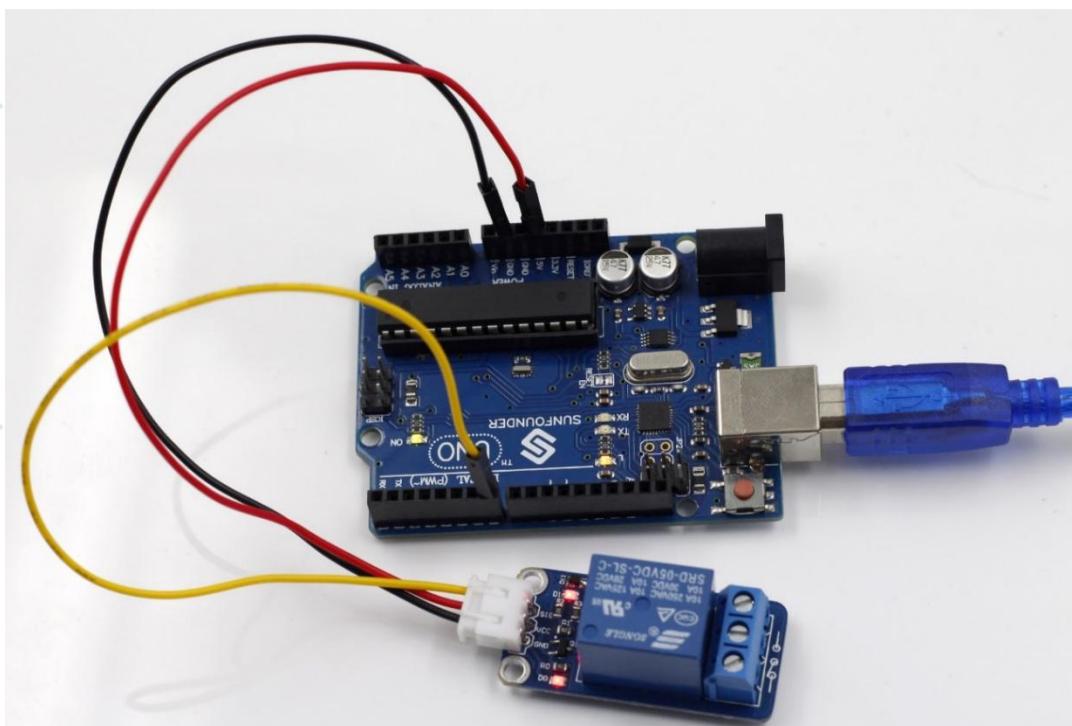
fritzing

Step 2: Open the code file

Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

Now, you may hear the ticktock. That's the normally closed contact opened and the normally open contact closed.



Lesson 20 Blinking an LED by Potentiometer

Introduction

A potentiometer can help to control the interval at which the LED on the SunFounder board blinks.



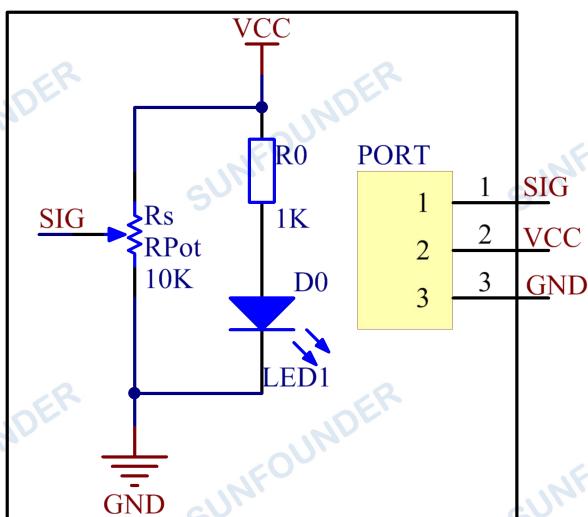
Components

- 1 * SunFounder Uno board
- 1 * 3-Pin anti-reverse cable
- 1 * Potentiometer module
- 1 * USB cable

Experimental Principle

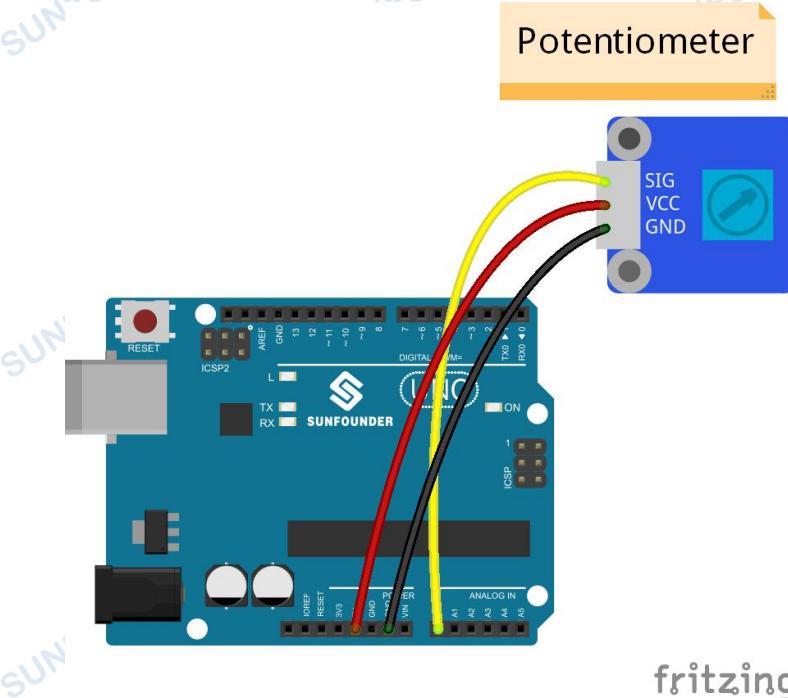
An analog potentiometer is an analog electronic component. What's the difference between an analog one and a digital one? Simply put, a digital potentiometer refers to just two states like on/off, high/low levels, i.e. either 0 or 1, while a digital one supports analog signals like a number from 1 to 1000. The signal value changes over time instead of keeping an exact number. Analog signals include light intensity, humidity, temperature, and so on.

In this experiment, hook up the pin SIG of the potentiometer module to A0 of the SunFounder Uno board and check the value at A0. Then use the value to control the interval at which the LED connected with pin 13 of the Uno board blinks. Rotate the shaft of the potentiometer and the LED blink interval will increases or decreases.



Experimental Procedures

Step 1: Build the circuit



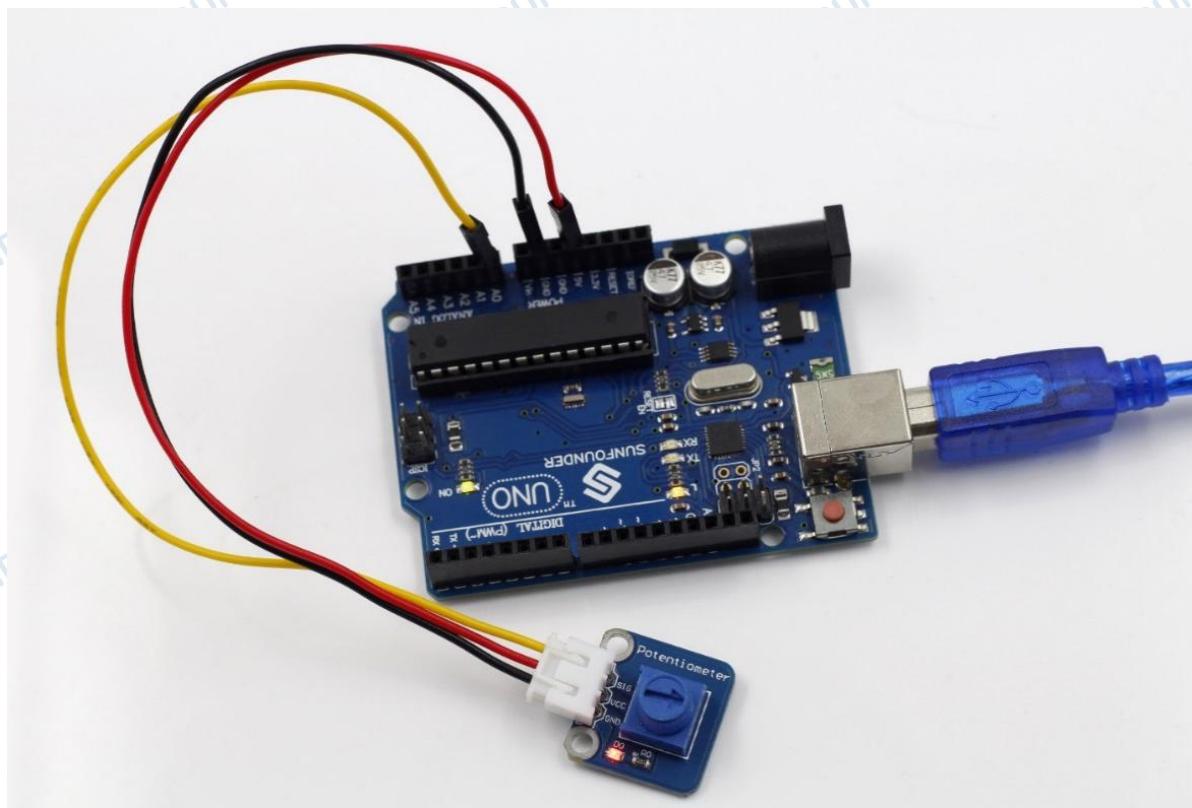
fritzing

Step 2: Open the code file

Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

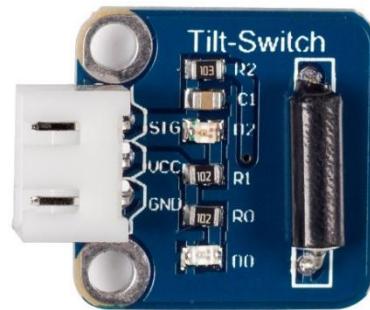
Rotate the shaft of the potentiometer and the interval at which the LED attached to pin 13 of the SunFounder Uno blinks will increase or decrease.



Lesson 21 Tilt Switch

Introduction

The tilt switch sensor module is a ball tilt switch with a metal ball inside. It is used to detect inclinations of a small angle.



Components

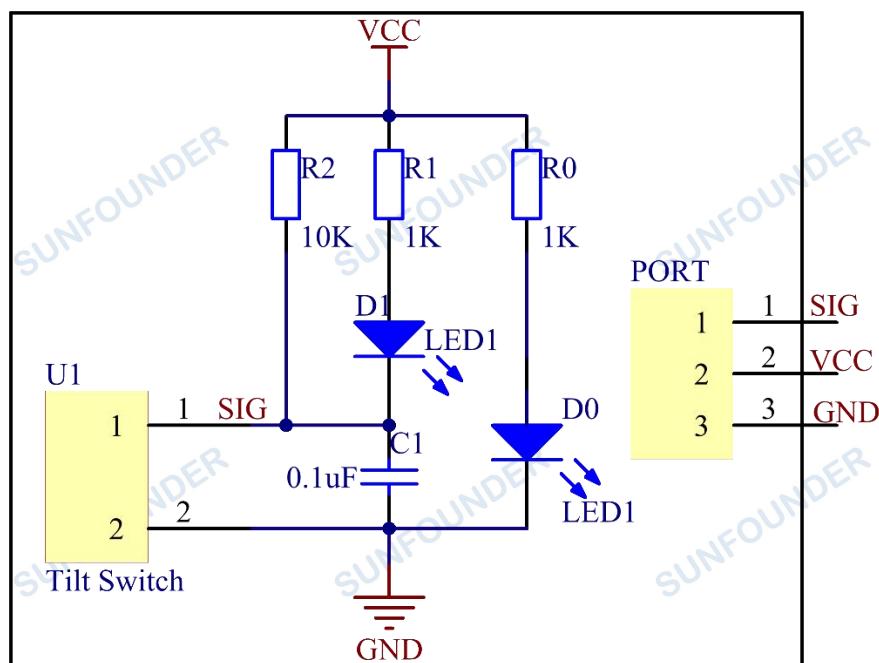
- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * Tilt switch module
- 1 * 3-Pin anti-reverse cable

Experimental Principle

The principle is very simple. When the switch is tilted in a certain angle, the ball inside rolls down and touches the two contacts connected to the pins outside, thus triggering circuits. Otherwise the ball will stay away from the contacts, thus breaking the circuits.

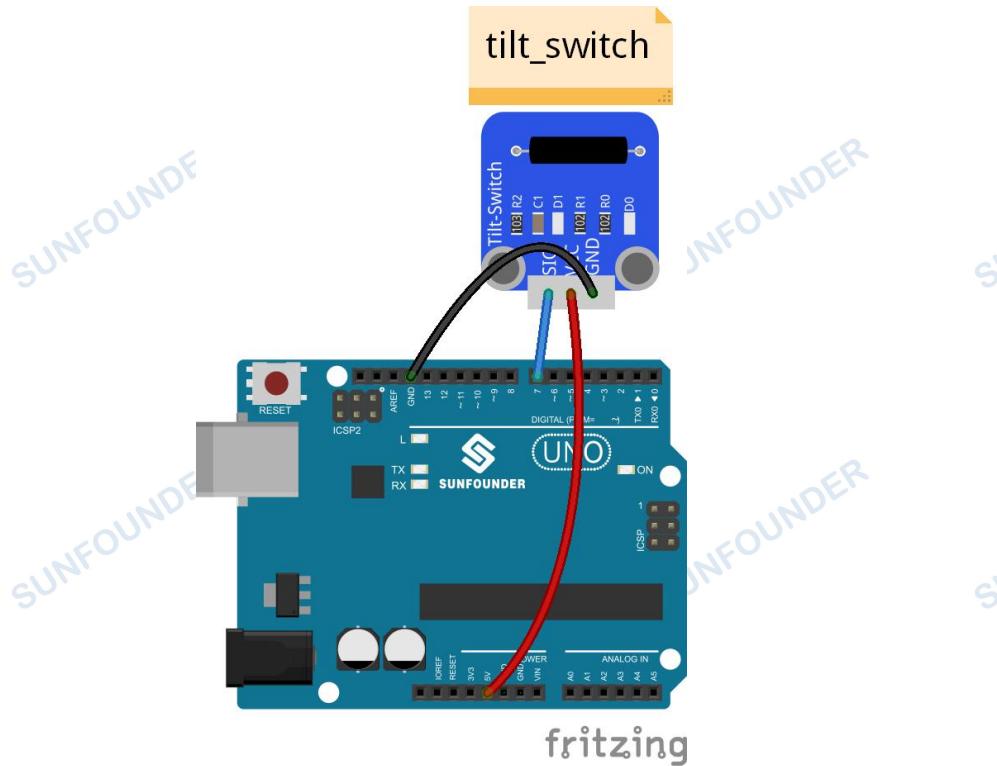
In this experiment, we use a tilt switch module and an LED that has been attached to pin 13 of the SunFounder board to build a simple circuit.

With the LED attached to pin 13, connect pin SIG to digital pin 7 of the SunFounder Uno board. Then the tilt switch outputs low signals and the LED will be on. Otherwise it will be off.



Experimental Procedures

Step 1: Build the circuit

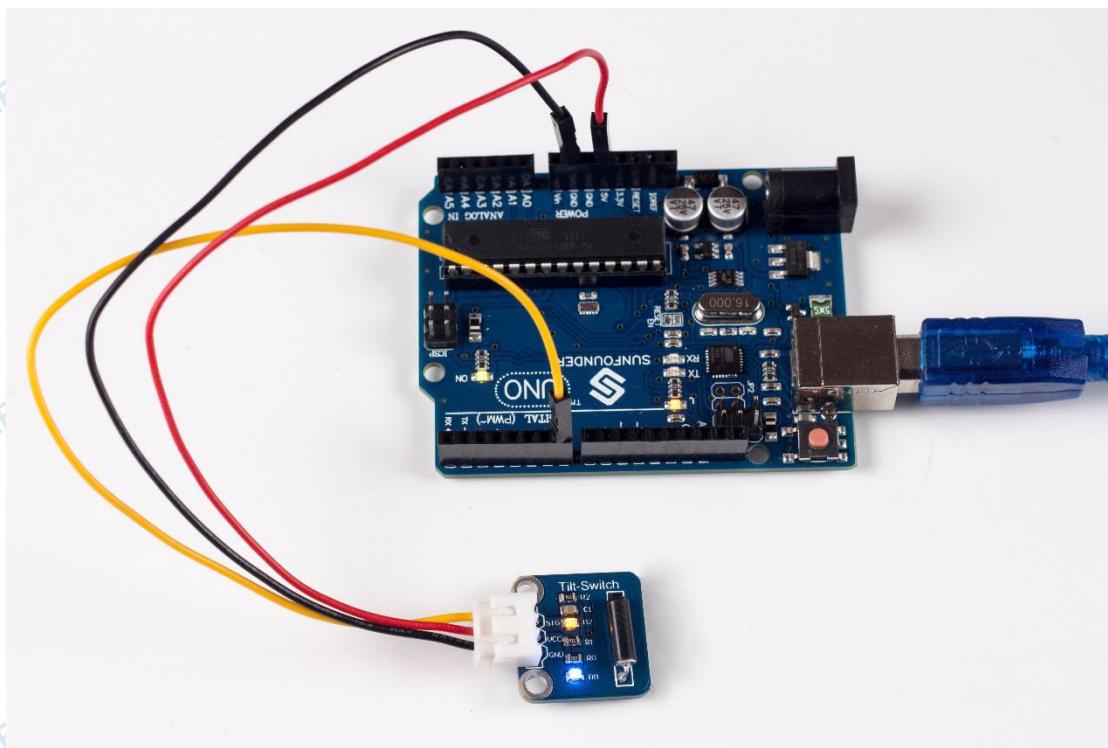


Step 2: Open the code file

Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

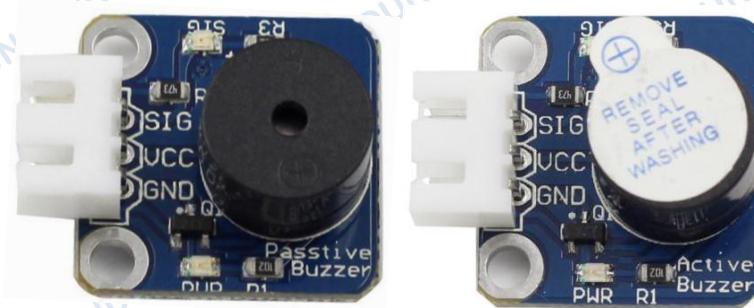
Now, tilt the switch and the LED attached to pin 13 on SunFounder Uno board will light up.



Lesson 22 Buzzer

Introduction

A buzzer is an audio signaling device. Buzzers can be categorized into active and passive ones (see as below).



Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * Active buzzer
- 1 * Passive buzzer
- 2 * 3-Pin anti-reverse cable

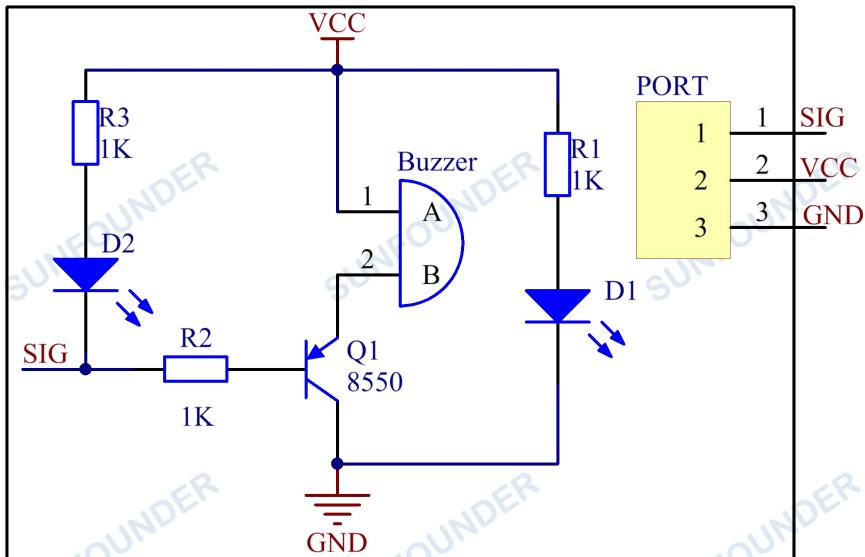
Experimental Principle

Place the pins of two buzzers face up and you can see the one with a green circuit board is a passive buzzer, while the other with a black tape, instead of a board, is an active buzzer, as shown below.



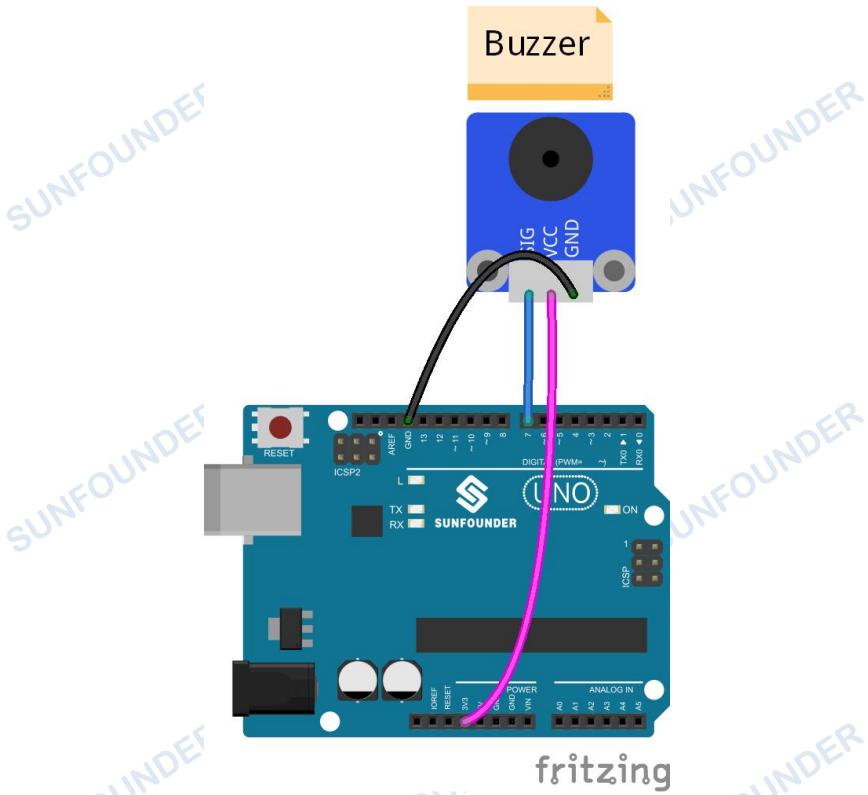
An active buzzer has a built-in oscillating source, so it will make sounds when electrified. But a passive buzzer does not have such source, so it will not beep if DC signals are used; instead, you need to use square waves whose frequency is between 2K and 5K to drive it. The active buzzer is often more expensive than the passive one because of multiple built-in oscillating circuits.

The schematic diagram:



Experimental Procedures

Step 1: Build the circuit



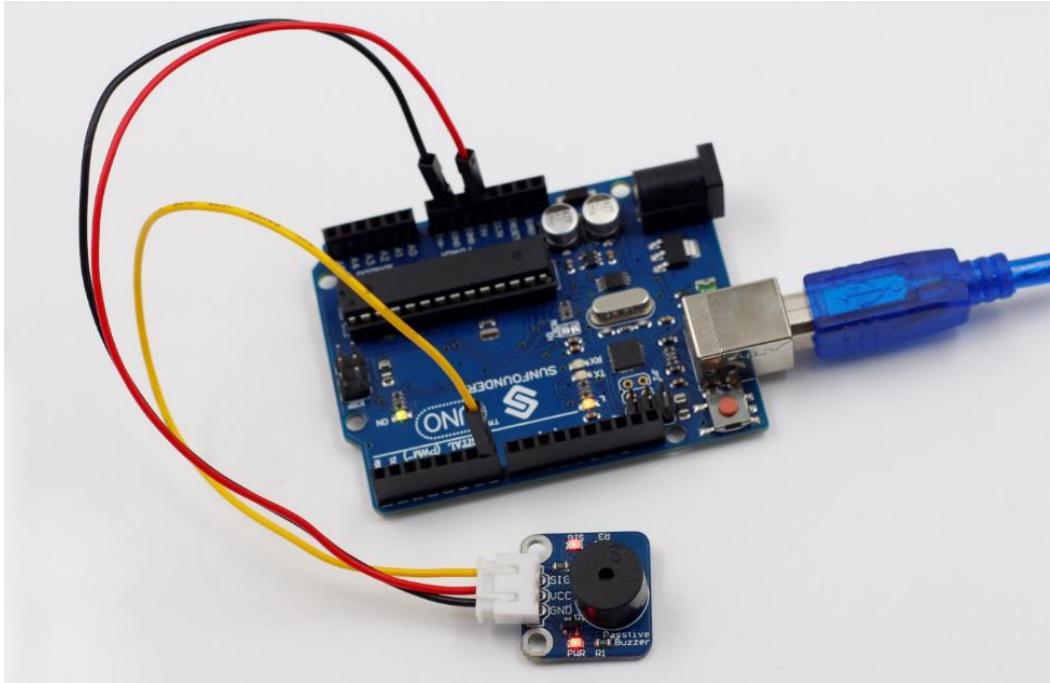
Passive Buzzer

Step 2: Open the code file (Passive)

Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

Now, you can hear the passive buzzer beeping. It also works in the same way if you use an active one here.



Active Buzzer

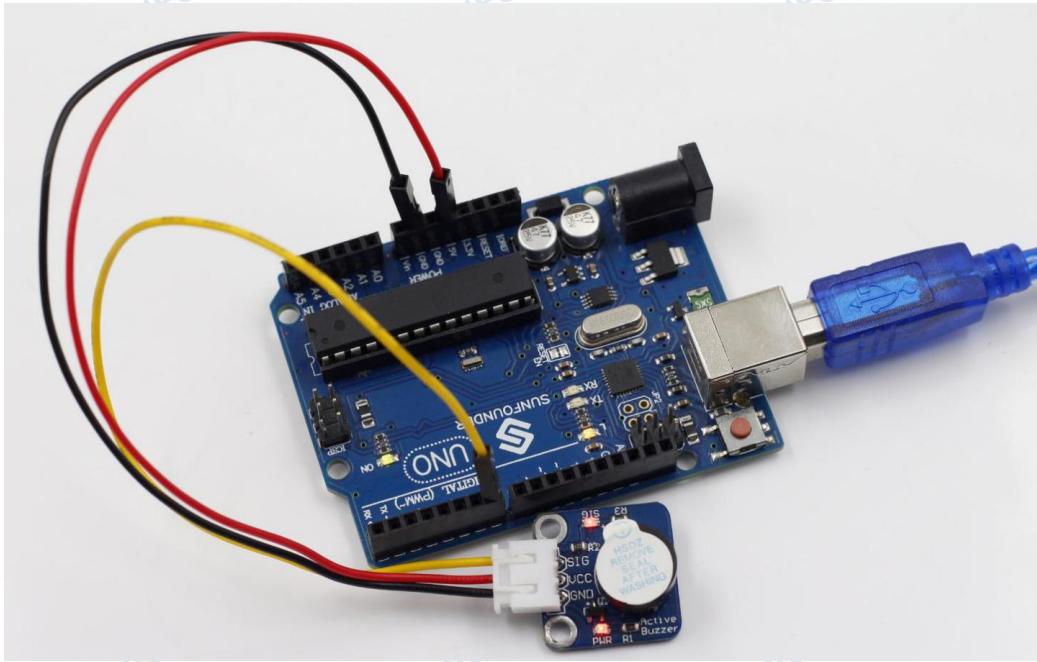
Note: The active buzzer has a built-in oscillating source, so it will beep as long as it is wired up.

Step 2: Open the code file (Active)

Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

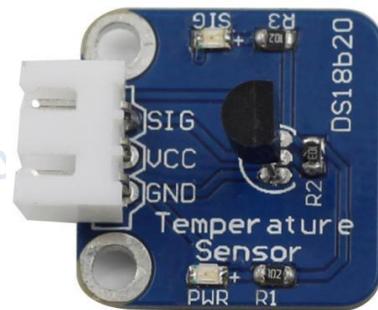
Now, you can hear the active buzzer beeping. But it won't work if you use a passive one here.



Lesson 23 Digital Temperature Sensor

Introduction

Temperature Sensor DS18B20 is a commonly used digital temperature sensor featured with small size, low-cost hardware, strong anti-interference capability and high precision. The digital temperature sensor is easy to wire and can be applied to various occasions after packaging. Different from conventional AD collection temperature sensors, it uses a 1-wire bus and can directly output temperature data.



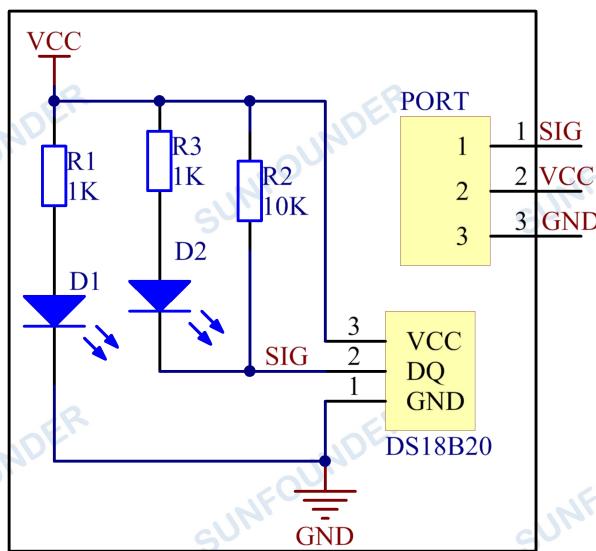
Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * DS18B20 Temperature Sensor module
- 1 * I2C LCD1602
- 1 * 3-Pin anti-reverse cable
- 1 * 4-Pin anti-reverse cable
- 1 * Dupont wire (F to F)

Experimental Principle

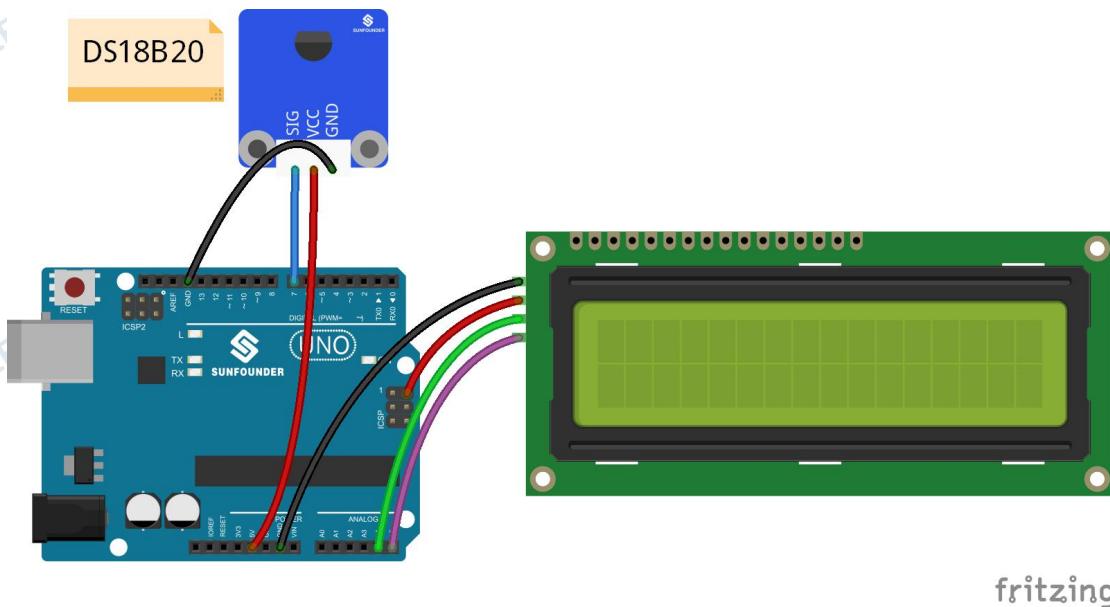
With a unique single-wire interface, DS18B20 requires only one pin for a two-way communication with a microprocessor. It supports multi-point networking to measure multi-point temperatures. Eight DS18B20s can be connected at most, because too many of

them will consume too much of the power supply and cause low voltage thus instability of signal transmission. The schematic diagram is as follows:



Experimental Procedures

Step 1: Build the circuit

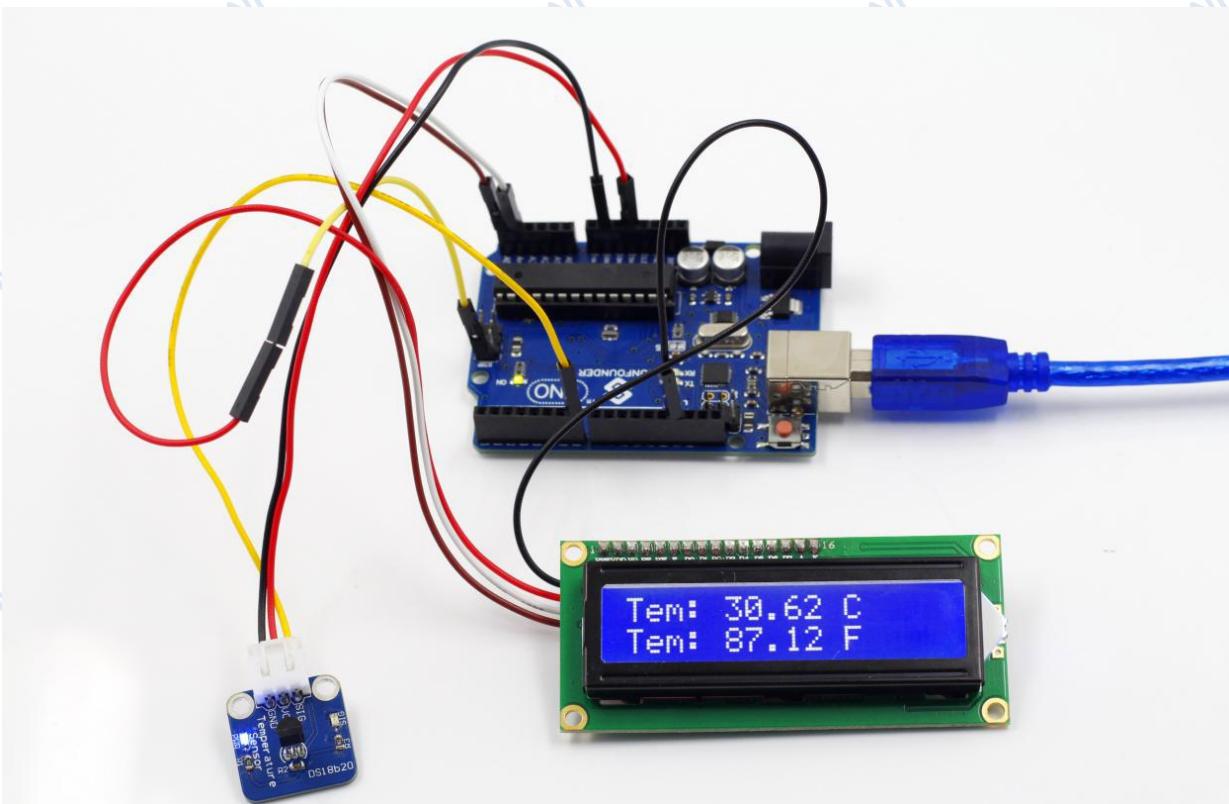


Step 2: Open the code file

Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

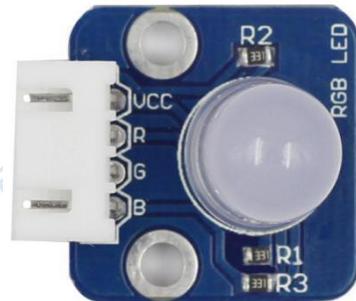
Now, you can see the value of current temperature displayed on the LCD.



Lesson 24 Rainbow LED

Introduction

RGB LED modules can emit various colors of light. Three LEDs of red, green, and blue are packaged into a transparent or semitransparent plastic shell with four pins led out. The three primary colors, red, green, and blue, can be mixed and compose all kinds of colors by brightness, so you can make an RGB LED emit colorful light by controlling the circuit.



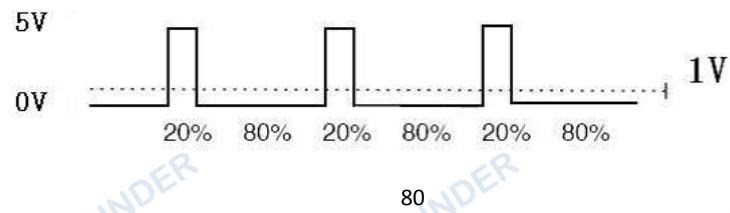
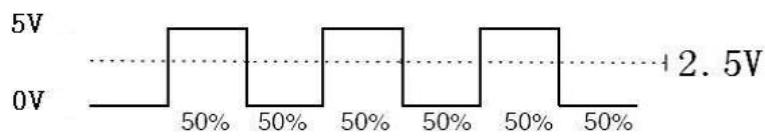
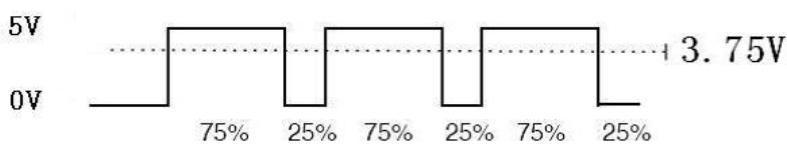
Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * RGB LED module
- 1 * 4-Pin anti-reverse cable

Experimental Principle

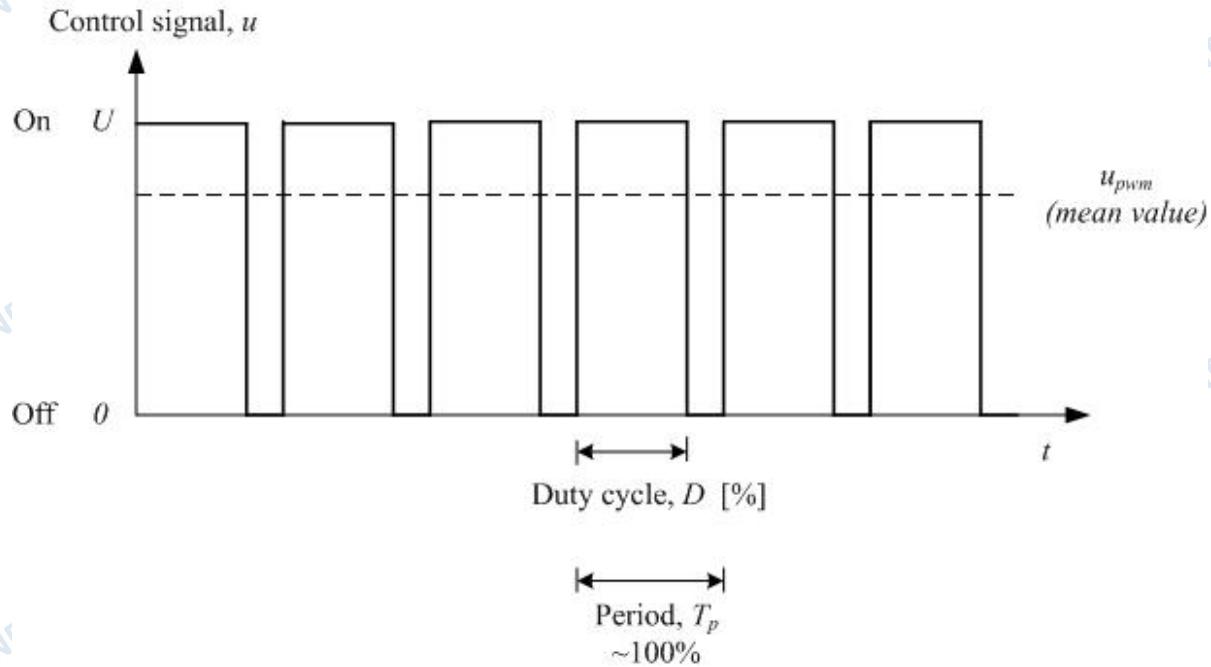
In this experiment, we will use PWM technology to the brightness of RGB.

Pulse Width Modulation, or PWM, is a technique for getting analog results with digital means. Digital control is used to create a square wave, a signal switched between on and off. This on-off pattern can simulate voltages in between full on (5V) and off (0V) by changing the portion of the time the signal spends on versus the time that the signal spends off. The duration of "on time" is called the pulse width. To get varying analog values, you change, or modulate, that pulse width. If you repeat this on-off pattern fast enough with an LED for example, the result is as if the signal is a steady voltage between 0 and 5v controlling the brightness of the LED. (See the PWM description on the official website of Arduino).



We can see from the oscillogram above that the amplitude of DC voltage output is 5V. However, the actual voltage output is only 3.75V through PWM, for the high level only takes up 75% of the total voltage within a period.

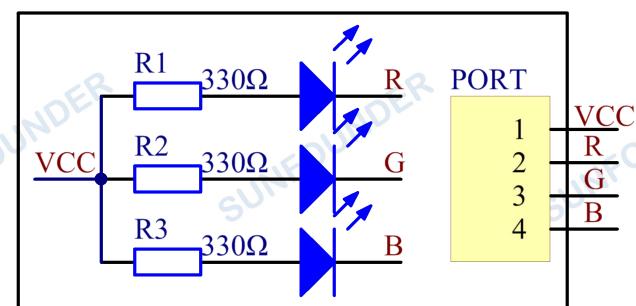
Here are the three basic parameters of PWM:



1. The term **duty cycle** describes the proportion of "on" time to the regular interval or "period" of time
2. **Period** describes the reciprocal of pulses in one second.
3. The voltage amplitude is 0-5V.

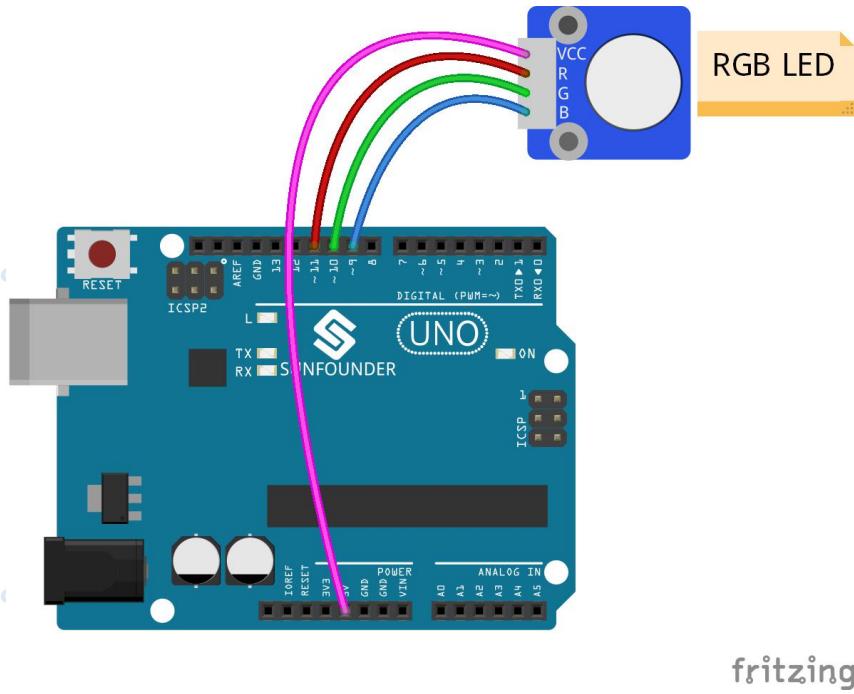
Here we input any value between 0 and 255 to the three pins of the RGB LED to make it display different colors.

RGB LEDs can be categorized into common anode LED and common cathode LED. In this experiment, we use a common anode RGB LED.



Experimental Procedures

Step 1: Build the circuit



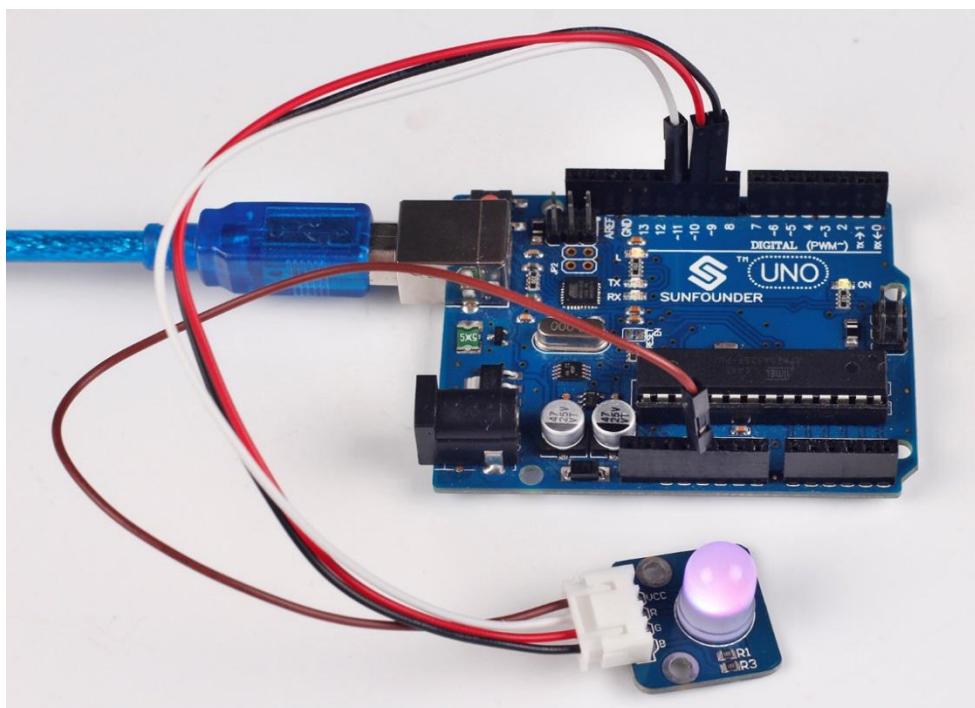
fritzing

Step 2: Open the code file

Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

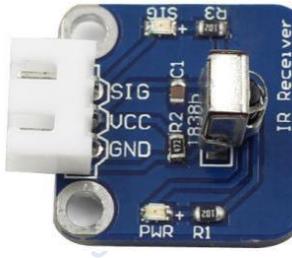
Now, you can see RGB LED flash red, green and blue first, and then change to red, orange, yellow, green, blue, indigo and purple.



Lesson 25 Infrared Receiver

Introduction

An infrared-receiver is a component which receives infrared signals and can independently receive infrared ray and output signals compatible with TTL level. It's similar with a normal plastic-packaged transistor in size and is suitable for all kinds of infrared remote control and infrared transmission.

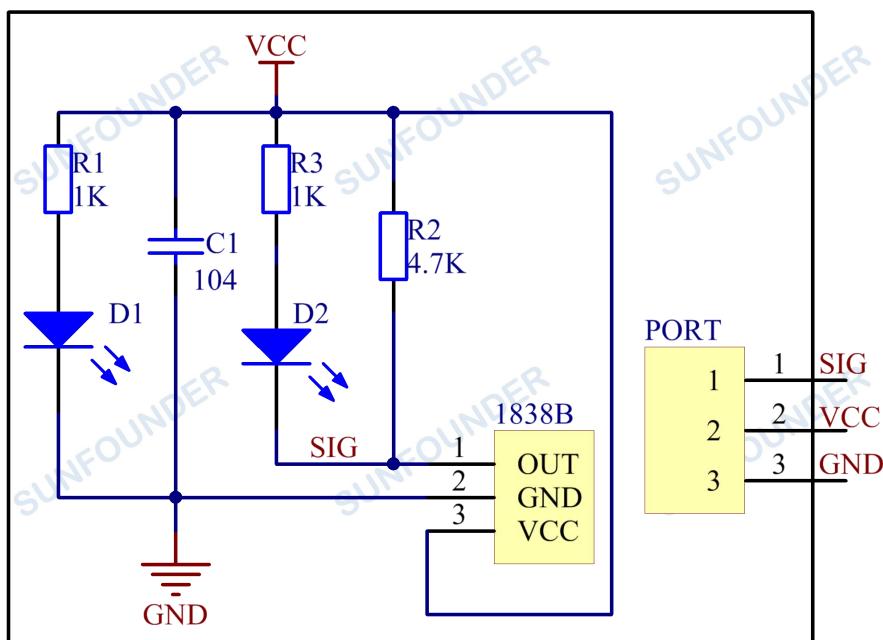


Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * Infrared-receiver module
- 1 * Remote controller
- 1 * 3-Pin anti-reverse cable

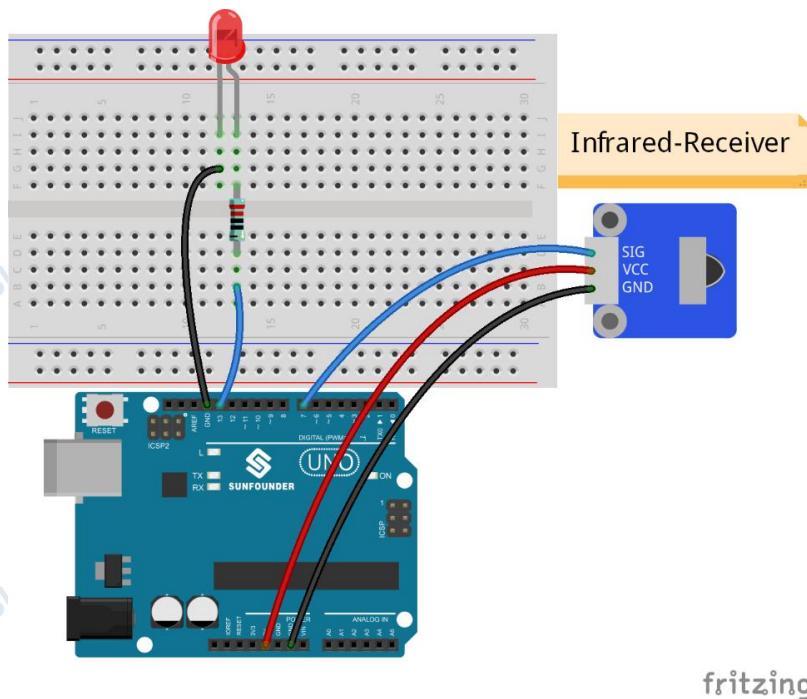
Experimental Principle

Control a certain key (for example, Power key) via a remote controller by programming. When you press the key, infrared rays will be emitted from the remote controller and received by the infrared receiver, and the LED on the SunFounder Uno board will light up. Add an LED to connect with pin 13 of the Uno board, so you can see remotely whether the Power or another key is pressed down.



Experimental Procedures

Step 1: Build the circuit



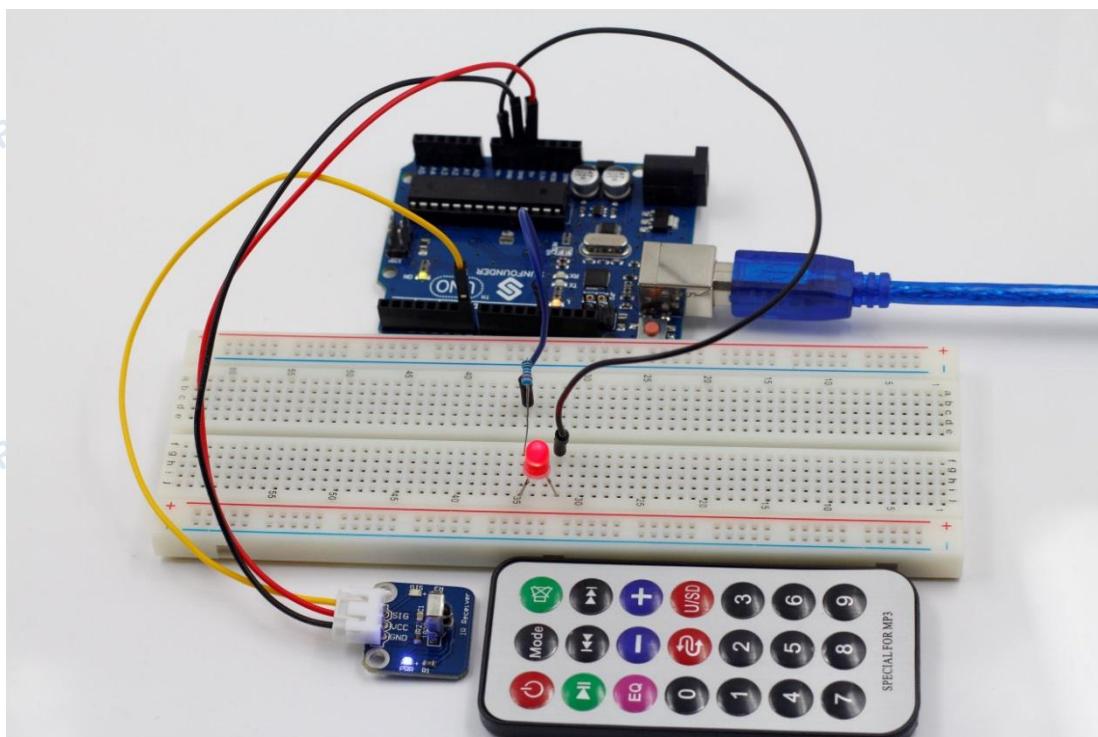
fritzing

Step 2: Open the code file

Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

Now, press the Power key of a remote controller, and the LED attached to pin 13 on the SunFounder Uno board will light up. Then press any other key, and the LED will go out.



Lesson 26 Dual-color LED

Introduction

A dual-color light emitting diode (LED) is capable of emitting two different colors of light, typically red and green, rather than only one color. It is housed in a 3mm or 5mm epoxy package. It has 3 leads; common cathode or common anode is available. A dual-color LED features two LED terminals, or pins, arranged in the circuit in anti-parallel and connected by a cathode/anode. Positive voltage can be directed towards one of the LED terminals, causing that terminal to emit light of the corresponding color; when the direction of the voltage is reversed, the light of the other color is emitted. In a dual-color LED, only one of the pins can receive voltage at a time. As a result, this type of LED frequently functions as indicator lights for a variety of devices, including televisions, digital cameras, and remote controls.

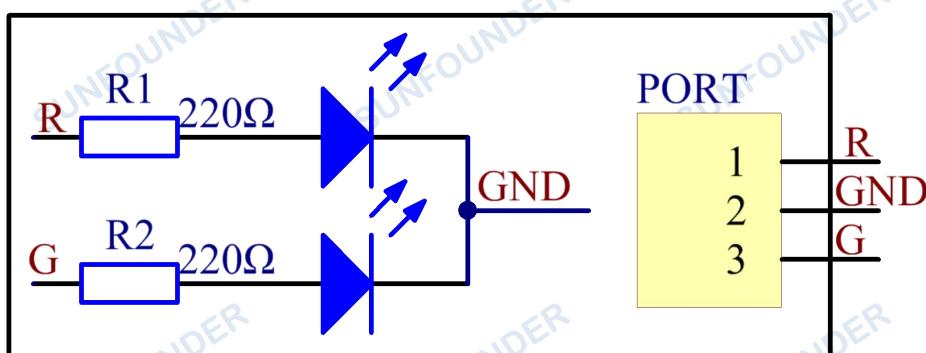


Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * Dual-color LED module
- 1 * 3-Pin anti-reverse cable

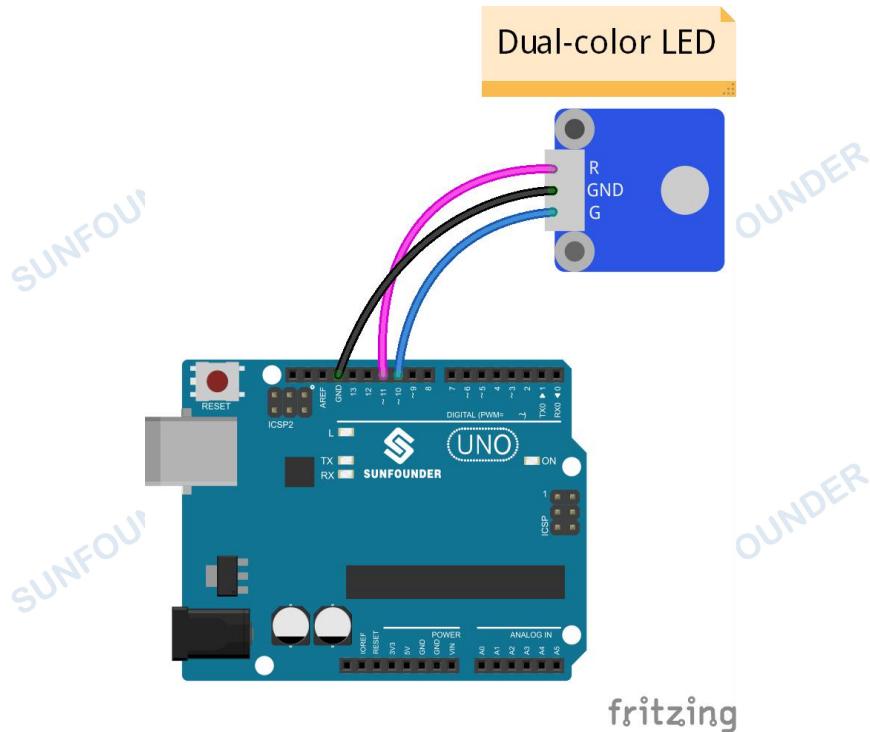
Experimental Principle

Control the LED brightness by the digital port. The color of the LED changes from red to green as well as flashes a mixed color.



Experimental Procedures

Step 1: Build the circuit

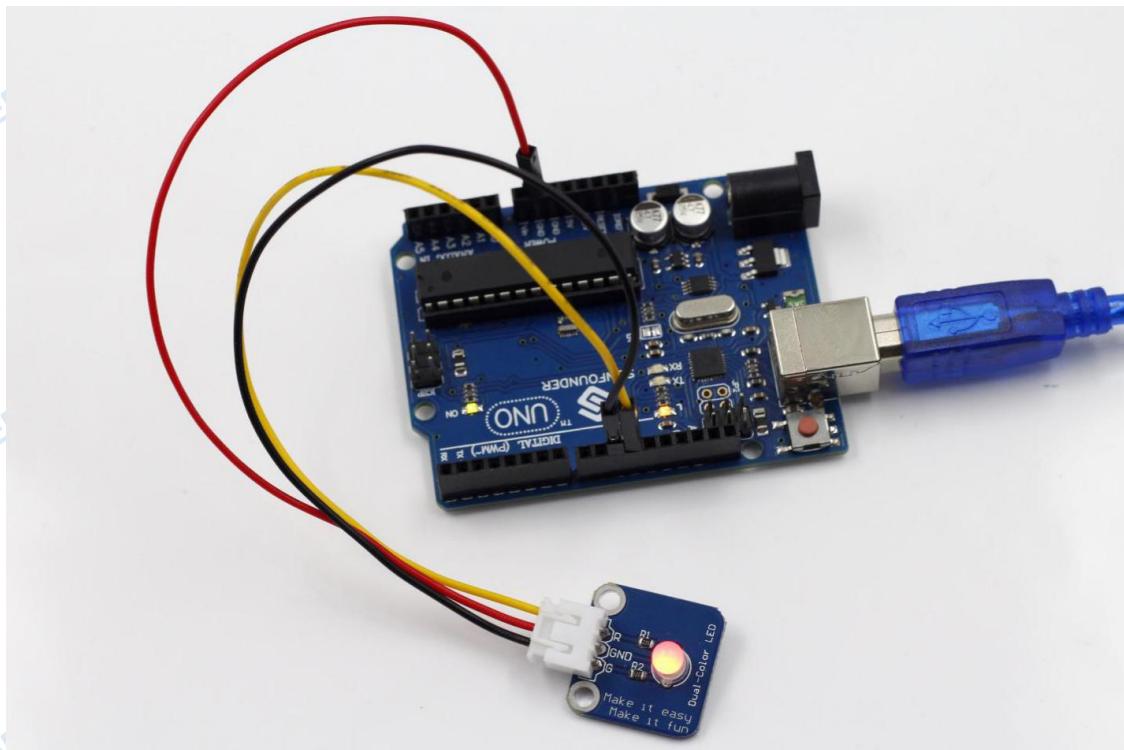


Step 2: Open the code file

Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

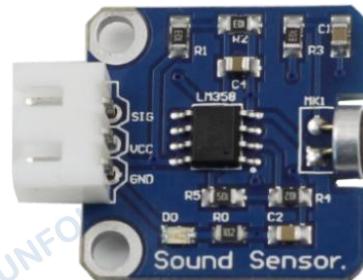
Now, you can see the dual-color LED changes from red to green alternately, as well as flashing a mixed color during the alternation.



Lesson 27 Sound Sensor

Introduction

Sound Sensor is a component that receives sound waves and converts them into electrical signals. It detects the sound intensity in ambient environment like a microphone.



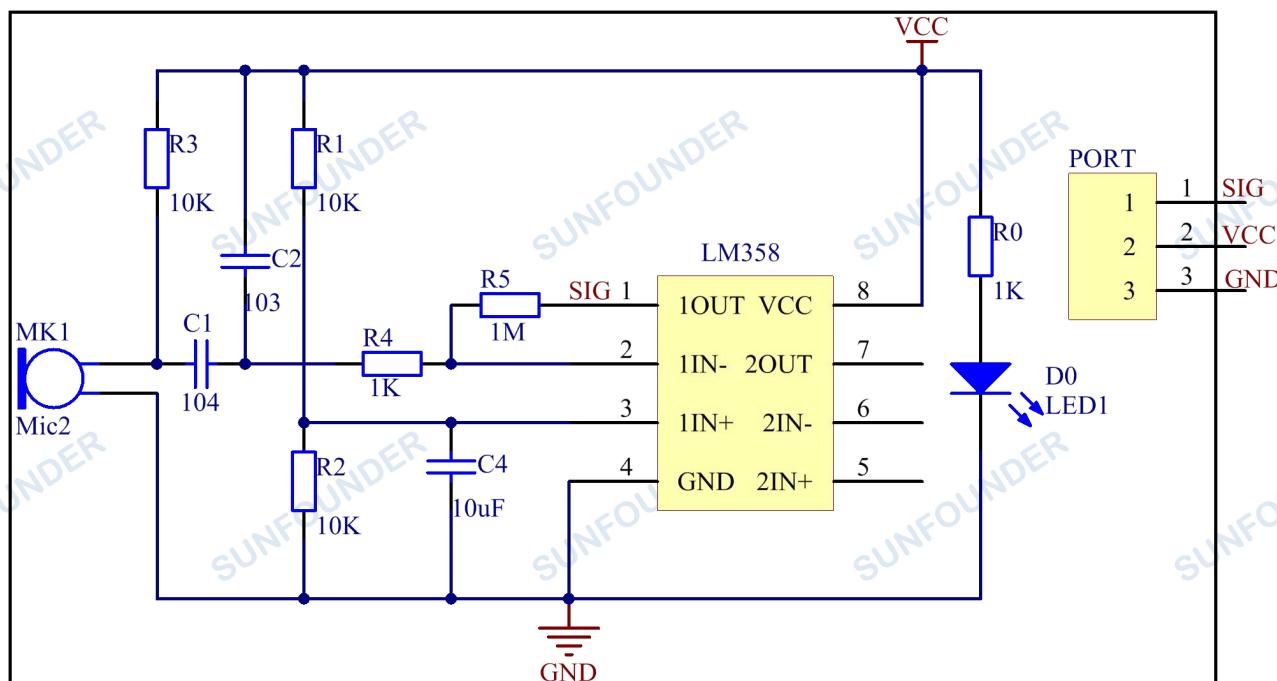
Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * Sound Sensor module
- 1 * 3-Pin anti-reverse cable

Experimental Principle

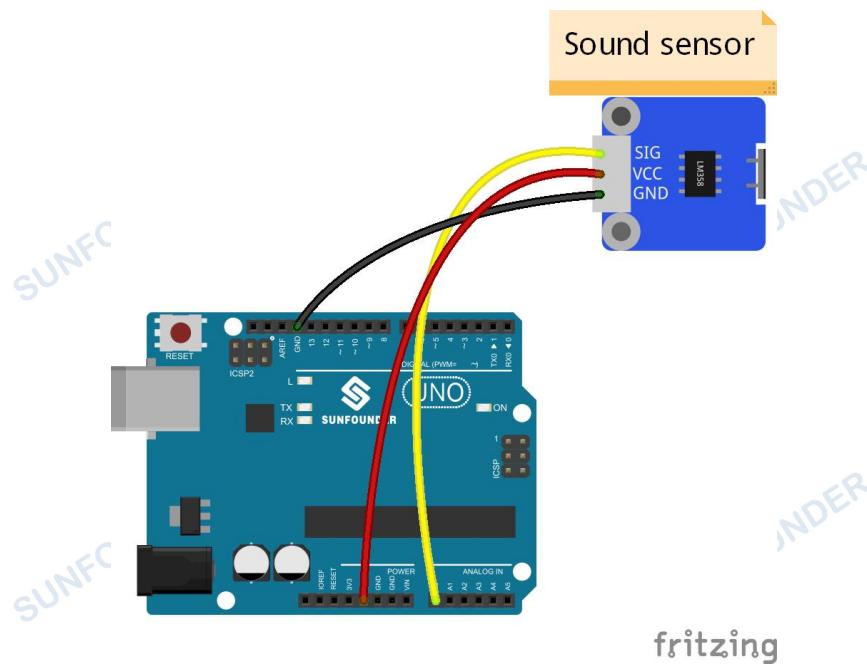
The sensor has a capacitive electret microphone which is sensitive to sound. Sound waves cause the thin film of the electret to vibrate and then the capacitance changes, thus producing the corresponding changed voltage. Since the voltage change is extremely weak, it needs to be amplified. LM358 here is a power amplifier of 100 times gain. Connect the SIG output pin of the sound sensor to A0 of the SunFounder Uno board. Then you can see the value of sound intensity on Serial Monitor, or display the wave forms on an oscilloscope if you have connected one.

The schematic diagram:



Experimental Procedures

Step 1: Build the circuit



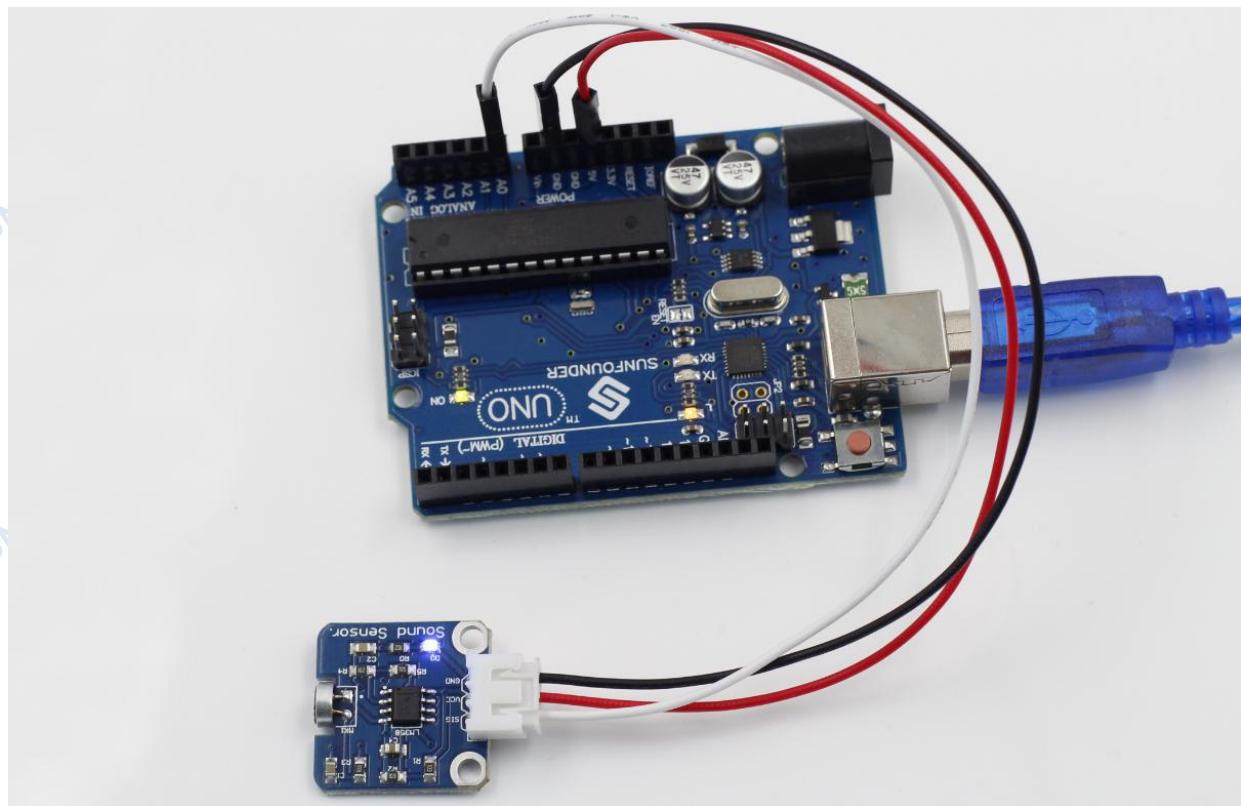
fritzing

Step 2: Open the code file

Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

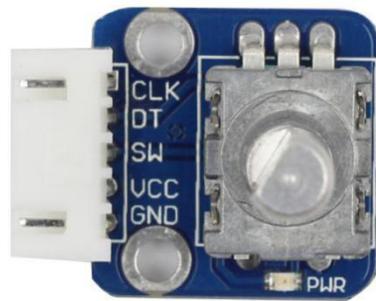
Now you can see the value of sound intensity on Serial Monitor. When the volume reaches to a certain value, the LED attached to pin 13 on the SunFounder Uno will light up.



Lesson 28 Rotary Encoder

Introduction

A rotary encoder is an electro-mechanical device that converts the angular position or motion of a shaft or axle to an analog or digital code. Rotary encoders are usually placed at the side which is perpendicular to the shaft. Rotary encoders act as sensors for detecting angle, speed, length, position and acceleration in automation field.



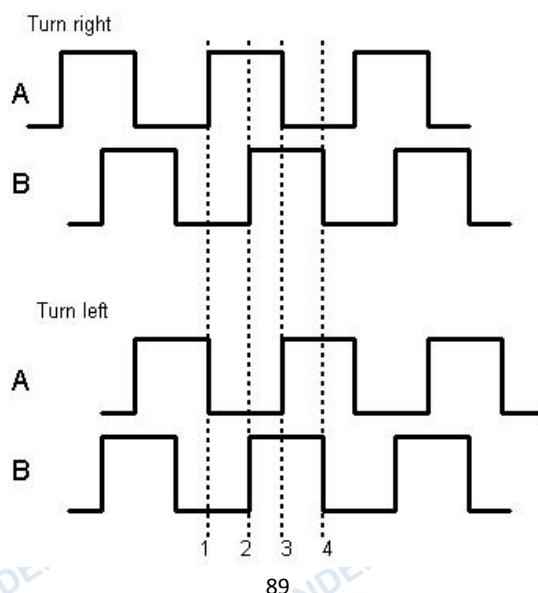
Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * Rotary Encoder module
- 1 * 5-Pin anti-reverse cable

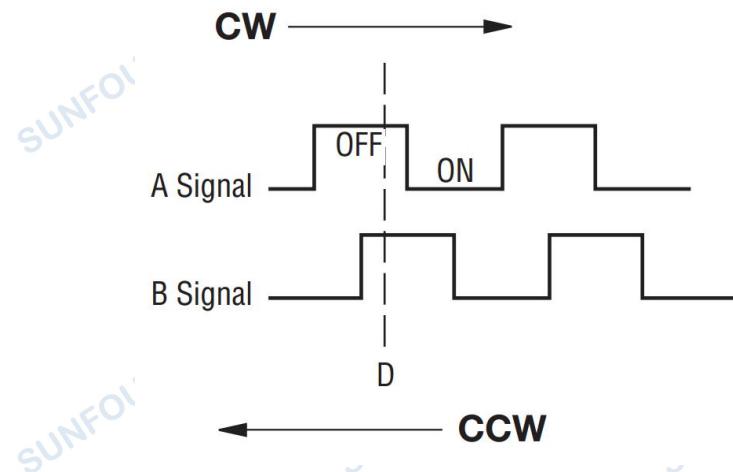
Experimental Principle

There are mainly two types of rotary encoder: absolute and incremental (relative) ones. The output of absolute encoders indicates the current position of the shaft, making them angle transducers. The output of incremental encoders provides information about the motion of the shaft, which is typically further processed elsewhere into information such as speed, distance, and position.

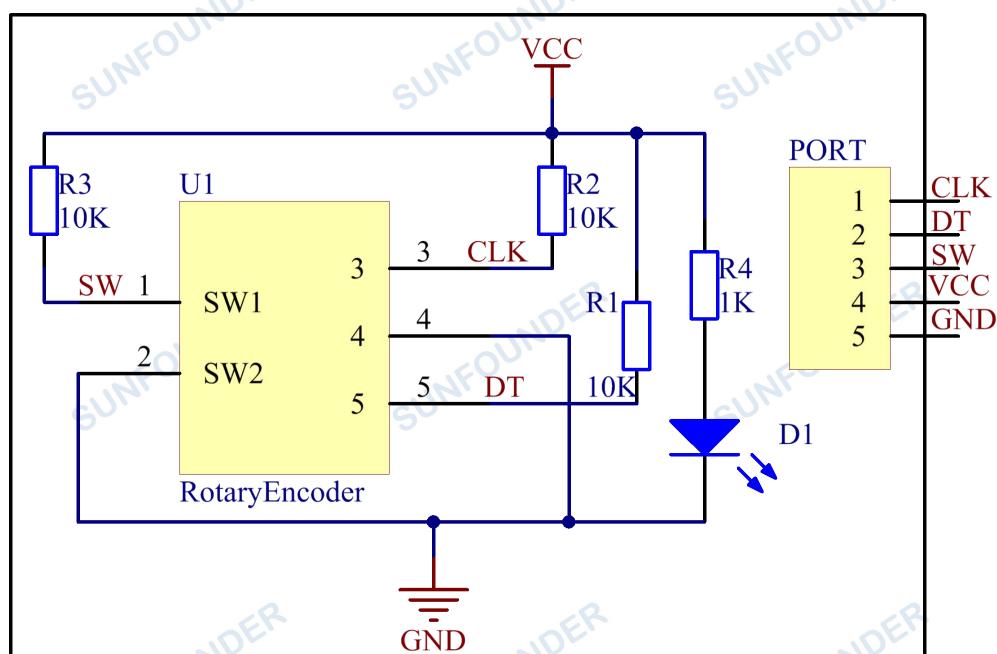
In this experiment, we will use the latter. An incremental encoder is a rotary sensor to turn rotational displacement into a series of digital pulse signals which are then used to control the angular displacement. It generates two-phase square waves whose phase difference is 90° . Usually the two-phase square waves are called channel A and channel B as shown below.



It is difficult to distinguish between the left turn and right turn during SCM programming. However, when using an oscilloscope to observe the left turn and right turn of a switch, you will find a phase difference between the signals of the two output pins as shown below.



It shows that if output 1 is high and output 2 is high, then the switch rotates clockwise; if output 1 is high and output 2 is low, then the switch rotates counterclockwise. As a result, during SCM programming, if output 1 is high, then you can tell whether the rotary encoder rotates left or right as long as you know the state of output 2.

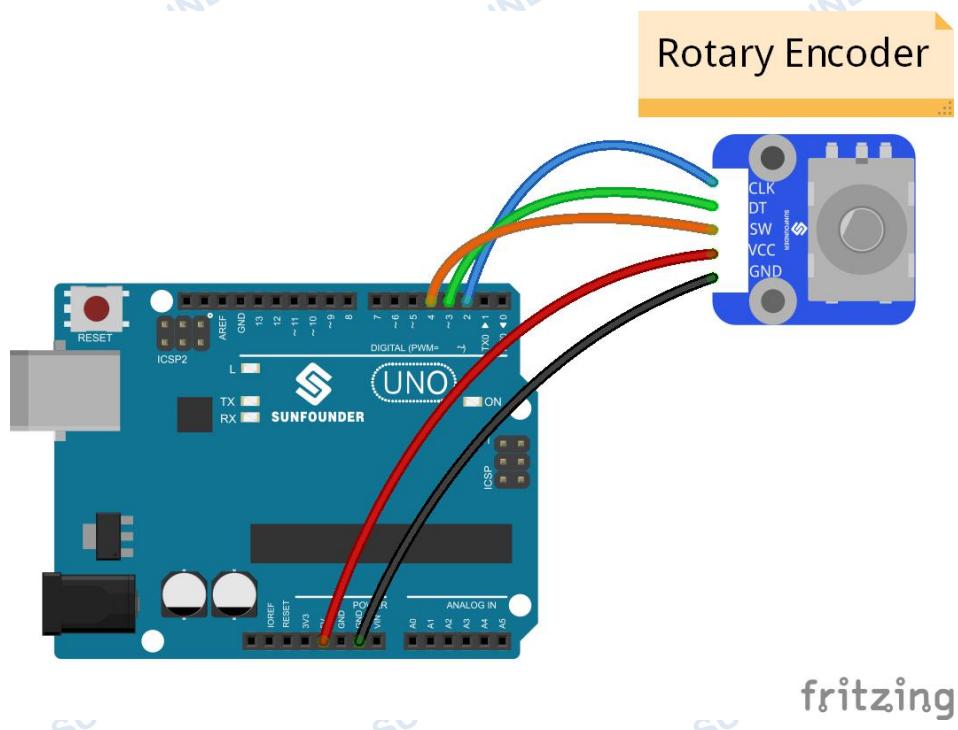


Experimental Procedures

Step 1: Build the circuit

The wiring between the rotary encoder and SunFounder Uno board:

Rotary Encoder	SunFounder Uno
CLK	2
DT	3
SW	4
VCC	5V
GND	GND

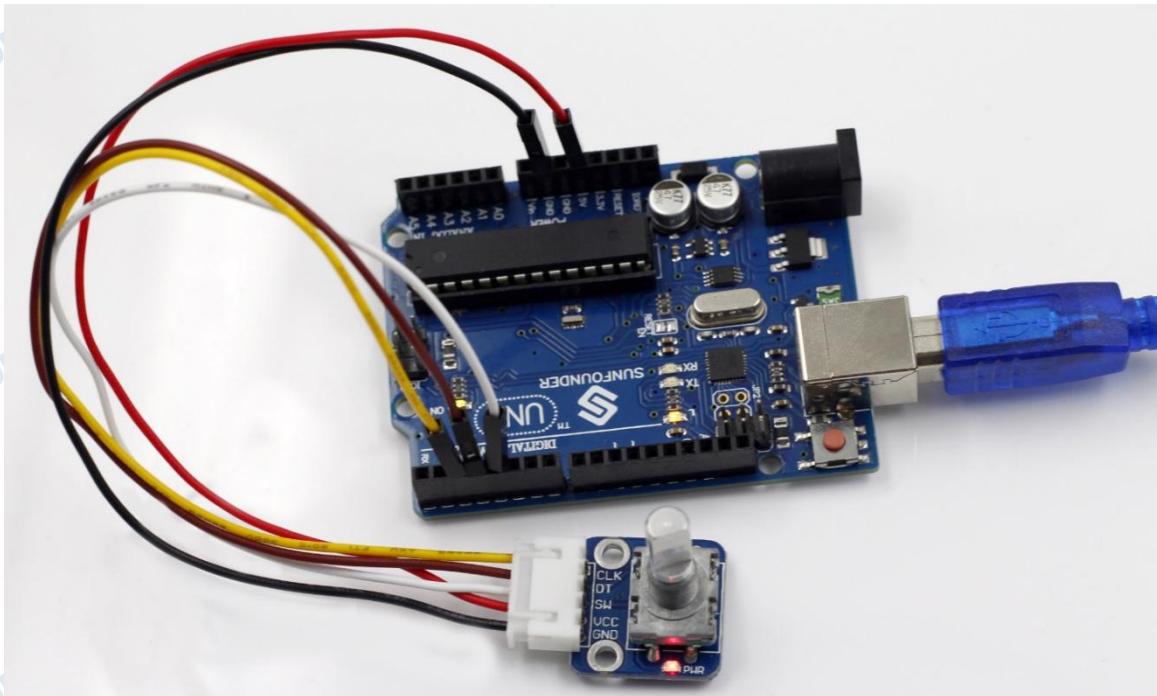


Step 2: Open the code file

Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

Now, you can see the angular displacement of the rotary encoder printed on Serial Monitor. When the rotary encoder rotates clockwise, the angular displacement increases; when it does counterclockwise, the value decreases. Press the switch on the rotary encoder, the value will return to zero.



Lesson 29 Laser Transmitter

Introduction

Laser is widely used in medical treatment, military, and other fields due to its good directivity and energy concentration. The Laser Transmitter module, as the name suggests, is a one that can emit laser.



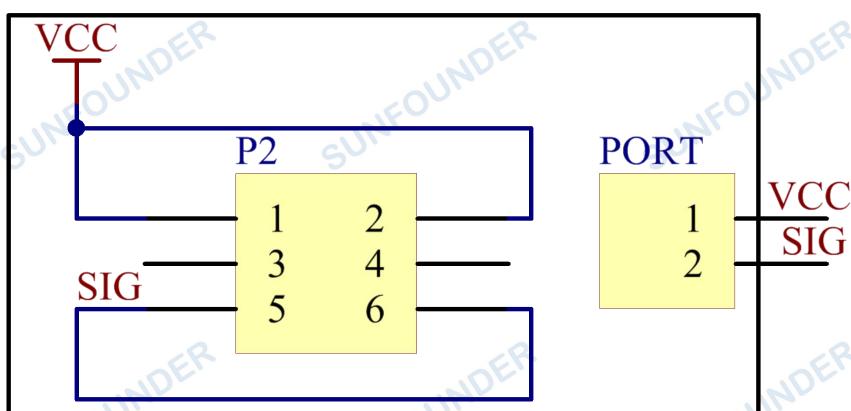
Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * Laser transmitter module
- 1 * 2-Pin anti-reverse cable

Experimental Principle

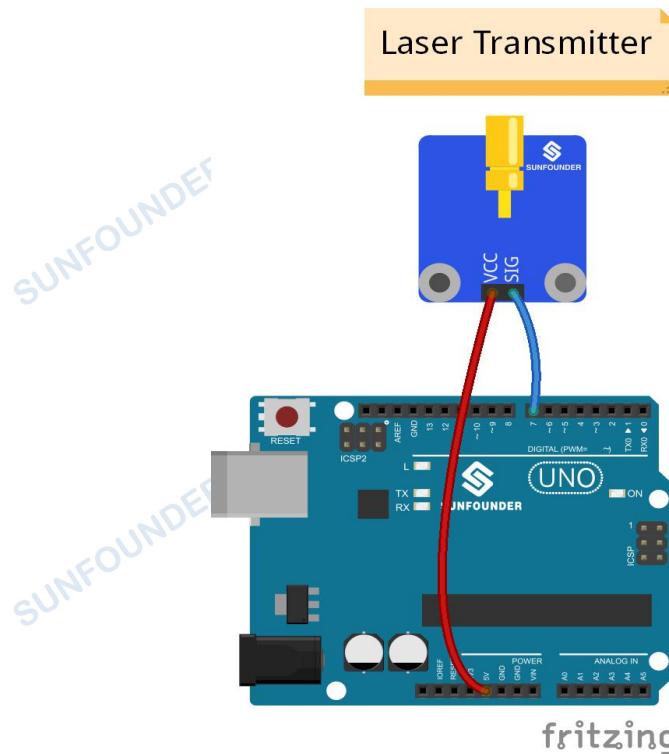
A laser is a device that emits light through a process of optical amplification based on the stimulated emission of electromagnetic radiation. Lasers differ from other sources of light because they emit light coherently.

Spatial coherence allows a laser to be focused to a tight spot, enabling applications like laser cutting and lithography, and a laser beam to stay narrow over long distances (collimation), enabling applications such as laser pointer. Lasers can also have high temporal coherence which allows them to have a very narrow spectrum, i.e., they only emit light of a single color. And its temporal coherence can be used to produce pulses of light—as short as a femtosecond.



Experimental Procedures

Step 1: Build the circuit

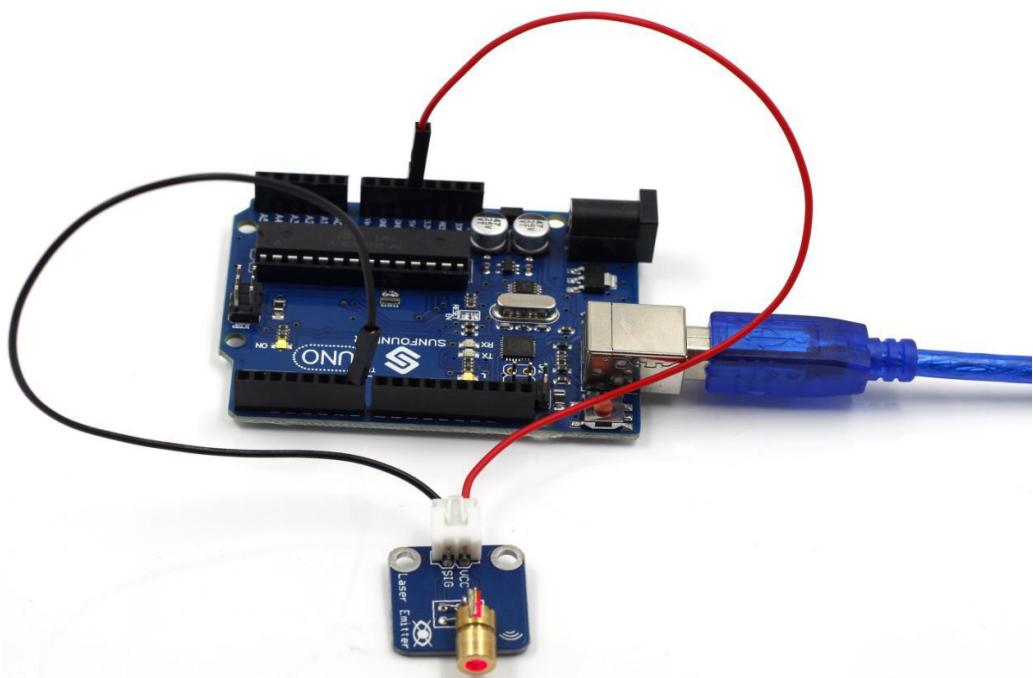


Step 2: Open the code file

Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

Now, you can see the Laser Transmitter module send out Morse signals.

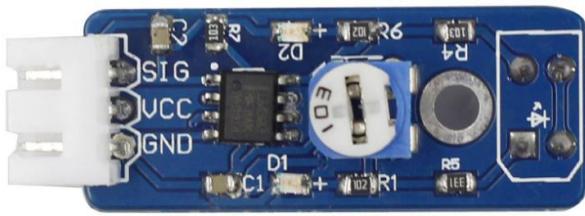


Note: DO NOT look directly at the laser head. It can cause great harm to your eyes.

Lesson 30 IR Tracking Sensor

Introduction

The infrared tracking sensor uses a TRT5000 sensor. The blue LED of TRT5000 is the emission tube and after electrified it emits infrared light invisible to human eye. The black part of the sensor is for receiving; the resistance of the resistor inside changes with the infrared light received.



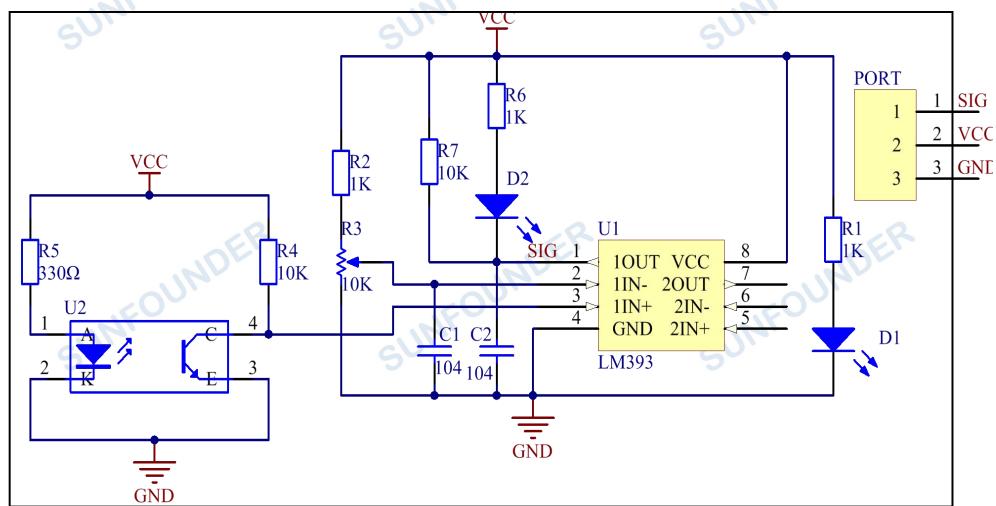
Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * Tracking sensor module
- 1 * 3-Pin anti-reverse cable

Experimental Principle

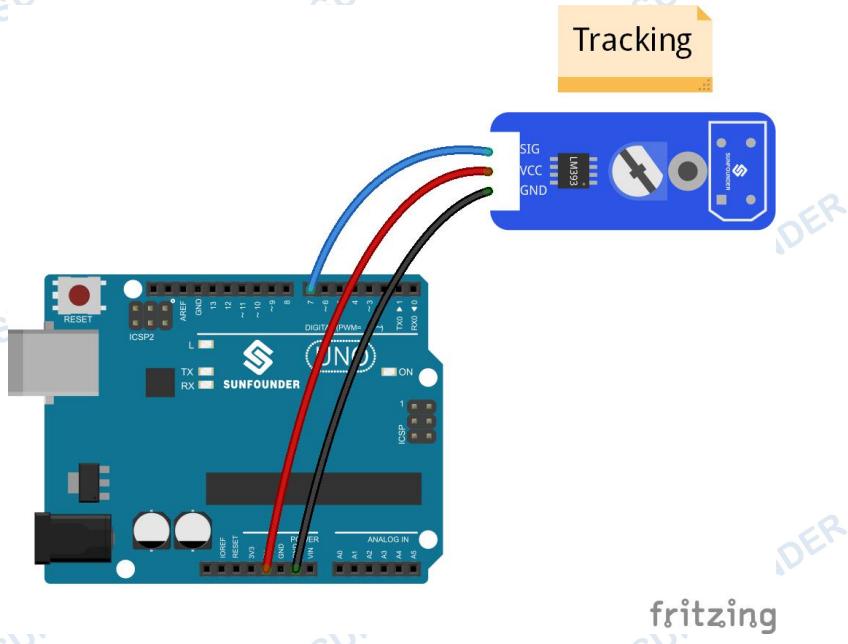
The IR emission tube of TCRT5000 sensor constantly emits infrared light. Since the black absorbs light, when the IR emission tube shines on a black surface, the reflected light is less and so less IR rays are received by the receiving tube. It indicates the resistance is large; then the comparator outputs high and the indicator LED goes out. Similarly, when it shines on a white surface, the reflected light becomes more. So the resistance of the receiving tube is lower; thus, the comparator outputs low and the indicator LED lights up.

In this experiment, use a tracking sensor module and the LED attached to pin 13 on the SunFounder Uno board to build a simple circuit. Since the LED has been attached to pin 13, connect the pin SIG to digital pin 7 of the Uno board. When the module gets on a black line, it output high and the corresponding LED stays off; when it meets a white line, it outputs low and the LED lights up. See the schematic diagram below.



Experimental Procedures

Step 1: Build the circuit



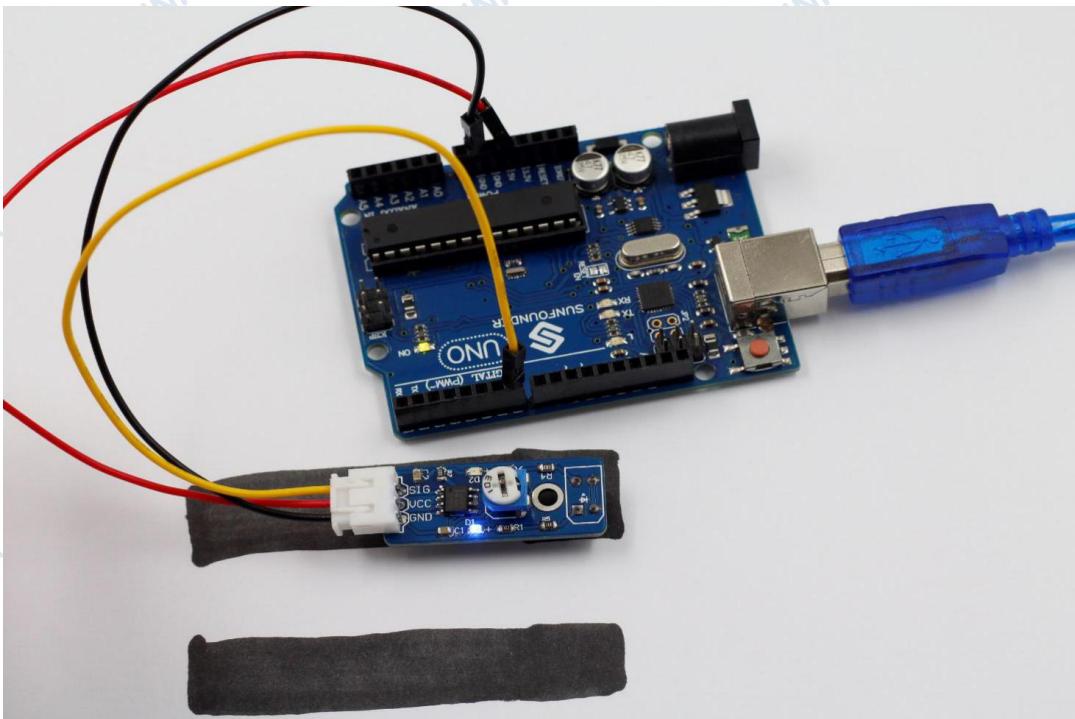
Step 2: Open the code file

Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

Now, draw two black bold lines on the paper. If the rays emitted by the sensor encounter the black lines, the LED attached to pin 13 on the SunFounder Uno board will light up; otherwise, it is off.

Note: The black line should be wider than the TCRT5000 sensor.



Lesson 31 IR Obstacle Avoidance Sensor

Introduction

An IR Obstacle Sensor works in accordance with the infrared reflection principle to detect obstacles. When there is no object, the infrared receiver receives no signals; when there is an object ahead which blocks and reflects the infrared light, the infrared receiver will receive signals.

Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * Obstacle avoidance sensor module
- 1 * 3-Pin anti-reverse cable

Experimental Principle

An obstacle avoidance sensor mainly consists of an infrared transmitter, an infrared receiver and a potentiometer. According to the reflecting character of an object, if there is no obstacle, the emitted infrared ray will weaken with the distance it spreads and finally disappear. If there is an obstacle, when the infrared ray encounters it, the ray will be reflected back to the infrared receiver. Then the infrared receiver detects this



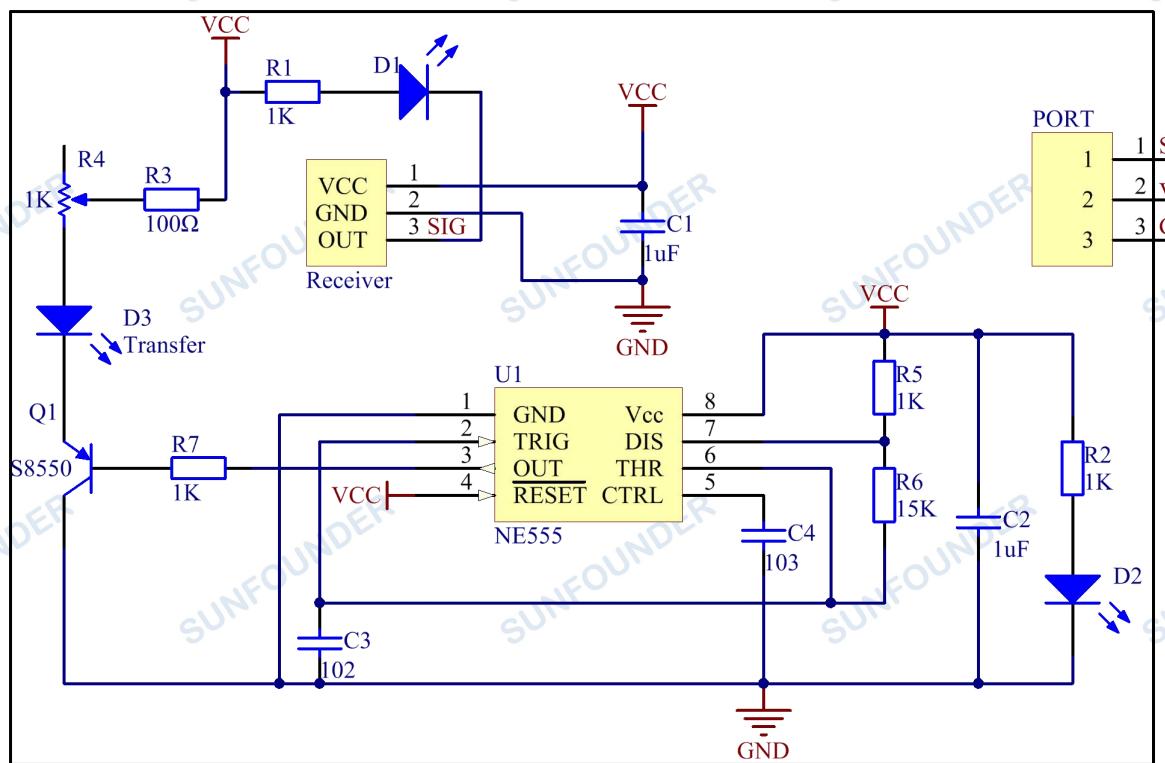
signal and confirms an obstacle in front.

In this experiment, we will use an Obstacle Avoidance Sensor module and the LED attached to pin 13 of the SunFounder Uno board to build a simple circuit.

Since the LED has been attached to pin 13, connect the pin SIG to digital pin 7 of the Uno board. When the Obstacle Avoidance Sensor detects an obstacle, the LED will be on. Otherwise it will be off.

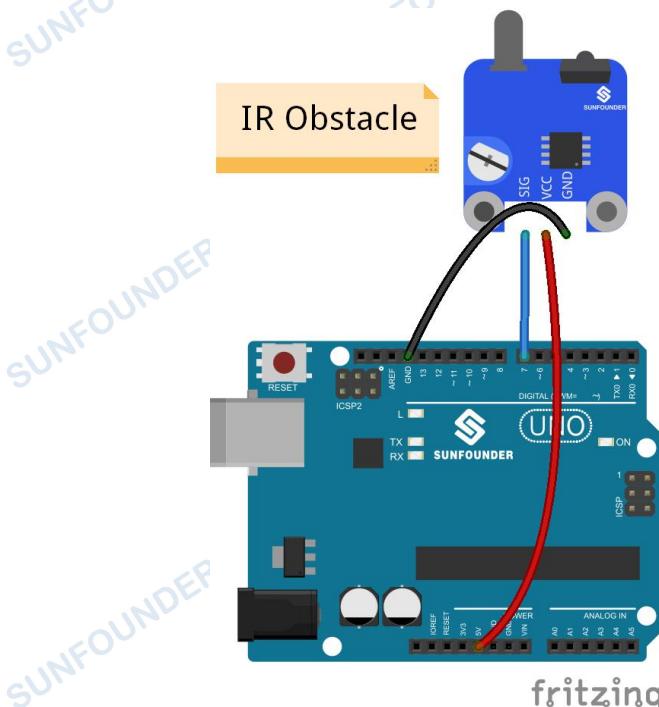
Note: *The detection distance of the infrared sensor is adjustable - you may adjust it by the potentiometer.*

The schematic diagram is as follows:



Experimental Procedures

Step 1: Build the circuit



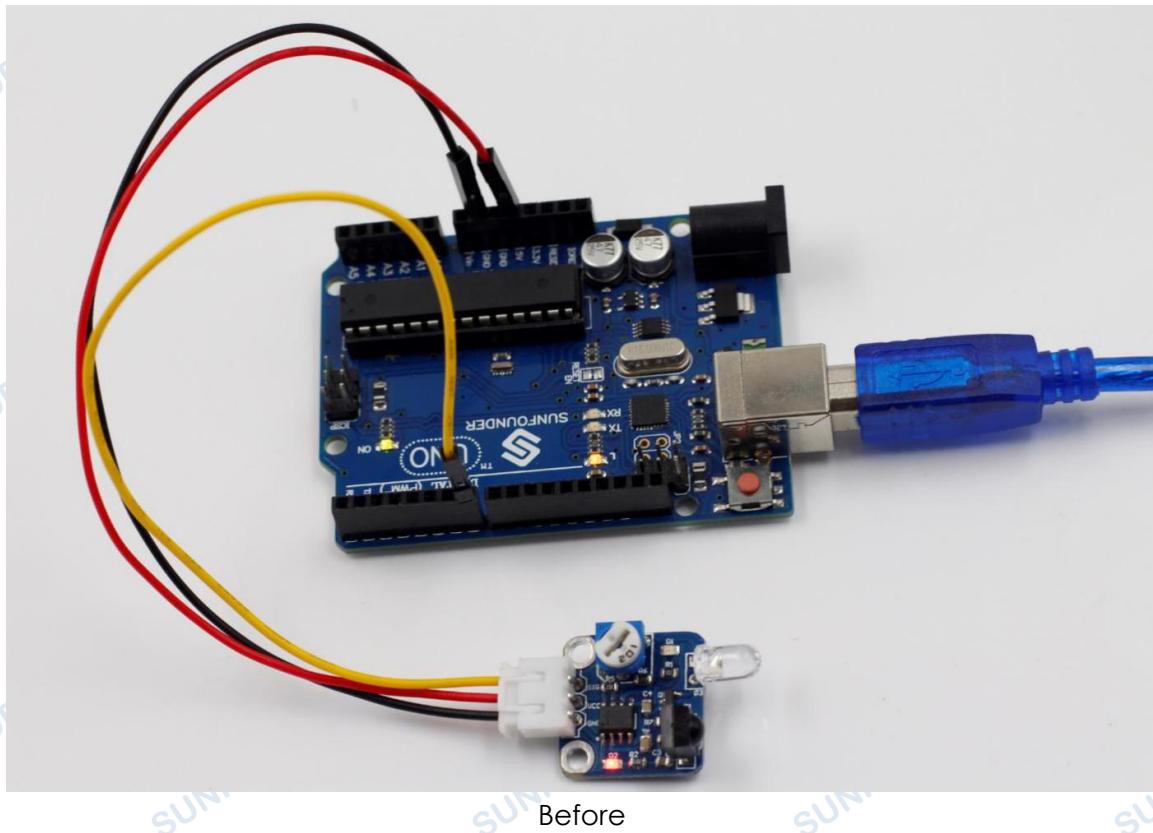
Step 2: Open the code file

Step 3: Select correct Board and Port

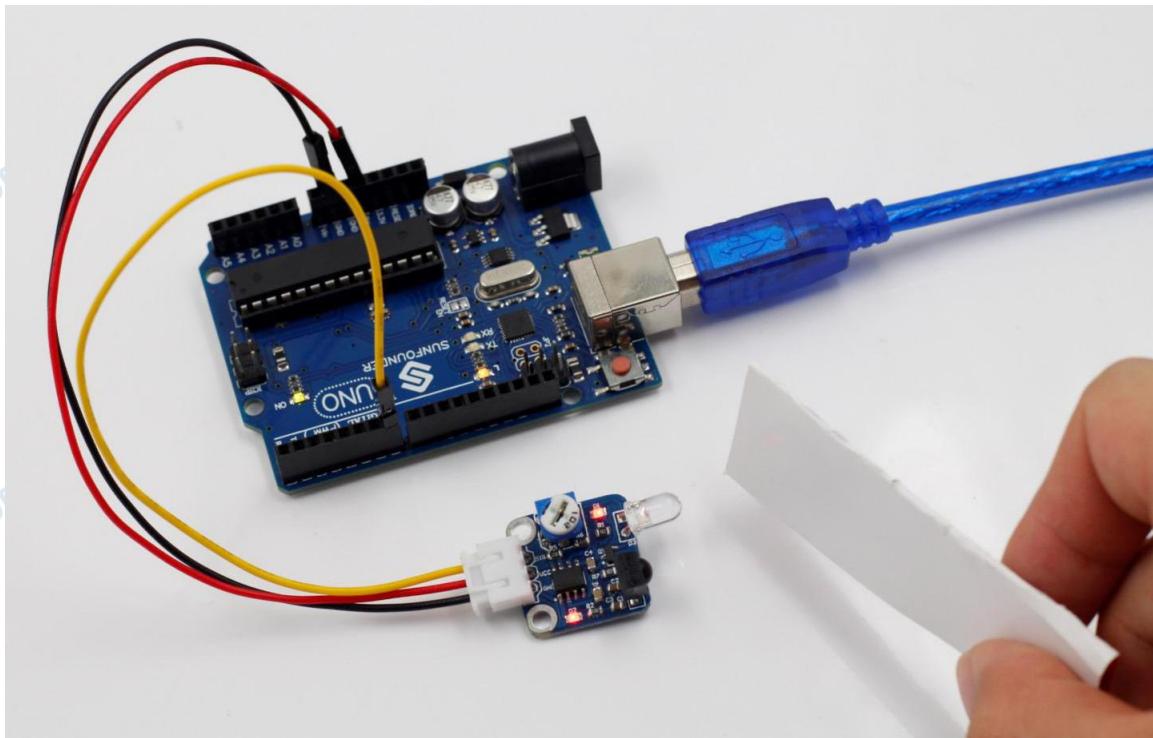
Step 4: Upload the sketch to the SunFounder Uno board

Now, place a piece of paper in front of the Obstacle Avoidance Sensor, and the LED attached to pin 13 on the SunFounder Uno board will light up.

Note: The obstacle should better be white.



Before

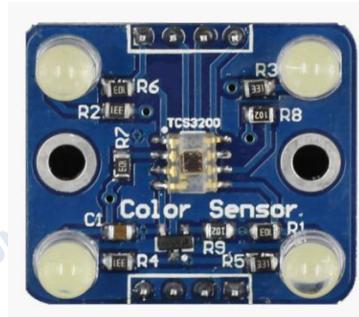


With obstacle

Lesson 32 Color Detection

Introduction

The Color Sensor is a complete color detector. It consists of a TAOS TCS3200 RGB sensor chip and 4 white LEDs. It can detect and measure a nearly limitless range of visible colors to a certain degree.



Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * Color sensor
- 1 * 4-Pin anti-reverse cable
- 1 * 3-Pin anti-reverse cable

Experimental Principle

The color of an object we can see in fact is the chromatic light the object reflects in the white light (sunlight) after it absorbs the rest ones. The white color is a mixture of various visible colors, which means it includes each colored light like red (**R**), yellow (**Y**), green (**G**), blue (**B**), and purple (**P**). Based on the theory of three primary colors, any color is made by mixing the three primary colors (red, green, and blue) in a certain proportion.

Thus, knowing the proportion you can get the color of the tested object. For TCS3200, when a color filter is selected, it only allows a specific primary color to pass through and blocks the other two colors. With the light intensity value of the three primary colors, by analysis we can know the color of light reflected to TCS3200D.

The TCS3200D sensor has 4 types of filter: red filter, green filter, blue filter, and clear with no filter. The filter is selected based on the high/low of pin S2 and S3 on the module (see the table below):

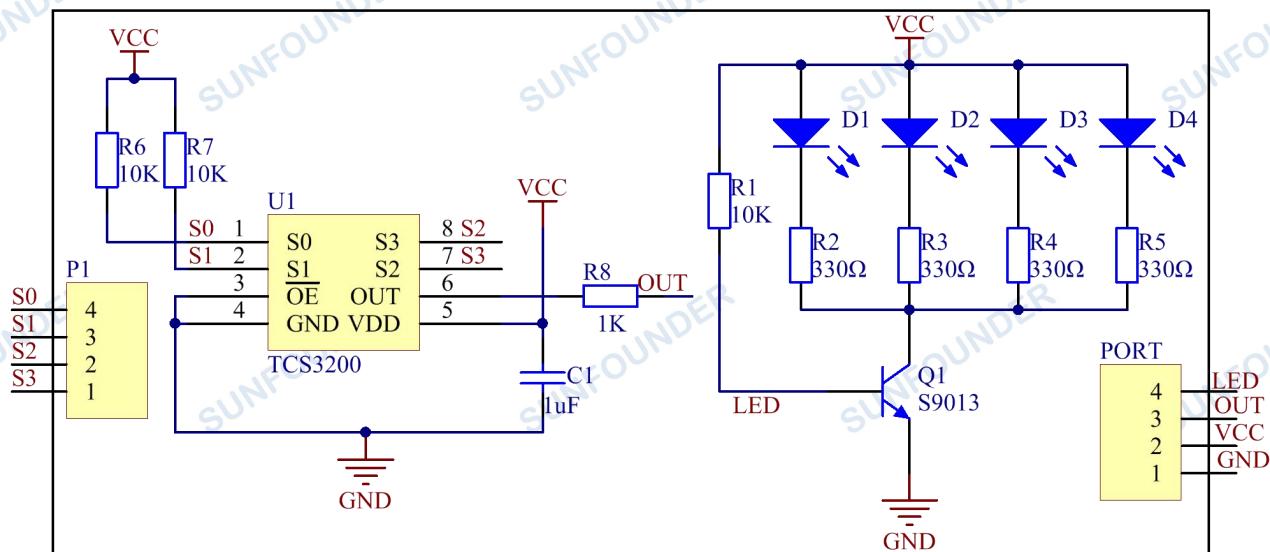
S2	S3	Photo Diode Type
L	L	Red
L	H	Blue
H	L	Clear (no filter)
H	H	Green

The module contains a programmable converter which transforms colorlight to frequency. When the part of RGB colors in the light reflected by the object passes through the filter selected to the TAOS TCS3200RGB chip, the built-in oscillator outputs square waves. The frequency of the waves is directly proportional to the light intensity –

the more intense the light is, the higher is the frequency. Also, the frequency of the OUT pin on the sensor module is proportional to that of the oscillator; the proportion depends on the high/low of pin S0 and S1, as shown in the table.

S0	S1	OUTPUT Frequency Scaling (f0)
L	L	Power Down
L	H	2%
H	L	20%
H	H	100%

The schematic diagram of the module:

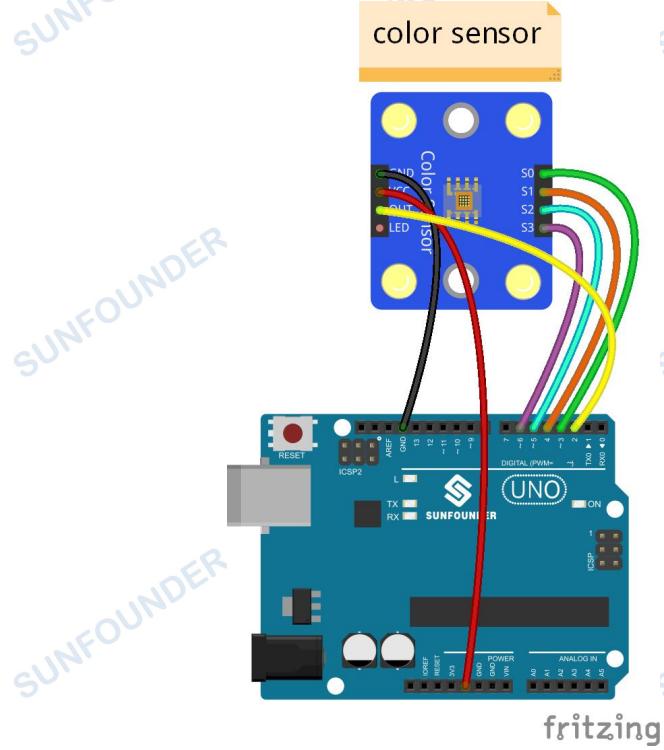


Experimental Procedures

Step 1: Build the circuit

The wiring between the color sensor and SunFounder Uno board:

Color Sensor	SunFounder Uno
GND	GND
VCC	5V
OUT	2
S0	3
S1	4
S2	5
S3	6



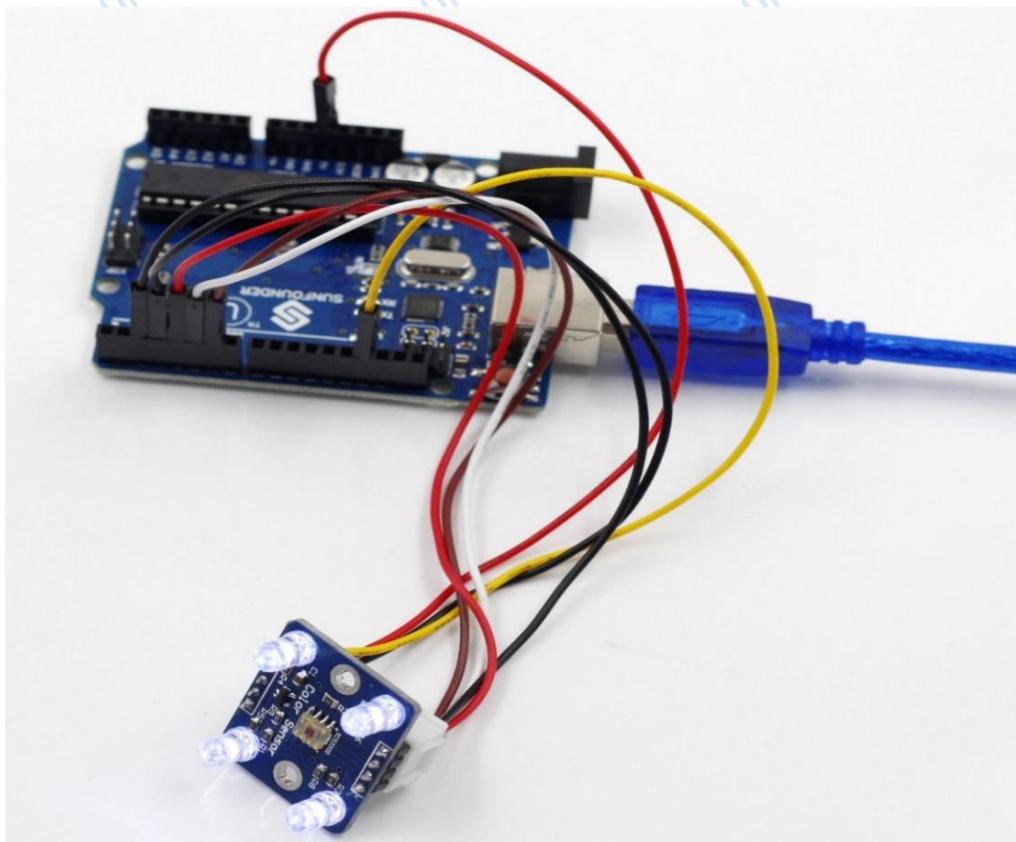
fritzing

Step 2: Open the code file

Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

Now you may check the RGB value of the color on Serial Monitor.



Lesson 33 Analog-Digital Converter

Introduction

The PCF8591 is a single-chip, single-supply and low-power 8-bit CMOS data acquisition device with four analog inputs, one analog output and a serial I2C-bus interface. Three address pins A0, A1 and A2 are used for programming the hardware address, allowing the use of up to eight devices connected to the I2C-bus without additional hardware. Address, control and data to and from the device are transferred serially via the two-line bidirectional I2C-bus.



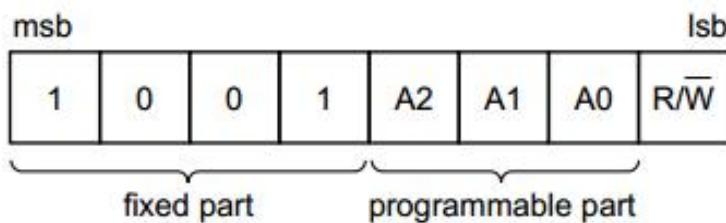
Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * AD/DA Converter PCF8591
- 5 * DuPont wires (M to F)

Experimental Principle

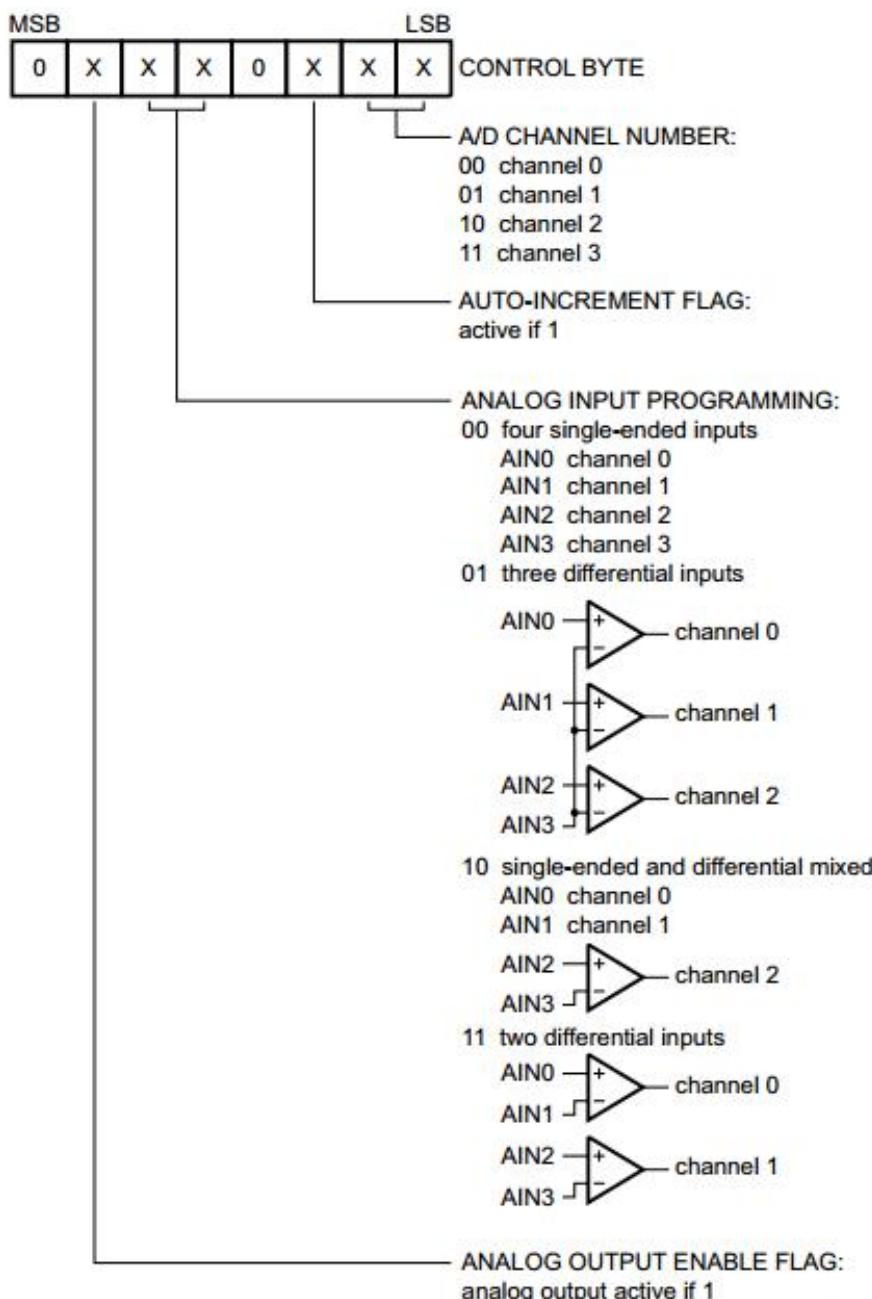
Addressing

Each PCF8591 device in an I2C-bus system is activated by sending a valid address to the device. The address consists of a fixed part and a programmable part. The programmable part must be set according to the address pins A0, A1 and A2. The address always has to be sent as the first byte after the start condition in the I2C-bus protocol. The last bit of the address byte is the read/write-bit which sets the direction of the following data transfer (see the figure below).

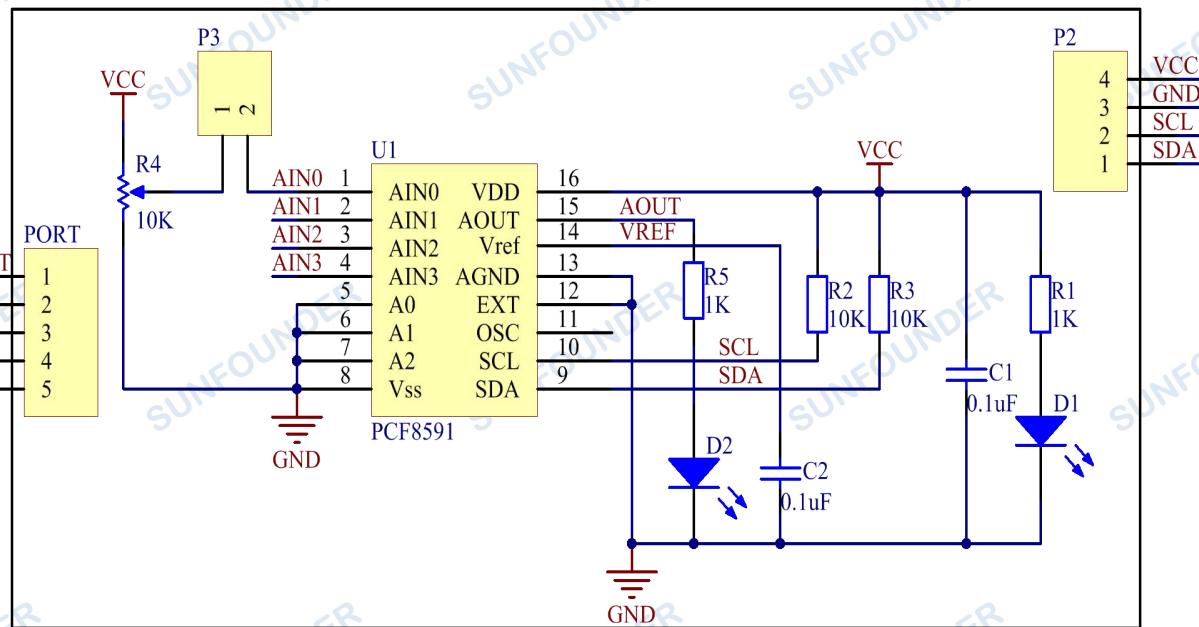


Control byte

The second byte sent to a PCF8591 device will be stored in its control register and is required to control the device function. The upper nibble of the control register is used for enabling the analog output, and for programming the analog inputs as single-ended or differential inputs. The lower nibble selects one of the analog input channels defined by the upper nibble (see Fig.5). If the auto-increment flag is set, the channel number is incremented automatically after each A/D conversion. See the figure below.



In this experiment, set the second byte sent to a PCF8591 device as high, so as to enable the analog output – make AOUT output an analog quantity which changes gradually. The indicator light D2 on the AD/DA converter PCF8591 gradually lights up and goes out alternately. The same happens to the LED attached to pin 13 of the SunFounder Uno board if it is hooked up with AOUT.



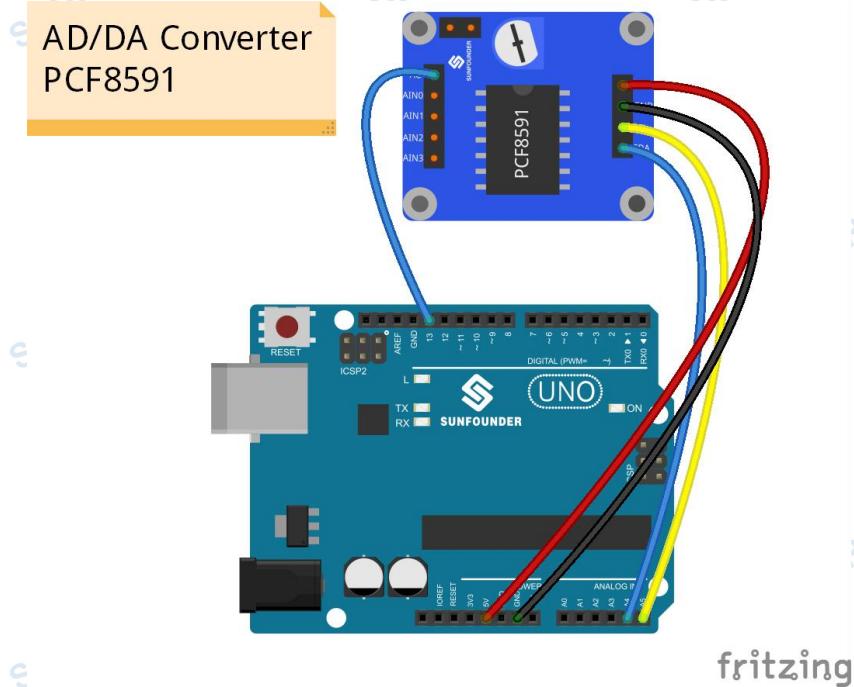
Experimental Procedures

Step 1: Build the circuit

The wiring between PCF8591 and SunFounder Uno board:

PCF8591	SunFounder Uno
VCC	5V
GND	GND
SDA	A4
SCL	A5
AOUT	13

AD/DA Converter
PCF8591



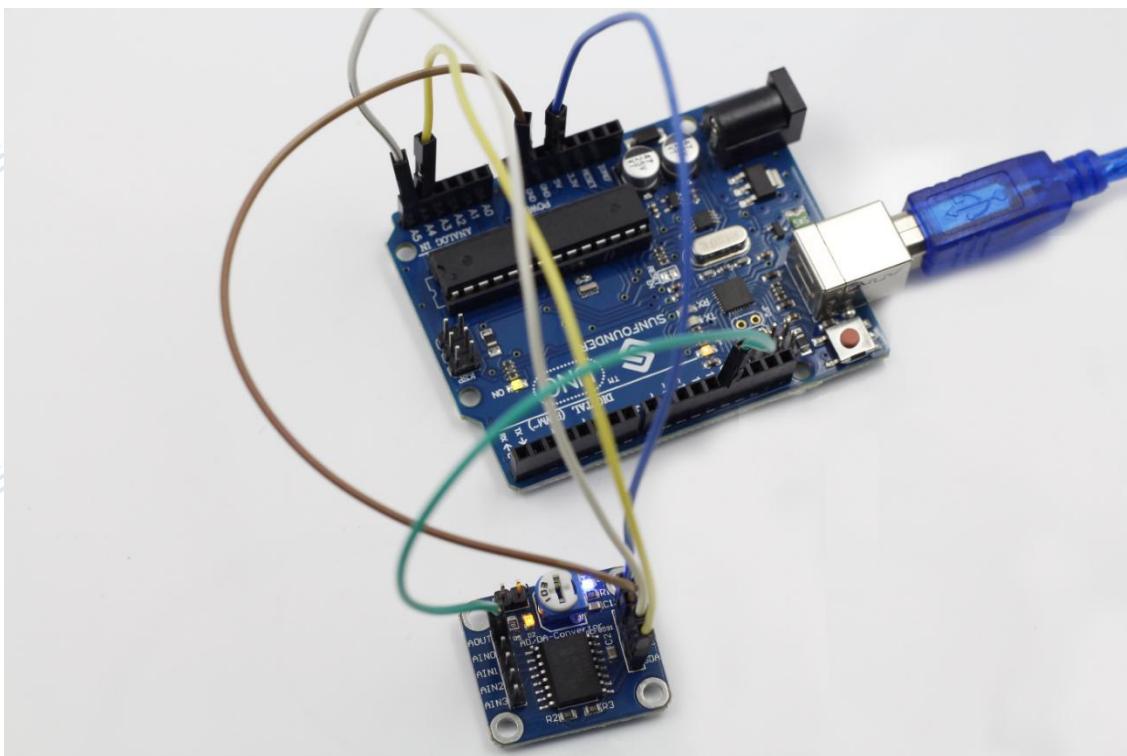
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Step 2: Open the code file

Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

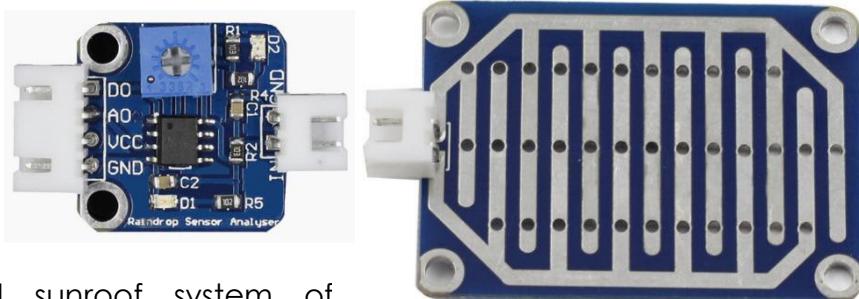
We can see the indicator light D2 on the AD/DA converter PCF8591 gradually lights up and goes out alternately. The same happens to the LED attached to pin 13 of the SunFounder Uno board



Lesson 34 Raindrop Detection

Introduction

A raindrop sensor, or raindrop detection sensor, is used to detect whether it is raining and also the rainfall. It is widely used in the automatic wiper system, smart lighting system and sunroof system of automobiles.



Components

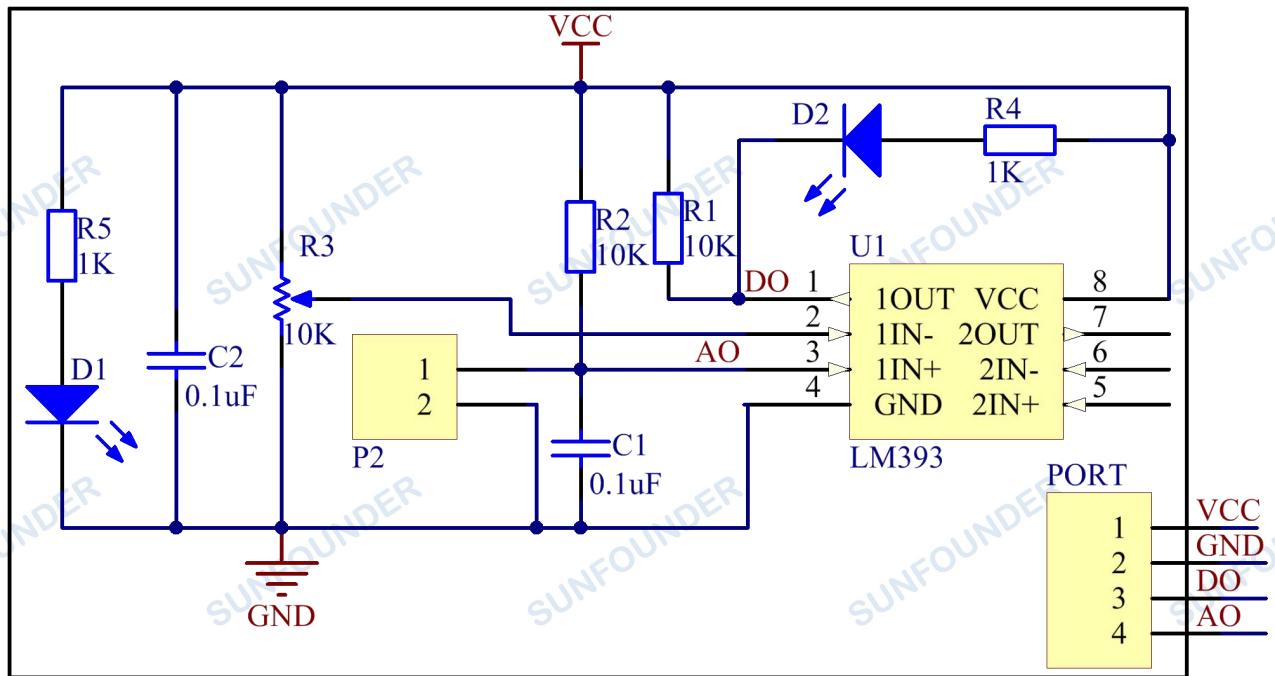
- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * Raindrop Sensor
- 1 * Raindrop Sensor Analyser
- 1 * 4-Pin anti-reverse cable
- 1 * 2-Pin ribbon cable

Experimental Principle

In a raindrop/water wiper system, detect the rainfall with the raindrop sensor and convert the signals detected by a controller. Then the interval of the wiper scraping will be set automatically based on the signals, so as to control the motor of the wiper conveniently. In a smart lighting system, detect the driving environment and adjust the lighting mode automatically, to improve the driving safety in a severe environment. In a smart sunroof system, detect whether it is raining – to close the sunroof automatically if raindrops are detected.

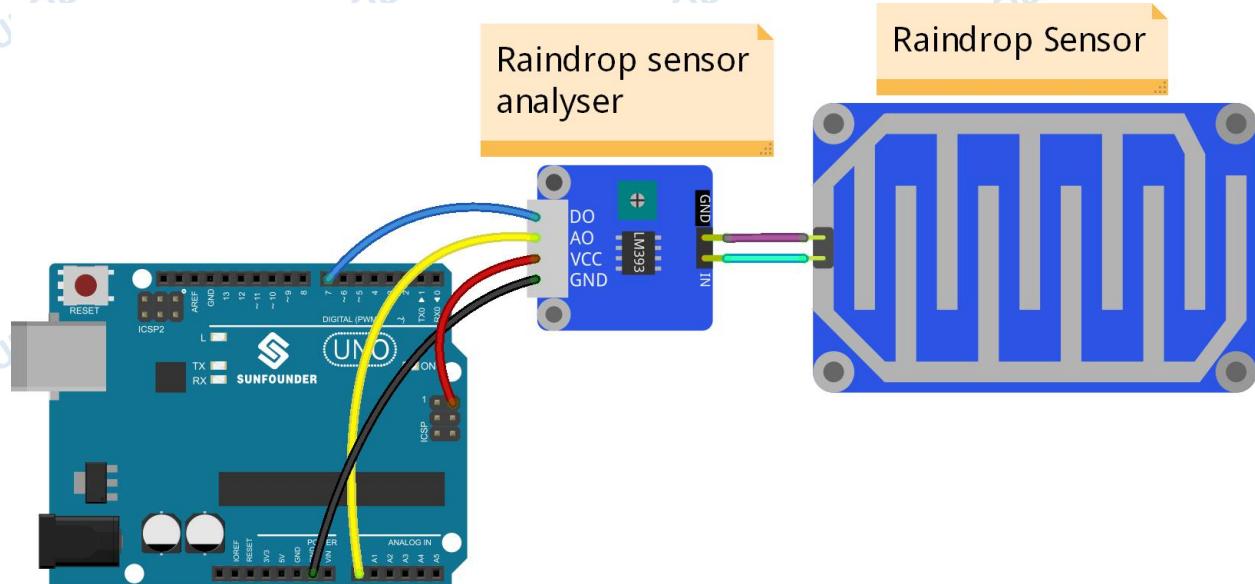
In this experiment, we use the module and the LED attached to pin 13 of the SunFounder Uno board to build a circuit. Hook up A0 of the raindrop sensor module with A0 of the Uno board, D0 to pin 7. Drop some water onto the sensor. The more drops, the lower value at A0. When the quantity of the raindrops exceeds the threshold set, D0 will change from high to low and the corresponding LED will light up.

The schematic diagram is shown as below:



Experimental Procedures

Step 1: Build the circuit

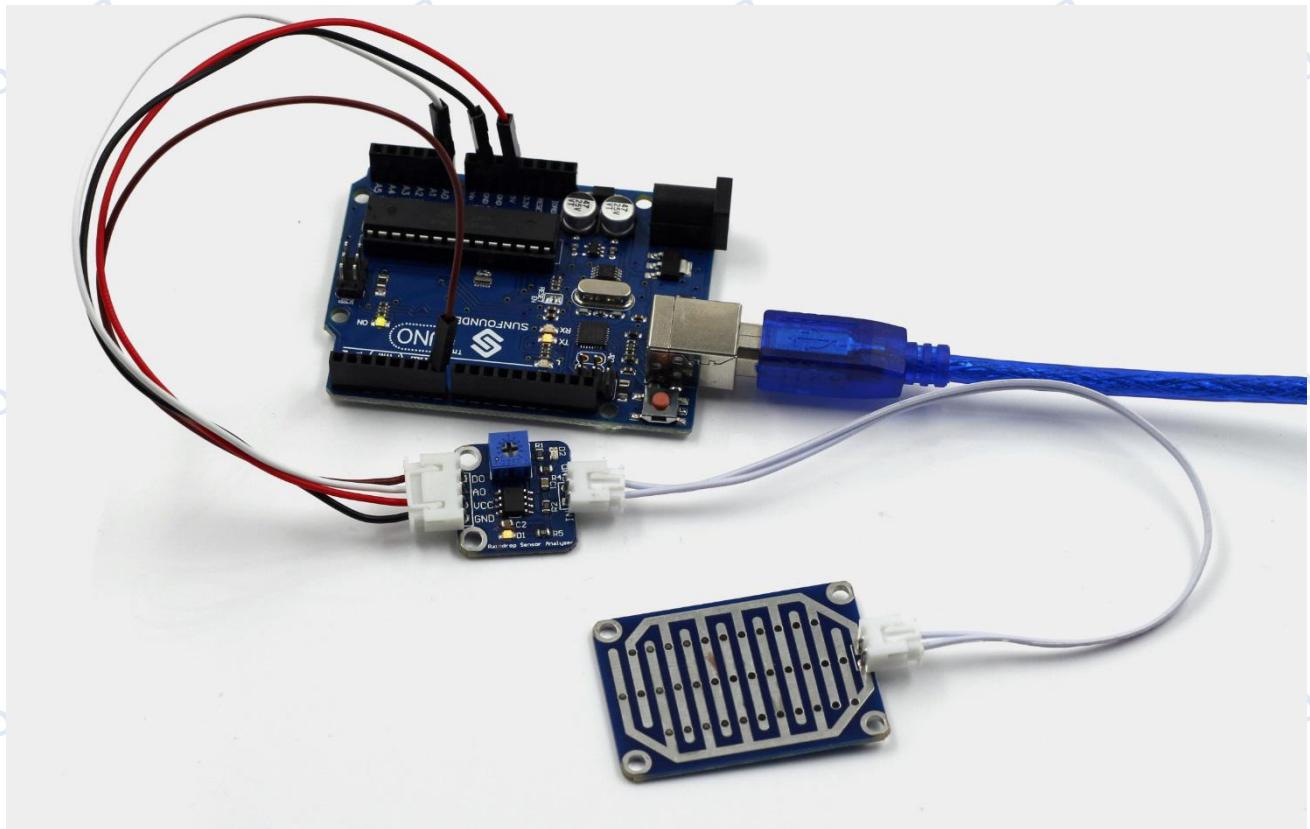


Step 2: Open the code file

Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

Now drop some water onto the sensor. When the quantities of the raindrops exceeds the threshold, the LED on the raindrop sensor module and that hooked up with pin 13 of the SunFounder Uno board light up; otherwise, they stay turned off. You may adjust the sensitivity of the sensor by the potentiometer on it, which means to set the threshold for it.



Lesson 35 Distance Detection by Ultrasonic

Introduction

The ultrasonic sensor uses sound to accurately detect objects and measure distances. It sends out ultrasonic waves and converts them into electronic signals



Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * Ultrasonic sensor
- 1 * I2C LCD1602
- 2 * 4-Pin anti-reverse cable
- 1 * Dupont wire (F to F)

Experimental Principle

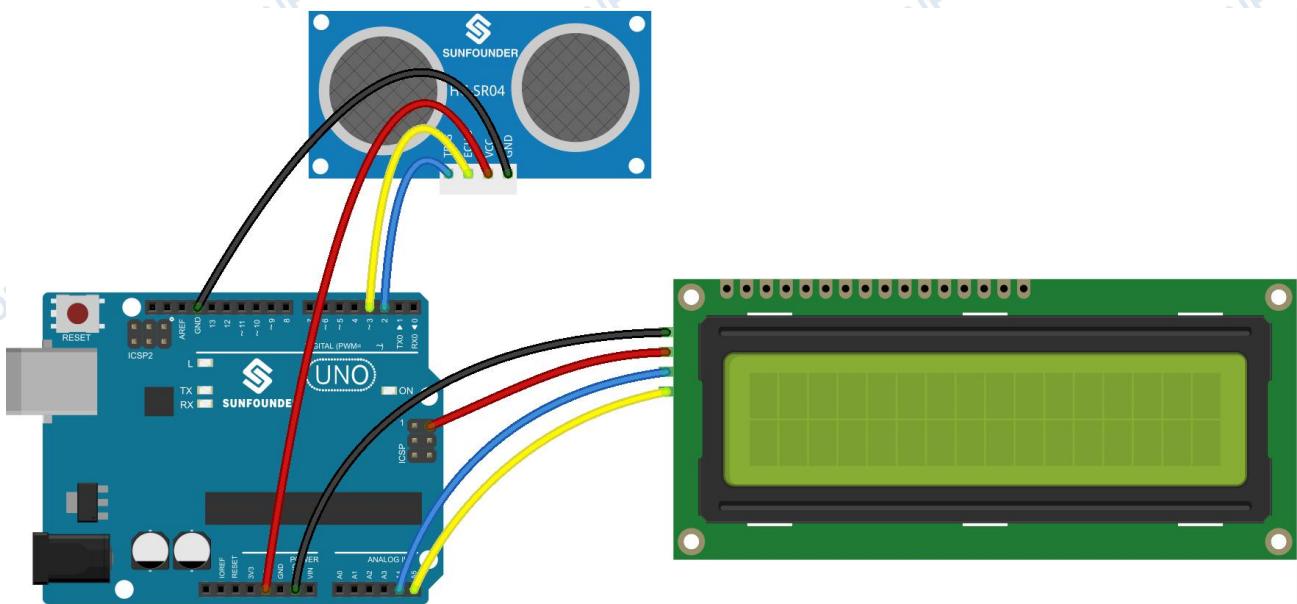
The sensor works by sending a sound wave out and calculating the time it takes for the sound wave to get back to the ultrasonic sensor. By doing this, it can tell us how far away objects are relative to the ultrasonic sensor.

Experimental Procedures

Step 1: Build the circuit

The wiring between the ultrasonic sensor and SunFounder Uno board:

Ultrasonic Sensor	SunFounder Uno
VCC	5V
Trig	2
Echo	3
GND	GND

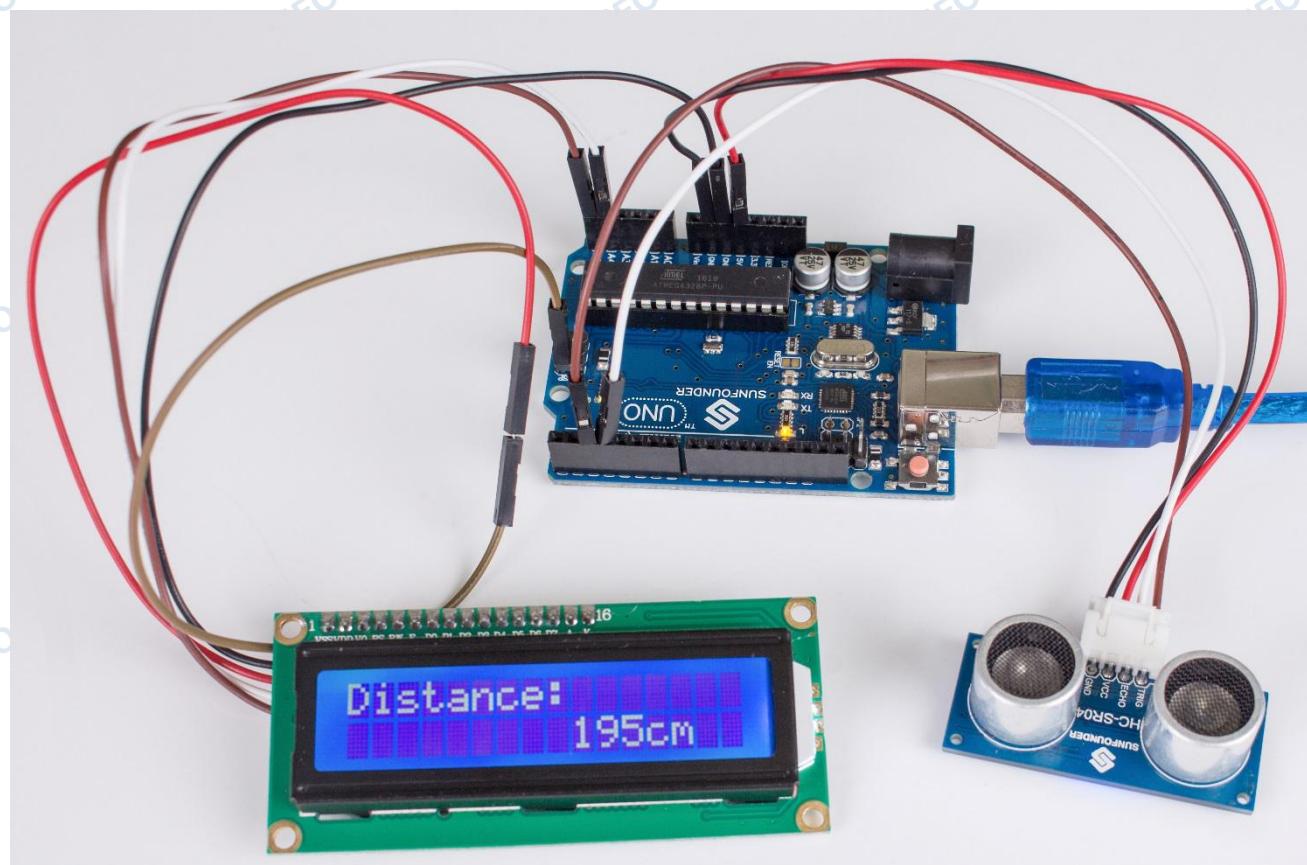


Step 2: Open the code file

Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

Now, move a piece of paper close to the sensor or remove it farther. You can see the value displayed on the LCD changes accordingly; it indicates the distance between the paper and the ultrasonic sensor.



Lesson 36 Thermostatic Water Tank

Introduction

After having learnt so many modules independently, let's combine these modules together to make some funny interactive works. In this lesson, we will use a Rotary Encoder module, a Thermistor module, a Relay module, a Button module and an I2C LCD1602, all of which we have learnt previously, to assemble a Thermostatic Water Tank. The tank can be used in the test department of medical organizations and colleges, scientific research, chemical industry, printing and dyeing industry to distil, dry, insipidate and heat chemical medicines and cultivate biological products in constant temperature, as well as to boil and disinfect equipment.

Components

- 1 * SunFounder Uno board
- 1 * USB data cable
- 1 * Rotary Encoder module
- 1 * Thermistor module
- 1 * I2C LCD1602
- 1 * Relay module
- 1 * Button module
- 3 * 3-Pin anti-reverse cable
- 1 * 5-Pin anti-reverse cable
- 1 * 4-Pin anti-reverse cable
- 2 * Dupont wire (M to M)
- 1 * Breadboard

Experimental Principle

How a thermostatic water tank works

Set a temperature value for the tank. When the temperature is lower than that set, the tank gets heated and is power off till the temperature reaches the set value. Thus, the tank can keep a constant temperature all the time.

Based on the principle, in this experiment, use an LCD screen and a thermistor module to both display value of the current temperature and the value set. Also use a rotary encoder to allow the set temperature value adjustable.

When the temperature is lower than that set, the normally open contact of the relay is closed and the characters on the LCD blur. Touch the thermistor with fingers and the temperature gets higher. When it reaches or is higher than the value set, the contact is open and the characters will become clear again.

For more about each component in the experiment, please see the previous experiments.

Experimental Procedures

Step 1: Build the circuit

The wiring between the Button module and SunFounder Uno board:

Button	SunFounder Uno
SIG	10
VCC	5V
GND	GND

The wiring between the Thermistor module and SunFounder Uno is as shown below:

Thermistor	SunFounder Uno
SIG	A0
VCC	5V
GND	GND

The wiring between the Rotary Encoder module and SunFounder Uno:

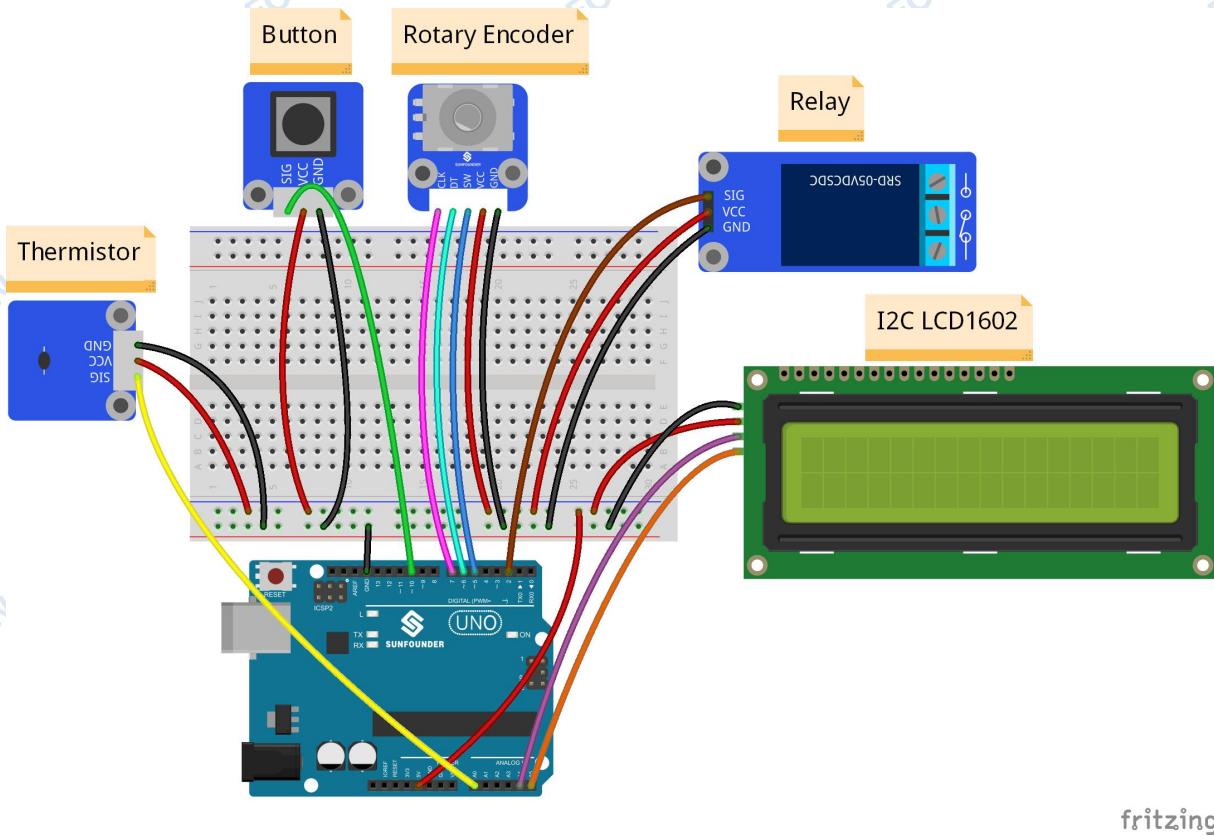
Rotary Encoder	SunFounder Uno
CLK	7
DT	6
SW	5
VCC	5V
GND	GND

The wiring between the Relay module and SunFounder Uno:

Relay	SunFounder Uno
SIG	2
VCC	5V
GND	GND

The wiring between the I2C LCD1602 module and SunFounder Uno:

I2C LCD1602	SunFounder Uno
VCC	5V
GND	GND
SDA	A4
SCL	A5



fritzing

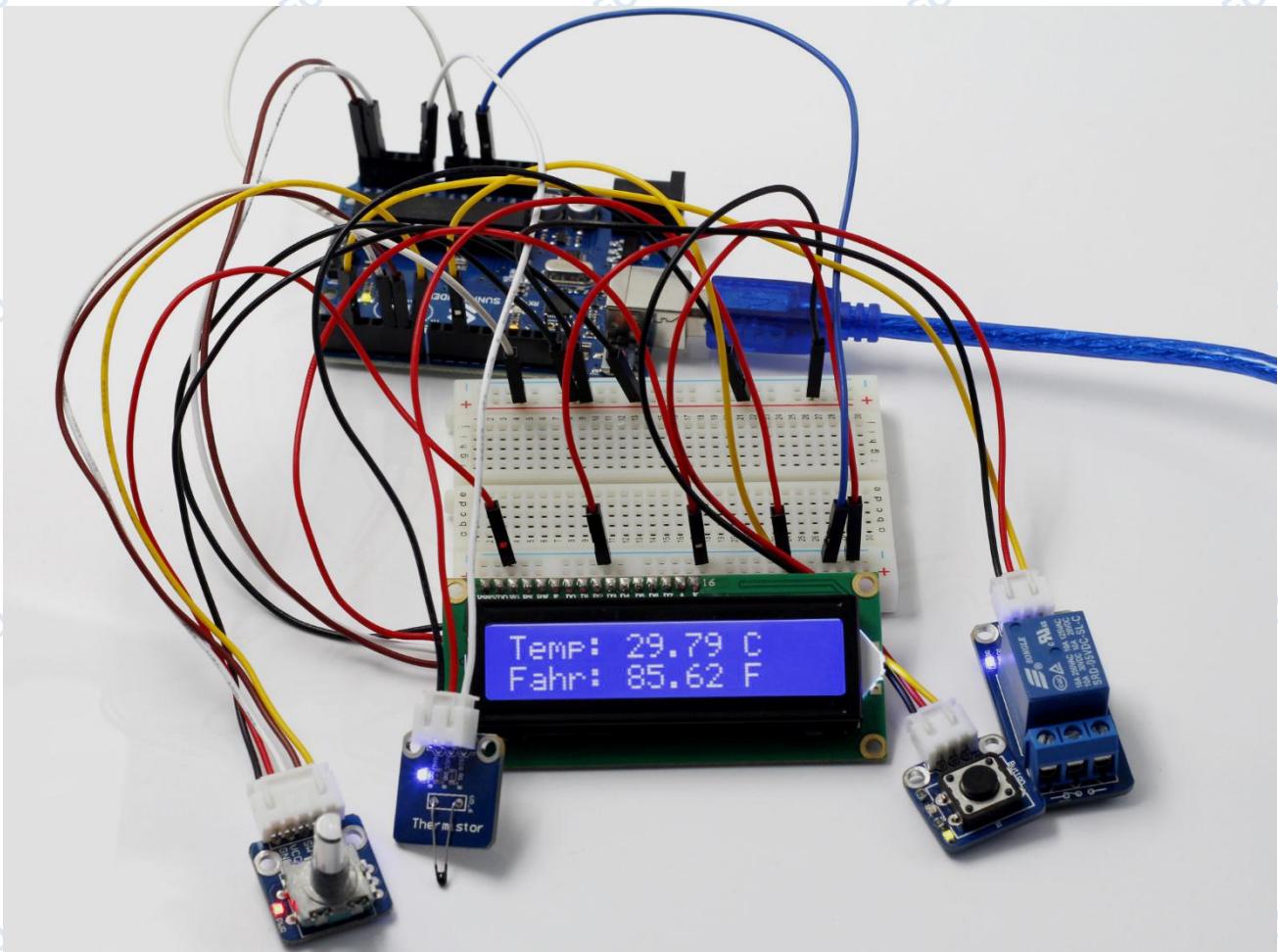
Step 2: Open the code file

Step 3: Select correct Board and Port

Step 4: Upload the sketch to the SunFounder Uno board

Now, after the startup, the LCD1602 first displays **Thermostatic Water Tank** and then the value of the current temperature. Press the button on the Button module to enter setup mode. Then rotate the Rotary Encoder to change the threshold of the temperature value. After setting a value, like 30°C, you can press the switch on the Rotary Encoder module to confirm.

If the current temperature is lower than 30°C (the threshold you just set), the normally open contact of the relay is closed. Thus, the characters on the LCD become blurred and the LED on the SunFounder Uno goes out. Touch the thermistor. Then the value displayed on the LCD will increase and at last the LED on the Uno board will light up. Release your fingers and the value of temperature displayed on the LCD will decrease. When the value reaches the threshold, the contact is open, characters on the LCD blurred, and LED out.



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