Component list

1 X I2C LCD1602
1 X RFID module
1 X RFID key ring
1 X RFID White card
1 X DS1302 clock module
1 X Voice Sensor
1 X Humiture sensor
1 X Water level measurement module
30 X Jumper wires(male to male)
1 X Breadboard
13 X Red LED
5 X Yellow LED
5 X Blue LED
Resistor Package（1k 10k 220R）
30 X Jumper wires (male to female)
1 X Potentiometer
1 X Active Buzzer
1 X Passive Buzzer
1 X 74HC595
1 X Infrared Receiver
1 X LM35
1 X Flame Sensor
2 X Tilt-switch
2 X Photoresistor
1 X Button Switch
1 X Remote controller
1 X Four-digit segment display
1 X 9V Battery Buckle
1 X RGB module
1 X 4*4 Keypad module
1 X 8*8 Dot-matrix module
1 X Stepper motor
1 X ULN2003 Driver
1 X Servo
1 X Relay module
1 X One-digit segment display

1 X Joystick PS2
4 X Button
1 x Small Button
1 x USB cable

Content

Lesson 1 Controlling LED by Button

Introduction

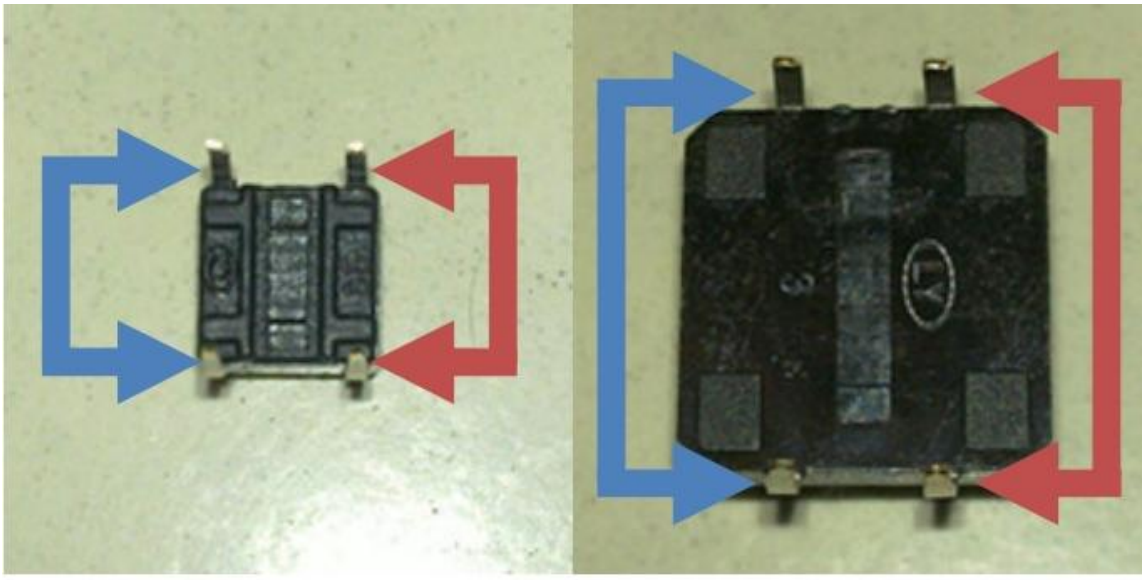
In this experiment, we will learn how to turn a single LED on or off with a button switch. I/O port refers to INPUT and OUTPUT port. We will use the input function of SUNFOUNDER UNO I/O port to read the output of the external device. And we will let you have a basic understanding about the I/O function through this experiment in which we will use a button and an LED to realize the combination of input and output. Since SUNFOUNDER UNO development board itself has an LED (connected to Pin 13), we will use the LED to accomplish the experiment for convenience.

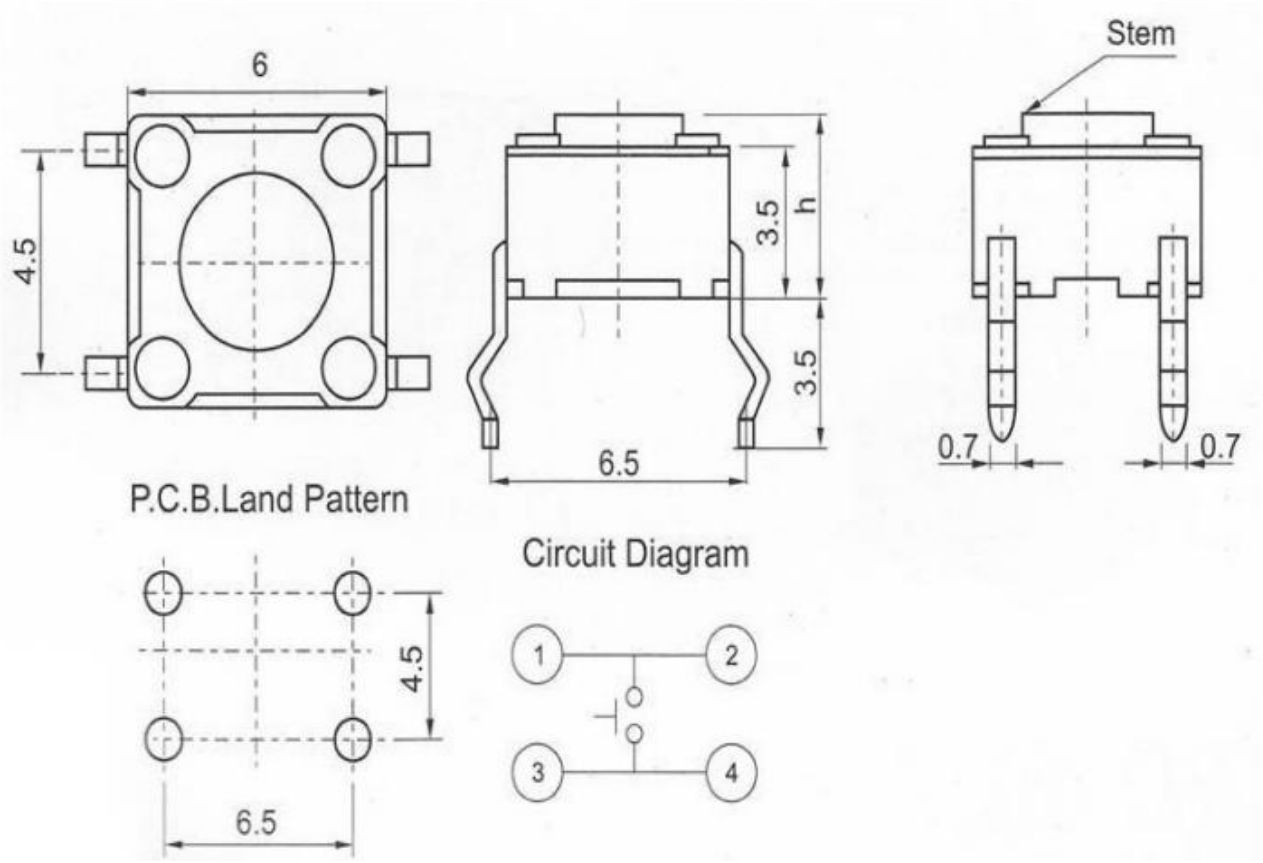
Components

- SUNFOUNDER UNO development board *1
- USB data cable *1
- Breadboard *1
- Small Button *1
- 10K Ohm resistor *1
- Several jumper wires

Principle

Buttons are a type of commonly used components to control electronic devices. Usually they are used as switches to connect or disconnect circuits to control the operation of electronic devices or other devices. Buttons have a variety of appearances, while the button used in this experiment is a 6mm mini-button as shown in the following pictures. The two pins pointed by the two arrows of same color are meant to be connected.





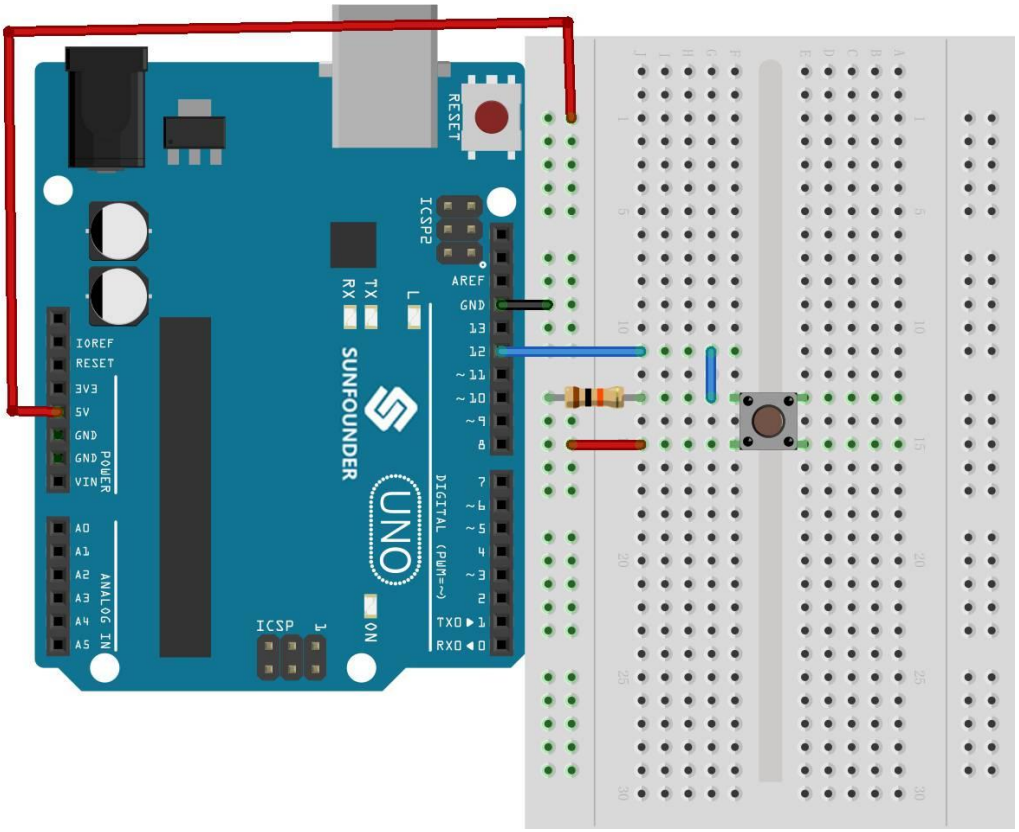
When you press the button, the pins pointed by the blue arrows will connect to the pins pointed by the red arrows.

Generally, we directly connect the button switch in series in an LED circuit to turn the LED on or off. This connection is relatively simple. However, sometimes the LED will light up automatically without pressing the button, which is caused by various interferences. In order to avoid these external interferences, we will connect a pull-down resistor, that is, connect a 1K-10K ohm resistor between the button port and GND. The function of the pull-down resistor is that when external interferences exist, they will be consumed during connecting to GND as long as the button switch is turned off.

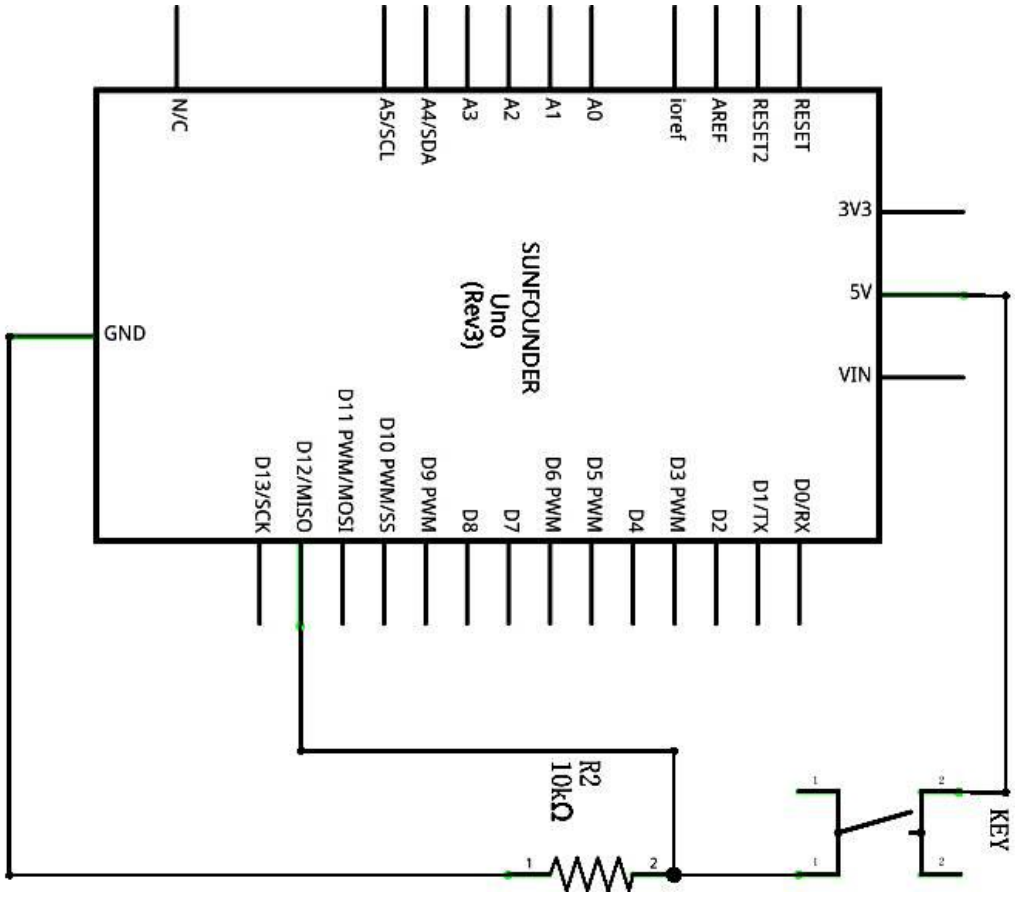
This circuit connection is widely used in numerous circuits and electronic devices. For example, when we press any button on our mobile phones, the backlight will light up.

Experimental Procedures

Step 1: Connect the circuit as shown in the following diagram

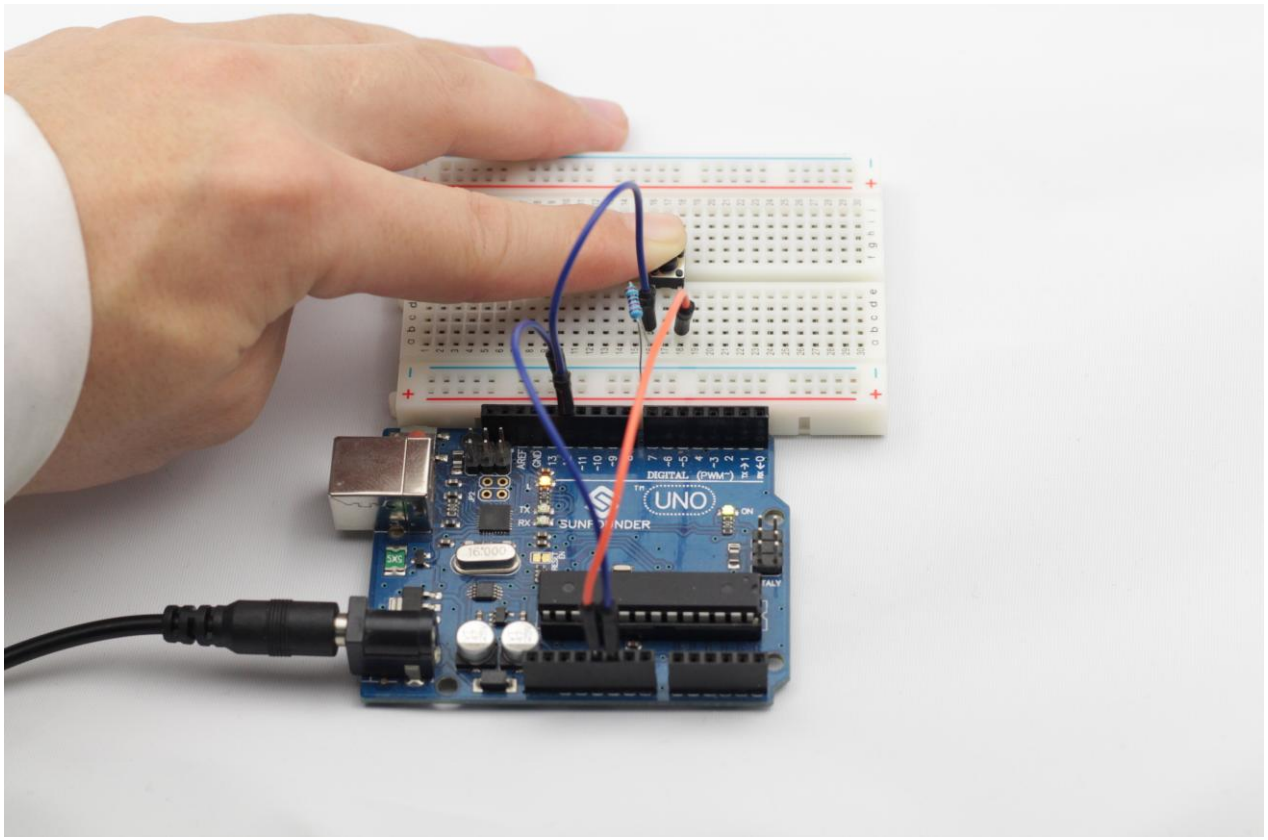


The corresponding circuit schematic diagram is shown as follow



Step 2: Program (Please refer to example code in our CD)
Step 3: Compile and debug the program
Step 4: Burn the program into SUNFOUNDER UNO board

Now, if you press the button, the LED will light up.



Lesson 2 Controlling LED by PWM

Introduction

Today let's play something easier. We will make gradual changes to the luminance of an LED through programming, which looks like breathing. So we give it a magical name - Breathing Light. This is what we called controlling the luminance of an LED by PWM (Pulse-width modulation). Can't wait to start? Now, let's check out the components we need.

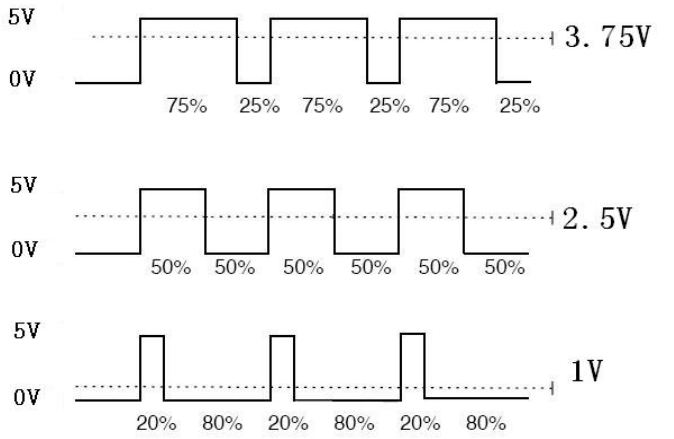
Components

- SUNFOUNDER UNO *1
- Breadboard *1
- Several connecting wires
- Red LED *1
- 220 Ohm Resistor *1

Principle

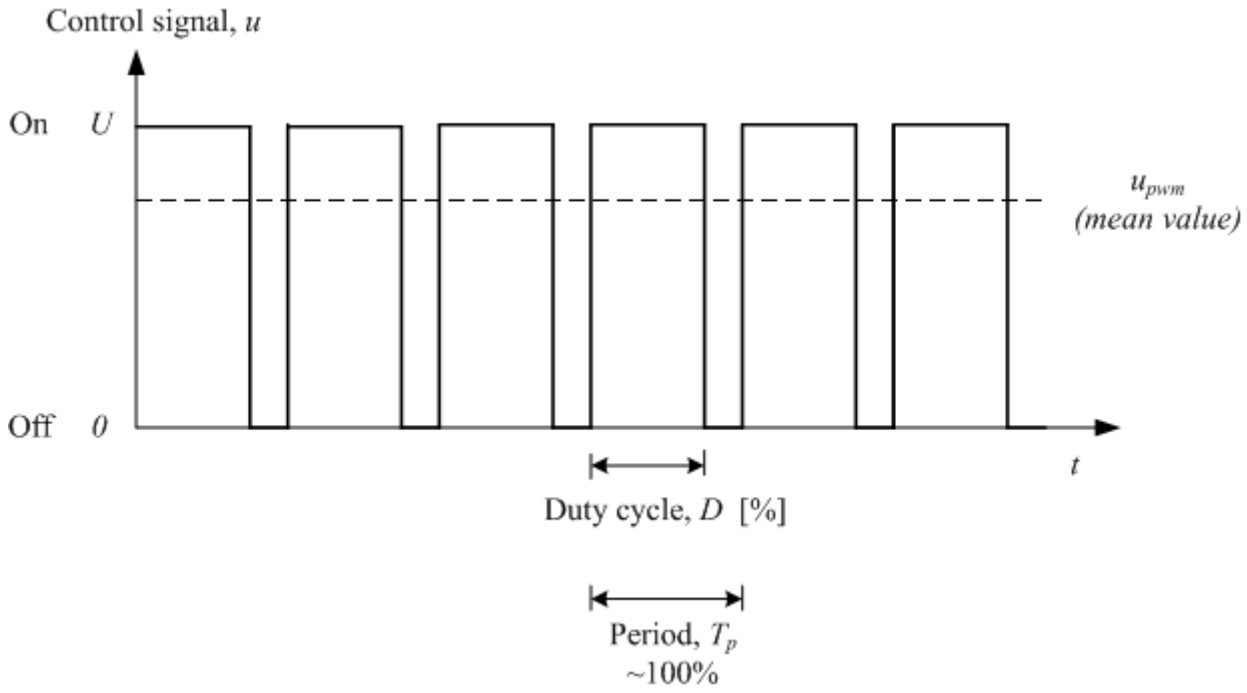
Before we talk about PWM, let's have a look at the applications of PWM first. PWM has been successfully applied in motor speed regulation, steering angle control, light intensity control and signal output. For example, when PWM is applied to a horn, it will make sounds. After we know about its special functions, let's find out what PWM really is.

Pulse Width Modulation commonly refers to PWM. Pulse Width Modulation (PWM) is a digital coding method for analog signal levels. Since a computer cannot output an analog voltage but digital voltage value 0V or 5V, we modulate the duty cycle of square waves to encode a specific level of analog signal by using a high-resolution counter. PWM signals are essentially digital signals, for the full amplitude DC power supply is either 5V (ON) or 0V (OFF) at any given time. Voltage or current source is applied to an analog load in the form of ON or OFF repetitive pulse sequence. When it is on, DC power supply will be applied to the load; when it is off, DC power supply will be disconnected. If only the bandwidth is wide enough, any analog value can be encoded by PWM. The output voltage value is calculated by the on and off time. $V_{out} = (T_{on}/ T)*V_{max}$.



We can see from the top oscillogram 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.

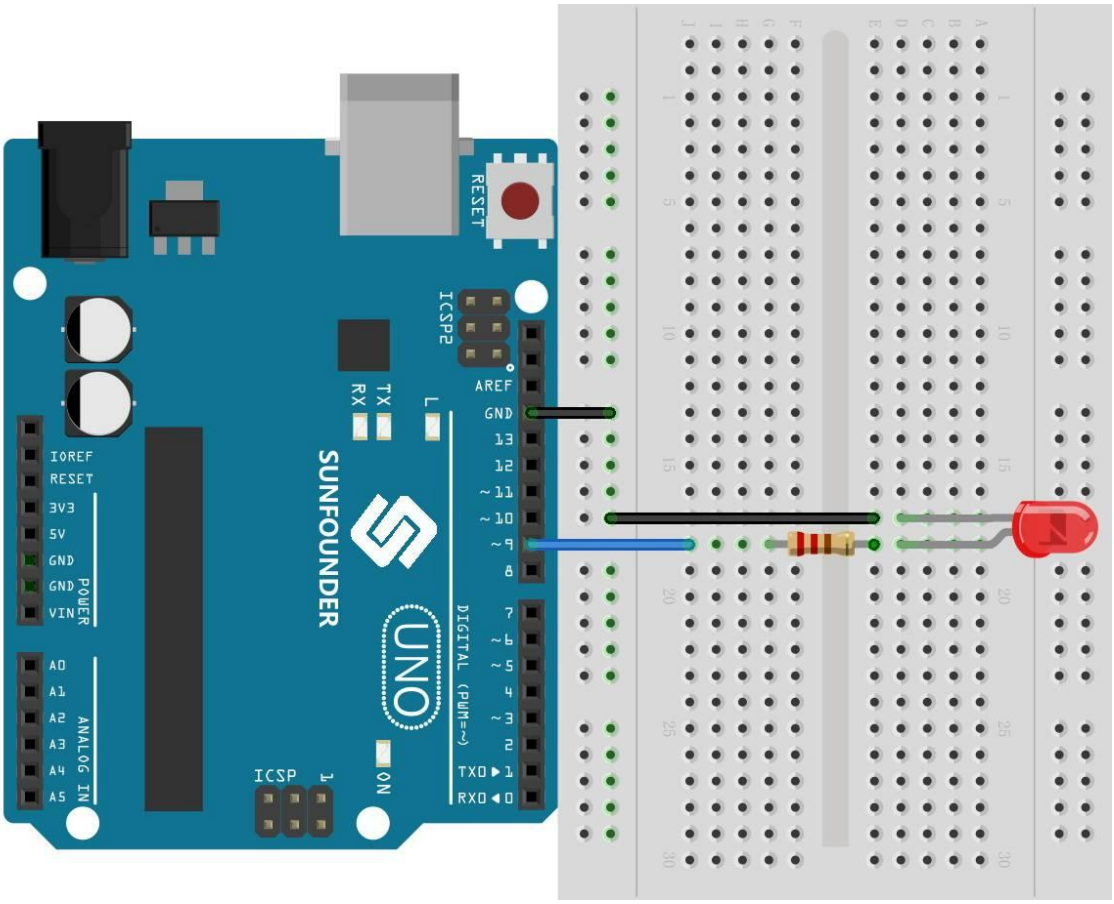
Here is the introduction to three basic parameters of PWM:



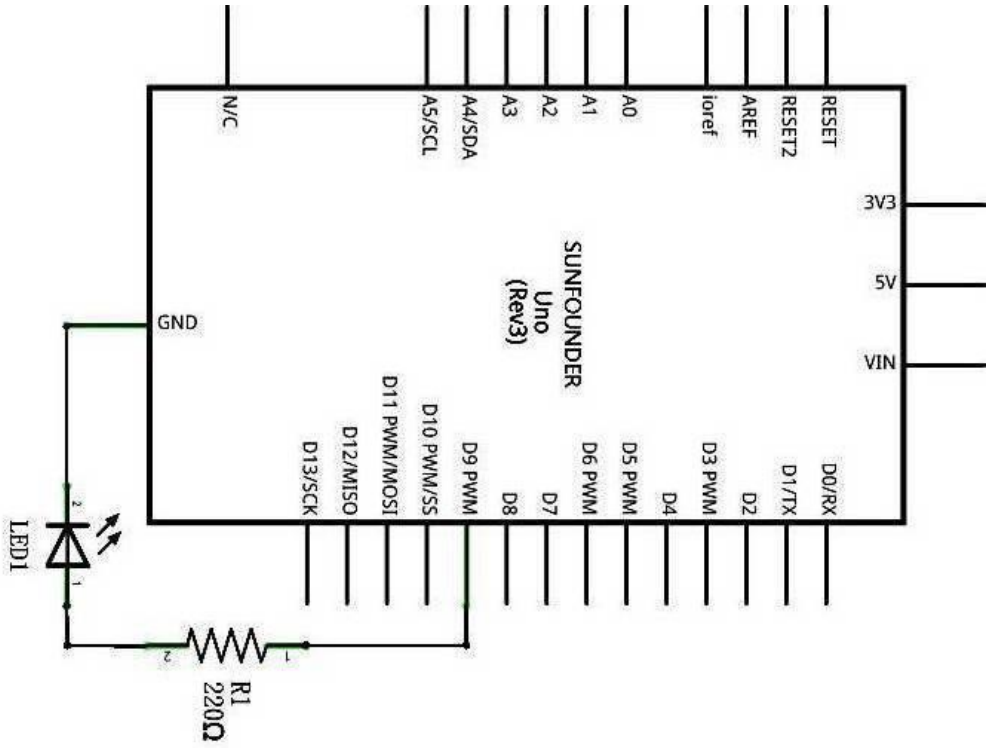
1. The term duty cycle describes the proportion of 'on' time to the regular interval or 'period' of time
2. The term *period* describes the reciprocal of pulses in one second
3. Voltage amplitude (e.g. 0V-5V)

Experimental Procedures

Step 1: Connect the circuit as shown in the following diagram

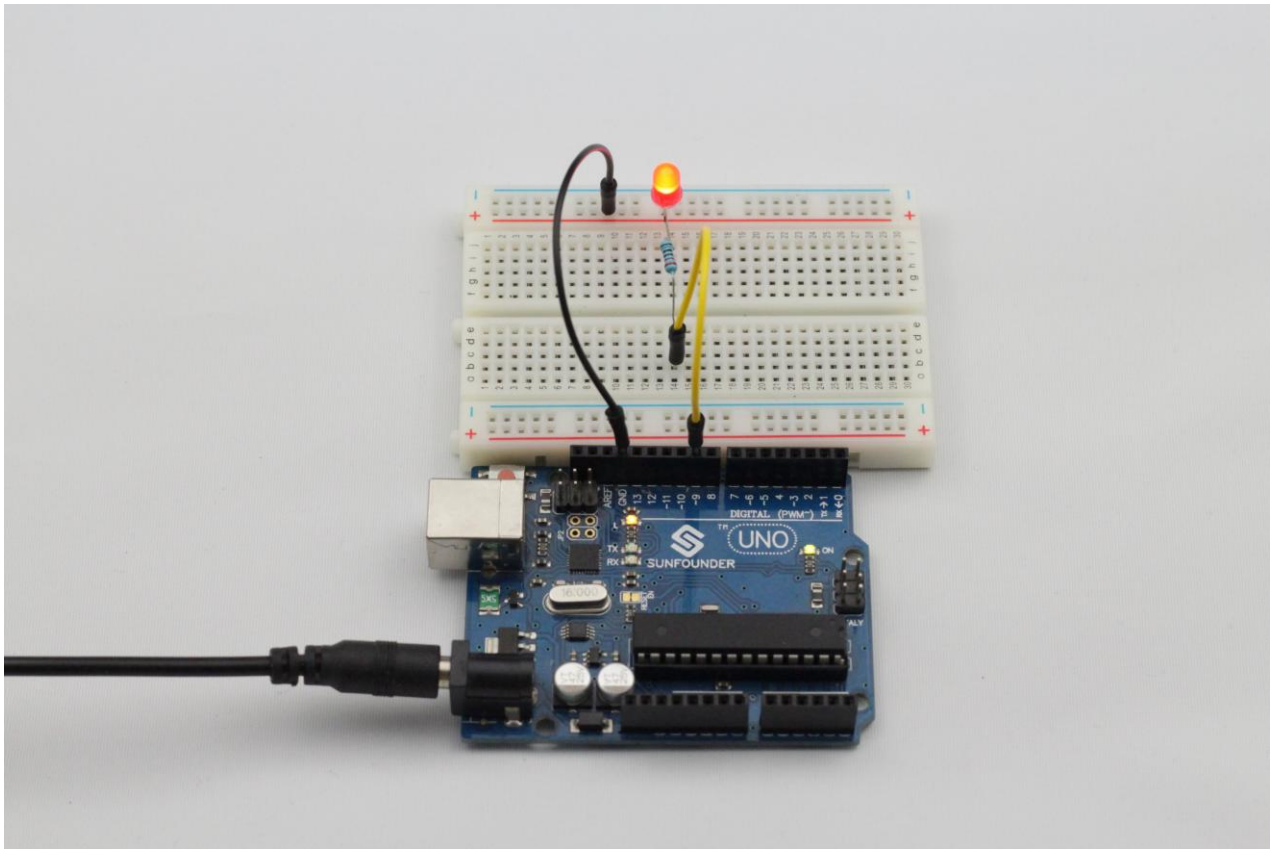


The corresponding schematic diagram is shown as follow



Step 2: Program (Please refer to example code in our CD)
Step 3: Compile and debug the program
Step 4: Burn the program into SUNFOUNDER UNO board

Now, you will see the luminance of the LED regularly vary.



Lesson 3 Interactive LED Flowing Lights

Introduction

I believe you have been familiar with LED flowing lights. Well, in this lesson, we will add a potentiometer on the basis of LED flowing lights to change the time interval of LEDs being lit by adjusting the potentiometer.

Components

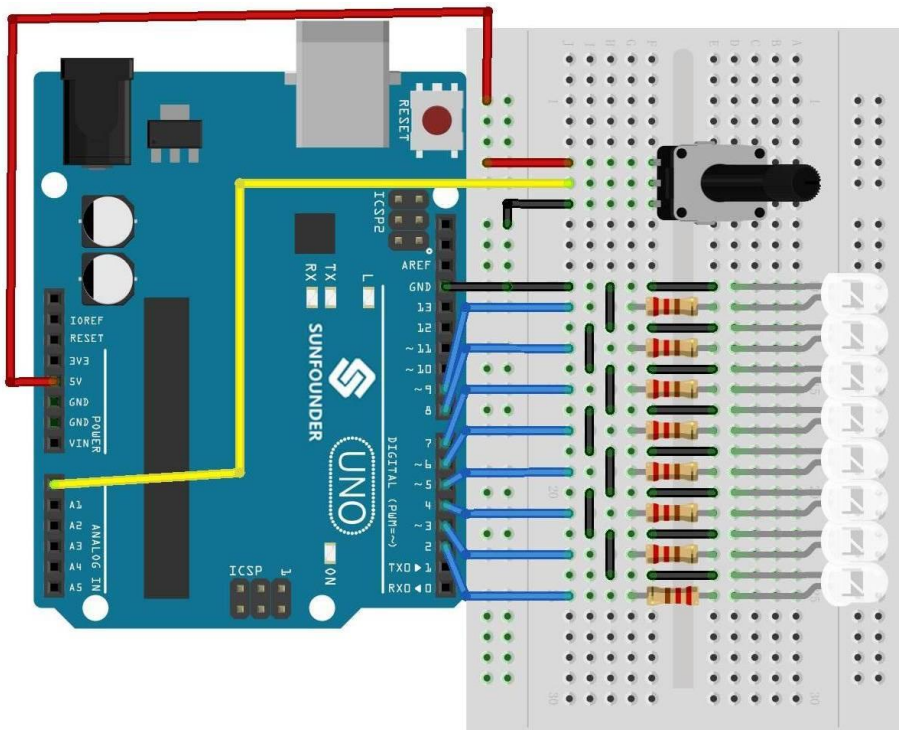
- 1*SUNFOUNDER UNO
- 1*Breadboard
- 8*LED
- 8*Resistor (220 Ohm)
- 1*Potentiometer
- 1*USB cable
- Several jumper wires

Principle

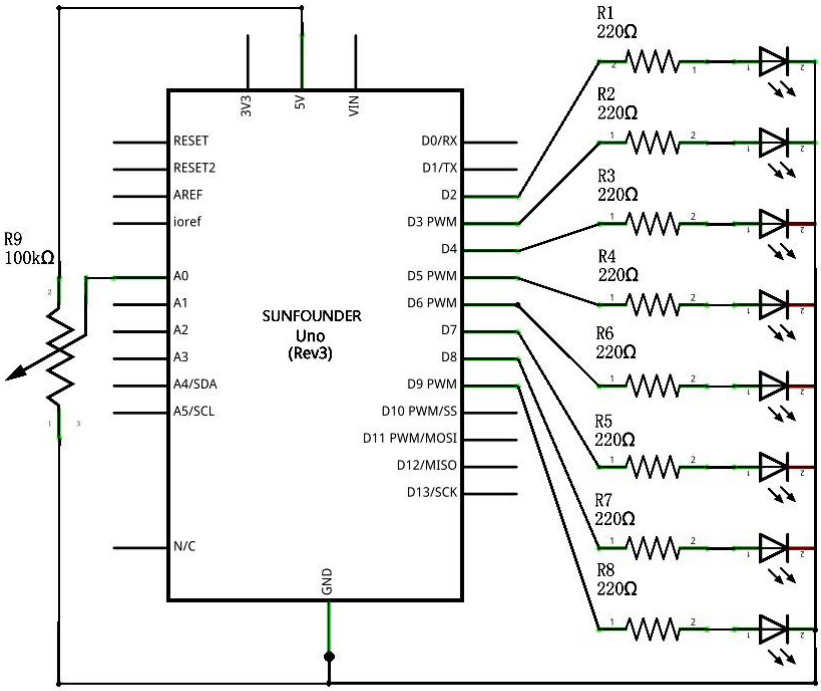
The principle of this experiment is quite simple, that is, turn eight LEDs on in certain turn. And then change the time interval of LEDs being lit by adjusting the potentiometer.

Experimental Procedures

Step 1: Connect the circuit as shown in the following diagram

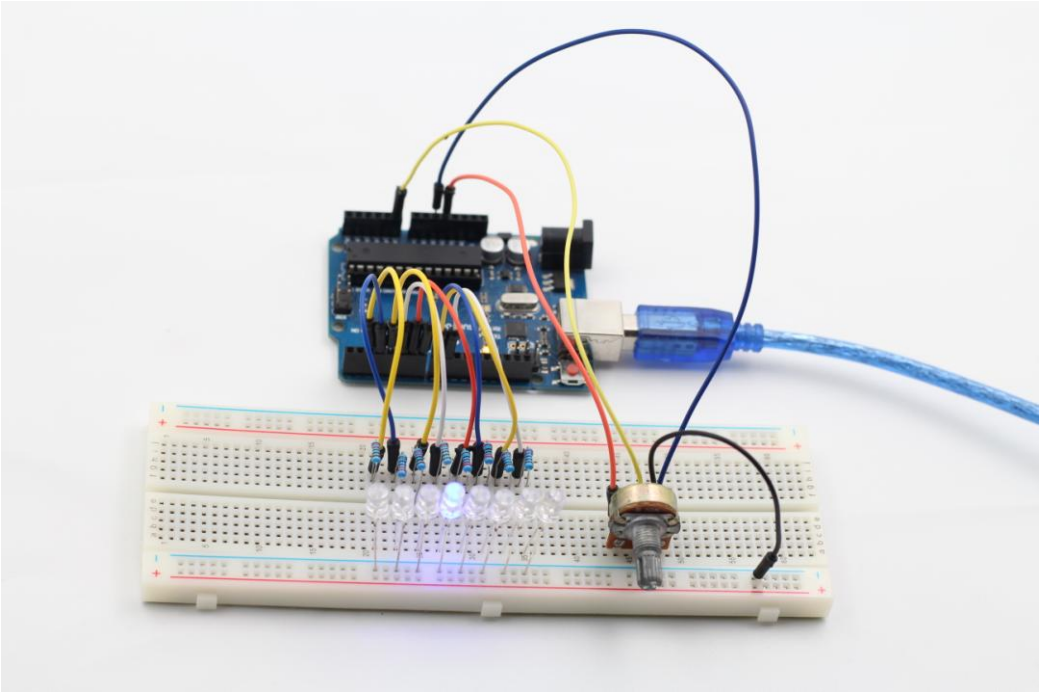


The corresponding schematic diagram is shown as below



Step 2: Program (Please refer to example code in our CD)
Step 3: Compile and debug the program
Step 4: Burn the program into SUNFOUNDER UNO board

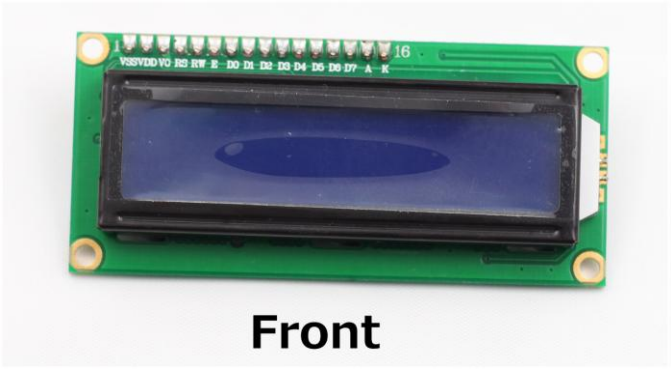
Now, you will see eight LEDs light up one by one in certain turn. If you adjust the potentiometer, you will find the time interval of LEDs being lit varies.

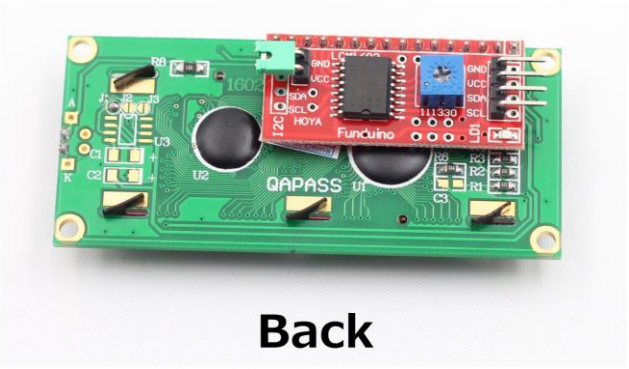


Lesson 4 I2C LCD1602

Introduction

I2C bus is a type of serial bus launched by PHLIPS. It is a high performance serial bus which has bus ruling and high or low speed device synchronization function required by multiple host system. I2C bus has only two bidirectional signal lines, Serial Data Line (SDA) and Serial Clock Line (SCL).





Components

- 1*SUNFOUNDER UNO board
- 1*Breadboard
- 1*I2C LCD1602 module
- 1*USB cable
- Several connecting wires

Principle

In this experiment, we will let I2C LCD1602 display “SUNFOUNDER” and “hello, world” by programming.

For more information about I2C operation principle, please visit http://en.wikipedia.org/wiki/I²C.

Experimental Procedures

Step 1: Connect the circuit

I2C LCD1602 module	SUNFOUNDER
SDA	A4
SCL	A5
VCC	5V

GND----------GND

Step 2: Program (Please refer to example code in our CD)

Step 3: Compile and debug the program

Step 4: Burn the program into SUNFOUNDER UNO board

Now, you can see your I2C LCD1602 display the flowing characters “SUNFOUNDER” and “hello, world!”.

Lesson 5 Buzzer

Introduction

A buzzer can be used whenever you want to make some noises.

Experimental Conditions

- 1*SUNFOUNDER UNO board
- 1*Breadboard
- 1*USB data cable
- 1*Buzzer (Active)
- Jumper wires

Experimental Principle

As a type of electronic buzzer with integrated structure, buzzers, which use DC power supply, are widely used in computers, printers, photocopiers, alarms, electronic toys, automotive electronic equipments, telephones, timers and other electronic products for voice devices. Buzzers can be categorized as piezoelectric and magnetic buzzers. A piezoelectric buzzer is mainly composed of multivibrator, piezoelectric buzzer slice, impedance matcher, resonance chamber, shell, etc. A magnetic buzzer is mainly composed of oscillator, electromagnetic coil, magnet, vibrating diaphragm, shell, etc. Buzzers can also be categorized as active and passive buzzers (See the following pictures). When we place the pins of two buzzers upwards, we can see the one with green circuit board is a passive buzzer, while the one without circuit board instead of enclosing with black tape is an active buzzer.

The difference between an active buzzer and a passive buzzer is:

The active buzzer has built-in oscillating source, so it will make sounds as long as it is electrified. While the passive buzzer does not have oscillating source, so it will not tweet if you use DC signals, instead you must use square waves whose frequencies are between

2K and 5K to drive it. The active buzzer is often more expensive than the passive because multiple built-in oscillating circuits exist.

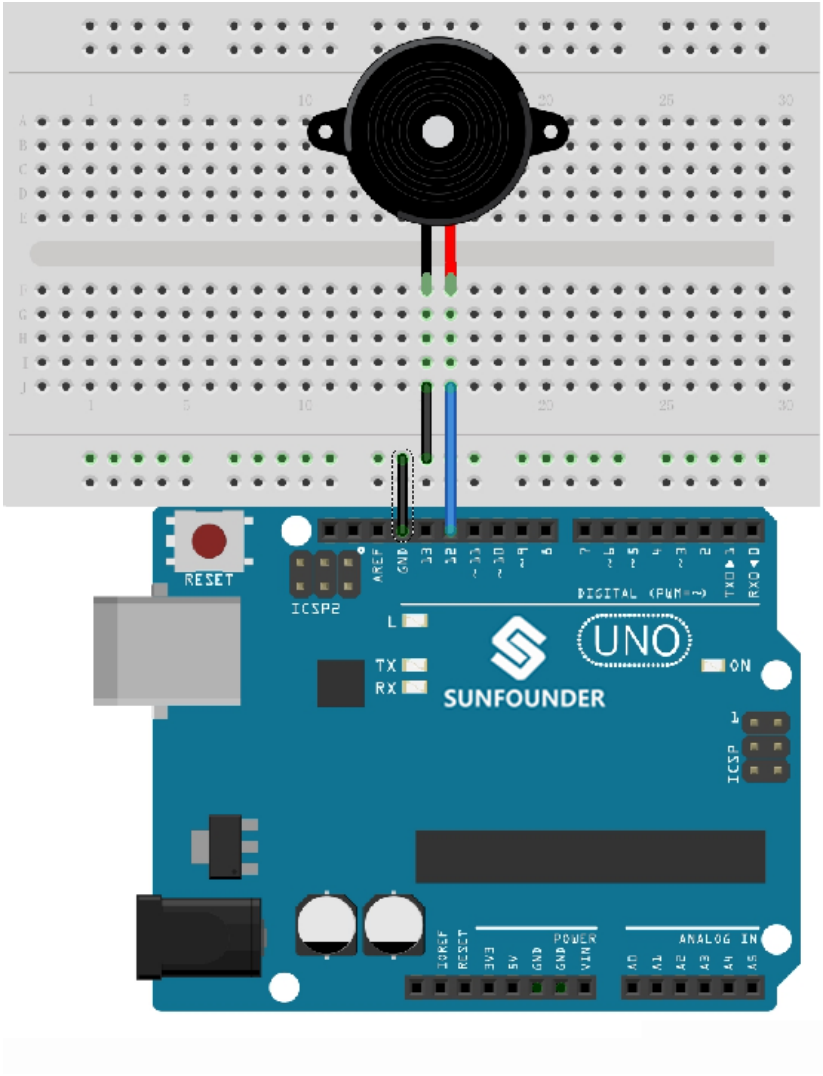
The advantage of a passive buzzer is:
1. Cheap
2. Voice frequency controllable
3. Able to share a control port with an LED in some special cases

The advantage of an active buzzer is:
Easy to control by the program

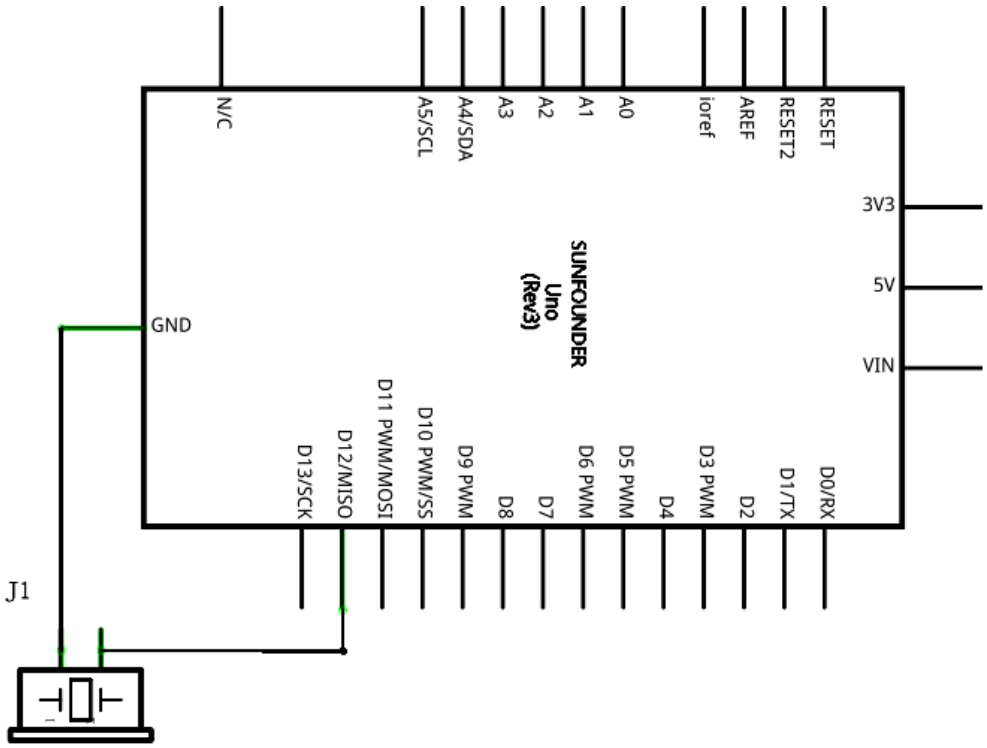
In this experiment, we use active buzzer.

Experimental Procedures

Step 1: Connect the circuit



The corresponding schematic diagram is shown as below

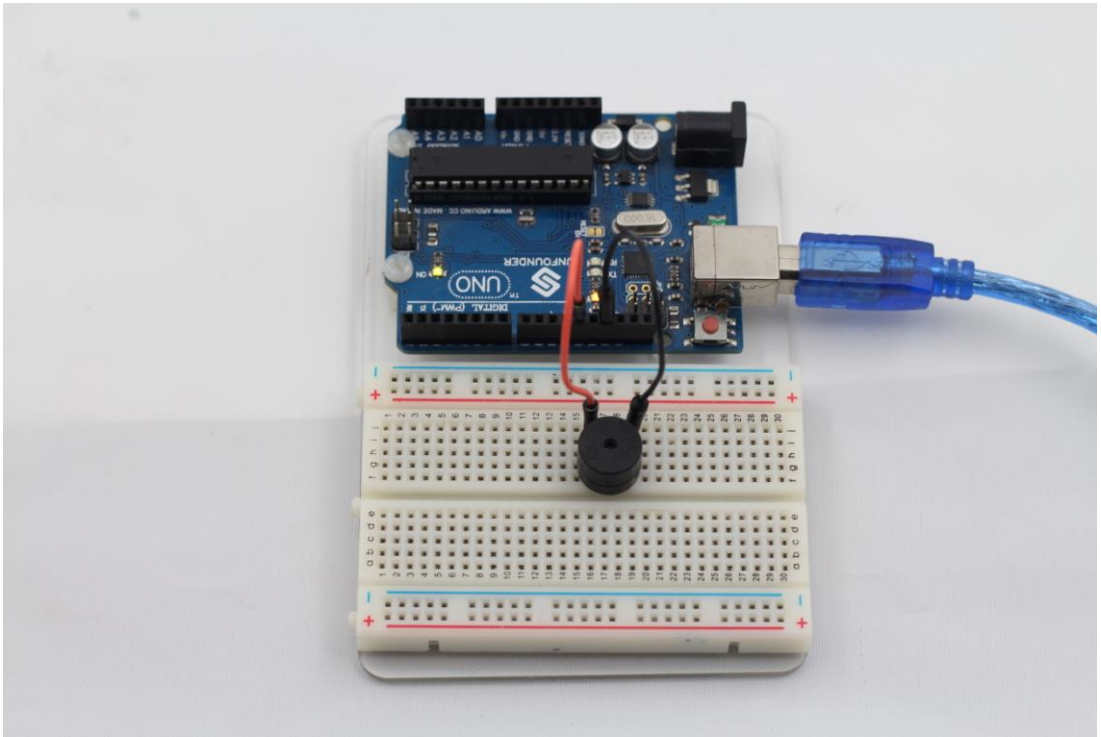


Step 2: Program (Please refer to example code in our CD)

Step 3: Compile and debug the program

Step 4: Burn the program into SUNFOUNDER UNO board

Now, you can hear the buzzer make sounds.



Lesson 6 Tilt-Switch

Introduction

The tilt-switch we use is a ball tilt-switch with a metal ball inside. It is used to detect small angle of inclination.

Components

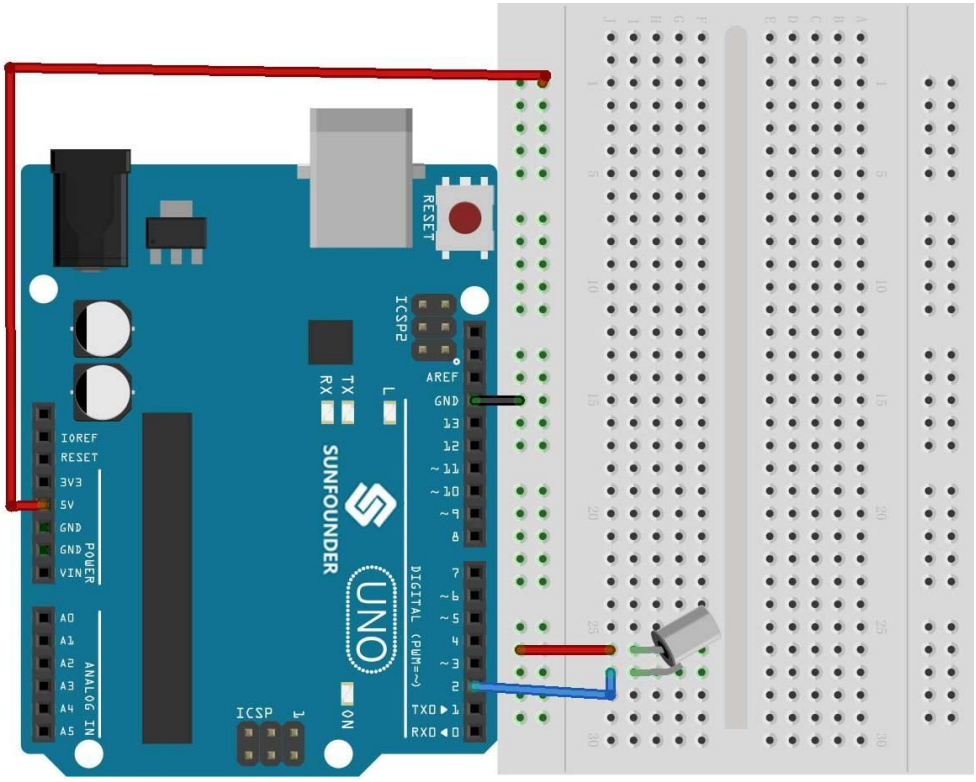
- 1*SUNFOUNDER UNO board
- 1*USB data cable
- 1*Tilt-switch
- Several jumper wires

Experimental Principle

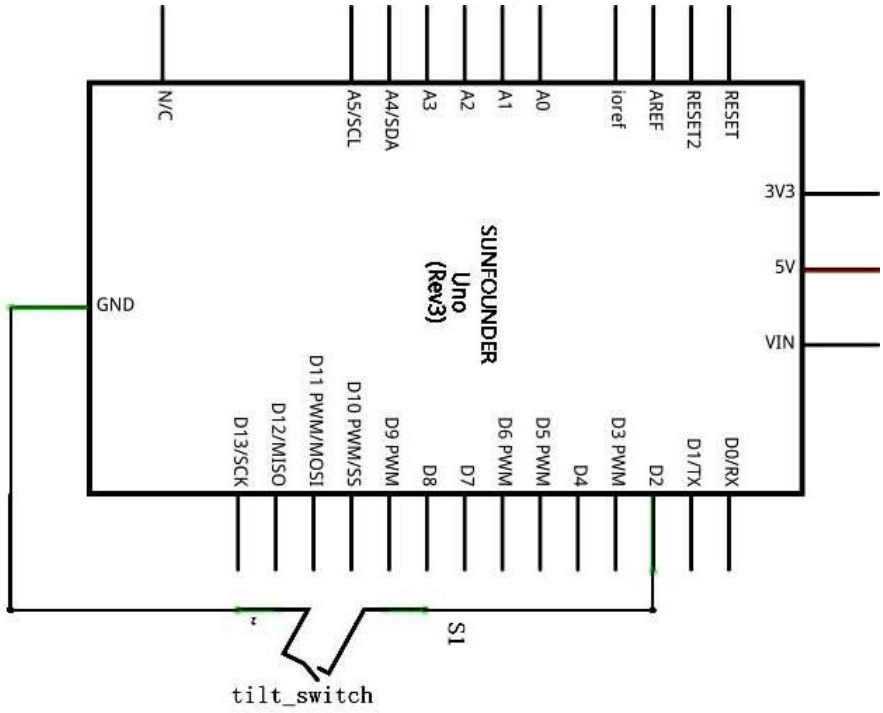
The principle is very simple. It mainly uses the ball in the switch changing with different angle of inclination to achieve the purpose of triggering circuits. When the ball in tilt switch runs from one end to the other end because of external force shaking, the tilt switch will conduct, or it will break.

Experimental Procedures

Step 1: Connect the circuit



The corresponding schematic diagram is shown as below

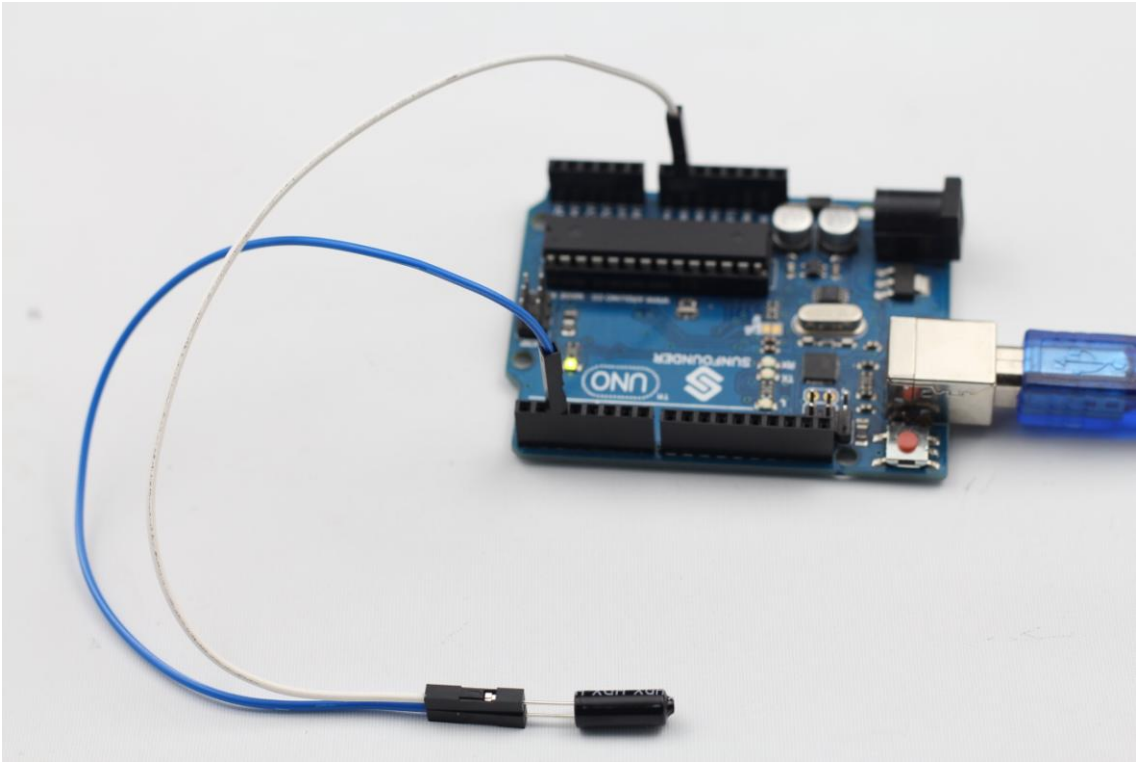


Step 2: Program (Please refer to example code in CD provided by us)

Step 3: Compile the program

Step 4: Burn the program into SUNFOUNDER UNO board

Now, if you tilt the switch, the LED attached to pin 13 on SUNFOUNDER UNO board will light up.



Lesson 7 Answer Machine

Introduction

In quiz show, especially entertainment activities (competitive answering activities), organizers often use answer machine in order to accurately, fairly and visually determine the seat number of a responder. Now answer machines can illustrate the accuracy and equity of the judgment by data, which has increased entertainment. At the same time, it is more fair and just. In this lesson, we will use some buttons, buzzers, and LEDs to make an answer machine.

Components

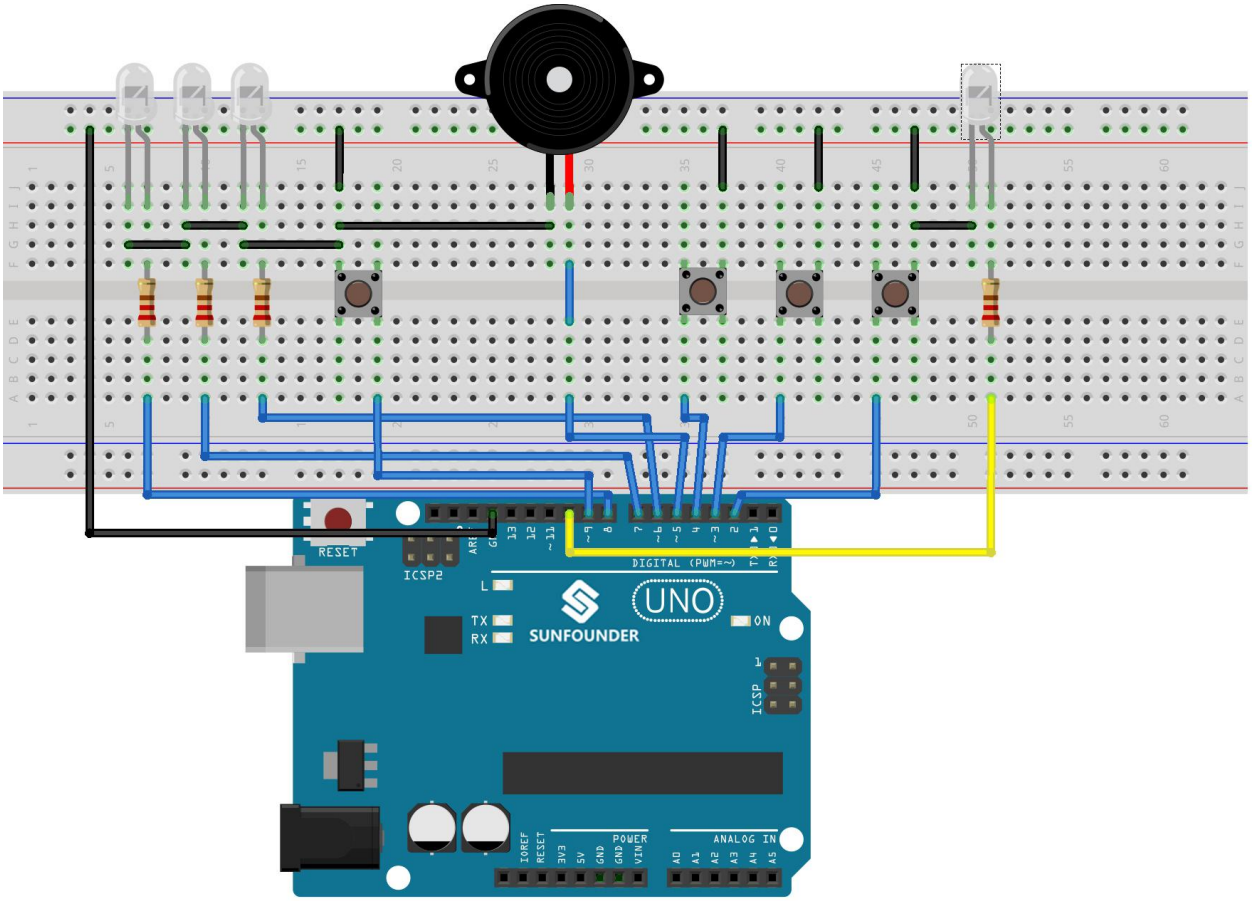
- 1*SUNFOUNDER UNO board
- 1*USB data cable
- 4*Button
- 4*LED
- 4*Resistor (220 Ohm)
- 1*Active Buzzer
- Several jumper wires

Experimental Principle

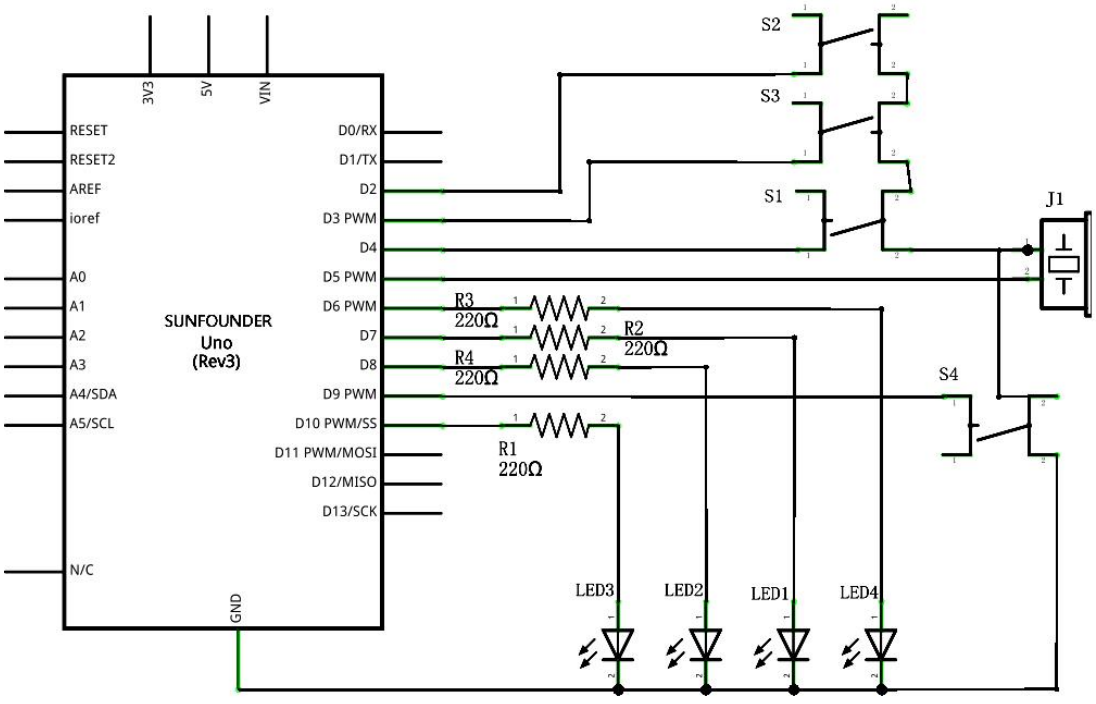
Button 1, 2 and 3 are answer buttons, and button 4 is reset button. If button 1 is pressed first, the buzzer will make beep sounds, the corresponding LED will light up and all the other LEDs will go out. If you want to start again, you can press button 4 to reset.

Experimental Procedures

Step 1: Connect the circuit

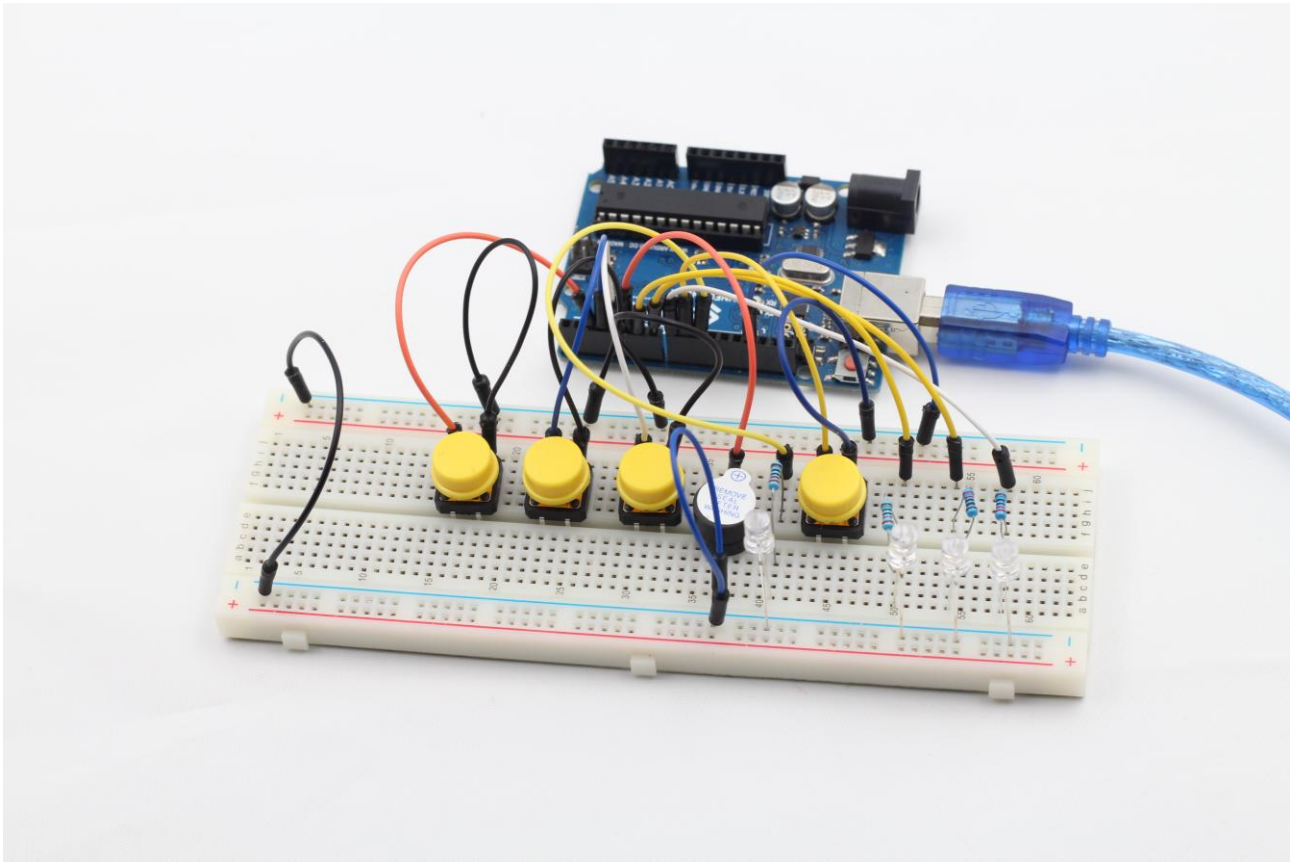


The corresponding schematic diagram is shown as below



Step 2: Program (Please refer to example code in CD provided by us)
Step 3: Compile the program
Step 4: Burn the program into SUNFOUNDER UNO board

Now, you must press button 4 to start. If you press button 1 first, you will see the corresponding LED light up and the buzzer will make beep sounds. Then you must press button 4 to reset in order to press other buttons.



Lesson 8 Serial Monitor

Introduction

In this experiment, we will learn how to turn LEDs on or off on a SUNFOUNDER UNO board through a computer and a SUNFOUNDER UNO serial monitor. The serial port is connected to the computer and the SUNFOUNDER UNO board. We can send and receive data via the serial port and can also control the SUNFOUNDER UNO board through the keyboard.

In this routine, you can input any color among red, yellow and blue into the serial monitor of the computer, and then the corresponding LED on the SUNFOUNDER UNO board will light up.

Components

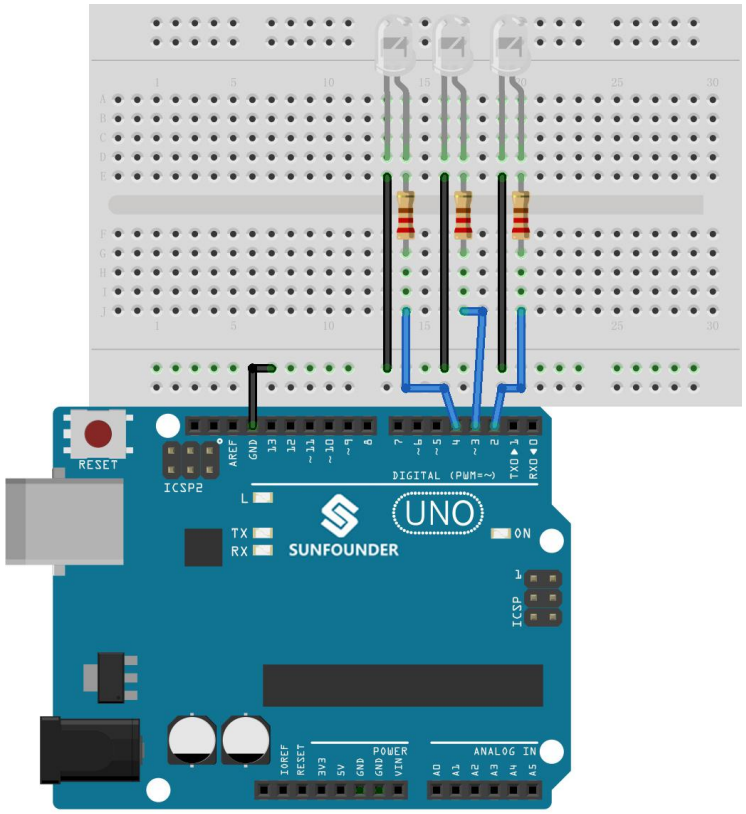
- SUNFOUNDER UNO board *1
- Breadboard*1
- LED*3
- 220 ohm resistor *3
- Several connecting wires

Principle

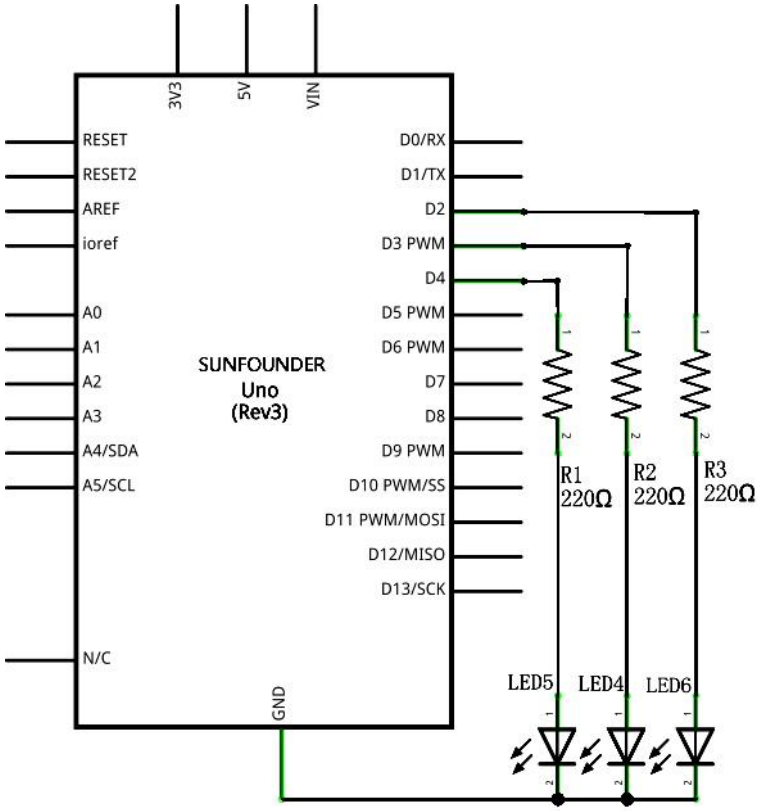
Here the serial port is a transfer station for communication between the computer and the SUNFOUNDER UNO board. The computer inputs data to the serial port, and then the SUNFOUNDER UNO board reads the data from the serial port via USB data cable. After that the SUNFOUNDER UNO board will perform related operations according to the contents having been read.

Experimental Procedures

Step 1: Connect the SUNFOUNDER UNO board to your computer via USB cable. Open the serial monitor and then input red, yellow, blue or any other colors.

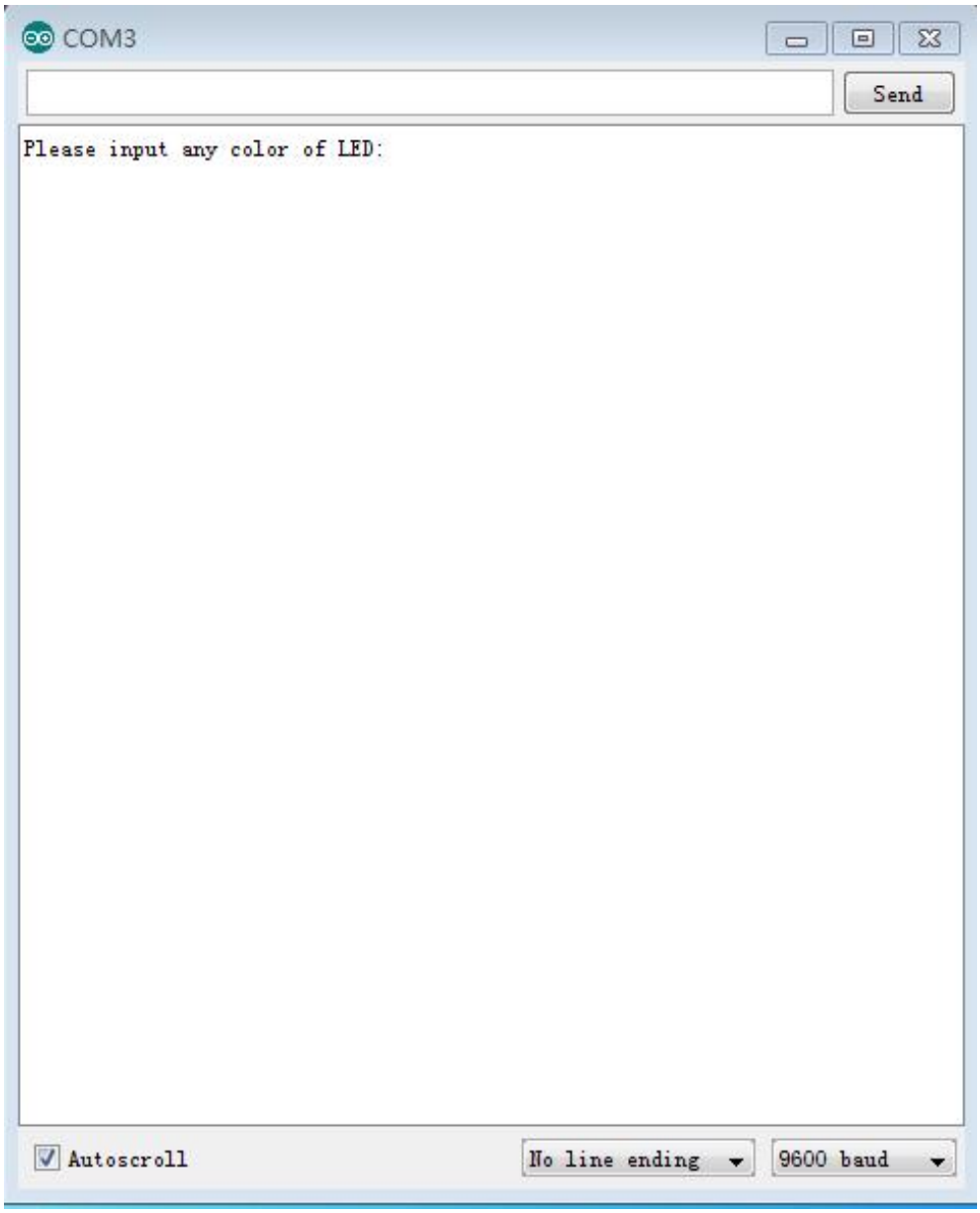


The corresponding schematic diagram is shown as follow



Step 2: Program (Please refer to example code in our CD)
Step 3: Compile and debug the program
Step 4: Burn the compiled program into SUNFOUNDER UNO board

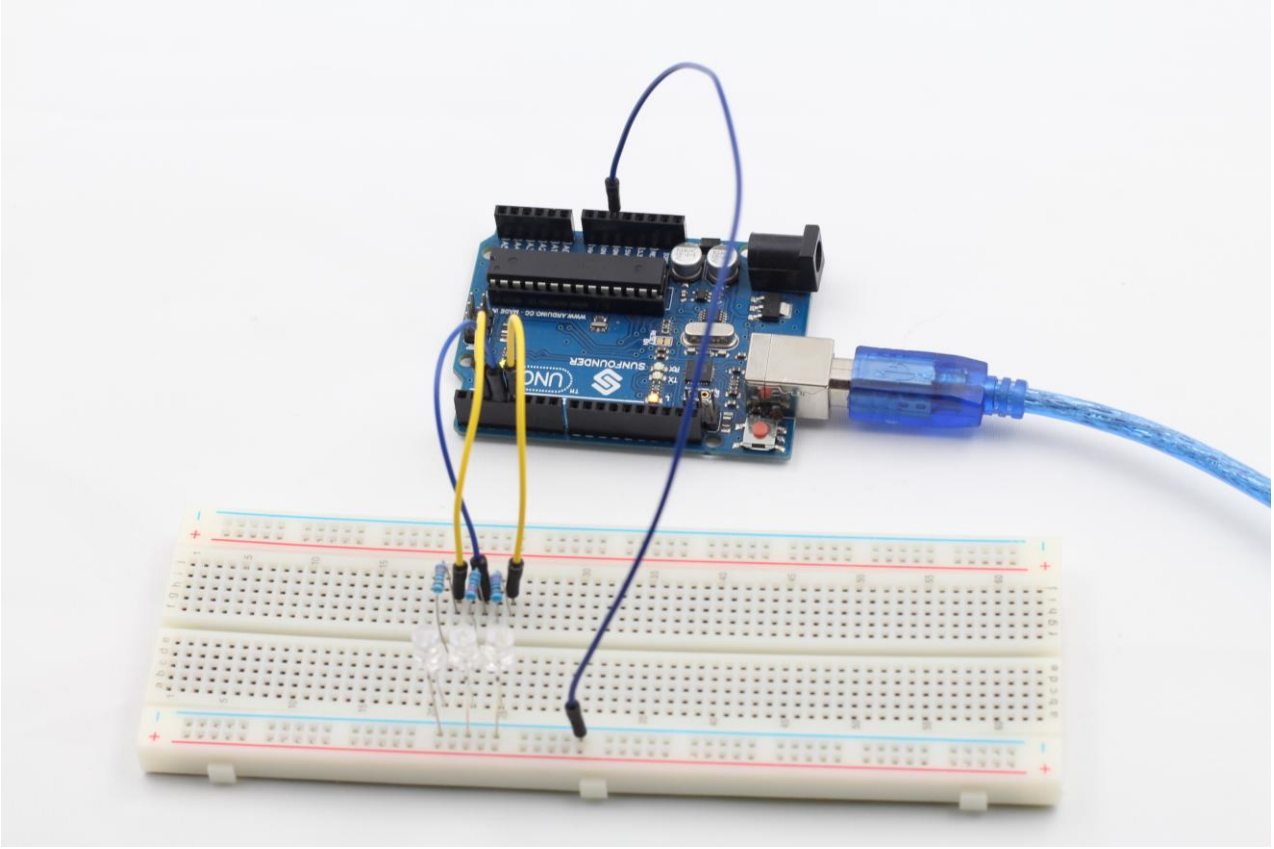
Now, if you click the icon on the upper-right corner of SUNFOUNDER UNO IDE, you will see the serial monitor window popup as shown in the following picture.



With this window, you can not only send information from your computer to the SUNFOUNDER UNO board via USB cable but also receive information from the board and display the information on the screen. When you open the serial monitor, it will display "**Please input any color of LED:**". You can input any color among red, yellow and blue, and then click **Send**. The corresponding LED light on the SUNFOUNDER UNO board will

light up. But if you input any other colors except of these three colors, LED lights will be off.

For example, we input red, you will see the red LED light up.



Experimental Summary

Now you have realized communication between your computer and the SUNFOUNDER UNO board. You can also modify the source code we provided appropriately. For example, if you input a number into the serial monitor, the corresponding LED will light up.

Lesson 9 Photoresistor

Introduction

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.

Experimental Conditions

- 1*SUNFOUNDER UNO board
- 1*USB data cable
- 1*Photoresistor
- 1*Resistor (10K ohm)
- 8*LED
- 8*Resistor (220 ohm)
- Jumper wires

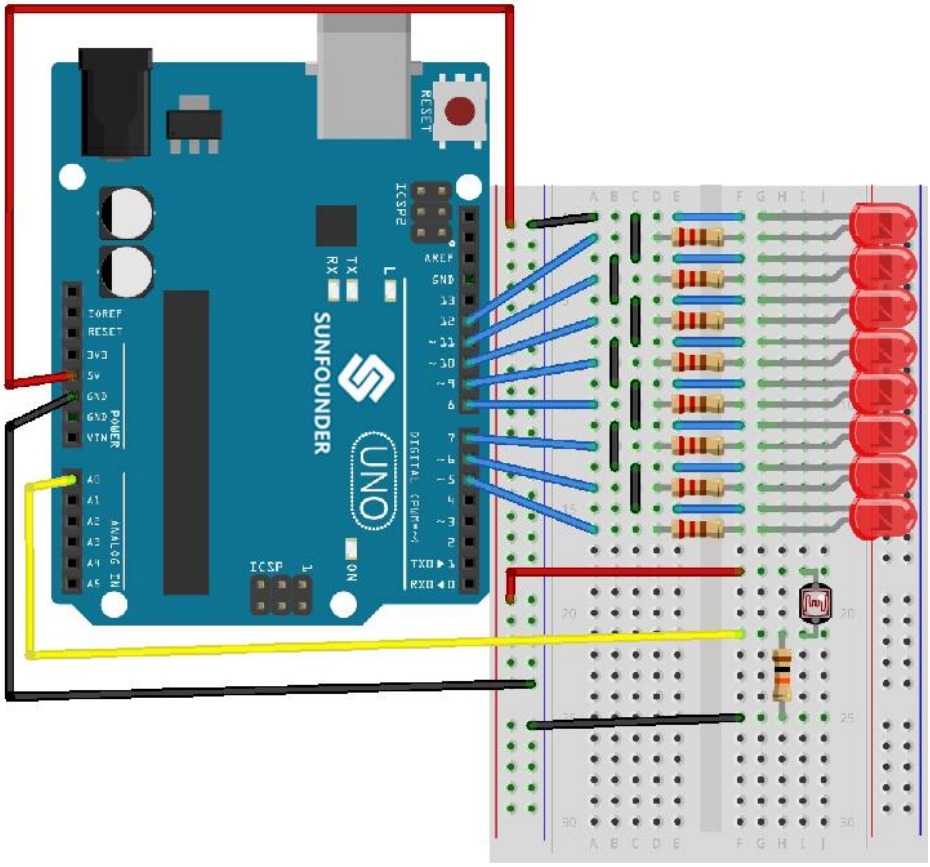
Experimental Principle

The resistance of the photoresistor changes with incident light intensity. If the incident light intensity is high, the resistance decreases; if the incident light intensity is low, the resistance increases.

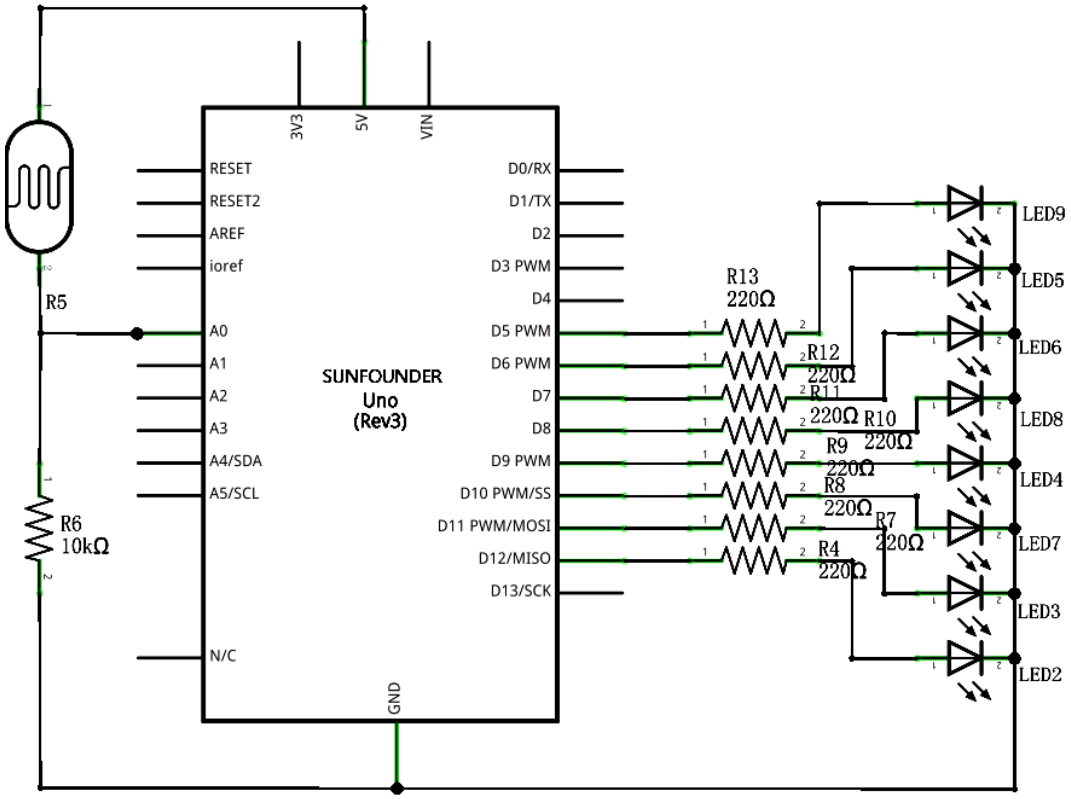
In this experiment, we will use eight LEDs to indicate light intensity. The higher the light intensity is, the more the LED is lit. When the light intensity is high enough, all the LEDs will be lit. When there is no light, all the LEDs will go out.

Experimental Procedures

Step 1: Connect the circuit

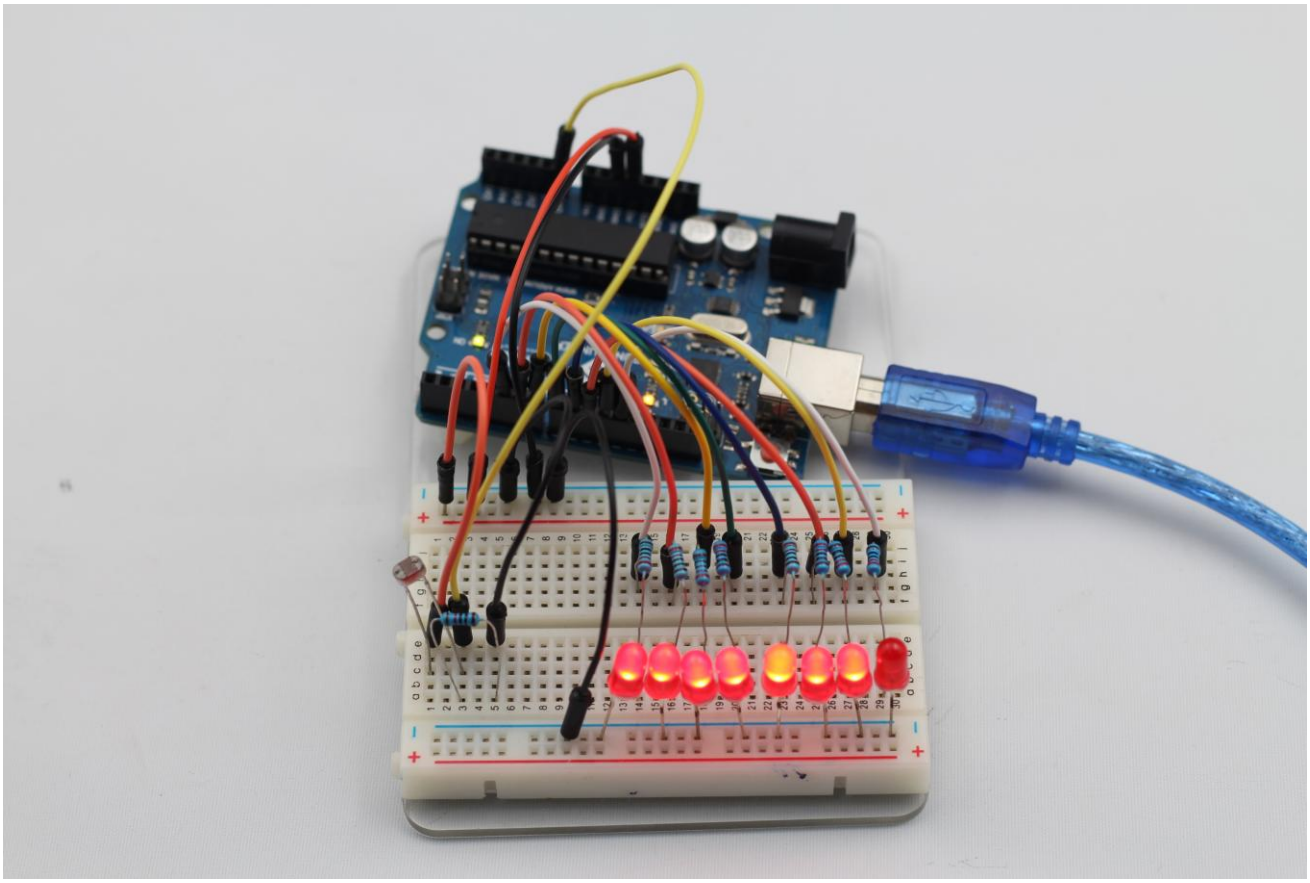


The corresponding schematic diagram is shown as below



Step 2: Program (Please refer to example code in CD provided by us)
Step 3: Compile the program
Step 4: Burn the program into SUNFOUNDER UNO board

Now, if you shine the photoresistor with a certain light intensity, you will see several LEDs light up. If you increase the light intensity, you will see more LEDs light up. When you place it in dark environment, all the LEDs will go out.



Exploration

In addition, you can replace the photoresistor with a microphone to use LEDs to indicate sound intensity. The higher the sound intensity is, the more LEDs are lit. You can realize this effect by yourself.

Lesson 10 Controlling Voice by Light

Introduction

A photoresistor, also called photocell, is commonly made of cadmium sulfide and some other materials, such as selenium, bismuth sulfide, aluminum sulfide, lead sulfide etc. These materials characterize that its resistance will decrease rapidly when shined by light with specific wavelengths. This is because the carriers generated by the light are all involved in the electric conduction and drift under the function of the external electric field, so as to make the resistance of the photoresistor drops rapidly.

Compoment

- 1*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1*USB data cable
- 1*Photoresistor
- 1*Buzzer
- 1*Resistor (10K)
- Several jumper wires

Experiment Principle

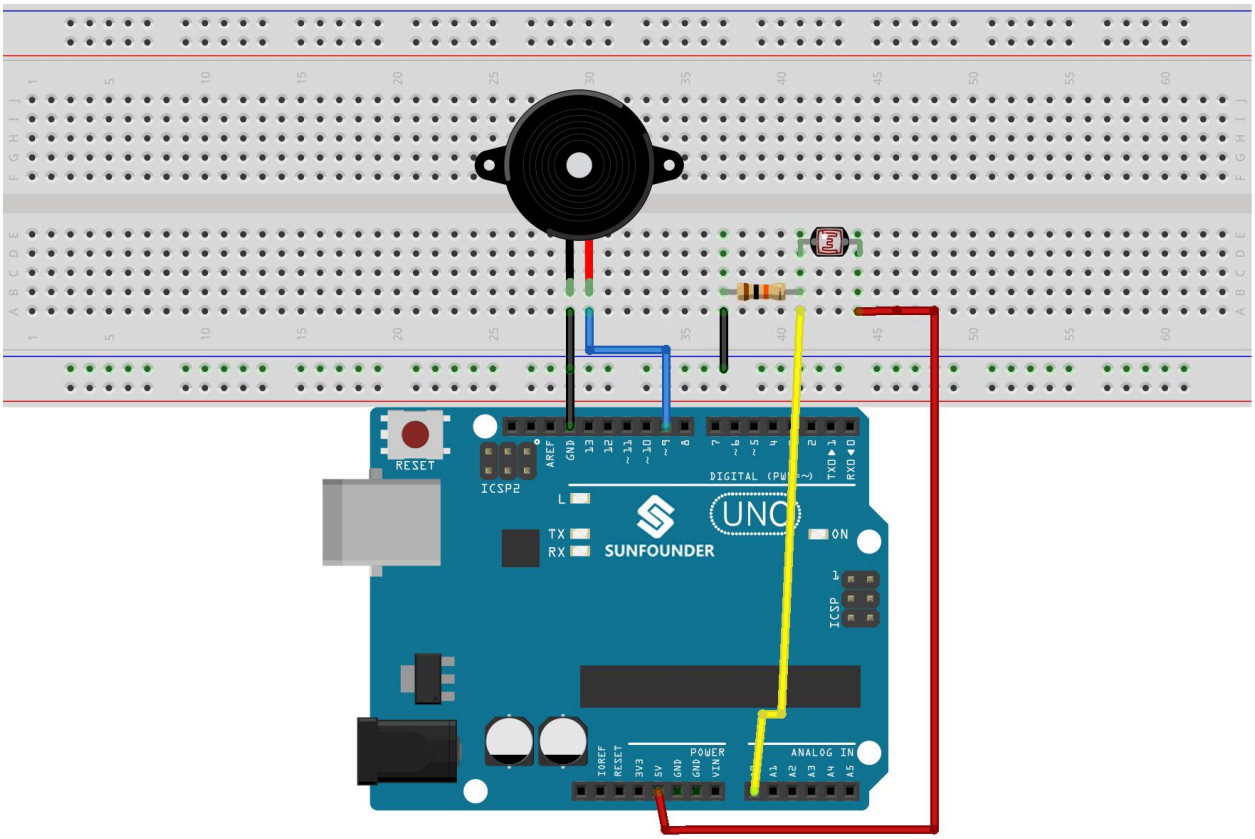
When being shined, if incident light is strong, the resistance of the photoresistor will decrease; if incident light is weak, the resistance of the photoresistor will increase.

The output of the photoresistor is sent to analog port A0 of SUNFOUNDER board and then processed by ADC to generate a digital signal. We use this digital signal as the parameter of function **delay** to make the buzzer beep.

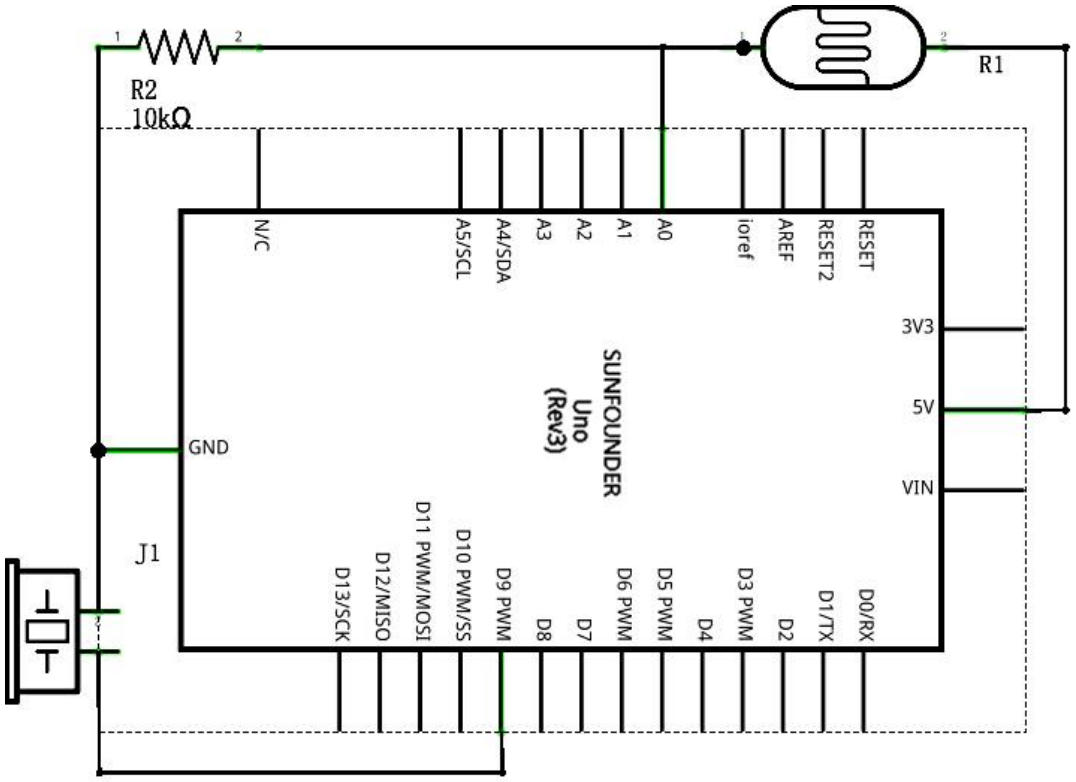
When the incident light is strong, the output value is big, thus the buzzer will tick slowly; when incident light is weak, the output value is small, thus the buzzer will tick hurriedly.

Experiment Procedures

Step 1: Connect the circuit

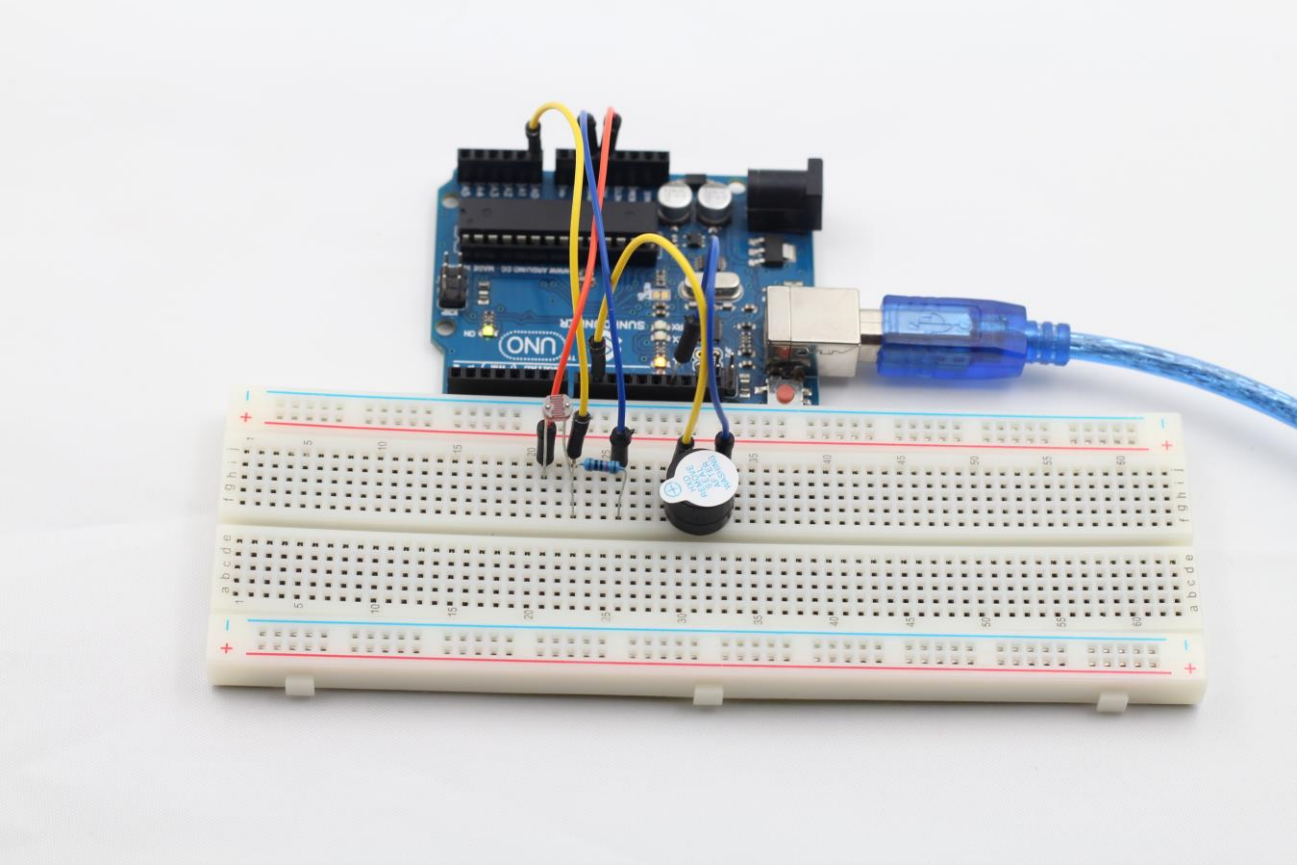


The corresponding schematic diagram is shown as below



Step 2: Program (Please refer to example code in CD provided by us)
Step 3: Compile the program
Step 4: Burn the program into SUNFOUNDER UNO board

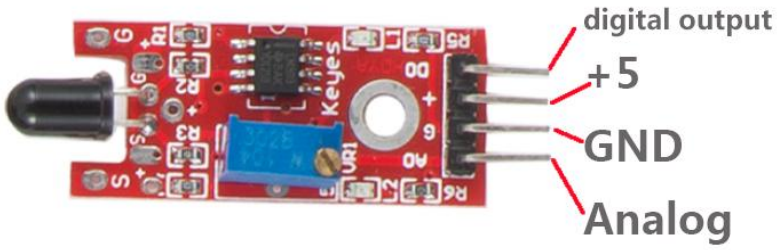
Now, if you place the photoresistor in dark environment, the buzzer will beep hurriedly; if you use a torch to shine the photoresitor, the buzzer will beep slowly.



Lesson 11 Flame Sensor

Introduction

A flame sensor (as shown below) performs detection by capturing infrared wavelengths from flame.



Components

- 1*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1*USB data cable
- 1*Flame sensor module
- Several jumper wires

Experimental Principle

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

In this experiment, we connect pin D0 to digital port 8 of SUNFOUNDER. When the Flame sensor detects flame signals, the LED will be on. Otherwise it will be off.

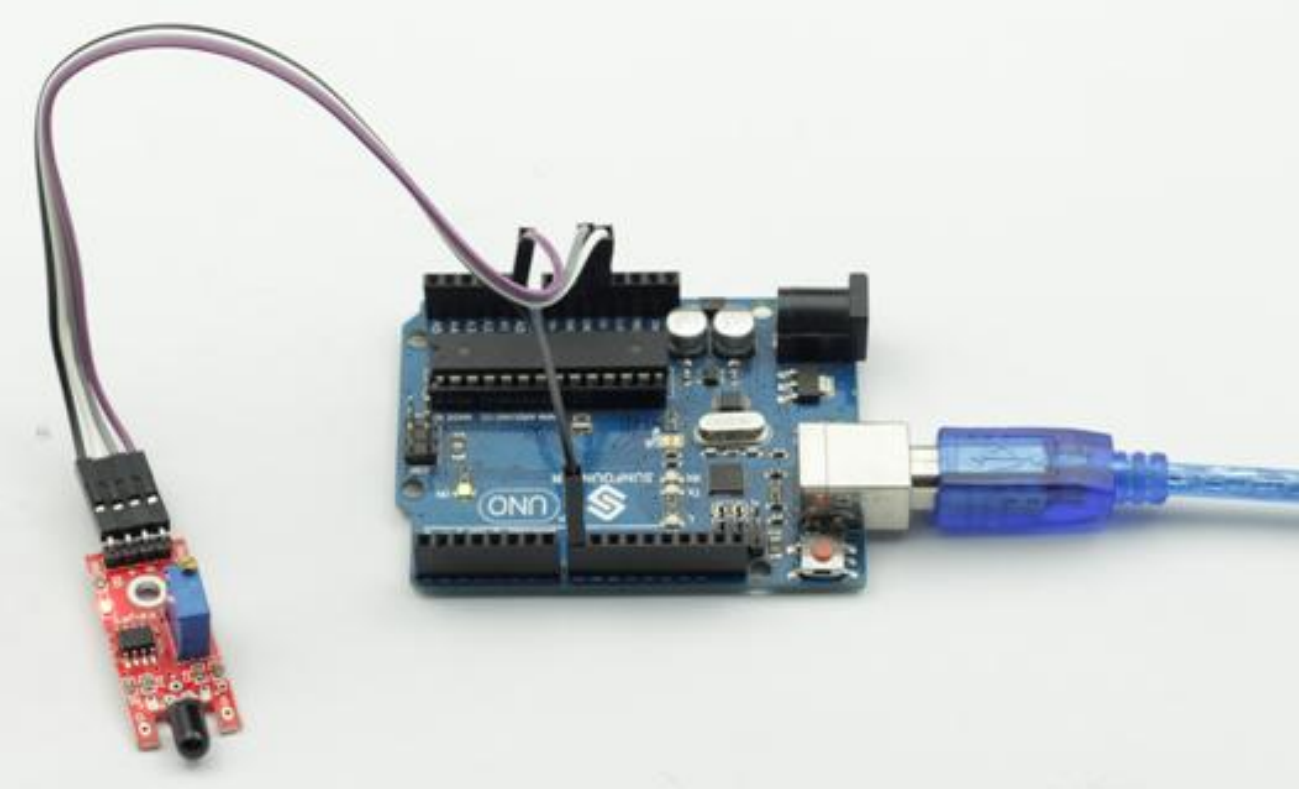
Experimental Procedures

Step 1: Connect the circuit according to the following method

Flame module	**SUNFOUNDER UNO**
AO	A0
G	GND
+	5V
DO	Digital 8

Step 2: Program (Please refer to example code in CD provided by us)
Step 3: Compile the program
Step 4: Burn the program into SUNFOUNDER UNO board

Now, if you ignite a lighter near the flame sensor, the LED on the flame sensor module and the LED attached to pin 13 on SUNFOUNDER board will light up.



Lesson 12 Voltmeter

Introduction

In this lesson, we will use a potentiometer and an I2C LCD1602 to make a voltmeter.

Components

- 1*SUNFOUNDER UNO board
- 1*USB data cable
- 1*Potentiometer
- 1*I2C LCD1602
- Several jumper wires

Experimental Principle

In this experiment, we use the potentiometer to divide voltage.

Since the MCU built-on SUNFOUNFRT UNO board can only read digital signals, but what the adjusting end of the potentiometer outputs is analog signal, so we need to convert these analog signals into digital signals with an ADC (Analog to Digital Convertor). Fortunately, the SUNFOUNFRT UNO board itself comes with an ADC which is 10-bit. Therefore, we can use it to finish this conversion. Then we make this digital output voltage display on the I2C LCD1602.

Experimental Procedures

Step 1: Connect the circuit

I2C 1602	**SUNFOUNDER**
GND	GND
VCC	5V
SDA	A4
SCL	A5

Potentiometer	**SUNFOUNDER**
Middle pin	A0
Left pin	5V

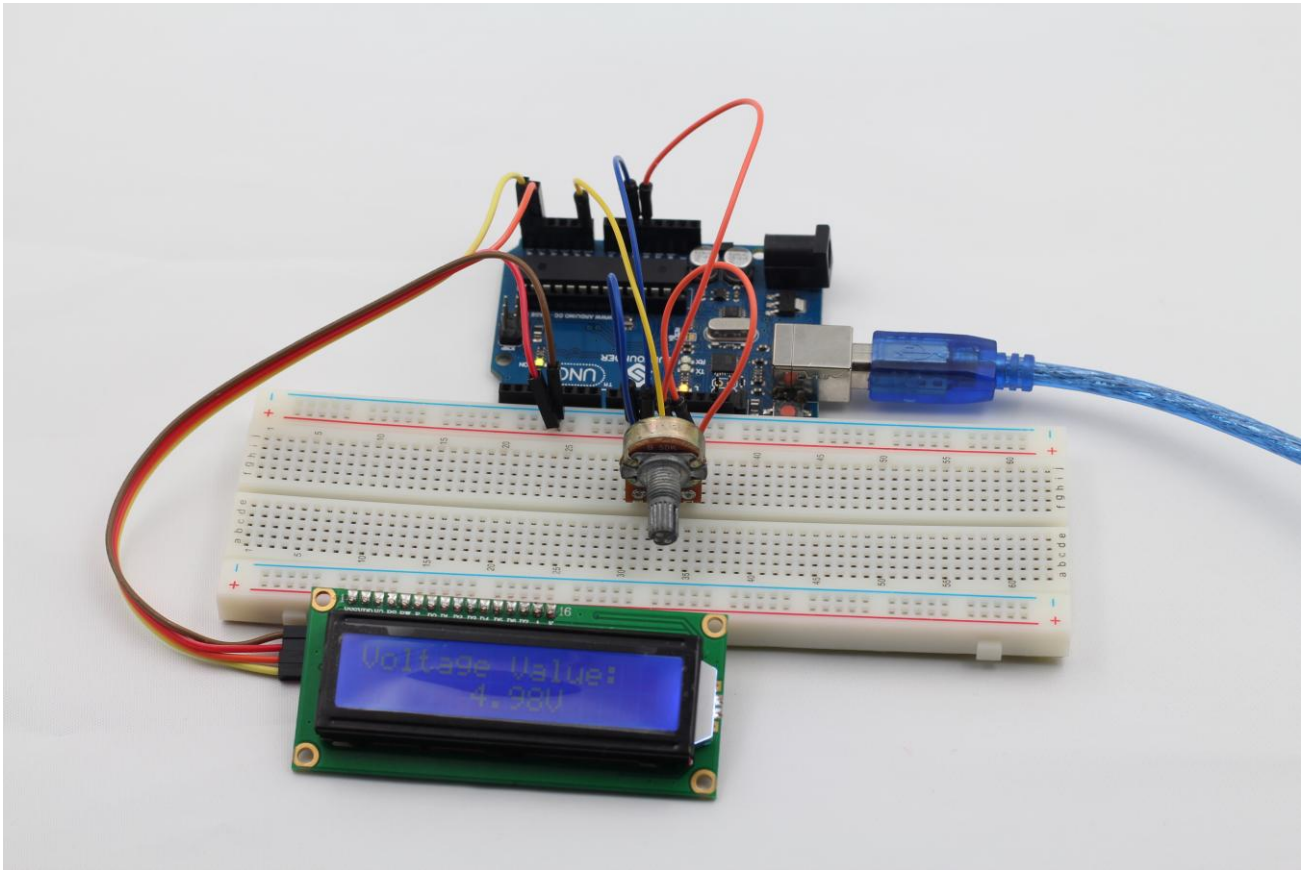
Right pin----------GND

Step 2: Program (Please refer to example code in CD provided by us)

Step 3: Compile the program

Step 4: Burn the program into SUNFOUNDER UNO board

Now, if you adjust the potentiometer, you will see the voltage value displayed on I2C LCD1602 varies.



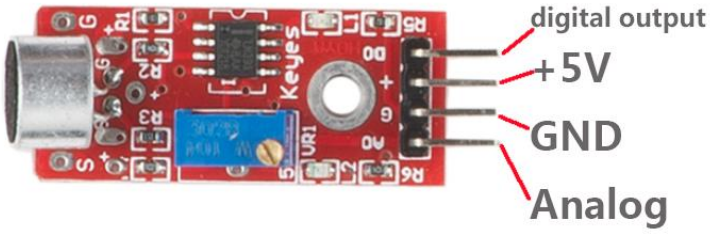
Lesson 13 Voice Sensor

Introduction

A voice sensor module (as shown below) has two outputs:

A0: analog output, used to output voltage signals from microphone in real-time

D0: When sound intensity reaches a certain threshold, the sensor outputs high or low level (threshold can be adjusted by potentiometer)

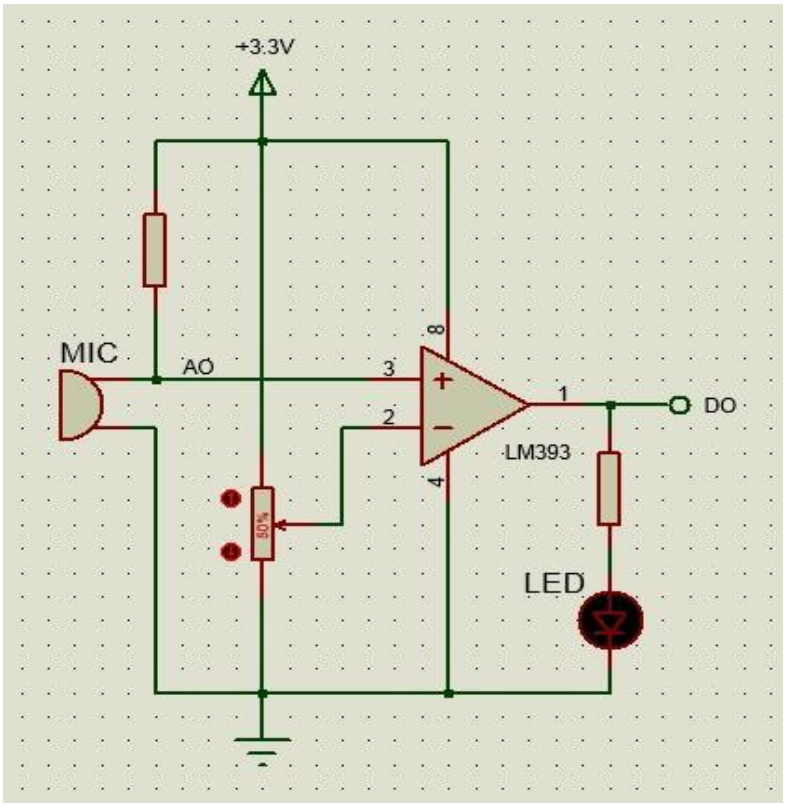


Components

- 1*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1*Breadboard
- 1*USB data cable
- 1*High-Sensitive voice sensor module
- Several jumper wires

Experimental Principle

Microphone can convert audio signal into electrical signal (analog quantity), then convert analog quantity into digital quantity by ADC and transfer it to MCU to process. The schematic diagram of voice sensor module is shown as below:



LM393 is a voltage comparator. When the voltage of in-phase terminal (pin 3) is higher than that of the inverting terminal (pin 2), output terminal (pin 1) will output high. Otherwise, it outputs low. First, adjust potentiometer to make the voltage for pin 2 of LM393 less than 5V. When there is no voice input, the resistance of the microphone is very large. The voltage for pin 3 of LM393 is close to power supply voltage (5V), pin 1 outputs high and the LED is turned on; when there is voice input, the resistance of the microphone decrease, pin 1 outputs low and the LED is turned off. We connect pin 1 to IO of SUNFOUNDER to detect whether a sound is made by programming.

Experimental Procedures

Step 1: Connect the circuit according to the following method

Microphone sensor module **SUNFOUNDER UNO**

AO ---------- A0

G ---------- GND

\+ ---------- 5V

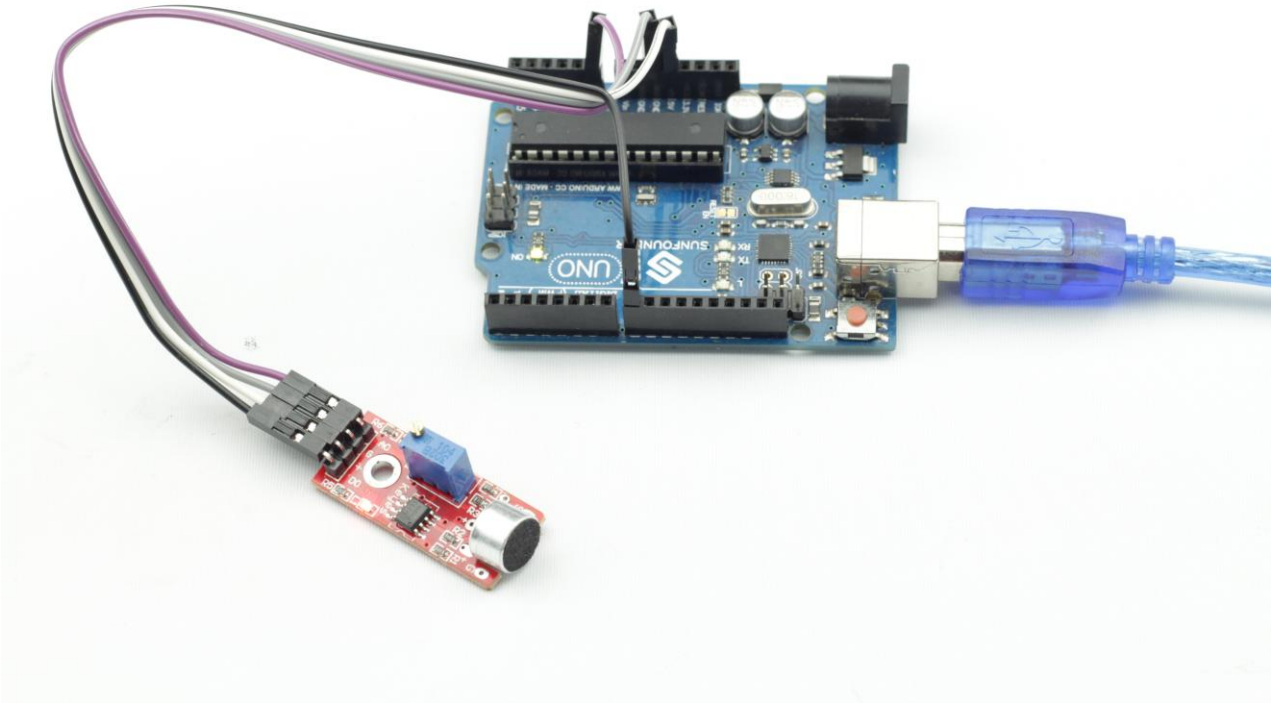
DO ----------Digital 8

Step 2: Program (Please refer to example code in CD provided by us)

Step 3: Compile the program

Step 4: Burn the program into SUNFOUNDER UNO board

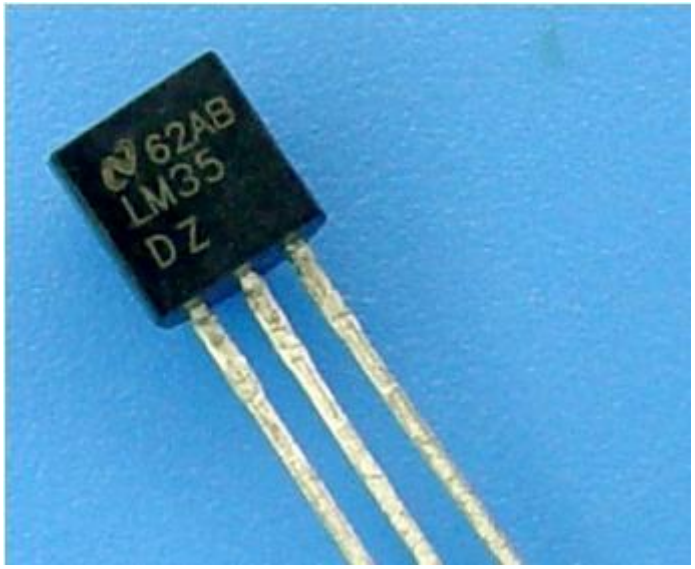
Now, when you speak or blow to the microphone, the LED attached to pin 13 on SUNFOUNDER board will light up.



Lesson 14 LM35 Temperature Sensor

Introduction

LM35 is a temperature sensor produced by national semiconductor. It has very high operational accuracy and wide operating range. With small size, low cost and reliability, LM35 is widely applied in engineering.



Components

- 1*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1*Breadboard
- 1*USB data cable
- 1*LM35 Temperature Sensor
- 1* I2C LCD1602
- Several jumper wires

Experimental Principle

The output voltage of LM35 has a linear relation with the Celsius temperature. When placed in 0℃ ambient temperature, it will output 0V. When ambient temperature increase 1℃, the output voltage will increase 10mV.

The calculation formula is as follows

$$V_{\text{out\_LM35}}(T) = 10\,\text{mV}/^{\circ}\text{C} \times T^{\circ}\text{C}$$

Experimental Procedures

Step 1: Connect the circuit

LM35	**SUNFOUNDER**
+Vs	5V
Vout	A0
GND	GND

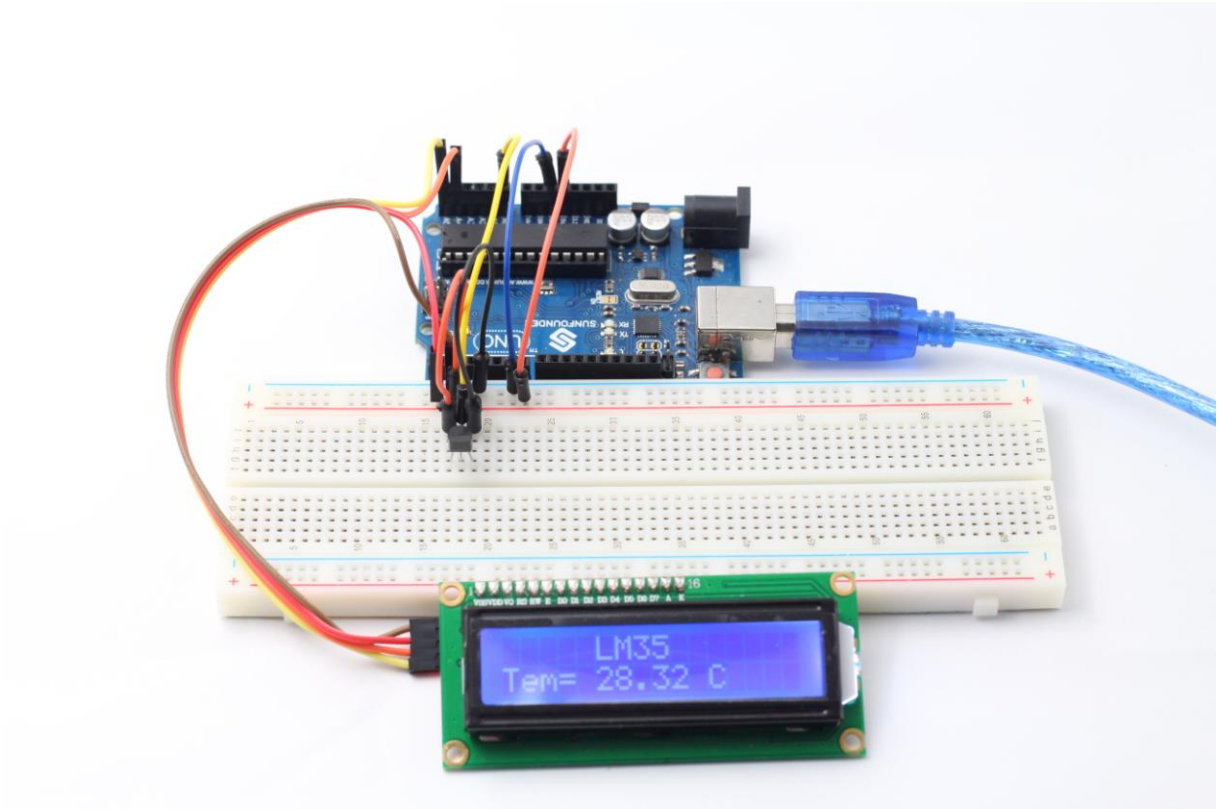
I2C LCD1602	**SUNFOUNDER**
GND	GND
VCC	5V
SDA	A4
SCL	A5

Step 2: Program (Please refer to example code in CD provided by us)

Step 3: Compile the program

Step 4: Burn the program into SUNFOUNDER UNO board

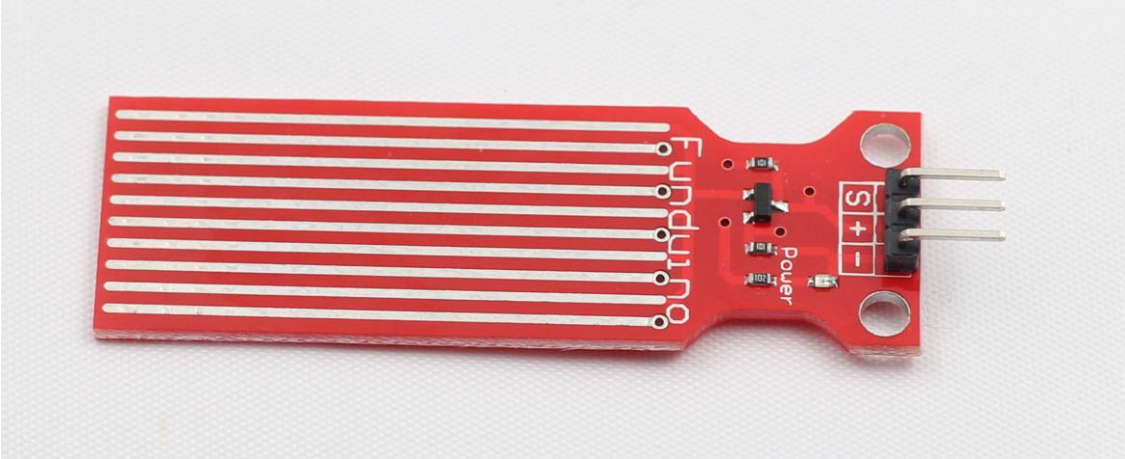
Now, you can see current temperature display on the I2C LCD1602.



Lesson 15 Water Level Sensor

Introduction

In this lesson, we will use a water level sensor to measure the depth of the water and display the result on I2C LCD1602.



Components

- 1*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1*Breadboard
- 1*USB data cable
- 1*Water level sensor
- 1*I2C LCD1602
- Several jumper wires

Experimental Principle

Water level sensor is a module which can sense the depth of the water, whose core part is an amplification circuit composed of a transistor and several comb PCB cables. When placed in water, the comb cable will change its resistance with the depth of the water so as to convert the depth signal of the water to electrical signal. With ADC on SUNFOUNDER UNO board, we can know water depth changes.

Experimental Procedures

Step 1: Connect the circuit

Water level sensor	**SUNFOUNDER**
"-"	GND
+	5V

S----------A0

I2C LCD1602 **SUNFOUNDER**

GND----------GND

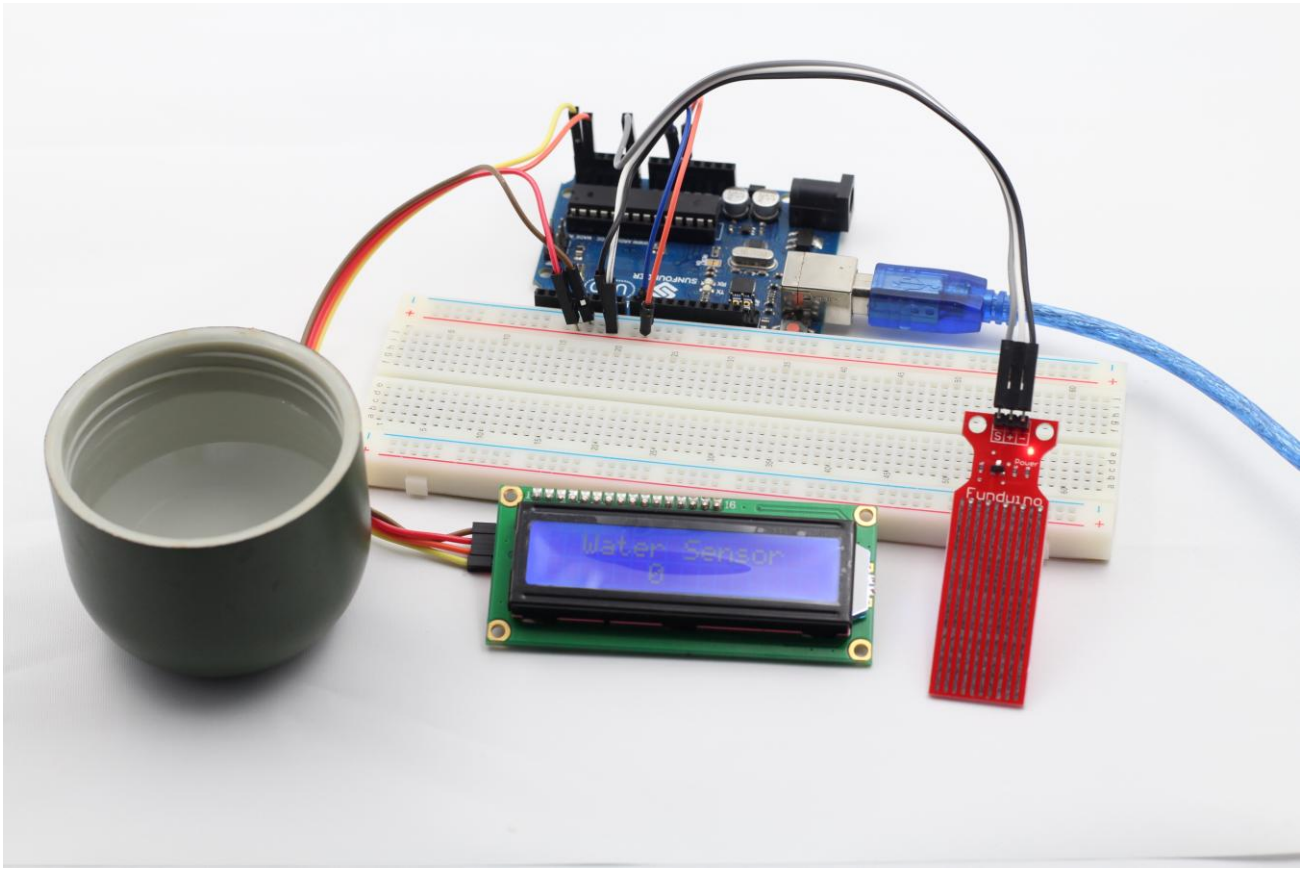
VCC----------5V

SDA----------A4

SCL----------A5

Step 2: Program (Please refer to example code in CD provided by us)
Step 3: Compile the program
Step 4: Burn the program into SUNFOUNDER UNO board

Now, if you immerse it in water, you can see the depth of the water in which the water level sensor soaked display on the I2C LCD1602.



Lesson 16 One Digit 7-Segment Display

Introduction

Today let us play with a one digit 7-segment display which is made up with an array of common cathode LEDs parallel connected together. A 7-segment display is a simple and common component for displaying numbers or characters. The code we use this time illumes only one light on the 7-segment display per unit time. The high refresh rate, higher than the resolution speed of our naked eyes, enables us to see the number 1, 2, 3, etc.. The 7-segment display has the advantage of high and uniform luminance.

Components

- SUNFOUNDER UNO board*1
- One Digit 7-segment display *1
- 220 Ohm resistor *8
- USB data cable *1
- Several connecting wires

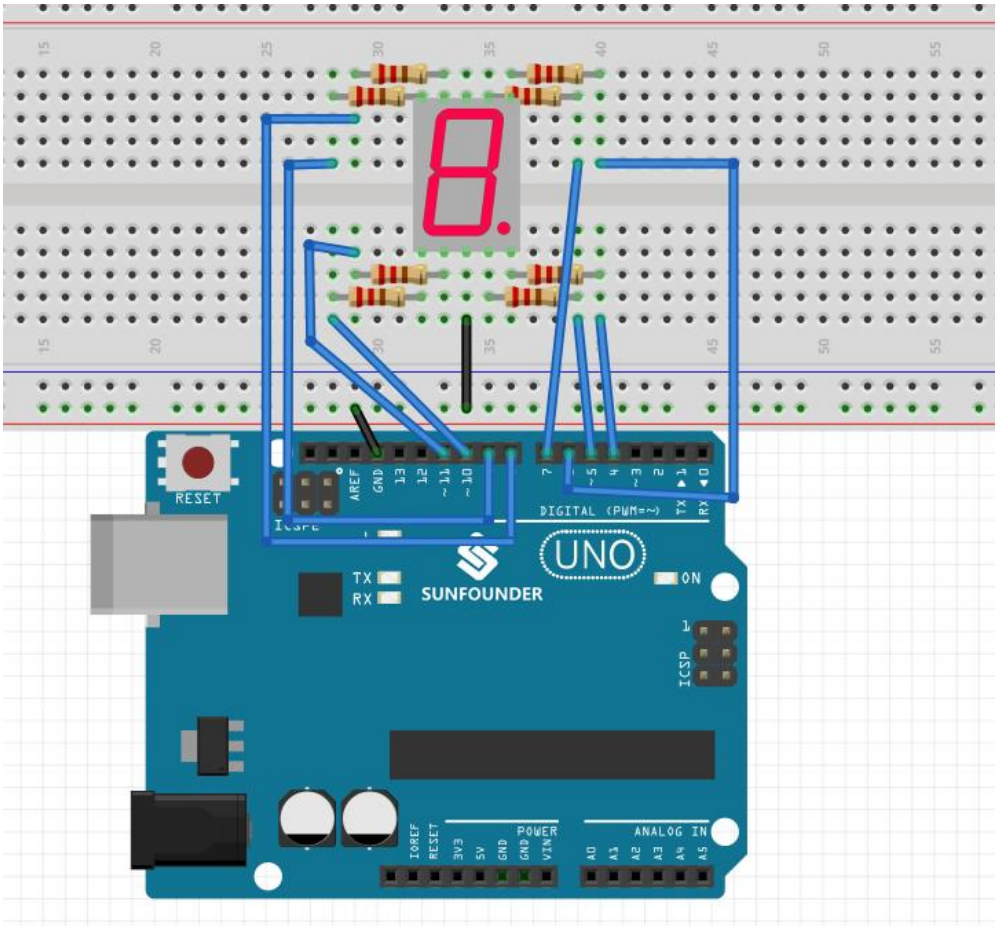
Principle

The 7-segment display, whose basic unit is the light-emitting diode, is a semiconductor light-emitting device. The 7-segment display can be categorized into seven-segment and eight-segment display by the number of segments, and the latter has one more light-emitting diode unit (or one more decimal point display) than the former one. The 7-segment display can be categorized into common anode and common cathode 7-segment display by the connection of light-emitting diodes. Common anode 7-segment display joins all the anodes of light-emitting diodes together to make a common anode (COM). When using common anode 7-segment display, you should connect the COM to +5V. When the cathode of light-emitting diode in a certain segment is low, this segment will be turned on. Whereas, when the cathode is high, the corresponding segment will be turned off. Common cathode 7-segment display joins all the cathodes of light-emitting diodes together to make a common cathode (COM). When using common cathode 7-segment display, you should connect the COM to GND. When the anode of light-emitting diode in a certain segment is high, this segment will be turned on. Whereas, when the anode is low, the corresponding segment will be turned off.

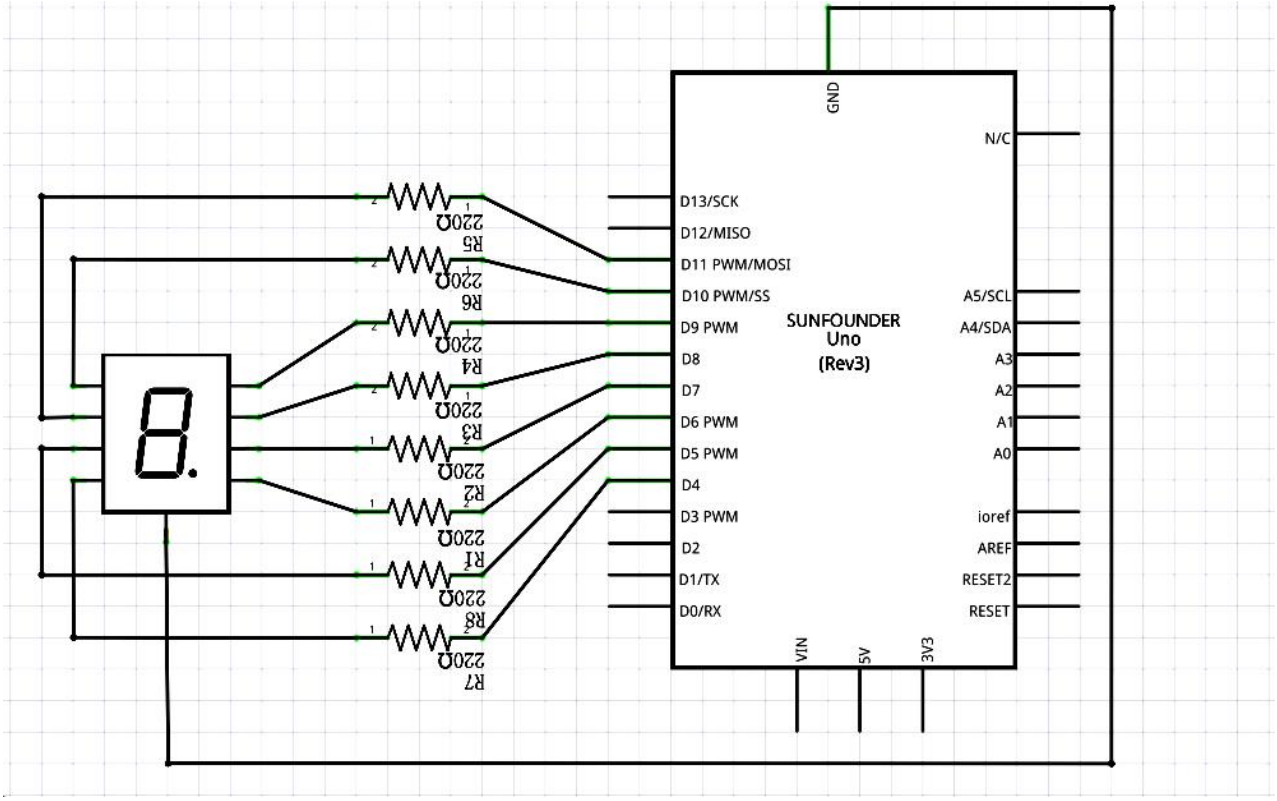
Every segment of the 7-segment display contains a light-emitting diode. As a result, when using a 7-segment display, you should connect a current-limiting resistor like using a light-emitting diode, or the light-emitting diode will be burned due to excessive current. In this experiment, we use common cathode 7-segment display. We should connect the COM to GND. When the anode of light-emitting diode in a certain segment is low, the corresponding segment will be turned off. Whereas, when the anode is high, the corresponding segment will be turned on. Having introduced the principle, let us start to practice.

Experimental Procedures

Step 1: Connect the circuit according to real connection diagram shown below

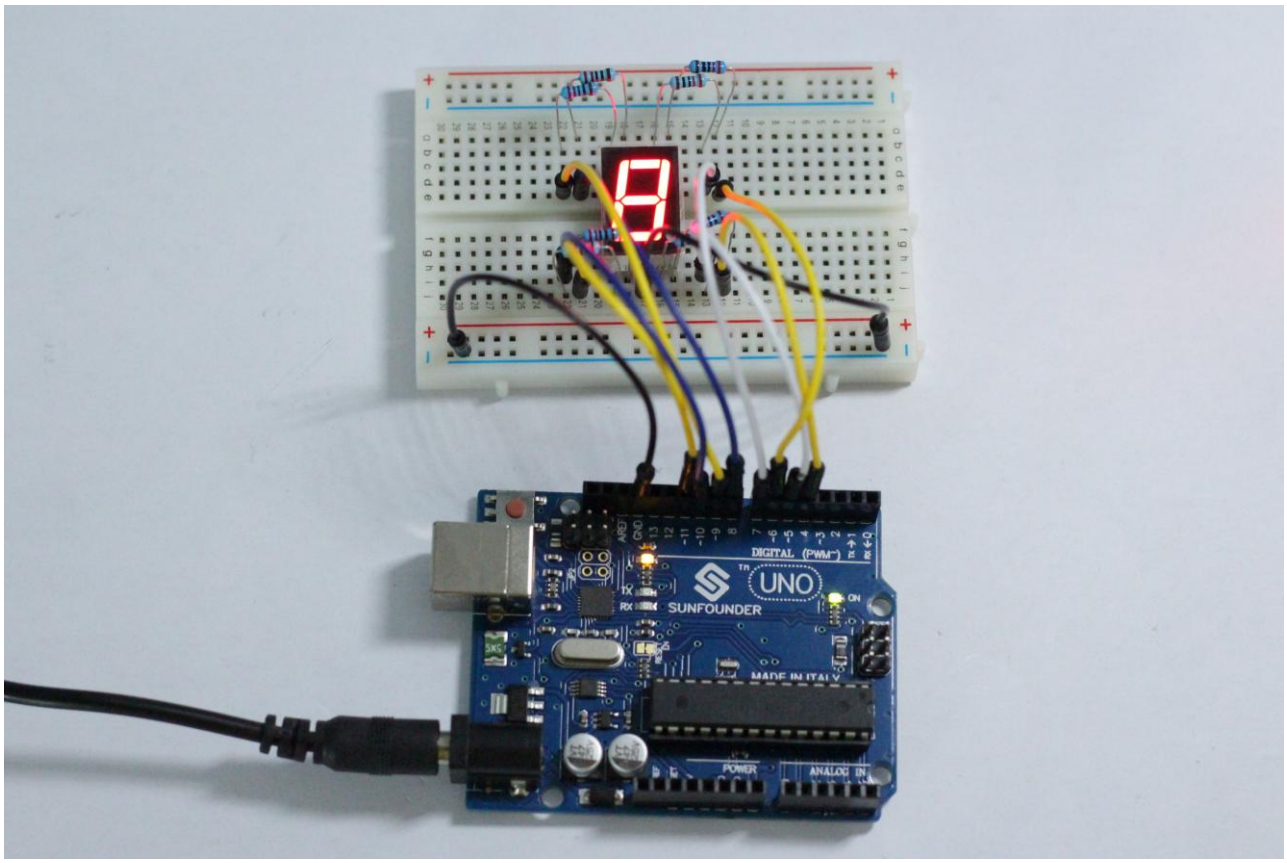


The corresponding schematic diagram is shown as follow



Step 2: Program (Please refer to example code in our CD)
Step 3: Compile and debug the program
Step 4: Burn the program into SUNFOUNDER UNO board

Now, you can see the 7-segment display circularly display from 0 to F. So far the experiment is successfully done.



Lesson 17 Stopwatch

Introduction

In this lesson, we will use a four digit 7-segment display to make a stopwatch.

Components

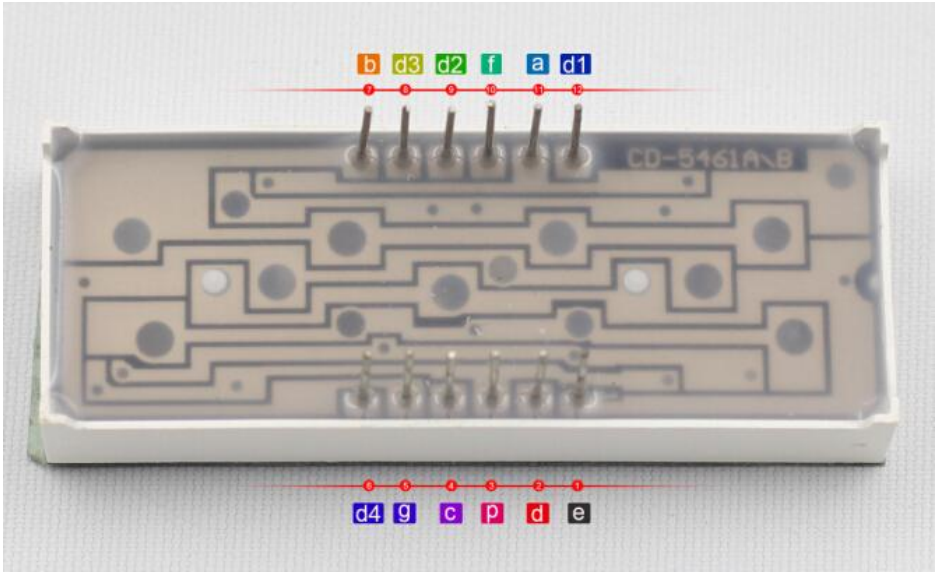
- 1*SUNFOUNDER UNO board
- 1*USB data cable
- 1*Four Digit 7-Segment Display
- 8*Resistor (220 Ohm)
- Several jumper wires

Experimental Principle

When using one digit 7-segment display, if it is common anode, we will connect common anode pin to power source; if it is common cathode, we will connect common cathode pin to GND. When using four digit 7-segment display, the common anode or common cathode pin are used to control which digit is displayed. There is only one digit working. However, based on the principle of Persistence of Vision, we can see four 7-segment display is all displaying numbers. This is because electronic scanning speed is fast and we cannot notice it.

Experimental Procedures

Step 1: Connect the circuit



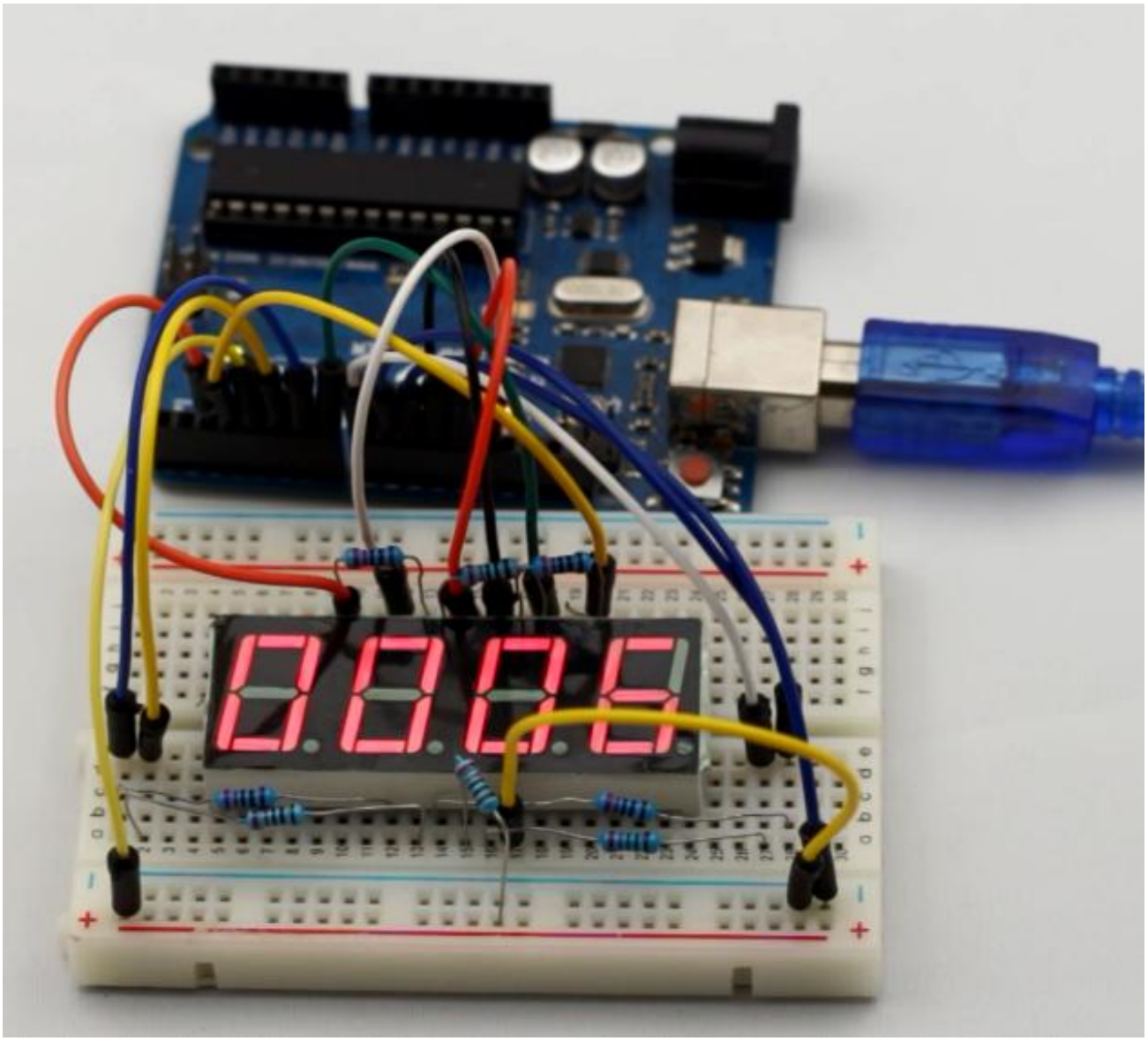
Connect pin a to digital port 2, pin b to digital port 3, pin c to digital port 4, pin d to digital port 5, pin e to digital port 6, pin f to digital port 7, pin g to digital port 8, pin p to digital port 9, d4 to digital port 10, d3 to digital port 11, d2 to digital port 12, d1 to digital port 13.

Step 2: Program (Please refer to example code in CD provided by us)

Step 3: Compile the program

Step 4: Burn the program into SUNFOUNDER UNO board

Now, you can see the number plus one per second on segment display.



Lesson 18 Dot-matrix Display

Introduction

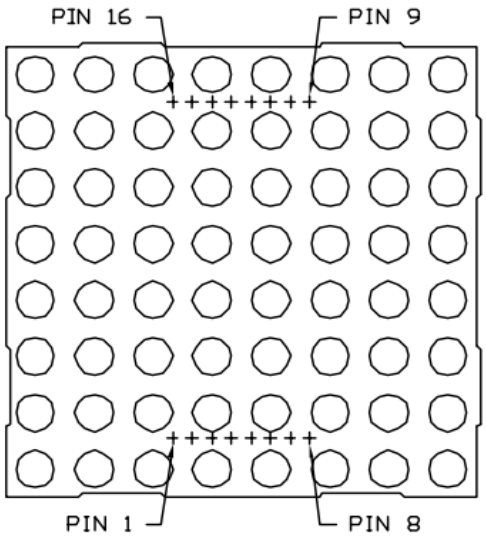
With low-voltage scanning, LED dot-matrix display has such advantages as power saving, long service life, low cost, high brightness, wide angle of view, long visual range, water proof and numerous specifications. LED dot-matrix display can meet the needs of different applications and therefore has a broad development prospect. This time we will conduct an LED dot-matrix experiment to experience the charm of LED dot-matrix by ourselves.

Components

- SUNFOUNDER UNO board*1
- 8*8 dot-matrix *1
- 220 ohm resistor *8
- Breadboard*1
- Several jumper wires

Principle

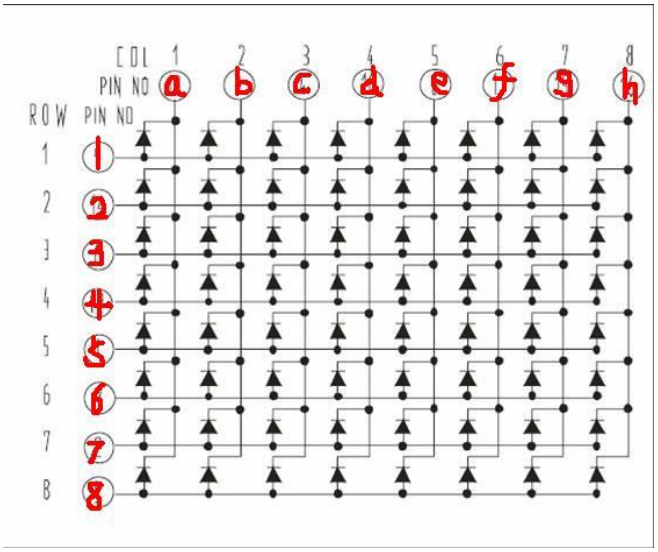
The external view of a dot-matrix is shown as follow:



The display principle of the 8*8 dot-matrix:

The 8*8 dot-matrix is made up of sixty-four LEDs and each LED is placed at the cross point of a row and a column. When the electrical level of a certain row is 1 and the electrical level of a certain column is 0, then the corresponding LED will light up; if you want to light the LED on the first dot, you should set PIN 1 to high level and PIN a to low level, then the LED on the first dot will light up; if you want to light the LEDs on the first row, you should set PIN 1 to high level and PIN (a, b, c, d, e, f, g, h) to low level, then all the LEDs on the first row will light up; if you want to light the LEDs on the first column,

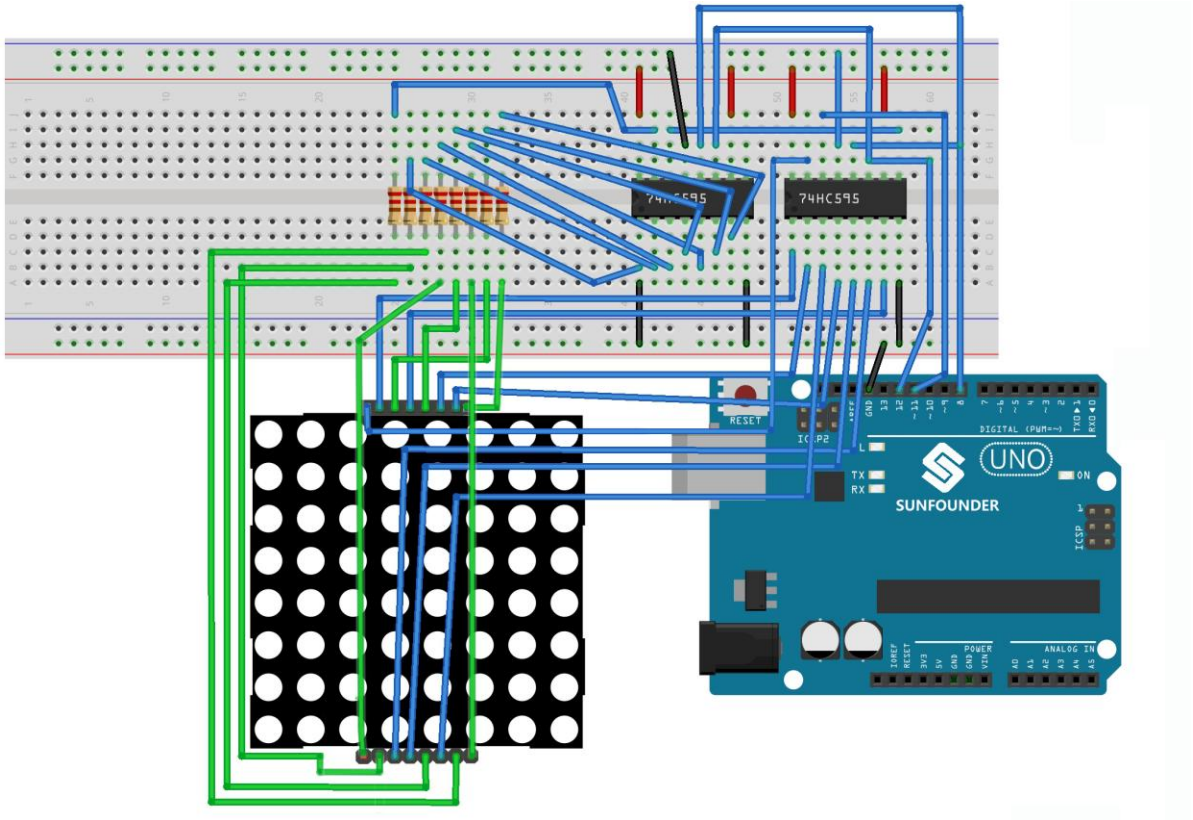
you should set PIN a to low level and PIN (1, 2, 3, 4, 5, 6, 7, 8) to high level, then all the LEDs on the first column will light up.



The principle of 74HC595 has been illustrated previously. One chip is used to control the rows of the dot-matrix while the other chip is used to control the columns.

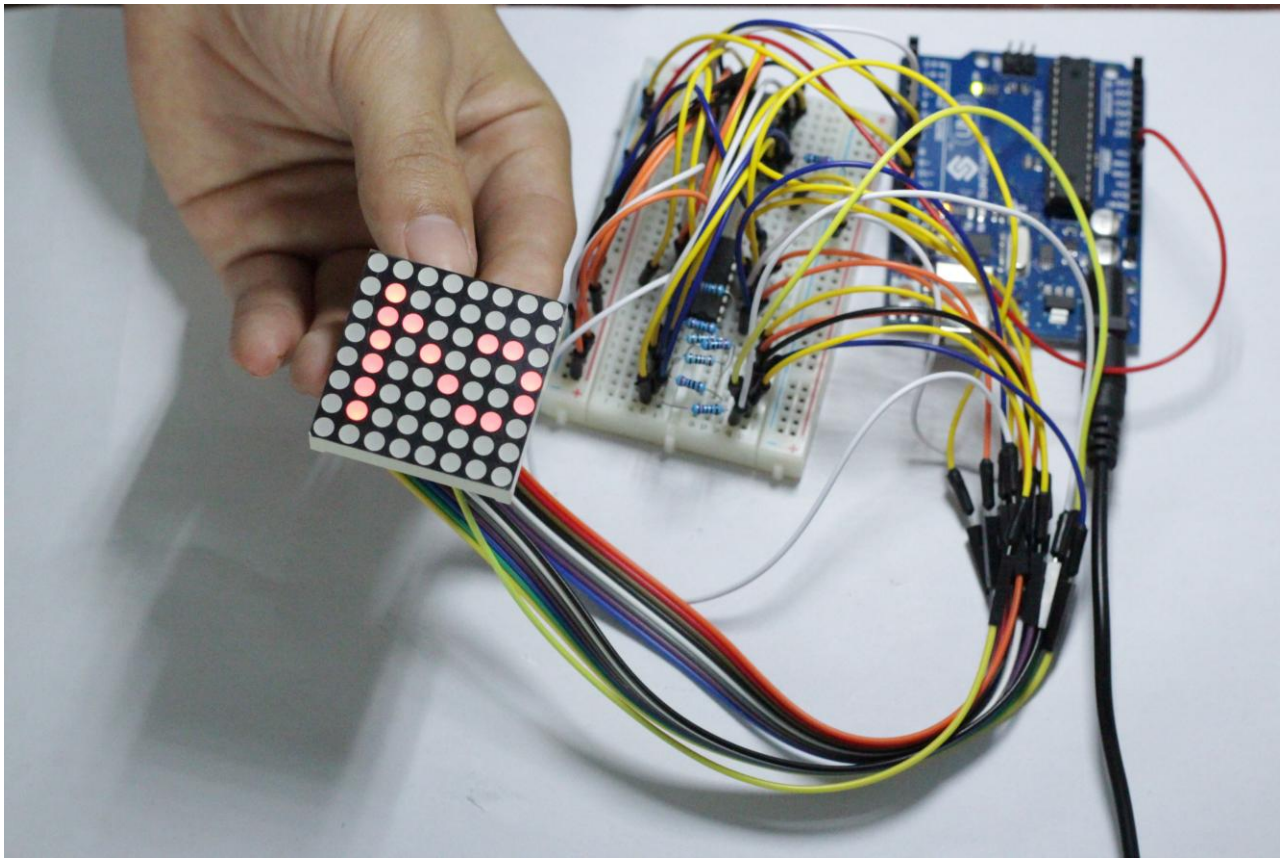
Experimental Procedures

Step 1: Connect the circuit as shown in the following diagram



Step 2: Program (Please refer to example code in our CD)
Step 3: Debug and compile the program
Step 4: Burn the compiled program into SUNFOUNDER UNO control board

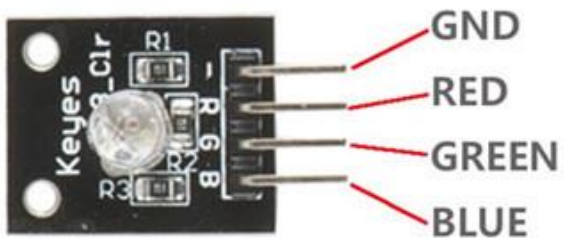
Now, you can see the dot-matrix display from 0 to F circularly.



Lesson 19 RGB LED

Introduction

RGB LEDs can emit various colors of light. They are manufactured by packaging three LEDs of red, green, and blue into a transparent or semitransparent plastic shell and lead out four pins. The three primary colors of red, green, and blue can be mixed to compose all kinds of colors by brightness, so you can make a RGB LED emit colorful light by controlling the circuit.



DIP Package

Components

- 1*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1*USB data cable
- 1*RGB LED module
- Several jumper wires

Experimental Principle

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

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 type and common cathode type. In this experiment, we use common cathode RGB LED.

Experimental Procedures

Step 1: Connect the circuit according to the following method

RGB LED module	**SUNFOUNDER UNO**
R	Digital 8
G	Digital 10

B ---------- Digital 9

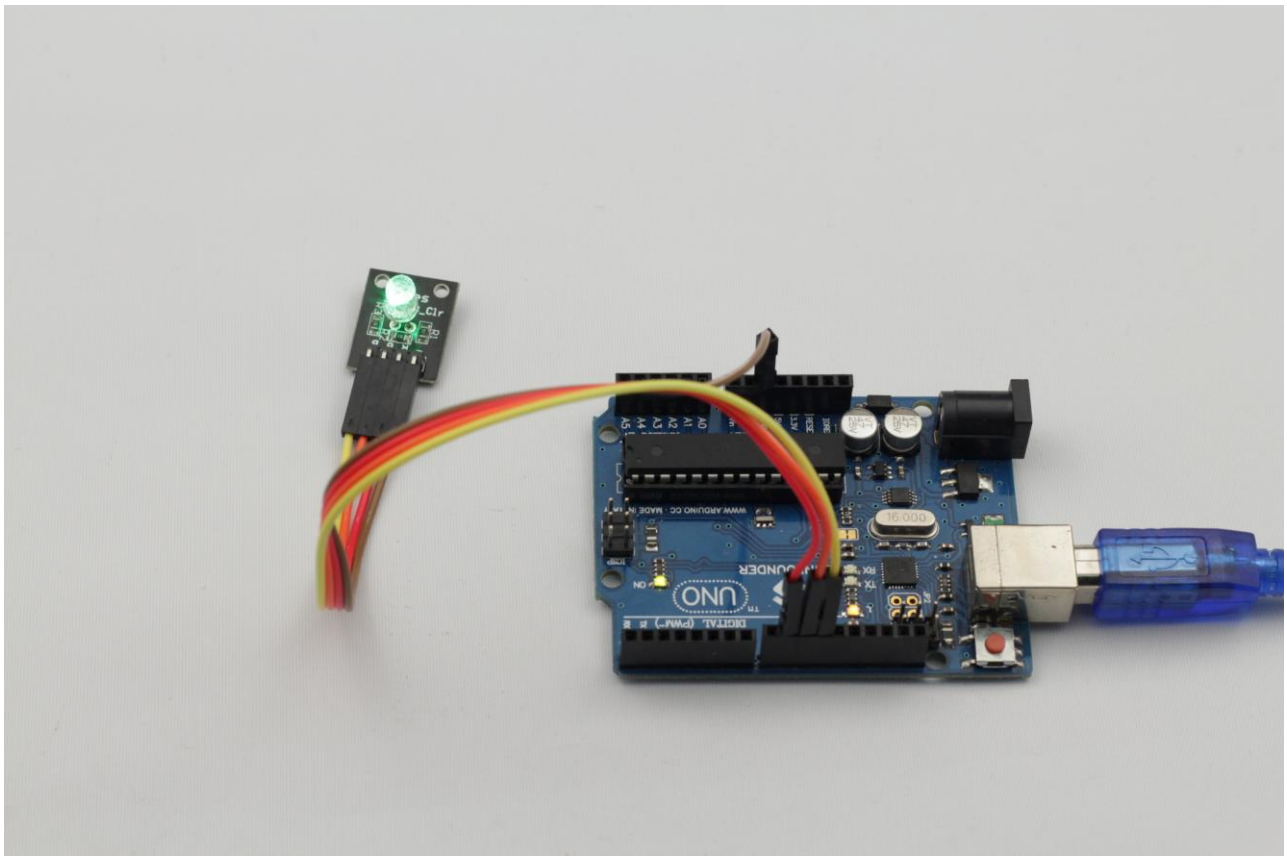
“-” ---------- GND

Step 2: Program (Please refer to example code in CD provided by us)

Step 3: Compile the program

Step 4: Burn the program into SUNFOUNDER UNO board

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



Lesson 20 74HC595

Introduction

In this experiment, we will learn how to use 74HC595 to drive an one digit 7-segment display to display numbers. Generally speaking, there are two methods to drive an one digit 7-segment display. One is to connect 8 pins directly to eight ports of the SUNFOUNDER UNO board, which we have learnt in previous experiment. And the other is to connect 74HC595 to three ports of the SUNFOUNDER UNO board and connect the 7-segment display to 74HC595. In this experiment, we will use the latter. The advantage of the latter method is that you can save five ports, which is very important for SUNFOUNDER UNO with limited ports.

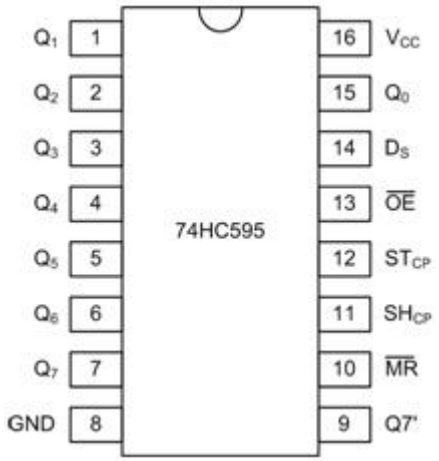
Components

- SUNFOUNDER UNO board*1
- Breadboard *1
- LED*8
- 220 Ohm resistor *8
- 74HC595*1
- Several connecting wires

Principle

74HC595 Principle of Operation

74HC595 has an 8-bit shift register and a memory with three-state output function. Its main function is to transform serial data input into parallel data output so that we can save the IO port resource of MCU. 74HC595 is mainly used in multipath LEDs indication or multi-bit segment displays driving. At the same time, it supports three-state output. When the 13th pin is high, there will be no output in 74HC595. With data latching function, 74HC595 does not affect the instant output during shifting process; with data output function, 74HC595 enable us to cascade 74HC595 more conveniently.



Introduction to Pins of 74HC595

Ds: Serial data input pin

Q0-Q7: 8-bit parallel data output pins, able to control 8 LEDs or 8 pins of 7-segment display directly

Q7': series output pin connected to DS pin of the next 74HC595 to connect multiple 595s in series

OE: output enable pin, effective at low level, connected to the ground directly

MR: reset pin, effective at low level, directly connected to 5V high level in practical applications

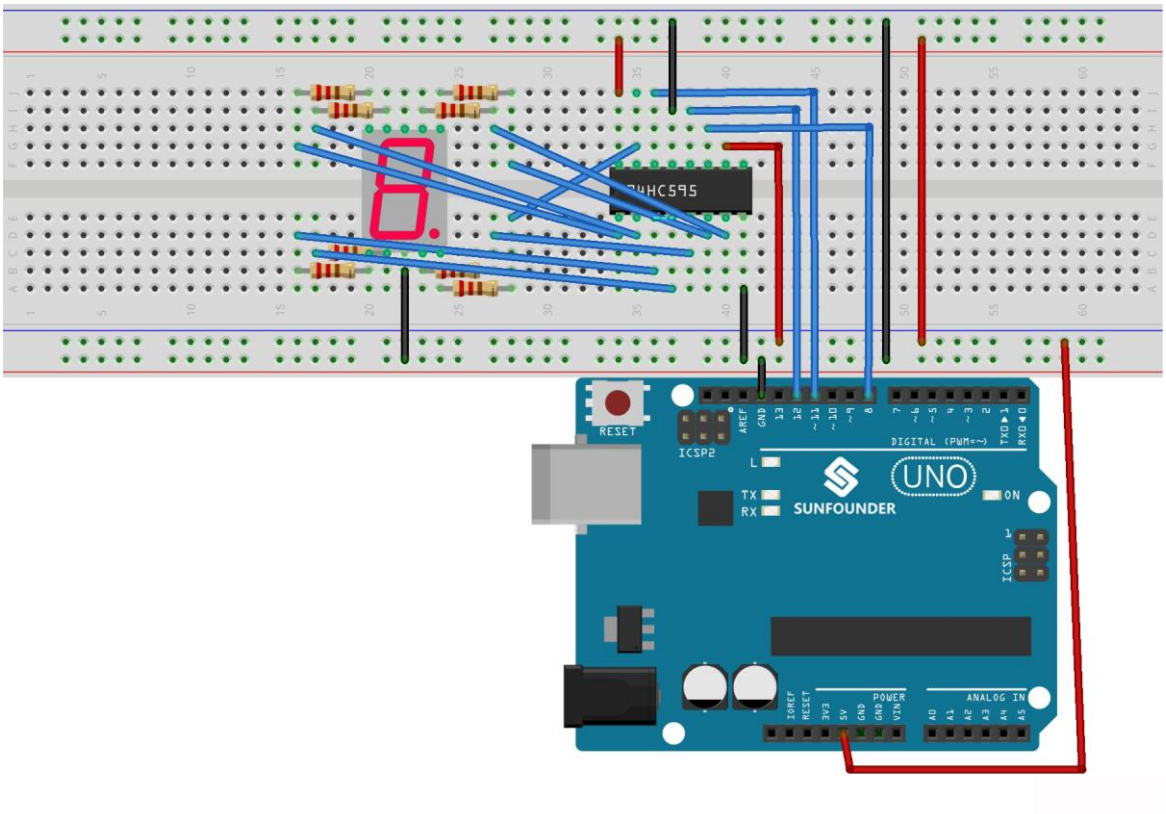
SH: time sequence input of shift register. On the rising edge, the data in shift register moves successively one bit, i.e. Data in Q1 moves to Q2, and so forth. While on the falling edge, the data in shift register remain unchanged

ST: time sequence input of memory register. On the rising edge, the data in shift register moves into memory register

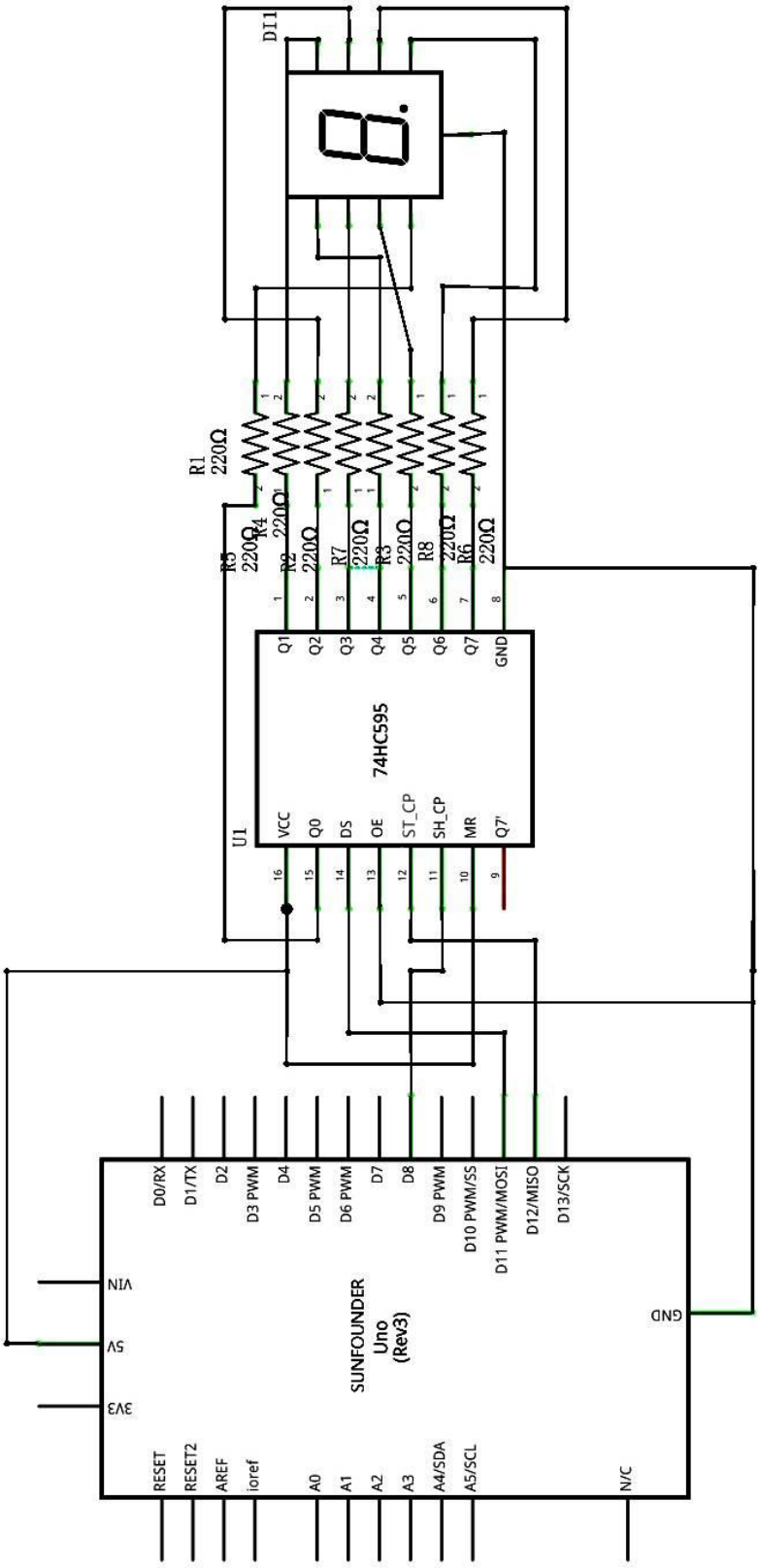
Here we have applied the **shiftout** function which comes with SUNFOUNDER IDE when programming. Just input a number from 0 to 255, memory register can transform it into 8-bit binary number and output it parallel so that you can easily control the 8 pins of the 7-segment display and let it display the patterns as you want.

Experimental Procedures

Step 1: Connect the circuit as shown in the following diagram

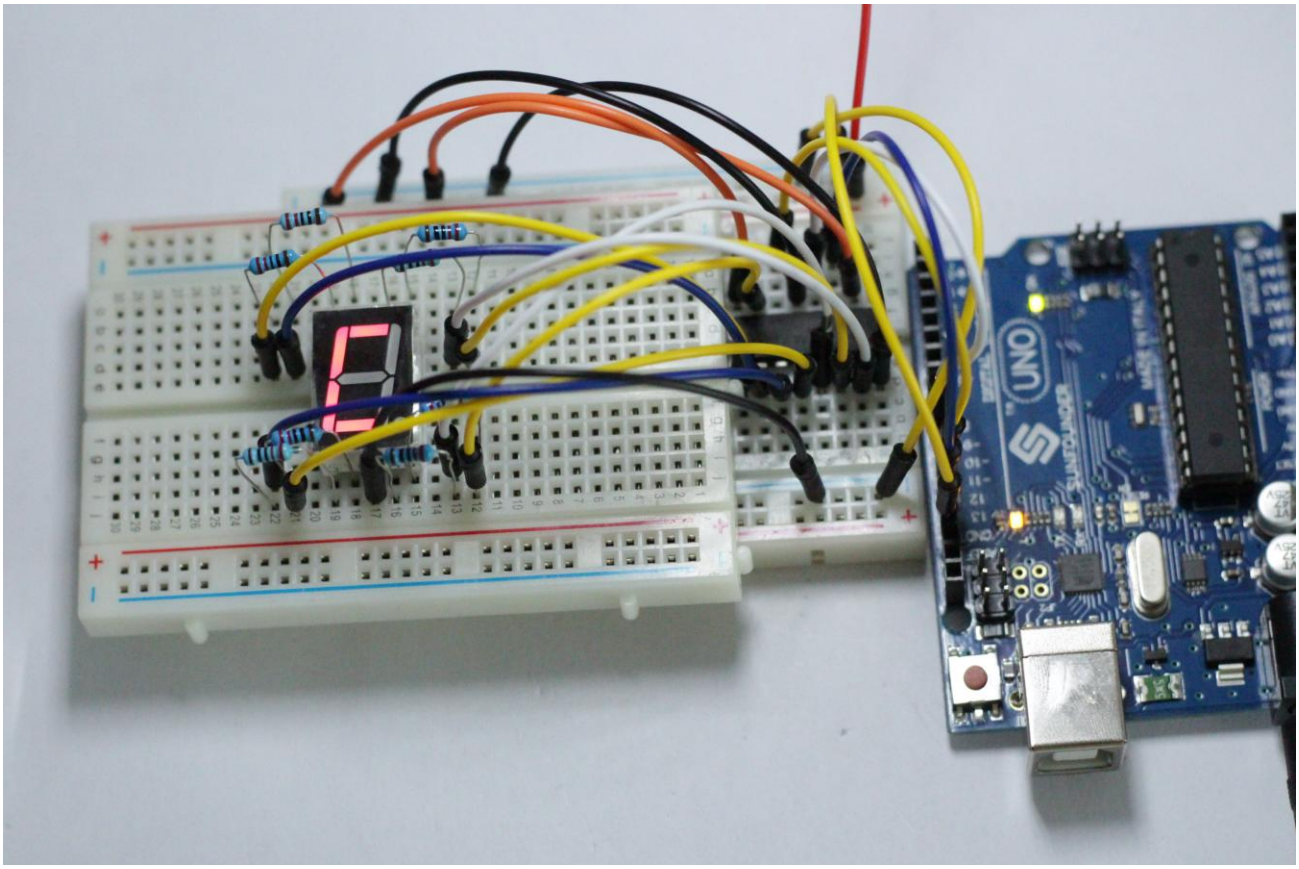


The corresponding schematic diagram is shown as follow



Step 2: Program (Please refer to example code in our CD)
Step 3: Compile and debug the program
Step 4: Burn the compiled program into SUNFOUNDER UNO board

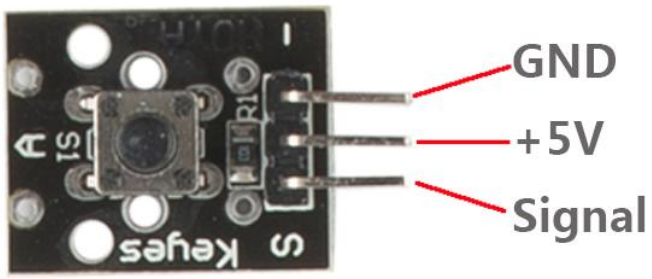
Now, you can see the 7-segment display circularly display from 0 to F.



Lesson 21 Button Switch

Introduction

Most SUNFOUNDER boards already have an LED attached to pin 13 on the board itself. So we will use a button module and this LED to build a simple circuit to make an LED light up.



Components

- 1*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1*USB data cable
- 1*Button module
- Several jumper wires

Experimental Principle

With the LED attached to pin 13, connect the button module to digital pin 8. When the button module inducts button-pressing signals, the LED will be on. Otherwise it will be off.

Experimental Procedures

Step 1: Connect the circuit according to the following method

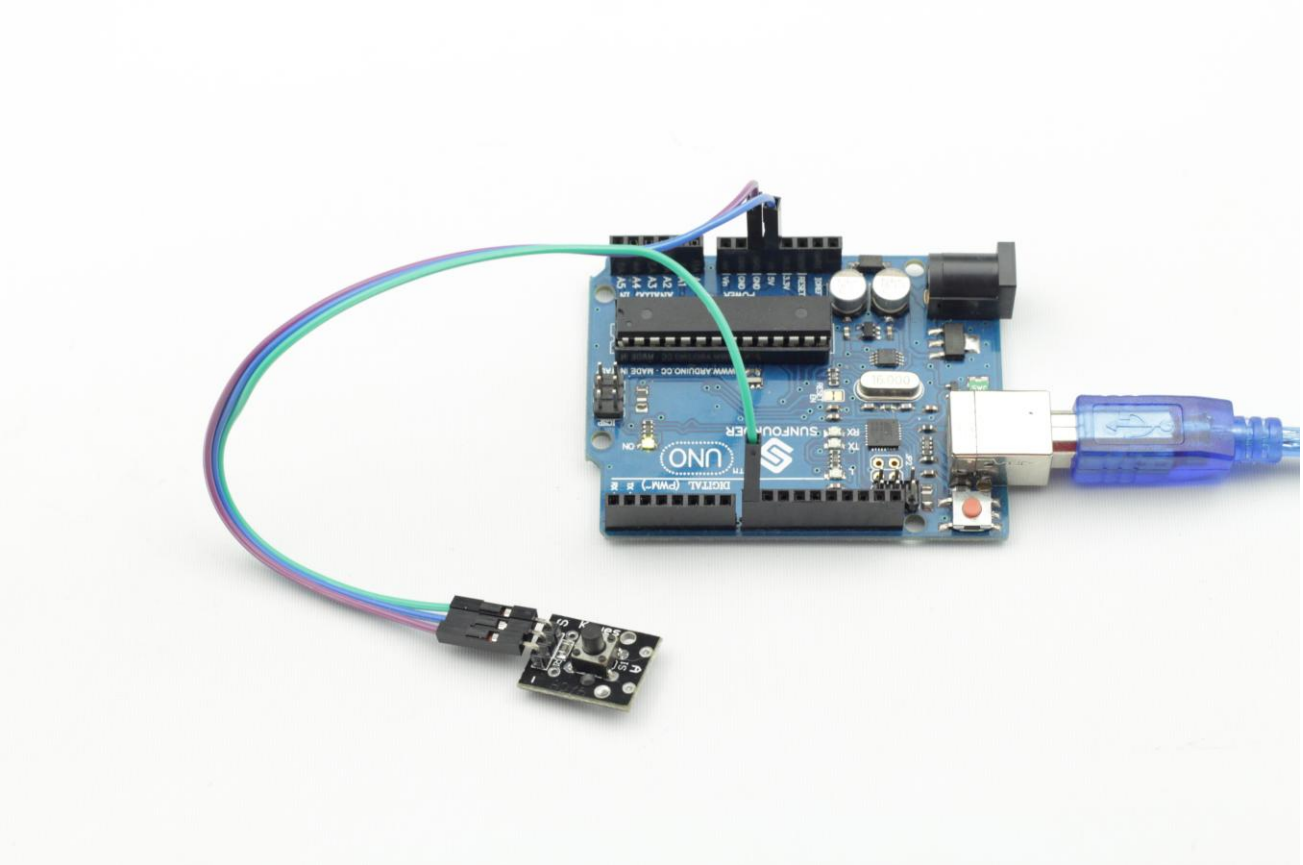
Button Module	**SUNFOUNDER UNO**
S	Digital 8
"-"	GND
+	5V

Step 2: Program (Please refer to example code in CD provided by us)

Step 3: Compile the program

Step 4: Burn the program into SUNFOUNDER UNO board

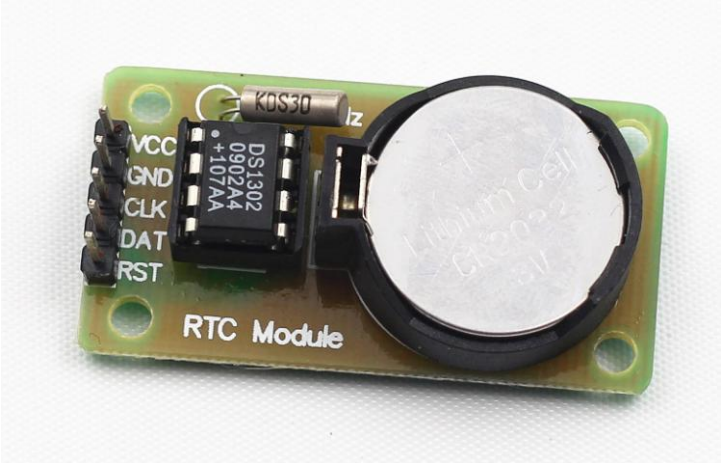
Now, if you press the button, the LED attached to pin 13 on SUNFOUNDER UNO board will light up.



Lesson 22 Clock Module

Introduction

There are many popular serial clock circuits today, such as DS1302, DS1307, PCF8485, etc. They are widely used due to their simple interfaces, low cost, and ease of use. In this lesson, we will use DS1302 real-time clock module as shown below:



Components

- 1*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1*USB data cable
- 1*RTC module
- 1*I2C LCD1602 module
- Several jumper wires

Experimental Principle

DS1302 is a trickle charging clock chip, which is 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 interfaces. 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 24-hour or 12-hour system by AM/PM selection. DS1302 can simply communicate with MCU in synchronous serial way and only need to use three interface cables: RST Reset, I/O data cable and SCLK serial clock.

Experimental Procedures

Step 1: Connect the circuit

I2C 1602	SUNFOUNDER
GND	GND
VCC	5V
SDA	A4
SCL	A5

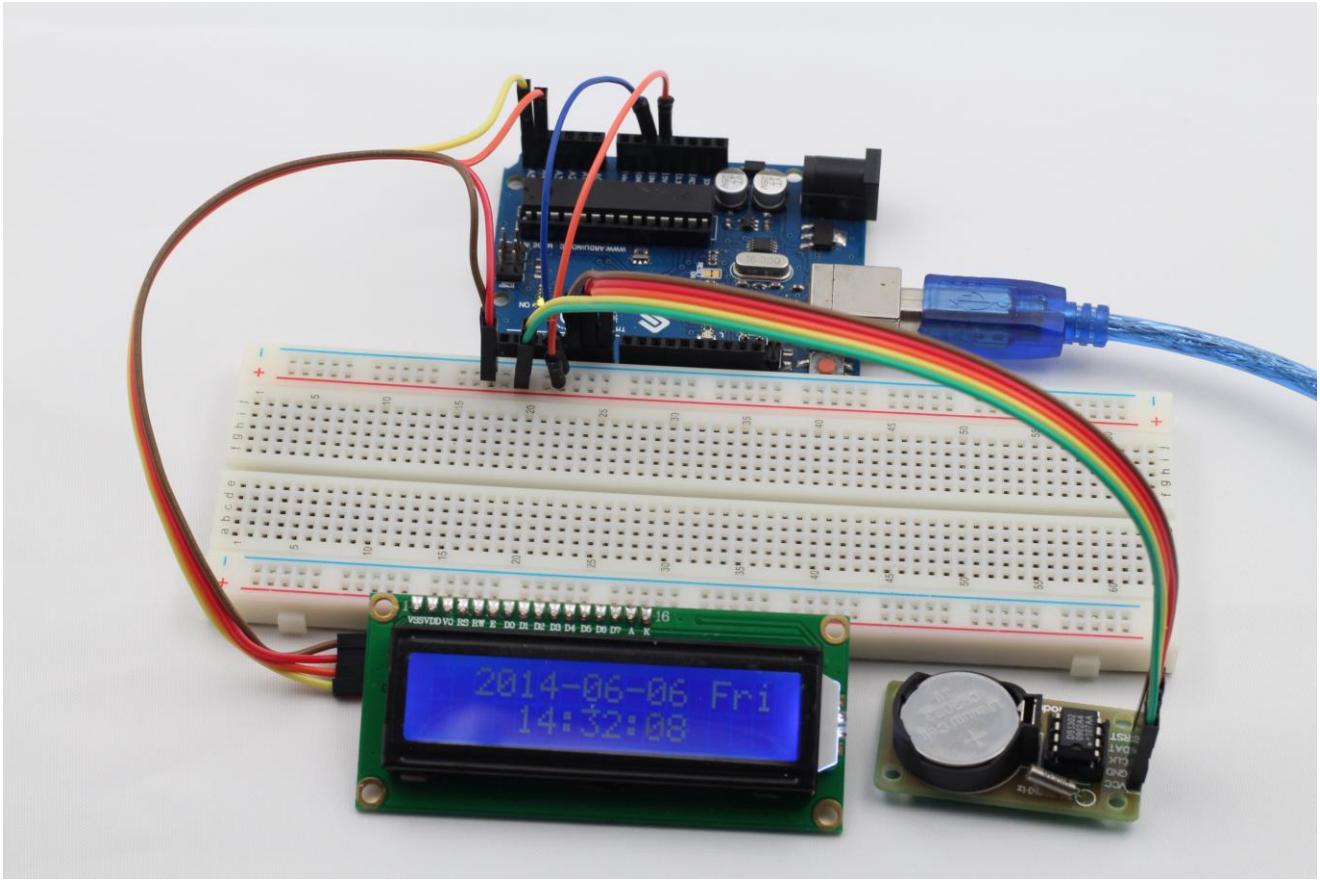
RTC Module	SUNFOUNDER
VCC	5V
GND	GND
CLK	7
DAT	6
RST	5

Step 2: Program (Please refer to example code in CD provided by us)

Step 3: Compile the program

Step 4: Burn the program into SUNFOUNDER UNO board

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

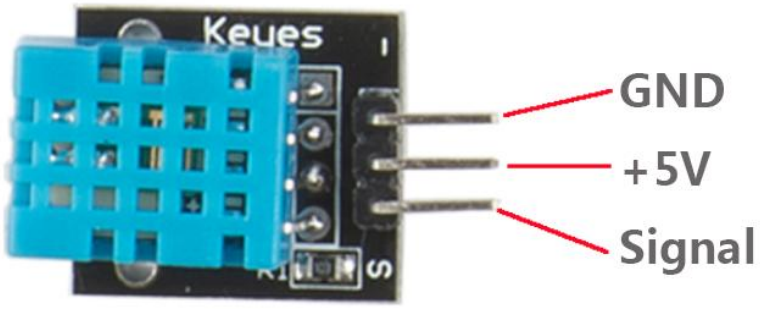


Lesson 23 Humiture Sensor

Introduction

DHT11 digital temperature and humidity sensor (as shown below) is a composite Sensor contains a calibrated digital signal output of the temperature and humidity. Apply a dedicated digital modules collection technology and the temperature and humidity sensing technology to ensure that the product has high reliability and excellent long-term stability.

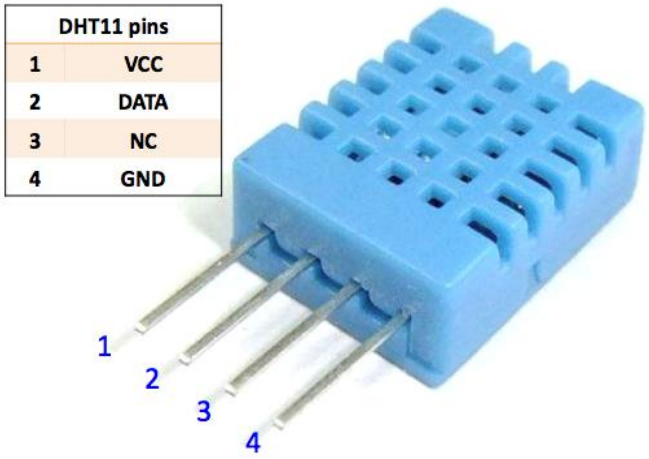
The sensor includes a resistive sense of wet component and a NTC temperature measurement device, and connected with a high-performance 8-bit microcontroller.



Experimental Conditions

- 1*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1*USB data cable
- 1*Humiture sensor module
- 1*I2C LCD1602
- Jumper wires

Experimental Principle



Only three pins are available for use, that is, VCC, GND, and DATA. Communication process begin with DATA line sending starting signal to DHT11, and DHT11 receives the signal and returns a answer signal, then the host receive the answer signal and begin 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 DHT11 datasheet.

Experimental Procedures

Step 1: Connect the circuit according to the following method

Humiture sensor module **SUNFOUNDER UNO**

S ---------- Digital 4

"-" ---------- GND

\+ ---------- 5V

I2C 1602 **SUNFOUNDER**

GND----------GND

VCC----------5V

SDA----------A4

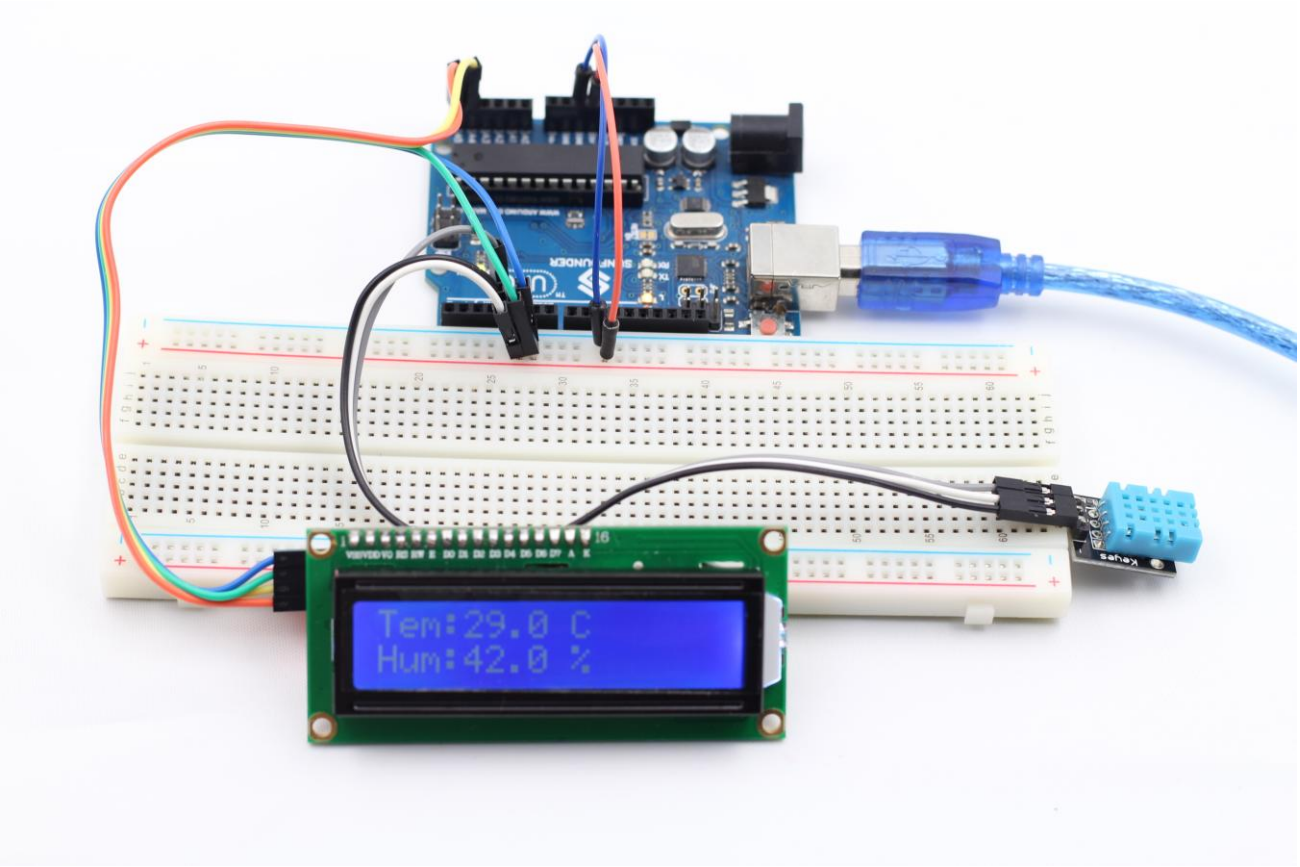
SCL----------A5

Step 2: Program (Please refer to example code in CD provided by us)

Step 3: Compile the program

Step 4: Burn the program into SUNFOUNDER UNO board

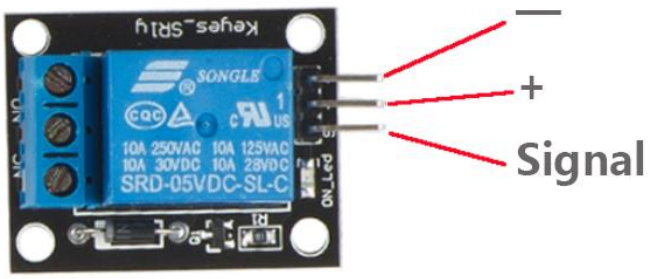
Now, you will see the current value of humidity and temperature displayed on the LCD.



Lesson 24 Relay Module

Introduction

Relays are suitable for driving high power electric equipment, such as lights, electric fans and air conditioning. We can use a relay to realize low voltage to control high voltage by connecting it to MCU.



Components

- 1*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1*USB data cable
- 1*Relay module
- Several jumper wires

Experimental Principle

When we make the IO connected to the SUNFOUNDER and the transistor outputs low level (0V) by programming, the transistor will conduct because of current saturation. The normally open contact of the relay will be closed, while the normally closed contact of the relay will be broken; when outputting high level (5V), the transistor will be cut off, and the relay will recover to initial state.

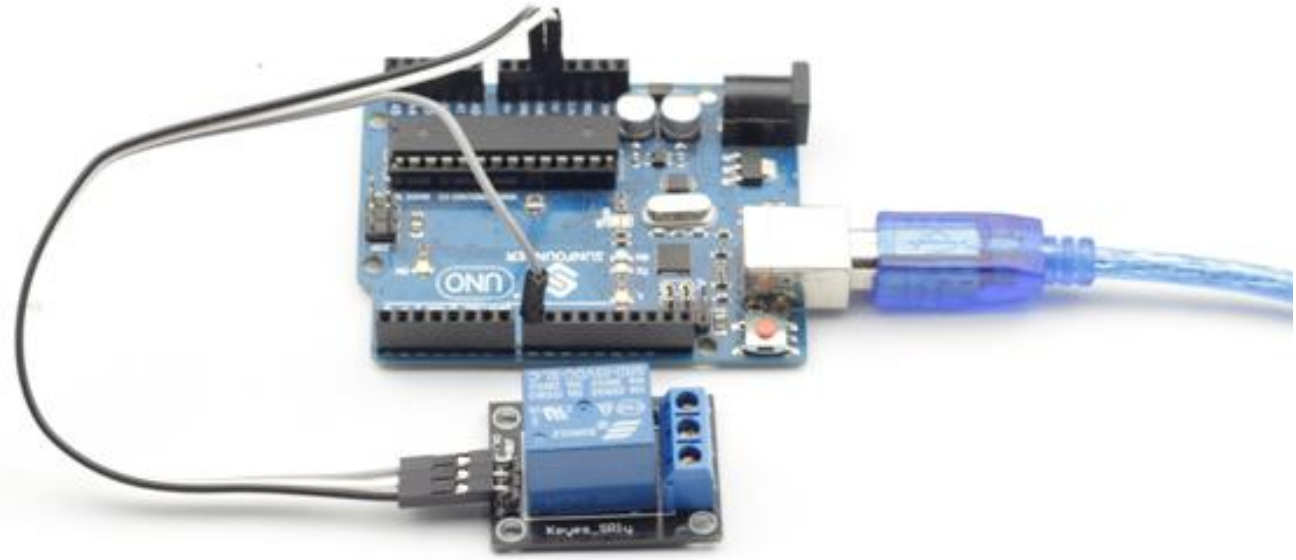
Experimental Procedures

Step 1: Connect the circuit according to the following method

Relay module	**SUNFOUNDER UNO**
S	Digital 8
"-"	GND
+	5V

Step 2: Program (Please refer to example code in CD provided by us)
Step 3: Compile the program
Step 4: Burn the program into SUNFOUNDER UNO board

Now, you should be able to hear ticktock. This sound is made by breaking normally closed contact and closing normally open contact.



Lesson 25 Stepper Motor

Introduction

Stepper motors, due to their unique design, can be controlled to a high degree of accuracy without any feedback mechanisms. The shaft of a stepper, mounted with a series of magnets, is controlled by a series of electromagnetic coils that are charged positively and negatively in a specific sequence, precisely moving it forward or backward in small "steps".

There are two types of steppers, Unipolars and Bipolars, and it is very important to know which type you are working with. In this experiment, we will use an Unipolar stepper.

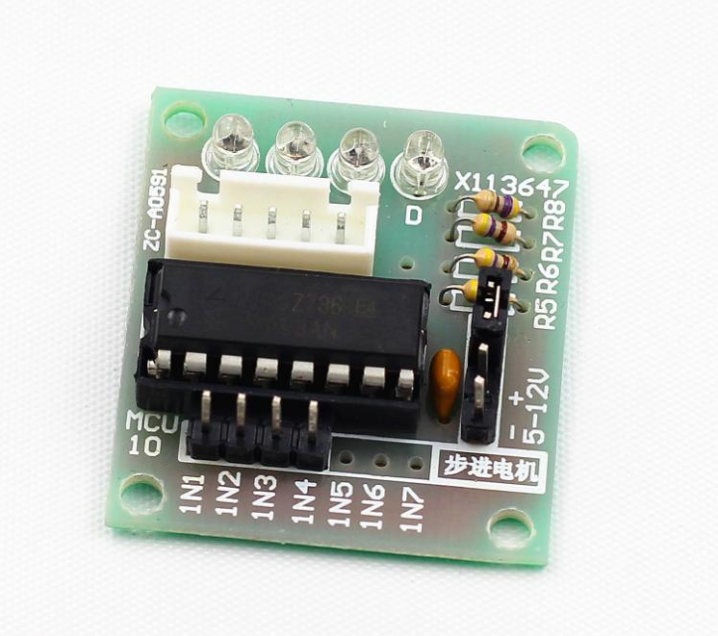
In this example, a potentiometer (or other sensor) on analog input 0 is used to control the movement of a stepper motor using the Arduino Stepper Library. The stepper is controlled by digital pins 2, 3, 4, and 5 for unipolar motor.

Components

- 1*SUNFOUNDER UNO board
- 1*USB data cable
- 1*Potentiometer
- 1*Stepper Motor
- 1*ULN2003 Driver
- Several jumper wires

Principle

The Sunfounder board and other MCUs cannot directly drive stepper motors. A driver circuit is necessary, so we choose an ULN2003 module here as shown below. There are four LEDs on the top. The white booth in the middle is connected to the stepper motor. The bottom is four IOs used to connect with MCUs. When an IO is high, the corresponding LED will light up. The black jump hat on the right is power source input end. The driving method for stepper motor can be categorized as four-beat and eight-beat. In this experiment, we take four-beat for example, for it is simple. You can drive the motor as long as you input HIGH to the four ports A, B, C and D in turn.



How many beats needed for the shaft to take a turn

It is 360 degrees for the shaft to take a turn. In this experiment, we set that it takes 100 steps to take a turn. So each step will be 360/100 = 3.6 degrees.

Experimental Procedures

Step 1: Connect the circuit

ULN2003	SUNFOUNDER
IN1	2
IN2	3
IN3	4
IN4	5

+ ----------5V

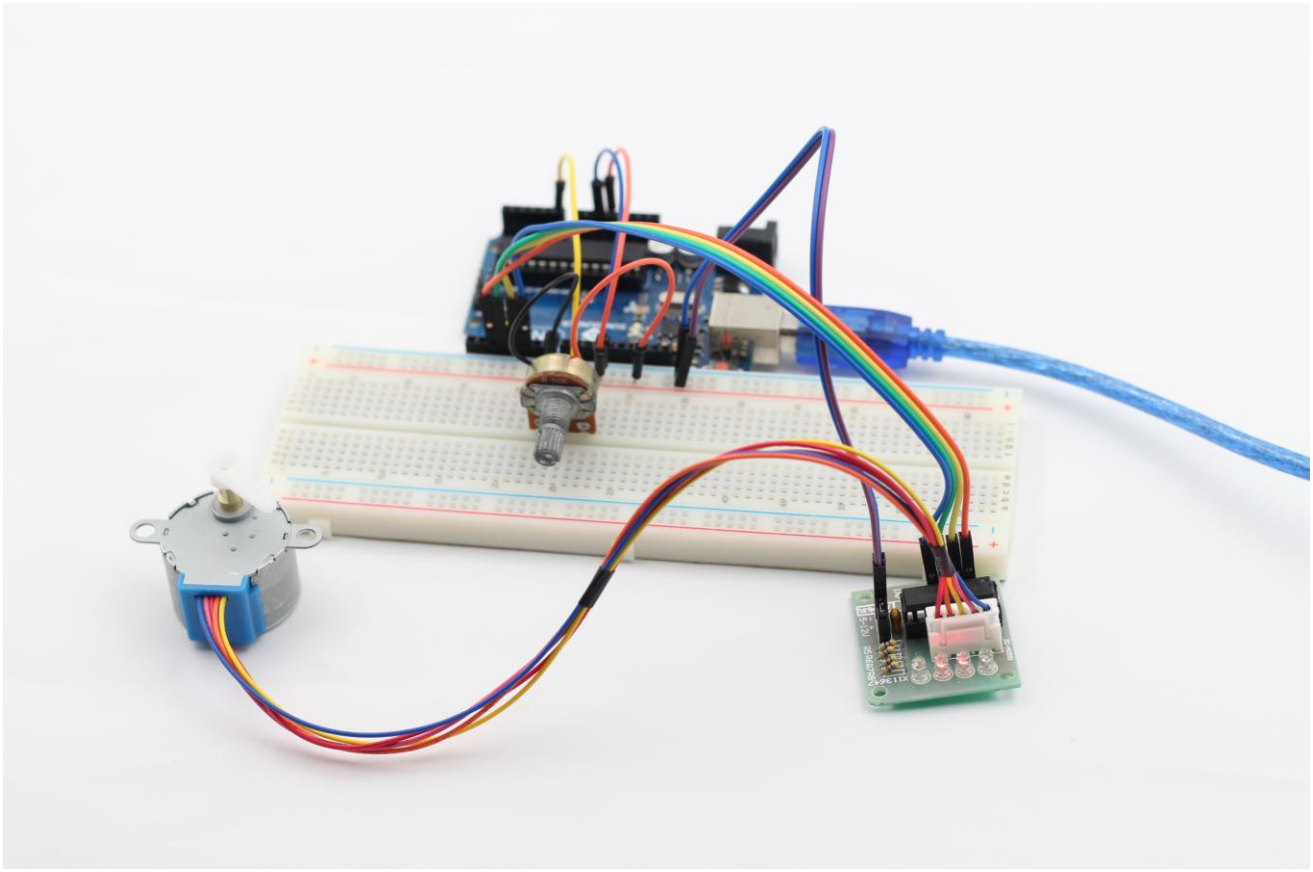
“-“----------GND

Step 2: Program (Please refer to example code in our CD)

Step 3: Compile and debug the program

Step 4: Burn the program into SUNFOUNDER UNO board

Now, if you adjust the potentiometer, the stepper motor will rotate corresponding degrees.



Lesson 26 Servo

Introduction

Servo is a type of geared motor that can only rotate 180 degrees. It is controlled by sending electrical pulses from your SUNFOUNDER. These pulses tell the servo what position it should move to.

A servo has three wires, the brown wire is GND, the red one is VCC, and the orange one is signal line.

Components

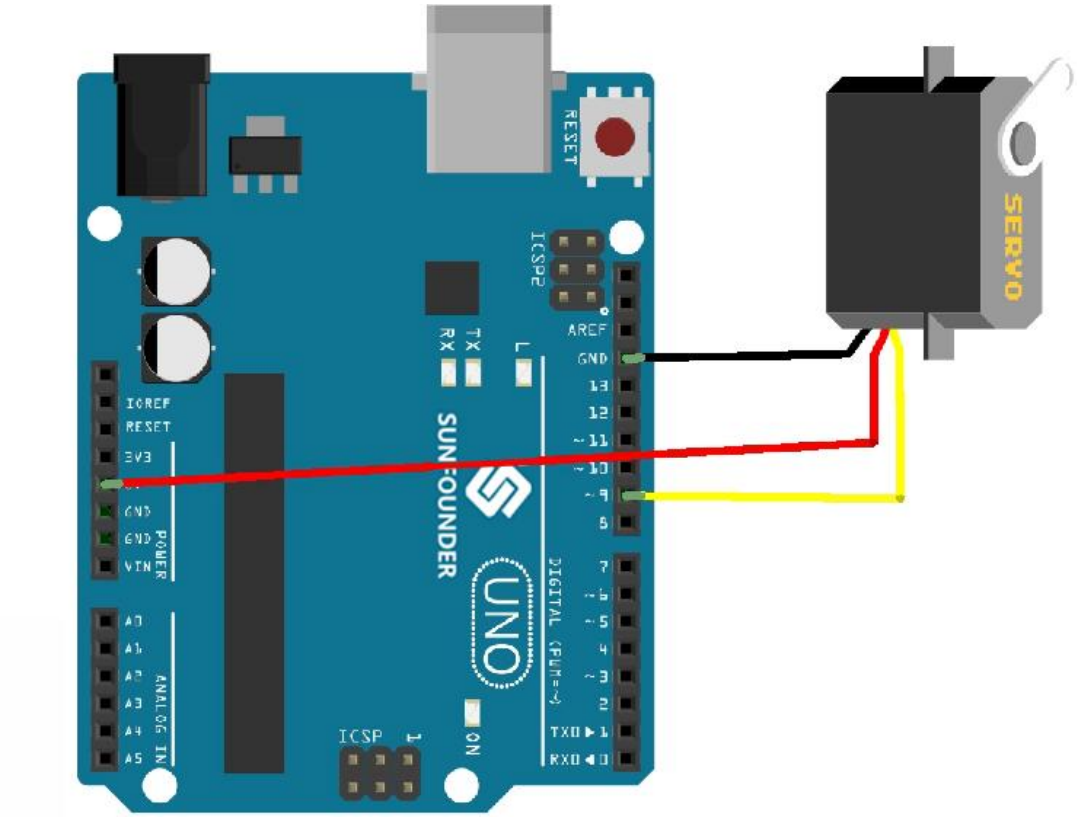
- 1*SUNFOUNDER UNO board
- 1*USB data cable
- 1*Servo
- Several jumper wires

Experimental Principle

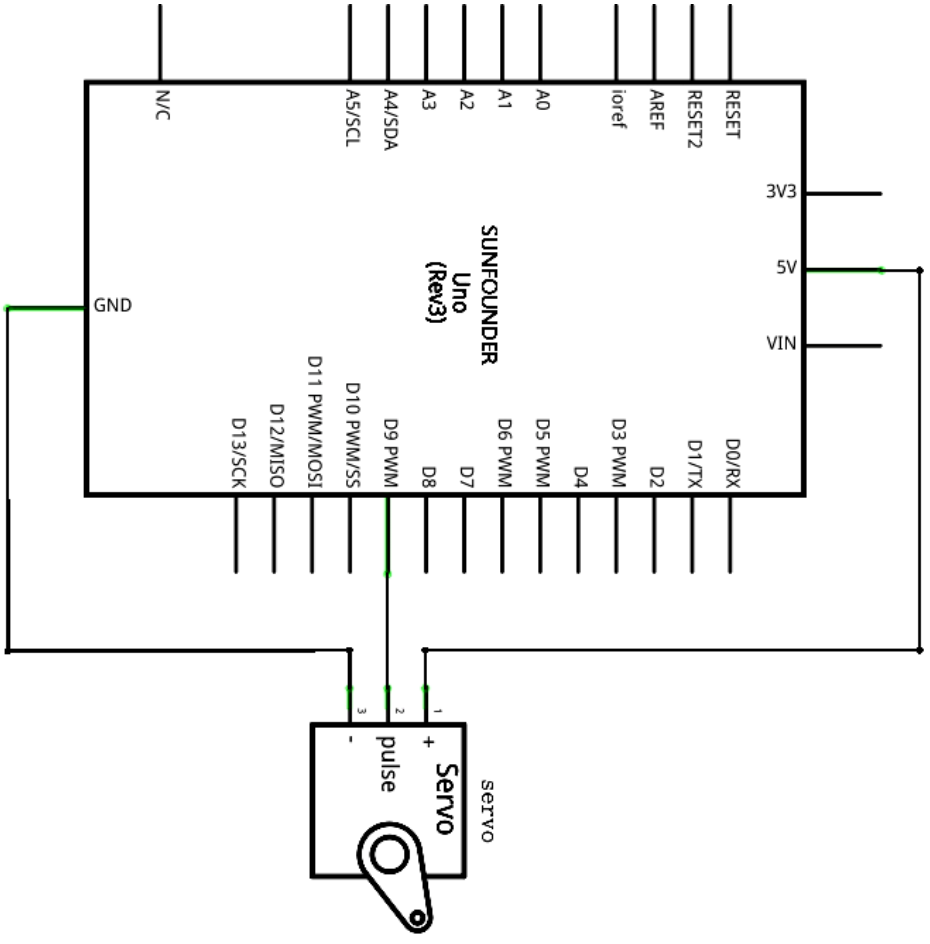
Servo consists of shell, circuit board, non-core motor, gear and location detection. Its working principle is as follow: SUNFOUNDER controller sends PWM signal to servo motor, and then this signal is processed by IC on circuit board to calculate rotation direction to drive motor, and then this driving power is transferred to swing arm by reduction gear. At the same time, position detector returns location signal to judge whether set location is reached or not.

Experimental Procedures

Step 1: Connect the circuit

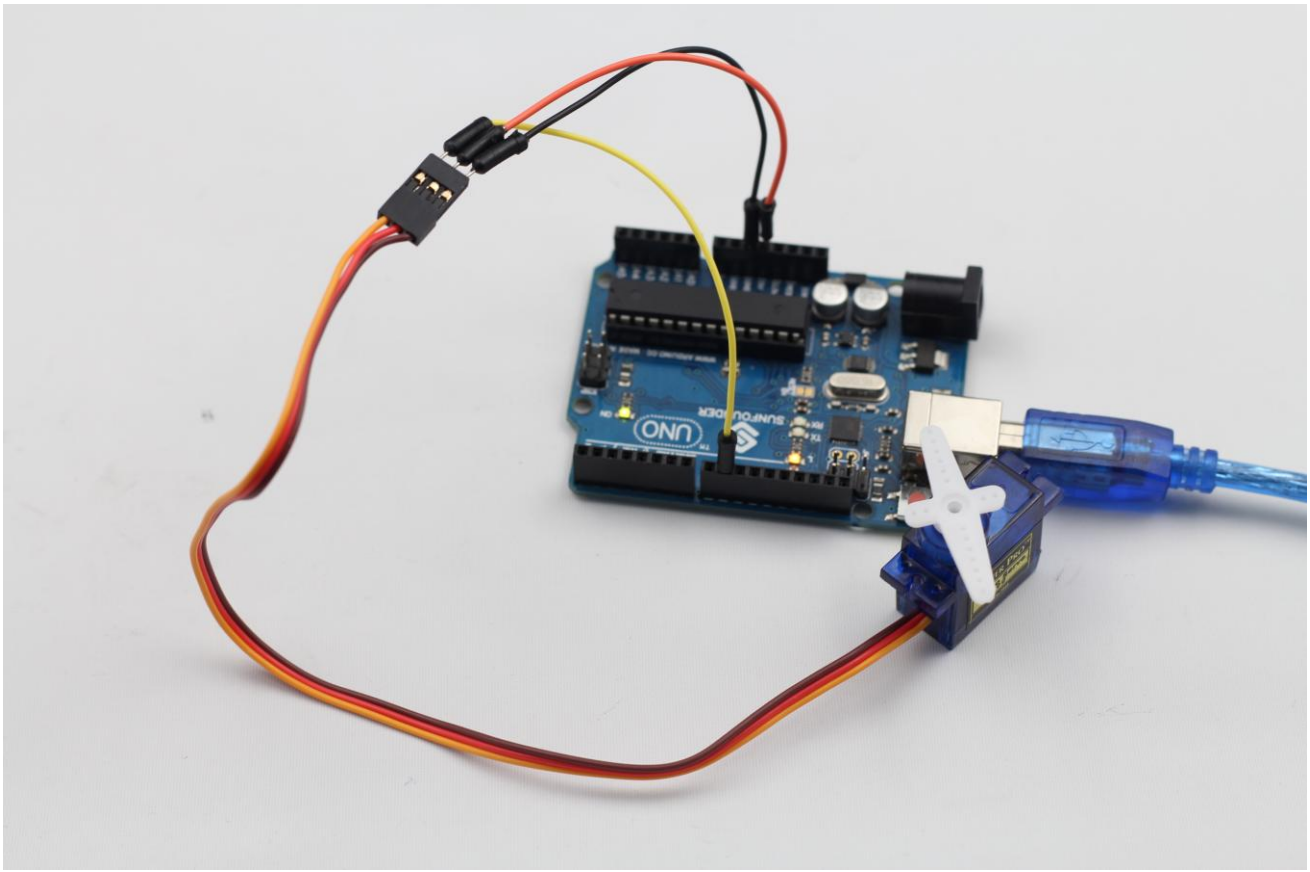


The corresponding schematic diagram is shown as below



Step 2: Program (Please refer to example code in CD provided by us)
Step 3: Compile the program
Step 4: Burn the program into SUNFOUNDER UNO board

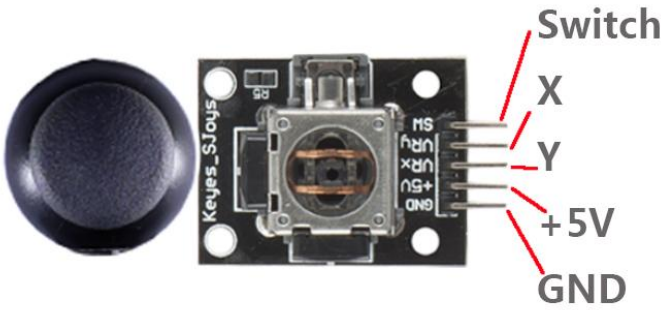
Now, you can see the servo motor rotate 90 degrees (rotate once every 15 degrees). And then rotate in opposite direction.



Lesson 27 Joystick PS2

Introduction

In this lesson, we will learn how to use joystick PS2.



Components

- 1*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1*USB data cable
- 1*Joystick PS2 module
- Several jumper wires

Experimental Principle

This module has two analog outputs (corresponding to X , Y biaxial offsets) and one digital output representing whether it is pressed on Z axis. The module integrates power indicator and can display operation condition.

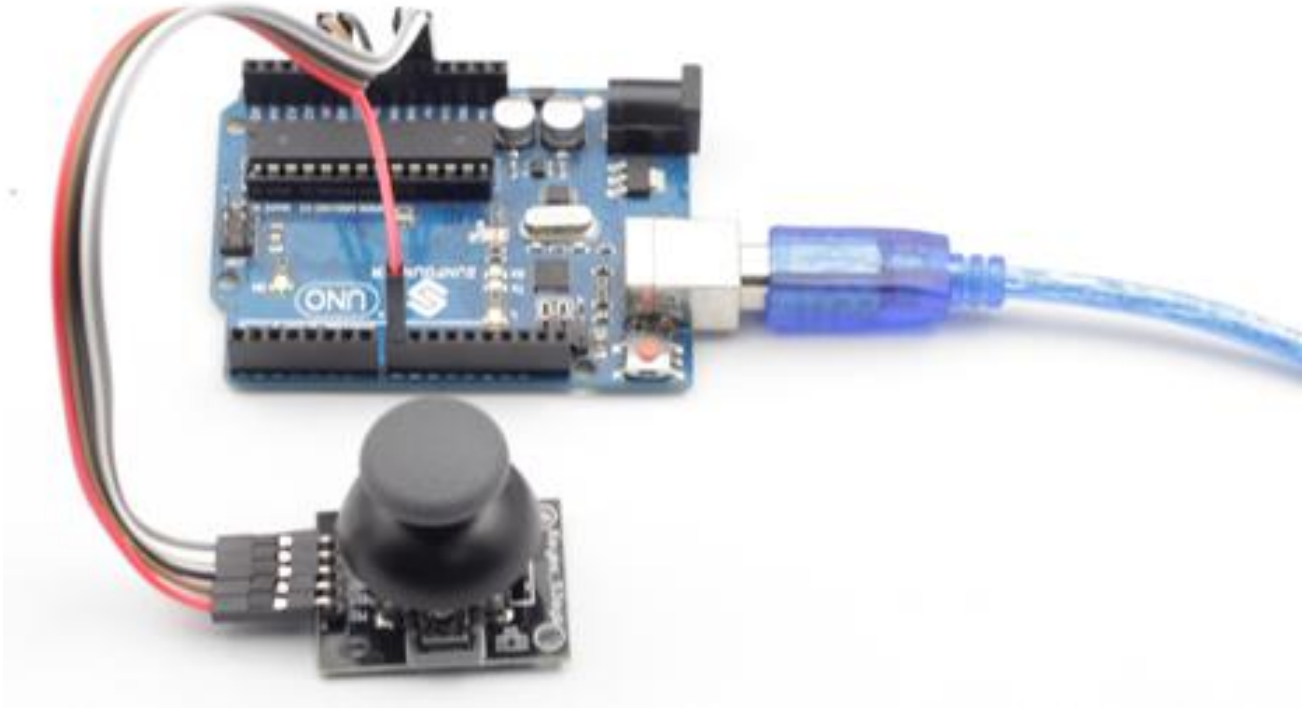
Experimental Procedures

Step 1: Connect the circuit according to the following method

Joystick PS2 module	**SUNFOUNDER UNO**
SW	Digital 8
VRx	A0
VRy	A1
+5V	5V
GND	GND

Step 2: Program (Please refer to example code in CD provided by us)
Step 3: Compile the program
Step 4: Burn the program into SUNFOUNDER UNO board

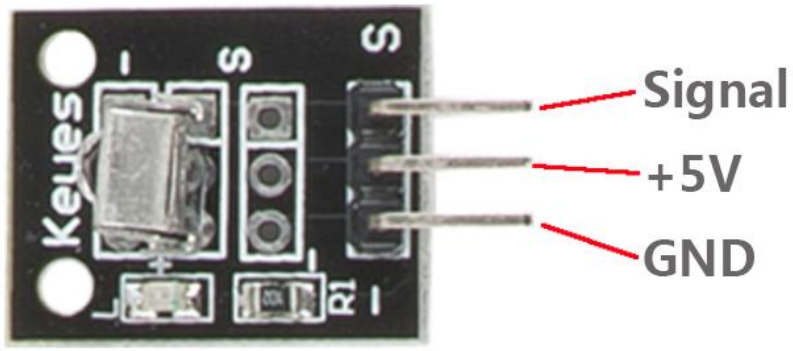
Now, if you shake the rocker the value of X, Y displayed on the screen will change accordingly; if you press the button, the value of Z=0 will display on the screen.



Lesson 28 Infrared-Receiver

Introduction

An infrared-receiver (as shown below) is a type of component which can receive infrared signals and can independently complete infrared ray reception and output compatible with TTL level signals. It has similar size with normal plastic package transistors and is appropriate for all kinds of infrared ray remote control and infrared ray data transmission.



Components

- 1*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1*USB data cable
- 1*Infrared-receiver module
- 1*Remote controller
- Several jumper wires

Experimental Principle

Control a certain key (for example, Power key) on a remote controller by programming. When we press this key, infrared rays will be emitted from the remote controller and received by the infrared-receiver, and the LED on SUNFOUNDER UNO board will light up.

Experimental Procedures

Step 1: Connect the circuit according to the following method

Infrared-receiver module **SUNFOUNDER UNO**

S ----------Digital 2

"-" ---------- GND

+ ---------- 5V

Step 2: Program (Please refer to example code in CD provided by us)

Step 3: Compile the program

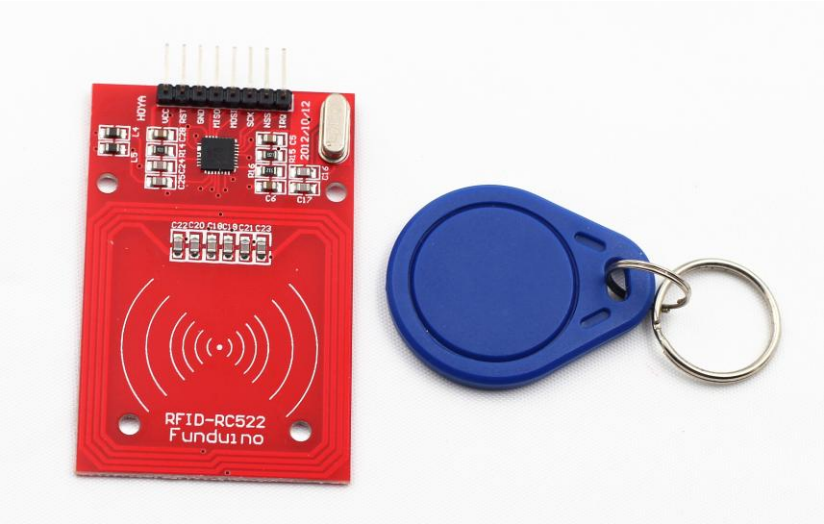
Step 4: Burn the program into SUNFOUNDER UNO board

Now, if you press Power key of a remote controller, the LED attached to pin 13 on the SUNFOUNDER UNO board will light up. If you press any other key, the LED will go out.

Lesson 29 RFID Entrance Guard System

Introduction

RFID is the abbreviation of radio frequency identification, called radio frequency technology.



In this experiment, we will use a RFID module, a relay, and an I2C LCD1602 to assemble an entrance guard system.

Components

- 1*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1*USB data cable
- 1*RFID module
- 1*Relay
- 1*I2C LCD1602
- Several jumper wires

Experimental Principle

First of all, we need to set a password for the IC card in advance. When we take the IC card to swipe on the RFID module, if the password is incorrect, the relay will be open and the LCD will display a string “hello unknown guy”; if the password is correct, the relay will be closed and the LCD will display a string “Hello SUNFOUNDER”.

Note: For this module, please use 3.3V power supply, or it will be burnt out.

Experimental Procedures

Step 1: Connect the circuit

RFID	SUNFOUNDER
VCC	3.3V
GND	GND
RST	9
MISO	12
MOSI	11
SCK	13
NSS	10

I2C 1602	SUNFOUNDER
GND	GND
VCC	5V
SDA	A4
SCL	A5

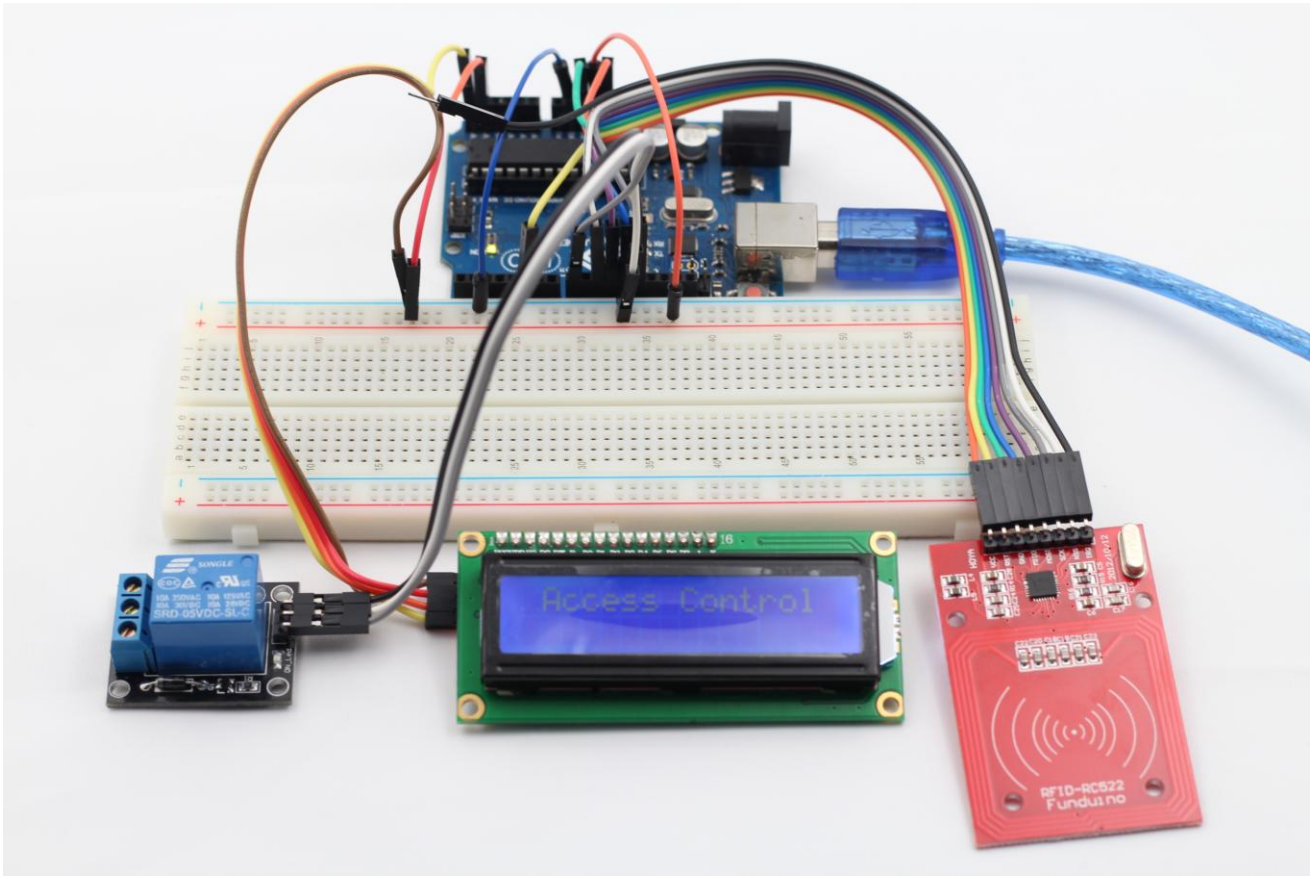
Relay Module	SUNFOUNDER
S	9
+	5V
"-"	GND

Step 2: Program (Please refer to example code in CD provided by us)

Step 3: Compile the program

Step 4: Burn the program into SUNFOUNDER UNO board

Now, When we take the IC card to swipe on the RFID module, if the password is incorrect, the relay will be open and the LCD will display a string "hello unknown guy"; if the password is correct, the relay will be closed and the LCD will display a string "Hello SUNFOUNDER".


Access Control
SRD-05VDC-SL-C
RFID-RC522
Fundu1no

Lesson 30 Password Lock

Introduction

After having learnt so many independent modules, let's combine these modules together to make some funny interactive works. In this lesson, we will use a I2C LCD1602, a Relay module, a potentiometer and a Keypad to assemble a simple password lock. It is based on SUNFONDER microcontroller and generally used to security door.

Components

- 1*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1*USB data cable
- 1*Relay module
- 1*I2C LCD1602
- 1*Keypad
- Several jumper wires

Experimental Principle

First, set a password (for example, 123456) by SUNFOUNDER controller. Then input a password by the keypad. If this password is consistent with that set by SUNFOUNDER controller, the relay will close and the LED indicator light will be on. Otherwise the relay will open and the LED indicator light will be off.

Experimental Procedures

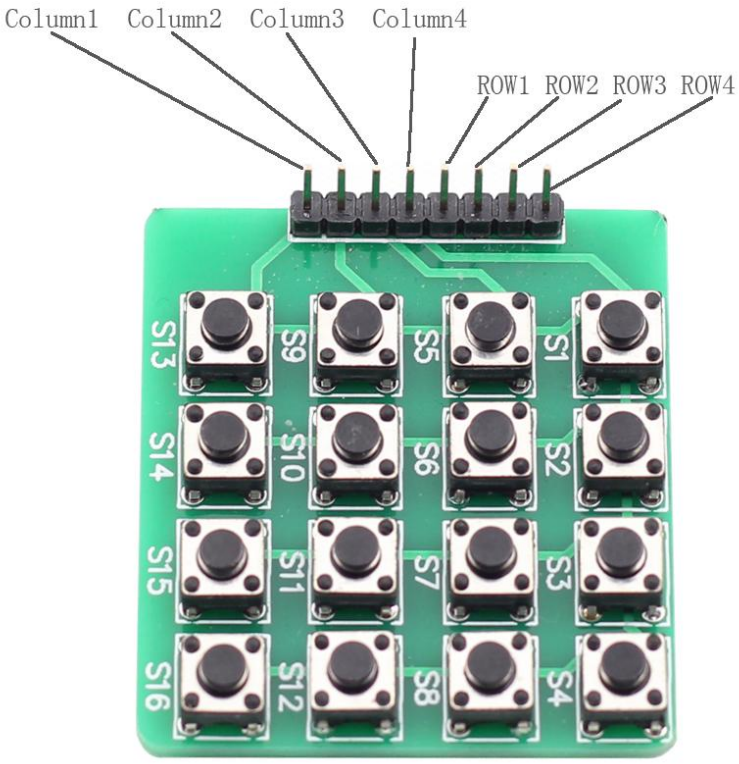
Step 1: Connect the circuit

I2C 1602	**SUNFOUNDER**
GND	GND
VCC	5V
SDA	A4
SCL	A5

Relay Module	**SUNFOUNDER**
S	13
+	5V

"-"---------- GND

KeyPad	SUNFOUNDER
Row1	11
Row2	10
Row3	9
Row4	8
Column1	7
Column2	6
Column3	5
Column4	4



NOTE: Through programming, we set the first column as 1,2,3,4; the second column as 5,6,7,8; the third column as 9,A,B,C,; the fourth column as D, *,0,#.

Step 2: Program (Please refer to example code in CD provided by us)
Step 3: Compile the program
Step 4: Burn the program into SUNFOUNDER UNO board

Now, LCD will display **Welcome** screen after power on. When you press * key, it will prompt **Input Your Code:**. If you input 123456 and press # key to confirm, it will display **Input Correctly Please Come In** and the LED will be on. If you input any other password, it will display **Input Error Please Again** and the LED will be off.