

# Preface

This sensor kit is suitable for SUNFOUNDER UNO, SUNFOUNDER MEGA 2560, SUNFOUNDER Duemilanove and SUNFOUNDER NANO. All the code in this user guide is also compatible with these boards.

Our SUNFOUNDER board is fully compatible with Arduino board.

Note: This kit is different from other kits. All the components in this kit are provided in the form of modules which integrate some necessary components, such as comparator, resistor, capacitor and so on. So it is convenient for circuit connection.

## **Component list**

Analog Hall Sensor x2  
Switch Hall Sensor x1  
RGB LED Module x2  
Two-color Common-Cathode LED x2  
Shock switch x1  
Knock sensor x1  
Infrared transmitter x1  
Laser Transmitter x1  
Reed switch x1  
Mini Reed x1  
Infrared-receiver x1  
Analog-temperature sensor x1  
Digital-temperature sensor x1  
Active Buzzer x1  
Passive Buzzer x1  
Button Switch x1  
Photo-interrupter x1  
Tilt-switch module x1  
Mercury switch module x1  
Magic Cup x2  
DS18B20 Temperature Sensor x1  
Rotary Encoder module x1  
7-color Auto-flash LED module x1  
Photoresistor Sensor x1  
Humiture Sensor x1  
Obstacle Avoidance Sensor x1  
Tracking Sensor x1  
Microphone Sensor x1  
High-sensitive Voice Sensorx1  
Metal Touch Sensor x1  
Flame Sensor x1  
Relay module x1  
Joystick PS2 x1  
MQ-2 Gas Sensor x1  
LCD1602 x1  
4 X 4Keypad x1

Remote controller x1  
250k Ohm Potentiometer x1  
470k Ohm Resistor x1  
MQ-2 Smoke sensor module x1  
Breadboard x1  
Jumper wires (male to female) x40  
Jumper wires (male to male) x20

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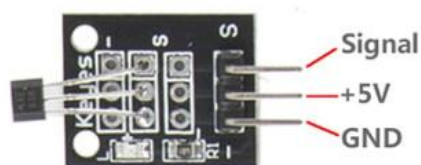
# Lesson 1 Hall Sensor

## Introduction

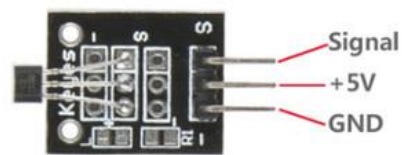
Based on hall effect, a hall sensor is a sensor that varies its output voltage in response to a magnetic field. Hall sensors are used for proximity switching, positioning, speed detection, and current sensing applications.

Hall sensors can be categorized into linear Hall sensors and switch Hall sensors. A switch Hall sensor consists of voltage regulator, Hall element, differential amplifier, Schmitt trigger, and output terminal. It outputs digital values. Linear Hall sensor consists of a Hall element, linear amplifier, and emitter follower, it outputs analog values.

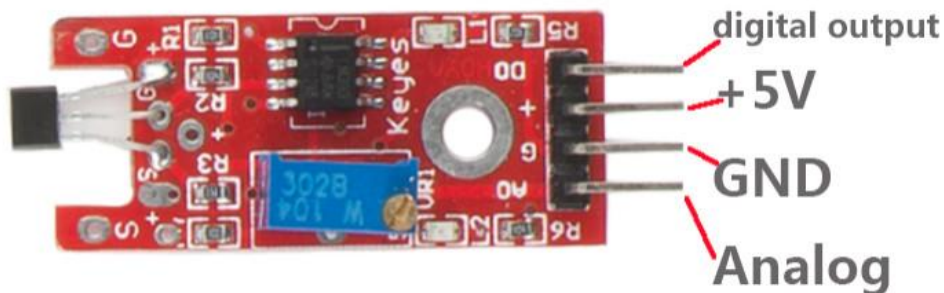
There are three different types of hall sensor modules in this kit (as shown below): linear hall sensor which outputs analog signals, switch hall sensor which outputs digital signals. If we add a comparator on the basis of linear hall sensor, it will be able to output both analog and digital signals.



**Linear Hall**



**Switch Hall**



**Linear Hall**

## Components

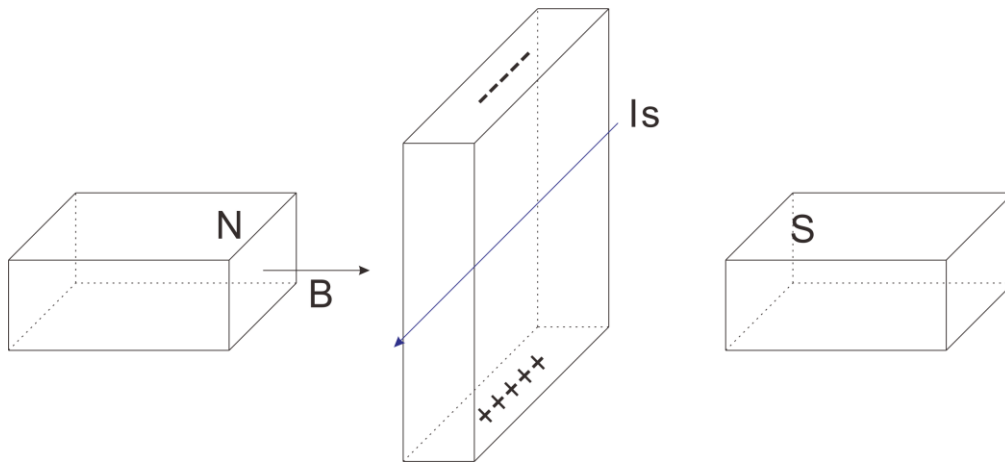
- 1\*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1\*USB data cable
- 1\*Hall sensor module
- 1\*LCD1602

- 1\*Potentiometer
- Several jumper wires

## 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. When a current is perpendicular to external magnetic field and flows through a conductor, a potential difference will be generated on the two surfaces of the conductor that is parallel to the direction of the magnetic field and the current. This phenomenon is Hall effect.



### Hall sensor

A hall sensor is a kind of magnetic field sensor based on hall effect.

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.

## Experimental Procedures

For **linear Hall sensor module**, please perform the following steps

**Step 1:** Connect the circuit according to the following method

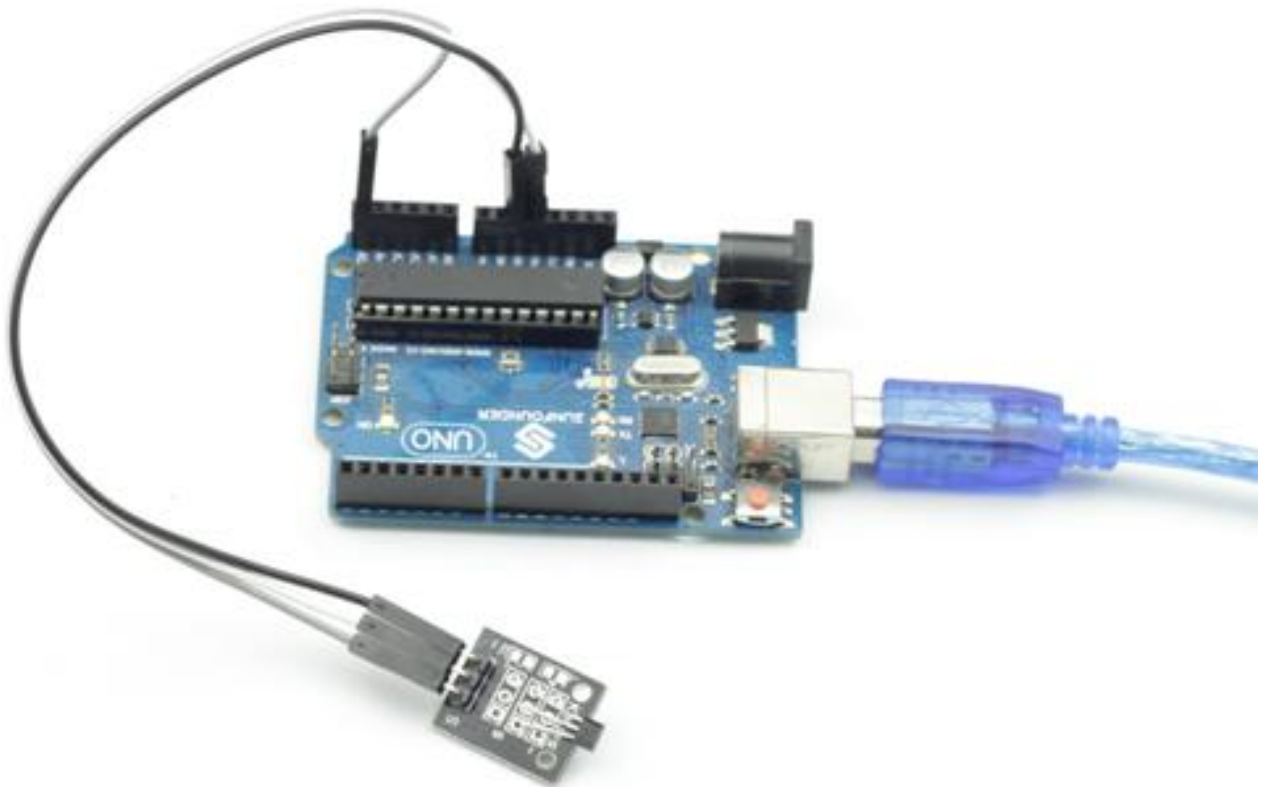
Linear Hall sensor module	SUNFOUNDER UNO
S -----	A5
"-" -----	GND
+ -----	5V

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

**Step 3:** Compile the program

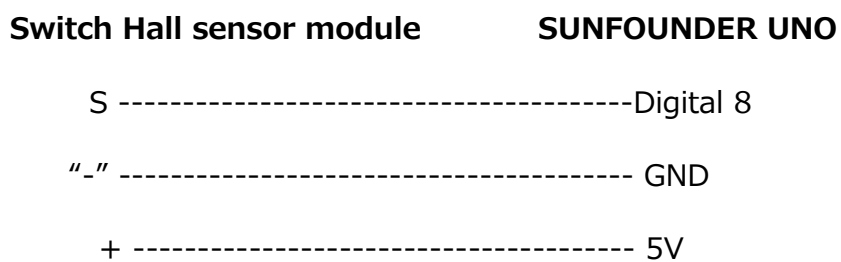
**Step 4:** Burn the program into SUNFOUNDER UNO board

Now, you can see the LED attached to pin 13 on SUNFOUNDER UNO board blinking. If a magnet approaches the linear Hall sensor, the blinking frequency of LED will increase or decrease.



For **switch Hall sensor module**, please perform the following steps

**Step 1:** Connect the circuit according to the following method

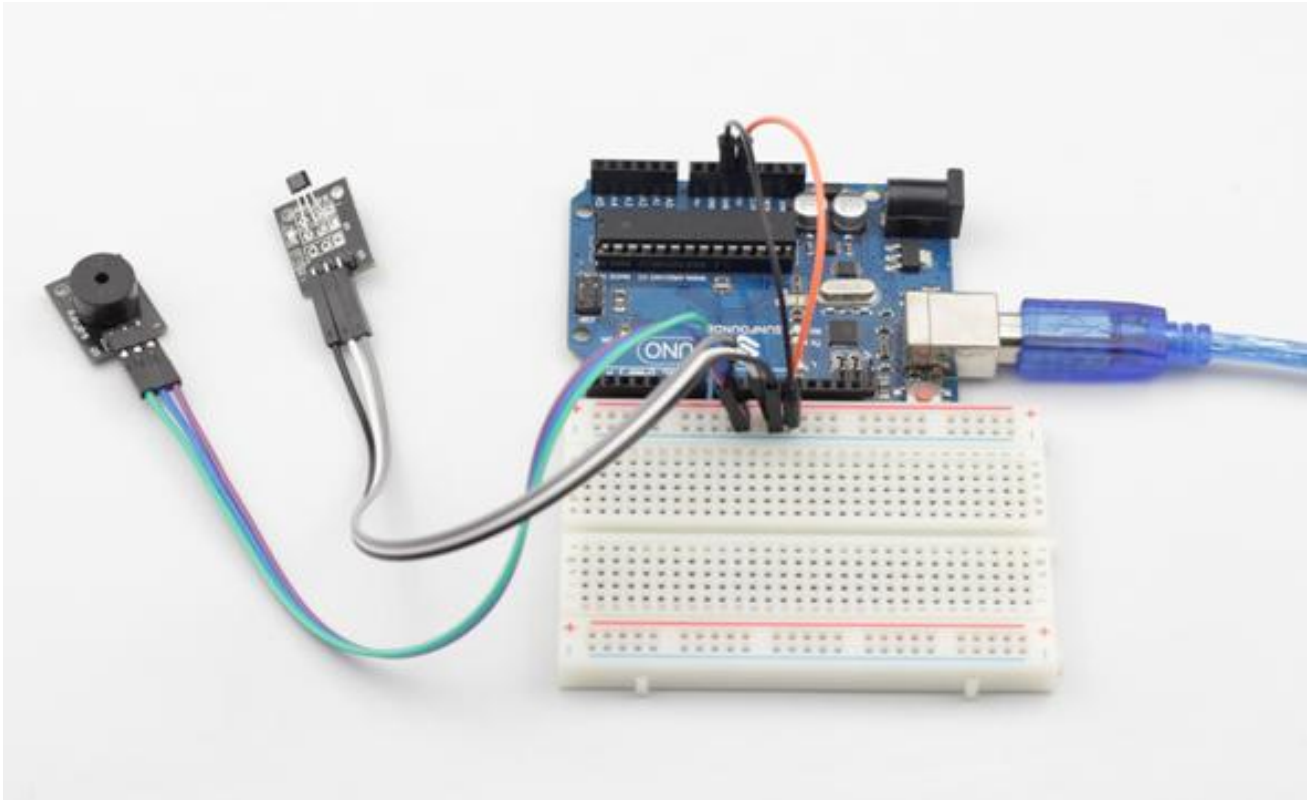


**Step 2:** Program (Please refer to example code in CD provided by us)

**Step 3:** Compile the program

**Step 4:** Burn the program into SUNFOUNDER UNO board

Now, if a magnet approaches the switch Hall sensor, the indicator light on the switch Hall sensor will light up and the buzzer will make sounds, and at the same time, the LED attached to pin 13 on SUNFOUNDER UNO board will light up.



For **linear Hall sensor module (added a comparator)**, please perform the following steps

**Step 1:** Connect the circuit according to the following method

<b>Linear Hall sensor module</b>	<b>SUNFOUNDER UNO</b>
AO -----	A0
DO -----	Digital 8
"_" -----	GND
+ -----	5V

**LCD1602 connection:** connect pin RS to digital pin 3; R/W to GND; E to digital pin 4; D4~D7 to digital pin 9 to 12; VSS to GND; VDD to 5V; A to 3.3V; K to GND



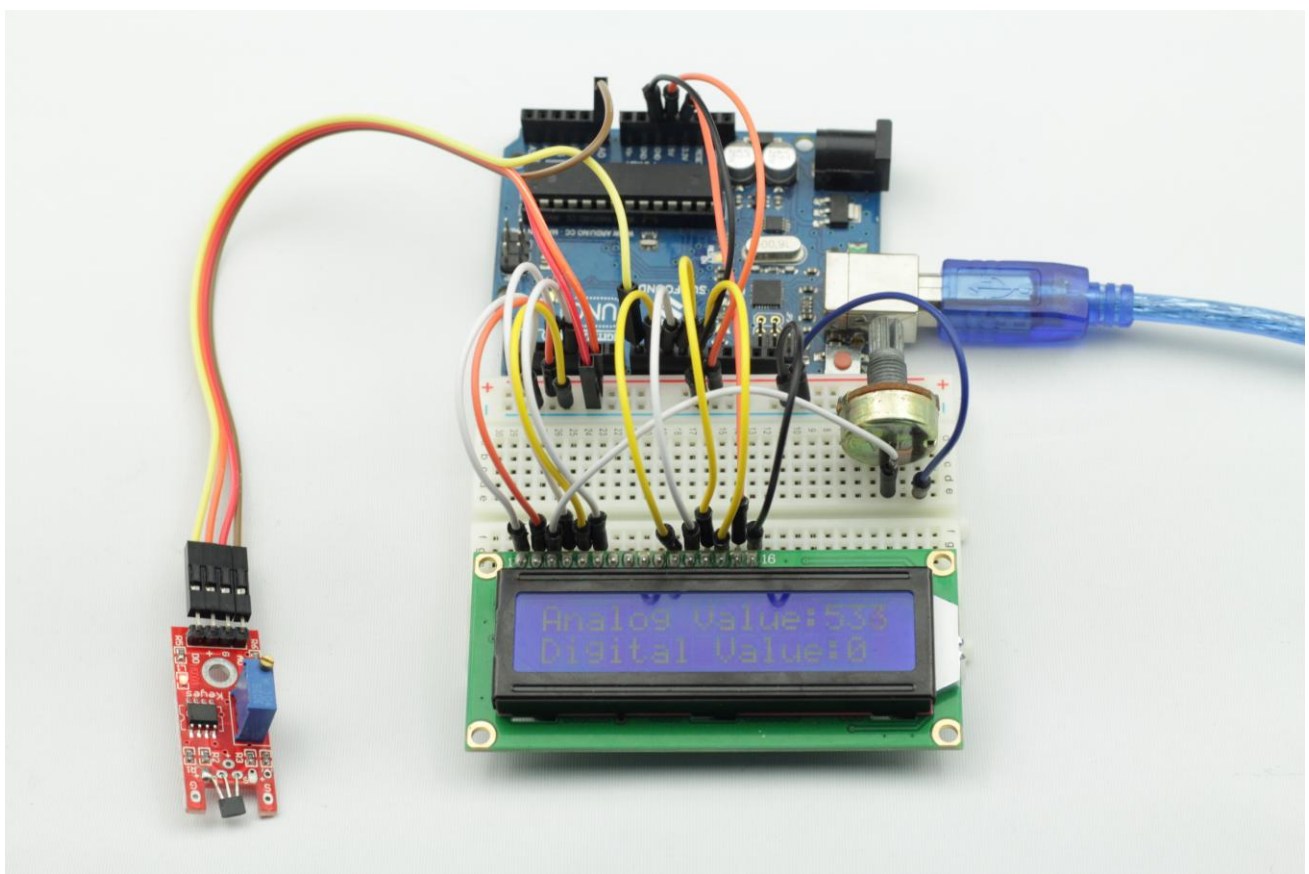
**Potentiometer connection:** Connect the middle pin to VO of LCD1602 and any other pin to GND

**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

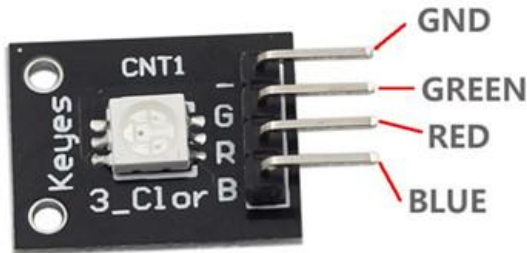
Now, if a magnet approaches the linear Hall sensor, the indicator light on the linear Hall sensor will light up, and at the same time, the analog and digital value displayed on the LCD will vary accordingly.



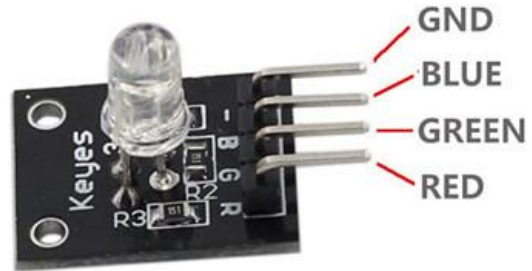
# Lesson 2 RGB LED

## Introduction

There are two kinds of packages for RGB LED (as shown below) in this kit. One is Surface Mount Device (SMD) type, and the other is Dual In-line Package (DIP) type.



**SMD Package**



**DIP Package**

## Components

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

## Experimental Principle

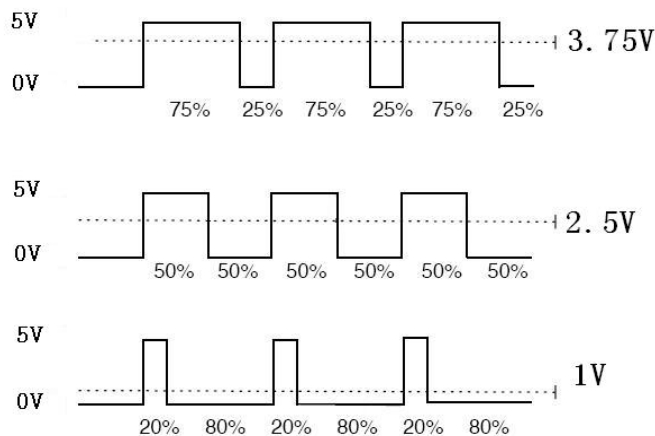
RGB LEDs can emit various colors of light. They are manufactured by packaging three LEDs of red, green, and blue into a transparent or semitransparent plastic shell and lead out four pins. The three primary colors of red, green, and blue can be mixed to compose all kinds of colors by brightness, so you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

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

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.

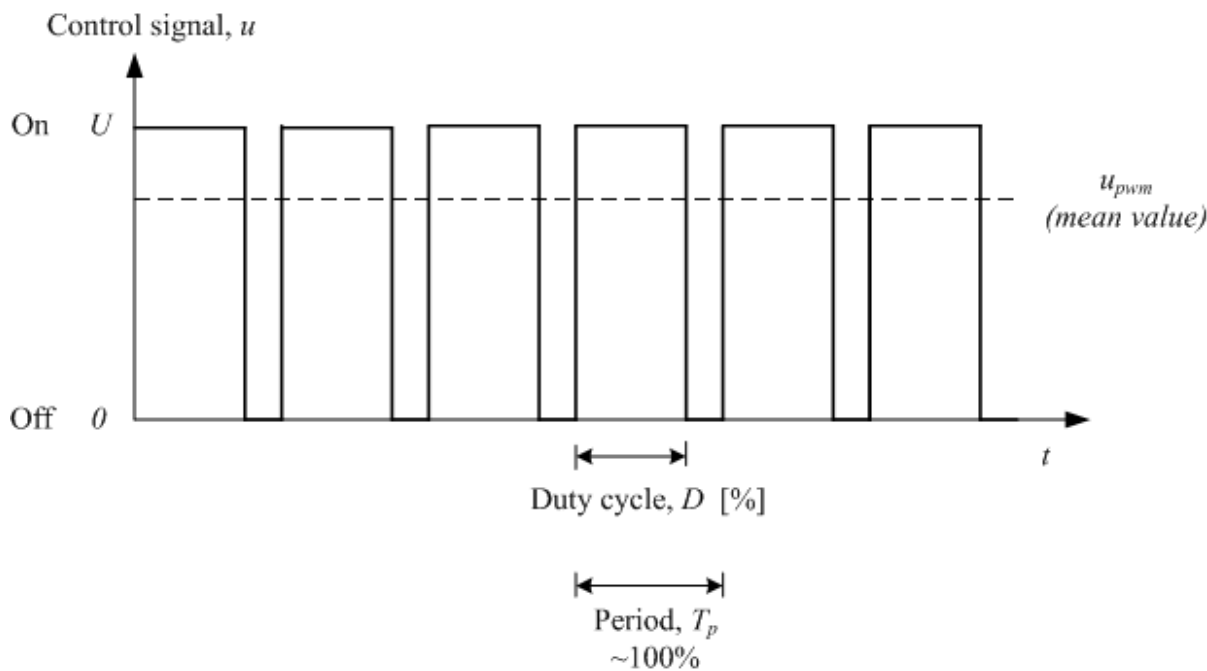
Pulse Width Modulation commonly refers to PWM. Pulse Width Modulation (PWM) is a digital coding method for analog signal levels. Since a computer cannot output an analog voltage but digital voltage value 0V or 5V, we modulate the duty cycle of square waves to encode a specific level of analog signal 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. The term  $U_{pwm}$  describes the mean value of output voltage (e.g. 0V-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 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

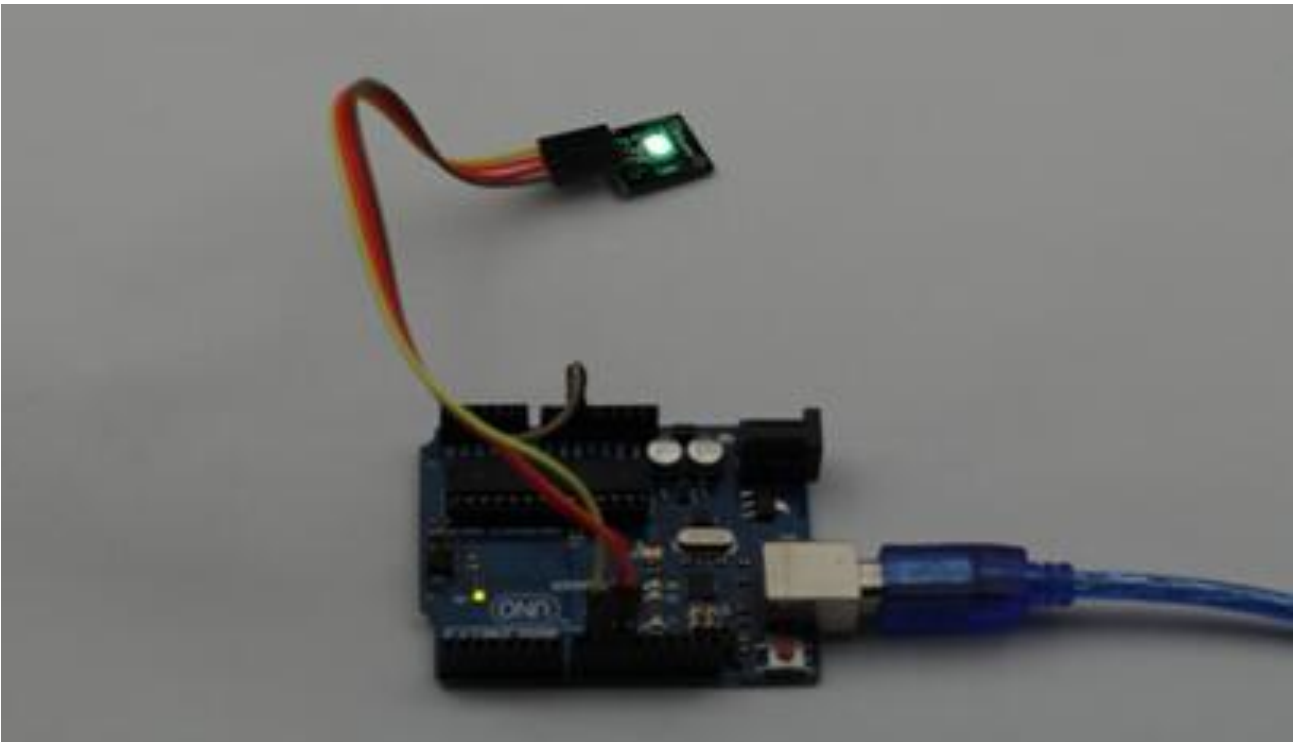
RGB LED module	SUNFOUNDER UNO
R -----	Digital 8
G -----	Digital 10
B -----	Digital 9
"-" -----	GND

**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 3 Two-color Common-Cathode LED

## Introduction

There are two kinds of two-color Common-Cathode LED in this kit. The only difference is their LED package size as shown below:



## Components

- 1\*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1\*USB data cable
- 1\*Two-color Common-Cathode LED module
- Several jumper wires

## Experimental Principle

Control the LED brightness by digital port. You can see the color of LED transit from yellow to green and their combinations.

## Experimental Procedures

**Step 1:** Connect the circuit according to the following method

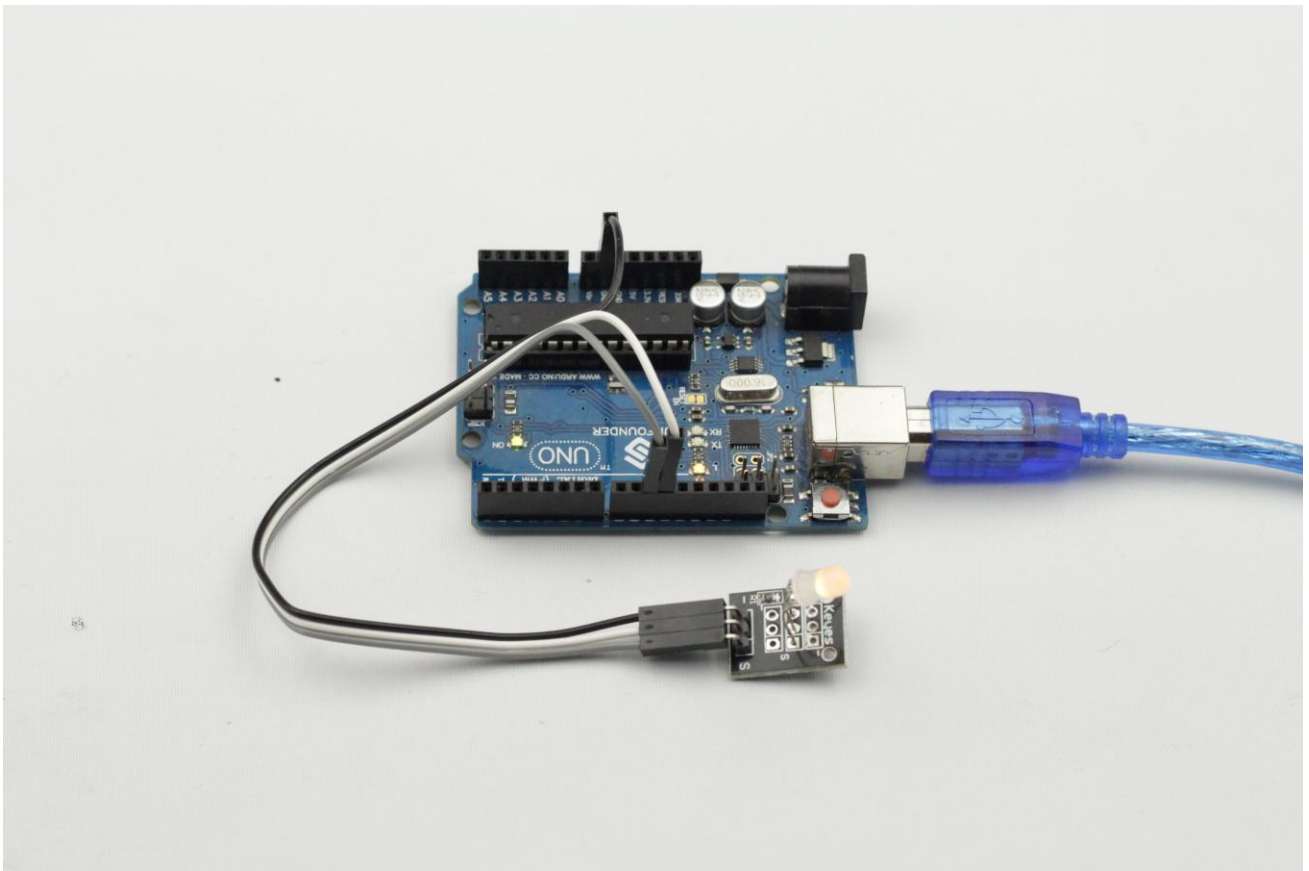
Two-color Common-Cathode LED module	SUNFOUNDER UNO
Y -----	Digital 10
"_" -----	GND
R -----	Digital 11

**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

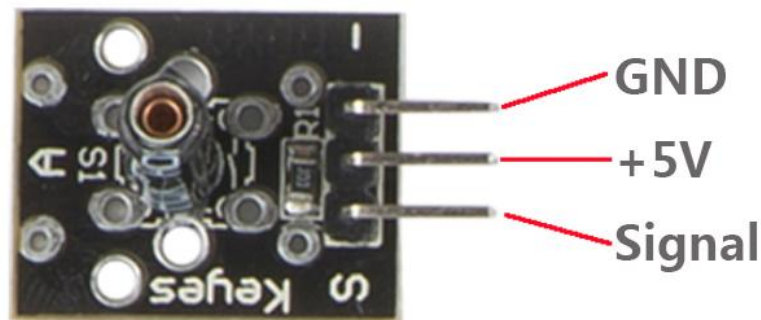
Now, you can see the two-color LED appears yellow, red, and transition colors.



# Lesson 4 Shock Switch

## Introduction

A shock switch (as shown below), also called vibration switch, spring switch or shock sensor, is an electronic switch which induces shock force and transfer induced result to circuit device to make the circuit start to work. It contains such main parts as conductive vibration spring, switch ontology, trigger pin, packaging agent and so on.



## Experimental Conditions

- 1\*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1\*USB data cable
- 1\*Shock switch module
- Jumper wires

## Experimental Principle

The main principle of shock switch is that, conductive vibration spring and trigger pin are precisely placed in switch ontology and bond to curing position through adhesive. Normally, the spring and the trigger pin do not contact. Once shook, the spring will shake and contact with trigger pin to conduct and generate trigger signals.

With the LED attached to pin 13, connect the shock switch to digital pin 8. When the shock switch inducts shock signals, the LED will light up.

## Experimental Procedures

**Step 1:** Connect the circuit according to the following method

## Shock switch module

## SUNFOUNDER UNO

S ----- Digital 8

"\_" ----- GND

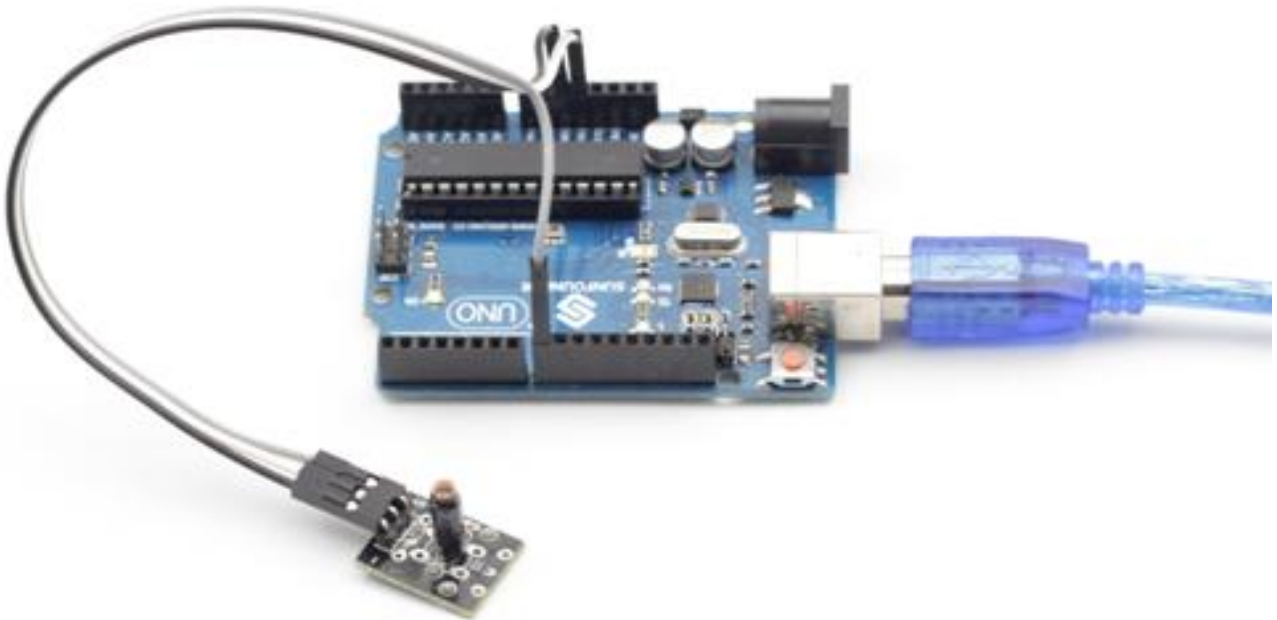
+ ----- 5V

**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 shake the switch module, you will see the LED attached to pin 13 on SUNFOUNDER UNO board light up.

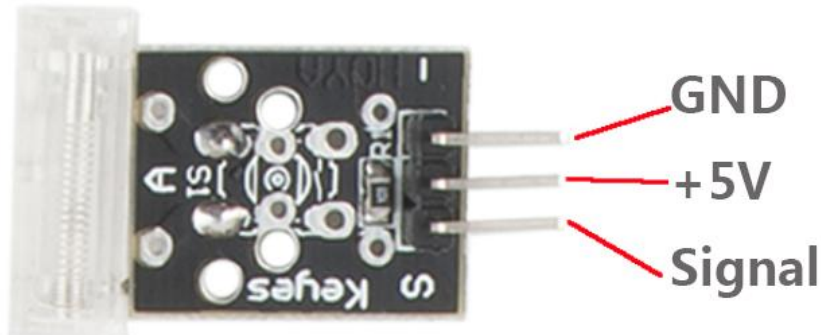




# Lesson 5 Knock Sensor

## Introduction

A knock sensor (as shown below) is similar to the shock switch. Just more sensitive. It can feel small amplitude vibration.



## Components

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

## Experimental Principle

Similar to the shock switch. Connect the knock switch sensor pin S to digital pin 3 to build a simple circuit. When the knock switch sensor inducts knock signals, the LED attached to pin 13 will light up.

## Experimental Procedures

**Step 1:** Connect the circuit according to the following method

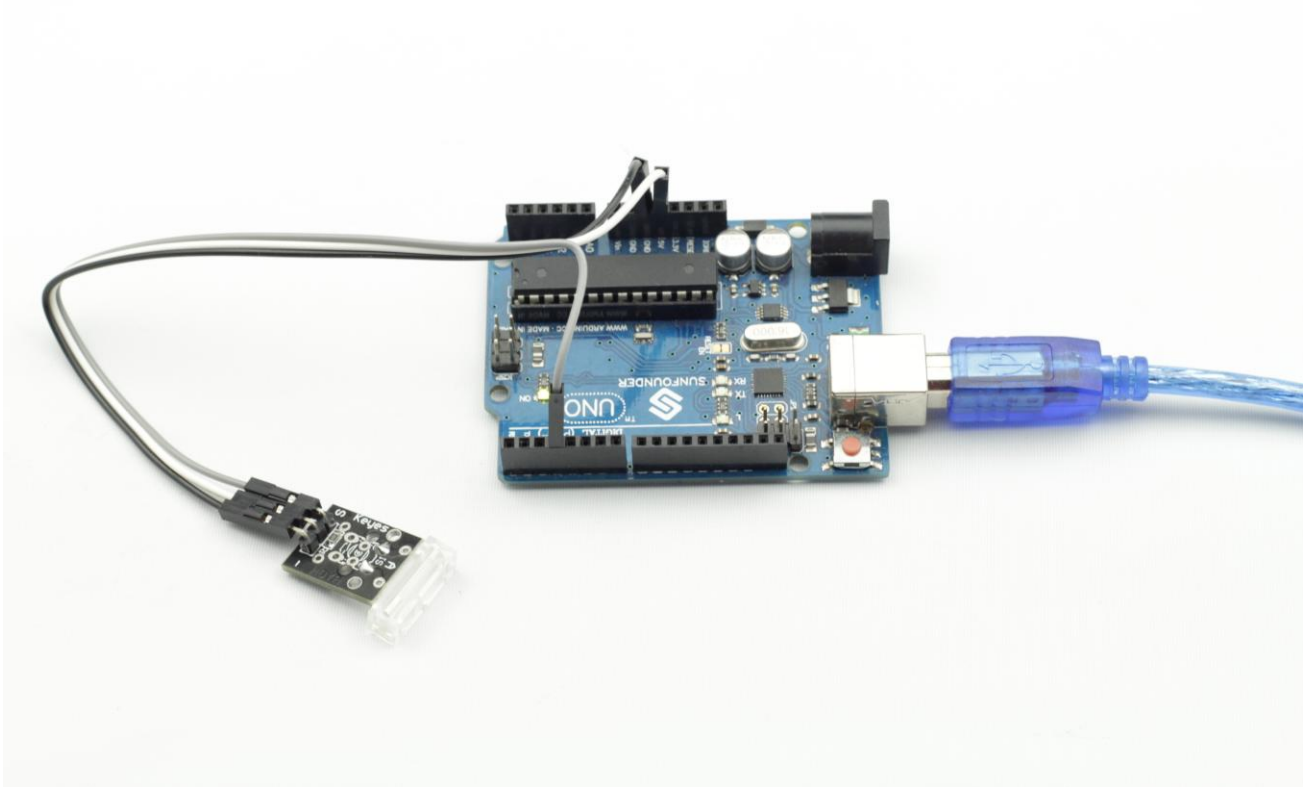
Knock sensor module	SUNFOUNDER UNO
S	-----Digital 3
"-"	----- GND
+	----- 5V

**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 knock the sensor, the LED attached to pin 13 on SUNFOUNDER UNO board will light up.



# Lesson 6 Infrared transmitter

## Introduction

An infrared transmitter module (as shown below) uses 38K modulation signal generated by MCU to emit infrared rays.



## Components

- 1\*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1\*USB data cable
- 1\*Infrared transmitter module
- 1\*LCD1602
- 1\*Potentiometer
- Several jumper wires

## Experimental Principle

An infrared transmitter is a type of remote control device with remote control function. It can emit rays within a certain range through infrared transmitting tube so as to control signals. Infrared transmitter is widely used in consumer electronics, industry and communication, etc.

In this experiment, we will connect pin S of the infrared transmitter module to digital pin 3 to build a simple circuit. When we input the coded value for an infrared ray by programming, and then let the infrared transmitter module emit the infrared ray, the LED attached to pin 13 will light up. In addition, we will display the coded value of the infrared ray on LCD1602.

## Experimental Procedures

**Step 1:** Connect the circuit according to the following method

**Infrared transmitter module**

**SUNFOUNDER UNO**

S -----Digital 3

"\_" ----- GND

**LCD1602 connection:** connect pin RS to digital pin 5; R/W to GND; E to digital pin 4; D4~D7 to digital pin 9 to 12; VSS to GND; VDD to 5V; A to 3.3V; K to GND

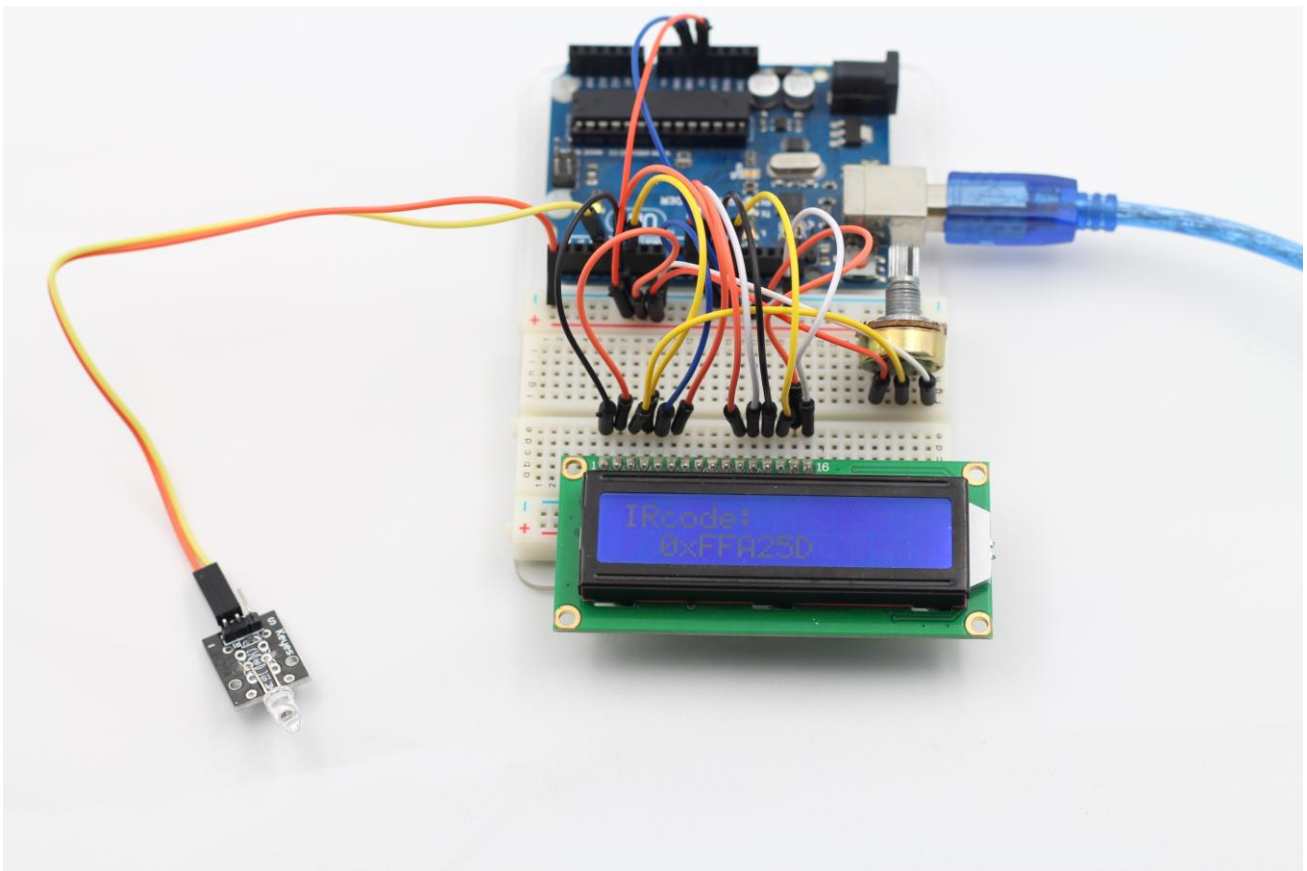
**Potentiometer connection:** Connect the middle pin to VO of LCD1602 and any other pin to GND

**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 the infrared transmitter emit infrared rays through a camera, and at the same time, the LED attached to pin 13 on SUNFOUNDER UNO board will be turned on and a coded value will display on the LCD.

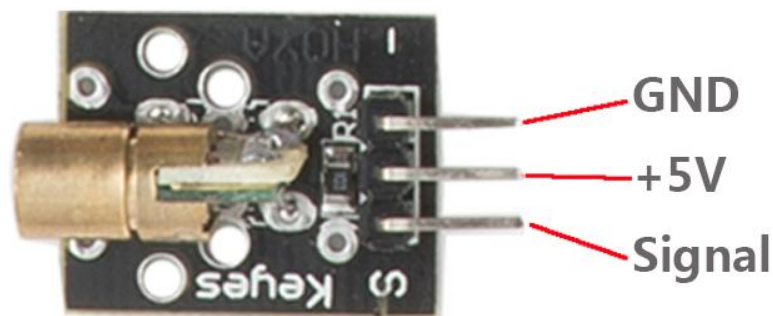


# Lesson 7 Laser Transmitter

## Introduction

Laser is widely used in medical treatment, military, and other fields due to its good directivity and energy concentration. In the world of art, laser is widely used in stage to make the effect of shadow and laser holography.

The appearance of a laser-transmit module is shown as below:



## Components

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

## Experimental Principle

A **laser** is a device that emits light through a process of optical amplification based on the stimulated emission of electromagnetic radiation. The term "laser" originated as an acronym for "light amplification by stimulated emission of 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. Spatial coherence also allows a laser beam to stay narrow over long distances (collimation), enabling applications such as laser pointers. Lasers can also have high temporal coherence which allows them to have a very narrow spectrum, i.e., they only emit a single color of light. Temporal coherence can be used to produce pulses of light—as short as a femtosecond.

## Experimental Procedures

**Step 1:** Connect the circuit according to the following method

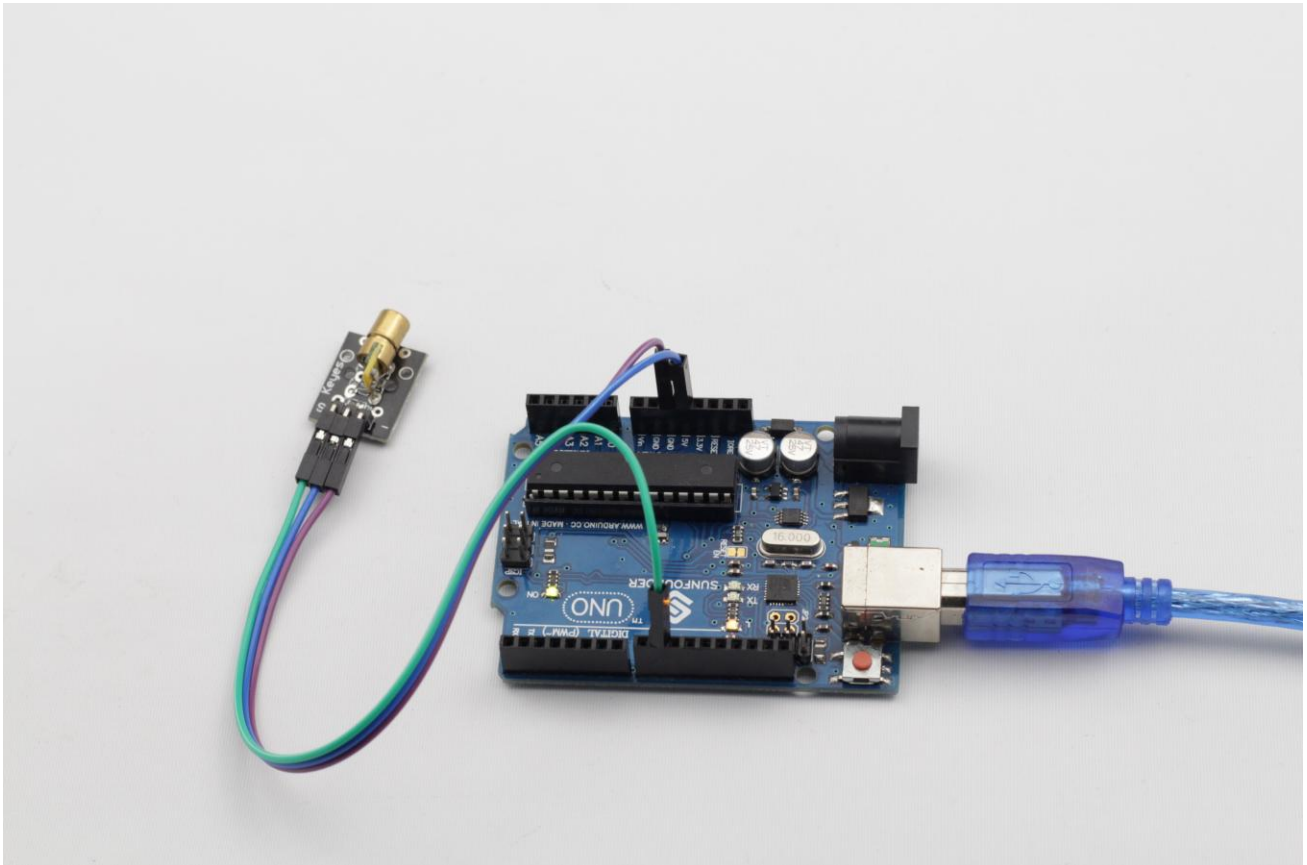
Laser transmitter module	SUNFOUNDER UNO
S	-----Digital 9
"_"	----- GND
+	----- 5V

**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 can see the laser transmitter module send Morse signals.



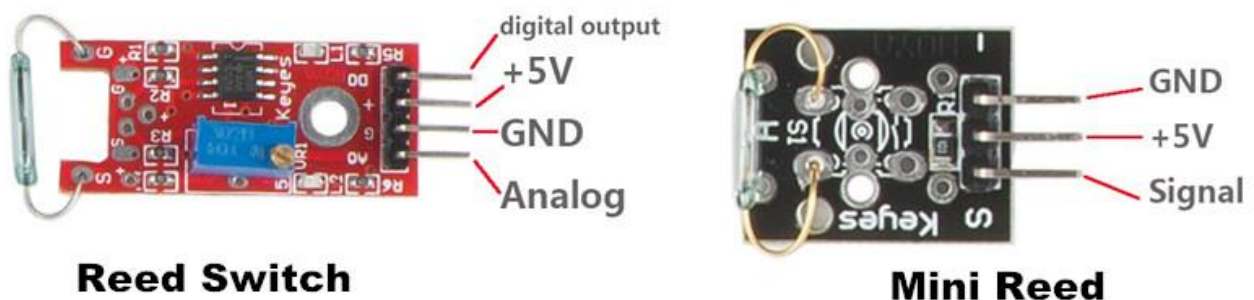
**Note:** Don't look directly at the laser head. It can cause great harm to your eyes.

# Lesson 8 Reed Switch

## Introduction

A reed switch (as shown below) is also a sensor used to detect the magnetic field. Hall sensors are generally used to measure intelligent vehicle speed and count assembly lines. While reed switches are often used to detect the existence of magnetic field.

There are two kinds of reed switches in this kit. One, we call it **reed switch**. The other, we call it **mini reed**. They have the same principle.



## Components

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

## Experimental Principle

A reed switch is a type of line switch component that controls 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 ease to 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 disappeared, 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, with LED attached to pin 13, we will connect pin D0 of the reed switch to digital pin 8 of SUNFOUNDER UNO board. When the reed switch inducts magnetic field signals, the LED will be on. Otherwise it will be off.

### Experimental Procedures

**Step 1:** Connect the circuit according to the following method

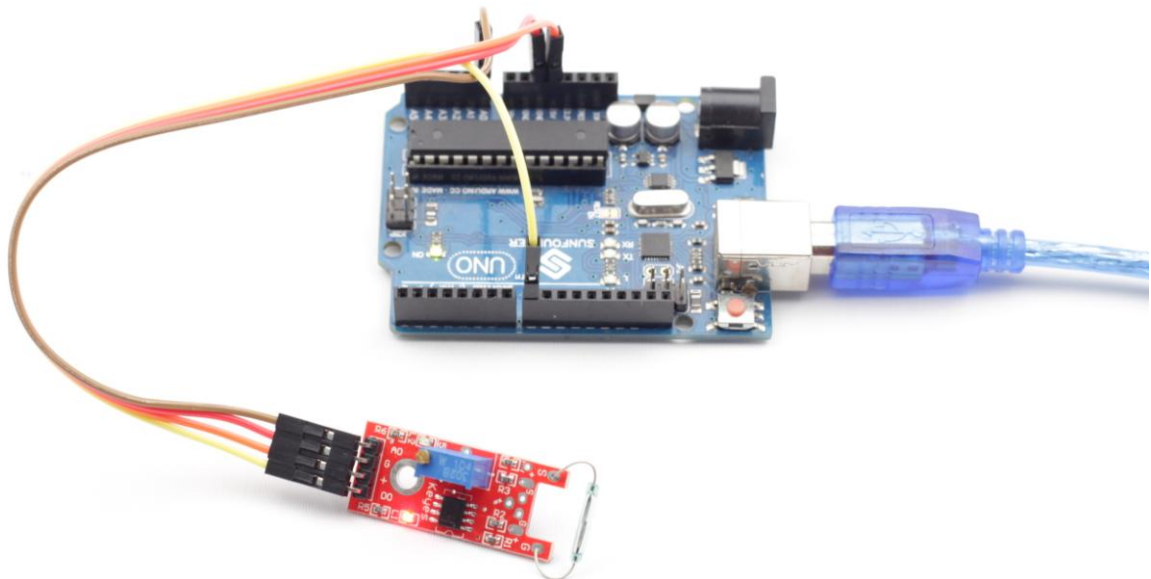
Reed switch module	SUNFOUNDER UNO
AO	A0
DO	Digital 8
"_"	GND
+	5V

**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

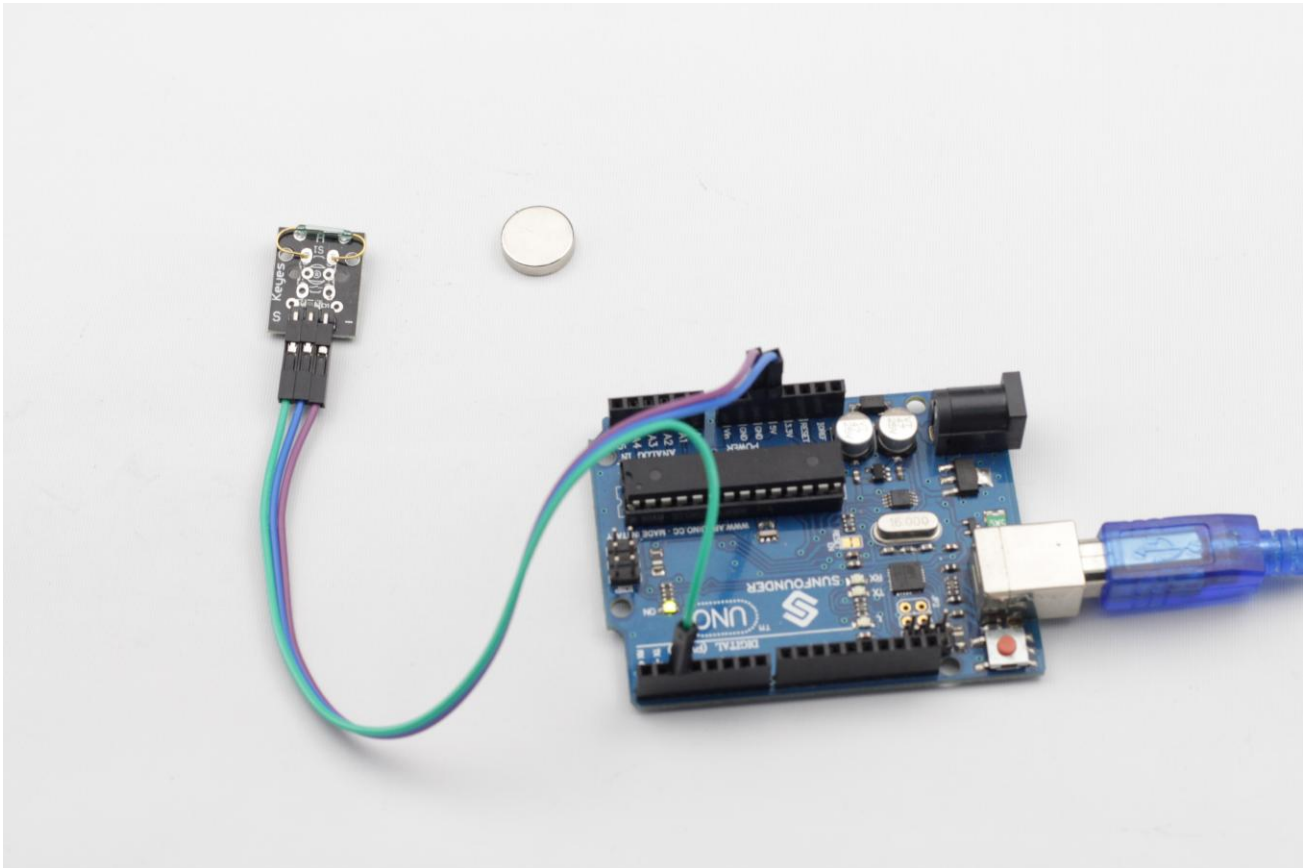
Now, if you use a magnet to approach the reed switch, you will see the LED attached to pin 13 on SUNFOUNDER UNO board light up.





## Mini Reed

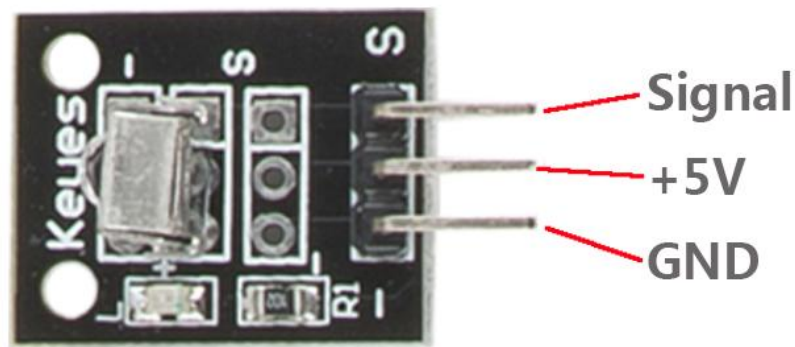
Its experimental procedures are the same with the above. Connect pin S to digital port 2 of SUNFOUNDER board, and you will see the LED attached to pin 13 light up when a magnet approaches the mini reed.



# Lesson 9 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

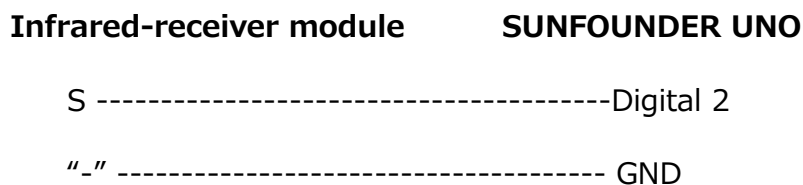
- 1\*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1\*USB data cable
- 1\*Infrared-receiver module
- 1\*Remote controller
- Several jumper wires

## 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



+ ----- 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

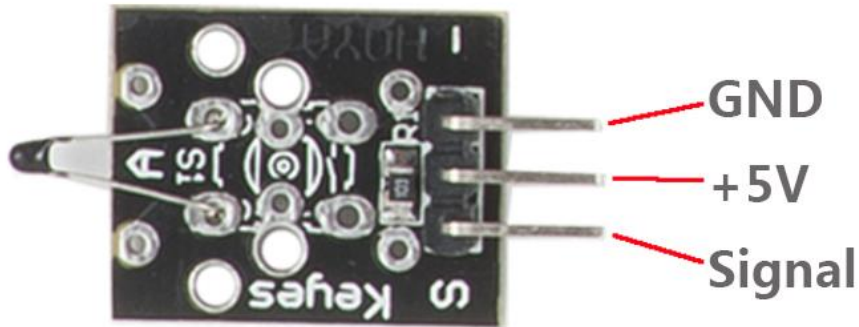
Now, if you press Power key of a remote controller, the LED attached to pin 13 on the SUNFOUNDER UNO board will light up. If you press any other key, the LED will go out.



# Lesson 10 Analog-temperature Sensor

## Introduction

A thermistor is the core component of an analog-temperature sensor (as shown below).



## Components

- 1\*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1\*USB data cable
- 1\*Analog-temperature Sensor module
- 1\*LCD1602
- 1\*Potentiometer
- Several jumper wires

## Experimental Principle

This module is based on thermistor principle, whose resistance varies significantly with ambient temperature. It can detect surrounding temperature changes in real time and send the temperature data to analog I/O port of SUNFOUNDER. Next we only need to convert sensor output to Celsius temperature by simple programming and display it on LCD.

## Experimental Procedures

**Step 1:** Connect the circuit according to the following method

**Analog-temperature Sensor module                      SUNFOUNDER UNO**

S -----A0

"-"----- GND  
+ ----- 5V

**LCD1602 connection:** connect pin RS to digital pin 4; R/W to GND; E to digital pin 5; D4~D7 to digital pin 9 to 12; VSS to GND; VDD to 5V; A to 3.3V; K to GND

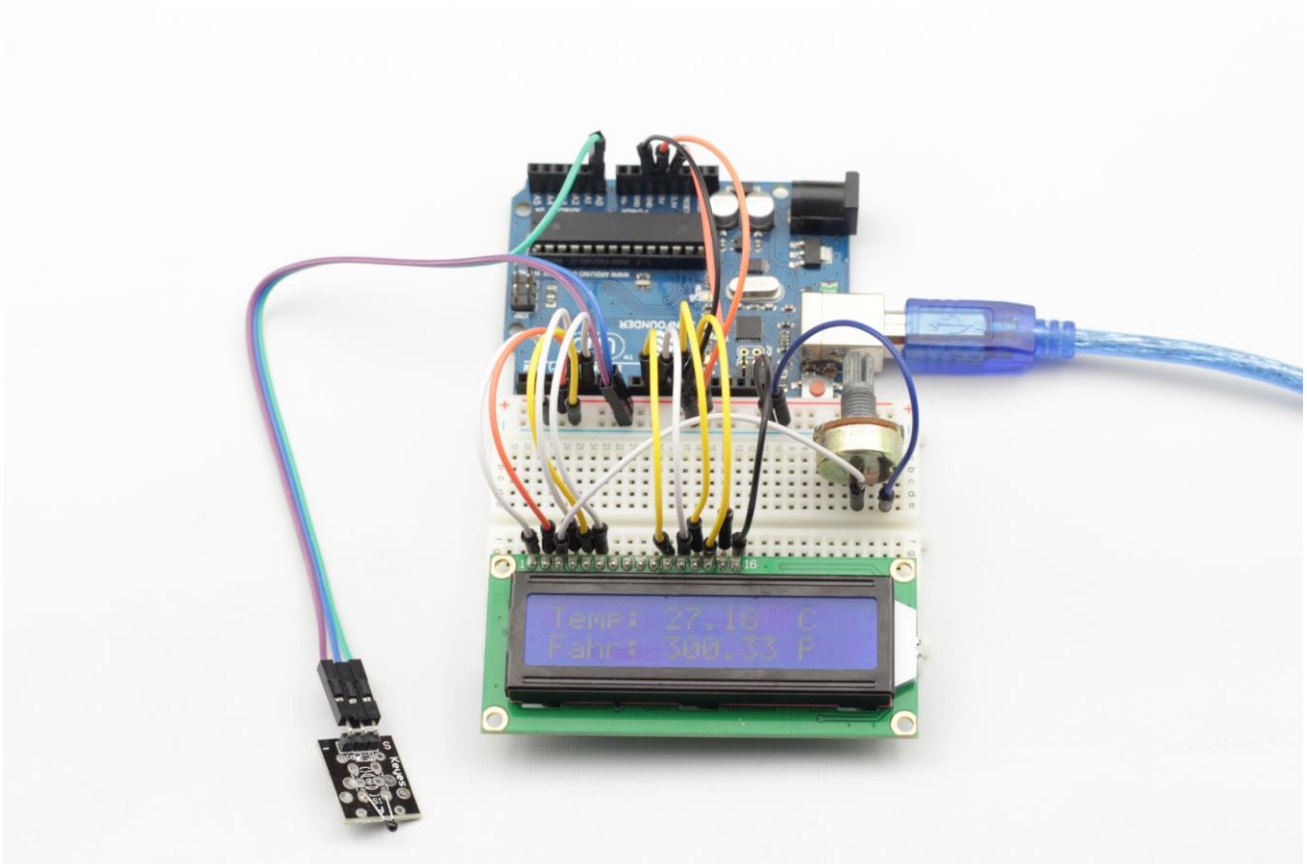
**Potentiometer connection:** Connect the middle pin to VO of LCD1602 and any other pin to GND

**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

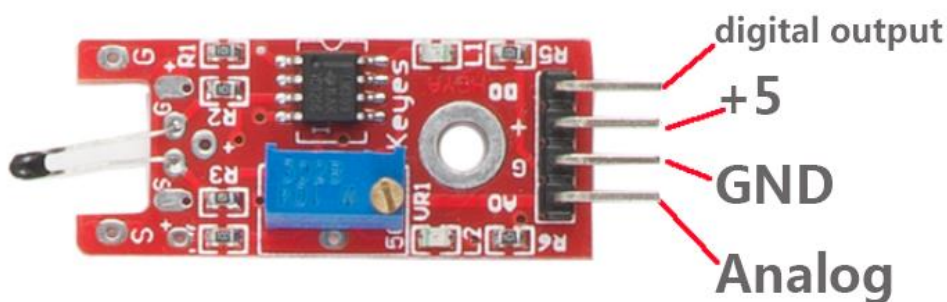
Now, you can see current temperature displayed on LCD both in Celcius and Fahrenheit degrees.



# Lesson 11 Digital-temperature Sensor

## Introduction

Compared with an analog-temperature sensor, a digital-temperature sensor (as shown below) only adds a digital output. You can adjust the threshold through a potentiometer. When an output is higher than the threshold, the sensor will output high; when an output is lower than the threshold, the sensor will output low.



## Components

- 1\*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1\*USB data cable
- 1\*Digital-temperature Sensor module
- Several jumper wires

## Experimental Principle

In this experiment, we will use a Digital-temperature Sensor module and an LED attached to pin 13 of SUNFOUNDER to build a simple circuit to make a temperature light.

With the LED attached to pin 13, connect the pin DO to digital pin 7 of SUNFOUNDER UNO. When the Digital-temperature Sensor inducts ambient temperature higher than a certain value (threshold), the LED will be on. Otherwise it will be off. You can adjust the threshold by adjusting the potentiometer.

## Experimental Procedures

**Step 1:** Connect the circuit according to the following method

## Digital-temperature Sensor module

## SUNFOUNDER UNO

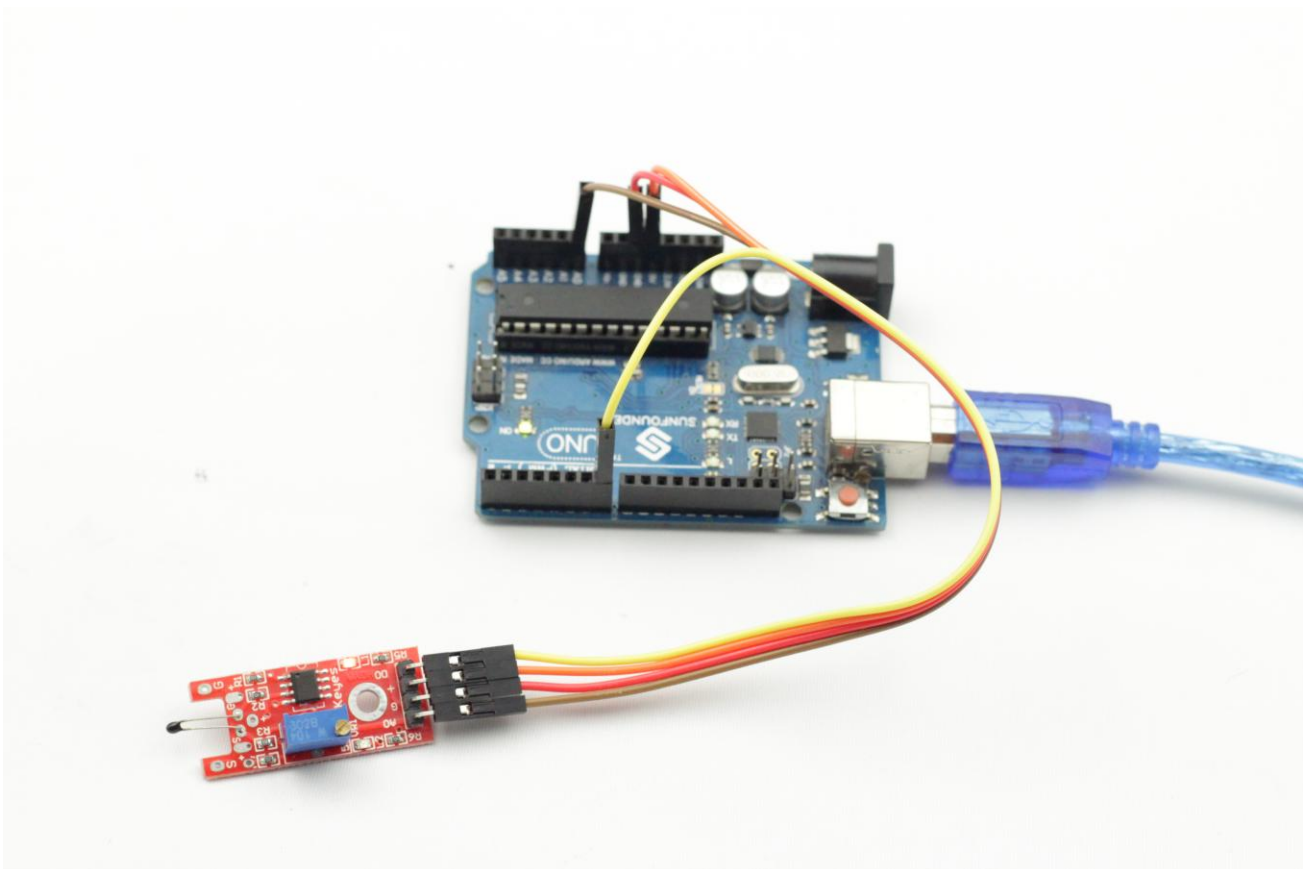
AO ----- A0  
DO ----- Digital7  
"\_" ----- GND  
+ ----- 5V

**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 touch the thermistor, you will see the LED attached to pin 13 on SUNFOUNDER UNO board light up after a while.



# Lesson 12 Buzzer

## Introduction

Buzzers can be categorized as active and passive buzzers (See the following picture).



## Components

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

## Experimental Principle

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 wired up. 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.

## Experimental Procedures

### Passive Buzzer

**Step 1:** Connect the circuit according to the following method

Passive Buzzer module	SUNFOUNDER UNO
-----------------------	----------------

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

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

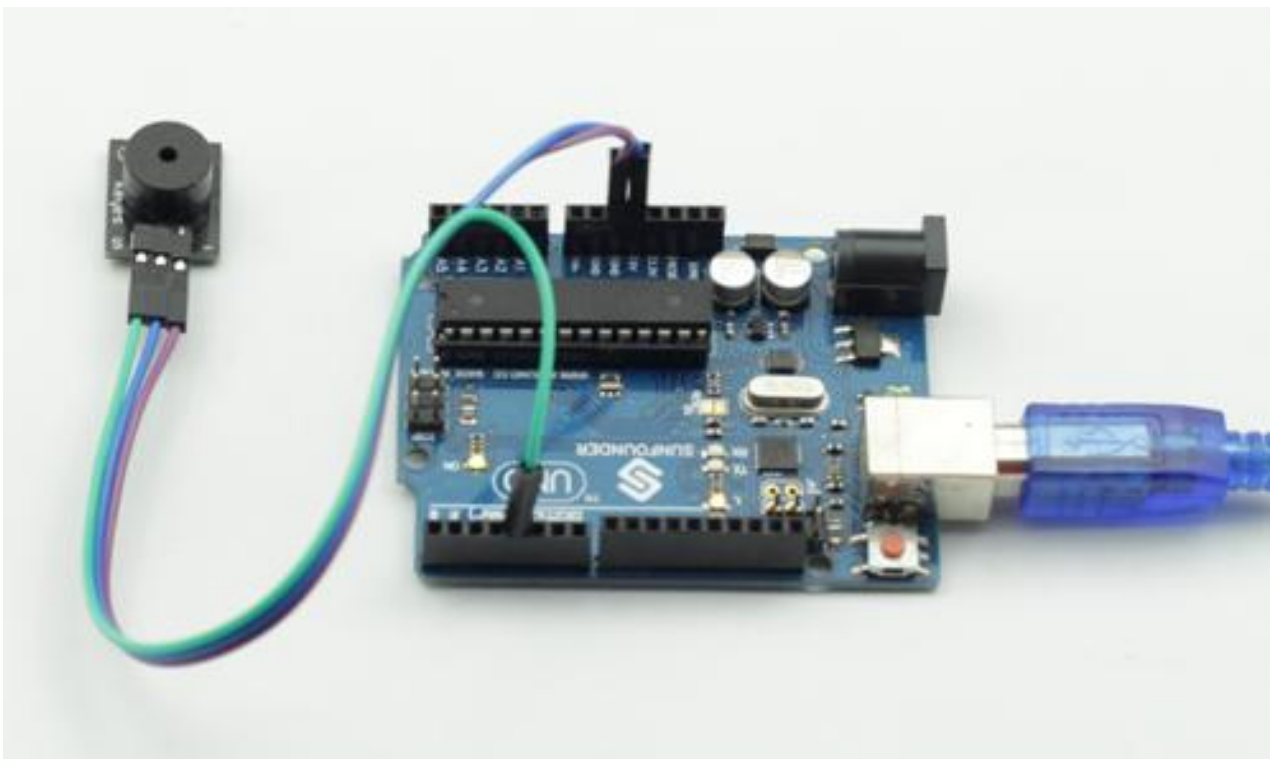
+ -----	5V
---------	----

**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 can hear the passive buzzer make air defense warning sounds.



### Active Buzzer

Note: The active buzzer has built-in oscillating source, so it will make sounds as long as it is wired up. But it can only make sounds with fixed frequency.

**Step 1:** Connect the circuit according to the following method

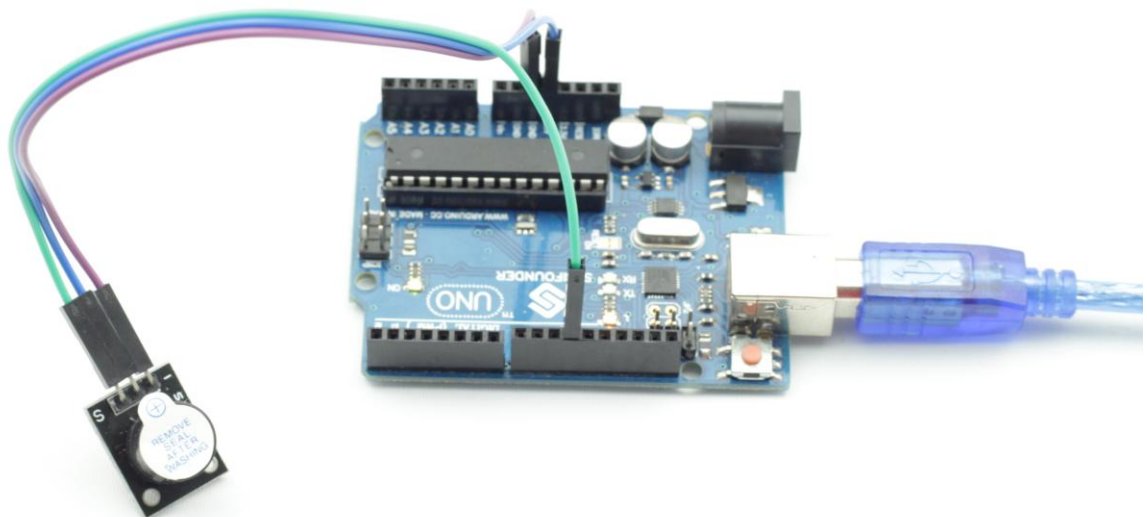
Active Buzzer module	SUNFOUNDER UNO
S	----- Digital 11
" - "	----- GND
+	----- 5V

**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

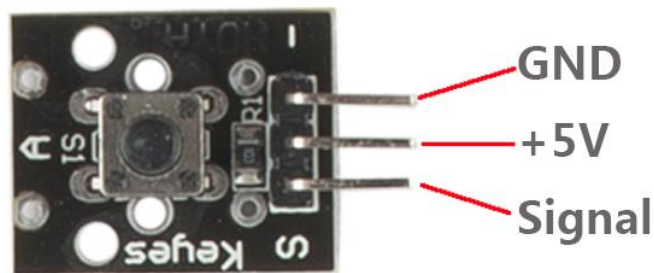
Now, you can hear the active buzzer make ticking sounds.



# Lesson 13 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

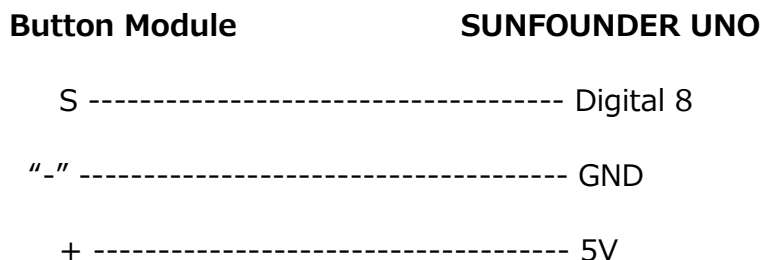
- 1\*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1\*USB data cable
- 1\*Button module
- Several jumper wires

## 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

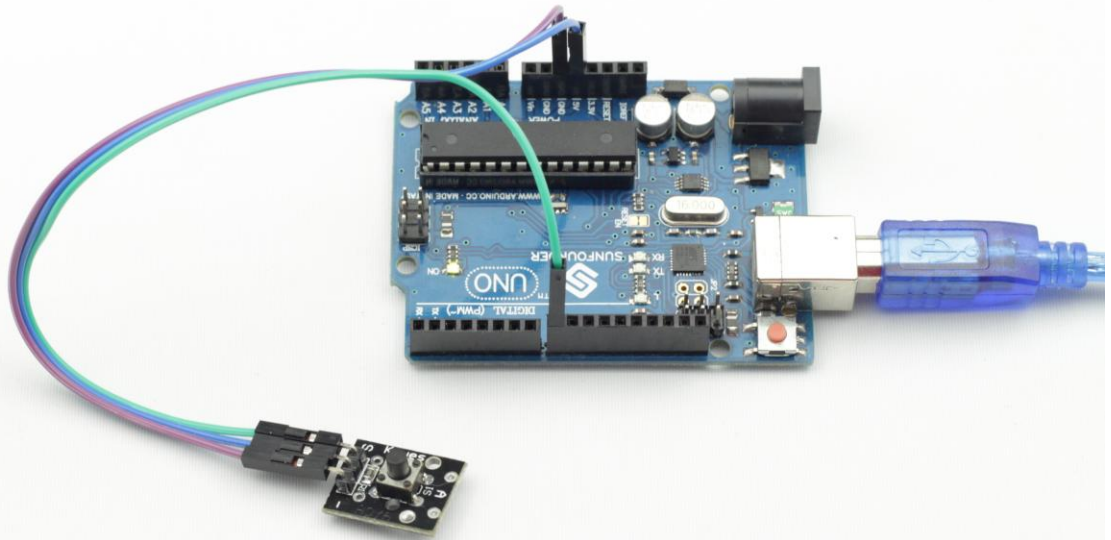


**Step 2:** Program (Please refer to example code in CD provided by us)

**Step 3:** Compile the program

**Step 4:** Burn the program into SUNFOUNDER UNO board

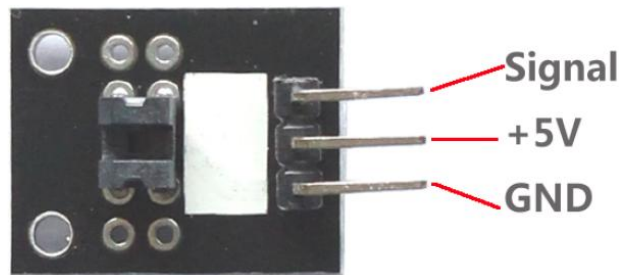
Now, if you press the button, the LED attached to pin 13 on SUNFOUNDER UNO board will light up.



# Lesson 14 Photo-interrupter

## Introduction

A photo-interrupter (as shown below) is a sensor that arranges light-emitting component and light-receiving component face-to-face and packages them together. It uses the principle that light will be interrupted when there is an object passing through the sensor to realize detection function. Photo-interrupters are widely used in speed measurement.



## Components

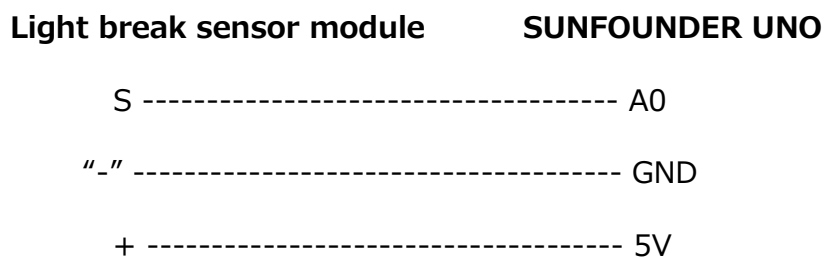
- 1\*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1\*USB data cable
- 1\*Light break sensor module
- Several jumper wires

## Experimental Principle

Well, basically a photo-interrupter consists of two parts: transmitter and receiver. Transmitter emits light (it could be, for example, an LED or a laser) and that light goes to receiver. If that light beam between transmitter and receiver is interrupted by some obstacles, and receiver detects no incoming light even for a brief moment – the output level will change. In this experiment, we will turn an LED on or off by this change.

## Experimental Procedures

**Step 1:** Connect the circuit according to the following method

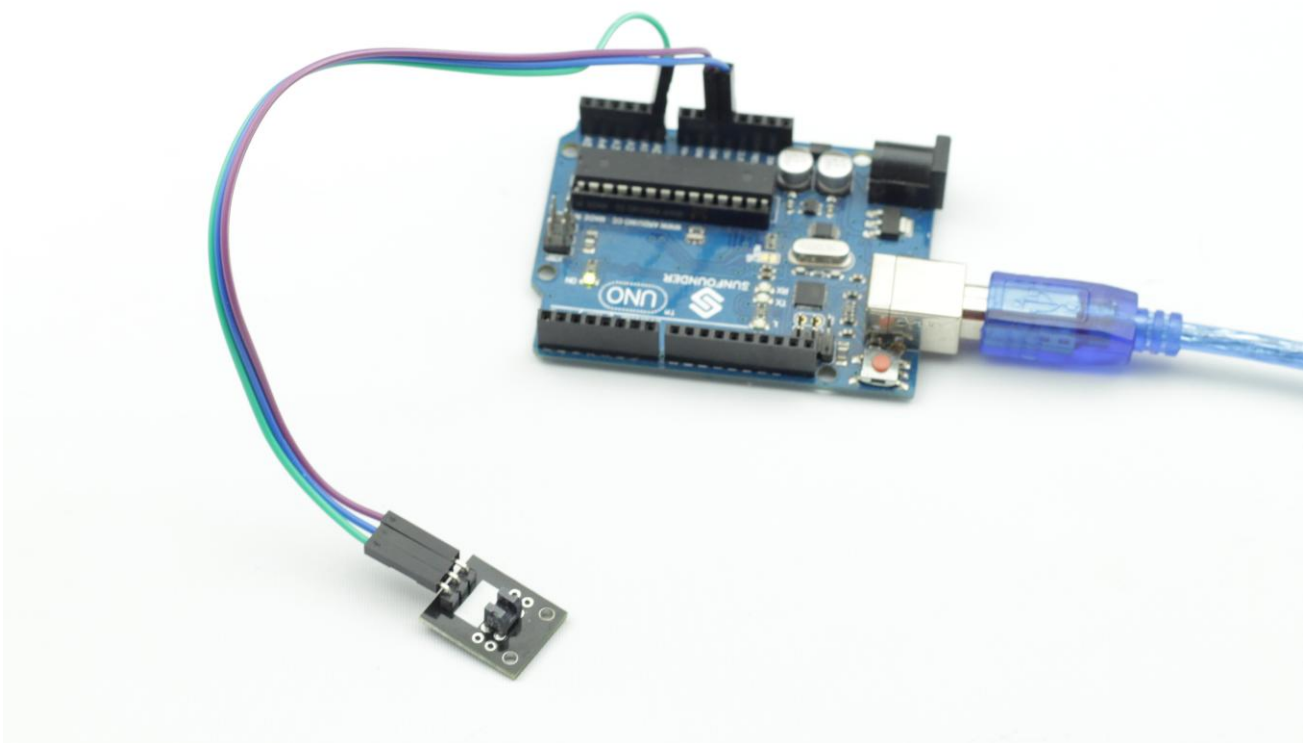


**Step 2:** Program (Please refer to example code in CD provided by us)

**Step 3:** Compile the program

**Step 4:** Burn the program into SUNFOUNDER UNO board

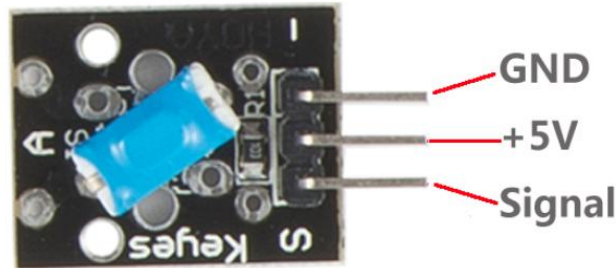
Now, if you break incoming light with a piece of paper, you will see the LED attached to pin 13 on SUNFOUNDER UNO board turned on; if you remove the paper, you will see the LED turned off.



# Lesson 15 Tilt-Switch

## Introduction

The tilt-switch (as shown below) we use here is a ball tilt-switch with a metal ball inside. It is used to detect small angle of inclination.



## Components

- 1\*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1\*USB data cable
- 1\*Tilt-switch module
- 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.

In this experiment, we will use a Tilt-switch module and an LED attached to pin 13 of SUNFOUNDER to build a simple circuit to make a tilt light.

With the LED attached to pin 13, connect the pin S to digital port 2 of SUNFOUNDER UNO board. When the Tilt-switch inducts tilt signals, the LED will be on. Otherwise it will be off.

## Experimental Procedures

**Step 1:** Connect the circuit according to the following method

**Tilt-switch module**

**SUNFOUNDER UNO**

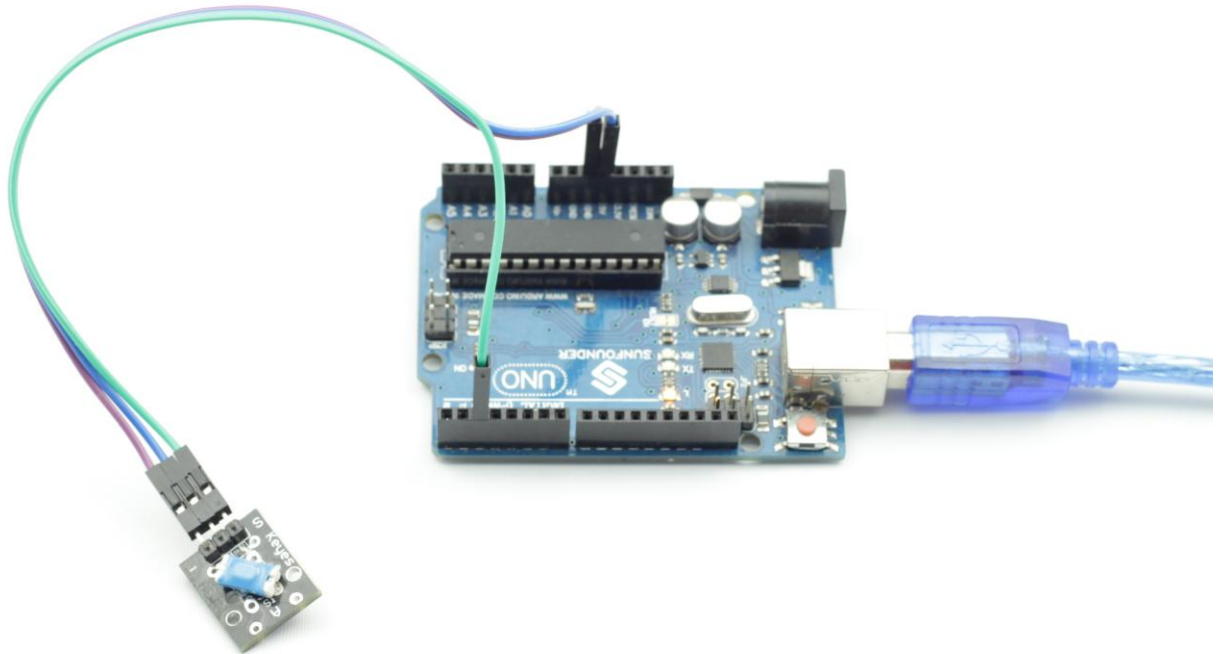
S ----- Digital 2  
"\_" ----- GND  
+ ----- 5V

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

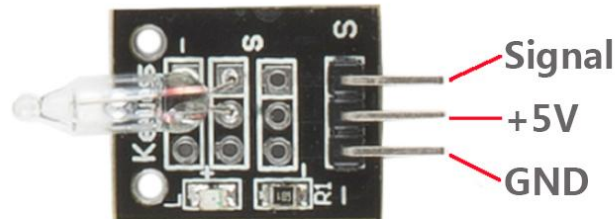




# Lesson 16 Mercury Switch

## Introduction

Similar to the tilt-switch, a mercury switch (as shown below) is used to detect slight large angle of inclinations.



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, an inert gas, or a 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 touches a set of contacts, thus completing the electrical circuit through those contacts. Tilting the switch the opposite direction causes the mercury to move away from that set of contacts, thus breaking that circuit. The switch may contain multiple sets of contacts, closing different sets at different angles, allowing, for example, single-pole, double-throw (*SPDT*) operation.

The difference between a mercury switch and a ball switch:

First, All materials of a ball switch can meet environmental protection requirements, while a mercury switch cannot meet this requirement because of the material itself.

Second, a ball switch conducts by the metal ball connecting with the trigger pin to generate signals. Since the contact area of the ball and the trigger pin is small and the ball can move, flash breaking phenomenon will occur when conduction. However, a mercury switch conducts by mercury contacting with the trigger end. Generally speaking, a mercury switch has more stable conduction effect because of its liquid state and large contact area.

Third, a ball switch has metal shell with good structural strength.

## Components

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

## Experimental Principle

With the LED attached to pin 13, connect the pin S to digital port 2 of SUNFOUNDER. When the Mercury switch inducts 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 breaking out. It should also be properly handled when no longer being used.

## Experimental Procedures

**Step 1:** Connect the circuit according to the following method

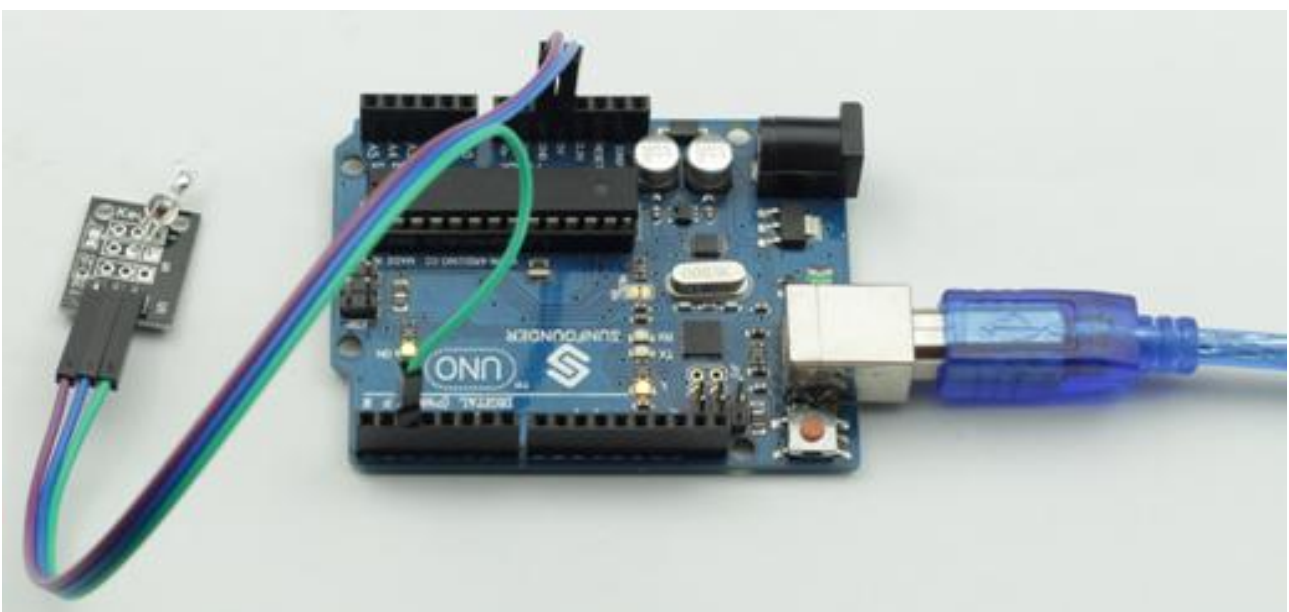
Mercury switch module	SUNFOUNDER UNO
S	Digital 2
"-"	GND
+	5V

**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

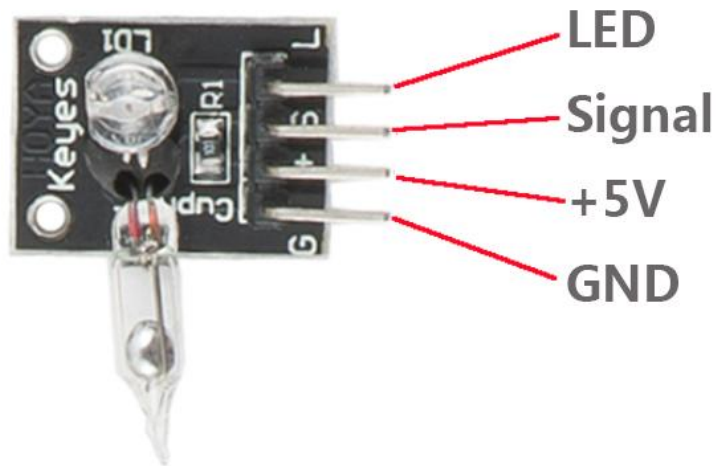
Now, if you tilt the switch, the LED attached to pin 13 on SUNFOUNDER UNO board will light up.



# Lesson 17 Magic Cup

## Introduction

It consists of two same modules, and each module adds a separate LED on the basis of Mercury switch.



## Components

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

## Experimental Principle

Connect one module pin S and pin L to digital pin 7 and pin 5 of SUNFOUNDER; connect the other module pin S and pin L to digital pin 4 and pin 6 of SUNFOUNDER.

When one mercury switch tilts, its attached LED will become darker and darker, while the other LED will become brighter and brighter. Just like telepathy.

## Experimental Procedures

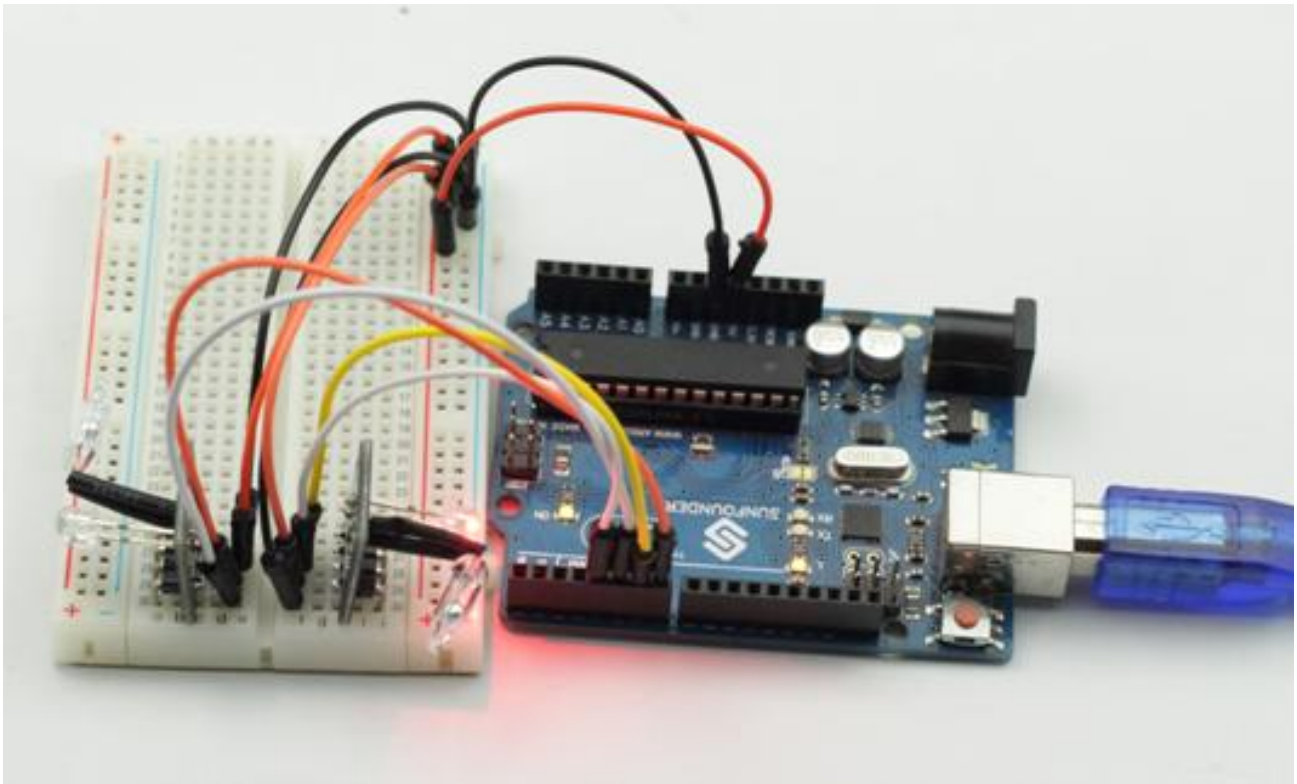
**Step 1:** Connect one module pin S and pin L to digital pin 7 and pin 5 of SUNFOUNDER; connect the other module pin S and pin L to digital pin 4 and pin 6 of SUNFOUNDER.

**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

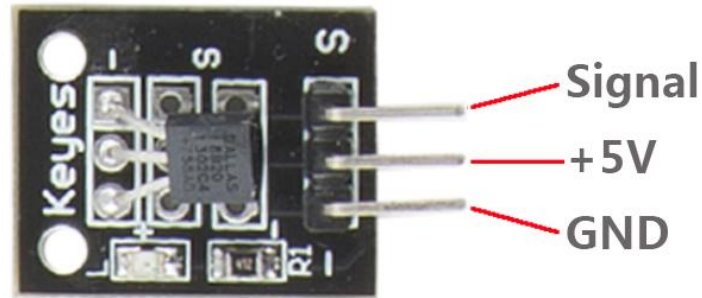
Now, when you tilt Magic cup, you will see the LED on one module become darker and darker, while the other LED become brighter and brighter.



# Lesson 18 DS18B20 Temperature Sensor

## Introduction

DS18B20 Temperature Sensor is different from traditional AD collection temperature sensor. It uses 1-wire bus and can directly output temperature data.



## Components

- 1\*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1\*USB data cable
- 1\*DS18B20 Temperature Sensor module
- 1\*LCD1602
- 1\*Potentiometer
- Several jumper wires

## Experimental Principle

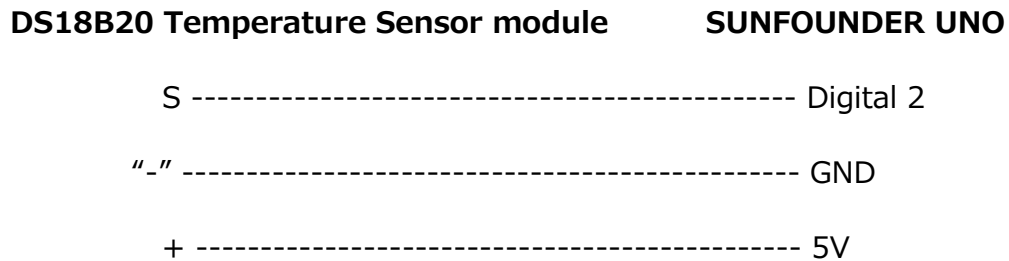
DS18B20 is a commonly used digital temperature sensor with the characters of small size, low hardware overhead, strong anti-interference ability and high precision. DS18B20 digital temperature sensor is easy to wire and can be applied to a variety of occasions after packaging, such as pipeline type, screw type, magnet adsorption type, and stainless steel package type. Packaged DS18B20 can be used to measure the temperature of cable trench, blast furnace water cycle, boiler, machine room, agriculture greenhouse, clean room, ammunition depot and other non extreme temperature occasions.

With unique 1-wire interface, DS18B20 requires only one port pin for two-way communication between microprocessor and DS18B20. It supports multi-point networking function, and up to eight DS18B20s can be connected to an only three-wire in parallel to

measure multi-point temperatures. Too many DS18B20s will make the power supply voltage too low and cause the instability of signal transmissions.

### Experimental Procedures

**Step 1:** Connect the circuit according to the following method



**LCD1602 connection:** connect pin RS to digital pin 4; R/W to GND; E to digital pin 5; D4~D7 to digital pin 9 to 12; VSS to GND; VDD to 5V; A to 3.3V; K to GND

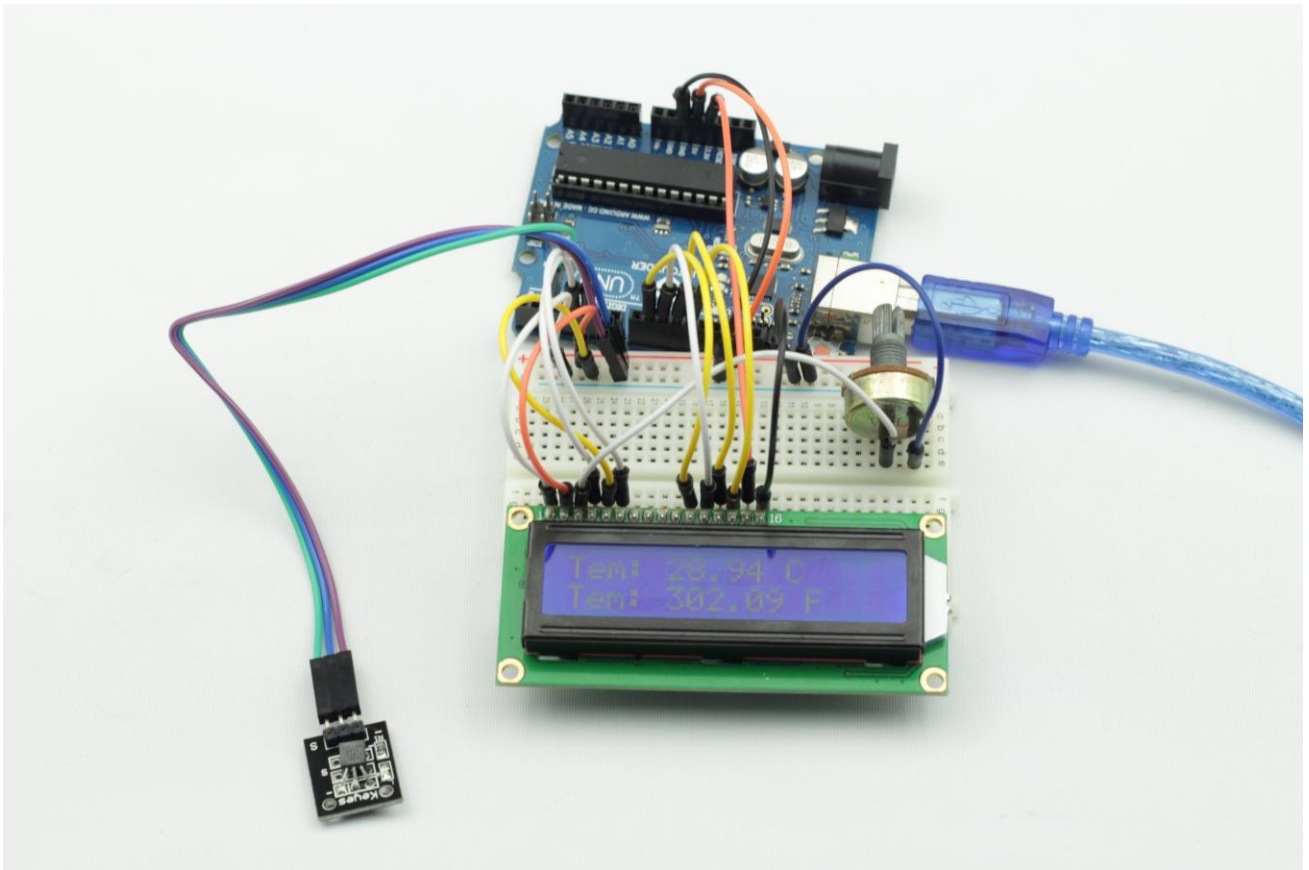
**Potentiometer connection:** Connect the middle pin to VO of LCD1602 and any other pin to GND

**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

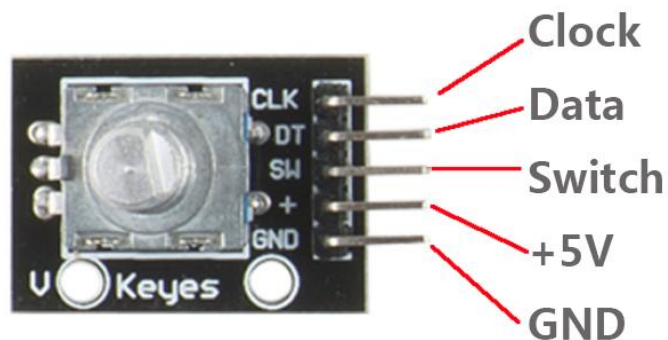
Now, you can see current temperature value displayed on LCD.



# Lesson 19 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.



## Experimental Conditions

- 1\*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1\*USB data cable
- 1\*Rotary Encoder module
- Jumper wires

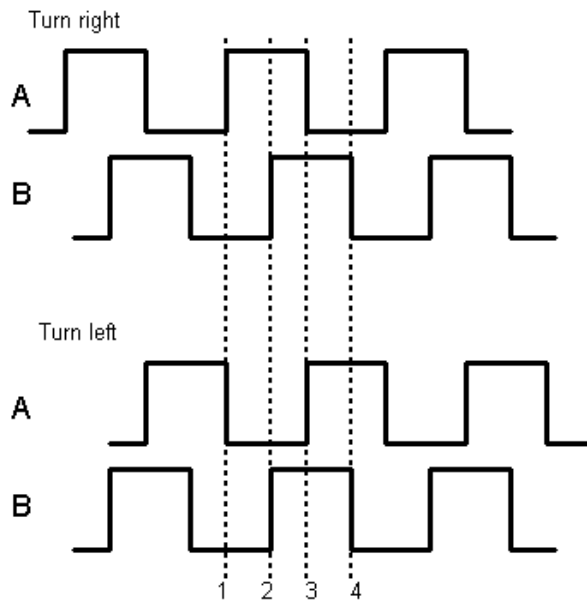
## Principle

There are two main types of rotary encoder: absolute and incremental (relative). 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.

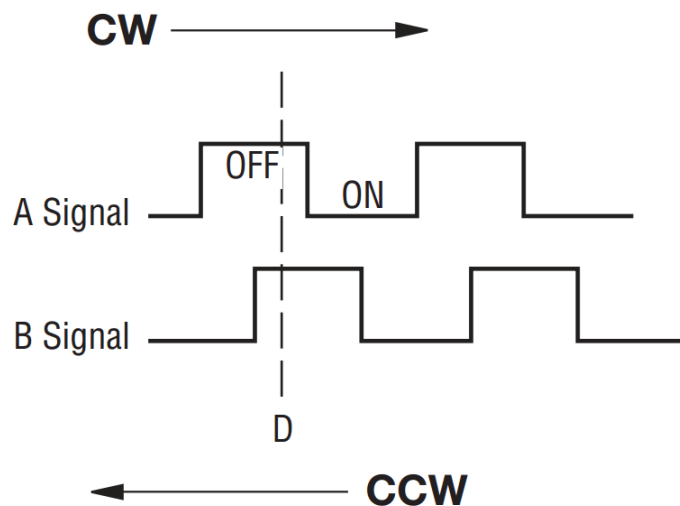
In this experiment, we will use the latter.

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 left turn and right turn during SCM programming. However, when using oscilloscope to observe left turn and right turn of a switch, you will find a phase difference exists between the signals of the two output pins. The phase difference is shown as follows:



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 judge whether the rotary encoder turns left or right as long as you know the state of output 2.

### Experimental Procedures

**Step 1:** Connect the circuit according to the following method

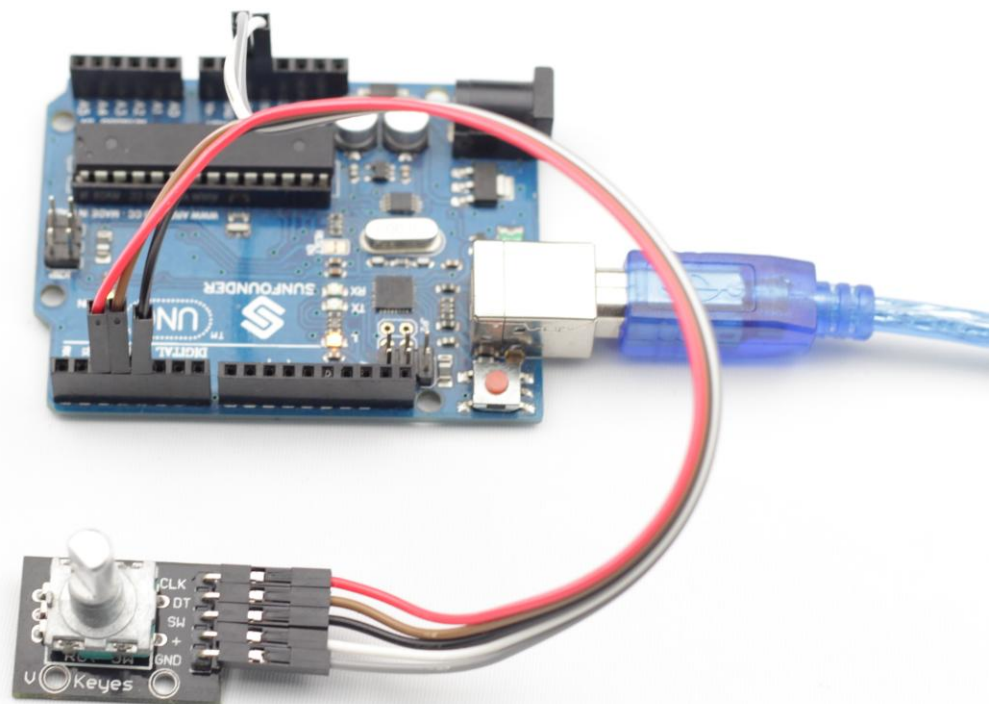
Rotary Encoder module	SUNFOUNDER UNO
CLK -----	Digital 2
DT -----	Digital 3
SW -----	Digital 4
+ -----	5V
"-"-----	GND

**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

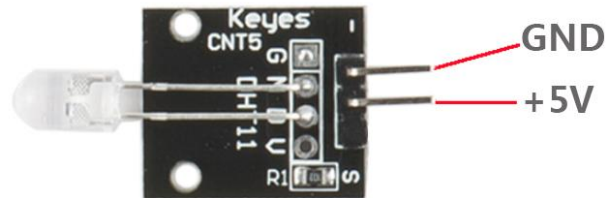
Now, you will see the angular displacement of rotary encoder printed on the serial monitor of the computer. When the rotary encoder rotates clockwise, the angular displacement is increased; when counterclockwise, decreased; if you press the switch on the rotary encoder, related readings will return to zero.



# Lesson 20 7-Color Auto-flash LED

## Introduction

It can automatically flash built-in colors after being power on.



## Experimental Conditions

- 1\*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1\*USB data cable
- 1\*7-color auto-flash LED module
- Jumper wires

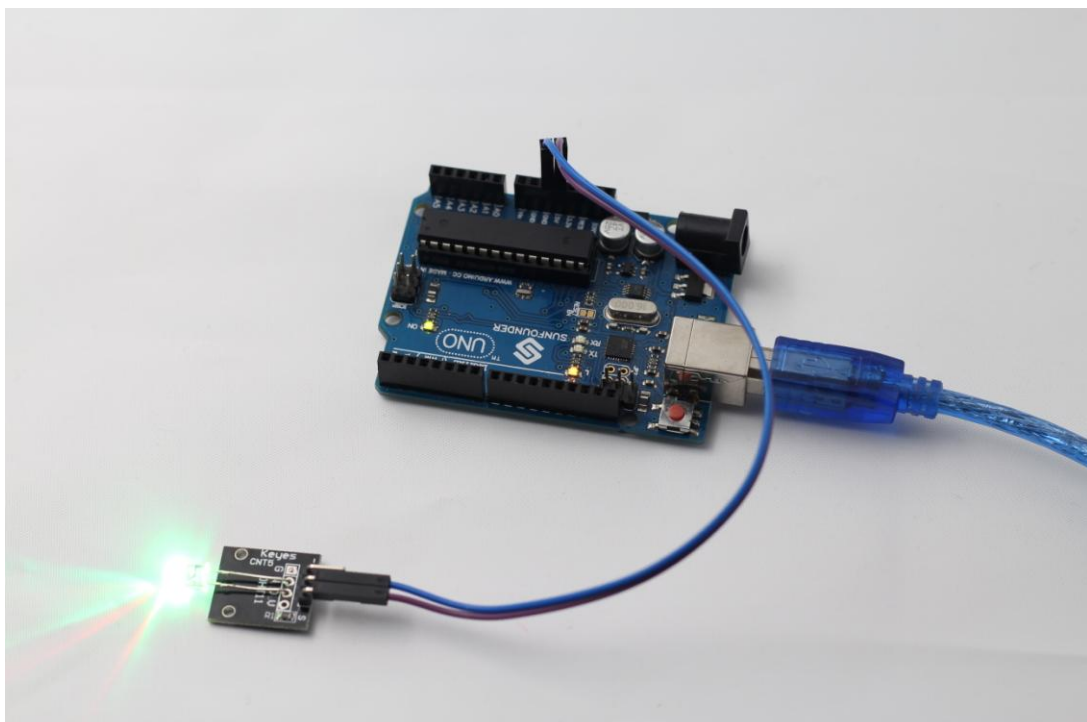
## Experimental Principle

When being power on, the 7-color auto-flash LED will flash built-in colors.

## Experimental Procedures

Just connect pin "S" to 5V of SUNFOUNDER UNO board and pin "-" to GND.

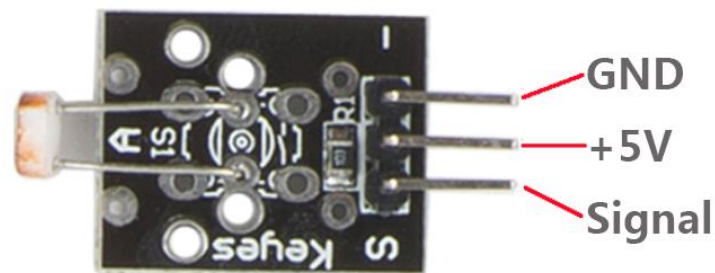
Now, you will see 7-color auto-flash LED flashing seven colors.



# Lesson 21 Photoresistor Sensor

## Introduction

It is actually a photoresistor, which can change its resistance with light intensity.



## Experimental Conditions

- 1\*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1\*USB data cable
- 1\*Photoresistor sensor module
- Jumper wires

## 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, we connect pin S to an analog port of SUNFOUNDER. When light intensity changes, the resistance of photoresistor will change accordingly. Thus change output voltage from pin S. We can read the output voltage and display it on LCD to observe the changes.

## Experimental Procedures

**Step 1:** Connect the circuit according to the following method

**Photoresistor sensor module**                      **SUNFOUNDER UNO**

S ----- A0

"-" ----- GND

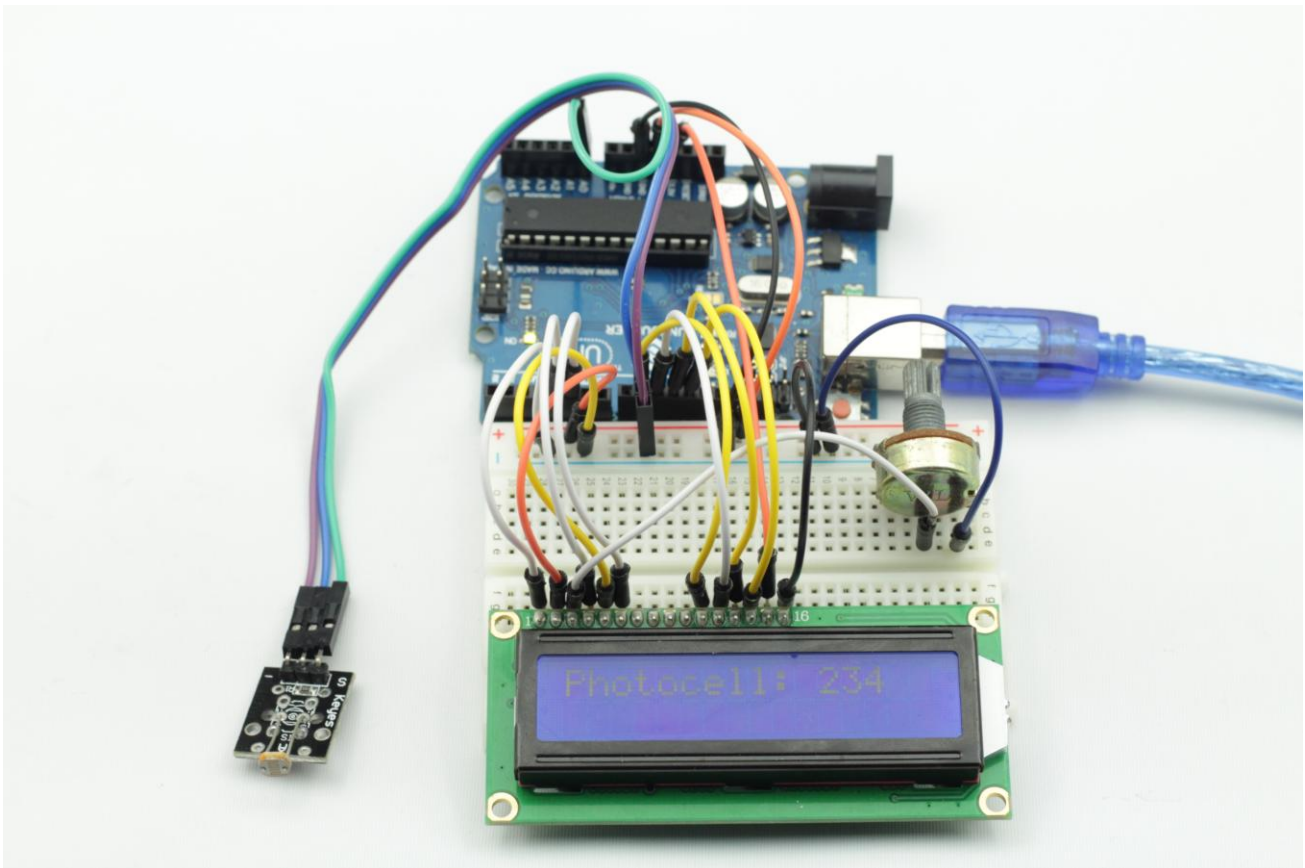
+ ----- 5V

**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 change light intensity, you will find the value displayed on the LCD change accordingly.

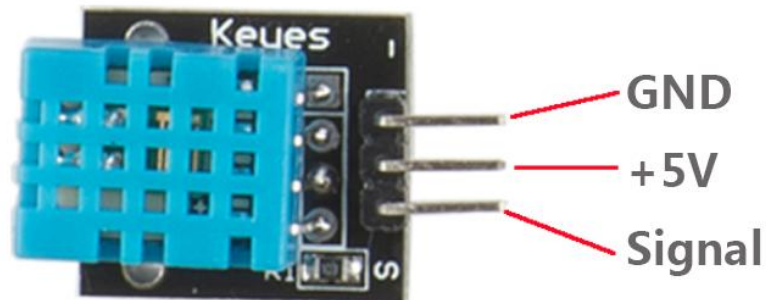


# Lesson 22 Humiture Sensor

## 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.

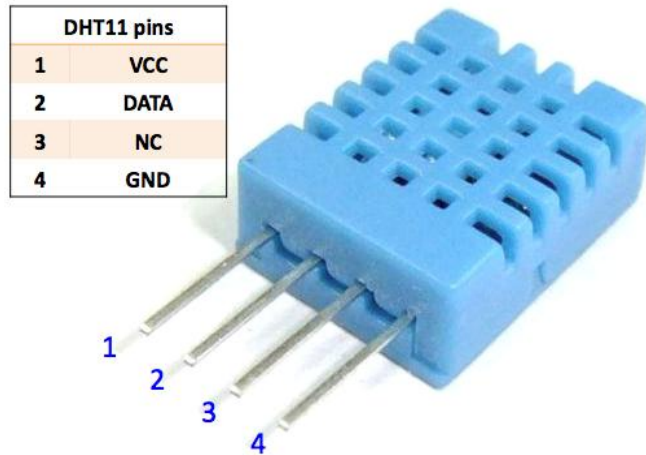
The sensor includes a resistive sense of wet component and a NTC temperature measurement device, and connected with a high-performance 8-bit microcontroller.



## Experimental Conditions

- 1\*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1\*USB data cable
- 1\*Humiture sensor module
- 1\*LCD1602
- 1\*Potentiometer
- 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

**LCD1602 connection:** connect pin RS to digital pin 5; R/W to GND; E to digital pin 6; D4~D7 to digital pin 9 to 12; VSS to GND; VDD to 5V; A to 3.3V; K to GND

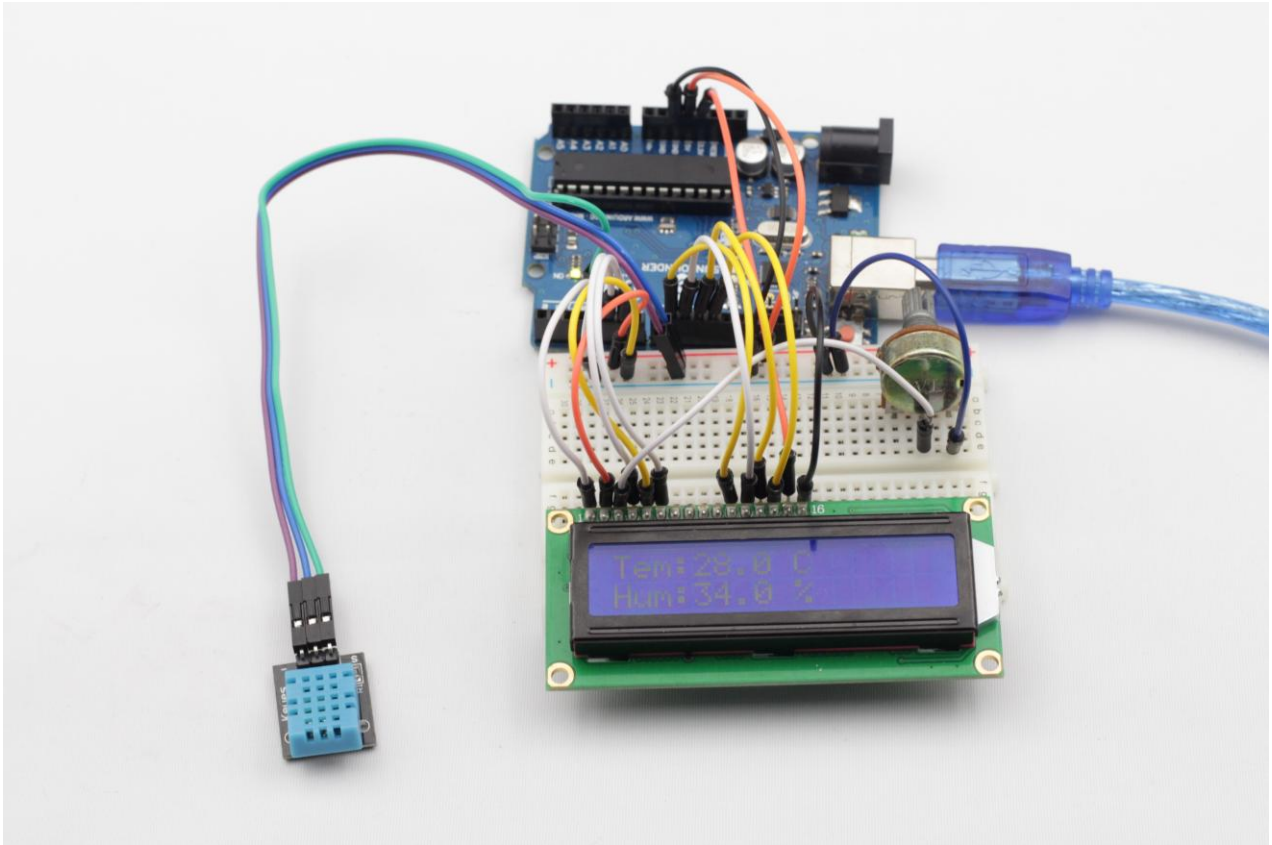
**Potentiometer connection:** Connect the middle pin to VO of LCD1602 and any other pin to GND

**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 will see the current value of humidity and temperature displayed on the LCD.

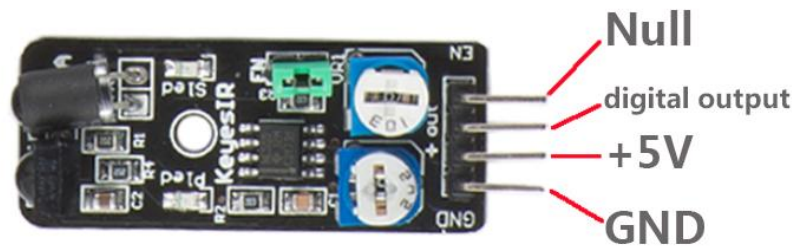




# Lesson 23 Obstacle Avoidance Sensor

## Introduction

An Obstacle Avoidance Sensor (as shown below) uses infrared reflection principle to detect obstacles. When there is no object in front, infrared-receiver cannot receive signals; when there is an object in front, it will block and reflect infrared light, then infrared-receiver can receive signals.



## Components

- 1\*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1\*USB data cable
- 1\*Obstacle Avoidance Sensor module
- Several jumper wires

## 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, emitted infrared ray will weaken with the propagation distance and finally disappear. If there is an obstacle, when infrared ray encounters an obstacle, it will be reflected back to the infrared-receiver. Then the infrared-receiver detects this signal and confirms an obstacle exists in front.

In this experiment, we will use an Obstacle Avoidance Sensor module and an LED attached to pin 13 of SUNFOUNDER to build a simple circuit to make an Obstacle Avoidance light.

With the LED attached to pin 13, connect the pin OUT to digital port 8 of SUNFOUNDER. When the Obstacle Avoidance Sensor detects an obstacle, the LED will be on. Otherwise it will be off.

Note: the obstacle avoidance distance of infrared sensor is adjustable, you can adjust the obstacle avoidance distance by adjust the potentiometer.

## Experimental Procedures

**Step 1:** Connect the circuit according to the following method

**Obstacle Avoidance Sensor module                      SUNFOUNDER UNO**

out ----- Digital 8

"\_" ----- GND

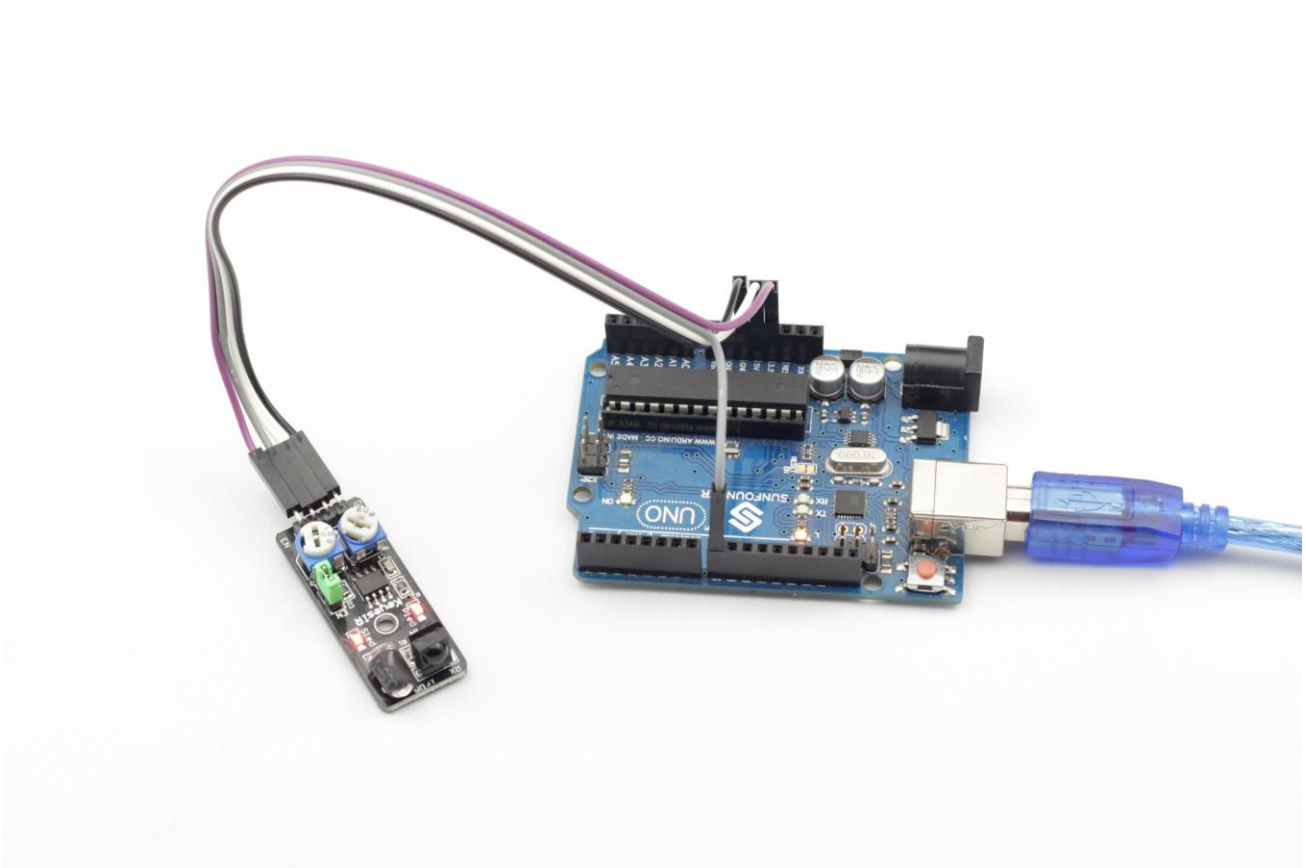
+ ----- 5V

**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

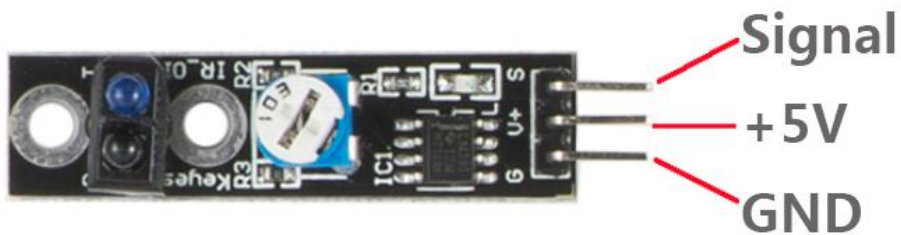
Now, if the Obstacle Avoidance Sensor encounters an obstacle, the LED attached to pin 13 on SUNFOUNDER UNO board will light up.



# Lesson 24 Tracking Sensor

## Introduction

A tracking sensor (as shown below) has the same principle with an Obstacle Avoidance Sensor but has small transmitting power.



## Components

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

## Experimental Principle

When infrared transmitter emits rays to ground, if the rays encounter white, it will be reflected and received by the receiver. The pin S will output low; if the rays encounter black lines, it will be absorbed and will not be received by the receiver. The pin S will output high.

In this experiment, we will use an Obstacle Avoidance Sensor module and an LED attached to pin 13 of SUNFOUNDER to build a simple circuit to make a tracking light.

With the LED attached to pin 13, connect the pin out to digital port 8 of SUNFOUNDER. When the Tracking Sensor detects reflection signals (white), the LED will be on. Otherwise it will be off (black line).

## Experimental Procedures

**Step 1:** Connect the circuit according to the following method

<b>Tracking sensor module</b>	<b>SUNFOUNDER UNO</b>
-------------------------------	-----------------------

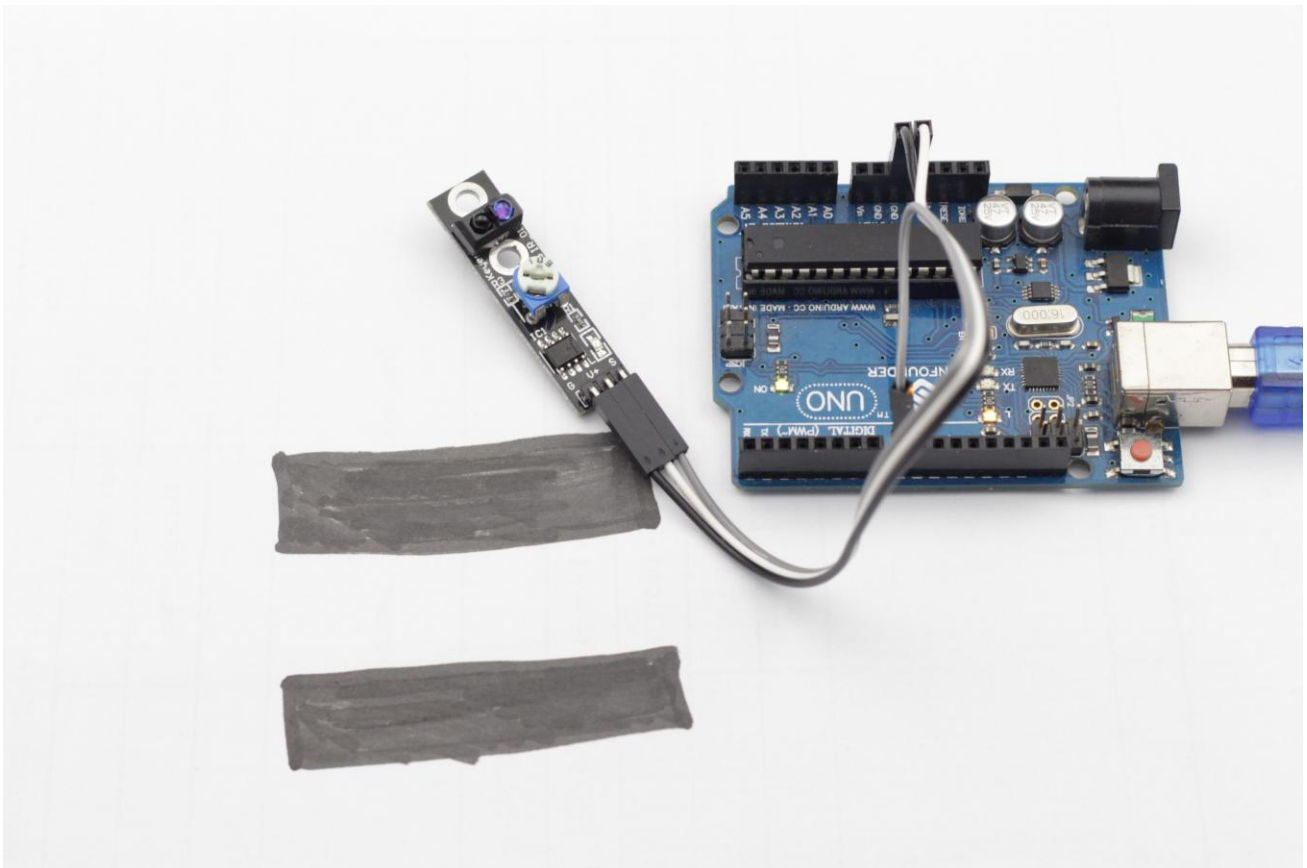
S ----- Digital 8  
"\_" ----- GND  
+ ----- 5V

**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, we draw two black thick lines on the paper. If the rays emitted by the sensor encounter the black lines, the LED attached to pin 13 on SUNFOUNDER UNO board will light up. Or it will go out.



# Lesson 25 Microphone Sensor

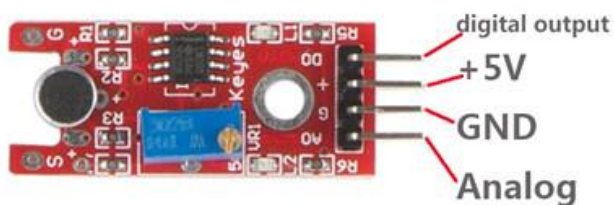
## Introduction

There are two kinds of microphone sensors in this kit (as shown below). One, we call it microphone sensor. The other, we call it high-sensitive voice sensor. The only difference between them is their sensitivity. The latter has higher sensitivity. In this experiment, we will take the microphone sensor as an example.

They both have two outputs:

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

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



**Microphone sensor**



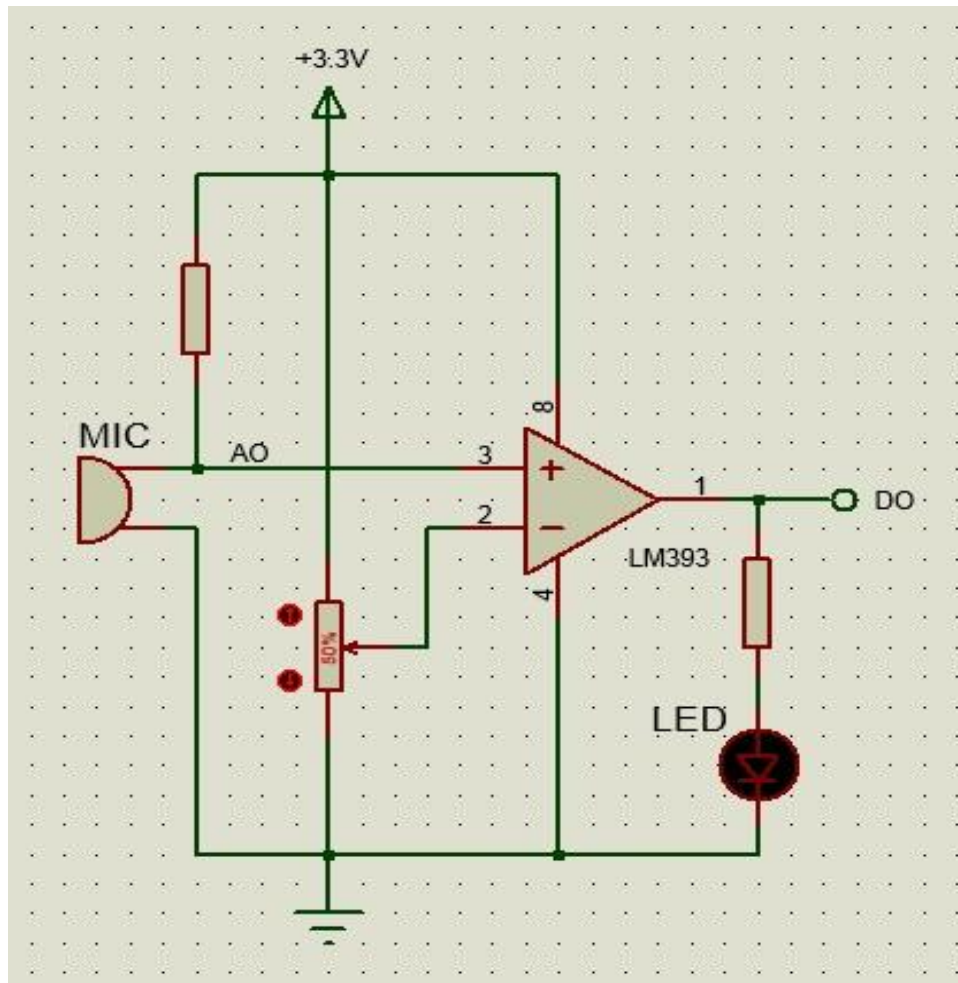
**High-sensitive voice sensor**

## Components

- 1\*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1\*Breadboard
- 1\*USB data cable
- 1\*Microphone sensor module (or 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 microphone sensor module is shown as follow:



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

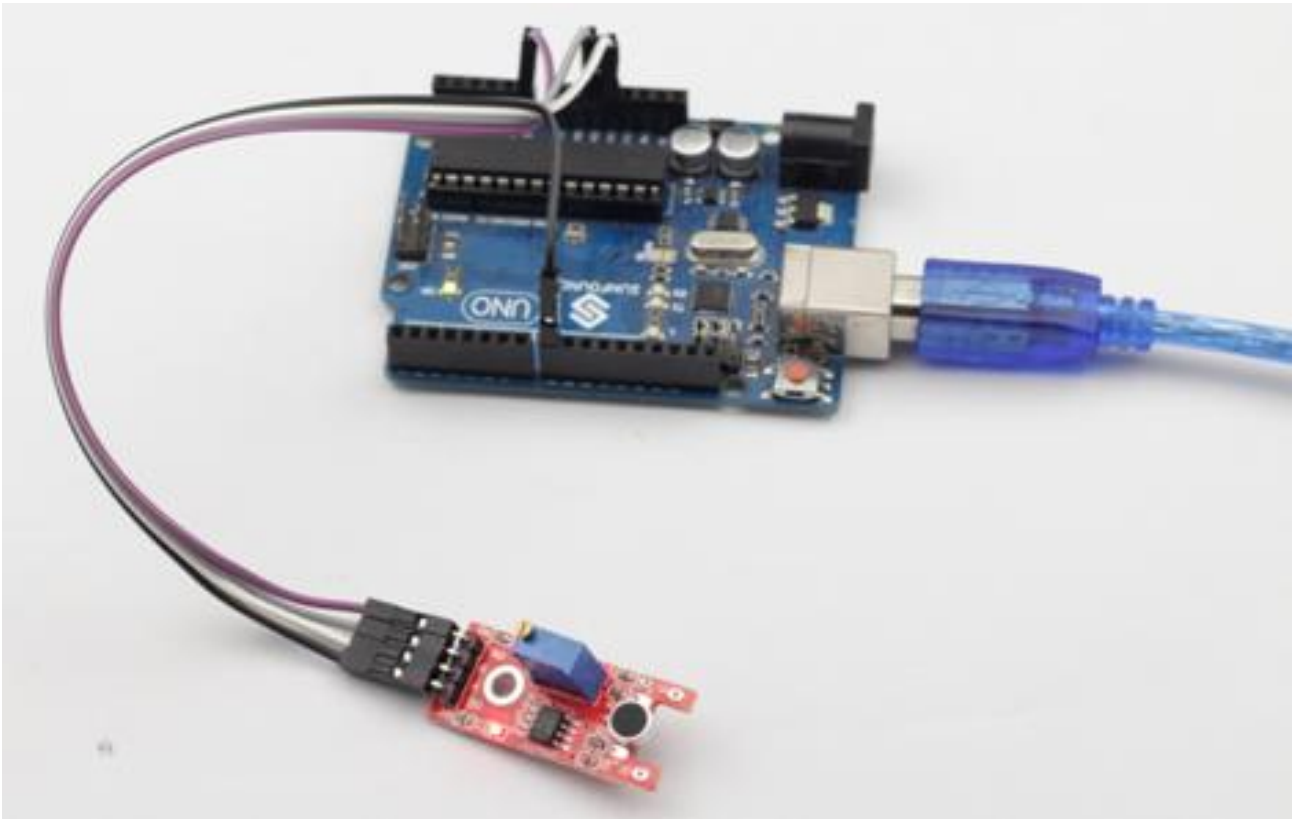
Microphone sensor module	SUNFOUNDER UNO
AO -----	A0
G -----	GND
+ -----	5V
DO -----	Digital 8

**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

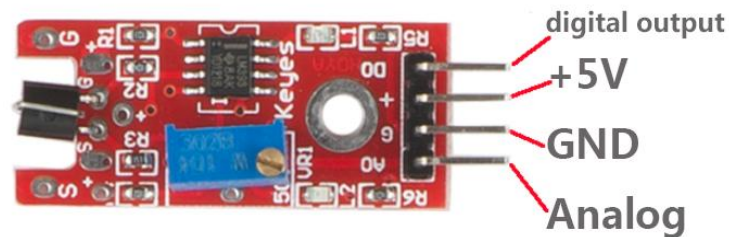
Now, when you speak or blow to the microphone, the LED attached to pin 13 on SUNFOUNDER board will light up.



# Lesson 26 Metal Touch Sensor

## Introduction

A **metal touch sensor** uses the conductivity of human body to operate. When you touch the metal on the base electrode of the transistor, the pin DO will output LOW.



## Components

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

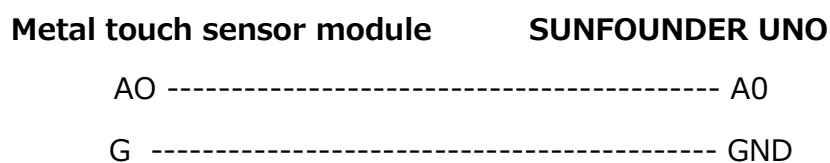
## Experimental Principle

In this experiment, we will use our fingers to touch the base electrode of the transistor to make it conduct as human body itself is a kind of conductor and an antenna that can receive electromagnetic waves in the air. These electromagnetic wave signals collected by human body are amplified by the transistor and processed by the comparator on the module to output steady signals.

With the LED attached to pin 13, we connect pin D0 to digital port 7 of SUNFOUNDER. When the metal touch sensor detects touch signals, the LED will be on. Otherwise it will be off.

## Experimental Procedures

**Step 1:** Connect the circuit according to the following method





+ ----- 5V

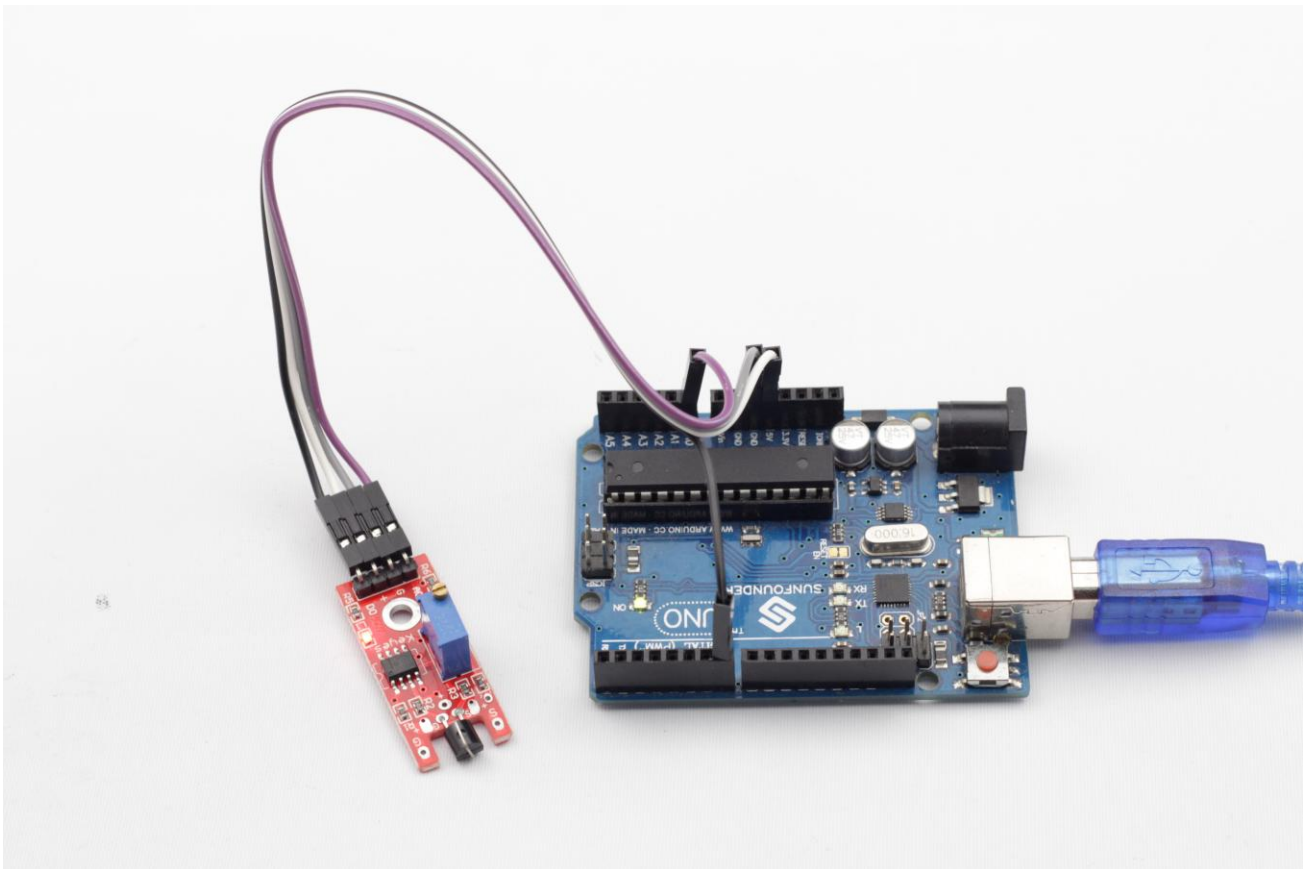
D0 ----- Digital 7

**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

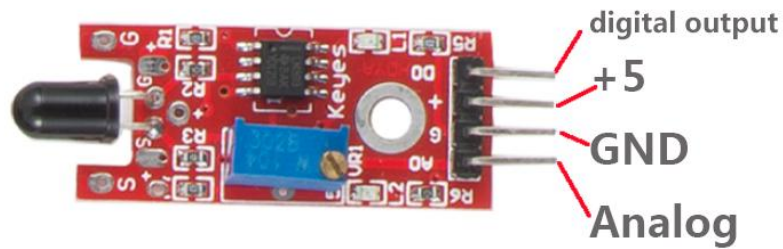
Now, if you touch the base electrode of the transistor, the LED attached to pin 13 on SUNFOUNDER board will light up.



# Lesson 27 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

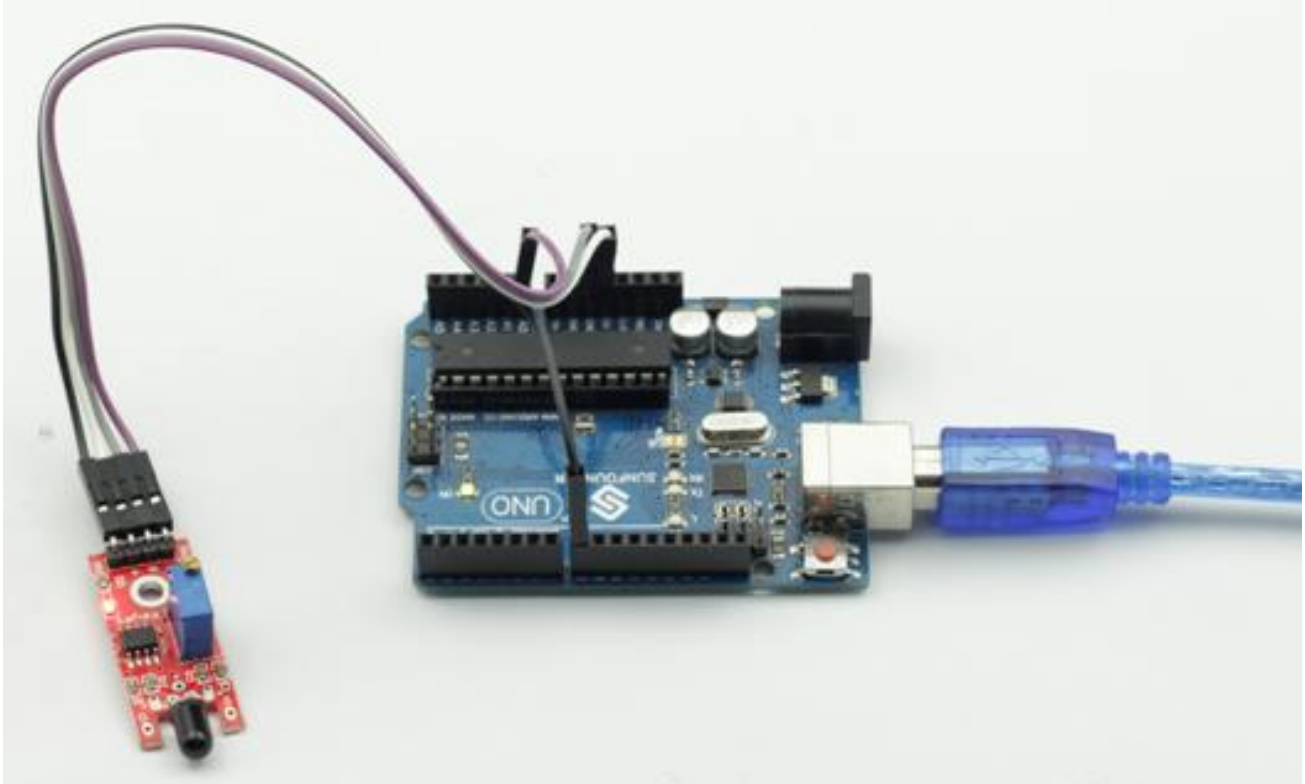
Flame module	SUNFOUNDER UNO
AO -----	A0
G -----	GND
+ -----	5V
DO -----	Digital 8

**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

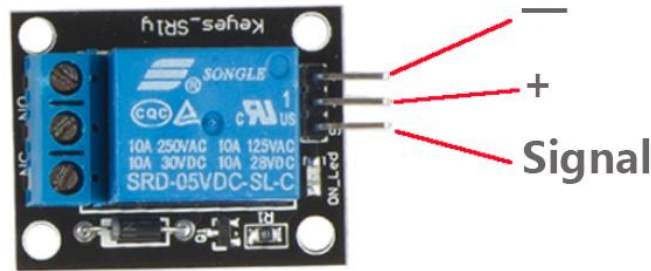
Now, if you ignite a lighter near the flame sensor, the LED on the flame sensor module and the LED attached to pin 13 on SUNFOUNDER board will light up.



# Lesson 28 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

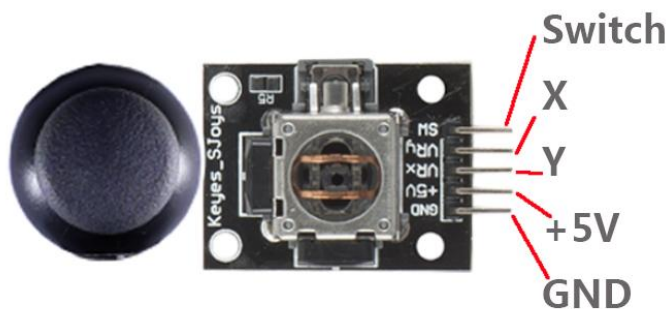
Now, you should be able to hear ticktock. This sound is made by breaking normally closed contact and closing normally open contact.



# Lesson 29 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

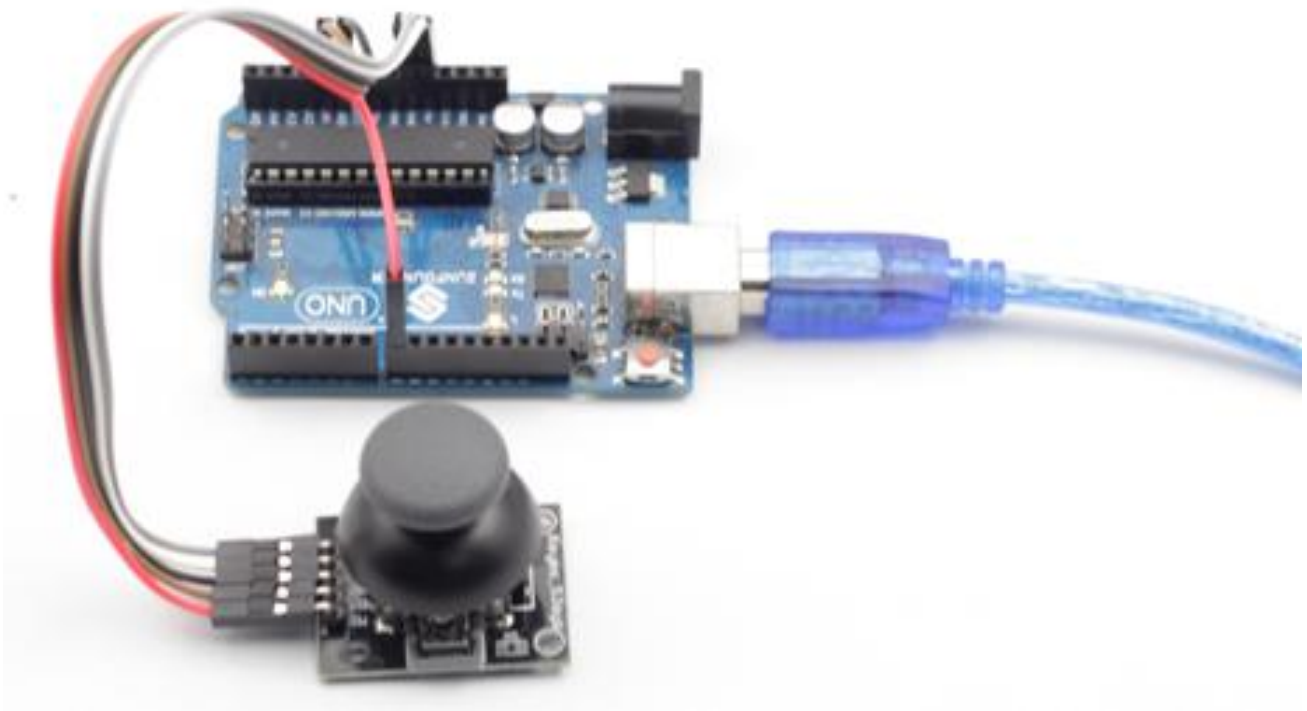
Joystick PS2 module	SUNFOUNDER UNO
SW -----	Digital 8
VRx -----	A0
VRy -----	A1
+5V -----	5V
GND -----	GND

**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 30 MQ-2 Gas Sensor

## Introduction

MQ-2 is a flammable gas and smoke sensor detects the concentrations of combustible gas in the air and outputs its reading as an analog voltage. They are used in gas detecting equipment for smoke and flammable gasses in family and industry or car.



## Components

- 1\*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1\*USB data cable
- 1\*MQ-2 Gas sensor module
- Several jumper wires

## Experimental Principle

MQ-2 gas sensor belongs to surface ion type N type semiconductor, which uses tin oxide semiconductor gas sensitive material. When ambient temperature is in  $200 \sim 300^{\circ}\text{C}$ , tin oxide will adsorb oxygen in the air and form oxygen anion adsorption to decrease electron density in semiconductor so as to increase its resistance. When in contact with the smoke, if grain boundary barrier is modulated by the smoke and changed, it could cause surface conductivity change. So you can gain the information of the smoke existence, the higher the smoke concentration is, the greater the conductivity, thus the lower the output resistance is.



In this experiment, we will measure the output voltage to judge conductivity changes.

### Experimental Procedures

**Step 1:** Connect the circuit according to the following method

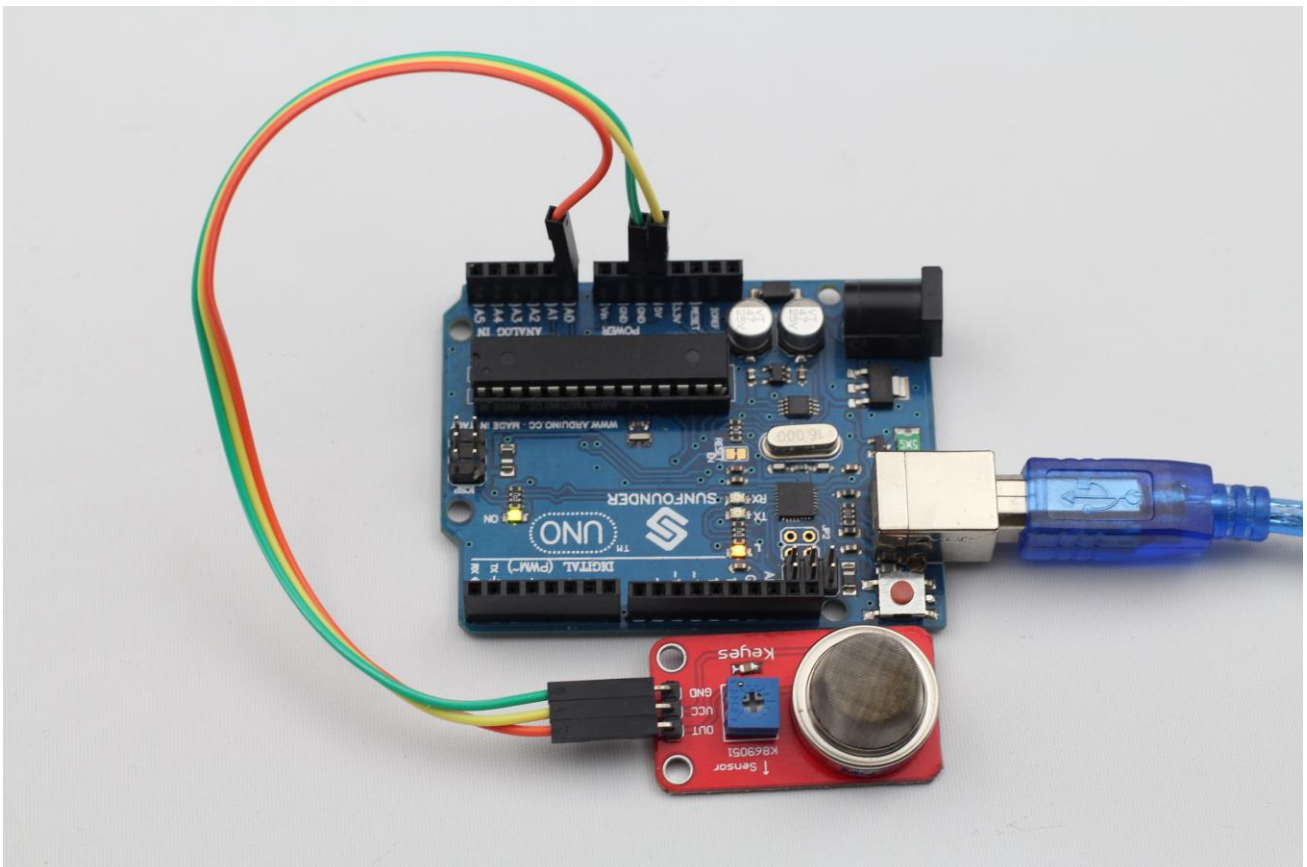
MQ-2 Gas sensor module	SUNFOUNDER UNO
OUT -----	A0
VCC -----	5V
GND -----	GND

**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, when you strike a lighter, you will find the value displayed on the screen change.



# Lesson 31 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 LCD1602, a Relay module, a potentiometer and a Keypad to assemble a simple password lock. It is based on SUNFOUNDER microcontroller and generally used to security door.

## Components

- 1\*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1\*USB data cable
- 1\*Relay module
- 1\*LCD1602
- 1\*Keypad
- 1\*Potentiometer
- 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

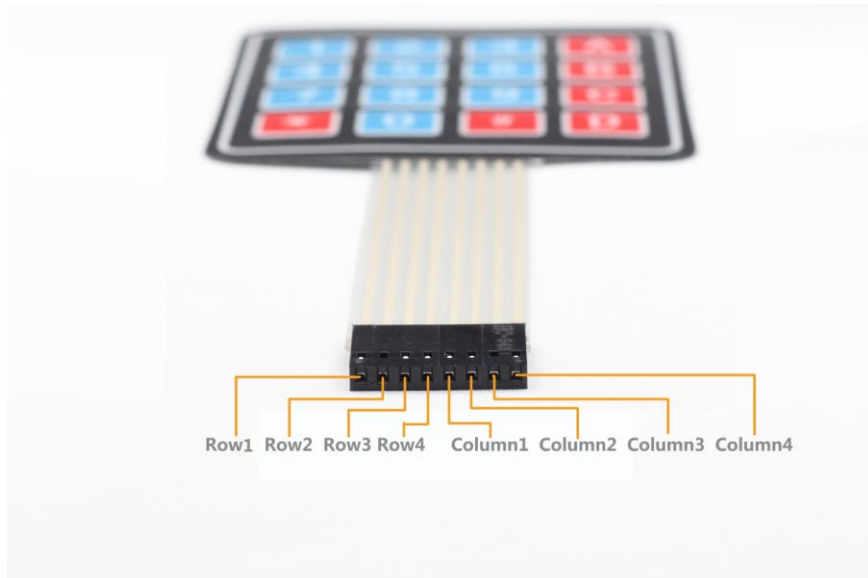
**Step 1:** Connect the circuit

**Relay connection:** Connect pin S to pin 13 on SUNFOUNDER, '-' to GND, '+' to 5V

**LCD1602 connection:** Connect pin RS to digital pin 0; R/W to GND; E to digital pin 1; D4~D7 to digital pin 2, 3, 4, and 12; VSS to GND; VDD to 5V; A to 3.3V; K to GND

**Potentiometer connection:** Connect the middle pin to VO of LCD1602 and any other pin to GND

**Keypad connection:** Connect row 1, 2, 3 and 4 to digital pin 11, 10, 9, and 8; connect column 1, 2, and 3 to digital pin 7, 6, and 5

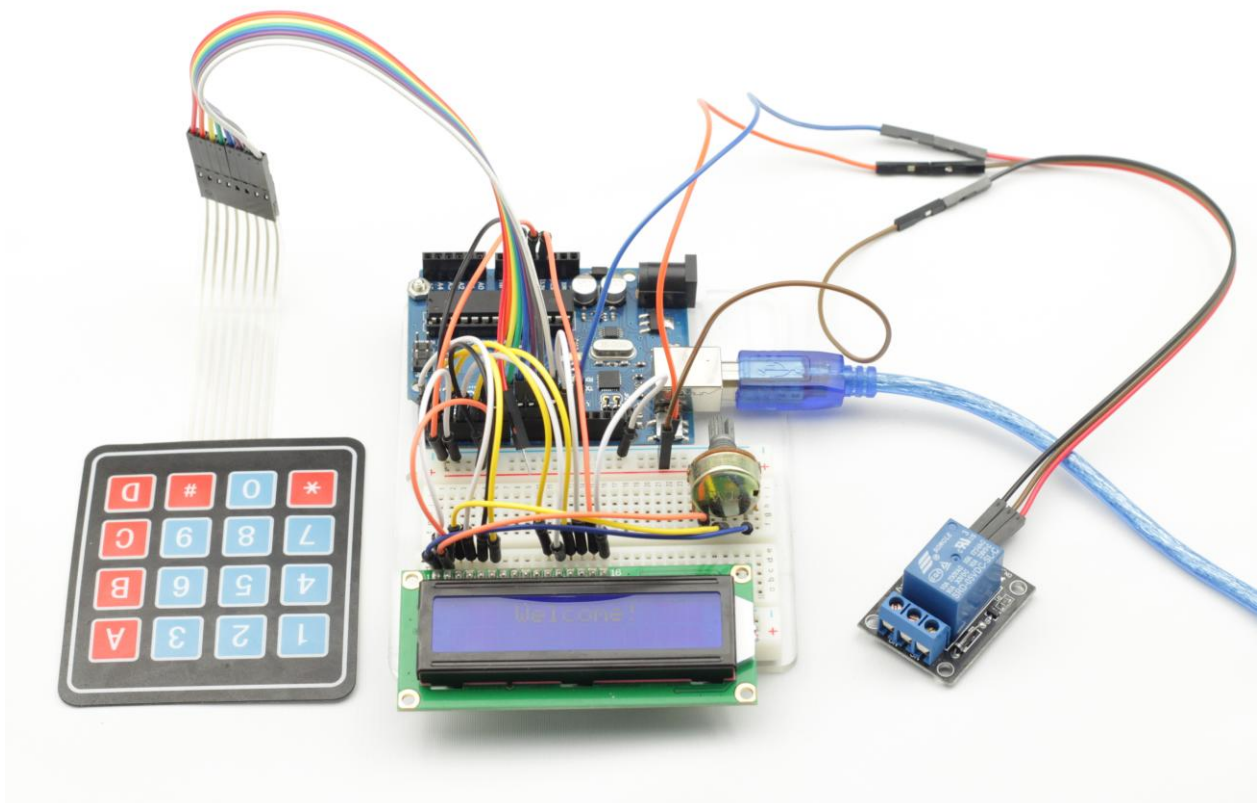


**Step 2:** Program (Please refer to example code in CD provided by us)

**Step 3:** Compile the program

**Step 4:** Burn the program into SUNFOUNDER UNO board

Now, 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.



# Lesson 32 Lie Detector

## Introduction

How can an Evil Genius be sure that their prisoners are telling the truth? By using a lie detector, of course. This lie detector uses an effect known as galvanic skin response. As a person becomes nervous—for example, when telling a lie—their skin resistance decreases. We can measure this resistance using an analog input and use an LED and buzzer to indicate an untruth. We use a multicolor LED that will display red to indicate a lie, green to indicate a truth, and blue to show that the lie detector should be adjusted by twiddling the variable resistor.

## Components

- 1\*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1\*USB data cable
- 1\*RGB module
- 1\*Buzzer module
- 1\*Potentiometer (250k)
- 1\*Resistor (470k)
- Several jumper wires

## Experimental Principle

The subject's skin resistance is measured by using the subject as one resistor in a potential divider and a fixed resistor as the other. The lower their resistance, the more analog input 0 will be pulled towards 5V. The higher the resistance, the closer to GND it will become.

The buzzer, despite the level of noise these things generate, is actually quite low in current consumption and can be driven directly from a SUNFOUNDER digital pin.

This experiment uses a RGB LED. In this case, however, we are not going to blend different colors but just turn one of the LEDs on at a time to display red, green, or blue.

## Experimental Procedures

**Step 1:** Connect the circuit

**RGB Connection:** Connect pin R to digital pin 9, G to digital pin 10, B to digital pin 11, and '-' to GND

**Buzzer Connection:** Connect pin S to digital pin 8, '+' to 5V, and '-' to GND

**Potentiometer Connection:** Connect the middle pin to analog port A1, and the other two pins to GND and 5V

**Resistor Connection:** connect one terminal to analog port A0, and the other terminal to GND

Then, take out two jumper wires, connect one terminal of one jumper wire to A0 and one terminal of the other jumper wire to 5V.

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

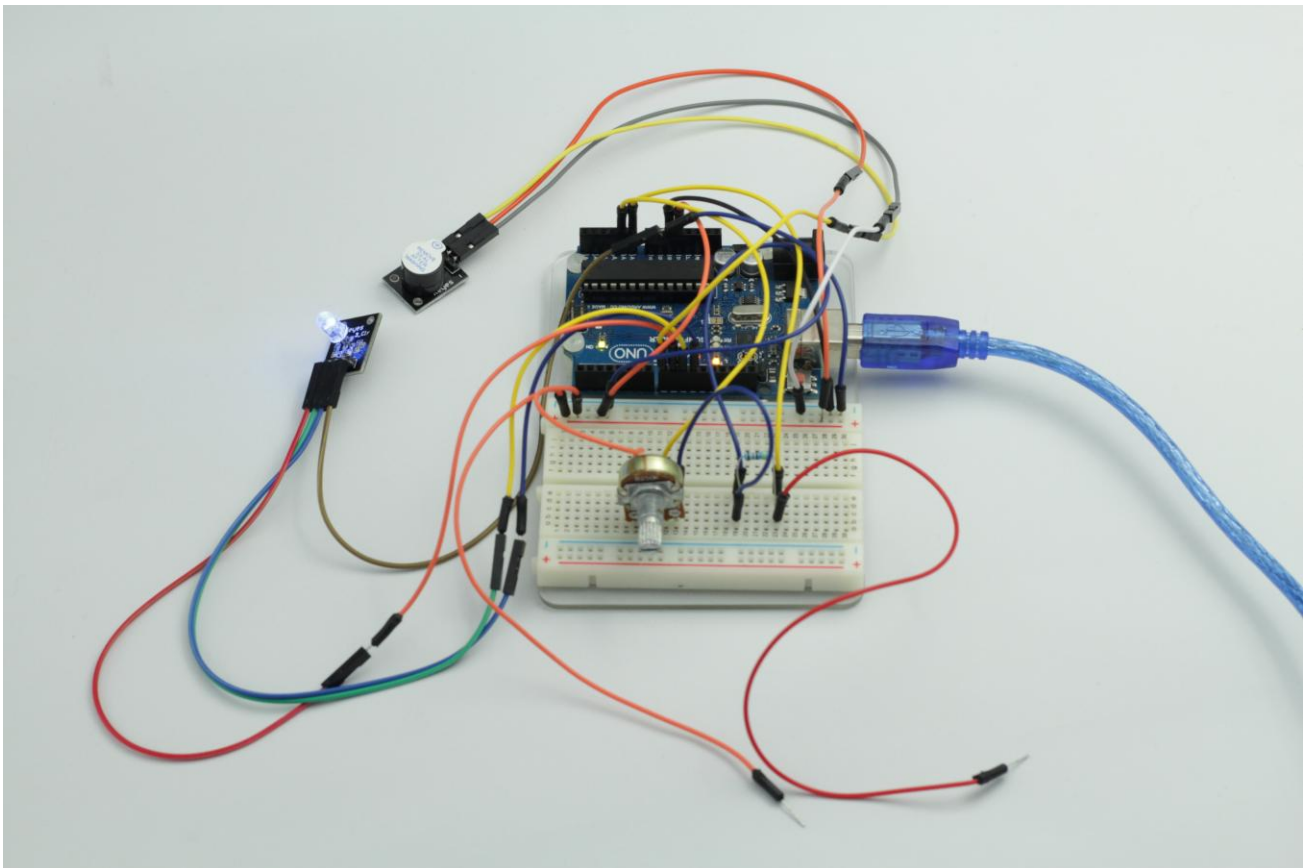
**Step 3:** Compile the program

**Step 4:** Burn the program into SUNFOUNDER UNO board

To test the lie detector, you really need a test subject, as you will need one hand free to adjust the knob.

First, get your subject to place two adjoining fingers on the other terminal of the two jumper wires. Then turn the knob on the variable resistor until the LED turns green.

You may now interrogate your victim. If he/she tells lies, the LED will display red and the buzzer will make sounds. If the LED changes to either red or blue, you should adjust the knob until it changes to green again and then continue the interrogation.



# Lesson 33 Fire Alarm

## Introduction

With the increase of modern home use of fire and electricity, home fire accidents occur more and more frequently. In this lesson, we will use a gas sensor, a flame sensor and a passive buzzer module to assemble a fire alarm.

## Components

- 1\*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1\*USB data cable
- 1\*MQ-2 Gas sensor module
- 1\*Flame sensor module
- 1\*Passive Buzzer module
- Several jumper wires

## Experimental Principle

Gas sensors can detect the concentration of the smoke to prevent fire. And flame sensors can detect the infrared rays emitted by fire. If we detect both smoke and fire, we can confirm that a fire happened. At the same time, the buzzer makes sounds.

## Experimental Procedures

**Step 1:** Connect the circuit

**Buzzer Connection:** Connect pin S to digital pin 3

**MQ-2 Gas Sensor Connection:** Connect pin OUT to analog A1, and VCC and GND to 5V and GND

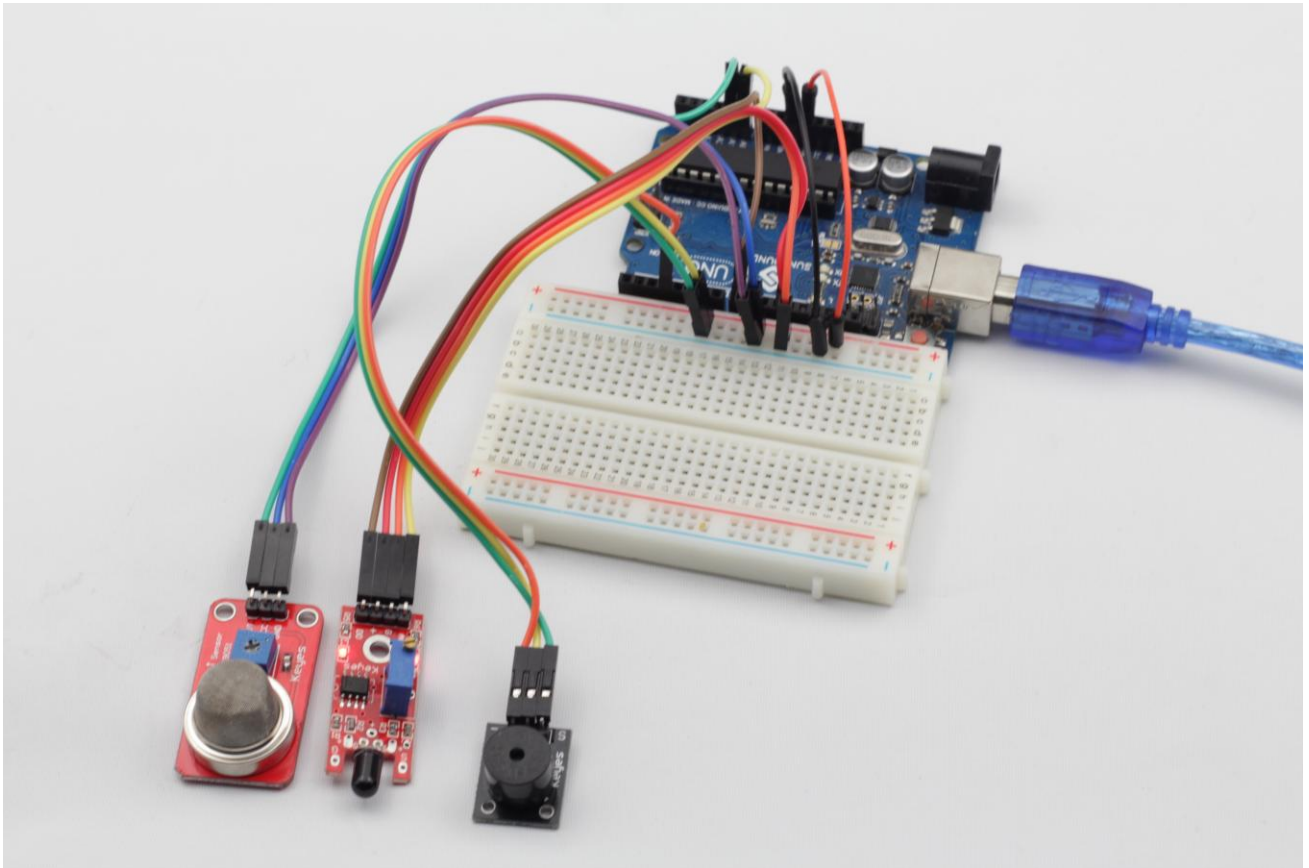
**Flame Sensor:** Connect pin DO to digital pin 8, 'G' to GND, and '+' to 5V

**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 light a lighter, you will see the LED attached to pin 13 light up and hear the buzzer make sounds.



# Lesson 34 Thermostatic Water Tank

## Introduction

In this lesson, we will use a Rotary Encoder module, an Analog-temperature sensor module, a Relay module, a Button module and a LCD1602, which we have learnt previously, to assemble a Thermostatic Water Tank. The thermostatic water tank can be used in test department of medical organization, college, scientific research, chemical industry, printing and dyeing industry to distill, dry, concentrate, heat chemical medicines and cultivate biological products in constant temperature, as well as to boil and disinfect equipment.

## Components

- 1\*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1\*USB data cable
- 1\*Rotary Encoder module
- 1\*Analog-temperature sensor module
- 1\*LCD1602
- 1\*Relay module
- 1\*Button module
- Several jumper wires

## Experimental Principle

This experiment uses an LCD screen and a thermistor temperature sensor to both display the current temperature and the set temperature. It uses a rotary encoder to allow the set temperature to be changed.

When the measured temperature is less than the set temperature, a relay is activated. Relays are old-fashioned electromagnetic components that activate a mechanical switch when a current flows through a coil of wire. They have a number of advantages. First, they can switch high currents and voltages, making them suitable for controlling mains equipment. They also electrically isolate the control side (the coil) from the switching side so that the high and low voltages never meet, which is definitely a good thing.

## Experimental Procedures

**Step 1:** Connect the circuit

**LCD1602 Connection:** connect pin RS to digital pin 12; R/W to GND; E to digital pin 11; D4~D7 to digital pin 10, 9, 8, and 7; VSS to GND; VDD to 5V; A to 3.3V; K to GND

**Button Connection:** connect pin S to digital pin 5, '-' to GND, and '+' to 5V

**Analog-temperature sensor Connection:** connect pin S to analog port A0, '-' to GND, and '+' to 5V



**Relay Connection:** connect pin S to digital pin 6, '-' to GND, and '+' to 5V

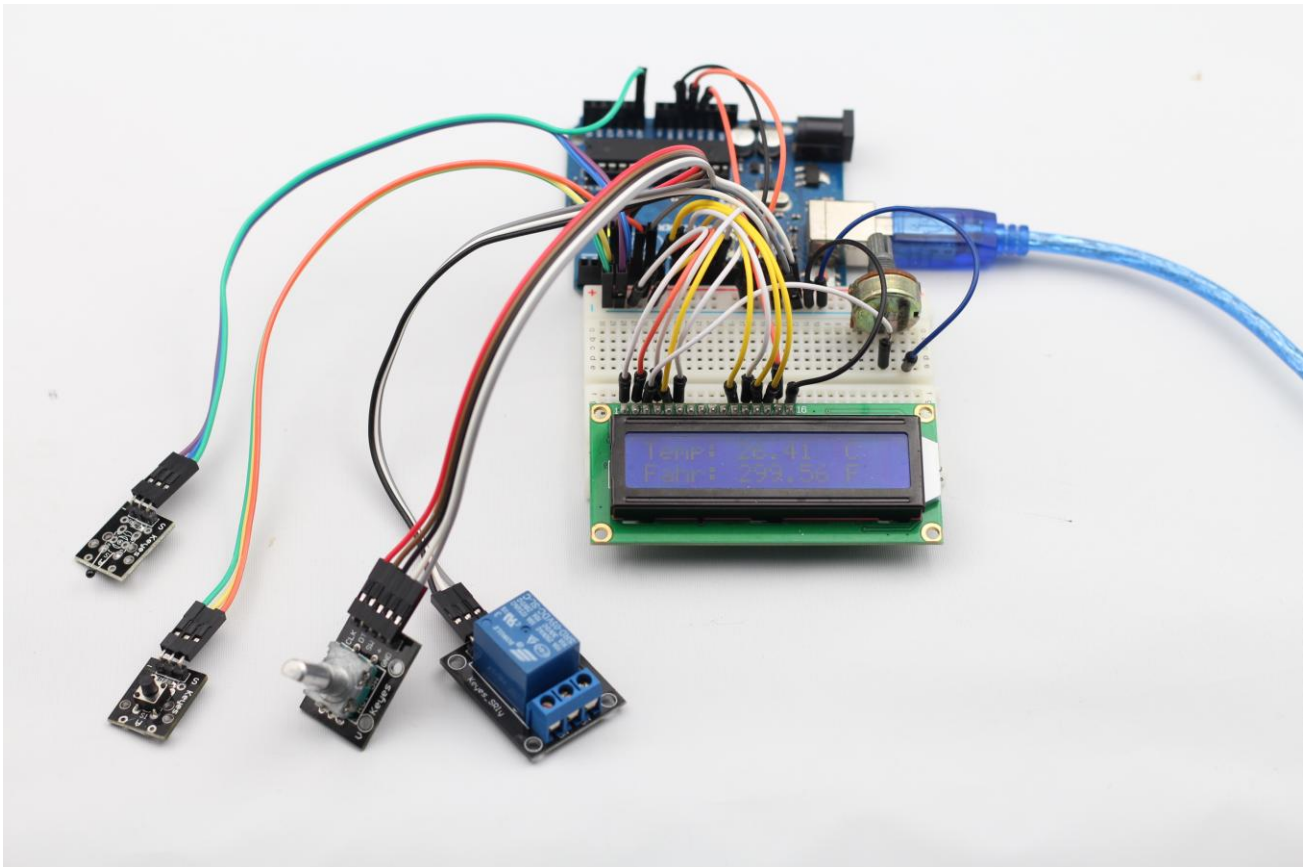
**Rotary Encoder Connection:** connect pin CLK to digital pin 2, DT to digital pin 3, SW to digital pin 4, '-' to GND, and '+' to 5V

**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, after start up, and you will see LCD1602 displays **Thermostatic Water Tank** and then displays current temperature. Press the button to enter setup mode. Then rotate the Rotary Encoder to change temperature threshold. After you finished your setting, for example, 30°C, you can press the Rotary Encoder to confirm. If you touch thermistor, you will find the value displayed on the LCD varies and finally the LED on SUNFOUNDER goes out, for the measured temperature is higher than the threshold.



# Lesson 35 Intelligent Environment Monitoring

## Introduction

After having learnt so many independent modules, do you want to combine these modules to make an interesting interactive work? Well, in this lesson, we will use a humidity Sensor module, a DS18B20 module, an infrared receiver module, a high-sensitive voice sensor module, a photoresistor module, an analog-hall sensor module, a LCD1602 and a remote controller to assemble an Intelligent Environment Monitoring system.

## Components

- 1\*SUNFOUNDER UNO board (or SUNFOUNDER MEGA2560 board)
- 1\*USB data cable
- 1\*DHT11 Humidity Sensor module
- 1\*DS18B20 module
- 1\*Infrared Receiver module
- 1\*Remote controller
- 1\*High-sensitive voice sensor module
- 1\*Photoresistor module
- 1\*Analog-hall sensor module
- 1\*LCD1602
- Several jumper wires

## Experimental Principle

After power on, when you press Power Key, it will display **Environment Monitor Begin:**. Next if you press digital 1 key, it will display DS18B20 and current temperature; if you press digital 2 key, it will display DHT11 and current humidity; if you press digital 3 key, it will display Big Sound and current sound; if you press digital 4 key, it will display Light Sensor and current light intensity; if you press digital 5 key, it will display Analog Hall and current magnetic field intensity; if you press digital 6 key, it will exit.

## Experimental Procedures

**Step 1:** Connect the circuit according to the following method

**LCD1602 Connection:** connect pin RS to digital pin 12; R/W to GND; E to digital pin 11; D4~D7 to digital pin 10, 9, 8, and 7; VSS to GND; VDD to 5V; A to 3.3V; K to GND

**Infrared Receiver module connection:** connect pin S to digital pin 3, '-' to GND, and '+' to 5V

**DS18B20 module connection:** connect pin S to digital pin 2, '-' to GND, and '+' to 5V

**DHT11 Humiture Sensor module connection:** connect pin S to digital pin 4, '-' to GND, and '+' to 5V

**High-sensitive voice sensor module connection:** connect pin A0 to analog port A0, '-' to GND, and '+' to 5V

**Photoresistor module connection:** connect pin S to analog port A1, '-' to GND, and '+' to 5V

**Analog-hall sensor module connection:** connect pin S to analog port A2, '-' to GND, and '+' to 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, it will display **Environment Monitor Begin:**. Next if you press digital 1 key, it will display DS18B20 and current temperature; if you press digital 2 key, it will display DHT11 and current humidity; if you press digital 3 key, it will display Big Sound and current sound; if you press digital 4 key, it will display Light Sensor and current light intensity; if you press digital 5 key, it will display Analog Hall and current magnetic field intensity; if you press digital 6 key, it will exit.

