# SKU:SEN0610 (https://www.dfrobot.com/product–2795.html)

- Introduction
- Characteristics
- Technical Specifications
- Interface Definitions
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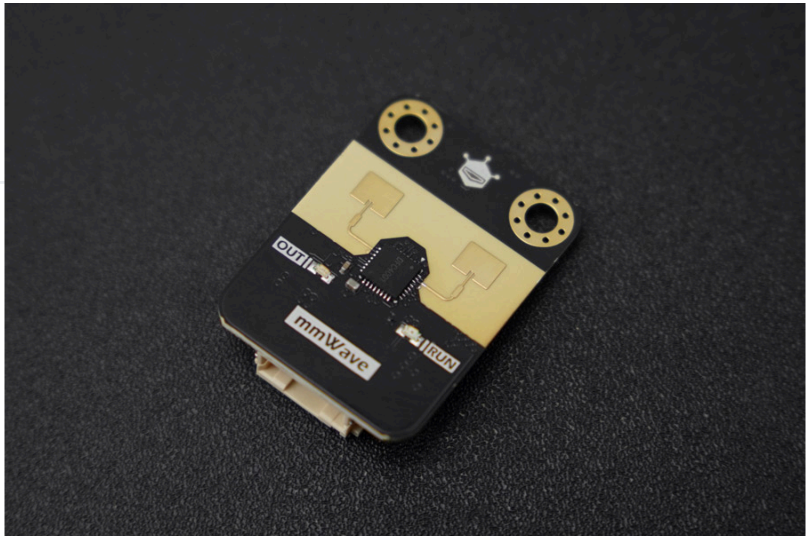
(https://www.dfrobot.com/product-2795.html)



# Introduction

C4001 (12m) millimeter wave presence sensor uses a wavelength signal of 24GHz, with a detection range of 100° horizontally, presence detection range of 8 meters, and motion detection and ranging range of 12 meters.

### Human detection

Compared to other types of human presence sensors, such as infrared sensors, the C4001 (12m) millimeter wave presence sensor has the advantage of detecting both static and moving objects. It also has a relatively strong anti-interference ability, making it less susceptible to factors such as temperature changes, variations in ambient light, and environmental noise. Whether a person is sitting, sleeping, or moving, the sensor can quickly and sensitively detect their presence.

| | Millimeter-wave Presence Sensor | Infrared Sensor |
|---|---|---|
| Sensing Principle | TOF radar principle + Doppler radar sensing principle (active detection) | Pyroelectric infrared sensing principle (passive radiation) |
| Motion Sensitivity | Can detect presence, slight movement, and motion of human body | Can only detect motion and close-range slight movement of human body |

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| | **Millimeter-wave Presence Sensor** | **Infrared Sensor** |
|---|---|---|
| Sensing Range | Can be adjusted to different sensing distances | Sensing range cannot be adjusted |
| Environmental Temperature Impact | Not affected by environmental temperature | Sensitivity decreases when temperature is close to human body temperature |
| Application Environment | Not affected by heat sources, light sources, air flow | Susceptible to heat sources and air flow |
| Penetration Ability | Can penetrate fabrics, plastics, glass, and other insulating materials | Can only penetrate some transparent plastics |
| Distance Measurement Support | Yes | No |
| **Distance and velocity detection** | | |

The C4001 (12m) millimeter wave presence sensor utilizes FMCW modulation for distance and speed measurement. It has a maximum detection range of 12 meters and a speed measurement range of 0.1 to 10 meters per second.

FMCW (Frequency Modulated Continuous Wave) is a type of radar system based on frequency modulation of continuous wave signals. Unlike traditional pulse radar, FMCW radar continuously emits a series of continuous wave signals with gradually changing frequencies while simultaneously receiving the reflected signals. By analyzing the received signals, measurements of parameters such as distance, speed, and angle can be achieved.

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Compared to traditional pulse radar technology, FMCW radar can continuously measure the distance of an object. By utilizing the Doppler effect, it can also obtain information about the velocity of the target object. This makes FMCW radar suitable for applications that require tracking the movement of objects. Additionally, FMCW radar can achieve continuous frequency scanning, providing higher measurement resolution. Since it does not require waiting for the return of echo signals, FMCW radar is suitable for applications that require real-time monitoring and tracking of target objects.

**What is a millimeter-wave radar sensor?**

Millimeter-wave radar technology is a non-contact sensing technology used to detect objects and provide information about their distance, velocity, and angle (in the case of humans, for example). The signals emitted by millimeter-wave sensors fall within the high-frequency spectrum with wavelengths between 24GHz and 300GHz, also known as the millimeter (mm) range.

## Characteristics

- Communication Methods: It supports two communication methods, I2C and UART.
- Interface: It uses the Gravity interface (PH2.0).
- Human Detection: It can detect the presence of humans up to 8 meters and detect human motion up to 12 meters.
- Distance Detection: It can measure distances from 1.2m to 12m.
- Speed Detection: It can detect speeds from 0.1m/s to 10m/s.
- Strong anti-interference capability: It is not affected by factors such as snow, haze, temperature, humidity, dust, light, and noise.
- Compact size and easy integration.

## Technical Specifications

- Operating Voltage: 3.3V/5V

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- Maximum Detection Range: 12m
- Beam Angle: 100*80°
- Modulation Mode: FMCW
- Operating Frequency: 24GHz
- Operating Temperature: -40~85°C
- Baud Rate: 9600
- I2C Address: 0x2A/0x2B
- Size: 22*30mm

## Interface Definitions

| Definition | Explanation |
|---|---|
| + | Power |
| - | Ground |
| C/R | I2C Clock Line / RX |
| D/T | I2C Data Line / TX |

## Installation Method

The millimeter-wave human body sensor is sensitive to the installation method, and improper installation can affect the performance and functionality of the sensor. The commonly used installation methods for this module include top installation, bottom installation, horizontal installation, and downward tilted installation.

## Top Installation

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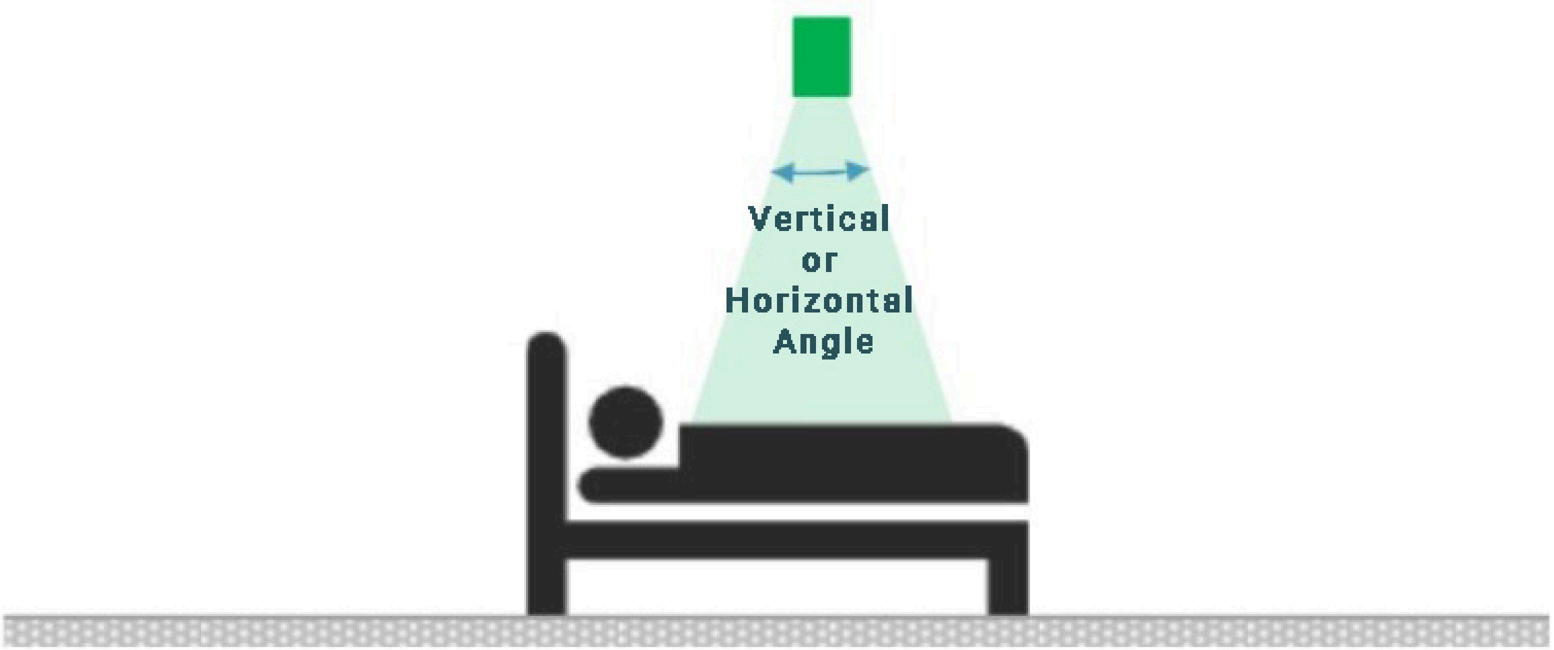

## Bottom Installation

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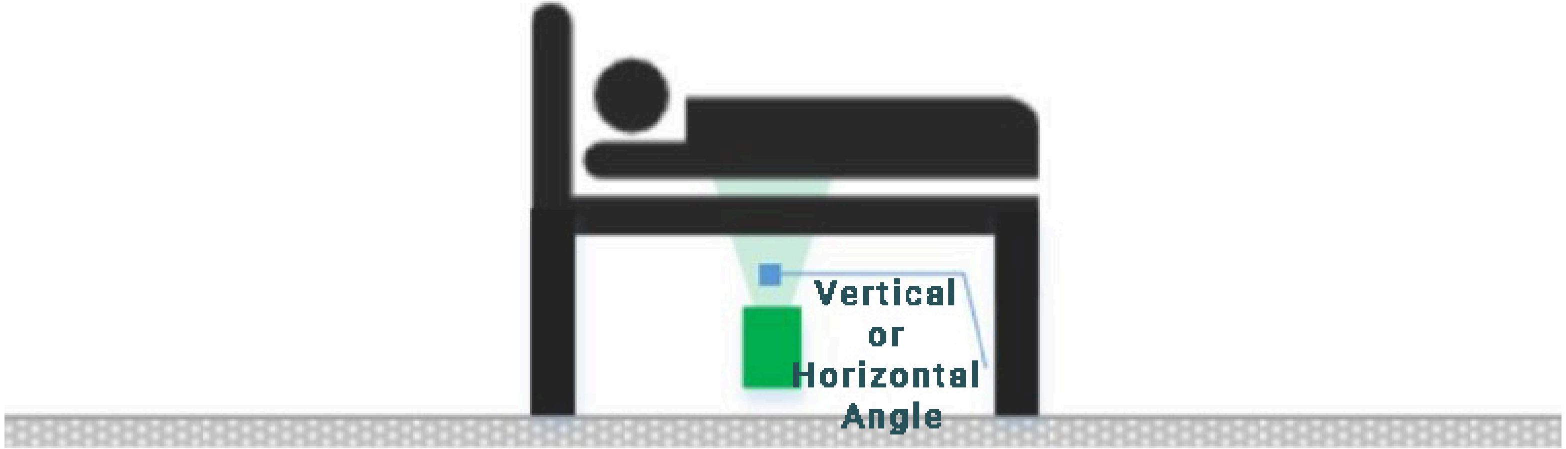
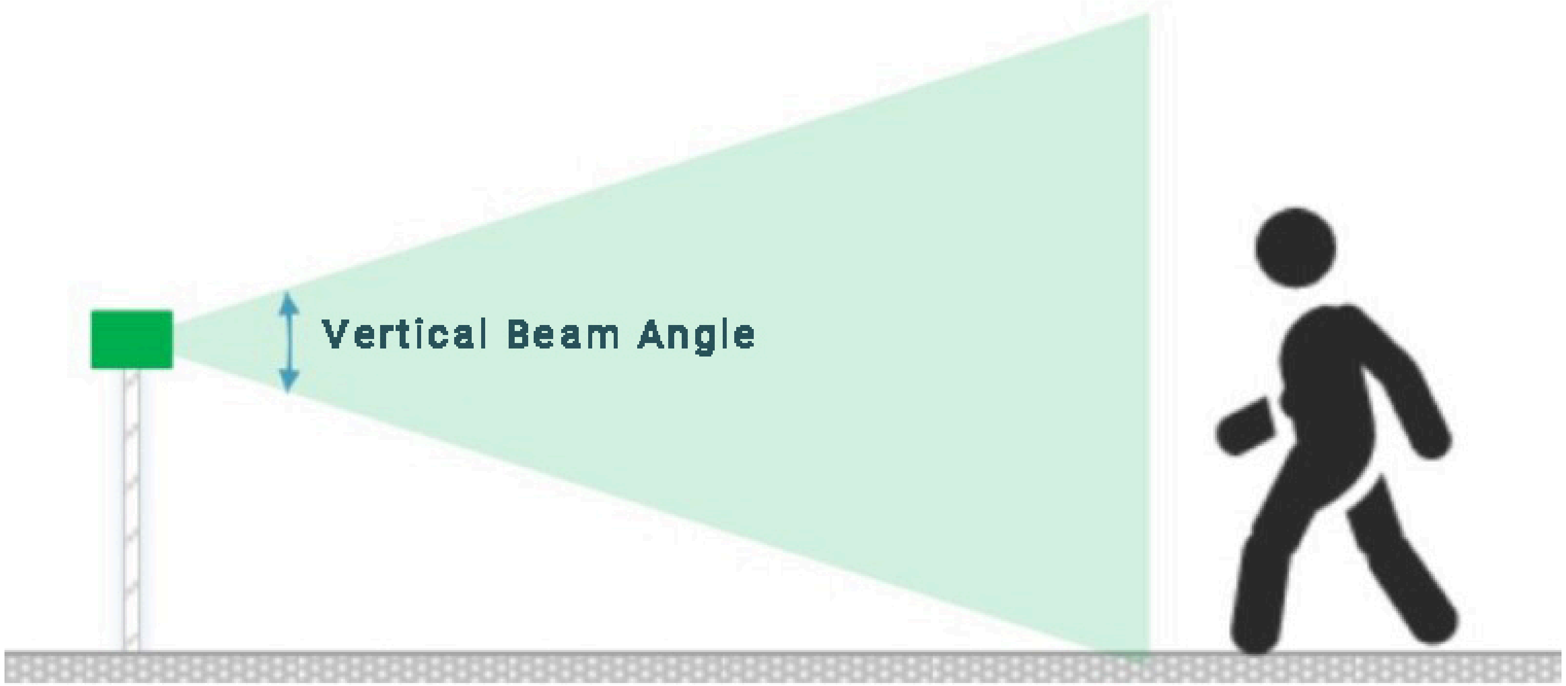


## Horizontal Installation



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# Demo Program

## Information Retrieval in UART Communication

### Preparation

- Hardware
  - C4001 Millimeter Wave Presence Sensor 12m
  - Arduino Uno
- Software

  Arduino IDE，Click to download Arduino IDE (https://www.arduino.cc/en/Main/Software)

  DFRobot_C4001 library，Click to download the DFRobot_C4001 library. (https://github.com/cdjq/DFRobot_C40001)

## Wiring diagram

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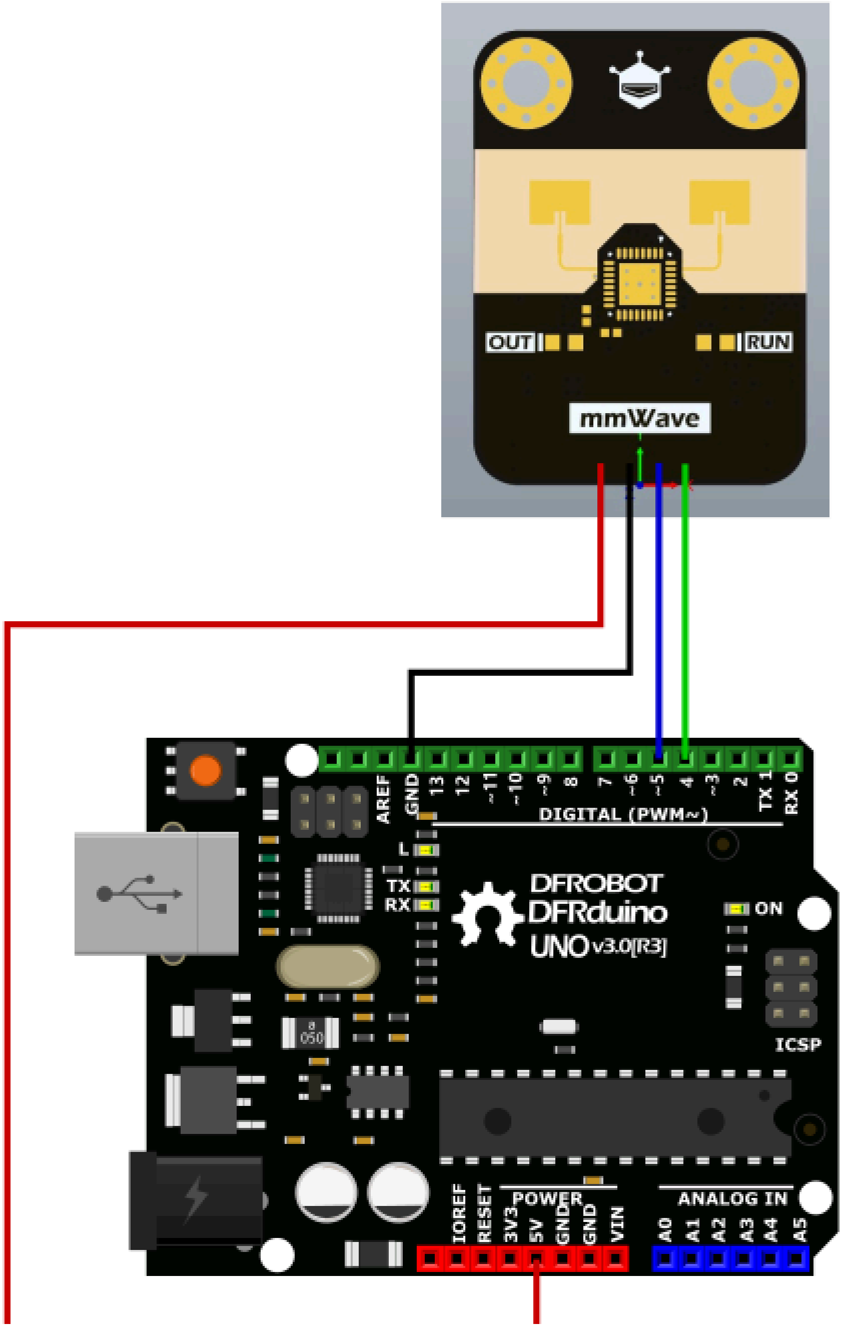

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| mmWave | Arduino Uno |
|---|---|
| VIN | 5V |
| GND | GND |
| C/R | D5 |
| D/T | D4 |

## Sample code

Please switch the DIP switch on the back of the sensor to the UART direction, and copy the following code to your Arduino IDE and upload it.

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```
 /*!
  * @file  motionDetection.ino
  * @brief  Example of radar detecting whether an object is moving
  * @copyright Copyright (c) 2010 DFRobot Co.Ltd (http://www.dfrobot.com)
  * @license The MIT License (MIT)
  * @author ZhixinLiu(zhixin.liu@dfrobot.com)
  * @version V1.0
  * @date 2024-02-02
  * @url https://github.com/dfrobot/DFRobot_C4001
  */

#include "DFRobot_C4001.h"

//#define I2C_COMMUNICATION  //use I2C for communication, but use the serial port for communi

#ifdef  I2C_COMMUNICATION
  /*
   * DEVICE_ADDR_0 = 0x2A     default iic_address
   * DEVICE_ADDR_1 = 0x2B
   */
  DFRobot_C4001_I2C radar(&Wire ,DEVICE_ADDR_0);
#else
/* ------------------------------------------------------------------------------------------
 *    board   |             MCU                | Leonardo/Mega2560/M0 |    UNO    | ESP8266 |
 *     VCC    |            3.3V/5V             |       VCC            |    VCC    |   VCC   |
 *     GND    |              GND               |       GND            |    GND    |   GND   |
 *     RX     |              TX                |     Serial1 TX1      |     5     |   5/D6  |
 *     TX     |              RX                |     Serial1 RX1      |     4     |   4/D7  |
 * ------------------------------------------------------------------------------------------
/* Baud rate cannot be changed */
  #if defined(ARDUINO_AVR_UNO) || defined(ESP8266)
    SoftwareSerial mySerial(4, 5);
    DFRobot_C4001_UART radar(&mySerial ,9600);
  #elif defined(ESP32)
    DFRobot_C4001_UART radar(&Serial1 ,9600 ,/*rx*/D2 ,/*tx*/D3);
```

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```
  #else
    DFRobot_C4001_UART radar(&Serial1 ,9600);
  #endif
#endif

void setup()
{
  Serial.begin(115200);
  while(!Serial);
  while(!radar.begin()){
    Serial.println("NO Deivces !");
    delay(1000);
  }
  Serial.println("Device connected!");

  // exist Mode
  radar.setSensorMode(eExitMode);

  sSensorStatus_t data;
  data = radar.getStatus();
  //  0 stop  1 start
  Serial.print("work status  = ");
  Serial.println(data.workStatus);

  //  0 is exist   1 speed
  Serial.print("work mode  = ");
  Serial.println(data.workMode);

  //  0 no init    1 init success
  Serial.print("init status = ");
  Serial.println(data.initStatus);
  Serial.println();

  /*
   * min Detection range Minimum distance, unit cm, range 0.3~25m (30~2500), not exceeding ma
   * max Detection range Maximum distance, unit cm, range 2.4~25m (240~2500)
```

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```
 * trig Detection range Maximum distance, unit cm, default trig = max
 */
if(radar.setDetectionRange(/*min*/30, /*max*/1000, /*trig*/1000)){
  Serial.println("set detection range successfully!");
}
// set trigger sensitivity 0 - 9
if(radar.setTrigSensitivity(1)){
  Serial.println("set trig sensitivity successfully!");
}

// set keep sensitivity 0 - 9
if(radar.setKeepSensitivity(2)){
  Serial.println("set keep sensitivity successfully!");
}
/*
 * trig Trigger delay, unit 0.01s, range 0~2s (0~200)
 * keep Maintain the detection timeout, unit 0.5s, range 2~1500 seconds (4~3000)
 */
if(radar.setDelay(/*trig*/100, /*keep*/4)){
  Serial.println("set delay successfully!");
}


// get confige params
Serial.print("trig sensitivity = ");
Serial.println(radar.getTrigSensitivity());
Serial.print("keep sensitivity = ");
Serial.println(radar.getKeepSensitivity());

Serial.print("min range = ");
Serial.println(radar.getMinRange());
Serial.print("max range = ");
Serial.println(radar.getMaxRange());
Serial.print("trig range = ");
Serial.println(radar.getTrigRange());
```

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```
  Serial.print("keep time = ");
  Serial.println(radar.getKeepTimerout());

  Serial.print("trig delay = ");
  Serial.println(radar.getTrigDelay());

}

void loop()
{
  // Determine whether the object is moving
  if(radar.motionDetection()){
    Serial.println("exist motion");
    Serial.println();
  }
  delay(100);
}
```

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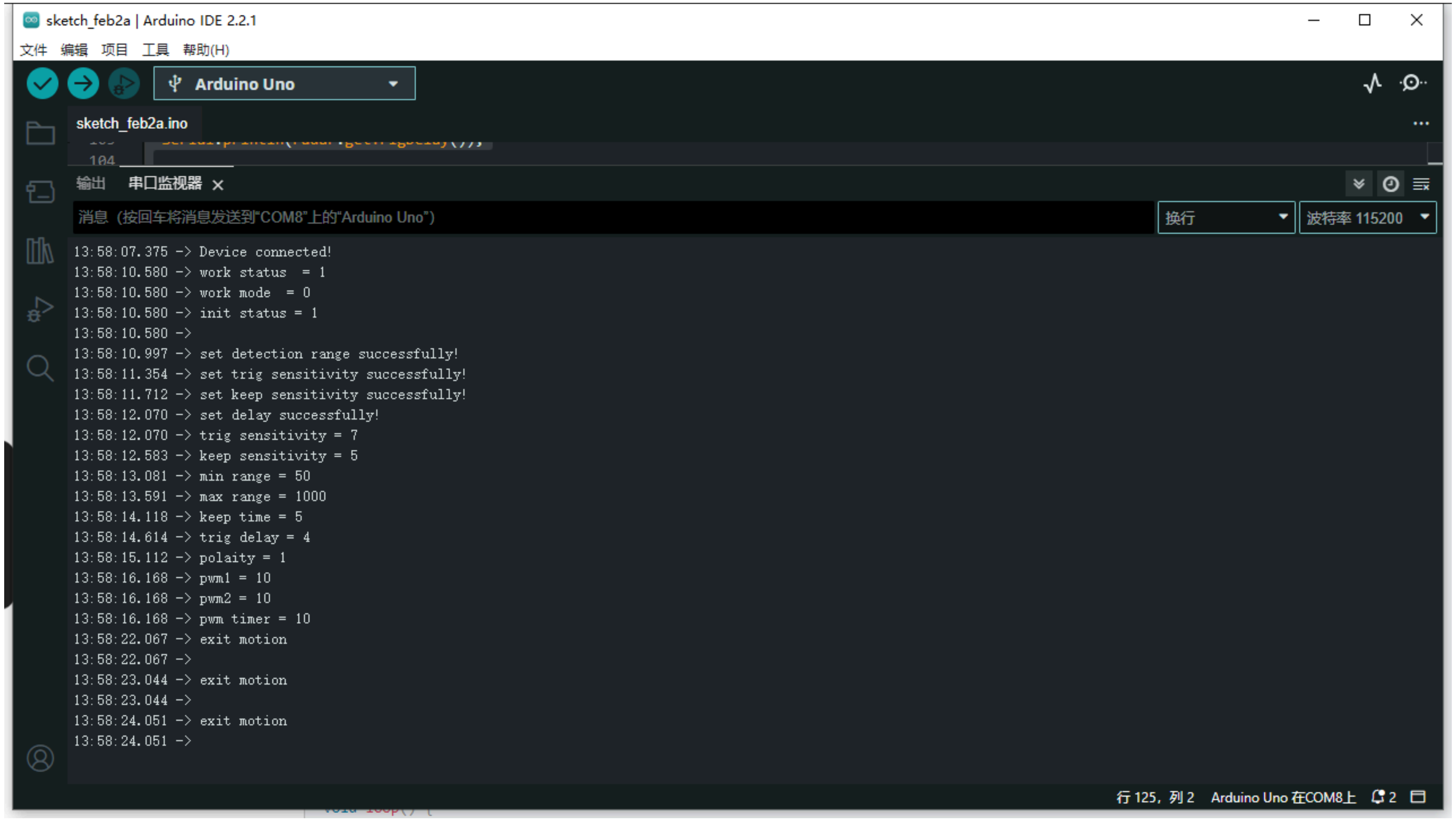
## Result


sketch_feb2a | Arduino IDE 2.2.1
文件 编辑 项目 工具 帮助(H)
Arduino Uno
sketch_feb2a.ino
输出
串口监视器
消息（按回车将消息发送到"COM8"上的"Arduino Uno"）
换行
波特率 115200
行 125，列 2 Arduino Uno 在COM8上 2

```
13:58:07.375 -> Device connected!
13:58:10.580 -> work status  = 1
13:58:10.580 -> work mode  = 0
13:58:10.580 -> init status = 1
13:58:10.580 ->
13:58:10.997 -> set detection range successfully!
13:58:11.354 -> set trig sensitivity successfully!
13:58:11.712 -> set keep sensitivity successfully!
13:58:12.070 -> set delay successfully!
13:58:12.070 -> trig sensitivity = 7
13:58:12.583 -> keep sensitivity = 5
13:58:13.081 -> min range = 50
13:58:13.591 -> max range = 1000
13:58:14.118 -> keep time = 5
13:58:14.614 -> trig delay = 4
13:58:15.112 -> polaity = 1
13:58:16.168 -> pwm1 = 10
13:58:16.168 -> pwm2 = 10
13:58:16.168 -> pwm timer = 10
13:58:22.067 -> exit motion
13:58:22.067 ->
13:58:23.044 -> exit motion
13:58:23.044 ->
13:58:24.051 -> exit motion
13:58:24.051 ->
```

## IIC communication distance speed acquisition

### Preparation

- Hardware
  - C4001 Millimeter Wave Presence Sensor 12m
  - Arduino Uno
- Software

Arduino IDE，Click to download Arduino IDE (https://www.arduino.cc/en/Main/Software)

DFRobot_C4001 library，Click to download the DFRobot_C4001 library. (https://github.com/cdjq/DFRobot_C40001)

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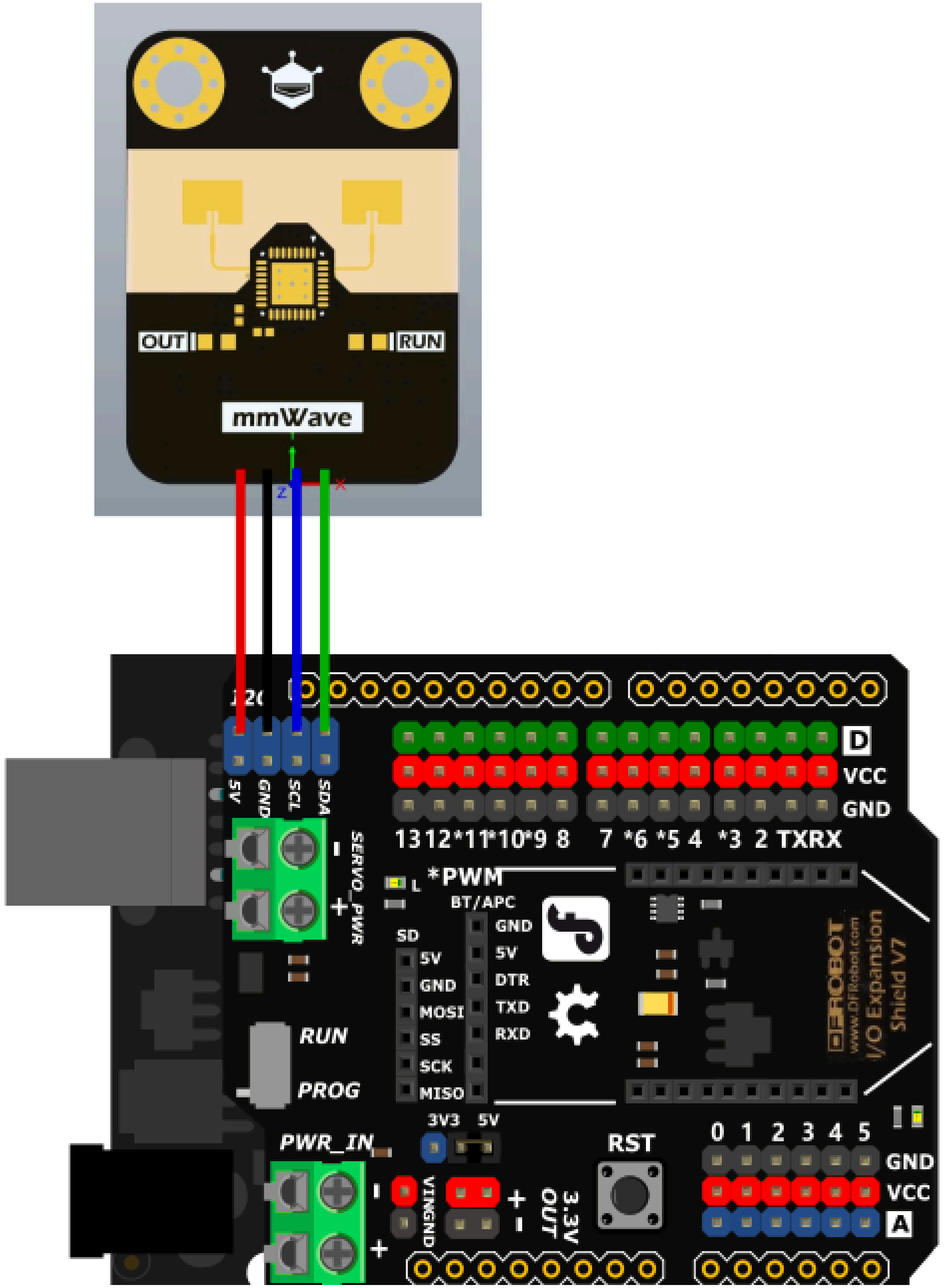

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## Sample code

Copy the following code and upload it to your Arduino IDE。

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```
/*!
  * @file  mRangeVelocity.ino
  * @brief  radar measurement demo
  * @copyright Copyright (c) 2010 DFRobot Co.Ltd (http://www.dfrobot.com)
  * @license The MIT License (MIT)
  * @author ZhixinLiu(zhixin.liu@dfrobot.com)
  * @version V1.0
  * @date 2024-02-02
  * @url https://github.com/dfrobot/DFRobot_C4001
  */

#include "DFRobot_C4001.h"

#define I2C_COMMUNICATION  //use I2C for communication, but use the serial port for communica

#ifdef I2C_COMMUNICATION
/*
   * DEVICE_ADDR_0 = 0x2A     default iic_address
   * DEVICE_ADDR_1 = 0x2B
   */
DFRobot_C4001_I2C radar(&Wire, DEVICE_ADDR_0);
#else
/* ------------------------------------------------------------------------------------------
 *    board   |             MCU                  | Leonardo/Mega2560/M0 |    UNO    | ESP8266 |
 *     VCC    |            3.3V/5V               |        VCC           |    VCC    |   VCC   |
 *     GND    |              GND                 |        GND           |    GND    |   GND   |
 *     RX     |              TX                  |     Serial1 TX1      |     5     |   5/D6  |
 *     TX     |              RX                  |     Serial1 RX1      |     4     |   4/D7  |
 * ------------------------------------------------------------------------------------------
/* Baud rate cannot be changed */
#if defined(ARDUINO_AVR_UNO) || defined(ESP8266)
SoftwareSerial mySerial(4, 5);
DFRobot_C4001_UART radar(&mySerial, 9600);
#elif defined(ESP32)
DFRobot_C4001_UART radar(&Serial1, 9600, /*rx*/ D2, /*tx*/ D3);
```

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```
#else
DFRobot_C4001_UART radar(&Serial1, 9600);
#endif
#endif

void setup() {
  Serial.begin(115200);
  while (!Serial)
    ;
  while (!radar.begin()) {
    Serial.println("NO Deivces !");
    delay(1000);
  }
  Serial.println("Device connected!");

  // speed Mode
  radar.setSensorMode(eSpeedMode);

  sSensorStatus_t data;
  data = radar.getStatus();
  //  0 stop  1 start
  Serial.print("work status  = ");
  Serial.println(data.workStatus);

  //  0 is exist   1 speed
  Serial.print("work mode  = ");
  Serial.println(data.workMode);

  //  0 no init    1 init success
  Serial.print("init status = ");
  Serial.println(data.initStatus);
  Serial.println();

  /*
   * min Detection range Minimum distance, unit cm, range 0.3~20m (30~2500), not exceeding ma
   * max Detection range Maximum distance, unit cm, range 2.4~20m (240~2500)
```

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```
   * thres Target detection threshold, dimensionless unit 0.1, range 0~6553.5 (0~65535)
   */
  if (radar.setDetectThres(/*min*/ 11, /*max*/ 1200, /*thres*/ 10)) {
    Serial.println("set detect threshold successfully");
  }

  // set Fretting Detection
  radar.setFrettingDetection(eON);

  // get confige params
  Serial.print("min range = ");
  Serial.println(radar.getTMinRange());
  Serial.print("max range = ");
  Serial.println(radar.getTMaxRange());
  Serial.print("threshold range = ");
  Serial.println(radar.getThresRange());
  Serial.print("fretting detection = ");
  Serial.println(radar.getFrettingDetection());
}

void loop() {
  Serial.print("target number = ");
  Serial.println(radar.getTargetNumber());  // must exist
  Serial.print("target Speed  = ");
  Serial.print(radar.getTargetSpeed());
  Serial.println(" m/s");

  Serial.print("target range  = ");
  Serial.print(radar.getTargetRange());
  Serial.println(" m");

  Serial.print("target energy  = ");
  Serial.println(radar.getTargetEnergy());
  Serial.println();
```

```
    delay(100);
  }
```

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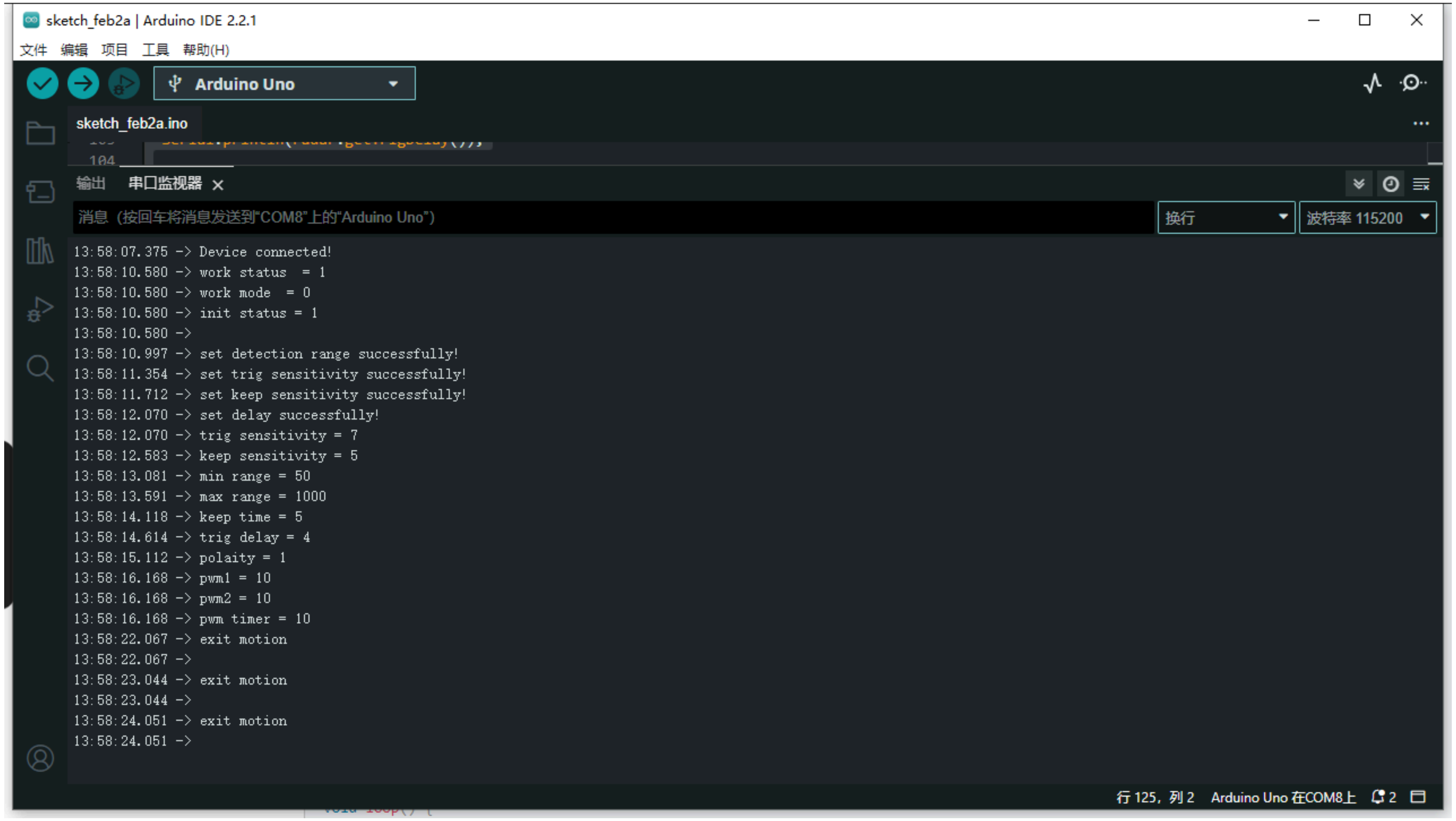
## Result



换行

波特率 115200

```
13:58:07.375 -> Device connected!
13:58:10.580 -> work status  = 1
13:58:10.580 -> work mode  = 0
13:58:10.580 -> init status = 1
13:58:10.580 ->
13:58:10.997 -> set detection range successfully!
13:58:11.354 -> set trig sensitivity successfully!
13:58:11.712 -> set keep sensitivity successfully!
13:58:12.070 -> set delay successfully!
13:58:12.070 -> trig sensitivity = 7
13:58:12.583 -> keep sensitivity = 5
13:58:13.081 -> min range = 50
13:58:13.591 -> max range = 1000
13:58:14.118 -> keep time = 5
13:58:14.614 -> trig delay = 4
13:58:15.112 -> polaity = 1
13:58:16.168 -> pwm1 = 10
13:58:16.168 -> pwm2 = 10
13:58:16.168 -> pwm timer = 10
13:58:22.067 -> exit motion
13:58:22.067 ->
13:58:23.044 -> exit motion
13:58:23.044 ->
13:58:24.051 -> exit motion
13:58:24.051 ->
```

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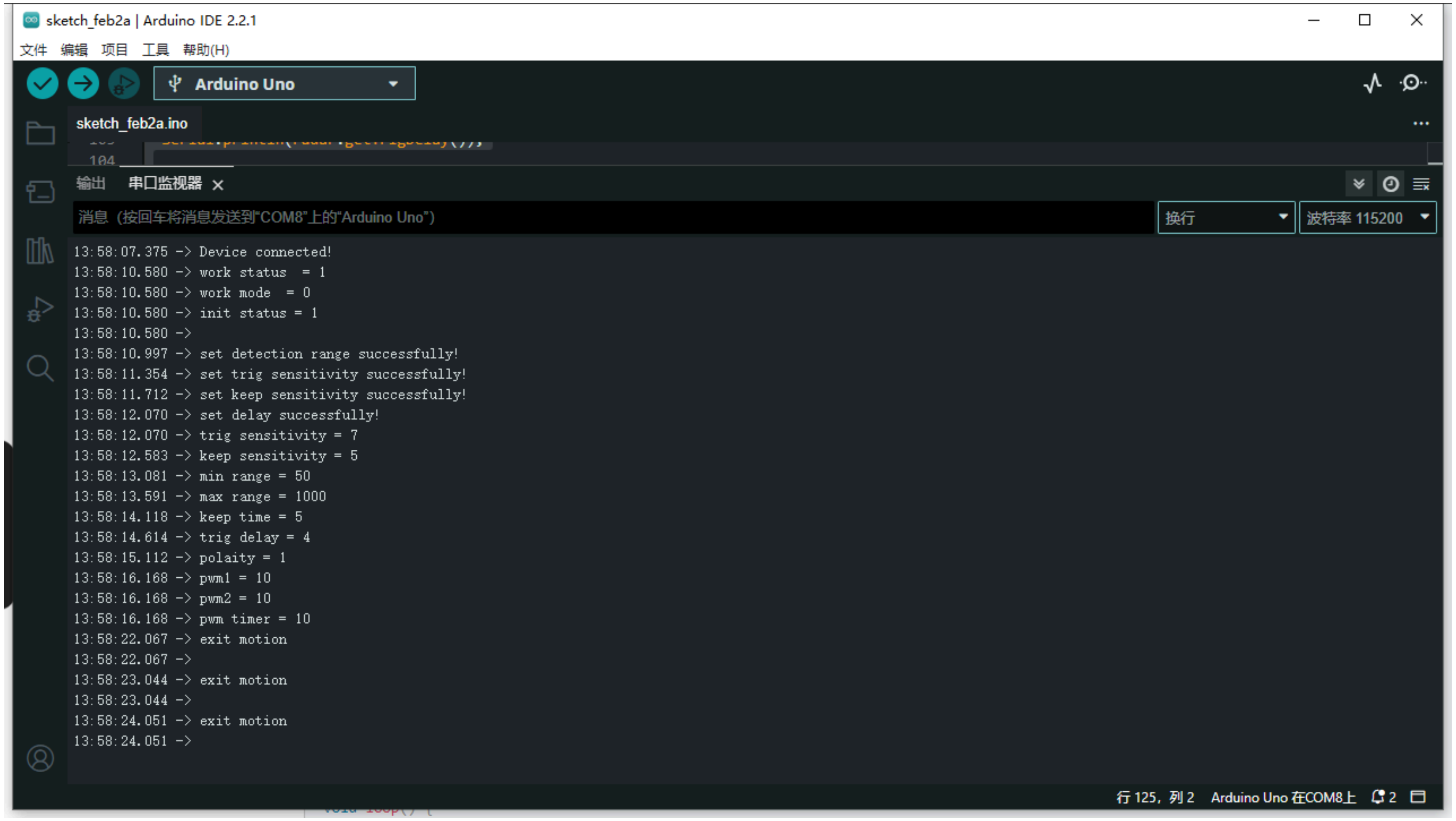
## result



消息（按回车将消息发送到"COM8"上的"Arduino Uno"）

换行

波特率 115200

```
13:58:07.375 -> Device connected!
13:58:10.580 -> work status  = 1
13:58:10.580 -> work mode  = 0
13:58:10.580 -> init status = 1
13:58:10.580 ->
13:58:10.997 -> set detection range successfully!
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13:58:14.614 -> trig delay = 4
13:58:15.112 -> polaity = 1
13:58:16.168 -> pwm1 = 10
13:58:16.168 -> pwm2 = 10
13:58:16.168 -> pwm timer = 10
13:58:22.067 -> exit motion
13:58:22.067 ->
13:58:23.044 -> exit motion
13:58:23.044 ->
13:58:24.051 -> exit motion
13:58:24.051 ->
```

## More Documents

Dimensional diagram (https://img.dfrobot.com.cn/wiki/5ea64bf6cf1d8c7738ad2881/cc7974df3517cfc57f7abab07b6cf609.pdf)

DFRobot Shopping mall purchase link (https://www.dfrobot.com)