**Item no.: 2705159**

# Data Sheet

**TOF050F**
**Time-of-Flight ranging Sensor-50CM**


1. Description

TOF050F ranging sensor is a laser ranging module designed and manufactured based on VL6180, which provides accurate and repeatable short-distance measurement function. Thanks to the highly integrated infrared transmitting and receiving mechanism and ST's innovative FlightSense technology, faster and more accurate distance measurement and higher ambient light immunity can be achieved.

TOF050F supports serial port mode, serial port simulation Modbus mode, and IIC mode at the same time, which is well adapted to various application scenarios.

It is equipped with a host computer for easy debugging.

TOF050F has a range of up to 50cm and can choose high-precision or long-distance test mode according to needs, making it more flexible. The ranges are as follows:

| Item | Attributes | Data | Period |
|---|---|---|---|
| 0 | High | 100periodms | 20cm |
| 1 | precisionMiddle | 100ms | 40cm |
| 2 | distanceLong | 100ms | 50cm |

Features

- 850nm laser meets the Class 1 operating conditions specified in the third edition of IEC 60825-1:2014
- Sensor size (20×16.8×6.0mm)
- The maximum measurement distance indoors can reach 0.5 meters, the accuracy is within 5%
- The measurement range has nothing to do with the reflectivity of the target object
- Can work in high infrared light environment
- High optical crosstalk compensation
- Measurement time is less than 30ms
- No need for additional optics
- Single power supply
- Standard TTL level serial port I2C
- High optical crosstalk compensation

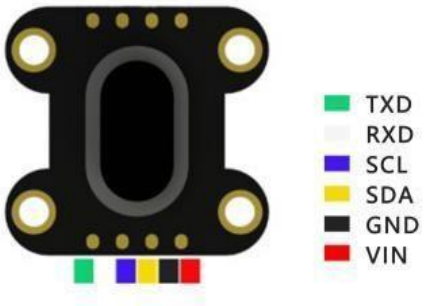
Applications

- High-speed auto focus
- Video continuous auto focus
- User detection of computers and other equipment
- Automatic gesture recognition of goods (such as faucets, refrigerators, etc.)

## 2. Characteristic description

2.1 Structural parameters

| | |
|---|---|
| Volume | 18mmX17mmX6mm(L*W*H) |
| Fixing | d=2mm, Spacing14/11mm |
| Weight | 3g |




TOF050F

2.2 Electrical performance parameters

| Project | Element | Minimum | Typical | Maximum | Unit |
|---|---|---|---|---|---|
| Measuring range | High precision | / | 200 | / | mm |
| | Middle distance | / | 400 | / | mm |
| | Long distance | / | 500 | 600 | mm |
| Operating Voltage | / | 3.0 | 3.3 | 5 | V |
| Working Current | / | / | / | 40 | mA |
| Operating Temperature | / | -20 | / | 70 | ·c |
| Storage temperature | / | -40 | / | 80 | ·c |

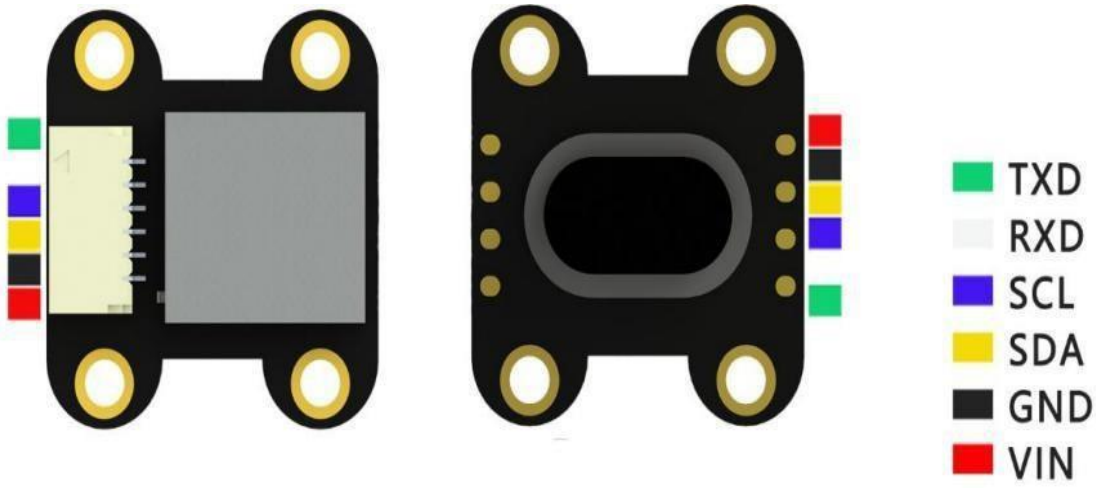
2.3 Optical parameters

| Items | Element | Minimum | Typical | Max | Unit |
|---|---|---|---|---|---|
| Vertical emission laser peak | / | / | 850 | / | nm |
| Vertical emission laser peak Wavelength current | / | / | 38 | / | mA |

2.4 Pin description

| Pin | Name | Attributes | Function |
|---|---|---|---|
| 1 | VIN | / | VIN+ 3 ~ 5V |
| 2 | GND | / | GNDGND |
| 3 | SDA | Input /Output | IIC clock port |

| | | | |
|---|---|---|---|
| 4 | SCL | Input | IIC data port |
| 5 | RX | Input | Serial input TTL level RXD |
| 6 | TX | Output | Serial output TTL level TXD |




## 3. Operating mode

| Mode | Switch | Detailed |
|---|---|---|
| Serial port mode (default) | No need to Switch | Single-machine serial port data sending and receiving, actually follow the Modbus_RTU protocol, and the supporting host computer can facilitate debugging and setting |
| Modbus protocol mode | | The standard Modbus_RTU can be used to access registers to facilitate interaction with industrial equipment. Separate addresses can be set, and broadcast addresses can be shared. It is very convenient to realize multi-module cooperative work. |
| IIC | Command switch | The module gives up the IIC bus and can directly use the IIC to access the sensor chip |

### 3.1 Serial + modbus mode

| Serial communication protocol description | |
|---|---|
| Bits per Second : | 115200 |
| Data Bits : | 8 |
| Parity : | None |
| Stop bits : | 1 |
| Stop bits : | None |

3.1.1 modbus Format description

Read command (take slave 0x01 as an example)

| Slave addr | Function number | Register High | Register Low addr | Data H | Data L | CRC Check L | CRC Check H |
|---|---|---|---|---|---|---|---|
| DR | RW | RegHaddr | RegL | DH | DL | CL | CH |
| 0x01 | 0x03 | RegH | RegL | DH | DL | CL | CH |
| Sensor return | | | | | | | |
| Slave addr | Function number | Number of data bytes | Data byte 1 high bit | Data byte 1 low bit | … | CRC Check L | CRC Check H |
| DR | RW | D | DATA1H | DATA1L | … | CL | CH |
| 0x01 | 0x03 | D | DATA1H | DATA1L | … | CL | CH |

Example: Host 01 03 00 10 00 01 85 CF Read the ranging value of 1 slave sends:

Module reply: 01 03 02 00 15 79 8B Ranging value is 0x0015 (21mm)

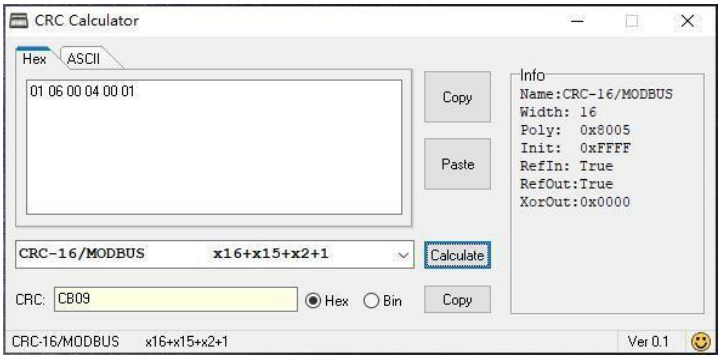
| Write command (take slave 0x01 as an example) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Slave addr | Function number | Register High | Register Low addr | Data H | Data L | CRC Check L | CRC Check H |
| DR | RW | RegHaddr | RegL | DH | DL | CL | CH |
| 0x01 | 0x06 | RegH | RegL | DH | DL | CL | CH |
| Sensor return | | | | | | | |
| Slave addr | Function number | Number of data bytes | Data byte 1 high bit | Data byte 1 low bit | … | CRC Check L | CRC Check H |
| DR | RW | RegH | RegL | DH | DL | CL | CH |
| 0x01 | 0x06 | RegH | RegL | DH | DL | CL | CH |

Example: Host sends: 01 06 00 04 00 01 09 CB Set the ranging mode of 1 slave to high precision

Module 01 06 00 04 00 01 09 CB Set successful response reply:

Special note: CRC check rule is CRC-16/MODBUS

$X^{16+}$The $X^{15+}$check code $X^{2+1}$ can be generated by the existing CRC check code generator or the matching module, which is convenient to use.



3.1.2 Register list

| Category | Data addr | Data | Function | W/R |
|---|---|---|---|---|
| Special register | 0x0001 | 0xAA55 | Restore default parameters | write |
| | | 0x1000 | Reboot | |
| | | 0x0000 | Test communication | |
| Device address register | 0x0002 | 0xXXXX | 0 : Broadcast addr | Read &write |
| Baud rate register | 0x0003 | 0x0001 | 1:38400 | Read &write |
| | | 0x0002 | 6.75 | |
| | | 0x0003/others | Others:115200 | |
| Range register | 0x0004 | 0x0001 | 1: High precision, 100ms, 0.2m | Read &write |
| | | 0x0002 | 2: Middle distance, 100ms, 0.4m | |
| | | 0x0003 | 3: Long distance, 100ms, 0.5m | |
| Continuous output control register | 0x0005 | 0x0000 | 0: no self-output | Read &write |
| | | 0xXXXX | XX:XXms | |
| Load calibration register | 0x0006 | 0x0000 | 0: do not load | Read &write |
| | | 0x0001 | 1 : load | |
| Offset correction value register | 0x0007 | 0xXXXX | Offset correction value | Read &write |
| xtalk correction value register | 0x0008 | 0xXXXX | xtalk correction value | Read &write |
| Disable iic enable register | 0x0009 | 0x0000 | 0: not prohibited (default) | Read &write |
| | | 0x0001 | 1: Prohibited (MCU releases | |
| Measurement | 0x0010 | 0x0001 | Distance value: mm | Read |
| result | 0x0020 | 0xXXXX | xx:The actual value is xx, 5cm is recommended | write |
| offset | | | | |
| calibration | | | | |
| register xtalk calibration | 0x0021 | 0xXXXX | xx:The actual value is xx | write |
| register | | | | |

| | | | |
|---|---|---|---|
| Gray | Indicates that the setting needs to be restarted to take effect | | |
| Application examples | Set mode | 01 06 00 04 00 01 09 CB | Set the distance measurement mode of unit 1 to high precision |
| | Read | | |
| | distance value | 01 03 00 10 00 01 85 CF | Read the ranging value of No. 1 |
| | Module restart | 02 06 00 01 10 00 D5 F9 | No. 2 slave module restarts |
| | Change the slave | 01 06 00 02 00 04 29 C9 | Slave 1 becomes slave 4 |
| | ID | | Set the baud rate of No. 4 machine to 9600, need to restart to take |

| | | | |
|---|---|---|---|
| | Set the | 04 06 00 03 00 02 F8 5E | effect |
| | baud rate | | |
| | Automatic output | 01 06 00 05 01 F4 99 DC | Set the No. 1 machine to automatically output the measured value in 500ms |
| | IIC mode | 01 06 00 09 00 01 98 08 | Set machine 1 to IIC mode |

3.2 IIC mode

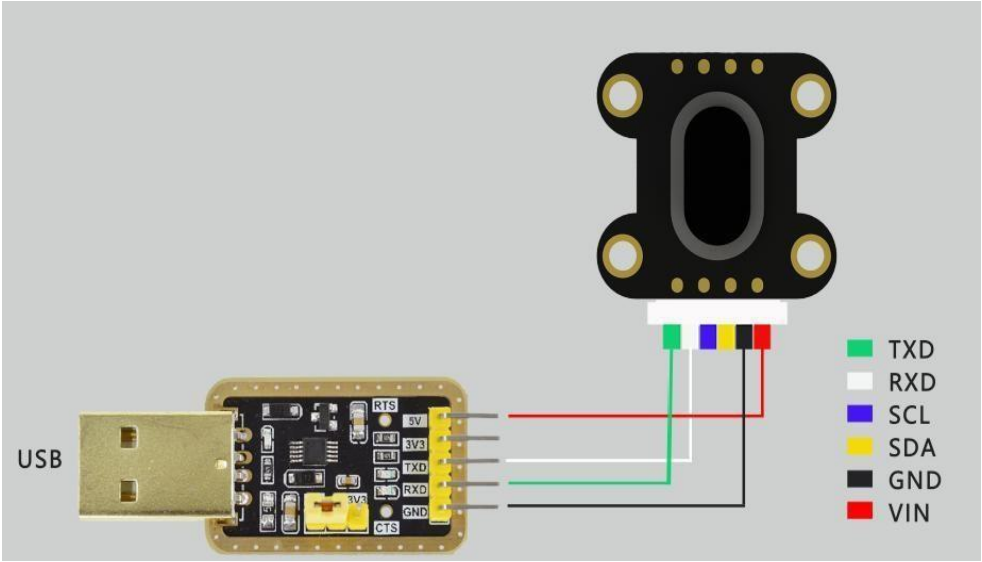
When set to IIC mode, the MCU releases the VL6180 sensor IIC bus. SDA and SCL are directly connected to the sensor (SDA and SCL are pulled up by internal 10K resistors). For specific data reading, please refer to the VL6180 data manual.

## 4 Commissioning instructions

4.1 Serial debugging instructions

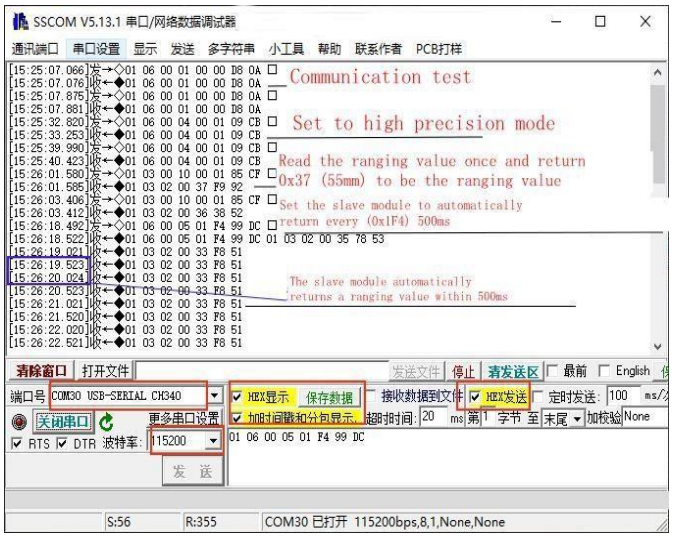
4.1.1Hardware connection

To connect to a computer, a serial port module with USB to TTL level is required. Note that TX and RX need to cross.




4.1.2 Serial software debugging

After connecting with the USB to TTL module, plug the serial port module into the computer USB port. Make sure to find the corresponding COM port after installing the driver of the serial port module. Open the serial port debugging software, connect for the first time, set the baud rate to the default 115200, you must select "HEX display" and "HEX send", and select "time stamp and sub-package display" as required. Finally, open the serial port and perform communication configuration according to the order of instructions from top to bottom as shown in the figure below to complete a complete debugging process. After setting, the ranging module works in high-precision mode and outputs a ranging value every 500ms.



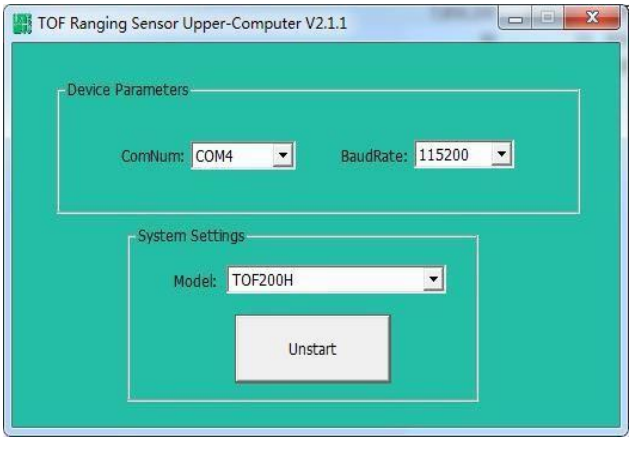

4.2 Supporting host computer debugging instructions

4.2.1Hardware connection

To connect to a computer, a serial port module with USB to TTL level is required. Note that TX and RX need to cross. Refer to section 4.1.1 for details.

4.2.2 PC debugging (take TOF200H as an example)

After connecting with the USB to TTL module, plug the serial port module into the computer USB port. Make sure to find the corresponding COM port after installing the driver of the serial port module. Open the host computer software of the TOF ranging sensor, connect for the first time, set the baud rate to the default 115200, select the corresponding model system in "System Configuration", and click "Start". You can see the real-time display of the measured distance column in the "status display", and the measured value is constantly refreshed as the actual distance changes.



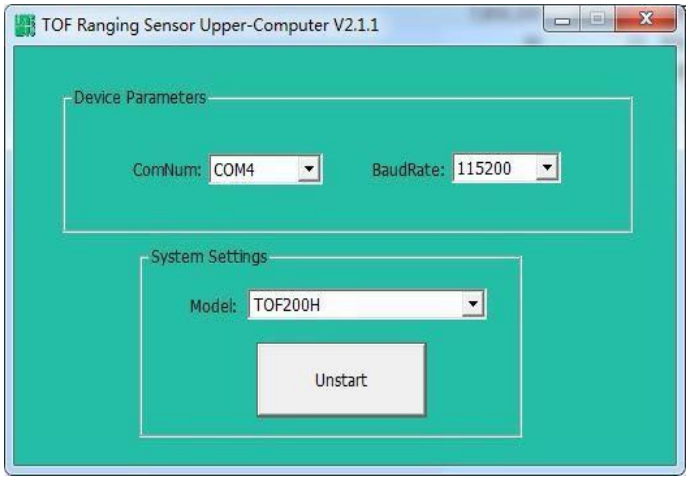


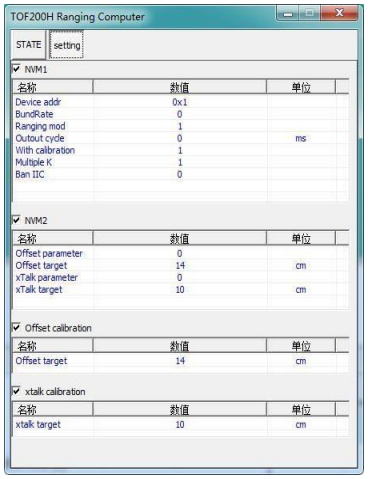
Select the parameter configuration column, you can see that there are 4 groups of parameters for users to set or observe, which is convenient for debugging. Storage parameter 1 is a commonly used setting function. The user can set the device address, baud rate, distance mode, output cycle, etc., and the parameters are saved immediately after setting and are effective when power off. Setting method: directly input the value of the required option in the value of the corresponding function line, and press Enter.

The device address is written directly; please refer to the instruction set for the parameters represented by the specific options of the baud rate/output cycle, for example, the baud rate 0 represents the default 115200; the output cycle is also written directly in ms (note that the output cycle is changed here) It is the serial port automatic output cycle, and the upper computer reads the data cycle is fixed). The correction K can specify the multiple of the output distance and the actual distance, which is suitable for special purposes. In the "Load Calibration" and "Disable iic" function lines, the value 1 means enable and 0 means disable.

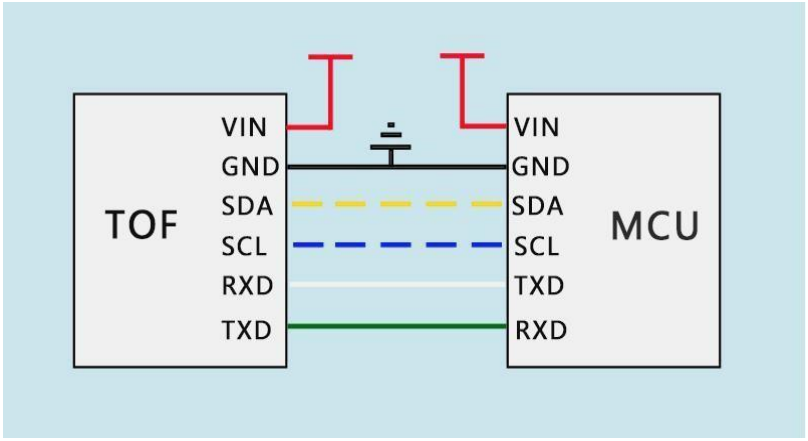
Storage parameter 2 is generally used for observation. For specific values, refer to the chip specification.

The last two calibration parameter settings apply to the calibration function. For offset calibration, it is recommended to use a white target object with 88% reflectivity in dark conditions and calibrate at an actual distance of 10cm. That is, the object is placed at the actual distance of 10cm, enter 10cm in the offset calibration function line, press Enter to start the calibration, and wait for the parameter display to return to normal to complete the calibration. The actual module has been calibrated once with a 10cm offset before leaving the factory and can be used directly. The xtalk calibration is mainly to correct the crosstalk factor generated by the cover window in front of the probe. This module has been equipped with a dedicated glass cover sheet and has been calibrated at the factory. When users need to use without cover sheet or use other cover windows, this function can be used for crosstalk calibration. The specific method is to recommend the use of a gray target with 17% reflectivity. The crosstalk distance value needs to refer to the chip specification and the actual use environment. After selection, refer to the upper computer operation process.



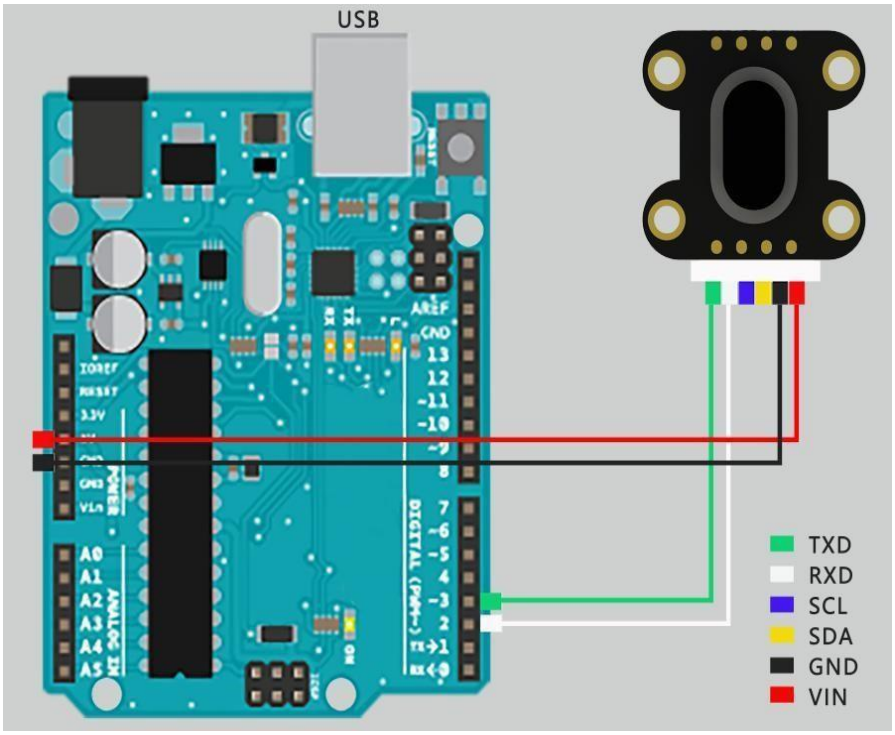

4.3 MCU connection

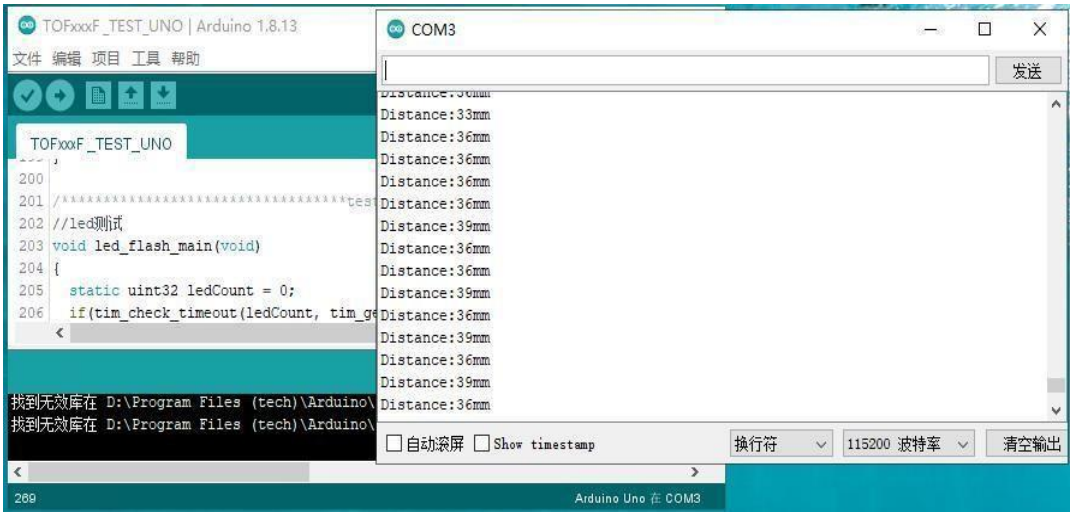



4.3.1 arduino

DEMO Connect UNO and TOF050H ranging module according to the wiring diagram, open the matching Uno test program, and upload it to the UNO development board. The test results are shown below.

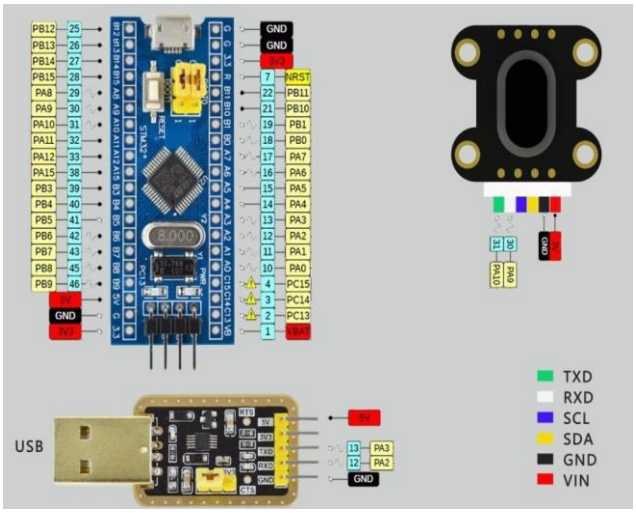
Wiring diagram




### 4.3.1 stm32 demo

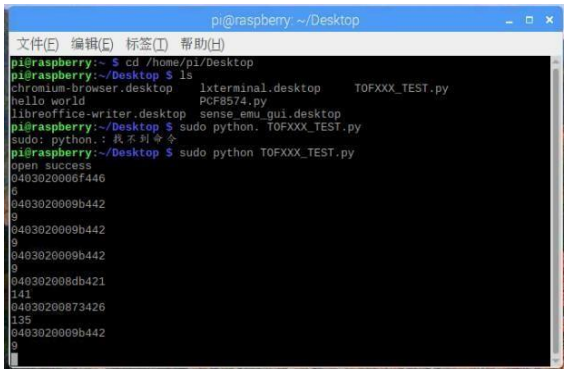
Connect STM32 and TOF050F ranging module according to the wiring diagram, open the supporting STM32 test program, and upload it to the STM32 development board. The test results are shown below.





4.3.1 Raspberry Pi demo

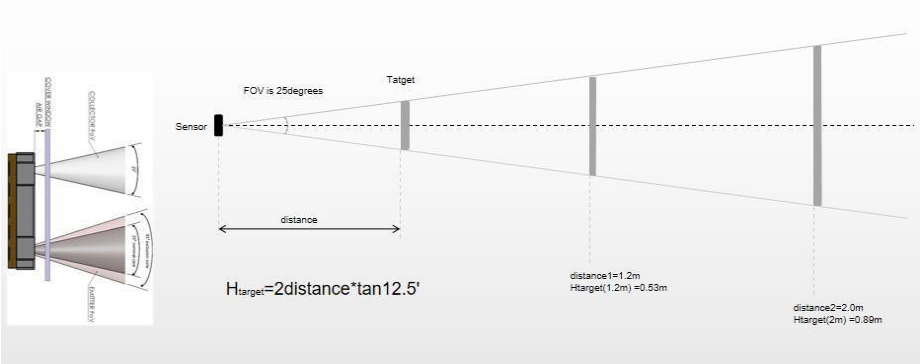
For the wiring method, please refer to the serial port debugging section, connect the serial port module with TOFXXXH, insert it into the USB port of the Raspberry Pi, and execute the TOFXXX_TEST.py file on the console. The effect is as follows:




## 5. Detailed Performance

5.1 Measurement condition

In all measurement tables in the document, it is considered that the full Field Of View (FOV) is covered. This system FOV is 25 degrees. The height of the target must meet this condition.




5.2 Ranging Characteristics

Ranging conditions：

- Targets reflectance used: Grey (17 %), White (88 %)
- Offset correction done at 10 cm from sensor
- Indoor: no infrared
- Outdoor: eq. 5 kLux equivalent sunlight (10 kcps/SPAD)

| Parameter | Precision | Minimum | Typical | Max | unit |
|---|---|---|---|---|---|
| Minimum distance (indoor | ±5% | 1 | 3 | | mm |
| Maximum range distance white) | ±4% | 400 | 500 | 600 | mm |
| Maximum range distance (indoor white) | ±7% | / | 400 | / | mm |
| Maximum range distance (indoor gray) | ±7% | 70 | 200 | | mm |
| Maximum range distance (white outdoor) | ±12% | 60 | 200 | | mm |
| Ranging speed (fastest) (grey outdoor) | | | | 100 | msec |

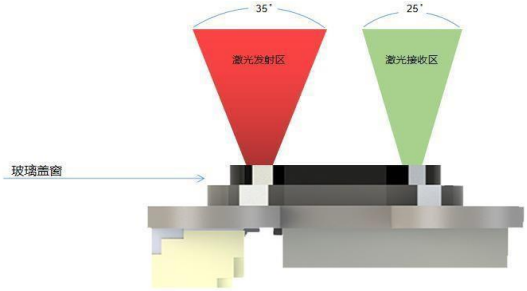
## 6. Comes with a cover glass

It is important to keep the cover window surface finish smooth.

Typically, the T OF 050H ranging module will be used in conjunction with a window covering.

The cover window serv es two main purposes:

1. Provides physical protection of the module, including dust ingress prevention.
2. To provide optical filtering for the module.



## 7. Outline Dimensions