

TF-LC02

Product Manual

V1.1

Jan 10, 2022

Foreword

Dear users:

Thanks for choosing TF-LC02 product and it's our pleasure to help you with any technical question.

To have a better experience, please read this manual carefully. We try to include all common problems and hope you find the deployment and installation easy and fun.

This manual will guide you through the installation and operation process and show you some solution to common problems. It is still possible that you encounter some difficulties that are not included, please check our support service and don't hesitate to contact our technical support engineers or leave a message on feedback page of our official website.

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Product Information

Model: TF-LC02

Full name : TF-LC02 LiDAR Module

Manufacturer

Company: ShenZhen SmartFly tech Co.,Ltd

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Warning: Since some electronic components of the module are exposed, and the ToF sensor is based on CMOS, it is vulnerable to ESD damage. Wearing anti-static gloves or anti-static wrist strap when handling the product. Do not touch the electronic components with hands or metal objects to prevent static electricity from damaging the module.

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1 Overview

1.1 Introduction

TF-LC02 is a high-precision ranging LiDAR module, based on ToF principle and built in TDC (Time-to-digital Converter) architecture, mainly used for different kinds of robots including vacuum cleaning robot, drone and intelligent household appliances. This product is easy to operate and install, and supports UART communication.

1.2 Maintenance and cleaning

- Before turning on the product, please check whether the exposed window is clean. If it is dirty, clean it in time.
- After usage, check whether the optical device is polluted. If it is polluted, clean it in time.
- The product works in harsh environments for a long time, clean the optical elements regularly.
- Before regular cleaning, please disconnect the power supply. When the product is turned off, use cotton cloth to gently wipe the window, avoid repeated and unnecessary wiping to damage the window.
- For a deep cleaning of internal optical elements, please contact XX@XXXX.com for professional support.

1.3 Disclaimer

- The warranty period of this product is one year. During this period, the company is responsible for repairing, replacing or compensating for the after-sales problems of the product itself.
- If there are after-sales problems caused by the product itself after the warranty, please provide the necessary proof to the company. The company will deal with the problem honestly and faithfully.
- The products must be purchased through formal channels, so that the company can trace the after-sales problems of the products.

1.4 Performance

Table 1 describes TF-LC02 parameters, the operating range and accuracy is measured indoor based on a standard whiteboard with reflectivity 90%. FoV is theoretical value, real value may be different.

Table 1 Parameters specification of TF-LC02

Type	Description	Parameter Value
Product performance	Operating range	3cm~200cm @ 90% reflectivity
	Data acquisition time	33msec
	Accuracy	$\pm 2\text{cm}$ @ (3cm~100cm); $\pm 5\%$ @ (100~200cm)
Optical parameters	Light source	VCSEL
	Central wavelength	940nm
	Photobiological safety	Class1 (IEC60825-1:2400)
	FoV	$\pm 9^\circ$
Electrical parameters	Supply voltage	3~3.6V
	Average current	$\leq 15\text{mA}$
	Power consumption	$\leq 50\text{mW}$
	Communication signal level	LVTTL (3.3V)
Others	Storage temperature	$-20^\circ\text{C}\sim 85^\circ\text{C}$
	Operating temperature	$-20^\circ\text{C}\sim 70^\circ\text{C}$
	Dimension	20mm*11.5mm*7.6mm(L*W*H)

1.5 Appearance and dimension

TF-LC02 appearance and dimension are shown in figure 1 and figure 2:

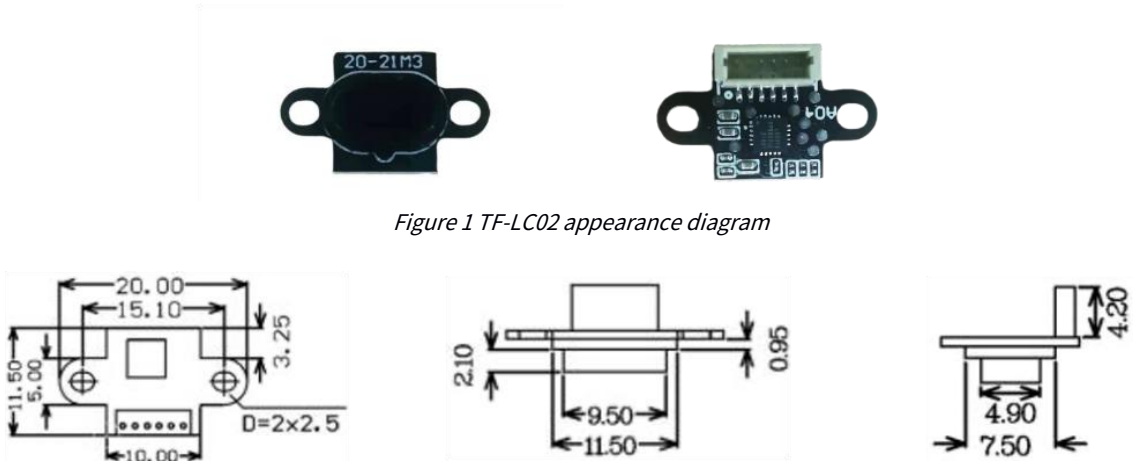


Figure 1 TF-LC02 appearance diagram

Figure 2 TF-LC02 dimension (Unit : mm)

1.6 Applications

When use this product, please read the product manual and datasheet carefully, to ensure that the product is used within its rated specifications. Meanwhile, please comply with the following specifications:

1. The product is designed for these applications:
 - Mobile/tablet/computer and other terminal devices
 - Measuring tools
 - Intelligent household
 - Home robot
 - Other consumer products

If the product is used without its rated specifications, please evaluate whether the reliability requirements of application are compatible with the product.

2. If the reliability and security requirements of application is strict, choose this product carefully, such as the following applications:

- Traffic control and safety equipment (planes, trains, cars, etc.)
- Traffic signal control
- Gas leakage device
- Rescue equipment
- Other equipment related to life safety and public safety

TF-LC02 is designed for consumer product, is not applicable to high reliability and high security scenarios.

1.7 Storage

- Store the product in an environment with a temperature of -20°C~85°C and a relative humidity of $\leq 60\%$ to ensure ventilation without the influence of corrosive gases.
- Please turn off the product and close the dust cover before storing the product, to keep the product clean.
- If the storage time is over three months, have a work test before use to ensure that the product is in a normal status.

2 Installation and usage

2.1 Notes

- Ensure that the installation environment and module lens are clean;
- Keep the module lens clean during usage, clean the dust, water and other contaminants with cotton in time;
- Do not touch the circuit board with your hands, wear anti-static gloves or anti-static wrist strap for operation;
- Any kind of debris between the module lens and the mounting surface may block the optical path and affect the measurement performance;
- Tighten the screws to ensure that the product do not slide, ensure that the module lens is horizontal.

※Warning : This product is recommended to be used in indoor with 100Klux ambient light condition, direct sunlight will cause performance degradation.

2.2 Usage introduction

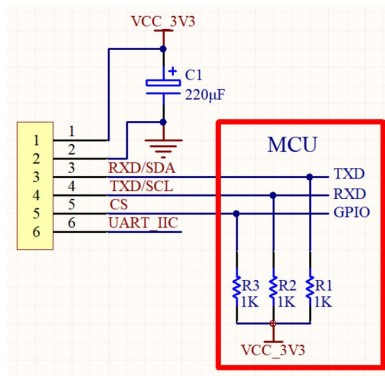


Figure 3 External connection

1. A high-frequency capacitor of more than 220 μ F needs to be added to the power supply pin of the module (the laser in module adopts the pulse method).
2. It is recommended to connect an external pull-up resistor with a resistance value of 1K Ω . If the pull-up resistor is not connected, the communication waveform may be deformed (the rising edge is arc-shaped); at the same time, during the communication process, it is susceptible to interference (especially when the serial port cable is very long, or when it passes through accessories such as motors, speakers, and ringers), causing the communication to fail.

3. If only one product is connected to the serial port bus, you can cancel R3 and connect the CS pin to ground directly, so that the serial port is always enabled.
4. In near measure range, the blind zone is 3cm, and the measured data in the blind zone is unstable or inaccurate. When designing the structure, pay attention to the blind zone.
5. When designing the structure, can't add baffle in front of the lens, can only make holes. The size of the hole should match the edge of the module lens and glue it with waterproof glue.
6. General working parameters of modules:
 - Power supply and communication level is 3.3V;
 - CS pin must be inactive;
 - Data acquisition time is 33ms;
 - The device starts sending stable data after 200ms for the first power-on time;
 - Currently the module version only supports UART, the I²C pin can be left floating. I²C communication mode will be updated in future versions.

3 Interface and protocol

3.1 Interface description

TF-LC02's function block diagram and interface pinout:

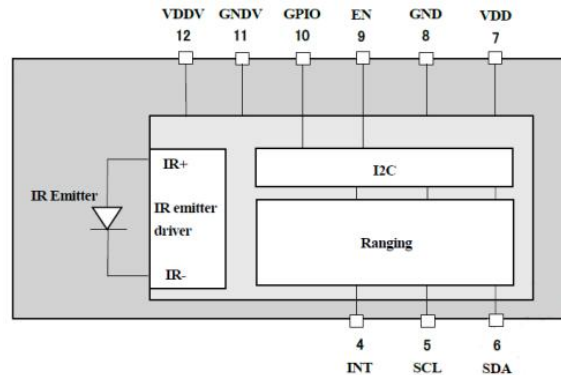


Figure 4 Function block diagram

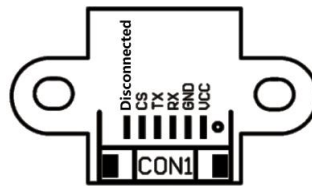


Figure 5 Interface pinout

3.2 Protocol and general command

3.2.1 Protocol

TF-LC02 adopts the serial port data communication protocol, as given in Table 2

Table 2 UART protocol's parameters

Parameter	Value	Description
Interface	UART	The communication interface
Default baud rate	115200	This parameter represents the UART communication baud rate
Data bit	8	Specifies the number of data bits transmitted or received in a frame
Stop bit	1	Specifies the number of stop bits transmitted
Parity check	none	Specifies the parity mode
Hardware flow control	none	Specifies whether the hardware flow control mode is enabled or disabled

The format of UART communication protocol data frame is fixed between the MCU and ToF sensor. The protocol data frame: Packet header + Command Code + Data length + Data + End flag.

Table3 Protocol composition

Offset(bytes)	Length(bytes)	Type	Description
0	2	uint16_t	Packet header: 0x55 0xAA
2	1	uint8_t	Command code
3	1	uint8_t	The length of the following parameter
4	N	array of uint8_t	Parameter, N=data length, N+4<32, depending upon ToF module buffer size
L	1	uint8_t	End flag: 0xFA, offset computational formula is L=data length+4

3.2.2 Command description

This chapter introduces the return code of command, and some general commands. The following command code has the same meaning regardless of the communication mode.

Table 4 Command description

Command code	Description
0x81	Measuring distance value and measurement status, Unit: mm
0x82	Crosstalk correction and correction result
0x83	Offset correction and correction result
0x84	Reset the ToF module
0x85	Get factory default settings, including offset, X_TALK and check
0x86	Get product information, including model, communication mode and version

1. Measuring distance value: 0x81

The command frame format is following:

Table 5 Measuring distance command frame format

Offset(bytes)	Length(bytes)	Type	Description
0	2	uint16_t	Range1, measuring distance value (Unit: mm)
2	1	uint8_t	Range1_status, measurement status1

2. Crosstalk correction: 0x82

Put the product in the dark box and there should be no barriers within 60cm. The product runs the crosstalk correction program after receiving the command, then store correction value and return the value to MCU. The command frame format is following:

Table 6 Crosstalk correction command frame format

Offset(bytes)	Length(bytes)	Type	Description
0	1	uint8_t	Error code, refer to factory calibration error code list sections
1	1	uint8_t	xtakLsb, crosstalk data_factory
2	1	uint8_t	xtakMsb, crosstalk data_factory

3. Offset correction: 0x83

Put the product in dark box and there should be 75% grayscale white card within 10cm. The product runs offset correction program after receiving the command, then stores correction value and return the value to MCU. The command frame format is following:

Table 7 Offset correction command frame format

Offset(bytes)	Length(bytes)	Type	Description
0	1	uint8_t	Error code, refer to factory calibration error code list sections
1	1	uint8_t	Offset_short1, offset for short range mode 1
2	1	uint8_t	Offset_short2, offset for short range mode 2
3	1	uint8_t	Offset_long1, offset for long range mode 1
4	1	uint8_t	Offset_long2, offset for long range mode 2

4. Reset ToF module: 0x84

If ToF module receives this command, the module will return the same command code, runs the reset program, and restart module.

5. Get factory default settings: 0x85

This command can get the factory default setting data stored in the module. The command frame format is following:

Table 8 Get factory default settings command frame format

Offset(bytes)	Length(bytes)	Type	Description
0	1	uint8_t	Offset_short1, offset for short range mode 1
1	1	uint8_t	Offset_short2, offset for short range mode 2

2	1	uint8_t	Offset_long1, offset for long range mode 1
3	1	uint8_t	Offset_long2, offset for long range mode 2
4	1	uint8_t	xtakLsb, crosstalk data_factory
5	1	uint8_t	xtakMsb, crosstalk data_factory

6. Get product information: 0x86

This command can get product information. The command frame format is following:

Table 9 Get product information command frame format

Offset(bytes)	Length(bytes)	Type	Description
0	1	uint8_t	Sensor_ic: 0x02: the sensor is gp2ap02vt 0x03: the sensor is gp2ap03vt
1	1	uint8_t	Port: 0x41('A'): firmware supports both UART and I ² C interfaces; 0x49('I'): firmware supports I ² C interface; 0x55('U'): firmware supports UART interface
2	1	uint8_t	Firmware version information for ToF module

3.2.3 Example

1. Measuring distance: 0x81

Command sent: 55 AA 81 00 FA

Reply: 55 AA 81 03 01 55 00 FA

Comments:

01 55 is measuring distance value, the distance value is 0x0155, because LiDAR data-packet follows big-endian format, which is 341mm in decimal form.

00 is the status, which means the value is valid. Other value means the value is invalid, error codes are shown in the following table:

Table 10 Error codes

Error Code	Error Status	Description
0x00	VALID_DATA	Valid value
0x01	VCSEL_SHORT	When the VCSEL is short-circuited. If this error occurs, the VCSEL current will not flow inside the IC
0x02	LOW_SIGNAL	The amount of reflected light obtained from the detected object is small
0x04	LOW_SN	The ratio of reflected light from the detected object and disturbance light is small
0x08	TOO_MUCH_AMB	Disturbance light is large
0x10	WAF	Wrapping error
0x20	CAL_ERROR	Internal calculation error
0x80	CROSSTALK_ERROR	Crosstalk from the panel is large

2. Reset module: 0x84

Command sent: 55 AA 84 00 FA

Reply: 55 AA 84 00 FA

The module resets after the response.

3. Get factory default settings: 0x85

Command sent: 55 AA 85 00 FA

Reply: 55 AA 85 07 2B 0E 17 01 08 01 03 FA

Comments:

2B is offset_short1, 0E is offset_short2;

17 is offset_long1, 01 is offset_long2;

The crosstalk value is 0x0108;

Calibration results: 00 Unchecked; 01 Crosstalk checked; 02 Offset checked; 03 Full checked.

4. Get product information: 0x86

Command sent: 55 AA 86 00 FA

Reply: 55 AA 86 03 02 55 01 FA

Comments:

0x41(A) means the module supports I²C and UART, 0x55(U) means the module supports UART,

0x49(I) means the module supports I²C.

01 is the software version.