ATOM LiDAR

SPECIFICATIONS

Model Name: ATOM LiDAR

CATALOGUE

General description

ATOM LiDAR is a cost effective ranging module based on TOF technology, using 850nm IR LED light source, combined with special optics, structure and electronics, and can meet the needs of medium-short ranging (0.2m ~ 12m). With the help of the filtering algorithm, extremely low distance noise can be realized.

ATOM LiDAR ranging module is equipped with an 850nm narrow band pass filter, which can effectively block 99% of the ambient light, ensuring the distance measurement accuracy for both indoor and outdoor applications.

ATOM LiDAR ranging module provides multiple communication interfaces, and supports IIC and UART communication, which is convenient for the integration. Besides, the module provides a variety of measurement modes, single measurement and continuous automatic measurement to meet the needs of different terminal products.

In terms of output data, you can choose to use filter to get smoother range data; or without the filter to get a faster dynamic response. During the non-measurement period, the module enters to IDEL status, thereby effectively reducing power consumption and ensuring the life of the light source.

ATOM LiDAR ranging module has gone through multi-channel calibration and testing before delivery, and has good consistency.

FEATURES

- ✧ Indoor/outdoor compatible
- ✧ medium-short range (0.2m～12m)
- ✧ miniaturization, easy to install
- ✧ multiple measurement types
- ✧ long working life
- ✧ high frame rate, higher than 500Hz (@5us integrated time)
- ✧ IR LED light source, eye safety
- ✧ cost-effective

APPLICATION

- ● single-point ranging Lidar
- ● robot avoiding obstacles
- ● SLAM modeling of sweepers
- ● security, access control monitoring
- ● object classification

Introduction

The product is a ranging module based on TOF (Time of Flight) principle, using 850nm LED light source, with unique optics, electronics and structure design, which can achieve high-speed and high-precision ranging.

Via the UART or IIC communication interface, the digital data of measured distance can be acquired. Due to the limitation of optical characteristics and emitting light power, the maximum effective range of the measurement is 10 meters and the minimum is 20cm.

1 Parameters(T=25℃，VCC=+5V，90% reflectivity，indoor)

1.1 Basic parameter table

Item	Specification
part name	ATOM LiDAR
Detection range	0.2~12m(indoor/90% reflectivity)①
Supply voltage	4.8~5.2V
operation mode	continuous mode② single mode
FOV of receiver	Half angle：1°
FOV of transmitter	Half angle：2°③
Ambient light	15 Klux max ⑤
Integration time	5us ~ 5000us
Signal amplitude	3400LSB ~ 7000LSB
range accuracy	20~350cm ±5cm 350~1200cm ±1.5%⑥
Distance noise(1σ)	2.5mm
IR centroid wavelength	850nm
Module dimensions	42mm×15mm×17mm
Operation temperature	-10℃~60℃(Non-condensing)
Storage temperature	-20℃~70℃
Communication interface	UART、IIC
Distance resolution	1mm
Frame rate	Max 500(Hz)④⑦

weight	4g

Note：

① The blind zone is 0 ¬ 0.2m, within which the distance data is invalid .

② The default mode is single measurement mode. The module performs a measurement action each time when a command is received.

③ The diameter of the illumination spot at 10 meters is about 0.75m. The object should be no smaller than this size.

④ In actual application, the integration time will be automatically adjusted inside the module, and the data will be output after the measurement is complete.

⑤ The ambient light is the direct intensity of the surface of the measured object. Whenthe incident angle is different, stronger ambient light is tolerable.

⑥ When the temperature changes drastically, range deviation maybe bigger.

⑦ If the target is far away or the reflectivity is low, the actual output frame rate may be slower due to the multi-frame processing .

When the module running with maximum integration time, frame rate will drop to about 10Hz.

1.2 Electrical parameter table

Item	symbol	Type Value	Unit
Input voltage	DC	5	V
Average current	I	80	mA
Average power	P	400	mW
Peak current	I_{max}	250	mA
UART voltage level	V_{TTL}	3.3	V
IIC voltage level	V_{TTL}	3.3	V

1.3 The minimum size of target VS distance

Distance/unit： m	1	2	3	4	5
Target size/unit： mm	70	140	210	279	349

Note： Generally, the side length of the measured target should be larger than the minimum side length, so that the module output data can be credible; otherwise, the deviation of measured distance will increase.

1.4 Module working life

Among the components inside the module, it is the emitter whose performance suffers the most from aging. Calculated based on factors such as the decay time of its luminous intensity and the maximum duty cycle during measurement, the cumulative time for reliable data measurement of the module is over 30,000 hours.

1.5 Ranging Method

continuous automatic measurement：

The host sends the output frame-rate of the module through serial interface. Then module will apply continuous measurement at a fixed frame-rate. After completing a measurement, the current result will be output immediately. The user only needs to receive the measurement result on the host side.

When no measurement is required, the host sends a continuous measurement shutdown command, and the module enters the standby state.

single measurement：

The host sends a distance measurement command through the serial interface, after completing measurement action the module will send out the result then enter IDEL status.

1.6 Filter processing method

For the measured distance result of the module, end customers can choose different methods for different scenarios.

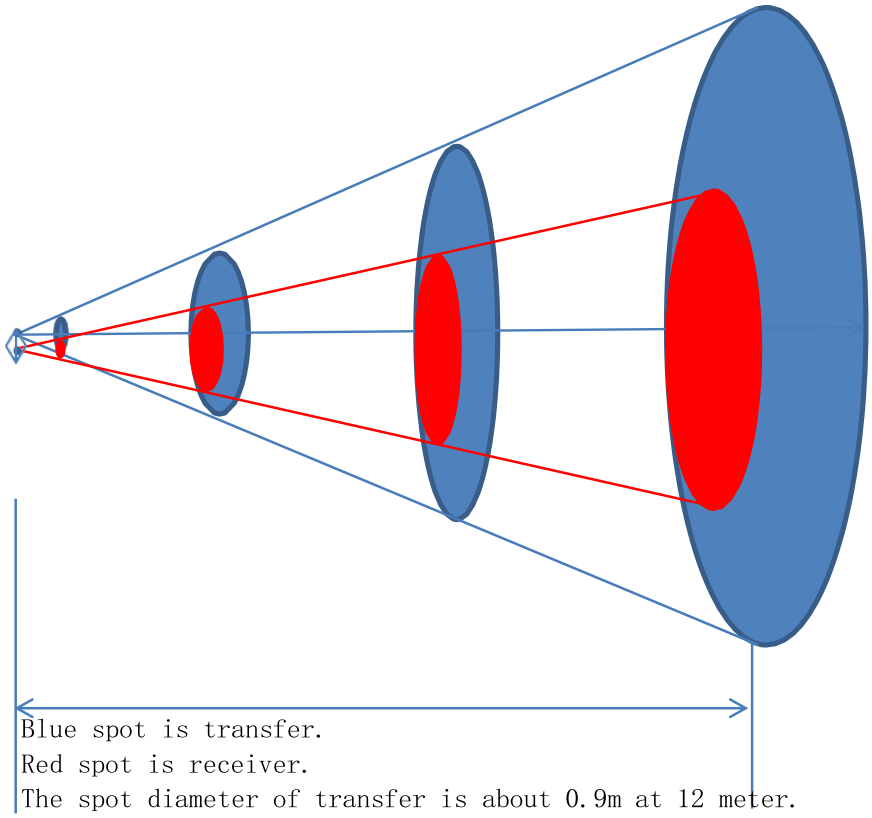
The integrated filter (median filter) processing inside the module can eliminate a certain distance noise and make the output distance value more stable and credible. But due to the filtering algorithm processing, between the output data and the current actual measurement value will have a certain deviation in time domain.

In order to get a higher response speed, terminal can choose the method without filter. Then performs further processing based on the value.

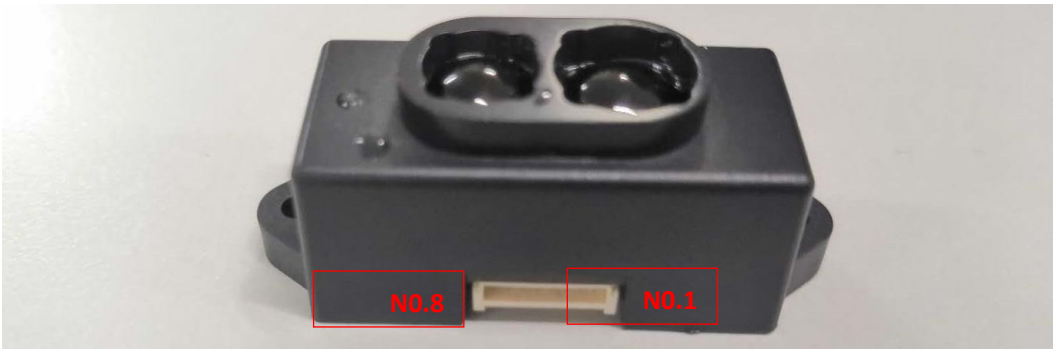
When the module filtering is effective, the frame rate can be increased to reduce the output delay in time domain.

1.7 Schematic diagram of transmit and receive light

The schematic diagram of the optical path of the transmitting/receiving of the module is as follows. When the measured object completely covers the transmitting light source, accurate distance data can be obtained, otherwise there will have some distance deviation.



2 Interface and function description

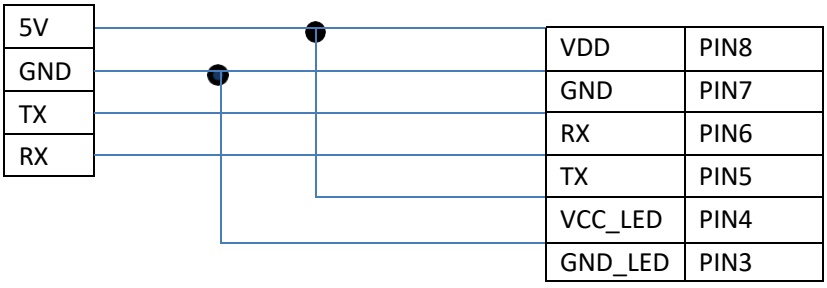


Pin NO	Symbol	Function description
8	VDD	Main power supply（5V）
7	GND	Main power ground
6	RX	UART receive line
5	TX	UART send line（DATA_READY for IIC）
4	VCC_LED	Power supply for LED（5V）
3	GND_LED	Ground for LED

2	SDA	IIC data line
1	SCL	IIC clock line

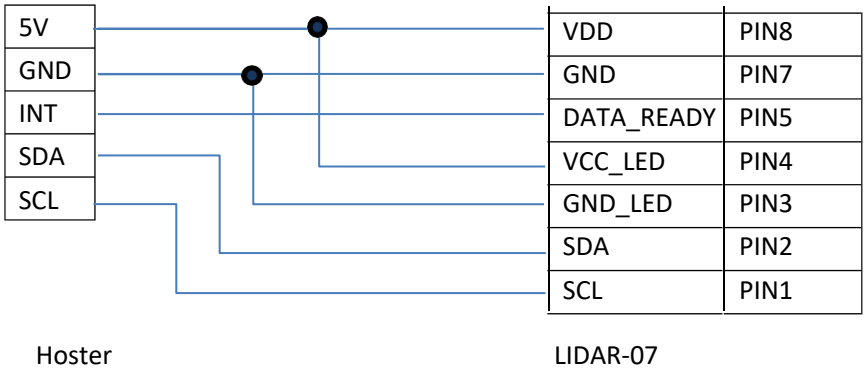
3 Typical application circuit

3.1 UART communication method



Using single power supply and UART communication, the module already has pull-up resistors for TX/RX, and there is no need to add additional circuits in the terminal side. UART communication parameters, refer to 4.1 UART communication configuration parameters

3.2 IIC communication method



Using single power supply and IIC communication, DATA_READY is the data readable interface for the module to notify terminal. the voltage of port changes from low to high When data can be read. Therefore, the port of host side needs to be set to the input state, otherwise an abnormality may occur. For the SDA/SCL communication line, the module already has a pull-up resistor, so there is no need to add additional circuits in terminal side. For the communication parameters of IIC, refer to 4.2 IIC Communication Configuration Parameters and 4.7 Communication Sequence.

4 Protocol of communication

4.1 UART Serial Port parameters

parameter	Value	unit	Remark
band rate	115200	Bit/s	
Start bit	1	Bit	Low active
Stop bit	1	Bit	
Data length	8	Bit	High active
parity	None		

4.2 IIC Serial port parameters

parameter	Value	Unit
mode	Slave	
Speed	400K	Bps
address	0x70	7bit

4.3 UART Communication protocol

Command format from hoster

Header	CMD		Data	CRC32
0xF5	W/R	TYPE	LSB--------MSB	LSB--------MSB
1 byte	1 byte		4 byte	4 byte

Response format from module

Header	CMD		Data length(N)		Data	CRC32
0xFA	W/R	TYPE	LSB	MSB	LSB-------MSB	LSB-------MSB
1 byte	1 byte		2 byte		N byte	4 byte

Command construction：(W/R) | TYPE

W(Write)：0x80

R(Read)：0x00

4.4 UART Communication protocol

The module works in slave mode; all read and write operations must be initiated from the host.

Write operation from host

START	Slave addr	Read/ write	ACK	CMD	ACK	DATA	ACK	DATA	ACK	DATA	ACK	DATA	ACK
	0x70	1				LSB						MSB	

CRC1	ACK	CRC2	ACK	CRC3	ACK	CRC4	ACK	STOP
LSB		…		…		MSB		

Read operation form host

When reading data, host need to write command first, and then read the data.

For Command and answer sequence, please refer to [4.7 Communication sequence]

Firstly write command

START	Slave addr	Read/ write	ACK	CMD	ACK	DATA	ACK	DATA	ACK	DATA	ACK	DATA	ACK
	0x70	1				LSB						MSB	

CRC1	ACK	CRC2	ACK	CRC3	ACK	CRC4	ACK	STOP
LSB		…		…		MSB		

Secondly read command

START	Slave addr	Read/ write	ACK	CMD	ACK	DATA 0	ACK	DATA 1	ACK	DATA	ACK	DATA n	ACK
	0x70	0				LSB						MSB	

CRC1	ACK	CRC2	ACK	CRC3	ACK	CRC4	ACK	STOP
LSB		…		…		MSB		

4.5 CRC calculation

The Cyclic Redundancy Check (CRC) calculation includes all bytes of the packet except the CRC itself.

- Byte wise： CRC32
- Init value： 0xFFFFFFFF
- Polynom： 0x04C11DB7
- Xor value： 0x00

4.6 Command

No	CMD name	CMD (HEX)	Description
1	Read version	0x43	Within this command user can get the software version.
2	Filtering control	0x59	User can enable or disable filtering function for different application
3	measurement start/stop	0x60	Value 0: if the module works in continuous automatic measurement mode, then stop the measurement. Value 1: start the measurement at once. If the module works in single measurement mode, the module will enter IDEL start after measurement completed.
4	Ranging Mode control	0x61	User can choose continuous automatic measurement or single measurement mode.
5	Frame rate set	0x62	When module works in continuous automatic measurement mode, user can set different frame rate.
6	Read system error status	0x65	User can use this command to catch out the system running error code.

4.6.1 Read version

command：

Read 0x43 | 0x00

Data ： None

example：

Command e.g. | 0xF5 | 0x43 | 0x00 0x00 0x00 0x00 | 0xAC 0x45 0x62 0x3B |

Response e.g. | 0xFA | 0x43 | 0x04 0x00 | 03 00 01 00 | 0xE0 0xDC 0x3C 0xA4 |

Response data ： 03 00: the first two byte is minor version (0)

01 00: the last two byte is major version (1)

4.6.2 Write/read frame rate

command：

Write 0x62 | 0x80

Read 0x62 | 0x00

data： Measurement interval period

This parameter is valid only in continuous automatic measurement mode, which is set in MS unit. The Minimum setting is 10ms (100Hz).

example： Period is 100ms (10Hz)

Command e.g. | 0xF5 | 0xE2 | 0x64 0x00 0x00 0x00 | 0x93 0xBF 0x91 0x3B|

Response e.g. | 0xFA | 0xE2 | 0x04 0x00 | 0x00 0x00 0x00 0x00 | 0xA8 0x41 0xFE 0xFB |

4.6.3 Ranging mode control

command：

Write 0x61 | 0x80

Read 0x61 | 0x00

data：

Single measurement mode

Continuous automatic measurement mode

example：set the module in single measurement mode

Command e.g. | 0xF5 | 0xE1 | 0x00 0x00 0x00 0x00 | 0xA5 0x8D 0x89 0xA7|

Response e.g. | 0xFA | 0xE1 | 0x04 0x00 | 0x00 0x00 0x00 0x00 | 0x3A 0x63 0x08 0x6D |

4.6.4 Measurement start/stop

command：0x60 | 0x80

date：

1: start measurement

2: stop measurement

example： Start measurement

Command e.g. | 0xF5 | 0xE0 | 0x01 0x00 0x00 0x00 | 0x9F 0x70 0xE9 0x32 |

Response e.g. | 0xFA | 0xE0 | 0x10 0x00 | distance (2 byte) | temperature (2 byte) | amplitude(2 byte) | ambient light(2 byte) | TOF phase information(8) byte) |CRC32(4 byte) |

Note：

When the module is in a single measurement mode, if received the start measurement command, the module starts distance measurement, then enters the standby state after sending the result.

When the module is in continuous automatic measurement mode, if received the start measurement command, the module will continuously measure according to the frame rate, , it will output the result after the end of each measurement.

4.6.5 Filter function control

command：

Write 0x59 | 0x80

Read 0x59 | 0x00

data：

1: Filtering on

0: Filtering off example：

Filtering on

Command e.g. | 0xF5 | 0xD9 | 0x01 0x00 0x00 0x00 | 0xB7 0x1F 0xBA 0xBA |

Response e.g. | 0xFA | 0xD9 | 0x04 0x00 | 0x01 0x00 0x00 0x00 | 0x88 0x87 0x0A 0xEC |

4.6.6 Readout system error code

command：

Read 0x65 | 0x00

data：

0x00000001 ： SPI communication error

0x00000002 ： Pixel saturation

0x00000004 ： ADC overflow

0x00000008 ： ADC underflow

0x00000010 ： Measurement error inside

0x00000020 ： Amplitude too high

0x00000040 ： Amplitude too low

example：

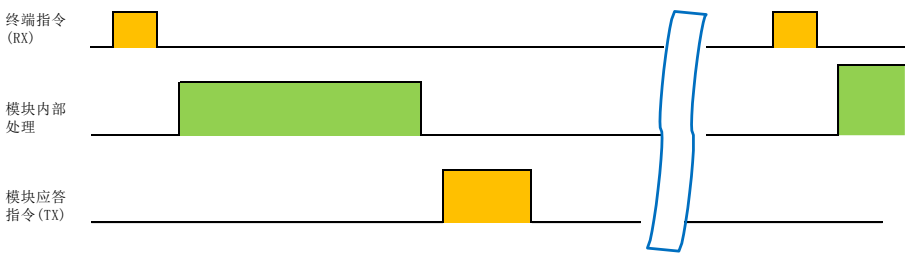
Command e.g. | 0xF5 | 0x65 | 0x00 0x00 0x00 0x00 | 0x9A 0x08 0xE9 0x8A |

Response e.g. | 0xFA | 0x65 | 0x04 0x00 | 0x01 0x00 0x00 0x00 | 0xAC 0x30 0x44 0x79 |

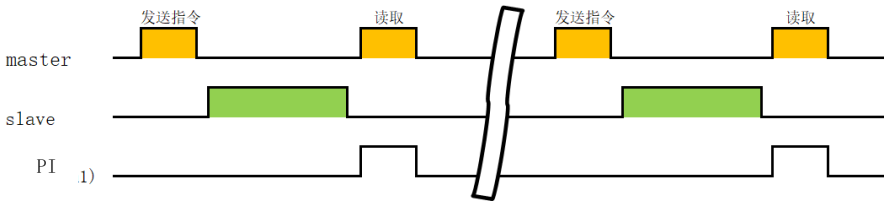
4.7 Communication sequence

When the host sends a command to the module via UART or IIC, the sequence between command and response is shown in the figure below.。

1) UART communication sequence



2) IIC communication sequence



Note：When reads measurement data, if the module finishes measurement, PIN5 will be set from low to high, thus notify host to read the result. After the data is read out, PIN5 will become low again.

Therefore, when using IIC interface, please connect this port to host side, and set the pin as external trigger.

4.8 Noise removal and filtering processing

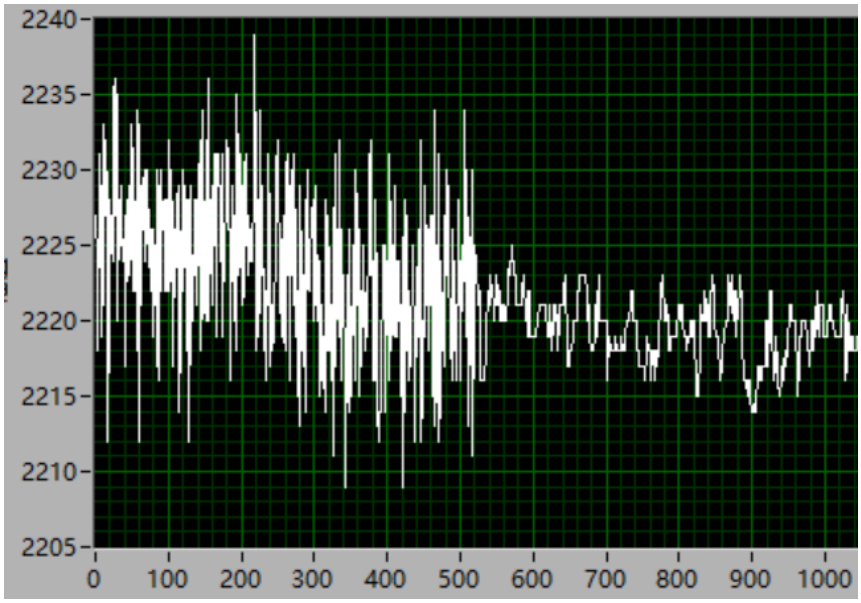
LIADR-07 module uses 3D TOF imaging for distance measurement. The distance noise is limited by the contour and depth of the measured object. This noise is also called time noise and varies with each measurement. Since the noise is a statistical value, its influence can be reduced by filtering. The default state of the LIDAR-07 module calculates the measurement results withoutany filtering processing to ensure the fastest dynamic measurement response

4.8.1 Built-in median filter in the module

Lightweight median filter processing has been implemented inside the module. if user wants to enable filter, set the command 0x19 to 0x00000001, then can get low-noise distance data.

In the figure below, the first part of the data (first 520 points) is without filtering, noise amplitude is 30mm.

In the figure below, the filter is turned on after 520 points, noise amplitude is 10mm



4.8.2 Kalman Filter

Besides the built-in median filtering in the above-mentioned modules, a filtering method based on Kalman theory can be used to significantly reduce noise without loss of system accuracy. For particular implementation methods, please contact your local sales

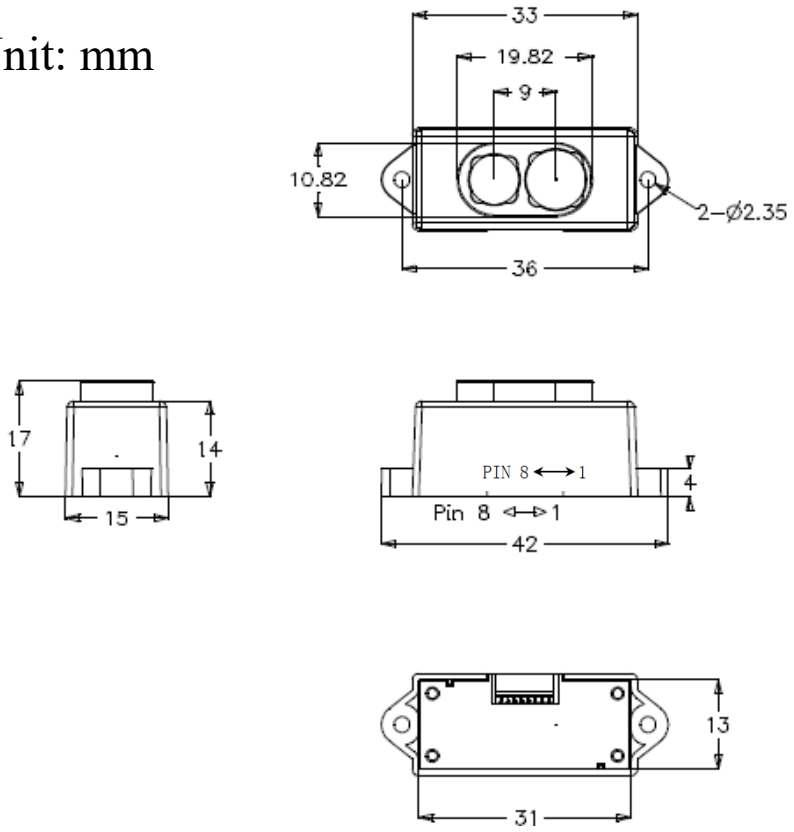
5 Mechanical dimensions

Connector

Maker	PART NO
XIN FU ER ELECTRONICS	1.0T-8AWB

Unit:mm

Unit: mm



6 IMPORTANT NITICE

Be careful to avoid damaging the module. In all the stages of storage, handling, assembly and testing, the product shall be prevented with falling and collision, ESD protection and dust protection also should be taken.

7 Revision history

NO	Detail	Version	Date
1	ATOM LiDAR first edition	1.0	2020/08/03
2	1) UART band rate change to 115200bps/s 2) Add the description of frame rate setting in continue automatic measurement mode.	1.1	2020/08/05
3	1) Change LED wavelength 850nm 2) Add system running error code 3) Correct the response the measurement start/stop command, TOF phase information length is 8 bytes. 4) Add the sequence of IIC reading.	1.2	2020/10/16
4	1) Change the command of protocol. 2) Add the part number of connector.	1.3	2020/11/23
5	1) Due to improve the performance of lens, the max measurable distance is extended to 12 meter. 2) Delete the power on command since the module will start the power automatically.	1.4	2020/12/30