Infrared Ranging Sensor

SPECIFICATIONS

Model Name: LIDAR07-100W-B
CATALOGUE

General description ........................................................................................................... 3

Introduction ......................................................................................................................... 4

1 Parameters(T=25℃, VCC=+5V, 90% reflectivity, indoor) ............................................. 4
   1.1 Basic parameter table ............................................................................................... 4
   1.2 Electrical parameter table ....................................................................................... 5
   1.3 The minimum size of target VS distance ................................................................. 5
   1.4 Module working life ................................................................................................. 5
   1.5 Ranging Method ....................................................................................................... 6
   1.6 Filter processing method ......................................................................................... 6
   1.7 Schematic diagram of transmit and receive light ..................................................... 6

2 Interface and function description .................................................................................. 7

3 Typical application circuit ............................................................................................... 8
   3.1 UART communication method ................................................................................ 8
   3.2 IIC communication method ................................................................................... 8

4 Protocol of communication ............................................................................................ 9
   4.1 UART Serial Port parameters ................................................................................ 9
   4.2 IIC Serial port parameters .................................................................................... 9
   4.3 UART Communication protocol ............................................................................. 9
   4.4 UART Communication protocol ............................................................................. 9
   4.5 CRC calculation ...................................................................................................... 11
   4.6 Command ................................................................................................................ 11
   4.7 Communication sequence ...................................................................................... 13
   4.8 Noise removal and filtering processing ................................................................. 14

5 Mechanical dimensions ................................................................................................. 16

6 IMPORTANT NOTICE .................................................................................................. 16

7 Revision history .............................................................................................................. 17
General description

LIDAR07 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.

LIDAR07 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.

LIDAR07 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.

LIDAR07 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 ($T=25^\circ\text{C}, \ VCC=+5V, \ 90\% \ \text{reflectivity, \ indoor}$)

1.1 Basic parameter table

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>part name</td>
<td>LIDAR07-100W-B</td>
</tr>
<tr>
<td>Detection range</td>
<td>0.2~12m(indoor/90% reflectivity) ※1</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>4.8~5.2V</td>
</tr>
<tr>
<td>operation mode</td>
<td>continuous mode ※2</td>
</tr>
<tr>
<td></td>
<td>single mode</td>
</tr>
<tr>
<td>FOV of receiver</td>
<td>Half angle: 1°</td>
</tr>
<tr>
<td>FOV of transmitter</td>
<td>Half angle: 2° ※3</td>
</tr>
<tr>
<td>Ambient light</td>
<td>15 Klux max ※5</td>
</tr>
<tr>
<td>Integration time</td>
<td>5us ~ 5000us</td>
</tr>
<tr>
<td>Signal amplitude</td>
<td>3400LSB ~ 7000LSB</td>
</tr>
<tr>
<td>range accuracy</td>
<td>20~350cm ±5cm</td>
</tr>
<tr>
<td></td>
<td>350~1200cm ±1.5% ※6</td>
</tr>
<tr>
<td>Distance noise(1σ)</td>
<td>2.5mm</td>
</tr>
<tr>
<td>IR centroid wavelength</td>
<td>850nm</td>
</tr>
<tr>
<td>Module dimensions</td>
<td>42mm×15mm×17mm</td>
</tr>
<tr>
<td>Operation temperature</td>
<td>-10°C~60°C (Non-condensing)</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-20°C~70°C</td>
</tr>
<tr>
<td>Communication interface</td>
<td>UART、IIC</td>
</tr>
<tr>
<td>Distance resolution</td>
<td>1mm</td>
</tr>
<tr>
<td>Frame rate</td>
<td>Max 5000(Hz) ※4 ※7</td>
</tr>
</tbody>
</table>
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. When the 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**

<table>
<thead>
<tr>
<th>Item</th>
<th>symbol</th>
<th>Type</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input voltage</td>
<td>DC</td>
<td></td>
<td>5</td>
<td>V</td>
</tr>
<tr>
<td>Average current</td>
<td>I</td>
<td></td>
<td>80</td>
<td>mA</td>
</tr>
<tr>
<td>Average power</td>
<td>P</td>
<td></td>
<td>400</td>
<td>mW</td>
</tr>
<tr>
<td>Peak current</td>
<td>I&lt;sub&gt;max&lt;/sub&gt;</td>
<td></td>
<td>250</td>
<td>mA</td>
</tr>
<tr>
<td>UART voltage level</td>
<td>V&lt;sub&gt;TTL&lt;/sub&gt;</td>
<td></td>
<td>3.3</td>
<td>V</td>
</tr>
<tr>
<td>IIC voltage level</td>
<td>V&lt;sub&gt;TTL&lt;/sub&gt;</td>
<td></td>
<td>3.3</td>
<td>V</td>
</tr>
</tbody>
</table>

**1.3 The minimum size of target VS distance**

<table>
<thead>
<tr>
<th>Distance/unit: m</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target size/unit: mm</td>
<td>70</td>
<td>140</td>
<td>210</td>
<td>279</td>
<td>349</td>
</tr>
</tbody>
</table>

**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.
Blue spot is transfer. Red spot is receiver. The spot diameter of transfer is about 0.9m at 12 meter.

2 Interface and function description

<table>
<thead>
<tr>
<th>Pin NO</th>
<th>Symbol</th>
<th>Function description</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>VDD</td>
<td>Main power supply (5V)</td>
</tr>
<tr>
<td>7</td>
<td>GND</td>
<td>Main power ground</td>
</tr>
<tr>
<td>6</td>
<td>RX</td>
<td>UART receive line</td>
</tr>
<tr>
<td>5</td>
<td>TX</td>
<td>UART send line (DATA_READY for IIC)</td>
</tr>
<tr>
<td>4</td>
<td>VCC_LED</td>
<td>Power supply for LED (5V)</td>
</tr>
<tr>
<td>3</td>
<td>GND_LED</td>
<td>Ground for LED</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>parameter</th>
<th>Value</th>
<th>unit</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>band rate</td>
<td>115200</td>
<td>Bit/s</td>
<td></td>
</tr>
<tr>
<td>Start bit</td>
<td>1</td>
<td>Bit</td>
<td>Low active</td>
</tr>
<tr>
<td>Stop bit</td>
<td>1</td>
<td>Bit</td>
<td></td>
</tr>
<tr>
<td>Data length</td>
<td>8</td>
<td>Bit</td>
<td>High active</td>
</tr>
<tr>
<td>parity</td>
<td>None</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.2 IIC Serial port parameters

<table>
<thead>
<tr>
<th>parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>mode</td>
<td>Slave</td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td>400K</td>
<td>Bps</td>
</tr>
<tr>
<td>address</td>
<td>0x70</td>
<td>7bit</td>
</tr>
</tbody>
</table>

4.3 UART Communication protocol

Command format from hoster

<table>
<thead>
<tr>
<th>Header</th>
<th>CMD</th>
<th>Data</th>
<th>CRC32</th>
</tr>
</thead>
<tbody>
<tr>
<td>0xF5</td>
<td>W/R</td>
<td>TYPE</td>
<td>LSB-........-MSB</td>
</tr>
<tr>
<td>1 byte</td>
<td>1 byte</td>
<td>4 byte</td>
<td>4 byte</td>
</tr>
</tbody>
</table>

Response format from module

<table>
<thead>
<tr>
<th>Header</th>
<th>CMD</th>
<th>Data length(N)</th>
<th>Data</th>
<th>CRC32</th>
</tr>
</thead>
<tbody>
<tr>
<td>0xFA</td>
<td>W/R</td>
<td>TYPE</td>
<td>LSB</td>
<td>LSB-........-MSB</td>
</tr>
<tr>
<td>1 byte</td>
<td>1 byte</td>
<td>2 byte</td>
<td>N byte</td>
<td>4 byte</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Address</th>
<th>Read/write</th>
<th>CMD</th>
<th>DATA</th>
<th>ACK</th>
<th>DATA</th>
<th>ACK</th>
<th>DATA</th>
<th>ACK</th>
<th>DATA</th>
<th>ACK</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x70</td>
<td>1</td>
<td></td>
<td></td>
<td>ACK</td>
<td></td>
<td></td>
<td></td>
<td>ACK</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CRC1 ACK CRC2 ... CRC3 ACK CRC4 ACK STOP

Read operation from 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

<table>
<thead>
<tr>
<th>Address</th>
<th>Read/write</th>
<th>CMD</th>
<th>DATA</th>
<th>ACK</th>
<th>DATA</th>
<th>ACK</th>
<th>DATA</th>
<th>ACK</th>
<th>DATA</th>
<th>ACK</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x70</td>
<td>1</td>
<td></td>
<td></td>
<td>ACK</td>
<td></td>
<td></td>
<td></td>
<td>ACK</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CRC1 ACK CRC2 ... CRC3 ACK CRC4 ACK STOP

Secondly read command

<table>
<thead>
<tr>
<th>Address</th>
<th>Read/write</th>
<th>CMD</th>
<th>DATA</th>
<th>ACK</th>
<th>DATA</th>
<th>ACK</th>
<th>DATA</th>
<th>ACK</th>
<th>DATA</th>
<th>ACK</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x70</td>
<td>0</td>
<td></td>
<td>0</td>
<td>ACK</td>
<td>1</td>
<td>ACK</td>
<td>n</td>
<td>ACK</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CRC1 ACK CRC2 ... CRC3 ACK CRC4 ACK STOP
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

<table>
<thead>
<tr>
<th>No</th>
<th>CMD name</th>
<th>CMD (HEX)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Read version</td>
<td>0x43</td>
<td>Within this command user can get the software version.</td>
</tr>
<tr>
<td>2</td>
<td>Filtering control</td>
<td>0x59</td>
<td>User can enable or disable filtering function for different application</td>
</tr>
<tr>
<td>3</td>
<td>measurement start/stop</td>
<td>0x60</td>
<td>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.</td>
</tr>
<tr>
<td>4</td>
<td>Ranging Mode control</td>
<td>0x61</td>
<td>User can choose continuous automatic measurement or single measurement mode.</td>
</tr>
<tr>
<td>5</td>
<td>Frame rate set</td>
<td>0x62</td>
<td>When module works in continuous automatic measurement mode, user can set different frame rate.</td>
</tr>
<tr>
<td>6</td>
<td>Read system error status</td>
<td>0x65</td>
<td>User can use this command to catch out the system running error code.</td>
</tr>
</tbody>
</table>

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)
0 0: 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
data:
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 0x8A 0x8A |
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

![IIC communication sequence diagram]

**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 calculate the measurement results without any 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 want 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

<table>
<thead>
<tr>
<th>Connector</th>
<th>Maker</th>
<th>PART NO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>XIN FU ER ELECTRONICS</td>
<td>1.01-BARB</td>
</tr>
</tbody>
</table>

Unit: mm

6 IMPORTANT NOTICE

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

<table>
<thead>
<tr>
<th>NO</th>
<th>Detail</th>
<th>Version</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LIDAR07-100W first edition</td>
<td>1.0</td>
<td>2020/08/03</td>
</tr>
</tbody>
</table>
| 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 |