

Eye-Safety Laser Ranging Module
User Manual

UBTLR3000

WWW.UNBTEK.COM

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Dear user,

Before starting to operate the ranging module, please read this manual carefully to ensure that you can use it correctly and obtain accurate measurement results, at the same time, ensure the safe use of the equipment and extend the service life of the equipment.





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Revision status:

Date	Version	Revisers	Revised content
2022.05.11	V1.0	Sbo	Prepare product manual;
2022.08.09	V1.1	Sbo	Correction of weight indicators; correction of product overview performance indicators.

1 Precautions for use

1.1 Safety mark

	【Danger】 Pay attention to laser radiation. The safety category of this product is class 1. Please do a good job in safety protection and do not look directly at the laser!
	【Warning】 Nonstandard operation will cause damage to the product and may cause personal injury!
	【Electrostatic protection】 Static electricity may cause irreversible damage to the internal devices of the product. Please do a good job in static electricity protection when using!
	【Environmental humidity】 When transporting, storing and using this product, pay attention to avoid humid environment. Working in humid environment prone to condensation and frost will affect the ranging performance and may cause damage to the module!

1.2 Precautions for use

1) During transportation and storage, please store the product in the delivered packaging. When using the product, please keep away from water and other liquids to avoid dust or other pollution. Please keep the optical glass surface (transmitting and receiving windows) clean. In case of dust or other deposits that are difficult to remove, please contact the after-sales department.

2) Do not disassemble the corresponding parts of the product. Any modification to the electronic, mechanical and optical components of the product will invalidate the warranty. Before using the product, please read the manual carefully. If it is used beyond the working conditions (working voltage / temperature range, impact vibration level, etc.), it will cause permanent damage to the product and invalidate the warranty. If there is any damage, please contact the after-sales department for further assistance.

3) Ranging objects with low surface reflectivity in strong light environment may reduce the ranging performance. Ranging through glass, optical filter, plexiglass or other translucent materials may lead to large ranging error. Rapid temperature change conditions and weather conditions such as rain, snow, fog, haze and dust will affect the performance.

4) Avoid ranging targets within 5m, especially close-range strong reflection targets (glass, smooth metal surface, etc.), avoid multiple ranging modules working towards each other in close range, and avoid high-energy laser light source shooting directly at the receiving antenna of the ranging module, and keep the receiving lens blocked during product assembly and commissioning, otherwise permanent damage may occur to the detection components.

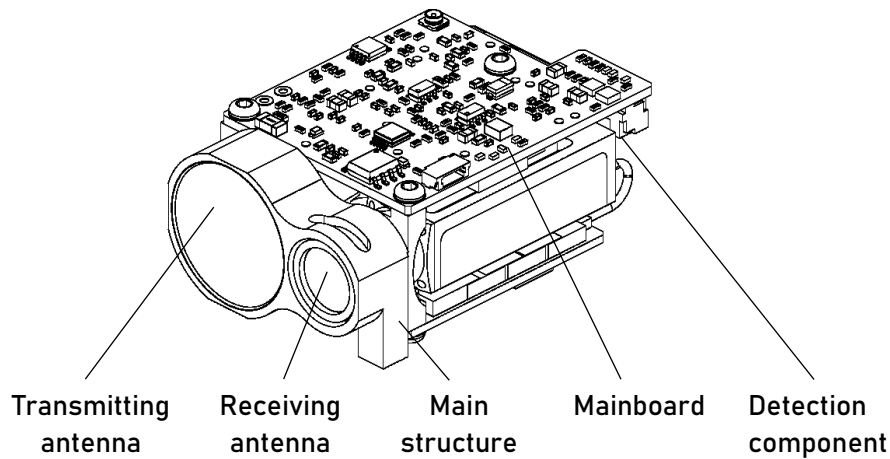
2 Product Overview

UBTLR3000 eye safety laser ranging module is developed based on 1 535nm erbium glass laser. It is a class I product for human eye safety. The product is single pulse ranging, with the maximum range $\geq 3\ 800\text{m}$, with UART (ttl_3.3v)

electrical interface, and provides upper computer test software, instruction set and communication protocol to facilitate the secondary development of users. The product has the characteristics of small volume, light weight, stable performance, high impact resistance, national production and so on.

3 Product composition

UBTLR3000 Eye-Safe Ranging Module is mainly composed of laser, transmitting antenna, receiving antenna, detection component, hardware circuit board, main structure, etc. The hardware circuit board is composed of main control board, power board and operational amplifier board.



4 Technical data

No	Project	Technical data
1	Eye safety	Class1/1M
2	Wavelength	1535±5 nm
3	Divergence	~0.6 mrad
4	Optical aperature	Φ16.5 mm
5	Receive FOV	~4.9 mrad/ 0.3°
6	Max range	≥3 800 m; NATO targets ≥3 000 m; Human targets ≥2 000 m; UAV targets ≥1 000 m; ¹⁾
7	Mix range	15 m
8	Accuracy	±1 m
9	Frequency	1~10 Hz
10	Range resolution	≤20 m
11	Angular resolution	≤1 mil
12	Detection probability	≥98 %
13	False alarm rate	≤1 %
14	Multi-target detection	Up to 3 targets
15	Data interface	UART (TTL_3.3 V)
16	Supply	DC 4.5~16 V
17	Standby power	≤1 mW

18	Peak power consumption	≤7 W @12 V
19	Weight	≤32±1 g
20	Dimension (L×W×H)	48×30.5×21 mm
21	Operation temperature	-40 ~ +70 °C
22	Storage temperature	-55 ~ +75 °C
23	Mechanical Shock	1 200 g, 1 ms
24	Vibration	5 ~ 50 ~ 5 Hz, 1 Octave range /min, 2.5 g
25	Temperature shock	+70 °C、-50 °C
26	Reliability	MTBF ≥ 1 500 h
27	Function	Ranging of first and last targets and multiple targets; Distance gating; External power control; Cumulative times of laser;
28	Response time	≤950 ms;

Notes:

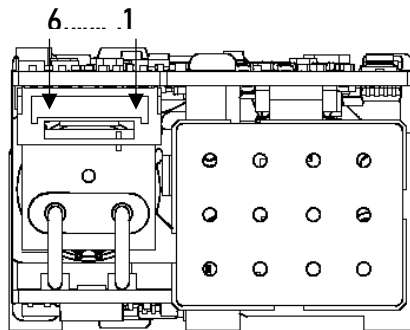
¹⁾ NATO targets size 2.3 m × 2.3 m; Human targets size 0.5 m × 1.7 m; UAV targets size 0.2 m × 0.3 m ; Reflectivity 30 %, Conspicuity ≥8 km;

5 User interface

5.1 Electrical interface

User Electrical interface: UART (TTL_3.3V)

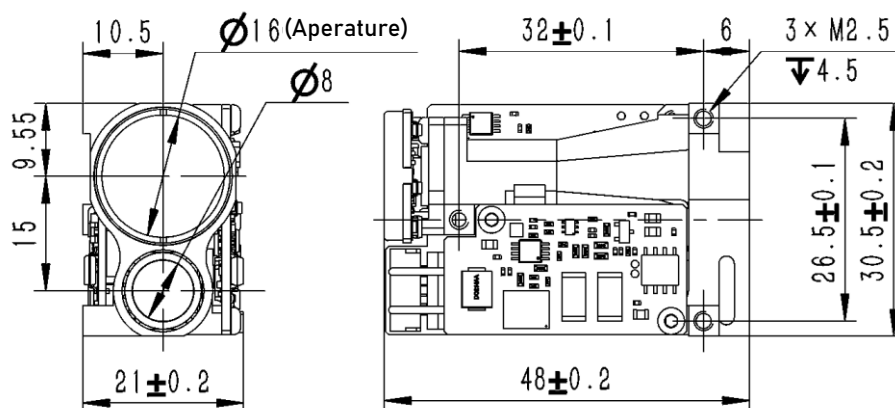
The connector model of electrical interface is A1257WR-S-6P, and the specific wiring definition is shown in the table below.



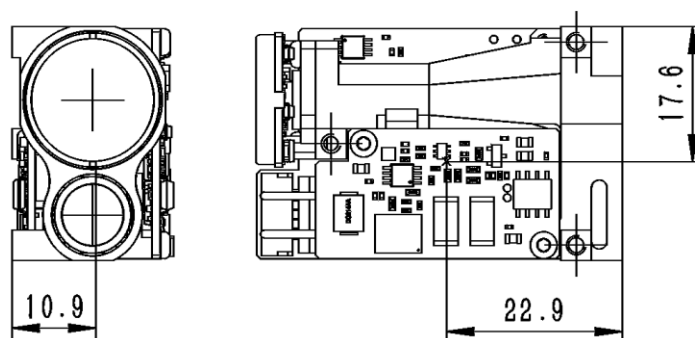
Pin	Definition	Description
1	Positive power supply	Power supply, 4.5 ~ 16V
2	Negative power supply	Power supply, ground
3	POWER_ON	Module power switch, TTL_ 3.3V level; Module on (> 2.7V), module off (< 0.3V);
4	UART_TX	Serial port sender, TTL_ 3.3V level
5	UART_RX	Serial port receiver, TTL_ 3.3V level
6	GND	Serial ground

5.2 Overall dimension

The overall dimension and user installation interface of the ranging module are shown in the figure below.



The centroid position of the ranging module is shown in the figure below.



6 Communication protocol

6.1 Protocol description

6.1.1 Communication rate and format

Format standard	Baud rate: 115200bps (ex factory) / 57600bps / 9600bps Byte data format: 1 start bit, 8 data bits, 1 stop bit, no verification
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6.1.2 Basic packet format

Section description	Section length(number of bytes)	Value range	Remarks
Frame header	2	0xEE 0x16	Fixed value
Data length	1	2~9	The data length is the total number of bytes in the three parts: device code, command code and command parameters
Equipment code	1	0x03	Fixed value, LRF S Series ranging module
Command	1	0~255	Indicates the control object of the current

code			control command
Command parameters	0~4	0~255	Indicates the control object parameters of the current control command
Checksum	1	0~255	Checksum is the sum of all byte data in the three parts of equipment code, command code and command parameters, with the lower 8 bits

6.1.3 control command (system → ranging module)

Command code	explain	Command parameter bytes
0x01	Equipment self inspection	0
0x02	Single ranging	0
0x03	Set first / last / multiple targets	1
0x04	Continuous ranging	0
0x05	Stop ranging	0
0xA0	Set baud rate of laser ranging module	4
0xA1	Set continuous ranging frequency	2
0xA2	Set minimum gating distance	2
0xA3	Query minimum gating distance	0
0xA4	Maximum gating distance	2
0xA5	Query the maximum gating distance	0
0xA6	Query FPGA software version number	0
0xA7	Query MCU software version number	0
0xA8	Query hardware version number	0
0xA9	Query Sn number	0
0x90	Total times of light output	0
0x91	Query the power on and light out times this time	0

6.1.4 Response data (ranging module → system)

Command code	explain	Command parameter bytes
0x01	Equipment self inspection	4
0x02	Single ranging	7
0x03	Set first / last / multiple targets	0
0x04	Continuous ranging	4
0x05	Stop ranging	0
0x06	Ranging abnormality (only when the state in the ranging abnormality command is abnormal, the command is returned after the response command of single ranging or continuous ranging is returned)	4
0xA0	Set baud rate of laser ranging module	4
0xA1	Set continuous ranging frequency	2

0xA2	Set minimum gating distance	2
0xA3	Query minimum gating distance	2
0xA4	Maximum gating distance	2
0xA5	Query the maximum gating distance	2
0xA6	Query FPGA software version number	4
0xA7	Query MCU software version number	4
0xA8	Query hardware version number	4
0xA9	Query Sn number	3
0x90	Total times of light output	3
0x91	Query the power on and light out times this time	3

6.1.5 Operation process

After the ranging module is powered on, it is in the standby mode by default. It needs to enable the module power switch (power_on is pulled up) for about 0.5 s (the driving capacitor completes charging), and then all the command operations in 6.2 below can be carried out.

6.2 Specific agreement

6.2.1 Equipment self inspection

1) Send to laser ranging module:

Byte	0	1	2	3	4	5
Describe	0xEE	0x16	0x02	0x03	0x01	0x04

2) Laser ranging module return:

Byte	0	1	2	3	4	5	6	7	8	9
Describe	0xEE	0x16	0x06	0x03	0x01	Status 3	Status 2	Status 1	Status 0	Check _sum

Status3: reserved

Status2: echo intensity 0x00~0xFF

Status1: bit0 -- FPGA system status; 1 Normal 0 Exception

bit1 -- laser light output state; 1 light output 0 no light

bit2 -- main wave detection status; 1 main wave 0 no main wave

bit3 -- echo detection status; 1 echo 0 no echo

bit4 -- bias switch status; 1 bias on 0 bias off

bit5 -- bias output state; 1 the bias voltage is normal 0 bias abnormal

bit6 -- temperature state; 1 the temperature is normal 0 temperature abnormal

bit7 -- light output off state; 1 valid 0 invalid

Status0: bit0 -- 5v6 power status; 1 normal 0 exception

6.2.2 Single ranging

1) Send to laser ranging module:

Byte	0	1	2	3	4	5
Describe	0xEE	0x16	0x02	0x03	0x02	0x05

2) Laser ranging module return:

Byte	0	1	2	3	4	5	6	7	8	9
Describe	0xEE	0x16	0x06	0x03	0x02	Status	Ranging value integer high 8 bits	Ranging value integer lower 8 bits	Ranging value decimal places	Check_sum

When ranging the first / last target:

Status: 0x00 indicates that the ranging result is a single target;
0x01 indicates that there is a front target in the ranging result;
0x02 indicates that there is a rear target in the ranging result;
0x03 reserved;
0x04 indicates that the ranging result is out of range;
0x05 reserved;

In case of multi-target ranging:

Status_bit3~0:

0x0 indicates that the ranging result is a single target;
0x1 indicates that there is a front target in the ranging result;
0x2 indicates that there is a rear target in the ranging result;
0x3 indicates that the ranging result has front target and rear target;
0x4 indicates that the ranging result is out of range;
0x5 reserved;

Status_bit7~4:

0x0 ~ 0xf indicates the current distance result number; Value range [0, N-1],
number of targets $1 \leq N \leq 16$;
Range value = range value integer high 8 bits \times 256 + range value integer low 8 bits +
range value decimal bits \times 0.1, unit m

6.2.3 Set first / last / multiple targets

1) Send to laser ranging module:

Byte	0	1	2	3	4	5	6
Describe	0xEE	0x16	0x03(data length)	0x03	0x03	Target	Check_sum
Target: 0x01 Set the first target ranging; 0x02 set terminal target ranging; 0x03 set multi-target ranging;							

2) Laser ranging module return:

Byte	0	1	2	3	4	5
Describe	0xEE	0x16	0x02	0x03	0x03	0x06

6.2.4 Continuous ranging

1) Send to laser ranging module:

Byte	0	1	2	3	4	5
Describe	0xEE	0x16	0x02	0x03	0x04	0x07

2) Laser ranging module return:

Byte	0	1	2	3	4	5	6	7	8	9
Desc	0x	0x16	0x06	0x03	0x04	Stat	Rangi	Rangi	Ranging	Check

rib	EE					us	ng value integ er high 8 bits	ng value integ er lower 8 bits	value decimal places	_sum
-----	----	--	--	--	--	----	--	---	----------------------------	------

When ranging the first and last targets:
 Status: 0x00 indicates that the ranging result is a single target;
 0x01 indicates that there is a front target in the ranging result;
 0x02 indicates that there is a rear target in the ranging result;
 0x03 reserved;
 0x04 indicates that the ranging result is out of range;
 0x05 reserved;
 In case of multi-target ranging:
 Status_ bit3~0:
 0x0 indicates that the ranging result is a single target;
 0x1 indicates that there is a front target in the ranging result;
 0x2 indicates that there is a rear target in the ranging result;
 0x3 indicates that the ranging result has front target and rear target;
 0x4 indicates that the ranging result is out of range;
 0x5 reserved;
 Status_ bit7~4:
 0x0 ~ 0xf indicates the current distance result number; Value range [0, N-1], number of targets $1 \leq N \leq 16$;

6.2.5 Stop ranging

1) Send to laser ranging module:

Byte	0	1	2	3	4	5
Describe	0xEE	0x16	0x02	0x03	0x05	0x08

2) Laser ranging module return:

Byte	0	1	2	3	4	5
Describe	0xEE	0x16	0x02	0x03	0x05	0x08

6.2.6 Ranging anomaly

Laser ranging module return:

Byte	0	1	2	3	4	5	6	7	8	9
Describe	0xEE	0x16	0x06	0x03	0x06	rese rve	rese rve	rese rve	Status1	Check_s um
Status1: bit0 -- FPGA system status; 1 normal 0 exception Bit1 -- laser light output state; 1 light output 0 no light Bit2 -- main wave detection status; 1 main wave 0 no main wave Bit3 -- echo detection status; 1 echo 0 no echo Bit4 -- bias switch status; 1 bias on 0 bias off Bit5 -- bias output state; 1 The bias voltage is normal 0 bias abnormal Bit6 -- temperature state; 1 The temperature is normal 0 abnormal temperature Bit7 -- light output off state; 1 valid 0 is invalid This instruction is returned only when bit0~7 in status1 is abnormal.										

6.2.7 Set baud rate of laser ranging module

1) Send to laser ranging module:

Byte	0	1	2	3	4	5	6	7	8	9
Describe	0xEE	0x16	0x06	0x03	0xA0	Baud High 24	Baud High 16	Baud Low 8	Baud Low 0	Check_sum

2) Laser ranging module return:

Byte	0	1	2	3	4	5	6	7	8	9
Describe	0xEE	0x16	0x06	0x03	0xA0	Baud High 24	Baud High 16	Baud Low 8	Baud Low 0	Check_sum

6.2.8 Set continuous ranging frequency

1) Send to laser ranging module:

Byte	0	1	2	3	4	5	6	7
Describe	0xEE	0x16	0x04(data length)	0x03	0xA1	Freq	Num	Check_sum
Freq: 0x01~0x0A Single / continuous ranging frequency Num: 0x00 reserve								

2) Laser ranging module return:

Byte	0	1	2	3	4	5
Describe	0xEE	0x16	0x02	0x03	0xA1	0xA4

6.2.9 Set minimum gating distance

1) Send to laser ranging module:

Byte	0	1	2	3	4	5	6	7
Describe	0xEE	0x16	0x04(data length)	0x03	0xA2	DIS_H	DIS_L	Check_sum
DIS_H: Distance high 8 bits DIS_L: Distance lower 8 bits DIS: 10~20000 Minimum gating distance range, in M								

2) Laser ranging module return:

Byte	0	1	2	3	4	5	6	7
Describe	0xEE	0x16	0x04(data length)	0x03	0xA2	DIS_H	DIS_L	Check_sum
DIS_H: Distance high 8 bits DIS_L: Distance lower 8 bits DIS: 10~20000 Minimum gating distance range, in M								

6.2.10 Query minimum gating distance

1) Send to laser ranging module:

Byte	0	1	2	3	4	5
Describe	0xEE	0x16	0x02	0x03	0xA3	0xA6

2) Laser ranging module return:

Byte	0	1	2	3	4	5	6	7
Describe	0xEE	0x16	0x04(data length)	0x03	0xA3	DIS_H	DIS_L	Check_sum

DIS_H:	Distance high 8 bits
DIS_L:	Distance lower 8 bits
DIS:	10~20000 Minimum gating distance range, in M

6.2.11 Set maximum gating distance

1) Send to laser ranging module:

Byte	0	1	2	3	4	5	6	7
describe	0xEE	0x16	0x04(data length)	0x03	0xA4	DIS_H	DIS_L	Check_sum
DIS_H:	Distance high 8 bits							
DIS_L:	Distance lower 8 bits							
DIS:	10~20000 Minimum gating distance range, in M							

2) Laser ranging module return:

Byte	0	1	2	3	4	5	6	7
describe	0xEE	0x16	0x04(data length)	0x03	0xA4	DIS_H	DIS_L	Check_sum
DIS_H:	Distance high 8 bits							
DIS_L:	Distance lower 8 bits							
DIS:	10~20000 Minimum gating distance range, in M							

6.2.12 Query maximum gating distance

1) Send to laser ranging module:

Byte	0	1	2	3	4	5
describe	0xEE	0x16	0x02	0x03	0xA5	0xA8

2) Laser ranging module return:

Byte	0	1	2	3	4	5	6	7
describe	0xEE	0x16	0x04(data length)	0x03	0xA5	DIS_H	DIS_L	Check_sum
DIS_H:	Distance high 8 bits							
DIS_L:	Distance lower 8 bits							
DIS:	10~20000 Minimum gating distance range, in M							

6.2.13 Query FPGA software version number

1) Send to laser ranging module:

Byte	0	1	2	3	4	5
describe	0xEE	0x16	0x02	0x03	0xA6	0xA9

2) Laser ranging module return:

Byte	0	1	2	3	4	5	6	7	8	9
describe	0xEE	0x16	0x06	0x03	0xA6	Version	Date	MonYear	Author	Check_sum
Version:	bit7~bit4 Major version number (1~15)									
	bit3~bit0 Minor version number (0~15)									
eg:	0x10——V1.0									
Data:	Date (1~31)									
MonYear:	bit7~bit4 month (1~12)									
	bit3~bit0 particular year (0~15) , Corresponding to 2020-2035									
Author:	0x6c cliu;									
	0x5d dwu									
	0xcc cycheng									

6.2.14 Query MCU software version number

1) Send to laser ranging module:

Byte	0	1	2	3	4	5
describe	0xEE	0x16	0x02	0x03	0xA7	0xAA

2) Laser ranging module return:

Byte	0	1	2	3	4	5	6	7	8	9
describe	0xEE	0x16	0x06	0x03	0xA7	Version	Date	MonYear	Author	Check_sum

Version: bit7~bit4 Major version number (1~15)
bit3~bit0 Minor version number (0~15)
eg: 0x10——V1.0
Data: Date (1~31)
MonYear: bit7~bit4 month (1~12)
bit3~bit0 particular year (0~15A) ,Corresponding to 2020-2035
Author: 0x00 jyang
0xf1 llfu
0x01 zqxiong

6.2.15 Query hardware version number

1) Send to laser ranging module:

Byte	0	1	2	3	4	5
describe	0xEE	0x16	0x02	0x03	0xA8	0xAB

2) Laser ranging module return:

Byte	0	1	2	3	4	5	6	7	8	9
describe	0xEE	0x16	0x06	0x03	0xA8	MBVS	CTVS	APDVS	LDVS	Check_sum

MBVS: Motherboard hardware version number
CTVS: Control board hardware version number
Apdvs: detection board hardware version number
LDVS: Driver board hardware version number
Bit7 ~ bit4 major version number (1 ~ 15)
bit3 ~ bit0 minor version number (0 ~ 15)
eg: 0x10——V1.0

6.2.16 Query Sn number

1) Send to laser ranging module:

Byte	0	1	2	3	4	5
describe	0xEE	0x16	0x02	0x03	0xA9	0xAC

2) Laser ranging module return:

Byte	0	1	2	3	4	5	6	7	8
describe	0xEE	0x16	0x05	0x03	0xA9	MonYear	Num_H	Num_L	Check_sum

Monyear: bit7 ~ bit4 months (1 ~ 12)
Bit3 ~ bit0 years (0 ~ 15), corresponding to 2020 ~ 2035
Num_H: The number is 8 digits high
Num_L: Lower 8 digits of No
Num: 1 ~ 999 No

6.2.17 Total times of light output

1) Send to laser ranging module:

Byte	0	1	2	3	4	5
describe	0xEE	0x16	0x02	0x03	0x90	0x93

2) Laser ranging module return:

Byte	0	1	2	3	4	5	6	7	8
describe	0xEE	0x16	0x05	0x03	0x90	PNUM3	PNUM2	PNUM1	Check_sum

PNUM3: total light output times, bit23 ~ bit16

PNUM2: total light output times, bit15 ~ bit8

PNUM1: total light output times, bit7 ~ bit0

6.2.18 Query the power on and light out times this time

1) Send to laser ranging module:

Byte	0	1	2	3	4	5
describe	0xEE	0x16	0x02	0x03	0x91	0x94

2) Laser ranging module return:

Byte	0	1	2	3	4	5	6	7	8
describe	0xEE	0x16	0x05	0x03	0x91	PNUM3	PNUM2	PNUM1	Check_sum

PNUM3: total light output times, bit23 ~ bit16

PNUM2: total light output times, bit15 ~ bit8

PNUM1: total light output times, bit7 ~ bit0

6.3 Instruction example

6.3.1 Equipment self inspection

SEND: ee 16 02 03 01 04

RECV: ee 16 06 03 01 ff 00 f7 ff f9

6.3.2 Single ranging

SEND: ee 16 02 03 02 05

RECV: ee 16 06 03 02 04 00 00 00 09

6.3.3 Continuous ranging

SEND: ee 16 02 03 04 07

RECV: ee 16 06 03 04 04 00 00 00 0b

RECV: ee 16 06 03 04 04 00 00 00 0b

RECV:

6.3.4 Stop ranging

SEND: ee 16 02 03 05 08

RECV: ee 16 02 03 05 08

6.3.5 Set first target

SEND: ee 16 03 03 03 01 07

RECV: ee 16 02 03 03 06

6.3.6 Set end goal

SEND: ee 16 03 03 03 02 08

RECV: ee 16 02 03 03 06

6.3.7 Set multiple targets

SEND: ee 16 03 03 03 03 09

RECV: ee 16 02 03 03 06

6.3.8 Set continuous ranging frequency 1Hz

SEND: ee 16 04 03 a1 01 00 a5

RECV: ee 16 02 03 a1 a4

6.3.9 Set continuous ranging frequency 5Hz

SEND: ee 16 04 03 a1 05 00 a9

RECV: ee 16 02 03 a1 a4

7 Inventory

SN	NAME	Qty.
1	UBTLR3000 Laser ranging module	1
2	Serial port cable	1
4	Product manual (electronic version)	1
5	Product test report	1
6	Factory inspection certificate	1