Product Manual of TF02-i

Specified Product

Product model: TF02-i

Product name: TF02-i LiDAR (Medium range sensor)

Manufacturer

Company name: Benewake (Beijing) Co., Ltd.

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Foreword

Dear users:

Thanks for choosing Benewake products, and it's our pleasure to help you to solve any technical question.

For the purpose of offering a better operation experience to you, we hereby write this manual for an easier and simpler operation of our product, hoping to better solve the common problems you maybe meet.

This operation manual covers the product operation introduction and common problem solutions, but it is really hard to cover all the problems you maybe meet. So, if you have any further questions or problems, please feel free to consult our technical support service (support@benewake.com). We will do our best to solve any problem related to the product. If you have any other good advice or suggestions, welcome to visit our official website and offer us your feedback there (http://en.benewake.com/support), and we are looking forwards to your participation.

We are Benewake who dedicated to making the best "Robotic Eyes" worldwide!

Catalog

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1   Attentions

1.1   About this Document

- This Manual provides information necessary for the use of this product.

- Please read this Manual carefully before using this product and make sure that you have fully understood its contents.

1.2   Installation and maintenance

- This product can only be maintained by qualified professionals and only the original spare parts can be used to ensure its performance and safety.

- The working temperature of the product is -20°C~60°C; please do not use it beyond this temperature range, so as to avoid risks.

- The storage temperature of the product is -30°C~80°C; please do not store it beyond this temperature range, so as to avoid risks.

- Do not open its enclosure for assembly or maintenance beyond this Manual; otherwise, it will affect the product performance.

- Do not twist the cable forcefully, so as to avoid damage to product.

- The product can't be aimed directly to the sun or another TF02-i, so as to avoid damage the detector by strong light. If there is such an application, please contact our technician.

1.3   Conditions with Potential Product Failure

- When the product transmitter and receiver lens are covered by dirt, there will be a risk of failures. Please keep the lens clean.

- The product will have a risk of failure when immersed completely in water. Do not use it underwater.

- When detecting objects with high reflectivity, such as mirrors and smooth tiles, the product may have a high risk of failures.

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2   Physical Interface

2.1   Wiring

Terminal model: MH1.25-7P-W/B, size of single wire is AWG26, diameter of single wire is 0.404mm, cross-sectional area is 0.129mm^2.
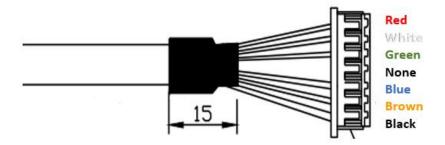

Figure 1 New Line Sequence of TF02-i

Table 1 Pin functions and connection instructions of TF02-i

No.	Color	Pin	Function
1	Red	VCC	Power supply
2	White/Yellow	RS485-B/ CAN_L	RS485-B/CAN bus
3	Green	RS485-A/ CAN_H	RS485-A/CAN bus
4	N/A	N/A	N/A
5	Blue/Orange	UART_RX	UART receive(debug)
6	Brown	UART_TX	UART transport(debug)
7	Black	GND	Ground

Note: The hardware of RS485 and CAN is different; Do not mix UART cable with RS485 or CAN bus, otherwise it will cause damage of MCU.

2.2   Electrical Characteristics

TF02-i has overvoltage and polarity protection.

Table 2 Main electrical parameters

Parameter	Typical value
Supply voltage	7V~30V
Peak current	100mA
Average current	≤70mA@12V
Average power consumption	≤0.85W@12V
Overvoltage protection	30V
Polarity protection	40V

3 Hardware and communication protocol

There are two communication interfaces available. The hardware of RS485 and CAN is different. The interface can not be switched by command.

3.1 Protocol of RS485

Modbus is the default setting. The parameters is shown as below. The default value of baudrate and slave ID is 115200 and 0x01.

Table 3 Communication protocol of TF02-i-485

Item	Parameter
Communication interface	RS485
Baud rate	115200
Data bit	8
Stop bit	1
Parity	None

3.1.1 Parameter configuration and description of Modbus

Baudrate of TF02-i supports 9600、14400、19200、38400、43000、57600、76800、115200、128000、230400、256000. Based on reliability considerations, it is not recommended to use a baud rate above 115200 for communication

When Modbus protocol is enabled, the Modbus reading distance command format:

Address field	Function code	Register address		Number of registers		CRC_low	CRC_high
01 (default)	03	00	00	00	01	xx	xx

The data frame returned by TF02-i is as follows:

Address field	Function code	Data length	Dist_high	Dist_low	CRC_low	CRC_high
01 (default)	03	02	xx	xx	xx	xx

Parameter configuration:

Category	Function	Instruction	Response	Description
UART instructions	Enable Modbus	5A 05 15 01 75	5A 05 15 01 75	Save settings and restart to take effect.
	Save settings	5A 04 11 6F	5A 05 11 00 70	
Modbus instructions	Read distance	01 03 00 00 00 01 84 0A	01 03 02 DH DL CL CH	DH and DL are 8 high-order and low-order bits of Distance;

			CH and CL are 8 high-order and low-order bits of CRC.
Read distance and signal strength	01 03 00 00 00 02 C4 0B	01 03 04 DH DL SH SL CL CH	DH and DL are 8 high-order and low-order bits of Distance; SH and SL are 8 high-order and low-order bits of signal Strength.
Read software version	01 03 00 06 00 02 24 0A	01 03 04 00 VM VS VC CL CH	VM,VS,VC are the major, minor and revised version number.
Set Baud rate	01 06 00 83 BH1 BH2 CL CH 01 06 00 84 BL1 BL2 CL CH	01 06 00 83 BH1 BH2 CL CH 01 06 00 84 BL1 BL2 CL CH	BH1,BH2,BL1,BL2 are high, secondary high, secondary low and low bytes of baud rate. For example, set baud rate to 9600，BH1=00 BH2=00 CL=78 CH=22, BL1=25 BL2=80 CL=D2 CH=D3
Set Slave ID	01 06 00 85 IH IL CL CH	01 06 00 84 IH IL CL CH	IH,IL are high and low bytes of ID. Set ID to 2，IH=00 IL=02 CL=19 CH=E2
Set output rate	01 06 00 86 FH FL CL CH	01 06 00 86 FH FL CL CH	FH,FL are high and low bytes of frame rate. Set frame rate to 100，FH=00 FL=64 CL=69 CH=C8
Set low-power consumption mode	01 06 00 88 LH LL CL CH	01 06 00 88 LH LL CL CH	H,LL are high and low bytes of low power sampling rate. Set it to 5HZ low-power consumption mode, LH=00 LL=05 CL=C9 CH=E3
Save settings	01 06 00 80 00 00 88 22	01 06 00 80 00 00 88 22	Save settings and restart to take effect
Restore factory setting	01 06 00 89 00 00 58 20	01 06 00 89 00 00 58 20	
Disable Modbus	01 06 00 82 00 01 E8 22	01 06 00 82 00 01 E8 22	Save settings and restart to take effect

Note: Only RTU mode is supported for communication in UART link.

Function code of TF02-i Modbus

Function code	Description
03	Read register
06	Write register

Register address description

①All register addresses are hexadecimal and register values are 16bit;

②After setting parameter, save and restart to take effect;

Register address list using function code: 0x03(read only)

Register address	Definition	Description
00 00	Dist	Distance, unit: cm
00 01	Strength	Signal strength
00 03	High16bit of timestamp	2 high-order bits of timestamp represent relative time of radar start up, unit: ms
00 04	Low16bit of timestamp	2 low-order bits of timestamp represent relative time of radar start up, unit: ms
00 06	High16bit of software version	00 + major version number
00 07	Low16bit of software version	Minor version number + revised version number

Register address list using function code: 0x06(write only)

Register address	Definition	Description
00 80	Save settings	Write any value to save settings
00 81	Power off/Restart	Register value： 0-Power off（unavailable currently） 1-Restart；
00 82	Disable Modbus	Register value： 1-Disable Modbus Others-Error reply
00 83	Baud rate High	Set baud rate. Restart to take effect
00 84	Baud rate Low	Set baud rate. Restart to take effect
00 85	Slave ID	Set TF02-i's ID. Restart to take effect(default 0x01)
00 86	fps	Set fps. Restart to take effect(default 100hz)
00 87	Working mode	Set working mode. Restart to take effect after saving Register value: 0- Continuously detection mode(default) 1-Triggering mode Others-Error reply
00 88	Low-power consumption mode	Set low-power consumption mode，Restart to take effect after saving Register value: 0-Disable(default) >0 and≤10-Enable(the value is inside sampling frequent)
00 89	Restore default	Write any value. Restart to take effect after saving

Examples:

1) Enable Modbus protocol：

5A 05 15 01 75   // Enable Modbus

5A 04 11 6F   // Save settings

Entry Modbus model and entry Modbus instructions after restarting

2) Disable Modbus protocol：

01 06 00 82 00 01 E8 22   // Default address 01, disable Modbus

01 06 00 80 00 00 88 22   // Default address 01, save setting

Restart and exit Modbus.

3.2 Protocol of CAN

The data protocol of CAN is shown in
Table 4. Each data frame consists of 8 bytes and the data contains the distance(unit: cm), signal strength and timestamp(unit: ms) information.

Table 4 Data protocol of TF02-i-CAN

Data byte	Definition	Description
Byte0	DIST_L	DIST low 8-bits
Byte1	DIST_H	DIST high 8-bits
Byte2	Strength_L	Signal strength low 8-bits
Byte3	Strength_H	Signal strength high 8-bits
Byte4	Timestamp	Low8bit of timestamp
Byte5	Timestamp	Secondary-low8bit of timestamp
Byte6	Timestamp	Secondary-high8bit of timestamp
Byte7	Timestamp	High8bit of timestamp

3.2.1 Parameter configuration and description of CAN

The default baudrate is 250kbps, the default type is standard frame, default receive and send id is 0x00000003.

The format of instruction is shown as below:

Byte	0	1	2	3	4	5-8	9-12	13
Description	0x5A	0x0E	0x51	Type	Baudrate	Recv_id	Send_id	Check_sum
Default				0	8	0x00000003	0x00000003	

Type: 0(Standard Frame), 1(Extended Frame);

Recv_id: LiDAR receive ID, Little Endian; Send_id: LiDAR send ID, Little Endian

The relation between Baudrate(unit: kbps) and Byte4 is shown as below:

Byte4	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Baudrate	1000	900	800	666	600	500	400	300	**250**	225	200	160	150	144	125	120	100

1) Examples of configuration

Example1: Standard frame, Baud rate 500kbps, receive ID=0x0010, send ID=0x0020

Command: 5A 0E 51 00 05 10 00 00 00 20 00 00 00 EE

Example2: Extended Frame, Baud rate 250kbps, receive ID=0x0000AABB,

send ID=0x0000CCDD

Command: 5A 0E 51 01 08 BB AA 00 00 DD CC 00 00 D0

2) CAN Terminating Resistor Configuration Instructions

Enable 120Ω Terminating Resistor: 5A 05 60 01 C0

Disable(**Default**) 120Ω Terminating Resistor: 5A 05 60 00 BF

3) Others

1) Other configuration instructions are the same as UART instructions of standard products, such as saving settings(5A 04 11 6F), resetting(5A 04 02 60) and so on. "Save setting" instruction must be sent after setting parameters, otherwise the parameter doesn't take effect after restarting.

2) When the command is longer than 8 bytes, it needs to be distributed into multiple CAN data frames. And interval between every data frame can't be longer than 20ms.

4   FAQ

Q1: Can the FOV (spot) of TF02-i be increased or decreased?

A1: Generally, this is a customized demand. You need to contact our sale colleague for further details. FOV is determined at the beginning of product design. Determination of FOV is also related to the optical system and the product structure. Therefore, it cannot be easily changed, and needs to be customized.

Q2: Can I change the frequency of data output?

A2: Yes, customization of parameter configuration is supported in TF02-i. You may consult our sales colleague or technical support for further details.

Other common questions please refer to **SJ-PM-TF02-Pro A01 Product Manual** on our website.