XT-M120

120 Lines Solid-State Flash Laser Radar

Product Manual

2024-4

About the manual

■ Using tips

・Please be sure to read the manual carefully before use the product, and operate the product following the instruction to avoid product damage, damage to other property, personal injury or violation of warranty terms

· This manual does not contain the product authentication information, please check the authentication information at the bottom of the product brand, and query the corresponding certification reminder.

· If this laser radar products is used as part of your product, please provide this manual to your product expectation users, or provide the acquiring methed of the manual.

■ Access

Please acqurie the latest version of manual through the following ways:

· Contact sales staff or corresponding sales channel staff of Toffuture

· Contact technical support of Toffuture: info@toffuture.com

■ Technical support

If the manual can't solve the problems, please contact us through the following way: info@toffuture.com

■ Legend

· Warning: be sure to follow the safety instructions or the correct operation method.

· Attention: supplementary information, for better usage of the product

Safety warning

■ Laser safety

	Laser Safety
	This product will emit unvisible laser during operation, please avoid eye damage during opertaion. This product pass the Class 1 safety level and has obtain the human eye safety CB certification, according to the EN60825 requirement, it will not damage the human eye and body during noraml operation. Please use the product correctly!(Avoid direct view to the Lidar)

Human eye sefaty

This is the laser product,in order to protect the user, it's strongly recommended that avoiding the direct view to the laser through the magnifying equipment(like microscope and any kind of magnifying lens) during prodect operation.

This product have no power switch, it will operate once the power is connected;

Both short circuit and open circuit will cause the laser to reduce or not emit light, but will not make the laser stronger.

During the product operation, the whole light cover can be treated like the laser emit area, direct look to the light cover could be treated like the direct view to the laser during operation.

■ High temperature

Avoid direct contact with the products shell during the product operation or right after the product opertation.

Please check the working temperature within the chapter "technical parameter" of the user manual, avoid the working environment which exceed the working temperature.
Operating in the environment like high/low temperature, strong vibration, heavy fog etc. might reduce the XT-M120 performance.

In addition, long working time in the high tempareture environment might impact the product performance or even damage the product.
It's strongly recommended that user add radiating precaution to make sure the shell temperature won't exceed 60 degree.

If the product temperature is too high, it will trigger the high temperature self-protection mechanism, XT-M120 will send out the high temperature warning, if the temperature is too high, XT-M120 will stop the operation, and restart only after the temperature reach the normal level.

Recommand storage environment:
Dry and ventilated environment, temperature 23±5℃, humidity 30%~70%.

■ Abnormal stop

If occure the following circumstances, please immediately stop using the product and contact the Toffuture or corresponding sales channel staff of Toffuture:

· Suspect product failure or damage, for example, the product have obvious noise, smell or smoke

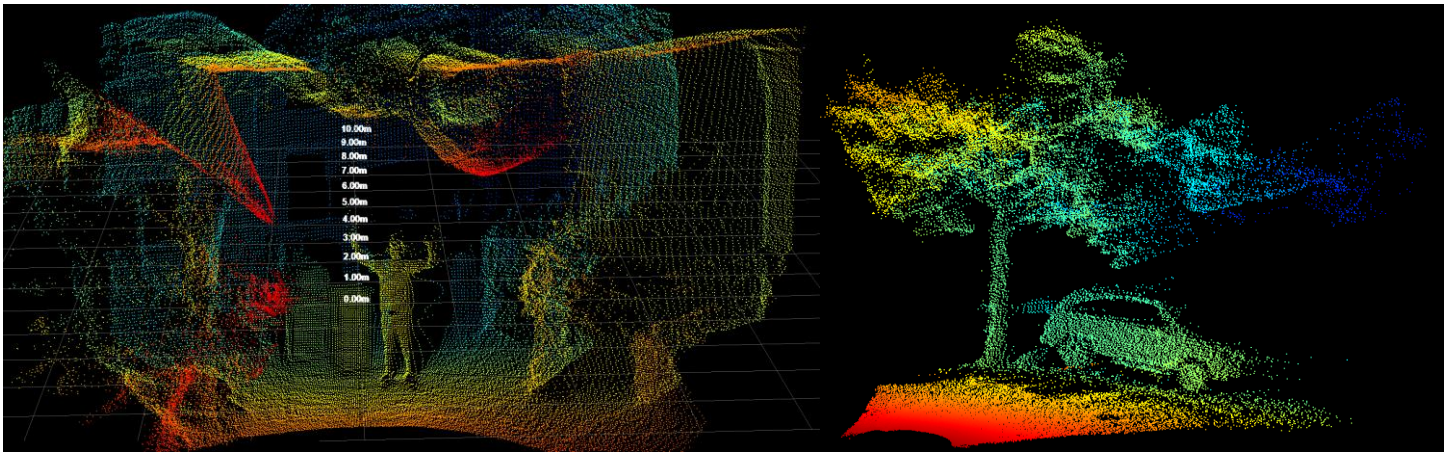
· User or people around feel any discomfort of themselves

· Abnormal running equipment in the surrounding environment

■ Disassembly prohibited

Without the written consent of Toffutre, disassembly is explicitly prohibited of this product.

About the manual....2
■ Using tips....2
■ Access....2
■ Technical support....2
■ Legend....2
Safety warning....3
■ Laser safety....3
■ High temperature....3
■ Abnormal stop....3
■ Disassembly prohibited....4
Product introduction....6
Product highlights....6
1、The product features....7
1.1Working principle....7
1.2 Technical parameters....7
2、 Products mechanical structure....8
3、 Products six view....8
Product shell....10
Light cover of the shell....10
High temperature....10
4、Installation Angle....11
4.1 Effective field of view (FOV) Angle range....11
4.2 Field of view(FOV) detection range....11
5、Installation and operation....12
The power supply....12
Electrical interface....13
6、Component description....13
7、Data output....14
7.1 Three different types of communication data：....14
7.2 Communication packet format(based on TCP/UDP/USB) packet format definition....14
7.3 Data flow....15
7.4 Command data....17
7.5 Command list：....18
7.6 Command type：....18



Product introduction

XT - M120 is a cost-effective, safe and reliable pure solid state flash blind detection lidar. It can be widely used in industry of automatic driving and handling robot, outdoor service robots, unmanned aerial vehicle, intelligent traffic areas, such as AGV, AMR, automatic forklift, field mower, cleaning robot, delivery robot, V2X vehicle and road synchronization and blind detect and corner lidar etc.

Product highlights

Solid State : No mechanical parts, reliable .
The ultra small size : 71 mm * 71 mm * 48 mm
120 Line : The equivalent of 120 lines, 38400 pixels/frame Angular.
AngularResolution: 0.66 °
Anti-blooming: In the 100Klux sunlight environment can work properly and provide stable point cloud
Multiple images: 3D point cloud, depth, the infrared gray, incredible figure, etc
Multiple interfaces: Aviation interface .
Automotive Grade: Mature silicon semiconductor technology, reliability, consistency, stability, security, high integration, simple structure, low fault rate and meet the mass demand of clients.

1、The product features

1.1Working principle

The distance measurement principle is the Flight Time measurement (Time of Flight).

1) Emit ultrashort laser pulses.

2) Laser reach the object and reflection, photosensitive receiver receives the reflected light.

3) By measuring the flight time of the laser in the air, we can accurately calculate the distance between target object and the sensors.

ToF is the abbreviation of Time - of - Flight, the Flight Time of light, essentially it is one kind of depth range camera to provied the high quality depth image, ToF, the structure light and the eyes constitute three mainstream of 3D visual technology.
iToF is the abbreviation of indirect Time - of - Flight, dToF is the abbreviation of direct Time - of - Flight.
For iToF, it has high resolution, high accuracy performance. On the other side, for dToF, it has high sensitivity and long detection range. For differnet application, different technical approach could be taken.

d = c*t/2	d: Distance c: Speed of Light t: Fly time of the laser pulse

Figure1.1 ToF distance calculation formula

1.2 Technical parameters

Product Series	M Series-Middle Range		M Series-Blind Detect	Customized
Product Name	**M120 Mini**	**M120 Pro**	**M120 Ultra**	**M Series**
Application	Medium Speed		Low/Medium Speed	All Range
FOV1	106°×80°	72°×58°	106°×80°	106°×30° 60°×45° 32°×24°
FOV2	120°×94°	77°×64°	120°×94°	110°×30° 58°×49° 40°×30°
Frame Rate（fps）	1-30		30	1-40
Light Wavelength(nm)	940			
Average Power(W)	12			6-12
Output Data	Infrared Image/Depth Image/3D Point Cloud			
SDK	C++/Python/Linux/Ros1&Ros2			
Accuracy	1-3%			
Angle Resolution	0.33°H×0.66°V （equal to 120 lines）	0.22°H×0.48°V （equal to 120 lines）	0.33°H×0.66°V （equal to 120 lines）	90-240 lines
Measurement Distance （50% Reflectivity）	20m outdoor （0.3-25m indoor）	30m outdoor （0.3-40m indoor）	40m@50% 10m@10% outdoor （0.3-50m indoor）	30\50\100m
Water/Dust Proof	IP67			IP67/IP68
Size（mm）	71×71×48	71×71×45	71×71×48	Customized
Weight（g）	293g	277g	293g	TBD
Voltage	12-25V@5A，avaition plug			
Working Tempreture	－40° to 85°			

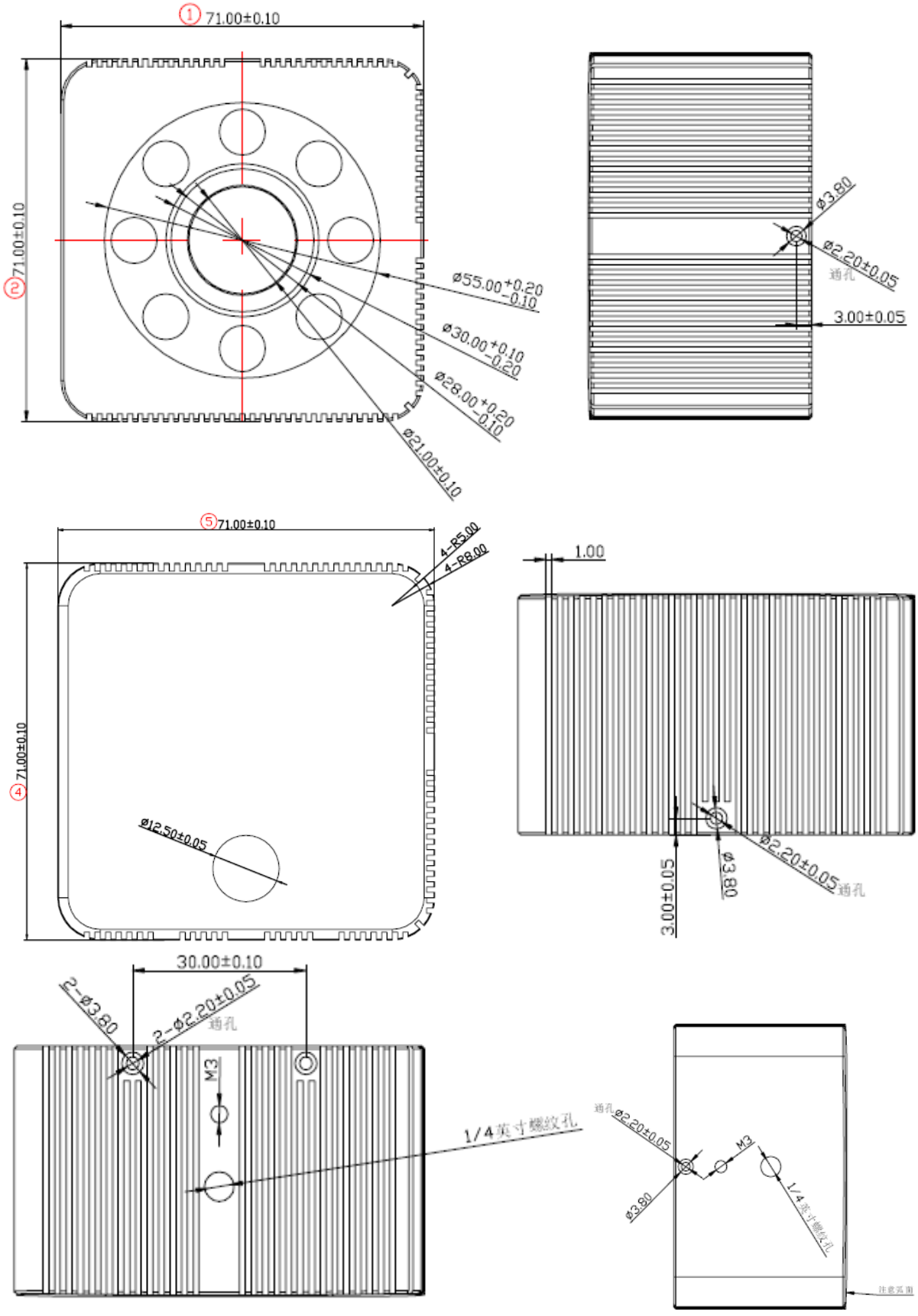
Special Reminder：

1．FOV1, represent the field of view of the image receiver side, which is the angleof the output image and 3D point cloud. Using FOV1 as the parameter for image, software, algorithm, point cloud related applications.

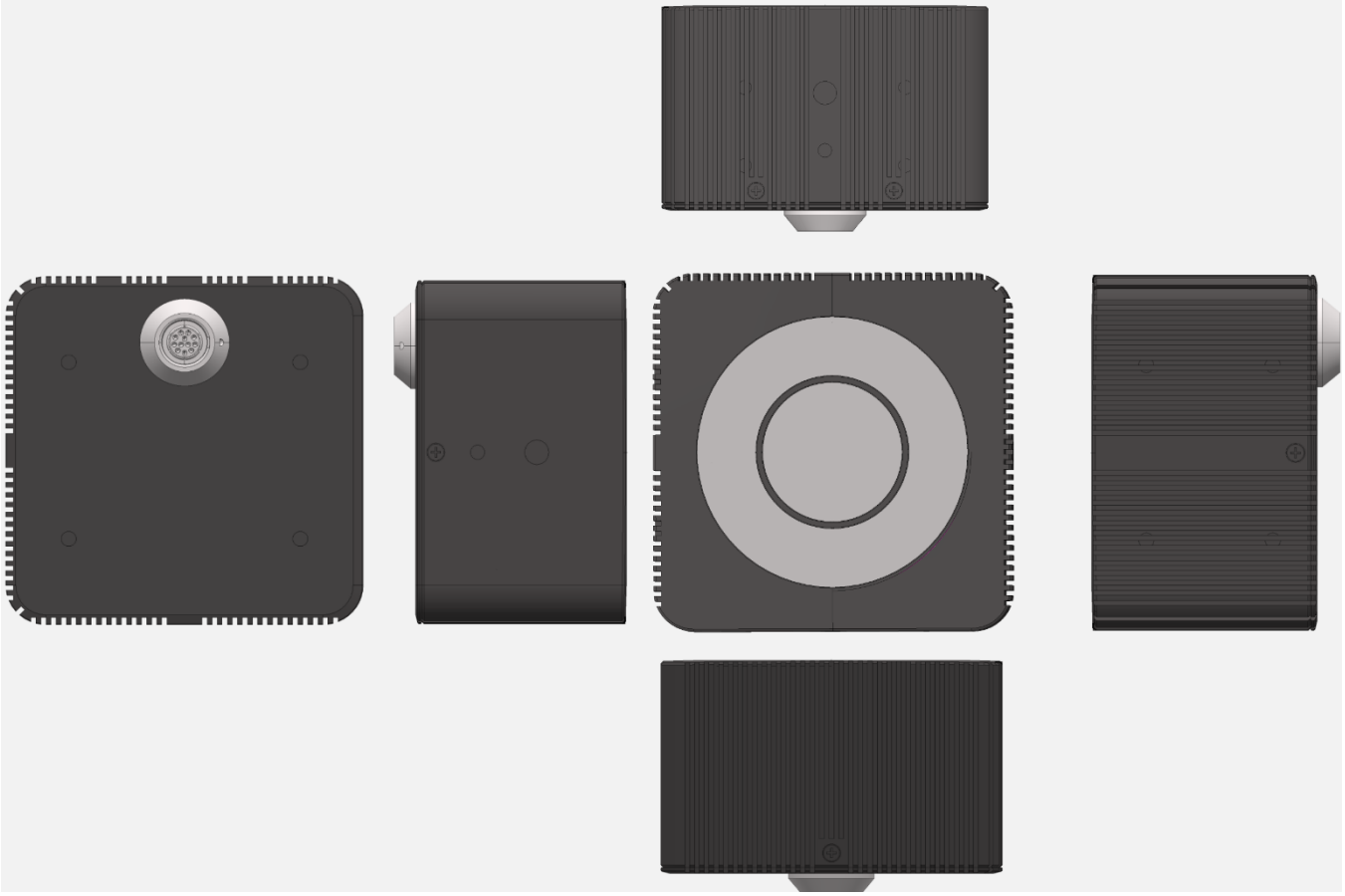
2．FOV2 represent the field of view of the laser emitter, due to light interference and multi-path interference, FOV2 must be larger than FOV1. Using FOV2 as the parameter for the photology, structure, machinery and installation related applications.

3. Marked on the 3D models, application and question related to mould making and precisemechanical structure, please contact the technical support for confirmation to avoid unnecessary lost. Thank you!

2、Products mechanical structure


①71.00±0.10
②71.00±0.10
ø55.00+0.20 -0.10
ø30.00+0.10 -0.20
ø28.00+0.20 -0.10
ø21.00±0.10
ø3.80
ø2.20±0.05
通孔
3.00±0.05
⑤71.00±0.10
4-R5.00
4-R8.00
④71.00±0.10
ø12.50±0.05
1.00
3.00±0.05
ø3.80
ø2.20±0.05通孔
30.00±0.10
2-ø3.80
2-ø2.20±0.05
通孔
M3
1/4英寸螺纹孔
通孔ø2.20±0.05
M3
ø3.80
1/4英寸螺纹孔

3、Product six views



Product shell

·The products are mainly made of metal, glass and copper clad, internal contain sensitive electronic components, must avoid dropping, burning and other improper operation.Once the product experience falling or burnning, please stop using immediately, and contact Toffuture for technical support.

·Avoid extrusion or puncture of the product. If the shell is damaged, please stop using immediately.

·Before active the product, please ensure that the product has been firmly fixed, and avoid the external force (such as the impact, wind, flying rock, etc.) which might move the product from a fixed position.

Light mask of the shell

·Do not touch the mask, lest the mask with fingerprints or dirt. If the mask is not clean already, please follow the decirbed methed in the section “instrument maintenance” of instructions to clean.

·Please avoid contact with hard or sharp object for scratches in the mask. Please stop using the product with serious scratches since it may affect the product performance.

High temperature

During the products operation or a certain period of time after the product operation, the product shell may be in high temperature condition, please note that：

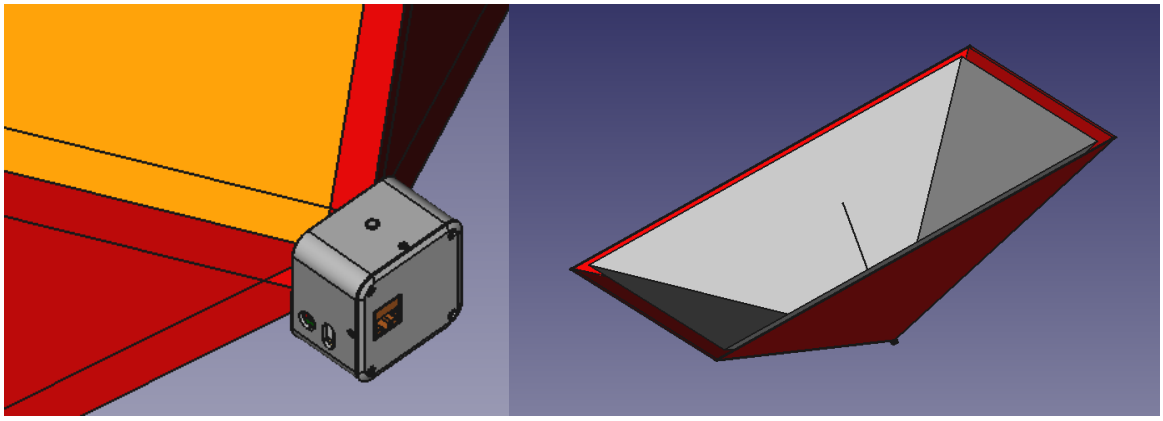
·Avoid direct skin contact with the product shell, which might casuing the skin burned.

·Avoid direct contact with product shell using combustible materials , which might cause a fire.

4、Installation Angle

4.1 Effective field of view (FOV) Angle range

XT - M120 Pro FOV is 72° x 58 °, pay attention to the FOV range, avoid blocking and interference. Contact the agent or info@toffuture.com for the FOV 3D model of the mechanical installation.



4.2 Field of view(FOV) detection range

The following model server the purpose to convenient customers to intuitive understand the detection range covering by the product (spherical coordinates) under different FOV and distance measuring range,in order to select a better corresponding FOV of products for different applications.

FOV	106° * 80°	72° * 58°	106° * 30°	60° * 45°	32° * 24°
Measurement Range （@5m）	13.3m * 8.4m	7.3m * 5.5m	13.3m * 2.7m	5.8m * 4.1m	2.9m * 2.1m
Measurement Covered Area	111.4 ㎡	40.3 ㎡	35.6 ㎡	23.9 ㎡	6.1 ㎡
Measurement Range （@10m）	26.5m * 16.8m	14.5m * 11.1m	26.5m * 5.3m	11.5m * 8.3m	5.7m * 4.3m
Measurement Covered Area	445.4 ㎡	161.1 ㎡	142.2 ㎡	95.7 ㎡	24.4 ㎡
Measurement Range （@20m）	53.1m * 33.6m	29.1m * 22.2m	53.1m * 10.7m	23.1m * 16.6m	11.5m * 8.5m
Measurement Covered Area	1781.6 ㎡	644.4 ㎡	568.9 ㎡	382.6 ㎡	97.5 ㎡

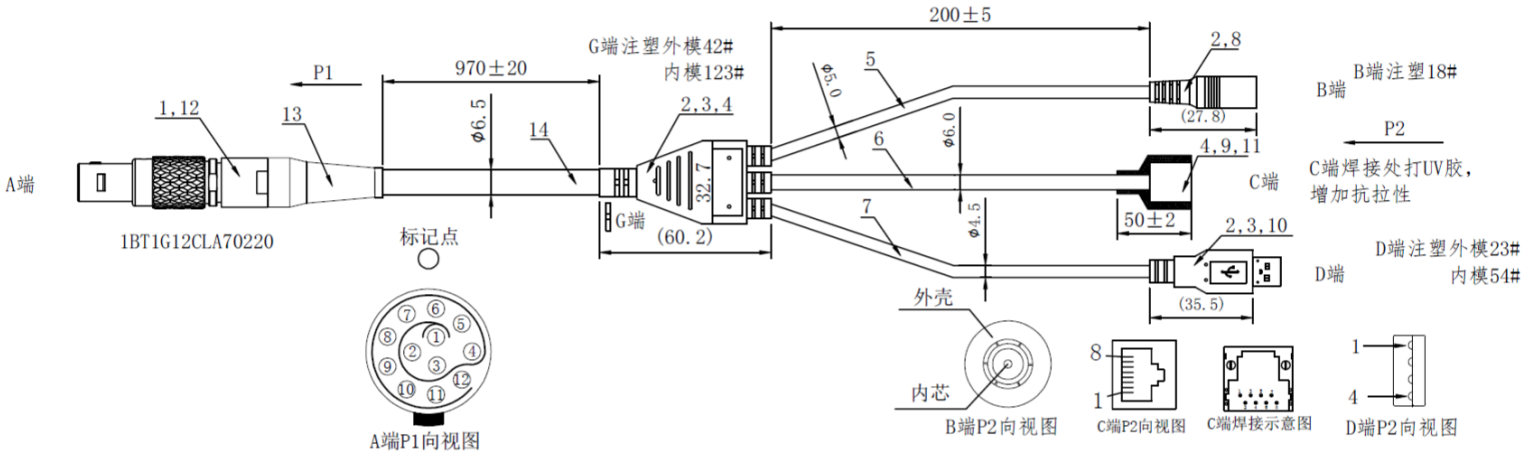
For more detail, check below:

http://www.toffuture.com/xzzl→不同 FOV 覆盖区域计算-芯探科技.xlsx

5、Installation and operation

The power supply

·Recommend to use power supply cable and power adapter offered by Toffture.



• For the customer design, configuration or selected power supply system (including cables) by themselves, please follow the relevant electrical parameters in the instructions, or contact the Toffuter for technical support. Using damaged cable, adapter or the power supply which dose not meet the requirement is forbidden.

Avaition plug

• M12 avaition plug line sequence and pin definition as below:

M12 Power,Network port, USB line sequence							
M12 avaition plug PIN	**Motherboard**	**Male head PIN**	**Signal**	**Attributes**	**Description**	**Comment**	**Color**
9	P 10	9	POWER+	power	DC 12V-24V	single line current 2A	yellow
10		10	POWER+	power	DC 12V-24V		green
11		11	GND	power	GND		purple
12		12	GND	power	GND		blue
1	P 11	1	Ethernet-TX+	signal	100BASE-TX+	single line current 0.5A or above	black
2		2	Ethernet-TX-	signal	100BASE-TX-		white
3		3	Ethernet-RX+	signal	100BASE-RX+		black
4		4	Ethernet-RX-	signal	100BASE-RX-		brown
5	P12	5	GND	power	GND		red
6		6	USB DM	signal	USB		white
7		7	USB DP	signal	USB		green
8		8	GND	power	GND		orange

Electrical interface

·Before power on, please make sure that the electrical outlet is dry and has no dirt. Please do not power on the product in the humid environment

·Please strictly follow the connector plug operation instructions. If you have already found abnormal interface (such as pin skewed, cable breakage and screw loosening, etc.), please stop using the product and contact Toffuture for technical support.

·Before you plug connector, please disconnect the power supply. Hot plug can lead to damage.

6、Component description

1. Big baffle Vcsel launch window, light through the window for launch, detect the objects within FOV range.

2. Small baffle is sensor receiving window, receiving the reflected light reflected from the object.

3. Aviation Interface, which has:

a.100 BasT card, provide laser radar data output

b. DC interface, power 12V - 25V (current above 5A)

c. Type C interface, USB with laser radar data output

4. M2 screws, outside the module using this Type of screw

5. Universal 1/4 threaded hole

7、Data output

This protocol is based on TCP/UDP

default radar TCP port: 7787

default UDP port:7687

7.1 Three different types of communication data：

- Video data with large data flow，

  Due to the consideration of the real time requirement, UDP protocol has be chosen. UDP data is transmitted by the radar and accpeted by the upper computert.

- Radar command interaction，

  Due to the requirement of the clear result of the excution interaction and the small amout of the data,TCP protocol has be chosen to secure the interaction integrity.

- Debug log information reported by radar，

  In order to make sure the upper computer recevied the debug log data, and with the small amount of the data flow, TCP protocol has be chosen.

  Checking the connection between the radar and upper computer:

  Option 1: Checking the heartbeat by checking the TCP conection

  Option 2: Upper computer send the command in certian period, check the time of the last received command by the radar

7.2 Communication packet format(based on TCP/UDP/USB) packet format definition

Start	data packet size	data	End
4Bytes(0x7EFFAA55)	4Bytes	0-30720	4Bytes(0XFF7E55AA)

Start	data packet size	ID	Command data	State code	Protocol version number	End
4Bytes(0x7EFFAA55)	4Bytes	1Byte	0-30720	1 Byte(b4-b7: state cod b0-b3:command reture code	1 Byte	4Bytes(0XFF7E55AA)

Using the network order(big endian as the byte oreder of the data。

Using the little endian for the storage in radar and upper computer

TCP/UDP level has the checksum for the network data, as the reslt the XT packet doesn't contain the checksum。

Dividing one frame data into multiple UDP packets to transfer(20 bytes packet header + 1400 bytes data), Because each network packet size is smaller than MTU

7.3 Data flow

Data include：depth, amplitude, grayscale, temperature, time

Output type：

1. depth + temperature + time
2. depth + amplitude + temperature + time
3. grayscale + temperature + time

Since one frame data is divied into multiple data pacekt, after receiving the data packets, it must be reformed into one complete frame to be used. Upper computer SDK convert the distance data coordinate into point cloud data.

Data format of one frame：

cmdid	output type	frame number	resolution	data	temperature	time mark	integration time	reserve	state code	version
1 Bytes 251	1 Byte	2 Bytes	4 Bytes	0-307200 Bytes pixel data	2 Bytes	8 Bytes Unit:us	8 Bytes	32 Bytes Device state info	1 Byte	1 Byte
Position: 8+0	8+1	8+2	8+4	8+8	8+8+Dsize	8+8+Dsize+12	8+8+Dsize+10	8+8+Dsize+18	8+8+Dsize+51	8+8+Dsize+52

Pixel format：

Output type	Description	Byte size
1	**Depth**	**2 Bytes**
2	**Depth + Amplitude**	**2Bytes + 2Bytes**

3	**Grayscale**	**2Bytes**

UDP packet division

One complete frame data will be divided into multiple UDP packets before transmission, recevier will reformed the UDP packets to the complete frame data

UDP packet structure

Packet Head	Data
20 Bytes	Max 1400 Bytes

UDP packet header structure

Frame number	**Frame size**	**Packet data size**	**transmitted size**	**Packet number in total**	**Packet number**
2 Bytes	4 Bytes	2 Bytes	4 Bytes	4 Bytes	4 Bytes

Attention: the data flow contain PTP synchronization time information

Command Response State Code

Devide state code: **DevStateCode**

id	Description
0	Unconnected
1	Device Initialization
2	Device Idle
3	Device Busy
4	Error: CSI interface
5	Error: I2C interface
6	Error: temperature too high

7	Error: temperature too low
8	Error: unknow
9-15	reserve

command response code: CmdRespCode

id	Description
0	Command excecute OK
1	Command unsupport
2	Device busy
3	reserve
4	reserve
5	reserve
6	reserve
7	Report message
8	Error: Command format/size/value
9	Error: Command data
10	Error: CSI interface
11	Error: I2C interface
12	Error: temperature too high
13	Error: temperature too low
14	Error: unknow

7.4 Command data

Command/Response/active report and same format

Blue fint showing the data size of current command, which will not be trasmitted, the packet size will contain the data size information

Command ID	data	dataszie
1 Byte	..	0 Byte

7.5 Command list:

Command	ID	Parameter	Description
Image	251		Send out one frame of the image data
Start	1	Type	Start measurment
Stop	2	-	Stop flow
Set IP address	3	IP address, subnet mask, network management IP	Set the internet address
Request device infomration	4	-	Internet infomation, device version, product serial number, chipid, calibration status
Request configuration information	5	-	Output image type, frequency, HDR, integration time, min amplitude, filter status
Set filter	6	Edge, Temporal	Set the filter function which to be open and the filter parameter
Set integration time	8	4 group integration time parameter, grayscale integration time	HDR compatible
Set min signal amplitude	9		Discard the signal with too low amplitude
Set HDR	10	Type	
Reset	13	Fixed string “XINTAN”	Reset the radar
Set modulation frequency	52	Frequency number	12m, 6m
Set ROI	51	x0,y0,x1,y1	
Trace output	209	Size, string	Send out the log information

7.6 Command type:

Blue fint showing the data size of current command, which will not be trasmitted, the packet size will contain the data size information.

	Command ID	Data	Data size
Flow Data	251		0 Byte

Start	Command ID	B0	B1	Data size
Command	1	Image type 1:Depth 2:Depth+Amplitude	Once/flow 0/1	2 Bytes

		3: Grayscale

	Command ID	Data size
Response	1	0 Byte

Stop	**Command ID**	**Data**	**Data size**
Command	**2**		**0 Byte**

	Command ID	**Data size**
Response	**2**	**0 Byte**

Set IP Address	**Command ID**	**Data**	**Data size**
Command	**3**	**IP 4Bytes Msk: 4 Bytes Gate: 4 Bytes**	**12 Bytes**

	Command ID	**Data size**
Response	**3**	**0 Byte**

Request Device info	**Command ID**	**Data**	**Data size**
Command	**4**		**0 Bytes**

	Command ID	**Data**	**Data size**
Response	**4**	**IP: 12 Byte Mac Address: 6 Bytes FW Ver: 18 Bytes SN: 28 Bytes Boot Ver: 14 Bytes Status: 1 Bytes Chip ID: 4 Bytes Calibration Status: 2 Bytes Reserve: Remaining Bytes**	**90 Bytes**

Request Configuration Info	**Command ID**	**Data**	**Data size**
Command	**5**		**0 Byte**

	Command ID	Data	Data size
Response	5	Output Image Type: 1 Byte Freq: 1 Byte HDR mode : 1 Byte Integration Time : 8 Bytes Min amplitude : 2 Bytes Kalman filter factor : 2 Bytes Kalman threshold : 2 Bytes Flying-spot filter threshold : 2 Bytes Reserve: Remaining Bytes	30 Bytes

Set Filter	Command ID	Data	Data size
Command	6	Kalman factor: 2 Bytes(0-1000), ‘0’means closed Kalman threshold: 2 Bytes(0-2000), ‘0’means closed Flying-spot threshold: 2 Bytes,’0’ menas closed	5 Bytes

	Command ID	Data size
Response	6	0 Byte

Set Integration Time	Command ID	Data	Data size
Command	8	4 groups integration time, 2 bytes for each group	8 Bytes

	Command ID	Data size
Response	8	0 Byte

Set Min Amplitude	Command ID	Data	Data size
Command	9	Unit 16 value (0-2000)	2 Bytes

	Command ID	Data size
Response	9	0 Byte

Set HDR	Command ID	Data	Data size
Command	10	0: closed 1: Space HDR 2:Time HDR	1 Byte

	Command ID	Data size
Response	10	0 Byte

Reset	Command ID	Data	Data size
Command	13		0 Byte

	Command ID	Data size
Response	13	0 Byte

Set Frequency	Command ID	Data	Data size
Command	52	0: 12M 1: 6M	1 Byte

	Command ID	Data size
Response	52	0 Byte

Trace Output	Command ID	Data	Data size
Command	209		X Bytes

Version History

Version	Description	Data
V1.0	First Version	202307
V1.1	Update	202310
V1.2	Update	202404