FORSENSE
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Dynamic inclination measurement module

FSS-AHRS20XS-X Product manual

Features

Tactical grade MEMS IMU

- 5.0°/h gyroscope zero bias instability
- 60ug accelerometer zero bias instability

Anti-interference dynamic tilt algorithm

- Resolution 0.01 degrees
- Low dynamic accuracy <0.8° @rms

Independent turntable calibration

- Independent calibration of each module: sensitivity, zero bias, non-orthogonal error

High strength condition tolerance

- Strong impact tolerance: 2000g (0.5ms, half sine, 3 axis)
- Strong vibration tolerance: 10g (10~2KHz, 3 axis)
- Full temperature environment stable operation: -40℃ ~ 85℃
- 100% magnetic shielding

Real-time and flexible digital interface, small size

- Configurable output sampling rate up to 100Hz
- Support for CAN interface
- Support RS-485 interface
- Support TTL interface
- RS-232 interface is supported

Product Overview

AHRS20XS-X is a dynamic inclination measurement sensor launched by Yuanji Technology based on industrial IMU platform for construction machinery, intelligent robots and other fields. All modules are equipped with ultra-wide temperature range of fine warming and independent calibration before delivery, to ensure the consistency and stability of the module. Built-in attitude fusion algorithm based on extended Kalman filter can effectively

suppress the influence of dynamic interference on attitude accuracy and ensure the stability of attitude accuracy.

Application Areas

- Construction machinery: excavator, unmanned forklift, aerial ladder, etc
- Intelligent robot
- Underwater robot

On the basis of standard performance and output parameters, Yuanji also provides customized software and LOGO customization services for your special needs, to help you in the product!

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FSS-AHRS20XS-X Product Sheet

Contents

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1. Performance parameters

AHRS20XS-X product performance indicators are shown in Table 1 below:

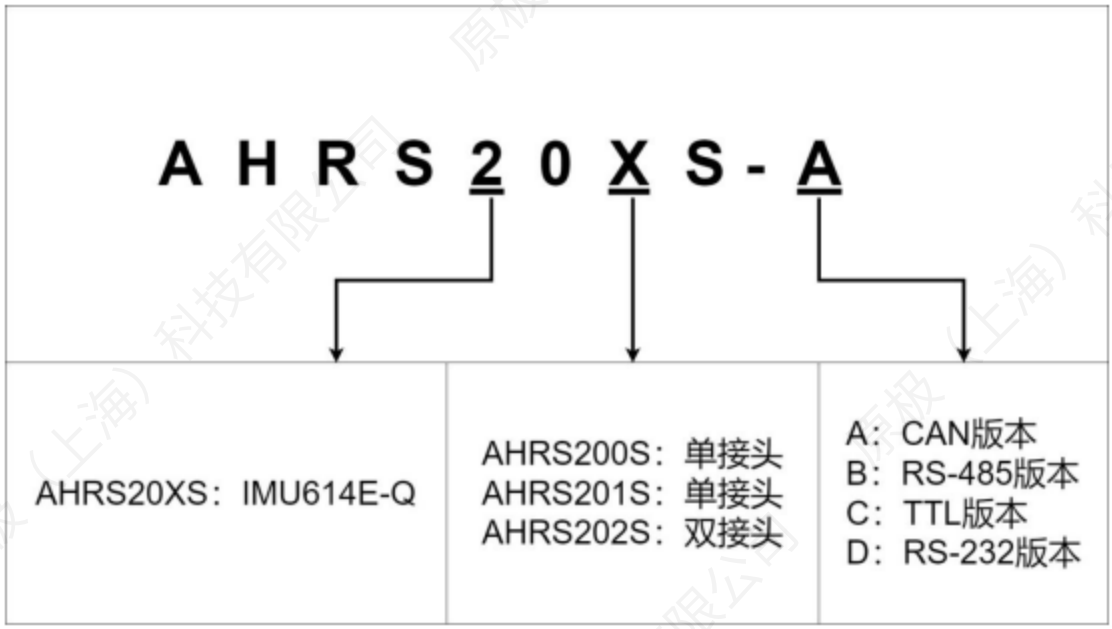
Table 1 Performance indicators

Sensor Performance	
Angle measuring range	Pitch Angle: ±80° Roll Angle: ±180°
Angle repeatability	< 0.05 °
Angular velocity measurement range	±450°/s
Resolution	0.01 °
Dynamic accuracy	0.7 °
Acceleration measurement range	±6g
Update rate	100hz
Electrical characteristics	
Voltage input	9-36 V
Power consumption	0.1 0.24 W
Interface	CAN/RS-485/RS-232/TTL
Physical Characteristics (AHRS200S-X)	
Connector type	GX12-4 core (male head)
Product size	55 * 37.6 * 24 mm
Waterproof rating	IP68
Physical characteristics (AHRS20XS-A)	
Connector type	M12 Aviation Connector 5 pin
Product size	**AHRS** 201S : 47*85*24mm **AHRS** 202S: 47*96.5*24mm
Waterproof rating	IP68
Ambient temperature	
Operating temperature	- 40 ~ 85 ℃
Storage Temperature (Tstg)	- 40 ~ 85 ℃

Note 1 For vehicle-mounted low dynamic scenarios, RMS error value after subtracting installation deviation Angle

2. Model description

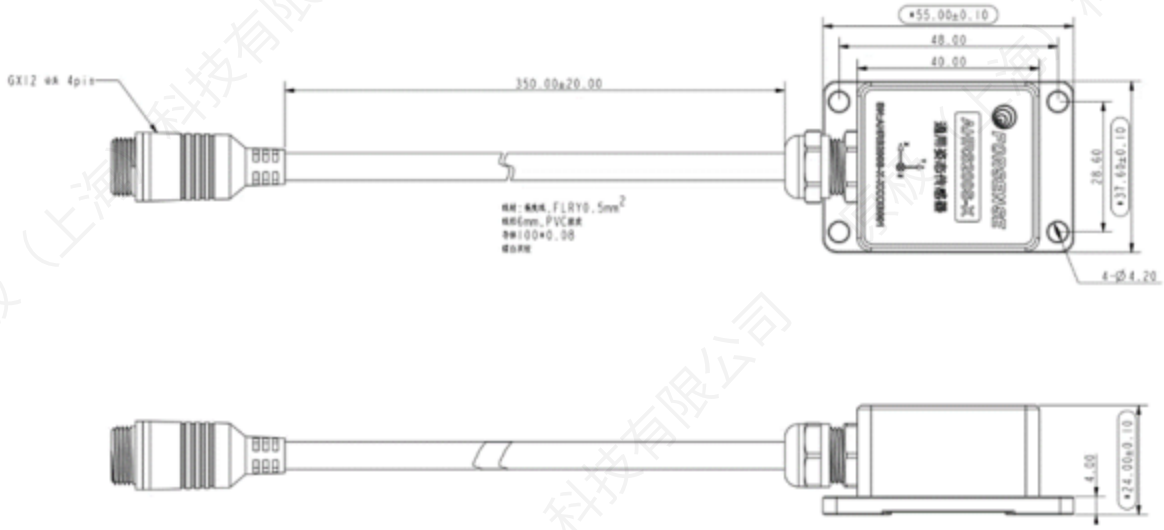
Table 1 Model definitions

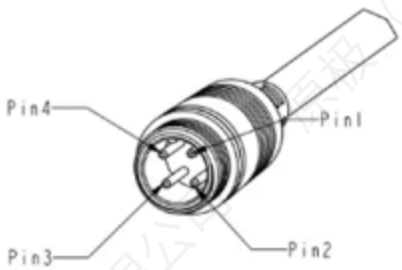


Name	Version type	Meaning
AHRS200S	A	CAN version
	B	RS-485 version
	C	TTL version
	D	RS-232 version
AHRS201S	A	Single connector version
AHRS202S	A	Double connector version

3 Form structure

Figure 1 AHRS200S-X outline structure





Pin	定义	颜色	描述
1	Vin	红	Vin 9~36V
2	GND	黑	GND
3	CAN_H	绿	CAN_BUS
4	CAN_L	白	

Figure 2 AHRS201S-A outline structure

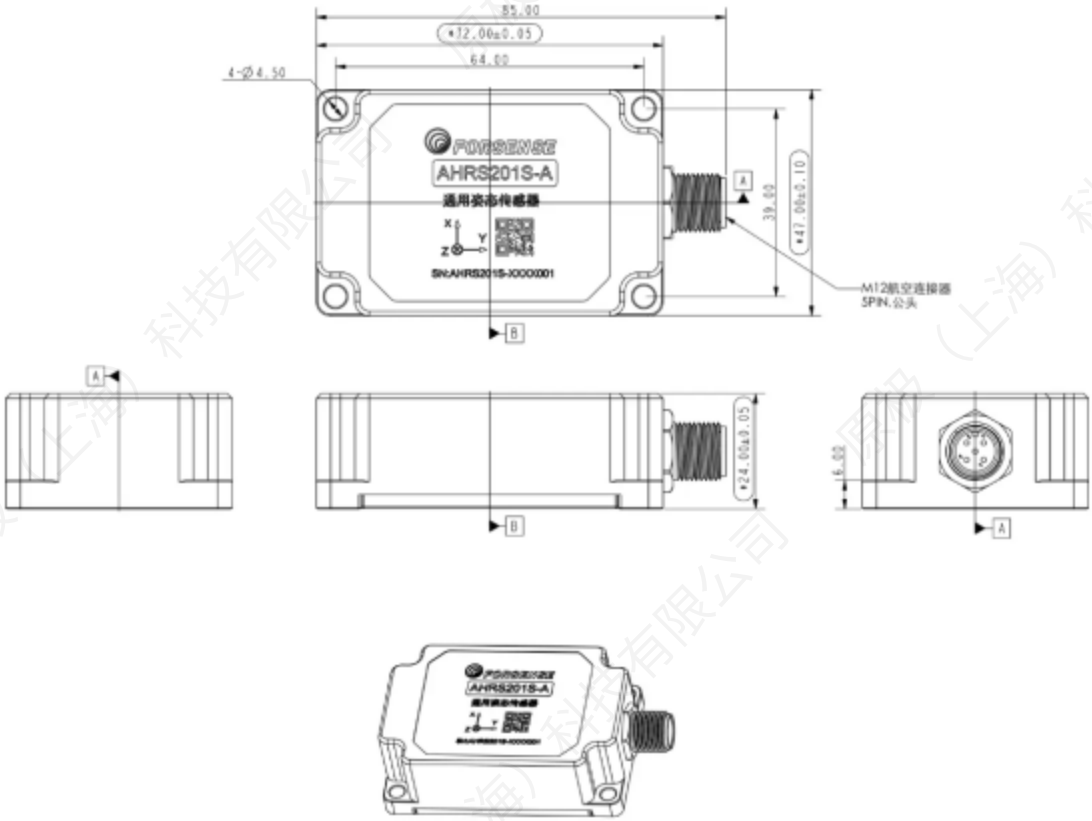
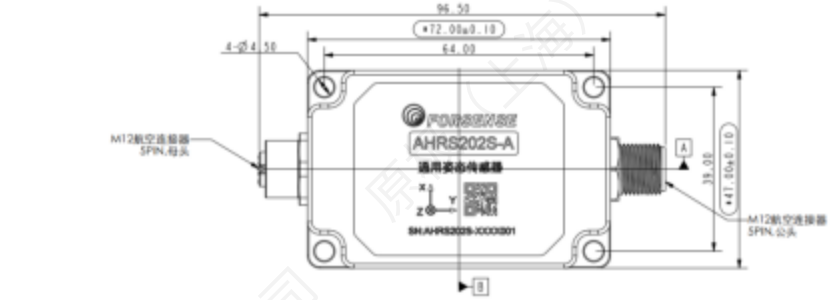
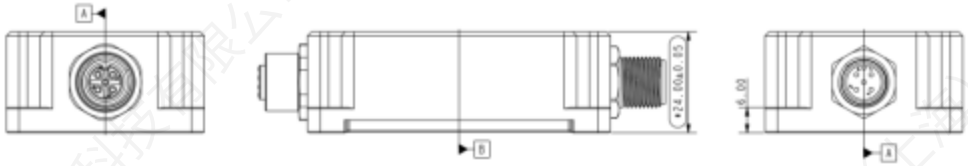
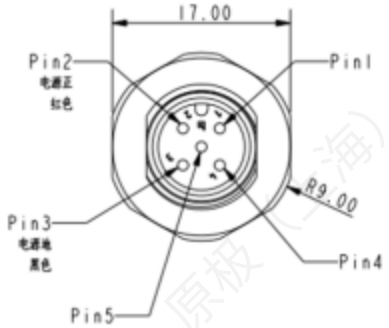
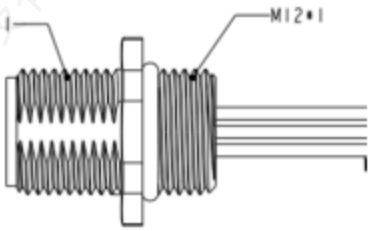


Figure 3 Outline structure of AHRS202S-A


96.50
φ72.00±0.10
64.00
4-Ø4.50
M12航空连接器
5PIN,母头
FORSENSE
AHRS202S-A
通用姿态传感器
SN:AHRS202S-XXXX001
39.00
φ47.00±0.10
M12航空连接器
5PIN,公头
A
B


A
B
φ24.00±0.05
6.00


17.00
Pin2
电源正
红色
Pin1
R9.00
Pin3
电源地
黑色
Pin4
Pin5


M12*1
M12*1

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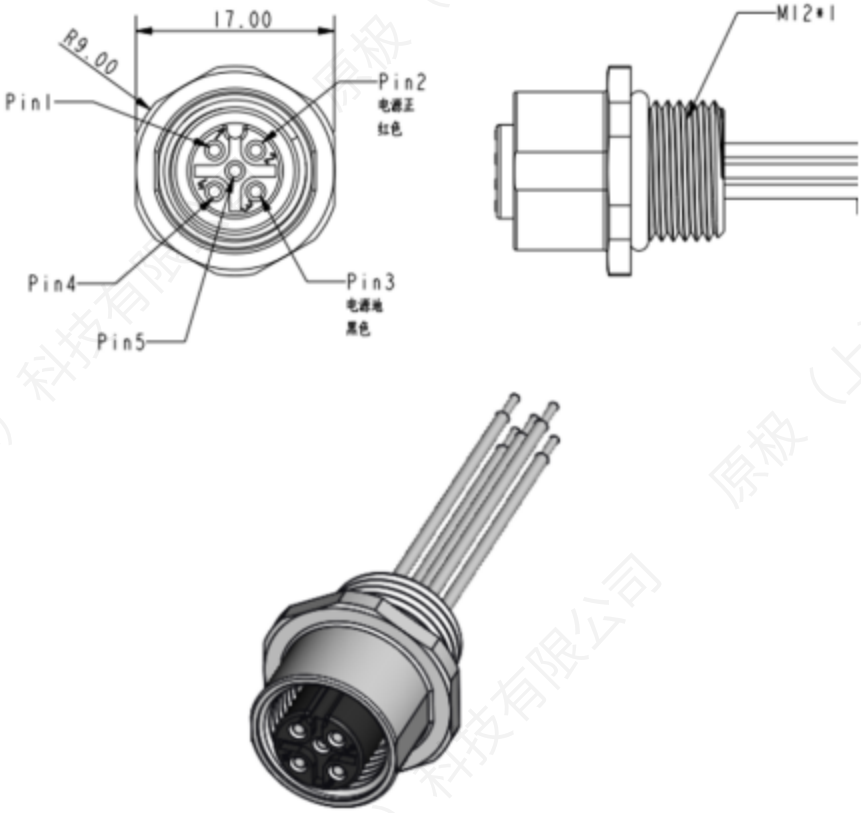

4. Electrical characteristics

4.1 Maximum tolerance value

Table 2 Maximum absolute rating

Parameters	Symbols	Range	Units
Supply voltage	VCC	9 to 36	V
Ground (GND)	GND	-	-
Temperature for use	Tot	-40 to 85	℃
Storage temperature	Tstg	-40 to 85	℃

4.2 Working Conditions

Table 3 Working conditions

Parameters	Symbols	Minimum value	Typical value	Maximum value	Units
Supply voltage	VCC	9	12	36	V
VCC maximum ripple	Vrpp	0		40	mV
AHRS200S-A power consumption	P		0.24		W
AHRS200S-B power consumption	P		0.16		W
AHRS200S-C power consumption	P		0.1		W
AHRS200S-D power consumption	P		0.1		W
AHRS201S-A power consumption	P		0.17		W
AHRS202S-A Power consumption	P		0.18		W
Use temperature	Tot	-40		85	℃
Storage temperature	Tstg	-40		85	℃

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4.3 Interface Definition

Table 4 AHRS200S-A interface definition

PIN	Definition	Description
1	VIN	9-36V DC input
2	GND	Ground (GND)
3	CAN_H	CAN_BUS
4	CAN_L	

Note: CAN communication baud rate is 500KHz, built-in matching resistance 120 ohms;

Table 5 AHRS200S-B interface definition

PIN	Definition	Description
1	VIN	9-36V DC input
2	GND	Power ground
3	DATA A	RS-485
4	DATA B	

Note: Built-in matching resistance 120 OHms;

Table 6 AHRS200S-C interface definition

PIN	Definition	Description
1	VIN	9-36V DC input
2	GND	Ground (GND)
3	RXD	LVTTL
4	TXD	

Table 7 AHRS200S-D interface definitions

PIN	Definition	Description
1	VIN	9-36V DC input
2	GND	Ground (GND)
3	RXD	RS232
4	TXD	

Table 8 AHRS20XS-A interface definition

PIN	Colors	Definition	Description
1	Shield	PE	Protected area
2	red	VIN	9-36V DC input
3	black	GND	Power ground

4	green	CAN_H	CAN_BUS
5	white	CAN_L	

Note: CAN communication baud rate of 500KHz, built-in matching resistance of 120 Ohms

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5 Upgrade the function

5.1 CAN version firmware upgrade

Connect the computer using the attachment USB to CAN module. Open the original IMU to test the upper computer -- select the corresponding serial port number -- select firmware upgrade -- Open firmware -- select CAN interface upgrade -- set the firmware baud rate after upgrade -- click Automatic upgrade.

Figure 4 CAN version of the upper computer upgrade interface

5.2 Firmware upgrade of RS-485/RS-232/TTL version

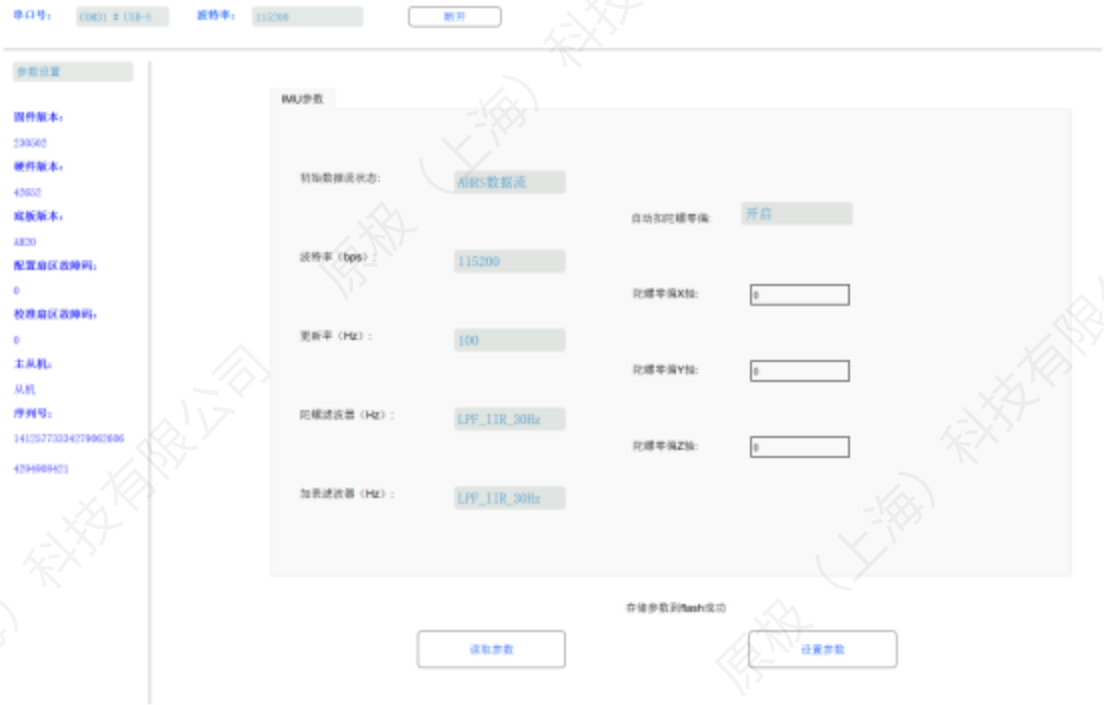
Test the upper computer using the primitive IMU - select Firmware upgrade - Open firmware - click Automatic Upgrade.

Figure 5 Upper computer upgrade interface of RS-485/RS-232/TTL version

6. User parameters function

Use the primitive IMU to test the upper computer, the user can configure the update rate and filter equivalent;

Figure 6 User parameter configuration interface



7. Communication protocol

7.1 CAN communication protocol

Example of CAN host read driver based on STM32:

https://www.forsense.cn/download/

7.1.1 Communication parameters

Interface form: CAN, standard frame

CAN rate: 250Kbps~1Mbps (configurable)

7.1.2 Standard frame format

Table 8 CAN Standard Frame Format 101

Standard Frame ID	1	2	3	4	5	6	7	8
101+ Nodes	ROLL				PITCH			

Table 9 CAN standard frame format 102

Standard	1	2	3	4	5	6	7	8
102+	YAW				Gx			

Table 10 CAN Standard Frame Format 103

Standard	1	2	3	4	5	6	7	8
103+	Gy				Gz			

Table 11 CAN Standard Frame Format 104

Standard	1	2	3	4	5	6	7	8
104+	Ax				Ay			

Table 12 CAN Standard Frame Format 105

Standard	1	2	3	4	5	6	7	8

105+	Az	TEMP	INDEX

Note 1: Attitude Angle, gyro, accelerometer data is expressed as float, temperature, meter value data is expressed as int16

Note 2: The unit of TEMP is 100* ° C, the unit of gyroscope output is °/s, the unit of accelerometer output is g, and the unit of attitude output is degree

7.1.3CAN parameter configuration

The CAN parameter configuration takes effect after the configuration is restarted. The flash is saved during the configuration. The command is responded only once within 3s, and the configuration command cannot be sent continuously within a short period.

7.1.3.1 Configuring the CAN Baud Rate

CAN Baud Rate	CAN ID	Configuration instructions	Answer CAN ID	Answer instruction
250kbps	ID=0X619	DATA=0x20 0x21 0x22 0x23 0x01 0x00 0x00 0x00	ID=0x519	DATA=0x01 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF
500kbps	ID=0X619	DATA=0x20 0x21 0x22 0x23 0x02 0x00 0x00 0x00	ID=0x519	DATA=0x02 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF
1000kbps	ID=0X619	DATA=0x20 0x21 0x22 0x23 0x03 0x00 0x00 0x00	ID=0x519	DATA=0x03 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF

Example: Change the baud rate to 250kbps

Send instructions:

ID=0x619, DATA=0x20 0x21 0x22 0x23 0x01 0x00 0x00 0x00 0x00

Answer instruction:

ID=0x519, DATA=0x01 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF

7.1.3.2 Configuring the node ID

The default node is 100, set the node ID to 0X0102, and configure the instructions:

ID=0x61A, DATA=0x30 0x31 0x32 0x33 0x01 0x02 0x00 0x00

Answer instructions:

ID=0x51A, DATA=0x01 0x02 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF

7.1.3.3 Querying the version number

Send instructions:

ID=0x618, DATA=0x10 0x11 0x12 0x13 0x00 0x00 0x00 0x00 0x00

Answer instruction:

ID=0x518, DATA=0x00 0x03 0x12 0x0E 0xFF 0xFF 0xFF 0xFF

The version number is :0X0003120E, that is, firmware version number: 201230

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7.1.3.4 Check Setting Terminal Resistors

Remove the terminal resistor and send configuration instructions:

ID=0x61B, DATA=0x10 0x11 0x12 0x13 0x01 0xFF 0xFF 0xFF

Answer instruction:

ID=0x51B, DATA=0x01 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF

Add terminal resistors and send configuration instructions:

ID=0x61B, DATA=0x10 0x11 0x12 0x13 0x02 0xFF 0xFF 0xFF

Answer instruction:

ID=0x51B, DATA=0x02 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xff

7.1.3.5 Setting the output frequency

Output frequency	CAN ID	Configuration instructions	Answer CAN ID	Answer instruction
1hz	ID=0x61C	DATA=0x10 0x11 0x12 0x13 0x01 0xFF 0xFF 0xFF	ID=0x51C	DATA=0x01 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF
10hz	ID=0x61C	DATA=0x10 0x11 0x12 0x13 0x02 0xFF 0xFF 0xFF	ID=0x51C	DATA=0x02 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF
50hz	ID=0x61C	DATA=0x10 0x11 0x12 0x13 0x03 0xFF 0xFF 0xFF	ID=0x51C	DATA=0x03 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF
100hz	ID=0x61C	DATA=0x10 0x11 0x12 0x13 0x04 0xFF 0xFF 0xFF	ID=0x51C	DATA=0x04 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF
200hz	ID=0x61C	DATA=0x10 0x11 0x12 0x13 0x05 0xFF 0xFF 0xFF	ID=0x51C	DATA=0x05 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF

Example: Set to 50hz

Send configuration instructions:

ID=0x61C, DATA=0x10 0x11 0x12 0x13 0x03 0xFF 0xFF 0xFF

The IMU replies as follows:

ID=0x51C, DATA=0x03 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xff

7.2 serial communication protocols

Examples of COM protocols based on QT, ROS and STM32:

https://www.forsense.cn/download/

Serial port communication has two modes: Stream Mode and Command Mode. After the IMU is powered on and initialized, the IMU enters the corresponding mode according to the mode value configured by the parameters.

Stream mode: Periodically output AHRS data at a fixed frequency.

Command mode: In this mode, the periodic output is stopped, and the user communicates with the IMU by sending commands. The sensor data, status, parameters, etc. can be obtained through the GET command, and the parameters of the IMU can also be configured.

7.2.1 Parameters of serial port interface

Table 13 Serial port parameters

Transmission rate range	115200bps to 1.5Mbps
Default transfer rate	115200bps
Start bit	1 bit
Data bits	8 bits
Stop bits	1 bit
Parity check	There is no

7.2.2 Packet Format

The packet structure of IMU output and user input is composed as follows:

Table 14 IMU output and user input data structures

Offsets	Data type	Name	Description
0	uint8	Frame header 1	The IMU output Frame header: 0xAA, 0x55 The user enters Frame header: 0x55, 0xAA
1	uint8	Frame header 2	
2	uint16	ID low	The lower byte of the serial communication frame ID
3		ID high byte	The upper byte of the serial communication frame ID
4	uint16	Data length low	The lowest byte of the serial

			communication frame length, length is the number of bytes occupied by the payload, that is, n
5		High data length	The upper byte of the serial communication frame length is the number of bytes carried by the payload, that is, n
6	uint8	Payload (n bytes)	Data load
6+n	Uint32	CRC_CEHCK (32-bit data low byte)	CRC check
7+n		CRC_CEHCK (low byte in 32-bit data)	
8+n		CRC_CEHCK (high byte in 32-bit data)	
9+n		RC_CEHCK (32-bit data high byte)	

Note 1: Data is transmitted in small-endian format, with low bytes first and high bytes last

Note 2: The initial value of crc32 is 1. CRC calculation does not include all the data of this frame itself. See the end of the document for table lookup calculation

7.2.3 Common AT instructions

7.2.3.1 Stop the current data stream output

Instruction: AT+SETNO\r\n

Answer: OK\r\n

You can stop the current data stream (without changing the Parameter of the data stream), and the output is OK, indicating that the next operation can be carried out.

If there is no response, you can continue to send AT\r\nAT+SETNO\r\n command until the output is OK.

7.2.3.2 Querying the version number

Instruction: AT+VERSION\r\n

Answer: SW_VERSION Firmware version
HW_VERSION Hardware version
BOARD_VERSION Base Plate version

None 7.2.3.3 Querying User Parameter

Instruction: AT+CONFIG\r\n

Answer: BAUD_RATE Baud rate of
the COM ORIENT current coordinate system
IMU_ODR Output frequency of the current IMU
STREAM_MODE1 STREAM_MODE2 Stream mode
of COM 2 STREAM_MODE3 Stream mode
of COM 3
LP_CONFIG_REG Filtering of the current IMU

7.2.3.4 Setting and Querying the ODR

Example: Set the output frequency ODR to 50hz

Command: AT+SET_ODR=50

Answer: IMU_ODR:50

Query the ODR command of the IMU
: AT+GET_ODR

Answer: IMU_ODR:

7.2.3.5 Setting and querying the coordinate system

Example: Set the IMU coordinate system to top right front

Instruction: AT+SET_ORIENT=101\r\n

Answer: orientation:101

Query the current IMU coordinate system

Instruction: AT+GET_ORIENT\r\n

Answer: orientation:

7.2.3.6 Setting and querying baud rate

Example: Set the baud rate of the IMU to 115200

Instruction: AT+SET_BAUD=115200\r\n

Answer: OK

Query the current baud rate of IMU

Instruction: AT+GET_BAUD\r\n

Answer: BAUD_RATE:

7.2.3.7 Setting and Querying Filters

Example: Set the filter of the IMU to 20hz

Instruction: AT+SET_LPF=20\r\n

Answer: LP_CONFIG_REG:20

Query the IMU current filter

Instruction: AT+GET_LPF\r\n

Answer: LP_CONFIG_REG:

7.2.3.8 Saving Parameter

Instruction: AT+SAVE\r\n

Answer: OK

7.2.4 Data Stream Frame — AHRS data

Table 15 AHRS data format of COM

	Frame header	Frame header	ID	length	payload	Frame trailer
Data type	uint8	uint8	uint16	uint16	A1	uint32
Coding	0xAA	0x55	0x0002	0x002C		crc32

Note 1: The maximum output Update Rate is not greater than 200Hz@115200bps

Table 16 COM A1 load data format

offset	name	Data type	Units	Description
0	timer	uint32	Mu s	Time scale
4	pitch	float	°	Pitch Angle
8	roll	float	°	Roll Angle
12	yaw	float	°	Course Angle
16	ax	float	g	X-axis acceleration
20	ay	float	g	Y-axis acceleration
24	az	float	g	Z-axis acceleration
28	gx	float	°/s	X axis Angular velocity
32	gy	float	°/s	Y-axis Angular velocity
36	gz	float	°/s	Z axis Angular velocity
40	temp	float	℃	IMU chip temperature

Example: Get AHRS data stream:

AA 55 02 00 2C 00 6D 89 16 05 8F C2 65 40 14 AE 07 BF 5C 0F B2 43 25 06 81 3D BC 74 13 3C 60 E5 80 BF EC 51 38 BD 0A D7 A3 BB CD CC CC BC D7 A3 EE 41 0C BF 84 80

The analysis is as follows:

Table 17 AHRS data flow obtained from COM A1

Descriptio	Raw Value	Analytic	Description	Raw Value	Analytic

n		value			value
ID	0200	02	Y-axis acceleration	BC74133C	0.009 g
Length	2C00	44	Z-axis acceleration	60E580BF	1.007 g
Time scale	6D891605	85363053	X axis Angular velocity	EC5138BD	0.045 ° / s
Pitch angle	8FC26540	3.59 °	Y-axis Angular velocity	0AD7A3BB	0.005 ° / s
Roll angle	14AE07BF	0.53 °	Z axis Angular velocity	CDCCCCBC	0.025 ° / s
Course Angle	5C0FB243	356.12 °	IMU chip temperature	D7A3EE41	29.83 ℃
X-axis acceleration	2506813D	0.063 g	crc32 Check	0CBF8480	2156183308

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7.2.5 Command Mode GET Output -- System status

Table 18 Serial port system status data format

	Frame Headers	Frame Headers	ID	length	payload	Frame tail
Data type	uint8	uint8	uint16	uint16	S1	uint32
Coding	0xAA	0x55	0x00FF	0x002A		crc32

Note 1: Depending on the IMU model, the length of this frame will vary, all represent the length of S1, need to be confirmed according to the IMU model.

Table 19 Load data format of serial port S1

offset	Name	Data type	Description
0	Software_ver	uint32	Software version number
4	Hardware_ver	uint32	Hardware version number
8	rev	uint16	Reserved bytes
10	sn0	uint32	First SN number
14	sn1	uint32	Second SN
18	sn2	uint32	Third SN
22	Board_version	uint32	Baseboard version number
26	Rev[16]	Uint8	All that follows is reserved bytes

Note 1: Reserved bytes vary based on the IMU model. The IMU614E is 16 bytes.

For example, obtain the IMU status

Enter data: 55 AA 01 00 18 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 BD DB 31 34

Response data: AA 55 FF 00 2A 00 1F 39 03 00 65 6F 01 00 50 83 30 33 35 55 34 50 15 FF 8F 5F FF FF 50 83 FF 1F 29 00 00 00 00 E0 00 07 10 17 08 50 D0 37 10 3B 7A C3 00 02

Based on the response data, the resolution yielded software version number 211231(1F 39 03 00) and hardware version number 94053(65 6F 01 00).

7.2.6 Command Mode GET output -- Read the Parameter

Table 20 COM Parameter Input data format

	Frame header	Frame header	ID	length	payload	Frame trailer
Data type	uint8	uint8	uint16	uint16	P1	uint32
encoding	0x55	0xAA	0x0006	0x0018		crc32

Table 21 Output data format of COM Parameter

	Frame headers	Frame Headers	ID	length	payload	Frame tail
Data type	uint8	uint8	uint16	uint16	P1	uint32
Coding	0xAA	0x55	0x7530	0x0018		crc32

Note 1: When reading Parameter, the IMU turns off the data stream

Table 22 Load data format of COM P1

offset	Name	Data type	Description
0	Param1	float	Obtained Parameter (input data can be ignored)
4	Param2	float	Keep, default to 0
8	Param3	uint32	Set the Parameter index
12	Param4	uint32	Reserved, the default value is 0
16	Param5	Int32	Keep, default is 0
20	Param6	Int32	Reserved. The default value is 0

Table 23 Index table of COM P1 load parameters

Param3	Param1	Units
3	The COM outputs the baud rate. The following baud rates are supported 115200 230400 460800 921600 1500000	bps
4	Coordinate system orientation (see Table 30 Coordinate System Orientation correspondence table)	
8	X-axis gyro zero bias calibration results, GYRO_X_OFF	°/s
9	Y-axis gyro zero bias calibration results, GYRO_Y_OFF	°/s
10	Z-axis gyro zero bias calibration results, GYRO_Z_OFF	°/s

21	AHRS output frequency, default 100Hz	Hz
31	Internal filter configuration, define the same SPI FILTER_CTRL table	

Example: Get AHRS output frequency

Input data: 55 AA 06 00 18 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 15 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 66 CB 46 AC

Response data: AA 55 30 75 18 00 00 00 00 48 42 00 00 00 00 00 00 00 00 15 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 31 2F A2 0A

According to the response data, the analysis results in an output frequency of 50hz (00 00 48 42).

7.2.7 Command mode SET instruction

Table 24 COM Input command format

	Frame header	Frame Headers	ID	length	payload	Frame tail
Data type	uint8	uint8	uint16	uint16	R1	uint32
Coding	0x55	0xAA	CMD	0x0018		crc32

Note 1: For details about the relationship between CMD and R1, see the R1 load Parameter index table

Table 25 COM R1 load data format

offset	Name	Data type	Description
0	Param1	float	Set Parameter
4	Param2	float	Keep, default to 0
8	Param3	uint32	Set the Parameter index
12	Param4	uint32	Reserved, the default value is 0
16	Param5	Int32	Keep, default is 0
20	Param6	Int32	Reserved. The default value is 0

Table 26 Index of Parameter of the COM R1 load

CMD	Param1	Param3	Description
1	0	0	Trigger to get system status data once
2	0	0	Trigger to obtain AHRS data once
3	<mode>	0	< mode > Set the output mode: Mode=1, data stream output AHRS Mode=100: disables the Stream Mode and enters the COMMAD mode
5	0	0	Save the current Parameter to FLASH
6	0	<value>	Read Parameter, value is the index of the Parameter to be read, that is, P1.index, see the COM response output - Parameter read For example, if you want to read AHRS output frequency (ODR), set value=21 For example, to read the baud rate of the COM, set the value to 3 For example, if you want to read the internal filter, set value=31 For example, if you want to read the coordinate system orientation, set value=4
9	0	0	Perform a software restart
14	<value>	3	To set the output baud rate of the serial port, the valid value in bps value is: 115200,230400,460800,921600,1500000 If value is other values, the default value is 115200bps After setting the baud rate parameter, you need to restart it for it to take effect. Procedure for setting the baud rate without power supply: Set the baud rate, save the parameter to the flash, and reset the software
14	<value>	21	Set the periodic AHRS data output frequency, common values in Hz value are: 1,10,50,100 Contact Primary Technology for other output frequencies
14	<value>	31	Internal filter configuration, defined as SPI accelerometer and gyro filter configuration, default 0xBB, i.e. 47Hz
14	<value>	4	Set the orientation of the IMU coordinate system. The value ranges from 101 to 124. See Table 30 for the corresponding relation of the orientation of the coordinate system

Note 1: Please note that all values in this table are in decimal

Note 2: The host computer command generator function can be used to generate corresponding commands to send, see the use of the host computer section of this manual

For example, to enable AHRS output:

CMD ID fill in 3, parameter 1 fill in 1, the generated hexadecimal array can be filled in the serial assistant or program array sent to the IMU.

7.2.8 Command Mode Output — User command response

Table 27 Setting parameters serial port response data format

	Frame Header	Frame Headers	ID	length	ACK	Param3	Frame end
Data type	uint8	uint8	uint16	uint16	uint16	uint16	uint32
Coding	0xAA	0x55	0x753D	0x0004	0x7534	Parameter index	crc32

Table 28 Reserved parameters Serial port response data format

	Frame Headers	Frame Headers	ID	length	ACK	result	Frame end
Data type	uint8	uint8	uint16	uint16	uint16	uint16	uint32
Coding	0xAA	0x55	0x753D	0x0004	0x0005	0x01	crc32

Table 29 Serial user command response data format

	Frame Headers	Frame Headers	ID	length	command	result	Frame Tail
Data type	uint8	uint8	uint16	uint16	uint16	uint16	uint32
Coding	0xAA	0x55	0x0064	0x0004	Command ID	0x01	crc32

Example: Set the serial output baud rate to 115200

Data input: 55, AA, 0 e, 00,18,00,00,00, E1, 47,00,00,00,00,03,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,56,2 B, 4 d, 93

Response data: AA 55 3D 75 04 00 34 75 03 00 A7 98 2A 54

Set the periodic AHRS data output frequency to 100hz

Input data: 55 AA 0E 00 18 00 00 00 00 C8 42 00 00 00 00 00 00 00 00 15 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 0A 2B 2C 8D

Response data: AA 55 3D 75 04 00 34 75 15 00 70 2D B2 48

Save the current parameter to FLASH

Input data: 55 AA 05 00 18 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 C9 2F E6 32

Response data: AA 55 3D 75 04 00 05 00 01 00 5A CF B1 7C

Set output mode to AHRS data stream

Input data: 55 AA 03 00 18 00 00 00 00 80 3F 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 52 D8 8E E8

Response data: AA 55 64 00 04 00 03 00 01 00 E7 87 E3 AD

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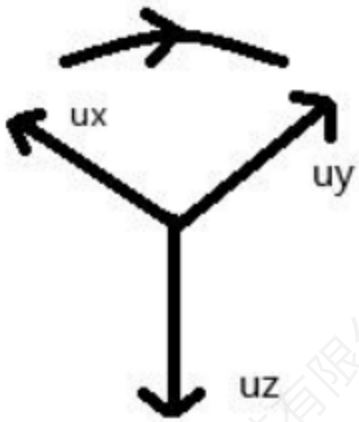
7.2.9 Coordinate system setting function

Set the firmware coordinate system and display the corresponding firmware design coordinate system in the upper computer

Figure 7 Original firmware coordinate system



According to the above rule, after x and y axes are determined, z axis is determined. The Z axis is perpendicular to the plane from the X to the Y axis.

There are a total of twenty-four orientations for the X/Y/Z triaxial axis, as shown in the table below:

The orientation of the coordinate system in Table 30 corresponds to the table

Orientation (value)	XAxis	YAXis	ZAxis	Instructions
101	+Ux	+Uy	+Uz	Default orientation
102	-Ux	-Uy	+Uz	
103	-Uy	+Ux	+Uz	
104	+Uy	-Ux	+Uz	
105	-Ux	+Uy	-Uz	
106	+Ux	-Uy	-Uz	
107	+Uy	+Ux	-Uz	
108	-Uy	-Ux	-Uz	
109	-Uz	+Uy	+Ux	
110	+Uz	-Uy	+Ux	
111	+Uy	+Uz	+Ux	

112	-Uy	-Uz	+Ux	
113	+Uz	+Uy	-Ux	
114	-Uz	-Uy	-Ux	
115	-Uy	+Uz	-Ux	
116	+Uy	-Uz	-Ux	
117	-Ux	+Uz	+Uy	
118	+Ux	-Uz	+Uy	
119	+Uz	+Ux	+Uy	
120	-Uz	-Ux	+Uy	
121	+Ux	+Uz	-Uy	
122	-Ux	-Uz	-Uy	
123	-Uz	+Ux	-Uy	
124	+Uz	-Ux	-Uy	

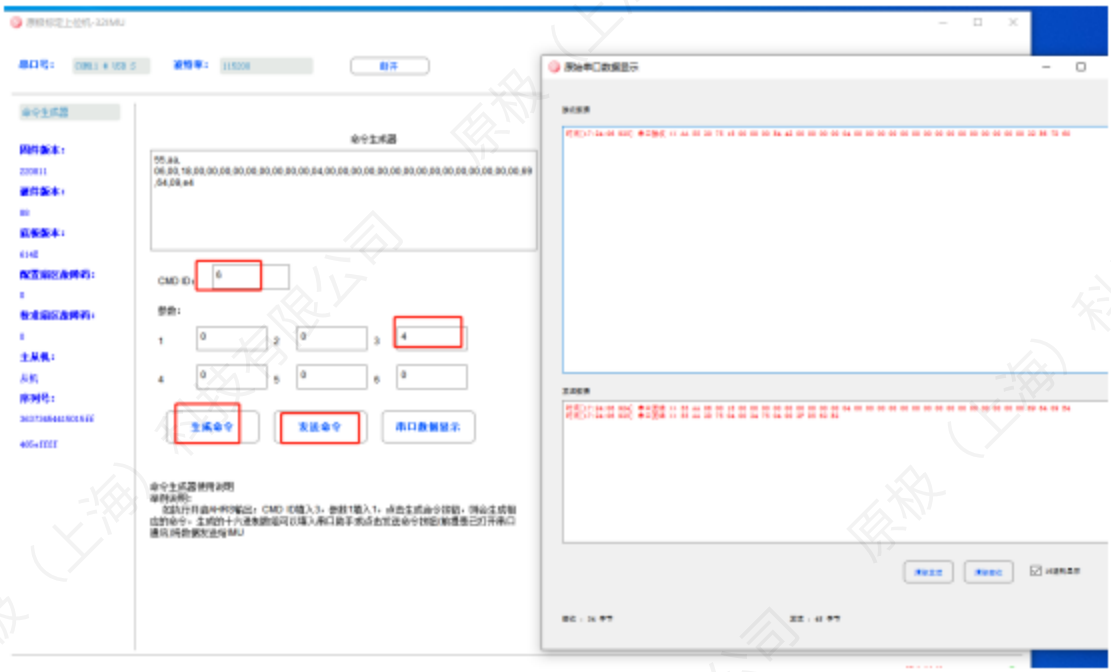
How to change the coordinate system to 102 orientation:

CMD ID fill in 14, parameter 1 fill in 102, parameter 3 fill in 4, and the resulting hexadecimal array can be filled into the serial assistant or program array and sent to the IMU.

How to read the coordinate system orientation:

CMD ID fill in 06, parameter 3 fill in 4, the resulting hexadecimal array can

be filled into the serial assistant or program array to send to the IMU.



Example: Set the coordinate system to face 115

Data input: 55, aa, 0 e, 00,18,00,00,00, e6,
42,00,00,00,00,04,00,00,00,00,00,00,00,00,00,00,00, 00,00,00,00,46,6 a, 4 e,
86

Response data: AA 55 3D 75 04 00 34 75 04 00 60 0E 6B 1B

According to Table 27, the index of Parameter is 04, and the parameter is set successfully

Read the coordinate system:

Input data: 55 AA 06 00 18 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 04 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 69 64 09 E4

Response data: AA 55 30 75 18 00 00 00 00 E6 42 00 00 00 00 00 00 00 00 04 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 B2 2F 2D 4E

According to Table 21 and Table 22, the resolution results in Parameter 1 being 115 (float) and Parameter 3 being 04. That is, the coordinate system is 115 orientation

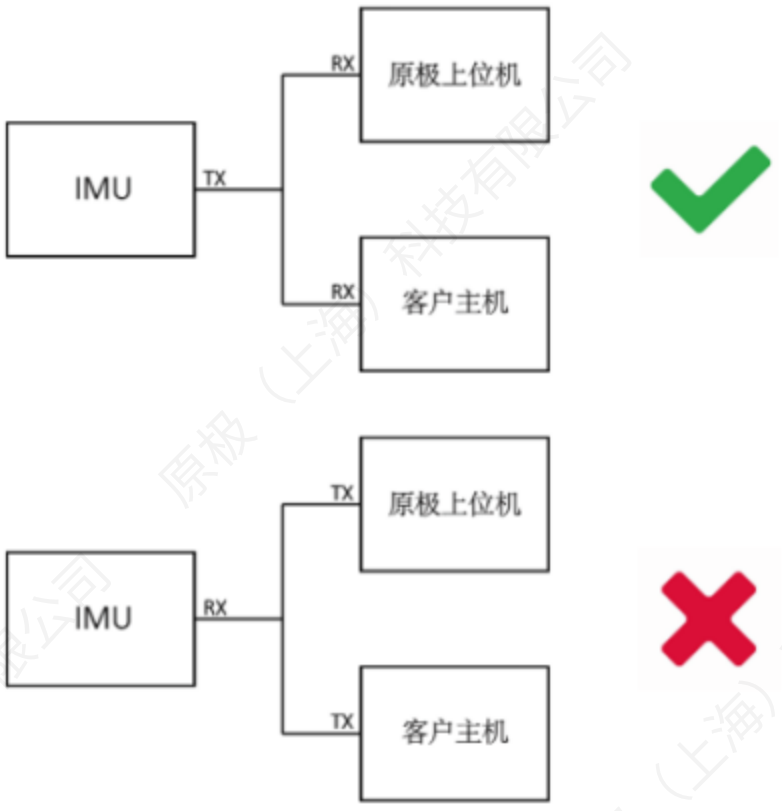
7.2.10 FAQs about COM Connection

1) The RX of the IMU cannot connect to two Master TX

The RX of the COM cannot be connected to two TX at the same time. Therefore, if the Forsense upper machine needs to be connected, it needs to disconnect the communication with the COM of the user's host. Otherwise, the upper computer cell can only receive data and cannot send commands to the IMU.

As shown in the following picture:

Figure 8 Schematic diagram of COM connection



注：IMU TX 可接多路 RX，RX 不可接多路 TX；
IMU串口不可同时连接客户主机和原极上位机；
IMU可以预留另外一路串口专门连接原极上位机。

2) The version number cannot be obtained

You are advised to use the COM of the FT232 chip. CH340 and PL2303 data cables may lose packets when the baud rate is high (>115200bps)

It is recommended that COM be connected directly, and it is not recommended to

be connected in series. If the interface of RS422 is connected to the computer, directly use RS422 to USB cable, and do not use RS422 to RS232+RS232Z to USB cable in series.

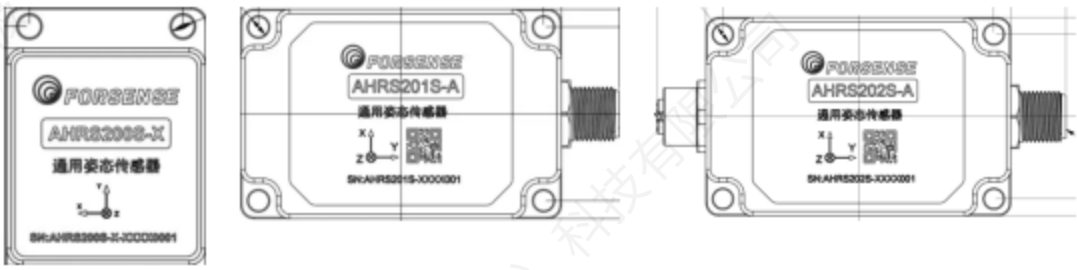
3) Upper computer software curve display lag

If it is an FT232 data line, use the system administrator to open the Upper computer software and automatically configure the COM delay

Manually configure COM delay in Device Manager.

8. Definition of coordinate system

Figure 9 Schematic diagram of coordinate system



The product coordinate system uses the forward-right-down (FRD) coordinate system, and the Euler Angle range is as follows:

Rotation around the Z axis: Yaw angle Yaw range: 0° ~360°;

Rotation around the X axis: Roll angle roll range: -180°~180°;

Rotation around the Y axis: Pitch angle pitch range: -90°~90°.

Roll, pitch, course Angle diagram is as follows:

FIG. 10 Schematic diagram of roll, pitch and Yaw angle

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9.CRC table lookup method calculation

```
C++
  static  const  uint32_t  crc32_tab [ ]  =  {
  0x00000000, 0x77073096, 0xee0e612c, 0x990951ba, 0x076dc419, None 706Af48F
  ,0xe963a535, 0x9e6495a3, 0x0edb8832, 0x79dcb8a4, 0xe0d5e91e, 0x97d2d988
  ,0x09b64c2b, 0x7eb17cbd, 0xe7b82d07, 0x90bf1d91, 0x1db71064, 0x6ab020f2
  ,0xf3b97148, 0x84be41de, 0x1adad47d, 0x6ddde4eb, 0xf4d4b551, 0x83d385c7
  ,0x136c9856, 0x646ba8c0, 0xfd62f97a, 0x8a65c9ec, 0x14015c4f, 0x63066cd9
  ,0xfa0f3d63, 0x8d080df5, 0x3b6e20c8, 0x4c69105e, 0xd56041e4, 0xa2677172
  ,0x3c03e4d1, 0x4b04d447, 0xd20d85fd, 0xa50ab56b, 0x35b5a8fa, 0x42b2986c
  ,0xdbbbc9d6, 0xacbcf940, 0x32d86ce3, 0x45df5c75, 0xdcd60dcf, 0xabd13d59
  ,0x26d930ac, 0x51de003a, 0xc8d75180, 0xbfd06116, 0x21b4f4b5, 0x56b3c423
  ,0xcfba9599, 0xb8bda50f, 0x2802b89e, 0x5f058808, 0xc60cd9b2, 0xb10be924
  ,0x2f6f7c87, 0x58684c11, 0xc1611dab, 0xb6662d3d, 0x76dc4190, 0x01db7106
  ,0x98d220bc, 0xefd5102a, 0x71b18589, 0x06b6b51f, 0x9fbfe4a5, 0xe8b8d433
  ,0x7807c9a2, 0x0f00f934, 0x9609a88e, 0xe10e9818, 0x7f6a0dbb,  0x086d3d2d
  ,0x91646c97,  0xe6635c01,  0x6b6b51f4,  0x1c6c6162,  0x856530d8,
0xf262004e
  ,0x6c0695ed,  0x1b01a57b, 0x8208f4c1, 0xf50fc457, 0x65b0d9c6, 0x12b7e950
  ,0x8bbeb8ea, 0xfcb9887c, 0x62dd1ddf, 0x15da2d49, 0x8cd37cf3, 0xfbd44c65
  ,0x4db26158, 0x3ab551ce, 0xa3bc0074, 0xd4bb30e2, 0x4adfa541, 0x3dd895d7
  ,0xa4d1c46d, 0xd3d6f4fb, 0x4369e96a, 0x346ed9fc, 0xad678846, 0xda60b8d0
  ,0x44042d73, 0x33031de5, 0xaa0a4c5f, 0xdd0d7cc9, 0x5005713c,  0x270241aa
  ,0xbe0b1010,  0xc90c2086,  0x5768b525,  0x206f85b3,  0xb966d409,
0xce61e49f
  ,0x5edef90e,  0x29d9c998, 0xb0d09822, 0xc7d7a8b4, 0x59b33d17, 0x2eb40d81
  ,0xb7bd5c3b, 0xc0ba6cad, 0xedb88320, 0x9abfb3b6, 0x03b6e20c, 0x74b1d29a
  ,0xead54739, 0x9dd277af, 0x04db2615, 0x73dc1683, 0xe3630b12, 0x94643b84
  ,0x0d6d6a3e, 0x7a6a5aa8, 0xe40ecf0b, 0x9309ff9d, 0x0a00ae27, 0x7d079eb1
  ,0xf00f9344, 0x8708a3d2, 0x1e01f268, 0x6906c2fe, 0xf762575d,  0x806567cb
  ,0x196c3671,  0x6e6b06e7,  0xfed41b76,  0x89d32be0,  0x10da7a5a,
0x67dd4acc
  ,0xf9b9df6f,  0x8ebeeff9,  0x17b7be43,  0x60b08ed5,  0xd6d6a3e8,
0xa1d1937e
```

```
  ,0x38d8c2c4,  0x4fdff252,  0xd1bb67f1,  0xa6bc5767,  0x3fb506dd,
0x48b2364b
  ,0xd80d2bda, 0xaf0a1b4c, 0x36034af6, 0x41047a60, 0xdf60efc3, 0xa867df55
  ,0x316e8eef, 0x4669be79, 0xcb61b38c, 0xbc66831a, 0x256fd2a0, 0x5268e236
  ,0xcc0c7795, 0xbb0b4703, 0x220216b9, 0x5505262f, 0xc5ba3bbe, 0xb2bd0b28
  ,0x2bb45a92, 0x5cb36a04, 0xc2d7ffa7, 0xb5d0cf31, 0x2cd99e8b, 0x5bdeae1d
  ,0x9b64c2b0, 0xec63f226,  0x756aa39c,  0x026d930a,  0x9c0906a9,
0xeb0e363f
  ,0x72076785,  0x05005713,  0x95bf4a82,  0xe2b87a14,  0x7bb12bae,
0x0cb61b38,0x92d28e9b
  , 0xe5d5be0d, 0x7cdcefb7, 0x0bdbdf21, 0x86d3d2d4, 0xf1d4e242,0x68ddb3f8
  , 0x1fda836e, 0x81be16cd, 0xf6b9265b, 0x6fb077e1, 0x18b74777,0x88085ae6
  , 0xff0f6a70, 0x66063bca, 0x11010b5c, 0x8f659eff, 0xf862ae69,0x616bffd3
  , 0x166ccf45, 0xa00ae278, 0xd70dd2ee, 0x4e048354, 0x3903b3c2
  ,0xa7672661, 0xd06016f7,  0x4969474d,  0x3e6e77db,  0xaed16a4a,
0xd9d65adc,0x40df0b66
  ,  0x37d83bf0,  0xa9bcae53,  0xdebb9ec5,  0x47b2cf7f,
0x30b5ffe9,0xbdbdf21c
  , 0xcabac28a, 0x53b39330, 0x24b4a3a6, 0xbad03605, 0xcdd70693,0x54de5729
  , 0x23d967bf, 0xb3667a2e, 0xc4614ab8, 0x5d681b02, 0x2a6f2b94,0xb40bbe37
  , 0xc30c8ea1, 0x5a05df1b,  0x2d02ef8d
  ,}
  uint32_t  crc_crc32(uint32_t  crc,  const  uint8_t  *buf,  uint32_t size)
{for  (uint32_t
    i=0;  i<size ;  i++)  {crc
  =  crc32_tab [ (crc  ^  buf [i ] )  &  0xff]  ^  (crc  >>  8 ) ;
  }
  return crc;
  }
```

10 Match accessories

USB to CAN module

485 COM

232 COM

TTL COM

Power signal pair cable

11 Update the record

Versions	Dates	Status/Comments
Version 1.0	2023.07.18	First issue
Version 1.1	2023.10.07	Update coordinate system definition

Version 1.2	2023.12.14	Add attachments
Version 1.3	2024.04.16	Added 201S-A&202S-A series

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