Catalogue

1. Product introduction

1.1 Technical Specifications

Attitude accuracy	Roll/Pitch :<0.2° rms Heading:<0.1° rms (Dual antenna use, 0.1°/1m baseline)	
Update rate	100hz	
Gyro range	±2000°/s	
Zero bias gyroscopic instability	2deg/ h@1σ	
Accelerometer range	±32g	
Accelerometer zero bias instability	0.02mg @1σ	
Position reckoning accuracy	< 30m@1σ (Lost star 1min, drone scene)	
Course holding accuracy	<2 deg @1σ < 2 deg @1min (Lost star, drone scene)	
RTK Metrics	Horizontal Positioning accuracy (RMS)	Single point: 1.5mRTK :1cm+1ppm
	Elevation positioning accuracy (RMS)	Single point: 2.5mRTK :1.5cm+1ppm
	Dual antenna directional accuracy (RMS)	0.1°/1m baseline
	Velocity Accuracy (RMS)	0.03 m/s
	PPS Accuracy (RMS)	20ns
	Replacement rate	10hz
	RTK initialization time	<5s

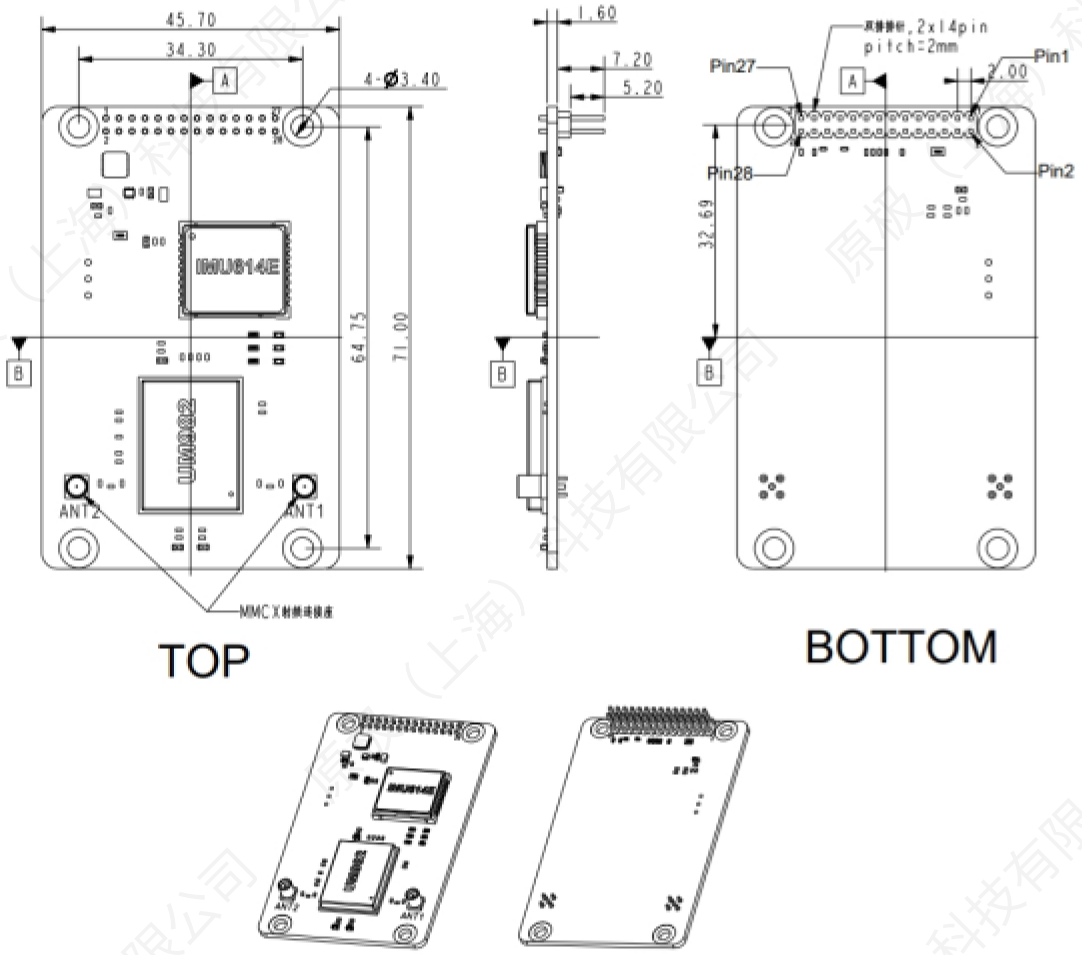
1.2 Product Overview

To meet the requirements of precision positioning and continuous positioning in UAV scenarios, a board level integrated navigation product FS982-UAV is designed based on the array IMU module and integrates the full-frequency high-precision positioning and orientation module UM982 of Xinskycom's whole system. The built-in multi-model intelligent position fusion algorithm of the primary pole is designed for UAV scenarios. It can provide UAV customers with high-precision continuous positioning and velocity measurement in the complex application scenarios of attitude, heading and occlusion interference. It can help the reliable operation of UAVs in all scenarios and improve the terminal application experience.

2. Hardware composition

2.1 Mechanical dimensions

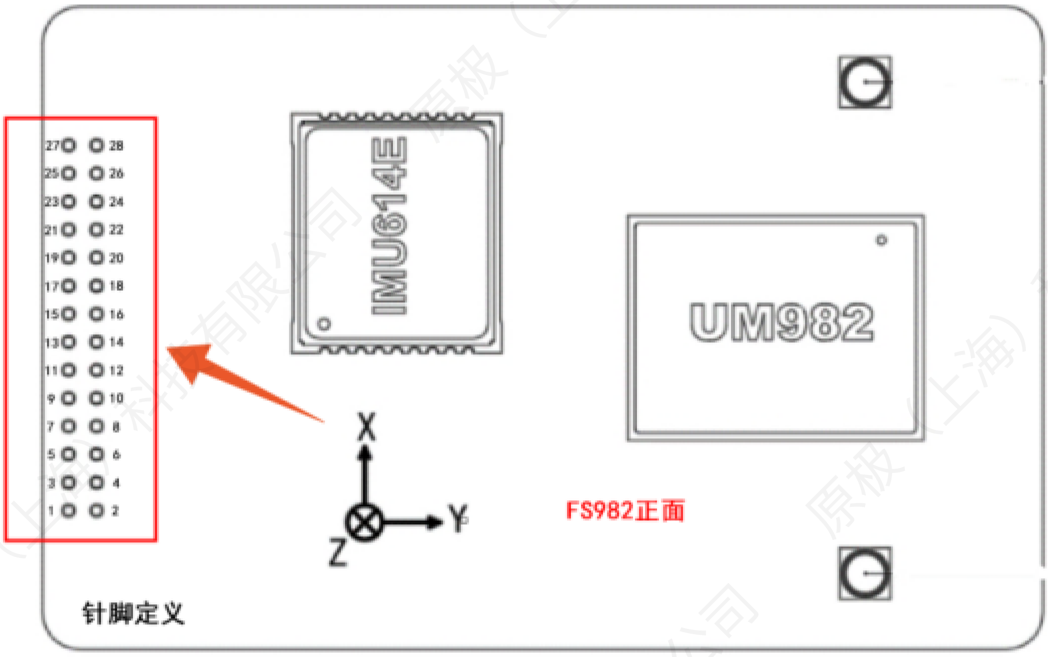
Figure 1 Mechanical dimensions (unit: mm)



2.2 Connector and PIN pin definition

In addition to ANT1 and ANT2 MMCX interfaces, FS982-UAV provides the following 28pin Cvilux double-row pins with pin spacing: 2.0mm; Pin length: 3.9mm; Seat thickness: 2.0mm.

Figure 2 Schematic diagram of the connector PIN



2.3 Pin function description

Table 1 Pin description

Pins	Signals	Input/output	Description	Remarks
1	RSV	-	Reserved	-
2	RSV	-	Reserved	-
3	RSV	-	Reserved	-
4	RSV	-	Reserved	-
5	RSV	-	Reserved	-
6	VCC	Power	Power input	5VDC
7	RSV	-	Reserved	-
8	RXD2_IMU	I	IMU COM 2 Receive (for firmware upgrade)	LVTTL level
9	RSV	-	Reserved	-
10	RSV	-	Reserved	-
11	RSV	-	Reserved	-
12	RSV	-	Reserved	-
13	TXD2_IMU	O	IMU serial port 2 Send (for firmware upgrade)	LVTTL level

14	GND	Power	Digital and Ground (GND)	
15	TXD1_IMU	O	IMU serial port 1 Send (user use)	LVTTL level
16	RXD1_IMU	I	IMU serial port 1 Receive (user use)	LVTTL level
17	GND	Power	Digital and power ground	
18	TX2_982	O	982 Serial port 2 Send	LVTTL level
19	RX2_982	I	982 Serial port 2 Receive	LVTTL level
20	GND	Power	Digital and power ground	
21	RSV	-	Reserved	-
22	GND	Power	Digital and power ground	
23	PPS	O	Time synchronization signal	LVTTL level
24	RSV	-	Reserved	-
25	RSV	-	Reserved	-
26	CAN_TX	O		LVTTL level
27	RSV	-	Reserved	-
28	CAN_RX	I		LVTTL level

2.4 Electrical Characteristics

Table 2 Maximum absolute rating

Parameters	Symbols	Minimum value	Maximum	Units
Supply voltage (VCC)	Vcc	-0.3	5.5	V
Input pin voltage	Vin	-0.3	3.3	V
VCC maximum ripple	Vrpp	0	40	mV
Input pin voltage (All other pins other than the foregoing)	Vin	-0.3	3.6	V
Main antenna RF input power	ANT1_IN input power		Plus or minus 15	dBm
Input power from the antenna RF	ANT2_IN input power		Plus or minus 15	dBm
Maximum acceptable ESD stress level	VESD(HBM)		±2000V	V

2.5 Operating Conditions

Table 3 Operating conditions

Parameters	Symbols	Minimum value	Typical value	Maximum value	Units	Conditions
Supply voltage (VCC)		4.75	5	5.25	V	
Power-on impulse current	Iccp			10	A	Vcc=5V
Input pin low level	Vin_low_1	-0.3		0.9	V	
Input pin high	Vin_high_1	2.4		3.6	V	
Output pin low	Vout_low	0		0.45	V	Iout=4mA
Output pin high	Vout_high	2.85		3.3	V	Iout=4mA
Optimum input gain	Gant	20		36	dB	
Power consumption	P		1.15		W	

2.6 Physical Characteristics

Table 4 Physical characteristics

Operating temperature	- 40 ℃ ~ + 85 ℃
Storage temperature	- 55 ℃ ~ + 95 ℃
Humidity	95% non-condensation

3 Hardware integration Guide

3.1 Design considerations

1. In order for the FS982-UAV to function properly, the following signals need to be properly connected:
2. The module VCC has good monotony when powered on, and the starting level is below 0.4V, and the downstroke and ringing are guaranteed in the 5%VCC range
3. Use VCC Pin to provide reliable power and ground all GND Pin of the board
4. ANT1, ANT2 MMCX interface provides feed to the antenna, module antenna port, no antenna, using a multimeter test, that is, the voltage provided when no load is DC4.8~5.4V; When the module RF port is connected to the antenna, it can provide DC4.6V±0.2V antenna feed when the working current is 30~100mA at normal temperature. Pay attention to the line 50 ohm impedance matching
5. Ensure that the COM 1 on the IMU outputs data. You need to use this COM to receive data on the IMU.
6. Ensure that the COM on the IMU is connected to a pad or connector. The COM is required for firmware upgrade
7. Ensure that the 982 COM 2 is output. You need to use this COM to receive location information
8. Board reset Pin FRESET_N to restore the board factory Settings, RESETIN to fast reset, please connect correctly to ensure that the board can be reliably reset
9. In order to obtain good performance, the design should also pay special attention to the following items:
10. Power supply: Good performance requires stable and low ripple power supply guarantee. Ripple voltage peak peak value should not exceed 50mVpp. It is recommended to use a power chip with current output capacity greater than 2A to supply power to the board. In addition to using LDO to ensure pure power supply, it is also necessary to consider:
11. – Widen power cables or use split copper surfaces to transmit current
12. – Place the LDO as close to the LDO as possible
13. – Do not route power cables through high-power and high-inductive devices such as magnetic coils
14. The UART interface ensures that the signals and baud rates of the user Master are consistent with those of the FS982-UAV board
15. The antenna line should be as short and smooth as possible, avoid going at acute angles and pay attention to impedance matching
16. Avoid running lines directly below the FS982-UAV
17. Try to keep the board away from hot air currents

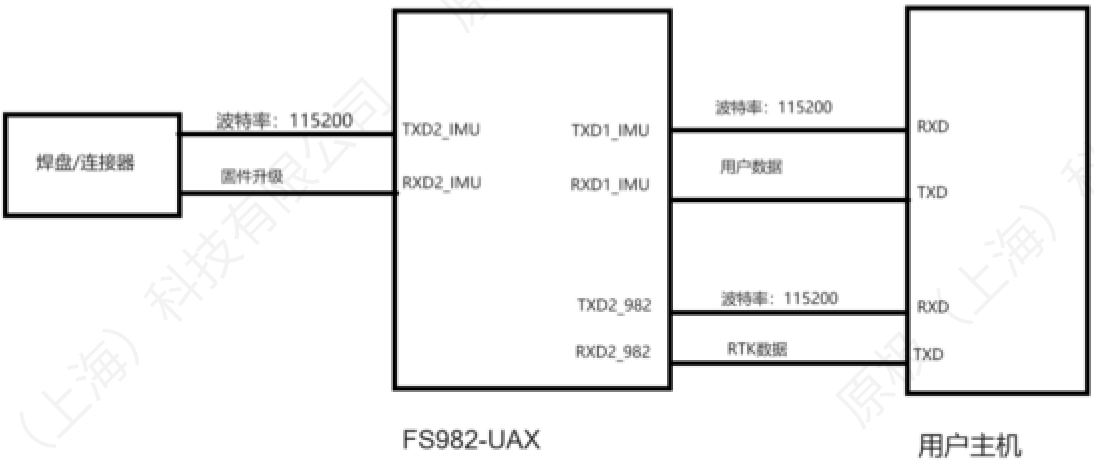
3.2 Pin Precautions

Feature	Pin	I/O	Description	Remarks
Power Supply	VCC	Power supply	Power supply	Stable, pure and low ripple power supply, ripple voltage peak peak value should not exceed 50mVpp
	ANT1/ANT2	Power supply	Antenna power	Active antennas provide power for the corresponding voltage. Module antenna port, no antenna, using a multimeter test, that is, when no load to provide voltage DC4.8~5.4V; When the module RF port is connected to the antenna, it is tested when the working current is 30~100mA at normal temperature. Can provide DC4.6V±0.2V antenna feed.
	GND	Power supply	to	Ground all GND signals on the board , and it is best to use a large area of copper for grounding
UART	TXD1_IMU	O	IMU serial port 1 Send	Output from serial port 1 on the IMU, which needs to be connected to the user host
	RXD1_IMU	I	IMU serial port 1 Receive	
	TXD2_IMU	O	IMU serial port 2 Send (for firmware upgrade)	IMU serial port 2 Output, connected to a pad or connector for firmware upgrade
	RXD2_IMU	I	IMU serial port 2 Receive (for firmware upgrade)	
	TXD2_982	O	982 Serial port 2 Send	982 Serial port 2 Output, needs to be connected to the user host
	RXD2_982	I	982 Serial port 2 Receive	

Table 5 Pin notes

3.3 Hardware wiring methods

Figure 3 Hardware connection method



3.4 Antenna

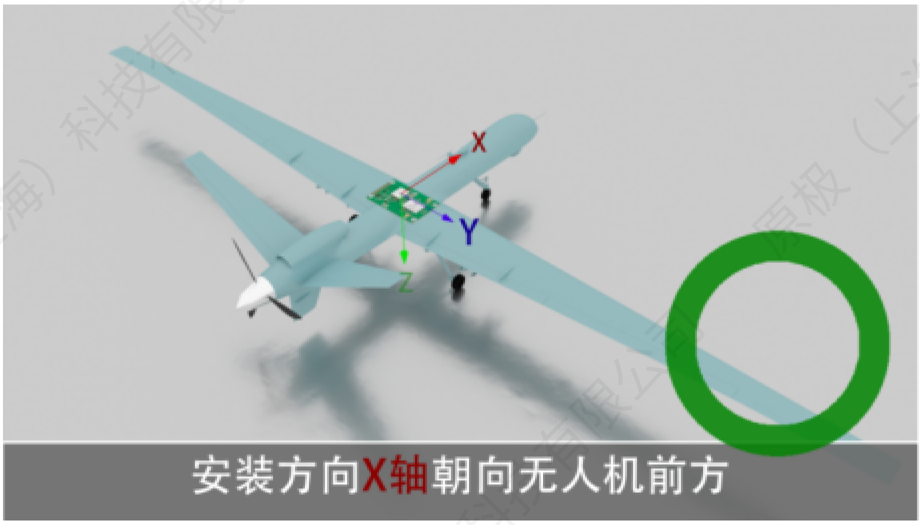
FS982-UAV board antenna input ANT1 and ANT2 MMCX interfaces to provide antenna feed, ANT1 and ANT2 antenna ports, no antenna, using a multimeter test, that is, the supply voltage is DC4.8~5.4V when unloaded; When the RF port of the module is connected to the antenna, it can provide DC4.6V±0.2V antenna feed when the working current is 30~100mA at normal temperature. When the active antenna is used on the FS982-UAV board, pay attention to the 50 ohm impedance matching between the antenna and the active antenna.

4. Use examples

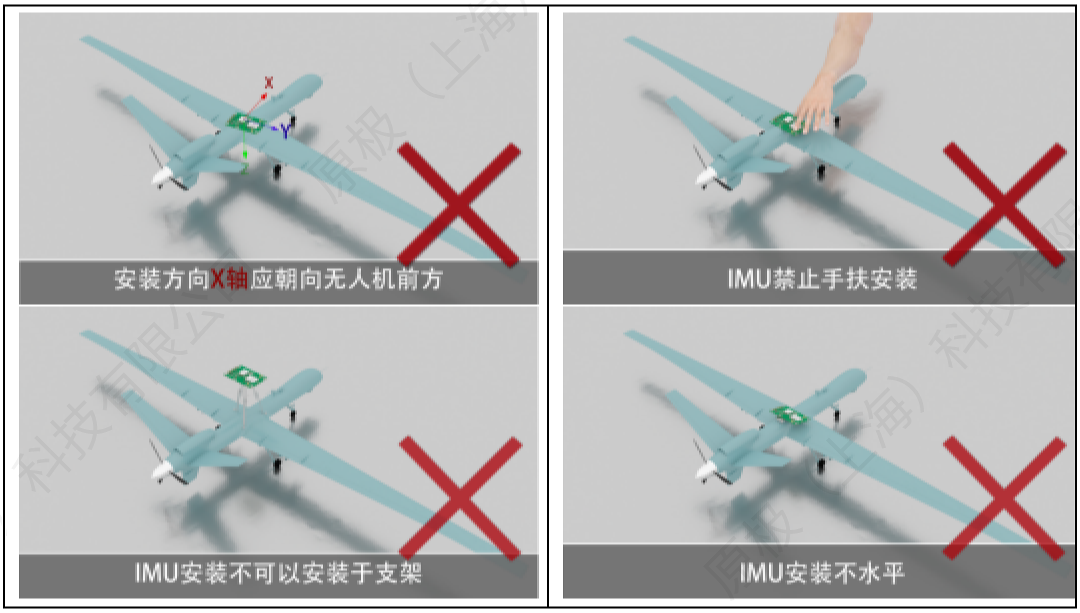
4.1 Equipment Installation

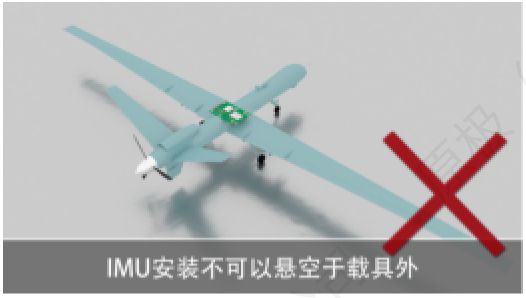
1. The module should be firmly fixed on a rigid plane to avoid being installed in a position with large vibration.
2. The module should be installed in the same direction as the head of the aircraft. The following installation diagram takes the body as an example, and the direction of the body head should be consistent when installed in the UAV.

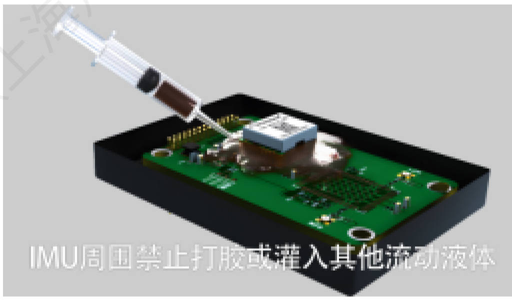
Figure 4 Correct installation diagram



The following installation methods are all wrong installation




IMU安装不可以悬空于载具外


IMU周围禁止打胶或灌入其他流动液体

4.2 RTK Differential data Import

The user must log in the network CORS account of Chihiro or six points through the user host, and output GPGGA message to the differential server by the RTK board (serial port will automatically output the statement for a while), the differential server will return the differential data and forward it back to the RTK serial port, so that RTK enters the fixed solution state, and can also complete the initialization based on the single point solution.

4.3 Parameter Configuration

4.3.1 Configuring the Baud Rate

If required, set the baud rate to 230400

Instruction: AT+SET_BAUD=230400

Answer: OK\r\n

4.3.2 Configuring the output frequency

Example: Set the output frequency to 100HZ

Instruction: AT+SET_ODR=100\r\n

Answer: IMU_ODR: 100\r\n

4.3.3 Configuring the main mast arm

To configure the pole arm, you need to enter the value in centimeter units, and the configuration value is the input value minus 200cm, for example, the configuration pole arm vector is X=0.5m,Y=-0.6m,Z=-1.0m

Instruction: AT+SETGPSX=250\r\n AT+SETGPSY=140\r\n AT+SETGPSZ=100\r\n

Answer: GPS_IMU_X: 50 GPS_IMU_Y=-60 GPS_IMU_Z=-100

Description: The rod arm vector is the three-dimensional vector (X,Y,Z) of the phase center of the main antenna of RTK relative to the phase center of the IMU, and the unit of the configuration instruction is centimeters. Where,

In the front lower right coordinate system

If the RTK main antenna is in front of the IMU, it is positive, otherwise it is negative;

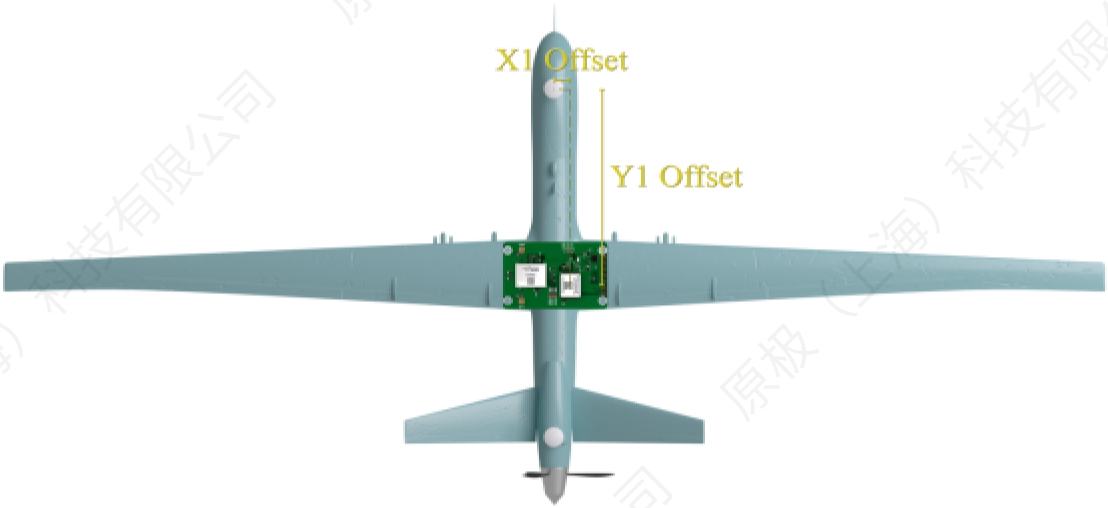
If the RTK main antenna is to the right of the IMU, it is positive, otherwise it is negative;

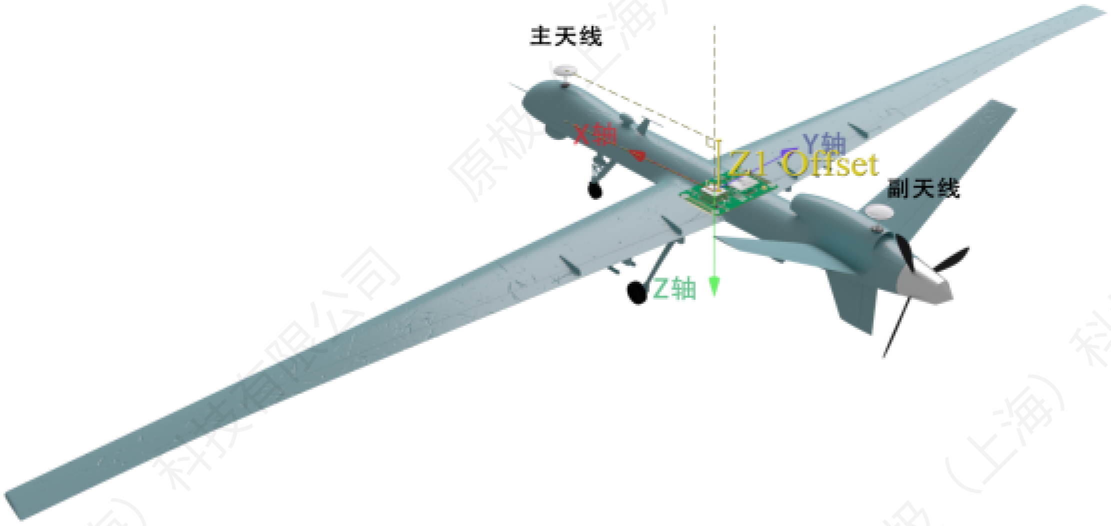
If the RTK main antenna is above the IMU, it is a **negative number**, otherwise it is a positive number (generally the antenna is above the device).

The coordinate system diagram is as follows: (Label should face up; if the IMU is not installed according to the following figure, the installation orientation should be configured)

FIG. 5 Coordinate system diagram

Figure 6 Diagram of the mast arm





4.3.4 Configuring the RTK Double antenna mounting Angle

The input value of double antenna Angle needs to be reduced by 180 degrees, if the configuration of RTK double antenna installation Angle is 0 degrees, the configuration instruction is:

Instruction: AT+RTKANGLE=180\r\n

Answer: RTK_ANGLE: 0\r\n

Description: The installation Angle is the Angle between the ray of the main antenna pointing to the secondary antenna and the direction of the front, clockwise is positive, counterclockwise is negative, and the Angle input range is -180°~180°

Note: After the configuration instruction is saved, power off and restart it to take effect; The distance between two antennas should be greater than 50cm

4.3.5 Configuring the Single point solution initialization

If there is no differential signal, single point solution initialization can be configured:

Instruction: AT+SINGLE=0\r\n

Answer: SETTING: 0\r\n

4.3.6 Setting and querying the coordinate system

Example: Set the coordinate system to the front right (default coordinate system), other coordinates refer to Table 1 coordinate system towards the corresponding table

Instruction: AT+SET_ORIENT=101\r\n

Answer: orientation:101

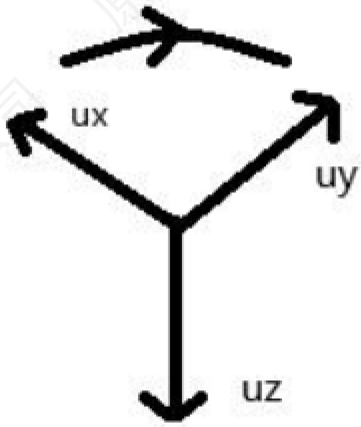
OK

Query the IMU current coordinate system

Instruction: AT+GET_ORIENT\r\n

Answer: orientation: current coordinate system

Figure 10 Firmware original 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 24 orientations for the X/Y/Z axis, as shown in the table below:

Table 1 Coordinate system orientations correspond to tables

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	

4.3.7 Save parameters

After all configuration instructions are configured, the SAVE parameter instruction "AT+SAVE\r\n" should be sent.

5. Output protocol

5.1 Combined navigation data flow description

Note:

- CRC check starts from the header of the frame, does not include CRC check bit itself, CRC check for all bytes of the frame, check calculation method and routine see section 7.
- The frame length is the total number of all data bytes except the frame header, frame ID, frame length and check bit.
- In small-endian mode, the low bytes are sent first

The configuration instructions are:

Instruction: AT+SETNAV\r\n

Answer: STREAM MODE: NAV\r\n

If the configuration does not output, the configuration instruction is:

Instruction: AT+SETNO\r\n

Answer: STREAM MODE: COMMAND MODE\r\n

Table 6 Binary Protocol - Compositional navigation data flow

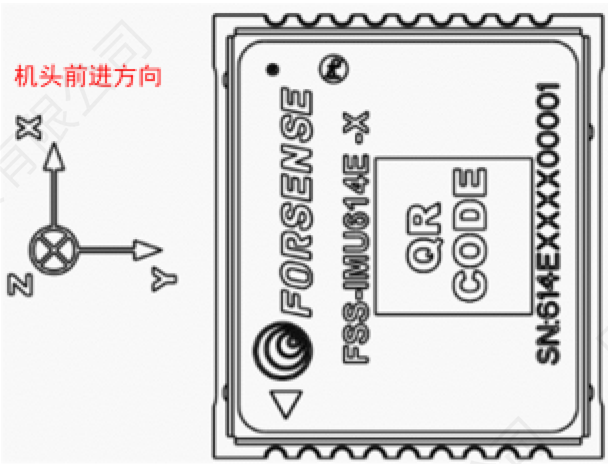
Content	Type	Relative position
Frame head 1:0 xAA	Uint8	0
Frame header 2:0x55	Uint8	1
Frame ID: 0x0166	Uint16	2
Frame length: 0x005E	Uint16	4
Seconds within a GPS week (ms)	Uint32	6
GPS Weekly count	Uint16	10
Latitude (degrees x 10000000)	Int32	12
Longitude (degrees x 10000000)	Int32	16
Height (mm)	Int32	20
Northbound speed (m/s)	Float	24
Eastbound velocity (m/s	Float	28
Ground velocity (m/s)	Float	32
Roll Angle (degree)	Float	36
Pitch Angle (degree)	Float	40
Heading Angle (degree)	Float	44
Single antenna case: AHRS Course (degrees) (no	Float	48

reference value) Dual antenna case: RTK dual antenna course (degree)		
Reserved	Float	52
Accelerometer X axis (g)	Float	56
Accelerometer Y-axis (g)	Float	60
Accelerometer Z-axis (g)	Float	64
Gyroscope X axis (deg/s)	Float	68
Gyroscope Y-axis (deg/s)	Float	72
Gyroscope Z-axis (deg/s)	Float	76
IMU Temperature (C)	Float	80
RTK positioning state (same as positioning state in GGA) 0: unpositioning 1: single point positioning 2: pseudo-distance differential positioning 4: fixed solution 5: floating point solution	Uint8	84
Number of satellites	Uint8	85
Differential delay	Uint8	86
Dual antenna orientation status 50 indicates that the antenna is oriented . Others indicate that the antenna is not oriented	Uint8	87
Position precision factor (cm) Integrated Navigation is valid after initialization	Uint16	88
Status bits: bit0:1 indicates that the RTK data is valid, 0 indicates that it is invalid Bit1:1 indicates that the PPS signal is valid, 0 indicates that it is invalid Bit2:1 indicates that the Integrated Navigation is initialized, 0 indicates that it is not initialized Bit3:1 indicates that the front wheel Angle is valid, and 0 indicates that it is invalid Bit4:1 indicates that Integrated Navigation has converged and 0 has not Bit5:1 means the front wheel gyro data is valid and 0 is not Bit6:1 means the steering wheel motor data is valid and 0 is not	Uint16	90

Bit7, Bit8: 01 indicates vehicle forward 10 means the vehicle is moving backwards 00 means invalid		
Reserve 1	Uint32	92
Reserved 2	Uint32	96
CRC check	Uint32	100

6. Definition of coordinate system

Figure 7 Diagram of coordinate system



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

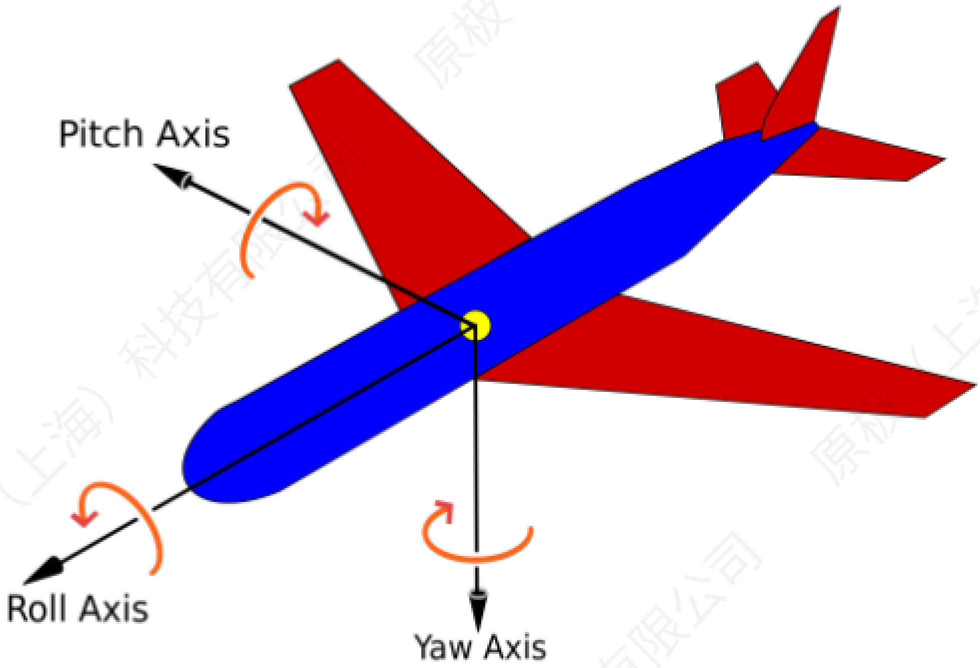
Rotation around the Z axis: course Angle Yaw range: 0° ~360°, clockwise is positive, counterclockwise is negative;

Rotation around the X-axis direction: Roll Angle roll range: -180°~180°, right tilt is positive, left tilt is negative;

Rotation around the Y-axis direction: Pitch Angle range: -90°~90°, head up is positive, head down is negative.

Roll, pitch, heading Angle diagram is as follows:

FIG. 8 Schematic diagram of roll, pitch and heading Angle



7. CRC table lookup method calculation

It is recommended to refer directly to the example code.

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, and CRC calculations do not include all the data in this frame itself

```
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, 0xe8b8d433,
 0x7807c9a2, 0x0f00f934, 0x9609a88e, 0x01db7106,0x98d220bc, 0xefd5102a,
0x71b18589, 0x06b6b51f,
 0x9fbfe4a5, 0xe8B8D433, 0x7807C9A2, 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, None 73DC1683, 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;
 }
```

8 Update the record

Version	Dates	Status/Comments
Version 1.0	2024.12.06	First Edition