MKT4052MEMS Inertial-Satellite Integrated Navigation System

User Manual

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1. System Overview

The MKT4052 Dual-Antenna MEMS Inertial-Satellite Integrated Navigation System leverages high-precision MEMS (Micro-Electro-Mechanical System) gyroscopes, accelerometers, and multi-mode, multi-frequency GNSS (Global Navigation Satellite System) receivers to provide dual-antenna-assisted, rapid, high-precision heading and integrated navigation functions. The system calculates real-time carrier position, velocity, heading, and attitude information, offering resistance to signal blockage and multipath interference. It ensures long-term, high-precision, and reliable navigation even in complex environments.The system supports real-time GNSS RTK (Real-Time Kinematic) functionality, using a compact design that is lightweight and small in size. It provides standardized communication protocols and excellent scalability.

This product can be widely used in fields such as autonomous driving, advanced driver assistance systems (ADAS), unmanned vehicles, robots, mapping vehicles, high-speed trains, ships, drones, aerial surveying, and agricultural machinery.

The product comes with accessories such as feedlines and antennas, with optional ground RTK reference stations and 4G communication modules available.

MEMS惯性-卫星
组合导航系统主机

4G通信模组

RTK参考站

卫星天线

Figure 1 MEMSInertial-satellite integrated navigation system

2. System composition

2.1 Hardware

	Product Name	Quantity	Unit	Remark
1	MEMS Inertial-satellite integrated navigation system Host	1	Tower	
2	Feeder	1	Root	
3	Satellite dish	2	Set	Optional satellite antennas of different models
4	4G Communication module (4G Module) (select match)	1	Indivual	Accessories include 4G antenna1 root, 4G Module Connection line 1 root
5	Ground terminal RTK Reference station (optional)	1	Set	Satellite antenna included 1 Set, Electric Source Line 1 root, 4G antenna 1root

2.1.1 MEMS Inertial-satellite integrated navigation system host

Figure 2 MEMSAppearance of the main unit of the inertial-satellite integrated navigation system

① ANT1 Main Antenna SMA Interface

② J30J Connector Socket

③ ANT2 Secondary Antenna SMA Interface

④ Power Indicator Light, solid when power supply is normal

⑤ Positioning Indicator Light, blinking when positioning is successful

⑥ Work Indicator Light, blinking when the system is operating normally

2.1.2Feeder and interface

	Name	Level	Interface Type	Interface Definition	Interface Function
①	COM 1	RS232Level	DB9interface	2-TX 3-RX 5-GND	Data output interface, at the same time Configurable AT Order
②	Power cord		DC Power Interface		Catch 4G Module or digital transmission Power supply
③	COM 2	RS232 Level	DB9 interface	2-TX 3-RX 5-GND	catch4GModule or digital transmission Radio station, transmissionRTCM data
④	COM 1	RS422 Level	DB9 interface	1-RX_P 2-RX_N 3-TX_P 4-TX_N	Data output interface, at the same time Configurable AT Order
⑤	Main power cord		DC Power Interface		System main power supply, rated 12V/1Apowered by
⑥	J30J connect Plug				

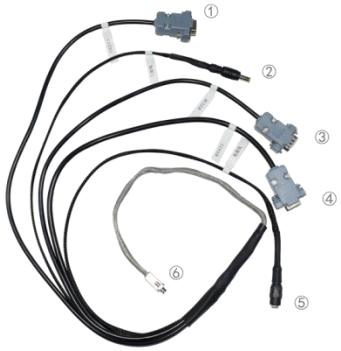


Figure 3 Feeder and interface appearance

2.1.3 Satellite dish

Figure 4 Satellite antenna appearance

2.1.4 4G Communication module (4G Module) (Optional)

① 4G Antenna Interface

② J30J Connector Socket

③ DC Power Cable

④ RTCM Port, outputs RTCM signal

⑤ Configuration Port, connects to a computer for configuring differential information for the 4G module

⑥ J30J Connector Plug, connects to the 4G module interface of the main 4G module host

Figure 5 4G ModuleHost appearance

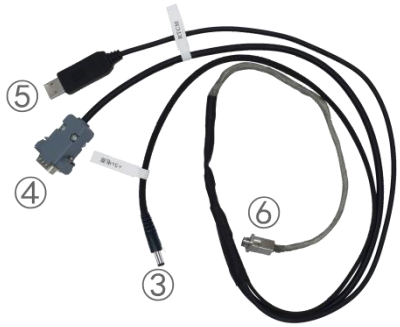


Figure 6 4G ModuleConnection cable appearance

2.1.5 Ground terminal RTK Reference station (optional)

Figure 7 Ground terminal RTK Reference station appearance

	Name	Illustrate
a	Battery indicator	Green Light: High battery level Blue Light: Medium battery level Blue Light Blinking: Low battery level
b	Charging port	Catch DC Charging cable

c	GNSS lamp	No light: Indicates that positioning has not been successful 1-second blinking (1 blink per second): Indicates that the module is receiving GNSS signals
d	RTK lamp	No light: Indicates that RTK data is not being transmitted Fast blinking: Indicates that RTK data is being transmitted
e	Work lamp	No light: Indicates that the system has not started successfully and is not in working statusSolid light: Indicates that the system has started successfully and is in working status
f	Power switch	Short press to turn on, short press to turn off
g	Charging indicator	When it is always on, it means it is in charging state, and it will automatically go out when it is fully charged.
h	4GAntenna interface	Catch 4G antenna
i	WIFIAntenna interface	Catch WIFI antenna
j	Debug interface	For debugging use
k	GNSSAntenna interface	Satellite antenna connection

Figure 8 4G antenna appearance

Figure 9 WIFI antenna appearance

2.2 Software

2.2.1 Serial Port Assistant Tool:UartAssist

Figure 10 Serial Port Assistant Tool Icon

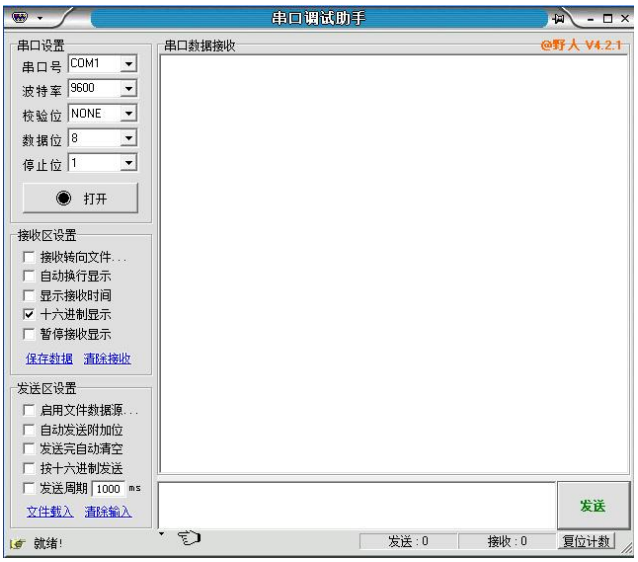


Figure 11 Serial Port Assistant Tool Main Interface

2.2.2 Host computer software: GkTest2

Figure 12 Host computer software icon

Figure 13 Main interface of host computer software

3. Technical Parameters

System indicators			
1	Heading accuracy	0.2°(Baseline length1m)(1σ)	
2	Pitch and roll accuracy	0.2°（1σ）	
3	Position accuracy	Single Point≤2m（CEP）	
		RTK≤2cm+1ppm（CEP）	
4	Speed accuracy	＜0.05m/s（1σ）	
5	GNSS Frequency band	GPS:L1 C/A, L2C,	
		BeiDou:B1, B2	
		GLONASS:L1,L2	
6	GNSS Loss of lock accuracy	0.3% (the ratio of error to distance loss)	
7	Data update rate	100Hz (Configurable)	
8	Initialization time	＜10s	
9	Time to First Fix	＜35s	
10	Orientation time	＜1min	
Inertial device characteristics			
11	Gyro	Range	±300°/s
		Bias stability	5.5°/h
12	Accelerometer	Range	±6g
		Bias stability	0.06mg
Communication interface			

13	Interface	supportRS232,RS422,and1Single-ended signal (PPS)
14	Transfer rate	115200~460800bps(Configurable)
Physical dimensions and electrical characteristics		
15	Supply voltage/operating current	24V DCRated (10~32V DC) /2A
16	Size	116*83*37mm
17	Weight	＜362g
18	Protection level	IP65
19	Operating temperature	-25°C~+65°C

4. Communication protocols and commands

4.1 Communication Protocol

The module can output three types of protocols: GIAVP, Hexadecimal Protocol 1, and Hexadecimal Protocol 2.The output baud rates are configurable: 115200, 256000, and 460800.mathematica
$GIAVP,GPSWeek,GPSTime,Heading,Pitch,Roll,Lattitude,Longitude,Altitude,Ve,Vn,Vu,Baseline,Nsv1,Nsv2,Status,SpeedStatus,VehicleSpeed,AccX,AccY,AccZ,GyroX,GyroY,GyroZ*cs<CR><LF>

Field Number	Name	Illustrate	Format	Example
1	Header	Protocol Header	$AACCC	$GIAVP
2	GPSWeek	since1980/1/6To current week number (Greenwich Mean Time)	wwww	1451
3	GPSTime	This Sunday0:00:00To current Seconds	ssssss.sss	368123.300
4	Heading	Heading angle (0-359.99)	ddd.dd	112.12
5	Pitch	Pitch angle (-90~90)	+ /-dd.dd	5.21
6	Roll	Roll angle (-180~180)	+ /-ddd.dd	10.12
7	Lattitude	latitude(-90,90)	+ /-dd.dd	28.224692
8	Longitude	longitude(-180~180)	+ /-ddd.dd	112.286135
9	Altitude	Height, unit (m)	+ /-hhh.hh	56.78
10	Ve	Eastward speed, unit (m/s)	+ /-eee.eee	5.412

11	Vn	North speed, unit (m/s)	+/-nnn.nnn	10.020
12	Vu	Celestial velocity, unit (m/s)	+ /-uuu.uuu	0.018
13	Baseline	Baseline length, unit (m)	+ /-bb.bbb	2.121
14	Nsv1	antenna1Number of satellites	nn	20
15	Nsv2	antenna2Number of satellites	nn	18
16	Status	Low ByteASCIIcode 0: Initialized/unpositioned 1: Single point positioning 2:RTD 4:RTKFixed solution 5: RTKFloating point solution	S	4
17	SpeedStatus	0: No vehicle speed information 1：With vehicle speed information	s	1
18	VehicleSpeed	Vehicle speedKm/h	+ /-vv.v	25.6
19	AccX	AccelerationXaxis,m/s2	+/-aa.aaa	1.658799
20	Y	AccelerationYaxis,m/s	+/-aa.aaa	11.132578
21	ZGar	AccelerationZaxis,m/s2	+/-aa.aaa	0.2874586
22	GyroX	GyroscopeXAxis, unit: °/s	+ /-gg.ggg	0.145852
23	Y	GyroscopeYAxis, unit: °/s	+ /-gg.ggg	1.89756
24	GyroZ	GyroscopeZAxis, unit: °/s	+ /-gg.ggg	0.36847
25	cs	check	*hh	* 64
26	<CR><LF>	Fixed tail		<CR><LF>

Data Hexadecimal Protocol 1, one frame 93B:

byte	Name	Illustrate	Data Types
1~4	Header	Fixed frame header0x553ACE01	uint32
5	UTC time:hours	hour	uint8
6	UTC time:minutes	point	uint8
7	UTC time: seconds	Second	uint8
8~9	UTC time:millisecond	millisecond	uint16
10~13	Heading	Heading angle (0-359.99)	float
14~17	Pitch	Pitch angle (-90~90)	float
18~21	Roll	Roll angle (-180~180)	float
22~29	Lattitude	latitude(-90,90)	double
30~37	Longitude	longitude(-180~180)	double
38~41	Altitude	Height, unit (m)	float
42~45	Ve	Eastward speed, unit (m/s)	float
46~49	Vn	North speed, unit (m/s)	float
50~53	Vu	Celestial velocity, unit (m/s)	float
54~57	baseline	Baseline length, unit (m)	float
58	Nsv1	antenna1Number of satellites	uint8
59	Nsv2	antenna2Number of satellites	uint8

60	Status	Low ByteASCIIcode 0: Initialized/unpositioned 1: Single point positioning 2:RTD 3: RTKFloating point solution 4:RTKFixed solution	uint8
61	SpeedStatus	0: No vehicle speed information 1：With vehicle speed information	uint8
62~65	VehicleSpeed	Vehicle speedKm/h	float
66~69	AccX	AccelerationXaxis,m/s2	float
70~73	Y	AccelerationYaxis,m/s	float
74~77	ZGar	AccelerationZaxis,m/s2	float
78~81	GyroX	GyroscopeXAxis, unit: °/s	float
82~85	Y	GyroscopeYAxis, unit: °/s	float
86~89	GyroZ	GyroscopeZAxis, unit: °/s	float
90	RTCMStatus	1:haveRTCMData Flow 0: noneRTCMData Flow	uint8
91	Odoíal	Odo_flag[7:4]: 1.Odometer calibration successful 2.Odometer not calibrated Al_status[3:0]: Combined navigation solution status 0: Initialization/Misalignment 1: Inertia solution 2: Vehicle constraints 3: Stationary detection 4：Combination solution	uint8
92~93	CheckSum	check	uint16

Data Hexadecimal Protocol 2, one frame 101B:

Byte	Name	Illustrate	Data Types
1~4	Header	Fixed frame header0x553ACE02	uint32
5~6	Week	Week of the second within the week	uint16
7~14	GPST	Seconds of the week, in (s)	double
15~18	Heading	Heading angle (0-359.99)	float
19~22	Pitch	Pitch angle (-90~90)	float
23~26	Roll	Roll angle (-180~180)	float
27~34	Lattitude	latitude(-90,90)	double
35~42	Longitude	longitude(-180~180)	double
43~46	Altitude	Height, unit (m)	float
47~50	Ve	Eastward speed, unit (m/s)	float

51~54	Vn	North speed, unit (m/s)	float
55~58	Vu	Celestial velocity, unit (m/s)	float
59~62	baseline	Baseline length, unit (m)	float
63	Nsv1	antenna1Number of satellites	uint8
64	Nsv2	antenna2Number of satellites	uint8
65	GPSStatus	Main antenna positioning status 0: Initialized/unpositioned 1: Single point positioning 2:RTD 4:RTKFixed solution 5:RTKFloating point solution	uint8
66	HeadingStatus	Heading positioning status 0: Initialized/unpositioned 4: RTKFixed solution 5:RTKFloating point solution	uint8
67	Status	Combined navigation solution status 0: Initialization/Misalignment 1: Inertia solution 2: Vehicle constraints 3: Stationary detection 4：Combination solution	uint8
68	VehicleAlign	0：Odometer calibration in progress 1: Odometer calibration successful	uint8
69	RTCMStatus	1:haveRTCMData Flow 0: noneRTCMData Flow	uint8
70	Reserved	reserve	uint8
71	SpeedStatus	0: No vehicle speed information 1：With vehicle speed information	uint8
72~75	VehicleSpeed	Vehicle speedKm/h	float
76~79	AccX	AccelerationXaxis,m/s2	float
80~83	Y	AccelerationYaxis,m/s	float
84~87	ZGar	AccelerationZaxis,m/s2	float
88~91	GyroX	GyroscopeXAxis, unit: °/s	float
92~95	Y	GyroscopeYAxis, unit: °/s	float
96~99	GyroZ	GyroscopeZAxis, unit: °/s	float
100~101	CheckSum	check	uint16

Hexadecimal Little-Endian Transmissionlow bytehigh bytechecksum methoduint16

```
uint16_t check_sum16(uint8_t *ptr, uint16_t len) {
```

```
    uint16_t i;
    uint16_t res_val = 0;

    if(!ptr)
        return 0;

    for(i=0; i<len; i++)
    {
        res_val += ptr[i];
    }

    return res_val;
}
```

4.2 Command Configuration Table

4.2.1Output (output)

$CMD,OUTPUT,COMx,protocol,freq*FF\r\n

Where x represents the COM port number, ranging from 0 to 3. COM3 is typically used as the RTCM reception port. Under normal circumstances, it outputs GGA, but in special cases, it can also be used as an output serial port.

Protocol indicates the output protocol (baudrate is special and does not represent a protocol; it represents the configuration baud rate, and in this case, freq indicates the baud rate value).Freq represents the output frequency. Below is the protocol field table:

Output Configuration Fields	Protocol Interpretation	Maximum output frequency Rate
GIAVP	$GIAVP protocol	100HZ
GPINS	$GPINS protocol	100HZ
HEX	HEX protocol 1	100HZ
HEX2	HEX protocol 2	100HZ
GGA	GNSS Analyzed from the original data GGA Data, undetermined	Single Antenna 1HZ

	Cannot output when in place	Dual Antenna5HZ
GNSS	GNSS Raw data	Single Antenna1HZ Dual Antenna5HZ
PACKED	The original data before the old version was parsed and packaged and entered the algorithm data	100HZ
RTCM	Depend on RTCM Receive data received by the serial port	1HZ
IMU	Parsed IMU data and parsed odometer data output in ASCII code.	200HZ
BAUDRATE	Baud rate	460800

For example: $CMD,OUTPUT,COM0,GIAVP,100*FF\r\n

Reply: $ACK,OUTPUT,COM0,GIAVP,100*FF\r\n

4.2.2 Configuration parameters (setparams)

$CMD,SETPARAMS,param_type,params,params...*FF\r\n

Where param_type represents the parameter to be configured, and params represents the values of the parameters, which can be multiple. Below is the parameter field table:

Parameter configuration fields	Parameter Explanation	Parameter value range
LEVERARM	Lever arm value	Each with 3 decimal places, unit: meters.
ODOM	Odometer Protocol CAN	Natural Numbers 0~N
DUALANT	Installation angle selection	- 1~1 Integer
ODOTHRD	Odometer Calibration Speed Threshold	Greater than 0, unit:m/s

INITVEC	Single antenna initialization heading speed threshold	Greater than 0, unit:m/s
ISRTK	Whether to use RTK	0~1
ISODOCAL	Whether to use odometer	0~1
CANBAUD	CAN Baud rate	100, 200, 250, 500 unit:10 3
CANSEND	Send CAN	0~1

For example: $CMD,SETPARAMS,ISRTK,1*FF\r\n

Reply: $ACK, SETPARAMS,ISRTK,1*FF\r\n

3. Special statements

$CMD,SAVECONF,1*FF\r\n

Save all configuration information

5. Usage Process

5.1 Hardware Installation

5.1.1 Fixed integrated navigation system host

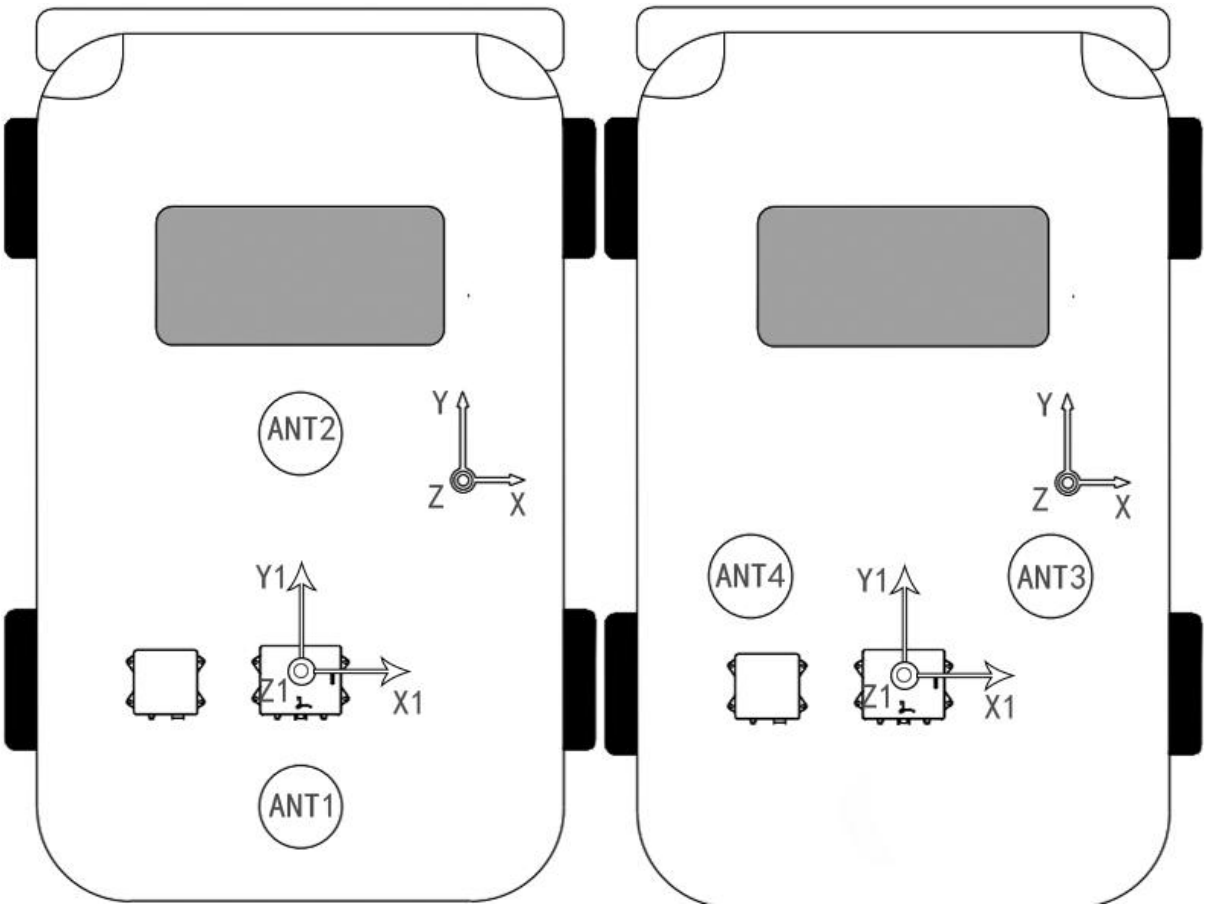


Figure 14A Integrated navigation system installation diagram Figure 14B Integrated navigation system installation diagram

During installation, the dual-antenna integrated navigation system host should be firmly connected to the vehicle. Ensure that the vehicle ’s forward direction Y is parallel to the forward axis Y1 of the MEMS Inertial-Satellite Integrated Navigation System module (as shown in Figure 14).

5.1.2 Fixed satellite dish

1. Front-Back Installation (Default Front-Back Installation):

Fix the satellite antennas near the dual-antenna integrated navigation system host. The main antenna should be installed at the rear of the vehicle, and the line connecting the two antennas must be parallel to the forward axis Y1 of the integrated navigation system (as shown in Figure 14A). The main antenna connects to the ANT1 port.

2. Left-Right Installation:

Fix the satellite antennas near the dual-antenna integrated navigation system host. The main antenna should be installed on the right side of the vehicle (passenger side), and the line connecting the two antennas must be parallel to the X1 axis (as shown in Figure 14B). The main antenna connects to the ANT1 port.

The positioning of the satellite antennas corresponds to different parameter configurations. Note: To ensure heading accuracy, the distance between the two satellite antennas must be at least 0.5 meters.

5.1.3 Fixing and configuration 4G Module (If optional)

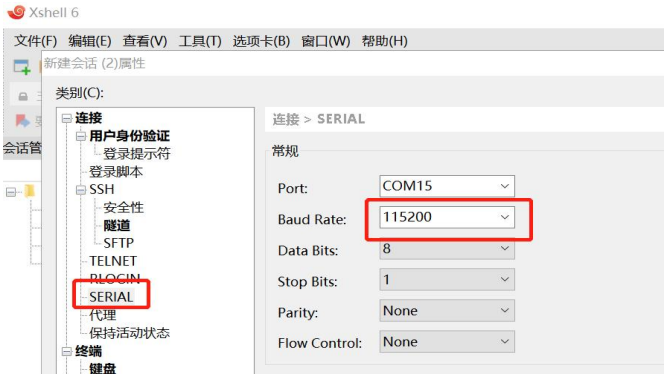
Connect the 4G Module cable in the feedline to the 4G Module, which should be fixed near the integrated navigation system host. There are no specific placement requirements for the 4G Module, as it is used for receiving RTK data.

The 4G Module comes with a built-in 4G IoT SIM card, and the supplier provides 1 year of 4G data support, with 1GB of data per month. After 1 year (starting from the IoT SIM card activation date, which is the first test date after production), the usage fees for the IoT SIM card will be borne by the purchaser, and the supplier will pay the fees on behalf of the purchaser.

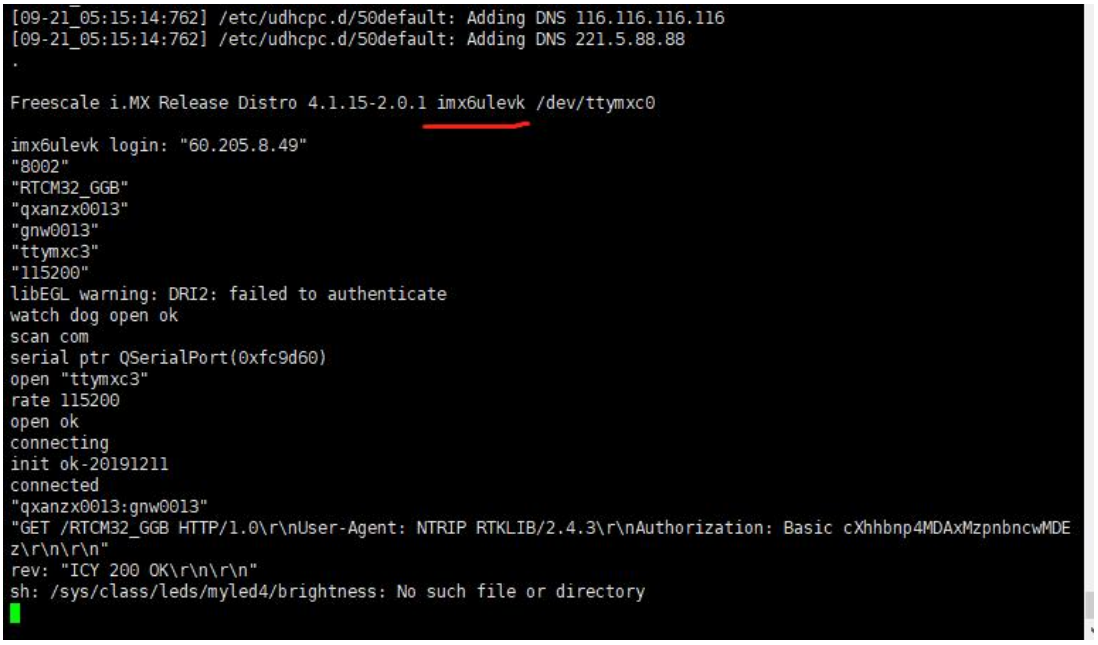
Users can set up their QX RTK service account by following these steps:

1. Power off the 4G Module, then insert the USB port into the computer. The computer will recognize it as a serial port.

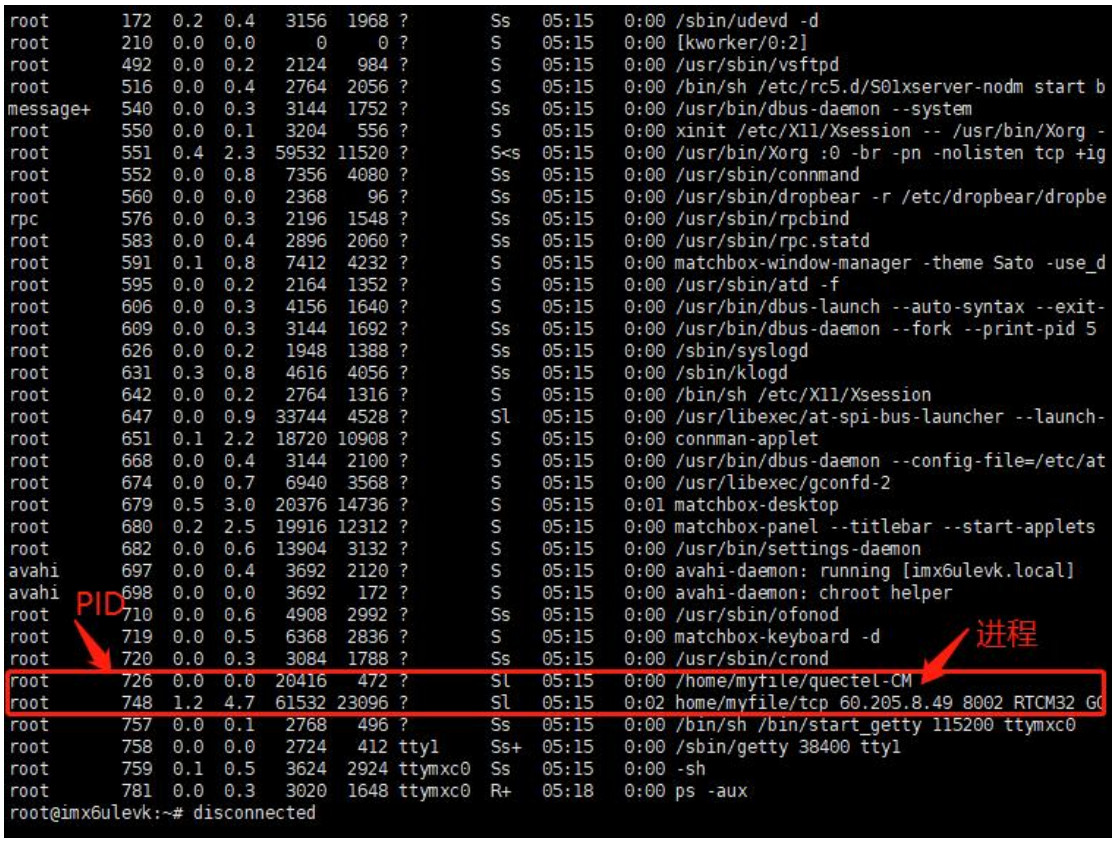
2. As shown in the image, use Xshell on the Windows operating system to connect to the 4G Module via the serial port. Note that the serial port baud rate should be 115200.



3. Power on the 4G Module and wait for the system to boot. When the prompt "imx6ulevk login:" appears, enter the password "root" and press Enter to log into the system.



4. Enter as shown belowps -auxAnd press Enter to view/home/myfile/quectel-CM andhome/myfile/tcp 60. 205.8.49 8002 RTCM32-GGProcess corresponding toPID;

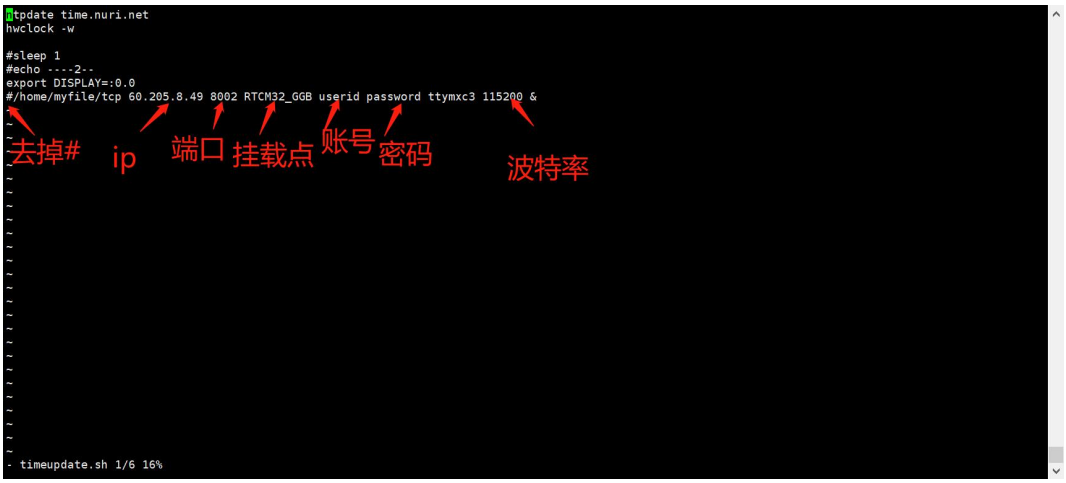



```
root       172  0.2  0.4   3156  1968 ?        Ss   05:15   0:00 /sbin/udevd -d
root       210  0.0  0.0      0     0 ?        S    05:15   0:00 [kworker/0:2]
root       492  0.0  0.2   2124   984 ?        S    05:15   0:00 /usr/sbin/vsftpd
root       516  0.0  0.4   2764  2056 ?        S    05:15   0:00 /bin/sh /etc/rc5.d/S01xserver-nodm start b
message+   540  0.0  0.3   3144  1752 ?        Ss   05:15   0:00 /usr/bin/dbus-daemon --system
root       550  0.0  0.1   3204   556 ?        S    05:15   0:00 xinit /etc/X11/Xsession -- /usr/bin/Xorg -
root       551  0.4  2.3  59532 11520 ?        S<s  05:15   0:00 /usr/bin/Xorg :0 -br -pn -nolisten tcp +ig
root       552  0.0  0.8   7356  4080 ?        Ss   05:15   0:00 /usr/sbin/connmand
root       560  0.0  0.0   2368    96 ?        Ss   05:15   0:00 /usr/sbin/dropbear -r /etc/dropbear/dropbe
rpc        576  0.0  0.3   2196  1548 ?        Ss   05:15   0:00 /usr/sbin/rpcbind
root       583  0.0  0.4   2896  2060 ?        Ss   05:15   0:00 /usr/sbin/rpc.statd
root       591  0.1  0.8   7412  4232 ?        S    05:15   0:00 matchbox-window-manager -theme Sato -use_d
root       595  0.0  0.2   2164  1352 ?        S    05:15   0:00 /usr/sbin/atd -f
root       606  0.0  0.3   4156  1640 ?        S    05:15   0:00 /usr/bin/dbus-launch --auto-syntax --exit-
root       609  0.0  0.3   3144  1692 ?        Ss   05:15   0:00 /usr/bin/dbus-daemon --fork --print-pid 5
root       626  0.0  0.2   1948  1388 ?        Ss   05:15   0:00 /sbin/syslogd
root       631  0.3  0.8   4616  4056 ?        Ss   05:15   0:00 /sbin/klogd
root       642  0.0  0.2   2764  1316 ?        S    05:15   0:00 /bin/sh /etc/X11/Xsession
root       647  0.0  0.9  33744  4528 ?        Sl   05:15   0:00 /usr/libexec/at-spi-bus-launcher --launch-
root       651  0.1  2.2  18720 10908 ?        S    05:15   0:00 connman-applet
root       668  0.0  0.4   3144  2100 ?        S    05:15   0:00 /usr/bin/dbus-daemon --config-file=/etc/at
root       674  0.0  0.7   6940  3568 ?        S    05:15   0:00 /usr/libexec/gconfd-2
root       679  0.5  3.0  20376 14736 ?        S    05:15   0:01 matchbox-desktop
root       680  0.2  2.5  19916 12312 ?        S    05:15   0:00 matchbox-panel --titlebar --start-applets
root       682  0.0  0.6  13904  3132 ?        S    05:15   0:00 /usr/bin/settings-daemon
avahi      697  0.0  0.4   3692  2120 ?        S    05:15   0:00 avahi-daemon: running [imx6ulevk.local]
avahi      698  0.0  0.0   3692   172 ?        S    05:15   0:00 avahi-daemon: chroot helper
root       710  0.0  0.6   4908  2992 ?        Ss   05:15   0:00 /usr/sbin/ofonod
root       719  0.0  0.5   6368  2836 ?        S    05:15   0:00 matchbox-keyboard -d
root       720  0.0  0.3   3084  1788 ?        Ss   05:15   0:00 /usr/sbin/crond
root       726  0.0  0.0  20416   472 ?        Sl   05:15   0:00 /home/myfile/quectel-CM
root       748  1.2  4.7  61532 23096 ?        Sl   05:15   0:02 home/myfile/tcp 60.205.8.49 8002 RTCM32 GG
root       757  0.0  0.1   2768   496 ?        Ss   05:15   0:00 /bin/sh /bin/start_getty 115200 ttymxc0
root       758  0.0  0.0   2724   412 tty1     Ss+  05:15   0:00 /sbin/getty 38400 tty1
root       759  0.1  0.5   3624  2924 ttymxc0  Ss   05:15   0:00 -sh
root       781  0.0  0.3   3020  1648 ttymxc0  R+   05:18   0:00 ps -aux
root@imx6ulevk:~# disconnected
```

5. enterkill -s 9 726Press Enter to enterkill -s9 748and press Enter (note,PIDValue and Not fixed, please enter actualPIDvalue to end the process);

6. Enter cd .. and press Enter to return to the previous directory. Then, type ls and press Enter to display the current directory. After that, type cd myfile and press Enter to enter the myfile folder. Next, type ls and press Enter again to display the current directory, then type vi timeupdate.sh and press Enter to open the timeupdate.sh file.

As shown in the image, in the current interface, press I to enter Edit Mode. Remove the "#" (if there is no "#" symbol, skip this step). Then, fill in the corresponding parameters. Typically, for QX RTK service, you only need to modify the account (userid) and password (password). Once you've made the changes, press Esc to exit edit mode, then type : and enter wq to save and quit. Afterward, power the system off and on again to apply the changes.



5.1.4 Ground terminal RTKPower on the reference station (if optional)

Place the RTK reference station in an open area and connect the antenna. Press the power switch to start the RTK reference station.

5.1.5 Feeder connection

1. Connect the main and secondary antennas to the dual-antenna integrated navigation system host via the antenna interfaces.

2. Power the dual-antenna integrated navigation system host through the main power supply line.

3. If the 4G Module is selected, connect the RTCM serial port and 5V power supply lines from the 4G Module to the corresponding interfaces on the dual-antenna integrated navigation system host's feedline, and install the 4G antenna at the 4G antenna interface. If not selected, this step can be ignored.

4. Connect the odometer line from the feedline to the vehicle ' s OBD port to obtain the vehicle's mileage data (supports CAN interface, compatible with only some vehicle models, customization available based on user needs).

5. Connect the main COM 0 serial port to the computer.

5.2 Lever arm measurement

As shown in "Figure 15: Antenna Arm Measurement Diagram," establish a vehicle space Cartesian coordinate system with the center of the dual-antenna integrated navigation system host as the origin. The coordinates of the main antenna in the Cartesian coordinate system are measured, which correspond to the main antenna lever arm parameters lever_ armX, lever_armY, and lever_armZ (units of X, Y, and Z are meters).

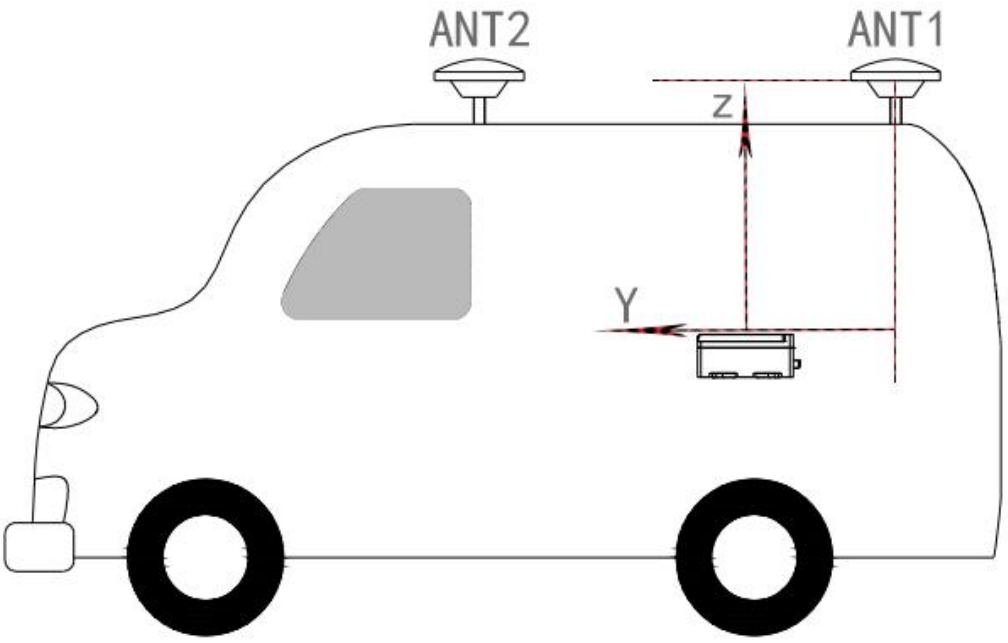


Figure 15 Lever arm measurement diagram

5.3 Software configuration and usage

5.3.1 Direction parameter configuration

When the main and secondary satellite antennas are installed in the front-back orientation, the installation direction parameters do not need to be changed, and no configuration using the serial port assistant tool is required. The default direction parameter is "0."

When the main and secondary satellite antennas are installed in the left-right orientation, follow these steps for configuration:

Open the UartAssist serial port assistant tool on the computer.

Click the downward triangle button next to "Baud Rate," select "Customize", and enter "460800".

Click the "Open" button. Data will be displayed in the "Serial Port Data Reception" area on the right, indicating that the serial port connection is successful.

In the input field, type "$cmd,setparams,dualant,1*ff" (then press Enter).

Click the "Send" button to send the command for configuration. Once the configuration is successful, the system will return "$ack,setparams,dualant,1*ff".

5.3.2 Lever arm parameter configuration

Open the UartAssist serial port assistant tool on the computer, select the corresponding baud rate, and click the "Open" button. Data will be displayed in the "Serial Port Data Reception" area on the right, indicating that the serial port connection is successful.

In the input field, type "$cmd,setparams,leverarm,X,Y,Z*ff" (where X, Y, and Z are the lever arm parameters), then press Enter. Click the "Send" button to send the command for configuration. Once the configuration is successful, the system will return "$ack,setparams,leverarm,X,Y,Z*ff" as a confirmation.

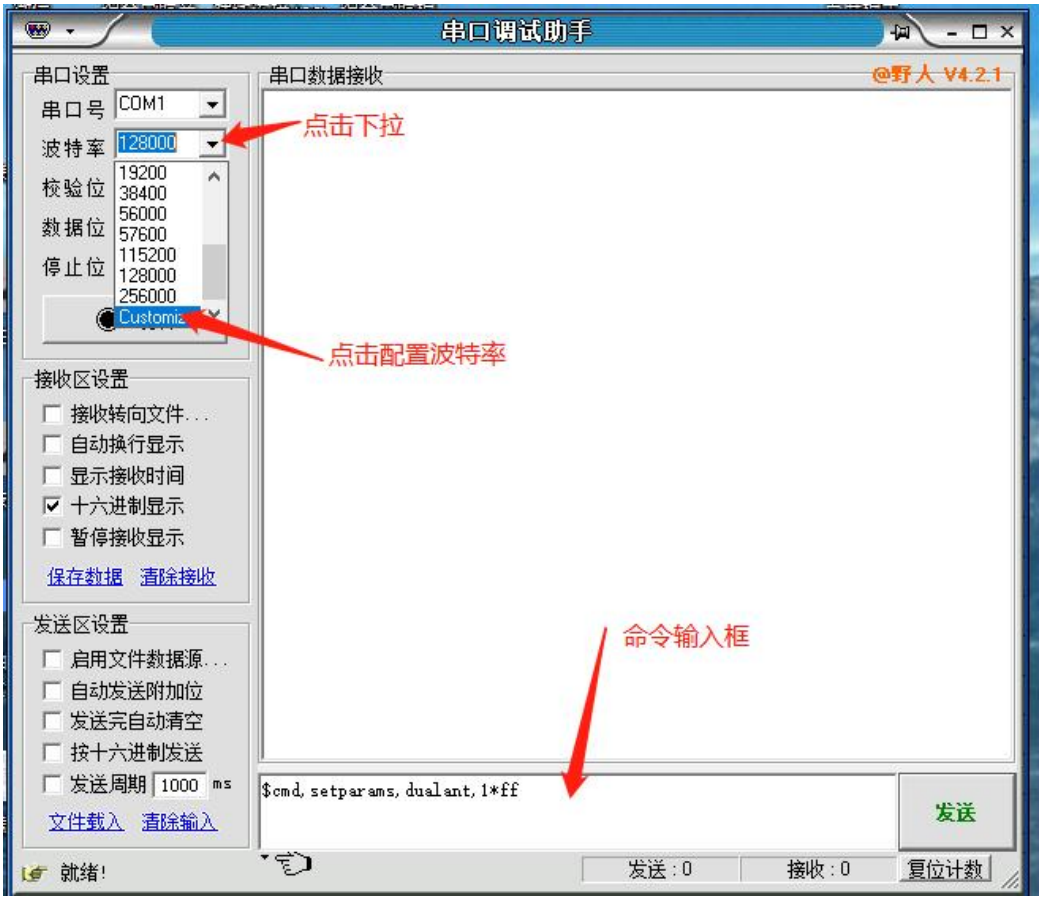


Figure 16 Serial port debugging assistant interface diagram

5.3.3 Other configuration commands

For other configuration commands, see the communication protocol documentation.

5.3.4 Host computer use

1. Ensure that the computer is connected to the network.

2. In the [GkTest2-win32-x64] folder on the computer, click [GkTest2.exe] to open the host computer software.

3. Click "Close Serial Port".

4. The default baud rate is 460800. If the baud rate has been modified, select the updated baud rate.

5. The default data refresh rate for the host computer is 20Hz. If the actual serial port data refresh rate is not 20Hz, click the dropdown button next to "20" and select the actual data refresh rate for configuration.

6. Click "Open Serial Port", and wait for the system to display information such as location, satellites, gyroscope, accelerometer, heading, pitch, and roll angles when positioning is successful.

7. If you need to replay data, close the serial port, select the log file, and click "Replay Log" to replay.

8. In the Attitude Angle Display interface, click the icons before "Pitch Angle", "Roll Angle", or " Heading Angle" to toggle the display of corresponding data.

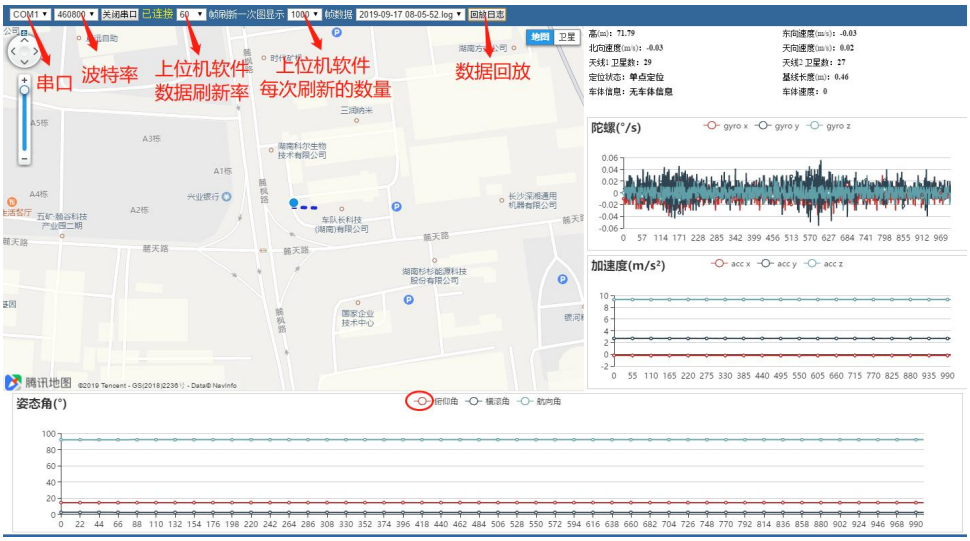


Figure 17 Schematic diagram of host computer software

6. Notes

1. The installation of the dual-antenna integrated navigation system host and the main and secondary antennas must strictly follow the installation requirements.

2. The dual-antenna system host, satellite antennas, and the carrier must be securely connected to maintain the same motion state.

3. The module will only output data after successfully acquiring satellite signal positioning. Please perform the installation and power-on initialization operation in a location with satellite signals.

4. The host computer software supports parsing of NMEA0183 GNGGA and Hexadecimal Protocol 1 and Hexadecimal Protocol 2 data. It does not currently support parsing NMEA0183 GIAVP data.

5. After sending the command, you must send the save command: [$cmd,saveconf,1*ff]. After successful configuration, the dual-antenna integrated navigation system host needs to be powered on again.

6. The odometer supports the CAN interface, but it is only compatible with certain vehicle models. Custom solutions can be provided according to user needs.

7. If using an odometer, odometer calibration is required. After successful positioning, when the carrier's speed exceeds the odometer calibration speed threshold (default: 10/ms, configurable) for two minutes, calibration will be completed. If calibration is not completed, the positioning effect may be slightly affected when entering the loss of lock state.

8. Differential positioning can be configured and modified via command. If configured to use differential data but the differential data is not provided, the device may fail to converge and affect performance.

9. When using the host computer software, ensure that the computer is connected to the internet; otherwise, the map will not load.

10. In the host computer software, the "Gyroscope", "Accelerometer", and "Attitude Angle" interfaces' Y-axis scales will dynamically update according to the data, and the scales cannot be manually set.

11. The module can output four types of protocols: NMEA0183 GPINS, NMEA0183 GIAVP, Hexadecimal Protocol 1, and Hexadecimal Protocol 2. The data format, refresh rate, and output rate can all be configured. Please refer to the product protocol for specific configuration details.

12. After use, first disconnect the main serial port from the computer, then power off the dual-antenna integrated navigation system host.

13. If an optional ground-based RTK reference station is provided, ensure that the 4G Module parameters match the ground-based RTK reference station.

14. The satellite antenna of the ground-based RTK reference station must be placed in an open area with minimal obstructions and positioned at a high location.

15. The satellite antenna should be placed at least 20 cm away from high-speed cameras (if any), and there must be isolation between the two.