TYPE 98 FIBER STRAPDOWN INERTIAL NAVIGATION SYSTEM

PRODUCT DESCRIPTION

FS98 Fiber Optic Integrated Navigation System, a cutting-edge solution that seamlessly integrates precision, cost-effectiveness, and versatility. This exceptional system revolves around a closed-loop fiber optic gyroscope, accelerometer, and a high-end GNSS receiving board, ensuring unmatched accuracy and reliability.

Through the utilization of advanced multi-sensor fusion and state-of-the-art navigation algorithms, the FS98 system delivers medium to high-precision measurements, meeting the rigorous demands of mobile measurement systems, large unmanned aerial vehicles (UAVs), and other applications that require precise attitude, heading, and position information.

With the FS98 Fiber Optic Integrated Navigation System, you can confidently elevate your operations to new heights. Whether it's surveying, mapping, or any other industry that demands pinpoint accuracy, this system is engineered to deliver exceptional performance and reliable results.

Experience the future of navigation technology with the FS98 Fiber Optic Integrated Navigation System and unlock new levels of precision, efficiency, and success in your endeavors.

MAIN FUNCTION

The system features both a combined inertial/satellite navigation mode and a pure inertial mode. In the inertial/satellite integrated navigation mode, the GNSS receiver is able to receive signals from satellites, providing positioning information for combined navigation. If the signal is lost, the system switches to an inertial solution for position, speed and attitude, delivering meter-level positioning accuracy in a short time.

Alternatively, the pure inertial mode provides accurate attitude measurement and can output pitch, roll and heading data. Additionally, it has the ability to statically seek north.

PRODUCT FEATURES

- Position accuracy up to centimeter level
- Attitude measurement error better than 0.01°
- Operating temperature range: -40~60°C
- Vibration environment: 20~2000Hz, 3.03g
- Rich interface types, support RS232, RS422, CAN and other standard interfaces
- Mean time between failures up to 30000h

PERFORMANCE INDEX

Parameters		Technical specifications
Position accuracy	Single Point (RMS)	1.2m
	RTK (RMS)	2cm+1ppm
	Post-processing (RMS)	1cm+1ppm

Parameters		Technical specifications
	Loss of lock accuracy (CEP)	2nm，Loss of lock for 60min①
Heading (RMS)	Combined Accuracy	0.1°②
	Post-processing	0.01°
	Loss-of-Lock Hold Accuracy	0.02°，Loss of lock for 60min①
	Self-seeking accuracy	0.1°SecL,Alignment 15min ③
Attitude (RMS)	Combined accuracy	0.01°
	Post-processing	0.006°
	Loss-of-Lock Holding Accuracy	0.02°，Loss of lock for 60min①
Horizontal velocity accuracy (RMS)	0.05m/s	
Timing accuracy	20ns	
Data output frequency	200Hz④	
Gyroscope	Range	300°/s
	Zero bias stability	0.02°/h⑤
	Scale Factor	50ppm
	Non-linearity	0.005°/√hr
Accelerometer	Angular random wander	16g
	Range	50ug⑤
	Zero Bias Stability	50ppm
	Scale Factor	0.01m/s/√hr
Physical dimensions and electrical characteristics	Nonlinearity	176.8mm×188.8mm×117mm
	Speed random wander	<5kg（Cable not included）
	Dimension	12～36VDC
	Weight	<24W（Homeostasis）
	Input Voltage	Reserved
Environmental specifications	Power consumption	-40℃~+60℃
	Storage	-45℃～+70℃
	Operating Temperature	3.03g，20Hz~2000Hz
	MTBF	30000h
Interface characteristics	PPS、EVENT、RS232、RS422、CAN（Optional）	
	Network port (reserved)	
	Antenna interface	
	Wheel speed sensor interface	

Note: ①Alignment is valid; ②On-board condition, need to be maneuvered; ③Double position alignment, the difference between the two position heading is greater than 90 degrees; ④Single-way output 200Hz; ⑤10s average.

🔷 *WORKING PRINCIPLE*

Product Composition

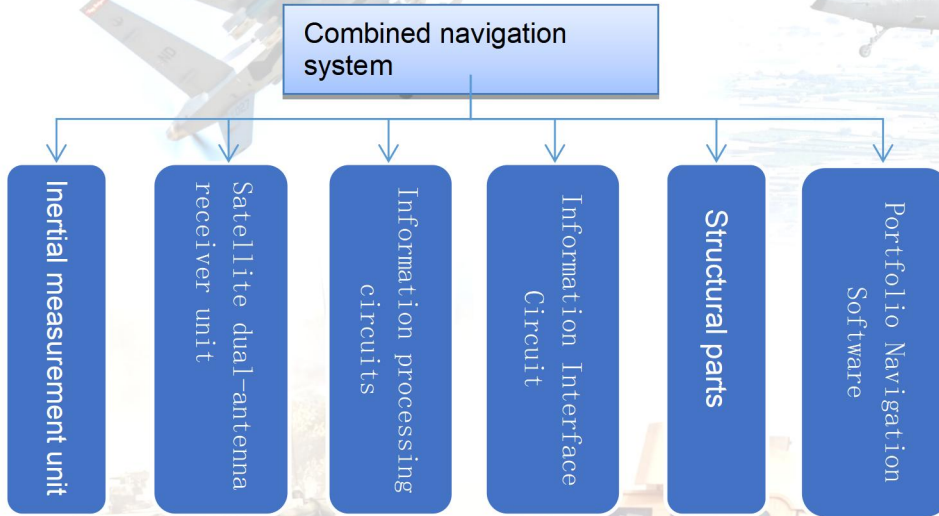The composition of the product is as follows Figure 1.

Figure 1 System Composition

Fundamentals

The inertial measurement unit consists of three accelerometers and three fiber optic gyroscopes, which are responsible for measuring the acceleration and angular velocity of the carrier and sending this information to the information processing circuit. The information processing circuit uses the acceleration and angular velocity measured by the inertial measurement unit for navigation settlement, and also receives satellite navigation information from the satellite receiver as a reference for combined navigation, corrects the navigation error of the inertial guidance, and outputs the navigation information through the information interface unit.

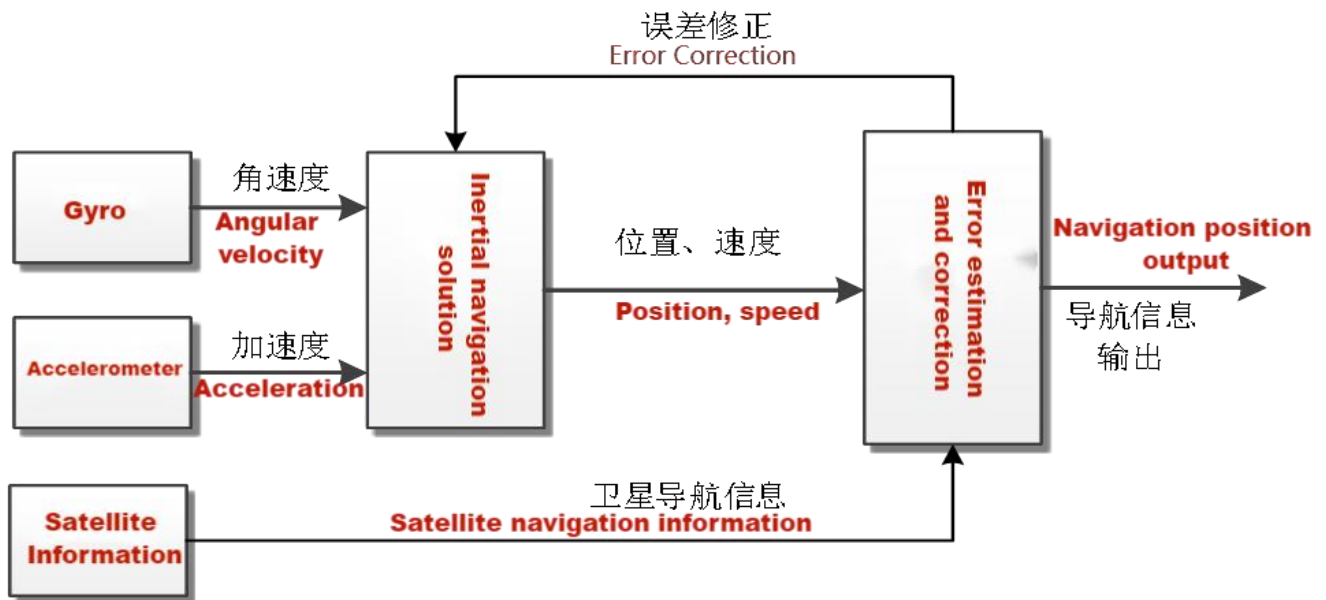The basic principle is shown in the following figure:

Figure 2 schematic diagram of working principle

📦 INSTRUCTIONS FOR USE

1、Form factor

Inertial measurement unit and satellite receiver using integrated design scheme, are integrated within the inertial guidance system, the system shape as shown in the figure below.

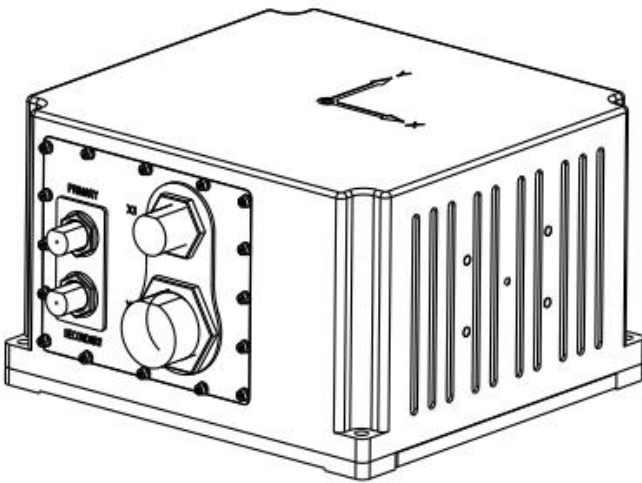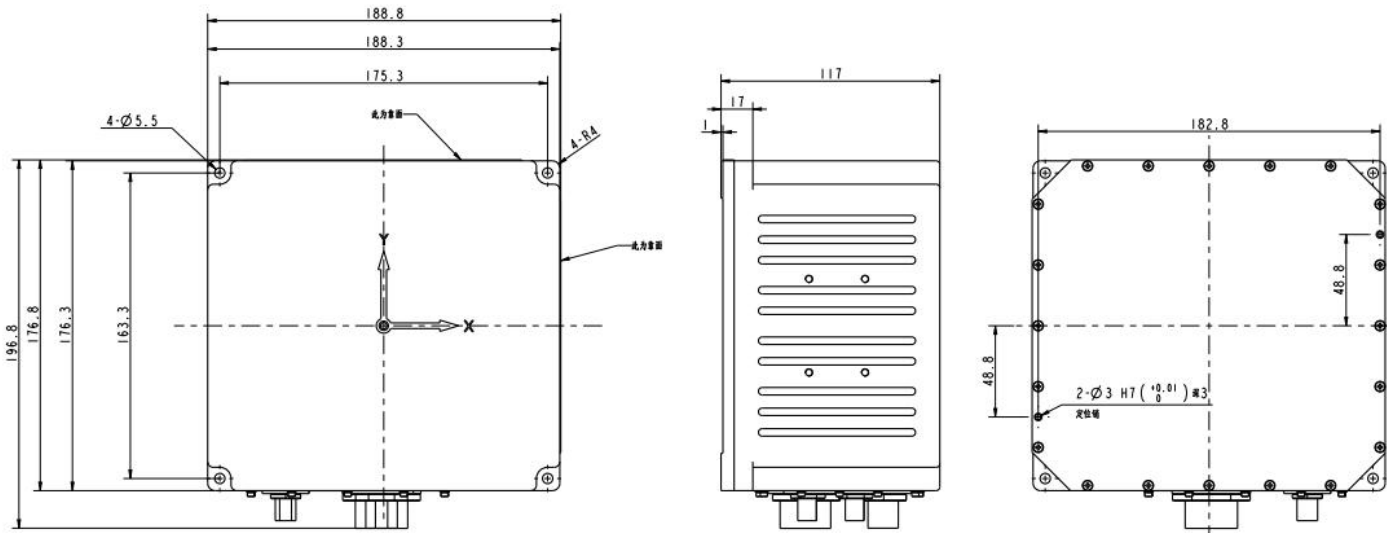System dimensions are: 176.8mm × 188.8mm × 117mm (L × W × H).

Figure 3 Outline structure diagram

2、electrical interfaces

The system has 4 external connectors:

a) one X1 power supply port, X2 communication interface

b) two RF line interface (TNC outer screw inner hole, which is connected to the upper master antenna, the lower slave antenna)

c) 1 power cable connected to X1 at one end and 13~36V DC at the other end;

d) a communication cable one end to X2, the other end is divided into five serial ports, respectively COM2 ~ COM5, where COM5 for RS232, COM2, COM3, COM4 for RS232, RS422 can be configured. COM2 can be used to send work mode command, COM5 can be configured inertial guide internal GNSS board;

External connector points are defined as shown in Tables 1 and 2:

Table 1 X1 connector point definition

X1(J599/26FA35SA)	Signal Definition	Plug wire label code	Remarks
1	DC+		
2	DC+	Red alligator clip, large	Power supply positive
3	DC+		
4	DC-		
5	DC-	Black alligator clip, large	Power supply negative
6	DC-		

Table 2 X2 Connector Point Definition

X2(J599/26FD35PA)	Signal Definition	Plug wire label code	Terminal number	Remarks
1	COM2_TXD_RS232		1-DB9 hole: 2	
2	COM2_RXD_RS232	COM1 (DB9 female)	1-DB9 hole: 3	Main processor program upgrade port, RS232
3	GND		1-DB9 hole: 5	
4	COMA_422T_N/RS232_T		2-DB9 holes: 2	
5	COMA_422T_P		2-DB9 hole: 6	The first road can be configured serial port RS422/RS232 Default RS232
6	COMA_422R_N	COM2 (DB9 female)	2-DB9 hole: 8	
7	COMA_422R_P/ RS232_R		2-DB9 hole: 3	
8	GND		2-DB9 hole: 5	
9	COMB_422T_N/RS232_T		3-DB9 hole: 4	
10	COMB_422T_P		3-DB9 hole: 3	The second channel can be configured with serial port RS422/RS232 Default RS422
11	COMB_422R_N	COM3 (DB9 female)	3-DB9 hole: 2	
12	COMB_422R_P/RS232_R		3-DB9 hole: 1	
13	GND		3-DB9 hole: 5	
14	COMC_422T_N/RS232_T		4-DB9 holes: 4	
15	COMC_422T_P		4-DB9 hole: 3	The third channel can be configured serial port RS422/RS232 Default RS422
16	COMC_422R_N	COM4 (DB9 female)	4-DB9 hole: 2	
17	COMC_422R_P/RS232_R		4-DB9 hole: 1	
18	GND		4-DB9 hole: 5	
19	RS232-718-TXD1		5-DB9 hole: 2	
20	RS232-718-RXD1	COM5 (DB9 female)	5-DB9 hole: 3	718D serial port 1
21	GND		5-DB9 hole: 5	
22	PPS	Plugless, Dump Cable	PPS	3.3V TTL
23	EVENT2	Plugless, Dump Cable	EVENT2	3.3V TTL
24	CAN1_P	Plugless, Dump Cable	CAN1_P	CAN
25	CAN1_N	Plugless, Dump Cable	CAN1_N	
26	DI1+	Unplugged, Cordless	DI1+	First odometer (5V-12V)
27	DI1-	Unplugged,	DI1-	

		Cordless		
28	DI2+	Unplugged, Cordless	DI2+	Second odometer
29	DI2-	Unplugged, Cordless	DI2-	
30	GND	Unplugged, Cordless	GND	
31	ETHER_TX_P (3 green-white)	Network port （RJ45）	1 (orange and white)	10/100 Ethernet interface
32	ETHER_TX_N (6 green)		2 (Orange)	
33	ETHER_RX_P (1 orange-white)		3 (Green-white)	
34	ETHER_RX_N (2 Orange)		6 (Green)	
35	CAN2_P	Unplugged, Cordless	CAN2_P	CAN
36	CAN2_N	Unplugged, Cordless	CAN2_N	
37	-	-	-	-

3、 Instructions for use

3.1 、System workflow

The inertial guidance system consists of two workflows, a combined navigation process and a pure inertial navigation process.

3.1.1、 Start-up prompt message

Connect the cable, power up the system, monitor the COM2 interface information through the serial debugging tool of the test computer, and send workflow instructions to the COM2 interface through the serial debugging tool after the interface displays "Please enter NaviMode within 20s! "#moddgi" is the instruction to enter the combined navigation work; if the instruction is not sent within 20s, the system will automatically enter the internal saved workflow after 20s.

3.1.2、 Combined navigation process

After entering the combined navigation process, the first binding satellite information, if the satellite is not positioned, it is in the state of waiting for satellite information; when the satellite information is valid, it will enter the alignment state, alignment time 1min, alignment period requires the inertial guide stationary, alignment is complete, the inertial guide can move, the system is in the combined navigation state.

3.1.3 、Pure inertial navigation process

After entering the pure inertial navigation process, the first 1min coarse alignment, if the satellite information is valid, the binding satellite information for 1500s fine alignment, if there is no satellite information, the static base must be aligned 1500s; alignment is completed after the transfer to the pure inertial navigation state, the inertial guide can move.

3.2、 System configuration commands

3.2.1 、Configuration scheme and save

Inertial guidance system provides four external serial ports (configuration number: com2~com5), and provides an internal storage channel (configuration number: file), each serial port function assignment and related configuration is as follows.

Table 1 inertial guidance system serial port function allocation table

Configuration number	Input items	Output items	Default
COM2	1. working mode command and process control command; 2. COM2~COM4 baud rate configuration; 3. COM2~COM4 protocol and update rate configuration; 4. Storage file port protocol configuration.	1. SNCNAVPVTB (0.2Hz, 1Hz, 5Hz, 10Hz, 20Hz, etc.); 2. GPFPD (0.2Hz, 1Hz, 5Hz, 10Hz, 20Hz, etc.); 3. BDFPD (0.2Hz, 1Hz, 5Hz, 10Hz, 20Hz, etc.); 4. INSPVASA (0.2Hz, 1Hz, 5Hz, 10Hz, 20Hz, etc.); 5. INSPBASB (0.2Hz, 1Hz, 5Hz, 10Hz, 20Hz, etc.); 6. RAWIMUSB (fixed 200Hz SPAN-ISA-100C format); 7. RAWDATA (RAWIMUSB in fixed 200Hz SPAN-ISA-100C format and containing data sent from satellite board COM2); 8. configuration prompt messages;	RS232； 460800bps； Output ： INSPVASA 1Hz；

COM3	None	Same as COM2	RS422; 460800bps; Output: None
COM4	None	1. Same as COM2 2. Can be configured to connect directly to COM3 port of 718D board	RS422; 460800bps; Output: None
COM5	OEM718D COM1 configuration items；	Configure outputs according to this interface, such as BESTPOSA, GPRMC, etc.	RS232; 9600bps； Output: None
file	The system automatically saves the stored information according to the user's configuration. The saved data file is named RECORDX.txt, where X is the file number. When a configuration query is made, the current latest file name is displayed.	1. Fixed will have SNCPOST protocol and can not be canceled, the protocol for data backup. 2. The system is powered on and the network port side is plugged into the computer for storing data export status.	None

After the system is powered on and the COM2 port displays the startup information, you can input commands such as COM2~COM5 serial port baud rate configuration, serial port protocol and update rate setting, etc. Each command output will return "cmd ok" if successful, otherwise it will display "cmd error ". After the input is finished, type "saveconfig" to save the configuration, the next reboot will automatically call this configuration, if you do not enter this command, the next reboot will restore the serial port configuration to the last saved configuration.

3.2.2 、Configuration Query

By typing "log loglist" or "log rxstatus" through COM2 port, all configurations of COM2~COM4 will be listed, including the following aspects

- Serial port number, serial port baud rate, serial port protocol and update rate.
- Function module open status: including zero speed correction status and smooth processing status, open for enable, close for disable; carrier type;
- Internal storage status information: including the file name of the last file, remaining space, etc;
- Initial binding latitude and longitude;
- System number and factory date;
- Software version number: including preprocessing software version number and navigation software version number;
- Operating mode: including combined navigation (DGI) and pure inertial navigation (INS).

3.2.3 、Baud Rate Configuration

Enter the following command in this mode to enter the serial port baud rate configuration:

com comX BAUDRATA

where X is 2~4 and BAUDRATA is the baud rate in bps.

For example, to set the baud rate of COM2 port to 460800bps, enter the following command:

com com2 460800

3.2.4、Serial RS232 Configuration

When configuring the serial port as RS232 (if configuring the serial port as COM3-COM4, you need to do an adapter cable, see section 4.2 Electrical Interface for wiring definitions), the command is as follows

rs232 COMX

where X is 2~4.

For example, to set COM3 port as RS232, enter the following command:

rs232 com3

3.2.5、Serial port RS422 configuration

When configuring the serial port as RS422 (if the serial port is configured as COM2, you need to do an adapter cable, see section 4.2 Electrical Interface for wiring definitions), the command is as follows

rs422 COMX

where X is 2~4.

For example, to set the COM2 port to RS422, enter the following command

rs422 com2

3.2.6、 Update Rate Configuration

The configuration of COM2~COM5 and memory file port GPFPD, BDFPD, inspvasa, and inspvasb protocols is performed through COM2 with the following configuration commands:

log comX/file LOG ontime updataTime

where comX can be com2~com4 configuration number, file is the memory interface configuration number; updataTime represents the update time, which can be 5(0.2Hz), 1(1Hz), 0.2(5Hz), 0.1(10Hz), 0.01(20Hz) and other periods that can be 200Hz division, unit s. LOG indicates the protocol name, can be inspvasa, inspvasb, gpfpd, bdfpd.

For example, to configure the COM2 port to output 10Hz GPFPD data, the following command can be entered via COM1:

log com2 gpfpd ontime 0.1

If you need to output 10Hz bdfpd data at COM2 at the same time, then you can enter the following command via COM1 again:

log com2 bdfpd ontime 0.1

For example, to store 1Hz inspvasa protocol data into the internal memory of the inertial guide, the following command can be entered via COM2：

log file inspvasa ontime 1

If you want to turn off a protocol, the configuration command is as follows:

log comX/file LOG off

To configure the rawimusb and rawdata protocols for the COM2~COM4 ports and the memory file port via COM2, the configuration command is as follows

log comX/file rawdata onchange

If you want to turn off the rawdata protocol for this serial port, configure the command as follows

log comX/file rawdata off

If you want to disable all protocols on the serial port, the command is as follows

unlogall comX/file

Note that increasing the update rate or outputting several protocols at the same time will increase the amount of data sent from the serial port. In general, the larger the amount of data, the higher the baud rate required.

3.2.7 、 Initial value latitude and longitude configuration

The initial latitude and longitude are configured with the following configuration command

initialpos LONGITUDE LATILUDE

where LONGITUDE and LATITUDE are the configured local latitude and longitude values in degrees.

3.2.8、 Function Module Configuration

The function modules with open configuration mainly include zero speed correction and output position smoothing.

3.2.8.1 、 "Zero Speed Correction" Configuration

Zero speed correction function mainly refers to the inertial guide to detect the sensitive information, if the inertial guide is judged to be zero speed, then make the corresponding correction.

If the satellite information is invalid for a long time in the combined navigation state, and the user wants to get pure inertial navigation information, it is recommended to turn off the zero speed correction mode.

The zero speed correction configuration command is as follows:

inszupt switch

The switch value is disable or enable, where disable means turn off the function and enable means turn on the function.

3.2.8.2、 "Position output smoothing" configuration

The position information in INSPVASA and GPFPD protocol is inertial navigation position information, in order to get smoother position information, the navigation software has added the position output smoothing function, the position noise after smoothing is smaller.

In this product, "position output smoothing" is turned off by default in the combined navigation process, but for the convenience of the user, this function can be configured with the following commands:

possmooth SWITCH

The switch value is disable, enable, where disable means turn off the function, enable means turn on the function.

3.2.9、 Satellite serial port mapping configuration

If the satellite card does not have a spare serial port to configure or use during use, the satellite card serial port can be mapped to the external interface COM4, which is configured with two commands as follows:

connect gpscard com2
connect gpscard com3
connect gpscard disable

Sending connect gpscard com2 command will map COM2 of the satellite card 718D to the external connection COM4, at this time COM4 port must be configured to 230400 in order to configure the satellite navigation card board, this command will make the inertial guidance work in an abnormal state, after the configuration of the board you need to reboot the inertial guidance, in order to carry out the normal state of the inertial guidance, and the command reboot after the inertial guidance. The command will make the inertial guidance work in an abnormal state, and the inertial guidance will not be saved after the reboot.

Send connect gpscard com3 command to map COM3 of satellite card 718D to COM4 of external connection port, at this time, COM4 port baud rate must be configured to COM3 of 718D for normal communication, if you need to save, send saveconfig command. Sending the connect gpscard disable command will restore the external COM4 serial port to the internal CPU output port.

3.2.10 、Carrier type configuration

According to the different carriers installed in the inertial guidance, the carrier type configuration is required, for different carrier types, the system internal processing of different algorithms.

The configuration commands are as follows:

carrier vehicle/ship/air

In order for the vehicle, ship and airborne.

After the configuration is complete, you need to enter the save command saveconfig, and then hard start or enter the #reset command, the carrier type configuration will be valid after the start. The inertial guide does not support the current configuration for current use during use, it must be restarted.

After the carrier type is configured as vehicle type, the inertial guide is required to be installed on the vehicle and fixed, and the inertial guide is oriented in the same direction as the front of the carrier vehicle, with an error of not more than 10 degrees.

3.2.11 、Online RTK

When using online RTK processing, com2 needs to input the following command.

 possmooth disable

com5, the com1 port of the 718D, is configured as follows

serialconfig com1 9600 (variable baud rate, according to the actual DTU configuration)

interfacemode com1 rtcmv3 novatel on

saveconfig

3.2.12 、GNSS antenna pole arm configuration

According to the relative installation relationship between the antenna and the inertial guide, the antenna pole arm configuration is required. The value of the rod arm between the configured inertial guide to the antenna must be measured to the millimeter (mm), any rod arm measurement error will go directly into the position error of the inertial guide output, when installed and used, the inertial guide is as close as possible to the main antenna, especially in the horizontal position. This command is required before the inertial guide is aligned with the static base or in the middle and before the dynamic base is aligned. Once this configuration is complete, it needs to be saved via "saveconfig".

The configuration includes the master antenna arm configuration and the slave antenna arm configuration.

The master antenna configuration command is as follows:

setimutoantoffset1 armX armY armZ

The slave antenna configuration command is as follows

setimutoantoffset2 armX armY armZ

where armX, armY and armZ are the configured pole arm values in meters, representing the vector from the inertial guide to the antenna phase center in the inertial guide carrier coordinate system, the inertial guide carrier coordinate system is selected as right front up (XYZ). For the example in Figure 5, armX and armY should have negative values and armZ should have positive values.
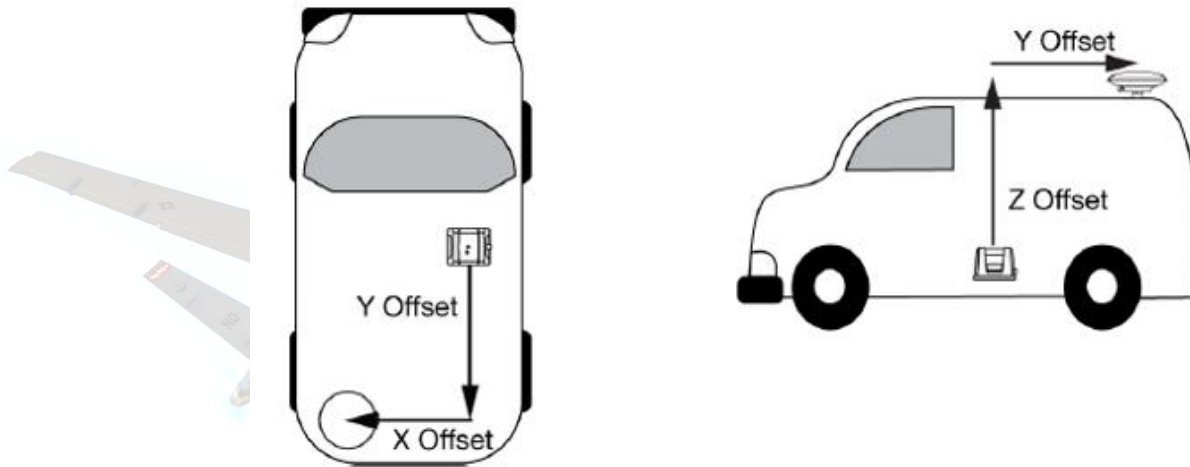
Figure 4 Schematic diagram of the antenna pole arm

3.2.13 Output lever arm setting

The default value of the product output lever arm configuration is [0, 0, 0] (right front up), which is the position and velocity value at the output inertial guide. If you need to output the position and velocity of the user test point, you need to set the output lever arm according to the relative installation relationship between the test point and the inertial guide.

The bar arm value between the configured inertial guide and the test point must be measured to the nearest millimeter (mm) and any bar arm measurement error will go directly into the position error of the inertial guide output. This command is required before the inertial guide's static base is aligned or before the inertial guide's dynamic base is aligned. Once this configuration is complete, it needs to be saved via "saveconfig".

The output lever arm configuration command is as follows:

setimutosensoroffset armX armY armZ

where armX, armY and armZ are the configured arm values in meters, representing the vector from the inertial guide to the test point in the inertial guide vector coordinate system, the inertial guide vector coordinate system is selected as the right front up (XYZ). Figure 6 example, armY, armZ should be positive values.
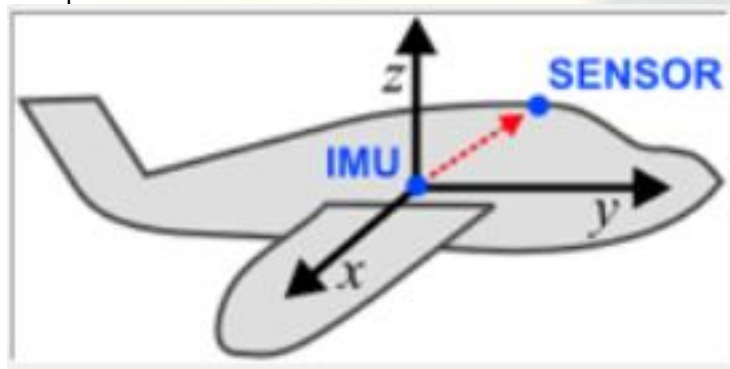

Figure 5 Schematic diagram of output lever arm

3.2.14 Mounting angle setting

The attitude and heading information output by the product are the Euler angles of the product coordinate system relative to the geographic coordinate system. The angular installation relationship between the product and the carrier coordinate system is the installation angle, and the configuration default value is [0, 0, 0] (pitch, heading, roll), which means that the product coordinate system is considered to overlap with the installation carrier coordinate system. If there is a mounting angle for the product installed on the carrier, and the product is required to output the Euler angle of the carrier coordinate system relative to the geographic coordinate system, the mounting angle should be set according to the relative mounting relationship between the product and the carrier.

The installation angle configuration command is as follows:

vehiclebodyrotation angleX angleZ angleY

where angleX, angleZ and angleY are the configured installation angle angle values in degrees, representing the angle from the carrier coordinate system to the combined navigation system coordinate system, in the order of pitch, heading and roll.
Note: This function will cause the output angular velocity, acceleration, attitude, etc. to change with the settings.

3.3 Protocol format

3.3.1、 Example of inertial configuration command:
log com2 sncnavpvtb ontime 1

Table 6 sncnavpvtb format

Byte Serial Number	Data	Data Type	Number of occupied bytes	Description
0	0x55	unsigned char	1	Fixed 0x55
1	0xAA	unsigned char	1	Fixed 0xAA
2	Class	unsigned char	1	Fixed 0x00
3	ID	unsigned char	1	Fixed 0x00
4-5	Frame Length	unsigned short	2	
6-7	Frame count	unsigned short	2	Add 1 for each frame sent
8-9	Week(GPS time)	unsigned short	2	Unit is the first few weeks
10-17	Weeks and seconds (in GPS time)	double	8	Unit is S
18-21	Heading	int	4	Units in degrees LSB=0.0001°
22-25	Pitch	int	4	Units in degrees LSB=0.0001°
26-29	Roll	int	4	Units in degrees LSB=0.0001°
30-33	East speed	int	4	Units in degrees LSB=0.0001 m/s
34-37	North	int	4	Units in degrees LSB=0.0001 m/s
38-41	sky speed	int	4	Units in degrees LSB=0.0001 m/s
42-45	Latitude	int	4	Units in degrees LSB=0.0000001°
46-49	Longitude	int	4	Units in degrees LSB=0.0000001°
50-53	Altitude	int	4	Unit is meter LSB=0.0001m
54-57	X-axis angular velocity(right-front-up)	int	4	Units in degrees LSB=0.000001°/s
58-61	Y-axis angular velocity (right-front-up)	int	4	Unit in degrees/second LSB=0.000001°/s
62-65	Z-axis angular velocity (right-front-up)	int	4	Unit in degrees/second LSB=0.000001°/s
66-69	X-axis acceleration (right-front-up)	int	4	Unit is m/s2 LSB=0.0000001 m/s2
70-73	Y-axis acceleration(right-front-up)	int	4	Unit is m/s2 LSB=0.0000001 m/s2
74-77	Z-axis acceleration (right-front-up)	int	4	Unit is m/s2 LSB=0.0000001 m/s2
78	Master antenna positioning stars	unsigned char	1	The unit is a grain LSB＝1
79	Slave antenna positioning stars	unsigned char	1	The unit is a grain LSB＝1
80	Navigation Status Word	unsigned char	1	Bit7-Bit0 0x00: Standby 0x10: Coarse alignment 0x20: Fine alignment 0x30: Combined navigation 0x31: Pure inertial navigation
81-82	GNSS Status Word	unsigned short	2	Bit2-Bit0 =0: invalid =1: single point positioning

				=2: pseudo-range differential =3: RTK differential positioning Bit3: Position-velocity data valid =0: invalid =1: valid Bit4: GNSS dual antenna heading is valid =0: invalid =1: valid Bit5: GPS time data is valid =0: invalid =1: valid Bit6-Bit15: Reserved for 0
83-84	Fault status word	unsigned short	2	Bit0: X-axis gyro fault word =0: normal =1: Fault Bit1: Y-axis gyro fault word =0：Normal =1: Fault Bit2: Z-axis gyro fault word =0: normal =1: Fault Bit3: X-axis acceleration fault word =0: Normal =1: Fault Bit4: Y-axis acceleration fault word =0: Normal =1: Fault Bit5: Z-axis acceleration fault word =0: Normal =1: Fault Bit6: GNSS board hardware fault word =0: Normal =1: Fault Bit7-Bit15: Reserved for 0
85-92	Reserved	-	8	-
93-94	Checksum	-	2	2-92 Accumulation takes the lower 16 bits

3.3.2 GPFPD

Example of inertial configuration command:

log com2 gpfpd ontime 1

Example of inertial guidance output

$GPFPD,2083,199022.049,271.356,-2.149,0.767,39.7085178,116.1311212,39.93,-11.422,-0.077,0.050,1.500,27,0,1*59

Table 4 GPFPD format

Serial number	Name	Meaning	Data Type	Unit
1	$GPFPD	Format header	—	—
2	GPSWeek	Current number of weeks since 1980-1-6 to present (GMT)	Integer	—
3	GPS Week Seconds	GPS week seconds	Floating Point	s
4	Yaw angle	Yaw angle 0~360 degrees, clockwise	Floating Point	°
5	Pitch angle	Pitch angle-90 degrees~90 degrees	Floating Point	°
6	Roll angle	Roll angle-180 degrees~180 degrees	Floating Point	°
7	Latitude	Inertial guidance output latitude -90 degrees ~ 90 degrees	Floating Point	°
8	Longitude	Longitude of inertial guidance output-180 degrees~180 degrees	Floating Point	°
9	altitude	Inertial guidance output altitude	Floating Point	m
10	East speed	Inertial guidance output east speed	Floating Point	m/s
11	North speed	Inertial guidance output north speed	Floating Point	m/s
12	Sky speed	Inertial guide output sky speed	Floating-point	m/s
13	Baseline length	Two satellite antenna center distance	Integer	m
14	NSV1	Antenna 1 satellite number	Integer	PCS
15	NSV2	Antenna 2 satellites	Integer	PCS
16	Satellite Status	Satellite status 0: not available, 1: available	Integer	—

17	Checksum code	Check code	Hexadecimal	—
18	<CR><LF>	Fixed packet tail	—	—

3.3.3、BDFPD

Example of inertial configuration command:

log com2 gpfpd ontime 1

Example of inertial guidance output

$BDFPD,2105,355160.246,90.96184,-1.14427,1.01899,39.71066564,116.11209956,46.076,-0.0037,-0.0065,0.0147,20,16,0*68

Table 5 BDFPD format

Serial number	Name	Meaning	Data Type	Unit
1	$BDFPD	Format header	—	—
2	GPSWeek	Current week number since 1980-1-6 to present (GMT)	Integer	—
3	GPS circumsecond	GPS week seconds	Floating point	s
4	Yaw angle	Yaw angle 0~360 degrees, clockwise	Floating-point	°
5	Pitch angle	Pitch angle-90 degrees~90 degrees	Floating point	°
6	Roll angle	Roll angle-180 degrees~180 degrees	Floating-point	°
7	Latitude	Inertial guidance output latitude -90 degrees ~ 90 degrees	Floating Point	°
8	Longitude	Longitude of inertial guidance output-180 degrees~180 degrees	Floating Point	°
9	altitude	Inertial guidance output altitude	Floating Point	m
10	East speed	Inertial guidance output east speed	Floating Point	m/s
11	North speed	Inertial guidance output north speed	Floating Point	m/s
12	Sky speed	Inertial guidance output sky speed	Floating-point	m/s
13	NSV1	Antenna 1 satellite number	Integer	PCS
14	NSV2	Antenna 2 satellites	Integer	PCS
15	Positioning type	pos type in bestpos	Integer	—
16	Orientation Type	Pos type in heading	Integer	—
17	Checksum	Checksum	Hexadecimal	—
18	<CR><LF>	Fixed packet tail	—	—

3.3.4 Short Message Protocol Header

There are two types of short header protocol headers, one is ASCII and the other is binary.

ASCII short header

Serial number	Name	Data Type	Meaning
1	%	Char	Fixed to '%'
2	Message Name	Char	Message type for this protocol
3	GPS Week	Ushort	GPS weeks (at GPS time)
4	GPS Week Seconds	float	GPS Week Seconds (GPS time)

Binary short header

Serial number	Name	Data Type	Meaning	Binary Bytes	Binary Offset
1	Synchronized Bytes	Char	Fixed Hex 0xAA	1	0
2	Synchronized Bytes	Char	Fixed Hex 0x44	1	1
3	Synchronization Bytes	Char	Fixed Hex 0x13	1	2
4	Message Length	Uchar	Message length, without headers and CRC checksum	2	3
5	Message ID	Ushort	Message ID	2	4
6	GPS Week	Ushort	GPS weeks (at GPS)	4	6
7	GPS Week Seconds	Int	GPS week seconds (in GPS time, in milliseconds)	4	8

3.3.5 、32-bit CRC checksum

The C code history is as follows

```
#define CRC32_POLYNOMIAL 0xEDB88320L
/* ------------------------------------------------------------------------
Calculate a CRC value to be used by CRC calculation functions.
------------------------------------------------------------------- */
unsigned long CRC32Value(int i)
{
```

```
        int j;
        unsigned long ulCRC;
        ulCRC = i;
        for ( j = 8 ; j > 0; j-- )
        {
            if ( ulCRC & 1 )
                ulCRC = ( ulCRC >> 1 ) ^ CRC32_POLYNOMIAL;
            else
                ulCRC >>= 1;
        }
        return ulCRC;
}
/* -------------------------------------------------------------------
Calculates the CRC-32 of a block of data all at once
ulCount - Number of bytes in the data block
ucBuffer - Data block
-------------------------------------------------------------------- */
unsigned long CalculateBlockCRC32( unsigned long ulCount, unsigned char*ucBuffer )
{
        unsigned long ulTemp1;
        unsigned long ulTemp2;
        unsigned long ulCRC = 0;
        while ( ulCount-- != 0 )
        {
            ulTemp1 = ( ulCRC >> 8 ) & 0x00FFFFFFL;
            ulTemp2 = CRC32Value( ((int) ulCRC ^ *ucBuffer++ ) & 0xFF );
            ulCRC = ulTemp1 ^ ulTemp2;
        }
        return( ulCRC );
}
```

3.3.6、 INSPVAS

The command is short message protocol output
Example of inertial configuration command:
log com2 inspvasa ontime 1 (ASCII)
log com2 inspvasb ontime 1 (binary)
ASCII example
%INSPVASA,1264,144059.000;1264,144059.002135700,51.116680071,-
114.037929194,515.286704183,277.896368884,84.915188605,-8.488207941. 0.759619515,-
2.892414901,6.179554750,INS_ALIGNMENT_COMPLETE*855d6f76

INSPVAS format

Serial number	Name	Meaning	Data Type	Binary Byte	Binary Offse
1	INSPVAS Header	Message Header	—	H	0
2	Week	GPS Week (in GPS time)	Ulong	4	H
3	Seconds	GPS Week Seconds (GPS time)	Double	8	H+4
4	Latitude	Latitude (WGS84) [degrees]	Double	8	H+12
5	Longitude	Longitude (WGS84) [degrees]	Double	8	H+20
6	Height	Height above mean sea level [metres]	Double	8	H+28
7	North Velocity	Northward velocity (negative values indicate a southward direction) [m/s]	Double	8	H+36
8	East Velocity	Eastward velocity (negative values indicate a westward direction) [m/s]	Double	8	H+44
9	Up Velocity	Skyward velocity [m/s]	Double	8	H+52
10	Roll	Roll [degrees]	Double	8	H+60
11	Pitch	Pitch [degrees]	Double	8	H+68
12	Azimuth	Heading angle (0-360) [degrees]	Double	8	H+76

Serial number	Name	Meaning	Data Type	Binary Byte	Binary Offse
13	Status	Inertial guidance status word	Enum	4	H+84
14	xxxx	32-bit CRC	Hex	4	H+88
15	[CR][LF]	Fixed endings (ASCII only)	-		—

Inertial guidance state

Binary	ASCII	Meaning
0	INS_INACTIVE	Inertial guidance ready state
1	INS_ALIGNING	Inertial Guidance Alignment State
3	INS_SOLUTION_GOOD	Inertial guidance combined navigation state
6	INS_SOLUTION_FREE	Inertial guidance pure inertial state

3.3.7 、 RAWIMUS

The command is short message protocol output (output binary only)
Example of inertial configuration command:
log com2 rawimusb onchanged (binary)

RAWIMUS format

Serial number	Name	Meaning	Data Type	Binary Byte	Binary Offse
1	RAWIMUS Header	Message Header	—	H	0
2	Week	GPS Week (in GPS time)	Ulong	4	H
3	Seconds	GPS Week Seconds (GPS time)	Double	8	H+4
4	IMU Status	IMU status word	Hex Ulong	4	H+12
5	Z Accel Output	Fixed 200HZ, divided by 250000.0 becomes Z acceleration m/s2 (right-front-up)	Long	4	H+16
6	- (Y Accel Output)	Fixed 200HZ, divided by -250000.0 becomes Y acceleration m/s2 (right-front-up)	Long	4	H+20
7	X Accel Output	Fixed 200HZ, divided by 2500000.0 becomes X acceleration m/s2 (right-front-up)	Long	4	H+24
8	Z Gyro Output	Fixed 200HZ, divided by 5000000.0 becomes Z angular velocity rad/s (right-front-up)	Long	4	H+28
9	- (Y Gyro Output)	Fixed 200HZ, divided by -5000000.0 becomes Y angular velocity rad/s (right-front-up)	Long	4	H+32
10	X Gyro Output	Fixed 200HZ, divided by 5000000.0 becomes X angular velocity rad/s (right-front-up)	Long	4	H+36
14	xxxx	32-bit CRC	Hex	4	H+40
15	[CR][LF]	Fixed endings (ASCII only)	-		—

Raw IMU scale

IMU Type	Gyro	Acceleration
ISA-100C	1.0E-9 rad/LSB	2.0E-9 m/s/LSB

3.3.8、 RAWDATA

The protocol is a collection of protocols, including the inertial guidance internal group IMU raw data RAWIMUSB (200HZ) protocol and the BESTPOSB (1HZ), BESTVELB (1HZ), PSRDOPB (1HZ), HEADINGB (1HZ), RANGECMPB (satellite Navigation raw data option) protocol.
Example of inertial guidance configuration commands:

log com2 rawdata onchanged

3.4 、Data Export

This product has data storage function, total storage space 16G (internal will contain system recovery partition and other files used by the system, so it will be less than the normal empty SD card). The system automatically saves the storage information according to the user's configuration. The saved data folder is named recordX, where X is the file number (the maximum is 39), and the number increases sequentially. When X is 39, the next storage will automatically overwrite record00, and X will still increase sequentially in the next storage. If the system is configured to store data state, the system will automatically delete the earliest data folder after each power-on operation, for example, if the current generated file is record08, there will be no record09 folder in the system memory. Users can use this as a basis to find the latest data file. In addition, the current latest file name is also displayed when a configuration query is made.

The recordX folder contains each protocol file configured by the user, and each protocol is a separate file with the protocol name.

The data export operation is as follows:

Connect the Ethernet interface to the test computer;

Set the IP address of the test computer to 192.168.1.22;

Power up the system;

Run the SSH software (SSH Secure File Transfer Client);

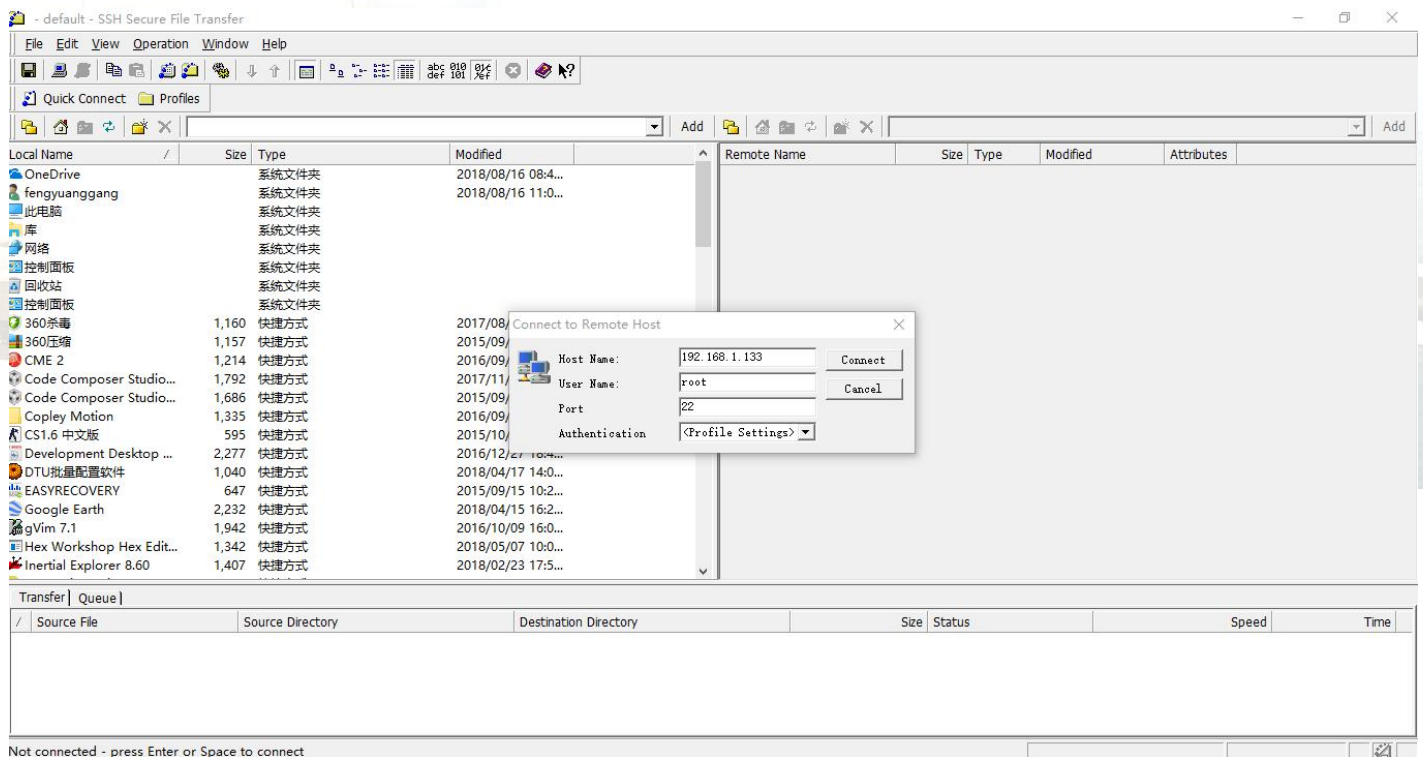Click Quick Connect and fill in the contents as shown in Figure 4;

Figure 4 SSH software connection diagram

- Click Connect, the SSH software will automatically pop up the "Enter Password" dialog box, no need to fill in the password, click OK to connect to the system;

- Type /media/mmcblk0p1 in the address bar on the right side of the above figure and enter, then find the corresponding storage directory in the directory below to download.

- After the download operation is completed, the system is powered off and the Ethernet interface is unplugged.

3.5、 System Maintenance

3.5.1 Firmware Upgrade

Operation steps are as follows:

- Connect the inertial guide COM1 and network port to the computer, and set the computer network port IP port to 192.168.1.22;

- open the host computer software CRT, open the corresponding serial port, serial port settings for baud rate 115200, 8-bit data, 1-

bit stop bit, no parity bit;

- power on the combined navigation system;
- Observe the CRT display, wait for the Linux boot to complete, enter the command $GPEXT, a command line will appear.
- Run SSH software (SSH Secure File Transfer Client), click Quick Connect and fill in the content as shown below.
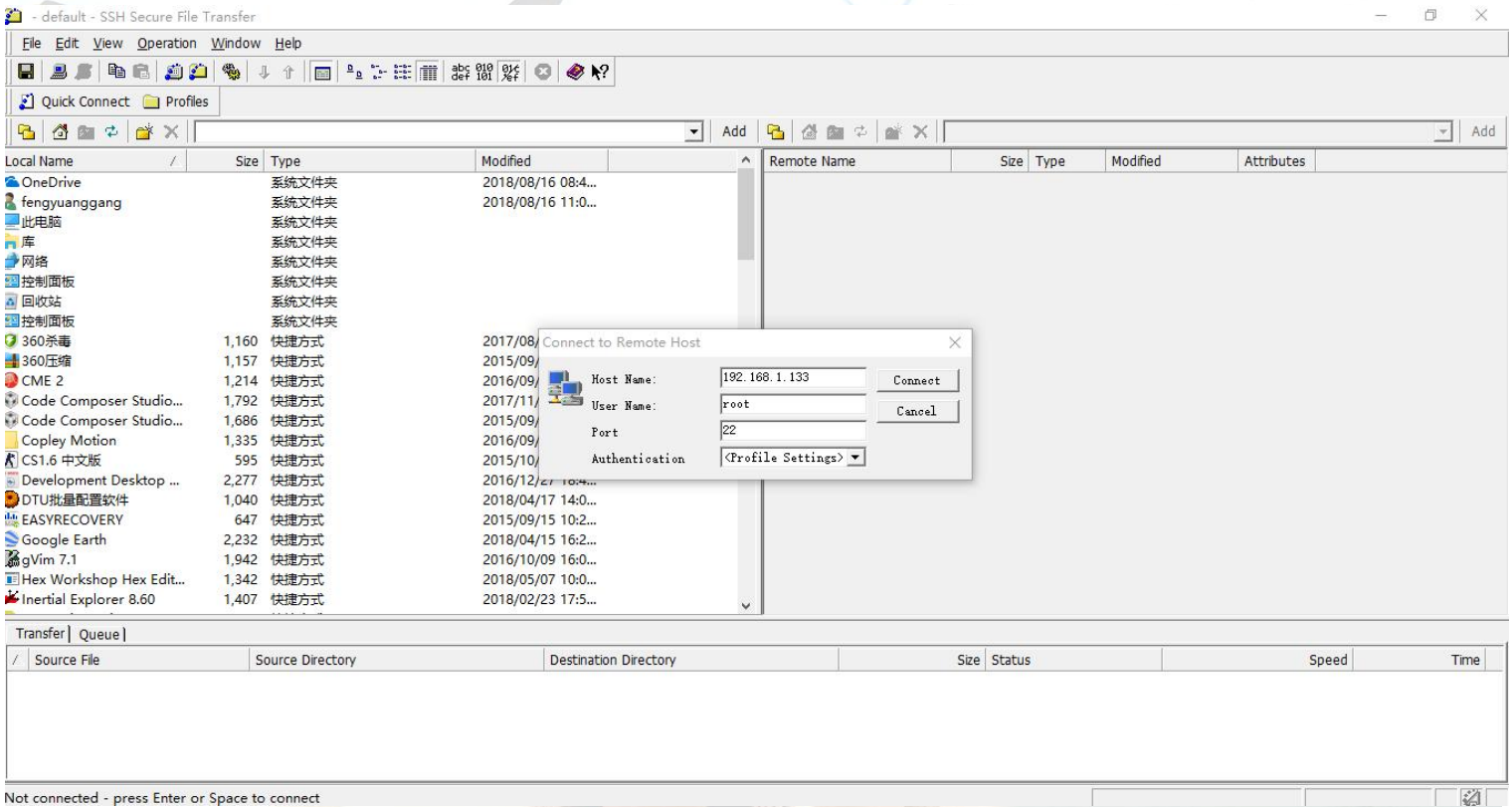
- Click Connect, the SSH software automatically pops up the "Enter Password" dialog box, no need to fill in the password, click OK, connect to the system;
- Type /home/root/install in the address bar on the right side of the above figure and enter, delete the files snc300_dgi(linux application), snc300_dgi_dsp.out(DSP program), snc300imu.bin(FPGA program), and copy the new snc300_dgi, snc300_dgi_dsp.out, snc300imu.bin, snc300_dgi.bin and snc300imu.bin, snc300_dgi_dsp.out, snc300imu.bin files, you need to select change the three files in the right-click properties, change the permission to 777, and then enter the sync command in COM1 to synchronize the files.
- If you need to upgrade the FPGA program, you need to send /home/root/update_fpga.sh from COM1, and wait for COM1 to indicate the successful upgrade.
- The upgrade is completed when the product is rebooted.

🔷 CAUTIONS

The main considerations are as follows:

- the inertial guidance system power-on and power-off time interval is not less than 30s, otherwise it is easy to cause damage to inertial devices;
- in the handling, installation and use process, should be lightly held and placed to avoid bumping, dropping and impact;
- after the inertial guide is turned on, you need to wait for the inertial guide to complete coarse alignment before linear motion, coarse alignment time of about 1min, otherwise affect the measurement accuracy;
- carrier type configuration for the vehicle type, the inertial guide is required to be installed in the car fixed, and the inertial guide direction and the direction of the front of the carrier car, the error is not more than 10 degrees.

📦 *APPENDIX*

1、Combined navigation system satellite receiver COM2, COM3 output configuration

The combined navigation system receives satellite navigation information through the port of the built-in satellite receiver. The COM2 port of the satellite receiver is configured with the following commands:

unlogall com2

serialconfig com2 460800

log com2 headingb onchanged

DUALANTENNAALIGN enable 5 5

log com2 psrdopb ontime 1

log com2 bestposb ontime 0.2

log com2 bestvelb ontime 0.2

log com2 timeb ontime 1

log com2 rangecmpb ontime 1 (note: without raw number card, this command is invalid)

frequencyout enablesync 100000 1000000000

saveconfig

Which if you want to use the COM3 of the satellite card can refer to section 4.3.2.7, but you need to configure the following command to turn the satellite card multiplex pin into serial COM3.

interfacemode usb1 none none

interfacemode usb2 none none

interfacemode usb3 none none

MARKCONTROL MARK1 DISABLE

interfacemode com3 novatel novatel

serialconfig com3 115200 (Note: Baud rate can be set to the baud rate you want to use, but the inertial guide COM4 port needs to be consistent with the baud rate here)

Saveconfig

2、Differential configuration description

The combined navigation system can receive the differential correction information sent by the reference station through the communication link and work in the differential state to achieve the centimeter-level positioning accuracy. The differential configuration mainly includes 3 parts: 1) reference station setting; 2) communication link setting; 3) mobile station setting. The data link is shown in the figure below.
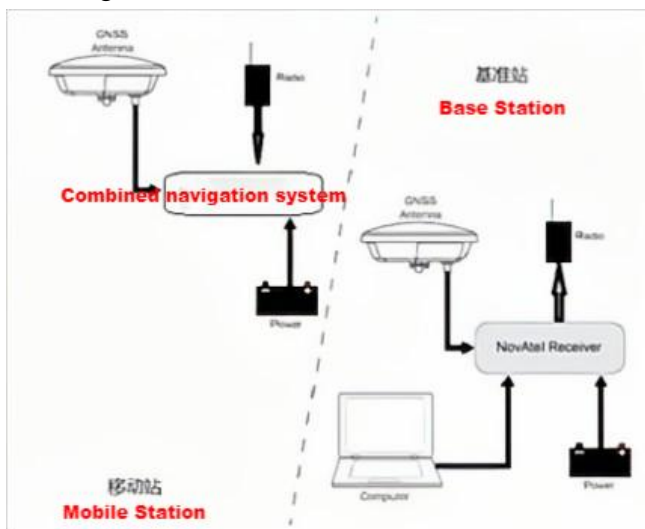

Figure 7 Schematic diagram of data link

2.1、 Reference station setting

Differential reference station is the satellite receiver antenna installed in a fixed position, the satellite receiver in the use of the process, need to ensure that the antenna position is fixed. The differential reference station sends the precise coordinates of the fixed position and the received satellite information to the mobile station (the point to be positioned) through the communication link, which is used for the mobile station to carry out differential positioning solution to realize differential high-precision positioning and achieve centimeter-level positioning accuracy.

The reference station can apply NovAtel-718D satellite receiver board and configure it as the reference station mode. The specific configuration instructions are as follows, and detailed instructions are provided in the NovAtel-718D user manual.

Table 14 Base station configuration commands

Serial number	Instruction	Description
1	fix position 39.8122 116.1515 60.5	Set the known precision coordinates (latitude 39.8122, longitude 116.1515, altitude 60.5) as the reference station coordinate values
	posave on 0.01 1.5 2.5	Receiver autonomous positioning 0.01h; or when the standard deviation of horizontal positioning <=1.5m and the standard deviation of altitude positioning <=2.5m, the average value of positioning is used as the coordinate value of the reference station
2	serialconfig com1 9600	Set the output baud rate of the reference station output interface COM1 to 9600bps
3	interfacemode com1 novatel rtcmv3 on	Configure COM1 input data type as novatel, output data type as rtcmv3, and enable command feedback
4	log com1 rtcm1075 ontime 1	GPS Differential Messages
5	log com1 rtcm1125 ontime 1	BDS Differential Messages
6	log com1 rtcm1085 ontime 1	GLO Differential Messages
7	log com1 rtcm1033 ontime 10	Receiver and Antenna Description
8	log com1 rtcm1005 ontime 10	RTK Base Station Antenna Reference Point Coordinates
9	saveconfig	Save Configuration

2.2 、 Communication link setting

The communication link can use 4G DTU or digital radio, and the coverage area of 4G DTU is the coverage area of network information; the coverage area of digital radio is about 10km due to the national law, and the setting of 4G DTU and digital radio can refer to the user manual of corresponding products.

2.3 、 Mobile station setting

The combined navigation system is a differential mobile station, which receives the differential correction information from the reference station in real time and receives satellite signals for differential positioning solution to achieve differential high-precision positioning. The combined navigation system supports RTCM and RTCMV3 standard data protocols. The GNSS_COM1 or GNSS_COM3 of the combined navigation system can be configured as the receiving interface for differential correction information, and the specific configuration commands are as follows.

Table 15 Mobile station configuration commands

Serial number	Instruction	Description
1	serialconfig com1 9600	Set the input baud rate of mobile station input interface COM1 to 9600bps
2	interfacemode com1 rtcmv3 novatel on	Configure COM1 output data type as novatel, input data type as rtcmv3, and enable command feedback
3	saveconfig	Save configuration