MEMS ins V 1.01.

BS-FN600-M-D6EC

Product characteristics

- Gyroscope measuring range: 500 ~ 2000 °/s optional
- 2 °/H gyroscope bias stability (Allan variance)
- Acceleration range: 16g
- Zero bias stability (Allan variance) for acceleration of 0.1 mg

Field of application

UAVNavigation | Vehicle & Robot Navigation | AUV &ROV

1. Product overview

The BS-FN600-M-D6EC is a compact, dual-axis, rotary micromachined (MEMS) inertial navigation system. The product can use the timing and positioning information provided by the external satellite navigation system (GNSS), the speed information provided by the external Doppler velocimeter (DVL), and the pressure altitude and airspeed information provided by the external barometer to perform inertial/GNSS/DVL/barometric integrated navigation. When the external auxiliary information is invalid, the product has a high ability to maintain the accuracy of pure inertial navigation.

The product has the ability of self-calibration, self-alignment and self-detection, and is maintenance-free in the whole life cycle.

The main functions of the product are: the function of shaking base/moving base alignment, the function of self-seeking north, the function of multi-sensor information fusion integrated navigation, and the function of maintaining accuracy for a long time without external information assistance.

The product supports users to customize according to their needs.

2. Main functions and indicators

2.1 Main functions

The product can receive the position, speed and other information provided by the external sensor for combined navigation, and provide the user with the combined navigation parameters such as position, speed, attitude, course, acceleration and angular velocity. When the external sensor is disabled, it can operate in pure inertial navigation mode to provide a full set of navigation parameters. External sensors include GNSS, DVL, barometer, etc.

Key features include:

A) initial alignment function: The product needs to be initially aligned before navigation to obtain accurate initial attitude information. Initial alignment includes coarse alignment and fine alignment. After the fine alignment is completed, it will automatically switch to the navigation state.

B) integrated navigation function: immediately turn to the integrated navigation state after initial alignment. The product uses the external sensor information for multi-sensor fusion integrated navigation, automatically judges the type of the received external sensor, independently selects the optimal combination mode for integrated navigation, and calculates the navigation information such as the speed, position and attitude of the carrier in real time.

C) inertial navigation function: After the external sensor information is invalid, the product has the function of keeping the pure inertial position, course and attitude within a certain period of time.

D) communication function: The product can output navigation information according to the set protocol.

Online upgrade function of e): the product has the ability to upgrade firmware online, and the software can be upgraded through the serial port without disassembling the product.

Internal storage function of f): The product has built-in storage, which can save the protocol information, and can be connected to the upper computer through the USB interface to download the internal storage data.

2.2 Performance indicators

Project	Test conditions	Indicators
Positioning	External GNSS Valid,	Better than external satellite positioning
Heading accuracy	Self-north seeking accuracy	0.6 ° SecL, alignment for 3min
		0.3 ° SecL, alignment for 15 min
	Maintain accuracy	1°/4h①
Attitude accuracy	GNSS is valid	0.2° (RMS)
	Attitude hold (GNSS	0.2°/4h (RMS) ①
Gyroscope	Measuring range	±400°/s
	Zero bias stability	≤0.3°/h②
Accelerometer	Measuring range	±16g
	Zero bias stability	≤100μg②
Physical dimensions and electrical characteristics	Voltage	9-36V DC
	Power consumption	≤8W
	Interface	2 RS 422,1 PPS (LVTTL/differential level
	Size	88mm × 88mm × 88mm (L, W, H)
	Weight	≤750g
Environmental characteristics	Operating temperature	-40℃~+60℃
	Storage temperature	-45℃~+70℃
	Vibration	20~2000Hz，6.06g③
	Impact	30g，11ms③
	Life span	> 15 years

Project	Test conditions	Indicators
	Continuous working	>24h
Note: the range of position movement during operation shall not exceed 100m; 10 s		

Table 1 Product Performance Index

3. How it works

3.1 Product composition

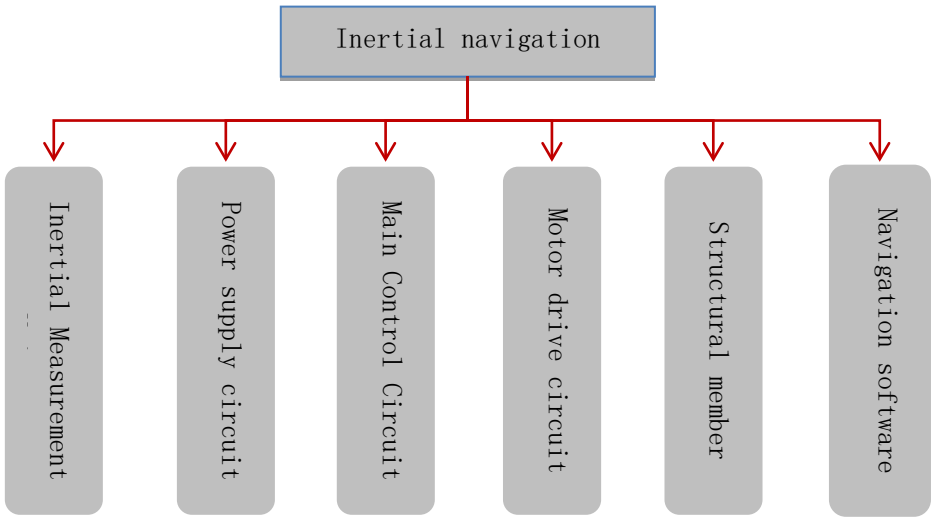

Figure 1 Product composition

3.2. Rationale

The inertial measurement unit consists of a three-axis accelerometer and a three-axis gyroscope, and is used for measuring the acceleration and the angular velocity of a carrier and sending the information to the main control circuit; and the main control circuit performs navigation calculation by using the acceleration and the angular velocity measured by the inertial measurement unit, simultaneously receives auxiliary navigation information provided by an external sensor, performs combined navigation, and corrects an inertial navigation error And output that combined navigation information.

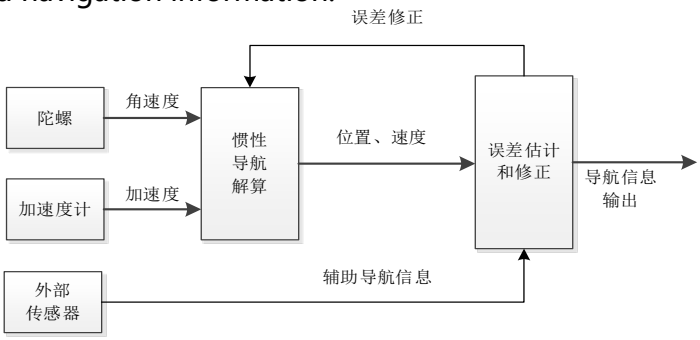

Fig. 2 Schematic diagram of working principle

4. Instructions for use

4.1 Overall dimensions

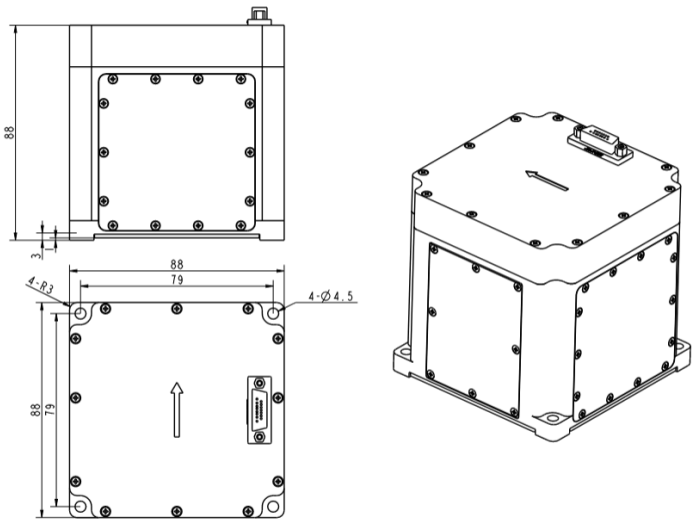

Fig. 3 Structure Diagram of Overall Dimensions

4.2 Electrical interface

The product has one external connector, and the product end socket model is J30JY-21ZKP37.

J30JY-21ZKP37		Terminal number	Explain
Code name	Terminal		
X1	1	24V_IN	
X1	12	24V_IN	
X1	2	24V_GND	
X1	13	24V_GND	
X1	4	RS422TX1+	COM 1, navigation interactive communication port, receiving external atmospheric data and DVL data, and outputting integrated navigation data
X1	5	RS422TX1-	
X1	6	RS422RX1+	
X1	7	RS422RX1-	
X1	16	24V_GND	
X1	8	RS422TX2+	COM 2, communication port of health guide
X1	9	RS422TX2-	
X1	10	RS422RX2+	
X1	11	RS422RX2-	
X1	14	PPS_+	LVTTL

J30JY-21ZKP37		Terminal number	Explain
Code name	Terminal		
X1	15	PPS_-	
X1	17	CANH	
X1	18	CANL	
X1	20	USB_P	
X1	21	USB_N	
X1	19	24V_GND	
X1	Other	—	If you need to use this point to cross the

Table 2 X1 Connector Point Definitions

4.3 Instructions for use

4.3.1 workflow

The product includes two workflows, an integrated navigation process and a pure inertial navigation process.

Figure 4 Work flow chart

4.3.1.1startup prompt message

Connect the cable, power on the product, monitor the COM1 interface information through the serial port debugging tool of the test computer, and display "Please enter command within 20s" on the interface! After "", the serial port debugging tool can be used to send the setting/configuration instructions through the COM1 interface. If the command is not sent within 20 seconds, the product automatically enters the internally saved workflow after 20 seconds.

4.3.1.2 integrated navigation proces

Aft entering that work flow, the satellite information is bound first, and if the satellite is not position, the satellite information is in a state of waiting for the satellite information; When the satellite information is valid, it enters the alignment state, and the alignment time is 15 min. The alignment includes rough alignment for 1 min and fine alignment for 14 min.

During the rough alignment, the product is required not to move as much as possible. After the rough alignment is completed, it automatically enters the fine alignment. After the fine alignment is completed, the product automatically enters the integrated navigation state.

4.3.1.3 pure inertial navigation proces

Aft entering that work flow, the satellite information is bound first, and if the satellite is not position, the satellite information is in a state of waiting for the satellite information; When the satellite information is valid, it enters the alignment state, and the alignment time is 15 min. The alignment includes rough alignment for 1 min and fine alignment for 14 min. During the rough alignment, the product is required not to move as much as possible. After the rough alignment is completed, it automatically enters the fine alignment. After the fine alignment is completed, the product automatically enters the inertial navigation state.

4.3.2 setting instruction

Within 20 seconds after the product is powered on, the serial port debugging tool can be used to send instructions to the product through the COM1 interface to enter the setting state. Send " $SETMODE" to enter the setup mode command through com1, and the product feeds back "Into Setup Mode", and the product enters the setup state, where it can receive setup instructions.

4.3.2.1 Setting Scheme and Saving

The product is externally provided with two serial ports (setting No.: com1 ~ com2) and one internal storage channel (setting No.: file). The function allocation and relevant settings of each serial port are shown in the following table.

Set the number	Enter the project	Output items	Default
COM1	1. working mode instruction and flow control instruction; 2.COM1-COM2 baud rate setting; 3. COM1-COM2 protocol and update rate setting; 4.Store the file port protocol settings.	1. inspvab, (0.2 Hz, 1Hz, 5Hz, 10Hz, 20Hz, etc.); 2. raw imub (0.2 Hz, 1Hz, 5Hz, 10Hz, 20Hz, etc.); 3. sncpost (0.2 Hz, 1 Hz, 5 Hz, 10 Hz, 20 Hz, etc.); 4.Set the prompt information.	RS422; 460800bps; Output: inspvab 1Hz;
COM2	None	1. inspvab, (0.2 Hz, 1Hz, 5Hz, 10Hz, 20Hz, etc.); 2. raw imub (0.2 Hz, 1Hz, 5Hz,	RS422; 460800bps; Output:

		10Hz, 20Hz, etc.); 3. sncpost (0.2 Hz, 1 Hz, 5 Hz, 10 Hz, 20 Hz, etc.);	None
file	The product automatically saves the storage information according to the user's settings, and displays the latest file name when querying the settings.	1. There will be a fixed sncpost protocol and it cannot be cancelled. This protocol is data backup. 2. Under the condition of power-on, the USB port is inserted into the computer to export the stored data.	None

Table 3 Distribution of serial port functions

After the product is powered on and the start information is displayed on the COM1 port, you can input the commands such as COM1 ~ COM2 serial port baud rate setting, serial port protocol and update rate setting. If each command is output successfully, it will return to the "cmd OK" ", otherwise it will display the cmd error". After the input is completed, type "saveconfig" to save the setting this time. The setting this time will be called automatically after the next restart. If the command is not input, the serial port setting will be restored to the setting saved last time after the next restart.

4.3.2.2 setting query

Type the "log loglist" "command through the COM1 port to list all settings of COM1 ~ COM2, including the following:

A) serial port number, serial port baud rate, serial port protocol and update rate;

Open state of b) function module: including zero speed correction state and smooth processing state, enable when open and disable when closed;

Types of c) carriers: including vehicle-mounted, ship-mounted and airborne;

Internal storage state information of the d), including the file name of the last file, remaining space, etc.;

E) initial binding longitude and latitude;

F) product number and date of manufacture;

G) software version number;

H) operation mode: including integrated navigation (DGI) and pure inertial navigation (INS).

4.3.2.3 baud rate setting

In this mode, enter the following command to enter the serial port baud rate setting: com comX BAUDRATA.

Where X is 1 ~ 2 and BAUDRATA is the baud rate in bps.

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

com com2 460800

4.3.2.4 update rate setting

Set the protocols of COM1 ~ COM2 and inspvab, rawimub of memory file port through COM1, and set the command: log comX/file LOG ontime updataTime.

Wherein comX can be the setting number of com1 to com2, and file is the setting number of the memory interface; The updataTime represents the update time, which can be a period of 5 (0.2 Hz), 1 (1 Hz), 0.2 (5 Hz), 0.1 (10 Hz), 0.05 (20 Hz), etc., which can be divided by 200 Hz, and the unit is s. LOG indicates the protocol name, which can be the name of the supported protocol.

For example, if you want to set the COM2 port to output 10Hz inspvab data, you can enter the following command through COM1:

log com2 inspvab ontime 0.1

If 10Hz rawimub data needs to be output at COM2 at the same time, the following command can be input through COM1:

log com2 rawimub ontime 0.1

As another example, to store inspvab protocol data at 1 Hz into the product internal memory, enter the following command from COM1: log file inspvab ontime 1

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

log comX/file LOG off

If you want to close all protocols of the serial port, the setting command is as follows:

unlogall comX/file

It should be noted that increasing the update rate or outputting several protocols at the same time will increase the amount of data sent by the serial port. It is necessary to set the appropriate baud rate before use, otherwise it may cause data loss. In general, the larger the amount of data, the higher the baud rate required.

4.3.2.5 Initial Value Longitude and Latitude Settings

Set the initial longitude and latitude, and set the command as initialpos LONGITUDE LATILUDE.

Where LONGITUDE and LATITUDE are the local longitude and latitude values set in

degrees.

4.3.2.6 function module settings

Functional modules with open settings mainly include zero speed correction and output position smoothing.

4.3.2.6.1 "Zero speed correction" settings

The zero speed correction function mainly refers to the detection of sensitive information by the product. If it is judged as zero speed, the corresponding correction will be made.

In the integrated navigation process of this product, the "zero velocity correction" is enabled by default. If the satellite information is invalid for a long time in the integrated navigation state, and the user wants to get the pure inertial navigation information, it is recommended to close the zero velocity correction mode.

The zero speed correction setting command is as follows:

inszupt switch

The switch value is either disable or enable, where disable turns the feature off and enable turns the feature on.

4.3.2.6.2 the Position Output Smoothing settings

The position information in the protocol is the position information of integrated navigation. In order to get more smooth position information, the position output smoothing function is added to the navigation software, and the position noise after smoothing is smaller.

In the integrated navigation process of this product, "Position Output Smoothing" is off by default. For the convenience of users, this function can be set. The setting instructions are as follows:

possmooth SWITCH

The switch values are disable and enable, where disable means to turn off the function and enable means to turn on the function.

4.3.2.7 Carrier Type Settings

The carrier type needs to be set according to the different carriers installed on the product. For different carrier types, different algorithms are processed inside the product. The setup instructions are as follows:

carrier vehicle/ship/air

They are vehicle-mounted, ship-mounted and airborne in turn.

After the setting is completed, you need to enter the save command save config, and then hard boot or enter the # reset command. The carrier type setting will be valid after startup. The product does not support current setting and current use during use, and must be

restarted.

Note: After the carrier type is set as the vehicle-mounted type, the product is required to be installed and fixed on the vehicle, and the product heading is consistent with the vehicle head direction, with an error of not more than 10 degrees.

4.3.2.8 GNSS antenna mast arm settings

According to the relative installation relationship between the antenna and the product, the antenna rod arm needs to be set. Set the lever arm value between the product and the antenna. The measurement must be accurate to millimeters (mm). Any measurement error of the lever arm will directly enter the position error of the product output. During installation and use, the product should be as close as possible to the main antenna, especially in the horizontal position. This directive requires that the alignment be completed before or during the alignment of the product on the stationary base and before the alignment of the product on the moving base. Once the setup is complete, it needs to be saved via "saveconfig".

The arrangement comprise a master antenna rod arm arrangement and a slave antenna rod arm arrangement.

The main antenna setting instructions are as follows:

setimutoantoffset1 armX armY armZ

The slave antenna setting command is as follows:

setimutoantoffset2 armX armY armZ

Where armX, armY, and armZ are the set lever arm values, in meters, representing the components of the vector from the product to the antenna phase center in the product carrier coordinate system, and the product carrier coordinate system is selected as the upper right front (XYZ). For the example in Figure 5, armX and armY should be negative, and armZ should be positive.

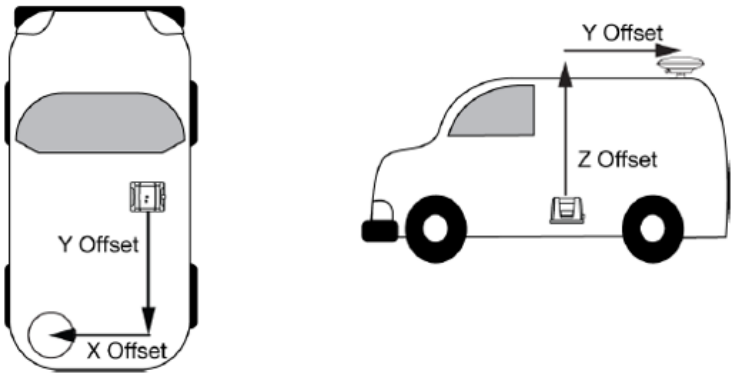

Figure 5 Schematic diagram of antenna rod arm

4.3.2.9 Output Lever Arm Settings

The product output lever arm setting defaults to [0,0,0] (top right front), which outputs the position and speed values at the geometric center of the product. To output the position and speed of the user's test point, set the output lever arm according to the relative installation relationship between the test point and the product.

Set the lever arm value between the product and the test point. The measurement must be accurate to millimeters (mm). Any lever arm measurement error will directly enter the position error of the product output. This directive requires that the alignment be completed before or during the alignment of the product on the stationary base and before the alignment of the product on the moving base. Once the setup is complete, it needs to be saved via "saveconfig".

The output lever arm setting commands are as follows:

setimutosensoroffset armX armY armZ

Where armX, armY, and armZ are the set lever arm values, in meters, representing the components of the vector from the product to the test point in the product carrier coordinate system, and the product carrier coordinate system is selected as the upper right front (XYZ). For the example in Figure 6, armY and armZ should be positive.

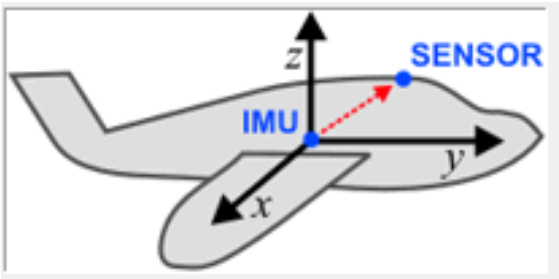

Fig. 6 Schematic diagram of output lever arm

Setting of mounting angle of 4.3.2.10

The attitude and heading information output by the product are Euler angles of the product coordinate system relative to the geographic coordinate system. The angle installation relationship between the product and the carrier coordinate system is the installation angle, and the default value is [0,0,0] (pitch, heading, roll), that is, the product coordinate system and the installation carrier coordinate system coincide. If there is an installation angle when the product is installed on the carrier, and the Euler angle of the carrier coordinate system relative to the geographic coordinate system needs to be output by the product, the installation angle should be set according to the relative installation relationship between the product and the carrier.

Mounting angle setting instructions are as follows:

vehiclebodyrotation angleX angleZ angleY

Where angleX, angleZ and angleY are the set installation angle values, in degrees, representing the angle from the carrier coordinate system to the product coordinate system, in the order of pitch, heading and roll.

Note: This function will cause the output angular velocity, acceleration and attitude to change with the setting.

4.3.2.11 Workflow Settings

In the setup mode, the product can receive a command to set the workflow to a combined navigation process and a pure inertial navigation process.

The instructions for setting the workflow as integrated navigation are as follows:

#moddgi

Set the workflow as inertial navigation flow instructions as follows:

#modins

4.3.3 protocol format

Serial	Data protocol	Type of	Output type	Support interface
	inspvab	Binary	ontime	COM1-COM2,file
	rawimub	Binary	ontime	COM1-COM2,file
	sncpost	Binary	ontime	COM1-COM2,file

Table 4 Output Data Protocol Description

The product can receive external atmospheric machine data through COM1 port, and the supported input formats of airspeed and pressure altitude are shown in the following table:

Serial	Data	Description	Remark	Type
Data[0]	0xEB	Frame header		U8
Data[1]	0x90			U8
Data[2]	0x13	Frame length	Number of all data bytes from frame	U8
Data[3]	0xA1	Frame ID		U8
Data[4]	U32 counter; //frame counter			Data structure
Data[5]	U8 state;			
Data[6]	//bit0 Pitot tube 0 normal 1 fault			

Data[7]	//bit1 Barometer 0 OK 1 Fault
	//bit3-7 standby
	S32 alt_baro; //unit: 0.01 m, barometric altitude
	F32 velocity_air; //m/s, airspeed			

Data[8]				
Data[9]				
Data[10]				
…				
…				
…				
Data[N-3]				
Data[N-2]	Low byte	Checksum	Data [0] ~ Data [N-3]'s accumulated sum is the lower two bytes	U8
Data[N-1]	High byte			U8

Table 5 External-to-Product Agreement Format

The product can receive the externally sent DVL data through the COM1 port, and the supported DVL output data format is NavQuest 300/NavQuest 600/NavQuest 600 Micro Doppler Velocity Log standard protocol of LinkQuest Inc. The output statements are SA, BI.

Note: DVL data and air data cannot be input at the same time.

The GNSS satellite guide input protocol supported by the product supports two forms, Novatel-like protocol and NMEA 0183 protocol, and the baud rate can be matched. The input format is shown in the following table:

Serial	Protocol	Cycle	Remark
1	bestposb	0.2	
2	headingb	On changed, normally 0.2	The two protocols do not appear together
3	heading2b	On changed, normally 0.2	
4	bestvelb	0.2	
5	timeb	0.2	
6	psrdopb	1	

Table 6 Novatel Protocol for Guided Input Class

Serial	Protocol	Cycle	Remark
1	gprmc	0.2	
2	gpgga	0.2	

3	gpgsa	1	
4	gphdt	On changed, normally 0.2	

Table 7 Guide Input NMEA 0183 Protocol

4.3.3.1 inspvab

Examples of setup commands:

log com2 inspvab ontime 1

Serial number	Data content	Definition	Remark	Type
Data[0]	0xEB(1)	Frame header		U8
Data[1]	0X90(2)			U8
Data[2]	122(3)	Frame length N	Number of all data bytes from frame header to checksum	U8
Data[3]	0xD1(4)	Frame ID	Navigation data	U8

Data[4]	U32 counter; Frame Counter (5-8)
	U8 state; Sensor Status (9)
	//Lower 3 bits: AHRS. 0 Initialization 1 OK 2 Error
	//bit3 Whether the compass needs to be calibrated 0 Normal 1 Needs to be calibrated
	//High 4 health status
	//bit4 Compass 0 OK 1 Fault
	//bit5 Gyroscope 0 normal 1 fault
	//bit 6 add 0 normal 1 fault
	//bit7 Barometer 0 OK 1 Fault
	F32 pitch; //unit: rad, AHRS + (10-13)
	F32 roll; //unit: rad, AHRS right roll positive (14-17)
	F32 yaw; //unit: rad, ahrs N 0d E 90d W -90d S +-180d (18-21)
	F32 yaw_gps; //GPS track direction//unit: d, GPS N 0 E 90d W -90d S +-180d (22-25)
	F32 pitch_rate; //unit: rad/s, AHRS + (26-29)
	F32 roll_rate; //unit: rad/s, AHRS right roll positive (30-33)
	F32 yaw_rate; //unit: rad/s, AHRS positive clockwise (34-37)
	S32 lon; //unit:0.0000001d, INS (38-41)
	S32 lat; //unit:0.0000001d, INS (42-45)
	S32 alt_baro; //unit: 0.01 m, barometer high raw pressure			

Data[5]				
Data[6]				
Data[7]				
Data[8]				
Data[9]				
Data[10]				
…				
…				
…				
Data[N-3]				Data structure

	(46-49)
	S32 alt_gps; //unit: 0.01 m, GPS original GPS altitude (50-53)
	S32 alt; //unit: 0.01 m, INS EKF filter height; Initialize by GPS altitude (54-57)
	F32 velocity_n; //unit: m/s, NED, INS N northbound velocity (58-61)
	F32 velocity_e; //unit: m/s, NED, INS E due east speed (62-65)
	F32 velocity_d; //unit: m/s, NED, INS D normal velocity (66-69)
	F32 velocity_air; //m/s, airspeed, invalid (70-73)
	F32 accel_n; //unit: m/s ^ 2, NED, AHRS N positive northward acceleration (74-77)
	F32 accel_e; //unit: m/s ^ 2, NED, AHRS E due east acceleration (78-81)
	F32 accel_d; //unit: m/s ^ 2, NED, AHRS D Normal Geodetic Acceleration (82-85)
	U8 satellite_num; //Number of satellites (86)
	U16 hdop; //0.01 m horizontal precision factor (87-88)
	U16 vdop; //0.01 m vertical precision factor (89-90)
	U8 gps_status;
	//NO _ GPS = 0, no GPS data
	//NO _ FIX = 1, GPS signal unlocked
	//GPS _ OK _ FIX _2 D = 2, 2D positioning
	//GPS _ OK _ FIX _3 D = 3, 3D positioning
	//GPS_OK_FIX_3D_DGPS = 4, 3D_DGPS
	//GPS_OK_FIX_3D_RTK_FLOAT = 5, 3D RTK Float
	//GPS_OK_FIX_3D_RTK_FIXED = 6, 3D RTK Fixed (91)
	U8 gps_hh; //GPS (92)
	U8 gps_mm; //GPS (93)
	U8 gps_ss; //GPS seconds (94)
	S8 temperature; //d deg C (95)
	S16 HDT; //d dual antenna heading 0 ~ 360 degrees unit 0.1 degree (96-97)
	S16 HDG_Dev; //d antenna heading standard deviation 0 ~ 360 degrees unit 0.1 degree (98-99)
	U8 redundancy; //Use status of each sensor
	//bit01 Add bit23 Gyro bit45 Compass bit67 GPS
	//add & gyro: 0 external 1 internal 1 2 internal 2
	//Compass: 0 external 1 internal	

	//GPS: 0 internal 1 external
	(100)
	U8 GPS 0_ DT;//Internal GPS Sampling Interval Unit 100ms
	(101)
	U8 GPS 1_ DT;//External GPS Sampling Interval Unit 100ms
	(102)
	F32 GPS_vn; //unit: m/s, NED, GPS N True North Velocity
	(103-106)
	F32 GPS_ve; //unit: m/s, NED, GPS E due east velocity
	(107-110)
	F32 GPS_vd; //unit: m/s, NED, GPS D normal velocity
	(111-114)
	U16 gps_ms; //milliseconds in GPS seconds, range 0-999
	(115-116)
	U8 gps_day; //GPS days of the week, range: 0-6 (117)
	U16 gps_week; //GPS week, range: 0-1023 (118-119)
	U8 ahrs_state; //AHRS Status (120)
	0x00: standby, 0x10: coarse alignment, 0x20: fine alignment,
	0x30: integrated navigation, 0x31: inertial navigation			

Data[N-2]	Low Byte (121)	Checksum	Data [0] ~ Data [N-3]'s accumulated sum is the lower two bytes	U8
Data[N-1]	High Byte (122)			U8

Table 8 inspvab format

4.3.3.2 rawimub

Examples of setup commands:

log com2 rawimub ontime 1

Serial number	Name	Content	Data type	Number of bytes	Unit
1	Frame header	0x5a	unsigned char	1	—
2	Frame header	0x5a	unsigned char	1	—
3	Frame identification	0x01	unsigned char	1	—
4	100D status word	Bit0: X gyro status Bit 1: y gyro status Bit2: Z gyro status Bit3: X Add table status	unsigned char	1	—

Serial number	Name	Content	Data type	Number of bytes	Unit
		Bit4: y Add table status Bit5: Z plus table status bit6-7：0 0: normal; 1: Exception			
5	100D-X-axis angular rate	IMU front, upper, right, before calibration	float	4	°/s
6	100D-Y-axis angular rate		float	4	°/s
7	100D-Z-axis angular rate		float	4	°/s
8	100D-X-axis acceleration		float	4	G
9	100D-Y-axis acceleration		float	4	G
10	100D-Z-axis acceleration		float	4	G
11	100D-X-axis gyro temperature	—	short	2	0.1℃
12	100D-Y-axis gyro temperature	—	short	2	0.1℃
13	100D-Z-axis gyro temperature	—	short	2	0.1℃
14	100D-plus gauge temperature	—	short	2	0.1℃
15	Inner loop encoder value	—	unsigned short	2	—
16	100 D Cycle Frame Count	—	unsigned char	1	—
17	Static IMU Status Word	Bit0: X gyro status Bit 1: y gyro status Bit2: Z gyro status	unsigned char	1	—

Serial number	Name	Content	Data type	Number of bytes	Unit
		Bit3: X Add table status Bit4: y Add table status Bit5: Z plus table status bit6-7：0 0: normal; 1: Exception			
18	Static IMU-X-axis angular rate	IMU front, upper, right, before calibration	float	4	°/s
19	Static IMU-Y axis angular rate		float	4	°/s
20	Static IMU-Z axis angular rate		float	4	°/s
21	Static IMU-X-axis acceleration		float	4	G
22	Static IMU-Y axis acceleration		float	4	G
23	Static IMU-Z axis acceleration		float	4	G
24	Static IMU temperature	Add the average temperature of the meter and gyro.	short	2	0.1℃
25	Static IMU Cycle Frame Count	—	unsigned char	1	—
26	Outer loop encoder value	—	unsigned short	2	—
27	100D-X-axis angular rate	IMU front, upper, right, after calibration	float	4	°/s
28	100D-Y-axis angular rate		float	4	°/s
29	100D-Z-axis angular rate		float	4	°/s

Serial number	Name	Content	Data type	Number of bytes	Unit
30	100D-X-axis acceleration		float	4	G
31	100D-Y-axis acceleration		float	4	G
32	100D-Z-axis acceleration		float	4	G
33	Static IMU-X-axis angular rate		float	4	°/s
34	Static IMU-Y axis angular rate		float	4	°/s
35	Static IMU-Z axis angular rate		float	4	°/s
36	Static IMU-X-axis acceleration		float	4	G
37	Static IMU-Y axis acceleration		float	4	G
38	Static IMU-Z axis acceleration		float	4	G
39	Frame count	—	unsigned char	1	—
40	Spare	—	—	8	—
41	Checksum	3-40 byte accumulation and lower 8 bits	Unsigned char	1	—

Table 9 raw imub format

4.3.3.3 sncpost

Examples of setup commands:

log com2 sncpost ontime 1

Serial number	Name	Content	Data type	Number of bytes	Unit
1	Frame header	0x5a	unsigned char	1	—
2	Frame header	0x5a	unsigned char	1	—

Serial number	Name	Content	Data type	Number of bytes	Unit
3	Frame identification	0x02	unsigned char	1	—
4	100D status word	Bit0: X gyro status Bit 1: y gyro status Bit2: Z gyro status Bit3: X Add table status Bit4: y Add table status Bit5: Z plus table status bit6-7：0 0: normal; 1: Exception	unsigned char	1	—
5	100D-X-axis angular rate	IMU front, upper, right, before calibration	float	4	°/s
6	100D-Y-axis angular rate		float	4	°/s
7	100D-Z-axis angular rate		float	4	°/s
8	100D-X-axis acceleration		float	4	G
9	100D-Y-axis acceleration		float	4	G
10	100D-Z-axis acceleration		float	4	G
11	100D-X-axis gyro temperature	—	short	2	0.1℃
12	100D-Y-axis gyro temperature	—	short	2	0.1℃
13	100D-Z-axis gyro temperature	—	short	2	0.1℃
14	100D-plus gauge temperature	—	short	2	0.1℃
15	Inner loop encoder	—	unsigned short	2	—

Serial number	Name	Content	Data type	Number of bytes	Unit
	value				
16	100 D Cycle Frame Count	—	unsigned char	1	—
17	Static IMU Status Word	Bit0: X gyro status Bit 1: y gyro status Bit2: Z gyro status Bit3: X Add table status Bit4: y Add table status Bit5: Z plus table status bit6-7：0 0: normal; 1: Exception	unsigned char	1	—
18	Static IMU-X-axis angular rate	IMU front, upper, right, before calibration	float	4	°/s
19	Static IMU-Y axis angular rate		float	4	°/s
20	Static IMU-Z axis angular rate		float	4	°/s
21	Static IMU-X-axis acceleration		float	4	G
22	Static IMU-Y axis acceleration		float	4	G
23	Static IMU-Z axis acceleration		float	4	G
24	Static IMU temperature	Add the average temperature of the meter and gyro.	short	2	0.1℃
25	Static IMU Cycle Frame Count	—	unsigned char	1	—
26	Outer loop encoder value	—	unsigned short	2	—

Serial number	Name	Content	Data type	Number of bytes	Unit
27	Navigation cycle seconds	—	unsigned int	4	1/1000s
28	Satellite Valid Mark	'A': Valid; 'V': Invalid	unsigned char	1	—
29	Location postype	—	unsigned char	1	—
30	Satellite Longitude	—	int	4	1/10000000°
31	Satellite latitude	—	int	4	1/10000000°
32	Satellite altitude	—	int	4	1/1000m
33	Satellite position time	—	unsigned int	4	1/1000s
34	Satellite location update flag bit	1: update; 0: Not updated	unsigned char	1	—
35	pdop		unsigned char	1	1/10
36	PPS update flag	1: update; 0: Not updated	unsigned char	1	—
37	PPS time	—	int	4	1/100000s
38	Satellite horizontal velocity	—	int	4	1/1000 m/s
39	Satellite Track Angle	—	unsigned int	4	1/1000°
40	Satellite vertical velocity	—	int	4	1/1000m/s
41	Speed latency	—	int	4	1/1000s
42	Satellite velocity time	—	unsigned int	4	1/1000s
43	Satellite speed update flag bit	1: update; 0: Not updated	unsigned char	1	—
44	Dual antenna postype	—	unsigned char	1	—
45	Dual antenna heading	—	unsigned int	4	1/1000°
46	Dual antenna time	—	unsigned int	4	1/1000s

Serial number	Name	Content	Data type	Number of bytes	Unit
47	Dual-antenna heading update sign	2: update and solution complete; 1: update; 0: Not updated	unsigned char	1	—
48	Number of main antenna satellites	—	unsigned char	1	—
49	Number of slave antenna stars	—	unsigned char	1	—
50	Barometric altitude	—	int	4	0.01m
51	Airspeed	—	float	4	m/s
52	Atmospheric status word	Bit 0: pitot tube Bit 1: barometer bit2-7：0 0: normal; 1: Exception	—	—	—
53	Frame count	—	unsigned int	4	—
54	Spare	—	—	8	—
55	Checksum	3-51 byte accumulation and lower 8 bits	unsigned char	1	—

Table 10 SNCPOST message protocol (LOG name: sncpost)

4.3.4 data export

Send the " $CFGMODE" command through COM1 within 20s after power on to set the product to enter the configuration mode. After receiving the valid command, the product returns the "Into Config Mode" "and sends the" $CONNECTUSB "command through COM1 to enter the data export state. Can be connected to the USB interface, the internal storage is automatically virtualized as a U disk, and the data can be directly downloaded and saved.

The product automatically saves the storage information according to the user's settings. The name of the saved data folder is X, where X is the file number (1-30), and the number increases in turn. When X is 30, 0 will be automatically overwritten in the next storage, and X will still increase in turn in the next storage.

Save inspvab. Txt, rawimub. Txt, scnpost. Txt and other types of files in the file according to the settings.

4.3.5 product maintenance

When a firmware upgrade is required, proceed as follows:

The a) is connected with a power line and a communication line, the COM1 port is connected with a computer, and the COM1 port is set according to the baud rate setting value of the COM1 port;

Power on the b) product, send the " $CFGMODE" command through COM1 within 20 s after power on, set the product to enter the configuration mode, feed back the "Into Config Mode" "after the product receives the command, send the" $GPUPD "command through COM1, and the product enters the firmware upgrade state;

Change the baud rate of COM1 to 256000 bps c);

The serial port tool interface of the d) displays the start countdown information, and the interface displays "30 …" 10 9 8 7 6 5 4 3 2 Before 1, send ":" (small colon, cancel the option of sending a new line) to the serial port, and the interface displays the updata flash information;

The e) selects the firmware (generally *.bin2 file) to be upgraded through the serial port tool and sends it;

After the f) waits for the sending to be completed, the program automatically reloads and starts, enters the start prompt information, and starts normally;

The g) firmware upgrade is complete.

5.Installation and commissioning

5.1 coordinate system and direction definition

Body coordinate system ("front-right-down"): X axis is forward along the vertical axis of the body, Y axis is right along the horizontal axis of the body, and Z axis is downward along the vertical axis of the body;

Geographic coordinate system- ("East-North-Sky"): east, north and sky are positive respectively.

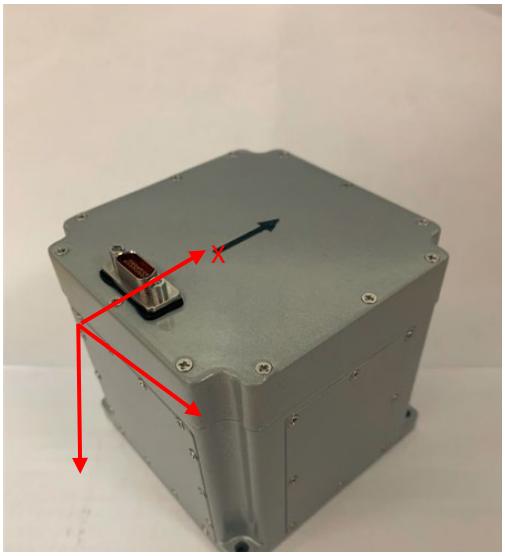

Figure 7 Definition of Coordinate System

5.2 Installation

The product installation elements are as follows (without shock absorber):

The a) product is installed on the carrier installation base through four M4 screws, and the arrow direction on the product points forward;

The b) measures the three-dimensional size of the product and the external receiver antenna, the product points to the three-dimensional coordinate of the antenna in the right front upper coordinate system of the product, and the measurement precision is better than the 0.05 m;

The bottom surface of the c) shall be firm and stable, preferably made of metal, with a thickness of not less than 5mm;

The connector outlet is installed on the d) product, and the upper side space distance is not less than 35mm, which is convenient for the connector to be plugged and fastened.

In case of severe vibration environment, it is necessary to consider installing a shock absorber. The parameters of the shock absorber shall be selected based on the vibration frequency band, vibration magnitude and other factors, and shall be determined separately in actual use.

5.3 Debugging

Product commissioning steps are as follows:

The a) product is installed or placed on a stable installation table;

A b) is connecte with a power supply cable and a communication cable of that product, and a COM1 port in the communication cable is connecte with a test computer so as to receive navigation information in real time; Regulate the DC stabilized voltage power supply to 24 V, and the power supply current shall not be less than 3A;

The c) checks the power supply of the product after the circuit is connected, and the COM1 port can receive the data after waiting for about 20s;

After the d) is debugged, the product is powered off.

6. Maintenance

6.1 Maintenance content

It is recommended to electrify the product once a quarter for more than 30 minutes each time. In case of any fault, the fault status shall be recorded accurately and reported to the manufacturer for maintenance or repair in time.

Requirements of 6.2 for testing and using personnel

Personnel engaged in product testing and use shall carefully read the technical documents and operation instructions, master the operation essentials of the specialty, and use the equipment and tools related to the operation of the specialty.

7. Precautions

The time interval between power-on and power-off of a) products shall not be less than 30s, otherwise it is easy to cause damage to inertial devices;

B) shall be handled with care during handling, installation and use to avoid collision, falling and impact;

After the c) product is started, it needs to wait for the product to complete the coarse alignment before it can move linearly. The coarse alignment time is about 1 minute, otherwise the measurement accuracy will be affected.

After the carrier type of the d) is set as the vehicle-mounted type, the product is required to be installed and fixed on the vehicle, and the heading direction of the product is consistent with that of the vehicle head, with an error of not more than 10 degrees.

8.Fault analysis and troubleshooting

Serial number	Fault symptom	Possible causes of failure	Exclusion method
1	Startup failure: the product does not start after being powered on, and there is no output;	The power supply or communication cable of the product is not connected properly; The power supply voltage or starting current does not meet the product requirements; Product circuit failure;	Check whether the cable connection is loose or missing; Check whether the power supply parameters of power supply meet the requirements; After eliminating A) and B), it still does not start after being powered on for many times, and it needs to be returned to the factory for maintenance;

2	It is in the standby state for a long time and does not enter the alignment state	The satellite signal of the location is poor, and the location is not determined; External satellite information is not normally input to the product;	A good satellite receive place is selected; Check whether the external satellite information input is connected correctly; After eliminating A) and B), the fault still occurs after being powered on for many times, and it needs to be returned to the factory for maintenance;
3	Alignment failed	During the alignment process, the product is in a non-static state and undergoes an obvious position change; Inertial device failure;	Ensure that the product is stationary during alignment; After elimination of A), the alignment still fails after several times of power-on, and it shall be returned to the factory for repair;
4	Gyroscope and accelerometer failure, navigation aborted	Gyroscopes and accelerometers are faulty;	Return to the factory for repair

9. Transport and storage

The product is equipped with a special packing box, which must be used in the process of separate transportation; Handle with care during disassembly and handling to avoid collision, turnover, knocking and rain. It is strictly prohibited to transport with corrosive substances such as acid and alkali, volatile substances, flammable and explosive substances. Well-packed products can be suitable for road, railway, waterway, aviation and other transportation.

In order to keep the products with higher precision and longer service life as far as possible, a better storage environment should be selected as far as possible. In general, the storage should meet the following requirements: the temperature is 5 ℃ ~ 40 ℃, the relative humidity is not more than 80%, and there is no corrosive substance in the warehouse.