V 1.01 of optical fiber integrated navigation system.

BS-FN300F-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 fiber-optic integrated navigation system BS-FN300F-M-D6EC is composed of a three-axis closed-loop fiber-optic gyroscope, an accelerometer and a navigation board card with high cost performance, and is realized through multi-sensor fusion and navigation calculation algorithm to meet the requirements of accurate measurement of attitude, heading, position and other information in the application fields of medium and high precision mobile measurement systems, medium and large unmanned aerial vehicles and the like.

2. Functions and indicators

2.1 Main functions

The system has inertial/satellite integrated navigation mode and pure inertial mode.

In the inertial/satellite integrated navigation mode, the satellite positioning information received by the internal GNSS receiver can be used for integrated navigation, and the pitch, roll, course, position, speed, time and other information of the carrier can be output; After the signal is lost, the position, velocity and attitude calculated by inertia are output, in which the pitch and roll are required to be accurate, the course keeping function is available in a short time, and the meter-level positioning accuracy is available in a short time.

After the pure inertial mode (i.e., GPS fusion has never been performed after power-on, and if it loses lock again after fusion, it belongs to the integrated navigation mode) is started, it has accurate attitude measurement function, can output the pitch and roll heading, and the pure inertial mode can find the north statically.

2.2 Performance indicators

Project	Test conditions	Indicators
Positioning accuracy	GNSS Valid, Single Point	1.5m
	GNSS Valid, RT K	2cm+1ppm
	Pure inertial horizontal positioning holding ①	80m/5min(CEP) 500m/10min(CEP) 1.5nm/30min(CEP)
	Airspeed combination horizontal positioning maintenance ②	0.8nm/30min (CEP)
Heading accuracy	Single antenna (RMS)	0.1°③
	Dual Antenna (RMS)	0.2 °/L (L = baseline length) (RMS)
	Course Keeping (RMS)	0.2°/30min(RM S), 0.5°/h
	Self-north seeking accuracy (RMS)	0.2 ° SecL, double position alignment for 15 min 1.0 ° SecL, single position alignment 5-10

		min
Attitude accuracy	GNSS is valid	0.02°(RMS)
	Attitude hold (GNSS failure)	0.2°/30min(RMS), 0.5°/h(RMS)
Speed accuracy	GNSS valid, single point L1/L2	0.1m/s(RMS)
Gyroscope	Measuring range	±400°/s
	Zero bias stability	≤0.3°/h
Accelerometer	Measuring range	±20g
	Zero bias stability	≤100μg
Physical dimensions and electrical characteristics	Voltage	9-36V DC
	Power consumption	≤ 12W (steady state)
	Interface	2 RS 232,1 RS 422, 1-channel PPS (LVTTL/422 level)
	Size	92.0 mm × 92.0 mm × 90.0 mm (L, W, H)
	Weight	≤1.0kg
Environmental characteristics	Operating temperature	-40℃~+60℃
	Storage temperature	-45℃~+70℃
	Vibration	5 ~ 2000Hz, 6.06 G (with shock absorber)
	Impact	30g, 11 ms (with shock)
	Life span	> 15 years
	Continuous working time	>24h

Note:

① The alignment is valid;

② For airborne use, there is a turning maneuver before the airspeed combination. The test takes the flight speed of 150km/H as an example, and the wind field is stable;

③ On-board conditions, need to be mobile;

Table 1 System Performance Requirements

3. How it works

3.1 Product composition

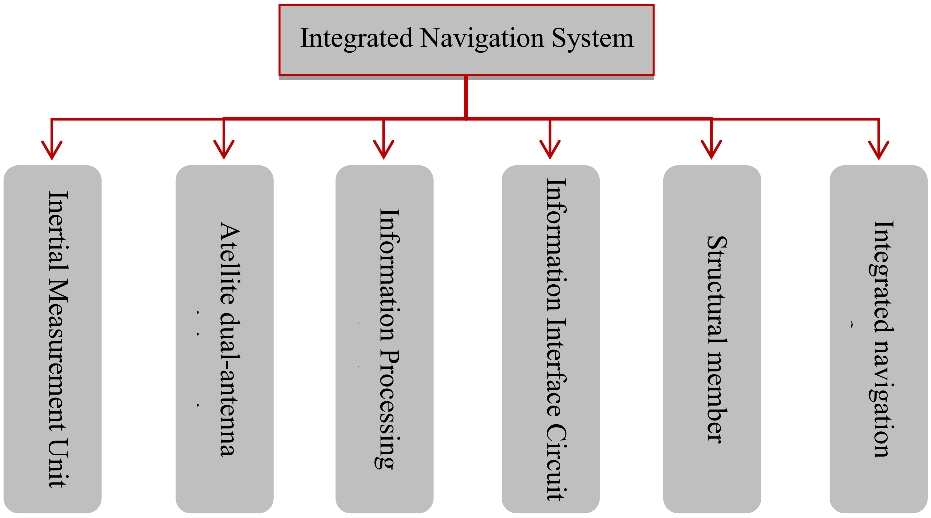

Figure 1 System composition

3.2. Rationale

The inertial measurement unit consists of three accelerometers and three optical fiber gyroscopes and is used for measuring the acceleration and the angular velocity of a carrier and sending the information to the information processing circuit; and the information processing circuit performs navigation settlement by using the acceleration and the angular velocity measured by the inertial measurement unit and simultaneously receives satellite navigation information of a satellite receiver as a reference to perform combined navigation, The navigation error of the inertial navigation is corrected, and the navigation information is output through the information interface unit.

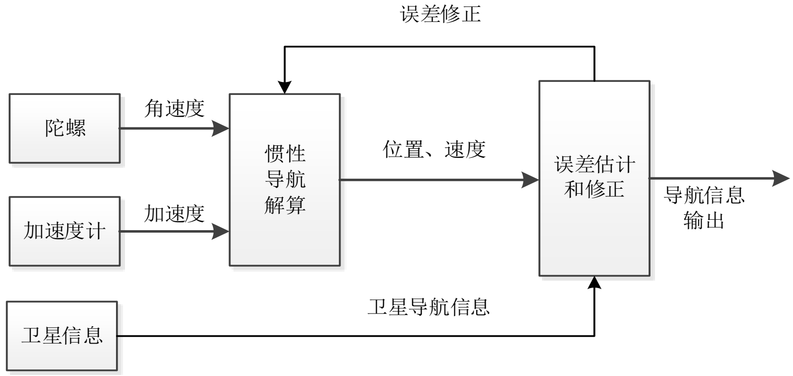

Fig. 2 Schematic diagram of working principle

4. Instructions for use

4.1 Overall dimensions

The inertial measurement unit and the satellite receiver are integrated in the inertial navigation system. The outline of the system is shown in the figure below. The overall dimensions of the system are: 92.0 mm × 92.0 mm × 90.0 mm (length × width × height).

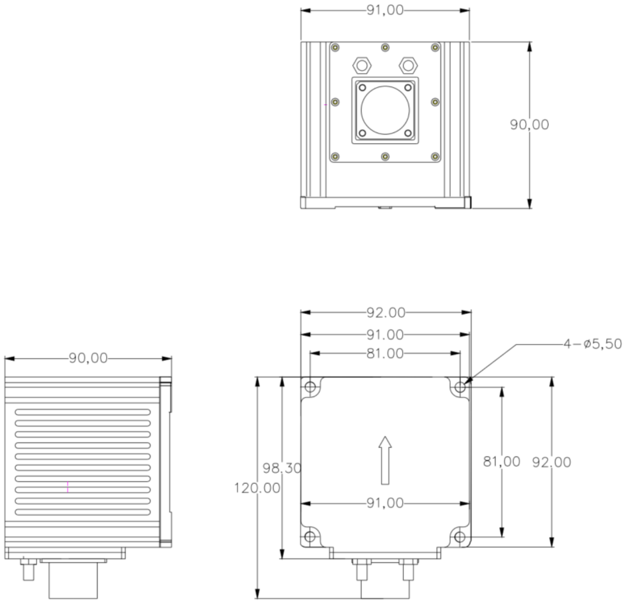

Fig. 3 Structure Diagram of Overall Dimensions

4.2 Electrical interface

The system has 1 external connector:

A) power supply and communication interface X1;

One end of d) 1 cable is connected to X1, and the other end is divided into a red and black clamp for power supply and 3 serial ports, which are COM1 ~ COM3, wherein COM1 is RS422, COM2 and COM3 are RS232. COM1 can be used to send working mode instructions;

<table>
<tr><th colspan="2">Connection Point 1(J599/26FD35PHA)</th><th colspan="3">Connection Point 2</th><th colspan="2" rowspan="2">Terminal number definition (Connection point 1)</th><th rowspan="2">Remark</th></tr>
<tr><th>Plug wire Mark Code</th><th>Terminal number</th><th>Plug wire Mark Code</th><th colspan="2">Terminal number</th></tr>
<tr><td>X1</td><td>30</td><td rowspan="3">COM4 (L138)</td><td colspan="2">3</td><td colspan="2">COM4_232R</td><td rowspan="3">Main processor program upgrade port, RS232</td></tr>
<tr><td>X1</td><td>16</td><td colspan="2">2</td><td colspan="2">COM4_232T</td></tr>
<tr><td>X1</td><td>23</td><td colspan="2">5</td><td colspan="2">GND</td></tr>
<tr><td>X1</td><td>20</td><td rowspan="2">COM2</td><td>1</td><td>3</td><td>COM2_ 422R+</td><td>COM2_ 232R</td><td rowspan="2">Inertial navigation serial port COM2 422/232 available Default 422</td></tr>
<tr><td>X1</td><td>2</td><td>2</td><td></td><td>COM2_ 422R-</td><td></td></tr>
</table>

X1	19		3		COM2_422T+		
X1	1		4	2	COM2_422T-	COM2_232T	
X1	23		5	5	GND	GND	
X1	21	COM1	1	3	COM1_422R+	COM1_232R	Inertial navigation serial port COM1 422/232 available Default 422
X1	3		2		COM1_422R-		
X1	17		3		COM1_422T+		
X1	18		4	2	COM1_422T-	COM1_232T	
X1	24		5	5	GND	GND	
X1	35	Guide COM1	3		Satellite Guide COM 1_ RXD		Uide board serial port 1 232
X1	36		2		Conductor COM 1_ TXD		
X1	24		5		GND		
X1	5	COM3	3		COM3_RXD		Inertial navigation serial port COM3 232
X1	22		2		COM3_TXD		
X1	34		5		GND		
X1	4	Wei Dao EVENT			Throw the line		Guard guide board EVENT
X1	34	GND			Throw the line		
X1	6	24V_2			Red alligator clip		Power supply input
X1	7	24V_1			Red alligator clip		
X1	8	24VGND			Black alligator clip		Power input ground
X1	11	ETHER_TX_P	Orange and white		ETHER_TX_P		Network port
X1	25	ETHER_TX_N	Orange		ETHER_TX_N		
X1	9	ETHER_RX_P	Green and white		ETHER_RX_P		
X1	10	ETHER_RX_N	Green		ETHER_RX_N		
X1	12	PPS+_1			Throw the line		PPS (default input)

X1	26	PPS-_1		Throw the line	
X1	14	DI1+		Throw the line	The first road odometer
X1	28	DI1-		Throw the line	
X1	13	DI2+		Throw the line	The second way odometer
X1	27	DI2-		Throw the line	
X1	15	DO1+		Throw the line	Output
X1	29	DO1-		Throw the line	
X1	37	CAN1H		Throw the line	First way CAN
X1	31	CAN1L		Throw the line	
X1	32	CAN2H		Throw the line	Second way CAN
X1	33	CAN2L		Throw the line	

Table 2 X2 Connector Point Definitions

4.3 Instructions for use

Workflow of 4.3.1 system

Inertial navigation system includes two work processes, one is integrated navigation process, the other is pure inertial navigation process.

4.3.1.1startup prompt message

Connect the cable, power up the system, and monitor the COM1 interface information through the serial port debugging tool of the test computer. After the interface displays "Please enter NaviMode within 20s!", the serial port debugging tool can be used to send workflow instructions to the COM1 interface. "# moddgi" is to enter the integrated navigation work instruction; "# modins" is to enter the pure inertial navigation work instruction. If no instruction is sent within 20s, the system will automatically enter the internally saved work flow after 20s.

4.3.1.2 integrated navigation proces

After entering the integrated navigation process, first bind the satellite information. If the satellite is not positioned, it is in the state of waiting for the satellite information. When the satellite information is valid, it enters the alignment state. The alignment time is 1 minute. During the alignment period, the inertial navigation is required to be static. After the alignment is completed, the inertial navigation can move and the system is in the integrated navigation state.

4.3.1.3 pure inertial navigation proces

After entering the pure inertial navigation process, first carry out rough alignment for 1min. If the satellite information is valid, bind the satellite information and carry out fine alignment for 1500s. If there is no satellite information, the stationary base must be aligned for 1500s. After the alignment is completed, turn to the pure inertial navigation state, and the inertial navigation can move.

4.3.2 system configuration instruction

4.3.2.1 Configuration Scheme and Storage

The inertial navigation system provides three external serial ports (configuration No.: com1, com2, com3) and one internal storage channel (configuration No.: file). All three serial ports can be configured. The function allocation and relevant configuration of each serial port are shown in the following table.

Configuration number	**Enter the project**	**Output items**	**Default**
COM1	1. working mode instruction and flow control instruction; 2.COM1, COM2, COM3 baud rate configuration; 3. COM1, COM2, COM3 protocol and update rate configuration; 4.Store the file port protocol configuration.	1.SNCNAVPVTA/SNCNAVPVTB; 2.INSPVASA/INSPVASB; 3.BDFPD; 4.RAWIMUSB (fixed 200Hz SPAN-ISA-100C format); 5. configure prompt information;	RS422; 460800bps; Output: BDFPD;
COM2	Same as COM1	Same as COM1	RS422; 460800bps; Output: None
COM3	Same as COM1	Same as COM1	RS232; 460800bps; Output: None
file	The system automatically saves the storage information according to the user's configuration. The name of the saved data file is RECORDX. Txt, where X is the file number. When a configuration query is made, the current latest file name is displayed.	1. There will be a fixed SNCPOSTB protocol and it cannot be cancelled. This protocol is data backup. 2. When the system is powered on, the network port is inserted into the computer to store and export data.	None

Table 3 Function Distribution of Serial Port of Inertial Navigation System

After the system is powered on and the startup information is displayed on the serial port, you can input the commands such as COM1, COM2 and COM3 serial port baud rate configuration, serial port protocol and update rate setting. If each command is output successfully, it will return to "cmd OK" "or" < OK ", otherwise it will display" cmd error "" or "< ERR". After the input is completed, type "saveconfig" to save the current configuration. The current configuration will be called automatically after the next restart. If the command is not input, the serial port configuration will be restored to the last saved configuration after the next restart. 4.3.2.2 configuration query

Enter the "log loglist" "command through the inertial navigation serial port to list all the configurations of COM1, COM2 and COM3, including the following contents:

a. Serial port number, serial port baud rate, serial port protocol and update rate;

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

c. Internal storage status information: including the file name of the last file, remaining space, etc.;

d. Initial binding longitude and latitude;

e. System number and date of manufacture;

f. Software version number: including pre-processing software version number and navigation software version number;

g. Operating 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 configuration:

com comX BAUDRATA

Where X is 1 ~ 3 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 configuration

Configure the protocols of COM1 ~ COM3 and SNCNAVPVTA/B, BDFPD, INSPVASA/B of memory file through the inertial navigation serial port. The configuration commands are as follows:

log comX/file LOG ontime updataTime

Where comX can be the configuration number of com1 to com3, file is the configuration number of the memory interface; updataTime represents the update time, which can be 5 (2 Hz), 1 (1 Hz), 0.2 (5 Hz), 0.1 (10 Hz), 0.01 (20 Hz) and other periods that can be divided by 200 Hz, and the unit is s. LOG indicates the protocol name, which may be inspvasa, inspvasb, bdfpd, etc.

For example, if you want to configure the COM2 port to output 10Hz SNCNAVPVTA data, you can input the following commands through the inertial navigation serial port:

log com2 sncnavpvta ontime 0.1

If 10Hz bdfpd data needs to be output at the same time on COM2, the following commands can be input through the inertial navigation serial port:

log com2 bdfpd ontime 0.1

For another example, to store 1 Hz inspvasa protocol data in the ins internal memory, enter the following command through the ins serial port:

log file inspvasa ontime 1

If you want to shut down a protocol, the configuration command is as follows:

log comX/file LOG off

Configure the rawimusb protocol of the COM1 ~ COM3 ports and the memory file port through the inertial navigation serial port. The configuration commands are as follows:

log comX/file rawimusb onchanged

If you want to disable the serial port rawimusb protocol, the configuration command is as follows:

log comX/file rawimusb off

If you want to close all protocols of the serial port, the configuration 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. Before use, it is necessary to configure the appropriate baud rate, otherwise it may cause data loss. In general, the larger the amount of data, the higher the baud rate required.

Longitude and latitude configuration of 4.3.2.5 initial values

Initial longitude and latitude configuration, the configuration command is:

initialpos LONGITUDE LATILUDE

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

4.3.2.6 function module configuration

Functional modules with open configuration mainly include zero velocity correction and output position smoothing.

4.3.2.6.1 "Zero Velocity Trim" Configuration

The zero-speed correction function mainly means that the inertial navigation system detects the sensitive information, and if the inertial navigation system is judged to be zero-speed, the corresponding correction is carried out.

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 configuration instructions are 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 Position Output Smoothing configuration

The position information in the INSPVASA and GPFPD protocols is the inertial navigation position information. In order to obtain 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. In order to facilitate the user's selection, this function can be configured. The configuration 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 configuration

According to the different carriers installed in the inertial navigation system, the carrier type configuration is required, and different algorithm processing is carried out in the system according to different carrier types.

The configuration instructions are as follows:

carrier vehicle/ship/air

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

After the configuration is completed, you need to enter the save command save config, and then hard start or enter the # reset command. The carrier type configuration will be valid after startup. The inertial navigation system does not support the current configuration and current use, and must be restarted.

After the carrier type is configured as the vehicle-mounted type, the inertial navigation system is required to be installed and fixed on the vehicle, and the heading of the inertial navigation system is consistent with the direction of the vehicle head, with an error of not more than 10 degrees.

4.3.2.8 GNSS antenna mast arm configuration

According to the relative installation relationship between the antenna and the inertial navigation system, it is necessary to configure the antenna rod arm. The lever arm value between the configuration inertial navigation and the antenna must be accurate to millimeters (mm) during measurement. Any measurement error of the lever arm will directly enter the position error output by the inertial navigation. During installation and use, the inertial navigation should be as close as possible to the main antenna, especially in the horizontal position. The command is required to be completed before the alignment of the inertial navigation static base or during the alignment of the inertial navigation static base and before the alignment of the dynamic base. Once the configuration is complete, it needs to be saved via "saveconfig".

The configurations include a master antenna rod arm configuration and a slave antenna rod arm configuration.

The main antenna configuration instructions are as follows:

setimutoantoffset1 armX army armZ

The slave antenna configuration instructions are as follows:

setimutoantoffset2 armX army armZ

Where armX, armY, and armZ are the configured lever arm values, in meters, representing the components of the vector from the inertial navigation to the antenna phase center in the inertial navigation carrier coordinate system, which is selected as the upper right front (XYZ). For the example in Figure 4, armX and armY should be negative, and armZ should be positive.

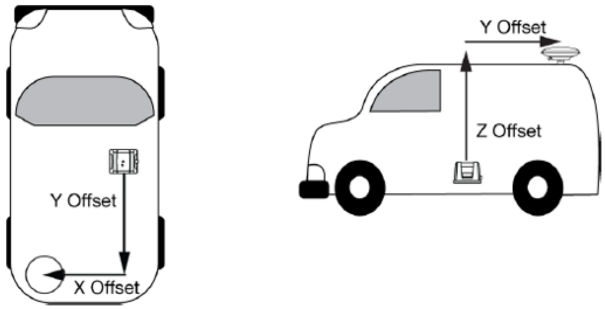

Figure 4 Schematic diagram of antenna rod arm

4.3.2.9 Output Lever Arm Settings

The default value for the product output lever arm configuration is [0,0,0] (upper right front), which is the position and velocity values at the output ins. If the position and speed of the user test point need to be output, the output lever arm should be set according to the relative installation relationship between the test point and the inertial navigation.

The lever arm value between the configuration inertial navigation and the test point must be accurate to millimeters (mm) during measurement, and any lever arm measurement error will directly enter the position error output by the inertial navigation. The command is required to be completed before the alignment of the inertial navigation static base or during the alignment of the inertial navigation static base and before the alignment of the dynamic base. Once the configuration is complete, it needs to be saved via "saveconfig".

The output lever arm configuration commands are as follows:

setimutosensoroffset armX armY armZ

Where armX, armY, and armZ are the configured lever arm values, in meters, representing the components of the vector from the inertial navigation to the test point in the inertial navigation carrier coordinate system, which is selected as the right front top (XYZ). For the example in Figure 5, armY and armZ should be positive.

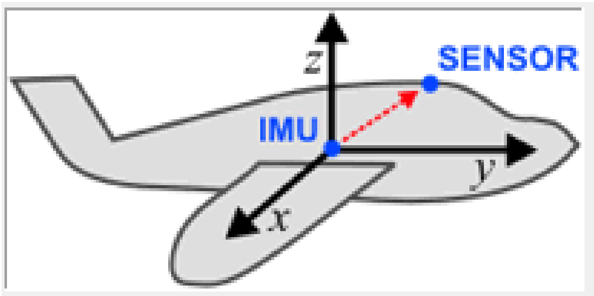

Fig. 5 Schematic diagram of output lever arm

Setting of mounting angle of 4.3.2.14

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 configuration value is [0, 0, 0] (pitch, heading, roll), that is, the product coordinate system is considered to coincide with the installation carrier coordinate system. 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 configuration instructions are as follows:

vehiclebodyrotation angleX angleZ angleY

Where angleX, angleZ and angleY are the configured installation angle values, in degrees, representing the angles from the carrier coordinate system to the integrated navigation system coordinate system, in the order of pitch, course and roll.

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

4.3.3 protocol format

The output protocols supported by the product are shown in the following table.

Serial number	Data protocol name	Type of agreement	Output type	Support interface
1	SNCNAVPVTB	Binary	ontime	COM1-COM3
2	SNCNAVPVTA	ASCII	ontime	COM1-COM3
3	BDFPD	ASCII	ontime	COM1-COM3
4	INSPVASA	ASCII	ontime	COM1-COM3
5	INSPVASB	Binary	ontime	COM1-COM3
6	RAWIMUSB	Binary	onchanged	COM1-COM3

Table 4. Output Data Protocol Description

4.3.3.1 SNCNAVPVTB

Examples of inertial navigation configuration commands:

log com2 sncnavpvtb ontime 1

Byte sequence number	Data	Data type	Number of bytes occupied	Explain
0	0x55	unsigned char	1	Fixed 0x55
1	0xAA	unsigned char	1	Fix 0 xAA
2	Class	unsigned char	1	Fix 0 x00
3	ID	unsigned char	1	Fix 0 x00
4-5	Frame length	unsigned short	2	
6-7	Frame count	unsigned short	2	Adds 1 for each frame sent
8-9	Week (GPS hour)	unsigned short	2	The unit is the week.
10-17	Cycles per second (GPS hours)	double	8	In S
18-21	Heading	int	4	Units are in degrees LSB=0.0001°
22-25	Pitch	int	4	Units are in degrees LSB=0.0001°
26-29	Roll	int	4	Units are in degrees LSB=0.0001°
30-33	East speed	int	4	Units are in degrees LSB=0.0001 m/s

34-37	North speed	int	4	Units are in degrees LSB=0.0001 m/s
38-41	Sky speed	int	4	Units are in degrees LSB=0.0001 m/s
42-45	Latitude	int	4	Units are in degrees LSB=0.0000001°
46-49	Longitude	int	4	Units are in degrees LSB=0.0000001°
50-53	Height	int	4	The unit is meter LSB=0.0001m
54-57	X-axis angular velocity (Right-front-up)	int	4	Units are in degrees LSB=0.000001°/s
58-61	Y-axis angular velocity (Right-front-up)	int	4	Units are degrees/second LSB=0.000001°/s
62-65	Z-axis angular velocity (Right-front-up)	int	4	Units are degrees/second LSB=0.000001°/s
66-69	X-axis acceleration (Right-front-up)	int	4	In m/S2 LSB=0.0000001 m/s2
70-73	Y-axis acceleration (Right-front-up)	int	4	In m/S2 LSB=0.0000001 m/s2
74-77	Z-axis acceleration (Right-front-up)	int	4	In m/S2 LSB=0.0000001 m/s2
78	Number of main antenna positioning star	unsigned char	1	The unit is piece LSB＝1
79	Position the	unsigned char	1	The unit is piece

	number of stars from the antenna			LSB＝1
80	Navigation status word	unsigned char	1	Bit7-Bit0 0 x00: Standby 0 x10: coarse alignment 0 x20: fine alignment 0x30: integrated navigation 0x31: pure inertial navigation
81-82	GNSS status word	unsigned short	2	Bit2-Bit0 = 0: Invalid = 1: single point positioning = 2: pseudorange differential = 3: RTK differential positioning Bit 3: Position and speed data are valid = 0: Invalid = 1: Valid Bit 4: GNSS dual-antenna heading is valid = 0: Invalid = 1: Valid Bit5: GPS data is valid = 0: Invalid = 1: Valid Bit 6-Bit 15: Reserved as 0
83-84	Fault status word	unsigned short	2	Bit 0: X-axis gyro fault word = 0: normal = 1: Fault Bit 1: 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 Bit 4: Y-axis acceleration fault word = 0: normal = 1: Fault Bit5: Z-axis acceleration fault word = 0: normal = 1: Fault Bit 6: GNSS board hardware fault word = 0: normal = 1: Fault Bit 7-Bit 15: Reserved as 0
85-92	Reserved	-	8	-
93-94	Checksum	-	2	Accumulate 2-92 to lower 16 bits

Table 5 sncnavpvtb format

4.3.3.2 SNCNAVPVTA

Examples of inertial navigation configuration commands:

log com2 gpfpd ontime 1

Components of the Agreement		Examples	Explain
Frame header	Protocol header	$SNCNAVPVTA	Message type
Content	Week (GPS hour)	2203	GPS hour weeks
	Seconds (GPS hours)	122515.000	Seconds in GPS hour week, three decimal places
	Heading angle	yyy.yyy	3 digits after the decimal point in °
	Pitch Angle	pp.ppp	3 digits after the decimal point in °
	Roll Angle	rr.rrr	3 digits after the decimal point in °
	Longitude	lll.lllllll	7 digits after the decimal point in °
	Latitude	lll.lllllll	7 digits after the decimal point in °
	Height	hhh.hhh	Height value, m

	East speed	XXX.XXX	3 digits after the decimal point, in m/s
	North speed	XXX.XXX	3 digits after the decimal point, in m/s
	Sky speed	XXX.XX	3 digits after the decimal point, in m/s
	X angular velocity (front-up-right)	XX.XXX	3 digits after the decimal point, in °/H
	Y Angular Velocity (Front-Top-Right)	XX.XXX	3 digits after the decimal point, in °/H
	Z Angular Velocity (Front-Top-Right)	XX.XXX	3 digits after the decimal point, in °/H
	X Acceleration (Front-Top-Right)	XX.XXX	3 digits after the decimal point in m/s ^ 2
	Y Acceleration (Front-Top-Right)	XX.XXX	3 digits after the decimal point in m/s ^ 2
	Z Acceleration (Front-Up-Right)	XX.XXX	3 digits after the decimal point in m/s ^ 2
	Navigation status word		Bit7-Bit0 0 x00: Standby 0 x10: coarse alignment 0 x20: fine alignment 0x30: integrated navigation 0x31: pure inertial navigation
	GNSS status word		Bit2-Bit0 = 0: Invalid = 1: single point positioning = 2: pseudorange differential = 3: RTK differential positioning Bit 3: Position and speed data are valid = 0: Invalid = 1: Valid Bit 4: GNSS dual-antenna heading is valid = 0: Invalid = 1: Valid Bit5: GPS data is valid

			= 0: Invalid = 1: Valid Bit 6-Bit 15: Reserved as 0
	Fault status word		Bit 0: X-axis gyro fault word = 0: normal = 1: Fault Bit 1: 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 Bit 4: Y-axis acceleration fault word = 0: normal = 1: Fault Bit5: Z-axis acceleration fault word = 0: normal = 1: Fault Bit 6: GNSS board hardware fault word = 0: normal = 1: Fault Bit 7-Bit 15: Reserved as 0
	Checksum	*24	Xor each byte from ' $' (but not $) to '*' (but not *)
Frame trailer	End of agreement	\r\n	Line feed and carriage return

Table 6 SNCNAVPVTA format

4.3.3.3 BDFPD

Examples of inertial navigation configuration commands:

log com2 bdfpd ontime 1

Ins output example

$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

Seria	Name	Meaning	Data type	Unit
1	$BDFPD	Format header	—	—
2	GPSWeek	Current week number (GMT) since January 6, 1980	Integer	—
3	GPS cycles	GPS cycles per second	Floating point	s
4	Yaw Angle	Yaw 0 ~ 360 degrees, clockwise	Floating-point	Degr
5	Pitch Angle	Pitch angle -90 ° ~ 90 °	Floating-point	Degr
6	Roll Angle	Roll angle -180 ° ~ 180 °	Floating-point	Degr
7	Latitude	Inertial navigation output latitude -90 ° ~ 90 °	Floating-point	Degr
8	Longitude	Inertial navigation output longitude -180 ° ~ 180 °	Floating-point	Degr
9	Height	Height of inertial navigation output	Floating-point	m
10	East speed	Inertial navigation output east speed	Floating-point	m/s
11	North speed	Inertial navigation output north speed	Floating-point	m/s
12	Sky speed	Inertial navigation outputs sky speed	Floating-point	m/s
13	NSV1	Number of satellites for antenna 1	Integer	A
14	NSV2	Number of satellites for antenna 2	Integer	A
15	Positioning	Pos type in bestpos	Integer	—
16	Directional	Pos type in heading	Integer	—
17	Check code	Check code	Hexadecimal	—
18	<CR><LF>	Fix the tail of the package	—	—

Table 7 BDFPD format

4.3.3.4 short message protocol head

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

Serial	Name	Data type	Meaning
1	%	Char	Fixed to '%'
2	Message name	Char	Message type for this protocol
3	GPS Week	Ushort	GPS weeks (GPS hours)
4	GPS cycles per	float	GPS Week Second (GPS Hour)

Table 8 ASCII Short Header

Seri	Name	Data type	Meaning	Binary	Binar
1	Sync Byte	Char	Fix Hex 0xAA	1	0

Seri	Name	Data type	Meaning	Binary	Binar
2	Sync Byte	Char	Fix Hex 0x44	1	1
3	Sync Byte	Char	Fix Hex 0x13	1	2
4	Message	Uchar	Message length, excluding header and	2	3
5	Message ID	Ushort	Message ID	2	4
6	GPS Week	Ushort	GPS weeks (GPS hours)	4	6
7	GPS cycles	Int	GPS cycle second (GPS hour,	4	8

Table 9 Binary short header

4.3.3.5 32-bit CRC check

The C language 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 );
}
```

4.3.3.6 INSPVAS

This command is a short message protocol output

Examples of inertial navigation configuration commands:

log com2 inspvasa ontime 1 (ASCII)

Log com2 inspvasb ontime 1 (binary)

ASCII example

$INS,091202,083559.00,A,4717.11437,N,00833.91522,E,499.6,M,0.004,77.52,0.02,0.00,0.00,327.19,001.69,000.00,0.00,0.00, 0.00,E*64

Components of the Agreement		Examples	Explain
Frame header	Protocol header	$INS	Message type
Content	UTC date	ddmmyy	Date, month, year format
	UTC time	hhmmss.ss	Hour, minute and second format
	Data status	A	A = valid, V = invalid
	Latitude	ddmm.mmmmm	Degree division format
	Latitude direction	N	N or S (north or south)
	Longitude	dddmm.mmmmm	Degree division format
	Longitude direction	E	E or W (East or West)
	Height of antenna above sea level	499.6	

	Height unit	M	M is the unit of meter
	Ground speed	0.004	
	Ground heading	77.52	Degrees, true north as reference datum
	X-axis speed	0.02	km/h
	Y-axis speed	-0.07	km/h
	Z-axis speed	0.00	km/h
	Pitch Angle	001.69	Degrees, -90 ~ 90 °
	Heading angle	127.19	Degrees, -180 to 180 °
	Roll Angle	000.00	In units of degrees,-180～180°
	Angular velocity		
	Acceleration		
	Magnetic declination		Degree
	Magnetic declination direction		E (East) or W (West)
	Checksum	*64	Xor each byte from ' $' (but not $) to '*' (but not *)
Frame trailer	End of agreement	\r\n	Line feed and carriage return

Table 10 INSPVAS format

4.3.3.7 RAWIMUS

This command is a short message protocol output (binary output only).

Examples of inertial navigation configuration commands:

Raw imusb onchanged of log com2 (binary)

Serial number	Name	Meaning	Data type	Binary Byte	Binary Offse
1	RAWIMUS Header	Message header	—	H	0
2	Week	GPS weeks (GPS hours)	Ulong	4	H
3	Seconds	GPS Week Second (GPS Hour)	Double	8	H+4
4	IMU Status	IMU status word	Hex Ulong	4	H+12

Serial number	Name	Meaning	Data type	Binary Byte	Binary Offse
5	Z Accel Output	Fixed 200 Hz, divided by 250000.0. Becomes Z acceleration m/S2 (right-front-up)	Long	4	H+16
6	- (Y Accel Output)	Fixed 200 Hz, divided by-250000.0. Becomes Y acceleration m/S2 (right-front-up)	Long	4	H+20
7	X Accel Output	Fixed 200 Hz, divided by 250000.0. Becomes X acceleration m/S2 (right-front-up)	Long	4	H+24
8	Z Gyro Output	Fixed 200 Hz, divided by 5000000.0. Becomes Z angular velocity rad/s (right-front-up)	Long	4	H+28
9	- (Y Gyro Output)	Fixed 200 Hz, divided by-5000000.0. Becomes Y angular velocity rad/s (right-front-up)	Long	4	H+32
10	X Gyro Output	Fixed 200 Hz, divided by 5000000.0. Becomes X angular velocity rad/s (right-front-up)	Long	4	H+36
11	xxxx	32-bit CRC	Hex	4	H+40
12	[CR][LF]	Fixed end (ASCII only)	-		—

Table 11 RAW IMUS format

IMU type	Peg-top	Acceleration
ISA-100C	1.0E-9 rad/LSB	2.0E-9 m/s/LSB

Table 12 Raw IMU Scale

4.3.4 data logging

This product has the function of data storage, with a total storage space of 16g (the internal system recovery partition and files used by other systems will be included, 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 name of the saved data folder is recordX, where X is the file number (up to 39), and the number increases in turn. When X is 39, record00 will be automatically overwritten in the next storage, and X will still increase in turn in the next storage. If the system is configured to store data, the system will automatically delete the oldest data folder after each power-on operation. For example, if the currently 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 will also be displayed during configuration query.

The recordX folder contains various protocol files configured by the user. Each protocol is a separate file, and the file name is the protocol name.

5. Precautions

The main considerations are as follows:

1) The power-on and power-off time interval of the inertial navigation system shall not be less than 30 s, otherwise the inertial device may be damaged;

2) Handle with care during handling, installation and use to avoid collision, falling and impact;

3) After the inertial navigation system is started, it is necessary to wait for the inertial navigation system 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;

4) After the carrier type is configured as the vehicle-mounted type, the inertial navigation system shall be installed and fixed on the vehicle, and the heading of the inertial navigation system shall be consistent with the head direction of the vehicle, with an error of not more than 10 degrees.