MEMS Inertial Navigation System V 1.0

BS-MN100C-M-D6EC

Product characteristics

- 0.05 ° roll & pitch attitude accuracy (GNSS valid)
- 0.1 ° azimuth accuracy (2m antenna baseline)
- 0.5 °/H gyroscope bias stability (10 s)
- ≤ 100 μg acceleration bias stability (10 s)

Field of application

- UAVNavigation
- /ehicle & Robot Navigation
- AUV &ROV

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1-General

BS-MN100C-M-D6EC integrated navigation system (hereinafter referred to as integrated navigation system) has built-in high-performance MEMS gyroscope and accelerometer, which can receive internal GNSS data, realize multi-sensor fusion and integrated navigation algorithm, and have short-term inertial navigation capability when GNSS is invalid. The product has high reliability and strong environmental adaptability. By matching different software, the products can be widely used in the fields of tactical and industrial unmanned aerial vehicles, unmanned vehicles, unmanned ships, aviation guided bombs, intelligent ammunition, rockets, mobile communication, mapping, seeker and stable platform.

2-Functions and indicators

2.1 Main functions

The integrated navigation system can use the satellite navigation information received internally to carry out integrated navigation, and output the information of the carrier, such as pitch, roll, course, position, speed, time and the like; After losing the satellite signal, it outputs the position, velocity and attitude information of inertial solution, and has a certain navigation accuracy maintenance function in a short time.

2.2 Performance indicators

The performance of integrated navigation system is shown in Table 1.

Table 1 System Performance Index

Project	Metrics (RMS)	Remark

Project		Metrics (RMS)	Remark
Heading accuracy			
	Dual GNSS	0.1°	2m baseline
	Single GNSS	0.1°	Need to maneuver
	Maintain accuracy	⩽0.3°	GNSS failure 0.5 H
Attitude accuracy			
	GNSS is valid	0.05°	Single-point L1/L2,
	Maintain accuracy	⩽0.3°/30min	GNSS failure
Horizontal positioning accuracy			
	GNSS is valid	1.2m	Single-point L1/L2
		2cm+1ppm	RTK
	Maintain accuracy	⩽2nm	GNSS failure 30 min
Horizontal velocity accuracy			
	GNSS is valid	0.05m/s	
Gyroscope			
	Measuring range	±450°/s	
	Zero bias stability	≤0.5°/h	10 s smooth
Accelerometer			
	Measuring range	±16g	Customizable 200 G
	Zero bias stability	≤100μg	10 s smooth
Communication interface			
	RS232	Route 1	
	RS422	Route 1	
Electrical characteristics			
	Voltage	9~36VDC	
	Power consumption	≤6W	
	Ripple	100 mV	P-P
Structural characteristics			
	Size	80 mm×60mm×31mm	
	Weight	≤200g	

Project		Metrics (RMS)	Remark
Use environment			
	Operating temperature	-40℃~+60℃	
	Storage temperature	-45℃~+65℃	
	Vibration	20~2000Hz，6.06g	
	Impact	30g，11ms	
	Degree of protection	IP65	
Reliability			
	MTBF	30000h	
	Life span	> 15 years	
	Continuous working time	>24h	

3. Working principle

3.1 Product composition

The composition of the product is shown in Figure 1.

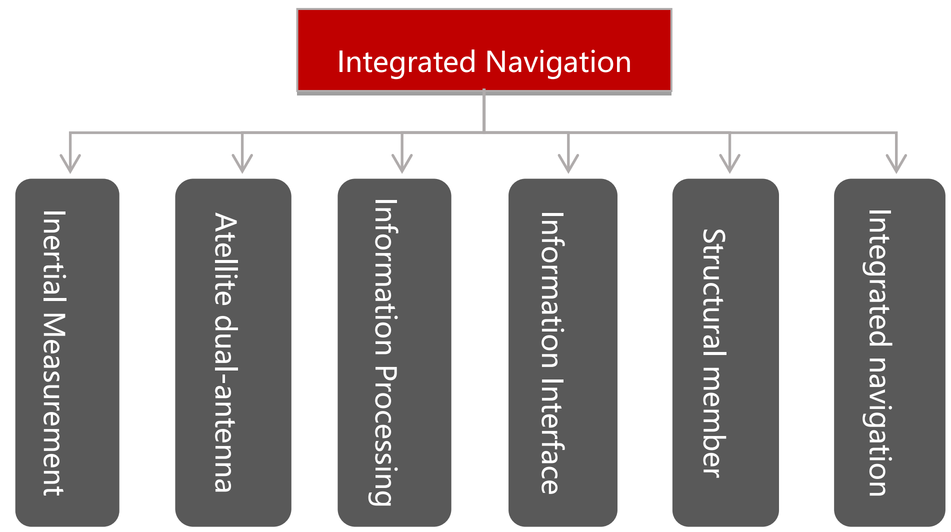

Figure 1 System composition

3.2 Fundamentals

The inertial measurement unit consists of three accelerometers and three 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 GNSS 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 circuit.

The basic principle is shown in Figure 2.

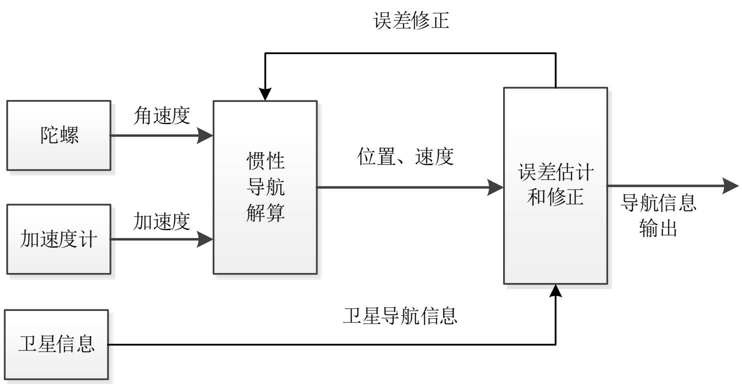

Fig. 2 Schematic diagram of working principle

4.Instructions for use

4.1 overall dimensions

The inertial measurement unit and GNSS receiver adopt an integrated design scheme and are integrated in the integrated navigation system. The system outline is shown in Figure 3.

The overall dimension of the integrated navigation system is 80mm × 60mm × 31mm (length × width × height).

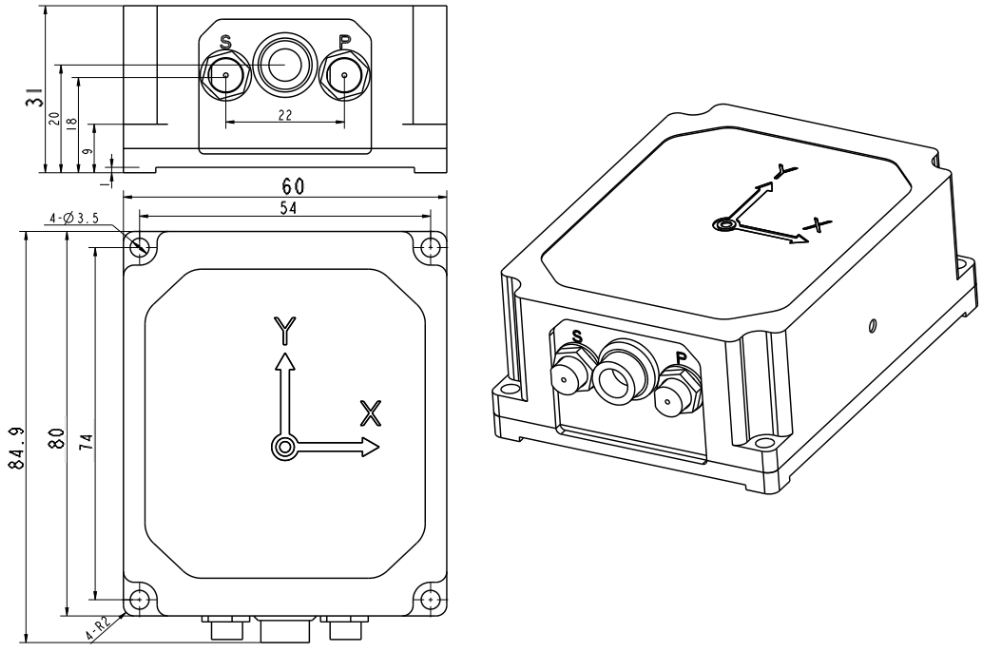

Fig. 3 Outline structure of integrated navigation system

4.2 Electrical interface

4.2.1 product interface

The system has 3 external connectors:

A power supply and communication interface, whose contact sequence is defined as shown in Figure 4;

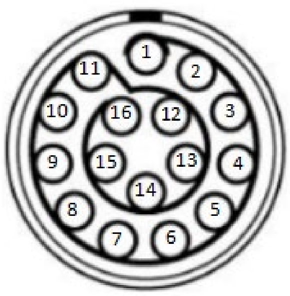

Fig. 4 Power supply and communication interface point number of integrated navigation system (product socket and welding surface)

Two RF line interfaces (SMA outer screw and inner hole), in which the mark P is connected to the main antenna (rear antenna), and the mark S is connected to the slave antenna (front antenna).

4.2.2 communication cable

One end of the communication cable is Ramo connector (FGG.0T.312.CLAC40), which is connected to the system, and the other end is divided into power line and communication line (line length is 1m):

Power cable: connected to 9 ~ 36 V DC, with external cable, and connected to red and black clips.

Communication cable: with 2 serial ports. COM1 is used to send working mode instructions and protocol output, which is RS232; COM2 is the RS422 protocol output interface.

Two RF cables: one end is connected to the antenna, and the other end is connected to the product.

The contact sequence of cable connector (FGG.0T.312.CLAC40) is defined as shown in Figure 4

Cable wiring is defined in Table 2.

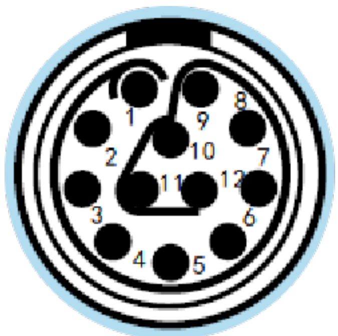

Fig. 4 Distribution of cable connector points (plug and soldering surface)

Table 2 Connector Point Definition

Connection point 1		Connection Point 2		Terminal number	Lengt
Plug wire	Termin	Plug wire	Termin		
P1 (FGG.0T.312.CLAC40)	3	DB9 female (COM2)	1	COM2_RS422R+	1 meter
	2		2	COM2_RS422R-	
	5		3	COM2_RS422T+	
	4		4	COM2_RS422T-	
	7		5	GND	
	12	DB9 female (COM1)	2	COM1_RS232T	
	11		3	COM1_RS232R	
	6		5	GND	
	1	Odometer	Throw	DI+	
	10		Throw	DI-	
	7	Black	GND	GND	
	6		GND	GND	
	9	Red alligator	24V_I	24V_IN	
	8		24V_I	24V_IN	

4.3 Instructions for use

Workflow of 4.3.1 system

After the system is started, it automatically enters the integrated navigation mode without any command control.

4.3.1.1 integrated navigation mode flow

After entering the integrated navigation process, the system automatically enters the coarse alignment state, and the coarse alignment time is 3s; in the coarse alignment state, the system waits for effective satellite navigation information, and the integrated navigation system is required to be static during the coarse alignment; when the satellite navigation information is effective, the system enters the integrated navigation state, otherwise, the system maintains the coarse alignment state; When the system is in the integrated navigation state, the integrated navigation system can move.

The 4.3.1.2 system is reset

During operation, input the "# reset" command, and the system will perform soft reset and display the startup information again.

4.3.2 system configuration instruction

4.3.2.1 Configuration Scheme and Storage

The integrated navigation system provides 2 serial ports to the outside, and the distribution and relevant configuration of each serial port are shown in Table 3.

Table 3 Serial port function distribution of integrated navigation system

String slogans	Enter the project	Output items	Default
COM1	1. working mode instruction and flow control instruction; 2. COM1 ~ COM2 baud rate, protocol and	1.inspvasa、bdfpd、bdfpdb、bdfpdl、gpfpd、INStest(0.2Hz、1Hz、5Hz、10Hz、100Hz... 200Hz, etc.); 2.rawimusb 、 rawdata 、 INSpost （200Hz）; 3.Configure the prompt message.	256000bps； Output: bdfpdl 1Hz;

String slogans	Enter the project	Output items	Default
	update rate configuration.		
COM2	None	Same as item 1-2 in COM 1	460800bps Output: INSpost

After the system is powered on and the start prompt is displayed on the COM1 port, you can input the commands such as COM1 ~ COM2 serial port baud rate configuration, 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 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

Type the "log loglist" or "log rxstatus" command through the COM1 port to list all the configurations of COM1-COM2, including the following contents:

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

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

Initial binding longitude and latitude;

Initially binding the included angle between the double-antenna heading and the integrated navigation system heading;

Initial binding antenna mast arm value;

System number and date of manufacture;

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

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

4.3.2.3 baud rate configuration

In this mode, enter the following command to enter the serial port baud rate configuration:

com comX BAUDRATA

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

For example, set the baud rate of the COM1 port to 115200 bps, and input the following command:

com com1 115200

4.3.2.4 protocol and update rate configuration

4.3.2.4.1 protocol and update rate configuration

Configure the output protocol of COM1 ~ COM2 through COM1, and the configuration command is as follows:

log comX LOG ontime updataTime

Where, comX can be the configuration number of com 1 ~ com2; 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), 0.01 (100 Hz), etc., which can be divided by 200 Hz, and the unit is s.

LOG indicates the protocol name, which can be inspvasa, bdfpd, gpfpd, etc.

For example, if you want to configure the COM2 port to output 10Hz bdfpd data, you can input the following command through COM1:

log com2 bdfpd ontime 0.1

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

log com2 inspvasa ontime 0.1

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

log comX LOG off

Configure the rawdata protocol of COM 1 ~ COM2 ports through COM1, and the configuration commands are as follows:

log comX rawdata onchanged

If you want to close the rawdata protocol of the serial port, the configuration command is as follows:

log comX rawdata off

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

unlogall comX

It should be noted that increasing the update rate or outputting multiple 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.

4.3.2.4.2 protocol format

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

Table 4 Output Data Protocol Description

Serial	Data protocol	Type of	Output type	Support
	gpfpd	ASCII	ontime	COM1-COM2
	bdfpd	ASCII	ontime	COM1-COM2
	bdfpdb	Binary	ontime	COM1-COM2
	rawimusb	Binary	onchanged	COM1-COM2
	inspvasa	ASCII	ontime	COM1-COM2
	rawdata	Binary	onchanged	COM1-COM2
	bdfpdl	ASCII	ontime	COM1-COM2

The ASCII type protocol conforms to the NMEA protocol format requirement and comprises the following fields: a statement identifier, a plurality of data fields,ChecksumEnd tag (with carriage return < CR > andLine break< LF >) separated by commas. Take the bdfpd protocol as an example, the format is as follows:

$BDFPD,<1>,<2>,<3>,<4>,<5>,<6>,<7>,<8>,<9>,<10>,<11>,<12>,<13>,<14>,

<15>*xx<CR><LF>

The protocol formats of gpfpd, bdfpd, bdfpdbl, inspvasa, bdfpdb, and rawimusb are shown in the following table.

Table 5 gpfpd format

Serial number	Name	Meaning	Data type	Unit
	$GPFPD	Format header	—	—
	GPSWeek	Current Week Number Since 1980-1-6 (GMT)	Integer	—
	GPS cycles per second	GPS cycles per second	Floating-point type	s
	Yaw Angle	Yaw 0 ~ 360 degrees, clockwise	Floating-point type	Degree
	Pitch Angle	Pitch angle -90 ° ~ 90 °	Floating-point type	Degree
	Roll Angle	Roll angle -180 ° ~ 180 °	Floating-point type	Degree
	Latitude	Combined Output Latitude -90 ° ~ 90 °	Floating-point type	Degree
	Longitude	Combined output longitude -180 ° ~ 180 °	Floating-point type	Degree
	Height	Height of the combined output	Floating-point type	m
	East speed	Combined output east speed	Floating-point type	m/s

Serial number	Name	Meaning	Data type	Unit
	North speed	Combined output north speed	Floating-point type	m/s
	Sky speed	Combined output speed	Floating-point type	m/s
	Baseline length	Distance between centers of two satellite antenna	Integer	Meters
	NSV1	Number of satellites for antenna 1	Integer	A
	NSV2	Number of satellites for antenna 2	Integer	A
	Satellite status	Satellite status 0: unavailable, 1: available	Integer	—
	Check code	Check code (value after exclusive or of number between $and *)	Hexadecimal	—
	<CR><LF>	Fix the tail of the package	—	—

Table 6 bdfpd format

Serial number	Name	Meaning	Data type	Unit
	$BDFPD	Format header	—	—
	GPSWeek	Current Week Number Since 1980-1-6 (GMT)	Integer	—
	GPS cycles per second	GPS cycles per second	Floating-point type	s
	Yaw Angle	Yaw 0 ~ 360 degrees, clockwise	Floating-point type	Degree
	Pitch Angle	Pitch angle -90 ° ~ 90 °	Floating-point type	Degree
	Roll Angle	Roll angle -180 ° ~ 180 °	Floating-point type	Degree
	Latitude	Combined Output Latitude -90 ° ~ 90 °	Floating-point type	Degree
	Longitude	Combined output longitude -180 ° ~ 180 °	Floating-point type	Degree
	Height	Height of the combined output	Floating-point type	m
	East speed	Combined output east speed	Floating-point type	m/s

Serial number	Name	Meaning	Data type	Unit
	North speed	Combined output north speed	Floating-point type	m/s
	Sky speed	Combined output speed	Floating-point type	m/s
	NSV1	Number of satellites for antenna 1	Integer	A
	NSV2	Number of satellites for antenna 2	Integer	A
	Positioning type	Postype in bestpos, see Table 12	Integer	—
	Directional type	Postype in heading, see Table 12	Integer	—
	Check code	Check code (value after exclusive or of number between $and *)	Hexadecimal	—
	<CR><LF>	Fix the tail of the package	—	—

Table 7 Format of bdfpdl

Serial number	Name	Meaning	Data type	Unit
	$BDFPD	Format header	—	—
	GPSWeek	Current Week Number Since 1980-1-6 (GMT)	Integer	—
	GPS cycles per second	GPS cycles per second	Floating-point type	s
	Yaw Angle	Yaw 0 ~ 360 degrees, clockwise	Floating-point type	Degree
	Pitch Angle	Pitch angle -90 ° ~ 90 °	Floating-point type	Degree
	Roll Angle	Roll angle -180 ° ~ 180 °	Floating-point type	Degree
	Latitude	Combined Output Latitude -90 ° ~ 90 °	Floating-point type	Degree
	Longitude	Combined output longitude -180 ° ~ 180 °	Floating-point type	Degree
	Height	Height of the combined output	Floating-point type	m
	East speed	Combined output east speed	Floating-point type	m/s

Serial number	Name	Meaning	Data type	Unit
	North speed	Combined output north speed	Floating-point type	m/s
	Sky speed	Combined output speed	Floating-point type	m/s
	X-axis angular rate	IMU is on the right	Floating-point type	°/s
	Y-axis angular rate	Before the IMU system	Floating-point type	°/s
	Z-axis angular rate	Attach the IMU	Floating-point type	°/s
	X-axis acceleration	IMU is on the right	Floating-point type	m/s2
	Y-axis acceleration	Before the IMU system	Floating-point type	m/s2
	Z-axis acceleration	Attach the IMU	Floating-point type	m/s2
	NSV1	Number of satellites for antenna 1	Integer	A
	NSV2	Number of satellites for	Integer	A

Serial number	Name	Meaning	Data type	Unit
		antenna 2		
	Positioning type	Postype in bestpos, see Table 12	Integer	—
	Directional type	Postype in heading, see Table 12	Integer	—
	System status word	0 x00: Standby 0 x10: coarse alignment 0 x20: fine alignment 0x30: integrated navigation 0x31: Inertial navigation		
	Check code	Check code (value after exclusive or of number between $and *)	Hexadecimal	—
	<CR><LF>	Fix the tail of the package	—	—

Table 8 Format of inspvasa

Serial number	Name	Meaning	Data type	Unit
	%INSPVASA	Format header	—	—
	GPSWeek	Current Week Number Since 1980-1-6 (GMT)	Integer	—
	GPS cycles per second	GPS cycles per second	Floating-point type	s
	GPSWeek	Current Week Number Since 1980-1-6 (GMT)	Integer	—
	GPS cycles per second	GPS cycles per second	Floating point number	s
	Latitude	Combined Output Latitude -90 ° ~ 90 °	Floating-point type	Degree
	Longitude	Combined output longitude -180 ° ~ 180 °	Floating-point type	Degree
	Height	Height of the combined output	Floating-point type	m
	North speed	Combined output north speed	Floating-point type	m/s
	East speed	Combined output east	Floating-poin	m/s

Serial number	Name	Meaning	Data type	Unit
		speed	t type	
	Sky speed	Combined output speed	Floating-point type	m/s
	Roll Angle	Roll angle -180 ° ~ 180 °	Floating-point type	Degree
	Pitch Angle	Pitch angle -90 ° ~ 90 °	Floating-point type	Degree
	Yaw Angle	Yaw 0 ~ 360 degrees, clockwise	Floating-point type	Degree
	INS status	See Table 11	—	—
	Check code	Check code (number between% and * 32-bit CRC check)	Hexadecimal	—
	<CR><LF>	Fix the tail of the package	—	—

Table 9 bdfpdb protocol description

Serial number	Number of bytes	Definition	Meaning	Data type	Remark
1	1	Frame header	0xaa	—	Header
	2		0x44	—	
	3		0x10	—	
2	4	Message length	0x3c	—	
3	5-8	Week of GNSS	Current Week Number Since 1980-1-6 (GMT)	unsigned int	—
4	9-12	Week second	GPS cycles per second	float	—
5	13-16	Yaw Angle	Yaw 0 ~ 360 degrees, clockwise	float	—
6	17-20	Pitch Angle	Pitch angle -90 ° ~ 90 °	float	—
7	21-24	Roll Angle	Roll angle -180 ° ~ 180 °	float	—
8	25-32	Latitude	Combined Output Latitude -90 ° ~ 90 °	double	—

Serial number	Number of bytes	Definition	Meaning	Data type	Remark
9	33-40	Longitude	Combined output longitude -180 ° ~ 180 °	double	—
10	41-44	Height	Height of the combined output	float	—
11	45-48	East speed	Combined output east speed	float	—
12	49-52	North speed	Combined output north speed	float	—
13	53-56	Sky speed	Combined output speed	float	—
14	57-58	NSV1	Number of satellites for antenna 1	unsigned short	—
15	59-60	NSV2	Number of satellites for antenna 2	unsigned short	—
16	61-62	Positioning type	Postype in bestpos, see Table 12	unsigned short	—
17	63-64	Directional	Postype in heading,	unsigned	—

Serial number	Number of bytes	Definition	Meaning	Data type	Remark
		type	see Table 12	short	
18	65-68	Checksum	5-64 bytes 4-byte accumulate sum check	—	—

Table 10 Description of raw imusb protocol

Serial number	Number of bytes	Definition	Meaning	Data type	Remark
1	1	Frame header	0xaa	—	Header
	2		0x44	—	
	3		0x13	—	
2	4	Message length	0x28	—	
3	5-6	Message ID number	0x145	—	—
4	7-8	Week of GNSS	—	unsigned short	—

Serial number	Number of bytes	Definition	Meaning	Data type	Remark
5	9-12	Week second	ms	unsigned int	—
6	13-16	Week of GNSS	—	unsigned int	
7	17-24	Week second	s	double	
8	25-28	IMU status word	See Table 13	unsigned int	
9	29-32	Z-direction accelerometer output (upper)	m/s2	int	200*200*2-31
10	33-36	-Y accelerometer output (rear)	m/s2	int	200*200*2-31
11	37-40	X-direction accelerometer output (right)	m/s2	int	200*200*2-31
12	41-44	Z-direction gyroscope	°/s	int	200*720*2-31

Serial number	Number of bytes	Definition	Meaning	Data type	Remark
		output (upper)			
13	45-48	-Y-gyro output (rear)	°/s	int	200*720*2-31
14	49-52	X-direction gyroscope output (right)	°/s	int	200*720*2-31
15	53-56	Checksum	1-52 byte 32-bit CRC check	unsigned int	—

Table 11 INS Status Description

INS status word	Status word description
INS_INACTIVE	IMU logs are present, but the alignment routine has not started; INS is inactive.
INS_ALIGNING	INS is in alignment mode.
INS_SOLUTION_GOOD	The INS filter is in navigation mode and the INS solution is good.

Table 12 postype description

Type numeric value	Type definition	Type description
0	NONE	No solution
1	FIXEDPOS	Position has been fixed by the FIX POSITION command
2	FIXEDHEIGHT	Position has been fixed by the FIX HEIGHT/AUTO command
8	DOPPLER_VELOCITY	Velocity computed using instantaneous Doppler
16	SINGLE	Single point position
17	PSRDIFF	Pseudorange differential solution
18	WAAS	Solution calculated using corrections from an WAAS
19	PROPAGATED	Propagated by a Kalman filter without new observations
20	OMNISTAR	OmniSTAR VBS position
32	L1_FLOAT	Floating L1 ambiguity solution
33	IONOFREE_FLOAT	Floating ionospheric-free ambiguity solution
34	NARROW_FLOAT	Floating narrow-lane ambiguity solution
48	L1_INT	Integer L1 ambiguity solution

Type numeric value	Type definition	Type description
50	NARROW_INT	Integer narrow-lane ambiguity solution
64	OMNISTAR_HP	OmniSTAR HP position
65	OMNISTAR_XP	OmniSTAR XP or G2 position
68	PPP_CONVERGING	Converging PPP solution
69	PPP	Converged PPP solution
70	OPERATIONAL	Solution accuracy is within UAL operational limit
71	WARNING	Solution accuracy is outside UAL operational limit but within warning limit
72	OUT_OF_BOUNDS	Solution accuracy is outside UAL limits

Table 13 IMU Status Word Description

Bit sequence number	Type description	
0	X Gyro status	1: normal, 0: fault

Bit sequence number	Type description	
1	Y Gyro status	
2	Z gyro status	
3	Spare	
4	X Accelerometer Status	1: normal, 0: fault
5	Y Accelerometer Status	
6	Z Accelerometer Status	
7-31	Spare	—

4.3.2.4.332 bit CRC check calculation method

The 32-bit CRC check calculation method can be obtained by using the following C language function.

```c
#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 );
}
```

4.3.2.5 initial value configuration

Initial longitude and latitude configuration, configuration instructions are:

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-velocity correction function mainly means that the integrated navigation system detects the sensitive information, and if the integrated navigation system is judged to be zero-velocity, 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

In order to get more smooth position information, the navigation software adds the function of position output smoothing, which makes the position noise smaller after smoothing.

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

4.3.2.7 carrier type configuration

According to different carriers installed in the integrated navigation system, the carrier type configuration is required, and different algorithm processing is carried out in the integrated navigation 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 "saveconfig", and then hard start or enter the "# reset" command. The carrier type configuration will be valid after startup. The integrated navigation system does not support current configuration and current use during use, and must be restarted.

After the carrier type is configured as the vehicle-mounted type, the integrated navigation system is required to be installed and fixed on the vehicle, and the heading of the integrated navigation system is consistent with the head direction of the vehicle, 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 integrated navigation system, it is necessary to configure the antenna rod arm. The lever arm value between the integrated navigation system and the antenna must be accurate to millimeter (mm) during measurement, especially during RTK operation. Any lever arm measurement error will directly enter the position error output by the integrated navigation system. During installation and use, the integrated navigation system should be as close as possible to the main antenna, especially in the horizontal position. The command is required to be completed before or during the alignment of the integrated navigation system on the stationary base and before the alignment of the integrated navigation system on the moving 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:

setimutoantoffset armXarmyarmZ

The slave antenna configuration instructions are as follows:

setimutoantoffset2 armXarmyarmZ

Where armX, armY and armZ are the configured lever arm values in meters, representing the components of the vector from the integrated navigation system to the antenna phase center in the integrated navigation system carrier coordinate system, and the integrated navigation system carrier coordinate system is selected as the right front top (XYZ). For the example in Figure 6, armX and armY should be negative, and armZ should be positive.

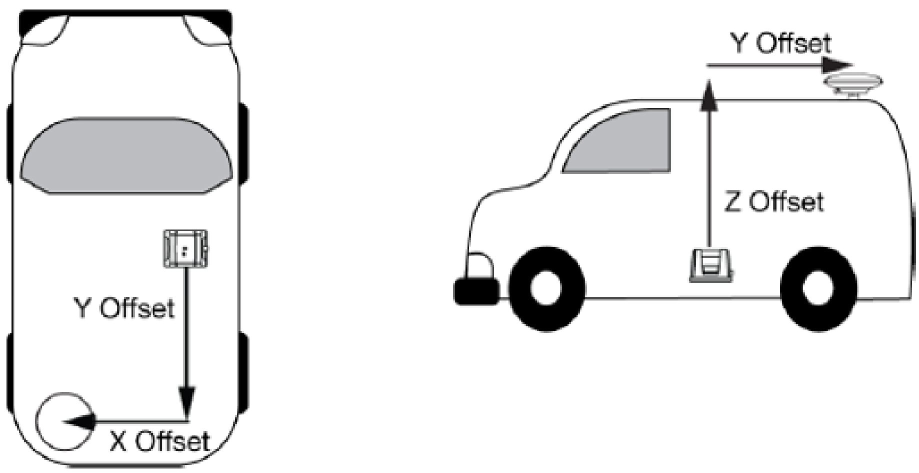

Figure 6 Schematic diagram of antenna rod arm

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 outputs the position and speed values at the integrated navigation system. If the position and speed of the user's 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 integrated navigation system.

The lever arm value from the configuration of integrated navigation system to the test point must be accurate to millimeters (mm) during measurement, especially during RTK operation, any lever arm measurement error will directly enter the position error output by the integrated navigation system. The command is required to be completed before or during the alignment of the integrated navigation system on the stationary base and before the alignment of the integrated navigation system on the moving base. Once the configuration is complete, it needs to be saved via "saveconfig".

The output lever arm configuration commands are as follows:

setimutosensoroffset armXarmyarmZ

Where armX, armY, and armZ are the configured lever arm values, in meters, representing the components of the vector from the integrated navigation system to the test point in the integrated navigation system carrier coordinate system, and the integrated navigation system carrier coordinate system is selected as the right front top (XYZ). For the example in Figure 7, armY and armZ should be positive.

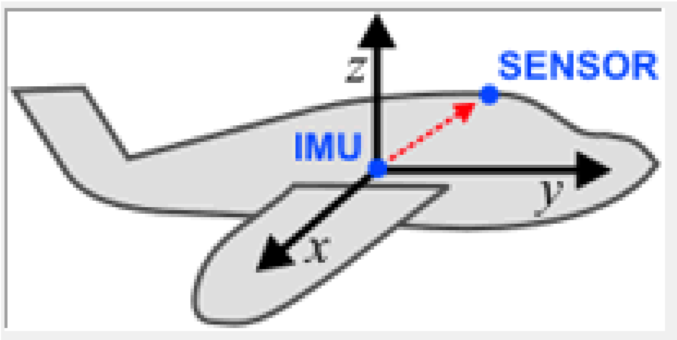

Fig. 7 Schematic diagram of output lever arm

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 configuration 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 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.

4.3.2.11 forced rotation inertial navigation

When the integrated navigation system is in the integrated navigation state, the integrated navigation system can receive the forced rotation inertial navigation instruction and switch to the inertial navigation state. In this state, the integrated navigation system still receives the satellite navigation information for protocol transmission, but does not use the satellite navigation information to participate in the integrated navigation calculation. After receiving the effective forced rotation inertial navigation command, the integrated navigation system feeds back the "cmd OK" "through the COM1 port.

Forced-turn inertial navigation commands are as follows:

#moddgitoins

4.3.3 system maintenance

4.3.3.1 firmware upgrade

When a firmware upgrade is required, proceed as follows:

Make sure that COM1 port is the configuration interface before starting;

Connect the power line and communication line, connect the COM1 port to the computer, and set the COM1 port according to the baud rate setting value of the COM1 port;

After sending the " $GPUPD" command, change the COM1 baud rate to the 256000 bps;

The serial port tool interface displays the start prompt information, and the interface displays "100 ..." 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;

Select the firmware (generally *.bin2 file) to be upgraded through the serial port tool and send it;

After the sending is completed, the program automatically reloads and starts, enters the start prompt information, and starts normally;

The firmware upgrade is complete.

4.3.3.2 parameter upload

In general, the user does not need to upload the calibration parameters, and the configuration has been completed before leaving the factory. Under special circumstances, if the user is required to upload and maintain the parameters, the following steps shall be followed:

After the system completes the startup prompt information normally, you can query the corresponding system number through the "log bdlist"/ "log rxstatus";

Send the "# modbd" command to the integrated navigation system through the COM1 port, and upload the "*.txt" calibration parameter file through the serial port after the "cmd OK" "is returned;

After the interface returns to the calibration parameter information, send the "# saveconfig"/ "saveconfig" command to save the parameters, and then reset the system by soft and hard reset to work normally.

5. Precautions

The main considerations are as follows:

A) The power-on and power-off time interval of the integrated navigation system shall not be less than 30 s, otherwise it is easy to cause damage to the inertial devices;

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

The output and baud rate configuration of the C) satellite board shall be as described in the appendix.

6. Appendix

Description of the differential configuration of the 6.1

The integrated navigation system can receive the differential correction information sent by the reference station through the communication link, work in the differential state, and achieve the positioning accuracy of centimeter level. Differential configuration mainly includes three parts: 1. Reference station setting; 2. Communication link setting; 3、 mobile station settings. The data link is shown in the following illustration.

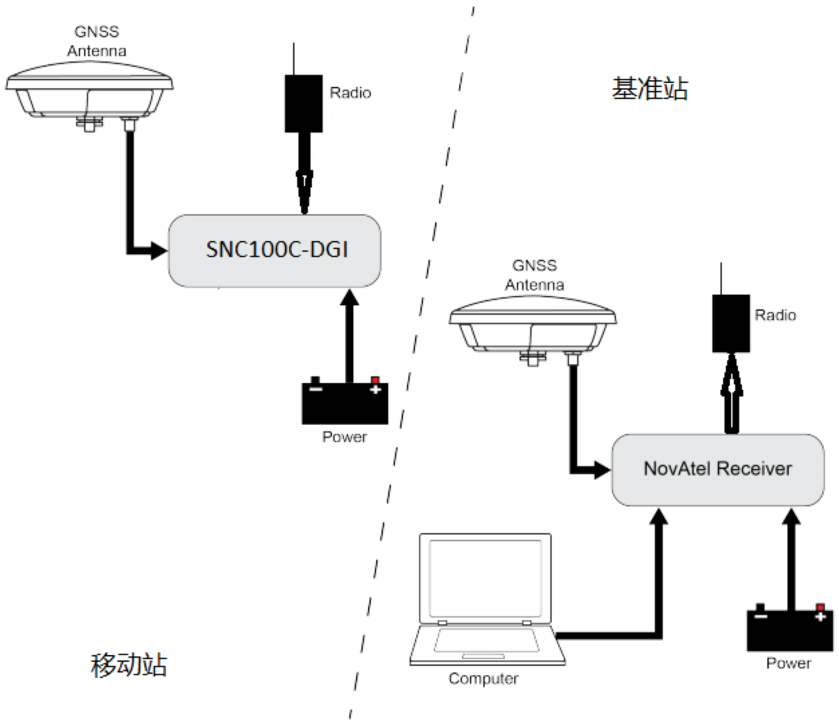

Figure 8 Data Link Diagram

Setting of 6.1.1 reference station

The differential reference station is the satellite receiver with the antenna of the satellite receiver installed in a fixed position. During the use of the satellite receiver, it is necessary to ensure that the antenna is fixed. In the working process of the differential reference station, the precise coordinates of the fixed position and the received satellite information are sent 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 calculation, realize differential high-precision positioning, and achieve centimeter-level positioning accuracy.

The NovAtel-718D satellite receiver card can be applied to the reference station, and it can be configured as the reference station mode. The specific configuration instructions are as follows. See the NovAtel-718D user manual for details.

Table 14 Reference Station Configuration Instructions

Serial number	Instruction	Explain
1	fix position39.8122 116.1515 60.5	Set the known precise coordinates (latitude 39.8122, 经度116.1515, altitude 60.5) as the reference station coordinate values
	posaveon 0.01 1.5 2.5	Autonomous positioning of the receiver 0.01 H; Or when the horizontal positioning standard deviation is less than or equal to 1.5 m and the height positioning standard deviation is less than or equal to 2.5 m, the average value of the positioning is taken as the coordinate value of the reference station
2	serialconfig com1 9600	Set the output baud rate of the output interface COM1 of the reference station to 9600 bps
3	interfacemode com1 novatel rtcmv3 on	Configure COM1 input data type as novatel, output data type as rtcmv3, and

Serial number	Instruction	Explain
		enable command feedback
4	log com1rtcm1075ontime 1	GPS differential message
5	log com1rtcm1125ontime 1	BDS differential message
6	log com1rtcm1085ontime 1	GLO differential message
7	log com1rtcm1033ontime 10	Description of receiver and antenna
8	log com1rtcm1005ontime 10	Antenna reference point coordinates of RTK reference station
9	saveconfig	Save the configuration

6.1.2 communication link settings

The communication link can use 4G DTU or data radio, and the coverage of 4G DTU is the coverage of network information; Limited by national laws, the coverage of the digital radio station is about 10km. For the setting of 4G DTU and digital radio, please refer to the user manual of the corresponding product.

6.1.3 mobile station settings

The integrated navigation system is a differential mobile station. The mobile station receives the differential correction information of the reference station in real time, and receives the satellite signal to calculate the differential positioning, so as to realize the differential high-precision positioning. The integrated navigation system supports RTCM and RTCMV3 standard data protocols. COM2 of the integrated navigation system can be configured as the receiving interface of differential correction information, and the specific configuration instructions are as follows.

Table 15 Mobile station configuration command

Serial number	Instruction	Explain
1	com com2 X	The input baud rate of the mobile station input interface COM2 is set to Xbps according to the differential input data baud rate
2	saveconfig	Save the configuration

7. Update records

Serial number	**Version**	**Change the date**	**Before the change**	**After the change**	**Reason for the change**	**Changed by**
1	V1.00	20230503		Version V1	New	ZZY