MS100-B0 Combined Navigation System

SKU :MS100-B0

PRODUCT DESCRIPTION

MS100-B0 Combined Navigation System (hereinafter referred to as Combined Navigation System) has built-in high-performance MEMS gyro and accelerometer, which can receive internal GNSS data, realize multi-sensor fusion and combined navigation solution algorithm, and have short-time inertial navigation capability when GNSS is invalid.

The product is highly reliable and highly adaptable to the environment. By matching different software, the product can be widely used in tactical and industrial UAVs, unmanned vehicles, unmanned ships, aerial guided bombs, smart munitions, rockets, kinetic mid-range, mapping, guidance heads and stabilization platforms.

MAIN FUNCTION

The combined navigation system is able to use the internally received satellite navigation information for combined navigation, outputting the carrier's pitch, traverse, heading, position, speed, time and other information; outputting the inertial solved position, speed and heading information after losing the signal, with a certain navigation accuracy maintenance function for a short time. When combined navigation, it can output raw information that can be used for post-processing for post-processing software.

PERFORMANCE INDEX

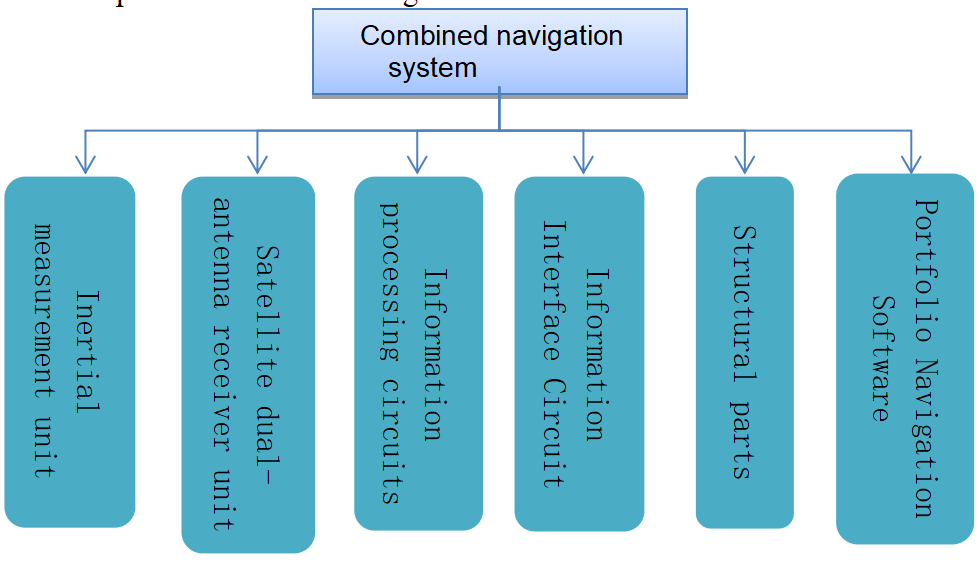
Projects		Metrics (RMS)	Remarks
Heading Accuracy	Dual GNSS	0.1°	2m baseline
	Single GNSS	**0.2°**	Maneuvering required
	Post-processing	0.03°	
	Maintain accuracy	**0.2°/min**	GNSS failure
Attitude accuracy	GNSS valid	**0.1°**	Single point L1/L2
	Inertial/odometry combination	0.1°（RMS）	Optional
	Post-processing	0.02°	
	Maintain accuracy	0.2°/min	GNSS Failure
	V-G mode	2°	GNSS failure time unlimited, no acceleration
Horizontal positioning accuracy	GNSS valid	1.2m	Single point L1/L2
		2cm+1ppm	RTK
	Inertial/odometer combination	2‰D(D indicates mileage, CEP)	Optional
	Post-processing	1cm+1ppm	

Projects		Metrics (RMS)	Remarks
	GNSS invalid	20m	Failure 60s
Horizontal speed accuracy	GNSS valid	0.1m/s	Single point L1/L2
	Inertial/odometry combination	0.1m/s（RMS）	Optional
	Inertial/DVL combination	0.2m/s（RMS）	Optional
Gyroscope	Measurement Range	±450°/s	
	Zero bias stability	2°/h	Allan variance
Accelerometer	Measurement Range	±16g	Customizable 200g
	Zero Bias Stability	30μg	Allan's variance
Communication interface	RS232	1 way	Optional 1-channel RS422, 1-channel RS232 or 2-channel RS232, 1-channel CAN
	RS422	1 way	
	CAN	1 way	
	Odometer differential input	1 way	Optional
	PPS output	1 way	Optional
	EVENT input	1 way	Optional
Electrical characteristics	Voltage	5~36VDC	
	Power consumption	≤3W	
	Ripple	100 mV	P-P
Structural characteristics	Dimension	77.5mm×45 mm×27.2mm	
	Weight	≤150g	
Operating Environment	Operating Temperature	-40℃~+60℃	
	Storage Temperature	-45℃~+65℃	
	Vibration	20~2000Hz，6.06g	
	Shock	30g，11ms	
	Protection Rating	IP65	
Reliability	MTBF	30000h	
	Life	>15 years	
	Continuous Operating Time	>24h	

WORKING PRINCIPLE

1、Product composition

The composition of the product is shown in Figure 1



2、Basic principle

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

The basic principle is shown in Figure 2.

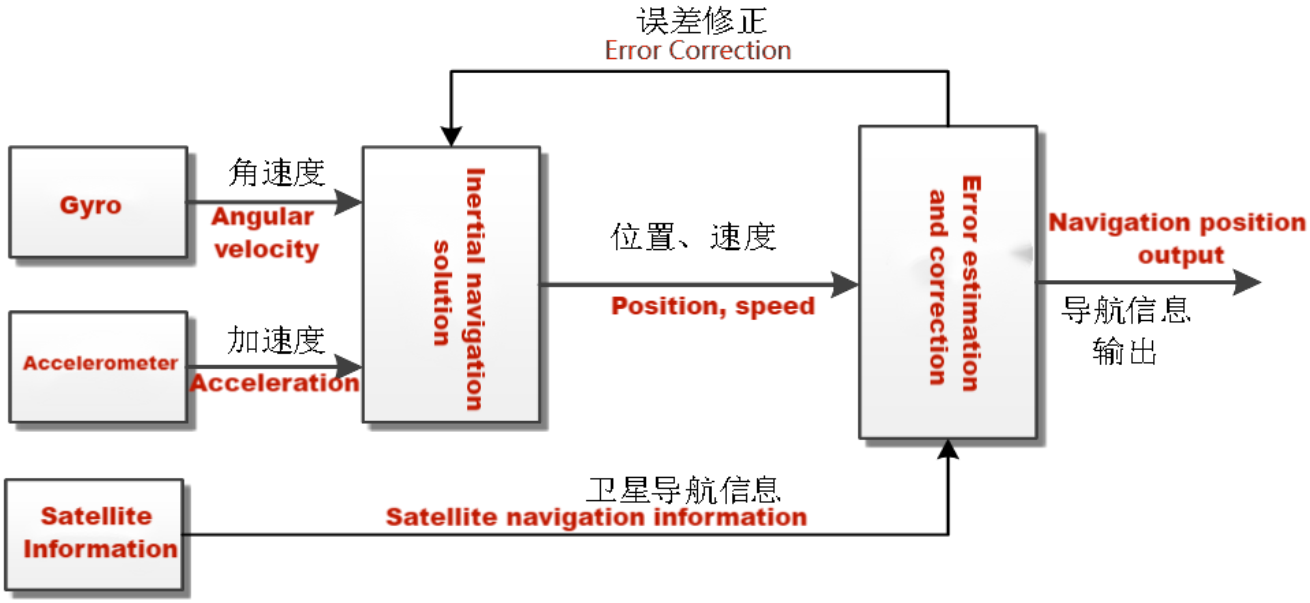


Figure 2 Schematic diagram of working principle

INSTRUCTIONS FOR USE

1、Form factor

The inertial measurement unit and GNSS receiver are integrated in the combined navigation system, and the system outline is shown in Figure 3.

The external dimensions of the combined navigation system are: 77.5mm×45 mm×27.2mm (L×W×H).

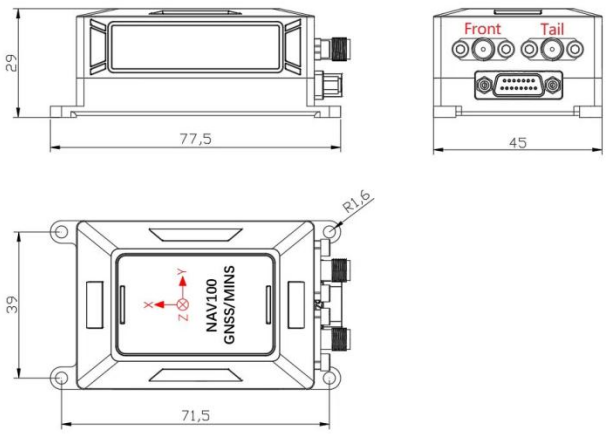


Figure 3 Combined navigation system shape structure diagram

2、Electrical interface

2.1、Product interface

The system has three external connectors:

- a power supply, communication interface (EEG.0T.312.CLN), whose contact sequence is defined as shown in Figure 4;

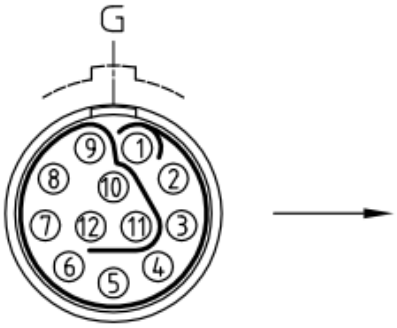


Figure 4 Combined navigation system power supply, communication interface point number (product socket, welding surface)

- two RF line interface (SMA outer screw inner hole, where the logo P connects to the master antenna and the logo S connects to the slave antenna).

2.2、 Communication cable

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

- Power cable: connected to 5~36V DC, working current not more than 0.2A when 24V power supply, external dump line, connected to red and black clips.
- Communication cable: with 2 serial ports. Among them, COM1 is used to send working mode command and protocol output, which is RS232; COM2 is protocol output interface, which is RS422.
- 2 RF cables: one end is connected to the antenna and the other end is connected to the product, respectively.

The cable connector (FGG.0T.312.CLAC40) contact sequence is defined as shown in Figure 5, and the cable wiring is defined as shown in Table 2.

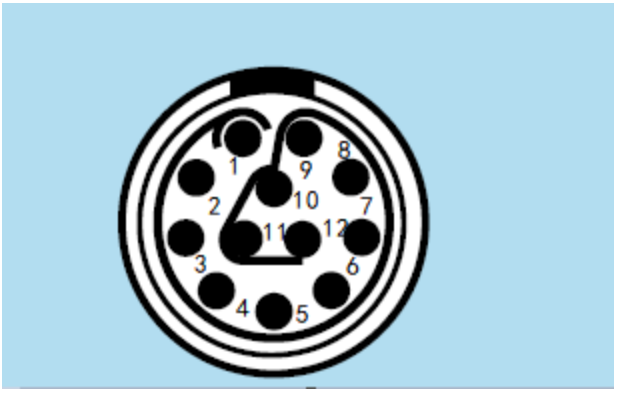


Figure 5 Cable connector point number distribution (plug, solder surface)

Table 2 Connector Point Definition

Connection point 1		Connection point 2		Terminal number definition	Length
Plug wire label code	Terminal number	Plug wire label code	Terminal number		
P1 (FGG.0T.312.CLAC40)	3	DB9 female connector (COM2)	1	COM2_RS422R+	1m
	2		2	COM2_RS422R-	
	5		3	COM2_RS422T+	
	4		4	COM2_RS422T-	
	7		5	GND	
	12	DB9 female connector (COM1)	2	COM1_RS232T	
	11		3	COM1_RS232R	
	6		5	GND	
	1	Odometer input	Dump Line	DI+	
	10		Dump Line	DI-	
	7	Black alligator clip	GND	GND	
	6		GND	GND	
	9	Red Alligator Clip	24V_IN	24V_IN	
	8		24V_IN	24V_IN	

3、Using instructions

3.1、System workflow

The system has two working modes, combined navigation mode and inertial navigation mode. The combined navigation mode is the default working mode after start-up. The default working mode can be changed by command. If the setting is successful, it will return "cmd ok", otherwise it will show "cmd error". After inputting, type "saveconfig" to save this configuration, and the next reboot will automatically call this configuration, if you don't input this command, the next reboot will revert to the last saved configuration.

If you do not enter this command, the configuration will be restored to the last saved configuration after next reboot:

#moddgi

The command to set the inertial navigation mode as the default mode of operation is

#modins

3.1.1、 Combined navigation mode process

After entering the combined navigation process, the system automatically enters the coarse alignment state, and the coarse alignment time is 3s; waiting for the valid satellite navigation information in the coarse alignment state, the combined navigation system is required to be stationary during the coarse alignment; when the satellite navigation information is valid, it enters the combined navigation state, otherwise it keeps the coarse alignment state; when the system is in the combined navigation state, the combined navigation system can move.

3.1.2、 Inertial navigation mode process

After entering the inertial navigation process, the system automatically enters the coarse alignment state, the coarse alignment time is 3s, waiting for valid satellite navigation information in the coarse alignment state, and the combined navigation system is required to be stationary during the coarse alignment; when the satellite navigation information is valid, it enters the fine alignment state, otherwise it automatically enters the fine alignment state after waiting for 1.5s; after 1500s of fine alignment, it automatically shifts to the inertial navigation state. When the system is in the fine alignment or inertial navigation state, the combined navigation system can move.

3.1.3 、System Reset

During operation, enter the "#reset" command to soft reset the system and redisplay the startup information.

3.2 、System configuration commands

3.2.1、 Configuration scheme and saving

The combined navigation system provides 2 serial ports to the outside world, and the allocation and related configuration of each serial port are shown in Table 3.

Table 3 Combined navigation system serial port function allocation table

Serial number	Input Items	Output items	Default
COM1	1. working mode commands and process control commands; 2.COM1~COM2 baud rate, protocol and update rate configuration.	1. inspvasa, bdfpd , bdfpdb, bdfpdl, gpfpd, snctest (0.2Hz, 1Hz, 5Hz, 10Hz, 100Hz...200Hz, etc.); 2. rawimusb, rawdata, sncpost (200Hz); 3. configuration prompt message.	256000bps; Output: bdfpdl 1Hz;
COM2	None	Same as items 1-2 in COM1	460800bps Output: sncpost

After the system is powered on and the COM1 port displays the start-up prompt message, you can input commands such as COM1~COM2 serial port baud rate configuration, serial protocol and update rate setting, etc. Each command output will return "cmd ok" if successful, otherwise it will display "cmd error ". After inputting, type "saveconfig" to save the current configuration, and the next reboot will automatically call the current configuration, if you don't enter the command, the next reboot will restore the serial port configuration to the last saved configuration.

3.2.2、 Configuration Query

By typing "log loglist" or "log rxstatus" command through COM1 port, all configurations of COM1~COM2 will be listed, including the following aspects

- Serial port number, serial port baud rate, serial protocol and update rate;
- Function module open status: including zero speed correction status and smooth processing status, open for enable, close for disable;
- Initial binding latitude and longitude;
- Initial binding dual antenna heading and combined navigation system heading angle;
- Initial binding antenna pole arm value;
- System number and factory date;
- Software version number: including pre-processing software version number and navigation software version number;
- Operating mode: including combined navigation (DGI) and pure inertial navigation (INS).

3.2.3、 Baud Rate Configuration

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

com comX BAUDRATA

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

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

com com1 115200

3.2.4. Protocol and update rate configuration

3.2.4.1, Protocol and update rate configuration

The output protocols of COM1~COM2 are configured through COM1 with the following configuration commands:

log comX LOG ontime updataTime

where comX can be com1~com2 configuration number; updataTime represents the update time, which can be 5(0.2Hz), 1(1Hz), 0.2(5Hz), 0.1(10Hz), 0.01(100Hz) and other periods that can be divided by 200Hz, unit s.

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

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

log com2 bdfpd ontime 0.1

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

log com2 inspvasa ontime 0.1

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

log comX LOG off

To configure the rawdata protocol for COM1~COM2 ports via COM1, the configuration command is as follows：

log comX rawdata onchanged

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

log comX rawdata off

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

unlogall comX

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

3.2.4.2、 Protocol Formats

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

Table 4 Description of output data protocols

Serial number	Data Protocol Name	Protocol Type	Output Type	Support Interface
1	gpfpd	ASCII	ontime	COM1-COM2
2	bdfpd	ASCII	ontime	COM1-COM2
3	bdfpdb	Binary	ontime	COM1-COM2
4	rawimusb	Binary	onchanged	COM1-COM2
5	inspvasa	ASCII	ontime	COM1-COM2
6	rawdata	Binary	onchanged	COM1-COM2
7	bdfpdl	ASCII	ontime	COM1-COM2

The ASCII protocols all conform to the NMEA protocol format requirements and include the following fields: statement identifier, several data fields, check and end marks (with carriage return <CR> and line feed <LF>), separated by several 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 following gives the gpfpd, bdfpd, bdfpdbl, inspvasa, bdfpdb, rawimusb protocol formats, as shown in the table below.

Table 5 gpfpd format

Serial number	Name	Meaning	Data Type	Unit
1	$GPFPD	Format header	—	—
2	GPSWeek	Current number of weeks since 1980-1-6 to present (GMT)	Integer	—
3	GPS周秒	GPS week seconds	Floating Point	s
4	Yaw angle	Yaw angle 0~360 degrees, clockwise	Floating Point	°
5	Pitch angle	Pitch angle-90 degrees~90 degrees	Floating Point	°
6	Roll angle	Roll angle-180 degrees~180 degrees	Floating Point	°
7	Latitude	Combined output latitude -90 degrees ~ 90 degrees	Floating Point	°
8	Longitude	Combined output longitude -180 degrees~180 degrees	Floating Point	°
9	altitude	Combined output altitude	Floating Point	m
10	East speed	Combined output east speed	Floating Point	m/s

Serial number	Name	Meaning	Data Type	Unit
11	North speed	Combined output north speed	Floating Point	m/s
12	Sky speed	Combined output sky speed	Floating-point	m/s
13	Baseline length	Distance between the center of two satellite antennas	Integer	m
14	NSV1	Antenna 1 satellites	Integer	PCS
15	NSV2	Antenna 2 satellites	Integer	PCS
16	Satellite Status	Satellite status 0: not available, 1: available	Integer	—
17	Checksum code	Check digit (the value after the number between $ and * isomerization)	Hexadecimal	—
18	<CR><LF>	Fixed packet tail	—	—

Table 6 bdfpd format

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

Table 7 bdfpdl format

Serial number	Name	Meaning	Data Type	Unit
1	$BDFPD	Format header	—	—
2	GPSWeek	Current week number since 1980-1-6 to present (GMT)	Integer	—
3	GPS circumsecond	GPS week seconds	Floating-point	s
4	Yaw angle	Yaw angle 0~360 degrees, clockwise	Floating-point	°
5	Pitch angle	Pitch angle-90 degrees~90 degrees	Floating-point	°
6	Roll angle	Roll angle-180 degrees~180 degrees	Floating Point	°
7	Latitude	Combined output latitude -90 degrees ~ 90 degrees	Floating Point	°
8	Longitude	Combined output longitude -180 degrees~180 degrees	Floating Point	°
9	altitude	Combined output altitude	Floating Point	m
10	East speed	Combined output east speed	Floating Point	m/s
11	North speed	Combined output north speed	Floating Point	m/s
12	Sky speed	Combined output sky speed	Floating Point	m/s
13	X-axis angular velocity	IMU system right	Floating Point	°/s
14	Y-axis angular velocity	IMU system front	Floating Point	°/s
15	Z-axis angular velocity	IMU system top	Floating Point	°/s

Serial number	Name	Meaning	Data Type	Unit
16	X-axis acceleration	IMU system right	Floating Point	m/s^2
17	Y-axis acceleration	IMU system front	Floating Point	m/s^2
18	Z-axis acceleration	IMU system up	Floating-point	m/s^2
19	NSV1	Antenna 1 satellites	Integer	PCS
20	NSV2	Antenna 2 satellites	Integer	PCS
21	Positioning type	Pos type in bestpos, see Table 12	Integer	—
22	Orientation type	heading in pos type, see Table 12	Integer	—
23	System Status Word	0x00: Standby 0x10: Coarse alignment 0x20: Fine alignment 0x30: Combined navigation 0x31: Inertial navigation		
24	Checksum	Check digit (the value after the number between $ and * isomerizes)	Hexadecimal	—
25	<CR><LF>	Fixed packet tail	—	—

Table 8 inspvasa format

Serial number	Name	Meaning	Data Type	Unit
1	%INSPVASA	Format header	—	—
2	GPSWeek	Current week number since 1980-1-6 to present (GMT)	Integer	—
3	GPS Week Seconds	GPS Week Seconds	Floating-point	s
4	GPSWeek	Current week number since 1980-1-6 to present (GMT)	Integer	—
5	GPS Week Seconds	GPS Week Seconds	Floating-point	s
6	Latitude	Combined output latitude -90 degrees ~ 90 degrees	Floating-point	°
7	Longitude	Combined output longitude -180 degrees ~ 180 degrees	Floating-point	°
8	Altitude	Combined output altitude	Floating Point	m
9	North Speed	Combined output north speed	Floating Point	m/s
10	East speed	Combined output east speed	Floating Point	m/s
11	Sky speed	Combined output sky speed	Floating Point	m/s
12	Rolling angle	Roll angle-180 degrees~180 degrees	Floating Point	°
13	Pitch angle	Pitch angle-90 degrees~90 degrees	Floating Point	°
14	Yaw angle	Yaw angle 0~360 degrees, clockwise	Floating Point	°
15	INS status	See Table 11	—	—
16	Checksum	Checksum (32-bit CRC checksum for the number between % and *)	Hexadecimal	—
17	<CR><LF>	Fixed packet tail	—	—

Table 9 bdfpdb protocol description

Serial number	Number of bytes	Definition	Meaning	Data Type	Remarks
1	1	Frame header	0xaa	—	Message header
	2		0x44	—	
	3		0x10	—	
2	4	Message length	0x3c	—	
3	5-8	GNSS week	Current number of weeks since 1980-1-6 to present (GMT)	unsigned int	—
4	9-12	Week Seconds	GPS Week Seconds	float	—
5	13-16	Yaw angle	Yaw angle 0~360 degrees, clockwise	float	—
6	17-20	Pitch angle	Pitch angle-90 degrees~90 degrees	float	—
7	21-24	Roll angle	Roll angle-180 degrees~180 degrees	float	—
8	25-32	Latitude	Combined output latitude -90 degrees ~ 90 degrees	double	—

Serial number	Number of bytes	Definition	Meaning	Data Type	Remarks
9	33-40	Longitude	Combined output longitude -180 degrees~180 degrees	double	—
10	41-44	altitude	Combined output altitude	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 sky speed	float	—
14	57-58	NSV1	Number of Antenna 1 satellites	unsigned short	—
15	59-60	NSV2	Number of antenna 2 satellites	unsigned short	—
16	61-62	Positioning type	Pos type in bestpos, see Table 12	unsigned short	—
17	63-64	Orientation Type	Pos type in heading, see Table 12	unsigned short	—
18	65-68	Checksum	5-64-byte 4-byte summation and checksum	—	—

Table 10 rawimusb protocol description

Serial number	Number of bytes	Definition	Meaning	Data Type	Remarks
1	1	Frame header	0xaa	—	Message header
	2		0x44	—	
	3		0x13	—	
2	4	Message length	0x28	—	
3	5-6	Message ID number	0x145	—	—
4	7-8	GNSS week	—	unsigned short	—
5	9-12	Week Seconds	ms	unsigned int	—
6	13-16	GNSS week	—	unsigned int	
7	17-24	Week Seconds	s	double	
8	25-28	IMU Status Word	See Table 13	unsigned int	
9	29-32	Z-directional accelerometer output (top)	m/s^2	int	$200*200*2^{-31}$
10	33-36	-Y-directional accelerometer output (back)	m/s^2	int	$200*200*2^{-31}$
11	37-40	X-directional accelerometer output (right)	m/s^2	int	$200*200*2^{-31}$
12	41-44	Z-directional gyro output (top)	°/s	int	$200*720*2^{-31}$
13	45-48	-Y-direction gyro output (back)	°/s	int	$200*720*2^{-31}$
14	49-52	X-directional gyro output (right)	°/s	int	$200*720*2^{-31}$
15	53-56	Calibration sum	1-52 bytes 32-bit CRC checksum	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 pos type description

Type 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

Type Value	Type Definition	Type Description
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
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 descriptions

Bit Serial Number	Type Description	
0	X gyro state	1: Normal, 0: Fault
1	Y gyro state	
2	Z gyro status	
3	Alternate	
4	X accelerometer status	1: Normal, 0: Fault
5	Y accelerometer status	
6	Z accelerometer status	
7-31	Alternate	—

3.2.4.3 、32-bit CRC Checksum Calculation Method

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

```
#define CRC32_POLYNOMIAL 0xEDB88320L
/* --------------------------------------------------------------------------
Calculate a CRC value to be used by CRC calculation functions.
-------------------------------------------------------------------------- */
unsigned long CRC32Value(int i) {
     int j;
     unsigned long ulCRC;
     ulCRC = i;
     for ( j = 8 ; j > 0; j-- ) {
          if ( ulCRC & 1 )
               ulCRC = ( ulCRC >> 1 ) ^ CRC32_POLYNOMIAL;
          else
               ulCRC >>= 1;
     }
     return ulCRC;
}

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

3.2.5、 Initial value configuration

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

initialpos LONGITUDE LATILUDE

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

3.2.6、 Function Module Configuration

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

3.2.6.1 、"Zero speed correction" configuration

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

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

The zero speed correction configuration command is as follows:

inszupt switch

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

3.2.6.2、 "Position output smoothing" configuration

In order to get smoother position information, the position output smoothing function is added to the navigation software, and the position noise after smoothing is smaller.

This product in the combination of navigation process "position output smoothing" default is off, in order to facilitate the user to choose, this function can be configured, configuration instructions are as follows:

possmooth switch

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

3.2.7、 Carrier type configuration

According to the different carriers installed in the combined navigation system, the carrier type configuration is required. For different carrier types, different algorithms are processed inside the combined navigation system.

The configuration commands are as follows:

carrier vehicle/ship/air

In order, it is vehicle, ship and airborne.

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

After the carrier type is configured as vehicle type, it is required that the combined navigation system is installed and fixed on the vehicle, and the combined navigation system heading is consistent with the direction of the front end of the carrier vehicle, with an error of not more than 10 degrees.

3.2.8、 GNSS antenna pole arm configuration

According to the relative installation relationship between the antenna and the combined navigation system, the antenna pole arm configuration is required. Configure the value of the pole arm between the combined navigation system to the antenna, the measurement must be accurate to millimeter (mm), especially when performing RTK operation, any pole arm measurement error will directly enter into the position error of the combined navigation system output, when installed and used, the combined navigation system as close as possible to the main antenna, especially in the horizontal position. This instruction is required before or during the static base alignment of the combined navigation system and before the dynamic base alignment. Once the configuration is complete, it needs to be saved via "saveconfig".

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

The master antenna configuration command is as follows:

setimutoantoffset armX armY armZ

The slave antenna configuration command is as follows

setimutoantoffset2 armX armY armZ

where armX, armY and armZ are the configured pole arm values in meters, representing the component of the vector from the combined navigation system to the antenna phase center within the combined navigation system carrier coordinate system, which is selected as right front up (XYZ). For the example in Figure 6, armX and armY should have negative values and armZ should have positive values.

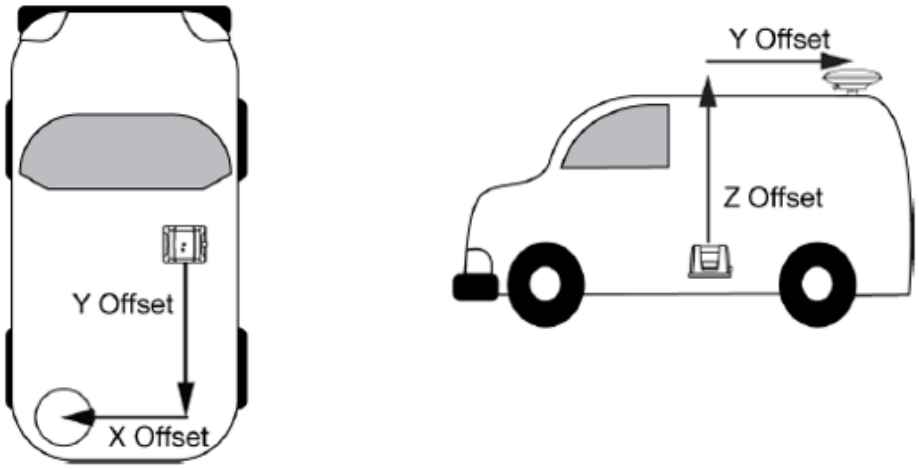


Figure 6 Schematic diagram of the antenna pole arm

3.2.9、 Output lever arm settings

The default value of the product output lever arm configuration is [0, 0, 0] (upper right front), which means the position and speed values at the combined navigation system are output. If you need to output the position and speed of the user test point, you need to set the output lever arm according to the relative installation relationship between the test point and the combined navigation system.

The pole arm value between the configured combined navigation system and the test point must be measured to the nearest millimeter (mm), especially when performing RTK operations where any pole arm measurement error will go directly into the position error output from the combined navigation system. This command is required to be done before or during the static base alignment of the combined navigation system and before the dynamic base alignment. Once this configuration is complete, it needs to be saved via "saveconfig".

The output lever arm configuration command is as follows:

setimutosensoroffset armX armY armZ

where armX, armY and armZ are the configured arm values in meters, representing the vector from the combined navigation system to the test point in the combined navigation system vector coordinate system, which is selected as the right front up (XYZ). Figure 7 example, armY, armZ should be positive values.

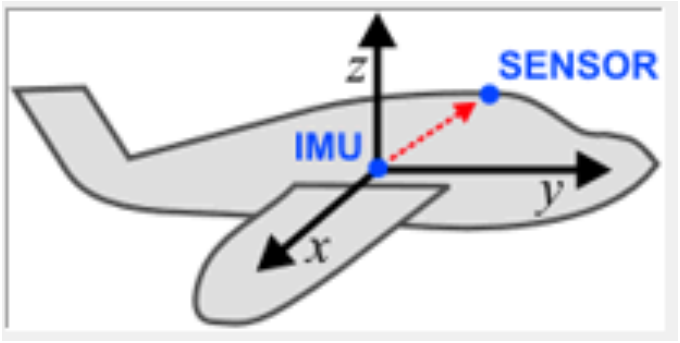


Figure 7 Schematic diagram of output lever arm

3.2.10 、Mounting angle setting

The attitude and heading information output by the product are the Euler angles of the product coordinate system relative to the geographic coordinate system. The angular installation relationship between the product and the carrier coordinate system is the installation angle, and the configuration default value is [0, 0, 0] (pitch, heading, roll),

which means that the product coordinate system is considered to overlap with the installation carrier coordinate system. If there is a mounting angle for the product installed on the carrier, and the product is required to output the Euler angle of the carrier coordinate system relative to the geographic coordinate system, the mounting angle should be set according to the relative mounting relationship between the product and the carrier.

The installation angle configuration command is as follows:

vehiclebodyrotation angleX angleZ angleY

where angleX, angleZ and angleY are the configured installation angle angle values in degrees, representing the angle from the carrier coordinate system to the combined navigation system coordinate system, in the order of pitch, heading and roll.

3.2.11、 Forced-to-inertial navigation

In the combined navigation system in the combined navigation state, it can receive the forced to inertial navigation command and turn into the inertial navigation state, in this state the combined navigation system still receives the satellite navigation information for protocol transmission, but does not use the satellite navigation information to participate in the combined navigation calculation. After receiving a valid forced inertial navigation command, the combined navigation system provides "cmd ok" feedback through COM1 port.

The forced-to-inertial navigation command is as follows:

#moddgitoins

3.3 、System Maintenance

3.3.1、 Firmware Upgrade

When a firmware upgrade is required follow the following operations:

- Ensure that the COM1 port is the configuration interface before starting;
- Connect the power cable and communication cable, connect the COM1 port to the computer, and set the COM1 port according to the COM1 port baud rate setting value;
- Send the command "$GPUPD" to change the COM1 baud rate to 256000bps;
- The interface of serial port tool shows the start-up prompt message, before the interface shows "100...10 9 8 7 6 5 4 3 2 1" to 1, send ":" (small colon, cancel the option of sending new line) to the serial port. interface displays the updata flash information;
- Select the firmware to be upgraded (usually *.bin2 file) through the serial port tool and send it;
- wait until the sending is finished, the program automatically reloads and starts, enters the boot prompt message and starts normally;
- Firmware upgrade is completed.

3.3.2、 Parameter upload

In general, there is no need for the user to upload the calibration parameters, which are already configured before leaving the factory. In special cases, if the user is required to upload parameters for maintenance, the following steps should be followed:

- After the system normally completes the start-up prompt message, the corresponding system number can be queried through "log bdlist"/"log rxstatus";
- Send "#modbd" command to the combined navigation system through COM1 port, and upload "*.txt" calibration parameters through serial port after "cmd ok" is returned. file;
- After the interface returns the calibration parameter information, send "#saveconfig"/"saveconfig" command to

save the parameter, then reset the system softly and hardly, and it can work normally.

PRECAUTIONS

The main precautions are as follows:

- The time interval between power-on and power-off of the combined navigation system is not less than 30s, otherwise it will easily cause damage to inertial devices;
- During handling, installation and use, it should be handled gently to avoid bumping, dropping and impact;
- The output and baud rate configuration of the satellite board card should be in accordance with the appendix description.

APPENDIX

1 、Differential configuration description

The combined navigation system can receive the differential correction information sent by the reference station through the communication link and work in the differential state to achieve the centimeter-level positioning accuracy. The differential configuration mainly includes 3 parts:

1) reference station setting;

2) communication link setting;

3) mobile station setting. The data link is shown in the figure below.

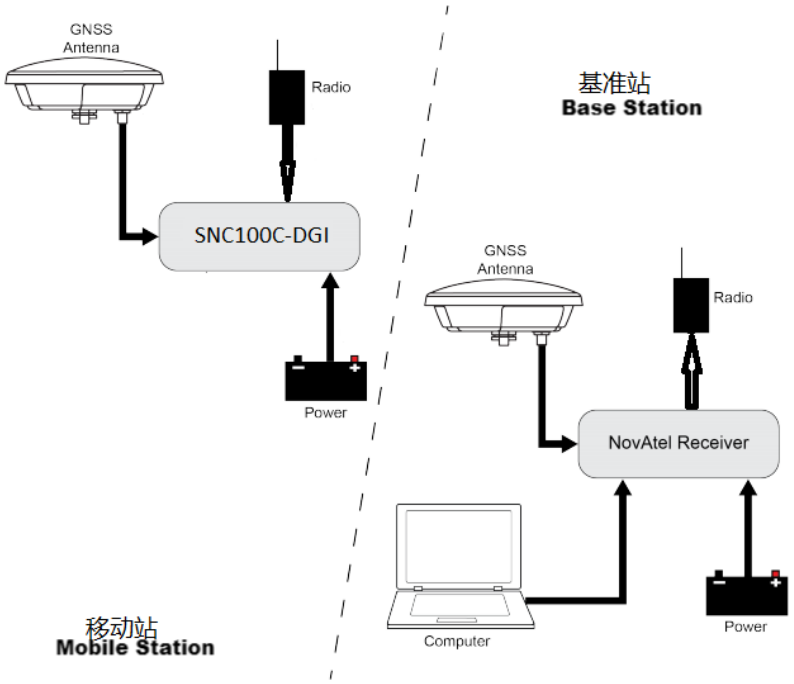


Figure 8 Schematic diagram of data link

1.1 、Reference station setting

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

The reference station can apply NovAtel-718D satellite receiver board and configure it as the reference station mode.

The specific configuration instructions are as follows, and detailed descriptions are provided in the NovAtel-718D user manual.

Table 14 Base Station Configuration Instructions

No. Instruction Description

1 fix position 39.8122 116.1515 60.5 Set known precision coordinates (latitude 39.8122, longitude 116.1515, altitude 60.5) as the base station coordinate value

posave on 0.01 1.5 2.5 Receiver autonomous positioning 0.01h; or when the standard deviation of horizontal positioning <= 1.5m and altitude positioning <= 2.5m, use the average value of positioning as the reference station coordinate value

2 serialconfig com1 9600 Set the output baud rate of the reference station output interface COM1 to 9600bps

3 interfacemode com1 novatel rtcmv3 on Configure COM1 input data type as novatel, output data type as rtcmv3, and enable command feedback

4 log com1 rtcm1075 ontime 1 GPS differential message

5 log com1 rtcm1125 ontime 1 BDS differential message

6 log com1 rtcm1085 ontime 1 GLO differential message

7 log com1 rtcm1033 ontime 10 Receiver and Antenna Description

8 log com1 rtcm1005 ontime 10 RTK base station antenna reference point coordinates

9 saveconfig Save configuration

1.2 、Communication link setting

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

1.3、 Mobile station setting

The combined navigation system is a differential mobile station, which receives the differential correction information from the reference station in real time and receives satellite signals for differential positioning solution to achieve differential high-precision positioning. The combined navigation system supports RTCM and RTCMV3 standard data protocols. COM2 of the combined navigation system can be configured as the receiving interface of differential correction information, and the specific configuration commands are as follows.

Table 15 Mobile station configuration commands.

Serial number	Instruction	Description
1	com com2 X	Based on the differential input data baud rate, set the input baud rate of mobile station input interface COM2 to Xbps
2	saveconfig	Save configuration