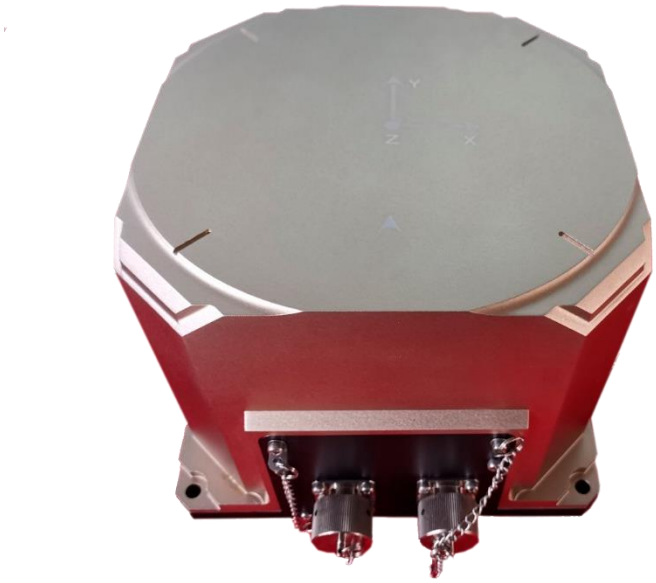
SENSSET
SENSOR SEQUENCE

SSI-NS412

High-precision combined navigation system



PRODUCTS FEATURES

- High-precision additive sampling circuit
- Navigation computer circuit
- GNSS module and power supply circuit, which realizes high-precision positioning and navigation in complex environment
- The product has high reliability and strong environmental adaptability
- Three fiber optic gyroscopes and three quartz accelerometers

1. Product performance indicators

Table 1.Gyroscope characteristics

Parameter	Value	Remarks
Range	-500°/s ~500°/s	
Resolution	≤0.01°/h	
Zero bias instability	-0.02°/h ～+0.02°/h	
Random walk coefficient	≤0.0015°/√h	
Zero bias stability at room temperature	≤0.01°/h（1σ,10s）	10 seconds smoothing, 1h test result
Zero bias stability at full temperature	≤0.015°/h（1σ,10s）	10 seconds smoothing, 1h test result
Zero bias repeatability at room temperature	≤0.01°/h（1σ）	Statistics for 6 tests
Zero bias repeatability at full temperature	≤0.015°/h（1σ）	Full temperature, 2 zero bias data for each of the high and low ambient temperatures
Non-linearity of scale factor	≤5ppm	Full temperature setting
Repeatability of scale factor	≤5ppm（1σ）	Full temperature setting
Gyro start time	≤5s	
Gyro Bandwidth	300Hz	Design assurance, batch testing
Residual mounting errors of the three-axis gyroscope	≤10"	

Table 2.accelerometers characteristics

Parameter	Value	Remarks
Range	-20g ~ 20g	Design Selection Guarantee
Resolution	≤80ug（1σ）	10 seconds smoothing, 1h test results
Zero bias repeatability at full temperature	-≤80ug（1σ）	All temperature, high temperature, low temperature, normal temperature, each take 2 zero bias data
Start-up time	≤5s	
Three axes plus installation error residuals	≤10"	

Table 3. Navigation solving technical characteristics

Parameter	Value	Remarks
Time to find the north	≤5min	The general standard is 3min or 5min
Repeatability of heading angle alignment	≤0.06°/cosL	1σ
Pitch angle alignment repeatability	≤0.005°	1σ
Repeatability of cross-roll angle alignment	≤0.005°	1σ
Way to find the north	Optional	Wobble base alignment, inter-travel GPS-assisted alignment, inter-travel odometer-assisted alignment, and main inertial guidance transfer alignment can be achieved

Table 4. Combined navigation accuracy (satellite valid)

Parameter	Value	Remarks
Accuracy of heading angle measurement	≤0.06°	1σ
Pitch angle measurement accuracy	≤0.02°	1σ
Cross-roll angle measurement accuracy	≤0.02°	1σ
Speed accuracy	≤0.03m/s	
Position accuracy	≤1.5m	Single Point Positioning by Satellite, CEP
Position accuracy	≤1cm+1ppm	Satellite RTK floating point solution, CEP

Table 5. Inertial navigation accuracy (satellite invalid)

Parameter	Value
Heading angle holding accuracy	≤0.06°/h
Pitch angle hold accuracy	≤0.02°/h
Cross roll angle holding accuracy	≤0.02°/h
Odometer combined navigation position positioning accuracy	≤0.2% (mileage greater than 3km)
Odometer combined navigation position positioning accuracy	≤0.3m（50s）

Table 6. GPS/BD performance indicators

Parameter	Value	Remarks
GPS cold start time	≤25s	Typical values
GPS hot start time	≤5s	Typical values
GNSS RTK initialization time	≤5s	Typical values
Receive satellite signal frequency	GPS L1CA/L5	
	BDS B1I/B2a	
	GLONASS L1	
	GALILEO E1/E5a	
	QZSS L1/L5	
Number of channels	198	
Single antenna track angle measurement accuracy	0.3°	Motorized conditions required
Single-point horizontal positioning accuracy	1.5m	RMS
Single point elevation positioning accuracy	3.0m	RMS
RTK floating point solution horizontal positioning accuracy	10mm+1ppm	RMS
RTK floating point solution for elevation positioning accuracy	20mm+1ppm	RMS
Speed accuracy	0.03m/s	RMS
PPS time accuracy	20ns	RMS
GPS data update rate	1Hz、5Hz、10Hz	

Table 7. Environmental adaptability technical indicators

Parameter	Value
Operating temperature	-40°C~70°C
Storage temperature	-45°C~70°C
Vibration Adaptability	20Hz～2000Hz；0.04g2/Hz
Shock	20g, 11ms, ½ sin

Table 8. General test technical indicators

Parameter	Value	Remarks
Dimension	178mm*178mm*134.5mm	Tolerance ±1mm
Installation Size	162mm*162mm (4*Φ6.5)	Tolerance ±0.2mm
Weight	≤6kg	
Supply voltage	9V～36V(DC)	
Steady-state power consumption	≤20W	Motorized conditions required
Peak power consumption	≤40W	RMS
Communication interface form	CAN	500Kbps, external wheel speed information, send navigation information
Communication interface form	RS422	Customizable baud rate and output frequency

2. Electrical interface

The system has 4 external connectors: one is the communication interface, one is the power supply interface, and two are the SMA interfaces for GPS, which are described in detail as follows:

Table 9. Power input interface definition

	Parameter	Number definition	Remarks
1	Input 28V power supply positive	1	+
2	Input 28V power supply negative	2	-
The connectors are shown on page 2			

Table 10. Test interface definition

	Parameter	Number definition	Remarks
1	Interface with user T+	5	Communication with user
2	Interface with user T-	4	
3	Interface with user R+	2	
4	Interface with user R-	1	
5	Self-reserved test interface T+	10	Self-test
6	Self-reserved test interface T-	9	
7	Self-reserved test interface R+	8	
8	Self-reserved test interface R-	7	
The connector model number is: Y50X5-1013Z10K. SMA socket is the female connector.			

3. Communication Interface

For current products, communication protocols can be customized according to customer requirements. The interface protocols currently common to our company are detailed in the table below.

Table 11. General purpose byte protocol

Serial number	Data Definition	Data Type	№ of bytes	Byte Serial Number	Unit	Remarks
1	Frame header	Short	2	0-1	-	0x55, 0xAA (0x55 is the low byte)
2	Frame serial number	Unsigned int	4	2-5	0.01 sec	Add 1 for every 0.01 seconds
3	System Status	Unsigned char	1	6	-	The current state of the inertial navigation system, 0x00 is the power-up ready state, 0x01 is the power-up ready state, 0x02 is the alignment in progress state, 0x03 is the pure inertial navigation state, 0x04 is the GPS combined navigation state state, 0x05 is the odometer combined navigation state
4	System error messages	Unsigned short int	2	7-8	-	Generally 0 is fault and 1 is normal
5	X-Gyro Raw Incremental Information	Float	4	9-12	LSB/°/s	At the initial moment, the raw output of the gyroscope and accelerometer, the initial moment to burn in the initial value of the parameter, does not affect the result of this data, except for changing the polarity.
6	Y-Gyro Raw Incremental Information	Float	4	13-16	LSB/°/s	
7	Z-Gyro Raw Incremental Information	Float	4	17-20	LSB/°/s	
8	X-accel. incremental information	Float	4	21-24	LSB/°/s	
9	Y-accel. incremental information	Float	4	25-28	LSB/°/s	
10	X-accel. incremental information	Float	4	29-32	LSB/°/s	

Table 11. General purpose byte protocol (continued)

Serial number	Data Definition	Data Type	№ of bytes	Byte Serial Number	Unit	Remarks
11	Angular increment information after X-axis compensation	Float	4	33-36	°/s	The specific content is determined according to the format in which the parameters are written. When the warm-up parameters are written, the data is the data after the warm-up; when the tool error compensation is completed it is Wibbx, Wibby, Wibbz, Fibbx, Fibby, Fibbz.
12	Angular increment information after Y-axis compensation	Float	4	37-40	°/s	
13	Angular increment information after Z-axis compensation	Float	4	41-44	°/s	
14	Information on linear speed increments after X-axis compensation	Float	4	45-48	m/s/s	
15	Information on linear speed increments after Y-axis compensation	Float	4	49-52	m/s/s	
16	Information on linear speed increments after Z-axis compensation	Float	4	53-56	m/s/s	
17	Angle of heading	Float	4	57-60	°	
18	Pitch angle	Float	4	61-64	°	The head is raised to the right
19	Roll angle	Float	4	65-68	°	Right tilt is positive

Table 11. General purpose byte protocol (continued)

Serial number	Data Definition	Data Type	№ of bytes	Byte Serial Number	Unit	Remarks
20	Eastward speed	Short int	2	69-70	m/s	1LSB=0.01m/s
21	Northbound speed	Short int	2	71-72	m/s	1LSB=0.01m/s
22	vertical speed	Short int	2	73-74	m/s	1LSB=0.01m/s
23	longitude	int	4	75-78	°	WGS84 coordinate system, East longitude is positive, West longitude is negative, 1LSB=180/(2^{32}-1)+70°
24	latitude	Int	4	79-82	°	WGS84 coordinate system, north is positive, south is negative, 1LSB=90/(2^{32}-1)°
25	Altitude	Float	4	83-86	m	WGS84 coordinate system altitude
26	Satellite (primary inertial guidance) eastward velocity	Short int	2	87-88	m/s	1LSB=0.01m/s
27	Satellite (primary inertial guidance) northward velocity	Short int	2	89-90	m/s	1LSB=0.01m/s
28	Satellite (primary inertial guidance) vertical velocity	Short int	2	91-92	m/s	1LSB=0.01m/s
29	Satellite (primary inertial guidance) longitude	Int	4	93-96	°	WGS84 coordinate system, east longitude is positive, west longitude is negative, 1LSB=180/(2^{32}-1)+70°
30	Satellite (main inertial guidance) latitude	Int	4	97-100	°	WGS84 coordinate system, north is positive, south is negative, 1LSB=90/(2^{32}-1)°
31	Satellite (main inertial guidance) altitude	Float	4	101-104	m	WGS84 coordinate system altitude

Table 11. General purpose byte protocol (continued)

Serial number	Data Definition	Data Type	№ of bytes	Byte Serial Number	Unit	Remarks
32	Gyro Temperature	Short int	2	105-106	°	1LSB=0.01°C
33	Add table temperature	Short int	2	107-108	°	1LSB=0.01°C
34	X gyro (2)	Float	4	109-112	LSB/ °/ s	-
35	Y gyro (2)	Float	4	113-116	LSB/ °/ s	
36	Z gyro (2)	Float	4	117-120	LSB/ °/ s	
37	X accel. (2)	Float	4	121-124	LSB/ °/ s²	
38	Y accel. (2)	Float	4	125-128	LSB/ °/ s²	
39	Z accel. (2)	Float	4	129-132	LSB/ °/ s²	
40	GPS PPS	Unsigned int	1	133-136	-	
41	GPS Quality	Unsigned char	1	137	-	GPS Quality Indicator 0 = Position not available or invalid 1 = Single point position 2 = Pseudo range differential 4 = RTK fixed solution 5 = RTK floating point solution 6 = GNSS/INS combined navigation 7 = User set position (Fixed Position)Displayed as a character
42	Wheel speed - left front	Float	4	138-141	^	Odometer totalization and data
43	Wheel speed- right front	Float	4	142-145	^	Odometer incremental data
44	Wheel speed - left rear	Float	4	146-149	^	Odometer totalization and data
45	Wheel speed - right rear	Float	4	150-153	^	Odometer incremental data

Table 11. General purpose byte protocol (continued)

Serial number	Data Definition	Data Type	№ of bytes	Byte Serial Number	Unit	Remarks
46	Reserved	Float	4	154-157		Default is 0
47	Reserved	Float	4	158-161		Default is 0
48	Reserved	Float	4	162-165		Default is 0
49	Data Checksum	Unsigned char	1	166	-	Sum all the bytes except the frame header, take the lowest byte of the sum, the high bit overflow is not counted

4. System parameters configuration

4.1. Configuration of the installation coordinate system

Currently, the "X, Y, Z" coordinates marked on the product, the default installation direction on the carrier is right front up, which can be changed through configuration instructions. At present, it is configured deterministically by the manufacturer before leaving the factory, and the subsequent open configuration.

4.2. Configuration of the GPS antenna mounting pole arm

Currently, the GPS outer pole arm is carried out by automatic estimation, with subsequent opening of the configuration of the outer pole arm parameters.

4.3. Configuration of carrier and inertial guidance mounting error angle

Currently, the installation error angle is performed by automatic estimation, and the configuration of this parameter is subsequently opened.

4.4. Odometer parameter configuration

Currently, odometer parameters are initially factory determined with the customer in a way that is carried out and estimated in real time, with subsequent opening of the odometer parameter configuration function.

4.5. RTK configuration

If customers need to use RTK positioning information, they must use to purchase a third-party service account and configure the relevant information to receive the wireless signal before they can use it.At present, this information has the manufacturer to configure in advance, and subsequently open its configuration function.

5. Basic Composition

Table 12.

Serial number	Component name	Quantity	Remarks
1	Fiber Optic Gyroscope	3	
2	High precision quartz accelerometer	3	
3	Power conversion circuits	1	
4	Navigation computer circuits	1	
5	High precision additive sampling circuit	1	
6	GPS/BD module	1	
7	External GPS/BD antenna	1	Default line length 2m

6. Principle of operation

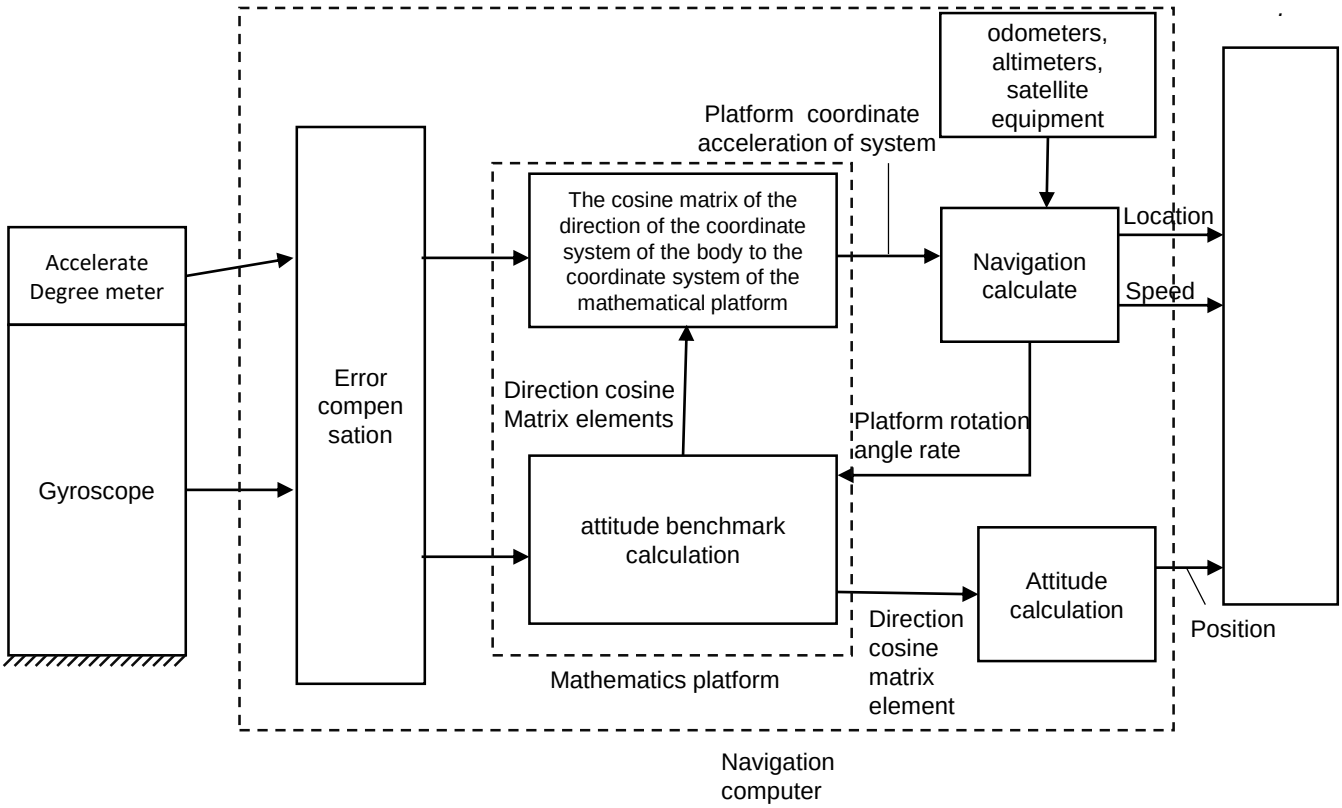


Diagram 6.1.

A inertial navigation system is a system that combines gyroscopes, accelerometers, odometers, and satellite equipment directly mounted on a vehicle. The gyroscopes and accelerometers measure the angular velocity vector and specific force vector, respectively, of the vehicle's coordinate system relative to the inertial coordinate system. The navigation computer is the physical device that performs data acquisition and navigation calculations. It uses the measured angular velocity from the gyroscopes to calculate the attitude matrix. The attitude and heading information of the vehicle are extracted from the elements of the attitude matrix. The accelerometer outputs are transformed from the vehicle coordinate system to the navigation coordinate system using the attitude matrix. Then, navigation information such as velocity, position, etc., is calculated. The externally obtained position and velocity information (provided by odometers, altimeters, satellite equipment) are combined with the navigation information using a Kalman filter for strapdown navigation updates, resulting in more accurate real-time position, velocity, and attitude information.

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