Nav-5.1M

Strapdown Inertial Navigation System

for marine applications

Data sheet

June 2016

1. Introduction

Nav-5.1M is strapdown inertial navigation system based on a modern IMU built on FOG sensors. System includes embedded dual system (GLONASS/GPS) GNSS receiver and barometric altimeter. The navigation system provides continuous determination and output of position coordinates, motion parameters and attitude angles. Per customer choice any multi-system GNSS receiver can be used.

To enhance accuracy characteristics in autonomous inertial mode the system can acquire data from speed log.

2. Technical Characteristics

2.1. System Architecture

Nav-5.1M navigation system consists of:

- Navigation system unit (incorporates an IMU with 3 FOG sensors, 3 quartz accelerometers, barometric altimeter and GNSS receiver)
- GNSS receiver antenna
- Commutation cables

Figure 1. Nav-5.1M navigation system

2.2. Specification

Table 1

Size	224×176×135 mm (8.82” x 6.93” x 5.31”)
Weight	7 kg (15.43 lbs)
Electrical	
Input voltage	9..36 VDC
Power	30 W (max)
Environment and life span	
Operating temperature	-30..+60°C
Storage temperature	-40..+80°C
Vibration (sine)	2g (20..2000 Hz)
Repeated shock	50g (3 ms)
Continuous work time (within life span)	unlimited
Mean time between failures	20 000 h
Service lifetime	10 years
Data output	
Interface	RS-232 (2 ports), RS-422 (2 ports)
Output data rate	100 Hz
Data format	binary
Cold start (including alignment with GNSS)	10 min
Operating ranges	
Angular rate	±150 °/s
Acceleration	±10g
Altitude	up to 20000 m
Pitch	±90°
Roll	±180°
Heading	0..360°
Latitude	±90°
Longitude	±180°

3. Accuracy[1]

Table 2

	INS+GNSS mode	INS + speed log mode
Horizontal coordinates	6 m	0.1% of distance travelled per 1 hour
Ground speed	0.08 m/s	0.3 m/s
Attitude (roll, pitch)		
dynamic accuracy	0.03°	0.015°
Heading	0.08°	0.2° (per 1 hour)
Depth	0.5 m	0.5 m

[1] Accuracy data subject to change without notice. All data is 1 σ

4. Warranty

Warranty period – 12 months after introduction into service. Number of unit runs is not limited.

5. Deployment

Nav-5.1M should be located within the moving vehicle in accordance with the following considerations:

A) The ideal location is close to the center of mass of the vehicle.

B) The unit must be fixed in the way the direction of the pin connector at the side of the unit coincides with the backward direction of the moving vehicle. Sensor axis direction is marked at the top of the navigation system unit. Tolerance of the mounting plate horizontal positioning and longitudinal vehicle axis positioning is ±5°.

C) The GNSS receiver antenna location must provide clear view of the sky.

D) The power cable should not run adjacent to heaters, engine exhausts, or other heat sources. Take care to route and tie the cable away from vehicle controls and cables.

After installation of the cabling and before installation of the equipment, ensure that power is applied only to the pins specified in the interconnection diagram.

6. Transportation and Storage

Transportation is allowed on board at the carrier or separately in the special packing. Packing must ensure system safety and protection from any damages. Transport should be carried out by any means of transport under the following environment conditions: temperature -40..+80°C, humidity under 98%.

Store in a heated space. If conservation is required, contact the manufacturer for conservation details.

7. Interface Protocol

7. 1 Binary Pack Format

The data are transmitted as binary packs. Each pack consists of a header with fixed size, pack body and checksum.

Pack #0 is output with 100 Hz rate. Packs #1-#12 are output between 100Hz packs when GNSS data is available, i.e. 1 Hz rate.

The header is unique for each pack and consists of 16 bits. The checksum is a result of binary XOR operation applied to the all pack content (excluding checksum itself). All data are transmitted as PC x86 processor compatible types: int, float, long (i.e. lower byte comes before higher byte).

Data output protocol subject to change per customer request.

Table 3. ***Pack #0***

<table>
<tr><th>Field number</th><th>Data type</th><th>Description</th></tr>
<tr><td>1</td><td>unsigned short int</td><td>0xFACE – header</td></tr>
<tr><td>2</td><td>short int</td><td>System status flags.
<table>
<tr><th>mask</th><th>“1”</th><th>“0”</th></tr>
<tr><td>0x0001
(1 bit)</td><td>GPSGap – GPS data unusable</td><td>GPSFixPos – GPS data usable</td></tr>
<tr><td>0x0002
(1 bit)</td><td>Motion detection: “Stop”</td><td>Motion detection: “Move”</td></tr>
<tr><td>0x0004
(1 bit)</td><td>RMC_Valid – GPS NMEA RMC message data valid</td><td>RMC_Invalid – GPS NMEA RMC message data valid</td></tr>
<tr><td>0x0030
(2 bits)</td><td colspan="2">GGA quality value
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>0</td><td>Fix not available or invalid</td></tr>
<tr><td>1</td><td>GPS SPS Mode, fix valid</td></tr>
<tr><td>2</td><td>Differential GPS, SPS Mode, fix valid</td></tr>
<tr><td>3</td><td>GPS PPS Mode, fix valid</td></tr>
</table></td></tr>
<tr><td>0x0100
(1 bit)</td><td>Navigation mode:“Nav”</td><td>Alignment mode: Align</td></tr>
<tr><td>0x3000
(2 bits)</td><td colspan="2">GSA CALCMODE – GPS coordinate calculation mode
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>1</td><td>Fix not available</td></tr>
<tr><td>2</td><td>2D</td></tr>
<tr><td>3</td><td>3D</td></tr>
</table></td></tr>
</table></td></tr>
<tr><td>1.</td><td>long int</td><td>Epoch counter</td></tr>
<tr><td>2.</td><td>Longint x16</td><td>Factory use only</td></tr>
<tr><td>3.</td><td>float</td><td>Integrated Heading (deg.) (0 - 360)</td></tr>
<tr><td>4.</td><td>float</td><td>reserved</td></tr>
<tr><td>5.</td><td>float</td><td>reserved</td></tr>
<tr><td>6.</td><td>float</td><td>reserved</td></tr>
<tr><td>7.</td><td>float</td><td>Barometric pressure, Pa</td></tr>
<tr><td>8.</td><td>float</td><td>Pitch (deg.) (from –90 to 90)</td></tr>
<tr><td>9.</td><td>float</td><td>Roll (deg.) (from –180 to 180)</td></tr>
<tr><td>10.</td><td>float</td><td>Track angle (deg) (0-360)</td></tr>
</table>

Field number	Data type	Description
11.	float	reserved
12.	float	Latitude (deg.) = #14 + #15 (integer part)[2]
13.	float	Latitude (deg.) = #14 + #15 (decimal part) [3]
14.	float	Longitude (deg.) = #11 + #12 (integer part)
15.	float	Longitude (deg.) = #11 + #12 (decimal part)
16.	float	Speed (m/sec)
17.	float	Height (m)
18.	float	g-load
19.	float	Vertical velocity (m/sec)
20.	float	Barometric height (m)
21.	long int	Number of epochs in current mode
22.	float	Specific force (m/sec^2) X axis.
23.	float	Specific force (m/sec^2) Y axis.
24.	float	Specific force (m/sec^2) Z axis.
25.	float	Angular Velocity (deg/sec), X axis
26.	float	Angular Velocity (deg/sec), Y axis
27.	float	Angular Velocity (deg/sec), Z axis
28.	float	East Velocity (X) (m/sec)
29.	float	North Velocity (X) (m/sec)
30.	unsigned short int	Check Sum (XOR 16 bit)

Table 4. ***Pack #1***

Field number	Data type	Description
1	unsigned short int	0xA522 –Head
2	float	Latitude (deg.) GGA = #2 + #3
3	float	Latitude (deg.) GGA = #2 + #3
4	float	Longitude (deg.) GGA = #4 + #5
5	float	Longitude (deg.) GGA = #4 + #5
6	float	GGA HDOP
7	float	Height GGA (m)
8	float	GGA UTC time, sec
9	long int	RMC Date
10	unsigned short int	Check Sum (XOR 16 bit)

Table 5. ***Pack #2***

Field number	Data type	Description
1	unsigned short int	0xA522 –Head
2	float	Latitude (deg.) GGA = #2 + #3
3	float	Latitude (deg.) GGA = #2 + #3
4	float	Longitude (deg.) GGA = #4 + #5
5	float	Longitude (deg.) GGA = #4 + #5
6	float	GGA HDOP
7	float	Height GGA (m)
8	float	GGA UTC time, sec
9	long int	RMC Date
10	unsigned short int	Check Sum (XOR 16 bit)

Table 6. ***Pack #3***

Field number	Data type	Description
1	unsigned short int	0xA533 – Head
2	float	RMC UTC time, sec
3	float	RMC mag. declination

[2] The coordinate value is obtained by arithmetic sum of both fields
[3] The coordinate value is obtained by arithmetic sum of both fields

4	short int	Array of satellites ID[12] from GSA
5	unsigned short int	Check Sum (XOR 16 bit)

Table 7. ***Pack #4***

Field number	Data type	Description
1	unsigned short int	0xA544 – Head
2	short int	Satellites count GGA
3	short int	GGA HDIFF;
4	short int	Satellites in view GSV
5	short int	Array of satellites ID[12] from GSV
6	short int	Mode
7	unsigned short int	Check Sum (XOR 16 bit)

Table 8. ***Pack #5***

Field number	Data type	Description
1	unsigned short int	0xA555 – Head
2	short int	Array of satellites elevations ELEV[12] GSV
3	short int	Array z[4], reserved
4	unsigned short int	Check Sum (XOR 16 bit)

Table 9. ***Pack #6***

Field number	Data type	Description
1	unsigned short int	0xA566 – Head
2	short int	Array of satellites azimuths GSV AZIM[12]
3	short int	Array z[4] , reserved
4	unsigned short int	Check Sum (XOR 16 bit)

Table 10. ***Pack #7***

Field number	Data type	Description
1	unsigned short int	0xA577 – Head
2	short int	Array of signal/noise SN[12] GSV
3	short int	Array of z[4] , reserved
4	unsigned short int	Check Sum (XOR 16 bit)

Table 11. ***Pack #8***

Field number	Data type	Description
1	unsigned short int	0xA588 – Head
2	float	RMC UTC time (seconds)
3	float	RMC magnetic declination
4	short int [12]	Array of satellite ID[12] from GSA
5	unsigned short int	Check Sum (XOR 16 bit)

Table 12. ***Pack #9***

Field number	Data type	Description
1	unsigned short int	0xA599 – Head
2	short int	GGA number of satellites
3	short int	GGA HDIFF – the difference between WGS84 ellipsoid height and geoid height
4	short int	Number of GLONASS satellites in view (from GSV message)
5	short int [12]	Array of satellite ID[12] from GSV
6	short int	Unit operation mode: 0 – helicopter (UAV) 1 – factory mode 2 – aviation

7	unsigned short int	Check Sum (XOR 16 bit)

Table 13. ***Pack #10***

Field number	Data type	Description
1	unsigned short int	0xA5AA – Head
2	short int [12]	Array of satellites elevations ELEV[12] (degrees) GSV
3	short int [4]	Array of z[4], reserved
4	unsigned short int	Check Sum (XOR 16 bit)

Table 14. ***Pack #11***

Field number	Data type	Description
1	unsigned short int	0xA5BB – Head
2	short int [12]	Array of satellites azimuth AZIM[12] (degrees) GSV
3	short int [4]	Array of z[4], reserved
4	unsigned short int	Check Sum (XOR 16 bit)

Table 15. ***Pack #12***

Field number	Data type	Description
1	unsigned short int	0xA5CC – Head
2	short int [12]	Array of signal/noise SN[12] GSV
3	short int [4]	Array of z[4], reserved
4	unsigned short int	Check Sum (XOR 16 bit)

Appendix 1. Dimensional Drawing