

- Strapdown Inertial Navigation Systems (SINS) on MEMS and fiber-optic gyroscopes
- Drivers / Motors
- Gyrostabilized platforms with remote control

TASKS:

SOLUTIONS:

- Navigation
- Stabilization
- Orientation

- Land
- Naval
- Aerospace

http://www.gyrolab.ru/en/ - here is more detailed information in English, including characteristics, prices, videos, documentation

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АРРROVED МИКГ.402138.006 РЭ-ЛУ

Inertial Navigation System GL150/2-M

Operating Manual МИКГ.402138.006 РЭ

Introduction

The operating manual is intended to familiarize technical personnel with STRAPDOWN INERTIAL NAVIGATION SYSTEM (SINS).

Technical personnel who have studied the present operating manual $MIK\Gamma.402138.006$ P \exists is admitted to operate the SINS product.

1 Purpose of product

The strapdown inertial navigation system (SINS) is intended for determination and delivery of orientation and navigation parameters with possibility of using data received from GPS/GLONASS satellite navigation systems and odometric sensors for mobile or stationary objects under the following operating conditions:

i) working ambient temperature from plus 55 °C to minus 50 °C,

limit storage temperatures from plus 85 °C to minus 50 °C,

air relative humidity from 5 to 98 %,

atmospheric pressure from 450 to 850 mm Hg,

longitude range $\pm 180^{\circ}$,

latitude range $\pm 70^{\circ}$,

range of angular velocity ± 500 °/s.

range of angular accelerations ± 1000 °/s²,

single limit accelerations to 90g (5 ms).

2 Technical characteristics

The product technical characteristics are listed in Table 1. Table 1

Value
from 18 to 32
5
5
6-00
0.045/cos(φ)
0.03
0.03
0.03
0.25
25
24
10.5

 ϕ – site latitude

3 Product set

The set of SINS product is given in Table 2 Table 2

Product	Product	Q-ty
designatio	name	
n		
БИНС GL150/2-М	МИКГ. 402138.006	1
Shock absorber SES-5A-5		4
Operating manual Passport	МИКГ.402138.006 РЭ МИКГ.402138.006 ПС	1 1

4 Design and functioning

4.1 **Operation principle**

Rigidly mounted in the sensing unit (SU) are three angular velocity sensors (AVS) and three accelerometers with sensitivity axes focused along Ox, Oy, Oz axes of rectangular coordinate system Oxyz associated with SU housing.

Reacting to angular velocities of rotation (ω_x , ω_y , ω_z) and base accelerations (a_x , a_y , a_z) representing vector projections ω_a of absolute angular rotation velocity and apparent acceleration vector Aa over axes Ox, Oy, Oz, these devices deliver signals primary for orientation problem solution.

Three accelerometers as part of the sensing unit form an orthogonal measuring system of object linear accelerations over two horizontal and one vertical channel (X, Y, Z).

Three sensors of angular velocity, constructed as per Sagnac ring interferometer scheme based on fiber-optical loop with servo feedback, form an orthogonal measuring system of object angular velocities.

The way of adding compass properties to SINS product is based on use of sensor indications of angular velocity and linear accelerations with their subsequent processing. The way of North direction determination is given in Figure 2.



Figure 2

Let's introduce geographical axes $0\xi_r$, $0\eta^r$, axes $0\times, 09$ representing projections of object axes to the horizon plane and device axes

0x d, 0y d (device N, device E).

True heading K differs from device K_d by value ΔK_i called heading correction.

$$\mathbf{K} = \mathbf{K}_{d} + \Delta \mathbf{K}_{i},\tag{1}$$

where K_d – heading value determined by device, deg.

Ki-heading correction, deg.

Angular velocity vector components of Earth rotation ${}^{U_{\xi r}}$ and ${}^{U\eta_r}$ s at zero object velocities are determined by formula:

$$U_{\boldsymbol{\xi}\boldsymbol{r}} = U \cdot \cos \boldsymbol{\varphi} \quad ; \quad U \boldsymbol{\eta}_{\boldsymbol{r}} = 0, \tag{2}$$

where U – angular rotation velocity vector of the Earth, deg/s,

 $\phi-object\ latitude,\ deg.$

Then U vector projection to Oy_{π} axis will be equal:

 $Uy_{\pi} = -U \cos \phi \sin \Delta K_i$

It follows that Uy_{π} with known latitude contains information on heading correction ΔK_i .

(3)

– projection of the Earth angular rotation velocity to device axis Oy_{π} measured by sensor of angular velocity.

From the last ratio the heading correction value will be equal:

(4)

Substituting defined value of ΔK_i to formula (1), the calculation algorithm forms a value of "device" heading "converging" to value of true heading.

Possible change of correction sign of the heading (ΔK_{i+1}) is fixed by the algorithm and does not influence the process of "converging" $0x\pi p$ and $0\xi_r$ axes in the calculation algorithm since the sign of the right part in formula (3) will change (see position of $0x'\pi p$, $0y'\pi p$. axes in figure 2).

For correction of system indications on heading, roll and trim angles during the object movement, the on-board computer can accept signals on latitude φ and longitude λ , velocity V, altitude h from the satellite navigation system and on distance traveled S from the wheel sensor mounted on the object.

The system delivers to the consumer the value of orientation angles ψ , γ , θ in analog form and in digital form as per coordinated protocol.

4.2 Design

The SINS system is built in a housing made of aluminum alloy and protected from moisture. The housing of SINS unit accommodates sensitive elements with necessary service electronics. The unit structure has four openings for fastening to object and two openings for fixing exact position of SINS sensitivity axes relative to object by means of pins.

The unit appearance is given in Figure 3

5 Marking

Each product unit should have the following marking:

- unit designation;

- number assigned to the unit in manufacturing.

Marking of the unit is made on the factory sign attached to the unit housing.

6 Use of product

6.1 Safety precautions

Technical personnel who have studied its operating instructions as per operating manual МИКГ.402138.006 РЭ is admitted to operate the product.

6.2 Orientation, preparation for operation, visual inspection of product, list of possible malfunctions

Device position installed on the basis at zero indications of scales is considered as initial. The system of axes associated with device housing is given in Figure 3.



Figure 3

At initial device position (zero heading, roll and pitch angles): X axis of device is directed to the North parallel to meridian, Y axis of the device is perpendicular to the horizon plane and is directed upwards. Z axis – supplements X, Y axes to the right coordinate system.

Locate the SINS unit inside the object on the platform parallel to the measuring device "seat" plane of the object.

Install the measuring device on the mounting platform using pins (if provided), at the same time the axis of azimuth reference mark should be parallel to the object longitudinal geometrical axis (passing through the line of pins) and directed forward (in the main direction of object movement). Fix SINS on the object.

Prepare product for operation in a sequence given below.

Check fastening, appearance of product, condition of product units coatings, lack of cracks and damages in the housing.

Connect PC to SINS.

6.2.1 Operability check-up

6.2.1.1 Product turn-on

Turn on PC and start VerticalGyro program.

Apply power to the device *Attention: The pause from the previous turn-on should be at least 5 min.*

On the monitor screen within five seconds look for data appearance in window in the VerticalGyro program, see Figure 4.

The device should deliver and receive information according to the document "Protocol of SINS data exchange. Main channel".

Ø Vertical Gyro		
<u>C</u> onfig <u>R</u> S-232 C <u>a</u> pture	GParameters Output Wind	dows <u>H</u> elp
🗅 🚅 🔚 📝 💉 🖿	8 🖌 📄 🛤 📄	
GParameters Configurator	Visual Controls Text Mess	sages Debug
Latitude, rad*e-8	Longitude, rad*e-8	Unused:
101211530	98076275	
Roll, degree 0.0780175253748894	Pitch, degree -0.129392325878143	Course, degree 75.7217330932617
Unused	Unused	Inused
0	0	0
Unused:	Unused:	Unused:
0	0	0
DS-232 Dy(2104 D)	vError:0	
Check recieve packets C	XC XC	

Figure 4

The state of the product according to Figure 5 is represented in NavyData window:

I	鵈 <navydata> 📃 🗖 🔀</navydata>									
ſ	GPara	meters Table					,			
	N۵	Name	Current Value	Unit	Save	Show	Outpul			
	1	State	110 1100	-	-	-	-			
	2	Ах	-0.00030419591348	g	-	-	-			
	3	Ay	1.00017976760864	g	-	-	-			
	4	Az	0.00073783478001	g	-	-	-			
	5	Wx	-0.00110490340739	degree/s	-	-	-			
	6	Wy	0.00434738304466	degree/s	-	-	-			
	7	₩z	-0.00360115617513	degree/s	-	-	-			
	8	Roll	-0.05675680562853	degree	-	-	-			
	9	Course	161.926910400391	degree	-	-	-			
	10	Pitch	-0.02836539782583	degree	-	-	-			
	11	Latitude	101229092	rad*e-8	-	-	-			
	12	Longitude	98157332	rad*e-8	-	-	-			
	13	Height	178.027053833008	m	-	-	-			
	< 1	1					>			
5		<i>v</i>								
	Show current values in table from capture file									

Figure 5

- Valid values of roll and pitch angles are displayed in Roll, Pitch lines, right after power on.
- Device status is displayed in the State line according to Table 3.

State word	
Bit 0	INS malfunction:
	1 – INS is faulty; 0 – INS is operable
Bit 1	SNS malfunction:
	1 – SNS is faulty; 0 – SNS is operable
Bit 2	Malfunction of magnetic compass (MC):
	1 - MC is faulty; $0 - MC$ is operable
Bit 3	Malfunction of barometric altimeter (BA):
	1 – BA is faulty; 0 – BA is operable
Bit 4	Sign of reliable navigation data of SNS:
	1 - data are reliable; $0 - data$ are not reliable
Bit 5	Sign of reliable data from the air velocity sensor (AVS):
	1 - AVS is faulty; $0 - AVS$ is operable
Bit 6	Sign – object movement:
	1 - fixed base; $0 - $ movement
Bit 7	Correction of coordinates by Fixed Base sign – drift correction:
	1 – correction performed; 0 – correction not performed
Bit 8	Correction of coordinates according to data from SNS:
	1 – correction performed; 0 – correction not performed
Bit 9	Alignment by known latitude:
	1 – performed; 0 – not performed
Bit 10	Correction on the known heading and latitude:
	1 – performed; 0 – not performed
Bit 11	Reserve
Bit 12	Reserve
Bit 13	Double gyrocompassing:
	1 – performed; 0 – not performed
Bit 14	Repeated setting for double gyrocompassing:
	1 - expected; $0 - $ not expected
Bit 15	Readiness of INS:
	1 – ready; 0 – not ready
Bit 16	Reserve
Bit 17	Accelerometer Correction mode
	1 – performed; 0 – not performed
Bit 18	Odometer Correction mode
	1 – performed; 0 – not performed
Bits 19–31	Reserve

Table 3

Within several seconds check data availability from the device and absence of SINS Malfunction bit.

Identifier	Pack name	Output frequency, Hz
112	Navigation and orientation data pack	25
51	SNS data pack	1
52	Pack of estimates	1
53	Wheel sensor parameter pack	1
112	Additional data pack	1
164	Pack of temporary parameters	1
	(setting time)	

6.2.1.2 List of delivered data via the main exchange channel from the start-up

6.2.1.3 List of possible malfunctions

The list of possible malfunctions arising during preparation for operation, their cause and remedies are given in Table 4.

Table 4

Malfunction	Cause	Remedies
No signals from the device	No supply voltage ±27	Check availability of
	V on the input connector	device supply voltage
	of the signal processing	±27 V
	unit	
No link with PC	The cable is not connected to	Check SINS
	PC	connection with PC
Odd value of device state is	Bit 0 sign set – sign of	Check SINS connections.
displayed in the State line	device malfunction	Restart the device. If the
		malfunction sign is still
		present – the device
		should be send to the
		manufacturer for repair

After product operability check-up according to item 6.2.1 of the present manual with positive check-up results the device is ready for operation.

6.3 Main modes of SINS

The product has three main modes:

- Standby;

- Fast Aligment;
- -Navigation.

After power is on, the SINS performs loading, self-test and initialization of devices. Functioning in this state continues at most 5 s. In the absence of errors during self-test, SINS switches over to Standby mode.

6.3.1 Standby mode

In this mode, SINS has the following cyclogram:

- 0–10 s: rough horizontalizing.

- 10–N s: rough alignment of heading angle.

SINS automatically starts Accelerated Setting No. 1 on coordinates from SNS in N seconds. Parameter N is set by user coefficient No. 1 USER_START_UP_TIME. If reliable coordinates from SNS are absent, the SINS is set on the saved coordinates.

6.3.2 Fast Alignment mode

The user can independently start Fast Alignment by known Latitude if the device is in Standby or Navigation modes (see para "3.3.2 Data input for management of operating modes 45 h" of the data exchange protocol).

For starting setting by means of technological panel: In Configurator tab enter actual values of latitude, longitude, altitude and command code, see Fig. 6.

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Config RS-232 Capture GParameters Output Windows Help										
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GParameters Configurator Visual Controls Text Messages Debug										
Header Code(HEX): 45 Data Length: 20										
GCommand: Nº Parameter Value Default Value Unit Format										
	1	Latitude	98301041	101229096	rad*e-8	Int32s				
Packet request EnterOroData	2	Longitude	76802234	98157317	rad*e-8	Int32s				
OutUserCoef	3	Height	15000000	0	m	Int32s				
WriteUserCoefToFlash	4	Head	0	0	degree*e-5	Int32s				
WriteOdoCoefToFlash	5	Command code	4	4	-	Int32s				
SetSensorDisplacment GPS_off DPP_off DPP_on InertDPP_Off InertDPP_On GPS_Antenna_Displ INSOutRotateAngles INSOutRotateAngles1 INSOutRotateAngles1										
RS-232 Rx:1816	R×Error:0	Tx:0								
Check recieve packets	CRC					Close				

Figure 6

On the panel it is necessary to enter values of latitude and longitude set in radians – as integers, for this purpose the initial fractional value is multiplied by 100,000,000, the received value of latitude is entered in the Latitude line, the received value of longitude is entered in the Longitude line. Enter integer value of altitude, for this purpose reference fractional value is multiplied by 100,000.

When setting with assigned heading, enter integer value of heading, for this purpose reference fractional value is multiplied by 100,000.

After input of coordinates, press the Send button to start independent fast setting of the product. Device switching over to Setting on latitude mode is checked, at the same time:

- in the status the Setting on latitude bit (bit No. 9) or Correction on known heading and latitude bit (bit No.10) should be set to 1;

- at the end of setting, the system will automatically clear bit No. 9 (or bit No.10) and will set Readiness of product bit (bit No. 15).

The system has several types of Fast Setting. The type of setting is assigned by means of command code (the fifth parameter):

No.	Name	Command code	Requirements to immobility	Refined parameters	Duration, s	Accepted parameters
1	Alignment by known coordinates	2, 4	swinging base is allowed	Heading, roll, pitch	350	 2 – coordinates are accepted from SNS, at their absence the device coordinates are not changed 4 – coordinates are accepted from the operator
2	Alignment by known coordinates and heading	3, 5	fixed base is required	Heading	2	 3 – coordinates are accepted from SNS, at their absence the device coordinates are not changed 5 – coordinates are accepted from the operator
3	Alignment by known coordinates	8	fixed base is required	Heading, roll, pitch	350	8 – coordinates are accepted from the operator. Double gyrocompassing condition is possible
4	Alignment by known coordinates with turns	17,18	swinging base is allowed	Heading, roll, pitch, tension of acceleromet ers, angular velocity sensor (AVS) drifts	350	18 – coordinates are accepted from SNS, at their absence the device coordinates are not changed 17– coordinates are accepted from the operator

6.3.2.1 Alignment No. 1 by known coordinates

Purpose: determination of heading angle with accuracy set as per specification on swinging base. The setting is started automatically at power on after termination of Standby mode.

6.3.2.2 Alignment No. 2 by known coordinates heading

Purpose: obtaining product readiness within 2 seconds.

6.3.2.3 Alignment No. 3 by known coordinates on fixed base, Double gyrocompassing condition is possible

Setting purpose: to exclude influence of accelerometer errors on its accuracy.

Double gyrocompassing:

Purpose: Refining heading angle and AVS drifts.

For Double gyrocompassing the user should perform the following operations:

a) Execute Fast Setting No.3 mode with command code 8. When performing this mode, the Expectation of repeated setting for Double gyrocompassing flag is set in the status (bit 14), the bit will automatically cleared after 180 s after the end of setting. At the end of setting the product sets Full readiness bit (bit 15).

b) Within three minutes, turn the product on heading angle from 70° to 180° . It is recommended to turn the device by maximum possible angle, i. e. ~180°.

c) Execute Fast Setting No.3 mode with command code 8. At the same time, Double gyrocompassing bit will be set in the status (bit 13). At the end of setting, the product:

- will correct the heading angle and angular velocity sensor drifts, using data of two performed settings,

- will clear Double gyrocompassing bit 13.

Note: The Double gyrocompassing mode requires fixed base.

6.3.2.4 Alignment No. 4 by known coordinates with base turns.

Purpose: Refining heading angle and AVS drifts.

For this setting the following cyclogram is desirable:

- set product on (the necessary heading angle of + γ deg),
- start setting, code = 18,
- wait for 170–180 seconds. Turn the product on the necessary heading angle,
- wait for device readiness.

where γ – turn on heading angle. It is recommended to turn the device to maximum possible angle, i. e. ~180°.

During setting it is allowed to perform more number of turns.

6.3.2.5 Canceling execution of Fast Alignment mode

To cancel alignment being executed, the user should send Data input for management of operating modes 45 h command to the device. The command code should be 50. After setting canceling, the device will be set with the heading:

a) equal to heading prior to gyrocompassing start, if from the moment of device turn-on the setting was completed;

b) equal to heading at the time of cancellation, if the alignment is made for the first time from the moment of device turn-on.

6.3.3 Navigation mode

After Fast Alignment mode termination, the SINS automatically switch over to Navigation mode, at the same time the Readiness of product bit appears in the status.

Duration of the mode is unlimited.

In this mode the system can refine parameters during data acquisition from SNS or odometric sensor.

Correction from odometric sensor is activated, if user coefficient No. 35 of "USE_DPP_IF_MORE100" is more than 100.

Correction from SNS is activated, if user coefficient No. 21 "GPS_CORRECTION_OFF_IF_MORE100" is less than 100.

6.4 Connection of odometric sensor

It is allowed to connect odometric sensor with amplitude of output signal from 9 to 24 V.

The conversion factor (MC) is set equal 0.1 m by default for each change of odometric sensor output signal status (on rising or falling edge).

The SINS will automatically perform SU adjustment in vehicle construction axes and odometric sensor MC, but previously it is recommended to set initial values:

- MC with accuracy of 30 %.

SU setting angles (Psi, Tetta) with accuracy of ± 5 degrees.

When making adjustments, SNS connection is not obligatory.

6.4.1 Versions of odometric sensor possible connections

Version 1: Frequency equivalent to motion speed arrives by "ODO_PHASE1" signal.

Discrete signal of back motion arrives by "ODO_PHASE2" signal. Frame ground means back motion. Open circuited signal means forward motion. For setting the mode, the user coefficient "DIRECTION_FOR_WHEEL_SENSOR" (No. 7) should be equal to 0.

Version 2: Frequency equivalent to motion speed arrives by "ODO_PHASE1" and "ODO_PHASE1" signals. Signals should be shifted relative to each other in phase for accounting the motion direction.

For setting the mode, the coefficient "DIRECTION_FOR_WHEEL_SENSOR" should be equal to 150.

Version 3: Frequency equivalent to motion speed arrives by "ODO_PHASE1", "ODO_PHASE1", "ODO_PHASE1", "ODO_PHASE1" signals. Signals should be shifted relative to each other in phase for accounting the motion direction.

For setting the mode, the coefficient "DIRECTION_FOR_WHEEL_SENSOR" should be equal to 250.

6.4.2 Automatic adjustment of SU in vehicle construction axes and odometric sensor MC

The SINS performs automatic adjustment of SU setting angles relative to vehicle construction axes and odometric sensor MC during vehicle movement.

The SINS displays current coefficients in the "Parameters of wheel sensor 35 h (53)" pack in fields:

No. 6 SF,

No. 7 Adj.angle Psi,

No. 8 Adj.angle Tetta.

For refining adjustment parameters, movement of vehicle within 8–10 minutes is sufficient. For checking calculated parameters, it is required to execute Fast Setting mode and to repeat movement. If during repeated movement:

amplitude of Psi and Tetta angle variations is less than 0.05 deg and,

- SFamplitude of variations is less than 0.1 %,

it is necessary to set user coefficient No.28 "ODO_UST_READY_IF_MORE1" equal more than 1.

6.4.3 Manual adjustment of SU in vehicle construction axes and odometric sensor MC Requirements to adjustment:

- distance of adjustment section, at least 50 m,
- variation of heading angle during adjustment, at most 5 deg,
- variation of pitch angle during adjustment, at most 3 deg,
- adjustment time, at most 180 seconds.

Sequence of adjustment procedures:

- Place the vehicle at the beginning of adjustment section;
- using panel, enter Initial Setting command with code 10, see Figure 7.

In State parameter, bit 18 "Correction of the Odometer mode" should be set to 1;

- right after setting bit 18, begin rectilinear movement to the end of section;
- upon termination of movement, repeatedly issue Initial Setting command with code 10;

- the SINS will automatically calculate coefficients and will issue them in "Parameters of wheel sensor 35 h (53)" pack in fields:

Calculated angle Psi, grad,

Calculated angle Tetta, grad,

Calculated scale factor of odometer m/imp.;

- if necessary, procedure is repeated for determination of root-mean-square difference of coefficients and their average values;

- enter calculated coefficients by means of the panel, Configurator tab, OdometerCoef command, press the Send key, see Figure 8;

- Select WriteOdoCoefToFlash command in Configurator tab, press the Send key.

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Config RS-232 Capture GParameters Output Windows Help									
D 🚅 🖶 📝 💉 🕍 🔳 🔳 🏥									
GParameters Configurator Visual Controls Text Messages Debug									
Header Code(HEX): 45 Data Length: 20									
GCommand: Nº Parameter Value Default Value Unit Format									
	1	Latitude	98301041	101229096	rad*e-8	Int32s			
Packet request EnterOrgData	2	Longitude	76802234	98157317	rad*e-8	Int32s			
OutUserCoef	3	Height	15000000	0	m	Int32s			
WriteUserCoefToFlash	4	Head	0	0	degree*e-5	Int32s			
WriteOdoCoefToFlash	5	Command code	10	4	-	Int32s			
SetSensorDisplacment GPS_off DPP_off DPP_off InertDPP_Off InertDPP_On GPS_Antenna_Displ INSOutRotateAngles INSOutRotateAngles INSOutRotateAngles SetUserCoefParameter									
RS-232 Rx:3057	RxError:0	Tx:0							
Check recieve packets	Check recieve packets CRC								

Figure 7

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Config <u>R</u> S-232 Capture	<u>C</u> onfig <u>R</u> S-232 Capture <u>G</u> Parameters <u>O</u> utput Windows <u>H</u> elp								
GParameters Configurator Visual Controls Text Messages Debug									
Header Code(HEX): 53	Header Code(HEX): 53 Data Length: 36 Set Default								
GCommand:	N≗	Parameter	Value	Default Value	Unit	Format			
	1	SF	0,1	0,1	м/imp	Fp32			
Packet request EnterOrgData	2	Adj.angle Psi	0	0	degree	Fp32			
OutUserCoef	3	Adj.angle Tetta	0	0	degree	Fp32			
WriteUserCoefToFlash OdometerCoef	4	Adj.angle Gamma	0	0	degree	Fp32			
WriteOdoCoefToFlash	5	Reserve	0	0	•	Fp32			
SetSensorDisplacment	6	Reserve	0	0	-	Fp32			
GPS_on	7	Reserve	0	0	•	Fp32			
DPP_off	8	Reserve	0	0	-	Fp32			
InertDPP_Off	9	Reserve	0	0	•	Fp32			
InertDPP_On GPS_Antenna_Displ INSOutRotateAngles INSOutRotateAngles1 INSAxisRotateAngles SetUserCoefParameter									
RS-232 Rx:3981 F	R5-232 Rx:3981 RxError:0 Tx:0								
Check recieve packets	CRC					Close			

Figure 8

6.5 Connection of SNS

6.5.1 Checking SNS connection

- Built circuit according to electric circuit diagram МИКГ.402138.006 Э5.
- Apply power to the device.

- Select GPS Data group in parameters tab, check the Time parameter in the GPS Data window appeared. The SNS is connected if the Time parameter variates per second, see Figure 9.

Unidirectional serial interface RS-422 is used as data transmission line. The following COMport settings are necessary for operation:

- one starting bit;

- 8 data bits
- one stop bit;
- parity check is not made;
- data flow control is absent.

By default, transfer rate makes 115,200 bit/s.

Additionally, PPS signal with amplitude from 3 to 44 V, duration from 2 to 10 ms, should be connected. (SINS from SNS uses NMEA packs: RMC, GSA, GGA).

SINS considers information from SNS to be reliable under condition:

HDOP \leq 3.5 in 2D coordinates

VDOP \leq 4 in 3D coordinates

Note: RMC, GSA, GGA packs should be transferred in no more than 0.6 s after PPS impulse.

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		N9	Name	Current Value	Unit	Save	Show	Output Wind
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Saving) averaging time (mSec): 0 😭	3	Ve_GPS	0	m/c	2	32 	121
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_	NavyData	6	Vground	0	m/c	10	(i)	14 4 88
2	GPS Data	7	HeadAngle	0	degree	-26	3 2	1121
3	Est_Data	8	Height	0	m	-	12 I.	12522
4	AddDataPacket_114	9	HDOP	100		*	(F)	-
5	WheelStructData_53	10	VDOP	100	2	36	(4 I)	1243
6	UserCoef	11	Time	0	sec	2	32 	(1 <u>1</u> 1)
7	PrimaryData_BHE_VOG	12	Quality	0	-	5	12 I)	12.22
8	ErrorPackets	13	RMS_Flag	0		*	(#	(* 3)
9	GPSErrorPacket	14	GGA_Flag	0	¥	16	a 1	11486 (Jack
10	HeadControl	15	GSA_Flag	0	2	25	3 2	121
11	GC info	16	Reserved1	0	-	-	10 I	1.54
12	CalibBHEData	17	Reserved2	0	. 	×	(#	(* 2)
13	DiscreteSignals(166)	18	Reserved3	0	Ψ	14	ii (6468
14	FlyingData(167)	< 1	11.]					>
RS-232	Rx:4387 RxError:0 Tx:0		Show current valu	es in table from cap	oture file			[] ⊆lose

Figure 9

6.5.2 Installation of SNS antenna

After antenna installation it is necessary to enter its location coordinates relative to SU center. Coordinates are defined in axes associated with SINS. Figure 10 shows an example of antenna arrangement. For arrangement specified, the following coordinates should be entered: X = +2 m, Y = +3 m, Z = +1 m. These correspond to user coefficients "X_ANTENNA_DISPL" (No. 2), "Y_ANTENNA_DISPL" (No. 3), "Z_ANTENNA_DISPL" (No. 4).



For recording coordinates, in Configurator tab select GPS_Antenna_Displ command, set corresponding values in 1, 2, 3 lines and press Send key (see "3.3.11 SNS antenna displacement pack relative to SU 75 h center" for data exchange protocol). Use WriteUserCoefToFlash command for saving the entered data in FLASH.

6.6 Change of SINS measuring axes orientation.

The user can set orientation of SINS measuring axes by turning on heading, pitch and roll angles. These correspond to user coefficients "AXIS_HEAD_ADJ" (No. 25), "AXIS_PITCH_ADJ" (No. 27), "AXIS_ROLL_ADJ" (No. 26).

For recording angles in the Configurator tab select "INSAxisRotateAngles", set corresponding values in 1, 2, 3 lines and press the Send key

Use WriteUserCoefToFlash command for saving the entered data in FLASH.

The product will apply the entered coefficients only after power restart.

6.7 Reduction of SINS measurements to object construction axes

For reduction of SINS measurements to object construction axes, the user can enter two turns with specified sequence:

1) on heading, pitch and roll angles. These correspond the user coefficients:

"HEAD_ADJ" (No. 13), "PITCH_ADJ" (No. 14), "ROLL_ADJ" (No. 15);

2) on heading, pitch and roll angles. These correspond the user coefficients:

"HEAD_ADJ1" (No. 12), "PITCH_ADJ1" (No. 31), "ROLL_ADJ" (No. 24).

Turns are applied to product output parameters for correction of:

heading, roll, and pitch angles,

- overloads on SINS measuring axes Ax, Ay, Az,

angular velocities on SINS measuring axes Wx, Wy, WAz,

transferred in "3.2.1 Navigation and orientation data pack 70 h" (of data exchange protocol).

- directional angle transferred in "3.2.3 Pack of additional data 72 h".

For transfer of angles to the product, in the Configurator tab select command:

INSOutRotateAngles for input of the first turn,

INSOutRotateAngles1 for input of the second turn.

Set corresponding values in 1, 2, 3 lines and press the Send key Use WriteUserCoefToFlash command for saving the entered data in FLASH.

6.8 Maintenance

The product is examined on absence of damages in housing and connectors, fastenings and appearance are checked. The product is wiped in the presence of dust.

7 Storage and packing

The product is packed and stored in container protecting it from shocks, pollution and corrosion.

The product orientation at storage is not regulated.

Storage conditions 4.1 as per GOST V 9.003 within three years.

Storage temperature from +40 $^{\circ}$ C to +5 $^{\circ}$ C.

8 Transportation

The product is transported by motor transport with any reloads, and also by air, railway and water.

Appendix 1 Description of main user coefficients

Coefficient No. 1 "USER_START_UP_TIME": Time of Fast setting on latitude automatic start-up after SINS turn-on, (s);

Coefficient No. 2 "X_ANTENNA_DISPL": SNS antenna displacement relative to SINS center along longitudinal axis, (m);

Coefficient No. 3 "Y_ANTENNA_DISPL": SNS antenna displacement relative to SINS center along vertical axis, (m);

Coefficient No. 4 "Z_ANTENNA_DISPL": SNS antenna displacement relative to SINS center along transverse axis, (m);

Coefficient No. 13 "HEAD_ADJ": Heading adjustment correction. Makes turn No.1 of SINS device axes on heading, (deg.);

Coefficient No. 14 "ROLL_ADJ": Roll adjustment correction. Makes turn No.1 of SINS device axes on roll, (deg.);

Coefficient No. 15 "PITCH_ADJ": Pitch adjustment correction. Makes turn No.1 of SINS device axes on pitch, (deg.);

Coefficient No. 12 "HEAD_ADJ1": Heading adjustment correction. Makes turn No.2 of SINS device axes on heading, (deg.);

Coefficient No. 24 "ROLL_ADJ1": Roll adjustment correction. Makes turn No.2 of SINS device axes on roll, (deg.);

Coefficient No. 31 "PITCH_ADJ1": Pitch adjustment correction. Makes turn No.2 of SINS device axes on pitch, (deg.);

Coefficient No. 21 "GPS_CORRECTION_OFF_IF_MORE100": If coefficient value exceeds 100, the system disconnects correction from SNS (n/d);

Coefficient No. 23 "GPS_FAULT_DETECTOR": Threshold of abnormal measurements determination from SNS, (m).

Coefficient No. 35 "USE_DPP_IF_MORE100": If coefficient value exceeds 100, the system enables correction from odometric sensor (n/d);

Note 1. Check current user coefficients in the UserCoef table (Parameters tab, VerticalGyro panel)
 2. For recording user coefficients into the product, use OutUserCoef command (Configurator tab) for revision of all coefficients or ChangeUserCoefPar command for revision of one parameter.
 3. For saving user coefficients in FLASH use WriteUserCoefToFlash command.

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