Product introduction:

Low-cost integrated navigation system BS-AU53-M-D6EC product is a measurement device with high cost performance based on MEMS technology and satellite navigation technology. It is widely used in navigation, control and dynamic measurement. The system ensures the measurement accuracy through a number of compensation technologies.And a strict production proces is adopted to ensure that that angular motion and linear motion parameter of the carrier can still be accurately measured under a severe environment.

Product features:

。 Wide range of application. With GPS/BD2 dual-mode satellite navigation system and high tracking sensitivity, it is not only suitable for positioning and navigation in open areas, but also suitable for complex environments such as streets and jungles.

。 Strong adaptability. Silicon micro MEMS device, strong vibration and impact resistance, working at full temperature of -40 ℃ ~ + 60 ℃.

The performance index is excellent. The integrated navigation system has a horizontal attitude of 0.3 (RMS), a position better than 5 m (RMS), and a velocity better than 0.15 m/s (RMS). It is small and light.

。 Good user experience. Support RS-422 and RS-232 multi-channel serial ports, support adjustable output bandwidth, support adjustable output protocol, support online uploading of programs/parameters, and support 9 V ~ 40 V wide voltage supply.

Field of application:



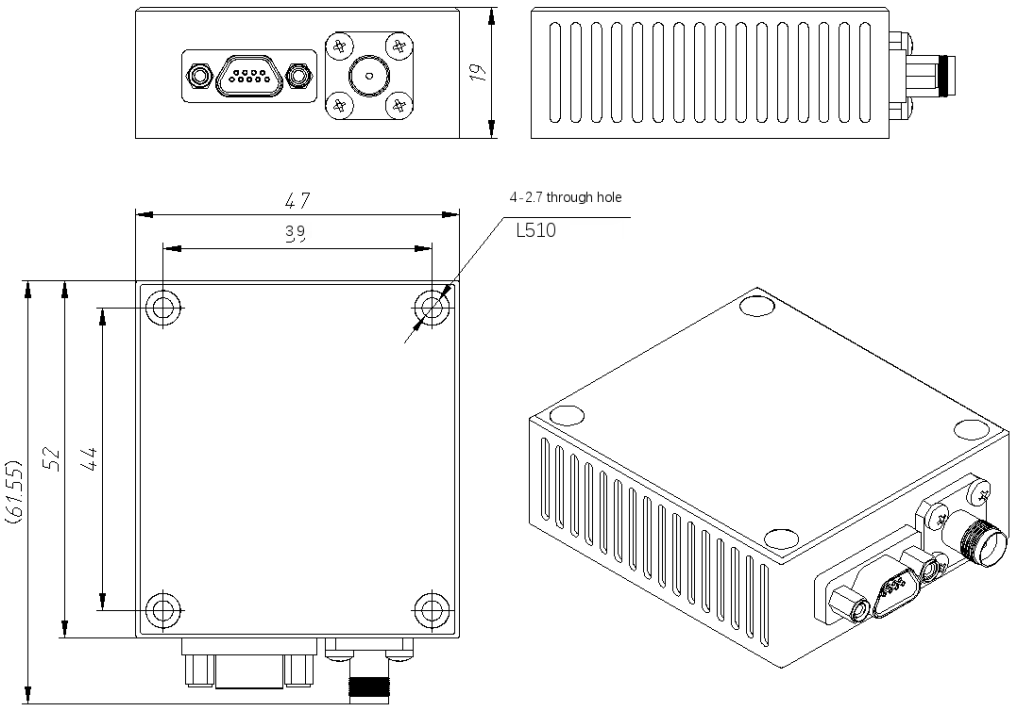

Performance indicators

Performance index of integrated navigation (nominal value)	
Heading accuracy (magnetic)	1°(rms)
Course accuracy (L1/B1 single point)	0.5°(rms)
Attitude accuracy	0.5°(rms)
Peg-top	
Range	± 300 (/s (customizable)
Zero bias stability	10 (/H (normal temperature, Allan variance)
Non-linearity	0.05%
Bandwidth	50Hz~200Hz
Accelerometer	
Range	±2-±20g
Zero bias stability	≤5mg
Zero bias stability	≤5mg
Non-linearity	0.05%

Space-based domain	Unmanned aerial vehicle	Aerial photography	Agricultural plant protection	Photoelectric detection is stable
Land-based domain	Car navigation	Vehicle-mounted satellite communication	Forest and land monitoring	Track inspection of high-speed railway
Sea-based field	Hydrographic survey	Channel detection	Shipborne positioning communication	Unmanned surface vehicle

Electrical/mechanical interface	
Power source	9-36V
Power	<1W
Start time	3s
Communication interface	RS-422/RS-232/TTL/CAN
Update rate	100Hz ~ 400Hz (IMU), attitude 100Hz
Installation dimension (housing)	47mm×61.5mm×19mm
Weight, G	<100g
Use environment	
Working temperature -40 ℃ ~ 70 ℃	
Vibration	6.06g(rms)
Impact	9g/11ms; 1000g/1ms
Attitude accuracy	0.3°(rms)

Installation dimensions



Installation method:

一、Coordinate system definition

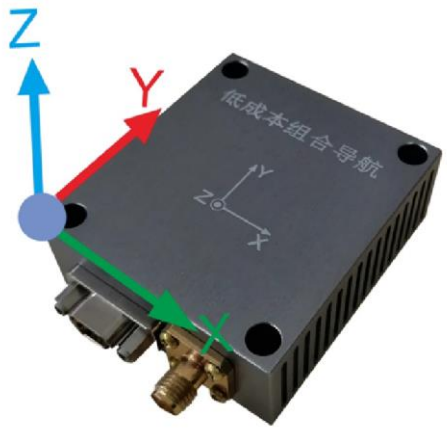


Figure 1. The coordinate system of the sensor

二、Installation position

- Use the product to measure the three-dimensional movement of the carrier. The installation position should be close to the "center" of the carrier. The installation surface should be parallel to the ground when the carrier is stationary. At the same time, ensure that the "Y arrow direction" on the housing is consistent with the "direction when the carrier moves straight ahead". After the installation is completed, it is best not to change the installation during use.

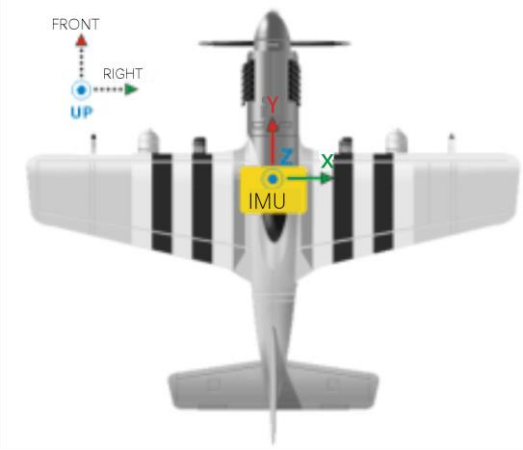


Figure 2. Installation diagram of integrated navigation on air-based carrier

- The product contains a three-axis magnetic sensor, which is used to measure the strength of the surrounding magnetic field and provide heading information when the object is stationary and no GPS satellite is found. If the user needs heading information in this environment, the product should be fully exposed to the earth's magnetic field as far as possible, while being relatively isolated from the interference magnetic field.The best method is to install the product outside any steel container (such as a vehicle) and as far away from the influence of the magnetic field as possible, and to carry out magnetic field calibration to compensate for the surrounding magnetic field interference.

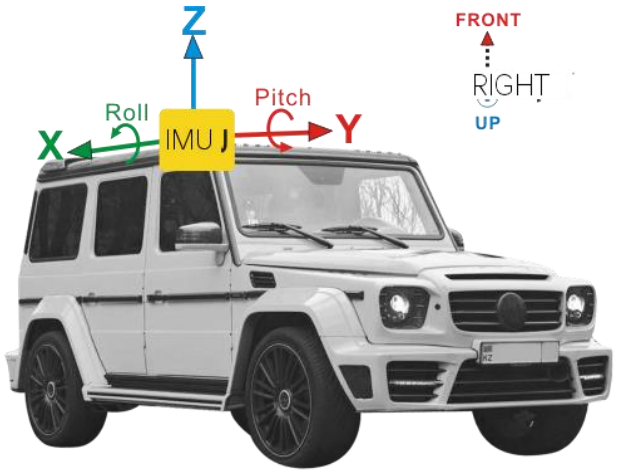


Figure 3. Schematic Diagram of Installation of Integrated Navigation on Subgrade Carrier

- During installation, the fixing method of integrated navigation and antenna is shown in the figure below. The antenna shall be installed right above the navigation or fixed in front of the navigation along the movement direction.

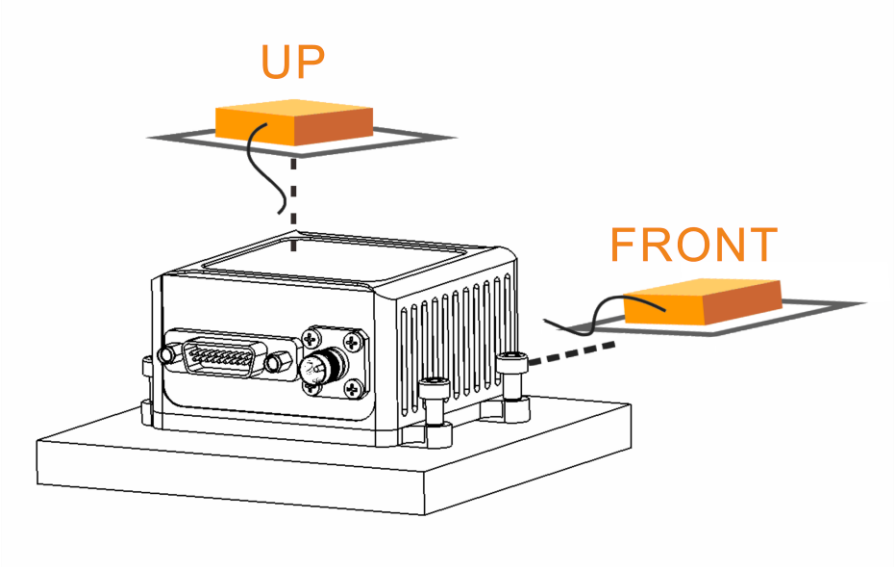


Figure 4. Installation diagram of integrated navigation and antenna

Special attention:

1. In order to achieve better performance, it is recommended that users first warm up for 15 minutes, then power off, and then power on again for two minutes.

In use, it is necessary to ensure that the carrier does not vibrate when it is powered on again.

2. The user performs a magnetic field calibration after each installation of the product and after the magnetic field environment has changed.

User communication protocol:

一、Debug Version Protocol (Embedded and VC Verify Debug)

Baud rate 460800 bps, 8 data bits, 1stop bit, no check bit, high byte first, low byte last.

Course definition: positive to the east of north and negative to the west, ranging from -180 to 180 degrees. Coordinate system definition: right front top (northeast sky).

Number of bytes	Name	Byte	Zoom	Range	Unit	Description
1~2	Frame header	U,2				0xAA 71
3~4	measuretype					High 2 bytes of measurement correction type
5~13	Gyro	S,3*3	1e-3	±8388.608	°/s	X/y/Z Front Right Top
14~22	Add Acc	S,3*3	1e-5	±83.88608	g	X/y/Z Front Right Top
23~28	Magnetic Magn	S,3*2	1e-2	±327.68	uT	X/y/Z Front Right Top
29~31	Hbar	U,1*3	1e-2	±83886.08	m	Barometer
32	flag	U,1				Bit1 -- Magnetic Valid Flag 1 -- Valid Bit2 -- Valid air pressure flag 1 -- Valid Bit3 -- GPS _ exist GPS information available 1 -- GPS information available **Bit4-GPS measurement type flagGPS 1-valid** Bit5 ~ 8 zero padding
33~36	Att attitude	S,2*2	1e-2	±327.68	°	Ptich ±90° Roll ±180°
37~38		U,1*2		655.36		**Yaw ± 180 degrees, positive west of north, positive east of north.**
39~47	Vn velocity	S,3*3	1e-4	±838.8608	m/s	Vel_E/N/U

Number of bytes	Name	Byte	Zoom	Range	Unit	Description
48~58	Pos position	S,2*4	1e-7	± 214.7483648	°	Longitude Lon/Latitude Lat with an accuracy of 0.01 m
		S,1*3	1e-2	±83886.08	m	Elevation
59	GPS_status	U,1				Bit1 ~ 4-Number of GPS positioning satellites (Max. 15)
60~61	measuretype	U,1				Lower 2 bytes of measurement correction type
62	Scenes and modes	U,1				Bit 1 ~ 4-working mode ALIGN = 1 INS = 2 AHRS= 3 VG= 4 Bit5 ~ 8--Work Scenario 1 = Vehicular 2 = Indoor 3 = Shipborne 4 = Fixed-wing 5 = Rotor 6 -- Helicopter
63						Bit5-8: system reserved word count Bit 4: padding zero. Bit1-3: 1st byte of IMU timestamp (highest)
64~67	IMU timestamp [2-4]	U,4				2nd to 5th bytes of IMU timestamp
68~71	System reserved word					
72~73	Temperature	S,2	1e-2	±327.68	℃	
74	Flag bit		Bit1 --flagVG2MC shake and sideslip switching flag 0 --VG 1 --MC Bit2--overRange overrange flare Bit3 ~ 4 -- initflagYaw heading initialization measurement flag 0 -- not initialized 1 -- already initialized 2 -- (out-of-range) heading not measured 3 -- re-initialization of heading after out-of-range Bit5 -- flag KfEnable filter enable flag 1 -- filter 0 -- pure inertia Bit6 ~ 7 -- initflagPV initialization velocity position mark 0 -- not initialized 1 -- barometric pressure initialization altitude 2 -- GPS initialization velocity position 3 -- GPS reinitializes velocity position after ejection Bit8 -- flagZUPT Quiet flag 1 -- Quiet			
75	Check					Cumulative sum of all characters before check digit

The contents of the reserved words of the system are as follows, mainly GPS data, which are sent through 14 cycles of 4 bytes each.

Number of cycles	Name	Byte	Zoom	Range	Unit	Description

Number of cycles	Name	Byte	Zoom	Range	Unit	Description
1	GPS time stamp	U,4		4294967296	ms	
2	GPS_velE	S,4*1	1e-3	±2147483.648	m/s	Eastbound speed
3	GPS_velN	S,4*1	1e-3	±2147483.648	m/s	Northbound speed
4	GPS_velU	S,4*1	1e-3	±2147483.648	m/s	Celestial speed
5	GPS_Lon	S,4*1	1e-7	±214.7483648	Degree	Longitude Lon, accuracy 0.01 m
6	GPS_Lan	S,4*1	1e-7	±214.7483648	Degree	Latitude Lan, accuracy 0.01 m
7	GPS_hMSL	S,4*1	1e-3	±2147483.648	m	Elevation
8	**GPS_headMot**	**S,4*1**	**1e-5**	**±21474.83648**	**Degree**	**Heading, ± 180 degrees, positive west of north, positive east of north.**
9	hAcc	U,4*1	1e-3	4294967.296	mm	Horizontal accuracy estimation
10	vAcc	U,4*1	1e-3	4294967.296	mm	Vertical accuracy estimation
11	headAcc	U,4*1	1e-5	42949.67296	Degree	Heading accuracy estimation
12	sAcc	U,4*1	1e-3	4294967.296	mm/s	Velocity accuracy estimation
13	gSpeed	I,4	1e-3		mm/s	Ground speed
14	GPS_PDop	U,2	1e-2			
	Fill zero					
15	GPS_DELAY	U,4	1E-3		Seconds	The current simulation does not use GPS delay.

Parameter setting:

When the product is powered on, it is in the default state of "number of consecutive transmissions". To set the parameters, the command of "stop output" must be sent first.

Note: After the following command is used, the user must power on and restart to automatically switch to the state of continuous number of rounds.

Default setting: Baud rate: 460800bps, output frequency: 400hz, working scene: vehicle-mounted, magnetic enable on, magnetic declination: 0 degree, customer magnetic field calibration parameters are cleared.

1. **Stop output**

Stopping the output is to switch the power-on default "number of consecutive rounds" state to the "parameter setting" state.

Send: * PA space GS01 space STOP carriage return

Return: * PA space GS01 space STOP space 0 carriage return failed

* PA space GS01 space STOP space 1 carriage return success

2. Set the baud rate

Baud rate 115200/230400/460800 bps optional. The power-on default baud rate is 460800 bps. The baud rate can be switched by sending a command.

Send: * PA space GS01 space BAUD space 1 carriage return

Return: * PA space GS01 space BAUD space 1 space 0 carriage return failed

* PA space GS01 space BAUD space 1 space 1 carriage return success

Note: The baud rate and output frequency are automatically matched. The underlined characters 1-115200bps (corresponding to the output frequency of 100hz), 2-230400 bps (corresponding to the output frequency of 100/200hz), and 3-460800 bps (the corresponding output frequency of 100/200/400hz) are optional.

3. Set the output frequency

The output frequency of frame bytes can be switched by sending a command. The default frequency is 400Hz.

Send: * PA space GS01 space OUT space FRE space 1 carriage return

Return: * PA space GS01 space OUT space FRE space 1 space 0 carriage return failed

* PA space GS01 space OUT space FRE space 1 space 1 carriage return success

Note: The contents of the underlined characters are 1-100Hz, 2-200Hz, 4-400Hz and 5-50Hz.

4. Set the magnetic enable switch

The magnetic calibration takes effect immediately after it is completed (new parameters are applied. When the gyro modulus is less than 0.5 degree, the state is considered to be stable, and the magnetic heading is reset). If the calibration effect is considered to be good, the parameters can be saved with the save command and called directly after the next power-on.

Send: * PA Space GS01 Space MAGN Space ON Enter Use Magnetic Parameters Geomagnetic Mode

Return: * PA space GS01 space MAGN space ON space 1 carriage return success

* PA space GS01 space MAGN space ON space 0 carriage return failed

Send: * PA Space GS01 Space MAGN Space OFF Enter Not applicable Magnetic Parameter Inertial Navigation Mode

Return: * PA space GS01 space MAGN space OFF space 1 carriage return success

* PA space GS01 space MAGN space OFF space 0 carriage return failed

5. Set up a work scenario

The product needs to switch the filter parameters according to different application scenarios. The working scenarios include vehicle-mounted, indoor (swing platform), shipborne, fixed-wing, multi-rotor and helicopter, among which the power-on defaults to vehicle-mounted scenarios.

Scene switching is to switch the power-on default "vehicle scene" to the actual scene.

Send: * PA space GS01 space SCENES space 1 carriage return

Return: * PA space GS01 space SCENES space 1 space 0 carriage return failed

* PA space GS01 space SCENES space 1 space 1 carriage return success

Note: The contents of the underlined characters are 1-vehicle, 2-indoor, 3-shipborne, 4-fixed wing, 5-multi-rotor and 6-helicopter.

6. Set the magnetic declination

The default declination is 0. Magnetic north is positive to the west and negative to the east, ranging from -20.0 to 20.0 degrees.

Send: * PA space GS01 space MDEC space/-XX. XX carriage return

Return: * PA space GS01 space MDEC space 0 carriage return failed

* PA space GS01 space MDEC space 1 carriage return success

Note: If the magnetic declination is -2.5 degrees north by east, the underlined string is -02.50; If the declination is + 1.5 degrees north by west, the underlined string is + 01.50.

7. Query parameters

Send: * PA Space GS01 Space INQUIRE Enter

Back: * PA space GS01 space INQUIRE space X1 space X2 space X3 space X4 space/-XX. XX carriage return

Note: The underlined character content X1 represents the output frequency, 1-115200 bps, 2-200Hz, 4-400Hz, 5-50Hz.

The content of the underscore character X2 represents the baud rate, 1-100hz, 2-230400 bps,

3-460800 bps.

The underlined character content X3 indicates the scene, 1-vehicle, 2-indoor, 3-shipborne, 4-fixed wing, 5-multi-rotor and 6-helicopter are optional.

The underlined character content X4 represents the magnetic enable switch, 1 -- enable on, 0 -- enable off.

The content of the underscore character/-XX. XX represents the magnetic declination. The default magnetic declination is 0. North by west is positive, and east by east is negative. If the magnetic declination is -2.5 degrees north by east, the underlined string is -02.50; If the declination is + 1.5 degrees north by west, the underlined string is + 01.50.

8. Restore factory settings

To restore the factory settings is to set the output frequency, baud rate, working scene, magnetic enable on, magnetic declination and magnetic field calibration parameters to the default values. The default settings are Baud rate 460800bps, output frequency 400hz, working scene on-board, magnetic enable on, magnetic declination 0 degree, and customer magnetic field calibration parameters cleared.

Send: * PA space GS01 space RESET

Return: * PA space GS01 space RESET space 0 carriage return failed

* PA space GS01 space RESET space 1 carriage return success

9. Magnetic field calibration

Magnetic sensor is inevitably affected by the surrounding electromagnetic field interference, which will lead to different degrees of offset deformation of the XYZ axis magnetic field intensity measured by the magnetic sensor. Magnetic field calibration is to compensate the soft and hard magnetic interference by learning the surrounding magnetic field environment through the algorithm. Therefore, we strongly recommend that:Field calibration should be performed after each installation and after a change in the field environment.

During the magnetic field calibration, the relative position of the peripheral interference substance and the product shall be kept unchanged during the rotation of the product (i.e., rotate with the product). Calibration requires the operator to be free of mobile phones, magnetic cards, keys and metal or electrified equipment that can affect the electromagnetic field.

Note that the magnetic field calibration operation has a compensating effect only within a limited interference range. The range of the magnetic sensor is about plus or minus 1 Gauss, which is about twice

the geomagnetic field in the northern hemisphere. If the magnetic field interference value exceeds plus or minus 0.5 Gauss, the magnetometer may reach saturation, preventing compensation. When the calibration fails, this is an indication of the problem.

❖ **2D calibration**

Note: When the product cannot rotate in 3D, 2D calibration can be used. It is recommended that the actual tilt angle of the product is less than 5 degrees. 2D calibration can be done by sending commands through the interface or serial port.

① **Start calibration:** before user calibration, send

Send: * PA space GS01 space MCAL space START ENTER

Return: * PA space GS01 space MCAL space START space 0 carriage return failed

* PA space GS01 space MCAL space START space 1 carriage return success

② **Stop calibration:** start to rotate horizontally for more than 2 circles, and send after completion

Send: * PA Space GS01 Space MCAL Space END Enter

Return: * PA space GS01 space MCAL space 0 carriage return failed

* PA space GS01 space MCAL space 1 space X: X. XX space Y: y. YY carriage return success

Note: The returned calibration result of 0.90 ~ 1 indicates that the calibration result is good, and > 1.1 or < 0.9 indicates that the calibration result is not very good.

③ **Save the calibration result:** after calibration, the user decides whether to save the result according to the calibration result.

Send: * PA space GS01 space MCAL space SAVE carriage return

Return: * PA space GS01 space MCAL space SAVE space 0 carriage return failed

* PA space GS01 space MCAL space SAVE space 1 carriage return success

④ **Clear the calibration result:** After calibration, the user decides whether to clear it according to the calibration result.

Send: * PA space GS01 space MCAL space CLEAR carriage return

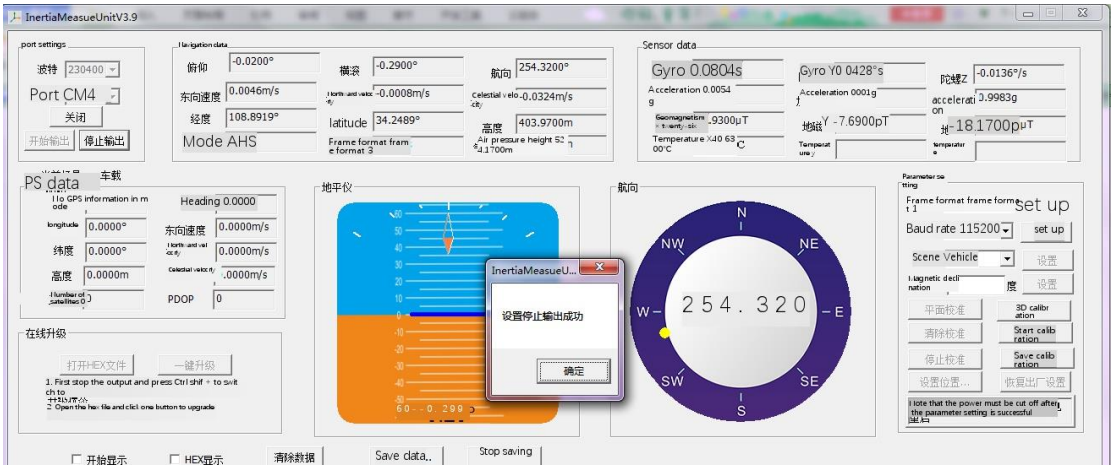
Return: * PA space GS01 space MCAL space CLEAR space 0 carriage return failed

* PA space GS01 space MCAL space CLEAR space 1 carriage return success

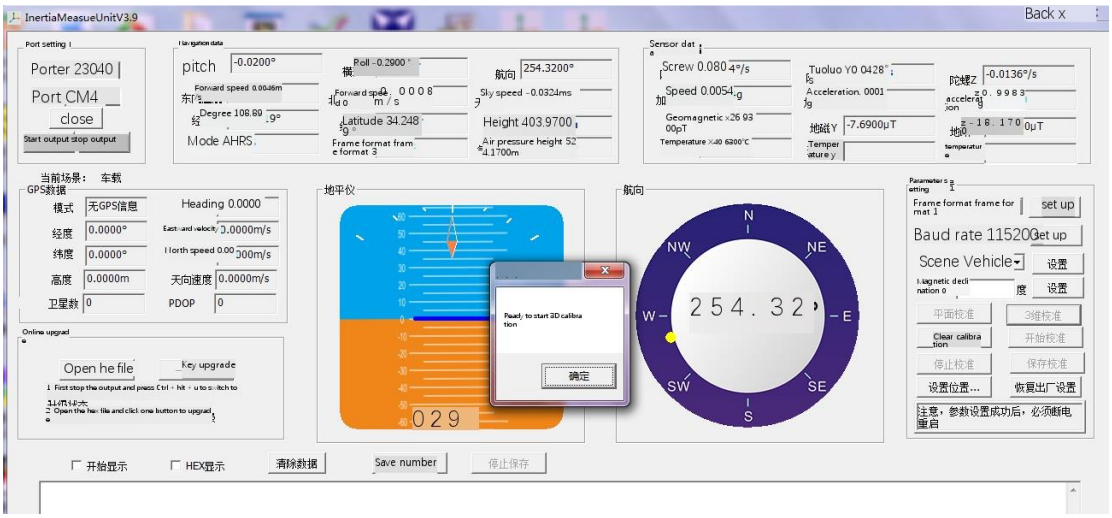
❖ **3D calibration**

Note: For better calibration accuracy, it is recommended to perform 3D calibration through the interface.

① Stop output

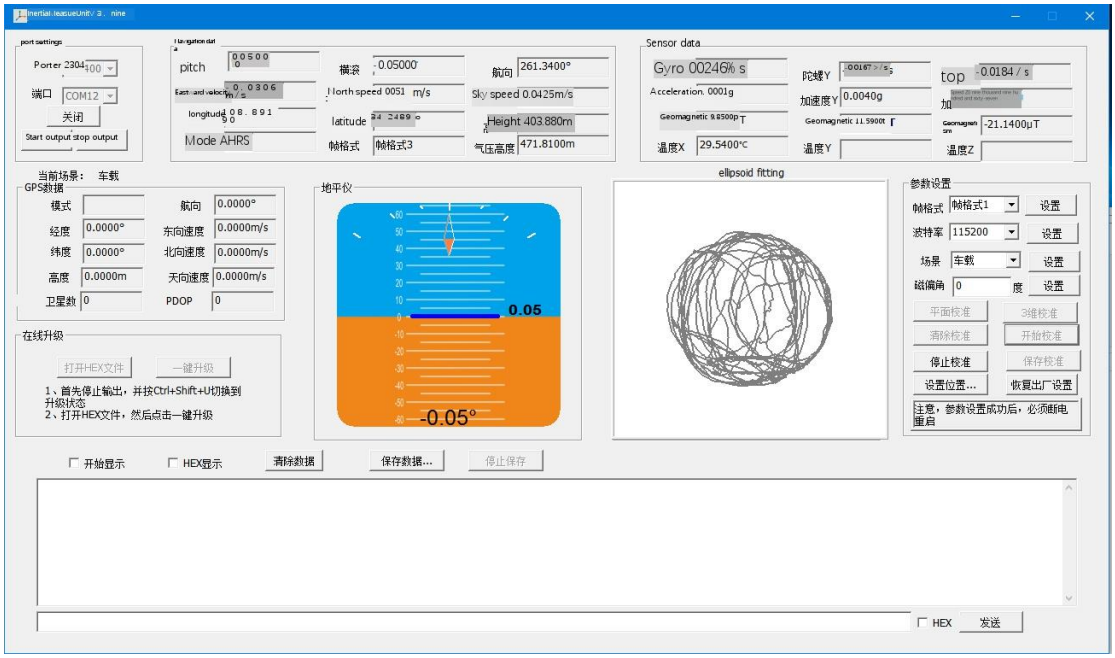


② Click 3D Calibration



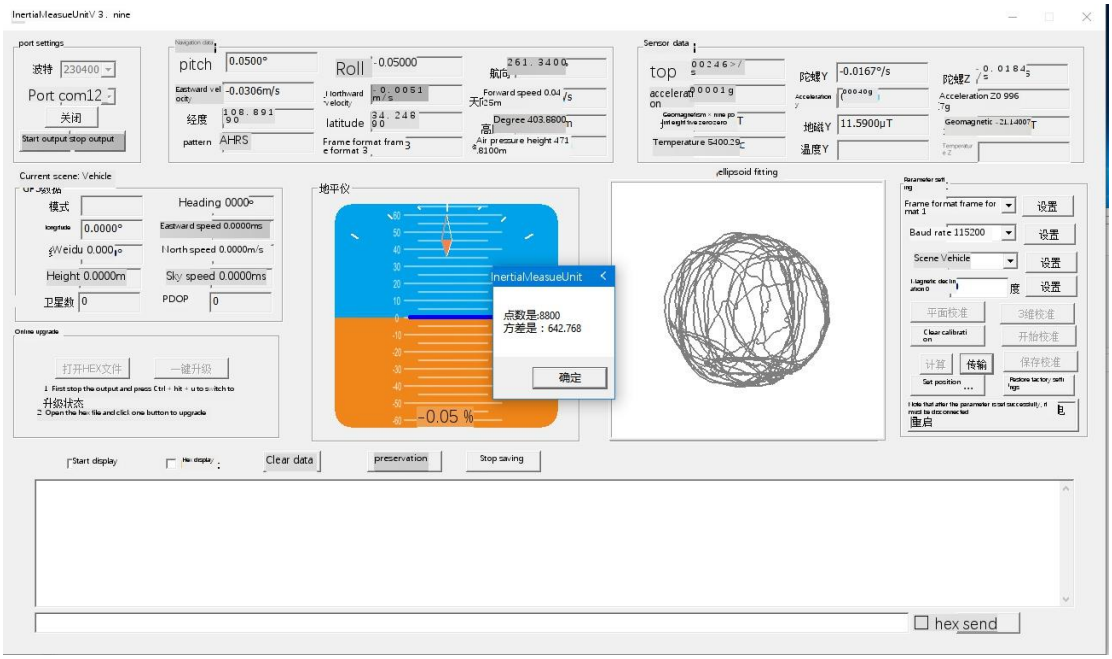
③ Click to clear calibration

④ Start calibration and ellipsoid fit

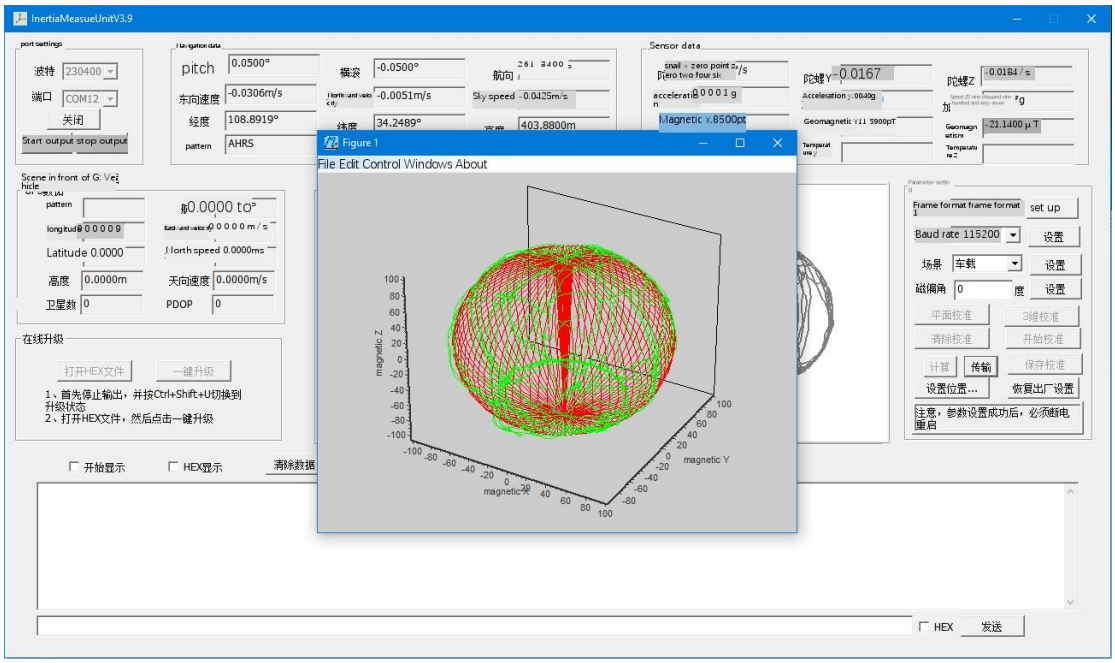


⑤ Click to stop the calibration, and the calculation button appears. Click to calculate, and the "Ready to start data transmission" dialog box pops up.

⑥ Click Transfer to save the data



Click OK to pop up the ellipsoid chart.



The more calibration points, the smaller the variance, that is, the more collection points attached to the ellipsoid, the better the calibration results.

Test software interface:

Instructions for use:

1. After the product is powered on, run the test interface and select the actual serial port serial number and baud rate to connect the serial port. Click "Start Output" to display the data in real time.

2. When the user needs to set the parameters, first click the "Stop" button to switch the "continuous transmission number state" (power-on default) to the "magnetic parameter setting state", and then the relevant operations can be carried out. When the operation is completed, the product must be powered off and restarted.

Caution:

1)The navigation system is a precision electronic product. When using it, pay attention to dust-proof, moisture-proof and mildew-proof. Handle it with care to avoid strong impact and vibration.

2)Although the metal shell is used, the module is not a waterproof design, so it must be avoided to use or soak in the rain.
3)Please check the connector before use to avoid loosening; Data power cables should be checked regularly to prevent kinking. After all cables of the equipment are connected, the equipment can be powered on and started, and it is strictly prohibited to plug and unplug the interface equipment with electricity;
4)Navigation module input voltage normal range (10 ~ 32 VDC), avoid overvoltage operation;
5)Note that the working environment of the receiver should be far away from high-power electromagnetic transmitting equipment and 1.5g band microwave transmitting equipment that will interfere with GNSS operation;
6)The factory test pins are strictly prohibited for customer use.

Transportation and storage:

1)The product shall be protected from direct rain and snow, prolonged exposure to the sun, corrosive gas and mechanical damage during transportation, and shall be handled with care;
2)Dampness, impact and collision shall be avoided during transportation and storage to prevent human and mechanical damage during transportation. During transportation and storage, the outer packing box shall be kept dry, clean and pollution-free;
3)The ambient temperature of the warehouse for long-term storage of products is 20 ± 10 ℃, and the relative humidity is not more than 80%. The warehouse shall be free of acid, alkali and corrosive gas, and free of strong mechanical vibration, impact and strong magnetic field.