



Cost-effective combination navigation GI320

Technical manual

V4.1

Introduction

GI320 adopts loose coupling integrated navigation technology, which deeply integrates IMU with RTK solution and observation preprocessing, and can provide real-time and high-precision navigation parameters such as position, speed and attitude.

The integrated navigation algorithm uses the GPS data as initial data for operation. If GPS data is lost, the system will run the strapdown inertial navigation calculation alone, and the calculated data will be sent to the Kalman filter for processing.

Feature

- GNSS/INS high-precision vehicle-grade integrated navigation system
- Cost-effective GNSS/INS integrated navigation
- Support raw data output and post-processing
- High-precision positioning and orientation
- System-wide full-frequency RTK solving
- Support precise point positioning PPP

Technical parameter



Performance Index

| | | |
|--------------------------|--|---|
| Satellite signals | BDS GPS Galileo GLONASS QZSS | B1I/B2I/B3I L1C/A/L2P(Y)/L2C/L5 E1/E5a/E5b G1/G2 L1/L2/L5 |
| Single Point Positioning | Plane Elevation | 1.5m 2.5m |

| | | |
|------------------------|--|---|
| DGPS | Plane Elevation | 0.4m 0.8m |
| RTK | Plane Elevation | 0.8cm+1ppm 1.5cm+1ppm |
| Time to first position | Cold start Warm start | <30s <15s |
| Maximum data rate | GNSS raw observation volume GNSS RTK positioning INS Integrated Navigation Positioning IMU raw rdata rate Positioning information output | 20HZ 20HZ 500HZ 500HZ 250Hz |

| | | | | |
|--|-------------------------------------|------|-------------------------------|---------|
| Measuring range of roll/pitch/yaw | Roll±180°, pitch±90°, Yaw 0~360° | | | |
| Orientation accuracy | 1m baseline | | 0.2° | |
| | 2m baseline | | 0.1° | |
| Roll/Pitch (1σ) | 0.1° | | | |
| GPS Loss of Lock Accuracy (on-board CEP) | Position drift(1km or 2min) | | 2% ,with odometer combination | |
| | Heading drift (1min) | | 0.15° | |
| Timing accuracy (RMS) | 20ns | | | |
| Velocimetric accuracy (RMS) | 0.03m/s | | | |
| Speed limit (RMS) | 300m/s | | | |
| Observation accuracy (RMS) | BDS | GPS | GLONASS | Galileo |
| B1I/B1C/L1C/A/E1/G1 | 10cm | 10cm | 10cm | 10cm |
| Pseudo-distance | | | | |

| | | | | |
|--|------|------|------|------|
| B1I/B1C/L1 C/A/E1/G1 Carrier phase | 1mm | 1mm | 1mm | 1mm |
| B2I/G2/L2P(Y)/L2C/E5b Pseudo-distance | 10cm | 10cm | 10cm | 10cm |
| B2I/B2a/B2b/L5/E5a/E5b Carrier phase | 1mm | 1mm | 1mm | 1mm |
| B3I/L5/E5a/B2a Pseudo-distance | 10cm | 10cm | 10cm | 10cm |
| B3I/L5/E5a/B2a Carrier phase | 1mm | 1mm | 1mm | 1mm |



Internal IMU parameters

| | | | |
|---------------------|--|------------------------------|--|
| Gyro range | $\pm 400^\circ/\text{s}$ | Gyro Bias Stability | 6°/h (10s smooth) 0.5°/h (allan variance) |
| Accelerometer range | $\pm 3.6\text{g}$ (default $\pm 1.2\text{g}$) | Accelerometer Bias Stability | 50ug (10s smooth) |
| Output frequency | 500Hz | | |

Communication Interface

- Interface Type**

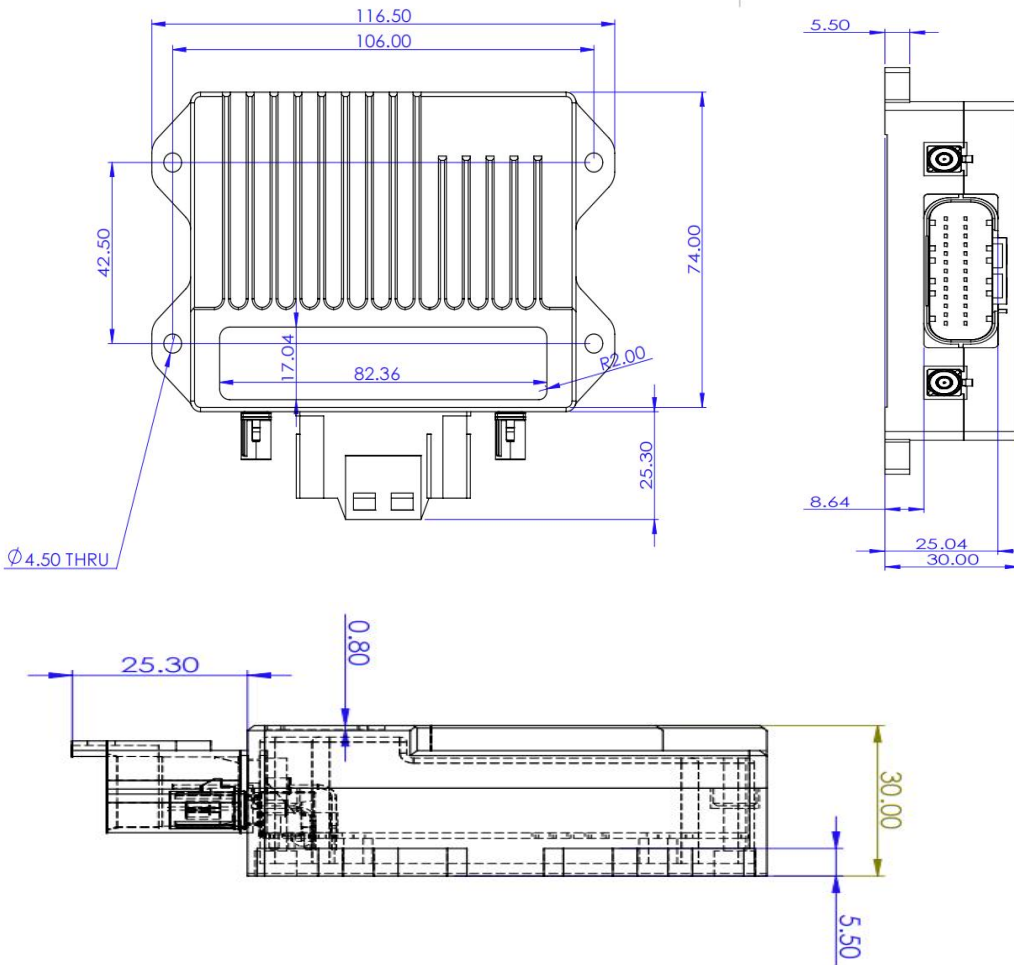
| | | |
|----------------------|--|----------------------------------|
| ANT1 | SMA External screw and internal needle | GNSS main antenna interface |
| ANT2 | SMA External screw and internal needle | GNSS secondary antenna interface |
| Automotive connector | MX23A26 | Automotive connector |

- Serial port settings

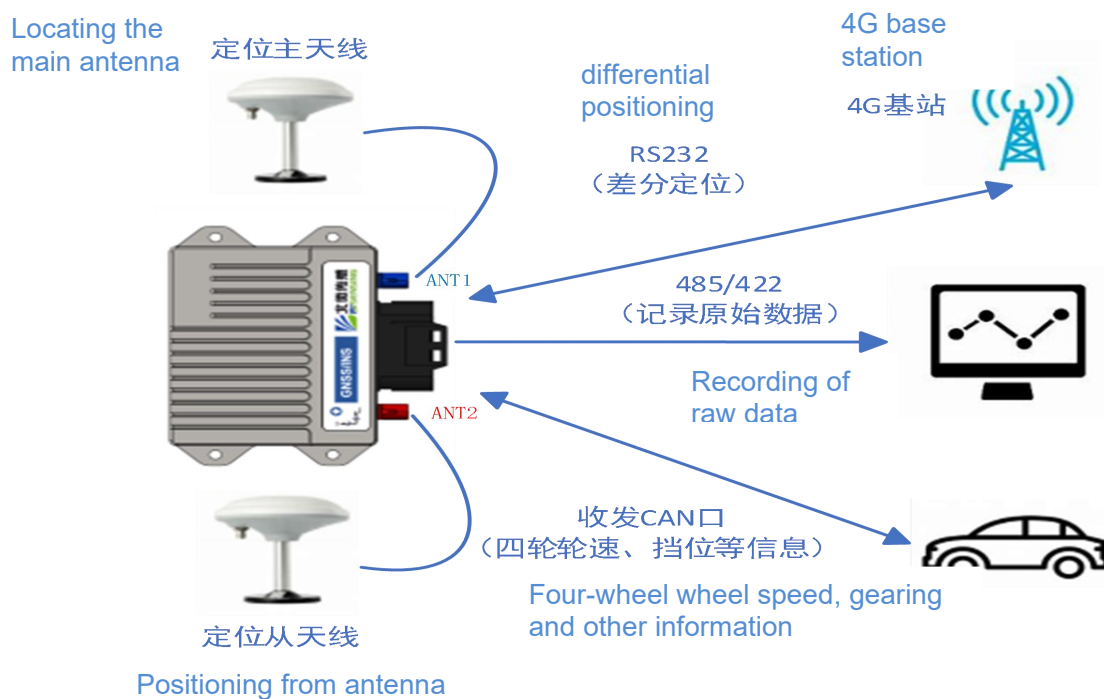
| | |
|-----------------------|---|
| Baud rate | 8000000/ 460800 / 230400 / 115200 / 19200 / 9600 / 2400 |
| Data bits | 8 |
| Default configuration | 115200 8 1 No checksum |
| Serial port optional | 422(485) / 232 |

Product List

| Type | Name | Model | Quantity |
|------------------|---------------------------|--|----------|
| Factory standard | GNSS | GI320 | 1 |
| Optional | Antenna | Antenna BT-300 antenna + large base stud + SMA feed cable (5m) | 1/2 |
| Optional | 4GDTU module | MD-649 | 1 |
| Optional | Automotive connector plug | MX23A26SF1 | 1 |

Installation and Requirements

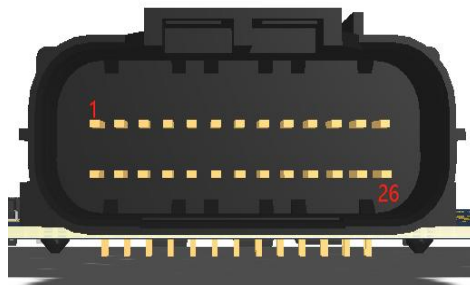
Basic Hardware Connection Diagram



Pin Definitions

| | | | | | |
|----|----------|---|----|--------------|------------------------------------|
| 1 | POWER_IN | Power supply positive (9-36) V | 14 | PPS_3.3V | Clock Synchronization Pulse (3.3V) |
| 2 | GND | Power supply negative | 15 | VSS | Digital Ground |
| 3 | KEY | Connect to power supply positive Equipment working | 16 | INT | Event Interrupt Input |
| 4 | CANH2 | Negative power supply Device stops | 17 | EVENT | Event Interrupt Output |
| 5 | CANL2 | CAN2 signal pin | 18 | VSS | Digital Ground |
| 6 | VSS | CAN2 signal pin | 19 | 232RXD | 232 communication pin |
| 7 | CANH1 | Digital ground | 20 | 232TXD | 232 Communication Pin |
| 8 | CANL1 | CAN1 signal pin | 21 | VSS | Digital ground |
| 9 | VSS | CAN1 signal pin | 22 | 485_A/422_T+ | 485/422 communication pin |
| 10 | ETH_RX+ | Digital Ground | 23 | 485_B/422_T- | 485/422 |

| | | | | | |
|----|---------|--------------|----|--------|--------------------------|
| | | | | | Communication Pin |
| 11 | ETH_RX- | Ethernet Pin | 24 | 422_R+ | 422 Communication Pin |
| 12 | ETH_TX+ | Ethernet Pin | 25 | 422_R- | 422 Communication Pin |
| 13 | ETH_TX- | Ethernet Pin | 26 | VSS | Digital Ground |



When using, please note that the wiring harness labeling may not match the actual situation, please connect the cables as shown above.



GNSS Antenna Specifications

The GNSS antenna used by the GI320S needs to be an active antenna. The GI320 provides a 5VDC antenna feed and supports a maximum of 200mA current. The recommended or required parameters are listed below:

1. Frequency points to be supported:

| GNSS | frequency | GNSS | frequency |
|---------|-------------|---------|------------|
| BDS | B1I/B2I/B3I | Galileo | E1/E5a/E5b |
| GPS | L1/L2/L5 | QZSS | L1/L2/L5 |
| GLONASS | G1/G2 | - | L-band |

2. Recommended gain: 40dB;
3. Recommended noise figure: NF<1.5;.
4. Feed: 2.8~5V;.
5. Phase center error: ±2mm.



RF coaxial cable specifications

Master antenna RF coaxial cable should be matched with the impedance of the antenna and receiver, the characteristic impedance is 50Ω , and the recommended line attenuation is less than 10dB. RF coaxial cable connector is adapted to the GNSS antenna at one end, and FAKRA-C is adapted to the master antenna interface of GI320 at the other end. Slave antenna RF coaxial cable should be matched with the impedance of the antenna and receiver, the characteristic impedance is 50Ω , the recommended line attenuation is less than 10dB. RF coaxial cable connector at one end to adapt to the GNSS antenna, at the other end of the FAKRA-D to adapt to the GI320 slave antenna interface.



Temperature and protection class

GI320 has the following temperature requirements.

1. Working temperature $-40^{\circ}\text{C}\sim 85^{\circ}\text{C}$.
2. Storage temperature $-40^{\circ}\text{C}\sim 85^{\circ}\text{C}$.

Protection grade: IP54



Power supply specifications

GI320 requires the following power supply specifications.

1. Voltage range $+9\text{V}\sim +24\text{VDC}$
2. At least 10W stable output power



Installation of GNSS antenna

The GI320 is currently available in dual antenna as well as single antenna versions.

The following considerations apply when installing the GNSS antenna:

1. The GNSS antenna location is open and unobstructed above the carrier.
2. The GNSS antenna is rigidly connected to the carrier to ensure that the antenna will not shake when the carrier is moved.
3. Under dual-antenna mode, it is recommended that the distance between the antennas should be more than 1 meter, and the farther apart, the better.

GNSS dual antenna mode recommended dual antenna baseline perpendicular to the carrier forward direction, as shown in the figure below:

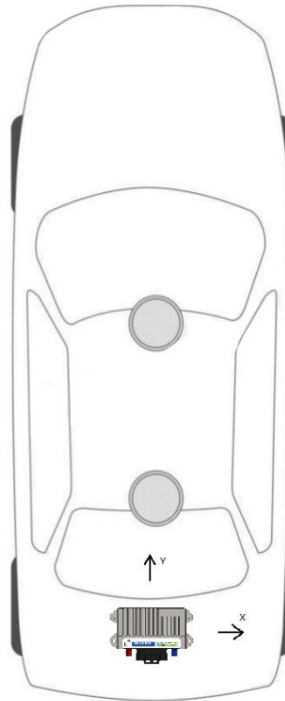




Installation of GI320 complete machine

In order to improve the accuracy, the IMU should be installed as close as possible to the main GNSS antenna in the horizontal direction, and it must be ensured that the GI320 is rigidly connected to the carrier, so as to ensure that the relative positions of the GI320 and the antenna on the carrier are fixed. And to ensure that the GI320 is installed firmly and reliably, in the carrier traveling process will not move or shake.

In order to simplify the system configuration, it is recommended that the combination of navigation system GI320 installed in close proximity to the position of the carrier rear axle, attitude to maintain a horizontal (that is, the Z-axis should be perpendicular to the ground pointing upward), the Y-axis of the GI320 should be pointing in the direction of the forward direction of the carrier (as shown in the figure below).



communication link

The GI320 can use the serial port to communicate with external communication devices. Currently, commands and RTK data can only be sent through the 232 port.



serial port (computing)

The Combined Navigation System GI320 provides two serial ports as shown below:

| serial number | RS-232 | RS-485 | RS-422 |
|---------------|---------------|---------------|---------------|
| COM1 | Support | Not Supported | Not Supported |
| COM2 | Not Supported | Support | Support |



power connection

Pin 1 POWER_IN and pin 3 KEY power enable pin in the connector are connected to the positive side of the power supply, and pin 2 GND is connected to the negative side of the power supply.



Check GI320 status

After installing GI320, turn on the power, send the command UNLOG, it should be noted that the use of the serial port assistant to send commands need to be checked to send a new line to confirm the normal operation of GI320, such as yes, the GI320 will respond to the following content:
\$Command response: OK.

Equipment use

Ensure that the GI320 has been installed as described in the previous section and is powered up and working before use.



serial port communication

The GI320 can communicate with computers and other devices through the serial port. Before the two can establish communication, both the GI320 and the computer need to be properly configured for the serial port parameters. The default serial port configuration for the GI320 is:

- 1.115200bps
2. No parity bit
- 3.8bit data bits
- 4.1bit stop bit
- 5.No parity bit

| command header | serial device | serial port parameter | Parameter Description |
|----------------|---------------|-----------------------|--|
| CONFIG | COM1 COM2 | Baud rate | Setting the baud rate of the serial port |

Only COM1 supports port configuration using the command CONFIG.
 An example of modifying the COM1 serial port configuration is shown below:

| directives | descriptive |
|-----------------------|--|
| config com1 115200 | Set com1 baud rate to 115200. You can set the baud rate of com1,com2,com3 to any one of 2400,9600,19200,115200, 230400,460800,8000000 respectively. |

The command format is:

CONFIG [serial port device number] [serial port attribute parameter]

Simplified ASCII syntax:

Command Header Serial device Serial port parameters Parameter Description

CONFIG COM1

COM2 Baud rate Sets the baud rate of the serial port.

GNGGA GNSS Multi-system Joint Positioning Data

This instruction is used to set the current serial port or specified serial port to output the result of multi-system joint positioning, and the output information contains the time and positioning related data of GNSS receiver. The statement starts with GNGGA. Depending on the satellite systems involved in positioning, it may be GPGGA, BDGGA, GLGGA, GAGGA, etc. When only the GPS satellite system is involved in the positioning solution, it will be output in the form of GPGGA; when only the BDS satellite system is involved, it will be output in the form of GPGGA.

When only the GPS satellite system is involved in the positioning solution, the output is in the form of GPGGA; when only the BDS satellite system is involved in the positioning solution, the output is in the form of BDGGA; when only the GLONASS

When only the GLONASS satellite system is involved in the positioning solution, the output is in the form of GLGGA; when only the Galileo satellite system is involved in the positioning solution, the output is in the form of GAGGA.

Output in the form of GAGGA. The output is in GNGGA when only GLONASS satellite system is involved in the position solution, and in GAGGA when only Galileo satellite system is involved in the position solution.

Simplified ASCII format:

GNGGA 1 Outputs 1Hz GNGGA information from the current serial port.

GNGGA COM2 1 Outputs a 1Hz GNGGA message at com2.

Message output:

\$GNGGA,025754.00,4004.74102107,N,11614.19532779,E,1,18,0.7,63.3224,M,-9.7848,m,00,0000*58

GNGGA Data Structure

| ID | field | Data Description | notation | typical example |
|----|------------|--|-----------|--------------------------------|
| 1 | \$GNGGA | Log header | | \$GNGGA |
| 2 | utc | The UTC time to which the location corresponds. | hhmmss.ss | 173568.00 |
| 3 | lat | hh/mm/ss.ss | IIII.II | 3251.2654 |
| 4 | Lat dir | Latitude (DDmm.mm) | a | N |
| 5 | lon | Longitude direction (N = North, S = South) | yyyy.yy | 12033.3592 |
| 6 | lon dir | Longitude (DDDmm.mm) | a | E |
| 7 | qual | Longitude direction (E = East, W = West) | x | 1 |
| 8 | # sats | GPS Quality Indicator | xx | 10 |
| 9 | hdop | 0 = Positioning unavailable or invalid | x.x | 1.0 |
| 10 | alt | 1 = Single point fix | x.x | 1021.45 |
| 11 | a-units | 2 = Pseudorange Differential or SBAS positioning | M | M |
| 12 | undulation | 4 = RTK fixed solution | x.x | -17.183 |
| 13 | u-units | 5 = RTK floating point solution | M | M |
| 14 | age | 6 = Inertial guidance positioning | xx | (00 without differential data) |
| 15 | stn ID | 7 = Fixed Position for User Setting | xxxx | (00 when no differential data) |
| 16 | *xx | Position) | *hh | *3F |
| 17 | [CR][LF] | Number of satellites in use. May not match the number seen | | [CR][LF] |

IMU Raw Data Information

This statement contains an indication of the IMU status and the measured values of the accelerometers and gyroscopes relative to the IMU housing coordinate system.

Command Format.

RAWIMUA COM1 1

RAWIMU Data Format

| ID | field | Data Description |
|----|-------------------|--|
| 1 | \$RAWIMUA | Log Header |
| 2 | Week | GNSS Week |
| 3 | Seconds Into Week | Seconds per week |
| 4 | Z Accel Output | Velocity varies along the Z-axis. |
| 5 | Y Accel Output | Velocity varies along the Y-axis. |
| 6 | X Accel Output | Velocity variation along the X-axis. |
| 7 | Z Gyro Output | The amount of angular change in the right-handed helix along the Z-axis. |
| 8 | Y Gyro Output | The amount of angular change in the right-handed helix along the Y-axis. |
| 9 | X Gyro Output | The amount of angular change in the right-handed helix along the X-axis. |
| 10 | *xx | Checksum |
| 11 | [CR][LF] | Statement terminator |

INSPVA Combined Navigation Position, Speed and Attitude Information

Sets up the output of the combined navigation and positioning results, with ASCII statements beginning with "#INSPVA".

Recommended input.

INSPVAA com2 1

INSPVA Data Structure

| ID | field | Data Description |
|----|----------|------------------|
| 1 | \$INSPVA | Log Header |
| 2 | Week | GNSS Week |
| 3 | Seconds | Seconds per week |

| | | |
|----|----------------|---|
| 4 | Latitude | Latitude (WGS84) [degrees] |
| 5 | Longitude | Longitude(WGS84) [degrees] |
| 6 | Height | Ellipsoid height (WGS84) [m] |
| 7 | East Velocity | Eastward velocity (negative for southward) [m/s] |
| 8 | North Velocity | Northward velocity (negative for westward direction) [m/s] |
| 9 | Up Velocity | Velocity in the sky direction [m/s] |
| 10 | Roll | Cross-roll angle (right-handed spiral along Y-axis) [degrees] |
| 11 | Pitch | Pitch angle (right hand spiral along X-axis) [degrees] |
| 12 | Azimuth | Heading angle, counterclockwise from north (right-handed helix around the Z axis), which is the inertial azimuth calculated by the IMU gyro through a combined filter |
| 13 | Status | INS Status |
| 14 | xxxx | 32-bit CRC |
| 15 | [CR][LF] | Statement terminator (ASCII only) |

INSPVB Combined Navigation Position, Velocity and Attitude Information

Sets up the output of the combined navigation and positioning results in a binary statement that starts with "#INSPVB".

Recommended input.

INSPVAB com2 1

INSPVB Data Structure

| ID | field | data description | typology | Byte Count | Byte Count | |
|----|-------------------------|------------------|----------|-------------|-------------|--|
| | | | | Byte Offset | Byte Offset | |
| 1 | Synchronization Segment | 0x57 | char | 1 | 0 | |
| 2 | Frame Information | 0x00 | char | 1 | 1 | |
| 3 | Length Segment | 0x5B | char | 1 | 2 | |
| 4 | Address Segment | 0x00 | char | 1 | 3 | |
| 5 | Command Segment | 0x03 | char | 1 | 4 | |

| | | | | | | |
|---|---------|----------------|---|--------|----|----|
| 6 | data | Week | GNSS Week | Ulong | 4 | 8 |
| | segment | Seconds | Seconds per week | Double | 8 | 16 |
| | | Latitude | Latitude (WGS84) [degrees] | Double | 8 | 24 |
| | | Longitude | Longitude (WGS84) [degrees]. | Double | 8 | 32 |
| | | Height | Ellipsoid Height (WGS84) [m] | Double | 8 | 40 |
| | | East Velocity | Eastward velocity (negative for southward) [m/s] | Double | 8 | 48 |
| | | North Velocity | Northward velocity (negative for westward direction) [m/s] | Double | 8 | 56 |
| | | Up Velocity | Velocity in the sky direction [m/s] | Double | 8 | 64 |
| | | Roll | Cross-roll angle (right-handed spiral along Y-axis) [degrees] | Double | 8 | 72 |
| | | Pitch | Pitch angle (right hand spiral along X-axis) [degrees] | Double | 8 | 80 |
| | | Azimuth | Heading angle, counterclockwise from north (right-handed helix around the Z axis), which is the inertial azimuth calculated by the IMU gyro through a combined filter | Double | 8 | 88 |
| | | Status | INS Status | Enum | 1 | 89 |
| 7 | xxxx | 32-bit CRC | Hex | 4 | 93 | |

Other commands

Unlog Stop Serial Port Output

This instruction is used to stop the serial port from outputting specific data messages. Configurable parameter [Statement] stops the output of corresponding data information;

Configurable parameter [Port] to stop port output. If no port is specified, the command defaults to the port currently receiving the command; if no message name is specified, the output of all messages will be stopped.

The command format is:

UNLOG [port] [message]

Simplified ASCII Syntax

UNLOG Stop outputting all messages for the current port.

UNLOG GNGGA Stop the output of GNGGA statement for the current serial port.

UNLOG COM1 Stop all messages from com1.

UNLOG COM2 GNGGA stops the GNGGA statement output from com2.

The parameters of the Unlog command are as follows

| command header | port number | Description |
|----------------|--------------|---|
| UNLOG | COM1 COM2 | Name of the message that will stop the output |

saveconfig Save User Configuration

This command saves the current user configuration.

The command format is:

SAVECONFIG

Simplified ASCII syntax:

SAVECONFIG

The parameters of the saveconfig command are as follows

| command header | command parameter | descriptive |
|----------------|-------------------|-------------|
| SAVECONFIG | — | 保存用户配置 |

IMU to Main Antenna Lever Arm Parameter Configuration

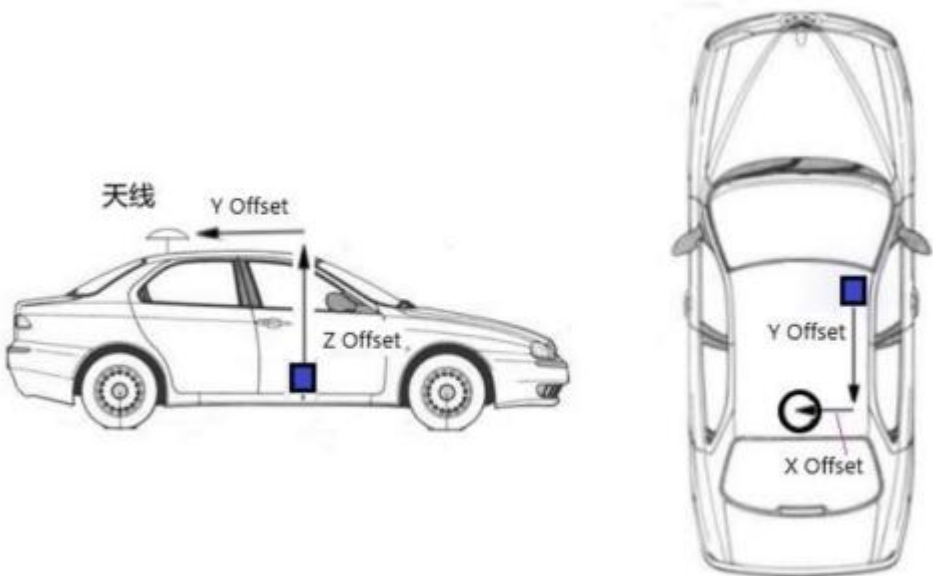
Use this command to enter the offset between the IMU and the GNSS main antenna phase center, i.e., the inertial guidance to main antenna pole arm

parameter. The measurement of the boom parameter should be as accurate as possible, especially in RTK mode, and an error of 1 cm is preferred. Any error in the boom

Any error in the pole arm parameter will be directly converted to an error in the inertial navigation system position. x, y, and z represent the IMU to main antenna phase center vector.

X, Y and Z represent the vector from the IMU to the center of phase of the main antenna.

To improve accuracy, the IMU should be mounted horizontally as close as possible to the main GNSS antenna, with the IMU positioned in the upper left corner of the GI320.



IMU Offset to Antenna Phase Center

Command Format.

CONFIG LEVER ARM x y z

Simplified ASCII syntax: CONFIG LEVER ARM 0.05 -1.05 0.03

CONFIG LEVER ARM 0.05 -1.05 0.03

IMU to main antenna arm parameter configuration

| command header | parameters | Parameter Description |
|------------------------|------------|--|
| CONFIG LEVER ARM | X | X-direction offset, unit: meter, range -100~100, retain two decimal places |
| | Y | Y direction offset, unit: meter, range -100~100, retain two decimal places |
| | Z | Z direction offset, unit: meter, range -100~100, retain two decimal places |

Appendix 2: Binary Protocol Format

| | | | | | | |
|-----------------------------------|-----------------------------|---------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------|
| synchronization segment 1 Byte | Frame Information 1 Byte | Length Segment 1/2/4 Byte | Address Segment 1/2/4 Byte | Command Segment 1/2/4 Byte | Command Segment 1/2/4 byte | Ending Paragraph 4 Byte |
|-----------------------------------|-----------------------------|---------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------|

GI320

Data frame description

| Name | Length | Description |
|-----------------------|------------|---|
| Synchronised segments | 1 Byte | Fixed to 0x57 for data frame synchronisation |
| Frame information | 1 Byte | <p>Indicates the information of the data frame</p> <p>Bit 7 Frame information check, 0 when the number of 1's in Bit 6 to Bit 0 is even, 1 when the number of 1's is odd</p> <p>Bit 6 Reserved, constant 0</p> <p>Bit 5:4 Data length of the length segment 00: 1 byte 01: 2 bytes 02: 4 bytes 03: Reserved</p> <p>Bit 3:2 Data length of the address segment 00: 1 byte 01: 2 bytes 02: 4 bytes 03: Reserved</p> <p>Bit 1:0 Data length of the command segment 00: 1 byte 01: 2 bytes 02: 4 bytes 03: Reserved</p> |
| Length Segment | 1/2/4 Byte | Number of bytes from the address segment (inclusive) to the end segment (inclusive), high byte first, number of bytes determined by Bit 5:4 of the frame information |
| Address segment | 1/2/4 Byte | Address of the target sensor of the data frame, high byte first, number of bytes determined by Bit 3:2 of the frame message. The sensor will only respond if this address is equal to the sensor address or if it is equal to 0 |
| Command segment | 1/2/4 Byte | <p>Command message of the data frame, high byte first, number of bytes determined by Bit 3:2 of the frame message.</p> <p>Determines the role of the data frame, the lowest bit is 0 for sending to the sensor and the lowest bit is 1 for returning from the sensor</p> |

**GI320**

| | | |
|------------------|-------------|---|
| Data segment | 0~n Byte | Data information corresponding to the command segment, typically sensor readings or configuration parameters |
| Ending paragraph | 4 Byte | Checksum information for the data frame, from the frame information (included) to the CRC checksum value of the data segment (included), with the high byte first The CRC information is as follows: Width: 32 bits Polynomial: 04C11DB7 Initial value: FFFFFFFF Resulting iso-or: 00000000 Input inverted: No Output inverted: No |

Combined navigation

Wuxi Bewis Sensing Technology LLC

Add: Building 30, NO. 58, Xiuxi Road, Binhu District,
Wuxi City, Jiangsu Province, China

Tel: +86 18921292620

Mail: sales@bwsensing.com

Web: www.bwsensing.com