Cost-effective combination navigation GI320

Technical manual

V4.1

Cost-effective Integrated Navigation System

GI320

Introduction

GI320 is a high-precision and cost-effective combination navigation product, which adopts tightly-coupled combination navigation technology, deeply fuses IMU and satellite information, and can also be fused and solved with external odometer information to provide high-precision position, speed and attitude navigation information for the carrier in real time.

GI320 starts fusion solving after acquiring the initial GNSS information, and if the GNSS signal is out of lock during operation, the system will carry out Jetlink inertial guidance solving and combine with the vehicle kinematics model, and then carry out multi-information fusion constraints through Kalman filter, which can effectively inhibit the rapid dispersion of the position and velocity errors, and can still maintain good Positioning accuracy can still be maintained within a certain period of time, making the one-kilometre positioning error in normal vehicle driving: less than 2% without odometry and less than 0.2% with odometry.

Feature

- GNSS/INS high-precision automotive-grade combined navigation
- Cost-effective GNSS/INS integrated navigation
- Support raw data output and post-processing
- Vehicle kinematics
- Support CAN FD communication protocol
- Full-system, full-frequency RTK solution
- Support precise point positioning PPP
- Special divergence suppression algorithm

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

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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 200HZ 200HZ 200Hz
Orientation accuracy	1m baseline 2m baseline			0.2° 0.1°
Timing accuracy (RMS) Velocimetric accuracy (RMS) Speed limit (RMS)	20ns 0.03m/s 300m/s			
Observation accuracy (RMS)	BDS	GPS	GLONASS	Galileo
B1I/B1C/L1C/A/E1/G1 Pseudo-distance	10cm	10cm	10cm	10cm
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

Measuring range of roll/pitch/yaw	Roll±180°, pitch±90°, Yaw 0~360°	
Heading accuracy (with GNSS signal)	0.05° static 0.1° dynamic	
Roll/Pitch（1σ） (with GNSS signal)	0.03° static 0.1° dynamic	
GPS Loss of Lock Accuracy (on-board CEP)	Position drift(1km or 2min)	0.2% ,with odometer combination
	Heading drift (1min)	0.15°

Internal IMU parameters

Gyro range	±400°/s	Gyro Bias Stability	6°/h（10s smooth） 0.5°/h（allan variance）
Accelerometer range	±3.6g (default ±1.2g)	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	RS422(RS485) / RS232

• Other interfaces

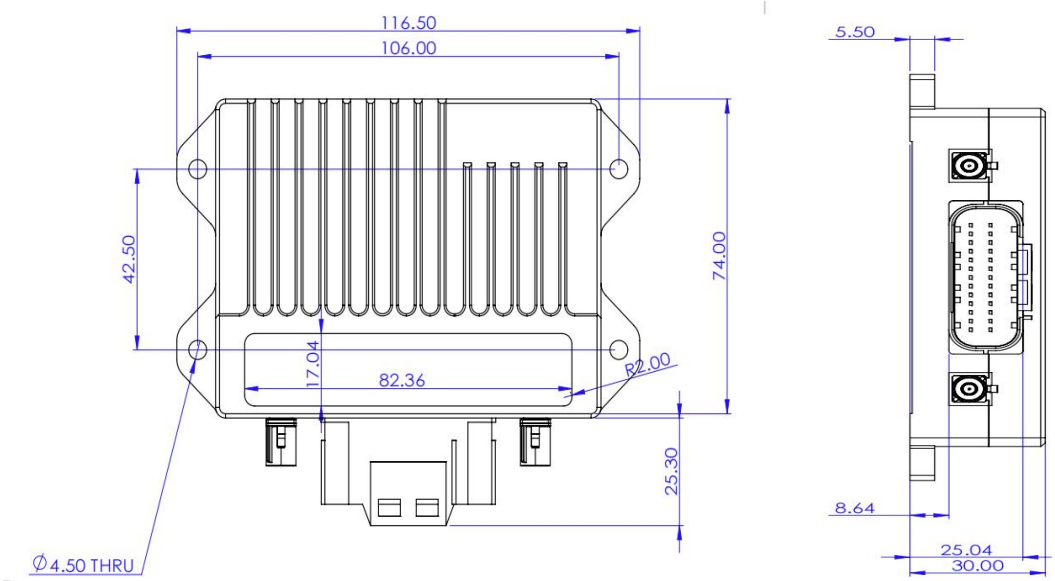
Two CAN FD interfaces
One Ethernet interface

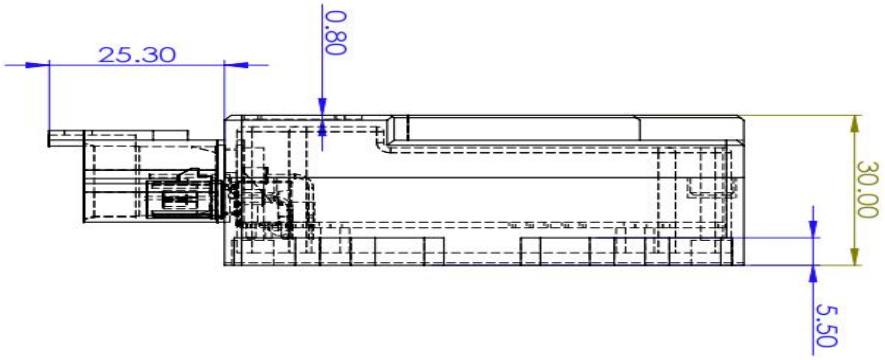
Product List

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

Installation and Requirements

Equipment Dimension

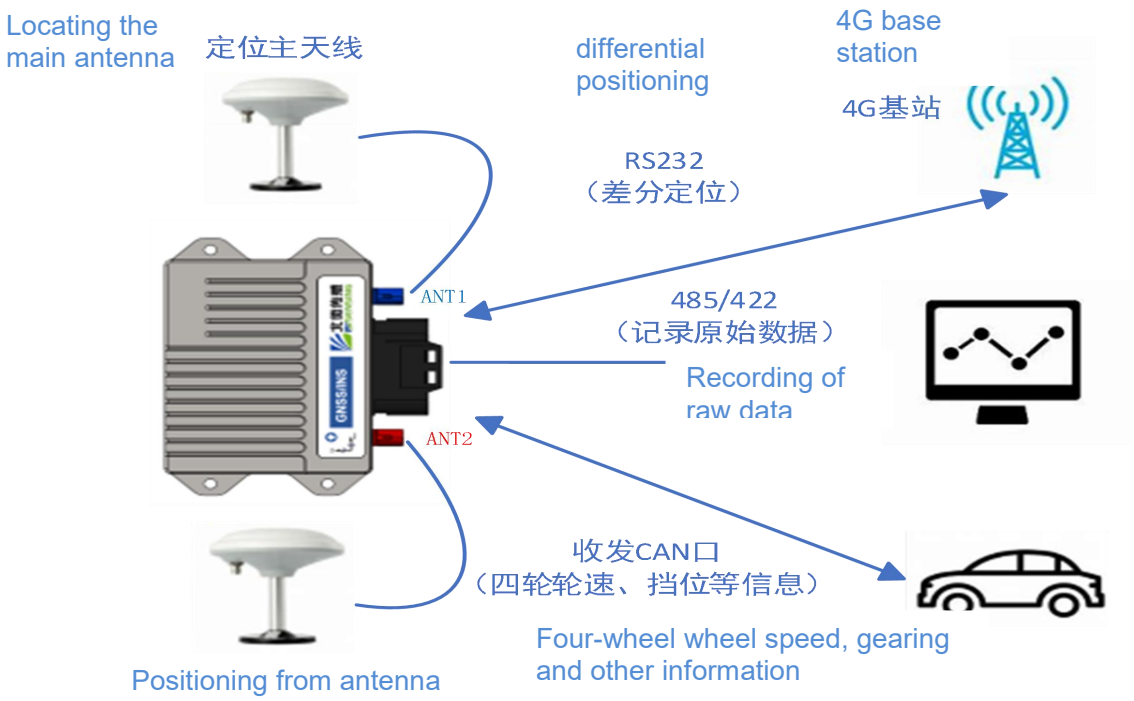




Equipment Weight

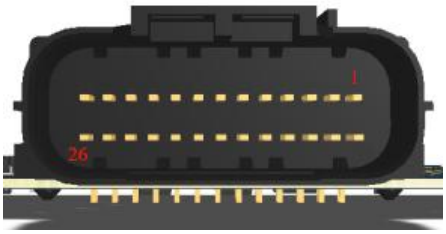
Net weight 200g

Basic Hardware Connection Diagram



Pin Definitions

1	ETH_TX-	Ethernet Pins	14	DGND	Digital Ground
2	ETH_TX+	Ethernet Pins	15	422_R-	422 Communication Pins
3	ETH_RX-	Ethernet Pins	16	422_R+	422 Communication Pin
4	ETH_RX+	Ethernet Pins	17	485_B/422_T-	485/422 Communication Pin
5	DGND	Digital Ground	18	485_A/422_T+	485/422 Communication Pin
6	CANL1	CAN1 Signal Pin	19	DGND	Digital Ground
7	CANH1	CAN1 Signal Pin	20	232TXD	232 Communication Pin
8	DGND	Digital Ground	21	232RXD	232 Communication Pin
9	CANL2	CAN2 pin	22	DGND	Digital Ground
10	CANH2	CAN2 signal pin	23	EVENT	Event Interrupt Output
11	KEY	Positive power supply Device working	24	INT	Event Interrupt Input
12	AGND	Power negative Device stop	25	DGND	Digital Ground
13	POWER_IN	Negative power supply	26	PPS_3.3V	Clock synchronisation pulse (3.3V)



Pin numbering and location diagrams

GNSS Antenna Specifications

The GNSS antenna used by the GI320 needs to be an active antenna.The GI320 provides a 5V DC 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℃~+85℃.

2.Storage Temperature -55℃~+95℃

Protection grade: IP54

Power supply specifications

GI320 requires the following power supply specifications.

1. Voltage range +9V~+36V DC
2. At least 10W stable output power

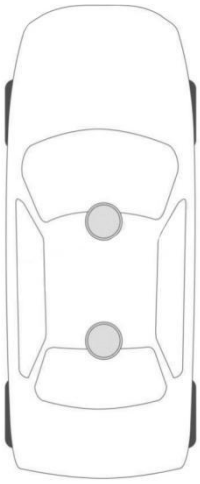
Installation of GNSS antenna

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 antenna distance is more than 1 metre, and the farther apart the better.

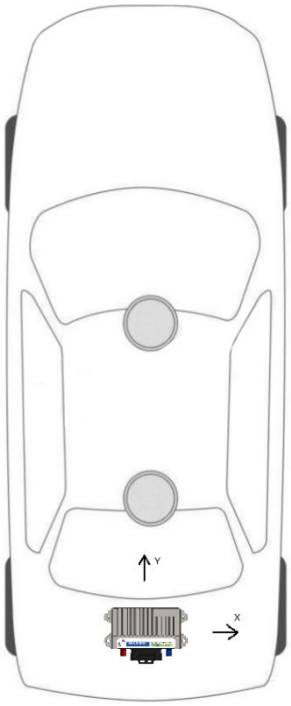
In GNSS dual antenna mode, it is recommended that the baseline of the dual antennas is horizontal to the forward direction of the carrier, as shown in the figure below:



Installation of GI320 complete machine

In order to improve the accuracy, the IMU should be installed horizontally as close as possible to the main GNSS antenna, and it must be ensured that the GI320 is rigidly connected to the carrier to ensure that the relative positions of the GI320 and the antenna on the carrier are fixed. And to ensure that the GI320 installation is stable and reliable, in the carrier travelling 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 carrier rear axle position, attitude to maintain a horizontal (i.e., 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

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 and send the command UNLOG, it should be noted that when using the serial assistant to send commands, you need to check the box to send a new line to confirm that the GI320 is running normally, if so, the GI320 will respond to the following content:

$Command response: OK.

Equipment use

serial port communication

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

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

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

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

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:

GNGGA GNSS Multi-system Joint Positioning Data

This instruction is used to set the current serial port or the specified serial port to output the result of multi-system joint positioning, and the output information contains the time of the GNSS receiver and positioning related data. The statement starts with GNGGA. Depending on the satellite systems involved in positioning, the output may be GPGGA, BDGGA, GLGGA, GAGGA, GPGGA when only GPS satellite system is involved in positioning solution, BDGGA when only BDS satellite system is involved, GLGGA when only GLONASS satellite system is involved, GLGGA when only Galileo satellite system is involved, GLGGA when only Galileo satellite system is involved, GLGGA when only Galileo satellite system is involved. 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 the form of GNGGA when only the GLONASS satellite system is involved in the position solution, and in the form of GAGGA when only the 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	Latitude direction (N = North, S = South)	yyyyy.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	undulatio n	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

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 westward) [m/s]
8	North Velocity	Northward velocity (negative for southward direction) [m/s]
9	Up Velocity	Velocity in the sky direction [m/s]
10	Roll	Cross-roll angle (Right hand spiral along the Y-axis, positive counterclockwise) [degrees]

11	Pitch	Pitch angle (Right hand spiral along the X-axis, positive counterclockwise) [degrees]
12	Azimuth	Heading angle, counterclockwise from north (right-handed helix around the Z axis,north by east is positive), 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 Offset	ID
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 segment	Week	GNSS Week	Ulong	4	8
		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 westward) [m/s]	Double	8	48
		North Velocity	Northward velocity (negative for southward 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,positive counterclockwise) [degrees]	Double	8	72
		Pitch	Pitch angle (right hand spiral along X-axis, positive counterclockwise) [degrees]	Double	8	80
		Azimuth	Heading angle, counterclockwise from north (right-handed helix around the Z axis, north by east is positive), 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:

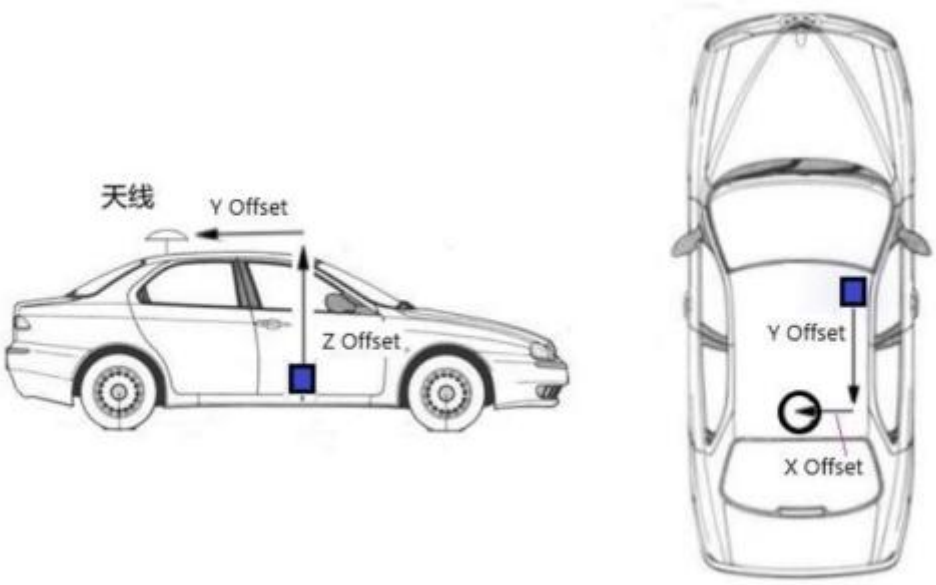
SAVECONFIG

The parameters of the saveconfig command are as follows

command header	command parameter	descriptive
SAVECONFIG	——	Save User Configuration

IMU to Main Antenna Lever Arm Parameter Configuration

Use this command to enter the offset between the IMU and the GNSS main antenna phase centre, i.e. the inertial guidance to main antenna rod arm parameter. The rod arm parameters should be measured as accurately as possible, especially in RTK mode, and an error of 1 cm is desirable. any error in the rod arm parameters will be directly converted to an error in the inertial navigation system position. x, y, and z represent the vectors from the IMU to the main antenna phase centre. To improve accuracy, the IMU should be mounted horizontally so that it is as close as possible to the main GNSS antenna.The IMU position is 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

Data frame description

Name	Length	Description
Synchronised segments	1 Byte	Fixed to 0x57 for data frame synchronisation
Frame information	1 Byte	Indicates the information of the data frame 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 Bit 6 Reserved, constant 0 Bit 5:4 Data length of the length segment 00: 1 byte 01: 2 bytes 02: 4 bytes 03: Reserved Bit 3:2 Data length of the address segment 00: 1 byte 01: 2 bytes 02: 4 bytes 03: Reserved Bit 1:0 Data length of the command segment 00: 1 byte 01: 2 bytes 02: 4 bytes 03: Reserved
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 messag.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	Command message of the data frame, high byte first, number of bytes determined by Bit 3:2 of the frame message. 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
Data segment	0~n Byte	Data information corresponding to the command segment, typically sensor readings or configuration parameters
Ending paragraph	4 Byte	Parity information of the data frame, CRC parity value from the frame information (included) to the data segment (included), 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

Appendix: Record of Changes

2024.5.16 -- V4.1	1. 'Positioning error is kept within 1%' in [Product Description] is revised to 'Positioning error is kept within 1%~2%'.
	2. Improve the measurement range and attitude accuracy in [Performance Parameters], and distinguish between GNSS heading accuracy and inertial measurement heading accuracy.
2024.6.14--V4.2	1. Add CAN as optional serial port in [Serial Port Settings].
2024.7.17--V4.3	1. Remove CAN from the optional serial port in [Serial Port Settings] and add 'Support CAN FD communication protocol' to the main features.
	2.INS combined navigation solution, internal IMU output frequency, positioning information output frequency changed to 200Hz.
	3. Add 'with GNSS signal' after heading accuracy and roll/pitch accuracy.
	4. Change the storage temperature to -55~+95℃.
	5. Delete line 13 'Status' 'INS status' in [INSPVA data structure].
	6. Add description of other interfaces: two CAN FD and one Ethernet in [Communication Interfaces].
	7. Remove com3 from the description of [Modify COM1 serial port configuration example].
	8. Modify the description statement in [Product Description].
	9. Changed 'vertical' to 'horizontal' in [Installation of GNSS antenna].
	10. Modify the hotline to 400-618-0510 in the footer.
2024.8.22--V4.4	1. Adjust the pin definition order and replace the 'Pin number and position diagram'.
	2. Revised the voltage range of [Power supply specification] to 9~36V DC.

GI320 series
Cost-effective combination navigation

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