GNSS/INS GI420

Technical manual

V3.0

Introduction

GI420 adopts deep 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
- Deeply coupled 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

Horizontal positioning accuracy	Single point positioning-GI420	1.5m
	RTK-GI420	1cm
Elevation positioning accuracy	Single point positioning-GI420	2.5m
	RTK-GI420	2.5cm
Maximum data rate	GNSS Raw observations	20Hz
	GNSS RTK position	20Hz
	INS Combined navigation and positioning	500Hz
	IMU Raw data rate	500Hz

Heading accuracy	Baseline = 1m	0.2°
	Baseline = 2m	0.1°
	Baseline = 4m	0.05°
Attitude accuracy	Static	0.1°
	Dynamic (good GNSS signal)	0.2°

Internal IMU parameters

Gyro range	±400° /s	Gyro Bias Stability	6° /h（10s smooth） 0.5° /h（allan variance）
Accelerometer range	±2g	Accelerometer Bias Stability	50ug（10s smooth）
Output frequency	200Hz		

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
4G	SMA External screw and internal needle	4G Antenna interface
Aviation plug	WS16-9	Aviation plug interface

- **Interface definition**

Type	Color	Description
Power supply	Red	POWER IN
	Black	GND
232	Green	RXD
	Yellow	TXD
422	Brown	A
	Orange	B
	White	Z
	Purple	Y
Other	Blue	NC

- **Serial port settings**

Baud rate	921600 / 460800 / 230400 / 115200 / 19200 / 9600 / 2400
Data bits	8
Default configuration	115200 8 Data bits 1 Stop bit No parity
Serial port optional	422 / 232

Product List

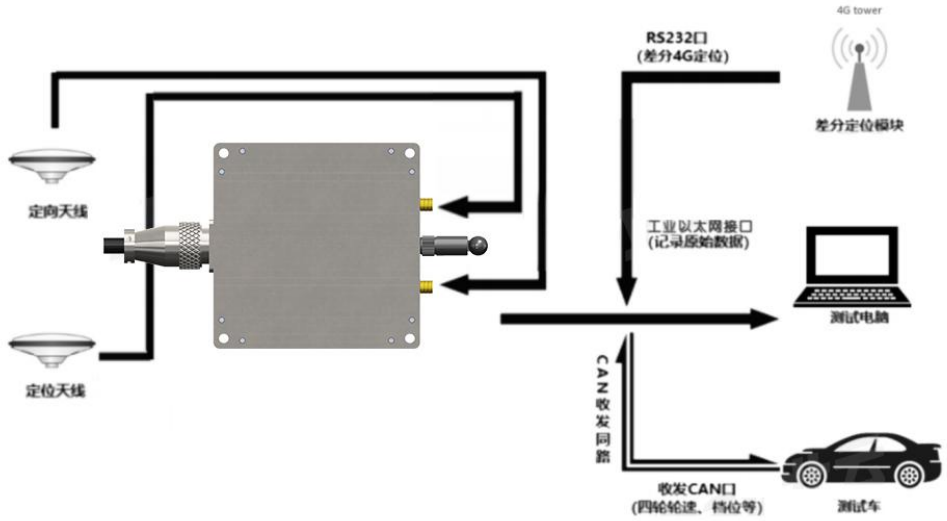
GI420	GIDL X 1	GPS antenna（Mushroom head） X 2	RF cable X 2	4G antenna X1

Installation and Requirements

- **Power Requirements**

9~24VDC Power 10W

- **Connection relationship**



Mode configuration

- **Mobile station model**

Automatically identify differential data input by serial port, support RTCM3.2

Differential text can also use the differential positioning service provided by Qianxun through the built-in 4g module

Raw observation data output

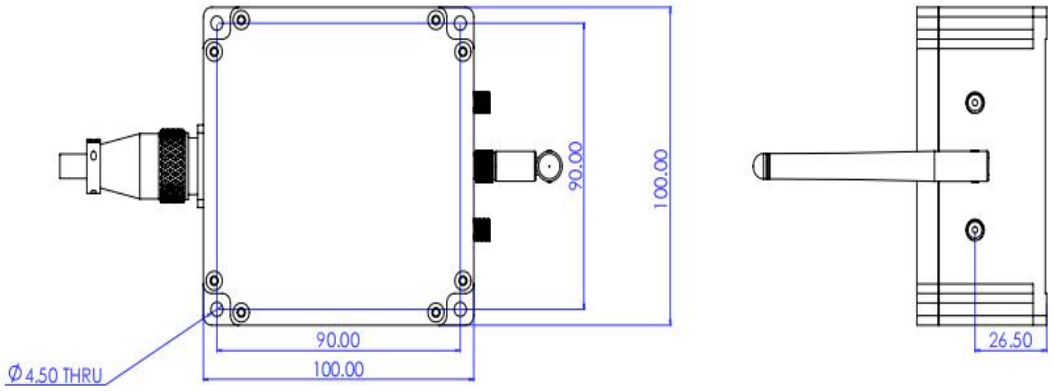
Differential data acquisition

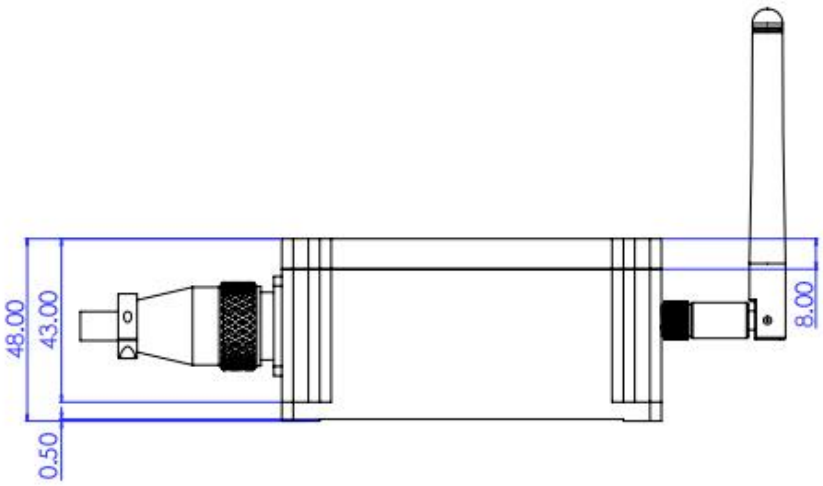
- **Qianxun SI**
- **Self-base station**

Product feature

Package product size

Product size：L100*W100*H48（mm）





Command configuration

Annex 1: Configuration instructions

Bewis sensor high-precision integrated navigation input command supports simplified ASCII format. The simplified ASCII format without parity digit is more convenient for user's command input. All commands consist of a command header and configuration parameters (the parameter part can be empty, then the command has only one command header), and the header field contains the command name or message header. Common commands are shown in the following table:

Command	Description
config com1 115200	Set com1 baud rate to 115200 You can set com1, com2, com3 to any baud rate of 2400, 9600, 19200, 115200, 230400, 460800, 921600
version	Query version number
unlog	Disable all output of the current serial port
Inspvaa 1	Output integrated navigation and positioning results, frequency: 1Hz
saveconfig	Save configuration

Serial port configuration

The serial port is the interface for the receiver to input and output data. The configuration command for the serial port uses CONFIG as the command header, followed by the device and serial port properties, which are used to set the baud rate, data bits, parity and stop bit characteristics of the serial port.

The High Precision Combination Navigation supports 2 serial ports, com1 and com2, both of which are functionally identical, but the data input and output of each port works independently in its own configuration.In addition, the two serial ports can be configured with each other, i.e. com1 can configure the serial port properties of com2, while com2 can configure the serial port properties of com1.

The command format is:

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

Simplified ASCII syntax:

CONFIG COM1 115200

List of serial device parameters

Command headers	Serial device	Serial port parameters	Parameter Description
CONFIG	COM1 COM2	Baud rate	Set the baud rate of the serial port

Inertial navigation installation angle configuration

This command is used to set the installation angle of the IMU relative to the XYZ direction of the carrier, so that the XYZ axis direction of the receiver inertial navigation device is consistent with the XYZ axis direction of the carrier.

The command format is:

CONFIG INS ANGLE [parameter] Simplified ASCII syntax:

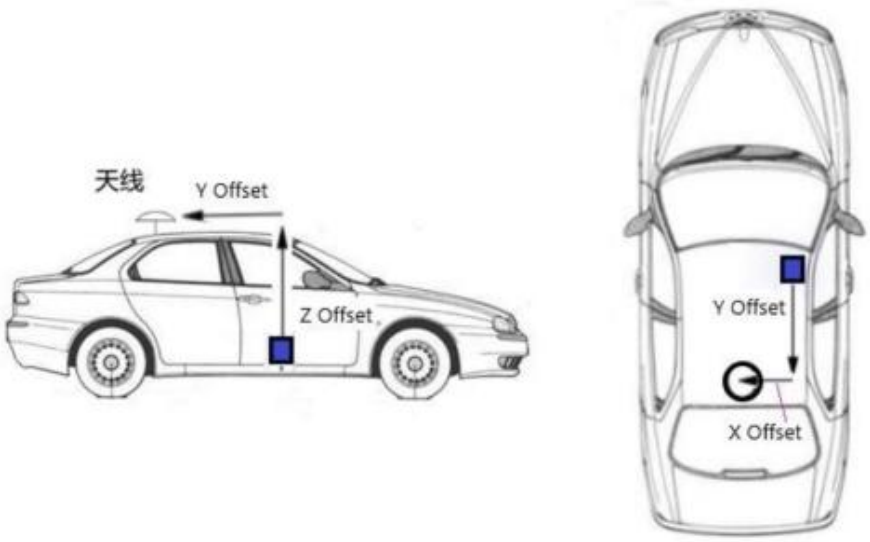
CONFIG INS ANGLE 0 9000 18000

Configure INS Mounting Corner

command header	Device	Angle	No.	Parameter	Parameter Description
CONFIG	INS	ANGLE	1	ANGLEX	The rotation angle of the X-axis of the inertial navigation module relative to the X-axis of the carrier coordinate (right-hand screw); unit: 0.01 degrees; range: 0-36000
			2	ANGLEY	The rotation angle of the Y-axis of the inertial navigation module relative to the Y-axis of the carrier coordinate (right-handed helix); unit: 0.01 degrees; range: 0-36000
			3	ANGELZ	The rotation angle of the inertial navigation module Z-axis relative to the carrier coordinate Z-axis (right-handed helix); unit: 0.01 degrees; range: 0-36000

IMU to main antenna mast arm parameter configuration

Use this command to enter the offset between the IMU and the GNSS main antenna phase center, the inertial to main antenna mast arm parameter. When measuring lever arm parameters, it should be as accurate as possible, especially in RTK mode, the error is preferably within 1mm. Any errors in the lever arm parameters will translate directly into errors in the inertial navigation system position. X, Y, and Z represent the vectors from the IMU to the phase center of the main antenna. The a, b and c fields are used to enter any possible errors in the measurement. For example, if the 'X' offset is measured in centimeters, enter 0.01 in the 'a' field. To improve accuracy, install the IMU as close as possible to the main GNSS antenna in the horizontal direction.



Offset of IMU to antenna phase centre

Command format:

CONFIG IMUTOANT OFFSET x y z [a] [b] [c]

Simplified ASCII syntax:

CONFIG IMUTOANT OFFSET 0.54 0.32 1.20 0.03 0.03 0.05

IMU to main antenna mast arm parameter

Command header	Parameter	Parameter Description
CONFIG IMUTOANT OFFSET	X	Offset in X direction, unit: meter, range -100~100
	Y	Offset in Y direction, unit: meter, range -100~100
	Z	Offset in Z direction, unit: meter, range -100~100
	a	The error of the offset in the X direction, unit: meters, range 0.01~10; (default is 10% of x-direction offset to minimum 0.01 m)

	b	The error of the offset in the Y direction, unit: meters, range 0.01~10; (default is 10% of y-direction offset to minimum 0.01 m）
	c	The error of the offset in the Z direction, unit: meters, range 0.01~10; (default is 10% of y-direction offset to minimum 0.01 m）

CONFIG QXWZ Configure QIANXUN Account

This command will set the QIANXUN account username。

The command format is:

CONFIG QXWZ [options] [message]

Simplified ASCII syntax:

CONFIG QXWZ USER xxxxxx

CONFIG QXWZ The command parameters are as follows

Command header	Account Number	Account Options	Account information
CONFIG	QXWZ	USER	xxxxxx
		PWD	xxxxxx

CONFIG DIFFERENTIAL DATA Configuring a differential data source

This command will set the differential data source.
The command format is:
CONFIG DIFFERENTIAL DATA [options]
Simplified ASCII syntax:

CONFIG DIFFERENTIAL DATA EXTERNAL

CONFIG DIFFERENTIAL DATA command are as follows

Command header	Options	Parameter	Parameter Description
CONFIG	DIFFERENTIAL DATA	EXTERNAL	External differential data acquisition
		BUILT-IN	Internal acquisition of differential data

NMEA0183 Output statement:

GNGGA GNSS multi-system joint positioning data

This command sets the current serial port or the specified serial port to output the result of the joint multi-system positioning. The output information contains the time and positioning-related data of the GNSS receiver. The statement starts with GNGGA. When only GPS satellite systems are involved, the output is GPGGA; when only BDS satellite systems are involved, the output is BDGGA; when only GLONASS satellite systems are involved, the output is GLGGA; when only Galileo satellite systems are involved, the output is GAGGA. When only the Galileo satellite system is involved, it is output as GAGGA. When two or more satellites are involved in the solution, it is output as GNGGA.

Simplified ASCII format:

GNGGA 1 Output 1Hz GNGGA message at the current serial port

GNGGA COM2 1 Output 1Hz GNGGA information 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	Symbol	Example
1	$GNGGA	Log header		$GNGGA
2	utc	The time in UTC corresponding to the location,hh/mm/ss.ss	hhmmss.ss	173568.00
3	lat	Latitude (DDmm.mm)	llll.ll	3251.2654
4	Lat dir	Latitude direction (N = North, S = South)	a	N
5	lon	Longitude (DDDmm.mm)	yyyyy.yy	12033.3592
6	lon dir	Longitude direction (E = East, W = West)	a	E
7	qual	GPS Quality Indicator 0 = Position not available or invalid 1 = Single point fix	x	1

		2 = Pseudorange differential or SBAS position 4 = RTK fixed solution 5 = RTK floating point solution 6 = Inertial guidance positioning 7 = User set position (Fixed Position)		
8	# sats	The number of satellites in use. May not match the number seen does not match	xx	10
9	hdop	Horizontal accuracy factor	x.x	1.0
10	alt	Elevation of the antenna, below the geoid is a negative value.	x.x	1021.45
11	a-units	Antenna altitude units (M = m)	M	M
12	undulation	Geodetic Gap - Distance between the geoid and WGS84 ellipsoid. Geodetic is positive if the geoid is above the ellipsoid, otherwise otherwise, a negative value.	x.x	-17.183
13	u-units	Geopotential Gap Units (M = m)	M	M
14	age	Difference data age in seconds	xx	(00 when differential data is not available)
15	stn ID	Differential base station ID, 0000-4096	xxxx	(00 when differential data is not available)
16	*xx	Checksum	*hh	*3F
17	[CR][LF]	Statement terminator		[CR][LF]

IMU raw data information

This statement contains an indication of the IMU status and the measured values of the accelerometer and gyroscope 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	Week Seconds
4	Z Accel Output	Velocity along Z-axis.
5	Y Accel Output	Velocity along Y-axis.
6	X Accel Output	Velocity along X-axis.
7	Z Gyro Output	Angular variation of the right-hand helix along the Z-axis.
8	Y Gyro Output	Angular variation of the right-hand helix along the Y-axis.
9	X Gyro Output	Angular variation of the right-hand helix along the X-axis.
10	*xx	Checksum
11	[CR][LF]	Statement terminator

INSPVA Combined Navigation Position, Speed and Attitude Information

Set the output of the combined navigation position, ASCII statement starting with "#INSPVA"

Recommended input:

INSPVAA 1

INSPVA data structure

ID	Field	Data description
1	$INSPVA	Log header
2	Week	GNSS Week
3	Seconds	Week Seconds
4	Latitude	Latitude (WGS84) [degrees]
5	Longitude	Longitude (WGS84) [degrees]
6	Height	Ellipsoidal height (WGS84) [m]
7	East Velocity	Eastward velocity (negative values are southward) [m/s]
8	North Velocity	Northward velocity (negative for westward) [m/s]

9	Up Velocity	Skyward speed [m/s]
10	Roll	Roll angle (right hand helix along Y-axis) [degrees]
11	Pitch	Pitch angle (right hand helix along X axis) [deg]
12	Azimuth	Heading angle, counterclockwise from north (right hand helix around Z axis), this is the inertial azimuth angle calculated from the IMU gyro by the combination filter
13	Status	INS state
14	xxxx	32-bit CRC
15	[CR][LF]	Statement terminator (ASCII only)

INSPVB Combined Navigation Position, Velocity and Attitude Information

Set the output of the combined navigation position with a binary statement starting with "#INSPVB"

Recommended input:

INSPVAB 1

INSPVB data structure

ID	Field		Data Description	Type	Number of bytes	Byte Offset
1	Synchronised 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	Week Seconds	Double	8	16
		Latitude	latitude (WGS84) [degrees]	Double	8	24
		Longitude	Longitude (WGS84) [degrees]	Double	8	32
		Height	Ellipsoidal height (WGS84) [m]	Double	8	40
		East Velocity	Eastward velocity (negative	Double	8	48

			values are southward) [m/s]			
		North Velocity	Northward velocity (negative for westward) [m/s]	Double	8	56
		Up Velocity	Skyward speed [m/s]	Double	8	64
		Roll	Transverse roll angle (right-hand helix along Y-axis) [degrees]	Double	8	72
		Pitch	Pitch angle (right hand helix along X-axis) [deg]	Double	8	80
		Azimuth	Heading angle, counterclockwise from north (right hand helix around Z axis), this is the inertial azimuth angle calculated from the IMU gyro by the combination filter	Double	8	88
		Status	INS state	Enum	1	89
7		xxxx	32-bit CRC	Hex	4	93

Inertial guidance solution state

Binary	Fields	Data Description
0	INS_INACTIVE	IMU data stored, but alignment not started; INS not solved
1	INS_ALIGNING	INS alignment mode
2	INS_HIGH_VARIANCE	The INS is in navigation mode but the heading angle error is over the threshold. For most IMUs, the default threshold is 2 degrees. INS solution is still valid, but you should monitor the uncertainty of the solution in the INSSTDEV

		log. When GNSS is used to help INS, you may experience this state
3	INS_SOLUTION_GOOD	Navigation mode is entered and the INS solution is normal
4	INS_SOLUTION_FREE	The INS filter is in navigation mode and the GNSS solution is suspected to be incorrect. This may be due to multipath or limited satellite visibility. The combination filter has rejected the GNSS position and is waiting for its quality to improve
5	INS_ALIGNMENT_COMPLETE	The INS filter is in navigation mode but does not yet have sufficient vehicle dynamics to enable it to meet the indicator.
6	DETERMINING_ORIENTATION	INS is using gravity to determine the IMU axis
7	WAITING_INITIALPOS	INS filter determines IMU orientation and waits for initial position estimate to start alignment process
8	WAITING_AZIMUTH	The INS filter has orientation, initial offset, initial position and effective traverse and pitch estimates. No further work begins until initial orientation is entered
9	INITIALIZING_BIASES	INS filter estimates initial offset for the first 10 seconds of static data
10	MOTION_DETECT	INS filter is not fully aligned, but motion is detected

Other commands

Unlog Stop Serial Output

This command is used to stop the serial port from outputting a specific data message. The configurable parameter [statement] stops the output of the corresponding data

message;

The parameter [port] can be configured to stop the port output. If no port is specified, the general default is the port currently receiving the command; if no message name is specified, all message output will be stopped.

The command format is:

UNLOG [port] [message]

Simplified ASCII syntax

UNLOG Stops all messages on the current serial port

UNLOG GNGGA Stops output of the GNGGA statement to the current serial port

UNLOG COM1 Stops all message output from com1

UNLOG COM2 GNGGA Stop GNGGA statement for com2 output

The Unlog command takes the following parameters

Command header	Port number	Description
UNLOG	COM1 COM2 COM3	Name of the message that will stop being output

Saveconfig Save user configuration

This command saves the current user configuration.

The command format is:

SAVECONFIG

Simplified ASCII syntax:

SAVECONFIG

The Saveconfig command takes the following parameters

Command header	Command parameter	Description
SAVECONFIG	——	Save user configuration

Appendix 1: Binary protocol formats

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	Data segment 0~n Byte	Ending segment 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	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

Integrated 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