FORSENSE
原极科技

High-Precision Dual-Antenna Integrated Navigation System

NAV680-AG

Product manual



Forsense (Shanghai) Technology Co., Ltd

Please read this user manual carefully before using this product.

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Forsense (Shanghai) Technology Co., Ltd

1. Product Introduction

1.1 Packing List

When opening the packaging box, please verify the following items:

Name	Quantity	Illustration
①NAV680-AGIntegrated Navigation System	1	
Satellite Antenna	2	
③ Antenna Cable Primary antenna Model: TNC Male to Fakra Female (Type C) (Blue) Secondary antenna Model: TNC Male to Fakra Female (Type D) (Purple)	2	
④ Antenna Suction Cup	2	
Antenna Mast	2	
⑥ Cable Harness (including 3 RS232, 2 CAN, 1 PPS, and 1 Power Interface (9-24V))	1	

Figure 1 Product Physical Image

If any items are missing, please contact the sales representative promptly.

1.2 Product Overview

To meet the requirements for precise and continuous positioning in low-speed autonomous driving under lightly obstructed scenarios such as farmland, orchards, scenic areas, and outdoors, Forsense is based on our proprietaryIMUmodule and combined algorithm, integratingfull-constellation,full-system,high-precision positioning and orientation module UM982,designedthis satelliteinertialnavigationcombined product NAV680-AG, supporting BDS B1I, B2I, B3I; GPS L1, L2, L5; GLONASS G1, G2; Galileo E1, E5a, E5b; QZSS L1, L2, L5. It does not require a wheel odometry interface. With built-in Forsense multi-model intelligent position fusion algorithms tailored for vehicle-mounted scenarios, it provides high-precision vehicle attitude, heading, continuous positioning, and speed measurement for agricultural machinery, inspection vehicles, scenic area tour buses, and other autonomous driving customers in open-sky or lightly obstructed application scenarios. This supports reliable operation of low-speed autonomous driving across all scenarios and enhances the the terminal application experience of autonomous driving devices.

To meet the requirement of measuring front wheel steering angles in scenarios such as agricultural machinery and mining vehicles, NAV680-AG can be connected to our Front Wheel Steering Angle Sensor G200, which candirectlyoutput steering angle of the front wheel.

1.3 Technical Specifications

Table 1

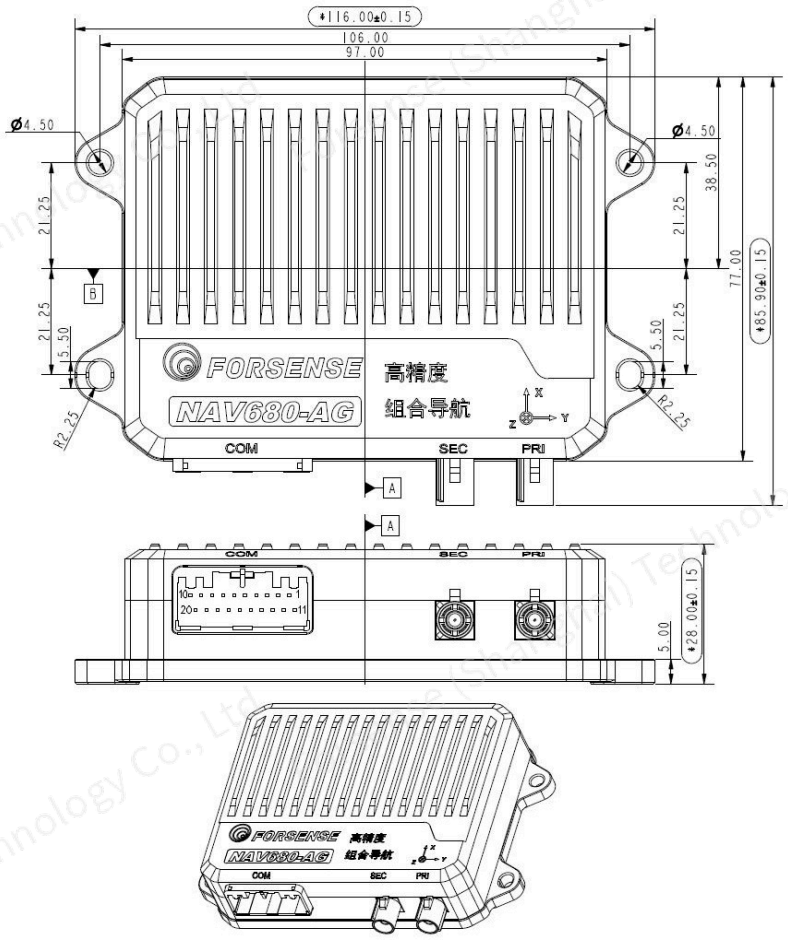
Attitude Accuracy	**Roll/Pitch :<0.2° rms** **Heading:<0.3° rms** **(Vehicle speed > 1 km/h, Ackermann steering vehicle scenarios)**
Update Rate	100hz
Gyroscope Range	±500°/s
Gyroscope Bias instability	4deg/h @1σ

Accelerometer Range	±6g	
Accelerometer Bias stability	0.04mg @1σ	
Position Reckoning Accuracy	<2% @1σ (Vehicle-mounted scenario, Satellite signal loss 30s, combined without wheel speed sensor)	
RTKMetrics	positioning accuracy(RMS)	Single Point: Horizontal 1.5m/Elevation 2.5mRTK: Horizontal 1cm+1ppm Elevation 2cm+1ppm
	Dual antenna Heading Accuracy (RMS)	0.1°/1m baseline
	velocity accuracy(RMS)	0.03m/s
	PPS Accuracy (RMS)	20ns
	Update Rate	10hz
	RTK initialize Time	<5s (Typical)
Interface	3×RS232 2×CAN 2×GNSS Antenna Interface 1×Power Interface 1×PPS Interface	

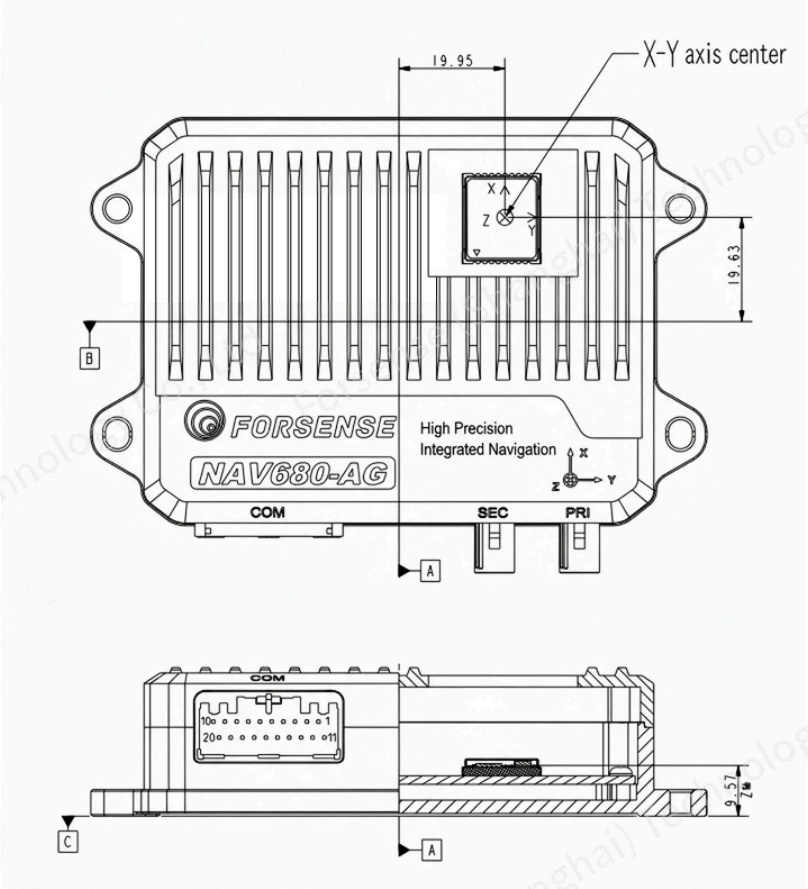
2. Hardware Composition

2.1 2.1 Mechanical Dimensions

Figure2 Mechanical Dimensions (Unit: mm)



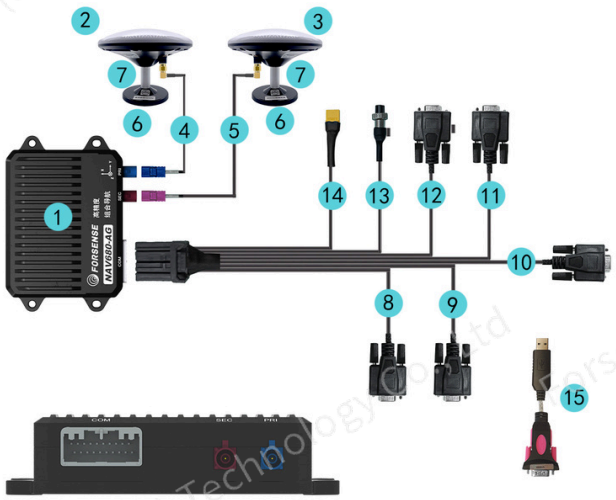
IMUMechanical Center Dimensions



2.2 2.2 Interface Description

NAV680-AG includes a COM bus interface with power and signal lines, PRI Primary antenna and SEC Secondary antenna.





	Name	Quantity
1	FSS-NAV680-AG Integrated Navigation System	1
2	Primary antenna (Positioning Antenna)	1
3	Secondary antenna (Directional Antenna)	1
4	Primary antenna Cable	1
5	Primary antenna Cable	1
6	Antenna suction Cup	2
7	Antenna Pole	2
8	Wire Harness - Power Supply Interface	1
9	Wire Harness - RS232-A Interface	1
10	Wire Harness - RS232-B Interface	1
11	Wire Harness - CAN-A Interface	1
12	Wire Harness - CAN-B Interface	1
13	Wire Harness - RS232-RTK Interface	1
14	Wire Harness - IO Interface	1
	Accessory Name	**Quantity**
15	RS232 to USB Serial Cable	1

2.3 2.3 Data Cable Interface Definition

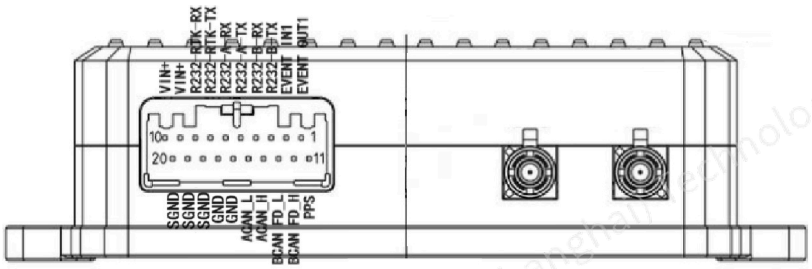
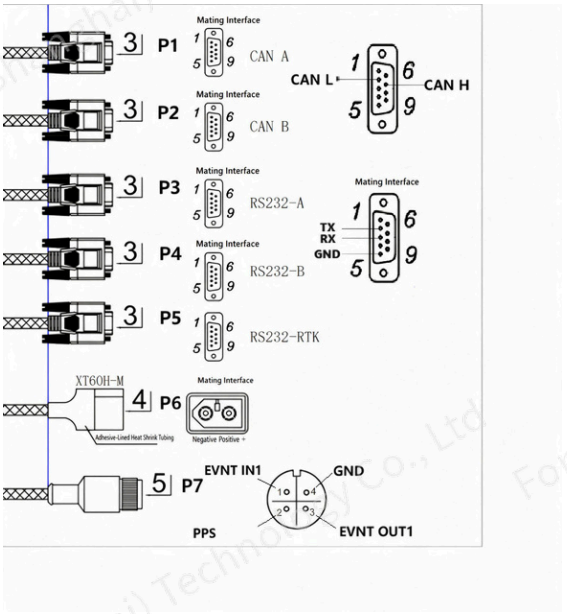


Figure 3 Data Cable Interface Definition Diagram

The definition corresponding to Pin is as follows

Pin Sequence	Definition	Port	

1	EVENT OUT1	IO Port (Reserved)
2	EVENT IN1	
3	MCU TX3 232	RS232-B
4	MCU RX3 232	
5	MCU TX2 232	RS232-A
6	MCU RX2 232	
7	RTK TX1 232	RS232-RTK
8	RTK RX1 232	
9	VIN+	Power Positive 9-24V
10	VIN+	Power Positive 9-24V
11	PPS	RTK PPS Signal
12	BCAN FD_H	CAN_FD B (Reserved)
13	BCAN FD_L	
14	ACAN_H	CAN_ A (Default Baud Rate: 500k)
15	ACAN_L	
16	GND	Ground (GND)
17	GND	
18	SGND	Signal Ground
19	SGND	
20	PGND	Shield Ground



Note: RS232-A Serial Port A, RS232-B Serial Port B, RS232-RTK Serial Port Differential Input, CAN A, CAN B (Undefined), XT60H-M Power, IO (Undefined).

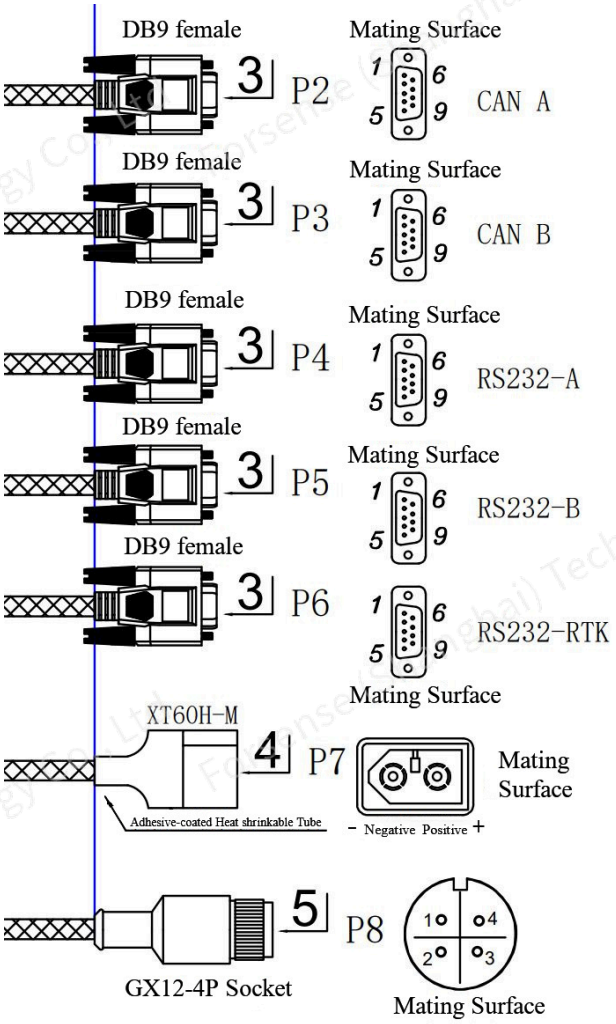
2.4 2.4 ElectricalPhysicalCharacteristics

Table 2

Parameter	Symbol	Min.	Typ.	Max.	Unit
Power Input	VIN	9	12	24	V
Ground (GND)	GND				
Power Consumption	P		1.8		W
Operating Temperature (Tot)	T	-40	\	85	℃
Storage Temperature (Tstg)	T	-40	\	95	℃
Humidity	95%non-condensing				
Dimensions	116*85.9*28mm				
Weight	203g				

3. Hardware Wiring Method

3.1 3.1 Hardware Wiring Method



3.2 3.2 Antenna

NAV680-AG provides PRI and SEC primary Secondary antenna interfaces. When no antenna is connected, the open-circuit voltage measured with a multimeter is DC4.8–5.4V. When the module RF Port is connected to an antenna, under normal temperature conditions with a working current of 30–100mA, it can externally provide antenna bias power of DC4.6V±0.2V. Note the 50-ohm impedance matching between NAV680-AG and the antenna when using active antenna.

4. Usage Example

4.1 Device Installation

1. Installation Requirements

1) single antenna installation. It must be mounted on a carrier and connected to Integrated Navigation. The satellite antenna should face the sky with no obstruction from the carrier. Connect the antenna to the PRI interface shown in Figure 21 for positioning. The installation schematic is shown in Figure 19;

2) Dual antenna Installation. To use the Dual antenna heading function, two antennas (primary and Secondary antenna) must be installed on the carrier and connected to Integrated Navigation. The satellite antennas must face the sky with no obstruction from the carrier. Primary antenna connects to PRI for positioning, and Secondary antenna connects to the SEC interface shown in Figure 21 for heading. The distance between the two antennas, i.e., the baseline length, must be greater than 0.5 m. The heights of the Dual antenna should be kept as consistent as possible. The installation diagram is shown in Figure 20;

3) Keep away from interference sources such as vehicle-mounted electrical components or systems that generate electromagnetic interference signals;

4) Screw the GNSS antenna onto a strong magnetic suction cup and fix it at the center of the test carrier. Place it as high as possible on the test carrier to ensure good GNSS signal reception;

5) For optimal performance, minimize the distance between the GNSS Primary antenna and the device Master, especially the horizontal distance.

6) Securely mount on a rigid plane and avoid locations with significant vibration.

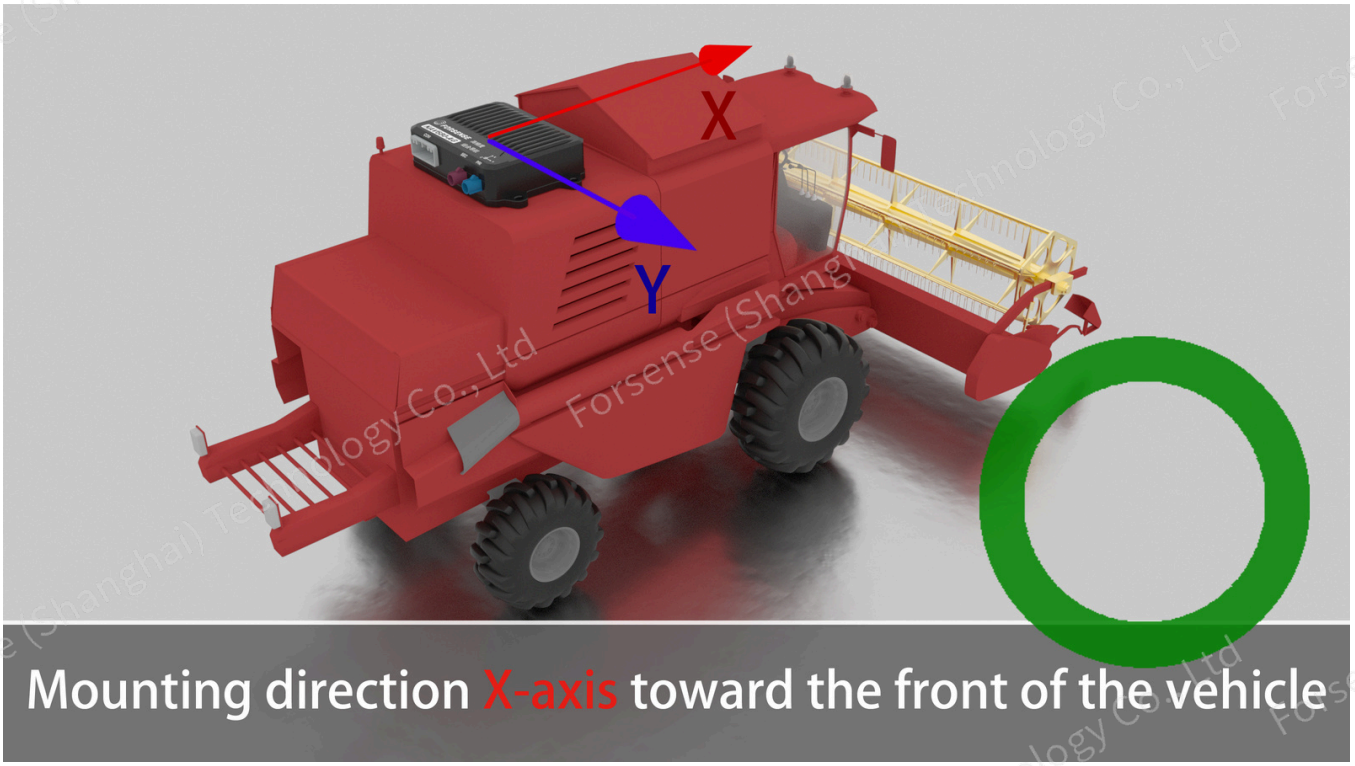
7) The X-axis installation orientation should maintain the relationship described in the figure below relative to the front of the vehicle.

	
single antenna Installation Diagram	Dual antenna Installation Diagram

The correct installation diagram is shown below

X-axis points toward the front of the vehicle

Figure4 Correct Installation Diagram



The following installation methods are allIncorrect Installation.













4.2 RTK Differential Data Import

Users must obtain RTK GPGGA messages via the RS232-RTK interface, log in to the network CORS account on Qianxun SI or Sixents Technology, and import differential data to enable RTK to enter the fixed solution state.

4.3 Parameter Configuration

4.3.1 Configure Primary antenna Lever Arm

For example, configure lever arm vector as X=0.5m, Y=-0.6m, Z=-1.0m

Command: AT+CLUB_VECTOR=0.5,-0.6,-1.0\r\n

Response: GPS_POS_X=0.5,GPS_POS_Y=-0.6,GPS_POS_Z=-1.0\r\n

Note: lever arm vector is the 3D vector (X,Y,Z) of the RTK Primary antenna phase center relative to the IMU phase center, in meters. Where,

Measure the distance from the antenna center to the device center along the X/Y/Z axes of the overall coordinate system to obtain three values: X1 Offset/Y1 Offset/Z1 Offset. Pay attention to the signs.

In the front-right-down vehicle body coordinate system

If the RTK Primary antenna is in front of the IMU, the value is positive; otherwise, it is negative;

If the RTK Primary antenna is to the right of the IMU, the value is positive; otherwise, it is negative;

If the RTK Primary antenna is above the IMU, it is**negative**; otherwise, it is positive (typically, the antenna is above the device).

The coordinate system diagram is shown below: (the label must face upward; if the IMU is not installed as shown in the figure below, configure the installation orientation per Section 8.2.2)

Figure5 Coordinate System Diagram



4.3.2 Configure Rear Axle Center Lever Arm

For example, configure lever arm vector as X=0.5m,Y=-0.6m,Z=1.0m

Command :AT+OD_VECTOR=0.5,-0.6,1.0\r\n

Response :OD_POS_X=0.5,OD_POS_Y=-0.6,OD_POS_Z=1.0\r\n

Note: lever arm vector is the 3D vector (X,Y,Z) of the rear axle center relative to the IMU phase center, in meters. Where,

In the front-right-down vehicle body coordinate system

If the rear axle center is in front of the IMU, the value is positive; otherwise, it is negative;

If the rear axle center is to the right of the IMU, the value is positive; otherwise, it is negative;

If the rear axle center is below the IMU, the value is**positive**; otherwise, it is negative (typically, the rear axle center is below the device).

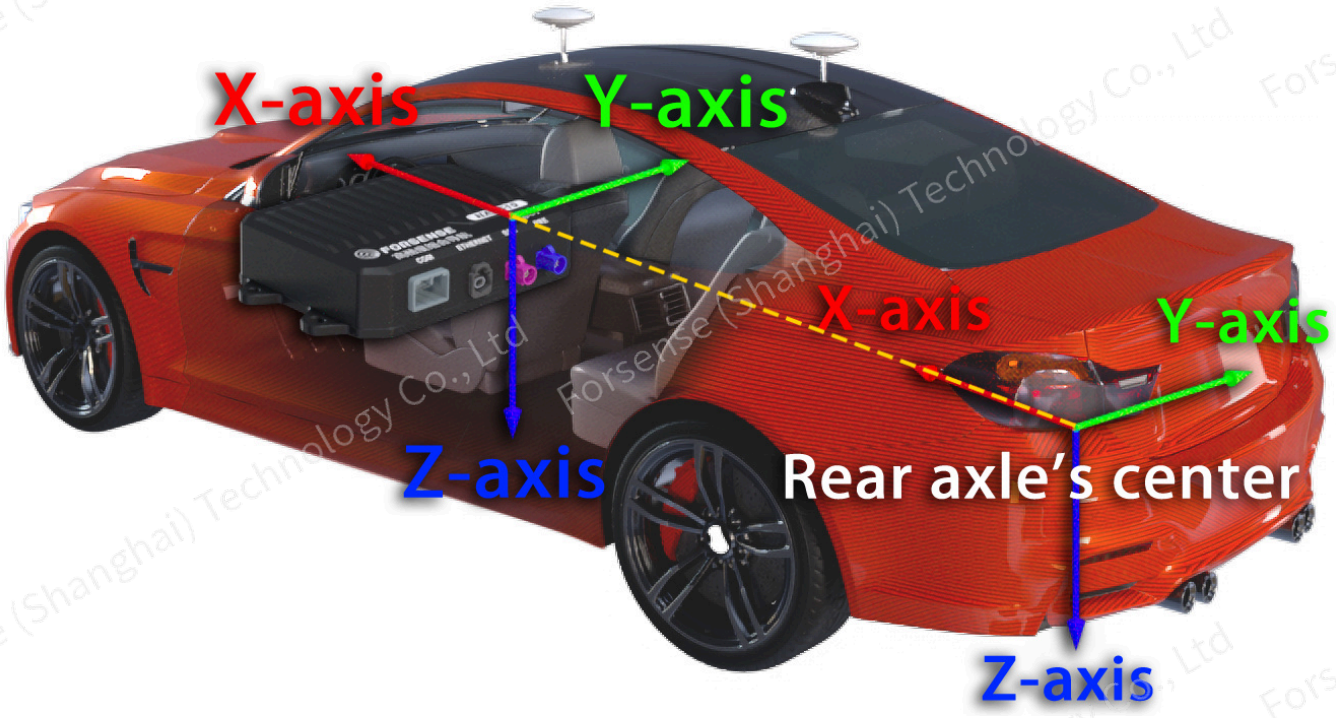


Figure 6 Coordinate System Diagram

4.3.3 Configure Vehicle Wheelbase

If the vehicle wheelbase is configured as 2m, the configuration command is:

AT+WHEEL_BASE=2\r\n

Note: Save the settings after configuring the command.

4.3.4 Configure RTK Dual antenna Installation Angle

If the RTK Dual antenna installation angle is configured as 0 degrees, the configuration command is:

Command : AT+RTK_ANGLE=0\r\n

Response : ANGLE=0\r\n

Description : The installation angle is the angle between the ray from Primary antenna to Secondary antenna and the vehicle heading direction. Clockwise is positive, counterclockwise is negative. The input range for the angle is -180°~180°

Note: Configuration commands take effect after saving and power cycling; the Dual antenna spacing must be greater than 50 cm

4.3.5 Enable Dual antenna fusion

Note: By default, Dual antenna fusion is disabled and used only for rapid initialize when stationary. To use Dual antenna heading throughout, enable Dual antenna fusion using the following command. A value of 1 enables Dual antenna fusion; other Parameter values disable Dual antenna fusion. Ensure synchronous calibration of Dual antenna installation errors to avoid fixed heading offsets relative to the vehicle body.

Command :AT+DRTK_USE=1

Response :OK

Note: Configuration commands take effect after saving and power cycling; the Dual antenna spacing must be greater than 50 cm

4.3.6 Calibrate Dual antenna

Dual antenna calibration procedure is as follows

1. Connect to Serial Port, enter AT+SETNO\r\n to disable all printing

2. Send command AT+RTK_BIAS_EST=1\r\n to start the calibration process

3. Drive the vehicle straight at a speed of no less than 3 km/h; when Serial Port returns RTK_BIASE_CORRECT_DONE, calibration is successful

4. Send the AT+CONFIG\r\n command to view the output RTK_BIAS_FLAG_AND_VALUE=99,XX (calibration angle); verify if it is reasonable, which should be less than 1 degree under normal installation conditions

5. Enter AT+SAVE\r\n to save the results and power cycle the device

4.3.7 Configure the position and velocity output projection points of Integrated Navigation

To configure the output of the projection points result set by Integrated Navigation, use the following command:

Command: AT+PROJ_VECTOR=1.0,2.0,3.0\r\n

Response: PROJ_VECTOR_X=1.0, PROJ_VECTOR_Y=2.0, PROJ_VECTOR_Z=3.0\r\n

Description: Integrated Navigation outputs antenna phase center coordinates by default. To output coordinates for other positions, configure the lever arm vector of the IMU phase center relative to this projection points position using the same method as7.1.1 Lever Arm Configuration

4.4 Save Parameter

After all configuration commands are set, send the save Parameter command "AT+SAVE\r\n"

5. Coordinate System Definition

Figure7 Coordinate System Schematic



This product uses the Front-Right-Down (FRD) coordinate system. The Euler angle ranges are as follows:

Rotation about the Z-axis: Yaw angle Yaw range: 0° to 360°;

Rotation about the X-axis: Roll angle Roll range: -180° to 180°;

Rotation about the Y-axis: Pitch angle Pitch range: -90° to 90°.

6. Integrated Navigation Output Protocol

6.1 Binary Protocol - AG Data Stream

Note:

- The CRC check starts from Frame header, excluding the CRC check bits themselves, and covers all bytes in the frame. For calculation methods and examples, refer to the appendix.
- The frame length is the total number of data bytes excluding Frame header, Frame ID, Frame Length, and Checksum.
- little-endian mode, send the low byte first.

Table3 Binary Protocol - AG Data Stream

Content	Type	Relative Position
Frame header 1:0xAA	Uint8	0
Frame header 2:0x55	Uint8	1
Frame ID: 0x0156	Uint16	2
Frame Length: 0x0032	Uint16	4
seconds in GPS week(ms)	Uint32	6
Roll angle (deg)	Float	10
Pitch angle (deg)	Float	14
Yaw angle (deg)	Float	18
Reserved	Float	22
3-Axis Angular velocity (deg/s, Forward-Right-Down)	Float*3	26
3-Axis Acceleration (g, Forward-Right-Down)	Float*3	38
RTK Positioning Status	Uint8	50
Attitude significant bits Bit0: 1 indicates valid attitude, 0 invalid Bit1: 1 indicates valid front wheel steering angle, 0 invalid	Uint8	51
Status bits: bit0: 1 indicates RTK data is valid, 0 indicates invalid Bit1: 1 indicates PPS signal is valid, 0 indicates invalid Bit2: 1 indicates Integrated Navigation has been initialize, 0 indicates not initialize (single antenna initialize conditions: RTK positioning status 4 + speed reaches above 0.5 m/s + straight-line driving with acceleration/deceleration, Dual antenna initialize Condition: RTK Positioning Status 4+RTK Orientation status 50) Bit3: 1 indicates front wheel steering angle is valid, 0 invalid Bit4: 1 indicates Integrated Navigation has converged, 0 indicates not converged Bit5: 1 indicates front wheel gyroscope data is valid, 0 indicates invalid (ignore if no external gyroscope) Bit6: 1 indicates steering motor data is valid, 0 indicates invalid Bit7,Bit8: 01 indicates vehicle moving forward (Bit7=1, Bit8=0) 10 indicates vehicle reversing (Bit7=0, Bit8=1) 00 indicates invalid (Bit7=0, Bit8=0)	Uint32	52

CRC Checksum	Uint32	56

6.2 Binary Protocol - Integrated Navigation Data Stream

Note:

- The CRC check starts from Frame header and does not include the CRC check bits themselves. It covers all bytes in the frame. For the calculation method and examples, refer to the appendix.
- Frame length is the total number of data bytes excluding Frame header, Frame ID, Frame Length, and Check Bits.
- little-endian mode, send the low byte first.
- For configuration methods, see7Section .1.9,Command: AT+SETNAV\r\n
- Cannot be output simultaneously with the NMEA data stream. If the binary protocol is enabled, the NMEA data stream cannot be output. Before switching data streams, press7.1.11 the command AT+SETNO\r\n to stop the current data stream output.

Content	Type	Relative Position
Frame header 1:0xAA	Uint8	0
Frame header 2:0x55	Uint8	1
Frame ID: 0x0166	Uint16	2
Frame Length: 0x005E	Uint16	4
seconds in GPS week(ms)	Uint32	6
GPS week number count	Uint16	10
Latitude (deg × 10000000)	Int32	12
Longitude (deg × 10000000)	Int32	16
Altitude (mm)	Int32	20
North Velocity (m/s)	Float	24
East Velocity (m/s	Float	28
Down Velocity (m/s)	Float	32
Roll angle (deg)	Float	36
Pitch angle (deg)	Float	40
Yaw angle (deg)	Float	44
single antenna: AHRS Heading(deg)(No Reference Value) In the case of Dual antenna: RTK Dual antenna Heading (deg) When the G200 front wheel gyroscope is connected: Front Wheel Gyroscope Z-axis Angular velocity(deg/s)	Float	48
Reserved (Displays as Front Wheel Angle when G200 is connected)	Float	52
Accelerometer X-axis (g)	Float	56
Accelerometer Y-axis (g)	Float	60
Accelerometer Z-axis (g)	Float	64
Gyroscope X-axis (deg/s)	Float	68
Gyroscope Y-axis (deg/s)	Float	72
Gyroscope Z-axis (deg/s)	Float	76

IMU Temperature (°C)	Float	80
RTK Positioning Status (Same as Fix Quality in GGA) 0: No Fix 1: single point positioning 2: Pseudo-range differential positioning 4:fixed solution 5:floating solution	Uint8	84
Number of Satellites	Uint8	85
differential delay	Uint8	86
Dual antenna Orientation status 50 indicates heading is determined Other values indicate heading is not determined	Uint8	87
Position Dilution of Precision (DOP) (cm) Valid after Integrated Navigation initialize	Uint16	88
Status bits: bit0: 1 indicates valid RTK data, 0 indicates invalid Bit1: 1 indicates valid PPS signal, 0 indicates invalid Bit2: 1 indicates Integrated Navigation has been initialize, 0 indicates not initialize (single antenna initialize conditions: RTK positioning status 4 + speed above 0.5 m/s + straight-line driving with acceleration and deceleration, Dual antenna initialize Condition: RTK Positioning Status 4 + RTK Orientation status 50) Bit3: 1 indicates the front wheel steering angle is valid, 0 indicates invalid Bit4: 1 indicates Integrated Navigation has converged, 0 indicates not converged Bit5: 1 indicates front wheel gyroscope data is valid, 0 indicates invalid (ignore if no external gyroscope) Bit6: 1 indicates steering motor data is valid, 0 indicates invalid Bit7,Bit8: 01 indicates vehicle moving forward (Bit7=1, Bit8=0) 10 indicates vehicle reversing (Bit7=0, Bit8=1) 00 indicates invalid (Bit7=0, Bit8=0)	Uint16	90
Reserved 1	Uint32	92
Reserved 2	Uint32	96
CRC Check	Uint32	100

6.3 NMEA Protocol

- Supports output of fused data in NMEA format
- Cannot be output simultaneously with the binary data stream. If the NMEA data stream is enabled, the binary data stream cannot be output. Before switching data streams, stop the current data stream output using the command described in Section 7.2.2.
- Currently supports the following sentences. For configuration methods, refer to Chapter 7.3

GPGGA

Message Description (Chinese)

Field	Structure	Description	Style	Example
1	$GPGGA	Message Header		$GPGGA
2	utc	UTC Time (Hour/Minute/Second/Fractional Second)	hhmmss.ss	202134
3	lat	Latitude (DDmm.mm)	llll.ll	5106.9847
4	lat dir	Latitude Direction (N = North, S = South)	a	N
5	lon	Longitude (DDDmm.mm)	yyyyy.yy	11402.2986
6	lon dir	Longitude Direction (E = East, W = West)	a	W
7	quality	Solution Status	x	1
8	# sats	Number of satellites used in the solution, which may differ from the number of visible satellites	xx	2
9	hdop	Horizontal Dilution of Precision (DOP)	x.x	1
10	alt	Antenna height above or below sea level	x.x	1062.22
11	a-units	Antenna height unit (M = metres)	M	M

12	undulation	Elevation Outlier	x.x	-16.271
13	u-units	Elevation Outlier Unit (M = metres)	M	M
14	age	Differential Age of Data, s	xx	1
15	stn ID	Differential Base Station ID	xxxx	8
16	*xx	Checksum	*hh	*48
17	[CR][LF]	Sentence Terminator		[CR][LF]

Official Message Description

Field	Structure	Description	Symbol	Example
1	$GPGGA	Log header		$GPGGA
2	utc	UTC time status of position (hours/minutes/seconds/ decimal seconds)	hhmmss.ss	202134.00
3	lat	Latitude (DDmm.mm)	llll.ll	5106.9847
4	lat dir	Latitude direction (N = North, S = South)	a	N
5	lon	Longitude (DDDmm.mm)	yyyyy.yy	11402.2986
6	lon dir	Longitude direction (E = East, W = West)	a	W
7	quality	refer to Table: GPS Quality Indicators	x	1
8	# sats	Number of satellites in use. May be different to the number in view	xx	10
9	hdop	Horizontal dilution of precision	x.x	1.0
10	alt	Antenna altitude above/below mean sea level	x.x	1062.22
11	a-units	Units of antenna altitude (M = metres)	M	M
12	undulation	Undulation - the relationship between the geoid and the WGS84 ellipsoid	x.x	-16.271
13	u-units	Units of undulation (M = metres)	M	M
14	age	Age of correction data (in seconds) The maximum age reported here is limited to 99 seconds.	xx	(empty when no differential data is present)
15	stn ID	Differential base station ID	xxxx	(empty when no differential data is present)
16	*xx	Check sum	*hh	*48
17	[CR][LF]	Sentence terminator		[CR][LF]

GPS Quality Indicators

Indicator	Description
0	Fix not available or invalid
1	Single point
	Converging PPP (TerraStar-L)
2	Pseudorange differential
	Converged PPP (TerraStar-L)
	Converging PPP (TerraStar-C PRO, TerraStar-X)
4	RTK fixed ambiguity solution
5	RTK floating ambiguity solution
	Converged PPP (TerraStar-C PRO, TerraStar-X)
6	Dead reckoning mode
7	Manual input mode (fixed position)
8	Simulator mode
9	WAAS (SBAS)[1]

GPRMC

Message Description (Chinese)

Field	Structure	Description	Style	Example
1	$GPRMC	Message Header		$GPRMC
2	utc	Fixed UTC Time	hhmmss.ss	144326
3	pos status	Positioning Status (A for Valid Positioning, V for Invalid Positioning)	A	A
4	lat	Latitude (DDmm.mm)	llll.ll	5107.0017737
5	lat dir	Latitude Direction (N = North, S = South)	a	N
6	lon	Longitude (DDDmm.mm)	yyyyy.yy	11402.3291611
7	lon dir	Longitude Direction (E = East, W = West)	a	W

8	speed Kn	Ground Speed	x.x	0.08
9	track true	Ground Course, Referenced to True North	x.x	323.3
10	date	UTC Date: (Year/Month/Day)	xxxxxx	210307
11	mag var	Magnetic Variation	x.x	0
12	var dir	Magnetic Variation Direction	a	E
13	mode ind	Positioning Mode Indicator	a	A
14	*xx	Checksum	*hh	*20
15	[CR][LF]	Sentence Terminator		[CR][LF]

Official Message Description

Field	Structure	Description	Symbol	Example
1	$GPRMC	Log header		$GPRMC
2	utc	UTC of position	hhmmss.ss	144326.00
3	pos status	Position status (A = data valid, V = data invalid)	A	A
4	lat	Latitude (DDmm.mm)	llll.ll	5107.0017737
5	lat dir	Latitude direction: (N = North, S = South)	a	N
6	lon	Longitude (DDDmm.mm)	yyyyy.yy	11402.3291611
7	lon dir	Longitude direction: (E = East, W = West)	a	W
8	speed Kn	Speed over ground, knots	x.x	0.080
9	track true	Track made good, degrees True	x.x	323.3
10	date	Date: dd/mm/yy	xxxxxx	210307
11	mag var	Magnetic variation, degrees Note that this field is the actual magnetic variation and will always be positive. The direction of the magnetic variation is always positive.	x.x	0.0
12	var dir	Magnetic variation direction E/W Easterly variation (E) subtracts from True course. Westerly variation (W) adds to True course.	a	E
13	mode ind	Positioning system mode indicator, see Table: NMEA Positioning System Mode Indicator	a	A
14	*xx	Check sum	*hh	*20
15	[CR][LF]	Sentence terminator		[CR][LF]

NMEA Positioning System Mode Indicator

Mode	Indicator
A	Autonomous
D	Differential
E	Estimated (dead reckoning) mode
M	Manual input
N	Data not valid

GPHDT (Heading Information)

Message Description in Chinese

Field	Structure	Description	Style	Example
1	$GPHDT	Message Header		$GPHDT
2	heading	Yaw angle	x.x	75.5554
3	TRUE	True North Angle	T	T
4	*xx	Checksum	*hh	*36
5	[CR][LF]	Statement Terminator		[CR][LF]

Official Message Description

Field	Structure	Description	Symbol	Example
1	$GPHDT	Log header		$GPHDT
2	heading	Heading in degrees	x.x	75.5554
3	True	Degrees True	T	T
4	*xx	Check sum	*hh	*36
5	[CR][LF]	Sentence terminator		[CR][LF]

GPVTG (Ground Speed Information)

Message Description in Chinese

Field	Structure	Description	Style	Example
1	$GPVTG	Message Header		$GPVTG
2	track true	Heading, referenced to True North	x.x	24.168
3	T	True North Indicator	T	T
4	track mag	Heading, referenced to Magnetic North	x.x	24.168
5	M	Magnetic North Indicator	M	M
6	speed Kn	Horizontal Velocity	x.x	0.4220347
7	N	Velocity Indicator, Knots	N	N
8	speed Km	Horizontal Velocity, km/s	x.x	0.781608
9	K	Velocity Indicator (K = km/hr)	K	K
10	mode ind	Positioning Mode Indicator	a	A
11	*xx	Checksum	*hh	*7A
12	[CR][LF]	Statement Terminator		[CR][LF]

Official Message Description

Field	Structure	Description	Symbol	Example
1	$GPVTG	Log header		$GPVTG
2	track true	Track made good, degrees True	x.x	24.168
3	T	True track indicator	T	T
4	track mag	Track made good, degrees Magnetic; Track mag = Track true + (MAGVAR correction) See the **MAGVAR** command	x.x	24.168
5	M	Magnetic track indicator	M	M
6	speed Kn	Speed over ground, knots	x.x	0.4220347
7	N	Nautical speed indicator (N = Knots)	N	N
8	speed Km	Speed, kilometres/hour	x.x	0.781608
9	K	Speed indicator (K = km/hr)	K	K
10	mode ind	Positioning system mode indicator, see Table: NMEA Positioning System Mode Indicator	a	A
11	*xx	Check sum	*hh	*7A
12	[CR][LF]	Sentence terminator		[CR][LF]

NMEA Positioning System Mode Indicator

Mode	Indicator
A	Autonomous
D	Differential
E	Estimated (dead reckoning) mode
M	Manual input
N	Data not valid

GPZDA (UTC Time and Date)

Message Description in Chinese

Field	Structure	Description	Style	Example
1	$GPZDA	Message Header		$GPZDA
2	utc	UTC Time	hhmmss.ss	220238
3	day	Day, 01 -31	xx	15
4	month	Month, 01 -12	xx	7
5	year	Year	xxxx	1992
6	null	Local Area Code, Not Available	xx	(empty when no data is present)
7	null	Local Zone Minute Description, Not Available	xx	(empty when no data is present)
8	*xx	Checksum	*hh	*6F
9	[CR][LF]	Statement Terminator		[CR][LF]

Official Message Description

Field	Structure	Description	Symbol	Example
1	$GPZDA	Log header		$GPZDA
2	utc	UTC time status	hhmmss.ss	220238.00
3	day	Day, 01 to 31	xx	15
4	month	Month, 01 to 12	xx	07
5	year	Year	xxxx	1992
6	null	Local zone description—not available Local time zones are not supported by OEM7 family receivers. Fields 6 and 7 are always null.	xx	(empty when no data is present)
7	null	Local zone minutes description—not available	xx	(empty when no data is present)
8	*xx	Check sum	*hh	*6F
9	[CR][LF]	Sentence terminator		[CR][LF]

GPATT (Forsense Custom Message)

Name	Unit	Format	Example	Description
Message Header		String	$GNATT	
UTC Time		hhmmss.sss	170834.000	17:08:34 UTC
Status		Character	1	0: Invalid, 1: Valid
Roll angle	degree	3 decimal place	-4.891	Range ±180°, defined as right-down positive Positive
Roll angle Indicator		Character	R	Roll angle Indicator
Pitch angle	degree	3 decimal place	3.122	Range is ±90°, defined as positive upward is positive
Pitch angle Indicator		Character	P	Pitch angle Indicator
Yaw angle	degree	3 decimal place	124.005	Range is 0° to 360°, referenced to True North, clockwise rotation is positive
Roll angle Uncertainty	degree	3 decimal place	0.432	Range: 0~360
Pitch angle Uncertainty	degree	3 decimal place	0.811	Range: 0~360
Yaw angle Uncertainty	degree	3 decimal place	1.202	Range: 0~360
Checksum		HEX	*68	Used to check for transmission errors

The GPATT format is shown in the table below

Name	*Unit*	*Format*	*Example*	*Description*
Sentence Identifier		String	$GNATT	
Time		hhmmss.sss	170834.000	17:08:34 UTC
Status		Character	1	0: invalid 1: valid
Roll Angle	degree	3 decimal places	-4.891	range ±90, right side down defined as positive
Indicator for roll		character	R	Roll indicator
Pitch Angle	degree	3 decimal places	3.122	range ±90, head up defined as positive
Indicator for Pitch		character	P	Pitch indicator
Heading Angle	degree	3 decimal places	124.005	range 0~360, to true North, counter clockwise defined as positive
Roll Angle uncertainty	degree	3 decimal places	0.432	range 0~360
Pitch Angle uncertainty	degree	3 decimal places	0.811	range 0~360
Heading Angle uncertainty	degree	3 decimal places	1.202	range 0~360
Checksum		Hex	*68	Used by program to check for transmission errors

GPCHC (Forsense Custom Message: GPCHC Data Protocol)

GPCHC The format is shown in the table below

$GPCHC,GPSWeek,GPSTime,Heading,Pitch,Roll,gyrox,gyroy,gyroz,accx,accy,accz,Lattitude,Longitude,Altitude,Ve,Vn,Vu,V,NSV1,NSV2,Status,Age,WarmingCs<CR><LF>

Note: If the system status does not indicate initialize, it represents GNSS results, including position, velocity, and attitude (the lower nibble of Status: 0 and 1 are GNSS data; 2 and 3 are fused data)

Field	Name	Description	Format	Example
1	Header	GPCHC Protocol Header	$GPCHC	$GPCHC
2	GPSWeek	Number of weeks since 1980-1-6 (GPS Time)	www	1980
3	GPSTime	Seconds since Sunday 0:00:00 of the current week (GPS Time)	ssssss.ss	16897.68
4	Heading	Yaw Angle (0 to 359.99)	hhh.hh	289.19
5	Pitch	Pitch angle (-90 to 90)	+/-pp.pp	-0.42
6	Roll	Roll angle (-180 to 180)	+/-rrr.rr	0.21
7	gyro x	Gyroscope X Axis, Unit (°/s)	+/-ggg.gg	-0.23
8	gyro y	Gyro Y-Axis, Unit (°/s)	+/-ggg.gg	0.07
9	gyro z	Gyro Z-Axis, Unit (°/s)	+/-ggg.gg	-0.06
10	acc x	Accelerometer X-Axis, Unit (G)	+/-a.aaaa	0.0009
11	acc y	Accelerometer Y-Axis, Unit (G)	+/-a.aaaa	0.0048
12	acc z	Accelerometer Z-Axis, Unit (G)	+/-a.aaaa	-1.0037
13	Latitude	Latitude (-90° to 90°)	+/-ll.lllllll	38.8594969
14	Longitude	Longitude (-180° to 180°)	+/-ll.lllllll	121.5150073
15	Altitude	Altitude, Unit (m)	+/-aaaaa.aa	121.51
16	Ve	East Velocity, Unit (m/s)	+/-eee.eee	-0.023
17	Vn	North Velocity, Unit (m/s)	+/-nnn.nnn	0.011
18	Vu	Up Velocity, Unit (m/s)	+/-uuu.uuu	0.000
19	V	Vehicle Speed, Unit (m/s)	+/-uuu.uuu	1.500
20	NSV1	Primary antenna 1 Satellite Count	nn	14
21	NSV2	Secondary antenna 2 Satellite Count	nn	6
22	Status	System Status (Lower Nibble): 0: initialize ; 1: GNSS Mode ; 2: Integrated Navigation Mode ; 3: Pure INS Mode ; Satellite Status (Upper Nibble): 0: No Position and No Attitude; 1: single point positioning Attitude; 2: Pseudo-range differential positioning Attitude; 3: Combined Dead Reckoning; 4: RTK Fixed Solution Position and Attitude; 5: RTK floating solution Position and Attitude; 6: single point positioning No Attitude; 7: Pseudo-range differential positioning No Attitude; 8: RTK Fixed Solution Position No Attitude; 9: RTK floating solution Position No Attitude;	ss	4
23	Age	differential delay	aa	0
24	Warning	bit0: 1: No GPS Message, 0: Normal bit1: 1: No Vehicle Message, 0: Normal bit3: 1: Gyroscope Error, 0: Normal bit4: 1: Accelerometer Error, 0: Normal	ww	2
25	Cs	Checksum	*hh	*47
26	<CR><LF>	Fixed Packet Tail		<CR><LF>

6.4 CAN Protocol

Table9 CAN Extended Frame Format 0x19FF CC9A (Note: Unit is deg*100, int16 type)

Extended Frame ID	1	2	3	4	5	6	7	8
0x19FF CC9A	Roll angle		Pitch angle		Yaw angle		track angle	

Table10CAN Extended Frame Format 0x19FF CD9A (Note: Unit is deg/s*52.0127, int16 type)

Note: Reserved: If connected to G200, outputs front wheel angle

Extended Frame ID	1	2	3	4	5	6	7	8
0x19FF CD9A	gyro_x		gyro_y		gyro_z		Reserved	

Table 11 CAN Extended Frame Format 0x19FF CE9A (Note: Unit is g, int16 type)

Status bits:

Bit0: RTK board data valid flag bit, 1 indicates valid, 0 indicates invalid

Bit1: PPS valid flag bit, 1 indicates valid, 0 indicates invalid

Bit2: Front wheel steering angle valid flag bit, 1 indicates valid, 0 indicates invalid

Bit3: Front wheel Gyroscope valid flag bit, 1 indicates valid, 0 indicates invalid

Bit4: RTK positioning fixed solution flag, 1 indicates fixed solution, 0 indicates not fixed solution

Bit5: RTK heading fixed solution flag, 1 indicates fixed solution, 0 indicates not fixed solution

Bit6: Heading initialize flag, 1 indicates initialize, 0 indicates not initialize (only for single antenna vehicle gyro)

Extended Frame ID	1	2	3	4	5	6	7	8
0x19FF CE9A	accel_x		accel_y		accel_z		Status bits	

Table12 CAN Extended Frame Format 0X19FFCE9B (Note: Speed Direction: 1: Forward, -1: Reverse)

Extended Frame ID	1	2	3	4	5	6	7	8
0X19FFCE9B	Seconds of Week				Estimated Antenna Installation Bias Angle		Velocity Direction	Reserved

Table13 CAN Extended Frame Format 0X19CCFF9A (Note: The format is in degrees and requires division by 1e7; Int32 type)

The device adopts the WGS84 coordinate system. Latitude and longitude are output at the Primary antenna phase center by default; when projection points is configured, they are output at the projection points position;

Latitude is 0° at the equator. A Latitude greater than 0° indicates the Northern Hemisphere, otherwise the Southern Hemisphere;

Longitude is 0° at the Prime Meridian. A Longitude greater than 0° indicates the Eastern Hemisphere, otherwise the Western Hemisphere.

Extended Frame ID	1	2	3	4	5	6	7	8
0X19CCFF9A	Latitude				Longitude			

Table14 CAN Extended Frame Format 0X19CCFF9B (Note: Elevation is Ellipsoidal height, needs to be divided by 1e7, Int32 type)

Extended Frame ID	1	2	3	4	5	6	7	8
19CCFF9B	Elevation				Seconds of Week			

Table15 CAN Extended Frame Format 0X19FFD29A (Note: Unit is cm/s, int16 type)

Extended Frame ID	1	2	3	4	5	6	7	8
19FFD29A	North Velocity		East Velocity		Down Velocity		Ground Speed (Horizontal Speed)	

6.5 RTK Positioning Status Table

Binary	ASCII	Description
0	NONE	No Solution
1	FIXEDPOS	Position specified by FIX POSITION command
2	FIXEDHEIGHT	Not Supported
8	DOPPLER_VELOCITY	Velocity derived from real-time Doppler information
16	SINGLE	single point positioning
17	PSRDIFF	Pseudo-range differential positioning
18	WAAS	SBAS Positioning
32	L1_FLOAT	L1 floating solution
33	IONOFREE_FLOAT	Floating solution for mitigating ionospheric effects
34	NARROW_FLOAT	Narrow lane floating solution
48	L1_INT	L1 fixed solution
49	WIDE_INT	Wide lane fixed solution
50	NARROW_INT	Narrow-lane fixation Solution

7. Parameter Configuration

7.1 Configured via Serial Port

7.1.1 Configure Primary antenna Lever Arm

For example, configure lever arm vector as X=0.5m,Y=-0.6m,Z=-1.0m

Command :AT+CLUB_VECTOR=0.5,-0.6,-1.0\r\n

Response :GPS_POS_X=0.5,GPS_POS_Y=-0.6,GPS_POS_Z=-1.0\r\n

Description: lever arm vector is the 3D vector (X,Y,Z) of the RTK Primary antenna phase center relative to the IMU phase center, in meters. Where,

In the front-right-down vehicle body coordinate system

If the RTK Primary antenna is forward of the IMU, it is positive; otherwise, it is negative;

If the RTK Primary antenna is to the right of the IMU, it is positive; otherwise, it is negative;

If RTK Primary antenna is above the IMU, it is **negative**, otherwise positive (the antenna is generally above the device).

Figure8 Coordinate System Diagram



7.1.2 Configure Rear Axle Center Lever Arm

For example, configure lever arm vector as X=0.5m,Y=-0.6m,Z=1.0m

Command: AT+OD_VECTOR=0.5,-0.6,1.0\r\n

Response: OD_POS_X=0.5,OD_POS_Y=-0.6,OD_POS_Z=1.0\r\n

Description: lever arm vector is the 3D vector (X,Y,Z) from the IMU phase center to the rear axle center, in meters. Where,

In the front-right-down vehicle coordinate system

If the rear axle center is forward of the IMU, it is positive; otherwise, it is negative;

If the rear axle center is to the right of the IMU, it is positive; otherwise, it is negative;

If the rear axle center is below the IMU, it is**positive**, otherwise negative (the rear axle center is generally below the device).

The coordinate system is illustrated in the figure below: (the label must face upward; if the IMU is not installed as shown, configure the mounting orientation per Section 8.2.2)

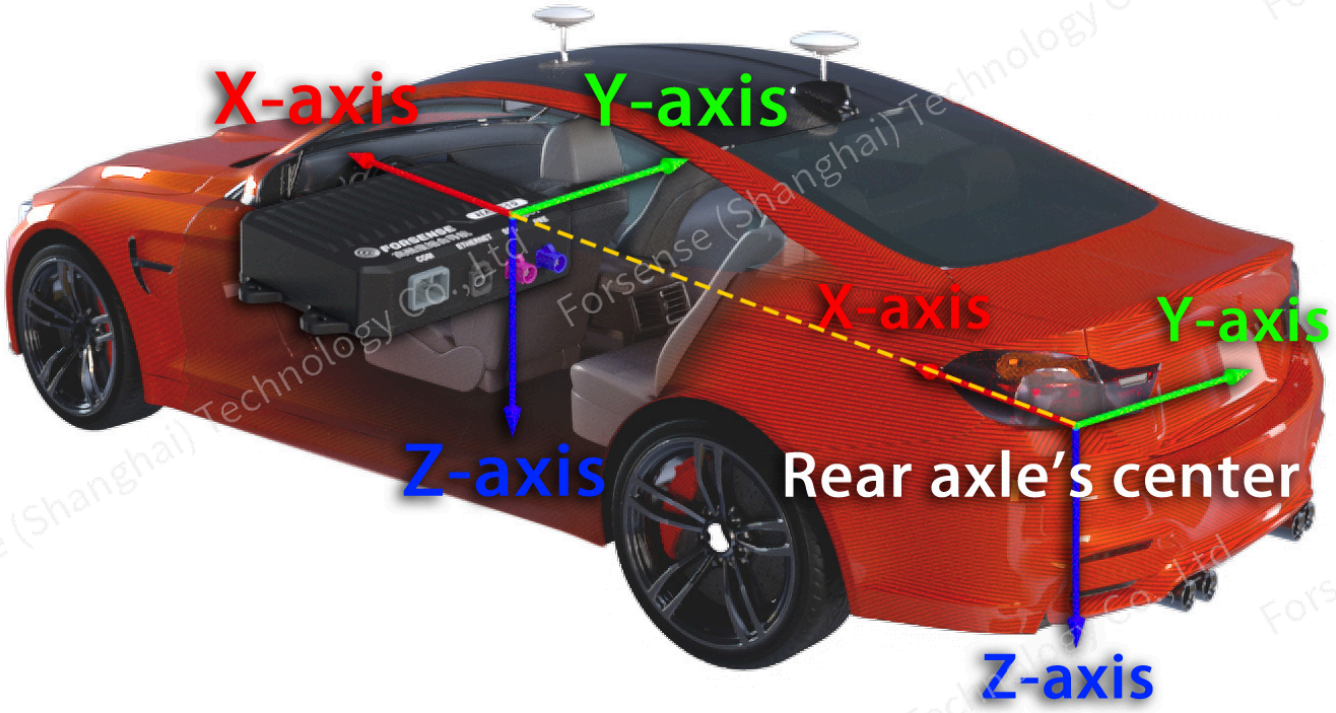


Figure9 Coordinate System Diagram

7.1.3 Configure Vehicle Wheelbase

If the vehicle wheelbase is configured as 2m, the configuration command is:

AT+WHEEL_BASE=2\r\n

Note: Save settings after configuring commands.

7.1.4 Configure RTK Dual antenna Mounting Angle

If the RTK Dual antenna mounting angle is configured as 0 degrees, the configuration command is:

Command : AT+RTK_ANGLE=0

Response : ANGLE=0

Description : The mounting angle is the angle between the ray from Primary antenna pointing to Secondary antenna and the vehicle heading direction. Clockwise is positive, counterclockwise is negative. Input range: -180°~180°

Note: Configuration commands take effect after power cycle; Dual antenna spacing must be greater than 50 cm

7.1.5 Enable Dual antenna fusion

Note: By default, Dual antenna fusion is disabled and used only for fast initialize when stationary. To use Dual antenna heading throughout, enable Dual antenna fusion using the following command. Set to 1 to enable Dual antenna fusion; any other Parameter disables Dual antenna fusion. Ensure synchronous calibration of Dual antenna installation error to avoid a fixed offset relative to vehicle heading.

Command :AT+DRTK_USE=1\r\n

Response : OK

Note: Configuration commands take effect after power cycle; Dual antenna spacing must be greater than 50 cm

7.1.6 Calibrate Dual antenna

Dual antenna CalibrationProcedure is as follows

1. Connect to Serial Port and enter AT+SETNO\r\n to disable all printing

2. Send the command AT+RTK_BIAS_EST=1\r\n to start the calibration process

3. Drive the vehicle straight at a speed of no less than 3 km/h; calibration is successful when Serial Port returns RTK_BIASE_CORRECT_DONE

4. Send the AT+CONFIG\r\n command to view the output RTK_BIAS_FLAG_AND_VALUE=99,XX (calibration angle); verify if it is reasonable, which should be less than 1 degree under normal installation conditions

5. Enter AT+SAVE\r\n to save the results and power cycle the device

7.1.7 Configure the position and velocity projection points output by Integrated Navigation

To configure the output of the projection points result set by Integrated Navigation, use the following command:

Command: AT+PROJ_VECTOR=1.0,2.0,3.0\r\n

Response : PROJ_VECTOR_X=1.0, PROJ_VECTOR_Y=2.0, PROJ_VECTOR_Z=3.0\r\n

Description : The Integrated Navigation output defaults to antenna phase center coordinates. To output coordinates of other positions, configure the lever arm vector of the IMU phase center relative to this projection points position. The configuration method is the same as the lever arm configuration in Section 8.1.1.

7.1.8 Configure Binary Output - AG Data Stream

If AG data stream output is configured, Integrated Navigation data streams in Section 7.2 and NMEA protocol in Section 7.3 are not output.

To switch to the 7.2 Integrated Navigation data stream or 7.3 NMEA protocol output, first follow the7.1.11 command to stop the current data stream output

Command: AT+SETAG\r\n

Response: OK\r\n

If configured to stop output

Command: AT+SETNO\r\n

Response: OK\r\n

7.1.9 Configure Binary Integrated Navigation Data Stream Output

If Integrated Navigation data stream output is configured, the AG data stream in Section 7.1 and the NMEA protocol in Section 7.3 will not be output

To switch toIntegrated Navigation Data Stream or NMEA Protocol Output in Sections 7.2 and 7.3, first use the command in Section7.1.11 to stop the current data stream output

The configuration command is as follows

Command: AT+SETNAV\r\n

Response: OK\r\n

To configure stop output

Command: AT+SETNO\r\n

Response: OK\r\n

7.1.10 Configure NMEA Format Data Stream Output

If NMEA sentence output is configured, the data stream in Section 7.2 Integrated Navigation is not output.

To switch to7.2 Integrated Navigation data stream output,7follow the 7.1.11 command to stop the current data stream output

The configuration commands are as follows

GPGGA

Example: Output GPGGA sentences at a frequency of 5 Hz: AT+GPGGA=5

Response: OK

GPRMC

Example: Output GPRMC sentences at a frequency of 1 Hz: AT+GPRMC=1

Response: OK

GPHDT (Heading Information)

Example: Output GPHDT sentences at a frequency of 1 Hz: AT+GPHDT=1

Response: OK

GPVTG (Ground Speed Information)

Example: Output GPVTG sentences at a frequency of 1 Hz: AT+GPVTG=1\r\n

Response: OK\r\n

GPZDA (UTC Time and Date)

Example: Output GPZDA sentences at a frequency of 1 Hz: AT+GPZDA=1\r\n

Response: OK\r\n

GPATT (Custom Message)

Example: Output GPATT sentences at a frequency of 1 Hz: AT+GPATT=1\r\n

Response: OK\r\n

To configure stop output

Command: AT+SETNO\r\n

Response: OK\r\n

7.1.11 Configure current data stream to stop output

Command: AT+SETNO\r\n

Response: OK\r\n

7.1.12 Configure Data Output Frequency

If the data output frequency is configured to 10Hz, the configuration command is:

Note: Maximum support is 100Hz

Command: AT+OUTRATE=10\r\n

Response: OK\r\n

7.1.13 Configure Baud Rate

Only baud rates of 115200 or 230400 are supported. The default baud rate is 115200.

If the IMU serial port baud rate baud rate is configured to 230400, the configuration command is:

Command: AT+BAUD=230400\r\n

Response: BAUD=230400\r\n

Note: Configuration commands take effect after saving and power cycling.

7.1.14 Configure CAN Baud Rate

Only baud rates of 250K, 500K, and 1M are supported. The default baud rate is 500K.

Example: To configure the CAN baud rate to 500K, use the following command:

Command: AT+CAN_BAUD=500\r\n

Response: OK

Note: Configuration commands take effect after saving and power cycling.

7.1.15 Configure CAN Output Frequency

To configure the CAN data output frequency to 10 Hz, use the following command:

Command: AT+CAN_ODR=10

Response: OK

Note: Maximum supported frequency is 100 Hz. Changes take effect immediately and persist after power cycle if saved.

7.1.16 Print All Configuration Information

To query all configured information, use the following command:

AT+CONFIG\r\n

7.1.17 Query Version Number

AT+VERSION\r\n

7.1.18 Configure Output Carrier XYZ Velocity

After configuration, once initialize is complete, the North, East, and Down velocities in the combined data stream will switch to the carrier's XYZ three-axis velocities.

1 enables carrier velocity output; all other Parameter values disable it.

Command: AT+NAV_OUTPUT_XYZ=1

Response: OK

7.1.19 Subtract Gravitational Acceleration from Acceleration Data

1. Command to remove gravitational acceleration: AT+DEDUCTIONG=1

A return of OK after sending indicates successful transmission and immediate effect.

Send AT+SAVE\r\n to save the configuration; otherwise, it will be lost after reboot.

2. Command to restore gravity acceleration: AT+DEDUCTIONG=0\r\n

A return of OK indicates successful transmission and immediate effect.

Send AT+SAVE\r\n to save the configuration; otherwise, it will be lost after reboot.

7.1.20 Configure Installation Rotation Angle

Currently only the following rotation angles are supported:

X-axis rotated by 180°

Z-axis rotated by 90°, 180°, or 270°

The configuration command is as follows

If the Installation Rotation Angle is set to 180 degrees around the X-axis, the configuration command is:

Command: AT+INSTALL_ANGLE=180,0,0

Response: INST_ANGLE_X=180.000,INST_ANGLE_Y=0.000,INST_ANGLE_Z=0.000

If the Installation Rotation Angle is set to 180 degrees around the Z-axis, the configuration command is:

Command: AT+INSTALL_ANGLE=0,0,180

Response: INST_ANGLE_X=0.000,INST_ANGLE_Y=0.000,INST_ANGLE_Z=180.000

7.1.21 Save Parameter

The above includes Parameter such as lever arm, data stream, and output frequency. After configuration, the save command must be entered for changes to take effect after a restart.

Command: AT+SAVE

Response: OK

7.2 Configure via CAN

Note: All CAN messages use little-endian mode, with the low byte first.

7.2.1 Query Version Number

Example:

ID = 0x19FFF326

Data = 0x9A 0x07 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF

Response

Example: (Version 1805)

ID = 0x19FFF29A

Data = 0x26 0xC7 0x00 0x00 0x07 0x0D 0xFF 0xFF

Note: The first two bytes 0x26 0xC7 are fixed Frame header

7.2.2 Configure Wheelbase and Lever Arm

Example

ID = 0X0DFFC126

Data = Wheelbase 2 bytes + Lever Arm 2 bytes * 3 (Unit: cm)

Response

ID = 0X19FFC09A

Data = Wheelbase 2 bytes + Lever Arm 2 bytes * 3 (Unit: cm)

7.2.3 Query Wheelbase and Lever Arm

ID = 0X0DFFC226

Data =0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF

Response

ID = 0X19FFC29A

Data = Wheelbase 2 bytes + Lever Arm 2 bytes*3 (unit: cm)

7.2.4 Configure CAN Output Update Rate and Baud Rate

Supported baud rates: 1M, 500K, 250K (represented as 0x01, 0x02, 0x03 respectively)

Update Rate supports 20, 50, 100Hz (represented as 0x14, 0x32, 0x64 respectively)

Restart to apply the configuration.

ID = 0x19FFF326

Data = 0x9A 0x4A Baud Rate Update Rate 0xFE 0xFB 0xF9 0xFF

Response

ID =0x19FFF59A

Data =0xFF 0x4A Baud Rate Update Rate 0xFF 0xFF 0xFF 0xFF

7.2.5 Query Update Rate and baud rate:

ID = 0x19FFF426

Data =0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF

Response

ID =0x19FFF49A

Data =0xFF 0x4A Baud Rate Update Rate 0XFF 0XFF 0XFF 0xFF

7.2.6 Configure Rear Wheel Center Lever Arm

ID = 0X0BC00114

Data=Lever Arm 2 bytes*3+FF*2 (Unit cm)

Response

ID=0X0BCBB114

Data=Lever Arm 2 bytes*3+00*2 (Unit cm)

7.2.7 Configure projection points Lever Arm

ID = 0X0BC00111

Data = Lever Arm 2 bytes * 3 + FF * 2 (Unit: cm)

7.2.8 Query projection points Lever Arm

ID = 0X0BCFF111

Data=0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF

Response

ID = 0X0BCBB111

Data = Lever Arm 2 bytes * 3 + 00 * 2 (Unit: cm)

7.2.9 Configure Dual antenna Installation Misalignment Angle

ID = 0X0DFFC326

Data = Angle (init16) + FF * 6 (Unit: deg * 100)

7.2.10 Query Dual antenna Installation Misalignment Angle

ID = 0X0DFFC526

Data=0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF

Response

ID = 0X19FFC29A

Data = Angle + FF * 6 (Unit: deg * 100)

7.2.11 Configure Low-Pass Filter

ID = 0X0DFFC626

Data = Filter Value 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF

Response

ID=0X19FF69A

Data = Filter Value 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF

7.2.12 Query Low-Pass Filter

ID=0X0DFFC726

Data=0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF

Response

ID=0X19FF79A

Data = Filtered Value 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF

7.2.13 Enable PPS(Standard Frame)

ID=0x400

Data=0X00 0X00 0X00 0X00 0X00 0X00 0X00 0X00

Response

ID=0XBCBB116

Data=0X00 0X00 0X00 0X00 0X00 0X00 0X00 0X00

7.2.14 Disable PPS(Standard Frame)

ID=0x399

Data=0X00 0X00 0X00 0X00 0X00 0X00 0X00 0X00

Response

ID=0xBCBB116

Data=0X01 0X00 0X00 0X00 0X00 0X00 0X00 0X00

7.2.15 Configure IMU Installation Rotation Angle

The first 6 bytes represent the rotation angle of each axis in pairs of two bytes

Example: X-axis rotated by 180 degrees

ID:0X0BC00110

Data =B4 00 00 00 00 00 00 00

7.2.16 Query Configured IMU Installation Rotation Angle

ID:0X0BCFF110

Data =00 00 00 00 00 00 00 00

Response:

ID:0X0BCBB110

Data =B4 00 00 00 00 00 00 00

7.2.17 Configure Dual antenna Fusion Enable/Disable

Setting to 0x99 enables it; other values disable it

Example: Enable Dual antenna Fusion

ID:0X0BC00115

Data =99 00 00 00 00 00 00 00

Response

ID:0X0BCBB115

Data =01 00 00 00 00 00 00 00

7.2.18 Save Parameter Command

ID = 0X0DFFCF26

Data =0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF

Response

ID = 0X19FFCF9A

Data=0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF

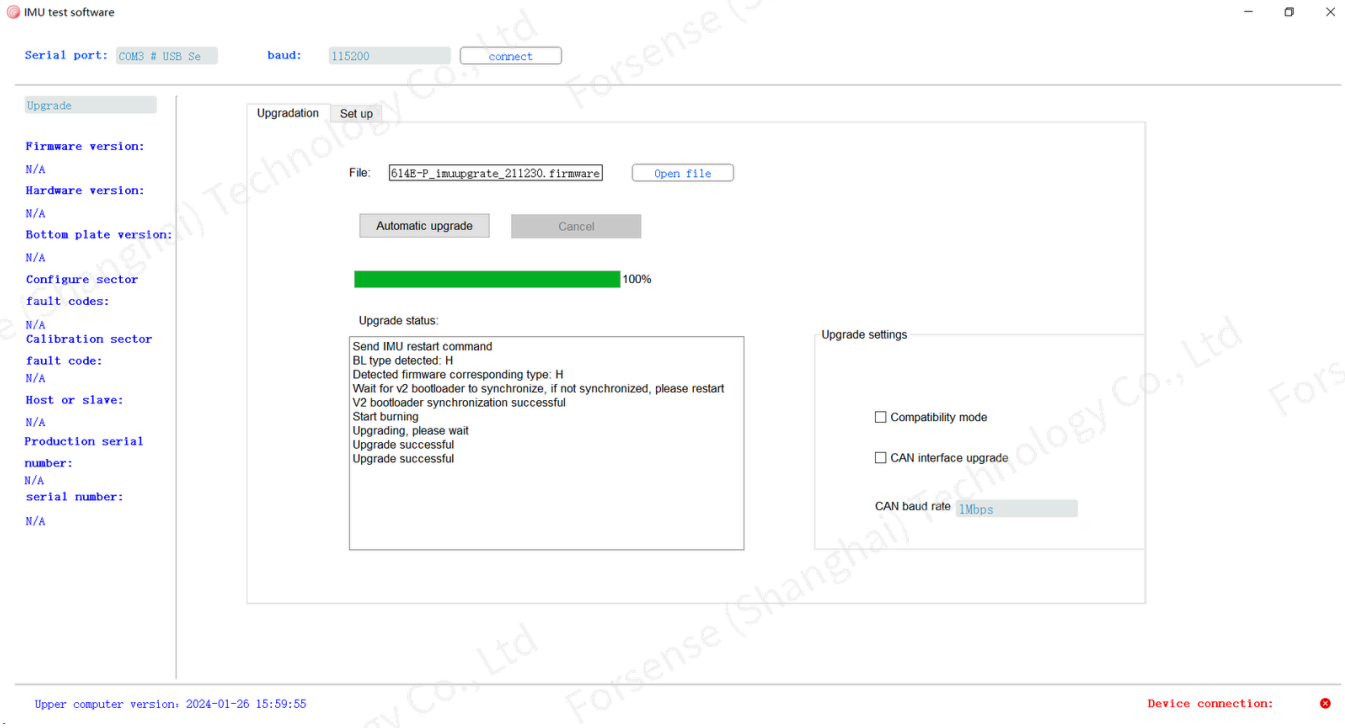
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8. Firmware Update

8.1 Via PC software

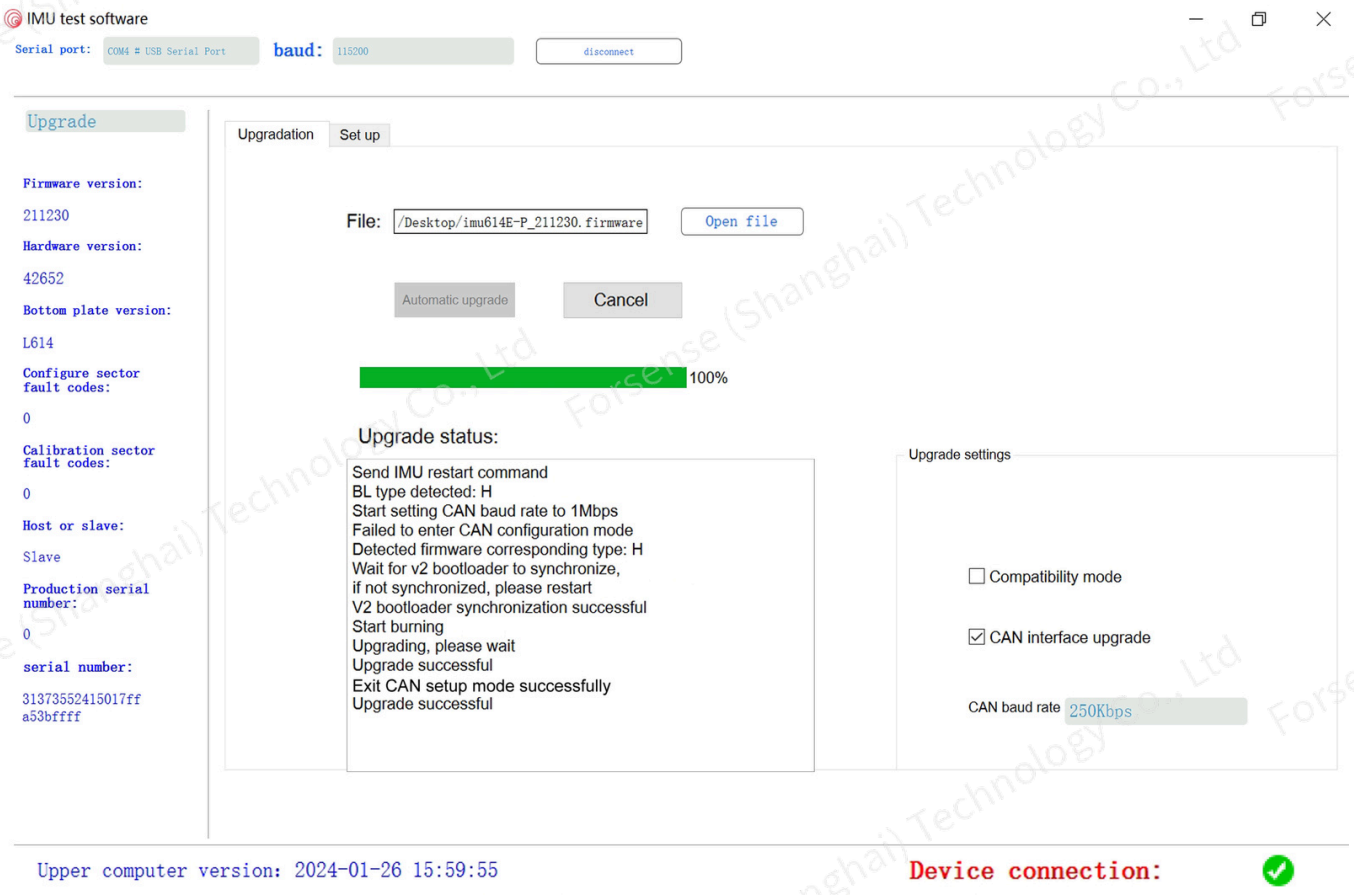
8.1.1 R232 Direct Connection to Serial Port

Use Forsense IMU to Test PC software — Select Firmware Update — Open Firmware — Click Auto Upgrade.



8.1.2 Use the included USB-to-CAN adapter

Use Forsense IMU to test PC software — Select Firmware Update — Open Firmware — Select CAN Interface for Update — Set Post-Update Firmware Baud Rate — Click Auto Update.



8.2 serial push

The update process consists of the following steps:

Step 1: Send Update Command

Send the update command to prepare the module for updating. After the command is sent, the device records an update flag in a specific flash region and then performs a soft reset. At this point, the IMU module enters

the BOOTLOADER.

```
上位机发送升级指令如下：
  cmd_bl[34] ={0x55,0xaa,0xbb,0x88,0x18,0x00,0x00,0x00,0xc8,0x42,0x00,0x00,
  0x48,0x43,0x2c,0x01,0x00,0x00,0x90,0x01,0x00,0x00,0xf4,0x01,0x00,0x00,
  0x58,0x02,0x00,0x00,0x40,0x97,0x46,0x6a};
  此时 imu 模块将会重启后进入 bootloader 中
```

Step 2: Send **HC32MCU_FORSENSE** String

After the IMU module enters bootloader mode, it actively sends the HC32_UPLOADER string. During this period, PC software must send the HC32MCU_FORSENSE string. Once the IMU module receives this string, it will not jump to the APP and will remain in bootloader mode in a pending upgrade state, while also

stopping the active transmission of any messages.

```
//发送完升级指令后，紧接着发送如下字符串，确保 imu 模块不会跳转到 APP 区域，同时处于待升级状态
```

```
QString str = "HC32MCU_FORSENSE" ;
for(int i=0;i<10;i++)
{
  _port_device->write(str.toLatin1()); sleep_ms(50);
}
```

Step 3: Send Synchronization Command

When the IMU module is in bootloader mode with a pending upgrade status, it does not actively send information but only passively responds to commands from PC software. At this point, PC software sends the command Send_CMD_LONG(0X21,0,0,0,0,0,0) and waits for the response from the IMU module. Upon receiving this command, the IMU immediately replies with Send CMD ACK (0x64,0x10,0)

data. Once PC software determines that this data has been received, synchronization is considered complete.

```
上位机与 imu 模块同步过程：
1.上位机发送同步命令，命令码为 0x21，发送后等待 imu 模块响应
 Send_CMD_LONG(0x21,0,0,0,0,0,0);
2.imu 模块收到 0x21 的命令码后，发送响应数据，数据命令如下：
Send_CMD_ACK(0x64,0x10,0);
3.上位机判断是否收到了 imu 的响应数据，如收到则表示完成了同步
注：Send_CMD_LONG 函数与 Send_CMD_ACK 函数见文章末尾
```

Step 4: Send Erase Command

PC software sends the erase command Send_CMD_LONG(0x23,0,0,0,0,0,0). After the command is sent, the IMU module erases all content in the APP area and reports the final execution result to PC software. PC software decides whether to resend the erase command based on the execution result. Once the erase is successful, the IMU module's APP cannot be restored. Additionally, PC software must wait for the successful erase response from the IMU before proceeding to the next step; otherwise,

subsequent upgrade failures may occur.

```
1.上位机发送擦除命令，命令码为 0x23，发送完此命令后耐心等待 imu 回复执行结果
  Send_CMD_LONG(0x23,0,0,0,0,0,0);
2.imu 收到 0x23 的命令码后，将会把 APP 区域数据擦除干净，并将最终的执行结果回复给上位机
  send_CMD_ACK(0x64,0x10,0); //表示擦除成功
```

```
  send_CMD_ACK(0x64,0x11,0); //表示擦除失败，需要重新擦除
  注意：上位机必须收到擦除成功的响应，才能进行下一步
```

Step 5: Send Upgrade Data Packet

After successful erasure, the most critical step of sending firmware data begins. The function Send_Upload_Data is used to send the data. PC software splits the upgrade firmware into packets, each with a fixed size of 64 bytes; the last packet sends the actual number of bytes if it is less than 64. Each frame contains the valid data length and its offset address within the entire firmware. PC software After sending each frame, wait for the response from the IMU module. Only after confirming that the IMU has successfully received the current frame should the next frame be sent. Once the IMU module successfully receives PC software packets, it sends response data and writes to the specified Flash address based on offset address.

If writing to Flash fails, send a failure command; otherwise, do not send anything.

```
例：将大小 1000 字节的升级文件 uint8_t Upgrade_Data[1000]发送给 imu 模块
 //发送第一包：
  1.1 通过函数将 0~63 字节发送到 imu 模块
  Send_Upload_Data（0x27,0,0,0x40,Upgrade_Data);
  //上面函数第一参数 0x27 为固定值，第二参数 0 为固定值，第三参数 0 为偏移地址，
    第四参数 0x40 为有效字节长度，第五参数为发送数据的首地址

 1.2 imu 成功收到数据后，会发送响应数据，并根据偏移地址写入指定的 flash 地址
   send_CMD_ACK(0x753D,0x00,0);
   //上面函数第一参数 0x753D 为固定值，第二参数 0 为固定值，第三参数为偏移地址。
   imu 模块将数据写入 flash 过程中如果写入失败将发送失败命令 send_CMD_ACK(0x64,0x11,0);

  //发送第二包：
   2.1 上位机收到 imu 响应数据后，将发送第二包数据 Send_Upload_Data（0x27,0,0x40,0x40,Upgrade_Data+0x40);
   2.2 imu 成功收取到第二包数据后，发送响应： send_CMD_ACK(0x753D,0x00,0x40);
   2.3 imu 模块将数据写入 flash 过程中如果写入失败将发送失败命令 send_CMD_ACK(0x64,0x11,0);



  //发送第三包
   3.1 上位机收到 imu 响应数据后，将发送第三包数据 Send_Upload_Data（0x27,0,0x80,0x40,Upgrade_Data+0x80);
   3.2 imu 成功收取到第三包数据后，发送响应： send_CMD_ACK(0x753D,0x00,0x80);
   3.3 imu 模块将数据写入 flash 过程中如果写入失败将发送失败命令 send_CMD_ACK(0x64,0x11,0);

  //发送第十五包：
```

```
   15.1 上位机收到 imu 响应数据后，将发送第十五包数据 Send_Upload_Data（0x27,0,0x380,0x40,Upgrade_Data+0x380);
   15.2 imu 成功收取到第十五包数据后，发送响应： send_CMD_ACK(0x753D,0x00,0x380);
   15.3 imu 模块将数据写入 flash 过程中如果写入失败将发送失败命令 send_CMD_ACK(0x64,0x11,0);
  //发送第十六包：
   15.1 上位机收到 imu 响应数据后，将发送第十六包数据 Send_Upload_Data（0x27,0,0x3C0,0x28,Upgrade_Data+0x3C0);
   15.2 imu 成功收取到第十六包数据后，发送响应： send_CMD_ACK(0x753D,0x00,0x3C0);
   15.3 imu 模块将数据写入 flash 过程中如果写入失败将发送失败命令 send_CMD_ACK(0x64,0x11,0);
  发送结束
```

Step 6: Obtain**CRC** Checksum

Generally, the firmware update command format is imu614e-b#CRC1373387121.firmware , followed immediately by the pre-calculated CRC checksum value after the CRC string. After sending the update file, the host software must send a verification command to check if the IMU module received the file correctly. After sending Send_CMD_LONG(0x29,0,0,0,0,0,0) via PC software, retrieve the CRC check digit calculated by the IMU module.

If PC software indicates that the CRC checksum value is incorrect, restart the update process from Step 4 (Erase Command).

```
上位机发送获取 crc 校验码指令，等待 imu 响应
 Send_CMD_LONG(0x29,0,0,0,0,0,0);
imu 模块响应发送 crc 校验值数据：
send_CMD_ACK(0x753C,0x10,crc32_data);
 其中 crc32_data 值为 imu 模块本身计算的 crc32 数据
```

Step 7: Send Restart Command

After PC software confirms that the CRC checksum is correct, send the restart command to complete the update successfully.

```
判断 crc 校验值正确后，发送重启命令：
 Send_CMD_LONG(0x30,0,0,0,0,0,0,0);
```

Once the firmware update is complete, power cycle the device and verify success by reading the version number.

Function Definition:

1. The definition of the Send_CMD_LONG function is as follows:

```
struct  MULTI_LONG_CMD_STRUCT
{
uint8_t header1;
uint8_t header2;
uint16_t id;
uint16_t length;
float param1;
float param2;
uint32_t param3;
uint32_t param4;
int32_t param5;
int32_t param6;
uint32_t check_crc;
}__attribute__((packed));
```

```
void  :Send_CMD_LONG(uint16_t cmd_id,float cm1,float cm2,uint32_t cm3,uint32_t cm4,int32_t cm5,int32_t cm6)
{
    uint8_t check_sum=0;
    struct MULTI_LONG_CMD_STRUCT data_cmd_long __attribute__((packed));
    data_cmd_long.header1=0x55;
    data_cmd_long.header2=0xAA;
    data_cmd_long.id=cmd_id;
    data_cmd_long.length=sizeof(data_cmd_long)-10;
    data_cmd_long.param1=cm1;
    data_cmd_long.param2=cm2;
    data_cmd_long.param3=cm3;
    data_cmd_long.param4=cm4;
    data_cmd_long.param5=cm5;
    data_cmd_long.param6=cm6;
    int len=sizeof(data_cmd_long)-4;
    uint32_t check_crc=1;
    data_cmd_long.check_crc=crc_crc32(check_crc,(uint8_t *)(&data_cmd_long), len);
    send((uint8_t *)(&data_cmd_long),sizeof(data_cmd_long));
}
```

2. The definition of the Send_CMD_ACK function is as follows:

```
struct  CMD_ACK_STRUCT
{
uint8_t header1;
uint8_t header2;
uint16_t id;
```

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```
uint16_t length;
uint32_t command;/*<   Command ID (of acknowledged command).*/
uint32_t result;/*<   Result of command.*/
uint32_t check_crc;
}__attribute__((packed));

void Send_CMD_ACK(uint16_t cmd_id,uint16_t ack_id,uint32_t result)
{
    uint32_t check_crc=0;
    struct CMD_ACK_STRUCT data_cmd_ack __attribute__((packed));
    data_cmd_ack.header1=0xAA;
    data_cmd_ack.header2=0x55;
    data_cmd_ack.id=cmd_id;
    data_cmd_ack.length=sizeof(data_cmd_ack)-10;
    data_cmd_ack.command=ack_id;
    data_cmd_ack.result=result;
    int len=sizeof(data_cmd_ack)-4;
    check_crc=1;
    data_cmd_ack.check_crc=crc_crc32(check_crc,(uint8_t *)(&data_cmd_ack),len);
    Cout((uint8_t *)(&data_cmd_ack),sizeof(data_cmd_ack));
}
```

The definition of the Send_Upload_Data function is as follows:

```
struct  UPLOAD_DATA
{
uint8_t header1;
uint8_t header2;
uint16_t id;
uint16_t length;
uint8_t param[64];
uint32_t offset;
uint16_t size;
uint8_t cmd;
uint32_t check_crc;
}__attribute__((packed));

struct UPLOAD_DATA upload_data;
void Send_Upload_Data(uint8_t cmd_id,uint8_t cmd,uint32_t offset,uint16_t size,uint8_t* param)
{
    upload_data.header1=0x55;
```

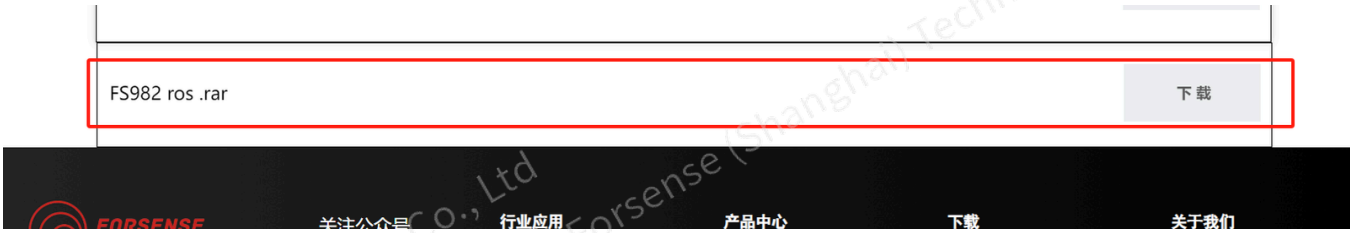
```
    upload_data.header2=0xAA;
    upload_data.id=cmd_id;
    upload_data.length=sizeof(UPLOAD_DATA)-10;
    upload_data.cmd=cmd;
    for(int i=0;i<size;i++)
    upload_data.param[i] = *(param+i);
    upload_data.offset=offset;
    upload_data.size=size;
    int len=sizeof(UPLOAD_DATA)-4;
    uint32_t check_crc=1;
    upload_data.check_crc=crc_crc32(check_crc,(uint8_t *)(&upload_data), len);
    send((uint8_t *)(&upload_data),sizeof(UPLOAD_DATA));
}
```

4. The CRC32 verification function is as follows:

```
static const uint32_t crc32_tab[] = {
    0x00000000, 0x77073096, 0xee0e612c, 0x990951ba, 0x076dc419, 0x706af48f,
    0xe963a535, 0x9e6495a3, 0x0edb8832, 0x79dcb8a4, 0xe0d5e91e, 0x97d2d988,
    0x09b64c2b, 0x7eb17cbd, 0xe7b82d07, 0x90bf1d91, 0x1db71064, 0x6ab020f2,
    0xf3b97148, 0x84be41de, 0x1adad47d, 0x6ddde4eb, 0xf4d4b551, 0x83d385c7,
    0x136c9856, 0x646ba8c0, 0xfd62f97a, 0x8a65c9ec, 0x14015c4f, 0x63066cd9,
    0xfa0f3d63, 0x8d080df5, 0x3b6e20c8, 0x4c69105e, 0xd56041e4, 0xa2677172,
    0x3c03e4d1, 0x4b04d447, 0xd20d85fd, 0xa50ab56b, 0x35b5a8fa, 0x42b2986c,
    0xdbbbc9d6, 0xacbcf940, 0x32d86ce3, 0x45df5c75, 0xdcd60dcf, 0xabd13d59,
    0x26d930ac, 0x51de003a, 0xc8d75180, 0xbfd06116, 0x21b4f4b5, 0x56b3c423,
    0xcfba9599, 0xb8bda50f, 0x2802b89e, 0x5f058808, 0xc60cd9b2, 0xb10be924,
    0x2f6f7c87, 0x58684c11, 0xc1611dab, 0xb6662d3d, 0x76dc4190, 0x01db7106,
    0x98d220bc, 0xefd5102a, 0x71b18589, 0x06b6b51f, 0x9fbfe4a5, 0xe8b8d433,
    0x7807c9a2, 0x0f00f934, 0x9609a88e, 0xe10e9818, 0x7f6a0dbb, 0x086d3d2d,
    0x91646c97, 0xe6635c01, 0x6b6b51f4, 0x1c6c6162, 0x856530d8, 0xf262004e,
    0x6c0695ed, 0x1b01a57b, 0x8208f4c1, 0xf50fc457, 0x65b0d9c6, 0x12b7e950,
    0x8bbeb8ea, 0xfcb9887c, 0x62dd1ddf, 0x15da2d49, 0x8cd37cf3, 0xfbd44c65,
    0x4db26158, 0x3ab551ce, 0xa3bc0074, 0xd4bb30e2, 0x4adfa541, 0x3dd895d7,
    0xa4d1c46d, 0xd3d6f4fb, 0x4369e96a, 0x346ed9fc, 0xad678846, 0xda60b8d0,
    0x44042d73, 0x33031de5, 0xaa0a4c5f, 0xdd0d7cc9, 0x5005713c, 0x270241aa,
    0xbe0b1010, 0xc90c2086, 0x5768b525, 0x206f85b3, 0xb966d409, 0xce61e49f,
    0x5edef90e, 0x29d9c998, 0xb0d09822, 0xc7d7a8b4, 0x59b33d17, 0x2eb40d81,
    0xb7bd5c3b, 0xc0ba6cad, 0xedb88320, 0x9abfb3b6, 0x03b6e20c, 0x74b1d29a,
    0xead54739, 0x9dd277af, 0x04db2615, 0x73dc1683, 0xe3630b12, 0x94643b84,
    0x0d6d6a3e, 0x7a6a5aa8, 0xe40ecf0b, 0x9309ff9d, 0x0a00ae27, 0x7d079eb1,
    0xf00f9344, 0x8708a3d2, 0x1e01f268, 0x6906c2fe, 0xf762575d, 0x806567cb,
    0x196c3671, 0x6e6b06e7, 0xfed41b76, 0x89d32be0, 0x10da7a5a, 0x67dd4acc,
```

9. ROS Driver

ROS Driver Download URL:https://www.forsense.cn/download/



9.1 Install ROS Serial

Install the ROS serial package. This example relies on the serial package provided by ROS to implement serial communication.

First, execute the following command to download and install the serial package:

sudo apt-get install ros -melodic-serial

Then enter roscd serial command to enter the serial download mode. If the installation is successful, the following will appear:

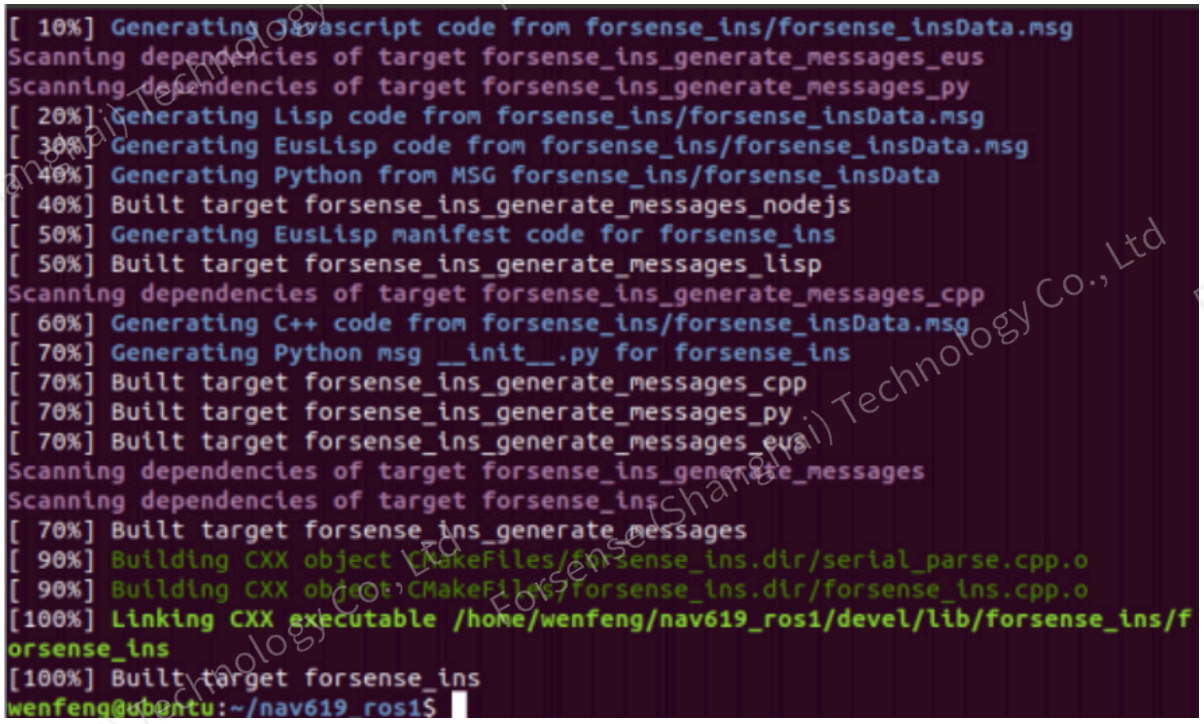
The following information:

/opt/ros/melodic/share/serial

9.2 Compile Code

cd FS982_ros/

catkin_make

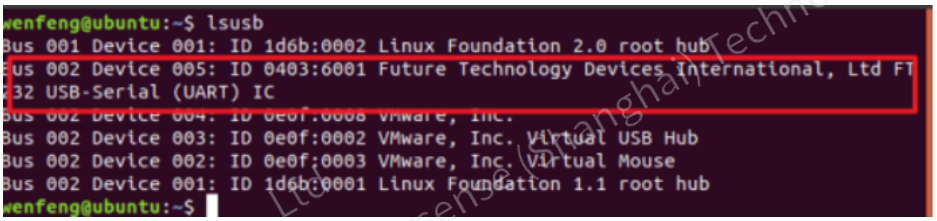


Compilation Complete

9.3 Connect the IMU to the system via USB

Check if connected:

lsusb



Check USB port number:

ls /dev/ttyU*



Configure and open USB to serial port privileges:

sudo chmod 777 /dev/ttyUSB0

9.4 View Data

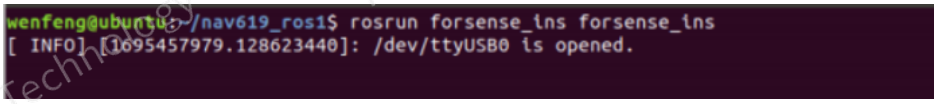
Execute roscore to start ROS

Return to the serial_imu_ws folder and execute

source devel/setup.bash

Execute rosrun to start

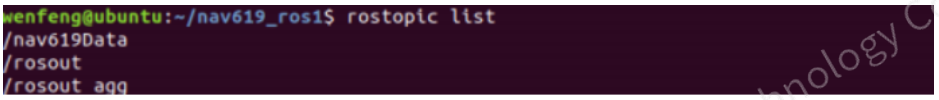
rosrun forsense_ins forsense_ins



Open a new window

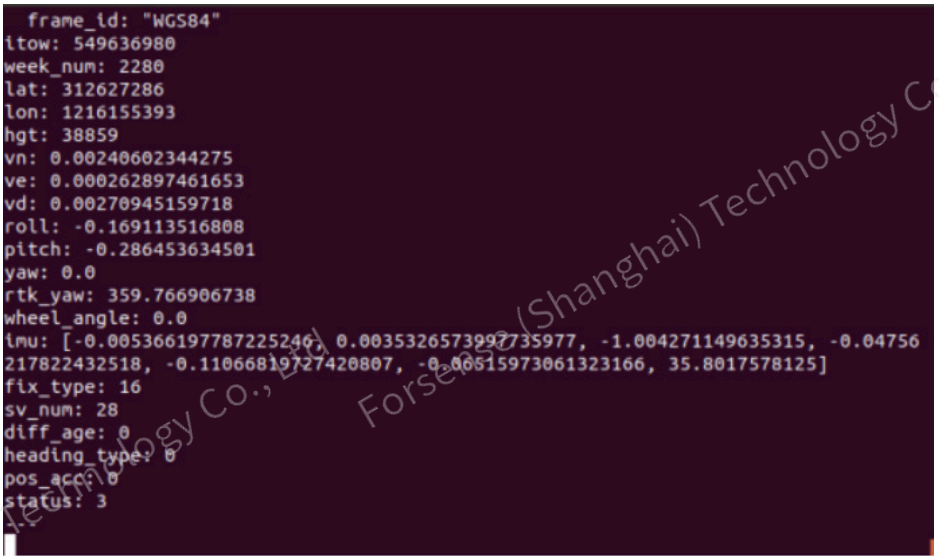
source devel/setup.bash

rostopic list



Enter command to view IMU data

rostopic echo /FS982Data


frame_id: "WGS84"
itow: 549636980
week_num: 2280
lat: 312627286
lon: 1216155393
hgt: 38859
vn: 0.00240602344275
ve: 0.000262897461653
vd: 0.00270945159718
roll: -0.169113516808
pitch: -0.286453634501
yaw: 0.0
rtk_yaw: 359.766906738
wheel_angle: 0.0
imu: [-0.00536619778722524 6, 0.003532657399773 5977, -1.004271149635315, -0.04756
217822432518, -0.11066819727420807, -0.00515973061323166, 35.8017578125]
fix_type: 16
sv_num: 28
diff_age: 0
heading_type: 0
pos_acc: 0
status: 3

10. Use with G200

1. Installation Requirements for G200:

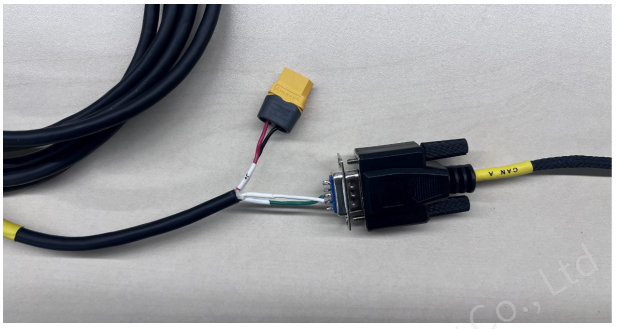
A. G200 must be installed on the front wheelfront axle(in a horizontal rigid position that rotates with the front wheel)

B. Install with the G200 cable outlet pointing toward the rear of the vehicle

2. Connect the CAN interface of G200 to theharnessCAN A,InputPowerMaximum support is 15V; 5V or 12V power supply is recommended.

Figure 10 Wiring Diagram

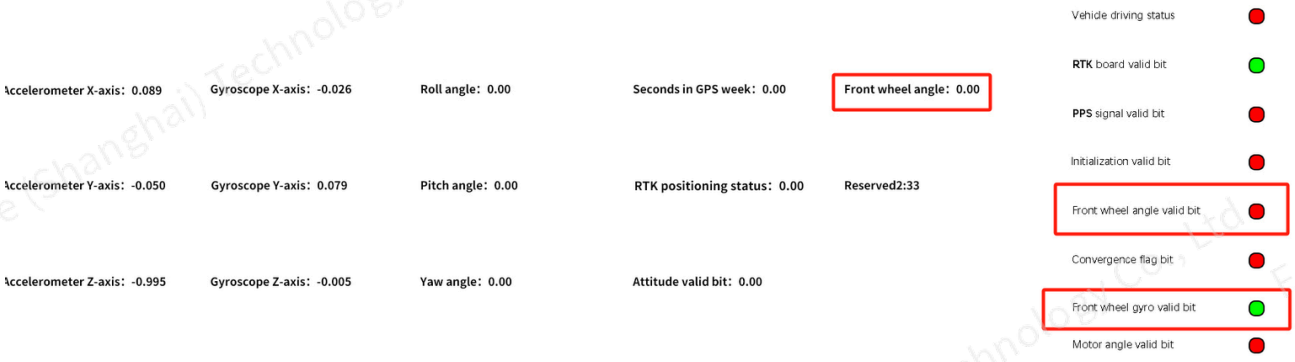




3. First measure the vehicle's wheelbase. Taking a wheelbase of 2m as an example, Master'sSerial PortConnect to the Serial Port Assistant, send AT+WHEEL_BASE=2, receive the response WHEEL_BASE=2, then send the savecommandAT+SAVE, receive the response OK, and power cycle the device

4. Device Connection FS982-AG DecodingPC software V3.3.4, enter the home page of PC software, selectSerial Port number, baud rate (default 115200), click Connect. If device information appears on the left, connection is successful. Click Mode Start in the bottom-left corner. When G200 is correctly connected, the front wheel gyroscope significant bits displays green; otherwise red. After vehicle initialize succeeds, the front wheel steering angle significant bits displays green; otherwise red. Once the vehicle moves, front wheel steering angle data is output in real time.

Figure 11 Correct Connection Diagram for G200



11. 11. Attachments

Standard accessories:



NAV680-AG Master



HarnessHarness



Primary antenna(positioning antenna)



Secondary antenna (Directional Antenna)



Primary antenna Cable



Secondary antenna Cable

Optional accessories



RS232 Serial Port Cable XT60





G200

12. FAQs List

Issue	Solution
PC software Connection Failed	Please check if Serial Port is occupied and if the product is properly powered on. If PC software disconnects during connection, Serial Port may be loose. Try unplugging and replugging the Serial Port cable, then reopen PC software.
Positioning Status is Always 1	Verify that differential data is received correctly. Check if the baud rate, differential account, and mount point are correct.
Dual antenna Orientation status Never Reaches 50	Please check the following factors: (1) If Orientation status remains 0, verify whether Secondary antenna is connected properly and whether antenna feeder is damaged. (2) If Orientation status is not 0 but never reaches 50, ensure the test environment is open and that the distance for Dual antenna is greater than 50 cm.
Signal is normal when connected to active antenna, but no signal when connected to passive antenna.	passive antenna feeder must not exceed 1.5M.
Signal is normal when the antenna is connected to active power splitter, but no signal when the antenna is powered by the device.	Check whether short-circuited or electrostatic discharge caused by plugging/unplugging the antenna during power-on has resulted in abnormal power supply circuit for the antenna feeder. The current circuit design includes a fuse; the system can be restored after re-powering.
Unable to initialize	initialize requires the following conditions: single antenna: Positioning status fixed solution + driving speed above 0.5 m/s + straight-line driving with acceleration and deceleration Dual antenna: Positioning status fixed solution + Orientation status 50
Serial Port packet loss	Please check the following factors: 1. The Serial Port cable must support a baud rate of at least 115200. 2. The PC Serial Port delay must be configured to 2 ms.
How to determine if the physical connection of G200 is correct	Parse the value of Status bits to check if bit5 is valid
With G200 connected, the front wheel gyroscope significant bits is invalid	Use a CAN analyzer to verify that the CAN baud rate of G200 matches that of AG. If they differ, adjust them to be consistent. Refer to the Parameter configuration page in the G200 and AG manuals for specific commands.
With G200 connected, the front wheel gyroscope significant bits is valid, but the front wheel angle is abnormal	Please check the following factors: 1. The prerequisite for correct front wheel angle output is that the AG device must complete initialize before it can output the correct front wheel angle 2. Whether the wheelbase is configured; an unconfigured wheelbase will result in invalid front wheel steering angle
After configuring lever arm via CAN and Dual antenna angle information, the results do not match the configuration	Check if the configuration follows this method: little-endian mode, low byte first, unit in CM, negative numbers require two's complement
Can NMEA protocol and binary protocol output synchronously?	Not supported; only one of the protocols can be output at a time.
With G200 connected, the front wheel steering angle is asymmetric when turned fully left or fully right.	Please check the following factors: 1. Whether G200 is installed horizontally 2. If powered on only while stationary, power on at 0 degrees, or drive straight manually for a short distance to correct it
Why is there still a satellite count when the antenna is disconnected?	UM982 has strong signal tracking capability. If signal sources are nearby, it may continue to track for a period via coupling even with the antenna disconnected. In actual satellite loss-of-lock scenarios, the antenna remains connected and external signals cannot enter, so usage is not affected.
Using a metal pot lid to block the antenna simulates loss of lock, but the status remains fixed solution	Incorrect test method: A metal pot lid only blocks signals from directly above. Lateral signals reflect off the vehicle roof onto the underside of the lid and then onto the antenna, causing a false fixed solution.
ROS Driver Cannot Read Data	The device is not configured to output combined data streams by default upon power-on. Configuring the default combined data output on power-on resolves this issue.
Large Heading Error	Possible causes include: 1. Incorrect lever arm or wheelbase configuration; units may be scaled up by a factor of 10. 2. Verify that the device is rigidly mounted. 3. Check if the device is located away from strong vibration sources.
Attitude error relative to the reference exceeds the limit	Verify whether installation errors are subtracted during statistics (typically, the mean error relative to the reference is considered the installation error)
How to perform two's complement operations when configuring CAN commands in little-endian mode	Two's complement applies to negative numbers. For -20: X - 65536 = -20, so X = 65516. The hexadecimal value of 65516 is FFEC, and that of 65535 is FFFF. Since counting starts from 0, the maximum value is 65536; the current result minus the maximum value yields the two's complement

13. Update Log

Address of the latest manual version: NAV680-AG_Datasheet_产品手册

Version	Date	Status/Notes
Version 1.0	2024.01.09	Initial Release
Version1.1	2024.01.12	AddRTKPerformance Specifications
Version1.2	2024.01.15	Added Update Records
Version1.3	2024.01.18	Adjusted Main Secondary antenna Accessory Images
Version1.4	2024.01.24	Removed CAN B
Version1.5	2024.01.26	1. Added Content Related to CAN Protocol, 2. Added RTK positioning status indicator
Version1.6	2024.02.20	Corrected lever arm configuration description
Version1.7	2024.02.22	Corrected rotation angle configuration response description
Version1.8	2024.03.26	Added description for slope mode usage with G200
Version1.9	2024.06.12	1. Added some new AT commands 2. Added CAN protocol latitude/longitude and Elevation messages 3. Added FAQs list
Version1.10	2025.01.23	Adjusted table and figure numbering