User Manual

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BX50M-TAP GNSS RTK&PPP Board User Manual

Sales Enquiry: sales@tersus-gnss.com
Technical Support: support@tersus-gnss.com
More details, please visit www.tersus-gnss.com

Revision History

Rev	Description	Date
1.0	Initial release	20240326
1.1	Update TAP	20240513
1.2	Update Section3.1	20240607

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Notices

The following notices apply to Tersus BX50M-TAP board.

⚠	Changes or modifications to this equipment not expressly approved by Tersus could void the user's authority to operate this equipment or even has risk to damage the GNSS RTK Boards.

Conventions

The following conventions are used in this manual:

!	Information that supplements or clarifies text.

⚠	A caution that actions, operation or configuration may lead to incorrect or improper use of the hardware.

⚠	A warning that actions, operation or configuration may result in regulatory noncompliance, safety issues or equipment damage.

In this manual, all the commands are in capital letters, which is just for easy identification, the commands are not case-sensitive.

1. Introduction

1.1 Overview of BX50M-TAP GNSS board

The BX50M-TAP adopts Tersus Antares chip, and provides real-time monitoring of interference signals and automatic filtering. It tracks all current GNSS constellations including GPS, GLONASS, Galileo, BeiDou, QZSS, SBAS, and IRNSS to improve continuity and reliability of RTK solutions that provide centimeter positioning.

The BX50M-TAP includes TAP, the satellite-based precise point positioning service developed by Tersus GNSS. With TAP, the GNSS rover receiver will not need to work with the local RTK base station or CORS, but directly receives corrections broadcast by the satellite, such as ephemeris error, satellite clock error, etc.

The BX50M-TAP board supports multiple constellations and multiple frequencies to improve the continuity and reliability of the RTK solution even in harsh environments. In-built 8GB memory makes data collection easy. It features compatibility with other GNSS boards in the market via flexible interfaces, smart hardware design, and commonly used log/command formats.

For further information about BX50M-TAP GNSS board, refer to https://www.tersus-gnss.com/ for more details.

1.2 Receiver features

The BX50M-TAP Receiver has the following features:

- Supports multiple constellations & frequencies

- GPS L1 C/A, L1C, L2C, L2P, L5C

- GLONASS L1OF, L2OF, L3OC

- BeiDou B1I, B2I, B3I, B1C, B2a, B2b

- Galileo E1, E5a, E5b, E5AltBOC, E6

- QZSS L1 C/A, L1C, L2C, L5C

- SBAS L1 C/A, L5

- IRNSS L5

- L-Band

- Supports 1792 channels
- Centimeter-level position accuracy
- Flexible interfaces such as TTL, USB, CAN, Ethernet
- Supports PPS output and event mark input
- Supports up to 20Hz RTK solution updates and raw data output
- In-built 8GB memory makes data collection easy
- Pin-to-pin compatible with UB482
- Log/command compatible with NovAtel protocol

1.3 Related information

Table 1.1 Document / Software used in this User Manual

Name	Description	Link
Log & Command document	Document providing all the loggings output from BX50M-TAP receivers and all the commands to the receivers	BX50C GNSS OEM Board | Tersus GNSS (tersus-gnss.com)
Tersus Tool Suite	Tersus Tools including TersusDownload, TersusGeoPix, TersusGNSSCenter, TersusUpdate, TersusRinexConverter	https://www.tersus-gnss.com/software
RTKLIB	A free & popularly used Post processing tool	http://www.rtklib.com/

Support

If there is any problem and the information needed cannot be found in the product documentation, request technical support by sending email to support@tersus-gnss.com or logging a ticket in our tracking system https://tersus.supportsystem.com/ .

1.4 BX50M-TAP System Overview

To make BX50M-TAP board work, the following parts are necessary:

- ✧ Interface board and cables
- ✧ Power supply
- ✧ Data communications equipment
- ✧ GNSS antenna with Low Noise Amplifier (LNA)

The BX50M-TAP receiver is illustrated in the figure below.

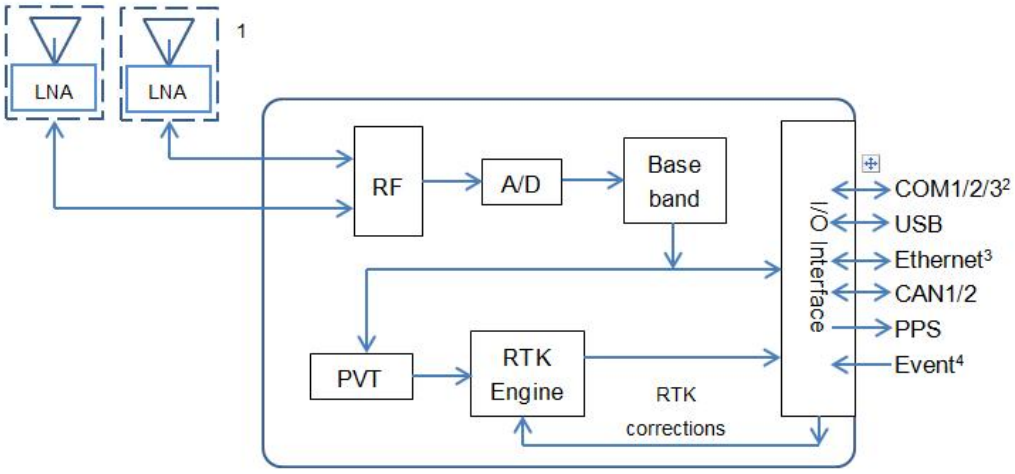


Figure 1.1 System Overview of BX Boards

Note 1. BX50M-TAP only support single antenna.

1.4.1 BX50M-TAP Board

The BX50M-TAP board is shown below.

Figure 1.2 The BX50M-TAP Board

BX50M-TAP board consists of a Radio Frequency (RF) section and a digital section.

Radio Frequency (RF) Section

The receiver obtains filtered, amplified GNSS signals from the antenna. The RF section down converts the incoming RF signals to Intermediate Frequency (IF) signals which are processed by the digital section. The RF section also supplies power to the active antenna LNA through the coaxial cable. The RF section has been designed to reject common sources of interference.

Digital Section

The core of the digital section is the base band, which is realized with a FPGA chip. The digital section digitizes and processes the base band signals to obtain a PVT (Position, Velocity and Time) solution. If RTK corrections from the base are received, the receiver will output cm-level position. The digital section also processes the system I/O, shown in Figure 1.1.

1.4.2 Antenna

The antenna converts electromagnetic signals transmitted by GNSS satellites into electrical signals that can be used by the receiver.

An active GNSS antenna is required for optimal receiver performance. Tersus is providing active GNSS antennas with precise phase centers and robust enclosures (refer to https://www.tersus-gnss.com/product/accessories for more information about antennas.

1.4.3 Power Supply

A power supply capable of delivering the minimum receiver operating voltage and power is required. The receiver operates at 3.3V.

1.4.4 Communication Equipment

A computer, a tablet or other data communications device are necessary to communicate with the receiver, and to receive and store the data that the receiver outputs.

1.4.5 Internal eMMC

BX50M-TAP receiver supports up to 8GB internal eMMC.

2. Installation

!	The BX50M-TAP board can be integrated to the customer's system in various packages, and all actions can refer to the installation guide in this chapter.

2.1 Unpacking

Inspect the shipping cartons visually for any signs of damage or mishandling before unpacking the receiver. Immediately report any damage to the shipping carrier.

Please check each item according to your order and the item list to confirm that all the accessories are correct for the purchased order.

2.2 Environmental conditions

Install the receiver in a location situated in a dry environment with ESD protection. Avoid exposure to extreme environment conditions including:

- Water or excessive moisture
- Excessive heat greater than 75 °C (167 °F)
- Excessive cold less than –35 °C (–31 °F)
- Corrosive fluids and gases

Avoiding these conditions improves the receiver's performance and long-term reliability.

2.3 Selecting a GNSS antenna

The BX50M-TAP tracks multiple GNSS frequencies, ensure that the antenna you choose supports the frequencies you need to track.

The antennas provided by Tersus can be found on Tersus website https://tersus-gnss.com/product/accessories. It is highly recommended that the antennas from Tersus are used to work with BX50M-TAP.

⚠	Contact Tersus support if problem occurs when an antenna from other vendors is used.

When installing the antenna:

- Choose an antenna location with a good view of the sky so that there is no obstruction from horizon to horizon.
- Mount the antenna on a secure, stable structure capable of safe operation in the specific environment.
- Avoid areas with high vibration, excessive heat, electrical interference, and strong magnetic fields.
- Avoid mounting the antenna close to stays, electrical cables, metal masts, and other antennas.
- Avoid mounting the antenna near transmitting antennas, radar arrays, or satellite communication equipment.

2.4 Power Supply

⚠	Power to the BX50M-TAP board must be applied for >150ms before any of the external interfaces are powered on by the integrator's board. Hold the RESETIN pin low during power up and for >150ms after power is applied.

⚠	The receiver operates at 3.3V. If the voltage supplied is below the specification, the receiver suspends operation.

⚠	The BX50M-TAP receiver supports reversed polarity protection.

2.5 Installation

When the appropriate equipment is selected, complete the following steps to set up and begin using the BX50M-TAP.

a) Install the BX50M-TAP board in an enclosure or on a mother board.
b) Mount the GNSS antenna to a secure, stable structure.
c) Connect the GNSS antenna to the receiver with a GNSS antenna cable.
d) Apply power to the board, as described in section 1.4.3.
e) Connect the board to a computer or other data communications equipment.

⚠	When BX50M-TAP board is handled, follow the guides below to avoid damage from ESD. ● Always wear a properly grounded anti-static wrist strap when handling BX50M-TAP board. ● Always hold the board by the corners or the RF shield: avoid direct contact with any of the components. ● Never let the board come in contact with clothing. The ground strap cannot dissipate static charges from fabrics. ● Failure to follow accepted ESD handling practices could cause damage to the board permanently. ● The warranty may be void if equipment is damaged by ESD.

2.6 Tersus GNSS Center Software

BX50M-TAP GNSS RTK board has serial ports, hence lots of serial tools can be used to communicate with the board. Tersus GNSS Center is a windows-platform-based serial tool, which is recommended to communicate with the BX50M-TAP board. Tersus GNSS Center can be downloaded from Tersus website https://tersus-gnss.com/software .

Connect BX50M-TAP to a laptop/PC with an external cable. Run Tersus GNSS Center, the following config page is shown, input the port and band rate (default is 115200).

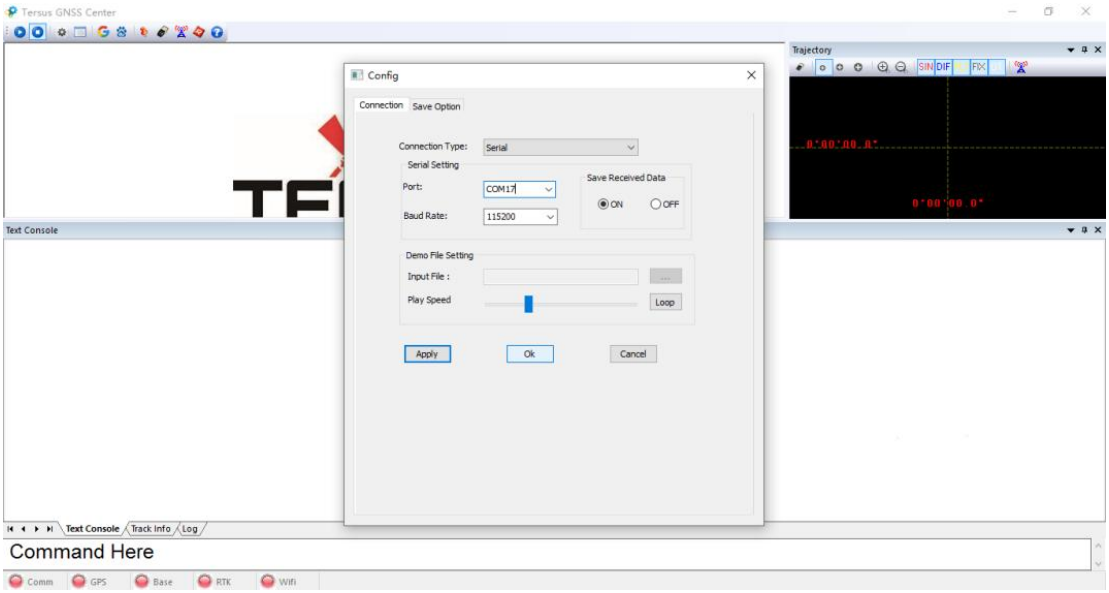


Figure 2.1 Config Page of Tersus GNSS Center

The following table gives definition for the five lights at the bottom of Tersus GNSS Center interface.

Table 2.1 Definition of the lights on Tersus GNSS Center

Lights	Description
Comm	GREEN: the communication with the receiver is established. RED: the communication with the receiver is not established.
GPS	GREEN: valid GPGGA is received. RED: No valid GPGGA is received.
Base	GREEN: valid corrections are received. RED: No valid corrections are received.
RTK	SOLID GREEN: RTK solution is got. BLINK GREEN: float solution is got. RED: other solutions are got.
Wifi	Reserved.

Commands can be input in the text console window, an [OK] response is output after a command is input, or the command is not input successfully.

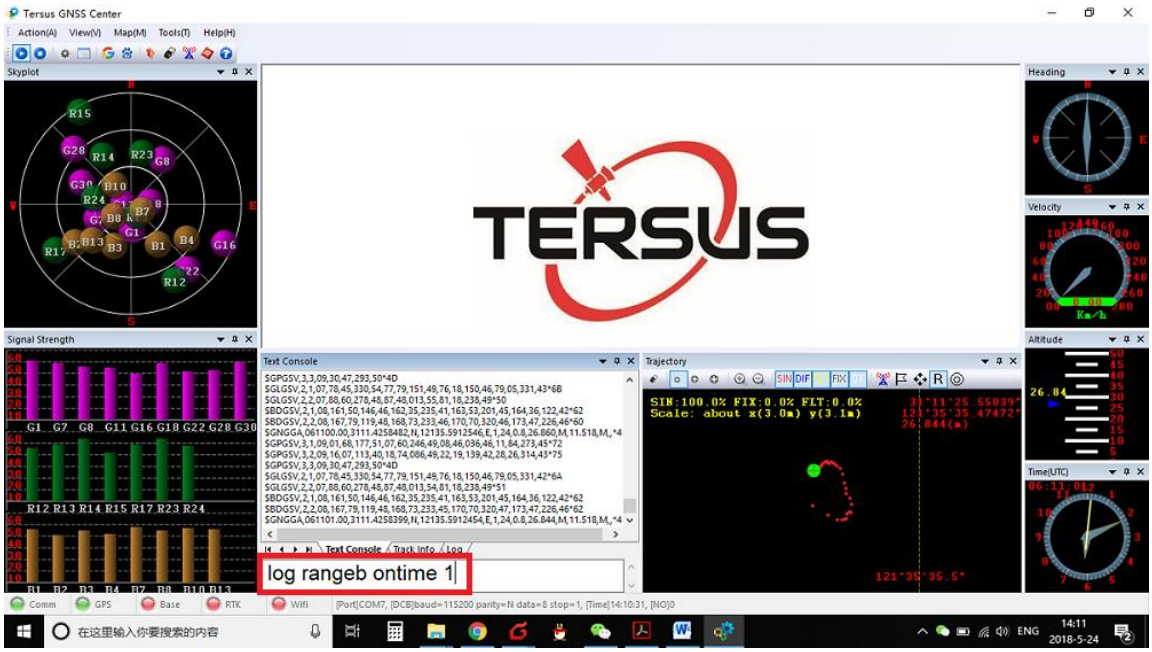


Figure 2.2 Main Windows of Tersus GNSS Center

!	To active the skyplot, signal strength, trajectory and other windows, the antenna signals must be received and the following three loggings must be input to the receiver: LOG GPGGA ONTIME 1 // output position and time LOG GPGSV ONTIME 1 // output SVs in view, elevation and SNR (Signal Noise Ratio) LOG RNAGEB ONTIME 1 // output PSR (Pseudorange) and ADR (Accumulated Doppler Range.)

refer to *Log & Command Reference document* for details.

2.7 RTK Configuration

Example of RTK configuration (base mode):

UNLOGALL //remove all logs

UNDULATION USER 0.0 //Set user specified undulation value for ellipsoid height

FIX POSITION B L H //B: latitude (degree), L: longitude (degree), H: ellipsoid height (m)

For example: FIX POSITION xx.xxxxxx xx.xxxxxxx xx.xx

or POSAVE ON 0.02 //Turn on position average for 0.02 hour (72s)

LOG COM2 RTCM1006 ONTIME 10 //output the base coordinate

LOG COM2 RTCM1074 ONTIME 1 //output GPS observations

LOG COM2 RTCM1084 ONTIME 1 //output GLONASS observations

LOG COM2 RTCM1094 ONTIME 1 //output Galileo observations

LOG COM2 RTCM1114 ONTIME 1 //output QZSS observations

LOG COM2 RTCM1124 ONTIME 1 //output BeiDou observations

LOG COM2 RTCM1230 ONTIME 10 //output GLONASS bias information

LOG COM2 RTCM1033 ONTIME 10 //output antenna, receiver information

SAVECONFIG //save the configuration above

Example of RTK configuration (rover mode):

UNLOGALL //remove all logs

FIX NONE //cancel the fixed coordinate of a base station

LOG GPGGA ONTIME 1 //output GPGGA to check position type

SAVECONFIG //save the configuration above

!	The antenna of the base must be static and its position must be input, several ways can be used to input the position of the base: ● If the base's position is known, input it directly with command FIX.

	• If the base's position is unknown, and the accuracy of the base can be meter-level, then it is recommended to use command POSAVE to setup the base, refer to the Log & Command document for more about this command. Please note the base's position will be different after a power cycle even if the antenna is installed at the same point if POSAVE command is input. • If you require a cm level accuracy of base and rover, then: a. Configure the base receiver as a rover, receive RTK corrections from a CORS nearby, this receiver can get cm-level accuracy position. b. Collect raw measurements for half an hour, process it with post processing software or send the data to an online processing web, e.g. OPUS, to get an accurate position.

3. Technical Specifications

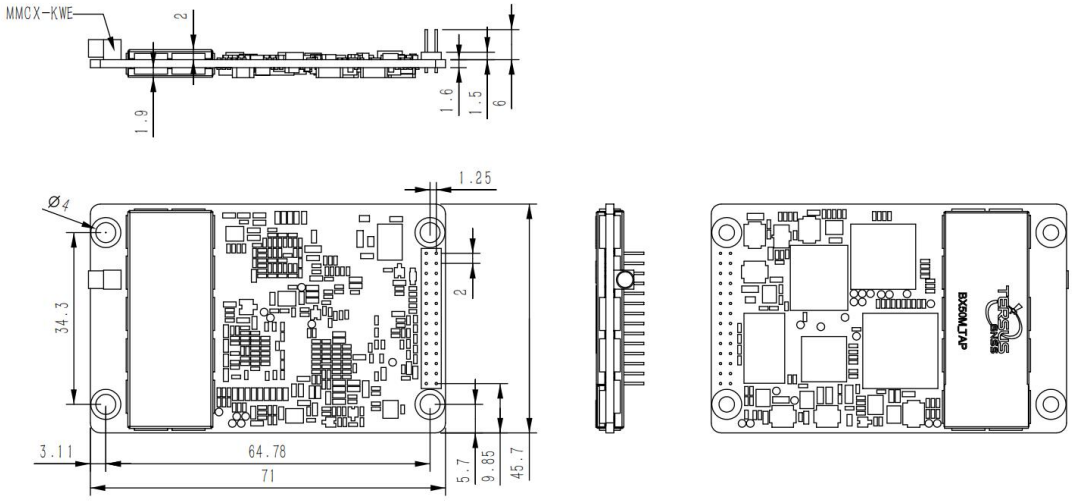
3.1 BX50M-TAP specifications

Table 3.1 BX50M-TAP Board Specifications

Performance		
Signal Tracking	GPS L1 C/A, L1C, L2C, L2P, L5C GLONASS L1OF, L2OF, L3OC BeiDou B1I, B2I, B3I, B1C, B2a, B2b Galileo E1, E5a, E5b, E5AltBOC, E6 QZSS L1 C/A, L1C, L2C, L5C SBAS L1 C/A, L5 IRNSS L5 L-Band	
GNSS Channels	1792	
Position Accuracy(RMS)	Single point positioning	1.5m (Horizontal)
		3.0m (Vertical)
	RTK positioning	8mm+1ppm (Horizontal)
		15mm+1ppm (Vertical)
	DGPS positioning	0.25m (Horizontal)
		0.5m (Vertical)
	High-Precision Static	2.5mm+0.1ppm (Horizontal)
		3.5mm+0.4ppm (Vertical)
TAP	Positioning Accuracy(RMS)	15mm(Horizontal)
		30mm(Vertical)
	Convergence Time	3 minutes
	Coverage	Global

	Signal stability	99.99%
Observation Accuracy (zenith direction):	C/A Code P Code Carrier Phase	10cm 10cm 1mm
Time to First Fix	Cold Start Warm Start	<35s <10s
Reacquisition	<1s	
Time Accuracy(RMS)	20ns	
Velocity Accuracy(RMS)	0.03m/s	
Initialization (typical)	4s	
Initialization Reliability	>99.99%	
Correction	RTCM 2.3/3.0/3.1/3.2/CMR/CMR+	
Data output	NMEA-0183 and Tersus Binary Format	
Data Rate	20Hz	
Storage	In-built 8GB memory	
Communication		
Serial ports	LV TTL x3	
COM baud rate	Up to 921600bps	
USB ports	USB 2.0 device x1	
PPS ports	LVTTL x1	
Event mark	LVTTL x1	
Electrical		
Input Voltage	+3.3 VDC ±5%	
Power Consumption	1.9W (typical)	
Physical		
Size	71 * 46 * 11 mm^3	
Weight	24g	

IO connectors	28pin header
Antenna Connector	MCX female x1
Environmental	
Operating Temperature	-35°C ~ +75°C
Storage Temperature	-55°C ~ +95°C
Mechanical Drawing	



3.2 System integration

3.2.1 Connectors on BX50M-TAP board

Table 3.2 28-pin header signals definition

Pin	Signal	Type	Description
1	SPI_MOSI	SPI DATA	Reserved
2	SPI_CS	SPI CS	Reserved
3	SPI_CLK	SPI CLK	Reserved
4	TPO_MID	TPO_MID	Reserved
5	RSV	Reserved	
6	VCC	Power input	3.3~5V DC
7	SPI_MISO	SPI data	Reserved
8	RXD3	COM3 Input Receive Data	LV TTL
9	RESETIN_N	Reset Input	LV TTL, Active low, duration>5ms
10	FRESET_N	Restore Factory Settings	LV TTL, Active low, long press over 5s
11	EVENT	Input	LV TTL
12	RSV	Reserved	
13	TXD3	COM3 Output Transmit Data	LV TTL
14	GND	Digital and Power Ground	
15	TXD1	COM1 Output Transmit Data	LV TTL
16	RXD1	COM1 Input Receive Data	LV TTL
17	GND	Digital and Power Ground	
18	TXD2/SDA	COM2 Output Transmit Data/I2C SDA	LV TTL
19	RXD2/SCL	COM2 Input Receive Data/I2C SCL	LV TTL
20	GND	Digital and Power Ground	
21	PV	Position Validity Indicator	
22	GND	Digital and Power Ground	
23	PPS	Clock output	LV TTL
24	RSV	Reserved	
25	TPO+	TPO+	Reserved
26	TP1+	TP1+	Reserved
27	TPO-	TPO-	Reserved
28	TP1-	TP1-	Reserved

4. Typical Application

4.1 Communicate with STRSVR Tool

The steps of BX50M-TAP communicating with STRSVR tool are as follows:

1) Power on the BX50M-TAP receiver, connect COM1 and COM2 to the computer. COM2 is to communicate with Tersus GNSS Center, COM1 is to receive RTK corrections from a NTRIP caster.
2) Run RTKLIB -> STRSVR, select serial for output type. And click the option button for serial port COM1 and configure it.

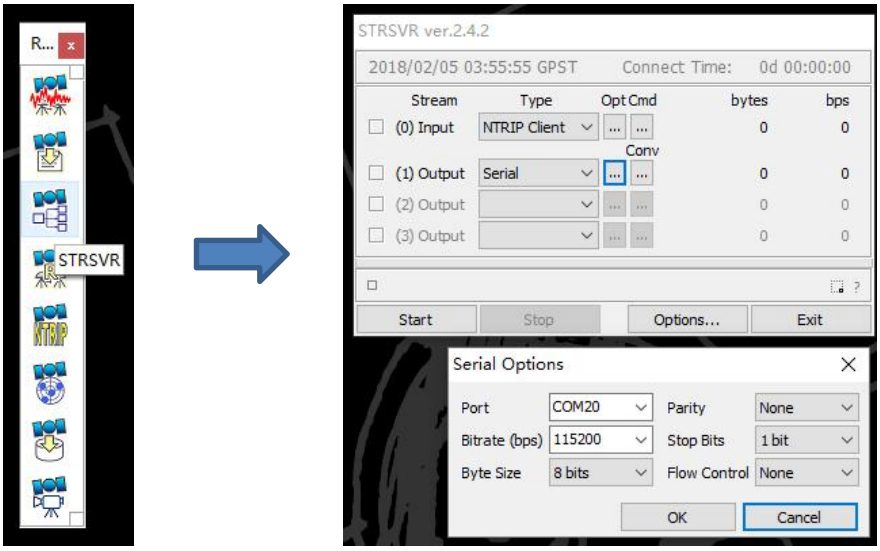


Figure 4.1 Configure serial port COM1

3) Select NTRIP client for input type, click the Opt button for NTRIP, and fill all the five fields for NTRIP client configuration.

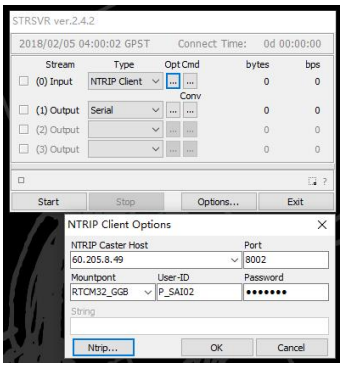


Figure 4.2 NTRIP client configuration

4) If needed, draft position of the board is input, refer to the following figure.

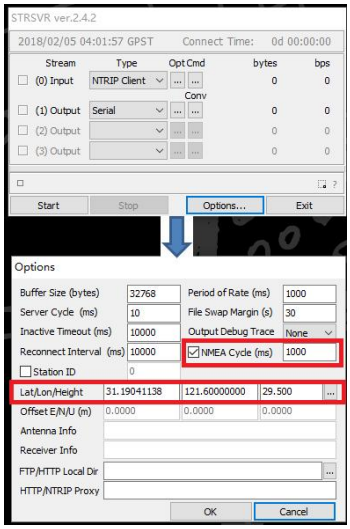


Figure 4.3 Draft position of the board

5) Go back to the main page, and click [Start]. If everything is [OK] the following page will be shown. The input and output data will increase with time. And the position type of the receiver can be checked in Tersus GNSS Center software.

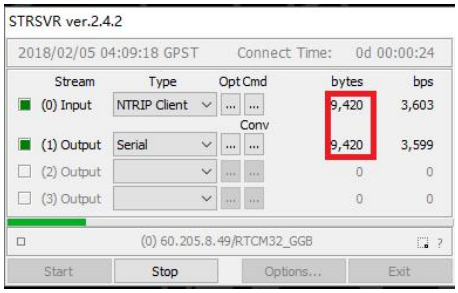


Figure 4.4 Input and Output data in progress

5. Terminology

ASCII	American Standard Code for Information Interchange
CMR	Compact Measurement Record
DC	Direct Current
ESD	Electro-Static Discharge
ECEF	Earth Center Earth Fixed
EGNOS	European Geostationary Navigation Overlay Service
GAGAN	GPS Aided Geo Augmented Navigation
GLONASS	GLObal NAvigation Satellite System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
IF	Intermediate Frequency
IMU	Inertial Measurement Unit
IO	Input / Output
LED	Light Emitting Diode
LNA	Low Noise Amplifier
MPU	Micro Processing Unit
NMEA	National Marine Electronics Association
PC	Personal Computer
PPS	Pulse Per Second
QZSS	Quasi-Zenith Satellite System
RF	Radio Frequency
RINEX	Receiver Independent Exchange format
RMS	Root Mean Squares
RTK	Real-Time Kinematic

RTCM	Radio Technical Commission for Maritime Services
SBAS	Satellite-Based Augmentation System
SNR	Signal-to-Noise Ratio
SMA	Sub-Miniature-A interface
TTFF	Time to First Fix
TTL	Transistor-Transistor Logic level
UART	Universal Asynchronous Receiver/Transmitter
USB	Universal Serial BUS
UTC	Universal Time Coordinated
VRS	Virtual Reference Station
WAAS	Wide Area Augmentation System
WGS84	World Geodetic System 1984