User Manual

Precis-BX305

Precise GNSS RTK board

www.tersus-gnss.com

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Proprietary Notice

Revision History

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1. Introduction

1.1. Overview

The Precis-BX305 board provides millimeter level carrier phase observation as well as centimeter level RTK positioning accuracy. It also supports chip level multi path mitigation, RTK positioning and instant heading technology, especially suitable for high accuracy navigation and positioning used in moving objects like cars, unmanned aerial vehicles(UAV) etc. it also applies for the control of agriculture machinery, engineering machinery and port machinery, as well as displacement measurement and GIS etc.

Figure 1 Outlook of Precis-BX305 Board

1.2. Receiver Features

- Support GPS L1/L2, GLONASS L1, and Beidou B1/B3;
- Support single satellite system positioning and multi-system positioning;
- Support sub-meter RTD positioning and centimeter level RTK positioning;
- Support log raw observations.
- Support 2 UART(COM)s and 1 PPS(Pulse Per Second accuracy timing); High reliability and stability even in harsh environment;
- Update rate up to 20Hz;
- Powered by +5V micro USB power supply;
- Onboard 6DOF IMU, support integrated navigation system (INS).

1.3. System overview

Precis block diagram is presented as follows

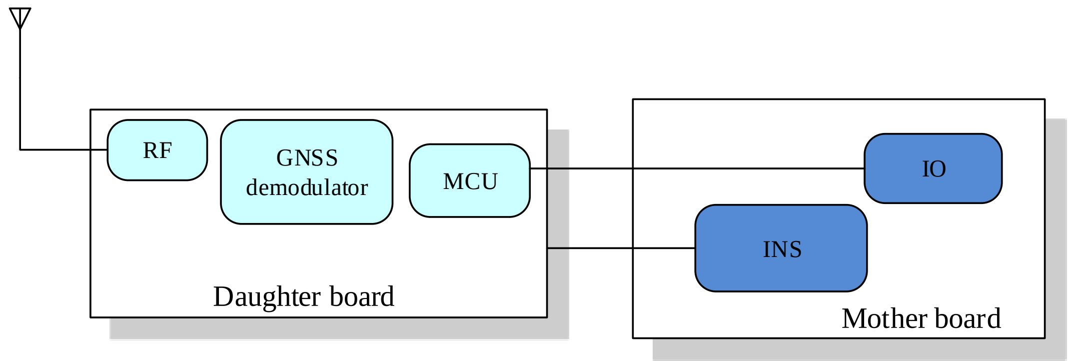

Figure 2 System block diagram

RF module: Receives GNSS signals from antenna, sends to baseband module as IF signal after filtering and low noise amplifying.

Baseband: Demodulates GNSS IF signals into navigation message.

MPU: A microprocessor for PVT calculation, differential position processing, and data transfer to and from peripherals.

INS: INS integrates an IMU with 3-axis accelerometer, a 3-axis gyroscopes and a 3-axis magnetic sensor, can provide motion tracking information under obstacles environment where GNSS signal is lost.

IO: Includes COMs, LED and power supply etc. interface.

1.4. Electronic Characteristics

1.4.1. Absolute Maximum Ratings

Table 1 Description of Absolute Maximum Ratings

Parameter	Symbol	Condition	Min	Max	Unit
Power Supply Voltage (From Micro-USB)	Vin			6	V
Input pin applied DC Voltage	RXD_UART			3.6	V
	Vin_USB			3.6	V
	Vrfin			0	V
DC current trough any digital I/O pin (except supplies)	Ipin			10	mA
Input power at RF_IN	Prfin	Source impedance = 50 Ω, continuous wave		13	dBm
Antenna bias voltage	V_ANT			6	V
Antenna bias current	I_ANT			100	mA
Storage temperature	Tstg		-40	85	℃

Note: Stressing the device beyond the “Absolute Maximum Ratings” may cause permanent damage. These are stress ratings only. The product is not protected against overvoltage or reversed voltages. If necessary, voltage spikes exceeding the power supply voltage specification, given in table above, must be limited to values within the specified boundaries by using appropriate protection diodes.

1.4.2. Operation Ratings

Table 2 Description of Operation Ratings

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Power Supply Voltage (From Micro-USB)	Vin_USB			5		V
Power Consumption (Total)	Ptol				3.5	W
Digital IO Pin Low level input voltage	RXD_UART, TXD_UART		0	0	0.66	V
Digital IO Pin High level input voltage	RXD_UART, TXD_UART		2.3	3.3		V
Digital IO Pin Low level output voltage	RXD_UART, TXD_UART, PPS	Iol = 4 mA		0	0.4	V
Digital IO Pin High level output voltage	RXD_UART, TXD_UART, PPS	Iol = 4 mA	2.9	3.3		V
Output Power voltage (VCC_3V3)	Vout		3.135	3.3	3.465	V
Output Power current (VCC_3V3)	Iout				200	mA
V_ANT antenna bias voltage	V_ANT		4.75		5.1	V
Antenna bias voltage drop	V_ANT_DROP			0.1	13	dBm
Antenna bias current	I_ANT				100	mA
RF Input Level	Prf		-105		-85	dBm
RF Signal Type	GNSS		Beido B1/B3, GPS L1/L2, GLONASS L1			
Receiver Chain Noise Figure	NF_tol			3.5		dB
Operation temperature	Topt		-40		85	℃

Note: All specifications are at an ambient temperature of 25℃. Extreme operating temperatures can significantly impact specification values. Applications operating near the temperature limits should be tested to ensure the specification.

Note: The serial port definitions of the serial ports are different for different version of mother board design. There are two version of mother board: v1.1 and v2.0. The version information has been marked on the receivers (see Figure 4). The pin definition of the serial port for v1.1 and v2.0 are listed respectively (see Table 4 to 7). Please pay attention to this particular issue if you intend to use your own cable. If you have any problems in operation, please feel free to contact us at sales@tersus-gnss.com.

1.4.3. Port Description (Precis-BX305 V1.1 & V2.0)

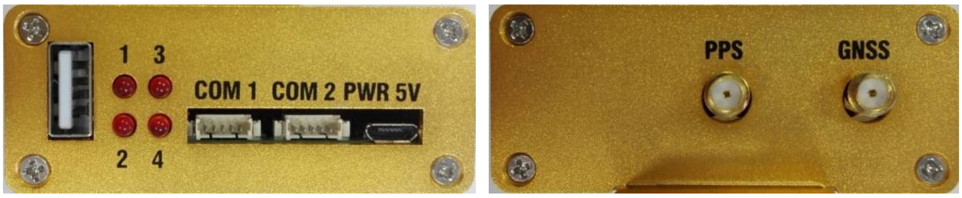

Figure 3 Port Description of Precis-BX305

Note: The difference between Precis-BX305 V1.1 and Precis-BX305 V2.0 are pin definition in COM1 and COM2 ports. The pin descriptions of V1.1 and V2.0 COM1 and COM2 are labeled independently at the back of Precis-BX305 (See Figure 4).

Figure 4 Identify Precis-BX305 V1.1 & V2.0 and Pin Definitions

Note: No labels on Precis-BX305 receivers and accessory cables before August 2016, the product version could be found on the top left corner of Precis-BX305 (See Figure 5).

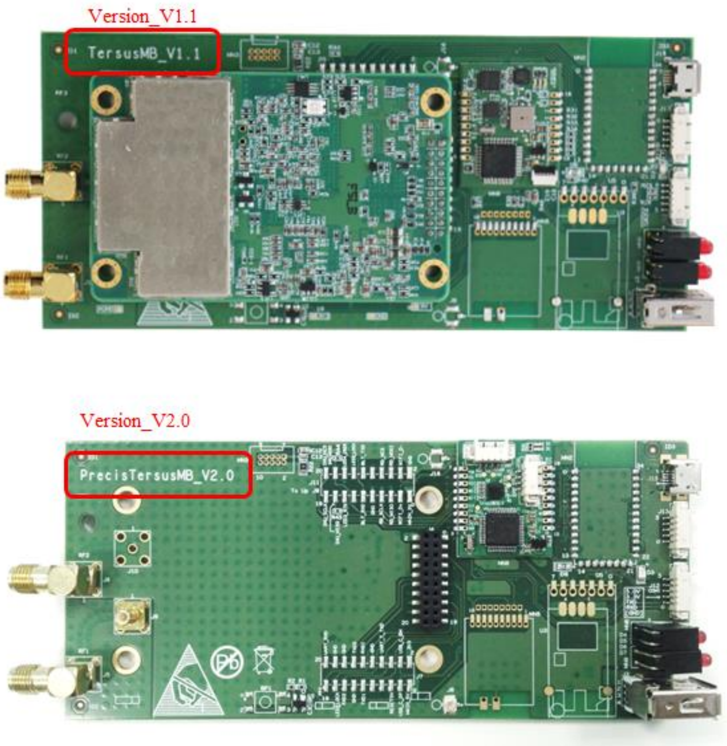

Figure 5 Identify Precis-BX305 V1.1 & V2.0 by Printed Labels

Table 3 Description of Precis-BX305 Electronic Interfaces

Interfaces	Descriptions
COM1	5pin PicoBlade receptacle connector with LVTTL voltage level
COM2	5pin PicoBlade receptacle connector with LVTTL voltage level
LED	Indicate running status
Host USB port	Not available
Micro USB	5V DC power supply
SMA1	For GNSS RF Input
SMA2	For PPS output

1.4.3.1. Micro_USB Power Supply Port

BX305 could be powered by three ports. One is Micro_USB port, and the other two are VIN pins in COM1 and COM2 port. (**Note: The VIN pins in the three ports could not be connected to different power supply contemporary. Or not, the board will be damaged.**)

At the Micro_USB port, only VBUS and GND Pin are connected. VBUS Pin is for the whole Receiver Box power supply. And the supply voltage range is from 4.3V~ 6.0V. The internal circuit of the port is as Figure 6.

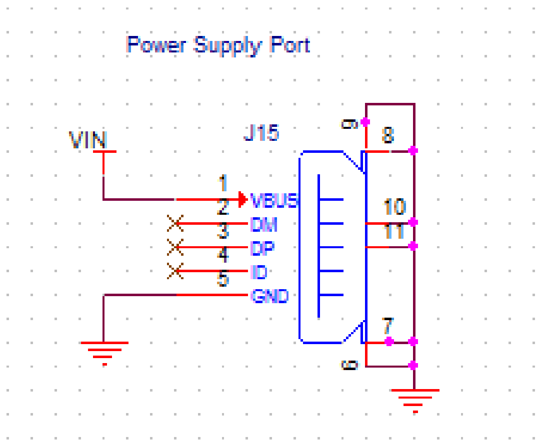

Figure 6 Schematic of Internal Micro_USB Connector

1.4.3.2. COM1/COM2 Port

Please note the difference between Precis-BX305 V1.1 and Precis-BX305 V2.0).
The following are the back panel of Precis-BX305 V1.1/V2.0.

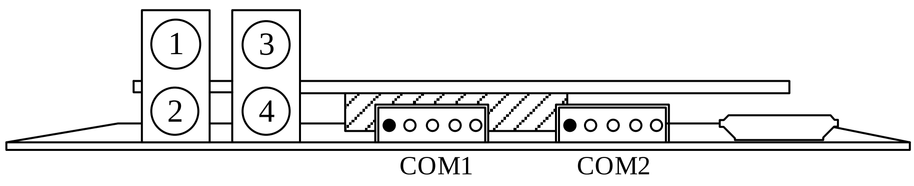

Figure 7 Back Panel View of Precis-BX305 Board

- Precis-BX305 V1.1 COM1 and COM2 port pin list and pin definition

Table 4 Pin list of Precis-BX305 V1.1 COM1 and COM2 Port

	Pin1	Pin2	Pin3	Pin4	Pin5
COM1	VIN	VCC_3V3	TxD1	RxD1	GND
COM2	VIN	VCC_3V3	RxD2	TxD2	GND

Table 5 Pin definition of Precis-BX305 V1.1 COM1 and COM2 Port

Port	Pin number	Name	I/O	Description
COM1	PIN1	VIN	I	Input Power Supply for the whole BOX. The voltage range is from 4.3V~6.0V
	PIN2	VCC_3V3	O	Output Power Supply for the accessories. The voltage range is from 3.3V
	PIN3	TxD1	O	UART1 Tx. 3.3V LVTTL type.
	PIN4	RxD1	I	UART1 Rx. 3.3V LVTTL type.
	PIN5	GND	-	Ground
COM2	PIN1	VIN	I	Input Power Supply for the whole BOX. The voltage range is from 4.3V~6.0V
	PIN2	VCC_3V3	O	Ouput Power Supply for the accessories. The voltage range is from 3.3V
	PIN3	RxD2	I	UART2 Rx. 3.3V LVTTL type.
	PIN4	TxD2	O	UART2 Tx. 3.3V LVTTL type.
	PIN5	GND	-	Ground

- Precis-BX305 V2.0 COM1 and COM2 port pin list and pin definition

Table 6 Pin list of Precis-BX305 V2.0 COM1 and COM2 Port

Port	Pin1	Pin2	Pin3	Pin4	Pin5
COM1	GND	RxD1	TxD1	VCC_3V3	VIN
COM2	GND	RxD2	TxD2	VCC_3V3	VIN

Table 7 Pin list of Precis-BX305 V2.0 COM1 and COM2 Port

COM1	PIN1	GND	-	Ground
	PIN2	RxD1	I	UART1 Rx. 3.3V LVTTL type.
	PIN3	TxD1	O	UART1 Tx. 3.3V LVTTL type.
	PIN4	VCC_3V3	O	Ouput Power Supply for the accessories. The voltage range is from 3.3V
	PIN5	VIN	I	Input Power Supply for the whole BOX. The voltage range is from 4.3V~6.0V
COM2	PIN1	GND	-	Ground
	PIN2	RxD2	I	UART2 Rx. 3.3V LVTTL type.
	PIN3	TxD2	O	UART2 Tx. 3.3V LVTTL type.
	PIN4	VCC_3V3	O	Outddput Power Supply for the accessories. The voltage range is from 3.3V
	PIN5	VIN	I	Input Power Supply for the whole BOX. The voltage range is from 4.3V~6.0V

1.4.3.3. LED Indicator

The LED indicators show the operational status of Precis-BX305 board. The functions of these indicators are defined in Table 8. The Precis-BX305 performs self-check and initialization procedure before it starts work. If you are in trouble, please go to chapter 7 for trouble shooting.

Table 8 Definition of LED indicators

LED1	LED2	LED3	LED4
Reserved	Reserved	Positioning status	Power indicator

1.4.3.4. SMA1 Port

The SMA1 connector receives GNSS RF signal and contemporary supplies 5V voltage for the LNA in the active GNSS Antenna. The current is limited to 100mA. For details of the RF signal and Antenna Bias voltage and current, please refer to Table 2.

1.4.3.5. SMA2 Port

PPS output signal from SMA2 connector is 3.3V LVTTL signal. The following table is the details of the signal description. About the electronics details, please refer to Table 2.

Table 9 PPS signal Description

Signal	Input/Output	Factory Default	Comment
PPS	Output	Active Low	High voltage is 3.3V and IO type is LVTTL.A time synchronization output. This is a pulse where the leading edge is synchronized to receiver-calculated GNSS Time. The polarity, period and pulse width can be configured using PPSCONTROL command

1.4.3.6. USB Port

USB port is not available in V_1.1 and V_2.0.

1.5. Accessories and connection

There are two types of cables for Precis-BX305. One is for Precis-BX305 V1.1 and the other is for Precis-BX305 V2.0. The version and the pin definition are labeled on the cables.

1.5.1. UART_To_USB Converter Module

This module's function is to convert UART LVTTL signal to USB signal. The female PicoBlade connector should be connected to BX305 COM1, and the USB type a connector could be inserted to PC or Laptop. The following are the pin definition of the two versions.

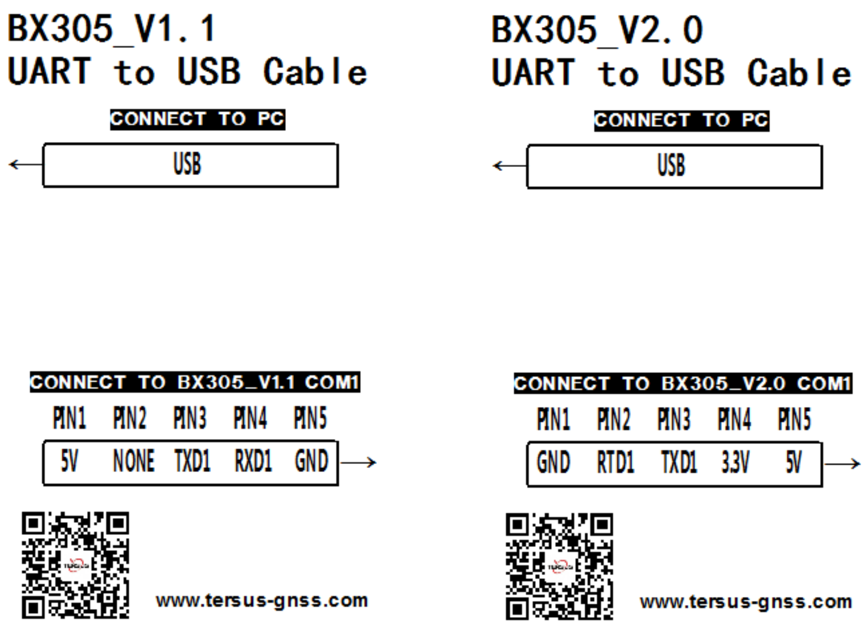

Figure 8 Labels of Precis-BX305 V1.1 & V2.0 UART_To_USB Converter Cables

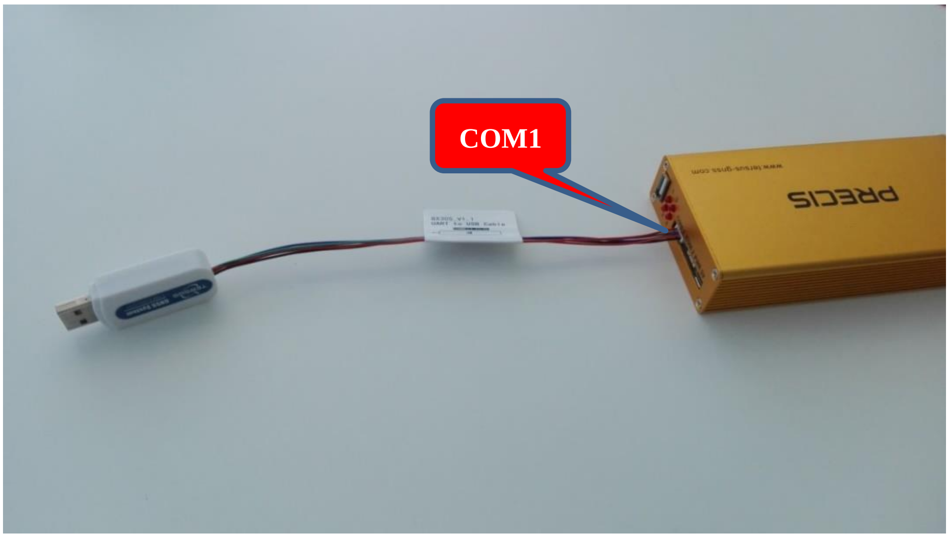

Figure 9 Connection between Precis-BX305 and UART_to_USB Converter

1.5.2. Data Logger Module and Cable

Data logger module support log data to SD card from serial port at 115200 baud rate (More details please refer to chapter 2.6). Data logger cable is to connect the board with data logger from COM1. The following are the pin definition of the two versions.

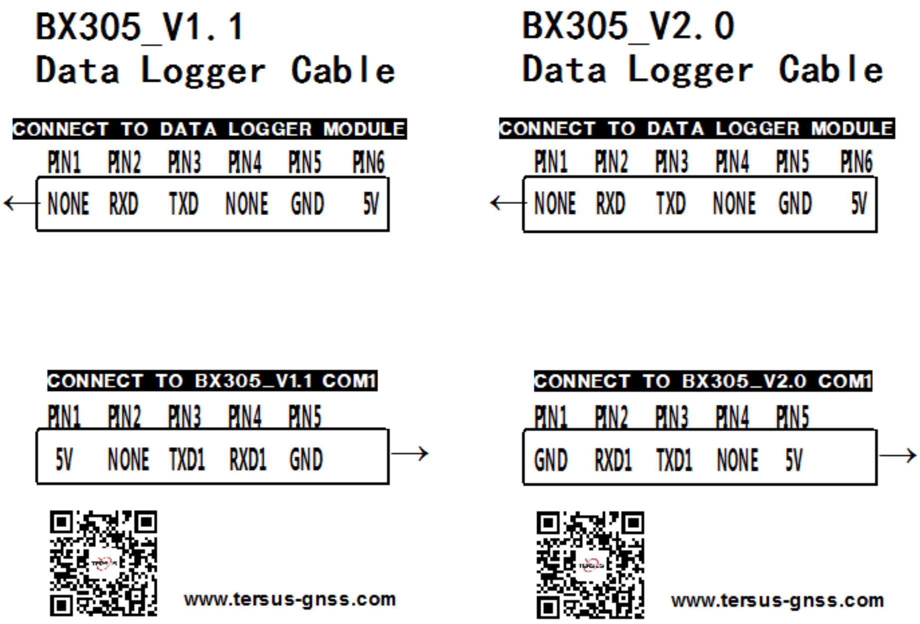

Figure 10 Labels of Precis-BX305 V1.1 & V2.0 Data logger Cables

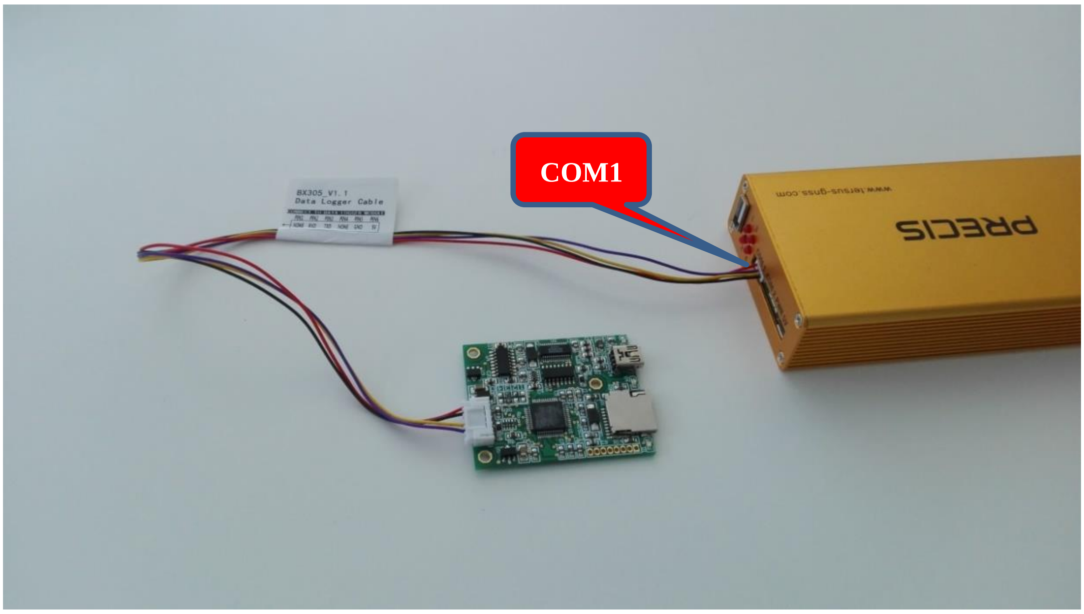

Figure 11 Connection between Precis-BX305 and UART_to_Data Logger

1.5.3. Pixhawk Cable

Pixhawk cable is to connect the board with Pixhawk of UAV from COM1. The following are the pin definition of the two versions.

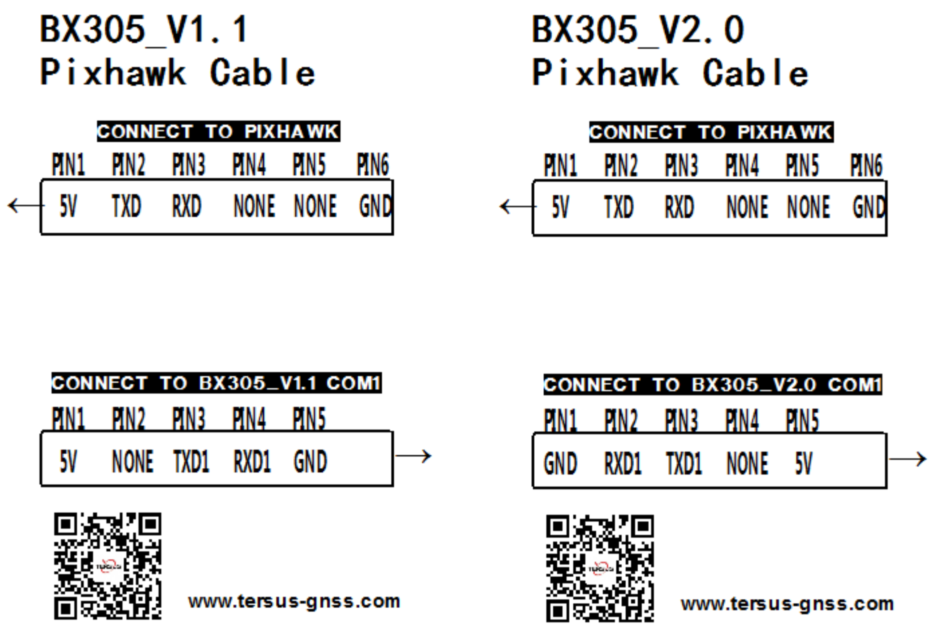

Figure 12 Labels of Precis-BX305 V1.1 & V2.0 Pixhawk Cables

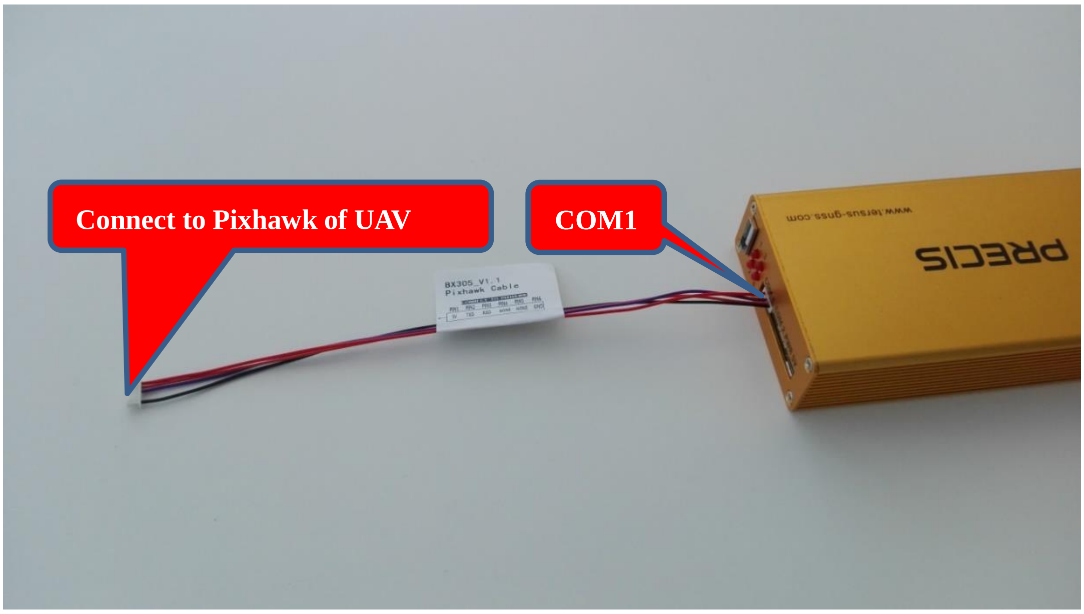

Figure 13 Connection between Pixhawk and Precis-BX305

1.5.4. Radio Module and Cable

The function of radio module is to transmit RTCM stream data from base station to rover station (More details please refer to chapter 2.3.1). Radio cable is to connect the board with radio from COM2. The following are the pin definition of the two versions.

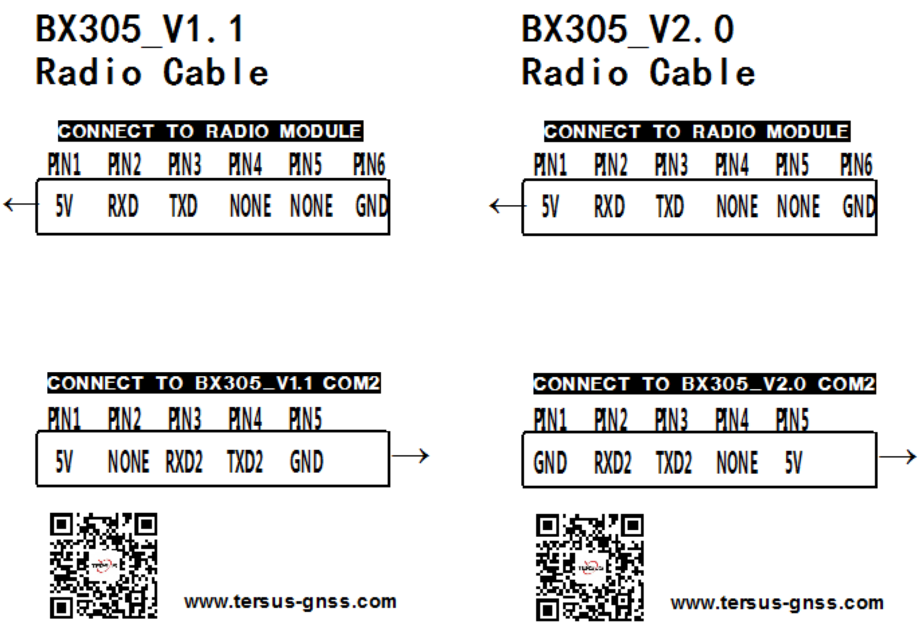

Figure 14 Labels of Precis-BX305 V1.1 & V2.0 Radio Cables

Figure 15 Connection between Pixhawk and Precis-BX305

1.5.5. Bluetooth Module and Cable

The function of Bluetooth module is to communicate the board with Bluetooth instrument (More details please refer to Chapter 2, Section 2.3.2). Bluetooth cable is to connect the board with Bluetooth module from COM2. The following are the pin definition of the two versions.

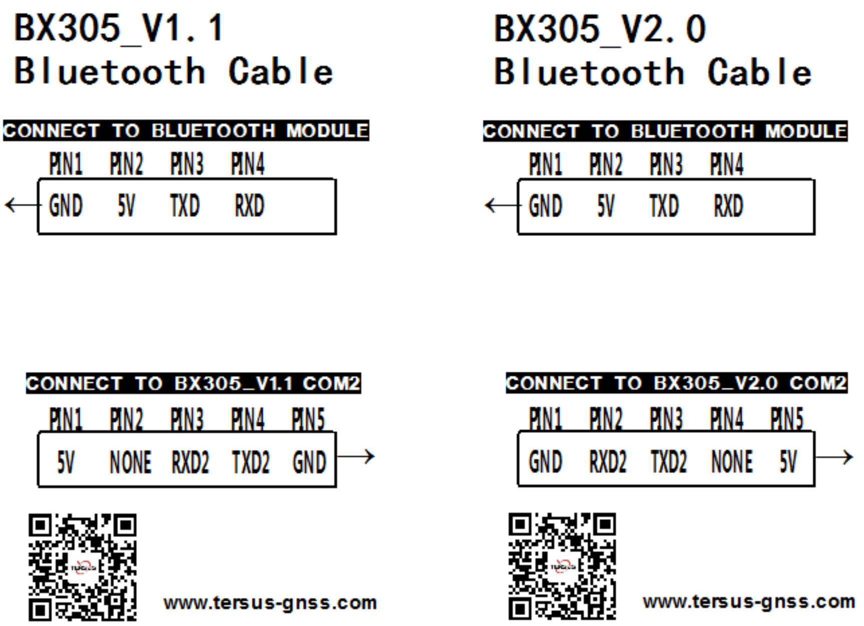

Figure 16 Labels of BX305 V1.1 & V2.0 Bluetooth Cables

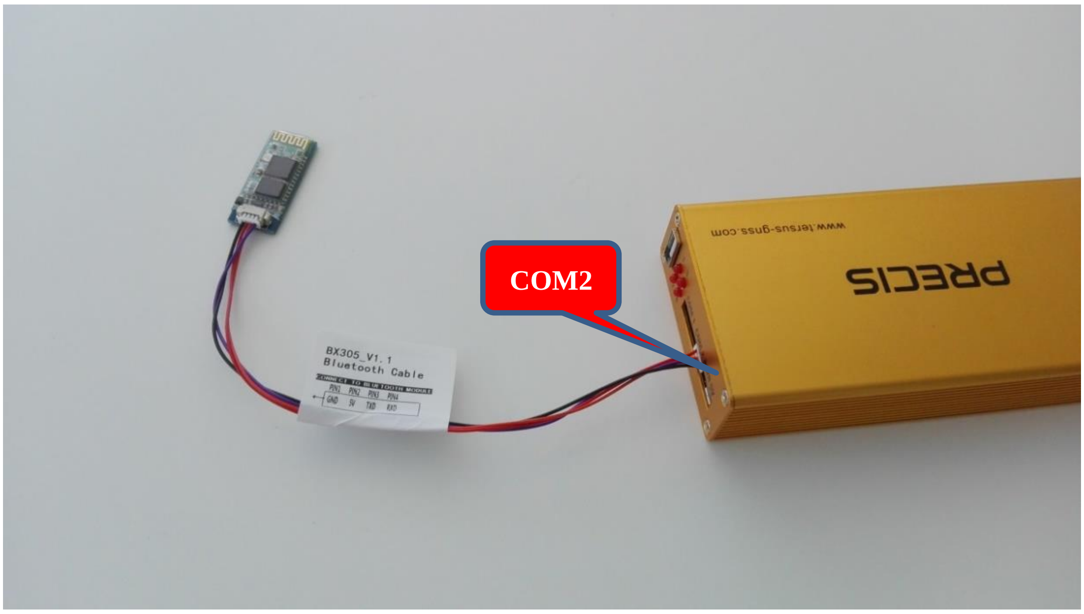

Figure 17 Connection between Bluetooth module and Precis-BX305

2. Setting up the Receiver

This chapter describes how to setting up the Precis-BX305 board to make it work. In order to perform RTK positioning, Precis-BX305 need the GNSS signals input from SMA1 and differential data stream input from COM2 port or wireless Internet work. COM1 port is used for configuration and solution output. Precis-BX305 has its own configuration tools Tersus GNSS Center.

2.1. Connect to Computer

The first step of setting up your receiver is configuring it with Precis Tools, which is running on Windows. Before running the tools, you need physically connect your Precis-BX305 board to your computer. Tersus USB connector can be used to connect the COM1 of the board and USB port of your computer (see Figure 18). The power can also supply power for the board. A USB driver is required to let your computer recognize our device and it can be downloaded from our website. There is a LED indicator on the connector to shows whether data is received and transmitted.

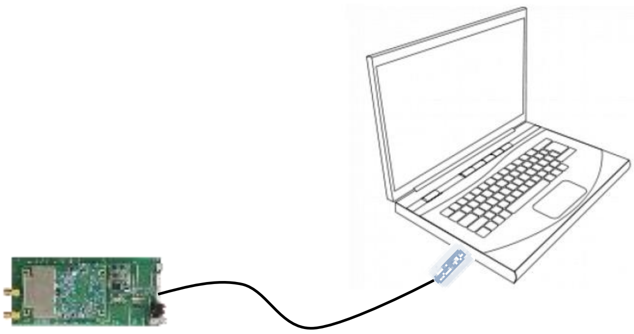

Figure 18 Demonstration of wired connection to computer

If Precis-BX305 board is installed on your computer successfully, you can find it in device manager (see Figure 19). (Device manager can be found in right click "This Computer" icon on desktop and choose 'Manage', then select Device manager on the right panel). Precix-BX305 is shown as "USB Serial Port" and you can read solution of Precis-BX305 board by connecting this serial port with any serial tools. The default serial connection parameter is of Precis-BX305 COM1 and COM2 are listed in Table 10. Then you can use serial tools to receiving data from the board. We recommend you connect the board with the Tersus GNSS Center software, which can be freely downloaded from our website.

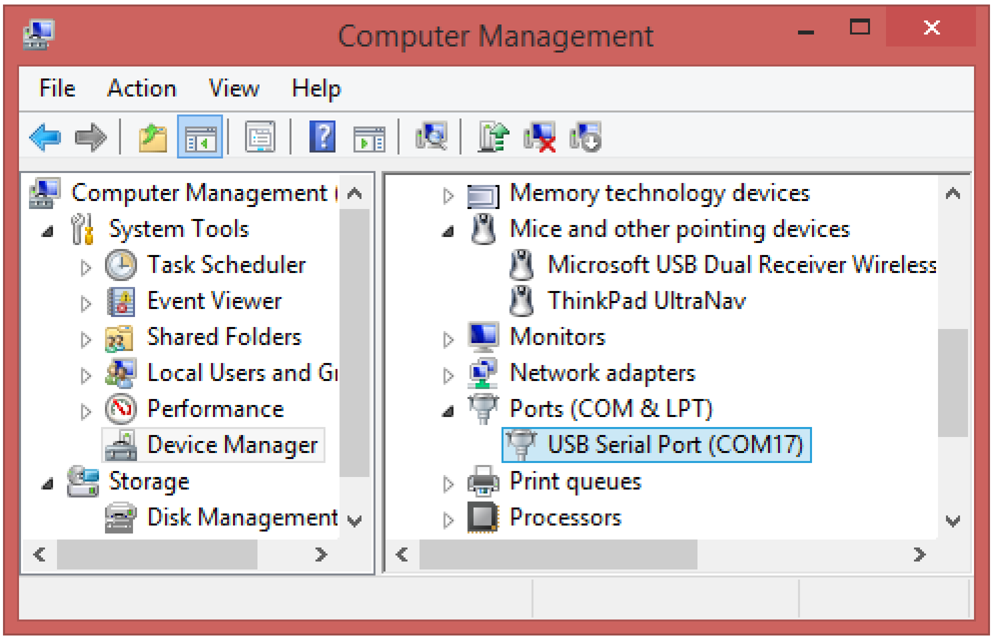

Figure 19 Demonstration of Precis board in Window device manager

Table 10 Default Serial port parameter of Precis-BX305 COM1 and COM2

Serial port parameter	Default value
Baud rate	115200
Byte Size	8 bits
Parity	None
Stop Bits	1bit
Flow Control	None

2.2. Connect to Antenna

Precis-BX305 provides a SMA female connector for connecting to GNSS antenna. Both active and passive GNSS antennas are acceptable. For active antenna, Precis-BX305 board can provide 3.3V, up to 100mA current to support LNA. Two recommended Antenna types are shown in Figure 20. The left one is the miniaturized GPS L1/GLONASS G1/Beidou B1 high performance antenna, which has stable phase center and 70mm diameter. It is designed for UAV and vehicles. The right antenna is a geodetic grade antenna with 140mm diameter, which supports GPS L1/L2, GLONASS G1/G2, Beidou B1/ B2/ B3 frequencies. This antenna is recommended for base station or other static platform.

Figure 20 Recommended GNSS Antenna for Precis-BX305

2.3. Connect to Base Station

RTK technique requires a real-time stream from (virtual) reference station to perform relative position. Considering the signal transmission medium, Precis-BX305 board allows to connect to base station in three manners: wired connection, UHF connection and Wi-Fi connection. A demonstration of the ways to access the data stream from the base station is shown in Figure 21.

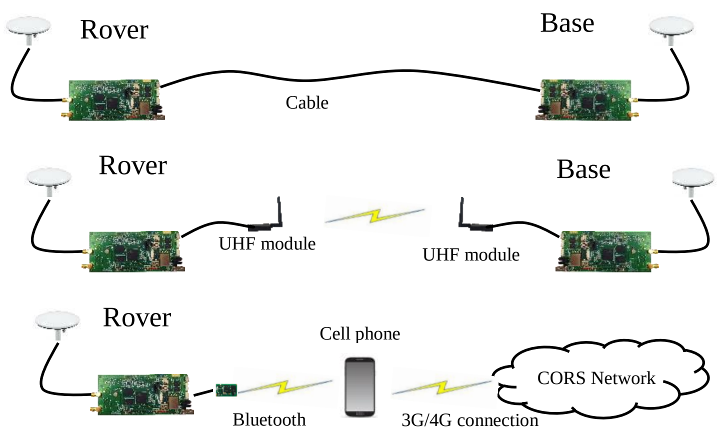

Figure 21 Three ways to connect to the base station data stream: wired connection (upper), UHF connection (middle)

Wired connection method is simplest way, but it is limited to a few meters. In this case, a cable directly connect the COM2 ports of both base and rover station for serial communication. No additional communication device requires. It is often used in altitude determination or other ultra-short baseline determination applications. The details of the other two connection methods will be discussed in following sections.

2.3.1. Connect to Base Station with UHF radio module

GNSS RTK is a precise relative positioning technique, which achieves centimeter positioning accuracy. RTK positioning requires two set of Tersus RTK boards at minimum, which are used as the base station and the rover station respectively. Normally, the base station is set up on a fixed known point and it consistently transmits differential corrections to the rover station. The rover station receives differential corrections from the base station and calculating very precise RTK solution. The following figure is an over view of Tersus GNSS RTK system, which demonstrates how does it works. We recommend using COM2 to transmit and receiving the differential data (in RTCM format) and using COM1 for configuration and logging RTK solution.

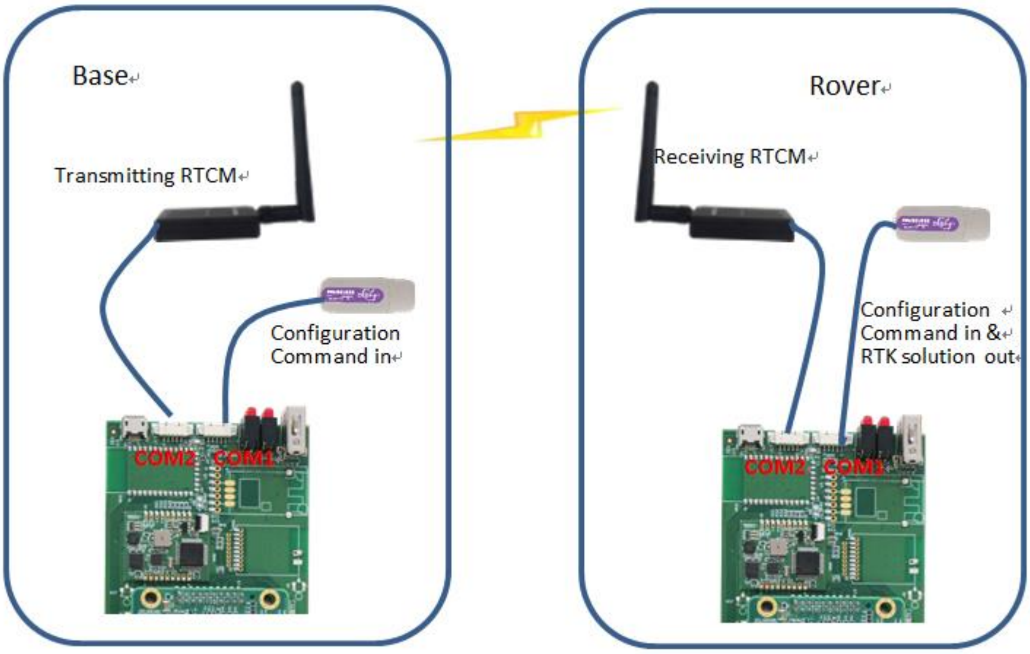

Figure 22 Overview of Tersus GNSS RTK Systems

（1） Hardware & Software Requirement

- Hardware required
  - Precis-BX305 RTK board ×2
  - Tersus USB connector ×2
  - GNSS antenna ×2
  - GNSS Antenna cable ×2
  - UHF module ×2
  - UHF module cable ×2
  - 5V DC Power supplier ×2

Precis-BX305 bundle kit includes all hardware listed above except power supplier. Power supplier can be any portable cellphone charger with USB output. If you have the Precis-BX305 board only, you need to refer to the electrical specification in the user guide to choose compatible accessories.

- Software required
  - Tersus USB connector driver
  - Tersus GNSS Center

You can download above software freely through our website.

www.tersus-gnss.com/pages/document-software

（2） Configuration of Precis-BX305 RTK Boards

Before starting field work, the first step is to configure the board into the right mode. What you need to do is to connect the board to your PC and key in commands with the Tersus GNSS Center software. The detailed steps are given as follows:

- Connect the board to you PC with Tersus USB connector (see section 2.1).
- Connect the board with Tersus GNSS Center. Launch Tersus GNSS Center. Choose serial as the connection type and choose the right serial port and baud rate (115200 by default). Click 'OK' to establish the serial connection. If the connection is successfully established, the COMM indicator on the status bar will turn to green.

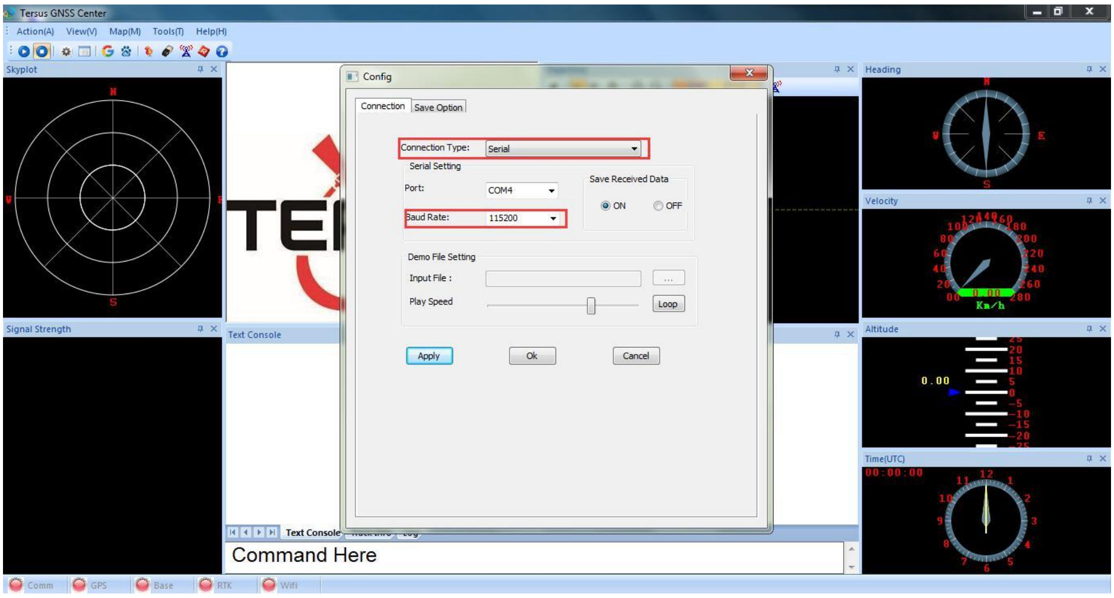

Figure 23 Establish Serial Connection with Tersus GNSS Center

- Enter commands in the text console window

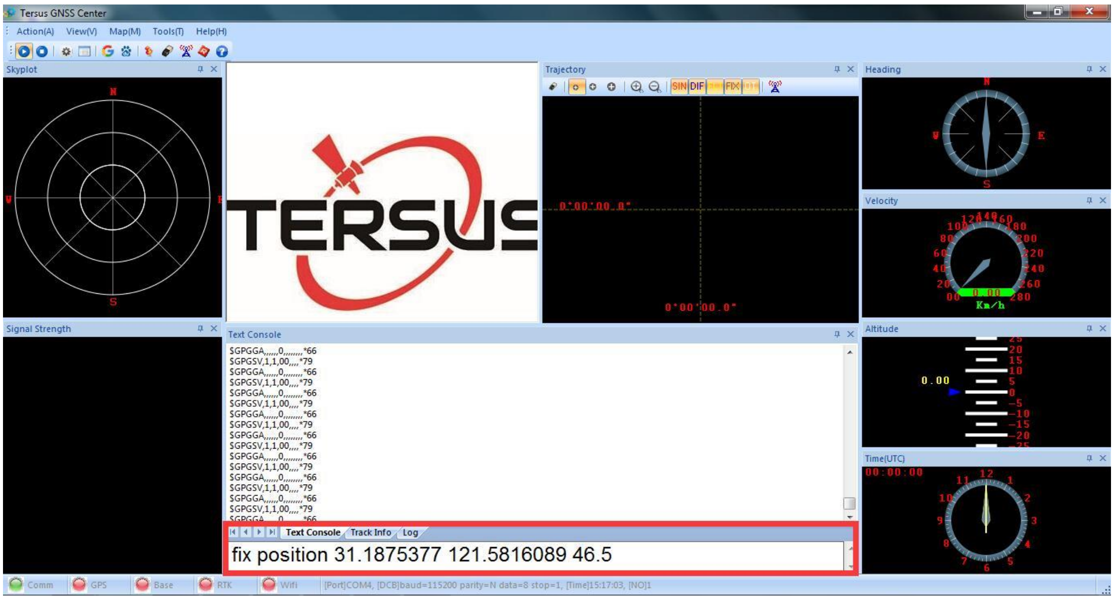

Figure 24 Text Console Window of Tersus GNSS Center

Commands for the Base Station Board:

fix position 31.1874808 121.58111234 41.4618

log com2 rtcm1074 ontime 1

log com2 rtcm1084 ontime 1

log com2 rtcm1124 ontime 1

log com2 rtcm1005 ontime 10

saveconfig

These commands fix the coordinate of the base station and configure RTCM message to be transmitted. The coordinates are expressed in degree/meter. After each command is sent, the board will automatically acknowledge a ‘>OK’, which means the configuration takes effect. If no acknowledge is received, please refer to ‘trouble shooting’ section in the user guide or contact us. If the base station coordinate is unknown, you can get it by averaging the point position solution for a while.

2.3.2. Connect to CORS with external Bluetooth module and mobile phone

The CORS is an appealing way to do RTK due to its convenience and large coverage area. While Tersus Precis-BX305 currently does not support build-in NTRIP client feature. An alternative way to connect CORS network is employing external Bluetooth module and a cellphone. Here is a detailed procedure about how to connect to CORS Network with Precis-BX305 board.

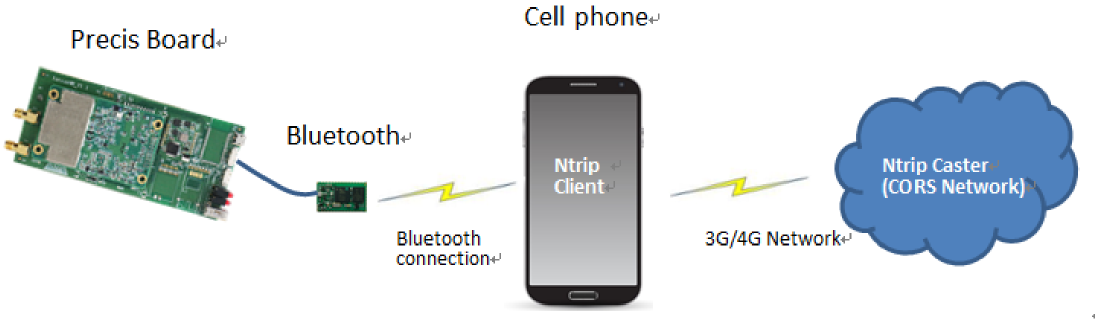

Figure 25 Demonstration of connecting Precis BX305 to CORS Network

（1） Hardware & Software Requirement

- Hardware required
  - Precis-BX305
  - GNSS antenna
  - GNSS antenna cable
  - External Bluetooth module
  - Bluetooth cable
  - Cell phone (android system)
  - 5V DC charger
- Software required
  - Ntrip client (free android apps)

（2） Connect to CORS Network

Please follow below steps.

- Connect GNSS antenna to Precis-BX305.
- Connect external Bluetooth module to either COM1 or COM2 of the board
- Connect to power supplier and plug in/turn on the power

Figure 26 Demonstration of connecting Bluetooth module, mobile phone, Precis-BX305 and supply supplier

- Turn on the Bluetooth of the mobile phone and scan and pair the mobile phone with the external Bluetooth device. By default, the external Bluetooth device name is 'HC-06' and the default PIN is '1234'. You can manually change the device name when you are trying to connect multiple Bluetooth devices.
- Install NTRIP Client APP from App store and launch this App.
- Configure Settings->Receiver Settings. Set Receiver Connection as 'External via Bluetooth'. Set Bluetooth Connection Method as Secure. Tick Auto-Enable Bluetooth.
- Configure Settings->Ntrip Settings. Launch NTRIP Client and configure the NTRIP Settings as below, then click Connect
    - Network Protocol：NTRIP V1.0
    - Caster IP & Port:
    - Username & Password:
    - Data Stream: RTCM32
    - Reported Location: Automatic

As the CORS network may require the approximate location of users, the Ntrip client allows to report the location by automatic or manual way. By automatic means that the client read NMEA GGA data from the board and sends it to Ntrip caster, so the board has to be output NMEA GGA sentences in this way. Failure to report user location may cause connection failure. Alternatively, you can manually report the latitude and longitude to the Ntrip caster.

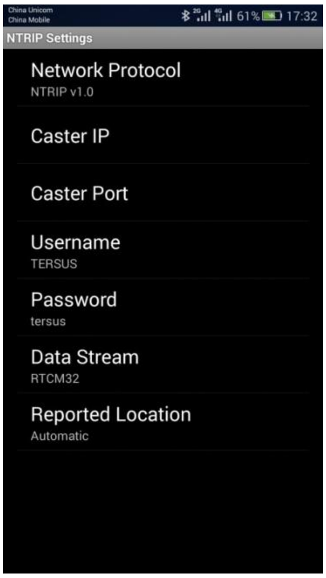

Figure 27 Example of NTRIP Settings

- After configuration, return to main panel and click connect to establish a Ntrip connection. If you receive message 'Connected to server ****', it means the connection are established successfully.

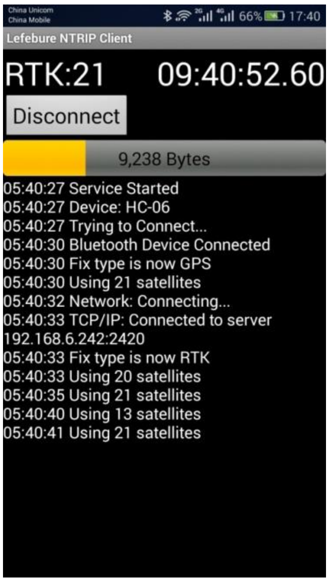

Figure 28 Demonstration of Connection Status

2.4. Integration with Autopilots

Precis-BX305 board can be integrated with autopilots. In this section, the connecting to Pixhawk flight control is used as an example. A cable is used to connect the COM1 port of Precis-BX305 board and the GPS port of the Pixhawk (see Figure 29). It is noticed that the GPS port need a 6pin PicoBlade connector while the COM1 port is a 5pin PicoBlade connector. The pin definition of the Pixhawk GPS port is listed in Table 11. With regarding to the power consumption, we recommend using external power sources. Please also pay attention to the baud rate setting of Pixhawk as the default baud rate of Precis-BX305 board is 115200. The Pixhawk can only recognize the NMEA sentence with GP NMEA talker. Incorrect NMEA talker configuration may cause connection failure.

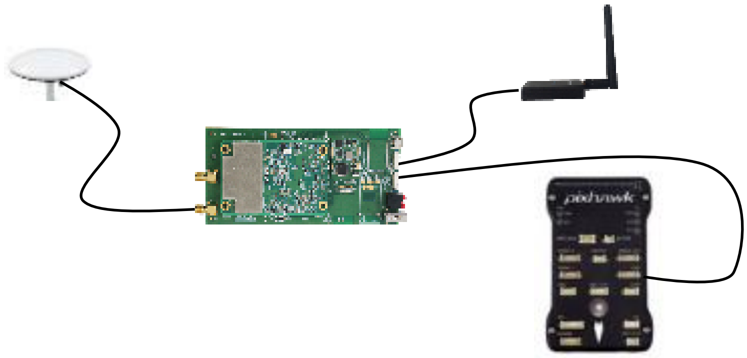

Figure 29 Demonstration of Integration with Pixhawk autopilot

Table 11 Pin definition of Pixhawk GPS port (from left to right)

Pin	Pin1	Pin2	Pin3	Pin4	Pin5	Pin6
Signal	VCC	TX	RX	CAN2 TX	CAN2 RX	GND
Voltage	+5V	+3.3V	+3.3V	+3.3V	+3.3V	GND

Then you need to mount the GNSS antenna and tether the board on your vehicle. Please beware of following instructions when you mount the GNSS antenna to your drone.

- Place the module on the outside of your vehicle (in an elevated position if appropriate) with a clear view of the sky
- Distance the module from DC power wiring and the batteries by at least 10cm

Next step is setting up the Pixhawk with mission planner. Open Mission planner software and choose the right COM port on the top right corner. Choose 115200 as baud rate (default baud rate of Precis BX305 COM1 port). Then click ‘connect button’ on the right. Then the Precis-BX305 is recognized by mission planner if the GPS status becomes ‘3D Fix’ (see Figure 30).

Figure 30 Precis-BX305 board is recognized by Pixhawk and Mission Planner

2.5. Set up Base Station

RTK positioning requires a rover station and a base station. Normally, the base station is set up on a known point and it is assumed that the base station does not move during RTK positioning procedure (except moving based case). There are 3 issues need to pay attention during base station:

2.5.1. Obtain the coordinate of the base station.

RTK is a kind of relative positioning technique; it actually measures the coordinate difference between the rover station and the base station. If the base station coordinate has a small offset (up to a few meters), the rover position will offset the same amount. Therefore, if your positioning results need to be compatible with others (e.g. map, reference trajectory), then you need set your base station coordinate compatible with your target coordinate system. You can obtain your base station coordinate by relative positioning, precise point positioning (PPP) or standard point positioning (SPP):

- Relative Positioning. You can observe on your base station and another site with known coordinate. Then performing relative positioning with professional software to deliver precise known position to your base station. You can also uses CORS service for convenient.
- PPP. Many institutes also provide online PPP services for free. What you need prepare is GNSS data in RINEX format. After uploading your file to their online platform, you can acquire precise base station.
- SPP. If you only need obtain a good self-repeatability, you can input a single point

positioning (SPP) result as base station for first time and record it. You need input this coordinates as known when you set up your base station on the same site next time.

2.5.2. Antenna installation

For normal RTK positioning case, the base station does not change, so the antennas need to be installed on a stable platform, such as tripod or pier. A key issue of antenna installation is measuring the antenna offset. As the known point is normally a monument or a mark on the ground, while what GNSS measured is to the antenna phase center. Therefore the offset between the ground mark and the antenna phase center need to be measured during antenna installation. This offset is normally expressed as north, east and height and normally the first two components are negligible. Therefore, the antenna height (shown as Δh in Figure 31) need to be measured during antenna installation. The measure method is antenna dependent, so we recommend you refer to GNSS antenna installation guide.

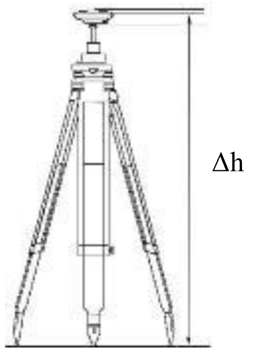

Figure 31 Demonstration of antenna height measurement

2.5.3. Observation environment

GNSS signals can be severely contaminated by multipath effect, so it is necessary to avoid some unnecessary inference from environments. Tersus recommends following conditions when you choose your base station site:

- Open sky. No blockage/ very few blockage above 15 degree.
- Keep away from signal emission source, such as large radar antenna, radio transceiver, etc.
- Keep away from voltage transformer, and high voltage power line.
- Keep away from tall buildings and water, such as lake, pool.
- Select a stable site to avoid antenna shaking

2.6. Log Data to SD Card

Precis BX305 does not have onboard SD Card slot, but it support data logging with external data logger. This section will introduce how to log raw observations to SD Card.

2.6.1. Hardware and software required

- 1*Precis-BX305 RTK Board
- 1*External data logger
- 1*SD Card (formatted into FAT32 file system)
- GNSS antenna
- GNSS antenna cable
- Cable for data logger
- Power supplier
- Cable for power supply (micro USB cable)
- Tersus GNSS Center (software)

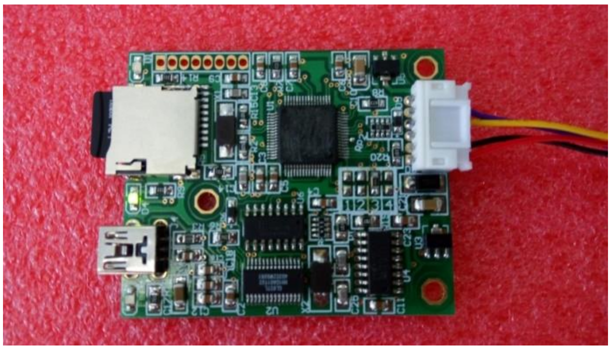

Figure 32 External data logger

2.6.2. Configuring raw observation output

- Connect COM1 of the board to your PC with Tersus USB Connector, and then establish a serial connection to board with Tersus GNSS Center.
- Enter the following commands in the text console window to log the raw observation and broadcast ephemeris data.

  unlogall

  log rangecmpb ontime 1

  log gpsephemb ontime 60

  log bd2ephemb ontime 60

  log gloephemerisb ontime 60

  saveconfig

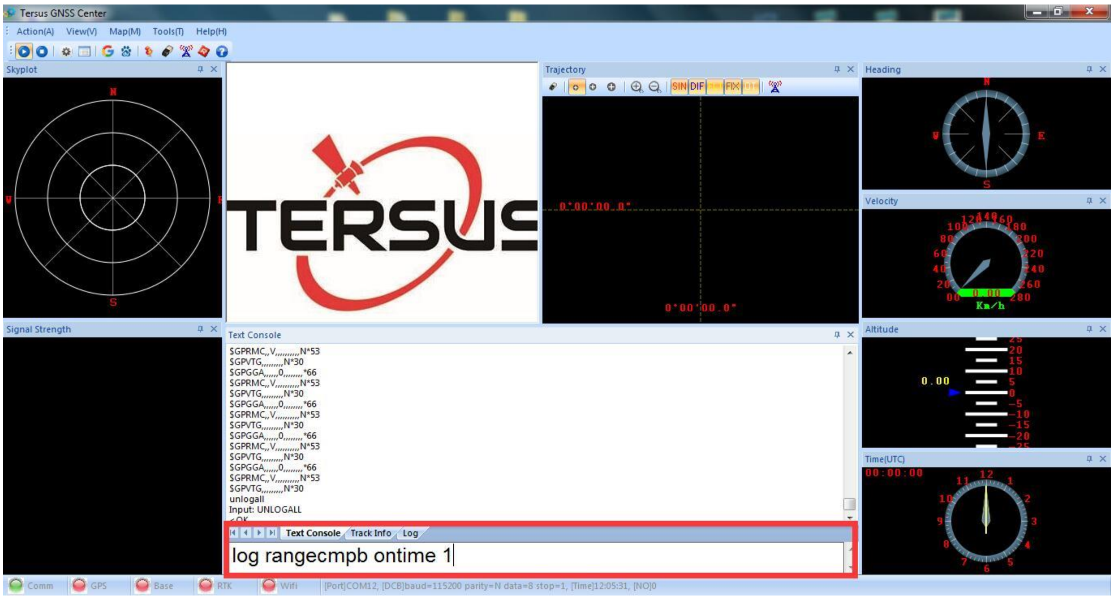

Figure 33 Enter commands for logging raw observation and broadcasting ephemeris data

2.6.3. Connect to data logger

Disconnect with Tersus USB Connector and connect the external data logger to COM1 of Precis-BX305. Connect the GNSS antenna to the board and power up the board. The board can supply power to the data logger and the data logger can automatically log the received data. By default, the data logger accept data stream from serial port at 115200 baud rate.

There are two indicators on the data logger. The green indicator shows whether the SD card is well connected to the board and the red indicator blinking shows whether the SD card is working as expected. A solid red indicator shows the SD is not correctly mounted. In this case, please check whether the SD card is inserted into the slot properly or whether the SD card is formatted in to FAT32 file system.

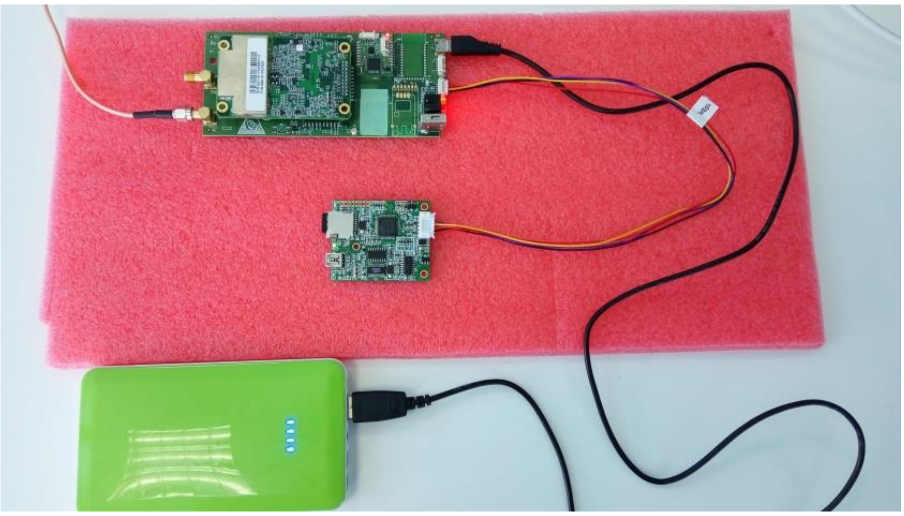

Figure 34 Connection of Precis-BX305, external data logger and power supplier

2.6.4. Export logged data and format conversion

The data logger can log the required data without any manipulation. After finished data collection, you simply disconnect the data logger from the board to finalize data logging. The logged binary observation data can be converted in to RINEX 3.2 format with Tersus RINEX Converter or Tersus GNSS Center. Then you can connect the data logger from the mini USB port to your PC, then the data logger works as a USB storage mode. You can access the logged file as just like a USB disk. The data will be automatically saved in the file named as ‘mydata.txt’.

If you try to log data multiple times, the logged data will automatically append the end of the file. Therefore, we recommend you move or manually rename the file after you finish data logging.

2.7. Installation and Operation Guideline

At last, introduces the guideline of Precis-BX305 installation and operation to avoid misuse or damage of device.

2.7.1. ESD protection

To prevent any electronic devices in Precis-BX305 board suffering harmful effects from ESD, it’s required to read following cautions before you open the anti-static packing box:

- Please handle the board on an anti-static table, from where connect an anti-static wrist strap to you. If anti-static table is not available, please connect your anti-static wrist strap to the metal case.
- Please touch the fringe area only when you take the board on and off, touch the electronic components directly should be avoided. Please check if any components obviously dropped off or damaged at the first time you receive the board, otherwise please contact your local dealer.

- Please keep the anti-static packing box well in case you need transfer Precis-BX305 with it later.

2.7.2. Avoid signal inference

Strong electromagnetic inference may interrupt GNSS signal tracking or degrade GNSS positioning performance. Keep your antenna away from following noise source during operation:

- High-voltage power line
- Power generators
- Power switch
- Voltage transformer
- High power wireless signal generator

3. Commands description

3.1. Overview of Command System

Precis-BX305 board allows users modify its configuration with command systems. Here are some general remarks on this command systems:

1. All commands are NOT case-sensitive
2. All log related command must specify the serial port, if the serial port is not specified, then the command is applied to current serial port
3. If the commands are executed successfully, the board returns OK, otherwise, returns an error message.

3.2. Serial Port Control Commands

Serial port control includes baud rate configuration, serial port mode configuration and configuration display.

3.2.1. Configuring serial port baud rate (COM)

This command is used to change the baud rate of the serial port to adapt its host device requirement.

Table 12 Configuring serial port baud rate command

Name	Value
Command:	COM port bps
Example:	COM COM1 115200
Function:	change baud rate of serial port
Parameters description:	
port:	COM1/ COM2
bps:	baud rate, 9600/19200/38400/57600/115200

3.2.2. Configuring serial port mode (INTERFACEMODE)

This command is used to configure the read and write mode of the serial port.

Table 13 Change serial port mode

Name	Value
Command:	Interfacemode port rxtype txtype resp
Example:	Interfacemode COM1 automatic automatic on
Function:	change input/output mode of serial port
Parameters description:	
port:	the serial port number of the board,COM1 and COM2
rxtype:	receiving mode, see *Table 14*
txtype:	transmitting mode, see *Table 14*
resp	whether response commands, always set as on

Table 14 Serial port mode

Mode	Description
NONE	Disable receiving/transmitting function of serial port
AUTOMATIC	Enable receiving/transmitting function of serial port

3.2.3. Display current serial port configuration (LOG COMCONFIG)

This command is used to enquire current serial port configurations.

Table 15 Display current serial port configuration

Name	Value
Command:	Log comconfig
Example:	Log comconfig
Function:	Display current serial port configurations
Response	<COMCONFIG COM1 0 98.000000 UNKNOWN 0 0.000000 00000000 100 0
	< 3
	< COM1 115200 N 8 1 N OFF ON AUTOMATIC AUTOMATIC ON
	< COM2 115200 N 8 1 N OFF ON AUTOMATIC AUTOMATIC ON
	< COM3 115200 N 8 1 N OFF ON NONE NONE ON

The response sentences are formatted as: serial port number, baud rate, parity, bits, stop bit, handshake, echo, breaks, receiving mode, transmitting mode, response.

3.3. Satellite Control Commands

Satellite controlling commands includes enable/disable satellite system and set elevation angle for each satellite system.

3.3.1. Controlling satellite system (SYSCONTROL)

This command is used enable or disable one satellite system.

Table 16 enable/disable satellite system

Name	Value
Command:	Syscontrol switch system
Example:	Syscontrol disable GPS
Function:	Enable or disable the satellite constellation
Parameters description:	
swith	enable/disable
system	GPS/GLONASS/BD2

3.3.2. Set elevation mask (ECUTOFF)

This command is used to set the elevation mask for each satellite system. This command is extremely useful when there is blockage or inference in low elevation angle area.

Table 17 Set elevation mask

Name	Value
Command:	ECUTOFF sys ele
Example:	Ecutoff gps 15.0
Function:	Set the elevation cutoff for each satellite system
Parameters description:	
sys:	GPS/GLONASS/BD2
ele:	0.0~45.0 (a decimal number, not an integer)

3.4. Station Coordinate Control Commands

Station coordinate commands are used to manage whether fix the station coordinate. For RTK scenario, the coordinates should be fixed as known value when it serves as the base station.

3.4.1. Fix base station coordinate (FIX POSITION)

Fix the coordinate of base station coordinate. The coordinate refers to the antenna phase center. If your coordinate is subject to the monument or marks on the ground, please convert to the antenna phase center manually.

Table 18 Fix the coordinate of the base station.

Name	Value
Command:	Fix position lat lon ht
Example:	Fix position
Function:	Fix the coordinate in base station mode
Parameters description:	
Lat:	Latitude in degree (-90.0~90.0)
Lon:	Longitude in degree (-180.0~180.0)
Ht:	Default is Mean Sea Level (MSL) height in meter. UNDULATION command can be used to set this parameter as ellipsoidal height.

Please notice that the base coordinates are expressed in DEGREE and METER, so you need to input with right unit. The station coordinate refers to the antenna phase center, so you need to correct the antenna height manually.

3.4.2. Cancelling fixed coordinate (FIX NONE)

When switch the role of the board from base station to rover station, removed the fixed coordinate is necessary. In this case, use this command to remove the fixed coordinate.

Table 19 Cancel the fixed coordinate

Name	Value
Command:	Fix none
Example:	Fix none
Function:	Cancel the fixed coordinate

3.4.3. Choose undulation (UNDULATION)

This command is used to enter a specific geoidal undulation value. The default undulation table is EGM96.

Table 20 Sets ellipsoid-geoid separation

Name	Value
Command:	Undulation Option [Separation]
Example:	Undulation osu89b
Function:	Set ellipsoid-geoid separation
Parameters description:	
Option:	undulation table to be used, can be EGM96, OSU89B or USER

Separation:	The undulation value required for the USER option (±1000.0 m)

3.5. Output Control Commands

Precis-BX305 board can output NMEA0183 format, RTCM2.X/3.2 format and its own observation format. In this section, the output related commands are introduced.

3.5.1. NMEA talker configuration (NMEATALKER)

NMEA0183 format defines different talkers. Precis-BX305 board support different talker settings. Some specific applications, e.g. the autopilot, have its own NMEA talker requirement, so the NMEA talker needs to be changed accordingly.

Table 21 change the NMEA talker during NMEA output

Name	Value
Command:	Nmeatalker id
Example:	Nmeatalker GP
Function:	change nmeatalker
Parameters description:	
id	GP/AUTO

3.5.2. Configuring NMEA output (LOG NMEA)

This command is used to configure the NMEA output. Currently, Precis BX305 support 5 NMEA sentences. The command is described as follows and the format description of these sentences is described in section 5.1.

Table 22 log nmea message

Name	Value
Command:	Log port message ontime interval
Example:	Log gpgga ontime 1
Function:	Log positioning solution and status in NMEA format
Parameters description:	
port:	COM1/ COM2
message:	gpgga/gpgsa/gpgsv/gpvtg/gprmc
interval:	0.05/0.1/0.2/0.5/1/2/3/…

3.5.3. Configuring raw observation output (LOG RANGECMPB)

This command is used to log the raw observations data of Precis-BX305. The logged observation data can be converted to RINEX format Tersus Rinex Converter software (Download here).

Table 23 Log compressed binary version of observation data

Name	Value
Command:	Log rangecmpb ontime interval
Example:	Log rangecmpb ontime 1
Function:	Log compressed binary version of observation data
Parameters description:	
Interval:	0.2/0.5/1/2/3/…
Response:	None readable binary data

3.5.4. Configuring GPS ephemeris output (LOG GPSEPHEMB)

This command is used to log GPS broadcast ephemeris in binary format. The logged observation data can be converted to RINEX format Tersus Rinex Converter software (Download here)

Table 24 Configuring GPS ephemeris output

Name	Value
Command:	Log gpsephemb onchanged/ (ontime interval)
Example:	Log gpsephemb onchanged
Function:	Log GPS binary ephemeris
Parameters description:	
Interval:	1/2/3/…
Response:	None readable binary data

3.5.5. Configuring GLONASS ephemeris output (LOG GLOEPHEMRISB)

This command is used to log GLONASS broadcast ephemeris in binary format. The logged observation data can be converted to RINEX format Tersus Rinex Converter software (Download here).

Table 25 Configuring GLONASS ephemeris output

Name	Value
Command:	Log gloephemerisb onchanged/ (ontime interval)
Example:	Log gloephemerisb onchanged
Function:	Log GLONASS binary ephemeris
Parameters description:	
Interval:	1/2/3/…
Response:	None readable binary data

3.5.6. Configuring Beidou Ephemeris output (LOG BD2EPHEMB)

This command is used to log Beidou Ephemeris in binary format. The logged observation data can be converted to RINEX format Tersus Rinex Converter software (Download here).

Table 26 Configuring Beidou Ephemeris output

Name	Value
Command:	Log bd2ephemb onchanged/ (ontime interval)
Example:	Log bd2ephemb onchanged
Function:	Log BDS ephemeris in binary format
Parameters description:	
Interval:	1/2/3/…
Response:	None readable binary data

3.5.7. Configuring RTCM2 output (LOG RTCM)

This command is used to log the observation and station information in RTCM2 format. This command is used when Preci-BX305 board is served as the base station. The details of RTCM2 messages are introduced in section 5.2.1.

Table 27 log observations in RTCM2.X format

Name	Value
Command:	Log port message ontime interval
Example:	Log com2 rtcm1819 ontime 1
Function:	change input/output mode of serial port
Parameters description:	
port:	COM1/ COM2
message	rtcm1/rtcm3/rtcm1819/rtcm24/rtcm31/rtcm32
interval:	0.05/0.1/0.2/0.5/1/2/3/…

3.5.8. Configuring RTCM 3 output (LOG RTCM3)

This command is used to log the observation and station information in RTCM3 format. This command is used when Preci-BX305 board is served as the base station. The details of RTCM2 messages are introduced in section 5.2.2

Table 28 log observations in RTCM3 information

Name	Value
Command:	Log port message ontime interval
Example:	Log com2 rtcm1074 ontime 1
Function:	change input/output mode of serial port
Parameters description:	
port:	COM1/ COM2
message	rtcm1001/rtcm1002/rtcm1003/rtcm1004/rtcm1005/rtcm1006/ rtcm1007/ rtcm1009/ rtcm1010/ rtcm1011/ rtcm1012/ rtcm1019/ rtcm1020/ rtcm1074/ rtcm1075/ rtcm1084/ rtcm1085/ rtcm1124/ rtcm1125

interval:	0.05/0.1/0.2/0.5/1/2/3/…

3.6. Version Information Commands (LOG VERSION)

This command is used to display the version information of the current board. This command is extremely useful to decide whether upgrade the firmware.

Table 29 Display version information

Name	Value
Command:	Log version
Example:	Log version
Function:	change input/output mode of serial port
Response:	<VERSION COM1 0 96.000000 FINE 1888 548418.000000 00000000 14 0 < 1 < "ENCLOSURE" "B13G12R1E0S-HMRBD0011-S50-P50-L:2115-1-26" "080101007500-941101152500028" "PRECIS "R4.10Build15122" "1.4-8127" "0x000005bc" "2016/02/04" AB0010

The version information includes S/N code and firmware version.

3.7. Configuration Management Commands

This section introduces the commands to saving and removing configurations. Save configuration is extremely important since all configuration would be lost if power down, unless you saved them.

3.7.1. Saving configurations (SAVECONFIG)

This command is used to save current configurations to non-volatile memory. The saved configurations are still valid after reboot the board.

Table 30 Save current configuration

Name	Value
Command:	saveconfig
Example:	saveconfig
Function:	Save current configuration to non-volatile memory

3.7.2. Reset to factory mode (FRESET)

This command is used to remove all configurations and reset to the factory mode.

Table 31 reset to factory mode

Name	Value
Command:	freset
Example:	freset
Function:	change input/output mode of serial port

3.7.3. Check logged message types

This command is used to check all logged message types.

Table 32 Check logged message types

Name	Value
Command:	Log loglist once
Example:	Log loglist
Function:	List all logged message types
Response:	<LOGLIST COM1 0 88.000000 FINE 1906 266440.000000 00000000 54449709 0 < 7 < LOG COM2 RTCM1005 ONTIME 1.00 0 NOHOLD < LOG COM2 RTCM1074 ONTIME 1.00 0 NOHOLD < LOG COM2 RTCM1084 ONTIME 1.00 0 NOHOLD < LOG COM2 RTCM1124 ONTIME 1.00 0 NOHOLD < LOG COM1 GPGGA ONTIME 0.20 0 NOHOLD < LOG COM1 GPRMC ONTIME 0.20 0 NOHOLD < LOG COM1 GPVTG ONTIME 0.20 0 NOHOLD

3.8. Configuring PPS output

This command is used to configure the output of Pulses Per Second (PPS)

Table 33 Check logged message types

Name	Value
Command:	ppsconfig timerefsys switch polarity width period RFDelay USERDelay
Example:	ppsconfig bd2 enable positive 10000 100 0 0
Function:	PPS output configuration
Parameters description:	
Timerefsys	Reference time system GPS/BD2
Switch	Enable/disable, enable/disable PPS output
Polarity	Positive/negative, set raising edge/trailing edge
Width	PPS pulses width (always smaller than period) in microsecond
Period	PPS pulses output period in millisecond 50/100/200/250/500/1000/2000…
RFDelay	RF delay in nanosecond
USERDelay	User defined delay in nanosecond

3.9. Output Cancellation Commands

The above sections introduces the commands to output information, this section introduce the commands to stop outputs.

3.9.1. Cancelling particular output (UNLOG)

This command is used to stop specified output.

Table 34 Cancel a particular output

Name	Value

Command:	Unlog port message
Example:	Unlog COM1 GPGGA
Function:	change input/output mode of serial port
Parameters description:	
port:	COM1 / COM2
message	NMEA message /rtcm message/ observation message/ …

3.9.2. Cancelling all output (UNLOGALL)

This command is used to stop all output from specified serial port

Table 35 Cancell all output

Name	Value
Command:	Unlogall port
Example:	Unlogall COM1
Function:	Cancel all output
Parameters description:	
port:	COM1 / COM2

4. Specifications

The detailed performance specification and physical specification of Precis-BX305 is introduced in this chapter.

4.1. Performance Specification

Table 36 Performance specification of Precis-BX305

Feature	Specification
Channel Number	192
Supported Signals	GPS L1+L2/BDS B1+B3/GLONASS G1
Standard Positioning Accuracy	
Horizontal (RMS)	1.5m
Vertical (RMS)	3.0m
RTK Positioning Accuracy	
Horizontal	10mm+1ppm
Vertical	15mm+1ppm
Observations Accuracy	
C/A Code (zenith direction)	10cm
P Code (zenith direction)	10cm
Carrier Phase (zenith direction)	1mm
Time to First Fix (TTFF)	
Cold start	<50s
Warm start	<10s
Initialization	<10s (typically)
Initialization reliability	>99.9%
Timing Accuracy (RMS)	20ns
Velocity Accuracy (RMS)	0.03m/s
Differential Data Format	RTCM2.x/RTCM 3.2/CMR
Max. Update Rate	20Hz

4.2. Physical Specification

Table 37 Physical Specification of Precis-BX305

Feature	Specification
Power	5V DC +5% ~ -3%
Ripple	100mV p-p (Max)
Power Consumption	2.6W (Typical)
Active Antenna Input Impedance	50Ω
Max. Antenna Bias Current Draw	100mA
GNSS input sensitivity	-85 dBm ~ -105 dBm
Size	130×60×18mm
Weight	48g
Temperature	-40℃～+85℃
Humidity	95% non-condensing
Vibration	MIL-STD-810
Shock	MIL-STD-810
Antenna Connector	SMA Receptacle×2
Serial Port	5pin receptacle PicoBlade connector (TTL level)
COM baud rate	Up to 230400bps
PPS Port	Receptacle SMA port (TTL level)

5. Output Format

Precis-BX305 board support NMEA0183 format, RTCM 2.X, RTCM 3.2 and private observation format, which are used to transmit its solution and observation respectively.

5.1. NMEA Sentences

The National Marine Electronics Association (NMEA) standard defines an electrical interface and data protocol for communications between marine instrumentation. The solution output of Tersus follows NMEA0183 format, so that it can be easily integrated with host devices.

5.1.1. General sentence format

All data is transmitted in the form of *sentences*. Only printable ASCII characters are allowed, plus CR(carriage return) and LF (line feed). Each sentence starts with a "$" sign and ends with <CR><LF>. Tersus support talker sentences and proprietary sentences.

Talker Sentences. The general format for a talker sentence is:

$ttsss,d1,d2,....*xx<CR><LF>

The first two letters following the „$" are the *talker identifier*. The next three characters (sss) are the *sentence identifier*, followed by a number of *data fields* separated by commas, followed by *checksum*, and terminated by carriage return/line feed. The data fields are uniquely defined for each sentence type. A sentence may contain up to 80 characters plus "$" and CR/LF. If data for a field is not available, the field is omitted, but the delimiting commas are still sent, with no space between them. The checksum field consists of a "*" and two hex digits representing the exclusive OR of all characters between, but not including, the "$" and "*".

Proprietary Sentences. The Proprietary sentences start with "$P", then a 3 letter manufacturer ID, Tersus defines its manufacturer ID as TRS. Tersus currently support tow Proprietary sentences includes PTRSE and PTRSV, which are used to support integration with external sensors like IMU.

5.1.2. GGA sentence

GGA sentences contains Global Positioning System Fix Data, including Time, Position and fix related data for a GPS receiver.

$GxGGA,<1> ,<2>,<3>,<4>,<5>,<6>,<7>,<8>,<9>,<10>,<11>,<12>,<13>,<14>*xx<CR><LF>

Gx: NMEA taker identifier. Different identifier can be applied according to user configuration, e.g. GP, GN
<1> Time (UTC), format: hhmmss.ss
<2> Latitude, format ddmm.mmmm
<3> N or S (North or South)
<4>Longitude, format ddmm.mmmm
<5>E or W (East or West)
<6>GPS Quality Indicator: 0: unknown 1: single point positioning, 2 DGPS, 3 invalid PPS, 4 RTK fixed solution, 5: RTK float solution, 6: Estimating 7: user constrained positioning 8: Simulation 9: WAAS
<7>Number of satellites in view
<8> Horizontal Dilution of precision
<9> Antenna Altitude above/below mean-sea-level (geoid)
<10> Units of antenna altitude, meters
<11> Geoidal separation, the difference between the WGS-84 earth ellipsoid and mean-sea-level (geoid), "-" means mean-sea-level below ellipsoid
<12> Units of geoidal separation, meters
<13>Age of differential GPS data, time in seconds since last SC104 type 1 or 9 update, null field when DGPS is not used
<14> Differential reference station ID, 0000-1023
* end of sentence
xx checksum of the all ASCII code
<CR><LF> carriage return and line feed
Example:
$GPGGA,092204.999,4250.5589,S,14718.5084,E,1,04,24.4,M,19.7,M,,,0000*1F

5.1.3. RMC sentence

RMC sentence contains Recommended Minimum Navigation Information
$GxRMC,<1>,<2>,<3>,<4>,<5>,<6>,<7>,<8>,<9>,<10>,<11>*xx<CR><LF>
Gx: NMEA taker identifier. Different identifier can be applied according to user configuration, e.g. GP, GN
<1> Time (UTC), format: hhmmss.sss
<2> Status, V = Navigation receiver warning
<3>Latitude
<4> N or S
<5>Longitude
<6>E or W
<7>Speed over ground, knots
<8>Track made good, degrees true
<9>Date, format:ddmmyy

<10> Magnetic Variation, degrees
<11> E or W
* end of sentence
xx checksum of the all ASCII code
<CR><LF> carriage return and line feed
Example:
$GPRMC,024813.640,A,3158.4608,N,11848.3737,E,10.05,324.27,150706,,,A*50

5.1.4. VTG sentence

VTG contains Track Made Good and Ground Speed
$GxVTG, <1>,<2>,<3>,<4>,<5>,<6>,<7>,<8>*xx<CR><LF>
Gx: NMEA taker identifier. Different identifier can be applied according to user configuration, e.g. GP, GN
<1> Track Degrees
<2>T = True
<3>Track Degrees
<4>M = Magnetic
<5>Speed Knots
<6>N = Knots
<7>Speed Kilometers Per Hour
<8>K = Kilometres Per Hour
* end of sentence
xx checksum of the all ASCII code
<CR><LF> carriage return and line feed
Example:
$GPVTG,89.68,T,,M,0.00,N,0.0,K*5F

5.1.5. GSA sentence

GSA contains GPS DOP and active satellites information.
$GxGSA, <1>,<2>,<3>,<4>,…,<14>,<15>,<16>,<17>*xx<CR><LF>
Gx: NMEA taker identifier. Different identifier can be applied according to user configuration, e.g. GP, GN
<1>Selection mode: A: automatic M:manual
<2> Mode: 1: no position 2: 2D position 3:3D position
<3>PRN of 1st satellite used for fix
<4> PRN of 2nd satellite used for fix
...
<14> PRN of 12th satellite used for fix
<15> Positioning Dilution of precision (PDOP)
<16> Horizontal Dilution of precision (HDOP)

<17> Vertical Dilution of precision (VDOP)
* end of sentence
xx checksum of the all ASCII code
<CR><LF> carriage return and line feed
Example:
$GPGSA,A,3,01,20,19,13,,,,,,,,,40.4,24.4,32.2*0A

5.1.6. GSV sentence

GSV contains information of Satellites in view.
$GxGSV,<1>,<2>,<3>,<4>,<5>,<6>,<7>,...*xx<CR><LF>
Gx: NMEA taker identifier. Different identifier can be applied according to user configuration, e.g. GP, GN
<1>total number of messages
<2> message number
<3> satellites in view
<4>satellite number
<5>elevation in degrees
<6>azimuth in degrees to true
<7>SNR in dB
more satellite infos like 4)-7)
* end of sentence
xx checksum of the all ASCII code
<CR><LF> carriage return and line feed
Example:
$GPGSV,3,1,10,20,78,331,45,01,59,235,47,22,41,069,,13,32,252,45*70

5.2. RTCM Messages

RTCM 2.X and RTCM 3.2 standard are supported, which is used to deliver the base station information to user side. RTCM defined a set of message types to deliver different information.

5.2.1. RTCM 2 messages

Here is a list of RTCM 2 message types supported by Precis-BX305. More details of RTCM 2.protocols refers to the official document (RTCM10402.3 recommended standards for differential GNSS (Global Navigation Satellite Systems) service version 2.3)

Table 38 Collection of supported RTCM2 message

Message Type	Description
1	Differential GPS Corrections
3	GPS Reference Station Parameter (X, Y, Z coordinates in ECEF coordinate system)
18	Uncorrected Carrier phase measurements
19	Uncorrected pseudorange measurements
24	Reference station Antenna Reference Point Parameter (X, Y, Z coordinates in ECEF coordinate system) with antenna height, which is more precise than message type 3
31	Differential GLONASS Corrections
32	GLONASS Reference Station Parameters (X, Y, Z coordinates in ECEF coordinate system)

5.2.2. RTCM 3 messages

Here is a list of RTCM 3 message types that supported by Precis-BX305. More details of RTCM 2.protocols refers to the official document (RTCM10403.2 Differential GNSS (Global Navigation Satellite Systems) services-Version 3).

Table 39 Collection of supported RTCM3.2 message types

Message Type	Description
1001	L1 only GPS RTK observables
1002	Extended L1-only GPS RTK observables
1003	L1&L2 GPS RTK observables
1004	Extended L1&L2 GPS RTK observables
1005	Stationary RTK Reference Station ARP
1006	Stationary RTK Reference Station ARP with Antenna Height
1009	L1 only GLONASS RTK observables
1010	Extended L1-only GLONASS RTK observables
1011	L1&L2 GLONASS RTK observables
1012	Extended L1&L2 GLONASS RTK observables
1019	GPS Ephemerides
1020	GLONASS Ephemerides
1074	GPS MSM4, includes pseudorange, carrier phase and C/N0 observation
1075	GPS MSM5, includes pseudorange, carrier phase, phase rate and C/N0 observation
1084	GLONASS MSM4, includes pseudorange, carrier phase and C/N0 observation

1085	GLONASS MSM5, includes pseudorange, carrier phase, phase rate and C/N0 observation
1124	Beidou MSM4, includes pseudorange, carrier phase and C/N0 observation
1125	Beidou MSM5, includes pseudorange, carrier phase, phase rate and C/N0 observation

6. RTK Configure Example

Example of RTK configuration (base mode):

FIX POSITION 31.000302123 114.289244543 26.130
ECUTOFF BD2 15.0
ECUTOFF GPS 15.0
ECUTOFF GLONASS 15.0
INTERFACEMODE COM2 AUTOMATIC AUTOMATIC ON
LOG COM2 RTCM1074 ONTIME 1
LOG COM2 RTCM1084 ONTIME 1
LOG COM2 RTCM1124 ONTIME 1
LOG COM2 RTCM1005 ONTIME 10
SAVECONFIG

Example of RTK configuration (rover mode):

FIX NONE
INTERFACEMODE COM1 AUTOMATIC AUTOMATIC ON
LOG GPGGA ONTIME 1
SAVECONF

7. Trouble Shooting

7.1. Why the Precis-BX305 board does not output RTCM data after I key in the RTCM output related commands?

It can be caused by following reasons:

(1) Fix the coordinate is the prerequisite of RTCM output. Therefore, use Fix position command (see section 3.4.1) to fix the coordinate first.

(2) Check the interfacemode. If the target serial port is not in right mode, it may not output RTCM properly. Use the interfacemode command (see 3.2.2) to set the serial mode.

7.2. Why mission planner cannot recognize my Precis-BX305 board?

It can be caused by following reasons:

(1) Check power supply. Precis-BX305 board power consumption is about 1.5w. Although Pixhawk can also supply power, we still recommend external power source. A voltage transformer is recommended to convert 12V power output from battery to 5V and then connect to Precis-BX305 board.

(2) Please check the baud rate settings in Mission planner. It cannot be recognized if incorrect baud rate is used. By default, the baud rate of Precis-BX305 COM1 port is 115200 bps.

(3) Please check the NMEA output. Mission planner requires GPS sensors output NMEA GGA sentence, RMC sentence and VTG sentence at 5Hz. Missing VTG sentence or low update rate may cause failure to recognition.

(4) Check the NMEA talker. Pixhawk can only recognize the NMEA sentence with GP NMEA talker. Incorrect NMEA talker may cause failure to

7.3. Why my configuration lost after the board is power off?

You need execute 'saveconfig' (see section 3.7.1) command to save your configuration to the non-volatile memory before power off; otherwise, your configuration will lost as long as it is powered off.

7.4. Why I can receive NMEA data from the board, but I cannot configure it?

It depends on the serial tool you are using. The board can only recognize the command end up with '\r\n' (carriage and line feed) and these two characteristics need to be added automatically by the serial tools, which is often referred as 'new line mode'. In order to avoid this case, we recommend you configure the board with Tersus GNSS Center, which can be downloaded from our website.

8. Terminology

ASCII	American Standard Code for Information Interchange
CMR	Compact Measurement Record
DC	Direct Current
ESD	Electro Static Discharge
ECEF	Earth Center Earth Fixed
GLONASS	GLObal NAvigation Satellite System
GNSS	Globan 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
RF	Radio Frequency
RINEX	Receiver Independent Exchange format
RMS	Root Mean Squares
RTK	Real-Time Kinematic
RTCM	Radio Technical Commission for Maritime Services
SMA	Sub-Miniature-A interface
TTFF	Time to First Fix
TTL	Transistor-Transistor Logic level
UART	Universal Asynchronous Receiver/Transmitter
USB	Universal Serial BUS
WGS84	Word Geodetic System 1984