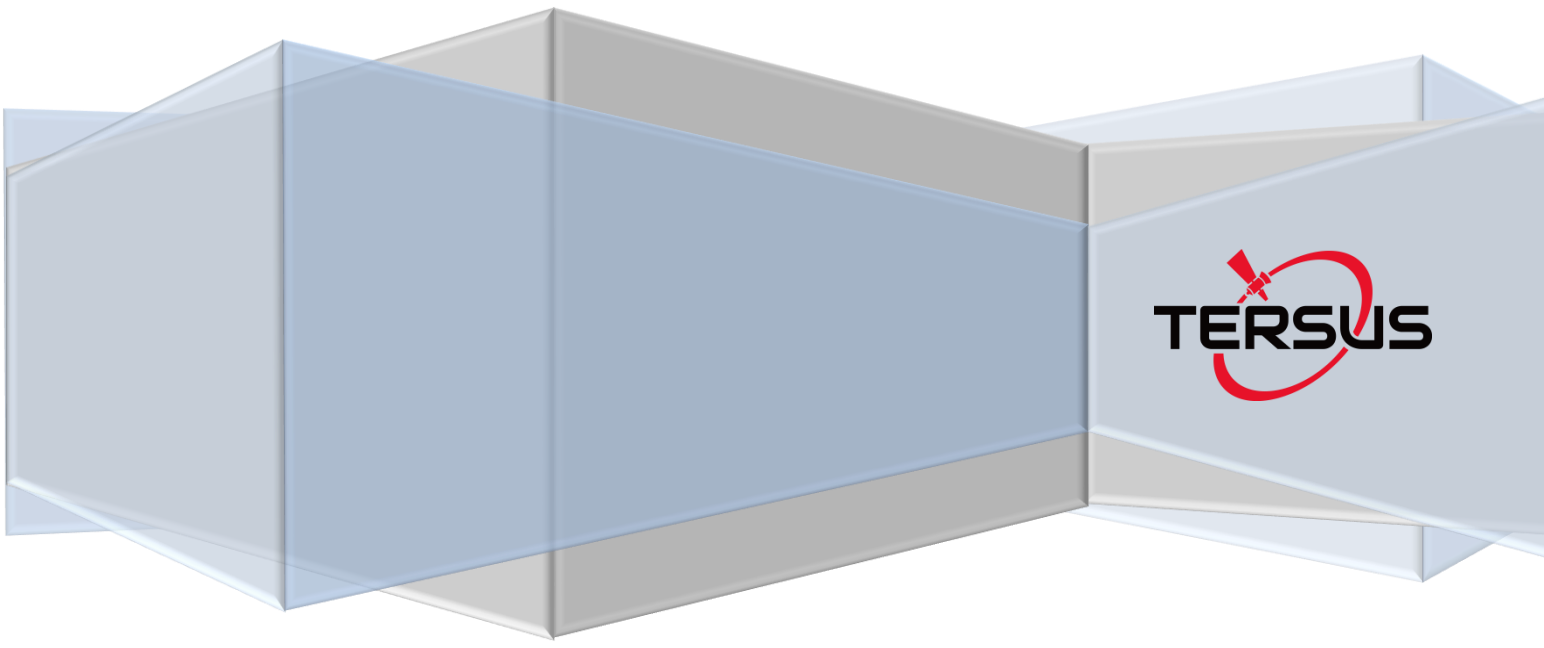
**User Manual**

Version V1.0-20180629

# User Manual
# For BX Series GNSS Receiver





| Revision | Description | Date | Owner |
|---|---|---|---|
| 1 | Issued for Review | 2018/06/29 | CB |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

# Table of Content

# List of Figures

# List of Tables

# Notices

## FCC Notices

The BX306 enclosure has been tested and found to comply with the radiated and conducted emission limits for a Class A digital device. The Class A limits are designed to provide reasonable protection against harmful interference in a residential installation.

The BX316 enclosure has been tested and found to comply with the radiated and conducted emission limits for a Class A digital device. The Class A limits are designed to provide reasonable protection against harmful interference in a residential installation.

## CE Marking

Tersus Inc. declares that BX306 enclosure and BX316 enclosure are in compliance with the essential requirements (radio performance, electromagnetic compatibility and electrical safety) and other relevant provisions of Directive 1999/5/EC, EMC Directive 2004/108/EC, and the RoHS Recast Directive 2011/65/EU. Therefore the equipment is labeled with the following CE-marking.

The Declaration of Conformity may be obtained from Tersus Inc.

The following notices apply to all Tersus BX series receivers.

| | |
|---|---|
| ⚠ | 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 receivers. |

## 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. |

Tersus is providing BX series GNSS receivers with OEM version as well as with enclosure in a metal box. When a board is mentioned, it's OEM version of the receiver, specifically. When enclosure is mentioned, it's receiver version in a box, specifically.

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

Table 1 The Document / Software Used in This User Manual

| Name | Description | Link |
|---|---|---|
| Log & Command document | Document giving all the loggings output from BX series receivers and all the commands to them | https://www.tersus-gnss.com/document |
| Tersus GNSS Center | Graphical tool to communicate with BX series receivers | https://www.tersus-gnss.com/software |
| Tersus Download | A tool to download files on the internal eMMC card to a computer | https://www.tersus-gnss.com/assets/upload/file/20180608172619305.rar |
| RTKLIB | A free & popularly used Post processing tool | http://www.rtklib.com/ |
| Mission Planner | A popular Ground Station software | http://firmware.ardupilot.org/Tools/MissionPlanner/MissionPlanner-latest.msi |

# Support

If you have a problem and cannot find the information you need in the product documentation, request technical support using the Tersus website at https://www.tersus-gnss.com/, or mail to support@tersus-gnss.com.

# 1. Introduction

## 1.1 Overview of BX Series GNSS Receivers

BX series GNSS receivers are cost-efficient GNSS RTK board for cm-level positioning, which can be used for real-time RTK positioning as well as raw data collection for post-processing application. BX receivers are supporting existing and planned GPS, BDS and GLONASS signals. Both the cards and the enclosures are designed for the flexibility of integration and configuration.

BX series receivers are delivered with OEM cards as well as in enclosures. For further information about BX receivers, refer to https://www.tersus-gnss.com/ for more detail.

### 1.1.1 BX GNSS OEM Boards

OEM BX306 board - refer to section 1.2.1 for details
OEM BX306Z board - refer to section 1.2.2 for details
OEM BD316D board - refer to section 1.2.3 for details

### 1.1.2 BX GNSS Enclosures

BX306 enclosure – refer to section 1.2.4 for details
BX316 enclosure - refer to section 1.2.5 for details
BX316R enclosure - refer to section 1.2.6 for details

## 1.2 Related Documents and Information

### 1.2.1 OEM BX306 Board


Figure 1 Overview of BX306 Board

Table 2 Features of BX306 Board

| | |
|---|---|
| Supports three constellations, six frequencies: GPS L1/L2, GLONASS G1/G2, BDS B1/B2 | Supports NMEA-0183 and Tersus Binary format |
| Log & Command compatible with Novatel Protocol | Pin to Pin compatible with Novatel 615 |
| Correction: RTCM 2.x/3.x/CMR/CMR+ | Up to 20Hz RTK solution and raw data output[1] |
| Up to 4GB internal eMMC for data collection. | Compact design |

The technical specification of BX306 board is provided in chapter 4.

Note 1: 20Hz solution is related to FW release, contact Tersus support before it's used.

Two LEDs are installed on the BX306 board, whose definition is given in Table 3:


Table 3 LED Definition of BX306 board

| LED | Colour | Description |
|---|---|---|
| LED1 (left) | ORANGE | Blink 1Hz: if log is output at 1Hz or less.<br>Blink the same rate as the log if log output rate >1Hz. |
| LED2 (right) | GREEN | ON: RTK fixed.<br>Blink: RTK float solution.<br>OFF: Other position types. |

| | |
|---|---|
| ⚠ | After power on, both LED1 and LED2 are ON for 3 – 5 seconds, then both are OFF for 2 seconds. After that, LED1 will blink at 1Hz.<br>The BX306 board is NOT booting up successfully if the LEDs are not acting as the above. |

### 1.2.2 OEM BX306Z Board

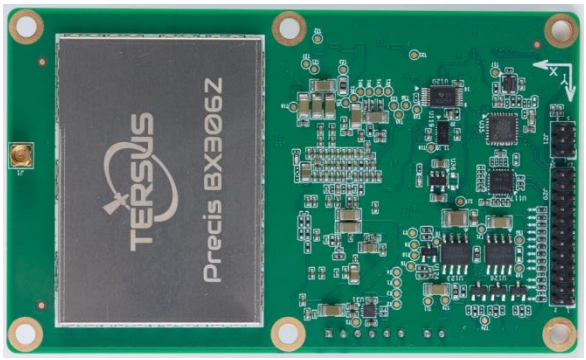



Figure 2 Overview of BX306Z Board

Table 4 Features of BX306Z Board

| | |
|---|---|
| Supports three constellations, six frequencies<br>GPS L1/L2, GLONASS G1/G2, BDS B1/B2 | Supports NMEA-0183 and Tersus Binary format |
| Log & Command compatible with Novatel Protocol | Pin to Pin compatible with Trimble BD970 |
| Correction: RTCM 2.x/3.x/CMR/CMR+ | Up to 20Hz RTK solution and raw data output[1] |
| Up to 4GB internal eMMC for data collection. | |

The technical specification of BX306Z card is provided in chapter 5

Note 1: 20Hz solution is related to FW release, contact Tersus support before it's used.

Three LEDs are on the BX306Z board, the definition is given in Table 5.


Table 5 LED Definition of BX306Z Board

| LED | Colour | Description |
|---|---|---|
| LED1 (left) | ORANGE | ON: RTK corrections are received.<br>OFF: RTK corrections are not received. |
| LED2 (middle) | ORANGE | ON: after power on. |
| LED3 (right) | GREEN | Blink: RTK float.<br>ON: RTK fixed.<br>OFF: other position types |

| | |
|---|---|
| ⚠ | After power on, all the three LEDs are ON for 3 – 5 seconds, then all are OFF. After 2 seconds, LED2 will be ON. |

| | |
|---|---|
| | The BX306Z board is NOT booting up successfully if the LEDs are not acting as the above. |

### 1.2.3 OEM BX316D Board

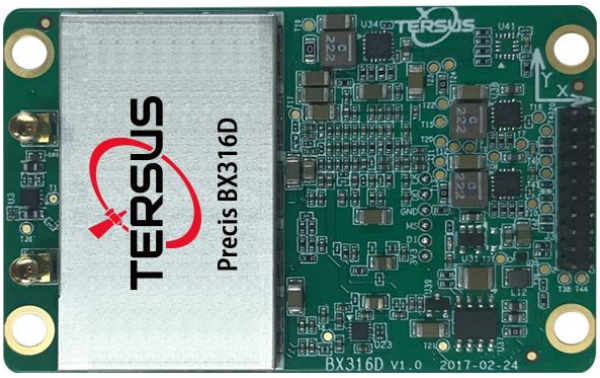



Figure 3 Overview of BX316D Board

Table 6 Features of BX316D Board

| | |
|---|---|
| Supports three constellations, six frequencies<br>GPS L1/L2, GLONASS G1/G2, BDS B1/B2 | Supports NMEA-0183 and Tersus Binary format |
| Log & Command compatible with Novatel Protocol | Pin to Pin compatible with Novatel 617D |
| Correction: RTCM 2.x/3.x/CMR/CMR+ | Up to 20Hz RTK solution and raw data output[1] |
| Supporting heading | Compact design |
| Up to 4GB internal eMMC for data collection. | |

The technical specification of BX316D board is provided in chapter 6.

Note 1: 20Hz solution is related to FW release, contact Tersus support before it's used.

Two LEDs are installed on the BX316D board, whose definition is given in Table 7:

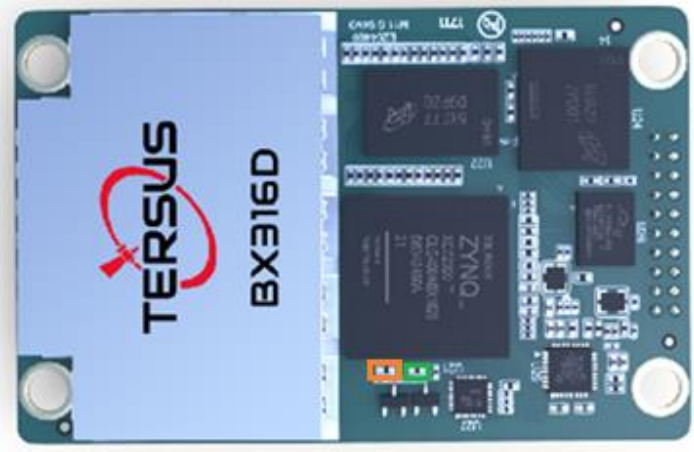



Table 7 LED Definition of BX316D Board

| LED | Colour | Description |
|---|---|---|
| LED1 (left) | ORANGE | Blink 1Hz: if log is output at 1Hz or less.<br>Blink the same rate as the log if log output rate >1Hz. |
| LED2 (right) | GREEN | ON: RTK fixed.<br>OFF: RTK not fixed. |

| | |
|---|---|
| ⚠ | After power on, both LED1 and LED2 are ON for 3 – 5 seconds, then both are OFF for 2 seconds. After that, LED1 will blink at 1Hz.<br>The BX316D board is NOT booting up successfully if the LEDs are not acting as the above. |

### 1.2.4 BX306 Enclosure


Figure 4 Overview of BX306 Enclosure

Table 8 Features of BX306 Enclosure

| Feature | BX306 Enclosure |
|---|---|
| OEM Card | BX306 board |
| Serial ports | 2 LVTTL serial port [1] |
| Antenna interface | Single SMA |
| USB | USB 2.0 |
| Input power | +5~+12VDC |
| Power interface | USB type A |
| GPS+BDS+GLONASS positioning | Yes |
| PPS | Yes |
| Event | Yes |

The technical specification of BX306 enclosure is provided in chapter 7.

Note 1: The specific 20-pin cable has a COM3 connector, but its function is related to the firmware version, please check with Tersus support.

Two LEDs are given on the BX306 enclosure panel, the definition is in Table 9.


Figure 5 BX306 Enclosure Panel

Table 9 LED Definition of BX306 Enclosure

| LED | Colour | Description |
|---|---|---|
| LED1 | RED | ON: RTK fixed.<br>OFF: RTK not fixed. |
| LED2 | RED | ON: after power on. |

| | |
|---|---|
| ⚠ | After power on, both LED1 and LED2 are ON for 3 – 5 seconds, then LED1 will be OFF, while LED2 keeps ON.<br>The BX306 enclosure is NOT booting up successfully if the LEDs are not acting as the above. |

### 1.2.5 BX316 Enclosure


Figure 6 Overview of BX316 Enclosure

Table 10 Features of BX316 Enclosure

| Feature | BX316 Enclosure |
|---|---|
| OEM Card | BX316 board |
| Serial ports | 2 LVTTL serial port [1] |
| Antenna interface | Double SMA |
| Input power | +5~+12VDC |
| Power interface | USB type A |
| USB | USB 2.0 |
| GPS+GLONASS+BDS in position and heading | Depends on the antenna mode, refer to command ANTENNAMODE in the Log & Command document for detail. |
| External SD card | Yes |
| Heading | Yes |
| PPS | Yes |
| Event | Yes |

The technical specification of BX316 enclosure is provided in chapter 8.

Note 1: The specific 40-pin cable has a COM3 and Ethernet connectors, but their function is related to the firmware version, please check with Tersus support.

Refer to section 2.8 for detail about how to output heading.

Four LEDs are provided on the BX316 enclosure panel, see Table 11 for definition.


Figure 7 BX316 Enclosure Panel

Table 11 LEDs on BX316 Enclosure Panel

| LED | Colour | Description |
|---|---|---|
| PWR & Log | GREEN | ON: if there is no data collection to SD or eMMC card.<br>Blink: data saved to SD or eMMC card. |
| GPS | WHITE | Default: 1Hz blink<br>If data output at higher rate, the blink rate will increase accordingly. |
| Base | GREEN | OFF: no RTK corrections are received.<br>ON: RTK corrections can be received. |
| RTK | BLUE | OFF: RTK not fixed.<br>ON: RTK fixed. |

| | |
|---|---|
| ⚠ | After power on, All the four LEDs are ON for 3 – 5 seconds, then all are OFF for 2 seconds, PWR&Log LED will be ON or blink. GPS LED will blink.<br>The BX316 enclosure is NOT booting up successfully if the LEDs are not acting as the above. |

### 1.2.6 BX316R Enclosure

BX316R enclosure is designed specifically for post processing applications, such as mobile mapping or monitoring system. It has the same hardware as that of BX316, but it can't support RTK positioning or heading.

| | |
|---|---|
| ! | BX316R can support RTK positioning and heading after an auth code is input. Contact Tersus sales for more detail about business. |


Figure 8 Overview of BX316R Enclosure

Table 12 Features of BX316R Enclosure

| Feature | BX316R Enclosure |
|---|---|
| OEM Card | BX316R board |
| Serial ports | 2 LVTTL serial port [1] |
| Antenna interface | Two SMA connectors[2] |
| Input power | +5~+12VDC |
| Power interface | USB type A |
| USB | USB 2.0 |
| GPS+GLONASS+BDS in position | Yes |
| External SD card | Yes |
| Heading | Yes |
| PPS | Yes |
| Event | Yes |
| Heading | No |

The technical specification of BX316R enclosure is provided in chapter 9.

Note 1: The specific 40-pin cable has a COM3 connector, but its function is related to the firmware version.
Note 2: Only P-ANT interface can work.

BX316R enclosure has the same LEDs on panel as BX316 enclosure, and has the same the booting up mode as BX316 enclosure. Refer to section 1.2.5 for the LEDs definition of BX316R.

## 1.3 BX Receivers System Overview

To make OEM BX series boards work, the following parts are necessary:

- ✧ Interface board, or enclosure and cables
- ✧ Power supply
- ✧ Data communications equipment
- ✧ GNSS antenna with Low Noise Amplifier

The BX series receivers are illustrated in Figure 9

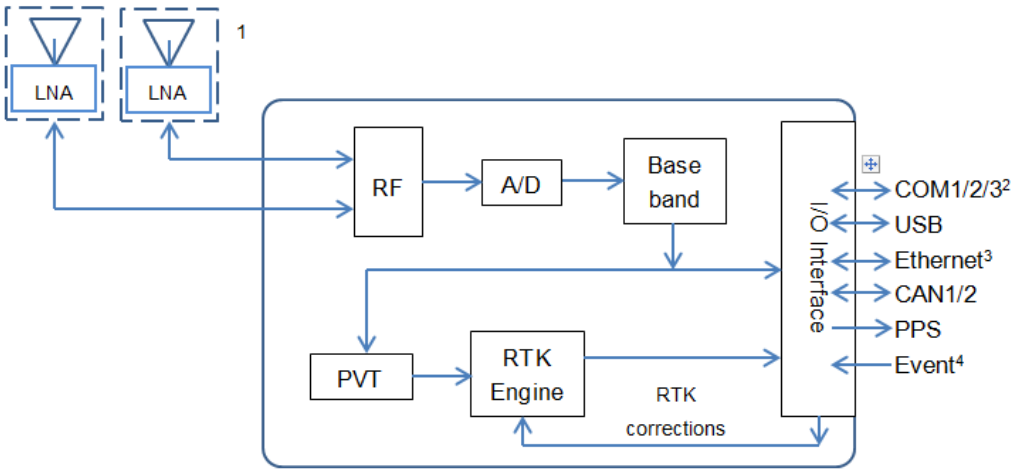



Figure 9 System Overview of BX Boards

Note 1: Only BX316 and BX316D can support the secondary antenna.

2: COM3 is related to FW version, please contact support before it's used.

3: Only BX316 and BX316R can support Ethernet port.

4: Some receivers can support two event inputs, please contact Tersus support before event2 is used.

### 1.3.1 BX Series OEM Boards

BX series OEM boards consist 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 heart 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 9.

### 1.3.2 BX Enclosures

An enclosure is necessary to protect the OEM BX series boards from environmental extremes and high levels RF interference, and it brings convenience for the customers to use the receivers.

### 1.3.3 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 about antennas.

### 1.3.4 Power Supply

A power supply capable of delivering the minimum receiver operating voltage and power is required. See section 2.4 for detail.

### 1.3.5 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.

### 1.3.6 External SD/Internal eMMC Card

| | |
|---|---|
| ! | The external SD card must meet:<br>Size ≤ 16GB.<br>File system: FAT32. |

| | |
|---|---|
| ! | The SD card must be installed into the external datalogger before it's used, refer to section 10.4 for detail.<br>All the BX receivers are supporting up to 4GB internal eMMC card by FW0020 or later release. |

The data can be saved on an external SD or an internal eMMC card manually or automatically, which is determined by command LOGFILE.

### 1.3.7 Enable Heading

| | |
|---|---|
| ! | Only OEM BX316D board and BX316 enclosure can support heading output. |

The defaults configure of BX316D and BX316 is in single antenna mode, in which heading output is not supported. Heading output is supported only when they're in dual antenna mode. Command ANTENNAMODE must be input to select the antenna mode, see chapter 2.8 Heading Output for detail.

| | |
|---|---|
| ! | When in single antenna mode, the connector for the secondary antenna connector can be left float. |

# 2. Installation

This chapter describes how to set up a BX receiver to make it work. In order to perform RTK positioning, BX receiver need the GNSS satellites signals input from the antenna and RTK corrections input from a serial port.

| | |
|---|---|
| ! | The installation is take BX306 enclosure as the example, BX series OEM boards can be integrated to the customer's system in various packages, all actions can refer to the installation guide in this chapter. |

## 2.1 Shipping Box

Generally, the BX series receivers are shipped in a plastic box. The following receivers/accessories can be in the standard KIT package.


Figure 10 Parts in the Kit Package

## 2.2 USB Adapter

The BX enclosure receivers will communicate with other devices via a serial port, which could be connected to a USB adapter, see Figure 11.

Figure 11 USB Adapter

Please download the proper USB adapter driver according to your operating system from http://www.ftdichip.com/Drivers/VCP.htm

After the USB adapter is installed on your computer successfully, you can find it in device manager, see Figure 12. BX306 is connected to the USB adapter and any serial software tool can communicate with the BX306.

Tersus GNSS Center, a graphic serial tool, is recommended to communicate with the receiver. It can be freely downloaded from https://www.tersus-gnss.com/software . Figure 16 shows the main windows of Tersus GNSS Center, refer to section 2.6 for more.

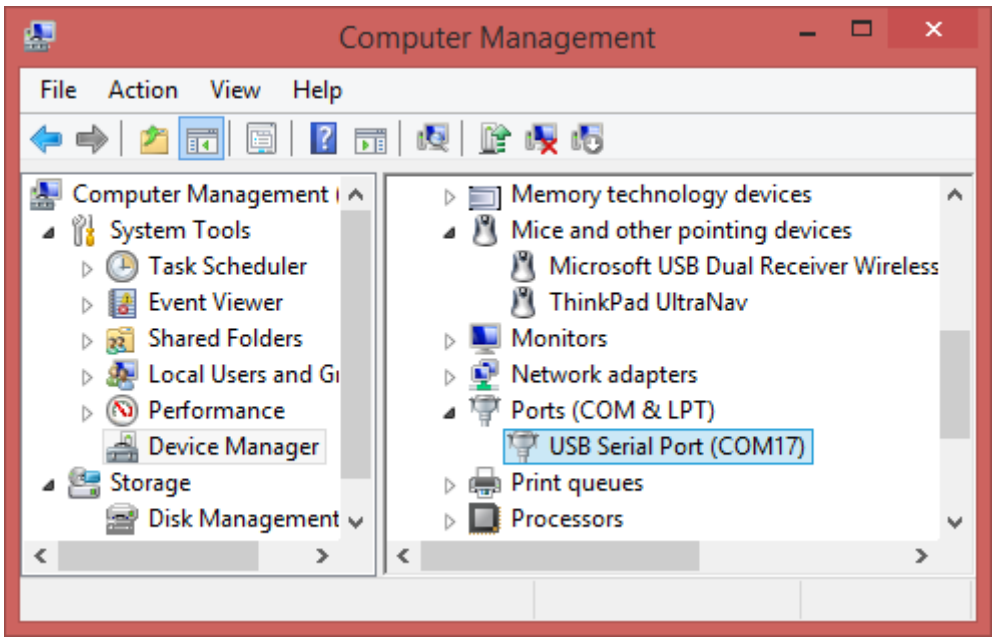



Figure 12 Device Manager

## 2.3 Selecting a GNSS Antenna

The antennas provided by Tersus can be found in https://www.tersus-gnss.com/product/accessories. It's highly recommended the antennas from Tersus are used to work with BX series receivers.

Figure 13 Antennas from Tersus

Generally, AX3702 is widely used in survey application and is recommended for all other applications.

AX3703 is recommended for UAV application.

AX3704 is for Tersus TX series receivers.

AX3705 is a solution for UAV.

| | |
|---|---|
| ⚠ | Contact Tersus support if problems happen when an antenna from other vendors are 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.

## 2.4 Power Supply Requirement

| | |
|---|---|
| ⚠ | Power to the BX series OEM boards must be applied for >150ms before any of the external interfaces are powered on by the integrator's card.<br>Hold the RESETIN pin low during power up and for >150ms after power is applied. |

| | |
|---|---|
| ⚠ | If the voltage supplied is below the minimum specification, the receiver suspends operation. If the voltage supplied is above the maximum specification, the receiver may be permanently damaged, voiding the warranty. |

| | |
|---|---|
| ⚠ | The LEDs on the OEM boards/enclosures can tell whether the receiver is booting up successfully or not, see the detailed info from section 1.2.1 to 1.2.6. |

The input power requirement for the BX series receivers are given in Table 13

Table 13 Input Power Requirements

| BX series receivers | Input Power Requirement |
|---|---|
| OEM BX306 board | +3.3 VDC +5%/-3% with less than 100 mV ripple |
| OEM BX306Z board | +3.3 VDC +5%/-3% with less than 100 mV ripple |
| OEM BX316D board | +3.3 VDC +5%/-3% with less than 100 mV ripple |
| BX306 enclosure | +5~+12VDC |
| BX316 enclosure | +5~+12VDC |
| BX316R enclosure | +5~+12VDC |

| | |
|---|---|
| ⚠ | None of the BX receivers are supporting reversed polarity protection |

## 2.5 OEM Boards Installation Overview

When the appropriate equipment is selected, complete the following steps to set up and begin using the BX series receivers.

a) Install the BX 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 RF cable.
d) Apply power to the receiver, as described in section 2.4.
e) Connect the receiver to a computer or other data communications equipment.

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

## 2.6 Tersus GNSS Center Software

BX receivers have serial ports, so lots of serial tools can be used to communicate with the receivers. Terus GNSS Center is a windows-platform-based serial tool, which is recommended to communicate with the BX receivers. Tersus GNSS Center can be downloaded in https://www.tersus-gnss.com/software

Run Tersus GNSS Center, the following config page is shown, input the port and band rate (default is 115200).

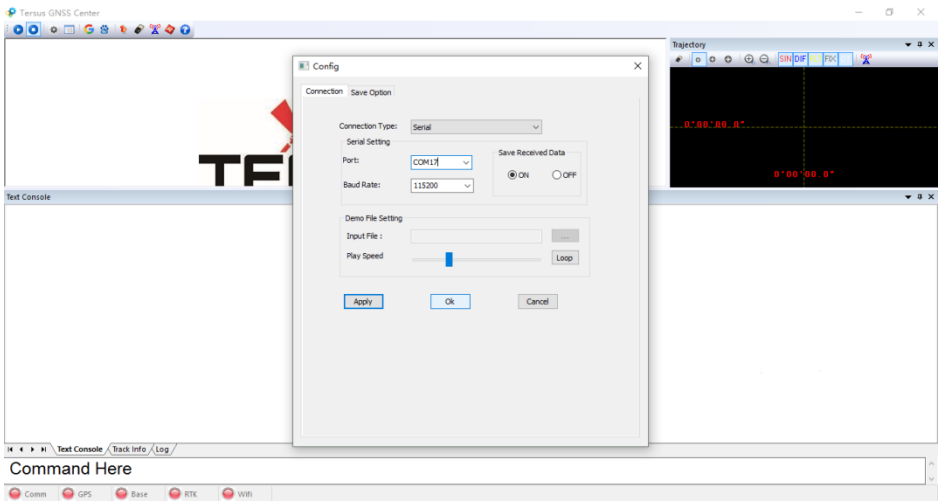



Figure 14 Config Page of Tersus GNSS Center

Table 14 gives definition for the four LEDs at the bottom of Tersus GNSS Center.

Table 14 Definition of the LEDs on Tersus GNSS Center

| LEDs | Description |
|---|---|
| COMM | GREEN: the communication with the receiver is established.<br>RED: the communication with the receiver is not established. |
| GPS | GREEN: valid GPGGA is received.<br>RED: No valid GPGGA is received. |
| Base | GREEN: valid corrections are received.<br>RED: No valid corrections are received. |
| RTK | SOLID GREEN: RTK solution is got.<br>BLINK GREEN: float solution is got.<br>RED: other solutions are got. |
| Wifi | Reserved. |


Figure 15 BX306 Enclosure Connected to a Laptop

Figure 15 shows a BX306 enclosure is connected to a laptop with a 20-pin cable and an USB adapter.

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 successfullly.

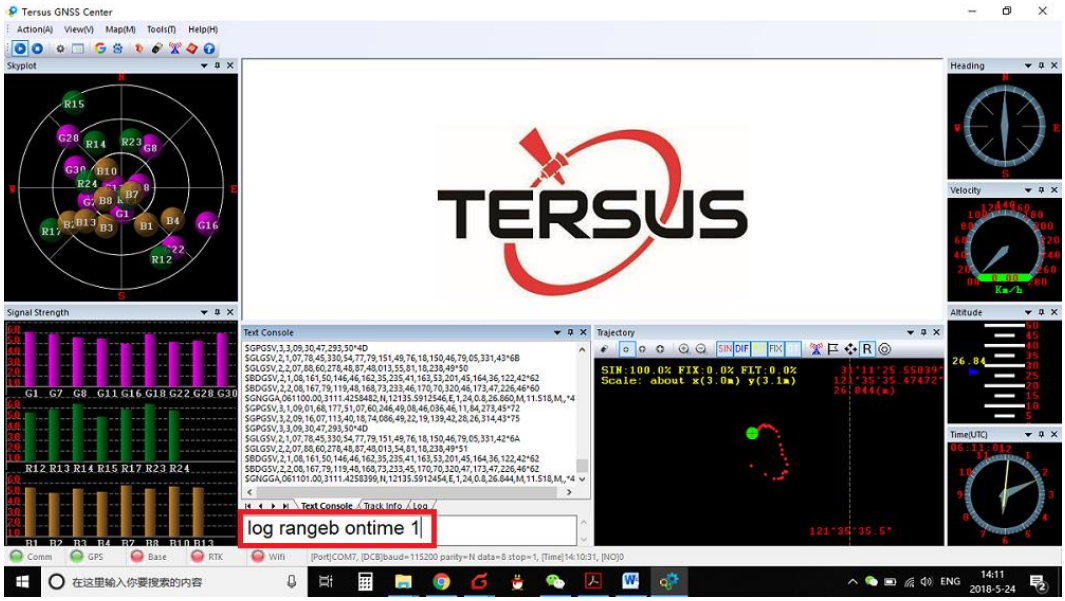



Figure 16 Main Windows of Tersus GNSS Center

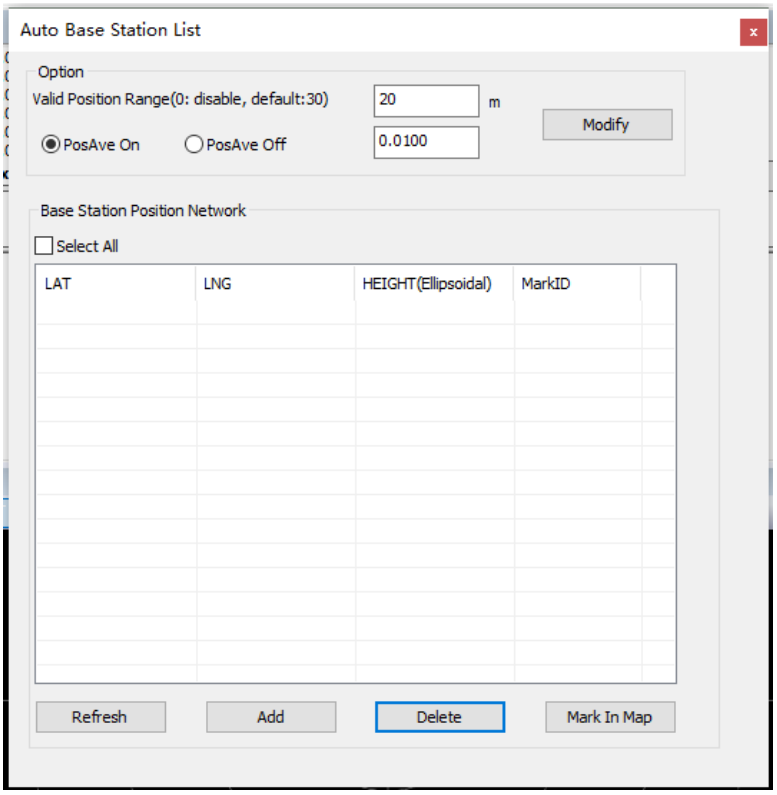
| | |
|---|---|
| ! | To active the skyplot, signal strength, trajectory and other windows, the antenna signals must be received and the following three loggings must be input to the receiver:<br>LOG GPGGA ONTIME 1 // output position and time<br>LOG GPGSV ONTIME 1 // output SVs in view, elevation and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

### 2.6.1 Auto Base Station List Function

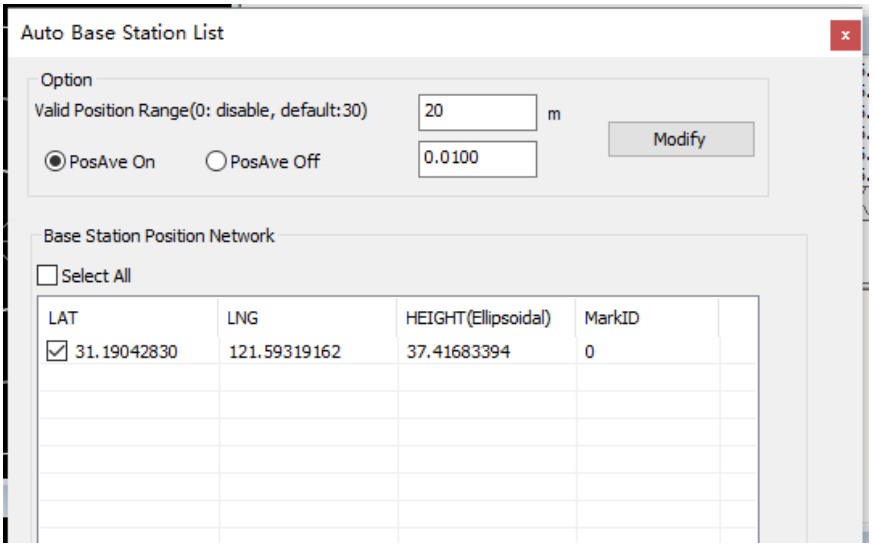
If a base is setup with command POSAVE, according to its origianl definition, even if the receiver is installed at the same point. Aftera a power cycle, the fixed position may be different, see more about coommand POSAVE in the Log & Command document. For the users who what the base to keep the same fixed position after a power cycle, auto base station list function is introduced.

The procdure is introduced below:

1) Communicate the receiver with Tersus GNSS Center, refer to section 2.6.
2) Go to Menu Tool -> Base Network for Posave, the follwing page will be displayed.




3) Fill the valid position range, PosAve On and fill the time (unit is hour), press the Modify button. It's recommended that valid position range is >20m.
4) After the time (in the example, 0.01 hour, that is, 36 seconds), the base will be fixed with the 36 seconds averaging position.
5) Press Refresh button, the fixed position will be displayed on the window.




6) Then after a power cycle, if the base is not moved 20m away from the last position, it will fixed with the same position, in the example, latitude will keep 31.19042830,

longitude will keep 121.59319162 and ellipsoid height will keep 37.4168.

## 2.7 Transmitting and Receiving Corrections

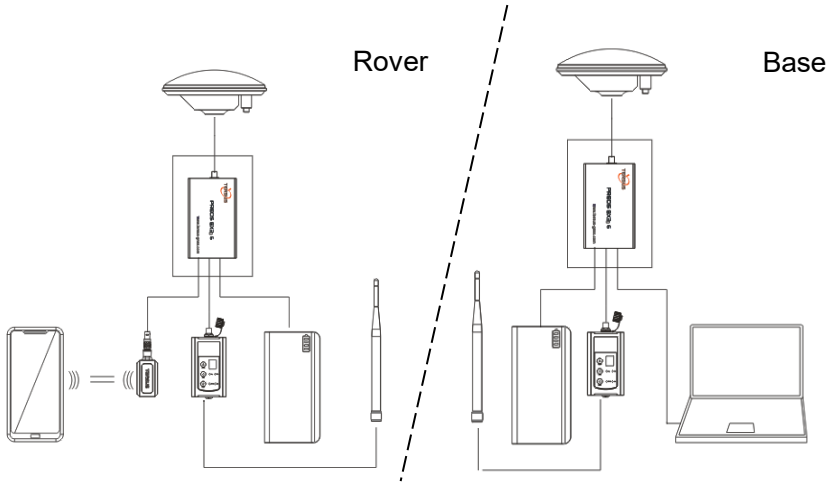



Figure 17 Base/Rover Configure

Example of RTK configuration (base mode):

COM COM2 115200 //set the baud rate, optional
INTERFACEMODE COM2 AUTO AUTO ON //set the interfacemode, optional
FIX POSITION LAT LON HGT //input the position of the base

LOG COM2 RTCM1074 ONTIME 1 //output GPS RTK raw measurements
LOG COM2 RTCM1084 ONTIME 1 // output GLONASS raw measurements
LOG COM2 RTCM1124 ONTIME 1 // output BDS RTK raw measurements
LOG COM2 RTCM1005 ONTIME 10 // output the base's position
SAVECONFIG //save the configure above

Example of RTK configuration (rover mode):

COM COM2 115200 //set the baud rate, optional
INTERFACEMODE COM2 AUTO AUTO ON //set the interfacemode, optional
LOG GPGGA ONTIME 1 //output GPGGA to check position type
SAVECONFIG //save the configure above

| | |
|---|---|
| ! | The base's antenna must be static and its position must be input, several ways can be used to input the base's position: |

| | |
|---|---|
| | • If the base's position is known, input it directly with command FIX.<br>• If the base's position is unknown, and the accuracy of the base can be meter-level, then it's recommended to use command POSAVE to setup the base, see 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.<br>• If you require a cm level accuracy of base and rover, then:<br>A. Configure the base receiver as a rover, receive RTK corrections from a CORS nearby, this receiver can get cm-level accuracy position.<br>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. |

## 2.8 Heading Output

| | |
|---|---|
| ! | Only BX316D board and BX316 enclosure can support heading output. |

The defaults configure of BX316D and BX316 is in single antenna mode; heading output is supported only when they're in dual antenna mode. To output heading, follow the steps below:

1) Connect two GNSS antennas to the primary and secondary connectors, respectively.
2) Input one of the two commands below to select dual antenna mode.

ANTENNAMODE DUALGPSBDS // Primary antenna tracks GPS L1/L2, BDS B1/B2; secondary antenna tracks GPS L1, BDS B2
ANTENNAMODE DUALGPSGLO // Primary antenna tracks GPS L1/L2, GLO G1/G2; secondary antenna tracks GPS L1, GLO G2

3) LOG HEADING ONTIME 1 // heading output
4) SAVECONFIG // save the configure above.
5) Power cycle the receiver.

| | |
|---|---|
| ⚠ | The command ANTENNAMODE will not work before a power cycle is input. |

| | |
|---|---|
| ! | In single antenna mode, the raw measurements in RANGE log are from the primary antenna only. |

| | |
|---|---|
| | In dual antenna mode, the raw measurements from both the primary antenna and the secondary one are included in RANGE log. |

| | |
|---|---|
| ! | It's recommended that the distance between two antennas is >1m.<br>It's strongly recommended the distance is 0.5m at least. |

# 3 FW Update and Auth Code

## 3.1 Firmware Updates

If a new firmware update is released, it will be available on the Tersus web site, or you can get the updates from Tersus support.

The FW version of a Tersus receiver can be updated in field. Connect the COM2 port of the receiver with Tersus GNSS Center, and input 'LOG VERSION', the following info will be output:

VERSION COM1 0 0.0 UNKNOWN -1 0.000 00000000 0 20161214
< 1
< BX306 G2SB2G2 008001181300000026 0020 20161123 3.0 Mar 16 2018 00:39:52

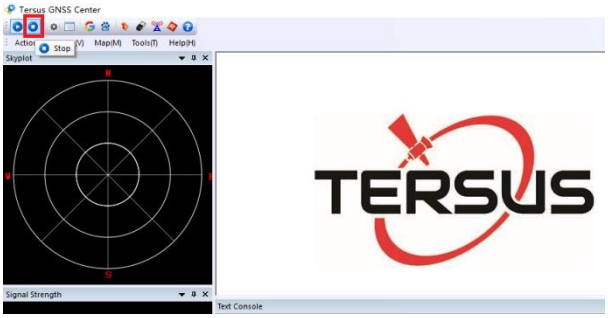
0020 is the FW version. See 'VERSION' in Tersus GNSS Log & Command Reference document for more detail.

## 3.2 Upgrading FW Using Tersus GNSS Center

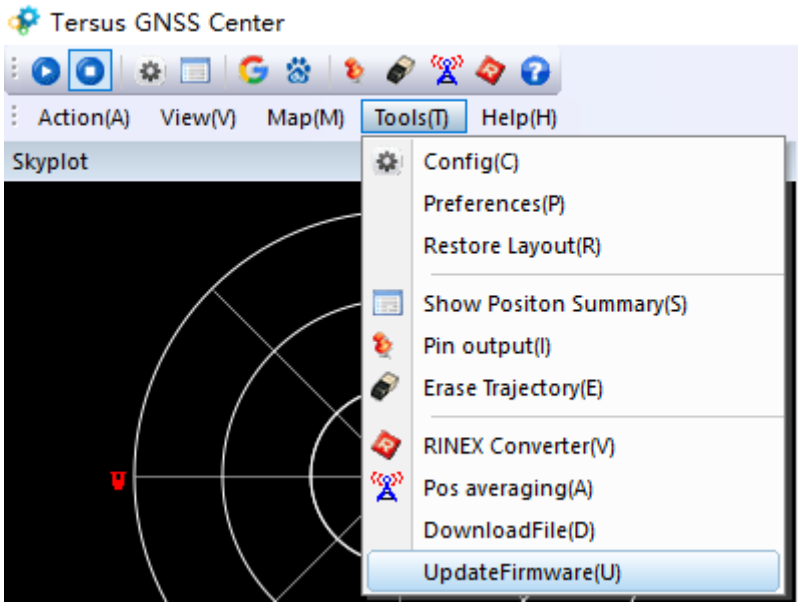
Please follow the steps below to upgrade the FW.

1) Power on the receiver.
2) Run Tersus GNSS Center software and communicate with the receiver, see section 2.6 for detail. Make sure the receiver has finished initialization, which can be confirmed by input 'LOG VERSION' in the console window and the receiver will output feedback.

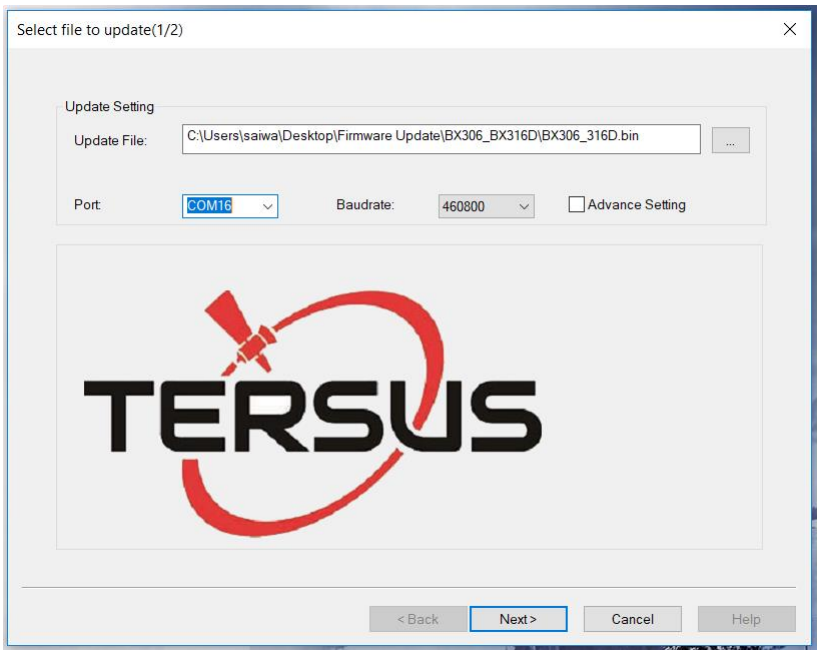

3) Press Stop button to terminal the communication between the computer and the receiver.



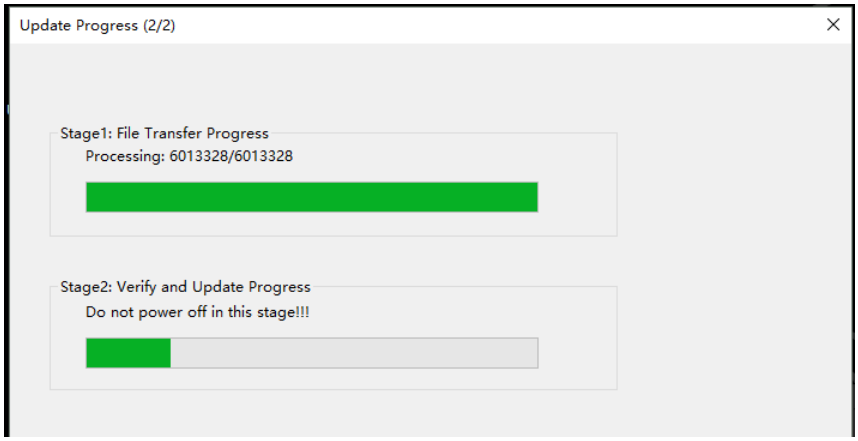

4) Select Tools ->UpdateFirmware




5) Select the upgrade file, when a file is selected, the file will be shown in the Update File bar. Select the port and baud rate, press Next

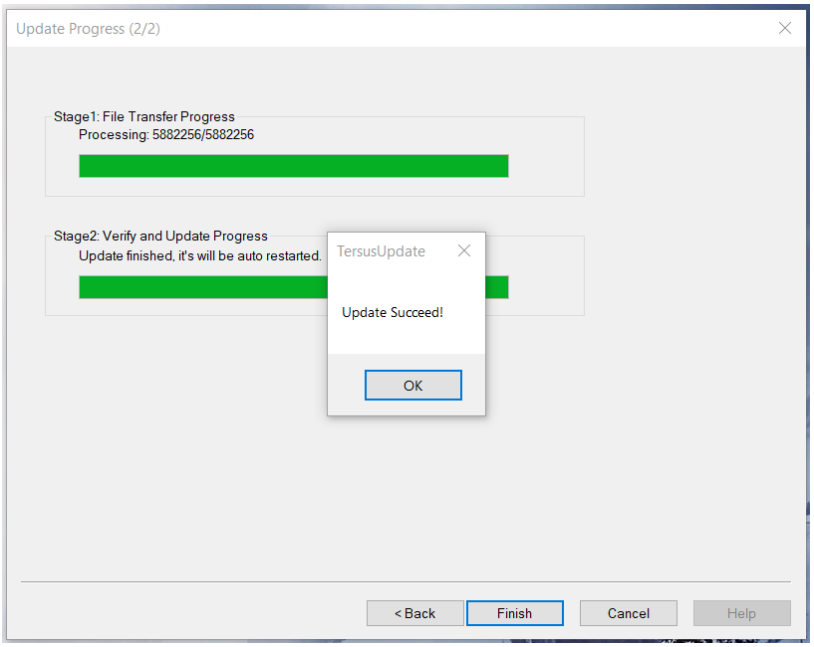



6) The following figure shows the FW is upgrading, two progresses are included in the FW update.




| | |
|---|---|
| ⚠ | Do not power off the receiver during the verify and update process. |

7) After the FW is upgraded successfully, The following show




8) Press OK and Finish buttons to close the FW upgrade windows, the receiver will reset automatically.

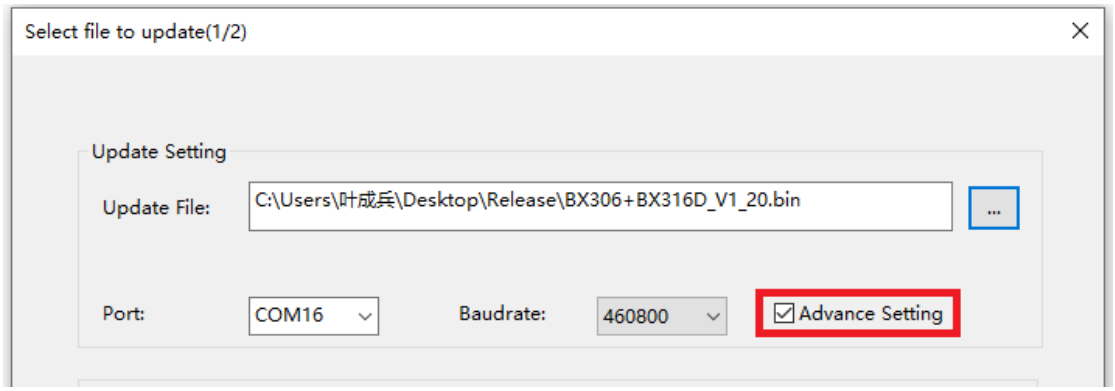
9) After the board is booted, you can confirm the FW version by connecting to the receiver and input ‘LOG VERSION’ and check the FW version.

**There is Advance Setting option in the FW update page, If a receiver**

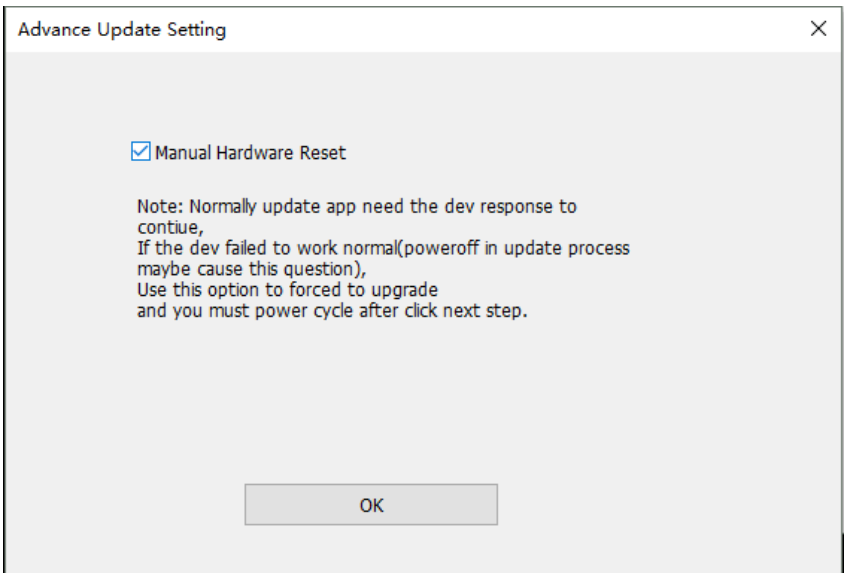
- **can’t boot up successfully, or**

- **can’t work well after boot up, or**
- **can’t finish FW update successfully according to the above steps,**

**you can select Advance Setting option to start FW update again.**




**If it’s selected, the following page will be displayed, select ‘Manual Hardware Reset’ and press OK.**




**Press Next in the former page and power off the receiver, wait for 5 seconds and power on it again.**

**After FW update is finished, power off the receiver, wait for 5 seconds and power on it again.**

| | |
|---|---|
| ⚠ | **This option is for sophisticated users. If you’re not sure whether it should be selected, contact Tersus support before select this option.** |

## 3.3 Auth Code

An auth code is used to determine the features and valid time for a receiver. If the auth code is expired, the receiver will not work. And a license requirement is output from all the ports.

Before you contact Tersus for new auth code, input:

LOG VERSION
LOG AUTHLIST

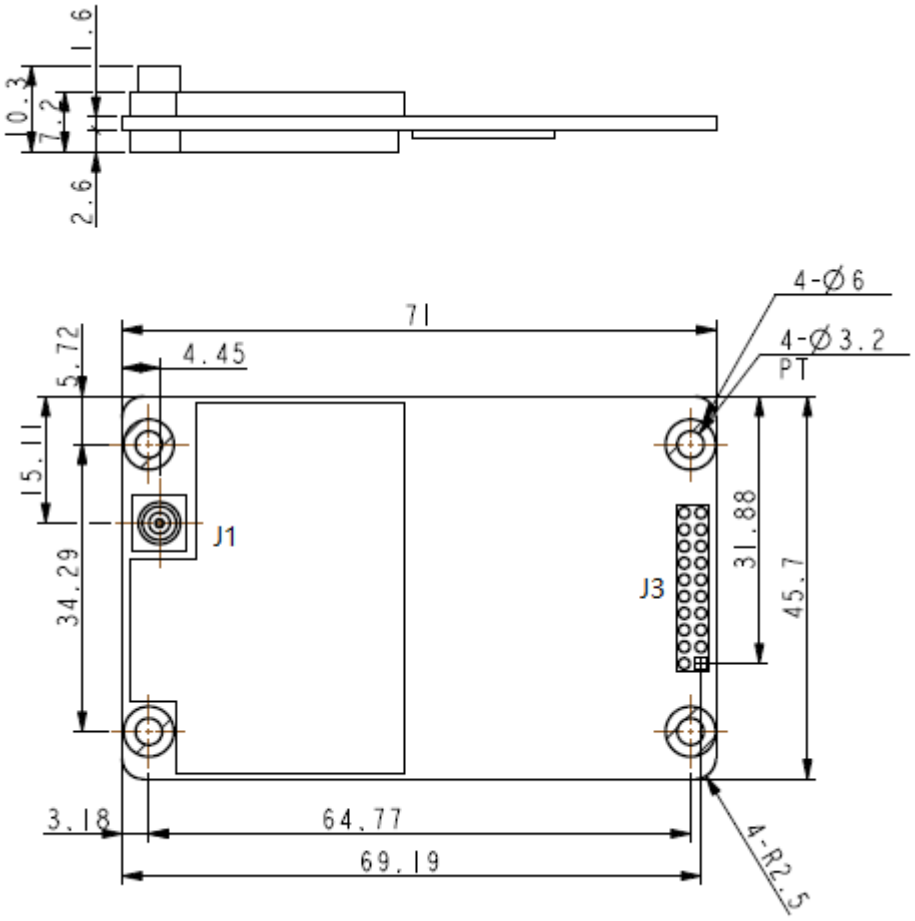
to the receiver, and send all the output info to Tersus support. If the auth code application is approved, you will get a txt file, in which command AUTHCODE and the code will be given, just copy all of them (Ctrl-A & Ctrl-C) and input them to the receiver.

# APPENDIX A

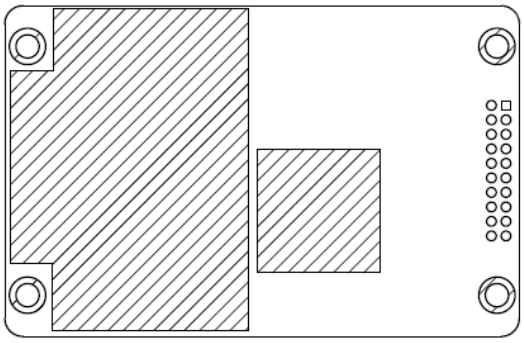
## 4 BX306 Board Technical Specifications

Table 15 BX306 Board Performance

| GNSS Performance | | | |
|---|---|---|---|
| Position Accuracy | Single positioning | 1.5m RMS (Horizontal) | |
| | | 3.0m RMS (Vertical) | |
| | RTK Positioning | 10mm+1ppm (Horizontal) | |
| | | 15mm+1ppm (Vertical) | |
| Time to First Fix | Cold Start: <50s<br>Warm Start: <30s | | |
| Reacquisition | 0.5 s L1 (typical)<br>1.0 s L2 (typical) | | |
| Data Rate | Measurements | 20Hz | |
| | Position | 5Hz | |
| Time Accuracy | 20ns RMS | | |
| Velocity Accuracy | 0.03m/s RMS | | |
| Measurement Precision | GPS | L1 PSR | 6 cm |
| | | L1 ADR | 1.0mm |
| | | L2 PSR | 8 cm |
| | | L2 ADR | 1.2mm |
| | BDS | L1 PSR | 6 cm |
| | | L1 ADR | 1.0mm |
| | | L2 PSR | 8 cm |
| | | L2 ADR | 1.0mm |
| | GLONASS | L1 PSR | 8 cm |
| | | L1 ADR | 1.0mm |
| | | L2 PSR | 8 cm |
| | | L2 ADR | 1.0mm |
| **Physical Description** | | | |
| Size | 71 * 46 * 8.8 $mm^3$ | | |
| Weight | 26g | | |
| **Mechanical Drawing** | | | |




**HEAT SINK POSITION[1]**



**ENVIRONMENTAL**

| | |
|---|---|
| Operating Temperature | -40C to +85C |
| Storage Temperature | -55C to +95C |
| Humidity | MIL-STD-810G, Method 507.5 Procedure II (95%) |
| Random Vibration | MIL-STD 810G Method 514.6, Category 24 (7.7 g RMS) |
| Sinusoidal Vibration | IEC 60068-2-6 (5 g) |
| Bump | ISO 9022-31-06 (25 g) |

| | |
|---|---|
| Shock | Operating: MIL-STD-810G, Method 516.6, Procedure I (40 g)<br>Non-operating: MIL-STD-810G, Method 516.6, Procedure V (75 g) |
| **Power Requirement** | |
| Input Voltage | +3.3 +5%/-3% VDC |
| Allowable Voltage Ripple | 100 mV p-p maximum |
| Power Consumption | 2.8W (typical) |

Note 1: when BX306 board is assembled in a box, a head sink must be installed between the hatch area and the metal box, or the thermal performance of the card will be decreased.

## 4.1 Connectors on BX306 board

There are two connectors on the BX306 board, J1 and J3, see the mechanical drawing in the above table.

J1: MCX jack receptacle, straight (Johnson P/N 133-3711-202 or SAMTEC P/N MCX-J-P-HST-SMI or equivalent)

J3: 2x10 header, 2 mm pitch (SAMTEC P/N TMM-110-03-G-D)

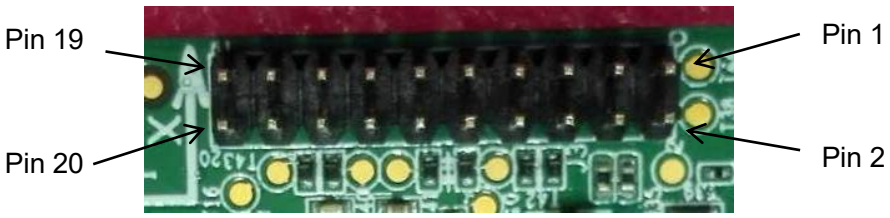



Table 16 Interface Signals Definition

| Pin | Signal | TYPE | Description | Comments |
|---|---|---|---|---|
| 1 | LNA_PWR | PWR | Antenna power input | Power to antenna, 3.3~12VDC. |
| 2 | 3V3 | PWR | Power to the board | 3.3 V +5%/-3% |
| 3 | USB_D- | IO | USB data (-) | One-half of a differential pair (pins 3 and 4). Match lengths and route as a 90 Ω differential pair if USB is required |
| 4 | USB_D+ | IO | USB data (+) | |

| | | | | |
|---|---|---|---|---|
| 5 | /RESETIN | I | Reset input t | Active low reset |
| 6 | USERVARF | IO | Variable frequency output | |
| 7 | EVENT2 | IO | Event 2 Input | |
| 8 | N.C | | | |
| 9 | EVENT1 | IO | Event1 input | Has a 10K pull-up resistor on card. |
| 10 | GND | PWR | Signal and power ground | |
| 11 | TXD1 | O | COM1 transmit data | LVTTL level, the max band rate is 921600 bps. |
| 12 | RXD1 | I | COM1 receive data | |
| 13 | GND | PWR | Signal and power ground | |
| 14 | TXD2 | O | COM2 transmit data | LVTTL level, the max band rate is 921600 bps. |
| 15 | RXD2 | I | COM2 receive data | |
| 16 | GND | PWR | Signal and power ground | |
| 17 | PV | O | Position valid indicator | High: when RTK solution is got. Low: other position types. |
| 18 | GND | PWR | Signal and power ground | |
| 19 | PPS | O | Pulse per second output, | This pin has an internal 50 ohm line driver. Route as a 50 Ω single-ended trace |
| 20 | N.C | | | |

## 4.2 Reference Schematic of the Interface Board

If an interface board is designed to work with BX306 card, the following are the reference schematics for the power, serial port, USB port, CAN port and Ethernet port. Please contact Tersus support if you need more about the interface board.

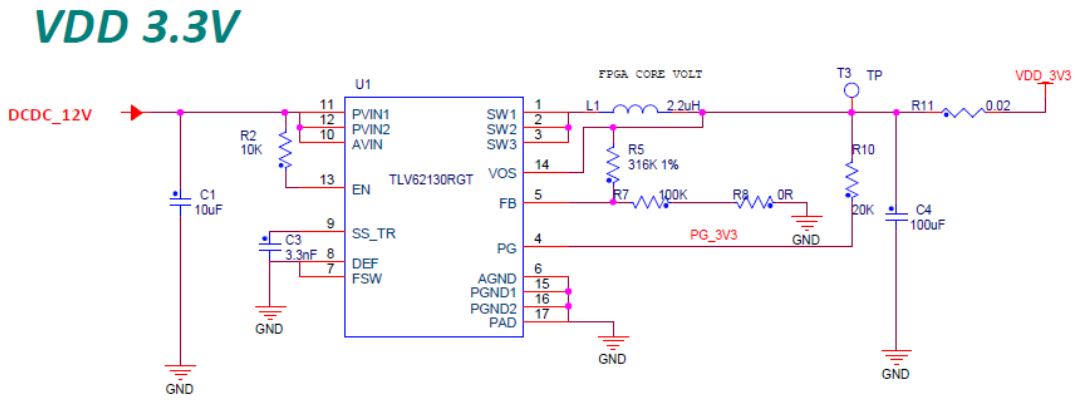



Figure 18 3.3V Reference Schematic

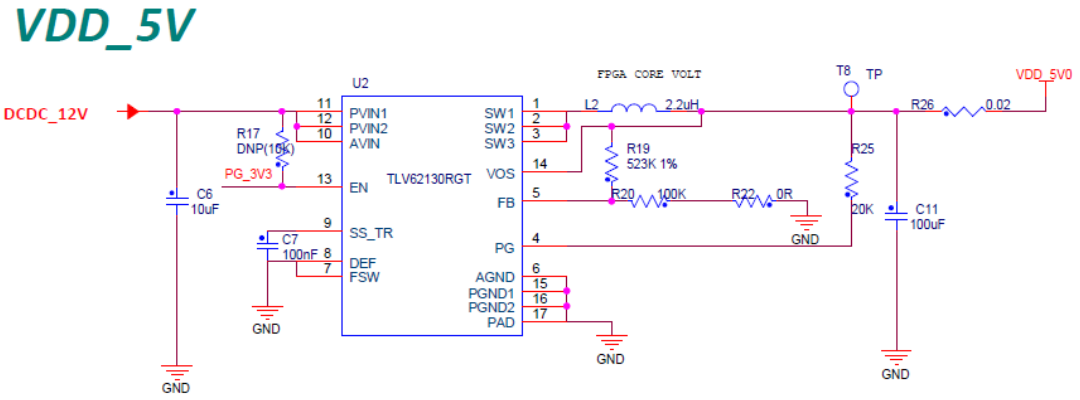



Figure 19 5V Reference Schematic

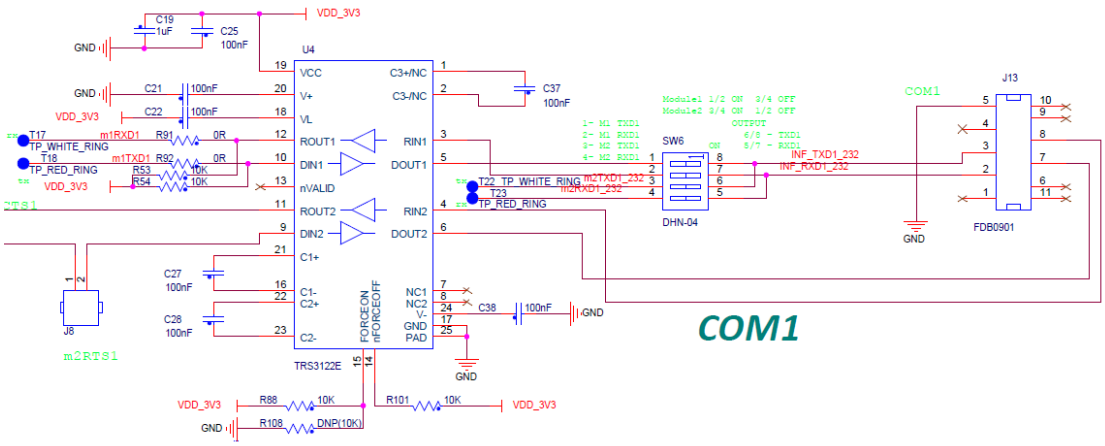



Figure 20 Reference Schematic for a Serial Port

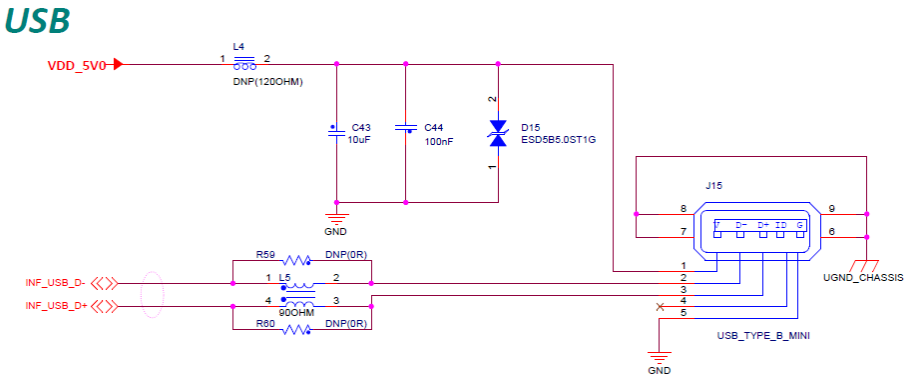



Figure 21 Reference Schematic for USB

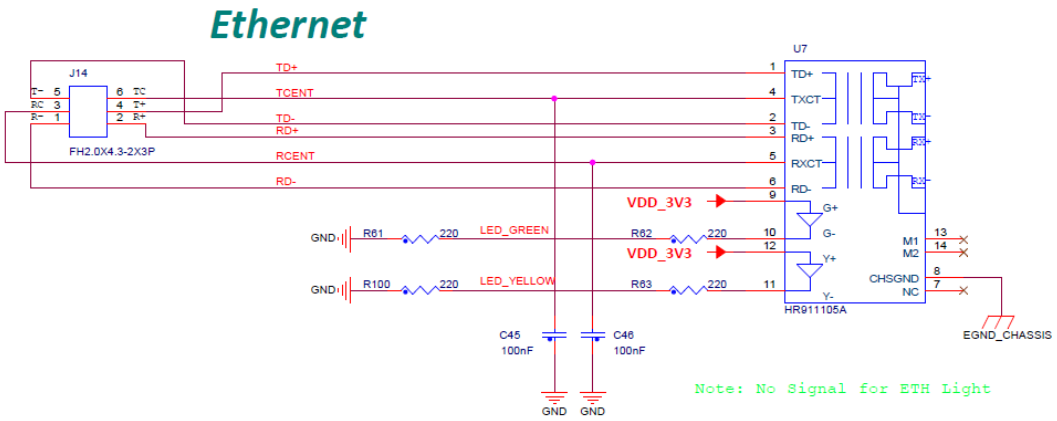


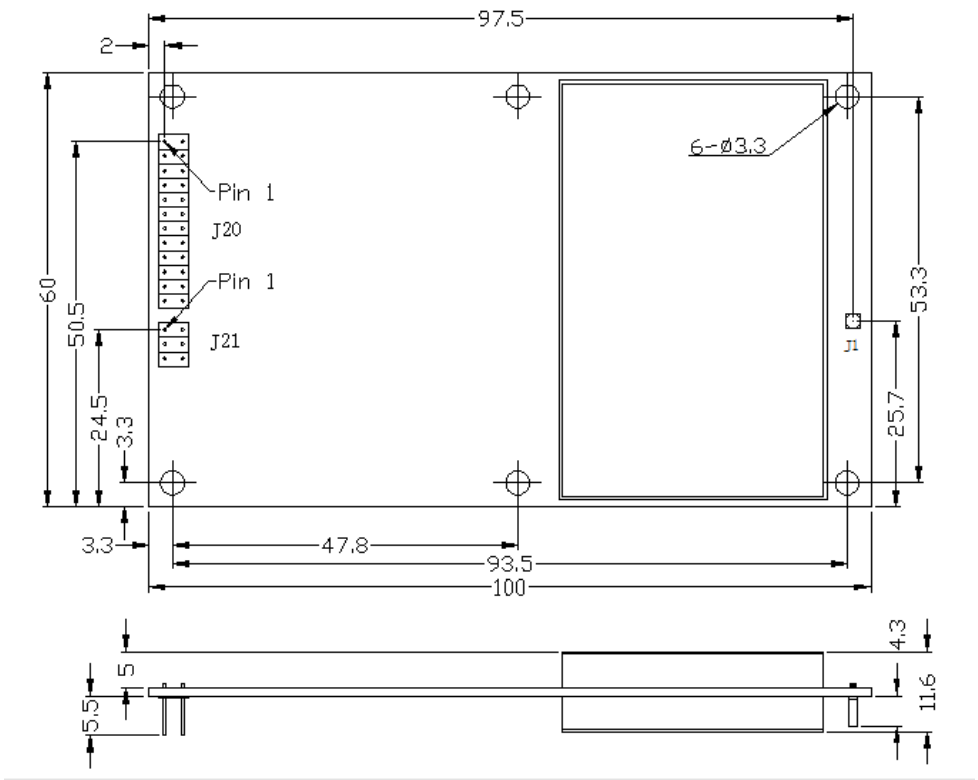

Figure 22 Reference Schematic for Ethernet

# APPENDIX B

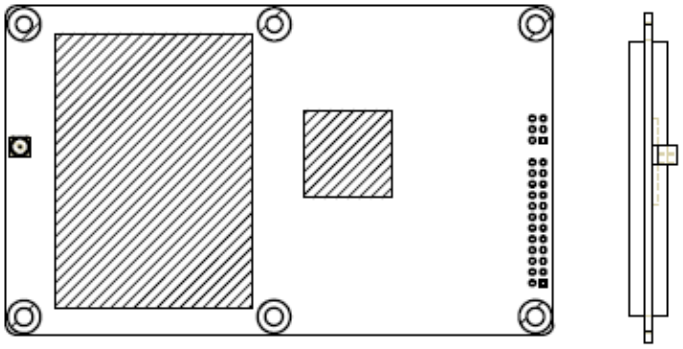
## 5. BX306Z Board Technical Specifications

Table 17 BX306Z Board Performance

| GNSS Performance | | | |
|---|---|---|---|
| Position Accuracy | Single positioning | 1.5m RMS (Horizontal) | |
| | | 3.0m RMS (Vertical) | |
| | RTK Positioning | 10mm+1ppm (Horizontal) | |
| | | 15mm+1ppm (Vertical) | |
| Time to First Fix | Cold Start: <50s<br>Warm Start: <30s | | |
| Reacquisition | 0.5 s L1 (typical)<br>1.0 s L2 (typical) | | |
| Data Rate | Measurements | 20Hz | |
| | Position | 5Hz | |
| Time Accuracy | 20ns RMS | | |
| Velocity Accuracy | 0.03m/s RMS | | |
| Measurement Precision | GPS | L1 PSR | 6 cm |
| | | L1 ADR | 1.0mm |
| | | L2 PSR | 8 cm |
| | | L2 ADR | 1.2mm |
| | BDS | L1 PSR | 6 cm |
| | | L1 ADR | 1.0mm |
| | | L2 PSR | 8 cm |
| | | L2 ADR | 1.0mm |
| | GLONASS | L1 PSR | 8 cm |
| | | L1 ADR | 1.0mm |
| | | L2 PSR | 8 cm |
| | | L2 ADR | 1.0mm |
| **Physical Description** | | | |
| Size | 100 * 60 * 11.6 $mm^3$ | | |
| Weight | 46g | | |
| **Mechanical Drawing** | | | |




## HEAT SINK POSITION[1]



## ENVIRONMENTAL

| | |
|---|---|
| Operating Temperature | -40C to +85C |
| Storage Temperature | -55C to +95C |
| Humidity | MIL-STD-810G, Method 507.5 Procedure II (95%) |
| Random Vibration | MIL-STD 810G Method 514.6, Category 24 (7.7 g RMS) |
| Sinusoidal Vibration | IEC 60068-2-6 (5 g) |
| Bump | ISO 9022-31-06 (25 g) |
| Shock | Operating: MIL-STD-810G, Method 516.6, Procedure I (40 g)<br>Non-operating: MIL-STD-810G, Method 516.6, Procedure V |

| | |
|---|---|
| | (75 g) |
| **Power Requirement** | |
| Input Voltage | +3.3 +5%/-3% VDC |
| Allowable Voltage Ripple | 100 mV p-p maximum |
| Power Consumption | 2.9W (typical) |

Note 1: when BX306Z card is assembled in a box, a head sink must be installed between the hatch area and the metal box, or the thermal performance of the card will be decreased.

## 5.1 Connectors on BX306Z Board

There are three connectors on the BX306Z card, J1, J20 and J21, see the mechanical drawing in the above table.

1. J20: 2x12 header, 2 mm pitch (SAMTEC P/N TMM-112-03-G-D)
2. J21: 2x3 header, 2 mm pitch (SAMTEC P/N TMM-103-03-G-D)
3. J1: MMCX jack receptacle, straight


Table 18 Interface Signals Definition

| Pin | Signal | TYPE | Description | Comments |
|---|---|---|---|---|
| 1 | GND | PWR | | |
| 2 | RTK LED | O | RTK LED. Flashes when an RTK correction is present. | To drive an LED, a series resistor with a 300Ohms is required. |
| 3 | POWER_OFF | I | Powers the unit on and off. | Drive high with a 3.3V to turn off, leave floating or ground to keep the unit on. |

| | | | | |
|---|---|---|---|---|
| 4 | PPS | O | Pulse per second output | This is 3.3V TTL level, 4mA max drive capability. |
| 5 | VCC | PWR | Power to the card | 3.3V +5%/-3% |
| 6 | VCC | PWR | Power to the card | 3.3V +5%/-3% |
| 7 | Event2[1] / CAN1_RX / COM3_RX[1] | I | Event2 – Event input<br>CAN1_RX – CAN Receive line<br>COM3_RX – COM3 Receive line | Event2 must be 3.3V TTL level.<br><br>Connect COM3_RX to a transceiver if RS-232 level is required. |
| 8 | Event1 | I | Event input | must be 3.3 V TTL level |
| 9 | Power LED | O | POWER Indicator,<br>High when unit is on. | When used to drive an LED, a series resistor with a typical value of 300Ohm is required. |
| 10 | Satellite LED | O | Satellite LED.<br>Rapid flash: <5 satellites.<br>Slow flash: >5 satellites. | To drive an LED, a series resistor with 300Ohm is required. |
| 11 | COM2_CTS | I | COM2 Clear to Send – TTL Level | Connect COM2_CTS to a transceiver if RS-232 level is required. |
| 12 | RESET_IN | I | RESET_IN – ground to reset | Drive low to reset the unit. |
| 13 | COM2_RTS | O | COM2 Request to Send – TTL Level | Connect COM2_RTS to a transceiver if RS-232 level is required. |
| 14 | COM2_RX | I | COM2 Receive line | Connect COM2_RX to a transceiver if RS-232 level is required. |
| 15 | No Connect | | Reserved | |
| 16 | COM2_TX | O | COM2 transmit line | Connect COM2_TX to a transceiver if RS-232 level is required. |
| 17 | No Connect | | Reserved | |
| 18 | COM1_RX | I | COM1 Receive line | RS-232 Level |
| 19 | CAN1_TX / COM3_TX[1] | O | CAN1_TX – CAN Transmit line<br>COM3_Transmit Data – TTL Level | Connect CAN1_TX to TX line of a CAN driver.<br>Connect COM3_TX to a transceiver if RS-232 level is required |
| 20 | COM1_TX | O | COM1 Transmit Data | RS-232 Level |

| | | | | |
|---|---|---|---|---|
| 21 | USB- | I/O | USB D (-) Bi-directional USB interface data (-) | Device Mode only. |
| 22 | USB+ | I/O | USB D (+) Bi-directional USB interface data (+) | Device Mode only. |
| 23 | GND | PWR | | |
| 24 | GND | PWR | | |

| Pin | Signal | TYPE | Description | Comments |
|---|---|---|---|---|
| 1 | ETH_RD-[1] | Differential pair. | Ethernet Receive line minus. | Connect to Magnetics RD-. |
| 2 | ETH_RD+[1] | Differential pair. | Ethernet Receive line plus. | Connect to Magnetics RD+. |
| 3 | CENT_RD[1] | | RD Magnetic center tap. | Connect to Magnetics RD Centre Tap. |
| 4 | ETH_TD+[1] | Differential pair. | Ethernet Transmit line plus. | Connect to Magnetics TD+. |
| 5 | ETH_TD-[1] | Differential pair. | Ethernet Transmit line minus. | Connect to Magnetics TD-. |
| 6 | CENT_TD[1] | | TD Magnetic center tap. | Connect to Magnetics TD Center Tap. |

Note 1: all the ports are related to FW release, contact Tersus support before use them.

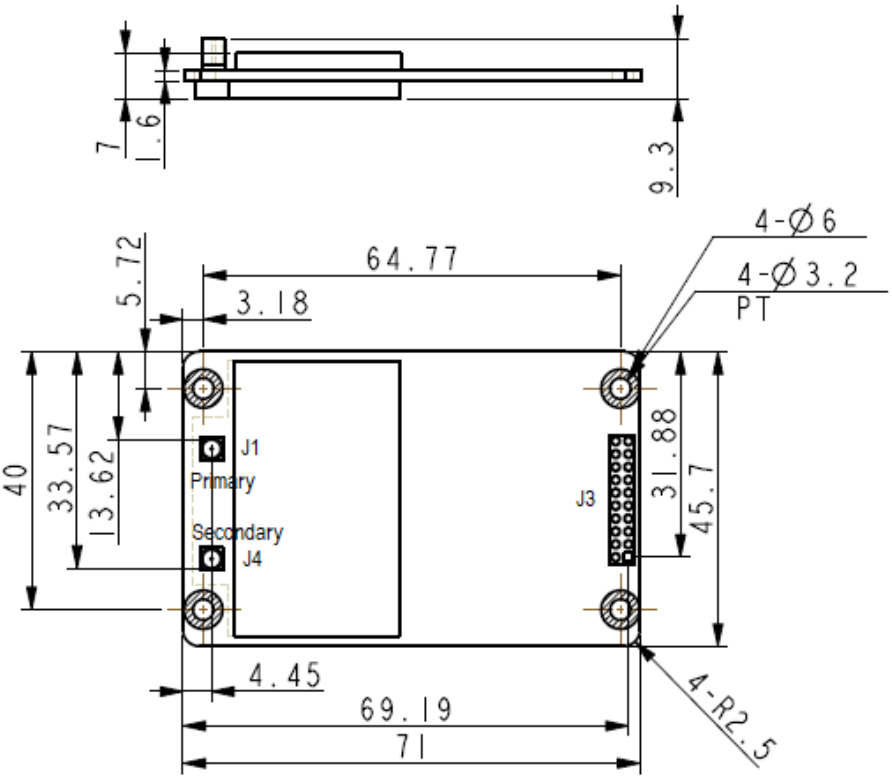
Refer to section 4.2 if interface board is designed.

# APPENDIX C

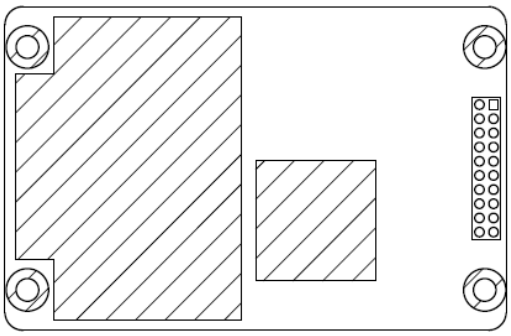
## 6. BX316D Board Technical Specifications

Table 19 BX306D Board Performance

| GNSS Performance | | | |
|---|---|---|---|
| Position Accuracy | Single positioning | 1.5m RMS (Horizontal) | |
| | | 3.0m RMS (Vertical) | |
| | RTK Positioning | 10mm+1ppm (Horizontal) | |
| | | 15mm+1ppm (Vertical) | |
| Heading Accuracy | 0.2 degree (Baseline is 1m) | | |
| Time to First Fix | Cold Start: <50s<br>Warm Start: <30s | | |
| Reacquisition | 0.5 s L1 (typical)<br>1.0 s L2 (typical) | | |
| Data Rate | Measurements | 20Hz | |
| | Position | 5Hz | |
| Time Accuracy | 20ns RMS | | |
| Velocity Accuracy | 0.03m/s RMS | | |
| Measurement Precision | GPS | L1 PSR | 6 cm |
| | | L1 ADR | 1.0mm |
| | | L2 PSR | 8 cm |
| | | L2 ADR | 1.2mm |
| | BDS | L1 PSR | 6 cm |
| | | L1 ADR | 1.0mm |
| | | L2 PSR | 8 cm |
| | | L2 ADR | 1.0mm |
| | GLONASS | L1 PSR | 8 cm |
| | | L1 ADR | 1.0mm |
| | | L2 PSR | 8 cm |
| | | L2 ADR | 1.0mm |
| **Physical Description** | | | |
| Size | 71 * 46 * 9.3 $mm^3$ | | |
| Weight | 28g | | |
| **Mechanical Drawing** | | | |




**HEAT SINK POSITION[1]**



**ENVIRONMENTAL**

| | |
|---|---|
| Operating Temperature | -40C to +85C |
| Storage Temperature | -55C to +95C |
| Humidity | MIL-STD-810G, Method 507.5 Procedure II (95%) |
| Random Vibration | MIL-STD 810G Method 514.6, Category 24 (7.7 g RMS) |
| Sinusoidal Vibration | IEC 60068-2-6 (5 g) |
| Bump | ISO 9022-31-06 (25 g) |
| Shock | Operating: MIL-STD-810G, Method 516.6, Procedure I (40 g)<br>Non-operating: MIL-STD-810G, Method 516.6, Procedure V |

| | |
|---|---|
| | (75 g) |
| **Power Requirement** | |
| Input Voltage | +3.3 +5%/-3% VDC |
| Allowable Voltage Ripple | 100 mV p-p maximum |
| Power Consumption | 2.9W (typical) |

Note 1: when BX316D card is assembled in a box, a head sink must be installed between the hatch area and the metal box, or the thermal performance of the card will be decreased.

## 6.1 Connectors on BX316D Board

There are three connectors on the BX316D board, J1, J3 and J4, see the mechanical drawing in the above table.

1. J1/J4: MMCX jack receptacle, straight
2. J3: 2x10 header, 2 mm pitch (SAMTEC P/N TMM-110-03-G-D)

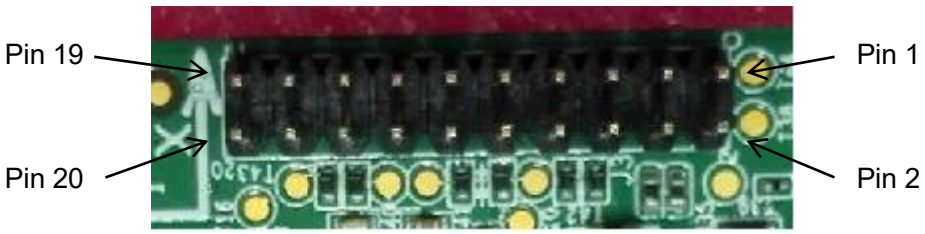



Table 20 Interface Signals Definition

| Pin | Signal | TYPE | Description | Comments |
|---|---|---|---|---|
| 1 | LNA_PWR | PWR | Antenna power input | Power to antenna, should be input 5VDC. |
| 2 | 3V3 | PWR | Power to the board | 3.3V +5%/-3% |
| 3 | USB_D- | IO | USB data (-) | One-half of a differential pair (pins 3 and 4). Match lengths and route as a 90 Ω differential pair if USB is required |
| 4 | USB_D+ | IO | USB data (+) | |
| 5 | /RESETIN | I | Reset input t | Active low reset |
| 6 | USERVARF | IO | Variable frequency | |

| | | | | |
|---|---|---|---|---|
| | | | output | |
| 7 | EVENT2 | IO | Event 2 Input | |
| 8 | N.C | | | |
| 9 | EVENT1 | IO | Event1 input | Has a 10K pull-up resistor on card. |
| 10 | GND | PWR | Signal and power ground | |
| 11 | TXD1 | O | COM1 transmit data | LVTTL level, the max band rate is 921600 bps. |
| 12 | RXD1 | I | COM1 receive data | |
| 13 | GND | PWR | Signal and power ground | |
| 14 | TXD2 | O | COM2 transmit data | LVTTL level, the max band rate is 921600 bps. |
| 15 | RXD2 | I | COM2 receive data | |
| 16 | GND | PWR | Signal and power ground | |
| 17 | PV | O | Position valid indicator | High: when RTK solution is got. Low: other position types. |
| 18 | GND | PWR | Signal and power ground | |
| 19 | PPS | O | Pulse per second output, | This pin has an internal 50 ohm line driver. Route as a 50 Ω single-ended trace |
| 20 | N.C | | | |

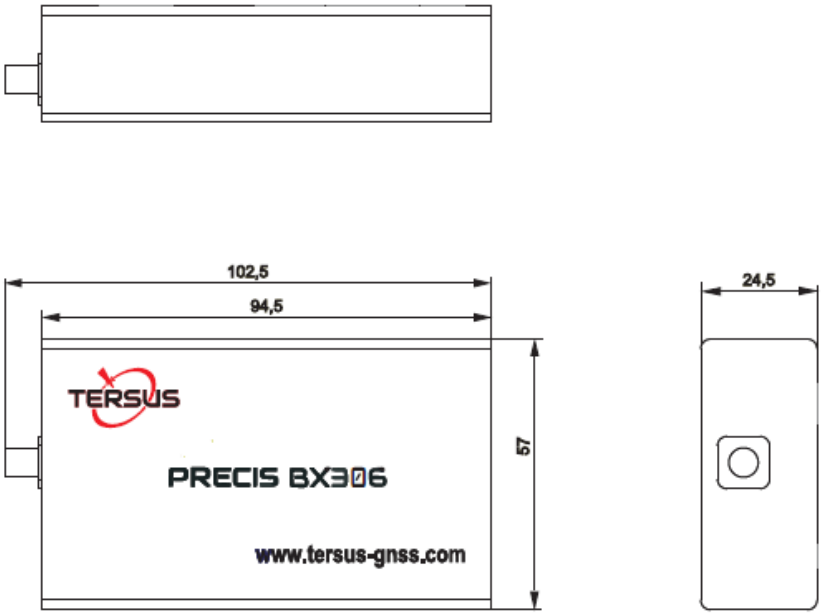
Refer to section 4.2 if interface board is designed.

# APPENDIX D

## 7. BX306 Enclosure Technical Specifications

Table 21 BX306 Enclosure Performance

| GNSS Performance | | |
|---|---|---|
| Position Accuracy | Single positioning | 1.5m RMS (Horizontal) |
| | | 3.0m RMS (Vertical) |
| | RTK Positioning | 10mm+1ppm (Horizontal) |
| | | 15mm+1ppm (Vertical) |
| Time to First Fix | Cold Start: <50s<br>Warm Start: <30s | |
| Reacquisition | 0.5 s L1 (typical)<br>1.0 s L2 (typical) | |
| Data Rate | Measurements | 20Hz |
| | Position | 5Hz |
| Time Accuracy | 20ns RMS | |
| Velocity Accuracy | 0.03m/s RMS | |
| Measurement Precision | Refer to BX306 board in chapter 4. | |
| **Physical Description** | | |
| Size | 102.5 * 57 * 24.5 $mm^3$ | |
| Weight | 150g | |
| **Mechanical Drawing** | | |




| ENVIRONMENTAL | |
|---|---|
| Operating Temperature | -40C to +85C |
| Storage Temperature | -55C to +95C |
| Humidity | MIL-STD-810G, Method 507.5 Procedure II (95%) |
| Random Vibration | MIL-STD 810G Method 514.6, Category 24 (7.7 g RMS) |
| Sinusoidal Vibration | IEC 60068-2-6 (5 g) |
| Bump | ISO 9022-31-06 (25 g) |
| Shock | Operating: MIL-STD-810G, Method 516.6, Procedure I (40 g)<br>Non-operating: MIL-STD-810G, Method 516.6, Procedure V (75 g) |
| **Power Requirement** | |
| Voltage | +5 – 12 VDC |
| Power Consumption | 3.2W (typical) |

## 7.1 20-Pin Cable

A 20-pin cable is provided with the BX306 enclosure.

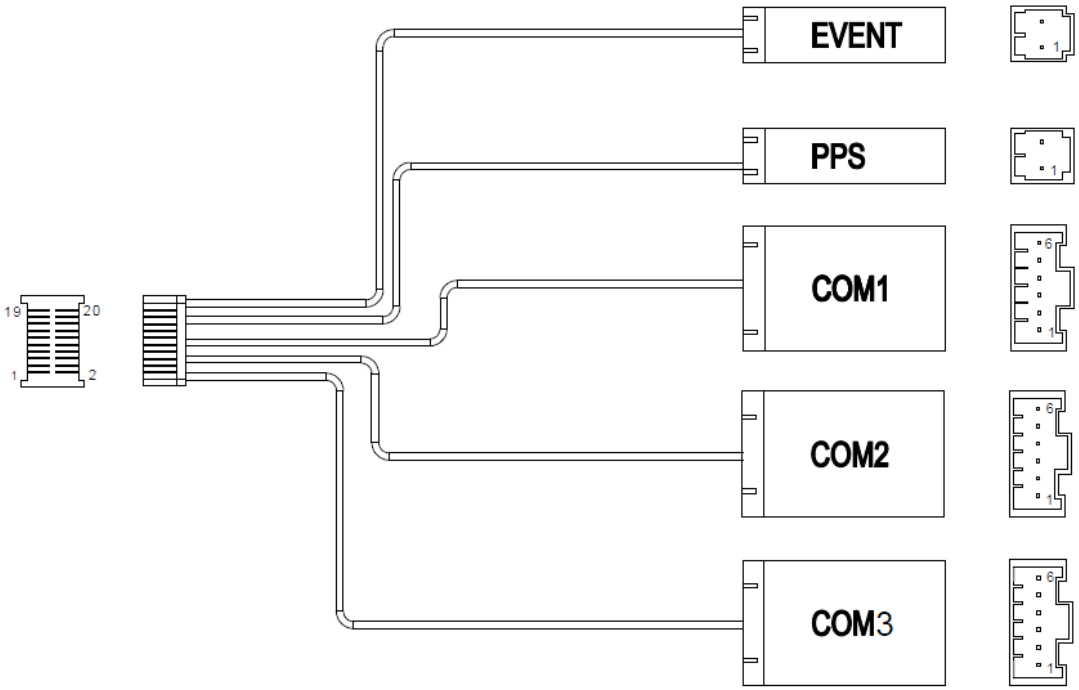



Figure 23 Outline of the 20-pin Cable

The 20-pin connector of the cable is Mouser's DF50S-20DS-1L or equivalent, the connectors at the other side of the cable are 3pcs Mouser's 7980DF1EA-6EP-2.5C and 2pcs 7980DF1EA-2EP-2.5C:

Table 22 Pin Definition of the 20-pin Cable

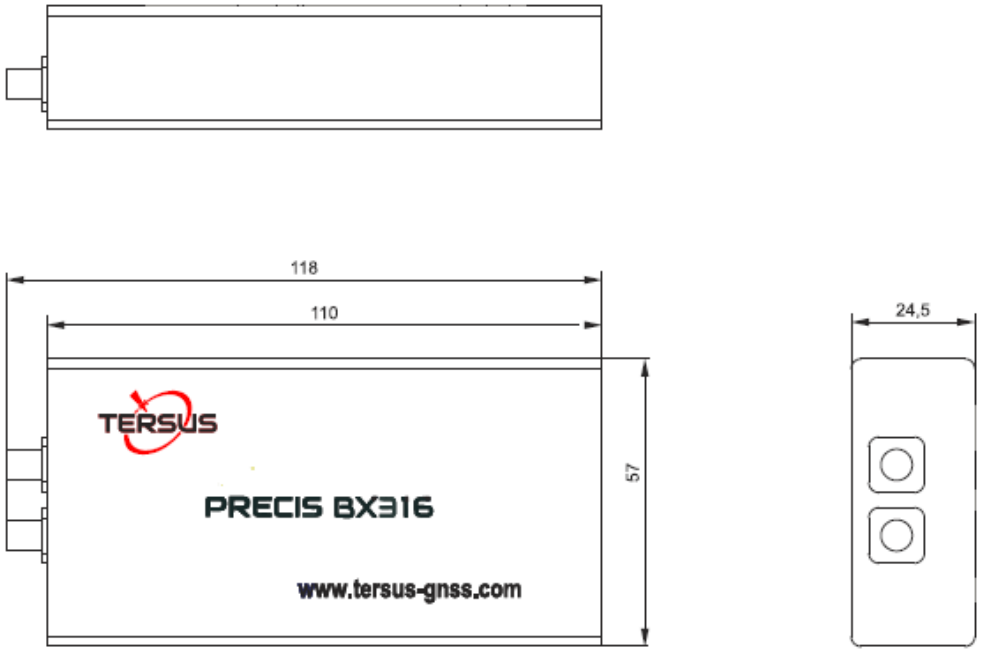
| No. | Signal Definition | COM1 | COM2 | COM3 | EVENT | PPS |
|---|---|---|---|---|---|---|
| 1 | GND | Pin 6 | | | | |
| 2 | N.C | | | | | |
| 3 | COM1_TX | Pin 2 | | | | |
| 4 | COM2_RX | | Pin 3 | | | |
| 5 | COM1_RX | Pin 3 | | | | |
| 6 | COM2_TX | | Pin 2 | | | |
| 7 | 3.3V | Pin 1 | | | | |
| 8 | 3.3V | | | | | |
| 9 | PPS | | | | | Pin 1 |
| 10 | COM2_SCL | | Pin 4 | | | |
| 11 | EVENT1 | | | | Pin 1 | |
| 12 | COM2_SDA | | Pin 5 | | | |
| 13 | GND | | | Pin 6 | | |
| 14 | GND | | Pin 6 | | | |
| 15 | COM3_TX | | | Pin 2 | | |
| 16 | GND | | | | | Pin 2 |
| 17 | COM3_RX | | | Pin 3 | | |
| 18 | GND | | | | Pin 2 | |
| 19 | 3.3V | | Pin 1 | Pin 1 | | |
| 20 | N.C | | | | | |

# APPENDIX E

## 8. BX316 Enclosure Technical Specifications

Table 23 BX316 Enclosure Performance

| GNSS Performance | | | |
|---|---|---|---|
| Position Accuracy | Single positioning | 1.5m RMS (Horizontal) | |
| | | 3.0m RMS (Vertical) | |
| | RTK Positioning | 10mm+1ppm (Horizontal) | |
| | | 15mm+1ppm (Vertical) | |
| Heading accuracy | 0.2 degree (1m baseline) | | |
| Time to First Fix | Cold Start: <50s<br>Warm Start: <30s | | |
| Reacquisition | 0.5 s L1 (typical)<br>1.0 s L2 (typical) | | |
| Data Rate | Measurements | 20Hz | |
| | Position | 5Hz | |
| Time Accuracy | 20ns RMS | | |
| Velocity Accuracy | 0.03m/s RMS | | |
| Measurement Precision | GPS | L1 PSR | 6 cm |
| | | L1 ADR | 1.0mm |
| | | L2 PSR | 8 cm |
| | | L2 ADR | 1.2mm |
| | BDS | L1 PSR | 6 cm |
| | | L1 ADR | 1.0mm |
| | | L2 PSR | 8 cm |
| | | L2 ADR | 1.0mm |
| | GLONASS | L1 PSR | 8 cm |
| | | L1 ADR | 1.0mm |
| | | L2 PSR | 8 cm |
| | | L2 ADR | 1.0mm |
| **Physical Description** | | | |
| Size | 118 * 57 * 24.5 $mm^3$ | | |
| Weight | 150g | | |

| Mechanical Drawing |
|---|
|  |

| ENVIRONMENTAL | |
|---|---|
| Operating Temperature | -40C to +85C |
| Storage Temperature | -55C to +95C |
| Humidity | MIL-STD-810G, Method 507.5 Procedure II (95%) |
| Random Vibration | MIL-STD 810G Method 514.6, Category 24 (7.7 g RMS) |
| Sinusoidal Vibration | IEC 60068-2-6 (5 g) |
| Bump | ISO 9022-31-06 (25 g) |
| Shock | Operating: MIL-STD-810G, Method 516.6, Procedure I (40 g)<br>Non-operating: MIL-STD-810G, Method 516.6, Procedure V (75 g) |
| **Power Requirement** | |
| Voltage | +5 – 12 VDC |
| Power Consumption | 3.2W (typical) |

## 8.1 40-Pin Cable

A 40-pin cable is provided with the BX316/BX316R enclosure.

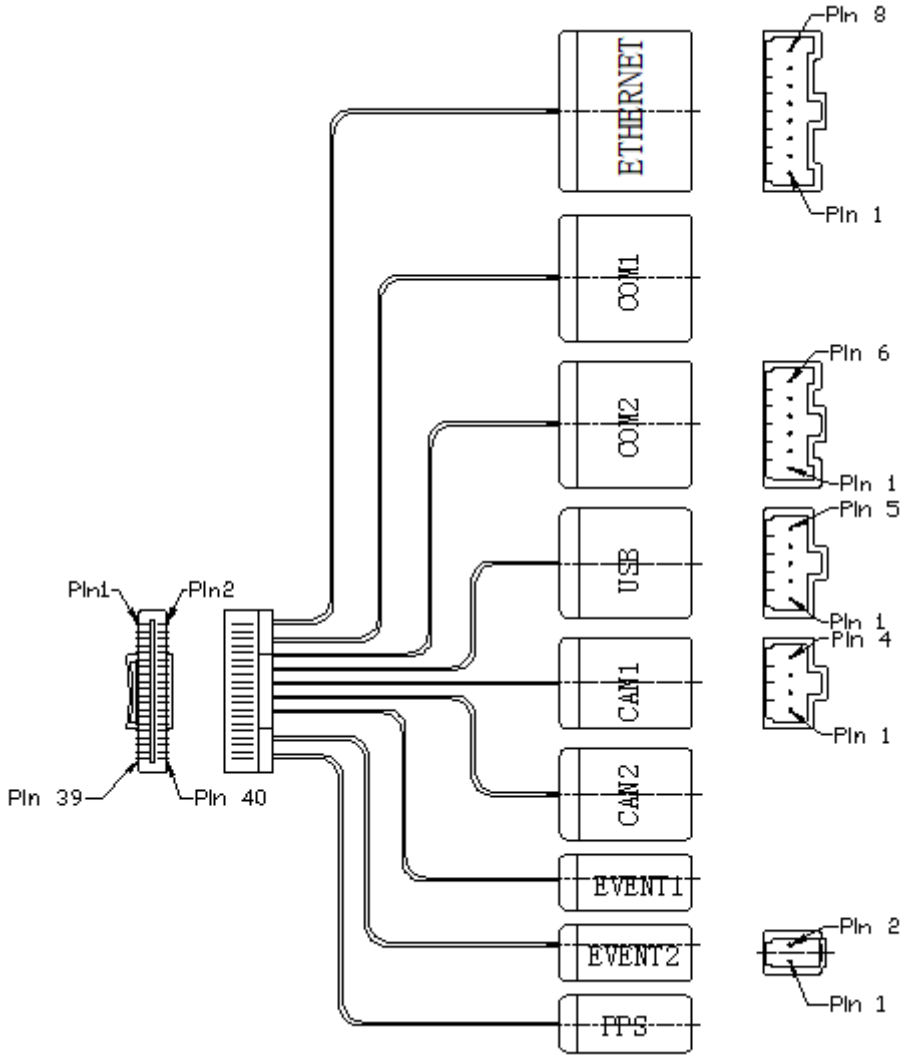



Figure 24 Outline of the 40-pin Cable

The 40-pin connector of the cable is Mouser's DF50S-40DS-1L or equivalent, the connectors at the other side of the cable are 3pcs Mouser's 7980DF1EA-6EP-2.5C and 2pcs 7980DF1EA-2EP-2.5C:

Table 24 Pin Definition of the 40-pin Cable

| Pin No. | Signal Name | Ethernet | COM1 | COM2 | USB | CAN1 | CAN2 | Event1 | Event2 | PPS |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | N.C | | | | | | | | | |
| 2 | TD1+ | 1 | | | | | | | | |
| 3 | EVENT2 | | | | | | | | 1 | |

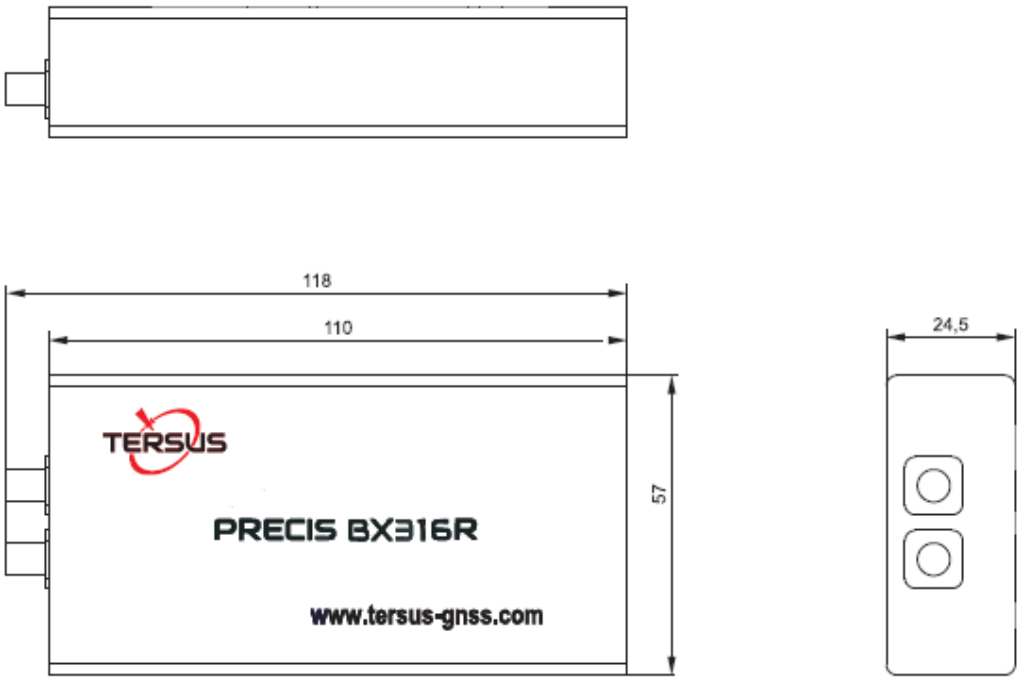
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | TD1- | 2 | | | | | | | | |
| 5 | GND | | | | | | | | 2 | |
| 6 | LED0 | 6 | | | | | | | | |
| 7 | RD1+ | 4 | | | | | | | | |
| 8 | LED1 | 7 | | | | | | | | |
| 9 | RD1- | 5 | | | | | | | | |
| 10 | GND | 8 | | | | | | | | |
| 11 | GND | 3 | | | | | | | | |
| 12 | GND | | | | | | | 2 | | |
| 13 | N.C | | | | | | | | | |
| 14 | EVENT1 | | | | | | | 1 | | |
| 15 | GND | | | | | | | | | 2 |
| 16 | PPS | | | | | | | | | 1 |
| 17 | GND | | | 6 | | | | | | |
| 18 | COM1_RXD | | 3 | | | | | | | |
| 19 | SDA | | | 5 | | | | | | |
| 20 | COM1_TXD | | 2 | | | | | | | |
| 21 | SCL | | | 4 | | | | | | |
| 22 | GND | | 6 | | | | | | | |
| 23 | COM2_RXD | | | 3 | | | | | | |
| 24 | 3.3V | | 1 | | | | | | | |
| 25 | COM2_TXD | | | 2 | | | | | | |
| 26 | 3.3V | | | | | 1 | | | | |
| 27 | 3.3V | | | 1 | | | | | | |
| 28 | CANH1_TXD | | | | | 2 | | | | |
| 29 | N.C | | | | | | | | | |
| 30 | CANH1_RXD | | | | | 3 | | | | |
| 31 | OTG_5V | | | | 1 | | | | | |
| 32 | GND | | | | | 4 | | | | |
| 33 | USB_DM | | | | 2 | | | | | |
| 34 | 3.3V | | | | | | 1 | | | |
| 35 | USB_DP | | | | 3 | | | | | |
| 36 | CANH2_TXD | | | | | | 2 | | | |
| 37 | USB_ID | | | | 4 | | | | | |
| 38 | CANH2_RXD | | | | | | 3 | | | |
| 39 | GND | | | | 5 | | | | | |
| 40 | GND | | | | | | 4 | | | |

# APPENDIX F

## 9. BX316R Enclosure Technical Specifications

Table 25 BX316R Enclosure Performance

| GNSS Performance | | | |
|---|---|---|---|
| Position Accuracy | Single positioning | 1.5m RMS (Horizontal) | |
| | | 3.0m RMC (Vertical) | |
| Time to First Fix | Cold Start: <50s<br>Warm Start: <30s | | |
| Reacquisition | 0.5 s L1 (typical)<br>1.0 s L2 (typical) | | |
| Data Rate | Measurements | 20Hz | |
| | Position | 5Hz | |
| Time Accuracy | 20ns RMS | | |
| Velocity Accuracy | 0.03m/s RMS | | |
| Measurement Precision | GPS | L1 PSR | 6 cm |
| | | L1 ADR | 1.0mm |
| | | L2 PSR | 8 cm |
| | | L2 ADR | 1.2mm |
| | BDS | L1 PSR | 6 cm |
| | | L1 ADR | 1.0mm |
| | | L2 PSR | 8 cm |
| | | L2 ADR | 1.0mm |
| | GLONASS | L1 PSR | 8 cm |
| | | L1 ADR | 1.0mm |
| | | L2 PSR | 8 cm |
| | | L2 ADR | 1.0mm |
| **Physical Description** | | | |
| Size | 118 * 57 * 24.5 $mm^3$ | | |
| Weight | 150g | | |
| **Mechanical Drawing** | | | |




| ENVIRONMENTAL | |
|---|---|
| Operating Temperature | -40C to +85C |
| Storage Temperature | -55C to +95C |
| Humidity | MIL-STD-810G, Method 507.5 Procedure II (95%) |
| Random Vibration | MIL-STD 810G Method 514.6, Category 24 (7.7 g RMS) |
| Sinusoidal Vibration | IEC 60068-2-6 (5 g) |
| Bump | ISO 9022-31-06 (25 g) |
| Shock | Operating: MIL-STD-810G, Method 516.6, Procedure I (40 g)<br>Non-operating: MIL-STD-810G, Method 516.6, Procedure V (75 g) |
| **Power Requirement** | |
| Voltage | +5 – 12 VDC |
| Power Consumption | 3.2W (typical) |

# APPENDIX G

## 10. Typical Application

### 10.1. Uninstall the Cable from BX306 Enclosure

The 20-pin/40-pin cable is self-locking, the connection will be reliable after the cable is installed. The following gives how to uninstall the cable from the receiver with the 20-pin cable as an example.

After installed, the cable is like this:


Figure 25 Cable is Assembled

Insert the gap with a flathead screwdriver, then pull out the cable.


Figure 26 Uninstall the Cable

## 10.2. Connect BX306 to Pixhawk

A specific Pixhawk cable is used to connect the BX306 receiver to Pixhawk's GPS port.

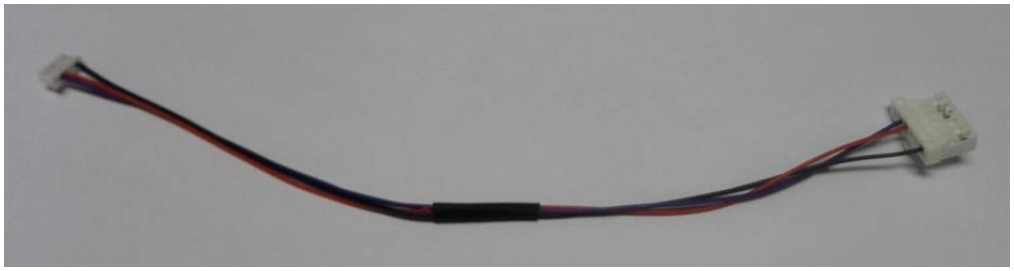


Figure 27 Cable between Pixhawk and BX306


Figure 28 Outline of BX306 Connected to Pixhawk

Table 26 Configure for Pixhawk

| |
|---|
| 1. Refer to Figure 28 to create hardware installation with Pixhawk. |
| 2. Power on the BX306 receiver. |
| 3. The configure for the BX306 receiver:<br><br>COM COM1 115200 //Configure the baud rate, must be the same as the GPS port.<br>NMEATALKER GP //All NMEA will have GP talker<br>LOG COM1 GPGGA ONTIME 0.2 //Output GPGGA at 5Hz<br>LOG COM1 GPVTG ONTIME 0.2 //Output GPVTG at 5Hz<br>LOG COM1 GPRMC ONTIME 0.2 //Output GPRMC at 5Hz<br>SAVECONFIG //Save the configure above |

Run Mission Planner software and create communication with the Pixhawk. The GPS data from the BX306 is recognized by Mission Planner if the GPS status becomes '3D Fix' (see Figure 29).


Figure 29 Pixhawk Get Position from BX306

To get the cm-level position, RTK corrections must be transmitted to the BX306 enclosure, which is connected to the Pixhawk. Two methods are used to transmit RTK corrections:

1) The BX306 on the UAV is connected to a radio, which is used to receive the RTK corrections from a base on ground, refer to section 11.3.

2) If a data link between the UAV and the on-ground laptop has been created, then a base BX306 can be installed on ground and COM1 of the BX306 is connected to the laptop.

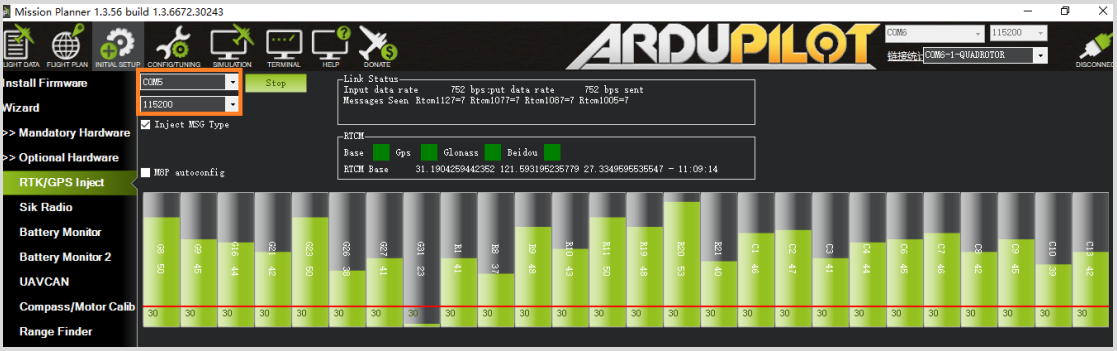
Table 27 Main Steps to Create RTK Base for Pixhawk

1. The configure for the base BX306 receiver:

FIX POSITION LATITUDE LONGITUDE HEIGHT //Fix the base's position
LOG COM1 RTCM1005 ONTIME 1 // Output the base's position
LOG COM1 RTCM1077 ONTIME 1 //Output GPS L1/L2 raw data
LOG COM1 RTCM1087 ONTIME 1 //Output GLONASS L1/L2 raw data
LOG COM1 RTCM1127 ONTIME 1 //Output BDS B1/B2 raw data

2. Communicate Mission Planner with the Pixhaw, open the Initial Setup -> Optional Hardware -> RTK GPS Inject screen

3. Select the serial port and baud rate, press Connect, the following figure will show the RTK corrections from the base BX306 are received.




4. After the rover BX306 is outputting RTK solution to the Pixhawk, the GPS status will change from '3D fix' to 'rtk Fixed'.

## 10.3. Connect BX306 to a Radio

An external radio can be used to receive RTK corrections, transmit RTK corrections or transmit GNSS PVT solutions. BX306 receiver can connect to any radio which has a LVTTL serial interface. Tersus is providing a transfer cable between LVTTL and RS-232 level, see Figure 30, contact support@tersus-gnss.com for more.

Figure 30 Transfer Cable

| | |
|---|---|
| ⚠ | Two radios must have the same channel and the same protocol before they can communicate each other. |

| | |
|---|---|
| ! | It's highly recommended that the radio at the base side and the one at the rover side are from one company. Compatibility and reliability problems may happen if two radios are from different companies, although they're compatible. |

Figure 31 shows a BX306 receiver connected to Tersus RS05R radio, see more about this radio in https://www.tersus-gnss.com/product/radio-rs05r.

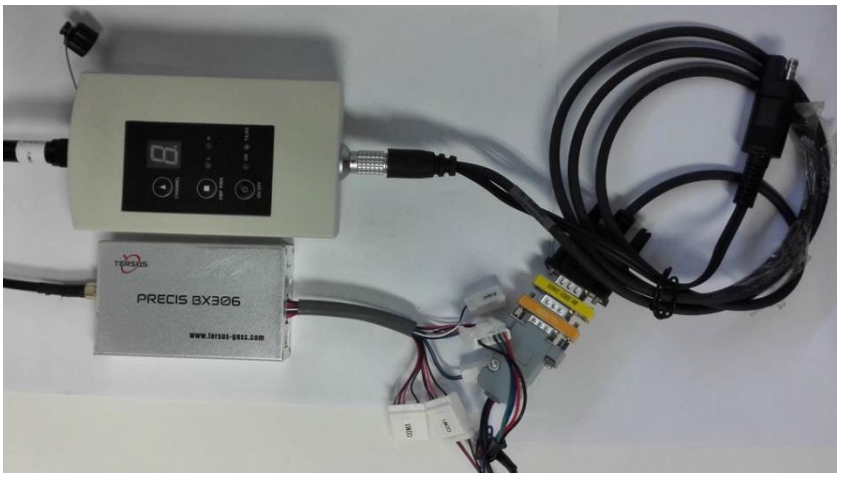



Figure 31 Outline of BX306 Connected to RS05R Radio

### 10.3.1 Radio to Receive RTK Corrections

1) Connect an antenna to the BX306.
2) Connect the COM1 of the BX306 to a laptop.
3) Connect the COM2 of the BX306 to the radio.

4) Power on the BX306.
5) Connect to an antenna to RS05R radio and power on it.
6) Run Tersus GNSS Center to communicate with the BX306 enclosure.

7) Ensure COM2 has the same baud rate as the radio's serial port.
8) Check the position type of the BX306 in Tersus GNSS Center.

### 10.3.2 Radio to Transmit RTK Corrections

Follow step 1) to 6) in section 0.

7) Input the following commands/loggings to the BX306 enclosure in Tersus GNSS Center:

```
FIX POSITION LATITUDE LONGITUDE HEIGHT //Fix the base
LOG COM2 RTCM1074 ONTIME 1        //Output GPS raw measurements
LOG COM2 RTCM1084 ONTIME 1        //Output GLONASS raw measurements
LOG COM2 RTCM1124 ONTIME 1        //Output BDS raw measurements
SAVECONFIG                         //Save the configure above
```

### 10.3.3 Radio to Transmit the PVT Solutions

Follow step 1) to 6) in section 0.

7) Input the loggings interested in Tersus GNSS Center, for example:

```
LOG COM2 GPGGA ONTIME 1          //Output GPGGA
LOG COM2 TIMEB ONTIME 1          //Output time
……
SAVECONFIG                       //Save the configure above
```

## 10.4. Save Data to an External Datalogger

Tersus is providing an external datalogger DL207, see Figure 32. DL207 can support up to 32GB SD card with FAT32 format. See https://www.tersus-gnss.com/product/external-data-logger-dl207 for more about it.

Figure 32 Datalogger DL207


Figure 33 Outline of BX306 Connected to DL207

1) Install a SD card to the DL207.
2) Connect an antenna to the BX306.
3) Connect COM2 of the BX306 to a laptop.

4) Power on the BX306.
5) Run Tersus GNSS Center to communicate with the COM2 of BX306.
6) Input all the data needed to save on the DL207, for example:

```
LOG COM1 RANGEB ONTIME 1              //Save raw measurements
LOG COM1 GPGGA ONTIEM 1               //Save GPGGA info
LOG COM1 GPSEPHEMB ONTIME 30          //Save the GPS ephemeris
    …..
SAVECONFIG                            //Save the configure above
```

7) Power off the BX306, connect the DL207 to the COM1 port of the BX306.
8) Power on the BX306, the data will be saved on the SD card.
9) Power off the BX306 after the data collection is finished.
10) Uninstall the SD card from the DL207, copy the file on the SD card to your laptop with a SD reader.

## 10.5. Connect BX306 to an External Bluetooth

Tersus is providing an external Blutooth BT120, as well as the cable for the BX306 receiver. For more details about the Bluetooth module, please go to https://www.tersus-gnss.com/product/bluetooth-bt120

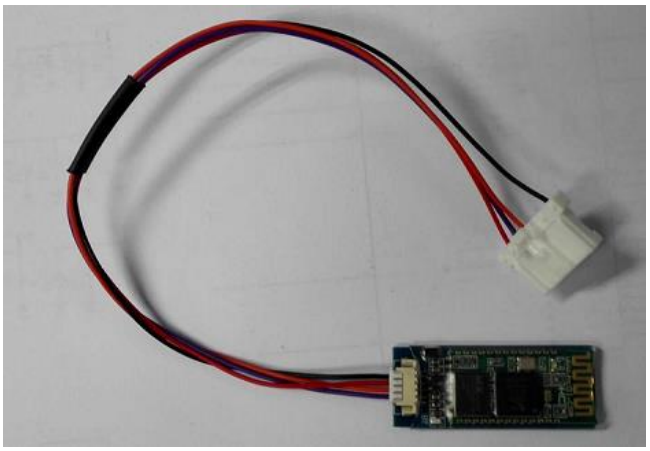


Figure 34 BT120 and the Cable


Figure 35 Outline of BX306 Connected to BT120

The function of Bluetooth module is to communicate the BX306 enclosure with other Bluetooth device.

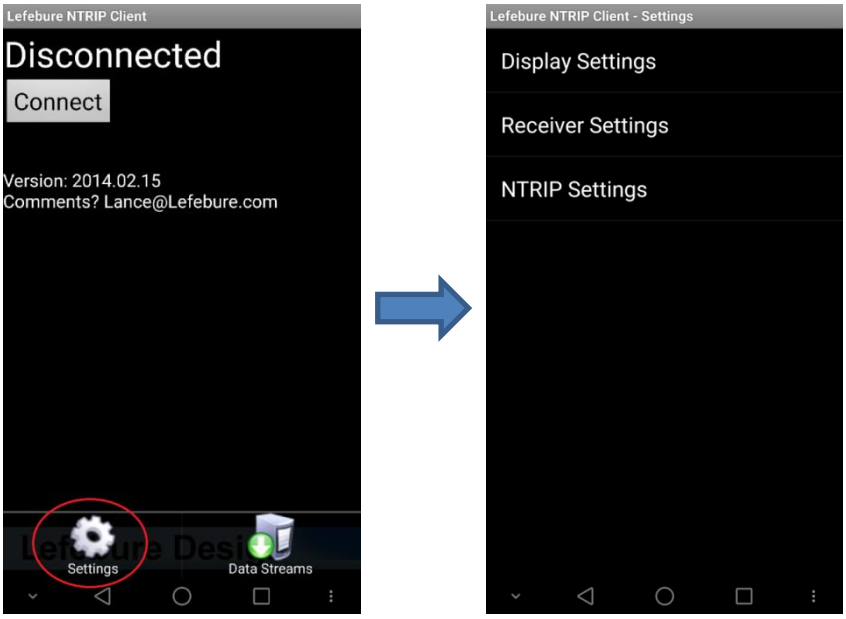
| | |
|---|---|
| ⚠ | BT120 can only be paired with an Android phone or tablet; it can't be paired with an iPhone. |

### 10.5.1 Communicate with NTRIP Client App.

1) Connect a BT120 to COM1 of the BX306 enclosure.
2) Connect COM2 of the BX306 to a laptop.
3) Connect an antenna to the BX306, and power on it.

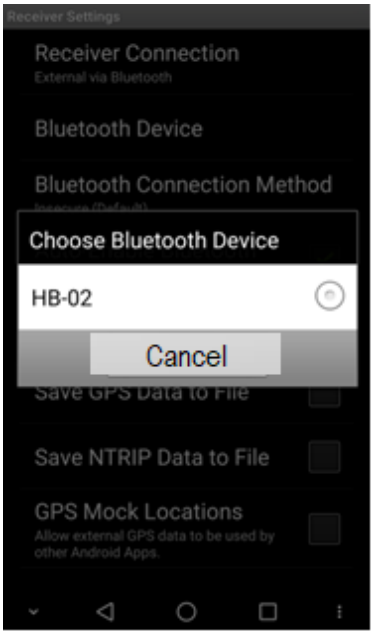
4) Pair your Smartphone with the BT120. The default ID of BT120 is HB-02, the pair password is 1234, after paired, HB-02 will be listed in the paired devices.

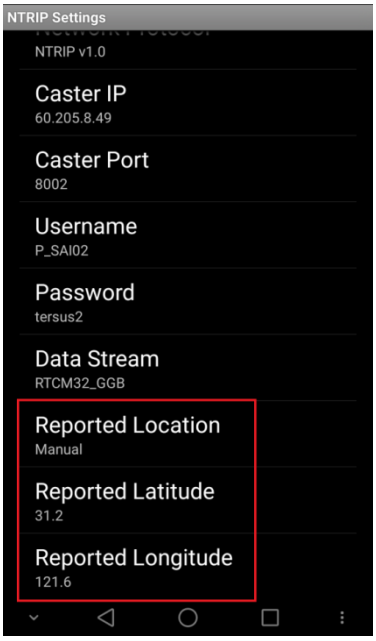
5) Run NTRIP Client App in the Smartphone, press the Settings button to go to the Settings page:



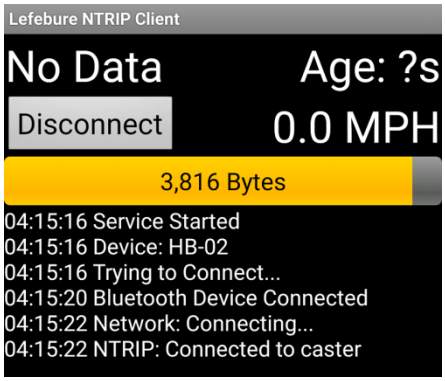

6) In the ‘Receiver Settings’, input the Bluetooth name which has been paired in step 3), all other options can keep the default.

7) In the ‘NTRIP Settings’, all the upper six fields (Network Protocol, Caster IP, Caster Port, Username, Password and Data Stream) are mandatory, please input them with the info you’ve gotten from the NTRIP service provider. If needed by the caster, input the draft location of the receiver in the three fields below.



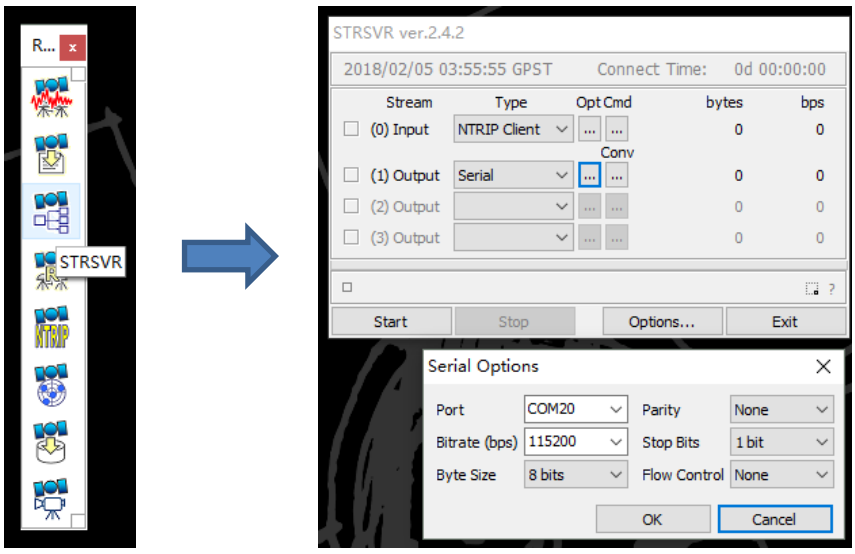

8) Go back to the first page of NTRIP and press ‘CONNECT’ button, if everything is OK, you will see the following page, which shows RTK corrections are being received and forwarded to the receiver via the Bluetooth.



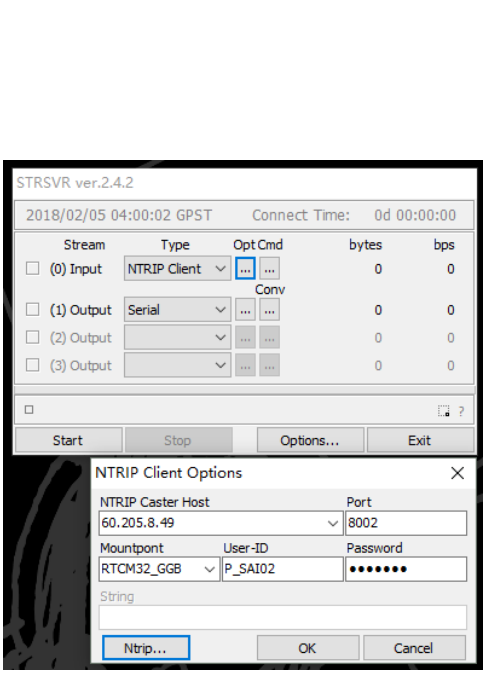

9) Check the position type of the BX306.

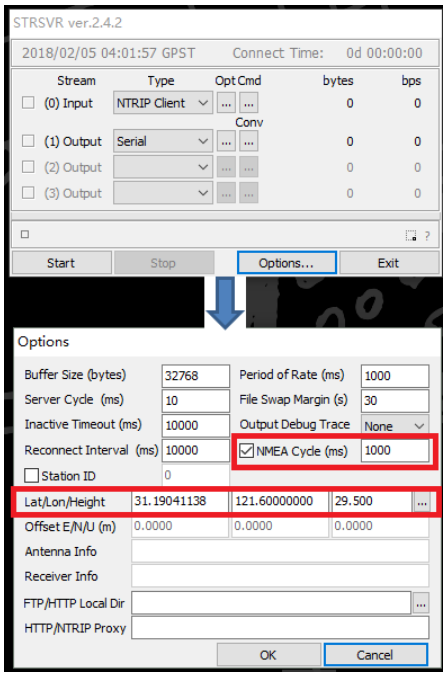
## 10.6 Communicate with STRSVR Tool

1) Power on the BX306 enclosure, connect COM1 and COM2 to the computer. COM1 is communicating with Tersus Center, COM2 is to receive RTK corrections from a NTRIP caster.
2) Run RTKLIB -> STRSVR, select serial for output type. And press the option button for serial port COM2 and configure it.

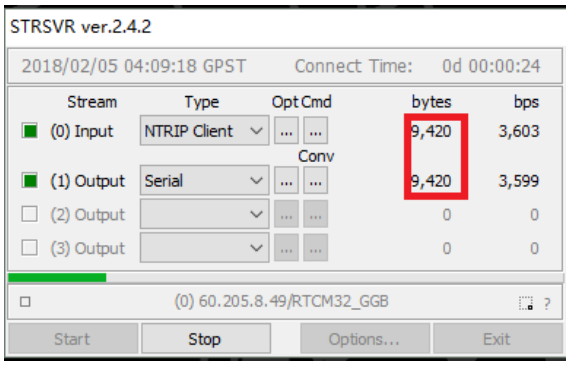



3) Select NTRIP client for input type, press the Opt button for NTRIP, fill all the five fields for NTRIP configure.
4) If needed, draft position of the receiver is input, see the following figure.




5) Go back to the main page, and press Start button. If everything is OK the following page will be shown. The input and output data will increase with time. And you can check the position type of the receiver in Tersus Center.




## 10.7 Data Collection on Internal eMMC Card

All the BX cards/enclosures are providing up to 4GB internal eMMC card, which brings convenience for data collection.

| | |
|---|---|
| ⚠ | Before data collection, please ensure enough space is available on the internal eMMC card, refer to Table 30 to delete files on the internal eMMC card if needed. |

| | |
|---|---|
| ! | The size of the logging:<br><br>LOG FILE RANGEB ONTIME 1 (about 110KByte/min if 20 satellites are tracked, about 165KByte/min if 30 satellites are tracked)<br><br>If the collection frequency is increased, the data size will be increased proportionately. |

| | |
|---|---|
| ! | Rules for the file name & update time in the external SD card:<br><br>1) Name: file name is the 00..00xx..xx.dat, totally 8 digits, in which xxxx is the working time (seconds/100) of the receiver. For example, the receiver has worked 500 hours 40min, (500*3600 + 40*60)/100 = 18024, the file name will be 00018024.dat.<br>2) Update time: if the receiver hasn't gotten the GNSS time, the update time of the files will be19800000 0:0 (YYYYMMDD HH:MM). If the receiver has gotten the GNSS time, the update time will be the UTC time. |

Two modes can be selected for data collection: manually (default) and automatically.

If you want to save the loggings manually after the board is power on, please follow the steps in Table 28 to configure the BX306 enclosure:

Table 28 Dave Data on eMMC Card Manually

| |
|---|
| 1. STORETYPE EMMC //the data will be saved on the internal EMMC card |
| 2. Input all the loggings to be saved, for example:<br>LOG FILE GPGGA ONTIME 1 //save GPGGA loggings<br>LOG FILE PASSUSBB ONNEW //save the data from the USB port<br>LOG FILE RANGEB ONTIME 1 //save raw measurements |
| 3. SAVECONFIG //save the configure above |
| 4. LOGFILE OPEN //open the file to start data collection |
| 5. LOGFILE CLOSE //close the file to stop data collection |

If you want to save the loggings automatically after the board is power on, please follow the steps in Table 29:

Table 29 Save Data on eMMC Card Automatically

| |
|---|
| 1. STORETYPE EMMC //(the data will be saved on the internal eMMC card |
| 2. Input all the loggings to be saved, for example:<br>LOG FILE GPGGA ONTIME 1 //save GPGGA info<br>LOG FILE PASSCOM1B ONNEW //save the data from the COM1<br>LOG FILE RANGEB ONTIME 1 //save raw measurements |
| 3. LOGFILE AUTO //configure auto data collection |
| 4. SAVECONFIG //save the configure above |
| 5. Power cycle the board and data collection start. |
| 6. LOGFILE CLOSE //close the file after data collection is finished |

The last step is recommended although it’s not mandatory. If power is off during the file collection, the data collected in the last second may not be saved.

| | |
|---|---|
| ⚠ | The data collection will not be executed without a power cycle. |

## 10.8 Download Files from Internal eMMC Card

The files saved on the internal eMMC card can be copied to the computer via a serial port.

If files are downloaded from a BX316 or a BX316R enclosure, the USB port is recommended. A specific USB cable is used to connect the USB port to the computer, refer to Figure 38 and Figure 24.

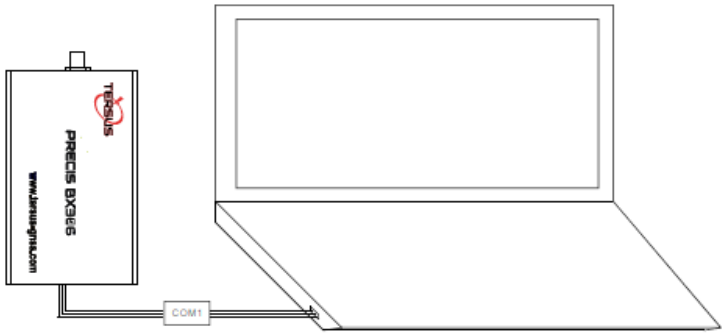



Figure 36 Download Files from eMMC Card with a Serial Port

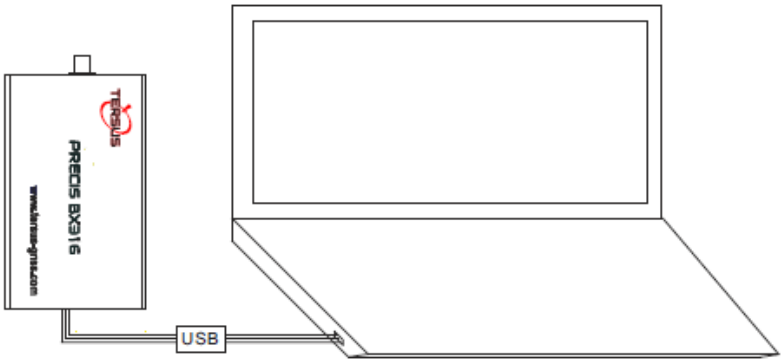



Figure 37 Download Files from eMMC Card with an USB Port

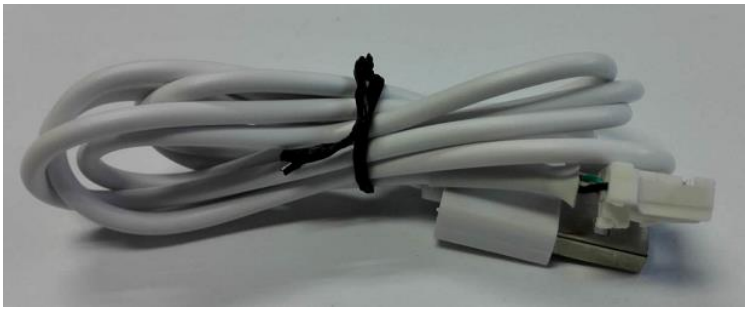


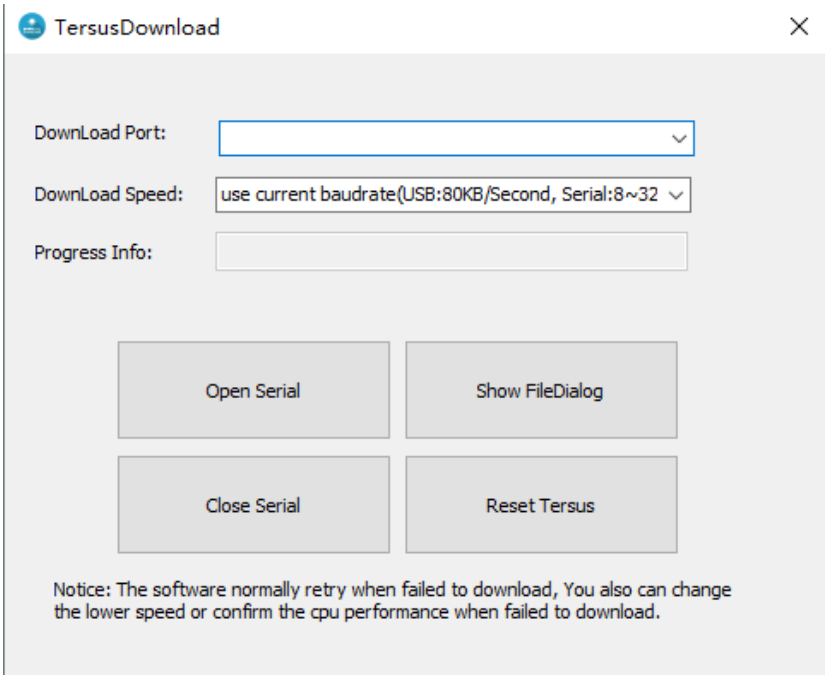
Figure 38 USB Cable

After the USB adapter or the USB cable is installed into the computer, it will be mapped to a serial port, refer to 2.2 USB Adapter.

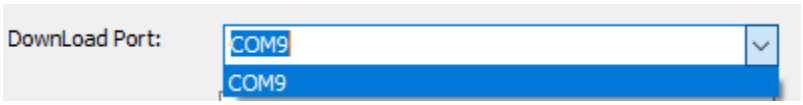
Table 30 Detailed Steps to Download Files from eMMC Card

1. Refer to Figure 36 and Figure 37 to create connection between a BX306/BX316 receiver and a computer.

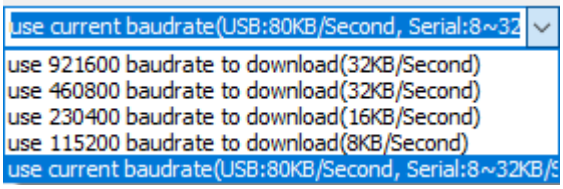
2. Run the TersusDownload, the following page will be shown:



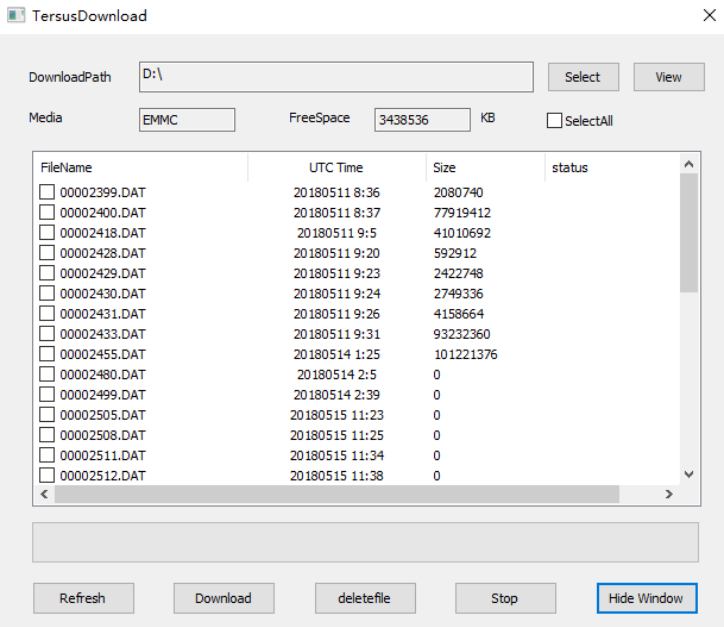

3. Choose the serial port to communicate with the receiver.



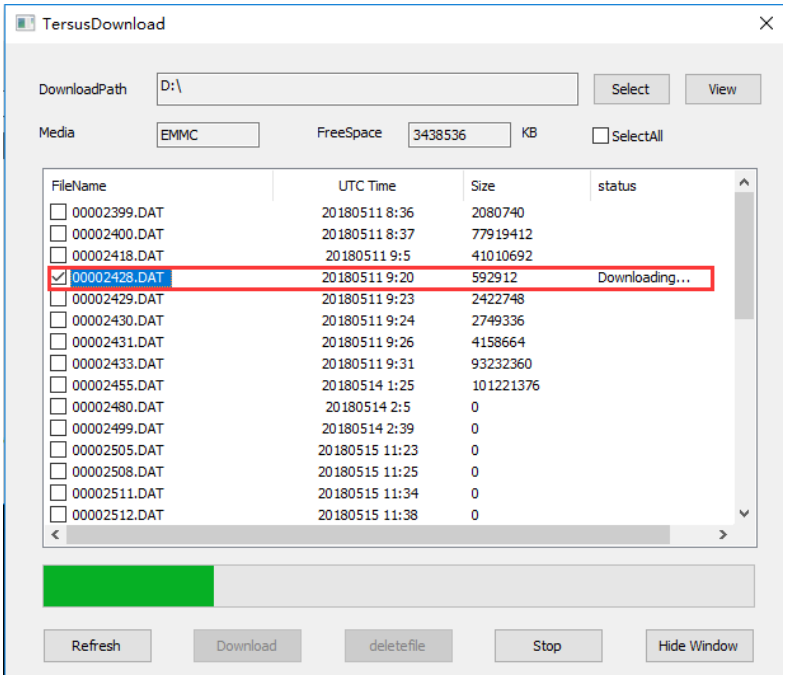

4. In the Download Speed menu, if the serial port is used, select the download speed. If the USB is used, choose the USB port.




5. Press the Open Serial button, all the files on the eMMC card will be read and shown




6. Input the DownloadPath and select the files to be downloaded, press Download button to start downloading.




7. After the downloading is finished, check the files in the directory.

# 11 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 | 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 |
| 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 |