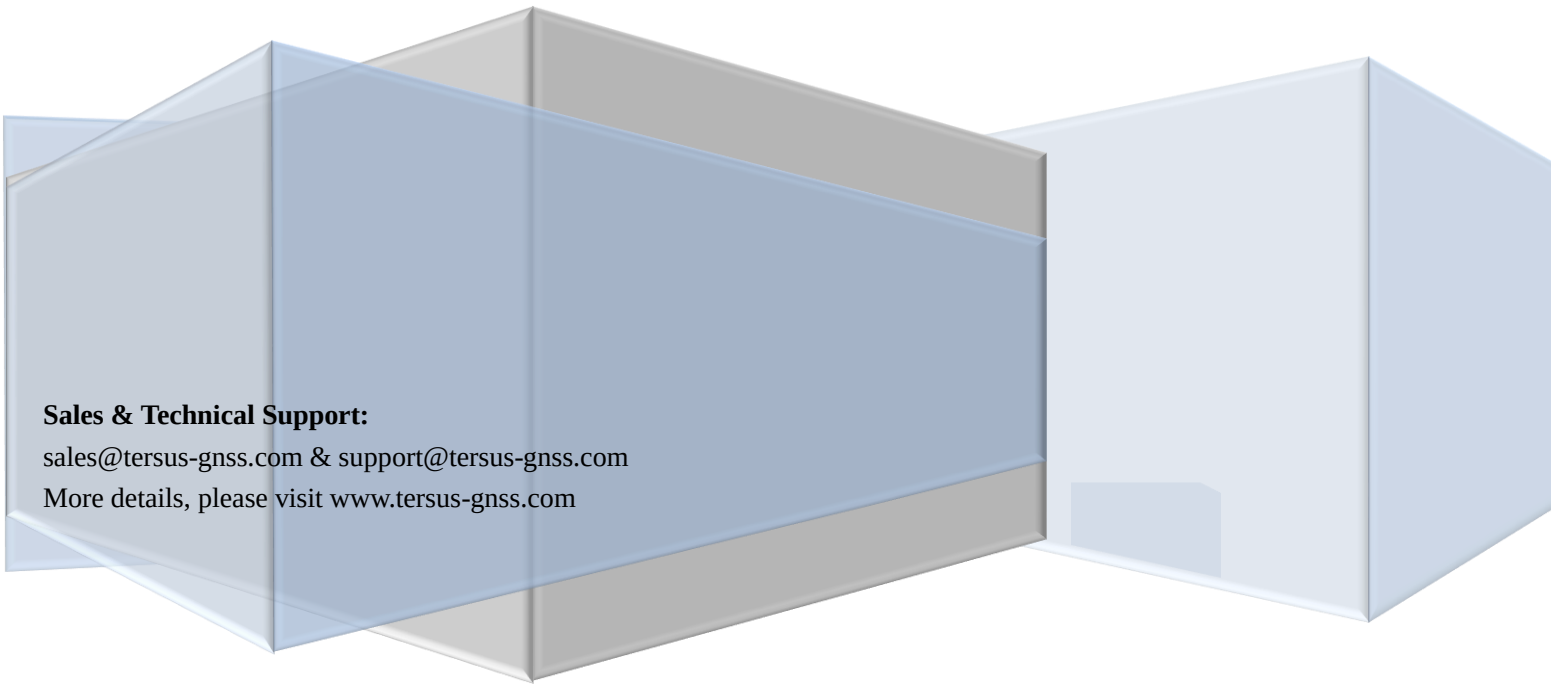
User Manual

Version V1.0-20171106

User Manual
For BX316/BX316R/BX316D Receivers



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Proprietary Notice

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1. Introduction

Precis-BX316 and Precis-BX316R share the same hardware, the only difference between them is that BX316R doesn't support real time RTK solution output, which is controlled by license.

Precis-BX316D is an OEM version board, which can support dual antenna too. Its size and interface are different from those of BX316 or BX316R. The user must install it on an interface board before it's in operation.

All contents in this manual are valid for the three kinds of receivers unless there is a specific note. So if only BX316 is mentioned, please note it's valid for BX316R and BX316D, too.

1.1 Overview of BX316 receiver

All the three receivers are supporting dual antennas. BX316/BX316D can output the heading angle between the primary antenna and the secondary one. After receiving RTK corrections from a base, BX316/BX316D board can output real time RTK solution of the primary antenna. BX316R can only support single positioning. All the receivers can provide GNSS (Global Navigation Satellites System) raw measurements from the two antennas.

Figure 1 Outlook of BX316/BX316R receiver

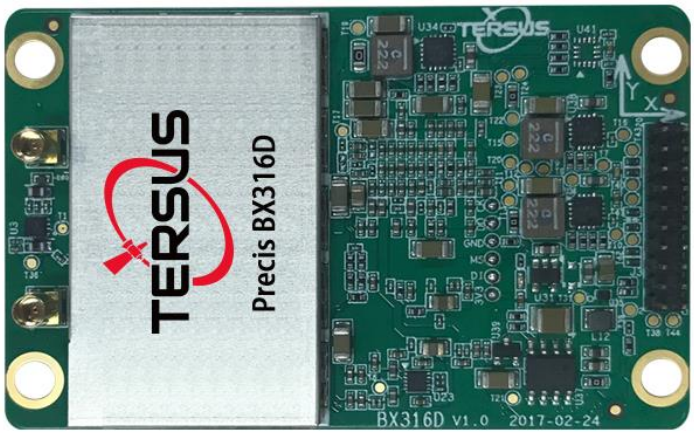


Figure 2 Outlook of BX316D

1.2 Features of the receivers

- Support GPS L1/L2, GLONASS L1/L2, and BDS B1/B2 from primary antenna;
- Support GPS L1+GLONASS G2 or GPS L1+BDS B2 from secondary antenna;
- BX316/BX316D supports heading and RTK positioning; BX316R supports single positioning;
- BX316/BX316D support RTK corrections receiving/transmitting, BX316R support RTK corrections transmitting.
- Support RTCM 2.x/3.x/CMR/CMR+ correction formats.
- Support up to 20Hz raw measurements output.
- Support 2 COMs (LVTTL level).
- BX316/BX316R support an USB and an Ethernet port[1];
- Support event mark input and PPS (Pulse Per Second accuracy timing) output;
- BX316/BX316R are powered by 5~12V for board;
- Onboard 6DOF IMU, support integrated navigation system (INS).

Note 1: The Ethernet port is related to BX316/BX316R's firmware version.

1.3 System Overview

The receiver diagram is presented as following:

S-Ant

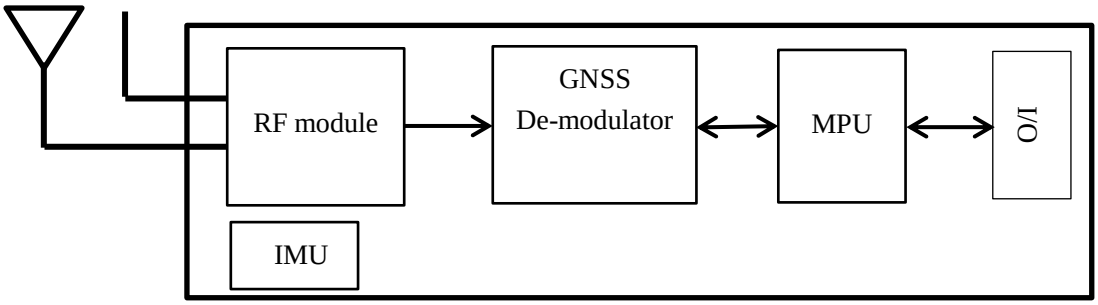


Figure 3 The receiver block diagram

RF module: Receives GNSS signals from the primary and the secondary antennas, 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/from peripheral ports.
IMU: An on-board 6 axis IMU can provide motion tracking information under obstacles environment where GNSS signal is lost.
I/O interfaces: Includes two serial ports, a USB, an Ethernet port, event mark and power supply etc.

1.4 Connectors and Indicator Locations for BX316 and BX316R

- Two SMA connectors, which are used for RF signals input from the antennas and power output to the LNA in the active antennas. P-Ant is for the primary antenna; S-Ant is for the secondary antenna. If only one antenna is installed, connect it to P-Ant and S-Ant is left float.
- Four LEDs to show the status of the receiver. See Table 1 LED definition for the definition.
- Universal comm-port[1], a specific 40-pin connector is used to communication between the receiver and a computer or a controller. Two serial ports, a USB, two CAN ports, an event input, a PPS output and an Ethernet are included in this connector. See Figure 9 for more detail.
- Power connector for power input, see Figure 8 for detail about the power cable.
- Data log button[1], press to log the data to the SD card.
- SD card slot, max 32G Micro SD card is supported.
- Reset button[1]. Reset the receiver if this button is pressed. The function is the same as input 'RESET' command to the receiver, see Log and Command reference manual for more about this command.

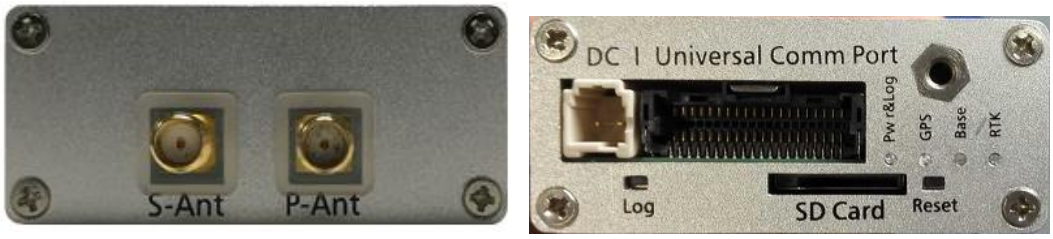


Figure 4 Connectors

Note 1 These buttons are related to FW version, please contact Tersus support before you use them.

Table 1 LED definition

LED	Description
Pwr & Log	Will be solid ON after the receiver is power on, and blink during data collection to the SD card.
GPS	Will blink at the same frequency as the log output.
Base	Will be solid ON after RTK corrections are received.
RTK	Will blink when position type is float; will be solid ON when fixed solution is got, and will be OFF in other position types.

2. The Receiver installation

The RF signals from GNSS antenna are necessary for BX316/BX316R/BX316D to work. BX316/BX316R have two SMA connectors for the antenna signals. If only one antenna is installed, connect it to P-Ant and leave S-Ant float.

COM1/2 ports are used for configure commands input and corrections/solution output. The level of COM1/2 is LVTTL, if RS-232 is required, a level transfer cable is provided, see section 3.3.2.

Default parameters of COM1/2 are given in Table 2, which can be changed with COM command; refer to Log & Command Reference document for detail about this command.

Table 2 Default Serial port parameter of Precis-BX316 COM1 and COM2

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

2.1 Antenna installation

Precis-BX316 provides two SMA male connectors for connecting to GNSS antennas. Both active and passive GNSS antennas are supported. For active antenna, BX316 board can provide 5V, up to 100mA current to the LNA in the antenna. Two recommended antennas are shown in Figure 5 Recommended GNSS Antennas for Precis-BX316. For more about the antennas, visit our accessories website at https://www.tersus-gnss.com/collections/gnss-accessories.

Figure 5 Recommended GNSS Antennas for Precis-BX316

The installation location for an antenna is supposed to have good view of sky and far away from any high-power transmitter.

The two serial ports and the USB port on a Precis-BX316 can be used to communicate with it. The USB port is mapping to a serial port in the computer. Any serial tools on a computer can be used to communicate with the receiver, it's recommended to communicate it with graphical tool Tersus GNSS Center, the link is here.

2.2 SD card operation

BX316 is supporting on-board Micro-SD card, which make it easy for customer to save data for post processing. BX316D doesn't support SD card.

Before the SD card is plugged, please ensure:

- The max. size of the SD card is 32GB.
- The SD card is formatted, and the file system is FAT32 or NTFS

The SD card can be inserted to the slot when the receiver is power on. Place the SD card into the slot, and plug it gently toward the bottom of the slot until you feel a click. After the data collection is finished, press the card gently toward the bottom of the slot until it's unplugged.

Note: Please ensure the data collection is finished before the SD card is unplugged, otherwise, the files on the SD card may be corrupted, or even the SD card can be damaged.

Data collection:
Data collection is divided into manual and auto.

- If you want to save the loggings automatically after the board is power on, please follow:

1) Input all the loggings to be saved, for example, input ‘log file gpgga ontime 1’, ‘log file rangeb ontime 1’
2) Input ‘logfile auto’
3) Input ‘saveconfig’
4) Power cycle the board and file saving will start.
5) Input ‘logfile close’ when file saving is completed.

The last step above is recommended although it’s not mandatory. If power is off during the file saving, up to 4K data will be lost.

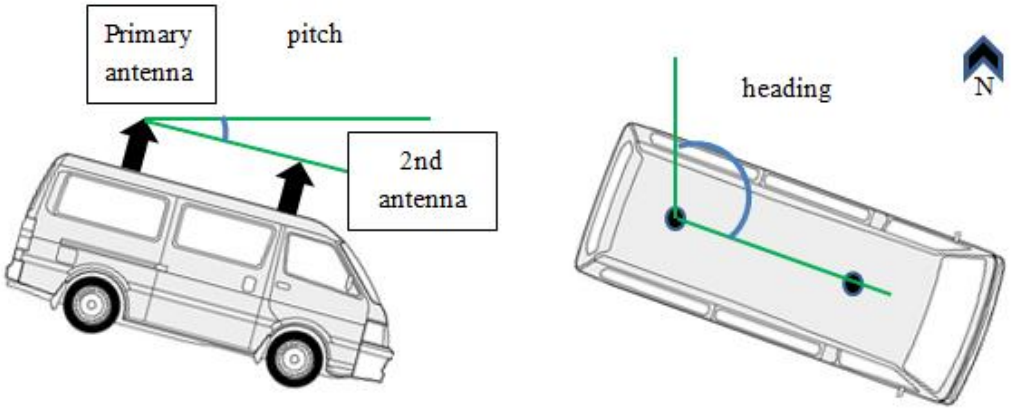
- If you want to save the loggings manually after the board is power on, please follow:

1) Input all the loggings to be saved, for example, input ‘log file gpgga ontime 1’, ‘log file rangeb ontime 1’
2) Input ‘saveconfig’
3) Input ‘logfile open’ when you want to start file saving.
4) Input ‘logfile close’ when file saving is completed.

If no file name is input, a name related to the board operating time will be given.

2.3 Heading output

The BX316 can output real time heading angle between the true north and the vector from the primary to the secondary antenna. If the two antennas are installed parallel to the velocity direction, then pitch and heading angles will be output.



To output the heading, BX316 must be configured to dual antenna mode, the command is:

ANTENNAMODE DUALGPSBDS or
ANTENNAMODE DUALGPSGLO

After that, save the configure, then power cycle your receiver or input command reset.

Then you can output pitch and heading angles with:
LOG HEADING ONTIME 1

2.4 Reset button[1]

The BX316 can be reset by press the reset button on the right panel, this action works as input 'RESET' command to the receiver, refer to Tersus Log&Command Reference document for more about this command.

Note 1: This feature is not finalized; please contact Tersus support for the latest information about the operation.

3. Specifications

The detailed performance and physical specification of Precis-BX316 is introduced in this chapter.

3.1 Performance Specification

The performance of BX316 board is listed in Table 3.

Table 3 Performance specification of Precis-BX316

Feature	Specification
Channel Number	192
Supported Signals by P-Ant	GPS L1/L2/+GLONASS G1/G2+BDS B1/B2
Supported Signals by S-Ant	GPS L1+GLONASS G2 or GPS L1+BDS B2
Standard Positioning Accuracy	
Horizontal (RMS)	1.5m
Vertical (RMS)	3.0m
Post-Process Accuracy	
Horizontal (RMS)	10mm + 1ppm
Vertical (RMS)	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
Max. Update Rate	20Hz

3.2 Electronic Characteristics

3.2.1. Absolute Maximum Ratings

Table 4 Description of Absolute Maximum Ratings for BX316 board

Parameter	Symbol	Condition	Min	Max	Unit
Power Supply Voltage	Vin	BX316/316R	5	12	V
		BX316D		3.6	V
Input pin applied DC Voltage	RXD_UART			3.6	V
	Vin			3.6	V
DC current through any digital input pin	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.

3.2.2. Operation Ratings

Table 5 Description of Operation Ratings for BX316 board

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Power Supply Voltage	VCC	BX316/316R	5		12	V
		BX316D	3.2		3.465	V
Typical power	P	BX316/316R			3.5	W
		BX316D			3.2	W
Digital IO Pin Low level input voltage	RXD_UART		0	0	0.66	V
Digital IO Pin High			2.3	3.3		V

level input voltage	TXD_UAR				
Digital EVENT input	T			0.8	V
voltage	V_{IL}	2.0			V
Digital PPS output	V_{IH}			0.55	V
voltage	V_{OL}	2.3			V
	V_{OH}				
Output Power voltage	Vout	3.135	3.3	3.465	V
Output Power current	Iout			200	mA
Antenna bias current	I_ANT			100	mA
RF Input Level	Prf	-122		-85	dBm
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.

3.3 Physical Specification

3.3.1 Physical Specification for BX316/BX316R receiver

Table 6 Physical Specification of Precis-BX316/BX316R receiver

Feature	Specification
Power	5~12VDC
Power Consumption	3.5W (Typical)
Active Antenna Input Impedance	50Ω
Max. Antenna Bias Current Draw	100mA
GNSS input sensitivity	-85 dBm ~ -122 dBm
Size	120×57×24 mm^3
Weight	200g[1]
Temperature	-40℃～+85℃
Humidity	95% non-condensing
Vibration	TBD
Shock	TBD

Note: 1 Total weight of the receiver, the power cable and the universal comm cable.

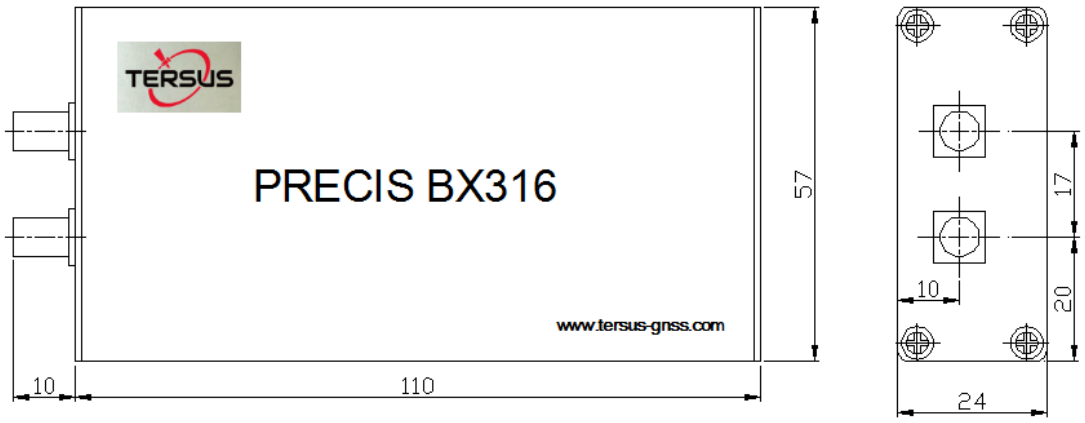


Figure 6 BX316 receiver dimension

3.3.2 Physical Specification for BX316D board

Table 7 Physical Specification of Precis-BX316D board

Feature	Specification
Power	3.3V DC +5% ~ -5%
Ripple	100mV p-p (Max)
Power Consumption	3.2W (Typical)
Active Antenna Input Impedance	50Ω
Max. Antenna Bias Current Draw	100mA
GNSS input sensitivity	-85 dBm ~ -122 dBm
Size	71×41×11mm
Weight	27g
Temperature	-40℃～+85℃
Humidity	95% non-condensing
Vibration	TBD
Shock	TBD

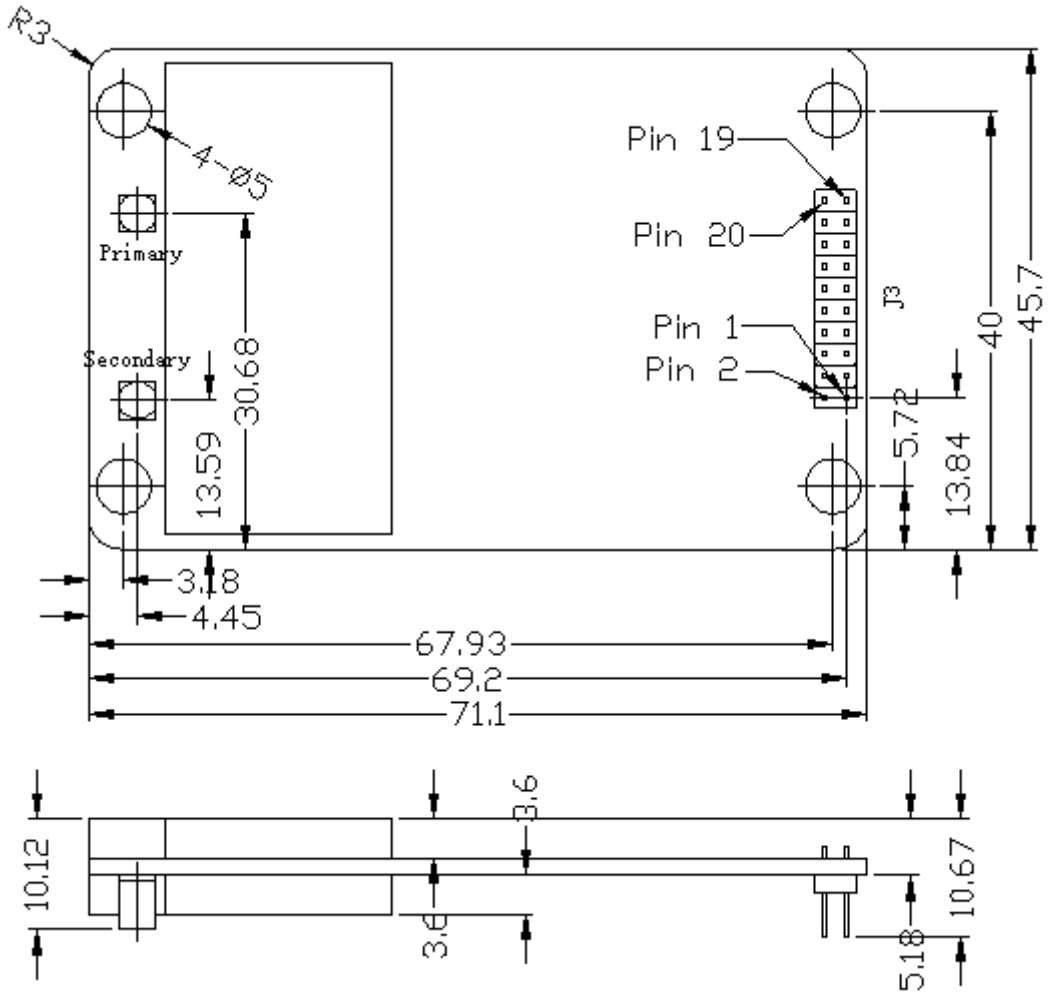


Figure 7 BX306 board dimension

Note:

1. Dimensions are in millimetres.
2. Primary and secondary antenna: MMCX jack receptacle, straight
   (Johnson P/N 135-3711-201 or Molex P/N 73415-2063 or equivalent)
3. J3: 2x10 header, 2 mm pitch
   (Samtec P/N TMM-110-03-G-D or equivalent)

Table 8 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	3.3 V ±5%
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	O	Variable frequency output	
7	EVENT2	I	Event 2 Input	
8	NC			
9	EVENT1	I	Event1 input	Has a 10K pull-up resistor on board.
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	Active high output
18	GND	PWR	Signal and power ground	
19	PPS	O	Pulse per second	This pin has an internal 50 ohm line

			output,	driver. Route as a 50 Ω single-ended trace
20	NC			

3.3.3 Cables for BX316/BX316R receiver

Power cable

Tersus provides a power cable as the accessory of the BX316 receiver. The other end is an USB male type-A connector, which can be inserted into the USB port in a computer.

Figure 8 Power cable

Universal comm cable

A specific cable assembly is used to connect to the universal comm port. The 40-pin connector at one end of the cable is Mouser's DF50S-40DS-1V or equivalent, the connectors at the other end includes:

Mouser's 798-DF1EA-8EP-2.5C 1pcs
Mouser's 798-DF1EA-6EP-2.5C 2pcs
Mouser's 798-DF1EA-5EP-2.5C 1pcw
Mouser's 798-DF1EA-4EP-2.5C 2pcs
Mouser's 798-DF1EA-2EP-2.5C 3pcs

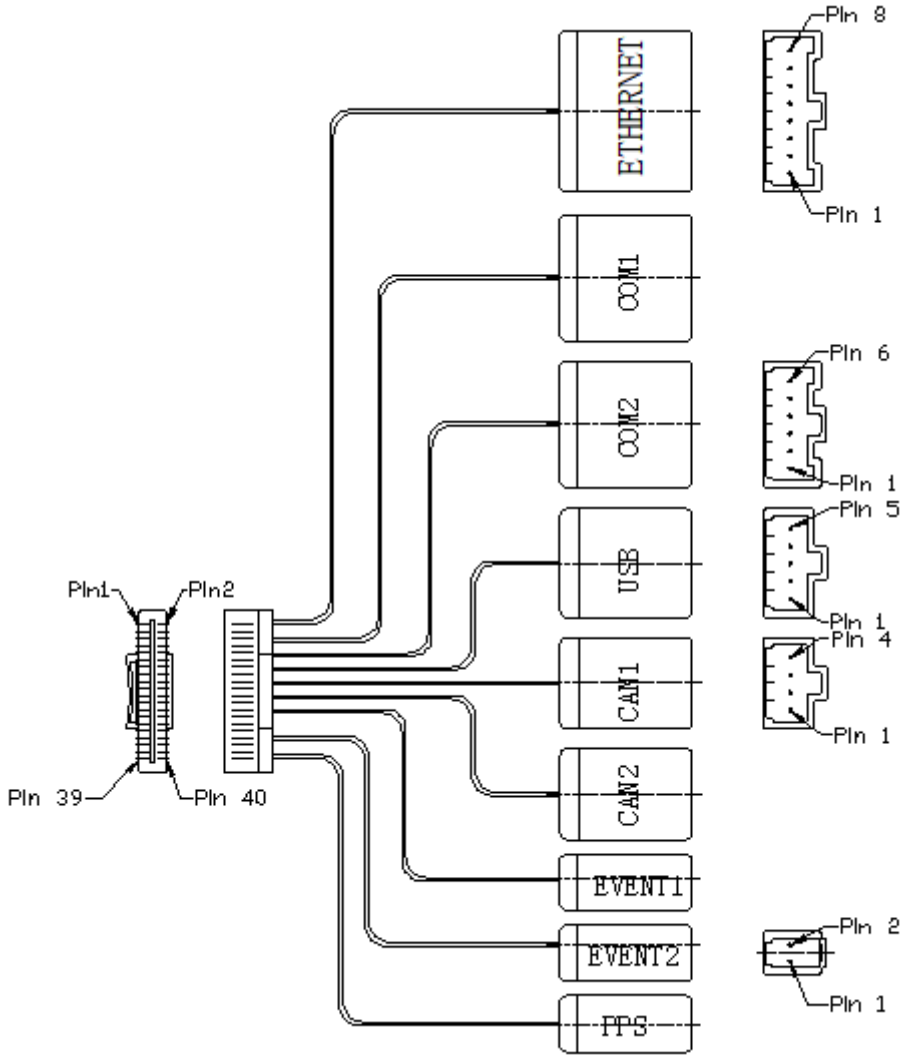


Figure 9 Universal comm cable

40Pin Connector	Signal Name	Ethernet	COM1	COM2	USB	CAN1	CAN2	Event1	Event2	PPS
1	-									
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	-									
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	-									
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			

Serial level transer cable[1]

This cable is used to transfer the serial level from LVTTL to RS-232.

Figure 10 Serial level transfer cable

USB cable[1]

This cable is used to connect the USB port in the 40-pin cable to a computer's USB type-A port. The USB cable will be mapped to a serial port after inserted. When the USB port is used, the band rate in the mapping serial port does not work and can be neglected.

Figure 11 USB cable

Note: 1 Only the power cable and the universal comm cable are in the standard delivery package, please contact Tersus sales if you need the serial level transfer cable or/and the USB cable.

3.3.4 Cable uninstallation

The 40-pin universal cable is self-locking, and the connection will be reliable after the cable is installed. The following gives how to uninstall the cable from the receiver.

After installed, the cable is like this:

Figure 12 Installation successfully

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

Figure 13 Uninstallation of the cable

4. Configure Example

● RTK Configure for BX316/BX316D

Base mode: (RTK corrections are transmitted to COM2)

FIX POSITION *latitude longitude mean-sea-level_ height*; (input the base's position)
INTERFACEMODE COM2 AUTO AUTO ON (optional)
COM COM2 *band_rate* (optional)
LOG COM2 RTCM1074 ONTIME 1
LOG COM2 RTCM1084 ONTIME 1
LOG COM2 RTCM1124 ONTIME 1
LOG COM2 RTCM1005 ONTIME 10
SAVECONFIG

Rover mode: (RTK corrections are received from COM2)

INTERFACEMODE COM2 AUTO AUTO ON (optional)
COM COM2 *band_rate* (optional)
LOG HEADINGA ONTIME 1
LOG GPGGA ONTIME 1
SAVECONFIG

● Data collection to SD card for Post-processing

For both the base and the rover modes:

LOG FILE GPGGA ONTIME 1
LOG FILE RANGEB ONTIME 1
LOG FILE GPSEPHEMB ONTIME 30
LOG FILE BDSEPHEMERISB ONTIME 30
LOG FILE GLOEPHEMERISB ONTIME 30
SAVECONFIG
LOGFILE OPEN ; To start raw measurements collection
LOGFILE CLOSE ; To stop raw measurements collection

5. Trouble Shooting

5.1 Why my configuration lost after the board is power off?

You need execute 'saveconfig' 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.

5.2 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.

6. 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