AsteRx SBi3

User Manual

User Manual Revision 1.0
Applicable to version 1.3.0 of the AsteRx SBi3 firmware

May 06, 2021
Thank you for choosing the AsteRx SBi3! This user manual provides detailed instructions on how to use AsteRx SBi3 and we recommend that you read it carefully before you start using the device.

Please note that this manual provides descriptions of all functionalities of the AsteRx SBi3 product family however, the particular AsteRx SBi3 you purchased may not support functions specific to certain variants.

While we try to keep the manual as complete and up-to-date as possible, it may be that future features, functionality or other product specifications change without prior notice or obligation. The information contained in this manual is subject to change without notice. We recommend you to look for new or updated information in our Knowledge Base at https://customersupport.septentrio.com/s/topiccatalog

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1 Introduction

1.1 User Notices

1.1.1 CE Notice

AsteRx SBi3 receivers carry the CE mark and are as such compliant with the 2014/53/EU âĂŞ Radio Equipment Directive (RED), 2011/65/EU âĂŞ Restriction of Hazardous Substances (RoHS) Directive and 93/68/EC - CE-marking Directive.

With regards to EMC, the AsteRx SBi3 receiver is declared as class A, suitable for residential or business environment. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

1.1.2 ROHS/WEEE Notice

The AsteRx SBi3 is compliant with the latest WEEE, RoHS and REACH directives. For more information see www.septentrio.com/en/environmental-compliance.

1.1.3 Safety information

Statement 1: The power supply provided by Septentrio (if any) should not be replaced by another. If the receiver is used with a different power supply than provided by Septentrio, it must have a double isolated construction and must match the specifications of the provided power supply. In addition, the power supplies needs to comply with safety standard IEC 62368-1 and SELV.

Statement 2: Ultimate disposal of this product should be handled according to all national laws and regulations.

Statement 3: The equipment and all the accessories included with this product may only be used according to the specifications in the delivered release note, manual or other documents delivered with the receiver.

1.1.4 Support

For first-line support please contact your AsteRx SBi3 dealer.

Additional documentation can be found in the following manuals:

- **The AsteRx SBi3 Reference Guide** (contained inside the Firmware Package zip on our website) includes information on the receiver operation, the full list of receiver commands and a description of the format and contents of all SBF (Septentrio Binary Format) blocks.
- **The RxTools Manual** covers the RxTools software suite, including RxControl and RxLogger.

The Septentrio website has a dedicated Support section (http://www.septentrio.com/support), where the User Manual, the Firmware Reference Guide and the latest officially supported Firmware version are readily available for download.

In case the AsteRx SBi3 does not behave as expected and you need to contact Septentrio's Technical Support department, you should attach a short SBF log file containing the support blocks and a Diagnostic Report of the receiver.

http://www.septentrio.com

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2 AsteRx SBi3 Overview

The AsteRx SBi3 is a housed INS solution which fuses multi-frequency and multi-constellation GNSS with an industrial-grade IMU (Inertial Measurement Unit), delivering precise positioning, 3D orientation and coasting functionality. IP68 compliant, this housed high performance GNSS/INS system is ideal for rapid integration into machine control or safety applications.

The AsteRx SBi3 can be used as a dual antenna GNSS/INS receiver for systems with any kind of motion pattern. It can also be used as a single antenna receiver for systems with no slip motion.

Use of the AsteRx SBi3 as a single antenna INS solution should be limited to use cases where the heading of the vehicle matches the direction of motion.

2.1 Physical and Environmental Specifications

Size:	102 x 36 x 118 mm (4.0 x 1.4 x 4.6 in)
Weight:	490 g (17.3 oz)
Operating temperature:	-30 °C to +65 °C (-22 °F to +149 °F)
Storage temperature:	-40 °C to +75 °C (-40 °F to +167 °F)
Ingress Protection:	IP68
Humidity	MIL-STD-810G, Method 507.5, Procedure I
Dust	MIL-STD-810G, Method 510.5, Procedure I
Shock	MIL-STD-810G, Method 516.6, Procedure I/II
Vibration	MIL-STD-810G, Method 514.6, Procedure I

2.2 Power Consumption

Input voltage:	5 to 36V DC
Power consumption:	1.3 W typical (GPS/GLONAS L1/L2) 1.5 W typical (all signals, all constellations)

The power consumption of the AsteRx SBi3 depends on its configuration. The following settings directly influence the amount of power consumed:

- The number of enabled GNSS frequency bands. For example, a receiver configured to track signals only in the L1 and L2 bands will consume less than a receiver configured to track in the L1, L2 and L5 bands. Use the **setSignalTracking** command to enable/disable signals. Note that a given frequency band is disabled only when all GNSS signals in that band are disabled.
- The activation of the Ethernet interface. In power-critical applications, it is recommended to not use Ethernet and to turn off the associated hardware. This can be done with the **setEthernetMode** command.
- The activation of the Wideband Interference mitigation (WBI) with the **setWBIMitigation** command.

The following table shows the nominal power consumption measured when 12 VDC is supplied to the PWR connector:

Configuration	Typical Power Consumption
GPS + GLONASS L1 + L2, RTK, Single antenna (externally powered), 10Hz internal logging active	1.3 W
GPS + GLONASS L1 + L2, RTK, Dual antenna (externally powered), 10Hz internal logging active	1.65 W
Ethernet on	+0.3 W
Antenna powered	Antenna type dependent

2.3 Powering the receiver

The receiver can be powered through either:

- The PWR connector (5 to 36 VDC)
- The Ethernet connector (Power over Ethernet - PoE, 37-57 VDC). (Please note that only mode A, as specified in the 802.3af standard, is supported.)

2.4 AsteRx SBi3 design

2.4.1 Front Panel

The AsteRx SBi3's front panel features two antenna TNC connectors.

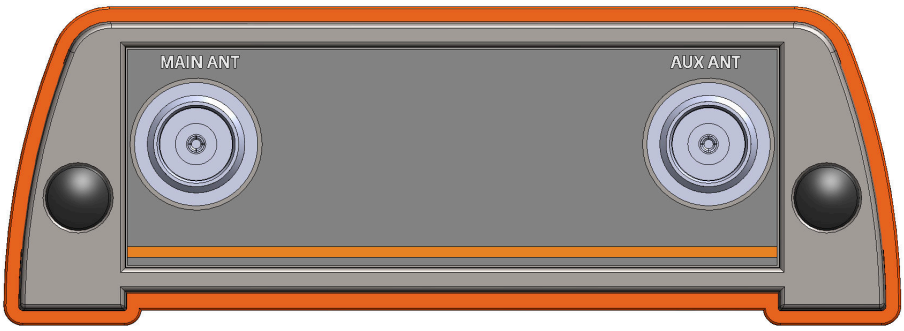

Figure 2-1: The front panel of the AsteRx SBi3

2.4.2 Rear Panel

Figure 2-2 shows the layout of the rear-panel connectors of the AsteRx SBi3. The rear panel has three connectors: a 7-pin female PWR-COM2/3/USB socket, a 7-pin female COM1-GPIO socket and a 4-pin female ETH socket. A full description of the connector PIN layout of the rear panel ports can be found in Appendix A.

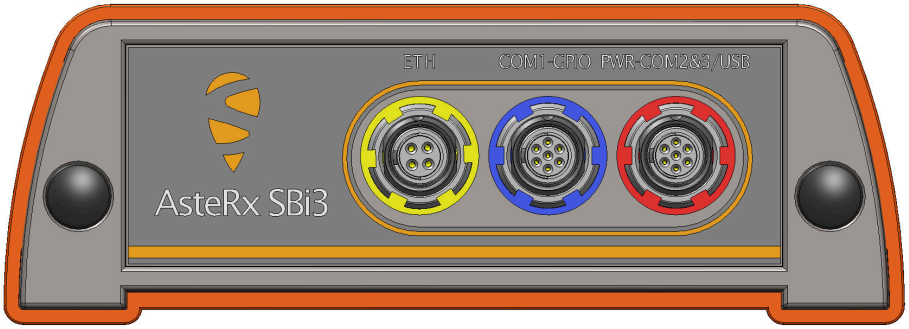

Figure 2-2: The rear panel of the AsteRx SBi3

2.4.3 Top case

The AsteRx SBi3's top of the case shows the Septentrio logo as well as the engraving of the IMU reference point, to be used for defining the antenna lever arm (see section 3.2). There is an offset of 17 mm on the Z axis (as indicated in the engraving) to be accounted for during the lever arm measurement.

Figure 2-3: The top of the AsteRx SBi3

3 Configuring the AsteRx SBi3

3.1 Connecting to the AsteRx SBi3

3.1.1 Connecting via Ethernet using the web interface

Step 1: Connect the Power and Ethernet cables

Connect the Ethernet cable to the connector labeled 'ETH' on the rear panel of the receiver as shown in Figure 3-1 and make sure it is connected to a LAN network. Then connect the power cable to the receiver and make sure the correct input voltage is applied (between 4.5 and 36 V DC).

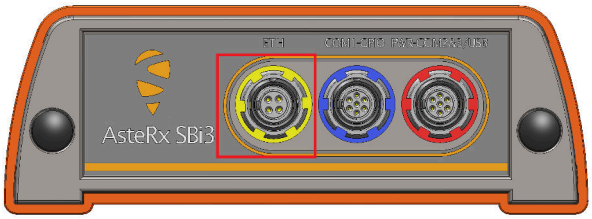

Figure 3-1: Rear panel Ethernet socket

Step 2: Open a web browser and connect to the AsteRx SBi3

By default, the AsteRx SBi3 has the hostname 'http://asterxsbi3-xxxxxxx', where xxxxxxx are the 7 digits of the serial number of the receiver board inside the AsteRx SBi3. This hostname can be used on a local area network to connect to the AsteRx SBi3 if the IP address assigned by the DHCP server is unknown. The hostname can be found on a sticker on the bottom of the receiver housing. Figure 3-2 shows a screenshot of an Ethernet connection to a receiver with serial number 9900035 using 'http://asterxsbi3-9900035'.

Figure 3-2: Connecting to the Web Interface via Ethernet

3.1.2 Connecting via COM

In case you do not have an Ethernet cable or LAN network available, you may still connect to the receiver using one of the receiver's COM ports and RxControl.

Step 1: Connect the Power and COM cables

Connect the COM cable to the connector labeled 'COM-GPIO' on the rear panel of the receiver as shown in Figure 3-3 and connect the other end to a computer. It may be necessary to use a serial-to-USB converter if the computer does not have a serial port. Now connect the power cable to the receiver and make sure the correct input voltage is applied (between 4.5 and 36 V DC).

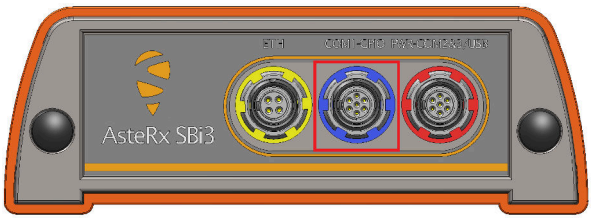

Figure 3-3: Rear panel COM1 socket

Step 2: Open RxControl and connect to the AsteRx SBi3

Once connected, open RxControl on the computer to which the receiver is connected and follow the sequence of steps described in Figure 3-4 to open a connection to the AsteRx SBi3. Note that RxControl is part of the RxTools software suite which can be freely downloaded from the Septentrio website.

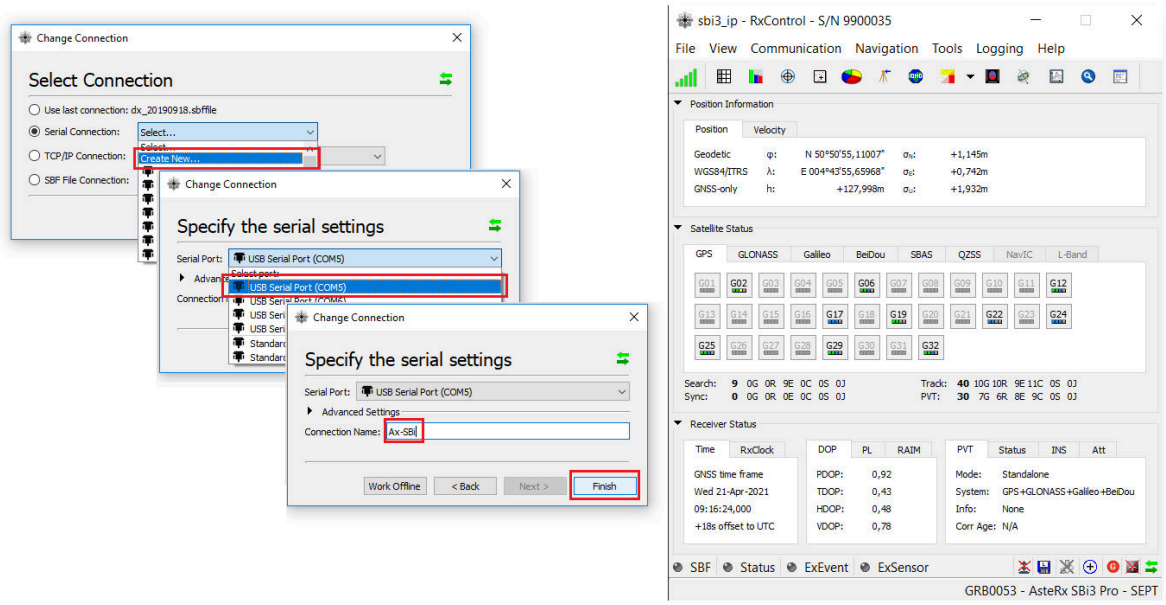

Figure 3-4: Connecting to the receiver via COM using RxControl. Select 'Serial Connection' and choose 'Create New'. Next, choose the correct serial port, define a name for the connection and press Finish.

3.2 How to measure and compensate for the Antenna Lever Arm

The antenna lever-arm is the relative position between the IMU reference point and the GNSS Antenna Reference Point (ARP). The IMU reference point is clearly marked on the top panel of the receiver. Refer to the data sheet of your GNSS antenna for the exact location of the ARP.
It is important to compensate for the effect of the lever arm, otherwise the receiver may not be able to calculate an accurate INS position. The higher the accuracy of the lever-arm dimensions, the better the accuracy of the INS solution calculated by the receiver. As shown in Figure 3-5, lever arm offsets can occur in three dimensions.

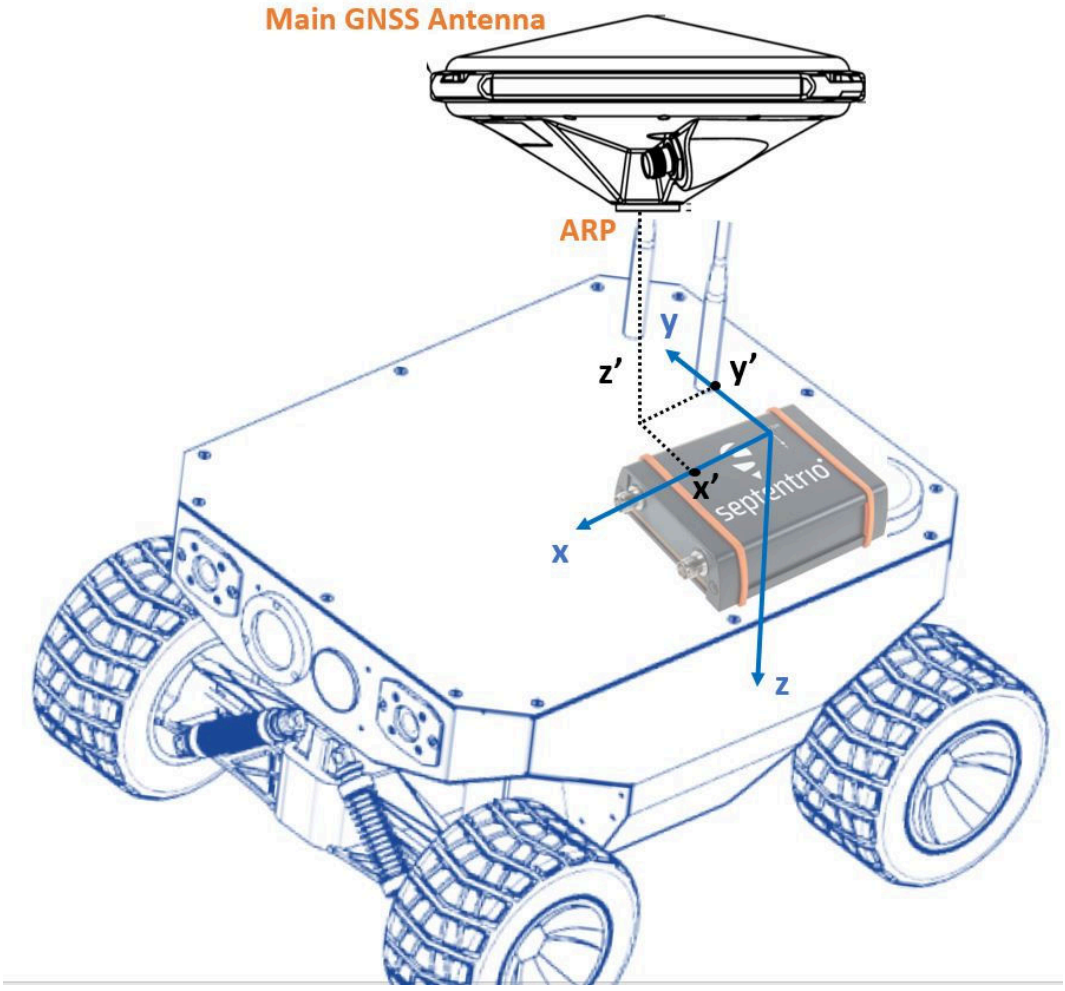

Figure 3-5: Example of the relative IMU/antenna position in the vehicle's frame (in blue). In this example, the lever arm X and Y components are equal to X' and Y' (positive), while the Z component is Z' (negative) + 1.7cm.

Values representing the relative position of the main antenna ARP with respect to the IMU reference point in the three dimensions of the vehicle reference frame can be provided to the receiver in the web interface under GNSS/INS > External Sensor Setup as shown in Figure 3-6. Note that in order to correctly reference to the antenna's ARP, it is necessary to compensate for phase center variations. This can be done in the web interface by going to GNSS/INS > Position and selecting the correct antenna type in the 'Antenna Information' field.

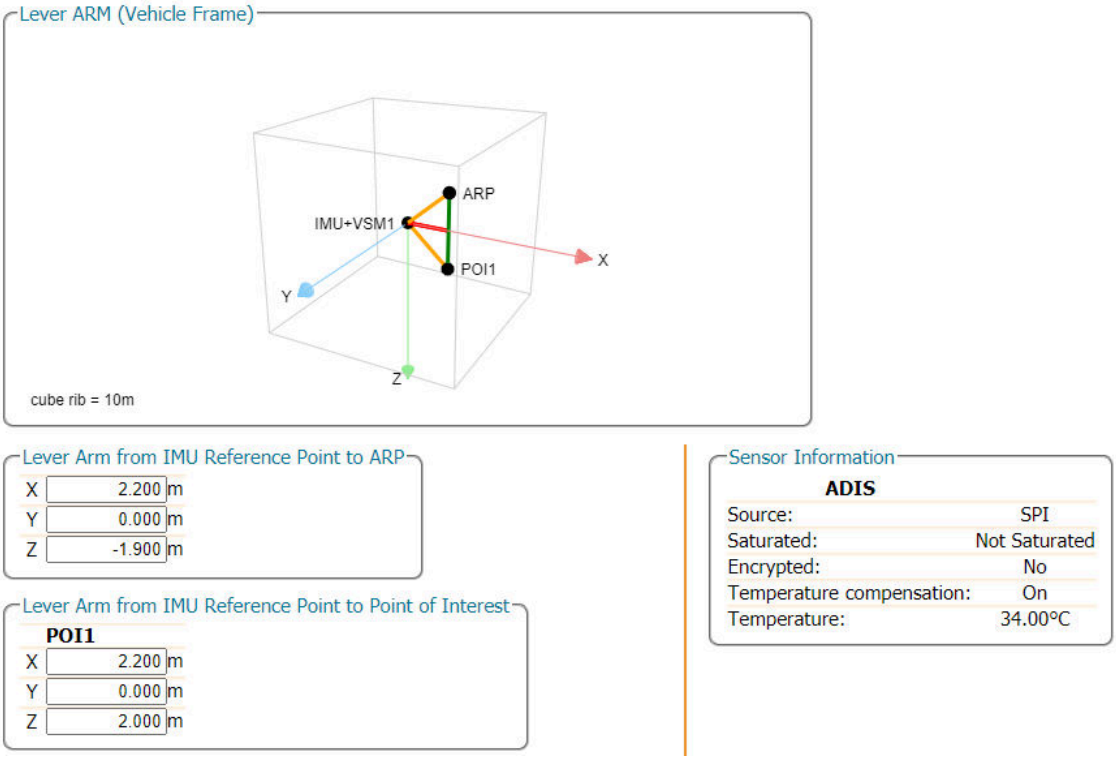

Figure 3-6: Setting the lever arm offsets.

The External Setup page in the receiver web interface provides a visualization tool that allows users to get an idea of the relative positioning of the ARP and POI in the vehicle reference frame with given lever-arm settings.
Accurately determining the lever-arm can be difficult. Ideally, both the IMU and the antenna are installed in known locations so that existing 3D models can be used to determine the lever-arm offsets in the X, Y and Z dimensions. If the locations of either the antenna or the IMU are not known, point clouds obtained from 3D laser scanning or similar techniques could be used to build a reference frame that allows for the lever-arm to be accurately measured. For temporary setups or test purposes where the accuracy of the INS solution is not of paramount importance, it may be sufficient to measure the lever arm manually, e.g. using a tape ruler. However, this should never be the method of choice for permanent installations.

3.3 How to compensate for deviations in the antenna orientation

The attitude of a vehicle can be determined from the orientation of the baseline between two antennas attached to the vehicle. By default, the receiver determines the attitude angles assuming that the baseline between the antenna ARP is parallel to the longitudinal axis of the vehicle. Attitude biases appear when this is not the case. The user can provide the value of the attitude offset angles in the web interface under GNSS/INS > INS/Attitude > Advanced as shown in Figure 3-7. Providing this information will let the receiver compensate for the offsets before calculating the attitude by subtracting them from the attitude angles.

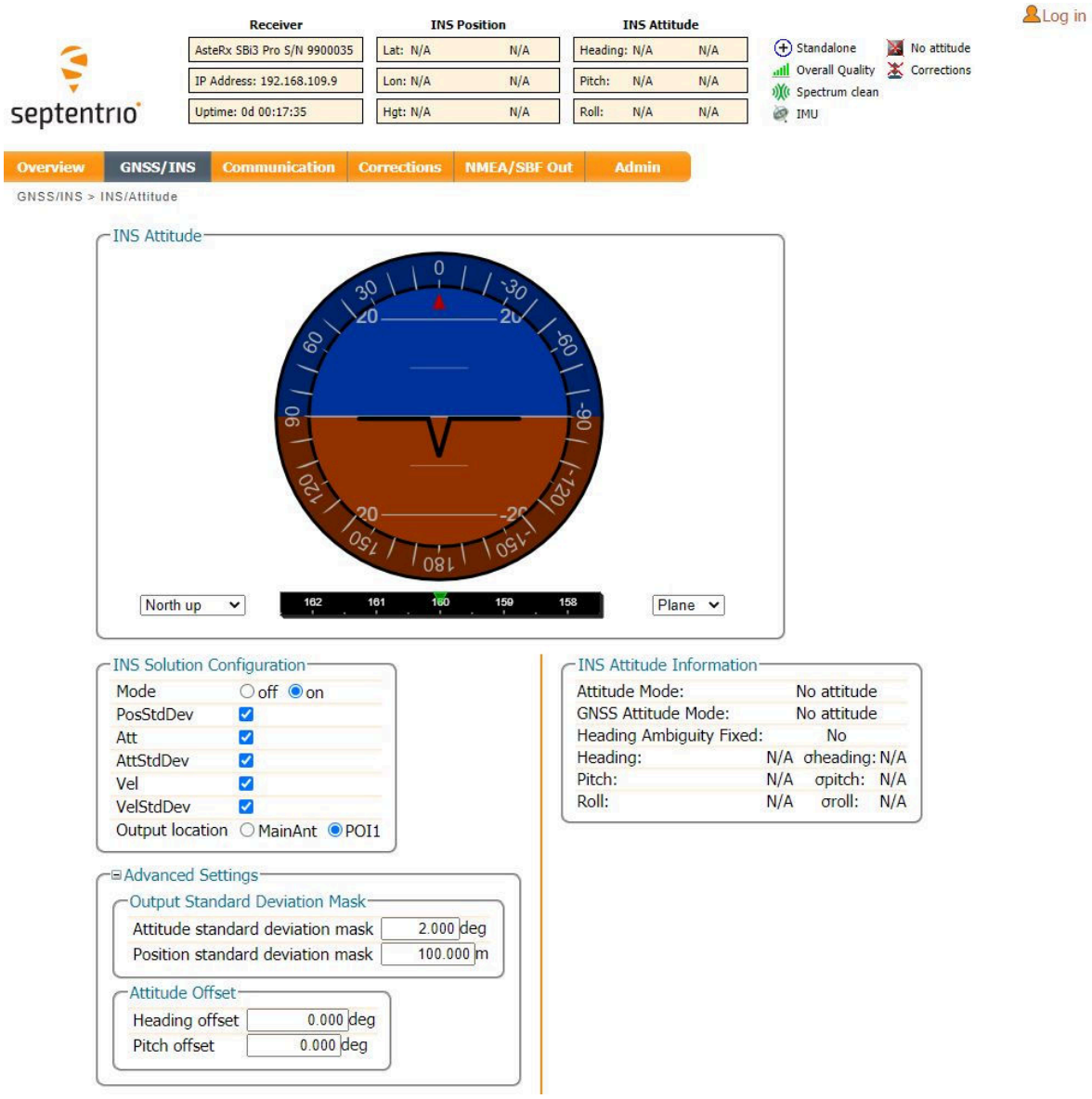

Figure 3-7: Setting the attitude offset.

In many cases the antenna baseline will not align perfectly with the vehicle's longitudinal axis or its perpendicular and in these circumstances the provided attitude offset value can also be used to compensate for small angular deviations. Note that, in order to ensure the integrity of the solution, offsets greater than 5 degrees from the longitudinal axis or its perpendicular are not recommended.

An increase in angle between the antenna baseline and the vehicle's longitudinal axis in the clockwise direction corresponds to a positive change in the value of the heading offset To better explain this, a few examples of possible setups are given below in Figure 3-8.

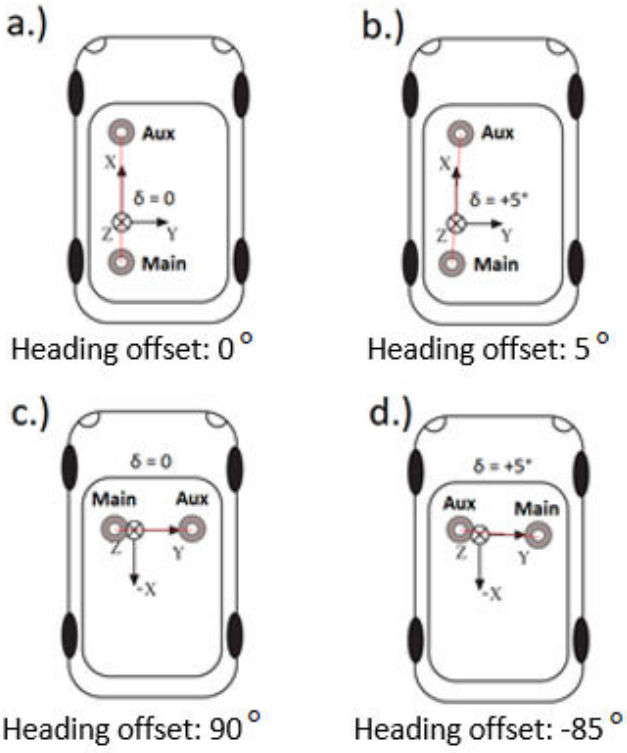

Figure 3-8: Examples of a number of antenna setups and the corresponding heading offsets. a.) The default setup for which the angle between the antenna baseline and the longitudinal axis is 0 and no heading offset needs to be set. b.) a slight deviation (5Âř) from the longitudinal axis in the clockwise direction is reflected by a positive increase in the heading offset. c.) An alternative antenna configuration where the antennas are placed perpendicular to the longitudinal axis. d.) An alternative antenna configuration where the antennas are placed perpendicular to the longitudinal axis with a small deviation.

The examples above all relate to a heading offset but the antenna orientation can also be characterized by a vertical offset. Vertical offsets can be compensated for by adjusting the Pitch offset. This may be necessary in cases where the antenna baseline is not exactly parallel to the longitudinal axis of the vehicle or in situations where the two antenna ARPs may not be exactly at the same height in the vehicle reference frame. Since pitch is defined as the right-handed rotation about the vehicle Y axis, a situation where the main antenna is mounted lower than the aux antenna (assuming the default antenna setup) will result in a positive pitch a shown in Figure 3-9.

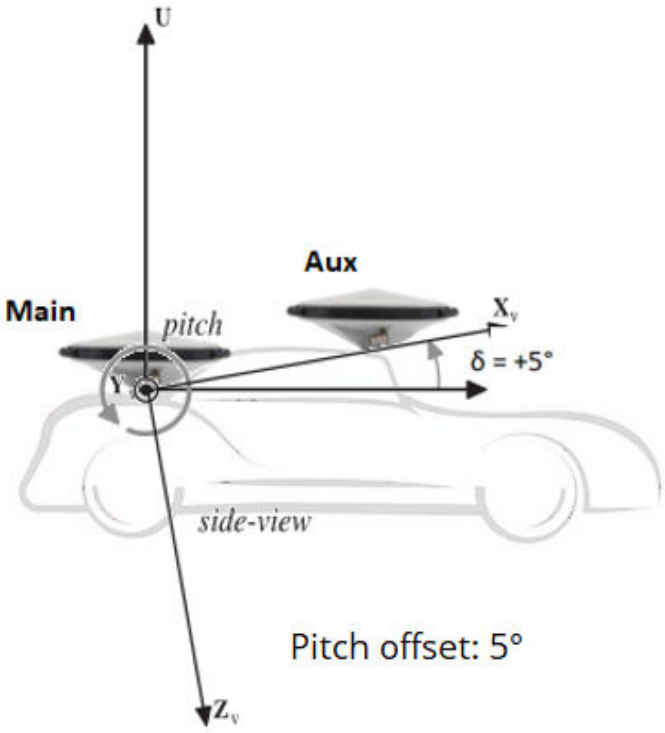

Figure 3-9: Visual representation of the effect of vertical offset between the two antennas on the Pitch offset. Assuming the default antenna configuration, the aux antenna being mounted higher will result in a positive value for the pitch.

3.4 How to compensate alternative IMU/Receiver orientations

It is important to take into consideration the mounting direction of the receiver, therefore the IMU, in the body frame of the vehicle. To correctly translate the motion of the receiver in the same axes of the body frame it is essential to account for the differences in the axes orientations.
As such, for many installations, including when the receiver is installed horizontally with the front panel facing the direction of travel, it will be necessary to compensate for the IMU's orientation to make sure the IMU reference frame is aligned with the vehicle reference frame. The IMU's orientation can be changed by specifying the orientation angles (Theta X, Theta Y, Theta Z) as shown in Figure 3-10.

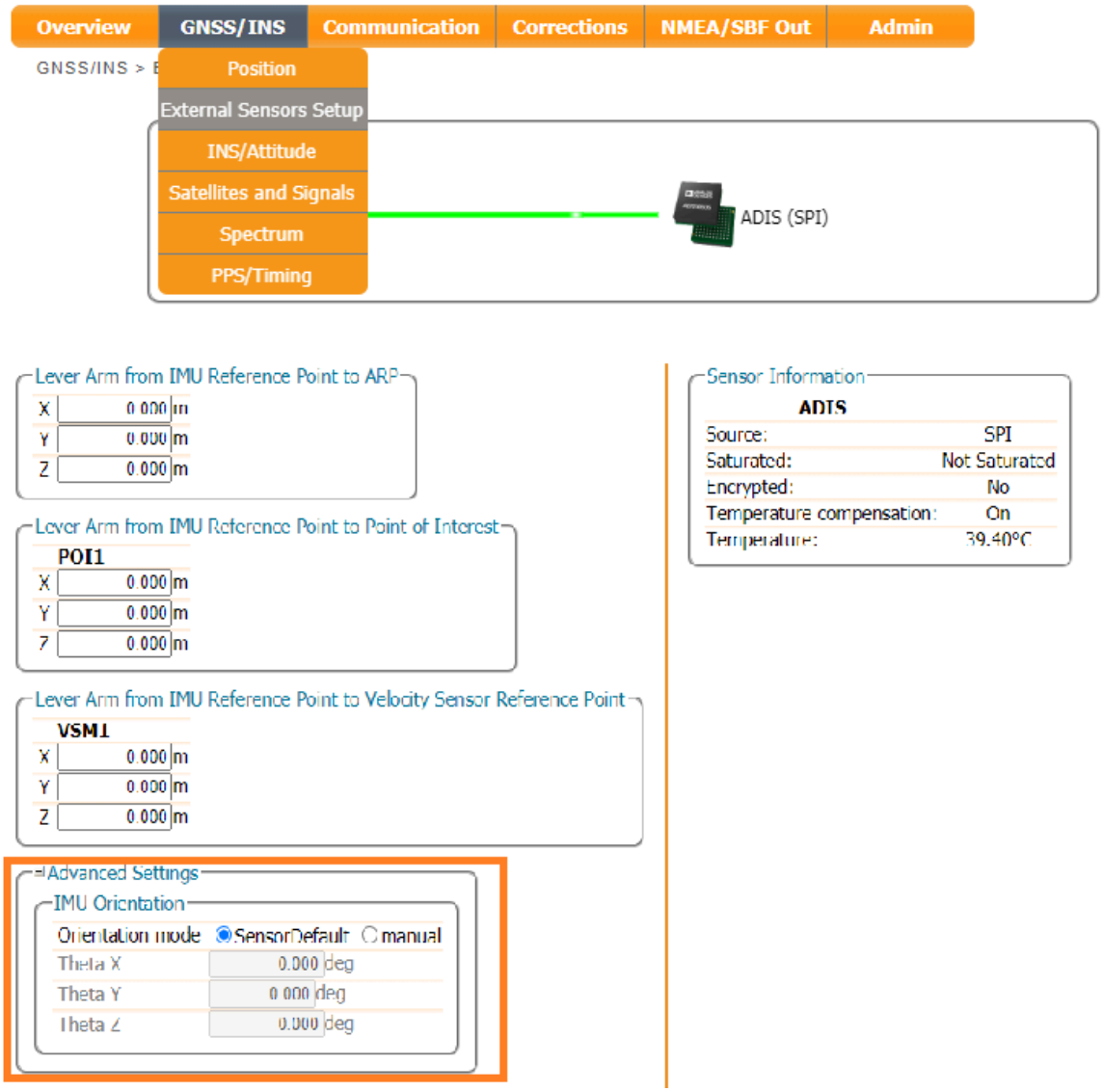

Figure 3-10: Setting the IMU orientation.

Examples of typical receiver installations in a vehicle frame are given in Figure 3-11.

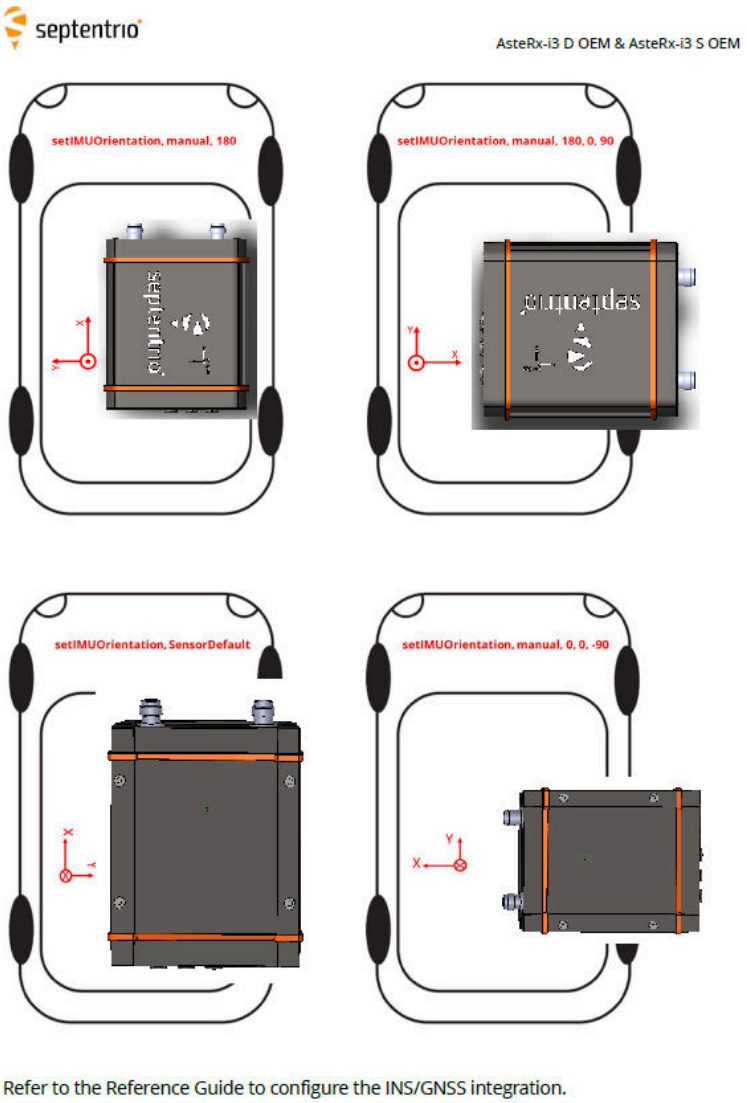

Figure 3-11: Examples illustrating the orientation of the IMU reference frame with the associated IMU orientation for the depicted installation.

3.5 How to see if the IMU is outputting data?

An easy way to determine if communication is taking place between the IMU and the GNSS receiver is by inspecting the External Sensor Setup page where the data stream connection is indicated and the raw sensor data can be visualized. When the IMU is communicating to the GNSS receiver, there should be a line visible between the AsteRx SBi3 and SPI as shown in Figure 3-12.

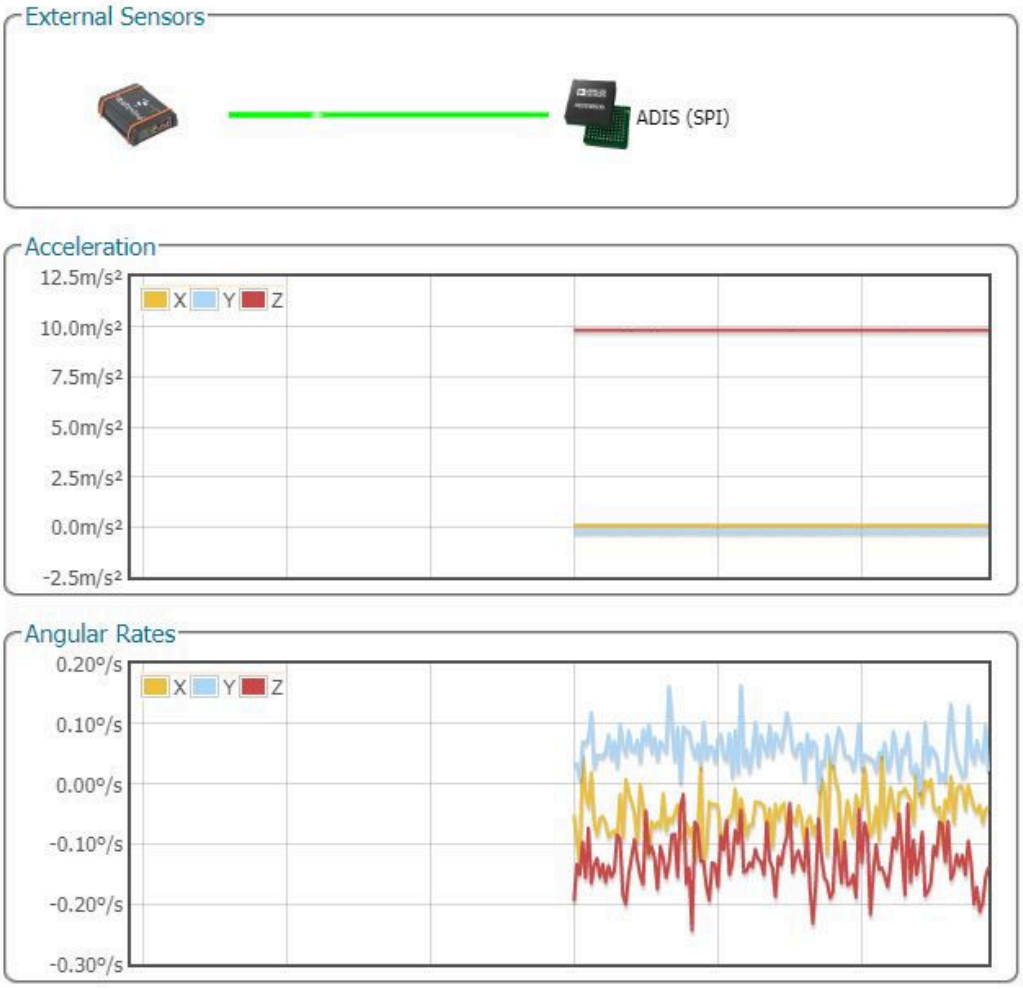

Figure 3-12: The Data Stream window on the Overview page should show a line symbolizing a connection between the AsteRx SBi3 and the IMU which is connected to SPI.

A more robust way of verifying that the IMU is not only connected but that the IMU data is being received and processed correctly involves inspecting the IMU View in RxControl or web interface. After establishing a connection with the AsteRx SBi3 using RxControl, navigate to View > IMU View as shown in Figure 3-13. The acceleration and angular rate plots should display information similar as shown in Figure 3-13. These plots are based on the unfiltered IMU sensor measurements and provide an unambiguous way of checking that the IMU is outputting data.

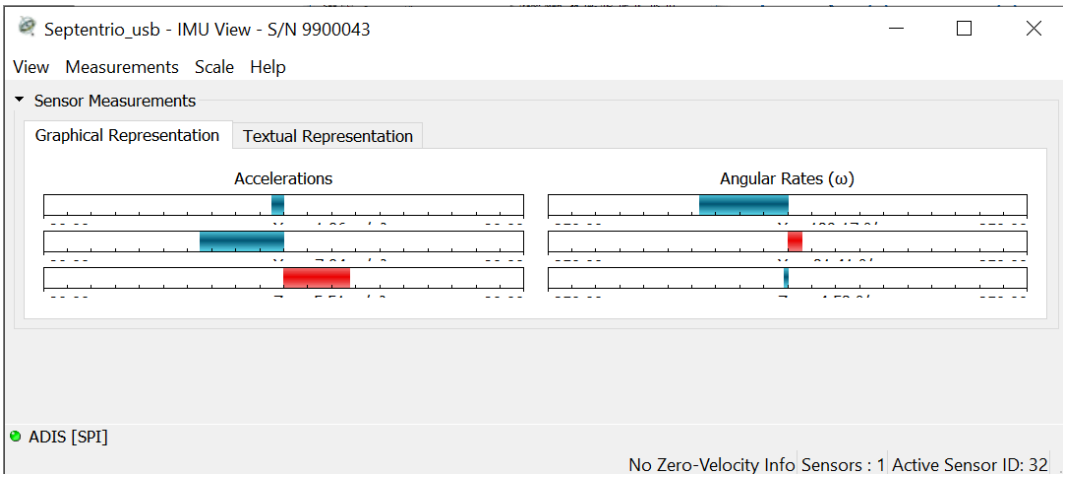

Figure 3-13: Checking the IMU view in RxControl provides an unambiguous way of checking whether ot not the IMU is outputting data

3.6 Vehicle velocity input

The AsteRx SBi3 can receive vehicle velocity information and use it as part of the integrated position. The use of the vehicle velocity it is not required for the function of the device. Vehicle velocity input improves the dead reckoning performance and heading performance in single antenna. It is important to highlight that the contribution of the vehicle velocity input to the AsteRx SBi3 performance is function of the velocity computation accuracy and latency. The expected velocity input is an already computed vehicle speed, NMEA VSM stream, and not raw sensor data. For the communication details please look into the AsteRx SBi3 Firmware Reference Guide.

4 Common Receiver Operations

4.1 How to configure SBF and NMEA output

The AsteRx SBi3 can output position and GNSS data in both standard NMEA format and Septentrio's proprietary compact binary format SBF. The following sections detail how to configure connections to other devices in order to send data.

SBF and NMEA can also be logged on the internal 16 GB disk of the AsteRx SBi3 Pro+. Section 4.2.1 and 4.3 detail how to log data on the receiver and how to download data logged on the receiver.

4.1.1 Output over a serial COM connection

The AsteRx SBi3 can be connected via a serial COM cable to an RS-232 compatible secondary device.

Step 1: Configure the serial COM port

The COM port of the AsteRx SBi3 should be configured with the same baud rate and flow control setting of the coupled device. These settings can be configured via the **Communication/Serial Port** tab as shown in Figure 4-1. In this example, COM3 is set with a speed of 19200 baud.

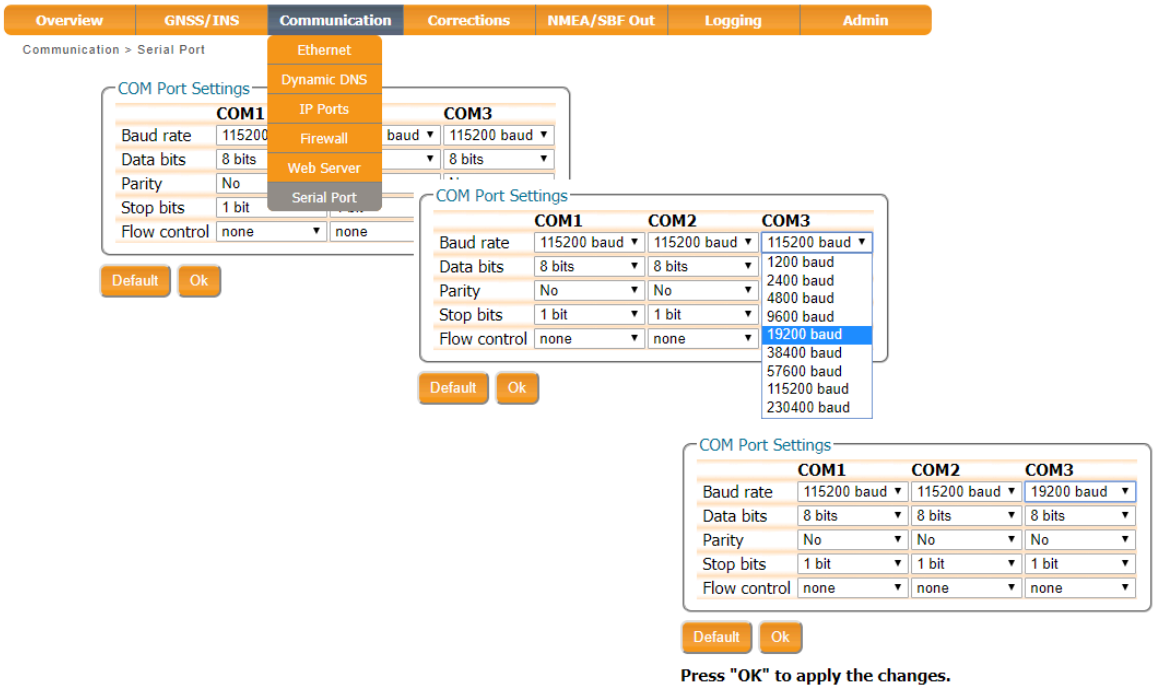

Figure 4-1: Configure the baud rate and flow control of the AsteRx SBi3

Step 2: Configure data output

NMEA

In the **NMEA/SBF Out** tab, clicking on **New NMEA Stream** will guide you through the steps needed to configure NMEA output as shown in Figures 4-2 and 4-3.

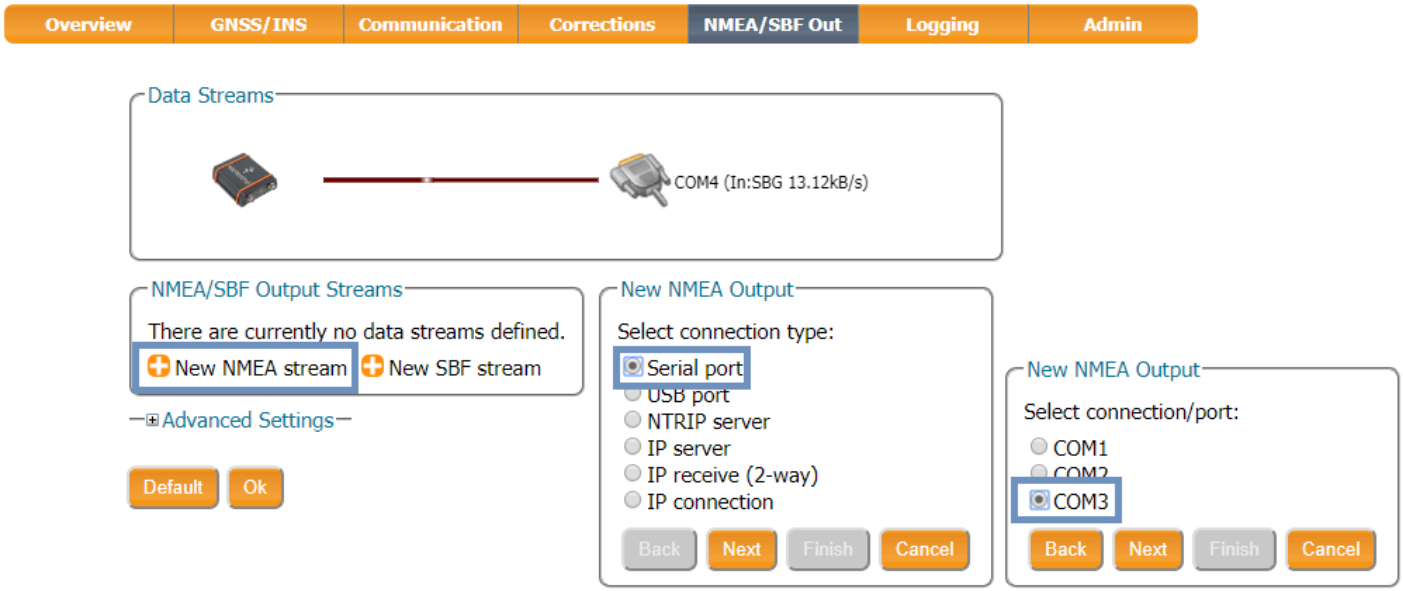

Figure 4-2: Selecting to output NMEA data on COM3

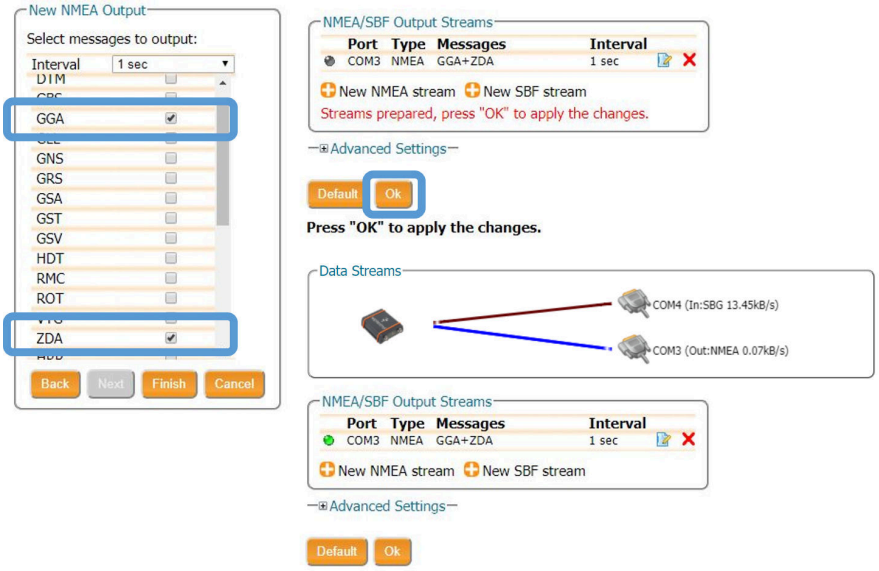

Figure 4-3: Selecting to output the GGA and ZDA NMEA message every second

SBF

By clicking **New SBF stream** in the **NMEA/SBF Out** window, a second output stream can be configured. In the example shown in Figures 4-4 and 4-5 the PVTCartesian SBF data block will be output over COM1 once per second.

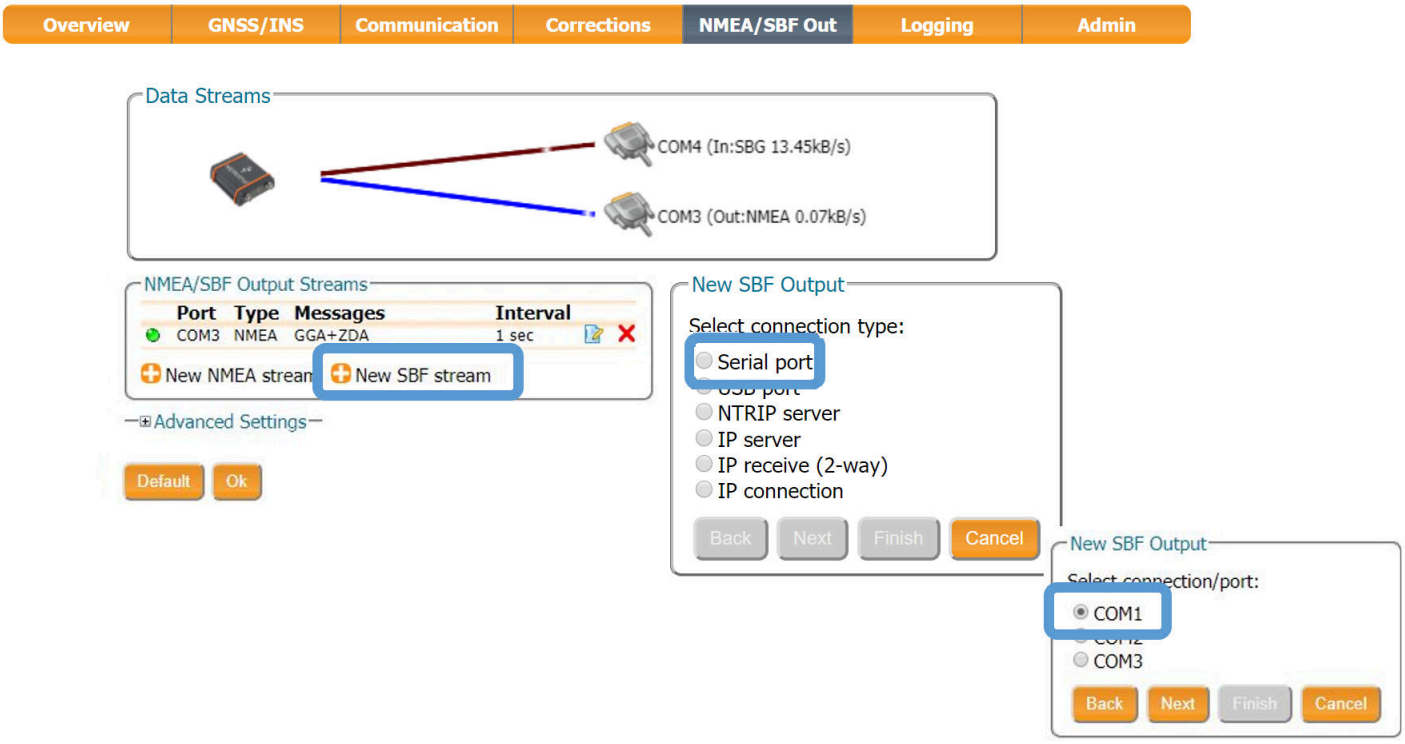

Figure 4-4: Selecting to output SBF data on COM1

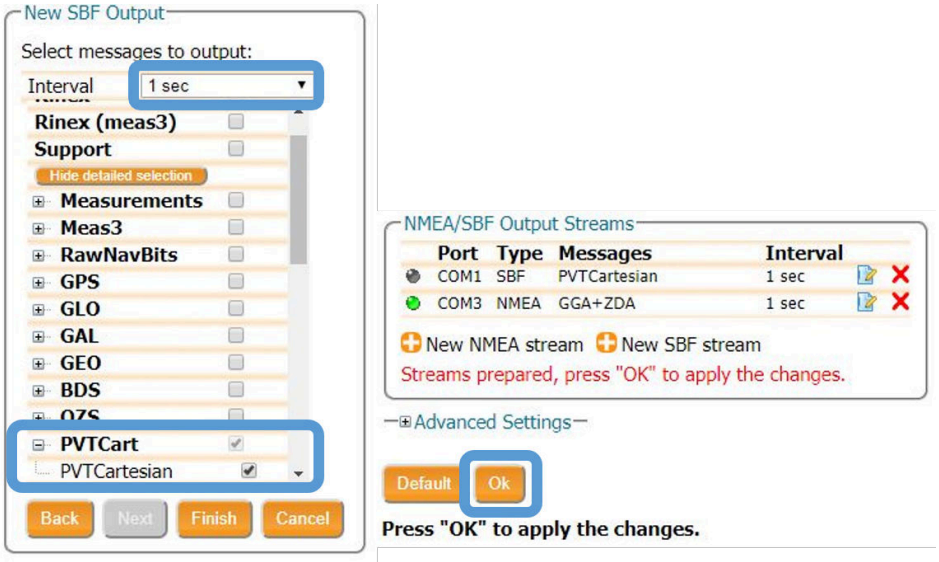

Figure 4-5: Selecting to output the PVTCartesian SBF block every second

Step 3: Verifying the configuration

Having configured the data output and clicked on **Ok**, the **NMEA/SBF Out** page will now display a summary of all data output as shown in Figure 4-6.

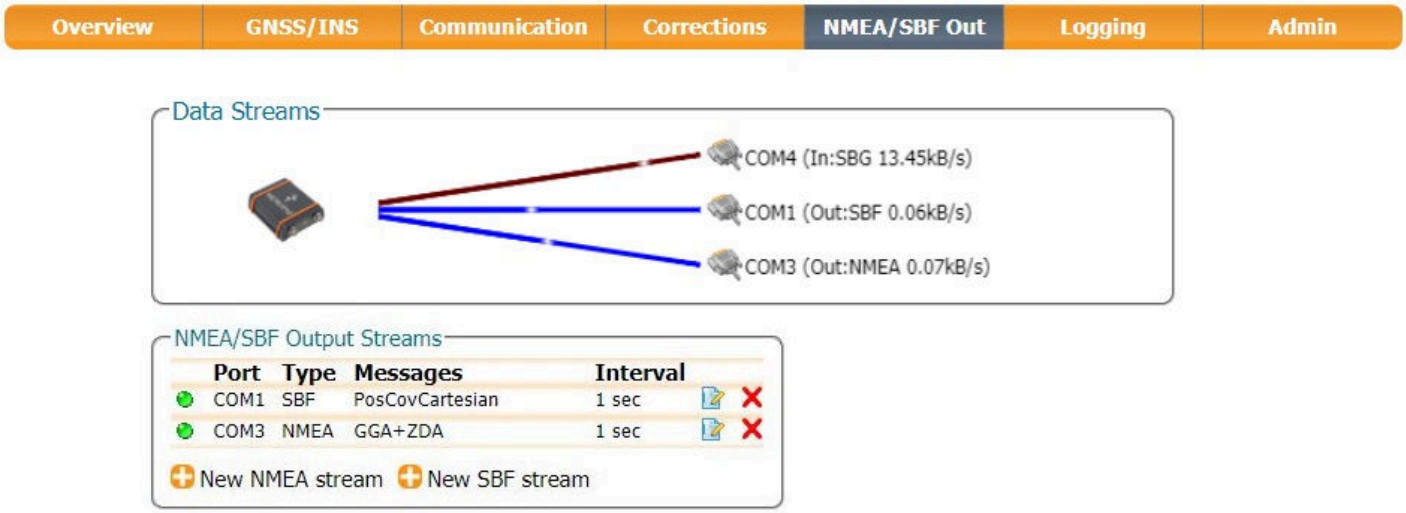

Figure 4-6: Summary of all configured data output streams

Figure 4-7 shows the actual data output. NMEA is in ASCII and is thus readable unlike SBF which is formatted in binary. In this example, the serial COM was connected to a PC via a USB adapter which maps the serial connection to a virtual COM9 of the PC.

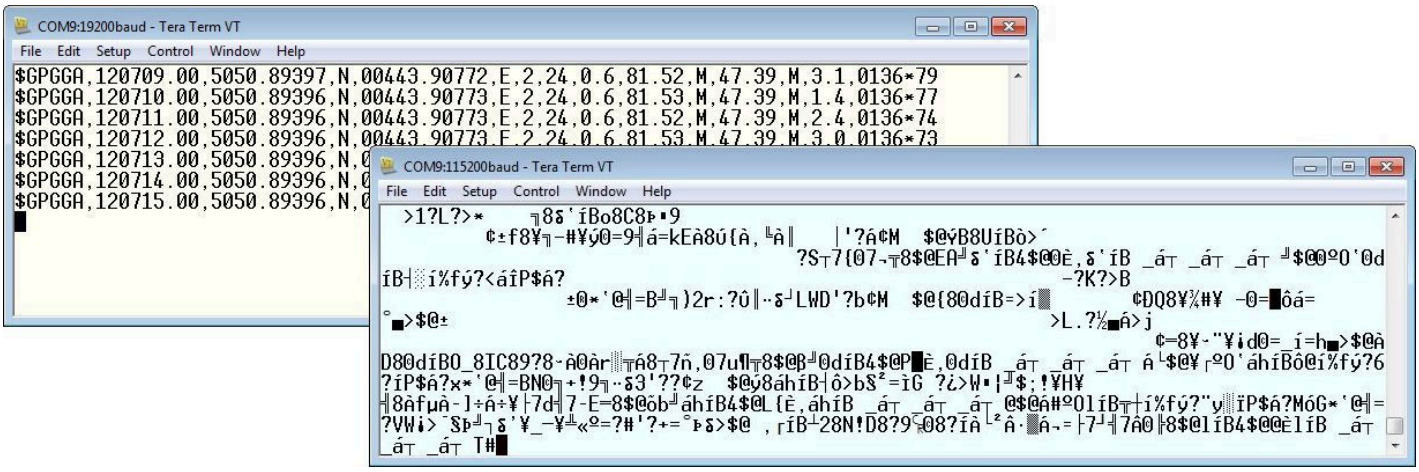

Figure 4-7: Example showing output of NMEA GGA (left panel) and SBF PVTCartesian (right panel) data

4.1.2 Output over Ethernet

SBF and NMEA data can be sent over an Ethernet connection from the AsteRx SBi3.

Step 1: Configure an IP connection on the AsteRx SBi3

The Ethernet port settings can be configured by selecting **IP Ports** from the **Communication** menu. In the example shown in Figure 4-8, port 600 has been configured as connection IPS1 in **TCP2Way** mode so data can be received as well as transmitted over the connection. When choosing a port number, avoid conflicts with other applications such as the commands port (28784), the webserver port (80), the FTP port (21) as well as the default NTRIP port (2101) and the NTP port (123).

Note that a new IP port can also be configured by followings the sequence of settings for NMEA output described in ***Step 2***.

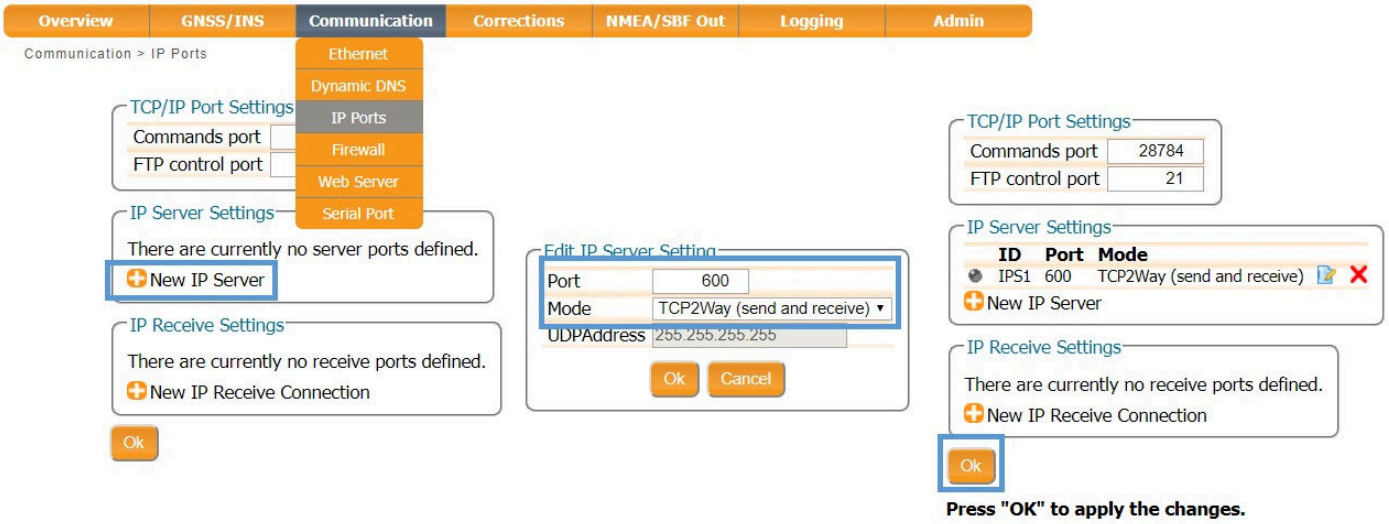

Figure 4-8: Configuring the TCP/IP server port setting for data output

Step 2: Configure output of NMEA messages

In the **NMEA/SBF Out** window, click on **New NMEA stream** and follow the sequence of windows to configure the data you want to output. In the example shown in Figure 4-9, the NMEA GGA message will be output every second. Ensure that the previously configured IPS1 port is selected for output as highlighted.

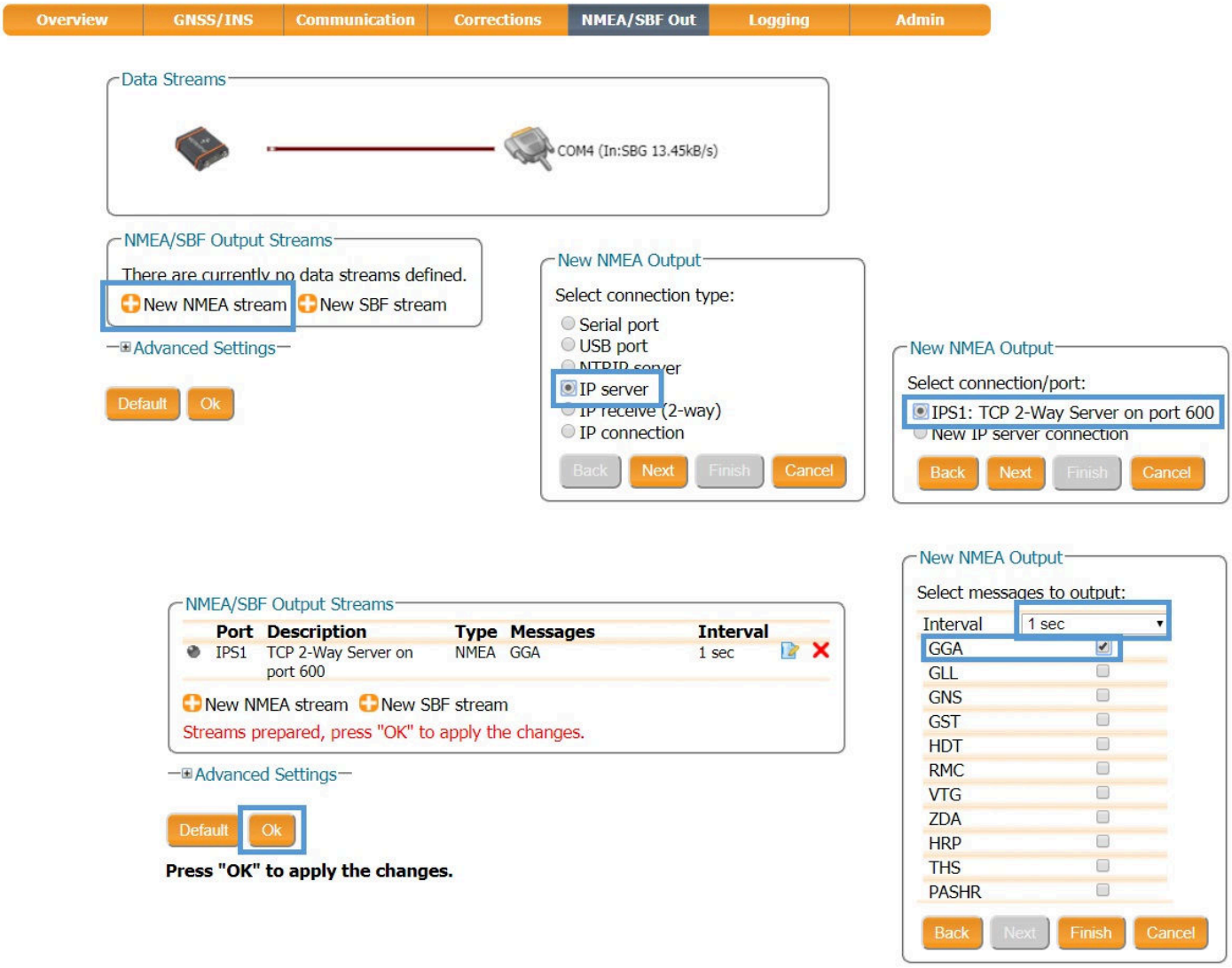

Figure 4-9: Outputting NMEA GGA over the configured IPS1 connection

Similar steps can be followed to output SBF messages.

Step 3: Configure Data Link to listen for NMEA output

The screenshots in Figure 4-10 show how the Septentrio GUI tool Data Link can be configured to listen for the AsteRx SBi3 GGA output.

Click on the **TCP/IP Client** button to configure the connection. In the highlighted fields insert the IP address or hostname of the receiver and the port number configured in ***Step 1***. Click on **Connect**.

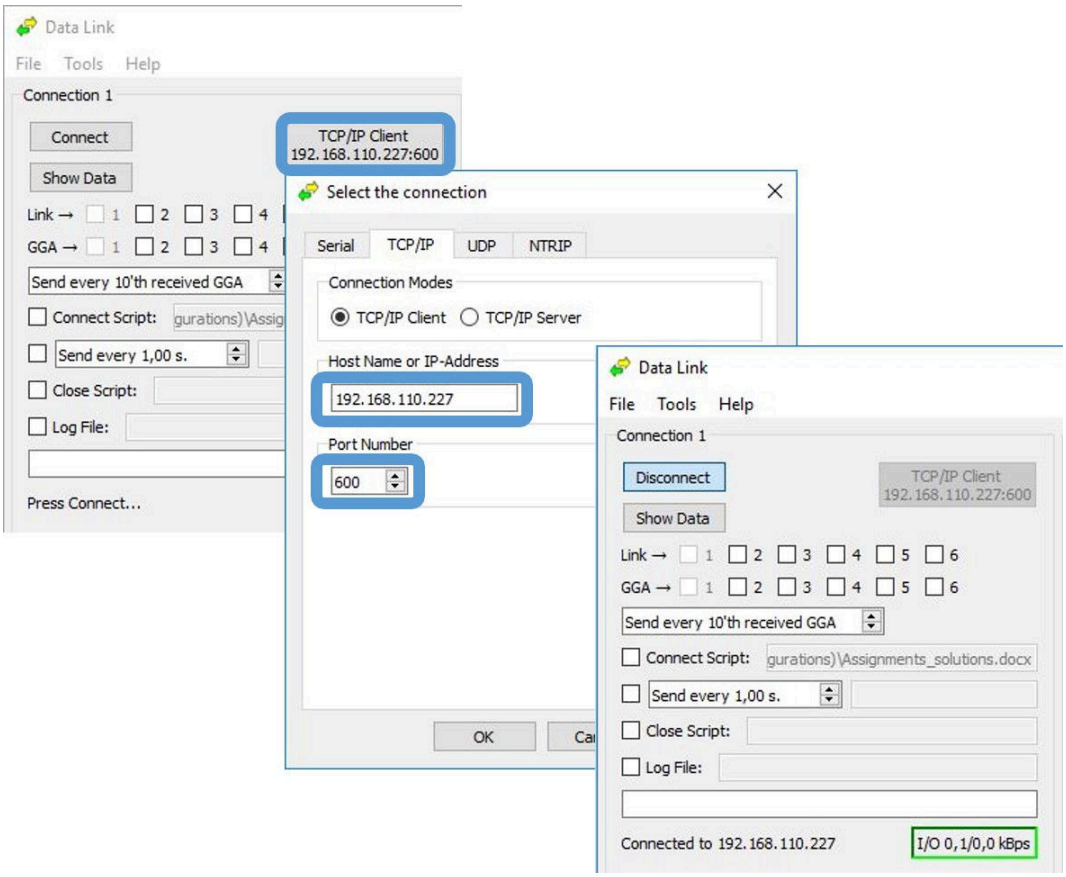

Figure 4-10: Configure the TCP/IP connection settings in Data Link

The info line at the bottom of the window should indicate that a connection has been made. Click on the **Show Data** button to display the GGA data coming from the receiver as in Figure 4-11.

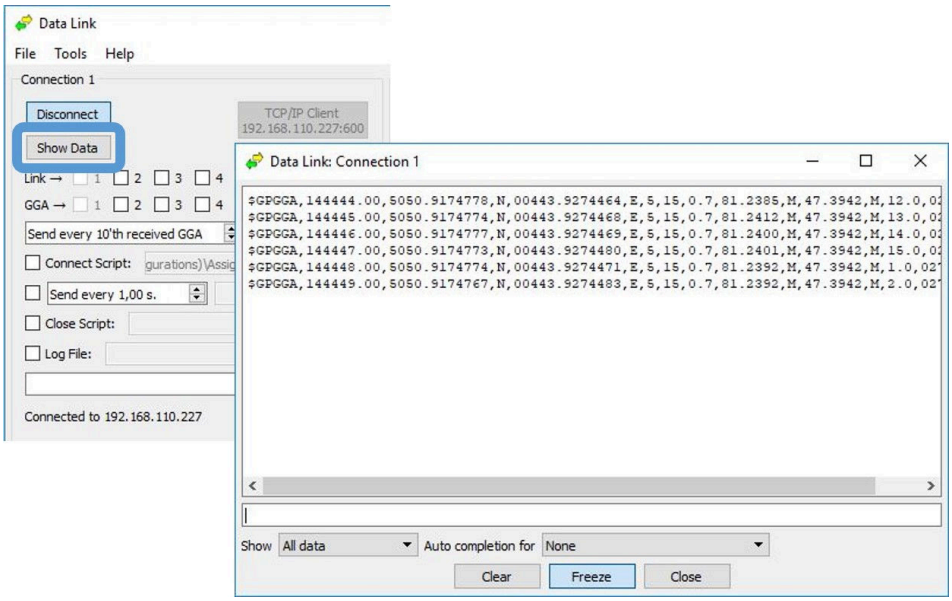

Figure 4-11: The **Show data** window of Data Link showing the NMEA GGA message coming from the AsteRx SBi

4.2 How to log data

The AsteRx SBi3 Pro+ has 16 GB of memory for internal data logging.

4.2.1 Internal logging

Step 1: Defining the Disk Full action

When setting up a logging session for the first time, it is a good idea to define what you would like to happen when the internal memory is full. This can be configured in the **Advanced** tab of the main page of the **Logging** menu as shown in Figure 4-12. There are two options, either the receiver stops logging when the memory is full or it continues logging by making space for new files by deleting the oldest files. The default setting is 'Stop logging in all sessions'.

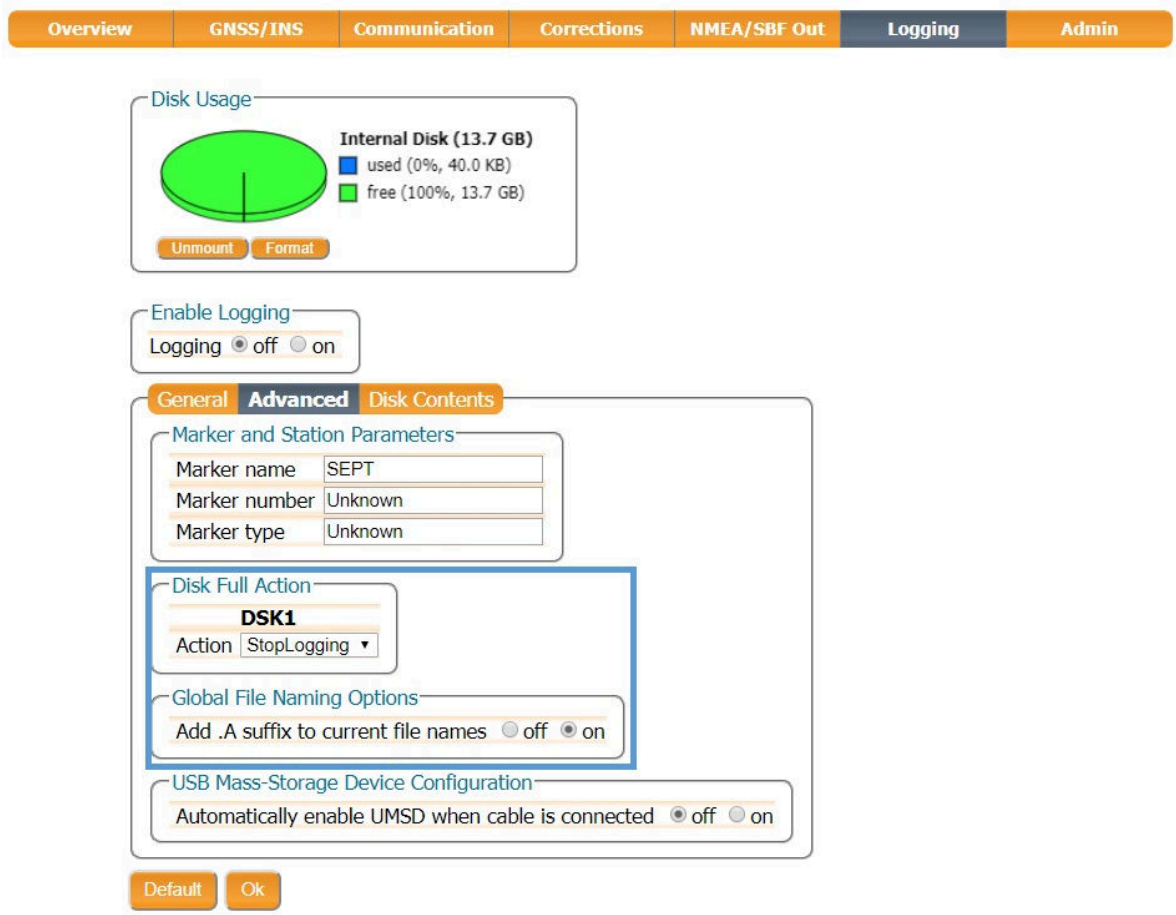

Figure 4-12: Selecting what you wish to happen when the internal 16 GB memory is full

Step 2: Configuring a logging session

To define a new logging session, press **New NMEA Stream** or **New SBF Stream** as shown in Figure 4-13.

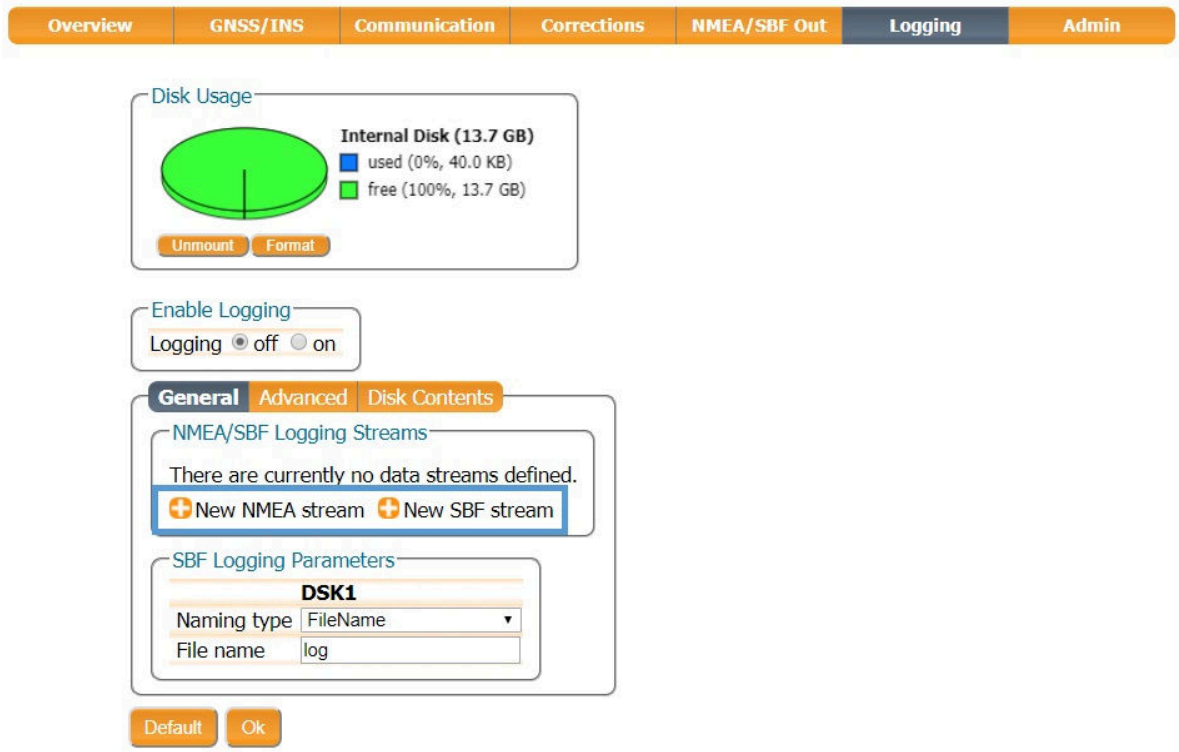

Figure 4-13: Defining a new logging session

You can then follow the sequence of steps shown in Figure 4-14, selecting the various configuration settings for the logging session. In the **Edit SBF Stream** window, the messages required for RINEX generation have been selected as well as those useful for the Support department for diagnosing problems. SBF messages can also be selected individually. In the **SBF Logging Parameters** field you can select the naming convention. The **IGS** options names files according to IGS convention but files can also be freely named using either **Filename** or **Incremental** options. After you have finished configuring the log session, do not forget to enable logging and press Ok.

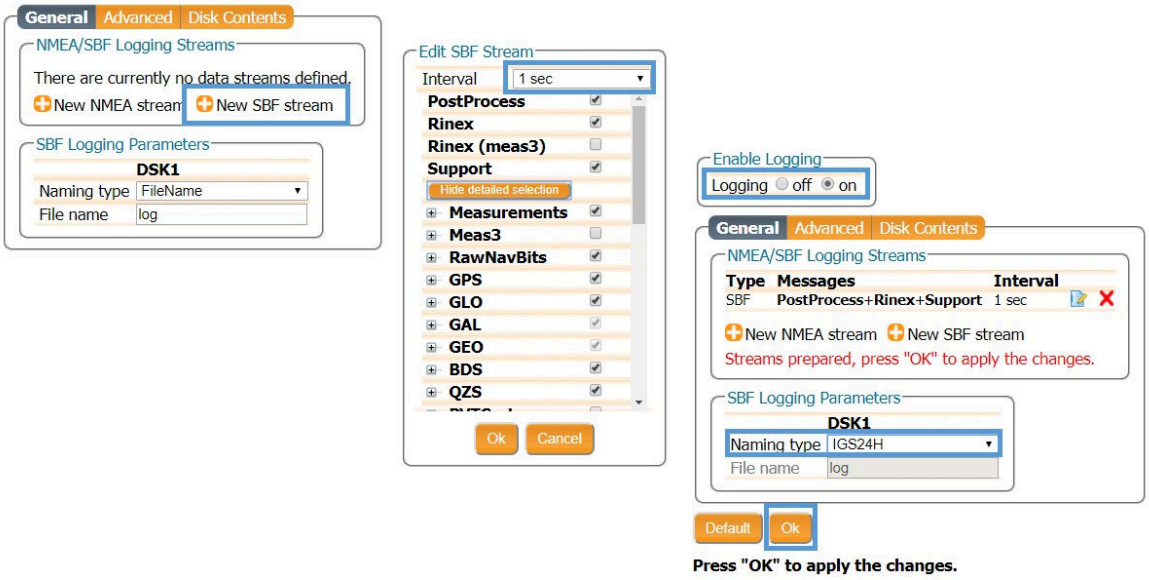

Figure 4-14: Follow the sequence of windows to fully configure the logging session

Step 3: Verifying the configuration

When you have finished configuring the logging session, the **Log Sessions** window will show a summary of the defined logging sessions as in Figure 4-15. An estimate of the daily size of data generated with the current logging configuration is also given.

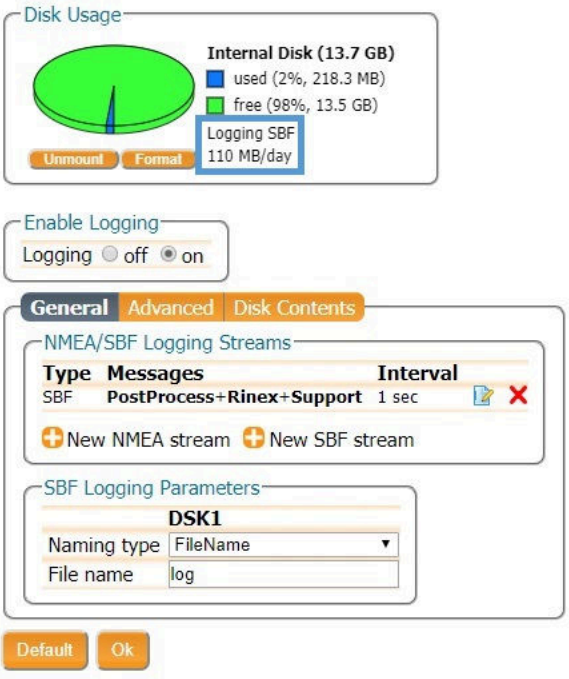

Figure 4-15: A summary of the newly defined logging sessions showing the expected amount of data generated daily

4.3 Downloading logged data from the receiver

Data files logged by the AsteRx SBi3 Pro+ can be downloaded using the web interface using the **Disk Contents** tab on the main page of the **Logging** menu. Individual files can be downloaded by clicking on the green download arrow next to the file name as shown in Figure 4-16. Obsolete files can be deleted by clicking the button.

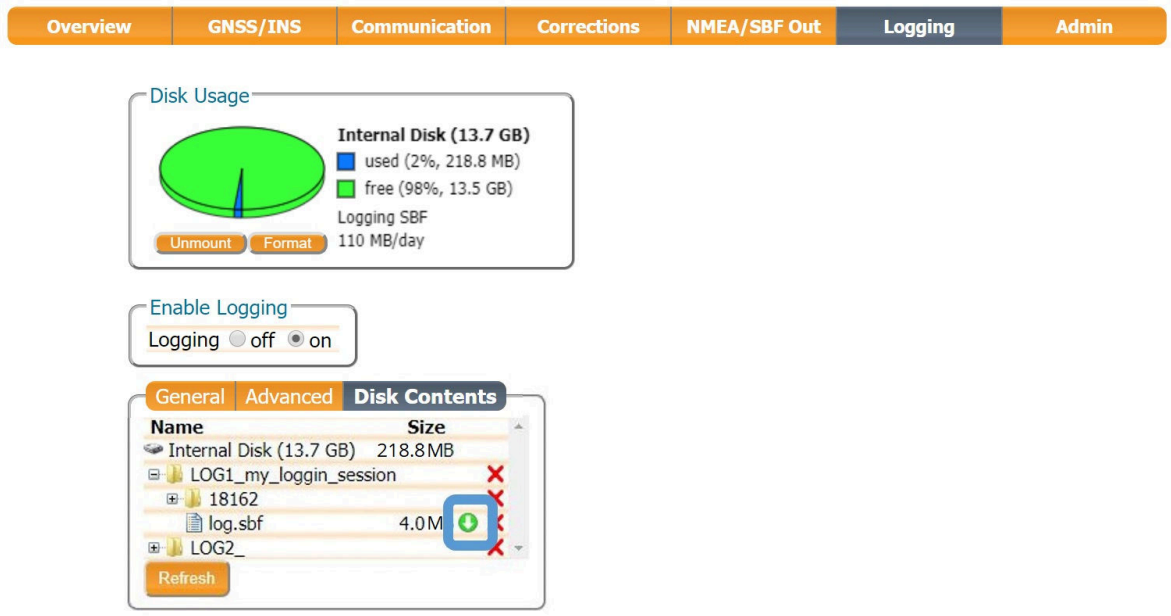

Figure 4-16: Downloading logged files

A Rear-panel port descriptions

A.1 PWR-COM2&3/USB

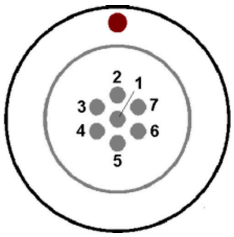

Figure A-1: Solder view of the 7-pin female PWR-COM2&3/USB socket on the rear panel of the AsteRx SBi3

The 7-pin connector type is an ODU MINI-SNAP F Circular Connector Series S40F1C-P07MCD0-500S.

PIN #	Colour	COM mode	USB mode	Comment
1	Red	PWR	Not connected	5-36 VDC input (1.3A) Pink wire with Red heat-shrink tube
2	Black	GND	GND	Ground Brown wire with Black heat-shrink tube
3	Green	RxD3	USB D-	**EITHER** Serial COM3 receive line **OR** Negative USB 2.0 FS device node. Selection is done via pin 7.
4	Yellow	TxD3	Not connected	Serial COM3 transmit line
5	Grey	RxD2	USB D+	**EITHER** Serial COM2 receive line **OR** Positive USB 2.0 FS device node. Selection is done via pin 7.
6	White	TxD2	Not connected	Serial COM2 transmit line
7	Blue	Not connected	VBus	4.4-5.25 V input. **If present**, USB-mode is selected. **If not present**, UART Serial COM mode is selected.

A.2 COM1-GPIO

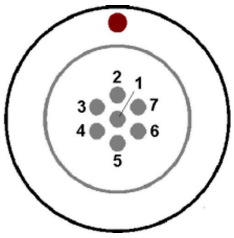

Figure A-2: Solder view of the 7-pin female COM1-GPIO socket on the rear panel of the AsteRx SBi3

The 7-pin connector type is an ODU MINI-SNAP F Circular Connector Series S40F1C-P07MCD0-500S.

PIN #	Colour	Name	Comment
1	Pink	EVENTA	First EVENT input (Max. V_{IL} = 1V, Min. V_{IH} = 2V, Max. V_{IH} = 24V, Internal delay to detection < 1 μs, 15 KΩ pull-down)
2	Black	GND	Ground Brown wire with Black heat-shrink tube
3	Green	COM1 CTS/ EVENTB	COM1 Clear to Send. This also connects to the second event EVENTB input. It has the same electrical specifications as EVENTA (see pin 1).
4	Yellow	COM1 RTS / PPS OUT	COM1 Request To Send / PPS Out PPS OUT low = 0V, PPS OUT high = 5V
5	Grey	RxD1	Serial COM1 receive line
6	White	TxD1	Serial COM1 transmit line
7	Red	5V OUT	5V +/- 5%, 300 mA DC output Blue wire with Red heat-shrink tube

A.3 ETH

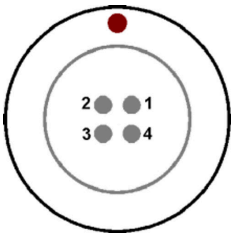

Figure A-3: Solder view of the 4-pin female ETH socket on the rear panel of the AsteRx SBi3

The 4-pin connector type is an ODU MINI-SNAP F Circular Connector Series S40F1C-P04MFG0-50OO.

PIN #	Name	Description
1	TXP	Ethernet TX+
2	TXN	Ethernet TX-
3	RXP	Ethernet RX+
4	RXN	Ethernet RX-

A.4 MAIN ANT / AUX ANT (TNC)

Connect an active GNSS antenna to these connectors. The gain at the connectors (antenna gain minus cable losses) must be in the range 15 to 50dB.

By default, the receiver provides a 3.3V DC supply on both the MAIN and AUX connectors to feed the antennas. The supplied antenna voltage can be changed to 5V DC with the command *setAntennaVoltage*. The maximum supported current is 150mA.

Never inject a DC voltage into the MAIN or AUX connectors as it may damage the receiver. When using a splitter to distribute the antenna signal to several receivers, make sure that no more than one output of the splitter passes DC. Use DC-blocks otherwise.