EMBox GNSS System

Technical Reference Guide

Advanced Navigation Solutions

Applicable Modules

This document applies to the ANavS **EMBox** modules based around the ANavS Ethernet Mosaic Board (EMB) and Septentrio MOSAIC chipset. The EMBox is available in two variants, **Positioning** and **Heading.**

Contents

History

Version	Date	Description
1.0	10/20/2025	First issue

External Reference Documents

ID	Document Title	Link	Version
RD-01	mosaic-X5 Firmware v4.14.4 Reference Guide	https://www.septentrio.com/en/products/gps/gnss-receiver-modules/mosaic-x5#resources	4.14.10
RD-02	mosaic-H Firmware v4.14.4 Reference Guide	https://www.septentrio.com/en/products/gps/gnss-receiver-modules/mosaic-h#resources	4.14.10

Module Variant Overview

The ANavS EMBox systems are using the Septentrio Mosaic family of GNSS receivers. The **Positioning** variant is based around the Mosaic-X5 and provides a comprehensive level of features for Positioning. The **Heading** variant on the MOSAIC-H is providing positioning and heading.

All variants are survey grade, industry-leading anti-jamming and anti-spoofing technology GNSS receivers and capable of tracking multi-frequency signals across all constellations.

EMBox Positioning	**EMBox Heading**
P/N: 90.21.0.61.0.0	P/N: 90.21.0.62.0.0
• Compact and robust form factor • High update rates (up to 100 Hz) and low latency • High accuracy, centimeter level positioning. Multi-constellations and all-frequency tracking. • Ideal for positioning, timing, surveying as well as control systems and autonomous applications	• Same features as the EMBox Positioning • Second GNSS antenna input for precise, reliable and positioning independent heading information • Reduced update rate to 20 Hz for RTK + Heading • Dual band GNSS signal tracking • Ideal for applications with the need of immediate initialization of inertial sensors which would rely on movement for their attitude measurements

1 GNSS Performance

Highlighted Features

AIM+ industry leading anti-jamming, anti-spoofing interference monitoring & mitigation technology

IONO+ advanced scintillation mitigation

APME+ a posteriori multipath estimator for code and phase multipath mitigation

LOCK+ superior tracking robustness under heavy mechanical shocks or vibrations

RAIM+ receiver autonomous integrity monitoring

OSNMA supported

RTK

Moving Base RTK (only EMBox Positioning)

GNSS heading (only EMBox Heading)

GNSS bands

EMBox Positioning

GPS	L1C/A, L1C, L1PY, L2C, L2P, L5
Galileo	E1, E5a, E5b, E5 AltBoc, E6
GLONASS	L1CA, L2CA, L2P, L3 CDMA
Beidou	B1I, B1C, B2a, B2b, B2I, B3
QZSS	L1C/A, L1C/B, L2C, L5
Navic	L5
SBAS	Egnos, WAAS, GAGAN, MSAS, SDCM (L1, L5)
L-band	Yes

EMBox Heading

GPS	L1, L2
Galileo	E1, E5b
GLONASS	L1, L2
Beidou	B1, B2, B3
QZSS	L1C/A, L1C/B, L2
SBAS	Egnos, WAAS, GAGAN, MSAS, SDCM (L1)

Accurate RTK Positioning (1σ)

Horizontal accuracy	0.006 m ± 0.5 ppm
Vertical accuracy	0.010 m ± 1 ppm

Other positioning modes accuracy (1σ)

Standalone	1.2 m Horizontal, 1.9 m Vertical
SBAS	0.6 m Horizontal, 0.8 m Vertical
DGNSS	0.4 m Horizontal, 0.7 m Vertical

Accurate Attitude (1σ, EMBox Heading only)

1m antenna spacing	
Roll and Pitch	0.25°
True Heading	0.15°
5m antenna spacing	
Roll and Pitch	0.05°
True Heading	0.03°

Velocity Accuracy 0.03 m/s RMS

Maximum update rate:

Measurements only	100 Hz
Position	100 Hz
For the EMBox Heading:	
Standalone, SBAS, DGPS + attitude	50 Hz
RTK + attitude	20 Hz

Latency < 10ms

Time to first fix

Cold start	< 45 s
Warm start	< 20 s
Re-acquisition	1 s

Tracking performance (C/N0 threshold)

Tracking	20 dB-Hz
Acquisition	33 dB-Hz

2 Getting Started

2.1 Use via a Web Browser

The receiver can be controlled and configured using a web browser. As standard the system is delivered with a static IP address. This address can be used to access the web UI for configuration and to receive the output data streams.

Default Static IP address: **10.0.0.111**

To access the web interface, make sure you connect the system to your machine which is set to a static IP address in the same address space (10.0.0.x). You can then open it via web browser by entering the IP address of the system.

Alternatively, you can access also via a URL. If your receiver's hostname is mosaic-x5-1234567, simply use the following URL in your web browser: http://mosaic-x5-1234567 or, for a secure connection: https://mosaic-x5-1234567. You can get the host name from the web app.

The HTTPS certificate (.pem file) can be uploaded through the Communication > Web Server/TLS menu of the web interface.

Most user commands, described in section 3.2 in MOSAIC-X5 Firmware Reference Guide (RD-01, RD-02), can be accessed graphically from the web interface. You can also go to Admin > Expert Control > Expert Console to manually type ASCII commands and view replies.

By default, the web interface provides unrestricted read and write access to the receiver. This can be changed, as further explained in section 1.24 of this document. Note that a lightweight (text only) version of the web interface is available by appending /lite to the URL, for example:

http://mosaic-x5-1234567/lite

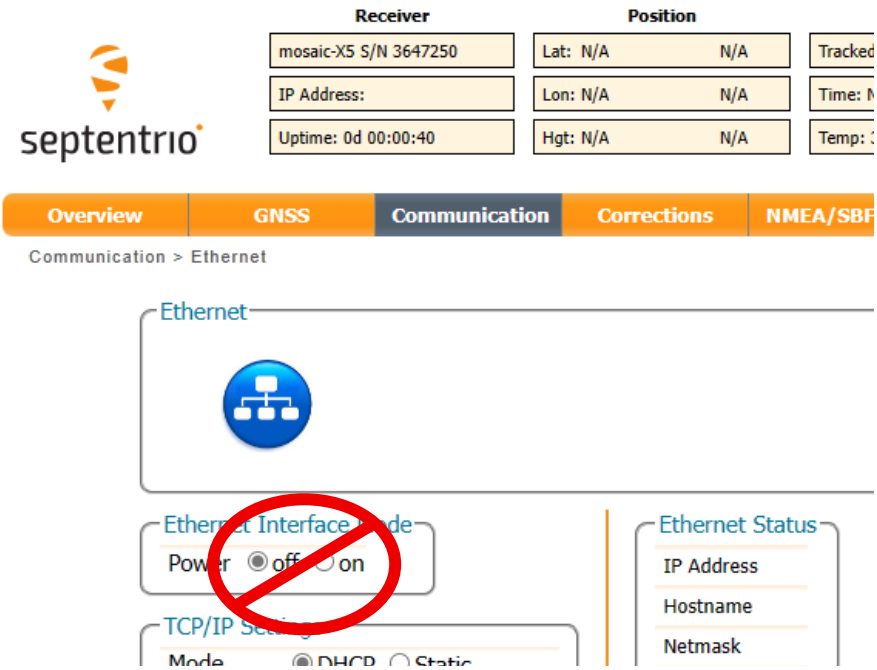
2.2 Ethernet port settings

In the web app it is possible to change the ethernet settings, like the IP address or set Dynamic IP. Dynamic IP address allocation requires the availability of a DHCP server in your local network. In the absence of a DHCP server, or when a fixed IP address is desirable, it is possible to disable the DHCP client (default) and use a fixed address. This is done using the **setIPSettings** command.

You can also enable the PTP time server functionality in the web app or via commands (GNSS->Timing).

As the ethernet point is the only method of communication to the device, change the settings carefully as there is the risk of locking out. **You must not set the Ethernet Interface Mode to off** as you would then have no possibility to access the device again.

In case you locked yourself out, contact ANavS Support to get assistance.



2.3 Data via TCP/IP

The system supports up to eight independent TCP/IP connections in parallel, through ports 28783 and 28784. These can be configured for different stream types, like SBF (default) or NTRIP.

Communication through port 28783 is TLS encrypted, while port 28784 uses plaintext (unencrypted) transmission. These ports can be enabled or disabled with the setIPServices command and their number can be changed with the setIPPortSettings command.

Plaintext communication is not recommended on public networks, as it can be intercepted or modified by malicious third parties. Using the encrypted IP port is advised when possible. Data exchange over the encrypted port is secured using Transport Layer Security (TLS), the successor to Secure Sockets Layer (SSL).

By default, the receiver presents a self-signed certificate during TLS handshake, which is susceptible to man-in-the-middle attacks. Preferably, a .pem file containing a trusted certificate and its corresponding private key can be uploaded through the Communication > Web Server/TLS menu of the web interface.

In older firmware versions, anonymous users could control the receiver over a TCP/IP connection. For enhanced security, it is now mandatory to log in with a valid username and password before issuing any commands. So, after establishing a TCP/IP connection, the first command should always be login.

3 Interfaces

3.1 Protocols

The EMBox supports a wide range of different protocols which can be configured in the web app. Standard protocols like NMEA allow an easy integration in existing systems.

Overview of supported protocols:

- Septentrio Binary Format (SBF)
- NMEA 0183, v2.3, v3.03, V4.0
- RINEX v2.x, v3.x
- RTCM v2.x, v3.x (MSM included)
- CMR v2.0 (out/in), CMR+ (input only)
- PTP timing server

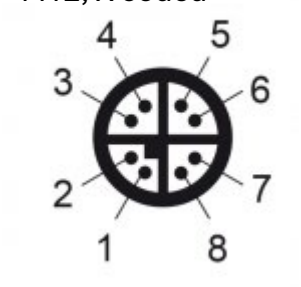
A ROS1 and ROS2 driver is available trough the open-source ROSaic project which allows easy use in robotics applications:

https://github.com/septentrio-gnss/septentrio_gnss_driver/

3.2 Physical

Ethernet port: The EMBox exposes a Fast-Ethernet interface though it's female, M12 8-pos, X-coded connector. This connector provides data via the Ethernet interface, as well as Power over the PoE Protocol. Use a standard male M12 X-coded ethernet cable to interact.

M12, X coded

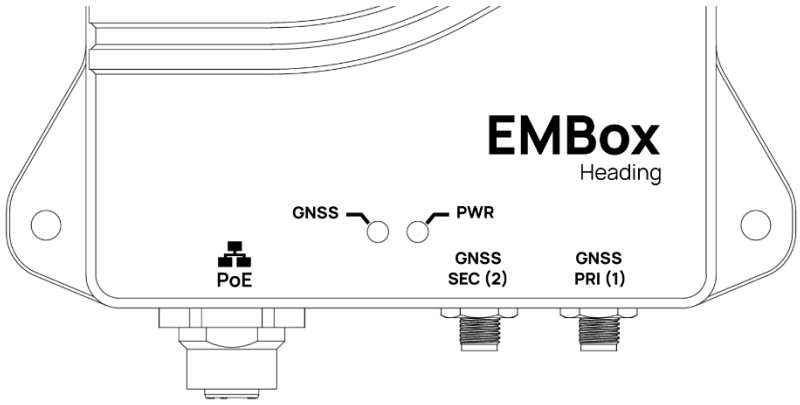


	DC on spares		mixed DC & data	
Pin 1	Rx +		Rx +	DC +
Pin 2	Rx −		Rx −	DC +
Pin 3	Tx +		Tx +	DC −
Pin 4		DC +	Unused	
Pin 5		DC +		
Pin 6	Tx −		Tx −	DC −
Pin 7		DC −	Unused	
Pin 8		DC −		

MDI/MDI-X is supported i.e., RX/TX and DC+/- can be swapped

GNSS PRI (1): SMA connector for primary GNSS Antenna

GNSS SEC (2): (only for EMBox Heading): SMA connector for secondary GNSS Antenna.



4 Electricals

4.1 Electrical Specification

The EMB is powered via passive Power over Ethernet (PoE). Power consumption of the EMB module varies slightly depending on the current activity state, and which signals are actively being used.

Power	Power consumption max 2.3 W, typ 1.8 W Voltage Range 4.5 – 28 V
Power-over-Ethernet	IEEE802.3af compliant
Temperature range	-40 … +85 °C
GNSS antennas	LNA supply: 4.5 – 5 V, max. 150 mA EMBox Positioning: 15-50 dB (AGC gain: 15-50dB) EMBox Heading: 15-35dB (AGC gain: 30-50dB) ESD protected

4.2 GNSS Antenna LNA

A DC voltage is available via the one or two coax connectors to power low noise amplifiers (LNA) inside the GNSS antenna. The LNA supply is **4.5 – 5 V,** interlay limited to **150 mA.**

The Mosaic chipset only provides LNA power supply on one output (Ant 1). This is routed to the LNA output to both coax antenna connecters Ant 1 and Ant 2. The total power budget is thus shared between both antennas, with the combined total current limit of 150 mA.
In the case of an overcurrent event, such as a shorted antenna cable, the current is first limited to 150 mA and the disabled after 10ms. The module will attempt to reenable the LNA supply periodically to check if the short condition is resolved. You can read out the antenna status with a corresponding message.

4.3 Pre-amplification Gain Range

Pre-amplification for the onboard Mosaic chipset is specified for an input gain range of 15-50 dB for EMBox Positioning and 15-35 dB for EMBox Heading.

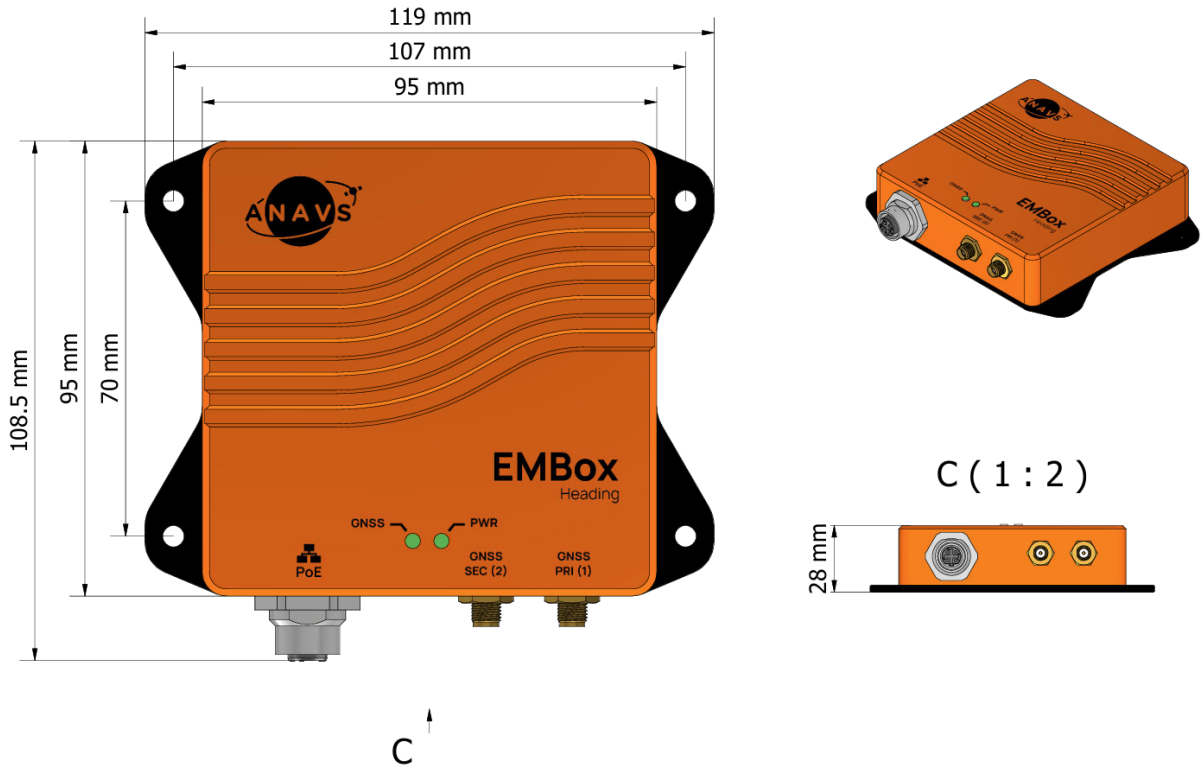
It is recommended that attenuators are used if pre-amp gain is higher than 35 dB.

It is also noted that pre-amplification gain should not differ more than 5dB. Ideally both IN1 and IN2 should have the same model of antenna and, where possible, similar lengths of antenna cable.

5 Physical and Environmental

Ingress protection	IP68
Operating temp	-40 to 85° C
Storage temp	-55 to 85° C
Vibration	MIL-STD-810G
Certification	RoHS, WEEE, CE, FCC

5.1 Dimensions



Any questions?

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