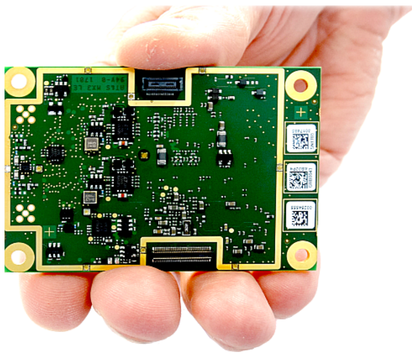
Upgrading to the AsteRx-m2



How To...

How To: Upgrading to the AsteRx-m2 version 1.4

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Introducing the AsteRx-m2

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The AsteRx-m2 is a high-end ultra-low power GNSS board. Its low power and credit-card footprint make it the ideal receiver for integration in UAS and hand-held devices. The combination of multi-constellation, multi-frequency tracking and the GNSS+ toolset mean that the AsteRx-m2 comes into its own in difficult conditions.

1.1 Key Features

- All-in-view tracking
- Lowest power of any comparable receiver
- cm-level RTK and PPP positioning
- Full EMI shielding
- AIM+: the benchmark for on-board interference mitigation of GNSS signals
- RxTools: a comprehensive software toolset for receiver monitoring, configuration, data logging, analysis and conversion
- Focus on ease-of-integration

1.2 Improving on the AsteRx-m

The AsteRx-m2 offers significant improvement on the AsteRx-m including:

- Addition of BeiDou, Galileo, QZSS and IRNSS tracking
- Simultaneous triple-frequency tracking of all constellations
- 2-channel L-band demodulator for TerraStar services
- PPP positioning
- Maximum data output rate increased to 100 Hz
- Time and frequency synchronisation using the REF IN and TimeSync (PPS IN) inputs
- 60-pin connector to include extra functionality
- Two active/passive antenna connections
- SDIO interface for data logging now supports eMMC
- 4 Hi-speed serial ports

How To...

What improvements does the AsteRx-m2 bring? 2

2.1 Tracking all satellites on multiple frequencies

If you are out in the open with an unobstructed view of the sky and are not too worried about occasional position biases of several centimetres, then maybe GPS L1 signals can suffice. In all other cases, you will need more satellites and more frequencies. L1 only RTK positioning can aslo take several minutes to converge and without a second frequency, there is also a much larger possibility of a wrong position fix.

If only GPS satellites are available, the number of satellites available for positioning can be restrictively low as Figure 1 shows. The satellite availability over the course of 24 hrs is rarely above the GDOP threshold when the elevation mask is 15°. When GLONASS and GALILEO are included, the situation is rather different as Figure 2 shows. As an illustration, a 15 m tree at a distance of 55 m and a 6 m building at 20 m will block out satellite signals with an elevation of 15°.

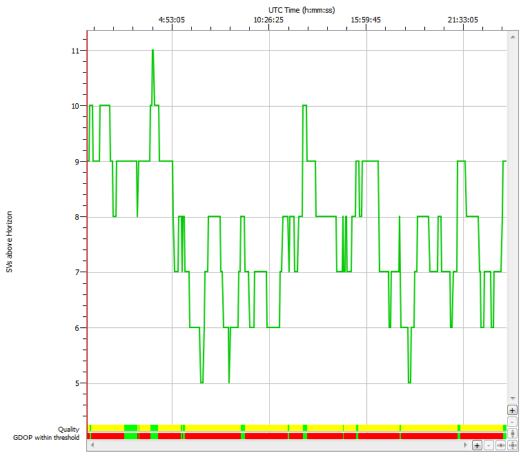


Figure 1: *GPS satellite availability over 24 hours with an elevation mask of 15°*

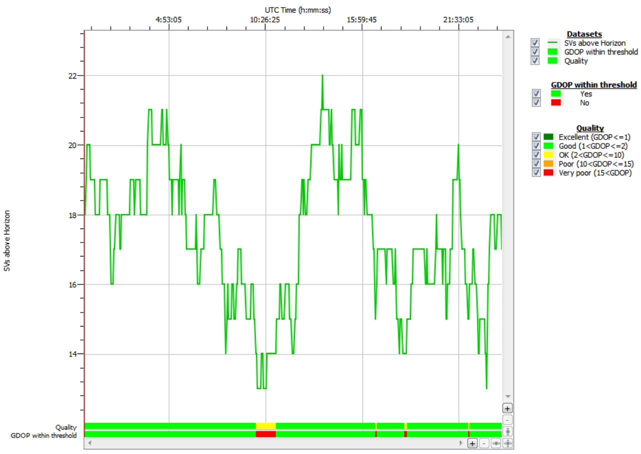
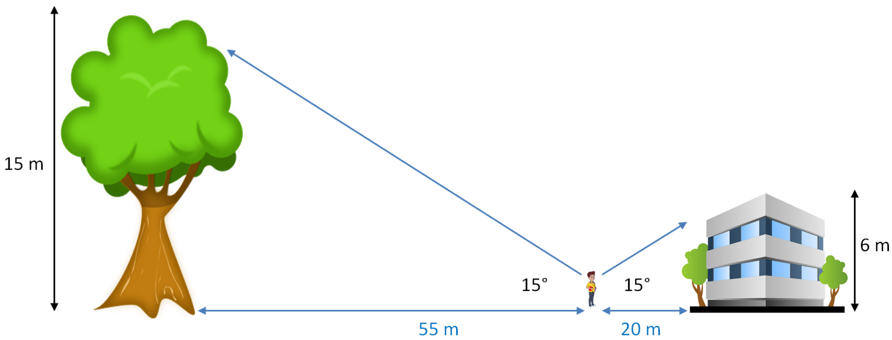


Figure 2: *GPS, GLONASS and GALILEO satellite availability over 24 hours with an elevation mask of 15°*



2.2 Ultra-low power consumption

When tracking all visible GPS and GLONASS satellites on L1 and L2 frequencies, the AsteRx-m2 consumes less than 800 mW - the lowest on the market of any comparable device[1]. Lower power consumption means longer operation on a single battery charge. It can also mean a reduction in overall weight as lower capacity, lighter batteries can be used. This is particularly relevant for UAV applications where payload translates directly into time in the air and to the design and complexity of the system.

2.3 Low latency and high-data rate

With a latency of <10 ms and a data output rate of up to 100 Hz, the specifications of the AsteRx-m2 are machine-control level. The AsteRx-m2 can thus be used in the highest dynamic applications where high-precision, real-time RTK positioning is required.

2.4 PPP positioning: cm-level without a base station

Similar to RTK positioning, PPP uses not only the code information modulated onto the satellite signals but also the phase of the signals themselves. The crucial difference is that PPP doesn't need a base station as it gets correction information via satellite transmissions in the L-band. The AsteRx-m2 has a 2-channel L-Band demodulator to track and decode PPP correction data[2].

Using PPP simplifies the setup significantly. For real-time cm-level positioning, there is no need for an additional communication link for correction data from a base station. There is also no need to get a subscription for a network provider or even, as many users are forced to do, purchase and setup your own base station receiver.

Another crucial difference is that unlike RTK, PPP correction data is globally applicable and so the position precision is constant at any location on Earth. For RTK, precision degrades at a rate of 1 mm per 1 km distance from the base station. The typical precision for TerraStar C PPP is 4 cm while for short baseline (<20 km) RTK, the precision is around 1-2 cm.

2.5 Interference mitigation with AIM+

With GNSS signals barely distinguishable from the background, they can be vulnerable to any passing interferer. Interference considerations were at the forefront of the AsteRx-m2 design and incorporated into every stage of signal processing.

The AsteRx-m2 features AIM+ which offers built-in protection against intentional and unintentional jamming using a sophisticated system of sampling and mitigation mechanisms.

[1] Refer to the AsteRx-m2 hardware manual for the full power consumption specifications
[2] Please note that a TerraStar subscription is needed for PPP positioning

The AsteRx-m2 can suppress the widest variety of interferers from simple continuous narrow-band signals to the more complex wideband and pulsed transmitters. Figure 3 illustrates the effectiveness of AIM+ against wideband interference from a chirp jammer.

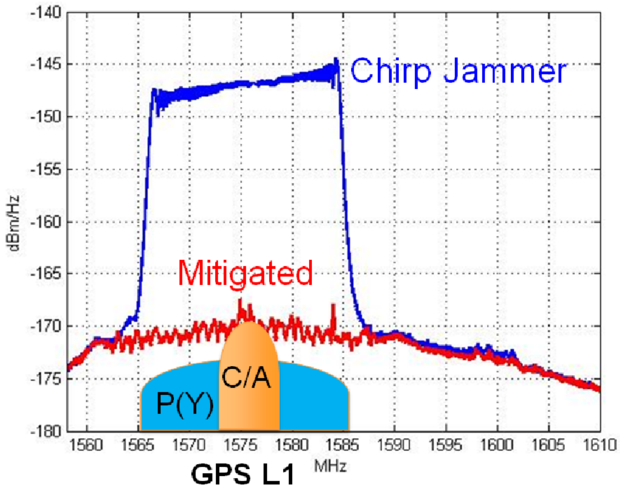


Figure 3: *The GPS L1 signal contaminated with a chirp jammer signal both before (blue) and after (red) activation of AIM+ Interference Mitigation*

More information on the particular interference hazards liable to be encountered in UAV application and what AIM+ can do to combat them are detailed in the white paper 'GNSS Interference in Unmanned Aerial Systems'.

2.6 Easy to integrate

The AsteRx-m2 was developed with ease-of-integration in mind. To get your system up and running as quickly and easily as possible, the AsteRx-m2 includes the following features:

- AsteRx-m2 is the receiver module in the AsteRx-m2 UAS (see Section 4) which is designed for fast and easy integration into UAS applications
- Easy-to-integrate logging interface
- Support of all common format standards (NMEA, RTCM, RINEX, etc.)
- Septentrio Binary Format (SBF), fully documented with sample parsing tools
- Intuitive and fully-documented RxControl GUI tool for configuring, monitoring and logging data
- Advanced set of tools for easy integration (RxTools, Message API SDK)
- Fully compatible GeoTagZ and PP-SDK for seamless re-processing

3 Upgrading from the AsteRx-m

How To...

3.1 Drop-in replacement

The AsteRx-m2 was designed to be a slot-in upgrade of the AsteRx-m. It has the same footprint and a slightly slimmer height profile compared to the AsteRx-m.

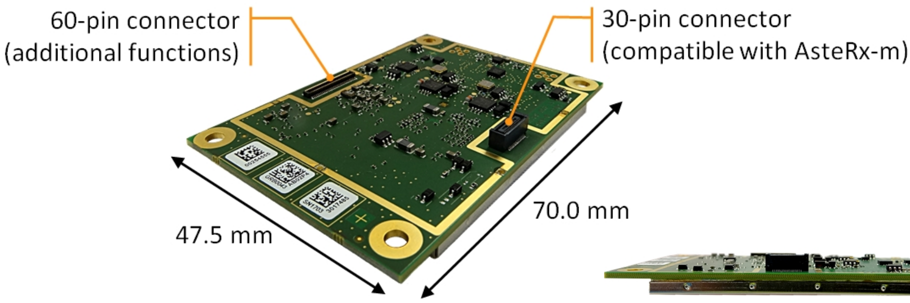


Figure 4: *Dimensions of the AsteRx-m2 and locations of the 30 and 60-pin connectors*

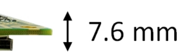


Figure 5: *Height profile of the AsteRx-m2 (4.2 mm board + 3.4 mm 30-pin)*

3.2 Hardware improvements

The AsteRx-m2 offers several hardware improvements over the AsteRx-m. These improvements have been implemented with a view to maximising backwards compatibility with applications designed for use with the AsteRx-m.

Refinements to the existing 30-pin connector

PIN 19	On the AsteRx-m, this pin was the input for Event A only and was pulled up internally. On the AsteRx-m2, as well as the Event A input, this pin is also the TimeSync input and is pulled down internally. If this pin was also externally pulled up for an AsteRx-m integration using a resistor greater than 10 kΩ then, when connecting an AsteRx-m2 board, this pin may not behave as expected.

Additional connectivity via the new 60-pin connector[3]

In addition to the 30-pin connector that was also present on the AsteRx-m, the AsteRx-m2 features an additional 60-pin connector (2 mm lower in height than the 30-pin connector) and indicated in Figure 4. The 60-pin connector offers the extra functionalities listed below:

[3] In future, USB OTG, Ethernet and CAN connectivity will also be available via the 60-pin connector

- Connection via an additional serial port, COM 4
- 2 General Purpose Output connections configurable using the **setGPIOFunctionality** command
- An additional event input, EventB
- Inputs for time and frequency synchronisation with an external timing reference

aux

Improvements to antenna connectivity

There are two electronically-identical U.FL connectors on the AsteRx-m2 board to connect the RF signal from an antenna[4]. The two connections are named **ANTA** and **ANTB** as Figure 6 shows. Both active and passive antennas are supported. The AsteRx-m2 will by default, automatically detect the presence of an antenna or, the default can be overruled using the **setAntennaConnector** command.

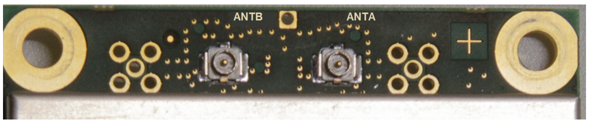


Figure 6: *AsteRx-m2 board showing two U.FL antenna connectors*

Please note that, as the AsteRx-m2 is able to track more satellite constellations and frequency bands than the AsteRx-m, the antenna used will need to be capable of tracking these additional signals.

3.3 AsteRx-m2 firmware and command improvements

Upgrading AsteRx-m2 firmware

The added functionality of the AsteRx-m2 compared with the AsteRx-m has necessarily lead to an increase in firmware file sizes. For this reason, when upgrading the firmware of the AsteRx-m2, it is recommended to use either the USB connection or a serial connection with a high baud rate in order that the process doesn't become prohibitively long.

Using a baud rate of 921600, the AsteRx-m2 firmware will upgrade in about 5 minutes and, the higher the baud rate, the faster the upgrade will be. The serial ports of the AsteRx-m2 support baud rates of up to 3 Mbaud[5]. Alternatively, upgrading over USB will take approximately 2 minutes.

[4] The two connectors are designed to provide integration flexibility and cannot be used to calculate heading
[5] Baud rates above 921600 are not typically supported on computers and so upgrades cannot be carried out over RS232. To upgrade using baud rates above 921600, the TTL serial lines can be used.

Changes to receiver configuration commands and SBF data blocks

New commands and SBF blocks

New commands have been added to the AsteRx-m2 to configure the new features:

- Tracking of GALILEO, BeiDou, IRNSS, QZSS and L-band
- Configuration of AIM+ Interference Mitigation
- Configuration of PPP positioning
- Configuration of the additional serial COM4 port as well as the higher baud rates now available on all COM ports

Additional measurements and navigation SBF blocks are now present to accommodate the new constellations and signals. These blocks are selected automatically when for example, the **Support**, **PostProcess** or **RINEX** groups are selected for logging or output. The size of the files or data throughput when selecting these groups will consequently be larger. The commands and contents of the SBF blocks are fully documented in the *AsteRx-m2 GNSS Firmware Reference Guide*.

Removed commands and SBF blocks

The information in certain SBF blocks has been regrouped with the loss of some blocks. The following SBF blocks have been discontinued:

- PVTSatCartesian
- PVTResiduals
- RAIMStatistics
- GEOCorrections
- BaseLine
- IQCorr

The discontinued blocks will no longer appear as part of the **GUI** or **PVTExtra** groups.

The following AsteRx-m configuration commands cannot be used with the AsteRx-m2:

- **`setNWALevels`**
- **`setFixReliability`**
- **`setFrontendMode`**
- **`setChannelConfiguration`**.

Again, the commands and contents of the SBF blocks are fully documented in the *AsteRx-m2 GNSS Firmware Reference Guide*.

4 The AsteRx-m2 UAS

The AsteRx-m2 UAS is a quick and convenient way to get access to the AsteRx-m and AsteRx-m2 without any hardware integration. The AsteRx-m2 UAS, which can be used as a development kit, consists of an AsteRx-m2 receiver board mounted on an interface card that is specifically designed to ease integration in UAS and mobile mapping applications. The UAS interface board only offers access to functionality available via the 30-pin connector and not the 60-pin connector.

4.1 Mounting the AsteRx-m2 on the UAS board

The two boards are connected via 30-pin connectors as shown in Figure 7.

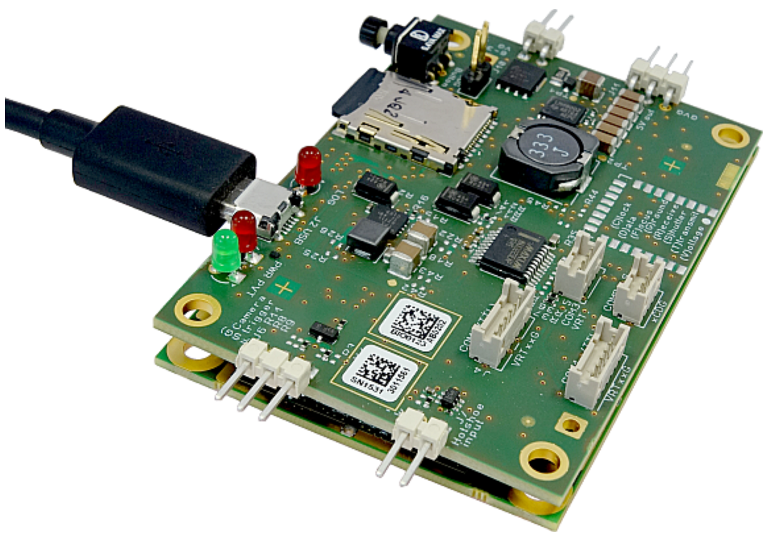


Figure 7: *AsteRx-m2 mounted on the UAS interface board*

4.2 Powering the AsteRx-m2

The easiest way to power the AsteRx-m2 is via USB. Connect the USB cable between the micro USB connector on the UAS board and a computer. When the UAS board is powered, the red LED labelled ‘PWR’ will be lit.

4.3 Communicating with the AsteRx-m2

The USB connector of the AsteRx-m2 maps on to two virtual serial COM ports. Using the GUI software tool RxControl, you can connect to the receiver using either of these COM ports as Figure 8 shows.

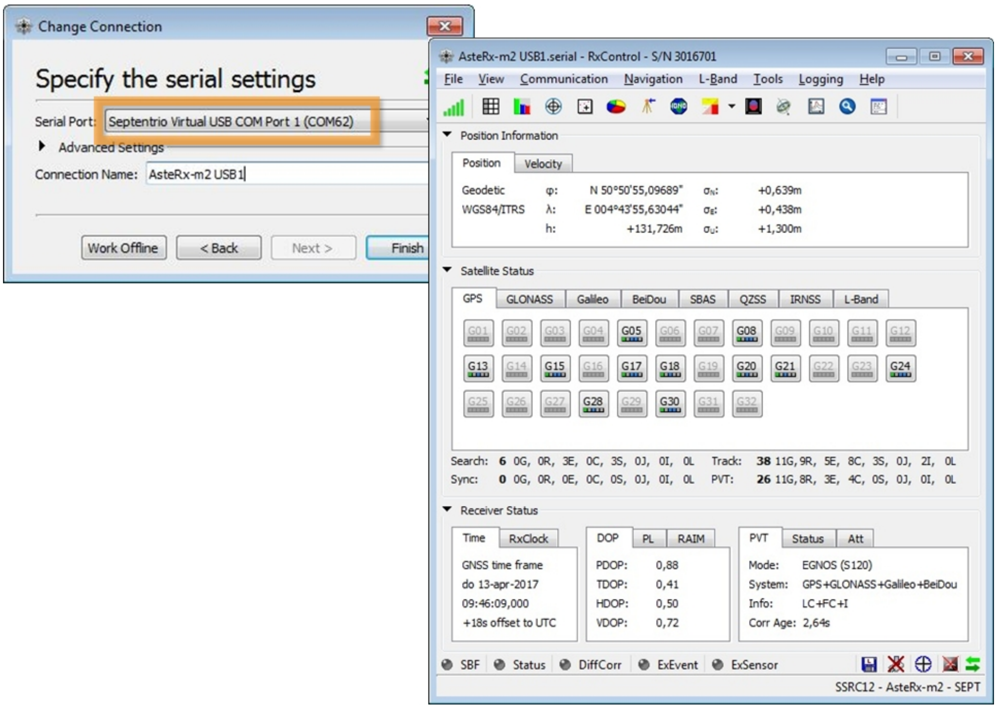


Figure 8: *Connect via USB and select one of the two virtual serial COM ports on RxControl*

When connected using RxControl, you can fully monitor and configure the AsteRx-m2. With an antenna connected, the various plots showing signal tracking and quality will be filled. Two of the most important monitoring plots are shown in Figures 9 and 10. When the antenna has a clear view of the sky, there should be about 3 satellites with an L1 carrier-to-noise level above 50 dB-Hz.

Figure 10 shows the RF spectrum from the antenna in the L1-band. The small bump is the central frequency of the GPS L1CA signal and any other activity in this plot may indicate interference.

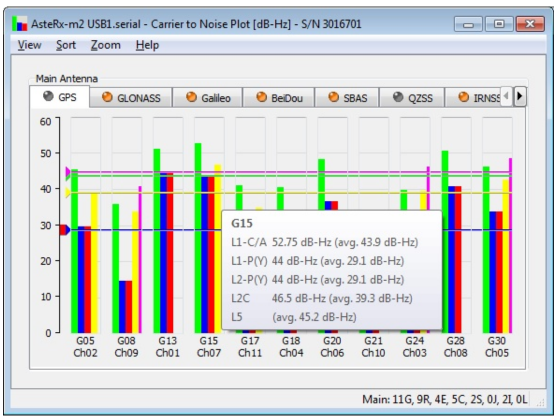


Figure 9: *The AsteRx-m2 carrier-to-noise plot when connected to an antenna with a clear-sky view*

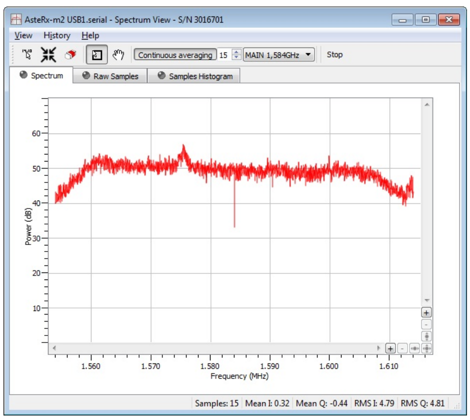


Figure 10: *Spectrum view plot of RxControl showing the L1 frequency band*

5 RPK processing with GeoTagZ and PPSDK

In applications such as aerial survey, RTK positioning is not needed in real time instead, data logged using AsteRx-m2 can be reprocessed offline using correction data from a base station using GeoTagZ or PPSDK. The AsteRx-m2 can log measurement data at up to 100 Hz so there is no reduction in precision quality for very-high dynamic positioning which is particularly relevant in the case of fixed-wing drones. Using the AsteRx-m2 data and processing it with the base station data, GeoTagZ is able to stamp each photograph taken during the flight with a precise RTK position. GeoTagZ can be either integrated in an application or used out-of-the-box with the GeoTagZ GUI shown in Figure 11.

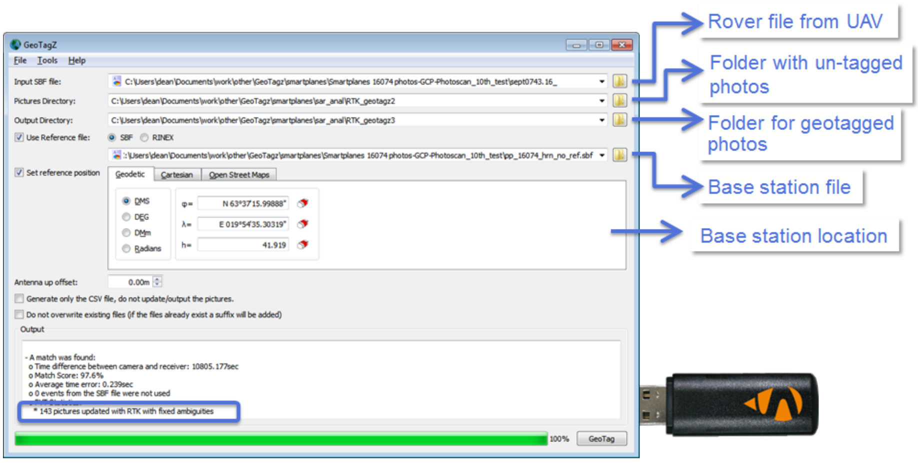


Figure 11: *The GeoTagZ GUI*

For aerial survey, the position accuracy of the photographs translates directly into precision on the ground as Table 11 shows.

File	GCP/check points	Mode	checkpoints RMS error (m)		
			XY	Z	3D
s_1	10 GCP, 10 check points	RTK	0.016	0.019	**0.025**
s_2	20 check points	RTK	0.021	0.022	**0.031**
s_3	20 check points	SA	1.22	3.09	**3.32**

Table 1: *The results of Agisoft processing using photographs processed using GeoTagZ. In the first two tests (s_1 and s_2) GeoTagZ was used for RTK positioning while in the third test (s_3), standalone positioning was used.*

GeoTagZ is designed to provide input for photogrammetry processing software however for other applications, PP-SDK offers full flexibility. PP-SDK is a professional software development kit that includes all the necessary tools to incorporate re-processing functionality into your own applications and products. It is compatible with common programming languages such as C/C++.

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AsteRx-m2 Specifications

A

Signal tracking

GPS (L1, L2, L5)
GLONASS (L1, L2, L3)
Galileo (E1, E5a, E5b, AltBoc)
BeiDou (B1, B2)
SBAS (EGNOS, WAAS, GAGAN, MSAS, SDCM) (L1, L5)
IRNSS (L5)
QZSS (L1, L2, L5)
Integrated dual channel L-band receiver

Power comsumption

GPS/GLO L1/L2 (22 sats in tracking)	770 mW
All Signals all GNSS constellations (33 sats in tracking)	950 mW
All Signals all constellations + L-Band	1050 mW
Enabling wideband interference mitigation	+80 mW
Connecting the UAS interface board	+150 mW

Physical

Input voltage	3.3 VDC $\pm$ 5%
Size	47.5 x 70 x 7.6 mm
Weight	28 g

I/O connectors

30 pin Hirose DF40 socket
60 pin Hirose DF40 socket for expanded connectivity

Connectivity

4 Hi-speed serial ports
1 USB device port
Time and Frequency synchronization
User configurable xPPS output (max 100Hz)
2 Event markers
SDIO interface for logging (covers μSD, SD, eMMC)
Outputs to drive external LEDs
General Purpose output

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How To...

Formats

Septentrio Binary Format (SBF), fully documented with sample parsing tools
NMEA 0183, v2.3, v3.01, v4.0
RINEX v2.x, 3.x
RTCM v2.x, 3.x (MSM messages included)
CMR v2.0 and CMR+ (CMR+ input only)

Maximum update rates

Position	100 Hz
Measurements only	100 Hz

Latency

$<$10 ms

Antenna

Connectors	2 x U.FL
Antenna supply voltage	3-6 VDC
Maximum current	200 mA
Detection current	6 mA