Ellipse AHRS & INS

High Performance, Miniature Inertial Sensors

Hardware Manual

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Support support@sbg-systems.com
+33 1 80 88 45 00

SBG Systems
3bis, chemin de la Jonchère
92500 Rueil-Malmaison
FRANCE

SBG SYSTEMS

Revision history

Rev.	Date	Author	Information
1.2	Mar 6, 2017	Alexis Guinamard	[ELIDOC-39] Split the User manual into hardware manual and other common documentations (firmware manual and Technical Reference Manual) [ELIDOC-38] Document the automatic 1Hz GGA output on PORT-C for ELLIPSE-D when RTCM corrections are enabled [ELIDOC-40] Detail interfaces and ports capabilities depending on Ellipse model [ELIDOC-36] Update support contact details [ELIDOC-32] Updated RS-232/RS-422 electrical specifications [ELIDOC-41] Updated warranty period (2 years) [ELIDOC-42] Clarified automotive dead reckoning performance [ELIDOC-44] Added SPLIT cables description
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1	Oct 7, 2014	Alexis Guinamard	First public version
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PRE1	Mar 6, 2014	Alexis Guinamard	First pre-version of this document

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Terminology

ADC: Analog to Digital Converter
AHRS: Attitude and Heading Reference System
CAN (Bus): Controller Area Network
DHCP: Dynamic Host Configuration Protocol
DVL: Doppler Velocity Log
EKF: Extended Kalman Filter
EEPROM: Electrically-Erasable Programmable Read-Only Memory
FIR: Finite Impulse Response (filter)
FTP: File Transfer Protocol
FS: Full Scale
FOG: Fiber Optic Gyroscope
GNSS: Global Navigation Satellite System
GPS: Global Positioning System
IIR: Infinite Impulse Response (filter)
IMU: Inertial Measurement Unit
INS: Inertial Navigation System
IP: Internet Protocol
LBL: Long Baseline
MAC (address): Media Access Control
MEMS: Micro Electro-Mechanical Systems
NED: North East Down (coordinate frame)
NA: Not applicable
NMEA (NMEA 0183): National Marine Electronics Association (standardized communication protocol)
PPS: Pulse Per Second (signal)
RAM: Random Access Memory
RMA: Return Merchandize Authorization
RMS: Root Mean Square
RTCM: Radio Technical Commission for Maritime Services (Protocol)
RTK: Real Time Kinematics
SI: International System of Units
TBD: To Be Defined
TCP: Transmission Control Protocol
UDP: User Datagram Protocol
UTC: Coordinated Universal Time
USBL: Ultra Short Base Line
VRE: Vibration Rectification Error
WGS84: World Geodetic System 1984
WMM: World Magnetic Model

1. Introduction

Ellipse series is a line of miniature, high-performance MEMS based Inertial Systems which achieve exceptional orientation and navigation performance in a miniature and affordable package. It includes an Inertial Measurement Unit (IMU) and runs an on-board enhanced Extended Kalman Filter (EKF). The Ellipse line is divided in a comprehensive set of sensors:

Figure 1.1: The Ellipse INS (N model)

- The Ellipse-A version is an attitude and Heading Reference System (AHRS), providing accurate orientation in dynamic conditions.
- The Ellipse-E, N and D models are Inertial Navigation Systems (INS), providing both orientation and navigation data. The use of GNSS data or other aiding equipment such as odometer or internal barometric sensor can be used to provide accurate navigation data, but also to improve orientation accuracy:
  - The Ellipse-E model can be connected to an external GNSS receiver.
  - The Ellipse-N model embeds an industrial GNSS receiver in a miniature package.
  - The Ellipse-D embeds a survey grade GNSS receiver with dual antenna heading for excellent heading performance in magnetic denied environments. Targeting demanding application, it is also capable of post-processing, thanks to the internal GNSS raw data output.

To achieve the best performance in every project, specific error models have been implemented to meet applications requirements. Sensor configuration is made easy through the sbgCenter interface, provided in the SDK. The Ellipse supports a proprietary protocol for best performance, but also standard protocols such as NMEA for direct integration into existing applications.

1.1. Ellipse Overview

The following diagram shows the basic organization of an Ellipse-E or N. On the Ellipse-A version, this block diagram is slightly simplify as there is no GPS, barometer inside.

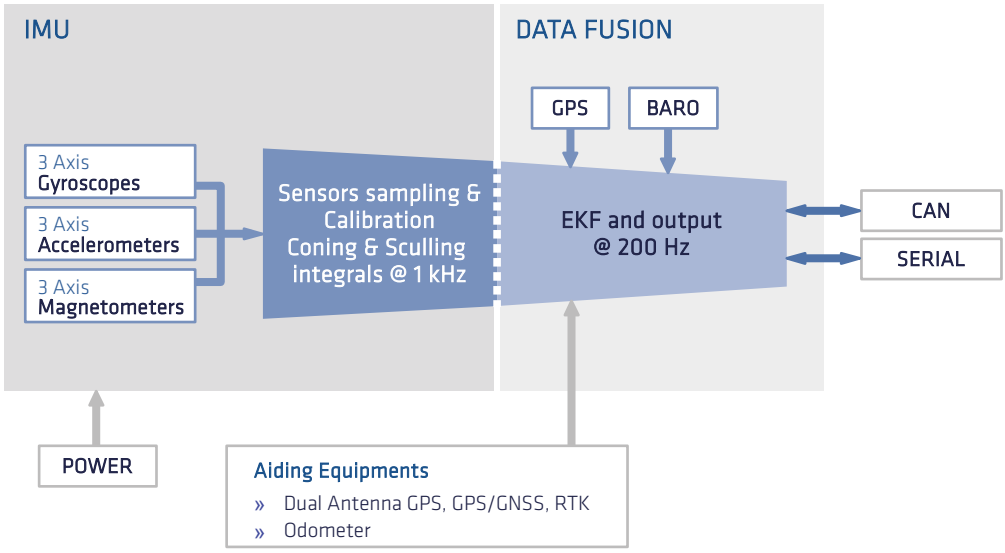


Figure 1.2: Ellipse simplified block diagram

1.2. Inertial measurement unit

As an IMU is the main component of an inertial navigation system, the Ellipse IMU has been carefully designed to take full advantage and performance of MEMS technology.

1.2.1. Accelerometers

The Ellipse IMU embeds a set of 3 MEMS capacitive accelerometers. Coupled with advanced filtering techniques and sculling integrals, these accelerometers will provide consistent performance, even in vibrating environment.

	A2	A3	Remarks
Full scale (*g*)	8	16	
Scale factor stability (%)	0.1	0.1	
Non-Linearity (% of FS)	0.2	0.2	
One year bias stability (m*g*)	5	10	
Velocity Random Walk (µ*g*/√hz)	100 (X, Y) 150 (Z)	200 (X, Y) 300 (Z)	Allan variance – @ 25°C
In run bias instability (µ*g*)	20	40	Allan variance – @ 25°C
Vibration Rectification Error (m*g*/*g*²)	7	4	
Bandwidth (Hz)	250	250	Internal low pass filters attenuation < 3 dB
Sampling rate (kHz)	3	3	
Orthogonality (°)	< 0.05	< 0.05	

1.2.2. Gyroscopes

The set of 3 high end industrial grade MEMS gyroscopes is sampled at 10 KHz. An efficient FIR filter and coning integrals computations ensures best performance in vibrating environments.

	G2	G3	G4	G5	Remarks
Full scale (°/s)	100	200	450	1000	
Scale factor stability (%)	0.05	0.05	0.05	0.05	
Non-Linearity (% of FS)	0.05	0.05	0.05	0.05	
One year bias stability (°/s)	0.2	0.2	0.2	0.4	Total composite bias
In run bias instability (°/hr)	8	8	8	10	Allan variance – @ 25°C
Angular Random Walk (°/√hr)	0.16	0.16	0.18	0.18	Allan variance – @ 25°C
Bandwidth (Hz)	133	133	133	133	Internal Gyro bandwidth
Sampling rate (kHz)	10	10	10	10	Advanced anti-aliasing FIR filter
Orthogonality (°)	0.05	0.05	0.05	0.05	

1.3. Aiding sensors

Many different aiding sensors can be used to aid the Ellipse INS.

1.3.1. Internal Magnetometers

A set of three Anisotropic Magneto-resistive magnetometers is embedded within the Ellipse. This technology provides a very high sensitivity compared to coil based technologies.

Although part of the Ellipse internal IMU, the magnetometer is in fact considered as an "aiding sensor" and is not mandatory for proper operation.

Nevertheless, in many applications such AHRS applications, airborne or several marine applications, this magnetometer is still a reliable and efficient way to observe heading.

Note: Magnetometer use requires a specific in place calibration in order to compensate surrounding ferromagnetic materials and magnets. Please refer to the Ellipse Hard and Soft Iron Calibration Manual for more information about this.

Warning: Note that magnetometer sampling design makes it impossible to reject signal frequencies above 180Hz. User should ensure that high frequency noise is not disturbing magnetometers at the sensor's location.

	Specifications	Remarks
Full scale (Gauss)	8	
Scale factor stability (%)	0.5	
Linearity (% of FS)	0.1	
Noise (µGauss)	200	Over 1 to 25 Hz band
Bias stability (m Gauss)	0.5	
Bandwidth (Hz)	110	
Resolution (mGauss)	2	
Sampling rate (Hz)	220	
Orthogonality (°)	0.1	After user magnetic calibration

1.3.2. Ellipse-N internal GNSS receiver

The Ellipse-N embeds an industrial GNSS receiver (L1 GPS + GLONASS or GPS + BEIDOU), capable of DGPS positioning using either SBAS or third party base station. With a refresh rate of 5Hz, this receiver has an excellent sensitivity for continuous tracking under challenging environments.

	Specification		Remark
Channels	72		
Signal tracking	**GPS** L1 C/A **GLONASS** L10F **QZSS** L1 C/A **BeiDou** B1 **SBAS** L1 C/A: WAAS, EGNOS, MSAS		
Horizontal position accuracy	2.0 m CEP		GPS + GLONASS + SBAS or DGPS
Velocity accuracy	0.1 m/s RMS		
Sensitivity	Tracking & Navigation; Cold start:	-167dBm -148dBm	
Time to First Fix	Cold start	< 26 s	
	Hot start	< 1.5s	
Output frequency	5 Hz		
Diff. corrections	RTCM 2.3		Sent via PORT D
Operational limits	Dynamics: < 4*g* Velocity: 500 m/s Altitude: 50 000 m		

1.3.3. Ellipse-D internal GNSS receiver

The Ellipse-D embeds a survey grade GNSS receiver (L1/L2 GPS, GLONASS, BEIDOU, GALILEO), capable of DGPS positioning using either SBAS or third party base station. With a refresh rate of 5Hz, this receiver provides best accuracy and reliability in harsh GNSS environments.

	Specification		Remark
Channels	120		
Signal tracking	**GPS**: L1, L2, L2C **GLONASS**: L1, L2 **Galileo**: E1, E5b	**Beidou** B1, B2, **SBAS**, **QZSS**	GPS L1/L2, SBAS, QZSS in standard. Other signals available in option
Horizontal position accuracy	Single point L1	1.5 m	RTK precision available in option
	Single point L1/L2	1.2 m	
	SBAS / DGPS	0.6 m / 0.4 m	
	RTK	1 cm + 1ppm	
Velocity accuracy	0.03 m/s RMS		
True Heading Accuracy	0.2° 0.1°	1m baseline 2m baseline	Baseline should not exceed 3m
Velocity limit	515 m/s		Due to export licenses
Time to First Fix	Cold start	< 50 s	
	Hot start	< 35s	
Signal reacquisition	L1	< 0.5 s	
	L2	< 1.0 s	

	Specification	Remark
Output frequency	5 Hz	
Diff. Corrections	RTCA, RTCAOBS2 RTCM V2.3, V3 CMR, CMR+	Sent via serial PORT D
Options	BEIDOU, GLONASS, RTK	

1.3.4. Internal barometric altimeter

The Ellipse-N, E and D models embed a MEMS pressure sensor, used as altimeter. This pressure sensor is fully calibrated and temperature compensated making it ideal to measure accurately absolute pressure.

The Ellipse converts this absolute pressure into altitude using the Standard Atmosphere model, assuming a constant temperature gradient over altitude, and a sea pressure level of 1013,25 hPa.

Barometer specifications

Pressure sensor	Specification	Remarks - Conditions
Resolution	1.2 Pa	10 cm resolution
Pressure accuracy	± 50 Pa ± 200 Pa ± 350 Pa	Relative – [25°C], 700...1100 hPa Absolute – [0...50°C], 450...1100 hPa Absolute – [-20...85°C], 450...1100 hPa
Long term stability	< 100 Pa/yr	
Update Rate	100 Hz	

1.3.5. External sensors

1.3.5.1. Third party GNSS receiver

The Ellipse-E model does not include a GNSS receiver, but can be connected to an external GNSS module. All GNSS receivers will provide velocity and position aiding. In some applications such as automotive ones, the GPS course can also be used as heading reference input.

Dual antenna systems can also provide a True Heading aiding. RTK GPS receivers can be used to improve positioning accuracy.

1.3.5.2. Odometer

In addition to the GNSS aiding, the Ellipse-N and E versions includes an odometer input which can greatly improve performance in challenging environments such as urban canyons. The odometer provides a reliable velocity information even during GPS outages. This increases significantly the dead reckoning accuracy.

The Ellipse handles quadrature output or compatible odometers in order to support forward and backward directions.

Note: Odometer integration is made really simple as the Kalman filter will finely adjust odometer's gain and will correct residual errors in the odometer alignment and lever arm.

1.4. System Performance

All specifications are rated to 1 σ, over -40°C to +85°C (-40 to 185°F) unless otherwise stated.

These specifications have been measured based on typical mission scenarios with simulated GPS outages and compared to post processed RTK data of a high end FOG based INS.

1.4.1. Ellipse-A orientation performance

1.4.1.1. Orientation specifications

	Performance	Remarks
Measurement range	360° in all axes, no mounting limitation	
Roll / Pitch accuracy	< 0.2°	Medium dynamic conditions – No long term accelerations
Yaw Accuracy	0.8°	Clean magnetic environment – Magnetic calibration performed

1.4.2. Ellipse-E/ N orientation and navigation performance

For each application, the accuracy parameters are defined in different positioning modes, explained below:

- SP refers to Single Point mode and is the default L1 GPS / GLONASS fix quality
- RTK stands for Real Time Kinematics with a typical 1 cm accuracy position
- Odometer Aiding is specified when an odometer provides velocity (automotive applications)

1.4.2.1. Land applications

All specifications are valid with DMI (odometer) aiding for typical land applications trajectories.

Outage Duration	Positioning Mode	Position Accuracy		Velocity Accuracy		Attitude Accuracy (°)	
		Horizontal	Vertical	Horizontal	Vertical	Roll / Pitch	Heading
No Outage	SP	2 m	2.5 m	0.1 m/s	0.1 m/s	0.2 °	0.3 °
	RTK	0.02 m	0.04 m	0.05 m/s	0.05 m/s	0.2 °	0.3 °
10 s	SP	2.5 m	3 m	0.1 m/s	0.1 m/s	0.2 °	0,3 °
	RTK	0.7 m	0.6 m	0.1 m/s	0.1 m/s	0.2 °	0.3 °
60 s / 1km	SP	9 m	6 m	0.1 m/s	0.1 m/s	0.2 °	0.5 °
	RTK	7 m	4 m	0.1 m/s	0.1 m/s	0.2 °	0.5 °

1.4.2.2. Marine & Subsea applications

Outage Duration	Positioning Mode	Position Accuracy		Velocity Accuracy		Attitude Accuracy (°)	
		Horizontal	Vertical	Horizontal	Vertical	Roll / Pitch	Heading
No outage	SP	2 m	2.5 m	0.1 m/s	0.1 m/s	0.2 °	0.8 °
	RTK / Dual antenna GPS	0.02 m	0.04 m	0.05 m/s	0.05 m/s	0.2 °	0.2 °
10 s	SP	3 m	3.5 m	0.2 m/s	0.2 m/s	0.3 °	0.8 °
	RTK / Dual antenna GPS	1 m	1 m	0.15 m/s	0.15 m/s	0.3 °	0.3 °

Note: In case of standalone dual antenna GNSS system use, heading accuracy parameters listed in "RTK / Dual antenna GPS" lines may apply.

1.4.2.3. Airborne applications

Positioning Mode	Position Accuracy		Velocity Accuracy		Attitude Accuracy (°)	
	Horizontal	Vertical	Horizontal	Vertical	Roll / Pitch	Heading
SP	2 m	2.5 m	0.1 m/s	0.1 m/s	0.2 °	0.5 °
RTK	0.02 m	0.04 m	0.05 m/s	0.05 m/s	0.1 °	0.4 °

1.4.3. Ellipse-D orientation and navigation performance

For each application, the accuracy parameters are defined in different positioning modes, explained below:

- SP refers to Single Point mode and is the default L1/L2 GPS fix quality
- RTK stands for Real Time Kinematics with a typical 1 cm accuracy position
- Odometer Aiding is specified when an odometer provides velocity (automotive applications)
- DVL aided refers to Doppler velocity Log sensor, providing velocity information (bottom tracking)
- PPK refers to the Post-processing Kinematic solution

1.4.3.1. Land applications

All specifications are valid with DMI (odometer) aiding for typical land applications trajectories.

Outage Duration	Positioning Mode	Position Accuracy		Velocity Accuracy		Attitude Accuracy (°)	
		Horizontal	Vertical	Horizontal	Vertical	Roll / Pitch	Heading
No outage	SP	1.2 m	1.5 m	0.03 m/s	0.03 m/s	0.1 °	0.2 °
	RTK	0.02 m	0.04 m	0.03 m/s	0.03 m/s	0.1 °	0.2 °
	PPK	0.01 m	0.02 m	0.02 m/s	0.02 m/s	0.05 °	0.1 °
10 s	SP	1.7 m	2 m	0.1 m/s	0.1 m/s	0.1 °	0.2 °
	RTK	0.5m	0.4 m	0.1 m/s	0.1 m/s	0.1 °	0.2 °
	PPK	0.1 m	0.1 m	0.05 m/s	0.05 m/s	0.05°	0.1°
60 s / 1km	SP	7 m	7 m	0.1 m/s	0.1 m/s	0.15 °	0.4 °
	RTK	5,5 m	5 m	0.1 m/s	0.1 m/s	0.15 °	0.4 °
	PPK	1 m	1 m	0.1 m/s	0.1 m/s	0.08°	0.2°

1.4.3.2. Marine & Subsea applications

Outage Duration	Positioning Mode	Position Accuracy		Velocity Accuracy		Attitude Accuracy (°)	
		Horizontal	Vertical	Horizontal	Vertical	Roll / Pitch	Heading
No outage	SP	1.2 m	1.5 m	0.03 m/s	0.03 m/s	0.1 °	0.2 °
	RTK	0.02 m	0.04 m	0.03 m/s	0.03 m/s	0.1 °	0.2 °
	PPK	0.01 m	0.02 m	0.02 m/s	0.02 m/s	0.05 °	0.1 °
10 s	SP	3 m	3.5 m	0.2 m/s	0.2 m/s	0.15 °	0.3 °
	RTK	1 m	1 m	0.15 m/s	0.15 m/s	0.15 °	0.3 °
	PPK	0.1 m	0.1 m	0.05 m/s	0.05 m/s	0.05°	0.1°

1.4.3.3. Airborne applications

Positioning Mode	Position Accuracy		Velocity Accuracy		Attitude Accuracy (°)	
	Horizontal	Vertical	Horizontal	Vertical	Roll / Pitch	Heading
SP	1.2 m	1.5 m	0.03 m/s	0.03 m/s	0.1 °	0.2 °
RTK	0.02 m	0.04 m	0.03 m/s	0.03 m/s	0.1 °	0.2 °
PPK	0.01 m	0.02 m	0.02 m/s	0.02 m/s	0.05 °	0.1 °

1.4.4. Heave performance

The following performance parameters apply to all Ellipse sensors.

	Real Time Heave	Remark
Range	50 meters	
Period	0 to 15 s	
Accuracy	10 cm or 10%	Whichever is greater; Velocity aiding available, or no turn or speed change.
Mode	Real time, auto tuning	

2. Mechanical and Electrical specifications

2.1. Mechanical specifications

All dimensions are expressed in millimeters using the International System of Units (SI) conventions.

2.1.1. Overview

The Ellipse enclosure is composed of two anodized aluminum parts, one for the cover and one for the base plate. The device uses high quality alloys and connectors to offer a full IP-68 enclosure and a good resistance to harsh environments.

The Ellipse-N and E versions include a sophisticated venting system maintain IP-68 protection while allowing ambient pressure measurements to be performed.

The Ellipse connectors are high quality Ultimate Fischer connectors that offers IP-68 protection even unconnected. The Ellipse-N version also includes a SMA connector to connect the GPS antenna. When used with a waterproof GPS antenna cable, this connector offers an IP-68 protection.

Note 1: If you are planing to use Ellipse internal magnetometers, please make sure that you don't use ferromagnetic materials to mount the device.

2.1.2. Specifications

The table below summarizes all mechanical and environmental specifications.

Item	Specification	Remarks
Size	**A, E, N:** 46 x 45 x 24 mm (1.8 x 1.77 x 0.9") **D:** 67 x 87 x 31.5 mm (2.64 x 3.43 x 1.24")	
Weight	**A:** 45 g / 0.1 lbs **N:** 47 g / 0.1 lbs **E:** 49 g / 0.1 lbs **D:** 180g / 0.4 lbs	
Shocks	< 2 000*g*	
Operating Vibrations	1g RMS – 20Hz to 2 kHz as per MIL-STD-810G	Specified performance for 8g options
	3g RMS – 20Hz to 2 kHz as per MIL-STD-810G	Specified performance for 16g options

Environmental Specifications		
Enclosure	Anodized Aluminum	
IP rating	IP-68 (1 hour at 2 meters)	
Operating temperature	**A, E, N:** **D:**	-40 to 85°C (-40 to 185°F) -40 to 75°C (-40 to 167°F)
Storage	-40 to 85°C (-40 to 185°F)	
Humidity	Sealed, no limit	
MTBF (computed)	50.000 hours	
Calibration interval	None required, maintenance free	

2.1.3. Device mechanical alignment

For best measurement accuracy, a good mechanical alignment is required. During manufacturing, the Ellipse measurement frame has been carefully aligned to 0.05° with the base plate for roll, pitch and yaw angles.

To ease the yaw alignment (X axis), the base Ellipse A, E and N plate features two alignment holes Ø 2mm H8 that guarantees with two taper pins Ø 2mm h7 a yaw alignment better than ±0.05°. The Ellipse-D provides similar alignment holes but with 3mm diameter.

2.1.4. Origin of measurements

The center of measurement for acceleration, velocity and position is represented on the mechanical outlines by the ◓ symbol. It is referenced to the base plate fine alignment hole.

2.1.5. Device labels

SBG Systems manufacturing process is based on EN-9100 system with individual and full traceability of every component and operation. Each Ellipse is identified by a unique serial number that can be used to trace all operations during the product lifetime such as manufacturing, calibration, tests and repairs.

In addition to a unique serial number, a product code is used to define exactly the device type and options.

You can find on the back side of the Ellipse a laser printed label that hold all these identification information. This label also includes a data-matrix code that encodes the device unique serial number.

In addition, the Ellipse packaging includes a second label that provides other useful information such as installed firmware.

Figure 2.1: Ellipse device label sample

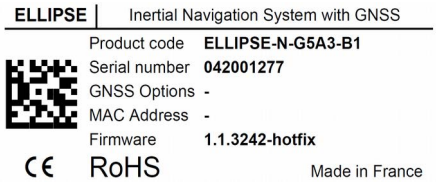


Figure 2.2: Ellipse packaging label sample

2.1.6. Ellipse-A mechanical outline

All dimensions are in mm.

2.1.6.1. Front view

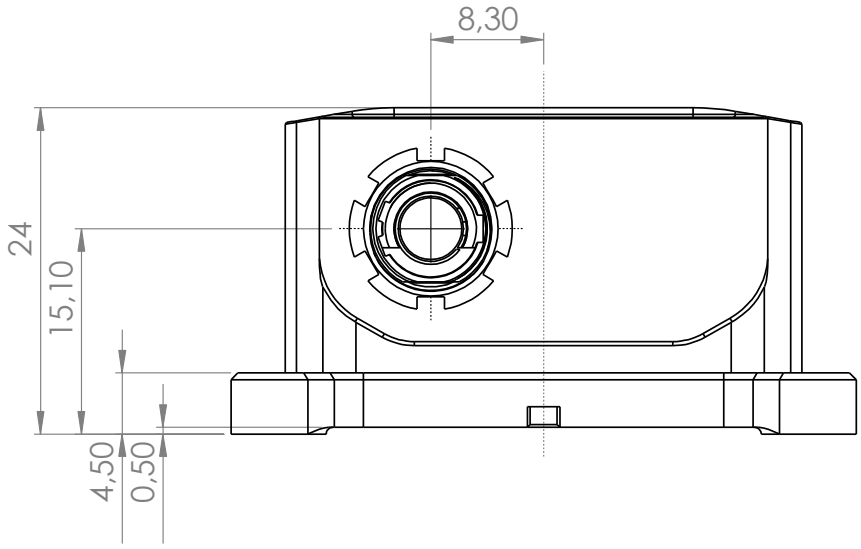


Figure 2.3: Ellipse-A front view

2.1.6.2. Top view

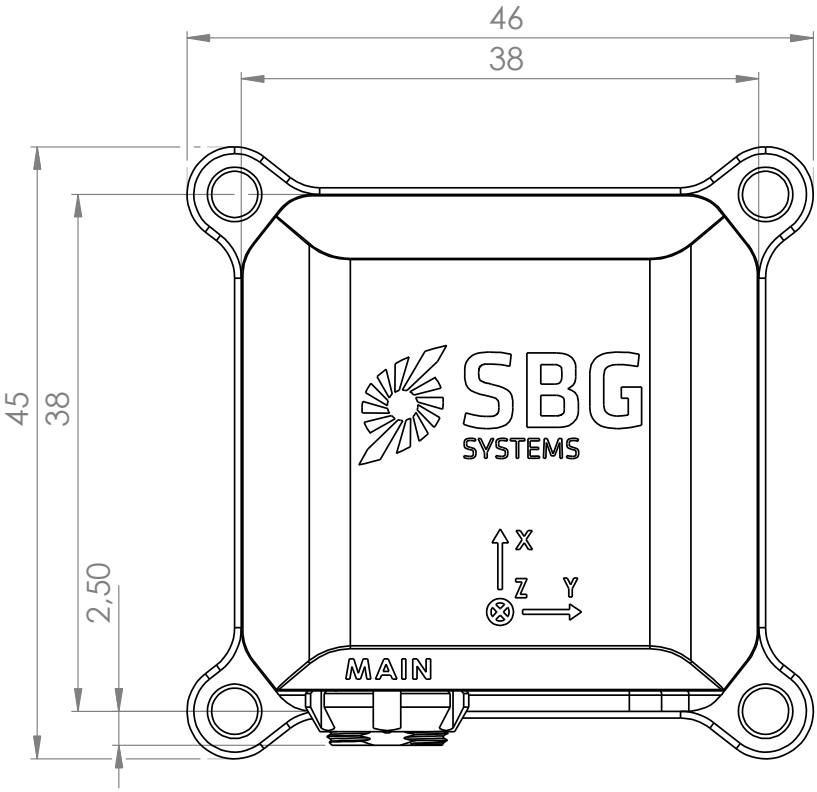


Figure 2.4: Ellipse-A top view

2.1.6.3. Right view

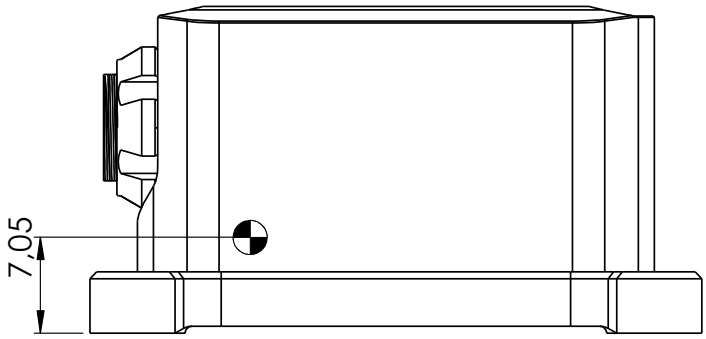


Figure 2.5: Ellipse-A right view

2.1.6.4. Bottom view

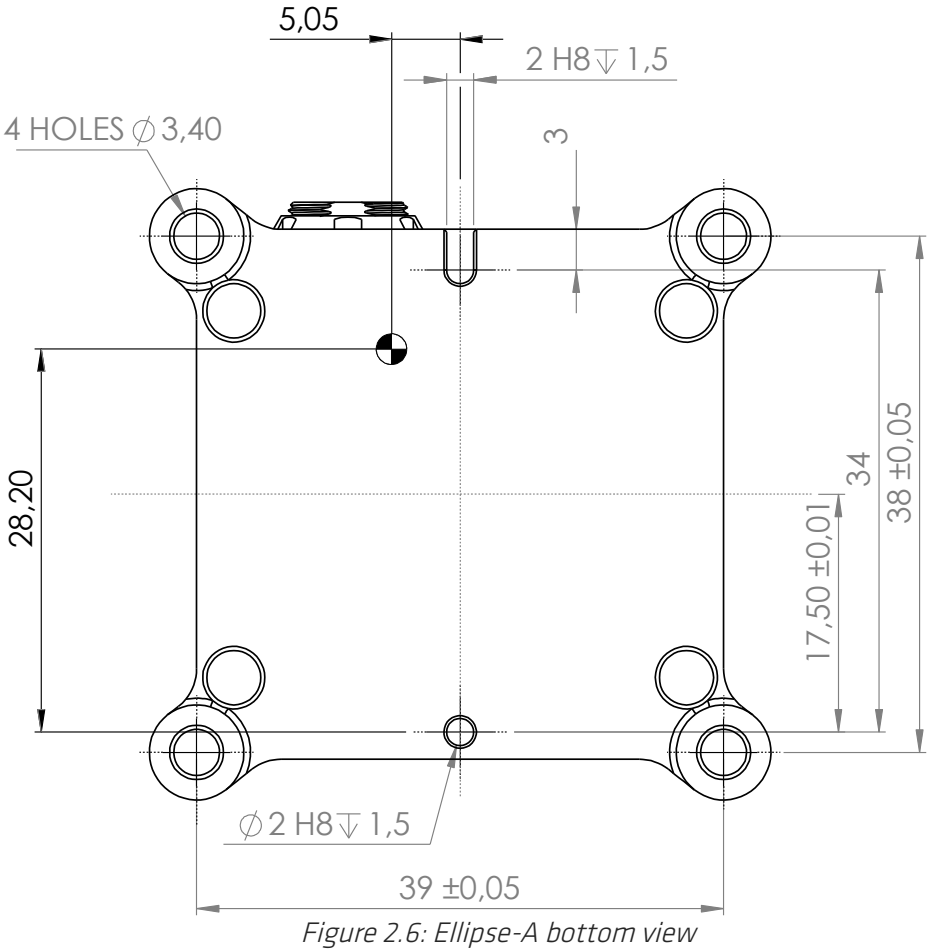


Figure 2.6: Ellipse-A bottom view

2.1.7. Ellipse-E mechanical outline

All dimensions are in mm.

2.1.7.1. Front view

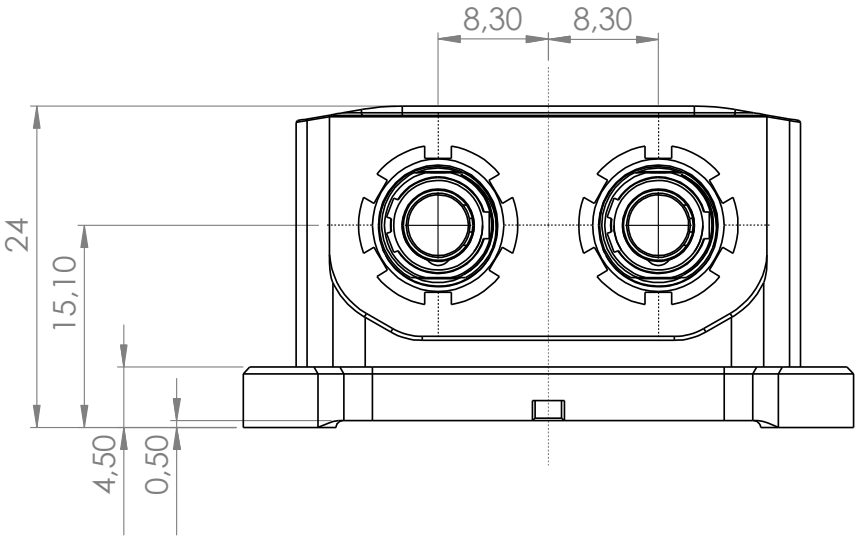


Figure 2.7: Ellipse-E front view

2.1.7.2. Top view

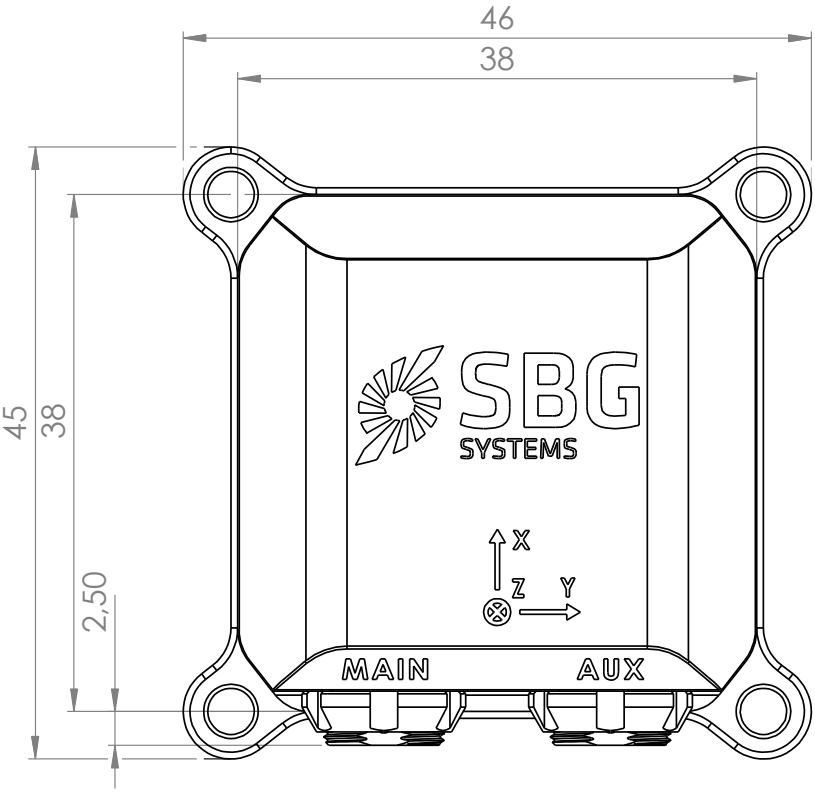


Figure 2.8: Ellipse-E top view

2.1.7.3. Right view

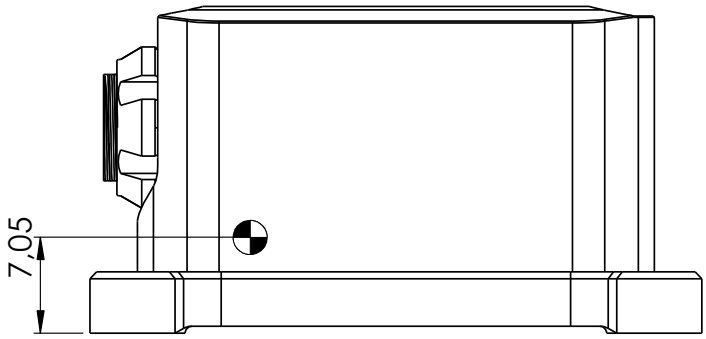


Figure 2.9: Ellipse-E right view

2.1.7.4. Bottom view

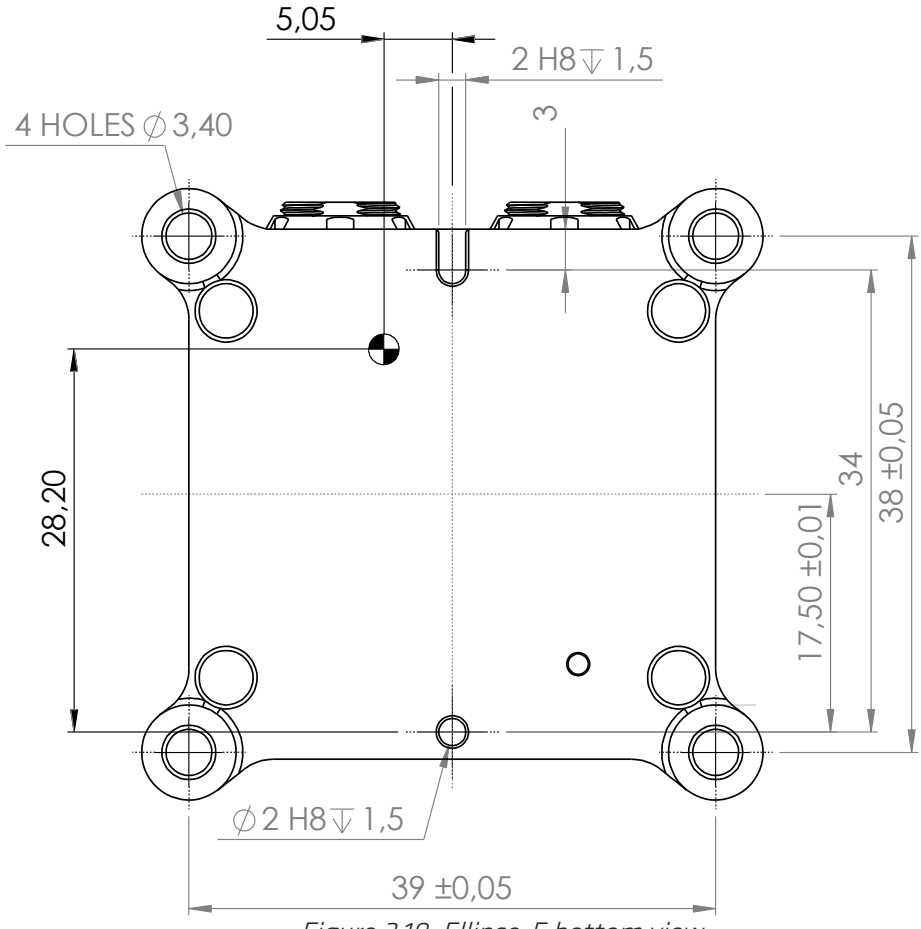


Figure 2.10: Ellipse-E bottom view

2.1.8. Ellipse-N mechanical outline

All dimensions are in mm.

2.1.8.1. Front view

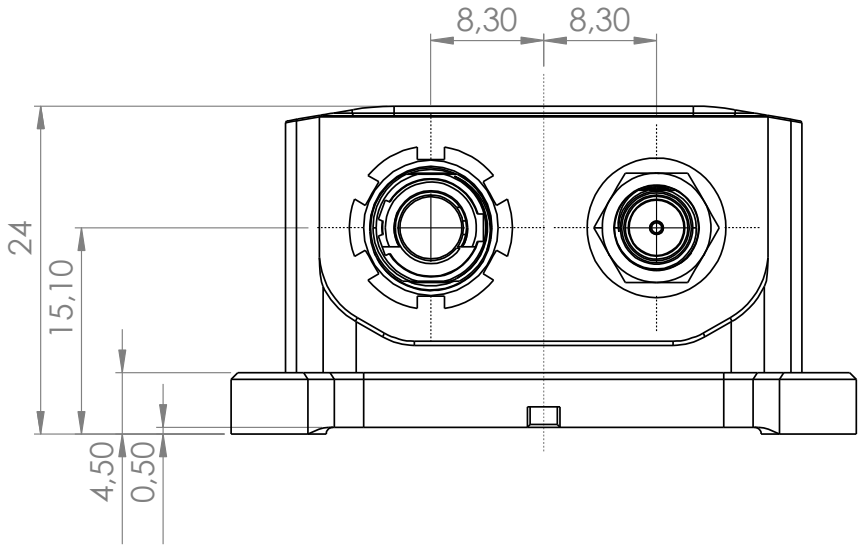


Figure 2.11: Ellipse-N front view

2.1.8.2. Top view

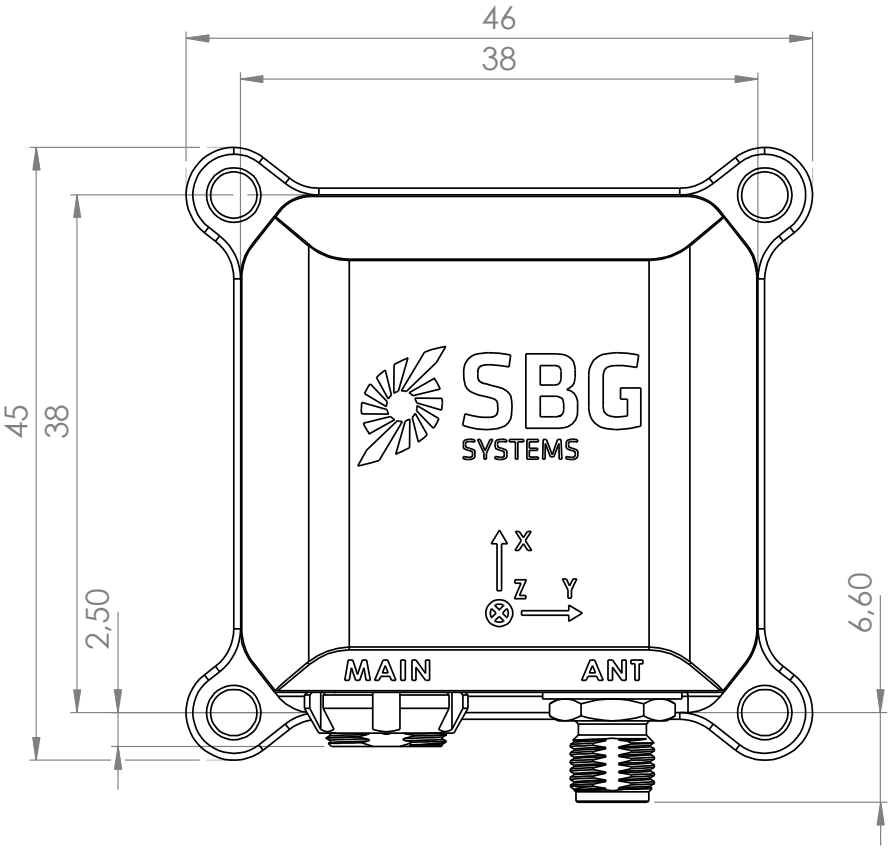


Figure 2.12: Ellipse-N top view

2.1.8.3. Right view

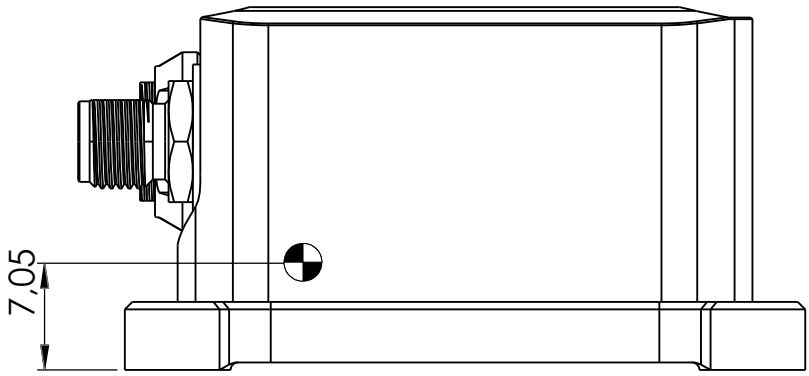


Figure 2.13: Ellipse-N right view

2.1.8.4. Bottom view

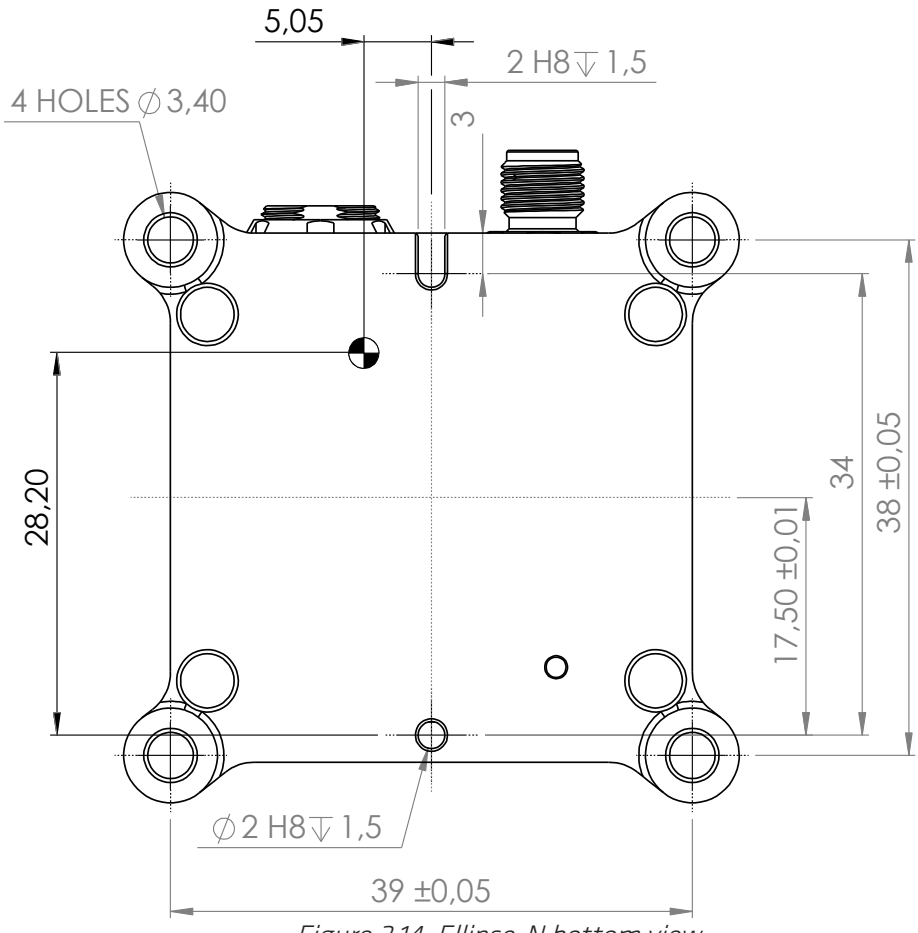


Figure 2.14: Ellipse-N bottom view

2.1.9. Ellipse-D mechanical outline

All dimensions are in mm.

2.1.9.1. Front view

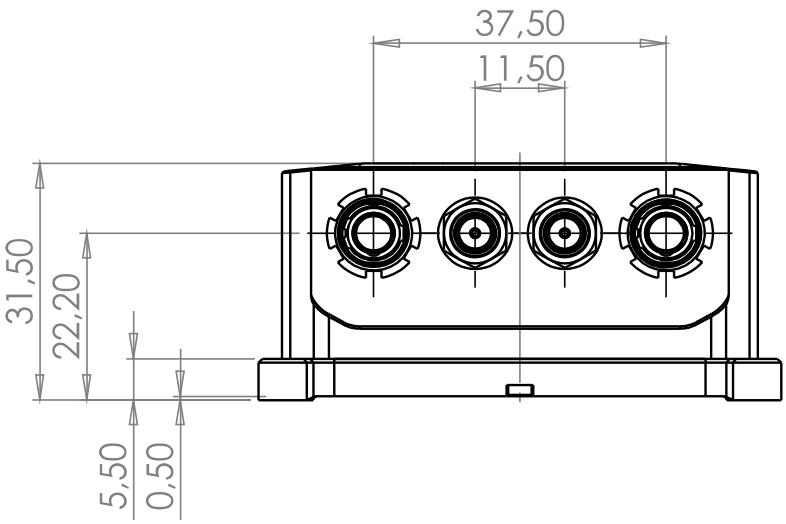


Figure 2.15: Ellipse-D front view

2.1.9.2. Top view

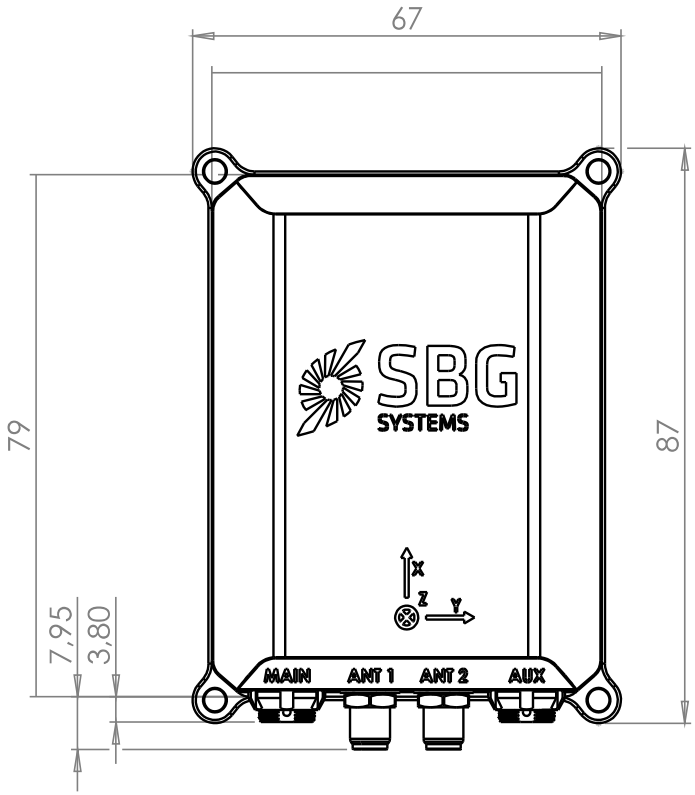


Figure 2.16: Ellipse-D top view

2.1.9.3. Right view

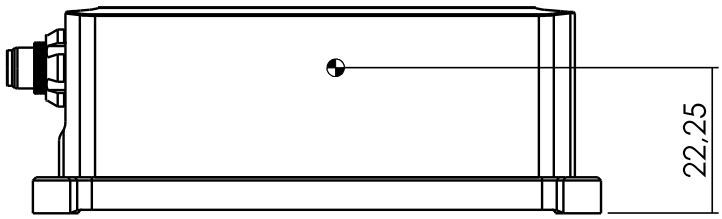


Figure 2.17: Ellipse-D right view

2.1.9.4. Bottom view

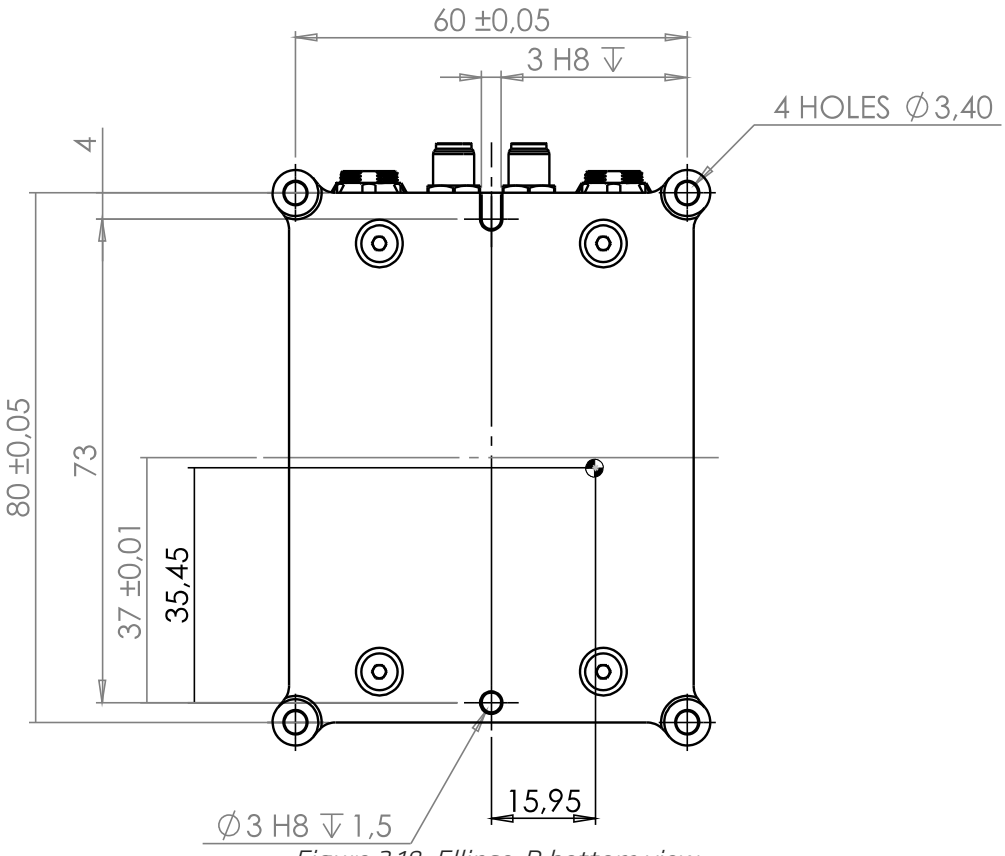


Figure 2.18: Ellipse-D bottom view

2.2. Electrical specifications

The Ellipse connectors are all placed on the front panel. The connectors are referenced and identified by laser marking on the enclosure.

SBG Systems has selected high quality connectors designed for harsh environments. They offer an IP-68 protection when the plug is properly mounted.

Note: The Ellipse development kit cables are not designed to offer an IP-68 protection. Contact SBG Systems to get further support about IP-68 protection.

2.2.1. Ellipse-A without GPS aiding

Figure 2.19: Ellipse AHRS

2.2.2. Ellipse-E with external aiding only

Figure 2.20: Ellipse INS without GPS (E version)

2.2.3. Ellipse-N with embedded GNSS

Figure 2.21: Ellipse INS with GNSS receiver (N version)

2.2.4. Ellipse-D with embedded dual antenna GNSS

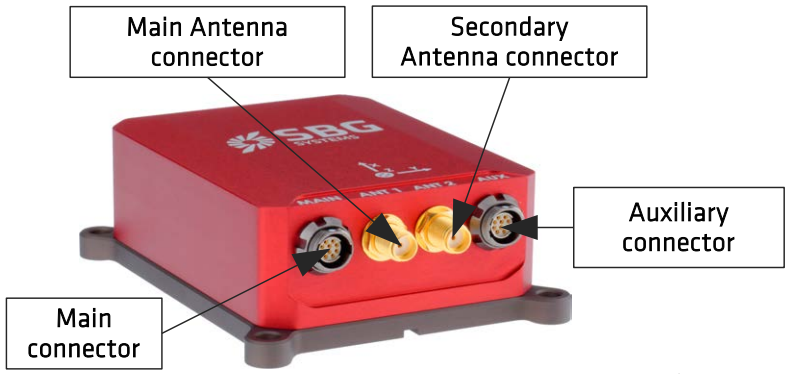


Figure 2.22: Ellipse INS with dual antenna GNSS receiver (D version)

2.2.5. Main connector

The main connector provides access to most Ellipse features in a modular way. It provides:

- The main serial port (PORT A) that supports full-duplex communication. It operates in RS-232, or alternatively in RS-422 on B1 devices by pulling down to GND the pin 5.
- An optional RS-232 port (PORT E) that can be enabled on B1 devices, when PORT A is configured in RS-232 mode.
- One CAN 2.0A/B connection that supports up to 1 Mbit/s data rate used to output data – on B2 devices only
- Two multi-function input pins that can be used for:
  - Clock synchronization or event marker input pins
  - Uni or bi-directional Odometer input
  - Miscellaneous RS-232 input (PORT B) for RTCM data input on Ellipse-N.
- A Synchronization output signal for time stamping and to trigger some equipment.

2.2.5.1. Connector specifications

The main connector uses a 10 ways UltiMate Fischer connector. The exact receptacle reference is: UR02W07 F010P BK1 E2AA.

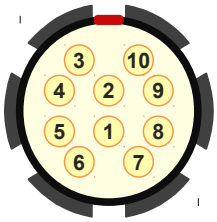


Figure 2.23: Main receptacle front view

The Ellipse connector will mate with the reference UP01L07 M010S BK1 Z2ZA. Don't forget that this reference don't include the cable clamp sets. Other plugs with right angle or other options may be found if required.

Figure 2.24: Main plug top view

2.2.5.2. Connector pin out for Ellipse B1 versions

Pin #	Name	Description
1	SYNC IN A – ODO B	Multi function input. May be used as clock/event, or odometer input
2	SYNC IN B – PORT B RX - ODO A	Multi function input. May be used as clock/event, odometer input, or RS-232 Rx line for RTCM correction input
3	VIN	Power supply input
4	GND	Ground return signal
5	PORT A RS-232/$\overline{\text{RS-422}}$	Port A RS-232 or RS-422 selector. Tie to GND to select RS-422
6	SYNC OUT A	Synchronization output signal.
7	PORT E TX – PORT A RS422 TX+	Port E Tx line, or Port A Tx+ in RS-422 mode
8	PORT A RS232 TX – PORT A RS422 TX-	Port A RS-422 Tx- or RS-232 Tx line
9	PORT A RS232 RX – PORT A RS422 RX+	Port A RS-422 Rx+ or RS-232 Rx line
10	PORT E RX – PORT A RS422 RX-	Port E Rx line, or Port A Rx- in RS-422 mode

Note: By default, if you leave the RS-232/$\overline{\text{RS-422}}$ signal unconnected, the Port A will operate in RS-232 mode.

2.2.5.3. Connector pin out for Ellipse B2 versions

Pin #	Name	Description
1	SYNC IN A – ODO B	Multi function input. May be used as clock/event, or odometer input
2	SYNC IN B – PORT B RX - ODO A	Multi function input. May be used as clock/event, odometer input, or RS-232 Rx line for RTCM correction input
3	VIN	Power supply input
4	GND	Ground return signal
5	NC	Not used. Leave unconnected.
6	SYNC OUT A	Synchronization output signal.
7	CAN L	CAN Low
8	PORT A RS232 TX	Port A RS-232 Tx line
9	PORT A RS232 RX	Port A RS-232 Rx line
10	CAN H	CAN high

2.2.6. Auxiliary connector (Ellipse-E)

The external aiding connector is mainly used to connect aiding equipment to the Ellipse-E. It features the following connections:

- A full duplex RS-232 / RS-422 port for GNSS aiding connection (PORT C)
- An additional RS-232 input for upward compatibility (PORT D)
- Two synchronization input signals used for internal clock synchronization, data time stamping and/or event markers
- A Synchronization output signal for time stamping and to trigger some equipment.

2.2.6.1. Connector specifications

Please refer to section 2.2.5.1 Connector specifications for more details as the same connector type is used for Main and Aux connectors.

2.2.6.2. Connector pin out

Pin #	Name	Description
1	SYNC IN C	May be used as clock/event input
2	SYNC IN D	May be used as clock/event input
3	PORT D RX	RS-232 input for miscellaneous applications
4	GND	Ground return signal
5	NC	Not internally connected
6	SYNC OUT B	Synchronization output signal.
7	PORT C RS422 TX+	Port C RS-422 Tx+. Not used in RS-232 connection.
8	PORT C RS232 TX – PORT C RS422 TX-	Port C RS-422 Tx- or RS-232 Tx line
9	PORT C RS232 RX – PORT C RS422 RX+	Port C RS-422 Rx+ or RS-232 Rx line
10	PORT C RS422 RX-	Port C RS-422 Rx-. Not used in RS-232 connection.

2.2.7. Auxiliary connector (Ellipse-D)

The auxiliary connector is mainly used to provide RTCM data input to the internal GNSS receiver. It features the following connections:

- An RS-232 / RS-422 port for RTCM corrections input
- An additional RS-232 input for upward compatibility
- A synchronization input signal used for internal clock synchronization, data time stamping and/or event marker
- A Synchronization output signal for time stamping and to trigger some equipment.

2.2.7.1. Connector specifications

Please refer to section 2.2.5.1 Connector specifications for more details as the same connector type is used for Main and Aux connectors.

2.2.7.2. Connector pin out

Pin #	Name	Description
1	NC	Not internally connected
2	SYNC IN D	May be used as clock/event input
3	PORT D RX	RS-232 input for miscellaneous applications
4	GND	Ground return signal
5	PORT C RS-232/$\overline{\text{RS-422}}$	Port C RS-232 or RS-422 selector. Tie to GND to select RS-422
6	SYNC OUT B	Synchronization output signal.
7	PORT C RS422 TX+	Port C RS-422 Tx+. Not used in RS-232 connection.
8	PORT C RS232 TX – PORT GPS RS422 TX-	Port C RS-422 Tx- or RS-232 Tx line
9	PORT C RS232 RX – PORT GPS RS422 RX+	Port C RS-422 Rx+ or RS-232 Rx line
10	PORT C RS422 RX-	Port C RS-422 Rx-. Not used in RS-232 connection.

2.2.8. Electrical specifications

2.2.8.1. Electrical specifications

Recommended electrical specifications from -40°C to 85°C.

Item	Conditions	Min	Typical	Max	Unit
Power supply					
Input voltage range	Models A, E, N	5		36	V
	Model D	9		36	V
Power consumption	Model A		440		mW
	Model E		460		mW
	Model N – Not including GNS ant.		650		mW
	Model D – Not including GNS ant.		2500		mW
RS-232 Receivers, Sync In pins					
Input range		-15		15	V
Low level threshold		0.6			V
High level threshold				2.0	V
Input resistance		3	5	7	kΩ
RS-422 Receivers					
Input differential threshold		-200	-125	-50	mV
Input hysteresis			25		mV
Input resistance		96			kΩ
RS-232 Transmitters					
Output range		+/-5	+/-5.5		V
RS-422 transmitters					
Differential output voltage		2			V
Common mode output voltage				3	V
Sync Out pins					
High Level Output voltage	I_{Load} < 100µA I_{Load} < 16mA	3.2 2.6			V V
Low Level Output voltage	I_{Load} < 100µA I_{Load} < 16mA			0.1 0.4	V V
CAN bus					
Recessive Bus Voltage		2	2.5	3	V
CAN H Output Voltage	dominant	2.75	3.5	4.5	V
CAN L Output Voltage	dominant	0.5	1.25	2.25	V
Absolute input voltage	CANH, CANL	-58		58	V
Differential input voltage	CANH, CANL	0.5	0.7	0.9	V

2.2.9. GPS antenna connector (Ellipse-N and D)

To connect an external GNSS antenna, the Ellipse-N includes an IP-68 SMA connector. The Ellipse-D includes two of these connectors. The internal GNSS receiver only supports active GNSS antennas.

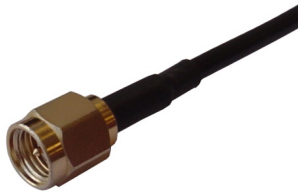


Figure 2.25: SMA antenna connector

Please be advise that the Ellipse doesn't implement any lightning protection. The GPS antenna and cable are very sensitive to strikes and a proper installation with lightning protection devices may be required.

Note: For best performance, the antenna(s) should be connected before the power is applied. The Ellipse GPS estimates the noise floor of the antenna during the startup sequence.

2.2.9.1. GPS antenna advice for Ellipse-N

The Ellipse-N embeds a high sensitivity GNSS receiver that supports L1 GPS and GLONASS signals. For best performance and robustness, please use low noise and high gain active GPS antennas that support the frequencies band you are planning to use.

Recommended electrical specifications from -40°C to 85°C.

Parameter	Specifications	Remark, conditions
Antenna connector	SMA female	IP-68 when connected
Input impedance	50 Ω	
LNA supply voltage	3.0 VDC	
LNA supply current	< 20 mA	
RF input frequencies	**GPS L1:** 1575.42 MHz **GLONASS L1:** 1596 – 1610 MHz **Beidou B1:** 1561.098 MHz	
Minimum gain	15 dB	
Maximum gain	50 dB	
Maximum noise figure	<< 1.5 dB	

Table 1: GNSS antenna requirements

SBG Systems has selected some high quality GPS antennas for different applications. Please refer to the section 5.4 GNSS antennas to get more details on available antennas.

2.2.9.2. GPS antenna advice for Ellipse-D

The Ellipse-D embeds a survey grade GNSS receiver that supports L1/L2 GPS, GLONASS, Beidou and Gallileo signals. For best performance and robustness, please use low noise and high gain active GPS antennas that support the frequencies band you are planning to use.

In order to enable proper heading measurements, L1/L2 GPS antennas are required.

Don't forget to also check the GPS antenna LNA power requirements such as input voltage (must accepts 5 VDC) and input current (must be below 70 mA).

SBG Systems has selected some high quality GPS antennas for different applications. Please refer to the section 5.4 GNSS antennas to get more details on available antennas.

Note: As a rule of thumb, true heading and/or RTK measurements require higher quality GPS antennas to achieve the stated accuracies.

3. Interfaces specifications

3.1. Overview

The Ellipse features up to five serial interfaces (Port A to Port E) which provide all the main features of the Ellipse: Configuration, data input, data output.

In addition, the Ellipse supports CAN 2.0A/B connectivity to output log messages. Due to the CAN implementation and limitations (payload limited to 8 bytes), the CAN interface is not handled like the other interfaces.

Due to the limited number of pins inside the Ellipse connectors, some pins provide different functions which are multiplexed and cannot be used at the same time.

3.1.1. Interfaces availability and multiplexing

The following table provides more details about each port specificity in terms of availability, and capabilities:

Port	Available on models	Available on package options	Tx / Rx capability	RS-232/422 configuration Cable / software defined	Other functions / multiplexing
PORT A	All	All	Tx/Rx	Cable	RS-422 available on B1 and L2 units only
PORT B	E	All	Rx	RS-232 only	Multiplexed with Sync IN B and OOD A
PORT C	E / D	All	Tx/Rx	Software on ELLIPSE-E Cable on ELLIPSE-D	Tx function on ELLIPSE-D is limited to certain standard NMEA messages (direct GPS outputs)
PORT D	E/D	All	Rx	RS-232 only	
PORT E	All	B1, L1,L2	Tx/Rx	RS-232 only	Only available when PORT A is in RS-232 mode
CAN	All	B2, L1, L2	Tx only	-	
SYNC IN A	All	All	input	-	Multiplexed with ODO B
SYNC IN B	All	All	input	-	Multiplexed with PORT B and ODO A
SYNC IN C	E	All	input	-	
SYNC IN D	E, D	All	input	-	
SYNC OUT A	All	All	output	-	
SYNC OUT B	All	All	output	-	
ODO A	E/N/D	All	input	-	Multiplexed with SYNC IN B and PORT B
ODO B	E/N/D	All	input	-	Multiplexed with SYNC IN A

3.2. Serial interfaces

The Ellipse features up to 5 physical RS-232/RS-422 serial connections (PORT A, B, C, D, and E). These serial ports have different uses as described in the next sections.

The Ellipse Serial interfaces support the following baudrates:

- 4 800 bps
- 9 600 bps
- 19 200 bps
- 38 400 bps
- 57 600 bps
- 115 200 bps
- 230 400 bps
- 460 800 bps
- 921 600 bps

Note: The Ellipse automatically limits the serial signals slew-rate to minimize EMI and reduce communication error when the baud rate is below 230 400 bps.

3.2.1. Supported protocols

The Ellipse has been designed to be connected to a large range of aiding equipment and materials. In addition to the native sbgECom binary protocol, other third party or standard protocols are also supported such as NMEA, RTCM, TSS1, Ublox Binary protocol and others.

3.2.2. Ports functions Mapping

Due to the specificities of the internal GNSS embedded inside the ELLIPSE N and D versions, and also due to the number of available pins in the different sensor configurations, there are some variations in the different ports capabilities from one product to another.

The following tables provide more details about which functions are available on which port for each Ellipse model.

Note: Please remind that PORT E is only available on B1 units (box) and on L1/L2 units (OEM).

3.2.2.1. Ellipse A version

	PORT A	PORT E
Binary commands (sbgECom)	•	•
Regular outputs (sbgECom, NMEA or third party output)	•	•
Legacy protocol output (sbgCom)	•	
1KHz IMU output		•

3.2.2.2. Ellipse E version

	PORT A	PORT B	PORT C	PORT D	PORT E
Binary commands (sbgECom)	•				
Regular outputs (sbgECom, NMEA or third party output)	•		•		•
Legacy protocol output (sbgCom)	•				
1KHz IMU output			•		•
External GNSS input		•	•	•	•

3.2.2.3. Ellipse N

	PORT A	PORT B	PORT E
Binary commands (sbgECom)	•		
Regular outputs (sbgECom, NMEA or third party output)	•		•
Legacy protocol output (sbgCom)	•		
1KHz IMU output			•
RTCM input		•	

3.2.2.4. Ellipse D version

On Ellipse D, the PORT C output capabilities are limited to some standard NMEA messages (direct output from GNSS receiver). This is sufficient for many LIDAR synchronization or NTRIP clients connection applications.

PORT B and PORT D are essentially available for upward compatibility on ELLIPSE-D.

	PORT A	PORT B	PORT C	PORT D	PORT E
Binary commands (sbgECom)	•				
Regular outputs (sbgECom, NMEA or third party output)	•				•
Legacy protocol output (sbgCom)	•				
1KHz IMU output					•
1Hz GGA output (direct from GPS)			•		
RTCM input			•		

3.3. CAN 2.0 A/B interface

The main port contains a CAN 2.0 A/B interface that supports transfer rate at up to 1 Mbits/s. This CAN interface is mainly used to output log messages. By default, the CAN interface is disabled.

The CAN bus implementation and especially timing settings complies with the CAN in Automation (CiA) DS-102 standard.

The Ellipse supports the following standard CAN bus bitrates:

- 1 000 kBit/s
- 500 kBit/s
- 250 kBit/s
- 125 kBit/s
- 100 kBit/s
- 50 kBit/s
- 20 kBit/s
- 10 kBit/s

Note: The Ellipse does not include any termination resistor, and it belongs to user to ensure that the CAN bus includes termination resistors in order to get proper communications.

4. Important notices

4.1. Absolute maximum ratings

Stresses above those listed under the Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Parameter	Rating
VDD – GND	+/- 36 V
Rx+, Rx-, Logic inputs pins input voltage to signal GND	±18V
Logic output Max current	150 mA
CANH, CANL	±80 V
ESD protection (Tx, Rx, Input & Output pins, CANH, CANL)	15 kV
Shock	2000 g for 0.3ms
Operating temperature range	-40 to 85°C (-40 to 185°F)
Storage temperature range	-40 to 85°C (-40 to 185°F)

Table 2: Absolute maximum ratings

4.2. Maintenance

The Ellipse will not require any specific maintenance when properly used. In the case you observe sub-optimal performance, please contact SBG Systems support.

Nevertheless, if you would like to maintain your sensor performance to the highest level, SBG Systems can provide a maintenance service with regularly planned checkups and calibrations.

Using the Ellipse in salt water environments is not recommended. In the event the Ellipse has been exposed to salt water, the Ellipse enclosure must be rinsed with clear water to remove any long term presence of salt on the enclosure.

4.2.1. Cleaning

Disconnect the Ellipse from the power supply as well as other connections. Use damp cloth to clean the enclosure. Do not use any solvent or abrasive materials for cleaning.

4.3. Support

Our goal is to provide the best experience to our customers. If you have any question, comment or problem with the use of your product, we would be glad to help you, so feel free to contact us:

EMEA:

SBG Systems S.A.S.
3 bis, chemin de la Jonchère
92500 Rueil-Malmaison
FRANCE

Phone: +33 1 80 88 43 70
support@sbg-systems.com

Americas:

SBG Systems North America, Inc
5932 Bolsa Avenue, Suite #103
Huntington Beach, CA 92649
USA

Phone: +1 (657) 549-5807
support@sbg-systems.com

4.4. Warranty, liability and return procedure

SBG Systems provides a warranty covering this product against any defect in materials or manufacture for a period of two (2) years from the date of shipment. In the event that such a defect becomes obvious during the stipulated warranty period, SBG Systems will undertake, at its sole discretion, either to repair the defective product, bearing the cost of all parts and labor, or to replace it with an identical product.

In order to avail itself of this warranty, Customer must notify SBG Systems of the defect before expiry of the warranty period and take all steps necessary to enable SBG Systems to proceed. Upon reception of required information (Sensor serial number, defect description), SBG Systems will issue an RMA and will provide return instructions. Customer shall be responsible for the packaging and the shipment of the defective product to the repair center notified by SBG Systems, the cost of such shipment being borne by Customer.

This warranty shall not be construed as covering defects, malfunctions or damages caused by improper use or inadequate maintenance of the product. Under no circumstances shall SBG Systems be due to provide repair or replacement under this warranty in order a) to repair damage caused by work done by any person not representing SBG Systems for the installation, repair or maintenance of the product; b) to repair damage caused by improper use or connection to incompatible equipment, and specifically, the opening of the housing of the equipment under warranty shall cause the warranty to be automatically canceled.

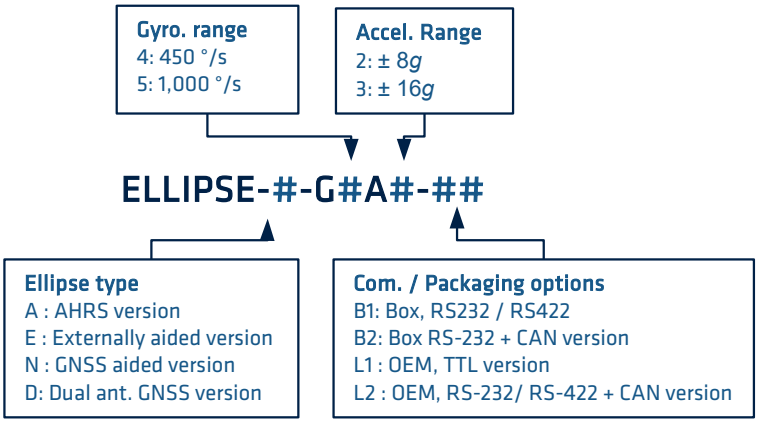
This warranty covers the product here-under and is provided by SBG Systems in place of all and any other warranty whether expressed or implied. SBG Systems does not guarantee the suitability of the product under warranty for sale or any specific use.

SBG Systems' liability is limited to the repair or replacement of defective products, this being the sole remedy open to Customer in the event the warranty becomes applicable. SBG Systems cannot be held liable for indirect, special, subsequent or consequential damage, irrespective of whether SBG Systems has or has not received prior notification of the risk of occurrence of such damage.

5. Appendix A: Ordering codes and Accessories

5.1. Ellipse ordering codes

The following diagram showing the different sensors and interfaces options available, might help you ordering an Ellipse module.



5.2. Development kits

5.2.1. DK-ELI-[B, L]

The Development Kit is an essential accessories that should be used along with the Ellipse series. The Development kit provides the following items:

- Small sized transport case
- USB cable to quickly connect the Ellipse sensor
- A USB Stick that contains the SDK:
  - sbgCenter analysis software suite
  - Magnetic calibration tools and C library
  - sbgECom C library and C code examples
- Unlimited software upgrades
- Unlimited phone and email support.

Figure 5.1 : DK-ELI-B

The following development kits are available:

Ordering code	Description
DK-ELI-B	Development kit for Ellipse-A, E and N in Box versions (B1 or B2)
DK-ELI-L	Development Kit for Ellipse series, OEM, versions (L1 or L2)

5.2.2. DK-ELI-D

The Development Kit is an essential accessories that should be used along with the Ellipse series. The Development kit provides the following items:

- Rugged transport case
- USB cable to quickly connect the Ellipse sensor
- An AC/DC power supply with international plugs to power the Ellipse sensor
- A USB Stick that contains the SDK:
  - sbgCenter analysis software suite
  - Magnetic calibration tools and C library
  - sbgECom C library and C code examples
- Unlimited software upgrades
- Unlimited phone and email support.

Figure 5.2 : DK-ELI-D

5.3. Cables

5.3.1. CA-ELI-USB-3M

This 3 meters long cable provides an easy connection of an Ellipse-A, E or N device to any PC.

It includes in the USB plug a RS-232 to USB converter, and provides power to the Ellipse sensor.

Weight: 103g

Figure 5.3 : CA-ELI-USB

5.3.2. CA-ELI-D-USB-3M

This 3 meters long cable provides an easy connection of an Ellipse-D device to any PC.

It includes in the USB plug a RS-232 to USB converter and a 2.1mm jack DC power input connector.

Weight: 110g

Figure 5.4 : CA-ELI-D-USB

5.3.3. CA-PSU-12V-1.5M

This 1.5 meters long AC/DC international power supply can be used to provide power to an Ellipse sensor from an 110/220V AC power plug.

It supports US, UK and Europe standards and includes a standard DC 2.1mm jack plug. The output voltage is 12V.

Figure 5.5: Power adapter

5.3.4. CA-ELI-RS232-CAN-3M

This cable provides access to the Ellipse Main and Aux connectors. It's designed to communicate in RS-232 with the Ellipse B1 versions, but can also be used with the Ellipse B2 versions and Aux connectors. It has the following characteristics:

Figure 5.6 : CA-ELI-RS232-CAN-3M

- 1x UP01L07 M010S BK1 Z2ZA connector
- 1x open end
- Water proof
- 3 meters long
- Weight: 77g

Cable wiring is the following:

Pin on Fischer connector	Color	Main connector signal (B1 version)	Main connector signal (B2 version)	Aux connector signal	Aux connector signal (Ellipse-D)
1	GREEN	SYNC IN A – ODO B	SYNC IN A – ODO B	SYNC IN C	NC
2	BLUE	SYNC IN B – PORT B RX ODO A	SYNC IN B – PORT B RX ODO A	SYNC IN D	SYNC IN D
3	RED	VIN	VIN	PORT D RX	PORT D RX
4	BLACK	GND	GND	GND	GND
5	N/A	NC	NC	NC	NC
6	BROWN	SYNC OUT A	SYNC OUT A	SYNC OUT B	SYNC OUT B
7	WHITE	PORT E TX	CAN L	PORT C RS422 TX+	Reserved
8	YELLOW	PORT A RS232 TX	PORT A RS232 TX	PORT C RS232 TX PORT C RS422 TX-	PORT C RS232 TX
9	ORANGE	PORT A RS232 RX	PORT A RS232 RX	PORT C RS232 RX PORT C RS422 RX+	PORT C RS232 RX
10	GREY	PORT E RX	CAN H	PORT C RS422 RX-	Reserved

5.3.5. CA-ELI-RS422-3M

This cable provides access to the Ellipse Main and Aux connectors. It's designed to communicate in RS-422 with the Ellipse B1 versions, but can also be used with the Ellipse B2 versions and Aux connectors. It has the following characteristics:

Figure 5.7 : CA-ELI-RS422-3M

- 1x UP01L07 M010S BK1 Z2ZA connector
- 1x open end
- Water proof
- 3 meters long
- Weight: 77g

Cable wiring is the following:

Pin on Fischer connector	Color	Main connector signal (B1 version)	Main connector signal (B2 version)	Aux connector signal (Ellipse-E)	Aux connector signal (Ellipse-D)
1	GREEN	SYNC IN A – ODO B	SYNC IN A – ODO B	SYNC IN C	NC
2	BLUE	SYNC IN B – PORT B RX ODO A	SYNC IN B – PORT B RX ODO A	SYNC IN D	SYNC IN D
3	RED	VIN	VIN	PORT D RX	PORT D RX
4	BLACK	GND	GND	GND	GND
5	N/A	Internally connected to GND for RS-422 comm.	Internally connected to GND	Internally connected to GND	Internally connected to GND for RS-422 comm.
6	BROWN	SYNC OUT A	SYNC OUT A	SYNC OUT B	SYNC OUT B
7	WHITE	PORT A RS422 TX+	CAN L	PORT C RS422 TX+	PORT C RS422 TX+
8	YELLOW	PORT A RS422 TX-	PORT A RS232 TX	PORT C RS232 TX PORT C RS422 TX-	PORT C RS422 TX-
9	ORANGE	PORT A RS422 RX+	PORT A RS232 RX	PORT C RS232 RX PORT C RS422 RX+	PORT C RS422 RX+
10	GREY	PORT A RS422 RX-	CAN H	PORT C RS422 RX-	PORT C RS422 RX-

5.3.6. CA-ELI-SPLIT-RS232-DB-0.5M

This cable provides an easy access through standard DB-9 plugs, to the different functions accessible on the ELLIPSE Main port.

The cable is composed of the following elements:

- 1x UP01L07 M010S BK1 Z2ZA connector
- Total length of 50cm (25cm before / after cable splitter)
- 2x Male DB-9 plugs
- 1x DC 2.1mm jack socket for power supply input
- Weight: 130g

Figure 5.8 : CA-ELI-SPLIT-RS232-DB-0.5M
Lengths not to scale

Cable wiring of the two DB-9 connectors is the following:

Pin on DB-9 "PORT A"	Function
1	-
2	PORT A RX
3	PORT A TX
4	-
5	GND
6	-
7	-
8	-
9	

Pin on DB-9 "SYNC/PORT E"	Function
1	SYNC IN A
2	PORT E RX
3	PORT E TX
4	SYNC OUT A
5	GND
6	-
7	-
8	SYNC IN B
9	-

The DC Jack plug is wired with VCC on the central pin and GND on the outer pin.

5.3.7. CA-ELI-SPLIT-CAN-DB-0.5M

This cable provides an easy access through standard DB-9 plugs, to the main serial port as well as the CAN bus output on the ELLIPSE.

The cable is composed of the following elements:

- 1x UP01L07 M010S BK1 Z2ZA connector
- Total length of 50cm (25cm before / after cable splitter)
- 1x Male DB-9 plugs (for serial PORT A)
- 1x Female DB-9 plug (for CAN bus)
- 1x DC 2.1mm jack socket for power supply input
- Weight: 130g

Figure 5.9 : CA-ELI-SPLIT-CAN-DB-0.5M
Lengths not to scale

Cable wiring of the two DB-9 connectors is the following:

Pin on DB-9 "SYNC/PORT A"	Function
1	SYNC IN A
2	PORT A RX
3	PORT A TX
4	SYNC OUT A
5	GND
6	-
7	-
8	SYNC IN B
9	

Pin on DB-9 "CAN"	Function
1	-
2	CAN L
3	GND
4	-
5	-
6	-
7	CAN H
8	-
9	-

The DC Jack plug is wired with VCC on the central pin and GND on the outer pin.

5.3.8. CA-ELI-SPLIT-RS232-DB-0.5M

This cable provides an easy access through standard DB-9 plugs, to the AUX serial port or ELLIPSE E and D models. It can be used for data output as well as connecting external GNSS receiver or sending RTCM corrections to ELLIPSE D.

Figure 5.10 : CA-ELI-SPLIT-AUX-RS232-DB-0.5M
Lengths not to scale

The cable is composed of the following elements:

- 1x UP01L07 M010S BK1 Z2ZA connector
- Total length of 50cm (25cm before / after cable splitter)
- 2x Male DB-9 plugs (for serial PORT C and D)
- Weight: 120g

Cable wiring of the two DB-9 connectors is the following:

Pin on DB-9 "PORT C"	Function
1	SYNC IN C
2	PORT C RX
3	PORT C TX
4	SYNC OUT B
5	GND
6	-
7	-
8	-
9	-

Pin on DB-9 "PORT D"	Function
1	SYNC IN D
2	PORT D RX
3	-
4	-
5	GND
6	-
7	-
8	-
9	-

5.4. GNSS antennas

5.4.1. ANT-TAL-TW-32-2410-00-3000 and ANT-TAL-TW-32-2710-00-3000

These high performance antennas have been especially chosen for their excellent performance/size compromise.

The TW2410 provides GPS L1 + GLONASS tracking, while the TW2710 provides additionally BEIDOU B1 and GALLILEO E1 signals tracking.

Those two antennas share the same specifications as defined below:

Figure 5.11 : Tallysman TW2410 & TW2710 antennas

5.4.1.1. Performance specifications

Parameter	Specification
Architecture	Dual, Quadrature Feeds One LNA per feed line, mid section High rejection SAW filter
LNA Gain	> 28 dB
Noise figure	< 1dB
VSWR (at LNA output)	< 1.5:1
Power consumption	15 mA
Antenna gain (100mm ground plane)	4,25 dBic
Dimensions	Diameter: 57mm Height: 15mm
Cable length, type, Connector	3m, RG174, SMA
Weight	110g (w/o cable) 150g (w cable)
Environmental	-40 to +85°C IP-67 housing

5.4.1.2. Mechanical drawing

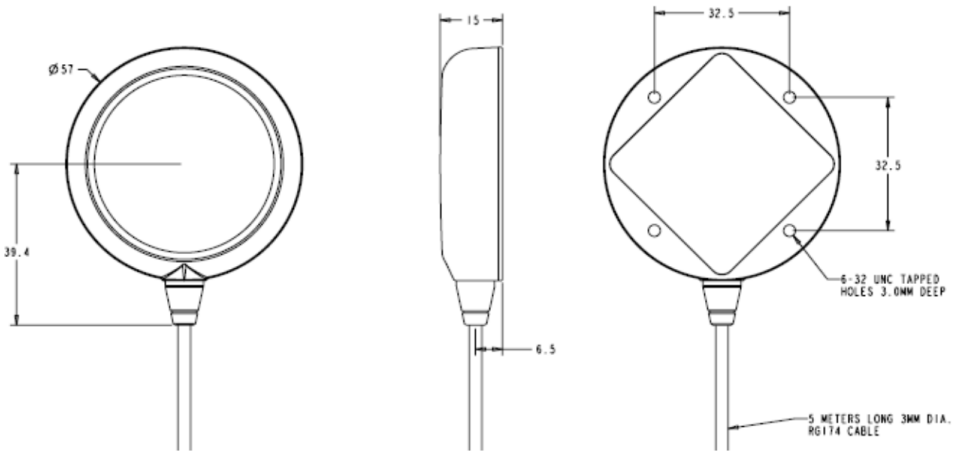


Figure 5.12: Tallysman TW2410 / TW2710 mechanical drawing

5.4.2. ANT-ACM-G5ANT-1A196MNS-1

This GNSS L1/L2 antenna is especially selected to be compliant with Ellipse-D requirements in both terms of signal tracking and small size / weight.

This antenna provides GPS L1/L2 tracking as well as GLONASS and BEIDOU and GALLILEO.

This antenna should be used with a ground plane for optimal performance.

Figure 5.13 : Antcom G5 antenna

5.4.2.1. Performance specifications

Parameter	Specification
LNA Gain	> 32dB
Noise figure	< 3dB
Power consumption	50 mA
Antenna gain at zenith (100mm ground plane)	GPS L1, Galileo E1, E2: 3.2 dBic GPS L2, Beidou B2: 3 dBic GLONASS L1: 3.6 dB GLONASS L2, Galileo E6, Beidou B3: 2.3 dBic
Dimensions	Square: 50.8 mm Height: 20.45mm
Cable length, type, Connector	5m, RG316B, SMA
Weight	105g (w/o cable) 200g (w cable)
Environmental	-55 to +85°C Hermetically sealed

5.4.2.2. Mechanical drawing

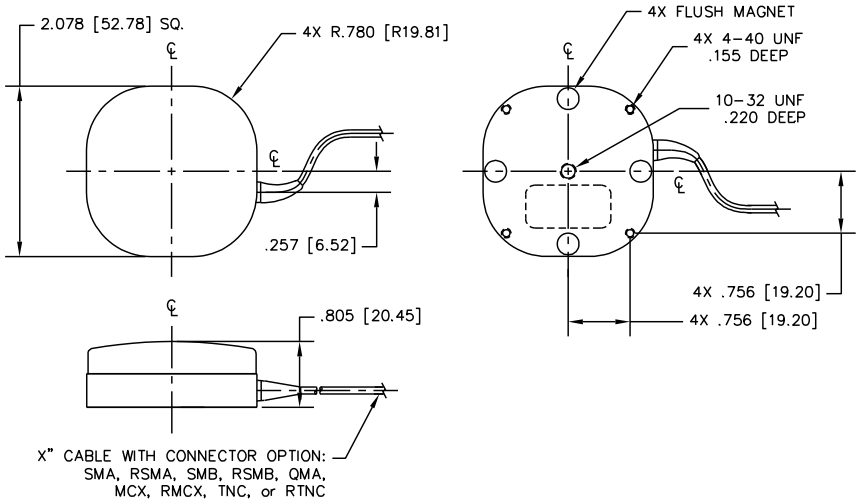


Figure 5.14: Antcom G5 antenna mechanical layout. dimensions are in inches [mm]

5.4.3. High performance GNSS antennas

The following GNSS antennas are recommended for the Ellipse-D model, when highest accuracy, or long cables are required.

Product code	Description	Photo
ANT-ACM-G5ANT-3AMT1	ANTCOM L1/L2 GPS + GLONASS Active Antenna with magnetic mount, TNC Connector This antenna is the most suitable in case a long cable is required between the Ellipse and the Antennas. *Dimensions*: Ø88.9mm ; h=24.66mm *Weight*: 360g	
ANT-SEP-POLANT-MC	Septentrio survey grade rugged antenna, L1/L2/L5, GPS, GLONASS, GALILEO, Beidou with L-band signals This antenna is recommended in high demanding applications. *Dimensions*: Ø146mm ; h=62.5mm *Weight*: 420g	

5.4.3.1. TNC Cables

Finally, to connect the high performance GNSS antennas to an Ellipse sensor, TNC cables can be provided. All TNC cables are sealed. The following lengths:

Product code	Description – Remarks	Photo
CA-SMA-TNC-MF-RG316-0.15M	0.15m TNC to SMA cable adapter. Required to connect a TNC antenna to an Ellipse sensor *Weight*: 17g	
CA-TNC-MM-RG223-3M	3 meters sealed cable with straight TNC/TNC male plugs. Flexible RG223 coaxial cable *Weight*: 190g	
CA-TNC-MM-RG223-5M	5 meters sealed cable with straight TNC/TNC male plugs Flexible RG233 coaxial cable *Weight*: 280g	
CA-TNC-MM-LMR240-10M	10 meters sealed cable with straight TNC/TNC male plug Low loss LMR240 coaxial cable *Weight*: 520g	