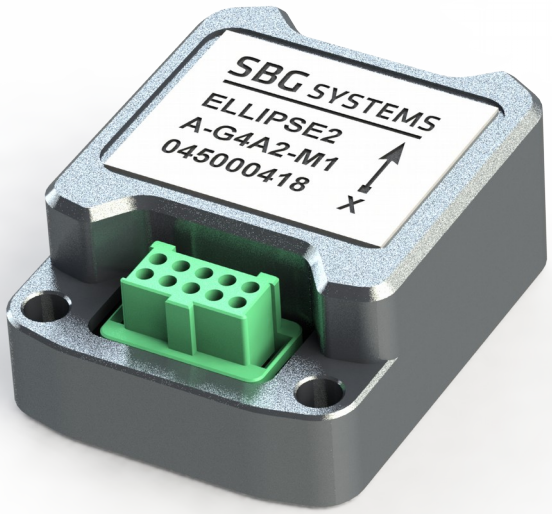
ELLIPSE Micro series

High Performance, Micro-Inertial Sensors

Hardware Manual



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Revision history

Rev.	Date	Author	Information
1.1	Jul 10, 2018	Alexis Guinamard	[ELI2MHM-1] - Fixed Cable assembly reference provided page 14 [ELI2MHM-3] - Added support for ELLIPSE Micro M2 hardware
1.0	Apr 10, 2018	Alexis Guinamard	First official version of this document
0.9	Oct 24, 2017	Alexis Guinamard	First draft 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 Merchandise 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

The Ellipse2 Micro series is a line of sub-miniature, high-performance MEMS based Inertial Systems which achieve exceptional orientation and navigation performance in a tiny 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:

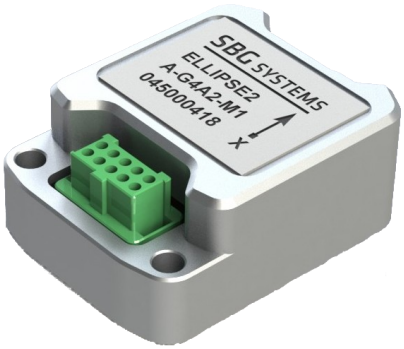

Figure 1.1: The Ellipse Micro

- The Ellipse2 Micro IMU is an Inertial Measurement Unit that can be used for high performance motion monitoring, thanks to its factory calibrated gyroscopes, accelerometers and magnetometer outputs.
- The Ellipse2 Micro AHRS version is an attitude and Heading Reference System (AHRS), providing accurate orientation in dynamic conditions.
- The Ellipse2 Micro INS is an Inertial Navigation System (INS), providing both orientation and navigation data. An external GNSS data can be connected to the Ellipse2 Micro, and other aiding equipment such as odometer can be used to provide accurate navigation data under harsh conditions, but also to improve orientation accuracy:

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.

The Ellipse2 Micro series is fully compatible with the larger size Ellipse modules as it shares the same communication protocol.

1.1. Ellipse Micro Overview

The following diagram shows the basic organization of an Ellipse Micro module.

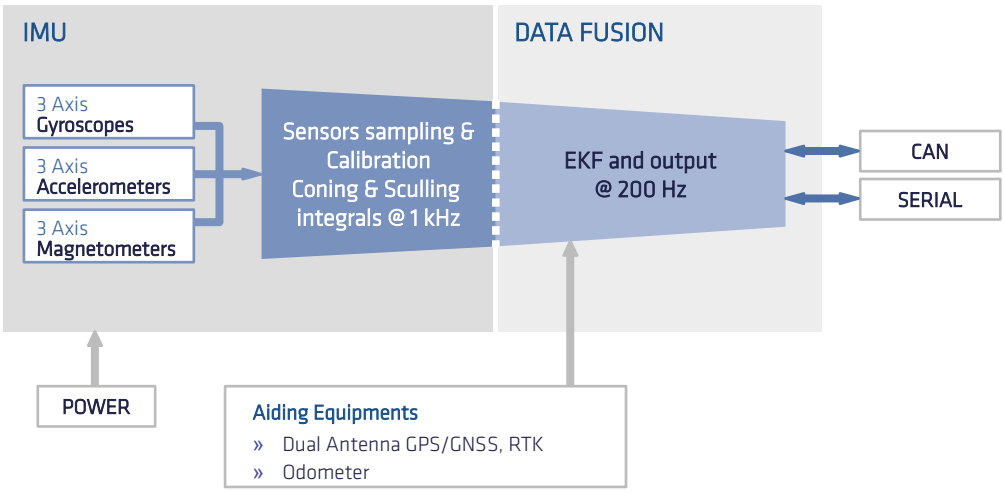

Figure 1.2: Ellipse simplified block diagram

1.2. Inertial measurement unit specifications

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

1.2.1. Accelerometers

The Ellipse Micro IMU embeds 3 high performance, industrial grade MEMS accelerometers. Coupled with a cutting edge calibration, advanced filtering techniques and sculling integrals, these accelerometers will provide excellent performance, even in highly vibrating environment.

The A2 version is dedicated to marine applications requiring high performance heave measurements, while the A3 version is suitable to all other applications.

	A2	A3	A4	Remarks
Full scale (*g*)	8	16	40	
Scale factor stability (ppm)	1000	1000	1000	After one year accelerated aiging
Non-Linearity (ppm of FS)	6300	1500	1500	Best Fit Straight Line
One year bias stability (m*g*)	2	5	5	After one year accelerated aiging
Velocity Random Walk (µ*g*/√hz)	12	57	57	
In run bias instability (µ*g*)	3	14	14	Allan variance – @ 25°C
Vibration Rectification Error (µ*g*/*g*²)	200	50	50	Tested up to 3g RMS for A2 and 10g RMS for A3/A4
Bandwidth (Hz)	390	390	390	Internal low pass filters attenuation < 3 dB
Sampling rate (kHz)	4	4	4	Advanced anti-aliasing FIR filter
Orthogonality (°)	0.05	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.

G4 range is suitable to most applications, while the G5 is adapted for high dynamic applications.

	G4	G5	Remarks
Full scale (°/s)	450	1000	
Scale factor stability (ppm)	500	500	After one year accelerated aiging
Non-Linearity (% of FS)	50	50	
One year bias stability (°/s)	0.2	0.4	After one year accelerated aiging
Angular Random Walk (°/√hr)	0.15	0.18	Allan variance – @ 25°C
In run bias instability (°/hr)	7	8	Allan variance – @ 25°C
Vibration Rectification Error (°/h/g²)	< 1	< 1	Tested up to 10g RMS
Bandwidth (Hz)	133	133	Internal Gyro bandwidth
Sampling rate (kHz)	10	10	Advanced anti-aliasing FIR filter
Orthogonality (°)	0.05	0.05	

1.3. Aiding sensors

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

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 75Hz. User should ensure that high frequency noise is not disturbing magnetometers at the sensor's location.

	Specifications	Remarks
Full scale (Gauss)	50	
Scale factor stability (%)	0,5	
Noise (mGauss)	3	Over 1 to 25 Hz band
Bias stability (m Gauss)	1	
Bandwidth (Hz)	22	-3dB attenuation
Resolution (mGauss)	1.5	
Sampling rate (Hz)	100	
Orthogonality (°)	0.1	After user magnetic calibration

1.3.2. External sensors

1.3.2.1. 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.

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

1.3.2.2. Odometer

In addition to the GNSS aiding, the Ellipse micro 'E' version includes two sync inputs that can be used as odometer input. This 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.

Warning: In a typical INS setup, one sync IN will be dedicated to PPS input and the second can be used as odometer input. It means that the Ellipse Micro can only handle uni-directional odometers. If you need direction detection please consider using the full featured Ellipse sensor instead of Ellipse Micro.

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. AHRS specifications

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.

	Performance	Remarks
Measurement range	360° in all axes, no mounting limitation	
Roll / Pitch accuracy	< 0.1°	Low dynamic conditions – No long term accelerations
Yaw Accuracy	0.8°	Clean magnetic environment – Magnetic calibration performed

1.5. INS specifications

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)

1.5.1. 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	0.1 °	0.3 °
	RTK	0.02 m	0.04 m	0.05 m/s	0.05 m/s	0.1 °	0.3 °
10 s	SP	2.5 m	3 m	0.2 m/s	0.2 m/s	0.1 °	0,3 °
	RTK	0.8 m	0.8 m	0.15 m/s	0.15 m/s	0.1 °	0.3 °
60 s	SP	9 m	6 m	0.1 m/s	0.1 m/s	0.1 °	0.5 °
	RTK	7 m	4 m	0.1 m/s	0.1 m/s	0.1 °	0.5 °

1.5.2. Marine 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	0.1 °	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.

1.5.3. 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	0.1 °	0.5 °
RTK	0.02 m	0.04 m	0.05 m/s	0.05 m/s	0.1 °	0.4 °

2. Mechanical and Electrical specifications

2.1. Mechanical specifications

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

The Ellipse micro enclosure is made in aluminum to ensure robust integration into your system. However, the Ellipse micro is not intended to be used outdoor. That's why the enclosure is not waterproof. Sensors MEMS elements are all sealed to ensure good stability over time.

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.

Warning: The enclosure is not waterproof. For outdoor operation, please use the full featured Ellipse sensor instead.

The table below summarizes all mechanical and environmental specifications.

Item	Specification	Remarks
Size	26.8 x 18.8 x 9.5 mm	
Weight	10g	
Shocks	< 2 000g	
Operating Vibrations	3g RMS – 20Hz to 2 kHz as per MIL-STD-810G	Specified performance for A2 range
	8g RMS – 20Hz to 2 kHz as per MIL-STD-810G	Specified performance for A3 / A4 ranges

Environmental Specifications	
Enclosure	Aluminum
IP rating	N/A
Operating / storage temperature	-40 to 85°C (-40 to 185°F)
Humidity	98% – Non condensing
MTBF (computed)	50.000 hours
Calibration interval	None required, maintenance free

2.1.1. Device mechanical alignment

For best measurement accuracy, a good mechanical alignment is required. During manufacturing, the Ellipse measurement frame has been carefully aligned to 0.1° with the base plate for roll, pitch and yaw angles.

In order to align properly the IMU frame with your own system, SBG Systems recommends the use of 3x alignment pins, located along two perpendicular sections of the enclosure.

2.1.2. 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.

2.1.3. Device coordinate frame

Device coordinate frame is identified on the product by the axis X direction.

The whole coordinate frame is as explained in following diagram:

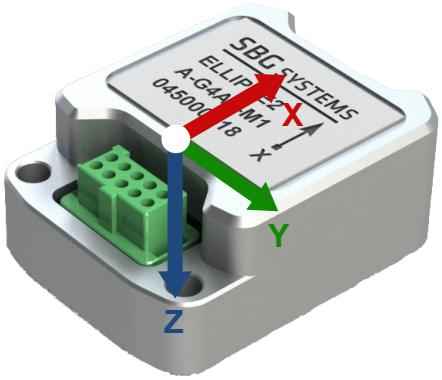

Figure 2.1: Device coordinate frame

2.1.4. 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 top and bottom sides of the Ellipse micro, laser printed labels that hold all these identification information. These labels also include a data-matrix code that encodes the device unique serial number. Finally, the topside label identifies the IMU X axis direction.

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

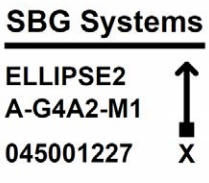

Figure 2.2: Ellipse device label sample (top side)

Figure 2.3: Ellipse device label sample (bottom side)

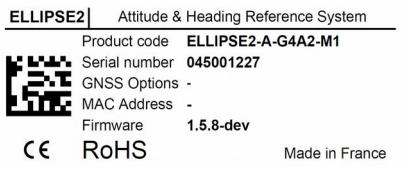

Figure 2.4: Ellipse packaging label sample

2.1.5. Ellipse micro mechanical outline

All dimensions are in mm.

2.1.5.1. Front view

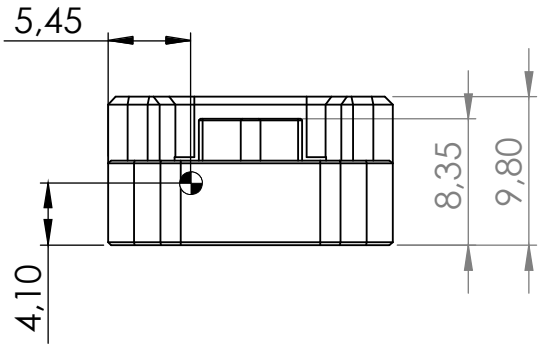

Figure 2.5: Ellipse Micro front view

2.1.5.2. Top view

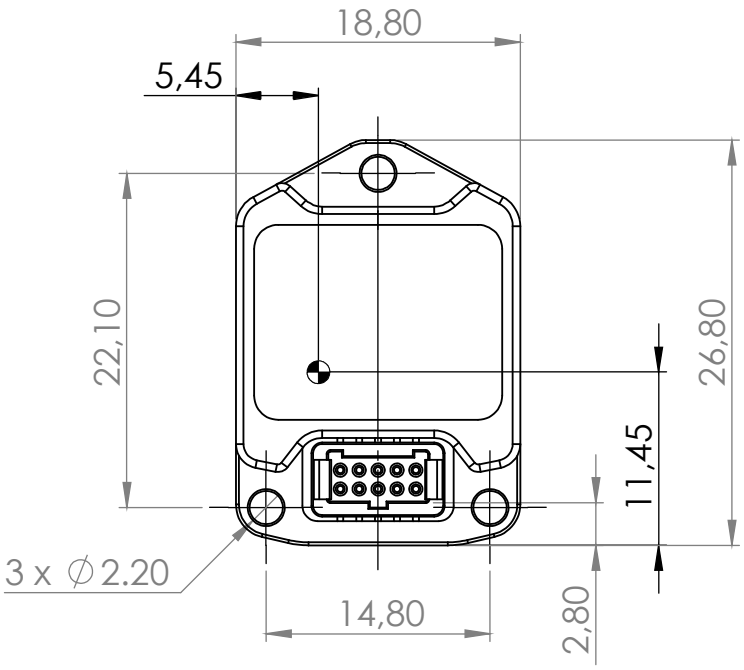

Figure 2.6: Ellipse Micro top view

2.1.5.3. Right view

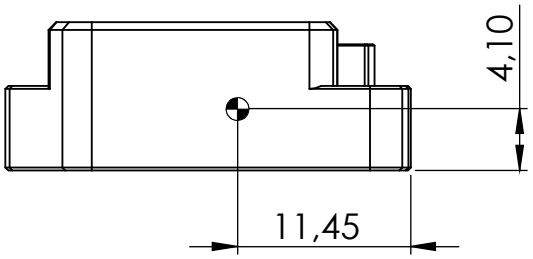

Figure 2.7: Ellipse-A right view

2.2. Electrical specifications

2.2.1. Main connector

SBG Systems has selected a specific connector designed for high reliability. The main connector provides access to all Ellipse Micro features through a modular way. It provides:

- The main serial port (PORT A) that supports full-duplex communication. It operates by default in RS-422 in the versions M1, or in RS-232 on M2 devices
- An auxiliary RS-232 port (PORT E), available only when Ellipse Micro is operated in RS-232
- One CAN 2.0A/B connection that supports up to 1 Mbit/s data rate used to output data
- Two multi-function input/output pins that can be used for:
  - Clock synchronization or event marker input pins
  - Single channel Odometer input
  - Synchronization output signals for time stamping and to trigger some equipment.

2.2.1.1. Connector specifications

The main connector uses a 10 ways Harwin Gecko connector. The exact receptacle reference is: G125-FS11005L0P.

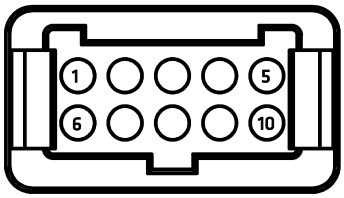

Figure 2.8: Main receptacle front view

The Ellipse Micro connector will mate with the cable mounted reference G125-3041096L4 (Harwin). Don't forget that this reference doesn't include the contacts.

For lowest cost and high volume integration, SBG Systems recommends the use of a board to board connector: G125-MS11005L0P (surface mount) or G125-MV11005L0P (through hole mount).

For cable connections, it is also possible to purchase cable assemblies from Harwin: G125-MC21005L4-0150L and G125-MC21005L0-0150M. For shorter lead time, SBG Systems provides the following cable assembly reference CA-ELI-M-OW-0.25M.

Other plugs with right angle or other options may be found if required.

Figure 2.9: Main plug in board to wire configuration

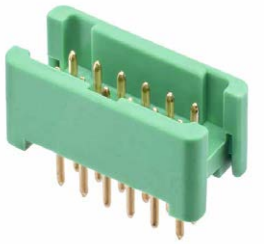

Figure 2.10: Main plug in board to board configuration (through hole mounting)

2.2.1.2. Pin out in RS-422 mode

Pin #	Name	Description
1	GND	Ground return signal
2	PORT A Rx+	Port A RS-422 Rx+ line
3	PORT A Tx+	Port A RS-422 Tx+ line
4	SYNC A	Synchronization signal A. May be used as SYNC IN A or SYNC OUT A
5	CAN H	CAN High

Pin #	Name	Description
6	VIN	Power supply Input
7	PORT A RX-	Port A RS-422 Rx- line
8	PORT A TX-	Port A RS-422 Tx- line
9	SYNC B	Synchronization signal B. May be used as SYNC IN B, SYNC OUT B, or ODO input
10	CAN L	CAN Low

2.2.1.3. Pin out in RS-232 mode

Pin #	Name	Description
1	GND	Ground return signal
2	PORT A Rx	Port A RS-232 Rx line
3	PORT E Tx	Port E RS-232 Tx line
4	SYNC A	Synchronization signal A. May be used as SYNC IN A or SYNC OUT A
5	CAN H	CAN High

Pin #	Name	Description
6	VIN	Power supply Input
7	PORT E RX	Port E RS-232 Rx line
8	PORT A TX	Port A RS-232 Tx line
9	SYNC B	Synchronization signal B. May be used as SYNC IN B or SYNC OUT B or ODO input
10	CAN L	CAN Low

2.2.2. Electrical specifications

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

Item	Conditions	Min	Typical	Max	Unit
Power supply					
Input voltage range		4		15	V
Power consumption			400		mW
RS-232 Receivers					
Input range		-15		15	V
Low level threshold		0.6	1.2		V
High level threshold			1.5	2.0	V
Input resistance		3	5	7	kΩ
RS-422 Receiver					
Input differential threshold	Common mode Voltage [-7V; 12V]	-200	-125	-50	mV
Input hysteresis			25		mV
Input resistance		100	120	155	kΩ
RS-232 Transmitters					
Output range		+/-5	+/-5.5		V
RS-422 transmitters					
Differential output voltage	RL=100ohm	2			V
Common mode output voltage				3	V
Sync In pins					
Input range		0		3.3	V
Low level threshold				1	V
High level threshold		2.3			V
Sync Out pins					
High Level Output voltage	I_{Load} < 6mA	2.6			V
Low Level Output voltage	I_{Load} < 6mA			0.4	V
CAN bus					
Recessive Bus Voltage		1.45	1.95	2.45	V
CAN H Output Voltage	dominant	2.15	2.9	3.3	V
CAN L Output Voltage	dominant	0.5	0.9	1.65	V
Differential input voltage	CANH, CANL	0.5		0.9	V

3. Interfaces specifications

3.1. Overview

The Ellipse features up to two serial interfaces 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 connector, 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	Tx / Rx capability	Other functions / multiplexing
PORT A	Tx/Rx	In RS-422 by default on M1 devices In RS-232 by default on M2 devices RS-232/422 Software selectable.
PORT E	Tx/Rx	Only available when PORT A is configured in RS-232 mode
CAN	Tx only	
SYNC A	Input/output	Can be used as SYNC IN A for event or PPS input, or SYNC OUT A for event or PPS output
SYNC B	Input/output	Can be used as SYNC OUT B for event or PPS output. Can also be used as Odometer input.

3.2. Serial interfaces

The Ellipse Micro features one RS-422 or two RS-232 serial connections (PORT A and E). These serial ports have different uses as described in the next sections.

The Ellipse Serial interfaces support the standard 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 and 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 Micro has been designed to be connected to a large range of equipment. In addition to the native sbgECom binary protocol, other third party or standard protocols are also supported such as NMEA, TSS1. In addition to the output capabilities, the Ellipse Micro E can be connected to an external GNSS receiver (Ublox Binary protocol and others).

3.2.2. Ports functions Mapping

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

	PORT A	PORT E (RS-232 mode)
Binary commands (sbgECom)	•	
Regular outputs (sbgECom, NMEA or third party output)	•	•
Legacy protocol output (sbgCom)	•	
1KHz IMU output		•
GNSS input (Ellipse E only)		•

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	-0,3 to +20V
Rx+, Rx-	±18V
SYNC A, SYNC B to GND	-0.3V / +4.0V
CANH, CANL	±60 V
ESD protection (Tx, Rx, Input & Output pins, CANH, CANL)	15 kV

Table 1: 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.

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:

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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 hereunder 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 Micro ordering codes

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

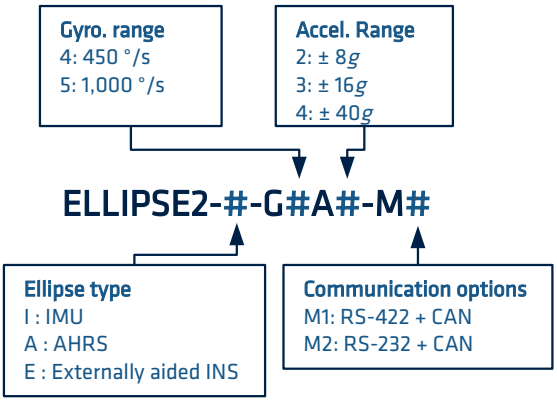


Figure 5.1: Ellipse Micro ordering codes

Note: All Ellipse Micro sensors are RS-232 / RS-422 software selectable. However, the factory default configuration (including firmware update procedure) is set according to the M1/M2 configuration.

5.2. Development kits

5.2.1. DK-ELI-M

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

- Small sized transport case
- An evaluation board to quickly test and configure the Ellipse micro sensor
  - Integrated GNSS module for INS applications
  - RS-232 / RS-422 capable
  - Direct access to all inputs/outputs
- 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
- Fast and efficient support.

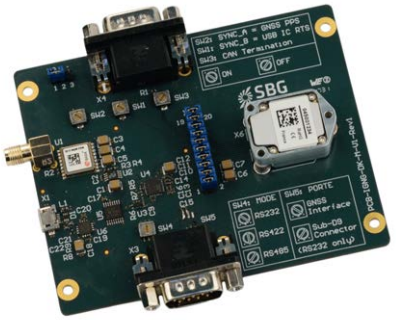
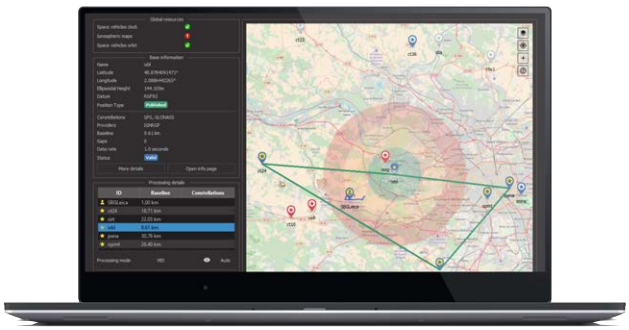


Figure 5.2 : DK-ELI-M

5.3. Associated Software

5.3.1. SW-QINERTIA-LITE (GNSS/INS Post Processing Software)

Qinertia is a 100% in-house post-processing software solution. This full-featured software enhances SBG Systems inertial navigation systems performance by post processing inertial data with raw GNSS observable in both forward and backward directions.



Key Features:

- Tight Coupling INS/GNSS fusion
- Achieve highest possible accuracy
- + 7,000 Base Stations always up-to-date
- Open to all Industry Standards
- Fastest Processing available on the market
- Modern & Intuitive Interface

5.4. Cables

5.4.1. CA-ELI-M-OW-0.25M

This open ended cable provides an easy access to all Harwin Gecko connector on the Ellipse Micro. The cable is 25cm long and has following pin-out:

Figure 5.3 : CA-ELI-M-OW-0.25M

Pin #	Color	Signal (M1 units)	Signal (M2 units)
1	BLACK	GND	GND
2	WHITE	PORT A Rx+	PORT A Rx
3	YELLOW	PORT A Tx+	PORT E TX
4	BROWN	SYNC A	SYNC A
5	BLUE	CAN H	CAN H
6	RED	VIN	VIN
7	GREY	PORT A Rx-	PORT E RX
8	ORANGE	PORT A Tx-	PORT A Tx
9	GREEN	SYNC B	SYNC B
10	PURPLE	CAN L	CAN L

5.5. GNSS antennas

5.5.1. ANT-TAL-TW-32-2710-00-3000

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

The TW2710 provides a multi-constellation tracking, featuring GPS L1, GLONASS L1, BEIDOU B1 and GALILEO E1 signals tracking.

The following specifications apply to the TW2710:

Figure 5.4 : Tallysman TW2710 antenna

5.5.1.1. 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

5.5.1.2. Mechanical drawing

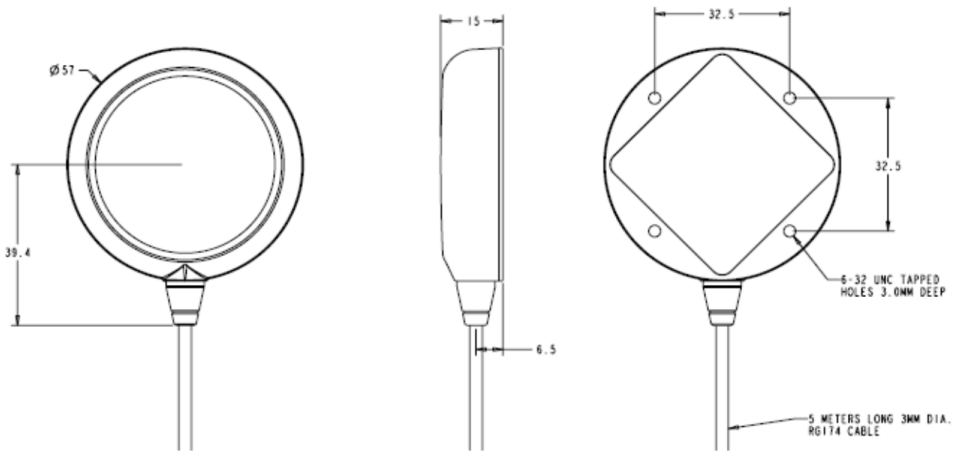


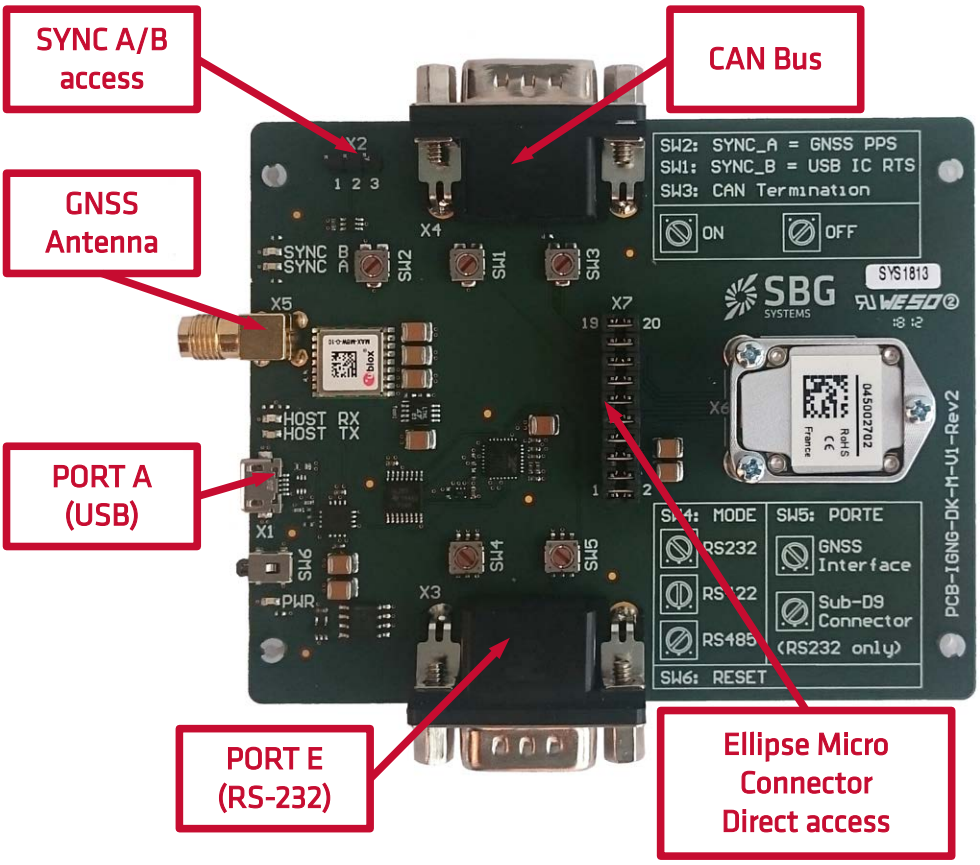
Figure 5.5: Tallysman TW2710 mechanical drawing

6. Appendix B: Evaluation board documentation

6.1. Board overview

The evaluation board has been designed to test most of the Ellipse Micro functions and also to configure the device without the need to develop specific cabling.

Following connectors provide easy access to the board functionalities:



6.2. Board configuration Switches

In addition to the connectors, several switches are present on the board to configure the behavior, enable or disable specific features:

SW4 and SW5 should be combined together to enable following functions:

Ports configuration	SW4	SW5
PORT A RS-422 PORT E disabled		
PORT A RS-232 PORT E to ublox GNSS		
PORT A RS-232 PORT E to DB-9		

Other switches provide a more simple mode of operation:

SYNC B Configuration	SW1
SYNC B connection to USB RTS signal	
SYNC B direct access through X2	

SYNC A Configuration	SW2
SYNC A connection to ublox GNSS PPS	
SYNC A direct access through X2	

CAN termination	SW3
120 Ohm termination enabled	
No CAN bus termination	

6.3. Flashing a firmware using the Ellipse Micro development board

The specificity of Ellipse Micro and associated development board require to use the RS-422 communication mode for running the bootloader (used to upgrade firmware, and regardless of the user configuration).

Because of that, the sbgFirmwareUpdater might not be able to automatically detect an Ellipse Micro module configured in RS-232.

In order to easily upgrade the firmware you should do the following operations:

- Plug the Ellipse Micro on the development board
- Select on the development board RS-422 mode by setting the SW4 and SW5 in following positions: SW4:  SW5: 
- Launch sbgFirmwareUpdater
- when sbgFirmwareUpdater ask you to disconnect the unit, press Next.
- When sbgFirmwareUpdater ask you to reconnect the unit, press Reset button (SW6) and wait for the process to complete.
- Put back the evaluation board switches to match the ELLIPSE configuration (either RS-232 or RS-422 mode).

Note: If you use the sbgFirmwareUpdater to restore default settings, please remember that the ELLIPSE micro will go back to default RS-422 communications mode.

6.4. Schematics

This section documents the evaluation board schematics. It can be used as design reference and to understanding the Ellipse Micro integration on the evaluation board.

USB Connector

X1
629105136821
VBUS
USB_DM
USB_DP
Shield

USB
IGNG-DK-M_USB.SchDoc
FTDI_UART_TX
FTDI_UART_RX
FTDI_TXDEN
FTDI_CTS
FTDI_RTS

SW1
CS-4-12XTA

RTS <> SYNC B switch

SYNC_B = RTS
No connection

INTERFACE
IGNG-DK-M_INTERFACE.SchDoc
FTDI_UART_TX
FTDI_UART_RX
FTDI_TXDEN
GPS_UART_TX
GPS_UART_RX
IMU_PORTE_RS232_RX
IMU_PORTE_RS232_TX
IMU_RS422_RX_P/RS232_RX_A
IMU_RS422_RX_N/RS232_RX_E
IMU_RS422_TX_N/RS232_TX_A
IMU_RS422_TX_P/RS232_TX_E

GNSS
IGNG-DK-M_GNSS.SchDoc
GNSS_UART_TX
GNSS_UART_RX
GNSS_PPS

SW2
CS-4-12XTA

PPS <> SYNC A switch

SYNC_A = PPS
No connection

IMU
IGNG-DK-M_IMU.SchDoc
IMU_RS422_RX_P/RS232_RX_A
IMU_RS422_RX_N/RS232_RX_E
IMU_RS422_TX_N/RS232_TX_A
IMU_RS422_TX_P/RS232_TX_E
IMU_SYNC_A
IMU_SYNC_B
IMU_CAN_L
IMU_CAN_H

SYNC Connector

SYNC A = pin #1

SYNC B = pin #3

X2
M20-9990345

VDD_3.3V
C8 100nF
U7
SN74LVC2G34DCK
VCC
1A
2A
1Y
2Y
GND
R10 330
R11 330
LED1 HSMG-C191
LED2 HSMS-C191

PORTE Connector

Only available on RS232 devices

(SW4=RS232 & SW5=DB9 Connector)

X3
3-1634580-2
SHIELD

CAN Connector

X4
3-1634580-2
SHIELD

SW3
CS-4-12XTA
R1 120

CAN Termination

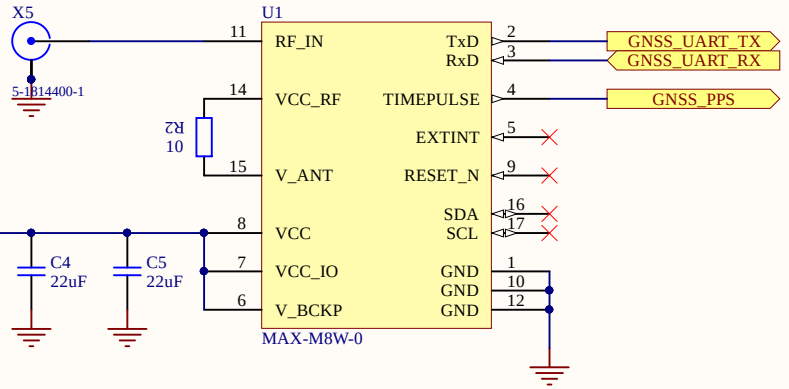
Enabled
Disabled

Hardware & Fasteners

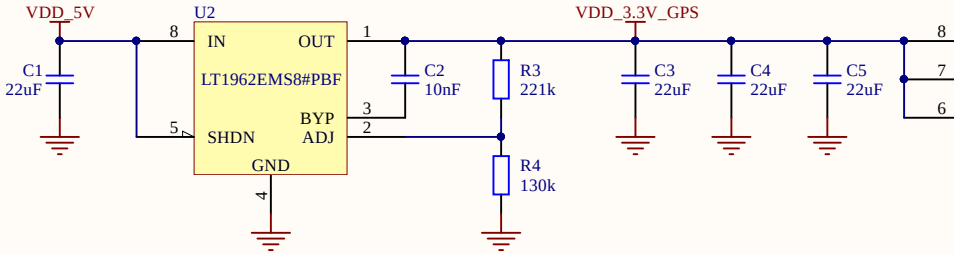
SPCR1 702915000
SPCR2 702915000
SPCR3 702915000
SPCR4 702915000

Title: IGNG-DK			SBG-Systems 3bis, chemin de la Jonchère 92500 RUEIL-MALMAISON FRANCE
Size: A3	Author: S.Mouton	Version 1 - Rev. 2	
Date: 23/01/2018	Time: 10:51:16	Sheet: 1 of 5	
File: D:\hardware\projects\IGNG\IGNG-DK-M\IGNG-DK-M.SchDoc			

GNSS Receiver



LDO for GNSS 3.3V power



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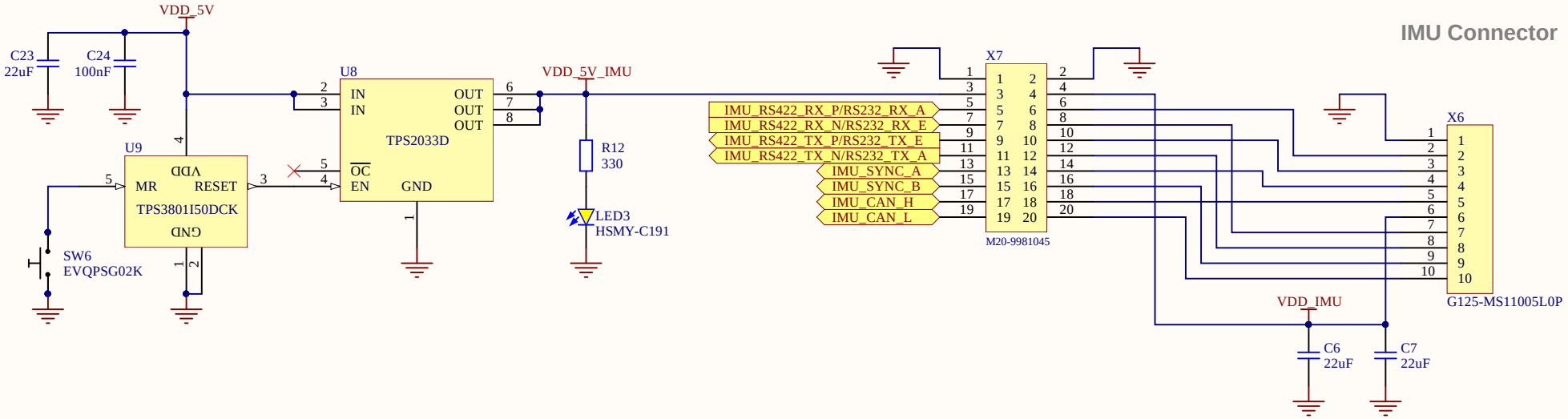
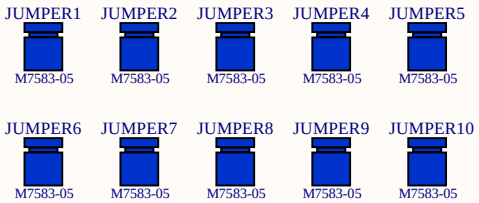
File: D:\hardware\projects\IGNG\IGNG-DK-M\IGNG-DK-M_GNSS.SchDoc			

IMU Signals Jumpers

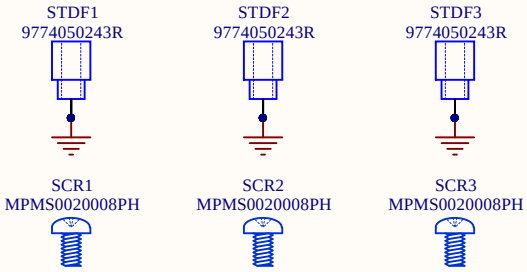


Sockets Jumpers

Use with the M20-9981045 connector, 20cts, 2.54mm pitch



IMU Mounting Standoffs and Screws



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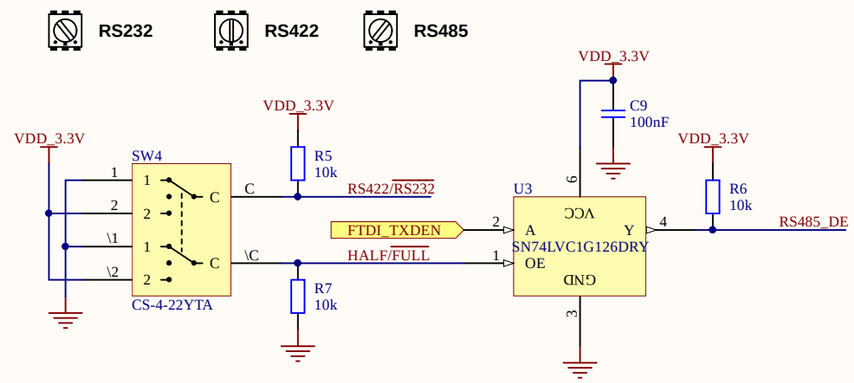
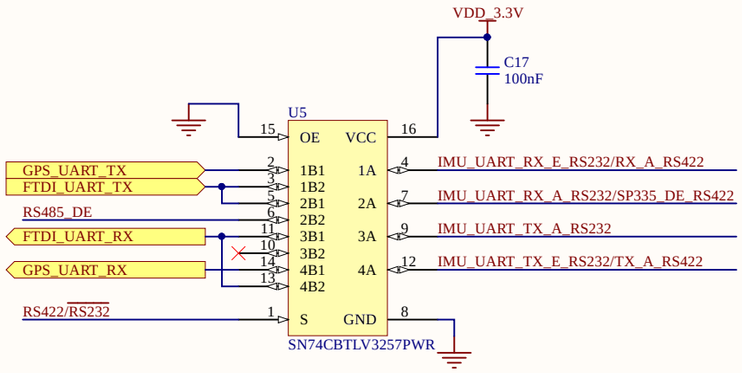
Date: 23/01/2018	Time: 10:51:16	Sheet: 3 of 5	
File: D:\hardware\projects\IGNG\IGNG-DK-M\IGNG-DK-M_IMU.SchDoc			

Transceiver Protocol Selector

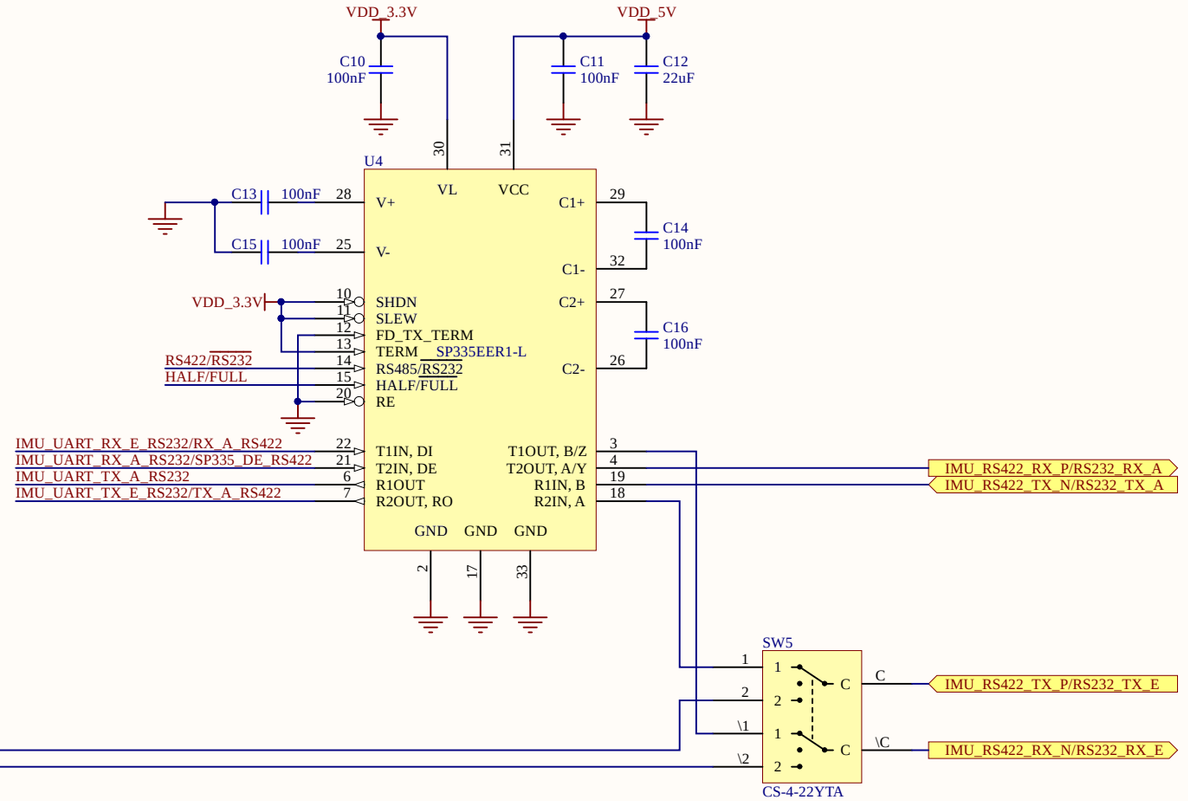


UART Multiplexer

(used to redirect SP335's UART IOs depending on the used protocol)



RS232/RS422 Transceiver



Internal GNSS/D-Sub9 Connector Selector for PORTE

(function only available for RS232 devices)

PORTE <=> Internal GNSS Receiver

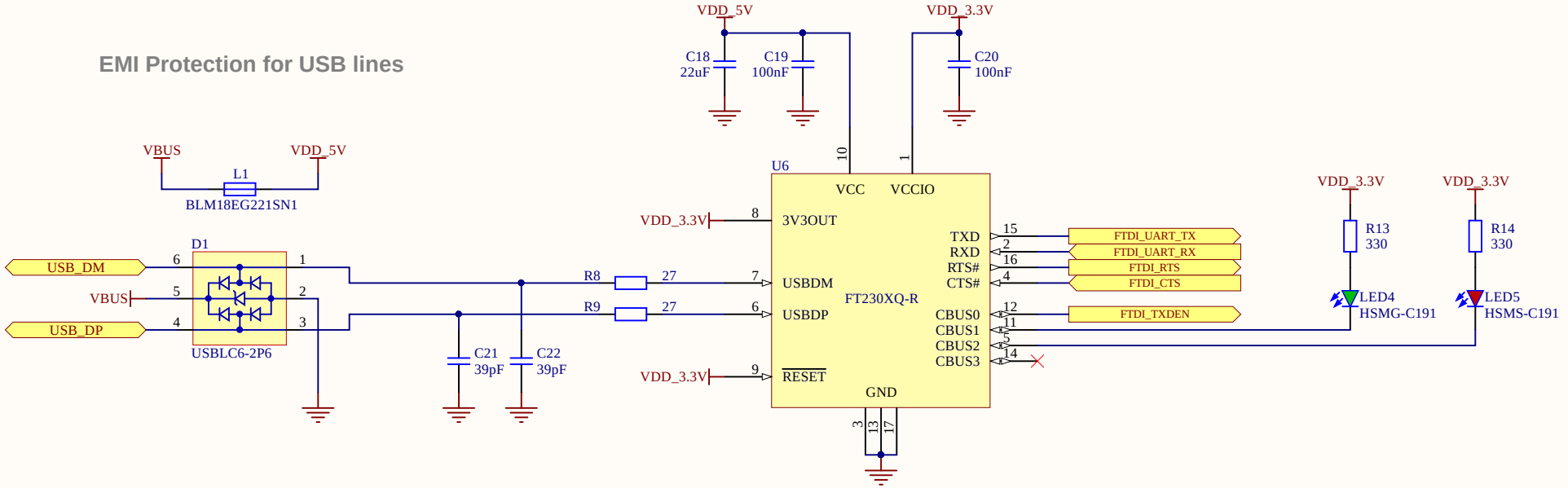
(this position must also be used for RS422 or RS845 proper operation)

PORTE <=> D-Sub 9 Connector

Title: **IGNG-DK Interface**			**SBG-Systems** 3bis, chemin de la Jonchère 92500 RUEIL-MALMAISON FRANCE
Size: A3	Author: S.Mouton	Version 1 - Rev. 2	
Date: 23/01/2018	Time: 10:51:16	Sheet: 4 of 5	
File: D:\hardware\projects\IGNG\IGNG-DK-M\IGNG-DK-M_INTERFACE.SchDoc			

USB to UART Converter

EMI Protection for USB lines



Title: **IGNG-DK USB**			**SBG-Systems** 3bis, chemin de la Jonchère 92500 RUEIL-MALMAISON FRANCE
Size: A4	Author: S.Mouton	Version 1 - Rev. 2	
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File: D:\hardware\projects\IGNG\IGNG-DK-M\IGNG-DK-M_USB.SchDoc			