DS-IMU/GYRO

DEWESoft®

SOFTWARE USER MANUAL

DS-IMU/GYRO V22-1

1. Table of contents

2. About this document

2.1. Legend

The following symbols and formats will be used throughout the document.

Important
It gives you important information about the subject.
Please read carefully!

Hint
It gives you a hint or provides additional information about a subject.

Example
Gives you an example of a specific subject.

2.2. Online versions

DewesoftX® homepage
http://www.dewesoft.com
you can download DewesoftX® plugins when you go to: Downloads – Plugins

3. Foundation knowledge

This chapter is a learning reference that briefly covers knowledge essential to understanding DS-IMU/GYRO products and the following chapters. It explains the concepts in simple terms so that people unfamiliar with the technology may understand it.

3.1. GNSS

GNSS stands for global navigation satellite system. A GNSS consists of a number of satellites in space that broadcast navigation signals. These navigation signals can be picked up by a GNSS receiver on the earth to determine the receiver's position and velocity. For a long time the only operational GNSS was the United States GPS. However the Russian GLONASS is now fully operational with similar performance to GPS. The Chinese BeiDou is in the process of becoming operational and the European GALILEO should be operational within ten years.

GNSS is excellent for navigational purposes and provides a fairly accurate position (2.5 meters) and velocity (0.03 m/s). The main drawback of GNSS is that the receiver must have a clear signal from at least 4 satellites. GNSS satellite signals are very weak and struggle to penetrate through buildings and other objects obstructing view of the sky. GNSS can also occasionally drop out due to disturbances in the upper atmosphere.

3.2. INS

INS stands for inertial navigation system. An inertial navigation system can provide position and velocity similar to GNSS but with some big differences. The principle of inertial navigation is the measurement of acceleration, which is then integrated into velocity and then with second integration into position. Due to noise in the measurement and the compounding of that noise through the integration, inertial navigation has an error that increases exponentially over time. But on the other hand such systems have a very low relative error over short time periods, which can dramatically increase over a long period of time.

3.3. GNSS/INS

By combining GNSS and INS together in a mathematical algorithm, it is possible to take advantage of GNSS long-term accuracy/stability and INS short-term accuracy. This provides an overall enhanced position and velocity solution that can withstand short GNSS drop outs.

3.4. AHRS

AHRS stands for attitude and heading reference system. An AHRS uses accelerometers, gyroscopes and magnetometers combined in a mathematical algorithm to provide orientation, which consists of three body angles: roll, pitch and heading.

3.5. The sensor Coordinate frame

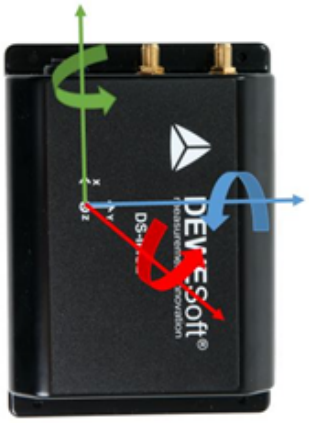
Inertial sensors have 3 different axes: X, Y and Z which determine the directions of angles and accelerations. It is very important to align the axes correctly in installation otherwise the system won't work correctly. These axes are marked on the top of the device as shown in Illustration below with the X axis pointing in the direction of the connectors (green arrow), the Z axis pointing down through the base of the unit (red arrow) and the Y axis pointing off to the right (blue arrow), which can be also presented as Right hand rule → Illustration of hand with the same color coordinate system

Image 1: Sensors coordinate frame can be presented as a right hand rule

When installed in an application the X axis should be aligned such that it points forwards and the Z axis aligned so that it points down when level.

3.6. Roll, Pitch and Heading

Orientation can be described by the three angles: Roll, Pitch and Heading, which are known as the Euler angles. They are best described with the image below.

Roll - is the angle around X axis (green arrows)	
Pitch – is the angle around Y axis (blue arrows)	
Heading – is the angle around Z axis (0 degrees is when X axis points to the North → red arrows)	*Image 2: Roll, pitch and heading*

To remember in which way the orientation is positive, it's best to use the second right hand rule, which is shown by the Illustration7, where we point a thumb in the positive direction of that axis and then the direction that your fingers curl over is the positive rotation on that axis.

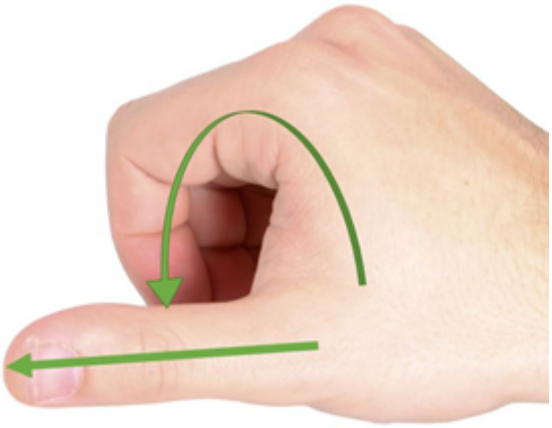


Image 3: Point a thumb in the positive direction of the axis in order to see the rotation direction

3.7. Geodetic coordinate system

The geodetic coordinate system is the most popular way of describing an absolute position on the Earth. It's made up of the angles of latitude and longitude combined with a height relative to the ellipsoid. Latitude is the angle that specifies the north to south position of a point on the Earth's surface. Longitude is the angle that specifies the east to west position of a point on the Earth's surface. The line of zero latitude is the equator and the line of zero longitude is the prime meridian. Image 4 shows how latitude and longitude angles are used to describe a position on the surface of the Earth.

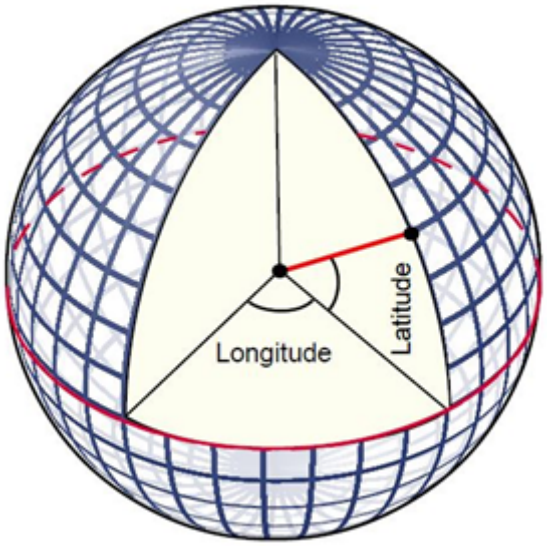


Image 4: Longitude and latitude positions presented *on the Earth*

On the map above we have latitude and longitude which gives the 2D point on the surface of the Earth. They are combined with height to give the 3D position on the Earth.

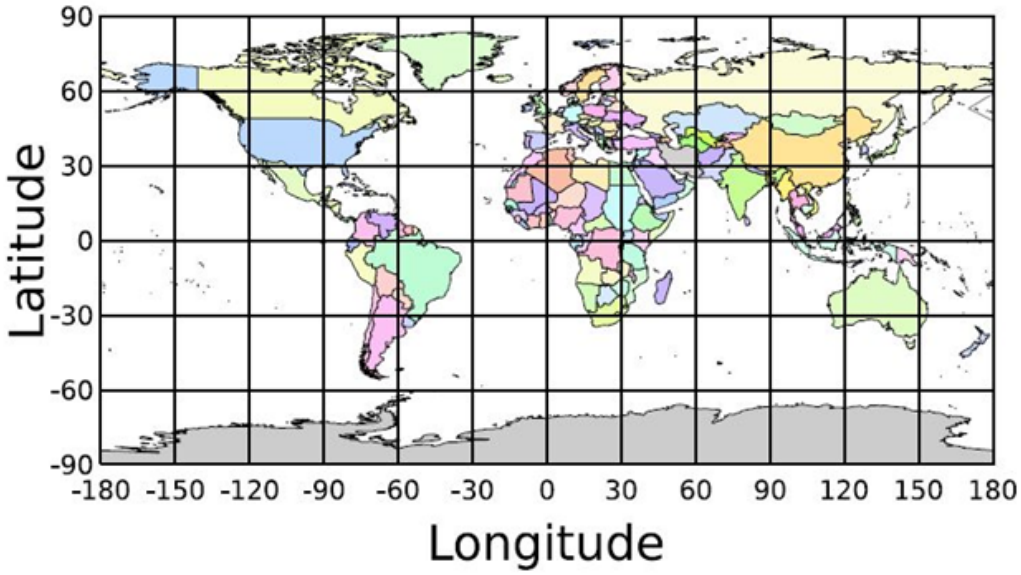


Image 5: Longitude and latitude values

Height means the height above the WGS84 reference ellipsoid. This ellipsoid is a model used to approximate sea level across the Earth, therefore the height should be considered approximately relative to sea level. Due to the approximate nature of the WGS84 model, this height will not be the same as the actual sea level --> it can vary up to 20 m.

3.8. NED coordinate frame

The NED (North, East, Down) coordinate frame is used to express velocities and relative positions. The origin of the coordinate frame can be considered the current position. From that origin, the north axis points true north and parallel to the line of latitude at that point. The east axis points perpendicular to the north axis and parallel to the line of longitude at that point. The down axis points directly down towards the center of the Earth. See the Illustration 6 for a graphical representation of the NED coordinate frame at some position on the Earth.

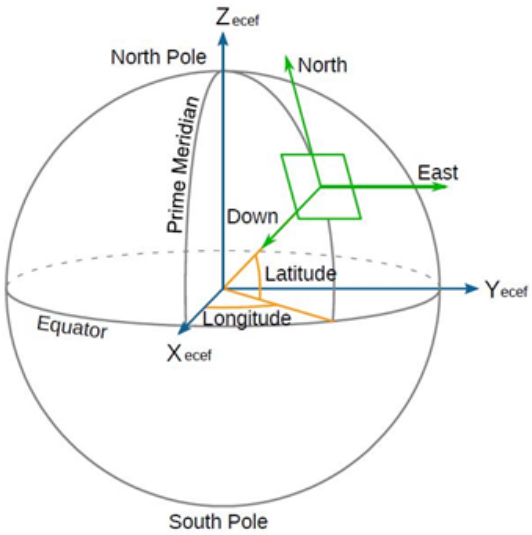


Image 6: NED coordinate frame

4. Introduction

DS-IMU2 and DS-IMU1 are miniature GNSS/INS & AHRS systems that provide accurate position, velocity, acceleration and orientation under the most demanding conditions.
DS-GYRO1 is a miniature orientation sensor and AHRS that provides accurate orientation under very difficult conditions.
All of them are a combination of temperature calibrated accelerometers, gyroscopes and magnetometers in a sophisticated fusion algorithm to deliver accurate and reliable orientation.
All 3 instruments can provide amazing results but they need to be set up properly and operated with an awareness of its limitations. Please read through this manual carefully to ensure success within your application.
The software is downloadable from our webpage:
www.dewesoft.com

4.1. Options

There are 3 DewesoftX's inertial navigation instruments available:

- DS-IMU2
- DS-IMU1
- DS-GYRO1

4.2. DS-IMU2

- DS-IMU2 is a ruggedized and reliable GPS aided navigation system
- Combines inertial sensors together with dual antenna GNSS receiver coupled in a sophisticated fusion algorithm to deliver accurate and reliable navigation and orientation
- GNSS receiver supports GPS, GLONASS, BeiDou, GALILEO, WASS, EGNOS, Gagan and Real-time kinematic --> RTK
- IP67 & MIL-STD-810G environmental protection
- Up to 500 Hz output data rate
- Connected over USB
- Fast and Easy-to-install

Image 7: DS-IMU2

4.2.1. Scope of supply

DS-IMU2 is supplied in a kit that contains everything required to get started operating the system right away. It's supplied in a rugged transport case to protect the equipment during the shipment.

Image 8: Complete DS-IMU2 supply package

4.2.1.1. Kit contents

- DS-IMU2
- 2x GPS/GLONASS/BeiDou/Galileo L1/L2/L5 GNSS antenna with 5/8-11 surver mounts
- 2x 5m GNSS antenna cable
- 2x Magnetic holder with antenna mounting
- Interface cable harness (with USB, Power and Sync connector)
- Optional: RF modem with RF cable + antenna

4.2.1.2. Quick start

- Position the two GNSS antennas in a level orientation with a clear view of the sky. The primary antenna should be positioned directly forwards of the secondary antenna with separation of at least 0.5 meters.
- Connect the coaxial cables between the antennas and DS-IMU2.
- Plug the interface cable into DS-IMU2.
- Plug the USB cable into your computer

- Download DewesoftX® software and the plugin from www.dewesoft.com.
- Install the driver for RS232 converter
- Run DewesoftX® software --> go to Settings --> Devices --> Click on the plus button and under Plugins you will find the DS-IMU option.

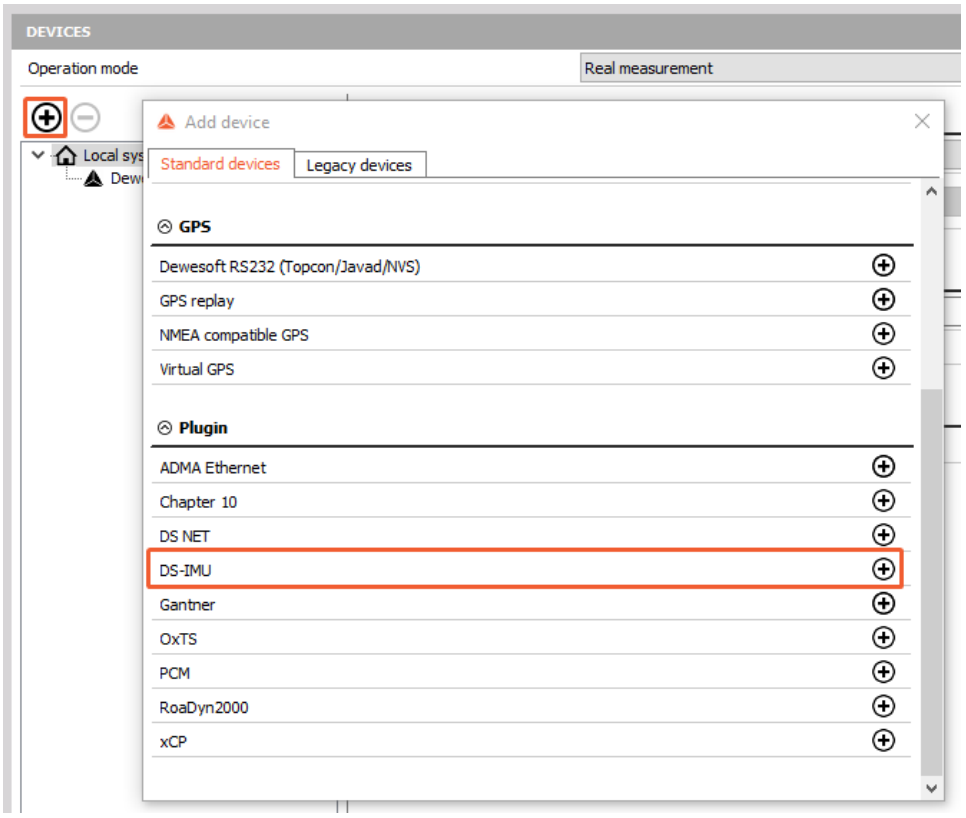


Image 9: Add DS-IMU as a device

- The device should be automatically recognized, if not press the Rescan device.

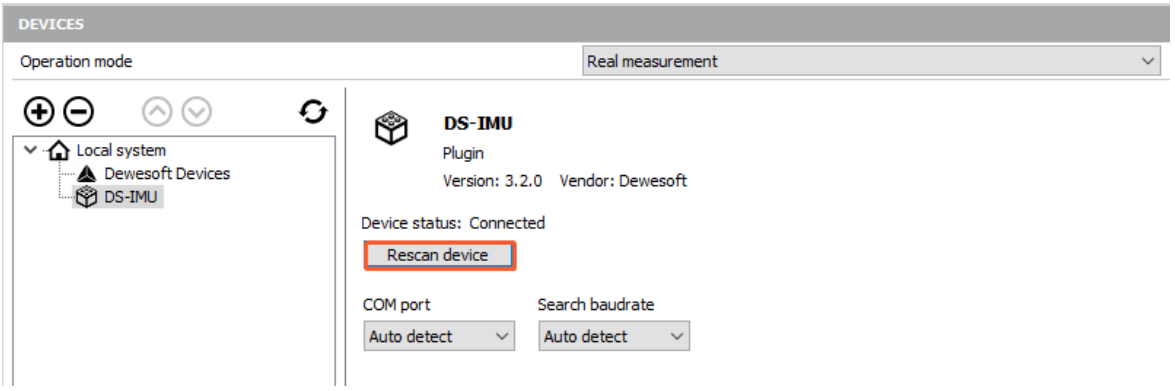


Image 10: If the device is not automatically recognized, press the Rescan device button

- After recognizing the device press OK.
- The dual antenna heading will take a short time to initialize. The progress can be seen in the top of the DS-IMU plugin window
- Device will send the data all the time, so you can watch them already in the Channel setup.

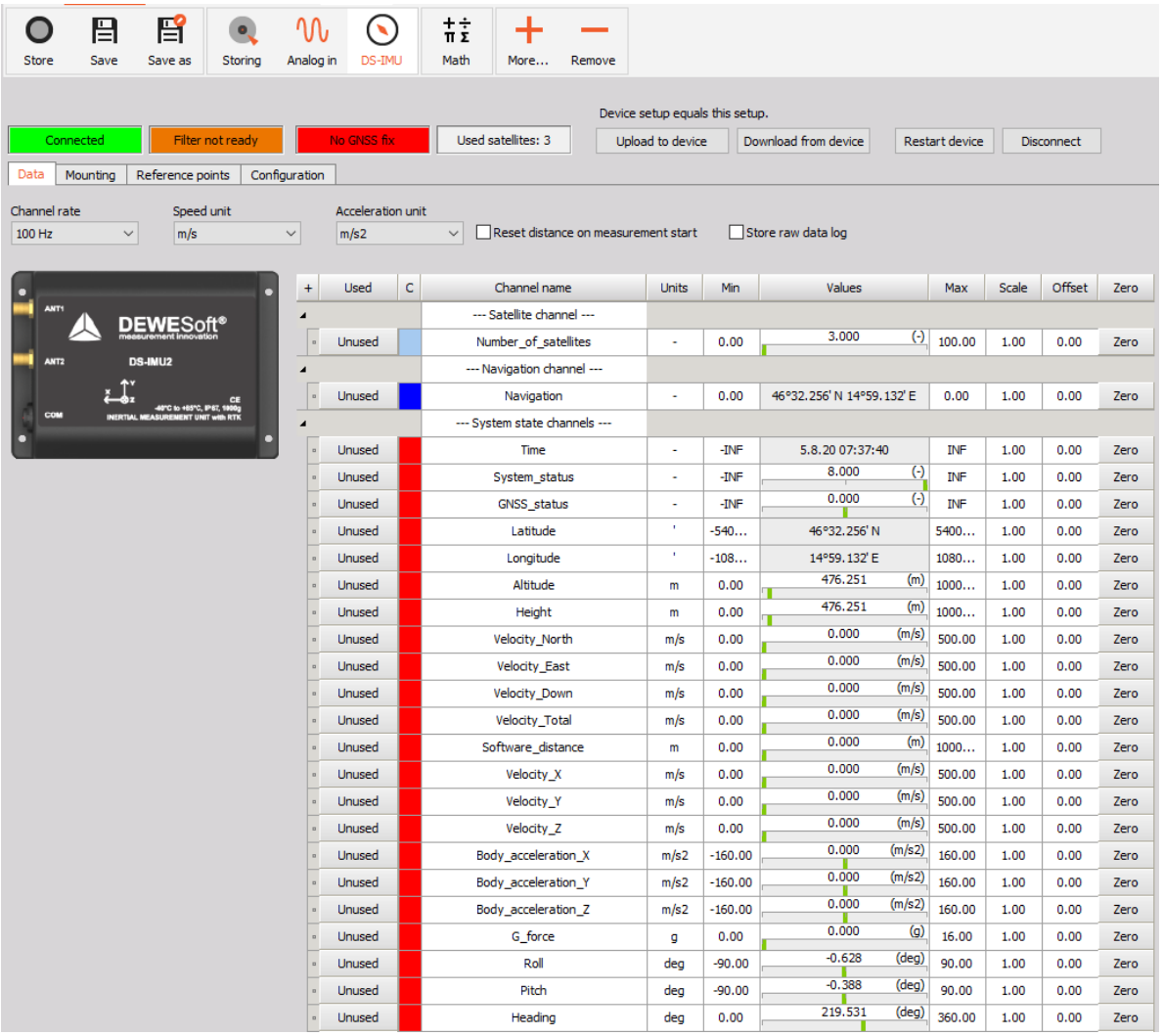


Image 11: You can preview the device data inside Channel setup

Important recommendation

We do **not** recommend using a magnetometer on a metal car with a SINGLE antenna option on IMU2! When using a dual antenna the magnetometer is automatically enabled and magnetic calibration is executed automatically!

4.2.2. Specifications

4.2.2.1. Mechanical drawings

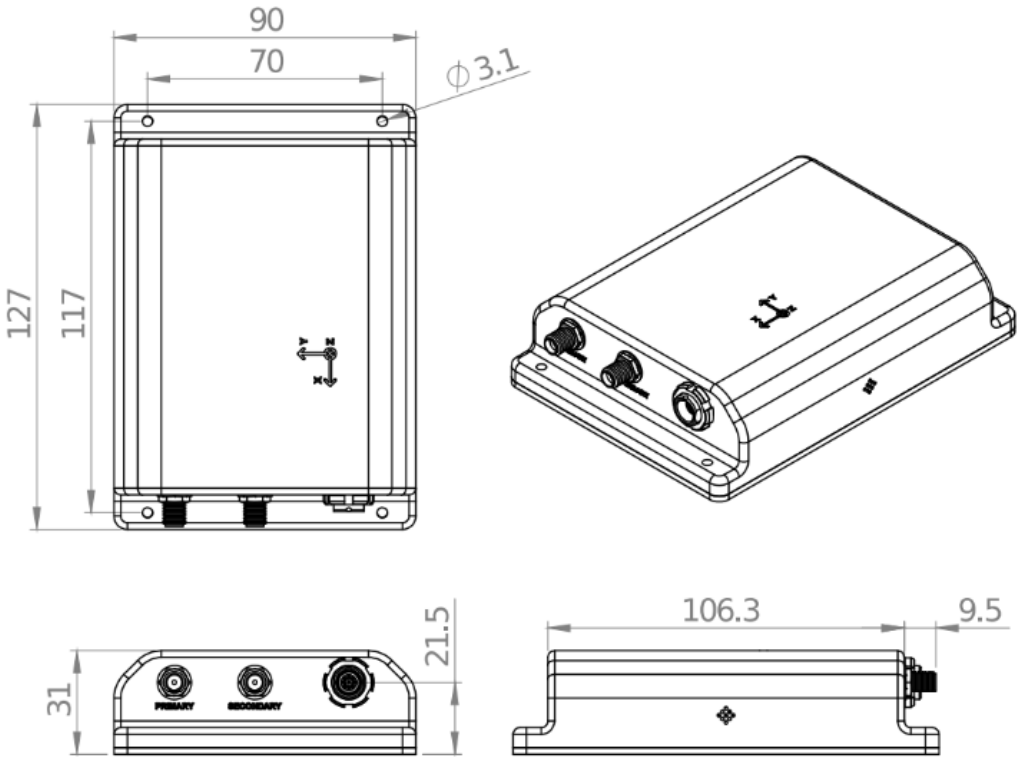


Image 12: Drawing from front view

4.2.2.2. Navigation specifications

Parameter	Value
Horizontal position accuracy	1.2 m
Vertical position accuracy	2.0 m
Horizontal position accuracy (SBAS)	0.5 m
Horizontal position accuracy (SBAS)	0.8 m
Horizontal position accuracy (Omnistar) *1	0.1 m
Vertical position accuracy (Omnistar) *1	0.2 m
Horizontal position accuracy (RTK) *2	0.008 m
Vertical position accuracy (RTK) *2	0.015 m
Velocity accuracy	0.01 m/s
Roll & Pitch accuracy (static)	0.1 °
Heading accuracy (static)	0.1 °
Roll & Pitch accuracy (dynamic)	0.15 °
Heading accuracy (dynamic)	0.1 °
Slip accuracy	0.1 °
Orientation range	Unlimited
Hot start time	500 ms
Internal filter rate	1000 Hz
Output data rate	Up to 500 Hz

*1 can be purchased at Omnistar
*2 with base station and optional RF modem

4.2.2.3. Heading accuracy

Antenna separation	Accuracy
1 m	0.1 °
2 m	0.07 °

4.2.2.4. Sensor specifications

Parameter	Accelerometers	Gyroscopes	Magnetometers	Pressure
Range (dynamic)	2 g 4 g 16 g	250 °/s 500 °/s 2000 °/s	2 G 4 G 8 G	10 to 120 kPa
Noise density	150 µg/√Hz	0.009 °/s/√Hz	210 µg/√Hz	0.56 Pa/√Hz
Non-linearity	< 0.05 %	< 0.05 %	< 0.05 %	-
Bias stability	20 µg	4 °/hr	-	100 Pa/yr
Scale factor stability	< 0.05 %	< 0.05 %	< 0.05 %	-
Cross-axis alignment error	< 0.05 °	< 0.05 °	< 0.05 °	-
Bandwidth	400 Hz	400 Hz	110 Hz	50 Hz

4.2.2.5. GNSS Specifications

Parameter	Value
Supported navigation systems	GPS L1, L2, L5 GLONASS L1, L2 GALILEO E1, E5 *1 BeiDou B1, B5 *2
Supported SBAS systems	WAAS, EGNOS, MSAS, GAGAN, QZSS Omnistar HP/XP/G2 *3
Update rate	20 Hz
Hot start first fix	3 s
Cold start first fix	30 s
Horizontal position accuracy	1.2 m
Horizontal position accuracy (SBAS)	0.5 m
Horizontal position accuracy (RTK) *4	0.008 m
Velocity accuracy	0.01 m/s

Timing accuracy	20 ns
Acceleration limit	11 g

*1 additional license to purchase
*2 additional license to purchase
*3 can be purchased at Omnistar
*4 with base station and optional RF modem

4.2.2.6. Hardware specifications

Parameter	Value
Operating voltage	9 to 36 V
Input protection	- 40 to 100 V
Power consumption	220 mA @ 12 V (typical)
Hot start battery capacity	> 24 hours
Hot start battery capacity	30 mins
Hot start battery endurance	> 10 years
Operating temperature	- 40 °C to 85 °C
Environmental sealing	IP 67 MIL-STD-810G
Shock limit	2000 g
Dimensions	90 x 127 x 31 mm
Weight	285 grams
Interface	USB
Peripheral interface	1x GPIO and 1x NMEA/RTK
GPIO Level	5V or RS232

4.2.2.7. Electrical specifications

Parameter	Minimum	Typical	Maximum
Power supply			
Input supply voltage	9 V		36 V
Input protection range	- 40V		100 V
RS 232			
Tx voltage low		-5.4 V	-5 V
Tx voltage high	5 V	5.4 V	
Tx short circuit current			±60 mA
Rx voltage low	0.8 V	1.3 V	
Rx voltage high		1.7 V	2.5 V
GPIO			
Output voltage low	0 V		0.3 V
Output voltage high	4.8 V		5 V
Input voltage	-20 V		20 V
Input threshold low			1.5 V
Input threshold high	3.5 V		
Output current			5 mA
GNSS Antenna			
Active antenna supply voltage	4.8 V		5 V
Antenna supply current			100 mA

4.2.2.8. Power consumption

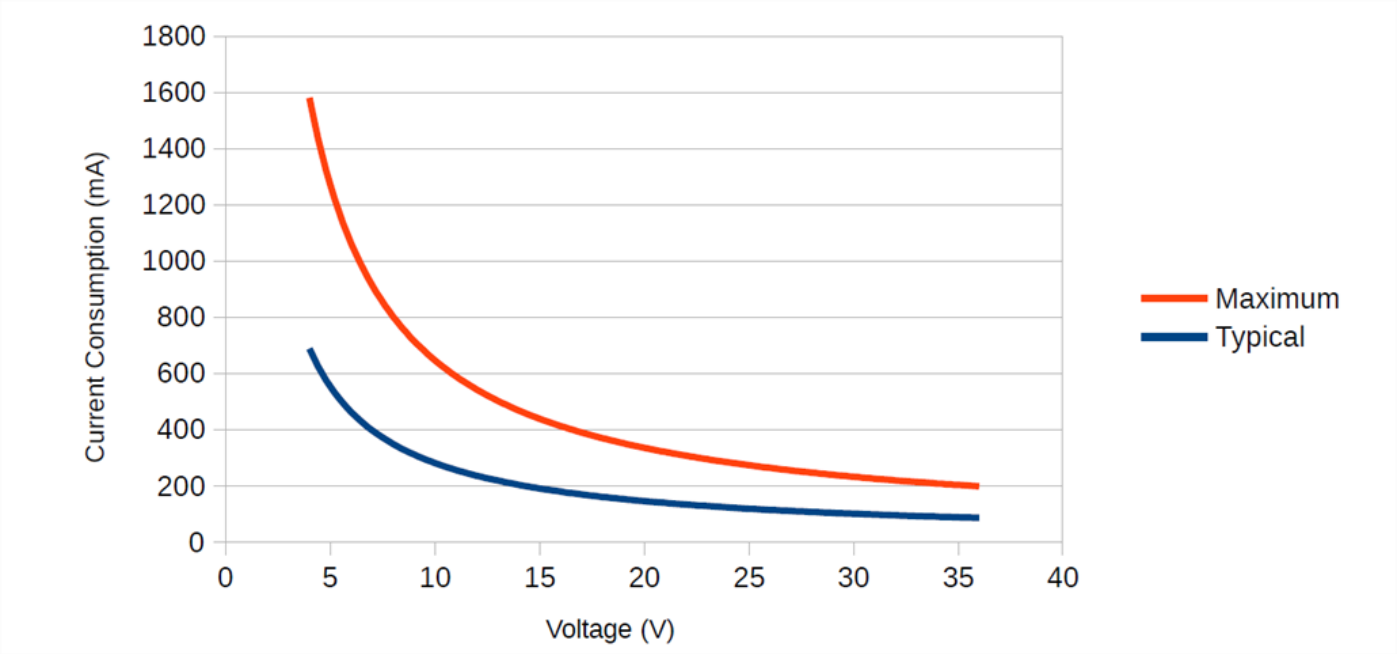


Image 13: Maximal and typical power consumption diagram

4.3. DS-IMU1

- DS-IMU1 is a miniature, ruggedized and reliable GPS aided navigation system
- Combines inertial sensors together with GNSS receiver coupled in a sophisticated fusion algorithm to deliver accurate and reliable navigation and orientation
- GNSS receiver supports GPS, GLONASS, BeiDou, GALILEO, WAAS, EGNOS and GAGAN (HW version 6.1 or earlier supports SBAS, HW v7.0 and newer supports DGNSS)
- IP67 & MIL-STD-810G environmental protection
- Up to 100 Hz output data rate
- Connected over USB
- Fast and Easy-to-install

Image 14: DS-IMU1

4.3.1. Scope of supply

DS-IMU1 is supplied in a kit that contains everything required to get started operating the system right away. It's supplied in a carry case to protect the equipment during the shipment.

Image 15: DS-IMU1 supply kit

4.3.1.1. Kit contents

- DS-IMU1
- GPS/GLONASS/BeiDou/Galileo L1/L2/L5 GNSS antenna with 5/8-11 survey mounts
- 5m GNSS antenna cable
- Suction cup with antenna mounting
- Interface cable harness (with USB, Power and Sync connector)

4.3.1.2. Quick start

- Position the GNSS antenna in a level orientation with a clear view of the sky.
- Connect the coaxial cables between the antennas and DS-IMU1.
- Plug the interface cable into DS-IMU1.
- Plug the USB cable into your computer
- Download DewesoftX® software and the plugin from www.dewesoft.com.
- Install the driver for RS232 converter
- Run DewesoftX® software --> go to Settings --> Devices --> Click on the plus button and under Plugins you will find the DS-IMU option.

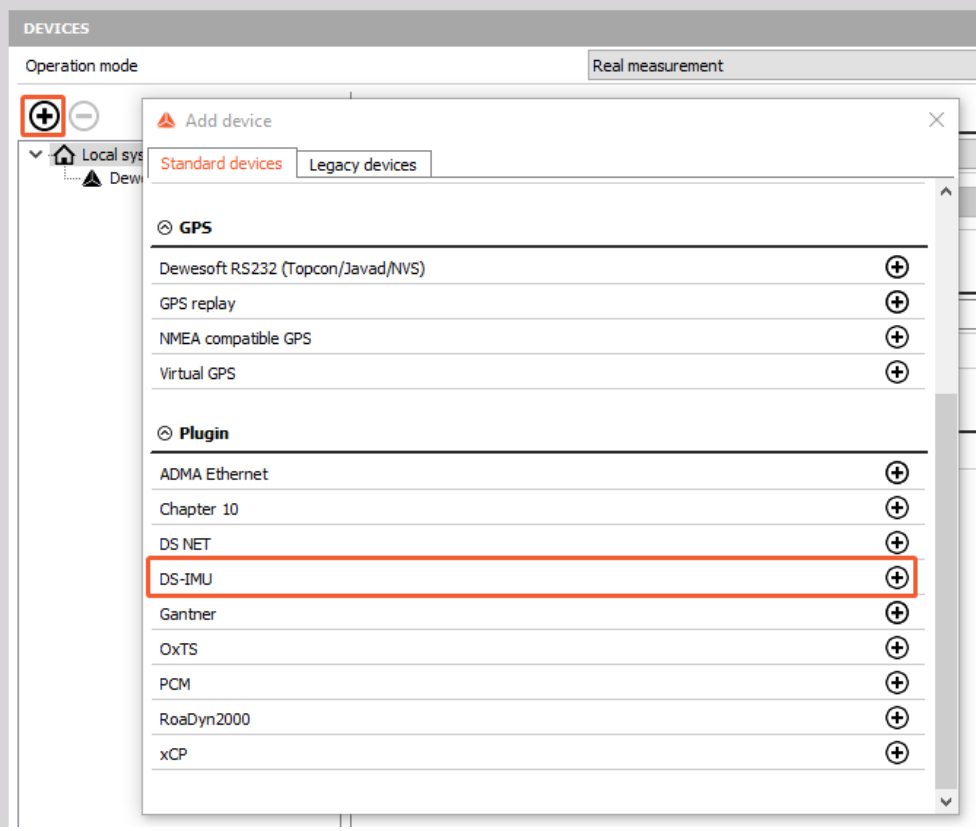


Image 16: Add DS-IMU device inside settings

- The device should be automatically recognized, if not press the Rescan device.

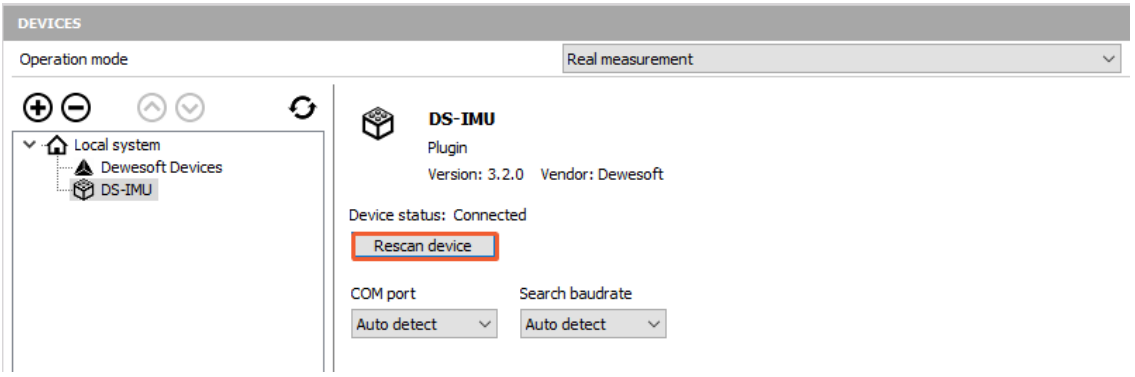


Image 17: Click on Rescan device button if the device is not automatically recognized

- After recognizing the device press OK.
- Device will send the data all the time, so you can watch them already in the Channel setup.

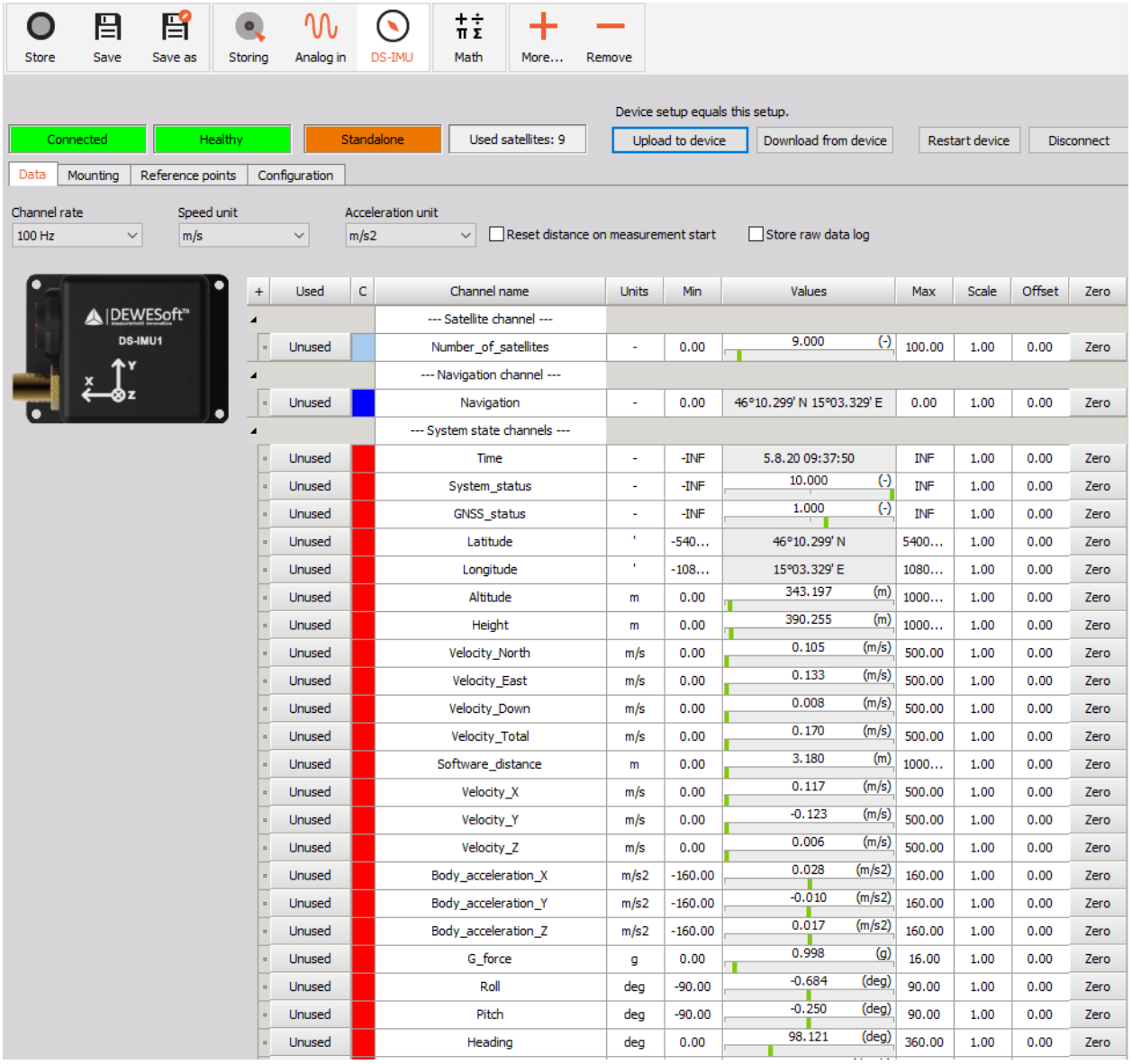


Image 18: DS-IMU tab preview in channel setup

Important recommendation

We do **not** recommend using IMU1 on a metal CAR with magnetometer enabled!

4.3.2. Specifications

4.3.2.1. Mechanical drawings

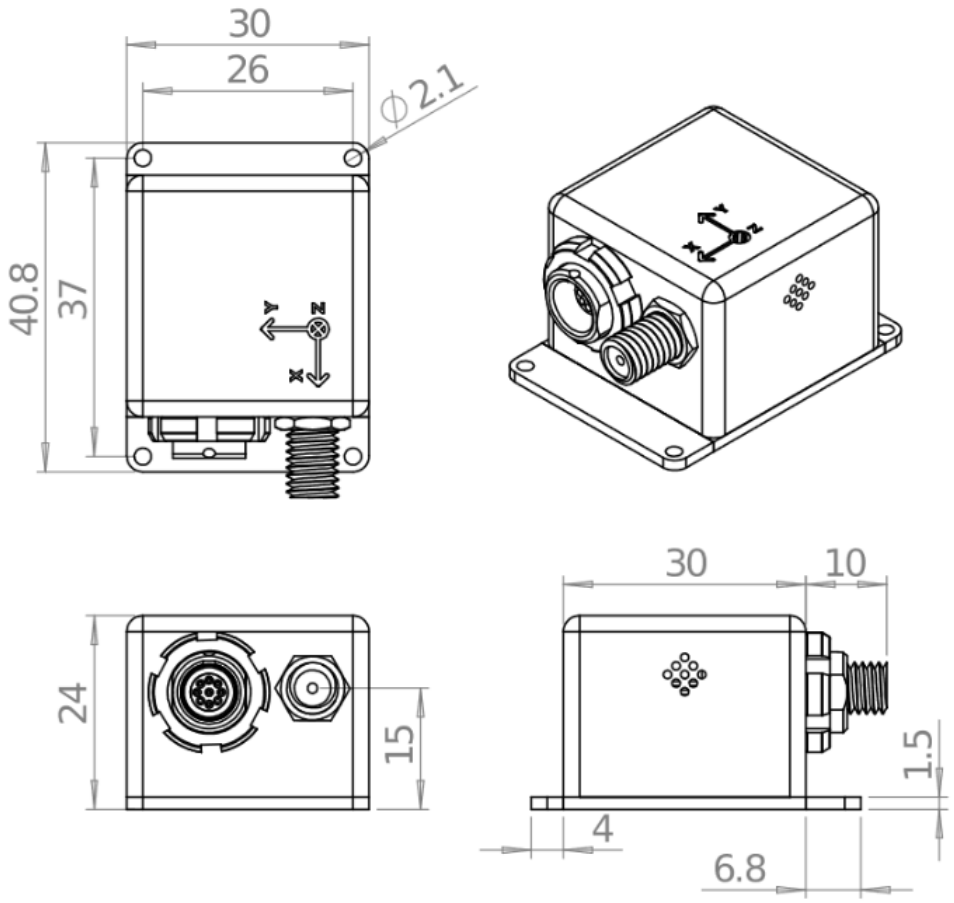


Image 19: Mechanical drawing of DS-IMU1

4.3.2.2. Navigation specifications

Parameter	Value
Horizontal position accuracy	2.0 m
Vertical position accuracy	3.0 m
Velocity accuracy	0.05 m/s
Roll & Pitch accuracy (static)	0.1 °
Heading accuracy (static)	0.5 °
Roll & Pitch accuracy (dynamic)	0.2 °
Heading accuracy (dynamic with GNSS)	0.2 °
Heading accuracy (dynamic with only magnetometer)	0.8 °

Slip accuracy	0.5 °
Orientation range	Unlimited
Hot start time	500 ms
Internal filter rate	1000 Hz
Output data rate	Up to 100 Hz

4.3.2.3. Sensor specifications

Parameter	Accelerometers	Gyroscopes	Magnetometers	Pressure
Range (dynamic)	2 g 4 g 16 g	250 °/s 500 °/s 2000 °/s	2 G 4 G 8 G	10 to 120 kPa
Noise density	150 µg/√Hz	0.008 °/s/√Hz	210 µg/√Hz	0.56 Pa/√Hz
Non-linearity	< 0.05 %	< 0.05 %	< 0.05 %	-
Bias stability	60 µg	3 °/hr	-	100 Pa/yr
Scale factor stability	< 0.05 %	< 0.05 %	< 0.05 %	-
Cross-axis alignment error	< 0.05 °	< 0.05 °	< 0.05 °	-
Bandwidth	400 Hz	400 Hz	110 Hz	50 Hz

4.3.2.4. GNSS Specifications

Parameter	Value
Supported navigation systems	GPS L1 GLONASS L1 GALILEO E1 BeiDou B1
Update rate	10 Hz
Cold start sensitivity	-148 dBm
Tracking sensitivity	-167 dBm
Hot start first fix	1 s
Cold start first fix	26 s
Horizontal position accuracy	2.5
Velocity accuracy	0.05 m/s
Timing accuracy	30 ns
Acceleration limit	4 g

4.3.2.5. Hardware specifications

Parameter	Value
Operating voltage	5 to 36 V
Input protection	± 40 V
Power consumption	100 mA @ 5 V (typical)
Hot start battery capacity	> 24 hours
Hot start battery charge time	30 mins
Hot start battery endurance	> 10 years
Operating temperature	- 40 °C to 85 °C
Environmental sealing	IP 67 MIL-STD-810G
Shock limit	c
Dimensions	30 x 40.6 x 24 mm
Weight	37 grams
Interface	USB
Peripheral interface	1x GPIO and 1x NMEA Output
GPIO Level	5V or RS232

4.3.2.6. Electrical specifications

Parameter	Minimum	Typical	Maximum
Power supply			
Input supply voltage	5 V		36 V
Input supply voltage	- 40V		40 V
RS 232			
Tx voltage low		-5.7 V	-5 V
Tx voltage high	5 V	6.2 V	
Tx short circuit current		±35 mA	±70 mA
Rx voltage low	0.8 V	1.3 V	
Rx voltage high		1.7 V	2.5 V
GPIO			
Output voltage low	0 V		0.3 V

Output voltage high	4.8 V		5 V
Output voltage high	-20 V		20 V
Input threshold low			1.5 V
Input threshold low	3.5 V		
Output current			5 mA
GNSS Antenna			
Active antenna supply voltage	2.9 V	3 V	3.1 V
Antenna supply current			75 mA

4.3.2.7. Power consumption

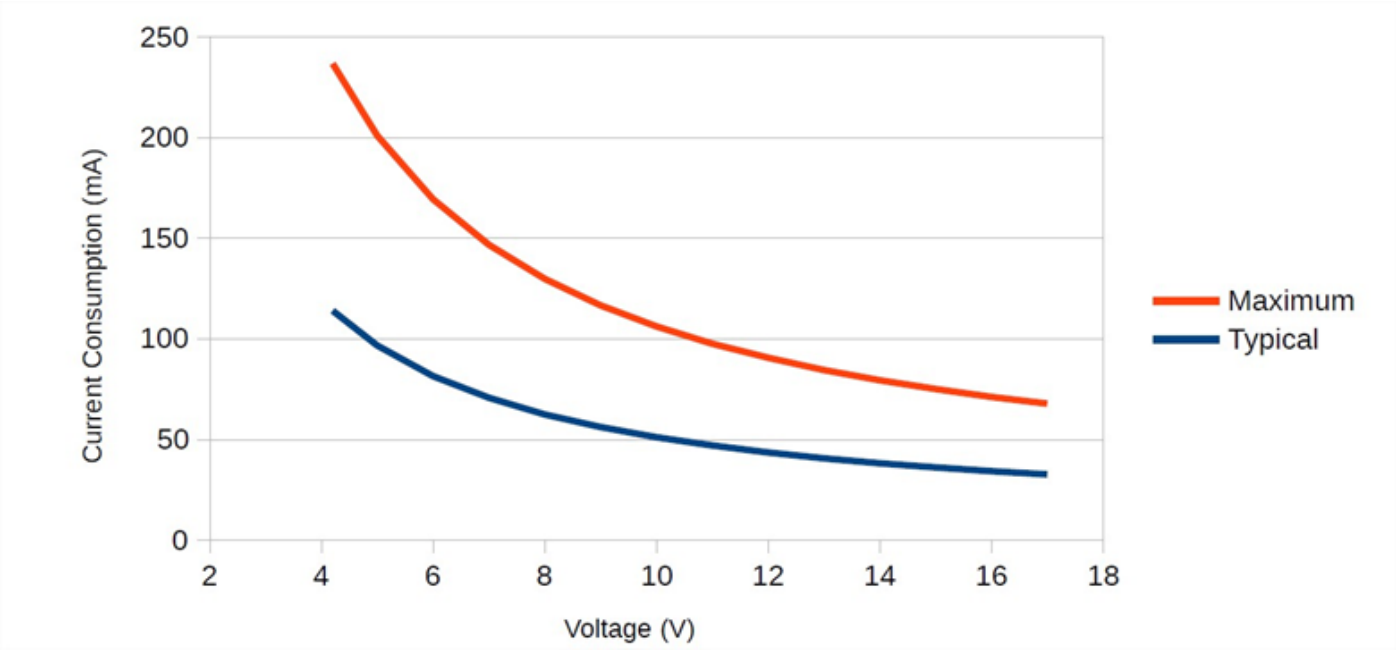


Image 20: Maximal and typical power consumption

4.4. DS-GYRO1

- DS-GYRO1 is a miniature, ruggedized and reliable inertial navigation unit
- Combines inertial sensors in a sophisticated fusion algorithm to deliver accurate and reliable orientation
- IP67 & MIL-STD-810G environmental protection
- Up to 500 Hz output data rate
- Connected over USB
- Fast and Easy-to-install

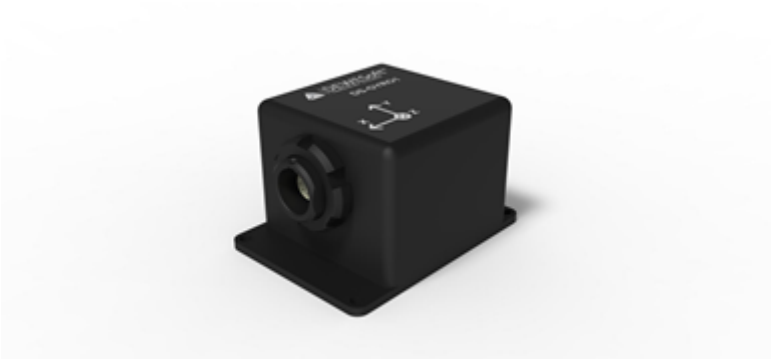


Image 21: DS-GYRO1

4.4.1. Scope of supply

DS-GYRO1 is supplied in a kit that contains everything required to get started operating the system right away. It's supplied in a carry case to protect the equipment during the shipment.

Image 22: DS-GYRO1 supply kit

4.4.1.1. Kit contents

- DS-GYRO1
- Interface cable harness (with USB and Power)

4.4.1.2. Quick start

- Position the DS-GYRO1 in the vehicle.
- Plug the interface cable into DS-GYRO1.
- Plug the USB cable into your computer
- Download DewesoftX® software and the plugin from www.dewesoft.com.
- Install the driver for RS232 converter
- Run DewesoftX® software --> go to Settings --> Devices --> Click on the plus button and under Plugins you will find the DS-IMU option.

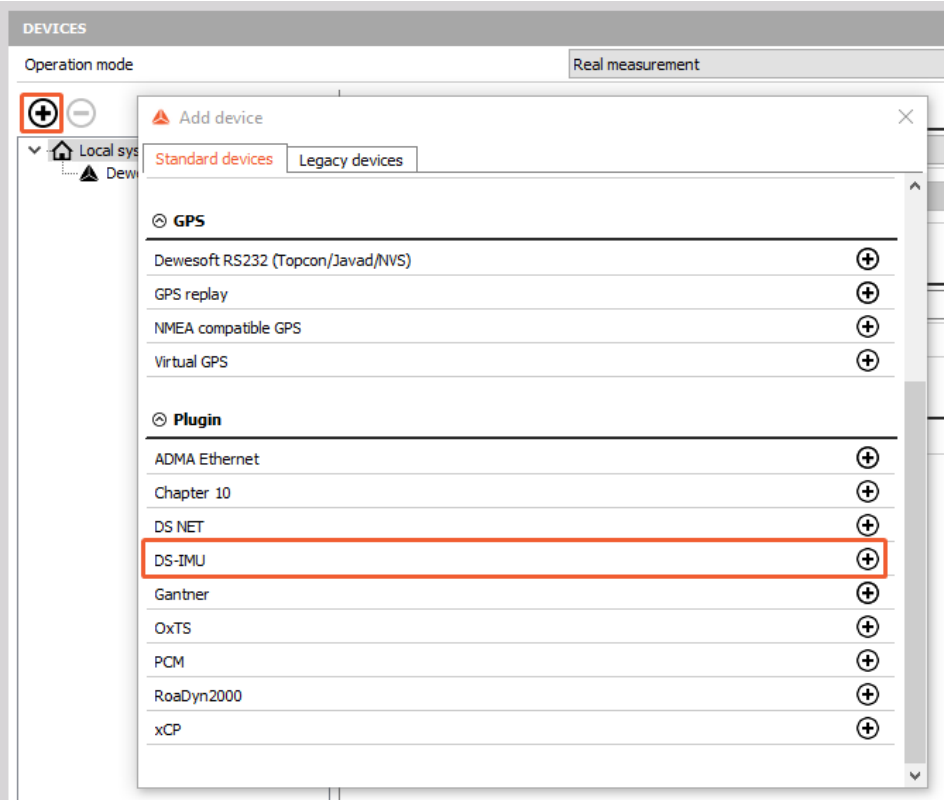


Image 23: Add DS-IMU device inside settings

- The device should be automatically recognized, if not press the Rescan device.

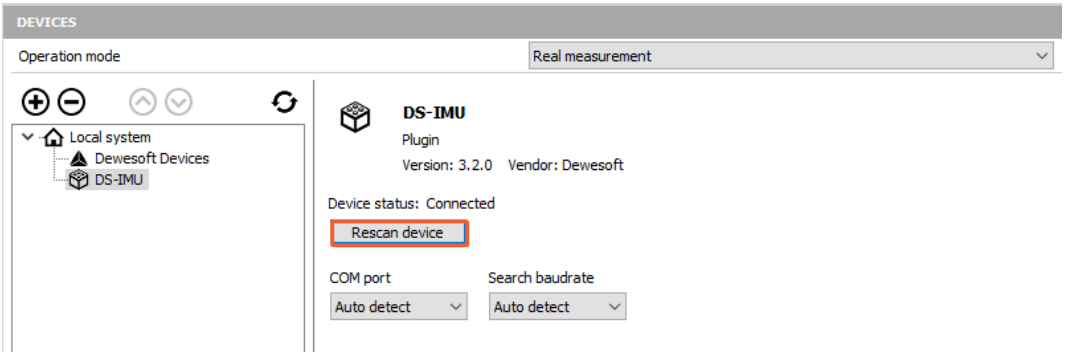


Image 24: Click on Rescan device button if the device is not automatically recognized

- After recognizing the device press OK.

- Device will send the data all the time, so you can watch them already in the Channel setup.

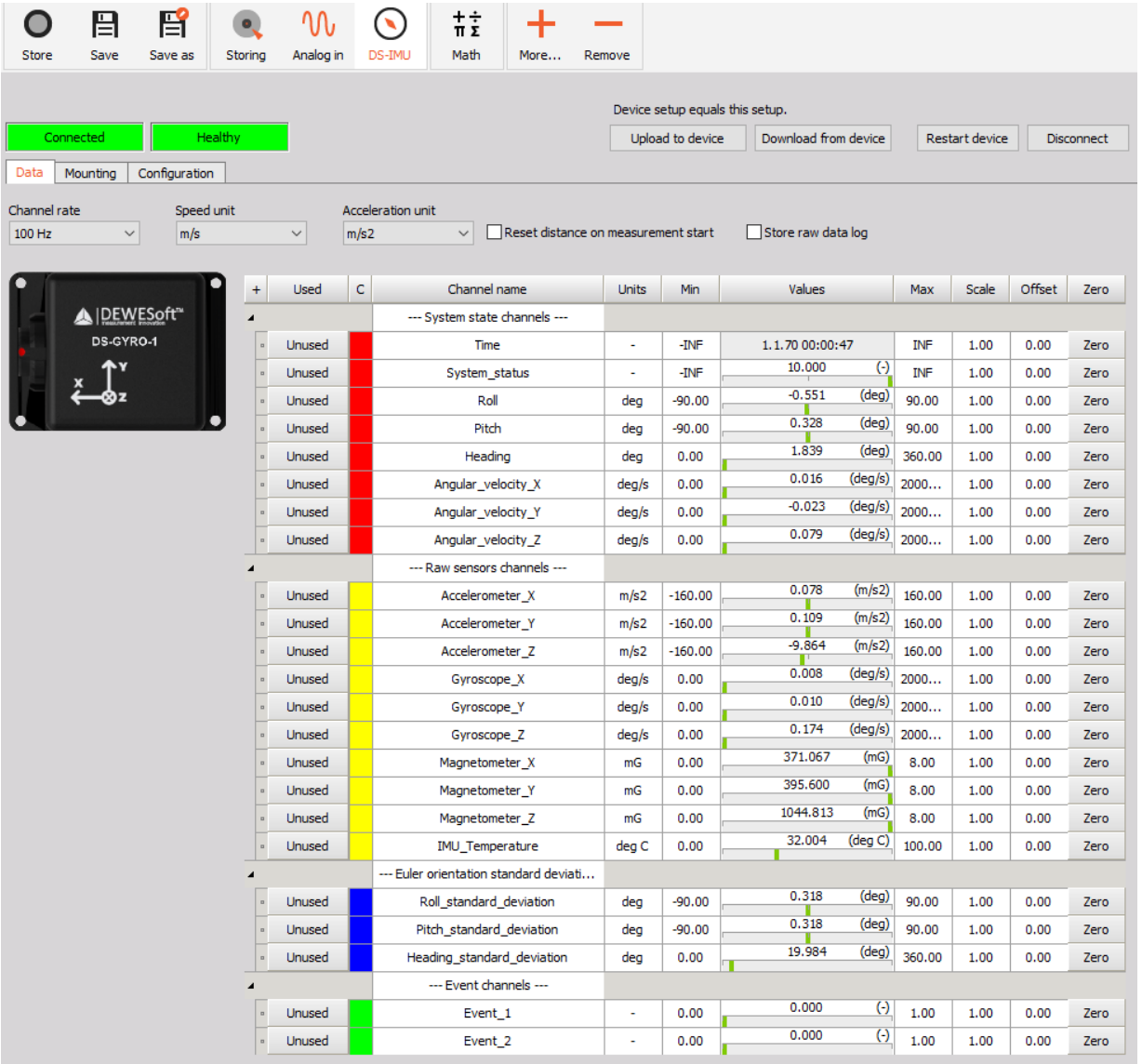


Image 25: DS-IMU tab preview in channel setup

4.4.2. Specifications

4.4.2.1. Mechanical drawings

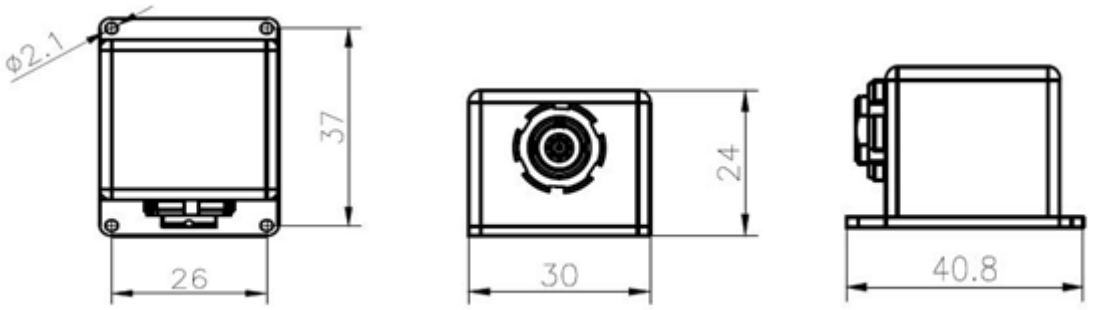


Image 25: Mechanical drawing for DS-GYRO1

4.4.2.2. Navigation specifications

Parameter	Value
Roll & Pitch accuracy (static)	0.2 °
Heading accuracy (static)	0.5 °
Roll & Pitch accuracy (dynamic)	0.6 °
Heading accuracy (dynamic)	1.0 °
Orientation range	Unlimited
Hot start time	500 ms
Internal filter rate	1000 Hz
Output data rate	Up to 500 Hz

4.4.2.3. Sensor specifications

Parameter	Accelerometers	Gyroscopes	Magnetometers
Range (dynamic)	2 g 4 g 16 g	250 °/s 500 °/s 2000 °/s	2 G 4 G 8 G
Noise density	400 µg/√Hz	0.005 °/s/√Hz	210 µg/√Hz
Non-linearity	< 0.05 %	0.005 °/s/√Hz	< 0.05 %
Bias stability	60 µg	18 °/hr	-
Scale factor stability	< 0.05 %	< 0.05 %	< 0.05 %

Cross-axis alignment error	< 0.05 °	< 0.05 °	< 0.05 °
Bandwidth	256 Hz	256 Hz	110 Hz

4.4.2.4. Hardware specifications

Parameter	Value
Operating voltage	4 to 36 V
Input protection	± 40 V
Power consumption	65 mA @ 5 V (typical)
Operating temperature	- 40 °C to 85 °C
Environmental sealing	IP 68
Shock limit	2000 g
Dimensions	30 x 40.6 x 24 mm
Weight	25 grams
Interface	USB

4.4.2.5. Electrical specifications

Parameter	Minimum	Typical	Maximum
Power supply			
Input supply voltage	4 V		36 V
Input protection range	- 40V		40 V

4.4.2.6. Power consumption

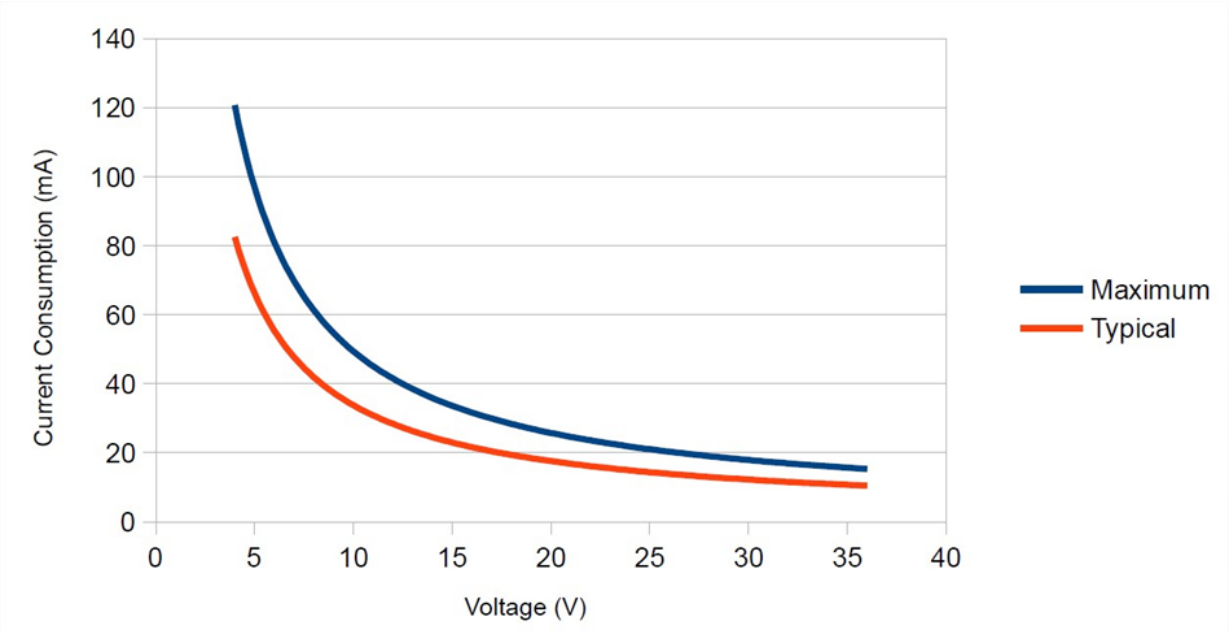
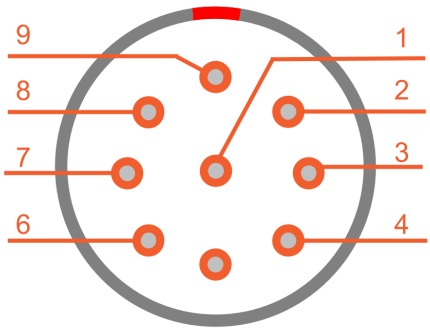


Image 26: Power consumption specifications

4.5. Connector pin-out

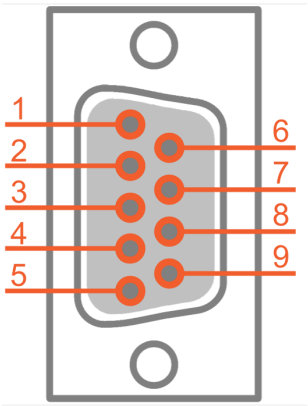
Power supply and signal connections are made through a ODU Mini-Snap Series B 9 pin connector, which provides a reliable and rugged connection to all the instruments under demanding conditions and is rated to IP68 in the mated condition. Plugs are supplied with 2 meters of unterminated shielded TPE cable.



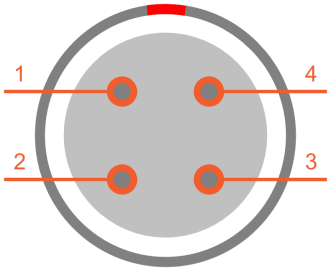
Pin	Colour	Function
1	BLack	Signal ground
2	Brown	Power supply
3	White	GPIO
4	Green	PPS
5	Red	Primary RS232 Tx
6	Orange	Primary RS232 Rx
7	Yellow	Auxiliary RS232 Tx
8	Blue	Auxiliary RS232 Rx
9	Pink	Power ground

4.6. Cable harness

4.6.1. DS-IMU2 cable



PIN	Description
1	+5V (USB)
2	TX AUX
3	RX AUX
4	PPS FLT
5	GND
6	PPS RADIO
7	Not Connected
8	GPI01 FLT
9	+15V (Ext power)



Sync connector: pin-out (4-pin LEMO female)

Pin	Name	Description
1	CLK	Clock
2	Trigg	Trigger
3	GPS-PPS	GPS - PPS
4	DGND	Digital Ground

Interface connector: EEG.00.304.CLL
Mating connector: FGG.00.304.CLAD27Z

The DS-IMU-2 needs additional Power-supply.

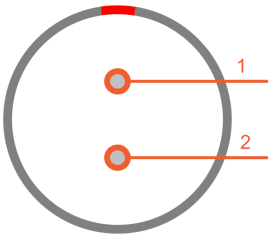
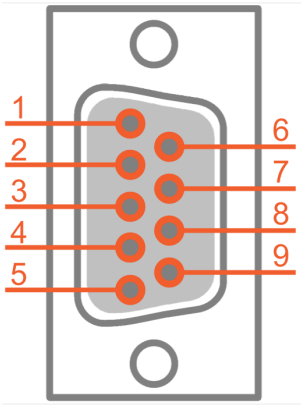


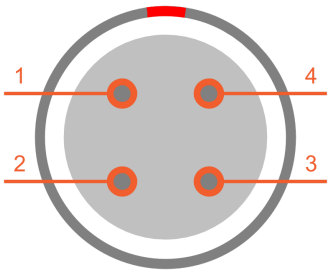
Image 10: Power supply connector (2-pin LEMO male) EXJ.1B.302.HLD

Pin	Description
1	+9 to +36 VDC power supply
2	GND power supply

4.6.2. DS-IMU1 cable and DS-GYRO1 cable



PIN	Function
1	+5V (USB)
2	TX AUX
3	RX AUX
4	PPS FLT
5	GND
6	PPS RADIO
7	Not Connected
8	GPIO1 FLT
9	Not Connected



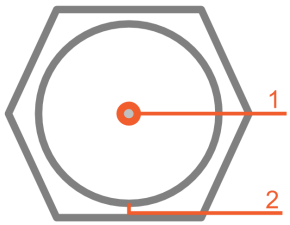
Sync connector: pin-out (4-pin LEMO female)

Pin	Name	Description
1	CLK	Clock
2	Trigg	Trigger
3	GPS-PPS	GPS - PPS
4	DGND	Digital Ground

Interface connector: EEG.00.304.CLL
Mating connector: FGG.00.304.CLAD27Z

4.7. Antenna connection

- DS-IMU-2 has two Antenna connectors
- DS-IMU-1 has one Antenna connector
- DS-GYRO1 does not have Antenna connector



Pin	Description
1	Hot
2	shield

Interface connector: SMA female
Mating connector: SMA male

5. Installations

5.1. Position and alignment

When installing DS-IMU and DS-GYRO1 products into a vehicle, correct positioning and alignment are essential to achieve good performance. There are a number of goals in selecting a mounting site in your application, these are:

- The unit should be mounted in an area that is not going to exceed its temperature range.
- The unit should be mounted away from high levels of vibration where possible.
- The unit should be mounted within several meters of the GNSS antennas where possible.
- If atmospheric altitude is going to be used, the two vents on the sides of DS-IMU products should not be obstructed.
- The unit should be mounted close to the center of gravity of the vehicle where possible.
- For best performance during GNSS outages, DS-IMU products should be mounted at least 10 cm away from sources of dynamic magnetic interference i.e. high current wiring, large motors,..

5.1.1. Alignment of device

The easiest way to align DS-IMU and DS-GYRO1 is by installing it with the sensor axes aligned with the vehicle axes. This means that the X axis points forward towards the front of the vehicle and the Z axis points down towards the ground. See the Illustration below.

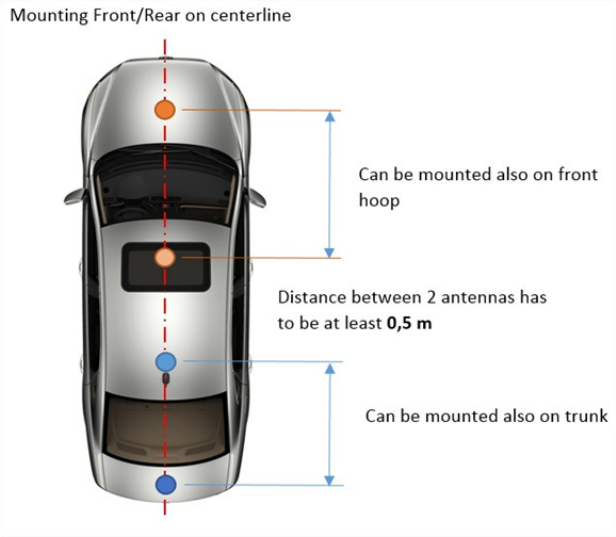
Image 30: Alignment of device

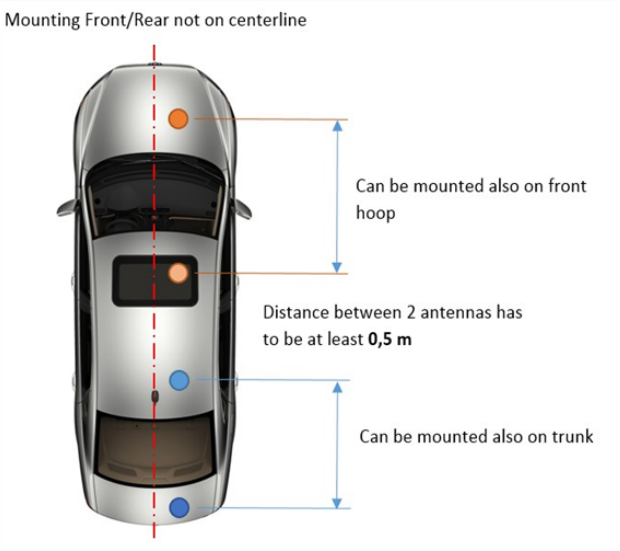
If aligning the units with the vehicle's axes is not possible or not optimal, it may be mounted in a different alignment and the alignment offset should be configured using DewesoftX® software package, which is described in 6.2.2 section.

5.1.2. Alignment of Dual antenna

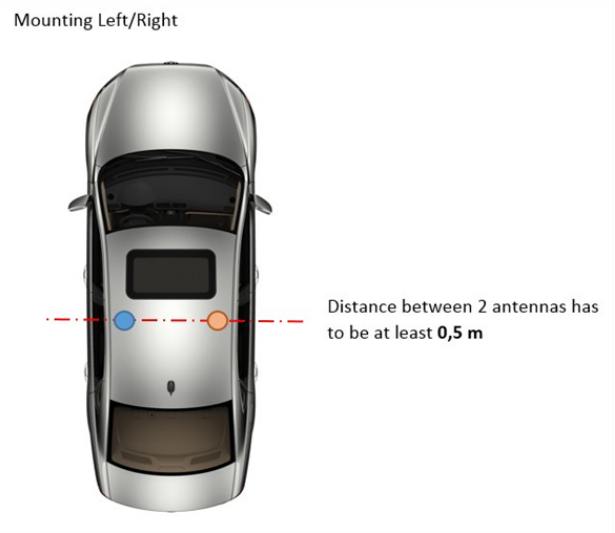
Since DS-IMU2 is dual antenna system, both antennas has to be aligned in one of the 4 possibilities:

1. Primary antenna front – Secondary antenna rear
2. Secondary antenna front – Primary antenna rear





3. Primary antenna left – Secondary antenna right
4. Secondary antenna left – Primary antenna right



How to set up DS-IMU2 with Antenna alignment is written in 6.2.2.

5.2. GNSS antennas

The GNSS antennas should be installed level with a clear unobstructed view of the sky and close to the DS-IMU unit where possible. The antennas should be mounted away from any RF emitters. It is important to have a ground plane (flat conductive surface such as a piece of plate aluminum) under the antenna with a minimum radius of 60mm. Correct antenna positioning is very important for DS-IMU2 heading to function correctly.

The primary antenna position offset should be configured in the DS-IMU products by using the alignment dialogue in the DS-IMU plugin, see section. The antenna offset is measured from the center of the DS-IMU unit to the central base of the antenna in the body frame. It is very important to set the antenna offset accurately as DS-IMU2 corrects for lever arm velocities. Incorrect GNSS antenna offset will lead to performance degradation under turning and angular rotations.

The secondary antenna should be mounted directly behind the primary antenna with as much separation as possible. The higher the separation the better the orientation accuracy. Both antennas should be mounted at exactly the same vertical height on the vehicle, if used with automatic offset settings. See Illustration for example mounting on a car. If it is impractical to mount the secondary antenna directly behind the primary antenna, it can be mounted in another position. In this case the secondary antenna offset must be accurately measured and entered using the secondary antenna configuration dialogue in the DS-IMU plugin, see section.

The standard antenna supplied in the DS-IMU2 evaluation kit is the Antcom G5Ant-53A4T1. It is an L1/L2/L5 RTK antenna that supports GPS, GLONASS, BeiDou, Galileo, Omnistar and SBAS. It is environmentally sealed to the IP68 standard.

If you are sourcing your own antenna, please note the following antenna guidelines:

- The antenna should be capable of receiving both L1 and L2. Heading performance will be significantly degraded with an L1 only antenna.

- The antenna needs to have an accurate phase center to be RTK capable. This is required for the dual antenna heading to function correctly. Low performance (cheap) antennas are typically not able to achieve good heading performance.
- The antenna should have an LNA gain of at least 35dB.
- The antenna should support both GPS and GLONASS.
- The antenna should be environmentally sealed, including connectors.

If you are sourcing your own antenna cables it is important to ensure that the antenna has enough gain to support the loss over the cable. DS-IMU2 requires a minimum of 33dB of gain at the connector. With the standard 5 meter LMR240 antenna cables supplied by Dewesoft, the minimum antenna gain is 34.5dB.

5.2.1. GNSS antenna cables

The antenna cables should be routed away from powerful RF emitters, high current wiring, high temperatures and any rotating or reciprocating machinery. It is very important not to bend the antenna cable beyond its maximum bend radius. It is recommended to use wide cable ties and be careful not to do them up too tight. Dewesoft recommends using either RG58 low loss or LMR240 coaxial cable combined with high quality connectors. LMR300 and LMR400 can also be used to minimize loss for very long antenna cables.

Cable type	Minimum bend radius	Signal loss
RG-58/U low loss	20 mm	~0.92 dB/m
LMR240	20 mm	~0.33 dB/m
LMR300	22.2 mm	~0.26 dB/m
LMR400	25.4 mm	~0.17 dB/m

5.3. Power supply

A high level of power supply filtering has been built into DS-IMU products, however it is still recommended that the power supply is free of significant noise. DS-IMU products contain a fully isolated power supply and have separate grounds for power and signal to ensure that power supply noise does not corrupt communications or cause ground loops with other equipment. When wiring the system, the signal ground should be routed with the primary RS232, auxiliary RS232 and GPIO pins. The power ground should be routed with the power supply to the power source.

A power supply should be selected that can provide at least the maximum current calculated from the graph mentioned above.

DS-IMU2 contains an active protection circuit on the power supply input that protects the unit from under-voltage, over-voltage and reverse polarity events. The protection circuit shuts off power and automatically recovers the unit to full operation once the fault is removed. Take care when running the unit close to its under-voltage lockout of 8.5 V because small voltage drops can engage the

under-voltage shutdown and potentially oscillate between the on and off state. It is recommended that the unit is always run at 9.5 V or more to avoid issues associated with this.

6. Operation

6.1. Filter

DS-IMU products contain a very sophisticated filter which it uses to fuse all its sensors into a state estimation. The filter is a set of custom algorithms that have similar principles to a kalman filter, but operate differently. DS-IMU's custom filter makes decisions based upon context and history which greatly improves performance and makes it more resilient to error sources than a standard kalman filter.

Under rare conditions, when there are large errors present that DS-IMU's filter cannot compensate for, it can become unstable. If DS-IMU's filter does become unstable a monitoring process will immediately reset the filter to the last known good state. The filter initialized flag will remain reset until the filter stabilizes again. In real time control applications it is very important to monitor DS-IMU's filter status, so that data can be ignored if a situation occurs causing the filter to reset.

6.2. Initialisation

When DS-IMU2 starts up, it assumes that it can be in any orientation. To determine it's orientation it uses the accelerometers to detect the gravity vector. Whilst this is occurring, if there are random accelerations present, these can cause an incorrect orientation to be detected. To prevent this, DS-IMU2 monitors the accelerometers and gyroscopes and restarts the orientation detection if there are sudden movements. It is however still possible under some circumstances for it to miss movements and start with a small orientation error. In this scenario DS-IMU2 will progressively correct the orientation error over a period of several seconds.

After orientation detection, DS-IMU's filter takes several minutes to achieve it's full accuracy. It is recommended to wait two minutes after power on for applications requiring high accuracy.

6.3. Hot start

DS-IMU products are the first GNSS/INS on the market with hot start functionality. This allows it to start inertial navigation within 500 milliseconds and obtain a GNSS fix in as little as 3 seconds. This hot start is always on and fully automatic.

A next generation backup battery system within DS-IMU2 provides the hot start ability for more than 24 hours without power. When DS-IMU2 hot starts it assumes that it is in the same position it was when it lost power and begins navigating from that position. The hot start also provides ephemeris, almanac and time information to the GNSS receiver which allows it to achieve a fix far more quickly than it otherwise would. When the GNSS achieves its first fix, if this position deviates from the hot start position, DS-IMU2 will jump to the new position without causing any side effects to the filter.

Whilst DS-IMU products are without power it keeps track of the time accurately to within 1 second so that the time is immediately valid on a hot start.

DS-IMU's hot start is of particular benefit to vehicle tracking and robotics applications. The primary benefits are immunity and fast recovery from power failure as well as fast startup time.

6.4. Time

DS-IMU products are designed to provide a highly accurate time reference. When a GNSS fix is available the time of instruments is accurate to within 50 nanoseconds. When a GNSS fix is lost this time accuracy typically remains within 10 microseconds over extended time periods. At hot start the time accuracy is typically within 1 second immediately on startup and corrected to within 50 nanoseconds as soon as a GNSS fix is achieved. To synchronize with DS-IMU products PPS and GPS time has to be used.

6.5. Correction data

6.5.1. Omnistar

DS-IMU2 internal GNSS receiver supports the Omnistar corrections service. The Omnistar corrections service allows the DS-IMU2 to achieve higher positional accuracy than standard GNSS, see section Omnistar is a satellite based service and the corrections are received using the same GNSS antenna used for positioning, this means that there is no additional infrastructure equipment required to use Omnistar. Omnistar is a paid subscription service with a yearly fee. Please contact your local Omnistar representative for pricing information. The current Omnistar subscription can be viewed in the Settings → Extensions → DS-IMU → Connected device.

6.5.2. RTK

DS-IMU2's internal GNSS receiver supports RTK GNSS which uses correction data from a base station to provide significantly higher positional accuracy than standard GNSS. RTK requires additional infrastructure equipment to receive corrections and is not practical for all applications. There are two different options for receiving RTK corrections. For applications that are within good cellular coverage we recommend cellular RTK corrections. For applications that have poor or no cellular coverage we recommend base station radio modem RTK corrections.

6.5.2.1. Cellular RTK corrections

For cellular RTK corrections, Dewesoft recommends the JAVAD Jlink GSM cellular corrections receiver. This unit can be plugged directly into DS-IMU2's RS232 port to receive cellular RTK correction. This solution is also supplied by Dewesoft as a package by request.

6.5.2.2. Base station radio modem RTK corrections

Base station radio modem RTK corrections require two additional pieces of hardware, these are the RTK base station and the radio modem receiver. The base station is set up at a fixed location and transmits corrections to the radio modem receiver that is connected to the mobile DS-IMU2 unit. The radio modem receiver and DS-IMU2 unit must remain within range of the base station to receive these corrections, typically this range is approximately 20 km, but it depends on the RF antenna which are used.

6.6. Environmental exposure

Whilst DS-IMU products are environmentally protected, there are clearly defined limits to this protection that must be adhered to for reliable operation. Products are only protected when connectors are mated and SMA GNSS antennas are attached to them. When any of these connections are not securely connected the unit offers no environmental protection. Spanners or tools should never be used to tighten the connectors. They should only ever be finger tight.

6.6.1. Temperature

DS-IMU products should not be subjected to temperature's outside of its operating range. If the temperature rises above 90 degrees Celsius, units will automatically shut off power to its sensors and GNSS in an attempt to prevent damage, this will also send the filters into reset. Subjecting DS-IMU products to temperature's outside of the storage range can affect the factory sensor calibration which will cause a permanent performance degradation.

6.6.2. Water

DS-IMU products are water-proof to the IP67 standard which means that it can be submerged in water to a depth of up to 1 meter only. Submersion to depths beyond 1 meter can cause water entry and destruction of the internal electronics.

6.6.3. Salt

DS-IMU products are made from marine grade aluminum which gives it reasonably good salt water corrosion resistance. However units cannot tolerate extended periods of time in salt water environments. After any contact with salt water environments, devices should be thoroughly rinsed with fresh water.

6.6.4. Dirt and dust

DS-IMU products are completely sealed against dirt and dust entry. It is important to note that this is only the case when the connectors are mated. When un-mating the connectors if the units are dirty or dusty, the dirt should be rinsed off with fresh water first and then dried off. This is to prevent dirt or dust entering the connectors which can cause them to fail.

6.6.5. pH level

Environments with a high or low pH level can cause the enclosure to corrode. If DS-IMU comes into contact with these environments it should be rinsed in fresh water as soon as possible. It is not recommended to operate devices in non neutral PH environments.

6.6.6. Shocks

DS-IMU products can tolerate shocks to 2000g, however continuous shocks of this severity are likely to cause premature failure. Shocks above 2000g can affect the factory sensor calibration and degrade performance. Normally shocks to these units when mounted in a vehicle are fine. Even a high speed car crash is likely to reach a peak of only 50g. Shocks directly to device enclosure can more easily go over the limit however care should be taken when handling the unit prior to mounting.

7. Connecting to DewesoftX®

There are several different ways to connect DS-IMU devices and use them inside DewesoftX® software. Each of the product lines will be described with all the possibilities of how to connect it.

7.1. DS-IMU1

DS-IMU1 can be connected in 4 different ways.

- Standalone DS-IMU1 with **PPS** synchronization (used when only DS-IMU1 is connected to the computer).
- Standalone DS-IMU1 with **Master clock** synchronization (used when only DS-IMU1 is connected to the computer and will be used inside DewesoftX's **NET option**)
- DS-IMU1 + several additional **SIRIUS/43 – more then 1 unit or SIRIUS + triggered camera → PPS synchronization** has to be used for DS-IMU1
- DS-IMU1 **+ 1 additional SIRIUS/43** can be synchronized in **Master clock mode** and then used with
- DewesoftX's **NET option** to connect multiple vehicles/testing places

7.1.1. Standalone DS-IMU1 with PPS synchronization

To use this synchronization mode only DS-IMU1's USB has to be connected (over which it is powered and data is transferred). **Sync (4 pin 0B Lemo) connector must not be connected**, otherwise the unit will not send the data. Details on how to set the software are written in the next chapter, where **PPS synchronization** has to be picked.

Image 31: Connection of DS-IMU device

7.1.2. Standalone DS-IMU1 with Master clock synchronization

To use this synchronization mode only DS-IMU1's USB has to be connected (over which it is powered and data is transferred). **Sync (4 pin 0B Lemo) connector must not be connected**, otherwise the unit will

not send the data. Details on how to set the software are written in the next chapter, where **Master clock synchronization** has to be picked.
With this mode DS-IMU1 can be used in the **NET option** to synchronize with other computers, which has a GPS device, which outputs PPS.

7.1.3. DS-IMU1 with more than 1 SIRIUS/43 or with SIRIUS/43 + triggered camera in PPS synchronization mode

Synchronization mode, where there is more than 1 additional SIRIUS/43, DS-IMU1, has to be **PPS sync**. Which means that only samples from DS-IMU1 will be related to PPS and not a complete system, because SIRIUS/43 can have either input/output on the Sync connector. The result of such synchronization is that there might be a small delay between IMU data and analog/camera data.

The same is valid for systems where SIRIUS/43 + triggered cameras are used, because on SYNC connectors there is a sample rate divider, which has to trigger the camera and therefore cannot be used for PPS synchronization. Therefore in such cases **SYNC connector from the IMU must not be connected**.

Details on how to set the software are written in the next chapter, where **PPS synchronization** has to be picked.

7.1.4. DS-IMU1 with 1x SIRIUS/43 in Master clock synchronization mode

In this configuration DS-IMU1 is connected together with a single Dewesoft device (either 43/SIRIUS) and is providing Time + PPS signal to this system. With such usage data from DS-IMU1 and SIRIUS/43 data will be synchronized with accuracy higher than 0.001 ms.

Image 32: Connection of DS-IMU device

This system can then be used in the **NET option** with another system and will be totally synchronized to it. **In such systems PPS has to be connected** and **Master clock** mode has to be turned ON.

Synchronization of SIRIUS/43 **must be set to External → GPS PPS**, otherwise DS-IMU1 will not output data.
Details on how to set the software are written in the next chapter, where **Master clock synchronization** has to be picked.

7.2. DS-IMU2

DS-IMU1 can be connected in 4 different ways.

- Standalone DS-IMU2 with PPS synchronization (used when only DS-IMU2 is connected to the computer).
- Standalone DS-IMU2 with Master clock synchronization (used when only DS-IMU2 is connected to the computer and will be used inside DewesoftX's NET option)
- DS-IMU2 + several additional SIRIUS/43 – more then 1 unit has to be synchronized with PPS synchronization mode (used when there is more than one external slice of SIRIUS or 43, because it is possible to synchronize only one unit at a time)
- DS-IMU2 + 1 additional SIRIUS/43 can be synchronized in Master clock mode and then used with DewesoftX's NET option to connect multiple vehicles/testing places

7.2.1. Standalone DS-IMU2 with PPS synchronization

To use this synchronization mode only DS-IMU2's USB has to be connected (over which it is powered and data is transferred). **Sync (4 pin 0B Lemo) connector must not be connected**, otherwise the unit will not send the data. Details on how to set the software are written in the next chapter, where **PPS synchronization** has to be picked.

Image 33: Connection of DS-IMU device

7.2.2. Standalone DS-IMU2 with Master clock synchronization

To use this synchronization mode only DS-IMU2's USB has to be connected (over which it is powered and data is transferred). **Sync (4 pin 0B Lemo) connector must not be connected**, otherwise the unit will not send the data. Details on how to set the software are written in the next chapter, where **Master clock synchronization** has to be picked.

With this mode DS-IMU2 can be used in the **NET option** to synchronize with other computers, which has a GPS device, which outputs PPS.

7.2.3. DS-IMU2 with more then 1 SIRIUS/43 or with SIRIUS/43 + triggered camera in PPS synchronization mode

Synchronization mode, where there is more than 1 additional SIRIUS/43, DS-IMU2, has to be **PPS sync**. Which means that only samples from DS-IMU2 will be related to PPS and not complete systems, because SIRIUS/43 can have either input/output on a Sync connector. The result of such synchronization is that there might be a small delay between IMU data and analog/camera data.

The same is valid for systems where SIRIUS/43 + triggered cameras are used, because on SYNC connectors there is a sample rate divider, which has to trigger the camera and therefore cannot be used for PPS synchronization. Therefore in such cases **SYNC connectors from the IMU must not be connected**.

Details on how to set the software are written in the next chapter, where **PPS synchronization** has to be picked.

7.2.4. DS-IMU2 with 1x SIRIUS/43 in Master clock synchronization mode

In this configuration DS-IMU2 is connected together with a single Dewesoft device (either 43/SIRIUS) and is providing Time + PPS signal to this system. With such usage data from DS-IMU1 and SIRIUS/43 data will be synchronized with accuracy higher than 0.001 ms.

Image 34: Connection of DS-IMU device

This system can then be used in **NET option** with another system and will be totally synchronized to it. **In such systems PPS has to be connected** and **Master clock** mode has to be turned ON.

Synchronization of SIRIUS/43 must be set to **External → GPS PPS**, otherwise DS-IMU2 will not output data.
Details on how to set the software are written in the next chapter, where **Master clock synchronization** has to be picked.

7.3. DS-GYRO1

DS-GYRO1 can be connected in 4 different ways, but practically there are just 3 possibilities.

- Standalone DS-GYRO1 with PPS/Master clock synchronization (used when only DS-GYRO1 is connected to the computer).
- DS-GYRO1 + several additional SIRIUS/43 – more then 1 unit or SIRIUS + triggered camera → PPS synchronization has to be used for DS-GYRO1
- DS-GYRO1 + 1 additional SIRIUS/43 can be synchronized in Master clock mode, where data coming from the gyro device and SIRIUS/43 will be synchronized

7.3.1. Standalone DS-GYRO1 with PPS synchronization

To use this synchronization mode only DS-GYRO1's USB has to be connected (over which it is powered and data is transferred). **Sync (4 pin 0B Lemo) connector must not be connected**, otherwise the unit will not send the data. Details on how to set the software are written in the next chapter, where **PPS or Master clock synchronization** has to be picked.

Image 35: Connection of DS-IMU device

DS-GYRO1 can not be used in the NET option, because devices don't have real PPS, but just generated out of an internal clocking system, to be able to synchronize one additional SIRIUS/43.

7.3.2. DS-GYRO1 with more then 1 SIRIUS/43 or with SIRIUS/43 + triggered camera in PPS synchronization mode

Synchronization mode, where there is more than 1 additional SIRIUS/43, DS-GYRO1, has to be PPS sync. Which means that only samples from DS-GYRO1 will be related to internal PPS and not complete systems, because SIRIUS/43 can have either input/output on the Sync connector. The result of such synchronization is that there might be a small delay between GYRO data and analog/camera data.

The same is valid for systems where SIRIUS/43 + triggered cameras are used, because on SYNC connectors there is a sample rate divider, which has to trigger the camera and therefore cannot be used

for PPS synchronization. Therefore in such cases **SYNC connector from the GYRO must not be connected**.

Details on how to set the software are written in the next chapter, where **PPS synchronization** has to be picked.

7.3.3. DS-GYRO1 with 1x SIRIUS/43 in Master clock synchronization mode

In this configuration DS-GYRO1 is connected together with a single Dewesoft device (either 43/SIRIUS) and is providing Time + PPS signal to this system. With such usage data from DS-GYRO1 and SIRIUS/43 data will be synchronized with accuracy higher than 0.001 ms.

Image 36: Connection of DS-GYRO device

This system **can not** be used in **NET option** with another system, because the PPS signal is generated from the internal clock and not related to GPS PPS signal.

Synchronization of SIRIUS/43 **must be set to External → GPS PPS**, otherwise DS-IMU1 will not output data.
Details on how to set the software are written in the next chapter, where **Master clock synchronization** has to be picked.

8. Software configuration

8.1 Settings

After connecting the device to the PC installation of the RS232 driver is needed.

Important

If using Dewesoft inertial measurement units with S-BOX connect USB to the back of S-BOX into USB2.0 port.

- Download DewesoftX® software and plugin from www.dewesoft.com.
- Install driver for RS232 converter (CDM v2.10.00 WHQL Certified file)
- Run DewesoftX® software --> go to Settings --> Devices --> Click on the plus button and under Plugins you will find the DS-IMU option.

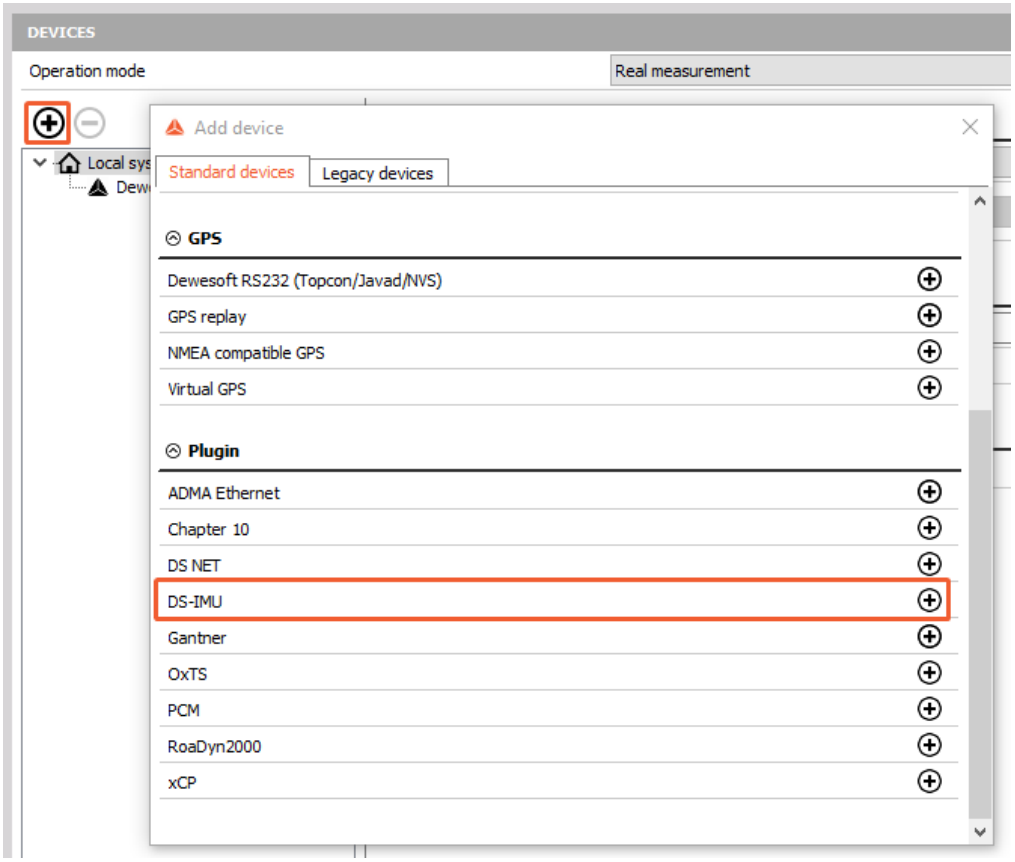


Image 37: How to add DS-IMU device

- The device should be automatically recognized, if not press the Rescan device.

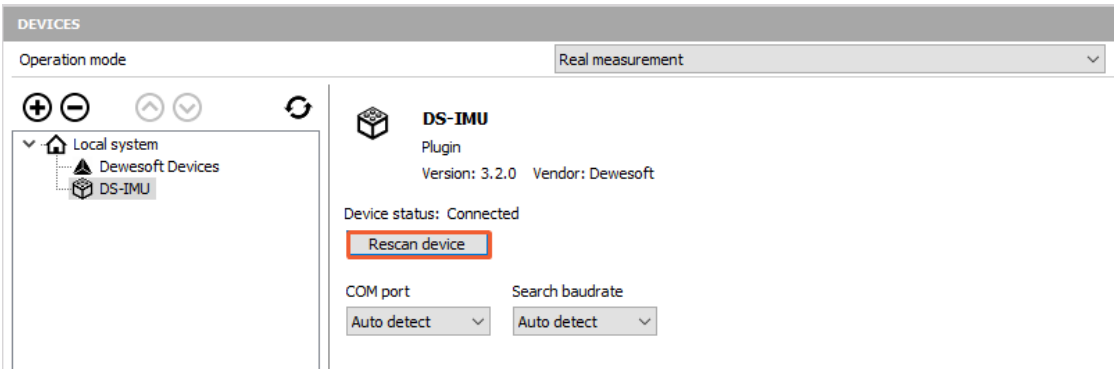


Image 38: Rescan the device

- If device is successfully recognized you will see all of the Device Info

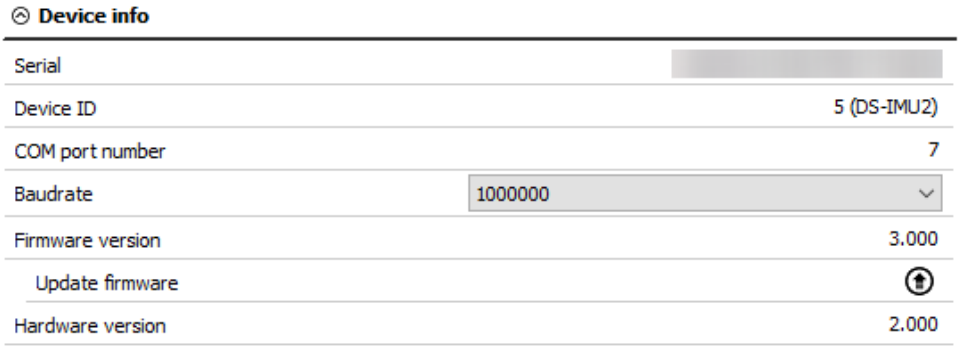


Image 39: Device Information in Settings

- Next step is to select the synchronization. You need to click on the "Local system" to switch to the synchronization settings.

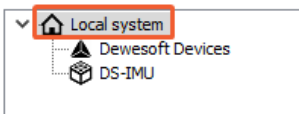


Image 40: Synchronization options

1. Soft-sync → means that the device is in SoftSync

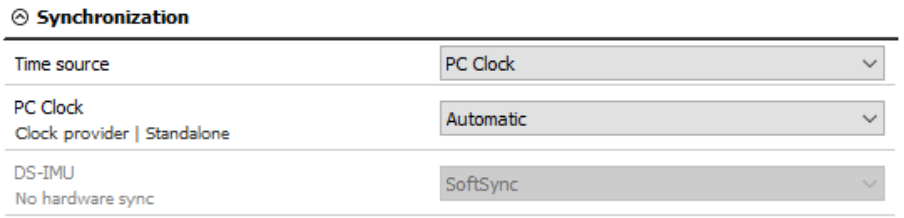


Image 41: Soft-Sync Synchronization options

2. Master clock → means the device will use PPS and GPS time for synchronization of all Dewesoft devices. By using this function all analog data will be synchronized to GPS time. For this option you need to choose a DS-IMU device as Time Source.

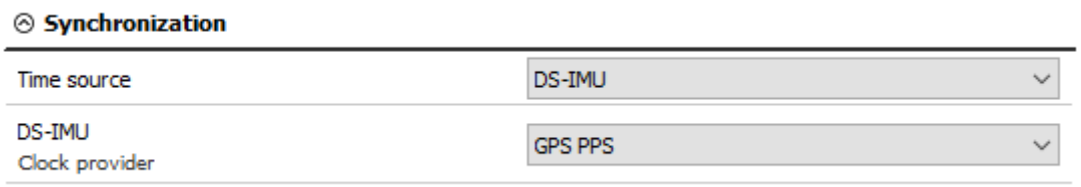


Image 42: Master-Clock synchronization

3. Clock slave → When there is an additional GPS master clock the DS-IMU is in Clock slave mode

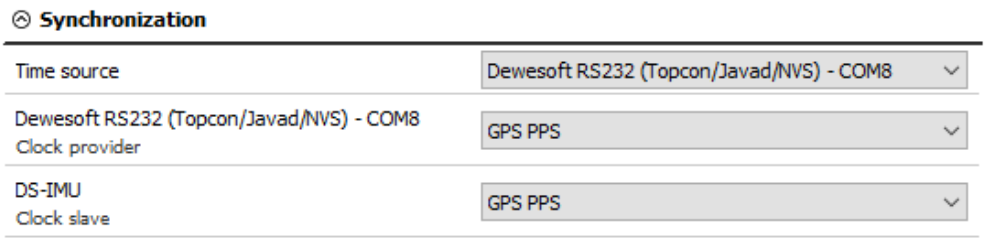


Image 43: Clock slave synchronization

- After performing all the changes press OK to confirm them.

8.2. Channel setup

Screen similar to the one below should show up:

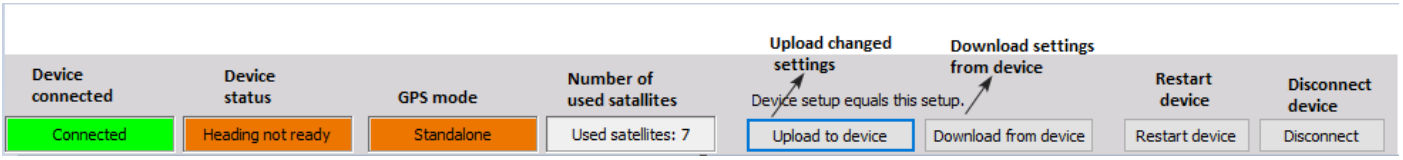


Image 44: Channel setup notification bar

In top of the screen it's possible to see:

- If device is connected or disconnected
- Which device is connected and serial number of it
- Which timing mode you have selected Settings
- Device status
- GPS mode (Standalone, DGPS, Omnistar, RTK fixed)
- Number of used satellites
- Reset device (to re-initialize internal filter values)
- With widgets Data – Mounting – Configuration you can move between different screen options

8.2.1. Data

In the widget “Data” channels, which can be stored are shown. In the channel list it's possible to change channel name, color, default units, scaling, offset and zero offset to all of them.

Several conversion units are already predefined and can be chosen from drop-down list:

- Speed unit (meters/second, kilometers/hours, miles/hour)
- Acceleration unit (meters/second2 , g=9.80665 meters/second2)

It's possible to change the update rate of channels as well. Maximum for DS-IMU2 and DS-GYRO is 500 Hz and for DS-IMU1 is 100 Hz. Several channels are stored at lower sample rate, due to the limitation of RS232, otherwise there is Data overrun and you would start losing samples.

The last option in this widget is to enable “Reset distance on start of measurement” or in other words reset distance on start of storing inside measure mode.

Index	Channel name	Description	Channel rate
0	Time	GPS time (date + time in microseconds)	Up to 500 Hz
1	System status	Status of internal filter and device	Up to 500 Hz
2	GNSS status	GNSS status (Standalone, DGPS, RTK mode,..)	Up to 500 Hz
3	Latitude	Latitude is a geographic coordinate that specifies the north-south position of a point on the Earth's surface	Up to 500 Hz
4	Longitude	Longitude is a geographic coordinate that specifies the east-west position of a point on the Earth's surface	Up to 500 Hz
5	Height	Height above the WGS84 reference ellipsoid (model to approximate sea level across the Earth)	Up to 500 Hz
6	Virtual latitude	Software shifting GPS antenna into other position - Latitude	Up to 500 Hz
7	Virtual longitude	Software shifting GPS antenna into other position - Longitude	Up to 500 Hz
8	Virtual height	Software shifting GPS antenna into other position - Height	Up to 500 Hz
9	Velocity north	Velocity north in ECEF coordinate system (described in section 3.8)	Up to 500 Hz

10	Velocity east	Velocity east in ECEF coordinate system (described in section 3.8)	Up to 500 Hz
11	Velocity down	Velocity down in ECEF coordinate system (described in section 3.8)	Up to 500 Hz
12	Velocity total	Total velocity (vector sum of all 3 directions)	Up to 500 Hz
13	Software distance	Calculated distance out of Velocity total	Up to 500 Hz
14	Velocity X	Velocity X in local coordinate system of device (coordinate system shown on device)	Up to 500 Hz
15	Velocity Y	Velocity Y in local coordinate system of device (coordinate system shown on device)	Up to 500 Hz
16	Velocity Z	Velocity Z in local coordinate system of device (coordinate system shown on device)	Up to 500 Hz
17	Body acceleration X	Acceleration in X axis of the device compensated for Roll and Pitch	Up to 500 Hz
18	Body acceleration Y	Acceleration in Y axis of the device compensated for Roll and Pitch	Up to 500 Hz
19	Body acceleration Z	Acceleration in Z axis of the device compensated for Roll and Pitch	Up to 500 Hz
20	G force	G force is a vector sum of all 3 acceleration components shown in [g]	Up to 500 Hz
21	Roll	Roll is angle of the vehicle around X axis.	Up to 500 Hz
22	Pitch	Pitch is angle of the vehicle around Y axis.	Up to 500 Hz
23	Heading	Heading/Jaw is angle of the vehicle around Z axis.	Up to 500 Hz
24	Angular velocity X	Angular velocity X shows amount of rotation which an object has per second around X axis.	Up to 500 Hz
25	Angular velocity Y	Angular velocity Y shows amount of rotation which an object has per second around Y axis.	Up to 500 Hz
26	Angular velocity Z	Angular velocity Z shows amount of rotation which an object has per second around Z axis.	Up to 500 Hz
27	Slip angle	Slip angle is the angle between vehicle actual direction and direction where vehicle is pointing at	Up to 500 Hz
28	Accelerometer X	Raw acceleration in X axis	Up to 500 Hz

29	Accelerometer Y	Raw acceleration in Y axis	Up to 500 Hz
30	Accelerometer Z	Raw acceleration in Z axis	Up to 500 Hz
31	Gyroscope X	Raw angular velocity X	Up to 500 Hz
32	Gyroscope Y	Raw angular velocity Y	Up to 500 Hz
33	Gyroscope Z	Raw angular velocity Z	Up to 500 Hz
34	Magnetometer X	Measurement of magnetic field in X direction	Up to 500 Hz
35	Magnetometer Y	Measurement of magnetic field in Y direction	Up to 500 Hz
36	Magnetometer Z	Measurement of magnetic field in Z direction	Up to 500 Hz
37	IMU temperature	Internal temperature of device	Up to 500 Hz
38	Pressure	Outside pressure	Up to 500 Hz
39	Raw latitude	Raw latitude is latitude coming directly from GNSS receiver (not filtered)	20 Hz
40	Raw longitude	Raw longitude is longitude coming directly from GNSS receiver (not filtered)	20 Hz
41	Raw height	Raw height is height coming directly from GNSS receiver (not filtered)	20 Hz
42	Raw velocity north	Raw velocity north is velocity north coming directly from GNSS receiver (not filtered)	20 Hz
43	Raw velocity east	Raw velocity east is velocity north coming directly from GNSS receiver (not filtered)	20 Hz
44	Raw velocity down	Raw velocity down is velocity north coming directly from GNSS receiver (not filtered)	20 Hz
45	Raw velocity total	Raw velocity total is a vector sum of velocity north, east and down	20 Hz
46	Number of satellites	Number of satellites used by GNSS receiver	20 Hz

8.2.2. Mounting

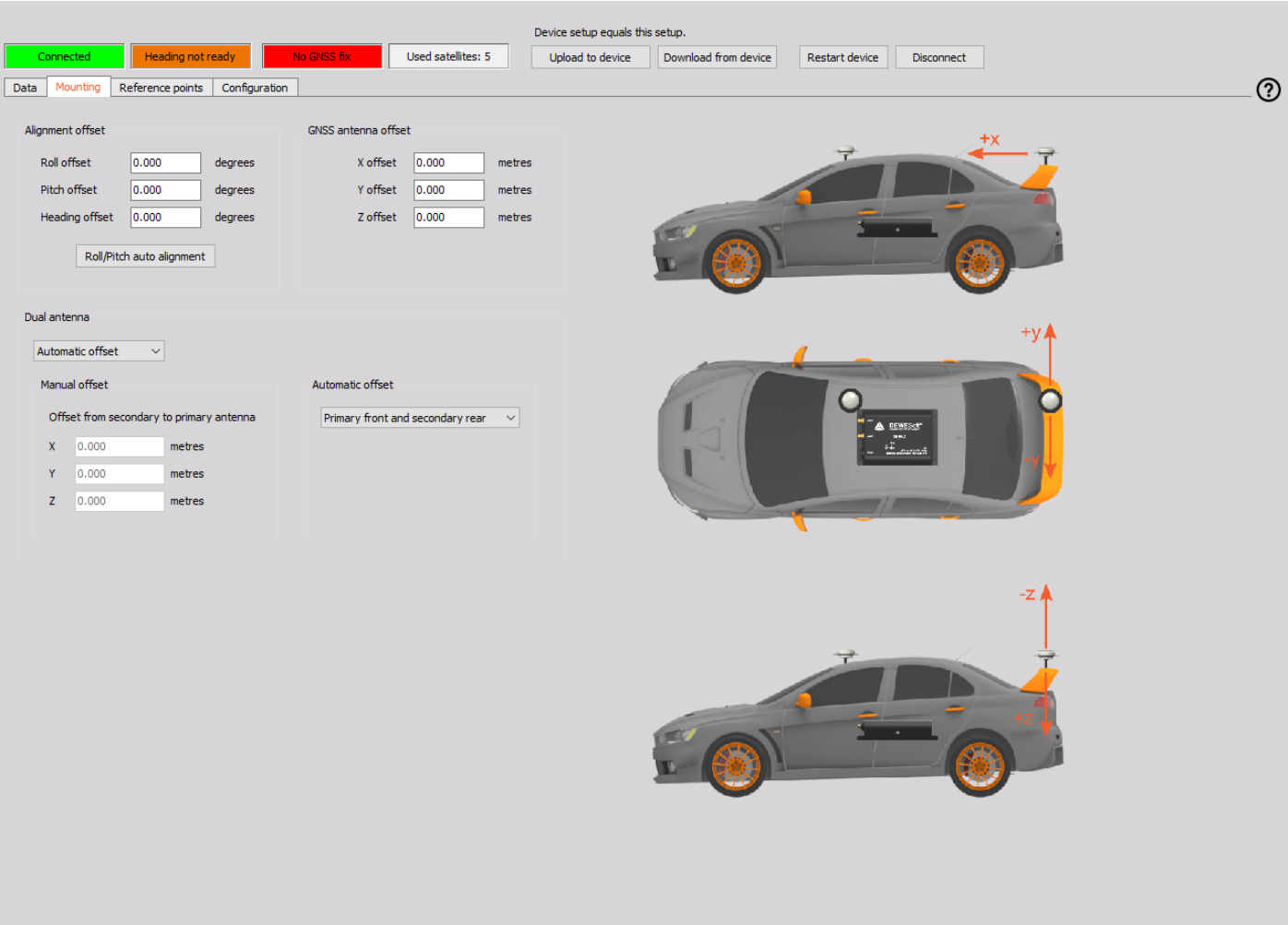


Image 45: Mounting settings

When you hover over different settings, the pictures will adjust accordingly.

8.2.2.1. Alignment offset

In this area it's possible to input angle offsets. This has to be done to compensate error of mounting and surface inclination. The most effective way of doing this is to drive on location, where you want to test (proving grounds, test circuit or just standing vehicle) and press the Set zero button. With doing this several outputs are compensated for Roll and Pitch offset.

8.2.2.2. GNSS antenna offset

This parameter has to be measured and filled carefully, because error of velocity can increase significantly due to different position of IMU and GPS antenna. Here you have to enter the distance between the GNSS antenna or in case of the DS-IMU2 primary GNSS antenna and inertial measurement unit.

8.2.2.3. Virtual measurement point

With this offset it's possible to shift position data to another point. So if you want to shift position data to CoG just enter offset from inertial platform to center of gravity.

8.2.2.4. Dual antenna (only available at DS-IMU2)

Here it's possible to choose either:

- Automatic offset (which measures offset between antenna automatically)
- Manual offset (which is more accurate → therefore data output is more accurately, but you have to measure distance between primary and secondary antenna in coordinate system of IMU

8.2.3. Configuration

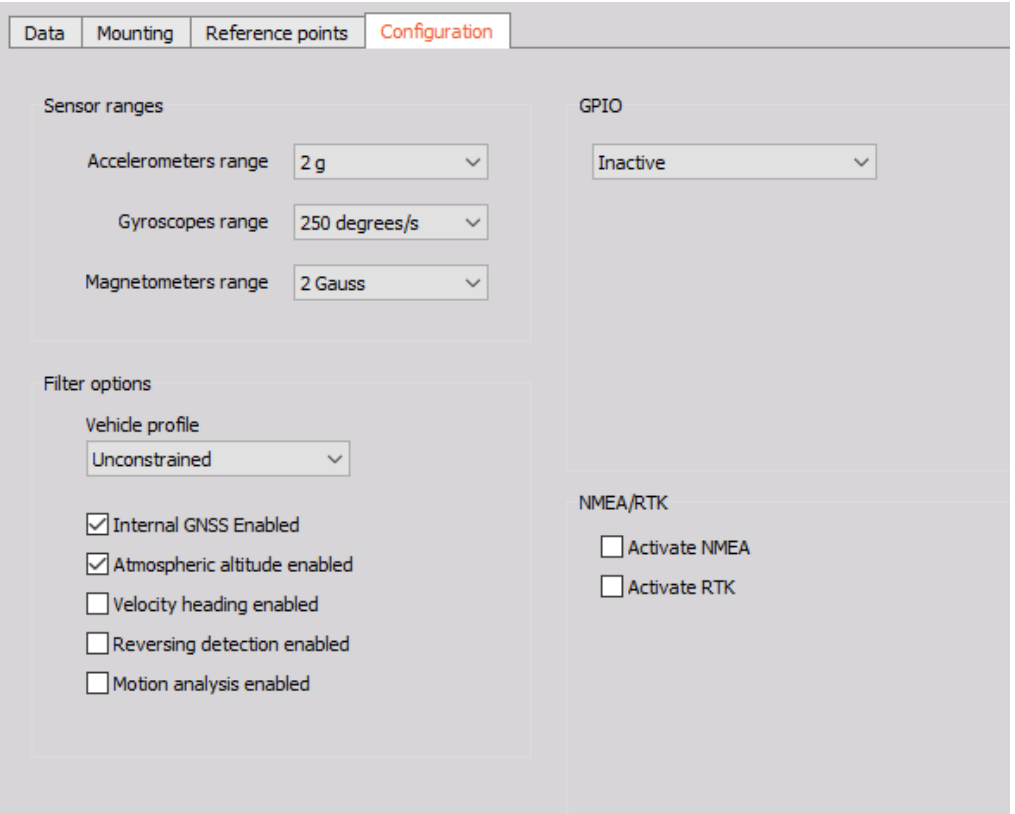


Image 46: Configuration settings

8.2.3.1. Sensor ranges

At all inertial measurement units (DS-IMU1, DS-IMU2 and DS-GYRO1) it is possible to select different dynamic ranges of inertial sensors.

Accelerometer range: 2g, 4g and 16g,

Gyroscope range: 250 deg/s, 500 deg/s and 2000 deg/s,

Magnetometer range: 2 Gauss, 4 Gauss and 8 Gauss.

With selecting different ranges we limit the profile of movement and with this achieving higher resolution in certain ranges. Also the Kalman filter is then tuned to a certain range. If you go out of range at measurement, some of the results might be incorrect. Sensors over range can be detected in the System status channel.

8.2.3.2. Filter options

Since those sensors are made for different applications (automotive, aerospace, surveying, marine,.. testing), you have to choose a vehicle profile to increase performance of internal fusion filters to certain behavior.

Therefore you have to choose vehicle profile:

- Unconstrained
- Bicycle or Motorcycle
- Car
- Hovercraft
- 3D Underwater vehicle
- Fixed Wing Plane...

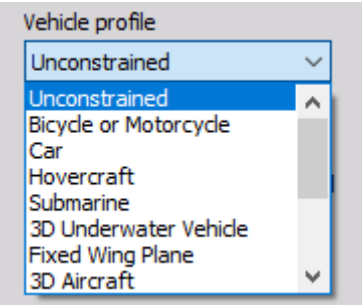


Image 47: Vehicle profile

After doing this, there are different configurations of sensor available:

- Internal GNSS Enabled (to use internal GNSS receiver instead of external)
- Atmospheric altitude enabled (to use pressure sensors to smooth altitude) → DS-IMU contains a sophisticated venting system that allows it to measure air pressure whilst keeping water out. There are two sets of vent holes on each side of the enclosure. It is very important that these remain clean and clear of debris. If debris gets into the vents they should be rinsed with fresh water. Foreign bodies should never be poked into the vent holes, this will break the environmental seal and void the warranty on the unit.
- Velocity heading enabled (to use velocity for heading, at DS-IMU2 means instead of using dual antenna, receiver uses only primary antenna for heading → no static heading, in mathematics it means heading derived from direction of velocity and acceleration. This option is working well with vehicles that do not move sideways. This heading is accurate only at velocity higher than 5 km/h. With DS-IMU2 we suggest using dual antennas unless there are problems with mounting secondary antennas.
- Reversing detection enabled (algorithm to find out when the vehicle is traveling in reverse) → if DS-IMU is mounted to the vehicle that does not reverse or does not use velocity heading or odometer, this function should be disabled.

- Motion analysis enabled (to use at nearly stationary movement, for better performance at very low velocity and is activated by dead reckoning)
- Magnetometers enabled (enabling algorithm to use internal magnetometer for in tunnel driving → available at DS-IMU1, at DS-IMU2 it's always enabled and calibrated with dual antenna)

8.2.3.3. Input/Output functions

DS-IMU2 and DS-IMU1 have one extra connector on which you can input some data (from speed sensor, OBDII, pitot tube) or output (PPS, GNSS data, NMEA data).

Both of them also have extra standard NMEA output on RS232 level. By activating this field, another field for configuration of NMEA output shows up. There you can choose different standard messages with up to 50 Hz output data rate.

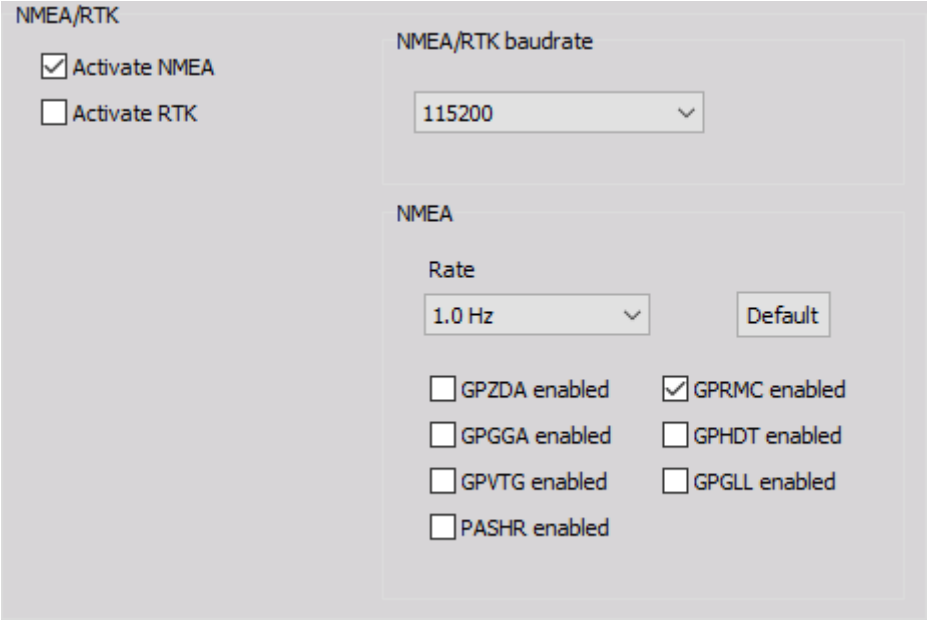


Image 48: Input/Output function

DS-IMU1 and DS-IMU2 also have the function of activating the RTK calculations (RTK1 for IMU1). This is used with either an external base station or for use with RTK Network to receive correction data inside the receiver. This port is also working on RS232 level.

Important

DS-IMU has to find satellites and then RTK connector should be connected, otherwise GNSS receiver receivers RTK correction data before it locks to the satellites and can mix it up. If this happens the unit has to be repowered and the RTK connection has to be removed as long as the unit does not receive 3D fixed.

9. Warranty information

Notice
The information contained in this document is subject to change without notice.

Note:
Dewesoft d.o.o. shall not be liable for any errors contained in this document. Dewesoft MAKES NO WARRANTIES OF ANY KIND WITH REGARD TO THIS DOCUMENT, WHETHER EXPRESS OR IMPLIED. DEWESOFT SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Dewesoft shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any other legal theory, in connection with the furnishing of this document or the use of the information in this document.

The copy of the specific warranty terms applicable to your Dewesoft product and replacement parts can be obtained from your local sales and service office. To find a local dealer for your country, please visit https://dewesoft.com/support/distributors.

9.1 Calibration

Every instrument needs to be calibrated at regular intervals. The standard norm across nearly every industry is annual calibration. Before your Dewesoft data acquisition system is delivered, it is calibrated. Detailed calibration reports for your Dewesoft system can be requested. We retain them for at least one year, after system delivery.

9.2 Support

Dewesoft has a team of people ready to assist you if you have any questions or any technical difficulties regarding the system. For any support please contact your local distributor first or Dewesoft directly.

Dewesoft d.o.o.
Gabrsko 11a
1420 Trbovlje Slovenia

Europe Tel.: +386 356 25 300
Web: http://www.dewesoft.com
Email: Support@dewesoft.com
The telephone hotline is available Monday to Friday from 07:00 to 16:00 CET (GMT +1:00)

9.3. Service/repair

The team of Dewesoft also performs any kinds of repairs to your system to assure a safe and proper operation in the future. For information regarding service and repairs please contact your local distributor first or Dewesoft directly on https://dewesoft.com/support/rma-service.

9.4. Restricted Rights

Use Slovenian law for duplication or disclosure. Dewesoft d.o.o. Gabrsko 11a, 1420 Trbovlje, Slovenia / Europe.

9.5. Printing History

Version 2.0.0, Revision 217 Released 2015 Last changed: 23. July 2018 at 16:54.

9.6. Copyright

9.7. Trademarks

We take pride in our products and we take care that all key products and technologies are registered as trademarks all over the world. The Dewesoft name is a registered trademark. Product families (KRYPTON, SIRIUS, DSI, DS-NET) and technologies (DualCoreADC, SuperCounter, GrandView) are registered trademarks as well. When used as the logo or as part of any graphic material, the registered trademark sign is used as a part of the logo. When used in text representing the company, product or technology name, the ® sign is not used. The Dewesoft triangle logo is a registered trademark but the ® sign is not used in the visual representation of the triangle logo.

10. Safety instructions

Your safety is our primary concern! Please be safe!

10.1 Safety symbols in the manual

Warning
Calls attention to a procedure, practice, or condition that could cause the body injury or death

Caution
Calls attention to a procedure, practice, or condition that could possibly cause damage to equipment or permanent loss of data.

10.2. General Safety Instructions

Warning

The following general safety precautions must be observed during all phases of operation, service, and repair of this product. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the product. Dewesoft d.o.o. assumes no liability for the customer's failure to comply with these requirements.

All accessories shown in this document are available as an option and will not be shipped as standard parts.

10.2.1. Environmental Considerations

Information about the environmental impact of the product.

10.2.2. Product End-of-Life Handling

Observe the following guidelines when recycling a Dewesoft system:

10.2.3. System and Components Recycling

Production of these components required the extraction and use of natural resources. The substances contained in the system could be harmful to your health and to the environment if the system is improperly handled at its end of life! Please recycle this product in an appropriate way to avoid unnecessary pollution of the environment and to keep natural resources.

This symbol indicates that this system complies with the European Union's requirements according to Directive 2002/96/EC on waste electrical and electronic equipment (WEEE). Please find further information about recycling on the Dewesoft web site www.dewesoft.com

Restriction of Hazardous Substances

This product has been classified as Monitoring and Control equipment and is outside the scope of the 2002/95/EC RoHS Directive. However, we take care of our environment and the product is lead-free.

10.2.4. General safety and hazard warnings for all Dewesoft systems

Safety of the operator and the unit depend on following these rules.

- Use this system under the terms of the specifications only to avoid any possible danger.
- Read your manual before operating the system.
- Observe local laws when using the instrument.
- DO NOT touch internal wiring!
- DO NOT use higher supply voltage than specified!
- Use only original plugs and cables for harnessing.
- You may not connect higher voltages than rated to any connectors.
- The power cable and connector serve as Power-Breaker. The cable must not exceed 3 meters, the disconnect function must be possible without tools.
- Maintenance must be executed by qualified staff only.
- During the use of the system, it might be possible to access other parts of a more comprehensive system. Please read and follow the safety instructions provided in the manuals of all other components regarding warning and security advice for using the system.
- With this product, only use the power cable delivered or defined for the host country.
- DO NOT connect or disconnect sensors, probes or test leads, as these parts are connected to a voltage supply unit.
- Ground the equipment: For Safety Class 1 equipment (equipment having a protective earth terminal), a non-interruptible safety earth ground must be provided from the mains power source to the product input wiring terminals.
- Please note the characteristics and indicators on the system to avoid fire or electric shocks. Before connecting the system, please read the corresponding specifications in the product manual carefully.
- The inputs must not, unless otherwise noted (CATx identification), be connected to the main circuit of category II, III and IV.
- The power cord separates the system from the power supply. Do not block the power cord, since it has to be accessible for the users.
- DO NOT use the system if equipment covers or shields are removed.
- If you assume the system is damaged, get it examined by authorized personnel only.
- Adverse environmental conditions are Moisture or high humidity Dust, flammable gases, fumes or dissolver Thunderstorm or thunderstorm conditions (except assembly PNA) Electrostatic fields, etc.
- The measurement category can be adjusted depending on module configuration.
- Any other use than described above may damage your system and is attended with dangers like short-circuiting, fire or electric shocks.
- The whole system must not be changed, rebuilt or opened.
- DO NOT operate damaged equipment: Whenever it is possible that the safety protection features built into this product have been impaired, either through physical damage, excessive moisture, or any other reason, REMOVE POWER and do not use the product until the safe operation can be verified by service-trained personnel. If necessary, return the product to Dewesoft sales and service office for service and repair to ensure that safety features are maintained.
- If you assume a more riskless use is not provided anymore, the system has to be rendered inoperative and should be protected against inadvertent operation. It is assumed that a more riskless operation is not possible anymore if the system is damaged obviously or causes strange

noises. The system does not work anymore. The system has been exposed to long storage in adverse environments. The system has been exposed to heavy shipment strain.

- Warranty void if damages caused by disregarding this manual. For consequential damages, NO liability will be assumed!
- Warranty void if damage to property or persons caused by improper use or disregarding the safety instructions.
- Unauthorized changing or rebuilding the system is prohibited due to safety and permission reasons (CE).
- Be careful with voltages >25 VAC or >35 VDC! These voltages are already high enough in order to get a perilous electric shock by touching the wiring.
- The product heats during operation. Make sure there is adequate ventilation. Ventilation slots must not be covered!
- Only fuses of the specified type and nominal current may be used. The use of patched fuses is prohibited.
- Prevent using metal bare wires! Risk of short circuit and fire hazard!
- DO NOT use the system before, during or shortly after a thunderstorm (risk of lightning and high energy over-voltage). An advanced range of application under certain conditions is allowed with therefore designed products only. For details please refer to the specifications.
- Make sure that your hands, shoes, clothes, the floor, the system or measuring leads, integrated circuits and so on, are dry.
- DO NOT use the system in rooms with flammable gases, fumes or dust or in adverse environmental conditions.
- Avoid operation in the immediate vicinity of high magnetic or electromagnetic fields, transmitting antennas or high-frequency generators, for exact values please refer to enclosed specifications.
- Use measurement leads or measurement accessories aligned with the specification of the system only. Fire hazard in case of overload!
- Do not switch on the system after transporting it from a cold into a warm room and vice versa. The thereby created condensation may damage your system. Acclimatise the system unpowered to room temperature.
- Do not disassemble the system! There is a high risk of getting a perilous electric shock. Capacitors still might be charged, even if the system has been removed from the power supply.
- The electrical installations and equipment in industrial facilities must be observed by the security regulations and insurance institutions.
- The use of the measuring system in schools and other training facilities must be observed by skilled personnel.
- The measuring systems are not designed for use in humans and animals.
- Please contact a professional if you have doubts about the method of operation, safety or the connection of the system.
- Please be careful with the product. Shocks, hits and dropping it from already- lower level may damage your system.
- Please also consider the detailed technical reference manual as well as the security advice of the connected systems.
- This product has left the factory in safety-related flawlessness and in proper condition. In order to maintain this condition and guarantee safety use, the user has to consider the security advice and warnings in this manual.

EN 61326-3-1:2008

IEC 61326-1 applies to this part of IEC 61326 but is limited to systems and equipment for industrial applications intended to perform safety functions as defined in IEC 61508 with SIL 1-3.

The electromagnetic environments encompassed by this product family standard are industrial, both indoor and outdoor, as described for industrial locations in IEC 61000-6-2 or defined in 3.7 of IEC 61326-1.

Equipment and systems intended for use in other electromagnetic environments, for example, in the process industry or in environments with potentially explosive atmospheres, are excluded from the scope of this product family standard, IEC 61326-3-1.

Devices and systems according to IEC 61508 or IEC 61511 which are considered as “operationally well-tried”, are excluded from the scope of IEC 61326-3-1.

Fire-alarm and safety-alarm systems, intended for the protection of buildings, are excluded from the scope of IEC 61326-3-1.

10.3. Documentation version history

Version	Date	Notes
1.0.0	31-03-2015	☑ initial revision
V20-1	5-08-2020	Changed to the new template and update images
V20-2	12-10-2020	Updated connectors for all devices, added new synchronization options
V21-1	17-02-2021	Updated SBAS information for DS-IMU1 devices. SBAS is no longer present for IMU1 v6.1 and earlier.
V22-1	01-10-2022	Magnetic calibration removed and added recommendations about using magnetometer