

# ECUMASTER GPStoCAN

**Manual**  
Revision 1.4  
(Firmware 17.x)

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## 1. Copyright and trademarks

All trademarks, service marks, trade names, trade dress, product names and logos appearing in this documents are the property of their respective owners.

## 2. Introduction

This document provides information about the ECUMASTER GPStoCAN module including a device description, specifications, available features and use cases.

Document created for firmware version 17.x. Description of all the features can differ for other firmware versions, so upgrade is recommended.

## 3. Description

GPStoCAN is a device designed to provide position information over CAN bus. This module can use combination of different navigation systems (GPS, GLONASS, BeiDou, Galileo) as well as IMU (Inertial Measurement Unit) to provide position updates at a rate of 20Hz. Position data can be used to measure lap times, estimate current lap time, draw track maps and analyze vehicle logs with respect to track position.

## 4. Specifications

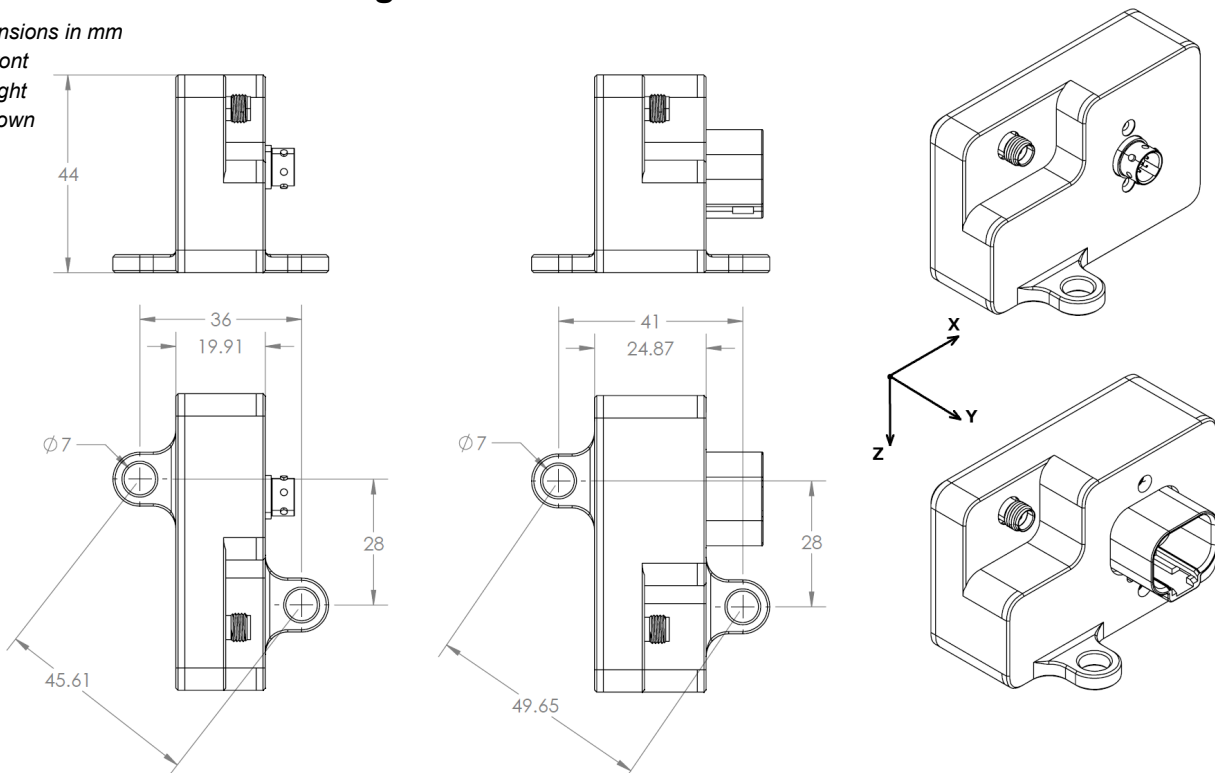
### 4.1. Mechanical drawings

Dimensions in mm

X – front

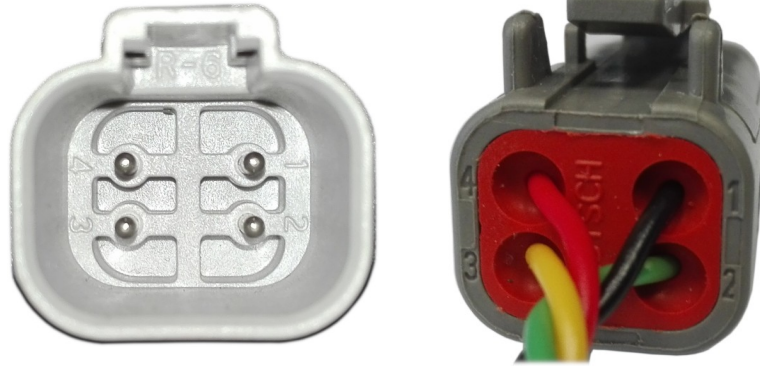
Y – right

Z – down

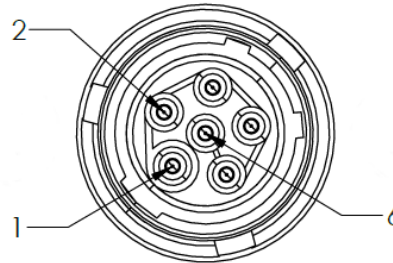
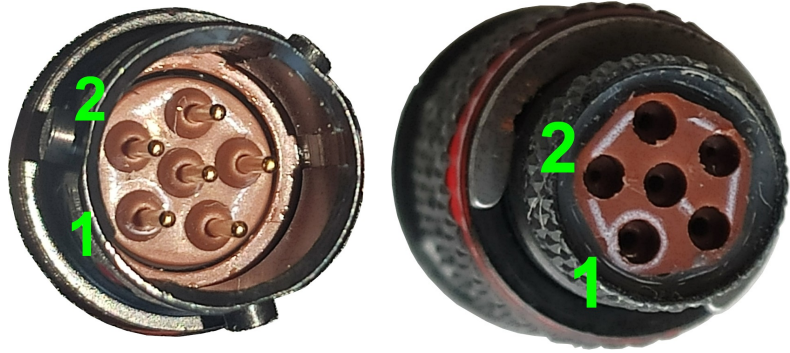


## 4.2. Connectors pinout

DEUTSCH DT	
Pin	Description
1	Ground
2	CAN High
3	CAN Low
4	12V (after ignition)



DEUTSCH AS	
Pin	Description
1	12V (after ignition)
2	CAN High
3	Short these pins together to add CAN termination resistor
4	
5	CAN Low
6	Ground



## 4.3. Specification table

General		
Operating supply voltage	6-22 V, immunity to transients according to ISO 7637	
Reverse polarity protection	Yes, internal up to 16 V	
Temperature range	-40 to +85 °C	
Enclosure	IP65, bespoke CNC machined aluminum	
Size and weight (DT version)	66×53×44 mm, 92 g	
Size and weight (AS version)	66×49×44 mm, 74 g	
Connector (DT version)	Plug: DEUTSCH DT06-4S	Socket: DEUTSCH DT15-4P
Connector (AS version)	Plug: DEUTSCH ASX602-06SN	Socket: DEUTSCH ASX202-06PN
CAN-bus bitrate	1 Mbps, 500 kbps, 250 kbps, 125 kbps	
PC communication	Using USB to CAN interface (ECUMASTER USBtoCAN, PEAK, Kvaser)	
Navigation		
Supported systems	GPS, GLONASS, BeiDou, Galileo	
Supported antennas	Active	

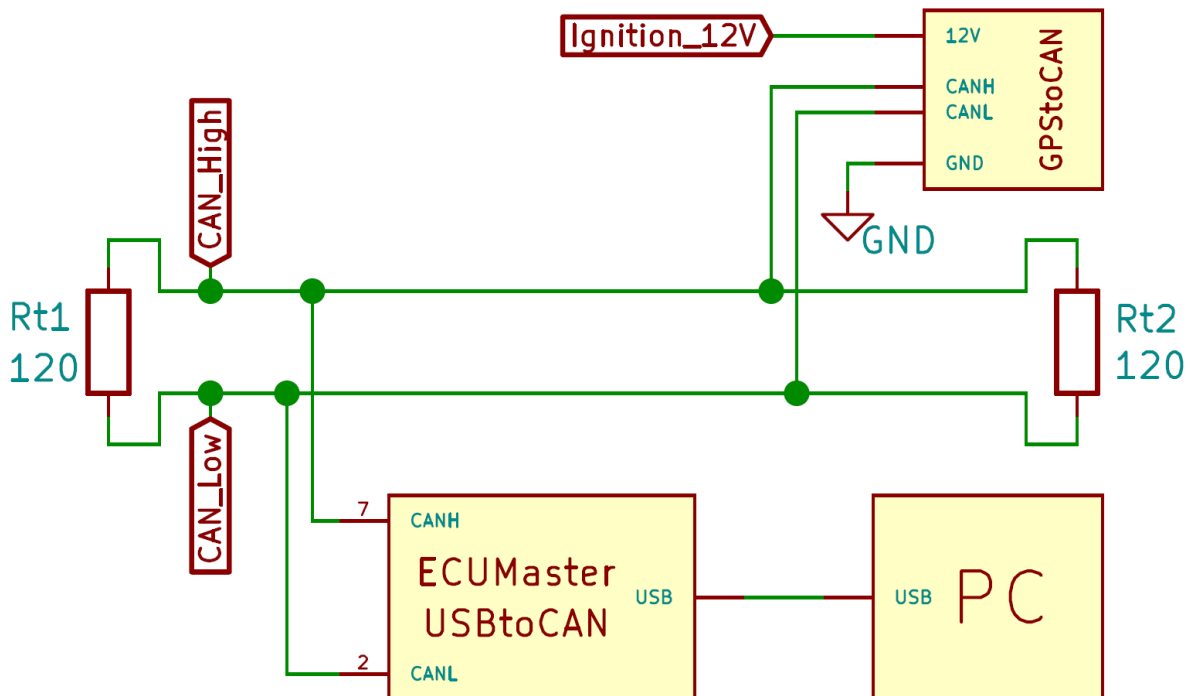
Update frequency	20 Hz (up to 10 Hz with IMU fusion disabled and GPS only)
Calibrated IMU update frequency	1 Hz (axes aligned with the vehicle frame)
High rate IMU update frequency	100 Hz (axes aligned with the enclosure of the device)
Velocity accuracy	0.5 m/s
Velocity maximum	500 m/s
Velocity resolution	0.01 m/s
Velocity latency	< 20 ms
Position accuracy	2 m
Height accuracy	2.5 m
Heading accuracy	1°
Heading resolution	0.01°
Acquisition	Cold starts: 26 sec Aided starts: 3 sec Re-acquisition: 1 sec

## 5. PC connection

Communication with PC software is done using CAN bus. This requires a special interface which converts CAN bus communication to USB 2.0. Interface is an independent device and must be purchased separately. Supported interfaces:

- ECUMASTER USBtoCAN (driver and manual: <http://www.ecumaster.com/download/>)
- PEAK-System
- Kvaser

Wiring diagram:

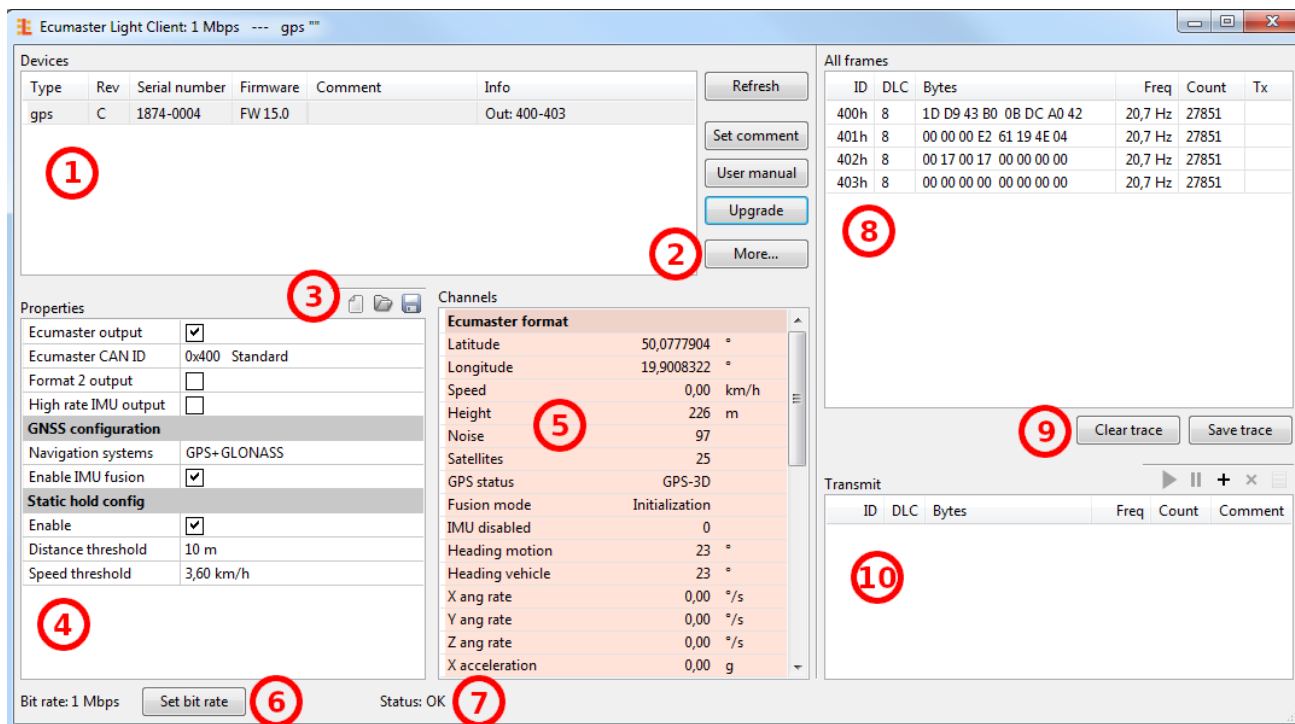


## 6. Light Client description

ECUMASTER Light Client is the configuration software for many ECUMASTER products as well as tool for CAN bus monitoring. Light Client can be used to check available devices on the CAN bus, display channel values, change CAN bus bitrate and device specific properties. Monitoring of CAN bus is possible thanks to list of frames grouped by ID, saving traffic trace file and sending custom messages on the CAN bus.

Software and manual can be downloaded from:

<https://www.ecumaster.com/products/light-client/>



Light Client with GPSToCAN connected:

User interface description:

1) List of devices compatible with the Light Client that are available on the CAN bus. General information about the device. Double click a row to select the device and display its channels and properties.

2) Devices control buttons:

- Refresh – refresh devices list
- Set comment – set a comment for the device
- User manual – view the online user manual in a web browser
- Upgrade – the device firmware upgrade, online or local file

- More:
  - Load project – open previously saved project file
  - Save project – save project file of the currently selected device
  - Restore project to default – restore default properties of the currently selected device
  - Mount device from file... – open a virtual device from local file and append it to list of devices
  - Mount device from ECUMASTER.com... – open a virtual device from Internet and append it to list of devices
  - Export CAN definition .CANX... – export to .CANX file for importing in other ECUMASTER products
  - Export CAN definition .DBC... – export to .DBC file for importing in other products
  - About – application information
- 3) Device properties management toolbar:
  - Restore project to default – restore default properties of the currently selected device
  - Load project – open previously saved project file
  - Save project – save project file of the currently selected device
- 4) List of properties for the selected device
- 5) List of channels sent over the CAN bus
- 6) Button for changing bit rate of all the devices compatible with Light Client
- 7) CAN bus status information
- 8) List of received frames on the CAN bus, grouped by ID
- 9) Clear trace button removes all received frames from history and Save trace button saves that history to a text file
- 10) Transmit window allows you to set custom frames which will be sent over the CAN bus

## 7. Software features

### 7.1. Channels

Channels are different data values that are sent over CAN bus. Channels are sent as raw values, which means that obtaining a value with the correct unit requires some calculations.

$$Value[unit] = \frac{Value[raw] * Multiplier}{Divider} + Offset$$

Tables below describe how each channel is positioned inside CAN frames and how to obtain the correct value. All values are Big Endian.

**Ecumaster format output:**

Byte (bit)	Channel	Data type	Range	Multiplier	Divider	Offset	Unit
<b>Ecumaster output ID (default: 0x400)</b>							
0	Latitude	32bit signed	-90 – 90	1	10 <sup>7</sup>	0	°
4	Longitude	32bit signed	-180 – 180	1	10 <sup>7</sup>	0	°
<b>Ecumaster output ID+1 (default: 0x401)</b>							
0	Speed	16bit signed	-1179 – 1179	36	1000	0	km/h
2	Height	16bit signed	-32768 – 32767	1	1	0	m
4	Noise	8bit unsigned	0 – 255	1	1	0	-
5	Satellites number	8bit unsigned	0 – 72	1	1	0	-
6 (0)	GPS frame index	4bit unsigned	0 – 16	1	1	0	-
6 (4)	Empty frame index	4bit unsigned	0 – 16	1	1	0	-
7 (0)	GPS status	3bit unsigned	1 – 5	1	1	0	-
7 (3)	IMU fusion status	3bit unsigned	0 – 4	1	1	0	-
<b>Ecumaster output ID+2 (default: 0x402)</b>							
0	Heading motion	16bit unsigned	0 – 360	1	1	0	°
2	Heading vehicle	16bit unsigned	0 – 360	1	1	0	°
4	X angle rate	16bit signed	-250 – 250	1	100	0	°/s
6	Y angle rate	16bit signed	-250 – 250	1	100	0	°/s
<b>Ecumaster output ID+3 (default: 0x403)</b>							
0	Z angle rate	16bit signed	-250 – 250	1	100	0	°/s
2	X acceleration	16bit signed	-4 – 4	1	100	0	g
4	Y acceleration	16bit signed	-4 – 4	1	100	0	g
6	Z acceleration	16bit signed	-4 – 4	1	100	0	g
<b>Ecumaster output ID+4 (default: 0x404)</b>							
0	UTC year	8bit unsigned	0 – 255	1	1	2000	-
1	UTC month	8bit unsigned	1 – 12	1	1	0	-
2	UTC day	8bit unsigned	1 – 31	1	1	0	-
3	UTC hour	8bit unsigned	0 – 23	1	1	0	-
4	UTC minute	8bit unsigned	0 – 59	1	1	0	-
5	UTC second	8bit unsigned	0 – 60	1	1	0	-
6	UTC millisecond	16bit unsigned	0 – 65535	1000	65536	0	-

Channels description:

**Latitude** – latitude position in degrees

**Longitude** – longitude position in degrees

**Speed** – ground speed in kilometers per hour

**Height** – height above mean sea level in meters

**Noise** – satellite signal noise, lower is better

**Satellites number** – number of currently visible satellites

**GPS frame index** – increments cyclically from 0 to 15 for each position frame

**Empty frame index** – increments cyclically from 0 to 15 for each empty frame

**GPS status** – position fix status:

- 1 - “NoFix” - no position fix acquired
- 2 - “IMU” - position is fixed using inertial measurement unit only
- 3 - “GPS-2D” - position is fixed in 2D space using GNSS satellites
- 4 - “GPS-3D” - position is fixed in 3D space using GNSS satellites
- 5 - “GPS+IMU” - position is fixed in 3D space using GNSS satellites and IMU

**IMU fusion status** – inertial navigation status:

- 0 - “Initialization” - initialization and calibration of inertial sensors
- 1 - “Fusion” - inertial sensors are used to create position fix
- 2 - “Suspended” - temporary error of inertial sensors
- 3 - “Disabled (error)” - sensors disabled due to hardware error
- 4 - “Disabled (user)” - fusion disabled by user

**Heading motion** – direction of vehicle motion in degrees

**Heading vehicle** – direction in which vehicle front is heading in degrees

**X, Y, Z angle rate** – angular velocity around longitudinal, lateral and vertical axis (referenced to the vehicle frame)

**X, Y, Z acceleration** – longitudinal, lateral and vertical acceleration (referenced to the vehicle frame)

**UTC year, month, day** – UTC date from navigation satellites

**UTC hour, minute, second, millisecond** – UTC time from navigation satellites



**Format M output:**

Byte (bit)	Channel	Data type	Range	Multiplier	Divider	Offset	Unit
<b>Format M output ID (default: 0x680)</b>							
0	Latitude (M)	32bit signed	-90 – 90	1	10 <sup>7</sup>	0	°
4	Longitude (M)	32bit signed	-180 – 180	1	10 <sup>7</sup>	0	°
<b>Format M output ID+1 (default: 0x681)</b>							
0	Time (M)	32bit signed	0 – 235959999	1	1	0	-
4	Speed (M)	16bit unsigned	0 – 1800	1	10	0	km/h
6	Altitude (M)	16bit signed	-32768 – 32767	1	10	0	m
<b>Format M output ID+2 (default: 0x682)</b>							
0	Date (M)	24bit unsigned	0 – 311299	1	1	0	-
3	Valid (M)	8bit signed	-1 – 1	1	1	0	-
4	True course (M)	16bit signed	-250 – 250	1	10	0	°
7	Satellites (M)	8bit unsigned	0 – 255	1	1	0	-
<b>Format M output ID+3 (default: 0x683)</b>							
4	FAA mode (M)	8bit signed	-1 – 1	1	1	0	-
5	Fix quality (M)	8bit signed	-1 – 1	1	1	0	-

Channels description:

**Latitude (M)** – latitude position in degrees

**Longitude (M)** – longitude position in degrees

**Time (M)** – time in HHMMSS.sss format

**Speed (M)** – ground speed in kilometers per hour

**Altitude (M)** – height above mean sea level in meters

**Date (M)** – date in DDMMYY format

**Valid (M)** – position data valid:

- -1 - “Warning” - position data may be invalid
- 0 - “Unknown” - position data is unknown
- 1 - “Valid” - position data is valid

**True course (M)** – direction of vehicle motion in degrees

**Satellites (M)** – number of currently visible satellites

**FAA mode (M)** – duplicate of ‘Fix quality 2’ field, see below

**Fix quality (M)** – fix quality status:

- -1 - “Unknown” - unknown fix quality
- 0 - “Invalid” - not enough satellites, invalid fix quality
- 1 - “GPS” - standard GPS signal position fix

## High rate IMU output:

Byte (bit)	Channel	Data type	Range	Multiplier	Divider	Offset	Unit
<b>High rate IMU output ID (default: 0x408)</b>							
0	HR X ang rate	16bit signed	-250 – 250	1	100	0	°/s
2	HR Y ang rate	16bit signed	-250 – 250	1	100	0	°/s
4	HR Z ang rate	16bit signed	-250 – 250	1	100	0	°/s
<b>High rate IMU output ID+1 (default: 0x409)</b>							
0	HR X accel	16bit signed	-4 – 4	1	100	0	g
2	HR Y accel	16bit signed	-4 – 4	1	100	0	g
4	HR Z accel	16bit signed	-4 – 4	1	100	0	g

### Channels description:

**HR X, Y, Z ang rate** – high rate angular velocity around longitudinal, lateral and vertical axis (referenced to the enclosure of the device)

**HR X, Y, Z accel** – high rate longitudinal, lateral and vertical acceleration (referenced to the enclosure of the device)

## 7.2. Properties

Device properties can be changed using the ECUMASTER Light Client software and connection interface. Each property is described below:

### Ecumaster output:

- **Enable** – enable Ecumaster CAN frames output
- **Output CAN ID** – base frame ID for Ecumaster output

### Format M output:

- **Enable** – enable format M CAN frames output
- **Output CAN ID** – base frame ID for format M output

### High rate IMU output:

- **Enable** – enable high rate IMU CAN frames output
- **Output CAN ID** – base frame ID for high rate IMU output

### GNSS configuration:

- **Navigation systems** – selected navigation systems to use in positioning
- **IMU fusion enable** – enable IMU fusion for positioning

### Static hold config:

- **Enable** – enable static hold, this option holds position constant and speed equal to 0 until distance or speed threshold is exceeded
- **Distance threshold** – threshold in meters for static hold to deactivate
- **Speed threshold** – threshold in kilometers per hour for static hold to deactivate

## **8. Device installation**

### ***8.1. Mounting method and location***

Ideal mounting position is in the middle of the vehicle, attached to a vehicle frame using included rubber dampers and orientation that is shown in the “Mechanical drawings” chapter.

GPStoCAN module must be mounted with rubber dampers in a vertical orientation (Z-axis pointing down). Mounting the module to a vertical plane with dampers horizontally can introduce problems with the IMU since bumps on the road could significantly move the module up and down relative to the vehicle.

Rotation of the module around the Z-axis is not critical and can be changed. Inertial sensors will be calibrated automatically, but calibration process will take longer compared to ideal orientation. Another downside of rotated mounting position is that high rate inertial data (100 Hz) is aligned to the device enclosure and will not be aligned with the vehicle.

### ***8.2. Inertial measurement unit calibration***

IMU will automatically start calibration process after the first start. Ideal calibration process requires good GNSS signal conditions and couple of minutes in the following situations:

- stationary vehicle with engine running,
- steady low/high speed driving in a straight line,
- acceleration and deceleration in a straight line,
- steady left and right turns.

Calibration is always working in the background and making corrections based on vehicle dynamics. Moving the device to a different location inside the vehicle will invalidate current calibration and start a new one automatically. Updating firmware or changing configuration of the module will also reset the IMU calibration.

When calibrating the module on a race track care must be taken to create best conditions for the calibration process. That means not driving on the limit of the grip, moderate acceleration, deceleration and steering, avoiding curbs and any other significant bumps. Few laps with steady driving should allow for the calibration process to finish correctly. “GPS status” and “IMU fusion status” channels can be used to check the calibration process.

In case of a very strong vibrations which cannot be damped mechanically or other problems with navigation using IMU there is a possibility to disable IMU fusion for position calculations. Disabling IMU fusion decreases position update rate from 20 Hz to 10 Hz or less (depends on the number of used navigation systems) and calibrated IMU data aligned to the vehicle frame will not be available.

NOTE: ADU version 85.1 or higher must be used to allow for correct lap timing with position update rate different than 20 Hz.

*Position fix type is indicated by the LED on the back of the device:*

**Red** – there is no position fix currently

**Blue** – position fix using GNSS satellites or IMU

**Green** – position fix using GNSS satellites and IMU

### 8.3. Antenna connection

The GPStoCAN module is designed to work with active antennas. Ideal antenna placement is on a big metal plane (roof, hood, trunk) with a clear view of the sky and directly over the GPStoCAN module. The most common way to mount the antenna is to put it on the roof (using the magnetic base), placing it exactly above the GPS device.

Antenna wire should be placed away from any harness with high currents or voltages (like engine harness). Fast changing current or voltage can generate noise in the antenna wire and interfere with GNSS signal.

## 9. Document revision history

Revision	Date	Changes
1.4	17-05-2021	<ul style="list-style-type: none"> <li>- updated for firmware version 17.x</li> <li>- added possibility to disable IMU fusion (navigation using IMU)</li> <li>- added high rate IMU data output (100Hz)</li> <li>- added static hold configuration</li> <li>- added UTC data output</li> <li>- added "Format M" data output</li> <li>- added accuracy specification</li> <li>- added Light Client description</li> <li>- expanded information on mounting and calibration</li> <li>- default configuration changed</li> <li>- minor corrections</li> </ul>
1.0	14-06-2019	<ul style="list-style-type: none"> <li>- official release</li> <li>- minor corrections</li> </ul>
0.1	20-08-2018	<ul style="list-style-type: none"> <li>- initial release</li> </ul>