RaceGrade GPS

Part # M GPS BL V3
Available in 10 Hz or 20 Hz
Available with Multi-GNSS option
Availble with RaceGel option

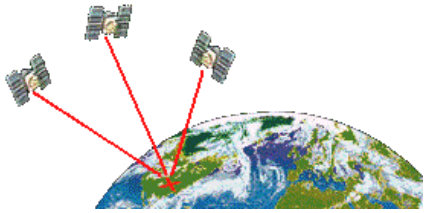
USER MANUAL **Version 3.0**

27 September, 2019

Contents

Introduction

Thank you for purchasing a ***RaceGrade v3 GPS*** receiver. This user's guide was written to help you understand how the ***RaceGrade v3 GPS*** (Global Positioning System) device works. Please read it thoroughly. Installation is very important and understanding how GPS works will help you get the most from this sensor.



The RaceGrade v3 GPS device uses a multiband GPS specific antenna to track satellites in orbit around Earth. It takes a minimum of three satellites to identify your position on earth, and a fourth to calculate accurate timing. Satellites are constantly moving, and a satellite which the antenna sees at the start of an event might not be visible minutes later. Satellites used in the GPS solution are dynamically added or dropped based on signal quality. Ideally you should have 8 or more satellites being tracked in order to obtain good accuracy. Anything under 6 satellites is quite poor. With more satellites, there is more information to correctly identify your position with less error. The key to accuracy is your antenna having a clear, unobstructed line of sight to the satellites in the sky.

The system uses a multi-frequency receiver to reference the GPS, GLONASS, BeiDou, and Galileo constellations currently in operation. Additionally, in certain parts of the world the GPS is able to use up to three special geostationary satellites known as a Space Based Augmentation System (SBAS). These satellites provide the means to calculate DGPS (differential GPS) via reference station and atmospheric modeling corrections.

The GPS system provides different levels of accuracy based on where it is operated in the world. Without differential correction, you can expect 8.2ft (2.5m) positional accuracy. When differential correction is available, 95% of all data transmitted will be within 2.0ft (0.6m) positional accuracy. Even more impressive is that up to 60% of all data received with differential correction will have 1.0ft (0.3m) positional accuracy. Satellite position and availability plays a large role in this accuracy, so the more that are used in the position solution the better chances you will have the higher accuracy in your position. This is why the Multi-GNSS option is offered and strongly suggested for precision oriented tasks.

Warm Up Time

When the GPS receiver is first powered, it will start searching for satellites to lock onto. This process takes time. It will take longer the first time you power up at a new location from where you had previously turned it off. Normal “cold” start up times, meaning being in a new area from the previous location, can be anywhere from 2 to 10 minutes. Subsequent “warm” start up times at the same location normally takes 30 seconds to 2 minutes. If you are outside of North American, expect the very first time to take up to 20 minutes.

Internal Battery

There is an internal battery to store the recent location during power off. This will aid in warm starts instead of cold starts, resulting in dramatically less time to lock onto satellites. The internal battery is rechargeable and after being off for several months may require recharging to return warm start performance. The internal battery is charged by system power and may take up to 24 hours to reach full capacity.

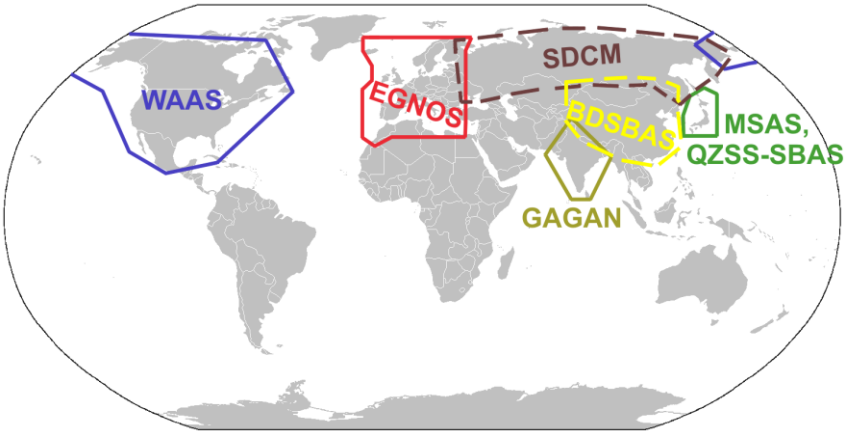
Status LEDs

There are 4 LEDs on the front face of the unit labeled as follows:

LED	Color	Function
PWR	RED	Power is applied
GPS	YEL	GPS satellites are being tracked
SBAS	YEL	Correction satellites are being tracked for differential position solution
DIFF	GRN	Differential position calculation in use which denotes high accuracy position state (< 2.3ft / 0.7m)

There are only two required lights for operation, one is POWER and the other GPS. The DIFF and DGPS lights indicate increased accuracy of the data. With differential correction, you will get the most accurate data. Therefore best operation is achieved with these lights on. The

differential corrections are only available in regions of the world where such correctional data is broadcast. The currently operational systems referenced are WAAS (USA) and EGNOS (Europe). As future SBAS systems come on line the receiver may need firmware updates to allow for the correction.



RS-232 Serial Output

Standard NMEA-0183 message strings GPGGA and GPRMC are sent out by default at a baud rate of 57,600. The baud rate and type of messages can only be changed prior to sale or by sending the unit back to MoTeC USA, Inc. on an RMA with the requested changes stated.

CAN Output

The RaceGrade GPS version 3 receive includes a CAN output. The CAN bus speed operates at 1 mbit/s and on the base ID of 0x146. The CAN output is based off the MoTeC GPS with STC (serial to CAN) which mimics the NMEA0183 serial packet transmission. Simply select the “GPS Async” template for MoTeC devices. A limited number of alternate baud rate and message address can be requested if the standard is not suitable for your application. They can only be changed prior to sale or by sending the unit back to MoTeC USA, Inc. on an RMA with the requested changes stated.

20 Hz Update *Option

This option allows both the CAN and serial messages to update at a true 20 Hz rate instead of the base 10Hz rate:

*** Options must be specified at the time of ordering**

Multi-GNSS *Option

This option allows the multiband GPS receiver to connect additional GPS constellations currently including GLONASS (Russian), BeiDou (Chinese), and Galileo (European)

you buy it afterwards, the unit must be sent to RaceGrade for updating.

*** Options must be specified at the time of ordering**

RaceGel *Option

This option adds IP68 like environmental protection to the GPS unit by flooding the enclosure with our proprietary potting. This option requires at least two days lead time from the confirmation of an order. The mass of the GPS receiver is significantly increased from 5.6oz / 158g to 8.0oz / 227g.

*** Options must be specified at the time of ordering**

Installation

GPS Receiver

The enclosure is made from 6061 Aluminum alloy. It should be mounted in a safe location, away from electrical noise, vibration and temperature. Maximum operating temperature is 70°C or 158°F.

NOTE: ***To counter any possible vibration damage, please mount the receiver with compliant hook and loop material. In high vibration environments the RaceGel option is highly recommended***

Antenna

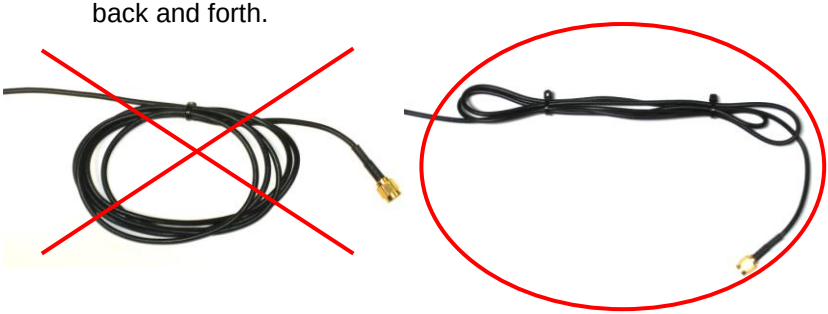
The RaceGrade GPS antenna included with your unit is an active (powered) high quality miniature dual band passive device with a magnetic base. The antenna is replaceable with our part number M GPS BL ANT. Older versions of this antenna are NOT dual band and would significantly degrade the performance of the Multi-GNSS feature. If you are upgrading or mixing parts please be sure to keep the new antenna paired with the v3 GPS. Non Multi-GNSS units will work with either antenna, and the new dual frequency antennas will work with older GPS units.

The location of the antenna is VERY important. It should be mounted such that it can have a clear view of the sky out to 5 degrees above the horizon. Poor mounting locations will have a negative impact on the results from its calculated data.

Normally the best location would be on top of the vehicle. For motorcycles, on top of the rear fairing works well. On a closed-wheel race car the best choice is the roof. For best performance, do not place the antenna under the front or rear window. For open-wheeled cars, on top of the roll hoop, or just in front of the cockpit works best.

Antenna

- GPS signals are easily blocked by electrical noise, especially in the 1.5 to 1.6GHz range where GPS signals are transmitted. Keep the antenna more than 6” from any other antennas such as car-to-pit voice radios, telemetry and other GPS antennas.
- For cars with “live TV coverage cameras”, most of them send their signal at the same frequency as GPS. Therefore you must separate the GPS antenna and wire to the opposite side of the car. Keep the TV antenna and wire as far away as possible from the GPS antenna and wire.
- Keep the antenna outside any of any metal or carbon fiber enclosed space, as these materials will block satellite signals. Plastic, duct tape as well as fabric convertible tops are generally ok.
- The antenna should be kept flat or parallel to the ground. If mounted on a slope then the ability to receive signals will decrease slightly. Keep this in mind when mounting on a motorcycle as the bike leans from corner to corner.
- Try to keep the antenna mounted on the centerline of the vehicle. As with normal wheel speeds, during cornering the speed of the inner side of the chassis is less than the speed of the outer side of the chassis.
- The antenna has a magnet base to hold itself onto a metal surface. If you use double sided tape or hook & loop, when removing please be careful not to remove the bottom silver sticker from the antenna. This sticker has a metal film that help reject false signals and shield it from noise.
- Any extra antenna wire can be zip tied in a back and forth bundle. **Do not coil the extra antenna wire length in a circle** or wrap it around anything. Simply run the extra antenna wire back and forth.



Loss of Signal

As mentioned earlier, the antenna must see as many satellites as possible. The antenna should have a clear view of the sky, ideally a clear line of sight to the sky down to 5 degrees above the horizon. If part of the sky is blocked by a building, tree or bridge then the GPS unit will loose track of those satellites being blocked. When this happens, a reacquisition will take place which can take some length of time. Loss of signal can occur when driving under bridges. The size of the bridge and satellite location (time of day) has an impact on the acquisition of satellites. You should always log your satellite count to be aware of what the antenna saw while traveling around the race track.

GPS Quality

The channel “GPS Sats Used” is a value that represents the number of satellites used in the calculations. A value of 8 to 10 is excellent. A value of 6 or 7 is decent but may suffer some noise. Values below 6 will have very poor accuracy.

For the RaceGrade GPS with the Multi-GNSS option, the number of satellites should typically be in the neighborhood of 18 to 24 depending on location and time of day. Prioity is always given to locking to the GPS constellation first, and then foreign systems are added as their data is confirmed to be reasonable with respect to the GPS data already received.

The RaceGrade GPS carefully attempts to screen for multipath (reflections of the same signal) which is why you will find it more difficult to get lock inside of buildings or next to tall structures. Most other GPS units accept multi-path signal and therefore lock more easily. For these reasons the channel “GPS Sats Used” can not be analyzed to estimate accuracy with any degree of precision in comparison between systems other than RaceGrade receivers.

Setup for Motec Data Loggers

For Motec Loggers, please select the template "GPS - Standard RMC GGA" listed under the communications RS-232. Verify 57,600 for the baud rate. You'll be able to log the following channels of information:

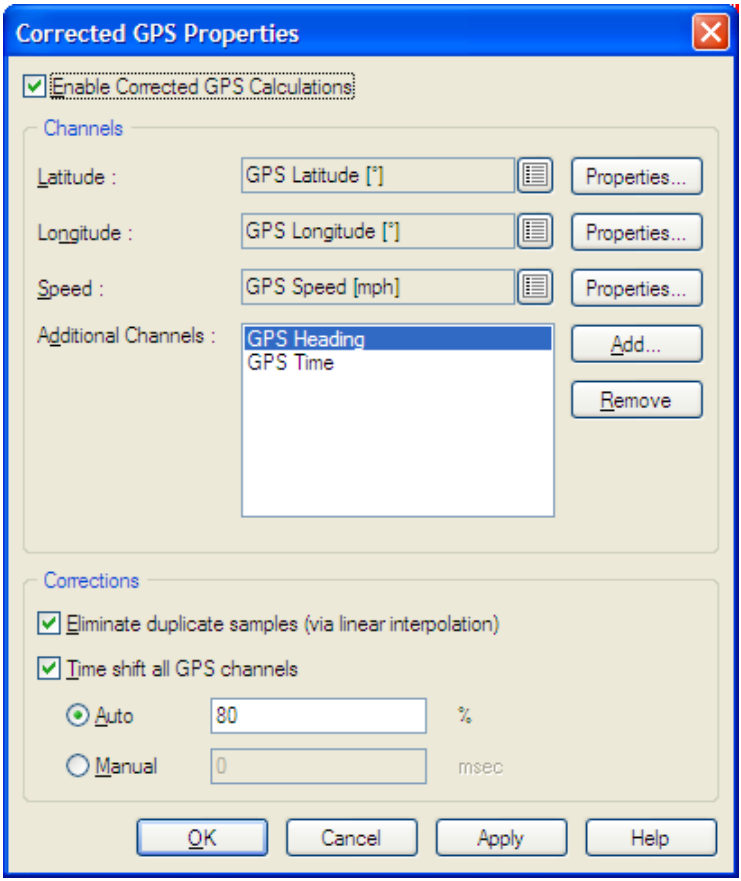
Recommended Logging Rates

Update Option:	*10 Hz*	*20 Hz*
• GPS Latitude	20 Hz	50 Hz
• GPS Longitude	20 Hz	50 Hz
• GPS Speed	20 Hz	50 Hz
• GPS Heading	20 Hz	50 Hz
• GPS Date	1 Hz	1 Hz
• GPS Time	10 Hz	10 Hz
• GPS Sats Used	10 Hz	10 Hz
• GPS Altitude	10 Hz	10 Hz

For the 10 Hz update rate, channels should be logged at 20 Hz even though they only update at 10 Hz. This will help minimize the time delay between when the data arrives to the logging device through the serial stream and the moment the values are logged. For the 20 Hz option, those channels which update at 20 Hz should be logged at 50 Hz. GPS Date should only be logged at 1 Hz. See the table above.

"i2" Analysis Math

GPS data will have an inherent time lag. The sequence of delays are from receiving real-time satellite signals, processing them, sending the data into the logger and the logger logging them. MoTeC's "i2" has a built-in "Corrected GPS" function found under the "Tools" pull down menu. This function should only be used with data originating from a MoTeC Data Logger or ECU.



Actual shift may vary. You can use either the Auto function or manually adjust the time delay. The 10 Hz unit typically has a delay of approximately 130 msec. The 20 Hz unit typically has a delay of approximately 110 msec.

Appendix

GPS Engine Specifications

- 49-channel GPS engine capable of tracking GPS (USA), GLONASS (Russian), BeiDou (Chinese), and Galileo (European) GPS constellations when the Multi GNSS option is purchased
- Horizontal accuracy < 2.3 feet / 0.7 meter at 95% with DGPS
- Horizontal accuracy < 1.3 feet / 0.4 meter at 60% with DGPS
- Horizontal accuracy < 8.5 feet / 2.6 meter without DGPS
- Battery backed location storage for faster start up
- Option IP68 RaceGel potting available for extreme environments or high vibration installations
- Update rate of 10 Hz or optional 20 Hz CAN and Serial
- Screw on SMA antenna connector.

Output Streams:

- RS-232 serial at 57600 baud rate formatted NMEA GGA and RMC messages.
- CAN output for MoTeC devices (bus speed is 1 Mbit/s)

Power Supply

Operating Voltage: 6 to 18 Volts DC

Operating Current: 0.420 Amps at 12 Volts

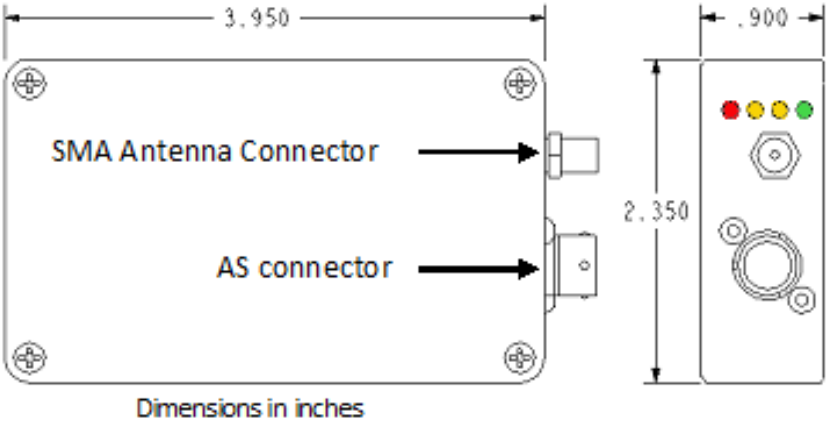
Operating Temperature

Ambient Temperature Range:	-22°F to 158°F / -30°C to 70°C
Housing Material:	Anodized 6061 Aluminum

Physical

Case Size: 3.95 x 2.35 x 0.9 inches (excluding connectors)
100 x 60 x 23 mm (excluding connectors)

Weight: 153 grams w/o antenna (227 grams w/IP68 option)



Connection

The mating connector is an ASL-606-05SN

- pin 1 – Ground, negative battery (do not use a 0v line)
- pin 2 – RS-232 Tx, serial data out
- pin 3 – 12 volt supply, 6 to 18 volts allowed
- pin 4 – CAN Low
- pin 5 – CAN High