RaceGrade GPS

Part # M GPS BL V2
Available in 10 Hz or 20 Hz

USER MANUAL **Version 2.2**

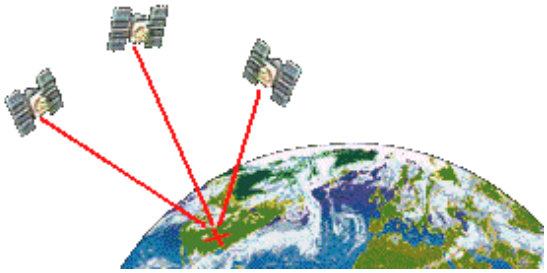
Race Grade GPS

17 October, 2013

Contents

Introduction

Thank you for purchasing a ***RaceGrade GPS*** receiver. This user's guide was written to help you understand how the ***RaceGrade*** 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 GPS device uses an antenna on top of the vehicle 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 the race 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. So it's easy to see the importance of your antenna having a clear line of sight to the satellites in the sky.

The system is a 12 channel receiver, and able to use up to two of the tracked satellites as special geostationary satellites (SBAS) which provide DGPS (differential GPS) via WAAS correction. Therefore the maximum reported satellites in the data will be 10. Differential GPS uses those SBAS satellites to more accurately calculate your position. Positional accuracy goes from 3 meters to under 0.7 meters with Differential GPS.

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 also now 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 has a 10 year life and is not user replaceable. After ten years please contact JGM Automotive Tooling for replacement.

Status LEDs

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

- POWER (red): Unit has power.
- GPS (yellow): GPS signals have been acquired and calculated data is being sent out.
- DIFF (yellow): SBAS differential satellite available.
- DGPS (green): Differential corrections are active, resulting in improved data. This is the light you really want to see on.

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.

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 be changed by sending the unit back to RaceGrade.

CAN Output

The RaceGrade GPS version 2 receive now 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). Simply select the “GPS Async” template for MoTeC devices.

20 Hz Update *Option

This option allows the following four channels to update at a true 20 Hz rate:

- GPS Latitude
- GPS Longitude
- GPS Speed
- GPS Heading

It’s best to buy this option at the time of purchase. If you buy it afterwards, the unit must be sent to RaceGrade for updating.

*** 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 box on soft Velcro, not the hard industrial type or even double sided foam tape.***

Antenna

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 large negative impact on the results from its calculated data.

Normally the best location would be on top of the race car. 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.

It's best to have the correct length specified when ordering.

- GPS signals are easily blocked by electrical noise. 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, the number of satellites does not include the SBAS or WAAS DGPS satellites. So a value of 10 is the maximum possible even though the unit is capable of tracking 12 satellites. Most other GPS units include these in the reported satellites used. Most other GPS units accept multi-path signal and therefore the channel "GPS Sats Used" can not be analyzed to estimate accuracy with any degree of precision.

Setup for SDL, ADL2, ADL3, ACL

For ADL2, SDL or ACL use, 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:

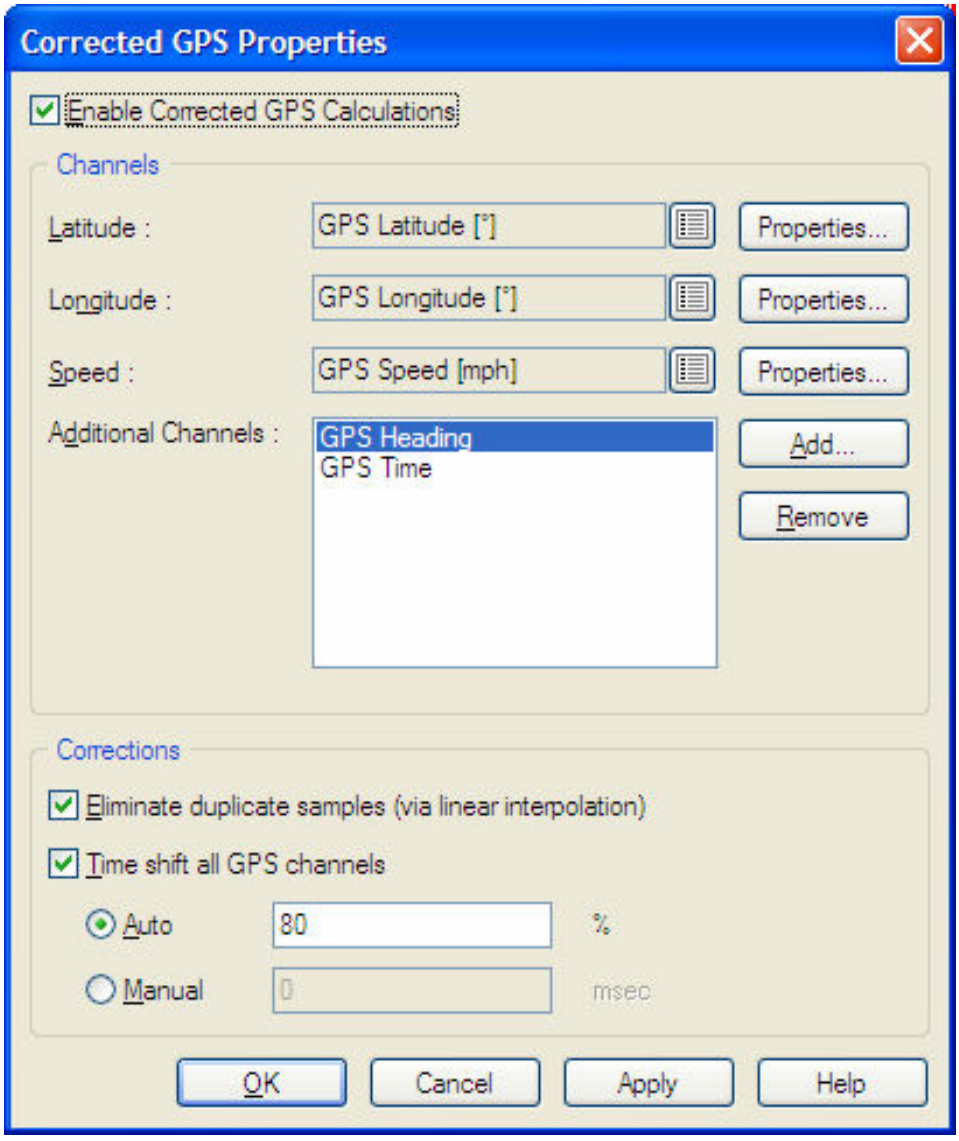
Recommended Logging Rates

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 ADL2, SDL or ACL.



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

12-channel GPS engine.

Horizontal accuracy < 1 meter at 95% with DGPS

Update rate of 10 Hz or optional 20 Hz.

Screw on SMA antenna connector.

57600 kbit/s baud rate, other rates available upon request.

NMEA message output types GGA and RMC, other messages available upon request.

Optional CAN output (bus speed of 1 Mbit/s)

Digital output pulse: 0-5v with 50% duty cycle
94 Hz per 1 m/s
940 Hz per 36 km/h
1933 Hz per 46 mph
1.0638 cm per pulse

(can be connected to inputs which have a 12v pull up resistor but output will still be 0-5v square wave)

Power Supply

Operating Voltage: 6 to 18 Volts DC

Operating Current: 0.380 Amps at 12 Volts

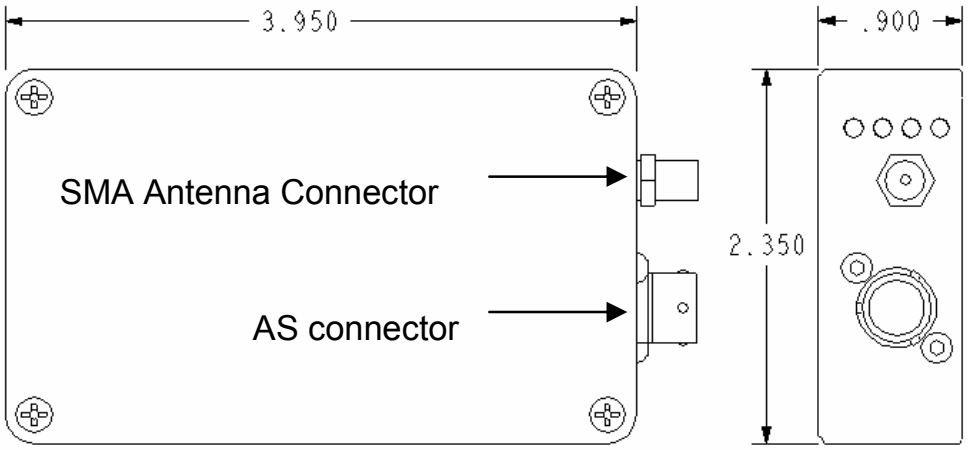
Operating Temperature

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: 160 grams without antenna



Dimensions in inches

Connection

The mating connector is a ASL-606-05SN.

- pin 1 – Ground, negative battery (do not use a 0v line)
- pin 2 – RS-232 Tx, serial data out,
  For ADL2 or ADL3 connect to pin 79
  For SDL connect to pin 34
  For ACL connect to pin 15 or pin 20
- pin 3 – 12 volt supply, 6 to 18 volts allowed
- pin 4 – CAN Low
- pin 5 – CAN High