MoTeC USA GPS

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

USER MANUAL **Version 1.4**

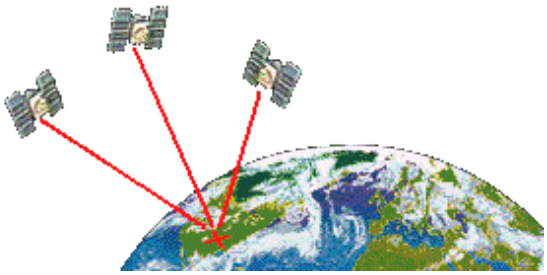
MoTeC USA GPS

15 August, 2008

Contents

Introduction

Thank you for purchasing a ***MoTeC USA GPS*** receiver. This user's guide was written to help you understand how the MoTeC USA 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 60 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 get good results. Anything under 6 satellites is 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, but two of the tracked satellites are special geostationary SBAS which provide DGPS (differential GPS) via WAAS correction. Therefore the maximum reported satellites in the data will be 10. Differential GPS uses those additional satellites to more accurately calculate your position. Positional accuracy goes from 3 meters to under 1 meter 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 30 minutes.

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.

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 MoTeC for updating.

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 MoTeC.

Speed Output Pulse

This output is for devices that can't accept a RS-232 serial input. It provides a 0-5 volt square wave output which can be fed into a digital input on any MoTeC product. The frequency output calibration in different speed units is:

94 Hz per 1 m/s

940 Hz per 36 km/h

1933 Hz per 46 mph

1.0638 cm per pulse

Speed Ready Output

The speed ready output pin is pulled high to 5v when the speed signal is good, and low to 0v when there is not enough data for accurate speed information. The speed output pulse incorporates this speed ready signal to prevent the speed output from floating around to erroneous values when the vehicle is stopped.

Variable Voltage Option

You can choose at the time of order to replace the speed output pulse with a variable voltage output. The speed range should be specified when ordering.

Installation

GPS Receiver

The enclosure is made from 6061 Aluminum alloy. It should be mounted in a safe location, away from electrical noise and vibration. We recommend hook & loop or double sided foam tape. Maximum operating temperature is 70°C or 158°F.

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 calculated data.

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

The antenna has a magnet base to hold itself onto a metal surface. Any extra antenna wire can be zip tied in a back and forth bundle. Do not form a coil with the extra wire or wrap it around anything.

- GPS signals are easily blocked by electrical noise. Keep the antenna 12” away from any electrical device. It should also be more than 6” from any other antennas such as car-to-pit voice radios, telemetry and other GPS antennas.
- 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. 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.
- If you use double sided tape or hook & loop, when removing please be careful not to remove the bottom sticker from the antenna. This sticker has a metal film that help reject false signals and shield it from noise.

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.

Connection

The mating connector is a yellow band AS 610-35SA.
Some early units have the red band AS 610-35SN.

- pin 1 – 12 volt supply, 6 to 18 volts allowed
- pin 2 – Ground, *not 0v but ground or battery negative*
- pin 3 – Speed Ground, *optional, internally connected to Ground*
- pin 4 – Speed Pulse, connects to digital input
- pin 5 – Speed Ready Signal
- pin 6 – N/C
- pin 7 – N/C
- pin 8 – N/C
- pin 9 – Serial Ground, *optional, internally connected to Ground*
- pin 10 – N/C
- pin 11 – RS-232 Tx, serial data out
- pin 12 – N/C
- pin 13 – RS-232 Rx, usually not required

Setup for ADL2 / SDL / 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.

You can optionally hook up the speed output pulse to a digital input or speed input set to hall effect with a custom calibration. The speed output pulse should be logged at 50 Hz. Use a general purpose channel with 1 dps and rename it to "Speed Pulse". The calibration table will contain 2 rows as follows:

0 Hz = 0.0 mph

1933 Hz = 46.0 mph

Setup for M400 / M600 / M800

Wire the speed output pulse into a digital input on the ECU. For the calibration number, use one of the following:

9400 for km/h

15128 for mph

The maximum speed which can be measured on the ECU through the digital input is 675 km/h or 420 mph.

Setup for ADL

The ADL does not offer full 32bit logging of GPS positional data. This limitation prevents the ability to do positional track mapping. Under the communications setup, select the template "GPS for ADL - RMC GGA". You'll be able to log the following channels of information:

	Recommended Logging Rates	
Update Option:	*10 Hz*	*20 Hz*
• GPS Speed	10 Hz	20 Hz
• GPS Heading	10 Hz	20 Hz
• GPS Altitude	10 Hz	10 Hz
• GPS Sats Used	10 Hz	10 Hz
• Fix Status (Obsolete)	10 Hz	10 Hz
• Year, Month, Day	1 Hz	1 Hz
• Minutes, Sec	10 Hz	10 Hz
• Hundredths of Sec	10 Hz	10 Hz

Channels should be logged at their default rate or the rate at which they update.

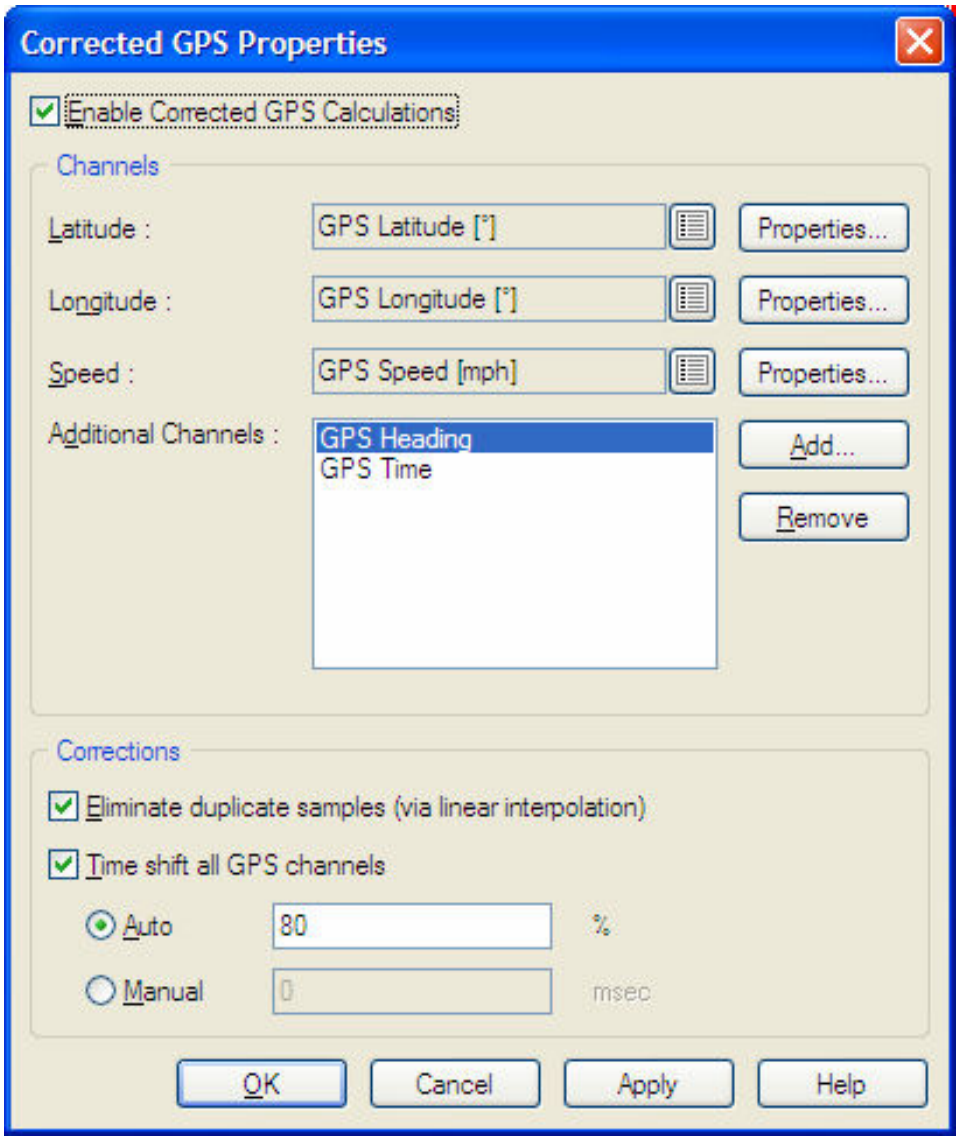
You can optionally hook up the speed output pulse to a digital input or speed input set to hall effect with a custom calibration. The speed output pulse should be logged at 50 Hz. Use a general purpose channel with 1 dps and rename it to "Speed Pulse". The calibration table will contain 2 rows as follows:

0 Hz = 0 mph

1933 Hz = 46 mph

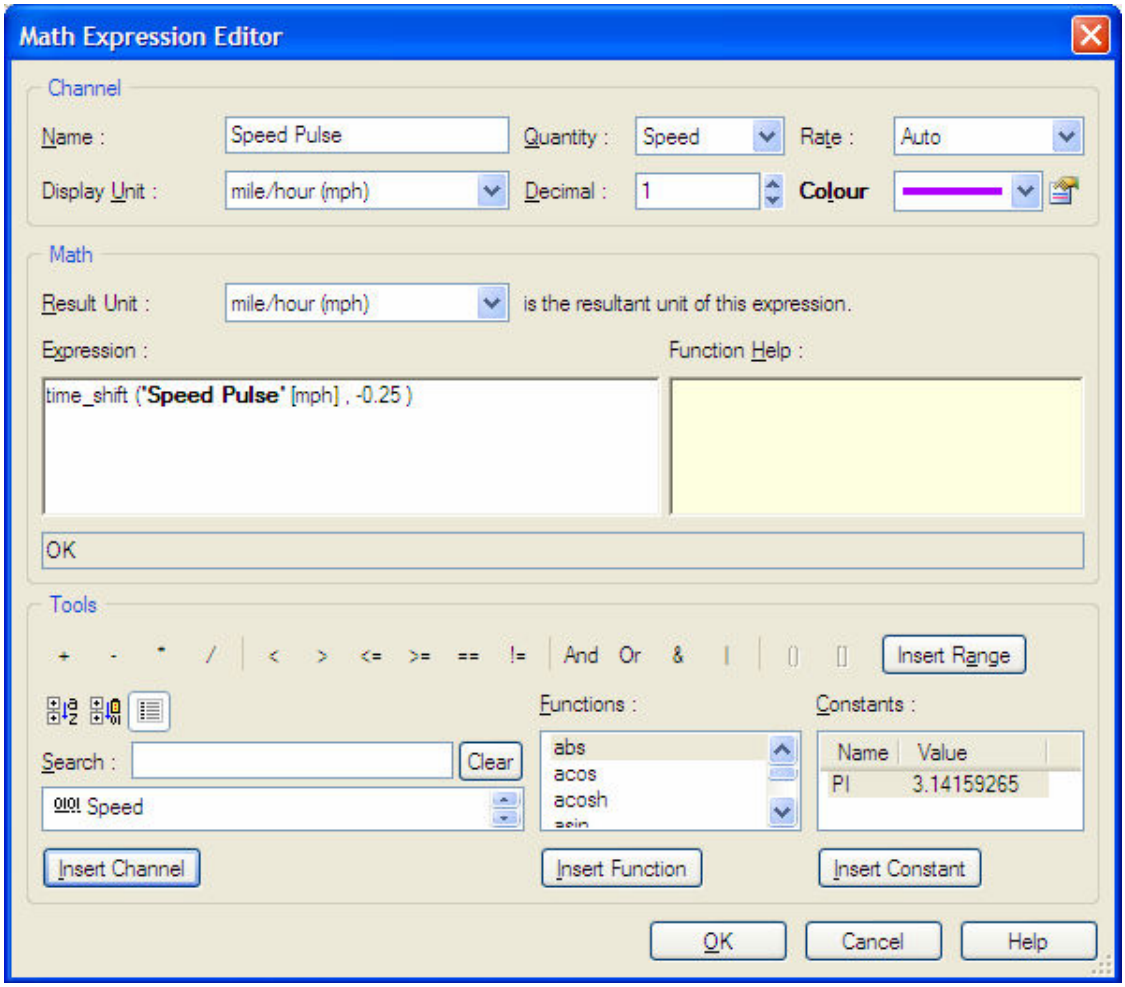
"i2" Analysis Math

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.

The speed output pulse or variable voltage output should not be included in the “Corrected GPS” calculations. It will require a separate time shift function. In “i2” add the following math expression for your speed pulse channel:



For the Motec ADL, the built in “Corrected GPS” function can not be used. All channels streaming through the RS-232 interface should have separate math expressions similar to the above, with a -0.13 second time shift. For the 20 Hz, -0.11 should be used on those channels. The speed output pulse and speed ready output will have a time shift of -0.25 seconds.

Appendix

GPS Engine Specifications

12-channel GPS engine.

Horizontal accuracy < 1 meter at 95%

Update rate of 10 Hz or 20 Hz optional.

Screw on SMA antenna connector.

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

NMEA standard $GPGGA and $GPRMC data, other messages available upon request.

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

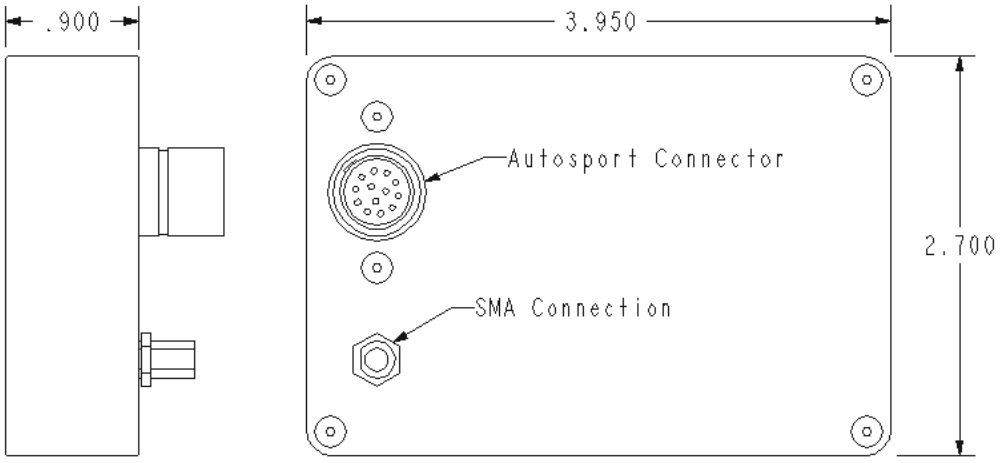
Ambient Temperature Range:	-22°F to 158°F / -30°C to 70°C
Housing Material:	Anodized 6061 Aluminum

Physical

Case Size: 3.95” x 2.7” x 0.9” (excluding connectors)

100 mm x 69 mm x 23 mm (excluding connectors)

Weight: 164 grams without antenna



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- pin 5 – Speed Ready Signal
- pin 6 – N/C
- pin 7 – N/C
- pin 8 – N/C
- pin 9 – Serial Ground, *optional*, internally connected to Ground
- pin 10 – N/C
- pin 11 – RS-232 Tx, serial data out,
  For ADL or ADL2 connect to pin 79
  For SDL connect to pin 34
  For ACL connect to pin 15 or pin 20
- pin 12 – N/C
- pin 13 – RS-232 Rx, usually not required