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| Title | | GPS Beacons and Track Mapping | |
| Approved By | | JA | |
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# Introduction

This document outlines the procedure for using GPS receivers with a MoTeC data logging system.

GPS receivers are becoming more popular in racing due to their ability to capture the global position of your vehicle as Latitude, Longitude and altitude. Logging this data provides the line driven around a race track, making it easy to overlay the driven lines from lap to lap and compare lines through a corner to, for example, entry and exit speeds.

To add to this further, the inside and outside edges of a track can be plotted by logging the GPS data while driving these lines. This data can be used later to show an actual track outline, overlaying the race lines then shows where on the track the vehicle is in relation to the edge and if the driver is using all of the available space to maximise corner speed.

Another use for GPS in motorsport is to create beacon points based on Latitude and Longitude for lap timing. The logging device is configured with one or more sets of coordinates and when the vehicle passes that point a beacon is triggered.

# Scope

This document applies to the following products.

MoTeC logger - ACL v1.30C, ADL2 v4.42T or SDL v1.60E (or later software of any of these devices)

Note: Not compatible with ADL.

i2 standard or i2 Pro v1.02.0019 or later

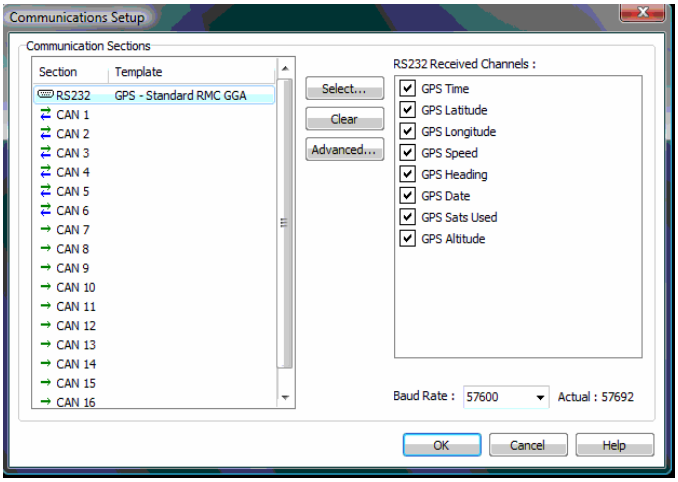
Also requires a GPS receiver that transmits data via RS232 (NMEA messages RMC and GGA)

## Configuration of MoTeC logger for use with GPS

GPS receivers generally transmit data via RS232, providing position and various other data. Channels received include Latitude, Longitude, Altitude, Heading, Speed, Time, Date and Satellites in View. This is the same for ADL2 / SDL Dash Manager and ACL Manager.

To configure your logger:

1. In 'Inputs – Communications' select the RS232 GPS template and set the Baud Rate to match the receiver.
2. Select GPS channels to be received, normally all can remain ticked.




Note: Only Latitude and Longitude are required for track mapping and GPS beacons. GPS Speed is recommended as it can be more accurate than speeds generated from wheels.

3. Log the GPS channels at the same rate as the GPS Receiver transmits.

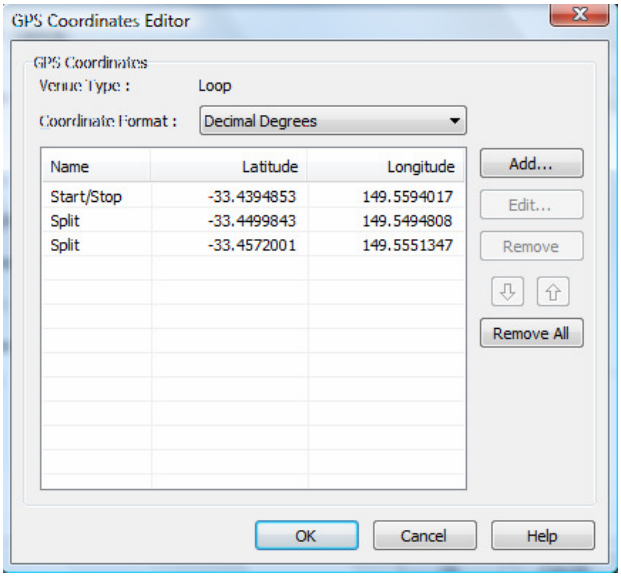
## GPS Beacons

Lap and split Beacons can be triggered using GPS position. There are two methods of setting the point at which the beacons are triggered. One is by entering the GPS coordinates into the configuration and the other is by pressing a button to record the current GPS position. GPS Beacons have the same functionality as other beacon types however are not quite as accurate due to the drift inherent in the GPS itself. Vehicle speed must be above 20kmh to trigger a GPS beacon.

### Setup for Coordinate method

1. Within Dash/ACL Manager, open the configuration file or use 'Online – Get Configuration' to download it from the Dash/ACL.
2. Select 'Calculations – Lap Time and Number' from the menu.
3. Select GPS as the beacon type and coordinate as the trigger.
4. Set the Detection Radius as described below and Ignore time.
5. The coordinates can be set by pressing Edit on the Beacon setup page. These Latitude and Longitude points are venue specific so are saved for each venue. Check your Venue details are correct in 'File – Edit Details' and the 'Venue' tab.
6. A number of points may be entered by pressing Add. Each venue includes Start and Stop point/s and optionally multiple split points. Google Earth can be used to find the Latitude and Longitude of a particular track however the maps are not always accurate and the coordinates should be checked at the track. Logging a few laps and reading the Latitude and Longitude from i2 is preferred.

   **Note:** SDL does not support split beacons so only uses the Start/Stop point for a Loop or Crossover Venue. Else the Start and the Stop points for an Open venue type.
7. Click OK and Send the configuration to the Dash/ACL.




Every time the vehicle comes within the detection radius of an entered point, a beacon is triggered as it passes the centre line, as long as the Beacon Ignore time has passed.

### Setup for Button Method

1. Within Dash/ACL Manager, open the configuration file or use 'Online – Get Configuration' to download it from the Dash/ACL.
2. Assign the Beacon channel to an input under 'Inputs – Input Pins'. Select the pin the beacon button is connected to, preferably a switch or Analogue Temp input.
3. Press Select and in the search tab type 'beacon'. Select the Beacon channel and press OK.
4. Press Change to calibrate the button. This must be set so the status of the beacon channel is '0' when not pressed and '1' when pressed, normally 'Active Low'. This can be checked in 'Online – Monitor Channels'. Press OK and Close the Input Pins Setup.

Alternatively the Beacon channel can be set to a condition or similar so that a combination of existing buttons/inputs can be used (eg: Next Line and Previous Line Buttons pressed together can trigger the beacon).

5. Select 'Calculations – Lap Time and Number' and on the beacon setup select GPS as the Beacon Type and Push-Button as the Trigger.
6. Set the Detection Radius as described below and Ignore Time.
7. Click OK and Send the configuration to the Dash/ACL.

When out on the track and the button is pressed, the Latitude and Longitude are recorded and a beacon triggered. Every time this point is passed from then on a beacon is triggered. Two separate points can be recorded for an "open" type venue. If the venue type is Loop or Crossover, one press of the button records the Start/Stop point, while two presses of the button within one second records a Split point. If the venue type is Open, one press records the Start point and two presses within one second records the Stop point.

The recorded points can be viewed in menu 'Online – View – GPS Beacon Definitions'. This information can be useful to enter into the Venue details for use next time at the same track.

Note: SDL does not support split beacons so a double press sets the Start/Stop point when the venue type is Loop or Crossover.

### *Detection Radius*

A detection radius can be set with either GPS Beacon method so that when the vehicle comes within the specified distance of the beacon point, the beacon is triggered as it passes the centre line. This radius is made bigger to allow for wide tracks where the vehicle can cross the point at a wide distance. Or smaller to allow for tracks where the back part of the track comes close to the start/finish line and could be triggered if set too big.

## Logging Inner and Outer Lines of a Track

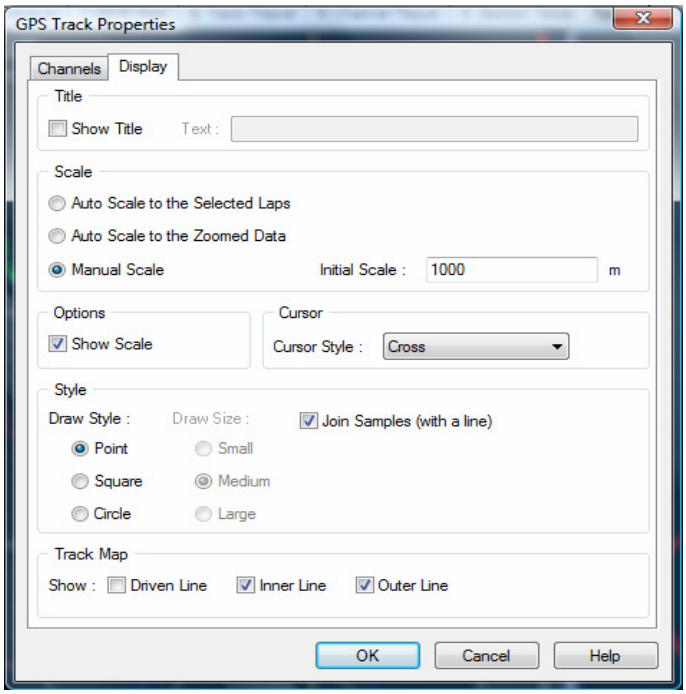
To setup the inner and outer lines of a track, first the lines need to be logged. Preferably using the race car or another car with the GPS receiver in the same position, drive moderately on the track keeping to the very edge of the track for one entire lap, overlapping at least a few meters with the starting point. Switch sides of the track and repeat. The start points do not need to be in the same place or at the start/finish line/beacon.

The lines recorded are not the actual track edges but will show the point at which a wheel leaves the track when the racing line crosses the inner or outer lines. The track drawn is actually the width of the car narrower. Other methods of recording the inner and outer lines may be used like walking or riding a bike on the track edge but this will give actual track edges and racing lines will not represent the position of the car on the track, especially if the GPS receiver is not in the middle of the race car.

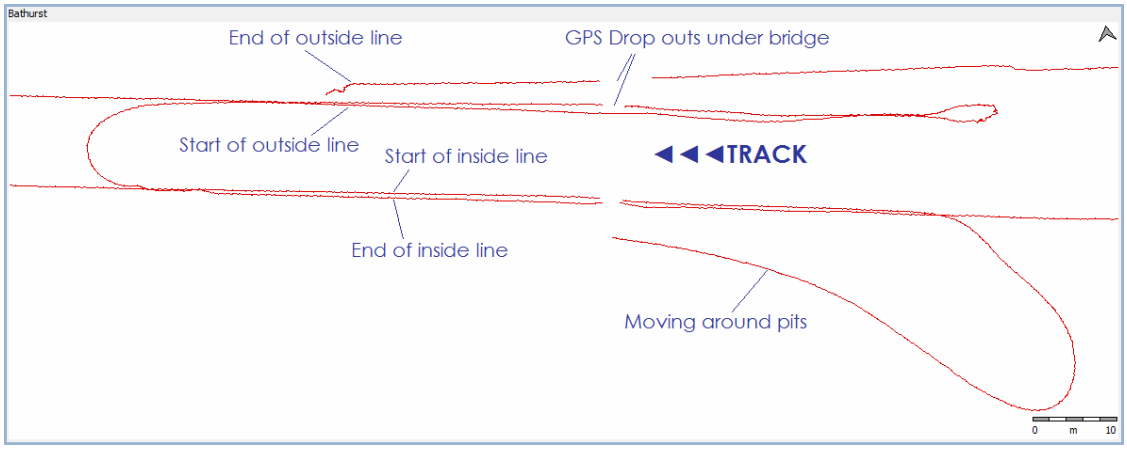
### *Setting up Inner and Outer Lines in i2*

To setup a GPS Track with inner and outer lines correctly, take the following steps.

1. Within i2, open the log file that contains the inner and outer lines, logged as previously described.
2. Add a GPS Track to your worksheet by right clicking on a blank area and select 'Add – GPS Track'. You may need to 'unlock' the layout in i2 standard: uncheck the menu item 'Layout - Lock Layout', then add a new worksheet, or move or delete items if using an existing worksheet.
3. Remove any logged beacons using 'Tools - Lap Editor', and check under 'Tools – Details' for the correct Venue name and edit as required. You should see the logged GPS lines for the entire data on the GPS Track.
4. Right click the GPS Track and select 'Properties'. On the Display tab, select to show Inner and Outer lines but not the Driven line. Change the scale to Manual Scale and click OK.



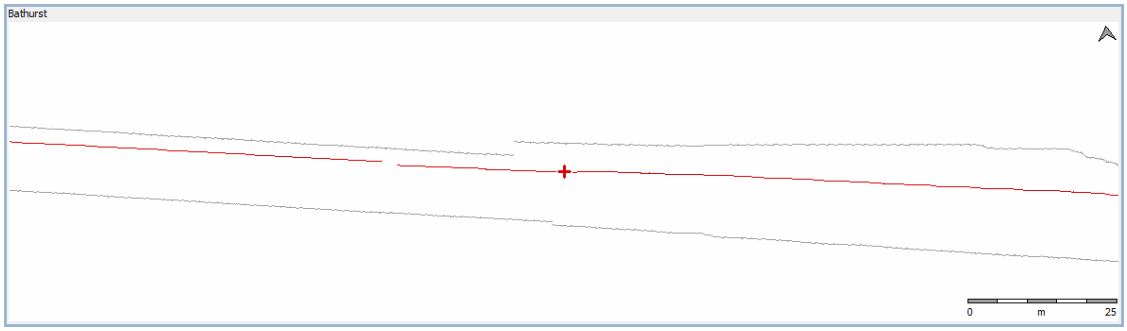

5. On the Track, click a point on the inside line where the lines overlap. Zoom into the Track with the UP and DOWN cursor keys to pick an appropriate point.
6. Select 'Data - Insert Beacon' at that point. Parts of your lines may disappear when inserting beacons, this is because the tracks shown are of the selected lap. Select the lap that corresponds to lines you need to see.
7. Pick the point next to your first point at the other end of the inside lap and insert another beacon. This should give you one full lap of the inside line marked as lap 1.
8. Repeat step 6 and 7 for the outside line giving you the full inside and outside lines as separate laps. You can check your lines at this point by selecting a lap to view and zooming in and out.




*Example of points to pick to insert beacon.*
*Note the drift from start to end of the outside line in this example.*

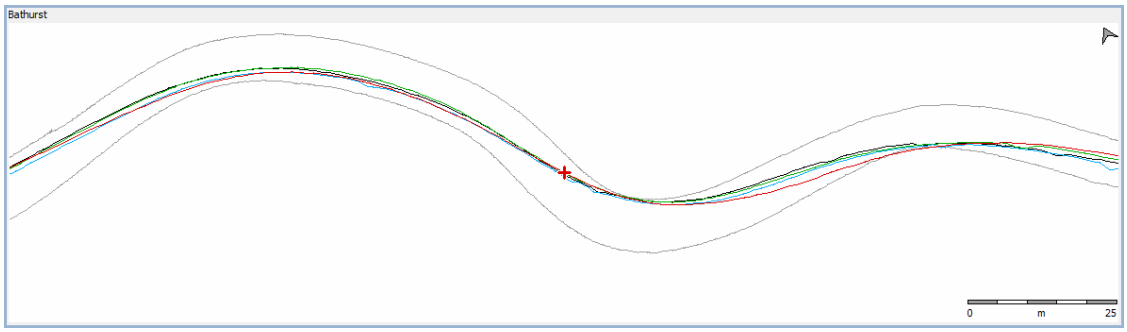
9. From the menu bar select 'Tools - Track Editor' then 'Generate Track' from the Track Editor window. Pick GPS as the method and the lap number of the inside line. Set the Lat and Long channels if logged as different names to the default channel names shown. Select the Type as Inside Line and press OK. Note: The inside line does not appear on the map in the Track Editor.

10. Go back to Generate Track. Select the lap number that corresponds to the outside line, select outside lap and press OK. Click OK on the Track Editor. You should now have a grey inner and outer line of the track on the GPS track map (and a red line as selected data).




*Inside and Outside Lines completed, red line is selected data.*

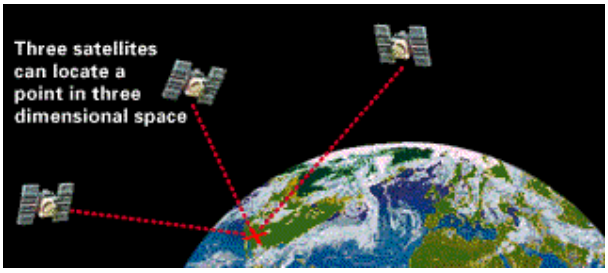
11. Open a log file from the race and find a good clean lap of normal race lines and correct beacon points.
12. Go back to 'Tools - Track Editor' and click on 'Generate Track'.
13. Select the lap number corresponding to the good lap, then select Drive Line and click OK. This time the map is shown in the Track Editor and sections can be divided up as required by clicking on 'Generate Sections'. Using this line as the actual track gives the correct lap distances and beacon points. Your GPS Track is now complete.




*GPS Track map showing inside and outside lines (grey), race line (red) and three race line overlays (black, green and blue).*

## How GPS works

While GPS is a very good way of accurately measuring position, depending on circumstances there are possible inaccuracies. To understand the cause of possible problems with GPS, first we need to understand a bit about how it works.




The receiver picks up radio signals sent by 24 satellites that orbit the earth. The signals sent contains time information that is synchronised between satellites with atomic clocks. Based on how long the satellites' transmission takes to reach it, the receiver can calculate its distance from the satellite. Using a minimum of 4 satellites, it can then triangulate its own position on the earth with error checking. The more satellites that a receiver can see, the more accurate the calculated position.

To calculate the position accurately, the GPS receiver must receive the signals directly, and not signals that are bounced off other objects. To reduce this possibility, the signals that are sent are weak so that bounced signals are too weak to pick up. Without a direct line of site to the sky (or minimal blockage), receivers are prone to 'drops outs' due to the signals being blocked by trees, buildings or bridges, and this cannot be helped.

Another problem with GPS is drift, the difference in reported position and actual position. This is caused by inaccuracies in the amount of time the signals take to reach the receiver caused by the earth's varying atmosphere, and the gravitational pull from the sun and moon on the satellites orbit. Drift can be up to 20m or more but generally around 5m. It can be corrected by using a fixed GPS receiver that calculates the amount of error at any time and sends this data to the moving GPS receiver, this is call DGPS. Accuracy down to a few centimetres can be achieved using this method but is also very expensive.

As time goes by, receivers are improving and becoming more accurate with better error checking and cheaper DGPS systems, so it won't be long before GPS drift is cut to within a meter at a price everyone can afford.