

Application Note

Creating Routes Using the GPSG-1000

Creating a route using the GPSG-1000 can be as simple as selecting two of the pre-set waypoints in memory, setting the speed and altitude to a desired rate, and running the simulation. Routes that require changes of direction speed, or altitude may need much more consideration to create a workable solution. This Application Note will discuss some of the methods and considerations for creating more complicated routes.

Routes are created from a series of Route Points. These may be selected from the list of pre-set waypoints or generated from scratch. Either way, the settings in each Route Point and the transition from one to another must meet the parameters of the selected Motion Model and the GPSG-1000 internal GPS algorithms.

It is advisable to use the Unlimited Motion Model when creating a new route. Once the route is established then the motion model may be changed to reflect the type of simulation you desire. Be aware that changes in Motion Model may result in warning messages or route errors. Adjustments in speed, acceleration, or even distance between Route Points may be necessary. See the GPSG-1000 Setup, Motion screen for Motion Model attributes.

Creating a Route is one method of generating a GPS simulation. For information on creating Trajectory files or KML files see the published Application Notes for these subjects.



Route Points

A Route Point is made up of 8 elements:

Name: Entered via alpha-numeric keypad. Pre-set waypoints may be renamed, created Route Points must be named. The user will define the name or naming convention for the Route / Route Point

Latitude: May be displayed in DD.DD°, DD°MM.MM', or DD°MM'SS.SS" format. Entered by sliding scale or by numeric keypad in decimal format.

Longitude: May be displayed in DDD.DD°, DD°MM.MM', or DD°MM'SS.SS" format. Entered by sliding scale or by numeric keypad in decimal format.

Altitude: Displayed in meters or feet. 0 – 18,288 M in 1 M steps. Entered by numeric keypad.

Speed: Displayed in Km/h or Mph. 0 – 1850.745 Km/h in .001 Km/h steps. Entered by numeric keypad.

Latitude, Longitude, Altitude, and Speed define the positional and movement characteristics of the simulation as it moves through the Route Point. The following Route Point settings define how the simulation will achieve the above settings. The speed of Route Point #1 is relevant only if the Route Loop Property is set to ON. It will then define the speed at which the simulation will proceed from the end of the route back to Route Point # 1.

Altitude Rate: Displayed in meters/min or feet/min. +/- 1800 m/min in .001 m/min steps. Entered by numeric key pad. The Altitude Rate is an absolute value; it may be entered as a positive or negative value for user information, but will be ignored by the GPSG-1000 for climb or descend values. Care must be taken that the altitude selected may be reached using the Altitude Rate; the simulation will run but may not reach the desired altitude if the rate is too low. The GPSG-1000 will note a route error.

Acceleration: Displayed in m/s² or ft/s². +/-100 m/s² in .001 m/s² steps. Entered by numeric keypad. Acceleration is an absolute value; it may be entered as a

positive or negative value for user information, but will be ignored by the GPSG-1000 for acceleration or deceleration rates. Care must be taken that the speed selected may be reached using the Acceleration; the simulation will run but may not reach the desired speed if the rate is too low. The GPSG-1000 will note a route error.

Turn Radius: Displayed in meters or feet. 1 – 100,000 m in .001 m steps. Entered by numeric keypad. Minimum Turn Radius of a body in motion may be calculated by the following equation:

$$\text{Turn Radius} = \frac{\text{Speed}^2 \text{ (in m/s)}}{\text{Acceleration}^2 \text{ (in m/s)}}$$

Speed in m/s may be calculated as:

$$\text{Turn Radius} = \frac{\text{Speed}^2 \text{ (in m/s)}}{\text{Acceleration}^2 \text{ (in m/s)}}$$

The separation between Route Points should be greater than four times the Turn Radius.

If the entered Turn Radius is too short to achieve the next Route Point the GPSG-1000 will note a route error and make an automatic correction.

As a simulation passes a Route Point, it will look to the next Route Point and attempt to reach the speed and altitude of the next Route Point as fast as the Altitude Rate and Acceleration of the next Route Point allows. If the mis-match between desired speed and acceleration, or speed and turn radius are too extreme, the GPSG-1000 simulation engine may over-shoot or wander as it attempts to fulfil the route. Intermediate Route Point should be used to prepare or adjust for changes in direction or altitude.

Creating a Route

A synopsis of the route that will be created in this exercise is as follows.

Route Point 1: The route will start at an altitude of 0 meters. For this purpose Route Point 1 is a marker position the simulation will move slowly from to allow

the GPS receiver to obtain a 3d position solution before the route fully commences. This is done for convenience of the equipment used at the factory for demonstration purposes. Depending on the circumstances of users GPS equipment and the specific route being created this may not be suitable or necessary.

Route Point 2: The simulation will proceed at a slow pace from Route Point 1 to Route Point 2 (10 Km/h). Route Point 2 is set to an altitude of 0 meters.

Route Point 3: The simulation proceeds to climb to an altitude of 50 meters at a speed of 200 Km/h.

Route Point 4: The simulation turns to the south west and proceeds to climb to an altitude of 300 meters at a speed of 350 Km/h.

Route Point 5: The simulation turns more westerly and continues to climb to 1000 meters and accelerate to 500 Km/h.

Route Point 6: The simulation turns to the south west and starts to descend to 750 meters and decelerate to 300 Km/h.

Route Point 7: The simulation turns to the south and continues to descend to 550 meters and decelerate to 200 Km/h.

Route Point 8: The simulation turns east and descends to 400 meters and decelerates to 75 Km/h.

Route Point 9: The simulation turns north and continues to descend to 200 meters and decelerate to 50 Km/h.

Route Point 10: The simulation continues north descending to 20 meters and decelerating to 25 Km/h.

Route Point 11: The simulation descends to 0M and decelerates to 10 Km/h.

Route Point 12: The simulation stops.

Given the start point and end points of the route are both at ground level and at very low speed, this route would be unsuitable for Loop testing.

This route is an example of how to put together a route with varying speeds, altitudes and accelerations. It is not a realistic flight simulation. Information on programming WAAS approaches or playing back GPS receiver recorded routes is covered in other application notes.

Step by Step Instructions

From the side menu select Route. See figure 1

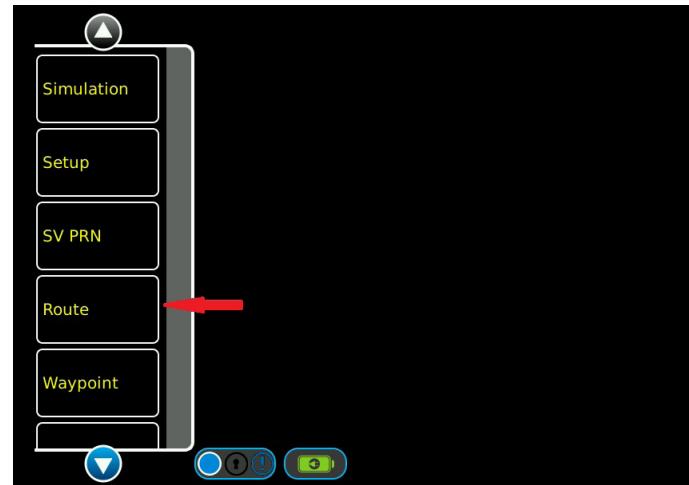


Figure 1. Side Menu.

The Route page opens and any Route that was selected earlier or the Default Route will be displayed. To clear the Route screen select Clear All. This will give you a blank route to start with. See Figure 2



Figure 2. Route Screen, Clear

To add Route Points select Add. See Figure 3.

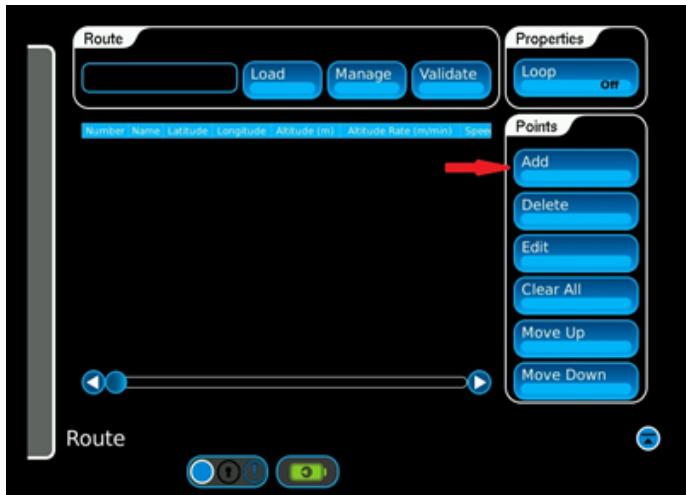


Figure 3. Route Screen Add

The Route Edit screen appears and you are shown the Stored Waypoints. In this case we are creating Route Points so select Next. See Figure 4.



Figure 4. Route Edit Screen, Next

The Route Point Edit screen appears. In this screen we are going to create the first Route Point. The route created for this tutorial will change altitudes, directions and speeds. See Figure 5.

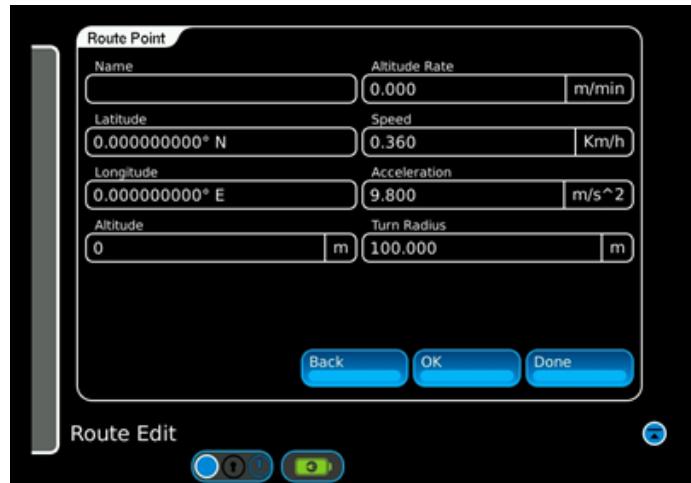


Figure 5. Route Edit Screen

Select the Name field. An alpha numeric key pad will appear. For this exercise we will name the Route Point KCIT01. Enter the name and select Enter. See Figure 6.

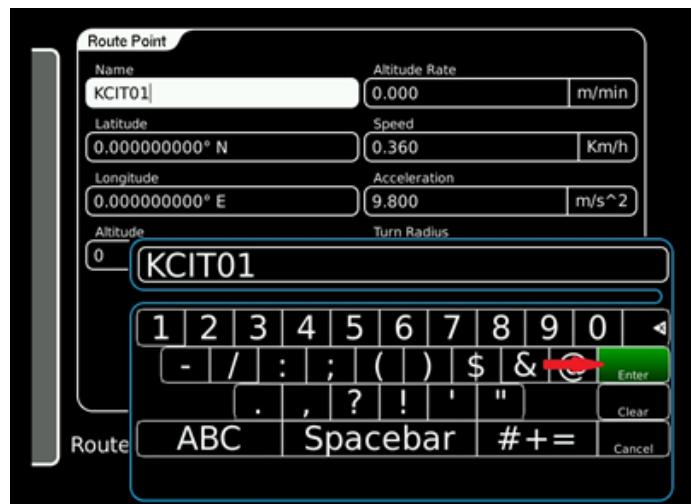


Figure 6. Route Edit Screen, Name



Select the Latitude field. Using the button, select the method and display type you desire, to enter the Route Point Latitude. Repeat this for the Longitude field. See figure 7.

Figure 7. Route Edit Screen, Lat / Long

Select the Altitude field. A numeric keypad will appear. Enter the desired altitude and press Enter. Repeat for the remaining fields. See Figure 8.

Figure 8. Route Edit Screen, Altitude

When all fields have been filled select Done. See Figure 9.

Figure 9. Route Edit Screen, Done

In the Route screen you can see the Route point that

was added. Repeat the entry steps for all remaining Route Points. See figures 10 and 11.

Figure 10. Route Screen, Route Point Added

Figure 11. Route Screen, Route Complete

At the top of the screen select Validate. If the route can be run as a simulation a green text bubble will appear stating the Route is Valid. If there are errors significant enough that the route will not run a red text bubble will appear stating that the Error(s) found in route. See Figure 12.

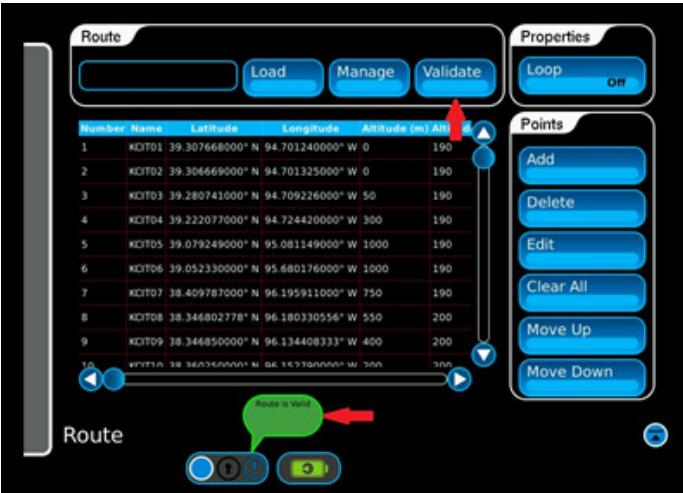


Figure 12. Route Screen, Route Validated

If a route has warnings, you can display them by touching



the button. This will show a message window with the last system message. By touching the message window the message log will appear. Routes that are judged valid may be run even with warning messages. To eliminate the warnings the Route Point parameters may be changed to suit. See figure 13. This figure is from a different route in memory.

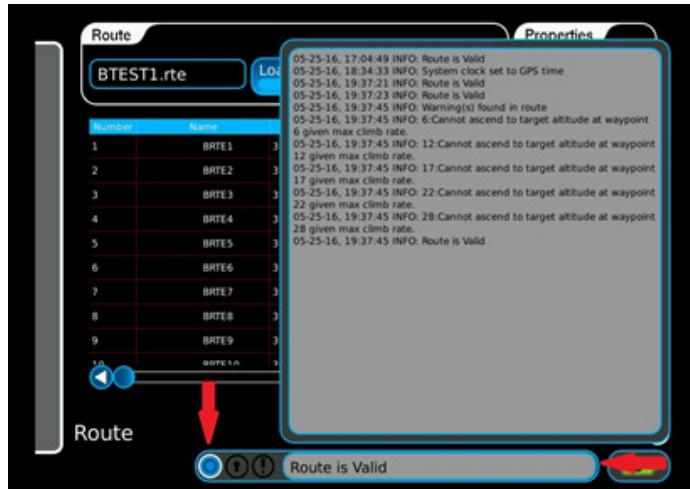


Figure 13. Route Screen, Warning Messages

If a route has significant errors that produce the red text bubble "Error(s) found in route" those messages will also be seen in the message log. Routes with errors will not run. The errors must be resolved. See Figure 14. This figure is from a route in memory with intentional fatal errors.



Figure 14. Route Screen, Errors in Route

Once the route is complete and save it by selecting Manage. A window will open with the route directory. Select the File name field and enter the file name via the alpha-numeric keypad. See Figure 15.

Figure 15. Route Screen, Manage Route

The route is now created and stored in memory. It may now be run as a Dynamic Simulation.

The created .rte file looks like this:

```

<Route>
  <Waypoint Longitude="-94.70124" MaxAcceleration="10" MaxClimbRate="3.16666666666667" Name="KCIT01"
    Latitude="39.307668" Altitude="0" TargetSpeed="0.277777777777778" TurningCircleRadius="1"/>
  <Waypoint Longitude="-94.701325" MaxAcceleration="32" MaxClimbRate="3.16666666666667"
    Name="KCIT02" Latitude="39.306669" Altitude="0" TargetSpeed="2.77777777777778"
    TurningCircleRadius="1"/>
  <Waypoint Longitude="-94.709226" MaxAcceleration="32" MaxClimbRate="3.16666666666667"
    Name="KCIT03" Latitude="39.280741" Altitude="50" TargetSpeed="55.5555555555556"
    TurningCircleRadius="97"/>
  <Waypoint Longitude="-94.7244199999999" MaxAcceleration="32" MaxClimbRate="3.16666666666667"
    Name="KCIT04" Latitude="39.222077" Altitude="300" TargetSpeed="97.2222222222223"
    TurningCircleRadius="295"/>
  <Waypoint Longitude="-95.081149" MaxAcceleration="32" MaxClimbRate="3.16666666666667"
    Name="KCIT05" Latitude="39.079249" Altitude="1000" TargetSpeed="138.8888888888889"
    TurningCircleRadius="603"/>
  <Waypoint Longitude="-95.680176" MaxAcceleration="32" MaxClimbRate="3.16666666666667"
    Name="KCIT06" Latitude="39.05233" Altitude="1000" TargetSpeed="138.8888888888889"
    TurningCircleRadius="603"/>
  <Waypoint Longitude="-96.195911" MaxAcceleration="32" MaxClimbRate="3.16666666666667" Name="KCIT07"
    Latitude="38.409787" Altitude="750" TargetSpeed="83.333333333334" TurningCircleRadius="218"/>
  <Waypoint Longitude="-96.1803305555556" MaxAcceleration="9.800000000000001"
    MaxClimbRate="3.3333333333333" Name="KCIT08" Latitude="38.3468027777778" Altitude="550"
    TargetSpeed="55.5555555555556" TurningCircleRadius="97"/>
  <Waypoint Longitude="-96.1344083333334" MaxAcceleration="32" MaxClimbRate="3.3333333333333"
    Name="KCIT09" Latitude="38.34685" Altitude="400" TargetSpeed="20.833333333334"
    TurningCircleRadius="14"/>
  <Waypoint Longitude="-96.15279" MaxAcceleration="32" MaxClimbRate="3.3333333333333" Name="KCIT10"
    Latitude="38.36025" Altitude="200" TargetSpeed="13.8888888888889" TurningCircleRadius="7"/>
  <Waypoint Longitude="-96.1456589999999" MaxAcceleration="32" MaxClimbRate="3.3333333333333"
    Name="KCIT11" Latitude="38.375551" Altitude="25" TargetSpeed="6.94444444444445"
    TurningCircleRadius="2"/>
  <Waypoint Longitude="-96.14628" MaxAcceleration="32" MaxClimbRate="3.16666666666667" Name="KCIT12"
    Latitude="38.385175" Altitude="0" TargetSpeed="2.77777777777778" TurningCircleRadius="1"/>
</Route>
```

For information on GPSG-1000 file types and importing or exporting them see the GPSG-1000 Operation Manual and the published Application Notes on these subjects.

For demonstration purposes Cobham uses a Ublox EVK GPS Evaluation Kit. Below is the completed route as displayed in the Ublox u-center software.

