



SGNav

GPS NAVIGATION SYSTEM & FLIGHT PATH DATA ACQUISITION

SGL has developed a flexible and simple navigation system, **SGNav**, specifically designed for the airborne geophysical environment. The system uses the high accuracy of the GPS system and a navigation computer to allow precise navigation in three dimensions anywhere in the world.

SGL's **SGNav** system steers the crew from their point of departure to the start of a specific line, then directs them along the survey line, to the next line or any other specified line, and then can direct them back to the airport at the end of the flight. While flying along a line the **SGNav** system shows the pilots the correct x, y location to fly, as well as showing them the correct altitude to fly based on a number of altitude sensors.

This position information is presented to the pilots on a small flat panel LCD screen mounted in the pilots' line of vision. The **SGNav** screen also shows the pilots the altitude profile of the line and their position on this profile. **SGNav** can also be used with a pre-planned drape surface to guide the aircraft's altitude in the survey area.

The **SGNav** system registers the aircraft flight path by recording the raw GPS measurements. The raw measurements, together with the measurements taken at a ground station, are processed post-mission using SGL's kinematic GPS positioning program GPSoft. GPSoft uses a robust U-D factorized Kalman filter to process double-differenced observations, which provides extremely accurate differentially corrected GPS flight path recovery.

■ BASIC SGNav SYSTEM COMPONENTS

1) Airborne GPS receiver and aircraft antenna

- NovAtel GNSS (Global Navigation Satellite System) incorporates GPS and other satellite positioning systems, sampling rate of 20 Hz
- In-flight positional accuracy of better than 5 m
- Post processed positional accuracy of better than 1 m
- Power requirement: nominal 10–35 VDC 10 watts

2) Airborne navigation control and flight path recording computer

- Provides three dimensional steering information on a graphical display
- Records the position of the aircraft and the raw GPS satellite range data necessary for post-mission differential processing at up to 10 Hz
- The system can also perform real-time differential GPS position corrections for 2–5 m accuracy in-flight
- Used to send UTC time and/or timing pulses to a camera or data acquisition system
- Data are recorded on removable storage media which are dependable in high vibration environments
- The computer, designed for airborne use, operates on 28 VDC, 60 watts
- RS232, optionally ARINC or RS422 data port
- Great circle, UTM or rhumb line flying

3) Post-flight software

- Enables the crew to list or view the recorded GPS flight path positions
- This software can be run on any PC computer, including the airborne computer
- GPSoft – post-mission differential GPS positioning software

4) GPS reference station for differential GPS position solutions

To take advantage of the maximum accuracy of the GPS system, the following is needed at the ground reference station site:

- NovAtel GNSS receiver
- Standard PC computer
- SGL's reference station recording software to record the data from the receiver

■ RAW GPS VS REAL-TIME CORRECTED GPS

SGL conducted an extensive study to compare actual flight paths flown using raw GPS data, and flight paths flown using real-time corrected GPS data, against the pre-planned track and altitude. Based on this study, we are convinced that there is no longer any advantage in using real-time differential corrections, and there are many surveys where it will actually hamper the crew's ability to follow the pre-planned flight lines. We therefore prefer not to use real-time differential corrections for navigation, and we continue to differentially correct all of our GPS post-flight using a local GPS reference station. Differential GPS receivers can be used to provide real-time differential corrections, if required.

We have reviewed various GPS receivers available and have concluded that the NovAtel GNSS receivers are most suitable for this application. These multi-frequency receivers incorporate GPS and other satellite positioning systems. Real-time differential navigation is also possible with the **SGNav** system.

The recorded reference GPS measurements, together with measurements recorded on the aircraft, are processed after the flight using SGL's GPS software kinematic differential GPS positioning program.

■ NAVIGATION AND FLIGHT PATH RECOVERY SYSTEMS

The **SGNav** navigation system can be configured to provide pilot guidance in any of the following manners:

- i. Raw GPS data
- ii. Real-time DGPS with corrections from a satellite service

NAVIGATION PARAMETERS DISPLAYED		
DTS distance to start of line	TTE time to end of line	XHT up/down error
DTE distance to end of line	SPD aircraft ground speed	TTW time to waypoint
DTK desired heading	TMG track made good	DTW distance to waypoint
TTS time to start of line	TKE track error (heading minus desired heading)	DFW distance from waypoint

In addition to this, the number of satellites being used, PDOP and various other parameters of the GPS system are displayed.

■ SGN_{av} PERFORMANCE SPECIFICATIONS

Differentially Corrected Position:

The accuracy achieved after differential correction is better than 1 m.

Single Receiver Position:

The accuracy achieved without differential correction is better than 5 m.

These specifications are given assuming that the GPS receivers are tracking a minimum of four satellites, with typical satellite geometry.