



***SDCM Functionality of GeoS-3 Family of GNSS
Modules: Validation Results***

February 2016

- There are three LUCH satellites in orbit at present;
- Only two of the three, specifically, the LUCH satellites assigned PRNs 125 and 141, periodically transmit the signals;
- These two satellites transmit both GLONASS and GPS corrections. Note that they also transmit Message 0, which indicates the satellites are operating in test mode currently;
- To override the SDCM test mode, the module's FW has been temporarily modified ("test mode bypass") so to enable using SDCM corrections.

PREREQUISITES

GeoS-3/3M firmware has been recently updated for supporting SDCM. The latest FW version v3.249 is able to receive and process SDCM signals transmitted by LUCH SVs.

OBJECTIVES

To validate SDCM functionality in different conditions – using both live and simulated signals.

INSTRUMENTAL TOOLS

- GeoSDemo3[®] software: logging output NMEA data;
- GeoStat[®] software: calculation of position accuracy metrics. GeoStat[®] is a PC-based post-processing software tool designed by Geostar;
- GeoStat[®] operates with NMEA data files and evaluates the following characteristics: total/valid position fix count, average HDOP, average number of SVs used in position fix, horizontal/vertical accuracies, ground speed accuracy.

TEST CONDITIONS: LIVE SIGNALS

- Antenna is placed on the roof of a building, open sky visibility;
- Antenna coordinates are a priori known with decimeter-level accuracy;
- Data collection time: ~24 hours;
- Output NMEA data are used for further analysis;
- The option “Kalman filtering” is off.

TEST CONDITIONS: SIMULATOR

- Simulator: GSS6700 (SPIRENT);
- All signal levels -130dBm;
- The module has been configured for GLONASS-only since the simulator is able to generate only GLONASS corrections in SDCM mode;
- ~5m errors have been intentionally induced to the orbit parameters of all SVs;
- Data collection time: ~8 hours;
- Output NMEA data are used for further analysis;
- The option “Kalman filtering” is off.

Standalone (SDCM off)

GeoStat v1.0

Settings

Mode: Static Dynamic

C/N0 chart: for all SVs for SVs used in fix

GGA GNS

calculate for reference file ignore CS

Reference point coordinates:
 Latitude: 55.84350
 Longitude: 37.53752
 Altitude (ellipsoid): 201.79

NMEA data input file: r4CU\data\160226-0623_geos3_10.nm
 NMEA data reference file: D:\Projects\Geos-3\Тесты\SDCM 3.249

Start

Results

| Parameter | Value | Units |
|---|----------------|-------|
| Total fix count, input/reference | 31009 | |
| Valid fix count, input/reference | 99.9 | % |
| HDOP, average, input/reference | 0.8 | |
| Number of SVs used in fix, average, input/reference | 13.5 | |
| Latitude error, M/RMS | 0.480 / 1.009 | m |
| Longitude error, M/RMS | -0.989 / 1.151 | m |
| Altitude error, M/RMS | -2.738 / 1.427 | m |
| Ground speed error, M/RMS | 0.000 / 0.002 | m/s |
| Horizontal accuracy, 95%/50% | 4.161 / 2.375 | m |
| Altitude accuracy, 95%/50% | 5.593 / 3.927 | m |
| Ground speed accuracy, 95%/50% | 0.004 / 0.002 | m/s |

Differential (SDCM on)

GeoStat v1.0

Settings

Mode: Static Dynamic

C/N0 chart: for all SVs for SVs used in fix

GGA GNS

calculate for reference file ignore CS

Reference point coordinates:
 Latitude: 55.84350
 Longitude: 37.53752
 Altitude (ellipsoid): 201.79

NMEA data input file: CU\data\160226-0623_geos3_05dif.nm
 NMEA data reference file: D:\Projects\Geos-3\Тесты\SDCM 3.249

Start

Results

| Parameter | Value | Units |
|---|----------------|-------|
| Total fix count, input/reference | 30996 | |
| Valid fix count, input/reference | 99.9 | % |
| HDOP, average, input/reference | 0.8 | |
| Number of SVs used in fix, average, input/reference | 13.5 | |
| Latitude error, M/RMS | -0.033 / 1.087 | m |
| Longitude error, M/RMS | -1.036 / 0.730 | m |
| Altitude error, M/RMS | -0.186 / 1.377 | m |
| Ground speed error, M/RMS | 0.000 / 0.000 | m/s |
| Horizontal accuracy, 95%/50% | 3.655 / 2.127 | m |
| Altitude accuracy, 95%/50% | 2.941 / 1.334 | m |
| Ground speed accuracy, 95%/50% | 0.000 / 0.000 | m/s |

Standalone (SDCM off)

GeoStat v1.0

Settings

Mode
 Static Dynamic

C/N0 chart
 for all SVs for SVs used in fix

GGA GNS

calculate for reference file ignore CS

Reference point coordinates
 Latitude
 Longitude
 Altitude (ellipsoid)

NMEA data input file

NMEA data reference file

Start

Results

| Parameter | Value | Units |
|---|-----------------|-------|
| Total fix count, input/reference | 8378 | |
| Valid fix count, input/reference | 100.0 | % |
| HDOP, average, input/reference | 0.8 | |
| Number of SVs used in fix, average, input/reference | 13.3 | |
| Latitude error, M/RMS | 1.287 / 1.748 | m |
| Longitude error, M/RMS | 1.108 / 1.455 | m |
| Altitude error, M/RMS | 14.135 / 1.840 | m |
| Ground speed error, M/RMS | 0.000 / 0.000 | m/s |
| Horizontal accuracy, 95%/50% | 6.247 / 3.594 | m |
| Altitude accuracy, 95%/50% | 17.815 / 15.669 | m |
| Ground speed accuracy, 95%/50% | 0.000 / 0.000 | m/s |

Differential (SDCM on)

GeoStat v1.0

Settings

Mode
 Static Dynamic

C/N0 chart
 for all SVs for SVs used in fix

GGA GNS

calculate for reference file ignore CS

Reference point coordinates
 Latitude
 Longitude
 Altitude (ellipsoid)

NMEA data input file

NMEA data reference file

Start

Results

| Parameter | Value | Units |
|---|----------------|-------|
| Total fix count, input/reference | 8384 | |
| Valid fix count, input/reference | 100.0 | % |
| HDOP, average, input/reference | 0.8 | |
| Number of SVs used in fix, average, input/reference | 13.3 | |
| Latitude error, M/RMS | -0.540 / 0.832 | m |
| Longitude error, M/RMS | 0.756 / 1.094 | m |
| Altitude error, M/RMS | 1.374 / 1.832 | m |
| Ground speed error, M/RMS | 0.000 / 0.000 | m/s |
| Horizontal accuracy, 95%/50% | 3.679 / 2.075 | m |
| Altitude accuracy, 95%/50% | 5.037 / 2.900 | m |
| Ground speed accuracy, 95%/50% | 0.000 / 0.000 | m/s |

| Parameter | Live Signals | | Simulator | |
|-----------------------------|--------------|-----------|------------|-----------|
| <i>SDCM</i> | <i>off</i> | <i>on</i> | <i>off</i> | <i>on</i> |
| Horizontal accuracy, 95%, m | 4.161 | 3.655 | 6.247 | 3.679 |
| Altitude accuracy, 95%, m | 5.593 | 2.941 | 17.815 | 5.037 |

1. For real signals, using SDCM yields approx. 15-25% improvement in positioning accuracy. This is similar to the level of improvement achievable with WAAS or EGNOS when using a GPS-only module (or a GNSS module running in GPS-only mode);
2. Unlike WAAS and SBAS, SDCM provides correction data for both GPS and GLONASS. This makes GNSS modules such as GeoS-3 especially beneficial in terms of positioning accuracy when running them within SDCM coverage.



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