Appendices

Appendix A: The RINEX navigation file format

Appendix B: Statistics for the orbit solutions

Appendix C: Statistics for the orbit solutions for the satellites as viewed from station 'tmgo'

Appendix D: The errors in the orbits of the satellites

Appendix E: The errors in the orbits of the satellites as viewed from station 'tmgo'

Appendix A: The RINEX navigation file format

The format of the RINEX (Receiver Independent Exchange Format) Version 2 is described in an document [Ref. 5]. The next two pages show the description of the navigation message file that contains the orbital parameters of the GPS satellites.

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+--------------------------------------------------------------------------+
|                              TABLE A3                                     |
|            NAVIGATION MESSAGE FILE - HEADER SECTION DESCRIPTION           |
+--------------------+---------------------------------------+-----------+
|   HEADER LABEL     |            DESCRIPTION                 |   FORMAT  |
|  (Columns 61-80)   |                                       |           |
+--------------------+---------------------------------------+-----------+
|RINEX VERSION / TYPE| - Format version (2)                  | I6,14X,   |
|                    | - File type ('N' for Navigation data) |  A1,19X   |
+--------------------+---------------------------------------+-----------+
|PGM / RUN BY / DATE | - Name of program creating current file|   A20,    |
|                    | - Name of agency  creating current file|   A20,    |
|                    | - Date of file creation               |   A20     |
+--------------------+---------------------------------------+-----------+
* |COMMENT            | Comment line(s)                       |   A60     |*
+--------------------+---------------------------------------+-----------+
* |ION ALPHA          | Ionosphere parameters A0-A3 of almanac | 2X,4D12.4 |*
|                    | (page 18 of subframe 4)               |           |
+--------------------+---------------------------------------+-----------+
* |ION BETA           | Ionosphere parameters B0-B3 of almanac | 2X,4D12.4 |*
+--------------------+---------------------------------------+-----------+
* |DELTA-UTC: A0,A1,T,W| Almanac parameters to compute time in UTC|3X,2D19.12,|*
|                    | (page 18 of subframe 4)               |    2I9    |
|                    | A0,A1: terms of polynomial            |           |
|                    | T    : reference time for UTC data     |           |
|                    | W    : UTC reference week number.      |           |
|                    |        Continuous number, not mod(1024)!|          |
+--------------------+---------------------------------------+-----------+
* |LEAP SECONDS       | Delta time due to leap seconds        |    I6     |*
+--------------------+---------------------------------------+-----------+
|END OF HEADER       | Last record in the header section.    |    60X    |
+--------------------+---------------------------------------+-----------+
```

Records marked with * are optional

```
+--------------------------------------------------------------------------+
|                              TABLE A4                                     |
|            NAVIGATION MESSAGE FILE - DATA RECORD DESCRIPTION              |
+--------------------+---------------------------------------+-----------+
|   OBS. RECORD      | DESCRIPTION                           |   FORMAT  |
+--------------------+---------------------------------------+-----------+
|PRN / EPOCH / SV CLK| - Satellite PRN number                |    I2,    |
|                    | - Epoch: Toc - Time of Clock          |           |
|                    |         year          (2 digits)      |    5I3,   |
|                    |         month                         |           |
|                    |         day                           |           |
|                    |         hour                          |           |
|                    |         minute                        |           |
|                    |         second                        |   F5.1,   |
|                    | - SV clock bias       (seconds)       |  3D19.12  |
|                    | - SV clock drift      (sec/sec)       |           |
|                    | - SV clock drift rate (sec/sec2)      |           |
+--------------------+---------------------------------------+-----------+
```

```
+------------------+---------------------------------------+-----------+
| BROADCAST ORBIT - 1| - IODE Issue of Data, Ephemeris     | 3X,4D19.12 |
|                  | - Crs                   (meters)      |           |
|                  | - Delta n               (radians/sec) |           |
|                  | - M0                    (radians)     |           |
+------------------+---------------------------------------+-----------+
| BROADCAST ORBIT - 2| - Cuc                   (radians)    | 3X,4D19.12 |
|                  | - e Eccentricity                      |           |
|                  | - Cus                   (radians)     |           |
|                  | - sqrt(A)               (sqrt(m))     |           |
+------------------+---------------------------------------+-----------+
| BROADCAST ORBIT - 3| - Toe Time of Ephemeris             | 3X,4D19.12 |
|                  |                         (sec of GPS week) |         |
|                  | - Cic                   (radians)     |           |
|                  | - OMEGA                 (radians)     |           |
|                  | - CIS                   (radians)     |           |
+------------------+---------------------------------------+-----------+
| BROADCAST ORBIT - 4| - i0                    (radians)    | 3X,4D19.12 |
|                  | - Crc                   (meters)      |           |
|                  | - omega                 (radians)     |           |
|                  | - OMEGA DOT             (radians/sec) |           |
+------------------+---------------------------------------+-----------+
| BROADCAST ORBIT - 5| - IDOT                  (radians/sec)| 3X,4D19.12 |
|                  | - Codes on L2 channel                 |           |
|                  | - GPS Week # (to go with TOE)         |           |
|                  |   Continuous number, not mod(1024)!   |           |
|                  | - L2 P data flag                      |           |
+------------------+---------------------------------------+-----------+
| BROADCAST ORBIT - 6| - SV accuracy           (meters)    | 3X,4D19.12 |
|                  | - SV health             (MSB only)    |           |
|                  | - TGD                   (seconds)     |           |
|                  | - IODC Issue of Data, Clock           |           |
+------------------+---------------------------------------+-----------+
| BROADCAST ORBIT - 7| - Transmission time of message      | 3X,4D19.12 |
|                  |         (sec of GPS week, derived e.g.|           |
|                  |       from Z-count in Hand Over Word (HOW)|       |
|                  | - spare                               |           |
|                  | - spare                               |           |
|                  | - spare                               |           |
+------------------+---------------------------------------+-----------+
```