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SALP

RINEX DORIS 3.0

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For	DS2	DS4	DS5	DH2	TP	ENVISAT	JASON1	DCY	LTA-SIRAL
Application to									
For	SMM	SALP				SARAL	JASON2	CRY2	
Application to		X				X	X	X	

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SUMMARY

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0.1	**08/09/2006**	**§ 1 control character, § 6.3 to 6.6 example, § 6.7 no reference to APID numbers, § 6.14 precision numeration, § 8 formatting** **SALP-DM-M-391-CN rev.1**	
0.2	**23/01/2007**	**§ 6.14, § 6.17, § 6.18 & § 6.19 inserted, § 7.2.1, A1 and A3 modified, for pseudo-range unit modification. Take into account the minutes of the meeting referenced SALP-CR-MA-EA-15632-CN du 23/10/06** **SALP-DM-M-405-CN rév.1**	
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ABBREVIATIONS

Sigle	Definition

APPLICABLE AND REFERENCE DOCUMENTS

Reference	Document title
	DA1.
	DR1.

TBC AND TBD LIST

TBC/TBD	Paragraph	Brief description
		None

CONTENTS

1. PURPOSE

This document describes the RINEX DORIS 3.0 format.

It is used for the DGXX exchange between the raw data from telemetry, processed by the DORIS Control Centre. This ASCII format is used as the file format output of the DCC.

Each line ended by LF character, Unix compressed, Hatanaka format.

This format is based on the RINEX V3.0, **"The Receiver Independent Exchange Format"**, 2006/02/01 description.

2. APPLICABILITY

This document is applicable for the output of the 1.0 processing of the Doppler telemetry of the DGXX instruments.

3. INTRODUCTION

The "Receiver Independent Exchange Format" RINEX has been developed by the Astronomical Institute of the University of Berne for the easy exchange of the GPS data to be collected during the large European GPS campaign EUREF 89. This format has since become a world-wide standard for the exchange of GNSS data. It offers the advantage of being widely accepted and understood. It is assumed herein that the reader is familiar with this format. If not please refer to the description available at the IGS data centers.

The RINEX format can be used for DORIS as it makes little assumption about the actual content of the data file, but only constrains the formatting of the data. Thus it can be easily adapted to contain data other that GNSS.

This proposed RINEX DORIS format is an (unofficial) extension of the basic RINEX format which is satellite based rather than station based.

Reference RINEX, The **Receiver Independent Exchange Format, Version 3.00, February 1st, 2006**.

4. GENERAL FORMAT DESCRIPTION

The DORIS RINEX format consists of one ASCII file which contains both the space-based observation data and the ground-based meteorological data collected at the stations and relayed by the satellite:

As for GNSS RINEX, the file consists of a header section and a data section. The header section contains global information for the entire file and is placed at the beginning of the file. The header section contains header labels in columns 61-80 for each line contained in the header section. These labels are mandatory and must appear exactly as given in these descriptions and examples.

DORIS is basically running on its own proper time which is constantly linked to TAI. Time tags are given in instrument time, clock offsets are given between instrument time and TAI, not GPS time. In order to remove possible misunderstandings and ambiguities, the header records "TIME OF FIRST OBS" and (if present) "TIME OF LAST OBS" in DORIS observation files contain a time system identifier defining the system that all time tags in the file are referring to: "TAI" to identify TAI time.

The actual format descriptions are given in the Tables at the end of the paper.

DORIS data in RINEX files are stored in chronological order.
At a given time a record contains as many lines as there are observations. Observations are referenced by a station code composed of the letter D followed by a 2-digit integer. A table of correspondence between these codes, the standard four letter station identifiers, the station names, DOMES numbers and a few technological parameters is given in the header section.

A station appears only once in the observation list even though it can be tracked by many channels simultaneously. In generating RINEX files, information from all the channels which track a same station are combined to provide phase continuity over the longest possible time interval.

5. DEFINITION OF THE OBSERVABLES

DORIS observables include three fundamental quantities that need to be defined:

Time, Phase, and Pseudo-Range.

6. HEADER SECTION DESCRIPTION

6.1. RINEX VERSION / TYPE

The RINEX version is the 3.00
The label D is used for DORIS RINEX TYPE

6.2. PGM / RUN BY / DATE

The format of the generation time of the RINEX files stored in the second header record
PGM is the source of the processing.
RUN BY represents the entity which performs the data processing.
DATE is now defined to be

yyyymmdd hhmmss zone

zone: 3 – 4 character code for the time zone

It is recommended to use **UTC** as time zone. Set **zone** to **LCL** if local time was used with unknown local time system code.

6.3. SATELLITE NAME

This field defines the satellite which carries the receiver which performed the measurements.

JASON-2
CRYOSAT-2

6.4. COSPAR NUMBER

The COSPAR number of the satellite. Exp: “2001-055A“

6.5. MARKER TYPE

In order to indicate the nature of the marker a **MARKER TYPE** header record has been defined:

GEODETIC	Earth-fixed, high-precision monumentation
NON_GEODETIC	Earth-fixed, low-precision monumentation
SPACEBORNE	Orbiting space vehicle
AIRBORNE	Aircraft, balloon, etc.
WATER_CRAFT	Mobile water craft
GROUND_CRAFT	Mobile terrestrial vehicle
FIXED_BUOY	"Fixed" on water surface
FLOATING_BUOY	Floating on water surface
FLOATING_ICE	Floating ice sheet, etc.
GLACIER	"Fixed" on a glacier
BALLISTIC	Rockets, shells, etc
ANIMAL	Animal carrying a receiver
HUMAN	Human being

Table 1: Proposed marker type keywords

The record is required except for **GEODETIC** and **NON_GEODETIC** marker types.

Attributes other than **GEODETIC** and **NON_GEODETIC** will tell the user program that the data were collected by a moving transmitter. The inclusion of a "start moving antenna" record (event flag 2) into the data body of the RINEX file is therefore not necessary. Event flags 2 and 3 are still necessary to flag alternating kinematic and static phases of a transmitter.

Users may define other project-dependent keywords

For DORIS measurements this field must be set to SPACEBORNE, because all the measurements are performed onboard satellites.

6.6. OBSERVER / AGENCY

These fields define the processing identification and the agency providing the RINEX file.
Exp. “STILO   CNES”

6.7. REC # / TYPE / VERS

REC defines the DORIS chain used (chain1 or chain2), exp. “CHAIN1”.

TYPE defines the DORIS instrument type; exp. “DGXX”

VERS defines the software version used on board DORIS/DIODE, exp. “1.00”.

6.8. ANT # / TYPE
The antenna number is “DORIS”
The antenna type is “STAREC”

6.9. APPROX POSITION XYZ
For the processing of data collected by receivers on a vehicle the following information must be provided in this record:

Antenna position (position of the antenna reference point) in a body-fixed coordinate system of the satellite: **APPROX POSITION X/Y/Z**

6.10. CENTER OF MASS
The center of mass of the vehicle (for space borne receivers): **CENTER OF MASS: XYZ**, defined at the beginning of the mission.
The evolving of the inertia and the center of mass of the satellite has to be provided by separate file in the same body-fixed coordinate system.

6.11. SYS / # / OBS TYPES

The label D is used for DORIS measurements.

Types
- L for phase
- C for pseudo-range

New types are introduced for DORIS measurements:
- W for the power level received at each frequency, unit dBm
- F for the relative frequency offset of the receiver’s oscillator ($f-f_0$) / f_0, unit 10^{-11}
- P for ground pressure at the station, unit 100 Pa (mBar)
- T for ground temperature at the station, unit degree Celsius
- H for ground humidity at the station, unit percent

6.12. TIME OF FIRST OBS

DOR is for the DORIS system time. The DORIS time is the on-board receiver proper time (monitored with respect to TAI).

6.13. SYS / SCALE FACTOR

The label D is used for DORIS measurements
A factor of 100 has to be used to divide stored pseudo-range data.
Only the C1 and C2 observation types are involved.

6.14. L2 / L1 DATE OFFSET

This value represents the constant shift between the date of the 400MHz phase measurement and the date of the 2GHz phase measurement.

By convention, this value is positive if the measurement of phase 400 MHz is performed after the measurement of phase 2 GHz. The unit is the microsecond.

6.15. # OF STATIONS

It represents the number of stations, for which observations are stored in the file.

6.16. STATION REFERENCE

This is a list of information about the stations used in the data records of the file.
Each station is described once by:

An internal identifier, as Dxx
The station name (acronym and complete name)
The DOMES number
A station type
A station frequency shift factor (K)

S1 frequency shift = 543*5E6*3/4*87*K/5/2^26
U2 frequency shift = 107*5E6*3/4*87*K/5/2^26

The stations numbers xx are defined chronologically depending of their order of appearance in the data record processing.

6.17. # TIME REF STATIONS

This parameter is the number of the time reference stations in the DORIS RINEX product.

6.18. TIME REF STATION

This field gives the three parameters here after :

- The beacon reference identity is made by the “D” character and an the internal number of this beacon
- The difference between the station reference time and the TAI reference time at the date defined in the TIME REF STAT DATE field. The unit is the micro second
- The shift of the Time beacon reference at date defined in the TIME REF STAT DATE field. The unit is 1 E-14 second/second.

6.19. TIME REF STAT DATE

This date corresponds to the day of the first measurement performed on the first time reference beacon in the DORIS RINEX product, at 00h 00mn 00s.

7. DATA RECORD DESCRIPTION

7.1. EPOCH / OFFSETS:

The timing of events such as phase sampling and pseudo-range acquisition are given in the receiver time scale.

The L2 / L1 Date offset is measured with respect to the 2 GHz that is to say to L1 .

This epoch is by construction the instrument time of the event corrected for instrumental delays, so that it is the time at which the event happened at the phase center of the antenna.

The TAI time of these events can be obtained by adding the Receiver clock offset to the epoch.

The Receiver clock offset flag positioned to 1, indicates that the receiver clock offset is computed from an extrapolation of the receiver clock model.

The Receiver clock offset flag positioned to 0, indicates that the receiver clock offset is computed from a polynomial model of the receiver clock offsets based on the data in the file measurements.

7.2. OBSERVATIONS

The observation record includes 10 measurements, 2 phases, 2 pseudo-ranges, 2 received power levels, the on-board oscillator relative frequency offset, and the 3 meteorological data (pressure, temperature, humidity).
These 10 values are written on 2 lines of 5 measurements each.
Flags are added to each data type.
Phase 2 Ghz flags:
- Flag11=1 2 GHz central frequency measurement
- Flag12=1 discontinuity of 2 GHZ measurement

Phase 400 MHz flags:
- Flag21=1 400 MHz central frequency measurement
- Flag22=1 discontinuity of 400 MHZ measurement

Pseudo-range 2 GHz flags:
- Flag31 not used
- Flag32=1 Unit processing number

Pseudo-range 400 MHz flags:
- Flag41= not used
- Flag42=1 Unit processing number

Power 2 GHz flags:
- Flag51=1 station on restart mode
- Flag52=0-7 station warming period

Power 400 MHz flags:
- Flag61=1 station on restart mode
- Flag62=0-7 station warming period

Relative frequency shift flags:
- Flag71 not used
- Flag72 not used

Pressure flags:
- Flag81 not used
- Flag82=1 invalid pressure measurement

Temperature flags:
- Flag91 not used
- Flag92=1 invalid temperature measurement

Humidity flags:
- Flag101 not used
- Flag102=1 invalid humidity measurement

7.2.1. PSEUDO-RANGE

The pseudo-range is the distance from the station antenna to the satellite antenna including transmitter and receiver clock offsets (and other biases, such as tropospheric and ionospheric delays):

In the DORIS system stations are not synchronized, so the pseudo-range reflects the behavior of the free running station clock. However, the DORIS system contains a few time reference stations; These stations contain frequency standards that ensure a low short-term noise and long term variations in the time of these stations are permanently monitored with respect to TAI. Pseudo-ranges for these stations are corrected for long term drifts with respect to TAI. Pseudo-ranges from these stations reflect the small short-term fluctuations of the station clocks, and they reference TAI on average.

The pseudo-range is stored in units of 0.01 kilometers.
The stored pseudo-range observations have to be divided by a factor 100 before use, in order to be compliant with kilometer pseudo-range unit for DORIS.

The observables are not corrected for external effects like atmospheric refraction, etc.

7.2.2. PHASE

DORIS DGXX receivers measure the unambiguous received phase over a pass. at two frequencies.
The phase measurement does not contain any systematic contribution from intentional offsets of the transmitter or receiver oscillators leading to non zero beat frequencies.

8. THE EXCHANGE OF DORIS RINEX FILES:

A naming convention similar to that of GPS files can be adopted:

ssssdddf.yyt

ssss:	4-character satellite designator for observation data
ddd:	day of the year of first record
f:	file sequence number within day
0:	file contains all the existing data of the current day
yy:	year
t:	file type:
O:	Observation file

Similarly GPS naming conventions for observation files compressed using the Hatanaka file compression scheme can be used.

REFERENCES

Gurtner, W., RINEX format description

8.1. OBSERVATION CODES

The new signal structures for GPS and Galileo make it possible to generate code and phase observations based on one or a combination of several channels: Two-channel signals are composed of I and Q components, three-channel signals of A, B, and C components. Moreover a wideband tracking of a combined E5a + E5b frequency tracking is possible. In order to keep the observation codes short but still allow for a detailed characterization of the actual signal generation the length of the codes is increased from two (Version 1 and 2) to three by adding a signal generation attribute:

The observation code **tna** consists of three parts:

- **t** : observation type: **C** = pseudorange, **L** = carrier phase, **D** = doppler, **S** = signal strength)
- **n** : band / frequency: **1**, **2**,…,**8**
- **a** : attribute: tracking mode or channel, e.g., **I**, **Q**, etc

Examples:

- **L1C:** C/A code-derived L1 carrier phase (GPS, Glonass)
  Carrier phase on E2-L1-E1 derived from C channel (Galileo)
- **C2L:** L2C pseudorange derived from the L channel (GPS)

For Galileo the band/frequency number **n** does not necessarily agree with the official frequency numbers: **n** = 7 for E5b, **n** = 8 for E5a+b.

In the next table we have introduced the 2 DORIS frequencies.

System	Freq. Band	Frequency	Channel or Code	Observation Codes			
				Pseudo Range	Carrier Phase	Doppler	Signal Strength
GPS	L1	1575.42	C/A	C1C	L1C	D1C	S1C
			P	C1P	L1P	D1P	S1P
			Z-tracking and similar (AS on)	C1W	L1W	D1W	S1W
			Y	C1Y	L1Y	D1Y	S1Y
			M	C1M	L1M	D1M	S1M
			codeless	--	L1N	D1N	S1N
	L2	1227.60	C/A	C2C	L2C	D2C	S2C
			L1(C/A)+(P2-P1) (semi-codeless)	C2D	L2D	D2D	S2D
			L2C (M)	C2S	L2S	D2S	S2S
			L2C (L)	C2L	L2L	D2L	S2L
			L2C (M+L)[1]	C2X	L2X	D2X	S2X
			P	C2P	L2P	D2P	S2P
			Z-tracking and similar (AS on)	C2W	L2W	D2W	S2W
			Y	C2Y	L2Y	D2Y	S2Y
			M	C2M	L2M	D2M	S2M
			codeless	--	L2N	D2N	S2N
	L5	1176.45	I	C5I	L5I	D5I	S5I
			Q	C5Q	L5Q	D5Q	S5Q
			I+Q	C5X	L5X	D5X	S5X
Glonass	G1	1602+k*9/16 k=0…13 or -7...+6	C/A	C1C	L1C	D1C	S1C
			P	C1P	L1P	D1P	S1P
	G2	1246+k*7/16	C/A (Glonass M)	C2C	L2C	D2C	S2C
			P	C2P	L2P	D2P	S2P
Galileo	E2-L1-E1	1575.42	A PRS	C1A	L1A	D1A	S1A
			B OS/CS/SoL	C1B	L1B	D1B	S1B
			C no data	C1C	L1C	D1C	S1C
			B+C	C1X	L1X	D1X	S1X
			A+B+C	C1Z	L1Z	D1Z	S1Z
	E5a	1176.45	I OS	C5I	L5I	D5I	S5I
			Q no data	C5Q	L5Q	D5Q	S5Q
			I+Q	C5X	L5X	D5X	S5X
	E5b	1207.140	I OS/CS/SoL	C7I	L7I	D7I	S7I
			Q no data	C7Q	L7Q	D7Q	S7Q

[1] Example: Trimble NetRS and Septentrio PolaRx2C track L2C on the combined code M+L, therefore attribute **X** has to be used for these observables.

			I+Q	C7X	L7X	D7X	S7X
	E5a+b (AltBOC)	1191.795	I	C8I	L8I	D8I	S8I
			Q	C8Q	L8Q	D8Q	S8Q
			I+Q	C8X	L8X	D8X	S8X
	E6	1278.75	A PRS	C6A	L6A	D6A	S6A
			B CS	C6B	L6B	D6B	S6B
			C no data	C6C	L6C	D6C	S6C
			B+C	C6X	L6X	D6X	S6X
			A+B+C	C6Z	L6Z	D6Z	S6Z
SBAS	L1	1575.42	C/A	C1C	L1C	D1C	S1C
	L5	1176.45	I	C5I	L5I	D5I	S5I
			Q	C5Q	L5Q	D5Q	S5Q
			I+Q	C5X	L5X	D5X	S5X
DORIS	S1	2036.25		C1	L1	-	W1
	U2	401.25		C2	L2	-	W2

Table 1: RINEX Version 3 observation codes

Antispoofing (AS) of GPS: True codeless GPS receivers (squaring-type receivers) use the attribute N. Semi-codeless receivers tracking the first frequency using C/A code and the second frequency using some codeless options use attribute **N**. Z-tracking under AS or similar techniques to recover pseudo-range and phase on the "P-code" band use attribute **W**. Y-code tracking receivers use attribute **Y**.

8.2. OBSERVATION DATA RECORDS

Apart from the new observation code definitions the most conspicuous modification of the RINEX format concerns the observation records. As the types of the observations and their order within a data record depend on the satellite system, the new format should make it easier for programs as well as human beings to read the data records. Each observation record begins with the satellite number **snn**, the epoch record starts with special character **>**. It is now also much easier to synchronize the reading program with the next epoch record in case of a corrupted data file or when streaming observation data in a RINEX-like format.

For the following list of observation types for the four satellite systems **G,S,E,R,D**

```
G    5 C1P L1P L2C C2C S2C                                    SYS / # / OBS TYPES
R    2 C1C L1C                                                SYS / # / OBS TYPES
E    2 L1B L5I                                                SYS / # / OBS TYPES
S    2 C1C L1C                                                SYS / # / OBS TYPES
D   10  L1  L2  C1  C2  W1  W2   F   P   T   H                SYS / # / OBS TYPES
```

Table 8: Example for a list of observation types

the epoch and observation records look as follows:

```
> 2006 03 24 13 10 54.0000000  0  7      -0.123456789210
G06  23619095.450      -53875.632 8   -41981.375 5  23619112.008          24.158
G09  20886075.667      -28688.027 9   -22354.535 6  20886082.101          38.543
G12  20611072.689       18247.789 9    14219.770 8  20611078.410          32.326
R21  21345678.576       12345.567 5
R22  22123456.789       23456.789 5
```

```
E11      65432.123 5      48861.586 7
S20   38137559.506      335849.135 9
           ***** for DORIS *****                              COMMENT
> 2006 06 18 13 10 54.0000000  0  1      -20.123456789
D07      75906.427       14962.329 -2040839286.36  -2040837607.52         -126.750
         -114.850         1884.736        1013.000          27.300          45.000
```

Table 9: Example for observation data records

APPENDIX: RINEX FORMAT DEFINITIONS AND EXAMPLES

A 1 GNSS OBSERVATION DATA FILE - HEADER SECTION

Records marked with * are optional

```
 +--------------------------------------------------------------------------------+
 |                                  TABLE A1                                      |
 |          GNSS OBSERVATION DATA FILE - HEADER SECTION DESCRIPTION              |
 +--------------------+-------------------------------------------+------------+
 |    HEADER LABEL    |               DESCRIPTION                 |   FORMAT   |
 |  (Columns 61-80)   |                                           |            |
 +--------------------+-------------------------------------------+------------+
 |RINEX VERSION / TYPE| - Format version : 3.00                   | F9.2,11X,  |
 |                    | - File type: O for Observation Data       |   A1,19X,  |
 |                    | - Satellite System: G: GPS                |   A1,19X   |
 |                    |                     R: GLONASS            |            |
 |                    |                     E: Galileo            |            |
 |                    |                     S: SBAS payload       |            |
 |                    |                     D: DORIS              |            |
 |                    |                     M: Mixed              |            |
 +--------------------+-------------------------------------------+------------+
 |PGM / RUN BY / DATE | - Name of program creating current file   |    A20,    |
 |                    | - Name of agency  creating current file   |    A20,    |
 |                    | - Date and time of file creation          |            |
 |                    |   Format: yyyymmdd hhmmss zone            |    A20     |
 |                    |     zone: 3-4 char. code for time zone.   |            |
 |                    |           UTC recommended!                |            |
 |                    |           LCL if local time with unknown  |            |
 |                    |               local time system code      |            |
 +--------------------+-------------------------------------------+------------+
*|COMMENT             | Comment line(s)                           |    A60     |*
 +--------------------+-------------------------------------------+------------+
 |SATELLITE NAME      | Name of satellite                         |    A60     |
 +--------------------+-------------------------------------------+------------+
 |COSPAR NUMBER       | COSPAR number of satellite                |    A20     |
 +--------------------+-------------------------------------------+------------+
*|MARKER TYPE         | - Type of the marker.                     |  A20,40X   |*
 |                    |                                           |            |
 |                    | GEODETIC     : Earth-fixed, high-         |            |
 |                    |                precision monumentation    |            |
 |                    | NON_GEODETIC : Earth-fixed, low-          |            |
 |                    |                precision monumentation    |            |
 |                    | SPACEBORNE   : Orbiting space vehicle     |            |
 |                    | AIRBORNE     : Aircraft, balloon, etc.    |            |
 |                    | WATER_CRAFT  : Mobile water craft         |            |
 |                    | GROUND_CRAFT : Mobile terrestrial vehicle|            |
 |                    | FIXED_BUOY   : "Fixed" on water surface   |            |
 |                    | FLOATING_BUOY: Floating on water surface  |            |
 |                    | FLOATING_ICE : Floating ice sheet, etc.   |            |
 |                    | GLACIER      : "Fixed" on a glacier       |            |
 |                    | BALLISTIC    : Rockets, shells, etc       |            |
 |                    | ANIMAL       : Animal carrying a receiver|            |
 |                    | HUMAN        : Human being                |            |
```

		Record required except for **GEODETIC** and **NON_GEODETIC** marker types. Users may define other project-dependent keywords.		
	OBSERVER / AGENCY	Name of observer / agency	A20,A40	
	REC # / TYPE / VERS	Receiver chain, type, and version (Version: e.g. Internal Software Version)	3A20	
	ANT # / TYPE	Antenna number and type	2A20	
	APPROX POSITION XYZ	Position of 2 GHz phase center, in the platform reference frame (Units: Meters, System: ITRS recommended)	3F14.4	
*	**ANTENNA: DELTA H/E/N**	- Antenna height: Height of the antenna reference point (ARP) above the marker - Horizontal eccentricity of ARP relative to the marker (east/north) All units in meters	F14.4, 2F14.4	*
*	**ANTENNA: DELTA X/Y/Z**	Position of antenna reference point for antenna on vehicle (m): XYZ vector in body-fixed coord. system	3F14.4	*
*	**ANTENNA: PHASECENTER**	Average phase center position w/r to antenna reference point (m) - Satellite system (**G**/**R**/**E**/**S**) - Observation code - North/East/Up (fixed station) or X/Y/Z in body-fixed system (vehicle)	 A1, 1X,A3, F9.4, 2F14.4	*
*	**ANTENNA: B.SIGHT XYZ**	Direction of the "vertical" antenna axis towards the GNSS satellites. Antenna on vehicle: Unit vector in body-fixed coord. system Tilted antenna on fixed station: Unit vector in N/E/Up left-handed system	3F14.4	*
*	**ANTENNA: ZERODIR AZI**	Azimuth of the zero-direction of a fixed antenna (degrees, from north)	F14.4	*
*	**ANTENNA: ZERODIR XYZ**	Zero-direction of antenna Antenna on vehicle: Unit vector in body-fixed coord. system Tilted antenna on fixed station: Unit vector in N/E/Up left-handed system	3F14.4	*
*	**CENTER OF MASS: XYZ**	Current center of mass (X,Y,Z, meters) of vehicle in body-fixed coordinate system. Same system as used for attitude.	3F14.4	*
	SYS / # / OBS TYPES	- Satellite system code (**G**/**R**/**E**/**S**/**D**) - Number of different observation types for the specified satellite system - Observation descriptors: - Type - Band	A1, 2X,I3, 13(1X,A3)	

```
 |                    |   - Attribute                            |            |
 |                    |                                          |            |
 |                    | Use continuation line(s) for more than   |    6X,     |
 |                    | 13 observation descriptors.              | 13(1X,A3)  |
 |                    |                                          |            |
 |                    | In mixed files: Repeat for each          |            |
 |                    | satellite system.                        |            |
 |                    |                                          |            |
 |                    | These records should precede any         |            |
 |                    | SYS / DCBS APPLIED or                    |            |
 |                    | SYS / SCALE FACTOR records (see below).  |            |
 |                    |                                          |            |
 |                    | The following observation descriptors    |            |
 |                    | are defined in RINEX Version 3.00:       |            |
 |                    |                                          |            |
 |                    | Type: C = Code / Pseudorange             |            |
 |                    |       L = Phase                          |            |
 |                    |       W = Power received                 |            |
 |                    |       F = Relative Frequency offset      |            |
 |                    |       P = Pressure                       |            |
 |                    |       T = Temperature                    |            |
 |                    |       H = Humidity                       |            |
 |                    | Band: 1 = S1                       (DOR) |            |
 |                    |       2 = U2                       (DOR) |            |
 |                    | Attribute:                               |            |
 |                    |   blank : for unknown tracking mode      |            |
 |                    |                                          |            |
 |                    | All characters in uppercase only!        |            |
 |                    |                                          |            |
 |                    | Units : Phase        : full cycles       |            |
 |                    |         Pseudorange : kilometers         |            |
 |                    |         Power        : dBm               |            |
 |                    |         Rel.Freq.    : 1 E-11            |            |
 |                    |         Pressure     : 100 Pa            |            |
 |                    |         Temperature : degree Celsius     |            |
 |                    |         Humidity     : percent           |            |
 |                    | Sign definition: See text.               |            |
 |                    |                                          |            |
 |                    | The sequence of the observations in the  |            |
 |                    | observation records has to correspond to |            |
 |                    | the sequence of the types in this record |            |
 |                    | of the respective satellite system.      |            |
 |                    |                                          |            |
 |                    | The attribute can be left blank if not   |            |
 |                    | known. See text!                         |            |
 +--------------------+------------------------------------------+------------+
*|SIGNAL STRENGTH UNIT| - Unit of the signal strength            |  A20,40X   |*
 |                    |   observables Snn (if present)           |            |
 |                    |                                          |            |
 |                    |     DBHZ : S/N given in dbHz             |            |
 |                    |      ...                                 |            |
 +--------------------+------------------------------------------+------------+
*|INTERVAL            | Observation interval in seconds          |  F10.3     |*
 +--------------------+------------------------------------------+------------+
 |TIME OF FIRST OBS   | - Time of first observation record       | 5I6,F13.7, |
 |                    |   (4-digit-year, month,day,hour,min,sec) |            |
 |                    | - Time system: GPS (=GPS time system)    |  5X,A3     |
 |                    |                GLO (=UTC time system)    |            |
 |                    |                GAL (=Galileo System Time)|            |
 |                    |                DOR (=DORIS system Time)  |            |
 |                    |   Compulsory in mixed GNSS files         |            |
 |                    |   Defaults: GPS for pure GPS files       |            |
```

```
 |                    |          GLO for pure GLONASS files          |            |
 |                    |          GAL for pure Galileo files          |            |
 |                    |          DOR for pure DORIS files            |            |
 +--------------------+------------------------------------------+------------+
*|TIME OF LAST OBS    | - Time of last  observation record       | 5I6,F13.7, |*
 |                    |   (4-digit-year, month,day,hour,min,sec) |            |
 |                    | - Time system: Same value as in          |   5X,A3    |
 |                    |                TIME OF FIRST OBS record  |            |
 +--------------------+------------------------------------------+------------+
*|RCV CLOCK OFFS APPL | Epoch, code, and phase are corrected by  |     I6     |*
 |                    | applying the realtime-derived receiver   |            |
 |                    | clock offset: 1=yes, 0=no; default: 0=no |            |
 |                    | Record required if clock offsets are     |            |
 |                    | reported in the EPOCH/SAT records        |            |
 +--------------------+------------------------------------------+------------+
*|SYS / DCBS APPLIED  | - Satellite system (G/R/E/S/D)           |    A1,     |*
 |                    | - Observ. code of affected observable    |    A3,     |
 |                    | - Satellite system (G/R/E/S/D) and       |  1X,A1,    |
 |                    | - Observ. code of reference observable   |    A3,     |
 |                    | - Correction to pseudorange (m)          |   F8.3,    |
 |                    | - Corrections applied: 1 = yes, 0 = no   |  1X,I1,    |
 |                    | - Source of corrections                  |  1X,A20,   |
 |                    | - Program name used to apply corrections |    A20     |
 |                    |                                          |            |
 |                    | Repeat for each observable if necessary. |            |
 +--------------------+------------------------------------------+------------+
*|SYS / SCALE FACTOR  | - Satellite system (G/R/E/S/D)           |    A1,     |*
 |                    | - Factor to divide stored observations   |  1X,I4,    |
 |                    |   with before use (1,10,100,1000)        |            |
 |                    | - Number of observation types involved.  |  2X,I2,    |
 |                    |   0 or blank: All observation types      |            |
 |                    | - List of observation types              | 12(1X,A3)  |
 |                    |                                          |            |
 |                    | Use continuation line(s) for more than   |   10X,     |
 |                    | 12 observation types.                    | 12(1X,A3)  |
 |                    |                                          |            |
 |                    | Repeat record if different factors are   |            |
 |                    | applied to different observation types.  |            |
 |                    |                                          |            |
 |                    | A value of 1 is assumed if record is     |            |
 |                    | missing.                                 |            |
 +--------------------+------------------------------------------+------------+
 |L2 / L1 DATE OFFSET | - Satellite system (D for DORIS)         |    A1,     |
 |                    | - shift between 400MHz measurement       | 2X,F14.3   |
 |                    | date and 2GHz measurement date at the    |            |
 |                    | antenna phase center.                    |            |
 +--------------------+------------------------------------------+------------+
*|LEAP SECONDS        | Number of leap seconds since 6-Jan-1980  |     I6     |*
 |                    | as transmitted by the GPS almanac.       |            |
 |                    | Recommended for mixed GLONASS files      |            |
 +--------------------+------------------------------------------+------------+
 |# OF STATIONS       | Number of stations, for which            |     I6     |
 |                    | observations are stored in the file      |            |
 +--------------------+------------------------------------------+------------+
 |STATION REFERENCE   | - Internal number used in data records   | A1,I2,2X,  |
 |                    | - 4-character station code               |  A4,1X,    |
 |                    | - Station name                           |   A30,     |
 |                    | - DOMES number                           |   A10,     |
 |                    | - Type,                                  |   1X,I1    |
 |                    |         1 for beacon 1.0                 |            |
 |                    |         2 for beacon 2.0                 |            |
 |                    |         3 for beacon 3.0                 |            |
 |                    | - Frequency shift factor K (signed)      |  1X,I3     |
```

```
 |                    |                                         |  or 4X     |
 |                    |                                         |            |
 |                    |                                         |            |
 |                    | This record is (these records are)      |            |
 |                    | repeated for each station present in    |            |
 |                    | the data file                           |            |
 +--------------------+-----------------------------------------+------------+
 |# TIME REF STATIONS | - Number of time reference stations     |    I6      |
 +--------------------+-----------------------------------------+------------+
 |TIME REF STATION    | - Internal number used in data records  |  A1,I2,2X  |
 |                    | - bias of the time beacon reference VS  |  F14.3,2X  |
 |                    | TAI reference time, unit 1 micro second |            |
 |                    | - Time beacon reference shift           |  F14.3     |
 |                    | unit 1 E-14 second/second               |            |
 +--------------------+-----------------------------------------+------------+
 |TIME REF STAT DATE  | - time processing of the time bias and  |  5I6,F13.7 |
 |                    | the time shift reference                |            |
 |                    | date (year,month,day,hour,min,sec)      |            |
 +--------------------+-----------------------------------------+------------+
*|# OF SATELLITES     | Number of satellites, for which         |    I6      |*
 |                    | observations are stored in the file     |            |
 +--------------------+-----------------------------------------+------------+
*|PRN / # OF OBS      | Satellite numbers, number of observations|    3X,    |*
 |                    | for each observation type indicated     |  A1,I2.2,  |
 |                    | in the SYS / # / OBS TYPES record.      |    9I6     |
 |                    |                                         |            |
 |                    |   If more than 9 observation types:     |            |
 |                    |   Use continuation line(s)              |   6X,9I6   |
 |                    |                                         |            |
 |                    | This record is (these records are)      |            |
 |                    | repeated for each satellite present in  |            |
 |                    | the data file                           |            |
 +--------------------+-----------------------------------------+------------+
 |END OF HEADER       | Last record in the header section.      |    60X     |
 +--------------------+-----------------------------------------+------------+
```

A 2 GNSS OBSERVATION DATA FILE - DATA RECORD DESCRIPTION

```
+----------------------------------------------------------------------------+
|                                TABLE A2                                    |
|            GNSS OBSERVATION DATA FILE - DATA RECORD DESCRIPTION            |
+----------------------------------------------------------------+-----------+
| DESCRIPTION                                                    |  FORMAT   |
+----------------------------------------------------------------+-----------+
|                                                                |           |
| EPOCH record                                                   |           |
|                                                                |           |
| - Record identifier : >                                        |    A1,    |
| - Epoch :                                                      |           |
|   - year (4 digits)                                            |  1X,I4,   |
|   - month,day,hour,min (two digits)                            | 4(1X,I2.2),|
|   - sec                                                        |  F13.9,   |
| - Epoch flag                                                   |  2X,I1,   |
|          0: OK                                                 |           |
|          1: power failure between previous and current epoch   |           |
|         >1: Special event                                      |           |
| - Number of stations observed in current epoch                 |    I3,    |
|   (reserved)                                                   |    6X,    |
| - Receiver clock offset (seconds, optional)                    | F13.9,  | |
| - Receiver clock offset flag,                                  |  1X,I1,1X |
|          1 if extrapolated, 0 otherwise                        |           |
+----------------------------------------------------------------+-----------+
| Epoch flag = 0 or 1: OBSERVATION records follow                |           |
|                                                                |           |
| - Satellite number or station number, first line               |  A1,I2.2, |
|         if more than 5 measurements then for the other lines   |    3X     |
|                                                                |           |
| - Observation      | repeat within record for each observation|  m(F14.3, |
| -
| for DORIS                                                      |           |
| - flag m1          | Each value represents a different         |    I1,    |
| - flag m2          | information, m is the rank of information|    I1)    |
| m = 1 and 2, flagm1 = 1 for central frequency measurement      |           |
                      Blank otherwise
|             flagm2 = LLI, 0 for continuity,                    |           |
                     blank for not known
                   1 for discontinuity / cycle slip possible   |           |
| m = 3 and 4, flagm1 = not used, blank                          |           |
|              flagm2 = UT number                                |           |
| m = 5 and 6, flagm1 = 1 for a beacon 3.0 on Restart Mode,RS=1,|           |
|                       blank otherwise                          |           |
|              flagm2 = beacon 3.0 warming period,               |           |
|                       blank otherwise                          |           |
| m = 7        flag71 = not used, blank                          |           |
|              flaf72 = not used, blank                          |           |
| m= 8,9 or 10 flagm1 = not used, blank                          |           |
|              flagm2 = 1 for a non valid measurement,           |           |
|                       0 otherwise                              |           |
| Warming period : 0 for t < 4 hours                             |           |
|                  1 for 4 hours < t < 24 hours                  |           |
|                  2 for 24 hours < t < 72 hours                 |           |
|                  3 for 72 hours < t < 240 hours                |           |
|                  4 for 240 hours < t < 720 hours               |           |
|                  5 for 720 hours < t < 1440 hours              |           |
|                  6 for 1440 hours < t < 2046 hours             |           |
|                  7 for 2046 hours < t                          |           |
|                                                                |           |
```

```
| This record is repeated for each station having been              |            |
| observed in the current epoch. The record length is given by      |            |
| number of observations.                                           |            |
|                                                                   |            |
| Observations: Definition see text.                                |            |
| Missing observations are written as 0.0 or blanks                 |            |
|                                                                   |            |
| Phase values overflowing the fixed format F14.3 have to be        |            |
| clipped into the valid interval (e.g add or subtract 10**9),      |            |
| set LLI indicator.                                                |            |
|                                                                   |            |
| Loss of lock indicator (LLI).                                     |            |
|  0 : OK or blank : not known                                      |            |
|  Bit 0 set : Lost lock between previous and current               |            |
|              observation: Cycle slip possible.                    |            |
|              For phase observations only.                         |            |
|                                                                   |            |
| Signal strength projected into interval 1-9:                      |            |
|  1: minimum possible signal strength                              |            |
|  5: average S/N ratio                                             |            |
|  9: maximum possible signal strength                              |            |
|  blank: not known,                                 |             |
|  Standardization for S/N values given in dbHz: See text.          |            |
|                                                                   |            |
+-------------------------------------------------------------------+------------+
|                                                                   |            |
| Epoch flag  2-5: EVENT: Special records may follow                |            |
|                                                                   |            |
|    - Epoch flag                                                   |  [2X,I1]   |
|      2: start moving antenna                                      |            |
|      3: new site occupation (end of kinem. data)                  |            |
|         (at least MARKER NAME record follows)                     |            |
|      4: header information follows                                |            |
|      5: external event (epoch is significant,                     |            |
|         same time frame as observation time tags)                 |            |
|                                                                   |            |
|    - "Number of stations" contains number of special records      |    [I3]    |
|       to follow. 0 if  no special records follow.                 |            |
|      Maximum number of records: 999                               |            |
|                                                                   |            |
|    For events without significant epoch the epoch fields in       |            |
|    the EPOCH RECORD can be left blank                             |            |
+-------------------------------------------------------------------+------------+
|                                                                   |            |
| Epoch flag = 6: EVENT: Cycle slip records follow                  |            |
|                                                                   |            |
|    - Epoch flag                                                   |  [2X,I1]   |
|      6: cycle slip records follow to optionally report            |            |
|         detected and repaired cycle slips (same format as         |            |
|         OBSERVATIONS records;                                     |            |
|         - slip instead of observation;                            |            |
|         - LLI and signal strength blank or zero)                  |            |
+-------------------------------------------------------------------+------------+
```

Blank = not used or not known value

A 3 GNSS Observation Data File - Example

```
+----------------------------------------------------------------------------+
|                                 TABLE A3                                   |
|                   GNSS OBSERVATION DATA FILE - EXAMPLE                     |
+----------------------------------------------------------------------------+

----|---1|0---|---2|0---|---3|0---|---4|0---|---5|0---|---6|0---|---7|0---|---8|0--

     3.00           O                   D                   RINEX VERSION / TYPE
Expert              CNES                20071220 154538 UTC PGM / RUN BY / DATE
G = GPS R = GLONASS E = GALILEO S = GEO M = MIXED D = DORIS COMMENT
Example of a DORIS RINEX FILE VERSION 3.00                  COMMENT
The file contains Doris measurements performed by JASON2    COMMENT
Satellite on the nominal chain of a DGXX instrument         COMMENT
JASON-2                                                     SATELLITE NAME
9205201                                                     COSPAR NUMBER
STILO               CNES                                    OBSERVER / AGENCY
CHAIN1              DGXX                1.00                REC # / TYPE / VERS
DORIS               STAREC                                  ANT # / TYPE
        0.0921        1.0921        0.8647                  APPROX POSITION XYZ
        0.1230        0.4560        0.7890                  CENTER OF MASS: XYZ
D   10  L1  L2  C1  C2  W1  W2   F   P   T   H              SYS / # / OBS TYPES
  2001     8    21     0     0   39.0000000     DOR         TIME OF FIRST OBS
D  100   2  C1  C2                                          SYS / SCALE FACTOR
D          -2.000                                           L2 / L1 DATE OFFSET
    48                                                      # OF STATIONS
D01  STJB ST JOHN S                             10 3   0    STATION REFERENCE
D02  TLHA TOULOUSE                              10 3   0    STATION REFERENCE
...
D47  EASB EASTER ISLAND                         10 3   0    STATION REFERENCE
D48  KRAB KRASNOYARSK                           10 3   0    STATION REFERENCE
     1                                                      # TIME REF STATIONS
D02           0.000            0.000                        TIME REF STATION
  2001     8    21     0     0    0.0000000                 TIME REF STAT DATE
                                                            END OF HEADER
> 2001 08 21 00 00 39.939956370  0  2       -1.084696938 0
D01  -1907631.062 1   -375988.691 1  32743488.281 1  32743301.603 1      -130.250 7
         -116.250 7      2361.256        1000.820 1         0.000 1        72.732 1
D02        -0.000 1        -0.000 1  32884249.705 2  32884916.645 2      -139.000 7
         -126.400 7      2361.256        1000.773 1        16.628 1        72.738 1
> 2001 08 21 00 00 42.939956370  0  2       -1.084696938 0
D01  -1805705.773 1   -355899.685 1  32744988.881 1  32744801.882 1      -130.250 7
         -116.250 7      2361.256        1000.820 1         0.000 1        72.732 1
D02    -53937.326 1    -10628.958 1  32883455.396 2  32884122.388 2      -139.000 7
         -126.400 7      2361.256        1000.773 1        16.628 1        72.738 1
...

> 2001 08 22 00 00 29.939956370  0  1       -1.086734424 0
D12  -2330840.416     -459369.507    32718027.970 1  32718155.462 1      -122.550 7
         -107.500 7      2356.072        1012.721 1        23.279 1        75.721 1
> 2001 08 22 00 00 32.939956370  0  1       -1.086734424 0
D12  -2314975.071     -456242.760    32718261.571 1  32718389.029 1      -122.550 7
         -107.500 7      2356.072        1012.721 1        23.279 1        75.721 1
----|---1|0---|---2|0---|---3|0---|---4|0---|---5|0---|---6|0---|---7|0---|---8|0--
```

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