



INTRODUCTION TO DORIS RINEX

(Issue 1.0)

ACRONYMS

DGXX	Third generation DORIS Instrument serial model characterised by internal redundary and 7 measurement channels
DORIS	Doppler Orbitography and Radio Positioning Integrated by satellite
GNSS	Global Navigation Satellite System
IDS	International Doris Service
PANDOR	Pré traitement et ANalyse des mesures DORis
RINEX	Receiver Independent Exchange Format
SIMBAD	French acronym for : DORIS Beacons Database
SSALTO	Multi-Mission Ground Segment for Altimetry precise positionning and Orbitography, (CNES)
STILO	French Acronyme for Altimetry, Precise Orbit Determination, Positionning Instruments Telemtry Processing

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1. PURPOSE

RINEX is the format of files containing the DORIS measurements, for DORIS DGXX instruments.

Those files are delivered regularly, they are available on the IDS website:

ftp://doris.ensg.ign.fr/pub/doris/data/<mission>/<YYYY>/

ftp://cddis.gsfc.nasa.gov/pub/doris/data/<mission>/<YYYY>/

with:

mission: name of the Doris mission: cs2, ja2, h2a, srl

YYYY: year of the data

The goal of this document is to give a quick description of this RINEX format.

A detailed description is given in a specific document (RINEX DORIS 3.0).

ftp://ftp.ids-doris.org/pub/ids/data/RINEX_DORIS.pdf

Here we describe some parameters considered as mainly significant and useful for scientific applications.

The principle chosen in this document is to take an example of RINEX content and describe the main parameters.

Note: the RINEX format was designed initially for GNSS measurements. Some adaptations were done, so some parameters may be quite surprising.

The RINEX files are divided into 2 parts:

- The header
- The data

On the following page, an example of RINEX files is given, showing these 2 parts.

Each part is then described in the following paragraphs.

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Header

> 2012 02 26 00 00 27.359947870 0 2 1.497442592 0 D01 -1519613.114 -1952438.990 -44654714.02001 -44654784.45901 -121.1507 -112.050 7 4280.724 862.154 1 17.615 1 D02 -1552063.063 -1132345.482 -43858499.60912 -43858764.93512 -118.700 4 4280.724 995.000 5.800 0 77.000 0 -122.550 4 995.000 0 77.000 0 > 2012 02 26 00 00 30.359947870 0 2 1.497442592 0 D01 -1613019.154 -1970844.901 -44656089.20001 -44656159.64601 -121.150 7 -112.050 7 4280.724 862.154 1 17.615 1 58.462 1 D02 -1530058.107 -1128009.416 -43858175.62512 -43858440.94512 -122.550 4 995.000 0 5.800 0 -118.700 4 4280.724 77.000 0

Data

2. HEADER

Here is an example of a RINEX header with a description of the main parameters

3.00 Expert G = GPS R =	O D CNES 20120227 071 GLONASS E = GALILEO S = G		RINEX VERSION / TYPE PGM / RUN BY / DATE RIS COMMENT	
JASON-2 2008-032A STILO_BN1_3	3.0 CNES		SATELLITE NAME COSPAR NUMBER OBSERVER / AGENCY	name of the satellite carrying the DORIS instrument
CHAIN1	DGXX 1.00		REC # / TYPE / VERS	DORIS on-board instrument characteristics
DORIS	STAREC		ANT # / TYPE	On-board antenna characteristics
1.1940	-0.5980 1.0220		APPROX POSITION XYZ	
0.9768	0.0001 0.0011		CENTER OF MASS: XYZ	
	C1 C2 W1 W2 F P T H		SYS / # / OBS TYPES	System, observed observation types (cf.detailed description)
2012 02)R	TIME OF FIRST OBS	Time of the first measurement of the file, given in TAI scale
D 100 2 C1	C2		SYS / SCALE FACTOR	scale factor: 100 to apply to pseudo range C1, C2 (values in the file have to be divided by 100)
D 1.900			L2 / L1 DATE OFFSET	time delay between L1 measurement and L2 measurement
48			# OF STATIONS	Number of DORIS stations received in the file
D01 HBMB	HARTEBEESTHOEK	30302S008 3 0	STATION REFERENCE	List of the DORIS stations received with their
D02 MATB	MARION ISLAND	30313S003 3 0	STATION REFERENCE	characteristics
D03 LICB	LIBREVILLE	32809S004 3 0	STATION REFERENCE	
D04 REUB	LA REUNION	97401S002 3 0	STATION REFERENCE	D01: DORIS station number in the current RINEX file
D05 DJIB	DJIBOUTI	39901S003 3 0	STATION REFERENCE	HBMB: DORIS antenna point mnemonic
D06 GAVB	GAVDOS	12618S001 3 18	STATION REFERENCE	HARTEBEESTHOEK :DORIS site name
D07 DIOB	DIONYSOS	12602S012 3 0	STATION REFERENCE	30302S008: Domes number
D08 KIUB D09 GR3B	KITAB GRASSE	12334S006 3 0 10002S018 3 -15	STATION REFERENCE STATION REFERENCE	3: Beacon generation 0: K factor (frequency shift factor)
D10 METB	METSAHOVI	10503S015 3 0	STATION REFERENCE	I
D10 ME1B	TOULOUSE	10003S005 3 0	STATION REFERENCE	Note: the correspondence
D12 BADB	BADARY	12338S002 3 0	STATION REFERENCE	station number / mnemonic-name changes for every
D13 KRBB	KRASNOYARSK	12349S002 3 0	STATION REFERENCE	RINEX
D14 SPJB	NY-ALESUND	10317S005 3 0	STATION REFERENCE	
D15 SAKB	YUZHNO-SAKHALINSK	12329S002 3 0	STATION REFERENCE	
D16 COBB	COLD BAY	49804S004 3 0	STATION REFERENCE	
D17 KOLB	KAUAI	40424S009 3 0	STATION REFERENCE	
D18 BETB D19 PAUB	BETIO PAPEETE	50305S001 3 0	STATION REFERENCE STATION REFERENCE	
DIS PAUB	PAPEEIE	92201S010 3 0	STATION REFERENCE	

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3. DATA

> 2012 02 26 00 00 27.359947870 0 2 1.497442592 0 D01 -1519613.114 -1952438.990 -44654714.02001 -44654784.45901 -112.050 7 4280.724 862.154 1 17.615 1 58.462 1	-121.150 7	Record block 1
D02 -1552063.063 -1132345.482 -43858499.60912 -43858764.93512 -118.700 4 4280.724 995.000 0 5.800 0 77.000 0	-122.550 4	
> 2012 02 26 00 00 30.359947870 0 2 1.497442592 0 D01 -1613019.154 -1970844.901 -44656089.20001 -44656159.64601 -112.050 7 4280.724 862.154 1 17.615 1 58.462 1	-121.150 7	Record block 2
D02 -1530058.107 -1128009.416 -43858175.62512 -43858440.94512 -118.700 4 4280.724 995.000 5.800 77.000 0	-122.550 4	

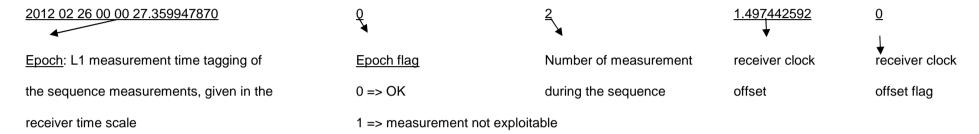
3.1. RECORD BLOCK

> 2012 02 26 00 00 27.359947870 0 2 1.497442592 0	Sequence characteristics
D01 -1519613.114 -1952438.990 -44654714.02001 -44654784.45901 -121.150 7 -112.050 7 4280.724 862.154 1 17.615 1 58.462 1	First measurement of the sequence
D02 -1552063.063 -1132345.482 -43858499.60912 -43858764.93512 -122.550 4 -118.700 4 4280.724 995.000 0 5.800 0 77.000 0	Second measurement of the sequence

3.2. RECORD DESCRIPTION:

3.2.1. SEQUENCE CHARACTERISTICS:

> 2012 02 26 00 00 27.359947870 0 2 1.497442592 0



Nota: The TAI time tag of L1 of the sequence is determined by the expression: date TAI = epoch + receiver clock offset (cf ANN 1)

3.2.2. FIRST MEASUREMENT OF THE SEQUENCE

Num (D01)	: DORIS station number. In the example, if we look at the header, D01 corresponds to the mnemonic HBMB and the site HARTEBEESTHOEK
L1 (-1519613.114)	: 2GHz phase measurement, given in full cycles (F14.3) (optionally followed by 2 flags on 2 characters)
L2 (-1952438.990)	: 400MHz phase measurement, given in full cycles (F14.3) (optionally followed by 2 flags on 2 characters)
	Note: these phases are equal to the phases measured by the DORIS instrument with the opposite sign.
C1 (-44654714.020)	: 2GHz pseudo-range, given in km (F14.3) 01: indicator flags (see DR1)
C2 -44654784.459	: 400MHz pseudo-range, given in km (F14.3) 01: indicator flags (see DR1)
-121.150	:W1 (F14.3): 2GHz power received (dBm) (optionally followed by 2 flags on 2 characters, see DR1): here flag = 7
-112.050	:W2 (F14.3): 400MHz power received (dBm) (optionally followed by 2 flags on 2 characters, see DR1): here flag = 7
4280.724	:F (F14.3): relative frequency offset (10 ⁻¹¹) (optionally followed by 2 flags on 2 characters, see DR1)
862.154	:P (F14.3): atmospheric pressure (100 Pa) (optionally followed by 2 flags on 2 characters, see DR1): here flag = 1
17.615	:P (F14.3): atmospheric pressure (100 Pa) (optionally followed by 2 flags on 2 characters, see DR1): here flag = 1
58.842	:H (F14.3): humidity (%) (optionally followed by 2 flags on 2 characters, see DR1): here flag = 1

4. ADDITIONAL INFORMATION:

Intended for all users of RINEX files

4.1. DATA SEQUENCING:

As already mentioned, there can be two sets of measurements in sequences of 10 seconds, the first at T0, the second at T0 + 3s. The dates introduced by the ">" sign therefore indicate alternately the date of the first series of a sequence and then the date of the second series of the same sequence. In the file given as an example, it must therefore be read:

- => Record block 1: first measurements set of the first sequence
- => Record block 2: second measurement set of the first sequence

etc.

It should be noted that both series are not always present. In particular at the start of a pass or following a stall due to Doppler collision, the first series (phase measurements at T0) is absent because of the time the receiver takes to lock on (or reconnect to) the signal. In this case, the first step in the sequence will be at T0 + 3s.

4.2. DATA ACCURACY:

Accuracy of the measurements:

In DORIS RINEX, two dual-frequency phase measurements are delivered every 10 seconds: the first at T0, the second at $T0 + \sim 3s$.

This may be of interest to those who want faster temporal sampling than 1 every 10 seconds.

In RINEX, the measurements are dated to a few microseconds in the TAI scale. This avoids the need for users to repeat a BT/UT match.

Pseudo Range:

The DORIS measurement of pseudo-range is not very accurate ~ 1km at 400MHz and ~ 5km at 2GHz

The phase measurement is more accurate.

Phase:

Phase measurement is accurate to a few millimetres.

Time tagging

DIODE epoch (raw RINEX)

Pandor epoch (Pandor redated for RINEX)

How to treat flags

Some flag values need to be monitored so that the data can be edited if necessary.

A more detailed description is given in DR1.

NOTA:

L2 / L1 DATE OFFSET: this parameter gives the delay between:

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- L1 measurement time: 2GHz phase sampling
- And L2 measurement time: 400MHz phase sampling

This delay is due to the independence of the two sampling scales. Both sampling scales have an elementary schedule of 4 microseconds. This means that this delay is between 0 and 4 microseconds.

It is measured by the instrument and updated for each RINEX file.

5. ADDITIONAL DATA USEFUL FOR RINEX EXPLOITATION:

Ephemeris:

The position of the satellite will be provided in an ephemeris file (values to interpolate with the dates of the measurements)

Coordinates:

The coordinates (positions/speed) of DORIS stations (antenna points) are available, either via the site logs available on the site under ids-doris.org http://ids-doris.org/network/sitelogs.html, or via a database (SIMBAD) in the current ITRF coordinate framework (currently ITRF_2008).

6. SUPPLYING RINEX FILES TO USERS

DORIS RINEX data are made available **daily** on IDS for the Jason2, Cryosat2 and Hy-2A missions.

The HY-2A files are sometimes incomplete (gap in the telemetry); in this case, a second version may be published within a month.

Update the document: RINEX DORIS 3.0 (SALP 15578)

A description of the "RINEX DORIS" format can be found at: ftp://ftp.ids-doris.org/pub/ids/data/RINEX_DORIS.pdf

7. ANNEXES

These annexes contain a few additional details

7.1. ANN 1:

The date (for example: > 2012 02 26 00 00 27.359947870) is expressed in the onboard (BT) scale. To convert it to the TAI scale, just add the given offset in seconds on the same line, after the indicator of the number of measurements.

Example:

> 2012 02 26 00 00 27.359947870 0 2 1.497442592 0

TAI date of the measurements = 2012 02 26 00 00 27.3599 + 1.49744259247870 = 2012 02 26 00 00 28.857390462

It should be noted that the first series of measurements in the sequence falls nominally on a TAI date whose modulo [10 seconds] = ~ -1.15 seconds (a value better known by the name of nominal time shift between onboard and ground time frame).

The flag that follows the offset ("0" in the example above) indicates whether the offset for correspondence between BT and TAI is derived from an interpolation ("0") or an extrapolation ("1"). It is usually "0" and can be ignored (it does not affect the accuracy of the dating in TAI, which is always, and regardless of the method used, to about the nearest microsecond, as this error is dominated by the noise of the measurement of pseudo-range).

7.2. ANN 2:

As can be seen, the phase measurements are expressed in cycles with 3 decimal places. The term "full cycles" which has been used in the RINEX 3.0 document is slightly confusing - an update will be considered.