

ESDS-RINEX RFC

Status of this Memo

This memo informs the NASA Earth Science Data Systems (ESDS) community describing the Receiver Independent Exchange Format (RINEX) data format. Distribution of this memo is unlimited.

Change Explanation

This is the first version RFC for RINEX format.

Copyright Notice

This is a work of the U.S. Government and is not subject to copyright protection in the United States. Foreign copyrights may apply.

Abstract

This document designates the Receiver Independent Exchange Format (RINEX) as the NASA Earth science standard data interchange format for raw Global Navigation Satellite System (GNSS) data.

Suggested Citation

Pollack, N. (2024). Receiver Independent Exchange (RINEX) Format RFC. NASA Earth Science Data and Information System Standards Coordination Office.

<https://doi.org/10.5067/DOC/ESCO/ESDS-RFC-052V1>

1 Introduction

RINEX is a data interchange format for raw satellite navigation system data. This standard format allows end users to combine data from one or more types of receiver equipment, and one or more satellite constellations, consistently in processing software. It also allows users to ingest broadcast GNSS orbit information from disparate receiver types, and from ancillary meteorological instruments whose data flow through the GNSS receiver.

RINEX is the current standard format for GNSS data received, archived, and distributed by NASA's Crustal Dynamics Data Information System (CDDIS).

The RINEX data format specification can be viewed at: <https://igs.org/formats-and-standards/>

1.1 Background

The IGS/RTCM (International GNSS Service / Radio Technical Commission for Maritime Services) Receiver INdependent EXchange (RINEX) Committee was established in December

of 2011 to update and maintain the RINEX format to meet the needs of the IGS and the GNSS Industry. Since the RINEX format is widely used by the GNSS scientific community and industry it was decided that it should be jointly managed by the IGS and the Radio Technical Commission for Maritime Services – Special committee 104 (RTCM-SC104). In this way the Committee consists of IGS scientific and institutional members and RTCM-SC104 industry members. RINEX documents will continue to be freely distributed both by the IGS and RTCM-SC104.

The following major format versions of RINEX have been developed and published to date:

- The original RINEX Version 1 presented at and accepted by the 5th International Geodetic Symposium on Satellite Positioning in Las Cruces, 1989. [Gurtner et al., 1989], [Evans, 1989]
- RINEX Version 2 presented at and accepted by the Second International Symposium of Precise Positioning with the Global Positioning System in Ottawa, 1990, mainly adding the possibility to include tracking data from different satellite systems (GLONASS, SBAS). [Gurtner and Mader, 1990a, 1990b], [Gurtner, 1994]
- RINEX Version 3 developed in the early 2000s to support multi-GNSS and to clearly identified the tracking modes of each of the observations by introducing and defining 3-character observation codes for all GNSS constellations.
- RINEX Version 4 introduced in 2021 as a necessary step to support the modern multi GNSS navigation messages by introducing and defining navigation ‘data records’ to hold both individual satellite navigation messages, constellation-wide parameters and global parameters as transmitted by the different GNSS constellations.

1.2 Evidence of Implementation

RINEX data format can be seen in use by the International GNSS Service (IGS) and can be found in over [50 data collections at CDDIS](#). CDDIS GNSS data is currently offered primarily in RINEX version 3: https://cddis.nasa.gov/Data_and_Derived_Products/GNSS/RINEX_Version_3.html

2 RINEX Data Structure

RINEX defines three different file types:

- Observation data file which contains the following measurements
 - Time: the recorded time of the GNSS receiver for the received signals expressed in GPS time
 - Pseudo-range: approximate distance (m) from the satellite to the receiver including clock offsets and atmospheric delays
 - Phase: number of waveforms (β) measured since locking with the satellite including the fractional initial waveform (α) and assuming no slips (loss of lock commonly caused by power loss, an obstruction, or low signal-to-noise ratio)
 - Marker type

- Antenna references and phase centers
- Receiver platform
- Differential Code Bias corrections
- Corrections of antenna phase center variations
- Phase Cycle Shifts
- Half-wavelength observations and ambiguities
- Receiver clock offset.
- Code/Phase Alignment

- Navigation message file
 - The navigation file contains broadcast ephemeris of the satellites and includes position, velocity, and clock information for the US GPS system.
- Meteorological data file - Contains information such as:
 - PR : Pressure (mbar)
 - TD : Dry temperature (deg Celsius)
 - HR : Relative humidity (percent)
 - ZW : Wet zenith path delay (mm)(for WVR data)
 - ZD : Dry component of zenith path delay(mm)
 - ZT : Total zenith path delay (mm)
 - WD : Wind azimuth (deg) from where the wind blows
 - WS : Wind speed (m/s)
 - RI : Rain increment (1/10 mm): Rain accumulation since last measurement
 - HI : Hail indicator: 1 = Hail detected since last measurement
 - Position (height) of the meteorological sensor

Each file consists of a header section containing meteorological equipment related information and a main body with the actual data. The files have a maximum record length of 80 characters and are written in ASCII to guarantee an easy exchange between different computer systems. More details can be seen here: <https://igs.org/formats-and-standards/>

3 Interoperability and Applicability Considerations

RINEX files are designed for interoperability within the variations of raw satellite navigation system data. As with any format designed for a specific purpose, its use within NASA should be confined to appropriate data.

4 Updates to Format

Future development to the RINEX standard can be tracked at: <https://www.navcen.uscg.gov/the-rinex-format-current-status-future-developments>

5 References

Normative References

- <https://igs.org/formats-and-standards/>

6 Authors' Addresses

ESDIS Standards and Coordination Office (ESCO)

Email: esco-staff@lists.nasa.gov

Web: <https://earthdata.nasa.gov/esdis/esdis-standards-office-esco>

Appendix A - Glossary of acronyms

<u>Acronym</u>	<u>Description</u>
GNSS	Global Navigation Satellite System
IGS	International GNSS Service
RTCM	Radio Technical Commission for Maritime Services
RINEX	Receiver INdependent EXchange