

GNSS Data Formats

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Data Formats: NMEA, RINEX, RTCM

References: <https://www.nmea.org/>
<http://freenmea.net/docs>

National Marine Electronics Association (NMEA) Format

- NMEA is format to output measurement data from a sensor in a pre-defined format in ASCII
- In the case of GPS, It outputs GPS position, velocity, time and satellite related data
- NMEA sentences (output) begins with a “Talker ID” and “Message Description”
 - Example: \$GPGGA,123519,4807.038,N,01131.000,E,1,08,0.9,545.4,M,46.9,M,,*47
 - “\$GP” is Talker ID
 - “GGA” is Message Description to indicate for Position Data

NMEA Data Format

GGA - Fix data which provide 3D location and accuracy data.

\$GPGGA,123519,4807.038,N,01131.000,E,1,08,0.9,545.4,M,46.9,M,,*47

Where: GGA Global Positioning System Fix Data

123519 Fix taken at 12:35:19 UTC

4807.038, N Latitude 48 deg 07.038' N

01131.000, E Longitude 11 deg 31.000' E

1 Fix quality:

0 = invalid ,

1 = GPS fix (SPS),

2 = DGPS fix,

3 = PPS fix,

4 = Real Time Kinematic

5 = Float RTK

6 = estimated (dead reckoning) (2.3 feature)

7 = Manual input mode

8 = Simulation mode

08 Number of satellites being tracked

0.9 Horizontal dilution of position

545.4,M Altitude, Meters, above mean sea level

46.9,M Height of geoid (mean sea level) above WGS84 ellipsoid

(empty field) time in seconds since last DGPS update (empty field) DGPS station ID number

*47 the checksum data, always begins with *

RINEX Data Format

- RINEX: Receiver Independent Exchange Format is a data exchange format for raw satellite data among different types of receivers.
 - Different types of receivers may output position and raw data in proprietary formats
 - For post-processing of data using DGPS or RTK it is necessary to use data from different types of receivers. A common data format is necessary for this purpose.
 - Example: How to post process data from Trimble, Novatel and Septentrio receivers to compute a position?
- RINEX only provides Raw Data. It does not provide position output.
 - User has to post-process RINEX data to compute position
 - Raw data consists of Pseudorange, Carrierphase, Doppler, SNR
- RINEX basically consists of two data types
 - “*.N” file for Satellite and Ephemeris Related data.
 - Also called Navigation Data
 - “*.O” file for Signal Observation Data like Pseudorange, Carrier Phase, Doppler, SNR
 - Also called Observation Data
- The latest RINEX version is 3.04, 23 NOV 2018
 - Note: Not all the software and receivers are yet compatible with the latest version
 - Make sure which version of RINEX works the best with your software

RINEX "N" File for GPS

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2.11 NAVIGATION DATA GPS (GPS) RINEX VERSION / TYPE
cnvtToRINEX 2.90.0 convertToRINEX OPR 05-Jul-17 03:38 UTC PGM / RUN BY / DATE
----- COMMENT
0.8382D-08 0.2235D-07 -0.5960D-07 -0.1192D-06 ION ALPHA
0.8602D+05 0.6554D+05 -0.1311D+06 -0.4588D+06 ION BETA
-0.931322574615D-09-0.355271367880D-14 405504 1947 DELTA-UTC: A0,A1,T,W
18 LEAP SECONDS
END OF HEADER
32 17 05 01 00 00 0.0-0.400723423809D-03-0.110276232590D-10 0.000000000000D+00
0.370000000000D+02-0.806250000000D+01 0.455840416154D-08-0.192420920137D+01
-0.353902578354D-06 0.111064908560D-02 0.826455652714D-05 0.515371503258D+04
0.864000000000D+05-0.782310962677D-07 0.675647076441D-01-0.838190317154D-07
0.958529124300D+00 0.221156250000D+03-0.265074890978D+01-0.796390315710D-08
-0.389659088008D-09 0.100000000000D+01 0.194700000000D+04 0.000000000000D+00
0.240000000000D+01 0.000000000000D+00 0.465661287308D-09 0.370000000000D+02
0.795120000000D+05 0.400000000000D+01 0.000000000000D+00 0.000000000000D+00
24 17 05 01 00 00 0.0-0.341213308275D-04-0.454747350886D-12 0.000000000000D+00
0.100000000000D+02 0.787812500000D+02 0.459340561950D-08 0.167267059468D+01
0.404566526413D-05 0.564297637902D-02 0.102464109659D-04 0.515370226479D+04
0.864000000000D+05-0.782310962677D-07 0.108986675687D+01 0.484287738800D-07
0.945651423640D+00 0.170906250000D+03 0.490563049326D+00-0.815641117584D-08
-0.128933942045D-09 0.100000000000D+01 0.194700000000D+04 0.000000000000D+00
0.240000000000D+01 0.000000000000D+00 0.279396772385D-08 0.100000000000D+02
0.792180000000D+05 0.400000000000D+01 0.000000000000D+00 0.000000000000D+00

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RINEX “N” File for QZSS

RINEX “N” File for GLONASS

RINEX “N” File for GALILEO

RINEX “N” File for BEIDOU

RINEX “N” File for SBAS

RINEX "O" File GPS, GLONASS, GALILEO, QZSS, SBAS

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2.11 OBSERVATION DATA Mixed(MIXED) RINEX VERSION / TYPE
cnvtToRINEX 2.90.0 convertToRINEX OPR 05-Jul-17 03:38 UTC PGM / RUN BY / DATE
----- COMMENT
KMBA MARKER NAME
KMBA MARKER NUMBER
DM UT OBSERVER / AGENCY
5536R50102 TRIMBLE NETR9 5.20 REC # / TYPE / VERS
UNKNOWN EXT ANT # / TYPE
-3955510.8982 3357111.6791 3697796.5495 APPROX POSITION XYZ
0.0000 0.0000 0.0000 ANTENNA: DELTA H/E/N
1 1 0 WAVELENGTH FACT L1/2
8 C1 C2 C3 L1 L2 L3 P1 P2 # / TYPES OF OBSERV
1.000 INTERVAL
2017 5 1 0 0 0.0000000 GPS TIME OF FIRST OBS
2017 5 1 23 59 59.0000000 GPS TIME OF LAST OBS
0 RCV CLOCK OFFS APPL
18 LEAP SECONDS
59 # OF SATELLITES
G01 23351 23350 0 23350 46694 0 0 23344 PRN / # OF OBS
G02 22293 0 0 22293 22286 0 0 22286 PRN / # OF OBS
G03 19633 19632 0 19632 39259 0 0 19627 PRN / # OF OBS
G05 25303 25302 0 25299 50599 0 0 25297 PRN / # OF OBS
G06 24709 24708 0 24709 49411 0 0 24703 PRN / # OF OBS
G07 27766 27764 0 27764 55505 0 0 27741 PRN / # OF OBS

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RINEX "O" File, Continued from previous slide

S37	86400	0	0	86400	0	0	0	0	PRN / # OF OBS	
S40	56700	0	0	56700	0	0	0	0	PRN / # OF OBS	
CARRIER PHASE MEASUREMENTS: PHASE SHIFTS REMOVED									COMMENT	
									END OF HEADER	
17	5	1	0	0	0.0000000	0	19G10G12G14G15G18G24G25G31G32R01R02R03			
							R11R12R13S28S29S37S40			
21375379.406	7	21375388.078	9				112328384.475	7	87528640.180	9
							21375388.41448			
20991588.469	7	20991594.418	9				110311559.942	7	85957091.970	9
							20991594.71548			
23097788.500	6						121379711.146	6	94581624.25147	
							23097793.85247			
24539464.648	6	24539473.480	8				128955722.954	6	100484989.893	8
							24539473.66046			
21890081.000	6						115033147.870	6	89636240.02147	
							21890086.53547			
22760846.398	6	22760855.313	9				119609048.681	6	93201876.319	9
							22760854.86347			
20303284.266	7	20303294.227	9				106694510.219	7	83138615.317	9
							20303294.01248			
23440741.258	6	23440748.211	8				123181935.734	6	95985961.100	8
							23440748.62147			
21395760.742	7	21395769.145	9				112435502.496	7	87612113.685	9
							21395769.30548			

RTCM

- RTCM : Radio Technical Commission for Maritime Services
 - An internationally accepted data transmission standard for base-station data transmission to a rover defined. The standards are defined and maintained by RTCM SC-104
- RTCM SC-104 (Special Committee 104)
 - Defines data formats for Differential GPS and
 - RTK (Real-Time Kinematic Operations)
- The Current Version is RTCM-3 (10403.3)
- Refer <https://www.rtcn.org/> for detail information and document
 - Documents are not free
 - A normal user does not need RTCM document.
 - GNSS receivers with base-station capabilities will setup necessary messages for RTK
 - If you are developing a system or application you may need it