



RINEX ver3-base QZSS Extension (Version 1.00)

Hiroaki Tateshita/Shinichi Nakamura
Japan Aerospace Exploration Agency



Introduction

Basically, new RINEX is based on “RINEX version 3.01” (17 December 2010)

In this presentation, only modification points are described.

JAXA has proposed this RINEX format QZSS Extension to

IGS. JAXA hopes this format will become a de fact standard and will be integrated to original RINEX format published by IGS. When this format is integrated to the original RINEX format and published on the IGS website, this format will be abolished.



3.5 Satellite numbers

Starting with RINEX Version 2 the former two-digit satellite numbers **nn** are preceded by a one-character system identifier **s**:

| snn | |
|---|---|
| | |
| +-- | nn: PRN (GPS, Galileo, Compass) slot number (GLONASS) PRN-100 (SBAS Geostationary) PRN-192 (QZSS) |
| +--- | s: satellite system identifier |
| | G : GPS R : GLONASS S : SBAS payload E : Galileo C : Compass J : QZSS |
| SBAS: Satellite-Based Augmentation System | |

2010/06/11

For Example

QZS-1 (PRN=193) → J01

QZS-2 (PRN=194) → J02

Table 1: Satellite numbers

The same satellite system identifiers are also used in all header records when appropriate.

QZSS RINEX Modification Points (P.6)



| File Types | All platforms uncompressed | UNIX | VMS compressed | DOS |
|---------------------------------|-------------------------------|---------------|-------------------|-------------|
| Obs Files | .yyO | .yyO.Z | .yyO_Z | .yyY |
| Obs Files (Hatanaka Compressed) | .yyD | .yyD.Z | .yyD_Z | .yyE |
| GPS NAV Message File | .yyN | .yyN.Z | .yyN_Z | .yyX |
| GLONASS Nav Message File | .yyG | .yyG.Z | .yyG_Z | .yyV |
| ~ | ~ | ~ | ~ | ~ |
| Clock File (see sep.doc.) | .yyC | .yyC.Z | .yyC_Z | .yyW |
| QZSS Nav Message File | .yyQ | .yyQ.Z | .yyQ_Z | .yyJ |



Table 5 : RINEX Version 3.01 obseravation codes

| System | Freq. Band | Frequency | Channel or Code | Observation Codes | | | | |
|--------|------------|-----------|-----------------|-------------------|---------------|---------|-----------------|------------|
| | | | | Pseudo Range | Carrier Phase | Doppler | Signal Strength | |
| QZSS | L1 | 1575.42 | C/A | C1C | L1C | D1C | S1C | |
| | | | L1C(D) | C1S | L1S | D1S | S1S | ←Data Ch. |
| | | | L1C(P) | C1L | L1L | D1L | S1L | ←Pilot Ch. |
| | | | L1C(D+P) | C1X | L1X | D1X | S1X | |
| | L2 | 1277.60 | L2C(M) | C2S | L2S | D2S | S2S | ← Data ch. |
| | | | L2C(L) | C2L | L2L | D2L | S2L | ← No Data |
| | | | L2C(M+L) | C2X | L2X | D2X | S2X | |
| | L5 | 1176.45 | I | C5I | L5I | D5I | S5I | |
| | | | Q | C5Q | L5Q | D5Q | S5Q | |
| | | | I+Q | C5X | L5X | D5X | S5X | |
| | LEX | 1278.75 | S | C6S | L6S | D6S | S6S | ← Data ch. |
| | | | L | C6L | L6L | D6L | S6L | ← No Data |
| S+L | | | C6X | L6X | D6X | S6X | | |

QZSS RINEX
Modification Points (P.8 on RINEX Format)



QZSS–pseudorandom noise (PRN) code assignments:

See e.g., <http://www.losangeles.af.mil/library/factsheets/factsheet.asp?id=8618>



8.1 Time system identifier

(Insert new sentence after GPS description)

QZSS runs on QZSST, which has the following characteristics. QZSST conforms to UTC (NICT) and the offset with respect to the GPS time system is controlled.

- **One second length**

The length of one second is identical to International Atomic Time (TAI). It is also the same for GPS and Galileo.

- **Integer second offset for TAI**

The integer second offset for TAI is the same as for GPS. TAI is always 19 seconds ahead of QZSST.

- **Starting point of Week Number for QZSST**

The starting point of the Week Number for QZST is identical to GPST.



8.2 Pseudorange definition

(At 2nd paragraph)

In a mixed-mode GPS/GLONASS/Galileo/QZSS receiver referring all pseudorange observations to one receiver clock only,

Modification Points (P.A1)

A 1 GNSS Observation Data File - Header Section Description

| TABLE A1 GNSS OBSERVATION DATA FILE - HEADER SECTION DESCRIPTION | | |
|---|---|--------------------------------|
| HEADER LABEL (Columns 61-80) | DESCRIPTION | FORMAT |
| RINEX VERSION / TYPE | - Format version : 3.00 - File type: 0 for Observation Data - Satellite System: G: GPS R: GLONASS E: Galileo S: SBAS payload M: Mixed | F9.2,11X, A1,19X, A1,19X |
| PGM / RUN BY / DATE | - Name of program creating current file | A20. |

Adding new Satellite System indicator for QZSS,

J: QZSS



Modification Points (P.A2)

SYS / # / OBS TYPES

- Satellite system code (G/R/E/S)
- Number of different observation types for the specified satellite system
- Observation descriptors:
 - Type
 - Band
 - Attribute

Use continuation line(s) for more than 13 observation descriptors.

In mixed files: Repeat for each satellite system.

These records should precede any **SYS / SCALE FACTOR** records (see below).

The following observation descriptors are defined in RINEX Version 3.00:

- Type: C = Code / Pseudorange
 L = Phase
 D = Doppler
 S = Raw signal strength
 I = Ionosphere phase delay
 X = Receiver channel numbers
- Band: 1 = L1 (GPS, SBAS)
 G1 (GLO)
 E2-L1-E1 (GAL)
- 2 = L2 (GPS)
 G2 (GLO)
- 5 = L5 (GPS, SBAS)

A1,
 2X, I3,
 13 (1X, A3)

6X,
 13 (1X, A3)

Adding new Satellite System Code for QZSS,
J: QZSS

Observation descriptors for QZSS is as follows,

- Type: inheriting original definition
- Band: 1 = L1 (QZSS)
 2 = L2 (QZSS)
 5 = L5 (QZSS)
 6 = LEX (QZSS)

[conti.]

Modification Points (P.A3 on RINEX Format)

```

        E5a                (GAL)
    6 = E6                (GAL)
    7 = E5b              (GAL)
    8 = E5a+b           (GAL)
    0 for type X        (all)
Attribute:
    P = P code-based    (GPS,GLO)
    C = C code-based    (SBAS,GPS,GLO)
    Y = Y code-based    (GPS)
    M = M code-based    (GPS)
    N = codeless        (GPS)
    A = A channel       (GAL)
    B = B channel       (GAL)
    C = C channel       (GAL)
    I = I channel       (GPS,GAL)
    Q = Q channel       (GPS,GAL)
    S = M channel       (L2C GPS)
    L = L channel       (L2C GPS)
    X = B+C channels    (GAL)
        I+Q channels    (GPS,GAL)
        M+L channels    (GPS)
    W = based on Z-tracking (GPS)
        (see text)
    Z = A+B+C channels  (GAL)
blank : for types I and X (all)
        or unknown tracking mode
    
```

Attribute:

- C = C/A code (L1 QZSS)
- S = L1C Data ch. (L1 QZSS)
- L = L1C Pilot ch. [No Data] (L1 QZSS)
- S = M channel [Data ch.](L2C QZSS)
- L = L channel [No.Data](L2C QZSS)
- I = I channel (L5 QZSS)
- Q = Q channel (L5 QZSS)
- S = LEX code [Data ch.] (LEX QZSS)
- L= LEX code [No Data] (LEX QZSS)
- X= D+P ch. (L1C QZSS)
 - M+L ch. (L2C QZSS)
 - I+Q ch. (L5 QZSS)



| | | |
|-------------------|--|---------------------------|
| TIME OF FIRST OBS | <ul style="list-style-type: none"> - Time of first observation record (4-digit-year, month, day, hour, min, sec) - Time system: GPS (=GPS time system) <li style="padding-left: 20px;">GLO (=UTC time system) <li style="padding-left: 20px;">GAL (=Galileo System Time) <p>Compulsory in mixed GNSS files Defaults: GPS for pure GPS files GLO for pure GLONASS files GAL for pure Galileo files</p> | 5I6, F13.7, 5X, A3 |
|-------------------|--|---------------------------|

Adding new Time system for QZSS

Time system: QZS (=QZSS time system)

RINEX Observation Data File (P.A4)



| | | | |
|-----------------------------|---|---|---|
| <p>* SYS / DCBS APPLIED</p> | <ul style="list-style-type: none"> - Satellite system (G/R/E/S) - Program name used to apply differential code bias corrections - Source of corrections (URL) <p>Repeat for each satellite system.</p> <p>No corrections applied: Blank fields or record not present.</p> | <p>A1, 1X,A17 1X,A40</p> | <p>*</p> <p>Adding new indicator as Satellite system</p> <p>Satellite system: J (=QZSS)</p> |
| <p>* SYS / PCVS APPLIED</p> | <ul style="list-style-type: none"> - Satellite system (G/R/E/S) - Program name used to apply phase center variation corrections - Source of corrections (URL) <p>Repeat for each satellite system.</p> <p>No corrections applied: Blank fields or record not present.</p> | <p>A1, 1X,A17 1X,A40</p> | <p>*</p> <p>Adding new indicator as Satellite system</p> <p>Satellite system: J (=QZSS)</p> |
| <p>* SYS / SCALE FACTOR</p> | <ul style="list-style-type: none"> - Satellite system (G/R/E/S) - Factor to divide stored observations with before use (1,10,100,1000) - Number of observation types involved. 0 or blank: All observation types - List of observation types <p>Use continuation line(s) for more than 12 observation types.</p> <p>Repeat record if different factors are applied to different observation types.</p> <p>A value of 1 is assumed if record is missing.</p> | <p>A1, 1X,I4, 2X,I2, 12(1X,A3 10X, 12(1X,A3)</p> | <p>*</p> <p>Adding new indicator as Satellite system</p> <p>Satellite system: J (=QZSS)</p> |

Modification Points (P.A8)

A 4 GNSS Navigation Message File - Header Section Description

| TABLE A4 GNSS NAVIGATION MESSAGE FILE - HEADER SECTION DESCRIPTION | | |
|---|--|--------------------------------|
| HEADER LABEL (Columns 61-80) | DESCRIPTION | FORMAT |
| RINEX VERSION / TYPE | <ul style="list-style-type: none"> - Format version : 3.00 - File type ('N' for navigation data) - Satellite System: G: GPS <li style="padding-left: 20px;">R: GLONASS <li style="padding-left: 20px;">E: Galileo <li style="padding-left: 20px;">S: SBAS Payload <li style="padding-left: 20px;">M: Mixed | F9.2,11X, A1,19X, A1,19X |

Adding new indicator as Satellite system for QZSS
J: QZSS(L1C/A message)



Modification Points (P.A8)

* IONOSPHERIC CORR

Ionospheric correction parameters

- Correction type
 - GAL** = Galileo ai0 - ai2
 - GPSA** = GPS alpha0 - alpha3
 - GPSB** = GPS beta0 - beta3
- Parameters
 - GPS: alpha0-alpha3 or beta0-beta3
 - GAL: ai0, ai1, ai2, zero

A4,

4D1

* TIME SYSTEM CORR

Corrections to transform the system time to UTC or other time systems

- Correction type
 - GAUT** = GAL to UTC a0, a1
 - GPUT** = GPS to UTC a0, a1
 - SBUT** = SBAS to UTC a0, a1
 - GLUT** = GLO to UTC a0=TauC, a1=zero
 - GPGA** = GPS to GAL a0=A0G, a1=A1G
 - GLGP** = GLO to GPS a0=TauGPS, a1=zero

A4,

As for QZS, we propose that

- Correction type
 - QZSA = QZS alpha0 - alpha3
 - QZSB = QZS beta0 - beta 3

- Parameters
 - QZS: alpha0-alpha3 or beta0 - beta3

- Correction type
 - QZGP = QZS to GPS a0, a1
 - QZUT = QZS to UTC a0, a1

Modification Points (P.A9)

A 5 GNSS Navigation Message File – GPS Data Record Description

TABLE A5
GNSS NAVIGATION MESSAGE FILE - GPS DATA RECORD DESCRIPTION

| OBS. RECORD | DESCRIPTION | FORMA |
|----------------------------|---|--|
| <i>SV / EPOCH / SV CLK</i> | - Satellite system (G), sat number (PRN) - Epoch: Toc - Time of Clock (GPS) - year (4 digits) - month, day, hour, minute, second - SV clock bias (seconds) - SV clock drift (sec/sec) - SV clock drift rate (sec/sec ²) | A1, I2. 1X, I4 5 (1X, I2 3D19.1 *) |

Satellite system (J), sat number (PRN)
PRN=XXX-192, XXX=PRNof QZSS

Example

QZS-1 PRN=193 → Other obs. signals J01
QZS-2 PRN=194 → Other obs. signals J02

Note that

PRN number run from 193 to 210 for QZSS other observation signals.

JAXA's idea is PRN-192 rule for all QZSS L1, L2 and L5. According to this rule, QZS-1's (PRN=193) signals are expressed by J01.

Modification Points (P.A13)

A 11 GNSS Navigation Message File – SBAS Data Record Description

TABLE A11
GNSS NAVIGATION MESSAGE FILE – SBAS DATA RECORD DESCRIPTION

| OBS. RECORD | DESCRIPTION | FO |
|---------------------|--|--------------------------|
| SV / EPOCH / SV CLK | <ul style="list-style-type: none"> - Satellite system (S), satellite number (slot number in sat. constellation) - Epoch: Toc - Time of Clock (UTC) <ul style="list-style-type: none"> - year (4 digits) - month, day, hour, minute, second - SV clock bias (sec) (aGf0) - SV relative frequency bias (aGf1) - Transmission time of message (start of the message) in GPS seconds of the week | A1, 1X 5 (1X 3D |

Satellite system (J), sat number (PRN)
PRN=XXX-192, XXX=PRNof QZSS

Example

QZS-1 PRN=193 → Other obs. signals J01
QZS-2 PRN=194 → Other obs. signals J02