CLASLIB ver. 0.8.2 Manual

April 30, 2025

Contents

1 Overview

This manual describes the detail of the CLAS (Centimeter Level Augmentation Service) test library called CLASLIB. The purpose of distributing CLASLIB is to facilitate the user algorithm implementation of CLAS. CLASLIB is constructed based on RTKLIB and GSILIB and consists of two utilities, SSR2OSR and RNX2RTKP.

SSR2OSR is a conversion utility to make offset values of observations from Compact SSR (State Space Representation). An offset value is called "correction" hereafter. Users can confirm the algorithm to make OSR (Observation Space Representation) data by comparing the results of their own to the output of SSR2OSR.

RNX2RTKP is a utility for post-process positioning. It implements a new processing mode to make use of CLAS. Its processing mode is called PPP-RTK (Precise Point Positioning – Real Time Kinematic). Users can refer to its output as a reference to achieve performance criteria of CLAS.

To obtain RNX2RTKP, an application form must be submitted. For information on how to obtain the source code or executable of RNX2RTKP, please refer to following WEB page or contact the following e-mail address.

URL: https://sys.qzss.go.jp/dod/en/downloads/clas.html
e-mail: IS.PS-QZSS-L6@rm.MitsubishiElectric.co.jp

The following section describes:

- The design concept of CLASLIB
- Measurement models
- Usage of utilities

Please note that the definition of symbols is the same as the one in the RTKLIB manual [1]. Equations in this document are numbered so as not to overlap with it. In addition, positioning algorithms for both kinematic and static mode are not mentioned here, because they are basically the same as RTKLIB. Please refer to Section E.7 of the RTKLIB manual for them.

2 Design Concept

CLASLIB is developed to show a reference implementation of user's algorithm utilizing CLAS service. It has an SSR to OSR converter and PPP-RTK engine, namely SSR2OSR and RNX2RTKP. These utilities use compact SSR Messages specified in RTCM STANDARD 10403.2 [2] Section 3.5.12 "State Space Messages".

The SSR to OSR converter, SSR2OSR, implements an algorithm based on IS-QZSS-L6 [3]. The PPP-RTK engine, RNX2RTKP, implements kinematic and static modes for internal filters. Basic algorithm in the PPP-RTK engine part such as the Extended Kalman Filter and the LAMBDA method is almost the same as the one in RTK engine of RTKLIB.

The options or parameters of RNX2RTKP shown in this manual are recommended values to meet the performance level of CLAS specified in PS-QZSS [4] if a user observation is done in a static condition. Note that the value must be modified otherwise. The performance level could be satisfied if the following conditions are met.

Compact SSR Correction Condition:

- Carrier phase-range error: 8cm (95%, Single difference between satellites)

External Condition:

- Pseudorange receiver noise and code multipath : 0.34 [m] (sigma)
- Carrier phase receiver noise and carrier phase multipath : 0.9 [cm] (sigma)
- A number of satellites : 5 satellites (minimum)
- Dilution of Precision (DOP) : Horizontal 1.1(average), Vertical 1.8 (average)
- Ionosphere condition : Normal Condition

  The guide indicator is as following:

  Rate of TEC change Index (ROTI) <= 0.16 [TECU/min][1]

[1] This value is based on the value of Rate of TEC (ROT) at all the continuously operating reference stations (CORS) existing in the area of the same network ID. The value is derived from the average of the variance value every 5 minutes over an hour per network [5].

3 GNSS Signal Measurement Models

The following signal measurement models are used commonly in both SSR2OSR and RNX2RTKP's PPP-RTK mode.

(1) ZD measurement models

The phase-range $\Phi_{\mathrm{r}}^{\mathrm{s}}$ and pseudorange $\mathrm{P}_{\mathrm{r}}^{s}$ measurements for the satellite s are expressed by using (E.3.4) and (E.3.2) of [1] as:

$$\Phi_{\mathrm{r}}^{\mathrm{s}} = \overline{\Phi}_{\mathrm{r}}^{\mathrm{s}} + B_r^s + d\Phi_r^s + \epsilon_\Phi \quad \text{(E.9.1a)}$$

$$\mathrm{P}_{\mathrm{r}}^{s} = \overline{\mathrm{P}}_{\mathrm{r}}^{\mathrm{s}} + dP_r^s + \epsilon_\Phi \quad \text{(E.9.1b)}$$

Where $\mathrm{B}_{\mathrm{r}}^{\mathrm{s}}$ is the carrier-phase bias in m and $\mathrm{d}\Phi_{\mathrm{r}}^{\mathrm{s}}$ or $\mathrm{dP}_{\mathrm{r}}^{\mathrm{s}}$ is carrier-phase or pseudorange correction terms expressed as:

$$d\Phi_{\mathrm{r}}^{\mathrm{s}} = -d_{\mathrm{r,pco}}^{T} e_{r,enu}^{s} + d_{r,pcv}(El) - d_{r,disp}^{T} e_{r,enu}^{s} + d_{rel}^{s} + \lambda\phi_{pw} \quad \text{(E.9.2a)}$$

$$d\mathrm{P}_{\mathrm{r}}^{s} = -d_{\mathrm{r,pco}}^{T} e_{r,enu}^{s} + d_{r,pcv}(El) - d_{r,disp}^{T} e_{r,enu}^{s} + d_{rel}^{s} \quad \text{(E.9.2b)}$$

$\overline{\Phi}_{\mathrm{r}}^{\mathrm{s}}$ and $\overline{\mathrm{P}}_{\mathrm{r}}^{\mathrm{s}}$ are the virtual reference measurement for phase range and code range similar to type 20/21 messages of RTCM 2.3 [6] can be defined as follows:

$$\overline{\Phi}_{\mathrm{r}}^{\mathrm{s}} = \rho_r^s + c(dt_r(t_r) - dT^s(t^s)) + \delta\Phi_r^s \quad \text{(E.9.3a)}$$

$$\overline{\mathrm{P}}_{\mathrm{r}}^{s} = \rho_r^s + c(dt_r(t_r) - dT^s(t^s)) + \delta P_r^s \quad \text{(E.9.3b)}$$

Where the range correction for phase and code except the clock range correction and the orbit range correction are defined as:

$$\delta\Phi_{\mathrm{r}}^{\mathrm{s}} = -I_r^s + T_r^s + \delta b_p^s \quad \text{(E.9.4a)}$$

$$\delta\mathrm{P}_{\mathrm{r}}^{s} = I_r^s + T_r^s + \delta b_{\mathrm{c}}^{s} \quad \text{(E.9.4b)}$$

Where, $\delta b_{\mathrm{c}}^{\mathrm{s}}$ or $\delta b_{\mathrm{p}}^{\mathrm{s}}$ is code bias or phase bias for satellite s respectively. The clock range correction and orbit range correction required for calculation ρ_r^s can be defined by using RTCM SSR orbit and clock correction parameters described in Section E.4(7) of [1].

Note that update timing of "Network Bias correction" included in sub-type 6 is different from the Compact SSR orbit correction message (sub-type 2) in CLAS. This may cause a discontinuity in corrected measurement when the latest orbit correction message is applied while previous "Network Bias correction" is still used. Thus in CLASLIB, the discontinuity is compensated by subtracting difference of the sum of clock and orbit correction between before and after the update of orbit from the Network Bias correction by default. If you want to disable this function, the disable option "**`pos1-posopt10`**" should be set to "**`on`**".

Additionally, update interval concerning ionosphere correction (sub-type8 and 9) is 30 seconds. By using dual frequency measurement data, users can compensate time variation of ionosphere delay. If this concept is employed, the option "**`pos1-posopt6`**" is set to "**`meas`**". Where the range correction is defined as:

$$\delta\Phi^{s}_{r,L1}(t) = -I^{s}_{r}(t_0) + T^{s}_{r}(t) + \delta b^{s}_{p}(t_0) - \frac{f_2^2}{f_1^2 - f_2^2}\left(\Phi^{s}_{r,LC}(t) - \Phi^{s}_{r,LC}(t_0)\right) \qquad \text{(E.9.5a)}$$

$$\delta\Phi^{s}_{r,L2}(t) = -I^{s}_{r}(t_0) + T^{s}_{r}(t) + \delta b^{s}_{p}(t_0) - \frac{f_1^2}{f_1^2 - f_2^2}\left(\Phi^{s}_{r,LC}(t) - \Phi^{s}_{r,LC}(t_0)\right) \qquad \text{(E.9.5b)}$$

$$\Phi^{s}_{r,LC}[m] = \Phi^{s}_{r,L1} - \Phi^{s}_{r,L2} \qquad \text{(E.9.5c)}$$

$\Phi^{s}_{r,LC}$ is geometry-free liner combination (LC). t_0 is the exact second of QZSST that is sent in the header part of Message that contains the information (refer to the data field "GPS Epoch Time 1s" and "GNSS Hourly Epoch Time 1s" of the L6 message).

(2) Receiver and satellite antenna phase center model

The same model is used as PPP mode in RTKLIB described in section E.8 (2) and (3) of [1].

The user antenna's PCO (phase center offset) $d^{T}_{r,pco} e^{s}_{r,enu}$ and PCV (phase center variation) $d_{r,pcv}(El)$ should be corrected towards the range measurements. User may use the igs antex file attached in this archive. The option "**`pos1-posopt2`**" should be set "**`on`**".

(3) Site displacement by earth tides, pole tides, and ocean loading

For the site displacement $d_{r,disp}$ by earth tides, pole tides, and ocean loading, the same model is used as PPP mode in RTKLIB described in section E.8 (4) of [1]. The option "**`pos1-tidecorr`**" should be set to "**`on`**".

(4) Phase windup correction

The phase windup effect is the phase advance and delay by the relative rotation between the receiver and satellite antennas.

The coordinate transformation matrix E_s from the satellite body-fixed coordinates to ECEF coordinates is defined as:

$$e_z^s = -\frac{r^s}{|r^s|},\ e_s^s = \frac{v^s + \Omega_e \times r^s}{|v^s + \Omega_e \times r^s|},\ e_y^s = \frac{e_z^s \times e_s^s}{|e_z^s \times e_s^s|},\ e_x^s = e_y^s \times e_z^s \tag{E.9.6}$$

$$E_s = \left(e_x^s, e_y^s, e_z^s\right) \tag{E.9.7}$$

The phase-windup is modeled as:

$$E_r = \left(e_{r,x}^T, e_{r,y}^{\mathrm{T}}, e_{r,z}^T\right)^T \tag{E.9.8}$$

$$D^s = e_x^s - e_u^s(e_u^s \cdot e_x^s) - e_u^s \times e_y^s \tag{E.9.9}$$

$$D_{\mathrm{r}} = e_{r,x} - e_{\mathrm{r}}^s\left(e_r^s \cdot e_{r,x}\right) + e_r^s \times e_{r,y} \tag{E.9.10}$$

$$\phi_{\mathrm{pw}} = sign\left(e_r^s \cdot (D^s \times D_r)\right) \arccos \frac{D^s \cdot D_r}{|D^s||D_r|} \frac{1}{2\pi} + N \tag{E.9.11}$$

Where, N is the integer ambiguity, which is determined as to avoiding cycle-jumps.

The definition is same as (E.8.5)-(E.8.9) and (E.8.11)-(E.8.15) of [1] except for e_s^s.

The option "**pos1-posopt3**" should be set to "**on**".

(5) General relativistic delay

The general relativistic delay due to earth gravity [7] can be defined as follows:

$$d_{\mathrm{rel}}^s = \frac{2\mathrm{GM}_{\mathrm{earth}}}{\mathrm{c}^2} \ln\left(\frac{|r_s| + |r_r| + |r_s - r_r|}{|r_s| + |r_r| - |r_s - r_r|}\right) \tag{E. 9.12}$$

The option "**pos1-posopt8**" should be set to "**on**".

(6) Receiver dependent bias

User receiver's inter system biases should be set according to receiver type or user's own development receiver. The user can use the bias tables (*isb.tbl* and *l2cs.tbl*) attached in this archive. This table format is as same as that of GSILIB [8].

The values in the *isb.tbl* are between GPS (L1 C/A code, L2P code) and QZS (L1 C/A code and L2C(X) code) which should be subtracted from the rover measurements. The values in the L2C quarter cycle shift table should be set from the rover measurements. For setting the inter-system bias, refer to the Section 5-2 of the reference document [9].

The option "**pos2-isb**" and "**file-isbfile**" and "**pos2-isbbyprn**" (only for Topcon NET-G5) should be set for compensation of the inter-system biases. The option "**pos2-phasshft**" and "**file-phacycfile**" should be set for compensation of L2C quarter cycle shift.

4 Usage of Utilities

4.1 Input and Output

4.1.1 SSR2OSR

SSR2OSR is a CUI-AP which outputs corrections represented in observation space from QZSS L6 message (.l6) and RINEX or BINEX OBS/NAV (.o or .obs, .n or .nav or .bnx).The corrections are output to a solution status file (.osr). In addition, SSR2OSR can also output the coordinates to generate the corrections into NMEA0183-GGA (.nmea). The coordinates are derived from single-point positioning solution.

Input = (1) RINEXv3.x (.o or .obs, .n or .nav) or BINEX (.bnx)
(2) one or two L6 Message(s) (.l6)
Output= (1) Corrections represented in observation space (.osr)
(2) Coordinates to generate the corrections (.nmea)
(Coordinates are based on single-point positioning solution.)

4.1.2 RNX2RTKP

RNX2RTKP is a CUI-AP which outputs PPP-RTK positioning solution (.nmea) and corrections represented in observation space (.osr) from QZSS L6 message (.l6) and RINEX or BINEX OBS/NAV (.o or .obs, .n or .nav or .bnx).

Input = (1) RINEXv3.x (.o or .obs, .n or .nav) or BINEX (.bnx)
(2) one or two L6 Message(s) (.l6)
Output= (1) Corrections represented in observation space (.osr)
(2) PPP-RTK positioning solution (.nmea)

Note: When performing post-processing, make sure to input a valid/matching ephemeris. For example, in the case of the IODE of L6 Message from 22:00 to 24:00 indicating the ephemeris at 00:00 next day, the matching ephemeris at 00:00 needs to be inputted.

4.2 Configure options

4.2.1 SSR2OSR

The keywords which can be included in the configuration file for SSR2OSR are shown in the following tables. Some items specified in these options are also explained in the Section. 3

Item	Descriptions	Configuration File	Notes
Mode	Coordinates to use for conversion are fixed or not. - SSR2OSR: Coordinates are based on point positioning. - SSR2OSR-FIXED: Coordinates are fixed. To use the SSR2OSR-FIXED mode, set the coordinates in the options "**ant1-pos1**", **ant1-pos**2", and "**ant1-pos3**".	**pos1-mode**	
Frequency	Set the used frequency. The following combination is supported. - L1+L2 - L1+L2+L5	**pos1-frequency**	
Elevation Mask	Set elevation mask angle in degree	**pos1-elemask**	
SNR Mask	Set SNR thresholds to reject satellite signals for each 10 deg elevation bin.	**pos1-snrmask_r, snrmask_L1 snrmask_L2 snrmask_L5**	Applicable to "**meas**" mode of **pos1-posopt6**
Site Displacements	Set whether site displacements is applied or not - OFF: Not apply site displacements [default] - SOLID: solid earth tides - SOLID+OTL-STATION+POLE: apply displacements (solid earth tide + ocean loading effect + pole tide) for Japanese CORS stations - SOLID+OTL-CLASGRID+POLE: apply displacements (solid earth tide + ocean loading effect + pole tide) for static or moving rovers To apply OTL correction, set the OTL coefficients file path in the option "**file-blqfile**" and the marker name has to be included in the input RINEX file to select the station in BLQ file. To apply pole tide, set ERP(earth rotation parameter) file path in the option "**file-eopfile**"	**pos1-tidecorr**	
Satellite Ephemeris/ Clock	Set the type of satellite ephemeris - BRDC+SSRAPC: Broadcast ephemeris with RTCM SSR correction	**pos1-sateph**	
Rec PCV	Set whether the receiver antenna PCV (phase center variation) model is used or not. To use the feature, set the PCV file path in the option "**ant1-rectype**"	**pos1-posopt2**	

Item	Descriptions	Configuration File	Notes
PhWindup	Set whether the phase windup correction for SSR2OSR or SSR2OSR_FIXED modes is applied or not	**pos1-posopt3**	
Compensation of Frequency Dependent Term	Compensate time variation of frequency dependent term (satellite signal bias, STEC) of the SSR parameters - OFF: No compensation [default] - SSR: Compensation based on using CSSR's parameters over two generations, calculating the time change rate from the difference between the parameters before and after the update timing and multiplying the extrapolation time to the time change rate - MEAS: Compensation based on using dual frequency observation data, adding the time variation of the geometry-free LC carrier-phase combination to the correction converted from the SSR parameters	**pos1-posopt6**	
Shapiro time delay correction	Compensate Shapiro time delay - OFF - ON [default]	**pos1-posopt8**	
Compensation of Network Bias	Compensate time variation of Network Bias correction due to the difference of update timing of GNSS Clock correction and Orbit correction - OFF: enable [default] - ON: disable	**pos1-posopt10**	
Usage frequency (GPS/QZSS)	Usage frequency for GPS and QZSS - 2:l1+l2 - 3:l1+l5	**pos1-posopt11**	
Excluded Satellites (+PRN: Included)	Set the excluded satellites for the conversion processing. Fill in the PRN numbers of the satellites separated by spaces. For QZSS, use Jnn.	**pos1-exclsats**	
Navigation System	Set the used internal number of navigation satellite systems. If "+" is added to each internal number, the multi GNSSs are used for the processing. - 1:GPS - 8:Galileo - 16:QZSS	**pos1-navsys**	
CLAS Grid Definition File	Input the grid definition file of CLAS	**file-cssrgridfile**	
Ocean Loading BLQ File	Input the file path of an OTL coefficients file. The format of the OTL coefficients file is BLQ format.	**file-blqfile**	
EOP File	Input the file path of an EOD data file. The format of the EOP data file shall be IGS ERP format version.2	**file-eopfile**	

Item	Descriptions	Configuration File	Notes
Receiver Antenna PCV File ANTEX	If you apply the receiver antenna phase center offset and PCV correction, input ANTEX antenna parameters file path	**file-rcvantfile**	
Inter-System Bias	Set inter system bias (ISB) correction method - OFF [default] - TABLE	**pos2-isb**	
Inter-System Bias (ISB) Table File	Set ISB table file The format of ISB data files is as same as GSILIB [8].	**file-isbfile**	
Phase Cycle Shift	Set phase cycle shift correction method - OFF [default] - TABLE	**pos2-phasshft**	
Phase Cycle Shift Table File	Set 1/4 cycle shift table file	**file-phasecycfile**	
User Receiver Type	Set the type of the user receiver	**pos1-rectype**	
User Antenna Type	Set the type of the user antenna	**ant1-anttype**	
Reference Receiver Type	Set the reference receiver type - CLAS [default]	**pos2-rectype**	
Code/Carrier-Phase Error Rate L1/L2	Set the ratio of standard deviations of pseudo-range errors to carrier-phase errors for L1 and L2	**stats-eratio1** **stats-eratio2**	
Carrier-Phase Error	Set the base term of carrier-phase error standard deviation (m)	**stats-errphase**	
Carrier-Phase Error/sin(el)	Set the elevation dependent term of carrier-phase error standard deviation (m/sin(el))	**stats-errphaseel**	
Lat/Lon/Height (deg/m)	Set the coordinate if you select "SSR2OSR-FIXED" mode in the option "**pos1-mode**"	**ant1-postype, pos1,pos2,pos3**	

4.2.2 RNX2RTKP

The keywords which can be included in the configuration file for RNX2RTKP are shown in the following tables. Some items specified in these options are also explained in the Section. 3.

The same options as described in section 3.5 of the RTKLIB manual [1] are not stated. Only extended options from the original RNX2RTKP of RTKLIB are listed.

Item	Descriptions	Configuration File	Notes
Mode	Set positioning mode - PPP-RTK - VRS-RTK	**pos1-posmode**	Only support PPP-RTK and VRS-RTK mode
Ionosphere Correction	Set ionospheric correction options.Ionospheric delay for each satellite is estimated. - EST-ETEC: Estimate ionospheric parameter STEC - EST-ADAPTIVE: Estimate ionospheric parameter STEC adaptively	**pos1-ionoopt**	Only applicable to PPP-RTK and VRS-RTK mode
PhWindup	Set whether the phase windup correction for PPP-RTK modes is applied or not.	**pos1-posopt3**	Only applicable to PPP-RTK mode
Compensation of Frequency Dependent Term	Compensate time variation of frequency dependent term (satellite signal bias, STEC)of the SSR parameters - OFF: No compensation - SSR: Compensation based on using CSSR's parameters over two generations, calculating the time change rate from the difference between the parameters before and after the update timing and multiplying the extrapolation time to the time change rate - MEAS: Compensation based on using dual frequency observation data, adding the time variation of the geometry-free LC carrier-phase combination to the correction converted from the SSR parameters	**pos1-posopt6**	Only applicable to PPP-RTK mode
Partial Ambiguity Resolution	Set partial integer ambiguity resolution mode: - OFF: Integer Ambiguity Resolution for all observed satellites on all frequencies - ON: Integer Ambiguity Resolution in which an elevation criterion is used to remove the low-precision ambiguity estimates for AR.	**pos1-posopt7**	Only applicable to PPP-RTK and VRS-RTK mode
Shapiro time delay correction	Compensate Shapiro time delay - OFF - ON	**pos1-posopt8**	Only applicable to PPP-RTK mode

Item	Descriptions	Configuration File	Notes
Reference Satellite	Selects a reference satellite among - OFF: GPS and QZS - ON: GPS	**pos1-posopt9**	Only applicable to PPP-RTK and VRS-RTK mode
Compensation of Network Bias	Compensate time variation of Network Bias correction due to the difference of update timing of GNSS Clock correction and Orbit correction - OFF :enable [default] - ON: disable	**pos1-posopt10**	Only applicable to PPP-RTK mode
Usage frequency (GPS/QZSS)	Usage frequency for GPS and QZSS - 2:l1+l2 - 3:l1+l5	**pos1-posopt11**	Only applicable to PPP-RTK and VRS-RTK mode
The threshold of distance for Single Grid Selection Mode	When the nearest grid is within setting distance [m] from the approximate position (single solution), only one grid is used for PPP-RTK positioning.	**pos1-gridsel**	Only applicable to PPP-RTK and VRS-RTK mode
Ambiguity fixing between GPS and QZSS	Set ambiguity fixing mode for GPS and QZSS - off: unfix ambiguities of QZSS satellites - on: fix ambiguities among QZSS satellites - gps-qzs: fix ambiguities between GPS and QZSS	**pos2-qzsarmode**	Only applicable to PPP-RTK and VRS-RTK mode
Significance Level of Ratio Test	Set significance level of ratio test Threshold of ratio test is variable with respect to the number of ambiguities (satellites) and significance level (0:0.1%, 1:0.5%, 2:1%, 3:5%, 4:10%, 5:20%).	**pos2-aralpha**	Only applicable to PPP-RTK and VRS-RTK mode
Minimum Number of Partial Ambiguity Fixing	Set the minimum number of ambiguities to try to calculate partial ambiguity fixing. When ambiguities are not fixed, the processing of partial ambiguity resolution is continued until the specified ambiguity number is reached.	**pos2-arminamb**	Only applicable to PPP-RTK and VRS-RTK mode
Reject Threshold solution of PPP-RTK	Set the reject threshold of difference of positioning result between Single and PPP-RTK (or VRS-RTK)	**pos2-rejdiffpse**	Only applicable to PPP-RTK and VRS-RTK mode
Reject Threshold of Innov.	Set the reject threshold of L1/L2 residuals, dispersive residuals, and non-dispersive (l0) residuals (sigma)	**pos2-rejiono1** **rejiono2** **rejiono3**	Only applicable to PPP-RTK and VRS-RTK mode
Reject Threshold of Chi-square	Set the reject threshold of Fix&Hold threshold (chi-square times) and Fix threshold (chi-square times)	**pos2-rejiono4** **rejiono5**	Only applicable to PPP-RTK and VRS-RTK mode

Item	Descriptions	Configuration File	Notes
Reject Threshold of Positioning Error	Set the reject threshold of positioning error to reset all states	**pos2-poserrcnt**	Only applicable to PPP-RTK and VRS-RTK mode
Forgetting Factor of Ionospheric Delay	Set the forgetting factor of ionospheric delay estimation [0.0～1.0] To use the feature, set the option "**pos1-ionoopt=est-adaptive**"	**pos2-forgetion**	Only applicable to PPP-RTK and VRS-RTK mode
Adaptive Filter Gain for Ionospheric Delay	Set the gain of the adaptive filter for ionospheric delay estimation. To use the feature, set the option "**pos1-ionoopt=est-adaptive**"	**pos2-afgainion**	Only applicable to PPP-RTK and VRS-RTK mode
Adjust Process Noise of Position/Velocity/Acceleration	Adjust adaptively process noise of position, velocity, and acceleration - 0: OFF - 1: ON	**pos2-prnadapt**	Only applicable to PPP-RTK and VRS-RTK mode
Forgetting Factor of Position/Velocity/Acceleration	Set the forgetting factor of position, velocity, and acceleration estimation [0.0～1.0]	**pos2-forgetpva**	Only applicable to PPP-RTK and VRS-RTK mode
Adaptive Filter Gain for Position/Velocity/Acceleration	Set the gain of the adaptive filter of position, velocity, and acceleration.	**pos2-afgainpva**	Only applicable to PPP-RTK and VRS-RTK mode
Receiver Position Horiz/Vertical	Set the process noise standard deviation of receiver position as the horizontal or vertical component (m).	**stats-prnposith, prnpositv**	Only applicable to PPP-RTK and VRS-RTK mode
Adaptive Ionospheric Delay Estimation	Set the maximum process noise standard deviation of ionospheric delay (m).	**stats-prnionomax**	Only applicable to EST-ADAPTIVE mode
Vertical Ionospheric Residual Delay	Set the time constant [s] of Kalman Filter for vertical ionosphere residual delay	**stats-tconstiono**	Only applicable to PPP-RTK and VRS-RTK mode
Number of Trials to Reset Filter For Starting	Set the number of trials to reset filter from starting of PPP-RTK (or VRS-RTK) positioning	**misc-retrycnt**	Only applicable to PPP-RTK and VRS-RTK mode

<table>
<tr><th>Item</th><th>Descriptions</th><th>Configuration File</th><th>Notes</th></tr>
<tr><td>Unfix Count to Reset Filter For Starting</td><td>Set the number of unfixing epoch count to reset filter from starting of PPP-RTK (or VRS-RTK) positioning (counter)</td><td>misc-epochtoretry</td><td>Only applicable to PPP-RTK and VRS-RTK mode</td></tr>
<tr><td>Float Count to Reset Filter</td><td>Set the number of float continuation epoch to reset the filter</td><td>misc-floatcnt</td><td>Only applicable to PPP-RTK and VRS-RTK mode</td></tr>
<tr><td>Signal Priority of GPS L2 Band Signal</td><td>Set the priority of signals for GPS and QZS when two signals are present.
<table>
<tr><th>Settings</th><th>Prioritized Signal for GPS</th><th>Prioritized Signal for QZS</th></tr>
<tr><td>-OFF</td><td>L2P</td><td>L1C/A</td></tr>
<tr><td>-GL2X</td><td>L1C</td><td>L1C/A</td></tr>
<tr><td>-JL1C</td><td>L2P</td><td>L1C</td></tr>
<tr><td>-GL2X -JL1C</td><td>L2C</td><td>L1C</td></tr>
</table></td><td>misc-rnxopt1</td><td>-GL2X and -JL1C are only applicable to PPP-RTK and VRS-RTK mode.</td></tr>
<tr><td>Inter-System Bias</td><td>Set inter system bias (ISB) correction method
- OFF
- Table</td><td>pos2-isb</td><td>Only applicable to PPP-RTK and VRS-RTK mode</td></tr>
<tr><td>Inter System Bias Table File</td><td>Set ISB table file</td><td>file-isbfile</td><td>Only applicable to PPP-RTK and VRS-RTK mode</td></tr>
<tr><td>Phase Cycle Shift</td><td>Set the phase cycle shift correction method
- OFF
- Table</td><td>pos2-phasshft</td><td>Only applicable to PPP-RTK mode</td></tr>
<tr><td>Phase Cycle Shift Table File</td><td>Set 1/4 cycle shift table file</td><td>file-phacycfile</td><td>Only applicable to PPP-RTK and VRS-RTK mode</td></tr>
<tr><td>User Receiver Type</td><td>Set the user receiver type</td><td>pos1-rectype</td><td></td></tr>
<tr><td>Reference Receiver Type</td><td>Set the reference receiver type
- CLAS [default]</td><td>Pos2-rectype</td><td></td></tr>
<tr><td>CLAS Grid Definition File</td><td>Set the grid definition file of CLAS</td><td>cssr-gridfile</td><td></td></tr>
</table>

4.3 CUI Command References and Recommended Options

4.3.1 SSR2OSR

SYNOPSIS

ssr2osr [option ...] files

DESCRIPTION

Read RINEX 3.x or BINEX OBS/NAV and L6 message (.l6) files, compute receiver rough positions by point positioning, and output the rough positions (NMEA0183-GGA) and corrections represented in observation space (Solution Status File).

All of the input file paths can include wild‐cards (*). To avoid command line deployment of wild‐cards, use "..." for paths with wild‐cards.

Command line options are as follows ([]: default). With the `-k` option, the processing options are input from the configuration file. In this case, command line options precede options in the configuration file.

OPTIONS

-k file input options from configuration file [off]

-ti tint time interval (sec) (1 or 30)[1]

-ts ds ts start day/time (ds=y/m/d ts=h:m:s) [obs start time]

-te de te end day/time (de=y/m/d te=h:m:s) [obs end time]

-l6w WEEK specify GPS week corresponding to the start time of .l6 file.

[obs start time]

-o set output file [NMEA-GGA]

-dump output parsed each compact ssr subtype message

-x level debug trace level (0:off) [2]

EXAMPLE

Using configuration file, output Solution Status File including OSR conversion results

```
> ssr2osr.exe -k post.conf -ts 2018/06/05 21:00:00 -te 2018/06/05 21:59:59
  156960627V.obs 156960627V.nav 2018156V.l6 –x 0 -n
```

CONFIGURATION FILE (Recommendation Setting)

A configuration file containing processing options, solution options, and file options. That is a text file which contains the Keyword = Value form records indicating the various options. For enumeration values, the selectable value is either of a number (0,1,2,...) or an enumeration label (off, on, ...). The line starting with # and the texts after # in a line are treated as comments, which are the same as RTKLIB.

```
# Setting for ssr2osr's conversion models
pos1-posmode       =ssr2osr   # (10:ssr2osr,11:ssr2osr-fixed)
pos1-frequency     =l1+l2+l5  # (2:l1+l2, 3:l1+l2+l5)
pos1-elmask        =15         # (deg)
pos1-snrmask_r     =on         # (1:on)
pos1-snrmask_L1    =10,10,10,10,30,30,30,30,30 # SNR mask for L1 (Trimble)
pos1-snrmask_L2    =10,10,10,10,30,30,30,30,30 # SNR mask for L2 (Trimble)
pos1-snrmask_L5    =10,10,10,10,30,30,30,30,30 # SNR mask for L5 (Trimble)
pos1-tidecorr      =solid+otl-station+pole
                    #(2:solid+otl-station+pole,3:solid+otl-clasgrid+pole)
                    # 2:for Japanese CORS stations
                    # 3:for static or moving rovers
pos1-sateph        =brdc+ssrapc# (3:brdc+ssrapc)
pos1-posopt2       =on         # receiver antenna model(1:on)
pos1-posopt3       =on         # phase windup correction(1:on)
pos1-posopt6       =meas       # compensate time variation of ionosphere
                               # delay. Extrapolation based on the change of
                               # phase measurement data is executed(2:meas)
pos1-posopt8       =on         # shapiro time delay correction (1:on)
pos1-posopt10      =off        # compensate time variation due to difference of
                                 update timing of network bias(0:off is
                                 effective)
pos1-navsys        =25         # (1:gps+8:galileo+16:qzs)
file-cssrgridfile  =clas_grid.def # use cssrgrid_201709.def before April. 2018
file-blqfile       =ERP_all_20170107.blq # for Japanese CORS stations
                  #=clas_grid.blq        # for static or moving rovers
file-eopfile       =igu00p01.erp

# Setting for point positioning
stats-eratio1      =50         # code/phase error ratio
stats-errphase     =0.01       # (m) measurement error
stats-errphaseel   =0.006      # (m) measurement error elevation dependent
```

```
# Setting only for ssr2osr-fixed mode
ant1-postype        =llh        # (0:llh,1:xyz)
ant1-pos1           =           # (deg|m)
ant1-pos2           =           # (deg|m)
ant1-pos3           =0          # (m|m)
```

4.3.2 RNX2RTKP

SYNOPSIS

rnx2rtkp [option ...] files [...]

DESCRIPTION

Read RINEX 3.x or BINEX OBS/NAV, L6 message (.l6) files, compute PPP-RTK processing, and output rough position solutions to generate corrections (NMEA0183-GGA), corrections in observation space (Solution Status File) and PPP-RTK positioning solutions (NMEA0183-GGA). Switching between static mode and kinematic mode is performed by switching "on" or "off" of the option "**pos1-dynamics**" and changing the value of the option"**pos2-rejionno1**","**pos2-rejionno2**","**pos2-rejionno3**","**pos2-prnadpt**","**pos2-prnposith**", "**pos2-prnpositv**", "**stats-prnaccelh**", and "**stats-prnaccelv**". For the configuration file, refer to the following section. Please note that the original RNX2RTKP options except for described in the below and the next section are not confirmed as CLASLIB.

OPTIONS

```
-k file input options from configuration file [off]
-ti tint time interval (sec) (1 or 30)[1]
-ts ds ts start day/time (ds=y/m/d ts=h:m:s) [obs start time]
-te de te end day/time (de=y/m/d te=h:m:s) [obs end time]
-l6w WEEK specify GPS week corresponding to the start time of .l6 file.
       [obs start time]
-o output NMEA-0183 GGA sentence [off]
-x level debug trace level (0:off) [2]
-s set output osrfile [off]
-l6msg mode L6 message 2ch mode (0:off,1:on) [0]
```

EXAMPLE

PPP-RTK mode, L1+L2+L5, using configuration file, output NMEA-GGA

```
 >./rnx2rtkp.exe -ti 1 -ts 2018/06/05 21:00:00 -te 2018/06/05 21:59:59
```

```
-k erp0627.conf 156960627V.obs 156960627V.nav 2018156V.l6
-o 156960627V.nmea
```

CONFIGURATION FILE (Recommendation Setting for PPP-RTK mode)

```
# Setting for observation models
pos1-posmode       =ppp-rtk    # (9:ppp-rtk for CLAS)
pos1-frequency     =l1+l2+l5   # (2:l1+l2, 3:l1+l2+l5)
pos1-soltype       =forward    # (0:forward)
pos1-elmask        =15         # (deg)
pos1-snrmask_r     =on         # (1:on)
pos1-snrmask_L1    =10,10,10,10,30,30,30,30,30 # SNR mask for L1 (Trimble)
pos1-snrmask_L2    =10,10,10,10,30,30,30,30,30 # SNR mask for L2 (Trimble)
pos1-snrmask_L5    = 10,10,10,10,30,30,30,30,30 # SNR mask for L5 (Trimble)
pos1-dynamics      =on         # (0:off for static, 1:on  for kinematic mode)
pos1-tidecorr      =solid+otl-station+pole
                    #(2:solid+otl-station+pole,3:solid+otl-clasgrid+pole)
                    # 2:for Japanese CORS stations
                    # 3:for static or moving rovers
pos1-ionoopt       =est-adaptive # (4:est-stec, 9: est-adaptive)
pos1-tropopt       =off        # (0:off)
pos1-sateph        =brdc+ssrapc# (3:brdc+ssrapc)
pos1-posopt1       =off        # satellite antenna model(0:off)
pos1-posopt2       =on         # receiver antenna model(1:on)
pos1-posopt3       =on         # phase windup correction(1:on)
pos1-posopt4       =on         # exclude measurements of eclipsing
                               # satellite(1:on)
pos1-posopt5       =off        # raim fde(0:off)
pos1-posopt6       =meas       # compensate time variation of ionosphere
                               # delay. Extrapolation based on the change of
                               # phase measurement data is executed(2:meas)
pos1-posopt7       =on         # partial ambiguity resolution(0:off,1:on)
pos1-posopt8       =on         # shapiro time delay correction (1:on)
pos1-posopt9       =on         # exclude QZS as a reference satellite
                               #(0:off,1:on)
pos1-posopt10      =off        # compensate time variation due to difference
```

```
                                # of update timing of network bias(0:off is
                                # effective)
pos1-posopt11      =l1+l2       # Usage frequency for GPS and
                                # QZSS(2:l1+l2,3:l1+l5)
pos1-navsys        =25          # (1:gps+8:galileo+16:qzs)
pos1-gridsel       =1000        # nearest gird distance[m] for single grid
                                # interpolation
misc-rnxopt1       =            # GPS L2 signal priority(Default:L2P,-GL2X:L2C)
file-cssrgridfile  =clas_grid.def
                                # use grid file attached in IS-QZSS-L6
file-blqfile       =ERP_all_20170107.blq # for Japanese CORS stations
                  #=clas_grid.blq       # for static or moving rovers
file-eopfile       =igu00p01.erp

# Setting for parameters of user receiver and antenna
file-rcvantfile    =ngs14.atx
pos2-isb           =table                 # isb correction method
                                          #(0:off,1:table)
file-isbfile       =isb.tbl
pos2-phasshft      =table                 # 1/4 cycle phase shift correction
                                          #  method in case of L2C
                                          # (0:off,1:table)
file-phacycfile    =l2csft.tbl
pos1-rectype       =Trimble NetR9         # User receiver type
ant1-anttype       =TRM59800.80     NONE  # User antenna type
pos2-rectype       =CLAS                  # Reference receiver type
                                          # (always fixed as CLAS)
# Setting for parameters of Ambiguity Resolution
pos2-armode        =fix-and-hold # (3:fix-and-hold)
pos2-qzsarmode     =on          # (0:off,1:on,2:gps-qzs)
pos2-aralpha       =10%         # significance level
                                #  5%:for IS-QZSS-L6-001
                                # 10%:for IS-QZSS-L6-003 or later
pos2-arlockcnt     =5           # min lock count to fix ambiguity
pos2-arelmask      =20          # elevation mask of AR for rising satellite
                                # (deg)
```

```
pos2-elmaskhold    =30        # elevation mask of AR hold for rising
                              # satellite (deg)
pos2-aroutcnt      =1         # outage to reset ambiguity slip thres
pos2-arminfix      =0         # set minimum fix count for fix-and-hold
pos2-varholdamb    =0.001     # variance for fix-and-hold psuedo measurements
                              # (cycle^2)
pos2-slipthres     =0.05      # cycle‐slip thres (m) of geometry‐free LC(m)
pos2-rejionno1     =2.0       # (sigma) reject threshold for L1/L2 residuals
                              # 4.0 for static mode
                              # 2.0 for kinematic mode
pos2-rejionno2     =3.0       # (sigma) reject threshold for dispersive
                              # residuals
                              # 6.0 for static mode
                              # 3.0 for kinematic mode
pos2-rejionno3     =3.0       # (sigma) reject threshold for non-dispersive
                              # (l0) residuals
                              # 6.0 for static mode
                              # 3.0 for kinematic mode
pos2-rejionno4     =0.5       # (-) Fix&Hold threshold  (chi-square times)
pos2-rejionno5     =5.0       # (-) Fix threshold   (chi-square times)
pos2-niter         =1         # number of iteration in the measurement update
                              # of the estimation filter
pos2-baselen       =0         # baseline length(m)
pos2-basesig       =0         # standard deviation of the baseline length (m)
pos2-arminamb      =6         # min number of ambiguities for PAR
                              # 4:for IS-QZSS-L6-001
                              # 6:for IS-QZSS-L6-003 or later
pos2-armaxdelsat   =4         #  max number of excluded satellites for PAR
pos2-maxage        =30        # maximum value of age of differential (s)
pos2-rejdiffpse    =10        # maximum position error to reset filter (m)
pos2-poserrcnt     =5         # Reject threshold of positioning error (count)
pos2-forgetion     =0.3       # forgetting factor of iono (0.0~1.0)
pos2-afgainion     =3.0       # adaptive filter gain in iono estimation
pos2-prnadpt       =off       # adjust adaptively pos/vel/acc process noise
                              # (0:off,1:on)
                              # on for static mode
```

```
                                    # off for kinematic mode
pos2-forgetpva      =0.3            # forgetting factor of pos/vel/acc (0.0~1.0)
pos2-afgainpva      =1.0            # adaptive Filter gain in pos/vel/acc

# Setting for parameters of kalman filter
stats-eratio1       =50             # code/phase error ratio
stats-errphase      =0.010          # phase error std (m)
stats-errphaseel    =0.005          # elevation dependent phase error std(m)
stats-errphasebl    =0.000          # baseline-length dependent phase error(m/10km)
stats-errdoppler    =10             # doppler errors std(Hz)
stats-stdbias       =50             # initial-state std bias (cycle)
stats-stdiono       =0.010          # initial-state std iono (m) L1 iono
stats-stdtrop       =0.005          # initial-state std trop (m)
stats-prnaccelh     =0.20000        # process-noise std acc h (m/s^2)
                                    # 0.05000 for static mode
                                    # 0.20000 for kinematic mode
stats-prnaccelv     =0.10000        # process-noise std acc v (m/s^2)
                                    # 0.02500 for static mode
                                    # 0.10000 for kinematic mode
stats-prnposith     =0.0000         # process-noise std pos h (m)
                                    # 0.0001 for static mode
                                    # 0.0000 for kinematic mode
stats-prnpositv     =0.0000         # process-noise std pos v (m)
                                    # 0.0001 for static mode
                                    # 0.0000 for kinematic mode
stats-prnbias       =0.00100        # process-noise std bias(m)
stats-prnionomax    =0.05000        # process-noise for est-adaptive mode (m)
stats-prniono       =0.00100        # process-noise std iono(m) L1 iono
stats-prntrop       =0.00100        # process-noise std trop(m)
stats-tconstiono    =10.0           # time constant of ionosphere variation (s)
stats-clkstab       =5.00e-12       # satellite clock stability(s/s)
ant1-postype        =single         # rover antenna type (2:single)
ant1-antdele        =0.0000         # (m)
ant1-antdeln        =0.0000         # (m)
ant1-antdelu        =0.0000         # (m)
ant2-postype        =xyz            # base station antenna type (0:llh,1:xyz)
```

```
ant2-pos1           =0           # (deg|m)
ant2-pos2           =0           # (deg|m)
ant2-pos3           =0           # (m|m)
ant2-anttype        =*
ant2-antdele        =0.0000      # (m)
ant2-antdeln        =0.0000      # (m)
ant2-antdelu        =0.0000      # (m)
misc-timeinterp     =on          # time interpolation of virtual reference
                                 # observation data (0:off,1:on)
misc-maxobsloss     =90          # reset all states if time difference
                                 # between current and previous exceeds
                                 # this time[s]
misc-retrycnt       =4           # number of trials to reset filter for starting
                                 # of PPP-RTK positioning (cnt)
misc-epochtoretry   =15          # unfix epoch count to reset filter for
                                 # starting of PPP-RTK positioning (epoch)
misc-floatcnt       =0           # float epoch count to reset filter (epoch)
                                 # 120 for static mode
                                 # 0 for kinematic mode
# Setting for output file format
out-solformat       =nmea        # (0:llh,1:xyz,2:enu,3:nmea)
out-outhead         =on          # (1:on)
out-outopt          =on          # (0:off,1:on)
out-timesys         =gpst        # (0:gpst,1:utc,2:jst)
out-timeform        =tow         # (0:tow,1:hms)
out-timendec        =3           # number of decimals in the time format
out-degform         =deg         # (0:deg,1:dms)
out-fieldsep        =            # separator for fields
out-height          =ellipsoidal# (0:ellipsoidal,1:geodetic)
out-geoid           =internal    # (0:internal)
out-solstatic       =all         # (0:all,1:single)
out-nmeaintv1       =0           # (s)
out-nmeaintv2       =0           # (s)
out-outstat         =residual    # (0:off,1:state,2:residual)
```

Appendix. A Solution Status File format

for corrections represented in observation space

DESCRIPTION

A solution status file is an output result that is a text file which contains the internal status of the positioning process. The following table shows the format of the corrections represented in observation space converted from each Compact SSR parameter.

Record/Field	Description	Corresponding Equation
Indicator	\$OSRRES	-
Time	QZSST [s]	-
GNSS ID	GNSS ID	4.1.2.2.2 (8) of IS-QZSS-L6 [6]
PRN	PRN number	-
Phase bias1	satellite phase bias δb_p^s for L1/E1 [m]	A part of E.9.4a
Phase bias2	satellite phase bias δb_p^s for L2 [m]	A part of E.9.4a
Phase bias5	satellite phase bias δb_p^s for L5/E5 [m]	A part of E.9.4a
Code bias1	satellite code bias δb_c^s for C1 [m]	A part of E.9.4b
Code bias2	satellite code bias δb_c^s for P2(LC) [m]	A part of E.9.4b
Code bias5	satellite code bias δb_c^s for C5 [m]	A part of E.9.4b
Troposphere	troposphere delay correction T_r^s [m]	A part of E.9.4a and E.9.4b
Ionosphere	ionosphere slant delay correction I_r^s [m]	A part of E.9.4a and E.9.4b
Antenna PCV1	antenna phase center variation $d_{r,pcv}$ for L1[m]	E.8.4 in [1]
Antenna PCV2	antenna phase center variation $d_{r,pcv}$ for L2[m]	E.8.4 in [1]
Antenna PCV5	antenna phase center variation $d_{r,pcv}$ for L5[m]	E.8.4 in [1]
Relativistic	relativistic delay d_{rel}^s [m]	E.9.12
Windup1	phase wind up effect ϕ_{pw} for L1/E1 [m]	E.9.11
Windup2	phase wind up effect ϕ_{pw} for L2 [m]	E.9.11
Windup5	phase wind up effect ϕ_{pw} for L5 [m]	E.9.11
Compensate1	compensation of time variation of frequency dependent error for L1/E1 [m]	In the case of using option "**`pos1-posopt6`**" is set to "**`on`**"
Compensate2	compensation of time variation of frequency dependent error for L2 [m]	In the case of using option "**`pos1-posopt6`**" is set to "**`on`**"
Compensate5	compensation of time variation of frequency dependent error for L5/E5 [m]	In the case of using option "**`pos1-posopt6`**" is set to "**`on`**"
CompensateN	compensation of difference of Network bias's update timing [m]	In the case of using option "**`pos1-posopt10`**" is set to "**`off`**"
Carrier phase correction1	carrier phase correction except for orbit and clock correction as OSR for L1 [m]	E.9.4a
Carrier phase correction2	carrier phase correction except for orbit and clock correction as OSR for L2 [m]	E.9.4a
Carrier phase correction5	carrier phase correction except for orbit and clock correction as OSR for L5 [m]	E.9.4a
Pseudo-range correction1	pseudo range correction except for orbit and clock correction as OSR for C1 [m]	E.9.4b
Pseudo-range	pseudo range correction except for orbit and	E.9.4b

correction2	clock correction as P2(LC) [m]	
Pseudo-range correction5	pseudo range correction except for orbit and clock correction as C5 [m]	E.9.4b
Orbit Correction	Orbit correction component in the line of sight from the receiver to the satellite [m]	As a reference value Not used in the measurement model
Clock correction	clock correction component in the line of sight from the receiver to the satellite [m]	As a reference value Not used in the measurement model
Coordinates	Coordinates to generate corrections from the L6 message [Latitude(deg)/Longitude (deg)/Height(m)]	-

EXAMPLE

msg,tow,sys,prn,pbias1,pbias2,pbias5,cbias1,cbias2,cbias5,trop,iono,antr1,antr2,antr5,relatv,wup1,wup2,wup5,compI1,compI2,compI5,compN,CPC1,CPC2,CPC5,PRC1,PRC2,PRC5,orb,clk,lat,lon,alt

OSRRES,250113.0,8,5,0.425,0.000,1.029,0.000,0.000,0.440,3.449,2.677,-0.074,0.000,0.000,0.015,-0.028,0.000,-0.038,-0.001,0.000,-0.002,0.028,1.672,0.000,0.685,5.475,0.000,7.644,-0.185,-0.723,36.103633603,140.086318429,69.771

OSRRES,250114.0,1,10,-0.099,0.023,0.000,0.000,1.640,0.000,5.259,2.674,-0.049,-0.062,0.000,0.015,-0.033,-0.042,-0.044,-0.001,-0.001,0.000,0.012,2.997,1.749,1.482,7.308,10.283,9.010,-0.608,-0.834,36.103633725,140.086318219,69.774

OSRRES,250114.0,1,12,1.536,2.026,0.000,0.000,-0.360,0.000,4.800,0.976,-0.056,-0.068,0.000,0.015,0.026,0.033,0.035,-0.012,-0.019,0.000,0.048,5.500,5.485,3.437,5.519,5.640,6.179,-1.066,1.883,36.103633725,140.086318219,69.774

Appendix. B Another utility for conventional RTK applications

DESCRIPTION

SSR technology can provide backward compatibility. The conventional RTK positioning technology, so-called VRS-RTK (Virtual Reference Station - Real-Time-Kinematic), can be utilized at rover side by converting SSR to virtual observations. For that purpose, CLASLIB includes another conversion utility, named SSR2OBS and prepares another positioning mode in RNX2RTKP, which is called VRS-RTK mode. CUI Command References of SSR2OBS and RNX2RTKP's VRS-RTK mode are as follows:

B.1 SSR2OBS

SYNOPSIS

ssr2obs [option …] files [...]

DESCRIPTION

Read L6 message (.l6) files and virtual station's position in configuration (.conf) file and output virtual observation files in RINEXv3 or RTCMv3 MSM format.

All of the input file paths can include wild - cards (*). To avoid command line deployment of wild - cards, use "..." for paths with wild - cards.

Command line options are as follows ([]: default). With option `-k`, the processing options are input from the configuration file. In this case, command line options precede options in the configuration file.

OPTIONS

```
-k file input options from configuration file [off]
-ts ds ts start day/time (ds=y/m/d ts=h:m:s) [obs start time]
-te de te end day/time (de=y/m/d te=h:m:s) [obs end time]
-ti tint time interval (sec) [1]
-l6w WEEK specify GPS week corresponding to the start time of .l6 file.
       [obs start time]
-x level debug trace level (0:off) [2]
-b output in RTCM3 MSM format
-r output in RINEX3 format
```

Using configuration file, output virtual observations in RINEXv3 format

```
> ssr2obs.exe -k sample.conf -ts 2018/09/18 00:00:00 -te 2018/09/18 01:00:00
  -ti 1 2018261A.l6 2018261.nav -r -o vrs2018261A.obs
```

Using configuration file, output virtual observations in RTCMv3 format

```
> ssr2obs.exe -k sample.conf -ts 2018/09/18 00:00:00 -te 2018/09/18 01:00:00
  -ti 1 2018261A.l6 2018261.nav -b -o vrs2018261A.obs
```

B.2 RNX2RTKP's VRS-RTK mode

SYNOPSIS

rnx2rtkp [option ...] files [...]

DESCRIPTION

Read RINEX 3.x or BINEX OBS/NAV or RTCM MSM files, compute VRS-RTK processing, and output VRS-RTK positioning solutions (NMEA0183-GGA). Switching between static mode and kinematic mode is performed by switching "on" or "off" of the option "**pos1-dynamics**" and changing the value of the option"**pos2-rejionno1**","**pos2-rejionno2**","**pos2-rejionno3**","**pos2-prnadpt**","**pos2-prnposith**","**pos2-prnpositv**","**stats-prnaccelh**","**stats-prnaccelv**" and "**misc-floatcnt**". For the configuration file, refer to section 4.2.2. and sample configuration files included in the folder 'util/rnx2rtkp'.

OPTIONS

-k file input options from configuration file [off]

-ts ds ts start day/time (ds=y/m/d ts=h:m:s) [obs start time]

-te de te end day/time (de=y/m/d te=h:m:s) [obs end time]

-ti tint time interval (sec)[1]

-l6w WEEK specify GPS week corresponding to the start time of .l6 file.
[obs start time]

-o output NMEA-0183 GGA sentence [off]

-x level debug trace level (0:off) [2]

EXAMPLE

VRS-RTK processing by static mode, L1+L2+L5, using configuration file, output NMEA-GGA

```
 > rnx2rtkp.exe -ti 1 -x 2 -k static_vrs.conf
   -ts 2018/09/18 00:00:00 -te 2018/09/18 01:00:00
   rover2018261A.obs 2018261.nav vrs2018261A.obs -o 2018261A.nmea
```

Appendix. C L6 Message Dump File

DESCRIPTION

L6 Message dump files are output in the case of specifying the option "-dump" in SSR2OSR/SSR2OBS, that are text files. All the data fields of each compact ssr sub type message included in L6 message are parsed and output. The output format is described in the first line of each dump file. The first line is always enumerated, even if any subtype message is not included in L6 messages. The following table shows the supported sub type and the corresponding dump file names.

Supported Sub type	Dump File Name	Note
Compact SSR Mask	parse_cssr_type1.csv	
Compact SSR GNSS Orbit Correction	parse_cssr_type2.csv	
Compact SSR GNSS Clock Correction	parse_cssr_type3.csv	
Compact SSR GNSS Satellite Code Bias	parse_cssr_type4.csv	
Compact SSR GNSS Satellite Phase Bias	parse_cssr_type5.csv	
Compact SSR GNSS Satellite Code and Phase Bias	parse_cssr_type6.csv	
Compact SSR GNSS URA	parse_cssr_type7.csv	
Compact SSR STEC Correction	parse_cssr_type8.csv	
Compact SSR GNSS Gridded Correction	parse_cssr_type9.csv	
Compact SSR GNSS Combined Correction	parse_cssr_type11.csv	
Compact SSR Atmospheric Correction	parse_cssr_type12_stec.csv parse_cssr_type12_grid.csv	*1

*1 Added from version 0.7.0.

References

[1] RTKLIB ver. 2.4.2 Manual, April 29, 2013

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[3] IS-QZSS-L6-003, August 20, 2020

[4] PS-QZSS-002, August 20, 2020

[5] Yuki Sato et al., Monitoring of Network Residual Ionosphere using ROT Index and its Application to "Centimeter-Level Augmentation Service (CLAS), Proceedings of the 27th International Technical Meeting of the ION Satellite Division, ION GNSS+2014, 2014.

[6] RTCM Recommended Standards for Differential GNSS (Global Navigation Satellite Systems) Service version 2.3, August 20, 2001

[7] G.Petit and B.Luzum (eds.), IERS Technical Note No.36, IERS Conventions (2010), 2010

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[9] Multi GNSS survey manual (draft) - Utilization of modernized GPS, Galileo etc. - Commentary, Geospatial Information Authority of JAPAN (GSI), 2015.