SINEX_BIAS—Solution (Software/technique) INdependent EXchange Format for GNSS BIASes Version 1.00

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0. Revision History

0.1. Update from V0.01 to V1.00:

- (A detailed listing will be added after the workshop discussion of format V1.00.)
- (PLEASE NOTE that there is a number of open questions indicated with "(??)" in this draft.)

1. Foreword and Acknowledgment

In 2011, a preliminary bias data format, called *SINEX_BIAS V0.01*, was proposed by Tim Springer (ESA/ESOC) for handling of GNSS bias estimates as part of the TGVF (Time and Geodetic Validation Facility) and the OVF (Orbit Validation Facility) of Galileo [Springer, 2011]. This format proposal was made on the basis of the *SINEX_TRO Format for combination of TROpospheric estimates Version 0.01* [Gendt, 1997].

The *SINEX_BIAS Format Version 1.00* is the result of a substantial update made on the basis of the *SINEX_BIAS V0.01*. It includes generalizations, extensions, and a considerable number of added detailed definitions, descriptions, and examples. The SINEX_BIAS format description document was completely rewritten. The original bias format concept—using the SINEX formalism—as formed by Tim Springer is acknowledged.

2. The Philosophy and General Features

2.1. Bias Data Format

In the face of a steadily growing variety of GNSS signals and observables, an adequate data format for GNSS bias products became indispensable.

The files should have a simple, but flexible structure, so that the IGS Analysis Centers (ACs) can straightforward reformat their internal bias estimates as well as users of IGS products can easily read and handle the bias products.

The proposed format is based on the SINEX Format [SINEX 2.02]. A number of format blocks may be taken directly from [SINEX 2.02], in particular:

```
FILE/REFERENCE
SITE/ID
SITE/RECEIVER
```

Some other format blocks are defined within this document:

```
BIAS/DESCRIPTION      (Mandatory)
BIAS/SOLUTION         (Mandatory)
```

The IGS ACs should submit daily files containing the estimated GNSS biases from all global sites and satellites. Only information directly connected to the bias estimates should be given.

2.2. Main Features of SINEX_BIAS

The `BIAS/SOLUTION` format structure of SINEX_BIAS V1.00 does allow the following main features:

- different parameter representations in the time domain: (i) *piece-wise constant*, (ii) *piece-wise linear*, (iii) *epoch-wise*;
- support of biases responding to: (i) *system*, (ii) *satellite*, (iii) *receiver*, (iv) *satellite-receiver*, and even (v) biases attributed to *specific receiver types*;
- *differential* (relative) **or** *observable* (pseudo-absolute) bias parameters;,
- the possibility to define extra linear combinations of GNSS observables (in addition to the *geometry-free* and the *ionosphere-free* LC supported by default);
- consideration of bias parameters with respect to *code* **and** *phase* observations;
- the possibility to define *GNSS observable groups* (to be treated with one common bias parameter).

The above listing of features shows a distinct **flexibility** for handling of any kind of GNSS bias values. It should be obvious that SINEX_BIAS should be well suited for further applications, such as PPP ambiguity resolution (PPP-AR), etc.

3. SINEX_BIAS File Naming

In the following, we provide a file naming convention for both *short* and *long* filenames. Filenames may be in *uppercase* or in *lowercase*. The filename extension should be: `.BIA` or `.bia` (conforming to the SINEX keyword "`BIA`" internally used).

3.1. Short Filenames

The files are named:

`CCCWWWWD.BIA` or `CCCYYDDD.BIA`

where

`CCC`:	3-figure Analysis Center (AC) designator
`WWWW`:	GPS week
`D`:	Day of week (0–6) or 7 for a weekly file
`YY`:	2-digit year
`DDD`:	Day of year

Examples: `COD18646.BIA[.gz]` or `cod15276.bia[.gz]`

3.2. Long Filenames

Based on a proposal for a new product naming convention worked out by colleagues from GFZ in analogy with the new RINEX naming scheme, we would propose to name the daily bias files in the following manner:

The full filename specification is given with:

`AAAVPPPTTT_YYYYDDDHHMM_LEN_SMP_CNT.FMT[.?*]`

```
01-03  AAA  3-char AC name (e.g.: DLR for "Deutsches Zentrum f r Luft- und Raumfahrt")
04       V  1-char version/solution identifier (here: nominally 0)
05-07  PPP  3-char campaign/project specification (e.g.: MGX)
08-10  TTT  3-char product type specification (e.g.: FIN for "final")
11     _    1-char separator (underscore)
12-15  YYYY 4-digit year of start epoch
16-18  DDD  3-digit day-of-year of start epoch
10-20  HH   2-digit hour of start epoch (here: 00)
21-22  MM   2-digit minute of start epoch (here: 00)
23     _    1-char separator (underline)
24-26  LEN  2-digits+1-char intended (nominal) product period
             (here: 01D for 1-day)
27     _    1-char separator (underline)
28-30  SMP  2-digits+1-char sampling interval
             (here: 01D for 1-day)
31     _    1-char separator (underscore)
32-34  CNT  3-char content type
35     .    1-char separator
36-38  FMT  3-char format extension (here: "BIA")

Optional:
39     .    extension
40-XX       compression file type (here: ".gz")
```

Example: `DLR0MGXFIN_20150010000_01L_01D_DCB.BIA.gz`

NOTE: Should any other bias file attribute be considered for the long filenames? E.g.: "BIAS MODE" (??).

4. SINEX_BIAS Version 1.00—Detail Format Description

4.1. Header and Footer Lines (Mandatory)

```
Description:

The Header line must be the first line in a SINEX_BIAS file.
The Footer line must be the last  line in a SINEX_BIAS file.

Contents:
```

H_E_A_D_E_R___L_I_N_E		
__Field_____	______Description_____	___Format_____
File Identifier	%=BIA	A5
Format Version	Four digits indicating the version of SINEX_BIAS format used. '1.00' for this version.	1X,F4.2
File Agency Code	Identify the agency creating the file.	1X,A3
Time	Creation time of this SINEX_BIAS file (preferably in UTC).	1X,I2.2, ':',I3.3,':',I5.5
Agency Code	Identify the agency providing the data in the SINEX_BIAS file.	1X,A3
Time	Start time of solution in the this SINEX_BIAS file (see also 'TIME SYSTEM' descriptor).	1X,I2.2, ':',I3.3,':',I5.5
Time	End time of the solution in the this SINEX_BIAS file (see also 'TIME SYSTEM' descriptor).	1X,I2.2, ':',I3.3,':',I5.5
Observation Code	Technique(s) used to generate the SINEX_BIAS solution. 'P' (GNSS) in case of SINEX_BIAS.	1X,A1
Number of Estimates	Number of parameters included in this SINEX_BIAS file.	1X,I5.5
Constraint Code	Single character indicating the constraint in the SINEX solution. 0-fixed/tight constraints, 1-significant constraints, 2-unconstrained. '2' in case of regular SINEX_BIAS; '1' should be chosen in cases with "internal" constraints,	1X,A1

	e.g., if GLONASS LCB biases are treated to be equal for identical GLONASS frequency channel numbers; '0' should be chosen in cases with "external" constraints, e.g, if a number of specific bias values was taken over from an external source. NOTE: Those values should be included in the SINEX_BIAS file (and indicated with STD DEV values set to zero).	
Solution Contents	Specification of the bias file contents. The corresponding keyword may be used to flag a bias file which contains non-specified data records (for test purposes). 'SINEX_BIA' indicates a regular SINEX_BIAS file. Any other keyword indicates an experimental bias file (e.g. of a special project).	1X,A9
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F_O_O_T_E_R___L_I_N_E		
__Field__	______Description_____	___Format_____
File Identifier	%=ENDBIA	A8
		8

4.2. BIAS/DESCRIPTION Block (Mandatory)

Description:

This block gives important parameters from the analysis and defines the fields in the block 'BIAS/SOLUTION'.

Contents:

BIAS/DESCRIPTION__D_A_T_A__L_I_N_E		
__Field__	______Description_____	___Format_____
Information Type	Describes the type of information present in the next field. May take on the following values:	1X,A39
	'OBSERVATION SAMPLING'	
	- Observation sampling interval [sec] used for data analysis.	1X,I12
	Mandatory information.	
	'PARAMETER SPACING'	
	- Parameter spacing interval [sec] used for parameter representation.	1X,I12
	Mandatory information.	
	'DETERMINATION METHOD'	
	- Determination method used to generate the bias results.	1X,A39
	Recommended entries are:	

	o 'DIRECT ESTIMATION' (analysis of observable differences only) o 'CLOCK ANALYSIS' (analyzing the ionosphere-free linear combination of the basic observables) o 'IONOSPHERE ANALYSIS' (analyzing the geometry-free/ionospheric linear combination) o 'COMBINED ANALYSIS' (results from both clock and ionosphere analysis) o 'PPP BIAS ANALYSIS' (determination of biases suited for PPP-AR) o 'CALIBRATION' (hardware calibration) o 'COMBINATION' (results from a combination of various bias products) Mandatory information.		
'BIAS MODE'	- The bias mode describes how the included bias values have to be interpreted and applied, respectively. Possible modes are: o 'DIFFERENTIAL' o 'OBSERVABLE' Obviously, this implies that inclusion of either o DIFFERENTIAL (relative) or o OBSERVABLE-specific (pseudo-absolute) bias values is allowed in a SINEX_BIAS file. Mandatory information.	1X,A39	
'TIME MODE'	- The time mode describes how the included bias values are represented in time (or how they were modeled in time). Possible modes are: o 'WINDOWS' o 'EPOCHS' Obviously, this implies that inclusion of either o time-window-specific or o epoch-specific bias values is allowed in a SINEX_BIAS file. NOTE: With WINDOWS, a piece-wise constant parameter model is assumed; with EPOCHS, piece-wise linear interpolation (between two consecutive epochs) is recommended (at least two epochs should be provided). Mandatory information.	1X,A39	
'TIME SYSTEM'	- The time tags specified in the BIAS/SOLUTION block have be give in a common TIME SYSTEM. Possible time systems are: o RINEX GNSS system flag (e.g. 'G '), o 'UTC' - Coordinated Universal Time, o 'TAI' - International Atomic Time.	1X,A3	

	NOTE: The declared 'TIME SYSTEM' should be consistent with the 'TIME SYSTEM ID' declared in an associated Clock-RINEX.		
	Compulsory information.		
'REFERENCE SYSTEM'			
	- Reference GNSS used for clock estimation. System code according to RINEX3 standards. E.g.: 'G'	1X,A1	
	Mandatory in case of clock analysis, else optional.		
'OBSERVABLE GROUP'			
	- GNSS flag,	1X,A1,	
	- number of given observable codes,	2X,I4,	
	- list of observable codes.	6(1X,A4)	
	NOTE: The first code is used as observable group code. This implies that by adding a non-existing RINEX3 code an extra observable group code could be defined. Further, only observable group codes may be used to address an observable of a defined observable group. HINT: '@' might be used to for indication of group codes (e.g.: '@C1P'). (??) Standardized OBSERVABLE GROUP codes: (??) IGS standardization for GNSS observable group codes might be requested (or highly desirable). (??)		
	Optional information (to be repeated for each desired GNSS observable line).		
'REFERENCE OBSERVABLES'			
	- Each involved GNSS,	1X,A1,	
	- reference code observable, or group of the first frequency,	2X,A4,	
	- reference code observable, or group of the second frequency.	1X,A4	
	NOTE: Observable codes have to be declared following RINEX3 standards (if it is not a group code). Already supported GNSS are: G - GPS R - GLONASS E - Galileo J - QZSS C - BeiDou I - IRNSS S - SBAS payload NOTE: In particular cases (e.g. the case with GLONASS LCB biases specific to satellite-receiver), the two observable code fields may be ' ' as the selection of observables may be considered for a user of a corresponding GLONASS clock product.		
	Mandatory data record (to be repeated for multiple GNSS).		
'ZERO-MEAN CONDITIONS'			
	- Each involved GNSS,	1X,A1,	
	number of effective zero-mean conditions:		
	- total number. This number	2X,I4,	

	has to be the sum of such conditions with respect to: - system (all biases), - satellite biases, - receiver biases, - satellite-receiver biases, - frequency channel number dependence (e.g. GLONASS), - other.	6(1X,I4)
	Mandatory data record (to be repeated for multiple GNSS).	
	'EXTRA LINEAR COMBINATION' (??) - Associated GNSS, - desired LC code, - number of observables, - list of RINEX3 observable names. NOTE: The first character of the desired LC code has to be '#' (hash). Examples are: #001, #W01, #WL1, #WLB, #W_G.	1X,A1, 2X,A4, 1X,I4, 5(1X,A4)
	Optional data record (to be repeated if required).	
	Any of the above fields may be and in any order.	

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4.3. BIAS/SOLUTION Block (Mandatory)

Description:

This block contains the bias estimates for all time intervals, or epochs.

Contents:

BIAS/SOLUTION_D_A_T_A_L_I_N_E		
Field	Description	Format
BIAS	Bias type identifier. Available types are: ' ': Blank/undefined means - differential bias or - observable bias (depending on the BIAS MODE specified in the BIAS/DESCRIPTION block); 'LCB ': ionosphere-free linear combination (LB) of the biases for the given reference observables; 'WLB ': wide-lane bias; (??) 'NLB ': narrow-lane bias. (??)	1X,A4
SVN	Satellite SVN code "CNNN": "C" - satellite system flag (according to RINEX3); "NNN" - SVN number (or GLONASS number).	1X,A4
PRN	Satellite PRN code "CNN": "C" - satellite system flag (according to RINEX3); "NN" - PRN number (or slot number for GLONASS).	1X,A3

Site Code	Station 4-character identifier, or name. The site code must be consistent with ITRF if a DOMES code is appended. Remark: Support A9 site code (??)	1X,A4
Unique Monument Identification (DOMES Code)	Unique alphanumeric monument identification. For ITRF purposes, it is a nine character DOMES/DOMEX number (five/six digits, followed by the single letter 'M' or 'S', followed by four/three digits).	1X,A9
OBS1 and OBS2 Observable Codes	Observables used for estimating the biases. The observable codes have to be given according to RINEX3 format definitions. If BIAS MODE is declared with 'OBSERVABLE', only OBS1 must be given (and no OBS2). IMPORTANT NOTE: Please be aware that distinction between - code (or pseudorange) and - phase biases is done on the basis of the given GNSS observable codes.	2(1X,A4)
Time	Start time or epoch for the bias estimate (depending on the TIME MODE specified). NOTE: The time tags specified here have to be given in a common time system (see also 'TIME SYSTEM' descriptor).	1X,I2.2, ':',I3.3, ':',I5.5
Time	End time for the bias estimate or blank (depending on the TIME MODE specified in the BIAS/DESCRIPTION block). Format for "end time" if blank:	1X,I2.2, ':',I3.3, ':',I5.5 1X,12X
Unit	Bias estimates are given in the specified unit. Unit has to be: 'ns' (nanoseconds) in any case. 'cyc' (cycles) for PPP-AR (??)	1X,A4
Bias Parameter Estimate	Estimated (total) value of the bias parameter.	1X,E21.15
Bias Parameter Standard Deviation	Estimated standard deviation for the bias parameter. NOTE: Bias values taken over from an external source should be indicated with a zero value.	1X,E11.6

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4.3.1. YY:DDD:SSSSS Time Tags

Please note that time tags are commonly given in a `YY:DDD:SSSSS` formatted representation (see also Appendix B, specifically Sections B.2, B.3.2).

Field	Description	Format
Time	YY:DDD:SSSSS. "UTC" YY = last 2 digits of the year, if YY <= 50 implies 21-st century, if YY > 50 implies 20-th century, DDD = 3-digit day in year, SSSSS = 5-digit seconds in day.	I2.2, ':',I3.3, ':',I5.5

Remark: `':'` corresponds to `1H:` (as originally used in the SINEX detail format descriptions).

4.3.2. COMMENT Lines and Floating Number Exponent

COMMENT lines starts with "`*`" in Col. 1 and can be anywhere within or outside a block, though for the clarity sake, beginning and ends of blocks are preferable.

For increased portability, the floating number exponent of "`E`" should be used rather than "`D`" or "`d`" which is not recognized by some compiler/installations.

See also: Appendix B, specifically Sections B.2, B.3.2, B.3.4.

5. General Notes on Bias Handling

5.1. Bias Parameter Representation in the Time Domain

There are two modes (`TIME MODE`) for the bias parameter representation in the time domain available:

- `TIME MODE = WINDOWS:` A piece-wise constant parameter model is assumed (see top subfigure of Figure 1).
- `TIME MODE = EPOCHS:` A piece-wise linear interpolation (between two consecutive epochs) may be used (see middle subfigure of Figure 1).

From a user's perspective, the bottom subfigure of Figure 1, which shows the extreme case ("epoch-wise") estimating and providing bias parameters for each observation epoch, may be considered and thus used as a "piece-wise linear" bias product. It is obvious that an "epoch" bias product with `OBSERVATION SAMPLING` and `PARAMETER SPACING` of, e.g., 30 seconds (the two values must be equal for an "epoch" bias product) should be applicable for high-rate (e.g. 1-Hz) observation data, too.

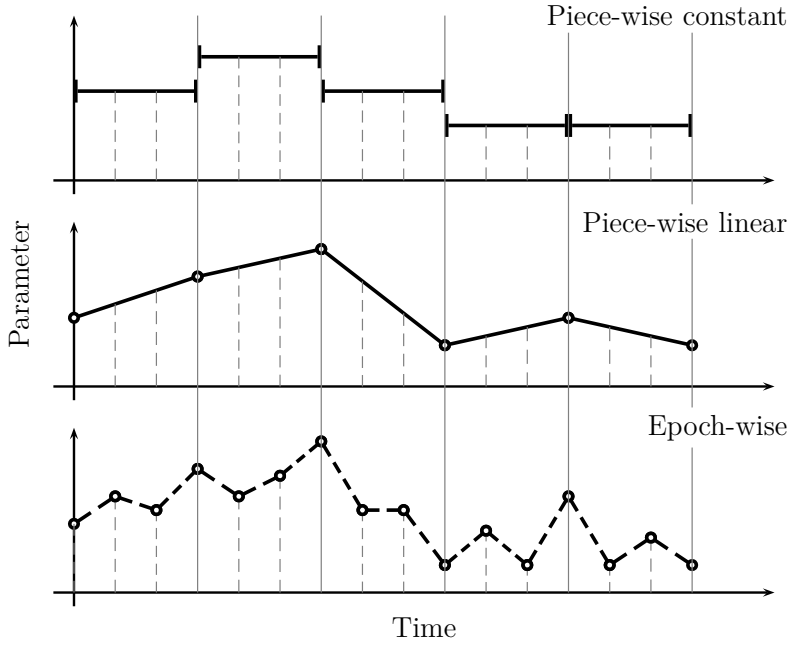

Figure 1: Different parameter representation modes in the time domain, as supported by the Bias-SINEX V1.00.

5.2. Definition of GNSS Observable Groups

The possibility to define specific *GNSS observable groups* may be considered as a very essential feature! More details will be added. Discussion needed. (??)

5.3. Notes on SVN/PRN and SITE Usage in BIAS/SOLUTION Block

The fields SVN/PRN and SITE may used for coding of biases with four different characteristics:

- **Satellite bias:** If a bias depends only on a satellite, SVN/PRN should be filled, site may be left empty.
- **Station bias:** If a bias depends only on a station and a particular GNSS, SITE should be filled and SVN/PRN should have the system code only (e.g. "G", "R", "E" for GPS, GLONASS, Galileo).
- **Satellite-station (satellite-receiver) bias:** If a bias depends on both satellite and station, all three fields should be used SVN/PRN/SITE.
- **System bias:** If a bias depends only on a particular GNSS, SVN/PRN should have the system code only (e.g. "G", "R", "E" for GPS, GLONASS, Galileo).

Remark: If SITE is filled, DOMES should be filled as well of course.

Examples for the four cases (listed above) may look like:

```
*------------------------------------------------------------------------------
+BIAS/SOLUTION
*BIAS SVN_ PRN SITE DOMES____ OBS1 OBS2 BIAS_START__ BIAS_END____ UNIT __ESTIMATED_VALUE____ _STD_DEV___
      G063 G01                C1P  C1C  15:276:00000 15:276:86399 ns   0.148022937908458E+01 .398201E-01
 LCB  C    C   ABMF 97103M001 C1I  C7I  15:276:00000 15:276:86399 ns   0.240909461328850E+02 .835246E+00
 LCB  R730 R01 AUCK 50209M001 C1P  C2P  15:276:00000 15:276:86399 ns   0.104868834341878E+02 .101419E+01
 LCB  G    G                 C1P  C2P  15:276:00000 15:276:86399 ns   0.000000000000000E+00 .000000E+00
-BIAS/SOLUTION
*------------------------------------------------------------------------------
```

5.4. Biases Specific to Receiver Types

There is a possibility foreseen for coding/providing bias values that depend on particular receiver types (e.g. for DCPB relevant for GLONASS ambiguity resolution).

The SITE field is used to link BIAS/SOLUTION (bias values) and SITE/RECEIVER (receiver types). Such a link may be defined by using a hash mark (**#**) as first character for a SITE code.

Example:

```
*------------------------------------------------------------------------------
+SITE/RECEIVER
*SITE PT SOLN T DATA_START__ DATA_END____ DESCRIPTION_________ S/N__ FIRMWARE___
 #001  A    1 P 15:276:00000 15:276:86399 RECEIVER TYPE 1      ----- -----------
 #002  A    1 P 15:276:00000 15:276:86399 RECEIVER TYPE 2      ----- -----------
 #003  A    1 P 15:276:00000 15:276:86399 RECEIVER TYPE 3      ----- -----------
...
-SITE/RECEIVER
*------------------------------------------------------------------------------
+BIAS/SOLUTION
*BIAS SVN_ PRN SITE DOMES____ OBS1 OBS2 BIAS_START__ BIAS_END____ UNIT __ESTIMATED_VALUE____ _STD_DEV___
 LCB  R    R   #001           L1P  L2P  15:276:00000 15:276:86399 ns   0.000000000000000E+00 .000000E+00
 LCB  R    R   #002           L1P  L2P  15:276:00000 15:276:86399 ns   0.000000000000000E+00 .000000E+00
 LCB  R    R   #003           L1P  L2P  15:276:00000 15:276:86399 ns   0.000000000000000E+00 .000000E+00
...
-BIAS/SOLUTION
*------------------------------------------------------------------------------
```

This example also shows that it is possible to provide differential code-phase bias (DCPB) values in a SINEX_BIAS file. They are treated as LC phase bias (or, alternatively, as observable phase bias (OPB).

5.5. Order of BIAS/SOLUTION Data Records

BIAS/SOLUTION data records may be listed in any arbitrary order. However, we recommend to list the included bias parameters starting with those responding to (i) system, (ii) satellite, (iii) receiver, (iv) satellite-receiver, (v) other. Furthermore, to keep the bias parameters in chronological order may be helpful.

6. Basic Definitions and Rules Concerning GNSS Biases

6.1. Sign Convention

The following sign convention is used for bias values:

$$\text{bias} = \text{estimator} - (\text{true or unbiased}) \text{ parameter} \tag{1a}$$

$$\text{bias} = \text{observation} - \text{true (or unbiased) observation} \tag{1b}$$

$$\text{observation} = \text{true observation} + \text{bias} \tag{1c}$$

$$\text{true observation} = \text{observation} - \text{bias} \tag{1d}$$

Numerical example: ground truth 11, observed 7, bias (or error) -4.

6.2. Bias Arithmetics

In the following, B is used to address bias values. C denotes pseudorange (or code) observations, L would be used for phase observations.

6.2.1. Basic Bias Equation

Using this notation, we may write:

$$\tilde{C}_{\text{true}} = C_{\text{observed}} - B_{\text{C}} \tag{2}$$

6.2.2. Satellite and Receiver Bias Components (and Total Bias)

The **total bias** (or overall bias), if a separation into a satellite component $B_{\text{satellite}}$ and into a receiver component B_{receiver} is assumed, is defined as follows:

$$B_{\text{total}} = B_{\text{satellite}} + B_{\text{receiver}} \tag{3}$$

6.2.3. Differential Code Bias (DCB)

A differential code bias (DCB) may be expressed as:

$$B_{\text{C1P-C1C}} = B_{\text{C1P}} - B_{\text{C1C}} \tag{4}$$

Using Equation (4), we may further derive that direct estimation of $B_{\text{C1P-C1C}}$ is possible just by analyzing the difference of $C_{1\text{P}}$ and $C_{1\text{C}}$:

$$B_{\text{C1P-C1C}} = B_{\text{C1P}} - B_{\text{C1C}} = (C_{1\text{P}} - \tilde{C}_1) - (C_{1\text{C}} - \tilde{C}_1) = C_{1\text{P}} - C_{1\text{C}} \tag{5}$$

where $\tilde{C}_1$ is used to denote the true (or unbiased) observations.

A DCB correction may be applied in the following way:

$$C_{1\text{P}} = C_{1\text{C}} + B_{\text{C1P-C1C}} \tag{6}$$

6.2.4. Ionosphere-Free Bias (LCB)

A ionosphere-free bias (LCB) may be written as

$$B_{\mathrm{LC(C1P,C2P)}} = \kappa_1 B_{\mathrm{C1P}} + \kappa_2 B_{\mathrm{C2P}} \tag{7}$$

where κ_1 and κ_2 are the two factor used for the computation of the ionosphere-free linear combination (LC). To be more specific, $\kappa_1 = \nu_1^2/(\nu_1^2 - \nu_2^2) = 2.546$, $\kappa_2 = -\nu_2^2/(\nu_1^2 - \nu_2^2) = -1.546$; ν_i is the frequency of the i-th carrier. C1P and C2P observables are assumed in this example.

6.2.5. Observable Code Bias (OCB)

The following equation system may be used to derive the inverse transformation from *differential* (relative) to *observable-specific* (pseudo-absolute) code biases (or simply DCB to OCB). The first equation describes the relationship of the OCBs for the ionosphere-free case (clock analysis), the second equation accordingly for the geometry-free case (ionosphere analysis).

$$\kappa_1 B_{\mathrm{C1P}} + \kappa_2 B_{\mathrm{C2P}} = B_{\mathrm{LC(C1P,C2P)}} \tag{8a}$$

$$B_{\mathrm{C1P}} - B_{\mathrm{C2P}} = B_{\mathrm{C1P\text{-}C2P}} \tag{8b}$$

By substituting $B_{\mathrm{C2P}} = B_{\mathrm{C1P}} - B_{\mathrm{C1P\text{-}C2P}}$, we may write $\kappa_1 B_{\mathrm{C1P}} + \kappa_2 (B_{\mathrm{C1P}} - B_{\mathrm{C1P\text{-}C2P}}) = B_{\mathrm{C1P}} - \kappa_2 B_{\mathrm{C1P\text{-}C2P}} = B_{\mathrm{LC(C1P,C2P)}}$. The two pseudo-absolute bias components thus result in:

$$B_{\mathrm{C1P}} = \kappa_2 B_{\mathrm{C1P\text{-}C2P}} + B_{\mathrm{LC(C1P,C2P)}} \tag{9a}$$

$$B_{\mathrm{C2P}} = (\kappa_2 - 1) B_{\mathrm{C1P\text{-}C2P}} + B_{\mathrm{LC(C1P,C2P)}} = -\kappa_1 B_{\mathrm{C1P\text{-}C2P}} + B_{\mathrm{LC(C1P,C2P)}} \tag{9b}$$

Equation (9) describes the DCB-to-OCB transformation, Equation (8) the OCB-to-DCB transformation. Let us give a numerical example. The following OCB values, $B_{\mathrm{C1P}} = +10.73\,\mathrm{ns}$ and $B_{\mathrm{C2P}} = +15.73\,\mathrm{ns}$, are conform to the following LCB/DCB values, $B_{\mathrm{LC(C1P,C2P)}} = +3\,\mathrm{ns}$ and $B_{\mathrm{C1P\text{-}C2P}} = -5\,\mathrm{ns}$.

For a user, consideration of an OCB bias correction would be very convenient (as just the observable type has to be known):

$$C_{1,\mathrm{ref}} = C_{1\mathrm{C}} - B_{\mathrm{C1C}} \tag{10}$$

where (at present) commonly $C_{1,\mathrm{ref}} = C_{1\mathrm{P}} - B_{\mathrm{C1P}}$.

Important note: For pseudo-absolute bias values, the selection of the reference observables is absolutely essential. Advantage: A user may just consider bias correction values specific to the given observable types. Disadvantage: The thus corrected observations are consistent to the original definition of the reference observables (and consistent to a GNSS clock product relying on the same definition).

6.3. GPS Group Delay

It is worth mentioning that Equation (9a) actually corresponds to the relationship between the interfrequency "group delays," τ_{GD}, broadcast by the GPS system and the interfrequency satellite DCB, $B_{\mathrm{C1P\text{-}C2P}}$:

$$\tau_{\mathrm{GD}} = \kappa_2 \, B_{\mathrm{C1P\text{-}C2P}} + \tau_0. \tag{11}$$

There may be an arbitrary offset, indicated by τ_0. Consequently, the size of τ_{GD} corresponds to the single-frequency pseudorange correction (strictly speaking only for $C_{1\mathrm{P}}$, not for $C_{1\mathrm{C}}$ observations, assuming GPS satellite clock information being consistent to "LC(C1P,C2P)".

6.4. Datum Definition for LCB Bias Parameters in Multi-GNSS Clock Analysis

LCB bias parameters of more than one GNSS considered are directly connected with respect to each other. A clear definition of the LCB bias datum is therefore needed. As a consequence of this, we suggest that those receiver LCB bias parameters which are assumed to be zero must be explicitly included and listed in a SINEX_BIAS file (see, e.g., Example #7). Note that this should concern all LCB bias parameters with respect to the given "REFERENCE SYSTEM" and stations/receivers with the given "REFERENCE OBSERVABLES" (of that reference system). Last but not least, we may argue that the inclusion of "zero-valued", or "reference" receiver LCB bias parameters is not only a cosmetic issue. To have corresponding "reference" observable codes available (for the respective observation pair used) and to see whether a respective observation pair was actually used, respectively, are strong reasons that legitimate this requirement (of inclusion).

There seems to be no necessity for an inclusion of corresponding "reference" satellite LCB bias parameters. Nevertheless, the provision of corresponding satellite LCB information in SINEX_BIAS is self-evident and, therefore, actually may be recommended—as the datum definition as imposed on the bias solution then becomes crystal-clear for a user of such a bias product.

OPEN QUESTION: Last point optional or mandatory? (??)

6.5. GPS Observables From Cross-Correlation Receivers in RINEX2 and CC2NONCC

Cross-correlation receivers (or simply CC-receivers) provide under Antispoofing (AS) a particular code (or pseudorange) observable for the second frequency. Using the RINEX2 notation, the recorded observable, here called P2', may be written as:

$$\mathrm{P2'} = \mathrm{C1} + (\mathrm{P2} - \mathrm{P1}) \tag{12}$$

However, such observables are labeled in RINEX2 observation files with P2 (in RINEX3 unambiguously with C2D). It is therefore necessary to apply corresponding DCB corrections to C1 and P2' (in order to make them consistent to P1 and P2):

$$\mathrm{P1} = \mathrm{C1} + B_{\mathrm{P1\text{-}C1}} \tag{13a}$$

$$\mathrm{P2} = \mathrm{P2'} + B_{\mathrm{P1\text{-}C1}} \tag{13b}$$

where $B_{\mathrm{P1\text{-}C1}}$ denotes the satellite P1-C1 DCB information (as provided, e.g, by CODE [Schaer, 2001]).

CC2NONCC, originally developed by Jim Ray, was a RINEX2 observation conversion utility for exactly this (P1–C1) bias correction. This utility program should no longer be used. P1–C1 bias information should be considered directly by the analysis software.

It is worth mentioning that IGS ACs processing RINEX2 observation files (e.g. as part of a reprocessing effort) are actually forced to store the list of concerned CC-receivers in a separate metadata file.

The list of known cross-correlation (CC) receivers (following the IGS naming convention as given in `rcvr_ant.tab`) includes:

```
AOA ICS-4000Z
ROGUE SNR-12
ROGUE SNR-12 RM
ROGUE SNR-8
ROGUE SNR-800
ROGUE SNR-8000
ROGUE SNR-8100
ROGUE SNR-8C
SPP GEOTRACER100
TOPCON GP-DX1
TOPCON TT4000SSI
TRIMBLE 4000SSE
TRIMBLE 4000SSI
TRIMBLE 4000SST
```

When using a wildcard character "*", the CC-receiver list may be reduced to:

```
AOA ICS-4000Z
ROGUE*
SPP GEOTRACER100
TOPCON GP-DX1
TOPCON TT4000SSI
TRIMBLE 4000SS*
```

CC-receivers behave differently if Antispoofing (AS) is turned off. Instead of C1/P2', P1/P2 may be expected. For this reason, a list of AS-free periods might be useful (especially for reprocessings):

```
! Check whether time argument in a AS-free period
! ------------------------------------------------
  IF ((mjd >           0d0 .AND. mjd < 49383.00000d0) .OR. &
      (mjd > 49826.87499d0 .AND. mjd < 49847.83334d0) .OR. &
      (mjd > 49886.99999d0 .AND. mjd < 49909.00002d0) .OR. &
      (mjd > 49999.99999d0 .AND. mjd < 50022.00001d0) .OR. &
      (mjd > 50480.99999d0 .AND. mjd < 50503.00000d0)) THEN
    asmode = 0
  ENDIF
```

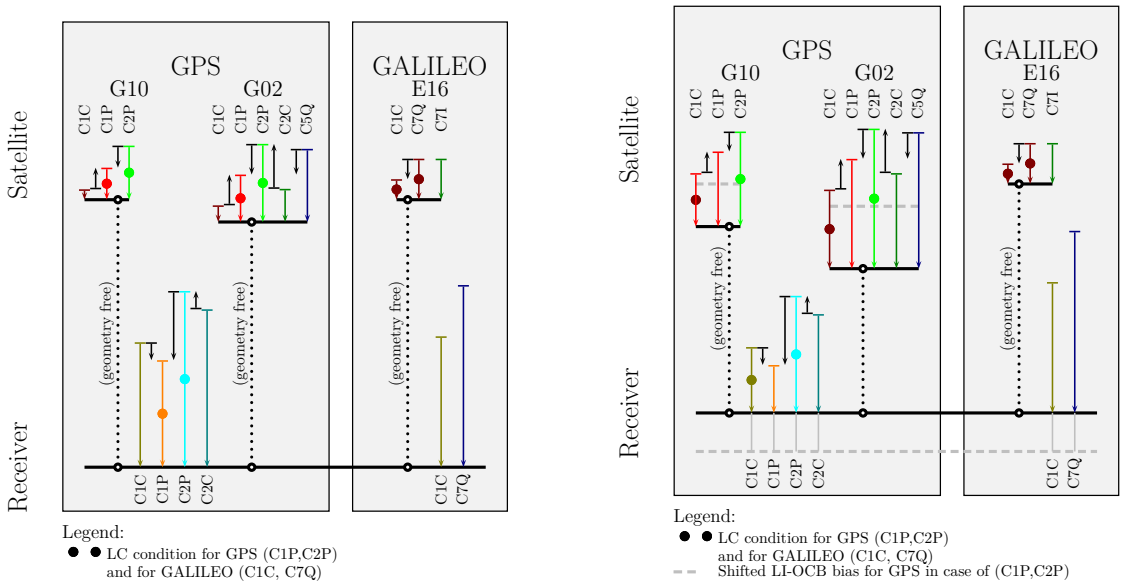

Figure 2: Illustration of **interfrequency** (from ionosphere analysis) differential code biases (DCB) and observable code biases (OCB) in case of a multi-GNSS observation scenario.

7. Illustration of Functional Principles of DCB, OCB, and LCB Biases

7.1. Illustration Regarding DCB/OCB Biases

The charts in Figure 2 illustrate the functional principles that hold for **interfrequency** code biases when analyzing the **geometry-free** (LI) linear combination of the GNSS code observables. As the geometry (and thus also clock information) does cancel out, differential code biases (DCB) are not connected among the individual GNSS considered.

Independent of the observable code bias (OCB) representation, the size of the DCB values remains unaffected. For the OCB representation, the choice of the reference observables is essential. Nevertheless, we just get a common shift for the GPS LI-OCB bias values when choosing C1C and C2P as reference observables (shown in the chart on the right-hand side of Figure 3) instead of C1P and C2P (as assumed for the chart shown on the left-hand side).

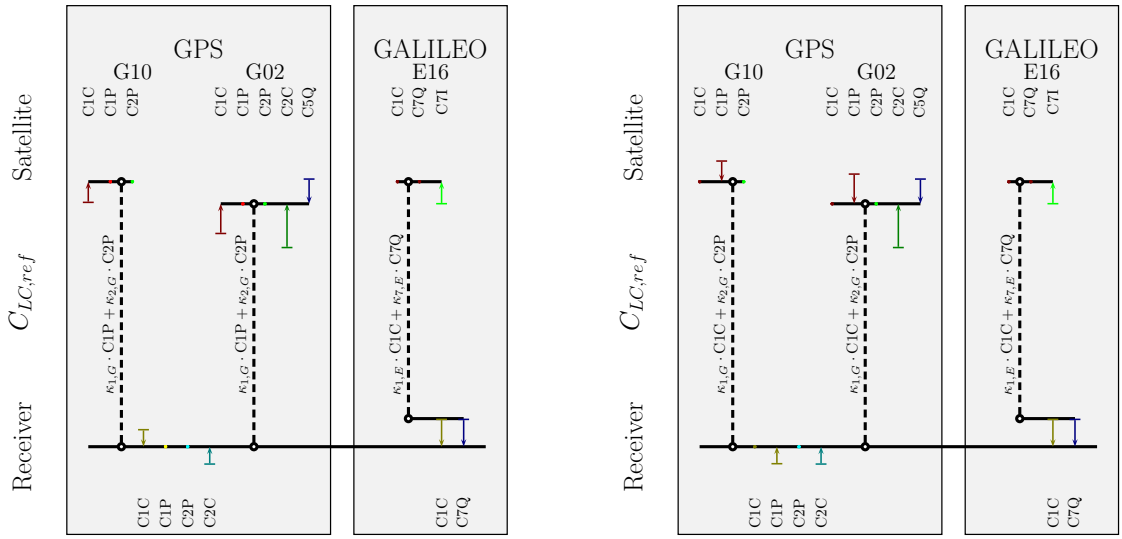

Figure 3: Illustration of **ionosphere-free LC** (from clock analysis) code biases (LCB) in case of a multi-GNSS observation scenario.

7.2. Illustration Regarding LCB Biases

The charts in Figure 3 illustrate the basis principles that hold for **ionosphere-free** (LC) code biases (LCB) occurring in the clock analysis when considering multiple GNSS. This kind of LCB parameters is **directly** connected among the individual GNSS considered.

8. General Remarks

8.1. "__X" Observable Issue

RINEX3 includes a clear definition of 3-character observable codes with respect to each supported GNSS system. However, one may have a suspicion that some receiver manufacturer misuse the third character of the corresponding RINEX3 observable code, i.e., they give an "`X`", independent of the tracking mode that was effectively used.

It will be one of the tasks for the IGS Bias and Calibration Working Group (BCWG) to identify such cases of misuse.

At CODE/AIUB, there is a dedicated analysis method (referred to as "(P1–C1) DCB multiplier" method) available for reliable determination of the (GPS) receiver tracking class [Schaer, 2002]. Corresponding anomalies (in RINEX2 observation data) could be revealed by CODE/AIUB in the past (see, e.g., [Ray, 2002]).

It is obvious that such a method might also be used for verification of all available GNSS observable declarations (made in RINEX3 observation files). It is intended to further develop the current RINEX2-oriented approach to a generalized ("GNSS code bias multiplier") approach for RINEX3 observation data.

How to handle known GNSS observables with unknown tracking mode? In the extreme case, one could think about treating affected observables in a **GLONASS-like** mode, where pseudorange biases are treated **satellite-receiver-specific**.

8.2. PPP Ambiguity Resolution (PPP-AR) Biases (??)

Should PPP-AR biases be covered by SINEX_BIAS V1.00? (??)

References

Gendt, G. (1997): *SINEX_TRO—Solution (Software/technique) INdependent EXchange Format for combination of TROpospheric estimates Version 0.01*, March 1, 1997: `https://igscb.jpl.nasa.gov/igscb/data/format/sinex_tropo.txt`

Ray, J. (2001): *Updated P1-C1 pseudorange bias corrections*, IGSMAIL #3160, January 5, 2001.

Ray, J. (2002): *C1/P1 biases for Leica and Trimble 5700 receivers*, IGSMAIL #3737, February 13, 2002.

RINEX: The Receiver Independent Exchange Format Version 3.03: `ftp://igscb.jpl.nasa.gov/igscb/data/format/rinex303.pdf`

RINEX Extensions to Handle Clock Information Version 3.00/3.02: `ftp://igscb.jpl.nasa.gov/igscb/data/format/rinex_clock300.txt` `ftp://igscb.jpl.nasa.gov/igscb/data/format/rinex_clock302.txt`

SINEX—Solution (Software/technique) INdependent EXchange Format Version 2.02: `http://www.iers.org/IERS/EN/Organization/AnalysisCoordinator/analysis.html`

Schaer, S. (2001): *CODE DCB archive initiated*, IGSMAIL #3212, February 23, 2001.

Schaer, S. (2002): *TRIMBLE 4700*, IGSMAIL #3887, May 18, 2002.

Schaer, S. (2012): *From differential to absolute code biases*. Workshop on GNSS Biases, Uni Bern, 18–19 January 2012.

Schaer, S. (2014): *Biases Relevant to GPS and GLONASS Data Processing*. IGS Workshop 2014, June 26, Pasadena, California, USA.

Springer, T. (2011): *SINEX_BIAS—Solution (Software/technique) INdependent EXchange Format for GNSS Biases Version 0.01*, June 29, 2011.

Appendix A Examples for Submissions of Bias Estimates in Bias-SINEX V1.00

A.1 Example #0: Original Bias-SINEX V0.01 example updated to V1.00 standards

```
%=BIA 1.00 PF2 11:180:59736 PF2 11:113:86385 11:114:86385 P 04774 2 SINEX_BIA
*------------------------------------------------------------------------------
* Bias Solution INdependent EXchange Format (Bias-SINEX)
*------------------------------------------------------------------------------
+FILE/REFERENCE
 REFERENCE FRAME    IGS08
 DESCRIPTION        European Space Operation Center (ESOC)
 INPUT              ESOC solutions in normal equation format
 OUTPUT             ESOC solutions in Bias-SINEX format
 CONTACT            Tim.Springer@esa.int.nospam
 HARDWARE           Linux dgnl2 2.6.27.19-5-default #1 SMP 2009-02-28 04:40:21
 SOFTWARE           Napeos 3.6 TAS 07/06/2011
-FILE/REFERENCE
*------------------------------------------------------------------------------
+BIAS/DESCRIPTION
*KEYWORD_________________________________ VALUE(S)_______________________________
 OBSERVATION SAMPLING                          300
 PARAMETER SPACING                           86400
 DETERMINATION METHOD                    CLOCK ANALYSIS
 BIAS MODE                               DIFFERENTIAL
 TIME MODE                               WINDOWS
 TIME SYSTEM                             G
 REFERENCE SYSTEM                        G
 REFERENCE OBSERVABLES                   E  C1C  C7Q
 REFERENCE OBSERVABLES                   G  C1P  C2P
 ZERO-MEAN CONDITIONS                    G    0    0    0    0    0    0    0
 ZERO-MEAN CONDITIONS                    E    1    0    0    1    0    0    0
-BIAS/DESCRIPTION
*------------------------------------------------------------------------------
+BIAS/SOLUTION
*BIAS SVN_ PRN SITE DOMES____ OBS1 OBS2 BIAS_START__ BIAS_END____ UNIT __ESTIMATED_VALUE____ _STD_DEV___
 LCB  G    G   GIEN 12724M003 C1P  C2P  11:113:86385 11:115:00285 ns   0.000000000000000E+00 .000000E+00
 LCB  G    G   GKIR 10403M003 C1P  C2P  11:113:86385 11:115:00285 ns   0.000000000000000E+00 .000000E+00
 LCB  G    G   GKOU 97301M211 C1P  C2P  11:113:86385 11:115:00285 ns   0.000000000000000E+00 .000000E+00
 LCB  G    G   GLPG 41510M002 C1P  C2P  11:113:86385 11:115:00285 ns   0.000000000000000E+00 .000000E+00
 LCB  G    G   GMAL 33201M002 C1P  C2P  11:113:86385 11:115:00285 ns   0.000000000000000E+00 .000000E+00
 LCB  G    G   GMIZ 21702M003 C1P  C2P  11:113:86385 11:115:00285 ns   0.000000000000000E+00 .000000E+00
 LCB  G    G   GNNO 50181M002 C1P  C2P  11:113:86385 11:115:00285 ns   0.000000000000000E+00 .000000E+00
 LCB  G    G   GNOR 13535M001 C1P  C2P  11:113:86385 11:115:00285 ns   0.000000000000000E+00 .000000E+00
 LCB  G    G   GOUS 50212M004 C1P  C2P  11:113:86385 11:115:00285 ns   0.000000000000000E+00 .000000E+00
 LCB  G    G   GTHT 92201M014 C1P  C2P  11:113:86385 11:115:00285 ns   0.000000000000000E+00 .000000E+00
 LCB  G    G   GUSN 40451M126 C1P  C2P  11:113:86385 11:115:00285 ns   0.000000000000000E+00 .000000E+00
 LCB  G    G   GVES 66037M002 C1P  C2P  11:113:86385 11:115:00285 ns   0.000000000000000E+00 .000000E+00
 LCB  E    E   GIEN 12724M003 C1C  C7Q  11:113:86385 11:115:00285 ns   -.157174143960592E+03 .259286E+02
 LCB  E    E   GKIR 10403M003 C1C  C7Q  11:113:86385 11:115:00285 ns   -.153942459345551E+03 .259286E+02
 LCB  E    E   GKOU 97301M211 C1C  C7Q  11:113:86385 11:115:00285 ns   -.163243805130824E+03 .259285E+02
 LCB  E    E   GLPG 41510M002 C1C  C7Q  11:113:86385 11:115:00285 ns   -.151698143836368E+03 .259290E+02
 LCB  E    E   GMAL 33201M002 C1C  C7Q  11:113:86385 11:115:00285 ns   -.156472089904428E+03 .259285E+02
 LCB  E    E   GMIZ 21702M003 C1C  C7Q  11:113:86385 11:115:00285 ns   -.167156432084244E+03 .259321E+02
 LCB  E    E   GNNO 50181M002 C1C  C7Q  11:113:86385 11:115:00285 ns   -.156922861008147E+03 .259665E+02
 LCB  E    E   GNOR 13535M001 C1C  C7Q  11:113:86385 11:115:00285 ns   -.153679440866705E+03 .259285E+02
 LCB  E    E   GOUS 50212M004 C1C  C7Q  11:113:86385 11:115:00285 ns   -.101593337222667E+03 .259439E+02
 LCB  E    E   GTHT 92201M014 C1C  C7Q  11:113:86385 11:115:00285 ns   -.159918985571303E+03 .259356E+02
 LCB  E    E   GUSN 40451M126 C1C  C7Q  11:113:86385 11:115:00285 ns   -.149146613879327E+03 .259279E+02
 LCB  E    E   GVES 66037M002 C1C  C7Q  11:113:86385 11:115:00285 ns   -.156221372596643E+03 .259288E+02
-BIAS/SOLUTION
*------------------------------------------------------------------------------
%=ENDBIA
```

A.2 Example #1: GPS C1P–C1C (or classic "P1–C1") DCB product (extracted from CODE GPS clock analysis)

```
%=BIA 1.00 COD 15:279:73754 IGS 15:276:00000 15:276:86399 P 00032 2 SINEX_BIA
*------------------------------------------------------------------------------
+FILE/REFERENCE
*INFO_TYPE_________ INFO_____________________________________________________
 DESCRIPTION        CODE, Astronomical Institute, University of Bern
 OUTPUT             CODE GPS clock analysis
 CONTACT            code@aiub.unibe.ch
 SOFTWARE           Bernese GNSS Software Version 5.3
 HARDWARE           UBELIX: Linux, x86_64
 INPUT              IGS GPS/GLONASS tracking data
-FILE/REFERENCE
*------------------------------------------------------------------------------
+BIAS/DESCRIPTION
*KEYWORD_______________________________ VALUE(S)_______________________________
 OBSERVATION SAMPLING                          300
 PARAMETER SPACING                           86400
 DETERMINATION METHOD                    CLOCK ANALYSIS
 BIAS MODE                               DIFFERENTIAL
 TIME MODE                               WINDOWS
 TIME SYSTEM                             G
 REFERENCE SYSTEM                        G
 OBSERVABLE GROUP                        G     2 C1P  C1W
 OBSERVABLE GROUP                        G     4 C2P  C2W  C2L  C2S
 REFERENCE OBSERVABLES                   G  C1P  C2P
 ZERO-MEAN CONDITIONS                    G     1    0    1    0    0    0    0
-BIAS/DESCRIPTION
*------------------------------------------------------------------------------
+BIAS/SOLUTION
*BIAS SVN_ PRN SITE DOMES____ OBS1 OBS2 BIAS_START__ BIAS_END____ UNIT __ESTIMATED_VALUE____ _STD_DEV___
      G063 G01               C1P  C1C  15:276:00000 15:276:86399 ns   0.136990291463586E+01 .495798E-02
      G061 G02               C1P  C1C  15:276:00000 15:276:86399 ns   -.116825398620806E+01 .521330E-02
      G069 G03               C1P  C1C  15:276:00000 15:276:86399 ns   0.154073114589892E+01 .498724E-02
      G034 G04               C1P  C1C  15:276:00000 15:276:86399 ns   0.553057343127956E+00 .495528E-02
      G050 G05               C1P  C1C  15:276:00000 15:276:86399 ns   0.150596519052711E+01 .516620E-02
      G067 G06               C1P  C1C  15:276:00000 15:276:86399 ns   0.182371144406284E+01 .525631E-02
      G048 G07               C1P  C1C  15:276:00000 15:276:86399 ns   0.918720233422413E+00 .500787E-02
      G072 G08               C1P  C1C  15:276:00000 15:276:86399 ns   0.494320991791880E-01 .495423E-02
      G068 G09               C1P  C1C  15:276:00000 15:276:86399 ns   0.158381203243076E+00 .505336E-02
      G036 G10               C1P  C1C  15:276:00000 15:276:86399 ns   0.127384795727486E+00 .380218E-01
      G046 G11               C1P  C1C  15:276:00000 15:276:86399 ns   -.186241742158861E+00 .503719E-02
      G058 G12               C1P  C1C  15:276:00000 15:276:86399 ns   0.822884097681954E+00 .512028E-02
      G043 G13               C1P  C1C  15:276:00000 15:276:86399 ns   0.747363413933297E+00 .510330E-02
      G041 G14               C1P  C1C  15:276:00000 15:276:86399 ns   -.501543087808895E+00 .505868E-02
      G055 G15               C1P  C1C  15:276:00000 15:276:86399 ns   0.139835207526154E+01 .517766E-02
      G056 G16               C1P  C1C  15:276:00000 15:276:86399 ns   -.119349048416255E+01 .504534E-02
      G053 G17               C1P  C1C  15:276:00000 15:276:86399 ns   0.939680694164286E+00 .516459E-02
      G054 G18               C1P  C1C  15:276:00000 15:276:86399 ns   -.938802084084508E+00 .502896E-02
      G059 G19               C1P  C1C  15:276:00000 15:276:86399 ns   -.233363668062039E+01 .496385E-02
      G051 G20               C1P  C1C  15:276:00000 15:276:86399 ns   -.193873007606566E+01 .516053E-02
      G045 G21               C1P  C1C  15:276:00000 15:276:86399 ns   -.130082602818353E+01 .497841E-02
      G047 G22               C1P  C1C  15:276:00000 15:276:86399 ns   -.261044253148914E+01 .492888E-02
      G060 G23               C1P  C1C  15:276:00000 15:276:86399 ns   -.961335267065625E-01 .495526E-02
      G065 G24               C1P  C1C  15:276:00000 15:276:86399 ns   0.135258580667365E+01 .519202E-02
      G062 G25               C1P  C1C  15:276:00000 15:276:86399 ns   -.541605529116360E+00 .509832E-02
      G071 G26               C1P  C1C  15:276:00000 15:276:86399 ns   0.235066050535949E+00 .506299E-02
      G066 G27               C1P  C1C  15:276:00000 15:276:86399 ns   -.581643847465688E-01 .496571E-02
      G044 G28               C1P  C1C  15:276:00000 15:276:86399 ns   -.899070827949663E+00 .501875E-02
      G057 G29               C1P  C1C  15:276:00000 15:276:86399 ns   0.137792299850169E+01 .503436E-02
      G064 G30               C1P  C1C  15:276:00000 15:276:86399 ns   -.368970377424869E+00 .502469E-02
      G052 G31               C1P  C1C  15:276:00000 15:276:86399 ns   0.857142063528477E+00 .507943E-02
      G023 G32               C1P  C1C  15:276:00000 15:276:86399 ns   -.164239288915549E+01 .492242E-02
-BIAS/SOLUTION
%=ENDBIA
```

A.3 Example #2: GPS/GLONASS C1P–C2P DCB product without consideration of GLONASS frequency channel dependence (extracted from CODE final ionosphere analysis)

```
%=BIA 1.00 COD 15:280:34714 IGS 15:276:00000 15:277:00000 P 00508 2 SINEX_BIA
*------------------------------------------------------------------------------
```

```
+FILE/REFERENCE
*INFO_TYPE_________ INFO_____________________________________________________
 DESCRIPTION        CODE, Astronomical Institute, University of Bern
 OUTPUT             CODE GPS/GLONASS ionosphere analysis
 CONTACT            code@aiub.unibe.ch
 SOFTWARE           Bernese GNSS Software Version 5.3
 HARDWARE           UBELIX: Linux, x86_64
 INPUT              IGS GPS/GLONASS tracking data
-FILE/REFERENCE
*-------------------------------------------------------------------------------
+BIAS/DESCRIPTION
*KEYWORD_________________________________ VALUE(S)_______________________________
 OBSERVATION SAMPLING                          300
 PARAMETER SPACING                           86400
 DETERMINATION METHOD                    IONOSPHERE ANALYSIS
 BIAS MODE                               DIFFERENTIAL
 TIME MODE                               WINDOWS
 TIME SYSTEM                             G
 REFERENCE SYSTEM                        G
 OBSERVABLE GROUP                        G     2 C1P  C1W
 OBSERVABLE GROUP                        G     4 C2P  C2W  C2L  C2S
 REFERENCE OBSERVABLES                   G  C1P  C2P
 REFERENCE OBSERVABLES                   R  C1P  C2P
 ZERO-MEAN CONDITIONS                    G     1    0    1    0    0    0    0
 ZERO-MEAN CONDITIONS                    R     1    0    1    0    0    0    0
-BIAS/DESCRIPTION
*-------------------------------------------------------------------------------
+BIAS/SOLUTION
*BIAS SVN_ PRN SITE DOMES____ OBS1 OBS2 BIAS_START__ BIAS_END____ UNIT __ESTIMATED_VALUE____ _STD_DEV___
      G063 G01               C1P  C2P  15:276:00000 15:277:00000 ns   -.789039492949038E+01 .118271E-01
      G061 G02               C1P  C2P  15:276:00000 15:277:00000 ns   0.887061550167960E+01 .122794E-01
      G069 G03               C1P  C2P  15:276:00000 15:277:00000 ns   -.541089919183528E+01 .117545E-01
      G034 G04               C1P  C2P  15:276:00000 15:277:00000 ns   -.108884593577450E+00 .118100E-01
      G050 G05               C1P  C2P  15:276:00000 15:277:00000 ns   0.275362757978975E+01 .123436E-01
      G067 G06               C1P  C2P  15:276:00000 15:277:00000 ns   -.707081693666030E+01 .124487E-01
      G048 G07               C1P  C2P  15:276:00000 15:277:00000 ns   0.292464612922085E+01 .115565E-01
      G072 G08               C1P  C2P  15:276:00000 15:277:00000 ns   -.745662924479037E+01 .119303E-01
      G068 G09               C1P  C2P  15:276:00000 15:277:00000 ns   -.495327694269251E+01 .117392E-01
      G036 G10               C1P  C2P  15:276:00000 15:277:00000 ns   -.888528257979836E+00 .192074E-01
      G046 G11               C1P  C2P  15:276:00000 15:277:00000 ns   0.340464289596011E+01 .121545E-01
      G058 G12               C1P  C2P  15:276:00000 15:277:00000 ns   0.364033121022956E+01 .118473E-01
      G043 G13               C1P  C2P  15:276:00000 15:277:00000 ns   0.292413413685829E+01 .119358E-01
      G041 G14               C1P  C2P  15:276:00000 15:277:00000 ns   0.162840242789764E+01 .120212E-01
      G055 G15               C1P  C2P  15:276:00000 15:277:00000 ns   0.249492760183708E+01 .121840E-01
      G056 G16               C1P  C2P  15:276:00000 15:277:00000 ns   0.240340374274539E+01 .120922E-01
      G053 G17               C1P  C2P  15:276:00000 15:277:00000 ns   0.270351860285290E+01 .121235E-01
      G054 G18               C1P  C2P  15:276:00000 15:277:00000 ns   0.285024218198860E+01 .117488E-01
      G059 G19               C1P  C2P  15:276:00000 15:277:00000 ns   0.549550724328732E+01 .120627E-01
      G051 G20               C1P  C2P  15:276:00000 15:277:00000 ns   0.117014366089120E+01 .122423E-01
      G045 G21               C1P  C2P  15:276:00000 15:277:00000 ns   0.298943332632011E+01 .115206E-01
      G047 G22               C1P  C2P  15:276:00000 15:277:00000 ns   0.691641150841678E+01 .115310E-01
      G060 G23               C1P  C2P  15:276:00000 15:277:00000 ns   0.876469896831230E+01 .115170E-01
      G065 G24               C1P  C2P  15:276:00000 15:277:00000 ns   -.610716951658093E+01 .120496E-01
      G062 G25               C1P  C2P  15:276:00000 15:277:00000 ns   -.784026353658018E+01 .119071E-01
      G071 G26               C1P  C2P  15:276:00000 15:277:00000 ns   -.907364717669699E+01 .121135E-01
      G066 G27               C1P  C2P  15:276:00000 15:277:00000 ns   -.545766718810367E+01 .118032E-01
      G044 G28               C1P  C2P  15:276:00000 15:277:00000 ns   0.263259102321284E+01 .115887E-01
      G057 G29               C1P  C2P  15:276:00000 15:277:00000 ns   0.225377118569203E+01 .117116E-01
      G064 G30               C1P  C2P  15:276:00000 15:277:00000 ns   -.665485523246876E+01 .115986E-01
      G052 G31               C1P  C2P  15:276:00000 15:277:00000 ns   0.422908095724109E+01 .121973E-01
      G023 G32               C1P  C2P  15:276:00000 15:277:00000 ns   -.213709713697665E+01 .116207E-01
      R730 R01               C1P  C2P  15:276:00000 15:277:00000 ns   -.551776988937030E+01 .134457E-01
      R747 R02               C1P  C2P  15:276:00000 15:277:00000 ns   0.425064850267759E+00 .137247E-01
      R744 R03               C1P  C2P  15:276:00000 15:277:00000 ns   0.497794199921310E+01 .136506E-01
      R742 R04               C1P  C2P  15:276:00000 15:277:00000 ns   0.625925925347753E+01 .137853E-01
      R734 R05               C1P  C2P  15:276:00000 15:277:00000 ns   -.159883904022208E+00 .139329E-01
      R733 R06               C1P  C2P  15:276:00000 15:277:00000 ns   0.376110594864806E+01 .135932E-01
      R745 R07               C1P  C2P  15:276:00000 15:277:00000 ns   0.406030937864426E+01 .130779E-01
      R743 R08               C1P  C2P  15:276:00000 15:277:00000 ns   0.606853785896045E+01 .131535E-01
      R736 R09               C1P  C2P  15:276:00000 15:277:00000 ns   0.575317459315177E+01 .131028E-01
      R717 R10               C1P  C2P  15:276:00000 15:277:00000 ns   -.794818850572049E+01 .133943E-01
      R723 R11               C1P  C2P  15:276:00000 15:277:00000 ns   -.168416665324092E+01 .137075E-01
      R737 R12               C1P  C2P  15:276:00000 15:277:00000 ns   -.656917243149297E+01 .142588E-01
      R721 R13               C1P  C2P  15:276:00000 15:277:00000 ns   -.150054842761781E+01 .186409E-01
```

```
      R715 R14                C1P  C2P  15:276:00000 15:277:00000 ns    -.857776284981976E+01 .137275E-01
      R716 R15                C1P  C2P  15:276:00000 15:277:00000 ns    -.392195884292312E+01 .134734E-01
      R738 R16                C1P  C2P  15:276:00000 15:277:00000 ns    0.153370789642926E+00 .129558E-01
      R714 R17                C1P  C2P  15:276:00000 15:277:00000 ns    -.252002743913137E+01 .135530E-01
      R754 R18                C1P  C2P  15:276:00000 15:277:00000 ns    -.587478965234422E+00 .135548E-01
      R720 R19                C1P  C2P  15:276:00000 15:277:00000 ns    0.627082424153356E+01 .137012E-01
      R719 R20                C1P  C2P  15:276:00000 15:277:00000 ns    -.240728927404397E+01 .136027E-01
      R755 R21                C1P  C2P  15:276:00000 15:277:00000 ns    0.347652911801385E+01 .134491E-01
      R731 R22                C1P  C2P  15:276:00000 15:277:00000 ns    0.483689507813546E+00 .135081E-01
      R732 R23                C1P  C2P  15:276:00000 15:277:00000 ns    -.640142699680085E+01 .134619E-01
      R735 R24                C1P  C2P  15:276:00000 15:277:00000 ns    0.610586664005156E+01 .134957E-01
      G    G   ABMF 97103M001 C1P  C2P  15:276:00000 15:277:00000 ns    0.280529318307038E+02 .501257E-01
      R    R   ABMF 97103M001 C1P  C2P  15:276:00000 15:277:00000 ns    0.401016267734374E+01 .545784E-01
      G    G   ABPO 33302M001 C1P  C2P  15:276:00000 15:277:00000 ns    -.687177661214301E+01 .532385E-01
      G    G   ADIS 31502M001 C1P  C2P  15:276:00000 15:277:00000 ns    -.137823411294387E+01 .567643E-01
      R    R   ADIS 31502M001 C1P  C2P  15:276:00000 15:277:00000 ns    -.945298918660656E+01 .605325E-01
...
      G    G   ZWE2 12330M003 C1P  C2P  15:276:00000 15:277:00000 ns    0.132594960282132E+00 .377574E-01
-BIAS/SOLUTION
%=ENDBIA
```

A.4 Example #3: GPS/GLONASS DCB product (obtained from both clock and ionosphere analysis)

A.5 Example #4: GPS OCB DCB product (obtained from both clock and ionosphere analysis)

A.6 Example #5: GPS/GLONASS OCB product (obtained from both both clock and ionosphere analysis)

A.7 Example #6: GPS/GLONASS DCB/LCB product with GLONASS LCB biases assumed to be frequency-channel-dependent parameters (extracted from CODE rapid clock analysis)

```
%=BIA 1.00 XYZ 15:277:57717 IGS 15:276:00000 15:276:86399 P 02282 2 SINEX_BIA
*------------------------------------------------------------------------------
+FILE/REFERENCE
*INFO_TYPE_________ INFO_____________________________________________________
 DESCRIPTION        CODE, Astronomical Institute, University of Bern
 OUTPUT             CODE's rapid GPS/GLONASS clock analysis
 CONTACT            code@aiub.unibe.ch
 SOFTWARE           Bernese GNSS Software Version 5.3
 HARDWARE           UBELIX: Linux, x86_64
 INPUT              IGS GPS/GLONASS tracking data
-FILE/REFERENCE
*------------------------------------------------------------------------------
+BIAS/DESCRIPTION
*KEYWORD_____________________________ VALUE(S)_______________________________
 OBSERVATION SAMPLING                          300
 PARAMETER SPACING                           86400
 DETERMINATION METHOD                CLOCK ANALYSIS
 BIAS MODE                           DIFFERENTIAL
 TIME MODE                           WINDOWS
 TIME SYSTEM                         G
 REFERENCE SYSTEM                    G
 OBSERVABLE GROUP                    G     2 C1P  C1W
 OBSERVABLE GROUP                    G     4 C2P  C2W  C2L  C2S
 REFERENCE OBSERVABLES               G  C1P  C2P
 REFERENCE OBSERVABLES               R
```

```
 ZERO-MEAN CONDITIONS                    G     1    0    1    0    0    0    0
 ZERO-MEAN CONDITIONS                    R    25    1    0    0   24    0    0
-BIAS/DESCRIPTION
*--------------------------------------------------------------------------------
+BIAS/SOLUTION
*BIAS SVN_ PRN SITE DOMES____ OBS1 OBS2 BIAS_START__ BIAS_END____ UNIT __ESTIMATED_VALUE____ _STD_DEV___
      G063 G01               C1P  C1C  15:276:00000 15:276:86399 ns   0.138208389409961E+01 .328591E-03
      G061 G02               C1P  C1C  15:276:00000 15:276:86399 ns   -.116510308334292E+01 .328617E-03
      G069 G03               C1P  C1C  15:276:00000 15:276:86399 ns   0.155838028414602E+01 .328625E-03
      G034 G04               C1P  C1C  15:276:00000 15:276:86399 ns   0.539167118951049E+00 .328595E-03
      G050 G05               C1P  C1C  15:276:00000 15:276:86399 ns   0.151083992433357E+01 .328636E-03
      G067 G06               C1P  C1C  15:276:00000 15:276:86399 ns   0.178247305606531E+01 .328658E-03
      G048 G07               C1P  C1C  15:276:00000 15:276:86399 ns   0.917045399649428E+00 .328576E-03
      G072 G08               C1P  C1C  15:276:00000 15:276:86399 ns   0.152808734870094E-01 .328643E-03
      G068 G09               C1P  C1C  15:276:00000 15:276:86399 ns   0.161250767477558E+00 .328602E-03
      G036 G10               C1P  C1C  15:276:00000 15:276:86399 ns   0.879954087980935E-01 .329099E-03
      G046 G11               C1P  C1C  15:276:00000 15:276:86399 ns   -.193036105715606E+00 .328623E-03
      G058 G12               C1P  C1C  15:276:00000 15:276:86399 ns   0.854997095287675E+00 .328603E-03
      G043 G13               C1P  C1C  15:276:00000 15:276:86399 ns   0.750950944857449E+00 .328620E-03
      G041 G14               C1P  C1C  15:276:00000 15:276:86399 ns   -.514966798061877E+00 .328616E-03
      G055 G15               C1P  C1C  15:276:00000 15:276:86399 ns   0.138797886619085E+01 .328627E-03
      G056 G16               C1P  C1C  15:276:00000 15:276:86399 ns   -.120893134817916E+01 .328622E-03
      G053 G17               C1P  C1C  15:276:00000 15:276:86399 ns   0.967914325902901E+00 .328621E-03
      G054 G18               C1P  C1C  15:276:00000 15:276:86399 ns   -.934227712752738E+00 .328582E-03
      G059 G19               C1P  C1C  15:276:00000 15:276:86399 ns   -.232028796479940E+01 .328612E-03
      G051 G20               C1P  C1C  15:276:00000 15:276:86399 ns   -.192097177672341E+01 .328620E-03
      G045 G21               C1P  C1C  15:276:00000 15:276:86399 ns   -.128711986362177E+01 .328572E-03
      G047 G22               C1P  C1C  15:276:00000 15:276:86399 ns   -.265466300432933E+01 .328576E-03
      G060 G23               C1P  C1C  15:276:00000 15:276:86399 ns   -.675749695928090E-01 .328589E-03
      G065 G24               C1P  C1C  15:276:00000 15:276:86399 ns   0.134601738322875E+01 .328626E-03
      G062 G25               C1P  C1C  15:276:00000 15:276:86399 ns   -.523147939254076E+00 .328611E-03
      G071 G26               C1P  C1C  15:276:00000 15:276:86399 ns   0.216971709602869E+00 .328618E-03
      G066 G27               C1P  C1C  15:276:00000 15:276:86399 ns   -.929483194382164E-01 .328609E-03
      G044 G28               C1P  C1C  15:276:00000 15:276:86399 ns   -.873197568393859E+00 .328591E-03
      G057 G29               C1P  C1C  15:276:00000 15:276:86399 ns   0.138979623722256E+01 .328593E-03
      G064 G30               C1P  C1C  15:276:00000 15:276:86399 ns   -.331054224162791E+00 .328576E-03
      G052 G31               C1P  C1C  15:276:00000 15:276:86399 ns   0.850216975578232E+00 .328626E-03
      G023 G32               C1P  C1C  15:276:00000 15:276:86399 ns   -.163113661807498E+01 .328574E-03
 LCB  G    G   ALBH 40129M003 C1?  C2?  15:276:00000 15:276:86399 ns   0.000000000000000E+00 .000000E+00
 LCB  R717 R10 ALBH 40129M003 C1P  C2P  15:276:00000 15:276:86399 ns   -.150999666860230E+02 .558695E-01
 LCB  R715 R14 ALBH 40129M003 C1P  C2P  15:276:00000 15:276:86399 ns   -.150999666860230E+02 .558695E-01
 LCB  R714 R17 ALBH 40129M003 C1P  C2P  15:276:00000 15:276:86399 ns   -.117352048092906E+02 .828816E-01
 LCB  R747 R02 ALBH 40129M003 C1P  C2P  15:276:00000 15:276:86399 ns   -.130638694042271E+02 .636397E-01
 LCB  R733 R06 ALBH 40129M003 C1P  C2P  15:276:00000 15:276:86399 ns   -.130638694042271E+02 .636397E-01
 LCB  R754 R18 ALBH 40129M003 C1P  C2P  15:276:00000 15:276:86399 ns   -.141815227040625E+02 .570969E-01
 LCB  R731 R22 ALBH 40129M003 C1P  C2P  15:276:00000 15:276:86399 ns   -.141815227040625E+02 .570969E-01
 LCB  R736 R09 ALBH 40129M003 C1P  C2P  15:276:00000 15:276:86399 ns   -.160419500960109E+02 .575086E-01
 LCB  R721 R13 ALBH 40129M003 C1P  C2P  15:276:00000 15:276:86399 ns   -.160419500960109E+02 .575086E-01
 LCB  R737 R12 ALBH 40129M003 C1P  C2P  15:276:00000 15:276:86399 ns   -.155830165645740E+02 .542713E-01
 LCB  R738 R16 ALBH 40129M003 C1P  C2P  15:276:00000 15:276:86399 ns   -.155830165645740E+02 .542713E-01
 LCB  R723 R11 ALBH 40129M003 C1P  C2P  15:276:00000 15:276:86399 ns   -.162126260972474E+02 .559828E-01
 LCB  R716 R15 ALBH 40129M003 C1P  C2P  15:276:00000 15:276:86399 ns   -.162126260972474E+02 .559828E-01
 LCB  R730 R01 ALBH 40129M003 C1P  C2P  15:276:00000 15:276:86399 ns   -.151802936562642E+02 .545090E-01
 LCB  R734 R05 ALBH 40129M003 C1P  C2P  15:276:00000 15:276:86399 ns   -.151802936562642E+02 .545090E-01
 LCB  R719 R20 ALBH 40129M003 C1P  C2P  15:276:00000 15:276:86399 ns   -.131007420678933E+02 .546833E-01
 LCB  R735 R24 ALBH 40129M003 C1P  C2P  15:276:00000 15:276:86399 ns   -.131007420678933E+02 .546833E-01
 LCB  R720 R19 ALBH 40129M003 C1P  C2P  15:276:00000 15:276:86399 ns   -.120165531910436E+02 .535750E-01
 LCB  R732 R23 ALBH 40129M003 C1P  C2P  15:276:00000 15:276:86399 ns   -.120165531910436E+02 .535750E-01
 LCB  R755 R21 ALBH 40129M003 C1P  C2P  15:276:00000 15:276:86399 ns   -.110857561145634E+02 .788283E-01
 LCB  R744 R03 ALBH 40129M003 C1P  C2P  15:276:00000 15:276:86399 ns   -.109534969491898E+02 .554497E-01
 LCB  R745 R07 ALBH 40129M003 C1P  C2P  15:276:00000 15:276:86399 ns   -.109534969491898E+02 .554497E-01
 LCB  R742 R04 ALBH 40129M003 C1P  C2P  15:276:00000 15:276:86399 ns   -.121498476643008E+02 .527010E-01
 LCB  R743 R08 ALBH 40129M003 C1P  C2P  15:276:00000 15:276:86399 ns   -.121498476643008E+02 .527010E-01
 LCB  G    G   ALGO 40104M002 C1?  C2?  15:276:00000 15:276:86399 ns   0.000000000000000E+00 .000000E+00
 LCB  R717 R10 ALGO 40104M002 C1P  C2P  15:276:00000 15:276:86399 ns   0.193084086050889E+02 .550688E-01
 LCB  R715 R14 ALGO 40104M002 C1P  C2P  15:276:00000 15:276:86399 ns   0.193084086050889E+02 .550688E-01
 LCB  R714 R17 ALGO 40104M002 C1P  C2P  15:276:00000 15:276:86399 ns   0.269419882192354E+02 .797214E-01
 LCB  R747 R02 ALGO 40104M002 C1P  C2P  15:276:00000 15:276:86399 ns   0.345083821451689E+02 .575340E-01
 LCB  R733 R06 ALGO 40104M002 C1P  C2P  15:276:00000 15:276:86399 ns   0.345083821451689E+02 .575340E-01
 LCB  R754 R18 ALGO 40104M002 C1P  C2P  15:276:00000 15:276:86399 ns   0.399541337291144E+02 .545219E-01
 LCB  R731 R22 ALGO 40104M002 C1P  C2P  15:276:00000 15:276:86399 ns   0.399541337291144E+02 .545219E-01
 LCB  R736 R09 ALGO 40104M002 C1P  C2P  15:276:00000 15:276:86399 ns   0.412224693658342E+02 .605533E-01
 LCB  R721 R13 ALGO 40104M002 C1P  C2P  15:276:00000 15:276:86399 ns   0.412224693658342E+02 .605533E-01
 LCB  R737 R12 ALGO 40104M002 C1P  C2P  15:276:00000 15:276:86399 ns   0.448530539826817E+02 .569100E-01
```

```
 LCB  R738 R16 ALGO 40104M002 C1P  C2P  15:276:00000 15:276:86399 ns   0.448530539826817E+02 .569100E-01
 LCB  R723 R11 ALGO 40104M002 C1P  C2P  15:276:00000 15:276:86399 ns   0.488672838396323E+02 .558652E-01
 LCB  R716 R15 ALGO 40104M002 C1P  C2P  15:276:00000 15:276:86399 ns   0.488672838396323E+02 .558652E-01
 LCB  R730 R01 ALGO 40104M002 C1P  C2P  15:276:00000 15:276:86399 ns   0.552172987477151E+02 .583256E-01
 LCB  R734 R05 ALGO 40104M002 C1P  C2P  15:276:00000 15:276:86399 ns   0.552172987477151E+02 .583256E-01
 LCB  R719 R20 ALGO 40104M002 C1P  C2P  15:276:00000 15:276:86399 ns   0.590653576087313E+02 .572153E-01
 LCB  R735 R24 ALGO 40104M002 C1P  C2P  15:276:00000 15:276:86399 ns   0.590653576087313E+02 .572153E-01
 LCB  R720 R19 ALGO 40104M002 C1P  C2P  15:276:00000 15:276:86399 ns   0.665897424003241E+02 .596719E-01
 LCB  R732 R23 ALGO 40104M002 C1P  C2P  15:276:00000 15:276:86399 ns   0.665897424003241E+02 .596719E-01
 LCB  R755 R21 ALGO 40104M002 C1P  C2P  15:276:00000 15:276:86399 ns   0.653412206361103E+02 .787950E-01
 LCB  R744 R03 ALGO 40104M002 C1P  C2P  15:276:00000 15:276:86399 ns   0.651827722448967E+02 .544648E-01
 LCB  R745 R07 ALGO 40104M002 C1P  C2P  15:276:00000 15:276:86399 ns   0.651827722448967E+02 .544648E-01
 LCB  R742 R04 ALGO 40104M002 C1P  C2P  15:276:00000 15:276:86399 ns   0.635121334604110E+02 .533628E-01
 LCB  R743 R08 ALGO 40104M002 C1P  C2P  15:276:00000 15:276:86399 ns   0.635121334604110E+02 .533628E-01
 LCB  G    G   ALIC 50137M001 C1?  C2?  15:276:00000 15:276:86399 ns   0.000000000000000E+00 .000000E+00
 LCB  R717 R10 ALIC 50137M001 C1P  C2P  15:276:00000 15:276:86399 ns   -.430176913111677E+02 .705991E-01
 LCB  R715 R14 ALIC 50137M001 C1P  C2P  15:276:00000 15:276:86399 ns   -.430176913111677E+02 .705991E-01
 LCB  R714 R17 ALIC 50137M001 C1P  C2P  15:276:00000 15:276:86399 ns   -.457462497474025E+02 .106665E+00
 LCB  R747 R02 ALIC 50137M001 C1P  C2P  15:276:00000 15:276:86399 ns   -.471192531666559E+02 .811568E-01
 LCB  R733 R06 ALIC 50137M001 C1P  C2P  15:276:00000 15:276:86399 ns   -.471192531666559E+02 .811568E-01
 LCB  R754 R18 ALIC 50137M001 C1P  C2P  15:276:00000 15:276:86399 ns   -.483802196365082E+02 .770150E-01
 LCB  R731 R22 ALIC 50137M001 C1P  C2P  15:276:00000 15:276:86399 ns   -.483802196365082E+02 .770150E-01
 LCB  R736 R09 ALIC 50137M001 C1P  C2P  15:276:00000 15:276:86399 ns   -.502402120064892E+02 .106030E+00
 LCB  R721 R13 ALIC 50137M001 C1P  C2P  15:276:00000 15:276:86399 ns   -.502402120064892E+02 .106030E+00
 LCB  R737 R12 ALIC 50137M001 C1P  C2P  15:276:00000 15:276:86399 ns   -.512678005097936E+02 .846019E-01
 LCB  R738 R16 ALIC 50137M001 C1P  C2P  15:276:00000 15:276:86399 ns   -.512678005097936E+02 .846019E-01
 LCB  R723 R11 ALIC 50137M001 C1P  C2P  15:276:00000 15:276:86399 ns   -.501067111090176E+02 .769388E-01
 LCB  R716 R15 ALIC 50137M001 C1P  C2P  15:276:00000 15:276:86399 ns   -.501067111090176E+02 .769388E-01
 LCB  R730 R01 ALIC 50137M001 C1P  C2P  15:276:00000 15:276:86399 ns   -.516734006694181E+02 .781776E-01
 LCB  R734 R05 ALIC 50137M001 C1P  C2P  15:276:00000 15:276:86399 ns   -.516734006694181E+02 .781776E-01
 LCB  R719 R20 ALIC 50137M001 C1P  C2P  15:276:00000 15:276:86399 ns   -.546266004176797E+02 .760129E-01
 LCB  R735 R24 ALIC 50137M001 C1P  C2P  15:276:00000 15:276:86399 ns   -.546266004176797E+02 .760129E-01
 LCB  R720 R19 ALIC 50137M001 C1P  C2P  15:276:00000 15:276:86399 ns   -.559590625949058E+02 .766997E-01
 LCB  R732 R23 ALIC 50137M001 C1P  C2P  15:276:00000 15:276:86399 ns   -.559590625949058E+02 .766997E-01
 LCB  R755 R21 ALIC 50137M001 C1P  C2P  15:276:00000 15:276:86399 ns   -.544352610108199E+02 .110008E+00
 LCB  R744 R03 ALIC 50137M001 C1P  C2P  15:276:00000 15:276:86399 ns   -.543867319822968E+02 .746355E-01
 LCB  R745 R07 ALIC 50137M001 C1P  C2P  15:276:00000 15:276:86399 ns   -.543867319822968E+02 .746355E-01
 LCB  R742 R04 ALIC 50137M001 C1P  C2P  15:276:00000 15:276:86399 ns   -.520208878507874E+02 .737697E-01
 LCB  R743 R08 ALIC 50137M001 C1P  C2P  15:276:00000 15:276:86399 ns   -.520208878507874E+02 .737697E-01
...
 LCB  G    G   ZECK 12351M001 C1?  C2?  15:276:00000 15:276:86399 ns   0.000000000000000E+00 .000000E+00
 LCB  R717 R10 ZECK 12351M001 C1P  C2P  15:276:00000 15:276:86399 ns   0.132880767273423E+02 .657057E-01
 LCB  R715 R14 ZECK 12351M001 C1P  C2P  15:276:00000 15:276:86399 ns   0.132880767273423E+02 .657057E-01
 LCB  R714 R17 ZECK 12351M001 C1P  C2P  15:276:00000 15:276:86399 ns   0.131236806897367E+02 .851828E-01
 LCB  R747 R02 ZECK 12351M001 C1P  C2P  15:276:00000 15:276:86399 ns   0.912114045943647E+01 .574081E-01
 LCB  R733 R06 ZECK 12351M001 C1P  C2P  15:276:00000 15:276:86399 ns   0.912114045943647E+01 .574081E-01
 LCB  R754 R18 ZECK 12351M001 C1P  C2P  15:276:00000 15:276:86399 ns   0.100102541560107E+02 .571440E-01
 LCB  R731 R22 ZECK 12351M001 C1P  C2P  15:276:00000 15:276:86399 ns   0.100102541560107E+02 .571440E-01
 LCB  R736 R09 ZECK 12351M001 C1P  C2P  15:276:00000 15:276:86399 ns   0.862005234813679E+01 .610708E-01
 LCB  R721 R13 ZECK 12351M001 C1P  C2P  15:276:00000 15:276:86399 ns   0.862005234813679E+01 .610708E-01
 LCB  R737 R12 ZECK 12351M001 C1P  C2P  15:276:00000 15:276:86399 ns   0.153586249430593E+02 .557170E-01
 LCB  R738 R16 ZECK 12351M001 C1P  C2P  15:276:00000 15:276:86399 ns   0.153586249430593E+02 .557170E-01
 LCB  R723 R11 ZECK 12351M001 C1P  C2P  15:276:00000 15:276:86399 ns   0.998738498954875E+01 .619438E-01
 LCB  R716 R15 ZECK 12351M001 C1P  C2P  15:276:00000 15:276:86399 ns   0.998738498954875E+01 .619438E-01
 LCB  R730 R01 ZECK 12351M001 C1P  C2P  15:276:00000 15:276:86399 ns   0.986707410211821E+01 .619897E-01
 LCB  R734 R05 ZECK 12351M001 C1P  C2P  15:276:00000 15:276:86399 ns   0.986707410211821E+01 .619897E-01
 LCB  R719 R20 ZECK 12351M001 C1P  C2P  15:276:00000 15:276:86399 ns   0.141153412114568E+02 .628927E-01
 LCB  R735 R24 ZECK 12351M001 C1P  C2P  15:276:00000 15:276:86399 ns   0.141153412114568E+02 .628927E-01
 LCB  R720 R19 ZECK 12351M001 C1P  C2P  15:276:00000 15:276:86399 ns   0.129775788594078E+02 .613880E-01
 LCB  R732 R23 ZECK 12351M001 C1P  C2P  15:276:00000 15:276:86399 ns   0.129775788594078E+02 .613880E-01
 LCB  R755 R21 ZECK 12351M001 C1P  C2P  15:276:00000 15:276:86399 ns   0.127492762428632E+02 .830148E-01
 LCB  R744 R03 ZECK 12351M001 C1P  C2P  15:276:00000 15:276:86399 ns   0.127109921890203E+02 .579514E-01
 LCB  R745 R07 ZECK 12351M001 C1P  C2P  15:276:00000 15:276:86399 ns   0.127109921890203E+02 .579514E-01
 LCB  R742 R04 ZECK 12351M001 C1P  C2P  15:276:00000 15:276:86399 ns   0.148705658908036E+02 .629627E-01
 LCB  R743 R08 ZECK 12351M001 C1P  C2P  15:276:00000 15:276:86399 ns   0.148705658908036E+02 .629627E-01
-BIAS/SOLUTION
%=ENDBIA
```

A.8 Example #7: Five-GNSS (MGEX) DCB/LCB product (extracted from CODE MGEX clock analysis)

```
%=BIA 1.00 COM 15:280:36620 COM 15:276:00000 15:276:86399 P 01020 2 SINEX_BIA
*------------------------------------------------------------------------------
* Bias Solution INdependent EXchange Format (Bias-SINEX)
*------------------------------------------------------------------------------
+FILE/REFERENCE
*INFO_TYPE_________ INFO_____________________________________________________
 REFERENCE FRAME    IGb08
 DESCRIPTION        Astronomical Institute, University of Bern
 OUTPUT             CODE MGEX bias estimates
 CONTACT            lars.prange@aiub.unibe.ch
 SOFTWARE           Bernese GNSS Software Version 5.3
 HARDWARE           UBELIX: Linux, x86_64
-FILE/REFERENCE
*------------------------------------------------------------------------------
+SITE/ID
*CODE PT __DOMES__ T _STATION DESCRIPTION__ APPROX_LON_ APPROX_LAT_ _APP_H_
 ABMF  A 97103M001 P Les Abymes, FR         298 28 20.9  16 15 44.3   -25.6
 ADIS  A 31502M001 P Addis Ababa, ET         38 45 58.7   9  2  6.5  2439.2
 AIRA  A 21742S001 P Aira, JP               130 35 58.5  31 49 26.6   314.7
...
 ZIMJ  A 14001M006 P Zimmerwald, CH           7 27 54.4  46 52 37.7   954.3
-SITE/ID
*------------------------------------------------------------------------------
+SITE/RECEIVER
*SITE PT SOLN T DATA_START__ DATA_END____ DESCRIPTION_________ S/N__ FIRMWARE___
 ABMF  A    1 P 15:274:00000 15:276:86399 LEICA GR25           ----- -----------
 ADIS  A    1 P 15:274:00000 15:276:86399 JPS LEGACY           ----- -----------
 AIRA  A    1 P 15:274:00000 15:276:86399 TRIMBLE NETR9        ----- -----------
...
 ZIMJ  A    1 P 15:274:00000 15:276:86399 JAVAD TRE_G3TH DELTA ----- -----------
-SITE/RECEIVER
*------------------------------------------------------------------------------
+BIAS/DESCRIPTION
*KEYWORD_________________________________ VALUE(S)_______________________________
 OBSERVATION SAMPLING                            300
 PARAMETER SPACING                             86400
 DETERMINATION METHOD                  CLOCK ANALYSIS
 BIAS MODE                             DIFFERENTIAL
 TIME MODE                             WINDOWS
 TIME SYSTEM                           G
 REFERENCE SYSTEM                      G
 OBSERVABLE GROUP                      G     2 C1P  C1W
 OBSERVABLE GROUP                      G     4 C2P  C2W  C2L  C2S
 REFERENCE OBSERVABLES                 C  C1I  C7I
 REFERENCE OBSERVABLES                 E  C1X  C5X
 REFERENCE OBSERVABLES                 G  C1P  C2P
 REFERENCE OBSERVABLES                 J  C1C  C2X
 REFERENCE OBSERVABLES                 R
 ZERO-MEAN CONDITIONS                  C     1    0    0    1    0    0    0
 ZERO-MEAN CONDITIONS                  E     1    0    0    1    0    0    0
 ZERO-MEAN CONDITIONS                  G     1    0    1    0    0    0    0
 ZERO-MEAN CONDITIONS                  J     1    0    0    1    0    0    0
 ZERO-MEAN CONDITIONS                  R    25    1    0    0   24    0    0
-BIAS/DESCRIPTION
*------------------------------------------------------------------------------
+BIAS/SOLUTION
*BIAS SVN_ PRN SITE DOMES____ OBS1 OBS2 BIAS_START__ BIAS_END____ UNIT __ESTIMATED_VALUE____ _STD_DEV___
      G063 G01                C1P  C1C  15:276:00000 15:276:86399 ns   0.148022937908458E+01 .398201E-01
      G061 G02                C1P  C1C  15:276:00000 15:276:86399 ns   -.121015187124460E+01 .463167E-01
      G069 G03                C1P  C1C  15:276:00000 15:276:86399 ns   0.180949540435891E+01 .393379E-01
      G034 G04                C1P  C1C  15:276:00000 15:276:86399 ns   0.517194875813799E+00 .396322E-01
      G050 G05                C1P  C1C  15:276:00000 15:276:86399 ns   0.146614662451426E+01 .417000E-01
      G067 G06                C1P  C1C  15:276:00000 15:276:86399 ns   0.193325919748383E+01 .434123E-01
      G048 G07                C1P  C1C  15:276:00000 15:276:86399 ns   0.915764959372799E+00 .398921E-01
      G072 G08                C1P  C1C  15:276:00000 15:276:86399 ns   0.300369893926593E+00 .404106E-01
      G068 G09                C1P  C1C  15:276:00000 15:276:86399 ns   0.340687761191245E+00 .379686E-01
      G036 G10                C1P  C1C  15:276:00000 15:276:86399 ns   -.244736900754275E-01 .125984E+00
      G046 G11                C1P  C1C  15:276:00000 15:276:86399 ns   -.309495058713671E+00 .401170E-01
      G058 G12                C1P  C1C  15:276:00000 15:276:86399 ns   0.784816696565082E+00 .383424E-01
      G043 G13                C1P  C1C  15:276:00000 15:276:86399 ns   0.619253340128303E+00 .399141E-01
      G041 G14                C1P  C1C  15:276:00000 15:276:86399 ns   -.450072279494563E+00 .457811E-01
      G055 G15                C1P  C1C  15:276:00000 15:276:86399 ns   0.124573985255184E+01 .406018E-01
      G056 G16                C1P  C1C  15:276:00000 15:276:86399 ns   -.101459576857837E+01 .406213E-01
      G053 G17                C1P  C1C  15:276:00000 15:276:86399 ns   0.852378253981761E+00 .458405E-01
```

```
      G054 G18                C1P  C1C  15:276:00000 15:276:86399 ns    -.109492803922454E+01 .449504E-01
      G059 G19                C1P  C1C  15:276:00000 15:276:86399 ns    -.245661458982554E+01 .411123E-01
      G051 G20                C1P  C1C  15:276:00000 15:276:86399 ns    -.190964953076551E+01 .463188E-01
      G045 G21                C1P  C1C  15:276:00000 15:276:86399 ns    -.130650273147965E+01 .387007E-01
      G047 G22                C1P  C1C  15:276:00000 15:276:86399 ns    -.243328676096964E+01 .414811E-01
      G060 G23                C1P  C1C  15:276:00000 15:276:86399 ns    -.182148442925021E+00 .383014E-01
      G065 G24                C1P  C1C  15:276:00000 15:276:86399 ns    0.131860039763121E+01 .394932E-01
      G062 G25                C1P  C1C  15:276:00000 15:276:86399 ns    -.571982846645502E+00 .394793E-01
      G071 G26                C1P  C1C  15:276:00000 15:276:86399 ns    0.371100950909413E+00 .402464E-01
      G066 G27                C1P  C1C  15:276:00000 15:276:86399 ns    0.638346935977304E-01 .398397E-01
      G044 G28                C1P  C1C  15:276:00000 15:276:86399 ns    -.965854594064209E+00 .429742E-01
      G057 G29                C1P  C1C  15:276:00000 15:276:86399 ns    0.129826128707329E+01 .379365E-01
      G064 G30                C1P  C1C  15:276:00000 15:276:86399 ns    -.461309363777909E+00 .383722E-01
      G052 G31                C1P  C1C  15:276:00000 15:276:86399 ns    0.813667651666248E+00 .433353E-01
      G023 G32                C1P  C1C  15:276:00000 15:276:86399 ns    -.173873565321104E+01 .379656E-01
LCB   G    G    ABMF 97103M001 C1?  C2?  15:276:00000 15:276:86399 ns    0.000000000000000E+00 .000000E+00
LCB   C    C    ABMF 97103M001 C1I  C7I  15:276:00000 15:276:86399 ns    0.240909461328850E+02 .835246E+00
LCB   E    E    ABMF 97103M001 C1X  C5X  15:276:00000 15:276:86399 ns    0.283943462310280E+02 .837023E+00
LCB   G    G    AIRA 21742S001 C1?  C2?  15:276:00000 15:276:86399 ns    0.000000000000000E+00 .000000E+00
LCB   J    J    AIRA 21742S001 C1C  C2X  15:276:00000 15:276:86399 ns    0.339467838586768E+01 .844428E+00
LCB   G    G    AJAC 10077M005 C1?  C2?  15:276:00000 15:276:86399 ns    0.000000000000000E+00 .000000E+00
LCB   C    C    AJAC 10077M005 C1I  C7I  15:276:00000 15:276:86399 ns    0.227493815869896E+02 .684065E+00
...
LCB   G    G    CAS1 66011M001 C1?  C2?  15:276:00000 15:276:86399 ns    0.000000000000000E+00 .000000E+00
LCB   C    C    CAS1 66011M001 C1I  C7I  15:276:00000 15:276:86399 ns    -.449508864157964E+01 .139643E+00
LCB   E    E    CAS1 66011M001 C1X  C5X  15:276:00000 15:276:86399 ns    0.140919876433476E+02 .249790E+00
LCB   J    J    CAS1 66011M001 C1C  C2X  15:276:00000 15:276:86399 ns    -.302029287476200E+01 .805993E+00
...
LCB   G    G    ZIMJ 14001M006 C1?  C2?  15:276:00000 15:276:86399 ns    0.000000000000000E+00 .000000E+00
LCB   E    E    ZIMJ 14001M006 C1X  C5X  15:276:00000 15:276:86399 ns    -.157405972813336E+02 .221344E+01
LCB   G    G    AUCK 50209M001 C1?  C2?  15:276:00000 15:276:86399 ns    0.000000000000000E+00 .000000E+00
LCB   R730 R01  AUCK 50209M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.104868834341878E+02 .101419E+01
LCB   R747 R02  AUCK 50209M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.839102657967896E+01 .815723E+00
LCB   R744 R03  AUCK 50209M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.135359520616739E+02 .773238E+00
LCB   R742 R04  AUCK 50209M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.134158942739078E+02 .129927E+01
LCB   R734 R05  AUCK 50209M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.837243105595812E+01 .132295E+01
LCB   R733 R06  AUCK 50209M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.820421636703761E+01 .954566E+00
LCB   R745 R07  AUCK 50209M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.135968774946661E+02 .903589E+00
LCB   R743 R08  AUCK 50209M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.138457954908824E+02 .100113E+01
LCB   R736 R09  AUCK 50209M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.790492775187953E+01 .104148E+01
LCB   R717 R10  AUCK 50209M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.524778105245740E+01 .134141E+01
LCB   R723 R11  AUCK 50209M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.948578261467121E+01 .130657E+01
LCB   R737 R12  AUCK 50209M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.972770928266179E+01 .909708E+00
LCB   R721 R13  AUCK 50209M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.373032097478001E+01 .859959E+00
LCB   R715 R14  AUCK 50209M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.674389168967504E+01 .985594E+00
LCB   R716 R15  AUCK 50209M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.786586700362409E+01 .936358E+00
LCB   R738 R16  AUCK 50209M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.866978813764577E+01 .869350E+00
LCB   R714 R17  AUCK 50209M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.732214133503972E+01 .101006E+01
LCB   R754 R18  AUCK 50209M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.757264066247209E+01 .863350E+00
LCB   R720 R19  AUCK 50209M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.121460448576070E+02 .970700E+00
LCB   R719 R20  AUCK 50209M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.111976195235630E+02 .103509E+01
LCB   R755 R21  AUCK 50209M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.120314836510983E+02 .929166E+00
LCB   R731 R22  AUCK 50209M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.111481315850749E+02 .884697E+00
LCB   R732 R23  AUCK 50209M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.129333545039342E+02 .999431E+00
LCB   R735 R24  AUCK 50209M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.105168215138981E+02 .110471E+01
LCB   G    G    CAS1 66011M001 C1?  C2?  15:276:00000 15:276:86399 ns    0.000000000000000E+00 .000000E+00
LCB   R730 R01  CAS1 66011M001 C1P  C2P  15:276:00000 15:276:86399 ns    -.142962087888634E+02 .538876E+00
LCB   R747 R02  CAS1 66011M001 C1P  C2P  15:276:00000 15:276:86399 ns    -.141428673312890E+02 .492828E+00
LCB   R744 R03  CAS1 66011M001 C1P  C2P  15:276:00000 15:276:86399 ns    -.144563866144409E+02 .489244E+00
LCB   R742 R04  CAS1 66011M001 C1P  C2P  15:276:00000 15:276:86399 ns    -.150524868063027E+02 .514893E+00
LCB   R734 R05  CAS1 66011M001 C1P  C2P  15:276:00000 15:276:86399 ns    -.148943556420188E+02 .535208E+00
LCB   R733 R06  CAS1 66011M001 C1P  C2P  15:276:00000 15:276:86399 ns    -.141091386524846E+02 .538231E+00
LCB   R745 R07  CAS1 66011M001 C1P  C2P  15:276:00000 15:276:86399 ns    -.150205576220032E+02 .588531E+00
LCB   R743 R08  CAS1 66011M001 C1P  C2P  15:276:00000 15:276:86399 ns    -.154528418397519E+02 .642259E+00
LCB   R736 R09  CAS1 66011M001 C1P  C2P  15:276:00000 15:276:86399 ns    -.155183816327803E+02 .624480E+00
LCB   R717 R10  CAS1 66011M001 C1P  C2P  15:276:00000 15:276:86399 ns    -.152895561383006E+02 .627324E+00
LCB   R723 R11  CAS1 66011M001 C1P  C2P  15:276:00000 15:276:86399 ns    -.138757885921803E+02 .546936E+00
LCB   R737 R12  CAS1 66011M001 C1P  C2P  15:276:00000 15:276:86399 ns    -.143352972342411E+02 .525732E+00
LCB   R721 R13  CAS1 66011M001 C1P  C2P  15:276:00000 15:276:86399 ns    -.193323182417826E+02 .656144E+00
LCB   R715 R14  CAS1 66011M001 C1P  C2P  15:276:00000 15:276:86399 ns    -.145005385943018E+02 .541529E+00
LCB   R716 R15  CAS1 66011M001 C1P  C2P  15:276:00000 15:276:86399 ns    -.155035695298621E+02 .480324E+00
LCB   R738 R16  CAS1 66011M001 C1P  C2P  15:276:00000 15:276:86399 ns    -.155009899627115E+02 .507940E+00
LCB   R714 R17  CAS1 66011M001 C1P  C2P  15:276:00000 15:276:86399 ns    -.131396020174200E+02 .551930E+00
LCB   R754 R18  CAS1 66011M001 C1P  C2P  15:276:00000 15:276:86399 ns    -.144292271009203E+02 .505692E+00
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 LCB  R720 R19 CAS1 66011M001 C1P  C2P  15:276:00000 15:276:86399 ns    -.141801404751045E+02 .573356E+00
 LCB  R719 R20 CAS1 66011M001 C1P  C2P  15:276:00000 15:276:86399 ns    -.145505046410718E+02 .525193E+00
 LCB  R755 R21 CAS1 66011M001 C1P  C2P  15:276:00000 15:276:86399 ns    -.149012826015975E+02 .496307E+00
 LCB  R731 R22 CAS1 66011M001 C1P  C2P  15:276:00000 15:276:86399 ns    -.130037079969488E+02 .531747E+00
 LCB  R732 R23 CAS1 66011M001 C1P  C2P  15:276:00000 15:276:86399 ns    -.138784061156290E+02 .605166E+00
 LCB  R735 R24 CAS1 66011M001 C1P  C2P  15:276:00000 15:276:86399 ns    -.143839030856901E+02 .602370E+00
 LCB  G    G   CEDU 50138M001 C1?  C2?  15:276:00000 15:276:86399 ns    0.000000000000000E+00 .000000E+00
 LCB  R730 R01 CEDU 50138M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.193893827924167E+02 .135805E+01
 LCB  R747 R02 CEDU 50138M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.192126665393477E+02 .152156E+01
 LCB  R744 R03 CEDU 50138M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.271950610593115E+02 .127412E+01
 LCB  R742 R04 CEDU 50138M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.297828161792865E+02 .128979E+01
 LCB  R734 R05 CEDU 50138M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.244315077458299E+02 .159370E+01
 LCB  R733 R06 CEDU 50138M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.188607477704492E+02 .248283E+01
 LCB  R745 R07 CEDU 50138M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.264919290069864E+02 .219594E+01
 LCB  R743 R08 CEDU 50138M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.288620506273102E+02 .153441E+01
 LCB  R736 R09 CEDU 50138M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.284471247343819E+02 .155226E+01
 LCB  R717 R10 CEDU 50138M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.309788159487919E+02 .139899E+01
 LCB  R723 R11 CEDU 50138M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.213263836510131E+02 .157847E+01
 LCB  R737 R12 CEDU 50138M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.199178858524953E+02 .232573E+01
 LCB  R721 R13 CEDU 50138M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.180503616769590E+02 .146855E+01
 LCB  R715 R14 CEDU 50138M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.282720316225087E+02 .124099E+01
 LCB  R716 R15 CEDU 50138M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.227191646822520E+02 .154990E+01
 LCB  R738 R16 CEDU 50138M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.183776066139295E+02 .178722E+01
 LCB  R714 R17 CEDU 50138M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.217932617651448E+02 .144117E+01
 LCB  R754 R18 CEDU 50138M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.201501264861387E+02 .175320E+01
 LCB  R720 R19 CEDU 50138M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.276394548613151E+02 .149600E+01
 LCB  R719 R20 CEDU 50138M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.323391442761390E+02 .136349E+01
 LCB  R755 R21 CEDU 50138M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.254892461514935E+02 .155014E+01
 LCB  R731 R22 CEDU 50138M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.166707246486941E+02 .181508E+01
 LCB  R732 R23 CEDU 50138M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.208479557474807E+02 .155389E+01
 LCB  R735 R24 CEDU 50138M001 C1P  C2P  15:276:00000 15:276:86399 ns    0.302532995431493E+02 .139198E+01
...
 LCB  G    G   ZIMJ 14001M006 C1?  C2?  15:276:00000 15:276:86399 ns    0.000000000000000E+00 .000000E+00
 LCB  R730 R01 ZIMJ 14001M006 C1P  C2P  15:276:00000 15:276:86399 ns    0.972885605391789E+01 .538791E+01
 LCB  R747 R02 ZIMJ 14001M006 C1P  C2P  15:276:00000 15:276:86399 ns    0.439564578686457E+01 .431303E+01
 LCB  R744 R03 ZIMJ 14001M006 C1P  C2P  15:276:00000 15:276:86399 ns    0.143070861993473E+02 .416080E+01
 LCB  R742 R04 ZIMJ 14001M006 C1P  C2P  15:276:00000 15:276:86399 ns    0.167308698561809E+02 .436484E+01
 LCB  R734 R05 ZIMJ 14001M006 C1P  C2P  15:276:00000 15:276:86399 ns    0.936495668212227E+01 .429330E+01
 LCB  R733 R06 ZIMJ 14001M006 C1P  C2P  15:276:00000 15:276:86399 ns    0.294782709523497E+01 .382497E+01
 LCB  R745 R07 ZIMJ 14001M006 C1P  C2P  15:276:00000 15:276:86399 ns    0.136642787424810E+02 .390642E+01
 LCB  R743 R08 ZIMJ 14001M006 C1P  C2P  15:276:00000 15:276:86399 ns    0.162814262174600E+02 .630349E+01
 LCB  R736 R09 ZIMJ 14001M006 C1P  C2P  15:276:00000 15:276:86399 ns    0.417520880953636E+01 .343112E+01
 LCB  R717 R10 ZIMJ 14001M006 C1P  C2P  15:276:00000 15:276:86399 ns    -.197295041048047E+00 .433052E+01
 LCB  R723 R11 ZIMJ 14001M006 C1P  C2P  15:276:00000 15:276:86399 ns    0.964335178943640E+01 .417314E+01
 LCB  R737 R12 ZIMJ 14001M006 C1P  C2P  15:276:00000 15:276:86399 ns    0.835381166884288E+01 .450339E+01
 LCB  R721 R13 ZIMJ 14001M006 C1P  C2P  15:276:00000 15:276:86399 ns    0.213722136254250E+01 .570818E+01
 LCB  R715 R14 ZIMJ 14001M006 C1P  C2P  15:276:00000 15:276:86399 ns    0.469333584577121E+01 .651020E+01
 LCB  R716 R15 ZIMJ 14001M006 C1P  C2P  15:276:00000 15:276:86399 ns    0.933410657672710E+01 .535240E+01
 LCB  R738 R16 ZIMJ 14001M006 C1P  C2P  15:276:00000 15:276:86399 ns    0.150472801010011E+02 .363863E+01
 LCB  R714 R17 ZIMJ 14001M006 C1P  C2P  15:276:00000 15:276:86399 ns    0.914230043919777E+00 .504956E+01
 LCB  R754 R18 ZIMJ 14001M006 C1P  C2P  15:276:00000 15:276:86399 ns    0.571084663887050E+01 .433465E+01
 LCB  R720 R19 ZIMJ 14001M006 C1P  C2P  15:276:00000 15:276:86399 ns    0.131271657640214E+02 .493972E+01
 LCB  R719 R20 ZIMJ 14001M006 C1P  C2P  15:276:00000 15:276:86399 ns    0.136544036815614E+02 .483610E+01
 LCB  R755 R21 ZIMJ 14001M006 C1P  C2P  15:276:00000 15:276:86399 ns    0.136580739546778E+02 .428415E+01
 LCB  R731 R22 ZIMJ 14001M006 C1P  C2P  15:276:00000 15:276:86399 ns    0.547618852828835E+01 .418279E+01
 LCB  R732 R23 ZIMJ 14001M006 C1P  C2P  15:276:00000 15:276:86399 ns    0.125084282479058E+02 .441406E+01
 LCB  R735 R24 ZIMJ 14001M006 C1P  C2P  15:276:00000 15:276:86399 ns    0.134921160156186E+02 .438454E+01
-BIAS/SOLUTION
%=ENDBIA
```

A.9 Example #8: Five-GNSS (MGEX) OCB product (obtained from both clock and ionosphere analysis)

A.10 More Examples? E.g. for PPP-AR Biases? (??)

Appendix B An Excerpt From SINEX (2.02) Format Descriptions

Appendix B contains an excerpt from the SINEX (2.02) format descriptions in order to complete this document for a reader who is not familiar with SINEX.

B.1 INTRODUCTION

```
The SINEX acronym was suggested by Blewitt et al. (1994) and the first
versions, 0.04, 0.05, 1.00 evolved from the work and contributions of
the SINEX Working Group of the IGS. The IGS Analysis Centres and
Associated Analysis Centres use the SINEX format for their weekly
solutions since mid 1995. Although the SINEX format was developed by
the IGS, the ILRS and IVS decided to use it for their pilot projects as
well because SINEX was designed to be modular and general enough to
handle GPS as well as other techniques. To meet all the requirements
for SLR and VLBI solutions some new elements and more detailed
specifications were added by the ILRS Analysis Working Group and by the
IVS. These extensions were merged with the previous SINEX version 1.00
to get a unique format definition for all space geodetic techniques,
and after an intensive discussion the new version called SINEX 2.00
could be finalized. We have to thank the IGS Reference Frame Working
Group chaired by R. Ferland, the ILRS Analysis Coordinator R. Noomen
and the ILRS Analysis Working Group, the IVS Analysis Coordinator
A. Nothnagel and Z. Altamimi from the ITRF section of IGN for their
contributions and advice concerning a new SINEX format definition.  The
changes from version 1.00 to 2.00 are given in the next section of this
document. The complete and detailed format definition can be seen in
APPENDIX I, and the relevant least squares adjustment formulas with
their relations to the SINEX format are summarized in APPENDIX II.
```

B.2 SINEX SYNTAX

```
SINEX is an ASCII file with lines of 80 chars or less. It consists of a
number of blocks which are mutually referenced (related) through station
codes/names, epochs and/or index counters. Some blocks consist of
descriptive lines (starting in Col.2) and/or fixed format fields with
numerous headers and descriptive annotations.

The first line is MANDATORY and must start with "%" in col 1, and contains
information about the agency, file identification, solution spans, techniques, type
of solution, etc. (for more details see the Appendix I or II). The last line ends
with "%ENDSNX".

The SINEX format consists of a number BLOCKS which start with "+" in the first col.
followed by a standardized block labels, and each block ends with "-" and the block
label. Each block data starts in the column 2 or higher. Blocks can be in any order,
provided that they start with (+) and end with (-) block labels. The first header
line and most blocks are related through epochs or time stamps in the following
format: YY:DOY:SECOD YY-year; DOY- day of year; SECOD -sec of day; E.g. the epoch
95:120:86399 denotes April 30, 1995 (23:59:59UT). The epochs 00:00:00000 are allowed
in all blocks, except the first header line if the SINEX file is an output of a data
analysis (in case of a SINEX template the epoch 00:00:00000 is allowed in the header
line as well) and default into the start or end epochs of the first header line which
must always be coded. This is particularly useful for some blocks, such as the ones
related to hardware, occupancy, which should be centrally archived by IGSCB with
00:00:00000 as the end (current) epochs, and which should be readily usable by ACs
for SINEX and other analysis/processing as official (authoritative) IGS information.

COMMENT lines starts with "*" in Col. 1 and can be anywhere within or
outside a block, though for the clarity sake, beginning and ends of blocks are
preferable. For increased portability, the floating number exponent of "E" should be
used rather than "D" or "d" which is not recognized by some compiler/installations.
Fields not coded should be filled with "-" characters to allow efficient row and
column format readings.
```

B.3 SINEX VERSION 2.00—DETAIL FORMAT DESCRIPTION

```
1.       INTRODUCTION
2.       DATA STRUCTURE
3.       HEADER LINE
4.       FILE/REFERENCE BLOCK
5.       FILE/COMMENT BLOCK
6.       INPUT/HISTORY BLOCK
7.       INPUT/FILES BLOCK
8.       INPUT/ACKNOWLEDGMENTS BLOCK
9.       NUTATION/DATA BLOCK
10.      PRECESSION/DATA BLOCK
11.      SOURCE/ID BLOCK
12.      SITE/ID BLOCK
13.      SITE/DATA BLOCK
14.      SITE/RECEIVER BLOCK
15.      SITE/ANTENNA BLOCK
16.      SITE/GPS_PHASE_CENTER BLOCK
17.      SITE/ECCENTRICITY BLOCK
18.      SOLUTION/EPOCHS BLOCK
19.      BIAS/EPOCHS BLOCK
20.      SOLUTION/STATISTICS BLOCK
21.      SOLUTION/ESTIMATE BLOCK
22.      SOLUTION/APRIORI BLOCK
23.      SOLUTION/MATRIX_ESTIMATE BLOCK
24.      SOLUTION/MATRIX_APRIORI BLOCK
25.      SOLUTION/NORMAL_EQUATION_VECTOR BLOCK
26.      SOLUTION/NORMAL_EQUATION_MATRIX BLOCK
27.      FOOTER LINE
```

B.3.1 1. Introduction

```
This document describes the Software Independent Exchange (SINEX) format. It
started in early 1995 with an effort by a number of IGS participants and it was
designed to be easily extended. For the new IERS structure, operational since
January 1, 2001, and due to the use of SINEX by the ILRS (pilot project
'positioning and earth orientation') and the IVS as well, some extensions were
made with the purpose to have a unique format description for all techniques.
```

B.3.2 2. Data Structure

```
Each SINEX line has at most 80 ASCII characters.
The SINEX file is subdivided in groups of data called blocks. Each block is
enclosed by a header and trailer line. Each block has a fixed format. The
blocks contain information on the file, its input, the sites and the solution.
All elements within a line are defined. A character field without information will
have "-"s within its field and a missing numerical element will have a value of 0
within its field. Therefore the SINEX file is accessible "column-wise" as well as
"line-wise". Character fields should be left hand justified whenever applicable.

The first character of each line identifies the type of information that the
line contains. Five characters are reserved. They have the following
meaning when they are at the beginning of a line, they identify:
Character Definition
"%" Header and trailer line,
"*" Comment line within the header and trailer line,
"+" Title at the start of a block
"-" Title at the end of a block
" " Data line within a block

No other character is allowed at the beginning of a line!

A SINEX file must start with a header line and ends with a footer line.

The following blocks are defined:

FILE/REFERENCE
FILE/COMMENT
INPUT/HISTORY
```

```
INPUT/FILES
INPUT/ACKNOWLEDGMENTS
NUTATION/DATA
PRECESSION/DATA
SOURCE/ID
SITE/ID
SITE/DATA
SITE/RECEIVER
SITE/ANTENNA
SITE/GPS_PHASE_CENTER
SITE/GAL_PHASE_CENTER
SITE/ECCENTRICITY
SATELLITE/ID
SATELLITE/PHASE_CENTER
BIAS/EPOCHS
SOLUTION/EPOCHS
SOLUTION/STATISTICS
SOLUTION/ESTIMATE
SOLUTION/APRIORI
SOLUTION/MATRIX_ESTIMATE {p} {type}
SOLUTION/MATRIX_APRIORI {p} {type}
SOLUTION/NORMAL_EQUATION_VECTOR
SOLUTION/NORMAL_EQUATION_MATRIX {p}

        Where:  {p}     L or U
                {type}  CORR or COVA or INFO
```

These block titles are immediately preceded by a "+" or a "-" as they mark the beginning or the end of a block. The block titles must be in capital letters. After a block has started(+) it must be ended(-) before another block can begin. The general structure is as follows:

```
%=SNX..... (Header line)----------|
.............                     |
+(BLOCK TITLE)-------------|       |
 .............             |      |
 .............             |      |
 .............             |      |
-(BLOCK TITLE)-------------|       |
.............                     |
+(BLOCK TITLE)-------------|       |
 .............             |      |
 .............             |      |
 .............             |      |
-(BLOCK TITLE)------------ |       |
.............                     |
%ENDSNX          (Trailer line)---------|
```

Most fields within a SINEX line are separated by a single space. In the following sections, each SINEX line is defined by its field name, a general description and the (FORTRAN) format.

A comment line (not to be confused with the FILE/COMMENT Block) can be written anywhere within the header and the footer line. All comment lines must start with a "*" in the first column. With the use of this character information can be hidden from the software reading the file without deleting it from the file. A comment line is defined as follows:

Field	Description	Format
Comment	Any general comment relevant to the SINEX file.	1H*,A79
		80

Some fields are found in several blocks. To keep the description short, they are described in detail here, and will be referred to in the sections with additional information added when necessary. The fields defined below will be referenced to by putting them within square brackets [] when encountered in the

following sections.

Field	Description	Format
Time	YY:DDD:SSSSS. "UTC" YY = last 2 digits of the year, if YY <= 50 implies 21-st century, if YY > 50 implies 20-th century, DDD = 3-digit day in year, SSSSS = 5-digit seconds in day.	I2.2, 1H:,I3.3, 1H:,I5.5
Constraint Code	Single digit indicating the constraints: 0-fixed/tight constraints, 1-significant constraints, 2-unconstrained.	A1

B.3.3 4. FILE/REFERENCE Block (Mandatory)

Description:

This block provides information on the Organization, point of contact, the software and hardware involved in the creation of the file.

Contents:

FILE/REFERENCE/DATA/LINE		
Field	Description	Format
Information Type	Describes the type of information present in the next field. May take on the following values: 'DESCRIPTION' - Organization(s) gathering/altering the file contents. 'OUTPUT' - Description of the file contents. 'CONTACT' - Address of the relevant contact. e-mail 'SOFTWARE' - Software used to generate the file. 'HARDWARE' - Computer hardware on which above software was run. 'INPUT' - Brief description of the input used to generate this solution. Any of the above fields may be and in any order.	1X,A18
Information	Relevant information for the type indicated by the previous field.	1X,A60
		80

B.3.4 5. FILE/COMMENT Block (Optional)

Description:

This block can be used to provide general comments about the SINEX data file.

Contents:

FILE/COMMENT/DATA/LINE		
Field	Description	Format
Comment	Any general comment providing relevant information about the SINEX file.	1X,A79
		80

B.3.5 12. SITE/ID Block (Mandatory)

Description:

This block provides general information for each site containing estimated parameters.

Contents:

SITE/ID/DATA/LINE		
Field	Description	Format
[Site Code]	Call sign for a site.	1X,A4
[Point Code]	Physical monument used at a site	1X,A2
Unique Monument Identification	Unique alpha-numeric monument identification. For ITRF purposes, it is a nine character DOMES/DOMEX number (five/six digits, followed by the single letter 'M' or 'S', followed by four/three digits)	1X,A9
[Observation Code]	Observation technique(s) used.	1X,A1
Station Description	Free-format description of the site, typically the town and/or country.	1X,A22
Approximate Longitude	Approximate longitude of the site in degrees(E/+), minutes and seconds.	1X,I3, 1X,I2, 1X,F4.1
Approximate Latitude	Approximate latitude of the site in degrees(NS/+-), minutes and seconds.	1X,I3, 1X,I2, 1X,F4.1
Approximate Height	Approximate height of the site in metres.	1X,F7.1
		75

Comments:

For DOMES numbers and station description as well as for Site Codes please

```
refer to
  ftp://lareg.ensg.ign.fr/pub/itrf/iers_dir.sta

If a DOMES number is not available (e.g. for a new station), please ask Zuheir
Altamimi for a DOMES number (altamimi@ensg.ign.fr).

Use the minus sign for negative approximate longitude or latitude only in the
"degrees" component and don't repeat it in the "minutes" and "seconds"
component.

Following the ISO6709 specification, the range of longitude should be
[-180  +180 [.
```

B.3.6 14. SITE/RECEIVER Block (Mandatory for GPS)

```
Description:

List the receiver used at each site during the observation period of
interest.

Contents:
```

S I T E R E C E I V E R D A T A L I N E		
Field	Description	Format
[Site Code]	Site code for which some parameters are estimated.	1X,A4
[Point Code]	Point Code at a site for which some parameters are estimated.	1X,A2
[Solution ID]	Solution Number at a Site/Point code for which some parameters are estimated.	1X,A4
[Observation Code]	Identification of the observation technique used.	1X,A1
[Time]	Time since the receiver has been operating at the Site/Point. Value 00:000:00000 indicates that the receiver has been operating at least since the "File Epoch Start Time".	1X,I2.2, 1H:,I3.3, 1H:,I5.5
[Time]	Time until the receiver is operated at a Site/Point. Value 00:000:00000 indicates that the receiver has been operating at least until the "File Epoch End Time".	1X,I2.2, 1H:,I3.3, 1H:,I5.5
Receiver Type	Receiver Name & model.	1X,A20
Receiver Serial Number	Serial number of the receiver. Takes on value '-----' if unknown.	1X,A5
Receiver Firmware	Firmware used by this receiver during the epoch specified above. Takes on value '---------- ' if unknown.	1X,A11

```
                                                        |     80       |
                                                        |--------------|
Comments:

- For IGS standard receiver names please refer to
  ftp://igscb.jpl.nasa.gov/igscb/station/general/rcvr_ant.tab
```