SINEX -   Solution (Software/technique) INdependent EXchange Format
                         Version 2.02 (December 01, 2006)

   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. During 2002, these extensions were merged with the
previous SINEX version 1.00 to get a unique format definition for all space geodetic
techniques. After an intensive discussion with 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, the version called SINEX 2.00 could be finalized. The latest
changes to version 2.02 are mainly due to an extended list of parameters and the
demands of GALILEO.
The changes between the different versions (1.00, 2.00, 2.01, 2.02) 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.

CHANGES FROM VERSION 2.01 TO 2.02

1) The version number in the header line changes to 2.02.

2) The epoch 00:000:00000 is now explicitly allowed for the SINEX template created at
the IGS Central Bureau.

3) The list of allowed parameter types has increased. As additional
parameters you can include in the SINEX file:

- CN   = Normalized spherical harmonic coefficient of the Earth's gravity field
             (cosine term)
- SN   = Normalized spherical harmonic coefficient of the Earth's gravity field
             (sine term)
- NUT_X = Nutation angle DELTA_X (correction to a priori model; new paradigm)
- NUT_Y = Nutation angle DELTA_Y (correction to a priori model; new paradigm)
- NUTR_X = Linear drift for nutation angle DELTA_X
- NUTR_Y = Linear drift for nutation angle DELTA Y

The new paradigm for the nutation angles is documented in Capitaine et al. (2002) or
McCarthy and Petit (2004).
The degree and order of the spherical harmonic coefficients is stored in the columns
'Site Code' and 'Solution ID', respectively.

4) Following the actual usage of the nutation parameters the SINEX specification is
adapted: the nutation parameters (NUT_LN, NUT_OB, NUT_X, NUT_Y, NUTPLN, NUTPOB,
NUTP_X, NUTP_Y) should no longer represent the total nutation angles but they
represent corrections to the a priori model used in the analysis. The information
about the a priori model is provided in the block NUTATION/DATA.
Furthermore, the unit recommended for the nutation angles is changed to [mas] and
[mas/d] instead of [rad] and [rad/d], respectively.

5) In order to prepare the SINEX format for the inclusion of Galileo observations,
the description is extended for the 'Site Code', the 'Point Code', the 'PRN' in the
SATELLITE/ID block and the 'Frequency Code' in the SATELLITE/PHASE_CENTER block. The
coding of the frequencies is aligned to the RINEX 3.00 standard.
Additionally, a new block SITE/GAL_PHASE_CENTER is included. The structure of this
new block is similar to the GPS counterpart SITE/GPS_PHASE_CENTER. But as the

information for more than two frequencies has to be stored for Galileo, the new block is defined to have three lines per antenna, each with the phase center offsets for two frequencies, and the order of the frequencies is predefined.

6) The specification of the geographical longitude according to ISO6709 as values within the range [-180° +180°[(see point 10 in the CHANGES FROM VERSION 1.00 to 2.00) is skipped, because that does not fit into the data field I3 in the SITE/ID block. In order to keep the compatibility with older SINEX files, the I3 field is kept and the range for longitude is [0° 360°[.

CHANGES FROM VERSION 2.00 TO 2.01

1) The version number in the header line changes to 2.01.

2) The list of allowed estimated parameter types has increased. As additional parameters you can include in your solution:

- SATA_Z   = satellite antenna Z offset [m]
- SATA_X   = satellite antenna X offset [m]
- SATA_Y   = satellite antenna Y offset [m]

3) Due to these new parameters a character defining antenna parameters ('A') was added to the field 'Solution Contents' in the HEADER LINE and in the block INPUT/HISTORY. The character 'A' may also be used for VLBI antenna parameters.

4) Two new blocks were added:

- SATELLITE/ID (Recommended for GNSS, if available)
- SATELLITE/PHASE_CENTER (Mandatory for GNSS, if satellite antenna offsets are not estimated)

 CHANGES FROM VERSION 1.00 TO 2.00

1) The version number in the header line changes to 2.00.

2) The list of allowed estimated parameter types has increased. As additional parameters you can include in your solution:

- XGC   \
- YGC   - = coordinates of the geocenter [m]
- ZGC   /
- RS_RA   = right ascension of a radio source [rad]
- RS_DE   = declination of a radio source [rad]
- RS_RAR   = rate of right ascension of a radio source [rad/y]
- RS_DER   = rate of declination of a radio source [rad/y]
- RS_PL   = radio source parallax [rad]
- NUT_LN   = nutation total in longitude [rad]
- NUT_OB   = nutation total in obliquity [rad]
- NUTRLN   = nutation rate in longitude [rad/d]
- NUTROB   = nutation rate in obliquity [rad/d]
- TGNWET   = troposphere gradient in north for the wet part [m]
- TGNDRY   = troposphere gradient in north for the dry part [m]
- TGNTOT   = total troposphere gradient in north (wet + dry part) [m]
- TGEWET   = troposphere gradient in east for the wet part [m]
- TGEDRY   = troposphere gradient in east for the dry part [m]
- TGETOT   = total troposphere gradient in east (wet + dry part) [m]
- AXI_OF   = VLBI antenna axis offset [m]
- RBIAS   = range bias [m]
- TBIAS   = time bias [ms]
- SBIAS   = scale bias [ppb]
- ZBIAS   = troposphere bias in zenith [m]

The parameters LODR and UTR (LOD and UT1-UTC reduced for the short periodic terms up to 35 days) are no official SINEX parameters and should not be used.
The coordinates of geocenter already appear in some IGS solutions, so we decided to define these parameters as officially allowed.
The coordinates of radio sources (right ascension, declination) and their rates, the parallax of radio sources, the nutation parameters and their rates, the troposphere gradients and the antenna axis offsets are new parameters requested for VLBI solutions.
The four bias parameters are taken from the ILRS implementation of SINEX.

3) Due to these new parameters the field 'Solution Contents' in the HEADER LINE and in the block INPUT/HISTORY must be changed.

All parameters belonging to the stations are summarized in only one character:
'S' = station coordinates (STAX, STAY, STAZ),
      station velocities (VELX, VELY, VELZ),
      all four bias parameters (RBIAS, TBIAS, SBIAS, ZBIAS),
      geocenter coordinates (XGC, YGC, ZGC).
That means, the character 'X' for station coordinates and 'V' for station velocities are dropped.

A new character is defined for all parameters belonging to the celestial reference frame:
'C' = right ascension and declination of the radio sources (RS_RA, RS_DE),
      rates for right ascension and declination of the radio sources
      (RS_RAR, RS_DER),
      parallax of radio sources (RS_PL).

The other new parameters can be attached easily to the existing characters of SINEX version 1.00:
'T' = for all troposphere parameters (including the new parameters for the
      troposphere gradients TGNWET, TGNDRY, TGNTOT, TGEWET, TGEDRY, TGETOT),
'E' = for all earth orientation parameters (including the new nutation
      parameters NUT_LN, NUT_OB, NUTRLN, NUTROB).

The orbit parameters 'O' are not changed.

4) The block SOLUTION/STATISTICS is now RECOMMENDED if the requested values are available because for a further combination of solutions it is necessary to have the complete statistical information.

The preference is given to the original values like 'NUMBER OF OBSERVATIONS' and 'NUMBER OF UNKNOWNS' instead of 'DEGREE OF FREEDOM'.

The 'NUMBER OF OBSERVATIONS' should represent only the number of 'real' observations.

A new value became necessary if unconstrained normal equations are stored because the variance factor contains the constraints of the solution. Therefore the weighted square sum of the vector 'observed minus computed' should be given in the SOLUTION/STATISTICS block to become independent of the influence of the constraints on the variance factor: (o-c)' P (o-c), where (o-c) represents the vector 'observed minus computed' and P denotes the weigth matrix. This new value can be stored under the name
WEIGHTED SQUARE SUM OF O-C

5) The list of allowed parameter types in the block SOLUTION/APRIORI is extended following some IGS solutions: if you apply inner constraints to your solution you can add the constrained transformation parameters to the SOLUTION/APRIORI block.

That means for the particular fields of this block:

- Parameter Type:
TX, TY, TZ   for translation restrictions in x, y and z direction
RX, RY, RZ   for rotation restrictions around the x, y and z axis
SC   for scale restriction

```
TXR, TYR, TZR  for restrictions on the rates of the translation in x, y  and z
RXR, RYR, RZR  for restrictions on the rates of the rotation around the
               x, y and z axis
SCR            for restriction on the rate of the scale

- The fields Site Code, Point Code, Solution ID are filled with '-'

- Time:
the reference epoch of the inner constraints

- Parameter Units:
 m     for translation parameters, i.e. [m]
 mas   for rotation parameters, i.e. [mas]
 ppb   for the scale, i.e. [ppb]
 m/y   for the rates of translation parameters, i.e. [m/y]
 ma/y  for the rates of rotation parameters, i.e. [mas/y]
 pb/y  for the rate of the scale, i.e. [ppb/y]

- Constraint Code:
0 for tight constraints

- Parameter Apriori:
the value on which you constrained the transformation parameter or its rate for the
transformation of your solution according to the apriori reference frame
(e.g. if the apriori reference frame represents the desired reference frame for your
solution the apriori parameters are 0.0)

- Parameter Standard Deviation:
the sigma you choose for constraining the particular transformation parameter or its
rate

To decide which stations were contributing to the inner constraints, the appropriate
station parameters (coordinates and velocities if the rates are given as well) must
be given in the block SOLUTION/APRIORI as well and should contain a '1' in the field
'CONSTRAINT CODE'.


6) With the new SINEX version the delivery of normal equations will be defined more
precisely. We have now three possibilities include normal equation systems in the
SINEX file:

a) In principle it was already possible in version 1.00 to store normal equation
   matrices in the two SOLUTION/MATRIX blocks (ESTIMATE and APRIORI) if you use
   matrix type INFO. And together with the two vectors in SOLUTION/ESTIMATE and
   SOLUTION/APRIORI you are able to reconstruct the original (reduced) normal
   equation system without constraints. But this procedure of removal the constraints
   and compute the right hand side of the normal equation system is always a little
   bit critical, and in addition to that problem, the procedure depends on the
   solution vector given in SOLUTION/ESTIMATE.

For a further combination of several solutions there would be less problems if the
original normal equation system without any constraints can be stored directly in the
SINEX file. In that case you have the advantage that the constraints applied in the
individual solutions (SOLUTION/MATRIX_APRIORI) and the resulting solution vector
(SOLUTION/ESTIMATE) have no influence on the combination. These considerations led to
two other possibilities of storing normal equations in the SINEX file, but for both
we had to introduce two new blocks for the original normal equation system:
- SOLUTION/NORMAL_EQUATION_VECTOR
This block contains the vector of the right hand side of the reduced normal  equation
system
b = A' P l
  where
  A'  is the transposed of the Jacobi-Matrix,
  P   is the weight matrix of the observations and
  l   is the vector observed minus computed with apriori values.
- SOLUTION/NORMAL_EQUATION_MATRIX
This block contains the reduced normal equation matrix WITHOUT constraints (i.e. the
'free' / original solution):
N = A` P A
The structure of this block is similar to the other two MATRIX blocks.
```

The indices of both new blocks must be consistent with the indices in
SOLUTION/ESTIMATE.

With these two additional blocks the second and third possibility of storing normal
equations look as follows:

b) You store the complete information about your solution in the following blocks:
   - original normal equation matrix N = A' P A : SOLUTION/NORMAL_EQUATION_MATRIX
   - vector of right hand side of original normal equation b = A' P l :
     SOLUTION/NORMAL_EQUATION_VECTOR
   - apriori values of the unknown parameters x0: SOLUTION/APRIORI
   - normal equation matrix of applied constraints in your solution dN:
     SOLUTION/MATRIX_APRIORI
   - resulting unknown parameters of the constrained solution
     x = x0 + inv(N + dN) b : SOLUTION/ESTIMATE
   The advantage of this method is the availability of the whole information, i.e.
   the original normal equation can be used for a further combination without any
   problems of constraints removal like in method a), and other users who are
   interested in the parameters of the constrained solution itself can take the
   vector in SOLUTION/ESTIMATE.
   A problem might occur when generating such a SINEX file because you need both,
   the original normal equation system as well as the solution estimate (as in case
   a)) and in most software packages the normal equation matrix might already be
   inverted at the time when you have the solution estimate available.

c) The third possibility is storing only the original normal equation system in the
   SINEX file, i.e.
   - original normal equation matrix N = A' P A : SOLUTION/NORMAL_EQUATION_MATRIX
   - vector of right hand side of original normal equation b = A' P l :
     SOLUTION/NORMAL_EQUATION_VECTOR
   - apriori values of the unknown parameters x0: SOLUTION/APRIORI
   For a further combination with other solutions this would be enough information
   and there wouldn't be any problems with constraints removal.
   On the other hand the documentation of the estimated parameters is missing.

To reconstruct the statistical information about the original solution for the last
two possibilities (points b) and c)) it is necessary to store the weighted square sum
of the vector observed minus computed, i.e. l' P l in the SOLUTION/STATISTICS block
because only this part of the variance factor is independent of the constrained
solution and can be taken for a combination
(v' P v = l' P l – (x – x0)' b):
WEIGHTED SQUARE SUM OF O-C
(see as well point 4) of the changes from version 1.00 to 2.00)

7) For more clearness and with regards to a good documentation how the solution in
SOLUTION/ESTIMATE was created, the block SOLUTION/APRIORI is now mandatory.
The block SOLUTION/MATRIX_APRIORI is only mandatory if the matrix in
SOLUTION/MATRIX_ESTIMATE contains some constraints.

 If you deliver normal equations in your SINEX file some more blocks are mandatory,
depending on the method of storing normal equations:
For method 6a)
- SOLUTION/MATRIX_APRIORI (INFO type)
- SOLUTION/MATRIX_ESTIMATE (INFO type)
- SOLUTION/STATISTICS (#observations, #unknowns, weighted square sum of o-c)
For method 6b)
- SOLUTION/MATRIX_APRIORI
- SOLUTION/NORMAL_EQUATION_MATRIX
- SOLUTION/NORMAL_EQUATION_VECTOR
- SOLUTION/STATISTICS (#observations, #unknowns, weighted square sum of o-c)
For method 6c)
- SOLUTION/NORMAL_EQUATION_MATRIX
- SOLUTION/NORMAL_EQUATION_VECTOR
- SOLUTION/STATISTICS (#observations, #unknowns, weighted square sum of o-c)

8) Besides the new blocks for normal equations we have introduced some other new
blocks in the SINEX format 2.00:

- NUTATION/DATA:
to store the information about the nutation model used in the analysis;
This block contains two fields: one for the name of the nutation model and one for
some comments.

- PRECESSION/DATA:
to store the information about the precession model used in the analysis;
This block contains two fields: one for the name of the precession model and one for
some comments.

- SOURCE/ID:
to provide information about the radio sources observed with VLBI;
There are 3 fields for source names: the Source Code (used for SINEX internal
referencing), the IERS designation and the ICRF designation.

- BIAS/EPOCHS:
important if bias parameters are included in the solution (from SLR solutions)

9) The matrix type SRIF (for Square Root Information Filter Matrix) in the two blocks
SOLUTION/MATRIX_APRIORI and SOLUTION/MATRIX_ESTIMATE is no longer allowed.

10) The longitude sign definition in the SITE/ID block is redefined according to the
ISO6709 definition (that is the way the information was already stored in most of the
SINEX files):
- positive longitudes have to be used for east direction with respect to the
Greenwich meridian
- following the ISO6709 specification, the range of longitude should be
[-180° +180°[

11) The value "-----" in the field 'Antenna Serial Number' of the
SITE/GPS_PHASE_CENTER block is redefined:
it signifies that the phase center offsets for L1 and L2 that are given in the
following columns apply to ALL antennas of the same type that is indicated in the
field 'Antenna Type'.
As a consequence, if the phase center offsets for one antenna name and the given
model are the same for all antenna serial numbers, it is enough to store only one
data line (with "-----" for the 'Antenna Serial Number') in the SITE/GPS_PHASE_CENTER
block for each antenna type that appears in the SITE/ANTENNA block.

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.

The most important blocks are the SOLUTION blocks. They are in fixed format (For more information on the format, see APPENDIX I).
The mandatory SOLUTION blocks depend on the contents of the SINEX file.
If you deliver variance-covariance matrices or correlation matrices in your SINEX files the blocks
- SOLUTION/ESTIMATE
- SOLUTION/APRIORI
- SOLUTION/MATRIX_ESTIMATE
are mandatory.
The block SOLUTION/MATRIX_APRIORI is only mandatory if the matrix in SOLUTION/MATRIX_ESTIMATE contains some constraints.
Important but not mandatory (though STRONGLY RECOMMENDED if available for IERS purposes) is the block SOLUTION/STATISTICS, especially the information about the number of observations, the number of unknowns and the variance factor.

  If you deliver normal equations in your SINEX file the mandatory SOLUTION blocks depend on the method of storing normal equations:
For method 6a)
- SOLUTION/APRIORI
- SOLUTION/ESTIMATE
- SOLUTION/MATRIX_APRIORI (INFO type)
- SOLUTION/MATRIX_ESTIMATE (INFO type)
- SOLUTION/STATISTICS (#observations, #unknowns, weighted square sum of o-c)
For method 6b)
- SOLUTION/APRIORI
- SOLUTION/ESTIMATE
- SOLUTION/MATRIX_APRIORI
- SOLUTION/NORMAL_EQUATION_MATRIX
- SOLUTION/NORMAL_EQUATION_VECTOR
- SOLUTION/STATISTICS (#observations, #unknowns, weighted square sum of o-c)
For method 6c)
- SOLUTION/APRIORI
- SOLUTION/NORMAL_EQUATION_MATRIX
- SOLUTION/NORMAL_EQUATION_VECTOR
- SOLUTION/STATISTICS (#observations, #unknowns, weighted square sum of o-c)

Storing the (reduced) normal equation system in one of the possible ways described before is encouraged for combination research purposes within the IERS to avoid the critical step of constraints removal.

The scale of estimated and apriori standard deviations can, in principle, be arbitrary (note even apriori scaling is arbitrary, depending on the observation weighting). However, both estimated and apriori standard deviations (and the corresponding matrices) MUST use the same scaling (i.e. variance) factor stored in the block SOLUTION/STATISTICS. Otherwise the apriori information cannot be rigorously removed to form free solutions (e.g. normal matrices). Scaling between different SINEX solutions is beyond the SINEX format and must be dealt with at the combination/analysis stage.

REFERENCES

- Blewitt, G., Y. Bock and J. Kouba: "Constraining the IGS Polyhedron by Distributed Processing", workshop proceedings : Densification of ITRF through Regional GPS Networks, held at JPL, Nov30-Dec 2, 1994, pp. 21-37.

- Capitaine, N., D. Gambis, D.D. McCarthy, G. Petit, J. Ray, B. Richter, M. Rothacher, E.M. Standish and J. Vondrak (eds.): Proceedings of the IERS Workshop on

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Paris, France, 18-19 April 2002. IERS Technical Note No. 29. Verlag des Bundesamts
fuer Kartographie und Geodaesie, Frankfurt/Main, 2002.

- McCarthy, D.D. and G. Petit (eds.): IERS Conventions (2003). IERS Technical Note
No. 32. Verlag des Bundesamts fuer Kartographie und Geodaesie, Frankfurt/Main, 2004.

- SINEX version 1.00 description:
  ftp://igscb.jpl.nasa.gov/igscb/data/format/sinex.txt

- ILRS implementation of the SINEX format (R.Noomen, V.Husson):
  ftp://ilrs.gsfc.nasa.gov/ilrs/sinex_file_description.html
  http://ilrs.gsfc.nasa.gov/awg_min_toulouse2001.html

- Proposal for extending the SINEX 1.0 format for geodetic and astrometric VLBI:
  ftp://giub.geod.uni-bonn.de/vlbi/IVS-AC/sinex_proposal.html

- Requirements for SINEX solutions contributing to the ITRF97:
  ftp://lareg.ensg.ign.fr/ITRF/ITRF-SINEX.html

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                        Version 2.02 (December 01, 2006)

                        A P P E N D I X   I

                              S I N E X

                      V E R S I O N   2 . 0 2

              D E T A I L E D   F O R M A T   D E S C R I P T I O N

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.

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/ACKNOWLEDGEMENTS
 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
C_O_M_M_E_N_T___D_A_T_A___L_I_N_E		
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

Parameter Type	Type of parameter. List of allowed parameters and the units provided:
	
	STAX – station X coordinate, m
	STAY – station Y coordinate, m
	STAZ – station Z coordinate, m
	VELX – station X velocity, m/y
	VELY – station Y velocity, m/y
	VELZ – station Z velocity, m/y
	XGC – geocenter X coordinate, m
	YGC – geocenter Y coordinate, m
	ZGC – geocenter Z coordinate, m
	RS_RA – radio source right
	           ascension, rad
	RS_DE – radio source declin., rad
	RS_RAR – radio source right
	           ascension rate, rad/y
	RS_DER – radio source
	           declination rate, rad/y
	RS_PL – radio source parallax, rad
	LOD – length of day, ms
	UT – delta time UT1-UTC, ms
	XPO – X polar motion, mas
	YPO – Y polar motion, mas
	XPOR – X polar motion rate, mas/d
	YPOR – Y polar motion rate, mas/d
	NUT_LN – nutation correction
	           in longitude, mas
	NUT_OB – nutation correction
	           in obliquity, mas
	NUTRLN – nutation rate in
	           longitude, mas/d
	NUTROB – nutation rate in
	           obliquity, mas/d
	NUT_X – nutation correction X, mas
	NUT_Y – nutation correction Y, mas
	NUTR_X – nutation rate in X mas/d
	NUTR_Y – nutation rate in Y mas/d
	SAT__X – Satellite X coord., m
	SAT__Y – Satellite Y coord., m
	SAT__Z – Satellite Z coord., m
	SAT_VX – Satellite X velocity, m/s
	SAT_VY – Satellite Y velocity, m/s
	SAT_VZ – Satellite Z velocity, m/s
	SAT_RP – Radiation pressure,
	SAT_GX – GX scale,
	SAT_GZ – GZ scale,
	SATYBI – GY bias, m/s2
	TROTOT – wet + dry Trop. delay, m
	TRODRY – dry Trop. delay, m
	TROWET – wet Trop. delay, m
	TGNTOT – troposphere gradient
	           in north (wet + dry), m
	TGNWET – troposphere gradient
	           in north (only wet), m
	TGNDRY – troposphere gradient
	           in north (only dry), m
	TGETOT – troposphere gradient
	           in east (wet + dry), m
	TGEWET – troposphere gradient
	           in east (only wet), m
	TGEDRY – troposphere gradient
	           in east (only dry), m
	RBIAS – range bias, m
	TBIAS – time bias, ms
	SBIAS – scale bias, ppb
	ZBIAS – troposphere bias at
		A6

```
|                  |       zenith,                m|              |
|                  | AXI_OF - VLBI antenna axis    |              |
|                  |         offset,             m|              |
|                  | SATA_Z - sat. antenna Z offset   m|          |
|                  | SATA_X - sat. antenna X offset,  m|          |
|                  | SATA_Y - sat. antenna Y offset,  m|          |
|                  | CN     - spherical harmonic   |              |
|                  |          coefficient C_nm     |              |
|                  | SN     - spherical harmonic   |              |
|                  |          coefficient S_nm     |              |
```

Site Code	- For stations: Call sign for a site.(It should be consistent with ITRF, see below). - For satellites (orbits, antenna offsets etc.): Use "CNNN" where C is the GNSS code (G=GPS, R=GLONASS, E=Galileo) and NNN is the SVN number (GPS and Galileo) or GLONASS number. - For spherical harmonics CN, SN: Degree n of the coefficient	A4

Point Code	- For stations: A two character code identifying physical monument within a site. Typically has a code A, but could vary if the site has more than one monument. - For satellite antenna offsets: Frequency or linear combination for which phase center offsets are estimated. GPS: L1, L2, LC GLONASS: L1, L2, LC (LC: ionosphere-free linear combination of L1 and L2) Galileo: L1, L5, L7, L8, L6 Following the RINEX definition: L1=E1, L5=E5a, L7=E5b, L8=E5a+E5b L6=E6 Galileo ionosphere-free linear combinations are to be identified as follows: 15: L1 and L5 linear combination 16: L1 and L6 linear combination 17: L1 and L7 linear combination 18: L1 and L8 linear combination 56: L5 and L6 linear combination ... etc. - For bias parameters: satellite ID L1, L2 for LAGEOS-1 or -2; LC for combined LAGEOS; E1, E2 for Etalon 1 or 2; EC for combined Etalon;	A2

Solution ID	- For stations: Character identifying the solution given for a point at a site. "----" applies to all. - For spherical harmonics CN, SN: Order m of the coefficient	A4

Observation Code.	A single character indicating the technique(s) used to arrive at the solutions obtained in this SINEX file. It should be consistent with the IERS convention. This character code may be: C-Combined techniques used. D-DORIS, L-SLR, M-LLR, P-GNSS, R-VLBI.	A1

Comment:

For the official IERS sites the values of the 'Site Code' are listed in ftp://lareg.ensg.ign.fr/pub/itrf/iers_dir.sta

'Per year' means 365.25 days in this context.

3. Header Line (Mandatory)

Description

The header line must be the first line in a SINEX file.

Contents:

H_E_A_D_E_R___L_I_N_E		
__Field_____	_____Description_____	___Format_____
First Character	Single character '%' in column #1. No other character than '%' is al-lowed.	A1
Second Character	Single character '=' in column #2. Indicates 'resultant' solution. No other character than '=' is al-lowed.	A1
Document Type	Three characters 'SNX' in columns 3 to 5. Indicates that this is a SINEX document.	A3
Format Version	Four digits indicating the version of SINEX format used. '2.10' for this version.	1X,F4.2
File Agency Code	Identify the agency creating the file.	1X,A3
[Time]	Creation time of this SINEX file.	1X,I2.2, 1H:,I3.3, 1H:,I5.5
[Agency Code]	Identify the agency providing the data in the SINEX file	1X,A3

Field	Description	Format
[Time]	Start time of the data used in the SINEX solution Value 00:000:00000 should be avoided in case of an analysis output (for a SINEX template it can be used).	1X,I2.2, 1H:,I3.3, 1H:,I5.5
[Time]	End time of the data used in the SINEX solution Value 00:000:00000 should be avoided in case of an analysis output (for a SINEX template it can be used).	1X,I2.2, 1H:,I3.3, 1H:,I5.5
[Observation Code]	Technique(s) used to generate the SINEX solution	1X,A1
Number of Est-timates	Number of parameters estimated in this SINEX file. Mandatory field.	1X,I5.5
[Constraint Code]	Single character indicating the constraint in the SINEX solution. Mandatory field.	1X,A1

Solution Contents	Solution types contained in this SINEX file. Each character in this field may be one of the following:
	    S – all station parameters,
	        i.e. station coordinates,
	        station velocities, biases,
	        geocenter,
	    O – Orbits,
	    E – Earth Orientation Parameter
	    T – Troposphere,
	    C – Celestial Reference Frame,
	    A – Antenna parameters
	    BLANK
		6(1X,A1)

		79

Relationship with other blocks:

This line is duplicated as the resultant line of the INPUT/HISTORY block with the exception of its first character.

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:

F_I_L_E___R_E_F_E_R_E_N_C_E___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,A18

```
|                     | '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.                    |               |
|_____|_____|_____|
|                     |                                      |               |
| Information         | Relevant information for the type    | 1X,A60        |
|                     | indicated by the previous field.     |               |
|_____|_____|_____|
|                     |                                      |               |
|                     |                              80      |               |
|                     |                              _____|
```

5. FILE/COMMENT Block (Optional)

 Description:

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

 Contents:

```
 _____
|_____F_I_L_E___C_O_M_M_E_N_T___D_A_T_A___L_I_N_E_____|
|                     |                                      |               |
|__Field_____|_____Description_____|___Format_____|
|                     |                                      |               |
| Comment         | Any general comment providing        | 1X,A79        |
|                     | relevant information about the       |               |
|                     | SINEX file.                          |               |
|_____|_____|_____|
|                     |                                      |               |
|                     |                              80      |               |
|                     |                              _____|
```

6. INPUT/HISTORY Block (Recommended)

 Description:

 This block provides information about the source of the information used to
create the current SINEX file.

 Contents:

```
 _____
|_____I_N_P_U_T___H_I_S_T_O_R_Y___D_A_T_A___L_I_N_E_____|
|                     |                                      |               |
|__Field_____|_____Description_____|___Format_____|
|                     |                                      |               |
| File Code       | Only one of the following charac-    | 1X,A1         |
|                     | ters is permitted:                   |               |
|                     |    '+' - This character indicates    |               |
|                     |          that the information that   |               |
|                     |          follows identify an input   |               |
```

	solution contributing to this SINEX file. '=' – This character indicates that the information that follows identify the output solution file.	
Document Type	Three characters 'SNX' in columns 3 to 5. Indicates that this is a SINEX document.	A3
Format Version	Four digits indicating the version of SINEX format used. '2.01' for this version.	1X,F4.2
[Agency Code]	Identify the agency creating the file.	1X,A3
[Time]	Creation time of this SINEX file.	1X,I2.2, 1H:,I3.3, 1H:,I5.5
[Agency Code]	Identify the agency providing the data in the SINEX file.	1X,A3
[Time]	Start time of the data used in the SINEX solution.	1X,I2.2, 1H:,I3.3, 1H:,I5.5
[Time]	End time of the data used in the SINEX solution.	1X,I2.2, 1H:,I3.3, 1H:,I5.5
[Observation Technique]	Technique(s) used to generate the SINEX solution.	1X,A1
Number of Est-timates	Number of parameters estimated in this SINEX file.	1X,I5.5
[Constraint Code]	Single digit indicating the constraint in the SINEX solution.	1X,A1
Solution Contents	Solution types contained in this SINEX file. Each character in this field may be one of the following: S – all station parameters, i.e. station coordinates, station velocities, biases, geocenter, O – Orbits, E – Earth Orientation Parameter T – Troposphere, C – Celestial Reference Frame, A – Antenna parameters BLANK	6(1X,A1)

```
                                                          |_____|
                                                          |               |
                                                          |       79      |
                                                          |               |
                                                          |_____|
```

Comment:

 The final data line "=" describes the current SINEX file and match the
header line with the exception of the first character.

7. INPUT/FILES Block (Optional)

 Description:

 This block identify the input files (and the current SINEX file) and allow for a
short comment to be added to describe those files.

 Contents:

```
      _____
     |_____I_N_P_U_T___F_I_L_E_S___D_A_T_A___L_I_N_E_____|
     |                    |                                    |          |
     |__Field_____|_____Description_____|___Format_____|
     |                    |                                    |          |
     |  [Agency   Code]| Agency creating the solution des-  |  1X,A3     |
     |                    | cribed in this data line.          |          |
     |                    |                                    |          |
     |_____|_____|_____|
     |                    |                                    |          |
     |  [Time]            | Time of creation of the input     |  1X,I2.2, |
     |                    | SINEX solution                     |  1H:,I3.3,|
     |                    |                                    |  1H:,I5.5,|
     |                    |                                    |          |
     |_____|_____|_____|
     |                    |                                    |          |
     |  File Name         | Name of the file containing the   |  1X,A29   |
     |                    | solution described in the current |          |
     |                    | data line.                         |          |
     |                    |                                    |          |
     |_____|_____|_____|
     |                    |                                    |          |
     |  File              | General description of the file   |  1X,A32   |
     |  Description       | referred to on this data line.    |          |
     |_____|_____|_____|
                          |                                    |          |
                          |                                    |    80    |
                          |                                    |          |
                          |_____|_____|
```

 Comments:

 There must be exactly one INPUT/FILES data line for every INPUT/HISTORY data
line. The final data line must describe this current SINEX file.

8. INPUT/ACKNOWLEDGEMENTS Block (Optional)

 Description:

 This block defines the agency codes contributing to the SINEX file.

 Contents:

```
      _____
     |___I_N_P_U_T___A_C_K_N_O_W_L_E_D_G_M_E_N_T_S___D_A_T_A___L_I_N_E___|
     |                    |                                    |          |
     |__Field_____|_____Description_____|___Format_____|
     |                    |                                    |          |
     |  [Agency Code]     | Agency(ies) contributing to this  |  1X,A3    |
     |                    | SINEX file.                        |          |
     |                    |                                    |          |
     |_____|_____|_____|
     |                    |                                    |          |
     |  Agency            | Description of agency code.        |  1X,A75   |
     |  Description       |                                    |          |
     |_____|_____|_____|
                          |                                    |          |
                          |                                    |    80    |
                          |                                    |          |
                          |_____|_____|
```

9. NUTATION/DATA Block (Mandatory for VLBI)

Description:

This block contains the nutation model used in the analysis procedure.

Contents:

N_U_T_A_T_I_O_N D_A_T_A L_I_N_E		
Field	Description	Format
Nutation Code	Code for nutation reference: IAU1980 IERS1996 IAU2000a IAU2000b	1X,A8
Comments	General description of the nutation model used	1X,A70
		80

COMMENT:

It must be a generally accepted model which is accessible to all users.

10. PRECESSION/DATA Block (Mandatory for VLBI)

Description:

This block contains the precession model used in the analysis procedure.

Contents:

P_R_E_C_E_S_S_I_O_N D_A_T_A L_I_N_E		
Field	Description	Format
Precess. Code	Code for precession reference: IAU1976 IERS1996	1X,A8
Comments	General description of the nutation model used	1X,A70
		80

COMMENT:

It must be a generally accepted model which is accessible to all users.

11. SOURCE/ID (Mandatory for VLBI)

Description:

This block contains information about the radio sources estimated in the analysis, especially the names used in ICRF and for IERS.

Contents:

Field	Description	Format
R_A_D_I_O___S_O_U_R_C_E___D_A_T_A___L_I_N_E		
Source Code	Call sign for a source	1X,A4
IERS des.	IERS designation of the radio source	1X,A8
ICRF des.	ICRF designation of the radio source	1X,A16
Comments	Comments or other names of the radio source	1X,A68
		80

12. SITE/ID Block (Mandatory)

Description:

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

Contents:

Field	Description	Format
S_I_T_E___I_D___D_A_T_A___L_I_N_E		
[Site Code]	Call sign for a site.	1X,A4
[Point Code]	Physical monument used at a site	1X,A2
Unique Monument Identification	Unique alpha-nummeric 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 latitude only in the "degrees" component
and don't repeat it in the "minutes" and "seconds" component.

 The range of longitude is [0° +360°[.

13. SITE/DATA Block (Optional)

 Description:

 This block gives the relationship between the estimated station parameters
in the SINEX file and in the input files.

 Contents:

S_I_T_E___D_A_T_A___L_I_N_E		
Field	Description	Format
[Site Code]	Site Code for solved station coordinates.	1X,A4
[Point Code]	Point Code for solved station coordinates.	1X,A2
[Solution ID]	Solution number to which the input in this data line is referred to.	1X,A4
[Site Code]	Site Code from an input SINEX file	1X,A4
[Point Code]	Point code from an input SINEX file.	1X,A2
[Solution ID]	Solution Number for a Site/Point from an input SINEX file.	1X,A4
[Observation Code]	Observation Code for a Site/Point/ Solution Number from an input SINEX file.	1X,A1
[Time]	Time of start of data for the input SINEX file.	1X,I2.2, 1H:,I3.3, 1H:,I5.5
[Time]	Time of end of data for the input	1X,I2.2,

		1H:,I3.3, 1H:,I5.5
[Agency Code]	Creation Agency Code for the input SINEX file.	1X,A3
[Time]	Creation time for the input SINEX file.	1X,I2.2, 1H:,I3.3, 1H:,I5.5
		71

Comment:

Times must refer to observation epochs.

14. SITE/RECEIVER Block (Mandatory for GNSS)

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 opera-ted 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

15. SITE/ANTENNA Block (Mandatory for GNSS)

Description:

List of antennas used at each site used in the SINEX file.

Contents:

S I T E A N T E N N A 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 antenna has been installed at the Site/Point. Value 00:000:00000 indicates that the antenna has been installed at least since the "File Epoch Start Time".	1X,I2.2, 1H:,I3.3, 1H:,I5.5
[Time]	Time until the antenna is instal- led at a Site/Point. Value 00:000:00000 indicates that the antenna has been installed at least until the "File Epoch End Time".	1X,I2.2, 1H:,I3.3, 1H:,I5.5
Antenna Type	Antenna name & model.	1X,A20
Antenna Serial Number	Serial number of the antenna. Takes on value '-----' if unknown.	1X,A5

Comments:

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

16a. SITE/GPS_PHASE_CENTER Block (Mandatory for GPS)

 Description:

 List of GPS phase center offsets for the antennas described in the Site
Antenna block. The offset is given from the Antenna Reference Point (ARP) to
the L1 and L2 phase centers respectively.

 Contents:

G_P_S___P_H_A_S_E___C_E_N_T_E_R___D_A_T_A___L_I_N_E		
Field	Description	Format
Antenna Type	Antenna name & model.	1X,A20
Antenna Serial Number	Serial number of the antenna. Takes on value '-----' if the phase center offsets apply to all antennas of the same type.	1X,A5
L1 Phase Center Up Offset	Up(+) offset from the ARP to the L1 phase center in meters.	1X,F6.4
L1 Phase Center North Offset	North(+) offset from the ARP to the L1 phase center in meters.	1X,F6.4
L1 Phase Center East Offset	East(+) offset from the ARP to the L1 phase center in meters.	1X,F6.4
L2 Phase Center Up Offset	Up(+) offset from the ARP to the L2 phase center in meters.	1X,F6.4
L2 Phase Center North Offset	North(+) offset from the ARP to the L2 phase center in meters.	1X,F6.4
L2 Phase Center East Offset	East(+) offset from the ARP to the L2 phase center in meters.	1X,F6.4
Antenna Cali- bration Model	Name of the antenna model used in the correction of the observations for phase center variations.	1X,A10
		80

 Comments:

 For IGS purposes see the IGS Central Bureau Information System for ARPs and antenna
phase center offsets:
 directory: ftp://igscb.jpl.nasa.gov/igscb/station/general
 files: antenna.gra, igs05_wwww.atx respectively (with 'wwww' for the GPS week of
      last update)

If the phase center offsets for one antenna type (antenna name and the given model)
are the same for all antenna serial numbers, it is enough to store only one data line
(with '-----' for the 'Antenna Serial Number') in this block for each antenna type
that appears in the SITE/ANTENNA block.

16b. SITE/GAL_PHASE_CENTER Block (Mandatory for Galileo)

 Description:

 List of Galileo phase center offsets for the antennas described in the Site
Antenna block. The offset is given from the Antenna Reference Point (ARP) to
the appropriate phase centers. Three lines per antenna are required:
- line 1: frequencies L1 and L5
- line 2: frequencies L6 and L7
- line 3: frequency L8

 Contents:

G_A_L P_H_A_S_E C_E_N_T_E_R D_A_T_A L_I_N_E 1
Field	Description	Format
Antenna Type	Antenna name & model.	1X,A20
Antenna Serial Number	Serial number of the antenna. Takes on value '-----' if the phase center offsets apply to all antennas of the same type.	1X,A5
L1 Phase Center Up Offset	Up(+) offset from the ARP to the L1 phase center in meters.	1X,F6.4
L1 Phase Center North Offset	North(+) offset from the ARP to the L1 phase center in meters.	1X,F6.4
L1 Phase Center East Offset	East(+) offset from the ARP to the L1 phase center in meters.	1X,F6.4
L5 Phase Center Up Offset	Up(+) offset from the ARP to the L5 phase center in meters.	1X,F6.4
L5 Phase Center North Offset	North(+) offset from the ARP to the L5 phase center in meters.	1X,F6.4
L5 Phase Center East Offset	East(+) offset from the ARP to the L5 phase center in meters.	1X,F6.4
Antenna Calibration Model	Name of the antenna model used in the correction of the observations for phase center variations.	1X,A10
		80

G_A_L P_H_A_S_E C_E_N_T_E_R D_A_T_A L_I_N_E 2
Field	Description	Format
Antenna Type	Antenna name & model.	1X,A20

Field	Description	Format
Antenna Serial Number	Serial number of the antenna. Takes on value '-----' if the phase center offsets apply to all antennas of the same type.	1X,A5
L6 Phase Center Up Offset	Up(+) offset from the ARP to the L6 phase center in meters.	1X,F6.4
L6 Phase Center North Offset	North(+) offset from the ARP to the L6 phase center in meters.	1X,F6.4
L6 Phase Center East Offset	East(+) offset from the ARP to the L6 phase center in meters.	1X,F6.4
L7 Phase Center Up Offset	Up(+) offset from the ARP to the L7 phase center in meters.	1X,F6.4
L7 Phase Center North Offset	North(+) offset from the ARP to the L7 phase center in meters.	1X,F6.4
L7 Phase Center East Offset	East(+) offset from the ARP to the L7 phase center in meters.	1X,F6.4
Antenna Cali- bration Model	Name of the antenna model used in the correction of the observations for phase center variations.	1X,A10
		80

G A L P H A S E C E N T E R D A T A L I N E 3		
Field	Description	Format
Antenna Type	Antenna name & model.	1X,A20
Antenna Serial Number	Serial number of the antenna. Takes on value '-----' if the phase center offsets apply to all antennas of the same type.	1X,A5
L8 Phase Center Up Offset	Up(+) offset from the ARP to the L8 phase center in meters.	1X,F6.4
L8 Phase Center North Offset	North(+) offset from the ARP to the L8 phase center in meters.	1X,F6.4
L8 Phase Center East Offset	East(+) offset from the ARP to the L8 phase center in meters.	1X,F6.4
	Empty field; Room for one more frequency	3(1X,F6.4)

Antenna Cali- bration Model	Name of the antenna model used in the correction of the observations for phase center variations.	1X,A10
		80

Comments:

If the phase center offsets for one antenna type (antenna name and the
given model) are the same for all antenna serial numbers, it is enough to
store only one group of three data lines (with '-----' for the 'Antenna
Serial Number') in this block for each antenna type that appears in the
SITE/ANTENNA block.

17. SITE/ECCENTRICITY Block (Mandatory)

Description:

 List of antenna eccentricities from the Marker to the Antenna Reference
Point (ARP) or to the intersection of axis.

Contents:

S_I_T_E E_C_C_E_N_T_R_I_C_I_T_Y__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 ID 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 antenna has been installed at the Site/Point. Value 00:000:00000 indicates that the antenna has been installed at least since the "File Epoch Start Time".	1X,I2.2, 1H:,I3.3, 1H:,I5.5
[Time]	Time until the antenna is instal- led at a Site/Point. Value 00:000:00000 indicates that the antenna has been installed at least until the "File Epoch End Time".	1X,I2.2, 1H:,I3.3, 1H:,I5.5
Eccentricity Reference System	Reference system used to describe vector distance from monument benchmark to the antenna reference point or intersection of axis: 'UNE' - Local reference system Up, North, East. 'XYZ' - Cartesian Reference System	1X,A3

	X, Y, Z. All units are in meters.	
Up / X Eccentricity	Up / X offset from the marker to the Antenna reference point (ARP).	1X,F8.4
North / Y Eccentricity	North/Y offset from the marker to the Antenna reference point (ARP).	1X,F8.4
East / Z Eccentricity	East/Z offset from the marker to the Antenna reference point (ARP).	1X,F8.4
		72

Comments:

- At the moment the local ties used in the ITRF2000 primary combination are only available throughout a login/password ftp access. To get access to these values please contact Zuheir Altamimi (altamimi@ensg.ign.fr).

- An older (March 23, 1999) listing of the official values for IERS sites is available at
  ftp://lareg.ensg.ign.fr/pub/itrf/iers.ecc

- For GPS (antenna heights) you can refer to the daily generated IGS SINEX template:
  ftp://igscb.jpl.nasa.gov/pub/station/general/igs.snx

- For VLBI solutions you can use
  http://gemini.gsfc.nasa.gov/solve_save/ECCDAT.ecc

- The official ILRS eccentricity files (in SINEX format) are
  ftp://cddisa.gsfc.nasa.gov/pub/slrocc/ecc_une.snx
      for eccentricities in Up, North, East
  and
  ftp://cddisa.gsfc.nasa.gov/pub/slrocc/ecc_xyz.snx
      for eccentricities in X, Y, Z

18. SATELLITE/ID Block (Recommended for GNSS, if available)

Description:

List of GNSS satellites used in the SINEX file.

Contents:

S A T E L L I T E I D D A T A L I N E		
Field	Description	Format
[Site Code]	Satellite code "CNNN": C - GNSS code NNN - SVN or GLONASS number	1X,A4
PRN	GPS and Galileo: Pseudo-random noise number GLONASS: Slot number	1X,A2
COSPAR ID	ID assigned by the World Data Center for Satellite Information at the NASA Goddard Space Flight Center following the spacecraft launch. COSPAR ID format: YYYY-XXXA	1X,A9

Field	Description	Format

	YYYY - year of when the launch
	        vehicle was put in orbit
	XXX - sequential launch vehicle
	        number for that year
	A - alpha numeric sequence
	        number within a launch	

[Observation Code]	Observation technique(s) used.	1X,A1
[Time]	Time since the satellite has been launched. Value 00:000:00000 indicates that the satellite has been launched at least since the "File Epoch Start Time".	1X,I2.2, 1H:,I3.3, 1H:,I5.5
[Time]	Time until the satellite is decommissioned from active service. Value 00:000:00000 indicates that the satellite has been active at least until the "File Epoch End Time".	1X,I2.2, 1H:,I3.3, 1H:,I5.5
Antenna Type	Strict IGS rcvr_ant.tab satellite antenna name.	1X,A20
		67

Comments:

- For GPS information (SVN, PRN, launch date, etc.) please refer to
  ftp://tycho.usno.navy.mil/pub/gps/gpsb1.txt   and
  ftp://tycho.usno.navy.mil/pub/gps/gpsb2.txt

- For GLONASS information (GLONASS number, slot number, launch date, etc.) please
  refer to
  http://www.glonass-ianc.rsa.ru/

- For COSPAR IDs please refer to
  http://www.aiub.unibe.ch/download/BSWUSER50/GEN/SATELLIT.   or
  http://ilrs.gsfc.nasa.gov/satellite_missions/list_of_satellites/glonass/

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

19. SATELLITE/PHASE_CENTER Block (Mandatory for GNSS, if satellite antenna offsets
      are not estimated)

 Description:

  List of GNSS satellite antenna phase center corrections. The antenna offsets are
given from the center of mass (CM). More than one line per satellite is necessary, if
the satellite transmits on more than two frequencies.

 Contents:

S A T E L L I T E P H A S E C E N T E R D A T A L I N E		
Field	Description	Format
[Site Code]	Satellite code "CNNN": C - GNSS code	1X,A4

	NNN – SVN or GLONASS number	

Frequency Code	A single character indicating the frequency for which the phase center offset is given within the following three data fields.
	  GPS: 1 – L1
	              2 – L2
	              5 – L5
	  GLONASS: 1 – L1
	              2 – L2
	              5 – L5
	  Galileo (following RINEX 3.00):
	              1 – E1
	              5 – E5a
	              6 – E6
	              7 – E5b
	              8 – E5a + E5b
		1X,A1

Phase Center Z Offset	Z(+) offset from the CM to the phase center in meters.	1X,F6.4
Phase Center X Offset	X(+) offset from the CM to the phase center in meters.	1X,F6.4
Phase Center Y Offset	Y(+) offset from the CM to the phase center in meters.	1X,F6.4

Frequency Code	A single character indicating the frequency for which the phase center offset is given within the following three data fields.
	  GPS: 1 – L1
	              2 – L2
	               5 – L5
	  GLONASS: 1 – L1
	              2 – L2
	              5 – L5
	  Galileo (following RINEX 3.00):
	              1 – E1
	              5 – E5a
	              6 – E6
	              7 – E5b
	              8 – E5a + E5b
		1X,A1

Phase Center Z Offset	Z(+) offset from the CM to the phase center in meters.	1X,F6.4
Phase Center X Offset	X(+) offset from the CM to the phase center in meters.	1X,F6.4
Phase Center Y Offset	Y(+) offset from the CM to the phase center in meters.	1X,F6.4
Antenna Cali-bration Model	Name of the antenna model used in the correction of the observations for phase center variations (PCVs).	1X,A10
PCV Type	Phase center variation type	1X,A1

	A – absolute values R – relative values	
PCV Model Application	F – full PCV model applied E – elevation-dependent PCVs applied only	1X,A1
		66

Comments:

For IGS purposes see the IGS Central Bureau Information System for satellite antenna phase center offsets:
directory: ftp://igscb.jpl.nasa.gov/igscb/station/general
file: igs05_wwww.atx ('wwww' for GPS week of the last update)

20. SOLUTION/EPOCHS Block (Mandatory)

Description:

List of solution epoch for each Site Code/Point Code/Solution Number/Observation Code (SPNO) combination.

Contents:

S_O_L_U_T_I_O_N___E_P_O_C_H_S___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]	Start time for which the solution identified (SPNO) has observations	1X,I2.2, 1H:,I3.3, 1H:,I5.5
[Time]	End time for which the solution identified (SPNO) has observations	1X,I2.2, 1H:,I3.3, 1H:,I5.5
[Time]	Mean time of the observations for which the solution (SPNO) is derived.	1X,I2.2, 1H:,I3.3, 1H:,I5.5
		54

21. BIAS/EPOCHS Block (Mandatory if bias parameters are included)

Description:

 List of epochs of bias parameters for each Site Code/Point Code/Solution
Number/Bias Type (SPNB) combination for which a bias parameter is solved.

 Contents:

```
 _____
|_____B_I_A_S___E_P_O_C_H_S___D_A_T_A___L_I_N_E_____|
|                   |                                 |                  |
|__Field_____  |_____Description_____|___Format_____    |
|                   |                                 |                  |
|  [Site Code]      | Site code for which some biases |    1X,A4         |
|                   | are estimated (station ID)      |                  |
|_____|_____|                  |
|                   |                                 |                  |
|  [Point Code]     | satellite ID for which some biases|  1X,A2         |
|                   | are estimated:                  |                  |
|                   | e.g. L1, L2 for LAGEOS-1 and -2 |                  |
|                   |      respectivly                |                  |
|_____|_____|                  |
|                   |                                 |                  |
|  [Solution ID]    | sequential number of the bias for|  1X,A4         |
|                   | this particular station         |                  |
|                   | (if just one bias is solved for a|               |
|                   | particular station, this parameter|              |
|                   | remains "1").                   |                  |
|_____|_____|                  |
|                   |                                 |                  |
|  Bias Type        | Specification of the type of bias:|  1X,A1        |
|                   | R - range bias                  |                  |
|                   | T - time bias                   |                  |
|                   | S - scale bias                  |                  |
|                   | Z - troposphere bias at zenith  |                  |
|_____|_____|                  |
|                   |                                 |                  |
|  [Time]           | Epoch of 1st observation of the |   1X,I2.2,       |
|                   | solution identified (SPNB)      |   1H:,I3.3,      |
|                   |                                 |   1H:,I5.5       |
|_____|_____|                  |
|                   |                                 |                  |
|  [Time]           | Epoch of last observation of the|   1X,I2.2,       |
|                   | solution identified (SPNB)      |   1H:,I3.3,      |
|                   |                                 |   1H:,I5.5       |
|_____|_____|                  |
|                   |                                 |                  |
|  [Time]           | Weighted mean time of the       |   1X,I2.2,       |
|                   | observations for which the      |   1H:,I3.3,      |
|                   | solution (SPNB) is derived.     |   1H:,I5.5       |
|_____|_____|                  |
|                   |                                 |                  |
|                   |                                 |    54            |
|                   |                                 |_____|
```

22. SOLUTION/STATISTICS Block (Recommended if available)

 Description:

 Statistical information about the solution contained in the SINEX file.

 Contents:

```
 _____
|____S_O_L_U_T_I_O_N___S_T_A_T_I_S_T_I_C_S_____L_I_N_E_____|
|                   |                                 |                  |
|__Field_____  |_____Description_____|___Format_____    |
|                   |                                 |                  |
|  Information      | Describes the type of information|  1X,A30         |
|  Type             | present in the next field. May  |                  |
|                   | take on the following values:   |                  |
|                   |                                 |                  |
```

```
|                        | 'NUMBER OF OBSERVATIONS'        |            |
|                        |    # of observations used in the|            |
|                        |    adjustment.                  |            |
|                        | 'NUMBER OF UNKNOWNS'            |            |
|                        |    # of unknowns solved in the  |            |
|                        |    adjustment.                  |            |
|                        | 'SAMPLING INTERVAL (SECONDS)'   |            |
|                        |    Interval in seconds between  |            |
|                        |    successives observations.    |            |
|                        | 'SQUARE SUM OF RESIDUALS (VTPV)'|            |
|                        |    Sum of squares of residuals. |            |
|                        |    (V'PV); V - resid. vector;   |            |
|                        |            P - weight matrix    |            |
|                        | 'PHASE MEASUREMENTS SIGMA'      |            |
|                        |    Sigma used for the phase     |            |
|                        |    measurements.                |            |
|                        | 'CODE MEASUREMENTS SIGMA'       |            |
|                        |    Sigma used for the code (pseudo-|          |
|                        |    range) measurements.         |            |
|                        | 'NUMBER OF DEGREES OF FREEDOM'  |            |
|                        |    # of observations minus the  |            |
|                        |    # of unknowns                |            |
|                        |    (df)                         |            |
|                        | 'VARIANCE FACTOR'              |            |
|                        |    Sum of squares of residuals  |            |
|                        |    divided by the degrees of    |            |
|                        |    freedom (V'PV/df). Equivalent|            |
|                        |    to  Chi-squared/df.          |            |
|                        | 'WEIGHTED SQUARE SUM OF O-C'    |            |
|                        |    Sum of squares of the vector |            |
|                        |    'observed minus computed':   |            |
|                        |    (o-c)'P(o-c)                 |            |
|                        |    with P - weigth matrix       |            |
|------------------------|---------------------------------|------------|
| Information            | Relevant information for the type| 1X,F22.15 |
|                        | indicated by the previous field.|            |
|------------------------|---------------------------------|------------|
|                        |                                 |            |
|                        |                                 |   54       |
|                        |                                 |_____|
```

Comments:

 The mentioned 'Information Types' may be in any order but the name of the fields
should be identical to the names listed above.

 Note that the NUMBER OF UNKNOWNS contains all parameters of the adjustment, i.e.,
not only the parameters stored in the SINEX file but as well all the pre-eliminated
parameters.

 The NUMBER OF OBSERVATIONS should contain only the real observations and not the
pseudo-observations used for constraining.

 In principle the estimated variance-covariance matrix should be normalized /
multiplied by the VARIANCE FACTOR of this statistic block.

23. SOLUTION/ESTIMATE Block (Mandatory)

 Description:

 Estimated parameters.

 Contents:

```
 _____
|_____S_O_L_U_T_I_O_N___E_S_T_I_M_A_T_E___D_A_T_A___L_I_N_E_____|
|                   |                                  |             |
|__Field_____  |_____Description_____|___Format____|
|                   |                                  |             |
| Estimated Para-   | Index of estimated parameters.   |  1X,I5      |
```

meters Index	values from 1 to the number of parameters.	
[Parameter Type]	Identification of the type of parameter.	1X,A6
[Site Code]	Site code for which the parameter is estimated.	1X,A4
[Point Code]	Point Code for which the parameter is estimated.	1X,A2
[Solution ID]	Solution ID at a Site/Point code for which the parameter is estimated.	1X,A4
[Time]	Epoch at which the estimated parameter is valid. For bias parameters the beginning of the pass (identical to the BIAS/EPOCHS block).	1X,I2.2, 1H:,I3.3, 1H:,I5.5
Parameter Units	Units used for the estimates and sigmas. The notations are: m (metres), m/y (metres per year), m/s2 (metres per second**2), ppb (parts per billion), ms (milliseconds), msd2 (milliseconds per day**2), mas (milli-arc-seconds), ma/d (milli-arc-seconds / day), rad (radians), rd/y (radians per year), rd/d (radians per day).	1X,A4
[Constraint Code]	Constraint applied to the parameter.	1X,A1
Parameter Estimate	Estimated value of the parameter.	1X,E21.15
Parameter Standard Deviation	Estimated standard deviation for the parameter.	1X,E11.6
		80

Comments:

  For the demanded units of the estimated parameters and their standard deviation
please refer to the list of possible parameter types (2. Data Structure).
  'Per year' means 365.25 days in this context.

24. SOLUTION/APRIORI Block (Mandatory)

 Description:

Apriori information for estimated parameters, either the used apriori values for the
adjustment or the parameters of a Helmert Transformation for applied inner
constraints with the constraint given in the field 'Standard Deviation'.

Contents:

```
 _____
|_____S_O_L_U_T_I_O_N___A_P_R_I_O_R_I___D_A_T_A___L_I_N_E_____|
|                   |                                     |             |
|__Field_____|_____Description_____|___Format____|
|                   |                                     |             |
| Parameter         | Index of apriori parameters.        | 1X,I5       |
| Index             |                                     |             |
|_____|_____|_____|
|                   |                                     |             |
| [Parameter Type]  | Identification of the type of       | 1X,A6       |
|                   | parameter.                          |             |
|                   | For apriori values of estimated     |             |
|                   | parameters see parameter list       |             |
|                   | above;                              |             |
|                   | For inner constraints:              |             |
|                   | TX - Translation in X-direction   m |             |
|                   | TY - Translation in Y-direction   m |             |
|                   | TZ - Translation in Z-direction   m |             |
|                   | RX - Rotation around X-axis     mas |             |
|                   | RY - Rotation around Y-axis     mas |             |
|                   | RZ - Rotation around Z-axis     mas |             |
|                   | SC - Scale                      ppb |             |
|                   | TXR - Rate for translation in       |             |
|                   |       X-direction           m/y     |             |
|                   | TYR - Rate for translation in       |             |
|                   |       Y-direction           m/y     |             |
|                   | TZR - Rate for translation in       |             |
|                   |       Z-direction           m/y     |             |
|                   | RXR - Rate for rotation around      |             |
|                   |       X-axis                mas/y   |             |
|                   | RYR - Rate for rotation around      |             |
|                   |       Y-axis                mas/y   |             |
|                   | RZR - Rate for rotation around      |             |
|                   |       Z-axis                mas/y   |             |
|                   | SCR - Rate for scale        ppb/y   |             |
|_____|_____|_____|
|                   |                                     |             |
| [Site Code]       | Site code with apriori parameter    | 1X,A4       |
|                   | estimate.                           |             |
|                   | ---- for inner constraints          |             |
|_____|_____|_____|
|                   |                                     |             |
| [Point Code]      | Point Code with apriori parameter   | 1X,A2       |
|                   | estimate.                           |             |
|                   | -- for inner constraints            |             |
|_____|_____|_____|
|                   |                                     |             |
| [Solution ID]     | Solution ID at a Site/Point         | 1X,A4       |
|                   | code with apriori parameter         |             |
|                   | estimate.                           |             |
|                   | ---- for inner constraints          |             |
|_____|_____|_____|
|                   |                                     |             |
| [Time]            | Epoch at which the apriori          | 1X,I2.2,    |
|                   | parameter or the inner constraint   | 1H:,I3.3,   |
|                   | is valid.                           | 1H:,I5.5    |
|_____|_____|_____|
|                   |                                     |             |
| Parameter Units   | Units used for the aprioris and     | 1X,A4       |
|                   | sigmas. For the demanded units      |             |
|                   | look at SOLUTION/ESTIMATE block.    |             |
|                   | For the inner constraints the       |             |
|                   | units should be:                    |             |
|                   | m    for translations,              |             |
|                   | mas  for rotations,                 |             |
```

	ppb for scale, m/y for translation rates, ma/y for rotation rates, pb/y for scale rates	
[Constraint Code]	Constraint applied to the parameter. If inner constraints are applied: 1 for contributing stations	1X,A1
Parameter Apriori	Apriori value of the parameter or transformation parameter for the inner constraint.	1X,E21.15
Parameter Standard Deviation	Apriori standard deviation for the parameter or applied inner constraint.	1X,E11.6
		80

Comments:

  If inner constraints are applied to the solution (i.e. parameters like TX, TY, TZ, RX,... are included) the stations contributing to these inner constraints should be listed with a '1' in the field 'Constraint Code' in this SOLUTION/APRIORI block.

25. SOLUTION/MATRIX_ESTIMATE Block (Mandatory)

 Description:

 The Estimate Matrix can be stored in an Upper or Lower triangular form. Only the Upper or Lower portion needs to be stored because the matrix is always symmetrical.
 The matrix contents can be:
CORR - Correlation Matrix
COVA - Covariance Matrix
INFO - Information Matrix (of Normals), i.e. COVA^(-1)
The distinction between the form and its contents is given by the title block which must take one of the following forms:

 SOLUTION/MATRIX_ESTIMATE L CORR
 SOLUTION/MATRIX_ESTIMATE U CORR
 SOLUTION/MATRIX_ESTIMATE L COVA
 SOLUTION/MATRIX_ESTIMATE U COVA
 SOLUTION/MATRIX_ESTIMATE L INFO
 SOLUTION/MATRIX_ESTIMATE U INFO

 Contents:

S_O_L_U_T_I_O_N__M_A_T_R_I_X__E_S_T_I_M_A_T_E___D_A_T_A__L_I_N_E_		
__Field_____	_____Description_____	___Format_____
Matrix Estimate Row Number	Row index for the Matrix Estimate. It must match the parameter index in the SOLUTION/ESTIMATE block for the same parameter.	1X,I5
Matrix Estimate Column Number	Column index for the Matrix Estimate. It must match the parameter index in the SOLUTION/ESTIMATE block for the same parameter.	1X,I5

Field	Description	Format
First Matrix Estimate Element	Matrix element at the location (Row Number , Column Number).	1X,E21.14
Second Matrix Estimate Element	Matrix element at the location (Row Number , Column Number + 1).	1X,E21.14
Third Matrix Estimate Element	Matrix element at the location (Row Number , Column Number + 2).	1X,E21.14
		78

Comment:

 The Matrix Estimate Row/Column Number correspond to the Estimated Parameters
Index in the SOLUTION/ESTIMATE block.
 If the CORR matrix is used, standard deviations must be stored in the diagonal
elements instead of 1.000.
 Missing elements in the matrix are assumed to be zero (0); consequently, zero
elements may be omitted to reduce the size of this block.

 NOTE: The same scale (variance) factor MUST be used for both MATRIX_ESTIMATE
and MATRIX_APRIORI, as well as for the standard deviations in the ESTIMATE
and APRIORI Blocks. This scale factor should be stored as 'Variance Factor' in the
SOLUTION/STATISTICS block.

 If you use the INFO type this block should contain the constrained normal equation
matrix of your least square adjustment.

26. SOLUTION/MATRIX_APRIORI Block (Recommended/Mandatory)

 Description:

 The Apriori Matrix can be stored in an Upper or Lower triangular form. Only
the Upper or Lower portion needs to be stored because the matrix is always
symmetrical. Mandatory if any significant constraint have been applied to the
SOLUTION/ESTIMATE.
 The matrix contents can be:
CORR - Correlation Matrix
COVA - Covariance Matrix
INFO - Information Matrix (of Normals), i.e. COVA^(-1)
The distinction between the form and its contents is given by the title block
which must take one of the following forms:

 SOLUTION/MATRIX_APRIORI L CORR
 SOLUTION/MATRIX_APRIORI U CORR
 SOLUTION/MATRIX_APRIORI L COVA
 SOLUTION/MATRIX_APRIORI U COVA
 SOLUTION/MATRIX_APRIORI L INFO
 SOLUTION/MATRIX_APRIORI U INFO

 Contents:

__S_O_L_U_T_I_O_N__M_A_T_R_I_X__A_P_R_I_O_R_I___D_A_T_A__L_I_N_E_		
__Field_____	_____Description_____	___Format_____
Matrix Apriori Row Number	Row index for the Matrix Apriori. It must match the parameter index in the SOLUTION/APRIORI block for the same parameter.	1X,I5
Matrix Apriori Column Number	Column index for the Matrix Apriori. It must match the parameter index in the SOLUTION/APRIORI block for the	1X,I5

	same parameter.	
First Matrix Estimate Element	Matrix element at the location (Row Number , Column Number).	1X,E21.16
Second Matrix Estimate Element	Matrix element at the location (Row Number , Column Number + 1).	1X,E21.16
Third Matrix Estimate Element	Matrix element at the location (Row Number , Column Number + 2).	1X,E21.16
		78

Comment:

 The Matrix Apriori Row/Column Number correspond to the Apriori Parameters Index
in the SOLUTION/APRIORI block. If the apriori constraint matrix is diagonal and
no loss of significant digits occurs by using the Parameter Standard Deviation
in the SOLUTION/APRIORI block, then, this block becomes redundant.
 If the CORR matrix is used, Standard deviations must be stored in the diagonal
elements instead of 1.000.
 Missing elements in the matrix are assumed to be zero (0); consequently, zero
elements may be omitted to reduce the size of this block.

 NOTE: The same scale (variance) factor MUST be used for both MATRIX_ESTIMATE
and MATRIX_APRIORI, as well as for the standard deviations in the ESTIMATE
and APRIORI Blocks. This scale factor should be stored as 'Variance Factor' in the
SOLUTION/STATISTICS block.

 If you use the INFO type this block should contain the normal equation matrix of the
constraints applied to your solution in SOLUTION/ESTIMATE.

27. SOLUTION/NORMAL_EQUATION_VECTOR Block (Mandatory for normal equations)

 Description:

 If the SINEX file shall provide the normal equation directly this block is mandatory
and contains the vector of the right hand side of the unconstrained (reduced) normal
equation.

 Contents:

_SOLUTION__N_O_R_M_A_L___E_Q_U_A_T_I_O_N___V_E_C_T_O_R___DATA_LINE_		
__Field_____	_____Description_____	___Format_____
Estimated Para- meters Index	Index of estimated parameters. Values from 1 to the number of parameters. It must match the parameter index in the block SOLUTION/ESTIMATE for the same parameter.	1X,I5
[Parameter Type]	Identification of the type of parameter.	1X,A6
[Site Code]	Site code for which the parameter is estimated.	1X,A4
[Point Code]	Point Code for which the parameter is estimated.	1X,A2

[Solution ID]	Solution ID at a Site/Point code for which some parameters are estimated.	1X,A4
[Time]	Epoch at which the estimated parameter is valid. For bias parameters the beginning of the pass (identical to the BIAS/EPOCHS block).	1X,I2.2, 1H:,I3.3, 1H:,I5.5
Parameter Units	see SOLUTION/ESTIMATE	1X,A4
[Constraint Code]	Constraint applied to the parame- ter.	1X,A1
Right hand side of normal equation	Value of the right hand side of the normal equation for the corresponding parameter.	1X,E21.15
		68

Comment:

 The indices correspond to the indices of the SOLUTION/ESTIMATE block.

28. SOLUTION/NORMAL_EQUATION_MATRIX Block (Mandatory for normal equations)

 Description:

 This block is mandatory if the normal equation is to be provided directly in the SINEX file.
 The block should contain the original (reduced) normal equation matrix (i.e., without constraints).
 The normal equation matrix can be stored in an Upper or Lower triangular form. Only the Upper or Lower portion needs to be stored because the matrix is always symmetrical. The distinction between the forms is given by the title block which must take one of the following forms:

 SOLUTION/NORMAL_EQUATION_MATRIX L
 SOLUTION/NORMAL_EQUATION_MATRIX U

 Contents:

_SOLUTION__N_O_R_M_A_L___E_Q_U_A_T_I_O_N___M_A_T_R_I_X___DATA_LINE_		
__Field_____	_____Description_____	___Format_____
NEQ-Matrix Row Number	Row index for the normal equation matrix. It must match the parameter index in the SOLUTION/ ESTIMATE block for the same parameter.	1X,I5
NEQ-Matrix Column Number	Column index for the normal equation matrix. It must match the parameter index in the SOLUTION/ ESTIMATE block for the same parameter.	1X,I5
First Matrix	Matrix element at the location	1X,E21.14

Element	(Row Number , Column Number).	
Second Matrix Element	Matrix element at the location (Row Number , Column Number + 1).	1X,E21.14
Third Matrix Element	Matrix element at the location (Row Number , Column Number + 2).	1X,E21.14
		78

Comment:

 The NEQ-Matrix Row/Column Number correspond to the Estimated Parameters
Index in the SOLUTION/ESTIMATE block.
 Missing elements in the matrix are assumed to be zero (0); consequently, zero
elements may be omitted to reduce the size of this block.

29. Footer Line (Mandatory)

 Description:

 Marks the end of the SINEX file.

 Contents:

F_O_O T E R___L I_N_E		
__Field_____	_____Description_____	___Format_____
End of SINEX	The seven characters %ENDSNX at the beginning of the last line mark the end of the SINEX file.	A7
		7

 +

    SINEX -   Solution (Software/technique) INdependent EXchange Format
                    Version 2.02 (December 01, 2006)

                       A P P E N D I X   II

          S U M M A R Y   O F   F O R M U L A S   A N D

       T H E I R   C O N N E C T I O N   T O   S I N E X

This document gives a short summary of the basic formulas used for least squares
adjustment and it gives instructions which vector or matrix of the normal equation
system belongs to the individual SINEX blocks.

 SUMMARY OF LEAST SQUARES ADJUSTMENT FORMULAS

You have n_obs linearized observation equations

(1)   v = A dx - l

where
 n_obs   number of observations
 v   residual vector
 A   Jacobian matrix
 dx   corrections for the unknowns x concerning the apriori values x0
         i.e. x = x0 + dx
with
 n_unk   number of unknowns
 l   vector 'observed' minus 'computed with apriori values'.

 P   denotes the weight matrix for the observations.

The goal of least square adjustment is to minimize the square sum of residuals:

(2)   v' P v = min

where v' is the transposed vector of v.

This condition leads to the so called normal equation

(3) A' P A dx = A' P l

with normal equation matrix

(4) N = A' P A

and the vector of the right hand side of the normal equation

(5) b = A' P l .

The resulting unknown parameters can be determined with

(6) x = x0 + inv(A' P A) A' P l = x0 + inv(N) b

where inv stands for the inverse matrix and x0 are the apriori values.

The residuals can be computed with equation (1) and the aposteriori variance factor
is then

(7) s0 = (v' P v) / (n_obs - n_unk) .

The weighted square sum o fthe vector l (= observed minus computed) can be obtained
with

(8) l'Pl = v'Pv + dx' b
         = v'Pv + dx' A' P l .

The variance-covariance matrix of the unknowns results in

(9) K = s0 inv(N).

If you introduce constraints as pseudo-observations with n_constr linearized
observation equations

(10) v_c = H dx - h

with
 n_constr number of constraints as pseudo-observations
 v_c   residuals over the constraints
 H   Jacobian matrix for pseudo-observation equations
 h   vector 'observed' minus 'computed' for the constraints.

P_c denotes the weight matrix for your pseudo-observations.

The least square methods lead to the normal equation for the pseudo-observations

(11) H' P_c H dx = H' P_c h

with normal equation matrix of constraints

(12) N_constr = H' P_c H

and vector of the right hand side of normal equation for constraints

(13) b_constr = H' P_c h.

The complete normal equation system for the constrained solution can easily be computed:

(14) (A' P A + H' P_c H) dx = A' P l + H' P_c h

with the constrained normal equation matrix

(15) N_total = A' P A + H' P_c H = N + N_constr

and the vector of the right hand side of the constrained normal equation system

(16) b_total = A' P l + H' P_c h = b + b_constr .

The unknown parameters of the constrained solution can be computed with

(17) x_c = x0 + inv(N_total) b_total .

Ater computing the residuals over the constraints with equation (10) the weighted square sum of residuals of the constrained normal equation system can be obtained with

(18) v'Pv + v_c' P_c v_c

and the number of degrees of freedom of the constrained normal equation system is

(19) dof = n_obs + n_constr – n_unk .

The aposteriori variance-factor for the constrained normal equation system is then

(20) s0_c = (v' P v + v_c' P_c v_c) / dof .

The variance-covariance matrix for the unknowns of this constrained normal equation system can be computed with

(21) K_xx = s0_c inv(N_total)

And the variance-covariance matrix for the constraints is

(22) K_constr = s0_c inv(N_constr) .

 IMPLEMENTATION IN SINEX

The different elements belonging to the normal equations can be stored in SINEX files in the following way:

SOLUTION/STATISTICS block:
     n_unk   = NUMBER OF UNKNOWNS
     n_obs   = NUMBER OF OBSERVATIONS
 (20) s0_c   = VARIANCE FACTOR
 (18) v' P v + v_c' P_c v_c = SQUARE SUM OF RESIDUALS (VTPV)
 (19) dof   = NUMBER OF DEGREES OF FREEDOM

SOLUTION/ESTIMATE block:
 (17) x_c   in field "Parameter Estimate"

```
SOLUTION/APRIORI block:
      x0  in field "Parameter Apriori"


SOLUTION/MATRIX_ESTIMATE block:
 (21) Type COVA:  K_xx
      Type CORR:  correlation matrix of K_xx
 (15) Type INFO:  N_total  =  N + N_constr


SOLUTION/MATRIX_APRIORI block:
 (22) Type COVA:  K_constr
      Type CORR:  correlation matrix of K_constr
 (12) Type INFO:  N_constr


SOLUTION/NORMAL_EQUATION_VECTOR block:
 (5)  b  =  A' P l


SOLUTION/NORMAL_EQUATION_MATRIX block:
 (4)  N  =  A' P A
```