Satellite Navigation Digital Standard for R&S®WinIQSIM2™

User Manual

User Manual

Version 04

ROHDE&SCHWARZ

This document describes the software options for satellite navigation: GPS, Galileo, GLONASS, COMPASS/BeiDou
Described are the following software options:

- R&S®SMBV-K244/-K266/-K294/-K407
  1415.8260.02, 1415.8590.02, 1415.8690.02, 1419.2721.xx
- R&S®SMW-K244/-K266/-K294/-K407
  1413.4880.xx, 1413.7015.xx, 1413.7067.xx, 1413.7115.xx
- R&S®SGT-K244/-K266/-K294/-K407
  1419.6104.02, 1419.7000.02, 1419.7400.02, 1419.7452.02
- R&S®SMU-K244/-K266/-K294/-K407
  1408.5818.02, 1408.8630.02, 1408.8617.02, 1408.8775.02
- R&S®SMJ-K244/-K266/-K294/-K407
  1409.0810.02, 1409.3502.02, 1409.3483.02, 1409.3648.02
- R&S®AMU-K244/-K266/-K294/-K407
  1402.7902.02, 1403.0976.02, 1403.0953.02, 1403.1072.02
- R&S®AFQ-K244/-K266/-K294/-K407
  1401.6454.02, 1415.0330.02, 1415.0318.02, 1410.8556.02
- R&S®CMW-KW620/-KW621/-KW622/-KW623
  1203.6008.02, 1207.8305.02, 1207.8357.02, 1208.8280.02
- R&S®SFU-K244
  2115.2266.02
- R&S®WV-K1144
  2114.8302.02

This manual version corresponds to software version 4.20.047.xx and later of the R&S®WinIQSIM2™.

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The following abbreviations are used throughout this manual: R&S®WinIQSIM2™ is abbreviated as R&S WinIQSIM2, R&S®SMBV100A is abbreviated as R&S SMBV, R&S®SMW200A is abbreviated as R&S SMW, R&S®SGT100A is abbreviated as R&S SGT, R&S®SMU200A is abbreviated as R&S SMU, R&S®SMJ100A is abbreviated as R&S SMJ, R&S®AMU200A is abbreviated as R&S AMU, R&S®AFQ100A and R&S®AFQ100B are abbreviated as R&S AFQ, R&S®CMW500 is abbreviated as R&S CMW, R&S®SFU is abbreviated as R&S SFU, R&S®BTC is abbreviated as R&S BTC; the license types 02/03/07/11/13/16/12 are abbreviated as xx.

Contents

1 Preface 5

1.1 About this Manual 5

1.2 Documentation Overview 6

1.2.1 Getting Started Manual 6

1.2.2 User Manual and Help 6

1.2.3 Service Manual 6

1.2.4 Instrument Security Procedures 7

1.2.5 Basic Safety Instructions 7

1.2.6 Data Sheets and Brochures 7

1.2.7 Release Notes and Open Source Acknowledgment (OSA) 7

1.2.8 Application Notes, Application Cards, White Papers, etc 7

2 Welcome to the GNSS Satellite Navigation Standards 8

2.1 Accessing the GNSS Dialog 9

2.2 Scope 9

3 About the GNSS Standards 10

4 GNSS Configuration and Settings 13

4.1 General Settings 13

4.2 Navigation Data 17

4.3 Almanac Configuration Settings 20

4.4 Time Conversion Configuration Settings 21

4.5 Satellite Configuration Settings 23

4.5.1 General Satellites Settings 24

4.5.2 Configuration of the Satellite Constellation 25

4.5.3 Individual Satellite Settings 26

4.6 Navigation Message Configuration 28

4.7 Marker Settings 37

5 How to Generate a Signal with the GNSS Option 40

5.1 How to Generate a One-Satellite Static Generic GNSS Signal 40

5.2 How to Play a GNSS Waveform with Rohde & Schwarz Signal Generator 41

6 Remote-Control Commands 42

6.1 Programming Examples....43
6.2 Primary Settings....43
6.3 Navigation Data....48
6.4 Almanac / RINEX Configuration....51
6.5 Time Conversion Configuration....56
6.6 Satellites Configuration and Satellites Signal Settings....60
6.7 Navigation Message Configuration....66
6.8 Marker Settings....86

List of Commands....89

Index....94

1 Preface

1.1 About this Manual

This user manual provides all the information **specific to the GNSS options**. All general instrument functions and settings common to all applications and operating modes are described in the main R&S WinIQSIM2 user manual.

The main focus in this manual is on the provided settings and the tasks required to generate a signal. The following topics are included:

- **Welcome to the GNSS options R&S SMx-K244/-K266/-K294/-K407**
  Introduction to and getting familiar with the options
- **About the GNSS options**
  Background information on basic terms and principles in the context of the signal generation
- **GNSS Configuration and Settings**
  A concise description of all functions and settings available to configure signal generation with their corresponding remote control command
- **How to Generate a Signal with the GNSS Options**
  The basic procedure to perform signal generation tasks and step-by-step instructions for more complex tasks or alternative methods
  As well as detailed examples to guide you through typical signal generation scenarios and allow you to try out the application immediately
- **Remote Control Commands**
  Remote commands required to configure and perform signal generation in a remote environment, sorted by tasks
  (Commands required to set up the instrument or to perform common tasks on the instrument are provided in the main R&S WinIQSIM2 user manual)
  Programming examples demonstrate the use of many commands and can usually be executed directly for test purposes
- **List of remote commands**
  Alphabetical list of all remote commands described in the manual
- **Index**

Contents and scope

This description assumes R&S WinIQSIM2 equipped with all availabe options. Depending on your model and the installed options, some of the functions may not be available on your instrument.

Notes on screenshots

When describing the functions of the product, we use sample screenshots. These screenshots are meant to illustrate as much as possible of the provided functions and possible interdependencies between parameters. The shown values may not represent realistic usage scenarios.

The screenshots usually show a fully equipped product, that is: with all options installed. Thus, some functions shown in the screenshots may not be available in your particular product configuration.

1.2 Documentation Overview

This section provides an overview of the R&S WinIQSIM2 user documentation. Unless specified otherwise, you find the documents on the R&S WinIQSIM2 product page at:

www.rohde-schwarz.com/manual/winiqsim2

1.2.1 Getting Started Manual

Introduces the R&S WinIQSIM2 and describes how to set up and start working with the product. Includes basic operations, typical measurement examples, and general information, e.g. safety instructions, etc. A printed version is delivered with the instrument.

1.2.2 User Manual and Help

Separate manuals for the base unit and the software options are provided for download:

- Base unit manual
  Contains the description of all instrument modes and functions. It also provides an introduction to remote control, a complete description of the remote control commands with programming examples, and information on maintenance, instrument interfaces and error messages. Includes the contents of the getting started manual.
- Software option manual
  Contains the description of the specific functions of an option. Basic information on operating the R&S WinIQSIM2 is not included.

The contents of the user manuals are available as help in the R&S WinIQSIM2. The help offers quick, context-sensitive access to the complete information for the base unit and the software options.

All user manuals are also available for download or for immediate display on the Internet.

1.2.3 Service Manual

Describes the performance test for checking the rated specifications, module replacement and repair, firmware update, troubleshooting and fault elimination, and contains mechanical drawings and spare part lists.

The service manual is available for registered users on the global Rohde & Schwarz information system (GLORIS, https://gloris.rohde-schwarz.com).

1.2.4 Instrument Security Procedures

Deals with security issues when working with the R&S WinIQSIM2 in secure areas. It is available for download on the Internet.

1.2.5 Basic Safety Instructions

Contains safety instructions, operating conditions and further important information. The printed document is delivered with the instrument.

1.2.6 Data Sheets and Brochures

The data sheet contains the technical specifications of the R&S WinIQSIM2. It also lists the options and their order numbers and optional accessories.

The brochure provides an overview of the instrument and deals with the specific characteristics.

See www.rohde-schwarz.com/brochure-datasheet/winiqsim2

1.2.7 Release Notes and Open Source Acknowledgment (OSA)

The release notes list new features, improvements and known issues of the current software version, and describe the software installation.

The open source acknowledgment document provides verbatim license texts of the used open source software.

See www.rohde-schwarz.com/software/winiqsim2

1.2.8 Application Notes, Application Cards, White Papers, etc.

These documents deal with special applications or background information on particular topics.

See www.rohde-schwarz.com/application/winiqsim2.

2 Welcome to the GNSS Satellite Navigation Standards

The R&S SMx-K244/-K266/-K294/-K407 are firmware applications that add functionality to generate signals in accordance with the GPS, Galileo, GLONASS and COMPASS/BeiDou.

Differences between the GNSS implementation in GNSS Simulator R&S SMBV100A and R&S WinIQSIM2

The GNSS implementation in the R&S WinIQSIM2 allows you to generate waveform files that can be loaded to the following Rohde&Schwarz instruments:

- R&S SMBV100A
- R&S SMW200A
- R&S SGT100A
- R&S SMU200A
- R&S SMJ100A
- R&S AMU200A
- R&S AFQ100A
- R&S CMW500
- R&S CMW280
- R&S CMW270
- R&S SFU
- R&S BTC

Depending on the availability of the respective options, e.g. R&S®SMW-K244/-K266/-K294/-K407 you can simulate **one** GPS, Galileo, GLONASS or BeiDou satellite respectively on the generator.

As a major difference to the real-time solution of the R&S SMBV100A, the satellite signal generated with the R&S WinIQSIM2 is limited to a certain time period. It depends on the ARB capacity of the signal generator and the user configurable sample rate of the satellite signal.

This user manual contains a description of the functionality that the application provides, including remote control operation.

All functions not discussed in this manual are the same as in the base software and are described in the R&S WinIQSIM2 user manual. The latest version is available at the product page at:

http://www.rohde-schwarz.com/product/WinIQSIM2.html > "Downloads" > "Manuals".

2.1 Accessing the GNSS Dialog

To open the dialog with GNSS settings

► In the block diagram of the R&S WinIQSIM2, select "Baseband > Satellite Navigation".

A dialog box opens that displays the provided general settings.

The signal generation is not started immediately. To start signal generation with the default settings, select "State > On".

Notes on screenshots

When describing the functions of the product, we use sample screenshots. These screenshots are meant to illustrate as much as possible of the provided functions and possible interdependencies between parameters. The shown values may not represent realistic usage scenarios.

The screenshots usually show a fully equipped product, that is: with all options installed. Thus, some functions shown in the screenshots may not be available in your particular product configuration.

2.2 Scope

Tasks (in manual or remote operation) that are also performed in the base unit in the same way are not described here.

In particular, it includes:

- Managing settings and data lists, like storing and loading settings, creating and accessing data lists, or accessing files in a particular directory.
- Information on marker signals and filter settings, if appropriate.
- General instrument configuration, such as configuring networks and remote operation
- Using the common status registers

For a description of such tasks, see the R&S WinIQSIM2 user manual.

3 About the GNSS Standards

The global navigation satellite system (GNSS) employs the radio signals of several navigation standards, like GPS, Galileo, GLONASS, BeiDou etc. For several years, GPS used to be the only standard available for civilian navigation through its C/A civilian code. Nowadays, the GNSS signals and systems are undergoing fast development, some systems are getting modernized and some are completely new. In the foreseeable future, several more GNSS satellites utilizing more and new frequency will be available.

Brief introduction to the GNSS standards

- **GPS**
  The Global Positioning System (GPS) consists of several satellites circling the earth in low orbits. The satellites transmit permanently information that can be used by the receivers to calculate their current position (ephemeris) and about the orbits of all satellites (almanac). The 3D position of a receiver on the earth can be determined by carrying out delay measurements of at least four signals emitted by different satellites.
  Being transmitted on a single carrier frequency, the signals of the individual satellites can be distinguished by means of correlation (Gold) codes. These ranging codes are used as spreading code for the navigation message which is transmitted at a rate of 50 baud.
- **Galileo**
  Galileo is the European global navigation satellite system that provides global positioning service under civilian control. It is planed to be inter-operable with GPS and GLONASS and other global satellite navigation systems.
  The fully deployed Galileo system consists of 30 satellites (27 operational and 3 spares). Three independent CDMA signals, named E5, E6 and E1, are permanently transmitted by all Galileo satellites. The E5 signal is further sub-divided into two signals denoted E5a and E5b (see Figure 3-1).
- **GLONASS**
  Glonass is the russian global navigation satellite system. It is expected to be fully operational before the end of 2011 with 24 Modernized Glonass Satellites touring the globe. Together with GPS, up to 54 GNSS Satellites are provided, which will improve the availability and consequently the navigation performance in high urban areas.

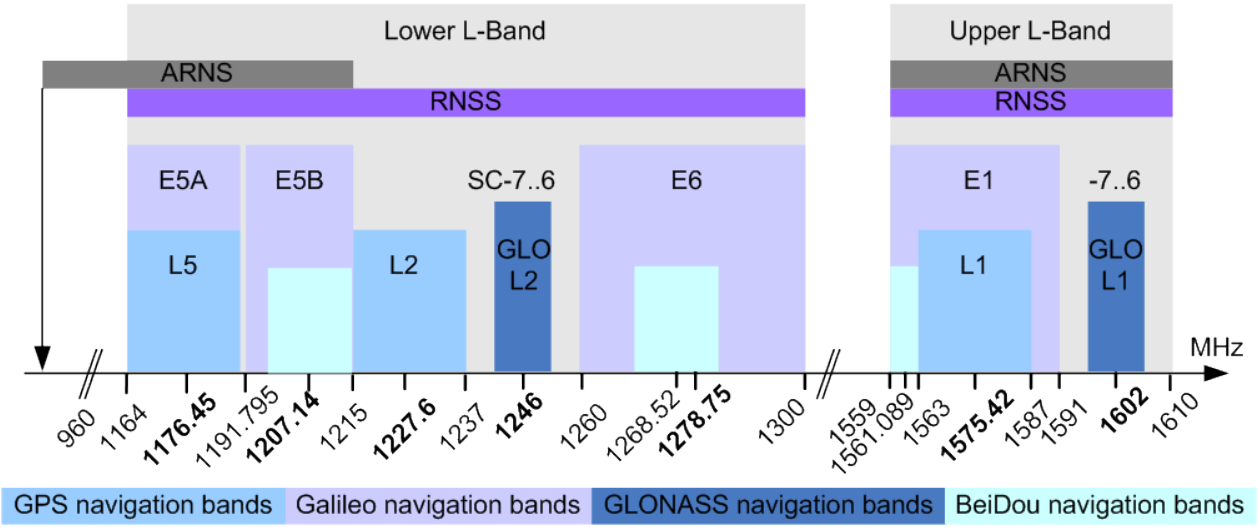


Figure 3-1: GNSS frequency bands

- **COMPASS/BeiDou**
  The fully deployed BeiDou Navigation Satellite System (BDS) is a Chinese satellite navigation system. This navigation system is also know as BeiDou-2 and is expected in 2020. The BDS is a global satellite navigation systems that uses a constellation of 35 satellites to cover the globe. This constellation includes 5 geostationary orbit satellites (GEO) and 30 non-geostationary satellites; 27 in medium earth orbit (MEO) and 3 in inclined geosynchronous orbit (IGSO).
  The BDS uses frequency allocated in the E1, E2, E5B, and E6 bands.

Single-satellite GNSS signal

This section gives an overview of the basic offline options GPS (R&S SMx-K244), Galileo (R&S SMx-K266), GLONASS (R&S SMx-K294) and BeiDou (R&S SMx-K407).

R&S WinIQSIM2 calculates a single satellite GNSS signal, where static satellites with constant Doppler shifts are provided for simple receiver test, like receiver sensitivity, acquisition and tracking test, etc. production tests. Selection and configuration of any localization data, such as receiver location for instance, is not enabled.

A generic workflow is described in Chapter 5, "How to Generate a Signal with the GNSS Option", on page 40.

Almanacs

The instrument supports the configuration of the almanac files used. One almanac file per GNSS navigation standard can be selected.

The Galileo and Beidou satellite constellation are not yet fully in orbit. Hence, no almanac files for Galileo and BeiDou are available. In this implementation, predicted Galileo and Beidou almanac files are provided for test purposes. The almanac files for GPS and Galileo use the same format.

Current GNSS almanac data can be downloaded via the Internet and stored on the hard disk of the instrument:

- US Coast Guard Navigation Center GPS Homepage http://www.navcen.uscg.gov/?pageName=gpsAlmanacs
  The almanac files are named `xxx.alm` (for YUMA files) or `xxx.al3` (for SEM files),
  Where xxx denotes the day of a year
- http://www.celestrak.com/GPS/almanac/
  The naming convention of the almanac file is: `almanac.sem/yuma.weekXXXX.YYYYYY.txt`,
  Where `xxxx` denotes the GPS week and `yyyyyy` the time of almanac (TOA)
- ftp://ftp.glonass-iac.ru/MCC/ALMANAC/
  The file extension of the Glonass almanac file is: `xxx.agl`
- Japanese Space Agency homepage http://qz-vision.jaxa.jp/USE/en/almanac
  Available are QZSS almanacs or QZSS+GPS almanac data files.
  The almanac files are named `zzyyyyxxx.alm` (for YUMA files) or `zzyyyyxxx.alm.xml` (for XML files),
  Where `zz=q` for QZSS almanacs and `zz=qg` for QZSS+GPS almanacs;
  `yyyy` denotes the year and `xxx` denotes the day of a year.

For detailed information on the content and frame structure of navigation data, refer to the specifications.

4 GNSS Configuration and Settings

Access:

1. Select "Baseband > Satellite Navigation".
2. Select the desired satellite standard, e.g. GPS.
   To simplify the description, the selected satellite standard is referred as an "entry standard".

   Note: Most of the parameters provided for configuration are similar and do not depend on the entry standard. This description uses the GPS standard as a reference.
   Satellite standard dependent settings are described separately or the differences are explicitly stated.

   The provided settings enable you to perform general configurations, like to set the default settings or access further dialogs.

The screenshots provided in this description show parameter values that have been selected to illustrate as much as possible of the provided functions and possible interdependencies between them.

These values are not necessarily representative of realistic test situations.

The remote commands required to define these settings are described in Chapter 6, "Remote-Control Commands", on page 42.

Settings:

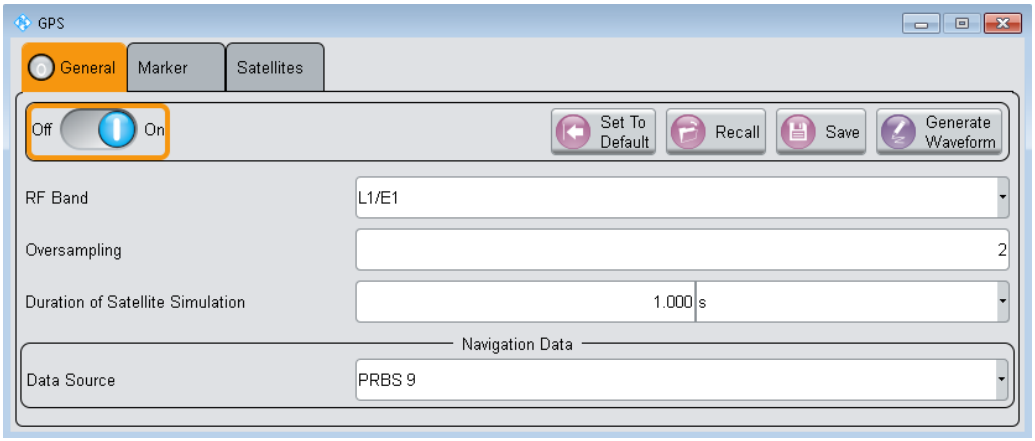
- General Settings 13
- Navigation Data 17
- Almanac Configuration Settings 20
- Time Conversion Configuration Settings 21
- Satellite Configuration Settings 23
- Navigation Message Configuration 28
- Marker Settings 37

4.1 General Settings

Access:

1. Select "Baseband > Satellite Navigation".
2. Select the desired satellite standard, e.g. GPS.
3. Select "General".

This tab provides access to the default and the "Save/Recall" settings, as well as the settings of the simulated satellite. Depending on the selected data source, the parameters vary.



Settings:

State....14
Set to default....14
Save/Recall....15
Generate Waveform File....15
RF Band....15
Simulation Mode....16
Oversampling....16
Duration Of Satellite Simulation....16

State
Activates the standard and deactivates all the other digital standards and digital modulation modes in the same path.

Remote command:
`<subsystem>:STATe` on page 45

Set to default
Calls the default settings. The values of the main parameters are listed in the following table.

Parameter	Value
State	Not affected by "Set to default"
RF Band	L1/E1
Simulation Mode	Static
Almanac	GPS_SEM678.txt/GAL_Yuma678.txt/GLO_678.agl/ Beidou_Yuma678.txt
Oversampling Duration of Satellite Simulation	2 1s
Data Source	PRBS9

Parameter	Value
System Time	Time basis of the entry standard
Satellite configuration	
Maximum Number of Satellites	1
State satellite 1	On
Standard	GPS, Galileo, GLONASS or BeiDou (depending on the entry standard)
Signal	C/A, E1-DEF, R-C/A or B1-C/A (depending on the entry standard)

Remote command:
`<subsystem>:PRESet` on page 44

Save/Recall
Accesses the "Save/Recall" dialog, that is the standard instrument function for saving and recalling the complete dialog-related settings in a file. The provided navigation possibilities in the dialog are self-explanatory.

The filename and the directory, in which the settings are stored, are user-definable; the file extension is however predefined.

The following file extensions are used: `*.gps`, `*.galileo`, `*.glonass` respectively.

Remote command:
`[:SOURce<hw>]:BB:GPS:SETTing:CATalog?` on page 45
`[:SOURce<hw>]:BB:GALileo:SETTing:CATalog?` on page 45
`<subsystem>:SETTing:STORe` on page 46
`<subsystem>:SETTing:LOAD` on page 46
`<subsystem>:SETTing:DELete` on page 46

Generate Waveform File
With enabled signal generation, triggers the instrument to store the current settings as an ARB signal in a waveform file. Waveform files can be further processed by the ARB and/or as a multi-carrier or a multi-segment signal.

The filename and the directory it is stored in are user-definable; the predefined file extension for waveform files is `*.wv`.

See also:
- Chapter 5.1, "How to Generate a One-Satellite Static Generic GNSS Signal", on page 40
- Chapter 5.2, "How to Play a GNSS Waveform with Rohde & Schwarz Signal Generator", on page 41 .

Remote command:
`<subsystem>:WAVeform:CREate` on page 47

RF Band
Determines the RF band, i.e. the upper or lower RNSS band.

The different satellites are modulated on their corresponding standard carrier frequencies.

See Table 4-1).

Table 4-1: Carrier frequencies

Navigation Standard	"RF Band"	Carrier Frequency, GHz	Required SW Option
GPS	L1 L2	1.57542 1.2276	R&S SMx-K244
GALILEO	E1	1.57542	R&S SMx-K266
GLONASS	L1 L2	1.602 1.246	R&S SMx-K294
BeiDou	L1	1.561098	R&S SMx-K407

Remote command:
`<subsystem>:RFBand` on page 45

Simulation Mode
Indicates Sets the simulation mode.

"Static" Enables you to configure the satellite signal.

Remote command:
`<subsystem>:SMODe` on page 45

Oversampling
Determines the upsampling factor.

A higher upsampling factor improves the filtering but increases the waveform size proportionally and hence limits the maximum Duration Of Satellite Simulation.

Remote command:
`<subsystem>:FILTer:OSAMpling` on page 47

Duration Of Satellite Simulation
Determines the duration of the satellite simulation.

The resulting duration of the simulation is calculated as follows:

$$Duration\ of\ Simulation = \frac{Duration\ of\ Satellite\ Simulation}{1 + \frac{Doppler\ Shift}{F_{Carrier}}}$$

Where $F_{Carrier}$ is the frequency selected with the parameter RF Band.

The maximum duration of satellite simulation depends on the Oversampling and the ARB memory size of the connected instrument.

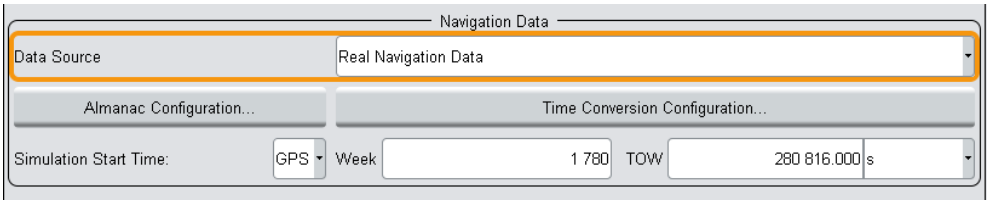
Remote command:
`<subsystem>:DURation` on page 46

4.2 Navigation Data

Access:

► Select "GNSS Main Dialog > Navigation Data"

With the provided settings, you can define the data source for navigation information.



Data Source 17
Time Conversion Configuration 18
Simulation Start Time 18
Almanac Configuration 19

Data Source
Selects data source for the navigation information.

Navigation data is essential for calculating the positions of the satellites. It also contains the information about the currently valid space vehicle IDs.

"Real Navigation Data"
You can download Almanac files ("Real Navigation Data") from the Internet and store them on the hard disk of your instrument. If necessary, reconfigure manually these downloaded files.
If you work in "User Localization" mode, you can also use RINEX files.
Almanac files for Galileo and BeiDou are not available for download. To simulate the movement of Galileo and BeiDou satellites on their designed orbits, you find predicted almanacs provided with this software.
Use the Almanac Configuration parameter to select the almanac file per navigation standard.

"PRBSxx/Data List/Pattern"

Arbitrary data is available in "Static" mode.
A GNSS receiver recognizes signals generated in this way. There is no real navigation data modulated with the GNSS spreading code but the signal is sufficient for simple functional tests and sensitivity tests. The receiver measures and displays the carrier to noise ratio of the signal.

The following standard data sources are available:

- "All 0, All 1"
  An internally generated sequence containing 0 data or 1 data.
- "PNxx"
  An internally generated pseudo-random noise sequence.
- "Pattern"
  An internally generated sequence according to a bit pattern.
  Use the "Pattern" box to define the bit pattern.
- "Data List/Select DList"
  A binary data from a data list, internally or externally generated.
  Select "Select DList" to access the standard "Select List" dialog.
  – Select the "Select Data List > navigate to the list file *.dm_iqd > Select" to select an existing data list.
  – Use the "New" and "Edit" functions to create internally new data list or to edit an existing one.
  – Use the standard "File Manager" function to transfer external data lists to the instrument.

  See also section "Custom Digital Modulation > Data Source" in the R&S WinIQSIM2 user manual.

"Zero Navigation Data"

Navigation data with the ephemeris, almanac and satellite clock correction parameters set to zero.
Synchronization, timing and structure (e.g. channel coding) of the message are the same as for "Real Navigation Data".
In this mode, you can select from the full set of SV-IDs for all GNSS.
In the "Real Navigation Data" mode, available are only the almanac records that are existing in the almanac file and the healthy satellites.

Remote command:

`<subsystem>:NAVigation:DATA` on page 48
`<subsystem>:NAVigation:DATA:DSELect` on page 49
`<subsystem>:NAVigation:DATA:PATTern` on page 49

Time Conversion Configuration

Opens the Time Conversion Configuration Settings dialog.

Simulation Start Time

Sets the simulation start time in the format of the selected "Time Basis".

"Time Basis" Per default, the timebase of the entry standard is used. If different timebase is selected, the time is automatically recalculated and displayed in the selected time format.

Note: Use the Time Conversion Configuration Settings dialog to configure the parameters, necessary for time conversion between the proprietary time of the navigation standard and the UTC.

Remote command:
`<subsystem>:NAVigation:SIMulation:TBASis` on page 49

"Date [dd.mm.yyyy], Time [hh:mm:ss:xxx]"
(enabled for "Data Source > Real Navigation Data" and "Time Basis > UTC/GLO")
Enters the date for the simulation in DD.MM.YYYY format of the Gregorian calendar and the exact simulation start time in UTC time format. The simulation time is not limited to the almanac week.

Remote command:
`<subsystem>:NAVigation:SIMulation:DATE` on page 49
`<subsystem>:NAVigation:SIMulation:TIME` on page 50

"Week Number, Time of Week (TOW)"
(enabled for "Time Basis > GPS/GST/BDT/QZSST" and "Data Source > Real Navigation Data")
The satellite clocks in the GPS and Galileo navigation systems are not synchronized to the UTC. They use a proprietary time, the GPS and the Galileo system time. The format used for these systems is week number (WN) and Time of Week (TOW), that is the simulation start time within this week.
The Time of Week (TOW) is expressed in number of seconds and covers an entire week. The value is reset to zero at the end of each week.

The weeks are numbered starting from a reference time point (WN_REF=0), that depends on the navigation standard:
- GPS reference point: January 6, 1980 (00:00:00 UTC)
- GALILEO reference point: August 22, 1999
- BeiDou reference point: January 01, 2006

The default value of this parameter is equal to the Week of the almanac that corresponds to the navigation standard used as an entry standard.

Remote command:
`<subsystem>:NAVigation:SIMulation:WNUMber` on page 50
`<subsystem>:NAVigation:SIMulation:TOWeek` on page 50

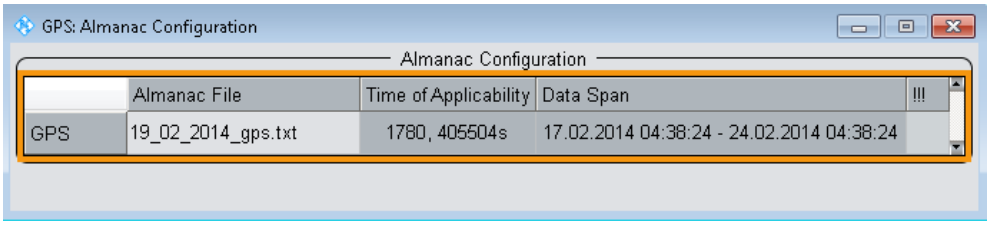
Almanac Configuration
Accesses the Almanac Configuration settings.

You can select one almanac file per navigation standard.

4.3 Almanac Configuration Settings

To access this dialog:

1. Select "GNSS > General > Navigation Data"
2. Select "Data Source > Real Naviagtion Data"
3. Select "Almanac"



In this dialog, you select the almanac files.

Almanac Configuration
Displays the settings of the selected almanac files per navigation standard.

One almanac file can be selected per navigation standard. Predefined or user-defined almanac files can be loaded.

When an almanac file is selected, the time information of the file (Week, SEM and TOA) is indicated in the table. The SEM and TOA are indicated in Greenwich Mean Time.

Parameter	SCPI command
"Almanac File"	`<subsystem>:NAVigation:ALManac:<GNSS>:FILE` on page 52 `<subsystem>:SVID:<GNSS>:LIST` on page 55
"Time of Applicability (TOA)"[1)]	`<subsystem>:NAVigation:ALManac:<GNSS>:TOAPplicability:TOWeek` on page 55 `<subsystem>:NAVigation:ALManac:<GNSS>:TOAPplicability:WNUMber` on page 55
	`<subsystem>:NAVigation:ALManac:GLONass:TOAPplicability:DATE?` on page 53 `<subsystem>:NAVigation:ALManac:GLONass:TOAPplicability:TIME?` on page 54
"Data Span"	`<subsystem>:NAVigation:ALManac:<GNSS>:SPAN?` on page 52
"Week Number"[2)]	`<subsystem>:NAVigation:ALManac:<GNSS>:WNUMber` on page 55
"Week Span"[2)]	`<subsystem>:NAVigation:ALManac:<GNSS>:DATE:BEGIn` on page 53 `<subsystem>:NAVigation:ALManac:<GNSS>:DATE:END` on page 53

- [1)] TOA format for GPS: *(WN, TOW) WN_REF (6 Jan 1980 00:00:00 UTC)*
  TOA format for Galileo: *(WN, TOW) WN_REF (22 August 1999 00:00:00 UTC)*
- [2)] "Week Number" and "Week Span": no SCPI command for Glonass

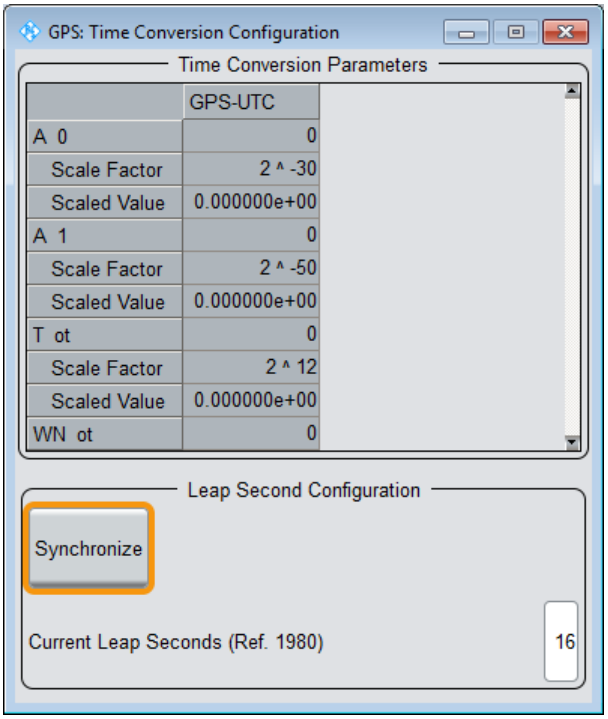
For an overview of the supported almanac files, see "Almanacs" on page 11.

4.4 Time Conversion Configuration Settings

Access:

1. Select "Baseband > Satellite Navigation".
   Select the satellite standard, for example "GPS".
2. Select "Navigation Data > Data Source > Real Navigation Data".
3. Select "Navigation Data > Time Conversion Config...".

   This dialog contains the settings required to configure the time conversion from a navigation standard, for example GPS to UTC. The conversion settings are necessary for switching from one time basis to another.



The time conversion is performed according to the following formula:

$t_{UTC} = (t_E - delta\_t_{UTC})\ modulo\ 86400$, where $delta\_t_{UTC}$ and t_E are as follows:

$delta\_t_{UTC} = delta\_t_{LS} + A_0 + A_1 (t_E - T_{ot} + 604800(WN - WN_{ot}))$ and

$t_E = t_{GPS}$ or $t_{Galileo}$

The GNSS implementation in the R&S WinIQSIM2 is a simplified offline version of the real-time one and provides the capability to generate a one-satellite generic signal. Therefore the time conversion parameters table is adjusted accordingly to one satellite in R&S WinIQSIM2. You find the differences explicitly stated in the description.

Time Conversion Parameters....22
Leap Second Configuration....22
UTC-UTC(SU)....22

Time Conversion Parameters

The basis for the time conversion is the UTC. The parameters of each of the navigation standards are set as an offset to the UTC.

For better readability, the values of the time correction parameters are input as integer in the same way as they are included in the satellite's navigation message. The corresponding "Scale Factor" and the "Scaled Value" are also displayed.

Parameter	Description	SCPI Command
"A_0"	Constant term of polynomial, A_0	`<subsystem>:NAVigation:TCONversion:GPS:AZERo` on page 57
"A_1"	1st order term of polynomial, A_1	`<subsystem>:NAVigation:TCONversion:GPS:AONE` on page 57
"t_ot"	UTC data reference Time of Week, t_{ot}	`<subsystem>:NAVigation:TCONversion:GPS:TOT` on page 58
"WN_t"	UTC data reference Week Number, WN_t	`<subsystem>:NAVigation:TCONversion:GPS:WNOT` on page 58

Leap Second Configuration

The GPS time does not consider time corrections that are typical for the UTC, such as the leap second for instance.

The date of the next expected correction is determined by the parameter "Next Leap Second Date".

As of June 30, 2012, the value of the "Current Leap Second", is 16 seconds.

Parameter	Description	SCPI Command
"Synchronize"	Synchronizes the leap second according to the simulation time.	`<subsystem>:NAVigation:TCONversion:LEAP:SYNC` on page 59
"Current Leap Seconds (Ref. 1980)"	Displays the currently used leap second.	`<subsystem>:NAVigation:TCONversion:LEAP:SEConds` on page 59

UTC-UTC(SU)

(for GLONASS satellites)

The Universal Time Coordinate (UTC) as used for GPS and Galileo can have a phase shift and a frequency drift compared to the Russian UTC basis (UTC(SU)). These settings are provided for configuration of the UTC differences UTC - UTC(SU) as transmitted by GLONASS satellites.

Parameter	Description	SCPI Command
"UTC(SU) Reference Date"	Indicates the UTC-UTC (SU) time conversion reference date.	`<subsystem>:NAVigation:TCONversion:UTCSu:DATE?` on page 59
"A_0"	Constant term of polynomial A_0 (virtual)	`<subsystem>:NAVigation:TCONversion:UTCSu:AZERo` on page 58
"A_1"	1st order term of polynomial, A_1 (virtual)	`<subsystem>:NAVigation:TCONversion:UTCSu:AONE` on page 58

The Glonass satellites transmit the offset between GPS and GLONASS system time as part of their navigation message. They assume only a delay and no frequency drift. The time offset is calculated as following:

```
GPS – GLONASS = "GPS – UTC" + "UTC – UTC(SU)" – "GLONASS –
(UTC(SU) + 3h)" – 3h
```

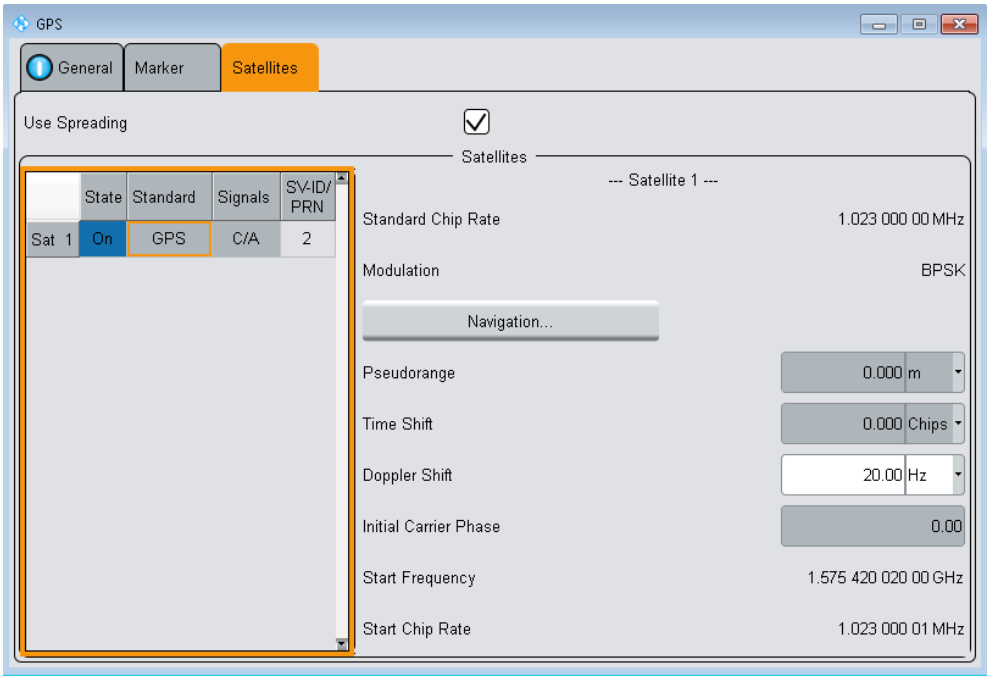
For hybrid GNSS configuration with activated GLONASS satellites, this GPS – GLONASS time offset is maintained constant. This is done by automatically adjusting the "GPS-UTC" drift parameters ("A_1","T_ot" and "WN_ot") while changing the "UTC – UTC(SU)" parameters.

4.5 Satellite Configuration Settings

Access:

1. Select "Baseband > Satellite Navigation".
   Select the desired satellite standard, for example GPS.

2. Select "Satellite Configuration".



The GNSS implementation in R&S WinIQSIM2 is a simplified offline version of the realtime option. In the offline version, you can generate a one-satellite generic signal; that is, only one satellite can be activated and configured. You find the differences between the real-time and the offline versions explicitly stated in the description.

4.5.1 General Satellites Settings

Use Spreading 24
Galileo Sat. Modulation 24

Use Spreading
Activates/deactivates spreading.

Remote command:
`<subsystem>:SPReading[:STATe]` on page 61

Galileo Sat. Modulation
Selects the modulation mode used for modulating the Galileo carrier signal.

Tip: Select BOC(1,1) modulation to reduce the sample rate required to simulate a certain period of time.

Remote command:
`<subsystem>:GALModulation` on page 61

4.5.2 Configuration of the Satellite Constellation

Maximum Number of Satellites 25
Satellite State 25
Standard 25
Signals 25
SV-ID/PRN 25

Maximum Number of Satellites
The GNSS implementation in the R&S WinIQSIM2 provides one satellite signal.

Remote command:
`<subsystem>:SATellite:COUNt` on page 61

Satellite State
Activates/deactivates the satellite.

Remote command:
`<subsystem>:SATellite<st>:STATe` on page 65

Standard
Indicates the navigation standard to that the satellite belongs.

Remote command:
`<subsystem>:SATellite<st>:STANdard` on page 65

Signals
Indicates the type of signal the satellite is using.

Table 4-2: Overview of the supported signals

Band	Entry Point	Standard	Signal	Minimum Required Option
L1/E1	GPS	GPS	C/A	R&S SMx-K244
	Galileo	Galileo	E1-DEF	R&S SMx-K266
	GLONASS	GLONASS	R-C/A	R&S SMx-K294
	BeiDou	BeiDou	B1-C/A	R&S SMx-K407

Remote command:
`<subsystem>:SATellite<st>:SIGNal` on page 64

SV-ID/PRN
Enters the Space Vehicle ID (SV-ID) or Pseudo-Random Noise (PRN) of the satellite to be simulated. This value is used to generate the corresponding spreading code.

Note: The SV IDs of the GLONASS satellites are with 64 smaller than their PRN number, e.g to GLONASS satellite R5 corresponds PRN=69.

If "Real Navigation Data" is used, you can select healthy satellites from the almanac records; otherwise, any ID can be selected.

SV ID set to "N.A." indicates a not assigned satellite.

Remote command:
`<subsystem>:SATellite<st>:SVID` on page 65

4.5.3 Individual Satellite Settings

Comprises the settings of the selected satellite.

Standard Chip Rate....26
Frequency Number....26
Orbit Type....26
Modulation....26
Navigation....27
Initial Code Phase....27
Pseudorange....27
Time Shift/ chips....27
Doppler Shift....27
Initial Carrier Phase....27
Resulting Start Frequency....28
Resulting Start Chip Rate....28

Standard Chip Rate
Displays the chip rate.

Remote command:
`<subsystem>:SATellite<st>:SCRate?` on page 64

Frequency Number
(enabled for GLONASS satellites)

Frequency number indicates the subcarrier used to modulate the GLONASS satellite.

If you use "Data Source > Real Navigation Data", the frequency number is retrieved from the selected almanac file. If you use arbitrary data, the frequency number is configurable.

Remote command:
`<subsystem>:SATellite<st>:FNUMber` on page 62

Orbit Type
(enabled for BeiDou satellites)

Indicates the orbit type the BeiDou satellite is using. The BeiDou global satellite navigation system uses a constellation of 35 satellites with following orbits:

"GEO"	Five geostationary orbit satellites with "SV-ID = 1 to 5"
"MEO"	27 middle earth orbits global satellites
"IGSO"	3 Inclined Geosynchronous Satellite Orbit regional satellites, visible only in China and Australia

Remote command:
`<subsystem>:SATellite<st>:ORBit?` on page 63

Modulation
Displays the modulation used for modulating the carrier signal.

Remote command:
`<subsystem>:SATellite<st>:MODulation?` on page 63

Navigation...
Accesses the dialog for configuring the parameters of the navigation message.

See Chapter 4.6, "Navigation Message Configuration", on page 28

Initial Code Phase
(enabled only in "Static" mode and for arbitrary navigation data source)

Sets the initial code phase.

In R&S WinIQSIM2, the actual simulated resolution for initial code phase depends on the sample rate. The selected Initial Carrier Phase is internally rounded to a sample. To increase the sample rate, use the Oversampling function.

Remote command:
`<subsystem>:SATellite<st>:CPHase` on page 63

Pseudorange
In R&S WinIQSIM2, it is fixed to 0.

Displays the propagation delay from satellite to receiver in meters that is calculated as follows:

`Pseudorange = Time Shift * c / Standard Chip Rate`, where `c` is the speed of light.

Remote command:
`<subsystem>:SATellite<st>:PRANge` on page 64

Time Shift/ chips
Displays the propagation delay from satellite to receiver. The time shift is displayed in chips.

In R&S WinIQSIM2, it is fixed to 0.

Remote command:
`<subsystem>:SATellite<st>:TSHift` on page 65

Doppler Shift
Sets the Doppler shift for a constant signal profile of the simulated signal of the satellite. The simulation of Doppler shifted signals can be used to check the receiver characteristics under more realistic conditions than with zero Doppler.

The instrument calculates also the variations in the chip rate of the code. Current values of the Doppler shifted carrier frequency and chip rate are displayed as:
- Resulting Start Frequency
- Resulting Start Chip Rate

Remote command:
`<subsystem>:SATellite<st>:DSHift` on page 62

Initial Carrier Phase
Displays the initial carrier phase.

In R&S WinIQSIM2, it is fixed to 0.

Remote command:
`<subsystem>:SATellite<st>:ICPHase` on page 63

Resulting Start Frequency
Indicates the currently valid values for Doppler shifted carrier frequency.

The resulting frequency is calculated according to the following:

- GPS, Galileo, BeiDou
  $f_{resulting} = f_{band} + f_{Doppler}$,
  Where f_{band} is set with parameter RF Band.
- Glonass
  $f_{band\_L1} = 1602\ MHz$, $f_{band\_L2} = 1247\ MHz$
  k = frequency number
  $f_{Glo\_L1\_resulting}, MHz = 1602 + (k * 0.5625) + f_{Doppler}$
  $f_{Glo\_L2\_resulting}, MHz = 1247 + (k * 0.4375) + f_{Doppler}$

Remote command:
`<subsystem>:SATellite<st>:FREQuency?` on page 62

Resulting Start Chip Rate
Indicates the currently valid values for the chip rate. The relevant change to the chip rate is carried out automatically if the Doppler shift is changed.

The resulting chip rate is calculated according to the following:

- GPS, Galileo, BeiDou
  $f_{resulting} = f_{code} * \{1 + f_{Doppler} / f_{band}\}$,
  Where f_{band} is set with parameter RF Band,
  $f_{code\_GPS/Galileo} = 1.023\ MHz$ and $f_{code\_BeiDou} = 2.046\ MHz$
- Glonass on L1/E1 band
  $f_{resulting} = f_{code} * \{1 + f_{Doppler} / [f_{band} + k * 562500\ (Hz)]\}$
- Glonass on L2 band
  $f_{resulting} = f_{code} * \{1 + f_{Doppler} /[f_{band} + k * 437500\ (Hz)]\}$

Remote command:
`<subsystem>:SATellite<st>:CACRate?` on page 61

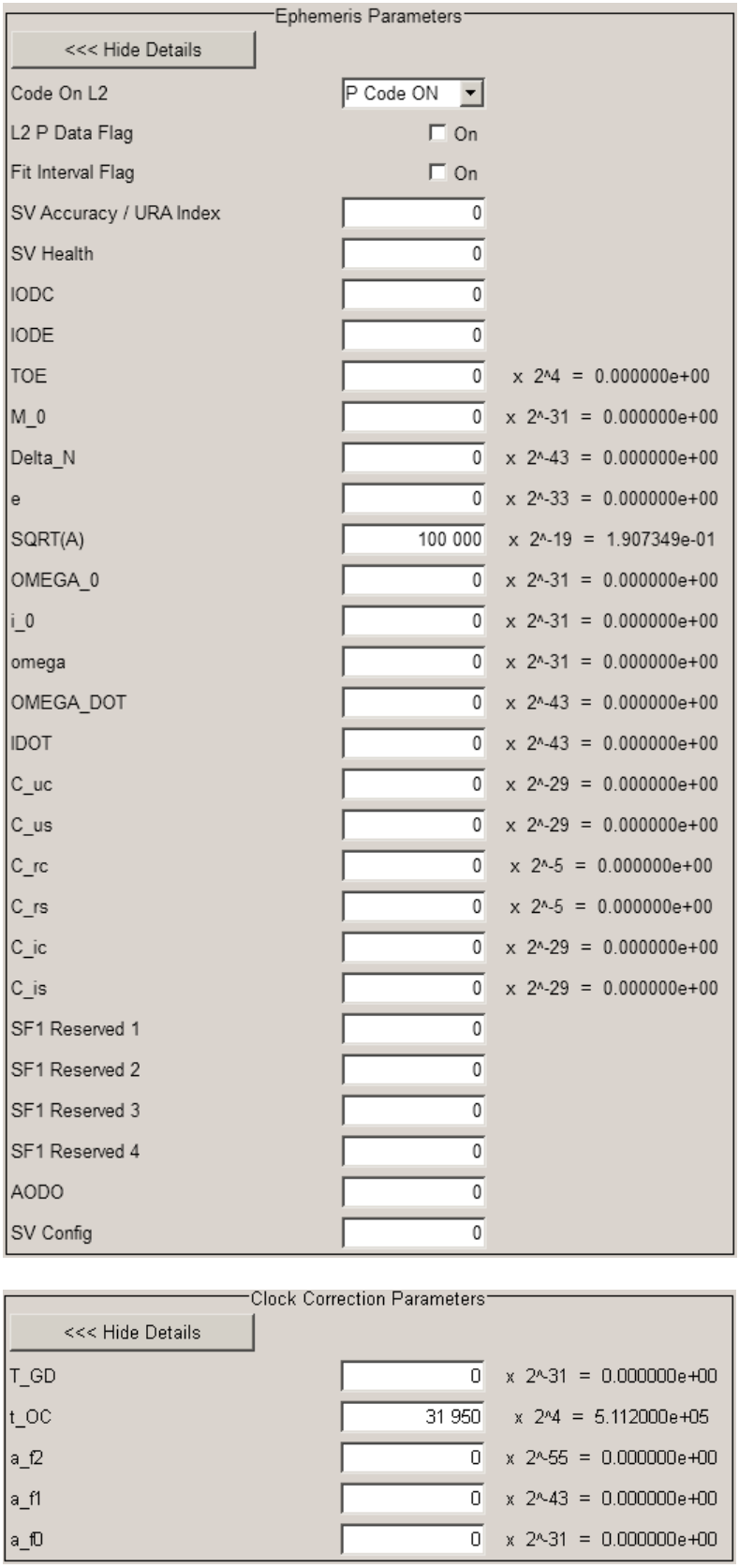
4.6 Navigation Message Configuration

To access these settings:

1. Select "Baseband > Satellite Navigation". Select the satellite standard, for example "GPS".
2. Select "Satellite Configuration > Navigation...".

   The parameters of the navigation message of each satellite are read only.

   The input parameters are integer values, so that you set them in the same way as they are included in the satellite's navigation message. The scaled values and the scaling factors are also displayed. Different scaling factors apply for the same parameters in the different GNSS standards.


Ephemeris Parameters
<<< Hide Details
Code On L2
P Code ON
L2 P Data Flag
On
Fit Interval Flag
On
SV Accuracy / URA Index 0
SV Health 0
IODC 0
IODE 0
TOE 0 x 2^4 = 0.000000e+00
M_0 0 x 2^-31 = 0.000000e+00
Delta_N 0 x 2^-43 = 0.000000e+00
e 0 x 2^-33 = 0.000000e+00
SQRT(A) 100 000 x 2^-19 = 1.907349e-01
OMEGA_0 0 x 2^-31 = 0.000000e+00
i_0 0 x 2^-31 = 0.000000e+00
omega 0 x 2^-31 = 0.000000e+00
OMEGA_DOT 0 x 2^-43 = 0.000000e+00
IDOT 0 x 2^-43 = 0.000000e+00
C_uc 0 x 2^-29 = 0.000000e+00
C_us 0 x 2^-29 = 0.000000e+00
C_rc 0 x 2^-5 = 0.000000e+00
C_rs 0 x 2^-5 = 0.000000e+00
C_ic 0 x 2^-29 = 0.000000e+00
C_is 0 x 2^-29 = 0.000000e+00
SF1 Reserved 1 0
SF1 Reserved 2 0
SF1 Reserved 3 0
SF1 Reserved 4 0
AODO 0
SV Config 0
Clock Correction Parameters
<<< Hide Details
T_GD 0 x 2^-31 = 0.000000e+00
t_OC 31 950 x 2^4 = 5.112000e+05
a_f2 0 x 2^-55 = 0.000000e+00
a_f1 0 x 2^-43 = 0.000000e+00
a_f0 0 x 2^-31 = 0.000000e+00

The provided parameters depend on the GNSS standard the satellite belongs to.

SV-ID / Standard 30
Show Details/Hide Details 30
GPS, Galileo, BeiDou Common Ephemeris Parameters 30
Common Ephemeris Parameters 31
GPS and QZSS Ephemeris Parameters 32
GPS, BeiDou Clock Correction Parameters 33
GLONASS Ephemeris Parameters 33
GLONASS Clock Correction Parameters 36
Galileo INAV Parameters 36
Galileo FNAV Parameters 37

SV-ID / Standard

Displays the SV ID and the navigation standard the navigation message is related to.

Remote command:

`<subsystem>:SATellite<st>:SVID` on page 65

`<subsystem>:SATellite<st>:STANdard` on page 65

Show Details/Hide Details

Shows/hides navigation message parameters depending on the selected GNSS system:

Table 4-3: Navigation message parameters for GNSS systems

Parameter Type	GNSS System
Ephemeris Parameters	GPS, Galileo, Glonass, BeiDou
Clock Correction Parameters	GPS, Glonass, BeiDou
Ionospheric Parameters	GPS, Galileo, BeiDou, QZSS, SBAS
INAV and FNAV Parameters	Galileo

GPS, Galileo, BeiDou Common Ephemeris Parameters

The ephemeris parameters correspond to the SV ID and navigation standard displayed with the parameter SV-ID / Standard.

Table 4-4: Common Ephemeris Parameters

Parameter	Description(1)	SCPI command
M_0	Mean Anomaly at Reference Time (M_0)	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:MZERo` on page 74
Delta_N	Mean Motion Difference From Computed Value (Δn)	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:NDELta` on page 75
e	Eccentricity	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:ECCentricity` on page 72

Parameter	Description[1]	SCPI command
SQRT(A)	Square Root of the Semi-Major Axis (√a)	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:SQRA` on page 76
OMEGA_0	Longitude of Ascending Node of Orbit Plane at Weekly Epoch (Ω_0)	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:OZERo` on page 76
i_0	Inclination Angle at Reference Time (i_0)	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:IZERo` on page 74
Omega	Argument of Perigee (Ω)	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:OMEGa` on page 75
OMEGA_DOT	Rate of Right Ascension	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:ODOT` on page 75
IDOT	Rate of Inclination Angle	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:IDOT` on page 73
C_uc	Amplitude of the Cosine Harmonic Correction Term to the Argument of Latitude	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:CUC` on page 71
C_us	Amplitude of the Sine Harmonic Correction Term to the Argument of Latitude	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:CUS` on page 72
C_rc	Amplitude of the Cosine Harmonic Correction Term to the Orbit Radius	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:CRC` on page 71
C_rs	Amplitude of the Sine Harmonic Correction Term to the Orbit Radius	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:CRS` on page 71
C_ic	Amplitude of the Cosine Harmonic Correction Term to the Angle of Inclination	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:CIC` on page 70
C_is	Amplitude of the Sine Harmonic Correction Term to the Angle of Inclination	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:CIS` on page 70
TOE	Time Of Ephemeris t_{oe}	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:TOE` on page 77

Common Ephemeris Parameters

The ephemeris parameters correspond to the SV ID and navigation standard displayed with the parameter SV-ID / Standard.

Table 4-5: Common Ephemeris Parameters

Parameter	Description	SCPI command
SV accuracy / URA Index SISA (Galileo)	Signal In Space Accuracy	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:URA` on page 77 `<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:SISA` on page 76 `<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:URA` on page 77
SV Health	This value does not have an impact on the actual health status of the generated satellite.	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:HEALth` on page 72
IODC (GPS/QZSS) AODC (BeiDou)	Issue of Data, Clock Age Of Data, Clock	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:IDOC` on page 73
IODE (GPS/QZSS) AODE (BeiDOu)	Issue of Data, Ephemeris Age Of Data, Ephemeris	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:IDOE` on page 73
IODnav IODa	Issue Of Data, Ephemeris and Clock Issue Of Data, Almanacs	`<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:IODNav` on page 74 `<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:IODA` on page 73

GPS and QZSS Ephemeris Parameters

The ephemeris parameters correspond to the SV ID and navigation standard displayed with the parameter SV-ID / Standard.

Table 4-6: GPS Ephemeris Parameters

Parameter	Description	SCPI command
Code on L2	Type of code for L2; This value does not have any impact on the actual used ranging code of the generated satellite. The used "Ranging Code" is set in the "Satellite Configuration" menu. • "Reserved" Reserved for future use. • "P Code on" Carrier L2 (f_L2= 1.2276 GHz) is modulated by P-code (BPSK). • "C/A Code on" Carrier L2 (f_L2= 1.2276 GHz) is modulated by C/A-code (BPSK).	`<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:CLTMode` on page 70
L2 P Data Flag	Use of carrier L2 P data flag This value does not have an impact on whether really data is transmitted on the satellite's carrier L2 or not.	`<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:LTPData` on page 74

Parameter	Description	SCPI command
Fit Interval Flag	Indicates the curve-fit interval used by the CS (Control Segment) in determining the ephemeris parameters	`<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:FIFLag` on page 72
SF1 Reserved 1/2/3/4		`<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:SF1Reserved<gr>` on page 76
AODO	Age of Data Offset	`<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:AODO` on page 70
SV Configurations		`<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:SVConfig` on page 77

GPS, BeiDou Clock Correction Parameters

The ephemeris parameters correspond to the SV ID and navigation standard displayed with the parameter SV-ID / Standard.

Table 4-7: GPS and BeiDou Clock Correction Parameters

Parameter	Description	SCPI command
T_GD	L1-L2 Correction Term	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:CCORection:TGD` on page 69
t_OC a_f2 a_f1 a_f0	Clock Correction Parameter	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:CCORection:TOC` on page 69 `<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:CCORection:AF<gr0>` on page 69

GLONASS Ephemeris Parameters

Comprises the GLONASS-specific ephemeris parameters.

Table 4-8: GLONASS-specific ephemeris parameters

Parameter	Description	SCPI command
Satellite Ephemeris Type (M)	Satellite ephemeris types GLONASS, GLONASS-M	`<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:SEType` on page 83
SV Health (B_n, 1_n)	A health value. The user navigation equipment analyzes only the MSB of this word. • B_n[3] = 1_n = 1 Satellite not healthy • B_n[3] = 1_n = 0 Satellite is healthy	`<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:HEALth` on page 82

Parameter	Description	SCPI command
Age of Ephemeris Page (P1)	Time interval between 2 adjacent values of TOE. It defines hence the age of the current Glonass Ephemeris page. This parameter maps to the P1 parameter in the navigation message as follows: • 01 Age of Ephemeris = 30 min • 10 Age of Ephemeris = 45 min • 11 Age of Ephemeris = 60 min **Note:** Tb-Interval and TOE displays depend on this value.	`<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:AOEP` on page 82
Tb-Index	Index of the Tb-time interval. Time of Ephemeris (TOE) corresponds to this value multiplied by 15 minutes. This value is actually a scaled TOE value with a unit of 15 minutes. **Note:** Tb-Interval and TOE displays depend on this value. Condition to be always met: • (Tb-Index – 1) An integer multiple of `(Age of Ephemeris[min]/15)` • Case 1: Age of Ephemeris = 30 min Tb-Index = 1, 3, 5... 95 • Case 2: Age of Ephemeris=45 min Tb-Index = 1, 4, 7... 94 • Case 3: Age of Ephemeris = 60 min Tb-Index = 1, 5, 9... 93	`<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:TINDex` on page 84
Tb-Alignment (P2)	Configures TOE to be aligned to an even or odd scale of 15 min for "Age of Ephemeris" = 30 min or 60 min. Forced to "1", hence odd in case of Age of Ephemeris = 45 min **Note:** All Ephemeris pages of an SVID have the same Tb alignment (P2). The **Tb-Interval** and **TOE** parameters depend on this value.	`<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:TALignment` on page 83
Tb-Interval	Displays the Tb-Interval in the current day where the Ephemeris set page is valid. `Tb-Interval = [((Tb - 1 + P2) * 15 * 60) -AgeOfEphemeris / 2` Examples: • tb = 45, P2 = 1 and Age of Ephemeris = 30 Tb-Interval = [11:00:00 11:30:00] • tb = 45, P2 = 1 and Age of Ephemeris = 45 Tb-Interval = [10:52:30 11:37:30] • tb = 45, P2 = 0 and Age of Ephemeris = 60 Tb-Interval=[10:30:00 11:30:00]	`<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:TINTerval?` on page 84

Parameter	Description	SCPI command
TOE (tb)	Displays the time of Ephemeris in the current day. Also referred to in the standard as the middle of the Tb-Interval or tb. This parameter is equivalent to `DayTime[(Tb - 1 + P2) * 15 * 60 seconds]` and independent of "Age of Ephemeris". Examples: • tb = 45, P2 = 1 • tb = 45, P2 = 1 • tb = 45, P2 = 0 TOE = 11:00:00	`<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:TOE?` on page 84
p	Reliability measure of system time conversion parameters. • 00 TAU_C and TAU_GPS relayed from control segment. • 01 TAU_C from control segment; TAU_GPS calculated on board GLONASS-M satellite. • 10 TAU_C on board GLONASS-M satellite and TAU_GPS relayed from CS. • 11 TAU_C and TAU_GPS calculated on board GLONASS-M satellites.	`<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:P` on page 83
X_n	The OX positions coordinate of the current satellite at TOE(tb), i.e. the middle of the Tb-Interval(1).	`<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:XN` on page 85
Y_n	The OY positions coordinate of the current satellite at TOE(tb), i.e. the middle of Tb-Interval(1).	`<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:YN` on page 85
Z-n	The OZ positions coordinate of the current satellite at TOE(tb), i.e. the middle of Tb-Interval(1).	`<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:ZN` on page 85
XDOT_n	The OX velocities coordinate of the current satellite at TOE(tb), i.e. the middle of Tb-Interval(1).	`<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:XDN` on page 85
YDOT_n	The OY velocities coordinate of the current satellite at TOE(tb), i.e. the middle of Tb-Interval(1).	`<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:YDN` on page 85
ZDOT_n	The OZ velocities coordinate of the current satellite at TOE(tb), i.e. the middle of Tb-Interval(1).	`<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:ZDN` on page 85
XDDOT_n	The OX accelerations coordinate of the current satellite due to solar and lunar gravitational effects at TOE(tb), i.e. the middle of Tb-Interval(1).	`<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:XDDN` on page 85

Parameter	Description	SCPI command
YDDOT_n	The OY accelerations coordinate of the current satellite due to solar and lunar gravitational effects at TOE(tb), i.e. the middle of Tb-Interval(1).	`<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:YDDN` on page 85
ZDDOT_n	The OZ accelerations coordinate of the current satellite due to solar and lunar gravitational effects at TOE(tb), i.e. the middle of Tb-Interval(1).	`<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:ZDDN` on page 85

GLONASS Clock Correction Parameters

Comprises the GLONASS-specific parameters for clock correction.

Table 4-9: GLONASS Clock Correction Parameters

Parameter	Description	SCPI command
TAU_n (-a_f0)	SV Clock bias correction coefficient	`<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:CCORrection:TAUN` on page 82
GAMMA_n (a_f1)	SV Clock drift correction coefficient	`<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:CCORrection:GAMN` on page 81
Delta_TAU_n	Time difference between navigation RF signal transmitted in L2 and navigation RF signal transmitted in L1 band	`<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:CCORrection:DTAU` on page 81
E_n	Age of operation information	`<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:CCORrection:EN` on page 81

Galileo INAV Parameters

Comprises the parameters of the Integrity navigation message I/NAV, provided by E5b and E1-B signals and supporting Safety of Life Service. The I/NAV message carries extended system integrity information.

Table 4-10: INAV Parameters

Parameter	Description	SCPI command
B_GD (E1-E5B)	E1-E5b Broadcast Group Delay BGD(E1,E5b)	`<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:INAV:BGD` on page 79
T_OC (E1-E5B)	Clock correction data reference Time of Week t_{oC}(E1,E5b)	`<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:INAV:TOC` on page 81
a_f2 (E1-E5B)	SV clock drift rate correction coefficient a_{f2}(E1,E5b)	`<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:INAV:AF<gr0>` on page 79
a_f1 (E1-E5B)	SV clock drift correction coefficient a_{f1}(E1,E5b)	
a_f0 (E1-E5B)	SV clock bias correction coefficient a_{fo}(E1,E5b)	

Parameter	Description	SCPI command
E1B_DVS	Data Validity Satellite Status, transmitted on E1-B (E1-B_{DVS})	`<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:INAV:E1BDVS` on page 80
E5B_DVS	Data Validity Satellite Status, transmitted on E5b (E5b_{DVS})	`<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:INAV:E5BDVS` on page 80
E1B_HS	Signal Health Status for E1 (E1-B_{HS})	`<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:INAV:E1BHS` on page 80
E5B_HS	Signal Health Status for E5b (E5b_{HS})	`<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:INAV:E5BHS` on page 80

Galileo FNAV Parameters

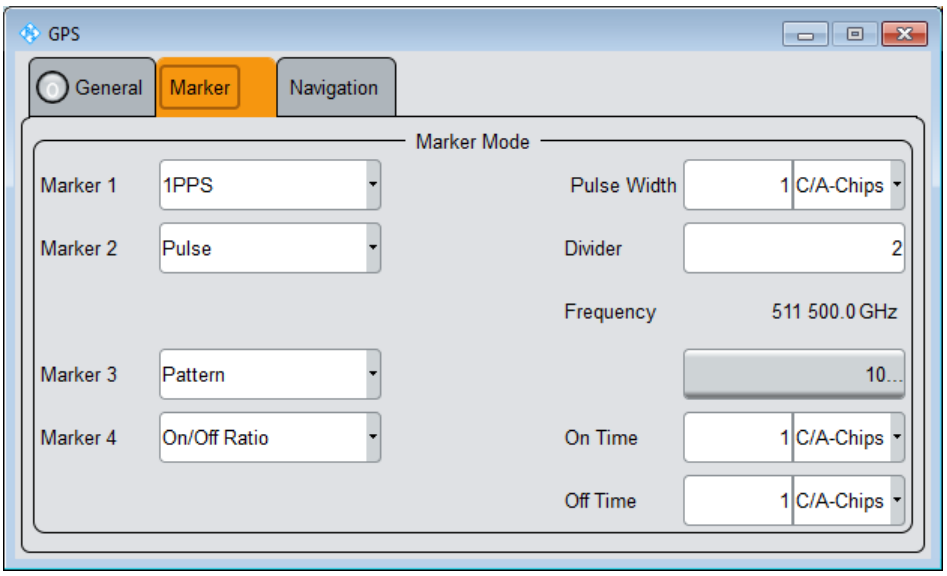
Comprises the parameters of the freely accessible navigation message F/NAV, provided by the E5a signal for Open Service.

Table 4-11: FNAV Parameters

Parameter	Description	SCPI command
B_GD (E1-E5A)	E1-E5a Broadcast Group Delay BGD(E1,E5a)	`<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:FNAV:BGD` on page 78
T_OC (E1-E5A)	Clock correction data reference Time of Week t_{oC}(E1,E5a)	`<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:FNAV:TOC` on page 79
a_f2 to a_f0 (E1-E5A)	SV clock drift rate correction coefficient a_{f2}, a_{f1} and a_{fo} (E1,E5a)	`<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:FNAV:AF<gr0>` on page 78
E5A_DVS	Data Validity Satellite Status, transmitted on E5a (E5a_{DVS})	`<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:FNAV:E5ADVS` on page 78
E5A_HS	Signal Health Status for E5a (E5a_{HS})	`<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:FNAV:E5AHS` on page 78
K	F-NAV Almanac Scheduling start index	`<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:FNAV:K` on page 79

4.7 Marker Settings

Provides the settings necessary to define the marker output signal for synchronizing external instruments.



Marker Mode
Marker configuration for up to 4 marker channels. The settings are used to select the marker mode defining the shape and periodicity of the markers. The contents of the dialog change with the selected marker mode; the settings are self-explanatory.

"Restart" A marker signal is generated continuously. A trigger event causes a restart.
This marker marks one repetition of the ARB and depends on the parameter Duration Of Satellite Simulation.

"1PPS" A marker signal is generated for every start of second. The used timebase is displayed right to the field.
The "Pulse Width" is set in the corresponding field. The input is expressed as a number of chips.

Remote command:
`<subsystem>:TRIGger:OUTPut<ch>:PULSe:WIDTh` on page 88

"10PPS" A marker signal is generated ten times per second or once every 100 ms.

"1PP2S" A marker signal is generated for every second start of second.

"Pulse" A regular marker signal is generated. The resulting clock frequency is displayed. The value is defined by the divider.

Remote command:
`<subsystem>:TRIGger:OUTPut<ch>:PULSe:DIVider` on page 87
`<subsystem>:TRIGger:OUTPut<ch>:PULSe:FREQuency?` on page 87

"Pattern" A marker signal that is defined by a bit pattern is generated.

Remote command:
`<subsystem>:TRIGger:OUTPut<ch>:PATTern` on page 87

"ON/OFF Ratio" A regular marker signal that is defined by an on/off ratio is generated. A period lasts one ON and OFF cycle.

Remote command:
`<subsystem>:TRIGger:OUTPut<ch>:ONTime` on page 87
`<subsystem>:TRIGger:OUTPut<ch>:OFFTime` on page 87

Remote command:
`<subsystem>:TRIGger:OUTPut<ch>:MODE` on page 86

5 How to Generate a Signal with the GNSS Option

This section provides some examples of typical workflow by working with one of the basic offline options.

The generated one-satellite static GNSS signal is suitable for basic tests.

5.1 How to Generate a One-Satellite Static Generic GNSS Signal

To generate a GNSS Satellite (GPS, Galileo, GLONASS or BeiDou) signal with R&S WinIQSIM2 and save it as a waveform follow the following general steps:

1. Execute "Set To Default" to adjust the instrument's settings to a standard set of operating conditions.
2. Select the required "RF Band".
3. Select an arbitrary data or "Real Navigation Data" as "Data Source".
4. When using "Real Navigation Data", use the "Almanac > Almanac File" function. Select an almanac file.
   The navigation message is automatically formed to be conforming to this almanac file.
5. Adjust the "Oversampling" parameter to increase or decrease the sample rate used to generate the GNSS Satellite Signal
6. Adjust the "Duration of Satellites Simulation".
7. Adjust the date and the simulation time (GNSS Mean Time).
8. Select "Satellite Configurations". Configure the satellite as required, e.g. "Space Vehicle ID (SV-ID)" and "Doppler Shift".
   For disabled "Real Time Navigation Message", the "Initial Code Phase" and the "Frequency Number" of the GLONASS satellites can be configured.

   Tip: For Galileo satellites, enable "BOC(1,1)" modulation instead of "CBOC(6,1)" to reduce the sample rate required to simulate a certain period of time.
9. Set "State > on" to enable the GNSS Satellite signal generation.
10. Select the "Generate Waveform File" to save the GNSS Satellite signal to a waveform file.

5.2 How to Play a GNSS Waveform with Rohde & Schwarz Signal Generator

1. Enable the R&S WinIQSIM2 to generate a one-satellite static generic GNSS signal with constant Doppler shift.
2. Generate a waveform file.
3. Connect the R&S WinIQSIM2 to the signal generator.
4. Transfer the waveform file.
   For detailed description, refer to the R&S WinIQSIM2 user manual.
5. In the R&S WinIQSIM2, select "Baseband > ARB". Load the waveform.

   The instrument loads the waveform in the ARB generator and displays a message, that states the frequency used during signal generation ("Resulting Frequency").

   Tip: Another possibility is to find out the carrier frequency is to use "ARB Waveform Info".

   Note: The carrier frequency of a signal generator that processes a waveform generated with the R&S WinIQSIM2 has to match the value of the parameter "Resulting Frequency".
6. Select the [FREQ] key to set the frequency in the header of the instrument to the resulting frequency of the generated waveform.
7. Set the "ARB State > on" to enable signal processing.

   The signal generator processes the GNSS signal generated by the R&S WinIQSIM2.

6 Remote-Control Commands

The following commands are required for signal generation with the satellite navigation options in a remote environment. We assume that the R&S WinIQSIM2 has already been set up for remote operation in a network as described in the R&S WinIQSIM2 documentation. A knowledge about the remote control operation and the SCPI command syntax are assumed.

Conventions used in SCPI command descriptions

For a description of the conventions used in the remote command descriptions, see section "Remote Control Commands" in the R&S WinIQSIM2 user manual.

The `SOURce:BB:GPS|GALileo|GLONass|BEIDou` subsystem contains commands for configuring the GNSS standards.

Placeholder <Subsystem>

To simplify the description of the remote control commands, the placeholder `<Subsystem>` is introduced. Depending on the navigation standard used as an entry standard, replace this placeholder `<Subsystem>` with for example `SOURce:BB:GPS` for GPS.

The replacement of the place holder `<Subsystem>` is mandatory, i.e. remote control commands containing this placeholder are not recognized and accepted by the instrument.

Example:

SCPI command: `<subsystem>:STATe`

- Entry standard = GPS
  `SOURce:BB:GPS:STATe`
- Entry standard = Galileo
  `SOURce:BB:GALileo:STATe`
- Entry standard = GLONASS
  `SOURce:BB:GLONass:STATe`
- Entry standard = BeiDou
  `SOURce:BB:BEIDou:STATe`
- Invalid command
  `<Subsystem>:STAT`

Placeholder <GNSS>

The placeholder `<GNSS>` is introduced to simplify the description of group of commands with similar syntax. Depending on the navigation standard to be controlled, replace the placeholder `<GNSS>` with `GPS`, `GALileo`, `GLONass`, or `BEIDou`.

Common suffixes

The following common suffixes are used in remote commands:

Suffix	Value range	Description
SOURce<hw>	[1]	available baseband signals
OUTPut<ch>	1 .. 4	available markers
SVID<ch>	1 .. 37 for GPS satellites 1 .. 50 for Galileo satellite	distinguishes between the SV IDs **Note:** The SV ID must correspond to a healthy satellite
Satellite<st>	1	distinguishes between the satellites

The following commands specific to the satellite standards are described here:

- Programming Examples....43
- Primary Settings....43
- Navigation Data....48
- Almanac / RINEX Configuration....51
- Time Conversion Configuration....56
- Satellites Configuration and Satellites Signal Settings....60
- Navigation Message Configuration....66
- Marker Settings....86

6.1 Programming Examples

The following sections provide simple programming examples for the R&S WinIQSIM2. The purpose of the examples is to present **all** commands for a given task. In real applications, one would rather reduce the examples to an appropriate subset of commands.

The programming examples have been tested with a software tool which provides an environment for the development and execution of remote tests. To keep the examples as simple as possible, only the "clean" SCPI syntax elements are reported. Non-executable command lines (e.g. comments) start with two // characters.

At the beginning of the most remote control program, an instrument (p)reset is recommended to set the R&S WinIQSIM2 to a definite state. The commands `*RST` and `SYSTem:PRESet` are equivalent for this purpose. `*CLS` also resets the status registers and clears the output buffer.

We assume that a remote PC is connected to the instrument, the remote PC and the instrument are switched on and a connection between them is established.

6.2 Primary Settings

The following examples use GPS entry standard.

Example: Save/Recall files with user settings

This example shows how to query and load settings files, stored with the save/recall function.

```
//////////////////////////////////////////
MMEM:CDIR 'D:/settings'
SOURce1:BB:GPS:SETTing:CATalog?
// Response: gps_settings,settings
SOURce1:BB:GLONass:SETTing:CATalog?
// Response: glo_settings,settings
SOURce1:BB:GALileo:SETTing:CATalog?
// Response: gal_settings
// There are five files in the D:/settings directory:
// gps_settings.gps, settings.gps, glo_settings.glonass,
// settings.glonass and gal_settings.galileo
SOURce1:BB:GPS:SETTing:STORe 'D:/settings/gps_settings_new'
SOURce1:BB:GPS:SETTing:LOAD 'D:/settings/gps_settings'
SOURce1:BB:GPS:SETTing:DELete 'D:/settings/settings'
// Deletes the file settings.gps
SOURce1:BB:GPS:SETTing:CATalog?
// Response: gps_settings,gps_settings_new
SOURce1:BB:GLONass:SETTing:CATalog?
// Response: glo_settings,settings
```

<subsystem>:PRESet....44
<subsystem>:STATe....45
<subsystem>:RFBand....45
<subsystem>:SMODe....45
<subsystem>:SETTing:CATalog....45
[:SOURce<hw>]:BB:BEIDou:SETTing:CATalog?....45
[:SOURce<hw>]:BB:GALileo:SETTing:CATalog?....45
[:SOURce<hw>]:BB:GLONass:SETTing:CATalog?....45
[:SOURce<hw>]:BB:GPS:SETTing:CATalog?....45
<subsystem>:SETTing:STORe....46
<subsystem>:SETTing:LOAD....46
<subsystem>:SETTing:DELete....46
<subsystem>:DURation....46
<subsystem>:FILTer:OSAMpling....47
<subsystem>:WAVeform:CREate....47

<subsystem>:PRESet

Sets the parameters of the digital standard to their default values (`*RST` values specified for the commands).

Not affected is the state set with the command `SOURce<hw>:BB:<GNSS>:STATe`.

Example: `SOURce1:BB:GPS:PRESet`

Usage: Event

Manual operation: See "Set to default" on page 14

<subsystem>:STATe <State>

Enables/disables the GNSS signal simulation.

Enabling this standard disables all the other digital standards and digital modulation modes.

Parameters:

<State> 0 | 1 | OFF | ON
*RST: 0

Example: `SOURce1:BB:GPS:STATe ON`

Manual operation: See "State" on page 14

<subsystem>:RFBand <RfBand>

Selects the RF band.

Parameters:

<RfBand> L1 | L2
Available values depend on selected standard.
*RST: L1

Example: `SOURce1:BB:GPS:RFBand L1`

Manual operation: See "RF Band" on page 15

<subsystem>:SMODe <SMode>

Selects the simulation mode.

Parameters:

<SMode> STATic
*RST: STATic

Manual operation: See "Simulation Mode" on page 16

<subsystem>:SETTing:CATalog
[:SOURce<hw>]:BB:BEIDou:SETTing:CATalog?
[:SOURce<hw>]:BB:GALileo:SETTing:CATalog?
[:SOURce<hw>]:BB:GLONass:SETTing:CATalog?
[:SOURce<hw>]:BB:GPS:SETTing:CATalog?

Reads out the files with GNSS settings in the default directory, set with the command `MMEM:CDIRectory`.

Listed are files with the file extension `.gps`, `.galileo`, `.glonass` and `.bdu`.

Return values:

<Catalog> string

Example: See Example "Save/Recall files with user settings" on page 44.

Usage: Query only

Manual operation: See "Save/Recall" on page 15

<subsystem>:SETTing:STORe <Filename>

Stores the current settings into the selected file; the file extension is assigned automatically.

Setting parameters:

<Filename> string

Filename or complete file path

Example: See Example "Save/Recall files with user settings" on page 44.

Usage: Setting only

Manual operation: See "Save/Recall" on page 15

<subsystem>:SETTing:LOAD <Filename>

Loads the selected file with GNSS settings form the directory set with the command `MMEM:CDIRectory`. A path can also be specified, in which case files in the specified directory are read. Loaded are files with the file extension `*.gps`, `*.galileo`, `*.glonass` or `*.bdu`.

Setting parameters:

<Filename> string

Example: See Example "Save/Recall files with user settings" on page 44.

Usage: Setting only

Manual operation: See "Save/Recall" on page 15

<subsystem>:SETTing:DELete <Filename>

Deletes the selected file with GNSS settings.

Setting parameters:

<Filename> string

Example: See Example "Save/Recall files with user settings" on page 44.

Usage: Setting only

Manual operation: See "Save/Recall" on page 15

<subsystem>:DURation <Duration>

Determines the duration of the satellite simulation.

The resulting duration of the simulation is calculated as follows:

$$Duration\ of\ Simulation = \frac{Duration\ of\ Satellite\ Simulation}{1 + \frac{Doppler\ Shift}{F_{Carrier}}}$$

Where $F_{Carrier}$ is the frequency set with the command `<subsystem>:RFBand`.

The maximum duration of satellite simulation depends on the oversampling factor and the ARB memory size of the connected instrument.

Parameters:

<Duration> float

Range: 20E-3 to 64
Increment: 1E-3
*RST: 1

Example: `SOUR:BB:GPS:DUR 20`
Sets 20 ms for the satellite simulation.

Manual operation: See "Duration Of Satellite Simulation" on page 16

<subsystem>:FILTer:OSAMpling <OSampling>

Determines the upsampling factor.

A higher upsampling factor improves the filtering but increases the waveform size proportionally. This leads to limitation for the maximum "Duration Of Satellite Simulation".

Parameters:

<OSampling> integer

Range: 2 to 32
*RST: 2

Manual operation: See "Oversampling" on page 16

<subsystem>:WAVeform:CREate <Filename>

Stores the current settings as an ARB signal in a waveform file (`*.wv`).

Setting parameters:

<Filename> string

Filename or complete file path; file extension is assigned automatically

Example:
```
MMEM:CDIR 'D:\user\waveform
BB:GPS:WAV:CRE 'gnss_1'
```

Usage: Setting only

Manual operation: See "Generate Waveform File" on page 15

6.3 Navigation Data

Example: Selecting real navigation data

The following example uses GPS entry standard.

```
SOURce1:BB:GPS:NAVigation:DATA RND
SOURce1:BB:GPS:NAVigation:ALMAnac:GPS:FILE "GPS_SEM585.txt"
SOURce1:BB:GPS:NAVigation:SIMulation:TBASis UTC
SOURce1:BB:GPS:NAVigation:SIMulation:DATE?
//Response: 2008,7,13
SOURce1:BB:GPS:NAVigation:SIMulation:TIME?
//Response: 17,4,0
SOURce1:BB:GPS:NAVigation:SIMulation:TBASis GPS
SOURce1:BB:GPS:NAVigation:SIMulation:WNUMber?
//Response: 1488
SOURce1:BB:GPS:NAVigation:SIMulation:TOWeek?
//Response: 61455
```

<subsystem>:NAVigation:DATA 48
<subsystem>:NAVigation:DATA:DSELect 49
<subsystem>:NAVigation:DATA:PATTern 49
<subsystem>:NAVigation:SIMulation:TBASis 49
<subsystem>:NAVigation:SIMulation:DATE 49
<subsystem>:NAVigation:SIMulation:TIME 50
<subsystem>:NAVigation:SIMulation:WNUMber 50
<subsystem>:NAVigation:SIMulation:TOWeek 50

<subsystem>:NAVigation:DATA <Data>

Sets the data source for the navigation information.

Parameters:

<Data> ZERO | ONE | PATTern | PN9 | PN11 | PN15 | PN16 | PN20 | PN21 | PN23 | DLISt | RNData | ZNData

RNData
Real navigation data provided by an almanac file.
Use the command `<subsystem>:NAVigation:ALMAnac:<GNSS>:FILE` to select the almanac file.

ZNData
Zero Navigation Data
Navigation data with the ephemeris, almanac and satellite clock correction parameters set to zero.

ZERO | ONE| PATTern | PNxx | DLISt
Standard data sources (a sequence of 0 or 1, a pseudo-random sequence with different length, a pattern or a data list)

*RST: RNData

Example: See Example "Selecting real navigation data" on page 48.

Manual operation: See "Data Source" on page 17

<subsystem>:NAVigation:DATA:DSELect <DSelect>

Selects an existing data list file from the default directory or from the specific directory.

Parameters:

<DSelect> string

Filename incl. file extension or complete file path

Example:
```
SOURce1:BB:GPS:NAVigation:DATA DLIS
SOURce1:BB:GPS:NAVigation:DATA:DLISt "D:
\temp\GNSS_list1"
```

Manual operation: See "Data Source" on page 17

<subsystem>:NAVigation:DATA:PATTern <Pattern>

Determines the bit pattern for `<subsystem>:NAVigation:DATA`PATTern.

Parameters:

<Pattern> 64 bit pattern

Example:
```
SOURce1:BB:GPS:NAVigation:DATA PATTern
SOURce1:BB:GPS:NAVigation:DATA:PATTern #H3F,8
```

Manual operation: See "Data Source" on page 17

<subsystem>:NAVigation:SIMulation:TBASis <SystemTime>

Determines the time basis used to enter the simulation start time.

Parameters:

<SystemTime> UTC | GPS | GST | GLO | BDT

*RST: UTC

Example: See Example "Selecting real navigation data" on page 48.

Manual operation: See "Simulation Start Time" on page 18

<subsystem>:NAVigation:SIMulation:DATE <Year>, <Month>, <Day>

Defines the date for the simulation in `DD.MM.YYYY` format of the Gregorian calendar.

This setting is only available for `<subsystem>:NAVigation:DATA` set to `RNData` and `<subsystem>:NAVigation:SIMulation:TBASis` set to `UTC`.

Parameters:

<Year> integer

Range: 1980 to 9999

<Month> integer

Range: 1 to 12

<Day> integer
Range: 1 to 31

Example: See Example "Selecting real navigation data" on page 48.

Manual operation: See "Simulation Start Time" on page 18

<subsystem>:NAVigation:SIMulation:TIME <Hour>, <Minute>, <Second>

For `<subsystem>:NAVigation:DATARNData` and `<subsystem>:NAVigation:SIMulation:TBASisUTC`, sets the simulation start time in UTC time format.

Parameters:

<Hour> integer
Range: 0 to 23

<Minute> integer
Range: 0 to 59

<Second> float
Range: 0 to 59.999
Increment: 0.001

Example: See Example "Selecting real navigation data" on page 48.

Manual operation: See "Simulation Start Time" on page 18

<subsystem>:NAVigation:SIMulation:WNUMber <Week>

Enters the week number (WN) the navigation signal is generated for.

This setting is only available for `<subsystem>:NAVigation:SIMulation:TBASis` set to `GPS` or `GST` and `<subsystem>:NAVigation:DATA` set to `RNData`.

Parameters:

<Week> integer
The weeks are numbered starting from a reference time point (WN_REF=0), that depends on the navigation standard.
Range: 0 to 9999*53
*RST: 0

Example: See Example "Selecting real navigation data" on page 48.

Manual operation: See "Simulation Start Time" on page 18

<subsystem>:NAVigation:SIMulation:TOWeek <TOW>

Defines the simulation start time within the defined week (see `<subsystem>:NAVigation:SIMulation:WNUMber`).

This setting is only available for `<subsystem>:NAVigation:SIMulation:TBASis` set to `GPS` or `GST`.

Parameters:

<TOW> float

Number of seconds since the beginning of the week

Range: 0 to 604799.999
Increment: 0.001
*RST: 0

Example: See Example "Selecting real navigation data" on page 48.

Manual operation: See "Simulation Start Time" on page 18

6.4 Almanac / RINEX Configuration

Example: Selecting an Almanac file

The following examples use GPS entry standard. It is assumed, that an RF band common for the GNSS standards is selected.

```
SOURce1:BB:GPS:NAVigation:ALManac:GPS:FILE 'GPS_SEM585.txt'
SOURce1:BB:GPS:SVID:GPS:LIST?
//Response:1
```

Some commands of the following description do not apply to the GLONASS satellites. If so, it is explicitly pointed out.

<subsystem>:NAVigation:ALManac:<GNSS>:FILE....52
<subsystem>:NAVigation:ALManac:BEIDou:FILE....52
<subsystem>:NAVigation:ALManac:GALileo:FILE....52
<subsystem>:NAVigation:ALManac:GLONass:FILE....52
<subsystem>:NAVigation:ALManac:GPS:FILE....52
<subsystem>:NAVigation:ALManac:<GNSS>:SPAN?....52
<subsystem>:NAVigation:ALManac:BEIDou:SPAN?....52
<subsystem>:NAVigation:ALManac:GALileo:SPAN?....52
<subsystem>:NAVigation:ALManac:GPS:SPAN?....52
<subsystem>:NAVigation:ALManac:<GNSS>:DATE:BEGIn....53
<subsystem>:NAVigation:ALManac:BEIDou:DATE:BEGin?....53
<subsystem>:NAVigation:ALManac:GALileo:DATE:BEGin?....53
<subsystem>:NAVigation:ALManac:GPS:DATE:BEGin?....53
<subsystem>:NAVigation:ALManac:<GNSS>:DATE:END....53
<subsystem>:NAVigation:ALManac:BEIDou:DATE:END?....53
<subsystem>:NAVigation:ALManac:GALileo:DATE:END?....53
<subsystem>:NAVigation:ALManac:GPS:DATE:END?....53
<subsystem>:NAVigation:ALManac:GLONass:TOAPplicability:DATE?....53
<subsystem>:NAVigation:ALManac:GLONass:TOAPplicability:TIME?....54
<subsystem>:NAVigation:ALManac:<GNSS>:TOAPplicability:TOWeek....55
<subsystem>:NAVigation:ALManac:BEIDou:TOAPplicability:TOWeek?....55

<subsystem>:NAVigation:ALMAnac:GALileo:TOAPplicability:TOWeek?....55
<subsystem>:NAVigation:ALMAnac:GPS:TOAPplicability:TOWeek?....55
<subsystem>:NAVigation:ALMAnac:<GNSS>:TOAPplicability:WNUMber....55
<subsystem>:NAVigation:ALMAnac:BEIDou:TOAPplicability:WNUMber?....55
<subsystem>:NAVigation:ALMAnac:GALileo:TOAPplicability:WNUMber?....55
<subsystem>:NAVigation:ALMAnac:GPS:TOAPplicability:WNUMber?....55
<subsystem>:NAVigation:ALMAnac:<GNSS>:WNUMber....55
<subsystem>:NAVigation:ALMAnac:BEIDou:WNUMber?....55
<subsystem>:NAVigation:ALMAnac:GALileo:WNUMber?....55
<subsystem>:NAVigation:ALMAnac:GPS:WNUMber?....55
<subsystem>:SVID:<GNSS>:LIST....55
<subsystem>:SVID<ch>:SBAS:LIST?....55
<subsystem>:SVID<ch>:BEIDou:LIST?....56
<subsystem>:SVID<ch>:GALileo:LIST?....56
<subsystem>:SVID<ch>:GLONass:LIST?....56
<subsystem>:SVID<ch>:GPS:LIST?....56

<subsystem>:NAVigation:ALMAnac:<GNSS>:FILE
<subsystem>:NAVigation:ALMAnac:BEIDou:FILE <Almanac>
<subsystem>:NAVigation:ALMAnac:GALileo:FILE <Almanac>
<subsystem>:NAVigation:ALMAnac:GLONass:FILE <Almanac>
<subsystem>:NAVigation:ALMAnac:GPS:FILE <Almanac>

Defines the almanac file for the navigation standard.

Parameters:

<Almanac> string

The filename is sufficient to select a predefined almanac file or almanacs in the default directory.
The complete file path with filename and extension is required to select almanac files stored elsewhere.

Example: See Example "Selecting an Almanac file" on page 51.

<subsystem>:NAVigation:ALMAnac:<GNSS>:SPAN?
<subsystem>:NAVigation:ALMAnac:BEIDou:SPAN?
<subsystem>:NAVigation:ALMAnac:GALileo:SPAN?
<subsystem>:NAVigation:ALMAnac:GPS:SPAN?

Queries the time span of the selected almanac file.

Return values:

<Span> <Start date and time> - <End date and time>

Almanac file span, where the start and end date and time strings follow the syntax `<DD.MM.YYYY HH:MM:SS>`

Example:
```
SOURce1:BB:GPS:NAVigation:ALMAnac:GPS:SPAN?
// "16.02.2014 00:00:00 - 23.02.2014 23:59:59"
```

Usage: Query only

<subsystem>:NAVigation:ALMAnac:<GNSS>:DATE:BEGIn
<subsystem>:NAVigation:ALMAnac:BEIDou:DATE:BEGin?
<subsystem>:NAVigation:ALMAnac:GALileo:DATE:BEGin?
<subsystem>:NAVigation:ALMAnac:GPS:DATE:BEGin?

Queries the start date of the week span of the selected almanac file for the navigation standard. The file is selected using `<subsystem>:NAVigation:ALMAnac:<GNSS>:FILE`.

Return values:

<Year> integer
Range: 1980 to 9999

<Month> integer
Range: 1 to 12

<Day> integer
Range: 1 to 31

Example: `BB:GPS:NAV:ALM:GAL:DATE:BEG?`
Response: `2010,11,07`

Usage: Query only

<subsystem>:NAVigation:ALMAnac:<GNSS>:DATE:END
<subsystem>:NAVigation:ALMAnac:BEIDou:DATE:END?
<subsystem>:NAVigation:ALMAnac:GALileo:DATE:END?
<subsystem>:NAVigation:ALMAnac:GPS:DATE:END?

Queries the end date of the week span of the selected almanac file for the navigation standard. The file is selected using `<subsystem>:NAVigation:ALMAnac:<GNSS>:FILE`.

Return values:

<Year> integer
Range: 1980 to 9999

<Month> integer
Range: 1 to 12

<Day> integer
Range: 1 to 31

Example: `BB:GPS:NAV:ALM:GAL:DATE:END?`
Response: `2010,11,14`

Usage: Query only

<subsystem>:NAVigation:ALMAnac:GLONass:TOAPplicability:DATE?

Queries the date of applicability of the selected almanac file for the navigation standard.

Note: This setting is available for Glonass. It is no longer supported for GPS and Galileo satellites. To get the applicability data of GPS and Galileo satellites, refer to the commands `<subsystem>:NAVigation:ALMAnac:<GNSS>:TOAPplicability:TOWeek` on page 55 and `<subsystem>:NAVigation:ALMAnac:<GNSS>:TOAPplicability:WNUMber` on page 55.

Return values:

<Year> integer
Range: 1996 to 9999

<Month> integer
Range: 1 to 12

<Day> integer
Range: 1 to 31

Example: `BB:GPS:NAV:ALM:GLON:TOAP:DATE?`
Response: `2010,11,07`

Usage: Query only

Manual operation: See "Almanac Configuration" on page 20

<subsystem>:NAVigation:ALMAnac:GLONass:TOAPplicability:TIME?

Queries the start time of applicability of the selected almanac file for the navigation standard.

Note: This setting is available for Glonass. It is no longer supported for GPS and Galileo satellites. To get the applicability data of GPS and Galileo satellites, refer to the commands `<subsystem>:NAVigation:ALMAnac:<GNSS>:TOAPplicability:TOWeek` on page 55 and `<subsystem>:NAVigation:ALMAnac:<GNSS>:TOAPplicability:WNUMber` on page 55.

Return values:

<Hour> integer
Range: 0 to 23

<Minute> integer
Range: 0 to 59

<Second> float
Range: 0 to 59.999
Increment: 0.001

Example: `BB:GPS:NAV:ALM:GLON:TOAP:TIME?`
Response: `17,0,0`

Usage: Query only

Manual operation: See "Almanac Configuration" on page 20

<subsystem>:NAVigation:ALMAnac:<GNSS>:TOAPplicability:TOWeek
<subsystem>:NAVigation:ALMAnac:BEIDou:TOAPplicability:TOWeek?
<subsystem>:NAVigation:ALMAnac:GALileo:TOAPplicability:TOWeek?
<subsystem>:NAVigation:ALMAnac:GPS:TOAPplicability:TOWeek?

Determines the Time of Week (TOW) the selected almanac is used for (time of applicability).

Return values:

<Tow> float

Range: 0 to 604799.999
Increment: 0.001
*RST: 0

Usage: Query only

<subsystem>:NAVigation:ALMAnac:<GNSS>:TOAPplicability:WNUMber
<subsystem>:NAVigation:ALMAnac:BEIDou:TOAPplicability:WNUMber?
<subsystem>:NAVigation:ALMAnac:GALileo:TOAPplicability:WNUMber?
<subsystem>:NAVigation:ALMAnac:GPS:TOAPplicability:WNUMber?

Determines the Week Number for which the selected almanac is used for (time of applicability).

Return values:

<WN> integer

Range: 0 to 9999.0*53
*RST: 1488

Usage: Query only

<subsystem>:NAVigation:ALMAnac:<GNSS>:WNUMber
<subsystem>:NAVigation:ALMAnac:BEIDou:WNUMber?
<subsystem>:NAVigation:ALMAnac:GALileo:WNUMber?
<subsystem>:NAVigation:ALMAnac:GPS:WNUMber?

Queries the week number of the selected almanac file for the navigation standard. The file is selected using `<subsystem>:NAVigation:ALMAnac:<GNSS>:FILE`.

Return values:

<WeekNumber> integer

Range: 0 to 529947
*RST: 1488

Example: `BB:GPS:NAV:ALM:GPS:WNUM?`
Response: `585`

Usage: Query only

<subsystem>:SVID:<GNSS>:LIST
<subsystem>:SVID<ch>:SBAS:LIST?

<subsystem>:SVID<ch>:BEIDou:LIST?
<subsystem>:SVID<ch>:GALileo:LIST?
<subsystem>:SVID<ch>:GLONass:LIST?
<subsystem>:SVID<ch>:GPS:LIST?

Queries the list of valid satellites (SV IDs) of the selected almanac file for the navigation standard.

To select the file, use the command `<subsystem>:NAVigation:ALManac:<GNSS>:FILE`.

Example: See Example "Selecting an Almanac file" on page 51.

Usage: Query only

6.5 Time Conversion Configuration

Example: Configuring the time conversion and leap seconds settings

The following example uses GPS entry standard.

```
SOURce1:BB:GPS:PRESet
SOURce1:BB:GPS:SMOD USER
SOURce1:BB:GPS:NAVigation:TCONversion:GPS:AZERo?
//Response: 0
SOURce1:BB:GPS:NAVigation:TCONversion:GPS:AONE?
//Response: 0
SOURce1:BB:GPS:NAVigation:TCONversion:GPS:TOT?
//Response: 0
SOURce1:BB:GPS:NAVigation:TCONversion:GPS:WNOT?
//Response: 0
SOURce1:BB:GPS:NAVigation:TCONversion:LEAP:SYNC
```

<subsystem>:NAVigation:TCONversion:<GNSS>:AONE....57
<subsystem>:NAVigation:TCONversion:BEIDou:AONE....57
<subsystem>:NAVigation:TCONversion:GALileo:AONE....57
<subsystem>:NAVigation:TCONversion:GLONass:AONE....57
<subsystem>:NAVigation:TCONversion:GPS:AONE....57
<subsystem>:NAVigation:TCONversion:<GNSS>:AZERo....57
<subsystem>:NAVigation:TCONversion:BEIDou:AZERo....57
<subsystem>:NAVigation:TCONversion:GALileo:AZERo....57
<subsystem>:NAVigation:TCONversion:GLONass:AZERo....57
<subsystem>:NAVigation:TCONversion:GPS:AZERo....57
<subsystem>:NAVigation:TCONversion:<GNSS>:TOT....57
<subsystem>:NAVigation:TCONversion:BEIDou:TOT....57
<subsystem>:NAVigation:TCONversion:GALileo:TOT....57
<subsystem>:NAVigation:TCONversion:GLONass:TOT....58
<subsystem>:NAVigation:TCONversion:GPS:TOT....58
<subsystem>:NAVigation:TCONversion:<GNSS>:WNOT....58
<subsystem>:NAVigation:TCONversion:BEIDou:WNOT....58

<subsystem>:NAVigation:TCONversion:GALileo:WNOT 58
<subsystem>:NAVigation:TCONversion:GLONass:WNOT 58
<subsystem>:NAVigation:TCONversion:GPS:WNOT 58
<subsystem>:NAVigation:TCONversion:UTCSu:AONE 58
<subsystem>:NAVigation:TCONversion:UTCSu:AZERo 58
<subsystem>:NAVigation:TCONversion:UTCSu:DATE? 59
<subsystem>:NAVigation:TCONversion:LEAP:SEConds 59
<subsystem>:NAVigation:TCONversion:LEAP:SYNC 59

<subsystem>:NAVigation:TCONversion:<GNSS>:AONE
<subsystem>:NAVigation:TCONversion:BEIDou:AONE <AOne>
<subsystem>:NAVigation:TCONversion:GALileo:AONE <AOne>
<subsystem>:NAVigation:TCONversion:GLONass:AONE <AOne>
<subsystem>:NAVigation:TCONversion:GPS:AONE <AOne>

For `<subsystem>:SMODeSTATic` or `USER`, defines the first order term of polynomial, A_1.

Parameters:

<AOne>
integer
Range: -8388608 to 8388607
*RST: 0

Example: See Example "Configuring the time conversion and leap seconds settings" on page 56.

Manual operation: See "Time Conversion Parameters" on page 22

<subsystem>:NAVigation:TCONversion:<GNSS>:AZERo
<subsystem>:NAVigation:TCONversion:BEIDou:AZERo <AZero>
<subsystem>:NAVigation:TCONversion:GALileo:AZERo <AZero>
<subsystem>:NAVigation:TCONversion:GLONass:AZERo <AZero>
<subsystem>:NAVigation:TCONversion:GPS:AZERo <AZero>

For `<subsystem>:SMODeSTATic` or `USER`, defines the constant term of polynomial, A_0.

Parameters:

<AZero>
integer
Range: -2147483648 to 2147483647
*RST: 0

Example: See Example "Configuring the time conversion and leap seconds settings" on page 56.

Manual operation: See "Time Conversion Parameters" on page 22

<subsystem>:NAVigation:TCONversion:<GNSS>:TOT
<subsystem>:NAVigation:TCONversion:BEIDou:TOT <Tot>
<subsystem>:NAVigation:TCONversion:GALileo:TOT <Tot>

<subsystem>:NAVigation:TCONversion:GLONass:TOT <Tot>
<subsystem>:NAVigation:TCONversion:GPS:TOT <Tot>

For `<subsystem>:SMODeSTATic` or `USER`, defines the UTC data reference time of week, t_{ot}.

Parameters:

<Tot> integer

Range: 0 to 255
*RST: 0

Example: See Example "Configuring the time conversion and leap seconds settings" on page 56.

Manual operation: See "Time Conversion Parameters" on page 22

<subsystem>:NAVigation:TCONversion:<GNSS>:WNOT
<subsystem>:NAVigation:TCONversion:BEIDou:WNOT <Wnot>
<subsystem>:NAVigation:TCONversion:GALileo:WNOT <Wnot>
<subsystem>:NAVigation:TCONversion:GLONass:WNOT <Wnot>
<subsystem>:NAVigation:TCONversion:GPS:WNOT <Wnot>

For `<subsystem>:SMODeSTATic` or `USER`, defines the UTC data reference week number, WN_t.

Parameters:

<Wnot> integer

Range: 0 to 255
*RST: 0

Example: See Example "Configuring the time conversion and leap seconds settings" on page 56.

Manual operation: See "Time Conversion Parameters" on page 22

<subsystem>:NAVigation:TCONversion:UTCSu:AONE <A_1>

Defines the first order term of polynomial, A_1.

Parameters:

<A_1> integer

Range: -512 to 511
*RST: 0

Options: R&S SMx-K294

Manual operation: See "UTC-UTC(SU)" on page 22

<subsystem>:NAVigation:TCONversion:UTCSu:AZERo <A_0>

Defines the constant term of polynomial, A_0.

Parameters:

<A_0> integer

Range: -1024 to 1023
*RST: 0

Options: R&S SMx-K294

Manual operation: See "UTC-UTC(SU)" on page 22

<subsystem>:NAVigation:TCONversion:UTCSu:DATE?

Enters the date for the UTC-UTC(SU) data in DMS format.

Return values:

<Year> integer

Range: 1996 to 9999

<Month> integer

Range: 1 to 12

<Day> integer

Range: 1 to 31

Usage: Query only

Options: R&S SMx-K294

Manual operation: See "UTC-UTC(SU)" on page 22

<subsystem>:NAVigation:TCONversion:LEAP:SEConds <LeapSeconds>

Defines the currently used leap second.

Parameters:

<LeapSeconds> integer

Range: 0 to 50
*RST: 16

Example: See Example "Configuring the time conversion and leap seconds settings" on page 56.

Manual operation: See "Leap Second Configuration" on page 22

<subsystem>:NAVigation:TCONversion:LEAP:SYNC

Synchronizes the leap second according to the simulation time.

Example: See Example "Configuring the time conversion and leap seconds settings" on page 56.

Usage: Event

Manual operation: See "Leap Second Configuration" on page 22

6.6 Satellites Configuration and Satellites Signal Settings

Example: Configuring the satellite's constellation

The following example uses GPS entry standard.

```
SOURce1:BB:GPS:PRESet
SOURce1:BB:GPS:SATellite:COUNt 1

SOURce1:BB:GPS:SATellite1:STANdard?
//Response: GPS
SOURce1:BB:GPS:SATellite1:SIGNal?
//Response: CAC
SOURce1:BB:GPS:SATellite1:SVID?
//Response: 30
SOURce1:BB:GPS:SATellite1:SCRate?
//Response: 1023000
SOURce1:BB:GPS:SATellite1:MODulation?
//Response: BPSK
SOURce1:BB:GPS:SATellite1:PRANge?
//Response: 20531267.5147461
SOURce1:BB:GPS:SATellite1:TSHift?
//Response: 70060.0902627953
SOURce1:BB:GPS:SATellite1:DSHift?
//Response: 1146.05037064872
SOURce1:BB:GPS:SATellite1:ICPHase?
//Response: 6.25362425028864
SOURce1:BB:GPS:SATellite1:FREQuency?
//Response: 1575421146.05037
SOURce1:BB:GPS:SATellite1:CACRate?
//Response: 1023000.74418801
SOURce1:BB:GPS:SVID19:GPS:MPAT:STATe?
//Response: 0
SOURce1:BB:GPS:SATellite1:STATe?
//Response: 1

SOURce1:BB:GPS:STATe ON
```

<subsystem>:SPReading[:STATe] 61
<subsystem>:GALModulation 61
<subsystem>:SATellite:COUNt 61
<subsystem>:SATellite<st>:CACRate? 61
<subsystem>:SATellite<st>:DSHift 62
<subsystem>:SATellite<st>:FNUMber 62
<subsystem>:SATellite<st>:FREQuency? 62
<subsystem>:SATellite<st>:CPHase 63
<subsystem>:SATellite<st>:ICPHase 63
<subsystem>:SATellite<st>:MODulation? 63
<subsystem>:SATellite<st>:ORBit? 63
<subsystem>:SATellite<st>:PRANge 64

<subsystem>:SATellite<st>:SCRate? 64
<subsystem>:SATellite<st>:SIGNal 64
<subsystem>:SATellite<st>:STANdard 65
<subsystem>:SATellite<st>:STATe 65
<subsystem>:SATellite<st>:SVID 65
<subsystem>:SATellite<st>:TSHift 65

<subsystem>:SPReading[:STATe] <State>

If `<subsystem>:SMODeSTATic`, activates spreading.

If spreading is deactivated, the pure navigation data is modulated onto the RF carrier.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 1

Example:
```
BB:GPS:SMOD STAT
BB:GPS:SPR:STAT ON
```

Manual operation: See "Use Spreading" on page 24

<subsystem>:GALModulation <Modulation>

Defines the modulation mode used for modulating the Galileo carrier signal.

Parameters:

<Modulation> BOC | CBOC

*RST: CBOC

Manual operation: See "Galileo Sat. Modulation" on page 24

<subsystem>:SATellite:COUNt <SatCount>

Defines the maximum number of satellites that can be simulated.

The number of satellites determines the value range of the suffix for `<subsystem>:SATellite<st>` commands.

Parameters:

<SatCount> integer

Range: 1 to 12

*RST: 1

Example: See Example "Configuring the satellite's constellation" on page 60.

Manual operation: See "Maximum Number of Satellites" on page 25

<subsystem>:SATellite<st>:CACRate?

Queries the currently valid values for the chip rate.

Return values:
<CACRate> float
Default unit: Hz

Example: See Example "Configuring the satellite's constellation" on page 60.

Usage: Query only

Manual operation: See "Resulting Start Chip Rate" on page 28

<subsystem>:SATellite<st>:DSHift <DopplerShift>

Sets the Doppler shift of the simulated signal of the satellite.

Parameters:
<DopplerShift> float
Range: -100E3 to 100E3
Increment: 0.01
*RST: 0
Default unit: Hz

Example: See Example "Configuring the satellite's constellation" on page 60.

Manual operation: See "Doppler Shift" on page 27

<subsystem>:SATellite<st>:FNUMber <FrequencyNumber>

Sets the frequency number, depending on the used data source. The parameter corresponds to the subcarrier used to modulate the GLONASS satellite.

Parameters:
<FrequencyNumber> integer
Range: -7 to 24
*RST: 0

Manual operation: See "Frequency Number" on page 26

<subsystem>:SATellite<st>:FREQuency?

Queries the currently valid values for Doppler shifted carrier frequency.

Return values:
<Frequency> float
Default unit: Hz

Example: See Example "Configuring the satellite's constellation" on page 60.

Usage: Query only

Manual operation: See "Resulting Start Frequency" on page 28

<subsystem>:SATellite<st>:CPHase <Code>

Sets the initial code phase in chips while working in static simulation mode and using arbitrary navigation data source.

Parameters:

<Code> float

Range: 0 to 20459.99
Increment: 0.01
*RST: 0

Manual operation: See "Initial Code Phase" on page 27

<subsystem>:SATellite<st>:ICPHase <ICPhase>

Sets the initial carrier phase.

This setting is only available for `<subsystem>:SMODeSTATic`. The parameter is updated automatically for `USER` and `AUTO`.

Parameters:

<ICPhase> float

Range: 0 to 6.28
Increment: 0.01
*RST: 0

Example: See Example "Configuring the satellite's constellation" on page 60.

Manual operation: See "Initial Carrier Phase " on page 27

<subsystem>:SATellite<st>:MODulation?

Queries the modulation used for modulating the carrier signal.

Return values:

<Modulation> BPSK | CBOC

*RST: BPSK

Example: See Example "Configuring the satellite's constellation" on page 60.

Usage: Query only

Manual operation: See "Modulation" on page 26

<subsystem>:SATellite<st>:ORBit?

For BeiDou satellites, querries the orbit type the corresponding satellite is using.

Return values:

<OrbitType> MEO | IGSO | GEO

*RST: GEO

Example: See Example "Configuring the satellite's constellation" on page 60.

Usage: Query only

Manual operation: See "Orbit Type" on page 26

<subsystem>:SATellite<st>:PRANge <Pseudorange>

For `<subsystem>:SMODeSTATic`, defines the propagation delay from satellite to receiver in meters.

Parameters:

<Pseudorange> float

Range: 0 to (2.499E6)/1.023E6*SPEED_OF_LIGHT
Increment: 0.001
*RST: 0
Default unit: m

Example: See Example "Configuring the satellite's constellation" on page 60.

Manual operation: See "Pseudorange" on page 27

<subsystem>:SATellite<st>:SCRate?

Queries the standard chip rate.

Return values:

<ChipRate> float

Default unit: Hz

Example: See Example "Configuring the satellite's constellation" on page 60.

Usage: Query only

Manual operation: See "Standard Chip Rate" on page 26

<subsystem>:SATellite<st>:SIGNal <Signal>

Selects the type of signal the corresponding satellite is using.

Parameters:

<Signal> CACode | E1Def | RCA | B1CA

*RST: CACode

Example: See Example "Configuring the satellite's constellation" on page 60.

Manual operation: See "Signals" on page 25

<subsystem>:SATellite<st>:STANdard <Standard>

Parameters:

<Standard> GPS | GALileo | GLONass | BEIDou

*RST: GPS

Example: See Example "Configuring the satellite's constellation" on page 60.

Manual operation: See "Standard" on page 25

<subsystem>:SATellite<st>:STATe <State>

Activates/deactivates the satellite.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: See Example "Configuring the satellite's constellation" on page 60.

Manual operation: See "Satellite State" on page 25

<subsystem>:SATellite<st>:SVID <Svid>

Defines the Space Vehicle ID of the satellite to be simulated. This value is used to generate the corresponding spreading code.

For `<subsystem>:NAVigation:DATA:RNData`, only the valid IDs which are listed in the almanac are selectable; for arbitrary data, any ID can be selected.

Parameters:

<Svid> integer

Range: 1 to 210

*RST: 1

`SV ID = -1` corresponds to the manual selection "N.A. (not assigned)"

Example: See Example "Configuring the satellite's constellation" on page 60.

Manual operation: See "SV-ID/PRN" on page 25

<subsystem>:SATellite<st>:TSHift <TimeShift>

Defines the propagation delay from satellite to receiver.

Parameters:

<TimeShift> float

Time shift in chips

Range: 0 to 2499999.999
Increment: 0.001
*RST: 0

Example: See Example "Configuring the satellite's constellation" on page 60.

Manual operation: See "Time Shift/ chips" on page 27

6.7 Navigation Message Configuration

<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:CCORection:AF<gr0>....69
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:CCORrection:AF<gr0>....69
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:CCORrection:AF<gr0>....69
<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:CCORection:TGD....69
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:CCORrection:TGD<gr>....69
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<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:IODA....73
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<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:IODC....73
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<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:IDOE....73
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:IODE....73
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:IODE....73
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:IODNav....74
<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:IZERo....74
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:IZERo....74
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:IZERo....74
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:IZERo....74
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:LTPData....74
<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:MZERo....74
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:MZERo....74
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:MZERo....75
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<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:NDELta....75
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:NDELta....75
<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:ODOT....75
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:ODOT....75
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:ODOT....75
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:ODOT....75
<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:OMEGa....75
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:OMEGa....75
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<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:OMEGa....75
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<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:OZERo....76
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<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:OZERo....76
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:SF1Reserved<gr>....76
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:SISA....76
<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:SQRA....76
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<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:SQRA....77
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<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:SVConfig....77
<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:TOE....77
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<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:URA....77
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:URA....77
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:URA....77
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:FNAV:AF<gr0>....78
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:FNAV:BGD....78
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:FNAV:E5ADVS....78
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:FNAV:E5AHS....78
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:FNAV:K....79
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:FNAV:TOC....79
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:INAV:AF<gr0>....79
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:INAV:BGD....79
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<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:INAV:E1BHS....80
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:INAV:E5BDVS....80
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:INAV:E5BHS....80
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:INAV:TOC....81
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<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:CCORrection:EN....81
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:CCORrection:GAMN....81
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:CCORrection:TAUN....82
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<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:HEALth....82
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<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:SEType....83
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<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:YDDN....85
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:ZDDN....85
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:XDN....85
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:YDN....85
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:ZDN....85

<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:CCORection:AF<gr0>
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:CCORrection:AF<gr0>
<Af>
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:CCORrection:AF<gr0>
<Af>

Defines the clock correction parameters a_f2, a_f1, a_f0.

Suffix:
<gr0> 0 | 1 | 2

Parameters:
<Af> integer

Value range (GPS parameters):
a_f2 = -2^7 to 2^7-1; a_f1 = -2^{15} to $2^{15}-1$; a_f0 = -2^{21} to $2^{21}-1$
Value range (BeiDou parameters):
a_f2 = -2^{10} to $2^{10}-1$; a_f1 = -2^{21} to $2^{21}-1$; a_f0 = -2^{23} to $2^{23}-1$

*RST: 0

<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:CCORection:TGD
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:CCORrection:TGD<gr>
<Tgd>
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:CCORrection:TGD <Tgd>

Defines the L1-L2 correction term.

Parameters:
<Tgd> integer

GPS parameter

Range: -128 to 127
*RST: 0

<Tgd> integer

BeiDou parameter

Range: -512 to 511
Increment: 1
*RST: 0

Example:
```
SOURce1:BB:GPS:SVID1:GPS:NMESsage:PAGE1:
CCORrection:TGD 10
```

<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:CCORection:TOC
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:CCORrection:TOC
<Toc>
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:CCORrection:TOC <Toc>

Defines the Clock Correction Parameter.

Parameters:

<Toc> integer

GPS parameter

Range: 0 to 65535
*RST: 0

Options: R&S SMx-K265

<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:AODO <Aodo>

Age of Data Offset

Parameters:

<Aodo> integer

Range: 0 to 31
*RST: 0

Manual operation: See "GPS and QZSS Ephemeris Parameters" on page 32

<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:CIC
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:CIC <Cic>
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:CIC <Cic>
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:CIC <Cic>

Amplitude of the Cosine Harmonic Correction Term to the Angle of Inclination

Parameters:

<Cic> integer

Range: -32768 to 32767
*RST: 0

<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:CIS
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:CIS <Cis>
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:CIS <Cis>
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:CIS <Cis>

Amplitude of the Sine Harmonic Correction Term to the Angle of Inclination

Parameters:

<Cis> integer

Range: -32768 to 32767
*RST: 0

<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:CLTMode
<CltMode>

Type of code for L2; This value does not have any impact on the actual used ranging code of the generated satellite.

Parameters:

<CltMode> REServed | PCODe | CACode

REServed
Reserved for future use.

PCODe
Carrier L2 (f_L2= 1.2276 GHz) is modulated by P-code (BPSK).

CACode
Carrier L2 (f_L2= 1.2276 GHz) is modulated by C/A-code (BPSK).

*RST: PCODe

Manual operation: See "GPS and QZSS Ephemeris Parameters" on page 32

<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:CRC
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:CRC <Crc>
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:CRC <Crc>
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:CRC <Crc>

Amplitude of the Cosine Harmonic Correction Term to the Orbit Radius

Parameters:

<Crc> integer

Range: -32768 to 32767
*RST: 0

<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:CRS
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:CRS <Crs>
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:CRS <Crs>
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:CRS <Crs>

Amplitude of the Sine Harmonic Correction Term to the Orbit Radius

Parameters:

<Crs> integer

Range: -32768 to 32767
*RST: 0

<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:CUC
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:CUC <Cuc>
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:CUC <Cuc>
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:CUC <Cuc>

Amplitude of the Cosine Harmonic Correction Term to the Argument of Latitude

Parameters:

<Cuc> integer

Range: -32768 to 32767
*RST: 0

<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:CUS
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:CUS <Cus>
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:CUS <Cus>
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:CUS <Cus>

Amplitude of the Sine Harmonic Correction Term to the Argument of Latitude

Parameters:

<Cus> integer

Range: -32768 to 32767
*RST: 0

<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:ECCentricity
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:ECCentricity <Eccentricity>
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:ECCentricity <Eccentricity>
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:ECCentricity <Eccentricity>

Eccentricity

Parameters:

<Eccentricity> integer

Range: 0 to 4294967295
*RST: 0

<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:FIFLag <FiFlag>

Indicates the curve-fit interval used by the CS (Control Segment) in determining the ephemeris parameters

Parameters:

<FiFlag> 0 | 1 | OFF | ON

*RST: 0

Manual operation: See "GPS and QZSS Ephemeris Parameters" on page 32

<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:HEALth
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:HEALth <Health>
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:HEALth <Health>

This value does not have an impact on the actual health status of the generated satellite.

Parameters:
<Health> integer
Range: 0 to 31 (for GPS), 1 (for BeiDou)
*RST: 0

<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:IDOT
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:IDOT <Idot>
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:IDOT
<Idot>
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:IDOT <Idot>

Rate of Inclination Angle

Parameters:
<Idot> integer
Range: -8192 to 8191
*RST: 0

<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:IODA
<Ioda>

Issue Of Data (Almanacs)

Parameters:
<Ioda> integer
Range: 0 to 15
*RST: 0

Manual operation: See "Common Ephemeris Parameters" on page 31

<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:IDOC
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:IODC
<Iodc>
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:IODC <Iodc>

Issue of Data, Clock

Parameters:
<Iodc> integer
Range: 0 to 1023 (for GPS), 31 (for BeiDou)
*RST: 0

<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:IDOE
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:IODE
<Iode>
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:IODE <Iode>

Issue of Data, Ephemeris

Parameters:
<Iode> integer
Range: 0 to 255 (for GPS), 31 (for BeiDou)
*RST: 0

<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:IODNav
<IodNav>

Issue Of Data (Ephemeris and Clock correction)

Parameters:
<IodNav> integer
Range: 0 to 1023
*RST: 0

Manual operation: See "Common Ephemeris Parameters" on page 31

<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:IZERo
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:IZERo
<Izero>
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:IZERo
<Izero>
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:IZERo <Izero>

Inclination Angle at Reference Time

Parameters:
<Izero> integer
Range: -2147483648 to 2147483647
*RST: 0

<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:LTPData
<LtpData>

Use of carrier L2 P data flag

This value does not have an impact on whether data is transmitted on the satellite's carrier L2 or not.

Parameters:
<LtpData> 0 | 1 | OFF | ON
*RST: 0

Manual operation: See "GPS and QZSS Ephemeris Parameters" on page 32

<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:MZERo
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:MZERo
<MZero>

<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:MZERo
<MZero>
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:MZERo
<MZero>

Mean Anomaly at Reference Time

Parameters:

<MZero> integer

Range: -2147483648 to 2147483647
*RST: 0

<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:NDELta
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:NDELta
<NDelta>
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:NDELta
<NDelta>
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:NDELta
<NDelta>

Mean Motion Difference From Computed Value

Parameters:

<NDelta> integer

Range: -32768 to 32767
*RST: 0

<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:ODOT
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:ODOT
<ODot>
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:ODOT
<ODot>
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:ODOT <ODot>

Rate of Right Ascension

Parameters:

<ODot> integer

Range: -8388608 to 8388607
*RST: 0

<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:OMEGa
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:OMEGa
<Omega>
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:OMEGa
<Omega>
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:OMEGa
<Omega>

Argument of Perigee

Parameters:

<Omega> integer

Range: -2147483648 to 2147483647
*RST: 0

<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:OZERo
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:OZERo
<OZero>
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:OZERo
<OZero>
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:OZERo
<OZero>

Longitude of Ascending Node of Orbit Plane at Weekly Epoch

Parameters:

<OZero> integer

Range: -2147483648 to 2147483647
*RST: 0

<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:
SF1Reserved<gr> <Reserved>

SF1 Reserved 1/2/3/4

Suffix:

<gr> 1|2|3|4

Parameters:

<Reserved> integer

Range: 0 to 67108864
*RST: 0

Manual operation: See "GPS and QZSS Ephemeris Parameters" on page 32

<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:SISA
<Sisa>

Signal In Space Accuracy

Parameters:

<Sisa> integer

Range: 0 to 255
*RST: 0

Manual operation: See "Common Ephemeris Parameters" on page 31

<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:SQRA
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:SQRA
<SqrA>

<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:SQRA <SqrA>
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:SQRA <SqrA>

Square Root of the Semi-Major Axis

Parameters:

<SqrA> integer

Range: 100000 to 4294967295
*RST: 100000

<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:SVConfig <SvConfig>

SV Configurations

Parameters:

<SvConfig> integer

Range: 0 to 15
*RST: 0

Manual operation: See "GPS and QZSS Ephemeris Parameters" on page 32

<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:TOE
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:TOE <ToE>
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:TOE <ToE>
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:TOE <ToE>

Time Of Ephemeris

Parameters:

<ToE> integer

Range: 0 to 65535
*RST: 0

<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:URA
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:URA <Ura>
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:URA <Ura>
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:URA <Ura>

SV accuracy / URA Index

Parameters:

<Ura> integer

Range: 0 to 15
*RST: 0

<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:FNAV:AF<gr0> <Af>

Defines the SV clock drift rate correction coefficients a_{f0}, a_{f1}, a_{f2}(E1,E5a) of the freely accessible navigation message F/NAV, provided by the E5a signal for Open Service.

Suffix:
<gr0> 0 | 1 | 2

Parameters:
<Af> integer

Value range:
af2 = -2^5 ... 2^5-1
af1 = -2^20 ... 2^20-1
af0 = -2^30 ... 2^30-1

*RST: 0

Manual operation: See "Galileo FNAV Parameters" on page 37

<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:FNAV:BGD <B_GD>

Defines the E1-E5a Broadcast Group Delay parameters "BGD(E1,E5a)" of the freely accessible navigation message F/NAV, provided by the E5a signal for Open Service.

Parameters:
<B_GD> integer

Range: -512 to 511
*RST: 0

Manual operation: See "Galileo FNAV Parameters" on page 37

<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:FNAV:E5ADVS <Dvs>

Defines the Data Validity Satellite Status, transmitted on E5a ($E5a_{DVS}$) of the freely accessible navigation message F/NAV.

Parameters:
<Dvs> integer

Range: 0 to 1
*RST: 0

Manual operation: See "Galileo FNAV Parameters" on page 37

<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:FNAV:E5AHS <Hs>

Defines the Signal Health Status for E5a ($E5a_{HS}$) of the freely accessible navigation message F/NAV, provided by the E5a signal for Open Service.

Parameters:
<Hs> integer

Range: 0 to 3
*RST: 0

Manual operation: See "Galileo FNAV Parameters" on page 37

<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:FNAV:K <K>

Defines the F-NAV Almanac Scheduling start index of the freely accessible navigation message F/NAV, provided by the E5a signal for Open Service.

Parameters:

<K> integer

Range: 0 to 3
*RST: 0

Manual operation: See "Galileo FNAV Parameters" on page 37

<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:FNAV:TOC <Toc>

Defines the Clock correction data reference Time of Week "t_{oC}(E1,E5a)" of the freely accessible navigation message F/NAV, provided by the E5a signal for Open Service.

Parameters:

<Toc> integer

Range: 0 to 16383
*RST: 0

Manual operation: See "Galileo FNAV Parameters" on page 37

<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:INAV:AF<gr0> <Af>

Defines the SV clock drift rate correction coefficients a_{f0}, a_{f1}, a_{f2}(E1,E5b) of the Integrity navigation message INAV.

Suffix:

<gr0> 0 | 1 | 2

Parameters:

<Af> integer

Value range:
af2 = -2^5 ... 2^5-1
af1 = -2^20 ... 2^20-1
af0 = -2^30 ... 2^30-1

*RST: 0

Manual operation: See "Galileo INAV Parameters" on page 36

<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:INAV:BGD <B_GD>

Defines the E1-E5b Broadcast Group Delay "BGD (E1,E5b)" parameter of the Integrity navigation message INAV.

Parameters:

<B_GD> integer

Range: -512 to 511
*RST: 0

Manual operation: See "Galileo INAV Parameters" on page 36

<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:INAV:E1BDVS <Dvs>

Defines the Data Validity Satellite Status, transmitted on E1-B ("E1-B_{DVS}") of the Integrity navigation message I/NAV provided by E5b and E1-B signals.

Parameters:

<Dvs> integer

Range: 0 to 1
*RST: 0

Manual operation: See "Galileo INAV Parameters" on page 36

<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:INAV:E1BHS <HS>

Defines the Signal Health Status for E1 ("E1-B_{HS}") of the Integrity navigation message I/NAV provided by E5b and E1-B signals.

Parameters:

<HS> integer

Range: 0 to 3
*RST: 0

Manual operation: See "Galileo INAV Parameters" on page 36

<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:INAV:E5BDVS <Dvs>

Defines the Data Validity Satellite Status, transmitted on E5b ("E5b_{DVS}") of the Integrity navigation message I/NAV.

Parameters:

<Dvs> integer

Range: 0 to 1
*RST: 0

Manual operation: See "Galileo INAV Parameters" on page 36

<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:INAV:E5BHS <Hs>

Defines the Signal Health Status for E5b ("E5b_{HS}") of the Integrity navigation message I/NAV provided by E5b and E1-B signals.

Parameters:

<Hs> integer

Range: 0 to 3
*RST: 0

Manual operation: See "Galileo INAV Parameters" on page 36

<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:INAV:TOC <Toc>

Defines the Clock correction data reference Time of Week "t_{oC}(E1,E5b)" parameter of the Integrity navigation message INAV.

Parameters:

<Toc> integer

Range: 0 to 16383
*RST: 0

Manual operation: See "Galileo INAV Parameters" on page 36

<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:CCORrection:DTAU <Delta_TAU_n>

Defines the time difference between navigation RF signal transmitted in L2 and navigation RF signal transmitted in L1 band.

Parameters:

<Delta_TAU_n> integer

Range: -16 to 15
*RST: 0

Manual operation: See "GLONASS Clock Correction Parameters" on page 36

<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:CCORrection:EN <E_n>

Sets the age of operation information.

Parameters:

<E_n> integer

Range: 0 to 31
*RST: 0

Manual operation: See "GLONASS Clock Correction Parameters" on page 36

<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:CCORrection:GAMN <GAMMA_n>

Defines the SV Clock drift correction coefficient.

Parameters:

<GAMMA_n> integer

Range: -1024 to 1023
*RST: 0

Manual operation: See "GLONASS Clock Correction Parameters" on page 36

<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:CCORrection:TAUN
<TAU_n>

Defines the SV Clock bias correction coefficient.

Parameters:

<TAU_n> integer

Range: -2097152 to 2097151
*RST: 0

Manual operation: See "GLONASS Clock Correction Parameters" on page 36

<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:AOEP
<AgeOfEph>

Sets the time interval between two adjacent values of TOE. It defines hence the age of the current GLONASS Ephemeris page.

Parameters:

<AgeOfEph> A30M | A45M | A60M

A30M
Age of Ephemeris = 30 min

A45M
Age of Ephemeris = 45 min

A60M
Age of Ephemeris = 60 min

*RST: A30M

Manual operation: See "GLONASS Ephemeris Parameters" on page 33

<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:HEALth
<Health>

A health value. The user navigation equipment analyzes only the MSB of this word.

Parameters:

<Health> integer

B_n[3] = 1_n = 1
Satellite is not healthy

B_n[3] = 1_n = 0
Satellite is healthy

Range: 0 to 7
*RST: 0

Manual operation: See "GLONASS Ephemeris Parameters" on page 33

<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:P <P>

Reliability measure of system time conversion parameters.

Parameters:

<P> integer

00
TAU_C and TAU_GPS relayed from control segment.

01
TAU_C from control segment; TAU_GPS calculated on board GLONASS-M satellite.

10
TAU_C on board GLONASS-M satellite and TAU_GPS relayed from CS.

11
TAU_C and TAU_GPS calculated on board GLONASS-M satellites.

Range: 0 to 3
*RST: 0

Manual operation: See "GLONASS Ephemeris Parameters" on page 33

<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:SEType <Type>

Selects the satellite ephemeris type.

Parameters:

<Type> GLO | GLOM

*RST: GLOM

Manual operation: See "GLONASS Ephemeris Parameters" on page 33

<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:TALignment <TbAlign>

Sets TOE to be aligned to an even or odd scale of 15 min for Age of Ephemeris = 30 min. or 60 min.

Parameters:

<TbAlign> EVEN | ODD

*RST: ODD

Example: `SUR:BB:GLON:SVID:GLON:NMES:EPH:TAL EVEN`

Manual operation: See "GLONASS Ephemeris Parameters" on page 33

<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:TINDex <TbIndex>

Defines the index of the Tb-time interval.

To define the duration of the Tb-time interval, use the command `<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:AOEP`.

Parameters:

<TbIndex> integer

Range: 1 to 95
*RST: 1

Manual operation: See "GLONASS Ephemeris Parameters" on page 33

<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:TINTerval?

Queries the Tb-Interval in the current day where the Ephemeris set page is valid.

Return values:

<TbInterval> string

Example:
```
SOUR:BB:GLON:SVID:GLON:NMES:EPH:TIND 0
SOUR:BB:GLON:SVID:GLON:NMES:EPH:AOEP 30
SOUR:BB:GLON:SVID:GLON:NMES:EPH:TINT?
```

Usage: Query only

Manual operation: See "GLONASS Ephemeris Parameters" on page 33

<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:TOE?

Queries the time of Ephemeris in the current day.

Return values:

<Hour> integer

Range: 0 to 23

<Minute> integer

Range: 0 to 59

<Second> float

Range: 0 to 59
Increment: 1

Usage: Query only

Manual operation: See "GLONASS Ephemeris Parameters" on page 33

<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:XN <X_n>
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:YN <Y_n>
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:ZN <Z_n>

Sets the OX | OY | OZ **position** coordinates of the current satellite at TOE(tb), i.e. the middle of Tb-Interval.

The coordinates correspond to the PZ-90 coordinate system.

Parameters:

<Z_n> integer

Range: -67108864 to 67108863
*RST: 0

Manual operation: See "GLONASS Ephemeris Parameters" on page 33

<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:XDDN
<XDDOT_n>
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:YDDN
<YDDOT_N>
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:ZDDN
<ZDDOT_n>

The OZ accelerations coordinate of the current satellite due to solar and lunar gravitational effects at TOE(tb), i.e. the middle of Tb-Interval.

The coordinates correspond to the PZ-90 coordinate system.

Parameters:

<ZDDOT_n> integer

Range: -16 to 15
*RST: 0

Manual operation: See "GLONASS Ephemeris Parameters" on page 33

<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:XDN
<XDOT_n>
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:YDN
<YDOT_n>
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:ZDN
<ZDOT_n>

Sets the OX | OY | OZ velocity coordinate of the current satellite at TOE(tb), i.e. the middle of Tb-Interval.

The coordinates correspond to the PZ-90 coordinate system.

Parameters:

<ZDOT_n> integer

Range: -8388608 to 8388607
*RST: 0

Manual operation: See "GLONASS Ephemeris Parameters" on page 33

6.8 Marker Settings

<subsystem>:TRIGger:OUTPut<ch>:MODE 86
<subsystem>:TRIGger:OUTPut<ch>:ONTime 87
<subsystem>:TRIGger:OUTPut<ch>:OFFTime 87
<subsystem>:TRIGger:OUTPut<ch>:PATTern 87
<subsystem>:TRIGger:OUTPut<ch>:PULSe:DIVider 87
<subsystem>:TRIGger:OUTPut<ch>:PULSe:FREQuency? 87
<subsystem>:TRIGger:OUTPut<ch>:PULSe:WIDTh 88

<subsystem>:TRIGger:OUTPut<ch>:MODE <Mode>

Defines the signal for the selected marker output.

Parameters:

<Mode> PULSe | PATTern | RATio | PPS | PP2S | TRIGger | DISabled | PPS10 | | RESTart

PULSe|PATTern|RATio
Regular marker signals

PPS | PP2S | PPS10
A marker signal is generated for every start of second, every second second or every tenth second (GPS time). The pulse width is defined with the `<subsystem>:TRIG:OUTP:PULSe:WIDTh` command

TRIGger
A marker signal is generated only when a trigger event occurs.

DISabled
Generation of a marker signal is deactivated.

Restart
The signal is generated continuously. A trigger event causes a restart.

*RST: PPS

Example:

```
BB:GPS:TRIG:OUTP1:MODE PATT
BB:GPS:TRIG:OUTP2:PATT #B000000011111111,15
```

Manual operation: See "Marker Mode" on page 38

<subsystem>:TRIGger:OUTPut<ch>:ONTime <OnTime>
<subsystem>:TRIGger:OUTPut<ch>:OFFTime <OffTime>

Sets the number of chips in a period (ON time + OFF time) during which the marker signal in setting `<subsystem>:TRIGger:OUTPut:MODE RATio` on the marker outputs is OFF.

Parameters:

<OffTime> integer

Range: 1 to 2^24 - 1 chips
Increment: 1 chip
*RST: 1

Example: `BB:GPS:TRIG:OUTP2:OFFT 200`
sets an OFF time of 200 chips for marker signal 2.

Manual operation: See "Marker Mode" on page 38

<subsystem>:TRIGger:OUTPut<ch>:PATTern <Pattern>

Defines the bit pattern used to generate the marker signal.

Parameters:

<Pattern> 64 bit pattern

0 = marker off, 1 = marker on.

Range: #B0,1 to #B111...1,64
*RST: #B0,1

Example:
```
BB:GPS:TRIG:OUTP2:PATT #B000000011111111,15
BB:GPS:TRIG:OUTP2:MODE PATT
```

Manual operation: See "Marker Mode" on page 38

<subsystem>:TRIGger:OUTPut<ch>:PULSe:DIVider <Divider>

Sets the divider for pulse marker mode (`<subsystem>:TRIG:OUTP:MODE PULSe`).

Parameters:

<Divider> integer

Range: 2 to 1024
*RST: 2

Example:
```
SOURce1:BB:GPS:TRIGger:OUTP2:MODE PULSe
SOURce1:BB:GPS:TRIGger:OUTP2:PULS:DIV 2
SOURce1:BB:GPS:TRIGger:OUTP2:FREQ?
// 511511.038
```

Manual operation: See "Marker Mode" on page 38

<subsystem>:TRIGger:OUTPut<ch>:PULSe:FREQuency?

Queries the pulse frequency of the pulsed marker signal

Return values:
<Frequency> float

Example: See <subsystem>:TRIGger:OUTPut<ch>:PULSe:DIVider on page 87

Usage: Query only

Manual operation: See "Marker Mode" on page 38

<subsystem>:TRIGger:OUTPut<ch>:PULSe:WIDTh <Width>

Sets the pulse width for 1PPS, 1PP2S and PPS10 marker mode.

Parameters:
<Width> integer

Range: 1 to 800
*RST: 1

Example:
```
BB:GPS:TRIG:OUTP2:MODE PPS
BB:GPS:TRIG:OUTP1:PULS:WIDT 2
```

Manual operation: See "Marker Mode" on page 38

List of Commands

[:SOURce<hw>]:BB:BEIDou:SETTing:CATalog?....45
[:SOURce<hw>]:BB:GALileo:SETTing:CATalog?....45
[:SOURce<hw>]:BB:GLONass:SETTing:CATalog?....45
[:SOURce<hw>]:BB:GPS:SETTing:CATalog?....45
<subsystem>:DURation....46
<subsystem>:FILTer:OSAMpling....47
<subsystem>:GALModulation....61
<subsystem>:NAVigation:ALMAnac:<GNSS>:DATE:BEGIn....53
<subsystem>:NAVigation:ALMAnac:<GNSS>:DATE:END....53
<subsystem>:NAVigation:ALMAnac:<GNSS>:FILE....52
<subsystem>:NAVigation:ALMAnac:<GNSS>:SPAN?....52
<subsystem>:NAVigation:ALMAnac:<GNSS>:TOAPplicability:TOWeek....55
<subsystem>:NAVigation:ALMAnac:<GNSS>:TOAPplicability:WNUMber....55
<subsystem>:NAVigation:ALMAnac:<GNSS>:WNUMber....55
<subsystem>:NAVigation:ALMAnac:BEIDou:DATE:BEGin?....53
<subsystem>:NAVigation:ALMAnac:BEIDou:DATE:END?....53
<subsystem>:NAVigation:ALMAnac:BEIDou:FILE....52
<subsystem>:NAVigation:ALMAnac:BEIDou:SPAN?....52
<subsystem>:NAVigation:ALMAnac:BEIDou:TOAPplicability:TOWeek?....55
<subsystem>:NAVigation:ALMAnac:BEIDou:TOAPplicability:WNUMber?....55
<subsystem>:NAVigation:ALMAnac:BEIDou:WNUMber?....55
<subsystem>:NAVigation:ALMAnac:GALileo:DATE:BEGin?....53
<subsystem>:NAVigation:ALMAnac:GALileo:DATE:END?....53
<subsystem>:NAVigation:ALMAnac:GALileo:FILE....52
<subsystem>:NAVigation:ALMAnac:GALileo:SPAN?....52
<subsystem>:NAVigation:ALMAnac:GALileo:TOAPplicability:TOWeek?....55
<subsystem>:NAVigation:ALMAnac:GALileo:TOAPplicability:WNUMber?....55
<subsystem>:NAVigation:ALMAnac:GALileo:WNUMber?....55
<subsystem>:NAVigation:ALMAnac:GLONass:FILE....52
<subsystem>:NAVigation:ALMAnac:GLONass:TOAPplicability:DATE?....53
<subsystem>:NAVigation:ALMAnac:GLONass:TOAPplicability:TIME?....54
<subsystem>:NAVigation:ALMAnac:GPS:DATE:BEGin?....53
<subsystem>:NAVigation:ALMAnac:GPS:DATE:END?....53
<subsystem>:NAVigation:ALMAnac:GPS:FILE....52
<subsystem>:NAVigation:ALMAnac:GPS:SPAN?....52
<subsystem>:NAVigation:ALMAnac:GPS:TOAPplicability:TOWeek?....55
<subsystem>:NAVigation:ALMAnac:GPS:TOAPplicability:WNUMber?....55
<subsystem>:NAVigation:ALMAnac:GPS:WNUMber?....55
<subsystem>:NAVigation:DATA....48
<subsystem>:NAVigation:DATA:DSELect....49
<subsystem>:NAVigation:DATA:PATTern....49
<subsystem>:NAVigation:SIMulation:DATE....49
<subsystem>:NAVigation:SIMulation:TBASis....49
<subsystem>:NAVigation:SIMulation:TIME....50
<subsystem>:NAVigation:SIMulation:TOWeek....50
<subsystem>:NAVigation:SIMulation:WNUMber....50
<subsystem>:NAVigation:TCONversion:<GNSS>:AONE....57

<subsystem>:NAVigation:TCONversion:<GNSS>:AZERo ... 57
<subsystem>:NAVigation:TCONversion:<GNSS>:TOT ... 57
<subsystem>:NAVigation:TCONversion:<GNSS>:WNOT ... 58
<subsystem>:NAVigation:TCONversion:BEIDou:AONE ... 57
<subsystem>:NAVigation:TCONversion:BEIDou:AZERo ... 57
<subsystem>:NAVigation:TCONversion:BEIDou:TOT ... 57
<subsystem>:NAVigation:TCONversion:BEIDou:WNOT ... 58
<subsystem>:NAVigation:TCONversion:GALileo:AONE ... 57
<subsystem>:NAVigation:TCONversion:GALileo:AZERo ... 57
<subsystem>:NAVigation:TCONversion:GALileo:TOT ... 57
<subsystem>:NAVigation:TCONversion:GALileo:WNOT ... 58
<subsystem>:NAVigation:TCONversion:GLONass:AONE ... 57
<subsystem>:NAVigation:TCONversion:GLONass:AZERo ... 57
<subsystem>:NAVigation:TCONversion:GLONass:TOT ... 58
<subsystem>:NAVigation:TCONversion:GLONass:WNOT ... 58
<subsystem>:NAVigation:TCONversion:GPS:AONE ... 57
<subsystem>:NAVigation:TCONversion:GPS:AZERo ... 57
<subsystem>:NAVigation:TCONversion:GPS:TOT ... 58
<subsystem>:NAVigation:TCONversion:GPS:WNOT ... 58
<subsystem>:NAVigation:TCONversion:LEAP:SEConds ... 59
<subsystem>:NAVigation:TCONversion:LEAP:SYNC ... 59
<subsystem>:NAVigation:TCONversion:UTCSu:AONE ... 58
<subsystem>:NAVigation:TCONversion:UTCSu:AZERo ... 58
<subsystem>:NAVigation:TCONversion:UTCSu:DATE? ... 59
<subsystem>:PRESet ... 44
<subsystem>:RFBand ... 45
<subsystem>:SATellite:COUNt ... 61
<subsystem>:SATellite<st>:CACRate? ... 61
<subsystem>:SATellite<st>:CPHase ... 63
<subsystem>:SATellite<st>:DSHift ... 62
<subsystem>:SATellite<st>:FNUMber ... 62
<subsystem>:SATellite<st>:FREQuency? ... 62
<subsystem>:SATellite<st>:ICPHase ... 63
<subsystem>:SATellite<st>:MODulation? ... 63
<subsystem>:SATellite<st>:ORBit? ... 63
<subsystem>:SATellite<st>:PRANge ... 64
<subsystem>:SATellite<st>:SCRate? ... 64
<subsystem>:SATellite<st>:SIGNal ... 64
<subsystem>:SATellite<st>:STANdard ... 65
<subsystem>:SATellite<st>:STATe ... 65
<subsystem>:SATellite<st>:SVID ... 65
<subsystem>:SATellite<st>:TSHift ... 65
<subsystem>:SETTing:CATalog ... 45
<subsystem>:SETTing:DELete ... 46
<subsystem>:SETTing:LOAD ... 46
<subsystem>:SETTing:STORe ... 46
<subsystem>:SMODe ... 45
<subsystem>:SPReading[:STATe] ... 61
<subsystem>:STATe ... 45
<subsystem>:SVID:<GNSS>:LIST ... 55

<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:CCORection:AF<gr0>....69
<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:CCORection:TGD....69
<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:CCORection:TOC....69
<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:CIC....70
<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:CIS....70
<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:CRC....71
<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:CRS....71
<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:CUC....71
<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:CUS....72
<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:ECCentricity....72
<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:HEALth....72
<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:IDOC....73
<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:IDOE....73
<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:IDOT....73
<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:IZERo....74
<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:MZERo....74
<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:NDELta....75
<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:ODOT....75
<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:OMEGa....75
<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:OZERo....76
<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:SQRA....76
<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:TOE....77
<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:URA....77
<subsystem>:SVID<ch>:BEIDou:LIST?....56
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:CCORrection:AF<gr0>....69
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:CCORrection:TGD<gr>....69
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:CCORrection:TOC....69
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:CIC....70
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:CIS....70
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:CRC....71
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:CRS....71
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:CUC....71
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:CUS....72
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:ECCentricity....72
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:HEALth....72
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:IDOT....73
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:IODC....73
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:IODE....73
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:IZERo....74
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:MZERo....74
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:NDELta....75
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:ODOT....75
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:OMEGa....75
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:OZERo....76
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:SQRA....76
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:TOE....77
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:EPHemeris:URA....77
<subsystem>:SVID<ch>:GALileo:LIST?....56
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:CIC....70
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:CIS....70

<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:CRC 71
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:CRS 71
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:CUC 71
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:CUS 72
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:ECCentricity 72
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:IDOT 73
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:IODA 73
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:IODNav 74
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:IZERo 74
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:MZERo 75
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:NDELta 75
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:ODOT 75
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:OMEGa 75
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:OZERo 76
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:SISA 76
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:SQRA 77
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:EPHemeris:TOE 77
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:FNAV:AF<gr0> 78
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:FNAV:BGD 78
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:FNAV:E5ADVS 78
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:FNAV:E5AHS 78
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:FNAV:K 79
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:FNAV:TOC 79
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:INAV:AF<gr0> 79
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:INAV:BGD 79
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:INAV:E1BDVS 80
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:INAV:E1BHS 80
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:INAV:E5BDVS 80
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:INAV:E5BHS 80
<subsystem>:SVID<ch>:GALileo:NMESsage[:PAGE<us>]:INAV:TOC 81
<subsystem>:SVID<ch>:GLONass:LIST? 56
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:CCORrection:DTAU 81
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:CCORrection:EN 81
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:CCORrection:GAMN 81
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:CCORrection:TAUN 82
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:AOEP 82
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:HEALth 82
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:P 83
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:SEType 83
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:TALignment 83
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:TINDex 84
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:TINTerval? 84
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:TOE? 84
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:URA 77
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:XDDN 85
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:XDN 85
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:XN 85
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:YDDN 85
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:YDN 85
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:YN 85

<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:ZDDN 85
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:ZDN 85
<subsystem>:SVID<ch>:GLONass:NMESsage[:PAGE<us>]:EPHemeris:ZN 85
<subsystem>:SVID<ch>:GPS:LIST? 56
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:CCORrection:AF<gr0> 69
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:CCORrection:TGD 69
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:CCORrection:TOC 69
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:AODO 70
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:CIC 70
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:CIS 70
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:CLTMode 70
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:CRC 71
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:CRS 71
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:CUC 71
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:CUS 72
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:ECCentricity 72
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:FIFLag 72
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:HEALth 72
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:IDOT 73
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:IODC 73
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:IODE 73
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:IZERo 74
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:LTPData 74
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:MZERo 75
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:NDELta 75
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:ODOT 75
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:OMEGa 75
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:OZERo 76
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:SF1Reserved<gr> 76
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:SQRA 77
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:SVConfig 77
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:TOE 77
<subsystem>:SVID<ch>:GPS:NMESsage[:PAGE<us>]:EPHemeris:URA 77
<subsystem>:SVID<ch>:SBAS:LIST? 55
<subsystem>:TRIGger:OUTPut<ch>:MODE 86
<subsystem>:TRIGger:OUTPut<ch>:OFFTime 87
<subsystem>:TRIGger:OUTPut<ch>:ONTime 87
<subsystem>:TRIGger:OUTPut<ch>:PATTern 87
<subsystem>:TRIGger:OUTPut<ch>:PULSe:DIVider 87
<subsystem>:TRIGger:OUTPut<ch>:PULSe:FREQuency? 87
<subsystem>:TRIGger:OUTPut<ch>:PULSe:WIDTh 88
<subsystem>:WAVeform:CREate 47

Index

A

a_f0 33
a_f1 33
a_f2 33
Age of Ephemeris Page (P1) 33
Almanac 19
    Conflict 20
    Data span 20
Amplitude of the Cosine Harmonic Correction Term to the Angle of Inclination 30
Amplitude of the Cosine Harmonic Correction Term to the Argument of Latitude 30
Amplitude of the Cosine Harmonic Correction Term to the Orbit Radius 30
Amplitude of the Sine Harmonic Correction Term to the Angle of Inclination 30
Amplitude of the Sine Harmonic Correction Term to the Argument of Latitude 30
Amplitude of the Sine Harmonic Correction Term to the Orbit Radius 30
Application cards 7
Application notes 7
Argument of Perigee 30

B

Brochures 7

C

C_ic 30
C_is 30
C_rc 30
C_rs 30
C_uc 30
C_us 30
Carrier frequencies 16
Clock Correction
    Galileo 33
    GLONASS 36
    GPS 33
Constellation table 25
Conventions
    SCPI commands 42

D

Data sheets 7
Data source 17
Data span
    Almanac 20
Date 18
Default settings 14
delta_N 30
Delta_TAU_n 36, 81
Documentation overview 6
Doppler Shift 27
Duration of Simulation 16, 47

E

e 30
E_n 36, 81
Eccentricity 30

F

Frequency number
    GLONASS satellite 26

G

Galileo sat. modulation 24
GAMMA_n (a_f1) 36, 81
Generate Waveform File 15
Getting started 6
GLONASS-specific ephemeris parameters 33
Greenwich Mean Time 18

H

Help 6

I

i_0 30
IDOT 30
Inclination Angle at reference Time 30
Initial Carrier Phase 27
Instrument help 6
Instrument security procedures 7
IODa 31
IODC 31
IODE 31
IODnav 31

L

Longitude of Ascending Node of Orbit Plane at Weekly Epoch 30

M

M_0 30
Marker Mode 38
Marker Period 38
Maximum Number of Satellites 25
Mean Anomaly at Reference Time 30
Mean Motion difference From Computed Value 30

O

omega 30
OMEGA_0 30
OMEGA_DOT 30
ON/OFF Ratio Marker 38
One-satellite GNSS signal
    Generating waveform file 40
    Processing in an ARB 41
Open source acknowledgment 7
Orbit type
    BeiDou satellite 26
OSA 7

P

P 33

R

Rate of Inclination Angle 30
Rate of Right Ascension 30
Release notes 7
Remote control
programming examples 43
Resulting Frequency 28
Resulting Start Chip Rate 28
RF band 15
RINEX configuration 51

S

Safety instructions 7
Satellite Ephemeris Type (M) 33, 83
Satellite signal 25
Satellite Standard 25
Satellite State 25
Satellites constellation 25
Save/Recall
GNSS settings 15
Service manual 6
Set to default 14
SF1 Reserved 1 .. 4 32
Signal dynamics
Doppler shift 27
Simulation Mode 16
Simulation start time 18
SISA 31
SQRT(A) 30
Square Root of the Semi-Major Axis 30
Standard settings 14
State
GNSS 14
Supported signals 25
SV Accuracy 31
SV accuracy / URA Index (F_T) 33
SV Health 31
SV Health (B_n, 1_n) 33
System Time 18

T

T_GD 33
t_OC 33
TAU_n (-a_f0) 36, 82
Tb-Index 33
Tb-Interval 33
Time of Ephemeris 30
Time of Week (TOW) 18
Time Shift (Chips) 27
TOE 30
TOE (tb) 33

U

URA Index 31
Use spreading 24
User manual 6
User Period 38

W

Week Number 18
White papers 7

X

X_n 33, 85
XDDOT_n 33
XDOT_n 33

Y

Y_n 33, 85
YDDOT_n 33
YDOT_n 33

Z

Z_n 33, 85
ZDDOT_n 33
ZDOT_n 33