Satellite Navigation
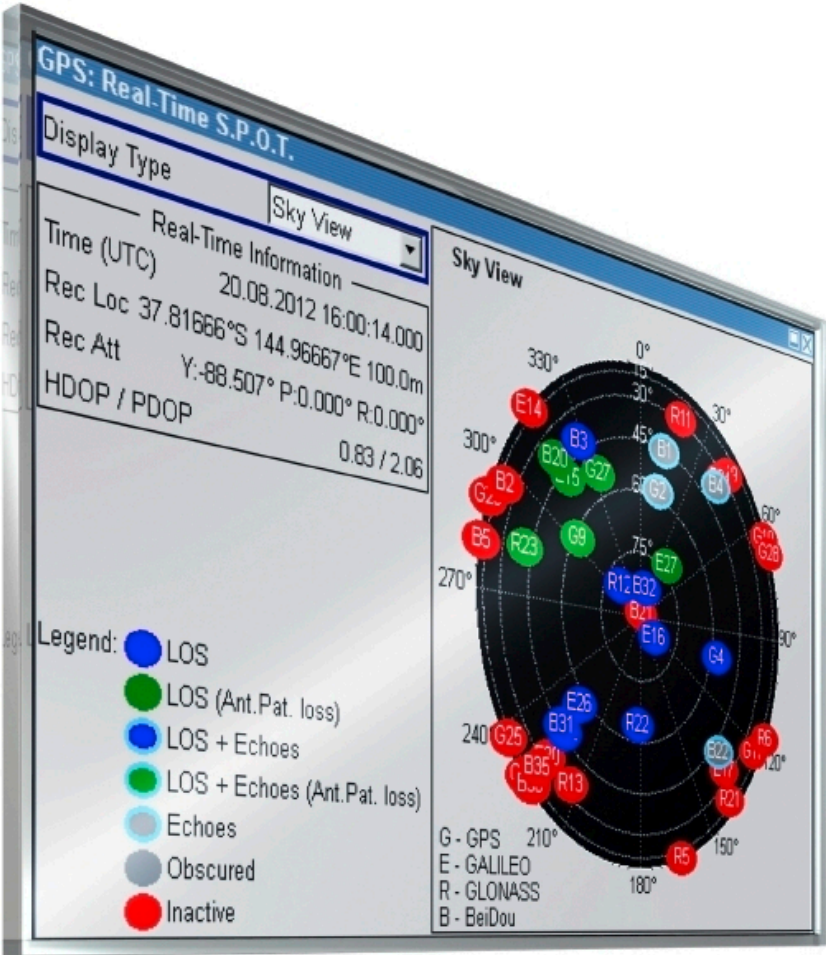# Digital Standards for R&S®SMBV and R&S®WinIQSIM2™
Operating Manual

ROHDE & SCHWARZ

This document describes the software options for satellite navigation: GPS, Assisted GPS, GPS P-Code, Galileo, Assisted Galileo, GLONASS, Assisted GLONASS, COMPASS/BeiDou, Enh. GNSS and GNSS Extensions, incl. Extension to 12 and 24 Satellites, Obscuration Simulation and Automatic Multipath, Antenna Pattern, Spinning and Attitude Simulation

Described are the following software options:

- R&S®SMBV-K44/K244/K65/K266/K66/K67/K91/K92/K93/K94/K294/K95/K96/K101/K102/K103/K107
  1415.8060.xx, 1415.8260.02, 1415.8560.xx, 1415.8590.02, 1415.8683.xx, 1419.2509.xx,
  1415.8577.xx, 1415.8583.xx, 1415.8660.xx, 1415.8677.xx, 1415.8690.02, 1419.2521.xx,
  1415.8790.xx, 1415.8802.xx, 1415.8819.xx, 1415.8825.xx, 1419.2709.xx

- R&S®AMU-K244/K266/K294
  1402.7902.02, 1403.0976.02, 1403.0953.02

- R&S®AFQ-K244/K266/K294
  1401.6454.02, 1415.0330.02, 1415.0318.02

- R&S®SMJ-K244/K266/K294
  1409.0810.02, 1409.3502.02, 1409.3483.02

- R&S®SMU-K244/K266/K294
  1408.5818.02, 1408.8630.02, 1408.8617.02

- R&S®SMW-K244/K266/K294
  1413.4880.02, 1413.7015.02, 1413.7067.02

- R&S®SFU-K244
  2115.2250.02

The following abbreviations are used throughout this manual: R&S®AMU200A is abbreviated as R&S AMU, R&S®SMATE200A is abbreviated as R&S SMATE, R&S®SMBV100A is abbreviated as R&S SMBV, R&S®SMJ100A is abbreviated as R&S SMJ, R&S®SMU200A is abbreviated as R&S SMU, R&S®SMW200A is abbreviated as R&S SMW, R&S®WinIQSIM2™ is abbreviated as R&S WinIQSIM2

Contents

1 Preface

1.1 Documentation Overview

The user documentation for the R&S SMBV consists of the following parts:

● Online Help system on the instrument,
● "Quick Start Guide" printed manual,
● Documentation CD-ROM with:
  – Online help system (*.chm) as a standalone help,
  – Operating Manuals for base unit and options,
  – Service Manual,
  – Data sheet and specifications,
  – Links to useful sites on the R&S internet.

Online Help

The Online Help is embedded in the instrument's firmware. It offers quick, context-sensitive access to the complete information needed for operation and programming. The online help contains help on operating the R&S SMBV and all available options.

Quick Start Guide

The Quick Start Guide is delivered with the instrument in printed form and in PDF format on the Documentation CD-ROM. It provides the information needed to set up and start working with the instrument. Basic operations and an example of setup are described. The manual includes also general information, e.g., Safety Instructions.

Operating Manuals

The Operating Manuals are a supplement to the Quick Start Guide. Operating Manuals are provided for the base unit and each additional (software) option.

These manuals are available in PDF format - in printable form - on the Documentation CD-ROM delivered with the instrument. In the Operating Manual for the base unit, all instrument functions are described in detail. Furthermore, it provides an introduction to remote control and a complete description of the remote control commands with programming examples. Information on maintenance, instrument interfaces and error messages is also given.

In the individual option manuals, the specific instrument functions of the option are described in detail. For additional information on default settings and parameters, refer to the data sheets. Basic information on operating the R&S SMBV is not included in the option manuals.

Service Manual

The Service Manual is available in PDF format - in printable form - on the Documentation CD-ROM delivered with the instrument. It describes how to check compliance with rated specifications, on instrument function, repair, troubleshooting and fault elimination. It contains all information required for repairing the instrument by the replacement of modules.

This manual can also be orderd in printed form (see ordering information in the data sheet).

Release Notes

The release notes describe new and modified functions, eliminated problems, and last minute changes to the documentation. The corresponding firmware version is indicated on the title page of the release notes. The current release notes are provided in the Internet.

Web Helps

Web helps are provided for the base unit and each additional (software) option. The content of the web helps correspond to the user manuals for the latest product versions.

The web help is an additional file format that offers quick online access. They are not intended to be downloaded but rather to access the required information directly form the R&S website.

Web helps are available at the R&S website, on the R&S SMBV product page at the "Downloads > Web Help" area.

1.2 Typographical Conventions

The following text markers are used throughout this documentation:

Convention	Description
"Graphical user interface elements"	All names of graphical user interface elements on the screen, such as dialog boxes, menus, options, buttons, and softkeys are enclosed by quotation marks.
KEYS	Key names are written in capital letters.
`File names, commands, program code`	File names, commands, coding samples and screen output are distinguished by their font.
Input	Input to be entered by the user is displayed in italics.
Links	Links that you can click are displayed in blue font.
"References"	References to other parts of the documentation are enclosed by quotation marks.

2   General Description

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.

Differences between the GNSS implementation in R&S SMBV and R&S WinIQ-SIM2

The GNSS implementation in the R&S SMBV provides you with the ability to generate the signal of up to 6, 12 or 24 GNSS satellites, depending on the installed options. Signal generation is done in real-time and thus it is not limited to a certain time period.

The GNSS implementation in the R&S WinIQSIM2 allows you to generate waveform files that can be loaded to an Rohde&Schwarz vector signal generator, e.g. the R&S SMU200A. It provides you the ability to generate the signal of one GPS, Galileo or Glonass satellite on either an R&S SMU200A, R&S SMJ100A, R&S AMU200A, R&S AFQ100A, R&S SMW200A or R&S SMBV100A. Depending on the availability of the respective options, e.g. R&S SMU-K244/-K266/-K294 you can simulate **one** GPS, Galileo, GLONASS satellite respectively on the generator.

As a major difference to the real-time solution, the satellite signal is limited to a certain time period depending on the ARB capacity of the vector signal generator and the user configurable sample rate of the satellite signal.

This description follows the GNSS implementation in the R&S SMBV.

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 2-1).

● **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.
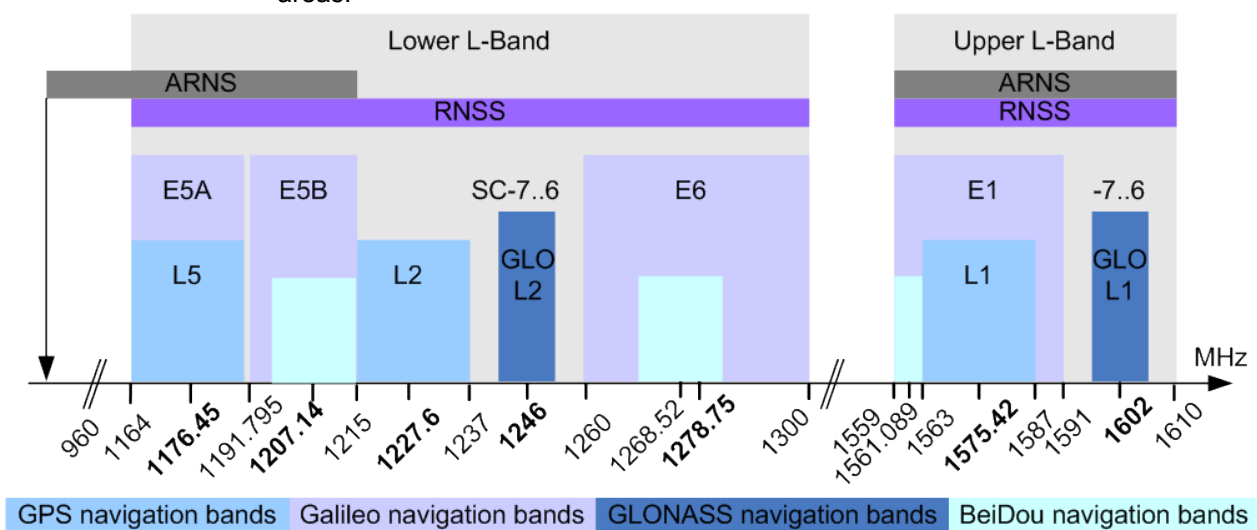
Fig. 2-1: GNSS frequency bands

● **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.

● **Assisted GNSS (A-GNSS)**

Assisted GNSS (A-GNSS) was introduced to different mobile communication standards to significantly reduce the Time To First Fix (TTFF) of a user equipment (UE) containing a GNSS receiver. This is achieved by transmitting information (assistance data) mainly about the satellites directly from a base station to the UE. For example, a stand-alone GPS receiver needs about 30-60 seconds for a first fix and up to 12.5 minutes to get all information (almanac).

In A-GNSS "UE based mode", the base station assists the UE by providing the complete navigation message along with a list of visible satellites and ephemeris data. In addition to this information, the UE gets the location and the current time at

the Base Station and that speeds up both acquisition and navigation processes of the GPS receiver and hence reduces TTFF to a few seconds.

In A-GNSS "UE assisted mode", the base station is even responsible for the calculation of the UE's exact location, i.e. the base station performs the navigation based on the raw measurements provided by the UE. Since the Acquisition Assistance Data provided by the Base Station already serves speeding up the acquisition process, the UE only has to track the code and carrier phase.

2.1 Functional Overview of the Basic Realtime GNSS Options GPS, Galileo, GLONASS and BeiDou

This section gives an overview of the options GPS (R&S SMBV-K44), Galileo (R&S SMBV-K66), GLONASS (R&S SMBV-K94) and BeiDou (R&S SMBV-K107).

> Throughout this description, these options are denoted as basic GNSS options.

2.1.1 Real-time generation

With the option R&S SMBV-K44, up to six GPS satellites transmitting L1 or L2 signals with C/A-code can be simulated in real-time.

With the option R&S SMBV-K66, up to six Galileo satellites transmitting E1 signal can be simulated in real-time.

With the option R&S SMBV-K94, up to six GLONASS satellites transmitting L1 or L2 signal can be simulated in real-time.

With the option R&S SMBV-K107, up to six BeiDou satellites transmitting L1 or L2 signal can be simulated in real-time.

2.1.2 Multi-satellite GNSS signal

The instrument calculates a multi-satellite GNSS signal in three different simulation modes, the static mode, the auto localization mode and the user localization mode.

In "Static mode", 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.

The generic workflow is described in chapter 2.10.2, "Generating GNSS Signal for Simple Receiver Tests (Static Mode)", on page 36.

The superposition signal of up to 6 dynamic satellites at a specific receiver location is generated in one of the localization modes. The major difference to the static mode implies the possibility to specify the receiver's location. Although, both the localization

modes are provided for the generation of a realistic GNSS signal, there are some differences between them.

- The "Auto Localization" mode is provided for the generation of a GNSS signal with automatic exchange of satellite whenever needed to improve the position dilution of precision and to ensure satellite visibility at the simulated receiver location. This mode ensures an optimal satellite constellation, automatic dynamic calculation of the satellite power at any moment and ephemeris projection from the selected **almanac**.
  In this simulation mode, the connected GNSS receiver can be forced to obtain a 3D fix at a predefined or user-defined static geographical location. Instrument equipped with the option GNSS enhanced R&S SMBV-K92 can also simulate moving receivers (see chapter 2.5.1, "Moving Scenarios", on page 26).

- The "User Localization" mode provides flexible configuration of the satellite constellation, the power settings and the individual satellites parameters. For instruments equipped with assistance option R&S SMBV-K65, this mode also enables the extraction of the navigation message from RINEX files. Dynamic exchange of satellites can be performed by means of deactivation and activation of the individual satellites. The power settings are enabled for configuration but the automatic dynamic calculation function of the instrument may also be utilized.
  This mode is required for the generation of user defined assisted GPS test scenarios.

The table 2-1 gives an overview of the supported functionality per simulation mode. Some functionality require additional options.

Table 2-1: Cross-reference between the simulation mode, supported functionality and the required options

Simulation Mode / Function	Static	Auto Localization	User Localization	Required Options
Configuration of static receiver location	no	yes	yes	R&S SMBV-K44/K66/K94/K107
GNSS System Configuration	yes	yes	yes	R&S SMBV-K44 and R&S SMBV-K66 and R&S SMBV-K94 and R&S SMBV-K107
Almanac/RINEX	almanac	almanac	Almanac and RINEX file supported	R&S SMBV-K44/K66/K94/K107 R&S SMBV-K65/K67/K95/K107 for RINEX files
Projection of Navigation Message	no	yes	yes	R&S SMBV-K44/K66/K94/K107
S.P.O.T. Display	no	yes	yes	R&S SMBV-K44/K66/K94/K107
Assistance GNSS Data Generation	no	no	yes	R&S SMBV-K44/K66/K94/K107 and R&S SMBV-K65/K67/K95
Configuration of Satellite Constellation	yes	no	yes	R&S SMBV-K44/K66/K94/K107

Simulation Mode / Function	Static	Auto Localization	User Localization	Required Options
Power Mode	User	Auto	Auto and User	R&S SMBV-K44/K66/K94/K107
Exchange of Satellites	no	automatic	manual	R&S SMBV-K44/K66/K94/K107
Maximum Number of Satellites	up to 12/24	up to 12/24	up to 12/24	R&S SMBV-K91/-K96
Motion Files Motion Smoothening Extract attitude from motion file	no	yes	yes	R&S SMBV-K92
Time Conversion Configuration	yes	no	yes	R&S SMBV-K92
Navigation Message Configuration	configurable	read-only	configurable	R&S SMBV-K92
Atmospheric Configuration	yes	yes	yes	R&S SMBV-K92
Static Multipath Configuration	no	no	yes	R&S SMBV-K92
Automatic Multipath&Osculation scenarios	no	yes	yes	R&S SMBV-K92 and R&S SMBV-K102
Antenna Pattern/Body mask entry	no	yes	yes	R&S SMBV-K102
Attitude/Body rotation angle files User defined vehicle spinning	no	yes	yes	R&S SMBV-K92 and R&S SMBV-K103
Hardware in the loop (HIL)	no	yes	yes	R&S SMBV-K92 (motion only) and R&S SMBV-K103 (motion and attitude)

2.1.3 GNSS System Configurations

Instrument equipped with the GNSS basic options GPS, Galileo, GLONASS and BeiDou can be configured to generate the signal of hybrid GNSS satellite constellation with radio signals of all navigation standards. Mixed configurations are enabled only in the common or close-range frequency bands, e.g. L1/E1.

GNSS system configurations can be also used to configure general purpose global parameters for the simulation.

2.1.4 Multiple almanacs

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

The Galileo satellite constellation is not yet in orbit. Hence, no almanac files for Galileo are available. In this implementation, Galileo 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:

- U.S.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) whereas 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`
  whereas `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`

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

2.1.5 On-the-fly configuration of the satellites constellation

The simulation mode "User Localization" makes the satellite constellation user-definable. Not only the individual satellite parameters and the navigation message parameters are enabled for configuration, but active satellites can be turned off or the satellite constellation can be extended with new satellites at any time and **on-the-fly**, without causing an interruption of the currently running signal calculation. Changes in ephemeris of an active satellite and the power settings are performed without signal calculation restart, too. Hence, satellites ephemeris adjustment can be performed during the time the satellite is disabled and the updated parameters will be used from the moment this satellite is active again. This functionality can be used to perform manual exchange of satellite's at user defined moment of time.

This on-the-fly re-configuration during signal generation is especially beneficial by time consuming measurements or test.

2.1.6 Signal generation with projection of the ephemeris navigation data

The instrument employs a special algorithm for projecting the ephemeris navigation data that allows the generation of a navigation message without limitation in the simulation time. The ephemeris are updated and there is no limitation problem of maximum allowed time span of two hours (GPS) or half an hour (Glonass) between the simulation time and the reference time of the current satellite ephemeris page.

2.1.7 Dynamic exchange of satellites

In this implementation, the exchange of satellites can be performed automatically or be configured and triggered by the user.

- To enable the instrument to perform automatic exchange of satellites, select the "Auto Localization" mode.

In this mode, the instrument constantly monitors and updates the simulated satellite's constellation based on two criteria, the optimal satellite constellation with minimum PDOP and the satellite's visibility respecting the Elevation Mask. While the PDOP is a constellation parameter that is calculated by the instrument and displayed in real-time, the satellite's visibility is a satellite parameter which indicates that the satellite elevation at a specific user location is above a configurable elevation mask.

Depending on the current satellite's conditions and the used number of satellites, a sophisticated algorithm decides how often the PDOP and the satellite's visibility have to be proved and at which moment of time the satellite's constellation has to be changed. Satellites that do not fulfill the criteria for minimum PDOP and sufficient visibility are exchanged **dynamically and on-the-fly**. Information about the expected time of the next upcoming exchange is provided by the parameter Next Constellation Change.

The generic workflow is described in chapter 2.10.3, "Generating GNSS Signal with Automatic Dynamic Exchange of the Satellites (Auto Localization Mode)", on page 36.

- In "User Localization" mode the exchange of the satellites is not performed automatically, but the satellite's constellation is fully configurable. Satellites can be turned off, reconfigured and turned on again, the existing satellite constellation can be extended with new satellites. Hence, an exchange of the satellites can be configured and performed at any moment of time, as defined by the user.
The generic workflow is described in chapter 2.10.4, "Generating GNSS Signal with Manual Exchange of the Satellites (User Localization Mode)", on page 36.

2.1.8 Flexible power configuration and automatic dynamic power control

The instrument employs a dynamic power control concept. To provide better flexibility, two power modes are provided, the "Auto" and the "User" power modes.

- "User" power mode is intended for dynamical configuration of the power of each satellite separately and manually.
- "Auto" power mode enables an internal dynamical automatic power control. The power is calculated automatically based on the satellite-to-receiver distance which varies with the time.

Refer to chapter 3.6.1, "Power Configuration", on page 92 for examples and information about the power calculation.

The generic workflow is described in chapter 2.10.12, "Adjusting the Power Settings", on page 42.

2.1.9 Simulation of uninterrupted location fix

The simulation of uninterrupted location fix requires a GNSS signal that fulfills the following conditions:

- An optimal satellite's constellation is selected and monitored constantly, i.e. the exchange of the satellites is performed automatically

- The power of the satellites is monitored and updated constantly depending on the satellite-to-receiver distance and some channel parameters, e.g. atmospheric effects.
- The age of the ephemeris (t - toe) is respected, for example the simulation time is always within the allowed time span of 2h around the GPS reference time of the current ephemeris page. For GLONASS, this time is usually 30 minutes.

The table 2-2 gives an overview how these criteria are fulfilled by the provided localization modes.

Table 2-2: Criteria for the generation of GNSS signal for simulation of uninterrupted location fix

Criteria Simulation Mode	Optimal Satellite's Constellation	Power Monitoring and Update	Age of Ephemeris
"Auto Localization"	selected and updated automatically automatic dynamic exchange of the satellites	performed automatically	projection of the ephemeris from the almanac
"User Localization"	initial optimal satellite's constellation manual user-defined exchange of the satellites	performed automatically	projection of the ephemeris or many ephemeris pages are made available

Hence, both localization modes provide a realistic signal; the decision which localization mode will be used is a trade-off between the much better accuracy of the ephemeris retrieved from a RINEX file or a manual ephemeris configuration and the automatic selection of the optimal satellite's constellation with automatic exchange of the satellites.

The generic workflow is described in chapter 2.10.3, "Generating GNSS Signal with Automatic Dynamic Exchange of the Satellites (Auto Localization Mode)", on page 36 and chapter 2.10.4, "Generating GNSS Signal with Manual Exchange of the Satellites (User Localization Mode)", on page 36.

2.1.10   Real-Time S.P.O.T. display

The real-word situation of disappearance and re-appearance of satellites, as well as the dynamic display of several parameters like HDOP, PDOP, receiver's location, elapsed time and the trajectory of a moving receiver can be observed in real-time in the special "Real-Time S.P.O.T." (Satellites and Position Online Tracker) display.

The Real-Time S.P.O.T. display is enabled for "Auto Localization" and "User Localization" modes.

2.2   Realtime Option GPS P-Code (R&S SMBV-K93)

The option GPS P-Code (R&S SMBV-K93) is only available for instruments equipped with option GPS (R&S SMBV-K44). It enhances the option GPS with the functionality

to generate a position accuracy (P-Code) signal and allows the configuration of P or C/A+P satellite signals in addition to the civilian C/A signal enabled by the basic GPS option (R&S SMBV-K44).

P-Codes are one week long codes with a high chip rate 10.23 MHz. The higher chip rate significantly increases the performance compared to the civilian C/A codes used by commercial receivers, i.e. P-Code signal provide better Carrier to Noise sensitivity. Another difference compared to the C/A signals is that P-Code signals are only sensible to less than 30 m multipath delay whereas C/A signals are sensible to 300 m.

The generic workflow is described in chapter 2.10.10, "Generating GPS Signal Modulated with P Code", on page 40.

2.3 Enhancements of Realtime Assisted GNSS Options GPS, Galileo and GLONASS

This section gives an overview of the options Assisted GPS (R&S SMBV-K65), Assisted Galileo (R&S SMBV-K67) and Assisted GLONASS (R&S SMBV-K95).

● The option Assisted GPS (R&S SMBV-K65) is only available for instruments equipped with option GPS (R&S SMBV-K44). It enhances the basic option with functionality required for A-GPS/A-GNSS test scenarios for 3GPP FDD, GSM and EUTRA/LTE.

● The option Assisted Galileo (R&S SMBV-K67) is only available for instruments equipped with option Galileo (R&S SMBV-K66). It enhances the basic option with functionality to generate user defined test scenarios.

● The option Assisted GLONASS (R&S SMBV-K95) is only available for instruments equipped with option GLONASS (R&S SMBV-K94). It enhances the basic option with functionality required for A-GLONASS/A-GNSS test scenarios for 3GPP FDD and EUTRA/LTE.

2.3.1 Support of RINEX files

Additionally to the almanac files, a Receiver Independent Exchange Format RINEX files are supported. RINEX files are very well known and are standard formats generated by Control Stations (CS) and many commercial receivers. RINEX Navigation Files usually comprise the ephemeris sets for several satellites with different TOE and TOC. Hence, only one RINEX File is enough to describe satellite orbits for a period longer than 2 hours and sometimes up to 1 day.

Current RINEX files can be downloaded via the Internet and stored on the hard disk of the instrument, e.g. http://cddis.gsfc.nasa.gov/gnss_datasum.html#brdc or ftp://ftp.glonass-iac.ru/MCC/BRDC

2.3.2 Full Set of Pre-defined Test Scenarios as Basis for A-GPS/A-GLO-NASS/A-GNSS Protocol and Conformance Test Cases

An instrument equipped with the assisted options supports test scenarios as basis for A-GPS/A-GLONASS/A-GNSS Protocol and Conformance Test cases. Some of the test cases may require additional options.

Test scenario vs. test case

An instrument equipped with the required options provides predefined test scenarios, not the standard conform test cases!

The provided test scenarios are suitable basis for the test cases. However, to perform a particular test case as specified by the 3GPP test specification, you have to subsequently configure several settings. You may have to adjust the receiver location, the simulation time, active satellites in the pre-selected satellite constellation, power setting, etc.

Refer to the corresponding 3GPP test specification for the required values.

See also chapter 2.10.7, "Generating A-GNSS Test Signal", on page 39.

The table 2-3 lists the currently supported predefined A-GPS test scenarios.

Table 2-3: A-GPS test scenarios overview

Test Scenario	Required for Test Case	Required SW Option
	GSM	
3GPP TS 51.010: 10.9 Signaling	3GPP TS 51.010-1 v.7.7.0 10.9: A-GPS Signaling scenario	R&S SMBV-K44/-K65
3GPP TS 51.010: 10.10 Performance 1	3GPP TS 51.010-1 v.7.7.0 10.10: A-GPS Performance Test Scenario 1	R&S SMBV-K44/-K65
3GPP TS 51.010: 10.10 Performance 2	3GPP TS 51.010-1 v.7.7.0 10.10: A-GPS Performance Test Scenario 2	R&S SMBV-K44/-K65
3GPP TS 51.010: 10.10 Performance 3	3GPP TS 51.010-1 v.7.7.0 10.10: A-GPS Performance Test Scenario 3	R&S SMBV-K44/-K65/-K92
	3GPP FDD	
3GPP TS 34.108: 10.7 Signaling	3GPP TS 34.108 v.8.0.0 10.7: A-GPS Signaling scenario	R&S SMBV-K44/-K65
3GPP TS 34.108: 10.1.2 Performance 1	3GPP TS 34.108 v.8.0.0 10.1.2: A-GPS Performance scenario 1	R&S SMBV-K44/-K65
3GPP TS 34.108: 10.1.2 Performance 2	3GPP TS 34.108 v.8.0.0 10.1.2: A-GPS Performance scenario 2	R&S SMBV-K44/-K65
3GPP TS 34.108: 10.1.2 Performance 3	3GPP TS 34.108 v.8.0.0 10.1.2: A-GPS Performance scenario 3	R&S SMBV-K44/-K65/-K92
	3GPP2	
3GPP2 C.S0036: 2.1.1 Stationary	3GPP2 C.S0036-0 V1.0 2.1.1: A-GPS Stationary	R&S SMBV-K44/-K65
3GPP2 C.S0036: 2.1.2 Moving	3GPP2 C.S0036-0 V1.0 2.1.2: A-GPS Moving	R&S SMBV-K44/-K65/-K91/-K92

Test Scenario	Required for Test Case	Required SW Option
	EUTRA/LTE	
3GPP TS 37.571-2: S7 Signaling ST1	3GPP TS 37.571-2 v.10.0.0 subclause 7: A-GPS Signaling scenario, Subtest 1	R&S SMBV-K44/-K65
3GPP TS 37.571-1: S7 Performance 1 ST1	3GPP TS 37.571-1 v.10.0.0 subclause 7: A-GPS Performance scenario 1, Subtest 1	R&S SMBV-K44/-K65
3GPP TS 37.571-1: S7 Performance 2 ST1	3GPP TS 37.571-1 v.10.0.0 subclause 7: A-GPS Performance scenario 2, Subtest 1	R&S SMBV-K44/-K65
3GPP TS 37.571-1: S7 Performance 5 ST1	3GPP TS 37.571-1 v.10.0.0 subclause 7: A-GPS Performance scenario 5, Subtest 1	R&S SMBV-K44/-K65/-K92

The table 2-4 lists the currently supported predefined A-GLONASS test scenarios.

Table 2-4: A-GLONASS test scenarios overview

Test Scenario	Required for Test Case	Required SW Option
	3GPP FDD	
3GPP TS 37.571-2: S6 Signaling ST1	3GPP TS 37.571-2 v.10.0.0 subclause 6: A-Glonass Signaling scenario, Subtest 1	R&S SMBV-K94/-K95
3GPP TS 37.571-1: S6 Performance 1	3GPP TS 37.571-1 v.10.0.0 subclause 6: A-Glonass Performance scenario 1, Subtest 1	R&S SMBV-K94/-K95
3GPP TS 37.571-1: S6 Performance 2	3GPP TS 37.571-1 v.10.0.0 subclause 6: A-Glonass Performance scenario 2, Subtest 1	R&S SMBV-K94/-K95
3GPP TS 37.571-1: S6 Performance 5	3GPP TS 37.571-1 v.10.0.0 subclause 6: A-Glonass Performance scenario 5, Subtest 1	R&S SMBV-K94/-K95/-K92
	EUTRA/LTE	
3GPP TS 37.571-2: S7 Signaling ST2	3GPP TS 37.571-2 v.10.0.0 subclause 7: A-Glonass Signaling scenario, Subtest 2	R&S SMBV-K44/-K95
3GPP TS 37.571-1: S7 Performance 1 ST2	3GPP TS 37.571-1 v.10.0.0 subclause 7: A-Glonass Performance scenario 1, Subtest 2	R&S SMBV-K44/-K95
3GPP TS 37.571-1: S7 Performance 2 ST2	3GPP TS 37.571-1 v.10.0.0 subclause 7: A-Glonass Performance scenario 2, Subtest 2	R&S SMBV-K44/-K95
3GPP TS 37.571-1: S7 Performance 5 ST2	3GPP TS 37.571-1 v.10.0.0 subclause 7: A-Glonass Performance scenario 5, Subtest 2	R&S SMBV-K44/-K95/-K92

The table 2-5 lists the currently supported predefined A-GNSS test scenarios.

Table 2-5: A-GNSS test scenarios overview

Test Scenario	Required for Test Case	Required SW Option
	3GPP FDD	
3GPP TS 37.571-2: S6 Signaling ST4	3GPP TS 37.571-2 v.10.0.0 subclause 6: A-GNSS Signaling scenario, Subtest 4	R&S SMBV-K44/-K65/-K95
3GPP TS 37.571-1: S6 Performance 1 ST4	3GPP TS 37.571-1 v.10.0.0 subclause 6: A-GNSS Performance scenario 1, Subtest 4	R&S SMBV-K44/-K65/-K95

Test Scenario	Required for Test Case	Required SW Option
3GPP TS 37.571-1: S6 Performance 2 ST4	3GPP TS 37.571-1 v.10.0.0 subclause 6: A-GNSS Performance scenario 2, Subtest 4	R&S SMBV-K44/-K65/-K95
3GPP TS 37.571-1: S6 Performance 5 ST4	3GPP TS 37.571-1 v.10.0.0 subclause 6: A-GNSS Performance scenario 5, Subtest 4	R&S SMBV-K44/-K65/-K92/-K95
	EUTRA/LTE	
3GPP TS 37.571-2: S7 Signaling ST4	3GPP TS 37.571-2 v.10.0.0 subclause 7: A-GNSS Signaling scenario, Subtest 4	R&S SMBV-K44/-K65/-K95
3GPP TS 37.571-1: S7 Performance 1 ST5	3GPP TS 37.571-1 v.10.0.0 subclause 7: A-GNSS Performance scenario 1, Subtest 5	R&S SMBV-K44/-K65/-K95
3GPP TS 37.571-1: S7 Performance 2 ST5	3GPP TS 37.571-1 v.10.0.0 subclause 7: A-GNSS Performance scenario 2, Subtest 5	R&S SMBV-K44/-K65/-K95
3GPP TS 37.571-1: S7 Performance 5 ST5	3GPP TS 37.571-1 v.10.0.0 subclause 7: A-GNSS Performance scenario 5, Subtest 5	R&S SMBV-K44/-K65/-K92/-K95

The generic workflow is described in chapter 2.10.7, "Generating A-GNSS Test Signal", on page 39.

2.3.3 Custom build scenarios

The assisted options (R&S SMBV-K65/-K67/-K95) and are not limited to be used for A-GNSS testing exclusively. Despite the predefined scenarios, it is also possible to define any user-specific test scenario.

For testing of stand-alone GNSS receivers, the assisted options offer full flexibility on the simulated satellites including definition of the complete navigation message. The simulation mode "User Localization" can be used to get an optimal satellite's constellation and to adjust the navigation message to the exact requirements.

The basic BeiDou option (R&S SMBV-K107) is sufficient for this kind of tests. Additional assisted option is not required.

The generic workflow is described in chapter 2.10.5, "Generating A-GPS Custom Build Scenarios (User Localization Mode)", on page 37.

2.3.4 Generation of assistance data

Besides generating the satellite signals for predefined test scenario, the assisted options (R&S SMBV-K65/-K67/-K95) are also able to provide all kinds of assistance data in line with the simulated scenario which can be provided to the UE by a protocol tester.

Certainly, this also applies to user-defined test scenarios.

For the generation of A-BeiDou user-defined test signals, the basic BeiDou option (R&S SMBV-K107) is sufficient. Additional assisted option is not required.

Refer to chapter 2.9.1, "Example of A-GPS Test Setup", on page 34 for an example of the A-GPS setup. The generic workflow is described in chapter 2.10.8, "Generating GNSS Assistance Data", on page 39.

2.4 Realtime Option Extension to 12 / 24 Satellites (R&S SMBV-K91/-K96)

These options extend the maximum number of simulated satellites.

- Instrument equipped with the option R&S SMBV-K91 is enabled to generate the signal of up to 12 configurable satellites.
  Any hybrid 12-satellite configuration is possible, for example a combination like 10 C/A GPS + 1 Galileo E1 + 1 GLONASS R-C/A. The available satellites depend on the availability of the basic options, respectively on the enabled standards in the "GNSS System Configurations" and the selected "RF Band"

- The R&S SMBV-K96 requires the option R&S SMBV-K91 and further extends the maximum number of simulated satellites.
  Instruments equipped with this combination are enabled to generate the signal of up to 24 GPS C/A, Galileo E1, Glonass R-C/A and BeiDou B1-C/A satellites if the respecitvely GNSS basic option or a combination there of is available.
  The option R&S SMBV-K96 does not enhance the number of P-code satellites/taps.

2.4.1 Channel Budget

There is a limitation of the maximum number of simulated satellites, depending on whether P code signal and BeiDou satellites are enabled in the GNSS system configuration or not.

Without satellites using position accuracy (P-Code) signals

The generation of up to 24-GPS C/A, Galileo E1 and/or GLONASS satellites hybrid signal is possible when no P-Code signals are activated. For the Use Position Accuracy (P-Code) GPS= *Off* case the following rules apply:

- The total number of available resource units depends on the "Activate GNSS Standards > BeidDou" state as follows:
  – 14a + 10 b, if "BeidDou = Off"
  – 24a, if "BeidDou = On"
- Any of the GPS C/A, Glonass R-C/A and BeiDou B-C/A satellite/multipath tap channel consumes 1a or 1b resource units
- A Galileo E1 satellite/multipath tap consumes 1a or 2b

Example:

The table 2-6 lists some of the GNSS constellations with 24 satellites that can be achieved.

Table 2-6: Possible GNSS hybrid configurations with 24 satellites

GPS C/A signal	Galileo E1 signal	GLONASS R-C/A signal	BeiDou B-C/A
24	0	0	0
12	0	12	0
8	8	8	0
12	0	0	12
0	0	0	24
8	0	8	8
5	2	5	10
etc.			

With activated P-code in the GNSS system configuration

For enabled Use Position Accuracy (P-Code) GPS or Maximum Number of Satellites is less or equal to 24, only a subset of hybrid GNSS configurations are possible (see table 2-8).

The table 2-7 describes the number of C/A and P-Code resource units needed per signal when both the C/A GPS and position accuracy P-Code GPS signals are activated in GNSS system configuration.

Table 2-7: Number of resource units required per signal

Standard	Required option	"Signal"	c C/A resource units	p P-code resource units
GPS	R&S SMBV-K44	C/A	1	0
			0	1
	R&S SMBV-K44 and R&S SMBV-K93	P	0	1
		(C/A+P)Q	1	1
			0	2
Galileo	R&S SMBV-K66	E1	2	0
			1	1
			0	2
GLONASS	R&S SMBV-K94	R-C/A	1	0
			0	1

Standard	Required option	"Signal"	c C/A resource units	p P-code resource units
BeiDou	R&S SMBV-K107	B-C/A	1	0
			0	1

Example:

According to the table, the GPS (C/A+P)Q signal requires 1c + 1p or 2p units.

The total available budget when GPS and P-code signals are activated in a hybrid GNSS system configuration is 12c + 12p.

> Instruments equipped with R&S SMBV-K92 can generate multipath signal. The generation of multipath satellite signal with *n* taps requires *n* times more resource units.

Example:

The table 2-8 lists some of the GNSS constellations that can be achieved based on the table 2-7.

Table 2-8: Possible GNSS hybrid configurations

GPS (C/A +P)Q signal	GPS P signal	GPS C/A signal	Galileo E1 signal	GLONASS R-C/A signal
12	0	0	0	0
11	0	0	0	2
10	0	0	1	2
9	0	0	2	2
8	4	4	0	0
8	4	2	0	2
8	0	8	0	0
8	0	4	0	4
8	0	0	0	8
8	0	0	4	0
8	0	3	2	1
8	0	0	3	2
8	0	0	2	4
8	0	0	1	6
7	0	0	3	4
6	0	0	4	4
5	0	0	3	8

2.5 Functional Overview of Realtime Option GNSS Enhanced (R&S SMBV-K92)

This option enhances the basic options R&S SMBV-K44/K66/K94/K107 with the following functionality:

- support of motion files
- smoothening of the used defined trajectories
- real time motion vectors or hardware in the loop (HIL)
- modeling static multipath profiles
- configuration of atmospheric effects
- system time conversion
- leap second simulation parameters.

For detailed description see:

2.5.1 Moving Scenarios

The option GNSS enhanced (R&S SMBV-K92) enhances the basic GNSS options by user-definable moving scenarios.

The following test scenario require moving scenario:

- A-GPS test scenarios for 3GPP FDD and GSM (Performance Test Scenario#3)
- CDMA test case "3GPP2 Moving Test Scenario"
- A-GNSS Scenario 5 for EUTRA/LTE

Another application field of the moving scenarios is the testing of stand-alone GNSS receivers.

In the R&S SMBV, a movement, i.e. a moving receiver is defined in one of the following ways:

- by a waypoint file that simulates a "moving" of the connected GNSS receiver
  A waypoint can be defined with:
  - the WGS 84 geodetic coordinates, see chapter A.1.1.1, "Waypoint File Format", on page 293
  - the East-North-Upper (ENU) 2D vector trajectoryparameters (line, arc), see chapter A.1.1.2, "Vector Trajectory File Format", on page 294
- by extracting of the the location data from the NMEA files, see chapter A.3, "NMEA Scenarios", on page 306

- by configurable locations in Cartesian or geodetic coordinates with potentially defined velocity vector or velocity magnitude parameters in the `*.xtd` file, see
- by the provided predefined waypoint files for the land, ship, aircraft and spacecraft vehicles
- by the `KML` file format of third-party software, like the Google Earth, Google Maps etc. For description of the file format, refer to the Google Earth documentation.

Moving vs. motion

All these file formats describe a moving receiver and are suitable for the simulation of a movement from one waypoint to the next.

Howerver, only the more extensive file format `*.xtd` is suitable to describe a motion including high dynamics e.g. velocity and attitude. In instruments equipped with the R&S SMBV-K103 option, this file format simulates additionally a body rotation and attitude profile of the receiver's vehicle.

See also

2.5.2 Static Multipath Signal Generation

The instrument provides the possibility to simulate the GNSS signal of one or more satellites that undergoes static multipath propagation effects.

The generic workflow is described in

2.5.3 Configuration of the Atmospheric Parameters

In instruments equipped with the option GNSS enhanced (R&S SMBV-K92), the ionospheric navigation parameters and both ionospheric and tropospheric models of the installed GNSS standards are enabled for configuration.

A possible application of the activation and deactivation of the ionospheric and tropospheric models is to simulate the variation in the pseudorange of the corresponding GNSS satellites. The ionospheric navigation parameters only define what the satellites are transmitting as ionospheric correction parameters whereas the model configuration describes the actual ionospheric and tropospheric models used in the satellite-receiver channel simulation.

2.5.4 Time Conversion Configuration

The instrument supports an advanced function for transformation of the GNSS time to the universal time coordinate basis (UTC) and vice versa. The provided GNSS system time conversion parameters are zero-order and first order system clock drift parameters in addition to the current leap second. The leap second describes the difference between the GPS, Galileo, GLONASS or BeiDou system time and UTC system time. It

is for example possible to simulate a system time drift between GPS and Galileo by configuring different time conversion sets for both UTC-GPS and UTC-Galileo conversion parameters.

The time conversion parameters can be either manually configured or fetched from the RINEX header. It is recommended to keep the default configurations without system time offset and/or drift.

2.5.5 Leap Second Simulation

The instrument enables the simulation of leap second in a straightforward way. The simulation requires only the date and sign of the next leap second, further calculations are performed automatically.

2.5.6 Internal Waypoint Resampling

For the simulation of motion and body rotation, the R&S SMBV uses a 100 Hz internal resolution. The motion files you load into the instrument may contain waypoint and/or attitude coordinates with a resolution that is either not constant or different than the internally used one. The R&S SMBV interpolates (resamples) externally supplied files and transform the user-defined rates to the internal resolution.

The internal resampling algorithm is based on the great circle approximation. The instrument resamples the vehicle attitude (yaw/heading, pitch/elevation, roll/bank) parameters linearly in a common reference basis. Depending on the contents of the motion file, in particular on the way the velocity is defined, the resampling is performed accordingly.

2.5.7 Motion Smoothening Using Vehicle Description File

The selected motion file (e.g. waypoint file) may contain a set of random waypoints, without knowledge about the realistic dynamic. Smoothening is a function that regenerates the motion file based on the specified maximum dynamics (speed, acceleration and jerk) and sampling rate, as they are defined in the vehicle description file `*.xvd`.

This approach ensures smoothening of the abrupt changes in the direction or in the velocity of a moving object.

Main characteristics of the smoothening algorithm:
● modified version of linear segment parabolic blend algorithm (LSPB)
● guaranteed continuity in acceleration (limited Jerk) between the waypoints

The smoothening algorithm uses a user-defined proximity parameter to determine:
● the maximum deviation from the user's input waypoints
● the number of inserted waypoints along the great circle

With a proximity value of zero, the motion is formed entirely of straight segments. At any of the specified waypoints, each direction change causes a motion stop.

For more information, refer to chapter A.4.1, "Detailes on the Smoothening Algorithm", on page 307.

For description of the file formats, refer to chapter A.1.1, "Movement or Motion Files", on page 293 and chapter A.1.2, "Vehicle Description Files (Used for Smoothening)", on page 300.

2.5.8 Hardware in the Loop (HIL)

The term Hardware in the Loop (HIL) describes the mode in which the R&S SMBV acts as a slave and is remotely controlled by master application software (see figure 2-2). The application software sends remote control commands in real time, possibly from a flight simulator. The R&S SMBV processes the received position, motion and attitude information and generates the required signal. The output GNSS signal is provided back to the application or to the flight simulator.
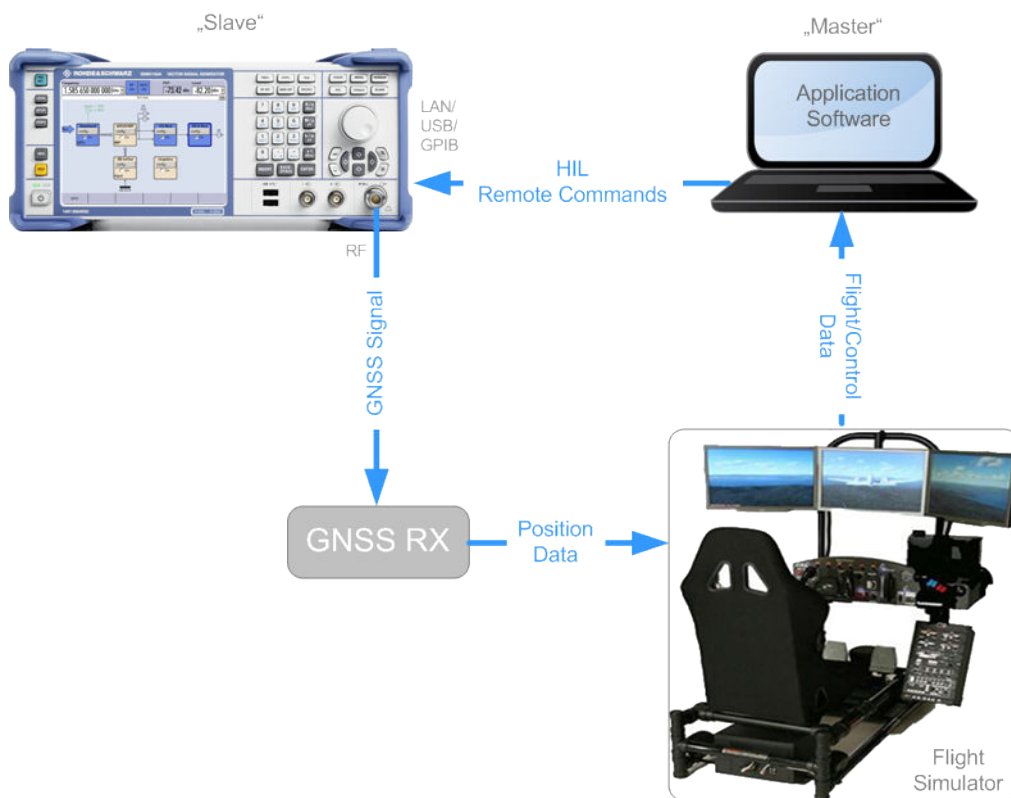
Fig. 2-2: Example of HIL test setup

To compensate for system latency, the R&S SMBV applies a prediction algorithm. The instrument uses the high order dynamics of the master application software and predicts the user's position at the subsequent GNSS signal update time.

The R&S SMBV accepts the real time HIL commands with a varying time resolution up to 100 Hz. If you enable the R&S SMBV to generate a 1PPS marker signal and synchronize the flight simulator to it, the flight simulator sends the real time commands right after 1PPS. This ensures a prediction latency of 10 ms.

2.6 Realtime Option GNSS Extension for Obscuration Simulation and Automatic Multipath (R&S SMBV-K101)

This option requires one of the basic realtime GNSS options R&S SMBV-K44, R&S SMBV-K66, R&S SMBV-K94 or R&S SMBV-K107. The automatic multipath functionality additionally requires the option R&S SMBV-K92.

In a real-word scenario, a static or a moving receiver may not always receive the signal of all theoretically visible satellites for its current position. In rural or suburban areas, in tunnels or in car parking places, some or more satellites may be partly or completely obscured by a wall or other vertical plane. Receivers experience additionally effects of signal reflection caused by a water surfaces (e.g. the sea) or the ground. This option enhances the basic GNSS options to automatically simulate different obscuration and multipath effects caused for example from surrounding buildings in static or moving scenarios, e.g. urban canyon.

The figure 2-3 is an example of a receiver placed in a car driving on a street. The combination option R&S SMBV-K101/-K92, allows you to define any test scenario, including the particular moving behavior and surrounding buildings with their height and the distance to the receiver, as well as the material they are built from.
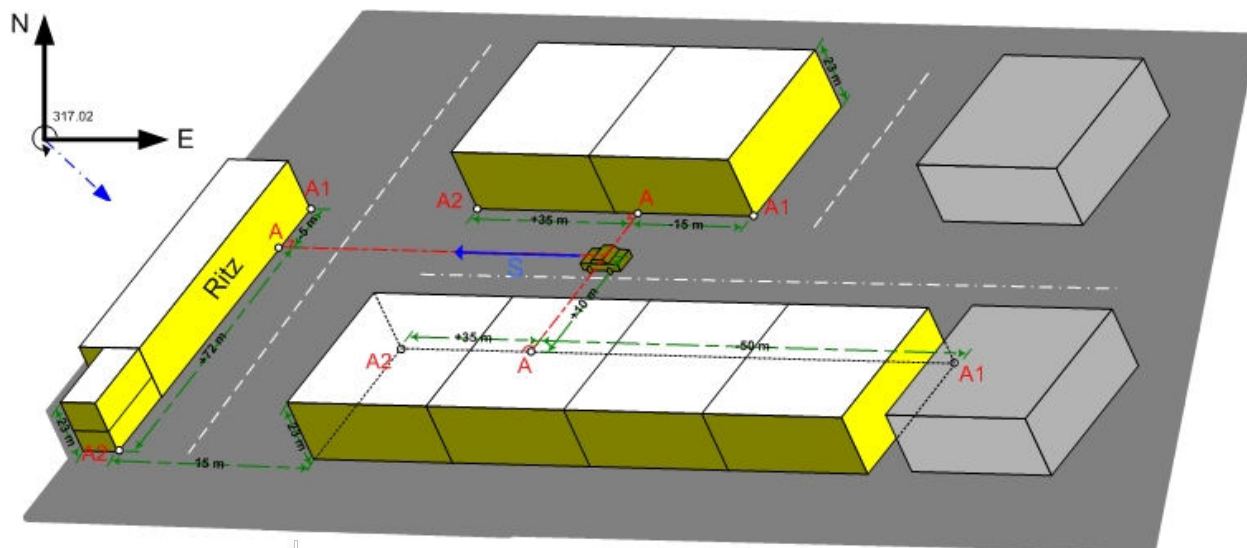

Fig. 2-3: Example: Vertical obstacles for simulation of obscuration and multipath from surrounding buildings

Approaches in the different simulation modes

In "User Localization" mode, the simulated user's environment conditions and effects are applied on the user defined subset of satellites.

In "Auto Localization" mode, the optimal satellites constellation is selected based on the enabled "Maximum Number of Satellites" and configured "Evaluation Mask". A line-of-sight propagation (LOS view) is assumed in the first stage and the satellites constellation is selected to minimize the HDOP/PDOP. Only now, the selected constellation is filtered by simulating the "user environment" model's obscuration and multipath effects on the satellite constellation. The satellite constellation is constantly proved and a satellite handover is performed automatically, whenever a new satellite appears or because of the receiver's movement profile, a satellite is not any more obscured.

To simulate a real-life scenario, it is recommended that you enable a hybrid GNSS simulation with 24 satellites. Refer to the corresponding description for an overview of all required options.

Internal sampling rate

The R&S SMBV samples the user's environment different, depending whether only obscuration or the combination of obscuration and automatic multipath is simulated. For example, the sampling rate of the model "Urban canyon" is 10 Hz if only obscuration is enabled and 5 Hz in the other case.

Error Message: Cut in the scenario dynamics

If a multipath scenario requires more than the maximum available channel budget, the instrument cuts the scenario dynamics.

See also chapter 2.4.1, "Channel Budget", on page 23.

2.7 Realtime Option GNSS Extension for Antenna Pattern (R&S SMBV-K102)

This option requires one of the basic realtime GNSS options R&S SMBV-K44, R&S SMBV-K66, R&S SMBV-K94 or R&S SMBV-K107.

This option enhances the basic options with the definition of different antenna patterns, body masks and the simulation of real-life scenarios, like a GNSS antenna placed in a car (see table 2-9). The instrument provides an interface for loading user-defined antenna patterns. The antenna patterns have to be defined in files with predefined file format and file extension `*.ant_pat` (see chapter A.1.3, "Antenna Pattern / Body Mask Files", on page 301).

Possible application fields

This option enables you to automatically simulate satellite power and carrier phase depending on the antenna pattern and the attitude parameters.

- Automotive applications
  The provided attitude parameters can forced to the motion direction, i.e. they are automatically extracted from the user-defined motion vector.
- Body mask applications

Two files describe an antenna, the antenna pattern `*.ant_pat` file and the phase response `*.phase` file.
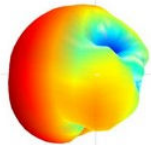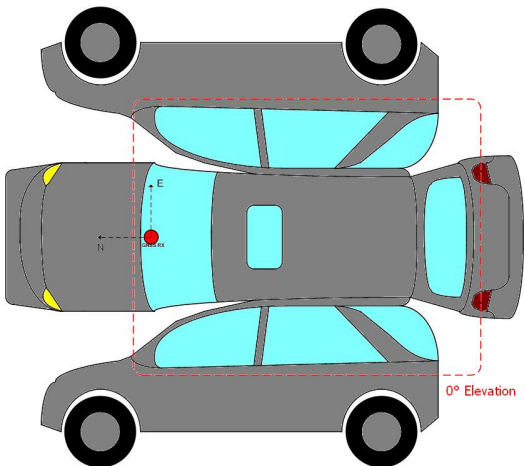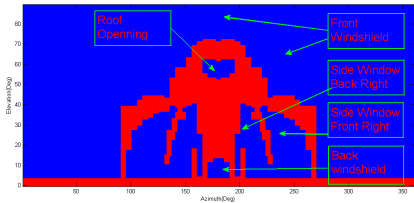
Both files must have the same file name and must be stored in the same directory. The `*.ant_pat` file describes the power response matrix of each antenna. The instrument retrieves the phase response matrix from the `*.phase` file.

If the required `*.phase` file does not exist, the instrument sets the carrier phase matrix to zero.

● Outdoor scenarios
  If the instrument is equipped with both options R&S SMBV-K101/-K102, the antenna pattern is applied on reflections from the defined user environment, e.g roadside plane.

● Indoor absorption scenarios
  The provided antenna pattern can be used to simulate the signal absorption as well as the carrier phase bias from every angle around a GNSS receiver.

The provided `*.ant_pat` file format enables you to define up to four antennas per vehicle and to perform antenna switching trough real time scheduling (see `<subsystem>:APATtern:ANTenna:ID`). The resolution of the antenna pattern power response and carrier phase offsets can go to 1° for both, the elevation and azimuth.

Table 2-9: Example: Power response matrix due to a car's body mask

Power and phase profile of an antenna	Car body mask	Power response matrix of the antenna (`*.ant_pat` file)

You can also load antenna patterns measured by some over-the-air (OTA) measurements, e.g the R&S®DST200 RF Diagnostic Chamber.

2.8 Realtime Option GNSS Extension for Spinning and Attitude Simulation (R&S SMBV-K103)

This option requires the GNSS option R&S SMBV-K102.

This option allows you to configure a vehicle attitude or the body rotation parameters yaw, pitch, and roll. The R&S SMBV calculates the power and the carrier phase response of a specific satellite or a multipath reflection at a specific angle of arrival (AoA). The calculation is based on the defined attitude profile and the selected antenna pattern. The firmware updates the powers and carrier phase offsets of all satellite signals in real time and with an update rate of 800 Hz.

In a real-word scenario, a receiver placed in an airplane may not always receive the signal of all theoretically visible satellites at its current position. Depending on the orientation of the vehicle, several satellites may be partly or completely obscured. The orientation of the vehicle is described with the three flight dynamics parameters, the yaw (heading), pitch (elevation) and roll (bank), see figure 2-4. With enabled spinning, the instrument additionally simulates a constant rate of change of the roll.
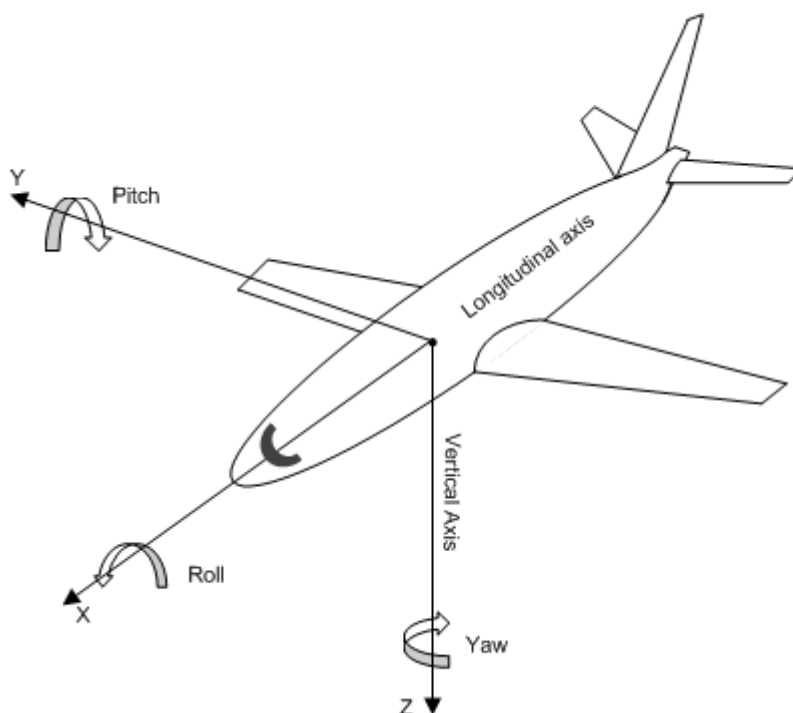
Fig. 2-4: Flight dynamics parameters: yaw/heading, pitch/elevation and roll/bank

2.9 Realtime Test Setups

2.9.1 Example of A-GPS Test Setup
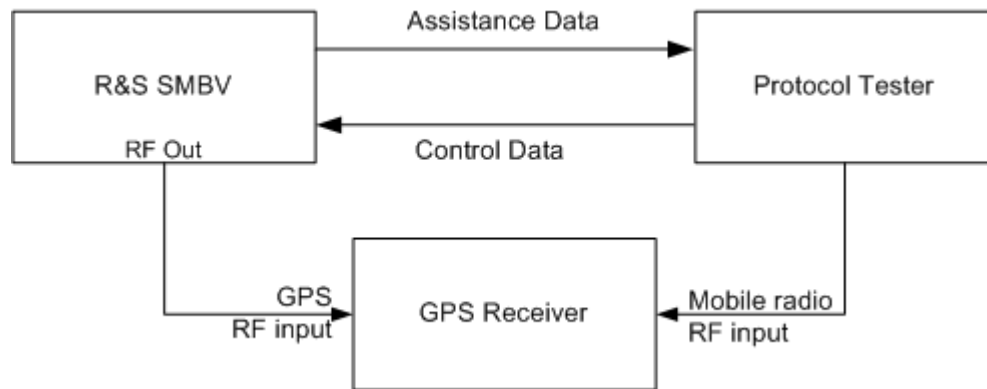
Fig. 2-5: Example of A-GPS Test Setup

2.10 Typical Realtime Workflow

The workflow examples provided in this section assume an instrument, fully equipped with all available GNSS options.

2.10.1 General Workflow

This section introduces the general workflow for configuring the primary settings, that are common for almost all further configurations workflow. The block diagram on the figure 2-6 shows an overview of the common configuration steps.

Step#

① Select Entry Point

② Execute „Set to Default"

③ Select „RF Band" and perform „Update RF Frequency"

④ Enable hybrid „GNSS System Configuration" (opt.)

⑤ Select „Simulation Mode"

General Settings

Auto&User Localization

Static

⑥ Define vehicle, configure static/movig „Ref. Location"

⑦ Adjust the „Obscuration&Auto Multipath" settings

⑧ Select „Antenna Pattern/Body Mask File"

„User Environment"

⑨ Select „Data Source"

Static&Auto Localization   User Localization

⑩ Select „Almanac"   Select „Almanac/RINEX" file

⑪ Adjust RINEX file settings

⑫ Adjust Simulation Start Time

„Navigation Data"

⑬ Set „Max. Number of Satellites" and adjust Satellite Constallation

User Localization

⑭ Static&Auto Localization   „Get Optimal Constellation"

⑮ Select „Power Mode" and adjust power settings

Static&User Localization

⑯ Auto Localization   Configure „Nav. Message" (opt.)

⑰ Adjust „Atmospheric Configiguration" (opt.)

User Localization

⑱ Static&Auto Localization   Enable static „Multipath" (opt.)

„Satellite Configurations"

⑲ Set „GNSS State" to ON

⑳ Open the „Real-Time S.P.O.T" display and compare the settings

Fig. 2-6: General workflow

2.10.2 Generating GNSS Signal for Simple Receiver Tests (Static Mode)

1. Perform steps 1 to 3 according to General Workflow.

2. If required, select "GNSS System Configuration" and enable a hybrid GNSS satellite constellation.

3. Select "GNSS Main Dialog > Simulation Mode > Static".

4. Perform relevant steps 9 to 17 from General Workflow.

5. Select "GNSS Main Dialog > State > ON".

    The generated GNSS signal is calculated according to the satellite configuration settings, the selected almanac file and selected moment of time (date and time).

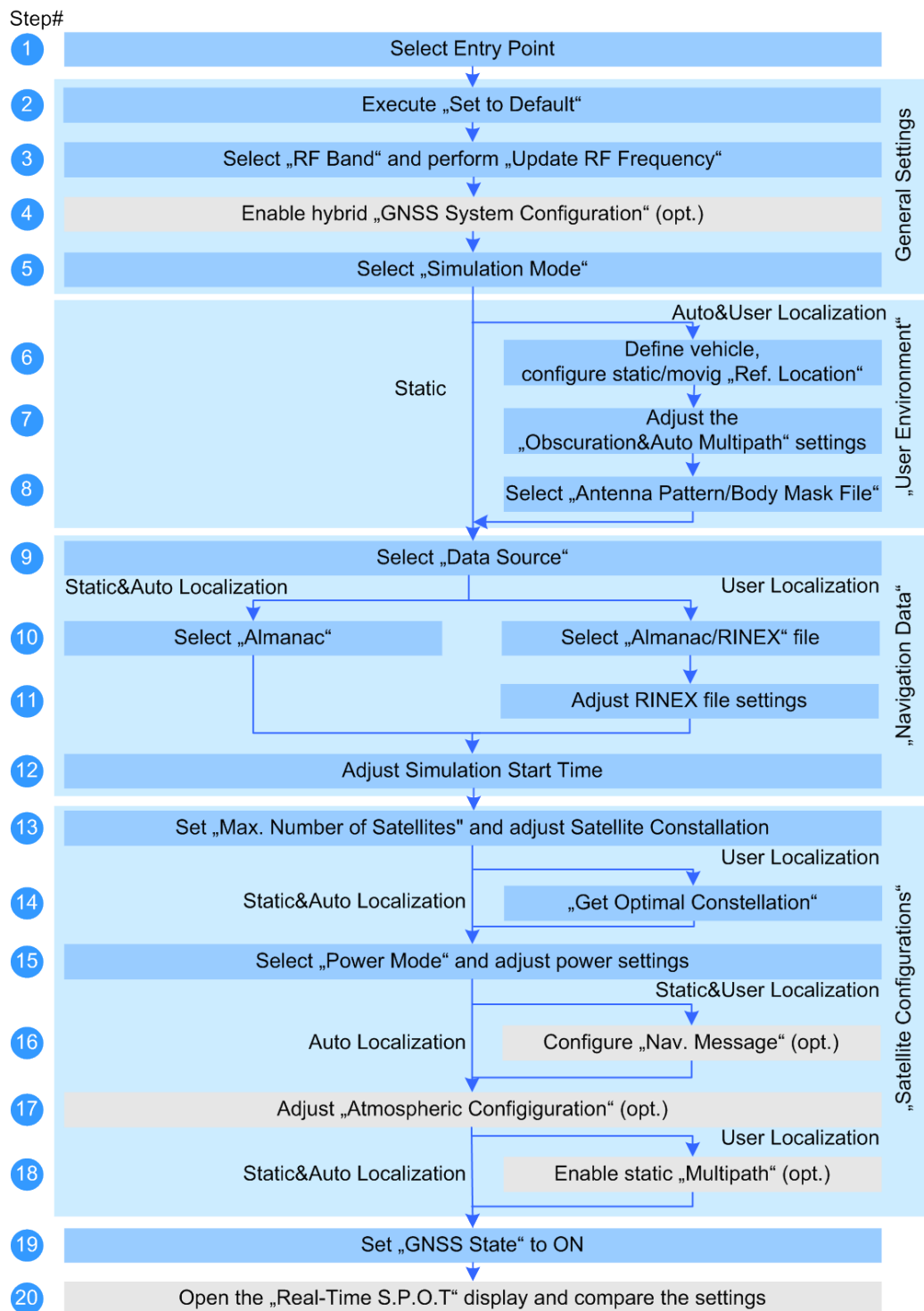### 2.10.3 Generating GNSS Signal with Automatic Dynamic Exchange of the Satellites (Auto Localization Mode)

1. Perform steps 1 to 3 according to General Workflow.

2. Select "GNSS Main Dialog > Simulation Mode > Auto Localization".

3. Perform relevant steps 6 to 17 from General Workflow.

4. Select "GNSS Main Dialog > State > On".

    The instrument generates the GNSS signal for the selected satellites' constellation, calculated to fulfill the minimum PDOP and satellite visibility criteria. The selected satellites are dynamically and on-the-fly exchanged as soon as an exchange of satellites is necessary. The satellites parameters displayed in the "Satellite Configurations" dialog and the "Navigation Message" parameters are read-only.
    Open the Real-Time S.P.O.T. display to show the position of the active and inactive satellites. The current values of the parameters "PDOP/HDOP", "Receiver Location" and simulation "Time" are also displayed. If a moving receiver has been configured, the "Real-Time S.P.O.T. > Map View" displays the trajectory the receiver should have.

2.10.4 Generating GNSS Signal with Manual Exchange of the Satellites (User Localization Mode)

1. Perform steps 1 to 3 according to General Workflow.

2. Select "GNSS Main Dialog > Simulation Mode > User Localization".

3. Perform steps 6 to 18 from General Workflow.

       a) To reproduce the exact satellite navigation message, it is recommended to select a RINEX file, if one exists.
For more information, see chapter 2.10.11, "Configuring the Navigation Parameters", on page 41.

       b) If required, select "GNSS Main Dialog > Satellite Configuration > Atmospheric Configuration" and adjust the settings.

       c) If required, select "GNSS Main Dialog > Satellite Configuration > Time Conversion Configuration" and adjust the settings.

       d) Select "GNSS Main Dialog > Satellite Configuration > Power Mode > Auto" to enable the dynamic automatic calculation of the power level and adjust the required power settings.
For more information, see chapter 2.10.12, "Adjusting the Power Settings", on page 42.

4. Select "GNSS Main Dialog > State > On".

   The instrument generates the GNSS signal for the selected satellites' constellation. The satellite parameters can be additionally reconfigured to simulate multipath effects for instance (see also chapter 2.10.9, "Generating Multipath Scenarios", on page 40).
   Open the Real-Time S.P.O.T. display to show the position of the active and inactive satellites. The current values of the parameters "PDOP/HDOP", "Receiver Location" and simulation "Time" are also displayed. If a moving receiver has been configured, the "Real-Time S.P.O.T. > Map View" displays the trajectory the receiver should have.

5. To trigger a manual satellite's exchange for Sat#3 for instance, select "GNSS Main Dialog > Satellite Configuration > Sat#3 > State > Off".

6. Select "Satellite Configuration > Sat#3 > Navigation Message" and adjust the parameters as required.

7. Enable the satellite again or add a new satellite to the satellite's constellation.

   The Real-Time S.P.O.T. displays the updated position of the active and inactive satellites.

2.10.5 Generating A-GPS Custom Build Scenarios (User Localization Mode)

This description lists the steps necessary to configure an A-GPS custom build scenario and explains the configuration in principle. The required steps for the other assisted scenarios are analogical.

1. Perform steps 1 to 3 according to General Workflow.

2. Select "GNSS Main Dialog > Simulation Mode > User Localization".

3. Perform steps 6 to 19 from from General Workflow.

a) It is recommended to select a RINEX file, if one exists.
For more information, see chapter 2.10.11, "Configuring the Navigation Parameters", on page 41.

b) Select a start simulation time around to beginning of the ephemeris span.
For GPS, the age of ephemeris is 2 hours and the selectd simulation time is aligned to the even hours of the day, for example, 00:00, 02:00, 04:00 etc.
See also chapter 2.1.9, "Simulation of uninterrupted location fix", on page 17.

c) Disable "Satellite Configuration > Global Ephemeris Real-Time Projection".

d) Select "Satellite Configuration > Sat# > Navigation Message" and adjust the parameters as required.
Note: The parameters "Satellite Configuration > Global Ephemeris Real-Time Projection" and "Satellite Configuration > Sat# > Navigation Message > Real-Time Projection" must be disabled!

e) Select "GNSS Main Dialog > Satellite Configuration > Power Mode > User" and adjust the required power settings.
For more information, see chapter 2.10.12, "Adjusting the Power Settings", on page 42.

4. Select "GNSS Main Dialog > State > On".

5. Generate the required "Assistance Data" (see also chapter 2.10.8, "Generating GNSS Assistance Data", on page 39).

The instrument generates an A-GPS signal according to the settings made.

2.10.6 Generating A-GPS Test Signal

The generic workflow for generation of A-GPS test scenarios in conformance to A-GPS 2G/3G Protocol and Conformance Test Cases is as follow:

1. Execute "GPS Main Dialog > Set To Default" to adjust the instrument's settings to a standard set of operating conditions.

2. Select "GPS Main Dialog > Test Scenario > A-GNSS" and select a predefined GSM, 3GPP FDD, 3GPP2 (CDMA2000) or EUTRA/LTE test scenario.
See also chapter 2.3.2, "Full Set of Pre-defined Test Scenarios as Basis for A-GPS/A-GLONASS/A-GNSS Protocol and Conformance Test Cases", on page 20.

3. Select "GNSS Main Dialog > State > ON".

The instrument generates an A-GPS signal according to the selected test scenario. Refer to the corresponding specification and customize the test scenario signal for the predefined specific test case, i.e. perform the necessary changes on the satellite constellation, receiver location, simulation time and power settings.

2.10.7   Generating A-GNSS Test Signal

The generic workflow for generation of A-GNSS test scenarios in conformance to Protocol and Conformance Test Cases is as follow:

1. Select "GNSS Main Dialog > Set To Default" to adjust the instrument's settings to a standard set of operating conditions.

2. Select "GNSS Main Dialog > Test Scenario > A-GNSS" and select a predefined 3GPP FDD or EUTRA/LTE test scenario, e.g. "3GPP TS 37.571-2: S7 Signaling ST4".

3. Select "GNSS Main Dialog > State > ON".

    The instrument generates an A-GNSS signal according to the selected test scenario.
    Refer to the corresponding specification and customize the test scenario signal for the predefined specific test case, i.e. perform the necessary changes on the satellite constellation, receiver location, simulation time and power settings.

2.10.8   Generating GNSS Assistance Data

This step-by-step description explains the configuration in principle.

> In hybrid A-GNSS scenario, generate the assistance data of the GNSS standards separately in different files.

1. Select "GNSS Main Dialog > Simulation Mode > User Localization" and perform the required settings (see e.g. chapter 2.10.5, "Generating A-GPS Custom Build Scenarios (User Localization Mode)", on page 37).

2. Execute "GNSS Main Dialog > Assistance Data" and select the "Assistance Mode > A-GPS/A-Galileo/A-GLONASS".

3. Select "Synchronize All" to align the assistance data settings with the settings that have been already made for the satellites of the selected standard.

4. If required, reselect the space vehicles for which assistance data is to be generated.

5. Reconfigure the reference location (i.e. enter the coordinates of the BS location instead of receiver location).

6. Adjust the "Duration" and the "Resolution" of assistance data.

7. Select the "Assistance Data generation > Acquisition Data Format".

8. Generate the required assistance data (almanac file, ionospheric file, etc.).

    The generated assistance data files are stored in the selected folder. Refer to the description of the corresponding file for description of the file format used.

2.10.9 Generating Multipath Scenarios

1. Perform steps 1 to 3 according to General Workflow.

2. Select "GNSS Main Dialog > Simulation Mode > User Localization".

3. Select "Satellite Configuration > Sat# > Multipath".

4. Select the "Number of Taps" and configure the additional "Time Shift", "Power", "Doppler Shift" and "Carrier Phase" per tap.

5. Select "Multipath Configuration > State > On".

    The graph displays the selected propagation conditions.

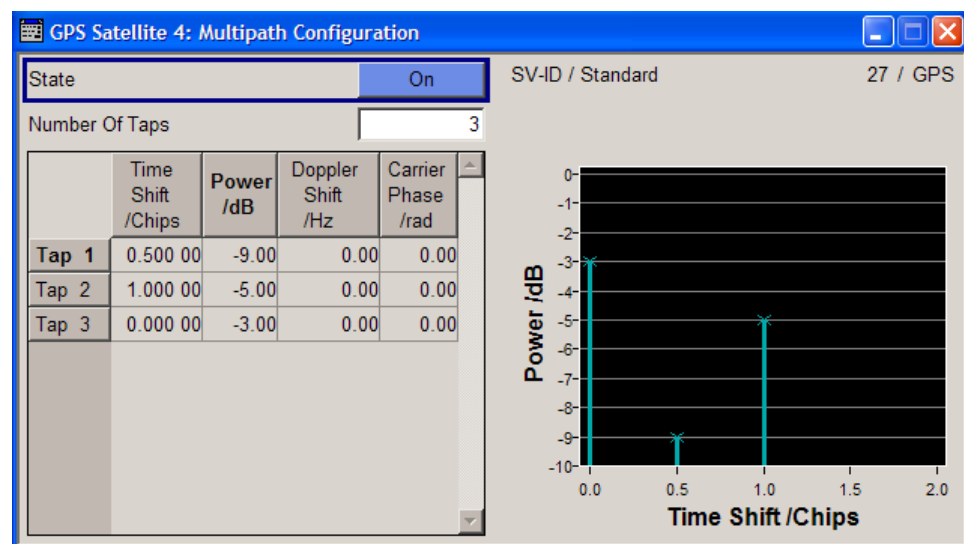*Fig. 2-7: Example of "Multipath Configuration"*

6. Select "GNSS Main Dialog > State > On".

    The instrument will generate the GNSS signal of satellites that experience static multipath propagation.

2.10.10 Generating GPS Signal Modulated with P Code

1. Perform steps 1 to 3 according to General Workflow.

2. In the "GNSS System Configuration" dialog enable "Activate GNSS Standards > GPS".

3. Enable "GNSS System Configuration > Use Position Accuracy (P-Code)".

4. In "Simulation Mode > User Localization", select "Satellite Configurations > Sat# > Standard > GPS" and enable "Signals > P" or "C/A+P" for this GPS satellite as required.

   Tip: Not enough hardware resources. This warning message appears and the satellite is disabled if the available hardware resources are not enough to generate the desired signal.
   Hybrid GNSS constellations, multipath configurations, signals modulated by P code and activated satellites consume hardware resources. Refer to chapter 2.4.1, "Channel Budget", on page 23 for description on the how the available hardware resources are distributed.

5. In "Simulation Mode > Auto Localization", select "Satellite Configurations > Global Signal Config" and adjust the signals of the GPS satellites.

6. Perform relevant steps 5 to 19 from General Workflow.

7. Select "GNSS Main Dialog > State > ON".

   The instrument generates the GNSS signal for the selected satellites' constellation.

2.10.11 Configuring the Navigation Parameters

Extracting the navigation message from the almanac file

► Select "GNSS Main Dialog > Almanac" and select an almanac file.

   The almanac file is used to extract all navigation parameters. These parameters are transmitted as part of the navigation message.

Manual configuration of the navigation parameters

1. Select "GNSS Main Dialog > Simulation Mode > User Localization".

2. Select "GNSS Main Dialog > Satellite Configuration > Sat# > Navigation".

3. Adjust the "Navigation Message Configuration > Number of Pages"

4. Select "Navigation Message Configuration > Page Number" and configure the content of the selected ephemeris page(s).

5. Repeat steps 2 to 4 for all GNSS satellites

Extracting the ephemeris, the satellite clock correction parameters and the GLONASS frequency numbers from RINEX file

1. Select "GNSS Main Dialog > Simulation Mode > User Localization".

2. Select "GNSS Main Dialog > RINEX" and select RINEX file.

3. Select "GNSS System Configuration > RINEX Configuration > Import RINEX Files".

4. Enable "GNSS System Configuration > RINEX Configuration > Update Frequency Number (GLONASS) > On".

5. Select "GNSS System Configuration > RINEX Configuration > State On".

    The ephemeris and satellite clock correction part of the navigation message are extracted from the selected RINEX file for a GNSS system and used to simulate the position of the satellites of this particular GNSS system. If a GLONASS file is used, the frequency number allocations are also extracted.
    The ephemeris and the clock correction parameters and, for GLONASS satellites, the frequency number allocation of all satellites that are not available in the RINEX files or had not been configured manually are extracted from the selected almanac of the corresponding GNSS system.

Extracting the ionospheric and time conversion parameters from RINEX file

1. Select "GNSS Main Dialog > Simulation Mode > User Localization".

2. Select "GNSS Main Dialog > RINEX" and select RINEX file.

3. Perform "GNSS System Configuration > RINEX Configuration > Import RINEX Files".

4. Enable "GNSS System Configuration > RINEX Configuration > Update UTC and Atmospheric Parameters".

5. Select "GNSS System Configuration > RINEX Configuration > State On".

    The ionospheric and time conversion parameters are extracted from the header of the selected RINEX file.
    If required, adjust the extracted ionospheric and time conversion parameters.

2.10.12 Adjusting the Power Settings

Refer to chapter 3.6.1, "Power Configuration", on page 92 for explanation and example on the power level calculation.

Power settings in "Auto" power mode

We assume, that the reference power is specified by a reference satellite.

1. Select "GNSS Main Dialog > Satellite Configuration > Power Mode > Auto".

2. Set the "Satellite Configuration > Reference Power".

3. Set the "Satellite Configuration > Reference Satellite".

4. If a hybrid "GNSS System Configuration" is activated, select "Satellite Power Tuning > Inter-Standard Tuning > Set to Standard" to simulate the nominal power difference between the GNSS standard as defined in the standard.

5. For the satellites undergoing static multipath effects:

      a) Select "Sat# > Multipath Configuration > Power" and adjust the power level of the corresponding fading tap.

      b) Enable "Multipath Configuration > State > On".

6. Set "GNSS Main Dialog > State > On".

    The power level of the generated GNSS signal is displayed with the parameter "Total Power".

The power levels displayed in the "Satellite Configuration > Constellation Table" are the power level at the simulation's start moment.

Select "Real-Time SPOT > Display Type > Power View" to display the current power levels.

Power settings in "User" power mode

This power mode is enabled in both "Auto Localization" and "User Localization" simulation modes.

1. Select "GNSS Main Dialog > Satellite Configuration > Power Mode > User".

2. Set the "Satellite Configuration > Reference Power".

3. Set the "Satellite Configuration > Constellation Table > Sat# > Power" level of the individual satellites.

4. For the satellites undergoing static multipath effects:

      a) Select "Sat# > Multipath Configuration > Power" and adjust the power level of the corresponding fading tap.

      b) Enable "Multipath Configuration > State > On".

5. If you work in "Auto Localization" mode, select "Satellite Configuration > Global Signal and Relative Power Configuration" and allocate the signals and the power values for the satellites that are not simulated yet.

6. If not already enabled, set "GNSS Main Dialog > State > On".

    The power level of the generated GNSS signal is displayed with the parameter "Total Power".

2.10.13 Handling NMEA Files

1. On your receiver, record the NMEA messages to a log file with an extension `*.nmea`.

2. Use an external hard disk, USB stick or a LAN connection and transfer this NMEA log file to a network directory or the instrument.

3. Select the "GNSS main dialog > Geographic Location > Waypoints".

4. Select the "GNSS main dialog > Select Waypoint File", navigate to the directory the loaded NMEA file is stored and select the file.

   The instrument decodes the logged NMEA file (`*.nmea`) and automatically configures the user location to the values retrieved from the logged file. The information about possible receiver's moving is considered too.
   If required, re-configure the automatically applied settings.

> The instrument decodes the complete NMEA file but settings related to deactivated or not installed navigation standards are ignored.

> Refer to chapter A.3, "NMEA Scenarios", on page 306 for detailed description of the NMEA file format.

2.10.14 Creating GNSS Scenarios in a User Environment

The R&S SMBV provides predefined files and settings to simplify the configuration of common scenarios. If you relay on the predefined files, it is recommended that you use the combinations listed in table 2-10.

Table 2-10: Suitable configurations

| Scenario	"Vehicle Type"	Predefined Vehicle Description File	Waypoint File	"Obscuration&Auto Multipath > Type"	"Antenna Pattern/Body Mask File"
Urban Canyon	Pedestrian Land Vehicle	Pedestrian1.xvd Land Vehicle1.xvd	Scen_Urban_Canyon_1.txt	Urban Canyon	Car_Medium Car_Medium_OpenRoof SUV VAN
City Block	Pedestrian Land Vehicle	Pedestrian1.xvd Land Vehicle1.xvd	Scen_City_Block.txt	City Block	Car_Medium Car_Medium_OpenRoof SUV VAN
Suburban	Pedestrian Land Vehicle	Pedestrian1.xvd Land Vehicle1.xvd	Scen_Circle_5km.txt	Suburban Area	Car_Medium Car_Medium_OpenRoof SUV VAN
Highway/Cutting	Land Vehicle	Land Vehicle1.xvd	Scen_Circle_5km.txt	Highway Cutting	Car_Medium Car_Medium_OpenRoof SUV VAN

Scenario	"Vehicle Type"	Predefined Vehicle Description File	Waypoint File	"Obscuration&Auto Multipath > Type"	"Antenna Pattern/Body Mask File"
Parking	Land Vehicle	Land Vehicle1.xvd	Scen_Parking_1min.txt Scen_Parking_10min.txt Scen_Parking_1h.txt	Parking - 1min Parking -10 min Parking -1 h	Car_Medium Car_Medium_OpenRoof SUV VAN
Bridge/Tunnels	Land Vehicle	Land Vehicle1.xvd	Scen_Circle_5km.txt	Bridge 1 Bridge 2 Long Tunnel Multiple Tunnels	Car_Medium Car_Medium_OpenRoof SUV VAN

To configure a city block scenario

This step-by-step description is based on the scenario City Block (see table 2-10) and explains the configuration steps in principle. The main goal is to demonstrate the impact of enabled obstacles and multipath effects on the simulated signal.

1. Execute "GNSS Main Dialog > Set To Default" to adjust the instrument's settings to a standard set of operating conditions.

2. Select "GNSS Main Dialog > GNSS System Configuration" and enable the required navigation systems, e.g. a hybrid GPS, Galileo and GLONASS configuration.

3. Enable "GNSS Main Dialog > Simulation Mode > Auto Localization".

4. Select "GNSS Main Dialog > Satellite Configuration > Maximum Number of Satellites > 24".

5. Select "GNSS Main Dialog > User Environment > Vehicle Type > Land Vehicle"

6. Select "GNSS Main Dialog > User Environment > Vehicle Description File" and select `LandVehicle1`.

7. Select "GNSS Main Dialog > Localization Data" and select "Geographic Location/ Attitude > Waypoints" to enable a moving receiver.

8. In the "Localization Data" dialog:

    a) select "Waypoints File > Select Predefined Waypoints", navigate to a predefined moving scenario, e.g. `Scen_City_Block.txt` and execute "Select"
   b) select "Read Out Mode > Round Trip"

    Tip: In automotive applications and if the instrument is not equipped with option R&S SMBV-K103, force the attitude to the motion direction of the vehicle. The attitude parameters are extracted from the selected waypoint file.

9. Select "GNSS Main Dialog > State > On" to enable signal generation.

10. Select "GNSS Main Dialog > Real-Time S.P.O.T > Display Type > Sky View" to visualize the automatically selected satellite constellation.
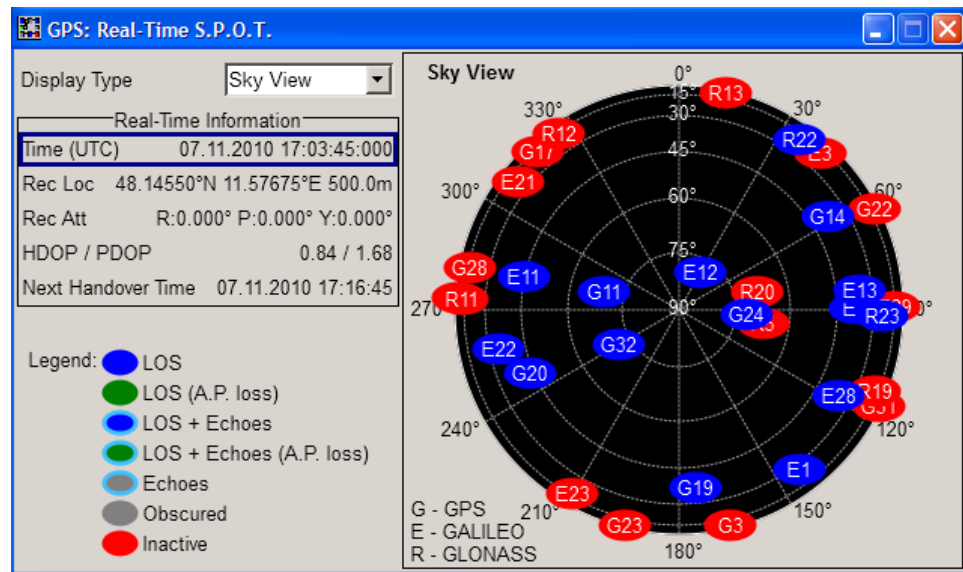
The "Sky View" displays the satellite constellation with the active GNSS satellites. To observe the movement trajectory, use the "Display Type > Map View".

11. Select "GPS Main Dialog > Obscuration&Auto Multipath > Type > City Block" and enable "Physical Model > Obscuration Only".

The instrument applies automatically the predefined "Obstacles File > City_Block" to simulate a real word environment conditions
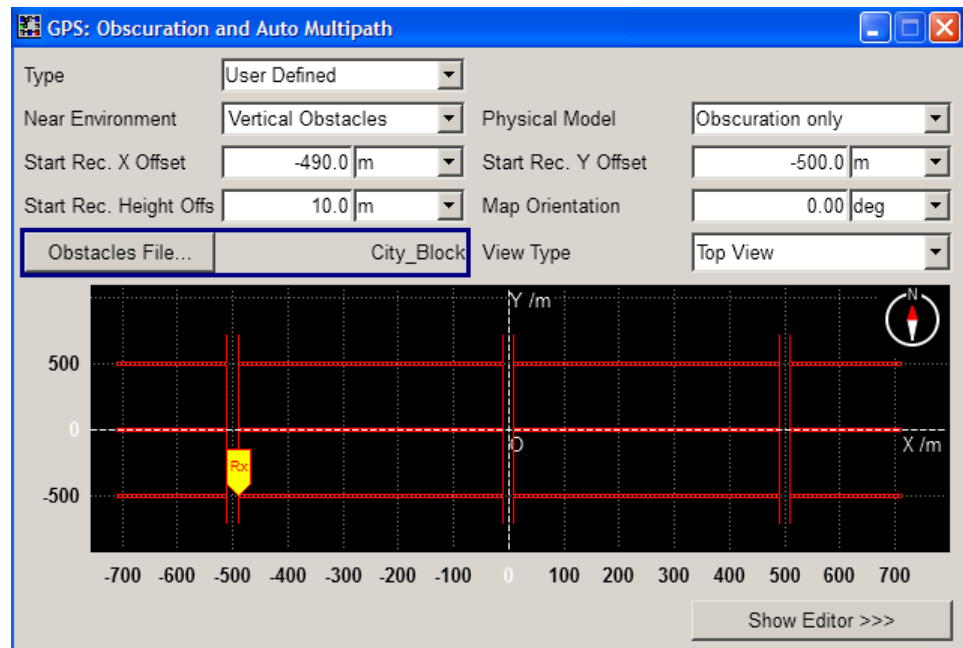

12. In the "GPS Main Dialog > Real-Time S.P.O.T > Display Type > Sky View", compare the displayed satellite constellation.
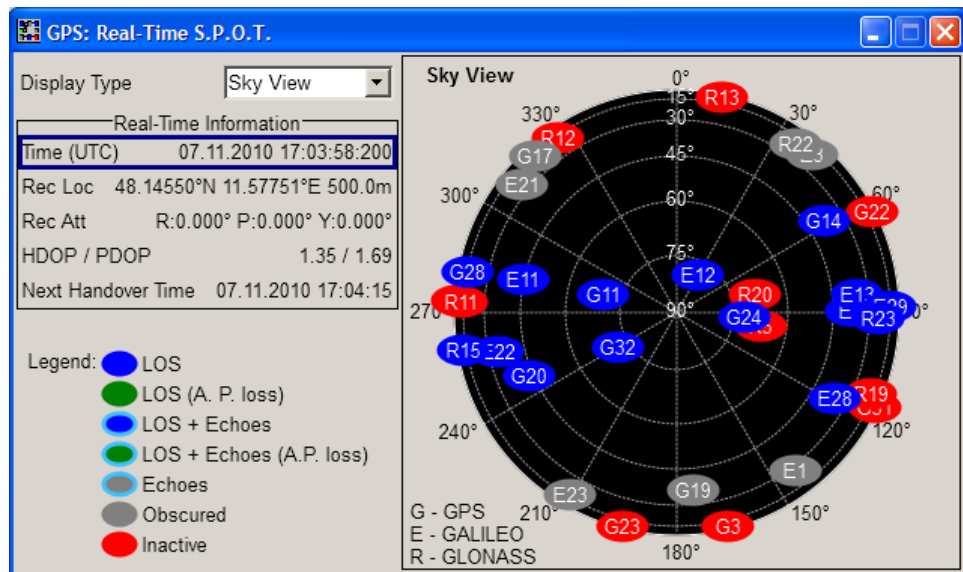
Grey color = invisible satellites, i.e. satellites that are obscured for example by buildings

For the current receiver's position in the selected environment, some of the satellites are not visible.

13. Select "GPS Main Dialog > Obscuration&Auto Multipath" and enable "Physical Model > Obscuration & Multipath".

14. In the "GPS Main Dialog > Real-Time S.P.O.T > Display Type > Sky View", compare the displayed satellite constellation.
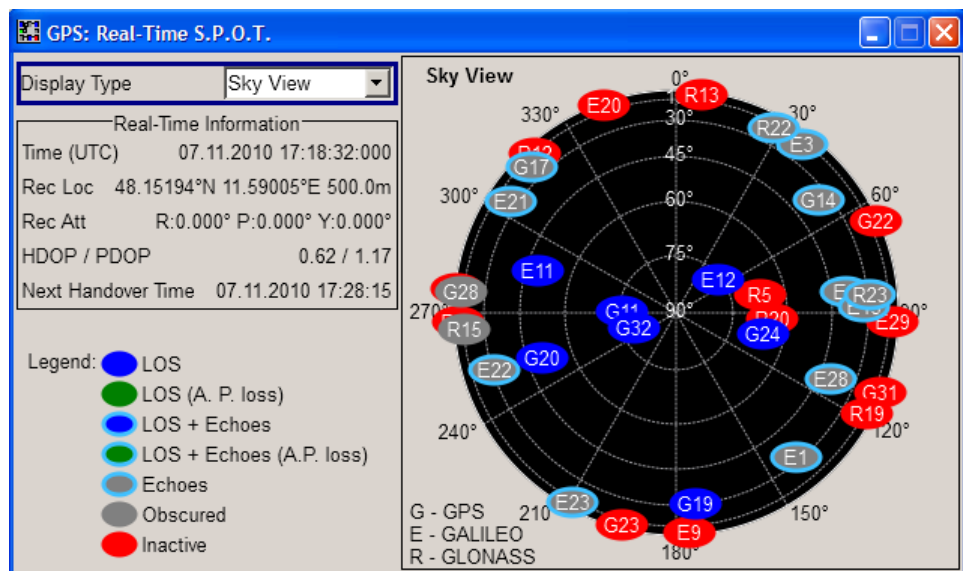

Blue border = satellites receiving an echo signal, for example from multipath

For the current receiver's position in the selected environment, the receiver receives the reflected signal from several of the invisible satellites.

15. To observe how the signal received by a receiver placed for example in a car changes:

a) select "GNSS Main Dialog > Antenna Pattern/Body Mask File > Select Predefined Antenna Pattern"

b) navigate to a predefined antenna pattern file, e.g. `Car_Small` and execute "Select"
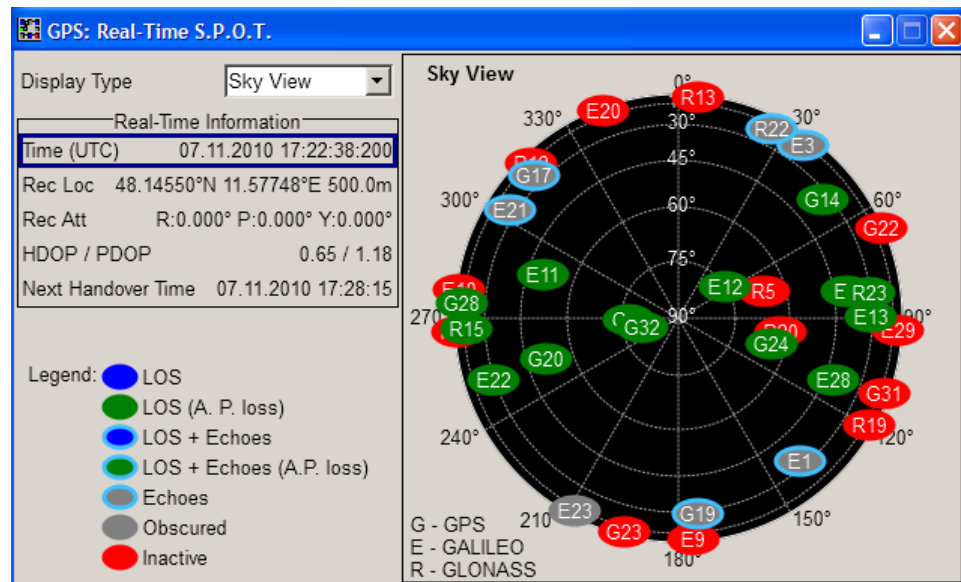
Green color = visible satellite with antenna power loss

Possible further configurations

- If your goal is to reproduce the exact satellite navigation message as in the reality, load a RINEX file.

- Adjust the start simulation time. The RINEX file should be around the same day of the start simulation time.

- Adjust the atmospheric parameters

2.10.15 Simulating the Effect of an Antenna Pattern

1. Execute "GNSS Main Dialog > Set To Default" to adjust the instrument's settings to a standard set of operating conditions.

2. Select "GNSS Main Dialog > GNSS System Configuration" and enable the required navigation systems, e.g. a hybrid GPS, Galileo and GLONASS configuration.

3. Enable "GNSS Main Dialog > Simulation Mode > Auto Localization".

4. Select "GNSS Main Dialog > Satellite Configuration > Maximum Number of Satellites > 24".

5. Select "GNSS Main Dialog > User Environment > Vehicle Type > Aircraft"

6. Select "GNSS Main Dialog > User Environment > Vehicle Description File > Select Predefined Vehicle Description > Aircraft1".

7. Select "GNSS Main Dialog > Localization Data" and select "Geographic Location/ Attitude > Waypoints" to enable a moving receiver.

8. In the "Localization Data" dialog:

   a) select "Waypoints File > Select Predefined Waypoints", navigate to a prede- fined moving scenario and execute "Select"
   b) select "Read Out Mode > Round Trip"
   c) set "Yaw/Pitch > From Motion > On"
   d) set "Roll > From Spinning > On"
   e) set "Spinning Rate > 0.25 Hz"

9. Select "GNSS Main Dialog > User Environment > Obscuration & Auto Multipath" and configure the settings as displayed on die figure.
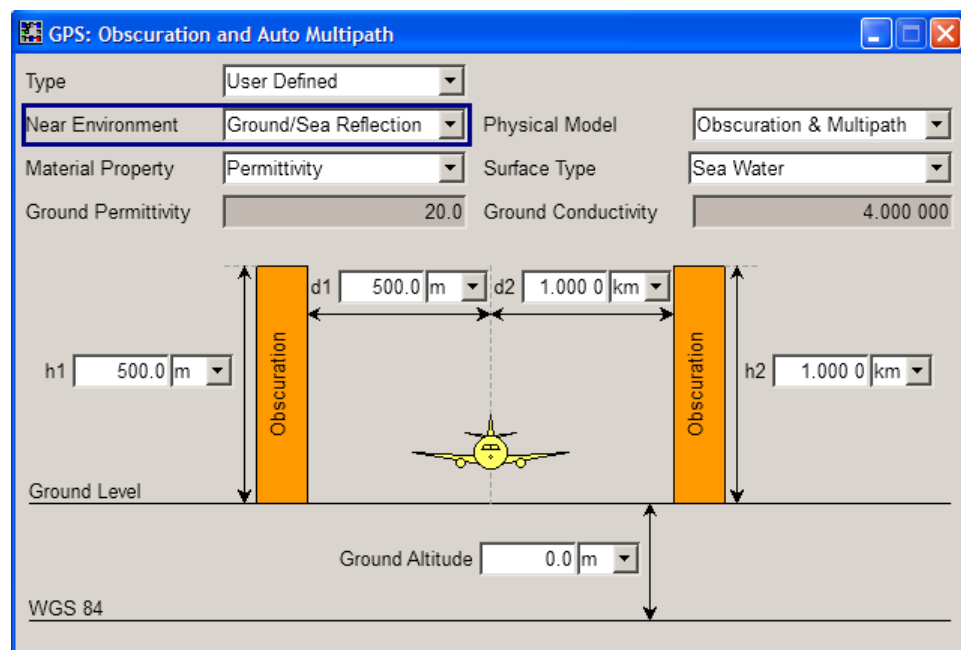

10. Select "GNSS Main Dialog > User Environment > Antenna Pattern/Body Mask File > Predefined/User Defined Files" and navigate to the `*.ant_pat` file.
    In this example, we use an user defined antenna pattern file that describes an antenna with four sectors, see example "Antenna with four sectors" on page 302.

11. Select "GNSS Main Dialog > State > On" to enable signal generation.

12. Select "GPS Main Dialog > Real-Time S.P.O.T > Display Type > Sky View".
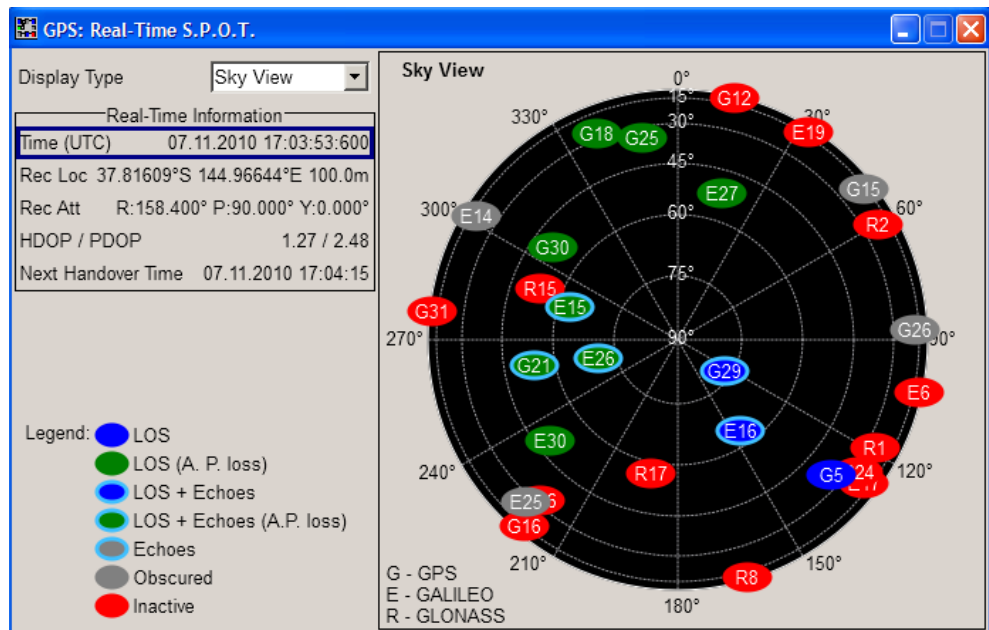
The display is updated in real time and you can observe how depending on the current GNSS receiver position, the spinning rate and the current active antenna sector the received GNSS signal changes.

13. Select "Display Type > Power View".
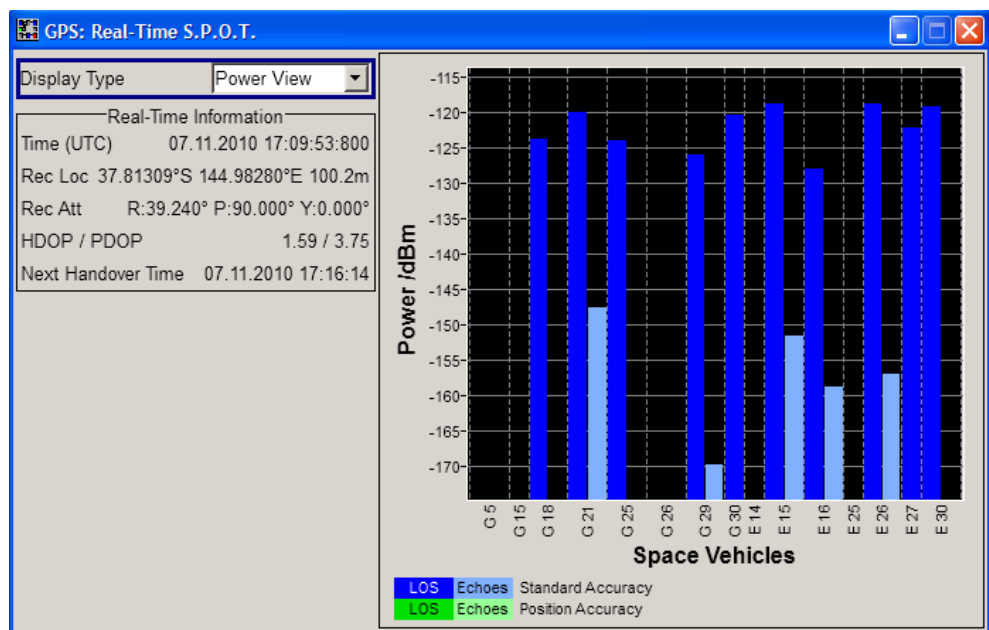
The power levels of the space vehicles are updated in real time.

2.11 Generating GNSS Signal with Several Instruments

This section provides example on connection and configuration of two R&S SMBV instruments for generating common GNSS signal.

Overview of required relevant options

Instrument#1

- option GPS (R&S SMBV-K44)
- GNSS global option R&S SMBV-K91 (Extension to 12 Satellites)
- generation of more than 12 satellites requires additionally GNSS global option R&S SMBV-K96 (Extension to 24 Satellites)
- option Phase Coherence (R&S SMBV-B90)

Instrument#2

- option GLONASS (R&S SMBV-K94)
- GNSS global option R&S SMBV-K91 (Extension to 12 Satellites)
- generation of more than 12 satellites requires additionally GNSS global option R&S SMBV-K96 (Extension to 24 Satellites)
- option Phase Coherence (R&S SMBV-B90)

In this description, only the GNSS related settings are discussed. For detailed information on cabling and required configuration, refer to:

- R&S SMBV Operating Manual, section "Synchronous Signal Generation"
- Application Note 1GP67 "Phase Adjustment"
- Application Note 1GP84 "Time Synchronous Signals with Multiple R&S SMBV100A Vector Signal Generators "

The figure 2-8 provides an example of test setup. The two instruments are connected to work in master-slave mode and the local oscillators (LO) are coupled. The first instrument provides the second one with its system clock, trigger, reference and LO signals.
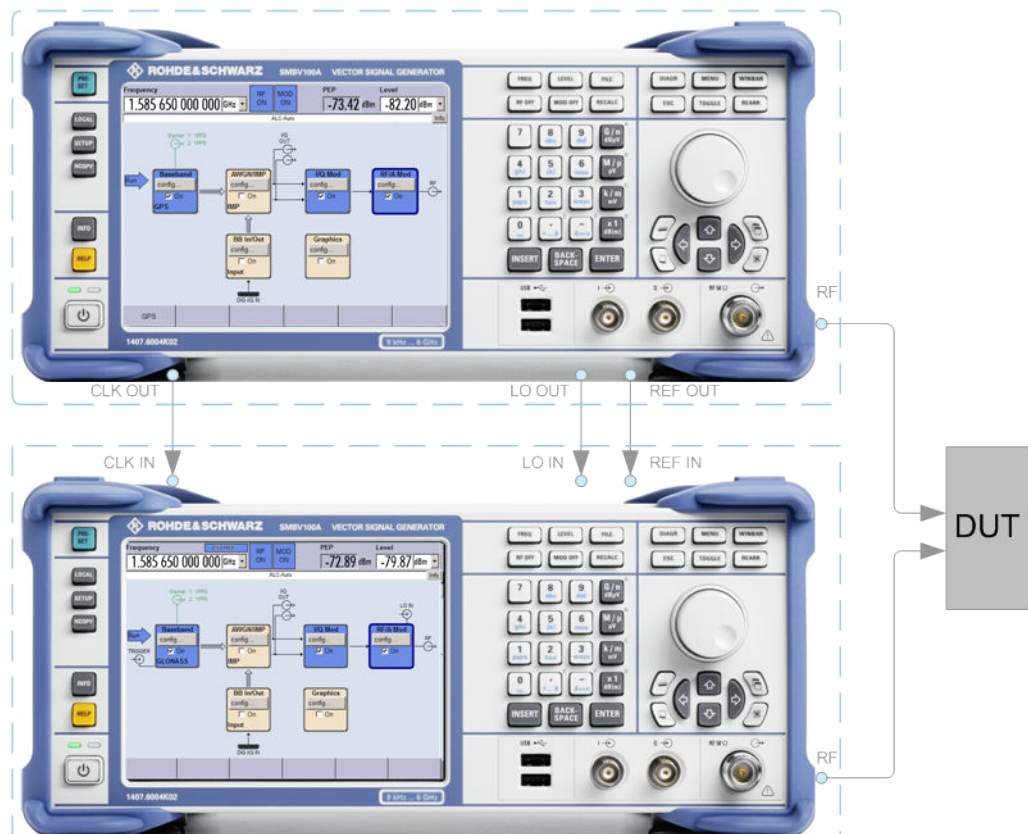
Fig. 2-8: Example: Connecting two R&S SMBV to generate GNSS signal using common RF frequency

> The following lists **only the required task related settings**.
>
> We assume that the instruments are configured to ensure a carrier phase coherence.

1. In the Instrument#1, perform the required steps according to General Workflow and configure the instrument to generate GPS signal with 12 or more satellites and "RF Band > L1/E1" (see also figure 2-1).

   a) Select "GPS > GNSS System Configuration > Use Common RF Frequency > ON".

   b) Execute "GPS > Update RF Frequency".

   The value in the "Frequency" display in the header of the instrument is set to 1.58565 GHz. The GPS signal is however modulated on the GPS frequency L1 = 1.57542 GHz.

2. In the Instrument#2, perform the required steps according to General Workflow and configure the instrument to generate GLONASS signal with 12 more satellites and "RF Band > L1/E1".

   a) Select "GLONASS > GNSS System Configuration > Use Common RF Frequency > ON".

   b) Execute "GLONASS > Update RF Frequency".

The value in the "Frequency" display in the header of the instrument is set to 1.58565 GHz. The GLONASS signal is however modulated on the GLONASS frequency L1 = 1.602 GHz.

3. In both instruments, in the "GNSS > Satellite Configuration" dialog, enable:

   a) "Reference Satellite > N.A."
   b) select the same "Reference Standard"
   c) set the same "Reference Power"

2.12 Functional Overview of the Basic Offline GNSS

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

2.12.1 Single-satellite GNSS signal

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 2.12.2.1, "Generating an one-satellite static generic GNSS signal with R&S WinIQSIM2", on page 53.

2.12.2 Typical Offline Workflow

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

2.12.2.1 Generating an one-satellite static generic GNSS signal with R&S WinIQSIM2

The generic workflow for generating a GNSS Satellite (GPS, Galileo, GLONASS or BeiDou) signal with R&S WinIQSIM2 and saving it as a waveform is as follow:

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 and choose an almanac file.
   The navigation message will be 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" and 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.

2.12.2.2 Loading and Processing a GNSS Waveform in the ARB of the Rohde&Schwarz Signal Generator

To load and process a GNSS waveform proceed as follow:

1. Enable the R&S WinIQSIM2 to generate a one-satellite static generic GNSS signal with constant Doppler shift and generate a waveform file.

2. Connect the R&S WinIQSIM2 to the R&S SMBV.

3. Transfer the waveform file. For detailed description, refer to the R&S WinIQSIM2 Software Manual.

4. In the R&S SMBV, select "Baseband > ARB" and 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 R&S SMBV that processes a waveform generated with the R&S WinIQSIM2 has to match the value of the parameter "Resulting Frequency".

5. Select the FREQ key to set the frequency in the header of the instrument to the resulting frequency of the generated waveform.

6. Set the "ARB State > On" to enable signal processing.

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

3 User Interface

- The instrument may be equipped with different satellite navigation options. To access the available satellite standards, select "Baseband block > Satellite Navigation" and select the desired satellite standard, e.g. GPS.
  To simplify the description, the selected satellite standard is referred as an "entry standard".

- Since most of the parameters provided for configuration are similar and do not depend on the entry standard, this description uses the SW option GPS/A-GPS (R&S SMBV-K44/-K65) and the GNSS global options R&S SMBV-K91/-K92/-K96 (Extension to 12 and 24 Satellites/GNSS Enhancements) as a reference. Satellite standard dependent settings are described separately or the differences are explicitly stated.

- The GNSS implementation in the R&S WinIQSIM2 is a simplified offline version of the real-time one and provides the capability to generate an one-satellite generic signal. Therefore the relevant parameters are adjusted accordingly in R&S WinIQSIM2. You find the differences explicitly stated in the description.
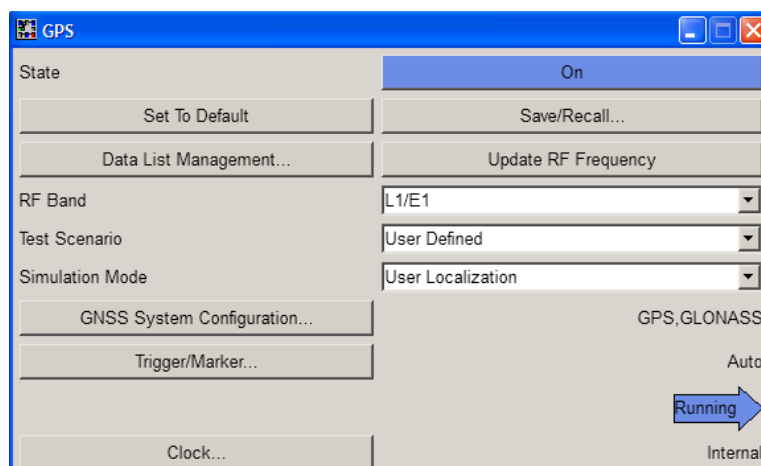
3.1 GNSS Main Dialog
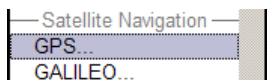
To access the available satellite standards:

► Select "Baseband > Satellite Navigation" and select the desired satellite standard, e.g. GPS.

The dialog is split into several sections.

The upper section of the dialog is where you enbale the GNSS digital standard, call the default settings and select the simulation mode.

In the real-time solution, the "User Environment" section comprises the settings of the satellite signals, the vehicle type and the obscurtion and enabled antenna.

The "Navigation Data" section comprises the navigation data source settings.

Additionally, you can access settings for configuring the satellite signals, generating assistance data and displaying the "Real-Time S.P.O.T.".

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 inter-dependencies between them.

These values are not necessarily representative of realistic test situations.

The remote commands required to define these settings are described in .

3.1.1 General Settings for GNSS Simulation

To access this settings:

► Select "Baseband > Satellite Navigation > GPS".

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

State
Enables/disables the GNSS signal simulation.

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

For R&S SMBV instruments, a continuous GNSS signal is generated for up to 24 satellites in real time mode. The maximum number is determined by the parameter Maximum Number of Satellites and the maximum value depends on the installed SW options.

For R&S WinIQSIM2, a time limited GNSS signal is generated for one satellite in offline mode. The time limited GNSS Signal is continuously played and repeated in the ARB of the vector signal generator. In this case, the "Restart" marker may be helpful to trigger a GNSS receiver module when simulating an offline generated GNSS Signal.

Note: Enabling the standard sets automatically the "Frequency" and "Level" displayed in the header of the instrument according to the selected settings, e.g. "RF Band" and "Total Power" at the simulation start time!

Remote command:
<subsystem>:STATe on page 159

Set to default
Calls the default settings. The following table gives an overview of the settings. Refer to the remote-control commands description for the preset value for each parameter.

Note: Use Update RF Frequency function to preset the RF Frequency and level.

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
(R&S WinIQSIM2) Oversampling Duration of Satellite Simulation	(R&S WinIQSIM2) 2 1s
Data Source	PRBS9
System Time	Time basis of the entry standard
GNSS System Configuration	GPS only, Galileo only, GLONASS only or BeiDou only (depending on 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 159

Save/Recall

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

The file name and the directory it is stored in are user-definable; the file extension is however predefined.

The follwoing file extension are used: `*.gps`, `*.galileo`, `*.glonass` respectively.

Determines whether the instrument performs an absolute or a differential storing of the settings.

Enable this function to accelerate the saving process by saving only the settings with values different to the default ones.

Note: This function is not affected by the "Preset" function.

Remote command:

`[:SOURce<hw>]:BB:GPS:SETTing:CATalog?` on page 162

`[:SOURce<hw>]:BB:GALileo:SETTing:CATalog?` on page 162

`<subsystem>:SETTing:STORe` on page 162

`<subsystem>:SETTing:STORe:FAST` on page 163

`<subsystem>:SETTing:LOAD` on page 163

`<subsystem>:SETTing:DELete` on page 163

Data List Management

Accesses the "Data List Management" dialog used to create and edit data lists.

All data lists are stored as files with the predefined file extension `*.dm_iqd`. The file name and the directory they are stored in are user-definable.

Note: All data lists are generated and edited by means of the `SOURce:BB:DM` subsystem commands. Files containing data lists usually end with `*.dm_iqd`. The data lists are selected as a data source for a specific function in the individual subsystems of the digital standard.

Generate Waveform File

(R&S WinIQSIM2 only)

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

See also:

- chapter 2.12.2.1, "Generating an one-satellite static generic GNSS signal with R&S WinIQSIM2", on page 53

- chapter 2.12.2.2, "Loading and Processing a GNSS Waveform in the ARB of the Rohde&Schwarz Signal Generator", on page 54.

Remote command:

<subsystem>:WAVeform:CREate on page 164

Update RF Frequency

(R&S SMBV only)

Sets the "Status Bar > Frequency" display to the resulting frequency. The RF Frequency is calculated automatically depending on the selected RF Band, on the entry standard and on the enabled navigation standards.

Note: RF Frequency vs RF Band.

- For navigation standards with overlapping carrier frequencies, e.g. GPS and Galileo in the L1/E1 upper RNSS band (see figure 2-1), the RF frequency is the carrier frequency L1 = E1 = 1.57542 GHz.
- For navigation standards with different RF Frequencies, e.g. GPS and GLONASS in the L1/E1 upper RNSS band, the resulting RF frequency is located between the GPS L1 and the GLONASS L1 frequency.

Remote command:

<subsystem>:PRFFrequency on page 160

RF Band

Determines the RF band, i.e. the upper or lower RNSS band (see figure 2-1).

The different satellites will be modulated on their corresponding standard carrier frequencies (see table 3-1).

Table 3-1: Carrier frequencies

Navigation Standard	"RF Band"	Carrier Frequency, GHz	Required SW Option
GPS	L1 L2	1.57542 1.2276	R&S SMBV-K44/-K244
GALILEO	E1	1.57542	R&S SMBV-K66/-K266
GLONASS	L1 L2	1.602 1.246	R&S SMBV-K94/-K294
BeiDou	L1	1.561098	R&S SMBV-K107

Remote command:

<subsystem>:RFBand on page 159

Test Scenario

(R&S SMBV only)

Selects a predefined A-GPS/A-GLONASS/A-GNSS test scenario (see chapter 2.3.2, "Full Set of Pre-defined Test Scenarios as Basis for A-GPS/A-GLONASS/A-GNSS Protocol and Conformance Test Cases", on page 20 for an overview).

The available test scenarios depend on the installed SW options. The A-GNSS test cases require hybrid GNSS configuration (see "Activate GNSS Standards" on page 86).

All parameters (simulated position, satellite configuration, Almanac, navigation data, etc.) will be set according to the selected test scenario.

The selection "User Defined" enables the configuration of all parameters.

Remote command:
[:SOURce<hw>]:BB:GPS:ATSCenario on page 160
[:SOURce<hw>]:BB:GLONass:ATSCenario on page 161

Simulation Mode
Sets the simulation mode.

Note: Refer to table 2-1 for an overview of the supported functionality per simulation mode. Some functionality require additional options.

"Static"   The satellite signals are configured by the user.
                        See also chapter 2.10.2, "Generating GNSS Signal for Simple
                        Receiver Tests (Static Mode)", on page 36 for R&S SMBV instru-
                        ments.
                        For WinIQSIM2, see chapter 2.12.2.1, "Generating an one-satellite
                        static generic GNSS signal with R&S WinIQSIM2", on page 53.

"Auto Localization"
                        (R&S SMBV only)
                        The satellite signals are configured corresponding to a 'real' user
                        defined location.
                        Four satellites will be selected depending on the selected almanac.
                        For instruments equipped with option R&S SMBV-K91/-K96, the num-
                        ber of configurable satellites is extended to 12 resp. 24. The number
                        of configurable satellites is adjusted with the parameter Maximum
                        Number of Satellites.
                        In this localization mode, a new satellite will be exchanged in real-
                        time with a current one as soon as the elevation of the latter is less
                        than the selected Elevation Mask or a new satellite constellation with
                        better PDOP is found.
                        The ephemeris are extracted from the almanac and displayed in the
                        Navigation Message Configuration dialog. The ephemeris data of all
                        satellites are updated automatically and projected automatically to
                        ensure that the age of the ephemeris is within the allowed time span.
                        Whenever a new almanac is selected, the start time of the simulation
                        will be set to the almanac's TOA (Time of Application).
                        See also chapter 2.10.3, "Generating GNSS Signal with Automatic
                        Dynamic Exchange of the Satellites (Auto Localization Mode)",
                        on page 36.

"User Localization"

> (R&S SMBV only)
>
> User localization mode enables the configuration of the satellites constellation at the beginning of the simulation and editing it in real-time, i.e. satellites can be enabled or disabled in real-time and without interruption of the signal generation.
>
> For instruments equipped with assistance option (e.g. R&S SMBV-K65/-K95/-K67), this mode additionally enables the configuration of all parameter of the Navigation Message, the generation of assistance data and the loading of RINEX files.
>
> This mode is useful for the generation of A-GNSS test signals different than the standardized ones (see chapter 2.10.5, "Generating A-GPS Custom Build Scenarios (User Localization Mode)", on page 37).

Remote command:
<subsystem>:SMODe on page 160

Oversampling

(R&S WinIQSIM2 only)

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.

Remote command:
<subsystem>:FILTer:OSAMpling on page 164

Duration Of Satellite Simulation

(R&S WinIQSIM2 only)

Determines the duration of the satellite simulation.

The resulting duration of the simulation is calculated as follow:

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

where $F_{Carrier}$ is the frequency selected with the parameter "RF Band" on page 59.

The maximum duration of satellite simulation depends on the "Oversampling" on page 61 and the ARB memory size of the connected instrument.

Remote command:
<subsystem>:DURation on page 163

GNSS System Configuration

(R&S SMBV only)

Opens the GNSS System/Almanac Configuration Settings dialog for defining the GNSS system configuration and selecting the almanac/RINEX files per navigation standards.

If a hybrid GNSS configuration is enabled, the name of the selected GNSS navigation standard is displayed next to the button.

Trigger/Marker, Marker

Calls the menu for selecting the trigger source, for setting the time delay of an external trigger signal and for configuring the marker signals (see chapter 3.14, "Trigger/Marker/ Clock Settings", on page 145). For R&S SMBV instruments, the currently selected trigger source is displayed to the right of the button.

Note: The trigger and clock functions are available for R&S SMBV instruments only.

Remote command:

n.a.

Arm

(R&S SMBV only)

Stops signal generation. This button appears only with "Running" signal generation in the "Armed_Auto" and "Armed_Retrigger" trigger modes.

Signal generation can be restarted by a new trigger (internally with "Execute Trigger" or externally).

Remote command:

<subsystem>:TRIGger:ARM:EXECute on page 283

Execute Trigger

(R&S SMBV only)

Executes trigger manually. A manual trigger can be executed only when an internal trigger source and a trigger mode other than "Auto" have been selected.

Remote command:

<subsystem>:TRIGger:EXECute on page 284

Clock

(R&S SMBV only)

Calls the menu for selecting the clock source and for setting a delay (see chapter 3.14, "Trigger/Marker/Clock Settings", on page 145).

Remote command:

n.a.

3.1.2 User Environment

The propagation channel between a GNSS satellite and an user is split into three environment characteristics:

- Satellite Configuration (orbit and satellite clock errors)
- Atmospheric Configuration (Ionosphere, troposphere)
- User Environment or near user environment (Environment model e.g. Urban canyon, vehicle type, vehicle's aerodynamics, vehicle's motion and attitude as well as antenna pattern)

With the "User Environment" parameters you can configure the near field parameters.

To access this settings:

1. Select "Baseband > Satellite Navigation > GPS".

2. Select "Simulation Mode > Auto Localization/User Localization".

3. Navigate to "User Environment".

Vehicle Type
Sets the vehicle type, e.g "Pedestrian", "Land Vehicle", "Ship", "Aircraft", "Spacecraft", "HIL (Hardware in the Loop)".

The selected vehicle type determines:
- the GNSS application e.g. automotive with "Pedestrian" and "Land Vehicle"
- the main elements of the vehicle as vehicle description file, localization data, Obscuration and Multipath models and antenna pattern/body mask.

When changing the selected vehicle type, a corresponding predefined vehicle description files as well as motion files (if necessary) are selected in order to ensure that the simulated receiver motion maps to the vehicle type and the particular application, e.g. aeronautics with "Aircraft".

"Aircraft/Spacecraft"
> A vehicle motion profile is pre-selected. Simulation with a static location simulation is not possible.

"HIL (Hardware in the Loop)"
> There are no predefined files available.
> The instrument expects the vehicle's motion and attitude coordinates in real time from for example an external application software (see figure 2-2).
> Smoothening is not possible.

Remote command:
<subsystem>:VEHicle:TYPE on page 166

Vehicle Description File
Provides an access to the standard "File Select" dialog to select a user defined vehicle description file. The vehicle description files are files with extension *.xvd and predefined file format, see chapter A.1.2, "Vehicle Description Files (Used for Smoothening)", on page 300. The *.xvd files include the limits on the vehicle's dynamics.

The firmware provides some predefined vehicle description files. These files are stored at a predefined system directory.

If a file is selected, the name of the selected file is displayed.

Remote command:
<subsystem>:VEHicle:CATalog:USER? on page 166
<subsystem>:VEHicle:CATalog:PREDefined? on page 166
<subsystem>:VEHicle:FILE on page 166

Localization Data
Access to the dialog with setting to configure a 'real' static or moving geographic location, see chapter 3.2, "Localization Data", on page 68.

A summary information on the selected location is displayed.

(Start) Geographic Location

Displays the coordinates of the static geographic location or the coordinates of the start geographic location as defined in the selected waypoint/attitude file.

See also "Location Coordinates" on page 71 and "Waypoint/Attitude File …" on page 70.

Obscuration and Auto Multipath

Available in instruments equipped with option R&S SMBV-K101 and enabled "Auto Localization" or "User Localization" mode, provides an access to the dialog to define the near environmental model, see chapter 3.3, "Obscuration and Auto Multipath Settings", on page 73.

A summary information on the enabled settings is displayed.

Antenna Pattern/Body Mask File

For instruments equipped with R&S SMBV-K102, provides an access to the standard "File Select" dialog to select a file, describing the antenna pattern or the body mask. Several predefined antenna patterns are provided.
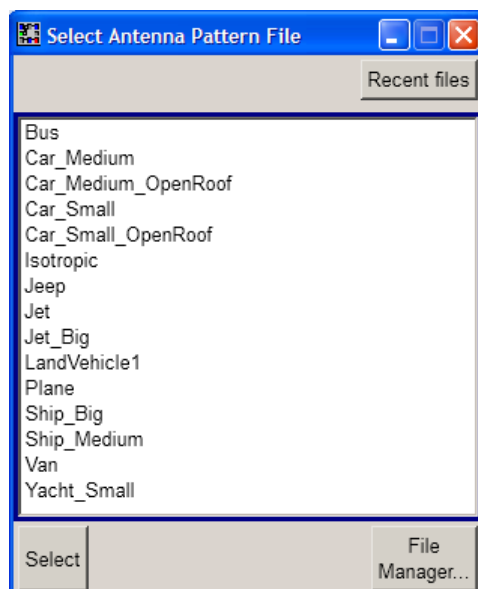
If a file is selected, the file name is displayed.

Two files describe an antenna, the antenna pattern `*.ant_pat` file and the phase response `*.phase` file. Both files must have the same file name and must be stored in the same directory. The `*.ant_pat` file describes the power response matrix of each antenna. The instrument retrieves the phase response matrix from the `*.phase` file. If the required `*.phase` file does not exist, the instrument sets the carrier phase matrix to zero.

With a selected antenna pattern, the instrument simulates the satellite power and carrier phase depending on the antenna pattern and attitude parameters. For automotive applications, enable the parameter "Localization Data > From Motion" to extract the attitude parameters from the waypoint file.

For more information, see chapter 2.7, "Realtime Option GNSS Extension for Antenna Pattern (R&S SMBV-K102)", on page 31 and chapter A.1.3, "Antenna Pattern / Body Mask Files", on page 301

Remote command:

`<subsystem>:APATtern:CATalog:PREDefined?` on page 167

`<subsystem>:APATtern:CATalog:USER?` on page 167

`<subsystem>:APATtern:FILE` on page 167

see also:

`<subsystem>:APATtern:ANTenna:LIST?` on page 167

`<subsystem>:APATtern:ANTenna:ID` on page 168

`<subsystem>:RT:UPDate:ANTenna` on page 168

3.1.3 Navigation Data

► To access this settings, select "main Dialog > Navigation Data"

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

Data Source

Selects data source for the navigation information.

Navigation data plays an extremely important role, since they are essential for calculating the positions of the satellites. It also contains the information about the currently valid space vehicle IDs.

Arbitrary data is supported only in "Static" mode. In "Auto Localization" and "User Localization" mode, "Real Navigation Data" is pre-selected and no other data source can be selected.

"Real Navigation Data"

"Real Navigation Data" (almanac/RINEX) can be downloaded from the internet and stored on the hard disk of the generator. If required, re-configure manually the downloaded files.

Hence, neither almanac nor RINEX files for Galileo are available. In the R&S SMBV, some predicted almanacs and Rinexes are provided to simulate the movement of Galileo satellites on their designed orbits.

Use the chapter 3.4, "GNSS System/Almanac Configuration Settings", on page 86 dialog to select the almanac file per navigation standard.

"PRBSxx/Data List/Pattern"

Arbitrary data can be used for basic tests on the GNSS signals. Signals generated in this way can be recognized by a GPS receiver. However, since there is no real navigation data modulated with the GNSS spreading code, only the signal level of the simulated satellite(s) as carrier to noise ratio can be measured and displayed by the receiver (sensitivity test).
A signal of this type is usually sufficient for performing simple function tests.

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 "Main Dialog > Data List Management".

Remote command:
<subsystem>:NAVigation:DATA on page 175
<subsystem>:NAVigation:DATA:DSELect on page 176
<subsystem>:NAVigation:DATA:PATTern on page 176

Almanac/RINEX
Opens the GNSS System/Almanac Configuration Settings dialog.

One almanac file and one RINEX file per navigation standard can be selected. The available navigation standards depend on the installed options.

Selection of RINEX files is enabled for "User Localization" mode and requires installed assistance option of the navigation standard used as an entry standard.

For description of the RINEX file format, see chapter A.2, "RINEX Files", on page 303.

Time Conversion Configuration
Opens the Time Conversion Configuration dialog.

System Time

Determines the time basis used to enter the simulation start time. Per default, the time basis of the entry standard is used but the user may choose or switch to a different time basis at any time. The time is then automatically recalculated and displayed in the selected time format.

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

Remote command:

<subsystem>:NAVigation:SIMulation:TBASis on page 176

Date [dd.mm.yyyy]

(enabled for "Data Source > Real Navigation Data" and "System Time > UTC/GLO")

Enters the date for the simulation in DD.MM.YYYY format of the Gregorian calendar. The simulation time is not limited to the almanac week.

In "Auto Localization" mode, the default value of this parameter depend on the selected almanac file. The retrieved value is the week day corresponding to the TOA of the entry standard.

Remote command:

<subsystem>:NAVigation:SIMulation:DATE on page 176

Time [hh:mm:ss:xxx]

(enabled for "Data Source > Real Navigation Data" and "System Time > UTC/GLO")

Enters the exact simulation start time in UTC time format.

In "Auto Localization" mode, the default value of this parameter is equal to the TOA of the almanac that corresponds to the navigation standard used as an entry standard.

Remote command:

<subsystem>:NAVigation:SIMulation:TIME on page 177

Week Number

(enabled for "System Time > GPS/GST/BDT")

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

The satellite clocks in the GPS and Galileo navigation systems are not synchronized to the UTC one but use a proprietary time, e.g. the GPS/Galileo System Time. The format used for these system time basis is week number and Time of Week (TOW).

The weeks are numbered starting form a reference point of time (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: Januar 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.

The parameter is only available if data source "Real Navigation Data" is selected.

Remote command:

<subsystem>:NAVigation:SIMulation:WNUMber on page 177

Time of Week (TOW)

(enabled for "System Time > GPS/GST/BDT")

Define the simulation start time within the Week Number.

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.

Remote command:
<subsystem>:NAVigation:SIMulation:TOWeek on page 178

3.1.4 Advanced Configuration

Satellite Configurations

Access the dialog for configuring the satellite data (see chapter 3.6, "Satellite Configuration", on page 91).

Real-Time S.P.O.T.

(enabled for "Localization" mode)

Access the dialog for real-time display of the current PDOP and HDOP values, display of the satellites states and position, display of the receiver position and display of the received satellite power (see chapter 3.13, "Real-Time S.P.O.T.", on page 139).

Assistance Data Generation

(enabled for "User Localization" mode and requires the basic BeiDou option R&S SMBV-K107 or installed assisted option, e.g. Assisted GPS R&S SMBV-K65.

Access the dialog Assistance Data Generation for generation of assistance data corresponding to the selected "Assistance Mode".

3.2 Localization Data

(R&S SMBV only)

To access this settings:

1. Select "Baseband > Satellite Navigation > GPS".

2. Select "Simulation Mode > Auto Localization/User Localization".

3. Select "User Environment > Localization Data".

   In the "Localization Data" dialog you can configure the satellites signal corresponding to a 'real' static or moving geographic location.
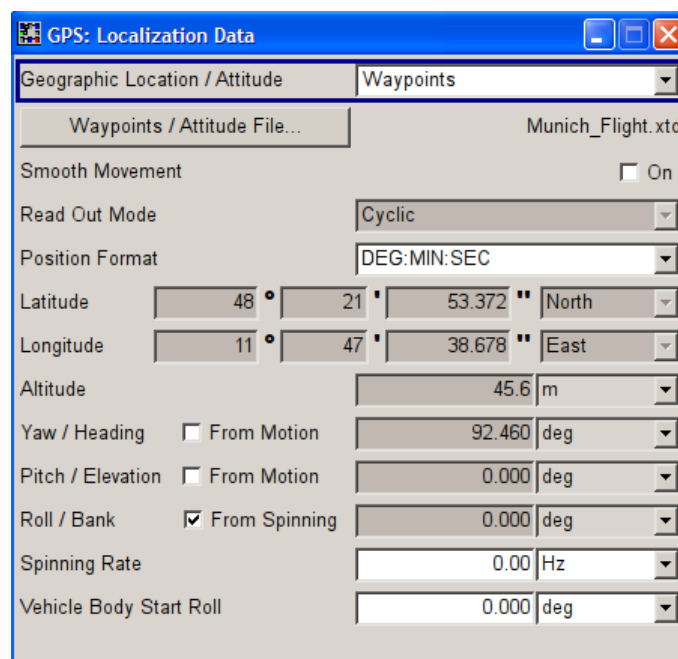
Geographic Location/Attitude
Selects the geographic location of the GNSS receiver.

"User Defined"   This mode enables the definition of the vehicle's body rotation param-
                 eters of the GNSS receiver when a static location in the WGS84 coor-
                 dinate system is defined:

                 ● "Latitude", "Longitude" and "Altitude"

                 ● in istrument equipped with R&S SMBV-K103, also the attitude
                   (yaw, pitch and roll)

                 The simulated altitude is the height above the ellipsoid (HAE) altitude.

"Waypoints"   (requires option GNSS Enhancements R&S SMBV-K92)
                 Enables the selection of a moving scenario, i.e. the simulation of
                 moving receiver. Predefined or user waypoint files can be loaded.
                 The parameters "Latitude", "Longitude" and "Altitude" are set accord-
                 ing to the first simulated position defined in the file describing the
                 movement, i.e. the raw waypoint, NMEA, KML, `*.xtd` or trajectory
                 description file.
                 For more information, see chapter 2.5.1, "Moving Scenarios",
                 on page 26 and chapter A.1, "User Environment Files", on page 293.
                 For information about the current position of the receiver, open the
                 Real-Time S.P.O.T. display and check the parameter "Receiver Loca-
                 tion" or the displayed receiver trajectory ("Map View").
                 Option R&S SMBV-K103 is required to simulate the attitude informa-
                 tion retieved from the waypoint/attitude file.

"City"   Selects one of the predefined fixed geographic locations (see
                   table 3-2).
                   The parameters "Latitude", "Longitude" and "Altitude" are set accord-
                   ing to the selected position.

Table 3-2: Coordinates of the Simulated Predefined Positions

Continent	City	Latitude	Longitude	Altitude
America	New York	40.7142	-74.0064	1 m
	San Fran- cisco	37.8194388888	-122.4784944	35 m
Asia	Beijing	39.905555555555	116.391388888888	60 m
	Seoul	37.5515	126.987794444444	265 m
	Singapore	1.3113111111111	103.826852777777	110 m
	Taipei	25.022344444444	121.514758333333	10 m
	Tokyo	35.683861111111	139.745058333333	45 m
Australia	Sydney	-33.8833	151.2167	3 m
Europe	London	51.500625	-0.1246222	22 m
	Moscow	55.752222	37.615556	200 m
	Munich	48,150	11,5833	508 m
	Paris	48.8584	2.29462777777777	66 m

Remote command:

<subsystem>:LOCation:CATalog? on page 170

<subsystem>:LOCation[:SELect] on page 170

Waypoint/Attitude File …

For selected "Geographic Location > Waypoints", access to the "Select Waypoint/Atti-
tude File" dialog to select predefined waypoint files.

A waypoint file is description of a moving scenario with possibly attitude coordinates
that may have different forms, like for example a sequence of positions or vector arc
movement. A waypoint file must have the extension *.txt, *.nmea, *.kml or *.xtd.

See also chapter A.1.1, "Movement or Motion Files", on page 293 for detailed descrip-
tion of the file formats.

Remote command:

<subsystem>:LOCation:WAYPoints:FILE on page 170

Smooth Movement

The location of the waypoints defined in the waypoints file may cause sharp changes in
the movement direction. In instruments equipped with R&S SMBV-K92, this parameter
uses an internal algorithm to smooth the trajectory to simulate more realistic move-
ment.

Remote command:

<subsystem>:LOCation:SMOVement on page 174

Read Out Mode

For selected "Geographic Location > Waypoints", defines the way the waypoint/attitude file is to be read.

The receiver trajectory can be observed in the "Map View" on the Real-Time S.P.O.T. display.

"Cyclic"   The waypoint file is read out cyclic.
                  Using this read out mode is only recommended for waypoint files that describe a circle moving scenario or moving scenario in which the start and the end point are close to each other.

"One Way"   The file is read out only once.
                  By reaching the end of the file, the last described position is assumed to be a static one.

"Round Trip"   By reaching the end of the file, the file is read out backwards.

Remote command:
<subsystem>:LOCation:WAYPoints:ROMode on page 171

Location Coordinates

In the ECEF WGS84 coordinate system, a geographic location is identified by three coordinates, the altitude, latitude and longitude. The last two can be displayed in decimal or DMS format. The display format is determined by the parameter "Position Format".

Parameter	Description
"Position Format"	Sets the format in which the Latitude and Longitude are displayed. • "DEG:MIN:SEC" The display format is Degree:Minute:Second and Direction, i.e. XX°XX'XX.XX" Direction, where direction can be North/South and East/West. • "Decimal Degree" The display format is decimal degree, i.e. +/-XX.XXXXX°, where "+" indicates North and East and "-" indicates South and West.
"Altitude"	Sets the geographic altitude of the reference location in meters above sea level. The simulated altitude is the height above the ellipsoid (HAE) altitude.
"Latitude"	Sets the latitude of the reference location.
"Longitude"	Sets the longitude of the reference location.

The altitude, latitude and longitude are only configurable for user defined geographic locations. If a value other than "User Defined" is selected in the "Geographic Location" field, these fields are read only.

Remote command:
to enter the coordinates in Degree:Minute:Second format
<subsystem>:LOCation:COORdinates:DMS on page 172
to enter the coordinates in decimal degree format
<subsystem>:LOCation:COORdinates:DECimal on page 171

Yaw/Heading, Pitch/Elevation, Roll/Bank

For instruments equipped with R&S SMBV-K103, sets the angles of rotation in the corresponding direction, i.e. the rotation around the respective yaw, pitch and roll axes. "Yaw/Heading, Pitch/Elevation, Roll/Bank" are defined relative to the local horizon.

See also figure 2-4.

Remote command:

<subsystem>:LOCation:YAW on page 173

<subsystem>:LOCation:PITCh on page 173

<subsystem>:LOCation:ROLL on page 173

see also <subsystem>:RT:RATTitude? on page 280

From Motion/From Spinning

Enable "From Motion/From Spinning" to extract the attitude parameters from the waypoint file. For scenarios with defined waypoints/attitude file this forces the attitude parameters to motion direction even if the Waypoint / Attitude has attitude information, like for example in a *.xtd file with <property waypointformat="position_attitude">.

For specific applications like automotive, it is realistic to set the yaw and pitch to vehicle's motion direction, because the usual body axes angles of a car are in the direction of the velocity vector. For other applications, however, like for example aeronautics with a landing plane, this parameter is not usefull (the nose of the plane is in an upward direction at the time when the plane is moving downwards).

Tip: Enable the parameter "From Motion" if you simulate an automotive scenario with instrument without the option R&S SMBV-K103.

Remote command:

<subsystem>:LOCation:YAW:FMOTion on page 173

<subsystem>:LOCation:PITCh:FMOTion on page 173

<subsystem>:LOCation:ROLL:FSPinning on page 173

Spinning Rate

For instruments equipped with R&S SMBV-K103, simulates a constant rate of change of the roll, defined with Vehicle Body Start Roll.

Remote command:

<subsystem>:LOCation:SPIN:RATE on page 174

Vehicle Body Start Roll

For instruments equipped with R&S SMBV-K103, defines the start angles of rotation of the vehicle.

Remote command:

<subsystem>:LOCation:SPIN:SRoll on page 174

3.3 Obscuration and Auto Multipath Settings

The "Obscuration and Auto Multipath" dialog is available for instrument equipped with the additional option R&S SMBV-K101.

To access this settings:

1. Select "Baseband > Satellite Navigation > GPS".

2. Select "Simulation Mode > Auto Localization/User Localization".

3. Select "User Environment > Obscuration and Auto Multipath".

   The provided settings enables you to select a predefined near environmental model or to customize the model as required. Most oft the user defined models are created in table form, where each row corresponds to a object that causes obscuration, reflection of the signal and/or multipath effects. The configured objects are displayed on a graphical view with selectable orientation. Each object is identified on the graphical view with its row index.

To simplify and accelerate the configuration, the instrument provides:

- a subset of predefined but customizable user environment models, like suburban area, urban canyon, tunnel, bridge, highway, etc. that can be used directly or as basis for further configurations.

- an interface for loading of generated files or storing current configurations into files (see "Obstacles File" on page 78 or "Planes File" on page 81).

- as well as setting for joint obstacle's configuration, like defining of a subset of obstacles and automatically repeating the configured subset (see "Repetition Window" on page 80).

Visualizing the obscured satellites

The defined user environment model is applied on the current satellite's constellation. For the current receiver's location, some satellites are not simulated, others are simulated but are obscured or not, have echos or with attenuated power due to antenna pattern response. To visualize the satellite's constellation state currently used by the receiver, use the "Sky View" in the Real-Time S.P.O.T. display.

3.3.1 Common Settings

This section describes the parameters that are common for all near environmental models.

Type
Selects a predefined obscuration&auto multipath model or enables the configuration of the near environment and physical model.

- Customizable Type

- User Defined: the parameters "Near Environment" and "Physical Model" are configurable
- Predefined Types
  - City Block
    The model assumes: average building height 20m
  - Urban Canyon
    Correspond to an urban canyonas in commercial city places.
    The model assumes: street width 30m, average building height 30m, gap between the buildings along a street 10m, street length 1200m
  - Suburban Area
    The model assumes: relatively high distance between the GNSS receiver and the main reflecting obstacles
  - Cutting
    The model assumes: obscuration effects from side barriers on the left and right of a vehicle moving on a highway
  - Highway
    The model assumes: effects of the barriers as well as cars moving in the opposite lines and subsequently interrupting the GNSS signal for a short time in a periodic way
  - Bridge
  - Parking
    The model assumes: a full signal obscuration in a parking for 1 min, 10 min or 1 hour.
    This model is useful by measuring the time a GNSS receiver needs to reacquire the GNSS satellites after leaving the obscured area.
  - Tunnel

To store a user-defined configuration, use the "Save As" function. User defined obscurations can be loaded at a latter time to repeat test with the same user environment.

Remote command:

<subsystem>:OBSCuration:TYPE on page 181

Near Environment
Determines the kind and nature of the obstacles.

Table 3-3: Available customizable near environment models in depending on the vehicle type and the geographic location

Near Environment	Vehicle Type	Moving location	Static location	Short Description
Vertical Obstacles	Pedestrian Land Vehicle	x	x	The model simulates the whole fix geometry of many objects (locations) to the left, right, front and back of the user's static location and is suitable for city block simulation The objects are defined relative to the map orientation, i.e to the street orientation. The map is built on the OX and OY axes and any point on the map can be defined as a reference point. Each object is defined with its length and its distance to this reference point. The receiver's position is configurable and defined as an offset to the reference point. See chapter 3.3.2, "Vertical Obstacles Settings", on page 76.
Roadside Planes	Pedestrian Land Vehicle	x		This model describes an environment where the user defined obstacles representing roadside planes or surfaces built from different materials are located to the left and/or to the right side of the receiver/ vehicle. In this mode the roadside planes are assumed parallel to the motion of the vehicle The model is enabled in instrument equipped with option R&S SMBV-K92. See chapter 3.3.3, "Roadside Planes Settings", on page 79.
Full Obscuration	Pedestrian Land Vehicle Ship	x		This model defines areas with configurable size in that the satellite signals are completely obscured. The model is enabled in instrument equipped with option R&S SMBV-K92. See chapter 3.3.4, "Full Obscuration Settings", on page 82
Ground/Sea Reflection	Ship Aircraft Spacecraft	x	x (Ship only)	Simulated is ground/sea reflection as well as obscuration of satellites due to modeled canyon obstacles (left and right) with configurable distance to vehicle, height and surface type with different properties. Use this model to simulate flights over sea/lakes with surrounding canyon or for ships crossing sea straits. See chapter 3.3.5, "Ground/Sea Reflection", on page 84
Line of Sight (LOS)	all	x	x	No near field environment is defined

The environment view displays the currently configured model.

Remote command:
<subsystem>:OBSCuration:ENVironment on page 181

Physical Model
For "Near Environment" different than "LOS", the physical model determines whether the satellite signals are obscured and/or multipath echoes are simulated.

The simulation of multipath effects in "Physical Model > Obscuration&Multipath" requires additionally the option R&S SMBV-K92.

Remote command:
<subsystem>:OBSCuration:PMODel on page 181

Viewport from/to, Zoom Out
Zooms in the displayed model to the selected range. To display the full model again, use the "Zoom Out" function.

3.3.2 Vertical Obstacles Settings

This section comprises the parameters, necessary to configure a "near environmental" model for simulation of obscurations and multipath effects expected in a city environment. The vertical obstacles are defined in a static (OX, OY) coordinate system and are either parallel to OX or OY axis following axis direction.

Examples of predefined environment based on the vertical obstacles are "City Block" and "Urban Canyon".
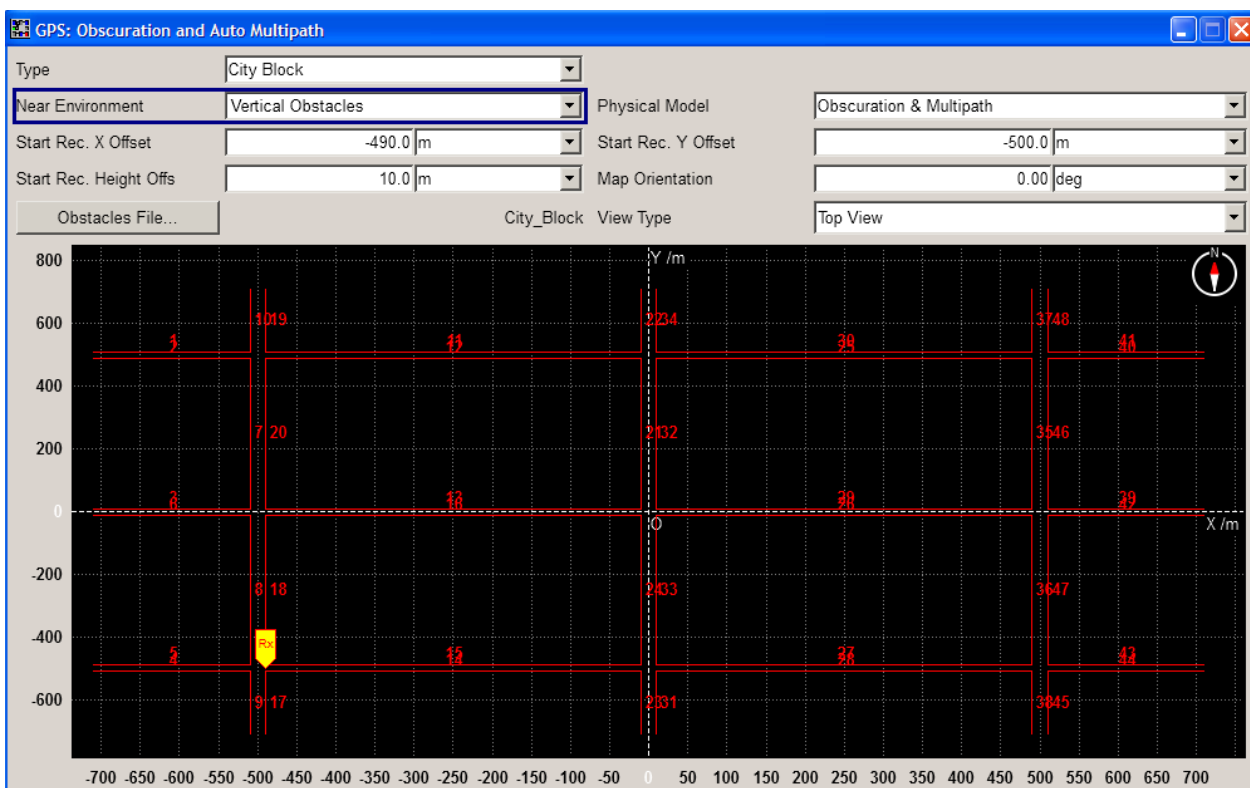
Fig. 3-1: Vertical obstacles settings on the basis of a predefined city block
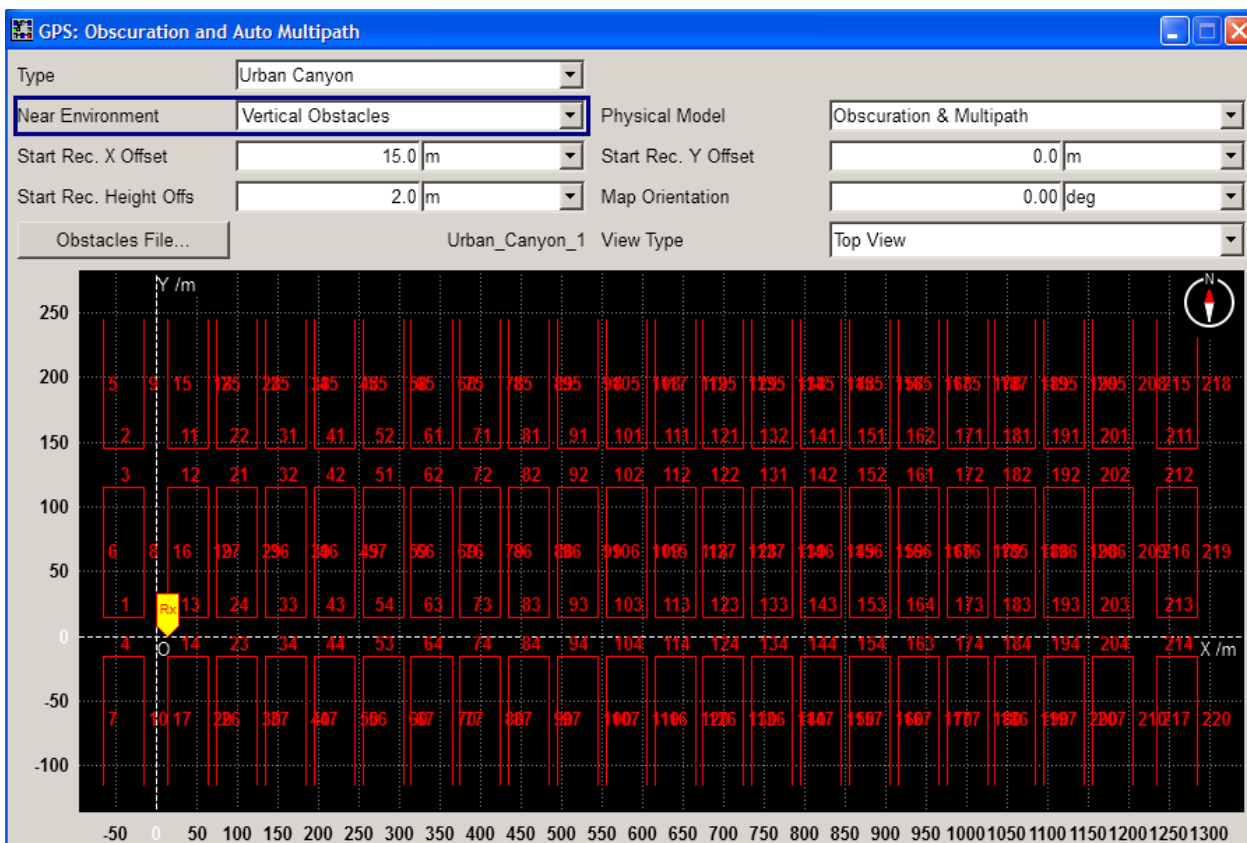
Fig. 3-2: Vertical obstacles settings on the basis of a predefined urban canyon

Receiver Offset

Determines the start position of a receiver/vehicle in terms of height and left/front offset relative to the reference point (i.e. the (0,0,0) coordinate). The reference point is the reference for the definition of the vertical obstacles.

Tip: Use this parameters to redefine the receiver's start location relative to the configured obstacles geometry without changing the obstacles definition in the table (Obstacles Configuration Table).

Note: Simulation of vehicle. If a vehicle is simulated, the position describes a vehicle geometric reference. The offset between antenna and the vehicle's reference is described in the antenna pattern (`*.ant_pat`). The simulated GNSS signal refers to the antenna and not the vehicle geometric reference.

"Start Receiver X Offset"

　　　　　　　　X offset of the first simulated receiver location in the (OX, OY) coordinate system

"Start Receiver Y Offset"

　　　　　　　　Y offset of the first simulated receiver location in the (OX, OY) coordinate system

"Start Receiver Height Offset"
Height offset

Remote command:

<subsystem>:OBSCuration:VOBS:ROFFset:X on page 182

<subsystem>:OBSCuration:VOBS:ROFFset:Y on page 182

<subsystem>:OBSCuration:VOBS:ROFFset:HEIGht on page 182

Map Orientation

The map is aligned to the points of the compass. The value represents the angle between East direction and 0X axis. A value of 0° means that OX axis is to the east and OY to North; a value of 90° corresponds to OX orientation to the north and OY to West.

A compass sign shows the current direction to the north.

Remote command:

<subsystem>:OBSCuration:VOBS:ROFFset:MORientation on page 182

Obstacles File

Provides an access to the standard "File Select" dialog to select a user defined obstacles description file (*.rs_obst).
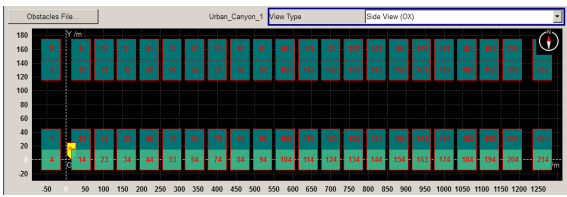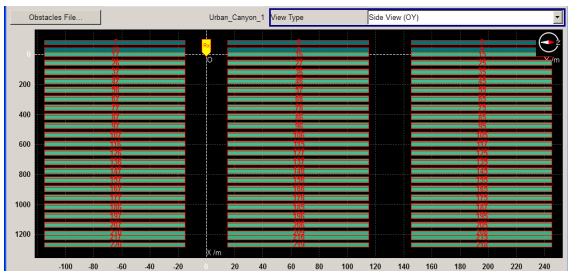
Remote command:

<subsystem>:OBSCuration:VOBS:CATalog:PREDefined? on page 183

<subsystem>:OBSCuration:VOBS:CATalog:USER? on page 183

<subsystem>:OBSCuration:VOBS:FILE on page 183

View Type

Change the display orientation of the model. The available view types depend on the current near environmental model.

Table 3-4: Graphical representation of the urban canyon

"Side View (OX)"	"Side View (OY)"

Obstacles Configuration Table

Each vertical obstacle is defined in one table row. The row index indicates the obstacle on the display view.

	Direc-tion	1st Edge X-Coord /m	1st Edge Y-Coord /m	Length /m	Height /m	Material	Per-mit-tivity
1 >	‖ OX	-710.0	510.0	200.0	20.0	User Def.	7.0
2	‖ OX	-710.0	490.0	200.0	20.0	User Def.	7.0
3	‖ OX	-710.0	10.0	200.0	20.0	User Def.	7.0
4	‖ OX	-710.0	-510.0	200.0	20.0	User Def.	7.0
5	‖ OX	-710.0	-490.0	200.0	20.0	User Def.	7.0
6	‖ OX	-710.0	-10.0	200.0	20.0	User Def.	7.0
7	‖ OY	-510.0	10.0	480.0	20.0	User Def.	7.0

Hide Editor <<<

Dir. Filter All
Mat. Prop. Permittivity

Insert

Delete   Undo All

Save

Direction axis ← Obstacles Configuration Table
Determines the alignment of the vertical obstacle, parallel to OX or to the OY axis.

First Edge X/Y Coordinates, m ← Obstacles Configuration Table
For vertical obstacles, sets the coordinate of the start point (first edge) of the obstacle in meters. First edge has the lowest coordinate value on its direction axis. The coordinate is interpreted on the OX or OY axis.

Length/Height ← Obstacles Configuration Table
Defines the obstacles' length and height in meters. The obstacle is parallel to the Direction axis

Material ← Obstacles Configuration Table
Defines the material the obstacle is build from. Available are "Glass", "Concrete", "Wood", "Gypsum", "Formica", "Marble", "Dry Wall", "Brick".

Permittivity/Power Loss ← Obstacles Configuration Table
Displays/defines the material property, permittivity or power loss, for the selected material. This value is a measure for the reflection caused by the obstacle.

Alignment Filter ← Obstacles Configuration Table
Filters the display of all obstacles for that the selected criteria is fulfilled.

Material Property ← Obstacles Configuration Table
Define whether the material is defined by its permittivity/conductivity or power loss characteristic.

Insert Left/Right, Delete, Undo All, Save ← Obstacles Configuration Table
Standard functions for adding/appending and removing table rows, undo and save changes.

3.3.3 Roadside Planes Settings

This model is enabled in instrument equipped with option R&S SMBV-K92.

This section comprises the parameters, necessary to configure a near environmental model for simulation of obscurations and multipath effects that a moving receiver experiences while moving on a road surrounded by buildings or other objects.

The vertical roadside planes are defined alongside the road and parallel to the motion direction of the moving receiver. A maximum of two vertical planes at max (left and right) are considered based on current user mileage. Examples of predefined environment based on roadside planes are "Suburban Area", "Highway" and "Cutting".
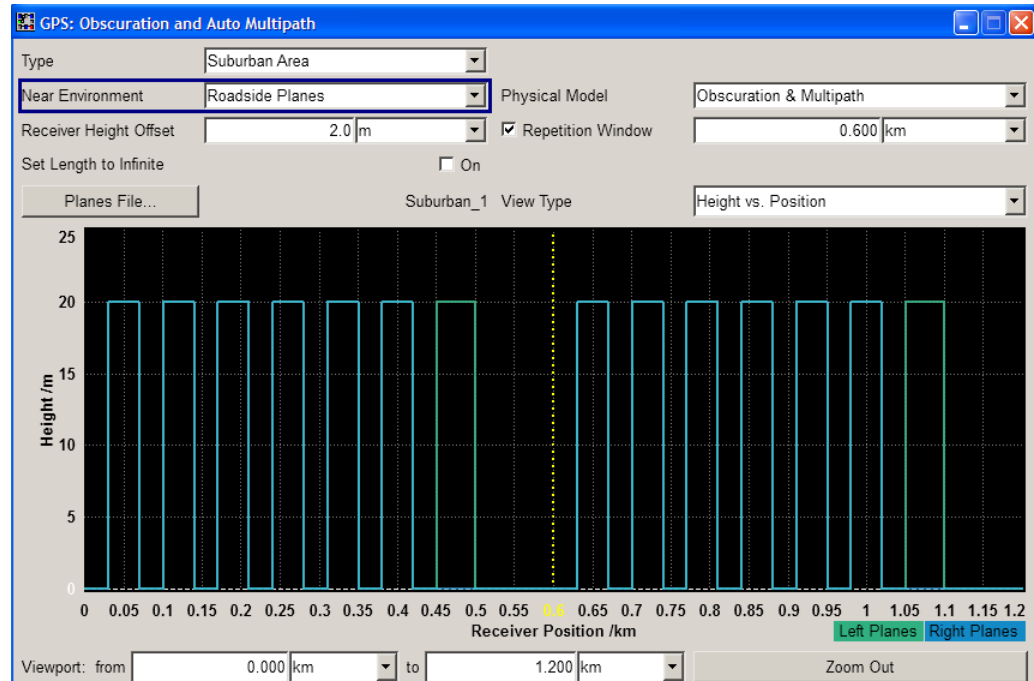
Fig. 3-3: Roadside planes settings on the basis of a predefined suburban area

Receiver Height Offset
Determines the start position of a receiver in terms of height offset relative to the reference point used to define the roadside planes.

Tip: Use this parameters to redefine thethe vehicle's height relative to the configured obstacles geometry without changing the obstacles definition in the table (Obstacles Configuration Table).

Remote command:
<subsystem>:OBSCuration:RPL:ROFFset:HEIGht on page 184

Repetition Window
Enables the repetition of the defined objects and determines the repeating period (in km).

Remote command:
<subsystem>:OBSCuration:RPL:RWINdow:STATe on page 184
<subsystem>:OBSCuration:RPL:RWINdow on page 184

Set Length to Infinite
If enabled, assumes planes with infinite width. Enable this parameter if a cutting scenario is simulated.

Remote command:
<subsystem>:OBSCuration:RPL:ILENgth on page 184

Planes File

Provides an access to the standard "File Select" dialog to select a user defined description file (`*.rs_buil`).

Remote command:

`<subsystem>:OBSCuration:RPL:CATalog:PREDefined?` on page 183

`<subsystem>:OBSCuration:RPL:CATalog:USER?` on page 183

`<subsystem>:OBSCuration:RPL:FILE` on page 183

View Type

Change the display orientation of the model. The available view types depend on the current near environmental model.

Table 3-5: Graphical representation of a highway model
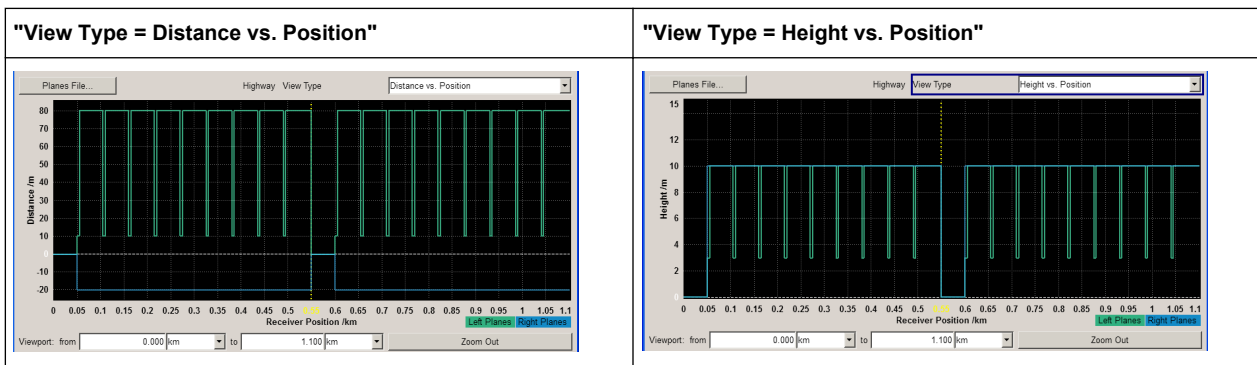
Obstacles Configuration Table

Each roadside plane is defined in one table row. The row index indicates the obstacle on the display view. The left and right planes are color-coded.

Alignment ← Obstacles Configuration Table

For roadsides planes, determines according to which axis (left or right) the location is aligned. The available values depend on the selected Alignment Filter.

Reference Receiver Position ← Obstacles Configuration Table

Distance (mileage) starting from which the corresponding roadside plane is considered for user obscuration and multipath simulation.

Distance ← **Obstacles Configuration Table**

Defines the distance of the vertical obstacle to the OX or OY axis. The distance is expressed in meters.

Height ← **Obstacles Configuration Table**

Defines the obstacles' height in meters.

Material ← **Obstacles Configuration Table**

Defines the material the obstacle is build from. Available are "Glass", "Concrete", "Wood", "Gypsum", "Formica", "Marble", "Dry Wall", "Brick".

Permittivity/Power Loss ← **Obstacles Configuration Table**

Displays/defines the material property, permittivity or power loss, for the selected material. This value is a measure for the reflection caused by the obstacle.

Material Property ← **Obstacles Configuration Table**

Define whether the material is defined by its permittivity/conductivity or power loss characteristic.

Alignment Filter ← **Obstacles Configuration Table**

Filters the display of all obstacles for that the selected criteria is fulfilled.

Insert Left/Right, Delete, Undo All, Save ← **Obstacles Configuration Table**

Standard functions for adding/appending and removing table rows, undo and save changes.

3.3.4 Full Obscuration Settings

This model is enabled in instrument equipped with option R&S SMBV-K92.

This section comprises the parameters, necessary to configure areas in that the satellite signal is fully obscured, like in tunnels. Examples of predefined environments based on full obscuration are "Bridge", "Parking" and "Tunnel".
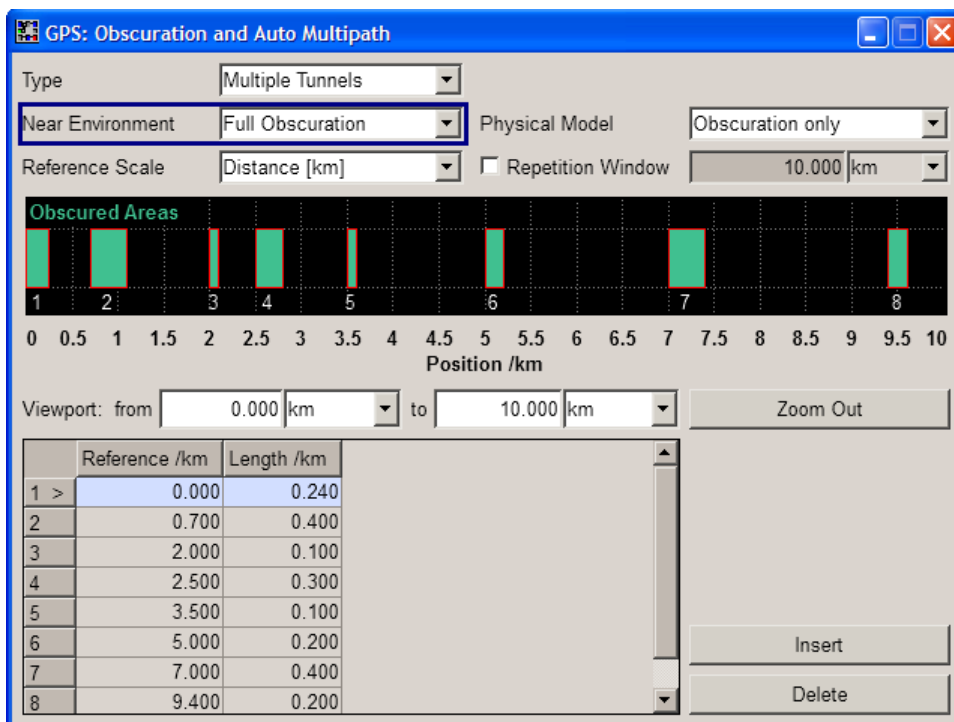
Reference Scale
Defines whether the obstacles' positions are defined as distance (in km) or as time (in s).

Note: Changing between the two scale without saving the configuration leads to data loss.

Remote command:
<subsystem>:OBSCuration:FULL:SCALe on page 185

Repetition Window
Enables the repetition of the defined objects and determines the repetition period (in km).

Remote command:
<subsystem>:OBSCuration:FULL:RWINdow:STATe on page 185
<subsystem>:OBSCuration:FULL:RWINdow on page 185

Full Obscuration Configuration Table
Defines the full obscured areas as a sequence of zones at defined position and with defined "Width". Each zone is defined in one table row.

Tip: To enable an area pattern, define the subset of areas and enable a "Repetition Window" with suitable repetition period. Adjust the displayed window size (Viewport from/to, Zoom Out), to visualize all configured full obscuration areas.

"Reference"   Defines the reference starting position or time stamp at which a specific obscured zone is applied.

Remote command:
<subsystem>:OBSCuration:FULL:AREA<ch>:REFerence on page 186

"Length"   Length of the obscured zone, defined in km or sec.

Remote command:
<subsystem>:OBSCuration:FULL:AREA<ch>:LENGth on page 187

Remote command:
<subsystem>:OBSCuration:FULL:AREA:COUNt? on page 186
<subsystem>:OBSCuration:FULL:AREA:APPend on page 186
<subsystem>:OBSCuration:FULL:AREA<ch>:INSert on page 186
<subsystem>:OBSCuration:FULL:AREA<ch>:DELete on page 186

3.3.5 Ground/Sea Reflection

This section comprises the parameters, necessary to configure a near environmental model for simulation of obscurations and multipath effects caused by ground and sea reflections.

The ground/sea reflections model is available for ship, aircraft and spacecraft vehicles and describes canyon vertical obstacles parallel to the motion direction of the user (direction axis).
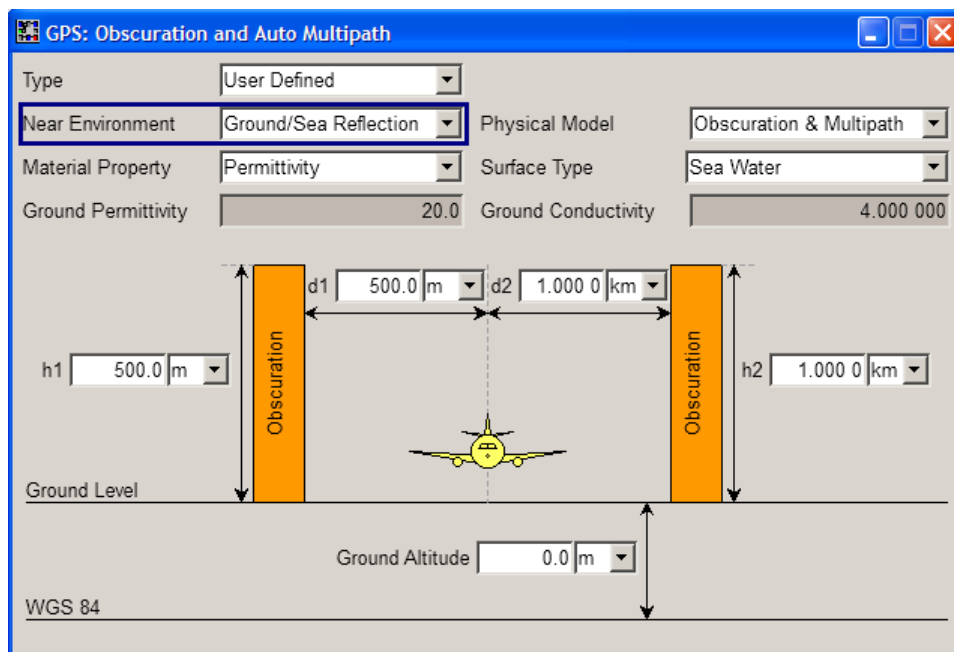
Material Property
Define whether the material is defined by its permittivity/conductivity or power loss characteristic.

The material properties depend on the selected surface type.

Remote command:
<subsystem>:OBSCuration:GSR:MPRoperty on page 187

Surface Type

Describes the surface. Available are "Dry Ground", "Medium Dry Ground", "Wet Ground", "Fresh Water" and "Sea Water". The different surfaces feature different reflection characteristics.

Remote command:

<subsystem>:OBSCuration:GSR:STYPe on page 187

Ground Permittivity/Conductivity, Power Loss

Displays/defines the surface property, permittivity, conductivity or power loss, for the selected surface type. This value is a measure for the reflection caused by the surface.

Remote command:

<subsystem>:OBSCuration:GSR:PERMittivity on page 187

<subsystem>:OBSCuration:GSR:CONDuctivity on page 188

<subsystem>:OBSCuration:GSR:PLOSs on page 188

h1/h2, d1/d2

Determines the height of the right/left obstacle and the distance between the receiver and the obstacles.

Remote command:

<subsystem>:OBSCuration:GSR:O1Distance on page 188

<subsystem>:OBSCuration:GSR:O2Distance on page 188

<subsystem>:OBSCuration:GSR:O1Height on page 189

<subsystem>:OBSCuration:GSR:O2Height on page 189

Ground Altitude

Sets the altitude of the ground level relative to the WGS84 ellipsoid, i.e. the terrain ground level is set relative to WGS84 zero level or sea level.

Remote command:

<subsystem>:OBSCuration:GSR:GALTitude on page 189

Obstacle Orientation

For "Geographic Location/Attitude" different than waypoint and "Vehicle Type = Aircraft/Ship/Spacecraft", defines the direction of the obstacles. If the vehicle is moving, the obstacles are assumed to be parallel to the motion.

The value zero means that the obstacles are parallel to the east direction.

Remote command:

<subsystem>:OBSCuration:GSR:OORientation on page 189

3.4 GNSS System/Almanac Configuration Settings

► To access this dialog, select "Main Dialog > GNSS System Configuration"
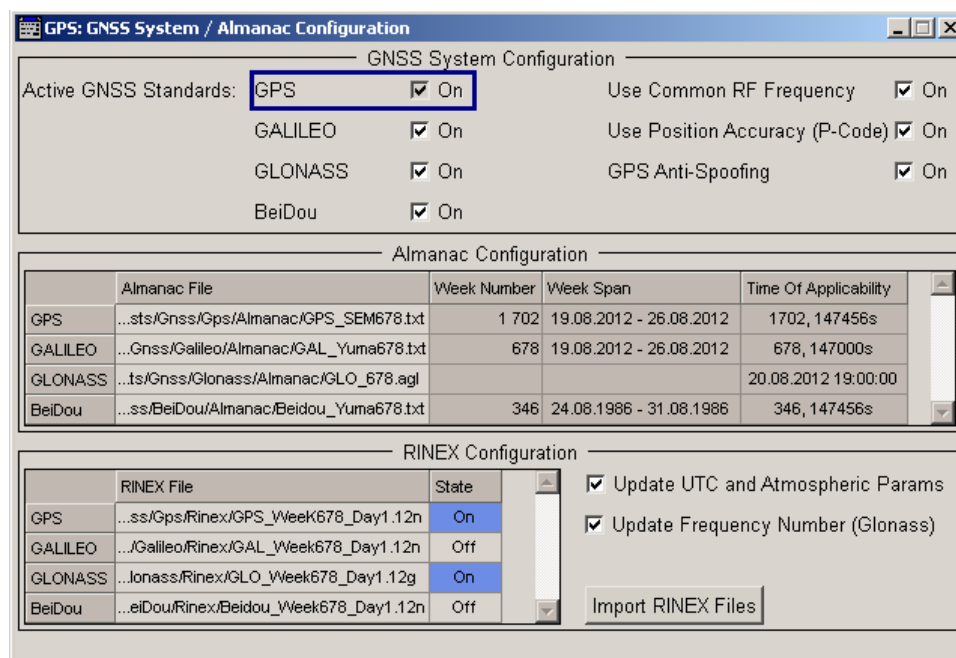
The dialog comprises the general settings for GNSS system configuration, such as selecting the GNSS standards, and configuring the almanac and RINEX files.

Activate GNSS Standards
Defines the navigation standards that will be part of the GNSS system configuration. Only the satellites of an enabled standard are configurable in the Satellite Configuration dialog.

The navigation standard of the entry point is always enabled. The further available navigation standards depend on the installed options.

Note: Throughout this description, the term hybrid cinfiguration denotes a GNSS system configuration comprising the satellites of two or more navigation standards.

Remote command:
`<subsystem>:HYBRid:<GNSS>[:STATe]` on page 193

Use Common RF Frequency
Enable this parameter if several R&S SMBV instruments are connected to generate GNSS signal in the same GNSS band (see figure 2-1) and phase coherent signal is required, e.g. two instruments generating respectively up to 24 GPS, 24 GLONASS and 24 BeiDou satellites in the L1/E1 RF band.

This feature triggers the instruments to shift the baseband signal in the frequency domain so that both instruments can use the same RF frequency. The effect is comparable with enabled hybrid GNSS configuration. With correct configured settings, instruments equipped with hardware option R&S SMBV-B90 generate phase coherent RF signals.

For more information on the required options, connection and configuration steps, refer to chapter 2.11, "Generating GNSS Signal with Several Instruments", on page 51.

Remote command:
`<subsystem>:UCRF` on page 193

Use Position Accuracy (P-Code) GPS
The generation of GPS signal modulated by P-code requires the additional software option R&S SMBV-K93.

This parameter is enabled only if GPS standard is activated in the GNSS system configuration. Activate "Use Position Accuracy" to enable the selection of P and C/A+P signals in the Satellite Configuration dialog.

Remote command:
`<subsystem>:UMGPs` on page 193

GPS Anti-Spoofing
Enables Anti Spoofing flag in the GPS navigation message.

Remote command:
`<subsystem>:SATellite:ASPoofing` on page 193

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 almanac files can be loaded.

The following almanac files are supported:
- **GPS and Galileo**
    - SEM-files with data extension `xxx.al3`
    - YUMA almanac files with data extension `xxx.alm`

    These files describe GPS and Galileo almanacs, whereas xxx denotes the day of a year.
    Note: Current GPS almanac data can be downloaded via the Internet and stored on the hard disk of the instrument:
    U.S.Coast Guard Navigation Center GPS Homepage http://www.navcen.uscg.gov/?pageName=gpsAlmanacs
- **Glonass**
    Almanac files with data extension `xxx.agl`
    Refer also to the download ftp site for Glonass almanacs: ftp://ftp.glonass-iac.ru/MCC/ALMANAC/

When an almanac file is selected, the time information of the file (Week, SEM and TOA) is indicated in the table. If RINEX file is not enabled, the satellite specific information (ephemeris) is also taken from the almanac.

The SEM and TOA are indicated in Greenwich Mean Time.

Parameter	SCPI command
"Almanac File"	`<subsystem>:NAVigation:ALManac:<GNSS>:FILE` on page 195
	`<subsystem>:SVID:<GNSS>:LIST` on page 200
"Week Number"[1]	`<subsystem>:NAVigation:ALManac:<GNSS>:WNUMber` on page 199
"Week Span"[1]	`<subsystem>:NAVigation:ALManac:<GNSS>:DATE:BEGIn` on page 196
	`<subsystem>:NAVigation:ALManac:<GNSS>:DATE:END` on page 196
"Time of Applicability (TOA)"[2]	`<subsystem>:NAVigation:ALManac:<GNSS>:TOAPplicability:TOWeek` on page 198
	`<subsystem>:NAVigation:ALManac:<GNSS>:TOAPplicability:WNUMber` on page 198
"Time of Applicability (TOA)"	`<subsystem>:NAVigation:ALManac:GLONass:TOAPplicability:DATE?` on page 197
	`<subsystem>:NAVigation:ALManac:GLONass:TOAPplicability:TIME?` on page 197

[1] "Week Number" and "Week Span": no SCPI command for Glonass

[2] 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)*

RINEX Configuration

Selects and activates one "RINEX File" per navigation standard. Predefined or user RINEX files can be loaded.

Perform "Import RINEX Files" to upload the selected file. The ephemeris and satellite clock parameters of the SV IDs included in the selected RINEX file are retrieved from this file. However, the parameters of SV IDs that are not included in the RINEX file are retrieved from the almanac of the corresponding GNSS.

Enable the "Update UTC and Atmospheric Parameters" to synchronize the time conversion parameters and the atmospheric parameters to the corresponding values retrieved from the RINEX file.

Enable the "Update Frequency Number (GLONASS)" to extract the frequency number allocations from the RINEX file.

See also
● chapter A.2, "RINEX Files", on page 303 for description of the RINEX file format
● chapter 2.10.11, "Configuring the Navigation Parameters", on page 41

Remote command:
`<subsystem>:NAVigation:RINex:GPS:FILE` on page 199
`<subsystem>:NAVigation:RINex:GPS:STATe` on page 200
`<subsystem>:NAVigation:RINex:IMPort` on page 200
`<subsystem>:NAVigation:RINex:UUAState` on page 200
`<subsystem>:NAVigation:RINex:UFNState` on page 200

3.5 Time Conversion Configuration

To access this settings:

1. Select "Baseband > Satellite Navigation > GPS".

2. Select "Localization Data > Time Convertion Configuration".

   This dialog provides the settings necessary to configure the time conversion from a navigation standard (GPS, Galileo, GLONASS or BeiDou) to UTC. The conversion settings are necessary for switching from one time basis to another.

GPS: Time Conversion Configuration

Time Conversion Parameters

	GPS-UTC	GALILEO-UTC	GLONASS-(UTC(SU)+3h)	BeiDou-UTC	
A_0	0	0	0	0	
Scale Factor	2 ^ -30	2 ^ -30	2 ^ -31	2 ^ -30	
Scaled Value	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	
A_1	0	0		0	
Scale Factor	2 ^ -50	2 ^ -50		2 ^ -50	
Scaled Value	0.000000e+00	0.000000e+00		0.000000e+00	
T_ot	21	0		0	
Scale Factor	2 ^ 12	3600		1	
Scaled Value	8.640000e+04	0.000000e+00		0.000000e+00	
WN_ot	1 702	0			

Leap Second Configuration

Synchronize

Current Leap Seconds (Ref. 1980)   16

Simulate Leap Second Transition   ☑ On

Next Leap Second Date   21.08.2012

Leap Sign   +1 ▼

UTC - UTC(SU)

UTC(SU) Reference Date   20.08.2012

A_0   0 x 2^-10 =   0.000 0 s

A_1   0 x 2^-16 =   0.000 000 s/msd

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 an 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

Configuration of the time conversion parameters require software option R&S SMBV-K92. The time conversion parameters are enabled only in "User Localization" and "Static" modes.

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.

To retrieve the time configuration parameters from an imported RINEX file, enable the parameter Update UTC and Atmospheric Parameters.

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 but the corresponding "Scale Factor" and the "Scaled Value" are displayed too.

Parameter	Description	SCPI Command
"A_0"	Constant term of polynomial, A_0	`<subsystem>:NAVigation:TCONversion: GPS:AZERo` on page 202
"A_1"	1st order term of polynomial, A_1	`<subsystem>:NAVigation:TCONversion: GPS:AONE` on page 202
"t_ot"	UTC data reference Time of Week, t_{ot}	`<subsystem>:NAVigation:TCONversion: GPS:TOT` on page 203
"WN_t"	UTC data reference Week Number, WN_t	`<subsystem>:NAVigation:TCONversion: GPS:WNOT` on page 203

Leap Second Configuration

The GPS time is not corrected to match the Earth's rotation and does not consider time corrections that are typical for the UTC, such as the leap second for instance. The UTC time corrections are performed periodically, 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 206
"Current Leap Seconds (Ref. 1980)"	Displays the currently used leap second.	`<subsystem>:NAVigation:TCONversion: LEAP:SEConds` on page 205
"Simulate Leap Second Transition" (R&S SMBV only)	Enables/disables the simulation of the leap second transition.	`<subsystem>:NAVigation:TCONversion: LEAP:SLSTransition[:STATe]` on page 205

Parameter	Description	SCPI Command
"Next Leap Second Date" (R&S SMBV only)	Determines the date of the next UTC time correction.	`<subsystem>:NAVigation:TCONversion:LEAP:DATE` on page 205
"Leap Sign" (R&S SMBV only)	The time correction is performed in steps of one second. One second may be added to or subtracted from the current leap second value.	`<subsystem>:NAVigation:TCONversion:LEAP:SIGN` on page 205

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 204
"A_0"	Constant term of polynomial A_0 (virtual)	`<subsystem>:NAVigation:TCONversion:UTCSu:AZERo` on page 204
"A_1"	1st order term of polynomial, A_1 (virtual)	`<subsystem>:NAVigation:TCONversion:UTCSu:AONE` on page 204

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 by automatically adjusting the "GPS-UTC" drift parameters ("A_1","T_ot" and "WN_ot") while changing the "UTC – UTC(SU)" parameters.

3.6 Satellite Configuration

To access this settings:

1. Select "Baseband > Satellite Navigation > GPS".

2. Select "Satellite Configuration".

    In the "Satellite Configuration" dialog, you can activate and confuigure the signal simulation of up to 24 satellites. The maximum number of the configurable satellites depends on the installed options.
    The GNSS implementation in R&S WinIQSIM2 is a simplified offline version of the realtime option. The offline version provides the possibility to generate an one-satellite generic signal, i.e. only 1 satellite can be activated and configured.
    In the following description, the relevant parameters are adjusted accordingly in R&S WinIQSIM2. You find the differences explicitly stated in the description.
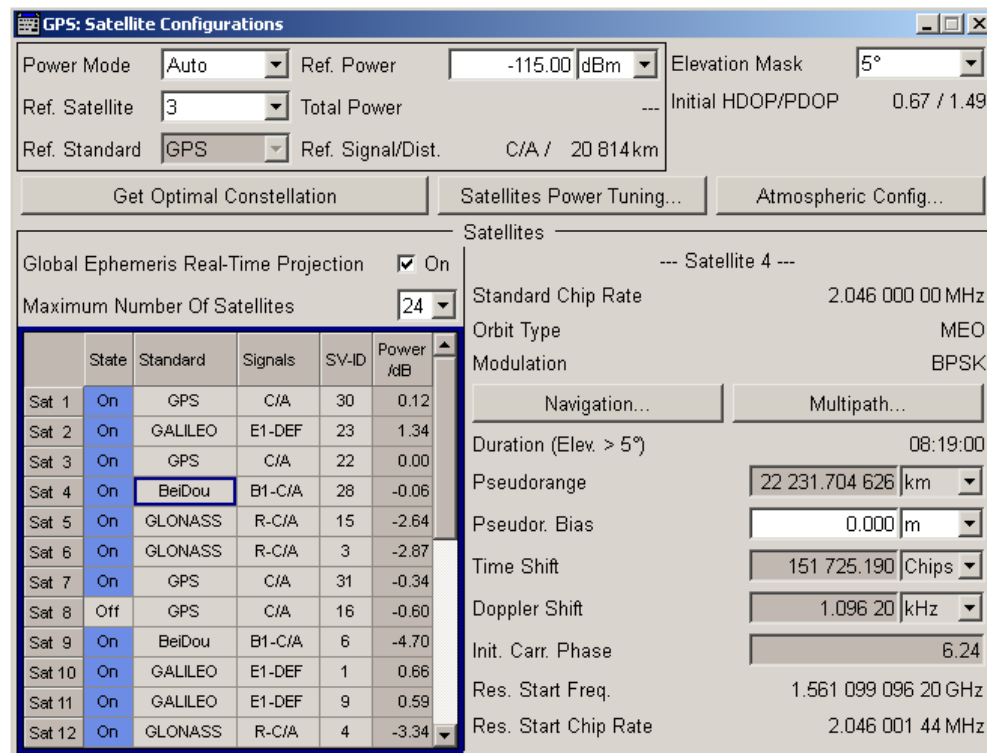
3.6.1 Power Configuration

> The power settings in the upper part of the dialog are relevant only for R&S SMBV instruments. Section "Satellites" applies also to WinIWQSIM, however, only one satellite can be configured.

This section comprises the power settings. The dynamic power control concept is based on two power modes, the "Auto" and the "User" mode. Use the auto mode if a dynamic automatic power calculation is preferred. For flexible real time configuration of the power settings per satellite, enable the user mode.

The table 3-6 gives an overview of the parameters that are considered by the calculation of the satellites' power levels.

Table 3-6: Overview of the parameters affecting the power level of the GNSS signal

Power Mode	Reference Power	Reference Satellite	Pseudorange	Inter-Standard Tuning	Additional Power per Tap	Relative/Displayed Power of the individual satellites signal component
Auto	yes	yes	yes	yes	yes	displays the power level at the simulation start time
User	yes	-	-	-	yes	yes

The table 3-7 shows how the power levels are calculated depending on the "Simulation Mode", the "Power Mode" and whether a signal component undergoes static multipath or not.

Table 3-7: Calculating the power levels of the satellite as a function of the "Power Mode" and the "Simulation Mode".

Power Mode/ Simulation Mode	Auto	User
"Static"	-	Absolute Power$_{Sat\#\_Signal}$ = Ref. Power + Relative Power$_{Sat\#\_Signal}$
"Auto Localization"	Absolute Power$_{Sat\#\_Signal}$ = Ref. Power + Power*$_{Sat\#\_Signal}$[1]	Absolute Power$_{Sat\#\_Signal,Tap\#}$ = Ref. Power + Power$_{Sat\#\_Signal}$ + Additional Power$_{tap\#}$
"User Localization"	Absolute Power$_{Sat\#\_Signal,Tap\#}$ = Ref. Power + Power*$_{Sat\#\_Signal}$[1] + Additional Power$_{tap\#}$	

[1] For a satellite in the satellite list with pseudorange at time t = Pseudorange$_t$ and "Ref. Standard = Std"

Power*$_{Sat\#\_Signal\_t}$ = $20\log_{10}$(Ref. Orbital Dist/ND$_{Ref.Std}$) + $20\log_{10}$(ND$_{Std}$/Pseudorange$_t$) +Inter-Standard Power$_{Sat\#\_Ref.Signal}$, where ND is the nominal orbital distance (see Reference Signal/ Reference Orbital Distance).

Example: Calculation of the Power* if "Ref. Sattellite" is different than N.A.

Power*$_{Sat\#\_Signal\_t}$ = $20\log_{10}$(Pseudorange$_{Ref.Sat\_t0}$/Pseudorange$_{Sat\#Signal\_t}$) + Inter-Standard Power$_{Sat\#\_Ref.Sat}$, where $t0$ represents the start moment of the simulation.

If "Ref. Satellite" different than N.A. , the power level displayed in the user inerface (Power) represents the power level at the start moment of the simulation ($t0$) and is calculated as follow:
Displayed Power$_{Sat\#\_Signal\_t0}$ = $20\log_{10}$(Pseudorange$_{Ref.Sat\_t0}$/Pseudorange$_{Sat\#Signal\_t0}$) + Inter-Standard Power$_{Sat\#\_Ref.Sat}$

The total power of the generated GNSS signal is displayed with the parameter Total Power.

Example: Power calculation in "User" power mode for GNSS signal undergoing static multipath propagation

Power calculation for the power settings and satellite constellation as shown on .

Fig. 3-4: Example: Power Configuration in User Power Mode

- Number of Satellites = 4
- Sat#1: Power$_{Sat\#1\_C/A}$ = -1 dB; static Multipath = Off
- Sat#2: Power$_{Sat\#2\_C/A}$ = 0 dB; static Multipath = Off
- Sat#3: Power$_{Sat\#3\_E1\text{-}DEF}$ = -5 dB; static Multipath = On (Additional Power$_{Tap\#1}$ = -5 dB, Additional Power$_{Tap\#2}$ = -3 dB)
- Sat#4: Power$_{Sat\#4\_E1\text{-}DEF}$ = -10 dB; static Multipath = Off
- Reference Power = -115 dBm

Calculation of the absolute power levels

- Absolute Power$_{Sat\#1\_C/A}$ = Ref. Power + Power$_{Sat\#1\_C/A}$ + Additional Power$_{tap\#}$ = -115 dBm + -1 dB = -116 dBm
- Absolute Power$_{Sat\#2\_C/A}$ = Ref. Power + Power$_{Sat\#2\_E1\text{-}DEF}$ + Additional Power$_{tap\#}$ = -115 dBm + 0 dB = -115 dBm
- Absolute Power$_{Sat\#3\_E1\text{-}DEF,Tap\#1}$ = Ref. Power + Power$_{Sat\#3\_E1\text{-}DEF}$ + Additional Power$_{Tap\#1}$ = -115 dBm + -5 dB + -5 dB = -125 dBm
  Absolute Power$_{Sat\#3\_E1\text{-}DEF,Tap\#2}$ = Ref. Power + Power$_{Sat\#3\_E1\text{-}DEF}$ + Additional Power$_{Tap\#2}$ = -115 dBm + -5 dB + -3 dB = -123 dBm
- Absolute Power$_{Sat\#4\_E1\text{-}DEF}$ = Ref. Power + Power$_{Sat\#4\_C/A}$ + Additional Power$_{tap\#}$ = -115 dBm + -10 dB = -125 dBm

Open the "Real-Time SPOT" dialog, set the "Display Type" to "Power View" and compare the displayed power levels.
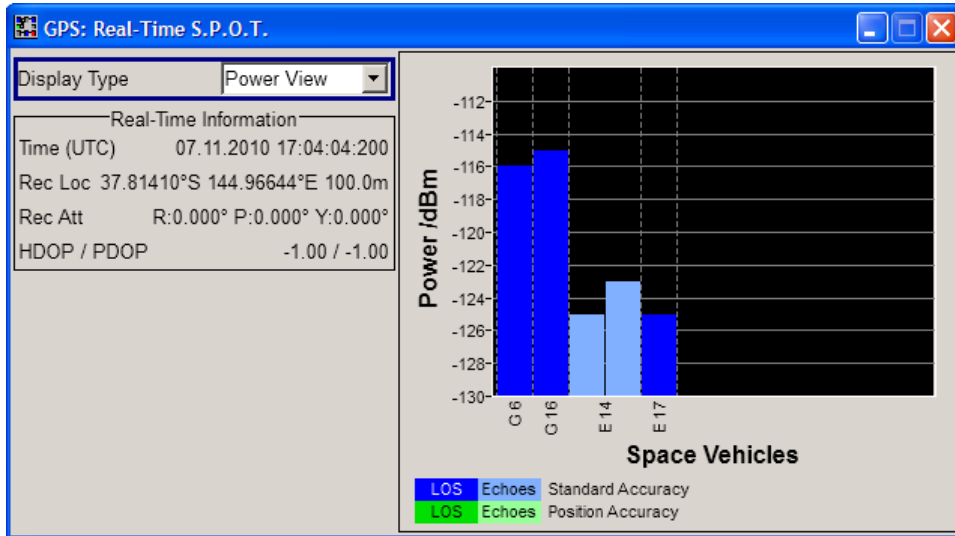
The power level are displayed sorted per navigation standard and in ascending order of the SV-ID.

Example: Power calculation in "Auto" power mode

Power calculation for the power settings and satellite constellation at the simulation start time as shown on figure 3-5.
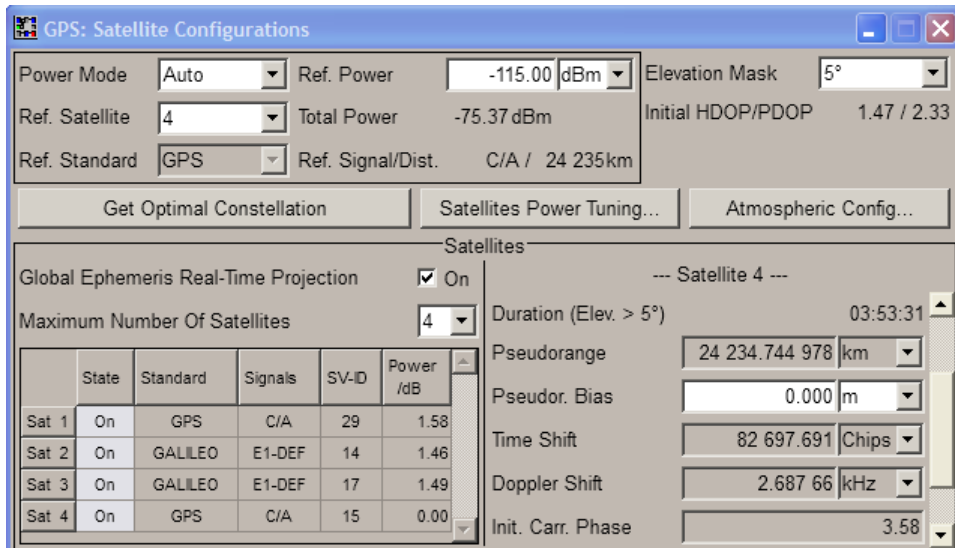
Fig. 3-5: Example: Power Configuration in Auto Power Mode

Note: The power values displayed in "Auto" power mode correspond to the start of the simulation ($t0$). The power levels change automatically as function of the satellite-receiver distance but the display is not updated.

Tip: Select "GNSS General Settings > Real-Time SPOT" and select "Display Type > Power View". The displayed power levels are updated in real-time.

Power levels at the beginning of the simulation (t=t0):

- Reference Power = -115 dBm
  The reference power is the nominal power of the reference satellite at the start time and location; the power of all other satellites are simulated as relative power to the power of the reference one.
- Reference Satellite = Sat#4
- Number of Satellites = 4
- for all satellites static Multipath = Off
- Sat#1: Displayed Power$_{Sat\#1\_C/A}$ = 1.58 dB
- Sat#2: Displayed Power$_{Sat\#2\_E1-DEF}$ = 1.46 dB
- Sat#3: Displayed Power$_{Sat\#2\_E1-DEF}$ = 1.49 dB
- Sat#4: Displayed Power$_{Sat\#4\_C/A}$ = 0 dB
- Inter-Standard Power Tuning$_{GPS\ C/A-GAL\ E1-DEF}$ = -1.5 dB , i.e. the displayed power levels of the Galileo satellites are internally boosted with 1.5 dB.

Calculation of the absolute power levels at the beginning of the simulation (t=t0):

- Absolute Power$_{Sat\#1\_C/A}$ = Ref. Power + Displayed Power$_{Sat\#1\_C/A}$ = -115 dBm + 1.58 dB = -113.42 dBm
- Absolute Power$_{Sat\#2\_E1-DEF}$ = Ref. Power + Displayed Power$_{Sat\#2\_E1-DEF}$ = -115 dB + 1.46 dB = -113.54 dB
- Absolute Power$_{Sat\#3\_E1-DEF}$ = Ref. Power + Displayed Power$_{Sat\#3\_E1-DEF}$ = -115 dBm + 1.49 dB = -113.51 dB
- Absolute Power$_{Sat\#4\_C/A}$ = Ref. Power = -115 dBm

Select "GNSS General Settings > Real-Time SPOT" and select "Display Type > Power View" and compare the displayed power levels.
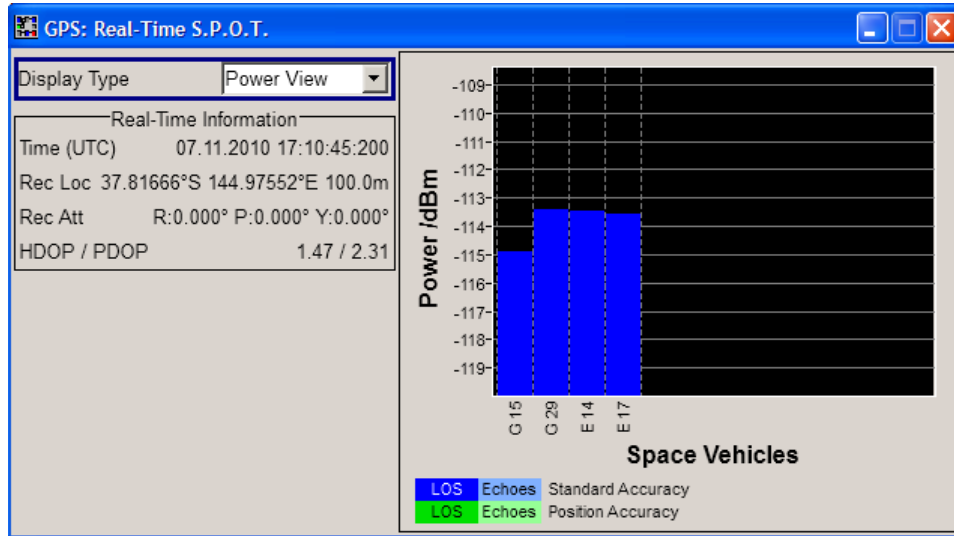
Fig. 3-6: Example: Power levels at the beginning of the simulation

Another way to query the current power levels is by using the corresponding SCPI command, e.g. see `<subsystem>:RT:<GNSS>:SVID<ch>:TAP<us>:POWer: ABSolute` on page 272.

The total power of the generated GNSS signal is displayed with the parameter "Total Power".

Example: Power calculation for mixed signals

Power calculation for the power settings and satellite constellation at the simulation start time as shown on figure 3-7.

Fig. 3-7: Example: Power Configuration with Mixed Signal

This example focus only on the power calculation of the mixed signal.

- Power Mode = User
  Number of Satellites = 4
  for all satellites Multipath = Off

- Sat#1: $\text{Power}_{\text{Sat\#1\_C/A+P}}$ = -1.31 dB; Power Reference = C/A; Intra-Standard $\text{Power}_{\text{Sat\#\_PowRef}}$ = 3 dB, i.e the C/A signal is boosted with 3 dB compared to the P-code signal.
- Sat#2: $\text{Power}_{\text{Sat\#2\_E1-DEF}}$ = 0 dB; $\text{Pseudorange}_{\text{Ref.Sat\_t0}}$ = 23384433.474 m
- Sat#3: $\text{Power}_{\text{Sat\#3\_R-C/A}}$ = -5.39 dB;
- Sat#4: $\text{Power}_{\text{Sat\#4\_C/A}}$ = -2.14 dB;
- Reference Power = -115 dBm

Calculation of the absolute power levels

- Absolute $\text{Power}_{\text{Sat\#1\_C/A}}$ = Ref. Power + $\text{Power}_{\text{Sat\#1\_C/A+P}}$ + Additional $\text{Power}_{\text{tap\#}}$ = -115 dBm + -1.31 dB = -116.31 dBm
  Absolute $\text{Power}_{\text{Sat\#1\_P}}$ = Ref. Power + $\text{Power}_{\text{Sat\#1\_C/A+P}}$ + Additional $\text{Power}_{\text{tap\#}}$ + Intra-Standard $\text{Power}_{\text{Sat\#\_PowRef}}$ = -115 dBm + -1.31 dB + -3 dB = -119.31 dBm
- Absolute $\text{Power}_{\text{Sat\#2\_E1-DEF}}$ = Ref. Power + $\text{Power}_{\text{Sat\#2\_E1-DEF}}$ + Additional $\text{Power}_{\text{tap\#}}$ = -115 dBm + 0 dB = -115 dBm
- Absolute $\text{Power}_{\text{Sat\#3\_R-C/A}}$ = Ref. Power + $\text{Power}_{\text{Sat\#3\_R-C/A}}$ + Additional $\text{Power}_{\text{tap\#}}$ = -115 dBm + -5.39 dB = -120.39 dBm
- Absolute $\text{Power}_{\text{Sat\#4\_C/A}}$ = Ref. Power + $\text{Power}_{\text{Sat\#4\_C/A}}$ + Additional $\text{Power}_{\text{tap\#}}$ = -115 dBm + -2.14 dB = -117.14 dBm

Open the "Real-Time SPOT" dialog, set the "Display Type" to "Power View" and compare the displayed power levels.
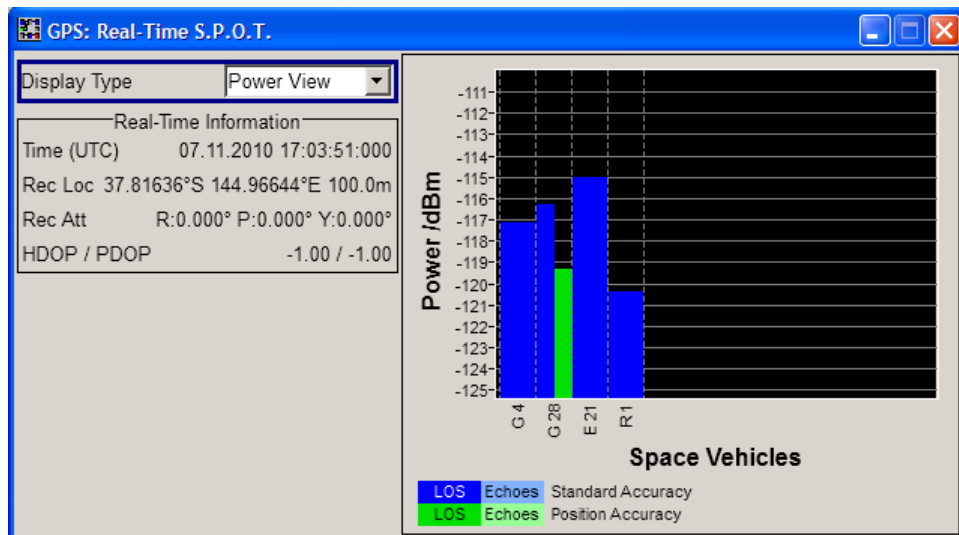
The power level are displayed sorted per navigation standard and in ascending order of the SV-ID.

Power Mode
Determines whether the power is calculated automatically or is based on user defined settings.

- "User" power mode is intended for dynamical configuration of the power of each satellite separately and manually.
- "Auto" power mode enables an internal dynamical automatic power control. The power of all satellites is calculated automatically based on the satellite-to-receiver distance and relative to the relative power of the reference satellite. The Reference Satellite is simulated as relative 0 dB at the start reference receiver location and at the simulation start time.
  The "Auto" power mode is enabled in "Auto Localization" and "User Localization" modes.

Remote command:
<subsystem>:POWer:MODE on page 222

Reference Power

Sets the power level that is used as a reference for the calculation of the power level of the satellites.

- In "Auto" power mode, the "Reference Power" is the power level of the reference signal component Reference Satellite at the reference orbital distance.
  Example:

"Ref. Orbital Dist" = 20300 km
"Ref. Standard"   = GPS
"Ref. Signal"   = C/A

  The "Inter-Standard Power Tuning" settings are applied automatically. The power levels of all satellites are calculated automatically based on this reference power level for each moment of time depending on the ratio of their dynamic satellite-receiver distance.
- In "User" power mode, the "Reference Power" represents the power level based on which all initial satellite power levels are calculated.

Remote command:
<subsystem>:POWer:REFerence[:POWer] on page 222

Reference Satellite

Determines the satellite used as a reference for the calculation of the power levels of the satellites in "Power Mode > Auto".

- For "Reference Satellite" different than "N.A."
  The values of Reference Standard and Reference Signal/ Reference Orbital Distance are updated for the selected "Reference Satellite" and the satellite to user distance at the start simulation time.
- For "Reference Satellite = N.A."
  "Reference Standard" is configurable and "Ref. Distance" is set to the nominal orbital distance ND of the selected "Reference Standard". See also Reference Signal/ Reference Orbital Distance.

Remote command:
<subsystem>:POWer:REFerence:SATellite on page 223

Total Power

By enabled signal generation, displays the total power of the generated GNSS signal at a moment of time. The total power is a real time parameter that follows the real time changes in the absolute power levels of all active satellites.

Remote command:

<subsystem>:POWer:TOTal? on page 225

Reference Standard

In "Power Mode > Auto", determines the reference standard.

Note: In a test setup involving two instruments, in both instruments, set the "Reference Satellite > N.A." and enable equal "Reference Power" and the same "Reference Standard".

Remote command:

<subsystem>:POWer:REFerence:STANdard on page 223

Reference Signal/ Reference Orbital Distance

("Power Mode > Auto" only)

- For "Reference Satellite" different than "N.A."
  displays the signal component of the current reference satellite used as reference for the power calculation and the pseudorange of the reference satellite at the beginning of the simulation (t=t0).
- For "Reference Satellite = N.A.", the following nominal orbit distances (ND) are used:
  - ND_{GPS} = 20300 km
  - $ND_{GLONASS}$ = 19100 km
  - $ND_{Galileo}$ = 23222 km
  - ND_{BeiDou_MEO} = 21528 km and $ND_{BeiDou\_IGSO/GEO}$ = 35786 km

Remote command:

<subsystem>:POWer:REFerence:SIGNal? on page 223

<subsystem>:POWer:REFerence:DISTance? on page 224

3.6.2 General Satellites Settings

Use Spreading

(enabled in "Static" mode only)

Activates/deactivates spreading. When spreading is deactivated the pure navigation data is modulated onto the RF carrier.

Remote command:

<subsystem>:SPReading[:STATe] on page 212

Galileo Sat. Modulation

(Galileo in WinIQSIM2 only)

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 213

Elevation Mask

(R&S SMBV instruments only)

(enabled for "Auto Localization" and "User Localization"mode)

Sets the satellite's elevation mask, i.e. determines the elevation filter applied during the "Get Optimal Constellation" process or, while using the Auto Localization mode, used to filter all low-elevation satellites which are closer to the horizon and may witness in reality more unwanted multipath effects.

When the elevation decreases below the selected elevation mask, the GPS satellite is considered as invisible by the receiver and hence the GPS receiver can not use this satellite for determining its position. The GPS receiver has to search for another satellite with better visibility.

Automatic dynamic exchange of the satellites is performed in "Auto Localization" only. The expected time of the next upcoming satellites handover is displayed in the "Real-Time S.P.O.T." view with the parameter Next Constellation Change.

While analyzing the generated signal, make sure that the "Satellite Elevation Mask" used by the signal generation is set to the elevation mask of the GNSS receiver.

Remote command:
<subsystem>:SEMask on page 212

Initial HDOP/PDOP

(R&S SMBV only)

Displays the HDOP (Horizontal Dilution of Precision) / PDOP (Position Dilution of Precision) of the selected satellite constellation at the beginning of the simulation.

The displayed HDOP/PDOP value is not updated. The dynamic "HDOP" and "PDOP" calculated on the current satellite constellation is displayed in the Real-Time S.P.O.T. dialog.

The HDOP can be used as an indication of 2D positioning quality; the PDOP is an indication of 3D positioning quality. The general rule here is that the smaller the HDOP/PDOP the better the precision of the position fix will be.

At least four different satellites have to be configured to get a reasonable value; otherwise -1 will be displayed.

This parameter is enabled only for "Auto Localization" and "User Localization"mode.

Remote command:
<subsystem>:HDOP? on page 213
<subsystem>:PDOP? on page 213

Atmospheric Configuration

(R&S SMBV only)

Access the Atmospheric Configuration dialog for configuring:
- the ionospheric tropospheric models used for the satellite channel's simulation

- the atmospheric parameters as transmitted in the corresponding GNSS navigation message.

Get Optimal Constellation

(R&S SMBV only)

In "User Localization" mode, the satellites are fully configurable. Use this function prior to and as basis for further configurations and retrieve an optimal satellites constellation for the selected Almanac/RINEX file, Elevation Mask and the selected Maximum Number of Satellites.

Note: The retrieved satellite's constellation includes satellites with "State Off", if the number of satellites with elevation higher than the selected "Elevation Mask" is less than the selected "Maximum Number of Satellites".

Remote command:

<subsystem>:GOConstellation on page 213

<subsystem>:RT:OCONstellation? on page 279

Satellites Power Tuning

(R&S SMBV only)

Opens the Satellites Power Tuning dialog for setting the power relation between the signals of different GNSS standards.

Global Signal (and Relative Power) Configuration

Enabled in "Auto Localization" mode. "Relative Power Configuration" is enabled in "Power Mode > User".

Opens the Global Signal Configuration dialog to determine:
- the type of signal a SV ID will use in the moment the corresponding satellite becomes visible
- in "Power Mode > User", the relative power per SV ID.

3.6.3 Configuration of the Satellite Constellation

This section comprises the setting of the satellites constellation and the individual settings of each enabled satellite. The satellite constellation is enabled for configuration in "Static" and "User Localization" mode.

Global Ephemeris Real-Time Projection

(R&S SMBV only)

Forces ephemeris projection for all satellites, i.e. enables the parameter "Sat# > Navigation Message Configuration > Real-Time Projection" for all satellites.

Note: "Global Ephemeris Real-Time Projection" has to be disabled, if assistance data will be generated.

Remote command:

<subsystem>:SATellite:GRTProjection on page 214

Maximum Number of Satellites

Determines the maximum number of satellites that can be simulated. The minimum allowed values depends on the selected Simulation Mode. Configurations with one satellite are allowed only in "Static" mode; "Auto Localization" and "User Localization" modes require four satellites or more.

Generating the navigation signal with more than 6 satellites is enabled only for instruments, equipped with option R&S SMBV-K91/-K96. The maximum number of satellites is additionaly limitted by the available hardware resources of the instrument, espessialy if P-Code modulated signals are enabled in the GNSS system configuration. Refer to chapter 2.4.1, "Channel Budget", on page 23 for detailed description.

The GNSS implementation in the R&S WinIQSIM2 provides one satellite signal.

The number of satellites selected determines the number of rows in the Constellation Table.

Remote command:

<subsystem>:SATellite:COUNt on page 214

Constellation Table

Comprises the setting of the satellites constellation. These settings are enabled for configuration in "Static" and "User Localization" mode.

Satellite State ← Constellation Table

Activates/deactivates the satellite.

Note:

In "User Localization" mode, changing the satellites state is performed **on-the-fly** and without interruption of the signal generation, unless:

- "Obscuration & Auto Multipath > Near Environment" is different than LOS or
- "Antenna Pattern / Body Mask File" is different than "Isotropic"

Note: Not enough hardware resources. This error message appears and the satellite is disabled if the available hardware resources are not enough to generate the desired signal.

Hybrid GNSS configurations, multipath configurations, signals modulated by P code and activated satellites consume hardware resources. Refer to chapter 2.4.1, "Channel Budget", on page 23 for description on how the available hardware resources are distributed.

Remote command:

<subsystem>:SATellite<st>:STATe on page 219

Standard ← Constellation Table

Selects the navigation standard the corresponding satellite belongs to. The available GNSS standards depend on the entry standard, the selected GNSS System/Almanac Configuration Settings and the installed options.

Remote command:

<subsystem>:SATellite<st>:STANdard on page 218

Signal(s) ← Constellation Table

Selects the type of signal the corresponding satellite is using.

According to the GPS specifications, the C/A code (f_ca = 1.023 MHz) is provided for civilian purposes. They are used as spreading codes for the navigation data which is transmitted at a rate of 50 baud. The carrier L1 or L2 signal can be modulated by C/A code only, P code only or by both (C/A+P). The modulation used is displayed with the parameter Modulation.

Note: The generation of GPS signal modulated by P code requires the additional software option R&S SMBV-K93. The configuration of "P" and "C/A+P" signals is enabled only in a hybrid GNSS configuration with GPS navigation standard and enabled parametr "GNSS System Configuration > Use Position Accuracy (P-Code) > On".

Table 3-8: Overview of the supported signals

Band	Entry Point	Standard	Signal	minimum Required Option
L1/E1	GPS	GPS	C/A P (C/A+P)Q[1] (C/A+P)I[1]	R&S SMBV-K44, R&S SMx/AMU-K244 R&S SMBV-K93
	Galileo	Galileo	E1-DEF	R&S SMBV-K66, R&S SMx/AMU-K266
	GLONASS	GLONASS	R-C/A	R&S SMBV-K94, R&S SMx/AMU-K294
	BeiDou	BeiDou	B1-C/A	R&S SMBV-K107
L2	GPS	GPS	C/A P (C/A+P)Q[1] (C/A+P)I[1]	R&S SMBV-K44, R&S SMBV-K244 R&S SMBV-K93
	GLONASS	GLONASS	R-C/A	R&S SMBV-K94, R&S SMBV-K294

[1](C/A + P)Q is the standard transmitted signal on L1 and P is the standard transmitted signal on L2; old generation IIA satellites did not transmit P on L2. The standard mentions some cases where C/A and P are in-phase on L2 and hence the availability of the configuration (C/A+P)I.

Note: Not enough hardware resources. This error message appears and the satellite is disabled if the available hardware resources are not enough to generate the desired signal.
Hybrid GNSS configurations, multipath configurations, signals modulated by P code and activated satellites consume hardware resources. Refer to chapter 2.4.1, "Channel Budget", on page 23 for description on the how the available hardware resources are distributed.

Remote command:
<subsystem>:SATellite<st>:SIGNal on page 218

SV-ID ← Constellation Table
Enters the Space Vehicle ID of the satellite to be simulated. This value is used to generate the corresponding spreading code.

Note: The SV ID 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, only the valid IDs which are listed in the almanac are selectable; for arbitrary data, any ID can be selected.

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

The SV-ID field is highlighted in dark blue color if a static multipath is activated.

Remote command:
<subsystem>:SATellite<st>:SVID on page 219

Power ← Constellation Table
(R&S SMBV instruments only)

The meaning of this parameter depends on the selected "Power Mode":
● In "User" power mode, this parameters sets the power offset of the satellite in dB. The offset determines the power ratio of the activated satellites.
Configuration of satellites power is performed on-the-fly and without interruption of the signal generation, unless:
– "Obscuration & Auto Multipath > Near Environment" is different than LOS or
– "Antenna Pattern / Body Mask File" is different than "Isotropic"
● In "Auto" power mode, the displayed value is the power level of the satellite at the start of the simulation (t0). A configured Inter-Standard Tuning is automatically applied. The power level changes automatically as function of the satellite-receiver distance (Pseudorange) but the display is not updated.

Refer to chapter 3.6.1, "Power Configuration", on page 92 for detailed information about the power calculation.

Remote command:
<subsystem>:SATellite<st>:POWer on page 224
<subsystem>:RT:<GNSS>:SVID<ch>:TAP<us>:POWer:ABSolute on page 272

3.6.4 Individual Satellite Settings

Comprises the settings of the selected satellite.

The values displayed in this section are the initial values of the parameters at the beginning of the simulation or at the time the specific satellite is activated. These values will be updated internally to implement moving satellites and receivers. However the displayed values are not updated.

Standard Chip Rate
Displays the chip rate.

Remote command:
<subsystem>:SATellite<st>:SCRate? on page 218

Frequency Number
(enabled for GLONASS satellites only)

Frequency number indicates the sub-carrier used to modulate the GLONASS satellite.

Depending on the selected Data Source, "Frequency Number" is either configurable or read only. If the frequency number is read directly from the Almanac or the RINEX file, i.e. if you use "Real Navigation Data" as data source, frequency number is read only. With "Pattern", "PRBS" or "Data List", you can set the value.

Remote command:

<subsystem>:SATellite<st>:FNUMber on page 215

Orbit Type

(R&S SMBV only)

(enabled for BeiDou satellites only)

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

"GEO"	5 geostationary orbit satellites with "SV-ID = 1.. 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 217

Modulation

Displays the modulation used for modulating the carrier signal.

Remote command:

<subsystem>:SATellite<st>:MODulation on page 217

Power Reference

For mixed Signal(s) like "C/A+P", displays the signal used as a reference by power calculation.

The power reference is fixed to "C/A" for mixed signals. For signals modulated only with the P code, the power reference is "P".

Remote command:

<subsystem>:SATellite<st>:POWer:RSIGnal? on page 224

Navigation...

Opens the chapter 3.10, "Navigation Message Configuration", on page 116 dialog for configuring the parameters of the navigation message.

Multipath...

(requires option R&S SMBV-K92)

Opens the Static Multipath Configuration dialog for configuring the static multipath propagation per satellite.

Duration (Elev. > 2.5/5/7.5/10°)

(R&S SMBV only)

This parameter is enabled only for "Localization" mode.

Displays the time the satellite's elevation will be higher than 2.5, 5, 7.5 or 10° starting at the first simulation moment of the satellite of interest, as selected with the parameter Elevation Mask. This parameter can be used to get an impression of how long the connected GNSS receiver may use this certain satellite for its position fix.

The value is displayed in format hh:mm:ss.

The displayed value is not updated but the elevation of each satellite is constantly monitored. Decreasing the satellite's elevation below the selected elevation mask value is one of the reasons for the automatic dynamic exchange of satellites. Thus, a change of the satellite constellation can occur before the initially calculated time elapses.

In "Auto Localization" mode, the expected time of each upcoming exchange is displayed in the "Real-Time S.P.O.T." view by the parameter Next Constellation Change.

Remote command:

`<subsystem>:SATellite<st>:DURation?` on page 215

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 hte sample rate, use the Oversampling function.

Remote command:

`<subsystem>:SATellite<st>:CPHase` on page 216

Pseudorange

Displays the propagation delay from satellite to receiver in meters and is calculated as follow:

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

In "Auto" power mode, this parameter affects the calculation of the displayed power level of the corresponding satellite.

The parameter is enabled for configuration in "Simulation Mode > Static".

In R&S WinIQSIM2, this parameter is fixed to 0.

Remote command:

`<subsystem>:SATellite<st>:PRANge` on page 217

Pseudorange Bias

(R&S SMBV instruments only)

Sets a bias to the Pseudorange. The parameter is updated on -the-fly and can be used to bias the pseudorange of a satellite.

The parameter is enabled for configuration in "Auto/User Localization" modes.

Remote command:

`<subsystem>:SATellite<st>:PRBias` on page 218

Time Shift/ chips

The parameter is enabled for configuration in "Static" mode. In R&S WinIQSIM2, it is fixed to 0.

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

In "Localization" mode, this parameter is not configurable and is set automatically depending on the simulated Geographic Location/Attitude and on the satellite's orbit.

Remote command:

<subsystem>:SATellite<st>:TSHift on page 219

Doppler Shift

The parameter is enabled for configuration in "Static" mode.

Enters the Doppler shift 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.

In "Localization" mode, this parameter is not configurable and is set automatically depending on the simulated "Geographic Location" and on the satellite's orbit.

The relevant change to the chip rate of the code is carried out automatically. The currently valid values for Doppler-shifted carrier frequency and chip rate are displayed under:

- Resulting Start Frequency
- Resulting Start Chip Rate
- Resulting P-Code Chip Rate

Remote command:

<subsystem>:SATellite<st>:DSHift on page 215

Initial Carrier Phase

The parameter is enabled for configuration in "Simulation Mode > Static".

Sets the initial carrier phase. The parameter is updated automatically in "Auto/User Localization" modes.

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

Remote command:

<subsystem>:SATellite<st>:ICPHase on page 216

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 216

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 214

Resulting P-Code Chip Rate

(R&S SMBV only)

Indicates the currently valid values for the chip rate of the P-code. The relevant change to the chip rate of the P-code is carried out automatically if the Doppler shift is changed.

The resulting P-chip rate is calculated according to the following:

$f_{P-resulting} = f_P * \{1 + f_{Doppler} / f_{band}\}$

where f_{band} is as set with parameter RF Band and f_P is fixed to 10.230 MHz.

Remote command:

<subsystem>:SATellite<st>:PCRate? on page 216

3.7 Global Signal Configuration

To access this settings:

1. Select "Baseband > Satellite Navigation > GPS".

2. Select "Simulation Mode > Auto Localization".

3. Select "Satellite Configuration > Global Signal Configuration".

   Use the provided settings to determine the type of signal a SV ID will use in the moment the corresponding satellite becomes visible.
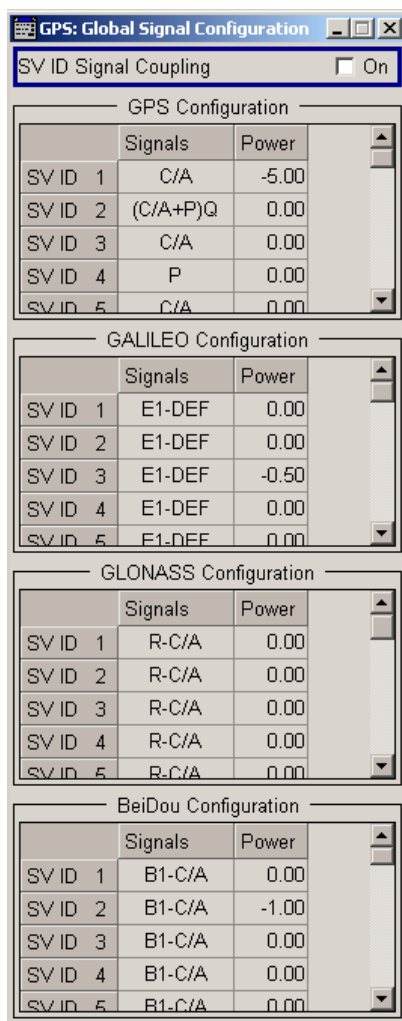
The dialog displays all available SV ID of each of the enabled GNSS standards according to the selected almanac. For each available SV ID a signal can be assigned. Refer to table 3-8 for an overview of the supported signals pre GNSS standard.

SV ID Signal Coupling
For quick configuration, enables the configuration of all SV IDs simultaneously, i.e. the value set for the first available SV ID is used for all other. Current settings are overwritten.

Remote command:
<subsystem>:SVID:SIGNal:COUPling on page 220

GPS/Galileo/GLONASS/BeiDou Signals and Power
In "Auto Localization" mode, determine the type of signal and the power a SV ID will use in the moment the corresponding satellite becomes visible.

Remote command:
<subsystem>:SVID<ch>:<GNSS>:SIGNal on page 220
<subsystem>:SVID<ch>:<GNSS>:POWer on page 220

3.8 Atmospheric Configuration

To access this dialog,

1. Select "Main Dialog > Satellite Configuration"

2. Select "Atmospheric Configuration".

GPS: Atmospheric Configuration			
Tropospheric Model	STANAG	Ionospheric Model	Klobuchar

Klobuchar Parameters

alpha_0	5	x 2^{-30} = 4.656613e-09
alpha_1	2	x 2^{-27} = 1.490116e-08
alpha_2	-1	x 2^{-24} = -5.960464e-08
alpha_3	-1	x 2^{-24} = -5.960464e-08
beta_0	39	x 2^{11} = 7.987200e+04
beta_1	4	x 2^{14} = 6.553600e+04
beta_2	-1	x 2^{16} = -6.553600e+04
beta_3	-6	x 2^{16} = -3.932160e+05

Ionospheric GPS Navigation Parameters

Show Details >>>

Ionospheric GALILEO Navigation Parameters

<<< Hide Details

a_i0	0	x 2^{-2} = 0.000000e+00
a_i1	0	x 2^{-8} = 0.000000e+00
a_i2	0	x 2^{-15} = 0.000000e+00
SF_1	0	
SF_2	0	
SF_3	0	
SF_4	0	
SF_5	0	

Ionospheric BeiDou Navigation Parameters

Show Details >>>

The atmospheric configuration comprises the parameters for adjusting the iono-spheric and tropospheric models of the simulation as well as the corresponding atmospheric navigation parameters transmitted by each GNSS if available. GPS and Galileo assume specific ionospheric models and hence transmit different atmospheric navigation parameters; the one for GLONASS is not yet specified by the time this firmware had been developed and hence Glonass satellites transmit no data on the atmosphere. The ionospheric navigation parameters only define what the satellites are transmitting as ionospheric correction parameters whereas the model configuration describes the actual ionospheric and tropospheric models used in the satellite-receiver channel simulation.

The parameters in this dialog are enabled for configuration only for instruments equipped with the option GNSS Enhanced (R&S SMBV-K92).

Tropospheric Model

Determines whether a STANAG tropospheric model is applied or not.

Remote command:

<subsystem>:ATMospheric:TROPospheric:MODel on page 250

Ionospheric Model

Determines whether a Klobuchar ionospheric model is applied or the ionospheric effects are not simulated.

Remote command:

<subsystem>:ATMospheric:IONospheric:MODel on page 251

Klobuchar Parameters

Defines the ionospheric model used by the channel simulation. The ionospheric model applies for all satellites, irrespectively to the navigation standards they belong to.

Parameter	Description	SCPI Command
"alpha_0 .. alpha_3"	Sets the parameter alpha_0 .. alpha_3 of the satellite's navigation message.	<subsystem>:ATMospheric: IONospheric:KLOBuchar: ALPHa<ch0> on page 251
"beta_0 .. beta_3"	Sets the parameter beta_0 .. beta_3 of the satellite's navigation message.	<subsystem>:ATMospheric: IONospheric:KLOBuchar: BETA<ch0> on page 251

GPS/BeiDou Ionospheric Parameters

Changing the ionospheric model has an impact on the satellite's parameters "Time Shift", "Doppler Shift" and "Duration (Elevation>2.5/5/7.5/10°)".

Parameter	Description	SCPI Command
"alpha_0 .. alpha_3"	Displays the parameter alpha_0 .. alpha_3 of the satellite's navigation message.	`<subsystem>:ATMospheric:GPS:IONospheric:ALPHa<ch0>` on page 251 `<subsystem>:ATMospheric:BEIDou:IONospheric:ALPHa<ch0>` on page 252
"beta_0 .. beta_3"	Displays the parameter beta_0 .. beta_3 of the satellite's navigation message.	`<subsystem>:ATMospheric:GPS:IONospheric:BETA<ch0>` on page 252 `<subsystem>:ATMospheric:BEIDou:IONospheric:BETA<ch0>` on page 252

GALILEO Ionospheric Parameters

The GALILEO ionospheric model includes the broadcast coefficients a_{i0}, a_{i1} and a_{i2} used to compute the Effective Ionization Level Az and the "Ionospheric Disturbance Flag", given for five different regions.

Changing the ionospheric model has an impact on the satellite's parameters "Time Shift", "Doppler Shift" and "Duration (Elevation>2.5/5/7.5/10°)".

Parameter	Description	SCPI Command
"a_i0 .. a_i2"	Displays the parameters effective Ionization level 1st .. 3rd order of the satellite's navigation message.	`<subsystem>:ATMospheric:GALileo:IONospheric:AI<ch0>` on page 252
"SF_1 .. SF_5"	Displays the parameters ionospheric disturbance flag for region 1 to 5 of the satellite's navigation message.	`<subsystem>:ATMospheric:GALileo:IONospheric:SF<ch>` on page 253

3.9 Satellites Power Tuning

The parameters of "Power Tuning" are only configurable for R&S SMBV instruments.

To access this dialog:

1. Select "Baseband > Satellite Navigation > GPS".

2. Select "Satellite Configuration > Satellites Power Tuning".
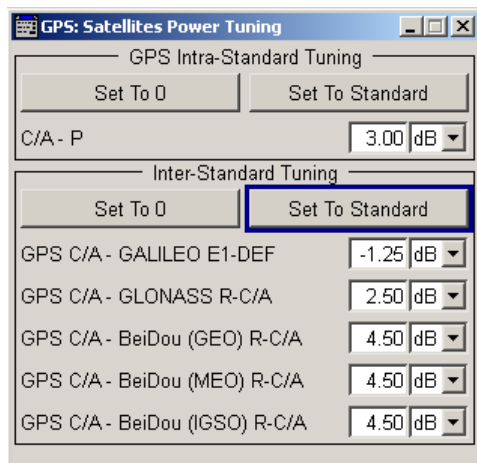
The "Satellite Power Tuning" dialog comprises the setting for inter-standard power relations and the power relation between the signals of a specific GNSS standard. The inter-standard parameters are required for the configuration of the nominal power difference between the different navigation standards. These parameters are considered only in "Auto Power Mode".
See chapter 3.6.1, "Power Configuration", on page 92 for information about the power calculation.

Intra-Standard Tuning
Intra-Standard power settings are provided for GPS mixed signals. The C/A signal is allways used as "Power Reference".

Set to 0 ← **Intra-Standard Tuning**
Sets the power relations between the signal components to 0 dB.

Remote command:
<subsystem>:POWer:INTRa:GPS:PZERo on page 226

Set to Standard ← **Intra-Standard Tuning**
Sets the power relation between the signals belonging to the same navigation standard according to the relation determined in the specifications.

Table 3-9: Intra-Standard Tuning

Parameter	Value
C/A - P	3 dB

Remote command:
<subsystem>:POWer:INTRa:GPS:PSTandard on page 226

C/A-P ← **Intra-Standard Tuning**
Sets the power relation between the signals belonging to the same navigation standard. Use the Set to Standard function to preset the values.

Remote command:
<subsystem>:POWer:INTRa:GPS:CAP on page 226

Inter-Standard Tuning

The inter-standard calculation is performed based on the GPS standard.

Set to 0 ← Inter-Standard Tuning

Sets the Inter-Standard Power relations to 0 dB.

Remote command:

<subsystem>:POWer:INTer:PZERo on page 225

Set to Standard ← Inter-Standard Tuning

Sets the power relation between the signals belonging to the different navigation standard according to the relation determined in the specifications.

Table 3-10: Inter-Standard Tuning

Parameter	Value
GPS C/A - CALILEO E1-DEF	-1.25 dB
GPS C/A - GLONASS R-C/A	3.03 dB
GPS C/A - BeiDou (GEO) B-C/A	4.5 dB
GPS C/A - BeiDou (MEO) B-C/A	4.5 dB
GPS C/A - BeiDou (IGSO) B-C/A	4.5 dB

Remote command:

<subsystem>:POWer:INTer:PSTandard on page 225

GPS C/A-GALILEO E1-DEF, GPS C/A-GLONASS R-C/A, GPS C/A-BeiDou (GEO/MEO/IGSO) B-C/A ← Inter-Standard Tuning

Sets the power relation between the signals belonging to the different navigation standards. Use the Set to Standard function to preset the values.

The power level of the GPS signal C/A is used as reference.

Remote command:

<subsystem>:POWer:INTer:CAE1Def on page 225

<subsystem>:POWer:INTer:CARCA on page 225

<subsystem>:POWer:INTer:CABCAGeo on page 225

<subsystem>:POWer:INTer:CABCAIgso on page 225

<subsystem>:POWer:INTer:CABCAMeo on page 225

3.10 Navigation Message Configuration

The parameters of the Navigation Message are only configurable for R&S SMBV instruments equipped with one of the assisted options, e.g. Assisted GPS (R&S SMBV-K65).

The parameters of the "Navigation Message Configuration" dialog are enabled for configuration only in "User Localization" and "Static Mode" mode on the R&S SMBV; in "Auto Localization" and R&S WinIQSIM2 "Static" modes, the parameters of the navigation message of each satellite are read only.

To access this dialog:

1. Select "Baseband > Satellite Navigation > GPS".

2. Select "Simulation Mode > User Localization".

3. Select "Satellite Configuration > Navigation Message Configuration".

    Although the navigation messages are fully configurable, it is recommended to use the almanac's parameter as basis for further configurations (see "Set To Almanac" on page 119).
    For better readability of the parameters in the "Navigation Message Configuration" dialog, the corresponding values are input as integer in the same way as they are included in the satellite's navigation message, but the scaled values and the scaling factors are also displayed. Different scaling factors may apply for the same parameters in the different GNSS standards.
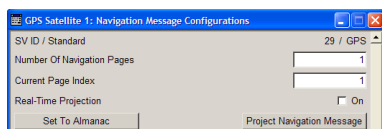
(R&S SMBV instruments only)

Ephemeris Parameters — GPS Satellite

<<< Hide Details

Parameter	Value	Scale	Result
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	$\times\ 2^4$	= 0.000000e+00
M_0	0	$\times\ 2^{-31}$	= 0.000000e+00
Delta_N	0	$\times\ 2^{-43}$	= 0.000000e+00
e	0	$\times\ 2^{-33}$	= 0.000000e+00
SQRT(A)	100 000	$\times\ 2^{-19}$	= 1.907349e-01
OMEGA_0	0	$\times\ 2^{-31}$	= 0.000000e+00
i_0	0	$\times\ 2^{-31}$	= 0.000000e+00
omega	0	$\times\ 2^{-31}$	= 0.000000e+00
OMEGA_DOT	0	$\times\ 2^{-43}$	= 0.000000e+00
IDOT	0	$\times\ 2^{-43}$	= 0.000000e+00
C_uc	0	$\times\ 2^{-29}$	= 0.000000e+00
C_us	0	$\times\ 2^{-29}$	= 0.000000e+00
C_rc	0	$\times\ 2^{-5}$	= 0.000000e+00
C_rs	0	$\times\ 2^{-5}$	= 0.000000e+00
C_ic	0	$\times\ 2^{-29}$	= 0.000000e+00
C_is	0	$\times\ 2^{-29}$	= 0.000000e+00
SF1 Reserved 1	0		
SF1 Reserved 2	0		
SF1 Reserved 3	0		
SF1 Reserved 4	0		
AODO	0		
SV Config	0		

Ephemeris Parameters — Galileo Satellite

<<< Hide Details

Parameter	Value	Scale	Result
SISA	0		
IODnav	0		
IODa	0		
TOE	1 020	$\times\ 60$	= 6.120000e+04
M_0	0	$\times\ 2^{-31}$	= 0.000000e+00
Delta_N	0	$\times\ 2^{-43}$	= 0.000000e+00
e	0	$\times\ 2^{-33}$	= 0.000000e+00
SQRT(A)	2 852 483 236	$\times\ 2^{-19}$	= 5.440680e+03
OMEGA_0	-763 549 932	$\times\ 2^{-31}$	= -3.555556e-01
i_0	668 106 027	$\times\ 2^{-31}$	= 3.111111e-01
omega	0	$\times\ 2^{-31}$	= 0.000000e+00
OMEGA_DOT	-46 442	$\times\ 2^{-43}$	= -5.279844e-09
IDOT	0	$\times\ 2^{-43}$	= 0.000000e+00
C_uc	0	$\times\ 2^{-29}$	= 0.000000e+00
C_us	0	$\times\ 2^{-29}$	= 0.000000e+00
C_rc	0	$\times\ 2^{-5}$	= 0.000000e+00
C_rs	0	$\times\ 2^{-5}$	= 0.000000e+00
C_ic	0	$\times\ 2^{-29}$	= 0.000000e+00
C_is	0	$\times\ 2^{-29}$	= 0.000000e+00

Ephemeris Parameters — BeiDou Satellite

<<< Hide Details

Parameter	Value	Scale	Result
SV Accuracy / URA Index	0		
SV Health	0		
IODC	1		
IODE	1		
TOE	18 000	$\times\ 2^3$	= 1.440000e+05
M_0	1 588 446 504	$\times\ 2^{-31}$	= 7.396780e-01
Delta_N	0	$\times\ 2^{-43}$	= 0.000000e+00
e	70 561 792	$\times\ 2^{-33}$	= 8.214474e-03
SQRT(A)	2 768 220 717	$\times\ 2^{-19}$	= 5.279962e+03
OMEGA_0	656 194 945	$\times\ 2^{-31}$	= 3.055646e-01
i_0	656 175 559	$\times\ 2^{-31}$	= 3.055556e-01
omega	334 053 012	$\times\ 2^{-31}$	= 1.555556e-01
OMEGA_DOT	-22 976	$\times\ 2^{-43}$	= -2.612069e-09
IDOT	0	$\times\ 2^{-43}$	= 0.000000e+00
C_uc	0	$\times\ 2^{-31}$	= 0.000000e+00
C_us	0	$\times\ 2^{-31}$	= 0.000000e+00
C_rc	0	$\times\ 2^{-6}$	= 0.000000e+00
C_rs	0	$\times\ 2^{-6}$	= 0.000000e+00
C_ic	0	$\times\ 2^{-31}$	= 0.000000e+00
C_is	0	$\times\ 2^{-31}$	= 0.000000e+00

GPS Satellite   Galileo Satellite   BeiDou Satellite

Ephemeris Parameters — GLONASS Satellite

<<< Hide Details

Parameter	Value	Scale	Result
Satellite Ephemeris Type (M)	GLONASS-M		
SV Accuracy / URA Index (F_T)	0		
SV Health (B_n,1_n)	0		
Age of Ephemeris Page (P1)	30 min		
Tb-Index	21		
Tb-Interval	[10:30:00-11:00:00]		
TOE (tb)	10:45:00		
P	0		
X_n	1 257 134	$\times\ 2^{-11}$	= 6.138350e+02
Y_n	-26 572 678	$\times\ 2^{-11}$	= -1.297494e+04
Z_n	44 967 143	$\times\ 2^{-11}$	= 2.195661e+04
XDOT_n	3 389 635	$\times\ 2^{-20}$	= 3.232608e+00
YDOT_n	2 092 723	$\times\ 2^{-20}$	= 1.995776e+00
ZDOT_n	1 144 420	$\times\ 2^{-20}$	= 1.091404e+00
XDDOT_n	0	$\times\ 2^{-30}$	= 0.000000e+00
YDDOT_n	0	$\times\ 2^{-30}$	= 0.000000e+00
ZDDOT_n	0	$\times\ 2^{-30}$	= 0.000000e+00

GLONASS Satellite

Clock Correction Parameters — GPS Satellite

<<< Hide Details

Parameter	Value	Scale	Result
T_GD	0	$\times\ 2^{-31}$	= 0.000000e+00
t_OC	31 950	$\times\ 2^4$	= 5.112000e+05
a_f2	0	$\times\ 2^{-55}$	= 0.000000e+00
a_f1	0	$\times\ 2^{-43}$	= 0.000000e+00
a_f0	0	$\times\ 2^{-31}$	= 0.000000e+00

Clock Correction Parameters — GLONASS Satellite

<<< Hide Details

Parameter	Value	Scale	Result
TAU_n (-a_f0)	192 512	$\times\ 2^{-30}$	= 1.792908e-04
GAMMA_n (a_f1)	0	$\times\ 2^{-40}$	= 0.000000e+00
Delta_TAU_n	0	$\times\ 2^{-30}$	= 0.000000e+00
E_n	0		

Clock Correction Parameters — BeiDou Satellite

<<< Hide Details

Parameter	Value	Scale	Result
T_GD	0	$\times\ 0.1$	= 0.000000e+00
t_OC	18 000	$\times\ 2^3$	= 1.440000e+05
a_f2	0	$\times\ 2^{-66}$	= 0.000000e+00
a_f1	-4 096	$\times\ 2^{-50}$	= -3.637979e-12
a_f0	1 482 860	$\times\ 2^{-33}$	= 1.726276e-04

GPS Satellite   GLONASS Satellite   BeiDou Satellite

Galileo Satellite   Galileo Satellite

SV-ID / Standard

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

Remote command:

n.a.

Number of Navigation Pages

(Requires installed assistance option, e.g. Assistance GPS R&S SMBV-K65)

Several navigation pages are available per satellite.

If RINEX file is used, the value of this parameter is retrieved from the file. A RINEX file may contains ephemeris information for up to 24h. Since the ephemeris are update every two hours, the RINEX file contains a maximum number of 12 navigation pages.

Remote command:

<subsystem>:SVID<ch>:<GNSS>:NMESsage:PAGE:COUNt on page 230

Current Page Index

(Requires installed assistance option, e.g. Assistance GPS R&S SMBV-K65)

Select a specific page from all available navigation pages (Number of Navigation Pages) and enables the set of ephemeris parameters of this page for configuration.

Remote command:

n.a.

Real-Time Projection

(enabled in "User Localization" mode and disabled "Satellite Configuration > Global Ephemeris Real-Time Projection")

Enables the instrument to internally perform a projection of the navigation message whenever this message is approaching its validity limit.

When using RINEX file containing information for up to 24 hours, the navigation page to be used is selected in the way, that the simulation start time is within the time span from TOE to TOE+2h, i.e. TOE <= Current Simulation Time <= TOE+2h.

It may however happen, that the required consecutive navigation page is missing in the RINEX file. The enabled "Real-Time Projection" assures the automatic projection of the navigation message, i.e. the ephemeris set will contain valid data again.

Note: "Real-Time Projection" have to be disabled, if assistance data will be generated.

Remote command:

<subsystem>:SVID<ch>:<GNSS>:NMESsage:RTPRojection on page 231

Set To Almanac

(enabled only in "User Localization" mode)

The navigation message's parameters will be calculated according to the selected almanac.

Using this option as basis for further reconfiguration is recommended.

Remote command:

<subsystem>:SVID<ch>:<GNSS>:NMESsage:PRESet on page 230

Project Navigation Message

(enabled only in "User Localization" mode)

Triggers the projection of the parameters of the navigation message. The values of the TOE and TOC are calculated according to the selected current simulation time (for "System Time UTC", as selected with the parameters Date [dd.mm.yyyy] and Time [hh:mm:ss:xxx]). The updated values of the ephemeris and clock correction are displayed.

Note: Use this function prior to the generation of assistance data, if RINEX files are not used.

The projection affects the parameters of the signal at the exact moment the satelilite is activated. Thus, if projection is required, trigger the projection at the beginning of the satellite signal generation.

Remote command:

<subsystem>:SVID<ch>:<GNSS>:NMESsage:PROJect on page 230

GPS, Galileo and BeiDou Common Ephemeris Parameters

The ephemeris parameters correspond to the SV ID and navigation standard displayed with the parameter SV-ID / Standard and to the navigation page determined by the Current Page Index.

Table 3-11: Common Ephemeris Parameters

Parameter	Description	SCPI command
M_0	Mean Anomaly at Reference Time [1]	<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:MZERo on page 238
Delta_N	Mean Motion Difference From Computed Value [1]	<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:NDELta on page 238
e	Eccentricity [1]	<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:ECCentricity on page 235
[1]	As this parameter affects the satellite's orbit, the value selected here also has an impact on the satellite's parameters "Time Shift", "Doppler Shift" and "Duration (Elevation>2.5/5/7.5/10°)". The value of these parameters will be updated automatically.	

Parameter	Description	SCPI command
SQRT(A)	Square Root of the Semi-Major Axis [1]	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:SQRA` on page 240
OMEGA_0	Longitude of Ascending Node of Orbit Plane at Weekly Epoch [1]	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:OZERo` on page 239
i_0	Inclination Angle at Reference Time [1]	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:IZERo` on page 237
Omega	Argument of Perigee [1]	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:OMEGa` on page 239
OMEGA_DOT	Rate of Right Ascension [1]	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:ODOT` on page 238
IDOT	Rate of Inclination Angle [1]	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:IDOT` on page 236
C_uc	Amplitude of the Cosine Harmonic Correction Term to the Argument of Latitude [1]	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:CUC` on page 234
C_us	Amplitude of the Sine Harmonic Correction Term to the Argument of Latitude [1]	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:CUS` on page 235
C_rc	Amplitude of the Cosine Harmonic Correction Term to the Orbit Radius [1]	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:CRC` on page 234
C_rs	Amplitude of the Sine Harmonic Correction Term to the Orbit Radius [1]	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:CRS` on page 234
C_ic	Amplitude of the Cosine Harmonic Correction Term to the Angle of Inclination [1]	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:CIC` on page 233
C_is	Amplitude of the Sine Harmonic Correction Term to the Angle of Inclination [1]	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:CIS` on page 233
TOE	Time Of Ephemeris [1]	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:TOE` on page 241
[1]	As this parameter affects the satellite's orbit, the value selected here also has an impact on the satellite's parameters "Time Shift", "Doppler Shift" and "Duration (Elevation>2.5/5/7.5/10°)". The value of these parameters will be updated automatically.	

GPS and BeiDou Ephemeris Parameters

The ephemeris parameters correspond to the SV ID and navigation standard displayed with the parameter SV-ID / Standard and to the navigation page determined by the Current Page Index.

Table 3-12: GPS and BeiDou Ephemeris Parameters

Parameter	Description	SCPI command
SV accuracy / URA Index		`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:URA` on page 241
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 236
IODC	Issue of Data, Clock	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:IDOC` on page 236
IODE	Issue of Data, Ephemeris	`<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris:IDOE` on page 237
[1])	As this parameter affects the satellite's orbit, the value selected here also has an impact on the satellite's parameters "Time Shift", "Doppler Shift" and "Duration (Elevation>2.5/5/7.5/10°)". The value of these parameters will be updated automatically.	

GPS Ephemeris Parameters

The ephemeris parameters correspond to the SV ID and navigation standard displayed with the parameter SV-ID / Standard and to the navigation page determined by the Current Page Index.

Table 3-13: 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 233

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 238

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 235

SF1 Reserved 1/2/3/4		`<subsystem>:SVID<ch>:GPS:`
		`NMESsage[:PAGE<us>]:EPHemeris:`
		`SF1Reserved<gr>` on page 239

AODO	Age of Data Offset	`<subsystem>:SVID<ch>:GPS:`
		`NMESsage[:PAGE<us>]:EPHemeris:`
		`AODO` on page 233

SV Configurations		`<subsystem>:SVID<ch>:GPS:`
		`NMESsage[:PAGE<us>]:EPHemeris:`
		`SVConfig` on page 240

[1]	As this parameter affects the satellite's orbit, the value selected here also has an impact on the satellite's parameters "Time Shift", "Doppler Shift" and "Duration (Elevation>2.5/5/7.5/10°)". The value of these parameters will be updated automatically.	

Galileo Ephemeris Parameters
Comprises the Galileo specific ephemeris parameters.

Table 3-14: Galileo Specific Ephemeris Parameters

Parameter	Description	SCPI command
SISA	Signal In Space Accuracy	`<subsystem>:SVID<ch>:GALileo:` `NMESsage[:PAGE<us>]:EPHemeris:` `SISA` on page 240
IODnav	Issue Of Data (Ephemeris and Clock correction)	`<subsystem>:SVID<ch>:GALileo:` `NMESsage[:PAGE<us>]:EPHemeris:` `IODNav` on page 237
IODa	Issue Of Data (Almanacs)	`<subsystem>:SVID<ch>:GALileo:` `NMESsage[:PAGE<us>]:EPHemeris:` `IODA` on page 236

GPS and BeiDou Clock Correction Parameters

The ephemeris parameters correspond to the SV ID and navigation standard displayed with the parameter SV-ID / Standard and to the navigation page determined by the Current Page Index.

Table 3-15: GPS and BeiDou Clock Correction Parameters

Parameter	Description	SCPI command
T_GD	L1-L2 Correction Term [1]	`<subsystem>:SVID<ch>:<GNSS>:` `NMESsage[:PAGE<us>]:CCORection:` `TGD` on page 232
t_OC a_f2 a_f1 a_f0	Clock Correction Parameter [1]	`<subsystem>:SVID<ch>:<GNSS>:` `NMESsage[:PAGE<us>]:CCORection:` `TOC` on page 232 `<subsystem>:SVID<ch>:<GNSS>:` `NMESsage[:PAGE<us>]:CCORection:` `AF<gr0>` on page 231

[1]: As this parameter affects the satellite's orbit, the value selected here also has an impact on the satellite's parameters "Time Shift", "Doppler Shift" and "Duration (Elevation>2.5/5/7.5/10°)".

The value of these parameters will be updated automatically.

GLONASS Ephemeris Parameters

Comprises the GLONASS specific ephemeris parameters.

Table 3-16: 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 247
SV accuracy / URA Index (F_T)	Provides the predicted satellite user range accuracy (URA).	`<subsystem>:SVID<ch>:GLONass:` `NMESsage[:PAGE<us>]:EPHemeris:` `URA` on page 249

Parameter	Description	SCPI command

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 246

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 246

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)
	  should be 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 248

Tb-Alignment (P2)	Configures TOE to be aligned to an even or odd scale of 15 min for "Age of Ephemeris" = 30 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 247

Parameter	Description	SCPI command
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 Eph = 30 Tb-Interval = [11:00:00 11:30:00] - tb = 45, P2 = 1 and Age of Eph = 45 Tb-Interval = [10:52:30 11:37:30] - tb = 45, P2 = 0 and Age of Eph = 60 Tb-Interval=[10:30:00 11:30:00]	`<subsystem>:SVID<ch>:GLONass: NMESsage[:PAGE<us>]:EPHemeris: TINTerval?` on page 248
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 248
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 247
X_n	The OX **position** 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 249
Y_n	The OY **position** 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 249
Z-n	The OZ **position** 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 249
XDOT_n	The OX **velocity** 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 250
YDOT_n	The OY **velocity** 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 250

Parameter	Description	SCPI command
ZDOT_n	The OZ **velocity** 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 250
XDDOT_n	The OX **acceleration** 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 249
YDDOT_n	The OY **acceleration** 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 249
ZDDOT_n	The OZ **acceleration** 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 249

[1]: The coordinates correspond to the PZ-90 coordinate system.

GLONASS Clock Correction Parameters

Comprises the GLONASS specific parameters for clock correction.

Table 3-17: 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 246
GAMMA_n (a_f1)	SV Clock drift correction coefficient	`<subsystem>:SVID<ch>:GLONass:` `NMESsage[:PAGE<us>]:` `CCORrection:GAMN` on page 245
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 245
E_n	Age of operation information	`<subsystem>:SVID<ch>:GLONass:` `NMESsage[:PAGE<us>]:` `CCORrection:EN` on page 245

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 3-18: 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 243
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 245
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 243
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)	
E1B_DVS	Data Validity Satellite Status, transmitted on E1-B (E1-B_{DVS})	`<subsystem>:SVID<ch>:GALileo: NMESsage[:PAGE<us>]:INAV:E1BDVS` on page 243
E5B_DVS	Data Validity Satellite Status, transmitted on E5b (E5b$_{DVS}$)	`<subsystem>:SVID<ch>:GALileo: NMESsage[:PAGE<us>]:INAV:E5BDVS` on page 244
E1B_HS	Signal Health Status for E1 (E1-B_{HS})	`<subsystem>:SVID<ch>:GALileo: NMESsage[:PAGE<us>]:INAV:E1BHS` on page 244
E5B_HS	Signal Health Status for E5b (E5b$_{HS}$)	`<subsystem>:SVID<ch>:GALileo: NMESsage[:PAGE<us>]:INAV:E5BHS` on page 244

Galileo FNAV Parameters

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

Table 3-19: 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 241
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 243
a_f2 (E1-E5A)	SV clock drift rate correction coeffi cient a_{f2}(E1,E5a)	`<subsystem>:SVID<ch>:GALileo: NMESsage[:PAGE<us>]:FNAV: AF<gr0>` on page 241
a_f1 (E1-E5A)	SV clock drift correction coeffi cient a_{f1}(E1,E5a)	

Parameter	Description	SCPI command
a_f0 (E1-E5A)	SV clock bias correction coeffi cient $a_{fo}(E1,E5a)$	
E5A_DVS	Data Validity Satellite Status, transmitted on E5a ($E5a_{DVS}$)	`<subsystem>:SVID<ch>:GALileo:` `NMESsage[:PAGE<us>]:FNAV:E5ADVS` on page 242
E5A_HS	Signal Health Status for E5a ($E5a_{HS}$)	`<subsystem>:SVID<ch>:GALileo:` `NMESsage[:PAGE<us>]:FNAV:E5AHS` on page 242
K	F-NAV Almanac Scheduling start index	`<subsystem>:SVID<ch>:GALileo:` `NMESsage[:PAGE<us>]:FNAV:K` on page 242

3.11 Static Multipath Configuration

The parameters of the "Multipath Configuration" are only configurable for instruments with equipped assisted option (R&S SMBV-K92).

To access this settings:

1. Select "Baseband > Satellite Navigation > GPS".

2. Select "Simulation Mode > User Localization".

3. Select "Satellite Configuration > Multipath".

   The "Multipath Configuration" dialog enables you to configure the signal parameters of the selected satellite, so that a signal undergoing multipath propagation is simulated. The provided settings enable configuration of the number of fading taps and individual configuration of the time and Doppler shift, power and carrier phase per tap. The resulting propagation is displayed in the graph on the right side of the dialog.
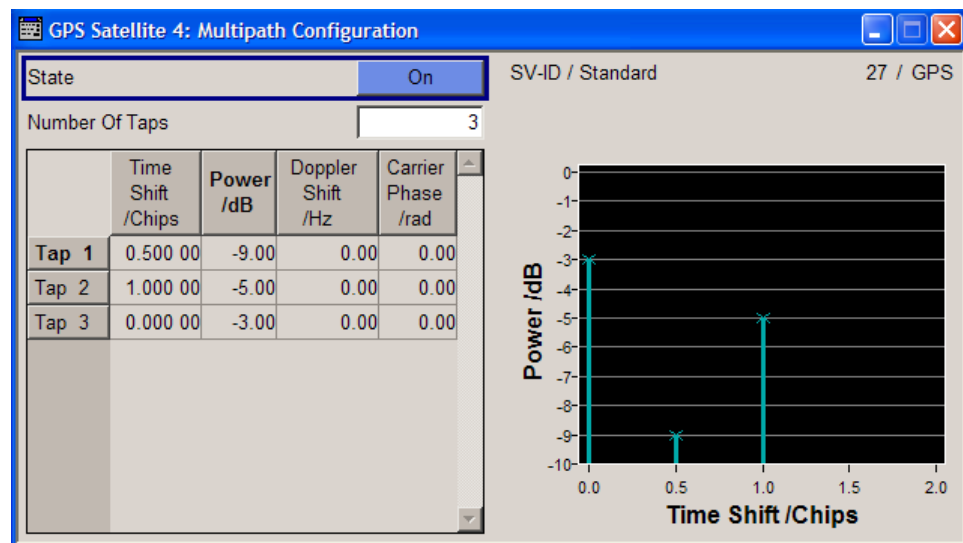
State

Enables/disables the generation of multipath signal for the satellite with the displayed SV ID belonging to the displayed GNSS standard. Settings made in the dialog are considered only if the multipath configuration is enabled.

Remote command:

<subsystem>:SVID<ch>:<GNSS>:MPATh:STATe on page 207

SV ID / Standard

Displays the SV ID and the GNSS standard the satellite is belonging to.

Remote command:
n.a.

Number of Taps

Sets the paths number. The value determines the number of rows available for configuration.

The maximum value for this parameter is calculated dynamically, see chapter 2.4.1, "Channel Budget", on page 23.

Remote command:

<subsystem>:SVID<ch>:<GNSS>:MPATh:TAP:COUNt on page 208

Multipath Taps Table

Comprises the settings of the taps. The number of taps, i.e. the table rows is determined by the parameter Number of Taps.

Time Shift / Chips ← Multipath Taps Table

Sets an additional delay of the selected satellite, used to simulate multipath conditions.

Remote command:

<subsystem>:SVID<ch>:<GNSS>:MPATh:TAP<us>:TSHift on page 209

Power ← Multipath Taps Table

Sets the additional power of the satellite in dB, used to simulate multipath conditions.

See chapter 3.6.1, "Power Configuration", on page 92 for information about the power calculation.

Remote command:

`<subsystem>:SVID<ch>:<GNSS>:MPATh:TAP<us>:POWer` on page 209

Doppler Shift /Hz ← Multipath Taps Table
Enters the additional Doppler shift of the simulated signal of the satellite, used to simulate multipath conditions.

Remote command:

`<subsystem>:SVID<ch>:<GNSS>:MPATh:TAP<us>:DSHift` on page 208

Carrier Phase /rad ← Multipath Taps Table
Sets the carrier phase, used in case of multipath simulation.

Remote command:

`<subsystem>:SVID<ch>:<GNSS>:MPATh:TAP<us>:CPHase` on page 208

3.12 Assistance Data Generation

The "Assistance Data Generation" dialog is available for instrument equipped with the basic BeiDou option (R&S SMBV-K107) or one of options for assisted satellite navigation, e.g. A-GPS (R&S SMBV-K65).

To access the "Assistance Data Generation" dialog:

1. Select "Main Dialog > Simulation Mode > User Localization"

2. Select "Assistance Data Generation".

   The "Assistance Data Generation" dialog is used to generate assistance data files for Assisted-GNSS testing. These files can be formatted into mobile communication's message formats and passed by the protocol tester to the DUT in order to speed up Time To First Fix (TTFF). See also chapter 2.10.8, "Generating GNSS Assistance Data", on page 39.
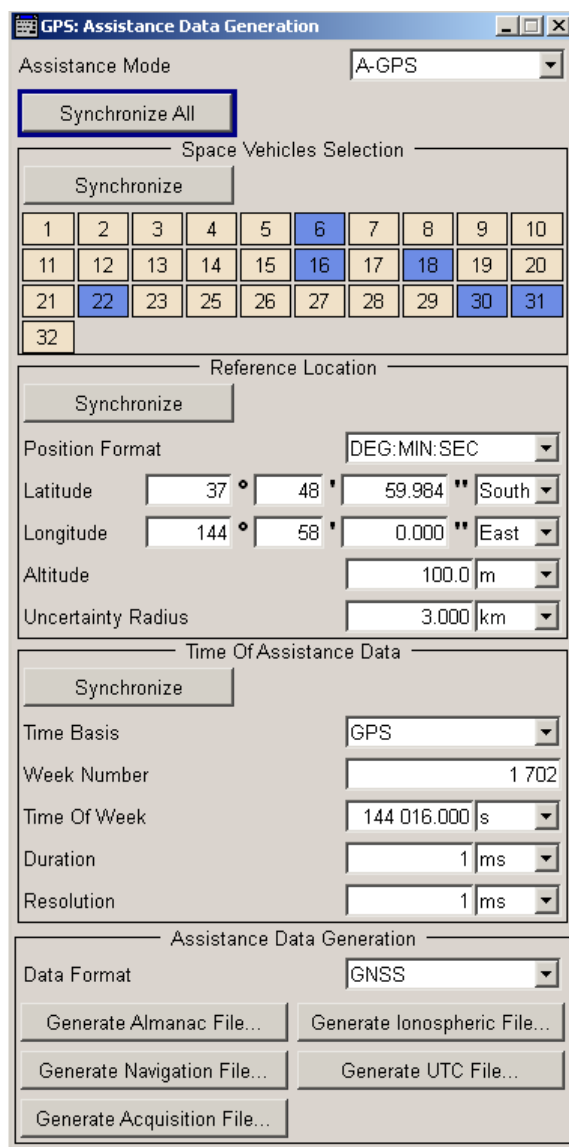
The upper part of the "Assistance Data Generation" dialog is where the "Assistance Mode" and the "Space Vehicle Selection" are set. The middle part of the dialog comprises the parameters of the "Reference Location" and "Time Configuration". The lower part of the dialog offers assistance in the generation of the "Almanac", "Ionospheric", "Navigation", "UTC" and "Acquisition" files.

The R&S SMBV provides a two-level synchronization concept. The "Synchronize All" function enables you to perform a fast reload of all parameters in the dialog. Selective settings alignment is enabled by means of the "Synchronize" functions in each of the individual parameter groups. Although the selection of the satellite, the configuration of the reference location and the time configuration parameters are fully user-definable, it is recommended to use the synchronisation function to retrieve the values for the relevant parameters from the GNSS main dialog as basis for further configuration.

Assistance Mode

Defines the type of assistance data to be loaded.

Value	Required Option
A-GPS	R&S SMBV-K65
A-GALILEO	R&S SMBV-K67
A-GLONASS	R&S SMBV-K95
A-BeiDou	R&S SMBV-K107

Remote command:

<subsystem>:ADGeneration:MODE on page 259

Synchronize All/Synchronize

Parameter	Description	SCPI command
"Synchronize All"	Synchronizes the parameters of the satellites configuration and of the reference location configuration blocks as well as the time configuration parameters with the settings made in the "Satellite Configuration" dialog and in the "GNSS Main Dialog". **Note:** Synchronized are only the satellites of the corresponding entry standard; all other satellites, are disregarded.	<subsystem>:ADGeneration:GPS:SYNChronize on page 259
"Synchronize"	Synchronizes the settings of the corresponding parameter group.	<subsystem>:ADGeneration:GPS:SVID:SYNChronize on page 259 <subsystem>:ADGeneration:GPS:LOCation:SYNChronize on page 259 <subsystem>:ADGeneration:GPS:TOAData:SYNChronize on page 259

Space Vehicle State

Enables/disables a space vehicle with the selected SV ID for generation of assistance data.

Use the "Synchronize" function to retrieve the SV ID belonging to the selected navigation standard (Assistance Mode), as configured in the "Satellite Configuration" dialog.

Remote command:

<subsystem>:ADGeneration:GPS:SVID<ch>:STATe on page 259

Reference Location

The reference location section provides access to the parameters for setting the coordinates of the reference location.

Parameter	Description
"Position Format"	Sets the format in which the Latitude and Longitude are displayed. ● "DEG:MIN:SEC" The display format is Degree:Minute:Second and Direction, i.e. $XX°XX'XX.XX"\ Direction$, where direction can be North/South and East/West. ● "Decimal Degree" The display format is decimal degree, i.e. $+/-XX.XXXXX°$, where "+" indicates North and East and "-" indicates South and West.
"Altitude"	Sets the geographic altitude of the reference location in meters above sea level.
"Latitude"	Sets the latitude of the reference location.
"Longitude"	Sets the longitude of the reference location.
"Uncertainty Radius"	Sets the maximum radius of the area within which the two dimensional location of the UE is bounded. The uncertainty radius determines the required sensitivity of the DUT.

Remote command:

<subsystem>:ADGeneration:GPS:LOCation:URADius on page 262

to enter the coordinates in Degree:Minute:Second format

<subsystem>:ADGeneration:GPS:LOCation:COORdinates:DMS on page 261

to enter the coordinates in decimal degree format

<subsystem>:ADGeneration:GPS:LOCation:COORdinates:DECimal

on page 260

Uncertainty Radius

Sets the Uncertainty Radius, i.e. sets the maximum radius of the area within which the two dimensional location of the UE is bounded.

The uncertainty radius determines the required sensitivity of the DUT.

Remote command:

<subsystem>:ADGeneration:GPS:LOCation:URADius on page 262

Time Basis

Determines the time basis used to enter the time of assistance data parameters.

Remote command:

<subsystem>:ADGeneration:GPS:TOAData:TBASis on page 262

Date [dd.mm.yyyy]

(enabled for "Time Basis" set to UTC or GLONASS)

Enters the date for the assistance data in DD.MM.YYYY format of the Gregorian calendar.

Remote command:

<subsystem>:ADGeneration:GPS:TOAData:DATE on page 263

Time [hh:mm:ss]

(enabled for "Time Basis" set to UTC or GLONASS)

Enters the exact start time for the assistance data in UTC time format.

Remote command:
<subsystem>:ADGeneration:GPS:TOAData:TIME on page 263

Week Number
(enabled for "Time Basis" set to GPS, GALILEO or BDT)

Enters week number (WN) the assistance data is generated for.

Remote command:
<subsystem>:ADGeneration:GPS:TOAData:WNUMber on page 265

Time of Week
(enabled for "Time Basis" set to GPS, GALILEO or BDT)

Determines the Time of Week (TOW) the assistance data is generated for.

Remote command:
<subsystem>:ADGeneration:GPS:TOAData:TOWeek on page 264

Duration
Sets the duration (in ms) of the assistance data.

Remote command:
<subsystem>:ADGeneration:GPS:TOAData:DURation on page 264

Resolution
Sets the resolution (in ms) of the assistance data.

Remote command:
<subsystem>:ADGeneration:GPS:TOAData:RESolution on page 264

Data Format
In "Assistance Mode > A-GPS", determines the data format, "GPS" or "GNSS", of the generated acquisition files.

Affected are the Almanac file, the Navigation file and the acquisition file.

Remote command:
<subsystem>:ADGeneration[:ACQuisition]:DFORmat on page 265

Generate Almanac File …
Access the "Generate Almanac File" dialog for saving the generated almanac file. The file name is user definable; the data format is defined with the parameter Data Format.

The almanac file is generated in one of the listed file formats:
- in a comma separated file format .rs_al (see table 3-20)
- as standard Yuma formatted file .rs_yuma
  – This file format is not supported for A-GLONASS.
  – In case of GPS, Galileo and BeiDou the .rs_yuma, the almanac file can be used as the main almanac source for the specific GNSS standard.

Table 3-20: Contents of the generated almanac file (GPS)

Parameter	Unit
SatID	-
e	dimensionless
toa	sec
delta_i	semi-circles
OMEGADOT	semi-circles/sec
SV Health	boolean
SQRT(A)	meters
OMEGA0	semi-circles
M0	semi-circles
w	semi-circles
af0	seconds
af1	sec/sec

The generated almanac file is conformant to the format appended to standards 3GPP 34.108 v.8.0.0, 3GPP TS 51.010-1v.7.7.0 and 37.571 v10.0. The file lists all possible satellites, available from the source almanac file.

See chapter 2.10.8, "Generating GNSS Assistance Data", on page 39 for description of the workflow for generation of assistance data.

Remote command:
<subsystem>:ADGeneration:ALManac:CREate on page 266

Generate Ionospheric File …
Access the "Select Ionospheric File" dialog for storing the generated ionospheric model.

The generated ionospheric file is file with extension .rs_ion and specified file name.

The parameters listed in this file (see the example in table 3-21) are according to the parameters used for describing the near satellite ionospheric model.
● With GPS Klobuchar parameters are exported
● With Galileo, Galileo Ionosphere parameters are exported
● With GLONASS, file is empty since GLONASS satellites do not transmit any information about the ionosphere

Table 3-21: Contents of the generated ionospheric file (GPS)

Parameter	Unit
alpha_0	seconds
alpha_1	sec/semi-circles
alpha_2	sec/(semi-circles)2
alpha_3	sec/(semi-circles)3
beta_0	seconds

Parameter	Unit
beta_1	sec/semi-circles
beta_2	sec/(semi-circles)2
beta_3	sec/(semi-circles)3

See chapter 2.10.8, "Generating GNSS Assistance Data", on page 39 for description of the workflow for generation of assistance data.

Remote command:

`<subsystem>:ADGeneration:IONospheric:CREate` on page 267

Generate Navigation File …

Access the "Select Navigation File" dialog for saving the generated navigation model (ephemeris). The generated navigation file is a file with extension `.rs_nav`, the selected file name and data format as defined with the parameter Data Format.

Additionally, RINEX file can be also generated to export the ephemeris assistance data. The reference for the generating of the ephemeris page of each satellite is the "Time of Assistance Data". The generated RINEX file is a file with extension `.<XX>n` for GPS and Galileo and `.<XX>g` for GLONASS, where `<XX>` stands for the year of the recording, e.g. `.12n` for GPS ephemeris recording in 2012. The generated RINEX file is conformed to the standard RINEX file format, as described in chapter A.2.1, "RINEX Format Description", on page 304.

The generated navigation file comprises the GNSS standard ephemeris and clock correction parameters of the navigation model (see table 3-22).

Table 3-22: Contents of the generated navigation file (GPS)

Parameter	Unit
SatID	-
Sat Status	-
C/A or P on L2	boolean
URA Index	boolean
SV Health	boolean
IODC	-
L2 P Data Flag	boolean
SF 1 Reserved	-
T_{GD}	sec
t_{oc}	sec
af2	sec/sec2
af1	sec/sec
af0	sec
Cr_s	meters

Parameter	Unit
delta_n	semi-circles/sec
M_0	semi-circles
C_{UC}	radians
e	-
C_{US}	radians
$(A)^{1/2}$	meters1/2
T_{oe}	sec
Fit Interval Flag	boolean
AODO	sec
C_{Is}	radians
I_0	semi-circles
C_{rc}	meters
omega	semi-circles
OMEGAdot	semi-circles/sec
Idot	semi-circles/sec

The generated `.rs_nav` comma separated format is conformant to the format appended to standards 3GPP 34.108 v.8.0.0, 3GPP TS 51.010-1v.7.7.0 and and 37.571v10.0. The file contains one row per satellite.

See section for description of the workflow for generation of assistance data.

Remote command:
`<subsystem>:ADGeneration:NAVigation:CREate`

Generate UTC File …
Access the "Select UTC File" dialog for saving the generated UTC file. The generated UTC file is a file with extension `.rs_utc` and the selected file name.

The file contains all standard UTC parameters (`SatID`, `A_0`, `A_1`, `delta_t_LS`, `t_ot`, `WN_t`, `WN_LSF`, `DN`, and `Delta_t_LSF`) that are necessary to transform GNSS time to the normal UTC time.

The generated UTC file contains one entry per standard.

See for description of the workflow for generation of assistance data.

Remote command:
`<subsystem>:ADGeneration:UTC:CREate`

Generate Acquisition File …

Access the "Select Acquisition File" dilaog for saving the generated acquisition file. The generated Acquisition file is a file with extension `.rs_acq`, the selected file name and data format as defined with the parameter Data Format.

This file consists of:

- one or more rows, each corresponding to
  - the Receiver Referenced GNSS Time of Week (`GNSS TOW`) for GPS, Galileo and BeiDou satellites
  - elapsed time, relative to GLONASS Time of Assistance data (`Time of Validity(ms)`) for GLONASS satellites.

  The number of generated rows is calculated as follow:
  Number Of Generated Rows = "Duration Of Assistance Data" / "Resolution of Assistance Data"

- one or more sequential acquisition blocks per row, where each block comprises the parameters listed in table 3-23.
  The number of the acquisition blocks depends on the number of enabled space vehicles.

The generated acquisition file is conformed to the format appended to standards 3GPP 34.108 v.8.0.0, 3GPP TS 51.010-1v.7.7.0 and 37.571v10.0.

Table 3-23: Contents of the generated acquisition file (one acquisition block)

Parameter	Description	Unit (GPS, BeiDou)	Unit (GLOANSS, Galileo)
SVID/PRNID	Satellite ID that corresponds to the record	-	-
Doppler (0th order term)	Zero Order Doppler Term	Hz	Hz
Doppler (1st order term)	1st order Doppler Term	Hz/sec	Hz/sec
Doppler Uncertainty	Uncertainty Doppler	Hz	m/s
Code Phase	Code Phase or half-Chip index at epoch Time of Transmission (GPS Sat Time)	chips	ms
Integer Code Phase	Integer Code Phase or ms unit index at epoch Time of Transmission (GPS Sat Time)	-	ms
GPS Bit Number	Corresponding Bit number (modulo 4) at epoch Time of Transmission (GPS Sat Time)	-	NA
Code Phase Search Window	Correlator Code phase Search Radius	chips	ms

Parameter	Description	Unit (GPS, BeiDou)	Unit (GLOANSS, Galileo)
Azimuth	Azimuth Angle of the Satellite in ENU orthonormal coordinate System centered at reference point	deg	deg
Elevation	Elevation Angle of the Satellite in ENU orthonormal coordinate System centered at reference point	deg	deg

See chapter 2.10.8, "Generating GNSS Assistance Data", on page 39 for description of the workflow for generation of assistance data.

Remote command:
`<subsystem>:ADGeneration:ACQuisition:CREate` on page 265

3.13 Real-Time S.P.O.T.

The parameters of the "Real-Time S.P.O.T." are only configurable for R&S SMBV instruments.

To access this settings:

1. Select "Baseband > Satellite Navigation > GPS".

2. Select "Simulation Mode > Auto Localization/User Localization".

    The "Real-Time S.P.O.T." (Satellites and Position Online Tracker) view is a dynamic display of the current satellite's constellation, receiver position, power levels of the active satellites.
    The "Real-Time S.P.O.T." view provides dynamic real-time information about several parameters like HDOP, PDOP, receiver's location and current simulation time.

The displayed settings are grouped into different views, the "Sky View", the "Map View", the "Power View", and the "Trajectory View".

● The "Sky View" displays the current position and state (active or inactive) of the satellites in the current satellites constellation. Enable "Simulation Mode > Auto Localization" to observe the situation of disappearance and re-appearance of satellites.
    For instruments equipped with option R&S SMBV-K101, the "Sky View" indicates also the obscured satellites, the satellites with echoes, etc. For example, the satellites which signal is not visible from the current receivers position because there is a obstacle between the receiver and the satellite, are displayed in grey color.
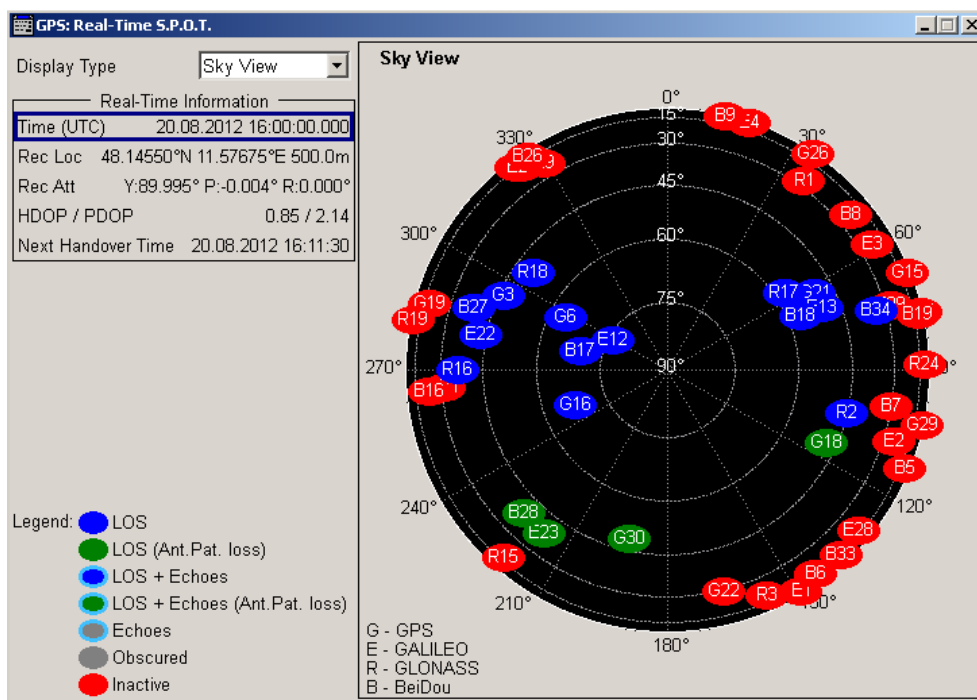
LOS   = Line of Sight; visible satellite
LOS (A.P. loss)   = Visible satellite with antenna pattern loss
LOS + Echoes   = Visible satellite with echoes
LOS + Echoes (A. P. loss)   = Visible satellite with antenna pattern loss and echoes
Echoes   = Obscured satellite, only echoes available for example due to buildings
Obscured   = Obscured satellite, for example due to buildings
Inactive   = Satellite is not simulated

To query the satellite's constellation for the selected time, use the SCPI command:
<subsystem>:RT:SCONstellation? on page 277

● The "Map View" display the trajectory of moving receiver or the position of a static one.
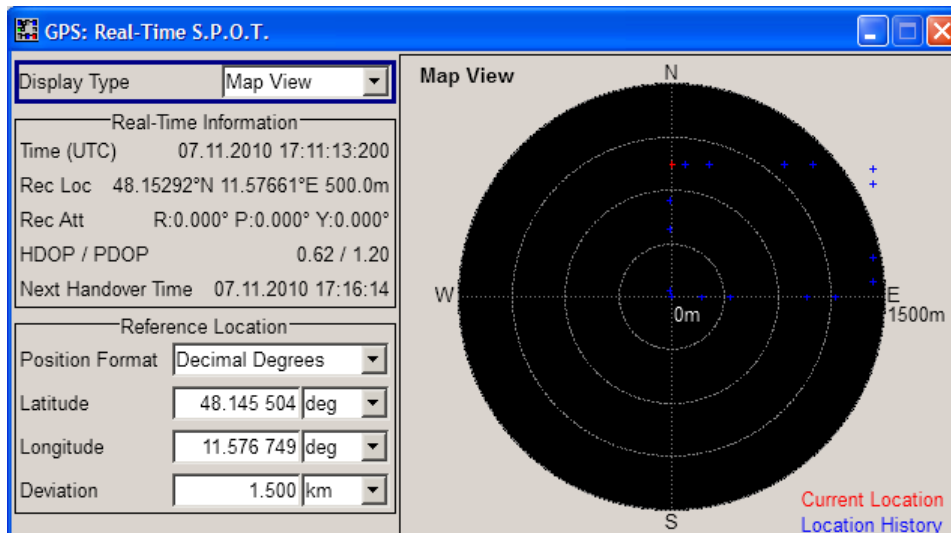
If GNSS receiver software is used to analyze the generated GNSS signal, a slight difference between the receiver position displayed on the "Map View" and the posi-

tion displayed on the receiver software may be noticed at the beginning of a simulation. This accuracy of the "Map View" display is progressively increasing with the time elapsed and after the first satellite handover the deviation should completely disappear.

To query the receiver location for the selected time, use the SCPI commands:

`<subsystem>:RT:RLOCation:COORdinates:DECimal?` on page 274

`<subsystem>:RT:RLOCation:COORdinates:DMS?` on page 275

● The "Power View" displays the current power levels of of the signals of the active satellites and their echos. The displayed values are updated in real time.
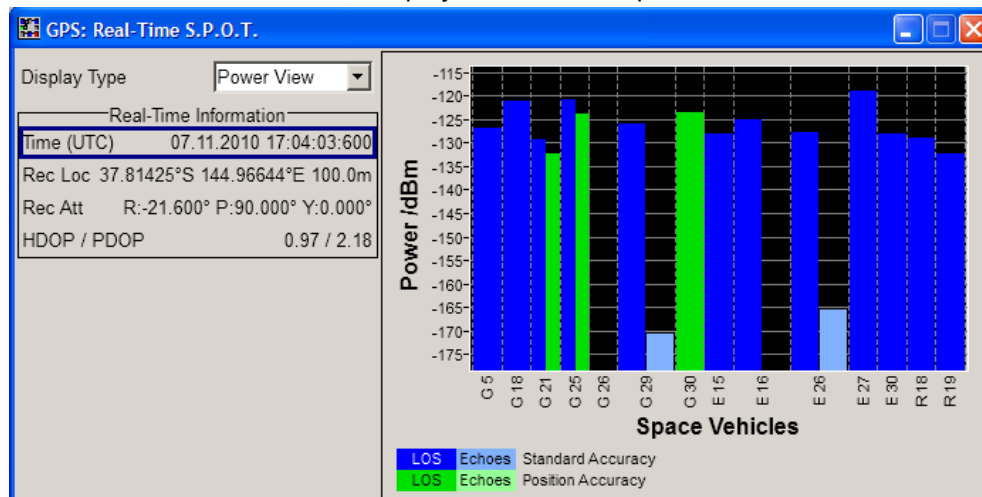
To query the satellite's absolute power for the selected time, use the SCPI command:

`<subsystem>:RT:<GNSS>:SVID<ch>:TAP<us>:POWer:ABSolute`
on page 272

● The "Trajectory View" displays the time variation of the azimuth and the satellite's elevation in the selected time window.
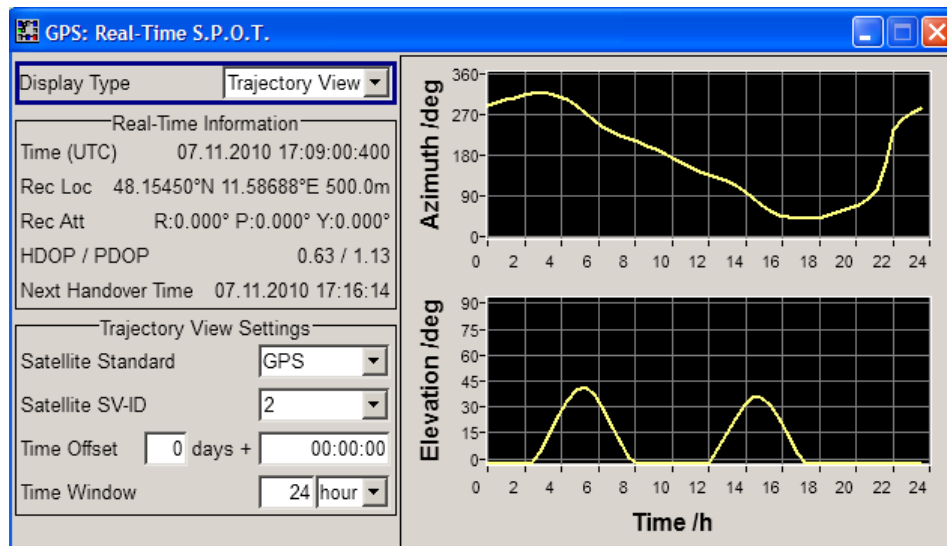
To query the satellite's position for the selected time, use the SCPI commands:

`<subsystem>:RT:<GNSS>:SVID<ch>:AZIMuth` on page 269

`<subsystem>:RT:<GNSS>:SVID<ch>:ELEVation` on page 271

Example:

The figures in this section show the "Real-Time S.P.O.T. > Sky View" display of the same custom build GPS, Galileo and GLONASS hybrid GNSS scenario with automatic exchange of the satellites but the second one is made around 15 min later (compare the value of the parameter "Time" in both figures).

Sky View (Start moment)   **Sky View (15 min later)**
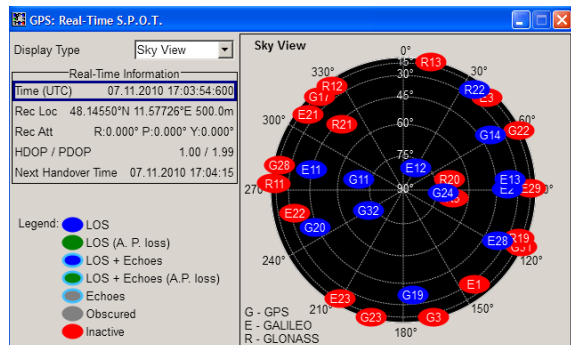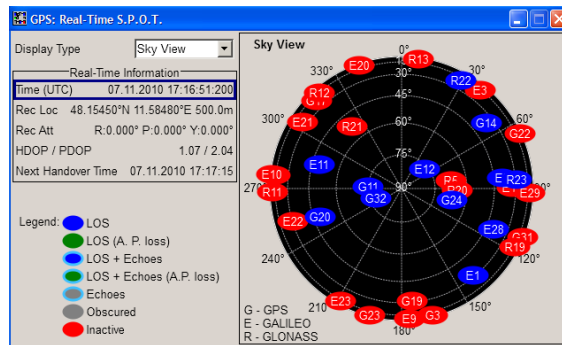
The current position and state of the satellites is displayed on the "Sky View". This is a hybrid GNSS scenario with 12 satellites. Compare the satellite constellations, the position and number of active and inactive satellites; some satellites had disappeared behind the horizon.

3.13.1 Display Type

Display Type
Switches between the available views. See chapter 3.13, "Real-Time S.P.O.T.", on page 139.

Remote command:
n.a

3.13.2 Real-Time Information

The "Real-Time Information" section is common for all views and provides dynamic real-time information about several parameters like "HDOP", "PDOP", "Receiver Location", "Elapsed Time" and "Time of Simulation".

Time (UTC)
Displays the current date and time of the simulation. The value is displayed in format DD.MM.YYY HH:MM:SS and is updated every 5 sec.

Remote command:
n.a

Receiver Location

Displays the current location of the receiver in decimal format.

For static Geographic Location/Attitude, the "Receiver Location" is as selected in the "Localization Data" dialog.

For moving receivers however, the receiver position specified in the "Localization Data" section of the main dialog is the initial location of the receiver. The current receiver location is retrieved from the waypoints file as function of the simulation "Time" and displayed in the "Real-Time S.P.O.T. > Map View" display.

Remote command:

n.a

Receiver Attitude

Displays the current receiver attitude parameters yaw/heading, pitch/elevation, roll/bank in degrees.

The initial receiver attitude parameters are selected in the "Localization Data" dialog.

Remote command:

<subsystem>:RT:RATTitude? on page 280

HDOP / PDOP

Displays the current HDOP and PDOP value of the selected satellite constellation.

The HDOP (Horizontal Dilution of Precision) can be used as an indication of 2D positioning quality. The PDOP (Position Dilution of Precision) can be used as an indication of 3D positioning quality.

The general rule here is that the smaller the HDOP and PDOP are, the better the precision of the position fix will be.

Remote command:

n.a.

Next Constellation Change

(enabled for "Auto Localization" mode)

Displays the expected date and time of the upcoming satellites handover.

Remote command:

<subsystem>:SPOT:NHOTime? on page 269

3.13.3 Reference Location

The "Reference Location" section is enabled in "Map View" display and provides the settings for configuration of the reference location.

Reference Location Coordinates

The reference location is identified by a latitude and a longitude. The values can be displayed in decimal or DMS format. The display format is determined by the parameter "Position Format".

For static receivers, the initial values of the latitude and longitude are automatically set to the values of the Geographic Location/Attitude selected in the Localization Data section of the main dialog. When simulating moving receivers, the initial values are derived from the waypoints file and set to the coordinates of the first receiver position.

Parameter	Description
"Position Format"	Sets the format in which the Latitude and Longitude are displayed. • "DEG:MIN:SEC" The display format is Degree:Minute:Second and Direction, i.e. `XX°XX'XX.XX" Direction`, where direction can be North/South and East/West. • "Decimal Degree" The display format is decimal degree, i.e. `+/-XX.XXXXX°`, where "+" indicates North and East and "-" indicates South and West. The Position Format selected heir changes the format the Receiver Location is displayed.
"Latitude"	Sets the latitude of the reference location.
"Longitude"	Sets the longitude of the reference location.

Remote command:
n.a

Deviation
Sets the deviation in terms of meters from the Reference Location and determines the radius of the "Map View" display.

Remote command:
`n.a.`

3.13.4 Trajectory View Settings

This settings section is available in the "Trajectory View" display and comprises the settings for customization of the displayed Azimuth and Elevation trajectories.

Satellite Standard
Determines the navigation standard the Satellite SV-ID is belonging to.

Remote command:
determined by the `<GNSS>` block of the SCPI command

Satellite SV-ID
Determines the SV-ID of the satellite for that the Azimuth and Elevation trajectories are displayed.

Remote command:
determined by the suffix in the `SVID<ch>` block of the SCPI command

Time Offset
Determines the time offset as number of days and number of hours.

Remote command:
n.a.

Time Window

Sets the time window the trajectories are displayed in, i.e. determines the resolution of the x-axis of the Trajectory View.

Remote command:
n.a.

3.14 Trigger/Marker/Clock Settings

To access this dialog, select "Main Dialog > Trigger/Marker".

The trigger and clock functions are available for R&S SMBV instruments only.

The "Trigger In" section is where the trigger for the signal is set. Various parameters will be provided for the settings, depending on which trigger source - internal or external - is selected. The current status of signal generation ("Running" or "Stopped") is indicated for all trigger modes.
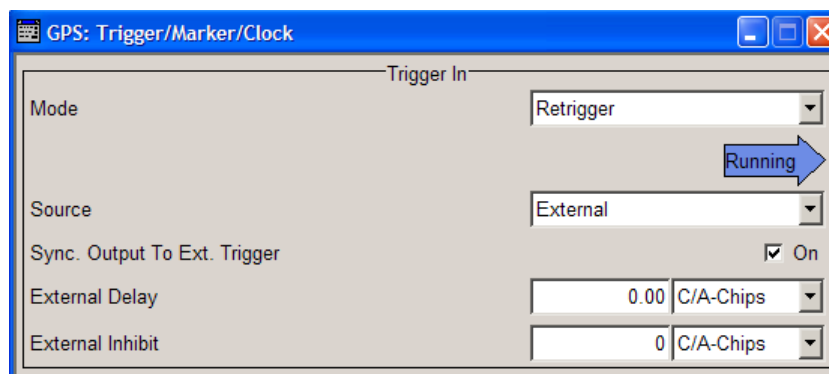
The "Marker Mode" section is where the marker signals at the MARKER output connectors are configured.

The "Marker Delay" section is where a marker signal delay can be defined, either without restriction or restricted to the dynamic section, i.e., the section in which it is possible to make settings without restarting signal and marker generation.

The "Clock Settings" section is where the clock source is selected and - in the case of an external source - the clock type.

The buttons in the last section lead to the submenu for general trigger, clock and mapping settings.

3.14.1 Trigger In

The "Trigger In" section is where the trigger for the signal is set. Various parameters will be provided for the settings, depending on which trigger source - internal or external - is selected. The current status of signal generation ("Running" or "Stopped") is indicated for all trigger modes.

Trigger Mode
Selects trigger mode.

The trigger mode determines the effect of a trigger on the signal generation.

"Auto"   The signal is generated continuously.

"Retrigger"   The signal is generated continuously. A trigger event (internal or
                external) causes a restart.

"Armed_Auto"	The signal is generated only when a trigger event occurs. Then the signal is generated continuously. Button "Arm" stops signal generation. A subsequent trigger event (internal with "Execute Trigger" or external) causes a restart.
"Armed_Ret-rigger"	The signal is generated only when a trigger event occurs. Then the signal is generated continuously. Every subsequent trigger event causes a restart. Button "Arm" stops signal generation. A subsequent trigger event (internal with "Execute Trigger" or external) causes a restart.
"Single"	The signal is generated only when a trigger event occurs. Then the signal is generated once to the length specified at "Signal Duration". Every subsequent trigger event (internal with "Execute Trigger" or external) causes a restart.

Remote command:

<subsystem>[:TRIGger]:SEQuence on page 282

Signal Duration

Defines the length of the signal sequence to be output in the "Single" trigger mode.

It is possible to output deliberately just part of the signal, an exact sequence of the signal, or a defined number of repetitions of the signal.

Remote command:

<subsystem>:TRIGger:SLENgth on page 282

Running/Stopped

Displays the status of signal generation for all trigger modes. This display appears only when signal generation is enabled ("State" On).

"Running"	The modulation signal is generated; a trigger was (internally or externally) initiated in triggered mode. If "Armed_Auto" and "Armed_Retrigger" have been selected, generation of signals can be stopped with the "Arm" button. A new trigger (internally with "Execute Trigger" or externally) causes a restart.
"Stopped"	The signal is not generated, and the instrument waits for a trigger event (internal or external).

Remote command:

<subsystem>:TRIGger:RMODe? on page 283

Arm

(R&S SMBV only)

Stops signal generation. This button appears only with "Running" signal generation in the "Armed_Auto" and "Armed_Retrigger" trigger modes.

Signal generation can be restarted by a new trigger (internally with "Execute Trigger" or externally).

Remote command:

<subsystem>:TRIGger:ARM:EXECute on page 283

Execute Trigger

(R&S SMBV only)

Executes trigger manually. A manual trigger can be executed only when an internal trigger source and a trigger mode other than "Auto" have been selected.

Remote command:

<subsystem>:TRIGger:EXECute on page 284

Trigger Source

Selects trigger source. This setting is effective only when a trigger mode other than "Auto" has been selected.

"Internal"   The trigger event is executed by "Execute Trigger".

"External"   The trigger event is executed with the aid of the active edge of an external trigger signal.
                  The trigger signal is supplied via the TRIGGER connector. The polarity, the trigger threshold and the input impedance of the TRIGGER input can be set in the "Global Trigger/Clock Settings" dialog.

Remote command:

<subsystem>:TRIGger:SOURce on page 284

Sync. Output to External Trigger

(enabled for Trigger Source External)

Enables/disables output of the signal synchronous to the external trigger event.

For or two or more R&S SMBVs configured to work in a master-slave mode for synchronous signal generation, configure this parameter depending on the provided system trigger event and the properties of the output signal. See the table below for an overview of the required settings.

Table 3-24: Typical Applications

System Trigger	Application	"Sync. Output to External Trigger"
Common External Trigger event for the master and the slave instruments	All instruments are synchronous to the external trigger event	ON
	All instruments are synchronous among themselves but starting the signal from first symbol is more important than synchronicity with external trigger event	OFF
Internal trigger signal of the master R&S SMBV for the slave instruments	All instruments are synchronous among themselves	OFF

"On"   Corresponds to the default state of this parameter.
                        The signal calculation starts simultaneously with the external trigger
                        event but because of the instrument's processing time the first sam-
                        ples are cut off and no signal is outputted. After elapsing of the inter-
                        nal processing time, the output signal is synchronous to the trigger
                        event.
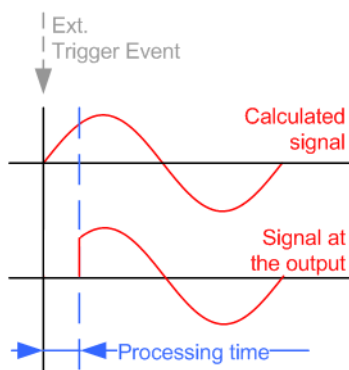
"Off"   The signal output begins after elapsing of the processing time and
                        starts with sample 0, i.e. the complete signal is outputted.
                        This mode is recommended for triggering of short signal sequences
                        with signal duration comparable with the processing time of the
                        instrument.
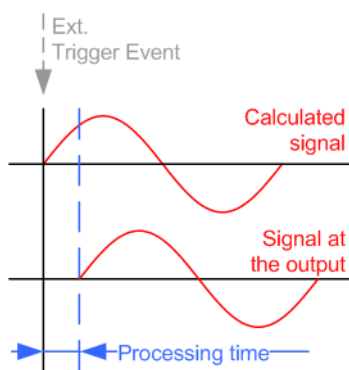
Remote command:
<subsystem>:TRIGger:EXTernal:SYNChronize:OUTPut on page 284

External Delay
Sets the trigger signal delay in chips on external triggering. This enables the instrument
to be synchronized with the device under test or other external devices.

Remote command:
<subsystem>:TRIGger[:EXTernal<ch>]:DELay on page 286

External Inhibit
Sets the duration for inhibiting a new trigger event subsequent to triggering. The input
is to be expressed in chips.

In the "Retrigger" mode, every trigger signal causes signal generation to restart. This restart is inhibited for the specified number of chips.

Remote command:

`<subsystem>:TRIGger[:EXTernal<ch>]:INHibit` on page 286

3.14.2 Marker Mode

The marker output signal for synchronizing external instruments is configured in the marker settings section "Marker Mode".

Marker Mode

Selects a marker signal for the associated "MARKER" output.

Note: One marker signal. In instruments equipped with option R&S SMBV-K96, disabled parameter Use Position Accuracy (P-Code) GPS and enabled satellites constellation with more than 12 satellites, only one marker signal is available!

"Restart"   (R&S WinIQSIM2 only)
                    A marker signal is generated continuously. A trigger event causes a restart.
                    This marker marks one repetition of the ARB and hence depends on "Duration Of Satellite Simulation".

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

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

"1PP2S"   A marker signal is generated for every second start of second. The used time basis is displayed rigth 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 289

"Pulse"   A regular marker signal is generated. The clock frequency is defined by entering a divider. The frequency is derived by dividing the chip rate by the divider. The input box for the divider opens when "Pulse" is selected, and the resulting pulse frequency is displayed.

Remote command:

`<subsystem>:TRIGger:OUTPut<ch>:PULSe:DIVider` on page 288
`<subsystem>:TRIGger:OUTPut<ch>:PULSe:FREQuency?` on page 289

"Pattern"   A marker signal that is defined by a bit pattern is generated. The pattern has a maximum length of 32 bits and is defined in an input field which opens when pattern is selected.

Remote command:

`<subsystem>:TRIGger:OUTPut<ch>:PATTern` on page 288

"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.
The "ON Time" and "OFF Time" are each expressed as a number of samples and are set in an input field which opens when ON/OFF ratio is selected.

Remote command:

`<subsystem>:TRIGger:OUTPut<ch>:ONTime` on page 288

`<subsystem>:TRIGger:OUTPut<ch>:OFFTime` on page 288

"Trigger" | A marker signal is generated only when a trigger event occurs. Then the signal is generated continuously. Every subsequent trigger event causes a restart.

Remote command:

`<subsystem>:TRIGger:OUTPut<ch>:MODE` on page 287

3.14.3 Marker Delay

The delay of the signals on the MARKER outputs is set in the"Marker Delay" section.

Marker x Delay
Enters the delay between the marker signal at the marker outputs and the start of the frame or slot.

The input is expressed as a number of chips. If the setting "Fix marker delay to dynamic range" is enabled, the setting range is restricted to the dynamic range. In this range the delay of the marker signals can be set without restarting the marker and signal.

Remote command:

`<subsystem>:TRIGger:OUTPut<ch>:DELay` on page 285

Current Range without Recalculation
Displays the dynamic range within which the delay of the marker signals can be set without restarting the marker and signal.

The delay can be defined by moving the setting mark.

Remote command:

`<subsystem>:TRIGger:OUTPut<ch>:DELay:MINimum?` on page 285

`<subsystem>:TRIGger:OUTPut<ch>:DELay:MAXimum?` on page 285

Fix marker delay to current range
Restricts the marker delay setting range to the dynamic range. In this range the delay can be set without restarting the marker and signal.

Remote command:

`<subsystem>:TRIGger:OUTPut:DELay:FIXed` on page 286

3.14.4 Clock Settings

The Clock Settings is used to set the clock source and a delay if required.

Sync. Mode
Selects the synchronization mode.

This parameter is used to enable generation of very precise synchronous signal of several connected R&S SMBVs.

Note: If several instruments are connected, the connecting cables from the master instrument to the slave one and between each two consecutive slave instruments must have the same length and type.
Avoid unnecessary cable length and branching points.

"None"   The instrument is working in stand-alone mode.

"Sync. Master"   The instrument provides all connected instrument with its synchronisation (including the trigger signal) and reference clock signal.
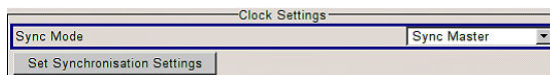
"Sync. Slave"   The instrument receives the synchronisation and reference clock signal from another instrument working in a master mode.

Remote command:
<subsystem>:CLOCk:SYNChronization:MODE on page 291

Set Synchronization Settings
Performs automatically adjustment of the instrument's settings required for the synchronization mode, selected with the parameter "Synchronization Mode".

Remote command:
<subsystem>:CLOCk:SYNChronization:EXECute on page 291

Clock Source
Selects the clock source.

"Internal"   The internal clock reference is used to generate the symbol clock.

"External"   The external clock reference is fed in as the symbol clock or multiple thereof via the CLOCK connector. The symbol rate must be correctly set to an accuracy of +/-2 % (see data sheet).
The polarity of the clock input can be changed with the aid of "Global Trigger/Clock Settings".

Remote command:
<subsystem>:CLOCk:SOURce on page 290

Clock Mode
Enters the type of externally supplied clock.

"Chip"   A chip clock is supplied via the CLOCK connector.

"Multichip"   A multiple of the chip clock is supplied via the CLOCK connector; the
                   sample clock is derived internally from this.
                   The "Multiplier" window provided allows the multiplication factor to be
                   entered.

Remote command:
<subsystem>:CLOCk:MODE on page 290

Clock Multiplier
Enters the multiplication factor for clock type "Multiple".

Remote command:
<subsystem>:CLOCk:MULTiplier on page 290

Measured External Clock
Provided for permanent monitoring of the enabled and externally supplied clock signal.

Remote command:
CLOCk:INPut:FREQuency?

3.14.5 Global Settings

The buttons in this section lead to submenu for general trigger, clock and mapping set-
tings.

Global Trigger/Clock Settings
Calls the "Global Trigger/Clock/Input Settings" dialog.

This dialog is used among other things for setting the trigger threshold, the input impe-
dance and the polarity of the clock and trigger inputs.

The parameters in this menu affect all digital modulations and standards, and are
described in chapter "Global Trigger/Clock/Input Settings" in the Operating Manual.

4 Remote-Control Commands

The following commands are required to perform signal generation with the satellite navigation options in a remote environment. We assume that the R&S SMBV has already been set up for remote operation in a network as described in the R&S SMBV documentation. A knowlage 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 SMBV operating manual.

The `SOURce:BB:GPS|GALileo|GLONass|BEIDou` subsystem contains commands for configuring hte 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 `SOURce:BB:GPS`, `SOURce:BB:GALileo` (for Galileo), `SOURce:BB:GLONass` (for GLONASS) or `SOURce:BB:BEIDou` (for BeiDou).

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
  `SOUR:BB:GPS:STAT`

- Entry Standard = Galileo
  `SOUR:BB:GAL:STAT`

- Entry Standard = GLONASS
  `SOUR:BB:GLON:STAT`

- Entry Standard = BeiDou
  `SOUR:BB:BEID:STAT`

- 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 this placeholder `<GNSS>` with `GPS`, `GALileo`, `GLONass` or `BEIDou`.

Example:

SCPI command: `<subsystem>:HYBRid:<GNSS>[:STATe]`

●   Entry Standard = GPS
    replace the placeholder`<subsystem>` with `SOUR:BB:GPS`

●   In a hybrid GNSS configuration, the navigation standard of the entry point (GPS) is
    always enabled. To enable the Galileo satellites, replace the placeholder `<GNSS>`
    with `GALileo`
    `SOUR:BB:GPS:HYBR:GAL:STAT`

●   invalid commands
    `<Subsystem>:HYBR:GAL:STAT`
    `SOUR:BB:GPS:HYBR:<GNSS>:STAT`

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 1 .. 2	available markers R&S SMBV supports two markers
`EXTernal<ch>`	1 .. 2	external trigger connectors
`SVID<ch>`	1 .. 37 for GPS satel-lites 1 .. 50 for Galileo sat-ellite	distinguishes between the SV IDs **Note:** The SV ID must correspond to a healthy satellie!
`TAP<us>`	1 .. 10	taps in the multipath configuration
`Satellite<st>`	1 .. 24	distinguishes between the satellites
`PAGE<us>`	1 .. 12	navigation page

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

In particular, this includes:

●   Managing settings and data lists, i.e. storing and loading settings, creating and
    accessing data lists, accessing files in a particular directory, etc.

●   Information on regular trigger, marker and clock signals as well as filter settings, if
    appropriate.

●   General instrument configuration, such as configuring networks and remote opera-
    tion

●   Using the common status registers

For a description of such tasks, see the R&S SMBV operating manual.

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

4.1　Programming Examples

The following sections provide simple programming examples for the R&S SMBV. 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 SMBV 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.

In all of the examples 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.

4.2　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.

```
************************************************
SOURce1:BB:GPS:SETTings:CATalog? '/var/user/settings'
// Response: gps_settings,settings
SOURce1:BB:GLONass:SETTings:CATalog? '/var/user/settings'
// Response: glo_settings,settings
SOURce1:BB:GALileo:SETTings:CATalog? '/var/user/settings'
// Response: gal_settings
// There are five files in the /var/user/settings directory:
// gps_settings.gps, settings.gps, glo_settings.glonass,
// settings.glonass and gal_settings.galileo
SOURce1:BB:GPS:SETTings:STORe '/var/user/settings/gps_settings_new'
SOURce1:BB:GPS:SETTings:LOADe '/var/user/settings/gps_settings'
SOURce1:BB:GPS:SETTings:DELete '/var/user/settings/settings'
// Deletes the file settings.gps
SOURce1:BB:GPS:SETTings:CATalog? '/var/user/settings'
// Response: gps_settings,gps_settings_new
SOURce1:BB:GLONass:SETTings:CATalog? '/var/user/settings'
// Response: glo_settings,settings
```

Example: Selecting a predefined test scenario

This example shows how to enable an A-GPS test scenario. The A-GNSS test scenarios require a GPS/GLONASS hybrid GNSS configuration.

```
***********************************
// select and enable the predefined A-GNSS test scenario
// 3GPP FDD Performance Test Scenario 2
// ***************************************
SOURce1:BB:GPS:PRESet
SOURce1:BB:GPS:ATSCenario W3GPER2
SOURce1:BB:GPS:STATe ON
```

<subsystem>:PRESet

Restores the default settings. The default values correspond to the `*RST` values in the descriptions of the SCPI commands.

Example:	See example "Selecting a predefined test scenario" on page 158.
Usage:	Event
Manual operation:	See "Set to default" on page 57

<subsystem>:STATe <State>

Enables/disables the GNSS signal simulation.

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

A continuous GNSS signal is generated for up to 24 satellites in real time mode. The number is determined by the command `<subsystem>:SATellite:COUNt` and the maximum value depends on the installed SW options.

Parameters:

<State>	0 | 1 | OFF | ON
	*RST: 0
Example:	See example "Selecting a predefined test scenario" on page 158.
Manual operation:	See "State" on page 56

<subsystem>:RFBand <RfBand>

Selects the center carrier frequency of the instrument.

Parameters:

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

Example:	`SOURce1:BB:GPS:RFBand L1`
	`SOURce1:BB:GPS:PRFLevel`
	sets the RF level to 1.575420 GHz

Example:	`SOURce1:BB:GALileo:RFBand L1`
	selects the Galileo E1 RF band
	`SOURce1:BB:GALileo:PRFLevel`
	sets the RF level to 1.575420 GHz

Manual operation: See "RF Band" on page 59

<subsystem>:PRFFrequency

Sets the RF frequency in the "Frequency" display in the header of the instrument to the carrier frequency.

Tip: The carrier frequency is calculated automaticaly and for hybrid signals may deviate from the frequency set with the command `<subsystem>:RFBand`.

Example:	`BB:GPS:RFB L1`
	`BB:GPS:PRFL`
	sets the RF level to 1.575420 GHz

Usage:	Event
Manual operation:	See "Update RF Frequency" on page 59

<subsystem>:SMODe <SMode>

Sets the simulation mode.

Parameters:

<SMode>	STATic | AUTO | USER Refer to "Simulation Mode" on page 60 for description of hte simulation modes. *RST: STATic
Manual operation:	See "Simulation Mode" on page 60

[:SOURce<hw>]:BB:GPS:ATSCenario <Scenario>

Selects the file with the predefined A-GPS/A-GNSS test scenario.

Table 4-1: A-GPS test scenarios

Test Scenario	SCPI
3GPP TS 51.010: 10.9 Signaling	`GSMSIG`
3GPP TS 51.010: 10.10 Performance 1/2/3	`GSMPER1|GSMPER2|GSMPER3`
3GPP TS 34.108: 10.7 Signaling	`W3GSIG`
3GPP TS 34.108: 10.1.2 Performance 1/2/3	`W3GPER1|W3GPER2|W3GPER3`
3GPP2 C.S0036: 2.1.1 Stationary	`W3G2M`
3GPP2 C.S0036: 2.1.2 Moving	`W3G2S`
3GPP TS 37.571-2: S7 Signaling ST1	`LTESIGST1`
3GPP TS 37.571-1: S7 Performance 1/2/5 ST1	`LTEPER1ST1|LTEPER2ST1|LTEPER5ST1`

Table 4-2: A-GNSS test scenarios

Test Scenario	SCPI
3GPP TS 37.571-2: S6 Signaling ST4	W3GSIGST4
3GPP TS 37.571-1: S6 Performance 1/2/5 ST4	W3GPER1ST4|W3GPER2ST4|W3GPER5ST4
3GPP TS 37.571-2: S7 Signaling ST4	LTESIGST4
3GPP TS 37.571-1: S7 Performance 1/2/5 ST5	LTEPER1ST5|LTEPER2ST5|LTEPER5ST5

Parameters:

<Scenario>　　　　USER | GSMSIG | GSMPER1 | GSMPER2 | GSMPER3 |
　　　　　　　　　W3GSIG | W3GPER1 | W3GPER2 | W3GPER3 | W3G2S |
　　　　　　　　　W3G2M | W3GSIGST4 | W3GPER1ST4 | W3GPER2ST4 |
　　　　　　　　　W3GPER5ST4 | LTESIGST1 | LTESIGST4 | LTEPER1ST1 |
　　　　　　　　　LTEPER1ST5 | LTEPER2ST1 | LTEPER2ST5 | LTEPER5ST1 |
　　　　　　　　　LTEPER5ST5

User
No predefined test scenario is selected.

*RST:　　　USER

Example:　　　　See example "Selecting a predefined test scenario"
　　　　　　　　　on page 158.

Manual operation:　See "Test Scenario" on page 59

[:SOURce<hw>]:BB:GLONass:ATSCenario <Scenario>

Selects the file with the predefined A-GLONASS/A-GNSS test scenario.

Table 4-3: A-GLONASS test scenarios

Test Scenario	SCPI
3GPP TS 37.571-2: S6 Signaling ST1	W3GSIGST1
3GPP TS 37.571-1: S6 Performance 1/2/5	W3GPER1ST1|W3GPER2ST1W3GPER5ST1
3GPP TS 37.571-2: S7 Signaling ST2	LTESIGST2
3GPP TS 37.571-1: S7 Performance 1/2/5 ST2	LTEPER1ST2|LTEPER2ST2|LTEPER5ST2

Table 4-4: A-GNSS test scenarios

Test Scenario	SCPI
3GPP TS 37.571-2: S6 Signaling ST4	W3GSIGST4
3GPP TS 37.571-1: S6 Performance 1/2/5 ST4	W3GPER1ST4|W3GPER2ST4|W3GPER5ST4
3GPP TS 37.571-2: S7 Signaling ST4	LTESIGST4
3GPP TS 37.571-1: S7 Performance 1/2/5 ST5	LTEPER1ST5|LTEPER2ST5|LTEPER5ST5

Parameters:

<Scenario>   USER | W3GSIGST1 | W3GSIGST4 | W3GPER1ST1 |
                          W3GPER5ST4 | W3GPER5ST1 | W3GPER2ST4 |
                          W3GPER2ST1 | W3GPER1ST4 | LTESIGST2 | LTESIGST4 |
                          LTEPER1ST2 | LTEPER1ST5 | LTEPER2ST2 | LTEPER2ST5 |
                          LTEPER5ST2 | LTEPER5ST5

                          User
                          No predefined test scenario is selected.

                          *RST: USER

Manual operation: See "Test Scenario" on page 59

<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 GPS/Galileo/GLONASS settings in the default directory. The
default directory is set using command `MMEM:CDIRectory`. Only files with the file
extension `.gps`, `.galileo` or respectively `.glonass` are listed.

Return values:

<Catalog>   string

Example: See example "Save/Recall Files with user settings"
                          on page 158.

Usage: Query only

Manual operation: See "Save/Recall" on page 57

<subsystem>:SETTing:STORe <Filename>

Stores the current settings of the specified GNSS standard into the selected file. The
directory is set using command `MMEM:CDIRectory`. A path can also be specified, in
which case the files in the specified directory are read. Only the file name has to be
entered. Configurations are stored with the predefined file extension `*.gps` (for GPS
settings) or `*.galileo` (for Galileo settings).

Setting parameters:

<Filename>   string

Example: See example "Save/Recall Files with user settings"
                          on page 158.

Usage: Setting only

Manual operation: See "Save/Recall" on page 57

<subsystem>:SETTing:STORe:FAST <Fast>

Determines whether the instrument performs an absolute or a differential storing of the settings.

Enable this function to accelerate the saving process by saving only the settings with values different to the default ones.

Note: This function is not affected by the "Preset" function.

Parameters:

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

Manual operation: See "Save/Recall" on page 57

<subsystem>:SETTing:LOAD <Filename>

Loads the selected file with GPS/Galileo/GLONASS settings. The directory is set using command `MMEM:CDIRectory`. A path can also be specified, in which case files in the specified directory are read. Only files with the file extension `*.gps`, `*.galileo` or `*.glonass` can be loaded.

Setting parameters:

<Filename>	string

Example:	See example "Save/Recall Files with user settings" on page 158.
Usage:	Setting only
Manual operation:	See "Save/Recall" on page 57

<subsystem>:SETTing:DELete <Filename>

Deletes the selected file with GPS or Galileo settings. The directory is set using command `MMEM:CDIRectory`. A path can also be specified, in which case files in the specified directory are deleted. Only files with the file extension `.gps` or `.galileo` are deleted.

Setting parameters:

<Filename>	string

Example:	See example "Save/Recall Files with user settings" on page 158.
Usage:	Setting only
Manual operation:	See "Save/Recall" on page 57

<subsystem>:DURation <Duration>

Determines the duration of the satellite simulation.

The resulting duration of the simulation is calculated as follow:

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

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

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

Parameters:

<Duration>	float
	Range: 20.0e-3 to 64
	Increment: 20.0e-3
	*RST: 20.0e-3

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

Manual operation:	See "Duration Of Satellite Simulation" on page 61

<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 61

<subsystem>:WAVeform:CREate <Filename>

(For R&S WinIQSIM2 only)

This command creates a waveform using the current settings of the GNSS dialog. The file is stored with the predefined file extension *.wv. The file name and the directory it is stored in are user-definable.

Setting parameters:

<Filename>	string

Example:	MMEM:CDIR 'D:\user\waveform
	sets the default directory.
	BB:GPS:WAV:CRE 'gnss_1'
	creates the waveform file gnss_1.wv in the default directory.

Usage:	Setting only

Manual operation: See "Generate Waveform File" on page 58

4.3 User Environment, Antenna Pattern and Body Mask

Example: Defining the vehicle type and selectg a *.xvd file

The following example uses the GPS entry standard.

```
//Query the available vehicle description files and load one of them
SOURce1:BB:GPS:SMODe AUTO
SOURce1:BB:GPS:VEHicle:TYPE PEDestrian
SOURce1:BB:GPS:VEHicle:CATalog:PREDefined?
// Response: Aircraft,Ship,Pedestrian,...
MMEM:CDIR "/var/user/myXVDFiles"
SOURce1:BB:GPS:VEHicle:CATalog:USER?
// Response: xvd_pedestrian
SOURce1:BB:GPS:VEHicle:FILE "/var/user/myXVDFiles/my_pedestrian"
```

Example: Selecting an antenna file

The following example uses the GPS entry standard. A user defined antenna pattern file exist. The file contents are described in chapter A.1.3, "Antenna Pattern / Body Mask Files", on page 301.

```
//Query the available antenna pattern files and loads one of them
SOURce1:BB:GPS:SMODe AUTO
SOURce1:BB:GPS:APATtern:CATalog:PREDefined?
// Response: Bus,Car_Small,Isotropic,...
MMEM:CDIR "/var/user/antenna_patterns"
SOURce1:BB:GPS:APATtern:CATalog:USER?
// Response: ant_pat_3ant
SOURce1:BB:GPS:APATtern:FILE "/var/user/antenna_patterns/ant_pat_3ant"
SOURce1:BB:GPS:APATtern:LIST?
// Response: 1,2,3
// three antennas with antenna IDs 1, 2 and 3 are defined
// select the antenna with antenna ID=2
SOURce1:BB:GPS:APATtern:ID 2
// switch the antenna in real time after elapsing the specified time
SOURce1:BB:GPS:RT:UPDate:ANTenna 12500,1
```

<subsystem>:VEHicle:CATalog:PREDefined?

Queries the names of the predefined vehicle description files in the system directory. Only files with the file extension `*.xvd` are listed.

Example:	see example "Defining the vehicle type and selectg a *.xvd file" on page 165
Usage:	Query only
Manual operation:	See "Vehicle Description File" on page 63

<subsystem>:VEHicle:CATalog:USER?

Queries the names of the user-defined vehicle description files in the default directory. The default directory is set using command `MMEM:CDIRectory`. Only files with the file extension `*.xvd` are listed.

Example:	see example "Defining the vehicle type and selectg a *.xvd file" on page 165
Usage:	Query only
Manual operation:	See "Vehicle Description File" on page 63

<subsystem>:VEHicle:FILE <Filename>

Loads the selected vehicle description file. Use the command `MMEM:CDIRectory` to define the directory. Only files with the file extension `*.xvd` are loaded.

Parameters:	
<Filename>	string
Example:	see example "Defining the vehicle type and selectg a *.xvd file" on page 165
Manual operation:	See "Vehicle Description File" on page 63

<subsystem>:VEHicle:TYPE <Type>

Sets the vehicle type.

Parameters:	
<Type>	HIL | SPACecraft | AIRCraft | SHIP | LVEHicle | PEDestrian
	HIL, Spacecraft, Aircraft, Ship, Land Vehicle, Pedestrian
Example:	see example "Defining the vehicle type and selectg a *.xvd file" on page 165
Manual operation:	See "Vehicle Type" on page 63

<subsystem>:APATtern:CATalog:PREDefined?

Queries the names of the predefined antenna pattern files in the system directory. Only files with the file extension `*.ant_pat` are listed.

Example:	see example "Selecting an antenna file" on page 165
Usage:	Query only
Options:	R&S SMBV-K102
Manual operation:	See "Antenna Pattern/Body Mask File" on page 64

<subsystem>:APATtern:CATalog:USER?

Queries the names of the user-defined antenna pattern files in the default directory. The default directory is set using command `MMEM:CDIRectory`. Only files with the file extension `*.ant_pat` are listed.

Example:	see example "Selecting an antenna file" on page 165
Usage:	Query only
Options:	R&S SMBV-K102
Manual operation:	See "Antenna Pattern/Body Mask File" on page 64

<subsystem>:APATtern:FILE <Filename>

Loads the selected antenna pattern file. Only files with the file extension `*.ant_pat` are loaded, see chapter A.1.3, "Antenna Pattern / Body Mask Files", on page 301.

Parameters:	
<Filename>	string
Example:	see example "Selecting an antenna file" on page 165
Options:	R&S SMBV-K102
Manual operation:	See "Antenna Pattern/Body Mask File" on page 64

<subsystem>:APATtern:ANTenna:LIST?

Queries the antenna identifiers <antenna id> specified in the selected `*.ant_pat` file.

Return values:	
<List>	<antenna id#1>,<antenna id#2>,<antenna id#2>,<antenna id#4>
	Returns a comma separated list of the used antenna identifiers (ID).
	A maximum of four antennas ca nbe specifed in one file, i.e. the list contains maximum of four <antenna id>.
Example:	see example "Selecting an antenna file" on page 165

Usage:	Query only
Options:	R&S SMBV-K102
Manual operation:	See "Antenna Pattern/Body Mask File" on page 64

<subsystem>:APATtern:ANTenna:ID <AntennaId>

Selects one particular antenna by its antenna ID. To query the list of all antenna IDs, use the `<subsystem>:APATtern:ANTenna:LIST?`.

Parameters:

<AntennaId>	integer
	Range: 0 to INT_MAX *RST: 0

Example:	see example "Selecting an antenna file" on page 165
Options:	R&S SMBV-K102
Manual operation:	See "Antenna Pattern/Body Mask File" on page 64

<subsystem>:RT:UPDate:ANTenna

Triggers the software to schedule a real time switch of the used antenna at a specific future time, as specified in the antenna pattern (`*.ant_pat`) file.

For description of the file format, refer to chapter A.1.3, "Antenna Pattern / Body Mask Files", on page 301.

The switching is scheduled only if the following rules are respected:

- the selected `<AntennaId>` is specified in the selected antenna pattern file
- the SCPI command is sent at least 5 seconds ahead of the execution time specified with the parameter `<ElapsedTime>`
- the execution of last successfully scheduled SCPI command `<subsystem>:RT:UPDate:ANTenna` is completed
- the selected `<AntennaId>` is different than the currently active antenna:
  - different from `<AntennaId>` specified in the last executed SCPI command
  - different from the initially selected `<AntennaId>`, if this is the first command

Note: The listed prerequisites for correct real time antenna switching are mandatory. If the SCPI command fails to abide by those rules, it will be ignored.

Parameters:

<ElapsedTime>	float
	Elapsed time from the simulation start time at which a switch to the defined `<AntennaId>` is performed.
	Range: 0 to 99999999 Increment: 0.01 Default unit: s

<AntennaId>	integer
	Use the command `<subsystem>:APATtern:ANTenna: LIST?` to query the antenna IDs defined in the currently selected antenna pattern file.
	Range: 1 to 100 Increment: 1
Example:	see example "Selecting an antenna file" on page 165
Usage:	Event
Options:	R&S SMBV-K102
Manual operation:	See "Antenna Pattern/Body Mask File" on page 64

4.4 Localization Data

Example: Selecting a waypoint file

The following example uses GPS entry standard.

```
SOURce1:BB:GPS:LOCation:CATalog?
// Response: User Defined,Waypoints,New York,San Francisco,Beijing,Seoul,...
SOURce1:BB:GPS:LOCation:SELect "Waypoints"
SOURce1:MMEM:CAT?'/var/user/Lists/Gnss/Waypoints'
// Response: 583768,52428800000,".,DIR,0","..,DIR,0","3gpp2.txt,ASC,233703",
// "Melbourne.txt,ASC,238949","Melbourne_Movement.txt,ASC,2104
SOURce1:BB:GPS:LOCation:WAYPoints:FILE '/var/user/Lists/Gnss/Waypoints/Melbourne.txt'
SOURce1:BB:GPS:LOCation:WAYPoints:ROMode CYCLic
SOURce1:BB:GPS:LOCation:COORdinates:DECimal?
// Response: 144.966658,-37.816663,100
// Coordinates of the first simulation position defined in the selected file
SOURce1:BB:GPS:LOCation:COORdinates:DMS?
// Response: 44,57,59.970,EAST,37,48,59.987,SOUT,100
```

<subsystem>:LOCation:CATalog?

Queries the names of the predefined geographic locations.

Example:	See example "Selecting a waypoint file" on page 169.
Usage:	Query only
Manual operation:	See "Geographic Location/Attitude" on page 69

<subsystem>:LOCation[:SELect] <Location>

Selects the geographic location of the GNSS receiver.

Parameters:

<Location>   "User Defined" | "New York" | "San Francisco" | "Beijing" |
                 "Seoul" | "Singapore" | "Taipei" | "Tokyo" | "Sydney" | "London" |
                 "Moscow" | "Munich" | "Paris" | "Waypoints"

User Defined
Enables the definition of the "Latitude", "Longitude" and "Altitude" of the GNSS receiver with fixed position in the ECEF WGS84 coordinate system.

Waypoints
(requires option GNSS Enhancements R&S SMBV-K92)
Enables defining a moving scenario, i.e. the simulation of a moving receiver.

"New York" | "San Francisco" | "Beijing" | "Seoul" | "Singapore" | "Taipei" | "Tokyo" | "Sydney" | "London" | "Moscow" | "Munich" | "Paris"
Selects one of the predefined fixed geographic locations.
The parameters "Latitude", "Longitude" and "Altitude" are set according to the selected position.

Example:	See example "Selecting a waypoint file" on page 169.
Manual operation:	See "Geographic Location/Attitude" on page 69

<subsystem>:LOCation:WAYPoints:FILE <WayPoints>

Selects a predefind waypoint file. A waypoint file must have the extension `.txt`, `.nmea` or `.xtd`.

This setting is only available if `<subsystem>:LOCation[:SELect]` is set to `Waypoints`.

Parameters:

<WayPoints>   string

Example:	See example "Selecting a waypoint file" on page 169.
Options:	R&S SMBV-K92
Manual operation:	See "Waypoint/Attitude File …" on page 70

<subsystem>:LOCation:WAYPoints:ROMode <RoMode>

Defines the way the waypoint file is to be read.

This setting is only available if `<subsystem>:LOCation[:SELect]` is set to `Waypoints`.

Parameters:

<RoMode>	CYCLic | RTRip | OWAY
	CYCLic The waypoint file is read out cyclic. Using this read out mode is only recommended for waypoint files that describe a circle moving scenario or moving scenario in which the start and the end point are close to each other.
	OWAY (One Way) The file is read out only once. When the end of the file is reached, the last described position is assumed to be a static one.
	RTRip (Round Trip) When the end of the file is reached, the file is read out backwards. *RST: OWAY
Example:	See example "Selecting a waypoint file" on page 169.
Options:	R&S SMBV-K92
Manual operation:	See "Read Out Mode" on page 71

<subsystem>:LOCation:COORdinates:DECimal <Longitude>, <Latitude>, <Altitude>

Defines the coordinates of the geographic location of the GNSS receiver in decimal format.

Parameters:

<Longitude>	float
	Range: -180 to 180 Increment: 1E-6 *RST: 0
<Latitude>	float
	Range: -90 to 90 Increment: 1E-6 *RST: 0

<Altitude>	float
	Altitude in meters above sea level.

Range: -10000 to 1600000
Increment: 0.1
*RST: 0

Example:	See example "Selecting a waypoint file" on page 169.
Manual operation:	See "Location Coordinates" on page 71

<subsystem>:LOCation:COORdinates:DMS <LongitudeDeg>, <LongitudeMin>,
     <LongitudeSec>, <LongitudeDir>, <LatitudeDeg>, <LatitudeMin>,
     <LatitudeSec>, <LatitudeDir>, <Altitude>

Defines the coordinates of the geographic location of the GNSS receiver in degrees, minutes and seconds.

Parameters:

<LongitudeDeg>	integer
	Defines the longitude degrees.

Range: 0 to 180
Increment: 1
*RST: 0

<LongitudeMin>	integer
	Defines the longitude minutes.

Range: 0 to 59
Increment: 1
*RST: 0

<LongitudeSec>	float
	Defines the longitude seconds.

Range: 0 to 59.999
Increment: 0.001
*RST: 0

<LongitudeDir>	EAST	WEST
	Defines the longitude direction.

*RST: EAST

<LatitudeDeg>	integer
	Defines the latitude degrees.

Range: 0 to 90
Increment: 1
*RST: 0

<LatitudeMin>	integer
	Defines the latitude minutes.
	Range: 0 to 59
	Increment: 1
	*RST: 0

<LatitudeSec>	float
	Defines the latitude seconds.
	Range: 0 to 59.999
	Increment: 0.001
	*RST: 0

<LatitudeDir>	NORTh | SOUTh
	Defines the latitude direction.
	*RST: NORT

<Altitude>	float
	Defines the altitude in meters above sea level.
	Range: -10000 to 1600000
	Increment: 0.1
	*RST: 0

Example: See example "Selecting a waypoint file" on page 169.

Manual operation: See "Location Coordinates" on page 71

<subsystem>:LOCation:YAW <Yaw>
<subsystem>:LOCation:PITCh <Pitch>
<subsystem>:LOCation:ROLL <Roll>

Sets the attitude parameters relative to the local horizon.

Parameters:

<Roll>	float
	Range: -180 to 180
	Increment: 0.001
	*RST: 0

Options: R&S SMBV-K103

Manual operation: See "Yaw/Heading, Pitch/Elevation, Roll/Bank" on page 72

<subsystem>:LOCation:YAW:FMOTion <State>
<subsystem>:LOCation:PITCh:FMOTion <State>
<subsystem>:LOCation:ROLL:FSPinning <FromSpinning>

Force the attitude parameters to motion direction. Usefull in automotive applications.

Parameters:

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

Options: R&S SMBV-K103 for <subsystem>:LOCation:ROLL:FSPinning

Manual operation: See "From Motion/From Spinning" on page 72

<subsystem>:LOCation:SPIN:RATE <Rate>

Simulates a constant rate of change of the roll.

Parameters:

<Rate>   float

                    Range: -500 to 500
                    Increment: 0.01
                    *RST: 0

Options: R&S SMBV-K103

Manual operation: See "Spinning Rate" on page 72

<subsystem>:LOCation:SPIN:SRoll <StartRollAngle>

Defines the start angles of rotation of the vehicle.

Parameters:

<StartRollAngle>   float

                    Range: -180 to 180
                    Increment: 0.001
                    *RST: 0

Example: `SOURce1:BB:GPS:LOCation:ROLL:FSPinning ON`
                    `SOURce1:BB:GPS:LOCation:SPIN:RATE 0.25`
                    `SOURce1:BB:GPS:LOCation:SPIN:SRoll 90`

Options: R&S SMBV-K103

Manual operation: See "Vehicle Body Start Roll" on page 72

<subsystem>:LOCation:SMOVement <SmoothMovement>

Enables an internal algorithm to smooth the trajectory, see also chapter 2.5.7, "Motion Smoothening Using Vehicle Description File", on page 28.

Parameters:

<SmoothMovement>   0 | 1 | OFF | ON

                    *RST: OFF

Example: `SOURce1:BB:GPS:LOCation:SMOVement`

Options: R&S SMBV-K92

Manual operation: See "Smooth Movement" on page 70

4.5 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 \<Data>

Determines the data source for the navigation information.

Parameters:

\<Data>	ZERO | ONE | PATTern | PN9 | PN11 | PN15 | PN16 | PN20 | PN21 | PN23 | DLISt | RNData
	RNData
	Real navigation data provided by an almanac file.
	Use the command \<subsystem>:NAVigation:ALManac: \<GNSS>:FILE to select the almanac file.
	ZERO | ONE| PATTern | PNxx | DLISt
	Standard data sources (a sequence of 0 or 1, a pseudo-random sequence with different lenght, a pattern or a data list)
	*RST: RNData
Example:	See example "Selecting Real Navigation Data" on page 175.
Manual operation:	See "Data Source" on page 65

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

Selects a data list as data source.

Data lists are files with file extensions `*.dm_iqd` that are stored in a directory of the user's choice.

To set the default directory, use the command `MMEMory:CDIR`. To access the files in this directory, you only have to give the file name, without the path and the file extension.

Parameters:

<DSelect>   string

Example: `SOURce1:BB:GPS:NAVigation:DATA DLIS`
                        `SOURce1:BB:GPS:NAVigation:DATA:DLISt`
                        `"/var/user/temp/GNSS_list1"`
                        selects file "`GNSS_list1`" as the data source.
                        This file must be in the directory `/var/user/temp/` and have the file extension `*.dm_iqd`.

Manual operation: See "Data Source" on page 65

<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 65

<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 175.

Manual operation: See "System Time" on page 67

<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
	Increment: 1
<Month>	integer
	Range: 1 to 12
	Increment: 1
<Day>	integer
	Range: 1 to 31
	Increment: 1

Example: See example "Selecting Real Navigation Data" on page 175.

Manual operation: See "Date [dd.mm.yyyy]" on page 67

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

Defines the exact simulation start time in UTC time format.

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

Parameters:

<Hour>	integer
	Range: 0 to 23
	Increment: 1
<Minute>	integer
	Range: 0 to 59
	Increment: 1
<Second>	float
	Range: 0 to 59.999
	Increment: 0.001

Example: See example "Selecting Real Navigation Data" on page 175.

Manual operation: See "Time [hh:mm:ss:xxx]" on page 67

<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 point of time (WN_REF=0), that depends on the navigation standard.

Range: 0 to 9999.0*53
Increment: 1
*RST: 0

Example: See example "Selecting Real Navigation Data" on page 175.

Manual operation: See "Week Number" on page 67

\<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 175.

Manual operation: See "Time of Week (TOW)" on page 68

4.6 Obscuration and Auto Multipath

Example: Defining a full obscuration environment
The following example uses GPS entry standard.

```
// Selecting and enabling a full obscuration user defined environment
SOURce1:BB:GPS:OBSCuration:ENVironment FULL
SOURce1:BB:GPS:OBSCuration:TYPE USER
SOURce1:BB:GPS:OBSCuration:OBSCuration

// Defining a full obscuration area as a sequence of obscured zones
SOURce1:BB:GPS:OBSCuration:FULL:SCALe DISTance
SOURce1:BB:GPS:OBSCuration:FULL:AREA:COUNt 2
SOURce1:BB:GPS:OBSCuration:FULL:AREA1:REFerence 0.5
SOURce1:BB:GPS:OBSCuration:FULL:AREA1:LENGth 0.1
SOURce1:BB:GPS:OBSCuration:FULL:AREA2:REFerence 2.5
SOURce1:BB:GPS:OBSCuration:FULL:AREA2:LENGth 1
```

```
SOURce1:BB:GPS:OBSCuration:FULL:AREA:APPend
SOURce1:BB:GPS:OBSCuration:FULL:AREA:COUNt?
// Response: 3
SOURce1:BB:GPS:OBSCuration:FULL:AREA3:DELete
SOURce1:BB:GPS:OBSCuration:FULL:AREA:COUNt?
// Response: 2
SOURce1:BB:GPS:OBSCuration:FULL:AREA1:INSert
SOURce1:BB:GPS:OBSCuration:FULL:AREA2:REFerence 1.5
SOURce1:BB:GPS:OBSCuration:FULL:AREA2:LENGth 0.5
SOURce1:BB:GPS:OBSCuration:FULL:AREA:COUNt?
Response: 3

// Defining a full obscuration area as a zone pattern
SOURce1:BB:GPS:OBSCuration:FULL:SCALe TIME
SOURce1:BB:GPS:OBSCuration:FULL:RWINdow 1000
SOURce1:BB:GPS:OBSCuration:FULL:RWINdow:STATe ON
// the defined objects are repeated eacht 1000 s
```

Example: Selectng a vertical obscuration environment

The following example uses GPS entry standard.

```
SOURce1:BB:GPS:SMODe AUTO
// Selecting and enabling a vertical obscuration environment
SOURce1:BB:GPS:OBSCuration:ENVironment VOBS
SOURce1:BB:GPS:OBSCuration:TYPE URB1
SOURce1:BB:GPS:OBSCuration:OMPath
// Query the available obstacles files and loads one of them
SOURce1:BB:GPS:OBSCuration:VOBS:CATalog:PREDefined?
// Response: Urban_Canyon_1
MMEM:CDIR "/var/user/my_vobs"
SOURce1:BB:GPS:OBSCuration:VOBS:CATalog:USER?
// Response: canyon_2
SOURce1:BB:GPS:OBSCuration:VOBS:FILE "/var/user/my_vobs/canyon_2"
// defining the receiver position
SOURce1:BB:GPS:OBSCuration:VOBS:ROFFset:X 15
SOURce1:BB:GPS:OBSCuration:VOBS:ROFFset:Y 2
SOURce1:BB:GPS:OBSCuration:VOBS:ROFFset:HEIGht 0
```

Example: Defining a user defined ground and sea reflection

The following example uses GPS entry standard.

```
SOURce1:BB:GPS:SMODe AUTO
SOURce1:BB:GPS:VEHicle:TYPE AIRCraft
// Selecting and enabling a ground and sea reflection environment
SOURce1:BB:GPS:OBSCuration:ENVironment GSR
SOURce1:BB:GPS:OBSCuration:TYPE USER
SOURce1:BB:GPS:OBSCuration:OMPath
// Defining the material property parameters
SOURce1:BB:GPS:OBSCuration:GSP:STYPe USER
SOURce1:BB:GPS:OBSCuration:GSP:MPRoperty PERM
```

```
SOURce1:BB:GPS:OBSCuration:GSP:PERMittivity 10
SOURce1:BB:GPS:OBSCuration:GSP:CONDuctivity 1
// Defining the obstacles and the distance to them and to ground
SOURce1:BB:GPS:OBSCuration:GSP:GALTitude 0
SOURce1:BB:GPS:OBSCuration:GSP:O1Height 500
SOURce1:BB:GPS:OBSCuration:GSP:O2Height 1000
SOURce1:BB:GPS:OBSCuration:GSP:O1Distance 1000
SOURce1:BB:GPS:OBSCuration:GSP:O2Distance 1000
```

<subsystem>:OBSCuration:TYPE <Type>

Selects a predefined obscuration model or enables the configuration of the near environment and physical model.

Parameters:

<Type>   USER | CITY | SUB1 | URB1 | LTUNnel | MTUNnel | BR1 | BR2 | P1M | P10M | P1H | HIGHway | CUTTing

`USER` = User defined
`CITY` = City block
`SUB1` = Suburban area
`URB1` = Urban canyon
`LTUNnel|MTUNnel` = Long tunnel | Multiple tunnel
`BR1|BR2` = Bridge 1/2
`P1M|P10M|P1H` = Parking 1min/10min/1h
`HIGHway` = Highway
`CUTTing` = Cutting

*RST: USER

Example: see example "Defining a full obscuration environment" on page 178

Options: R&S SMBV-K101

Manual operation: See "Type" on page 73

<subsystem>:OBSCuration:ENVironment <Environment>

Selects a near environment model for obscuration & auto multipath.

Parameters:

<Environment>   LOS | VOBS | RPL | FULL | GSR

`LOS` = Line of Sight (LOS)
`VOBS` = Vertical Obstacles
`RPL` = Roadside Planes
`FULL` = Full Obscuration
`GSR` = Ground/Sea Reflection

*RST: LOS

Example: see example "Defining a full obscuration environment" on page 178

Options: R&S SMBV-K101

Manual operation: See "Near Environment" on page 74

<subsystem>:OBSCuration:PMODel <PhysicalModel>

Selects the physical effects to be simulated on the GNSS signal, i.e. obscuration only (`OBSCuration`) or obscuration and multipath propagation (`OMPath`).

Parameters:

<PhysicalModel>	OBSCuration | OMPath
	*RST: OMP

Example: see example "Defining a full obscuration environment" on page 178

Options: R&S SMBV-K101, OMPath requires R&S SMBV-K92

Manual operation: See "Physical Model" on page 75

<subsystem>:OBSCuration:VOBS:ROFFset:X <XOffset>
<subsystem>:OBSCuration:VOBS:ROFFset:Y <YOffset>
<subsystem>:OBSCuration:VOBS:ROFFset:HEIGht <HeightOffset>

Determines the start position of a receiver in terms of height and X/Y offset.

Parameters:

<XOffset>	float
	Range: -1500 to 1500
	Increment: 0.1
	*RST: 0
<YOffset>	float
	Range: -1500 to 1500
	Increment: 0.1
	*RST: 0
<HeightOffset>	float
	Range: 0 to 500
	Increment: 0.1
	*RST: 0

Example: see example "Selectng a vertical obscuration environment" on page 179

Options: R&S SMBV-K101

Manual operation: See "Receiver Offset" on page 77

<subsystem>:OBSCuration:VOBS:ROFFset:MORientation <MapOrientation>

Represents the map orientation.

Parameters:

<MapOrientation>	float
	Range: 0 to 359.99
	Increment: 0.01
	*RST: 0

Example: `SOURce1:BB:GPS:OBSCuration:VOBS:ROFFset:`
`MORientation 90`
OX orientation to the north

Options:	R&S SMBV-K101
Manual operation:	See "Map Orientation" on page 78

<subsystem>:OBSCuration:VOBS:CATalog:PREDefined?
<subsystem>:OBSCuration:RPL:CATalog:PREDefined?

Queries the names of the predefined files in the system directory.

Listed are only predefined obstacles description files (`*.rs_obst`) respectively road-side buildings description files (`*.rs_buil`).

Example:	see example "Selectng a vertical obscuration environment" on page 179
Usage:	Query only
Options:	R&S SMBV-K101
Manual operation:	See "Planes File" on page 81

<subsystem>:OBSCuration:VOBS:CATalog:USER?
<subsystem>:OBSCuration:RPL:CATalog:USER?

Queries the names of the user-defined files in the default directory. The default directory is set using command `MMEM:CDIRectory`

Listed are only obstacles description files (`*.rs_obst`) respectively roadside buildings description files (`*.rs_buil`).

Example:	see example "Selectng a vertical obscuration environment" on page 179
Usage:	Query only
Options:	R&S SMBV-K101
Manual operation:	See "Planes File" on page 81

<subsystem>:OBSCuration:VOBS:FILE <Filename>
<subsystem>:OBSCuration:RPL:FILE <Filename>

Loads the selected file.

Loaded are only obstacles description files (`*.rs_obst`) respectively roadside buildings description files (`*.rs_buil`).

Parameters:
<Filename>	string

Example:	see example "Selectng a vertical obscuration environment" on page 179
Options:	R&S SMBV-K101
Manual operation:	See "Planes File" on page 81

<subsystem>:OBSCuration:RPL:ROFFset:HEIGht <Heigth>

Sets the receiver height offset, i.e. the antenna altitude relative to the ground.

Parameters:

<Heigth>	float
	Range: 0 to 500
	Increment: 0.1
	*RST: 0

Example:	SOURce1:BB:GPS:OBSCuration:RPL:ROFFset:HEIGht 20
	SOURce1:BB:GPS:OBSCuration:RPL:ILENgth ON

Options: R&S SMBV-K101

Manual operation: See "Receiver Height Offset" on page 80

<subsystem>:OBSCuration:RPL:RWINdow <RepWindow>

Sets the repeating period (in km) of repeating objects.

Parameters:

<RepWindow>	float
	Range: 1E to 1E6
	Increment: 1E
	*RST: 10E3

Options: R&S SMBV-K101

Manual operation: See "Repetition Window" on page 80

<subsystem>:OBSCuration:RPL:RWINdow:STATe <State>

Enables the repetition of the defined objects.

Parameters:

<State>	0	1	OFF	ON
	*RST: OFF

Example:	SOURce1:BB:GPS:OBSCuration:RPL:RWINdow 10E3
	SOURce1:BB:GPS:OBSCuration:RPL:RWINdow:STATe ON
	The defined objects are repeated eacht 10km

Options: R&S SMBV-K101

Manual operation: See "Repetition Window" on page 80

<subsystem>:OBSCuration:RPL:ILENgth <State>

If enabled, assumes roadside planes with infinite width.

Parameters:

<State>	0	1	OFF	ON
	*RST:　　ON

Options:　　　　　　　R&S SMBV-K101

Manual operation:　　See "Set Length to Infinite" on page 80

<subsystem>:OBSCuration:FULL:SCALe <ReferenceScale>

Defines whether the obstacles' positions are defined as distance (in km) or as time (in s).

Parameters:

<ReferenceScale>	TIME	DISTance
	*RST:　　DIST

Example:　　　　　　see example "Defining a full obscuration environment"
on page 178

Options:　　　　　　　R&S SMBV-K101

Manual operation:　　See "Reference Scale" on page 83

<subsystem>:OBSCuration:FULL:RWINdow <RepWindow>

Sets the repeating period (in km or s) of repeating objects.

Parameters:

<RepWindow>	integer
	Range:　　0　to　1000
	*RST:　　　10

Example:　　　　　　see example "Defining a full obscuration environment"
on page 178

Options:　　　　　　　R&S SMBV-K101

Manual operation:　　See "Repetition Window" on page 83

<subsystem>:OBSCuration:FULL:RWINdow:STATe <State>

Enables the repetition of the defined objects.

Parameters:

<State>	0	1	OFF	ON
	*RST:　　　OFF

Example:　　　　　　see example "Defining a full obscuration environment"
on page 178

Options:　　　　　　　R&S SMBV-K101

Manual operation:　　See "Repetition Window" on page 83

<subsystem>:OBSCuration:FULL:AREA:COUNt?

Sets the number of the obscured area/zones.

Return values:

<AreasCount>	integer
	Range: 0 to 50
	Increment: 1
	*RST: 0

Example:	see example "Defining a full obscuration environment" on page 178
Usage:	Query only
Options:	R&S SMBV-K101
Manual operation:	See "Full Obscuration Configuration Table" on page 83

<subsystem>:OBSCuration:FULL:AREA:APPend
<subsystem>:OBSCuration:FULL:AREA<ch>:INSert
<subsystem>:OBSCuration:FULL:AREA<ch>:DELete

Appends/inserts or deletes an obscured zone.

Example:	see example "Defining a full obscuration environment" on page 178
Usage:	Event
Options:	R&S SMBV-K101
Manual operation:	See "Full Obscuration Configuration Table" on page 83

<subsystem>:OBSCuration:FULL:AREA<ch>:REFerence <Reference>

Defines the reference starting position (in km) or time stamp (in s) of a specific obscured zone.

Suffix:

<ch>	1 to 50
	Use the command `<subsystem>:OBSCuration:FULL:AREA:COUNt?` to define the number of the obsured zones.

Parameters:

<Reference>	float
	Range: 0 to 1E4
	Increment: 1E-3
	*RST: 0

Example:	see example "Defining a full obscuration environment" on page 178
Options:	R&S SMBV-K101

Manual operation: See "Full Obscuration Configuration Table" on page 83

<subsystem>:OBSCuration:FULL:AREA<ch>:LENGth <Length>

Length of the obscuring zone, defined in km or sec.

Parameters:
<Length>   float

                          Range: 1E-3 to 50
                          Increment: 1E-3
                          *RST: 0.1

Example: see example "Defining a full obscuration environment"
                          on page 178

Options: R&S SMBV-K101

Manual operation: See "Full Obscuration Configuration Table" on page 83

<subsystem>:OBSCuration:GSR:MPRoperty <MaterialPropert>

Define whether the material is defined by its permittivity or power loss characteristic.

Parameters:
<MaterialPropert>   PLOSS | PERM

                          *RST: PERM

Example: see example "Defining a user defined ground and sea reflection"
                          on page 179

Options: R&S SMBV-K101

Manual operation: See "Material Property" on page 84

<subsystem>:OBSCuration:GSR:STYPe <SurfaceType>

Describes the surface.

Parameters:
<SurfaceType>   SEA | WATER | WET | MDRY | DRY | USER

                          *RST: USER

Example: see example "Defining a user defined ground and sea reflection"
                          on page 179

Options: R&S SMBV-K101

Manual operation: See "Surface Type" on page 85

<subsystem>:OBSCuration:GSR:PERMittivity <Permittyvity>

Sets the surface permittivity.

Parameters:

<Permittyvity>	float		
	Range:	1 to 100	
	Increment:	0.1	
	*RST:	10	

Example: see example "Defining a user defined ground and sea reflection" on page 179

Options: R&S SMBV-K101

Manual operation: See "Ground Permittivity/Conductivity, Power Loss" on page 85

<subsystem>:OBSCuration:GSR:CONDuctivity <Conductivity>

Sets the surface conductivity.

Parameters:

<Conductivity>	float		
	Range:	1E-6 to 20	
	Increment:	1E-6	
	*RST:	1	

Example: see example "Defining a user defined ground and sea reflection" on page 179

Options: R&S SMBV-K101

Manual operation: See "Ground Permittivity/Conductivity, Power Loss" on page 85

<subsystem>:OBSCuration:GSR:PLOSs <PowerLoss>

Sets the surface power loss.

Parameters:

<PowerLoss>	integer		
	Range:	0 to 20	
	*RST:	5	

Example: see example "Defining a user defined ground and sea reflection" on page 179

Options: R&S SMBV-K101

Manual operation: See "Ground Permittivity/Conductivity, Power Loss" on page 85

<subsystem>:OBSCuration:GSR:O1Distance <Distance>
<subsystem>:OBSCuration:GSR:O2Distance <Distance>

Sets the distance between the receiver and the obstacles.

Parameters:

<Distance>	float
	Range: 0 to 1000
	Increment: 0.1
	*RST: 150

Example:	see example "Defining a user defined ground and sea reflection" on page 179
Options:	R&S SMBV-K101
Manual operation:	See "h1/h2, d1/d2" on page 85

<subsystem>:OBSCuration:GSR:O1Height <Height>
<subsystem>:OBSCuration:GSR:O2Height <Height>

Determines the height of the left/right obstacle.

Parameters:

<Height>	float
	Range: 0 to 10000
	Increment: 0.1
	*RST: 100

Example:	see example "Defining a user defined ground and sea reflection" on page 179
Options:	R&S SMBV-K101
Manual operation:	See "h1/h2, d1/d2" on page 85

<subsystem>:OBSCuration:GSR:GALTitude <GroundAltitude>

Sets the altitude of the receiver according to the WGS84 geodetic system.

Parameters:

<GroundAltitude>	float
	Range: 0 to 10000
	Increment: 0.1
	*RST: 0

Example:	see example "Defining a user defined ground and sea reflection" on page 179
Options:	R&S SMBV-K101
Manual operation:	See "Ground Altitude" on page 85

<subsystem>:OBSCuration:GSR:OORientation <Orientation>

Sets the obstacle orientation.

Parameters:

<Orientation>	float

	Range:	0 to 359.99
	Increment:	0.01
	*RST:	0

Options: R&S SMBV-K101

Manual operation: See "Obstacle Orientation" on page 85

4.7 Hardware in the Loop (HIL)

<subsystem>:RT:HILPosition:MODE:A <ElapsedTime>, <X>, <Y>, <Z>, <XDot>,
    <YDot>, <ZDot>, <XDotDot>, <YDotDot>, <ZDotDot>, <XDotDotDot>,
    <YDotDotDot>, <ZDotDotDot>, <Yaw>, <Pitch>, <Roll>, <YawDot>, <PitchDot>,
    <RollDot>, <YawDotDot>, <PitchDotDot>, <RollDotDot>, <YawDotDotDot>,
    <PitchDotDotDot>, <RollDotDotDot>

Sets hardware in loop position of third order ECEF dynamics and attitude.

The yaw/heading, pitch/elevation, roll/bank rotation angles and their derivatives are
obtained by rotating the body (XYZ) frame starting from an aligned state with the local
NED frame by a sequence of three consecutive Euler rotations about z axis then y axis
and then x axis.

The attitude parameters `Yaw, Pitch, Roll, RDot` etc. are optional

Table 4-5: Parameter description

Parameter	Description	Default unit
<X>,<Y>,<Z>	coordinate in the Earth Fixed Earth Centered (ECEF) coordinate system	m
<XDot>,<YDot>,<ZDot>	(equivalently Vx, Vy,Vz) Velocity vector in ECEF	meter/second
<XDotDot>,<YDotDot>, <ZDotDot>	(equivalently Ax, Ay,Az) Acceleration vector in ECEF	meter/second^2
<XDotDotDot>, <YDotDotDot>, <ZDotDotDot>	(equivalently Jx, Jy,Jz) Jerk vector in ECEF	meters/second^3
[<Roll>,<Pitch>, <Yaw>]	attitude angles (yaw/heading, pitch/elevation, roll/bank) unlimited value range to simulate more that one cycle rotation between two updates	radians
[<RDot>,<PDot>, <YDot>]	attitude angular rate of change	rad/sec

Parameter	Description	Default unit
[<RDotDot>,<PDotDot>, <YDotDot>]	attitude angular second order derivative	rad/sec^2
[<RDotDotDot>, <PDotDotDot>, <YDotDotDot>]	attitude angular third order derivative	rad/sec^3

See also chapter 2.5.8, "Hardware in the Loop (HIL)", on page 29.

Parameters:

<ElapsedTime>　　　　　float

Elapsed time from the simulation start
For description of the other parameters, see table 4-5.

Range:　　　0 to 99999999

Usage:　　　　　　Setting only

Options:　　　　　R&S SMBV-K92 (motion only), R&S SMBV-K92/-K103 (motion +attitude)

<subsystem>:RT:HILPosition:MODE:B <ElapsedTime>, <Latitude>, <Longitude>, <Altitude>, <NDot>, <EDot>, <DDot>, <NDotDot>, <EDotDot>, <DDotDot>, <NDotDotDot>, <EDotDotDot>, <DDotDotDot>, <Yaw>, <Pitch>, <Roll>, <YawDot>, <PitchDot>, <RollDot>, <YawDotDot>, <PitchDotDot>, <RollDotDot>, <YawDotDotDot>, <PitchDotDotDot>, <RollDotDotDot>

Sets hardware in loop position of third order GEOD/NED dynamics and attitude.

The yaw/heading, pitch/elevation, roll/bank rotation angles and their derivatives are obtained by rotating the body (XYZ) frame starting from an aligned state with the local NED frame by a sequence of three consecutive Euler rotations about z axis then y axis and then x axis.

The attitude parameters `Yaw`, `Pitch`, `Roll`, `RDot` etc. are optional.

Table 4-6: Parameter description

Parameter	Description	Default unit
<Latitude>, <Longitude>, <Altitude>	Geodetic location	degrees
<NDot>,<EDot>,<DDot>	(equivalently Vn, Ve,Vd) Velocity vector in the North East Down (NED) coordinate system	meters/ second
<NDotDot>,<EDotDot>, <DDotDot>	(equivalently An, Ae,Ad) Acceleration vector in NED	meters/ second^2
<NDotDotDot>, <EDotDotDot>, <DDotDotDot>	(equivalently Jn, Je,Jd) Jerk vector in NED	meters/ second^3
[<Roll>,<Pitch>, <Yaw>]	attitude angles (yaw/heading, pitch/elevation, roll/bank) unlimited value range to simulate more that one cycle rotation between two updates	radians

Parameter	Description	Default unit
`[<RDot>,<PDot>, <YDot>]`	attitude angular rate of change	rad/sec
`[<RDotDot>,<PDotDot>, <YDotDot>]`	attitude angular second order derivative	rad/sec^2
`[<RDotDotDot>, <PDotDotDot>, <YDotDotDot>]`	attitude angular third order derivative	rad/sec^3

See also chapter 2.5.8, "Hardware in the Loop (HIL)", on page 29.

Parameters:

<ElapsedTime>   float

Elapsed time from the simulation start
For description of the other parameters, see table 4-6.

Range: 0 to 99999999

Usage: Setting only

Options: R&S SMBV-K92 (motion only), R&S SMBV-K92/-K103 (motion +attitude)

<subsystem>:RT:HILPosition:LATency?

Queries the time delay (or prediction latency) between the time specified with the parameter `<ElapsedTime>` in a HIL command (`<subsystem>:RT:HILPosition: MODE:A` or `<subsystem>:RT:HILPosition:MODE:B`) and the time this command is actually executed in the R&S SMBV.

You can use the determined value for latency calibration.

See also chapter 2.5.8, "Hardware in the Loop (HIL)", on page 29.

Return values:

<Latency>   float

Range: min to max
Increment: 0.001
*RST: 0

Example: `SOURce1:BB:GPS:RT:HILPosition:LATency?`

Usage: Query only

4.8 GNSS System Configuration

<subsystem>:HYBRid:<GNSS>[:STATe]
<subsystem>:HYBRid:BEIDou[:STATe] <State>
<subsystem>:HYBRid:GALileo[:STATe] <State>
<subsystem>:HYBRid:GLONass[:STATe] <State>
<subsystem>:HYBRid:GPS[:STATe] <State>

Defines the navigation standards that will be part of the hybrid configuration. Only the satellites of an enabled standard are configurable (see chapter 4.12, "Satellites Configuration and Satellites Signal Settings", on page 210).

Parameters:

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

Options: R&S SMBV-K44/K66/K94/K107

<subsystem>:UCRF <UseCentral_RF>

Use this command if several R&S SMBV instruments are connected to generate GNSS signal in the same GNSS band.

Parameters:

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

Manual operation: See "Use Common RF Frequency" on page 86

<subsystem>:UMGPs <State>

Enables the configuration of GPS signals modulates with P code, see <subsystem>: SATellite<st>:SIGNal.

Parameters:

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

Options: R&S SMBV-K93

Manual operation: See "Use Position Accuracy (P-Code) GPS" on page 87

<subsystem>:SATellite:ASPoofing <State>

Activates anti spoofing flag in the GPS navigation message.

Parameters:

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

Example: SOURce1:BB:GPS:SATellite:ASPoofing ON

Manual operation: See "GPS Anti-Spoofing" on page 87

4.9 Almanac/RINEX Configuration

Example: Selecting an Almanac file

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

```
SOURce1:BB:GPS:HYBRid:GALileo:STATe ON
SOURce1:BB:GPS:NAVigation:ALManac:GPS:FILE 'GPS_SEM585.txt'
SOURce1:BB:GPS:NAVigation:ALManac:GALileo:FILE 'GAL_Yuma585.txt'
SOURce1:BB:GPS:NAVigation:ALManac:GLONass:FILE 'GLO_585.agl'
SOURce1:BB:GPS:SVID:GPS:LIST?
//Response:2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,
// 28,29,30,31,32
SOURce1:BB:GPS:SVID:GALileo:LIST?
//Response:1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,
// 28,29,30
SOURce1:BB:GPS:SVID:GLONass:LIST?
//Response:1,2,5,8,9,10,11,12,13,15,16,17,18,19,20,21,22,23,24
```

Example: Configuring a RINEX file

The following examples use GPS entry standard.

```
SOURce1:BB:GPS:NAVigation:RINex:GPS:FILE
'/var/user/Lists/GNSS/GPS/Rinex/GPS_Week585_Day0.10n'
SOURce1:BB:GPS:NAVigation:RINex:GPS:IMPort
SOURce1:BB:GPS:NAVigation:RINex:GPS:UUAState
SOURce1:BB:GPS:NAVigation:RINex:GPS:STATe ON
```

> 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
<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.

For details see "Almanac Configuration" on page 87.

Parameters:

<Almanac>	string
	The file name is sufficient to select a predefined almanac file or almanacs in the default directory.
	The complete file path with file name and extension is required to select almanac files stored elsewhere
Example:	See example "Selecting an Almanac file" on page 194.

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

This setting is only available for GPS and Galileo satellites.

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
	Increment: 1
<Month>	integer
	Range: 1 to 12
	Increment: 1
<Day>	integer
	Range: 1 to 31
	Increment: 1
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?

This setting is only available for GPS and Galileo satellites.

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
	Increment: 1
<Month>	integer
	Range: 1 to 12
	Increment: 1
<Day>	integer
	Range: 1 to 31
	Increment: 1
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 198 and <subsystem>:NAVigation:ALManac:<GNSS>:TOAPplicability:WNUMber on page 198.

Return values:

<Year>	integer
	Range: 1996 to 9999
	Increment: 1
<Month>	integer
	Range: 1 to 12
	Increment: 1
<Day>	integer
	Range: 1 to 31
	Increment: 1
Example:	BB:GPS:NAV:ALM:GLON:TOAP:DATE?
	Response: 2010,11,07
Usage:	Query only
Manual operation:	See "Almanac Configuration" on page 87

<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 198 and `<subsystem>:NAVigation:ALManac:<GNSS>:TOAPplicability:WNUMber` on page 198.

Return values:

<Hour>	integer	
	Range:	0 to 23
	Increment:	1
<Minute>	integer	
	Range:	0 to 59
	Increment:	1
<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 87

<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?

This setting is only available for Galileo and GPS satellites.

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
	Increment: 1
	*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?

This setting is ony available for GPS and Galileo satellites.

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>:NAVigation:RINex:<GNSS>:FILE
<subsystem>:NAVigation:RINex:BEIDou:FILE <Filename>
<subsystem>:NAVigation:RINex:GALileo:FILE <Filename>
<subsystem>:NAVigation:RINex:GLONass:FILE <Filename>
<subsystem>:NAVigation:RINex:GPS:FILE <Filename>

Selects and activates one RINEX file per navigation standard. Perform
<subsystem>:NAVigation:RINex:IMPort to upload the selected file.

Parameters:

<Filename>	string

Example: See example "Configuring a RINEX file" on page 194.

Manual operation: See "RINEX Configuration" on page 88

<subsystem>:NAVigation:RINex:<GNSS>:STATe
<subsystem>:NAVigation:RINex:BEIDou:STATe <State>
<subsystem>:NAVigation:RINex:GALileo:STATe <State>

<subsystem>:NAVigation:RINex:GLONass:STATe <State>
<subsystem>:NAVigation:RINex:GPS:STATe <State>

Activates a RINEX configuration file previously selected (see `<subsystem>:`
`NAVigation:RINex:GPS:FILE`) and imported (see `<subsystem>:NAVigation:`
`RINex:IMPort`).

Parameters:

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

Example:	See example "Configuring a RINEX file" on page 194.
Manual operation:	See "RINEX Configuration" on page 88

<subsystem>:NAVigation:RINex:IMPort

Uploads the RINEX file selected by `<subsystem>:NAVigation:RINex:GPS:FILE`.

Example:	See example "Configuring a RINEX file" on page 194.
Usage:	Event
Manual operation:	See "RINEX Configuration" on page 88

<subsystem>:NAVigation:RINex:UUAState <State>

Synchronizes the time conversion and the atmospheric parameters to the correspond-
ing values retrieved from the RINEX file.

Parameters:

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

Example:	See example "Configuring a RINEX file" on page 194.
Manual operation:	See "RINEX Configuration" on page 88

<subsystem>:NAVigation:RINex:UFNState <State>

Updates the frequency number for Glonass satellites automatically at import of a
RINEX File.

Parameters:

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

Example:	BB:GPS:NAV:RIN:UFNS 1
Manual operation:	See "RINEX Configuration" on page 88

<subsystem>:SVID:<GNSS>: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 194.
Usage:	Query only

4.10 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
SOURce1:BB:GPS:NAVigation:TCONversion:LEAP:SLSTransition:STATe ON
SOURce1:BB:GPS:NAVigation:TCONversion:LEAP:SEConds?
//Response:15
SOURce1:BB:GPS:NAVigation:TCONversion:LEAP:DATE?
//Response: 2010,11,8
SOURce1:BB:GPS:NAVigation:TCONversion:LEAP:SIGN?
//Response: PLUS
```

<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>:SMODe` STATic or USER, defines the 1st order term of polynomial, A_1.

Parameters:

<AOne>	integer
	Range: -8388608 to 8388607
	Increment: 1
	*RST: 0

Example:	See example "Configuring the time conversion and leap seconds settings" on page 201.
Manual operation:	See "Time Conversion Parameters" on page 90

<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>:SMODe` STATic or USER, defines the constant term of polynomial, A_0.

Parameters:

<AZero>	integer
	Range: -2147483648 to 2147483647
	Increment: 1
	*RST: 0

Example:	See example "Configuring the time conversion and leap seconds settings" on page 201.
Manual operation:	See "Time Conversion Parameters" on page 90

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

Parameters:

<Tot>	integer
	Range: 0 to 255
	Increment: 1
	*RST: 0

Example:	See example "Configuring the time conversion and leap seconds settings" on page 201.
Manual operation:	See "Time Conversion Parameters" on page 90

<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>:SMODe` STATic or USER, defines the UTC data reference week number, WN_t.

Parameters:

<Wnot>	integer
	Range: 0 to 255
	Increment: 1
	*RST: 0

Example:	See example "Configuring the time conversion and leap seconds settings" on page 201.
Manual operation:	See "Time Conversion Parameters" on page 90

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

Defines the 1st order term of polynomial, A_1.

Parameters:

<A_1>	integer
	Range: -512 to 511
	Increment: 1
	*RST: 0

Options: R&S SMx/AMU-K294
R&S SMBV-K94

Manual operation: See "UTC-UTC(SU)" on page 91

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

Defines the constant term of polynomial, A_0.

Parameters:

<A_0>	integer
	Range: -1024 to 1023
	Increment: 1
	*RST: 0

Options: R&S SMx/AMU-K294
R&S SMBV-K94

Manual operation: See "UTC-UTC(SU)" on page 91

<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
	Increment: 1
<Month>	integer
	Range: 1 to 12
	Increment: 1
<Day>	integer
	Range: 1 to 31
	Increment: 1

Usage: Query only

Options: R&S SMx/AMU-K294
R&S SMBV-K94

Manual operation: See "UTC-UTC(SU)" on page 91

\<subsystem\>:NAVigation:TCONversion:LEAP:SLSTransition[:STATe] \<State\>

Enables/disables the simulation of the leap second transition.

Parameters:

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

Manual operation: See "Leap Second Configuration" on page 90

\<subsystem\>:NAVigation:TCONversion:LEAP:DATE \<Year\>, \<Month\>, \<Day\>

Defines the date of the next UTC time correction.

Parameters:

\<Year\>	integer
	Range: 1980 to 9999
	Increment: 1
\<Month\>	integer
	Range: 1 to 12
	Increment: 1
\<Day\>	integer
	Range: 1 to 31
	Increment: 1

Example: See example "Configuring the time conversion and leap seconds settings" on page 201.

Options: R&S SMBV-K92

Manual operation: See "Leap Second Configuration" on page 90

\<subsystem\>:NAVigation:TCONversion:LEAP:SEConds \<Seconds\>

Defines the currently used leap second.

Parameters:

\<Seconds\>	float
	Range: 0 to 50
	Increment: 1
	*RST: 15

Example: See example "Configuring the time conversion and leap seconds settings" on page 201.

Manual operation: See "Leap Second Configuration" on page 90

\<subsystem\>:NAVigation:TCONversion:LEAP:SIGN \<Sign\>

Defines whether one second is added to or subtracted from the current leap second value during synchronization.

Parameters:

<Sign>	PLUS | MINus
	*RST: PLUS

Example:	See example "Configuring the time conversion and leap seconds settings" on page 201.
Options:	R&S SMBV-K92
Manual operation:	See "Leap Second Configuration" on page 90

<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 201.
Usage:	Event
Manual operation:	See "Leap Second Configuration" on page 90

4.11 Static Multipath Configuration

> The multipath settings are enabled for instrument equipped with option GNSS Enhanced (R&S SMBV-K92).

Example: Configuring the multipath settings for SV ID#20

The following example uses GPS entry standard.

```
SOURce1:BB:GPS:PRESet
SOURce1:BB:GPS:SMOD USER
SOURce1:BB:GPS:SATellite:COUNt?
//Response: 8
SOURce1:BB:GPS:SATellite2:SVID?
//Response: 20
SOURce1:BB:GPS:SAT2:STAN?
//Response: GALileo
SOURce1:BB:GPS:SVID20:GALileoMPATh:TAP:COUNt 2
SOURce1:BB:GPS:SVID20:GALileoMPATh:TAP1:POWer -3
SOURce1:BB:GPS:SVID20:GALileoMPATh:TAP1:DSHift  100
SOURce1:BB:GPS:SVID20:GALileoMPATh:TAP1:CPHase 3.14
SOURce1:BB:GPS:SVID20:GALileoMPATh:TAP2:TSHift 1
SOURce1:BB:GPS:SVID20:GALileo:MPATh:TAP2:POWer -5
SOURce1:BB:GPS:SVID20:GALileo:MPATh:STATe ON
```

<subsystem>:SVID<ch>:<GNSS>:MPATh:STATe
<subsystem>:SVID<ch>:BEIDou:MPATh:STATe <State>
<subsystem>:SVID<ch>:GALileo:MPATh:STATe <State>
<subsystem>:SVID<ch>:GLONass:MPATh:STATe <State>
<subsystem>:SVID<ch>:GPS:MPATh:STATe <State>

Enables/disables the generation of multipath signals for the satellite with the specified
SV ID belonging to the specified GNSS standard. Settings made with the subsequent
`<subsystem>:SVID<ch>:<GNSS>:MPATh` commands are considered only if the
multipath configuration is enabled.

Parameters:

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

Example:	See example "Configuring the multipath settings for SV ID#20" on page 206.

Options:	R&S SMBV-K92

<subsystem>:SVID<ch>:<GNSS>:MPATh:TAP:COUNt
<subsystem>:SVID<ch>:BEIDou:MPATh:TAP:COUNt <Taps>
<subsystem>:SVID<ch>:GALileo:MPATh:TAP:COUNt <Taps>
<subsystem>:SVID<ch>:GLONass:MPATh:TAP:COUNt <Taps>
<subsystem>:SVID<ch>:GPS:MPATh:TAP:COUNt <Taps>

Sets the paths number. The value determines the number of rows available for config-uration.

For details see "Number of Taps" on page 129.

Parameters:

<Taps>	float	
	Range:	1 to 10
	Increment:	1
	*RST:	1

Example: See example "Configuring the multipath settings for SV ID#20" on page 206.

Options: R&S SMBV-K92

<subsystem>:SVID<ch>:<GNSS>:MPATh:TAP<us>:CPHase
<subsystem>:SVID<ch>:BEIDou:MPATh:TAP<us>:CPHase <Phase>
<subsystem>:SVID<ch>:GALileo:MPATh:TAP<us>:CPHase <Phase>
<subsystem>:SVID<ch>:GLONass:MPATh:TAP<us>:CPHase <Phase>
<subsystem>:SVID<ch>:GPS:MPATh:TAP<us>:CPHase <Phase>

Sets the carrier phase, used in case of multipath simulation.

Suffix:

<us>	1..10

Parameters:

<Phase>	float	
	Range:	0 to 6.28
	Increment:	0.01
	*RST:	0
	Default unit: rad	

Example: See example "Configuring the multipath settings for SV ID#20" on page 206.

Options: R&S SMBV-K92

<subsystem>:SVID<ch>:<GNSS>:MPATh:TAP<us>:DSHift
<subsystem>:SVID<ch>:BEIDou:MPATh:TAP<us>:DSHift <DopplerShift>
<subsystem>:SVID<ch>:GALileo:MPATh:TAP<us>:DSHift <DopplerShift>
<subsystem>:SVID<ch>:GLONass:MPATh:TAP<us>:DSHift <DopplerShift>
<subsystem>:SVID<ch>:GPS:MPATh:TAP<us>:DSHift <DopplerShift>

Defines the additional Doppler shift of the simulated signal of the satellite, used to sim-ulate multipath conditions.

Suffix:

<us>	1..10

Parameters:

<DopplerShift>   float

> Range: -10.0E3 to 10.0E3
> Increment: 0.01
> *RST: 0
> Default unit: Hz

Example: See example "Configuring the multipath settings for SV ID#20" on page 206.

Options: R&S SMBV-K92

<subsystem>:SVID<ch>:<GNSS>:MPATh:TAP<us>:POWer
<subsystem>:SVID<ch>:BEIDou:MPATh:TAP<us>:POWer <Power>
<subsystem>:SVID<ch>:GALileo:MPATh:TAP<us>:POWer <Power>
<subsystem>:SVID<ch>:GLONass:MPATh:TAP<us>:POWer <Power>
<subsystem>:SVID<ch>:GPS:MPATh:TAP<us>:POWer <Power>

Sets the additional power of the satellite in dB, used to simulate multipath conditions.

See chapter 3.6.1, "Power Configuration", on page 92 for information about the power calculation.

Suffix:

<us>	1..10

Parameters:

<Power>   float

> Range: -10 to 0
> Increment: 0.01
> *RST: 0
> Default unit: dB

Example: See example "Configuring the multipath settings for SV ID#20" on page 206 and example "Configuring the power settings " on page 221.

Options: R&S SMBV-K92

<subsystem>:SVID<ch>:<GNSS>:MPATh:TAP<us>:TSHift
<subsystem>:SVID<ch>:BEIDou:MPATh:TAP<us>:TSHift <TimeShift>
<subsystem>:SVID<ch>:GALileo:MPATh:TAP<us>:TSHift <TimeShift>
<subsystem>:SVID<ch>:GLONass:MPATh:TAP<us>:TSHift <TimeShift>
<subsystem>:SVID<ch>:GPS:MPATh:TAP<us>:TSHift <TimeShift>

Sets an additional delay of the selected satellite, used to simulate multipath conditions.

Suffix:

<us>	1..10

Parameters:

<TimeShift>	float
	Range: 0 to 9.99999
	Increment: 0.00001
	*RST: 0
	Default unit: Chips
Example:	See example "Configuring the multipath settings for SV ID#20" on page 206.
Options:	R&S SMBV-K92

4.12 Satellites Configuration and Satellites Signal Settings

Configurations with more than 6 satellites require option R&S SMBV-K91, more than 12 satelites require option R&S SMBV-K96.

Example: Configuring the satellite's constellation

The following example uses GPS entry standard.

```
SOURce1:BB:GPS:PRESet
SOURce1:BB:GPS:SMODe USER

// enable hybrid GNSS configuration
SOURce1:BB:GPS:HYBRid:GPS:STATe ON
SOURce1:BB:GPS:HYBRid:GALileo:STATe ON
SOURce1:BB:GPS:HYBRid:GLONass:STATe ON
SOURce1:BB:GPS:HYBRid:BEIDou:STATe ON

SOURce1:BB:GPS:PRFL

SOURce1:BB:GPS:SEMask 7.5
SOURce1:BB:GPS:SATellite:COUNt 8

SOURce1:BB:GPS:SATellite:GRTP ON
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:DURation?
//Response: 13329
SOURce1:BB:GPS:SATellite1:PRANge?
```

```
//Response: 20531267.5147461
SOURce1:BB:GPS:SATellite1:PRBias 0
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:SATellite5:STANdard?
//Response: BEID
SOURce1:BB:GPS:SATellite5:SIGNal?
//Response: B1C
SOURce1:BB:GPS:SATellite5:SVID?
//Response: 33
SOURce1:BB:GPS:SATellite5:ORBit?
//Response: MEO

SOURce1:BB:GPS:SATellite7:STANdard?
//Response: GLON
SOURce1:BB:GPS:SATellite7:SIGNal?
//Response: RCA
SOURce1:BB:GPS:SATellite7:SVID?
//Response: 14
SOURce1:BB:GPS:SATellite7:FNUMber?
//Response: -7
SOURce1:BB:GPS:SATellite7:SCRate?
//Response: 511000

SOURce1:BB:GPS:STATe ON
SOURce1:BB:GPS:HDOP?
//Response: 1.12895407129922
SOURce1:BB:GPS:PDOP?
//Response: 2.15878433755758
```

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

Activates/deactivates spreading. When spreading is deactivated the pure navigation data is modulated onto the RF carrier.

This setting is only available for `<subsystem>:SMODe`STATic.

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 100

<subsystem>:SEMask <SEMask>

For `<subsystem>:SMODe` AUTO or USER, sets the satellite's elevation mask.

Parameters:

<SEMask>	float
	Range: 2.5 to 10.0 *RST: 5

Example:	See example "Configuring the satellite's constellation" on page 210.

Manual operation:	See "Elevation Mask" on page 101

<subsystem>:HDOP?

For `<subsystem>:SMODe` AUTO or USER, queries the HDOP (Horizontal Dilution of Precision) of the selected satellite constellation at the beginning of the simulation.

Return values:

<Hdop>	float
	Increment: 0.01
Example:	See example "Configuring the satellite's constellation" on page 210.
Usage:	Query only
Manual operation:	See "Initial HDOP/PDOP" on page 101

<subsystem>:PDOP?

For `<subsystem>:SMODe` AUTO or USER, queries the PDOP (Position Dilution of Precision) of the selected satellite constellation at the beginning of the simulation.

Return values:

<PDop>	float
	Increment: 0.01
	*RST: 0
Example:	See example "Configuring the satellite's constellation" on page 210.
Usage:	Query only
Manual operation:	See "Initial HDOP/PDOP" on page 101

<subsystem>:GALModulation <Modulation>

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

BOC(1,1) modulation can be set with Galileo instead of CBOC(6,1) to reduce the sample rate required to simulate a certain period of time.

Parameters:

<Modulation>	BOC | CBOC
	*RST: CBOC
Manual operation:	See "Galileo Sat. Modulation" on page 100

<subsystem>:GOConstellation

Retrieves an optimal satellite constellation for the selected Almanac/RINEX file, elevation mask and the enabled maximum number of satellites.

Usage:	Event
Manual operation:	See "Get Optimal Constellation" on page 102

<subsystem>:SATellite:GRTProjection <Glb_RT_proj>

Forces ephemeris projection for all satellites, i.e. performs the same action as the command `<subsystem>:SVID<ch>:<GNSS>:NMESsage:RTPRojection`.

Parameters:

<Glb_RT_proj>   0 | 1 | OFF | ON

                       *RST: 0

Example: See example "Configuring the satellite's constellation"
                       on page 210.

Manual operation: See "Global Ephemeris Real-Time Projection" on page 102

<subsystem>:SATellite:COUNt <SatCount>

Defines the maximum number of satellites that can be simulated. The minimum allowed number depends on the selected simulation mode (see `<subsystem>:SMODe` on page 160) .

Configurations with one satellite are allowed only for `<subsystem>:SMODeSTATic`. For `<subsystem>:SMODeAUTO` or `USER`, four satellites or more are required.

Note: Generating the navigation signal with more than 6 satellites is enabled only for instruments equipped with option R&S SMBV-K91; more than 12 satellites require option R&S SMBV-K96.

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

Parameters:

<SatCount>   integer

                       Range: 1 to 24
                       Increment: 1
                       *RST: 1

Example: See example "Configuring the satellite's constellation"
                       on page 210.

Options: R&S SMBV-K91 (more than 6 satellites)
                       R&S SMBV-K96 (more than 12 satellites)

Manual operation: See "Maximum Number of Satellites" on page 103

<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 210.

Usage:	Query only
Manual operation:	See "Resulting Start Chip Rate" on page 109

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

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

Parameters:

<DopplerShift>	float	
	Range:	-100.0e3 to 100.0e3
	Increment:	0.01
	*RST:	0
	Default unit: Hz	

Example:	See example "Configuring the satellite's constellation" on page 210.
Manual operation:	See "Doppler Shift" on page 108

<subsystem>:SATellite<st>:DURation?

Queries the time the satellite's elevation is higher than 2.5, 5, 7.5 or 10° starting at the first simulation moment of the satellite of interest, as selected with the command `<subsystem>:SEMask`.

Return values:

<Duration>	float
	Default unit: s

Example:	See example "Configuring the satellite's constellation" on page 210.
Usage:	Query only
Manual operation:	See "Duration (Elev. > 2.5/5/7.5/10°)" on page 106

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

The command sets or queries the frequency number, depending on the used data source. The parameter corresponds to the sub-carrier used to modulate the GLONASS satellite.

Parameters:

<FrequencyNumber>	integer	
	Range:	-7 to 24
	Increment:	1
	*RST:	0

Manual operation:	See "Frequency Number" on page 105

<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 210.

Usage: Query only

Manual operation: See "Resulting Start Frequency" on page 108

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

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

Parameters:

<Code>	float	
	Range:	0 to 20459.99
	Increment:	0.01
	*RST:	0

Manual operation: See "Initial Code Phase" on page 107

<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 210.

Manual operation: See "Initial Carrier Phase " on page 108

<subsystem>:SATellite<st>:PCRate?

Queries the currently valid values for the chip rate of the P-code.

Return values:

<PCRate>	float

Usage: Query only

Options:	R&S SMBV-K93
Manual operation:	See "Resulting P-Code Chip Rate" on page 109

<subsystem>:SATellite<st>:MODulation <Modulation>

Defines the modulation used for modulating the carrier signal.

Parameters:

<Modulation>	BPSK | CBOC
	*RST: BPSK
Example:	See example "Configuring the satellite's constellation" on page 210.
Manual operation:	See "Modulation" on page 106

<subsystem>:SATellite<st>:ORBit <OrbitType>

(enabled for BeiDou satellites only)

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

Parameters:

<OrbitType>	MEO | IGSO | GEO
	*RST: GEO
Example:	See example "Configuring the satellite's constellation" on page 210.
Manual operation:	See "Orbit Type" on page 106

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

For `<subsystem>:SMODe` STATic, 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 210.
Manual operation:	See "Pseudorange" on page 107

<subsystem>:SATellite<st>:PRBias <PseudorangeBias>

Sets a bias to the pseudorange of a satellite (see also `<subsystem>: SATellite<st>:PRANge` on page 217).

This setting is only available for `<subsystem>:SMODe`AUTO or USER.

Parameters:

<PseudorangeBias>	float
	Range: -1000 to 1000
	Increment: 0.001
	*RST: 0
	Default unit: m

Example:	See example "Configuring the satellite's constellation" on page 210.
Manual operation:	See "Pseudorange Bias" on page 107

<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 210.
Usage:	Query only
Manual operation:	See "Standard Chip Rate" on page 105

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

Selects the type of signal the corresponding satellite is using.

Enabled `<subsystem>:UMGPs` is prerequisites for using P codes.

Parameters:

<Signal>	CACode | PCODe | CAPQ | CAPI | E1Def | RCA | B1CA
	*RST: CACode

Example:	See example "Configuring the satellite's constellation" on page 210.
Manual operation:	See "Signal(s)" on page 103

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

Selects the navigation standard the corresponding satellite belongs to.

The available GNSS standards depend on the selected hybrid GNSS configuration and the installed options.

Parameters:

<Standard>	GPS	GALileo	GLONass	BEIDou
	*RST: GPS

Example:	See example "Configuring the satellite's constellation" on page 210.

Manual operation:	See "Standard" on page 103

<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 210.

Manual operation:	See "Satellite State" on page 103

<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.

SV ID set to -1 corresponds to the manual selection "N.A. (not assigned)". It is not allowed to assign the same SV ID to more than one satellite of one GNSS standard. Hence, the selection N.A. can be used to exchange the assigned SV ID to different satellites belonging to the same standard.

Parameters:

<Svid>	integer	
	Range:	1 to 40
	Increment:	1
	*RST:	1

Example:	See example "Configuring the satellite's constellation" on page 210.

Manual operation:	See "SV-ID" on page 104

<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 210.

Manual operation: See "Time Shift/ chips" on page 108

4.13 Global Signal Configuration

<subsystem>:SVID:SIGNal:COUPling <State>

Enables the configuration of all SV IDs simultaneously. Current settings are overwritten.

Parameters:

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

Manual operation: See "SV ID Signal Coupling" on page 110

<subsystem>:SVID<ch>:<GNSS>:SIGNal
<subsystem>:SVID<ch>:BEIDou:SIGNal <Signal>
<subsystem>:SVID<ch>:GALileo:SIGNal <Signal>
<subsystem>:SVID<ch>:GLONass:SIGNal <Signal>
<subsystem>:SVID<ch>:GPS:SIGNal <Signal>

Sets the type of signal a SV ID will use in the moment the corresponding satellite becomes visible.

Parameters:

<Signal>   CACode | PCODe | CAPQ | CAPI | E1Def | RCA | B1CA

GPS signals: CACode|PCODe|CAPQ|CAPI
Galileo signals: E1Def
GLONASS signals: RCA
BeiDou signals: B1CA
*RST: CACode

Options: R&S SMBV-K93

<subsystem>:SVID<ch>:<GNSS>:POWer
<subsystem>:SVID<ch>:BEIDou:POWer <Power>
<subsystem>:SVID<ch>:GALileo:POWer <Power>

<subsystem>:SVID<ch>:GLONass:POWer <Power>
<subsystem>:SVID<ch>:GPS:POWer <Power>

Sets the power a SV ID will use the moment the corresponding satellite becomes visible and is simulated.

Parameters:

<Power>	float	
	Range:	-21 to 0
	Increment:	0.01
	*RST:	0

Options: R&S SMBV-K93

4.14 Power Tuning and Power Settings

Example: Configuring the power settings

The following example uses GPS entry standard and specifies a reference satellite.

```
SOURce1:BB:GPS:PRESet
SOURce1:BB:GPS:SMODe USER
SOURce1:BB:GPS:HYBRid:GALileo:STATe ON
SOURce1:BB:GPS:SATellite:COUNt 8
SOURce1:BB:GPS:GOConstellation
SOURce1:BB:GPS:SATellite2:STANdard?
//Response: GALileo
SOURce1:BB:GPS:SATellite2:SVID?
//Response: 23
SOURce1:BB:GPS:SVID23:GALileo:MPATh:TAP:COUNt 2
SOURce1:BB:GPS:SVID23:GALileo:MPATh:TAP1:POWer -3
SOURce1:BB:GPS:SVID23:GALileo:MPATh:TAP2:POWer -5
SOURce1:BB:GPS:SVID23:GALileo:MPATh:STATe ON
SOURce1:BB:GPS:SATellite2:STATe ON
SOURce1:BB:GPS:POWer:MODE AUTO
SOURce1:BB:GPS:POWer:REFerence:SAT 1
SOURce1:BB:GPS:POWer:REFerence:STANdard?
//Response: GPS
SOURce1:BB:GPS:POWer:REFerence:SIGNal?
//Response: CACode
SOURce1:BB:GPS:POWer:REFerence:DIStance?
//Response: 20720
SOURce1:BB:GPS:POWer:REFerence:POWer -115
SOURce1:BB:GPS:POWer:INTer:PZERo
SOURce1:BB:GPS:STATe ON
SOURce1:BB:GPS:SATellite2:POWer?

SOURce1:BB:GPS:POWer:INTer:PSTandard
SOURce1:BB:GPS:POWer:INTer:CAE1Def?
```

```
//Response: -1.25
SOURce1:BB:GPS:SATellite2:POWer?

SOURce1:BB:GPS:POWer -110
SOURce1:BB:GPS:POWer:TOTal?
```

<subsystem>:POWer:MODE <Mode>

Determines whether the power is calculated automatically or is based on user defined settings.

Parameters:

<Mode>	USER | AUTO
	USER
	Manual power configuration per satellite
	AUTO
	Automatic power calculation, based on the satellite-to-receiver distance and relative to the relative power of the reference satellite (`<subsystem>:POWer:REFerence:SATellite`).
	*RST: USER

Example: See example "Configuring the power settings " on page 221.

Manual operation: See "Power Mode" on page 98

<subsystem>:POWer:REFerence[:POWer] <ReferencePower>

Sets the power level that is used as a reference for the calculation of the power level of the satellites.

Parameters:

<ReferencePower>	float

Range: -145 to 20
Increment: 0.01
*RST: -30
Default unit: dBm

Example: See example "Configuring the power settings " on page 221.

Manual operation: See "Reference Power" on page 99

<subsystem>:POWer:REFerence:SATellite <Sat>

Sets the satellite used as a reference for the calculation of the power levels of the satellites in auto power mode.

Value -1 corresponds to N.A.

Parameters:

<Sat>	integer

Range: 1 to 24
Increment: 1
*RST: 1

Example: See example "Configuring the power settings " on page 221.

Manual operation: See "Reference Satellite" on page 99

<subsystem>:POWer:REFerence:STANdard <Standard>

Queries/sets the reference standard.

Parameters:

<Standard>	GPS | GALileo | GLONass | BEIDou
	*RST: GPS

Example: See example "Configuring the power settings " on page 221.

Manual operation: See "Reference Standard" on page 100

<subsystem>:POWer:REFerence:SIGNal?

Queries the signal component of the current reference satellite used as reference for the power calculation.

Return values:

<SignalType>	CACode | PCODe | CAPQ | CAPI | E1Def | RCA | B1CA
	*RST: CACode

Example: See example "Configuring the power settings " on page 221.

Usage: Query only

Manual operation: See "Reference Signal/ Reference Orbital Distance" on page 100

<subsystem>:POWer:REFerence:DISTance?

Queries the pseudorange of the reference satellite at the beginning of the simulation (t=t0).

Return values:

<Distance> float

Range: 0 to (0.2*SPEED_OF_LIGHT)
Increment: 1E3
*RST: 0

Example: See example "Configuring the power settings " on page 221.

Usage: Query only

Manual operation: See "Reference Signal/ Reference Orbital Distance" on page 100

<subsystem>:SATellite<st>:POWer <Power>

Sets/queries the power offset of the satellite in dB. The offset determines the power ratio of the activated satellites.

This setting command is only available for `<subsystem>:SMODe`USER.

See chapter 3.6.1, "Power Configuration", on page 92 for information about the power calculation.

Parameters:

<Power> float

Range: -20 to 20 dB (for the query command) / 0 dB (for the settings command)
Increment: 0.01
*RST: 0

Example: See example "Configuring the power settings " on page 221.

Manual operation: See "Power" on page 105

<subsystem>:SATellite<st>:POWer:RSIGnal? <RefSignal>

For mixed signals like "C/A+P", queries the signal used as a reference by power calculation.

The power reference is fixed to "C/A" for mixed signals. For signals modulated only with the P code, the power reference is "P".

Parameters:

<RefSignal> CA | P

*RST: CA

Usage: Query only

Options: R&S SMBV-K93

Manual operation: See "Power Reference" on page 106

<subsystem>:POWer:TOTal?

Queries the total power of the GNSS signal.

Return values:
<Power>   float

Range: -145 to 30
Increment: 0.01
*RST: 0
Default unit: dBm

Example: See example "Configuring the power settings " on page 221.

Usage: Query only

Manual operation: See "Total Power" on page 100

<subsystem>:POWer:INTer:PZERo

Sets the Inter-Standard Power relations to 0 dB.

Example: See example "Configuring the power settings " on page 221.

Usage: Event

Manual operation: See "Set to 0" on page 115

<subsystem>:POWer:INTer:PSTandard

Sets the power relation between the signals belonging to the different navigation standard according to the relation determined in the specifications.

Example: See example "Configuring the power settings " on page 221.

Usage: Event

Manual operation: See "Set to Standard" on page 115

<subsystem>:POWer:INTer:CABCAGeo <CaToGeo>
<subsystem>:POWer:INTer:CABCAIgso <CaToIgso>
<subsystem>:POWer:INTer:CABCAMeo <CaToBdsMeo>
<subsystem>:POWer:INTer:CAE1Def <CaToE1def>
<subsystem>:POWer:INTer:CARCA <CaToRca>

Sets the power relation between the signals belonging to the different navigation standards. The power level of the GPS signal C/A is used as reference.

Parameters:

<CaToRca>	float	
	Range:	0 to 6
	Increment:	0.01
	*RST:	3.03
	Default unit: dB	

<CaToE1def>	float	
	Range:	-6 to 0
	Increment:	0.01
	*RST:	-1.5
	Default unit: dB	

<CaToGeo>, <CaToIgso>, <CaToBdsMeo>	float	
	Range:	0 to 6
	Increment:	0.01
	*RST:	4.5
	Default unit: dB	

Example: See example "Configuring the power settings " on page 221.

Manual operation: See "GPS C/A-GALILEO E1-DEF, GPS C/A-GLONASS R-C/A, GPS C/A-BeiDou (GEO/MEO/IGSO) B-C/A" on page 115

<subsystem>:POWer:INTRa:GPS:PZERo

Sets the power relations between the signal components to 0 dB.

Usage: Event

Options: R&S SMBV-K93

Manual operation: See "Set to 0" on page 114

<subsystem>:POWer:INTRa:GPS:PSTandard

Sets the power relation between the signals belonging to the same navigation standard according to the relation determined in the specifications.

Usage: Event

Options: R&S SMBV-K93

Manual operation: See "Set to Standard" on page 114

<subsystem>:POWer:INTRa:GPS:CAP <CA_P>

Sets the power relation between the signals belonging to the same navigation standard.

Parameters:

<CA_P>   float

                         Range: 0 to 6
                         Increment: 0.01
                         *RST: 3

Manual operation: See "C/A-P" on page 114

4.15 Navigation Message Configuration

<subsystem>:SVID<ch>:<GNSS>:NMESsage:PAGE:COUNt
<subsystem>:SVID<ch>:BEIDou:NMESsage:PAGE:COUNt <NumberOfPages>
<subsystem>:SVID<ch>:GALileo:NMESsage:PAGE:COUNt <NumberOfPages>
<subsystem>:SVID<ch>:GLONass:NMESsage:PAGE:COUNt <NumberOfPages>
<subsystem>:SVID<ch>:GPS:NMESsage:PAGE:COUNt <NumberOfPages>

Number of navigation pages. Several navigation pages are available per satellite.

If a RINEX file is used, the value of this parameter is retrieved from the file. A RINEX file may contain ephemeris information for up to 24 hours. Since the ephemeris are updated every two hours, the RINEX file contains a maximum number of 12 navigation pages.

This setting is only available for <subsystem>:SMODeUSER.

Parameters:

<NumberOfPages>	float
	Range: 1 to 12
	Increment: 1
	*RST: 1
Options:	R&S SMBV-K65

<subsystem>:SVID<ch>:<GNSS>:NMESsage:PRESet
<subsystem>:SVID<ch>:BEIDou:NMESsage:PRESet
<subsystem>:SVID<ch>:GALileo:NMESsage:PRESet
<subsystem>:SVID<ch>:GLONass:NMESsage:PRESet
<subsystem>:SVID<ch>:GPS:NMESsage:PRESet

The navigation message's parameters are calculated according to the selected almanac.

This setting is only available for <subsystem>:SMODeUSER.

Usage: Event

<subsystem>:SVID<ch>:<GNSS>:NMESsage:PROJect
<subsystem>:SVID<ch>:BEIDou:NMESsage:PROJect
<subsystem>:SVID<ch>:GALileo:NMESsage:PROJect

<subsystem>:SVID<ch>:GLONass:NMESsage:PROJect
<subsystem>:SVID<ch>:GPS:NMESsage:PROJect

Triggers the projection of the parameters of the navigation message. The values of the TOE and TOC are calculated according to the selected current simulation time (for "System Time > UTC").

For details see "Project Navigation Message" on page 119

This setting is only available for `<subsystem>:SMODe`USER.

Usage: Event

<subsystem>:SVID<ch>:<GNSS>:NMESsage:RTPRojection
<subsystem>:SVID<ch>:BEIDou:NMESsage:RTPRojection <State>
<subsystem>:SVID<ch>:GALileo:NMESsage:RTPRojection <State>
<subsystem>:SVID<ch>:GLONass:NMESsage:RTPRojection <State>
<subsystem>:SVID<ch>:GPS:NMESsage:RTPRojection <State>

Enables the instrument to internally perform a projection of the navigation message whenever this message is approaching its validity limit.

For details see "Real-Time Projection" on page 118.

This setting is only available for `<subsystem>:SMODe` USER and `<subsystem>:SATellite:GRTProjection` OFF.

Parameters:

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

Options: R&S SMBV-K65

<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 $2^{23}-1$

              Increment: 1
              *RST: 0

<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:CCORection:TGD
<subsystem>:SVID<ch>:BEIDou:NMESsage[:PAGE<us>]:CCORrection:TGD
    <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
	Increment: 1
	*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. As this parameter affects the satellite's orbit, the value selected here also has an impact on the satellite's parameters "Time Shift", "Doppler Shift" and "Duration (Elevation>2.5/5/7.5/10°)" (see <subsystem>: SATellite<st>:TSHift on page 219, <subsystem>:SATellite<st>:DSHift on page 215, <subsystem>:SATellite<st>:DURation? on page 215).

This setting is only available for <subsystem>:SMODeUSER.

Parameters:

<Toc>	integer
	GPS parameter
	Range: 0 to 65535
	Increment: 1
	*RST: 0
<Toc>	integer
	BeiDou parameter
	Range: 0 to 131071
	Increment: 1
	*RST: 0

Options: R&S SMBV-K65

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

Age of Data Offset

Parameters:

<Aodo>   integer

                              Range: 0 to 31
                              Increment: 1
                              *RST: 0

Manual operation: See "GPS Ephemeris Parameters" on page 121

<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
                              Increment: 1
                              *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
                              Increment: 1
                              *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 Ephemeris Parameters" on page 121

\<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
                             Increment: 1
                             *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
                             Increment: 1
                             *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
                          Increment: 1
                          *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
                          Increment: 1
                          *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
                          Increment: 1
                          *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 Ephemeris Parameters" on page 121

<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)
                          Increment: 1
                          *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
                          Increment: 1
                          *RST: 0

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

Issue Of Data (Almanacs)

Parameters:

<Ioda>   integer

                          Range: 0 to 15
                          Increment: 1
                          *RST: 0

Manual operation: See "Galileo Ephemeris Parameters" on page 122

<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:

<lodc>   integer

                        Range: 0 to 1023 (for GPS), 31 (for BeiDou)
                        Increment: 1
                        *RST: 0

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

Issue of Data, Ephemeris

Parameters:

<lode>   integer

                        Range: 0 to 255 (for GPS), 31 (for BeiDou)
                        Increment: 1
                        *RST: 0

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

Issue Of Data (Ephemeris and Clock correction)

Parameters:

<lodnav>   integer

                        Range: 0 to 1023
                        Increment: 1
                        *RST: 0

Manual operation: See "Galileo Ephemeris Parameters" on page 122

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

Inclination Angle at Reference Time

Parameters:

<lzero>   integer

                        Range: -2147483648 to 2147483647
                        Increment: 1
                        *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 really transmitted on the satel-
lite's carrier L2 or not.

Parameters:

\<LtpData\>   0 | 1 | OFF | ON

                            *RST: 0

Manual operation: See "GPS Ephemeris Parameters" on page 121

\<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
                            Increment: 1
                            *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
                            Increment: 1
                            *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
                        Increment: 1
                        *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
                        Increment: 1
                        *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
                        Increment: 1
                        *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
> Increment: 1
> *RST: 0

Manual operation: See "GPS Ephemeris Parameters" on page 121

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

Signal In Space Accuracy

Parameters:

<Sisa>   integer

> Range: 0 to 255
> Increment: 1
> *RST: 0

Manual operation: See "Galileo Ephemeris Parameters" on page 122

<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
> Increment: 1
> *RST: 100000

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

SV Configurations

Parameters:

<SvConfig>   integer

> Range: 0 to 15
> Increment: 1
> *RST: 0

Manual operation: See "GPS Ephemeris Parameters" on page 121

<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
                Increment: 1
                *RST: 0

<subsystem>:SVID<ch>:<GNSS>:NMESsage[:PAGE<us>]:EPHemeris: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
                Increment: 1
                *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} ... $2^{30}-1$
                Increment: 1
                *RST: 0

Manual operation: See "Galileo FNAV Parameters" on page 127

<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
                              Increment: 1
                              *RST: 0

Manual operation: See "Galileo FNAV Parameters" on page 127

<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
                              Increment: 1
                              *RST: 0

Manual operation: See "Galileo FNAV Parameters" on page 127

<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
                              Increment: 1
                              *RST: 0

Manual operation: See "Galileo FNAV Parameters" on page 127

<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
                              Increment: 1
                              *RST: 0

Manual operation: See "Galileo FNAV Parameters" on page 127

<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
Increment:	1
*RST:	0

Manual operation: See "Galileo FNAV Parameters" on page 127

<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:
$af2 = -2^5 \ldots 2^5-1$
$af1 = -2^{20} \ldots 2^{20}-1$
$af0 = -2^{30} \ldots 2^{30}-1$

Increment:	1
*RST:	0

Manual operation: See "Galileo INAV Parameters" on page 126

<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
Increment:	1
*RST:	0

Manual operation: See "Galileo INAV Parameters" on page 126

<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
                     Increment: 1
                     *RST: 0

Manual operation: See "Galileo INAV Parameters" on page 126

<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
                     Increment: 1
                     *RST: 0

Manual operation: See "Galileo INAV Parameters" on page 126

<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
                     Increment: 1
                     *RST: 0

Manual operation: See "Galileo INAV Parameters" on page 126

<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
                     Increment: 1
                     *RST: 0

Manual operation: See "Galileo INAV Parameters" on page 126

<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
	Increment: 1
	*RST: 0

Manual operation: See "Galileo INAV Parameters" on page 126

<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
	Increment: 1
	*RST: 0

Manual operation: See "GLONASS Clock Correction Parameters" on page 126

<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
	Increment: 1
	*RST: 0

Manual operation: See "GLONASS Clock Correction Parameters" on page 126

<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
	Increment: 1
	*RST: 0

Manual operation: See "GLONASS Clock Correction Parameters" on page 126

<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
	Increment: 1
	*RST: 0

Manual operation: See "GLONASS Clock Correction Parameters" on page 126

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

Sets the time interval between 2 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 123

<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
	Increment: 1
	*RST: 0

Manual operation: See "GLONASS Ephemeris Parameters" on page 123

<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 satel-
lites.

Range: 0 to 3
Increment: 1
*RST: 0

Manual operation: See "GLONASS Ephemeris Parameters" on page 123

<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 123

<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 or
60 min.

The parameters **Tb-Interval** (`<subsystem>:SVID<ch>:GLONass:NMESsage[:`
`PAGE<us>]:EPHemeris:TINTerval?`) and **TOE** (`<subsystem>:SVID<ch>:`
`GLONass:NMESsage[:PAGE<us>]:EPHemeris:TOE?`) depend on this value.

Note: All Ephemeris pages of an SVID have the same Tb alignment (P2).

Parameters:

<TbAlign>   EVEN | ODD

*RST: ODD

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

Manual operation: See "GLONASS Ephemeris Parameters" on page 123

<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
                             Increment: 1
                             *RST: 1

Manual operation: See "GLONASS Ephemeris Parameters" on page 123

<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: `SUR:BB:GLON:SVID:GLON:NMES:EPH:TIND 0`
                             set Tb_index to 0.
                             `SOUR:BB:GLON:SVID:GLON:NMES:EPH:AOEP 30`
                             set age of Ephemeris to 30 min.
                             `SOUR:BB:GLON:SVID:GLON:NMES:EPH:TINT?`
                             Response: Tb-Interval is the interval between 00:00:00 and
                             00:30:00 in the current day.

Usage: Query only

Manual operation: See "GLONASS Ephemeris Parameters" on page 123

<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
                             Increment: 1

<Minute>   integer

                             Range: 0 to 59
                             Increment: 1

<Second>	float
	Range: 0 to 59
	Increment: 1

Usage: Query only

Manual operation: See "GLONASS Ephemeris Parameters" on page 123

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

Provides the predicted satellite user range accuracy (URA).

Parameters:

<SvAcc>	integer
	Range: 0 to 15
	Increment: 1
	*RST: 0

Manual operation: See "GLONASS Ephemeris Parameters" on page 123

<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
	Increment: 1
	*RST: 0

Manual operation: See "GLONASS Ephemeris Parameters" on page 123

<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 **acceleration** 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
	Increment: 1
	*RST: 0

Manual operation: See "GLONASS Ephemeris Parameters" on page 123

<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[1].

The coordinates correspond to the PZ-90 coordinate system.

Parameters:

<ZDOT_n>	integer
	Range: -8388608 to 8388607
	Increment: 1
	*RST: 0

Manual operation: See "GLONASS Ephemeris Parameters" on page 123

4.16 Atmospheric Configuration

<subsystem>:ATMospheric:TROPospheric:MODel <Model>

Determines the tropospheric model.

Parameters:

<Model>	NONE	STANag
	*RST: NONE

Manual operation: See "Tropospheric Model" on page 112

<subsystem>:ATMospheric:IONospheric:MODel <Model>

Determines the applied ionospheric model.

Parameters:

<Model>   NONE | KLOBuchar

                       *RST: NONE

Manual operation: See "Ionospheric Model" on page 112

<subsystem>:ATMospheric:IONospheric:KLOBuchar:ALPHa<ch0> <Alpha>

Sets the parameter alpha_0 .. alpha_3 of the satellite's navigation message.

Suffix:

<ch0>   0 .. 3

Parameters:

<Alpha>   integer

                       Range: -128 to 127
                       *RST: 0

Manual operation: See "Klobuchar Parameters" on page 112

<subsystem>:ATMospheric:IONospheric:KLOBuchar:BETA<ch0> <Beta>

Sets the parameter beta_0 .. beta_3 of the satellite's navigation message.

Suffix:

<ch0>   0 .. 3

Parameters:

<Beta>   integer

                       Range: -128 to 127
                       *RST: 0

Manual operation: See "Klobuchar Parameters" on page 112

<subsystem>:ATMospheric:GPS:IONospheric:ALPHa<ch0> <Alpha>

Sets the parameter alpha_0 .. alpha_3 of the satellite's navigation message.

Suffix:

<ch0>   0 .. 3

Parameters:

<Alpha>   float

                       Range: -128 to 127
                       Increment: 1
                       *RST: 0

Manual operation: See "GPS/BeiDou Ionospheric Parameters" on page 112

<subsystem>:ATMospheric:GPS:IONospheric:BETA<ch0> <Beta>

Sets the parameter beta_0 .. beta_3 of the satellite's navigation message.

Suffix:

<ch0>   0 .. 3

Parameters:

<Beta>   float

                             Range: -128 to 127
                             Increment: 1
                             *RST: 0

Manual operation: See "GPS/BeiDou Ionospheric Parameters" on page 112

<subsystem>:ATMospheric:BEIDou:IONospheric:ALPHa<ch0> <Alpha>

Sets the parameter alpha_0 .. alpha_3 of the satellite's navigation message.

Suffix:

<ch0>   0 .. 3

Parameters:

<Alpha>   integer

                             Range: -128 to 127
                             *RST: 0

Manual operation: See "GPS/BeiDou Ionospheric Parameters" on page 112

<subsystem>:ATMospheric:BEIDou:IONospheric:BETA<ch0> <Beta>

Sets the parameter beta_0 .. beta_3 of the satellite's navigation message.

Suffix:

<ch0>   0 .. 3

Parameters:

<Beta>   integer

                             Range: -128 to 127
                             *RST: 0

Manual operation: See "GPS/BeiDou Ionospheric Parameters" on page 112

<subsystem>:ATMospheric:GALileo:IONospheric:AI<ch0> <A_i>

Sets the parameters effective Ionization level 1st .. 3rd order of the satellite's navigation message.

Parameters:

<A_i>   float

                            Range: a_i0 (0..2047), a_i1 (-1024..1023), a_i2 (-8192..8191)

                            Increment: 1

                            *RST: 0

Manual operation: See "GALILEO Ionospheric Parameters" on page 113

<subsystem>:ATMospheric:GALileo:IONospheric:SF<ch> <SF>

Sets the parameters ionospheric disturbance flag for region 1 to 5 of the satellite's navigation message.

Suffix:

<ch>   1 .. 5

Parameters:

<SF>   float

                            Range: 0 to 1

                            Increment: 1

                            *RST: 0

Manual operation: See "GALILEO Ionospheric Parameters" on page 113

4.17 Assistance Data Settings

The Assistance Data Settings are only configurable for instrument equipped with assistance option (R&S SMBV-K65/K67/K95) or the basic option R&S SMBV-K107 and in "User Localization" mode.

Example: Generating of GPS assistance data

The following example uses GPS entry standard.

```
SOURce1:BB:GPS:SMODe USER
SOURce1:BB:GPS:ADGeneration:MODE GPS
SOURce1:BB:GPS:ADGeneration:GPS:SYNchronize
SOURce1:BB:GPS:ADGeneration:GPS:SVID15:STATe?
//Response:1
SOURce1:BB:GPS:ADGeneration:GPS:LOCation:COORdinates:DMS?
//Response:144,57,59.97,EAST,37,48,59.987,SOUT,100
SOURce1:BB:GPS:ADGeneration:GPS:LOCation:COORdinates:DECimal?
//Response:144.966658,-37.816663,100
SOURce1:BB:GPS:ADGeneration:GPS:LOCation:URADius 2500
SOURce1:BB:GPS:ADGeneration:GPS:TOAData:TBASis UTC
SOURce1:BB:GPS:ADGeneration:GPS:TOAData:DATE?
//Response:2010,11,7
```

```
SOURce1:BB:GPS:ADGeneration:GPS:TOAData:TIME?
//Response:17,4,0
SOURce1:BB:GPS:ADGeneration:GPS:TOAData:TBASis GPS
SOURce1:BB:GPS:ADGeneration:GPS:TOAData:WNUMber?
//Response:1609
SOURce1:BB:GPS:ADGeneration:GPS:TOAData:TOWeek?
//Response:61455
SOURce1:BB:GPS:ADGeneration:GPS:TOAD:DURation 10
SOURce1:BB:GPS:ADGeneration:GPS:TOAD:RES 0.001
SOURce1:BB:GPS:ADGeneration:ACQuisition:DFORmat GPS
SOURce1:BB:GPS:ADGeneration:ACQ:CREate '/var/user/ADG/acquisition'
SOURce1:BB:GPS:ADGeneration:ALManac:CREate '/var/user/ADG/almanac.rs_al'
SOURce1:BB:GPS:ADGeneration:ALManac:CREate '/var/user/ADG/almanac.rs_yuma'
SOURce1:BB:GPS:ADGeneration:UTC:CREate '/var/user/ADG/UTC'
SOURce1:BB:GPS:ADGeneration:NAVigation:CREate '/var/user/ADG/navigation'
SOURce1:BB:GPS:ADGeneration:NAVigation:CREate '/var/user/ADG/RINEX.110n'
SOURce1:BB:GPS:ADGeneration:IONigation:CREate '/var/user/ADG/ionospheric'
SOURce1:MMEM:CAT? '/var/user/ADG'
//Response: 25301,43275001856,".,DIR,0","..,DIR,0","acquisition.rs_acq,BIN,525",
// "almanac.rs_al,BIN,5518","almanac.rs_yuma,BIN,18344","ion.rs_ion,BIN,70",
// "navigation.rs_nav,BIN,245","RINEX.10n,BIN,525","UTC.rs_utc,BIN,74"
```

<subsystem>:ADGeneration:BEIDou:SVID<ch>:ACQuisition:BLOCk?
    <TimeOffset>
<subsystem>:ADGeneration:GPS:SVID<ch>:ACQuisition:BLOCk? <TimeOffset>

Queries part of the current assistance data settings.

Query parameters:

<TimeOffset>	Int
	Sets the offset of time to the beginning of the acquisition data generation set with the command `<subsystem>:ADGeneration:GPS:TOAData:TIME` or the command `<subsystem>:ADGeneration:GPS:TOAData:TOWeek`.

Return values:

<Block>	<Rx Time of Week>,<Satellite ID that corresponds to the record>,<Zero Order Doppler Term>,<1st order Doppler Term>,<Uncertainty Doppler>,<Code Phase (or half-Chip index at epoch Time of Transmission (GPS Sat Time))>,<Integer Code Phase (or ms unit index at epoch Time of Transmission (GPS Sat Time))>,<Corresponding Bit number (modulo 4) at epoch Time of Transmission (GPS Sat Time)>,<Correlator Code phase Search Radius>,<Azimuth Angle of the Satellite in ENU ortho-normal coordinate System centered at reference point>,<Elevation Angle of the Satellite in ENU orthonormal coordinate System centered at reference point>
	The returned value is exactly one row of the acquisition assistance data file (2G, 3G) that can be generated by the command `<subsystem>:ADGeneration:ACQuisition:CREate`.

Example:	`SOURce1:BB:GPS:ADGeneration:GPS:TOAData:TBASis UTC`
	`SOURce1:BB:GPS:ADGeneration:GPS:TOAData:TIME 17,04,00.000`
	sets the time of assistance data.
	`SOURce1:BB:GPS:ADGeneration:GPS:SVID2:ACQuisition:BLOCk? 0.1`
	queries the acquisition data for SV ID 2 and time offset of 0.1s, i.e. at UTC Time 17:04:00 + 0.1 s.
	`Response:`
	`589925,5,3733.3371910282908,0,0,599,18,1,11,225.32801752395233,11.17712126071662`
Usage:	Query only
Options:	R&S SMBV-K65/K107

<subsystem>:ADGeneration:GALileo:SVID<ch>:ACQuisition:BLOCk?
    <TimeOffset>
<subsystem>:ADGeneration:GLONass:SVID<ch>:ACQuisition:BLOCk?
    <TimeOffset>

Queries part of the current assistance data settings.

Query parameters:

<TimeOffset>	Int
	Sets the offset of time to the beginning of the acquisition data generation set with the command `<subsystem>:ADGeneration:GLONass:TOAData:TIME` or the command `<subsystem>:ADGeneration:GLONass:TOAData:TOWeek`.

Return values:

<Block>	<Rx Time of Week>,<Satellite ID that corresponds to the record>,<Zero Order Doppler Term>,<1st order Doppler Term>,<Uncertainty Doppler (m/s)>,<Code Phase (ms)>,<Integer Code Phase (ms)>,<Correlator Code phase Search Radius (ms)>,<Azimuth Angle of the Satellite in ENU orthonormal coordinate System centered at reference point>,<Elevation Angle of the Satellite in ENU orthonormal coordinate System centered at reference point>
	The returned value is exactly one row of the acquisition assistance data file (2G, 3G) that can be generated by the command `<subsystem>:ADGeneration:ACQuisition:CREate`.

Example:	`SOURce1:BB:GPS:ADGeneration:GLONass:TOAData:`
	`TBASis GLO`
	`SOURce1:BB:GPS:ADGeneration:GLONass:TOAData:`
	`DATE 2012,8,20`
	`SOURce1:BB:GPS:ADGeneration:GLONass:TOAData:`
	`TIME 19,00,00.000`
	sets the time of assistance data.
	`SOURce1:BB:GPS:ADGeneration:GLONass:SVID2:`
	`ACQuisition:BLOCk? 0.1`
	queries the acquisition data for SV ID 2 and time offset of 0.1s, i.e. at Glonass time 19:00:00 + 0.1 s.
	`Response:`
	`154800.1,2,431.205775308508,0,0,0.987,68,`
	`0.00764343745397626,151.707854408733,`
	`55.6703598896116,0`

Usage:	Query only
Options:	R&S SMBV-K67/K95

<subsystem>:ADGeneration:BEIDou:SVID<ch>:SAData? **<TimeOffset>,**
    <NumberOfSymbols>
<subsystem>:ADGeneration:GALileo:SVID<ch>:SAData? **<TimeOffset>,**
    <NumberOfSymbols>

<subsystem>:ADGeneration:GLONass:SVID<ch>:SAData? <TimeOffset>,
    <NumberOfSymbols>
<subsystem>:ADGeneration:GPS:SVID<ch>:SAData? <TimeOffset>,
    <NumberOfSymbols>

Queries selected number of symbols from the sensitivity assistance message for a specific satellite (SV ID) and at given specific time.

Query parameters:

<TimeOffset>   float

Sets the offset of time to the beginning of the acquisition data generation set with the command `<subsystem>:ADGeneration:GPS:TOAData:TIME` or the command `<subsystem>:ADGeneration:GPS:TOAData:TOWeek`.

<NumberOfSymbols> Default unit: bits
Determines the length of the sensitivity assistance data to be generated. The maximum length of the generated sensitivity assistance data is then 125 subframes, i.e. 25 pages or one complete navigation message.

Return values:

<Data>   list of floats

The R&S SMBV generates a sensitivity assistance message as a binary stream.
The returned value of this query for a healthy satellite is a sequence of integer values. The first integer is the size of the message in bits to be returned. The remaining, each of which is a 32 bits long block, represents the expected data bits of the navigation message.
The query returns 0, in case an unhealthy satellite has been selected.
An error will only be reported if an out of range value for any of the arguments has been selected.

Example: SOURce1:BB:GPS:ADGeneration:GPS:TOAData:TBASis UTC
                       SOURce1:BB:GPS:ADGeneration:GPS:TOAData:TIME 17,04,00.000
                       SOURce1:BB:GPS:ADGeneration:GPS:SVID1:SAData? 1,300
                       queries the sensitivity assistance data for SV ID 1.
                       Response: 0
                       The selected satellite is unhealthy.
                       SOURce1:BB:GPS:ADGeneration:GPS:SVID2:SAData? 2,300
                       queries the sensitivity assistance data for SV ID 2.
                       Response:
                       300,-1962933360,78782016,68160383,-10752,43007,
                       -172032,681727,-1009778689,-1
                       The first bits of the sensitivity assistance message are 1000 1011 …

Usage:	Query only

<subsystem>:ADGeneration:<GNSS>:SYNChronize
<subsystem>:ADGeneration:BEIDou:SVID:SYNChronize
<subsystem>:ADGeneration:BEIDou:LOCation:SYNChronize
<subsystem>:ADGeneration:BEIDou:TOAData:SYNChronize
<subsystem>:ADGeneration:BEIDou:SYNChronize
<subsystem>:ADGeneration:GLONass:SVID:SYNChronize
<subsystem>:ADGeneration:GLONass:LOCation:SYNChronize
<subsystem>:ADGeneration:GLONass:TOAData:SYNChronize
<subsystem>:ADGeneration:GLONass:SYNChronize
<subsystem>:ADGeneration:GALileo:SVID:SYNChronize
<subsystem>:ADGeneration:GALileo:LOCation:SYNChronize
<subsystem>:ADGeneration:GALileo:TOAData:SYNChronize
<subsystem>:ADGeneration:GALileo:SYNChronize
<subsystem>:ADGeneration:GPS:SVID:SYNChronize
<subsystem>:ADGeneration:GPS:LOCation:SYNChronize
<subsystem>:ADGeneration:GPS:TOAData:SYNChronize
<subsystem>:ADGeneration:GPS:SYNChronize

Synchronizes the affected parameters.

Example:	See example "Generating of GPS assistance data" on page 253.
Usage:	Event
Manual operation:	See "Synchronize All/Synchronize" on page 132

<subsystem>:ADGeneration:MODE <Mode>

Defines the type of assistance data to be loaded.

Parameters:

<Mode>	GPS | GALileo | GLONass | BEIDou
	*RST: GPS

Example:	See example "Generating of GPS assistance data" on page 253.
Options:	R&S SMBV-K65/K67/K95/K107
Manual operation:	See "Assistance Mode" on page 132

<subsystem>:ADGeneration:BEIDou:SVID<ch>:STATe <State>
<subsystem>:ADGeneration:GALileo:SVID<ch>:STATe <State>
<subsystem>:ADGeneration:GLONass:SVID<ch>:STATe <State>
<subsystem>:ADGeneration:GPS:SVID<ch>:STATe <State>

Enables/disables a space vehicle with the selected SV ID for generation of assistance data.

Parameters:

<State>	0 | 1 | OFF | ON
	*RST:　　OFF

Example:	See example "Generating of GPS assistance data" on page 253.
Manual operation:	See "Space Vehicle State" on page 132

<subsystem>:ADGeneration:BEIDou:LOCation:COORdinates:DECimal
　　　　<Longitude>, <Latitude>, <Altitude>
<subsystem>:ADGeneration:GALileo:LOCation:COORdinates:DECimal
　　　　<Longitude>, <Latitude>, <Altitude>
<subsystem>:ADGeneration:GLONass:LOCation:COORdinates:DECimal
　　　　<Longitude>, <Latitude>, <Altitude>
<subsystem>:ADGeneration:GPS:LOCation:COORdinates:DECimal <Longitude>,
　　　　<Latitude>, <Altitude>

Sets the geographic reference location in decimal format.

Parameters:

<Longitude>	float
	Range:　　　-180 to 180 Increment:　1E-6 *RST:　　　0
<Latitude>	float
	Range:　　　-90 to 90 Increment:　1E-6 *RST:　　　0
<Altitude>	float
	Defines the altitude in meters above sea level.
	Range:　　　-10000 to 1600000 Increment:　0.1 *RST:　　　0

Example:	See example "Generating of GPS assistance data" on page 253.
Manual operation:	See "Reference Location" on page 132

<subsystem>:ADGeneration:BEIDou:LOCation:COORdinates:DMS
　　　　<LongitudeDeg>, <LongitudeMin>, <LongitudeSec>, <LongitudeDir>,
　　　　<LatitudeDeg>, <LatitudeMin>, <LatitudeSec>, <LatitudeDir>, <Altitude>
<subsystem>:ADGeneration:GALileo:LOCation:COORdinates:DMS
　　　　<LongitudeDeg>, <LongitudeMin>, <LongitudeSec>, <LongitudeDir>,
　　　　<LatitudeDeg>, <LatitudeMin>, <LatitudeSec>, <LatitudeDir>, <Altitude>

<subsystem>:ADGeneration:GLONass:LOCation:COORdinates:DMS
    <LongitudeDeg>, <LongitudeMin>, <LongitudeSec>, <LongitudeDir>,
    <LatitudeDeg>, <LatitudeMin>, <LatitudeSec>, <LatitudeDir>, <Altitude>
<subsystem>:ADGeneration:GPS:LOCation:COORdinates:DMS <LongitudeDeg>,
    <LongitudeMin>, <LongitudeSec>, <LongitudeDir>, <LatitudeDeg>,
    <LatitudeMin>, <LatitudeSec>, <LatitudeDir>, <Altitude>

Sets the geographic reference location in degrees, minutes and seconds.

Parameters:

<LongitudeDeg>   integer

                        Defines the longitude degrees.

                        Range: 0 to 180
                        Increment: 1
                        *RST: 0

<LongitudeMin>   integer

                        Defines the longitude minutes.

                        Range: 0 to 59
                        Increment: 1
                        *RST: 0

<LongitudeSec>   float

                        Defines the longitude seconds.

                        Range: 0 to 59.999
                        Increment: 0.001
                        *RST: 0

<LongitudeDir>   EAST | WEST

                        Defines the longitude direction.

                        *RST: EAST

<LatitudeDeg>   integer

                        Defines the latitude degrees.

                        Range: 0 to 90
                        Increment: 1
                        *RST: 0

<LatitudeMin>   integer

                        Defines the latitude minutes.

                        Range: 0 to 59
                        Increment: 1
                        *RST: 0

<LatitudeSec>   float

                        Defines the latitude seconds.

                        Range: 0 to 59.999
                        Increment: 0.001
                        *RST: 0

<LatitudeDir>	NORTh | SOUTh
	Defines the latitude direction.
	*RST: NORT

<Altitude>	float
	Defines the altitude in meters above sea level.
	Range: -10000 to 1600000
	Increment: 0.1
	*RST: 0

Example: See example "Generating of GPS assistance data" on page 253.

Manual operation: See "Reference Location" on page 132

<subsystem>:ADGeneration:BEIDou:LOCation:URADius <Radius>
<subsystem>:ADGeneration:GALileo:LOCation:URADius <Radius>
<subsystem>:ADGeneration:GLONass:LOCation:URADius <Radius>
<subsystem>:ADGeneration:GPS:LOCation:URADius <Radius>

Sets the Uncertainty Radius, i.e. sets the maximum radius of the area within which the two dimensional location of the UE is bounded.

Parameters:

<Radius>	integer
	Range: 0 to 1.E6
	Increment: 1
	*RST: 3.E3

Example: See example "Generating of GPS assistance data" on page 253.

Manual operation: See "Reference Location" on page 132

<subsystem>:ADGeneration:BEIDou:TOAData:TBASis <TimeBasis>
<subsystem>:ADGeneration:GALileo:TOAData:TBASis <TimeBasis>
<subsystem>:ADGeneration:GLONass:TOAData:TBASis <TimeBasis>
<subsystem>:ADGeneration:GPS:TOAData:TBASis <TimeBasis>

Determines the time basis used to enter the time of assistance data parameters.

Parameters:

<TimeBasis>	UTC | GPS | GST | GLO | BDT
	*RST: UTC

Example: See example "Generating of GPS assistance data" on page 253.

Manual operation: See "Time Basis" on page 133

<subsystem>:ADGeneration:BEIDou:TOAData:DATE <Year>, <Month>, <Day>
<subsystem>:ADGeneration:GALileo:TOAData:DATE <Year>, <Month>, <Day>

<subsystem>:ADGeneration:GLONass:TOAData:DATE <Year>, <Month>, <Day>
<subsystem>:ADGeneration:GPS:TOAData:DATE <Year>, <Month>, <Day>

Enabled for UTC or GLONASS time basis (`<subsystem>:ADGeneration:GPS:`
`TOAData:TBASis`).

Enters the date for the assistance data in DMS format of the Gregorian calendar.

Parameters:

<Year>	integer
	Range: 1980 to 9999
	Increment: 1
<Month>	integer
	Range: 1 to 12
	Increment: 1
<Day>	integer
	Range: 1 to 31
	Increment: 1

Example: See example "Generating of GPS assistance data" on page 253.

Manual operation: See "Date [dd.mm.yyyy]" on page 133

<subsystem>:ADGeneration:BEIDou:TOAData:TIME <Hour>, <Minute>, <Second>
<subsystem>:ADGeneration:GALileo:TOAData:TIME <Hour>, <Minute>, <Second>
<subsystem>:ADGeneration:GLONass:TOAData:TIME <Hour>, <Minute>,
    <Second>
<subsystem>:ADGeneration:GPS:TOAData:TIME <Hour>, <Minute>, <Second>

Enabled for UTC or GLONASS time basis (`<subsystem>:ADGeneration:GPS:`
`TOAData:TBASis`).

Enters the exact start time for the assistance data in UTC time format.

Parameters:

<Hour>	integer
	Range: 0 to 23
	Increment: 1
<Minute>	integer
	Range: 0 to 59
	Increment: 1
<Second>	float
	Range: 0 to 59.999
	Increment: 0.001

Example: See example "Generating of GPS assistance data" on page 253.

Manual operation: See "Time [hh:mm:ss]" on page 133

\<subsystem\>:ADGeneration:BEIDou:TOAData:DURation \<Duration\>
\<subsystem\>:ADGeneration:GALileo:TOAData:DURation \<Duration\>
\<subsystem\>:ADGeneration:GLONass:TOAData:DURation \<Duration\>
\<subsystem\>:ADGeneration:GPS:TOAData:DURation \<Duration\>

Sets the duration of the assistance data.

Parameters:

\<Duration\>	float	
	Range:	1E-3 to 5E3
	Increment:	1E-3
	*RST:	1E-3
	Default unit: s	

Example: See example "Generating of GPS assistance data" on page 253.

Manual operation: See "Duration" on page 134

\<subsystem\>:ADGeneration:BEIDou:TOAData:RESolution \<Resolution\>
\<subsystem\>:ADGeneration:GALileo:TOAData:RESolution \<Resolution\>
\<subsystem\>:ADGeneration:GLONass:TOAData:RESolution \<Resolution\>
\<subsystem\>:ADGeneration:GPS:TOAData:RESolution \<Resolution\>

Sets the resolution of the assistance data.

Parameters:

\<Resolution\>	float	
	Range:	1.0E-3 to 5
	Increment:	1.0E-3
	*RST:	1.0E-3
	Default unit: s	

Example: See example "Generating of GPS assistance data" on page 253.

Manual operation: See "Resolution" on page 134

\<subsystem\>:ADGeneration:BEIDou:TOAData:TOWeek \<TOW\>
\<subsystem\>:ADGeneration:GALileo:TOAData:TOWeek \<TOW\>
\<subsystem\>:ADGeneration:GLONass:TOAData:TOWeek \<TOW\>
\<subsystem\>:ADGeneration:GPS:TOAData:TOWeek \<TOW\>

Enabled for GPS time basis (`<subsystem>:ADGeneration:GPS:TOAData:
TBASis`).

Determines the Time of Week (TOW) the assistance data is generated for.

Parameters:

\<TOW\>	integer	
	Range:	-604800 to 604800
	Increment:	1
	*RST:	0

Example: See example "Generating of GPS assistance data" on page 253.

Manual operation: See "Time of Week" on page 134

<subsystem>:ADGeneration:BEIDou:TOAData:WNUMber <WeekNumber>
<subsystem>:ADGeneration:GALileo:TOAData:WNUMber <WeekNumber>
<subsystem>:ADGeneration:GLONass:TOAData:WNUMber <WeekNumber>
<subsystem>:ADGeneration:GPS:TOAData:WNUMber <WeekNumber>

Enabled for GPS time basis (`<subsystem>:ADGeneration:GPS:TOAData:TBASis`).

Sets the week number (WN) the assistance data is generated for.

Parameters:

<WeekNumber>	integer
	Range: 0 to 9999.0*53
	Increment: 1
	*RST: 0

Example: See example "Generating of GPS assistance data" on page 253.

Manual operation: See "Week Number" on page 134

<subsystem>:ADGeneration[:ACQuisition]:DFORmat <DataFormat>

Sets the format, GPS or GNSS, of the generated acquisition files.

Parameters:

| <DataFormat> | GNSS | GPS |
| | *RST: GNSS |

Example: See example "Generating of GPS assistance data" on page 253.

Manual operation: See "Data Format" on page 134

<subsystem>:ADGeneration:ACQuisition:CREate <Create>

Stores the current assistance data settings into the selected acquisition file. The directory is set using command `MMEM:CDIRectory`. A path can also be specified, in which case the files in the specified directory are read. Only the file name has to be entered. Assistance data settings are stored as acquisition file with the specific file extensions `*.rs_acq`.

Parameters:

| <Create> | string |

Example: See example "Generating of GPS assistance data" on page 253.

Options: R&S SMBV-K65/K67/K95/K107

Manual operation: See "Generate Acquisition File …" on page 138

<subsystem>:ADGeneration:ALManac:CREate <Filename>

Stores the current assistance data settings into the selected almanac file. The directory is set using command `MMEM:CDIRectory`. A path can also be specified, in which case the files in the specified directory are read. Only the file name has to be entered. Assistance data settings are stored as almanac file with the specific file extensions `*.rs_al` or `*.rs_yuma`.

The default extension is `*.rs_al` and can be omitted in the file name.

To save an almanac file as file with extension `*.rs_yuma`, however, this extension has to be specified in the file name.

Parameters:

<Filename>   string

Example: See example "Generating of GPS assistance data" on page 253.

Options: R&S SMBV-K65/K67/K95

Manual operation: See "Generate Almanac File …" on page 134

<subsystem>:ADGeneration:UTC:CREate <Filename>

Stores the current assistance data settings into the selected UTC file. The directory is set using command `MMEM:CDIRectory`. A path can also be specified, in which case the files in the specified directory are read. Only the file name has to be entered. Assistance data settings are stored as UTC file with the specific file extensions `*.rs_utc`.

Parameters:

<Filename>   string

Example: See example "Generating of GPS assistance data" on page 253.

Manual operation: See "Generate UTC File …" on page 137

<subsystem>:ADGeneration:NAVigation:CREate <Filename>

Stores the current assistance data settings into the selected navigation file. The directory is set using command `MMEM:CDIRectory`. A path can also be specified, in which case the files in the specified directory are read. Only the file name has to be entered. Assistance data settings are stored as navigation file with the specific file extensions `*.rs_nav` or into RINEX files with extension `.10n`.

Parameters:

<Filename>   string

Example: See example "Generating of GPS assistance data" on page 253.

Manual operation: See "Generate Navigation File …" on page 136

<subsystem>:ADGeneration:IONospheric:CREate <Filename>

Stores the current assistance data settings into the selected ionospheric file. The directory is set using command `MMEM:CDIRectory`. A path can also be specified, in which case the files in the specified directory are read. Only the file name has to be entered. Assistance data settings are stored as ionospheric file with the specific file extensions `*.rs_ion`.

Parameters:

<Filename>   string

Example: See example "Generating of GPS assistance data" on page 253.

Manual operation: See "Generate Ionospheric File …" on page 135

4.18 S.P.O.T Configuration and Real-Time Commands

Example: Retrieving real-time settings

The following example uses GPS entry standard.

```
*RST

SOURce1:BB:GPS:SMODe AUTO
SOURce1:BB:GPS:HYBRid:GALileo:STATe 1
SOURce1:BB:GPS:HYBRid:GLONass:STATe 1
SOURce1:BB:GPS:HYBRid:BEIDou:STATe 1
SOURce1:BB:GPS:SATellite:COUNt?
// Response: 12
// constalation with 12 satellites

SOURce1:BB:GPS:VEHicle:TYPE?
// LVEH
SOURce1:BB:GPS:LOCation:SELect "Waypoints"
SOURce1:BB:GPS:LOCation:WAYPoints:FILE "Melbourne_Car_Motion.xtd"

SOURce1:BB:GPS:NAVigation:ALManac:GPS:FILE?
// ".../Lists/Gnss/Gps/Almanac/GPS_SEM678.txt"
SOURce1:BB:GPS:NAVigation:SIMulation:WNUMber?
// 1702
SOURce1:BB:GPS:NAVigation:SIMulation:TOWeek?
// 144016
SOURce1:BB:GPS:NAVigation:SIMulation:TBASis UTC
SOURce1:BB:GPS:NAVigation:SIMulation:DATE?
// 2012,8,20
SOURce1:BB:GPS:NAVigation:SIMulation:TIME?
// 16,0,0

SOURce1:BB:GPS:STATe 1
```

```
SOURce1:BB:GPS:SPOT:UPDate OFF


SOURce1:BB:GPS:RT:HWTime?
// Response: 36.16 sec
// elapsed time since simulation start


SOURce1:BB:GPS:SPOT:NHOTime?
// Response: 750 s
// 750 sec = 12 min 30 sec
// hence the next handover is expected at 12:30 min after 16:00:00 on 20.08.2012,
// that is, the Next Handover Time is 16:12:30


SOURce1:BB:GPS:RT:SCONstellation? GPS,1702,144050
//Response: 12,G2,G4,G9,G27,E15,E16,E26,E27,R12,R22,B25,B34,716
// constalation with 12 satellites
SOURce1:BB:GPS:RT:OCONstellation? GPS,1609,65455
//Response: 12,G9,E16,R12,E27,B25,R22,G2,G4,E26,G27,B34,E15
SOURce1:BB:GPS:RT:RLOCation:COORdinates:DMS? GPS,1702,144050
//Response: 144,57,59.195,EAST,37,48,37.615,SOUT,100.037
SOURce1:BB:GPS:RT:RLOCation:COORdinates:DECimal? GPS,1702,144050
//Response: 144.966443,-37.810449,100.037
SOURce1:BB:GPS:RT:RATTitude?
// Response: 0,0,-1.54474
SOURce1:BB:GPS:RT:GALileo:SVID27:TAP1:POWer:ABSolute? GST,1702,144100
//Response: -118.836975193809
SOURce1:BB:GPS:RT:GALileo:SVID27:AZIMuth? GST,1702,144100
//Response: 37.5699690788219
SOURce1:BB:GPS:RT:GALileo:SVID10:ELEVation? GST,1702,144100
//Response: 72.6122965557601
```

<subsystem>:SPOT:NHOTime?

In <subsystem>:SMOD AUTO, queries the time period that will pass from the simulation start before the next handover will be executed.

The time of the upcoming handover is calculated as: "Next Handover Time" = simulation start "Time" + <NHoTime>.

Return values:

<NHoTime>	integer
	Default unit: seconds

Example:	See example "Retrieving real-time settings" on page 267.
Example:	SOURce1:BB:GPS:NAVigation:SIMulation:DATE?
	Response: 2012,8,20
	SOURce1:BB:GPS:NAVigation:SIMulation:TIME?
	Response: 16,0,0
	SOURce1:BB:GPS:SPOT:NHOTime?
	Response: 750 s
	750 sec = 12 min 30 sec. Hence the next handover is expected at 12:30 min after 16:00:00 on 20.08.2012, that is, the Next Handover Time is 16:12:30
Usage:	Query only
Manual operation:	See "Next Constellation Change" on page 143

<subsystem>:RT:HWTime?

Queries the time elapsed since the simulation start.

Return values:

<ElapsedTime>	float	
	Range:	0 to INT_MAX
	Increment:	0.001
	*RST:	0

Example:	See example "Retrieving real-time settings" on page 267
Usage:	Query only

<subsystem>:RT:<GNSS>:SVID<ch>:AZIMuth
<subsystem>:RT:BEIDou:SVID<ch>:AZIMuth? <TimeBasis>, <Year>, <Month>, <Day>, <Hour>, <Minutes>, <Seconds>, <WeekNumber>, <TimeOfWeek>
<subsystem>:RT:GALileo:SVID<ch>:AZIMuth? <TimeBasis>, <Year>, <Month>, <Day>, <Hour>, <Minutes>, <Seconds>, <WeekNumber>, <TimeOfWeek>

<subsystem>:RT:GLONass:SVID<ch>:AZIMuth? <TimeBasis>, <Year>, <Month>,
    <Day>, <Hour>, <Minutes>, <Seconds>, <WeekNumber>, <TimeOfWeek>
<subsystem>:RT:GPS:SVID<ch>:AZIMuth? <TimeBasis>, <Year>, <Month>,
    <Day>, <Hour>, <Minutes>, <Seconds>, <WeekNumber>, <TimeOfWeek>

Queries the satellite azimuth in the selected moment of time. The required query parameters, depend on the selected time basis.

Query parameters:

<TimeBasis>	UTC | GPS | GST | GLO | BDT
	*RST: UTC
<Year>	integer
	required for `TimeBasis = UTC`
	Range: 1980 to 9999
	Increment: 1
<Month>	integer
	required for `TimeBasis = UTC`
	Range: 1 to 12
	Increment: 1
<Day>	integer
	required for `TimeBasis = UTC`
	Range: 1 to 31
	Increment: 1
<Hour>	integer
	required for `TimeBasis = UTC`
	Range: 0 to 23
	Increment: 1
<Minutes>	integer
	required for `TimeBasis = UTC`
	Range: 0 to 59
	Increment: 1
<Seconds>	float
	required for `TimeBasis = UTC`
	Range: 0 to 59.999
	Increment: 0.001
<WeekNumber>	integer
	required for `TimeBasis = GPS|GST|BDT`
	Range: 0 to 529947
	Increment: 1

<TimeOfWeek>	float	
	required for `TimeBasis = GPS|GST|BDT`	
	Range: 0 to 604799.999 Increment: 0.001	

Return values:

<Azimuth>	float	
Example:	See example "Retrieving real-time settings" on page 267.	
Usage:	Query only	

<subsystem>:RT:<GNSS>:SVID<ch>:ELEVation
<subsystem>:RT:BEIDou:SVID<ch>:ELEVation? <TimeBasis>, <Year>, <Month>, <Day>, <Hour>, <Minutes>, <Seconds>, <WeekNumber>, <TimeOfWeek>
<subsystem>:RT:GALileo:SVID<ch>:ELEVation? <TimeBasis>, <Year>, <Month>, <Day>, <Hour>, <Minutes>, <Seconds>, <WeekNumber>, <TimeOfWeek>
<subsystem>:RT:GLONass:SVID<ch>:ELEVation? <TimeBasis>, <Year>, <Month>, <Day>, <Hour>, <Minutes>, <Seconds>, <WeekNumber>, <TimeOfWeek>
<subsystem>:RT:GPS:SVID<ch>:ELEVation? <TimeBasis>, <Year>, <Month>, <Day>, <Hour>, <Minutes>, <Seconds>, <WeekNumber>, <TimeOfWeek>

Queries the satellite's elevation in the selected moment of time. The required query parameters, depend on the selected time basis.

Query parameters:

<TimeBasis>	UTC	GPS	GST	GLO	BDT	
	*RST: UTC	
<Year>	integer	
	required for `TimeBasis = UTC`	
	Range: 1980 to 9999 Increment: 1	
<Month>	integer	
	required for `TimeBasis = UTC`	
	Range: 1 to 12 Increment: 1	
<Day>	integer	
	required for `TimeBasis = UTC`	
	Range: 1 to 31 Increment: 1	
<Hour>	integer	
	required for `TimeBasis = UTC`	
	Range: 0 to 23 Increment: 1	

<Minutes>	integer
	required for `TimeBasis = UTC`
	Range: 0 to 59
	Increment: 1
<Seconds>	float
	required for `TimeBasis = UTC`
	Range: 0 to 59.999
	Increment: 0.001
<WeekNumber>	integer
	required for `TimeBasis = GPS|GST|BDT`
	Range: 0 to 529947
	Increment: 1
<TimeOfWeek>	float
	required for `TimeBasis = GPS|GST|BDT`
	Range: 0 to 604799.999
	Increment: 0.001

Return values:

<Elevation>	float
Example:	See
Usage:	Query only

<subsystem>:RT:<GNSS>:SVID<ch>:TAP<us>:POWer:ABSolute
<subsystem>:RT:BEIDou:SVID<ch>:TAP<us>:POWer:ABSolute? <TimeBasis>,
    <Year>, <Month>, <Day>, <Hour>, <Minutes>, <Seconds>, <WeekNumber>,
    <TimeOfWeek>
<subsystem>:RT:GALileo:SVID<ch>:TAP<us>:POWer:ABSolute? <TimeBasis>,
    <Year>, <Month>, <Day>, <Hour>, <Minutes>, <Seconds>, <WeekNumber>,
    <TimeOfWeek>
<subsystem>:RT:GLONass:SVID<ch>:TAP<us>:POWer:ABSolute? <TimeBasis>,
    <Year>, <Month>, <Day>, <Hour>, <Minutes>, <Seconds>, <WeekNumber>,
    <TimeOfWeek>
<subsystem>:RT:GPS:SVID<ch>:TAP<us>:POWer:ABSolute? <TimeBasis>,
    <Year>, <Month>, <Day>, <Hour>, <Minutes>, <Seconds>, <WeekNumber>,
    <TimeOfWeek>

Queries the absolute power of a specified Tap of a specific satellite at a selected
moment of time.

Note: The power refers to the reference signal component in case of many signals
simulated with this specific satellite e.g. C/A when simulating a satellite with signals
(C/A + P)Q.

Suffix:

<us>
1..10
Determines the tap number. The number of taps is set with the command `<subsystem>:SVID<ch>:GALileo:MPATh:TAP:COUNt`.

Query parameters:

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

*RST: UTC

<Year>
integer

required for UTC time basis only

Range: 1980 to 9999
Increment: 1

<Month>
integer

required for `TimeBasis = UTC`

Range: 1 to 12
Increment: 1

<Day>
integer

required for `TimeBasis = UTC`

Range: 1 to 31
Increment: 1

<Hour>
integer

required for `TimeBasis = UTC`

Range: 0 to 23
Increment: 1

<Minutes>
integer

required for `TimeBasis = UTC`

Range: 0 to 59
Increment: 1

<Seconds>
float

required for `TimeBasis = UTC`

Range: 0 to 59.999
Increment: 0.001

<WeekNumber>
integer

required for `TimeBasis = GPS|GST|BDT`

Range: 0 to 529947
Increment: 1

<TimeOfWeek>
float

required for `TimeBasis = GPS|GST|BDT`

Range: 0 to 604799.999
Increment: 0.001

Return values:

<Power>   float

Example: See example "Retrieving real-time settings" on page 267.

Usage: Query only

<subsystem>:RT:RLOCation:COORdinates:DECimal? <TimeBasis>, <Year>,
    <Month>, <Day>, <Hour>, <Minutes>, <Seconds>, <WeekNumber>,
    <TimeOfWeek>

Queries the coordinates of the receiver location in decimal format for the selected
moment of time. The required query parameters depend on the selected time basis.

Query parameters:

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

                  *RST: UTC

<Year>   integer

                  required for TimeBasis = UTC

                  Range: 1980 to 9999
                  Increment: 1

<Month>   integer

                  required for TimeBasis = UTC

                  Range: 1 to 12
                  Increment: 1

<Day>   integer

                  required for TimeBasis = UTC

                  Range: 1 to 31
                  Increment: 1

<Hour>   integer

                  required for TimeBasis = UTC

                  Range: 0 to 23
                  Increment: 1

<Minutes>   integer

                  required for TimeBasis = UTC

                  Range: 0 to 59
                  Increment: 1

<Seconds>   float

                  required for TimeBasis = UTC

                  Range: 0 to 59.999
                  Increment: 0.001

<WeekNumber>	integer
	required for `TimeBasis = GPS|GST|BDT`
	Range:　　0 to 529947
	Increment:　1

<TimeOfWeek>	float
	required for `TimeBasis = GPS|GST|BDT`
	Range:　　0 to 604799.999
	Increment:　0.001

Return values:

<Longitude>	float
	Range:　　-180 to 180
	Increment:　1E-6
	*RST:　　0

<Latitude>	float
	Range:　　-90 to 90
	Increment:　1E-6
	*RST:　　0

<Altitude>	float
	Range:　　-10000 to 1600000
	Increment:　0.1
	*RST:　　0

Example:	See example "Retrieving real-time settings" on page 267.
Usage:	Query only

<subsystem>:RT:RLOCation:COORdinates:DMS? <TimeBasis>, <Year>, <Month>, <Day>, <Hour>, <Minutes>, <Seconds>, <WeekNumber>, <TimeOfWeek>

Queries the coordinates of the receiver location in DMS format for the selected moment of time. The required query parameters depend on the selected time basis.

Query parameters:

<TimeBasis>	UTC	GPS	GST	GLO	BDT
	*RST:　　　UTC				

<Year>	integer
	required for `TimeBasis = UTC`
	Range:　　1980 to 9999
	Increment:　1

<Month>	integer
	required for `TimeBasis = UTC`
	Range:　　1 to 12
	Increment:　1

<Day>	integer
	required for `TimeBasis = UTC`
	Range: 1 to 31
	Increment: 1
<Hour>	integer
	required for `TimeBasis = UTC`
	Range: 0 to 23
	Increment: 1
<Minutes>	integer
	required for `TimeBasis = UTC`
	Range: 0 to 59
	Increment: 1
<Seconds>	float
	required for `TimeBasis = UTC`
	Range: 0 to 59.999
	Increment: 0.001
<WeekNumber>	integer
	required for `TimeBasis = GPS|GST|BDT`
	Range: 0 to 529947
	Increment: 1
<TimeOfWeek>	float
	required for `TimeBasis = GPS|GST|BDT`
	Range: 0 to 604799.999
	Increment: 0.001
Return values:	
<LongitudeDeg>	integer
	Range: 0 to 180
	Increment: 1
	*RST: 0
<LongitudeMin>	integer
	Range: 0 to 59
	Increment: 1
	*RST: 0
<LongitudeSec>	float
	Range: 0 to 59.999
	Increment: 0.001
	*RST: 0
<LongitudeDir>	EAST | WEST
	*RST: EAST

<LatitudeDeg>	integer
	Range: 0 to 90
	Increment: 1
	*RST: 0
<LatitudeMin>	integer
	Range: 0 to 59
	Increment: 1
	*RST: 0
<LatitudeSec>	float
	Range: 0 to 59.999
	Increment: 0.001
	*RST: 0
<LatitudeDir>	NORT	SOUT
	*RST: NORT
<Altitude>	float
	Range: -10000 to 1600000
	Increment: 0.1
	*RST: 0
Example:	See example "Retrieving real-time settings" on page 267.
Usage:	Query only

<subsystem>:RT:SCONstellation? <TimeBasis>, <Year>, <Month>, <Day>, <Hour>, <Minutes>, <Seconds>, <WeekNumber>, <TimeOfWeek>

Queries the constellation of the active satellites for the selected moment of time.

Query parameters:

<TimeBasis>	UTC	GPS	GST	GLO	BDT
	*RST: UTC
<Year>	integer
	required for TimeBasis = UTC
	Range: 1980 to 9999
	Increment: 1
<Month>	integer
	required for TimeBasis = UTC
	Range: 1 to 12
	Increment: 1
<Day>	integer
	required for TimeBasis = UTC
	Range: 1 to 31
	Increment: 1

\<Hour\>	integer
	required for `TimeBasis = UTC`
	Range: 0 to 23 Increment: 1
\<Minutes\>	integer
	required for `TimeBasis = UTC`
	Range: 0 to 59 Increment: 1
\<Seconds\>	float
	required for `TimeBasis = UTC`
	Range: 0 to 59.999 Increment: 0.001
\<WeekNumber\>	integer
	required for `TimeBasis = GPS|GST|BDT`
	Range: 0 to 529947 Increment: 1
\<TimeOfWeek\>	float
	required for `TimeBasis = GPS|GST|BDT`
	Range: 0 to 604799.999 Increment: 0.001

Return values:

\<Constellation\>	\<Number of Sats\>,\<STD/SV ID of Sat1\>,\<STD/SV ID of Sat2\>,...,\<Remaining Time\>
	The query returns a string composed of the number of simulated satellites at the selected moment of time, standard/SV-ID of all the satellites in the active constellation and if applicable the remaining time to the next exchange of satellites in seconds. The `<Remaining Time>` is returned as a valid positive integer in seconds only when working in a mode where exchange of stellites is predefined or made automatic at the beginning of the simulation, e.g while working in the auto localization mode (`<subsystem>:SMODe`); otherwise −1 is returned.

Example:	`BB:GPS:SMOD AUTO`
	`BB:GPS:RT:SCON? GPS,1609,61455`
	`Response: 6,G24,G10,G32,E11,E25,E14,1525`
	The 6 active satellites G24,G10,G32,E11,E25,E14 build the satellite constellation. An exchange of satellites will be performed in 1525s.

Example:	See also .
Usage:	Query only

<subsystem>:RT:OCONstellation? <TimeBasis>, <Year>, <Month>, <Day>, <Hour>,
   <Minutes>, <Seconds>, <WeekNumber>, <TimeOfWeek>

Queries the optimal constellation for the selected moment of time.

Query parameters:

<TimeBasis>	UTC | GPS | GST | GLO | BDT
	*RST: UTC
<Year>	integer
	required for `TimeBasis = UTC`
	Range: 1980 to 9999 Increment: 1
<Month>	integer
	required for `TimeBasis = UTC`
	Range: 1 to 12 Increment: 1
<Day>	integer
	required for `TimeBasis = UTC`
	Range: 1 to 31 Increment: 1
<Hour>	integer
	required for `TimeBasis = UTC`
	Range: 0 to 23 Increment: 1
<Minutes>	integer
	required for `TimeBasis = UTC`
	Range: 0 to 59 Increment: 1
<Seconds>	float
	required for `TimeBasis = UTC`
	Range: 0 to 59.999 Increment: 0.001
<WeekNumber>	integer
	required for `TimeBasis = GPS|GST|BDT`
	Range: 0 to 529947 Increment: 1
<TimeOfWeek>	float
	required for `TimeBasis = GPS|GST|BDT`
	Range: 0 to 604799.999 Increment: 0.001

Return values:

<Constellation>	<Number of Sats>,<STD/SV ID of Sat1>,<STD/SV ID of Sat2>,...
	The query returns a string composed of the number of satellites in the optimal constellation and the standard/SV-ID of the satellites. Use this information as a basis for manually performed exchange of satellites.
Example:	BB:GPS:SMOD USER BB:GPS:NAV:SIM:TBAS GPS BB:GPS:NAV:SIM:WNUM 1609 BB:GPS:NAV:SIM:TOW 61455 BB:GPS:GOC BB:GPS:RT:SCON? GPS,1609,61455 Response: 6,G11,E11,E19,E28,G19,G14,-1 The 6 active satellites G11,E11,E19,E28,G19,G14 build the satellite constellation. BB:GPS:RT:OCON? GPS,1609,65455 Response: 6,G20,E20,E23,G4,G24,E31 The optimal constellation for the selected moment of time consists of 6 satellites G20,E20,E23,G4,G24,E31.
Example:	See also example "Retrieving real-time settings" on page 267.
Usage:	Query only
Manual operation:	See "Get Optimal Constellation" on page 102

<subsystem>:RT:RATTitude? <TimeBasis>, <Year>, <Month>, <Day>, <Hour>, <Minutes>, <Seconds>, <WeekNumber>, <TimeOfWeek>

Queries the receiver attitude parameters yaw, pitch, roll in degrees for the selected moment of time.

Query parameters:

<TimeBasis>	UTC | GPS | GST | GLO | BDT
	*RST: UTC
<Year>	integer
	required for TimeBasis = UTC
	Range: 1980 to 9999 Increment: 1
<Month>	integer
	required for TimeBasis = UTC
	Range: 1 to 12 Increment: 1

<Day>	integer
	required for `TimeBasis = UTC`
	Range: 1 to 31 Increment: 1
<Hour>	integer
	required for `TimeBasis = UTC`
	Range: 0 to 23 Increment: 1
<Minutes>	integer
	required for `TimeBasis = UTC`
	Range: 0 to 59 Increment: 1
<Seconds>	float
	required for `TimeBasis = UTC`
	Range: 0 to 59.999 Increment: 0.001
<WeekNumber>	integer
	required for `TimeBasis = GPS|GST|BDT`
	Range: 0 to 529947 Increment: 1
<TimeOfWeek>	float
	required for `TimeBasis = GPS|GST|BDT`
	Range: 0 to 604799.999 Increment: 0.001
Return values:	
<Yaw>	float
	Range: -3.14 to 3.14 Increment: 0.01 *RST: 0
<Pitch>	float
	Range: -3.14 to 3.14 Increment: 0.01 *RST: 0
<Roll>	float
	Range: -3.14 to 3.14 Increment: 0.01 *RST: 0

Example:	SOURce1:BB:GPS:SMODe AUTO
	SOURce1:BB:GPS:RATTitude? GPS,1609,61455
	Response: 0.10,0.00,1.00
	The current receiver attitude parameters yaw (Y) = 0.1, pitch (P) = 0 and roll (R) = 1.0
Usage:	Query only
Manual operation:	See "Yaw/Heading, Pitch/Elevation, Roll/Bank" on page 72

4.19 Trigger Settings

<subsystem>[:TRIGger]:SEQuence <Sequence>

Selects the trigger mode.

Parameters:

<Sequence>	AUTO | RETRigger | AAUTo | ARETrigger | SINGle
	*RST: AUTO
Example:	BB:GPS:SEQ AAUT
	sets the "Armed_auto" trigger mode; the device waits for the first trigger (e.g. with *TRG) and then generates the signal continuously.
Manual operation:	See "Trigger Mode" on page 146

<subsystem>:TRIGger:SLENgth <SLength>

Defines the length of the signal sequence to be output in the "Single" trigger mode (SOUR:BB:GPS:SEQ SING). The unit of the entry is defined under "Signal Duration Unit". The maximum value for the sequence length depends on the selected unit.

It is possible to output deliberately just part of the signal, an exact sequence of the signal, or a defined number of repetitions of the signal.

Parameters:

<SLength>	integer
	Range: 1 to 4294967295
	Increment: 1
	*RST: 1023

Example: BB:GPS:SEQ SING

sets trigger mode Single.

BB:GPS:TRIG:SLEN 200

sets a sequence length of 200 chips. The first 200 chips of the current frame will be output after the next trigger event.

Manual operation: See "Signal Duration" on page 147

<subsystem>:TRIGger:RMODe?

Queries the current status of signal generation for all trigger modes with GPS modulation on.

Return values:

<RMode>	STOP | RUN
	*RST: STOP

Example: BB:GPS:TRIG:MODE ARET

selects the "Armed_Retrigger" mode.

BB:GPS:TRIG:SOUR EXT

sets external triggering via the TRIGGER 1 connector.

BB:GPS:TRIG:RMOD?

queries the current status of signal generation.

Response: RUN

the signal is generated, an external trigger was executed.

Usage: Query only

Manual operation: See "Running/Stopped" on page 147

<subsystem>:TRIGger:ARM:EXECute

Stops signal generation for trigger modes "Armed_Auto" and "Armed_Retrigger". A subsequent internal or external trigger event restarts signal generation.

Example: BB:GPS:TRIG:SOUR INT

sets internal triggering.

BB:GPS:TRIG:SEQ ARET

sets Armed_Retrigger mode, i.e. every trigger event causes signal generation to restart.

BB:GPS:TRIG:EXEC

executes a trigger, signal generation is started.

BB:GPS:TRIG:ARM:EXEC

signal generation is stopped.

BB:GPS:TRIG:EXEC

executes a trigger, signal generation is started again.

Usage:	Event
Manual operation:	See "Arm" on page 62

<subsystem>:TRIGger:EXECute

Executes a trigger. The internal trigger source must be selected using the command `<subsystem>:TRIG:SOUR INT` and a trigger mode other than `AUTO` must be selected using the command `<subsystem>:TRIG:SEQ`.

Example:	`BB:GPS:TRIG:SOUR INT`
	sets internal triggering.
	`BB:GPS:TRIG:SEQ ARET`
	sets "Armed_Retrigger" mode, i.e. every trigger event causes signal generation to restart.
	`BB:GPS:TRIG:EXEC`
	executes a trigger, signal generation is started.
	`BB:GPS:TRIG:ARM:EXEC`
	signal generation is stopped.
	`BB:GPS:TRIG:EXEC`
	executes a trigger, signal generation is started again.

Usage:	Event
Manual operation:	See "Execute Trigger" on page 62

<subsystem>:TRIGger:SOURce <Source>

Selects the trigger source.

Parameters:

<Source>	INTernal | EXTernal

Example:	`BB:GPS:TRIG:SING`
	selects a trigger mode that requires a trigger.
	`BB:GPS:TRIG:SOUR EXT`
	sets external triggering via the TRIGGER connector.

Manual operation:	See "Trigger Source" on page 148

<subsystem>:TRIGger:EXTernal:SYNChronize:OUTPut <Output>

(enabled for "Trigger Source" External)

Enables/disables output of the signal synchronous to the external trigger event.

Parameters:

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

Example: `BB:GPS:TRIG:SOUR EXT`
                     sets external triggering.
                     `BB:GPS:TRIG:EXT:SYNC:OUTP ON`
                     enables synchrounous output to external trigger.

Manual operation: See "Sync. Output to External Trigger" on page 148

\<subsystem\>:TRIGger:OUTPut\<ch\>:DELay \<Delay\>

Defines the delay between the signal on the marker outputs and the start of the signal, expressed in terms of chips. Command `:BB:GPS:TRIGger:OUTPut:DELay:FIXed` can be used to restrict the range of values to the dynamic range, i.e. the range within which a delay of the marker signals can be set without restarting the marker and signal.

Parameters:

\<Delay\>   float

Range:	0 to 2^{32} - 1 chips
Increment:	1 chip
*RST:	0

Example: `BB:GPS:TRIG:OUTP2:DEL 1600`
                     sets a delay of 1600 chips for the signal on connector MARKER 2.

Manual operation: See "Marker x Delay" on page 151

\<subsystem\>:TRIGger:OUTPut\<ch\>:DELay:MINimum?
\<subsystem\>:TRIGger:OUTPut\<ch\>:DELay:MAXimum?

Queries the maximum marker delay for setting `<subsystem>:TRIG:OUTP:DEL:FIX ON`.

Return values:

\<Maximum\>   float

Range:	0 to max

Example: `BB:GPS:TRIG:OUTP:DEL:FIX ON`
                     restricts the marker signal delay setting range to the dynamic range.
                     `BB:GPS:TRIG:OUTP:DEL:MAX?`
                     queries the maximum of the dynamic range.
                     `Response: 2000`
                     the maximum for the marker delay setting is 2000 chips.

Usage: Query only

Manual operation: See "Current Range without Recalculation" on page 151

<subsystem>:TRIGger:OUTPut:DELay:FIXed <Fixed>

Restricts the marker delay setting range to the dynamic range. In this range the delay can be set without restarting the marker and signal. If a delay is entered in setting ON but is outside this range, the maximum possible delay is set and an error message is generated.

Parameters:

<Fixed>   0 | 1 | OFF | ON

                                *RST: 0

Example: BB:GPS:TRIG:OUTP:DEL:FIX ON

                                restricts the marker signal delay setting range to the dynamic range.

Manual operation: See "Fix marker delay to current range" on page 151

<subsystem>:TRIGger[:EXTernal<ch>]:DELay <Delay>

Specifies the trigger delay (expressed as a number of chips) for external triggering.

Parameters:

<Delay>   float

                                Range: 0 to 65535
                                Increment: 0.01 chip
                                *RST: 0.0 chips

Example: BB:GPS:TRIG:SOUR EXT

                                sets an external trigger via the TRIGGER 1 connector.
                                BB:GPS:TRIG:DEL 50
                                sets a delay of 50 chips for the trigger.

Manual operation: See "External Delay" on page 149

<subsystem>:TRIGger[:EXTernal<ch>]:INHibit <Inhibit>

Specifies the number of chips by which a restart is to be inhibited following a trigger event. Applies only in the case of external triggering.

Parameters:

<Inhibit>   integer

                                Range: 0 to 67108863
                                Increment: 1 chip
                                *RST: 0

Example: BB:GPS:TRIG:SOUR EXT

                                selects an external trigger via the TRIGGER 1 connector.
                                BB:GPS:TRIG:INH 200
                                sets a restart inhibit for 200 chips following a trigger event.

Manual operation: See "External Inhibit" on page 149

4.20 Marker Settings

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

Defines the signal for the selected marker output.

Note: In instruments equipped with option R&S SMBV-K96, disabled `<subsystem>:UMGPs` and enabled satellites constellation with more than 12 satellites, only one marker signal is available.

Parameters:

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

PULSe|PATTern|RATio
Reqular marker signals

PPS | PP2S | PPS10
A marker signal is generated for every start of second, every second second or respectivelly 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
(R&S WinIQSIM2 only)
The signal is generated continuously. A trigger event causes a restart.

*RST: PPS

Example:
`BB:GPS:TRIG:OUTP2:PATT #B000000011111111,15`
sets a bit pattern.
`BB:GPS:TRIG:OUTP1:MODE PATT`
activates the marker signal according to a bit pattern on output MARKER 1.

Manual operation: See "Marker Mode" on page 150

<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 150

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

Defines the bit pattern used to generate the marker signal in the setting `<subsystem>:TRIGger:OUTPut:MODE PATTern`. 0 is marker off, 1 is marker on.

Parameters:

<Pattern>	64 bit pattern
	Range: #B0,1 to #B111...1,64
	*RST: #B0,1

Example: `BB:GPS:TRIG:OUTP2:PATT #B000000011111111,15`
sets a bit pattern.
`BB:GPS:TRIG:OUTP2:MODE PATT`
activates the marker signal according to a bit pattern on output MARKER 2.

Manual operation: See "Marker Mode" on page 150

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

Sets the divider for Pulse marker mode (`<subsystem>:TRIG:OUTP:MODE PULSe`). The resulting pulse frequency is derived by dividing the chip rate (1.023 MHz) by the divider.

Parameters:

<Divider>	integer
	Range: 2 to 1024
	Increment: 1
	*RST: 2

Example:	`BB:GPS:TRIG:OUTP2:PULS:DIV 2`
	sets the divider to 2 for the marker signal on output MARKER 2.
	`BB:GPS:TRIG:OUTP2:FREQ?`
	queries the resulting pulse frequency of the marker signal.
	`Response: 511511.038`
	the resulting pulse frequency is 511.511 kHz.
Manual operation:	See "Marker Mode" on page 150

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

Queries the pulse frequency of the pulsed marker signal in the setting
`<subsystem>:TRIGger:OUTPut:MODE PULSe`. The pulse frequency is derived by
dividing the symbol rate by the divider.

Return values:

<Frequency>	float
Example:	`BB:GPS:TRIG:OUTP2:PULS:DIV 2`
	sets the divider for the marker signal on output MARKER 2 to the value 2.
	`BB:GPS:TRIG:OUTP2:MODE PULS`
	enables the pulsed marker signal.
	`BB:GPS:TRIG:OUTP2:PULS:FREQ?`
	queries the pulse frequency of the marker signal.
	`Response: 511511.038`
	the resulting pulse frequency is 511.511 kHz.
Usage:	Query only
Manual operation:	See "Marker Mode" on page 150

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

Sets the Pulse Width for 1PPS and 1PP2S marker mode
(`<subsystem>:TRIG:OUTP:MODE PPS | PP2S`).

Parameters:

<Width>	integer
	Range: 1 to 800
	*RST: 1
Example:	`BB:GPS:TRIG:OUTP2:MODE PPS`
	enables the 1PPS marker signal.
	`BB:GPS:TRIG:OUTP1:PULS:WIDT 2`
	sets the pulse width for the marker signal on output MARKER 2 to the value 2.
Manual operation:	See "Marker Mode" on page 150

4.21 Clock Settings

<subsystem>:CLOCk:MODE <Mode>

Enters the type of externally supplied clock (`<subsystem>:CLOCk:SOURce EXTernal`).

When `MCHip` is used, a multiple of the chip clock is supplied via the CLOCK connector and the chip clock is derived internally from this. The multiplier is entered with the command `<subsystem>:CLOCk:MULTiplier`.

Parameters:

<Mode>	CHIP | MCHip
	*RST: CHIP

Example: `BB:GPS:CLOC:MODE CHIP`
selects clock type "Chip", i.e. the supplied clock is a chip clock.

Manual operation: See "Clock Mode" on page 152

<subsystem>:CLOCk:MULTiplier <Multiplier>

Specifies the multiplier for clock type "Multiplied" (`<subsystem>:CLOCk:MODE MCHip`) in the case of an external clock source.

Parameters:

<Multiplier>	integer
	Range: 1 to 64
	Increment: 1
	*RST: 4

Example: `BB:GPS:CLOC:SOUR EXT`
selects the external clock source. The clock is supplied via the CLOCK connector.
`BB:GPS:CLOC:MODE MCH`
selects clock type "Multiplied", i.e. the supplied clock has a rate which is a multiple of the chip rate.
`BB:GPS:CLOC:MULT 12`
the multiplier for the external clock rate is 12.

Manual operation: See "Clock Multiplier" on page 153

<subsystem>:CLOCk:SOURce <Source>

Selects the clock source.

For two-path instruments, selecting `EXTernal` is only possible for path A, since the external clock source is permanently allocated to path A.

Parameters:

<Source>   INTernal | EXTernal | AINTernal

                            INTernal
                            The internal clock reference is used to generate the chip clock
                            (1.023 MHz).

                            EXTernal
                            The external clock reference is supplied to the CLOCK connec-
                            tor.

                            *RST: INTernal

Example: BB:GPS:CLOC:SOUR EXT
                            selects an external clock reference. The clock is supplied via the
                            CLOCK connector.
                            BB:GPS:CLOC:MODE CHIP
                            specifies that a chip clock is supplied via the CLOCK connector.

Manual operation: See "Clock Source" on page 152

<subsystem>:CLOCk:SYNChronization:EXECute

Performs automatically adjustment of the instrument's settings required for the selected synchronization mode.

Usage: Event

Manual operation: See "Set Synchronization Settings" on page 152

<subsystem>:CLOCk:SYNChronization:MODE <Mode>

Selects the synchronization mode.

This parameter is used to enable generation of very precise synchronous signals from several connected R&S SMBVs.

Note: If several instruments are connected, the connecting cables from the master instrument to the slave and between each two consecutive slave instruments must have the same length and type. Avoid unnecessary cable length and branching points.

Parameters:

<Mode>	NONE | MASTer | SLAVe

NONE
The instrument is working in stand-alone mode.

MASTer
The instrument synchronizes all connected instruments, including the trigger and reference clock signals.

SLAVe
The instrument receives the synchronisation and reference clock signal from another instrument working in a master mode.

*RST: NONE

Example: BB:GPS:CLOC:SYNC:MODE MAST
Defines the current instrument as the master for synchronization of the connected instruments

Manual operation: See "Sync. Mode" on page 152

A Annex

A.1 User Environment Files

The R&S SMBV supports different file formats that describe a moving receiver. This section focus on:

A.1.1 Movement or Motion Files

A.1.1.1 Waypoint File Format

This file format is a list of coordinates (longitude, latitude, altitude) and a respective resolution in milliseconds (see example "3GPP Performance Test Scenario#3 "Melbourne" (WGS84 geodetic coordinates)" on page 293).

Example: 3GPP Performance Test Scenario#3 "Melbourne" (WGS84 geodetic coordinates)

The resolution command at the beginning of the format specifies the sampling interval to be used for the WGS84 geodetic coordinates list. The resolution gives the time (in ms) between two consecutive waypoints.

```
RESOLUTION: 50
144.966666334601,-37.8166633061788,100.000000009313
144.966662392613,-37.8166632247233,100.000000039116
144.966658453002,-37.8166630889914,100.00000008475
144.966654516955,-37.8166628990241,100.000000149943
144.966650585658,-37.8166626548785,100.000000235625
144.966646660296,-37.8166623566284,100.000000339001
144.966642742053,-37.8166620043635,100.000000461936
144.966638832109,-37.81666159819,100.000000603497
144.966634931642,-37.8166611382304,100.000000762753
144.96663104183,-37.8166606246233,100.000000941567
144.966627163843,-37.8166600575235,100.000001138076
144.96662329885,-37.8166594371019,100.000001354143
144.966619448018,-37.8166587635456,100.000001588836
144.966615612505,-37.8166580370574,100.000001840293
144.966611793469,-37.8166572578565,100.00000211224
144.96660799206,-37.8166564261776,100.00000240095
144.966574759635,-37.8166466260761,100.00000580959
etc.
```

A.1.1.2 Vector Trajectory File Format

This file format uses a script containing the commands defined in the following table:

Command	Description
REFERENCE: lon, Lat, alt	Specifies the Cartesian Reference of the ENU coordinates system. Given as a geodetic WGS84 point (longitude, Latitude, Altitude).
START: E ,N, U, Velocity	Start location i.e., initial "current location" in the ENU Cartesian coordinate of center "REFERENCE". East, North and UP (ENU) coordinates are then provided (m). The last argument is the start velocity in (m/s).
ARC: E, N, Angle	Specifies a 2-Dimensional ARC (East, North) with the first two arguments representing the center of the ARC (m) in the Cartesian basis. The last argument specifies the angle in degrees (°) of the Arc Starting the "current location". Angle sign is significant since it indicates positive direction (against clock movement) or negative direction (same as clock movement). The end edge of the arc represents the new "current location". Velocity doesn't change when using an ARC command.
LINE: ΔE, ΔN, Acceleration	Specifies a 2-Dimensional Line starting the "current location" as the first edge and (Current loc E + ΔE, Current loc N + ΔN) as the second edge (m). Constant acceleration/deceleration can be specified in the last argument e.g., (0 means constant velocity). Unit for acceleration is (m/s2). The second edge is again used as the "current location" for the next command. The speed at this second edge is also used as the start speed for the next command.
STAY: Time	Stay at the current location for Time period (ms).

Example: Example of Waypoint File

This example explains a waypoint file in the second format for the case of 3GPP Performance Test Scenario#3 "Melbourne", as described in 3GPP 34.108 v.8.0.0, 3GPP 34.171 v.7.0.1.

The GPS signals simulate the GPS-receiver moving on a rectangular trajectory of 940m by 1 440m with rounded corners defined in table 1-1 and figure 1-1.

The initial reference is first defined followed by acceleration to final speed of 100 km/h in 250 m.

The UE then maintains the speed for 400 m. This is followed by deceleration to final speed of 25 km/h in 250 m. The UE then turn 90 degrees with turning radius of 20 m at 25 km/h. This is followed by acceleration to final speed of 100 km/h in 250 m.

The sequence is repeated to complete the rectangle.

Table 1-1: Trajectory Parameters for Moving Scenario and Periodic Update Performance test case

Parameter	Distance (m)	Speed (km/h)
l_{11}, l_{15}, l_{21}, l_{25}	20	25
l_{12}, l_{14}, l_{22}, l_{24}	250	25 to 100 and 100 to 25
l_{13}	400	100
l_{23}	900	100

Fig. 1-1: Moving Scenario

The following is the content of the waypoint file.

The start tag MOVEMENT FILE is a mandatory element for each movement descrip-
tion. If this tag is omitted, the instrument interprets the coordinates described in the
waypoint file as static one.

```
****************************** MOVEMENT FILE ******************************
%%!! All empty lines or statements starting with %% will be ignored
%% This file format is used to load a continuous movement File into the signal generator
%% Enter the WGS-84 Reference Point's Coordinates S
REFERENCE: 144.96667027777777777777777777777777,-7.81666333333333333333333333333,100
%%From here on, we work in an ENU (EAST-NORTH-UPPER)
basis centered around the ENU reference point S.
%%And more specifically the movement description will start from "START"
%%"START", "EAST COORDINATE E0 relative to S", "NORTH COORDINATE N0 relative to S",
"UPPER COORDINATE N0 relative to S", "SPEED in (m/s)"
START: 0, 0, 0, 6.94444444444444444
%%Each movement segment is described in one line command in the file and the segments
%% are to be read sequentially.
%%It can be either a line description or an arc description... for a line,
%% we start by the syntax: "LINE" and for an arc
%%we start with the syntax "ARC"
%%In the current version, we will provide only EAST-NORTH Movement segments
%%"ARC", "Center EAST Coordinate", "Center NORTH Coordinate",
"ARC in degrees (pos or neg is necessary for orientation)"
ARC: 0, 20, -90
%%"LINE", "Second Edge EAST Coordinate, first edge is the current point
%% or last point of previous segment", "Second Edge NORTH Coordinate",
"Acceleration/Deceleration"
%%Acceleration is to be taken as the projection following the movement segment
LINE: 0, 250, 1.44675925925925925926
LINE: 0, 400, 0
```

```
LINE: 0, 250, -1.44675925925925925926
ARC: 0, 920, -90
LINE: 250, 0, 1.44675925925925925926
LINE: 900, 0, 0
LINE: 250, 0, -1.44675925925925925926
ARC: 1400, 920, -90
LINE: 0, -250, 1.44675925925925925926
LINE: 0, -400, 0
LINE: 0, -250, -1.44675925925925925926
ARC: 1400, 20, -90
LINE: -250, 0, 1.44675925925925925926
LINE: -900, 0, 0
LINE: -250, 0, -1.44675925925925925926
%%End of Trajectory description
```

A.1.1.3 NMEA Files as Source for Movement Information

The NMEA movement information (receiver-fix location) extracted from a standard NMEA file can be used as a source for the generation of the movement file of interest.

Refer to chapter A.3, "NMEA Scenarios", on page 306 for detailed description of the NMEA file format.

A.1.1.4 Trajectory Description Files

The trajectory description files are supported by instruments equipped with option R&S SMBV-K92. For some of the file contents (including attitude information), the option R&S SMBV-K103 is additionally required.

The trajectory description files use the file extension `*.xtd`. See example "Trajectory description files in <positiononly> waypoint format" on page 298 for a simple example of the file format.

The table 1-2 describes the used tags and parameters.

*Table 1-2: Format of *.xtd file*

Container	Tag name	Parameter	Description
<general>			
	<info>	<name>	Name of the trajectory

Container	Tag name	Parameter	Description

	<property>	<waypointfor-mat>	Defines the format of the waypoint data.
			The possible values are:
			● "positiononly"
			  only waypoint data
			● "position_attitude"
			  waypoint and attitude data
			● "position_velocitymagnitude"
			  waypoints and velocity magnitude information per point
			● "position_velocitymagnitude_attitude"
			  waypoints, velocity magnitude and attitude data
			● "position_velocityvector"
			  waypoints and velocity vector per location
			● "position_velocityvector_attitude"
			  waypoints, velocity vector and attitude per point
			
			The three `<property waypointformat="*_attitude">` formats require the option R&S SMBV-K103. An instrument not equipped with this option discards files containing these formats and displays an error message.
			
			Smoothening is only possible with `<property waypointformat="positiononly">` as well as NMEA, waypoints and `*.kml`.
			
			The description of the waypoints has to follow the selected format, e.g. `<waypointvector data="0.05,144.966662392613,-37.8166632247233, 100.000000039116"/>` with `<property waypointformat="positiononly"/>` and `<datavectorhastimestamp="yes">`.

		<datavectorhas-timestamp>	Determines the way the time stamp (elapsed time starting start simulation time) is defined.
			● With `<datavectorhastimestamp="yes">`
			  the time stamp of a waypoint is retrieved from the `<waypointvector data>`, as the first data vector parameter.
			● With `<datavectorhastimestamp="no">`
			  the time stamp is internally calculated based on the follwoing rule:
			  – The time stamp of first waypoint is $T_1 = 0$
			    the time stamp of the waypoint$_N$ is $T_N = (N–1)$*`<timeresolution>`

		<coordsystem>	Defines the coordinate system ("enu", "cart ecef" or "geod wgs84") used by the definition of the `<waypointvector data>`.
		<timeresolution>	If `<datavectorhastimestamp="no">`, applies implicitly time stamps to waypoints. Otherwise, the time stamp is retrieved automatically, see `<datavectorhastimestamp>`.
		<enurefpoint>	Coordinates of the reference waypoint in ENU format
		<endbehaviour>	Determines the behavior of the moving object at the end of the trajectory. The possible values are: "jump", "return", "stop"
		<attitudeunit>	Defines the unit ("rad" or "deg") the attitude is expressed in
		<noofway-points>	Number of the used waypoints vectors. Use the parameter to minimize the size of the waypoint without actually deleting the waypoints

Container	Tag name	Parameter	Description
		`<attitudecontinu-ous>`	If `<attitudecontinuous="no">`, the attitude angles to be read are bounded by 2*PI. The `<attitudecontinuous="yes">` means that they are not bounded.
`<waypoints>`			Description of the trajectory as a list of waypoint vectors.
	`<waypointvec-tor>`	`<data>`	Coordinates of the waypoint in the format selected by `<coordsystem>` • [time,]longitude,latitude,altitude (geod wgs84) • [time,]X,Y,Z (cart ecef) • [time,]EAST,NORTH,UPPER (enu) Depending on the `<datavectorhastimestamp>`, 3 or 4 values are evaluated with `<property waypointformat="positiononly"/>` Depending on the `<property waypointformat>`, more information can be provided. The following is a list of the information appended to the coordinates of the waypoint mentioned above. • `<property waypointformat="positiononly">` no additional information • `<property waypointformat="position_attitude">` **yaw/heading,pitch/elevation,roll/bank**, e.g. `[time,]longitude,latitude,altitude,yaw,pitch,roll` The vehicle attitude (yaw, pitch and roll) parameters are configured relative to the local horizon • `<property waypointformat="position_velocitymagnitude">` **vel**, e.g. `[time,]X,Y,Z,vel` • `<property waypointformat="position_velocitymagnitude_attitude">` **vel,yaw/heading,pitch/elevation,roll/bank**, e.g. `[time,]EAST,NORTH,UPPER,vel,yaw,pitch,roll` • `<property waypointformat="position_velocityvector">` velocity vector **Vx,Vy,Vz**, e.g. `[time,]X,Y,Z,Vx,Vy,Vz` • `<property waypointformat="position_velocityvector_attitude">` **yaw/heading,pitch/elevation,roll/bank,Vx,Vy,Vz**, e.g. `[time,]longitude,latitude,altitude,yaw,pitch,roll, Vx,Vy,Vz`. **Note:** If the waypoints are in geod wgs84, velocity vector is assumed in Cartesian ECEF coordinate system.

Example: Trajectory description files in <positiononly> waypoint format

The following are two examples in `<property waypointformat="positiononly">` format. The examples emphasize on the different formats and explain the used time stamp principle.

- The `<waypointvector data>` parameters in the following example are vectors with size of 3, because of the tag `<property datavectorhastimestamp="no">`. Even if a fourth value have been defined, it would have been ignored.
  The time stamp is defined with the tag `<property timeresolution="0.05">`: $T_1 = 0$, $T_2 = (2-1)*0.05 = 0.05$, etc. $T_{12} = (12-1)*0.05 = 0.55$

```
<trajectory>
    <general>
        <info name="position only and user defined time stamp"/>
```

```
            <property waypointformat="positiononly"/>
            <property datavectorhastimestamp="no" />
            <property coordsystem="enu" />
            <property timeresolution="0.05" />
            <property enurefpoint="54.0,10.0,12"/>
            <property endbehaviour="return"/>
            <property noofwaypoints="12"/>
        </general>
        <waypoints>
            <waypointvector data="0,0,0"/>
            <waypointvector data="0,1,0"/>
            <waypointvector data="0,2,0"/>
            <waypointvector data="0,3,0"/>
            <waypointvector data="0,4,0"/>
            <waypointvector data="0,5,0"/>
            <waypointvector data="0,6,0"/>
            <waypointvector data="0,7,0"/>
            <waypointvector data="0,8,0"/>
            <waypointvector data="0,9,0"/>
            <waypointvector data="0,10,0"/>
            <waypointvector data="0,11,0"/>
    </waypoints>
</trajectory>
```

- In the following example the tag `<property datavectorhastimestamp="yes">` and all four value in the `<waypointvector data>` parameters are evaluated. The time stamp is retrieved automatically; the time stamp of a waypoint is the first value in the corresponding `<waypointvector data>` parameter:
  T_1 = 0, T_2 = 0.05, etc. T_{12} = 0.55.

```
<trajectory>
    <general>
        <info name="position only with time stamp"/>
        <property waypointformat="positiononly"/>
        <property datavectorhastimestamp="yes"/>
        <property coordsystem="geod wgs84" />
        <property endbehaviour="return"/>
        <property duration="2.0"/>
    </general>
    <waypoints>
        <waypointvector data="0,144.966666334601,-37.8166633061788,100.000000009313"/>
        <waypointvector data="0.05,144.966662392613,-37.8166632247233,100.000000039116"/>
        <waypointvector data="0.10,144.966658453002,-37.8166630889914,100.00000008475"/>
        <waypointvector data="0.15,144.966654516955,-37.8166628990241,100.000000149943"/>
        <waypointvector data="0.20,144.966650585658,-37.8166626548785,100.000000235625"/>
        <waypointvector data="0.25,144.966646660296,-37.8166623566284,100.000000339001"/>
        <waypointvector data="0.30,144.966642742053,-37.8166620043635,100.000000461936"/>
        <waypointvector data="0.35,144.966638832109,-37.81666159819,100.000000603497"/>
        <waypointvector data="0.40,144.966634931642,-37.8166611382304,100.000000762753"/>
```

```
        <waypointvector data="0.45,144.96663104183,-37.8166606246233,100.000000941567"/>
        <waypointvector data="0.50,144.966627163843,-37.8166600575235,100.000001138076"/>
        <waypointvector data="0.55,144.96662329885,-37.8166594371019,100.000001354143"/>
    </waypoints>
</trajectory>
```

A.1.2 Vehicle Description Files (Used for Smoothening)

The vehicle description files use the file extension `*.xvd`. The following is a simple example of the file format.

```
<vehicle>
    <info name="Car"/>
    <limits>
        <property maxspeed="100.0"/>
        <property maxg="0.6"/>
        <property maxg_lateral="0.6"/>
        <property maxjerk="15"/>
        <property maxjerk_lateral="15"/>
        <property maxyawrate="0"/>
        <property maxyawacceleration="0"/>
        <property maxyawjerk="0"/>
        <property maxpitchangle="0"/>
        <property maxpitchrate="0"/>
        <property maxpitchacceleration="0"/>
        <property maxpitchjerk="0"/>
        <property maxrollangle="0"/>
        <property maxrollrate="0"/>
        <property maxrollacceleration="0"/>
        <property maxrolljerk="0"/>
        <property proximity="0"/>
    </limits>
</vehicle>
```

The table 1-3 describes the used tags and parameters.

*Table 1-3: Format of *.xvd file*

Container	Tag name	Parameter	Description
<info>			
	<name>		Vehicle name
<limits>			
	<property>	<maxspeed>	Maximal Speed (m/s)
		<maxg>	Maximum tangential acceleration in g unit
		<maxg_lateral>	Maximum radial acceleration (due to centrifugal force) in g unit
		<maxjerk>	Maximum tangential Jerk in m/s2
		<maxjerk_lateral>	Maximum radial Jerk in m/s2

Container	Tag name	Parameter	Description
		<maxyawrate>	Maximum rate of change of the yaw/heading (rad/s)
		<maxyawaccelera-tion>	Maximum second rate of change (acceleration) of the yaw/heading (rad/s2)
		<maxyawjerk>	Maximum third rate of change (jerk) of the yaw/heading (rad/s3)
		<maxpitchangle>	Maximum pitch/elevation angle (rad)
		<maxpitchrate>	Maximum rate of change of the pitch/elevation (rad/s)
		<maxpitchaccelera-tion>	Maximum second rate of change (acceleration) of the pitch/elevation (rad/s2)
		<maxpitchjerk>	Maximum third rate of change (jerk) of the pitch/elevation (rad/s3)
		<maxrollangle>	Maximum roll/bank angle (rad)
		<maxrollrate>	Maximum rate of change of the roll/bank (rad/s)
		<maxrollaccelera-tion>	Maximum second rate of change (acceleration) of the roll/bank (rad/s2)
		<maxrolljerk>	Maximum third rate of change (jerk) of the roll/bank (rad/s3)
		<proximity>	Specifies the maximum allowed deviation from the waypoints specified by the user (m)

A.1.3 Antenna Pattern / Body Mask Files

The antenna patterns files are supported by instruments equipped with option R&S SMBV-K102/103. Some parameters additionally require option R&S SMBV-K92.

Two files describe an antenna, the antenna pattern `*.ant_pat` file and the phase response `*.phase` file.

Both files must have the same file name and must be stored in the same directory. The `*.ant_pat` file describes the power response matrix of each antenna. The instrument retrieves the phase response matrix from the `*.phase` file.

If the required `*.phase` file does not exist, a zero phase response is assumed.

Both file `*.ant_pat` and `*.phase` should have the same content but different data section `<data>` (see table 1-4)

The following are two examples of the file format: an extract of the description of an antenna pattern with three antennas and description of an antenna with four sectors.

Example: Anntena pattern with three antennas

The follwoing is an extract of the description.

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<antenna_pattern>
  <antenna_descr count="3" use_same_pattern="no">
    <antenna id="1" YawAxis_Z_offset="-5.5" PitchAxis_Y_offset="0"
```

```
                                    RollAxis_X_offset="-11.0" Yaw_offset="0" Pitch_offset="0"
                                    Roll_offset="0" />
          <antenna id="2" YawAxis_Z_offset="5.5" PitchAxis_Y_offset="-4"
                                    RollAxis_X_offset="-11.0" Yaw_offset="0" Pitch_offset="0"
                                    Roll_offset="120" />
          <antenna id="3" YawAxis_Z_offset="5.0" PitchAxis_Y_offset="4"
                                    RollAxis_X_offset="-11.0" Yaw_offset="0" Pitch_offset="0"
                                    Roll_offset="240" />
      </antenna_descr>
      <az_res> 1.00000000e+000 </az_res>
      <elev_res> 1.00000000e+000 </elev_res>
      <data>
         -179.5,-178.5,-177.5,-176.5,-175.5,-174.5,-173.5,-172.5,-171.5,-170.5,-169.5,-168.5,
         -167.5,-166.5,-165.5,-164.5,-163.5,-162.5,-161.5,-160.5,-159.5,-158.5,-157.5,-156.5,
         -155.5,-154.5,-153.5,-152.5,-151.5,-150.5,-149.5,-148.5,-147.5,-146.5,-145.5,-144.5,
         -143.5,-142.5,-141.5,-140.5,-139.5,-138.5,-137.5,-136.5,-135.5,-134.5,-133.5,-132.5,
         ...
      </data>
</antenna_pattern>
```

Example: Antenna with four sectors

The follwoing is a file decribing an antenna with four sectors.

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<antenna_pattern>
 <antenna_descr count="1" use_same_pattern="no">
    <antenna id="1" YawAxis_Z_offset="0" PitchAxis_Y_offset="0"
                      RollAxis_X_offset="0" Yaw_offset="0" Pitch_offset="90"
                      Roll_offset="0" />
 </antenna_descr>
 <az_res> 90.00000000e+000 </az_res>
 <elev_res> 90.00000000e+000 </elev_res>
  <data>
               -135.0,-45.0,45.0,135,45.0,0.0,3.0,6.0,9.0,-45.0,0.0,3.0,6.0,9.0
  </data>
</antenna_pattern>
```

The table 1-4 describes the used tags and parameters.

Table 1-4: Format of *.ant_pat and *.phase file

Container	Tag name	Parameter	Description
<antenna_pattern>			Defines antenna pattern File
<antenna_descr>			Contains the descriptions of the antennas
		<count>	Number of antenna patterns. Value range = 1 to 4.
		<use_same_pattern>	Specify whether the same data section is used for all the antennas or not. • "yes": the data section will be used for all antennas • "no": the data section has to be augmented with the data of all antennas consecutively

Container	Tag name	Parameter	Description
	\<antenna>		Descriptions of the individual antenna
		\<id>	Antenna identification number
		\<YawAxis_Z_off-set> \<PitchAxis_Y_off-set> \<RollAxis_X_off-set>	Position shift of the antenna along the X/Y/Z axis with respect to the center of gravity of the body Value in meters
		\<Yaw_offset> \<Pitch_offset> \<Roll_offset>	Angular shift of the antenna along the X/Y/Z axis of the to the body Value in degrees
\<az_res>			Resolution of the columns in the data section value in degrees integer divider of 360
\<elev_res>			Resolution of the raws in the data section value in degrees integer divider of 180
\<data>			The file has to contain for every pattern: • [1 + 360/\<az_res>] columns • [1 + 180/\<elev_res>] rows Title column and row are disregarded If the \<use_same_pattern="yes"> only one pattern is sufficient, otherwise the other patterns must be appended after each others inside this section If the data represents the power response of the antenna (*.ant_pat file), the power loss values are in dB (between 0 and 40) If the data represents the phase response of the antenna (*.phase file), the phase values are in degrees

A.2 RINEX Files

The RINEX file format consists of three ASCII file types: observation data file, navigation message file and meteorological data file. The navigation RINEX files comprises the Ephemeris information of all visible satellites at a control station or a commercial receiver.

Each file type consists of a header section and a data section. The header section contains global information for the entire file and is placed at the beginning of the file. The format of the data records of the RINEX navigation message files may contain navigation messages of more than one satellite system (GPS, GLONASS, Galileo, etc.). See RINEX Format Description for description of the RINEX file format.

RINEX Navigation Files can be downloaded from http://cddis.gsfc.nasa.gov/gnss_data-sum.html#brdc.

A.2.1 RINEX Format Description

Records marked with * are optional

Table 1-5: Navigation message file - header section description

	HEADER LABEL (Columns 61-80)	DESCRIPTION	FORMAT
	RINEX VERSION / TYPE	• Format version (2) • File type ('N' for Navigation data)	I6,14X, A1,19X
	PGM / RUN BY / DATE	• Name of program creating current file • Name of agency creating current file • Date of file creation	A20, A20 A20
*	COMMENT	Comment line(s)	A60
*	ION ALPHA	Ionosphere parameters A0-A3 of almanac (page 18 of subframe 4)	2X,4D12.4
*	ION BETA	Ionosphere parameters B0-B3 of almanac	2X,4D12.4
*	DELTA-UTC: A0,A1,T,W	Almanac parameters to compute time in UTC (page 18 of subframe 4) A0,A1: terms of polynomial T : reference time for UTC data W : UTC reference week number. Continuous number, not mod(1024)!	3X,2D19.12, 2I9
*	LEAP SECONDS	Delta time due to leap seconds	I6
	END OF HEADER	Last record in the header section.	60X

Table 1-6: Navigation message file - data record description

	HEADER LABEL (Columns 61-80)	DESCRIPTION	FORMAT

	PRN / EPOCH / SV CLK	• Satellite PRN number
		• Epoch: Toc - Time of Clock
		  – year (2 digits)
		  – month
		  – day
		  – hour
		  – minute
		  – second
		• SV clock bias (seconds)
		• SV clock drift (sec/sec)
		• SV clock drift rate (sec/sec2)
			I2, 5I3, F5.1,
			
			3D19.12

	BROADCAST ORBIT - 1	• IODE Issue of Data, Ephemeris • Crs (meters) • Delta n (radians/sec) • M0 (radians)	3X,4D19.12

	BROADCAST ORBIT - 2	• Cuc (radians)
		  e Eccentricity
		  Cus (radians)
		  sqrt(A) (sqrt(m))
			3X,4D19.12

HEADER LABEL (Columns 61-80)	DESCRIPTION	FORMAT
BROADCAST ORBIT - 3	• Toe Time of Ephemeris (sec of GPS week) • Cic (radians) • OMEGA (radians) • CIS (radians)	3X,4D19.12
BROADCAST ORBIT - 4	• i0 (radians) • Crc (meters) • omega (radians) • OMEGA DOT (radians/sec)	3X,4D19.12
BROADCAST ORBIT - 5	• IDOT (radians/sec) • Codes on L2 channel • GPS Week # (to go with TOE) Continuous number, not mod(1024)! • L2 P data flag	3X,4D19.12
BROADCAST ORBIT - 6	• SV accuracy (meters) • SV health (MSB only) • TGD (seconds) • IODC Issue of Data, Clock	3X,4D19.12
BROADCAST ORBIT - 7	• Transmission time of message (sec of GPS week, derived e.g. from Z-count in Hand Over Word (HOW) • spare • spare • spare	3X,4D19.12

A.2.2 Example of a RINEX File

The following part of a script has the ephemeris info of satellites 4 and 9 at toc = toe = 352800.

```
2.10            N: GPS NAV DATA                        RINEX VERSION / TYPE
teqc  2002Mar14    Lisa McCormick    20090501 01:40:41UTCPGM / RUN BY / DATE
Solaris 2.7|Ultra 2|cc SC5.0|=+-|*Sparc                COMMENT
rnw               Dataflow Processing 04/30/2009 00:00:21 COMMENT
                                                      END OF HEADER

 4 09  4 30  2  0  0.0-7.157493382690D-05-1.523403625470D-11 0.000000000000D+00
    5.100000000000D+01 9.125000000000D+00 5.024495004670D-09-3.085066632770D+00
    3.930181264880D-07 8.587007410820D-03 7.828697562220D-06 5.153723627090D+03
    3.528000000000D+05 3.725290298460D-09 1.098217239560D-01-1.024454832080D-07
    9.410577584670D-01 2.186875000000D+02 4.847291251310D-01-8.071407635100D-09
   -3.571577341960D-10 1.000000000000D+00 1.529000000000D+03 0.000000000000D+00
    2.400000000000D+00 0.000000000000D+00-6.053596735000D-09 5.100000000000D+01
    3.456060000000D+05 4.000000000000D+00

 9 09  4 30  2  0  0.0 5.332380533220D-05 1.932676241270D-12 0.000000000000D+00
    1.070000000000D+02-7.959375000000D+01 4.243748197720D-09-2.353512095310D+00
   -4.012137651440D-06 2.042865683320D-02 3.149732947350D-06 5.153640602110D+03
    3.528000000000D+05 2.738088369370D-07-3.071164751940D+00 9.499490261080D-08
    9.762633443270D-01 3.201250000000D+02 1.469759572200D+00-7.773895242510D-09
```

```
1.046472161190D-10 1.000000000000D+00 1.529000000000D+03 0.000000000000D+00
2.400000000000D+00 0.000000000000D+00-5.587935447690D-09 1.070000000000D+02
3.456060000000D+05 4.000000000000D+00
```

A.3 NMEA Scenarios

The National Marine Electronic Association (NMEA) is a broadcasting standard supported by all navigation receivers. The NMEA files comprise information about common parameters related to the satellite constellation, navigation parameters, time, receiver location and dynamics. The table 1-7 defines the starting acronym for a NMEA command of a specific navigation standard. In the moment this firmware is released, the Galileo NMEA acronym has not been defined yet.

Table 1-7: Overview of the starting acronyms for the NMEA command

ID	Meaning
AG	Autopilot - General
AP	Autopilot - Magnetic
CC	Computer - Programmed Calculator (outdated)
CD	Communications - Digital Selective Calling (DSC)
CM	Computer - Memory Data (outdated)
CS	Communications - Satellite
CT	Communications - Radio-Telephone (MF/HF)
CV	Communications - Radio-Telephone (VHF)
CX	Communications - Scanning Receiver
DE	DECCA Navigation
DF	Direction Finder
EP	Emergency Position Indicating Beacon (EPIRB)
ER	Engine Room Monitoring Systems
GP	Global Positioning System (GPS)
GL	GLONASS
HC	Heading - Magnetic Compass
HE	Heading - North Seeking Gyro
HN	Heading - Non North Seeking Gyro
II	Integrated Instrumentation
IN	Integrated Navigation
LA	Loran A
LC	Loran C

ID	Meaning
MP	Microwave Positioning System (outdated)
OM	OMEGA Navigation System

Example of NMEA File

```
$GPVTG,,T,,M,0.000,N,0.000,K,A*23
$GPGGA,215810.00,3540.00066,N,13944.99611,E,1,04,1.61,6.8,M,39.4,M,,*5E
$GPGSA,A,3,06,09,04,10,,,,,,,,,2.47,1.61,1.87*01
$GPGSV,4,1,14,29,48,312,,26,47,312,,06,35,302,47,09,18,238,47*71
$GPGSV,4,2,14,27,47,312,,13,50,118,,04,72,181,47,30,48,312,*76
$GPGSV,4,3,14,14,39,070,,10,12,050,47,31,48,312,,07,64,349,*72
$GPGSV,4,4,14,25,47,312,,28,48,312,*7E
$GPGLL,3540.00066,N,13944.99611,E,215810.00,A,A*69
$GPZDA,215810.00,28,04,2023,00,00*64
$GPRMC,215811.00,A,3540.00066,N,13944.99611,E,0.000,,280423,,,A*7E
```

A.4 Used Algorithms

This section provides reference information on the algorithms applied by the generation of the GNSS signal.

A.4.1 Detailes on the Smoothening Algorithm

An important parameter in the smoothening application is the proximity parameter which specifies the maximum deviation from the user's input waypoints. This parameter also specifies the number of inserted waypoints along the great circle in case the user's input waypoints are far away from each other. This is done to ensure that the smoothened trajectory will not transverse the earth's surface.

The smoothening is based on a modified version of linear segment parabolic blend algorithm (LSPB) to specify the motion dynamics between two waypoints and geometric blend to change the direction of motion.

LSPB provides continuity in velocity (limited acceleration) but suffers from infinite Jerk.

The modified LSPB guarantees the continuity in acceleration (limited Jerk) between waypoints. Control points are inserted between each two waypoints and the motion is planned between these control points using fifth order polynomial regression which guarantees the continuity of the velocity and acceleration at the control points.

The acceleration at the starting and the reached waypoint is zero; this will guarantee the continuity when entering a blend to change the direction of motion since the blend is represented by a sixth order polynomial with zero initial and final acceleration. The blend is symmetric with respect to the axis bisecting the angle formed by three waypoints.

The starting and the exit waypoint coordinates of the blend in addition to the blend's sixth order polynomial coefficients and velocity are determined by the proximity parameter mentioned before. Once the starting and exit waypoints coordinates for the blends of all the user's input waypoints are determined, these waypoints can later be connected using the modified (LSPB) mentioned before to form the entire motion trajectory.

In case the user specifies zero proximity value then the motion is formed entirely of straight segments with no blends, since the starting and the exit waypoints are the user's input waypoints, in such a case the simulated motion will stop at every waypoint in order to change direction of motion.

List of Commands

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