GPS and Assisted GPS Digital Standard for R&S®Signal Generators

Operating Manual

1171.5248.12 ─ 17

Test & Measurement

Operating Manual

ROHDE&SCHWARZ

This document describes the following software options:

- R&S®AMU-K44/-K65
  1402.6406.02, 1403.0101.02
- R&S®SMATE-K44/-K65
  1404.5407.02, 1415.1372.02
- R&S®SMJ-K44
  1404.1401.02
- R&S®SMU-K44/-K65
  1161.0566.02, 1415.0053.02

This manual version corresponds to firmware version FW 2.20.360.54 and later of the R&S®SMU200A, R&S®SMATE200A, R&S®SMJ100A and R&S®AMU200A.

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The following abbreviations are used throughout this manual: R&S®AMU is abbreviated as R&S AMU, R&S®SMATE is abbreviated as R&S SMATE, R&S®SMJ is abbreviated as R&S SMJ, R&S®SMU is abbreviated as R&S SMU, R&S®WinIQSIM2™ is abbreviated as R&S WinIQSIM2

Contents

1 Preface

1.1 Documentation Overview

The user documentation for the R&S Signal Generator 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 Signal Generator 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 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 Signal Generator 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 Help

The web help provides online access to the complete information on operating the R&S Signal Generator and all available options, without downloading. The content of the web help corresponds to the user manuals for the latest product version.

The web help is available on the R&S Signal Generator product page at the Downloads > Web Help area.

Application Notes

Application notes, application cards, white papers and educational notes are further publications that provide more comprehensive descriptions and background information.

The latest versions are available for download from the Rohde & Schwarz website, at http://www.rohde-schwarz.com/appnotes.

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.

Convention	Description
Links	Links that you can click are displayed in blue font.
"References"	References to other parts of the documentation are enclosed by quotation marks.

1.3 Notes on Screenshots

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

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

2 Introduction

The R&S Signal Generator provides you with the ability to generate signals of up to four Global Positioning System (GPS) satellites per baseband path.

An instrument equipped with two-path is able to generate the GPS signal of eight satellites. Signal generation is done in real-time and thus it is not limited to a certain time period.

The Global Positioning System (GPS) consists of several satellites circling the earth in low orbits. The satellites permanently transmit information about their current position (ephemeris) and about the orbits of all satellites (almanac). Additionally transmitted time information enables the GPS receiver to determine the runtimes of the transmitted signals. 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.

With GPS, the folloing two ranging codes are defined:

- the Coarse/Acquisition code (C/A code) The C/A code (f_ca= 1.023 MHz) is freely avalilable and used for civilian purposes.
- the Precise code (P-Code).The P-Code (f_p=10.23 MHz) is restricted and used for military applications.

Both ranging codes are used as spreading code for the navigation message which is transmitted at a rate of 50 baud.

There are two carriers available:

- L1 (f_L1= 1.57542 GHz), which is modulated by both C/A code and P-code (QPSK)
- L2 (f_L2=1.2276 GHz), modulated only with P-Code (BPSK).

2.1 GPS system parameters

The table 2-1 gives an overview of the GPS system parameters.

Table 2-1: GPS system parameters

Carrier frequency	L1=1.57542 GHz L2=1.2276 GHz
Signal level, after antenna	Approx. –115 dBm, depending on receive conditions
Doppler shift	-100 kHz to +100 kHz selectable (individually for each satellite)
Symbol rate	1.023 Mcps (C/A code) 10.23 Mcps (P-code)
C/A codes	1 to 37 selectable, 1023 chips per C/A code

Modulation	BPSK (C/A code, P-code) QPSK (C/A code and P-code)
Information data rate (navigation message)	50 Hz
Frame structure of navigation data	25 frames consisting of 5 subframes where 1 subframe consists of 10 words, 1 word consists of 30 data bits, 1 data bit consists of 20460 C/A code chips.

2.2 Assisted GPS (A-GPS)

Assisted GPS (A-GPS) was introduced to different mobile communication standards to significantly reduce the Time To First Fix (TTFF) of a user equipment (UE) containing a GPS receiver. This is achieved by transmitting information about the satellites directly from the base station to the UE.

In order to obtain a valid position fix, a stand-alone GPS receiver performs the following steps:

1. Find visible satellites by searching different C/A codes over different Doppler shifts. (This process is also called acquisition.)
2. Read out ephemeris data from the satellite's signal in order to get the satellite's current position.
3. Read out the complete navigation message from the satellite's signal in order to get the ionospheric model and the positions of all satellites (almanac).
4. Perform measurements to get runtimes of the different satellite signals.
5. Calculate exact location based on the satellite's positions and the measurements taken. (This process is also called navigation.)

Depending on previous knowledge, 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-GPS "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-GPS "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 Doppler and Code Phase correlation, i.e. the acquisition process, the UE only has to perform the measurements for getting the runtimes of the different satellite signals. Complexity of the UE's GPS module is hence reduced which leads to lower power consumption.

2.3 Use of navigation data

The C/A code used is fundamental to the simulation of GPS signals. The C/A code specifies the satellites to be simulated.

Real navigation data (the almanac) contains the information about the currently valid space vechicle IDs. When using real navigation data, only valid SV IDs can be selected in the operating menu.

When using arbitrary data, the complete range of IDs, 1 to 37, is available.

In addition to this, navigation data play an extremely important role, since they are essential for calculating the positions of the four satellites, which are the minimum prerequisite for localization purposes. However, even if only one satellite is available, real navigation data can be used to check the decoding of navigation information (such as GPS time, almanac and ephemeris) in addition to the recognition of the C/A code.

Current almanac data can be downloaded via the Internet and stored on the harddisk of the R&S Signal Generator. The almanac data is also used for extracting the satellite-specific navigation information (ephemeris).

Almanacs are currently available at the following internet sites:

- U.S.Coast Guard Navigation Center GPS Homepage http://www.navcen.uscg.gov/GPS/almanacs.htm
  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).

For more detailed information on the content and frame structure of navigation data, as well as C/A code generation, refer to the specifications.

2.4 Functional Overview Option GPS (R&S SMx/AMU-K44)

This chapter gives an overview of the option GPS (R&S SMx/AMU-K44).

The generic workflow is described in chapter 2.8.8, "Generating an one-satellite static generic GPS signal with R&S WinIQSIM2", on page 26, and chapter 2.8.9, "Loading and Processing an GPS Waveform in the ARB of R&S Signal Generator", on page 27.

2.4.1 Real-time generation

With the option GPS, up to four satellites per baseband can be simulated in real-time.

In case of a two-path instrument equipped with two options GPS, up to 8 real satellites can be simulated and controlled within one dialog.

2.4.2 Multi-satellite GPS signal

The R&S Signal Generator calculates a multi-satellite GPS signal in two different modes, the generic mode and the localization mode.

In "Generic mode", static satellites with constant Doppler shifts are provided for simple receiver test.

The generic workflow is described in chapter 2.8.1, "Generating GPS Signal for Simple Receiver Tests (Generic Mode)", on page 22.

The signal of dynamic real-life satellites is generated in Localization mode.

To fulfill the simulation requirements of the different application fields, the following localization simulation modes are provided:

- the "Auto SV Selection" mode
- the "Auto SV Selection and Update" mode
- the "Full Configuration" mode (requires option Assisted GPS R&S SMx/AMU-K65).

Although, both the localization modes "Auto SV Selection" and "Auto SV Selection and Update" are provided for the generation of a realistic GPS signal without limitation in the in the validity of the navigation data, there are some differences between them. The "Auto SV Selection and Update" mode is provided for the generation of a valid GPS signal over long period of time and supports satellite's handover. The "Auto SV Selection" mode is used whenever a static satellite constellation is to be tested.

Together with the "Full Configuration" mode, "Auto SV Selection" mode is also required for the generation of customer build A-GPS test scenarios.

2.4.3 Generation of realistic GPS scenarios

The signal generation localization modes "Auto SV Selection" and "Auto SV Selection and Update" are provided for the generation of a realistic GPS signal. In each of these modes, the connected GPS-receiver can be forced to obtain a valid 3D fix at a predefined or user-defined static geographical location.

Simulation of moving receiver is also possible, but this requires an instrument equipped with the option Assisted GPS R&S SMx/AMU-K65 (see chapter 2.6, "Moving Scenarios", on page 17).

An R&S Signal Generator equipped with option GPS (R&S SMx/AMU-K44) and working in one of the localization modes "Auto SV Selection" or "Auto SV Selection and Update" does the whole configuration of visible satellites and the generation of the ephemeris based on the uploaded almanac. The user only needs to specify time and location; all other configurations are done automatically by the R&S Signal Generator. This assures the calculation of a realistic scenario with an optimal 4-satellite constellation i.e. minimum Position Dilution of Precision (PDOP).

The generic workflow is described in chapter 2.8.3, "Generating GPS Signal with Flexible Simulation Time (Localization Mode Auto SV Selection)", on page 23.

2.4.4 Signal generation with projection of the ephemeris navigation data

The R&S Signal Generator employs a special algorithm for projection of the ephemeris navigation data that allows the generation of a valid navigation message without limitation in the simulation time. The ephemerides are automatically updated and the limitation problem of maximum allowed time span of two hours between the simulation time and the TOE (Time of Ephemeris) is already solved.

Any moment between the TOA and the TOA + 3.5 days can be selected as start simulation time. While testing a GPS receiver with enabled Almanac protocol check, the maximum value of the simulation time will be limited by the fact, that the almanac files are valid for period not longer than 3.5 days.

The generic workflow is described in chapter 2.8.3, "Generating GPS Signal with Flexible Simulation Time (Localization Mode Auto SV Selection)", on page 23.

2.4.5 Satellite handover

The special signal generation localization mode "Auto SV Selection and Update" is provided for the generation of a valid GPS signal over long period of time. In this mode, the R&S Signal Generator constantly calculates the localization signal based on two criteria, the optimal 4-satellite constellation with minimum PDOP and the satellite's visibility respecting the Satellite Elevation Mask. While the PDOP is a system parameter that is calculated by the R&S Signal Generator and displayed in real-time, the satellite's visibility is a configurable parameter that can be adjust by the user to simulate satellites with different elevations.

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 **dynamic and on-the-fly** and the process is called satellite handover. Information about the expected time of the next upcoming handover is provided by the parameter Get Next Handover Time.

The generic workflow is described in chapter 2.8.4, "Generating GPS Signal with Satellite Handover (Localization Mode Auto SV Selection and Update)", on page 24.

2.4.6 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 displayed values are updated every 5 seconds.

The Real-Time S.P.O.T. display is enabled for "Auto SV Selection" and "Auto SV Selection and Update" modes only.

2.4.7 Multipath signal generation

The R&S Signal Generator provides the possibility to simulate the GPS signal of one or more satellites that undergoes multipath propagation effects.

The generic workflow is described in chapter 2.8.2, "Generating Multipath Scenarios", on page 22.

2.5 Enhancements of Option Assisted GPS (R&S SMx/AMU-K65)

2.5.1 Prerequisites

The option Assisted GPS (R&S SMx/AMU-K65) is only available for 2-path instruments equipped with two options GPS (R&S SMx/AMU-K44). It enhances the option GPS with functionalities required for A-GPS test scenarios for 3GPP FDD and GSM.

2.5.2 Full set of pre-defined test scenarios for A-GPS 2G/3G Protocol and Conformance Test Cases

An R&S Signal Generator equipped with the option Assisted GPS supports all test scenarios for A-GPS Protocol and Conformance Test cases. The following predefined A-GPS test scenarios are currently supported:

- GSM Signaling Test Scenario (3GPP TS 51.010-1 v.7.7.0)
- GSM Performance Test Scenario#1 (3GPP TS 51.010-1 v.7.7.0)
- GSM Performance Test Scenario#2 (3GPP TS 51.010-1 v.7.7.0)
- GSM Performance Test Scenario#3 (3GPP TS 51.010-1 v.7.7.0)
- 3GPP FDD Signaling Test Scenario (3GPP 34.108 v.8.0.0, 3GPP TS 34.123-3 v. 6.4.0)
- 3GPP FDD Performance Test Scenario#1 (3GPP 34.108 v.8.0.0, 3GPP 34.171 v. 7.0.1)
- 3GPP FDD Performance Test Scenario#2 (3GPP 34.108 v.8.0.0, 3GPP 34.171 v. 7.0.1)
- 3GPP FDD Performance Test Scenario#3 (3GPP 34.108 v.8.0.0, 3GPP 34.171 v. 7.0.1)
- 3GPP2 Static Test Scenario (3GPP2 C.S0036-0 V1.0)
- 3GPP2 Moving Test Scenario (3GPP2 C.S0036-0 V1.0)

The generic workflow is described in chapter 2.8.6, "Generating A-GPS Test Signal", on page 25.

2.5.3 Custom build scenarios

The option Assisted GPS (R&S SMx/AMU-K65) is not limited to be used for A-GPS testing exclusively. Despite the predefined scenarios, it is also possible to define any user-specific test scenario.

For testing of stand-alone GPS receivers, the option Assisted GPS (R&S SMx/AMU-K65) offers full flexibility on the simulated satellites including definition of the satellite's orbit and the complete navigation message.

The Localization mode "Auto SV Selection" can be used to get a reasonable GPS scenario, changing to "Full Configuration" however enables the user to adjust the scenario to his exact requirements. For example, a detailed configuration of the ionospheric model for each satellite is possible.

The generic workflow is described in chapter 2.8.5, "Generating A-GPS Custom Build Scenarios (Localization Mode Full Configuration)", on page 25.

2.5.4 Generation of assistance data

Besides generating the satellite signals for an A-GPS test scenario, the option Assisted GPS (R&S SMx/AMU-K65) is 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, like e.g. R&S CMU/CRTU family.

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

Refer to chapter 2.7.2, "Example of A-GPS Test Setup", on page 21 for an example of the A-GPS setup. The generic workflow is described in chapter 2.8.7, "Generating Assistance Data", on page 26.

2.5.5 Simulation of Moving Receivers

In addition to the possibility to generate a real GPS signal for a predefined or user-defined static geographical location, it is also possible to simulate moving receivers (see chapter 2.6, "Moving Scenarios", on page 17).

2.6 Moving Scenarios

As it is part of the A-GPS test scenarios for 3GPP FDD and GSM (Performance Test Scenario#3), the option Assisted GPS (R&S SMx/AMU-K65) enhances the option GPS (R&S SMx/AMU-K44) by user-definable moving scenarios, which can also be used for testing stand-alone GPS-receivers. The user has the possibility to define a movement

by means of a so-called "waypoint" file, which will lead to a "moving" of the connected GPS-receiver.

2.6.1 Waypoint file's formats

Two `.txt` formats can be used for the waypoint file:

- The first format is a list of coordinates (longitude, latitude, altitude) and a respective resolution in milliseconds, as shown for the case of 3GPP Performance Test Scenario#3 "Melbourne" (WGS 84 geodetic coordinates)
  The resolution command at the beginning of the format specifies the sampling rate to be used for the WGS-84 geodetic coordinates list.

```
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.
```

- The second 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 WGS-84 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.

Command	Description
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).

2.6.2 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 figure 2-1 and table 2-2.

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 2-2: 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

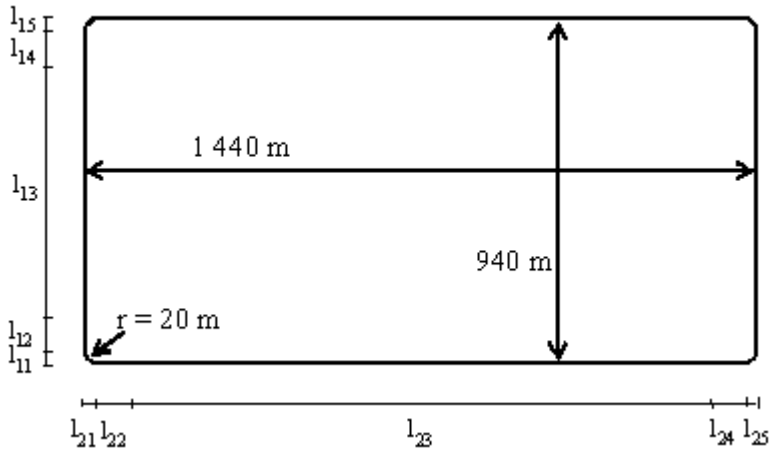


Fig. 2-1: Moving Scenario

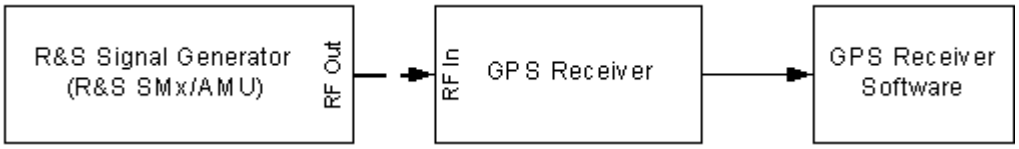
Movement Description

```
****************************** 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 SMU
%% 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/Decelerat
%%Acceleration is to be taken as the projection following the movement segment
LINE: 0, 250, 1.44675925925925926
LINE: 0, 400, 0
LINE: 0, 250, -1.44675925925925926
ARC: 0, 920, -90
LINE: 250, 0, 1.44675925925925926
LINE: 900, 0, 0
LINE: 250, 0, -1.44675925925925926
ARC: 1400, 920, -90
```

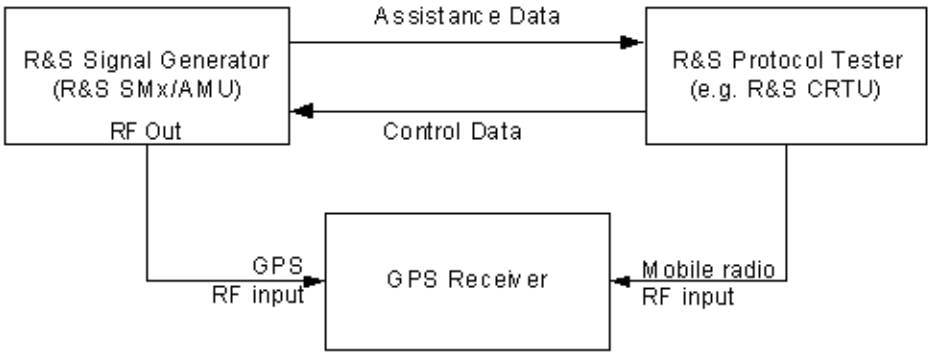
```
LINE: 0, -250, 1.44675925925925926
LINE: 0, -400, 0
LINE: 0, -250, -1.44675925925925926
ARC: 1400, 20, -90
LINE: -250, 0, 1.44675925925925926
LINE: -900, 0, 0
LINE: -250, 0, -1.44675925925925926
%%End of Trajectory description
```

2.7 Test Setups

2.7.1 Example of GPS Test Setup



2.7.2 Example of A-GPS Test Setup



2.8 Typical Workflows

This chapter provides examples of some typical generic workflows for working with:

- option GPS (R&S SMx/AMU-K44/K244)
- option Assisted-GPS (R&S SMx/AMU-K65)

2.8.1 Generating GPS Signal for Simple Receiver Tests (Generic Mode)

Enable this mode, if the generation of GPS signal of up to 4 configurable GPS satellites per baseband is required. The signal will be calculated for the selected predefined moment of time.

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. Adjust the output frequency of the instrument to the frequency selected with the parameter "RF Band":
   a) for RF instruments, select "Set to Default RF and Level" or
   b) select the FREQ key to set the frequency in the header of the instrument.
4. Set the parameters "Simulation Mode" to "Generic Mode".
5. Select an arbitrary data or "Real Navigation Data" as "Data Source".
6. When using Real Navigation Data, use the "Select Almanac File" function and choose an almanac file.
   The navigation message will be extracted from this almanac file.
7. Adjust the "Date" and the simulation time ("GPS Mean Time").
8. Select "Satellite Configurations" and configure the satellites as required.
9. Set the GPS "State" to ON to enable the GPS signal generation.

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

2.8.2 Generating Multipath Scenarios

1. Enable the instrument to work in "Generic Mode", "Localization Mode Auto SV Selection" or "Full Configuration" mode.
2. Select the "Satellite Configuration".
3. To simulate multipath, assign the same space vehicle ("SV ID") to more than one configuration columns (simulated satellites) and select different:
   a) Additional Time Shift
   b) Additional Power
   c) Additional Doppler Shift
4. Enable the GPS signal generation.

   The instrument will generate the GPS signal of satellite(s) that experiences multipath propagation.

2.8.3 Generating GPS Signal with Flexible Simulation Time (Localization Mode Auto SV Selection)

Enable this mode, if a simulation of realistic GPS scenario of up to 4 configurable GPS satellites per baseband and flexible simulation time is required. The signal will be calculated for the selected fixed or moving location. Simulation of moving receiver requires option Assisted GPS R&S SMx/AMU-K65.

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. Adjust the output frequency of the instrument to the frequency selected with the parameter "RF Band":
   a) for RF instruments, select "Set to Default RF and Level" or
   b) select the FREQ key to set the frequency in the header of the instrument.
4. Set the parameters "Simulation Mode" to "Localization Mode".
5. Set the "Localization Mode" to "Auto SV Selection".
6. Select and configure a static predefined or user-defined "Geographic Location" or a moving receiver.
   a) a static predefined geographic position (set the "Geographic Location" to "Munich" for instance)
   The "Altitude", "Latitude" and "Longitude" are set accordingly.
   b) a static user-defined location ("Geographic Location" set to "User Defined").
   The "Altitude", "Latitude" and "Longitude" have to be configured.
   c) a moving receiver ("Geographic Location" set to "Waypoints").
   Select a "Waypoint File" and the "Read Out Mode".
7. Use the "Select Almanac File" function and choose an almanac file.
   The navigation message will be extracted from this almanac file.
8. Adjust the "Date" and the simulation time ("GPS Mean Time"). Any simulation time in the week span can be selected. However, only the period between the Time of Almanac (TOA) and TOA+3.5 days ensures to lead to a receiver fix.
9. Choose the generation of GPS signal of 4 or 8 satellites.
10. Adjust the required "Satellite Elevation Mask" and set the elevation mask of the GPS receiver to this value.
11. Set the GPS "State" to ON to enable the GPS signal generation.

    The R&S Signal Generator generates a realistic GPS signal for 4 or 8 satellites' constellation, calculated to fulfill the minimum PDOP criteria. The selected satellites are displayed in the "Satellite Configurations" dialog. Most of the parameters are read-only; the satellite parameters can be additionally reconfigured to simulate multipath effects for instance (see also chapter 2.8.2, "Generating Multipath Scenarios", on page 22).

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", "Time of Simulation" and "Elapsed Time" are also displayed.
If a moving receiver had been configured, the "Real-Time S.P.O.T." displays the ideal trajectory the receiver should have.

2.8.4 Generating GPS Signal with Satellite Handover (Localization Mode Auto SV Selection and Update)

Enable this mode, if a simulation of realistic GPS scenario of up to 4 configurable GPS satellites per baseband with satellite handover is required. The signal will be calculated for the selected fixed or moving location. Simulation of moving receiver requires option Assisted GPS R&S SMx/AMU-K65.

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. Adjust the output frequency of the instrument to the frequency selected with the parameter "RF Band":
   a) for RF instruments, select "Set to Default RF and Level" or
   b) select the FREQ key to set the frequency in the header of the instrument.
4. Set the parameters "Simulation Mode" to "Localization Mode".
5. Set the "Localization Mode" to "Auto SV Selection and Update".
6. Select and configure a static predefined or user-defined "Geographic Location" or a moving receiver.
7. Use the "Select Almanac File" function and choose an almanac file.
   The navigation message will be extracted from this almanac file.
8. Adjust the "Date" and the simulation time ("GPS Mean Time").
9. Choose the generation of GPS signal of 4 or 8 satellites.
10. Adjust the required "Satellite Elevation Mask" and set the elevation mask of the GPS receiver to this value.
11. Set the GPS "State" to ON to enable the GPS signal generation.

    The R&S Signal Generator generates a realistic GPS signal for 4 or 8 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 a handover 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", "Time of Simulation" and "Elapsed Time" are also displayed. If a moving receiver had been configured, the "Real-Time S.P.O.T." displays the ideal trajectory the receiver should have.

2.8.5 Generating A-GPS Custom Build Scenarios (Localization Mode Full Configuration)

(for instruments equipped with option Assisted GPS (R&S SMx/AMU-K65) only)

1. Execute "Set To Default" to adjust the instrument's settings to a standard set of operating conditions.
2. Enable the instrument to work in "Localization Mode Auto SV Selection".

   Note: Do not use the "Auto SV Selection and Update" mode for the generation of A-GPS test signals.
3. Select "Full Configuration" mode.
4. Select the "Satellite Configuration" and reconfigure the satellites' parameters as required.
5. Configure the "Navigation Message" and for instance adjust the ionospheric model per satellite.
6. Set the GPS "State" to ON to enable the GPS signal generation.
7. Generate the required "Assistance Data".

   The R&S Signal Generator generates an A-GPS signal according to the settings made.

2.8.6 Generating A-GPS Test Signal

(for instruments equipped with option Assisted GPS (R&S SMx/AMU-K65) only)

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 "Set To Default" to adjust the instrument's settings to a standard set of operating conditions.
2. Select a predefined GSM or 3GPP FDD "AGPS Test Scenario".
3. Set the GPS "State" to ON to enable the GPS signal generation.

   The R&S Signal Generator generates an A-GPS signal according to the selected test scenario.

2.8.7 Generating Assistance Data

(for instruments equipped with option Assisted GPS (R&S SMx/AMU-K65) only)

The generic workflow for generation of assistance data files for A-GPS test scenarios is as follow:

1. Execute "Set To Default" to adjust the instrument's settings to a standard set of operating conditions.
2. Enable the instrument to work in "Localization Mode Auto SV Selection".

   Note: Do not use the "Auto SV Selection and Update" mode for the generation of A-GPS test signals.
3. Enable the instrument to work in "Full Configuration" mode.
4. Set the GPS "State" to ON to enable the GPS signal generation.
5. "Synchronize" the Assistance Data (Satellite Configurations and Reference Location Configuration) with the settings that have been already made.
6. Select the "Number of Satellites" and the Satellites IDs ("SV ID") for which assistance data is to be generated.
7. Reconfigure the reference location (i.e. BS location instead of receiver location).
8. Enter the "Time", "Duration" and "Resolution of Assistance Data".
9. Generate the required assistance data (almanac file, ionospheric file, etc.).

   The generated assistance data files are saved in the selected folder. Refer to the description of the corresponding file for description of the file format used. Generated almanac files can be later loaded at the instrument and used like the main almanac source.

2.8.8 Generating an one-satellite static generic GPS signal with R&S WinIQSIM2

The generic workflow for generating of GPS 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 "Select Almanac File" function and choose an almanac file.
   The navigation message will be extracted from this almanac file.
5. Adjust the "Duration of Satellites Simulation".

6. Adjust the "Date" and the simulation time ("GPS Mean Time").
7. Select a "Marker Delay" to overcome the limitation for the second's subfield and generate a signal with time of simulation different than 0s, 6s, 12s, etc.
8. Select "Satellite Configurations" and configure the satellite as required.
9. Set the GPS "State" to ON to enable the GPS signal generation.
10. Select the "Generate Waveform File" to save the GPS signal as waveform file.

2.8.9 Loading and Processing an GPS Waveform in the ARB of R&S Signal Generator

The generic workflow for loading and processing of GPS waveform is as follow:

1. Enable the R&S WinIQSIM2 to generate a one-satellite static generic GPS signal with constant Doppler shift and generate a waveform file.
2. Connect the R&S WinIQSIM2 to the R&S Signal Generator.
3. Transfer the waveform file. For detailed description, refer to the WinIQSIM2 Software Manual.
4. Load the waveform in the ARB of the R&S Signal Generator.
   While loading a waveform in the "ARB" menu, a message is displayed, that states the frequency used during signal generation ("Resulting Frequency").

   Note: The carrier frequency of a R&S Signal Generator 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" to ON to enable signal processing.

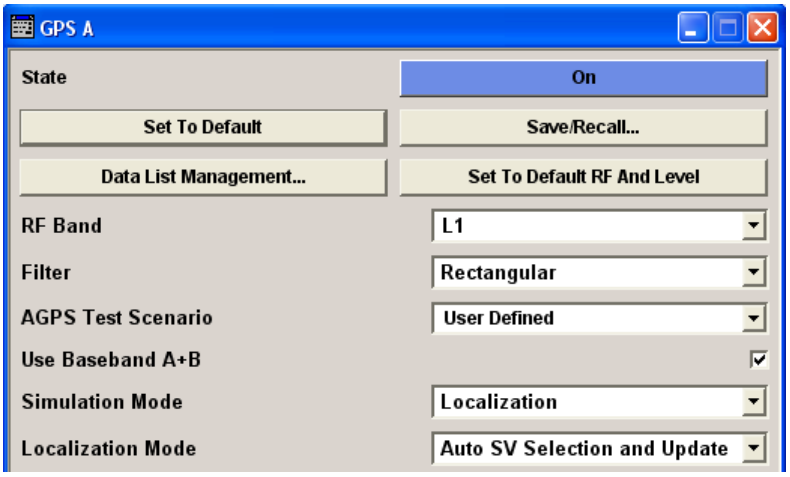
   The R&S Signal Generator processes the GPS signal generated by the R&S WinIQSIM2.

3 User Interface

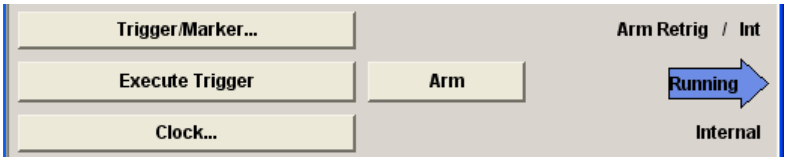
To access the dialog for setting the GPS digital standard, select "Baseband block > Satellite Navigation > GPS" or use the MENU key under "Baseband".

The dialog is split into several sections for configuring the standard. The choice of simulation mode determines which displays and parameters are made available in the lower section.

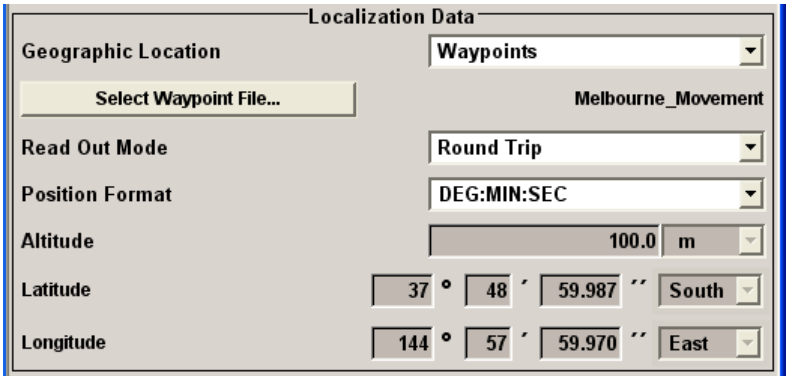
The upper section of the menu is where the GPS digital standard is enabled, the default settings are called and the simulation mode is selected. Buttons lead to the submenus for loading and saving the GPS configuration.



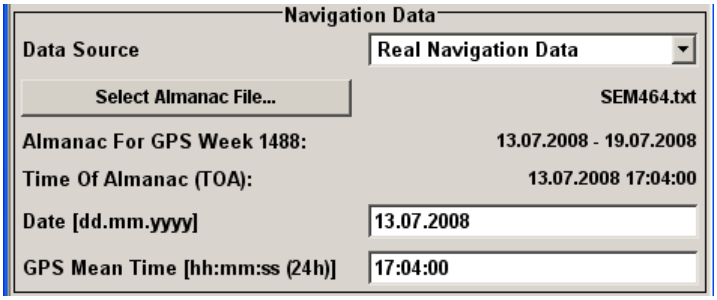
Buttons lead to the submenus for configuring the trigger and clock parameters.



The "Localization Mode" menu section is where the satellite signals is configured corresponding to a 'real' location which can be selected by the user

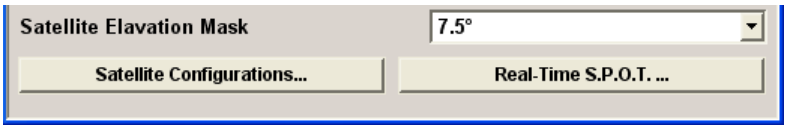


The "Navigation Data" menu section is where the data source for navigation information is selected and the data indicated (in case of real navigation data).



The button in the lower section leads to the submenu for configuring the satellite signals.

Additional buttons lead to dialogs for generating the 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 interdependencies between them.

These values are not necessarily representative of realistic test situations.

3.1 GPS Main Dialog

3.1.1 General Settings for GPS Simulation

The upper section of the menu is where the GPS digital standard is enabled, the default settings are called. Buttons lead to the submenus for loading and saving the GPS configuration.

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

Remote command:
`[:SOURce<hw>]:BB:GPS:STATe` on page 86

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

Note: For instruments with RF Output, the RF and level are preset with button "Set to default RF and Level".

Parameter	Value
State	Not affected by "Set to default"
RF Band	L1
Filter	Gauss
Simulation Mode	Generic
Navigation Data Source	Real navigation data
Select Almanac File	SEM299
Almanac for GPS Week	Week of Almanac
Date	Date of TOE
Time	Time of TOE
GPS Mean Time	Time
Satellite configuration	
Use Spreading	On
State satellite 1	On
Ranging Code	C/A
Doppler Shift	0 Hz

Remote command:
`[:SOURce<hw>]:BB:GPS:PRESet` on page 83

Save/Recall
Calls the Save/Recall menu.

From the "Save/Recall" menu the "File Select" windows for saving and recalling GPS configurations and the "File Manager" can be called.

GPS configurations are stored as files with the predefined file extension `*.gps`. The file name and the directory they are stored in are user-definable.

The complete settings in the "GPS" menu are saved and recalled.

"Recall GPS setting" — Opens the "File Select" window for loading a saved GPS configuration.
The configuration of the selected (highlighted) file is loaded by pressing the "Select" button.

"Save GPS setting" — Opens the "File Select" window for saving the current GPS signal configuration.
The name of the file is specified in the "File name" entry field, the directory selected in the "Save into" entry field. The file is saved by pressing the "Save" button.

"File Manager" Calls the "File Manager".
The "File Manager" is used to copy, delete and rename files and to create new directories.

Remote command:
[:SOURce<hw>]:BB:GPS:SETTing:CATalog? on page 84
[:SOURce<hw>]:BB:GPS:SETTing:LOAD on page 84
[:SOURce<hw>]:BB:GPS:SETTing:STORe on page 85
[:SOURce<hw>]:BB:GPS:SETTing:DELete on page 84

Data List Management
Calls the "Data List Management" menu. This menu is used to create and edit a data list.

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.

Example: Creating and editing the data list:

```
SOUR:BB:DM:DLIS:SEL "GPS"
SOUR:BB:DM:DLIS:DATA 1,1,0,1,0,1,0,1,1,1,1,0,0,0
SOUR:BB:DM:DLIS:DATA:APP 1,1,0,1,0,1,0,1,1,1,1,0,0
```

Set to default RF and Level
(For instruments with RF output only)

Calls the default RF and level settings for GPS signals.

The frequency is set to the GPS carrier frequency selected by parameter "RF Band" (L1 of 1.57542 GHz respectivelly L2 of 1.2276 GHz) and the output level is set to –115.0 dBm.

Note: To avoid any damage to connected receivers, the user must ensure that the signal level used is not too high. A downstream attenuator pad must be connected to generate output levels below -145 dBm.

Remote command:
[:SOURce<hw>]:BB:GPS:PRFLevel on page 83

RF Band
Selects the GPS carrier frequency used for Doppler calculation.

"L1" Selects GPS carrier frequency L1 = 1.57542 GHz.

"L2" Selects GPS carrier frequency L2 = 1.2276 GHz.

Remote command:
[:SOURce<hw>]:BB:GPS:RFBand on page 83

Filter
Sets the filter to GPS compliant rectangular mode or to Gauss mode.

Remote command:
[:SOURce<hw>]:BB:GPS:FILTer:TYPE on page 144

A-GPS Test Scenario
(enabled with option Assisted GPS (R&S SMx/AMU-K65) only)

Selects a predefined A-GPS test scenario according to A-GPS 2G/3G Protocol and Conformance Test Cases.

"User Defined" No predefined test scenario is selected. The parameters can be set by the user.

"GSM" One of the following predefined A-GPS GSM test scenarios can be selected:

- GSM Signalling Scenario
  (3GPP TS 51.010-1 v.7.7.0)
- GSM Performance Test Scenario 1
  (3GPP TS 51.010-1 v.7.7.0)
- GSM Performance Test Scenario 2
  (3GPP TS 51.010-1 v.7.7.0)
- GSM Performance Test Scenario 3
  (3GPP TS 51.010-1 v.7.7.0)

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

"3GPP FDD" One of the following predefined A-GPS 3GPP FDD test scenarios can be selected:

- 3GPP FDD Signalling Scenarion
  (3GPP 34.108 v.8.0.0, 3GPP TS 34.123-3 v.6.4.0)
- 3GPP FDD Performance Test Scenario 1
  (3GPP 34.108 v.8.0.0, 3GPP 34.171 v.7.0.1)
- 3GPP FDD Performance Test Scenario 2
  (3GPP 34.108 v.8.0.0, 3GPP 34.171 v.7.0.1)
- 3GPP FDD Performance Test Scenario 3
  (3GPP 34.108 v.8.0.0, 3GPP 34.171 v.7.0.1)

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

"3GPP2" One of the following predefined A-GPS 3GPP2 test scenarios can be selected:

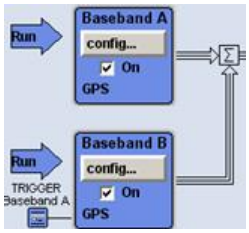
- 3GPP2 Static Test Scenarion
  (3GPP2 C.S0036-0 V1.0)
- 3GPP2 Moving Test Scenario
  (3GPP2 C.S0036-0 V1.0)

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

Remote command:
`[:SOURce<hw>]:BB:GPS:ATSCenario` on page 76

Use Baseband A+B
Enables/disables control of both paths via the GPS menu.

"ON" The signal of baseband B is routed to baseband A.



A total number of eight satellites can be configured simultaneously. Both basebands are automatically set to trigger mode "Armed Retrigger" and a trigger event has to be performed to start the signal generation. Changing of any parameter restarts the signal generation in both paths.

"OFF" Corresponds to normal operation, i.e. independent configuration of both paths.

Remote command:
`[:SOURce<hw>]:BB:GPS:BAB[:STATe]` on page 78

Simulation Mode
Sets the simulation mode.

The settings of the satellite signals are provided in the dialog Satellite Configuration.

"Generic" The satellite signals are configured by the user.
See also chapter 2.8.1, "Generating GPS Signal for Simple Receiver Tests (Generic Mode)", on page 22.

"Localization" The satellite signals are configured corresponding to a 'real' location which can be selected by the user.

Remote command:
`[:SOURce<hw>]:BB:GPS:SMODe` on page 85

Localization Mode
Sets the localization mode.

"Auto SV Selection"
Four satellites per baseband will be selected depending on the selected almanac.
For instruments equipped with two-paths, a total number of eight satellites will be selected.
The ephemerides are read out of the almanac and displayed in the Navigation Message Configuration dialog.
See also chapter 2.8.3, "Generating GPS Signal with Flexible Simulation Time (Localization Mode Auto SV Selection)", on page 23.

"Auto SV Selection and Update"
In this localization mode, a new satellite will be selected as soon as the elevation of a satellite is less then the selected Satellite Elevation Mask or a new satellite constellation with better PDOP is found.
The ephemeris data of all satellites are updated automatically.
In case the start time of the simulation differs to the TOA (Time of Almanac), the TOE (Time of Ephemeris) will be automatically updated.
See also chapter 2.8.4, "Generating GPS Signal with Satellite Handover (Localization Mode Auto SV Selection and Update)", on page 24.

"Full Configuration"
(enabled with option Assisted GPS R&S SMx/AMU-K65 only)
Selection "Full Configuration" as Localization mode enables the configuration of all parameter of the "Navigation Message".
Neither ephemeris data nor the visible satellites are updated but all parameter of the "Navigation Message" are enabled for configuration.
This mode is useful for the generation of A-GPS test signals different than the standardized ones (see chapter 2.8.5, "Generating A-GPS Custom Build Scenarios (Localization Mode Full Configuration)", on page 25).

Remote command:
`[:SOURce<hw>]:BB:GPS:LMODe` on page 78

Trigger/Marker
Calls the menu for selecting the trigger source, for configuring the marker signals and for setting the time delay of an external trigger signal (see chapter 3.6, "Trigger/Marker/Clock Settings", on page 65).

The currently selected trigger source is displayed to the right of the button.

Remote command:
`n.a.`

Execute Trigger
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:
`[:SOURce<hw>]:BB:GPS:TRIGger:EXECute` on page 133

Clock
Calls the menu for selecting the clock source and for setting a delay (see chapter 3.6.4, "Clock Settings", on page 72).

Remote command:
`n.a.`

3.1.2 Localization Data

The "Localization Mode" menu section is where the satellites signal are configured corresponding to a 'real' location which can be selected by the user.

Geographic Location
Selects the geographic location of the GPS receiver.

"User Defined"	Enables the definition of the "Latitude", "Longitude" and "Altitude" of the GPS receiver with fixed position.
"Waypoints"	(enabled with option Assisted GPS R&S SMx/AMU-K65 only) Enables defining a moving scenario, i.e. the simulation of moving receiver. The parameters "Latitude", "Longitude" and "Altitude" are set according to the first position of the Waypoint-File (see chapter 2.6, "Moving Scenarios", on page 17). For information about the current position of the receiver, open the Real-Time S.P.O.T. display and check the parameter "Receiver Location" or the displayed receiver trajectory ("Map View").
"<List of Predefined Positions>"	Selects one of the predefined fixed geographic locations (e.g. Munich). The parameters Latitude, Longitude and Altitude are set according to the selected position.

Remote command:
`[:SOURce<hw>]:BB:GPS:LOCation` on page 78

Select Waypoint File …
This selection is available only for "Geographic Location" set to Waypoints.

Call the "Select Waypoint File" menu. This menu is used to select predefined waypoint files.

A waypoint file is description of a moving scenario in form of a sequence of positions.

A waypoint file must have the extension `.txt`. See chapter 2.6.1, "Waypoint file's formats", on page 18 for detailed description of the waypoint file's format.

Remote command:
`[:SOURce<hw>]:BB:GPS:LOCation:WAYPoints` on page 82

Read Out Mode
This selection is available only for "Geographic Location" set to Waypoints.

Defines the way the waypoint 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:
`[:SOURce<hw>]:BB:GPS:LOCation:ROMode` on page 82

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.

Remote command:
`[:SOURce<hw>]:BB:GPS:LOCation:PFORmat` on page 82

Altitude
Sets the geographic altitude.

This field is only configurable for user defined geographic locations. If a value other than "User Defined" is selected in the "Geographic Location" field, the "Altitude" field is read only.

Remote command:
`[:SOURce<hw>]:BB:GPS:LOCation:ALTitude` on page 79

Latitude
Sets the latitude of the user defined geographic location.

This field is only configurable for user defined geographic locations. If a value other than "User Defined" is selected in the "Geographic Location" field, the "Latitude" field is read only.

Remote command:
for display format Degree:Minute:Second
`[:SOURce<hw>]:BB:GPS:LOCation:LATitude:DEGRees` on page 79
`[:SOURce<hw>]:BB:GPS:LOCation:LATitude:MINutes` on page 80
`[:SOURce<hw>]:BB:GPS:LOCation:LATitude:SEConds` on page 80
`[:SOURce<hw>]:BB:GPS:LOCation:LATitude:DIRection` on page 79
for display format decimal degree
`[:SOURce<hw>]:BB:GPS:LOCation:LATitude` on page 79

Longitude
Sets the longitude of the user defined geographic location.

This field is only configurable for user defined geographic locations. If a value other than "User Defined" is selected in the "Geographic Location" field, the "Longitude" field is read only.

Remote command:
for display format Degree:Minute:Second
`[:SOURce<hw>]:BB:GPS:LOCation:LONGitude:DEGRees` on page 80
`[:SOURce<hw>]:BB:GPS:LOCation:LONGitude:MINutes` on page 81
`[:SOURce<hw>]:BB:GPS:LOCation:LONGitude:SEConds` on page 81
`[:SOURce<hw>]:BB:GPS:LOCation:LONGitude:DIRection` on page 81
for display format decimal degree
`[:SOURce<hw>]:BB:GPS:LOCation:LONGitude` on page 80

3.1.3 Navigation Data

The "Navigation Data" menu section is where the data source for navigation information is selected and the data indicated (in case of real navigation data).

Data Source
Selects data source for the navigation information.

Navigation data play an extremely important role, since they are essential for calculating the positions of the four satellites, which are the minimum prerequisite for localization purposes. It also contains the information about the currently valid space vehicle IDs.

Note: If "Localization" is selected as simulation mode, "Real Navigation Data" is preselected and no other data source can be selected.

"Real Navigation Data"
"Real Navigation Data" (almanac) can be downloaded from the internet and stored on the hard disk of the generator.
The following almanac files are supported:

- SEM-files with data extension `*.txt`
- YUMA almanac files.

The almanac file to be used is selected in the file manager which is called with button "Select Almanac File...". The time information of the file is indicated below the button. The simulated date and time can be set within the time interval determined by the loaded almanac (GPS week).
The satellite specific information (ephemeris) is also taken from the almanac. The time of ephemeris is indicated.
All indications and entries are made in Greenwich Mean Time.

"PRBSxx/Data List/Pattern" Arbitrary data can be used for basic tests on the GPS signals.
Arbitrary data are supported only in "Generic" mode.
Data sources "PN9", "PN11", "PN15", "PN16", "PN20", "PN21", "PN23", "ALL0", "ALL1", and "Pattern" are all available.
If the "Pattern" data type is used, the bit pattern is defined in the "Pattern" input box. The length is limited to 64 bits.
"Data lists" are selected in the "File Select" window, which is called by means of the "Data List Management" button.
Signals generated in this way can be recognized by a GPS receiver. However, since there are no real navigation data on the C/A code, only the signal level of the simulated satellite(s) can be measured and displayed by the receiver.
A signal of this type is usually sufficient for performing simple function tests. It should be noted, however, that the receiver to be tested may have to be switched to a special test mode, since signals without correct navigation data are often not indicated (on a display, for example).

Remote command:
`[:SOURce<hw>]:BB:GPS:NAVigation:DATA` on page 91
`[:SOURce<hw>]:BB:GPS:NAVigation:DATA:PATTern` on page 93
`[:SOURce<hw>]:BB:GPS:NAVigation:DATA:DSELect` on page 92

Select Almanac File
Opens the file manager for selecting the almanac file.

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

The downloaded files can be copied to the R&S Signal Generator via USB interface or via a LAN network.

Almanacs are currently available at the following internet sites:

U.S.Coast Guard Navigation Center GPS Homepage (http://www.navcen.uscg.gov/GPS/almanacs.htm)

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).

Note: Supported almanac files are SEM-files with data extension `*.txt` and YUMA almanac files.

Remote command:
`[:SOURce<hw>]:BB:GPS:NAVigation:ALManac` on page 87

Almanac For GPS Week
Indicates the week in which the almanac was published. The simulation time ("Date") must be set within this time interval.

In "Full Configuration" mode, however, the simulation time is not limited to the almanac week.

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

Remote command:
[:SOURce<hw>]:BB:GPS:NAVigation:ALManac:BEGin:WNUMber? on page 89
[:SOURce<hw>]:BB:GPS:NAVigation:ALManac:BEGin:DAY? on page 88
[:SOURce<hw>]:BB:GPS:NAVigation:ALManac:BEGin:MONTh? on page 88
[:SOURce<hw>]:BB:GPS:NAVigation:ALManac:BEGin:YEAR? on page 89
[:SOURce<hw>]:BB:GPS:NAVigation:ALManac:END:DAY? on page 89
[:SOURce<hw>]:BB:GPS:NAVigation:ALManac:END:MONTh? on page 90
[:SOURce<hw>]:BB:GPS:NAVigation:ALManac:END:YEAR? on page 90

Time Of Almanac (TOA)
Indicates the time of almanac, i.e. the exact time up to the second to which the navigation data refers.

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

Remote command:
[:SOURce<hw>]:BB:GPS:NAVigation:ALManac:TOEPhemeris? on page 91

Date
Enters the date for the simulation. In "Auto SV Selection" mode, only values within the almanac GPS week are valid.

In "Full Configuration" mode, however, the simulation time is not limited to the almanac week.

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

The date format is: DD.MM.YYYY

Remote command:
[:SOURce<hw>]:BB:GPS:NAVigation:SIMulation[:BEGin]:DATE
on page 93

GPS Mean Time
Enters the exact time for the simulation. The used time zone is Greenwich Mean Time.

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

Remote command:
[:SOURce<hw>]:BB:GPS:NAVigation:SIMulation[:BEGin]:TIME
on page 94

Satellite Elevation Mask
(enabled for "Localization" mode)

Sets the satellite's elevation, i.e. determines the minimum angular distance of a satellite above the horizon.

When the elevation decreases below the selected elevation mask, the GPS satellite is considered as invisible 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. This process is called handover.

Satellites handover is performed in Localization mode set to "Auto SV Selection and Update" only. The expected time of the next upcoming satellites handover is displayed in the "Real-Time S.P.O.T." view with the parameter Real-Time S.P.O.T..

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

Remote command:
`[:SOURce<hw>]:BB:GPS:SEMask` on page 83

Satellite Configuration
Calls the dialog for configuring the satellite data (see chapter 3.2, "Satellite Configuration", on page 41).

Remote command:
`n.a.`

Real-Time S.P.O.T.
Calls the dialog for real-time display of the current PDOP and HDOP values, display of the satellites states and position and display of the receiver position (see Real-Time S.P.O.T.).

Remote command:
`n.a.`

Assistance Data Generation
(enabled with option Assisted GPS (R&S SMx/AMU-K65) only)

This button is available only for "Localization Mode" set to "Full Configuration".

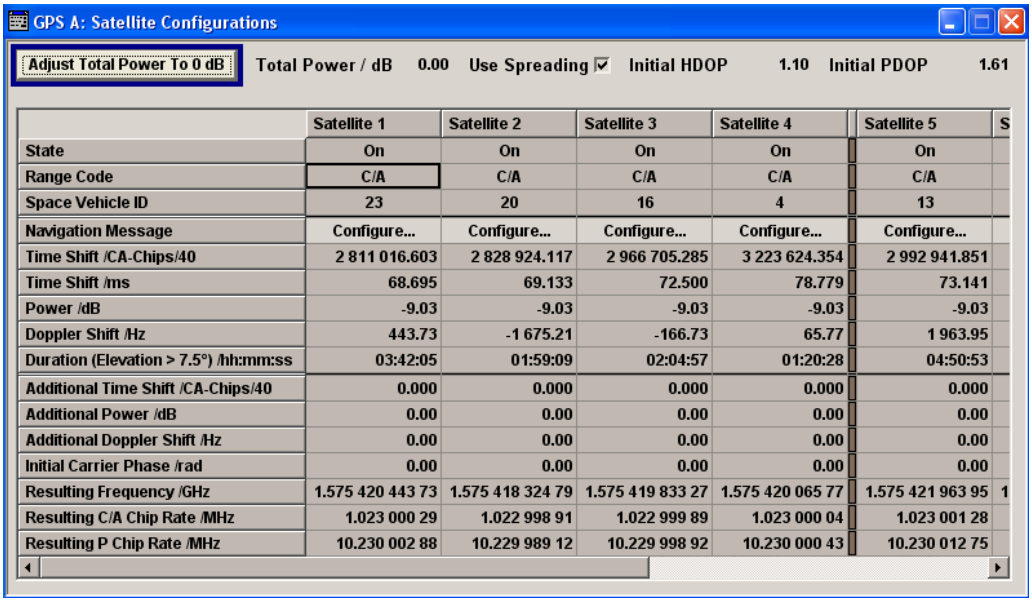
Calls the dialog for generation of assistance data (see chapter 3.4, "Assistance Data Generation", on page 54).

Remote command:
`n.a.`

3.2 Satellite Configuration

In the Satellite Configuration menu, the signal simulation of up to four satellites per path can be activated and configured, i.e. four satellites for one path instrument and eight satellites for two path instruments.

Configuration of eight satellites is only possible for two path instruments and enabled by parameter "Use Baseband A+B".



	Satellite 1	Satellite 2	Satellite 3	Satellite 4	Satellite 5	S
State	On	On	On	On	On	
Range Code	C/A	C/A	C/A	C/A	C/A	
Space Vehicle ID	23	20	16	4	13	
Navigation Message	Configure...	Configure...	Configure...	Configure...	Configure...	
Time Shift /CA-Chips/40	2 811 016.603	2 828 924.117	2 966 705.285	3 223 624.354	2 992 941.851	
Time Shift /ms	68.695	69.133	72.500	78.779	73.141	
Power /dB	-9.03	-9.03	-9.03	-9.03	-9.03	
Doppler Shift /Hz	443.73	-1 675.21	-166.73	65.77	1 963.95	
Duration (Elevation > 7.5°) /hh:mm:ss	03:42:05	01:59:09	02:04:57	01:20:28	04:50:53	
Additional Time Shift /CA-Chips/40	0.000	0.000	0.000	0.000	0.000	
Additional Power /dB	0.00	0.00	0.00	0.00	0.00	
Additional Doppler Shift /Hz	0.00	0.00	0.00	0.00	0.00	
Initial Carrier Phase /rad	0.00	0.00	0.00	0.00	0.00	
Resulting Frequency /GHz	1.575 420 443 73	1.575 418 324 79	1.575 419 833 27	1.575 420 065 77	1.575 421 963 95	1
Resulting C/A Chip Rate /MHz	1.023 000 29	1.022 998 91	1.022 999 89	1.023 000 04	1.023 001 28	
Resulting P Chip Rate /MHz	10.230 002 88	10.229 989 12	10.229 998 92	10.230 000 43	10.230 012 75	

Adjust Total Power to 0dB
Sets the power level of each satellite so that the sum of all levels results in 0 dB relative to the global level setting of the instrument.

The power ratio among the individual satellites is maintained.

Remote command:
`[:SOURce<hw>]:BB:GPS:POWer:ADJust` on page 95

Total Power
Displays the total power of all satellites.

The total power is calculated from the power ratio of the activated satellites.

After "Adjust Total Power to 0dB", this power corresponds to 0 dB.

If the value is not equal to 0 dB, the individual activated satellites (whilst still retaining the power ratios) are internally adapted so that the "Total Power" for achieving the set output level is 0 dB.

Remote command:
`[:SOURce<hw>]:BB:GPS:POWer[:TOTal]?` on page 95

Use Spreading
(enabled for Generic mode only)

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

Remote command:
`[:SOURce<hw>]:BB:GPS:SPReading[:STATe]` on page 100

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

The displayed HDOP value is not updated. The dynamic "HDOP" 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 general rule here is that the smaller the HDOP 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.

Note: This parameter is enabled only for "Localization" mode.

Remote command:
`[:SOURce<hw>]:BB:GPS:HDOP?` on page 87

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

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

The PDOP can be used as an indication of 3D positioning quality. The general rule hire is, that the smaller the PDOP the better the precision of the position fix will be.

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

Note: This parameter is enabled only for Localization mode.

Remote command:
`[:SOURce<hw>]:BB:GPS:PDOP?` on page 95

State
Activates/deactivates the generation of the satellite signal.

Remote command:
`[:SOURce<hw>]:BB:GPS:SATellite<st>:STATe` on page 99

Ranging Code
Selects the type of ranging code.

Note: Selecting the ranging code is only enabled for "Generic" simulation mode; for "Localization" mode this parameter is read-only.

The C/A code (f_ca = 1.023 MHz) is provided for civilian purposes. The P-code (f_p = 10.23 MHz) is provided for military purposes. They are used as spreading codes for the navigation data which is transmitted at a rate of 50 baud.

Note: For satellite 2, 3, and 4, the only available Ranging Code is C/A and cannot be changed.

"C/A"	Carrier L1 (f_L1= 1.57542 GHz) respectivelly carrier L2 (f_L2 = 1.2276 GHz) is modulated by C/A-code (BPSK).
"C/A + P"	(only available for Satellite 1) Carrier L1 respectivelly carrier L2 is modulated by C/A code and P-code (QPSK).

"P" (only available for Satellite 1)
Carrier L2 respectivelly carrier L2 is modulated by P-code (BPSK).

Remote command:
[:SOURce<hw>]:BB:GPS:SATellite<st>:RCODe on page 98

Space Vehicle ID
Enters the ID of the satellite to be simulated. This value is used to generate the corresponding C/A respectivelly P-code.

37 IDs are defined whereas 32 codes are used for identifying satellites.

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.

Remote command:
[:SOURce<hw>]:BB:GPS:SATellite<st>:SVID on page 99

Configure Navigation Message
Call the "Navigation Message Configurations" dialog (see chapter 3.3, "Navigation Message Configuration", on page 47).

Note: This parameter is enabled only for Localization mode.

Remote command:
n.a.

Time Shift / CA-Chips/40
Sets a delay of the selected satellite relative to the other satellites. The time shift is set in oversampled CA chips (Oversamling = 40).

In Localization mode, this parameter is not configurable and is set automatically depending on the simulated Geographic Location and on the satellite's orbit.

Note: The value displayed is the initial time shift at the beginning of the simulation. This value will be updated internally to implement moving satellites and receivers. However the value displayed is not updated.

Remote command:
[:SOURce<hw>]:BB:GPS:SVID<st>:TSCHips on page 101

Time Shift ms
Indicates the time shift of the code sequence in milliseconds.

Remote command:
[:SOURce<hw>]:BB:GPS:SVID<st>:TSSeconds? on page 101

Power
Sets the power offset of the satellite in dB. The offset determines the power ratio of the activated satellites.

After Adjust Total Power to 0dB has been performed, the resulting level of a certain satellite is calculated according to the following:

Resulting Level = Global Level + Satellite Power + Additional Power

Remote command:
[:SOURce<hw>]:BB:GPS:SVID<st>:POWer on page 101

Doppler Shift
Enters the Doppler shift of the simulated signal of the satellite.

The simulation of Doppler-shifted GPS signals can be used to check the receiver characteristics under more realistic conditions than with zero Doppler. In contrast to the real system, however, in "Generic mode" the set Doppler frequency is fixed.

In Localization mode, this parameter is not configurable and is set automatically depending on the simulated "Geographic Location" and on the satellite's orbit.

Note: The value displayed is the initial Doppler shift at the beginning of the simulation. This value will be updated internally to implement moving satellites and receivers. However the value displayed is not updated.

The relevant change to the chip rate of the C/A code is carried out automatically. The currently valid values for Doppler-shifted carrier frequency and chip rate are displayed under:

- Resulting Frequency
- Resulting C/A chip rate
- Resulting P chip rate

Remote command:
[:SOURce<hw>]:BB:GPS:SVID<st>:DSHift on page 100

Duration (Elevation > 2.5/5/7.5/10°)
Displays the time the satellite's elevation will be higher than 2.5, 5, 7.5 or 10° at the beginning of the simulation, as selected with the parameter Satellite Elevation Mask.

The value is displayed in format hh:mm:ss.

This parameter can be used to get an impression of how long the connected GPS receiver will use this certain satellite for its position fix.

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 satellite handover. Thus, a change of the satellite constellation can occur before the initially calculated time elapses.

The expected time of each upcoming handover is displayed in the "Real-Time S.P.O.T." view by the parameter Get Next Handover Time.

Note: This parameter is enabled only for "Localization" mode.

Remote command:
[:SOURce<hw>]:BB:GPS:SVID<st>:DURation? on page 100

Additional Time Shift / CA-Chips/40
Sets an additional delay of the selected satellite.

Additionally, the parameter can be used to simulate multipath conditions.

To simulate multipath, assign the same space vehicle (SV ID) to more than one configuration columns (simulated satellites) and select different "Additional Time Shift" (see also chapter 2.8.2, "Generating Multipath Scenarios", on page 22).

Remote command:
[:SOURce<hw>]:BB:GPS:SATellite<st>:ATSChips on page 97

Additional Power
Sets the additional power of the satellite in dB.

Additionally, the parameter can be used to simulate multipath conditions.

To simulate multipath, assign the same space vehicle (SV ID) to more than one configuration columns (simulated satellites) and select different "Additional Power" (see also chapter 2.8.2, "Generating Multipath Scenarios", on page 22).

After Adjust Total Power to 0dB has been performed, the resulting level of a certain satellite is calculated according to the following:

Resulting Level = Global Level + Satellite Power + Additional Power

Remote command:
[:SOURce<hw>]:BB:GPS:SATellite<st>:APOWer on page 96

Additional Doppler Shift
Enters the additional Doppler shift of the simulated signal of the satellite.

Additionally, the parameter can be used to simulate multipath conditions.

To simulate multipath, assign the same space vehicle (SV ID) to more than one configuration columns (simulated satellites) and select different "Additional Doppler Shift" (see also chapter 2.8.2, "Generating Multipath Scenarios", on page 22).

Remote command:
[:SOURce<hw>]:BB:GPS:SATellite<st>:ADSHift on page 96

Initial Carrier Phase /rad
Sets the initial carrier phase.

Additionally, the parameter is used in case of multipath simulation.

Remote command:
[:SOURce<hw>]:BB:GPS:SATellite<st>:ICPHase on page 98

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

The resulting frequency is calculated according to the following:

$f_{L1 \text{ or } L2 \text{ resulting}} = f_{L1 \text{ or } L2} + f_{Doppler}$,

where f_{L1}=1,575420GHz and f_{L2}=1,2276MHz as set with parameter RF Band.

Note: The carrier frequency of a R&S Signal Generator that processes a waveform generated with the R&S WinIQSIM2 has to match the value displayed with the parameter "Resulting Frequency".

While loading a waveform in the "ARB" menu, a message is displayed, that states the frequency used during signal generation ("Resulting Frequency"). To ensure proper signal processing, set the frequency in the header of the instrument's display to this value.

For more information, see sections chapter 2.8.8, "Generating an one-satellite static generic GPS signal with R&S WinIQSIM2", on page 26 and chapter 2.8.9, "Loading and Processing an GPS Waveform in the ARB of R&S Signal Generator", on page 27.

Remote command:
`[:SOURce<hw>]:BB:GPS:SATellite<st>:FREQuency?` on page 97

Resulting C/A Chip Rate
Indicates the currently valid values for the chip rate of the C/A code. The relevant change to the chip rate of the C/A code is carried out automatically if the doppler shift is changed.

The resulting C/A chip rate is calculated according to the following:

$f_{C/A\ resulting} = f_{C/A} \times \{1 + f_{Doppler} / f_{L1\ or\ L2}\}$,

where f_{L1}=1,575420GHz and f_{L2}=1,2276MHz as set with parameter $_{RF\ Band}$ and $f_{C/A}$ is fixed to 1.023 MHz.

Remote command:
`[:SOURce<hw>]:BB:GPS:SATellite<st>:CACRate?` on page 97

Resulting P Chip Rate
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:

$f_{P\text{-}resulting} = f_P \times \{1 + f_{Doppler} / f_{L1\ or\ L2}\}$

where f_{L1}=1,575420GHz and f_{L2}=1,2276MHz as set with parameter RF Band and f_P is fixed to 10.230 MHz.

Remote command:
`[:SOURce<hw>]:BB:GPS:SATellite<st>:PCRate?` on page 98

3.3 Navigation Message Configuration

The "Navigation Message Configuration" dialog is enabled only for "Localization" mode set to "Full Configuration".

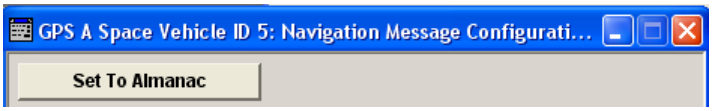
The parameters of the Navigation Message are only configurable for instrument equipped with option Assisted GPS (R&S SMx/AMU-K65).

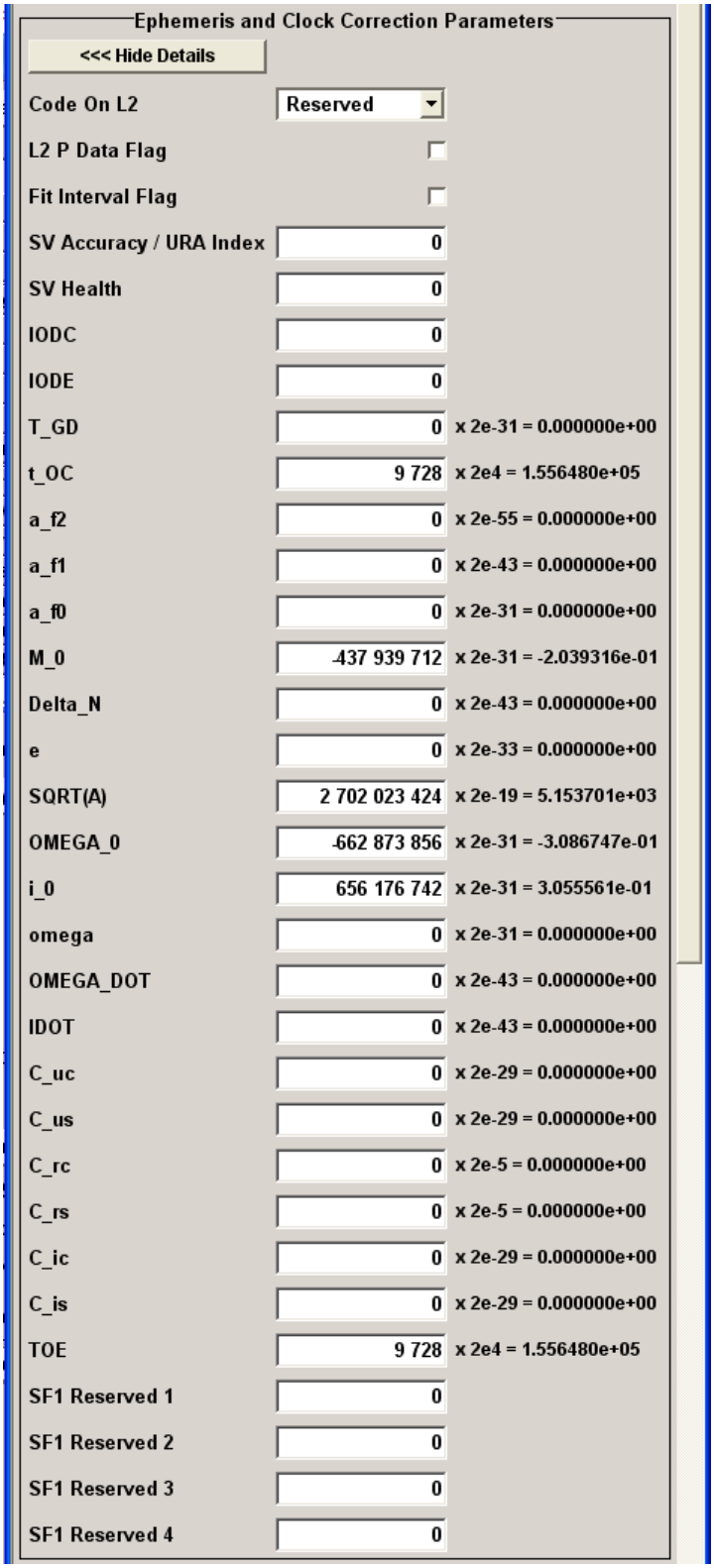
In the "Navigation Message Configuration" dialog, the navigation message of each satellite is displayed.

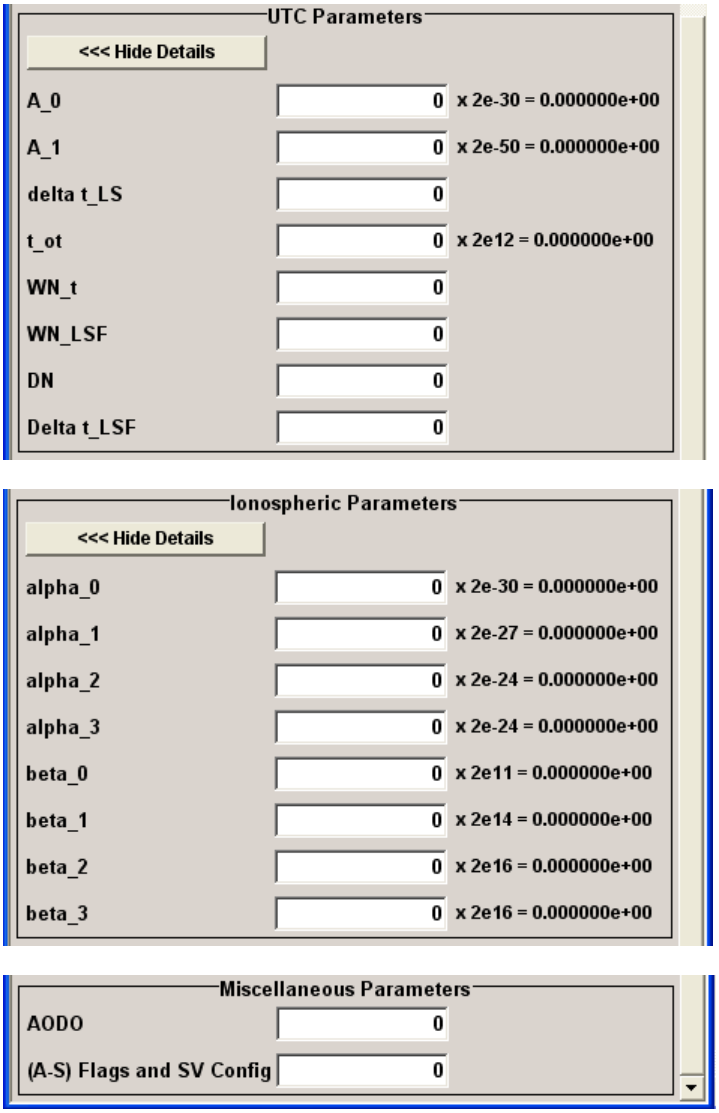
The menu comprises the sections "Ephemeris and Clock Correction Parameters", "UTC Parameters", "Ionospheric Parameters" and some "Miscellaneous Parameters", where the corresponding parameters are displayed.

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 50).

For better readability of the parameters in the "Navigation Message Configuration" menu, 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.




Ephemeris and Clock Correction Parameters
<<< Hide Details
Code On L2
Reserved
L2 P Data Flag
Fit Interval Flag
SV Accuracy / URA Index 0
SV Health 0
IODC 0
IODE 0
T_GD 0 x 2e-31 = 0.000000e+00
t_OC 9 728 x 2e4 = 1.556480e+05
a_f2 0 x 2e-55 = 0.000000e+00
a_f1 0 x 2e-43 = 0.000000e+00
a_f0 0 x 2e-31 = 0.000000e+00
M_0 -437 939 712 x 2e-31 = -2.039316e-01
Delta_N 0 x 2e-43 = 0.000000e+00
e 0 x 2e-33 = 0.000000e+00
SQRT(A) 2 702 023 424 x 2e-19 = 5.153701e+03
OMEGA_0 -662 873 856 x 2e-31 = -3.086747e-01
i_0 656 176 742 x 2e-31 = 3.055561e-01
omega 0 x 2e-31 = 0.000000e+00
OMEGA_DOT 0 x 2e-43 = 0.000000e+00
IDOT 0 x 2e-43 = 0.000000e+00
C_uc 0 x 2e-29 = 0.000000e+00
C_us 0 x 2e-29 = 0.000000e+00
C_rc 0 x 2e-5 = 0.000000e+00
C_rs 0 x 2e-5 = 0.000000e+00
C_ic 0 x 2e-29 = 0.000000e+00
C_is 0 x 2e-29 = 0.000000e+00
TOE 9 728 x 2e4 = 1.556480e+05
SF1 Reserved 1 0
SF1 Reserved 2 0
SF1 Reserved 3 0
SF1 Reserved 4 0



Set To Almanac
This button is only enabled for Localization mode "Full Configuration".

The navigation message's parameters will be calculated according to the selected almanac.

Using this option as basis for further reconfigurations is recommended.

Remote command:
`[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:PRESet` on page 113

Ephemeris Parameters
Note: The parameters of the Navigation Message are only configurable for instrument equipped with option Assisted GPS (R&S SMx/AMU-K65) and for Localization mode set to "Full Configuration".

Table 3-1: Ephemeris Parameters

Parameter	Descritpion	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).	`[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:CLTMode` on page 106
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.	`[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:FIFLag` on page 109
Fit Interval Flag	Indicates the curve-fit interval used by the CS (Control Segment) in determining the ephemeris parameters	`[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:FIFLag` on page 109
SV accuracy / URA Index		`[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:URA` on page 116
SV Health	This value does not have an impact on the actual health status of the generated satellite.	`[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:HEALth` on page 109
IODC	Issue of Data, Clock	`[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:IODC` on page 110
IODE	Issue of Data, Ephemeris	`[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:IODE` on page 110
M_0	Mean Anomaly at Reference Time (1)	`[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:MZERo` on page 111
Delta_N	Mean Motion Difference From Computed Value (1)	`[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:NDELta` on page 112
e	Eccentricity (1)	`[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:ECCentricity` on page 109
SQRT(A)	Square Root of the Semi-Major Axis (1)	`[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:SQRA` on page 114
OMEGA_0	Longitude of Ascending Node of Orbit Plane at Weekly Epoch (1)	`[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:OZERo` on page 113
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	Descritpion	SCPI command
i_0	Inclination Angle at Reference Time (1)	[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:IZERo on page 111
Omega	Argument of Perigee (1)	[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:OMEGa on page 112
OMEGA_DOT	Rate of Right Ascension (1)	[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:ODOT on page 112
IDOT	Rate of Inclination Angle (1)	[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:IDOT on page 110
C_uc	Amplitude of the Cosine Harmonic Correction Term to the Argument of Latitude (1)	[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:CUC on page 107
C_us	Amplitude of the Sine Harmonic Correction Term to the Argument of Latitude (1)	[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:CUS on page 108
C_rc	Amplitude of the Cosine Harmonic Correction Term to the Orbit Radius (1)	[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:CRC on page 107
C_rs	Amplitude of the Sine Harmonic Correction Term to the Orbit Radius (1)	[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:CRS on page 107
C_ic	Amplitude of the Cosine Harmonic Correction Term to the Angle of Inclination (1)	[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:CIC on page 106
C_is	Amplitude of the Sine Harmonic Correction Term to the Angle of Inclination (1)	[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:CIS on page 106
TOE	Time Of Ephemeris (1)	[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:TOE on page 116
SF1 Reserved 1/2/3/4		[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:REServed<ch> on page 113
AODO	Age of Data Offset	[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:AODO on page 104
(A-S) Flags and SV Configurations		[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:SVConfig on page 114
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.	

Clock Correction Parameters

Note: The parameters of the Navigation Message are only configurable for instrument equipped with option Assisted GPS (R&S SMx/AMU-K65) and for Localization mode set to "Full Configuration".

Table 3-2: Clock Correction Parameters

Parameter	Description	SCPI command
T_GD	L1-L2 Correction Term (1)	`[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:TGD` on page 114
t_OC a_f2 a_f1 a_f0	Clock Correction Parameter (1)	`[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:TOC` on page 115 `[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:AFTWo` on page 103 `[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:AFONe` on page 103 `[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:AFZero` on page 104

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.

UTC Parameters

Note: The parameters of the Navigation Message are only configurable for instrument equipped with option Assisted GPS (R&S SMx/AMU-K65) and for Localization mode set to "Full Configuration".

Parameter	Description	SCPI Command
"A_0"	Parameter A_0	`[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:AZERo` on page 105
"A_1"	Parameter A_1	`[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:AONE` on page 105
"delta t_LS"	Parameter Δt_{LS}	`[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:TLS` on page 115
"t_ot"	Parameter t_{0t}	`[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:TOT` on page 116
"WN_t"	Parameter WN_t	`[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:WNT` on page 117
"WN_LSF"	Parameter WN_{LSF}	`[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:WLSF` on page 117
"DN"	Parameter DN	`[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:DN` on page 108
"Delta t_LSF"	Parameter Δt_{LSF}	`[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:TLSF` on page 115

GPS Ionospheric Parameters

Note: The parameters of the Navigation Message are only configurable for instrument equipped with option Assisted GPS (R&S SMx/AMU-K65) and for Localization mode set to Full Configuration.

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.	`[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:ALPHa<ch0>` on page 104
"beta_0 .. beta_3"	Displays the parameter beta_0 .. beta_3 of the satellite's navigation message.	`[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:BETA<ch0>` on page 105

3.4 Assistance Data Generation

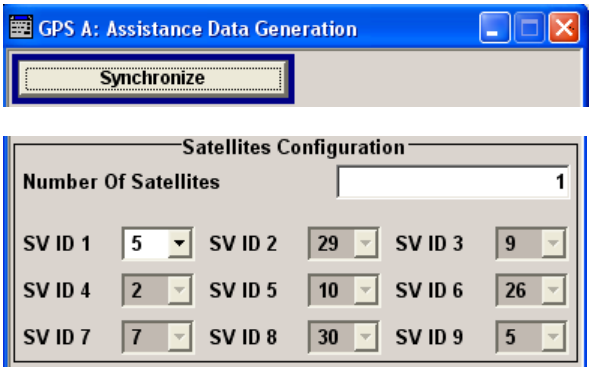
The "Assistance Data Generation" dialog is only available for instrument equipped with option Assisted GPS (R&S SMx/AMU-K65).

To access the "Assistance Data Generation" dialog, select "Main Dialog > Simulation Mode Localization", set the "Localization Mode" to *Full Configuration* and select "Assistance Data Generation".

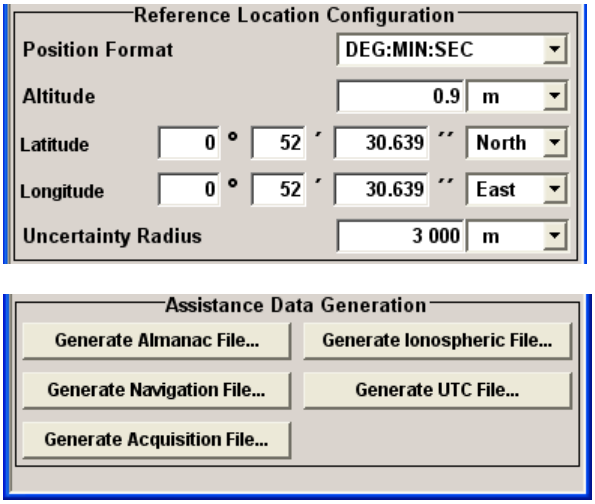
The "Assistance Data Generation" dialog is used to generate assistance data files for Assisted-GPS testing. These files can be formatted into mobile communication's message formats and passed by the protocol tester to the DUT in order to speed up Time To First Fix (TTFF).

See also chapter 2.8.7, "Generating Assistance Data", on page 26.

The upper part of the "Assistance Data Generation" menu is where the "Satellites Configuration" is set. A maximum of 9 satellites can be selected at one time for assistance data generation.



The middle part of the menu is where the parameters of the "Reference Location" and "Time Configuration" are set.



The lower part of the menu offers assistance in the generation of the "Almanac", "Ionospheric", "Navigation", "UTC" and "Acquisition" files.

Synchronize
Synchronizes the parameters of the satellites configuration and of the reference location configuration blocks as well as the parameter "Time of Assistance Data" with the settings made in the "Satellite Configuration" dialog and in the Main Dialog.

Remote command:
`[:SOURce<hw>]:BB:GPS:ADGeneration:SYNChronize` on page 127

Number Of Satellites
Sets the number of satellites for which the assistance data will be generate.

Remote command:
`[:SOURce<hw>]:BB:GPS:ADGeneration:SCOunt` on page 127

SV ID 1 .. 9
Sets the ID for the corresponding satellite (space vehicle) for which the assistance data will be generate.

Remote command:
`[:SOURce<hw>]:BB:GPS:ADGeneration:SATellite<st>:SVID` on page 127

Position Format (Assistance Data Generation)
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

Remote command:
`[:SOURce<hw>]:BB:GPS:ADGeneration:LOCation:PFORmat` on page 124

Altitude (Assistance Data Generation)
Sets the geographic altitude of the reference location in meters above sea level.

Remote command:
[:SOURce<hw>]:BB:GPS:ADGeneration:LOCation:ALTitude on page 120

Latitude (Assistance Data Generation)
Sets the latitude of the reference location.

Remote command:
for display format Degree:Minute:Second
[:SOURce<hw>]:BB:GPS:ADGeneration:LOCation:LATitude:DEGRees on page 121
[:SOURce<hw>]:BB:GPS:ADGeneration:LOCation:LATitude:MINutes on page 122
[:SOURce<hw>]:BB:GPS:ADGeneration:LOCation:LATitude:SEConds on page 122
[:SOURce<hw>]:BB:GPS:ADGeneration:LOCation:LATitude:DIRection on page 121
for display format decimal degree
[:SOURce<hw>]:BB:GPS:ADGeneration:LOCation:LATitude on page 121

Longitude (Assistance Data Generation)
Sets the longitude of the reference location.

Remote command:
for display format Degree:Minute:Second
[:SOURce<hw>]:BB:GPS:ADGeneration:LOCation:LONGitude:DEGRees on page 123
[:SOURce<hw>]:BB:GPS:ADGeneration:LOCation:LONGitude:MINutes on page 123
[:SOURce<hw>]:BB:GPS:ADGeneration:LOCation:LONGitude:SEConds on page 123
[:SOURce<hw>]:BB:GPS:ADGeneration:LOCation:LONGitude:DIRection on page 123
for display format decimal degree
[:SOURce<hw>]:BB:GPS:ADGeneration:LOCation:LATitude on page 121

Uncertainty Radius
Sets the Uncertainty Radius, i.e. sets the maximum radius of the area within which the two dimensional location of hte UE is bounded.

The uncertainty radius determines the required sensitivity of the DUT.

Remote command:
[:SOURce<hw>]:BB:GPS:ADGeneration:LOCation:URADius on page 124

Time of Assistance Data
Sets the starting time and date of the assistance data as GPS TOW (Time of Week).

Remote command:
[:SOURce<hw>]:BB:GPS:ADGeneration:TIME on page 127

Duration of Assistance Data
Sets the duration (in seconds) of the GPS Assistance Data.

Remote command:
`[:SOURce<hw>]:BB:GPS:ADGeneration:DURation` on page 120

Resolution of Assistance Data
Sets the resolution (in seconds) of the GPS Assistance Data.

Remote command:
`[:SOURce<hw>]:BB:GPS:ADGeneration:RESolution` on page 125

Generate Almanac File …
Opens the "Generate Almanac File" window for saving the generated Almanac File.

The name of the file is specified in the "File name" entry field. To save the file, press the "Save" button.

The almanac file is generated either in a GPS standard almanac file `.rs_al` format (see table below) or as standard Yuma formatted file `.rs_yuma` and can be therefore used as the main almanac source for 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 conformed to the format appended to standards 3GPP 34.108 v.8.0.0 and 3GPP TS 51.010-1v.7.7.0.

The file lists all possible satellites, available from the source Almanac File.

See chapter 2.8.7, "Generating Assistance Data", on page 26 for description of the workflow for generation of assistance data.

Remote command:
`[:SOURce<hw>]:BB:GPS:ADGeneration:ALMAnac:CREate` on page 119

Generate Ionospheric File …
(enabled with option Assisted GPS R&S SMx/AMU-K65 only)

Opens the "Select Ionospheric File" window for saving the generated ionospheric model.

The name of the file is specified in the "File name" entry field. To save the file, press the "Save" button.

The generated ionospheric file is file with extension `.rs_ion`.

The parameters listed in this file (see table below) are according to the parameters used for describing the near satellite ionospheric model "Klobuchar".

Parameter	Unit
SatID	-
alpha_0	seconds
alpha_1	sec/semi-circles
alpha_2	sec/(semi-circles)2
alpha_3	sec/(semi-circles)3
beta_0	seconds
beta_1	sec/semi-circles
beta_2	sec/(semi-circles)2
beta_3	sec/(semi-circles)3

The generated ionospheric file contains one row per satellite (maximum 9) that was assigned in the "Assistance Data Generation" menu.

See chapter 2.8.7, "Generating Assistance Data", on page 26 for description of the workflow for generation of assistance data.

Remote command:
`[:SOURce<hw>]:BB:GPS:ADGeneration:IONospheric:CREate` on page 120

Generate Navigation File ...
(enabled with option Assisted GPS R&S SMx/AMU-K65 only)

Opens the "Select Navigation File" window for saving the generated navigation model (ephemeris).

The name of the file is specified in the "File name" entry field. To save the file, press the "Save" button.

The generated navigation file is a file with extension `.rs_nav`.

The generated navigation file comprises the GPS standard ephemeris parameters of the Navigation Model (see table bellow).

Parameter	Unit
SatID	-
Sat Status	-
C/A or P on L2	boolean
URA Index	boolean

Parameter	Unit
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
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 navigation file is conformed to the format appended to standards 3GPP 34.108 v.8.0.0 and 3GPP TS 51.010-1v.7.7.0.

The file contains one row per satellite (maximum 9) that was assigned in the "Assistance Data Generation" menu.

See section chapter 2.8.7, "Generating Assistance Data", on page 26 for description of the workflow for generation of assistance data.

Remote command:
`[:SOURce<hw>]:BB:GPS:ADGeneration:NAVigation:CREate` on page 125

Generate UTC File …
(enabled with option Assisted GPS R&S SMx/AMU-K65 only)

Opens the "Select UTC" File window for saving the generated UTC file.

The name of the file is specified in the "File name" entry field. To save the file, press the "Save" button.

The generated UTC file is a file with extension `.rs_utc`.

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 GPS time to the normal UTC time.

The generated UTC file contains one row per satellite (maximum 9) that was assigned in the "Assistance Data Generation" menu.

See chapter 2.8.7, "Generating Assistance Data", on page 26 for description of the workflow for generation of assistance data.

Remote command:
`[:SOURce<hw>]:BB:GPS:ADGeneration:UTC:CREate` on page 128

Generate Acquisition File …
(enabled with option Assisted GPS R&S SMx/AMU-K65 only)

Opens the "Select Acquisition File" window for saving the generated acquisition file.

The name of the file is specified in the "File name" entry field. To save the file, press the "Save" button.

The generated Acquisition file is a file with extension `.rs_acq`.

This file consists of one ore more rows, each corresponding to the Receiver Referenced GPS Time of Week (GPS TOW). The number of generated rows depends on the settings made for in the "Assistance Data Generation" dialog and is calculated as follow:

Number Of Generated Rows = "Duration Of Assistance Data" / "Resolution of Assistance Data"

Each row includes several sequential Acquisition Blocks; each block comprises the parameters listed in table below.

The number of the acquisition blocks depends on the "Number Of Satellites" (maximum 9) that was assigned in the "Assistance Data Generation" menu.

The generated navigation file is conformed to the format appended to standards 3GPP 34.108 v.8.0.0 and 3GPP TS 51.010-1v.7.7.0.

Parameter	Unit
SatID	-
Doppler (0^{th} order term)	Hz
Doppler (1^{st} order term)	Hz/sec
Doppler Uncertainty	Hz
Code Phase	chips
Integer Code Phase	-

Parameter	Unit
GPS Bit Number	-
Code Phase Search Window	chips
Azimuth	deg
Elevation	deg

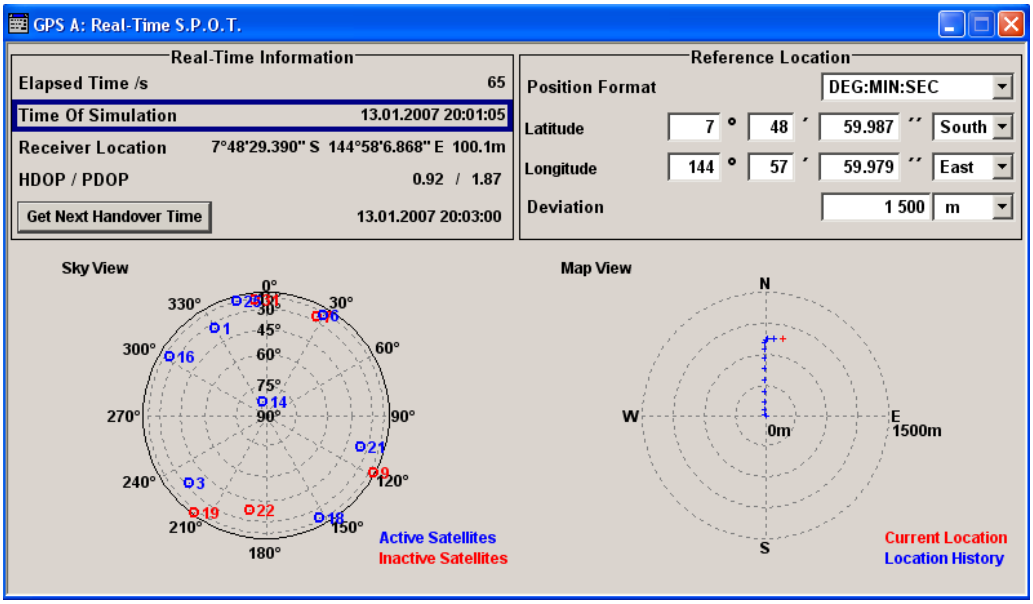
See chapter 2.8.7, "Generating Assistance Data", on page 26 for description of the workflow for generation of assistance data.

Remote command:
[:SOURce<hw>]:BB:GPS:ADGeneration:ACQuisition:CREate on page 119

3.5 Real-Time S.P.O.T.

The "Real-Time S.P.O.T." (Satellites and Position Online Tracker) view is a dynamic display of the current satellite's constellation and receiver position.

The display is enabled for "Auto SV Selection" and "Auto SV Selection and Update" modes only.



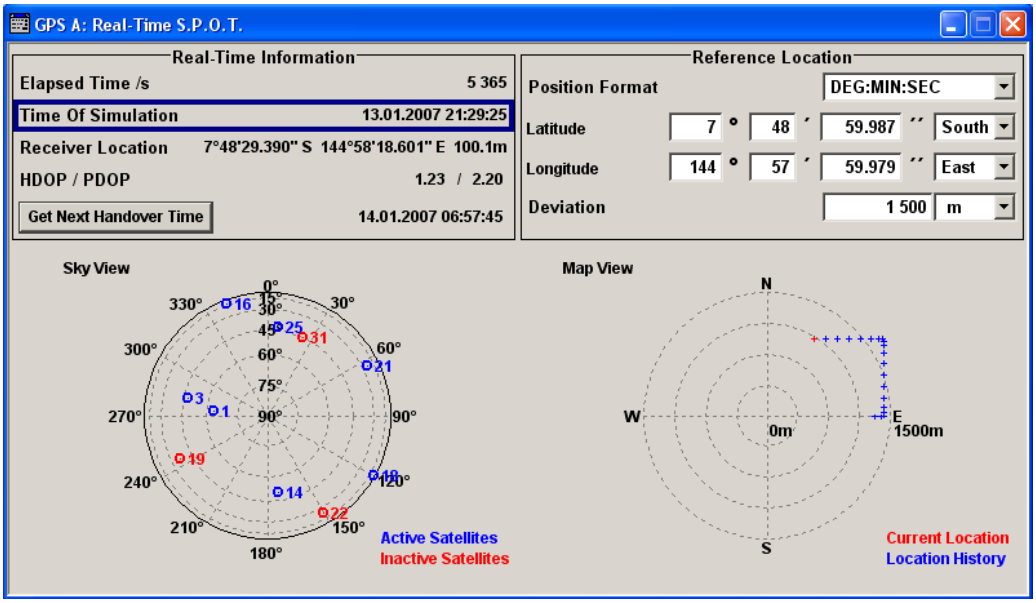
The "Real-Time S.P.O.T." view provides dynamic information about several parameters like HDOP, PDOP, receiver's location, elapsed time and trajectory of moving receiver, as well as the currently used satellite's constellation.

The "Sky View" section displays the current position and state (active or inactive) of the satellites. When "Auto SV Selection and Update" mode is selected, the real-word situation of disappearance and re-appearance of satellites can be observed.

The "Real-Time S.P.O.T." display is updated every 5 second and a special dynamic time tuning algorithm is used to optimize the presentation of the "Map View" display.

However, if GPS receiver software is used to analyze the generated GPS signal, a slight difference between the receiver position displayed on the Map View and the position 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.

Example:



Both figures in this section show the "Real-Time S.P.O.T." display of the same custom build GPS scenario with satellite handover but the second one is made around an hour and a half later (compare the values of the parameters "Time of Simulation" and "Elapsed Time" in both figures).

The "Map View" shows the current position of the receiver which in this particular case is a moving receiver with "Read Out Mode" set to "Round Trip" (compare both trajectories, the receiver on the first one is moving clockwise and on the second one counter-clockwise).

The current position and state of the satellites is displayed on the "Sky View". This is a GPS scenario with 8 satellites and a satellite handover had been performed (compare the satellite constellations, the position and number of active and inactive satellites is different; satellites with SV ID 6, 1 and 9 had disappeared behind the horizon).

3.5.1 Real-Time Information

The "Real-Time Information" section provides dynamic real-time information about several parameters like "HDOP", "PDOP", "Receiver Location", "Elapsed Time" and "Time of Simulation".

Elapsed Time
Displays the time elapsed form the beginning of the simulation.

The value is displayed in second and is updated every 5 sec.

Remote command:
`n.a.`

Time Of Simulation
Displays the current time of the simulation.

The current time is calculated form the selected "GPS Mean Time" and the "Elapsed Time".

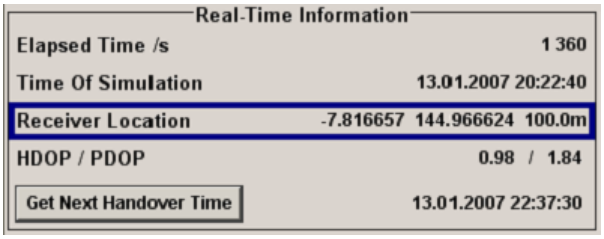
The value is displayed in format HH:MM:SS and is updated every 5 sec.

Remote command:
`n.a.`

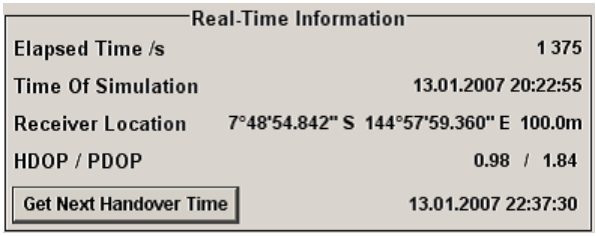
Receiver Location
Displays the current location of the receiver .

For static Geographic Location, the "Receiver Location" is as selected in the Localization Data section of the main menu.

For moving receivers however, the receiver position specified in the "Localization Data" section of the main menu is the initial location of the receiver. The current receiver location is retrieved from the waypoints file as function of the Elapsed Time. The value is displayed in the "Real-Time S.P.O.T." display.



The display format depends on the Position Format (S.P.O.T.) selected for the Reference Location.



Remote command:
[:SOURce<hw>]:BB:GPS:RLOCation:ALTitude? on page 129
[:SOURce<hw>]:BB:GPS:RLOCation:LATitude? on page 129
[:SOURce<hw>]:BB:GPS:RLOCation:LONGitude? on page 131
[:SOURce<hw>]:BB:GPS:RLOCation:LATitude:DEGRees? on page 130
[:SOURce<hw>]:BB:GPS:RLOCation:LATitude:MINutes? on page 130
[:SOURce<hw>]:BB:GPS:RLOCation:LATitude:SEConds? on page 131
[:SOURce<hw>]:BB:GPS:RLOCation:LATitude:DIRection? on page 130
[:SOURce<hw>]:BB:GPS:RLOCation:LONGitude:DEGRees? on page 131
[:SOURce<hw>]:BB:GPS:RLOCation:LONGitude:MINutes? on page 132
[:SOURce<hw>]:BB:GPS:RLOCation:LONGitude:SEConds? on page 132
[:SOURce<hw>]:BB:GPS:RLOCation:LONGitude:DIRection? on page 132

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.

Get Next Handover Time
(enabled for "Auto SV Selection and Updated" mode)

Displays the expected time of the upcoming satellites handover.

The time is expressed as a time offset (in seconds) to the beginning of the simulation set with the parameter GPS Mean Time.

Remote command:
[:SOURce<hw>]:BB:GPS:SPOT:NHOTime? on page 128

3.5.2 Reference Location

In the "Reference Location" section the reference location can be configured.

Position Format (S.P.O.T.)
Sets the format in which the Latitude and Longitude are displayed.

The Position Format selected heir changes the format theReceiver Location is 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.

Remote command:
`n.a.`

Latitude (S.P.O.T.)
Sets the latitude of the receiver location.

For static receivers, the initial value is automatically set to the latitude of the Geographic Location selected in the Localization Data section of the main menu.

When simulating moving receivers, the initial value is derived from the waypoints file and set to the latitude of the first receiver position.

Remote command:
`n.a.`

Longitude (S.P.O.T.)
Sets the longitude of the receiver location.

For static receivers, the initial value is automatically set to the longitude of the Geographic Location selected in the Localization Data section of the main menu.

When simulating moving receivers, the initial value is derived from the waypoints file and set to the longitude of the first receiver position.

Remote command:
`n.a.`

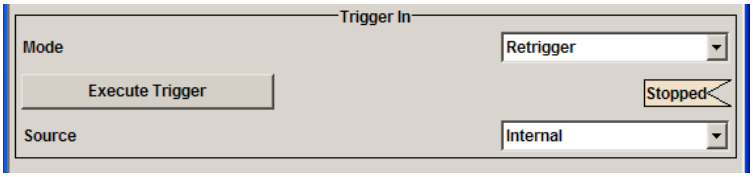
Deviation
Sets the deviation in terms of meters from the Reference Location and determines the radius of the "Map View" display.

Remote command:
`n.a.`

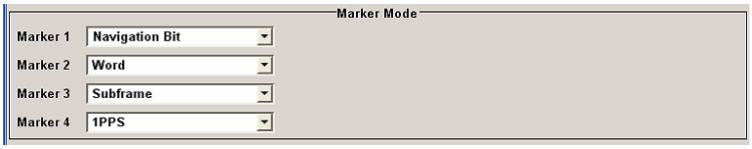
3.6 Trigger/Marker/Clock Settings

To access this dialog, select "Main Menu > Trigger/Marker".

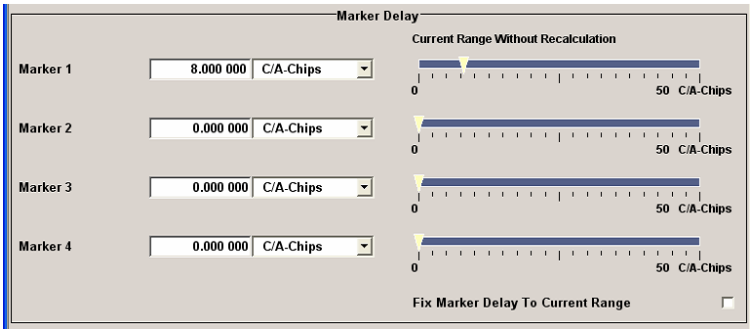
The "Trigger In" section is where the trigger for the signal is set. Various parameters will be provided for the settings, depending on which trigger source - internal or external - is selected. The current status of signal generation ("Running" or "Stopped") is indicated for all trigger modes.



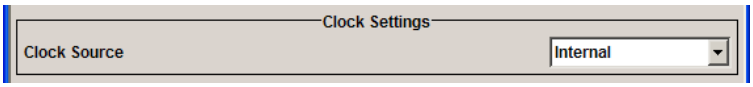
The "Marker Mode" section is where the marker signals at the MARKER output connectors are configured.



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 submenu for general trigger, clock and mapping settings.

3.6.1 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, i.e. determines the effect of a trigger event 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.
  An "Arm" stops the signal generation. A subsequent trigger event (internal with or external) causes a restart.
- "Armed_Retrigger"
  The signal is generated only when a trigger event occurs. Then the signal is generated continuously. Every subsequent trigger event causes a restart.
  An "Arm" stops signal generation. A subsequent trigger event (internal with 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 or external) causes a restart.

Remote command:
`[:SOURce<hw>]:BB:GPS[:TRIGger]:SEQuence` on page 138

Signal Duration Unit
Defines the unit for describing the length of the signal sequence to be output in the "Single" trigger mode.

Remote command:
`[:SOURce<hw>]:BB:GPS:TRIGger:SLUNit` on page 136

Signal Duration
Enters the length of the signal sequence to be output in the "Single" trigger mode.

Use this parameter to deliberately output part of the signal, an exact sequence of the signal, or a defined number of repetitions of the signal.

Remote command:
`[:SOURce<hw>]:BB:GPS:TRIGger:SLENgth` on page 135

Running/Stopped
For enabled modulation, displays the status of signal generation for all trigger modes.

- "Running"
  The signal is generated; a trigger was (internally or externally) initiated in triggered mode.
- "Stopped"
  The signal is not generated and the instrument waits for a trigger event.

Remote command:
`[:SOURce<hw>]:BB:GPS:TRIGger:RMODe?` on page 135

Arm
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:
`[:SOURce<hw>]:BB:GPS:TRIGger:ARM:EXECute` on page 133

Execute Trigger
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:
`[:SOURce<hw>]:BB:GPS:TRIGger:EXECute` on page 133

Trigger Source
Selects trigger source. This setting is effective when a trigger mode other than "Auto" has been selected.

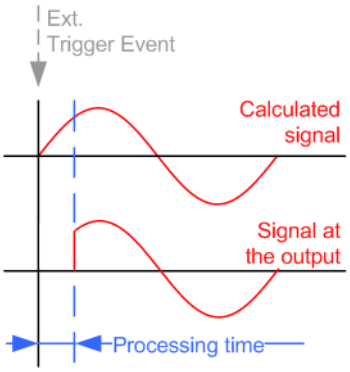
- "Internal"
  The trigger event is executed by "Execute Trigger".
- "Internal (Baseband A/B)"
  (two-path instruments)
  The trigger event is the trigger signal from the second path
- "External (Trigger 1/2)"
  The trigger event is the active edge of an external trigger signal, supplied at the TRIGGER 1/2 connector.
  Use the "Global Trigger/Clock Settings" dialog to define the polarity, the trigger threshold and the input impedance of the trigger signal.

Remote command:
`[:SOURce<hw>]:BB:GPS:TRIGger:SOURce` on page 136

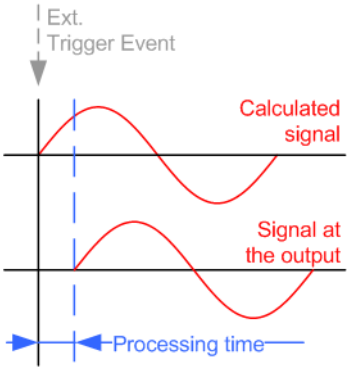
Sync. Output to External Trigger
(enabled for Trigger Source External)

Enables/disables output of the signal synchronous to the external trigger event.

"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 samples are cut off and no signal is outputted. After elapsing of the internal 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:
`[:SOURce<hw>]:BB:GPS:TRIGger:EXTernal:SYNChronize:OUTPut` on page 134

Trigger Delay
Delays the trigger event of the signal from:
- the external trigger source
- the other path

Use this setting to:
- synchronize the instrument with the device under test (DUT) or other external devices

Remote command:
`[:SOURce<hw>]:BB:GPS:TRIGger[:EXTernal<ch>]:DELay` on page 137
`[:SOURce<hw>]:BB:GPS:TRIGger:OBASeband:DELay` on page 134

Trigger Inhibit
Sets the duration for inhibiting a new trigger event subsequent to triggering. The input is to be expressed in samples.

In the "Retrigger" mode, every trigger signal causes signal generation to restart. This restart is inhibited for the specified number of samples.

This parameter is only available on external triggering or on internal triggering via the second path.

For two-path instruments, the trigger inhibit can be set separately for each of the two paths.

Remote command:
`[:SOURce<hw>]:BB:GPS:TRIGger[:EXTernal<ch>]:INHibit` on page 137
`[:SOURce<hw>]:BB:GPS:TRIGger:OBASeband:INHibit` on page 135

3.6.2 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.

The marker signal is always related to the first active satellite.

"Navigation Bit" — A marker signal is generated for every navigation data bit (20460 C/A chips)

"Word" — A marker signal is generated for every navigation data word (30 navigation bits).

"Subframe" — A marker signal is generated for every navigation subframe (corresponds to 10 words).

"1PPS" — A marker signal is generated for every start of second (GPS time). The "Pulse Width" is set in the corresponding field. The input is expressed as a number of chips.

"1PP2S" — A marker signal is generated for every second start of second (GPS time).
The "Pulse Width" is set in the corresponding field. The input is expressed as a number of chips.

Remote command:
`[:SOURce<hw>]:BB:GPS:TRIGger:OUTPut<ch>:PULSe:WIDTh` on page 142

"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 (1.023 MHz) by the divider. The input box for the divider opens when "Pulse" is selected, and the resulting pulse frequency is displayed.

Remote command:
`[:SOURce<hw>]:BB:GPS:TRIGger:OUTPut<ch>:PULSe:DIVider` on page 141
`[:SOURce<hw>]:BB:GPS:TRIGger:OUTPut<ch>:PULSe:FREQuency?` on page 142

"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:
`[:SOURce<hw>]:BB:GPS:TRIGger:OUTPut<ch>:PATTern` on page 141

"ON/OFF Period" 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:
`[:SOURce<hw>]:BB:GPS:TRIGger:OUTPut<ch>:ONTime` on page 140
`[:SOURce<hw>]:BB:GPS:TRIGger:OUTPut<ch>:OFFTime` on page 140

Remote command:
`[:SOURce<hw>]:BB:GPS:TRIGger:OUTPut<ch>:MODE` on page 139

3.6.3 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 symbols/samples. 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:
`[:SOURce<hw>]:BB:GPS:TRIGger:OUTPut<ch>:DELay` on page 138

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:
`[:SOURce<hw>]:BB:GPS:TRIGger:OUTPut<ch>:DELay:MINimum?` on page 139
`[:SOURce<hw>]:BB:GPS:TRIGger:OUTPut<ch>:DELay:MAXimum?` on page 139

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:
`[:SOURce<hw>]:BB:GPS:TRIGger:OUTPut:DELay:FIXed` on page 138

3.6.4 Clock Settings

The Clock Settings is used to set the clock source and a delay if required.

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".
In the case of two-path instruments this selection applies to path A.

Remote command:
`[:SOURce<hw>]:BB:GPS:CLOCk:SOURce` on page 143

Clock Mode
Enters the type of externally supplied clock.

"Chip" A chip clock is supplied via the CLOCK connector.

"Multiple" A multiple of the chip clock is supplied via the CLOCK connector; the chip clock is derived internally from this.
The "Multiplier" window provided allows the multiplication factor to be entered.

Remote command:
`[:SOURce<hw>]:BB:GPS:CLOCk:MODE` on page 143

Clock Multiplier
Enters the multiplication factor for clock type "Multiple".

Remote command:
`[:SOURce<hw>]:BB:GPS:CLOCk:MULTiplier` on page 143

Measured External Clock
Provided for permanent monitoring of the enabled and externally supplied clock signal.

Remote command:
`CLOCk:INPut:FREQuency?`

3.6.5 Global Settings

The buttons in this section lead to dialogs for general trigger, clock and mapping settings.

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 impedance and the polarity of the clock and trigger inputs.

The parameters in this dialog affect all digital modulations and standards, and are described in chapter "Global Trigger/Clock/Input Settings" in the Operating Manual.

User Marker / AUX I/O Settings
Calls the "User Marker AUX I/O Settings" dialog, used to map the connector on the rear of the instruments.

See also "User Marker / AUX I/O Settings" in the Operating Manual.

4 Remote-Control Commands

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

Conventions used in SCPI command descriptions

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

Common Suffixes

The following common suffixes are used in remote commands:

Suffix	Value range	Description
SOURce<hw>	[1]|2	available baseband signals
OUTPut<ch>	1 .. 4	available markers
EXTernal<ch>	1|2	external trigger connectors
SVID<st>	1 .. 37	space vehicles (requires option Assisted GPS R&S SMx/AMU-K65)

The SOURce:BB:GPS subsystem contains commands for the primary and general settings of the GPS standard. These settings concern activation and deactivation of the standard, setting the filter, clock, trigger and clipping settings and the sequence length, as well as the preset setting.

The SOURce:BB:GPS:SATellite and SOURce:BB:GPS:NAVigation systems contain commands for setting the characteristics of the satellite signals.

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 operation
- Using the common status registers

For a description of such tasks, see the R&S Signal Generator operating manual.

The following commands specific to the GPS are described here:

4.1 Primary Settings

[:SOURce<hw>]:BB:GPS:ATSCenario <AtScenario>

Selects the file with the predefined A-GPS test scenario.

Parameters:

<AtScenario> USER | GSMSIG | GSMPER1 | GSMPER2 | GSMPER3 | W3GSIG | W3GPER1 | W3GPER2 | W3GPER3 | W3G2S | W3G2M

User
No predefined test scenario is selected.

GSMSIG
Predefined A-GPS GSM Signalling Scenario (3GPP TS 51.010-1 v.7.7.0)

GSMPER1
Predefined A-GPS GSM Performance Test Scenario 1 (3GPP TS 51.010-1 v.7.7.0)

GSMPER2
Predefined A-GPS GSM Performance Test Scenario 2 (3GPP TS 51.010-1 v.7.7.0)

GSMPER3
Predefined A-GPS 3GPP FDD Performance Test Scenario 3 (3GPP TS 51.010-1 v.7.7.0)

W3GSIG
Predefined A-GPS 3GPP FDD Signalling Scenario (3GPP 34.108 v.8.0.0, 3GPP TS 34.123-3 v.6.4.0)

W3GPER1
Predefined A-GPS 3GPP FDD Performance Test Scenario 1 (3GPP 34.108 v.8.0.0, 3GPP 34.171 v.7.0.1)

W3GPER2
Predefined A-GPS 3GPP FDD Performance Test Scenario 2 (3GPP 34.108 v.8.0.0, 3GPP 34.171 v.7.0.1)

W3GPER3
Predefined A-GPS 3GPP FDD Performance Test Scenario 3 (3GPP 34.108 v.8.0.0, 3GPP 34.171 v.7.0.1)

W3G2S
Predefined A-GPS 3GPP2 Static Test Scenario (3GPP2 C.S0036-0 V1.0)

W3G2M
Predefined A-GPS 3GPP2 MovingTest Scenario (3GPP2 C.S0036-0 V1.0)

*RST: USER

Example: `BB:GPS:ATSC W3GPER2`
selects the predefined A-GPS test scenario 3GPP FDD Performance Test Scenario 2

Options: R&S SMx/AMU-K65

Manual operation: See "A-GPS Test Scenario" on page 33

[:SOURce<hw>]:BB:GPS:BAB[:STATe] <State>

Note: This parameter is available only in path A of two path instruments.

Enables/disables control of both paths via the GPS menu of path A.

If this parameter is enabled, a total number of eight satellites can be configured.

Note: Configuration of eight satellites is only possible for two path instruments.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: `BB:GPS:BAB:STAT ON`
Enables control of both paths via the GPS menu of path A. 8 Satellites can be configured.

Manual operation: See "Use Baseband A+B" on page 34

[:SOURce<hw>]:BB:GPS:LMODe <LMode>

Sets the localization mode.

Parameters:

<LMode> AUTO | AUPDate | FULL

AUTO
Eight satellites will be selected depending on the selected almanac.

AUPDate
Auto Update

FULL
Full Configuration

*RST: AUTO

Example: `BB:GPS:LMOD FULL`
sets the localization mode to full configuration.

Manual operation: See "Localization Mode" on page 34

[:SOURce<hw>]:BB:GPS:LOCation <Location>

Sets the geographic location of the GPS receiver.

The string is not case sensitive.

Parameters:

<Location> string

*RST: User Defined

Example: `BB:GPS:LOC "Munich"`
sets the geographic location to Munich.

Manual operation: See "Geographic Location" on page 36

[:SOURce<hw>]:BB:GPS:LOCation:ALTitude <Altitude>

Sets the geographic altitude.

Parameters:

<Altitude> float

Range: -10000 to 10000
Increment: 0.1
*RST: 0

Example: `BB:GPS:LOC ALT 500`
sets the geographic altitude to 500 m.

Manual operation: See "Altitude" on page 37

[:SOURce<hw>]:BB:GPS:LOCation:LATitude <Latitude>

Sets the latitude of the geographic location expressed as decimal degree. The value will be automatically converted into DEG:MIN:SEC format.

Parameters:

<Latitude> float

Range: -90.0 to 90.0

Example: `BB:GPS:LOC:LAT 12.12505`
sets the latitude to 12.12505

Manual operation: See "Latitude" on page 37

[:SOURce<hw>]:BB:GPS:LOCation:LATitude:DEGRees <Degrees>

Sets the latitude of the geographic location in ° (degrees).

Parameters:

<Degrees> integer

Range: 0 to 90
*RST: 0

Example: `BB:GPS:LOC:LAT:DEGR 48`
sets the latitude of the geographic location to 48° (degrees).

Manual operation: See "Latitude" on page 37

[:SOURce<hw>]:BB:GPS:LOCation:LATitude:DIRection <Direction>

Sets the direction of the geographic location related to the latitude.

Parameters:

<Direction> NORTh | SOUTh

*RST: NORTh

Example: `BB:GPS:LOC:LAT:DIR NORT`
sets the direction of the geographic location to NORTh.

Manual operation: See "Latitude" on page 37

[:SOURce<hw>]:BB:GPS:LOCation:LATitude:MINutes <Minutes>

Sets the latitude of the geographic location in ’ (minutes).

Parameters:

<Minutes> integer

Range: 0 to 59
*RST: 0

Example: `BB:GPS:LOC:LAT:MIN 9`
sets the latitude of the geographic location to 9’.

Manual operation: See "Latitude" on page 37

[:SOURce<hw>]:BB:GPS:LOCation:LATitude:SEConds <Seconds>

Sets the latitude of the geographic location in ’’ (seconds).

Parameters:

<Seconds> float

Range: 0.0 to 59.999
Increment: 0.001
*RST: 0.0

Example: `BB:GPS:LOC:LAT:SEC 0`
sets the latitude of the geographic location to 0’’.

Manual operation: See "Latitude" on page 37

[:SOURce<hw>]:BB:GPS:LOCation:LONGitude <Longitude>

Sets the longitude of the geographic location expressed as decimal degree. The value will be automatically converted into DEG:MIN:SEC format.

Parameters:

<Longitude> float

Range: -180.0 to 180.0
Increment: 1E-6

Example: `BB:GPS:LOC:LONG -18.05`
sets the longitude to -18.05

Manual operation: See "Longitude" on page 38

[:SOURce<hw>]:BB:GPS:LOCation:LONGitude:DEGRees <Degrees>

Sets the longitude of the geographic location in ° (degrees).

Parameters:

<Degrees> integer

Range: 0 to 180
*RST: 0

Example: `BB:GPS:LOC:LONG:DEGR 11`
sets the longitude of the geographic location to 11° (degrees).

Manual operation: See "Longitude" on page 38

[:SOURce<hw>]:BB:GPS:LOCation:LONGitude:DIRection <Direction>

Sets the direction of the geographic location related to the longitude.

Parameters:

<Direction> EAST | WEST

*RST: EAST

Example: `BB:GPS:LOC:LONG:DIR EAST`
sets the direction of the geographic location to EAST.

Manual operation: See "Longitude" on page 38

[:SOURce<hw>]:BB:GPS:LOCation:LONGitude:MINutes <Minutes>

Sets the longitude of the geographic location in ’ (minutes).

Parameters:

<Minutes> integer

Range: 0 to 59
*RST: 0

Example: `BB:GPS:LOC:LONG:MIN 35`
sets the longitude of the geographic location to 35’.

Manual operation: See "Longitude" on page 38

[:SOURce<hw>]:BB:GPS:LOCation:LONGitude:SEConds <Seconds>

Sets the longitude of the geographic location in ’’ (seconds).

Parameters:

<Seconds> float

Range: 0.0 to 59.999
Increment: 0.001
*RST: 0.0

Example: `BB:GPS:LOC:LAT:SEC 0`
sets the latitude of the geographic location to 0’’.

Manual operation: See "Longitude" on page 38

[:SOURce<hw>]:BB:GPS:LOCation:PFORmat <PFormat>

Sets the format in which the Latitude and Longitude are displayed.

Parameters:

<PFormat> DMS | DECimal

DMS
The position is specified in DEG:MIN:SEC.

DECimal
The position is specified in decimal degree, i.e. +/-XX.XXXXX°, where "+" indicates North and East and "-" indicates South and West.

*RST: DMS

Example: `BB:GPS:LOC:PFOR DMS`
position is specified in format DEG:MIN:SEC

Manual operation: See "Position Format" on page 37

[:SOURce<hw>]:BB:GPS:LOCation:ROMode <RoMode>

Defines the way the waypoint file is to be read.

Parameters:

<RoMode> CYCLic | RTRip | OWAY

CYCLic
The waypoint file is read out cyclic.

OWAY
The file is read out only once.

RTRip
By reaching the end of the file, the file is read out backwards.

*RST: OWAY

Example: `BB:GPS:LOC:ROM CYCL`
the waypoint file will be read out cyclic.

Manual operation: See "Read Out Mode" on page 36

[:SOURce<hw>]:BB:GPS:LOCation:WAYPoints <WayPoints>

(R&S SMx/AMU instruments only)

Selects the waypoint file. A waypoint file must have the extension `*.txt`.

Parameters:

<WayPoints> string

Example: `BB:GPS:LOC:WAYP "<root>waypoints.txt"`
selects the waypoint file

Manual operation: See "Select Waypoint File ..." on page 36

[:SOURce<hw>]:BB:GPS:PRESet

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

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

Example: `SOURce1:BB:GPS:PRESset`

Usage: Event

Manual operation: See "Set to default" on page 30

[:SOURce<hw>]:BB:GPS:PRFLevel

Sets the RF to GPS standard L1 (1.575420 GHz) and the power level to -115.0 dBm, i.e sets the commands `SOUR:FREQ` and `SOUR:POW`. The affected RF path depends on the signal routing of the selected baseband.

Example: `BB:GPS:PRFL`
sets the RF level to 1.575420 GHz and the level to -115.0 dBm.

Usage: Event

Manual operation: See "Set to default RF and Level" on page 32

[:SOURce<hw>]:BB:GPS:RFBand <RfBand>

Sets the GPS frequency.

Parameters:

<RfBand> L1 | L2

*RST: L1

Example: `BB:GPS:RFB L2`
sets the carrier frequency to 1.2276 GHz

Manual operation: See "RF Band" on page 32

[:SOURce<hw>]:BB:GPS:SEMask <SEMask>

(enabled for "Localization" mode)

Sets the satellite's elevation, i.e. determines the minimum angular distance of a satellite above the horizon.

Parameters:

<SEMask> 2.5 | 5 | 7.5 |
10 (only for instruments working in a coupling mode)

Range: 2.5 to 10.0
Increment: 0.5

Example: `BB:GPS:BAB:STAT ON`
enables control of both paths via the GPS menu of path A. 8 Satellites can be configured.
`BB:GPS:SEM 10`
sets the satellite eleation mask.

Manual operation: See "Satellite Elevation Mask" on page 40

[:SOURce<hw>]:BB:GPS:SETTing:CATalog?

Reads out the files with GPS settings in the default directory. The default directory is set using command `MMEM:CDIRectory`. Only files with the file extension `*.gps` will be listed.

Return values:
<Catalog> string

Example: `MMEM:CDIR '<root>gps`
sets the default directory
`BB:GPS:SETT:CAT?`
reads out all the files with GPS settings in the default directory.
`Response: 'gps_generic','gps_gen2'`
the files `gps_generic` and `gps_gen2` are available.

Usage: Query only

Manual operation: See "Save/Recall" on page 31

[:SOURce<hw>]:BB:GPS:SETTing:DELete <Filename>

Deletes the selected file with GPS settings. 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. The file extension may be omitted. Only files with the file extension `*.gps` will be deleted.

Setting parameters:
<Filename> string

Example: `BB:GPS:SETT:DEL 'gps'`
deletes file `gps`.

Usage: Setting only

Manual operation: See "Save/Recall" on page 31

[:SOURce<hw>]:BB:GPS:SETTing:LOAD <Filename>

Loads the selected file with GPS settings. 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. The file extension may be omitted. Only files with the file extension `*.gps` will be loaded.

Setting parameters:
<Filename> string

Example: `BB:GPS:SETT:LOAD 'gps'`
loads file `gps`.

Usage: Setting only

Manual operation: See "Save/Recall" on page 31

[:SOURce<hw>]:BB:GPS:SETTing:STORe <Filename>

Stores the current GPS settings 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. GPS settings are stored as files with the specific file extensions `*.gps`.

Setting parameters:
<Filename> string

Example: `BB:GPS:SETT:STOR 'gps_sem299'`
stores the current settings into file `gps_sem299`.

Usage: Setting only

Manual operation: See "Save/Recall" on page 31

[:SOURce<hw>]:BB:GPS: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

[:SOURce<hw>]:BB:GPS:SMODe <SMode>

Sets the simulation mode.

Parameters:
<SMode> GENeric | LOCalization
*RST: GENeric

Example: `BB:GPS:SMOD GEN`
generic satellite signals are generated.

Manual operation: See "Simulation Mode" on page 34

[:SOURce<hw>]:BB:GPS:STATe <State>

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

Parameters:

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

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

Manual operation: See "State" on page 30

4.2 Satellites Configuration and Satellites Signal Settings

[:SOURce<hw>]:BB:GPS:HDOP?

(enabled only for "Localization" mode)

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: `BB:GPS:HDOP?`
queries the initial HDOP
`Response: -1`
less than 3 different satellites are configured. The Initial HDOP can not be calculated

Usage: Query only

Manual operation: See "Initial HDOP" on page 42

[:SOURce<hw>]:BB:GPS:NAVigation:ALManac <Almanac>

Selects the almanac providing the navigation information.

Current almanac data can be downloaded via the Internet. The files are provided as text files (`*.txt`) or `YUMA` files.

The almanac files provided with this option are saved in the default directory of the instrument (`C:\Program Files\Rohde&Schwarz\SMUFirmware\Lists\Gps\Almanac`). To access the files in this default directory, only the file name is required, without the path and the file extension.

However, to access almanac files located in a directory different to the default one, the complete file path and file name are required.

Parameters:

<Almanac> string

*RST: SEM269

Example: `BB:GPS:NAV:ALM 'SEM299'`
the file `SEM299` in the default directory (`C:\Program Files\Rohde&Schwarz\SMUFirmware\Lists\Gps\Almanac`) is used for retrieving navigation information.
`BB:GPS:NAV:ALM '<root>SEM299'`
the file `SEM299` in the directory `<root>` is used for retrieving navigation information.

Manual operation: See "Select Almanac File" on page 39

[:SOURce<hw>]:BB:GPS:NAVigation:ALManac:BEGin:DAY?

Queries the start day of the week in which the almanac was published. The command is only available if data source Real Navigation Data is selected (`SOURce:BB:GPS:NAVigation:DATA RND`). The almanac is loaded with command `SOURce:BB:GPS:NAVigation:ALMananc`.

Return values:
<Day> integer
Range: 1 to 31
*RST: 13

Example: `BB:GPS:NAV:ALM:BEG:DAY?`
queries the start day of the GPS week.
`Response: 12`
the GPS week starts on the 12th of the month.

Usage: Query only

Manual operation: See "Almanac For GPS Week" on page 39

[:SOURce<hw>]:BB:GPS:NAVigation:ALManac:BEGin:MONTh?

Queries the start month of the week in which the almanac was published. The command is only available if data source Real Navigation Data is selected (`SOURce:BB:GPS:NAVigation:DATA RND`). The almanac is loaded with command `SOURce:BB:GPS:NAVigation:ALMananc`.

Return values:
<Month> integer
Range: 1 to 12
*RST: 7

Example: `BB:GPS:NAV:ALM:BEG:MONT?`
queries the start month of the GPS week.
`Response: 4`
the week starts in April.

Usage: Query only

Manual operation: See "Almanac For GPS Week" on page 39

[:SOURce<hw>]:BB:GPS:NAVigation:ALManac:BEGin:WNUMber?

Queries the GPS week number of the almanac. The command is only available if data source Real Navigation Data is selected (`SOURce:BB:GPS:NAVigation:DATA RND`). The almanac is loaded with command `SOURce:BB:GPS:NAVigation:ALMananc`.

Return values:

<WNumber> integer

Range: 0 to 529947
*RST: 1488

Example: `BB:GPS:NAV:ALM:BEG:WNUM?`
queries the GPS week number of almanac.
`Response: 1233`
the week number is 1233.

Usage: Query only

Manual operation: See "Almanac For GPS Week" on page 39

[:SOURce<hw>]:BB:GPS:NAVigation:ALManac:BEGin:YEAR?

Queries the year of the week in which the almanac was published. The command is only available if data source Real Navigation Data is selected (`SOURce:BB:GPS:NAVigation:DATA RND`). The almanac is loaded with command `SOURce:BB:GPS:NAVigation:ALMananc`.

Return values:

<Year> integer

Range: -9999 to 9999
*RST: 2008

Example: `BB:GPS:NAV:ALM:BEG:YEAR?`
queries the year of the GPS week.
`Response: 2007`
the year is 2007.

Usage: Query only

Manual operation: See "Almanac For GPS Week" on page 39

[:SOURce<hw>]:BB:GPS:NAVigation:ALManac:END:DAY?

Queries the final day of the week in which the almanac was published. The command is only available if data source Real Navigation Data is selected (`SOURce:BB:GPS:NAVigation:DATA RND`). The almanac is loaded with command `SOURce:BB:GPS:NAVigation:ALMananc`.

Return values:

<Day> integer

Range: 1 to 31
*RST: 19

Example: `BB:GPS:NAV:ALM:END:DAY?`
queries the final day of the GPS week.
`Response: 19`
the GPS week ends on the 19th of the month.

Usage: Query only

Manual operation: See "Almanac For GPS Week" on page 39

[:SOURce<hw>]:BB:GPS:NAVigation:ALManac:END:MONTh?

Queries the final month of the week in which the almanac was published. The command is only available if data source Real Navigation Data is selected (`SOURce:BB:GPS:NAVigation:DATA RND`). The almanac is loaded with command `SOURce:BB:GPS:NAVigation:ALMananc`.

Return values:

<Month> integer

Range: 1 to 12
*RST: 7

Example: `BB:GPS:NAV:ALM:END:MONT?`
queries the final month of the GPS week.
`Response: 4`
the GPS week ends in April.

Usage: Query only

Manual operation: See "Almanac For GPS Week" on page 39

[:SOURce<hw>]:BB:GPS:NAVigation:ALManac:END:YEAR?

Queries the year of the week in which the almanac was published. The command is only available if data source Real Navigation Data is selected (`SOURce:BB:GPS:NAVigation:DATA RND`). The almanac is loaded with command `SOURce:BB:GPS:NAVigation:ALMananc`.

Return values:

<Year> integer

Range: -9999 to 9999
*RST: 2008

Example: `BB:GPS:NAV:ALM:END:YEAR?`
queries the year of the GPS week.
`Response: 2007`
the year is 2007.

Usage: Query only

Manual operation: See "Almanac For GPS Week" on page 39

[:SOURce<hw>]:BB:GPS:NAVigation:ALManac:TOEPhemeris?

Queries the time of almanac, i.e. the exact time in seconds to which the navigation data refers.

The command is only available if data source Real Navigation Data is selected (`SOURce:BB:GPS:NAVigation:DATA RND`). The almanac is loaded with command `SOURce:BB:GPS:NAVigation:ALMananc`.

Return values:

<ToEphemeris> integer

Range: 0 to max
*RST: 589824

Example: `BB:GPS:NAV:ALM:TOEP?`
queries the time of almanac.
`Response: 589824`
the value is returned in seconds. Counting starts at 0.00 a.m. on Sunday of the GPS week.

Usage: Query only

Manual operation: See "Time Of Almanac (TOA)" on page 40

[:SOURce<hw>]:BB:GPS:NAVigation:DATA <Data>

Determines the data source for the navigation information.

Note: Arbitrary data are supported only in "Generic" mode.

Parameters:

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

RNData
Real navigation data provided by an almanac file is used. The file is loaded with command
`SOURce:BB:GPS:NAVigation:ALMananc`.

DLISt
A data list is used. The data list is selected with the command
`[:SOURce<hw>]:BB:GPS:NAVigation:DATA:DSELect`.

PNxx
The pseudo-random sequence generator is used as the data source. Different random sequence lengths can be selected.

ZERO | ONE
Internal 0 and 1 data is used

PATTern
Internal data is used The bit pattern for the data is defined by the command `[:SOURce<hw>]:BB:GPS:NAVigation:DATA:PATTern`.

*RST: RNData

Example: `BB:GPS:NAV:DATA PATT`
selects as the data source for the data fields of burst 0, the bit pattern defined with the following command.
`BB:GPS:NAV:DATA:PATT #H3F,8`
defines the bit pattern.

Manual operation: See "Data Source" on page 38

[:SOURce<hw>]:BB:GPS:NAVigation:DATA:DSELect <DSelect>

Selects the data list for the `DLISt` data source selection.

The lists are stored as files with the fixed file extensions `*.dm_iqd` in a directory of the user's choice. The directory applicable to the following commands is defined with 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: `BB:GPS:NAV:DATA DLIS`
selects the Data Lists data source.
`MMEM:CDIR '<root>Lists'`
selects the directory
`BB:GPS:NAV:DATA:DLIS 'GPS_list1'`
selects file `GPS_list1` as the data source. This file must be in the selected directory and have the file extension `*.dm_iqd`.

Manual operation: See "Data Source" on page 38

[:SOURce<hw>]:BB:GPS:NAVigation:DATA:PATTern <Pattern>

Determines the bit pattern for the `PATTern` selection. The maximum length is 64 bits.

Parameters:

<Pattern> 64 bits

*RST: #H0,1

Example: `BB:GPS:NAV:DATA:PATT #H3F,8`
defines the bit pattern.

Manual operation: See "Data Source" on page 38

[:SOURce<hw>]:BB:GPS:NAVigation:SIMulation[:BEGin]:DATE <Date>

Sets the date for the simulation. The command is only available if data source Real Navigation Data is selected (`SOURce:BB:GPS:NAV:DATA RND`).

Parameters:

<Date> YYYY,MM,DD

*RST: 2004,10,10

Example: `BB:GPS:NAV:SIM:DATE 2006,12,25`
sets the date for the simulation.

Manual operation: See "Date" on page 40

[:SOURce<hw>]:BB:GPS:NAVigation:SIMulation[:BEGin]:DAY <Day>

Sets the simulation start day. The command is only available if data source Real Navigation Data is selected (`SOURce:BB:GPS:NAV:DATA RND`).

Parameters:

<Day> integer

Range: 1 to 31
*RST: -

Example: `BB:GPS:NAV:SIM:DAY 10`
sets the simulation start day.

[:SOURce<hw>]:BB:GPS:NAVigation:SIMulation[:BEGin]:HOUR <Hour>

Sets the hour of the simulation start. The command is only available if data source Real Navigation Data is selected (`SOURce:BB:GPS:NAV:DATA RND`).

Parameters:

<Hour> integer

Range: 0 to 23
*RST: -

Example: `BB:GPS:NAV:SIM:HOUR 10`
sets the simulation start hour.

[:SOURce<hw>]:BB:GPS:NAVigation:SIMulation[:BEGin]:MINute <Minute>

Sets the minute of the simulation start. The command is only available if data source Real Navigation Data is selected (`SOURce:BB:GPS:NAV:DATA RND`).

Parameters:

<Minute> integer

Range: 0 to 59
*RST: -

Example: `BB:GPS:NAV:SIM:MIN 10`
sets the simulation start minute.

[:SOURce<hw>]:BB:GPS:NAVigation:SIMulation[:BEGin]:MONTh <Month>

Sets the month of the simulation start. The command is only available if data source Real Navigation Data is selected (`SOURce:BB:GPS:NAV:DATA RND`).

Parameters:

<Month> integer

Range: 1 to 12
*RST: -

Example: `BB:GPS:NAV:SIM:MON 10`
sets the simulation start month.

[:SOURce<hw>]:BB:GPS:NAVigation:SIMulation[:BEGin]:SECond <Second>

Sets the second of the simulation start. The command is only available if data source Real Navigation Data is selected (`SOURce:BB:GPS:NAV:DATA RND`).

Parameters:

<Second> integer

Range: 0 to 59
*RST: -

Example: `BB:GPS:NAV:SIM:SEC 10`
sets the simulation start second.

[:SOURce<hw>]:BB:GPS:NAVigation:SIMulation[:BEGin]:TIME <Time>

Enters the exact time for the simulation. The used time zone is Greenwich Mean Time. The command is only available if data source Real Navigation Data is selected (`SOURce:BB:GPS:NAV:DATA RND`).

Parameters:

<Time> HH,MM,SS

*RST: 0,0,0

Example: `BB:GPS:NAV:SIM:TIME 12,45,36`
sets the time for the simulation.

Manual operation: See "GPS Mean Time" on page 40

[:SOURce<hw>]:BB:GPS:NAVigation:SIMulation[:BEGin]:YEAR <Year>

Sets the year of the simulation start. The command is only available if data source Real Navigation Data is selected (`SOURce:BB:GPS:NAV:DATA RND`).

Parameters:

<Year> integer

Range: -9999 to 9999
*RST: -

Example: `BB:GPS:NAV:SIM:YEAR 10`
sets the simulation start year.

[:SOURce<hw>]:BB:GPS:PDOP?

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: `BB:GPS:SMOD LOC`
satellite signals are generated corresponding to a 'real' location.
`BB:GPS:PDOP?`
queries the PDOP of the selected satellite constellation.
Response: '2.80'

Usage: Query only

Manual operation: See "Initial PDOP" on page 43

[:SOURce<hw>]:BB:GPS:POWer:ADJust

Calculates the power level of each satellite so that the sum of all levels results in 0 dB.

Example: `BB:GPS:POW:ADJ`
the total power of all satellites is set to 0 dB, the power ratio among the satellites is unchanged.

Usage: Event

Manual operation: See "Adjust Total Power to 0dB" on page 42

[:SOURce<hw>]:BB:GPS:POWer[:TOTal]?

Queries the total power of all satellites. After "Power Adjust", this power corresponds to 0 dB.

Return values:
<Total> float
Increment: 0.01
*RST: 0.0

Example: `BB:GPS:POW?`
queries the total power of all satellites.
`Response: -22.5`
the total power is -25 dB.

Usage: Query only

Manual operation: See "Total Power" on page 42

[:SOURce<hw>]:BB:GPS:SATellite<st>:ADSHift <ADShift>

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

Parameters:
<ADShift> float
Range: -100E3 to 100E3
Increment: 0.01
*RST: 0

Example: `BB:GPS:SAT1:VID 4`
sets space vehicle 4 for the first satellite.
`BB:GPS:SAT2:VID 4`
sets space vehicle 4 for the second satellite.
`BB:GPS:SAT1:ADSH 10.5kHz`
sets the additional Doppler shift of satellite 1 to 10.5 KHz
`BB:GPS:SAT2:ADSH 1kHz`
sets the additional Doppler shift of satellite 2 to 1 KHz

Manual operation: See "Additional Doppler Shift" on page 46

[:SOURce<hw>]:BB:GPS:SATellite<st>:APOWer <Apower>

Sets the additional power of the satellite in dB.

Parameters:
<Apower> float
Range: -10 to 10
Increment: 0.01
*RST: 0

Example: `BB:GPS:SAT1:VID 4`
sets space vehicle 4 for the first satellite.
`BB:GPS:SAT2:VID 4`
sets space vehicle 4 for the second satellite.
`BB:GPS:SAT1:APOW -10.0`
sets the additional power of satellite 1 to -10dB
`BB:GPS:SAT2:APOW -5.0`
sets the additional power of satellite 2 to -5dB

Manual operation: See "Additional Power" on page 46

[:SOURce<hw>]:BB:GPS:SATellite<st>:ATSChips <ATsChips>

Sets an additional delay of the selected satellite.

Parameters:
<ATsChips> float

Range: 0 to 10.0e6
Increment: 0.001
*RST: 0

Example: `BB:GPS:SAT1:VID 4`
sets space vehicle 4 for the first satellite.
`BB:GPS:SAT2:VID 4`
sets space vehicle 4 for the second satellite.
`BB:GPS:SAT1:ATSC 10000`
sets the additional time shift of satellite 1 to 10000
`BB:GPS:SAT2:ATSC 20000`
sets the additional time shift of satellite 2 to 20000

Manual operation: See "Additional Time Shift / CA-Chips/40" on page 45

[:SOURce<hw>]:BB:GPS:SATellite<st>:CACRate?

Queries the currently valid values for the chip rate of the C/A code. The chip rate depends on the set Doppler shift.

Return values:
<CaCRate> float

Example: `BB:GPS:SAT1:CACR?`
queries the resulting C/A chip rate of satellite 1.
`Response: 1023022.077`
the chip rate is 1. 023022 08 MHz.

Usage: Query only

Manual operation: See "Resulting C/A Chip Rate" on page 47

[:SOURce<hw>]:BB:GPS:SATellite<st>:FREQuency?

Queries the currently valid value for the doppler-shifted carrier frequency.

Return values:
<Frequency> float

Example: `BB:GPS:SAT1:FREQ?`
queries the resulting carrier frequency of satellite 1.
`Response: 1575421111`
the resulting carrier frequency is 1.575421111 GHz.

Usage: Query only

Manual operation: See "Resulting Frequency" on page 46

[:SOURce<hw>]:BB:GPS:SATellite<st>:ICPHase <ICPhase>

Sets the initial carrier phase in radians.

Additionally, the parameter can be used to simulate multipath conditions.

Parameters:
<ICPhase> float

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

Example: `BB:GPS:SAT4:ICPH 3.14`
sets the initial carrier phase of satellite 4.

Manual operation: See "Initial Carrier Phase /rad" on page 46

[:SOURce<hw>]:BB:GPS:SATellite<st>:PCRate?

Queries the currently valid value for the resulting P-chip rate.

Return values:
<PCRate> float

Example: `BB:GPS:SAT4:PCR?`
queries the resulting P-chip rate of satellite 4.
`Response: 10230007.214285715`
the resulting P-chip rate is 10.230007 MHz.

Usage: Query only

Manual operation: See "Resulting P Chip Rate" on page 47

[:SOURce<hw>]:BB:GPS:SATellite<st>:RCODe <RCode>

Selects the ranging code for satellite 1.

For satellite 2, 3, and 4, only C/A is available and cannot be changed.

Note: Selecting the ranging code is only enabled for "Generic" simulation mode; for Localization mode this parameter is read-only.

Parameters:

<RCode> CACode | CAPCode | PCODe

CACode
Carrier L1 (f_L1= 1.57542 GHz) is modulated by C/A-code (BPSK).

CAPCode
(only available for Satellite 1)
Carrier L1 (f_L1= 1.57542 GHz) is modulated by C/A code and P-code (QPSK).

PCODe
(only available for Satellite 1)
Carrier L1 (f_L1= 1.57542 GHz) is modulated by P-code (BPSK).

*RST: CACode

Example: `BB:GPS:SMOD GEN`
generic satellite signals are generated.
`BB:GPS:SAT1:RCOD CAC`
sets the C/A ranging code for satellite 1.

Manual operation: See "Ranging Code" on page 43

[:SOURce<hw>]:BB:GPS:SATellite<st>:STATe <State>

Enables/disables generation of the signal of the selected satellite.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: SAT1: ON ; SAT<2|3|4>: OFF

Example: `BB:GPS:SAT1:STAT ON`
enables generation of the signal of satellite 1.

Manual operation: See "State" on page 43

[:SOURce<hw>]:BB:GPS:SATellite<st>:SVID <Svid>

Sets the ID of the satellite to be simulated. This value is used to generate the corresponding C/A code.

If "Real Navigation Data" is used, only the valid IDs which are listed in the almanac can be selected.

For arbitrary data, any IDs can be selected.

Parameters:

<Svid> integer

Range: 1 to 37
*RST: SAT1: 1 / SAT2: 2 / SAT3: 3 / SAT4: 4

Example: `BB:GPS:SAT1:VID 4`
sets id 4 for the first satellite.

Manual operation: See "Space Vehicle ID" on page 44

[:SOURce<hw>]:BB:GPS:SPReading[:STATe] <State>

The command activates/deactivates spreading. When spreading is deactivated the pure navigation data is modulated onto the RF carrier.

Note: This parameter is enabled only for "Generic" mode.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 1

Example: `BB:GPS:SMOD GEN`
selects generic mode
`BB:GPS:SPR ON`
activates spreading of simulated GPS satellite signals.

Manual operation: See "Use Spreading" on page 42

[:SOURce<hw>]:BB:GPS:SVID<st>:DSHift <DShift>

Sets the Doppler shift of the simulated signal of the selected satellite. The relevant change to the chip rate of the C/A code is carried out automatically.

The currently valid values for Doppler-shifted carrier frequency and chip rates are queried with commands:

- `[:SOURce<hw>]:BB:GPS:SATellite<st>:CACRate?` on page 97
- `[:SOURce<hw>]:BB:GPS:SATellite<st>:PCRate?` on page 98
- `[:SOURce<hw>]:BB:GPS:SATellite<st>:FREQuency?` on page 97

Parameters:

<DShift> float

Range: -100kHz to 100kHz
Increment: 0.01Hz
*RST: 0

Example: `BB:GPS:SVID5:SAT:DSH 5 kHz`
sets a Doppler shift of 5 kHz for satellite 1.

Manual operation: See "Doppler Shift" on page 45

[:SOURce<hw>]:BB:GPS:SVID<st>:DURation?

In localization mode, queries the time (in hh:mm:ss format) the satellite is visible (the satellite's elevation will be higher than 2.5/5/7.5/10°).

Return values:

<Duration> float

Range: 0 to 86400
Increment: 0.01
*RST: 0

Example: `BB:GPS:SMOD LOC`
satellite signals are generated corresponding to a 'real' location.
`BB:GPS:SVID2:DUR?`
queries the time the satellite's elevation will be higher then 2.5/5/7.5/10°.

Usage: Query only

Manual operation: See "Duration (Elevation > 2.5/5/7.5/10°)" on page 45

[:SOURce<hw>]:BB:GPS:SVID<st>:POWer <Power>

Sets the power offset of the satellite.

Parameters:

<Power> float

Range: -50 to 10
Increment: 0.01
*RST: 0

Example: `BB:GPS:SAT4:POW -2 dB`
sets a power offset of 2 dB.

Manual operation: See "Power" on page 44

[:SOURce<hw>]:BB:GPS:SVID<st>:TSCHips <TsChips>

Sets a delay of the selected satellite relative to the other satellites. The time shift is set in oversampled CA chips (Oversamling = 40).

Parameters:

<TsChips> float

Range: 0 to 10 000 000
Increment: 0.0001
*RST: 0

Example: `BB:GPS:SAT4:TSCH 100232`
sets a time shift of 100232 oversampled CA chips.

Manual operation: See "Time Shift / CA-Chips/40" on page 44

[:SOURce<hw>]:BB:GPS:SVID<st>:TSSeconds?

Queries the time shift of the code sequence in seconds.

Return values:

<TsSeconds> float

Range: 0 to max
Increment: 1E-6

Example: `BB:GPS:SAT4:TSS?`
queries the time shift in seconds.
`Response: 0.00979`
the time shift is 9.799 ms.

Usage: Query only

Manual operation: See "Time Shift ms" on page 44

4.3 Navigation Message Configuration

The parameters of the Navigation Message are only configurable for instrument equipped with option Assisted GPS (R&S SMx/AMU-K65) and in "Full Configuration" localization mode.

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:AFONe <AfOne>

Sets the clock correction parameter a_f1 of the satellite's navigation message.

Parameters:

<AfOne> integer

Range: -32768 to 32767
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the Localization mode to Full Configuration
`BB:GPS:SVID5:NMES:AFON 10000`
sets the value of the clock correction parameter a_f1

Options: R&S SMx/AMU-K65

Manual operation: See "Clock Correction Parameters" on page 52

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:AFTWo <AfTwo>

Sets the clock correction parameter a_f2 of the satellite's navigation message.

Parameters:

<AfTwo> integer

Range: -128 to 127
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the Localization mode to Full Configuration
`BB:GPS:SVID5:NMES:AFTW 100`
sets the value of the clock correction parameter a_f2

Options: R&S SMx/AMU-K65

Manual operation: See "Clock Correction Parameters" on page 52

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:AFZero <AfZero>

Sets the clock correction parameter a_f0 of the satellite's navigation message.

Parameters:

<AfZero> integer

Range: -2097152 to 2097151
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the Localization mode to Full Configuration
`BB:GPS:SVID5:NMES:AFZ 10000`
sets the value of the clock correction parameter a_f0

Options: R&S SMx/AMU-K65

Manual operation: See "Clock Correction Parameters" on page 52

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:ALPHa<ch0> <Alpha>

Sets the ionospheric parameters alpha_0, alpha_1, alpha_2 and alpha_3 of the satellite's navigation message.

Parameters:

<Alpha> integer

Range: -128 to 127
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the "Localization" mode to "Full Configuration"
`BB:GPS:SVID5:NMES:ALPH0 100`
sets the value of the ionospheric parameter alpha_0

Options: R&S SMx/AMU-K65

Manual operation: See "GPS Ionospheric Parameters" on page 53

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:AODO <Aodo>

Sets the parameter Age of Data Offset of the satellite's navigation message.

Parameters:

<Aodo> integer

Range: 0 to 31
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the "Localization" mode to "Full Configuration"
`BB:GPS:SVID5:NMES:AODO 20`
sets the value of the parameter age of data offset

Options: R&S SMx/AMU-K65

Manual operation: See "Ephemeris Parameters" on page 50

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:AONE <AOne>

Sets the UTC parameter A1 of the satellite's navigation message.

Parameters:

<AOne> integer

Range: -8388608 to 8388607
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the Localization mode to Full Configuration
`BB:GPS:SVID5:NMES:AONE 10000`
sets the value of the UTC parameter A1

Options: R&S SMx/AMU-K65

Manual operation: See "UTC Parameters" on page 53

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:AZERo <AZero>

Sets the UTC parameter A_0 of the satellite's navigation message.

Parameters:

<AZero> integer

Range: -2147483648 to 2147483647
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the Localization mode to Full Configuration
`BB:GPS:SVID5:NMES:AZER 10000`
sets the value of the UTC parameter A_0

Options: R&S SMx/AMU-K65

Manual operation: See "UTC Parameters" on page 53

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:BETA<ch0> <Beta>

Sets the parameter beta_0, beta_1, beta_2 and beta_3 of the satellite's navigation message.

Parameters:

<Beta> integer

Range: -128 to 127
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the Localization mode to Full Configuration
`BB:GPS:SVID5:NMES:BETA1 100`
sets the value of the ionospheric parameter beta_1

Options: R&S SMx/AMU-K65

Manual operation: See "GPS Ionospheric Parameters" on page 53

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:CIC <Cic>

Sets the parameter Amplitude of the Cosine Harmonic Correction Term to the Angle of Inclination of the satellite's navigation message.

Parameters:

<Cic> integer

Range: -32768 to 32767
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the Localization mode to Full Configuration
`BB:GPS:SVID5:NMES:CIC 100`
sets the value of the parameter C_ic

Options: R&S SMx/AMU-K65

Manual operation: See "Ephemeris Parameters" on page 50

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:CIS <Cis>

Sets the parameter Amplitude of the Sine Harmonic Correction Term to the Angle of Inclination of the satellite's navigation message.

Parameters:

<Cis> integer

Range: -32768 to 32767
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the "Localization" mode to "Full Configuration"
`BB:GPS:SVID5:NMES:CIS 100`
sets the value of the parameter C_is

Options: R&S SMx/AMU-K65

Manual operation: See "Ephemeris Parameters" on page 50

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:CLTMode <CltMode>

Sets the parameter type of code for L2 of the satellite's navigation message.

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

Example: `BB:GPS:LMOD FULL`
sets the "Localization" mode to "Full Configuration"
`BB:GPS:SVID5:NMES:CLTM PCOD`
sets the type of raging code for L2 to P-Code

Options: R&S SMx/AMU-K65

Manual operation: See "Ephemeris Parameters" on page 50

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:CRC <Crc>

Sets the parameter Amplitude of the Cosine Harmonic Correction Term to the Orbit Radius of the satellite's navigation message.

Parameters:
<Crc> integer
Range: -32768 to 32767
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the "Localization" mode to "Full Configuration"
`BB:GPS:SVID5:NMES:CRC 100`
sets the value of the parameter C_rc

Options: R&S SMx/AMU-K65

Manual operation: See "Ephemeris Parameters" on page 50

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:CRS <Crs>

Sets the parameter Amplitude of the Sine Harmonic Correction Term to the Orbit Radius of the satellite's navigation message.

Parameters:
<Crs> integer
Range: -32768 to 32767
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the Localization mode to Full Configuration
`BB:GPS:SVID5:NMES:CRS 100`
sets the value of the parameter C_rs

Options: R&S SMx/AMU-K65

Manual operation: See "Ephemeris Parameters" on page 50

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:CUC <Cuc>

Sets the parameter Amplitude of the Cosine Harmonic Correction Term to the Argument of Latitude of the satellite's navigation message.

Parameters:

<Cuc> integer

Range: -32768 to 32767
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the Localization mode to Full Configuration
`BB:GPS:SVID5:NMES:CUC 100`
sets the value of the parameter C_uc

Options: R&S SMx/AMU-K65

Manual operation: See "Ephemeris Parameters" on page 50

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:CUS <Cus>

Sets the parameter Amplitude of the Sine Harmonic Correction Term to the Argument of Latitude of the satellite's navigation message.

Parameters:

<Cus> integer

Range: -32768 to 32767
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the Localization mode to Full Configuration
`BB:GPS:SVID5:NMES:CUS 100`
sets the value of the parameter C_us

Options: R&S SMx/AMU-K65

Manual operation: See "Ephemeris Parameters" on page 50

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:DN <Dn>

Sets the UTC parameter DN of the satellite's navigation message.

Parameters:

<Dn> integer

Range: 0 to 7
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the "Localization" mode to "Full Configuration"
`BB:GPS:SVID5:NMES:DN 5`
sets the value of the parameter DN

Options: R&S SMx/AMU-K65

Manual operation: See "UTC Parameters" on page 53

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:ECCentricity <Eccentricity>

Sets the parameter Eccentricity of the satellite's navigation message.

Parameters:

<Eccentricity> integer

Range: 0 to 4294967295
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the "Localization" mode to "Full Configuration"
`BB:GPS:SVID5:NMES:ECC 1000000`
sets the value of the parameter e (Eccentricity)

Options: R&S SMx/AMU-K65

Manual operation: See "Ephemeris Parameters" on page 50

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:FIFLag <FiFlag>

Sets the parameter curve-fit interval flag of the satellite's navigation message.

Parameters:

<FiFlag> 0 | 1 | OFF | ON

*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the Localization mode to Full Configuration
`BB:GPS:SVID5:NMES:FIFL ON`
enables the curve-fit interval flag

Options: R&S SMx/AMU-K65

Manual operation: See "Ephemeris Parameters" on page 50

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:HEALth <Health>

Sets the parameter SV health of the satellite's navigation message.

Parameters:

<Health> integer

Range: 0 to 31
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the "Localization" mode to "Full Configuration"
`BB:GPS:SVID5:NMES:HEAL 10`
sets the SV health to 10

Options: R&S SMx/AMU-K65

Manual operation: See "Ephemeris Parameters" on page 50

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:IDOT <IDot>

Sets the parameter Rate of Inclination Angle of the satellite's navigation message.

Parameters:

<IDot> integer

Range: -8192 to 8191
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the "Localization" mode to "Full Configuration"
`BB:GPS:SVID5:NMES:IDOT 1000`
sets the parameter IDOT

Options: R&S SMx/AMU-K65

Manual operation: See "Ephemeris Parameters" on page 50

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:IODC <Iodc>

Sets the parameter Issue of Data, Clock of the satellite's navigation message.

Parameters:

<Iodc> integer

Range: 0 to 1023
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the Localization mode to Full Configuration
`BB:GPS:SVID5:NMES:IDOC 1000`
sets the parameter IDOC

Options: R&S SMx/AMU-K65

Manual operation: See "Ephemeris Parameters" on page 50

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:IODE <Iode>

Sets the parameter Issue of Data, Ephemeris of the satellite's navigation message.

Parameters:

<Iode> integer

Range: 0 to 255
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the "Localization" mode to "Full Configuration"
`BB:GPS:SVID5:NMES:IDOE 100`
sets the parameter IDOE

Options: R&S SMx/AMU-K65

Manual operation: See "Ephemeris Parameters" on page 50

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:IZERo <IZero>

Sets the parameter Inclination Angle at reference Time of the satellite's navigation message.

Parameters:

<IZero> integer

Range: -2147483648 to 2147483647
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the Localization mode to Full Configuration
`BB:GPS:SVID5:NMES:IZER 100000`
sets the parameter i_0

Options: R&S SMx/AMU-K65

Manual operation: See "Ephemeris Parameters" on page 50

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:LTPData <LtpData>

Sets the parameter use of carrier L2 P data flag of the satellite's navigation message.

Parameters:

<LtpData> 0 | 1 | OFF | ON

*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the Localization mode to Full Configuration
`BB:GPS:SVID5:NMES:LTPD ON`
enables the L2 P data Flag

Options: R&S SMx/AMU-K65

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:MZERo <MZero>

Sets the parameter Mean Anomaly at Reference Time of the satellite's navigation message.

Parameters:

<MZero> integer

Range: -2147483648 to 2147483647
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the Localization mode to Full Configuration
`BB:GPS:SVID5:NMES:MZER 100000`
sets the parameter M_0

Options: R&S SMx/AMU-K65

Manual operation: See "Ephemeris Parameters" on page 50

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:NDELta <NDelta>

Sets the parameter Mean Motion difference From Computed Value of the satellite's navigation message.

Parameters:

<NDelta> integer

Range: -32768 to 32767
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the Localization mode to Full Configuration
`BB:GPS:SVID5:NMES:NDEL 100`
sets the parameter Delta_N

Options: R&S SMx/AMU-K65

Manual operation: See "Ephemeris Parameters" on page 50

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:ODOT <ODot>

Sets the parameter Rate of Right Ascension of the satellite's navigation message.

Parameters:

<ODot> integer

Range: -8388608 to 8388607
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the "Localization" mode to "Full Configuration"
`BB:GPS:SVID5:NMES:ODOT 100000`
sets the parameter OMEGA_DOT

Options: R&S SMx/AMU-K65

Manual operation: See "Ephemeris Parameters" on page 50

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:OMEGa <Omega>

Sets the parameter Argument of Perigee of the satellite's navigation message.

Parameters:

<Omega> integer

Range: -2147483648 to 2147483647
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the "Localization" mode to "Full Configuration"
`BB:GPS:SVID5:NMES:OMEG 100000`
sets the parameter omega

Options: R&S SMx/AMU-K65

Manual operation: See "Ephemeris Parameters" on page 50

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:OZERo <OZero>

Sets the parameter Longitude of Ascending Node of Orbit Plane at Weekly Epoch of the satellite's navigation message.

Parameters:

<OZero> integer

Range: -2147483648 to 2147483647
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the "Localization" mode to "Full Configuration"
`BB:GPS:SVID5:NMES:OZER 100000`
sets the parameter OMEGA_0

Options: R&S SMx/AMU-K65

Manual operation: See "Ephemeris Parameters" on page 50

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:PRESet

Set navigation message parameters to values defined in almanac file.

Presetting the parameters of the navigation message is recommended as basis for further reconfigurations.

Example: `BB:GPS:LMOD FULL`
sets the "Localization" mode to "Full Configuration"
`BB:GPS:SVID5:NMES:PRS`
set navigation message parameters to values defined in almanac file

Usage: Event

Options: R&S SMx/AMU-K65

Manual operation: See "Set To Almanac" on page 50

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:REServed<ch> <Reserved>

Sets the parameter SF1 Reserved 1 .. 4 of the satellite's navigation message.

Parameters:

<Reserved> integer

Range: 0 to 8388608
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the "Localization" mode to "Full Configuration"
`BB:GPS:SVID5:NMES:RES3 100000`
sets parameter SF1 Reserved 3 to 1000000

Options: R&S SMx/AMU-K65

Manual operation: See "Ephemeris Parameters" on page 50

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:SQRA <SqrA>

Sets the parameter Square Root of the Semi-Major Axis of the satellite's navigation message.

Parameters:

<SqrA> integer

Range: 100000 to 4294967295
*RST: 100000

Example: `BB:GPS:LMOD FULL`
sets the "Localization" mode to "Full Configuration"
`BB:GPS:SVID5:NMES:SQRA 100000`
sets parameter SQRT(A) to 1000000

Options: R&S SMx/AMU-K65

Manual operation: See "Ephemeris Parameters" on page 50

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:SVConfig <SvConfig>

Sets the parameter (A-S) Flags and SV Config of the satellite's navigation message.

Parameters:

<SvConfig> integer

Range: 0 to 15
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the "Localization" mode to "Full Configuration"
`BB:GPS:SVID5:NMES:SVC 10`
sets parameter A-S Flag and SV Config to 10

Options: R&S SMx/AMU-K65

Manual operation: See "Ephemeris Parameters" on page 50

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:TGD <Tgd>

Sets the parameter L1-L2 Correction Term of the satellite's navigation message.

Parameters:

<Tgd> integer

Range: -128 to 127
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the Localization mode to Full Configuration
`BB:GPS:SVID5:NMES:TGD 100`
sets parameter T_GD

Options: R&S SMx/AMU-K65

Manual operation: See "Clock Correction Parameters" on page 52

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:TLS <Tls>

Sets the UTC parameter Δt_LS of the satellite's navigation message.

Parameters:

<Tls> integer

Range: -128 to 127
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the Localization mode to Full Configuration
`BB:GPS:SVID5:NMES:TLS 100`
sets parameter Δt_{LS}

Options: R&S SMx/AMU-K65

Manual operation: See "UTC Parameters" on page 53

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:TLSF <Tlsf>

Sets the UTC parameter Δt_{LSF} of the satellite's navigation message.

Parameters:

<Tlsf> integer

Range: -128 to 127
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the Localization mode to Full Configuration
`BB:GPS:SVID5:NMES:TLSF 100`
sets parameter Δt_LSf

Options: R&S SMx/AMU-K65

Manual operation: See "UTC Parameters" on page 53

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:TOC <Toc>

Sets the clock correction parameter t_OC of the satellite's navigation message.

Parameters:

<Toc> integer

Range: 0 to 65535
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the "Localization" mode to "Full Configuration"
`BB:GPS:SVID5:NMES:TOC 100`
sets parameter t_OC

Options: R&S SMx/AMU-K65

Manual operation: See "Clock Correction Parameters" on page 52

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:TOE <ToE>

Sets the parameter Time of Ephemeris of the satellite's navigation message.

Parameters:

<ToE> integer

Range: 0 to 65535
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the "Localization" mode to "Full Configuration"
`BB:GPS:SVID5:NMES:TOE 100`
sets parameter TOE

Options: R&S SMx/AMU-K65

Manual operation: See "Ephemeris Parameters" on page 50

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:TOT <Tot>

Sets the UTC parameter t0t of the satellite's navigation message.

Parameters:

<Tot> integer

Range: 0 to 602112
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the Localization mode to Full Configuration
`BB:GPS:SVID5:NMES:TOT 1000`
sets parameter t_ot

Options: R&S SMx/AMU-K65

Manual operation: See "UTC Parameters" on page 53

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:URA <Ura>

Sets the parameter SV accuracy/ URA index of the satellite's navigation message.

Parameters:

<Ura> integer

Range: 0 to 15
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the Localization mode to Full Configuration
`BB:GPS:SVID5:NMES:URA 10`
sets parameter SV accuracy/ URA index

Options: R&S SMx/AMU-K65

Manual operation: See "Ephemeris Parameters" on page 50

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:WLSF <Wlsf>

Sets the UTC parameter WN_{LSF} of the satellite's navigation message.

Parameters:

<Wlsf> integer

Range: 0 to 255
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the "Localization" mode to "Full Configuration"
`BB:GPS:SVID5:NMES:WLSF 10`
sets parameter WN_{LSF}

Options: R&S SMx/AMU-K65

Manual operation: See "UTC Parameters" on page 53

[:SOURce<hw>]:BB:GPS:SVID<st>:NMESsage:WNT <Wnt>

Sets the UTC parameter WNt of the satellite's navigation message.

Parameters:

<Wnt> integer

Range: 0 to 255
*RST: 0

Example: `BB:GPS:LMOD FULL`
sets the Localization mode to Full Configuration
`BB:GPS:SVID5:NMES:WNT 100`
sets parameter WNt

Options: R&S SMx/AMU-K65

Manual operation: See "UTC Parameters" on page 53

4.4 Assistance Data Settings

The `SOURce:BB:GPS:ADGeneration` subsystem contains commands for setting the assistance data settings.

The Assistance Data Settings are only configurable for instrument equipped with option Assisted GPS (R&S SMx/AMU-K65) and in "Full Configuration" localization mode.

[:SOURce<hw>]:BB:GPS:ADGeneration:ACQuisition:BLOCk?

Queries part of the current assistance data settings.

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 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 `[:SOURce<hw>]:BB:GPS:ADGeneration:ACQuisition:CREate`

Example:

```
SOURce1:BB:GPS:ADGeneration:TIME 1500
```

sets the time of assistance data.

```
SOURce1:BB:GPS:ADGeneration:ACQuisition:BLOCk? 2,0.1
```

queries the acquisition data for SV ID 2 and time offset of 0.1s, i.e. at GPS Time 1500 + 0.1 s.

```
Response:
589925,5,3733.3371910282908,0,0,599,18,1,11,
225.32801752395233,11.17712126071662
```

Usage: Query only

Options: R&S SMx/AMU-K65

[:SOURce<hw>]:BB:GPS: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:
```
MMEM:CDIR '<root>acq_files'
```
sets the default directory
```
SOURce1:BB:GPS:ADGeneration:TIME 1500
SOURce1:BB:GPS:ADGeneration:ACQuisition:CREate
'acquisition'
```
stores the current settings into file 'acquisition'
```
SOURce1:BB:GPS:ADGeneration:ACQuisition:BLOCk?
2,0.1
Response:
589925,5,3733.3371910282908,0,0,599,18,1,11,
225.32801752395233,11.17712126071662
```

Options: R&S SMx/AMU-K65

Manual operation: See "Generate Acquisition File …" on page 60

[:SOURce<hw>]:BB:GPS: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> <file_name>

Example:
```
MMEM:CDIR '<root>almanac_files'
```
sets the default directory
```
BB:GPS:ADG:ALM:CRE 'almanac_yuma.rs_yuma'
```
stores the current settings into file 'almanac_yuma.rs_yuma'
```
BB:GPS:ADG:ALM:CRE 'almanac'
```
stores the current settings into file 'almanac.rs_al'

Options: R&S SMx/AMU-K65

Manual operation: See "Generate Almanac File …" on page 57

[:SOURce<hw>]:BB:GPS:ADGeneration:DURation <Duration>

Sets the duration (in seconds) of the GPS Assistance Data.

Parameters:

<Duration> float

Range: 1E-3 to 5E3
Increment: 1E-3
*RST: 1E-3

Example: `BB:GPS:ADG:DUR 150`
sets the duration of assistance data to 150s

Options: R&S SMx/AMU-K65

Manual operation: See "Duration of Assistance Data" on page 57

[:SOURce<hw>]:BB:GPS: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: `MMEM:CDIR '<root>ionospheric_files'`
sets the default directory
`BB:GPS:ADG:ALM:CRE 'ionospheric'`
stores the current settings into file `ionospheric`

Options: R&S SMx/AMU-K65

Manual operation: See "Generate Ionospheric File …" on page 57

[:SOURce<hw>]:BB:GPS:ADGeneration:LOCation:ALTitude <Altitude>

Sets the geographic altitude of the reference location in meters above sea level.

Parameters:

<Altitude> float

Range: -10000 to 10000
Increment: 0.1
*RST: 0

Example: `BB:GPS:ADG:LOC:ALT 250`
sets the altitude of the reference location

Options: R&S SMx/AMU-K65

Manual operation: See "Altitude (Assistance Data Generation)" on page 56

[:SOURce<hw>]:BB:GPS:ADGeneration:LOCation:LATitude <Latitude>

Sets the latitude (expressed as decimal degree) of the reference location. The decimal value is automatically converted into `DEG:MIN:SEC` format.

Parameters:

<Latitude> float

Range: -90 to 90
Increment: 1E-6
*RST: 0

Example: `BB:GPS:ADG:LOC:LAT 12.05`
sets the latitude of the reference location

Options: R&S SMx/AMU-K65

Manual operation: See "Latitude (Assistance Data Generation)" on page 56

[:SOURce<hw>]:BB:GPS:ADGeneration:LOCation:LATitude:DEGRees <Degrees>

Sets the latitude of the reference location in ° (degrees).

Parameters:

<Degrees> integer

Range: 0 to 90
*RST: 0
Default unit: DEG

Example: `BB:GPS:ADG:LOC:LAT:DEGR 12`
sets the latitude of the geographic location to 12°

Options: R&S SMx/AMU-K65

Manual operation: See "Latitude (Assistance Data Generation)" on page 56

[:SOURce<hw>]:BB:GPS:ADGeneration:LOCation:LATitude:DIRection <Direction>

Sets the direction of the geographic location related to the latitude.

Parameters:

<Direction> NORTh | SOUTh

*RST: NORTh

Example: `BB:GPS:ADG:LOC:LAT:DIR SOUT`
sets the direction of the reference location to south

Options: R&S SMx/AMU-K65

Manual operation: See "Latitude (Assistance Data Generation)" on page 56

[:SOURce<hw>]:BB:GPS:ADGeneration:LOCation:LATitude:MINutes <Minutes>

Sets the latitude of the geographic location in ’ (minutes).

Parameters:

<Minutes> integer

Range: 0 to 59
*RST: 0

Example: `BB:GPS:ADG:LOC:LAT:MIN 15`
sets the latitude of the geographic location to 15'

Options: R&S SMx/AMU-K65

Manual operation: See "Latitude (Assistance Data Generation)" on page 56

[:SOURce<hw>]:BB:GPS:ADGeneration:LOCation:LATitude:SEConds <Seconds>

Sets the latitude of the geographic location in " (seconds).

Parameters:

<Seconds> float

Range: 0 to 59.999
Increment: 0.001
*RST: 0

Example: `BB:GPS:ADG:LOC:LAT:SEC 30.123`
sets the latitude of the geographic location to 30.123"

Options: R&S SMx/AMU-K65

Manual operation: See "Latitude (Assistance Data Generation)" on page 56

[:SOURce<hw>]:BB:GPS:ADGeneration:LOCation:LONGitude <Longitude>

Sets the longitude (expressed as decimal degree) of the reference location. The decimal value is automatically converted into `DEG:MIN:SEC` format.

Parameters:

<Longitude> float

Range: -180 to 180
Increment: 1E-6
*RST: 0

Example: `BB:GPS:ADG:LOC:LONG 25.123456`
sets the longitude to 25.123456

Options: R&S SMx/AMU-K65

[:SOURce<hw>]:BB:GPS:ADGeneration:LOCation:LONGitude:DEGRees <Degrees>

Sets the longitude (expressed as decimal degree) of the reference location. The decimal value is automatically converted into `DEG:MIN:SEC` format.

Parameters:

<Degrees> integer

Range: 0 to 180
*RST: 0

Example: `BB:GPS:ADG:LOC:LONG:DEGR 25`
sets the longitude of the geographic location to 25°

Options: R&S SMx/AMU-K65

Manual operation: See "Longitude (Assistance Data Generation)" on page 56

[:SOURce<hw>]:BB:GPS:ADGeneration:LOCation:LONGitude:DIRection <Direction>

Sets the direction of the geographic location related to the longitude.

Parameters:

<Direction> EAST | WEST

*RST: EAST

Example: `BB:GPS:ADG:LOC:LONG:DIR WEST`
sets the direction of the reference location west

Options: R&S SMx/AMU-K65

Manual operation: See "Longitude (Assistance Data Generation)" on page 56

[:SOURce<hw>]:BB:GPS:ADGeneration:LOCation:LONGitude:MINutes <Minutes>

Sets the longitude of the geographic location in ’ (minutes).

Parameters:

<Minutes> integer

Range: 0 to 59
*RST: 0

Example: `BB:GPS:ADG:LOC:LONG:MIN 15`
sets the longitude of the geographic location to 15'

Options: R&S SMx/AMU-K65

Manual operation: See "Longitude (Assistance Data Generation)" on page 56

[:SOURce<hw>]:BB:GPS:ADGeneration:LOCation:LONGitude:SEConds <Seconds>

Sets the longitude of the geographic location in " (seconds).

Parameters:

<Seconds> float

Range: 0.0 to 59.999
Increment: 0.001
*RST: 0

Example: `BB:GPS:ADG:LOC:LONG:SEC 15.123`
sets the longitude of the geographic location to 30.123"

Options: R&S SMx/AMU-K65

Manual operation: See "Longitude (Assistance Data Generation)" on page 56

[:SOURce<hw>]:BB:GPS:ADGeneration:LOCation:PFORmat <Pformat>

Sets the format in which the Latitude and Longitude are displayed.

Parameters:

<Pformat> DMS | DECimal

DMS
The position is specified in DEG:MIN:SEC.

DECimal
The position is specified in decimal degree, i.e.+/-XX.XXXXX°,

*RST: DMS

Example: `BB:GPS:ADG:LOC:PFOR DMS`
position is specified in format DEG:MIN:SEC

Options: R&S SMx/AMU-K65

Manual operation: See "Position Format (Assistance Data Generation)" on page 55

[:SOURce<hw>]:BB:GPS:ADGeneration:LOCation:URADius <URadius>

Sets the Uncertainty Radius.

Parameters:

<URadius> integer

Range: 0 to 1E6
*RST: 3E3

Example: `BB:GPS:ADG:LOC:URAD 2.5KM`
sets the uncertainty radius to 2500m

Options: R&S SMx/AMU-K65

Manual operation: See "Uncertainty Radius" on page 56

[:SOURce<hw>]:BB:GPS: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`.

Parameters:

<Filename> string

Example: `MMEM:CDIR '<root>navigation_files'`
sets the default directory
`BB:GPS:ADG:ALM:CRE 'navigation'`
stores the current settings into file `navigation`

Options: R&S SMx/AMU-K65

Manual operation: See "Generate Navigation File …" on page 58

[:SOURce<hw>]:BB:GPS:ADGeneration:RESolution <Resolution>

Sets the resolution (in seconds) of the GPS Assistance Data.

Parameters:

<Resolution> float

Range: 0.001 to 5
Increment: 0.001
*RST: 0.001

Example: `BB:GPS:ADG:DUR 100`
sets the duration of the assistance data to 100s
`BB:GPS:ADG:RES 25MS`
sets the resolution of assistance data to 25ms

Options: R&S SMx/AMU-K65

Manual operation: See "Resolution of Assistance Data" on page 57

[:SOURce<hw>]:BB:GPS:ADGeneration:SAData? <svId>,<NrSubframes>,<time of week>[,<week number>]

Queries a sensitivity assistance message for a specific satellite (SV ID) and at given specific time (Time of Week).

Query parameters:

<svId> The SV ID is the ID of the space vehicle for which the sensitivity assistance data is queried.

Range: 1 to 37

<NrSubframes> The Number of Subframes 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.

Range: 1 to 125

<time of week> Sets the starting time and date of the generated sensitivity assistance data as GPS TOW (Time of Week).
The `<time of week>` value must be aligned to 6 s. Otherwise, the value is automatically rounded down.
For example, `<time of week> = 61440 s` is aligned to 6 s; `<time of week> = 61442 s` would be rounded down to 61440 s.

<week number> Sets the week of the generated sensitivity assistance data.

Range: 0 to 1023

Return values:

<SaData> <SizeOfMessage>,<NavMessageDataBits>,<NavMessageDataBits>,<NavMessageDataBits>

The instrument 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:SAData? 1,1,3600,1`
queries the sensitivity assistance data for SV ID 1.
`Response: 0`
The selected satellite is unhealthy.
`SOURce1:BB:GPS:ADGeneration:SATellite1:SVID 5`
sets the satellite with SV ID 5 to be simulated from satellite 1
`SOURce1:BB:GPS:ADGeneration:SAData? 5,1,3600,1`
queries the sensitivity assistance data for SV ID 5.
`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

Options: R&S SMx/AMU-K65

[:SOURce<hw>]:BB:GPS:ADGeneration:SATellite<st>:SVID <SvId>

Sets the ID for the corresponding satellite (space vehicle) for which the assistance data will be generate.

Parameters:

<SvId> integer

Range: 1 to 37

Example: `BB:GPS:ADG:SAT4:SVID 16`
sets the satellite with SV ID 16 to be simulated from satellite 4

Options: R&S SMx/AMU-K65

Manual operation: See "SV ID 1 .. 9" on page 55

[:SOURce<hw>]:BB:GPS:ADGeneration:SCOunt <SCount>

Sets the Number of satellites for which the assistance data will be generate.

Note: Configuration of eight satellites is only possible for two path instruments.

Parameters:

<SCount> integer

Range: 1 to 9
*RST: 1

Example: `BB:GPS:BAB:STAT ON`
enables configuration of 8 satellites
`BB:GPS:ADG:SCO 7`
sets the number of satellites for which assistance data will be generate to 7

Options: R&S SMx/AMU-K65

Manual operation: See "Number Of Satellites" on page 55

[:SOURce<hw>]:BB:GPS:ADGeneration:SYNChronize

Synchronies the "assisted" satellites with GPS satellites.

Example: `BB:GPS:ADG:SYNC`

Usage: Event

Options: R&S SMx/AMU-K65

Manual operation: See "Synchronize" on page 55

[:SOURce<hw>]:BB:GPS:ADGeneration:TIME <Time>

Sets the starting time and date of the assistance data as GPS TOW (Time of Week).

Parameters:

<Time> integer

Range: -604800 to 604800
*RST: 0

Example: `BB:GPS:ADG:TIME 1500`
sets the time of assistance data

Options: R&S SMx/AMU-K65

Manual operation: See "Time of Assistance Data" on page 56

[:SOURce<hw>]:BB:GPS: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: `MMEM:CDIR '<root>utc_files'`
sets the default directory
`BB:GPS:ADG:ALM:CRE 'utc'`
stores the current settings into file `utc`

Options: R&S SMx/AMU-K65

Manual operation: See "Generate UTC File …" on page 60

4.5 Real-Time S.P.O.T.

[:SOURce<hw>]:BB:GPS:SPOT:NHOTime?

(enabled for A"uto SV Selection and Updated" mode)

Queries the expected time of the upcoming satellites handover.

The time is expressed as a time offset (in seconds) to the beginning of the simulation set with the command `[:SOURce<hw>]:BB:GPS:NAVigation:SIMulation[:BEGin]:TIME`.

Return values:

<NHoTime> integer
Increment: 1 sec

Example: `BB:GPS:SPOT:NHOT?`
queries the time of the upcoming satellites handover.
`Response: 12103`

Usage: Query only

Manual operation: See "Get Next Handover Time" on page 64

[:SOURce<hw>]:BB:GPS:RLOCation:ALTitude?

Queries the current geographic altitude of the receiver.

Return values:

<Altitude> float
Range: -10000 to 10000
Increment: 0.1
*RST: 0

Example: `BB:GPS:RLOC:ALT? 1.2`
queries the geographic altitude of a receiver with time offset of 1.2 sec.
`Response: 100`

Usage: Query only

Manual operation: See "Receiver Location" on page 63

[:SOURce<hw>]:BB:GPS:RLOCation:LATitude?

Queries the current latitude of the receiver's geographic location expressed as decimal degree.

Return values:

<Latitude> float
Range: -90 to 90
Increment: 1E-6
*RST: 0

Example: `BB:GPS:RLOC:LAT? 1360`
queries the receiver's latitude.
`Response: -7.816657`

Usage: Query only

Manual operation: See "Receiver Location" on page 63

[:SOURce<hw>]:BB:GPS:RLOCation:LATitude:DEGRees?

Queries the current latitude of the receiver's geographic location expressed in ° (degrees).

Return values:

<Degrees> integer

Range: 0 to 90
*RST: 0

Example: `BB:GPS:RLOC:LAT:DEGR? 1375`
queries the receiver's latitude.
`Response: 7`

Usage: Query only

Manual operation: See "Receiver Location" on page 63

[:SOURce<hw>]:BB:GPS:RLOCation:LATitude:DIRection?

Queries the current direction of the receiver's geographic location related to the latitude.

Return values:

<Direction> NORTh | SOUTh

*RST: NORTh

Example: `BB:GPS:RLOC:RLAT:DIR? 1375`
queries the receiver's direction.
`Response: SOUTh`

Usage: Query only

Manual operation: See "Receiver Location" on page 63

[:SOURce<hw>]:BB:GPS:RLOCation:LATitude:MINutes?

Queries the current latitude of the receiver's geographic location expressed in ' (minutes).

Return values:

<Minutes> integer

Range: 0 to 59
*RST: 0

Example: `BB:GPS:RLOC:LAT:MIN? 1375`
queries the receiver's latitude.
`Response: 48`

Usage: Query only

Manual operation: See "Receiver Location" on page 63

[:SOURce<hw>]:BB:GPS:RLOCation:LATitude:SEConds?

Queries the current latitude of the receiver's geographic location expressed ’’ (seconds).

Return values:

<Seconds> float

Range: 0 to 59.999
Increment: 0.001
*RST: 0

Example: `BB:GPS:RLOC:LAT:SEC? 1275`
queries the receiver's latitude.
`Response: 54.842`

Usage: Query only

Manual operation: See "Receiver Location" on page 63

[:SOURce<hw>]:BB:GPS:RLOCation:LONGitude?

Queries the current longitude of the receiver's geographic location expressed as decimal degree.

Return values:

<Longitude> float

Range: -180 to 180
Increment: 1E-6
*RST: 0

Example: `BB:GPS:RLOC:LONG? 1365`
queries the receiver's longitude.
`Response: 144.966624`

Usage: Query only

Manual operation: See "Receiver Location" on page 63

[:SOURce<hw>]:BB:GPS:RLOCation:LONGitude:DEGRees?

Queries the current longitude of the receiver's geographic location expressed in ° (degrees).

Return values:

<Degrees> integer

Range: 0 to 180
*RST: 0

Example: `BB:GPS:RLOC:LONG:DEGR? 1375`
queries the receiver's longitude.
`Response: 144`

Usage: Query only

Manual operation: See "Receiver Location" on page 63

[:SOURce<hw>]:BB:GPS:RLOCation:LONGitude:DIRection?

Queries the current direction of the receiver's geographic location related to the longitude.

Return values:

<Direction> EAST | WEST

*RST: EAST

Example: `BB:GPS:RLOC:LONG:DIR? 1375`
queries the receiver's direction.
`Response: EAST`

Usage: Query only

Manual operation: See "Receiver Location" on page 63

[:SOURce<hw>]:BB:GPS:RLOCation:LONGitude:MINutes?

Queries the current longitude of the receiver's geographic location expressed in ' (minutes).

Return values:

<Minutes> integer

Range: 0 to 59
*RST: 0

Example: `BB:GPS:RLOC:LONG:MIN? 1375`
queries the receiver's longitude.
`Response: 57`

Usage: Query only

Manual operation: See "Receiver Location" on page 63

[:SOURce<hw>]:BB:GPS:RLOCation:LONGitude:SEConds?

Queries the current longitude of the receiver's geographic location expressed in '' (seconds).

Return values:

<Seconds> float

Range: 0 to 59.999
Increment: 0.001
*RST: 0

Example: `BB:GPS:RLOC:LONG:SEC? 1365`
queries the receiver's longitude.
`Response: 59.260`

Usage: Query only

Manual operation: See "Receiver Location" on page 63

4.6 Trigger Settings

[:SOURce<hw>]:BB:GPS: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 68

[:SOURce<hw>]:BB:GPS:TRIGger:EXECute

Executes a trigger.

The internal trigger source must be selected using the command `:BB:GPS:TRIG:SOUR INT` and a trigger mode other than `AUTO` must be selected using the command `:BB:GPS: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 35

[:SOURce<hw>]:BB:GPS:TRIGger:EXTernal:SYNChronize:OUTPut <Output>

(enabled for "Trigger Source" External)

Enables/disables output of the signal synchronous to the external trigger event.

See also "Sync. Output to External Trigger" on page 68 for a detailed description of the applications of this parameter.

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 68

[:SOURce<hw>]:BB:GPS:TRIGger:OBASeband:DELay <Delay>

Specifies the trigger delay (expressed as a number of chips) for triggering by the trigger signal from the second path.

Parameters:
<Delay> float
Range: 0 to 65535
Increment: 0.01
*RST: 0

Example: `BB:GPS:TRIG:SOUR OBAS`
sets for path A the internal trigger executed by the trigger signal from the second path (path B).
`BB:GPS:TRIG:OBAS:DEL 50`
sets a delay of 50 chips for the trigger.

Manual operation: See "Trigger Delay" on page 69

[:SOURce<hw>]:BB:GPS:TRIGger:OBASeband:INHibit <Inhibit>

Specifies the number of chips by which a restart is to be inhibited following a trigger event. Applies only for triggering by the second path (two-path instruments only).

Parameters:

<Inhibit> integer

Range: 0 to 67108863
*RST: 0

Example: `BB:GPS:TRIG:SOUR OBAS`
sets for path A the internal trigger executed by the trigger signal from the second path (path B).
`BB:GPS:TRIG:INH 200`
sets a restart inhibit for 200 chips following a trigger event.

Manual operation: See "Trigger Inhibit" on page 70

[:SOURce<hw>]:BB:GPS: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 67

[:SOURce<hw>]:BB:GPS:TRIGger:SLENgth <SLength>

Defines the length of the signal sequence to be output in the single trigger mode (`SOUR:BB:GPS:SEQ SING`). 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> float

Range: 1 to Max
*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 67

[:SOURce<hw>]:BB:GPS:TRIGger:SLUNit <SLunit>

Defines the unit for the entry of the length of the signal sequence (`SOUR:BB:GPS:TRIG:SLEN`) to be output in the "Single" trigger mode (`SOUR:BB:GPS:SEQ SING`).

Parameters:

<SLunit> CHIP | SFRame | NBIT

SFRame
Unit subframe. A single subframe is generated after a trigger event.

CHIP
Unit Chip. A single chip is generated after a trigger event.

NBIT
Unit Navigation Bit. A single Navigation Bit is generated after a trigger event.

*RST: SFRame

Example: `BB:GPS:SEQ SING`
sets trigger mode Single.
`BB:GPS:TRIG:SLUN SFR`
sets unit Subframe for the entry of signal duration.
`BB:GPS:TRIG:SLEN 2`
sets a signal duration of 2 subframes. The current subframe will be output twice after the next trigger event.

Manual operation: See "Signal Duration Unit" on page 67

[:SOURce<hw>]:BB:GPS:TRIGger:SOURce <Source>

Selects the trigger source.

Parameters:

<Source> INTernal|OBASeband|BEXTernal|EXTernal

INTernal
manual trigger or *TRG.
EXTernal|BEXTernal
trigger signal on the TRIGGER 1/2 connector.
OBASeband
trigger signal from the other path

*RST: INTernal

Example: SOURce1:BB:GPS:TRIGger:SOURce EXTernal
sets external triggering via the TRIGGER 1 connector.

Manual operation: See "Trigger Source" on page 68

[:SOURce<hw>]:BB:GPS: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
*RST: 0

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 "Trigger Delay" on page 69

[:SOURce<hw>]:BB:GPS: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
*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 "Trigger Inhibit" on page 70

[:SOURce<hw>]:BB:GPS[: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 67

4.7 Marker Settings

This section lists the remote control commands, necessary to configure the markers.

[:SOURce<hw>]:BB:GPS:TRIGger:OUTPut:DELay:FIXed <Fixed>

Restricts the marker delay setting range to the dynamic range.

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 72

[:SOURce<hw>]:BB:GPS:TRIGger:OUTPut<ch>:DELay <Delay>

Defines the delay between the signal on the marker outputs and the start of the signal

Parameters:

<Delay> float

Range: 0 to 2^32 - 1 chips
*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 71

[:SOURce<hw>]:BB:GPS:TRIGger:OUTPut<ch>:DELay:MINimum?
[:SOURce<hw>]:BB:GPS:TRIGger:OUTPut<ch>:DELay:MAXimum?

Queries the maximum marker delay.

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 71

[:SOURce<hw>]:BB:GPS:TRIGger:OUTPut<ch>:MODE <Mode>

Defines the signal for the selected marker output.

Parameters:

<Mode> NBIT | WORD | SFRame | PULSe | PATTern | RATio | PPS | PP2S | DISabled

NBIT
A marker signal is generated for every navigation data bit (20460 C/A chips).

WORD
A marker signal is generated for every navigation data word (30 navigation bits).

SFRame
A marker signal is generated for every navigation subframe (corresponds to 10 words).

PPS
A marker signal is generated for every start of second (GPS time).
The pulse width is defined with the `[:SOURce<hw>]:BB:GPS:TRIGger:OUTPut<ch>:PULSe:WIDTh` command

PP2S
A marker signal is generated for every second second (GPS time).
The pulse width is defined with the `[:SOURce<hw>]:BB:GPS:TRIGger:OUTPut<ch>:PULSe:WIDTh` command.

PULSe
A pulsed marker signal is generated.

PATTern
A marker signal is generated according to the user defined pattern (command `[:SOURce<hw>]:BB:GPS:TRIGger:OUTPut<ch>:PATTern`).

RATio
An On/Off marker signal is generated.

*RST: NBIT

Example: `BB:GPS:TRIG:OUTP2:MODE WORD`
selects the word marker signal on output MARKER 2. A marker signal is generated for every navigation data word (30 navigation bits, 20460 C/A chips each).

Manual operation: See "Marker Mode" on page 70

[:SOURce<hw>]:BB:GPS:TRIGger:OUTPut<ch>:ONTime <OnTime>
[:SOURce<hw>]:BB:GPS:TRIGger:OUTPut<ch>:OFFTime <OffTime>

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

Parameters:

<OffTime> integer

Range: 1 to 2^24 - 1 chips
*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 70

[:SOURce<hw>]:BB:GPS:TRIGger:OUTPut<ch>:PATTern <Pattern>

Defines the bit pattern used to generate the marker signal in the setting `SOURce:BB:GPS:TRIGger:OUTPut:MODE PATTern`. 0 is marker off, 1 is marker on.

Parameters:

<Pattern> 64 bits

*RST: #H2,2

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 70

[:SOURce<hw>]:BB:GPS:TRIGger:OUTPut<ch>:PULSe:DIVider <Divider>

Sets the divider for Pulse marker mode (`SOUR:BB:GPS: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
*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 70

[:SOURce<hw>]:BB:GPS:TRIGger:OUTPut<ch>:PULSe:FREQuency?

Queries the pulse frequency of the pulsed marker signal in the setting `SOURce:BB:GPS:TRIGger:OUTPut:MODE PULSe`. The pulse frequency is derived by dividing the symbol rate by the divider.

Return values:

<Frequency> float
Range: 0 to max

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 70

[:SOURce<hw>]:BB:GPS:TRIGger:OUTPut<ch>:PULSe:WIDTh <Width>

Sets the Pulse Width for 1PPS and 1PP2S marker mode (`SOUR:BB:GPS: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 70

4.8 Clock Settings

This section lists the remote control commands, necessary to configure the clock.

[:SOURce<hw>]:BB:GPS:CLOCk:MODE <Mode>

Enters the type of externally supplied clock (`:BB:GPS:CLOCk:SOURce EXTernal`).

For two-path instruments, the only numerical suffix allowed for SOURce is 1, since the external clock source is permanently allocated to path A.

Parameters:

<Mode> CHIP | MCHip

*RST: CHIP

Example: `BB:GPS:CLOC:MODE CHIP`
selects clock type

Manual operation: See "Clock Mode" on page 72

[:SOURce<hw>]:BB:GPS:CLOCk:MULTiplier <Multiplier>

Specifies the multiplier for clock type "Multiplied" (`:BB:GPS:CLOCk:MODE MCHip`) in the case of an external clock source.

For two-path instruments, the only numerical suffix allowed for SOURce is 1, since the external clock source is permanently allocated to path A.

Parameters:

<Multiplier> integer

Range: 1 to 64
*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 72

[:SOURce<hw>]:BB:GPS: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 connector.

*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 72

4.9 Filter Settings

[:SOURce<hw>]:BB:GPS:FILTer:TYPE <Type>

Sets the filter to GPS compliant rectangular mode or to Gauss mode.

Parameters:

<Type> RECTangle | GAUSs

*RST: RECTangle

Example: `BB:GPS:FILTer:TYPE RECT`
sets the filter to rectangular mode.

Manual operation: See "Filter" on page 33

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