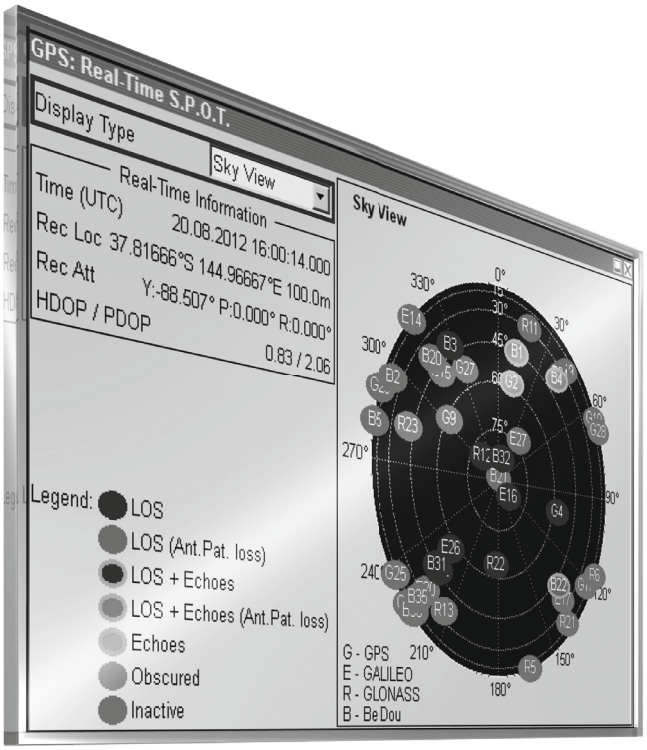
GNSS Simulator in the R&S®SMBV100A Vector Signal Generator

Specifications



ROHDE&SCHWARZ

Test & Measurement

Data Sheet | 05.00

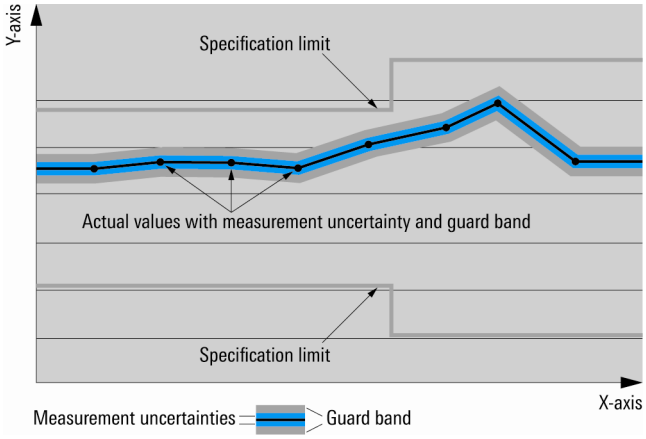
CONTENTS

Definitions

General
Product data applies under the following conditions:

- Three hours storage at ambient temperature followed by 30 minutes warm-up operation
- Specified environmental conditions met
- Recommended calibration interval adhered to
- All internal automatic adjustments performed, if applicable

Specifications with limits
Represent warranted product performance by means of a range of values for the specified parameter. These specifications are marked with limiting symbols such as <, ≤, >, ≥, ±, or descriptions such as maximum, limit of, minimum. Compliance is ensured by testing or is derived from the design. Test limits are narrowed by guard bands to take into account measurement uncertainties, drift and aging, if applicable.



Specifications without limits
Represent warranted product performance for the specified parameter. These specifications are not specially marked and represent values with no or negligible deviations from the given value (e.g. dimensions or resolution of a setting parameter). Compliance is ensured by design.

Typical data (typ.)
Characterizes product performance by means of representative information for the given parameter. When marked with <, > or as a range, it represents the performance met by approximately 80 % of the instruments at production time. Otherwise, it represents the mean value.

Nominal values (nom.)
Characterize product performance by means of a representative value for the given parameter (e.g. nominal impedance). In contrast to typical data, a statistical evaluation does not take place and the parameter is not tested during production.

Measured values (meas.)
Characterize expected product performance by means of measurement results gained from individual samples.

Uncertainties
Represent limits of measurement uncertainty for a given measurand. Uncertainty is defined with a coverage factor of 2 and has been calculated in line with the rules of the Guide to the Expression of Uncertainty in Measurement (GUM), taking into account environmental conditions, aging, wear and tear.

Device settings and GUI parameters are indicated as follows: “parameter: value”.

Typical data as well as nominal and measured values are not warranted by Rohde & Schwarz.

Overview

With the GNSS simulator solution for the R&S®SMBV100A, dynamic scenarios with up to 24 GPS, Galileo, Glonass and BeiDou satellite signals can be generated in realtime including moving scenarios, multipath, dynamic power control and atmospheric modeling. Assisted GPS, Galileo and Glonass test scenarios are additionally made available along with interfaces to generate user-defined GNSS assistance data. The GNSS simulator for the R&S®SMBV100A can also be used to easily simulate real-life user environments such as an urban canyon, rural area, tunnel and highway. The effects of antenna pattern and vehicle body mask can be simulated in realtime with dynamic variation of the vehicle's attitude.

Above and beyond GNSS signal generation, the R&S®SMBV100A is a flexible vector signal generator with excellent RF performance. It offers options for generating standard-compliant signals for all important digital communications standards (GSM, WCDMA, HSPA+, LTE, WiMAX™, WLAN, etc.) and radio standards (DAB, Sirius | XM Satellite Radio, HD Radio™, FM stereo).

This versatility allows mobile phone or car infotainment system manufacturers that integrate GNSS modules into their products to test the GNSS functionality and the normal functionality of their products with only one instrument.

This document contains the functional specifications of the GNSS-related software options for the R&S®SMBV100A:

- R&S®SMBV-K44 GPS
- R&S®SMBV-K65 assisted GPS
- R&S®SMBV-K93 GPS P code
- R&S®SMBV-K66 Galileo
- R&S®SMBV-K67 assisted Galileo
- R&S®SMBV-K94 Glonass
- R&S®SMBV-K95 assisted Glonass
- R&S®SMBV-K91 GNSS extension to 12 satellites
- R&S®SMBV-K96 GNSS extension to 24 satellites
- R&S®SMBV-K92 GNSS enhanced (e.g. moving scenarios, multipath)
- R&S®SMBV-K101 GNSS extension for obscuration simulation and automatic multipath
- R&S®SMBV-K102 GNSS extension for antenna pattern
- R&S®SMBV-K103 GNSS extension for spinning and attitude
- R&S®SMBV-K107 BeiDou
- R&S®SMBV-K111 ground-based augmentation system (GBAS)

For information on other digital standards or signal quality such as phase noise or spurious, see the following Rohde & Schwarz documents:

- R&S®SMBV100A data sheet, PD 5214.1114.22
- R&S®SMBV100A product brochure, PD 5214.1114.12
- Digital Standards for Signal Generators data sheet, PD 5213.9434.22

Abbreviations

The following abbreviations are used in this document:

- The R&S®SMBV-K44 is referred to as K44
- The R&S®SMBV-K65 is referred to as K65
- The R&S®SMBV-K66 is referred to as K66
- The R&S®SMBV-K67 is referred to as K67
- The R&S®SMBV-K91 is referred to as K91
- The R&S®SMBV-K92 is referred to as K92
- The R&S®SMBV-K93 is referred to as K93
- The R&S®SMBV-K94 is referred to as K94
- The R&S®SMBV-K95 is referred to as K95
- The R&S®SMBV-K96 is referred to as K96
- The R&S®SMBV-K101 is referred to as K101
- The R&S®SMBV-K102 is referred to as K102
- The R&S®SMBV-K103 is referred to as K103
- The R&S®SMBV-K107 is referred to as K107
- The R&S®SMBV-K111 is referred to as K111

Minimum hardware configuration

The following minimum hardware configuration is required for the R&S®SMBV100A as a prerequisite for testing GNSS functionality:

R&S®SMBV100A	vector signal generator
R&S®SMBV-B103	frequency range from 9 kHz to 3.2 GHz
R&S®SMBV-B10	baseband generator with digital modulation (realtime) and ARB (32 Msample), 120 MHz RF bandwidth
R&S®SMBV-B92	hard disk (removable)

Key features

GPS (R&S®SMBV-K44 option)

- Simulation of up to 6 GPS satellites with C/A code at frequencies L1 and L2
- Static mode and localization mode
- User-definable almanac file (SEM/YUMA) with real navigation data
- User-definable location and start time
- Automatic setup of GPS scenario with optimum satellite constellation
- Unlimited simulation time with automatic, on-the-fly exchange of satellites
- Dynamic power control of individual satellites in realtime
- Hybrid GNSS satellite constellations with up to 6 satellites (requires the R&S®SMBV-K66 Galileo, R&S®SMBV-K94 Glonass and/or R&S®SMBV-K107 BeiDou option)

Assisted GPS (R&S®SMBV-K65 option)

- Support of predefined and user-defined A-GPS test scenarios
- Generation of A-GPS assistance data for predefined and user-defined scenarios
- Fully user-defined configuration of GPS navigation message (manually or via import of RINEX ephemeris files)
- Requires the R&S®SMBV-K44 option

GPS P code (R&S®SMBV-K93 option)

- Simulation of up to 6 GPS satellites with P codes or combined civilian C/A and military P codes
- Requires the R&S®SMBV-K44 option
- Static mode and localization mode
- User-definable almanac file (SEM/YUMA) with real navigation data
- User-definable location and start time
- Automatic setup of GPS scenarios with optimum satellite constellation
- Unlimited simulation time with automatic, on-the-fly exchange of satellites
- Dynamic power control of individual satellites in realtime
- Hybrid GNSS satellite constellations with up to 6 satellites (requires the R&S®SMBV-K66 Galileo, R&S®SMBV-K94 Glonass and/or R&S®SMBV-K107 BeiDou option)

Galileo (R&S®SMBV-K66 option)

- Simulation of up to 6 Galileo satellites at frequency E1
- Static mode and localization mode
- User-definable almanac file (SEM/YUMA) with real navigation data
- User-definable location and start time
- Automatic setup of Galileo scenario with optimum satellite constellation
- Unlimited simulation time with automatic, on-the-fly exchange of satellites
- Dynamic power control of individual satellites in realtime
- Hybrid GNSS satellite constellations with up to 6 satellites (requires the R&S®SMBV-K44 GPS, R&S®SMBV-K94 Glonass and/or R&S®SMBV-K107 BeiDou option)

Assisted Galileo (R&S®SMBV-K67 option)

- Support of user-defined A-Galileo test scenarios
- Generation of A-Galileo assistance data
- Fully user-defined configuration of Galileo navigation message (manually or via import of RINEX ephemeris files)
- Requires the R&S®SMBV-K66 option

Glonass (R&S®SMBV-K94 option)

- Simulation of up to 6 Glonass satellites (FDMA) with civilian codes at frequencies L1 and L2
- Static mode and localization mode
- User-definable almanac file (.agl) with real navigation data
- User-definable location and start time
- Automatic setup of Glonass scenario with optimum satellite constellation
- Unlimited simulation time with automatic, on-the-fly exchange of satellites
- Dynamic power control of individual satellites in realtime
- Hybrid GNSS satellite constellations with up to 6 satellites (requires the R&S®SMBV-K44 GPS, R&S®SMBV-K66 Galileo and/or R&S®SMBV-K107 BeiDou option)

Assisted Glonass (R&S®SMBV-K95 option)

- Support of predefined and user-defined A-Glonass test scenarios
- Generation of A-Glonass assistance data for predefined and user-defined scenarios
- Fully user-defined configuration of Glonass navigation message (manually or via import of RINEX ephemeris files)
- Requires the R&S®SMBV-K94 option

BeiDou (R&S®SMBV-K107 option)

- Simulation of up to 6 BeiDou satellites at frequency B1
- Static mode and localization mode
- User-definable almanac file with real navigation data
- D1 and D2 navigation messages for MEO/IGSO and GEO satellites, respectively
- User-definable location and start time
- Automatic setup of BeiDou scenario with optimum satellite constellation
- Unlimited simulation time with automatic, on-the-fly exchange of satellites
- Dynamic power control of individual satellites in realtime
- Hybrid GNSS satellite constellations with up to 6 satellites (requires the R&S®SMBV-K44 GPS, R&S®SMBV-K66 Galileo and/or R&S®SMBV-K94 Glonass option)

GNSS extension to 12 satellites (R&S®SMBV-K91 option)

- Simulation of civilian signals from up to 12 GNSS satellites
- Requires the R&S®SMBV-K44, R&S®SMBV-K66, R&S®SMBV-K94 or R&S®SMBV-K107 option

GNSS extension to 24 satellites (R&S®SMBV-K96 option)

- Simulation of GPS C/A, Galileo, Glonass and BeiDou signals from up to 24 GNSS satellites
- Enhances the multipath budget of GPS C/A, Galileo, Glonass and/or BeiDou signals up to 24 (requires an additional R&S®SMBV-K92 option)
- Requires the R&S®SMBV-K91 option

GNSS enhanced (e.g. moving scenarios, multipath) (R&S®SMBV-K92 option)

- WGS84 waypoint interface and import of NMEA waypoint
- Import of Google Earth and Google Maps kml files
- East-North-Up (ENU) 2D vector trajectory interface (line, arc) for automatic waypoint generation
- Motion interface for dynamics input (velocity vector or velocity magnitude) in ENU and WGS84
- Predefined waypoint files for land vehicles, ships, aircraft and spacecraft
- User-definable and predefined vehicle description files for land vehicles, ships, aircraft and spacecraft
- Smoothing of waypoints using vehicle description files
- Hardware-in-the-loop (HIL) realtime feed of vehicle's motion data (position, velocity, acceleration and jerk)
- Configurable HIL streaming rate of up to 100 Hz
- HIL execution synchronous to 1 PPS; 10 ms system response delay and applied prediction algorithms
- User-definable multipath
- Configurable atmospheric models
- Configurable system time transformation parameters
- Configurable leap second simulation
- Requires the R&S®SMBV-K44, R&S®SMBV-K66, R&S®SMBV-K94 or R&S®SMBV-K107 option

GNSS extension for obscuration simulation and automatic multipath (R&S®SMBV-K101 option)

- User-definable vertical obstacles to model city block environments
- User-definable roadside planes to model highway and cutting environments
- User-definable interface to model aircraft and ship ground/sea reflection
- User-definable interface to model full obscuration as in tunnels
- Automatic realtime update of satellite visibility and multipath, depends on the modeled user environment in auto localization mode
- Up to 10 Hz obscuration and multipath environment sampling
- Configurable material property for vertical obstacles, roadside planes and ground/sea terrains
- Predefined environment models such as rural area, suburban area, urban canyon, tunnel, bridge, highway
- Requires the R&S®SMBV-K44, R&S®SMBV-K66, R&S®SMBV-K94 or R&S®SMBV-K107 option
- Automatic multipath update requires R&S®SMBV-K92

GNSS extension for antenna pattern (R&S®SMBV-K102 option)

- User-definable models for antenna patterns and vehicle body masks
- Predefined body masks for land vehicles, ships, aircraft and spacecraft
- Automatic realtime update of satellite power and carrier phase, depends on the antenna pattern and attitude parameters in auto localization mode
- 800 Hz satellite power and carrier phase update rate following antenna pattern
- Automatic attitude extraction from motion heading for automotive environments
- Simulation of up to four antenna patterns/body masks for a selected vehicle and their body offsets to the vehicle
- Realtime synchronous switch between antenna patterns by means of scheduling
- Requires the R&S®SMBV-K44, R&S®SMBV-K66, R&S®SMBV-K94 or R&S®SMBV-K107 option

GNSS extension for spinning and attitude (R&S®SMBV-K103 option)

- Configurable pitch/elevation, yaw/heading and roll/bank parameters
- Predefined attitude profiles as well as movement files
- Up to 400 Hz spinning rate
- Realtime feed of attitude data as well as motion data for hardware in the loop (HIL)
- Requires the R&S®SMBV-K102 option

GBAS (R&S®SMBV-K111 option)

- Provision of GBAS messages via VHF link
- Simultaneous simulation of up to 11 GBAS frequency channels emulating multiple VHF data broadcast (VDB) towers
- Generation of message types 1, 2, 4 and 11
- Support of real GBAS data generation based on user-configurable waypoint file and differential GNSS data

Global navigation satellite system (GNSS)

GPS (R&S®SMBV-K44 option)

GPS		in line with ICD-GPS-200 revision D
General settings		
Frequency		based on RF band and GNSS hybrid configuration
		user-selectable in entire frequency range depending on installed RF option (see R&S®SMBV100A data sheet)
Output power		based on selected power mode and individual satellite power parameters
		user-selectable in entire output power range depending on installed RF option (see R&S®SMBV100A data sheet)
RF bands		L1/E1, L2 default: L1/E1
Simulation modes		
Static mode		generation of up to 6 satellites in realtime with user-definable satellite time shift, power, Doppler and initial carrier phase, e.g. for sensitivity measurements
Auto localization mode		automatic dynamic simulation of up to 6 satellites at a receiver location based on user-definable almanac, location and time; simulation is not time-limited due to automatic dynamic exchange of simulated satellites based on visibility and when required for better position dilution of precision (PDOP); constellation and satellite power variation are automatically simulated
User localization mode		dynamic simulation of up to 6 satellites at a receiver location based on user-definable almanac, location and time; a complete user-definable constellation, satellite exchange in realtime and satellite power configuration in realtime are supported
GNSS hybrid configuration	available if K66, K94 or K107 is additionally installed	hybrid GNSS constellation with up to 6 satellites, e.g. 2 GPS satellites and 4 Galileo satellites; possible whenever the base option of the other GNSS standard is installed
User space coordinates	available in auto localization mode and user localization mode	geodetic coordinates in ECEF WGS84 coordinate system: • altitude: –10 000 m to +1 600 000 m in steps of 0.1 m • latitude: –90° to +90° in steps of 0.000001° • longitude: –180° to +180° in steps of 0.000001°
System time basis		GPS, UTC default: GPS
Simulation time		flexible date and time or GPS time configuration with a resolution of 1 ms
Current leap seconds	static mode and auto localization mode	automated
	user localization mode	user-configurable
Elevation mask	available in auto localization mode and user localization mode	2.5°, 5°, 7.5°, 10°; filtering of satellites below a specific threshold in case of limited channel availability, i.e. satellites with high elevation are preferred over satellites with low elevation

Get optimal constellation	available in user localization mode	optimal constellation search based on the real navigation data and the maximum number of satellites with minimized PDOP and an elevation above the elevation mask
Realtime satellite and position online tracker (SPOT) display	available in auto localization mode and user localization mode	dynamic constellation, user location, satellite absolute power and trajectory views in addition to HDOP/PDOP display; the time of the next satellite handover can be polled in auto localization mode
Power modes		
User power mode	available in static mode and user localization mode	21 dB dynamic range, user-configurable in realtime
Auto power mode	available in auto localization mode and in user localization mode	automatic simulation of satellite power values based on: • satellite-to-user distance • interstandard power tuning parameters (only for hybrid GNSS configuration)
Interstandard power tuning	available in auto power mode and if K66 is installed	simulates the nominal power difference between different standards
Marker		1 PPS
		1 PP2S
		10 PPS
		pulse
		pattern
		on/off ratio
		trigger
Triggering		see R&S®SMBV100A data sheet, "I/Q baseband generator" section
Navigation data source	identical for each satellite	All 0
		All 1
		pattern (up to 64 bit)
		PN 9 to PN 23
		data lists
		real navigation data: almanac file as source for ephemeris and almanac subframes; ephemeris subframes are projected from the almanac subframes
Use spreading code	available in static mode	on/off
GPS satellite configuration (separately settable for each satellite)		
Signals (chip rates)		coarse/acquisition C/A (1.023 MHz)
Modulation		BPSK (CDMA)
State		on/off
Space vehicle ID		C/A codes: 37 Gold codes, 1023 chips each
Initial code phase	configurable in case of static and no real navigation data	0.00 chips to 20 459.99 chips in steps of 0.01 chips
Pseudorange	configurable in static mode	0 m to 30 000 km
Pseudorange bias		–1000 m to +1000 m, updated in realtime without restarting the simulation
Satellite relative power	configurable in user power mode	–21 dB to 0 dB, updated in realtime without restarting the simulation
Doppler shift	configurable in static mode	–100 kHz to +100 kHz in steps of 0.01 Hz
Initial carrier phase	configurable in static mode	0 to 2π in steps of 0.01 rad
Navigation data format		GPS NAV
Data rate		50 Hz
Number of ephemeris pages		1
Ephemeris realtime projection	configurable in user localization mode	off/on; a projection (reference time shifted and ephemeris set adjusted accordingly) will be made whenever the ephemeris set approaches the 2 h validity threshold
Project navigation message	configurable in user localization mode	projects the ephemeris and satellite clock correction to the current simulation time

Dynamics		
Max. Doppler error		±0.015 Hz
Pseudorange error	RMS	±0.01 m
Max. velocity	R&S®SMBV-B10	599 m/s
	R&S®SMBV-B10F [1]	10 000 m/s
Max. acceleration		1600 m/s^2
Max. jerk		400 m/s^3 (as impulse)

[1] Subject to export control regulations and therefore not available in all countries and to all customers.

Assisted GPS (R&S®SMBV-K65 option)

The R&S®SMBV-K44 option must be installed on the respective instrument.

General settings		
A-GPS/A-GNSS test scenarios		
GSM	• 3GPP TS 51.010-1 v.7.7.0 10.9: A-GPS signaling scenario • 3GPP TS 51.010-1 v.7.7.0 10.10: A-GPS performance scenario 1 • 3GPP TS 51.010-1 v.7.7.0 10.10: A-GPS performance scenario 2 • 3GPP TS 51.010-1 v.7.7.0 10.10: A-GPS performance scenario 3 (requires K92)	
3GPP FDD	• 3GPP TS 34.108 v.8.0.0 10.7: A-GPS signaling scenario • 3GPP TS 34.108 v.8.0.0 10.1.2: A-GPS performance scenario 1 • 3GPP TS 34.108 v.8.0.0 10.1.2: A-GPS performance scenario 2 • 3GPP TS 34.108 v.8.0.0 10.1.2: A-GPS performance scenario 3 (requires K92) • 3GPP TS 37.571-2 v.10.0.0 subclause 6: A-GNSS signaling scenario, subtest 4 (requires K95) • 3GPP TS 37.571-1 v.10.0.0 subclause 6: A-GNSS performance scenario 1, subtest 4 (requires K95) • 3GPP TS 37.571-1 v.10.0.0 subclause 6: A-GNSS performance scenario 2, subtest 4 (requires K95) • 3GPP TS 37.571-1 v.10.0.0 subclause 6: A-GNSS performance scenario 5, subtest 4 (requires K95 and K92)	
3GPP2	• 3GPP2 C.S0036-0 V1.0 2.1.1: A-GPS stationary • 3GPP2 C.S0036-0 V1.0 2.1.2: A-GPS moving (requires K91 and K92)	
EUTRA/LTE	• 3GPP TS 37.571-2 v.10.0.0 subclause 7: A-GPS signaling scenario, subtest 1 • 3GPP TS 37.571-1 v.10.0.0 subclause 7: A-GPS performance scenario 1, subtest 1 • 3GPP TS 37.571-1 v.10.0.0 subclause 7: A-GPS performance scenario 2, subtest 1 • 3GPP TS 37.571-1 v.10.0.0 subclause 7: A-GPS performance scenario 5, subtest 1 (requires K92) • 3GPP TS 37.571-2 v.10.0.0 subclause 7: A-GNSS signaling scenario, subtest 4 (requires K95) • 3GPP TS 37.571-1 v.10.0.0 subclause 7: A-GNSS performance scenario 1, subtest 5 (requires K95) • 3GPP TS 37.571-1 v.10.0.0 subclause 7: A-GNSS performance scenario 2, subtest 5 (requires K95) • 3GPP TS 37.571-1 v.10.0.0 subclause 7: A-GNSS performance scenario 5, subtest 5 (requires K95 and K92)	
User-definable	additional test scenarios can be defined by the user	
Simulation modes (in addition to the K44 functionality)		
Static mode		GPS satellite navigation parameters can be manually adjusted
User localization mode		GPS satellite navigation parameters can be manually adjusted or imported from a GPS RINEX file
Generation of assistance data		• almanac file • ionospheric file • navigation file • UTC file • acquisition file and acquisition block (remote interface) • sensitivity block (remote interface) in comma separated values (CSV) format; for navigation file, also in standard RINEX format
Real navigation data (in addition to the K44 functionality)		ephemeris subframes can be configured manually or imported from a GPS RINEX file
Configuration of navigation data (separately settable for each satellite/each satellite ephemeris page)		
Number of ephemeris pages	user localization mode	1 to 12 (manual configuration or import from a GPS RINEX file)
	static mode and auto localization mode	1
Ephemeris parameters		range as defined in ICD-GPS-200 revision D, navigation message
Satellite clock correction parameters		range as defined in ICD-GPS-200 revision D, navigation message

GPS P code (R&S®SMBV-K93 option)

The R&S®SMBV-K44 option must be installed on the respective instrument.

Allows the simulation of up to 6 GPS satellites with P codes or combined civilian C/A and P codes or the legacy C/A signal type provided by K44.

GPS P code		in line with ICD-GPS-200 revision D (antispoofing disabled)
General settings		
Frequency		based on RF band and GNSS hybrid configuration
		user-selectable in entire frequency range depending on installed RF option (see R&S®SMBV100A data sheet)
Output power		based on selected power mode and individual satellite power parameters
		user-selectable in entire output power range depending on installed RF option (see R&S®SMBV100A data sheet)
RF bands		L1/E1, L2 default: L1/E1
Simulation modes		
Static mode		generation of up to 6 GPS C/A, P or C/A + P satellites in realtime with user-definable satellite time shift, power, Doppler and initial carrier phase, e.g. for sensitivity measurements
Auto localization mode		automatic dynamic simulation of up to 6 GPS C/A, P or C/A + P satellites at a receiver location based on user-definable almanac, location and time; simulation is not time-limited due to automatic dynamic exchange of simulated satellites based on visibility and when required for better position dilution of precision (PDOP); constellation and satellite power variation are automatically simulated
User localization mode		dynamic simulation of up to 6 GPS C/A, P or C/A + P satellites at a receiver location based on user-definable almanac, location and time; a complete user-definable constellation, satellite exchange in realtime and satellite power configuration in realtime are supported
GNSS hybrid configuration	available if K66, K94 or K107 is additionally installed	hybrid GNSS constellation with up to 6 satellites, e.g. 4 GPS (C/A + P) satellites and 2 Galileo satellites; possible whenever the base option of the other GNSS standard is installed
User space coordinates	available in auto localization mode and user localization mode	geodetic coordinates in ECEF WGS84 coordinate system: • altitude: –10 000 m to +1 600 000 m in steps of 0.1 m • latitude: –90° to +90° in steps of 0.000001° • longitude: –180° to +180° in steps of 0.000001°
System time basis		GPS, UTC default: GPS
Simulation time		flexible date and time or GPS time configuration with a resolution of 1 ms
Current leap seconds	static mode and auto localization mode	automated
	user localization mode	user-configurable

Elevation mask	available in auto localization mode and user localization mode	2.5°, 5°, 7.5°, 10°; filtering of satellites below a specific threshold in case of limited channel availability, i.e. satellites with high elevation are preferred over satellites with low elevation
Get optimal constellation	available in user localization mode	optimal constellation search based on the real navigation data and the maximum number of satellites with minimized PDOP and an elevation above the elevation mask
Realtime satellite and position online tracker (SPOT) display	available in auto localization mode and user localization mode	dynamic constellation, user location, satellite absolute power and trajectory views in addition to HDOP/PDOP display; the time of the next satellite handover can be polled in auto localization mode
Power modes		
User power mode	available in static mode and user localization mode	21 dB dynamic range, user-configurable in realtime
Auto power mode	available in auto localization mode and in user localization mode	automatic simulation of satellite power values based on: • satellite-to-user distance • interstandard power tuning parameters (only in case of a hybrid GNSS configuration)
Global signal configuration	available in auto localization mode	configures the signals of all possible GPS space vehicles to C/A, P or C/A + P
Intrastandard power tuning		configures the nominal power difference between the civilian and P code signal components of a GPS satellite
Interstandard power tuning	available in auto power mode and if K66 or K94 is installed	configures the nominal power difference between different standards
Marker		1 PPS
		1 PP2S
		10 PPS
		pulse
		pattern
		on/off ratio
		trigger
Triggering		see R&S®SMBV100A data sheet, "I/Q baseband generator" section
Navigation data source	identical for each satellite	All 0
		All 1
		pattern (up to 64 bit)
		PN 9 to PN 23
		data lists
		real navigation data: almanac file as source for ephemeris and almanac subframes; ephemeris subframes are projected from the almanac subframes
Use spreading code	available in static mode	on/off

GPS satellite configuration (separately settable for each satellite)		
Signals (chip rates)		coarse/acquisition C/A (1.023 MHz) and P (10.23 MHz)
Modulation		BPSK (CDMA)
State		on/off
Space vehicle ID		C/A codes: 37 Gold codes, 1023 chips each P codes: 37 orthogonal codes, one week long each
Initial code phase	configurable in case of static and no real navigation data	0.00 chips to 20459.99 chips in steps of 0.01 chips
Pseudorange	configurable in static mode	0 m to 30 000 km
Pseudorange bias		–1000 m to +1000 m, updated in realtime without restarting the simulation
Satellite relative power	configurable in user power mode	–21 dB to 0 dB, updated in realtime without restarting the simulation
Doppler shift	configurable in static mode	–100 kHz to +100 kHz in steps of 0.01 Hz
Initial carrier phase	configurable in static mode	0 to 2π in steps of 0.01 rad
Navigation data format		GPS NAV
Data rate		50 Hz
Number of ephemeris pages		1
Ephemeris realtime projection	configurable in user localization mode	off/on; a projection (reference time shifted and ephemeris set tuned accordingly) will be made whenever the ephemeris set approaches the 2 h validity threshold
Project navigation message	configurable in user localization mode	projects the ephemeris and satellite clock correction to the current simulation time
Dynamics		
Max. Doppler error		±0.015 Hz
Pseudorange error	RMS	±0.01 m
Max. velocity	R&S®SMBV-B10	599 m/s
	R&S®SMBV-B10F [2]	10 000 m/s
Max. acceleration		1600 m/s^2
Max. jerk		400 m/s^3 (as impulse)

[2] Subject to export control regulations and therefore not available in all countries and to all customers.

Galileo (R&S®SMBV-K66 option)

Galileo		in line with OS SIS ICD, E1 band
General settings		
Frequency		based on RF band and GNSS hybrid configuration
		user-selectable in entire frequency range depending on installed RF option (see R&S®SMBV100A data sheet)
Output power		based on selected power mode and individual satellite power parameters
		user-selectable in entire output power range depending on installed RF option (see R&S®SMBV100A data sheet)
RF bands		L1/E1
Simulation modes		
Static mode		generation of up to 6 satellites in realtime with user-definable satellite time shift, power, Doppler and initial carrier phase, e.g. for sensitivity measurements
Auto localization mode		automatic dynamic simulation of up to 6 satellites at a receiver location based on user-definable almanac, location and time; simulation is not time-limited due to automatic dynamic exchange of simulated satellites based on visibility and when required for better position dilution of precision (PDOP); constellation and satellite power variation are automatically simulated
User localization mode		dynamic simulation of up to 6 satellites at a receiver location based on user-definable almanac, location and time; a complete user-definable constellation, satellite exchange in realtime and satellite power configuration in realtime are supported
GNSS hybrid configuration	available if K66, K94 or K107 is additionally installed	hybrid GNSS constellation with up to 6 satellites, e.g. 2 GPS satellites and 4 Galileo satellites; possible whenever the base option of the other GNSS standard is installed
User space coordinates	available in auto localization mode and user localization mode	geodetic coordinates in ECEF WGS84 coordinate system: • altitude: –10 000 m to +1 600 000 m in steps of 0.1 m • latitude: –90° to +90° in steps of 0.000001° • longitude: –180° to +180° in steps of 0.000001°
System time basis		GPS, UTC default: GPS
Simulation time		flexible date and time or GPS time configuration with a resolution of 1 ms
Current leap seconds	static mode and auto localization mode	automated
	user localization mode	user-configurable
Elevation mask	available in auto localization mode and user localization mode	2.5°, 5°, 7.5°, 10°; filtering of satellites below a specific threshold in case of limited channel availability, i.e. satellites with high elevation are preferred over satellites with low elevation
Get optimal constellation	available in user localization mode	optimal constellation search based on the real navigation data and the maximum number of satellites with minimized PDOP and an elevation above the elevation mask

Realtime satellite and position online tracker (SPOT) display	available in auto localization mode and user localization mode	dynamic constellation, user location, satellite absolute power and trajectory views in addition to HDOP/PDOP display; the time of the next satellite handover can be polled in auto localization mode
Power modes		
User power mode	available in static mode and user localization mode	21 dB dynamic range, user-configurable in realtime
Auto power mode	available in auto localization mode and user localization mode	automatic simulation of satellite power values based on: • satellite-to-user distance • interstandard power tuning parameters (only in case of a hybrid GNSS configuration)
Interstandard power tuning	available in auto power mode and if K66 is installed	simulation of the nominal power difference between different standards
Marker		1 PPS
		1 PP2S
		10 PPS
		pulse
		pattern
		on/off ratio
		trigger
Triggering		see R&S®SMBV100A data sheet, "I/Q baseband generator" section
Navigation data source	identical for each satellite	All 0
		All 1
		pattern (up to 64 bit)
		PN 9 to PN 23
		data lists
		real navigation data: almanac file as source for ephemeris and almanac subframes; ephemeris subframes are projected from the almanac subframes
Use spreading code	available in static mode	on/off
GPS satellite configuration (separately settable for each satellite)		
Signals (chip rates)		coarse/acquisition C/A (1.023 MHz)
Modulation		BPSK (CDMA)
State		on/off
Space vehicle ID		C/A codes: 37 Gold codes, 1023 chips each
Initial code phase	configurable in case of static and no real navigation data	0.00 chips to 20459.99 chips in steps of 0.01 chips
Pseudorange	configurable in static mode	0 m to 30000 km
Pseudorange bias		–1000 m to +1000 m, updated in realtime without restarting the simulation
Satellite relative power	configurable in user power mode	–21 dB to 0 dB, updated in realtime without restarting the simulation
Doppler shift	configurable in static mode	–100 kHz to +100 kHz in steps of 0.01 Hz
Initial carrier phase	configurable in static mode	0 to 2π in steps of 0.01 rad
Navigation data format		GPS NAV
Data rate		50 Hz
Number of ephemeris pages		1
Ephemeris realtime projection	configurable in user localization mode	off/on; a projection (reference time shifted and ephemeris set tuned accordingly) will be made whenever the ephemeris set approaches the 2 h validity threshold
Project navigation message	configurable in user localization mode	projects the ephemeris and satellite clock correction to the current simulation time
Dynamics		
Max. Doppler error		±0.015 Hz
Pseudorange error	RMS	±0.01 m
Max. velocity	R&S®SMBV-B10	599 m/s

	R&S®SMBV-B10F [3]	10 000 m/s
Max. acceleration		1600 m/s^2
Max. jerk		400 m/s^3 (as impulse)

[3] Subject to export control regulations and therefore not available in all countries and to all customers.

Assisted Galileo (R&S®SMBV-K67 option)

The R&S®SMBV-K66 option must be installed on the respective instrument.

General settings		
A-Galileo test scenarios		
User-definable		test scenarios can be defined by the user
Simulation modes (in addition to the K66 functionality)		
Static mode		Galileo satellite navigation parameters can be manually adjusted
User localization mode		Galileo satellite navigation parameters can be manually adjusted or imported from a Galileo RINEX file
Generation of assistance data		• almanac file • ionospheric file • navigation file • UTC file • acquisition file and acquisition block (remote interface) • sensitivity block in comma separated values (CSV) format; for navigation file, also in standard RINEX format
Real navigation data (in addition to the K66 functionality)		INAV ephemeris can be configured manually or imported from a Galileo RINEX file
Configuration of navigation data (separately settable for each satellite/each satellite ephemeris page)		
Number of ephemeris pages	user localization mode	1 to 12 (manual configuration or import from a Galileo RINEX file)
	static mode and auto localization mode	1
Ephemeris parameters		range as defined in OS SIS ICD INAV navigation message
Satellite clock correction parameters		range as defined in OS SIS ICD INAV navigation message

Glonass (R&S®SMBV-K94 option)

Glonass		in line with Glonass ICD version 5.0
General settings		
Frequency		based on RF band and GNSS hybrid configuration
		user-selectable in entire frequency range depending on installed RF option (see R&S®SMBV100A data sheet)
Output power		based on selected power mode and individual satellite power parameters
		user-selectable in entire output power range depending on installed RF option (see R&S®SMBV100A data sheet)
RF bands		L1/E1, L2 default: L1/E1
Simulation modes		
Static mode		generation of up to 6 satellites in realtime with user-definable satellite time shift, power, Doppler and initial carrier phase, e.g. for sensitivity measurements
Auto localization mode		automatic dynamic simulation of up to 6 satellites at a receiver location based on user-definable almanac, location and time; simulation is not time-limited due to automatic dynamic exchange of simulated satellites based on visibility and when required for better position dilution of precision (PDOP); constellation and satellite power variation are automatically simulated
User localization mode		dynamic simulation of up to 6 satellites at a receiver location based on user-definable almanac, location and time; a complete user-definable constellation, satellite exchange in realtime and satellite power configuration in realtime are supported
GNSS hybrid configuration	available if K44, K66 or K107 is additionally installed	hybrid GNSS constellation with up to 6 satellites, e.g. 4 Glonass satellites and 2 GPS satellites; possible whenever the base option of the other GNSS standard is installed
User space coordinates	available in auto localization mode and user localization mode	geodetic coordinates in ECEF WGS84 coordinate system: • altitude: –10000 m to +1600000 m in steps of 0.1 m • latitude: –90° to +90° in steps of 0.000001° • longitude: –180° to +180° in steps of 0.000001°
System time basis		GLO, UTC default: GLO
Simulation time		flexible date and time or GLO time configuration with a resolution of 1 ms
Current leap seconds	static mode and auto localization mode	automated
	user localization mode	user-configurable
Elevation mask	available in auto localization mode and user localization mode	2.5°, 5°, 7.5°, 10°; filtering of satellites below a specific threshold in case of limited channel availability, i.e. satellites with high elevation are preferred over satellites with low elevation
Get optimal constellation	available in user localization mode	optimal constellation search based on the real navigation data and the maximum number of satellites with minimized PDOP and an elevation above the elevation mask

Realtime satellite and position online tracker (SPOT) display	available in auto localization mode and user localization mode	dynamic constellation, user location, satellite absolute power and trajectory views in addition to HDOP/PDOP display; the time of the next satellite handover can be polled in auto localization mode
Power modes		
User power mode	available in static mode and user localization mode	21 dB dynamic range, user-configurable in realtime
Auto power mode	available in auto localization mode and in user localization mode	automatic simulation of satellite power values based on: • satellite-to-user distance • interstandard power tuning parameters (only in case of a hybrid GNSS configuration)
Interstandard power tuning	available in auto power mode and if K66 is installed	simulates the nominal power difference between different standards
Marker		1 PPS
		1 PP2S
		10 PPS
		pulse
		pattern
		on/off ratio
		trigger
Triggering		see R&S®SMBV100A data sheet, "I/Q baseband generator" section
Navigation data source	identical for each satellite	All 0
		All 1
		pattern (up to 64 bit)
		PN 9 to PN 23
		data lists
		real navigation data: almanac file as source for ephemeris and almanac subframes; ephemeris automatically generated from .agl almanac file
Use spreading code	available in static mode	on/off
Glonass satellite configuration (separately settable for each satellite)		
Signals (chip rates)		coarse/acquisition R-C/A (511 kHz)
Frequency number	configurable in static mode with no real navigation data	–7 to +13
Modulation		BPSK (CDMA)
State		on/off
Space vehicle ID		1 CDMA code shared by all Glonass satellites, 511 chips per repetition
Initial code phase	configurable in case of static and no real navigation data	0.00 chips to 20459.99 chips in steps of 0.01 chips
Pseudorange	configurable in static mode	0 m to 30 000 km
Pseudorange bias		–1000 m to +1000 m, updated in realtime without restarting the simulation
Satellite relative power	configurable in user power mode	–21 dB to 0 dB, updated in realtime without restarting the simulation
Doppler shift	configurable in static mode	–100 kHz to +100 kHz in steps of 0.01 Hz
Initial carrier phase	configurable in static mode	0 to 2π in steps of 0.01 rad
Navigation data format		Glonass NAV
Data rate		50 Hz, 100 Hz (after applying the meander code)
Number of ephemeris pages		1
Ephemeris realtime projection	configurable in user localization mode	off/on; a projection (reference time shifted and ephemeris set tuned accordingly) will be made every 30, 45 or 60 minutes
Project navigation message	configurable in user localization mode	projects the ephemeris and satellite clock correction to the current simulation time

Dynamics		
Max. Doppler error		±0.015 Hz
Pseudorange error	RMS	±0.01 m
Max. velocity	R&S®SMBV-B10	599 m/s
	R&S®SMBV-B10F [4]	10 000 m/s
Max. acceleration		1600 m/s^2
Max. jerk		400 m/s^3 (as impulse)

[4] Subject to export control regulations and therefore not available in all countries and to all customers.

Assisted Glonass (R&S®SMBV-K95 option)

The R&S®SMBV-K94 option must be installed on the respective instrument.

General settings		
A-Glonass/A-GNSS test scenarios		
3GPP FDD	• 3GPP TS 37.571-2 v.10.0.0 subclause 6: A-Glonass signaling scenario, subtest 1 • 3GPP TS 37.571-1 v.10.0.0 subclause 6: A-Glonass performance scenario 1, subtest 1 • 3GPP TS 37.571-1 v.10.0.0 subclause 6: A-Glonass performance scenario 2, subtest 1 • 3GPP TS 37.571-1 v.10.0.0 subclause 6: A-Glonass performance scenario 5, subtest 1 (requires K92) • 3GPP TS 37.571-2 v.10.0.0 subclause 6: A-GNSS signaling scenario, subtest 4 (requires K65) • 3GPP TS 37.571-1 v.10.0.0 subclause 6: A-GNSS performance scenario 1, subtest 4 (requires K65) • 3GPP TS 37.571-1 v.10.0.0 subclause 6: A-GNSS performance scenario 2, subtest 4 (requires K65) • 3GPP TS 37.571-1 v.10.0.0 subclause 6: A-GNSS performance scenario 5, subtest 4 (requires K65 and K92)	
EUTRA/LTE	• 3GPP TS 37.571-2 v.10.0.0 subclause 7: A-Glonass signaling scenario, subtest 2 • 3GPP TS 37.571-1 v.10.0.0 subclause 7: A-Glonass performance scenario 1, subtest 2 • 3GPP TS 37.571-1 v.10.0.0 subclause 7: A-Glonass performance scenario 2, subtest 2 • 3GPP TS 37.571-1 v.10.0.0 subclause 7: A-Glonass performance scenario 5, subtest 2 (requires K92) • 3GPP TS 37.571-2 v.10.0.0 subclause 7: A-GNSS signaling scenario, subtest 4 (requires K65) • 3GPP TS 37.571-1 v.10.0.0 subclause 7: A-GNSS performance scenario 1, subtest 5 (requires K65) • 3GPP TS 37.571-1 v.10.0.0 subclause 7: A-GNSS performance scenario 2, subtest 5 (requires K65) • 3GPP TS 37.571-1 v.10.0.0 subclause 7: A-GNSS performance scenario 5, subtest 5 (requires K65 and K92)	
User-definable	additional test scenarios can be defined by the user	
Simulation modes (in addition to the K44 functionality)		
Static mode		Glonass satellite navigation parameters can be manually adjusted
User localization mode		Glonass satellite navigation parameters can be manually adjusted or imported from a Glonass RINEX file
Generation of assistance data		• almanac file • ionospheric file • navigation file • UTC file • acquisition file and acquisition block (remote interface) • sensitivity block (remote interface) in comma separated values (CSV) format; for navigation file, also in standard RINEX format
Real navigation data (in addition to the K94 functionality)		ephemeris can be configured manually or imported from a Glonass RINEX file
Configuration of navigation data (separately settable for each satellite/each satellite ephemeris page)		
Number of ephemeris pages	user localization mode	1 to 12 (manual configuration or import from a Glonass RINEX file)
	static mode and auto localization mode	1
Ephemeris parameters		range as defined in Glonass ICD version 5.0, navigation message
Satellite clock correction parameters		range as defined in Glonass ICD version 5.0, navigation message

BeiDou (R&S®SMBV-K107 option)

BeiDou		in line with BDS-SIS-ICD-B1I-1.0
General settings		
Frequency		based on RF band and GNSS hybrid configuration
		user-selectable in entire frequency range depending on installed RF option (see R&S®SMBV100A data sheet)
Output power		based on selected power mode and individual satellite power parameters
		user-selectable in entire output power range depending on installed RF option (see R&S®SMBV100A data sheet)
RF bands		B1I on L1/E1
Simulation modes		
Static mode		generation of up to 6 GEO, IGSO and/or MEO satellites in realtime with user-definable satellite time shift, power, Doppler and initial carrier phase, e.g. for sensitivity measurements; BeiDou satellite navigation parameters can be manually adjusted
Auto localization mode		automatic dynamic simulation of up to 6 GEO, IGSO and/or MEO satellites at a receiver location based on user-definable almanac, location and time; simulation is not time-limited due to automatic dynamic exchange of simulated satellites based on visibility and when required for better position dilution of precision (PDOP); constellation and satellite power variation are automatically simulated
User localization mode		dynamic simulation of up to 6 GEO, IGSO and/or MEO satellites at a receiver location based on user-definable almanac, location and time; a complete user-definable constellation, satellite exchange in realtime and satellite power configuration in realtime are supported; BeiDou satellite navigation parameters can be manually adjusted or imported from a BeiDou RINEX file
GNSS hybrid configuration	available if K44, K66 or K94 is additionally installed	hybrid GNSS constellation with up to 6 satellites, e.g. 2 GPS satellites and 4 BeiDou satellites; possible whenever the base option of the other GNSS standard is installed
User space coordinates	available in auto localization mode and user localization mode	geodetic coordinates in ECEF WGS84 coordinate system: • altitude: –10 000 m to +1 600 000 m in steps of 0.1 m • latitude: –90° to +90° in steps of 0.000001° • longitude: –180° to +180° in steps of 0.000001°
System time basis		BDT, UTC default: BDT
Simulation time		flexible date and time or BDT time configuration with a resolution of 1 ms
Current leap seconds	static mode and auto localization mode	automated
	user localization mode	user-configurable

Elevation mask	available in auto localization mode and user localization mode	2.5°, 5°, 7.5°, 10°; filtering of satellites below a specific threshold in case of limited channel availability, i.e. satellites with high elevation are preferred over satellites with low elevation
Get optimal constellation	available in user localization mode	optimal constellation search based on the real navigation data and the maximum number of satellites with minimized PDOP and an elevation above the elevation mask
Realtime satellite and position online tracker (SPOT) display	available in auto localization mode and user localization mode	dynamic constellation, user location, satellite absolute power and trajectory views in addition to HDOP/PDOP display; the time of the next satellite handover can be polled in auto localization mode
Generation of assistance data		• almanac file • ionospheric file • navigation file • UTC file • acquisition file and acquisition block (remote interface) • sensitivity block (remote interface) in comma separated values (CSV) format; for navigation file, also in standard RINEX format
Power modes		
User power mode	available in static mode and user localization mode	21 dB dynamic range, user-configurable in realtime
Auto power mode	available in auto localization mode and in user localization mode	automatic simulation of satellite power values based on: • satellite-to-user distance • interstandard power tuning parameters
Interstandard power tuning		simulates the nominal power difference between different standards
Marker		1 PPS
		1 PP2S
		10 PPS
		pulse
		pattern
		on/off ratio
		trigger
Triggering		see R&S®SMBV100A data sheet, "I/Q baseband generator" section
Navigation data source	identical for each satellite	All 0
		All 1
		pattern (up to 64 bit)
		PN 9 to PN 23
		data lists
		real navigation data: almanac file as source for ephemeris and almanac subframes; ephemeris subframes are projected from the almanac subframes; ephemeris can be manually configured or imported from a BeiDou RINEX file
Use spreading code	available in static mode	on/off
BeiDou satellite configuration (separately settable for each satellite)		
Signals (chip rates)		coarse acquisition B1-C/A (2.046 MHz)
Modulation		BPSK (CDMA)
State		on/off
Space vehicle ID		B1-C/A codes: 1-5: GEO, 6-37: MEO/IGSO 2046 chips each
Initial code phase	configurable in case of static and no real navigation data	0.00 chips to 20459.99 chips in steps of 0.01 chips
Pseudorange	configurable in static mode	0 m to 30 000 km

Pseudorange bias		–1000 m to +1000 m, updated in realtime without restarting the simulation
Satellite relative power	configurable in user power mode	–21 dB to 0 dB, updated in realtime without restarting the simulation
Doppler shift	configurable in static mode	–100 kHz to +100 kHz in steps of 0.01 Hz
Initial carrier phase	configurable in static mode	0 to 2π in steps of 0.01 rad
Navigation data format		BeiDou D1 and D2
Data rate		50 Hz and 500 Hz for D1 and D2, respectively
Ephemeris parameters		range as defined in BDS-SIS-ICD-B1I-1.0
Satellite clock correction parameters		range as defined in BDS-SIS-ICD-B1I-1.0
Number of ephemeris pages	user localization mode	1 to 12 (manual configuration or import from a BeiDou RINEX file)
	static mode and auto localization mode	1
Ephemeris realtime projection	configurable in user localization mode	off/on; a projection (reference time shifted and ephemeris set tuned accordingly) will be made whenever the ephemeris set approaches the 2 h validity threshold
Project navigation message	configurable in user localization mode	projects the ephemeris and satellite clock correction to the current simulation time
Dynamics		
Max. Doppler error		±0.015 Hz
Pseudorange error	RMS	±0.01 m
Max. velocity	R&S®SMBV-B10	599 m/s
	R&S®SMBV-B10F [5]	10 000 m/s
Max. acceleration		1600 m/s^2
Max. jerk		400 m/s^3 (as impulse)

GNSS extension to 12 satellites (R&S®SMBV-K91 option)

The R&S®SMBV-K44, R&S®SMBV-K66, R&S®SMBV-K94 or R&S®SMBV-K107 option must be installed on the respective instrument.

GNSS extension to 12 satellites		simulation of up to 12 GNSS satellites, e.g. 8 GPS and 4 Galileo satellites (if K44 and K66 are both installed) or 12 C/A + P satellites (if K44 and K93 are both installed)

GNSS extension to 24 satellites (R&S®SMBV-K96 option)

The R&S®SMBV-K91 option must be installed on the respective instrument.

GNSS extension to 24 satellites		simulation of up to 24 GPS C/A, Galileo, BeiDou and/or Glonass satellites, e.g. 12 GPS C/A, 8 Galileo E1 and 4 Glonass satellites (if K44, K66 and K94 are additionally installed)
The following restrictions apply while Galileo is simulated:		
Galileo only	19 × Galileo	max. no. of channels: 19
Galileo + GPS and/or Glonass	18 × Galileo + 2 × GPS/Glonass	max. no. of channels: 20
	17 × Galileo + 4 × GPS/Glonass	max. no. of channels: 21
	16 × Galileo + 6 × GPS/Glonass	max. no. of channels: 22
	15 × Galileo + 8 × GPS/Glonass	max. no. of channels: 23
	14 (or less) × Galileo + 10 (or more) × GPS/Glonass	max. no. of channels: 24
Galileo + GPS, Glonass and/or BeiDou (BeiDou active in GNSS system configuration)	11 × Galileo + 2 × GPS/Glonass/BeiDou	max. no. of channels: 13
	10 × Galileo + 4 × GPS/Glonass/BeiDou	max. no. of channels: 14
	6 × Galileo + 12 × GPS/Glonass/BeiDou	max. no. of channels: 18
	2 × Galileo + 20 × GPS/Glonass/BeiDou	max. no. of channels: 22
	1 × Galileo + 22 × GPS/Glonass/BeiDou	max. no. of channels: 23

[5] The item is subject to export control regulations and therefore not available in all countries and to all customers.

GNSS enhanced (e.g. moving scenarios, multipath) (R&S®SMBV-K92 option)

The R&S®SMBV-K44, R&S®SMBV-K66, R&S®SMBV-K94 or R&S®SMBV-K107 option must be installed on the respective instrument.

Enhances any available GNSS base option, e.g. K44, to be able to configure system time conversion, atmospheric modeling, moving scenario, motion smoothing, user-defined multipath, leap second simulation and realtime feed of vehicle's motion data (hardware in the loop).

Moving scenario	available in auto localization mode and user localization mode	minimum duration of 12 hours before waypoint repetition, up to 4 days if R&S®SMBV-K511 is installed, up to 16 days if R&S®SMBV-K512 is installed; supported formats: • comma separated waypoints in WGS84 • import Google Earth and Google Maps kml files • ENU 2D vector trajectory interface (line, arc) • NMEA • motion files with velocity vector or velocity magnitude ".xtd" in WGS84 and ENU
Waypoint smoothing		smooths trajectory and dynamics based on a selected vehicle description file ".xvd"
Realtime waypoint feed		hardware-in-the-loop realtime feed of vehicle's motion data (position, velocity, acceleration and jerk); streaming rate up to 100 Hz; synchronous to 1 PPS; 10 ms system response delay
Ionospheric navigation parameters		configuration of the ionospheric navigation parameters as they will be transmitted in the navigation message
Ionospheric model	available in auto localization mode and user localization mode	none, Klobuchar for GPS none for Galileo none for Glonass
Tropospheric model	available in auto localization mode and user localization mode	none, STANAG
Time conversion parameters	static mode and user localization mode	manual configuration or import from RINEX files, e.g. GPS to UTC, GST to UTC and GLO to UTC (SU)
	auto localization mode	set to 0
Leap second simulation	available in user localization mode	leap second transition at a definable date with a definable sign
Multipath (available in user localization mode; parameters separately settable for each satellite/tap)		
State		on/off
Channel budget	GPS C/A, Galileo E1 and Glonass (GPS P code not activated)	16 channels; 24 if K96 is additionally available
	GPS (C/A + P)	12 channels
Number of taps		1 to 10 depending on the remaining channel budget
Additional time shift		0 chips to 9.99999 chips in steps of 0.00001 chips
Additional power		–10 dB to 0 dB in steps of 0.01 dB
Additional Doppler shift		–10 kHz to +10 kHz in steps of 0.01 Hz
Additional carrier phase		0 to 2π in steps of 0.01 rad

GNSS extension for obscuration simulation and automatic multipath (R&S®SMBV-K101 option)

The R&S®SMBV-K44, R&S®SMBV-K66, R&S®SMBV-K94 or R&S®SMBV-K107 option must be installed on the respective instrument.

Enhances any available GNSS base option, e.g. K44, to automatically simulate satellite visibility and multipath depending on a modeled user environment, e.g. urban canyon. Automatic multipath simulation additionally requires K92.

Obscuration simulation and automatic multipath	available in auto localization mode and user localization mode	user-definable as well as predefined user environments: • rural area • suburban area • urban canyon • tunnel • bridge • highway
Near environment		
LOS	K101 is not required	no near field environment is defined
Vertical obstacles	available for pedestrians and land vehicle simulation	defined in a static (OX, OY) coordinate system; vertical obstacles are either parallel to OX or OY axis depending on axis direction; suitable for city block simulation
Start receiver X offset		X coordinate of the first simulated receiver location in the (OX, OY) coordinate system
Start receiver Y offset		Y coordinate of the first simulated receiver location in the (OX, OY) coordinate system
Start receiver height offset		height offset of the first simulated receiver location to the ground level of the vertical obstacles
Map orientation		0.00° to 359.99°; angle from east to X axis (anti-clockwise)
Direction axis		• OX: obstacle parallel to OX • OY: obstacle parallel to OY
First edge coordinates		X and Y coordinates of the first edge of the vertical obstacle; first edge has the lowest coordinate value on its direction axis; –1000 m to +1000 m on both axes
Length of obstacle		1 m to 500 m
Height of obstacle		1 m to 500 m
Material property	available when physical mode set to obscuration and multipath	• permittivity • power loss (selects the mode based on which a GNSS satellite multipath tap power will be attenuated relative to the theoretical LOS signal)
Material	available when physical mode set to obscuration and multipath and material property set to permittivity	• user-defined • glass • concrete • wood • gypsum • formica • marble • dry wall • brick
Permittivity	available when physical mode set to obscuration and multipath; configurable only when material set to user-defined	1 to 20
Power loss	available when physical mode set to obscuration and multipath, and material property set to power loss	0 dB to 20 dB

Roadside planes	available for pedestrian and land vehicle simulation; requires K92 option	vertical roadside planes are defined alongside the road and parallel to the heading vector of the user (direction axis); suitable for highway and cutting simulations; a maximum of two vertical planes (left and right) are considered based on user mileage; distance, height and material properties have the same meaning as in vertical obstacles
Reference receiver position		distance from which the corresponding roadside plane is applied for user obscuration and multipath simulation; 0.000 m to 1000.000 km
Set length to infinite		when set, obstacle assumed infinitely long; suitable for cutting when not set, length referenced to distance from current to next reference receiver position; suitable for highway simulations
Alignment		• left • right
Full obscuration	available for pedestrians, land vehicles and ships; requires K92 option	full obscuration is applied to user-defined obscuration areas; suitable for tunnel simulation
Reference		defines the reference starting position or timestamp at which a specific obscured zone is applied
Length of obscuring zone		0.001 km to 50 km or 0.1 s to 3600 s
Ground/sea reflection	available for ships, aircraft and spacecraft	simulates ground/sea reflections and obscuration due to vertical obstacles (e.g. canyons) parallel to the heading vector of the user (direction axis)
Material		• user-defined • dry ground • medium dry ground • wet ground • fresh water • sea water
Ground altitude		terrain ground level relative to WGS84 zero level or sea level
Distance to left obstacle		0.0 m to 1000.0 m
Distance to right obstacle		0.0 m to 1000.0 m
Height of left obstacle		0.0 m to 10 000.0 m
Height of right obstacle		0.0 m to 10 000.0 m
Number of channels		same channel budget as in R&S®SMBV-K92 section; if the available channel budget is insufficient, signals are filtered according to elevation, tap power and tap delay
Update rate		10 Hz with multipath not active and 5 Hz with multipath active; the modeled near field environment is sampled accordingly; the additional delay of multipath taps (referenced to the theoretical LOS) and carrier phase are linearly interpolated in between
Physical model		
Obscuration and multipath	requires K92	simulate satellite visibility and multipath depending on a modeled user environment
Obscuration only		simulate satellite visibility depending on a modeled user environment; multipath not simulated

GNSS extension for antenna pattern (R&S®SMBV-K102 option)

The R&S®SMBV-K44, R&S®SMBV-K66, R&S®SMBV-K94 or R&S®SMBV-K107 option must be installed on the respective instrument.

Enhances any available GNSS base option, e.g. K44, to automatically simulate satellite power and carrier phase depending on the antenna pattern and attitude parameters. Attitude parameters can be set to heading for automotive applications.

Antenna pattern/body mask	available in auto localization mode and user localization mode	simulates satellite and tap power and carrier phase response due to antenna pattern and body mask
Number of antenna patterns		1 to 4
Antenna pattern switching		possible through realtime scheduling
Antenna pattern resolution		down to 1° for elevation and azimuth
Antenna to vehicle body offset		angular and geometric body offset of the antenna to the vehicle on the body pitch, yaw and roll axes
Update rate		800 Hz
Attitude automation	requires K92	set to waypoint heading; suitable for automotive applications

GNSS extension for spinning and attitude (R&S®SMBV-K103 option)

The R&S®SMBV-K44, R&S®SMBV-K66, R&S®SMBV-K94 or R&S®SMBV-K107 option must be installed on the respective instrument.

Enhances any available GNSS base option, e.g. K44, to allow configuration of the angular body parameters (attitude) of a vehicle.

Requires K102.

Spinning and attitude	available in auto localization mode and user localization mode	allows the configuration of the vehicle's angular body parameters (attitude)
Attitude files	requires K92	minimum duration of 12 hours before attitude repetition; up to 4 days if R&S®SMBV-K511 is installed; up to 16 days if R&S®SMBV-K512 is installed; attitude to local horizon fed as well as waypoints
Attitude smoothing	requires K92	smooths attitude as well as waypoints based on a selected vehicle description file ".xvd"
Realtime attitude feed	requires K92	hardware-in-the-loop realtime feed of vehicle's attitude data; streaming rate up to 100 Hz; synchronous to 1 PPS; 10 ms system response delay
Vehicle's yaw/heading		–180.000° to +180.000°
Vehicle's pitch/elevation		–180.000° to +180.000°
Vehicle's roll/bank		–180.000° to +180.000°
Spinning		simulates a constant roll rate change of
Spinning rate		up to 400 Hz
Update rate for level changes		800 Hz

GBAS (R&S®SMBV-K111 option)

GBAS		in line with RTCA DO-246D
General settings		
Frequency mode	single frequency channel	allows simulation of one frequency band at a certain time
	multiple frequency channels	simulation of up to 11 adjacent frequency bands simultaneously, each with 25 kHz bandwidth
Gated power mode	available only with single frequency mode	synchronization of the absolute power to the nominal level of one assigned time slots
VHF data broadcast (VDB) tower configuration		
Number of VDB transmitters		generation of up to 8 VDB tower signals simultaneously; a tower is allocated on one frequency band and is allocated up to 8 time slots as scheduled by the user
GBAS ID		configures the ID of the ground station
SSID		station slot identifier; A-H indicating the index of the first allocated time slot
Frequency number		–5 to 5 references up to 11 adjacent frequency bands out of the 398 standard ones; frequency number 0 corresponds to the band as configured in the generator "frequency" field
Data source	identical for each VDB	• All 0 • All 1 • pattern (up to 64 bit) • PN 9 to PN 23 • data lists • real GBAS data: generation of GBAS message types 1, 2, 4 and 11 based on user configuration including waypoint file for TAP configuration and differential GNSS file for messages 1 and 11
Number of frames	R&S®SMBV-B55/-K511 not available	1 to 6095 in single frequency mode, 1 to 121 in multiple frequency mode
	R&S®SMBV-B55/-K511 available	1 to 48761 in single frequency mode, 1 to 975 in multiple frequency mode
	R&S®SMBV-K512 available	1 to 195044 in single frequency mode, 1 to 3900 in multiple frequency mode
Time slot configuration		
Scheduling	a time slot on one frequency band can be allocated to one VDB only	allows the user to reserve up to 8 time slots on a specific frequency band; the allocated time slots will be used in modulating the tower signal
State		activates or deactivates a specific time slot for the VDB modulation
Relative power		sets the relative power of the time slot of a specific VDB –21 dB to 0 dB −INF for inactive time slot

GBAS message configuration		
Message types	all messages can be modulated simultaneously if needed	• message type 1: differential corrections (100 s smoothed pseudoranges) • message type 2: GBAS related data • message type 4: final approach segment (FAS) and terminal area path (TAP) data • message type 11: differential corrections (30 s smoothed pseudoranges)
Waypoint file		used to load the TAP waypoint data modulated with GBAS message 4
Differential GNSS file		used to transmit differential GNSS corrections for GPS, Glonass and GBAS satellites in view; pseudorange correction (PRC) and range rate correction (RRC) among others are modulated in messages 1 and 11
Marker		1 PPS
		restart
		pulse
		pattern
		on/off ratio
		trigger
Triggering		see R&S®SMBV100A data sheet, "I/Q baseband generator" section
Filter		cosine filter with 0.6 rolloff factor, symbol rate at 10.5 kHz
Clipping		standard R&S®SMBV100A functionality
Modulation/coding	available in static mode	differential 8PSK, FEC encoding and bit scrambling

Ordering information

Designation	Type	Order No.
Base unit (including power cable, quick start guide and CD-ROM, with operating and service manual)		
Vector Signal Generator [6]	R&S®SMBV100A	1407.6004.02
Hardware options (GNSS related configuration) [7]		
Frequency Range, 9 kHz to 3.2 GHz	R&S®SMBV-B103	1407.9603.02
Baseband Generator with digital modulation (realtime) and ARB (32 Msample), 120 MHz RF bandwidth	R&S®SMBV-B10	1407.8607.04
Baseband Generator for GNSS with high dynamic range, digital modulation (realtime) and ARB (32 Msample), 120 MHz RF bandwidth	R&S®SMBV-B10F [8]	1419.2009.02
Hard Disk (removable)	R&S®SMBV-B92	1407.9403.02
Memory Extension for ARB to 256 Msample	R&S®SMBV-K511	1419.2544.02
Memory Extension for ARB to 1 Gsample	R&S®SMBV-K512	1419.2567.02
Software options (GNSS related only) [7]		
GPS	R&S®SMBV-K44	1415.8060.02
Assisted GPS	R&S®SMBV-K65	1415.8560.02
Galileo	R&S®SMBV-K66	1415.8590.02
Assisted Galileo	R&S®SMBV-K67	1419.2509.02
GNSS Extension to 12 Satellites	R&S®SMBV-K91	1415.8577.02
GNSS Enhanced (e.g. moving scenarios, multipath)	R&S®SMBV-K92	1415.8583.02
GPS P Code	R&S®SMBV-K93	1415.8660.02
Glonass	R&S®SMBV-K94	1415.8677.02
Assisted Glonass	R&S®SMBV-K95	1419.2521.02
GNSS Extension to 24 Satellites	R&S®SMBV-K96	1415.8790.02
GNSS Extension for Obscuration Simulation and Automatic Multipath	R&S®SMBV-K101	1415.8802.02
GNSS Extension for Antenna Pattern	R&S®SMBV-K102	1415.8819.02
GNSS Extension for Spinning and Attitude	R&S®SMBV-K103	1415.8825.02
BeiDou	R&S®SMBV-K107	1419.2709.02
GBAS	R&S®SMBV-K111	1419.2396.02
Recommended extras		
Hardcopy manuals (in English, UK)		1407.6062.32
Hardcopy manuals (in English, US)		1407.6062.39
19" Rack Adapter	R&S®ZZA-S334	1109.4487.00
Power Sensor, 9 kHz to 6 GHz	R&S®NRP-Z92	1171.7005.02
Keyboard with USB Interface (US character set)	R&S®PSL-Z2	1157.6870.04
USB Serial Adapter, for RS-232 remote control	R&S®TS-USB1	6124.2531.00
Accessories		
Documentation of Calibration Values	R&S®DCV-2	0240.2193.18
DAkkS (formerly DKD) Calibration in line with ISO 17025 and ISO 9000	R&S®SMBV-DKD	1415.8448.02

For product brochure, see PD 5214.5284.12 and www.rohde-schwarz.com

[6] The base unit must be ordered with an R&S®SMBV-B10x frequency option.

[7] For additional options, see the R&S®SMBV100A product brochure (PD 5214.1114.12), data sheet (PD 5214.1114.22) and www.rohde-schwarz.com.

[8] The item is subject to export control regulations and therefore not available in all countries and to all customers.

Service that adds value

- Worldwide
- Local and personalized
- Customized and flexible
- Uncompromising quality
- Long-term dependability

About Rohde&Schwarz

Rohde&Schwarz is an independent group of companies specializing in electronics. It is a leading supplier of solutions in the fields of test and measurement, broadcasting, radiomonitoring and radiolocation, as well as secure communications. Established more than 75 years ago, Rohde&Schwarz has a global presence and a dedicated service network in over 70 countries. Company headquarters are in Munich, Germany.

Environmental commitment

- Energy-efficient products
- Continuous improvement in environmental sustainability
- ISO 14001-certified environmental management system

Certified Quality System
ISO 9001

Rohde&Schwarz GmbH&Co. KG
www.rohde-schwarz.com

Regional contact

- Europe, Africa, Middle East | +49 89 4129 12345
  customersupport@rohde-schwarz.com
- North America | 1 888 TEST RSA (1 888 837 87 72)
  customer.support@rsa.rohde-schwarz.com
- Latin America | +1 410 910 79 88
  customersupport.la@rohde-schwarz.com
- Asia/Pacific | +65 65 13 04 88
  customersupport.asia@rohde-schwarz.com
- China | +86 800 810 8228/+86 400 650 5896
  customersupport.china@rohde-schwarz.com

PD 5214.5284.22 | Version 05.00 | December 2013 (fi)
GNSS Simulator in the R&S®SMBV100A
Data without tolerance limits is not binding | Subject to change

5214528422

5214.5284.22 05.00 PDP 1 en