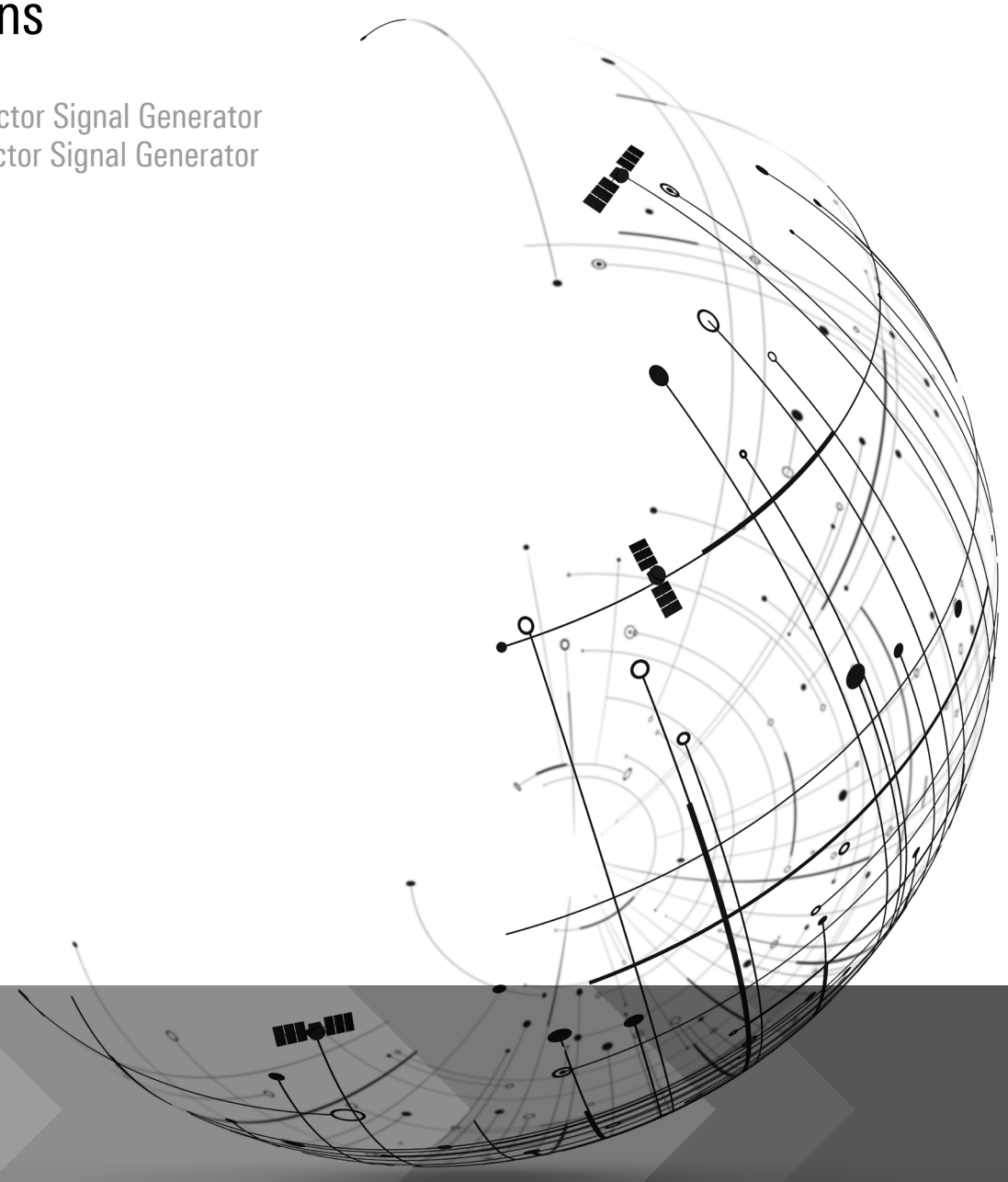
GNSS AND AVIONICS SIMULATION FOR ROHDE&SCHWARZ SIGNAL GENERATORS

Specifications

R&S®SMBV100B Vector Signal Generator
R&S®SMW200A Vector Signal Generator



Specifications
Version 16.00

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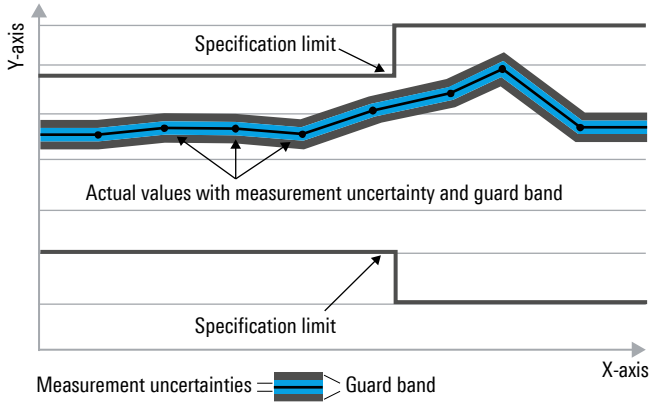
CONTENTS

Definitions

General
Product data applies under the following conditions:

- Three hours of storage at ambient temperature followed by 30 minutes of 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.



Non-traceable specifications with limits (n. trc.)
Represent product performance that is specified and tested as described under “Specifications with limits” above. However, product performance in this case cannot be warranted due to the lack of measuring equipment traceable to national metrology standards. In this case, measurements are referenced to standards used in the Rohde & Schwarz laboratories.

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 designated with the format “parameter: value”.

Non-traceable specifications with limits, typical data as well as nominal and measured values are not warranted by Rohde & Schwarz.

In line with the 3GPP standard, chip rates are specified in million chips per second (Mcps), whereas bit rates and symbol rates are specified in billion bit per second (Gbps), million bit per second (Mbps), thousand bit per second (kbps), million symbols per second (Msps) or thousand symbols per second (ksps), and sample rates are specified in million samples per second (Msample/s). Gbps, Mcps, Mbps, Msps, kbps, ksps and Msample/s are not SI units.

Overview

With the GNSS and avionics simulation solutions for the R&S®SMBV100B and the R&S®SMW200A, dynamic scenarios with GPS/SBAS/QZSS, Galileo, GLONASS and BeiDou signals can be generated in real time including moving scenarios, multipath, dynamic power control and atmospheric modeling. For moving scenarios, the effects of antenna pattern and vehicle body mask can be simulated in real time with dynamic variation of the vehicle's attitude. Above and beyond GNSS signal generation, the R&S®SMBV100B and the R&S®SMW200A are flexible vector signal generators with excellent RF performance. They offer options for generating standard-compliant signals for all important digital communications standards (GSM, WCDMA, HSPA+, LTE, WiMAX™, WLAN, etc.). 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®SMBV100B and the R&S®SMW200A:

Options	**R&S®SMBV100B**	**R&S®SMW200A**
GNSS		
GPS	R&S®SMBVB-K44	R&S®SMW-K44
Modernized GPS	R&S®SMBVB-K98	R&S®SMW-K98
Galileo	R&S®SMBVB-K66	R&S®SMW-K66
GLONASS	R&S®SMBVB-K94	R&S®SMW-K94
NavIC/IRNSS	R&S®SMBVB-K97	R&S®SMW-K97
BeiDou	R&S®SMBVB-K107	R&S®SMW-K107
Modernized GLONASS	R&S®SMBVB-K123	R&S®SMW-K123
Modernized BeiDou	R&S®SMBVB-K132	R&S®SMW-K132
SBAS/QZSS	R&S®SMBVB-K106	R&S®SMW-K106
Real-world scenarios	R&S®SMBVB-K108	R&S®SMW-K108
Real-time GNSS interfaces	R&S®SMBVB-K109	R&S®SMW-K109
P(Y)/M/PRS noise	–	R&S®SMW-K128
Single-satellite GNSS	R&S®SMBVB-K133	–
Virtual RTK reference station	R&S®SMBVB-K122	R&S®SMW-K122
MS GNSS Interf. Test	-	R&S®SMW-K129
Upgrade to dual-frequency GNSS	R&S®SMBVB-K134	R&S®SMW-K134
Upgrade to triple-frequency GNSS	R&S®SMBVB-K135	R&S®SMW-K135
Add 6 GNSS channels	R&S®SMBVB-K136	R&S®SMW-K136
Add 12 GNSS channels	R&S®SMBVB-K137	R&S®SMW-K137
Add 24 GNSS channels	–	R&S®SMW-K138
Add 48 GNSS channels	–	R&S®SMW-K139
ERA-GLONASS test suite	R&S®SMBVB-K360	R&S®SMW-K360
eCall test suite	R&S®SMBVB-K361	R&S®SMW-K361
GNSS test suite	R&S®SMBVB-K362	R&S®SMW-K362
Car navigation test suite	R&S®SMBVB-K363	R&S®SMW-K363
Avionics		
GBAS	R&S®SMBVB-K111	–
ILS	R&S®SMBVB-K151	–
VOR	R&S®SMBVB-K152	–
DME	R&S®SMBVB-K153	–

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

- R&S®SMBV100B specifications, PD 3607.8201.22
- R&S®SMBV100B product brochure, PD 3607.8201.12
- R&S®SMW200A specifications, PD 5214.1114.22
- R&S®SMW200A product brochure, PD 5214.1114.12
- Digital standards for signal generators specifications, PD 5213.9434.22

Abbreviations

The following abbreviations are used in this document:

- The R&S®SMBVB-K44 and the R&S®SMW-K44 are referred to as K44
- The R&S®SMBVB-K98 and the R&S®SMW-K98 are referred to as K98
- The R&S®SMBVB-K66 and the R&S®SMW-K66 are referred to as K66
- The R&S®SMBVB-K94 and the R&S®SMW-K94 are referred to as K94
- The R&S®SMBVB-K97 and the R&S®SMW-K97 are referred to as K97
- The R&S®SMBVB-K107 and the R&S®SMW-K107 are referred to as K107
- The R&S®SMBVB-K132 and the R&S®SMW-K132 are referred to as K132
- The R&S®SMBVB-K106 and the R&S®SMW-K106 are referred to as K106
- The R&S®SMBVB-K108 and the R&S®SMW-K108 are referred to as K108
- The R&S®SMBVB-K109 and the R&S®SMW-K109 are referred to as K109
- The R&S®SMBVB-K122 and the R&S®SMW-K122 are referred to as K122
- The R&S®SMBVB-K123 and the R&S®SMW-K123 are referred to as K123
- The R&S®SMBVB-K129 and the R&S®SMW-K129 are referred to as K129
- The R&S®SMBVB-K133 is referred to as K133
- The R&S®SMW-K128 is referred to as K128
- The R&S®SMBVB-K134 and the R&S®SMW-K134 are referred to as K134
- The R&S®SMBVB-K135 and the R&S®SMW-K135 are referred to as K135
- The R&S®SMBVB-K136 and the R&S®SMW-K136 are referred to as K136
- The R&S®SMBVB-K137 and the R&S®SMW-K137 are referred to as K137
- The R&S®SMW-K138 is referred to as K138
- The R&S®SMW-K139 is referred to as K139
- The R&S®SMBVB-K360 and the R&S®SMW-K360 are referred to as K360
- The R&S®SMBVB-K361 and the R&S®SMW-K361 are referred to as K361
- The R&S®SMBVB-K362 and the R&S®SMW-K362 are referred to as K362
- The R&S®SMBVB-K362 and the R&S®SMW-K362 are referred to as K363
- The R&S®SMBVB-K111 and the R&S®SMW-K111 are referred to as K111
- The R&S®SMBVB-K151 is referred to as K151
- The R&S®SMBVB-K152 is referred to as K152
- The R&S®SMBVB-K153 is referred to as K153
- Space vehicle is abbreviated as SV

GNSS testing with the R&S®SMW200A

The R&S®SMW200A can be equipped with two different types of baseband hardware. When equipped with R&S®SMW-B10(F) baseband generators, the maximum RF bandwidth is limited to 160 MHz which prevents the baseband from simultaneously generating GNSS signals from different GNSS frequency bands. This limitation can be overcome by using an R&S®SMW-B9(F) baseband generator. Being able to support a maximum RF bandwidth of 2 GHz, multi-frequency GNSS signals can be simulated out of one single baseband module. Compared to the R&S®SMW-B10(F) baseband module, the R&S®SMW-B9(F) also allows to simulate more GNSS channels and the number of channels can even be increased further by adding additional GNSS coder boards (2 × R&S®SMW-B15 or 4 × R&S®SMW-B15). The following table contains a comparison of some important GNSS simulation features when using different instrument configurations:

	With R&S®SMW-B10(F)	**With 2 × R&S®SMW-B9(F)**	**With 2 × R&S®SMW-B9(F) and 4 × R&S®SMW-B15**
Maximum number of channels per R&S®SMW	48	204	612
Maximum number of channels per baseband	24	102	102
Multi-frequency GNSS on one baseband	–	●	●
RF OUT	2	2	2

In addition to these different simulation capabilities, the type of baseband hardware being used in the R&S®SMW200A also determines which software options can be installed on the instrument. The following table lists all GNSS options that can be installed on an instrument equipped with an R&S®SMW-B10(F) or a R&S®SMW-B9(F) baseband, respectively:

Options		**Available in combination with R&S®SMW-B9(F)**	**Available in combination with R&S®SMW-B10(F)**
GPS	R&S®SMW-K44	●	●
Modernized GPS	R&S®SMW-K98	●	●
Galileo	R&S®SMW-K66	●	●
GLONASS	R&S®SMW-K94	●	●
NavIC/IRNSS	R&S®SMW-K97	●	●
BeiDou	R&S®SMW-K107	●	●
Modernized GLONASS	R&S®SMW-K123	●	–
P(Y)/M/PRS noise	R&S®SMW-K128	●	–
Modernized BeiDou	R&S®SMW-K132	●	●
SBAS/QZSS	R&S®SMW-K106	●	●
Real-world scenarios	R&S®SMW-K108	●	●
Real-time GNSS interfaces	R&S®SMW-K109	●	●
Virtual RTK reference station	R&S®SMW-K122	●	–
MS GNSS Interf. Test	R&S®SMW-K129	●	–
Upgrade to dual-frequency GNSS	R&S®SMW-K134	●	–
Upgrade to triple-frequency GNSS	R&S®SMW-K135	●	–
Add 6 GNSS channels	R&S®SMW-K136	●	–
Add 12 GNSS channels	R&S®SMW-K137	●	–
Add 24 GNSS channels	R&S®SMW-K138	●	–
Add 48 GNSS channels	R&S®SMW-K139	●	–
ERA-GLONASS test suite	R&S®SMW-K360	●	–
eCall test suite	R&S®SMW-K361	●	–
GNSS test suite	R&S®SMW-K362	●	–
Car navigation test suite	R&S®SMW-K363	●	–

Minimum instrument configuration for GNSS testing

The following minimum hardware configuration is required as a prerequisite for testing GNSS functionality:

Required options for R&S®SMBV100B		**Required options for R&S®SMW200A**	
R&S®SMBV100B	base unit incl. BB generator with ARB (64 Msample, 120 MHz RF bandwidth)	R&S®SMW200A	base unit
R&S®SMBVB-B103	frequency option, 8 kHz to 3 GHz	R&S®SMW-B1003	frequency option, RF path A, 100 kHz to 3 GHz
R&S®SMBVB-K520	real-time extension	R&S®SMW-B13	signal routing and baseband main module, one I/Q path to RF
		R&S®SMW-B10	baseband generator with ARB (64 Msample) and real-time coder, 120 MHz RF bandwidth

Minimum instrument configuration for avionics testing

The following minimum hardware configuration is required as a prerequisite for installing avionics options:

Required options for R&S®SMBV100B		**Required options for R&S®SMW200A**	
R&S®SMBV100B	base unit incl. BB generator with ARB (64 Msample, 120 MHz RF bandwidth)	–	–
R&S®SMBVB-B103	frequency option, 8 kHz to 3 GHz	–	–
R&S®SMBVB-K520	real-time extension	–	–

Global navigation satellite systems (GNSS)

Addressed GNSS applications

The main difference between the R&S®SMBV100B and the R&S®SMW200A in terms of GNSS testing is that the R&S®SMBV100B has one single RF output whereas the R&S®SMW200A can be equipped with two or even more RF outputs (with additional R&S®SGT instruments or by stacking several R&S®SMW instruments). That way, both instruments are able to address different types of GNSS test applications, which are summarized in the following tables:

Midrange GNSS applications with R&S®SMBV100B

Frequency bands	Applications	Tests
L1, L2 and L5	single and multi-frequency applications	• GNSS production testing • standard receiver tests for receiver characterization • standard receiver tests under special conditions (interference, multipath, leap seconds) • RAIM testing

High-end GNSS applications with R&S®SMW200A

Frequency bands	Applications	Tests
L1, L2 and L5	single and multi-frequency applications	• standard receiver tests for receiver characterization • standard receiver tests under special conditions (interference, multipath, leap seconds) • RAIM testing • ionospheric monitoring • atmospheric sounding
	multi-antenna applications	• baseline determination • beamforming (CRPA) • attitude determination • multipath direction finding
	multi-vehicle applications	• differential GNSS • collision avoidance • spacecraft formation flying • time and frequency transfer
	advanced interference simulation	• simulating of jamming/spoofing attacks • coexistence testing with several interferers

Signals and systems

Systems		Frequency bands	Supported signals	Required options for R&S®SMBV100B	Required options for R&S®SMW200A
GNSS	GPS	L1	C/A code, P code	R&S®SMBVB-K44	R&S®SMW-K44
		L1	L1C	R&S®SMBVB-K98	R&S®SMW-K98
		L1	P(Y) noise, M noise	–	R&S®SMW-K128
		L2	C/A code, P code	R&S®SMBVB-K44	R&S®SMW-K44
		L2	L2C	R&S®SMBVB-K98	R&S®SMW-K98
		L2	P(Y) noise, M noise	–	R&S®SMW-K128
		L5	L5	R&S®SMBVB-K98	R&S®SMW-K98
	GLONASS	L1	C/A code	R&S®SMBVB-K94	R&S®SMW-K94
		L2	C/A code	R&S®SMBVB-K94	R&S®SMW-K94
	Modernized GLONASS	L1	CDMA L1 [1]	R&S®SMBVB-K123	R&S®SMW-K123
		L2	CDMA L2 [1]	R&S®SMBVB-K123	R&S®SMW-K123
		L5	CDMA L3	R&S®SMBVB-K123	R&S®SMW-K123
	Galileo	E1	OS data/pilot	R&S®SMBVB-K66	R&S®SMW-K66
		E1	E1 PRS noise	–	R&S®SMW-K128
		E5	E5a data/pilot, E5b data/pilot	R&S®SMBVB-K66	R&S®SMW-K66
		E6	E6 data/pilot	R&S®SMBVB-K66	R&S®SMW-K66
		E6	E6 PRS noise	–	R&S®SMW-K128
	BeiDou	B1	B1-I	R&S®SMBVB-K107	R&S®SMW-K107
		B2	B2-I	R&S®SMBVB-K107	R&S®SMW-K107
		B1	B1C	R&S®SMBVB-K132	R&S®SMW-K132
		B2	B2a	R&S®SMBVB-K132	R&S®SMW-K132
		B2	B2b_I*	R&S®SMBVB-K132	R&S®SMW-K132
		B3	B3-I	R&S®SMBVB-K132	R&S®SMW-K132
RNSS	NavIC/IRNSS	L5	L5 SPS	R&S®SMBVB-K97	R&S®SMW-K97
SBAS	QZSS	L1	C/A code, L1C	R&S®SMBVB-K106	R&S®SMW-K106
	QZSS	L2	L2C	R&S®SMBVB-K106	R&S®SMW-K106
	QZSS	L5	L5	R&S®SMBVB-K106	R&S®SMW-K106
	WAAS	L1	C/A code	R&S®SMBVB-K106	R&S®SMW-K106
	EGNOS	L1	C/A code	R&S®SMBVB-K106	R&S®SMW-K106
	MSAS	L1	C/A code	R&S®SMBVB-K106	R&S®SMW-K106
	GAGAN	L1	C/A code	R&S®SMBVB-K106	R&S®SMW-K106
	WAAS	L5	Exp L5 [2]	R&S®SMBVB-K106	R&S®SMW-K106
	EGNOS	L5	Exp L5 [2]	R&S®SMBVB-K106	R&S®SMW-K106

In the R&S®SMBV100B and the R&S®SMW200A, the designators L1, L2 and L5 are used when referring to a specific GNSS frequency band. The following table shows how the supported signals are mapped to these bands:

	L1 frequency band	L2 frequency band	L5 frequency band
GPS	C/A, P, L1C	C/A, P, L2C	L5
Galileo	E1 OS (including OSNMA)	E6	E5a, E5b
GLONASS	C/A, CDMA L1 [1]	C/A, CDMA L2 [1]	CDMA L3
BeiDou	B1I, B1C	B3I	B2I, B2a, B2b_I [2]
NavIC/IRNSS	–	–	L5
SBAS	C/A	–	Exp L5 [3]
QZSS	C/A, L1C	L2C	L5

[1] The modernized GLONASS signals CDMA L1 and CDMA L2 are experimental. Any compliance to GLONASS ICD CDMA open service navigation signal in L1 frequency band or GLONASS ICD CDMA open service navigation signal in L2 frequency band is not warranted.

[2] B2b_I refers to non-GEO satellites 6 to 58, where only the B2b-I component is defined.

[3] The Exp L5 signals are experimental and not compliant to any existing or future ICDs. The navigation message is just a copy of the corresponding L1 message. The Exp L5 signals are available only for WAAS and EGNOS.

Key features

GNSS features (independent from instrument type)

- Support of all global satellite navigation systems (GPS, GLONASS, Galileo including OSNMA on E1OS, BeiDou)
- Support of satellite-based augmentation systems and regional systems (SBAS, QZSS and NavIC)
- Static and dynamic GNSS scenarios
- Moving receiver simulations based on predefined and user-defined waypoints with additional support of NMEA and KML files and waypoint smoothing using vehicle description files
- Support of predefined A-GNSS test scenarios, including generation of A-GNSS assistance data
- Support of predefined Galileo test cases based on OSNMA test vectors (see user manual for further details)
- Realistic GNSS scenarios with consideration of
  - Orbit perturbations and clock errors
  - Tropospheric and ionospheric effects
  - Signal obscuration and multipath
  - Antenna gain and phase patterns
  - User trajectories with consideration of vehicle attitude
  - Pseudorange steps and ramps for RAIM testing
- Interactive power control of individual satellites
- Optional internal noise generator
- Integrated GNSS simulation software with user-friendly simulation configuration, monitoring and interactive control capabilities using the instrument's large touchscreen
- Logging of user motion and satellite-related parameters
- Scenario generation can be fully automated using extensive remote control capabilities via Ethernet, USB or GPIB
- Automatic GNSS performance testing for ERA-GLONASS modules against GOST-R-55534/33471 performance criteria
- Automatic GNSS performance testing for eCall modules against EU2017/79 Annex VI and UNECE2016/07 performance criteria
- Automated and customizable GNSS receiver tests for GNSS receiver characterization
- Hardware-in-the-loop (HIL) real-time feed of vehicle's motion and attitude data (position, velocity, acceleration and jerk)

GNSS features (related to instrument type)

Feature	**R&S®SMBV100B**	**R&S®SMW200A**
Multi-frequency scenarios	yes	yes
GNSS frequency bands	L1, L2 and L5	L1, L2 and L5
Number of GNSS channels	6 to 102	24 to 612
Number of RF outputs	1	1 or 2 internal RFs
Maximum number of simulated antennas	1	6
Maximum number of simulated vehicles	1	2
Measured worst case pseudorange accuracy	< 1 cm	< 1 cm
Hardware update rate	100 Hz	100 Hz
Signal dynamics		
Velocity	max. 600 m/s	max. 600 m/s (with R&S®SMW-B10 or R&S®SMW-B9), max. 10000 m/s (with R&S®SMW-B10F or R&S®SMW-B9F)
Acceleration	max. 1600 m/s²	max. 1600 m/s²
Jerk	max. 400 m/s³	max. 400 m/s³
HIL streaming rate	100 Hz	100 Hz
HIL latency	20 ms	20 ms
Interference generation	yes	yes
Interference scenarios	GNSS + CW interference or GNSS + AWGN	• GNSS + CW interference • GNSS + AWGN • GNSS + communications signal (coexistence) • GNSS + jamming • spoofing

Common specifications for all GNSS options

Simulation configuration

		R&S®SMBV100B	R&S®SMW200A
Simulation time	flexible date and time (UTC) or GNSS system time configuration	resolution of 1 ms	
	leap second simulation		
Simulation modes/test modes	tracking	signal generation with constant or custom Doppler profiles for individual satellites	
	navigation	simulation of receiver positioning with realistic Doppler profiles relative to the motion of satellites and simulated user receiver	
	single satellite per system	simulation of one single satellite for the following systems: GPS, GLONASS, Galileo, BeiDou, NavIC	–
Coordinate systems for configuring static locations or user trajectories (ECEF WGS84 PZ-90.11)			
	altitude	–10 000 m to +50 000 000 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°	
Trajectory configuration	waypoint files with multiple formats	XTD (proprietary trajectory format, see user manual for format description), KML, TLE, NMEA formats	
	possibility to smooth the trajectory depending on vehicle dynamics		
Constellation configuration and navigation data sources	default constellations available that will be internally extrapolated for different simulation start times		
	data can be imported from multiple publicly available file formats	RINEX, YUMA, SEM, AGL, XML	
Channel selection criteria	satellite visibility time	• automatic exchange of invisible satellites with visible ones, with preference to those with longest visibility duration at the current position • visible satellites can be turned off and on without interrupting the simulation	
	satellite elevation	same as above, with preference on satellites of higher elevation	
	manual	satellites can be arbitrarily turned on and off without any automatic exchange	
Elevation mask	earth tangent, local horizon	excludes satellites below a specific elevation; range: –10° to +90°	
Tropospheric models	none	possibility of removing troposphere errors	
	STANAG	STANAG Doc. 4294	
	MOPS 229D	minimum operational performance standard for GPS/SBAS airborne equipment	
Ionospheric models	none	possibility of removing ionosphere errors	
	STANAG	STANAG Doc. 4294	
	NeQuick	NeQuick ionosphere model	
	MOPS 229D	minimum operational performance standard for GPS/SBAS airborne equipment	
Satellite vehicle parameters	state	switch satellites on/off, modifiable on-the-fly	

		R&S®SMBV100B	**R&S®SMW200A**
Power configuration	reference power	received power per signal assuming all offsets are zero (setting range: –145 dBm to –20 dBm)	
	satellite vehicle power offset	attenuation for all signals transmitted from a single satellite, modifiable on-the-fly	
	free space path-loss	automatically calculated attenuation due to the line of sight distance between transmit and receive antenna	
	signal power offset	additional attenuation of a specific signal (–21 dB to 0 dB, updated in real-time without restarting the simulation)	
	pseudorange errors		
	in navigation mode	• constant bias, modifiable on-the-fly • profile (steps, ramps): suitable for testing receiver autonomous integrity monitoring (RAIM) • synchronized with corrections broadcasted in SBAS: The ionosphere errors will match the MOPS grid broadcasted by SBAS. Moreover, for GPS satellite, the deviation between the simulated orbits and clock and those broadcasted by the satellites will match the amount of differential correction broadcasted in SBAS message about the individual GPS space vehicles.	
	constant signal dynamics		
	in tracking mode	• pseudorange (0 km to 119900 km) • pseudorange rate (–100 km/s to 100 km/s) • carrier doppler is coupled with pseudorange rate • initial carrier phase: 0 π rad to 2 π rad	
	high-order signal dynamics		
	in tracking mode	periodic profiles with acceleration, constant velocity and deceleration	
Connectivity	marker	• 1 PPS • 1 PP2S • 10 PPS • pulse • pattern • on/off ratio • trigger	
	triggering	see R&S®SMBV100B specifications, section: I/Q baseband generator	see R&S®SMW200A specifications, section: I/Q baseband generator

Simulation monitoring

	available in test mode	**R&S®SMBV100B**	**R&S®SMW200A**
Sky view	navigation	shows the distribution of GNSS satellites in the sky	
Power view	navigation and tracking	bar plot visualizing the signals' power levels	
Satellite vehicle trajectory	navigation	azimuth/elevation of individual space vehicles over 24 h relative to simulation start	
World map	navigation	shows the simulated user position on a world map	
Map view	navigation	shows the currently simulated user position along with a preview of the full trajectory	
Vehicle dynamics	navigation	visualizes position, velocity and attitude information (heading, elevation and bank) in the form of an artificial horizon	
Hardware channels view	navigation and tracking	• visualizes the assignment of each GNSS signal in the hardware channels and its corresponding power (in dBm) • each signal represents a unique combination of: vehicle/antenna/band/multipath-ray/signal type	

Simulation data logging

		R&S®SMBV100B	**R&S®SMW200A**
Logging mode[4]	real-time log, offline log	• logs simulation data during the currently running simulation • simulation run is performed as fast as possible without producing an RF signal for fast generation of logging data	
Log types	satellite data	• elapsed time, UTC date and time, system/SVID, elevation, azimuth, ECEF XYZ position (in m), ECEF XYZ velocity (in m/s), ECEF XYZ acceleration in (in m/s^2), clock bias (in m) • signal level (in dBm) • range, pseudorange (in m) • range, pseudorange rates (in m/s) • pseudorange bias (in m) • pseudorange bias rate (in m/s) • doppler shift (in Hz) • carrier phase (in deg) • tropospheric, ionospheric delays (in m)	
	vehicle motion	• elapsed time, UTC date and time • latitude (in deg) • longitude (in deg) • altitude (in m) • position XYZ (in m) • velocity XYZ (in m/s) • acceleration XYZ (in m/s^2) • jerk XYZ (in m/s^3) • position east, north, upper (in m) • velocity east, north, upper (in m/s) • ground speed (in m/s) • attitude rate yaw, pitch, roll (in deg) • attitude rate yaw, pitch, roll (in deg/s) • attitude acceleration yaw, pitch, roll (in deg/s^2) • attitude jerk yaw, pitch, roll (in deg/s^3) • GDOP, PDOP, HDOP, VDOP, TDOP • visible space vehicles	

[4] Not available in HIL operation mode.

Specifications for GNSS options

GPS (R&S®SMBVB/SMW-K44 option)

Can be installed once on the R&S®SMBV100B and twice on the R&S®SMW200A.

		R&S®SMBV100B	R&S®SMW200A
GPS		in line with ICD-GPS-200 revision H	
Simulation configuration, monitoring, logging		see section Common specifications for all GNSS options	
Channel budget		see section Channel allocation	
Frequency bands		L1, L2	L1, L2
Center frequencies		1575.42 MHz, 1227.60 MHz	1575.42 MHz, 1227.60 MHz
Signals		C/A code, P code	C/A code, P code
Number of GNSS channels		6	24
Channel extension options		K136/K137	K136/K137/K138/K139, in combination with B9(F)
Navigation data format		LNAV, data list, pattern, All0, All1, PRBS	
Space vehicles		PRNs 1 to 37	

Modernized GPS (R&S®SMBVB/SMW-K98 option)

Can be installed once on the R&S®SMBV100B and twice on the R&S®SMW200A.

		R&S®SMBV100B	R&S®SMW200A
GPS		in line with ICD-GPS-200 revision H and ICD-GPS-705 revision E	
Simulation configuration, monitoring, logging		see section Common specifications for all GNSS options	
Channel budget		see section Channel allocation	
Frequency bands		L2, L5	L2, L5
Center frequencies		1227.60 MHz, 1176.45 MHz	1227.60 MHz, 1176.45 MHz
Signals		L2C, L5	L2C, L5
Number of GNSS channels		6	24
Channel extension options		K136/K137	K136/K137/K138/K139, in combination with B9(F)
Navigation data format		CNAV, data list, pattern, All0, All1, PRBS	
Space vehicles		PRNs 1 to 37	

Galileo (R&S®SMBVB/SMW-K66 option)

Can be installed once on the R&S®SMBV100B and twice on the R&S®SMW200A.

		R&S®SMBV100B	R&S®SMW200A
Galileo		in line with OS SIS ICD, E1/E5 band	in line with OS SIS ICD, E1/E5 band, OSNMA for E1, in line with OSNMA SIS ICD, Issue 1.1, October 2023
Simulation configuration, monitoring, logging		see section Common specifications for all GNSS options	
Channel budget		see section Channel allocation	
Frequency bands		E1, E5, E6	E1, E5, E6
Center frequencies		1575.42 MHz, 1176.45 MHz, 1207.14 MHz, 1278.75 MHz	1575.42 MHz, 1176.45 MHz, 1207.14 MHz, 1278.75 MHz
Signals		E1 open service, E5a, E5b, E6	E1 open service, E5a, E5b, E6
Number of GNSS channels		6	24
Channel extension options		K136/K137	K136/K137/K138/K139, in combination with B9(F)
Navigation data format		I/NAV for E1/E5b, F/NAV for E5a, data list, pattern, All0, All1, PRBS	
Space vehicles		PRNs 1 to 30	
OSNMA test vectors		predefined scenarios with limited simulation time, in line with OSNMA Receiver Guidelines for the Test Phase, Issue 1.1, October 2022	predefined scenarios with limited simulation time, in line with OSNMA Receiver Guidelines for the Test Phase, Issue 1.1, October 2022 and with OSNMA Receiver Guidelines, Issue 1.1, October 2023

GLONASS (R&S®SMBVB/SMW-K94 option)

Can be installed once on the R&S®SMBV100B and twice on the R&S®SMW200A.

		R&S®SMBV100B	R&S®SMW200A
GLONASS		in line with GLONASS ICD version 5.0	
Simulation configuration, monitoring, logging		see section Common specifications for all GNSS options	
Channel budget		see section Channel allocation	
Frequency bands		L1, L2	L1, L2
Center frequencies		1602.0 MHz, 1246.0 MHz	1602.0 MHz, 1246.0 MHz
Signals		C/A code	C/A code
Number of GNSS channels		6	24
Channel extension options		K136/K137	K136/K137/K138/K139, in combination with B9(F)
Navigation data format		GLONASS NAV, data list, pattern, All0, All1, PRBS	
Space vehicles		PRNs 1 to 24	

Modernized GLONASS (R&S®SMBVB/SMW-K123 option)

Can be installed once on the R&S®SMBV100B and twice on the R&S®SMW200A.

		R&S®SMBV100B	R&S®SMW200A
GLONASS		in line with GLONASS ICD CDMA open service navigation signal in L3 frequency band	
Simulation configuration, monitoring, logging		see section Common specifications for all GNSS options	
Channel budget		see section Channel allocation	
Frequency bands		L1, L2, L3	L1, L2, L3
Center frequencies		1600.995 MHz, 1248.06 MHz, 1202.025 MHz	1600.995 MHz, 1248.06 MHz, 1202.025 MHz
Signals		C/A code, CDMA L1 [5], CDMA L2 [5], CDMA L3	C/A code, CDMA L1 [5], CDMA L2 [5], CDMA L3
Number of GNSS channels		6	24
Channel extension options		K136/K137	K136/K137/K138/K139, in combination with B9(F)
Navigation data format		GLONASS NAV, data list, pattern, All0, All1, PRBS	
Space vehicles		PRNs 1 to 24	

NavIC/IRNSS (R&S®SMBVB/SMW-K97 option)

Can be installed once on the R&S®SMBV100B and twice on the R&S®SMW200A.

		R&S®SMBV100B	R&S®SMW200A
NavIC/IRNSS		in line with ISRO-IRNSS-ICD-SPS version 1.1	
Simulation configuration, monitoring, logging		see section Common specifications for all GNSS options	
Channel budget		see section Channel allocation	
Frequency bands		L5	L5
Center frequencies		1176.45 MHz	1176.45 MHz
Signals		L5 SPS	L5 SPS
Number of GNSS channels		6	24
Channel extension options		K136/K137	K136/K137/K138/K139, in combination with B9(F)
Navigation data format		SPS, data list, pattern, All0, All1, PRBS	
Space vehicles		PRNs 1 to 14	

[5] The modernized GLONASS signals CDMA L1 and CDMA L2 are experimental. Any compliance to GLONASS ICD CDMA open service navigation signal in L1 frequency band or GLONASS ICD CDMA open service navigation signal in L2 frequency band is not warranted.

BeiDou (R&S®SMBVB/SMW-K107 option)

Can be installed once on the R&S®SMBV100B and twice on the R&S®SMW200A.

		R&S®SMBV100B	R&S®SMW200A
BeiDou		in line with BDS-SIS-ICD-BI-2.0	
Simulation configuration, monitoring, logging		see section Common specifications for all GNSS options	
Channel budget		see section Channel allocation	
Frequency bands		B1, B2	B1, B2
Center frequencies		1561.098 MHz, 1207.14 MHz	1561.098 MHz, 1207.14 MHz
Orbits		GSO, IGSO, MEO	
Signals		B1 I (GSO), B1 I (non-GSO), B2 I (GSO), B2 I (non-GSO),	
Number of GNSS channels		6	24
Channel extension options		K136/K137	K136/K137/K138/K139, in combination with B9(F)
Navigation data format		D1 NAV, D2 NAV, data list, pattern, All0, All1, PRBS	
Space vehicles		PRNs 1 to 35	

Modernized BeiDou (R&S®SMBVB/SMW-K132 option)

Can be installed once on the R&S®SMBV100B and twice on the R&S®SMW200A.

		R&S®SMBV100B	R&S®SMW200A
BeiDou		in line with BDS-SIS-ICD-B3I-1.0, BDS-SIS-ICD-B2a-1.0, BDS-SIS-ICD-B1C-1.0, BDS-SIS-ICD-B2b-1.0	
Simulation configuration, monitoring, logging		see section Common specifications for all GNSS options	
Channel budget		see section Channel allocation	
Frequency bands		B1, B2, B3	B1, B2, B3
Center frequencies		1575.42 MHz, 1176.45 MHz, 1207.14 MHz, 1268.52 MHz	1575.42 MHz, 1176.45 MHz, 1207.14 MHz, 1268.52 MHz
Signals		B1C, B2a, B3I (GSO, non-GSO) B2b_I [6] (non-GEO)	B1C, B2a, B3I (GSO, non-GSO) B2b_I [6] (non-GEO)
Number of GNSS channels		6	24
Channel extension options		K136/K137	K136/K137/K138/K139, in combination with B9(F)
Navigation data format		CNAV, D1 NAV, D2 NAV, data list, pattern, All0, All1, PRBS	
Space vehicles		PRNs 1 to 35	

P(Y)/M/PRS noise (R&S®SMW-K128 option)

Can be installed twice on the R&S®SMW200A.

		R&S®SMBV100B	R&S®SMW200A
GPS, Galileo			
Simulation configuration, monitoring, logging		see section Common specifications for all GNSS options	
Channel budget		see section Channel allocation	
Frequency bands		–	L1, L2
Center frequencies		–	1575.42 MHz, 1278.75 MHz, 1227.6 MHz
Signals		–	P(Y) noise, M noise, E1-PRS noise, E6-PRS noise [7]
Number of GNSS channels		–	37 for GPS, 30 for Galileo
Channel extension options		–	K136/K137/K138/K139, in combination with B9(F)
Navigation data format		LNAV (for GPS), I/NAV (for Galileo), data list, pattern, All0, All1, PRBS	
Space vehicles		PRNs 1 to 37 for GPS, PRNs 1 to 30 for Galileo	

[6] B2b_I refers to non-GEO satellites 6 to 58, where only the B2b-I component is defined.

[7] The noise signals P(Y) noise, M noise, E1-PRS noise and E6-PRS noise are pure random signals simulating spectral interference. The signals cannot be used for position calculations.

SBAS/QZSS (R&S®SMBVB/SMW-K106 option)

Requires the R&S®SMBVB/SMW-K44 option. Can be installed once on the R&S®SMBV100B and twice on the R&S®SMW200A.

		R&S®SMBV100B	**R&S®SMW200A**
SBAS		in line with: DO-229D, minimum operational performance standard for global positioning system/wide area augmentation system airborne equipment	
Simulation configuration, monitoring, logging		see section Common specifications for all GNSS options	
Channel budget		see section Channel allocation	
Frequency bands		L1, L5 (for WAAS/EGNOS [8]	L1, L5 (for WAAS/EGNOS [8]
Center frequencies		1547.42 MHz, 1176.45 MHz,	1547.42 MHz, 1176.45 MHz,
Signals		C/A code, experimental signal Exp L5 [8]	C/A code, experimental signal Exp L5 [8]
Number of channels		5	5
Navigation data format		SBAS-L1-NAV, data list, pattern, All0, All1, PRBS	
Regional systems		• WAAS • EGNOS • MSAS • GAGAN	
Space vehicles		PRN: 120, 124, 126, 131, 136, 122, 133, 134, 135, 138, 129, 137	
Differential corrections	automatically generated	The broadcasted corrections reflect the simulated errors in the GNSS constellation: Ionosphere model, pseudorange error, orbit and clock deviations.	
	replay of historical data		
	with possibility to edit	loading of downloaded daily data from EGNOS and WAAS FTP servers: • EGNOS message server EMS format and WAAS real-time data NSTB format • EGNOS message server EMS format and WAAS real-time data NSTB format; optionally the ionosphere model pseudorange error GPS satellite can be synchronized to the imported data	
Message types	• almanac • ephemeris • time conversion to UTC • ionosphere corrections • PRN mask • fast corrections • long-term corrections • degradation parameters • clock and ephemeris covariance matrix	• MT 17 • MT 9 • MT 12 • MT 18 and 26 • MT 1 • MT 2, 3, 4, 5, 6 and 24 • MT 25 and 24 • MT 7 and 10 • MT 28	
QZSS		in line with IS-QZSS V1.6 for L1, and IS-QZSS-PNT-003 for L1C, L2C and L5	
Simulation configuration, monitoring, logging		see section Common specifications for all GNSS options	
Channel budget		see section Channel allocation	
Frequency bands		L1, L2, L5	L1, L2, L5
Center frequencies		1547.42 MHz, 1227.60 MHz, 1176.45 MHz	1547.42 MHz, 1227.60 MHz, 1176.45 MHz
Signals		C/A code, L1C, L2C, L5	C/A code, L1C, L2C, L5
Number of channels		5	5
Navigation data format		QZSS-L1-NAV, CNAV, data list, pattern, All0, All1, PRBS	
Space vehicles		PRN: 193, 194, 195, 196, 197, 199	

[8] The Exp L5 signals are experimental and not compliant to any existing or future ICDs. The navigation message is just a copy of the corresponding L1 message. The Exp L5 signals are available only for WAAS and EGNOS.

Single-satellite GNSS (R&S®SMBVB-K133 option)

This option allows for single-frequency production testing. It provides one single satellite for each of the systems GPS, GLONASS, Galileo, NavIC/IRNSS and BeiDou and generates signals in one of the frequency bands L1, L2 or L5 (selectable). Upgrades to dual- or triple-frequency production testing are possible by adding the R&S®SMBVB-K134 and R&S®SMBVB-K135 options.

		R&S®SMBV100B
GPS		in line with ICD-GPS-200 revision H
Simulation configuration, monitoring, logging		see section Common specifications for all GNSS options
Frequency bands		L1, L2, L5
Center frequencies		1575.42 MHz, 1227.60 MHz, 1191.795 MHz
Signals		L1 C/A ode, L1 P code, L1C, L2C, L5, P(Y) noise [9], M noise [9]
Maximum number of SVs		1
Navigation data format		LNAV, CNAV, data list, pattern, All0, All1, PRBS
Space vehicles		PRNs 1 to 37
Galileo		in line with OS SIS ICD, E1/E5/E6 band
Simulation configuration, monitoring, logging		see section Common specifications for all GNSS options
Frequency bands		E1, E5, E6
Center frequencies		1575.42 MHz, 1191.795 MHz, 1278.75 MHz
Signals		E1 open service, E5a, E5b, E6, E1-PRS noise [9], E6-PRS noise [9]
Maximum number of SVs		1
Navigation data format		I/NAV for E1/E5b, F/NAV for E5a, data list, pattern, All0, All1, PRBS
Space vehicles		PRNs 1 to 30
GLONASS		in line with GLONASS ICD version 5.0
Simulation configuration, monitoring, logging		see section Common specifications for all GNSS options
Frequency bands		L1, L2
Center frequencies		1602.0 MHz, 1246.0 MHz
Signals		C/A code
Maximum number of SVs		1
Navigation data format		GLONASS NAV, data list, pattern, All0, All1, PRBS
Space vehicles		PRNs 1 to 24
NavIC/IRNSS		in line with ISRO-IRNSS-ICD-SPS-1.1
Simulation configuration, monitoring, logging		see section Common specifications for all GNSS options
Frequency bands		L5
Center frequencies		1176.45 MHz
Signals		SPS
Maximum number of SVs		1
Navigation data format		SPS, data list, pattern, All0, All1, PRBS
Space vehicles		PRNs 1 to 14

[9] The noise signals P(Y) noise, M noise, E1-PRS noise and E6-PRS noise are pure random signals simulating spectral interference. The signals cannot be used for position calculations.

		R&S®SMBV100B
BeiDou		in line with BDS-SIS-ICD-B1I-2.0, BDS-SIS-ICD-B3I-1.0, BDS-SIS-ICD-B2a-1.0, BDS-SIS-ICD-B2b-1.0, BDS-SIS-ICD-B1C-1.0
Simulation configuration, monitoring, logging		see section Common specifications for all GNSS options
Frequency bands		B1, B2, B3
Center frequencies		1561.098 MHz, 1207.140 MHz, 1268.52 MHz, 1176.45 MHz, 1575.42 MHz
Orbits		GSO, IGSO, MEO
Signals		B1 I (GSO), B1 I (non-GSO), B2 I (GSO), B2 I (non-GSO), B3 I (GSO), B3 I (non-GSO), B2a, B1C B2b_I* (non-GEO)
Maximum number of SVs		1
Navigation data format		D1 NAV, D2 NAV, CNAV, data list, pattern, All0, All1, PRBS
Space vehicles		PRNs 1 to 35

Upgrade to dual-frequency GNSS (R&S®SMBVB/R&S®SMW-K134 option)

Allows to configure dual-frequency GNSS scenarios. Requires at least one GNSS option (K44, K98, K66, K94, K97, K107, K123, K128, K132 or K133). The option allows the user to generate signals simultaneously in two of the three GNSS frequency bands (L1 + L2 or L1 + L5 or L2 + L5). The option can be installed once on the R&S®SMBV100B and twice on the R&S®SMW200A (once per RF output).

Upgrade to triple-frequency GNSS (R&S®SMBVB/R&S®SMW-K135 option)

Allows to configure triple-frequency GNSS scenarios. Requires the K134 option. The option allows the user to generate signals simultaneously in all three GNSS frequency bands (L1 + L2 + L5). The option can be installed once on the R&S®SMBV100B and twice on the R&S®SMW200A (once per RF output).

Add 6 GNSS channels (R&S®SMBVB/R&S®SMW-K136 option)

Extends the number of available GNSS channels by 6. Requires at least one GNSS option (K44, K98, K66, K94, K97, K107, K123, K128 or K132). Can be installed several times. The maximum number of available GNSS channels is 102 on the R&S®SMBV100B and 612 on the R&S®SMW200A.

Add 12 GNSS channels (R&S®SMBVB/R&S®SMW-K137 option)

Extends the number of available GNSS channels by 12. Requires at least one GNSS option (K44, K98, K66, K94, K97, K107, K123, K128 or K132). Can be installed several times. The maximum number of available GNSS channels is 102 on the R&S®SMBV100B and 612 on the R&S®SMW200A.

Add 24 GNSS channels (R&S®SMW-K138 option)

Extends the number of available GNSS channels by 24. Requires at least one GNSS option (K44, K98, K66, K94, K97, K107, K123, K128 or K132). Can be installed several times. The maximum number of available GNSS channels on the R&S®SMW200A is 612.

Add 48 GNSS channels (R&S®SMW-K139 option)

Extends the number of available GNSS channels by 48. Requires at least one GNSS option (K44, K98, K66, K94, K97, K107, K123, K128 or K132). Can be installed several times. The maximum number of available GNSS channels on the R&S®SMW200A is 612.

MS GNSS Interference test (R&S´ ®SMW-K129 option)

The matched spectrum GNSS interference test option extends the number of available GNSS channels to the maximum number possible on the hardware platform, but for all these GNSS channels the navigation data generation is disabled. This special test option allows generation of GNSS signals with correct PRN sequences and modulation for all installed GNSS options. It is possible to simulate all signals based on a realistic satellite constellation and user motion. The generated signals can be used for GNSS interference tests, but a PVT can not be calculated based on the generated signals.

Requires at least one GNSS option (K44, K98, K66, K94, K97, K107, K123, K128 or K132). For R&S®SMW200A additionally a R&S®SMW-B9(F) is needed. The maximum number of available GNSS channels on the R&S®SMW200A depends on physical hardware installed and may be up to 612. For the R&S®SMBVB the maximum GNSS channel number is 102.

Real-world scenarios (R&S®SMBVB/R&S®SMW-K108 option)

This option adds the following simulation features to the basic options K44, K98, K66, K94, K97, K107, K123, K128, K132 or K106 (can be installed once):

		R&S®SMBV100B	**R&S®SMW200A**
Receiver antenna pattern and body mask	maximum of one active antenna per option	four configurable antennas, one of them can be simulated	six (B9(F)) or four (B10(F)) configurable antennas, all of them can be activated
	antenna to vehicle attitude offsets	e.g. if the antenna frame is not aligned with the vehicle body frame; Note: antenna to vehicle position offsets are available in the basic options	
	separate files can be used for antenna patterns and body masks	XML file format with a resolution down to 1° (see user manual for format description)	
Receiver attitude (heading, elevation and bank)	constant	The vehicle will remain in the same orientation with respect to the earth-fixed-earth-centered (ECEF) frame.	
	from file	The vehicle will change attitude with a resolution up to the hardware update rate. The values are imported from an external file.	
	spinning	The vehicle will change bank at constant rate defined by the user (max. 50 Hz).	
Receiver environment	static multipath	user-defined initial code phase, code phase drift, power offset, initial carrier phase, Doppler shift, elevation/azimuth angles of arrival	
	additional obscuration and multipath models	• vertical obstacles • roadside planes • full obscuration • ground and sea reflection	

Real-time GNSS interfaces (R&S®SMBVB/R&S®SMW-K109 option)

This option adds the following simulation features to the basic options K44, K98, K66, K94, K97, K107, K123, K128, K132 or K106 (can be installed once):

		R&S®SMBV100B	**R&S®SMW200A**
Real-time trajectory feed		real-time feed of vehicle motion data (position, velocity, acceleration and jerk) for hardware in the loop applications	
Real-time attitude feed		real-time feed of vehicle attitude data (yaw, pitch and roll) for hardware in the loop applications	
Streaming rate		up to 100 Hz	up to 100 Hz
Latency		down to 20 ms	down to 20 ms

Virtual RTK reference station (R&S®SMBVB/R&S®SMW-K122 option)

This option adds the following simulation features to the basic options K44, K98, K66, K94, K107, K123 or K132 (can be installed once):

		R&S®SMBV100B	**R&S®SMW200A**
Number base stations		1	
Supported GNSS systems		GPS, Galileo, GLONASS, BeiDou	
Protocol		NTRIP 1.0 (HTTP) via IP	
Correction format		RTCM 3.3 (10403.3)	
Message update rate	1 Hz	1077, 1087, 1097, 1127	
	10 Hz	1006, 1013, 1033	

ERA-GLONASS test suite (R&S®SMBVB/R&S®SMW-K360 option)

Automatic GNSS performance testing against GOST-R-55534/33471 performance criteria. The supported test cases and the required R&S®SMBVB/SMW options are listed in the following table:

Test case	Performance tests	Required options	
		Minimum instrument configuration	**To add for full test coverage**
5.1	Availability of position/velocity for GLONASS L1	K44, K94 and K137 [10]	–
5.2	Availability of position/velocity for GPS L1		–
5.3	Availability of position/velocity for combined GPS/GLONASS L1 processing		–
5.4	Verify NMEA transmission from DUT		–
5.5	Functional RAIM test		–
5.6	Use of different reference systems (PZ-90/WGS-84)		–
5.7	Location accuracy (static receiver)		–
5.8	Location accuracy (moving receiver)		K108 [11]
5.9	Minimum update rate of NMEA stream		–
5.10	Reacquisition time		–
5.11	Time to first fix (TTFF) under cold start conditions		–
5.12	Tracking and acquisition sensitivity		–
5.13	Change update rate of NMEA stream		–
5.14	Check cutoff angle settings for navigation satellites		–
5.15	Check power-off time of navigation module (GNSS navigation receiver)		
5.16	Performance tests with consideration of CW interference	not covered by K360, because not specified in GOST-R-33471	
5.17	Performance tests with consideration of pulse interference	not covered by K360, because not specified in GOST-R-33471	

eCall test suite (R&S®SMBVB/R&S®SMW-K361 option)

Automatic GNSS performance testing against EU2017/79, Annex VI and UNECE 2016/07 performance criteria. The supported test cases and the required R&S®SMBVB/SMW options are listed in the following table:

Test case	Performance tests	Required options	
		Minimum instrument configuration	**To add for full test coverage**
2.1	NMEA-0183 messages output test	K44, K66, K106 and K137 [10]	K94 [12], K136 [1]
2.2	Positioning accuracy in autonomous static mode		K94 [12], K136 [1]
2.3	Positioning accuracy in autonomous dynamic mode		K94 [12], K136 [1]
2.4	Movement in shadow areas, areas of intermittent reception of navigation signals and urban canyons		K108 [11], K94 [12], K136 [1]
2.5	Cold start time to first fix test		K94 [12], K136 [1]
2.6	Test of reacquisition time of tracking signals after block out of 60 seconds		K94 [10], K136 [1]
2.7	Test of GNSS receiver sensitivity in cold start mode, tracking mode, and reacquisition scenario		K94 [12], K136 [1]

[10] K136, K137 only required for R&S®SMBV100B.

[11] Required for poor reception test mode; if K108 is not installed, the dynamic location accuracy test (5.8) can still be performed, but not under poor reception conditions.

[12] K94 required for testing against UNECE specification, not required for testing against EU specification.

GNSS test suite (R&S®SMBVB/R&S®SMW-K362 option)

Automated and customizable GNSS receiver tests for GNSS receiver characterization. Requires at least one of the following options: K44, K66, K94, K97, K98, K107 or K132. The supported test cases are listed in the following table:

Test case	Performance tests	Test description
1	Verify NMEA transmission from DUT	checks for compliance of the NMEA messages coming from the DUT against the NMEA specification, and detects missing or corrupts NMEA sentences
2	Location accuracy (static receiver)	measures the accuracy of the position obtained by the DUT relative to the actual (simulated, static) position
3	Location accuracy (moving receiver)	measures the accuracy of the position obtained by the DUT relative to the actual (simulated, moving) position
4	Time-to-first fix (TTFF) under cold start conditions	measures the time from switching on the DUT to the availability of the first valid location fix
5	Reacquisition time	measures how long it takes for the DUT to restore its position information after having lost the GNSS signals for a certain period of time
6	Tracking and acquisition sensitivity	determines the minimum required signal level that allows the receiver to successfully perform or maintain a position fix
7	Functional RAIM test	determines the DUT ability to detect and exclude faulty GNSS signals

The K362 allows to configure automated GNSS tests for the following signals and systems:

	L1 frequency band	L2 frequency band	L5 frequency band
GPS	C/A, P	C/A, P, L2C	L5
Galileo	E1 OS	E6	E5a, E5b
GLONASS	C/A	C/A	
BeiDou	B1-I, B1c	B3-I	B2a, B2-I, B2b_I (non-GEO)
QZSS	C/A		
SBAS	L1		

Car navigation test suite (R&S®SMBVB/R&S®SMW-K363 option)

Automatic GNSS performance testing against “Technical specification for on board satellite positioning system” (Chinese version) performance criteria. The supported test cases and the required R&S®SMBVB/SMW options are listed in the following table.

Within “Technical specification for on board satellite positioning system”, the test cases are not numbered but the naming conventions are pretty similar to the below test case list.

Several of the independent BeiDou tests need additional licenses for GPS, Galileo and GLONASS because of the cold start state definitions of Annex B in the technical specification definition.

Test case	Performance tests	Required options	
		Basic instrument configuration	**Additionally needed options on instrument**
1	Output	K107, K108	K44, K66, K94, K136+K137 [13]
2	Supporting satellite signal consistency		K44, K66, K94, K136+K137 [13]
3	Independent BeiDou static positioning accuracy open sky		K44, K66, K94, K136+K137 [13]
4	Static positioning accuracy open sky		K44, K66, K94, K136+K137 [13]
5	Independent BeiDou static positioning accuracy urban canyon		K44, K66, K94, K136+K137 [13]
6	Static positioning accuracy urban canyon		K44, K66, K94, K136+K137 [13]
7	Independent BeiDou dynamic positioning accuracy open sky		K44, K66, K94, K136+K137 [13]
8	Dynamic positioning accuracy open sky		K44, K66, K94, K136+K137 [13]
9	Independent BeiDou dynamic positioning accuracy urban canyon		K44, K66, K94, K136+K137 [13]
10	Dynamic positioning accuracy urban canyon		K44, K66, K94, K136+K137 [13]
11	Independent BeiDou velocity accuracy open sky		K44, K66, K94, K136+K137 [13]
12	Velocity accuracy open sky		K44, K66, K94, K136+K137 [13]
13	Independent BeiDou velocity accuracy urban canyon		K44, K66, K94, K136+K137 [13]
14	Velocity accuracy urban canyon		K44, K66, K94, K136+K137 [13]
15	Independent BeiDou cold start time to first fix		K44, K66, K94, K136+K137 [13]
16	Cold start time to first fix		K44, K66, K94, K136+K137 [13]
17	Independent BeiDou hot start time to first fix		–
18	Hot start time to first fix		K44, K66, K94, K136+K137 [13]
19	Independent BeiDou reacquisition time		–
20	Reacquisition time		K44, K66, K94, K136+K137 [13]
21	Independent BeiDou acquisition sensitivity		K44, K66, K94, K136+K137 [13]
22	Acquisition sensitivity		K44, K66, K94, K136+K137 [13]
23	Independent BeiDou reacquisition sensitivity		–
24	Reacquisition sensitivity		K44, K66, K94, K136+K137 [13]
25	Independent BeiDou tracking sensitivity		–
26	Tracking sensitivity		K44, K66, K94, K136+K137 [13]
27	Independent BeiDou timing performance open sky		see Note below
28	Timing performance open sky		K44, K66, K94, K136+K137 [13] see Note below
29	Independent BeiDou timing performance urban canyon		see Note below
30	Timing performance urban canyon		K44, K66, K94, K136+K137 [13] see Note below

Note:

For timing related tests 27-30, additional hardware equipment is needed to test the full timing specifications including hardware PPS output of the DUT. For this purpose, the K363 test suite supports seamless integration of the R&S®RTM3002 and R&S®RTM3004 oscilloscopes. Without an oscilloscope, only a simplified version of the timing tests can be executed for the DUT and therefore, the PPS output cannot be verified.

[13] K136, K137 only required for R&S®SMBV100B.

Channel allocation

For R&S®SMBV100B

- One channel is equivalent to a single signal component transmitted by a single satellite, e.g. GPS-L1C/A of SVID 1 requires one channel. This means for a space vehicle (SV) transmitting two signals (such as GPS L1 C/A and GPS L2 C/A), that two GNSS channels are required.
- 6 channels will be available when installing the first of the following basic GNSS options: K44, K97, K98, K66, K94, K107, K123, K128, K132
- When more than one basic option is installed, the total number of channels does not increase. Example: when licenses for GPS, GLONASS, Galileo and BeiDou are installed, the total number of available GNSS channels is still 6.
- The number of available channels can be increased by installing one or several channel extension options: R&S®SMBV-K136 and R&S®SMBV-K137. That way, the channel budget can be extended from 6 to a maximum of 102 channels
- The number of available SVs per system for a given instrument configuration depends on what constellations are active and what signals are to be simulated. Example: If GPS is the only active constellation, all available channels can be used for generating GPS L1 C/A signals; in this case, the number of available SVs equals the number of available channels. When simulating GPS L1 C/A and GPS P code (P(Y) noise, M noise, E1-PRS noise, E6-PRS noise, respectively) at the same time, the number of available SVs decreases as two channels per SVs are needed.
- Simulating E5a and E5b simultaneously requires 2 separate channels per Galileo SV
- During multipath simulations, each additional echo requires the same number of channels as the corresponding line of sight signal
- The maximum number of available GNSS channels per instrument is 102

For R&S®SMW200A with R&S®SMW-B10(F)

- One channel is equivalent to a single signal component transmitted by a single satellite, e.g. GPS-L1C/A of SVID 1. This also means that for a space vehicle (SV) transmitting two signals (such as GPS L1 C/A and GPS L2 C/A), two GNSS channels are required.
- 24 channels will be available when installing the first of the following basic GNSS options: K44, K97, K98, K66, K94, K107, K123, K128, K132
- All basic GNSS options can be installed twice (provided that two R&S®SMW-B10(F) are available on the R&S®SMW200A); if installed twice, the signals from that GNSS options can be used in RF path 1 and RF path 2. 24 GNSS channels are available in path 1, another 24 channels can be generated on path 2.
- When more than one basic GNSS option is used in the same baseband, the total number of channels does not increase. Example: when licenses for GPS, GLONASS, Galileo and BeiDou are installed in one single RF path, the number of available GNSS channels is still 24.
- The number of available channels per baseband cannot be increased. There are no channel extension options available for instruments equipped with R&S®SMW-B10(F) baseband generators.
- The number of available SVs per system for a given instrument configuration depends on what constellations are active and what signals are to be simulated. Example: If GPS is the only active constellation, all available channels can be used for generating GPS L1 C/A signals; in this case, the number of available SVs equals the number of available channels. When simulating GPS L1 C/A and GPS P code (P(Y) noise, M noise, E1-PRS noise, E6-PRS noise, respectively) at the same time, the number of available SVs decreases as two channels per SVs are needed.
- Simulating E5a and E5b simultaneously requires 2 separate channels per Galileo SV
- During multipath simulations, each additional echo requires the same number of channels as the corresponding line of sight signal

For R&S®SMW200A with R&S®SMW-B9(F)

- One channel is equivalent to a single signal component transmitted by a single satellite, e.g. GPS-L1C/A of SVID 1. This also means that for a space vehicle (SV) transmitting two signals (such as GPS L1 C/A and GPS L2 C/A), two GNSS channels are required.
- 24 channels will be available when installing the first of the following basic GNSS options: K44, K97, K98, K66, K94, K107, K123, K128, K132
- All basic GNSS options can be installed twice (provided that two R&S®SMW-B9(F) are available on the R&S®SMW200A); if installed twice, the total amount of available channels increases to 48. These 48 channels can used anywhere on the R&S®SMW200A and freely distributed among the signal paths.
- When more than one basic GNSS option is used in the same signal path, the total number of channels does not increase. Example: when licenses for GPS, GLONASS, Galileo and BeiDou are installed in one single RF path, the number of available GNSS channels is still 24.
- The number of available channels per instrument can be increased by installing one or several channel extension options: R&S®SMW-K136, R&S®SMW-K137, R&S®SMW-K138 and/or R&S®SMW-K138. That way, the channel budget can be extended to a maximum of 612 channels. Please note that increasing the number of channels beyond 204 requires additional hardware modules (R&S®SMW-B15) to be installed (see table below).
- The number of available SVs per system for a given instrument configuration depends on what constellations are active and what signals are to be simulated. Example: If GPS is the only active constellation, all available channels can be used for generating GPS L1 C/A signals; in this case, the number of available SVs equals the number of available channels. When GPS L1 C/A and GPS P code (P(Y) noise, M noise, E1-PRS noise, E6-PRS noise respectively) at the same time, the number of available SVs decreases as two channels per SVs are needed.
- Simulating E5a and E5b simultaneously requires 2 separate channels per Galileo SV
- During multipath simulations, each additional echo requires the same number of channels as the corresponding line of sight signal
- One RF path can generate a maximum of 102 channels, so that a dual-path SMW equipped with 2 × B9(F) is able to simulate up to 204 GNSS channels. In order to further increase the channel count, the SMW can be upgraded with wideband fading modules (R&S®SMW-B15), that can be used to simulate additional GNSS signals. The following minimum hardware configuration is needed to simulate a dedicated number of GNSS channels:

Minimum hardware configuration	**R&S®SMW200A base unit, R&S®SMW-B13XT, R&S®SMW-B1003, N × R&S®SMW-B9(F), M × R&S®SMW-B15**	
Number of GNSS channels	N (no. of B9(F))	M (no. of B15)
24 to 102	1	0
103 to 204	2	0
205 to 408	2	2
409 to 612	2	4

- The maximum number of simulated channels additionally depends on the simulated signals. As an example, 102 GPS P code channels (P(Y) noise, M noise, E1-PRS noise, E6-PRS noise, respectively) on a single board are not supported. One R&S®SMW-B9(F) or R&S®SMW-B15 board consists of three channel banks and several subbanks used for the generation of GNSS signals. Each bank can simulate only one frequency band L1, L2 or L5 at a time. The frequency band is assigned automatically, so that a maximum number of hardware resources from the channel banks are used. The channel capacity on each B9(F) or B15 board is described in following table:

Channel bank	**Subbank**	**Signal**	**Channel capacity**
0	0_A	C/A, E1 OS, B1I, B2I, B3I	12
	0_B	C/A, L1C, E1 OS, B1I, L5, E5a, E5b, B1I, B2I, B3I, B1C	12
	0_C	C/A, L1C, E1 OS, B1I, P, P(Y) noise, M noise, E1-PRS noise, E6-PRS noise, L5, E5a, E5b, B1I, B2I, B3I, B1C	18
	all subbanks	all signals except L2C	42
1	1_A	C/A, L1C, E1 OS, B1I, L2C, L5, E5a, E5b, B1I, B2I, B3I, B1C	16
	1_B	C/A, L1C, E1 OS, B1I, P, P(Y) noise, M noise, E1-PRS noise, E6-PRS noise, L2C, L5, E5a, E5b, B1I, B2I, B3I, B1C	16
	all subbanks	all signals	32
2	2_A	C/A, L1C, E1 OS, B1I, L2c, L5, E5a, E5b, B1I, B2I, B3I, B1C	28
	all subbanks	all signals except P, P(Y) noise, M noise, E1-PRS noise, E6-PRS noise	28
All banks			102

Avionics systems

Key features

GBAS (R&S®SMBVB/SMW-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
- Flexible message type scheduling

ILS (R&S®SMBV-K151 option)

- Emulation of instrument landing system (ILS)
- Generation of ILS localizer signal
- Generation of ILS glideslope signal
- Generation of marker beacons

VOR (R&S®SMBV-K152 option)

- Emulation of VHF omnidirectional radio range (VOR)
- Four different operating modes (NORM, VAR, subcarrier, subcarrier + FM)
- VOR bearing angle at a resolution of 0.01°

DME (R&S®SMBV-K153 option)

- Emulation of distance measuring equipment (DME)
- Interrogator mode and reply mode
- Allows testing of DME ground stations and DME aircraft equipment
- DME signal analysis in combination with R&S®NRP-Z81 power sensor

Specifications for avionics options

GBAS (R&S®SMBVB/R&S®SMW-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 timeslots
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 timeslots 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 timeslot
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	• All0 • All1 • 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
Timeslot configuration		
Scheduling	a timeslot on one frequency band can be allocated to one VDB only	allows the user to reserve up to 8 timeslots on a specific frequency band; the allocated timeslots will be used in modulating the tower signal
State		activates or deactivates a specific timeslot for the VDB modulation
Relative power		sets the relative power of the timeslot of a specific VDB: –21 dB to 0 dB, –INF for inactive timeslot

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 specifications, section I/Q baseband generator
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

ILS modulation (R&S®SMBVB-K151 option)

Attenuator mode: low distortion, level (PEP) within 0 dBm to –70 dBm. ILS-LOC specification valid for carrier frequency range from 108 MHz to 118 MHz. ILS-GS specification valid for carrier frequency range from 329 MHz to 335 MHz.

ILS modulation	generation of ILS localizer signal, COM/ID tone possible	ILS-LOC
	generation of ILS glideslope signal	ILS-GS
ILS operating modes	NORM	90 Hz + 150 Hz + COM/ID tone (ILS-LOC)
	90 Hz	suppression of 150 Hz modulation tone
	150 Hz	suppression of 90 Hz modulation tone
ILS modulation tones	If the frequency of the 90 Hz or 150 Hz tone is varied, the other tone is automatically changed in proportion.	
Frequency		
Error		< 0.02 Hz (meas.)
Setting range	90 Hz tone	60 Hz to 120 Hz
	150 Hz tone	100 Hz to 200 Hz
	COM/ID tone	0.1 Hz to 20 kHz
Setting resolution	90 Hz tone	0.3 Hz
	150 Hz tone	0.5 Hz
	COM/ID tone	0.1 Hz
External AM tone	input connectors at front	I and Q
Modulation depth	sum of modulation depths of 90 Hz, 150 Hz, COM/ID and external AM signal must not exceed 100 %	
Setting range	SDM of 90 Hz, 150 Hz, COM/ID tone	0 % to 100 %
	ILS-LOC default setting	40 %
	ILS-GS default setting	80 %
Setting resolution	SDM and COM/ID depth	0.1 %
AM depth error	SDM = 40 %	< 1.3 % AM depth (meas.)
	SDM = 80 %	< 0.8 % AM depth (meas.)
	SDM full range	< 1.3 % AM depth (meas.)
	COM/ID, tone = 1020 Hz	< 0.5 % AM depth (meas.)
External AM tone	sensitivity	0.01 V/%

Difference in depth of modulation (DDM)		
Setting range		0 to ±SDM
Setting resolution		0.0001
Error	SDM = 20 %	< 0.03 % AM depth (meas.)
	SDM = 40 %	< 0.01 % AM depth (meas.)
	SDM = 60 %	< 0.03 % AM depth (meas.)
	SDM = 80 %	< 0.03 % AM depth (meas.)
	SDM = 100 %	< 0.03 % AM depth (meas.)
ILS phase		
Setting range		0° to 120°
Setting resolution		0.01°
Error		< 0.2°(meas.)
Marker beacon modulation tones		
Marker frequencies		400 Hz, 1300 Hz and 3000 Hz
COM/ID tone frequency setting range		0.1 Hz to 20 kHz
COM/ID tone frequency setting resolution		0.1 Hz
Marker beacon modulation depth	sum of modulation depths of marker tone and COM/ID signal must not exceed 100 %	
AM depth		
Setting range		0 % to 100 %
	marker tone default setting	95 %
Setting resolution		0.1 %
Error	marker tone	< 0.5 % AM depth
	COM/ID, tone = 1020 Hz	< 0.5 % AM depth (meas.)

VOR modulation (R&S®SMBVB-K152 option)

Attenuator mode: low distortion, level (PEP) within 0 dBm to –70 dBm. VOR specification valid for carrier frequency range from 108 MHz to 118 MHz.

VOR operating modes	generation of VOR signal	NORM
	30 Hz VAR tone	VAR
	9.96 kHz carrier, unmodulated	subcarrier
	9.96 kHz carrier, modulated	subcarrier + FM
Modulation tones		
Frequency		
Error	30 Hz (VAR, REF)	< 0.003 Hz (meas.)
Setting range	30 Hz REF	10 Hz to 60 Hz
	9.96 kHz FM carrier	5 kHz to 15 kHz
	COM/ID tone	0.1 Hz to 20 kHz
Setting resolution		0.1 Hz
FM deviation		
Setting range	9.96 kHz FM carrier	0 Hz to 960 Hz
Setting resolution	9.96 kHz FM carrier	1 Hz
Error	9.96 kHz FM carrier at 480 Hz deviation	< 0.5 Hz (meas.)
External AM tone	input connectors at front	I and Q
Modulation depth	sum of modulation depths of 30 Hz (VAR) signal, 9.96 kHz FM carrier, COM/ID and external AM signal must not exceed 100 %	
AM depth		
Setting range		0 % to 100 %
Setting resolution		0.1 %
Error	30 Hz (VAR, REF), 30 % AM depth	< 0.5 % AM depth (meas.)
	30 Hz (VAR, REF), AM depth: whole range	< 0.8 % AM depth (meas.)
	9.96 kHz FM carrier, 30 % AM depth	< 0.2 % AM depth (meas.)
	9.96 kHz FM carrier, AM depth: whole range	< 1 % AM depth (meas.)
	COM/ID, tone = 1020 Hz	< 0.3 % AM depth (meas.)
External AM tone	sensitivity	0.01 V/%
Bearing angle		
Setting range		0° to 360°
	default setting	0.00°
Setting resolution		0.01°
Error		< 0.05° (meas.)

DME modulation (R&S®SMBVB-K153 option)

Specifications valid for carrier frequency range from 960 MHz to 1215 MHz, attenuator mode: auto, ALC state: auto, level (PEP) within specified level range and DME default settings.

DME operating modes	DME/N	DME interrogation
		DME reply
DME channel		X, Y
Single pulse	generation of a single pulse instead of a pulse pair	on/off
Squitter pulses	randomly distributed pulse repetition rate in line with EUROCAE ED-54	on/off
Level error	attenuator mode: auto, temperature range: +18 °C to +33 °C	
	pulse peak power uncertainty	< 0.8 dB
	pulse-to-pulse level difference	< 0.2 dB, < 0.1 dB (typ.)
On/off ratio		> 50 dB (meas.)
Pulse		
Shaping	cos² shape for rising and falling edge	cos²
	cos shape for rising edge; cos² shape for falling edge	cos cos²
	linear shape for rising and falling edge	linear
	gauss shaped for rising and falling edge	gauss
Rise/fall time setting range	10 % / 90 % of RF amplitude	0.5 µs to 20 µs
Width setting range	50 % / 50 % of RF amplitude	1 µs to 100 µs
Spacing setting range	50 % / 50 % of RF amplitude	1 µs to 100 µs
Parameter setting resolution	rise/fall time, pulse width, pulse spacing	0.01 µs
Rise/fall time error		< 0.05 µs (meas.)
Width error		< 0.05 µs (meas.)
Spacing error		< 0.05 µs (meas.)
Repetition rate setting rate	squitter off	10 pp/s to 6000 pp/s
	squitter on (mean pulse repetition rate)	10 pp/s to 6000 pp/s (nom.)
Repetition setting resolution	squitter off	1 pp/s
	squitter on (mean pulse repetition rate)	100 pp/s
Efficiency setting range		0 % to 100 %
Efficiency setting resolution		1 %
Range distance setting range		–2 NM to 400 NM
Range distance setting resolution		0.01 NM
Propagation simulation, only in DME reply mode		
Echo simulation	state	on (when squitter pulses are off), off
	delay	pulse width + pulse spacing + 0.5 × pulse rise time to 204 µs
	attenuation	0 dB to 50 dB
Velocity simulation	doppler offset due to movement (velocity)	–10000 kn to 10000 kn, when echo simulation is off, else 0 kn
Flight Simulation	straight line movement simulation via startpoint, endpoint and velocity	
	start distance	–400 NM to 400 NM
	stop distance	–400 NM to 400 NM
	controls	start/restart/stop/pause
Identification pulses, only in DME reply mode		
ID code		user-selectable four-character code
ID rate setting range		100 pp/s to 10000 pp/s
ID period setting range		10 s to 120 s
ID dot, dash, symbol space and letter space length setting range		50 ms to 500 ms
Monitor output	output connectors at back	I and Q
DME analysis		
Peak level range		–10 dBm to 20 dBm
Reply delay range		0 µs to 300 µs
Reply efficiency range		0 % to 100 %
Pulse repetition rate range		2 Hz to 10 kHz

Ordering information

R&S®SMBV100B

R&S®SMBVB-Bxxx = hardware option, R&S®SMBVB-Kxxx = software/key code option

Designation	Type	Order No.
Vector signal generator, including baseband generator with ARB (64 Msample, 120 MHz RF bandwidth), power cable and quick start guide	R&S®SMBV100B	1423.1003.02
Minimum instrument configuration for GNSS		
Frequency option, 8 kHz to 3 GHz	R&S®SMBVB-B103	1423.6270.02
Real-time extension	R&S®SMBVB-K520	1423.7676.02
Additional configuration options for GNSS		
Phase coherence	R&S®SMBVB-K90	1423.7601.02
Additive white Gaussian noise (AWGN)	R&S®SMBVB-K62	1423.7876.02
Software options for GNSS		
GPS	R&S®SMBVB-K44	1423.7753.02
Modernized GPS	R&S®SMBVB-K98	1423.7960.02
Galileo	R&S®SMBVB-K66	1423.7882.02
GLONASS	R&S®SMBVB-K94	1423.7953.02
NavIC/IRNSS	R&S®SMBVB-K97	1423.8708.02
BeiDou	R&S®SMBVB-K107	1423.7999.02
Modernized BeiDou	R&S®SMBVB-K132	1423.8789.02
SBAS/QZSS	R&S®SMBVB-K106	1423.7982.02
Real-world scenarios	R&S®SMBVB-K108	1423.8008.02
Real-time GNSS interfaces	R&S®SMBVB-K109	1423.8014.02
Virtual RTK reference station	R&S®SMBVB-K122	1423.8914.02
Modernized GLONASS	R&S®SMBVB-K123	1423.9104.02
Single-satellite GNSS	R&S®SMBVB-K133	1423.8743.02
Upgrade to dual-frequency GNSS	R&S®SMBVB-K134	1423.8750.02
Upgrade to triple-frequency GNSS	R&S®SMBVB-K135	1423.8766.02
Add 6 GNSS channels	R&S®SMBVB-K136	1423.8772.02
Add 12 GNSS channels	R&S®SMBVB-K137	1423.8795.02
GNSS waveforms, generated by R&S®WinIQSIM2		
GPS	R&S®SMBVB-K244	1423.8195.02
NavIC (IRNSS)	R&S®SMBVB-K297	1423.8695.02
Modernized GPS	R&S®SMBVB-K298	1423.8408.02
Galileo	R&S®SMBVB-K266	1423.8320.02
GLONASS	R&S®SMBVB-K294	1423.8395.02
BeiDou	R&S®SMBVB-K407	1423.8489.02
Modernized GLONASS	R&S®SMBVB-K423	1423.9110.02
Modernized BeiDou	R&S®SMBVB-K432	1423.8837.02
GNSS test automation		
ERA-GLONASS test suite	R&S®SMBVB-K360	1423.8650.02
eCall test suite	R&S®SMBVB-K361	1423.8666.02
GNSS test suite	R&S®SMBVB-K362	1423.8672.02
Car navigation test suite	R&S®SMBVB-K363	1423.9285.02
Avionics options		
GBAS	R&S®SMBVB-K111	1423.8020.02
ILS	R&S®SMBVB-K151	1423.8120.02
VOR	R&S®SMBVB-K152	1423.8137.02
DME	R&S®SMBVB-K153	1423.8143.02
Recommended extras		
19" rack adapter	R&S®ZZA-KNA33	1177.8090.00
USB serial adapter, for RS-232 remote control	R&S®TS-USB1	6124.2531.00
Documentation		
Documentation of calibration values	R&S®DCV-2	0240.2193.18
R&S®SMBV100B accredited calibration (ISO 17025, ISO 9000)	R&S®SMBVB-ACA	1423.8620.02

R&S®SMW200A

R&S®SMW-Bxxx = hardware option, R&S®SMW-Kxxx = software/key code option

Designation	Type	Order No.
Vector signal generator, including power cable and quick start guide	R&S®SMW200A	1412.0000.02
Minimum hardware configuration for GNSS		
Frequency option, RF path A, 100 kHz to 3 GHz	R&S®SMW-B1003	1428.4700.02
Signal routing and baseband main module, one I/Q path to RF	R&S®SMW-B13	1413.2807.02
Baseband generator with ARB (64 Msample) and real-time coder, 120 MHz RF bandwidth	R&S®SMW-B10	1413.1200.02
Recommended hardware configuration for multi-frequency GNSS		
Frequency option, RF path A, 100 kHz to 3 GHz	R&S®SMW-B1003	1428.4700.02
Signal routing and wideband baseband main module, two I/Q paths to RF	R&S®SMW-B13XT	1413.8005.02
Wideband baseband generator, with ARB (256 Msample), 500 MHz RF bandwidth	R&S®SMW-B9	1413.7350.02
Additional configuration option for GNSS		
Wideband baseband generator with ARB (256 Msample), 500 MHz RF bandwidth, high signal dynamics	R&S®SMW-B9(F)	1434.7808.02
Additional GNSS coder board	R&S®SMW-B15	1414.4710.02
Phase coherence	R&S®SMW-B90	1413.5841.02
Additive white Gaussian noise (AWGN)	R&S®SMW-K62	1413.3484.02
Multiple entities, for coexistence tests, only in combination with R&S®SMW-B10(F)	R&S®SMW-K76	1413.9624.02
Software options for GNSS		
GPS	R&S®SMW-K44	1413.3832.02
Modernized GPS	R&S®SMW-K98	1414.1533.02
Galileo	R&S®SMW-K66	1413.4380.02
GLONASS	R&S®SMW-K94	1414.1485.02
NavIC/IRNSS	R&S®SMW-K97	1414.6258.02
BeiDou	R&S®SMW-K107	1414.1585.02
Modernized GLONASS	R&S®SMW-K123	1413.3310.02
Modernized BeiDou	R&S®SMW-K132	1414.6606.02
SBAS/QZSS	R&S®SMW-K106	1414.2923.02
Real-world scenarios	R&S®SMW-K108	1414.2975.02
Real-time GNSS interfaces	R&S®SMW-K109	1414.3013.02
Virtual RTK reference station	R&S®SMW-K122	1414.6993.02
P(Y)/M/PRS noise	R&S®SMW-K128	1413.3361.02
MS GNSS Interference test	R&S®SMW-K129	1434.8410.02
Upgrade to dual-frequency GNSS	R&S®SMW-K134	1414.6770.02
Upgrade to triple-frequency GNSS	R&S®SMW-K135	1414.6793.02
Add 6 GNSS channels	R&S®SMW-K136	1414.6812.02
Add 12 GNSS channels	R&S®SMW-K137	1414.6835.02
Add 24 GNSS channels	R&S®SMW-K138	1414.6858.02
Add 48 GNSS channels	R&S®SMW-K139	1414.6935.02
GNSS waveforms, generated by R&S®WinIQSIM2		
GPS	R&S®SMW-K244	1413.4880.02
NavIC (IRNSS)	R&S®SMW-K297	1414.6287.02
Modernized GPS	R&S®SMW-K298	1414.3171.02
Galileo	R&S®SMW-K266	1413.7015.02
GLONASS	R&S®SMW-K294	1413.7067.02
BeiDou	R&S®SMW-K407	1413.7115.02
Modernized GLONASS	R&S®SMW-K423	1413.3410.02
Modernized BeiDou	R&S®SMW-K432	1414.6629.02
GNSS test automation		
ERA-GLONASS test suite	R&S®SMW-K360	1414.2800.02
eCall test suite	R&S®SMW-K361	1414.2846.02
GNSS test suite	R&S®SMW-K362	1414.6406.02
Car navigation test suite	R&S®SMW-K363	1434.8179.02
GBAS	R&S®SMW-K111	1414.3059.02

Recommended extras		
19" rack adapter	R&S®ZZA-KN4	1175.3033.00
Cable for connecting Rohde & Schwarz digital baseband interfaces	R&S®SMU-Z6	1415.0201.02
USB serial adapter, for RS-232 remote control	R&S®TS-USB1	6124.2531.00

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PD 3607.6896.22 | Version 16.00 | July 2024 (st)
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