MULTICHANNEL, MIMO, FADING AND RADAR ECHO GENERATION FOR THE R&S®SMW200A

Specifications

R&S®SMW200A Vector Signal Generator

Specifications
Version 03.00

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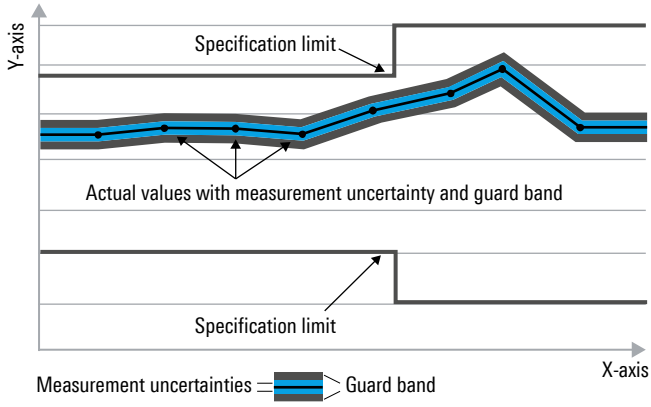
Definitions

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.

Multichannel, MIMO and fading

Fading simulator (R&S®SMW-B14 option)

The R&S®SMW-B14 option requires the standard baseband section, i.e. either R&S®SMW-B13 or R&S®SMW-B13T must be installed.

At least one R&S®SMW-B10 standard baseband generator must be installed.

All frequency and time settings are coupled to the internal reference frequency.

Number of installable R&S®SMW-B14 fading simulator modules		1, 2 or 4
Number of available fading channels (logical faders)	one R&S®SMW-B14 installed	1
	two or four R&S®SMW-B14 installed	2
	with R&S®SMW-K74 option, two R&S®SMW-B14 installed	up to 4 (see R&S®SMW-K74 specifications)
	with R&S®SMW-K74 option, four R&S®SMW-B14 installed	up to 16 (see R&S®SMW-K74 specifications)
	with R&S®SMW-K74 and R&S®SMW-K75 options, four R&S®SMW-B14 installed	up to 32 (see R&S®SMW-K75 specifications)
Number of fading paths (per logical fader)		20
	for 2x1x1 SISO (with 2 × R&S®SMW-B10 and 2 × or 4 × R&S®SMW-B14)	40
Bandwidth		up to 160 MHz
Start seed		0 to 9
Fading profiles		static path, pure Doppler, Rayleigh, Rice, constant phase, bell-shape TGn indoor, bell-shape TGn moving vehicle
Fading profile parameters		
Rayleigh	pseudo-noise interval	> 1 year
Constant phase	phase	0° to 360°
	phase resolution	0.1°
Pure Doppler	maximum resulting Doppler shift	frequency ratio · current Doppler frequency
	frequency ratio	–1 to +1
	resolution	0.01
Rician	combination of Rayleigh and pure Doppler	
	power ratio	–30 dB to +30 dB
Fading path loss	setting range	0 dB to 50 dB
	setting resolution	0.01 dB
	accuracy	< 0.01 dB
Fading path delay	The 20 fading paths are divided in four path groups. Each group consists of three fine delay and two standard delay paths. A basic delay can be set per path group and an additional delay per path. The total delay per path is the sum of the basic delay of the respective group and of the additional delay of the path.	
Basic delay per group		
Group 1	fixed value	0 s
Setting range for groups 2, 3, 4		0 s to 0.671 s
Setting resolution	scenarios with 1 to 8 fading channels	5 ns
	scenarios with 9 to 16 fading channels	10 ns
	scenarios with 17 to 32 fading channels	20 ns
Additional delay per path		
Setting range for path 1		0 µs to 40.9 µs
Setting range for paths 2, 3, 4, 5		0 µs to 20 µs
Fine delay path resolution	scenarios with 1 to 8 fading channels	2.5 ps
	scenarios with 9 to 16 fading channels	5 ps
	scenarios with 17 to 32 fading channels	10 ps
Standard delay path resolution	scenarios with 1 to 8 fading channels	5 ns
	scenarios with 9 to 16 fading channels	10 ns
	scenarios with 17 to 32 fading channels	20 ns
Speed range	at f = 1 GHz	0 km/h to 4320 km/h
	accuracy	< 0.1 %

Doppler frequency	setting range	0 Hz to 4000 Hz
	fading profile	
	SCM	0 Hz to 500 Hz
	bell-shape TGn indoor	0 Hz to 800 Hz
	bell-shape TGn moving vehicle	0 Hz to 97.56 Hz
	accuracy ($f_D \geq 0.05$ Hz)	< 0.1 %
Restart	standard	auto, baseband trigger
Synchronization	only with 2x1x1 system configuration	on/off
Total insertion loss	automatic or user-definable, with clipping indicator	–30 dB to 30 dB
Correlation	fading paths in signal path A pairwise with fading paths in signal path B	
	correlation coefficient	
	setting range	0 % to 100 %
	setting resolution	0.1 %
	correlation phase	
	setting range	0° to 360°
	setting resolution	0.05°
Lognormal	standard deviation	0 dB to 12 dB
	resolution	1 dB
	local constant	0 m to 200 m
	resolution	0.1 m
Predefined settings	standard	5G NR (TDL-A, TDL-B and TDL-C), LTE (CQI, EPA, EVA, ETU, MBFSN), GSM, CDMA2000, 1xEV-DO, IEEE 802.11n SISO, IEEE 802.11ac SISO, WiMAX ITU, NADC, PCN, TETRA, 3GPP models, HIPERLAN/2
	with R&S®SMW-K71 option	5G NR (HST, moving propagation), LTE (HST, moving propagation), 3GPP FDD WCDMA (HST, moving propagation, birth-death)
	with R&S®SMW-K72 option	WiMAX SUI, DAB, Watterson, IEEE 802.11p
	with R&S®SMW-K74 option	5G NR MIMO (TDL-A, TDL-B and TDL-C), LTE MIMO (EPA, EVA, ETU), IEEE 802.11n MIMO, IEEE 802.11ac MIMO, WiMAX MIMO
	with R&S®SMW-K74 and R&S®SMW-K71 options	LTE MIMO (HST)
	with R&S®SMW-K74 and R&S®SMW-K72 options	3GPP SCME channel models, LTE MIMO SCME channel models
	with R&S®SMW-K74 and R&S®SMW-K73 options	5G NR (CDL-A, CDL-B and CDL-C), 3GPP Geo SCME channel models, LTE MIMO Geo SCME channel models

Fading simulator on instruments with wideband baseband (R&S®SMW-B15 option)

The R&S®SMW-B15 option requires the wideband baseband section, i.e. R&S®SMW-B13XT (with DACW board revision 4.00 or higher) must be installed.

At least one R&S®SMW-B9 wideband baseband generator must be installed.

All frequency and time settings are coupled to the internal reference frequency.

Note: The following functions are not available when fading simulation is active: analog modulation, modulation sources for analog modulation, envelope tracking, AM/AM, AM/PM predistortion, Digital Doherty.

Number of installable R&S®SMW-B15 fading simulator modules	instrument equipped with one R&S®SMW-B9	1 or 2
	instrument equipped with two R&S®SMW-B9	2 or 4
Number of available fading channels (logical faders)	one R&S®SMW-B15 installed	1
	two or four R&S®SMW-B15 installed	2
	with R&S®SMW-K74 option, two R&S®SMW-B15 installed	up to 4 (see R&S®SMW-K74 specifications)
	with R&S®SMW-K74 option, four R&S®SMW-B15 installed	up to 16 (see R&S®SMW-K74 specifications)
	with R&S®SMW-K74 and R&S®SMW-K75 options, four R&S®SMW-B15 installed	up to 64 (see R&S®SMW-K75 specifications)
Number of fading paths (per logical fader)		20
Bandwidth		up to 200 MHz
	with R&S®SMW-K822	up to 400 MHz
	with R&S®SMW-K823	up to 800 MHz
Start seed		0 to 9
Fading profiles		static path, pure Doppler, Rayleigh, Rice, constant phase, bell-shape TGn indoor, bell-shape TGn moving vehicle
Fading profile parameter		
Rayleigh	pseudo-noise interval	> 1 year
Constant phase	phase	0° to 360°
	phase resolution	0.1°
Pure Doppler	maximum resulting Doppler shift	frequency ratio · current Doppler frequency
	frequency ratio	–1 to +1
	resolution	0.01
Rician	combination of Rayleigh and pure Doppler	
	power ratio	–30 dB to +30 dB
Fading path loss	setting range	0 dB to 50 dB
	setting resolution	0.01 dB
	accuracy	< 0.01 dB
Fading path delay	The 20 fading paths are divided in four path groups. Each group consists of three fine delay and two standard delay paths. A basic delay can be set per path group and an additional delay per path. The total delay per path is the sum of the basic delay of the respective group and the additional delay of the path.	
Basic delay per group		
Group 1	fixed value	0 s
Setting range for groups 2, 3, 4		0 s to 1.073 s
Setting resolution	scenarios with 1 to 8 fading channels	4 ns
Additional delay per path		
Setting range for path 1		0 µs to 32.72 µs
Setting range for paths 2, 3, 4, 5		0 µs to 16 µs
Fine delay path resolution (not available with R&S®SMW-K822 or R&S®SMW-K823)	scenarios with 1 to 8 fading channels	2 ps
	scenarios with 9 to 16 fading channels	4 ps
	scenarios with 17 to 32 fading channels	8 ps
Standard delay path resolution (up to 200 MHz baseband bandwidth)	scenarios with 1 to 8 fading channels	4 ns
	scenarios with 9 to 16 fading channels	8 ns
	scenarios with 17 to 32 fading channels	16 ns
Standard delay path resolution with R&S®SMW-K822	scenarios with 1 to 8 fading channels	2 ns
Standard delay path resolution with R&S®SMW-K823	scenarios with 1 to 4 fading channels	1 ns

Speed range	at f = 1 GHz	0 km/h to 4320 km/h
	accuracy	< 0.1 %
Doppler frequency	setting range	0 Hz to 4000 Hz
	fading profile	
	SCM	0 Hz to 500 Hz
	bell-shape TGn indoor, bell-shape TGn moving vehicle	0 Hz to 50 Hz
	MIMO system	
	3x2x2, 4x2x2	0 Hz to 3500 Hz
	2x8, 8x2, 4x4, 4x2, 2x4	0 Hz to 1500 Hz
	8x4, 4x8, 2x4x4	0 Hz to 400 Hz
	8x8, subset = 1 or 2	0 Hz to 200 Hz
	8x8, subset = ALL	0 Hz to 300 Hz
	accuracy ($f_D \geq 0.05$ Hz)	< 0.1 %
Restart	standard	auto, baseband trigger
Synchronization	only with 2x1x1 system configuration	on/off
Total insertion loss	automatic or user-definable, with clipping indicator	–30 dB to +30 dB
Correlation	fading paths in signal path A pairwise with fading paths in signal path B	
	correlation coefficient	
	setting range	0 % to 100 %
	setting resolution	0.1 %
	correlation phase	
	setting range	0° to 360°
	setting resolution	0.05°
Lognormal	standard deviation	0 dB to 12 dB
	resolution	1 dB
	local constant	20 m to 200 m
	resolution	0.1 m
Predefined settings	standard	5G NR (TDL-A, TDL-B and TDL-C), LTE (CQI, EPA, EVA, ETU, MBFSN), GSM, CDMA2000, 1xEV-DO, IEEE 802.11n SISO, IEEE 802.11ac SISO, WiMAX ITU, NADC, PCN, TETRA, 3GPP models, HIPERLAN/2
	with R&S®SMW-K71 option	5G NR (HST, moving propagation), LTE (HST, moving propagation), 3GPP FDD WCDMA (HST, moving propagation, birth-death)
	with R&S®SMW-K72 option	WiMAX SUI, DAB, Watterson, IEEE 802.11p
	with R&S®SMW-K74 option	5G NR MIMO (TDL-A, TDL-B and TDL-C), LTE MIMO (EPA, EVA, ETU), IEEE 802.11n MIMO, IEEE 802.11ac MIMO, WiMAX MIMO
	with R&S®SMW-K74 and R&S®SMW-K71 options	LTE MIMO (HST)
	with R&S®SMW-K74 and R&S®SMW-K72 options	3GPP SCME channel models, LTE MIMO SCME channel models
	with R&S®SMW-K74 and R&S®SMW-K73 options	5G NR (CDL-A, CDL-B and CDL-C), 3GPP Geo SCME channel models, LTE MIMO Geo SCME channel models

Dynamic fading (R&S®SMW-K71 option)

R&S®SMW-K71 on instruments with wideband baseband (R&S®SMW-B13XT)

At least one R&S®SMW-B15 fading simulator must be installed. If two or more R&S®SMW-B15 are installed, dynamic fading functions can be used on one signal path with one R&S®SMW-K71 option. For dynamic fading functions to be used on multiple signal paths simultaneously or in MIMO system configurations, two R&S®SMW-K71 must be installed.

Moving delay mode, moving channels = one		
Number of fading paths		2 per signal path
Fading profiles		none
Delay		0.15 µs to 31.85 µs
Delay variation	peak-to-peak	0.3 µs to 32 µs
	variation period	10 s to 500 s
	variation speed	0 µs/s to 3.2 µs/s
Delay step size		4 ps
Moving delay mode, moving channels = all		
Number of fading paths	four groups with three fading paths each	12 per signal path
Fading profiles		static path, pure Doppler, Rayleigh, constant phase
Additional delay per path		
Setting range for path 1		0 µs to 32.42 µs
Setting range for paths 2, 3		0 µs to 15.7 µs
Delay variation	peak-to-peak	0.3 µs to 10 µs
	variation period	5 s to 200 s
	variation speed	0 µs/s to 2 µs/s
Delay step size		4 ps
Birth-death mode		
System bandwidth		200 MHz
Number of fading paths		2 per signal path
Fading profiles		pure Doppler
Delay range		0 µs to 31.998 µs
Delay grid		1 ns to 16 µs
Positions		3 to 50 [1]
Hopping dwell		1 ms to 5 s
Start offset	separately settable for each signal path	0 ms to 200 ms
Delay resolution		1 ns
High-speed train		
Fading profiles		static path, pure Doppler, Rayleigh, Rice
Speed	at f = 1 GHz	
	static path, Rayleigh, Rice	0 km/h to 4317 km/h
	pure Doppler	0 km/h to 205058 km/h
D (min)		1 m to 150 m
D (s)		20 m to 2000 m
Start offset		0 s to (2 · D (s) / speed)

R&S®SMW-K71 on instruments with standard baseband (R&S®SMW-B13/-B13T)

At least one R&S®SMW-B14 fading simulator must be installed. If two or more R&S®SMW-B14 are installed, dynamic fading functions can be used on one signal path with one R&S®SMW-K71 option. For dynamic fading functions to be used on multiple signal paths simultaneously or in MIMO system configurations, two R&S®SMW-K71 must be installed.

Moving delay mode, moving channels = one		
Number of fading paths		2 per signal path
Fading profiles		none
Delay		0.15 µs to 39.85 µs
Delay variation	peak-to-peak	0.3 µs to 40 µs
	variation period	10 s to 500 s
	variation speed	0 µs/s to 4 µs/s
Delay step size		5 ps
Moving delay mode, moving channels = all		
Number of fading paths		12 per signal path
Fading profiles		static path, pure Doppler, Rayleigh, constant phase

[1] The maximum delay range of 32 µs cannot be exceeded.

Additional delay	path 1	0 µs to 40.6 µs
	paths 2, 3	0 µs to 19.7 µs
Delay variation	peak-to-peak	0.3 µs to 10 µs
	variation period	5 s to 200 s
	variation speed	0 µs/s to 2 µs/s
Delay step size		5 ps
Birth-death mode		
System bandwidth		160 MHz
Number of fading paths		2 per signal path
Fading profiles		pure Doppler
Delay range		0 µs to 39.998 µs
Delay grid		1 ns to 20 µs
Positions		3 to 50
Hopping dwell		1 ms to 5 s
Start offset	separately settable for each signal path	0 ms to 200 ms
Delay resolution		1 ns
High-speed train		
Fading profiles		static path, pure Doppler, Rayleigh, Rice
Speed	at f = 1 GHz	
	static path, Rayleigh, Rice	0 km/h to 4317 km/h
	pure Doppler	0 km/h to 205058 km/h
D (min)		1 m to 150 m
D (s)		20 m to 2000 m
Start offset		0 s to (2 · D (s) / speed)
Two-channel interferer		
Number of fading paths		2 per signal path
Fading profiles		static path, pure Doppler, Rayleigh
Fading profile parameter		
Rayleigh	pseudo-noise interval	> 1 year
	phase resolution	1°
Pure Doppler	maximum resulting Doppler shift	frequency ratio · current Doppler frequency
	frequency ratio	–1 to +1
	resolution	0.01
Fading path loss	setting range	0 dB to 50 dB
	setting resolution	0.01 dB
	accuracy	< 0.01 dB
Speed range	at f = 1 GHz	0 km/h to 4320 km/h
	accuracy	< 0.1 %
Minimum delay	path 1	0 µs to 1638 µs
	path 2	0 µs to 999.9 µs
Maximum delay	path 1	n.a.
	path 2	0.1 µs to 1000 µs
Moving mode	path 1	n.a.
	path 2	sliding, hopping
Dwell (hopping)		0.1 s to 10 s
Period (sliding)		50 s to 1000 s

Enhanced fading models (R&S®SMW-K72 option)

Instruments with wideband baseband (R&S®SMW-B13XT):
At least one R&S®SMW-B15 fading simulator must be installed. If two or more R&S®SMW-B15 are installed, extended statistic functions can be used on one signal path with one R&S®SMW-K72 option. For extended statistic functions to be used on multiple signal paths simultaneously or in MIMO system configurations, two R&S®SMW-K72 must be installed.

Instruments with standard baseband (R&S®SMW-B13/-B13T):
At least one R&S®SMW-B14 fading simulator must be installed. If two or more R&S®SMW-B14 are installed, extended statistic functions can be used on one signal path with one R&S®SMW-K72 option. For extended statistic functions to be used on multiple signal paths simultaneously or in MIMO system configurations, two R&S®SMW-K72 must be installed.

Fading profiles		
Gauss I, Gauss II	in line with DAB standard	sum of two Gaussian distributions
Gauss DAB 1	in line with DAB standard	Gaussian distribution, shifted in frequency
Gauss Doppler		sum of Gaussian distribution and pure Doppler
Gauss ($0.08 \cdot f_D$)		Gaussian distribution, standard deviation: $0.08 \cdot f_D$

Gauss ($0.1 \cdot f_D$)		Gaussian distribution, standard deviation: $0.1 \cdot f_D$
Gauss Watterson	in line with Watterson channel model	sum of two Gaussian distributions
WiMAX Doppler	in line with IEEE 802.16a-03-01	rounded Doppler PSD model
WiMAX Rice	in line with IEEE 802.16a-03-01	same as WiMAX Doppler plus pure Doppler
Customized fading profiles		
Modified Rayleigh	spectrum shape can be modified within the maximum Doppler frequency range	customizable bandwidth, frequency offset, lower cutoff frequency, upper cutoff frequency
Modified flat	spectrum shape can be modified within the maximum Doppler frequency range	customizable bandwidth, frequency offset, lower cutoff frequency, upper cutoff frequency
Predefined settings	in line with IEEE 802.16a-03-01	SUI1 to SUI6
	in line with 3GPP TS 34.121-1, annex D.2.2, table D.2.2.1A	ITU OIP-A, ITU OIP-B, ITU V-A
	in line with EN 50248-2001	DAB-RA, DAB-TU, DAB-SFN
	in line with “Experimental Confirmation of an HF Channel Model”, Watterson, et al., IEEE transactions on communication technology, vol. com-18, no. 6, Dec. 1970”	Watterson I1, Watterson I2, Watterson I3
	in line with C2C-CC channel models for IEEE 802.11p	rural LOS, urban approaching LOS, urban crossing LOS, highway LOS, highway NLOS
	with R&S®SMW-K74 option	
	in line with 3GPP TR 37.977	SCME Uma3, SCME Uma30, SCME Umi3, SCME Umi30
	with R&S®SMW-K74 and R&S®SMW-K73 option	
	in line with 3GPP TR 38.827	5G NR CDL-A (Uma, Umi, InO), 5G NR CDL B (Uma, Umi), 5G NR CDL-C (Uma, Umi)

OTA-MIMO fading enhancements (R&S®SMW-K73 option)

Instruments with wideband baseband (R&S®SMW-B13XT):
Two or four R&S®SMW-B15 must be installed (signal paths A and B); one R&S®SMW-K74 option and two R&S®SMW-K72 options are additionally required.

Instruments with standard baseband (R&S®SMW-B13/-B13T):
Two or four R&S®SMW-B14 must be installed (signal paths A and B); one R&S®SMW-K74 option and two R&S®SMW-K72 options are additionally required.

OTA-MIMO settings		
SCM fading profile		geometry based SCM fading profile and SCME user presets
Antenna polarization mode		single antenna pattern with slant angle; separate antenna patterns for each polarization component
Calculation mode		considering antenna spacing or antenna relative phase
Inverse channel matrix	only for 2x2 MIMO with R&S®SMW-B14	for radiated tests to counteract the channel matrix of the anechoic chamber

Customized dynamic fading (R&S®SMW-K820 option)

The R&S®SMW-K820 option allows the fading parameters of path loss, Doppler shift and delay over time to be varied. These descriptions are loaded into the R&S®SMW200A via user specific files.

At least one R&S®SMW-B15 or one R&S®SMW-B14 fading simulator and one R&S®SMW-K71 option must be installed. If two or more R&S®SMW-B15 or R&S®SMW-B14 are installed, customized dynamic fading functions can be used on one signal path with one R&S®SMW-K820 option. For dynamic fading functions to be used on multiple signal paths simultaneously or in MIMO system configurations, two R&S®SMW-K820 and two R&S®SMW-K71 options must be installed. (For each R&S®SMW-K820, an R&S®SMW-K71 must also be installed on the instrument.)

The customized dynamic fading configuration is available for all SISO and MIMO systems with 160 MHz/200 MHz bandwidth for standard/wideband baseband respectively (see supported scenarios under R&S®SMW-K74 and R&S®SMW-76 options).

Table preset	user	displays all 12 paths with full setting ranges
	LOS	displays only path 2 with pure Doppler profile and basic delay
	LOS and NLOS	displays only path 2 with pure Doppler profile and basic delay and path 7 and 8 with Rayleigh profile and additional delay
Number of fading paths		12
Profiles	paths 1 to 4	pure Doppler, Rayleigh, static path
	paths 5 to 12	Rayleigh, static path
Fading path delay	The 12 fading paths are divided in four path groups. Group 1 consists of three additional delay paths. Groups 2, 3 and 4 consist of one path which can be an additional or basic delay path and two additional delay paths. The total delay per path is the sum of the basic delay of the respective group and the additional delay of the path.	
Path groups	group 1	paths 1, 5, 6
	group 2	paths 2, 7, 8
	group 3	paths 3, 9, 10
	group 4	paths 4, 11, 12
Basic delay	paths 2, 3, 4	
	with R&S®SMW-B14	0 s to 671 ms
	with R&S®SMW-B15	0 s to 1073 ms
	paths 1, 5 to 12	0 s
	basic delay resolution	
	with R&S®SMW-B14	5 ns
	with R&S®SMW-B15	4 ns
Additional delay	path 1	
	with R&S®SMW-B14	0 µs to 40.9 µs
	with R&S®SMW-B15	0 µs to 32.72 µs
	paths 5 to 12	
	with R&S®SMW-B14	0 µs to 20 µs
	with R&S®SMW-B15	0 µs to 16 µs
	additional delay resolution	
	with R&S®SMW-B14	50 ps
	with R&S®SMW-B15	40 ps
Doppler frequency	Rayleigh	0.1 kHz to 4 kHz
	pure Doppler	
	with R&S®SMW-B14	0 kHz to 195 kHz
	with R&S®SMW-B15	0 kHz to 244 kHz
Additional Doppler shift	with R&S®SMW-B15	0 Hz to 1953 kHz
Pathloss	pure Doppler, static path	0 dB to 50 dB
	Rayleigh	10 dB to 50 dB
File format		Rohde & Schwarz proprietary file format: *.fad_udyn
Correlation	MIMO only	see section MIMO fading/routing (R&S®SMW-K74 option)

The R&S®SMW-K820 allows to load a file created by the user to one path, with the following file formats:

```
Interval[us] Delay[ms] Fd[kHz] Pathloss[dB]
100 10 0.1 1
100 20 0.2 2
100 30 0.3 3
...
```

Doppler shift only via Doppler frequency (column: Fd) per path

```
Interval[us] Delay[ms] Fd[kHz] Pathloss[dB] Fd_channel[kHz]
100 10 0.1 1 1000
100 20 0.2 2 1100
100 30 0.3 3 1200
...
```

Doppler shift via Doppler frequency (column: Fd) per path and additional Doppler shift per channel (column: Fd_channel), (only available with R&S®SMW-B15)

Number of fading paths		1
File name		rename the user file “*.txt” to “*.fad_udyn” before loading the file
File content		
Number of intervals		1 million to 12 million
Interval		100 µs to 440 s
	units	µs, ms, s
Delay	units	ns, µs, ms
Fd	units	Hz, kHz
Pathloss	units	dB
Fd_channel	units	Hz, kHz

MIMO fading/routing (R&S®SMW-K74 option)

R&S®SMW-K74 on instruments with wideband baseband (R&S®SMW-B9, R&S®SMW-B13XT)

The R&S®SMW-K74 option allows up to 16 fading channels to be simulated as is required for 4x4 MIMO receiver tests. At least two R&S®SMW-B15 options must be installed (signal paths A and B), and two baseband sources (R&S®SMW-B9) and the R&S®SMW-B13XT (with DACW board revision 4.00 or higher) option must be present.

Supported scenarios with two R&S®SMW-B15 options

Cells with gray background: up to 200 MHz bandwidth supported for this scenario
Cells with white background: up to 100 MHz bandwidth supported for this scenario

Entities (users, cells, carriers)	TX antennas	RX antennas	1	2
1	1		●	●
	2		●	●
2	1		●	●
	2		–	–

Supported scenarios with four R&S®SMW-B15 options

Cells with gray background: up to 200 MHz bandwidth supported for this scenario
Cells with white background: up to 100 MHz bandwidth supported for this scenario

Entities (users, cells, carriers)	TX antennas	RX antennas	1	2	3	4	8
1	1		●	●	●	●	●
	2		●	●	●	●	●
	3		●	●	●	●	–
	4		●	●	●	●	–
	8		●	●	–	–	–
2	1		●	●	●	●	–
	2		●	●	●	●	–
	3		●	●	–	–	–
	4		●	●	–	–	–
	8		–	–	–	–	–

Note: The following functions are not available: analog modulation, modulation sources for analog modulation, envelope tracking, AM/AM, AM/PM predistortion, Digital Doherty.

Parameters common to all scenarios		
Number of fading paths per fading channel		20 paths, see R&S®SMW-B15
Steering matrix	can be set by setting the diagonal elements of the correlation matrix	
Correlation	Correlation between corresponding fading paths of all TX/RX signal paths can be set in a correlation matrix. For each fading path index, an individual matrix can be set.	
	correlation coefficient	
	setting range	0 to 1
	setting resolution	0.0001
	correlation phase	
	setting range	0° to 360°
	setting resolution	0.02°
Correlation matrix setting		individually or with Kronecker assumption (RX and TX antenna correlation with automatic calculation of matrix) or by AoA/AoD parameterization
	with R&S®SMW-K72 option	SCME/WINNER
Matrix representation		(real, imaginary) or (magnitude, phase)
Additional SCME/WINNER parameters		
Number of clusters		up to 20
Number of subclusters		up to 3 per cluster

R&S®SMW-K74 on instruments with standard baseband (R&S®SMW-B10, R&S®SMW-B13T)

The R&S®SMW-K74 option allows up to 16 fading channels to be simulated as is required for 4x4 MIMO receiver tests. At least two R&S®SMW-B14 options must be installed (signal paths A and B), and two baseband sources (R&S®SMW-B10) and the R&S®SMW-B13T option must be present.

Supported scenarios with two R&S®SMW-B14 options

Cells with gray background: up to 160 MHz bandwidth supported for this scenario
Cells with white background: up to 80 MHz bandwidth supported for this scenario

Entities (users, cells, carriers)	TX antennas	RX antennas	1	2
1	1		●	●
	2		●	●
2	1		●	●
	2		–	–

Supported scenarios with four R&S®SMW-B14 options

Cells with gray background: up to 160 MHz bandwidth supported for this scenario
Cells with white background: up to 80 MHz bandwidth supported for this scenario

Entities (users, cells, carriers)	TX antennas	RX antennas	1	2	3	4	8
1	1		●	●	●	●	●
	2		●	●	●	●	●
	3		●	●	●	●	–
	4		●	●	●	●	–
	8		●	●	–	–	–
2	1		●	●	●	●	–
	2		●	●	●	●	–
	3		●	●	–	–	–
	4		●	●	–	–	–
	8		–	–	–	–	–

Note: For scenarios with more than two output signals (number of entities · number of RX antennas > 2), the following functions are not available: analog modulation, modulation sources for analog modulation, envelope tracking, AM/AM, AM/PM predistortion, Digital Doherty.

Parameters common to all scenarios		
Number of fading paths per fading channel		20 paths, see R&S®SMW-B14
Steering matrix	can be set by setting the diagonal elements of the correlation matrix	
Correlation	Correlation between corresponding fading paths of all TX/RX signal paths can be set in a correlation matrix. For each fading path index, an individual matrix can be set.	
	correlation coefficient	
	setting range	0 to 1
	setting resolution	0.0001
	correlation phase	
	setting range	0° to 360°
	setting resolution	0.02°
Correlation matrix setting		individually or with Kronecker assumption (RX and TX antenna correlation with automatic calculation of matrix) or by AoA/AoD parameterization
	with R&S®SMW-K72 option	SCME/WINNER
Matrix representation		(real, imaginary) or (magnitude, phase)
Additional SCME/WINNER parameters		
Number of clusters		up to 20
Number of subclusters		up to 3 per cluster

Higher-order MIMO (R&S®SMW-K75 option)

R&S®SMW-K75 on instruments with wideband baseband (R&S®SMW-B9, R&S®SMW-B13XT)

Four R&S®SMW-B15 options and the R&S®SMW-K74 option must be installed.

The R&S®SMW-K75 option enhances the R&S®SMW-K74 option to support higher-order MIMO modes. A common application is LTE carrier aggregation with each carrier using a 4x4 MIMO system (2x4x4) within one box.

For scenarios with more than four baseband signals, only the "coupled sources" baseband configuration is available, i.e. all generated baseband signals belong to the same digital standard. "Coupled sources" is supported by the LTE (R&S®SMW-K55 option and enhancement options) and WLAN (R&S®SMW-K54/-K86 options) digital standards and by the arbitrary waveform mode of the standard baseband generator (R&S®SMW-B9 option). Note that not all scenarios are supported by all digital standards.

Supported scenarios with R&S®SMW-K75 and wideband baseband (R&S®SMW-B9, R&S®SMW-B13XT)

Cells with gray background: up to 100 MHz bandwidth supported for this scenario
Cells with white background: up to 50 MHz bandwidth supported for this scenario

Entities (users, cells, carriers)	TX antennas	RX antennas	1	2	3	4	8
1	4						●
	8					●	●
2	1		–	–	–	–	
	2		–	–	–	–	
	3		–	–	●	●	
	4		–	–	●	●	

Note: For R&S®SMW-K75 scenarios, the following functions are not available: analog modulation, modulation sources for analog modulation, envelope tracking, AM/AM, AM/PM predistortion, Digital Doherty.

R&S®SMW-K75 on instruments with standard baseband (R&S®SMW-B10, R&S®SMW-B13T)

Four R&S®SMW-B14 options and the R&S®SMW-K74 option must be installed.

The R&S®SMW-K75 option enhances the R&S®SMW-K74 option to support higher-order MIMO modes. A common application is LTE carrier aggregation with each carrier using a 4x4 MIMO system (2x4x4) within one box.

For scenarios with more than four baseband signals, only the "coupled sources" baseband configuration is available, i.e. all generated baseband signals belong to the same digital standard. "Coupled sources" is supported by the LTE (R&S®SMW-K55 option and enhancement options) and WLAN (R&S®SMW-K54/-K86 options) digital standards and by the arbitrary waveform mode of the standard baseband generator (R&S®SMW-B10 option). Note that not all scenarios are supported by all digital standards.

Supported scenarios with R&S®SMW-K75 and standard baseband (R&S®SMW-B10, R&S®SMW-B13T)

Cells with white background: up to 40 MHz bandwidth supported for this scenario

Entities (users, cells, carriers)	TX antennas	RX antennas	1	2	3	4	8
1	4						●
	8					●	
2	1		–	–	–	–	
	2		–	–	–	–	
	3		–	–	●	●	
	4		–	–	●	●	

Note: For R&S®SMW-K75 scenarios, the following functions are not available: analog modulation, modulation sources for analog modulation, envelope tracking, AM/AM, AM/PM predistortion, Digital Doherty.

MIMO subsets for higher-order MIMO (R&S®SMW-K821 option)

R&S®SMW-K821 on instruments with wideband baseband (R&S®SMW-B9, R&S®SMW-B13XT)

Four R&S®SMW-B15 and the R&S®SMW-K74 option must be installed.

The R&S®SMW-K821 option enhances the R&S®SMW-K74 option to support higher-order MIMO modes with multiple boxes. The application of an 8x8 MIMO or 4x4 system within two boxes is supported with this option.

For 8x8 MIMO: Only the "coupled sources" baseband configuration is available, i.e. all generated baseband signals belong to the same digital standard. "Coupled sources" is supported by the LTE (R&S®SMW-K55 option and enhancement options) and WLAN (R&S®SMW-K54/-K86 options) digital standards and by the arbitrary waveform mode of the standard baseband generator (R&S®SMW-B9 option).
Note that not all scenarios are supported by all digital standards.

Supported scenarios with R&S®SMW-K821, R&S®SMW-K822 and wideband baseband (R&S®SMW-B9, R&S®SMW-B13XT)

Cells with gray background: up to 400 MHz bandwidth supported for this scenario

Entities (users, cells, carriers)	TX antennas	RX antennas	1	2	3	4	8
1	4					●	

Supported scenarios with R&S®SMW-K821 and wideband baseband (R&S®SMW-B9, R&S®SMW-B13XT)

Cells with gray background: up to 100 MHz bandwidth supported for this scenario

Entities (users, cells, carriers)	TX antennas	RX antennas	1	2	3	4	8
1	8						●

Note: For R&S®SMW-K821 scenarios, the following functions are not available: analog modulation, modulation sources for analog modulation, envelope tracking, AM/AM, AM/PM predistortion, Digital Doherty.

R&S®SMW-K821 on instruments with standard baseband (R&S®SMW-B10, R&S®SMW-B13T)

Four R&S®SMW-B14 options, the R&S®SMW-K74 option and the R&S®SMW-K75 option must be installed.

The R&S®SMW-K821 option enhances the R&S®SMW-K75 option to support higher-order MIMO modes with multiple boxes. The application of an 8x8 MIMO system within two boxes is supported with this option.

Only the "coupled sources" baseband configuration is available, i.e. all generated baseband signals belong to the same digital standard. "Coupled sources" is supported by the LTE (R&S®SMW-K55 option and enhancement options) and WLAN (R&S®SMW-K54/-K86 options) digital standards and by the arbitrary waveform mode of the standard baseband generator (R&S®SMW-B10 option).
Note that not all scenarios are supported by all digital standards.

Supported scenarios with R&S®SMW-K821 and standard baseband (R&S®SMW-B10, R&S®SMW-B13T)

Cells with white background: up to 40 MHz bandwidth supported for this scenario

Entities (users, cells, carriers)	TX antennas	RX antennas	1	2	3	4	8
1	8						●

Note: For R&S®SMW-K821 scenarios, the following functions are not available: analog modulation, modulation sources for analog modulation, envelope tracking, AM/AM, AM/PM predistortion, Digital Doherty.

Fading bandwidth extension to 400 MHz (R&S®SMW-K822 option)

At least one R&S®SMW-B15 option must be installed.

The R&S®SMW-K822 option enhances instruments equipped with one or more R&S®SMW-B15 options to support fading bandwidth up to 400 MHz. For fading bandwidth extension to be used on signal paths A and B simultaneously or in MIMO system configurations, two R&S®SMW-K822 and R&S®SMW-K74 (for MIMO) options must be installed.

Supported scenarios with one R&S®SMW-K822 and one R&S®SMW-B15 option

Cells with gray background: up to 400 MHz bandwidth supported for this scenario

Entities (users, cells, carriers)	TX antennas	RX antennas	1
1	1		●

Supported scenarios with two R&S®SMW-K822 and two R&S®SMW-B15 options

Cells with gray background: up to 400 MHz bandwidth supported for this scenario

Entities (users, cells, carriers)	TX antennas	RX antennas	1	2
1	1		●	●
	2		●	●
2	1		●	●
	2		●	–

Supported scenarios with two R&S®SMW-K822 and four R&S®SMW-B15 options

Cells with gray background: up to 400 MHz bandwidth supported for this scenario

Entities (users, cells, carriers)	TX antennas	RX antennas	1	2	3	4	8
1	1		●	●	●	●	–
	2		●	●	●	●	–
	3		●	●	–	–	–
	4		●	●	–	–	–
2	1		●	●	–	–	–
	2		●	●	–	–	–

Notes: The following functions are not available: analog modulation, modulation sources for analog modulation, envelope tracking, AM/AM, AM/PM predistortion, Digital Doherty.

Dynamic fading (R&S®SMW-K71 and R&S®SMW-K820) is not supported when 400 MHz fading bandwidth is used.

Fading bandwidth extension to 800 MHz (R&S®SMW-K823 option)

At least one R&S®SMW-B15 option and one R&S®SMW-K822 option must be installed.

The R&S®SMW-K823 option enhances instruments equipped with one or more R&S®SMW-B15 options to support fading bandwidth up to 800 MHz. For fading bandwidth extension to be used on signal paths A and B simultaneously or in MIMO system configurations, two R&S®SMW-K823, two R&S®SMW-K822 and R&S®SMW-K74 (for MIMO) options must be installed.

Supported scenarios with one R&S®SMW-K823 and one R&S®SMW-B15 option

Cells with gray background: up to 500 MHz bandwidth supported for this scenario

Entities (users, cells, carriers)	TX antennas	RX antennas	1
1	1		●

Supported scenarios with one R&S®SMW-K823, one R&S®SMW-K525 and one R&S®SMW-B15 option

Cells with gray background: up to 800 MHz bandwidth supported for this scenario

Entities (users, cells, carriers)	TX antennas	RX antennas	1
1	1		●

Supported scenarios with two R&S®SMW-K823 and two R&S®SMW-B15 options

Cells with gray background: up to 500 MHz bandwidth supported for this scenario

Entities (users, cells, carriers)	TX antennas	RX antennas	1	2
1	1		●	●
	2		●	–
	1		●	–

Supported scenarios with two R&S®SMW-K823, two R&S®SMW-K525 and two R&S®SMW-B15 options

Cells with gray background: up to 800 MHz bandwidth supported for this scenario

Entities (users, cells, carriers)	TX antennas	RX antennas	1	2
1	1		●	●
	2		●	–
	1		●	–

Supported scenarios with two R&S®SMW-K823 and four R&S®SMW-B15 options

Cells with gray background: up to 500 MHz bandwidth supported for this scenario

Entities (users, cells, carriers)	TX antennas	RX antennas	1	2
1	1		●	●
	2		●	●
2	1		●	–
	2		–	–

Supported scenarios with two R&S®SMW-K823, two R&S®SMW-K525 and four R&S®SMW-B15 options

Cells with gray background: up to 800 MHz bandwidth supported for this scenario

Entities (users, cells, carriers)	TX antennas	RX antennas	1	2
1	1		●	●
	2		●	●
2	1		●	–
	2		–	–

Notes: The following functions are not available: analog modulation, modulation sources for analog modulation, envelope tracking, AM/AM, AM/PM predistortion, Digital Doherty.

Dynamic fading (R&S®SMW-K71 and R&S®SMW-K820) is not supported when 400 MHz or 800 MHz fading bandwidth is used.

Multiple entities (R&S®SMW-K76 option)

R&S®SMW-K76 on instruments with wideband baseband (R&S®SMW-B9, R&S®SMW-B13XT)

Two R&S®SMW-B9 options and the R&S®SMW-B13XT option (with DACW board revision 4.00 or higher) must be installed.

The R&S®SMW-K76 option allows the generation of scenarios with up to eight baseband signals. Common applications are multistandard radio with eight SISO systems (8x1x1) within one box.

For scenarios with more than four baseband signals, only the "coupled sources" baseband configuration is available, i.e. all generated baseband signals belong to the same digital standard. "Coupled sources" is supported by the LTE (R&S®SMW-K55 option and enhancement options) and WLAN (R&S®SMW-K54/-K86 options) digital standards and by the arbitrary waveform mode of the wideband baseband generator (R&S®SMW-B9 option). Note that not all scenarios are supported by all digital standards.

Supported scenarios with R&S®SMW-K76 and wideband baseband (R&S®SMW-B9, R&S®SMW-B13XT)

Cells with gray background: up to 500 MHz bandwidth supported for this scenario
Cells with white background: up to 400 MHz bandwidth supported for this scenario

Entities (users, cells, carriers)	TX antennas	RX antennas	1
3	1		●
4	1		●
5	1		●
6	1		●
7	1		●
8	1		●

Supported scenarios with R&S®SMW-K76, two R&S®SMW-K525 and wideband baseband (R&S®SMW-B9, R&S®SMW-B13XT)

Cells with gray background: up to 800 MHz bandwidth supported for this scenario
Cells with white background: up to 400 MHz bandwidth supported for this scenario

Entities (users, cells, carriers)	TX antennas	RX antennas	1
3	1		●
4	1		●
5	1		●
6	1		●
7	1		●
8	1		●

Additional supported scenarios with R&S®SMW-K76 in combination with two R&S®SMW-K822 options, with fading active

Cells with gray background: up to 400 MHz bandwidth supported for this scenario.

Entities (users, cells, carriers)	TX antennas	RX antennas	1
3	1		●
4	1		●
5	1		●
6	1		●
7	1		●
8	1		●

Additional supported scenarios with R&S®SMW-K76 in combination with two R&S®SMW-K823 options, with fading active

Cells with gray background: up to 500 MHz bandwidth supported for this scenario.

Entities (users, cells, carriers)	TX antennas	RX antennas	1
3	1		●
4	1		●

Additional supported scenarios with R&S®SMW-K76 and two R&S®SMW-K525 in combination with two R&S®SMW-K823 options, with fading active

Cells with gray background: up to 800 MHz bandwidth supported for this scenario

Entities (users, cells, carriers)	TX antennas	RX antennas	1
3	1		●
4	1		●

Additional supported scenarios with R&S®SMW-K76 in combination with an R&S®SMW-K74 option and four R&S®SMW-B15 options

Note: The scenarios described here require the wideband baseband section, i.e. R&S®SMW-B13XT must be installed.
Cells with gray background: up to 200 MHz bandwidth supported for this scenario
Cells with white background: up to 100 MHz bandwidth supported for this scenario

Entities (users, cells, carriers)	TX antennas	RX antennas	1	2
3	1		●	●
	2		●	●
4	1		●	●
	2		●	●

Note: The following functions are not available: analog modulation, modulation sources for analog modulation, envelope tracking, AM/AM, AM/PM predistortion.

Fading capabilities in R&S®SMW-K76 scenarios

Note: The scenarios described here require the wideband baseband section, i.e. R&S®SMW-B13XT must be installed.
Individual fading can be applied to each entity based on the available fading options:

4 × R&S®SMW-B15 (and R&S®SMW-K822 or R&S®SMW-K823)	individual fading can be applied to all entities for system configurations 2x1x1 to 8x1x1 (SISO only)
4 × R&S®SMW-B15 and R&S®SMW-K74	individual fading can be applied to all entities for system configurations SISO and MIMO
2 × R&S®SMW-B15 (and R&S®SMW-K822 or R&S®SMW-K823)	individual fading can be applied to all entities for system configuration 2x1x1

R&S®SMW-K76 on instruments with standard baseband (R&S®SMW-B10, R&S®SMW-B13T)

Two R&S®SMW-B10 options and the R&S®SMW-B13T option must be installed.

The R&S®SMW-K76 option allows the generation of scenarios with up to 8 baseband signals. Common applications are multistandard radio with 8 SISO systems (8x1x1) or LTE carrier aggregation with each carrier using a 2x2 MIMO system (4x2x2) within one box.

For scenarios with more than 4 baseband signals, only the "coupled sources" baseband configuration is available, i.e. all generated baseband signals belong to the same digital standard. "Coupled sources" is supported by the LTE (R&S®SMW-K55 option and enhancement options) and WLAN (R&S®SMW-K54/-K86 options) digital standards and by the arbitrary waveform mode of the standard baseband generator (R&S®SMW-B10 option). Note that not all scenarios are supported by all digital standards.

Note: If the R&S®SMW200A is equipped with one fading simulator module (R&S®SMW-B14 option), the functionality of the R&S®SMW-K76 is limited to the generation of 2 baseband signals only. Therefore, we strongly recommend that you install the R&S®SMW-K76 option only on instruments with either 0 or 2 or 4 R&S®SMW-B14 options.

Supported scenarios with R&S®SMW-K76 and standard baseband (R&S®SMW-B10, R&S®SMW-B13T)
Cells with gray background: up to 160 MHz bandwidth supported for this scenario (depends on installed R&S®SMW-K522 bandwidth extension options)
Cells with white background: up to 80 MHz bandwidth supported for this scenario

Entities (users, cells, carriers)	TX antennas	RX antennas	1
3	1		●
4	1		●
5	1		●
6	1		●
7	1		●
8	1		●

Additional supported scenarios with R&S®SMW-K76 in combination with an R&S®SMW-K74 option and four R&S®SMW-B14 options

Note: The scenarios described here require the standard baseband section, i.e. R&S®SMW-B13T must be installed.

Cells with gray background: up to 160 MHz bandwidth supported for this scenario (depends on installed R&S®SMW-K522 bandwidth extension options)
Cells with white background: up to 80 MHz bandwidth supported for this scenario

Entities (users, cells, carriers)	TX antennas	RX antennas	1	2
3	1		●	●
	2		●	●
4	1		●	●
	2		●	●

Note: For scenarios with more than 2 output signals (number of entities · number of RX antennas > 2), the following functions are not available: analog modulation, modulation sources for analog modulation, envelope tracking, AM/AM, AM/PM predistortion.

Fading capabilities in R&S®SMW-K76 scenarios

Note: The scenarios described here require the standard baseband section, i.e. R&S®SMW-B13T must be installed.
Individual fading can be applied to each entity based on the available fading options:

4 × R&S®SMW-B14	individual fading can be applied to all entities for system configurations 2x1x1 to 8x1x1 (SISO only)
4 × R&S®SMW-B14 and R&S®SMW-K74	individual fading can be applied to all entities (MIMO and SISO)
2 × R&S®SMW-B14	individual fading can be applied to all entities for system configuration 2x1x1
1 × R&S®SMW-B14	individual fading can be applied to first entity for system configuration 2x1x1

Stream extender (R&S®SMW-K550 option)

Two R&S®SMW-B10 options (standard baseband generator), the R&S®SMW-B13T option and the R&S®SMW-K76 option (multiple entities) must be installed.

The stream extender option enables the R&S®SMW200A to duplicate generated baseband signals (streams) for specific system configurations. As a result, four baseband streams with real-time data sources can be generated in parallel as required for test cases such as the GSM AM suppression test specified in 3GPP TS 51.021.

The duplicated baseband streams have an identical content but appear to the receiver under test as different signals if shifted in frequency.

Note: None of the digital I/Q inputs and outputs are available in this mode.

System configuration	system configurations where the duplication of streams is available	3x1x1, 4x1x1
Duplicate streams	streams after baseband/fading block are duplicated and can be treated as individual streams, which allows adding AWGN (if R&S®SMW-K62 is available), shifting in frequency and mapping to outputs	on/off
Supported bandwidth		up to 80 MHz

Radar echo generation (R&S®SMW-K78 option)

At least one R&S®SMW-B14 option must be installed (signal path A), and one standard baseband generator (R&S®SMW-B10) and the R&S®SMW-B13 or R&S®SMW-B13T option must be present.

If two or four R&S®SMW-B14 are installed, one or two R&S®SMW-K78 options can be installed.

The R&S®SMW-K78 option allows echo generation of independent virtual static or moving radar objects at the same time. The echoes are generated regarding the object's individual velocity, range (variation) and RCS.

Note: R&S®SMW-K78 radar echo generation and R&S®SMW-B14 fading simulation modes cannot be used at the same time.

Supported transmit signal modes and bandwidth with R&S®SMW-K78

Mode	Further requirements	Bandwidth
R&S®SMW-B10 only	–	up to 160 MHz (with R&S®SMW-K522) (bandwidth is determined by RF bandwidth option of R&S®SMW200A)
External baseband via FSW and R&S®SMW-B10	FSW incl. R&S®FSW-B17, R&S®FSW-B80/-B160(R)/-B320(R)/ -B500/-B512(R) Note: An external attenuator may be required to protect the input stage of the FSW.	160 MHz or analysis bandwidth of FSW, whichever is lower (bandwidth is independent of RF bandwidth option of R&S®SMW200A)
Latest verified FSW firmware version		5.10

General parameters		
Number of available radar objects	one R&S®SMW-K78 option, one or two R&S®SMW-B14 installed	path A: up to 6
	one R&S®SMW-K78 option, four R&S®SMW-B14 installed	path A: up to 12
	two R&S®SMW-K78 options, two R&S®SMW-B14 installed	path A: up to 6, path B: up to 6
	two R&S®SMW-K78 options, four R&S®SMW-B14 installed	path A: up to 12, path B: up to 12
Bandwidth		up to 160 MHz
Test setups	radar under test (RUT) is directly connected to the R&S®SMW200A (and FSW) via cable	conducted test
	RUT and R&S®SMW200A (and FSW) are equipped with antennas and connected via air interface	over-the-air (OTA) test
Radar RX power setting	calculation of power received by RUT regarding two-way radar equation	radar equation
	power received by RUT is set manually	manual
Radar setup	availability of parameters depends on transmit signal mode, test setup and radar RX power setting	
Radar TX power		
Setting range	may be limited by setting range of reference level of FSW	–50 dBm to +100 dBm
Setting resolution		0.001 dBm
Radar antenna TX gain		
Setting range	may be limited by setting range of reference level of FSW	0 dBi to 100 dBi
Setting resolution		0.001 dBi
Radar antenna RX gain		
Setting range		0 dBi to 100 dBi
Setting resolution		0.001 dBi
System loss		
Setting range		0 dB to 100 dB
Setting resolution		0.001 dB
Pulse repetition frequency (PRF)		
Setting range		0.001 kHz to 1000 kHz
Setting resolution		0.001 kHz

Pulse repetition interval (PRI)		
Setting range		0.0374742 ms to 1000 ms
Setting resolution		0.01 ms
Scan period		
Setting range		0.0374742 ms to 10 000 ms
Setting resolution		0.01 ms
REG antenna RX gain		
Setting range	may be limited by setting range of reference level of FSW	0 dBi to 100 dBi
Setting resolution		0.001 dBi
REG antenna TX gain		
Setting range		0 dBi to 100 dBi
Setting resolution		0.001 dBi
OTA range offset		
Setting range	may be limited by setting range of reference level of FSW	0.01 m to 50 000 m
Setting resolution		0.01 m
External attenuator (analyzer)		
Setting range	maybe limited by setting range of reference level of FSW	–58 dB to +318 dB
Setting resolution		0.001 dB
Simulation setup		
System latency calibration	R&S®SMW-K78 measures the internal system (FSW and R&S®SMW200A) latency automatically (only available in transmit signal mode: external baseband via FSW and R&S®SMW-B10)	automatic
	user measures internal latency with external equipment (e.g. oscilloscope) and sets the system latency value manually	manual
System latency		
Measured system latency	with R&S®SMW200A and FSW	2100 m (meas.)
Setting range	system latency calibration: manual	0 m to 3000 m
Setting resolution	system latency calibration: manual	0.01 m
Correction value	system latency calibration: automatic	
Setting range		–100 m to +100 m
Setting resolution		0.01 m
Maximum uncertainty		±2.5 m
Use underrange	allows simulating objects at a range closer than the warranted range lower limit (but not closer than defined by the system latency)	on
	no influence	off
Use radar range ambiguity to reduce minimum range	All pulses per object are delayed so that a minimum range of 0.1 m is virtually possible (only for constant PRF).	on
	All pulses per object are delayed with regard to set range.	off
Object configuration		
Object type	arbitrary object types can run at the same time	
	echo is not generated	off
	echo for objects with variable range and constant velocity > 0 m/s is generated; use different doppler frequency for all spectral parts	moving
	echo for objects with constant range and no velocity is generated	static
	echo for objects with constant range and constant velocity > 0 m/s is generated; use same doppler frequency for all spectral parts	static and moving

Parameters common to all object types		
Object name		define 15-digit name
Range		
Setting range	use radar range ambiguity to reduce minimum range: off	
	use underrange: off	2.1 km to 10 000 km
	use underrange: on	“system latency” to 10 000 km
	use radar range ambiguity to reduce minimum range: on	0.0001 km to 10 000 km
	maximum difference in range (between start range and end range)	depends on simulation mode and RCS model
Setting resolution		0.1 m
Phase offset		
Setting range		0.0° to 359.9°
Setting resolution		0.1°
Radar RX power of start/end range	radar RX power setting: radar equation	
Setting range	may be limited by maximum output level of R&S®SMW200A	calculated with radar equation
Setting resolution		0.1 dBm
Radar RX power	radar RX power setting: manual	
Setting range	may be limited by maximum output level of R&S®SMW200A	–145 dBm to +30 dBm
Setting resolution		0.001 dBm
Parameters for moving objects		
Simulation mode	object remains at end range (i.e. appears as static object)	one way
	object jumps back to its start range within 1 s (only available for difference in range ≤ 6000 m)	cyclic
	object moves back to start position with set velocity after reaching its end position	round trip
Object velocity		
Setting range (objects 1, 2, 3 and 7, 8, 9)	the maximum Doppler shift of 10 MHz must not be exceeded	0.001 ms to v_{max}, v_{max} = 2000 m/s or (10 MHz / 2 · f) · c, whichever is lower
Setting range (objects 4, 5, 6 and 10, 11, 12)	the maximum Doppler shift of 190 kHz must not be exceeded	0.001 ms to v_{max}, v_{max} = 2000 m/s or (190 kHz / 2 · f) · c, whichever is lower
Setting resolution		0.001 m/s
Radar RX power dedicated to	radar RX power setting: manual	
	radar RX power is set for start range; RX power for end range is calculated with radar equation	start range
	radar RX power is set for end range; RX power for start range is calculated with radar equation	end range
	radar RX power equal at all ranges	all ranges
Parameters for static and moving objects		
Object velocity		
Setting range (objects 1, 2, 3 and 7, 8, 9)	the maximum Doppler shift of 10 MHz must not be exceeded	0.001 ms to v_{max}, v_{max} = (10 MHz / 2 · f) · c, i.e.: v_{max} = 499654 m/s for f = 3 GHz, v_{max} = 74948 m/s for f = 20 GHz, v_{max} = 37474 m/s for f = 40 GHz
Setting range (objects 4, 5, 6 and 10, 11, 12)	the maximum Doppler shift of 190 kHz must not be exceeded	0.001 ms to v_{max}, v_{max} = (190 kHz / 2 · f) · c, i.e.: v_{max} = 9 493 m/s for f = 3 GHz, v_{max} = 1 424 m/s for f = 20 GHz, v_{max} = 712 m/s for f = 40 GHz
Setting resolution		0.001 m/s
Direction	object flies toward RUT	approaching
	object flies away from RUT	departing

Ordering information

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

Designation	Type	Order No.
Multichannel, MIMO, fading and radar echo generation options		
Fading simulator	R&S®SMW-B14	1413.1500.02
Fading simulator and signal processor	R&S®SMW-B15	1414.4710.02
Dynamic fading	R&S®SMW-K71	1413.3532.02
Enhanced fading models	R&S®SMW-K72	1413.3584.02
OTA-MIMO fading enhancements	R&S®SMW-K73	1414.2300.02
MIMO fading/routing	R&S®SMW-K74	1413.3632.02
Higher-order MIMO	R&S®SMW-K75	1413.9576.02
Multiple entities	R&S®SMW-K76	1413.9624.02
Radar echo generation	R&S®SMW-K78	1414.1833.02
Stream extender	R&S®SMW-K550	1413.7315.02
Customized dynamic fading	R&S®SMW-K820	1414.2581.02
MIMO subsets, for higher-order MIMO	R&S®SMW-K821	1414.4403.02
Fading bandwidth extension to 400 MHz	R&S®SMW-K822	1414.6712.02
Fading bandwidth extension to 800 MHz	R&S®SMW-K823	1414.6735.02

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