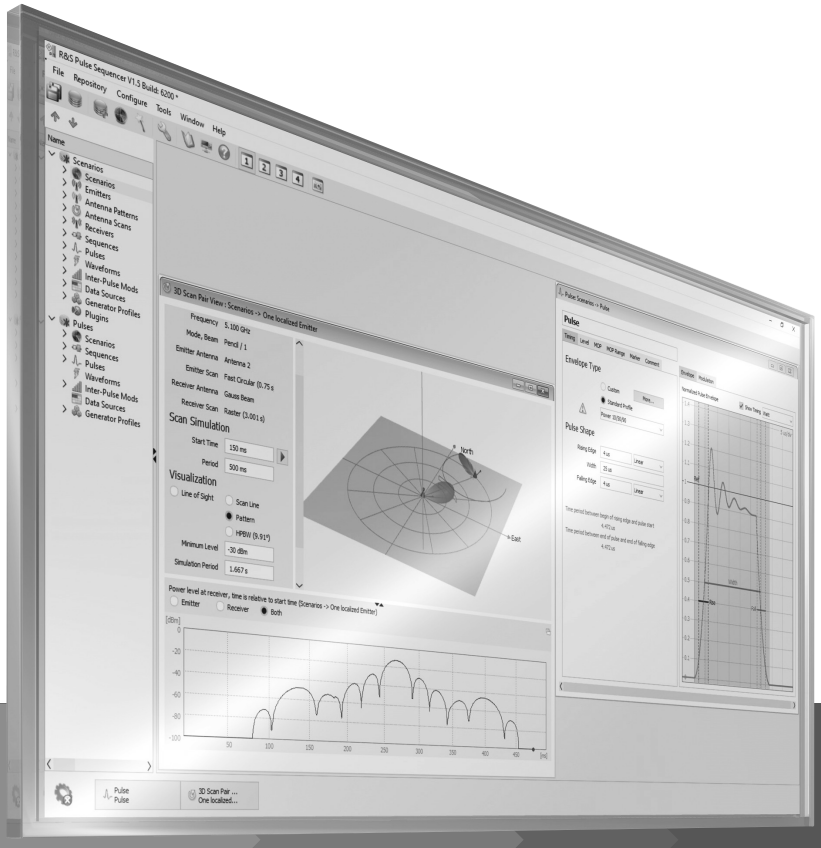
R&S®PULSE SEQUENCER SOFTWARE

Specifications

R&S®Pulse Sequencer RF
R&S®Pulse Sequencer Digital
R&S®Pulse Sequencer DFS



Specifications
Version 12.00

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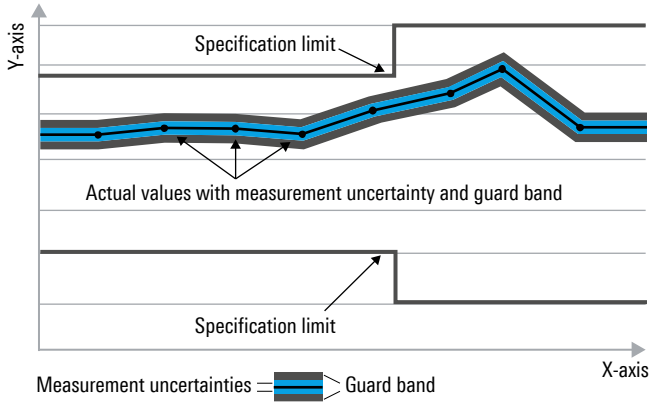
CONTENTS

Definitions

General
Product data applies under the following conditions:

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

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



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.

Notations and abbreviations

Instrument option names consist of the instrument name and a designation.
For example, R&S®SMW-K300 refers to pulse sequencing. This means that R&S®SMW-K300 is the basic pulse sequencing option for R&S®SMW200A; R&S®SMBVB-K300 is the pulse sequencing option for the R&S®SMBV100B vector signal generator.

If there is no further differentiation necessary, the options are abbreviated for example by K300, which summarizes the options R&S®SMW-K300, R&S®SMM-K300, R&S®SMBV-K300, R&S®SMBVB-K300 and R&S®SGT-K300.

Pure software options like the R&S®PULSE-K32 option of the R&S®Pulse Sequencer Digital software are independent of an instrument naming.

Introduction R&S®Pulse Sequencer Software products

This document describes the different R&S®Pulse Sequencer Software products.

The R&S®Pulse Sequencer Software is a powerful simulator specifically designed for the creation of complex pulsed radar signals for receiver testing, radar simulation, SIGINT applications and radio location.

In addition to its signal creation capabilities, the software performs realistic environment simulation, including antennas, scans, movement profiles and takes attenuation effects as well as Doppler effect and phase changes into account.

The software is available in three different versions for the following use cases:

R&S®Pulse Sequencer RF

This version of the software addresses RF testing, by directly playing back the generated scenarios on all supported Rohde & Schwarz signal generators. The available features and capabilities of the software are coupled with keycode options that have to be installed on the vector signal generators.

R&S®Pulse Sequencer Digital

This version of the software is a standalone software product, that is not related to Rohde & Schwarz signal generators, but addresses pure software based testing of algorithms, digital training and digital validation of radar related algorithms and systems. The available features are coupled with keycodes that have to be installed on a PC or workstation.

R&S®Pulse Sequencer DFS

This version of the software offers predefined and standardized test sequences for RF compliance testing of DFS capabilities of commercial Wi-Fi routers. The available features and capabilities of the software are coupled with the keycode option that have to be installed on the vector signal generators.

Introduction R&S®Pulse Sequencer RF

The R&S®Pulse Sequencer RF software and its respective keycode options for Rohde & Schwarz signal generators have been specifically developed for easy generation of pulsed signals.

The R&S®Pulse Sequencer RF software together with the K300 option allows generating pulsed signals with basic modulation schemes. Signals with simple pulses, pulse trains and repetition of pulses can be generated. In addition, pulse trains with different pulses and pulse breaks can be generated sequentially.

The K301 enhanced pulse sequencing option adds emitters and various control elements for sequencing applications. In addition, influences of antenna diagrams and antenna scans can be considered. Pulse sequences, antenna diagrams and antenna scans can be combined to an emitter. For scenario simulation, multiple emitters together with a receiver can be placed on a 2D map.

The R&S®SMW-K302 radar platforms option is available in combination with the R&S®SMW-B9 wideband baseband generator option and allows the simulation of platforms, on which several emitters can be placed and positioned. Together with the K304 moving emitters option, complex scenarios with real world vehicles can be simulated.

The R&S®SMW-K304 moving emitters option in combination with the R&S®SMW-B9 option adds movements to emitters, platforms and receiver in map-based scenario types providing a sophisticated waypoint interface as well as real world kinematics.

The R&S®SMW-K306 multiple emitters option in combination with the R&S®SMW-B9 option adds interleaving of multiple emitter signals into a single output signal using a priority-based dropping algorithm in order to increase the number of emitters and pulse density for a given hardware setup.

The R&S®SMW-K307 multiple emitters extension on top of the R&S®SMW-K306 option increases the maximum number of emitters per baseband to 512.

The R&S®SMW-K309 2D map import option adds the import of georeferenced maps and performs positioning and movement traces based on real world longitude and latitude coordinates that are based on the receiver position.

The K308 direction finding option adds simulation of angle of arrival (AoA) of emitters and platforms and supports direction finding applications. A receiver model which can have multiple antennas with individual positioning is introduced and individual receive signals for each antenna port are calculated.

The R&S®SMW-K501 extended sequencing option for R&S®SMW-B10 and the R&S®SMW-K502 wideband extended sequencing option for R&S®SMW-B9 use a pulse description word (PDW) based signal generation approach, which leads to dramatically increased simulation time and reduced calculation time.

The following sections describe the keycode options working with the PC-based R&S®Pulse Sequencer RF software for the following instruments:

- R&S®SMW200A
- R&S®SMM100A
- R&S®SMBV100A
- R&S®SMBV100B
- R&S®SGT100A

Key features

K300 pulse sequencing option adds:
- ARB based signal generation and multi segment waveform sequencing
- Pulse shape definition with custom rise and fall time, droop, ripple, overshoot
- Modulation on pulse (MOP) with all major formats like chirps, Barker codes, polyphase codes, PSKs, AM, FM
- Single pulse and pulse train generation with repetition count per pulse
- Inter pulse modulation of amplitude, phase, frequency, etc. values from pulse to pulse
- Internal and external (plug-ins) data sources for custom modulation
- Import of waveform files for sequencing with repetition count

K301 enhanced pulse sequencing option adds:
- Powerful sequencing with loops, nested loops, subsequences and overlays
- Antenna diagram definition and antenna scan definition
- Antenna diagrams like pencil beams, cosecans beams, Gaussian, user defined, phased array antenna diagrams
- Antenna scan types like helical scans, circular scans, conical scans
- Emitter definition by antenna diagram, antenna scan, attitude information, mode changes, EIRP and carrier frequency
- Receiver definition by antenna diagram, antenna scan and attitude information
- Calculation of signal considering one-way free space propagation according to emitter and receiver location on a 2D map
- Import of R&S®WinIQSIM2 or customer waveforms for interference generation on the 2D map

K302 radar platforms option adds:
- Simulation of real live vehicles, that carry multiple radar emitters on a common platform
- Emitters on a platform are positioned separately in 3D space
- All emitters carried by a platform can be configured for use of separate mode changes as well

K304 moving emitters option adds:
- Movement profiles for emitters, platforms and receiver to localized and direction-finding scenario types by
- Predefined line and arc movements, traces as well as waypoint import interface for complex movement traces
- WGS84 waypoint interface and import of NMEA waypoints
- Import of Google Earth and Google Maps .kml files
- East-North-Up (ENU) 2D vector trajectory interface (line, arc) for automatic waypoint generation
- Motion interface for dynamics input (velocity vector or velocity magnitude) in ENU and WGS84
- User-definable and predefined vehicle description files for land vehicles, ships, aircraft and spacecraft
- Smoothing of waypoints using vehicle description files

K306 multiple emitters option adds:
- Interleaving of multiple PDW lists in the PDW list scenario type and interleaving of emitters in emitters collection, localized emitters and direction-finding scenario types into a single output signal using a priority scheme for pulse dropping

K307 emitter interleaving extension:
- Upgrade to K306; extends the number of maximum interleaved emitters per baseband to 512

K308 direction finding option adds:
- Simulation of angle-of-arrival (AoA)
- Direction finding receiver definition with up to 20 antennas with individual positioning and pointing
- A new direction-finding scenario type
- Individual signal generation for each receive antenna port according to its antenna positioning and kinematics of emitters

K309 2D map import option adds:
- The import of georeferenced map files (.geoTiff)
- Positioning using real world longitude and latitude coordinates
- 2D and 3D visualization of map content

K501 extended sequencer option for R&S®SMW-B10 adds:
- Real-time signal generation for unmodulated rectangular CW pulses and pulses with linear frequency modulation or Barker codes
- Sequencer-based ARB playback with minimum calculation time and memory requirements for arbitrary pulse shapes
- Very long simulation time and dramatically decreased calculation times

K502 wideband extended sequencer option for R&S®SMW-B9 adds:
- Real-time signal generation for unmodulated rectangular CW pulses and pulses with linear frequency modulation or Barker codes
- Sequencer-based ARB playback with minimum calculation time and memory requirements for arbitrary pulse shapes
- Very long simulation time and dramatically decreased calculation times

K315 pulse-on-pulse simulation adds:
- Simulation of pulse-on-pulse situations of time overlapping signals
- Utilization of multiple R&S®SMW-B15 coprocessor boards to simulate up to 6 true parallel signals in a single instrument

I/Q baseband generators and memory size

Any signal produced with the R&S®Pulse Sequencer RF software requires an I/Q baseband generator with ARB installed on the respective Rohde & Schwarz vector signal generator.

For the R&S®SMW200A (standard model)	R&S®SMW-B10	baseband generator with ARB (64 Msample) and digital modulation (real-time), 120 MHz RF bandwidth
	The following enhancement options can be added to the R&S®SMW-B10 option:	
	R&S®SMW-K511	ARB memory extension to 512 Msample
	R&S®SMW-K512	ARB memory extension to 1 Gsample
	R&S®SMW-K522	bandwidth extension to 160 MHz RF bandwidth
For the R&S®SMW200A (wideband model)	R&S®SMW-B9	wideband baseband generator with ARB (256 Msample) and digital modulation (real-time), 500 MHz RF bandwidth
	The following enhancement options can be added to the R&S®SMW-B9 option:	
	R&S®SMW-K515	ARB memory extension up to 2 Gsample
	R&S®SMW-K525	baseband extension to 1 GHz RF bandwidth
	R&S®SMW-K527	baseband extension to 2 GHz RF bandwidth
For the R&S®SMM100A	R&S®SMM-B9	wideband baseband generator with ARB (64 Msample) and digital modulation (real-time), 120 MHz RF bandwidth
	The following enhancement options can be added to the R&S®SMW-B9 option:	
	R&S®SMW-K511	ARB memory extension to 512 Msample
	R&S®SMW-K512	ARB memory extension to 1 Gsample
	R&S®SMW-K513	ARB memory extension to 2 Gsample
	R&S®SMM-K523	ARB memory extension up to 2 Gsample
	R&S®SMM-K524	baseband extension to 1 GHz RF bandwidth
	R&S®SMM-K525	baseband extension to 2 GHz RF bandwidth
For the R&S®SMBV100A	R&S®SMBV-B10	baseband generator with digital modulation (real-time) and ARB (32 Msample), 120 MHz RF bandwidth
	R&S®SMBV-B10F	baseband generator for GNSS with high dynamics, digital modulation (real-time) and ARB (32 Msample), 120 MHz RF bandwidth
	R&S®SMBV-B51	baseband generator with ARB (32 Msample), 60 MHz RF bandwidth
	The following enhancement options can be added to the R&S®SMBV-B51 option:	
	R&S®SMBV-K521	bandwidth extension to 120 MHz RF bandwidth
	R&S®SMBV-K522	bandwidth extension to 160 MHz RF bandwidth
	The following enhancement options can be added to the R&S®SMBV-B10/-B10F/-B51 options:	
	R&S®SMBV-K511	ARB memory extension to 256 Msample
	R&S®SMBV-K512	ARB memory extension to 512 Msample
	R&S®SMBV-K522	bandwidth extension to 160 MHz RF bandwidth
For the R&S®SMBV100B	Base unit includes the ARB baseband generator (64 Msample, 120 MHz RF bandwidth)	
	R&S®SMBVB-K523	baseband extension to 240 MHz RF bandwidth
	R&S®SMBVB-K524	baseband extension to 500 MHz RF bandwidth
	R&S®SMBVB-K511	ARB memory extension to 256 Msample
	R&S®SMBVB-K512	ARB memory extension to 1 Gsample
	R&S®SMBVB-K513	ARB memory extension to 2 Gsample
For the R&S®SGT100A	R&S®SGT-K510	baseband generator with 32 Msample, 60 MHz RF bandwidth
	R&S®SGT-K511	extension to 256 Msample
	R&S®SGT-K512	extension to 1 Gsample
	R&S®SGT-K521	extension to 120 MHz RF bandwidth
	R&S®SGT-K522	extension to 160 MHz RF bandwidth

R&S®SMW-B9 and R&S®SMM-B9 are referred to as B9,
R&S®SMW-B10 and R&S®SMBV-B10 are referred to as B10.

For R&S®SMBV100A, it is required to install the R&S®SMBV-B92 option (hard disk).

The K300/K301/K302/K304/K306/K307/K308/K309 and K501/K502 options require the external PC-based R&S®Pulse Sequencer RF software for signal generation.

Related documents

This document contains the functional specifications of the PC-based R&S®Pulse Sequencer RF software.

For instrument-specific signal performance data such as ACLR or EVM, see the specifications of the respective Rohde & Schwarz instruments:

R&S®SMW200A: PD 3606.8037.22
R&S®SMM100A: PD 3608.7680.22
R&S®SMBV100A: PD 5214.1114.22
R&S®SMBV100B: PD 3607.8201.22
R&S®SGT100A: PD 3607.0217.22

Minimum configuration

The following minimum required configuration for the instruments is listed hereafter for K300 and K301 options.

R&S®SMW200A (standard model)	
R&S®SMW200A	vector signal generator
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 digital modulation (real-time), 120 MHz RF bandwidth
R&S®SMW-B103	frequency option: 100 kHz to 3 GHz
R&S®SMW-B106	frequency option: 100 kHz to 6 GHz
R&S®SMW200A (wideband model)	
R&S®SMW200A	vector signal generator
R&S®SMW-B13XT	wideband baseband main module, two I/Q paths to RF
R&S®SMW-B9	wideband baseband generator with ARB (256 Msample) and digital modulation (real-time), 500 MHz RF bandwidth
R&S®SMW-B103	frequency option: 100 kHz to 3 GHz
R&S®SMW-B106	frequency option: 100 kHz to 6 GHz
R&S®SMM100A	
R&S®SMM100A	vector signal generator
R&S®SMM-B9	baseband generator with ARB (64 Msample) and digital modulation (real-time), 120 MHz RF bandwidth
R&S®SMM-B1006	frequency option: 100 kHz to 6 GHz
R&S®SMBV100A	
R&S®SMBV100A	vector signal generator
R&S®SMBV-B51	baseband generator with ARB (32 Msample), 60 MHz RF bandwidth
R&S®SMBV-B92	hard disk (removable)
R&S®SMBV-B103	frequency option: 100 kHz to 3.2 GHz
R&S®SMBV-B106	frequency option: 100 kHz to 6 GHz
R&S®SMBV100B	
R&S®SMBV100B	vector signal generator
R&S®SMBVB-B103	frequency option 8 kHz to 3 GHz
R&S®SGT100A	
R&S®SGT100A	vector signal generator
R&S®SGT-K510	ARB baseband generator, 32 Msample, 60 MHz RF bandwidth
R&S®SGT-KB106	frequency extension to 6 GHz

If two I/Q baseband generators are installed and two pulse sequencing waveforms generated with the R&S®Pulse Sequencer RF software are to be output simultaneously, two corresponding software options (e.g. K300) must also be installed (e.g. R&S®SMW-K300 for an R&S®SMW200A). If only one R&S®SMW-K300 option is installed and the pulse sequencing waveform is loaded in one I/Q baseband generator, the other I/Q baseband generator is disabled for pulse sequencing waveforms. However, a software option is not tied to a specific I/Q baseband generator.

The following minimum configuration for R&S®SMW200A is listed hereafter for a direction-finding scenario with K300, K301 and K308 options. It allows the simulation of 2 RX antennas with a single emitter.

R&S®SMW200A	
R&S®SMW200A	vector signal generator
R&S®SMW-B13T	signal routing and baseband main module, one I/Q path to RF
R&S®SMW-B10	baseband generator with ARB (64 Msample) and digital modulation (real-time), 120 MHz RF bandwidth
R&S®SMW-B10	baseband generator with ARB (64 Msample) and digital modulation (real-time), 120 MHz RF bandwidth
R&S®SMW-B103/-B1003	frequency option: 100 kHz to 3 GHz
R&S®SMW-B203/-B2003	frequency option: 100 kHz to 3 GHz

Pulse sequencing

R&S®SMW-K300, R&S®SMM-K300, R&S®SMBV-K300, R&S®SMBVB-K300, R&S®SGT-K300

Pulses

Parameter type		
Timing		
Envelope types		custom envelope, standard profile
Timing related to % amplitude		0/100, voltage: 10/50/90, power: 10/50/90
Rising edge		0 s to 3600 s
Falling edge		0 s to 3600 s
Standard edge types		linear, cosine, root cosine, sqrt
Width		0 s to 3600 s
Custom envelope		list based, equation based
Level		
Attenuation top power		0 dB to 100 dB
Attenuation base power		0 dB to 100 dB
Droop		0 % to 50 % power
Overshoot		0 % to 50 % voltage
Overshoot decay parameter		1 to 100
Ripple		0 % to 50 % voltage
Ripple frequency		0 Hz to 300 MHz
MOP		
Available modulation types		see MOP section
Restrict MOP to certain area of pulse		no restriction, pulse width, exclude time (at beginning, at end), level threshold (rising edge, falling edge)
Marker		
Number of markers		M1 to M4 (depending on generator type)
Marker types		rise time, width, fall time, restart, gate, pre, post

Remark:
For an extended pulse on/off ratio the keycode option R&S®SMW-K22 pulse modulator can be installed. For technical details, refer to the R&S®SMW200A specifications (PD 3606.8037.22).

Inter pulse modulation (IPM)

Inter pulse modulation varies pulse parameters from pulse to pulse. The IPM mechanism is used to generated PRI stagger or frequency hopping, for example. The output of multiple IPM profiles can be combined.

Types of inter pulse modulation profiles		
Steps		
Start		-1×10^9 to 1×10^9
Increment		-1×10^9 to 1×10^9
Steps		1 to 10000
Burst length		1 to 1000
Burst period		1 ns to 10^9 s
List		
Parameters per entry		value, repetitions
Firing order		sequencing of list entries using text based macros
Number of entries		8000
Value		-1×10^9 to 1×10^9
List base		repetitions/time
Repetitions		1 to 10^9
Time		1 ns to 10^9 s
Waveform		
Type		ramp, sine, triangular
DC offset		-1×10^9 to 1×10^9
Phase offset		-1×10^9 to 1×10^9
Peak to peak		-1×10^9 to 1×10^9
Period time		1 ns to 10^9 s
Pulse count		1 to 10^9
Interpolated shape		
Parameters per entry		value
Number of entries		8000
Value		-1×10^9 to 1×10^9
Period time		1 ns to 10^9 s
Pulse count		1 to 10^9
Interpolation		linear, none (s/h)
Binomial		
Value 1		-1×10^9 to 1×10^9
Probability		0 % to 100 %
Value 2		-1×10^9 to 1×10^9
Unit of affected parameter		none, time in s, frequency in Hz, level in dB, phase in °, percent in %
Available parameters		
Level		overshoot in %, offset in dB, attenuation top in dB, ripple in %, droop in %, attenuation base in dB, ripple frequency in Hz
Modulation		AM modulation depth in %, FM deviation in Hz, FM frequency in Hz, chirp deviation in Hz, AM frequency in Hz
Timing		rise time in s, pulse width in s, delay in s, fall time in s, PRF in Hz, PRI in s
Phase		offset in °
Frequency		offset in Hz
Other		custom variables that can be used in equation parsers (sequencing, envelope, MOP, report generation)

Modulation on pulse (MOP)

The modulation on pulse describes the modulation used within a pulse. The R&S®Pulse Sequencer RF software supports a wide range of built-in MOP types. Custom MOP can be added by plug-ins.

MOP types		
AM		
Types		standard, LSB, USB, LSB+USB
Frequency		1 mHz to 1 GHz
Modulation depth		0 % to 100 %
ASK		
Modulation depth		0 % to 100 %
Inverted		yes, no
Symbol rate		1 Hz to 1 GHz
Data source		yes
Baseband filter		no
AM step		
Values per step		duration, level
Number of entries		1024
FM		
Frequency		1 mHz to 1 GHz
Deviation		1 mHz to 1 GHz
FSK		
Type		2/4/8/16/32/64FSK
Deviation		1 mHz to 1 GHz
Symbol rate		1 Hz to 1 GHz
Data source		yes
Baseband filter		no
FM step		
Values per step		duration, frequency
Number of entries		1024
MSK		
Symbol rate		1 Hz to 2 GHz
Data source		yes
Baseband filter		no
Linear chirp		
Types		up, down, sine, triangular
Deviation		1 Hz to 1 GHz
Chirp (equation-based)		
Polynomial chirp		
Values		term, coefficient
Coefficient range		-1×10^{22} to 1×10^{22}
Number of entries		1024
Barker		
Codes		R3, R4a, R4b, R5, R7, R11, R13
Transition time (const. envelope)		0 % to 50 %
Polyphase		
Codes		Frank, P1, P2, P3, P4
Length M		1 to 64
Custom phase		
Values		phase in °
Number of entries		1024
BPSK		
Types		standard, constant envelope
Symbol rate		auto fit to PW, 1 Hz to 1 GHz
Phase change		0° to 180°
Transition		linear, cosine
Transition duration		0 % to 50 %
Data source		yes
Baseband filter		yes
QPSK		
Types		standard, OQPSK, DQPSK, SOQPSK-A, SOQPSK-B, SOQPSK-TG
Symbol rate		1 Hz to 1 GHz
Data source		yes
Baseband filter		yes

8PSK		
Symbol rate		1 Hz to 1 GHz
Data source		yes
Baseband filter		yes
QAM		
Type		16/32/64/128/256QAM
Symbol rate		1 Hz to 1 GHz
Data source		yes
Baseband filter		yes
White noise		
Bandwidth		1 Hz to 1 GHz
Baseband filter	any filter can be used with the MOP types using baseband filters	
Filter types		none, rectangular, cosine, root cosine, Gaussian, low pass, Gaussian FSK
Filter parameter		
Filter parameter	cosine, root cosine (filter parameter α)	0.05 to 1.00
	Gaussian (filter parameter B × T)	0.15 to 2.50
Length		8 to 512
Bandwidth	rectangular, cosine, root cosine, low pass	1 Hz to 1 GHz
Coding	not all coding methods can be used with every type of modulation	none, differential, Gray, differential and Gray
Data sources		PRBS: 7, 9, 11, 15, 16, 20, 21, 23, All0, All1, pattern (length: 1 bit to 64 bit), data lists

Data sources

Data sources deliver binary data to certain modulation on pulse (MOP) profiles, such as ASK, BPSK or QPSK.

Types of data sources		
PRBS		
Mode		PRBS: 7, 9, 11, 15, 16, 20, 21, 23
Bits		1 to infinite
Pattern		
Mode		All0, All1, 1010, Barker R3, R4a, 4b, 5, 7, 11, 13
Bits		1 to 1000
User		
Data types		binary, hexadecimal, ASCII text

Sequences

A sequence combines multiple pulses or waveforms to the final output signal.

Sequencing element		
Pulse		
Repetition count		fixed, randomly selected, auto set by duration
IPM		static, any combination of available IPM profiles
Marker 1 to 4		first, last, all
		variable comparision against value (<, >, =, !=)
Delta frequency		–1 GHz to +1 GHz
Delta level		–100 dB to +30 dB
Phase		–180° to +180°
PRI		pulse duration to 10^9 s
Delay		0 to (PRI – pulse duration)
Wave		
Repetition count		fixed
IPM		static, any combination of available IPM profiles
Marker 1 to 4		from waveform
Delta frequency		–1 GHz to +1 GHz
Delta level		–100 dB to +30 dB
Phase		–180° to +180°
PRI		wave duration to 10^9 s
Delay		0 to (PRI – wave duration)
Global parameters		
Number of line items		1 to 256
Phase mode		absolute, continuous, memory

Waveforms and imported signals

Waveforms and signal data (PDWs) can be used in sequences if custom data shall be used instead of a computed pulse envelope or MOP. Using Rohde & Schwarz waveform files may require additional licensing options on the baseband generator.

Parameter type		
CW		
Multitone		
Tones		2 to 1024
Spacing		100 Hz to 10 MHz
AWGN		
Bandwidth		0 Hz to 300 MHz
PDW data		
Format		custom PDW data with import template
I/Q waveform		
Import from formats		
Rohde & Schwarz	.wv	ARB waveform files
	.iqtar	I/Q tar archive files
	.riq	PR100 files
		AMMOS IF
		AMMOS PDW
Custom		ASCII; I/Q delimited in columns
		binary (integer, real)
	.mat	complex vector
	.wav	audio waveforms using the left channel for I and the right channel for Q
PDW	.csv, .txt	text based custom PDW data in combination with an import template file
Maximum file size		10 Gbyte

Scenarios

The following scenario types are available.

Scenario type		
Single sequence		
Sequence		1 single sequence
Output		ARB waveform, multi-segment waveform segment
Clock rate		auto (oversampling 1 to 1000)
		manual (1 Hz to 2.4 GHz)
Duration		auto
		fixed duration (1 µs to 1843200 s)
Markers		sequence markers
		M1 at scenario start
Threshold for pulse generation		–100 dB to 0 dB
Waveform sequence		
Sequence		1 single sequence
Output		ARB waveform, multi-segment waveform segment
Clock rate		auto (oversampling 1 to 1000)
		manual (1 Hz to 2.4 GHz)
Duration		auto
		fixed duration (1 µs to 1843200 s)
Markers		sequence markers
		M1 at scenario start
Threshold for pulse generation		–100 dB to 0 dB
Sequences (collection)		
Sequences		1 to 1024
Output		ARB waveform, multi-segment waveform segment
Clock rate		auto (oversampling 1 to 1000)
		manual (1 Hz to 2.4 GHz)
Duration		auto
		fixed duration (1 µs to 1843200 s)
Markers		sequence markers
		M1 at scenario start
Threshold for pulse generation		–100 dB to 0 dB
PDW list (collection) requires R&S®SMW-K501/K502		
PDW file		1 waveform object with type PDW data
Number of PDW files		1 to 1024 (1 at a time or interleaved with R&S®SMW-K306/K307)
Absolute level		–130 dBm to +30 dBm
Frequency		0 Hz to 100 GHz
Output		extended sequencer file
Clock rate		auto
Duration		auto
Markers		M1 at scenario start, pulse
Threshold for pulse generation		–100 dB to 0 dB

Enhanced pulse sequencing

R&S®SMW-K301, R&S®SMM-K301, R&S®SMBV-K301, R&S®SMBVB-K301, R&S®SGT-K301

The K301 option is only available as add-on to the K300 option. Therefore, each K301 option requires a K300 option.
The complexity of a data repository has to be set to advanced K300/K301 mode.

Pulses

The following settings are available in addition to the features provided by K300 option.

Parameter type		
Timing		
Custom envelope types		value list, equation

Inter pulse modulation (IPM)

The following IPM profiles can be applied to pulse parameters in addition to the IPM profiles provided by the K300 option.

Types of inter pulse modulation profiles		
Equation		
Random list		
Burst length		1 to 8192
Burst period		1 ns to 10^9 s
Avoid reuse		yes, no
Values per entry		value
Number of entries		1024
Value		-1×10^6 to 1×10^6
Random steps		
Minimum		-1×10^6 to 1×10^6
Maximum		-1×10^6 to 1×10^6
Step size minimum		0 to 10^6
Step size maximum		0 to 10^6
Periodicity count		0 to 4096
Random		
Distribution		uniform, normal, U
Minimum		-1×10^9 to 1×10^9
Maximum		-1×10^9 to 1×10^9
Step		-1×10^9 to 1×10^9
Plug-in		
Format		64 bit Windows .dll, API specified in user manual

Modulation on pulse (MOP)

The following MOP types are available in addition to the MOP types provided by the K300 option.

Types of modulation on pulse		
Plug-in		
Data source		yes
Baseband filter		yes

Sequences

The following sequencing element types are available in addition to the ones provided by the K300 option.

Element types		
Loop		
Repetition count		fixed, randomly selected
Filler		
Signal		blank, CW, hold last sample
Mode		duration, time synchronization
Time		fixed, equation
Overlay		
Duration		0 s to 10^9 s
Sub sequence		
Repetition count		1
Global parameters		
Nesting level		0 to 6
Number of line items		1 to 256

Waveforms and imported signals

The following waveform types are available in addition to the ones provided by the K300 option.

Parameter type		
Background emitters		
Count		1 to 255
Bandwidth		1 kHz to 240 MHz
Duration		100 µs to 1 s
Pulse width range		100 ns to 1 s
PRI/PW ratio		1 to 1000
Level range		0 dB to 90 dB

Emitters

The following emitter properties are available.

Property types		
Emitter		
EIRP		–200 dBm to +200 dBm
Frequency		1 kHz to 100 GHz
Number of modes per emitter		32
Number of beams per mode		32
Modes		
Antenna pattern		1 per mode
Scan type		1 per mode
Beams		
Active		yes, no
Sequence		1 per beam
Frequency offset		–100 MHz to +100 MHz
Beam offset elevation		–180° to +180°
Beam offset azimuth		–180° to +180°

Antenna patterns

The following antenna patterns can be applied to emitters and the receiver.

Antenna types		
Dipole		
Cardiod		
Exponent		1 to 20
Parabolic		
Frequency		1 MHz to 100 GHz
Bandwidth		1 MHz to 100 GHz
Simulate back lobe		yes
Back lobe attenuation		0 dB to 100 dB
Diameter		0.05 m to 100 m
Gaussian		
Frequency		no
Bandwidth		no
Simulate back lobe		yes
Back lobe attenuation		0 dB to 100 dB
HPBW azimuth		0.1° to 60°
HPBW elevation		0.1° to 60°
Sin(x)/x		
Frequency		1 MHz to 100 GHz
Bandwidth		1 MHz to 100 GHz
Simulate back lobe		yes
Back lobe attenuation		0 dB to 100 dB
HPBW		0.1° to 45°
HPBW		0.1° to 45°
Pyramidal horn		
Frequency		1 MHz to 100 GHz
Bandwidth		1 MHz to 100 GHz
Simulate back lobe		yes
Back lobe attenuation		0 dB to 100 dB
Length X		0.01 m to 100 m
Length Z		0.01 m to 100 m
Cosecant squared		
Frequency		no
Bandwidth		no
Simulate back lobe		yes
Back lobe attenuation		0 dB to 100 dB
HPBW		0.01° to 30°
Theta 1		0.01° to 90°
Theta 2		0.01° to 90°
Planar phased array		
Frequency		1 MHz to 100 GHz
Bandwidth		1 MHz to 100 GHz
Simulate back lobe		yes
Back lobe attenuation		0 dB to 100 dB
Aperture distribution		uniform, parabolic, cosine, cosine squared, cos^N, triangular, Hamming, Hann
Antenna element type		omnidirectional, cosine
Elements X		1 to 1000
Elements Z		1 to 1000
Spacing X		0.001 m to 1 m
Spacing Z		0.001 m to 1 m
Pedestal		0 to 1 (parabolic, cosine, cosine squared, triangular, Hamming, Hann aperture distribution)
cos^N		2 to 10 (cos^N aperture distribution)

Custom phased array		
Frequency		1 MHz to 100 GHz
Bandwidth		1 MHz to 100 GHz
Simulate back lobe		yes
Back lobe attenuation		0 dB to 100 dB
Aperture distribution		uniform, parabolic, cosine, cosine squared, cos^N, triangular, Hamming, Hann
Antenna element type		omnidirectional, cosine
Geometry		uniform rect, uniform linear, uniform hex, circular planar
Uniform rect		
Elements		1 to 1000
Elements Z		1 to 1000
Spacing X		0.001 m to 1 m
Spacing Z		0.001 m to 1 m
Lattice		rectangular, triangular
Uniform linear		
Elements		1 to 1000
Spacing		0.001 m to 1 m
Uniform hex		
Elements/side		1 to 50
Spacing		0.001 m to 1 m
Circular planar		
Radius		1 to 50
Spacing		0.001 m to 1 m
Lattice		rectangular, triangular
Import from file		
Supported formats		.csv (comma separated values)
		.ffe (FEKO far field)
		.ant_pat (Rohde & Schwarz pattern file)
		.tsv (Antenna Magnus)
		.ffd (Ansys HFSS)
Frequency		yes
Bandwidth		yes
Simulate back lobe		yes
Custom		
Frequency		no
Bandwidth		no
Simulate back lobe		yes
Back lobe attenuation		0 dB to 100 dB
HPBW XY		0.01° to 90°
HPBW YZ		0.01° to 90°
Side lobe level		0 dB to 100 dB
Roll off factor		0 dB to 100 dB
Side lobe scale		0.2 to 5

Antenna scans

The following scan types can be applied to emitters and receivers. Certain scan types can be used as electronic scans for phased array antennas.

Scan types		
Circular		
Mode		rpm, sec
Scan period		6 ms to 6000s
Scan rate		0.01 rpm to 1000 rpm
Direction		CW, CCW
Nodding		on/off
Elevation rate		0.01°/s to 2000°/s
Elevation angle		0.01° to 90°
Palmer scan		on/off
Scan rate		100 mHz to 1 kHz
Squint angle		0.05° to 45°
Sector		
Electronic scan		on/off
Sector width		0.01° to 360°
Scan rate		0.01 rpm to 1000 rpm
Unidirectional		on/off
Flyback time		0 s to 1 s (with unidirectional = on)
Nodding		on/off
Elevation rate		0.01°/s to 2000°/s
Elevation angle		0.01° to 90°
Palmer scan		on/off
Scan rate		100 mHz to 1 kHz
Squint angle		0.05° to 45°
Raster		
Electronic scan		on/off
Raster width		0° to 360°
Bar width		0.01° to 180°
Scan rate		0.01 rpm to 10000 rpm
Bar count		1 to 1000
Retrace time		0 s to 1 s
Unidirectional		on/off
Direction		horizontal/vertical
Flyback time		0 s to 1 s (with unidirectional = on)
Bar transition time		0 s to 1 s (with unidirectional = off)
Rewind		on/off
Palmer scan		on/off
Scan rate		100 mHz to 10 kHz
Squint angle		0.05° to 90°
Conical		
Electronic scan		on/off
Scan rate		10 mHz to 1 kHz
Direction		CW, CCW
Squint angle		0.01° to 30°
Helical		
Electronic scan		on/off
Scan rate		0.01°/s to 1000°/s
Turns		1 to 1000
Step angle		0.01° to 30°
Retrace time		0 s to 1 s
Direction		CW, CCW
Spiral		
Electronic scan		on/off
Rounds		1 to 100
Round time		1 µs to 100 s
Angular step		0.1° to 5°
Retrace time		0 s to 1 s
Direction		CW, CCW
Palmer scan		on/off
Scan rate		100 mHz to 10 kHz
Squint angle		0.05° to 90°

Lobe switching		
Electronic scan		on/off
Lobes		2, 4
Squint angle		0.05° to 15°
Dwell time		1 µs to 1 s
Direction		vertical, horizontal with 2 lobes only
Rotation		CW, CCW with 4 lobes only
Sine		
Electronic scan		on/off
Width		1.00° to 180°
Height		1.00° to 90°
Scan rate		0.01 rpm to 1000 rpm
Direction		CW, CCW
Unidirectional		on/off
Invert up/down scan		on/off
Custom (list of entries)		
Electronic scan		on/off
Azimuth		–180° to +180°
Elevation		–90° to +90°
Dwell time		0 s to 3600 s
Interpolate to next		true/false (move or jump to next coordinate)
Transition time		0 s to 3600 s (if interpolate to next is true, this parameter resembles the time for the transition to the next coordinate)
Lissajous		
Electronic scan		on/off
Amplitude X		0.01° to 45°
Amplitude Z		0.01° to 45°
Frequency		0.01 Hz to 1000 Hz
Freq X ratio		1 to 10
Freq Z ratio		1 to 10
Phase X		0° to 360°
Phase Z		0° to 360°

Scenarios

The following emitter-based scenario types are available in addition to the scenario types provided by K300.

Scenario type		
Single emitter		
Yaw		0° to 360°
Pitch		–90° to +90°
Roll		0° to 360°
Output		ARB waveform, multisegment waveform segment
Clock rate		auto (oversampling 1 to 1000)
		manual (1 Hz to 2.4 GHz)
Duration		auto
		fixed duration (1 µs to 1843200 s)
Markers		scenario markers
		M1 at scenario start
Threshold for pulse generation		–100 dB to 0 dB
Emitters (collection)		
Emitter		sequence, antenna pattern, antenna scan, operation modes, beams
Number of emitters		1 to 1024 (1 at a time) or interleaved with R&S®SMW-K306/K307
Frequency offset		–2 GHz to +2 GHz
Scan delay		–3600 s to +3600 s
Absolute level		–130 dBm to +30 dBm
Operation mode		static/mode changes
Yaw		0° to 360°
Pitch		–90° to +90°
Roll		0° to 360°
Output		ARB waveform, multi-segment waveform
Clock rate		auto (oversampling 1 to 1000)
		manual (1 Hz to 2.4 GHz)
Duration		auto
		fixed duration (1 µs to 1843200 s)
Markers		scenario markers
		M1 at scenario start
Threshold for pulse generation		–100 dB to 0 dB
Localized emitters		
Number of platforms, emitters, interferers and background signals	definable with the R&S®Pulse Sequencer RF software	1 to 1024 (1 at a time) or interleaved with R&S®SMW-K306/K307
Maximum number of simultaneous playback of emitters, interferers and background signals	R&S®SMW200A	1 per baseband path
	R&S®SMW200A + 2 × R&S®SMW-B10 + 1 × R&S®SMW-K76	up to 4
	R&S®SMM100A	1 per baseband generator
	R&S®SMBV100A, R&S®SMBV100B, R&S®SGT100A	1 per baseband generator
Platform/emitter/interferer properties		
Emitter behavior		
Static configuration	static mode and beam	mode and beam (defines sequence, antenna pattern and antenna scan)
Mode changes configuration	per operation mode entry each entry consists of a mode/beam pair	mode and beam (defines sequence, antenna pattern and antenna scan), start and stop time of operation mode entry
Emitter parameters		sequence, antenna pattern, antenna scan, operation modes, beams
Interferer behavior		
Static configuration	static	antenna pattern and antenna scan
Interferer parameters		ARB waveform object, EIRP

Position mode		
Static		single static position
East		-1×10^9 m to 1×10^9 m
North		-1×10^9 m to 1×10^9 m
Height		-1×10^9 m to 1×10^9 m
Yaw		0° to 360°
Pitch		–90° to +90°
Roll		0° to 360°
Point to receiver		on/off
Steps		multiple static position steps
Background signals properties		
Signal source		any sequence or waveform
Level at receiver origin		–100 dB to +25 dB
Frequency		1 kHz to 100 GHz
Receiver properties		
Antenna pattern		all available antenna patterns
Scan		all available antenna scans
Gain		–120 dB to +120 dB
Position mode		
Static		single static position
Height		0 m to 10^9 m
Yaw		0° to 360°
Pitch		–90° to +90°
Roll		0° to 360°
Output		ARB waveform, multi-segment waveform segment
Clock rate		auto (oversampling 1 to 1000)
		manual (1 Hz to 2.4 GHz)
Duration		auto
		fixed duration (1 µs to 1843200 s)
Markers		scenario markers
		M1 at scenario start
Threshold for pulse generation		–100 dB to 0 dB

Radar platforms

R&S®SMW-K302

The K302 option is only available as add-on to the combination of the K300 and K301 options. Therefore, each K302 option requires a K300 and a K301 option. Radar platforms are simulation objects equipped with one or more emitters.

Platforms

The following platform properties are available.

Property types		
Emitters		
Number of emitters per platform		1 to 8
Individual emitter properties		
Static position relative to platform origin		
X		–2000 m to +2000 m
Y		–2000 m to +2000 m
Radius		0 m to 2000 m
Angle		0° to 360°
Height		–500 m to +500 m
Emitter		
Type		all available emitter types
Blank ranges	signal mutes in these sectors	start angle/stop angle 0° to 360°
Pointing direction		
Auto away from origin		on/off
Elevation		–90° to +90°
Azimuth		0° to 360°
Roll		–180° to +180°
Movements		
For movement types, refer to description of R&S®SMW-K304 in section Movements.		

Movements

R&S®SMW-K304

This option extends the position mode for platforms, emitters and the receiver to allow motion simulation. The motion trajectories can be created via the pulse sequencer GUI or by importing text-based waypoint files.

The K304 is only available as add-on to the combination of the K300, K301, K502 and B9 options. Therefore, each K304 option requires a K300, a K301, K502, and B9 option. The complexity of a data repository has to be set to advanced K300/K301 or to K308 mode.

Movement features

The following movement features become available for platforms, emitters and receivers in addition to the scenario features already provided with other options.

Position mode moving		
Trajectory line		
Start position		
East/north		-1×10^9 m to 1×10^9 m
Height		-1×10^9 m to 1×10^9 m
Speed		0.1 m/s to 5999 m/s
Acceleration		–100 m/s² to +100 m/s²
End position		
East/north		-1×10^9 m to 1×10^9 m
Height		-1×10^9 m to 1×10^9 m
Mode		cyclic, round trip, one way
Trajectory arc		
Start position		
East/north		-1×10^9 m to 1×10^9 m
Height		-1×10^9 m to 1×10^9 m
Speed		0.1 m/s to 5999 m/s
Angle		–360° to +360°
Center position		
East/north		-1×10^9 m to 1×10^9 m
Mode		cyclic, round trip, one way
Trajectory traces		
Trace point properties		
East/north		-1×10^9 m to 1×10^9 m
Height		-1×10^9 m to 1×10^9 m
Speed		0 m/s to 5999 m/s
Readout mode		cyclic, round trip, one way
Reference frame		WGS-84, PZ-90.11
Smoothing	trajectory smoothening based on vehicle description file	on/off
Vehicle description file		.xvd file format (see user manual)
Attitude behavior		align to motion, constant
Yaw	only for constant	–180° to +180°
Pitch	only for constant	–90° to +90°
Roll	only for constant, align to motion	–180° to +180°
Trajectory waypoints		
Waypoint file		XTD (proprietary tracjectory format), .kml, .nmea, .txt (see user manual)
Readout mode		cyclic, round trip, one way
Reference frame		WGS-84, PZ-90.11
Smoothing	trajectory smoothening based on vehicle description file	on/off
Vehicle description file		.xvd file format (see user manual)
Attitude behavior		from waypoint file, align to motion, const.
Yaw	only for constant	–180° to +180°
Pitch	only for constant	–90° to +90°
Roll	only for constant, align to motion	–180° to +180°
Receiver position properties		
Latitude	geodetic reference	–90° to +90°
Longitude	geodetic reference	–180 to +180°

Multiple emitters

R&S®SMW-K306

This option allows interleaving of manually created emitters in emitters collection, localized emitters and direction-finding scenario types using a priority based pulse dropping algorithm and interleaving of multiple PDW lists in the PDW list (collection) scenario type into a single PDW file.

The K306 option is only available as add-on to the combination of the K300, K301, K502 and B9 options. Therefore, each K306 option requires K300, K301, K502, and B9 option. The complexity of a data repository has to be set to advanced K300/K301 or to K308 mode.

Scenario features

The following features become available in addition to the scenario features already provided with the K300 and K301 options.

Scenario type		
PDW list (collection)		
Maximum number of PDW lists		1024
Maximum number of interleaved PDW lists	per R&S®SMW-K306 option	16 out of 1024
Interleaving		on/off
Threshold for pulse generation		–100 dB to 0 dB
Enable		select/deselect for interleaving
Time offset		$–1 \times 10^7$ s to 1×10^7 s
Priority		0 to 100 (0 corresponds to highest priority)
Level offset		–200 dB to 0 dB
Group		user created interleaving groups
Emitters (collection)		
Maximum number of emitters		1024
Maximum number of interleaved emitters	per R&S®SMW-K306 option	16 out of 1024
Interleaving		on/off
Threshold for pulse generation		–100 dB to 0 dB
Enable		select/deselect emitter for interleaving
Time offset		$–1 \times 10^7$ s to 1×10^7 s
Priority		0 to 100 (0 corresponds to highest priority)
Level offset		–200 dB to 0 dB
Group		user created interleaving groups
Localized emitters		
Maximum number of emitters		1024
Maximum number of interleaved emitters	per R&S®SMW-K306 option	16 out of 1024
Interleaving		on/off
Threshold for pulse generation		–100 dB to 0 dB
Enable		select/deselect emitter for interleaving
Time offset		$–1 \times 10^7$ s to 1×10^7 s
Priority		0 to 100 (0 corresponds to highest priority)
Level offset		–200 dB to 0 dB
Group		user created interleaving groups
Direction finding		
Maximum number of emitters		1024
Maximum number of interleaved emitters	per R&S®SMW-K306 option	16 out of 1024
Interleaving		on/off
Threshold for pulse generation		–100 dB to 0 dB
Enable		select/deselect emitter for interleaving
Time offset		$–1 \times 10^7$ s to 1×10^7 s
Priority		0 to 100 (0 corresponds to highest priority)
Level offset		–200 dB to 0 dB
Group		user created interleaving groups

Multiple emitters extension

R&S®SMW-K307

This option is an extension for the R&S®SMW-K306 multiple emitters option. It increases the maximum number of signals per baseband and interleaving group from 16 to 512.

Direction finding

R&S®SMW-K308, R&S®SMBV-K308, R&S®SMBVB-K308 and R&S®SGT-K308

The K308 option is only available as add-on to the combination of the K300 and K301 options. Therefore, each K308 option requires a K300 and a K301 option. Each simulation of an RF receiver port requires one K308 (R&S®SMW-B9).

Receivers

The following receiver properties are available.

Property types		
Model		
Type of receiver		Interferometer/TDOA/combined
Antennas		
Number of antennas per receiver		1 to 20
Individual antenna properties		
Position relative to receiver origin		
X		–2000 m to +2000 m
Y		–2000 m to +2000 m
Radius		0 m to 2000 m
Angle		0° to 360°
Height		–500 m to +500 m
Antenna pattern		
Type		all available patterns
Gain		–120 dB to +120 dB
Pointing direction		
Auto away from origin		on/off
Elevation		–90° to +90°
Azimuth		0° to 360°
Movements		
For movement types, refer to the description of R&S®SMW-K304 in section Movements.		

Scenario type

The following direction finding-based scenario types are available in addition to the scenario types provided with K300 and K301.

Scenario type		
Direction finding		
Number of emitters, interferers and background signals on the map	definable with the R&S®Pulse Sequencer RF software	1 to 1024
Maximum number of simultaneous waveform/signal playback, configuration examples [1]	R&S®SMBV100A, R&S®SMBV100B, R&S®SGT100A	1 ARB based signal per baseband generator
	R&S®SMW200A	1 ARB based signal per R&S®SMW-B9 wideband baseband generator
	R&S®SMW200A + 2 × R&S®SMW-B10 + 1 × R&S®SMW-K76	up to 4 ARB based signals per instrument
	R&S®SMW200A + 2 × R&S®SMW-B9 + 4 × R&S®SMW-B15 + R&S®SMW-K315 + R&S®SMW-K502 extended sequencer + R&S®Pulse Sequencer RF options	up to 6 PDW based signals per instrument
Platform/emitter/interferer properties		
Emitter behavior		
Static configuration	static mode and beam	mode and beam (defines sequence, antenna pattern and antenna scan)
Mode changes configuration	per operation mode entry, each entry consists of a mode/beam pair	mode and beam (defines sequence, antenna pattern and antenna scan) start and stop time of operation mode entry
Emitter parameters		sequence, antenna pattern, antenna scan, operation modes, beams
Interferer behavior (not available in K501/K502 extended sequencer mode)		
Static configuration	static	antenna pattern and antenna scan
Interferer parameters		ARB waveform object, EIRP
Position mode		
Static	single static position	
East		-1×10^9 m to 1×10^9 m
North		-1×10^9 m to 1×10^9 m
Height		-1×10^9 m to 1×10^9 m
Yaw		0° to 360°
Pitch		–90° to +90°
Roll		0° to 360°
Point to receiver		on/off
Steps	multiple static position steps	
Background signals properties		
Signal source		any sequence or waveform
Level at receiver origin		–100 dB to +25 dB
Frequency		1 kHz to 100 GHz
Receiver properties		
Receiver		any DF receiver
Position mode		
Static	single static position	
Height		-1×10^9 m to 1×10^9 m
Yaw		0° to 360°
Pitch		–90° to +90°
Roll		0° to 360°
Output		ARB waveform, multisegment waveform
Clock rate		auto (oversampling 1 to 1000)
		manual (1 Hz to 2.4 GHz)
Duration		sequence
		fixed duration (1 µs to 1843200 s)
		one antenna scan
Markers		scenario markers
		M1 at scenario start
Threshold for pulse generation		–100 dB to 0 dB

[1] Number of resulting signals/waveforms depends on number of configured receive antennas, e.g. a scenario with a single emitter and four receive antennas produces four signals/waveforms.

2D map import

R&S®SMW-K309

The K309 option is only available as add-on to the combination of the K300 and K301 options. Therefore, each K309 option requires a K300 and a K301 option.

Parameter type		
Map file format		
Supported formats		geoTiff
Positioning parameters		
Longitude		–180° to +180°
Latitude		–90° to +90°
Altitude		-1×10^9 m to 1×10^9 m

Extended sequencing for R&S®SMW-B10

The R&S®SMW-K501 extended sequencing option can be used manually via sequencing lists and waveform segments or via the R&S®Pulse Sequencer RF software and its R&S®SMW-K300 and R&S®SMW-K301 options. In both cases, memory requirements are reduced to a minimum and playtime is increased enormously.

The extended sequencing option is mainly intended for use with pulsed signals. It is based on a sequencing file that defines the relative start time of each pulse and additionally specifies parameters such as amplitude, offset frequency and phase. Pulses with rectangular envelope and common MOP types can be entirely generated in real time and do not require a waveform segment at all.

Parameter type		
Data format		
Sequencing file		mandatory, memory shared with I/Q data and segment addresses
I/Q data file		optional
Segment addresses		optional
Memory requirements		
Sequencing file	minimum	14 byte/pulse
	maximum	26 byte/pulse
Segment addresses		16 byte/waveform segment
I/Q data file		4 byte/I/Q sample
File size		
Sequencing file	rectangular pulses, unmodulated, variable amplitude, 5 ms PRI	187 kbyte/min
	rectangular pulse, linear FM, variable FM, variable amplitude, phase and frequency, 5 ms PRI	305 kbyte/min
Setting granularity		
Time	with R&S®SMW-B10 option	5 ns
Amplitude		16 bit (voltage-based)
Phase		< 0.01°
Frequency	with R&S®SMW-B10 option	0.05 Hz
I/Q segments		
Maximum individual segments		16 777 216
Length granularity	with R&S®SMW-B10 option	32 samples
Timing		
Maximum play time	with R&S®SMW-B10 option	24 h
Minimum pulse width	with R&S®SMW-B10 option, real-time	1 sample, 5 ns
	with R&S®SMW-B10 option, I/Q segment	1 samples, 5 ns
Minimum PRI/frequency switching	with R&S®SMW-B10 option	1 µs
Limitations		
Settings disabling extended sequencing data generation		non-0/100 timing, no blank signal between pulses, short PRI
Settings permitting real-time pulse generation		rectangular pulse envelope, unmodulated or real-time MOP
Real-time MOP types		
Linear FM		up, down, triangular
Phase		Barker
Marker signals		
Number of marker signals		3
Marker types	default M1, M2, M3	active during pulse
	sequence start signal enabled	M1 active at sequence start

Wideband extended sequencing for R&S®SMW-B9

The R&S®SMW-K502 extended sequencing option is controlled by the R&S®Pulse Sequencer RF software and its options R&S®SMW-K300 and R&S®SMW-K301. In both cases, memory requirements are reduced to a minimum and playtime is increased enormously.

The extended sequencing option is mainly intended for use with pulsed signals. It is based on a sequencing file that defines the relative start time of each pulse and additionally specifies parameters such as amplitude, offset frequency and phase. Pulses with rectangular envelope and common MOP types can be entirely generated in real time and do not require a waveform segment at all.

Parameter type		
Data format		
Sequencing file		mandatory, memory shared with I/Q data and segment addresses
I/Q data file		optional
Segment addresses		optional
Memory requirements		
Sequencing file		32 byte/pulse
Segment addresses		16 byte/waveform segment
I/Q data file		4 byte/I/Q sample
Setting granularity		
Time	with R&S®SMW-B9 option	417 ps
Amplitude		16 bit (voltage-based)
Phase		< 0.01°
Frequency	with R&S®SMW-B9 option	0.58 Hz
I/Q segments		
Maximum individual segments		16 777 216
Length granularity	with R&S®SMW-B9 option	32 samples
Timing		
Maximum play time	with R&S®SMW-B9 option	1843200 s
Minimum pulse width	with R&S®SMW-B9 option, real-time	3.3 ns
	with R&S®SMW-B9 option, I/Q segment	417 ps
Minimum PRI/frequency switching	with R&S®SMW-B9 option, real-time	0.3 µs
	with R&S®SMW-B9 option, I/Q segment	1 µs
Limitations		
Settings disabling extended sequencing data generation		non-0/100 timing, no blank signal between pulses, short PRI
Settings permitting real-time pulse generation		rectangular pulse envelope, unmodulated or real-time MOP
Real-time MOP types		
Unmod		rectangular pulse
Linear FM		up, down, triangular
Phase		Barker
Marker signals		
Number of marker signals		3
Marker types	default M1, M2, M3	active during pulse
	sequence start signal enabled	M1 active at sequence start

Pulse-on-pulse simulation

R&S®SMW-K315

This option can be used for two different applications:

- Radar signal generation using PDW streaming with R&S®SMW-K503/K504. Refer to the R&S®SMW200A specifications (PD 3606.8037.22)
- Radar signal generation with R&S®Pulse Sequencer RF software, which is described here

The option allows to generate up to six pulse-on-pulse (simultaneous) baseband signals in a single instrument. It allows the generation of time overlapping pulse-on-pulse signals. Thus, up to six emitters can be generated simultaneously on one R&S®SMW200A. Each R&S®SMW-B9 baseband generator, with an installed R&S®SMW-K306 option, can also be used to generate a group of 16 interleaved emitters instead of one. In case of interleaving emitters (R&S®SMW-K306), drop-out rates can be reduced by distributing emitters onto more baseband resources.

The K315 option in combination with R&S®Pulse Sequencer RF software is only available as add-on to the combination of the following minimum instrument configuration: 2 × R&S®SMW-B9 + 2 × K300, 2 × K301, 2 × K502 and 2 × R&S®SMW-B15 options. This particular configuration allows four pulse-on-pulse signals or emitters. The number of R&S®SMW-B15 boards can be increased to four in order to enable six pulse-on-pulse signals or emitters. The complexity of a data repository has to be set to advanced K300/K301 or to K308 mode.

PDW report generation

Pulse description words (PDW) describe the main properties of a single pulse. The R&S®Pulse Sequencer RF software can generate PDW reports during scenario calculation. A PDW report consists of a list of all calculated PDWs for a certain scenario. The PDW report feature is only available with a vector signal generator connected. The connected vector signal generator must be equipped with all necessary options for the scenario.

Report types		
Default		
Format		text (table), format can be customized
Parameters		TOA, RF center frequency, pulse width, power level, MOP type, bandwidth
Template		
Format		text (table)
Parameters		TOA, RF frequency, power level, MOP type, bandwidth, PRI, PRF, pulse width, rise time, fall time, phase, AOA (emit azi, emit ele), rx scan azi, rx scan ele, sequencing parameters, custom variables
Plug-in		
Format		64 bit Windows .dll, API specified in user manual

Path loss compensation

The R&S®Pulse Sequencer Software provides built-in routines for path loss compensation.

Alignment database location		home path, network drive, mass storage on signal generator
Compensation method		scalar level offset versus frequency
Supported power sensors		
R&S®NRPxxSN, R&S®NRPxxTN, R&S®NRPxxAN		directly via LAN, connected to signal generator (legacy mode)
R&S®NRPxxS, R&S®NRPxxT, R&S®NRPxxA, R&S®NRPxxP		directly via USB, connected to signal generator (legacy mode)
R&S®NRP-Zxx		connected to signal generator

Supported generators

The R&S®Pulse Sequencer RF software can use real connected generators and virtual generators to generate a signal. In order to generate a signal, generators must include a minimum set of options required by the scenario. For the generation of a real RF signal a physical generator must be linked to the PC. Virtual generators are intended for the signal generation on a file (ARB or K502 extended sequencer format) in case a real vector signal generator is not present. The following signal generators are supported.

Signal generator		
R&S®SMW200A		
Options		R&S®SMW-K300, R&S®SMW-K301, R&S®SMW-K302, R&S®SMW-K304, R&S®SMW-K306, R&S®SMW-K307, R&S®SMW-K308, R&S®SMW-K309, R&S®SMW-K315, R&S®SMW-K501, R&S®SMW-K502
R&S®SMM100A		
Options		R&S®SMM-K300, R&S®SMM-K301
R&S®SMBV100A		
Options		R&S®SMBV-K300, R&S®SMBV-K301, R&S®SMBV-K308
R&S®SMBV100B		
Options		R&S®SMBVB-K300, R&S®SMBVB-K301, R&S®SMBVB-K308
R&S®SGT100A		
Options		R&S®SGT-K300, R&S®SGT-K301, R&S®SGT-K308

Remote control of R&S®Pulse Sequencer Software

Interfaces		raw socket connection
Command set		SCPI 1999.5 or compatible command sets
Parameters		
Host		IPv4 address and port number
Access control		allow and deny list

PC hardware requirements

Minimum hardware configuration		
Operating system		Windows 10, 64 bit
CPU		dual-core, 3 GHz
RAM		8 Gbyte
Video		Nvidia Quadro 128 Mbyte or ATI Radeon
Video resolution		1280 × 1024 pixel
Rendering		OpenGL, shader model 3
Network		LAN, 1 Gbyte/s
Recommended hardware configuration		
CPU		Intel i7 hexa-core, Intel Xeon hexa-core, AMD FX series
RAM		32 Gbyte
Video resolution		1920 × 1200 pixel

Ordering information

Designation	Type	Order No.
Options with external R&S®Pulse Sequencer Software		
R&S®SMW200A		
Pulse sequencing	R&S®SMW-K300	1413.8805.02
Enhanced pulse sequencing	R&S®SMW-K301	1413.9776.02
Radar platforms	R&S®SMW-K302	1413.8857.02
Moving emitters	R&S®SMW-K304	1413.8957.02
Multiple emitters	R&S®SMW-K306	1413.9053.02
Multiple emitters extension	R&S®SMW-K307	1413.3510.02
Direction finding	R&S®SMW-K308	1414.1433.02
2D map import	R&S®SMW-K309	1414.6706.02
Pulse-on-pulse simulation	R&S®SMW-K315	1414.6529.02
Extended sequencing	R&S®SMW-K501	1413.9218.02
Wideband extended sequencing	R&S®SMW-K502	1413.9260.02
R&S®SMM100A		
Pulse sequencing	R&S®SMM-K300	1441.1153.02
Enhanced pulse sequencing	R&S®SMM-K301	1441.1201.02
R&S®SMBV100A		
Pulse sequencing	R&S®SMBV-K300	1419.2744.02
Enhanced pulse sequencing	R&S®SMBV-K301	1419.2780.02
Direction finding	R&S®SMBV-K308	1419.2973.02
R&S®SMBV100B		
Pulse sequencing	R&S®SMBVB-K300	1423.8414.02
Enhanced pulse sequencing	R&S®SMBVB-K301	1423.8420.02
Direction finding	R&S®SMBVB-K308	1423.8437.02
R&S®SGT100A		
Pulse sequencing	R&S®SGT-K300	1419.7652.02
Enhanced pulse sequencing	R&S®SGT-K301	1419.7700.02
Direction finding	R&S®SGT-K308	1419.7730.02

Introduction R&S®Pulse Sequencer Digital

The R&S®Pulse Sequencer Digital software and its respective software options have been specifically developed for easy generation of pulsed signals for software-based testing, digital training and digital validation of algorithms and systems.

Its generic output interface directly transfers PDW parameters to a user written plug-in in a specified format.

The R&S®Pulse Sequencer Digital software together with the R&S®PULSE-K32 option provides basic simulation capabilities.

In simple scenario complexities, it allows generating pulsed signals with basic modulation schemes. Signals with simple pulses, pulse trains and repetition of pulses can be generated. In addition, pulse trains with different pulses and pulse breaks can be generated sequentially.

For simulations with higher complexity, it supports the use of various control elements for sequencing applications. In addition, influences of antenna diagrams and antenna scans can be considered. Pulse sequences, antenna diagrams and antenna scans can be combined to an emitter. For scenario simulation, multiple emitters together with a receiver can be placed on a 2D map.

The R&S®PULSE-K32 standard version allows the simulation of platforms, on which several emitters can be placed and positioned.

The R&S®PULSE-K39 expert upgrade extends the R&S®Pulse Sequencer Digital software in combination with the R&S®PULSE-K32 option by advanced simulation capabilities.

By supporting dynamic simulations with moving emitters and a moving receiver, complex scenarios with real world vehicles can be simulated. Apart from easy to use point and click definition in map-based scenario types, a sophisticated waypoint interface as well as real world kinematics are supported.

The user can import georeferenced maps and perform positioning and movement traces based on real world longitude and latitude coordinates rather than relative ones that are based on the receiver position.

The R&S®PULSE-K39 expert upgrade also provides a scenario type for direction finding applications. A receiver model which can include multiple antennas with individual positioning is introduced and individual receive signals for each antenna port are calculated.

Multiple emitter signals for all scenario types can be merged into a single output signal either by using a priority-based dropping algorithm or time-based merging.

This section describes the software options working with the PC-based R&S®Pulse Sequencer Digital software:

- R&S®PULSE-K32 standard version of R&S®Pulse Sequencer Digital software
- R&S®PULSE-K39 expert upgrade of R&S®Pulse Sequencer Digital software

Key features

R&S®PULSE-K32 standard version of R&S®Pulse Sequencer Digital

Basic scenario complexity features:

- Pulse shape definition
- Modulation on pulse with all major formats like chirps, Barker codes, polyphase codes, PSKs, AM, FM
- Single pulse, pulse train generation with repetition count per pulse
- Inter pulse modulation of amplitude, phase, frequency, etc. values from pulse to pulse
- Import of PDW files

High scenario complexity features:

- Powerful sequencing with loops, nested loops
- Antenna diagram definition and antenna scan definition
- Antenna diagrams like pencil beams, cosecant beams, Gaussian, user defined, phased array antenna diagrams
- Antenna scan types like helical scans, circular scans, conical scans
- Emitter definition by waveforms, antenna diagram, antenna scan, attitude information, EIRP and carrier frequency
- Receiver definition by antenna diagram, antenna scan and attitude information
- Dynamic behavior using mode changes
- Calculation of signal considering one-way free space propagation according to emitter and receiver location on a 2D map
- Simulation of real live vehicles, that carry multiple radar emitters on a common platform
- All emitters carried by a platform can be configured for use of mode changes as well

R&S®PULSE-K39 expert upgrade of R&S®Pulse Sequencer Digital adds

- Enhanced localized and direction-finding scenario types by movement profiles for emitters and receivers
- Predefined line and arc movements, traces as well as waypoint import interface for complex movement traces
- WGS84 waypoint interface and import of NMEA waypoints
- Import of Google Earth and Google Maps .kml files
- East-North-Up (ENU) 2D vector trajectory interface (line, arc) for automatic waypoint generation
- Motion interface for dynamics input (velocity vector or velocity magnitude) in ENU and WGS84
- User-definable and predefined vehicle description files for land vehicles, ships, aircraft and spacecraft
- Smoothing of waypoints using vehicle description files
- Allows interleaving of multiple PDW lists in the PDW list scenario type and interleaving of emitters in emitters collection, localized emitters and direction-finding scenario types into a single output file.
- Direction-finding scenario type
- Direction finding receiver definition with up to 20 antennas with individual positioning and pointing
- Individual signal generation for each receive antenna
- Allows the import of georeferenced map files (.geoTiff)
- Positioning can be performed using real world longitude and latitude coordinates
- 2D and 3D visualization of map content

Minimum configuration

Minimum configuration is a single R&S®PULSE-K32 option installed on a workstation.

R&S®PULSE-K32 standard version of R&S®Pulse Sequencer Digital

Pulses

Parameter type		
Timing		
Rising edge		0 s to 3600 s
Falling edge		0 s to 3600 s
Standard edge types		linear
Width		0 s to 3600 s
MOP		
Available modulation types		see MOP section
Marker		
Number of markers		M1 to M4

Inter pulse modulation (IPM)

Inter pulse modulation varies pulse parameters from pulse to pulse. The IPM mechanism is used to generated PRI stagger or frequency hopping, for example. The output of multiple IPM profiles can be combined.

Types of inter pulse modulation profiles		
Steps		
Start		-1×10^9 to 1×10^9
Increment		-1×10^9 to 1×10^9
Steps		1 to 10000
Burst length		1 to 1000
Burst period		1 ns to 10^9 s
List		
Parameters per entry		value, repetitions
Firing order		sequencing of list entries
Number of entries		8000
Value		-1×10^9 to 1×10^9
List base		repetitions/time
Repetitions		1 to 10^9
Time		1 ns to 10^9 s
Waveform		
Type		ramp, sine, triangular
DC offset		-1×10^9 to 1×10^9
Phase offset		-1×10^9 to 1×10^9
Peak to peak		-1×10^9 to 1×10^9
Period time		1 ns to 10^9 s
Pulse count		1 to 10^9
Interpolated shape		
Parameters per entry		value
Number of entries		8000
Value		-1×10^9 to 1×10^9
Period time		1 ns to 10^9 s
Pulse count		1 to 10^9
Interpolation		linear, none (s/h)
Binomial		
Value 1		-1×10^9 to 1×10^9
Probability		0 % to 100 %
Value 2		-1×10^9 to 1×10^9
Equation		
Random list		
Burst length		1 to 8192
Burst period		1 ns to 10^9 s
Avoid reuse		yes, no
Values per entry		value
Number of entries		1024
Value		-1×10^6 to 1×10^6
Random steps		
Minimum		-1×10^6 to 1×10^6
Maximum		-1×10^6 to 1×10^6
Step size minimum		0 to 10^6
Step size maimum		0 to 10^6
Periodicity count		0 to 4096

Random		
Distribution		uniform, normal, U
Minimum		-1×10^9 to 1×10^9
Maximum		-1×10^9 to 1×10^9
Step		-1×10^9 to 1×10^9
Plug-in		
Format		64 bit Windows .dll, API specified in user manual
Unit of affected parameter		none, time in s, frequency in Hz, level in dB, phase in °, percent in %
Available parameters		
Level		offset in dB, attenuation base in dB
Modulation		AM modulation depth in %, FM deviation in Hz, FM frequency in Hz, chirp deviation in Hz, AM frequency in Hz
Timing		rise time in s, pulse width in s, delay in s, fall time in s, PRF in Hz, PRI in s
Phase		offset in °
Frequency		offset in Hz
Other		custom variables that can be used in equation parsers

Modulation on pulse (MOP)

The modulation on pulse describes the modulation used within a pulse. The R&S®Pulse Sequencer Digital software supports a wide range of built-in MOP types.

MOP types		
AM		
Types		standard, LSB, USB, LSB+USB
Frequency		1 mHz to 1 GHz
Modulation depth		0 % to 100 %
ASK		
Modulation depth		0 % to 100 %
Inverted		yes, no
Symbol rate		1 Hz to 1 GHz
AM step		
Values per step		duration, level
Number of entries		1024
FM		
Frequency		1 mHz to 1 GHz
Deviation		1 mHz to 1 GHz
FSK		
Type		2/4/8/16/32/64FSK
Deviation		1 mHz to 2 GHz
Symbol rate		1 Hz to 1 GHz
FM step		
Values per step		duration, frequency
Number of entries		1024
MSK		
Symbol rate		1 Hz to 1 GHz
Linear chirp		
Types		up, down, sine, triangular
Deviation		1 Hz to 1 GHz
Polynomial chirp		
Values		term, coefficient
Coefficient range		-1×10^{22} to 1×10^{22}
Number of entries		1024
Barker		
Codes		R3, R4a, R4b, R5, R7, R11, R13
Transition time (const. envelope)		0 % to 50 %
Polyphase		
Codes		Frank, P1, P2, P3, P4
Length M		1 to 64

Custom phase		
Values		phase in °
Number of entries		1024
BPSK		
Types		standard, constant envelope
Symbol rate		auto fit to PW, 1 Hz to 1 GHz
Phase change		0.1° to 180°
Transition		linear, cosine
Transition duration		0 % to 50 %
QPSK		
Types		standard, OQPSK, DQPSK, SOQPSK-A, SOQPSK-B, SOQPSK-TG
Symbol rate		1 Hz to 1 GHz
8PSK		
Symbol rate		1 Hz to 1 GHz
QAM		
Type		16/32/64/128/256QAM
Symbol rate		1 Hz to 1 GHz
White noise		
Bandwidth		1 Hz to 1 GHz

Sequences

A sequence combines multiple pulses or waveforms to the final output signal.

Sequencing element		
Pulse		
Repetition count		fixed, randomly selected, auto set by duration
IPM		static, any combination of available IPM profiles
Marker 1 to 4		first, last, all
		variable comparision against value (<, >, =, !=)
Delta frequency		–1 GHz to +1 GHz
Delta level		–100 dB to +30 dB
Phase		–180° to +180°
PRI		pulse duration to 10^9 s
Delay		0 to (PRI – pulse duration)
Loop		
Repetition count		fixed, randomly selected
Filler		
Signal		blank, CW, hold last sample
Mode		duration, time synchronization
Time		fixed, equation
Global parameters		
Number of line items		1 to 256
Phase mode		absolute, continuous, memory

Waveforms and imported signals

Waveforms can be used in sequences if custom data shall be used instead of a computed pulse.

Parameter type		
PDW		text based custom PDW data in combination with an import template file
AMMOS IF		Rohde & Schwarz specific format
AMMOS PDW		Rohde & Schwarz specific format
Maximum file size		10 Gbyte

Emitters

The following emitter properties are available.

Property types		
Emitter		
EIRP		–200 dBm to +200 dBm
Frequency		1 kHz to 100 GHz
Number of modes per emitter		32
Number of beams per mode		32
Modes		
Antenna pattern		1 per mode
Scan type		1 per mode
Beams		
Active		yes, no
Sequence		1 per beam
Frequency offset		–100 MHz to +100 MHz
Beam offset elevation		–180° to +180°
Beam offset azimuth		–180° to +180°

Antenna patterns

The following antenna patterns can be applied to emitters and receiver.

Antenna types		
Dipole		
Cardiod		
Exponent		1 to 20
Parabolic		
Frequency		1 MHz to 100 GHz
Bandwidth		1 MHz to 100 GHz
Simulate back lobe		yes
Back lobe attenuation		0 dB to 100 dB
Diameter		0.05 m to 100 m
Gaussian		
Frequency		no
Bandwidth		no
Simulate back lobe		yes
Back lobe attenuation		0 dB to 100 dB
HPBW Azimuth		0.1° to 60°
HPBW elevation		0.1° to 60°
Sin(x)/x		
Frequency		1 MHz to 100 GHz
Bandwidth		1 MHz to 100 GHz
Simulate back lobe		yes
Back lobe attenuation		0 dB to 100 dB
HPBW		0.1° to 45°
HPBW		0.1° to 45°
Pyramidal horn		
Frequency		1 MHz to 100 GHz
Bandwidth		1 MHz to 100 GHz
Simulate back lobe		yes
Back lobe attenuation		0 dB to 100 dB
Length X		0.01 m to 100 m
Length Z		0.01 m to 100 m
Cosecant squared		
Frequency		no
Bandwidth		no
Simulate back lobe		yes
Back lobe attenuation		0 dB to 100 dB
HPBW		0.01° to 30°
Theta 1		0.01° to 90°
Theta 2		0.01° to 90°

Planar phased array		
Frequency		1 MHz to 100 GHz
Bandwidth		1 MHz to 100 GHz
Simulate back lobe		yes
Back lobe attenuation		0 dB to 100 dB
Aperture distribution		uniform, parabolic, cosine, cosine squared, cos^N, triangular, Hamming, Hann
Antenna element type		omnidirectional, cosine
Elements X		1 to 1000
Elements Z		1 to 1000
Spacing X		0.001 m to 1 m
Spacing Z		0.001 m to 1 m
Pedestal		0 to 1 (parabolic, cosine, cosine squared, triangular, Hamming, Hann aperture distribution)
cos^N		2 to 10 (cos^N aperture distribution)
Custom phased array		
Frequency		1 MHz to 100 GHz
Bandwidth		1 MHz to 100 GHz
Simulate back lobe		yes
Back lobe attenuation		0 dB to 100 dB
Aperture distribution		uniform, parabolic, cosine, cosine squared, cos^N, triangular, Hamming, Hann
Antenna element type		omnidirectional, cosine
Geometry		uniform rect, uniform linear, uniform hex, circular planar
Uniform rect		
Elements		1 to 1000
Elements Z		1 to 1000
Spacing X		0.001 m to 1 m
Spacing Z		0.001 m to 1 m
Lattice		rectangular, triangular
Uniform linear		
Elements		1 to 1000
Spacing		0.001 m to 1 m
Uniform hex		
Elements/side		1 to 50
Spacing		0.001 m to 1 m
Circular planar		
Radius		1 to 50
Spacing		0.001 m to 1 m
Lattice		rectangular, triangular
Import from file		
Supported formats		.csv (comma separated values)
		.ffe (FEKO far field)
		.ant_pat (Rohde & Schwarz pattern file)
		.tsv (Antenna Magnus)
		.ffd (Ansys HFSS)
Frequency		yes
Bandwidth		yes
Simulate back lobe		yes
Custom		
Frequency		no
Bandwidth		no
Simulate back lobe		yes
Back lobe attenuation		0 dB to 100 dB
HPBW XY		0.01° to 90°
HPBW YZ		0.01° to 90°
Side lobe level		0 dB to 100 dB
Roll off factor		0 dB to 100 dB
Side lobe scale		0.2 to 5

Antenna scans

The following scan types can be applied to emitters and receivers. Certain scan types can be used as electronic scans for phased array antennas.

Scan types		
Circular		
Mode		rpm, sec
Scan period		6 ms to 6000s
Scan rate		0.01 rpm to 1000 rpm
Direction		CW, CCW
Nodding		on/off
Elevation rate		0.01°/s to 2000°/s
Elevation angle		0.01° to 90°
Palmer scan		on/off
Scan rate		100 mHz to 1 kHz
Squint angle		0.05° to 45°
Sector		
Electronic scan		on/off
Sector width		0.01° to 360°
Scan rate		0.01 rpm to 1000 rpm
Unidirectional		on/off
Flyback time		0 s to 1 s (with unidirectional = on)
Nodding		on/off
Elevation rate		0.01°/s to 2000°/s
Elevation angle		0.01° to 90°
Palmer scan		on/off
Scan rate		100 mHz to 1 kHz
Squint angle		0.05° to 45°
Raster		
Electronic scan		on/off
Raster width		0.01° to 180°
Bar width		0.01° to 180°
Scan rate		0.01 rpm to 10000 rpm
Bar count		1 to 1000
Retrace time		0 s to 1 s
Unidirectional		on/off
Direction		horizontal/vertical
Flyback time		0 s to 1 s (with unidirectional = on)
Bar transition time		0 s to 1 s (with unidirectional = off)
Rewind		on/off
Palmer scan		on/off
Scan rate		100 mHz to 1 kHz
Squint angle		0.05° to 45°
Conical		
Electronic scan		on/off
Scan rate		10 mHz to 1 kHz
Direction		CW, CCW
Squint angle		0.01° to 30°
Helical		
Electronic scan		on/off
Scan rate		0.01°/s to 1000°/s
Turns		1 to 1000
Step angle		0.01° to 30°
Retrace time		0 s to 1 s
Direction		CW, CCW
Spiral		
Electronic scan		on/off
Rounds		1 to 100
Round time		1 µs to 1 s
Angular step		0.1° to 5°
Retrace time		0 s to 1 s
Direction		CW, CCW
Palmer scan		on/off
Scan rate		100 mHz to 1 kHz
Squint angle		0.05° to 45°

Lobe switching		
Electronic scan		on/off
Lobes		2, 4
Squint angle		0.05° to 15°
Dwell time		1 µs to 1 s
Direction		vertical, horizontal with 2 lobes only
Rotation		CW, CCW with 4 lobes only
Sine		
Electronic scan		on/off
Width		1.00° to 180°
Height		1.00° to 90°
Scan rate		0.01 rpm to 1000 rpm
Direction		CW, CCW
Unidirectional		on/off
Invert up/down scan		on/off
Custom (list of entries)		
Electronic scan		on/off
Azimuth		–180° to +180°
Elevation		–90° to +90°
Dwell time		0 s to 3600 s
Interpolate to next		true/false (move or jump to next coordinate)
Transition time		0 s to 3600 s (if interpolate to next is true, this parameter resembles the time for the transition to the next coordinate)
Lissajous		
Electronic scan		on/off
Amplitude X		0.01° to 45°
Amplitude Z		0.01° to 45°
Frequency		0.01 Hz to 1000 Hz
Freq X ratio		1 to 10
Freq Z ratio		1 to 10
Phase X		0° to 360°
Phase Z		0° to 360°

Radar platforms

The following platform properties are available.

Property types		
Emitters		
Number of emitters per platform		1 to 8
Individual emitter properties		
Static position relative to platform origin		
X		–2000 m to +2000 m
Y		–2000 m to +2000 m
Radius		0 m to 2000 m
Angle		0° to 360°
Height		–500 m to +500 m
Emitter		
Type		all available emitter types
Blank ranges	signal mutes in these sectors	start angle/stop angle 0° to 360°
Pointing direction		
Auto away from origin		on/off
Elevation		–90° to +90°
Azimuth		0° to 360°
Roll		–180° to +180°
Movements		
For movement types, refer to description of R&S®PULSE-K39 in section Movements.		

Scenarios

The following scenario types are available:

Scenario type		
Single sequence		
Sequence		1 single sequence
Output		PDW
Duration		auto
		fixed duration (1 µs to 1843200 s)
Markers		sequence markers
		M1 at scenario start
Threshold for pulse generation		–100 dB to 0 dB
Sequences (collection)		
Sequences		1 to 1024
Output		PDW
Duration		auto
		fixed duration (1 µs to 1843200 s)
Markers		sequence markers
		M1 at scenario start
Threshold for pulse generation		–100 dB to 0 dB
PDW list (collection)		
PDW file		1 waveform object with type PDW data
Number of PDW files		1 to 1024 (1 per destination or interleaved with R&S®PULSE-K39 option)
Absolute level		–130 dBm to +30 dBm
Frequency		0 Hz to 100 GHz
Output		PDW
Duration		auto
Markers		M1 at scenario start, pulse
Threshold for pulse generation		–100 dB to 0 dB
Single emitter		
Yaw		0° to 360°
Pitch		–90° to +90°
Roll		0° to 360°
Output		PDW
Duration		auto
		fixed duration (1 µs to 1843200 s)
Markers		scenario markers
		M1 at scenario start
Threshold for pulse generation		–100 dB to 0 dB
Emitters (collection)		
Emitter		sequence, antenna pattern, antenna scan, operation modes, beams
Number of emitters		1 to 1024 (1 per destination or interleaved with R&S®PULSE-K39 option)
Frequency offset		–2 GHz to +2 GHz
Scan delay		–3600 s to +3600 s
Absolute level		–130 dBm to +30 dBm
Operation mode		static/mode changes
Yaw		0° to 360°
Pitch		–90° to +90°
Roll		0° to 360°
Output		PDW
Duration		auto
		fixed duration (1 µs to 1843200 s)
Markers		scenario markers
		M1 at scenario start
Threshold for pulse generation		–100 dB to 0 dB

Localized emitters		
Number of platforms, emitters, interferers and background signals		1 to 1024 (1 per destination or interleaved with R&S®PULSE-K39 option)
Platform/emitter/interferer properties		
Emitter behavior		
Static configuration	static mode and beam	mode and beam (defines sequence, antenna pattern and antenna scan)
Mode changes configuration	per operation mode entry each entry consists of a mode/beam pair	mode and beam (defines sequence, antenna pattern and antenna scan) start and stop time of operation mode entry
Emitter parameters		sequence, antenna pattern, antenna scan, operation modes, beams
Position mode		
Static	single static position	
East		-1×10^9 m to 1×10^9 m
North		-1×10^9 m to 1×10^9 m
Height		-1×10^9 m to 1×10^9 m
Yaw		0° to 360°
Pitch		–90° to +90°
Roll		0° to 360°
Point to receiver		on/off
Steps	multiple static position steps	
Background signals properties		
Signal source		any sequence or waveform
Level at receiver origin		–100 dB to +25 dB
Frequency		1 kHz to 100 GHz
Receiver properties		
Antenna pattern		all available antenna patterns
Scan		all available antenna scans
Gain		–120 dB to +120 dB
Position mode		
Static	single static position	
Height		-1×10^9 m to 1×10^9 m
Yaw		0° to 360°
Pitch		–90° to +90°
Roll		0° to 360°
Duration		auto
		fixed duration (1 µs to 1843200 s)
Markers		scenario markers
		M1 at scenario start
Threshold for pulse generation		–100 dB to 0 dB

R&S®PULSE-K39 expert upgrade of R&S®Pulse Sequencer Digital

The R&S®PULSE-K39 option extends the R&S®PULSE-K32 option with additional simulation capabilities, such as movements, interleaving and direction finding. This option is only available as add-on to the R&S®PULSE-K32 option.

Movements

Extends the position mode for platforms, emitters and the receiver to allow motion simulation. The motion trajectories can be created via the pulse sequencer GUI or by importing text-based waypoint files.

The following position options become available for platforms, emitters and receivers in addition to the scenario features already provided with the R&S®PULSE-K32 option.

Position mode moving		
Trajectory line		
Start position		
East		–1 × 10^9 m to 1 × 10^9 m
North		–1 × 10^9 m to 1 × 10^9 m
Height		–1 × 10^9 m to 1 × 10^9 m
Speed		0.1 m/s to 5999 m/s
Acceleration		–100 m/s^2 to +100 m/s^2
End position		
East		–1 × 10^9 m to 1 × 10^9 m
North		–1 × 10^9 m to 1 × 10^9 m
Height		–1 × 10^9 m to 1 × 10^9 m
Mode		cyclic, round trip, one way
Trajectory arc		
Start position		
East		–1 × 10^9 m to 1 × 10^9 m
North		–1 × 10^9 m to 1 × 10^9 m
Height		–1 × 10^9 m to 1 × 10^9 m
Speed		0.1 m/s to 5999 m/s
Angle		–360° to +360°
Center position		
East		–1 × 10^9 m to 1 × 10^9 m
North		–1 × 10^9 m to 1 × 10^9 m
Mode		cyclic, round trip, one way
Trajectory traces		
Trace point properties		
East		–1 × 10^9 m to 1 × 10^9 m
North		–1 × 10^9 m to 1 × 10^9 m
Height		–1 × 10^9 m to 1 × 10^9 m
Speed		0 m/s to 5999 m/s
Readout mode		cyclic, round trip, one way
Reference frame		WGS-84, PZ-90.11
Smoothing	based on vehicle description file	on/off
Vehicle description file		.xvd file format (see user manual)
Attitude behavior		align to motion, constant
Yaw	only for constant	–180° to +180°
Pitch	only for constant	–90° to +90°
Roll	only for constant, align to motion	–180° to +180°
Trajectory waypoints		
Waypoint file		XTD (proprietary tracjectory format), .kml, .nmea, .txt; see user manual for format description
Readout mode		cyclic, round trip, one way
Reference frame		WGS-84, PZ-90.11
Smoothing	based on vehicle description file	on/off
Vehicle description file		.xvd file format (see user manual)
Attitude behavior		from waypoint file, align to motion, const.
Yaw	only for constant	–180° to +180°
Pitch	only for constant	–90° to +90°
Roll	only for constant, align to motion	–180° to +180°
Receiver position properties		
Latitude	geodetic reference	–90° to +90°
Longitude	geodetic reference	–180 to +180°

Direction finding

Simulation of direction finding becomes available. Individual receive signals for each receive antenna are calculated.

The following receiver properties are available.

Property types		
Model		
Type of receiver		interferometer/TDOA/combined
Antennas		
Number of antennas per receiver		1 to 20
Individual antenna properties		
Position relative to receiver origin		
X/Y		–2000 m to +2000 m
Radius		0 m to 2000 m
Angle		0° to 360°
Height		–500 m to +500 m
Antenna pattern		
Type		all available patterns
Gain		–120 dB to +120 dB
Pointing direction		
Auto away from origin		on/off
Elevation		–90° to +90°
Azimuth		0° to 360°
Movements		
For movement types, refer to the description of R&S®PULSE-K39 in section Movements.		

The following direction finding-based scenario types are available in addition to the scenario types provided with the R&S®PULSE-K32 option.

Scenario type		
Direction finding		
Number of emitters		1 to 1024 (1 per destination or interleaved with R&S®PULSE-K39 option)
Platform/emitter/properties		
Emitter behavior		
Static configuration	static mode and beam	mode & beam (sequence, pattern & scan)
Mode changes configuration	per operation mode entry, each entry consists of a mode/beam pair	mode & beam (sequence, pattern & scan) start and stop time of operation mode entry
Emitter parameters		sequence, pattern & scan, operation modes, beams
Position mode		
Static	single static position	
East/North		–1 × 10^9 m to 1 × 10^9 m
Height		–1 × 10^9 m to 1 × 10^9 m
Yaw		0° to 360°
Pitch		–90° to +90°
Roll		0° to 360°
Point to receiver		on/off
Steps	multiple static position steps	
Background signals properties		
Signal source		any sequence or waveform
Level at receiver origin		–100 dB to +25 dB
Frequency		1 kHz to 100 GHz
Receiver properties		
Receiver		any DF receiver
Position mode		
Static	single static position	
Height		–1 × 10^9 m to 1 × 10^9 m
Yaw		0° to 360°
Pitch		–90° to +90°
Roll		0° to 360°
Duration		sequence
		fixed duration (1 µs to 1843200 s)
		one antenna scan
Markers		scenario markers
Threshold for pulse generation		–100 dB to 0 dB

Multiple emitters

Allows interleaving of multiple PDW lists in the PDW list (collection) scenario type into a single PDW file and interleaving of manually created emitters in emitters collection, localized emitters and direction-finding scenario types either using a priority-based pulse dropping algorithm or time-based merging.

The following options become available in addition to the scenario features already provided with the R&S®PULSE-K32 option.

Scenario type		
PDW list (collection)		
Maximum number of PDW lists		1024
Maximum number of interleaved PDW lists		1024
Interleaving		on/off
Interleaving mode		merge/drop
Threshold for pulse generation		–100 dB to 0 dB
Enable		select/deselect for interleaving
Time offset		-1×10^7 s to 1×10^7 s
Priority		0 to 100 (0 corresponds to highest priority)
Level offset		–200 dB to 0 dB
Group		user created interleaving groups
Emitters (collection)		
Maximum number of emitters		1024
Maximum number of interleaved emitters		1024
Interleaving		on/off
Interleaving mode		merge/drop
Threshold for pulse generation		–100 dB to 0 dB
Enable		select/deselect emitter for interleaving
Time offset		-1×10^7 s to 1×10^7 s
Priority		0 to 100 (0 corresponds to highest priority)
Level offset		–200 dB to 0 dB
Group		user created interleaving groups
Localized emitters		
Maximum number of emitters		1024
Maximum number of interleaved emitters		1024
Interleaving		on/off
Interleaving mode		merge/drop
Threshold for pulse generation		–100 dB to 0 dB
Enable		select/deselect emitter for interleaving
Time offset		-1×10^7 s to 1×10^7 s
Priority		0 to 100 (0 corresponds to highest priority)
Level offset		–200 dB to 0 dB
Group		user created interleaving groups
Direction finding		
Maximum number of emitters		1024
Maximum number of interleaved emitters		1024
Interleaving		on/off
Interleaving mode		merge/drop
Threshold for pulse generation		–100 dB to 0 dB
Enable		select/deselect emitter for interleaving
Time offset		-1×10^7 s to 1×10^7 s
Priority		0 to 100 (0 corresponds to highest priority)
Level offset		–200 dB to 0 dB
Group		user created interleaving groups

2D map import

This feature allows georeferenced positioning as well as the import of georeferenced maps into map-based scenarios.

Parameter type		
Map file format		
Supported formats		geoTiff
Positioning parameters		
Longitude		–180° to +180°
Latitude		–90° to +90°
Altitude		-1×10^9 m to 1×10^9 m

PDW export plug-in interface

Pulse description words (PDW) describe the main properties of a single pulse. The R&S®Pulse Sequencer Digital software transfers the following parameters for each calculated pulse to the export plug-in interface:

PDW export plug-in interface parameters		
Parameters		version tx_platform_id tx_id tx_platform_emit_id tx_list_id rx_id rx_antenna_id toa freq pulse_width level modulation bandwidth rise_time fall_time marker_mask azimuth elevation distance rx_antenna_azimuth rx_antenna_elevation longitude latitude altitude east north up yaw pitch roll speed
Supported modulation flags		unmodulated fm fm-step 2/4/8/16/32/64-fsk msk chirp-generic chirp-linear-up chirp-linear-down chirp-linear-triangular chirp-linear-piecewise chirp-sine barker-2,3,4a,4b,5,7,11,13 polyphase-frank polyphase-p1 polyphase-p2 polyphase-p3 polyphase-p4 bpsk qpsk 8psk phase-generic am-standard am-lsb am-usb am-lsb-usb am-step ask 16/32/64/128/256-qam noise unknown

PDW export plug-in		
Format		64 bit Windows .dll, API specified in user manual, examples provided

PDW report generation

Pulse description words (PDW) describe the main properties of a single pulse. The R&S®Pulse Sequencer Digital software can generate PDW reports during scenario calculation. A PDW report consists of a list of all calculated PDWs for a certain scenario.

Report types		
Default		
Format		text (table), format can be customized
Parameters		TOA, RF center frequency, pulse width, power level, MOP type, bandwidth
Template		
Format		text (table)
Parameters		TOA, RF frequency, power level, MOP type, bandwidth, PRI, PRF, pulse width, rise time, fall time, phase, AOA (emit azi, emit ele), rx scan azi, rx scan ele, sequencing parameters, custom variables
Plug-in		
Format		64 bit Windows .dll, API specified in user manual

Remote control

Interfaces		raw socket connection
Command set		SCPI 1999.5 or compatible command sets
Parameters		
Host		IPv4 address and port number
Access control		allow and deny list

PC hardware requirements

Minimum hardware configuration		
Operating system		Windows 10, 64 bit
CPU		dual-core, 3 GHz
RAM		8 Gbyte
Video		Nvidia Quadro 128 Mbyte or ATI Radeon
Video resolution		1280 × 1024 pixel
Rendering		OpenGL, shader model 3
Network		LAN, 1 Gbyte/s
Recommended hardware configuration		
CPU		Intel Core i7 hexa-core, Intel Xeon hexa-core, AMD FX series
RAM		32 Gbyte
Video resolution		1920 × 1200 pixel

Ordering information

Designation	Type	Order No.
R&S®Pulse Sequencer Digital options		
Standard version	R&S®PULSE-K32	1414.7077.02
Expert upgrade	R&S®PULSE-K39	1414.7125.02

Introduction R&S®Pulse Sequencer DFS

For R&S®SMW-K350, R&S®SMM-K350, R&S®SMBV-K350, R&S®SMBVB-K350, R&S®SMU-K350, R&S®SMJ-K350, R&S®SGT-K350

The R&S®Pulse Sequencer DFS software is limited to the features required for DFS signal generation. The software comes with preconfigured projects for the standards listed below. All test signals are generated as ARB waveforms and automatically uploaded to the vector signal generator. In addition, an excel spread sheet is generated that contains all signal parameters that were used during waveform generation.

The R&S®Pulse Sequencer DFS software and its respective software option for the Rohde & Schwarz signal generators have been specifically developed for generation of radar signals as specified by the FCC, ETSI or the Telec T403 standard. This document describes the software options for dynamic frequency selection DFS working with the PC-based R&S®Pulse Sequencer DFS software for the following instruments:

- R&S®SMW200A
- R&S®SMM100A
- R&S®SMBV100A
- R&S®SMBV100B
- R&S®SGT100A
- R&S®SMU200A
- R&S®SMJ100A

I/Q baseband generators and memory size

Any waveform produced with the R&S®Pulse Sequencer DFS software requires an I/Q baseband generator with ARB installed on the respective Rohde & Schwarz vector signal generator.

For R&S®SMW200A (standard model)	R&S®SMW-B10	baseband generator with ARB (64 Msample) and digital modulation (real-time), 120 MHz RF bandwidth
	The following enhancement options can be added to the R&S®SMW-B10 option:	
	R&S®SMW-K511	ARB memory extension to 512 Msample
	R&S®SMW-K512	ARB memory extension to 1 Gsample
	R&S®SMW-K522	bandwidth extension to 160 MHz RF bandwidth
For R&S®SMW200A (wideband model)	R&S®SMW-B9	wideband baseband generator with ARB (256 Msample) and digital modulation (real-time), 500 MHz RF bandwidth
	The following enhancement options can be added to the R&S®SMW-B9 option:	
	R&S®SMW-K515	ARB memory extension up to 2 Gsample
	R&S®SMW-K525	baseband extension to 1 GHz RF bandwidth
	R&S®SMW-K527	baseband extension to 2 GHz RF bandwidth
For R&S®SMM100A	R&S®SMM-B9	baseband generator with ARB (64 Msample) and digital modulation (real-time), 120 MHz RF bandwidth
	The following enhancement options can be added to the R&S®SMM-B9 option:	
	R&S®SMM-K511	ARB memory extension up to 512 Msample
	R&S®SMM-K512	ARB memory extension up to 1 Gsample
	R&S®SMM-K513	ARB memory extension up to 2 Gsample
	R&S®SMM-K523	baseband extension to 240 MHz RF bandwidth
	R&S®SMM-K524	baseband extension to 500 MHz RF bandwidth
	R&S®SMM-K525	baseband extension to 1 GHz RF bandwidth
For R&S®SMU200A	R&S®SMU-B9	baseband generator with ARB (128 Msample) and digital modulation (real-time)
	R&S®SMU-B10	baseband generator with ARB (64 Msample) and digital modulation (real-time)
	R&S®SMU-B11	baseband generator with ARB (16 Msample) and digital modulation (real-time)
For R&S®SMJ100A	R&S®SMJ-B9	baseband generator with ARB (128 Msample) and digital modulation (real-time)
	R&S®SMJ-B10	baseband generator with ARB (64 Msample) and digital modulation (real-time)
	R&S®SMJ-B11	baseband generator with ARB (16 Msample) and digital modulation (real-time)
	R&S®SMJ-B50	baseband generator with ARB (64 Msample)
	R&S®SMJ-B51	baseband generator with ARB (16 Msample)
For R&S®SMBV100A	R&S®SMBV-B10	baseband generator with digital modulation (real-time) and ARB (32 Msample), 120 MHz RF bandwidth
	R&S®SMBV-B10F	baseband generator for GNSS with high dynamics, digital modulation (real-time) and ARB (32 Msample), 120 MHz RF bandwidth
	R&S®SMBV-B51	baseband generator with ARB (32 Msample), 60 MHz RF bandwidth
	The following enhancement options can be added to the R&S®SMBV-B51 option:	
	R&S®SMBV-K521	bandwidth extension to 120 MHz RF bandwidth
	R&S®SMBV-K522	bandwidth extension to 160 MHz RF bandwidth
	The following enhancement options can be added to the R&S®SMBV-B10/-B10F/-B51 options:	
	R&S®SMBV-K511	ARB memory extension to 256 Msample
	R&S®SMBV-K512	ARB memory extension to 512 Msample
	R&S®SMBV-K522	bandwidth extension to 160 MHz RF bandwidth
For R&S®SMBV100B	Base unit includes the ARB baseband generator (64 Msample, 120 MHz RF bandwidth)	
	R&S®SMBVB-K523	baseband extension to 240 MHz RF bandwidth
	R&S®SMBVB-K524	baseband extension to 500 MHz RF bandwidth
	R&S®SMBVB-K511	ARB memory extension to 256 Msample
	R&S®SMBVB-K512	ARB memory extension to 1 Gsample
	R&S®SMBVB-K513	ARB memory extension to 2 Gsample
For R&S®SGT100A	R&S®SGT-K510	baseband generator with 32 Msample, 60 MHz RF bandwidth
	R&S®SGT-K511	extension to 256 Msample
	R&S®SGT-K512	extension to 1 Gsample
	R&S®SGT-K521	extension to 120 MHz RF bandwidth
	R&S®SGT-K522	extension to 160 MHz RF bandwidth

R&S®SMW-B9, R&S®SMM-B9, R&S®SMU-B9, R&S®SMJ-B9 are referred to as B9,
R&S®SMW-B10, R&S®SMU-B10, R&S®SMJ-B10, R&S®SMBV-B10 are referred to as B10,
R&S®SMU-B11 and R&S®SMJ-B11 are referred to as B11.

For R&S®SMBV100A, it is required to install the R&S®SMBV-B92 option (hard disk).

The K350 option requires the external R&S®Pulse Sequencer DFS software for waveform generation.

Related documents

This document contains the functional specifications of the PC-based software R&S®Pulse Sequencer DFS.

For instrument-specific signal performance data such as ACLR or EVM, see the specifications of the respective Rohde & Schwarz instruments:

R&S®SMW200A:	PD 3606.8037.22
R&S®SMM100A:	PD 3608.7680.22
R&S®SMBV100A:	PD 5214.1114.22
R&S®SMBV100B:	PD 3607.8201.22
R&S®SGT100A:	PD 3607.0217.22
R&S®SMU200A:	PD 0758.0197.22
R&S®SMJ100A:	PD 5213.5074.22

Dynamic frequency selection (DFS), K350 option

Supported standards for Europe, the US, Korea, China and Japan

Minimum configuration

The following minimum required configuration for the instruments is listed hereafter for the K350 option. Please note that in case the DUT requires a bandwidth, which is not covered by the minimum configuration, additional baseband extension options must be ordered.

R&S®SMW200A (standard model)	
R&S®SMW200A	vector signal generator
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 digital modulation (real-time), 120 MHz RF bandwidth
R&S®SMW-B103	frequency option: 100 kHz to 3 GHz
R&S®SMW-B106	frequency option: 100 kHz to 6 GHz
R&S®SMW200A (wideband model)	
R&S®SMW200A	vector signal generator
R&S®SMW-B13XT	wideband baseband main module, two I/Q paths to RF
R&S®SMW-B9	wideband baseband generator with ARB (256 Msample) and digital modulation (real-time), 500 MHz RF bandwidth
R&S®SMW-B103	frequency option: 100 kHz to 3 GHz
R&S®SMW-B106	frequency option: 100 kHz to 6 GHz
R&S®SMM100A	
R&S®SMM100A	vector signal generator
R&S®SMM-B9	baseband generator with ARB (64 Msample) and digital modulation (real-time), 120 MHz RF bandwidth
R&S®SMM-B1006	frequency option: 100 kHz to 6 GHz
R&S®SMBV100A	
R&S®SMBV100A	vector signal generator
R&S®SMBV-B51	baseband generator with ARB (32 Msample), 60 MHz RF bandwidth
R&S®SMBV-B92	hard disk (removable)
R&S®SMBV-B103	frequency option: 100 kHz to 3.2 GHz
R&S®SMBV-B106	frequency option: 100 kHz to 6 GHz
R&S®SMBV100B	
R&S®SMBV100B	vector signal generator including ARB (64 Msample, 120 MHz RF bandwidth)
R&S®SMBVB-B103	frequency option 8 kHz to 3 GHz
R&S®SGT100A	
R&S®SGT100A	vector signal generator
R&S®SGT-K510	ARB baseband generator, 32 Msample, 60 MHz RF bandwidth
R&S®SGT-KB106	frequency extension to 6 GHz
R&S®SMU200A	
R&S®SMU200A	vector signal generator
R&S®SMU-B13	baseband main module
R&S®SMU-B10	baseband generator with ARB (64 Msample) and digital modulation (real-time)
R&S®SMU-B106	frequency option: 100 kHz to 6 GHz
R&S®SMJ100A	
R&S®SMJ100A	vector signal generator
R&S®SMJ-B13	baseband main module
R&S®SMJ-B10	baseband generator with ARB (64 Msample) and digital modulation (real-time)
R&S®SMJ-B106	frequency option: 100 kHz to 6 GHz

For R&S®SMW-K350, R&S®SMM-K350, R&S®SMBV-K350, R&S®SMBVB-K350, R&S®SGT-K350, R&S®SMU-K350 and R&S®SMJ-K350 options, the required bandwidth extension options depend on the supported bandwidth of the DUT.

National standards

Standard		Last modification
USA		
FCC 0696		Sep 14, 2016
FCC 1322		Sep 14, 2016
FCC KDB 905462 D02		Jul 14, 0217
Europe		
ETSI EN 302502 V2.0.8		Jun 06, 2017
ETSI EN 301893 V1.8.5		Jun 06, 2017
ETSI EN 301893 V1.8.1		Sep 13, 2016
ETSI EN 301893 V2.1.1		Dec 05, 2018
ETSI EN 301893 V1.7.2		Jul 25, 2016
ETSI EN 302502 V1.2.1		Jun 06, 2017
ETSI EN 303258 V1.0.0		Jul 25, 2016
Japan		
MIC-W53/-W56		May 02, 2016
MIC-W53/-W56 07_2019 update		Oct 10, 2019
Korea		
Korea		Jun 22, 2016
China		
YD/T 2950-2015		Nov 15, 2017

USA

FCC 0696		
Signal types		1, 2, 3, 4, 5, 6 band limited hopping
Marker 1		end of burst
Marker 2		every pulse
Reporting		template or excel spread sheets
Trials per signal		30, automatically generated
FCC 1322		
Signal types		0, 1, 2, 3, 4
Marker 1		end of burst
Marker 2		every pulse
Reporting		template or excel spread sheets
Trials per signal		30, automatically generated
FCC KDB 905462 D02 New Rules v02		
Signal types		0, 1, 2, 3, 4, 5, 6 band limited hopping
Marker 1		end of burst
Marker 2		every pulse
Reporting		template or excel spread sheets
Trials per signal		30, automatically

Europe

ETSI EN 302502 V2.0.8		
Signal types		1, 2, 3, 4, 5, 6, D3.2-S1, D3.2-S2
Marker 1		end of pulse
Marker 2		every pulse
Reporting		template or excel spread sheets
Trials per signal		30, automatically generated
ETSI EN 301893 V2.1.1		
Signal types		reference, 1, 2, 3, 4, 5, 6, OFDM, LTE
Marker 1		end pf pulse
Marker 2		every pulse
Reporting		template or excel spread sheets
Trials per signal		20, automatically generated
ETSI EN 301893 V1.8.5		
Signal types		reference, 1, 2, 3, 4, 5, 6
Marker 1		end of pulse
Marker 2		every pulse
Reporting		template or excel spread sheets
Trials per signal		20, automatically generated

ETSI EN 301893 V1.8.1		
Signal types		reference, 1, 2, 3, 4, 5, 6
Marker 1		end of pulse
Marker 2		every pulse
Reporting		template or excel spread sheets
Trials per signal		20, automatically generated
ETSI EN 301893 V1.7.2		
Signal types		reference, 1, 2, 3, 4, 5, 6
Marker 1		end of pulse
Marker 2		every pulse
Reporting		template or excel spread sheets
Trials per signal		20, automatically generated
ETSI EN 302502 V1.2.1		
Signal types		1, 2, 3, 4, 5, 6, D3.2-S1, D3.2-S2
Marker 1		end of pulse
Marker 2		every pulse
Reporting		template or excel spread sheets
Trials per signal		30, automatically generated
ETSI EN 303258 V1.0.0		
Signal types		reference, 1, 2, 3, 4
Marker 1		end of burst
Marker 2		every pulse
Reporting		template or excel spread sheets
Trials per signal		20, automatically generated

Japan

MIC-W53/-W56		
Signal types		W53 1, 2; W56 1, 2, 3, 4, 5, 6; W56 band limited hopping
Marker 1		end of burst
Marker 2		every pulse
Reporting		template or excel spread sheets
Trials per signal		30, automatically generated
MIC-W53/-W56 07_2019 update		
Signal types		W53 1, 2, 3, 4, 5, 6, 7, 8; W56 1, 2, 3, 4, 5, 6; W56 band limited hopping
Marker 1		end of burst
Marker 2		every pulse
Reporting		template or excel spread sheets
Trials per signal		30, automatically generated

Korea

Korea		
Signal types		1, 2, 3
Marker 1		end of burst
Marker 2		every pulse
Reporting		template or excel spread sheets
Trials per signal		1, automatically generated

China

YD/T 2950-2015		
Signal types		reference, 1, 2, 3, 4, 5, 6
Marker 1		end of burst
Marker 2		every pulse
Reporting		template or excel spread sheets
Trials per signal		20, automatically generated

PDW report generation

Pulse description words (PDW) describe the main properties of a single pulse. The R&S®Pulse Sequencer DFS software can generate PDW reports during a waveform build process.

Report types		
Default		
Format		text (table), format can be customized
Parameters		TOA, RF center frequency, pulse width, power level, MOP type, bandwidth
Template		
Format		text (table)
Parameters		TOA, RF frequency, power level, MOP type, bandwidth, PRI, PRF, pulse width, rise time, fall time, phase, AOA (emit azi, emit ele), rx scan azi, rx scan ele, sequencing parameters, custom variables
Plug-in		
Format		64 bit Windows .dll, API specified in user manual

Path loss compensation

The R&S®Pulse Sequencer DFS software provides built-in routines for path loss compensation.

Alignment database location		home path, network drive, mass storage on signal generator
Compensation method		scalar level offset versus frequency
Supported power sensors		
R&S®NRPxxSN, R&S®NRPxxTN, R&S®NRPxxAN		directly via LAN, connected to signal generator (legacy mode)
R&S®NRPxxS, R&S®NRPxxT, R&S®NRPxxA, R&S®NRPxxP		directly via USB, connected to signal generator (legacy mode)
R&S®NRP-Zxx		connected to signal generator

Supported generators

The R&S®Pulse Sequencer DFS software uses generator profiles to describe minimum requirements that must be met for signal generation. For the generation of a real signal these generator profiles must be linked to physical instruments. The following signal generators are supported.

Signal generator		
R&S®SMW200A		
Option		R&S®SMW-K350
R&S®SMM100A		
Option		R&S®SMM-K350
R&S®SMBV100A		
Option		R&S®SMBV-K350
R&S®SMBV100B		
Option		R&S®SMBVB-K350
R&S®SMU200A		
Option		R&S®SMU-K350
R&S®SMJ100A		
Option		R&S®SMJ-K350
R&S®SGT100A		
Option		R&S®SGT-K350

Remote control

Interfaces		raw socket connection
Command set		SCPI 1999.5 or compatible command sets
Parameters		
Host		IPv4 address and port number
Access control		allow and deny list

PC hardware requirements

Minimum hardware configuration		
Operating system		Windows 10, 64 bit
CPU		dual-core, 3 GHz
RAM		8 Gbyte
Video		Nvidia Quadro 128 Mbyte or ATI Radeon
Video resolution		1280 × 1024 pixel
Rendering		OpenGL, shader model 3
Network		LAN, 1 Gbyte/s
Recommended hardware configuration		
CPU		Intel i7 hexa-core, Intel Xeon hexa-core, AMD FX series
RAM		32 Gbyte
Video resolution		1920 × 1200 pixel

Ordering information

Designation	Type	Order No.
Options with external R&S®Pulse Sequencer DFS software		
R&S®SMW200A		
DFS signal generation	R&S®SMW-K350	1413.9160.02
R&S®SMM100A		
DFS signal generation	R&S®SMM-K350	1441.1224.02
R&S®SMBV100A		
DFS signal generation	R&S®SMBV-K350	1419.2767.02
R&S®SMBV100B		
DFS signal generation	R&S®SMBVB-K350	1423.8443.02
R&S®SGT100A		
DFS signal generation	R&S®SGT-K350	1419.8107.02
R&S®SMU200A		
DFS signal generation	R&S®SMU-K350	1408.8830.02
R&S®SMJ100A		
DFS signal generation	R&S®SMJ-K350	1409.3702.02

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

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- ► Energy efficiency and low emissions
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ISO 9001

Certified Environmental Management
ISO 14001

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PD 3607.1388.22 | Version 12.00 | November 2023 (jr)
R&S®Pulse Sequencer Software
Data without tolerance limits is not binding | Subject to change

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