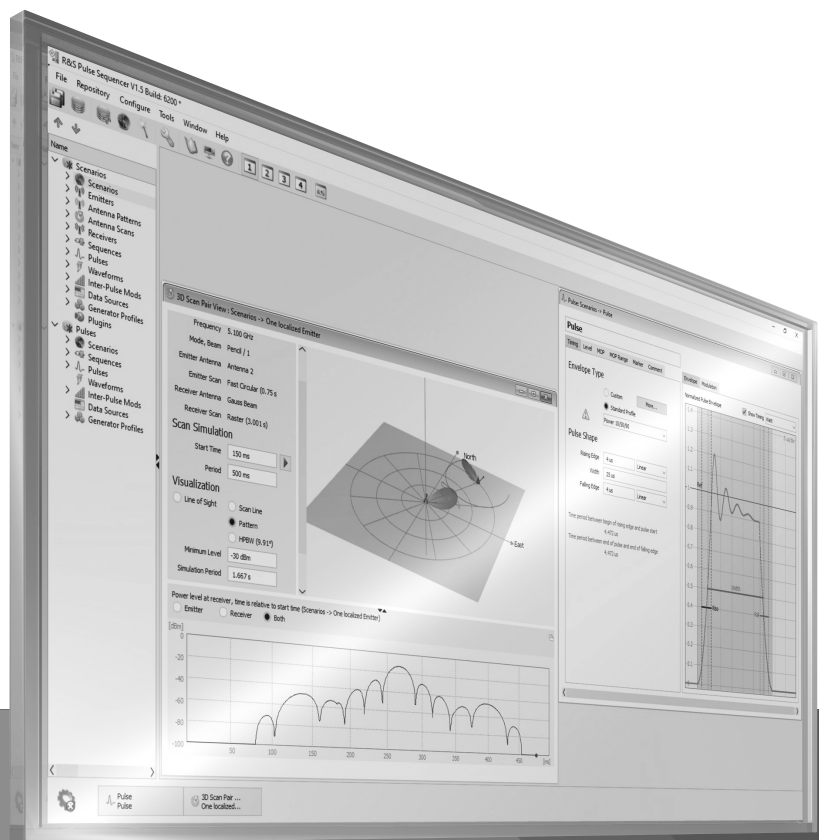


# R&S®PULSE SEQUENCER SOFTWARE

## Specifications

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



Specifications  
Version 13.00

**ROHDE & SCHWARZ**

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# CONTENTS

|                                                                     |           |
|---------------------------------------------------------------------|-----------|
| <b>Definitions .....</b>                                            | <b>4</b>  |
| <b>Notations and abbreviations.....</b>                             | <b>5</b>  |
| <b>Introduction R&amp;S®Pulse Sequencer Software products.....</b>  | <b>5</b>  |
| <b>Introduction R&amp;S®Pulse Sequencer RF .....</b>                | <b>6</b>  |
| Key features .....                                                  | 7         |
| I/Q baseband generators and memory size .....                       | 8         |
| Related documents.....                                              | 9         |
| Minimum configuration.....                                          | 9         |
| Pulse sequencing .....                                              | 10        |
| Enhanced pulse sequencing.....                                      | 16        |
| Radar platforms.....                                                | 24        |
| Movements.....                                                      | 25        |
| Multiple emitters .....                                             | 26        |
| Multiple emitters extension .....                                   | 26        |
| Direction finding.....                                              | 27        |
| 2D map import.....                                                  | 29        |
| Extended sequencing for R&S®SMW-B10 .....                           | 30        |
| Wideband extended sequencing for R&S®SMW-B9.....                    | 31        |
| Pulse-on-pulse simulation.....                                      | 32        |
| PDW report generation .....                                         | 33        |
| Path loss compensation.....                                         | 33        |
| Supported generators.....                                           | 33        |
| Remote control of R&S®Pulse Sequencer Software.....                 | 34        |
| PC hardware requirements .....                                      | 34        |
| Ordering information.....                                           | 34        |
| <b>Introduction R&amp;S®Pulse Sequencer Digital .....</b>           | <b>35</b> |
| Key features .....                                                  | 36        |
| Minimum configuration.....                                          | 36        |
| R&S®PULSE-K32 standard version of R&S®Pulse Sequencer Digital ..... | 37        |
| R&S®PULSE-K39 expert upgrade of R&S®Pulse Sequencer Digital .....   | 46        |
| PDW export plug-in interface .....                                  | 50        |
| PDW report generation .....                                         | 51        |
| Remote control .....                                                | 51        |
| PC hardware requirements .....                                      | 51        |
| Ordering information.....                                           | 51        |
| <b>Introduction R&amp;S®Pulse Sequencer DFS.....</b>                | <b>52</b> |
| I/Q baseband generators and memory size .....                       | 53        |
| Related documents.....                                              | 54        |

Dynamic frequency selection (DFS), K350 option ..... 55

PDW report generation ..... 58

Path loss compensation..... 58

Supported generators ..... 58

Remote control ..... 59

PC hardware requirements ..... 59

Ordering information ..... 59

# Definitions

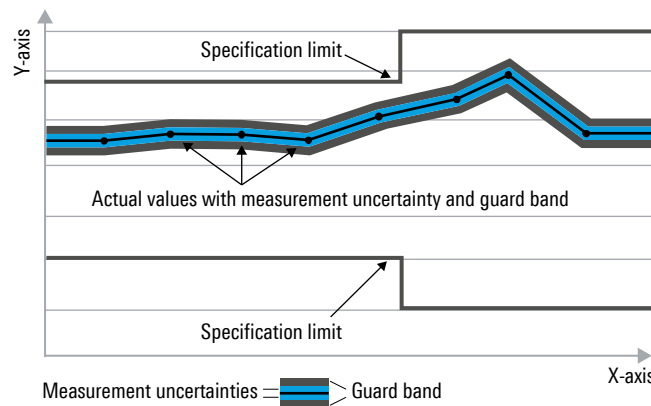
## General

Product data applies under the following conditions:

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

## Specifications with limits

Represent warranted product performance by means of a range of values for the specified parameter. These specifications are marked with limiting symbols such as  $<$ ,  $\leq$ ,  $>$ ,  $\geq$ ,  $\pm$ , 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 R&S®SMW-B9 wideband baseband generator option 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®WinQSIM2 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-K525                                                                         | baseband extension to 1 GHz 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.

|                                         |                                                                                                             |
|-----------------------------------------|-------------------------------------------------------------------------------------------------------------|
| <b>R&amp;S®SMW200A (standard model)</b> |                                                                                                             |
| 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                                                                          |
| <b>R&amp;S®SMW200A (wideband model)</b> |                                                                                                             |
| 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                                                                          |
| <b>R&amp;S®SMM100A</b>                  |                                                                                                             |
| 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                                                                          |
| <b>R&amp;S®SMBV100A</b>                 |                                                                                                             |
| 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                                                                          |
| <b>R&amp;S®SMBV100B</b>                 |                                                                                                             |
| R&S®SMBV100B                            | vector signal generator                                                                                     |
| R&S®SMBVB-B103                          | frequency option 8 kHz to 3 GHz                                                                             |
| <b>R&amp;S®SGT100A</b>                  |                                                                                                             |
| 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.

|                        |                                                                                                   |
|------------------------|---------------------------------------------------------------------------------------------------|
| <b>R&amp;S®SMW200A</b> |                                                                                                   |
| 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                                    |  | $-1 \times 10^9$ to $1 \times 10^9$                                                                                          |
| Increment                                |  | $-1 \times 10^9$ to $1 \times 10^9$                                                                                          |
| 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                                    |  | $-1 \times 10^9$ to $1 \times 10^9$                                                                                          |
| List base                                |  | repetitions/time                                                                                                             |
| Repetitions                              |  | 1 to $10^9$                                                                                                                  |
| Time                                     |  | 1 ns to $10^9$ s                                                                                                             |
| Waveform                                 |  |                                                                                                                              |
| Type                                     |  | ramp, sine, triangular                                                                                                       |
| DC offset                                |  | $-1 \times 10^9$ to $1 \times 10^9$                                                                                          |
| Phase offset                             |  | $-1 \times 10^9$ to $1 \times 10^9$                                                                                          |
| Peak to peak                             |  | $-1 \times 10^9$ to $1 \times 10^9$                                                                                          |
| 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                                    |  | $-1 \times 10^9$ to $1 \times 10^9$                                                                                          |
| Period time                              |  | 1 ns to $10^9$ s                                                                                                             |
| Pulse count                              |  | 1 to $10^9$                                                                                                                  |
| Interpolation                            |  | linear, none (s/h)                                                                                                           |
| Binomial                                 |  |                                                                                                                              |
| Value 1                                  |  | $-1 \times 10^9$ to $1 \times 10^9$                                                                                          |
| Probability                              |  | 0 % to 100 %                                                                                                                 |
| Value 2                                  |  | $-1 \times 10^9$ to $1 \times 10^9$                                                                                          |
| 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.

|                                     |  |                                           |
|-------------------------------------|--|-------------------------------------------|
| <b>MOP types</b>                    |  |                                           |
| <b>AM</b>                           |  |                                           |
| Types                               |  | standard, LSB, USB, LSB+USB               |
| Frequency                           |  | 1 mHz to 1 GHz                            |
| Modulation depth                    |  | 0 % to 100 %                              |
| <b>ASK</b>                          |  |                                           |
| Modulation depth                    |  | 0 % to 100 %                              |
| Inverted                            |  | yes, no                                   |
| Symbol rate                         |  | 1 Hz to 1 GHz                             |
| Data source                         |  | yes                                       |
| Baseband filter                     |  | no                                        |
| <b>AM step</b>                      |  |                                           |
| Values per step                     |  | duration, level                           |
| Number of entries                   |  | 1024                                      |
| <b>FM</b>                           |  |                                           |
| Frequency                           |  | 1 mHz to 1 GHz                            |
| Deviation                           |  | 1 mHz to 1 GHz                            |
| <b>FSK</b>                          |  |                                           |
| 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                                        |
| <b>FM step</b>                      |  |                                           |
| Values per step                     |  | duration, frequency                       |
| Number of entries                   |  | 1024                                      |
| <b>MSK</b>                          |  |                                           |
| Symbol rate                         |  | 1 Hz to 2 GHz                             |
| Data source                         |  | yes                                       |
| Baseband filter                     |  | no                                        |
| <b>Linear chirp</b>                 |  |                                           |
| Types                               |  | up, down, sine, triangular                |
| Deviation                           |  | 1 Hz to 1 GHz                             |
| <b>Chirp (equation-based)</b>       |  |                                           |
| <b>Polynomial chirp</b>             |  |                                           |
| Values                              |  | term, coefficient                         |
| Coefficient range                   |  | $-1 \times 10^{22}$ to $1 \times 10^{22}$ |
| Number of entries                   |  | 1024                                      |
| Symmetrical Chirp                   |  | yes/no                                    |
| <b>Custom chirp</b>                 |  |                                           |
| Values                              |  | frequency                                 |
| Range                               |  | -1 GHz to 1 GHz                           |
| Number of entries                   |  | 1024                                      |
| <b>Piecewise linear chirp</b>       |  |                                           |
| Values                              |  | duration, rate, offset                    |
| Duration range                      |  | 0 % to 100 %                              |
| Rate/ $\mu$ s range                 |  | -1 GHz to 1 GHz                           |
| Offset range                        |  | -1 GHz to 1 GHz                           |
| Number of entries                   |  | 1024                                      |
| <b>Barker</b>                       |  |                                           |
| Codes                               |  | R3, R4a, R4b, R5, R7, R11, R13            |
| Transition time (constant envelope) |  | 0 % to 50 %                               |
| <b>Polyphase</b>                    |  |                                           |
| Codes                               |  | Frank, P1, P2, P3, P4                     |
| Length M                            |  | 1 to 64                                   |
| <b>Custom phase</b>                 |  |                                           |
| Values                              |  | phase in °                                |
| Number of entries                   |  | 1024                                      |
| <b>BPSK</b>                         |  |                                           |
| 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                                                                                           |
| <b>QPSK</b>             |                                                                  |                                                                                               |
| Types                   |                                                                  | standard, OQPSK, DQPSK, SOQPSK-A, SOQPSK-B, SOQPSK-TG                                         |
| Symbol rate             |                                                                  | 1 Hz to 1 GHz                                                                                 |
| Data source             |                                                                  | yes                                                                                           |
| Baseband filter         |                                                                  | yes                                                                                           |
| <b>8PSK</b>             |                                                                  |                                                                                               |
| Symbol rate             |                                                                  | 1 Hz to 1 GHz                                                                                 |
| Data source             |                                                                  | yes                                                                                           |
| Baseband filter         |                                                                  | yes                                                                                           |
| <b>QAM</b>              |                                                                  |                                                                                               |
| Type                    |                                                                  | 16/32/64/128/256QAM                                                                           |
| Symbol rate             |                                                                  | 1 Hz to 1 GHz                                                                                 |
| Data source             |                                                                  | yes                                                                                           |
| Baseband filter         |                                                                  | yes                                                                                           |
| <b>White noise</b>      |                                                                  |                                                                                               |
| Bandwidth               |                                                                  | 1 Hz to 1 GHz                                                                                 |
| <b>Baseband filter</b>  | any filter can be used with the MOP types using baseband filters |                                                                                               |
| Filter types            |                                                                  | none, rectangular, cosine, root cosine, Gaussian, low pass, Gaussian FSK                      |
| <b>Filter parameter</b> |                                                                  |                                                                                               |
| Filter parameter        | cosine, root cosine (filter parameter $\alpha$ )                 | 0.05 to 1.00                                                                                  |
|                         | Gaussian (filter parameter $B \times T$ )                        | 0.15 to 2.50                                                                                  |
| Length                  |                                                                  | 8 to 512                                                                                      |
| Bandwidth               | rectangular, cosine, root cosine, low pass                       | 1 Hz to 1 GHz                                                                                 |
| <b>Coding</b>           | not all coding methods can be used with every type of modulation | none, differential, Gray, differential and Gray                                               |
| <b>Data sources</b>     |                                                                  | PRBS: 7, 9, 11, 15, 16, 20, 21, 23, AII0, AII1, 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.

|                              |  |                                                    |
|------------------------------|--|----------------------------------------------------|
| <b>Types of data sources</b> |  |                                                    |
| <b>PRBS</b>                  |  |                                                    |
| Mode                         |  | PRBS: 7, 9, 11, 15, 16, 20, 21, 23                 |
| Bits                         |  | 1 to infinite                                      |
| <b>Pattern</b>               |  |                                                    |
| Mode                         |  | AII0, AII1, 1010, Barker R3, R4a, 4b, 5, 7, 11, 13 |
| Bits                         |  | 1 to 1000                                          |
| <b>User</b>                  |  |                                                    |
| 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<br>variable comparison 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 <sup>9</sup> 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 <sup>9</sup> 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     | .vv        | 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)<br>manual (1 Hz to 2.4 GHz)     |
| Duration                                         |  | auto<br>fixed duration (1 $\mu$ s to 1843200 s)               |
| Markers                                          |  | sequence markers<br>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)<br>manual (1 Hz to 2.4 GHz)     |
| Duration                                         |  | auto<br>fixed duration (1 $\mu$ s to 1843200 s)               |
| Markers                                          |  | sequence markers<br>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)<br>manual (1 Hz to 2.4 GHz)     |
| Duration                                         |  | auto<br>fixed duration (1 $\mu$ s to 1843200 s)               |
| Markers                                          |  | sequence markers<br>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 175 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                                    |  | $-1 \times 10^6$ to $1 \times 10^6$                  |
| Random steps                             |  |                                                      |
| Minimum                                  |  | $-1 \times 10^6$ to $1 \times 10^6$                  |
| Maximum                                  |  | $-1 \times 10^6$ to $1 \times 10^6$                  |
| 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                                  |  | $-1 \times 10^9$ to $1 \times 10^9$                  |
| Maximum                                  |  | $-1 \times 10^9$ to $1 \times 10^9$                  |
| Step                                     |  | $-1 \times 10^9$ to $1 \times 10^9$                  |
| Plug-in                                  |  |                                                      |
| Format                                   |  | 64 bit Windows .dll,<br>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 <sup>9</sup> 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 175 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.

|                       |  |                                                                                             |
|-----------------------|--|---------------------------------------------------------------------------------------------|
| <b>Antenna types</b>  |  |                                                                                             |
| Dipole                |  |                                                                                             |
| Cardiod               |  |                                                                                             |
| Exponent              |  | 1 to 20                                                                                     |
| Parabolic             |  |                                                                                             |
| Frequency             |  | 1 MHz to 175 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 175 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 175 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 175 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)                                                       |

|                            |  |                                                                                                                                                 |
|----------------------------|--|-------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Custom phased array</b> |  |                                                                                                                                                 |
| Frequency                  |  | 1 MHz to 175 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                                                                                      |
| <b>Uniform rect</b>        |  |                                                                                                                                                 |
| 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                                                                                                                         |
| <b>Uniform linear</b>      |  |                                                                                                                                                 |
| Elements                   |  | 1 to 1000                                                                                                                                       |
| Spacing                    |  | 0.001 m to 1 m                                                                                                                                  |
| <b>Uniform hex</b>         |  |                                                                                                                                                 |
| Elements/side              |  | 1 to 50                                                                                                                                         |
| Spacing                    |  | 0.001 m to 1 m                                                                                                                                  |
| <b>Circular planar</b>     |  |                                                                                                                                                 |
| Radius                     |  | 1 to 50                                                                                                                                         |
| Spacing                    |  | 0.001 m to 1 m                                                                                                                                  |
| Lattice                    |  | rectangular, triangular                                                                                                                         |
| <b>Import from file</b>    |  |                                                                                                                                                 |
| Supported formats          |  | .csv (comma separated values)<br>.ffe (FEKO far field)<br>.ant_pat (Rohde & Schwarz pattern file)<br>.tsv (Antenna Magnus)<br>.ffd (Ansys HFSS) |
| Frequency                  |  | yes                                                                                                                                             |
| Bandwidth                  |  | yes                                                                                                                                             |
| Simulate back lobe         |  | yes                                                                                                                                             |
| <b>Custom</b>              |  |                                                                                                                                                 |
| 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                                                                                                                                        |
| <b>Rotation</b>            |  |                                                                                                                                                 |
| Rotation Z                 |  | -180° to +180°                                                                                                                                  |
| Rotation X                 |  | -180° to +180°                                                                                                                                  |

## 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 6000 s                         |
| 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°                           |

|                                 |  |                                                                                                                                |
|---------------------------------|--|--------------------------------------------------------------------------------------------------------------------------------|
| <b>Lobe switching</b>           |  |                                                                                                                                |
| 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                                                                                                      |
| <b>Sine</b>                     |  |                                                                                                                                |
| 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                                                                                                                         |
| <b>Custom (list of entries)</b> |  |                                                                                                                                |
| Electronic scan                 |  | on/off                                                                                                                         |
| Azimuth                         |  | -180° to +180°                                                                                                                 |
| Elevation                       |  | -90° to +90°                                                                                                                   |
| Dwell time                      |  | 0 s to 3600 s                                                                                                                  |
| Interpolate to next             |  | true/false<br>(move or jump to next coordinate)                                                                                |
| Transition time                 |  | 0 s to 3600 s<br>(if interpolate to next is true, this parameter resembles the time for the transition to the next coordinate) |
| <b>Lissajous</b>                |  |                                                                                                                                |
| 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°                                                                                                                     |
| <b>Offsets</b>                  |  |                                                                                                                                |
| Elevation offset                |  | -180° to 180°                                                                                                                  |
| Azimuth offset                  |  | -180° to 180°                                                                                                                  |

## 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)<br>manual (1 Hz to 2.4 GHz)                                                       |
| Duration                                                                                |                                                                     | auto<br>fixed duration (1 µs to 1843200 s)                                                                      |
| Markers                                                                                 |                                                                     | scenario markers<br>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)<br>manual (1 Hz to 2.4 GHz)                                                       |
| Duration                                                                                |                                                                     | auto<br>fixed duration (1 µs to 1843200 s)                                                                      |
| Markers                                                                                 |                                                                     | scenario markers<br>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 time interleaved with R&S®SMW-K306/K307                                              |
| Maximum number of simultaneous playback of emitters, interferers and background signals | R&S®SMW200A                                                         | 1 per baseband generator                                                                                        |
|                                                                                         | 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<br>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                           |  | $-1 \times 10^9$ m to $1 \times 10^9$ m |
| North                          |  | $-1 \times 10^9$ m to $1 \times 10^9$ m |
| Height                         |  | $-1 \times 10^9$ m to $1 \times 10^9$ 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 175 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    |
| 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.

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

|                                     |                                                          |                                                                          |
|-------------------------------------|----------------------------------------------------------|--------------------------------------------------------------------------|
| <b>Position mode moving</b>         |                                                          |                                                                          |
| Trajectory line                     |                                                          |                                                                          |
| Initial delay                       |                                                          | 0 s to $10^9$ m                                                          |
| Start position                      |                                                          |                                                                          |
| East/north                          |                                                          | $-1 \times 10^9$ m to $1 \times 10^9$ m                                  |
| Height                              |                                                          | $-1 \times 10^9$ m to $1 \times 10^9$ m                                  |
| Speed                               |                                                          | 0.1 m/s to 5999 m/s                                                      |
| Acceleration                        |                                                          | $-100 \text{ m/s}^2$ to $+100 \text{ m/s}^2$                             |
| End position                        |                                                          |                                                                          |
| East/north                          |                                                          | $-1 \times 10^9$ m to $1 \times 10^9$ m                                  |
| Height                              |                                                          | $-1 \times 10^9$ m to $1 \times 10^9$ m                                  |
| Heading                             |                                                          | 0° to 360°                                                               |
| Distance                            |                                                          | 0 m to $1 \times 10^9$ m                                                 |
| Mode                                |                                                          | cyclic, round trip, one way                                              |
| Trajectory arc                      |                                                          |                                                                          |
| Initial delay                       |                                                          | 0 s to $1^9$ m                                                           |
| Start position                      |                                                          |                                                                          |
| East/north                          |                                                          | $-1 \times 10^9$ m to $1 \times 10^9$ m                                  |
| Height                              |                                                          | $-1 \times 10^9$ m to $1 \times 10^9$ m                                  |
| Speed                               |                                                          | 0.1 m/s to 5999 m/s                                                      |
| Angle                               |                                                          | $-360^\circ$ to $+360^\circ$                                             |
| Center position                     |                                                          |                                                                          |
| East/north                          |                                                          | $-1 \times 10^9$ m to $1 \times 10^9$ m                                  |
| Mode                                |                                                          | cyclic, round trip, one way                                              |
| Trajectory traces                   |                                                          |                                                                          |
| Initial delay                       |                                                          | 0 s to $10^9$ m                                                          |
| Trace point properties              |                                                          |                                                                          |
| East/north                          |                                                          | $-1 \times 10^9$ m to $1 \times 10^9$ m                                  |
| Height                              |                                                          | $-1 \times 10^9$ m to $1 \times 10^9$ 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                                        | $-180^\circ$ to $+180^\circ$                                             |
| Pitch                               | only for constant                                        | $-90^\circ$ to $+90^\circ$                                               |
| Roll                                | only for constant, align to motion                       | $-180^\circ$ to $+180^\circ$                                             |
| Trajectory waypoints                |                                                          |                                                                          |
| Initial delay                       |                                                          | 0 s to $1 \times 10^9$ s                                                 |
| Waypoint file                       |                                                          | XTD (proprietary trajectory 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                                        | $-180^\circ$ to $+180^\circ$                                             |
| Pitch                               | only for constant                                        | $-90^\circ$ to $+90^\circ$                                               |
| Roll                                | only for constant, align to motion                       | $-180^\circ$ to $+180^\circ$                                             |
| <b>Receiver position properties</b> |                                                          |                                                                          |
| Latitude                            | geodetic reference                                       | $-90^\circ$ to $+90^\circ$                                               |
| Longitude                           | geodetic reference                                       | $-180$ to $+180^\circ$                                                   |

## 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 $1 \times 10^7$ 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 $1 \times 10^7$ 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 $1 \times 10^7$ 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 $1 \times 10^7$ 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 <sup>1</sup> | 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 <sup>9</sup> m to 1 × 10 <sup>9</sup> m                                                                |
| North                                                                                        |                                                                                                                                  | –1 × 10 <sup>9</sup> m to 1 × 10 <sup>9</sup> m                                                                |
| Height                                                                                       |                                                                                                                                  | –1 × 10 <sup>9</sup> m to 1 × 10 <sup>9</sup> 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 175 GHz                                                                                               |
| Receiver properties                                                                          |                                                                                                                                  |                                                                                                                |
| Receiver                                                                                     |                                                                                                                                  | any DF receiver                                                                                                |
| Position mode                                                                                |                                                                                                                                  |                                                                                                                |
| Static                                                                                       |                                                                                                                                  | single static position                                                                                         |
| Height                                                                                       |                                                                                                                                  | –1 × 10 <sup>9</sup> m to 1 × 10 <sup>9</sup> 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)<br>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                                                                                                |

<sup>1</sup> 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 <sup>9</sup> m to 1 × 10 <sup>9</sup> 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 sample, 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                                                       |
|                                                        | with R&S®SMW-B9 option, real-time   | 0.3 µs                                                       |
| 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),<br>format can be customized                                                                                                                                                                        |
| Parameters   |  | TOA, RF center frequency, pulse width,<br>power level, MOP type, bandwidth                                                                                                                                       |
| Template     |  |                                                                                                                                                                                                                  |
| Format       |  | text (table)                                                                                                                                                                                                     |
| Parameters   |  | TOA, RF frequency, power level, MOP<br>type, bandwidth, PRI, PRF, pulse width,<br>rise time, fall time, phase, AOA (emit azi,<br>emit ele), rx scan azi, rx scan ele,<br>sequencing parameters, custom variables |
| Plug-in      |  |                                                                                                                                                                                                                  |
| Format       |  | 64 bit Windows .dll,<br>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<br>on signal generator    |
| Compensation method                               |  | scalar level offset versus frequency                             |
| Supported power sensors                           |  |                                                                  |
| R&S®NRPxxSN, R&S®NRPxxTN,<br>R&S®NRPxxAN          |  | directly via LAN, connected to signal<br>generator (legacy mode) |
| R&S®NRPxxS, R&S®NRPxxT,<br>R&S®NRPxxA, R&S®NRPxxP |  | directly via USB, connected to signal<br>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,<br>R&S®SMW-K302, R&S®SMW-K304,<br>R&S®SMW-K306, R&S®SMW-K307,<br>R&S®SMW-K308, R&S®SMW-K309,<br>R&S®SMW-K315, R&S®SMW-K501,<br>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,<br>R&S®SMBV-K308                                                                                                                          |
| R&S®SMBV100B     |  |                                                                                                                                                                         |
| Options          |  | R&S®SMBVB-K300, R&S®SMBVB-K301,<br>R&S®SMBVB-K308                                                                                                                       |
| R&S®SGT100A      |  |                                                                                                                                                                         |
| Options          |  | R&S®SGT-K300, R&S®SGT-K301,<br>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.    |
|---------------------------------------------------------------|----------------|--------------|
| <b>Options with external R&amp;S®Pulse Sequencer Software</b> |                |              |
| 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                                    |  | $-1 \times 10^9$ to $1 \times 10^9$ |
| Increment                                |  | $-1 \times 10^9$ to $1 \times 10^9$ |
| 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                                    |  | $-1 \times 10^9$ to $1 \times 10^9$ |
| List base                                |  | repetitions/time                    |
| Repetitions                              |  | 1 to $10^9$                         |
| Time                                     |  | 1 ns to $10^9$ s                    |
| Waveform                                 |  |                                     |
| Type                                     |  | ramp, sine, triangular              |
| DC offset                                |  | $-1 \times 10^9$ to $1 \times 10^9$ |
| Phase offset                             |  | $-1 \times 10^9$ to $1 \times 10^9$ |
| Peak to peak                             |  | $-1 \times 10^9$ to $1 \times 10^9$ |
| 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                                    |  | $-1 \times 10^9$ to $1 \times 10^9$ |
| Period time                              |  | 1 ns to $10^9$ s                    |
| Pulse count                              |  | 1 to $10^9$                         |
| Interpolation                            |  | linear, none (s/h)                  |
| Binomial                                 |  |                                     |
| Value 1                                  |  | $-1 \times 10^9$ to $1 \times 10^9$ |
| Probability                              |  | 0 % to 100 %                        |
| Value 2                                  |  | $-1 \times 10^9$ to $1 \times 10^9$ |
| 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                                    |  | $-1 \times 10^6$ to $1 \times 10^6$ |
| Random steps                             |  |                                     |
| Minimum                                  |  | $-1 \times 10^6$ to $1 \times 10^6$ |
| Maximum                                  |  | $-1 \times 10^6$ to $1 \times 10^6$ |
| 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                     |  | $-1 \times 10^9$ to $1 \times 10^9$                                                                               |
| Maximum                     |  | $-1 \times 10^9$ to $1 \times 10^9$                                                                               |
| Step                        |  | $-1 \times 10^9$ to $1 \times 10^9$                                                                               |
| Plug-in                     |  |                                                                                                                   |
| Format                      |  | 64 bit Windows .dll,<br>API specified in user manual                                                              |
| Unit of affected parameter  |  | none, time in s, frequency in Hz,<br>level in dB, phase in °, percent in %                                        |
| <b>Available parameters</b> |  |                                                                                                                   |
| Level                       |  | offset in dB, attenuation base in dB                                                                              |
| Modulation                  |  | AM modulation depth in %,<br>FM deviation in Hz, FM frequency in Hz,<br>chirp deviation in Hz, AM frequency in Hz |
| Timing                      |  | rise time in s, pulse width in s, delay in s,<br>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<br>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.

|                                   |  |                                           |
|-----------------------------------|--|-------------------------------------------|
| <b>MOP types</b>                  |  |                                           |
| 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                 |  | $-1 \times 10^{22}$ to $1 \times 10^{22}$ |
| 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.

|                           |  |                                                                     |
|---------------------------|--|---------------------------------------------------------------------|
| <b>Sequencing element</b> |  |                                                                     |
| 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<br>variable comparison 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 <sup>9</sup> 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                                                     |
| <b>Global parameters</b>  |  |                                                                     |
| 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.

|                       |  |                                                                        |
|-----------------------|--|------------------------------------------------------------------------|
| <b>Parameter type</b> |  |                                                                        |
| 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 175 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                |  |                  |
| Cardioid              |  |                  |
| Exponent              |  | 1 to 20          |
| Parabolic             |  |                  |
| Frequency             |  | 1 MHz to 175 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 175 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 175 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 175 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 <sup>N</sup> , 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 <sup>N</sup>      |  | 2 to 10 (cos <sup>N</sup> aperture distribution)                                                                                                |
| Custom phased array   |  |                                                                                                                                                 |
| Frequency             |  | 1 MHz to 175 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 <sup>N</sup> , 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)<br>.ffe (FEKO far field)<br>.ant_pat (Rohde & Schwarz pattern file)<br>.tsv (Antenna Magnus)<br>.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 6000 s                         |
| 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°                           |

|                                 |  |                                                                                                                                |
|---------------------------------|--|--------------------------------------------------------------------------------------------------------------------------------|
| <b>Lobe switching</b>           |  |                                                                                                                                |
| 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                                                                                                      |
| <b>Sine</b>                     |  |                                                                                                                                |
| 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                                                                                                                         |
| <b>Custom (list of entries)</b> |  |                                                                                                                                |
| Electronic scan                 |  | on/off                                                                                                                         |
| Azimuth                         |  | –180° to +180°                                                                                                                 |
| Elevation                       |  | –90° to +90°                                                                                                                   |
| Dwell time                      |  | 0 s to 3600 s                                                                                                                  |
| Interpolate to next             |  | true/false<br>(move or jump to next coordinate)                                                                                |
| Transition time                 |  | 0 s to 3600 s<br>(if interpolate to next is true, this parameter resembles the time for the transition to the next coordinate) |
| <b>Lissajous</b>                |  |                                                                                                                                |
| 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.

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

## Scenarios

The following scenario types are available:

|                                |  |                                                                        |
|--------------------------------|--|------------------------------------------------------------------------|
| <b>Scenario type</b>           |  |                                                                        |
| Single sequence                |  |                                                                        |
| Sequence                       |  | 1 single sequence                                                      |
| Output                         |  | PDW                                                                    |
| Duration                       |  | auto                                                                   |
|                                |  | fixed duration (1 $\mu$ s 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 $\mu$ s 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 175 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 $\mu$ s 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 $\mu$ s 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<br>each entry consists of a mode/beam pair | mode and beam (defines sequence, antenna pattern and antenna scan)<br>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                                                              |                                                                     | $-1 \times 10^9$ m to $1 \times 10^9$ m                                                                           |
| North                                                             |                                                                     | $-1 \times 10^9$ m to $1 \times 10^9$ m                                                                           |
| Height                                                            |                                                                     | $-1 \times 10^9$ m to $1 \times 10^9$ 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 175 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                                                            |                                                                     | $-1 \times 10^9$ m to $1 \times 10^9$ m                                                                           |
| Yaw                                                               |                                                                     | 0° to 360°                                                                                                        |
| Pitch                                                             |                                                                     | -90° to +90°                                                                                                      |
| Roll                                                              |                                                                     | 0° to 360°                                                                                                        |
| Duration                                                          |                                                                     | auto                                                                                                              |
|                                                                   |                                                                     | fixed duration (1 $\mu$ s 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.

|                                     |                                    |                                                                                                |
|-------------------------------------|------------------------------------|------------------------------------------------------------------------------------------------|
| <b>Position mode moving</b>         |                                    |                                                                                                |
| Trajectory line                     |                                    |                                                                                                |
| Start position                      |                                    |                                                                                                |
| East                                |                                    | $-1 \times 10^9$ m to $1 \times 10^9$ m                                                        |
| North                               |                                    | $-1 \times 10^9$ m to $1 \times 10^9$ m                                                        |
| Height                              |                                    | $-1 \times 10^9$ m to $1 \times 10^9$ m                                                        |
| Speed                               |                                    | 0.1 m/s to 5999 m/s                                                                            |
| Acceleration                        |                                    | $-100$ m/s <sup>2</sup> to $+100$ m/s <sup>2</sup>                                             |
| End position                        |                                    |                                                                                                |
| East                                |                                    | $-1 \times 10^9$ m to $1 \times 10^9$ m                                                        |
| North                               |                                    | $-1 \times 10^9$ m to $1 \times 10^9$ m                                                        |
| Height                              |                                    | $-1 \times 10^9$ m to $1 \times 10^9$ m                                                        |
| Mode                                |                                    | cyclic, round trip, one way                                                                    |
| Trajectory arc                      |                                    |                                                                                                |
| Start position                      |                                    |                                                                                                |
| East                                |                                    | $-1 \times 10^9$ m to $1 \times 10^9$ m                                                        |
| North                               |                                    | $-1 \times 10^9$ m to $1 \times 10^9$ m                                                        |
| Height                              |                                    | $-1 \times 10^9$ m to $1 \times 10^9$ m                                                        |
| Speed                               |                                    | 0.1 m/s to 5999 m/s                                                                            |
| Angle                               |                                    | $-360^\circ$ to $+360^\circ$                                                                   |
| Center position                     |                                    |                                                                                                |
| East                                |                                    | $-1 \times 10^9$ m to $1 \times 10^9$ m                                                        |
| North                               |                                    | $-1 \times 10^9$ m to $1 \times 10^9$ m                                                        |
| Mode                                |                                    | cyclic, round trip, one way                                                                    |
| Trajectory traces                   |                                    |                                                                                                |
| Trace point properties              |                                    |                                                                                                |
| East                                |                                    | $-1 \times 10^9$ m to $1 \times 10^9$ m                                                        |
| North                               |                                    | $-1 \times 10^9$ m to $1 \times 10^9$ m                                                        |
| Height                              |                                    | $-1 \times 10^9$ m to $1 \times 10^9$ 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                  | $-180^\circ$ to $+180^\circ$                                                                   |
| Pitch                               | only for constant                  | $-90^\circ$ to $+90^\circ$                                                                     |
| Roll                                | only for constant, align to motion | $-180^\circ$ to $+180^\circ$                                                                   |
| Trajectory waypoints                |                                    |                                                                                                |
| Waypoint file                       |                                    | XTD (proprietary trajectory 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                  | $-180^\circ$ to $+180^\circ$                                                                   |
| Pitch                               | only for constant                  | $-90^\circ$ to $+90^\circ$                                                                     |
| Roll                                | only for constant, align to motion | $-180^\circ$ to $+180^\circ$                                                                   |
| <b>Receiver position properties</b> |                                    |                                                                                                |
| Latitude                            | geodetic reference                 | $-90^\circ$ to $+90^\circ$                                                                     |
| Longitude                           | geodetic reference                 | $-180$ to $+180^\circ$                                                                         |

## 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,<br>each entry consists of a mode/beam pair | mode & beam (sequence, pattern & scan)<br>start and stop time of operation mode entry |
| Emitter parameters             |                                                                      | sequence, pattern & scan,<br>operation modes, beams                                   |
| Position mode                  |                                                                      |                                                                                       |
| Static                         |                                                                      | single static position                                                                |
| East/North                     |                                                                      | $-1 \times 10^9$ m to $1 \times 10^9$ m                                               |
| Height                         |                                                                      | $-1 \times 10^9$ m to $1 \times 10^9$ 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 175 GHz                                                                      |
| Receiver properties            |                                                                      |                                                                                       |
| Receiver                       |                                                                      | any DF receiver                                                                       |
| Position mode                  |                                                                      |                                                                                       |
| Static                         |                                                                      | single static position                                                                |
| Height                         |                                                                      | $-1 \times 10^9$ m to $1 \times 10^9$ 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                             |  | $-1 \times 10^7$ s to $1 \times 10^7$ 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                             |  | $-1 \times 10^7$ s to $1 \times 10^7$ 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                             |  | $-1 \times 10^7$ s to $1 \times 10^7$ 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                             |  | $-1 \times 10^7$ s to $1 \times 10^7$ 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 <sup>9</sup> m to 1 × 10 <sup>9</sup> 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<br>tx_platform_id<br>tx_id<br>tx_platform_emit_id<br>tx_list_id<br>rx_id<br>rx_antenna_id<br>toa<br>freq<br>pulse_width<br>level<br>modulation<br>bandwidth<br>rise_time<br>fall_time<br>marker_mask<br>azimuth<br>elevation<br>distance<br>rx_antenna_azimuth<br>rx_antenna_elevation<br>longitude<br>latitude<br>altitude<br>east<br>north<br>up<br>yaw<br>pitch<br>roll<br>speed                                                                    |
| Supported modulation flags              |  | unmodulated<br>fm<br>fm-step<br>2/4/8/16/32/64-fsk<br>msk<br>chirp-generic<br>chirp-linear-up<br>chirp-linear-down<br>chirp-linear-triangular<br>chirp-linear-piecewise<br>chirp-sine<br>barker-2,3,4a,4b,5,7,11,13<br>polyphase-frank<br>polyphase-p1<br>polyphase-p2<br>polyphase-p3<br>polyphase-p4<br>bpsk<br>qpsk<br>8psk<br>phase-generic<br>am-standard<br>am-lsb<br>am-usb<br>am-lsb-usb<br>am-step<br>ask<br>16/32/64/128/256-qam<br>noise<br>unknown |

|                           |  |                                                                            |
|---------------------------|--|----------------------------------------------------------------------------|
| <b>PDW export plug-in</b> |  |                                                                            |
| Format                    |  | 64 bit Windows .dll,<br>API specified in user manual,<br>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.

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

|                                           |  |                                                                    |
|-------------------------------------------|--|--------------------------------------------------------------------|
| <b>Minimum hardware configuration</b>     |  |                                                                    |
| 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                                                     |
| <b>Recommended hardware configuration</b> |  |                                                                    |
| CPU                                       |  | Intel Core i7 hexa-core,<br>Intel Xeon hexa-core,<br>AMD FX series |
| RAM                                       |  | 32 Gbyte                                                           |
| Video resolution                          |  | 1920 × 1200 pixel                                                  |

## Ordering information

| Designation                                    | Type          | Order No.    |
|------------------------------------------------|---------------|--------------|
| <b>R&amp;S®Pulse Sequencer Digital options</b> |               |              |
| 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                                                                                         |
| 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                                                                                  |
| 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                                                                                      |
| 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)                                               |
|                                  | R&S®SMJ-B9                                                                             | baseband generator with ARB (128 Msample) and digital modulation (real-time)                                              |
| For R&S®SMJ100A                  | 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:             |                                                                                                                           |
| For R&S®SMBV100B                 | 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                                                                                       |
| 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                                                                                         |
| For R&S®SMBV100B                 | R&S®SMBV-K522                                                                          | extension to 160 MHz RF bandwidth                                                                                         |
|                                  | 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                                                                                |
| For R&S®SMBV100B                 | 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                                                                                         |
|                                  | R&S®SMBVB-K522                                                                         | bandwidth 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.

|                                         |                                                                                                             |
|-----------------------------------------|-------------------------------------------------------------------------------------------------------------|
| <b>R&amp;S®SMW200A (standard model)</b> |                                                                                                             |
| 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                                                                          |
| <b>R&amp;S®SMW200A (wideband model)</b> |                                                                                                             |
| 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                                                                          |
| <b>R&amp;S®SMM100A</b>                  |                                                                                                             |
| 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                                                                          |
| <b>R&amp;S®SMBV100A</b>                 |                                                                                                             |
| 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                                                                          |
| <b>R&amp;S®SMBV100B</b>                 |                                                                                                             |
| 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                                                                             |
| <b>R&amp;S®SGT100A</b>                  |                                                                                                             |
| 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                                                                                |
| <b>R&amp;S®SMU200A</b>                  |                                                                                                             |
| 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                                                                          |
| <b>R&amp;S®SMJ100A</b>                  |                                                                                                             |
| 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, 2017      |
| 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

|                                         |                                          |
|-----------------------------------------|------------------------------------------|
| <b>FCC 0696</b>                         |                                          |
| 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              |
| <b>FCC 1322</b>                         |                                          |
| 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              |
| <b>FCC KDB 905462 D02 New Rules v02</b> |                                          |
| 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 generated              |

## Europe

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

|                              |  |                                    |
|------------------------------|--|------------------------------------|
| <b>ETSI EN 301893 V1.8.1</b> |  |                                    |
| 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        |
| <b>ETSI EN 301893 V1.7.2</b> |  |                                    |
| 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        |
| <b>ETSI EN 302502 V1.2.1</b> |  |                                    |
| 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        |
| <b>ETSI EN 303258 V1.0.0</b> |  |                                    |
| 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**

|                                    |  |                                                                                  |
|------------------------------------|--|----------------------------------------------------------------------------------|
| <b>MIC-W53/-W56</b>                |  |                                                                                  |
| Signal types                       |  | W53 1, 2;<br>W56 1, 2, 3, 4, 5, 6;<br>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                                                      |
| <b>MIC-W53/-W56 07_2019 update</b> |  |                                                                                  |
| Signal types                       |  | W53 1, 2, 3, 4, 5, 6, 7, 8;<br>W56 1, 2, 3, 4, 5, 6;<br>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**

|                   |  |                                 |
|-------------------|--|---------------------------------|
| <b>Korea</b>      |  |                                 |
| 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**

|                       |  |                                 |
|-----------------------|--|---------------------------------|
| <b>YD/T 2950-2015</b> |  |                                 |
| 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),<br>format can be customized                                                                                                                                                                        |
| Parameters   |  | TOA, RF center frequency, pulse width,<br>power level, MOP type, bandwidth                                                                                                                                       |
| Template     |  |                                                                                                                                                                                                                  |
| Format       |  | text (table)                                                                                                                                                                                                     |
| Parameters   |  | TOA, RF frequency, power level, MOP<br>type, bandwidth, PRI, PRF, pulse width,<br>rise time, fall time, phase, AOA (emit azi,<br>emit ele), rx scan azi, rx scan ele,<br>sequencing parameters, custom variables |
| Plug-in      |  |                                                                                                                                                                                                                  |
| Format       |  | 64 bit Windows .dll,<br>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<br>on signal generator    |
| Compensation method                               |  | scalar level offset versus frequency                             |
| Supported power sensors                           |  |                                                                  |
| R&S®NRPxxSN, R&S®NRPxxTN,<br>R&S®NRPxxAN          |  | directly via LAN, connected to signal<br>generator (legacy mode) |
| R&S®NRPxxS, R&S®NRPxxT,<br>R&S®NRPxxA, R&S®NRPxxP |  | directly via USB, connected to signal<br>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

|                                           |  |                                                         |
|-------------------------------------------|--|---------------------------------------------------------|
| <b>Minimum hardware configuration</b>     |  |                                                         |
| 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                                          |
| <b>Recommended hardware configuration</b> |  |                                                         |
| 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.    |
|-------------------------------------------------------------------|----------------|--------------|
| <b>Options with external R&amp;S®Pulse Sequencer DFS software</b> |                |              |
| 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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