# EXHIBIT 1.0

# Outdoor Block-Upconverter
# Type
# VHBU3-VVV-WR22-OD-RIN-S02067

# User Manual


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# 1 Introduction

## 1.1 Application

The Block-Upconverters from WORK Microwave are used in modern satellite communication and broadcasting systems.

This document describes the functions, the installation and the Monitoring & Control interfaces (M&C) of the Upconverters.

## 1.2 Reference Documents

The Upconverters of WORK Microwave are designed in correspondence with the following references and standards.

Directive 1999/5/EC (R&TTE directive)
ETSI EN 301489-12
ETSI EN 301489-1
ETSI EN 301430-1
EN 55022, Class B
EN 61000-3-2
EN 61000-3-3
EN 60950-1

## 1.3 Reference to Firmware Versions

This issue of the user manual applies to the converter module firmware version FCA02.26 or higher and base firmware version XNA01.78 or higher.

The software versions of the converter can be queried by the multipoint command ID.

## 1.4 Abbreviations

| | |
|---|---|
| AC | Alternating current |
| BNC | Bayonet Neill Concelman |
| DC | Direct Current |
| EQ | Equalization |
| HTTP | Hypertext Transfer Protocol |
| HTTPS | Hypertext Transfer Protocol Secure |
| IC | Integrated Circuit |
| IF | Intermediate Frequency |
| IP | Internet Protocol |
| LCD | Liquid Crystal Display |
| LED | Light-Emitting Diode |
| LNA | Low Noise Amplifier |
| LNB | Low Noise Blockconverter |
| LO | Local Oscillator |
| M&C | Monitoring & Control |
| MAC | Media Access Control |
| MIB | Management Information Base |
| MPT | Multipoint |
| MW | Microwave |
| NTP | Network Time Protocol |
| OCXO | Oven-Controlled Crystal Oscillator |
| ODU | Outdoor Unit |
| OID | Object Identifier |
| OS | Operating System |
| PLL | Phase-Locked Loop |
| PLO | Phase-Locked Oscillator |
| Ref. | Reference |
| RF | Radio Frequency |
| RX | Receiver |
| SNMP | Simple Network Management Protocol |
| TCP | Transmission Control Protocol |
| TCXO | Temperature Controlled Crystal Oscillator |
| TX | Transmitter |
| UDP | User Datagram Protocol |
| USB | Universal Serial Bus |
| VFD | Vacuum Fluorescent Display |
| VHF | Very High Frequency |
| XML | Extensible Markup Language |

# 1.5 Compliances

## 1.5.1 Federal Communications Commission (FCC)

This equipment has been tested and found to comply with the limits for a Class A device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment.

This equipment generates, uses, and can radiate radio frequency energy. If not installed and used in accordance with the instruction manual, it may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference; in which case, users are required to correct the interference at their own expense.

**Note:** To ensure compliance, properly shielded cables for DATA I/O shall be used. More specifically, these cables shall be shielded from end to end, ensuring a continuous shield.

## 1.5.2 Safety Compliance EN 60950

Applicable testing is routinely performed as a condition of manufacturing on all units to ensure compliance with safety requirements of EN 60950.

This equipment meets the Safety of Information Technology Equipment specification as defined in EN 60950.

# 1.6 Safety Instructions

Please read this chapter carefully before you install and use this device from WORK Microwave.

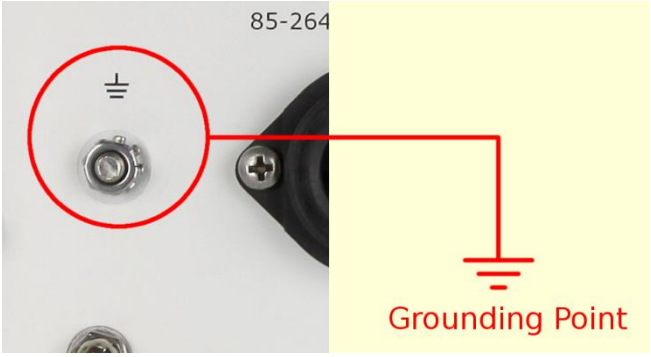
To ensure your safety, please make sure you observe the following important points:

- **The equipment described in this manual is designed to be used by properly trained personnel only!**

- **Electrical safety:**

  **If the information on electrical safety is not observed at all to the extent necessary, electric shock, either fire and/or serious personal injury or death may occur.**

  1. Prior to switching on the product, always ensure that the nominal voltage setting on the product matches the nominal voltage of the AC supply network. If a different voltage is to be set, the power fuse of the product may have to be changed accordingly.
  2. In the case of products of safety class I with movable power cord and connector, operation is permitted only on sockets with a ground contact and protective earth connection.
  3. Intentionally breaking the protective earth connection either in the feed line or in the product itself is not permitted. Doing so can result in the danger of an electric shock from the product. If extension cords or connector strips are implemented, they must be checked on a regular basis to ensure that they are safe to use.
  4. For save operation, the ground terminal of the device must be permanently connected to a grounding point. Otherwise, the device could be damaged.



5. Never use the product if the power cable is damaged. Check the power cable on a regular basis to ensure that it is in proper operating condition.
6. Do not insert the plug into sockets that are dusty or dirty. Insert the plug firmly and all the way into the socket. Otherwise, sparks that result in fire and/or injuries may occur.
7. Do not overload any sockets, extension cords or connector strips; doing so can cause fire or electric shocks.
8. Never remove the cover or any part of the housing while the product is in operation. Doing so will expose circuits and components and can lead to injuries, fire or damage to the product.
9. Use suitable overvoltage protection to ensure that no overvoltage (such as that caused by a bolt of lightning) can reach the product. Otherwise, the person operating the product will be exposed to the danger of an electric shock.
10. Unless specified otherwise, products are not liquid-proof. Therefore, the equipment must be protected against penetration by liquids. If the necessary precautions are not taken, the user may suffer electric shock or the product itself may be damaged, which can also lead to personal injury.
11. Prior to cleaning the product, disconnect it completely from the power supply. Use a soft, lint-free cloth to clean the product. Never use chemical cleaning agents such as alcohol, acetone or diluents for cellulose lacquers.

- **Operation and environmental**
    1. Operating the products requires special trained persons.
    2. It is the responsibility of the employer/operator to select suitable personnel for operating the devices.
    3. Should a fire occur the product might release hazardous substances (gases, fluids, etc.) that can cause health problems. Therefore, suitable measures must be taken, e.g. protective masks and protective clothing must be worn.
    4. Do not use the equipment in an environment in which the unit is exposed to:
        - Unpressurised altitudes higher than 3000 meters
        - Extreme temperatures outside the stated operating temperature range
        - Excessive vibration
        - Flammable gases
        - Corrosive or explosive atmospheres

- **Repair and service**
    1. The product may be opened only by authorized, specially trained personnel. Before any work is performed on the product or before the product is opened, it must be disconnected from the AC supply network. Otherwise, personnel will be exposed to the risk of an electric shock.
    2. Only electrical experts authorized by WORK Microwave may perform adjustments, replacement of parts, maintenance and repair.

# 2 Technical Description

## 2.1 General

The Block-Upconverters from WORK Microwave are designed to convert an input signal from L-Band to an RF output signal in C-, X- or Ku- Band.

## 2.2 System Characteristics

- Single conversion
- 3 Bands
- No spectrum inversion
- L-Band input frequency
- Low phase noise
- Redundant power supply (option)
- Adjustable attenuation (0.1 dB steps size)
- Potential free relay outputs for summary alarm
- Remote control via serial interface RS485/RS232 and Ethernet (TCP/IP, HTTP or SNMP)
- 16 programmable memory settings

## 2.3 Signal Flow

This Block-Upconverter is a three band device. The L-Band input-signal first passes through an adjustable gain amplifier to the signal mixer. A synthesizer generates a fixed LO-signal for each band. The reference for this synthesizer is either an internal 10 MHz OCXO or an optional external 5 or 10 MHz reference signal. The converted signal passes through a microwave bandpass-filter and is converted by a second mixer with adjustable LO to the final output frequency. The RF signal passes through a second bandpass and an output amplifier.

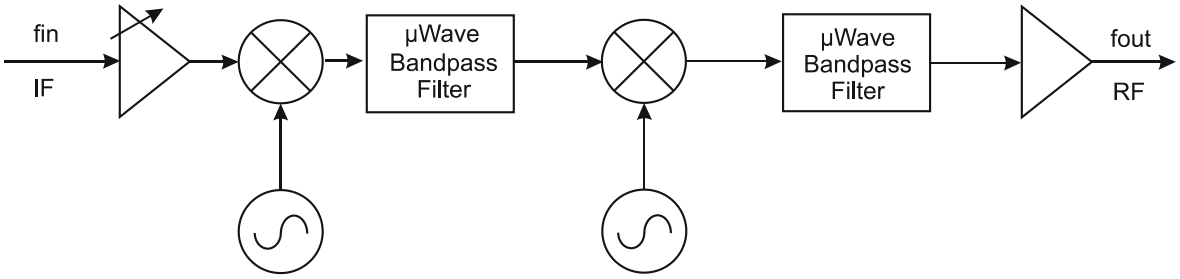



**Figure 1: Triple Band Upconverter, simplified block-diagram**

## 2.4 Connector Side of the Converter

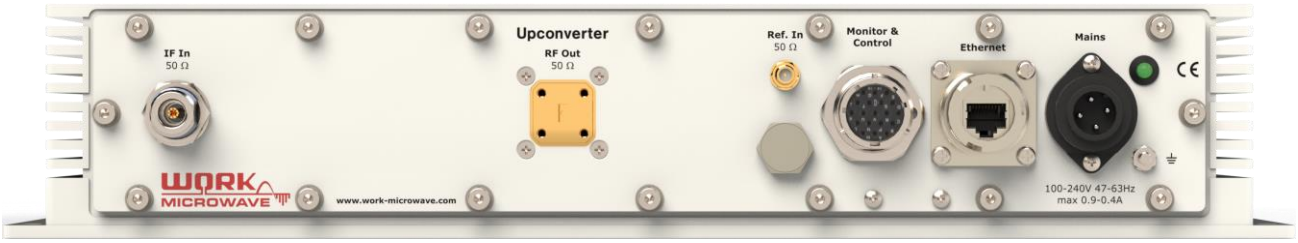



**Figure 2: Block-Upconverter**

Description of Figure 2: Block-UpconverterFigure 2 from left to right:

- IF input connector
- RF output connector
- External reference input connector (5 or 10 MHz)
- Pressure vent
- M&C interface with RS422/485, RS232, potential free contacts of alarm relays, RF mute input
- Ethernet interface
- AC power input connector 1
- Power LED 1
- Ground connection (thread bolt, M4)

### 2.4.1 Power Input Connector

**Please note:** For units with redundant power supply (option), to minimize power supply failures you have to connect both power input connectors to the mains supply. This device still works when only one power supply is connected.

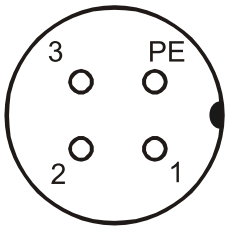



**Figure 3: AC Power Connector**

The following pin out applies:

| Pin | |
|---|---|
| PE | Protective Ground |
| 1 | 100… 240 V AC in (phase) |
| 2 | 100… 240 V AC in (neutral) |
| 3 | NC |

The Type of the Connector: Amphenol C16-1 male

The nominal input power range and frequency is 90 - 264 V max., 47-63 Hz max.
The nominal current draw is <1.7 A for 100W max. or <0.9 A for 48W max. power supply.
The Fuse type is 2.5 AT for 100W max. or 2.0 AT for 48W max. power supply.

## 2.4.2 M &C Connector

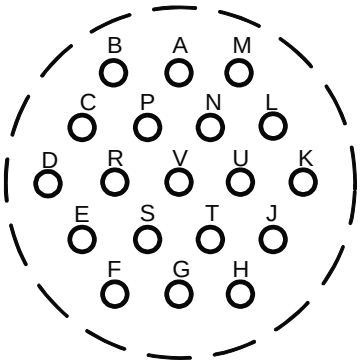



**Figure 4: M&C connector**

The type of the connector is MIL-C-26482: MS 3120 E 14-19 S.

The following pin out applies:

| Pin | | |
|---|---|---|
| U | 6.5 V out, max. 0.4 A (option) | |
| V | 24 V out, max. 0.4 A | |
| T | GND | |
| | | |
| E | RS-232 TxD out | 2) |
| D | RS-232 RxD in | 2) |
| N | RS-232 GND | |
| | | |
| F | RS-485 TxD- out | 3) |
| G | RS-485 TxD+ out | 3) |
| H | RS-485 RxD- in | 3) |
| J | RS-485 RxD+ in | 3) |
| K | RS-485 GND | |
| | | |
| A | Alarm 1a, open in normal operation<br>connected to pin B in alarm condition | 1) |
| B | Alarm 1c, common pin of the SPDT/Form C contact | 1) |
| C | Alarm 1b, connected to pin B in normal operation<br>open under alarm condition | 1) |
| P | Alarm 2a, open in normal operation<br>connected to pin R in alarm condition | 1) |
| R | Alarm 2c, common pin of the SPDT/Form C contact | 1) |
| S | Alarm 2b, connected to pin R in normal operation<br>open under alarm condition | 1) |
| M | Alarm GND | |
| | | |
| L | Mute in | 4) |

1) The maximum allowed current for the alarm contacts is 200 mA, the maximum allowed voltage is 42 V. Inside the ODU there are two internal alarm relays with changeover contacts (SPDT/Form C), which are switched by the same signal. In normal operation (unit is powered up and no alarm condition exists) the common pin “Alarm 1c” is connected to “Alarm 1b” and the common pin “Alarm 2c” is connected to “Alarm 2b”. If the unit is powered down or an alarm condition exists (at least one of the alarm bits is active, see software commands) “Alarm 1c” is connected to “Alarm 1a” and “Alarm 2c” is connected to “Alarm 2a”.

2) The RS-232 interface is able to connect the unit to a remote control unit and allows using the point to multipoint syntax. For the data format and the command syntax see the software command section. The factory default baud rate is 19200 (8N1).

3) The RS-485 interface can be used to connect the unit to a controller and allows using the point to multipoint command syntax. A RS422/RS485 4-wire bus connection or a 2-wire bus connection can be used. The factory default baud rate is 19200 (8N1).

4) “Mute in” is a 5 V TTL input, with an internal pull up. If muting via this input is enabled by the software (see software commands) then a low level (or connection to ground) enables the output of the converter and a high level (or open input) disables the output of the converter (applies to Firmware **FCA 2.05 or lower**). With Firmware **FCA 2.06 or higher** the external mute input can be either chose to be “LOW ACTIVE” or “HIGH ACTIVE”:

    a. LOW ACTIVE: low level or connection to ground **enables** the RF-Output

    b. HIGH ACTIVE: low level or connection to ground **disables** the RF-Output

**Important: When the “external Mute Input” is enabled and the “external mute level” is set to “LOW ACTIVE”, pin M and pin L of the alarm interface must be connected for normal operation!**

**Important: When the “external Mute Input” is enabled and the “external mute level” is set to “HIGH ACTIVE”, no additional connection is required for normal operation!**

## 2.4.3 Ethernet Interface

In addition to the serial interface, an Ethernet Interface can be installed for remote Monitoring and Control. This interface supports 10 or 100 Mbit/s Ethernet in full duplex or half-duplex mode.

The configuration of the IP Address, Subnet Mask, the IP Gateway and the Port for TCP/IP and UDP connections can be done by using multipoint commands via serial interface.

The factory default values are: IP address 192.168.2.10, subnet mask 255.255.255.0, IP gateway 192.168.2.1, TCP/IP port 50505, UDP port 161

Within the TCP/IP packets commands according to the multipoint syntax and command structure can be used for remote monitoring and control. The device address used within that command structure needs to match the internally configured multipoint address of the unit. The default address is 'A'.

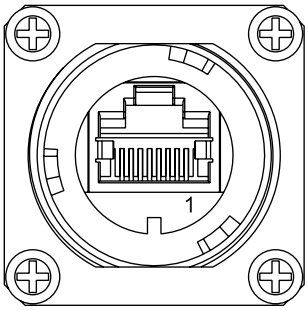



**Figure 5: Ethernet Interface (RJ-45 connector, IP67)**

**Ethernet Interface**

| Pin | |
|---|---|
| 1 | TX + |
| 2 | TX - |
| 3 | RX + |
| 4 | connected to 5 |
| 5 | connected to 4, 75 Ohm to GND |
| 6 | RX - |
| 7 | connected to 8 |
| 8 | connected to 7, 75 Ohm to GND |

### 2.4.4 Fallback IP address

The devices are equipped with a fallback IP address. The fallback IP still enables the access to the M&C interface, if the M&C interface of the WORK Microwave device is set to an unknown address.

The WORK Microwave devices have the following M&C fallback IP address and have the following M&C fallback subnet mask:

| M&C Fallback IP Settings | |
|---|---|
| M&C fallback IP address | 169.254.10.221 |
| M&C fallback subnet mask | 255.255.255.252 = 30 (CIDR notation) |

The M&C fallback IP address is a fixed IP address from the APIPA range. This IP address is rarely assigned in ordinary local area networks (= LAN), so that IP address clashes are improbable. To minimize the possibility of IP address clashes additionally, the subnet mask of the WORK Microwave device is chosen so as only two hosts are allowed. That means if you want to communicate to the WORK Microwave device via the fallback IP, you must have the IP address 169.254.10.222.

If you use WORK Microwave devices in networks in which ZeroConf is also used, we point you to the risk of IP address clashes, because ZeroConf uses also the APIPA range. ZeroConf is used for an automatically configuration of networks, inclusive the automatic assignment of IP addresses for networked devices.

### 2.4.5 Reference Input

At the “Ref. In” connector an external reference signal can be connected. The frequency can be either 10 MHz or 5 MHz.

The reference mode can be set by the remote command ‘X’. The following modes are available:

- INTERNAL (0)
- EXTERNAL (1)
- AUTO (2)

The converter is equipped with a 10 MHz OCXO as internal reference. In the mode “INTERNAL”, this OCXO is used as reference. In mode “EXTERNAL” an external reference connected to the “Ref In” connector is used to phase lock the 10 MHz internal reference. This external signal can be either a 5 MHz or a 10 MHz reference signal, which is automatically detected. If this signal is missing or not appropriate, an alarm is generated and the frequency output is muted.

In the mode “AUTO”, the unit monitors the power level of the external reference. If the power level is above a threshold value, the converter is switched to the external reference source. When the power level is below the threshold, the converter is switched back to the internal reference.

### 2.4.6 IF-Input

This is the L-band input connector for each channel. The connector type is N, female, 50 Ohm.

### 2.4.7 RF-Output

This is the output for the RF signal. The connector type is WR22, 50 Ohm.

## 2.5 Warm Up Mute

When the unit is powered on, it takes some time to boot the firmware (approx. 1 minute). After booting, sometime is required for the oven controlled crystal oscillator (OCXO) to warm up. Only after sufficient warm up the specified maximum frequency offset is established. Therefore a warm up time is foreseen, during which an oven cold warning is generated. The signal path is automatically switched off if the unit is in warm up period. The mute time after power up, depends on the internal temperature of the equipment and how long the equipment was switched off.

## 2.6 Mounting of the Upconverter, Outdoor Version

The Block-Upconverter, Outdoor Version should be mounted with the connector side down which guarantees optimal protection against water. Alternatively, the connector side can be in a vertical position. Although a lot of attention has been paid for protection against water immersion, it is not recommended to mount the Upconverter with the connector side up.

If no cables are connected to the unit, all the connectors are not completely protected against water immersion.

After installation of the IF cable and the RF cable, a rubber splicing tape or shrinking tube with adhesive is used to provide water sealing from the outer sleeve of the connector on the housing to the sheath of the cable.

A shielded cable shall be used for the M&C interface. The cable shielding shall be connected on both ends to the shielding ground (housing).

The mechanical details for mounting can be seen from Figure 6.

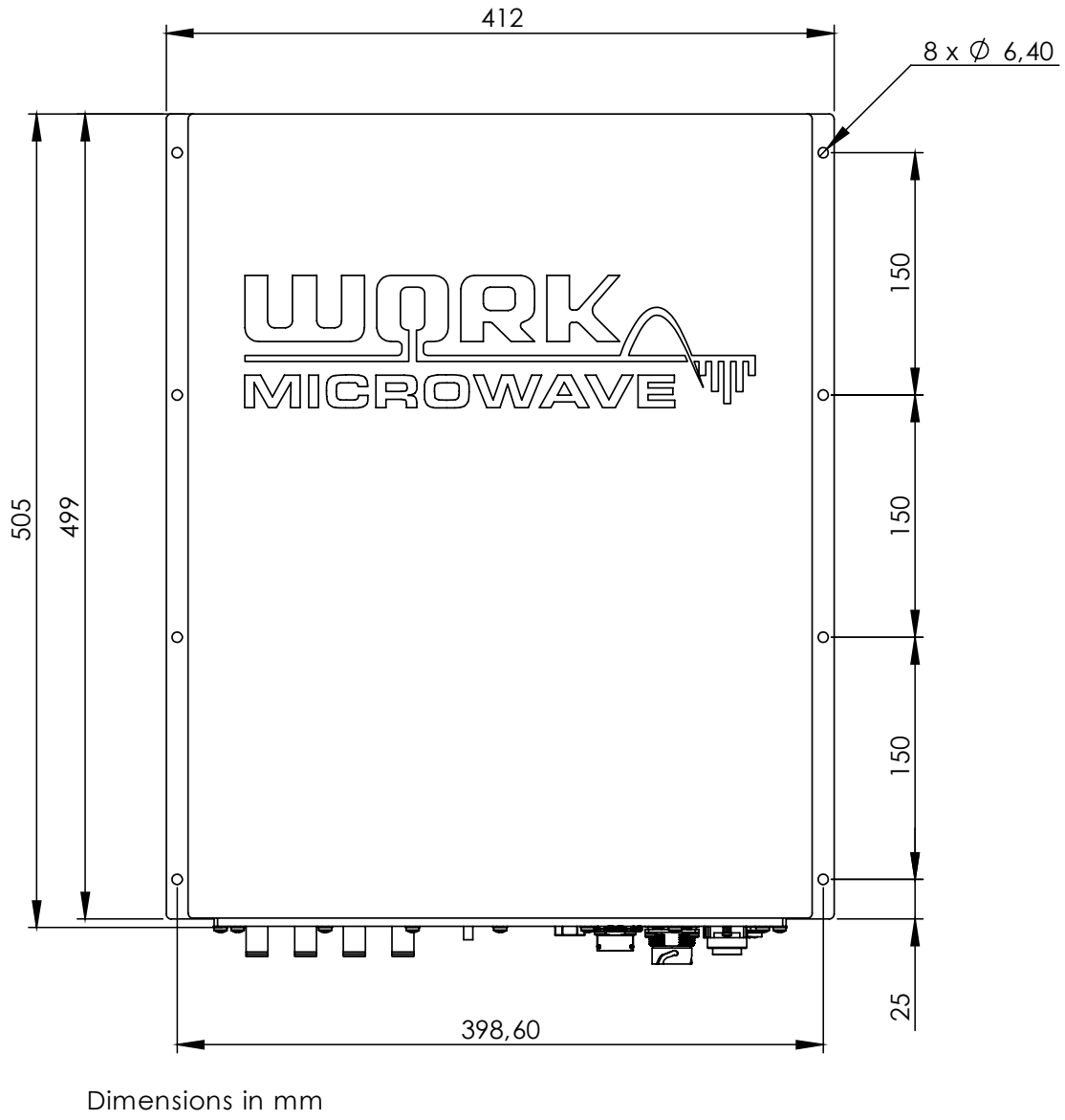



**Figure 6: Mechanical Dimensions and Mounting Holes**

# 3 Remote Control Description

## 3.1 Overview

The converter unit can be remotely controlled through the serial interface or the Ethernet/IP-interface.

The serial interface can be configured by commands or by the front panel menu to RS232 or to RS422/RS485. To support bus structured serial communication according to RS485 ‘MULTIPOINT’ commands are used as standard. Each device on the bus has its own address.

‘MULTIPOINT’ commands are also used for point-to-point communication through RS232 as well as within the packets sent and received over the Ethernet interface, when a TCP/IP connection is used.

Using the Ethernet interface the unit can also be remotely controlled through a web browser interface.

## 3.2 Syntax of MULTIPOINT Commands

### 3.2.1 What is a MULTIPOINT Command?

Multipoint commands are used widely in the satellite communications equipment industry to control equipment via a RS485 bus or also via RS232. The ‘MULTIPOINT’ commands support systems with a bus-structured remote control configuration with more than one controlled device connected to the same controller interface.

### 3.2.2 MULTIPOINT Command Structure

A ‘MULTIPOINT’ command consists of a string of ASCII characters with header, command, trailer and a checksum:

**Important:** In all commands, only capital letters are allowed!

| HEADER ’{‘ | device address | OPCODE | parameter (if necessary) | TRAILER ‘}’ | checksum |
|---|---|---|---|---|---|

HEADER: The character ‘{’.

Device address: Valid addresses are between 40h (‘@’) and 5Ah (‘Z’). The address of the device has to be configured manually in the special function menu of the controller or can also be changed by remote control. The default address is 'A'.

OPCODE: The OPCODE defines the function of the command.
The implemented OPCODEs are described in chapter 3.4

Parameter: The structure and size of the parameters depends on the OPCODE. Only the characters ‘0’ to ‘9’, ‘.’, ‘+’, ‘-‘ and ‘?’ are allowed. Leading zeros in values are ignored and do not produce an error.

TRAILER: The character ‘}’

Check sum X: The check sum is calculated with the following equation:

$$X = \left[ \sum_{i=1}^{N} (c_i - 32) \right] \bmod 95 + 32$$

- The single characters are converted to their decimal value $c_i$, , each $c_i$, is subtracted by decimal 32
- All decimal value are added (incl. header and trailer)
- calculate the result modulus decimal 95
- add to the result decimal 32
- the check sum is the ASCII character of this number

Example: The command '{AT105}' has the check sum 70 = 'F'.
Therefore, the complete command string is '{AT105}F'.

### 3.2.3 Commands, Responses and Error Codes

The Block-Upconverter unit sends a response for every received command. The response sent back has the following basic format:

| HEADER '{' | device address | OPCODE or error code | response value (if applicable) | TRAILER '}' | checksum |
|---|---|---|---|---|---|

If the controller executes a setting command successfully, only the OPCODE of the command is sent back.

If the controller executes a query command successfully, the OPCODE of the command and the response value is sent back.

If the controller receives an invalid command one of the following error codes is sent back (no response value is included) :

| | |
|---|---|
| 'a' | syntax error |
| 'b' | value out of range or value invalid |
| 'g' | general error |

Examples:

| **command** | **response** | |
|---|---|---|
| {AT010}A | {AT}o | correct level setting command |
| {AT?}/ | {AT120}C | correct level query command |
| {AT2000}R | {Ab}} | invalid command: out of range error code |
| {AMk}T | {Aa}\| | invalid command: syntax error code |
| {A}; | {Aa}\| | command without OPCODE: syntax error |
| {AT100}H | | command with wrong checksum: no reply |

## 3.3 Instrument States

The whole device configuration (interface settings, converter settings, system settings) can be saved in instrument states and loaded again. There are 16 (0 … 15) possible instrument states available. You can save a device configuration with the multipoint command 'S' and load it with the command 'R'.

After power up the instrument state 0 will be loaded automatically.

When the function "auto save" (command 'ZO') is enabled, the current parameters are stored automatically in instrument state 0. Therefore, after rebooting the last auto saved configuration will be active. The function "auto save" is enabled by default.

## 3.4 List of all Command OPCODEs

| OPCODE | Function | Allowed Parameters | Examples (device address 'A') |
|---|---|---|---|
| BS | Band selection | 0, 1, 2, ? | {ABS0}A *select frequency band 1*<br>{ABS1}B *select frequency band 2*<br>{ABS2}C *select frequency band 3* |
| F***xyz*** | RF frequency in MHz with floating point,<br>***x*** = channel A<br>A ≙ channel 1<br>***y*** = band A, B, C<br>A ≙ band 1<br>***z*** = LO A, B<br>A ≙ LO 1 | MHz, ? | {AFAAA?}% *read LO1 band 1*<br>{AFAAB?}& *read LO2 band 1*<br><br>{AFABA?}f *read LO1 band 2*<br>{AFABB?}g *read LO2 band 2*<br><br>{AFACA?}g *read LO1 band 3*<br>{AFACB?}h *read LO2 band 3* |
| T***xy*** | Attenuation in 1/10 dB,<br>***x*** = channel A<br>A ≙ channel 1;<br>***y*** = band A, B, C<br>A ≙ band 1; | Attenuation (1/10 dB), ? | {ATAA200}% *20.0 dB channel 1, band 1, 1. att.*<br>{ATAA?}q<br>{ATAB?}r *ch. 1, band 2*<br>{ATAC?}s *ch. 1, band 3* |
| M | Mute<br>RF output off | None; ? | {AM}h *Mute On*<br>{AM?} *Mute State request* |
| U | Unmute | None | {AU}p *Mute Off* |
| X | Reference Source | 0, 1, 2, ? | {AX0}$ *internal reference*<br>{AX1}% *external reference*<br>{AX2}& *auto reference*<br>{AX?}3 |
| XT | Reference Tune (alignment tuning for internal reference signal; requires FCA 2.14, CSA2.00/RE**x**1.38 or higher) | 0… 65534, ? | {AXT06003}B *Set value to reference*<br>{AXT?}g *Show set value* |
| XTD | Reference Tune Default value (from command XT) | None, ? | {AXTD?}, *Show reference default value*<br>{AXTD}l |
| ZG<br>G | External Mute Input | 0, 1, ? | {AZG0}M *disable ext. mute input*<br>{AZG1}N *enable ext. mute input*<br>{AZG?}\ |
| ZGL | External Mute Level (requires FCA 2.06 or higher) | 0, 1, ? | {AZGL0}y *low active*<br>{AZGL1}z *high active*<br>{AZGL?}) |
| ID<br>VW | Firmware Identification Strings | ID-No, None | {AID}) *Device ID*<br>{AID0}9 *Device ID*<br>{AID1}: *Base system ID*<br>{AID2}; *Interface module ID*<br>{AID3}< *OCXO reference module ID*<br>{AID4}= *Synthesizer module ID* |
| ZJ<br>J | Alarm Relay Inhibit | 0, 1, ? | {AZJ0}P *Alarm relay disabled*<br>{AZJ1}Q *Alarm relay enabled*<br>{AZJ?}_ |
| ZA<br>DA | MULTIPOINT Addr. | 64 to 90 ('@' to 'Z') | {AZA66}c *Set to MPT address 'B'*<br>{AZA?}V |

| | | | |
|---|---|---|---|
| S | Save Settings | 00 to 15 | {AS03}2 |
| R | Load and Set Settings | 00 to 15 | {AR01}/ |
| ZO<br>O | Auto Save Mode | 0, 1, ? | {AZO0}U *Autosave Off*<br>{AZO1}V *Autosave On*<br>*last settings are saved automatically*<br>{AZO?}d |
| ZR | Configures the Serial Control Interface (see Figure 10) | 0 to 255, ? | {AZR101}z *set baud rate to19200 (8N1)*<br>{AZR?}g *read value* |
| ZC | Configuration Byte (see Figure 11) | 0 to 127 | {AZC004}m<br>{AZC?}X |
| ZRR | Configures the RX bus termination for RS485 | 0, 1, ? | {AZRR0}+ *RX termination disabled*<br>{AZRR1}, *RX termination enabled* |
| ZRT | Configures the TX bus termination for RS485 | 0, 1, ? | {AZRT0}- *TX termination disabled*<br>{AZRT1}. *TX termination enabled* |
| ZI | IP Address | IP addr, ?, none | {AZI192.168.011.111}, *set IP address*<br>{AZI?}^ *read IP address*<br>{AZI}? *read IP address* |
| ZB | IP Subnet Mask | ZU mask, ?, none | {AZB255.255.255.000}) *set IP mask*<br>{AZB}8 *read IP mask*<br>{AZB?}W *read IP mask* |
| ZW | IP Gateway | ZW addr, ?, none | {AZW192.168.002.001}8 *set IP gateway addr.*<br>{AZW}M *read IP gateway addr.*<br>{AZW?}l *read IP gateway addr.* |
| ZP | TCP Port | ZP number, ?, none | {AZP50505}F *set TCP port number*<br>{AZP}F *read TCP port number*<br>{AZP?}e *read TCP port number* |
| ZT | Set/Get Time | Timecode (hhmm), ? | {AZT1035}4 *sets clock to 10:35*<br>{AZT?}I *read time*<br>*Response:*<br>{AZT175148} *time in hhmmss* |
| ZD | Set/Get Date | Date code (yyyymmdd), ? | {AZD20050429}q *set date*<br>{AZD?}Y *read date* |
| ZF | Factory reset (see Figure 12) | None | {AZF}< |
| EA | Alarm History Query | Number, ? | {AEA?}A *read number of history entries*<br>{AEA1}3 *read first history entry*<br>{AEA2}4 *read second history entry*<br>…<br>*Response:*<br>*{AEAnnSssssssssDyyyymmddThhmmss}*<br>*nn: max. history entries*<br>*ssssssss: Status (see Figure 7)*<br>*hhmmss: Time*<br>*yyyymmdd: Date* |
| EE | Stored Events Query | Number, ? | {AEE?}E *read number of stored events*<br>{AEE1}7 *read first stored event*<br>{AEE2}8 *read second stored event*<br>…<br>*Response:* |

| | | | |
|---|---|---|---|
| | | | *{AEEnnEeDyyyymmddThhmmss}*<br>*nn: max. history entries*<br>*e: Event (see Figure 9)*<br>*hhmmss: Time*<br>*yyyymmdd: Date* |
| EC | Clear Stored Alarms/Events | 1, 2 | {AEC1}5 *Clear stored alarms*<br>{AEC2}6 *Clear stored events* |
| SA<br>QS | Read device and system status in hex | None, 0, 1 | {ASA}0 *Device Status*<br>{AQS}@ *Device Status*<br>{ASA0}@ *Device Status*<br>{ASA1}A *System Status*<br><br>*answer {ASAssssssss}*<br>*ssssssss: Status*<br>*(hex. value see Figure 7 and Figure 8)* |
| QT | Read Temperature | 2, 3, 4 | {AQT1}R *Invalid for this device*<br>{AQT2}S *Controller temperature*<br>{AQT3}T *Reference board temperature*<br>{AQT4}U *Synth. module temperature* |
| A | Status Request A | None | {AA}\<br>*Response:*<br>{AFffffffffTtttLrliMm?abcdef}<br>ffffffff: LO frequency in kHz<br>**Note:** There are no leading zeros; therefore, the number of digits may be different for this value.<br><br>ttt: Attenuation in 1/10 dB (channel1)<br>r: Remote mode: 0=Local, 1=Remote<br>i: always 0<br>m: Mute Status: 0 = mute off, 1 = mute on<br><br>Warning and Alarm Bits:<br>a: Device alarm: 0=OK, 1=Alarm<br>b: reserved, always 0<br>c: reserved, always 0<br>d: reserved, always 0<br>e: reserved, always 0<br>f: reserved, always 0 |
| B | Status Request B | None | {AB}]<br>*Response:*<br>{BQqqqXxYyDdddAr?abcdefgh}<br>qqq: Equalization in dB/GHz<br>x: Reference source configuration: 0=int.,1=ext.,2=auto<br>y: Actual reference source: 0=int.,1=ext.<br>ddd: reserved, currently 000<br>r: Alarm relay: 0=disabled, 1=enabled<br><br>Warning and Alarm Bits:<br>a: OCXO oven cold: 0=Ok, 1=cold<br>b: Reference Alarm: 0=OK / 1=Alarm<br>c: reserved, always 0<br>d: reserved, always 0<br>e: reserved, always 0<br>f: reserved, always 0<br>g: reserved, always 0 |

| | | | |
|---|---|---|---|
| | | | h: Mute by external input: 0=Normal, 1=Mute |

### Device Status Bits

| Bit | Status |
|---|---|
| 31 | Signal output 3 off |
| 30 | Signal output off |
| 29 | External mute active |
| 28 | - |
| 27 | External pre-converter alarm |
| 26 | Signal output 2 off |
| 25 | Local mode active |
| 24 | External reference source |
| 23 | Test mode active |
| 22 | PLO module alarm |
| 21 | Block synthesizer alarm |
| 20 | MW Synthesizer alarm |
| 19 | MW output module alarm |
| 18 | IF/Amplifier module alarm |
| 17 | Reference alarm |
| 16 | Internal module alarm |

| Bit | Status |
|---|---|
| 15 | Deep fade warning |
| 14 | - |
| 13 | - |
| 12 | - |
| 11 | Signal output 5 off |
| 10 | Signal output 4 off |
| 9 | Output bandpass off |
| 8 | Input bandpass off |
| 7 | Automatic level control |
| 6 | - |
| 5 | - |
| 4 | - |
| 3 | - |
| 2 | Sweep generator enabled |
| 1 | Beacon receiver warning |
| 0 | OCXO Oven Cold Warning |

**Figure 7 Device Status for command SA and QS**

### System Status Bits

| Bit | Status |
|---|---|
| 31 | Summary alarm |
| 30 | - |
| 29 | - |
| 28 | - |
| 27 | Message bus warning |
| 26 | Webctl warning |
| 25 | SNMP warning |
| 24 | Webserver warning |
| 23 | Temperature low warning |
| 22 | Temperature high warning |
| 21 | EEPROM warning |
| 20 | Ethernet warning |
| 19 | Display warning (only indoor unit) |
| 18 | Real time clock warning |
| 17 | Keyboard warning (only indoor unit) |
| 16 | Temperature sensor warning |

| Bit | Status |
|---|---|
| 15 | - |
| 14 | - |
| 13 | - |
| 12 | - |
| 11 | - |
| 10 | - |
| 9 | - |
| 8 | - |
| 7 | - |
| 6 | Local mode active (only indoor unit) |
| 5 | Remote mode active (only indoor unit) |
| 4 | Alarm relay disabled |
| 3 | Alarm relay test |
| 2 | External mute input warning |
| 1 | - |
| 0 | Internal communication alarm |

**Figure 8 Device Status for command QS1 and SA1**

| No | Event |
|---|---|
| 0 | Power Up |
| 1 | - |
| 2 | Oven warm |
| 3 | Output off |
| 4 | Output on |
| 5 | ext. muting on |

| No | Event |
|---|---|
| 6 | ext. muting off |
| 7 | - |
| 8 | - |
| 9 | set to internal reference |
| 10 | set to external reference |
| | |

**Figure 9: Events for Command EE**

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| Baud Rate | | | - | Mode | | | |

**Baud rate:**

| Bit 7 | Bit 6 | Bit 5 | Baud rate |
|---|---|---|---|
| 0 | 0 | 0 | 4800 |
| 0 | 0 | 1 | 4800 |
| 0 | 1 | 0 | 9600 |
| 0 | 1 | 1 | 19200 |
| 1 | 0 | 0 | 38400 |
| 1 | 0 | 1 | 115200 |

**Mode:**

| Bit 3 | Bit 2 | Bit 1 | Bit 0 | Parity | Data bits | Stop bits |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | EVEN | 7 | 1 |
| 0 | 0 | 0 | 1 | ODD | 7 | 1 |
| 0 | 0 | 1 | 0 | NONE | 7 | 2 |
| 0 | 0 | 1 | 1 | EVEN | 7 | 2 |
| 0 | 1 | 0 | 0 | ODD | 7 | 2 |
| 0 | 1 | 0 | 1 | NONE | 8 | 1 |
| 0 | 1 | 1 | 0 | EVEN | 8 | 1 |
| 0 | 1 | 1 | 1 | ODD | 8 | 1 |
| 1 | 0 | 0 | 0 | NONE | 8 | 2 |

**Figure 10 Serial Interface Parameters for Command MR**

**Figure 11: Configuration byte for Command ZC**

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| 0 | reserved | reserved | reserved | reserved | reserved | Interface Send Delay | |

**Interface Send Delay:**

These bits sets the transmission delay of the serial interfaces. The answer on a received command can be delayed. This is helpful for two wire bus systems, where without additional delay collisions between a still active master device and an already active slave device may occur. The basic delay depends on the baud rate and is approx. 3 ms for 19200 baud. Possible additional delays are:

| Bit 1 | Bit 0 | Delay |
|---|---|---|
| 0 | 0 | 0 ms |
| 0 | 1 | 20 ms |
| 1 | 0 | 40 ms |
| 1 | 1 | 80 ms |

**Factory Default Values**

| Converter | Default Value |
|---|---|
| Frequency | Lower frequency band |
| Attenuation | 15 dB |
| Signal Output | Off |
| Reference source | Internal |
| **System** | |
| Auto save | On |
| External mute input | Disabled |
| Alarm relay | Enabled |

**Figure 12 Factory Default Values for Command ZF**

**Note:** After sending the ‘ZF’ command, the communication to the device is interrupted for some seconds!

## 3.5 Web Browser Interface

A web server is included within the firmware of the unit. It can be accessed with any web browser, preferable with Mozilla Firefox. A SSL based secure connection is also supported.

http://[IP-address] (example: http://192.168.2.10)
https://[IP-address] (example: https://192.168.2.10)

[IP-address] is the IP-address of the unit's M&C Ethernet interface, which can be configured e.g. by the front panel menu, and which has to match the address scheme of the IP-network, to which the unit is connected. If an IP connection through a router is required, also check for proper configuration of the network mask and the gateway address.

The web browser needs to be set to "Cookies enabled".

After getting access to the web-server, a login is required.

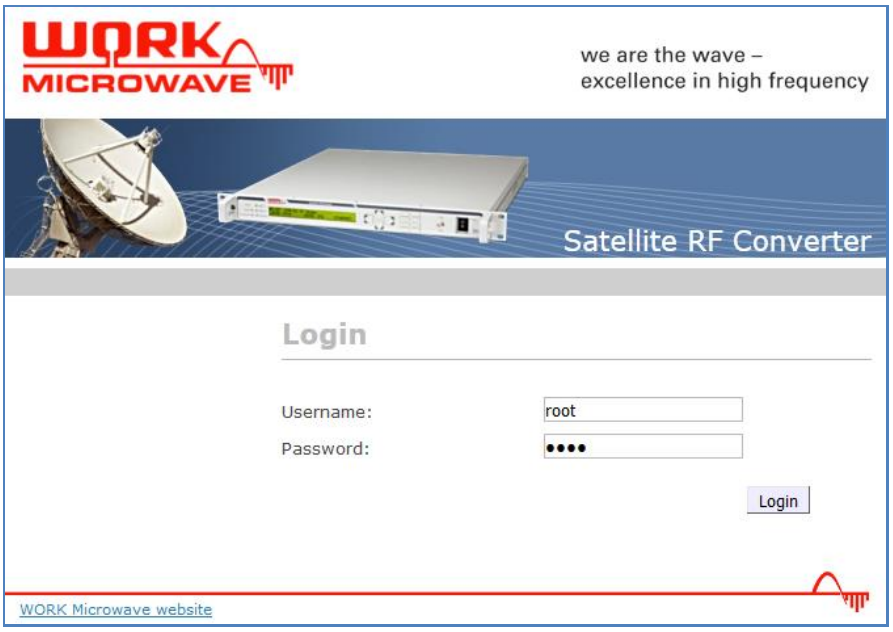



**Figure 13: Login page**

Possible user names are: 'root', 'user' or 'monitor'. The entry is case sensitive. The passwords are as default identical to the user names (e.g. user: "root" pw: "root"), but can be changed through the browser interface. User names cannot be changed.

The different user names correspond to different authorization levels, the following rules apply:

'root': all interactions supported by the web-browser interface can be executed.

'user': all interactions except reconfiguration of M&C interfaces or change of passwords can be executed.

'monitor': only reading out of parameters can be executed.

After login, the first configuration page is shown. The web interface is segmented in three main areas.


**Figure 14: Page sections**

1. Status indicators
2. Navigation bar
3. Main area

The three areas are described in the following chapters.

### 3.5.1 Status Indicators

The two most important status indicators of the device are always displayed on the upper left. The different status types are illustrated in the table below.

| Field | Symbol | Status explanation |
|---|---|---|
| Status | OK | There is no status warning or alarm. |
| | Warning | Device status warning active. For a detailed status description, see Figure 7. |
| | Alarm | An alarm condition is pending. |
| Signal | On | The output signal is switched on. |
| | Off | The output signal is switched off. |
| | Mute | The output signal is muted temporarily due to a warning or an alarm (e.g. oven cold warning). |

**Figure 15: Status Indicators**

### 3.5.2 Navigation Bar

On the left side of every subpage, there is a navigation bar, which allows direct access to all configuration parameters. The parameters are sorted in six main groups. They can be expanded or reduced by clicking on the + or – symbol in front of them.

The four main groups of the converter are:

- Converter Configuration:
  This menu includes the configuration parameters for the converter unit.
- Monitor:
  The converter allows a variety of parameters to be monitored. All important internal device parameters and operational parameters can be displayed below this menu.
- System Configuration:
  Below this menu general device settings can be done.
- Status:
  This menu allows access to the converter and system status word and the stored alarms.

### 3.5.3 Main Area

The main area is used to display the contents of the selected menu. This can be monitoring values (read only), input fields or drop down menus. The input value is displayed in red color if there was a change, which is not send to the device. To send the changes to the device press the “Apply” button.

## 3.6 Converter Configuration

The submenu “Converter Configuration in the main menu allows access to the configuration of the main operational parameters of the converter. The items of this submenu are explained in the following (Figure 16):

### 3.6.1 Signal Output

The option “Signal Output” allows enabling or disabling of the converter signal path. If the signal path is enabled and no alarm or warning condition is active to suppress the signal, the “RX On” LED is green. If the signal path is enabled and an alarm or warning condition is active, so that the signal path is currently not on, the “RX On” LED is yellow. If the signal path is disabled the “RX On” LED is off.

### 3.6.2 Band

The option Band allows the user to configure the used frequency band of the Upconverter. The range of this parameter depends on the converter type and can be seen from the attached data sheet at the end of this manual.

### 3.6.3 Attenuation Channel

The option “Attenuation” in the “Converter Configuration” submenu allows the configuration of the attenuation from the converter unit. The maximum conversion gain (typically 30 dB) is reduced by this attenuation value. The range of this setting is 00.0 dB to +30.0 dB in 0.1 dB steps.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Example: | Attenuation = 0 dB: | Overall | conversion | gain | = | 30 | dB |
| | Attenuation = 15 dB: | Overall | conversion | gain | = | 15 | dB |
| | Attenuation = 30 dB: | Overall | conversion | gain | = | 0 | dB |

### 3.6.4 Reference Source (Option)

The option “Reference Source” in the “Converter Configuration” submenu allows the configuration and the monitoring of the reference source within the unit. The parameter values that can be selected are “INT”, “EXT” and “AUTO”.

The Downconverter is equipped with a 10 MHz OCXO as internal reference. In the mode “INT”, this OCXO is used as reference. In mode “EXT” an external reference connected to the SMA connector “Ref In” at the connector panel of the unit is used to phase lock the 10 MHz internal reference. This external signal can be either a 5 MHz or a 10 MHz reference signal, which is automatically detected. If this signal is missing or not appropriate an alarm is generated.

In the mode “AUTO”, the unit monitors the power level of the external reference. If the power level is above a threshold value, the converter is switched to the external reference mode. When the power level is below the threshold, the converter is switched back to the internal reference.


**Figure 16: Converter Configuration for three bands**

## 3.7 Configuration Backup and Restore

The configuration of the Converter can be easily backed up and restored with the web interface. This can be happen either locally with an attached flash disk or remotely via file up- or download.


**Figure 17: Configuration backup and restore page**

### 3.7.1 Local Backup and Restore

For this option, a flash disk has to be attached to the USB interface of the device. The initialization of the backup- or restore process is done with the web interface (System Configuration – Upload/Download). To save the current configuration to a flash disk, the “Backup Configuration” Button has to be pressed. Please ensure that there is sufficient free disk space on the flash device (about 100kByte, depends on the complexity of the configuration). The configuration is written to the file “config.xml” at the root directory of the flash disk. The file contains the configuration in a XML based formatting.

To restore a configuration set, put a file with a valid configuration and the filename “config.xml” in the root directory of a flash disk and attach it to the USB interface of the Converter. The button “Restore Configuration” starts the process.

### 3.7.2 Remote Backup and Restore

The web interface provides an option to backup and restore the device configuration remotely. The item “Upload/Download” in the “System Configuration” menu provides the buttons “Download Configuration” and “Upload Configuration”.

To download the currently working configuration the “Download Configuration” button has to be pressed. The file “config.xml” is downloaded to the computer. It contains the device configuration in a XML format.

For uploading the configuration, the path to the file has to be entered in the line above the “Upload Configuration” button. The location of the file can also be navigated by using the “Browse” button. Choose a file with a valid configuration in XML format and with the name “config.xml”. The upload can be started by clicking on the “Upload Configuration” button.

### 3.7.3 Saved Configurations

Additionally, there is the possibility to save up to 16 different configuration sets locally in the device (“System Configuration” – “Saved States”). To save all current settings, press “Save” in one of the ten configuration Fields. “Restore” will restore this configuration. Note: When loading an invalid (not saved) instrument state a warning message box appears. The “Save State 0” is used to save the current configuration to the startup configuration (usage recommend when “Autosave” is off).

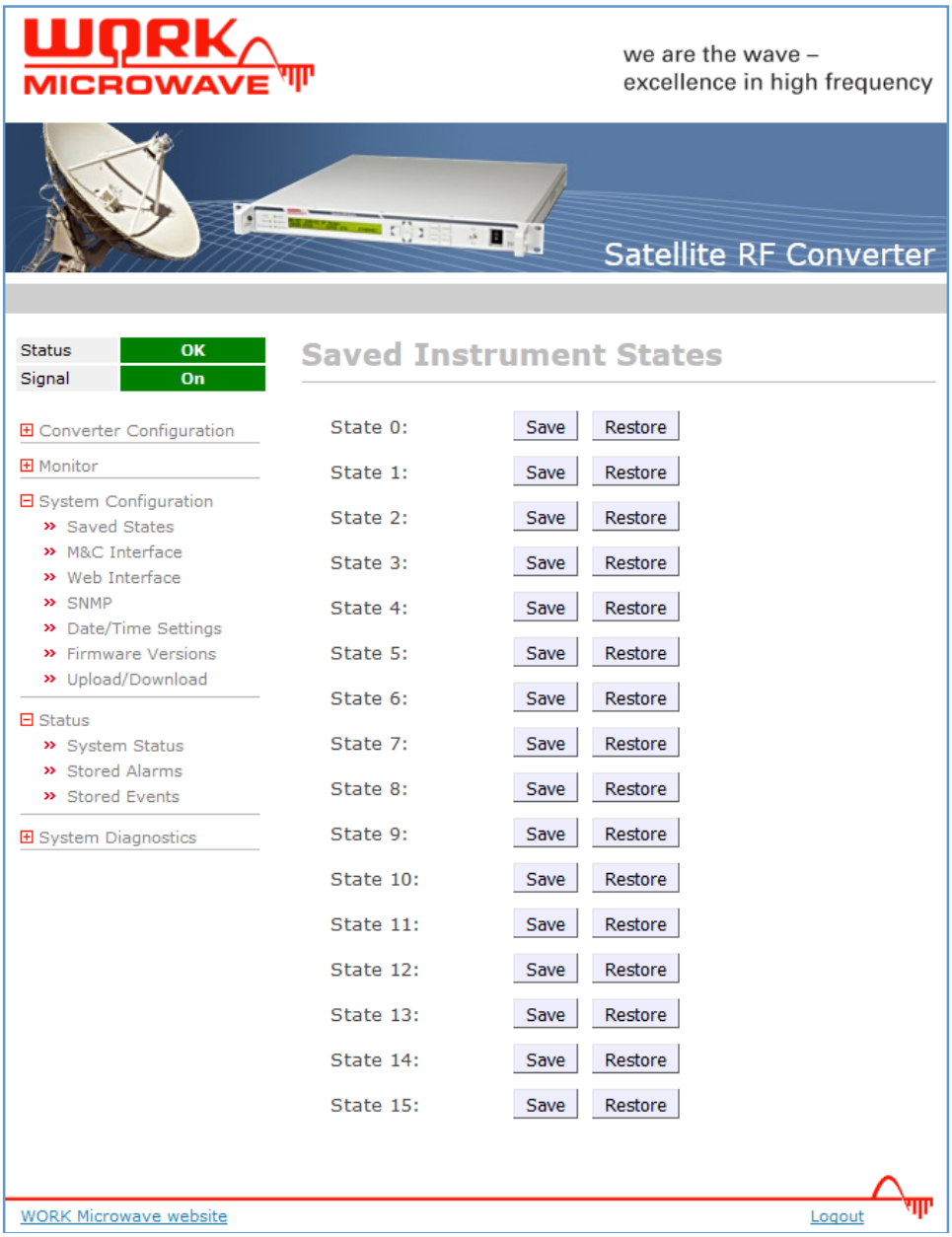



**Figure 18: Saved Configurations page**

### 3.7.4 Monitoring Communication Restore

This function allows to reset the device configuration to a specific Save State if a communication loss happens for a configurable timeout with a min. value of 2 sec. and a max value of 1day (86400 sec.) See Figure 19.

To reset the timeout, there needs to be an active communication over Ethernet with at least one of the following Protocols and commands:

- Web interface opened via Web browser
- Multipoint Commands for status and attenuation e.g. A, B, SA, SB, QS, QT, QD**x**, T**x**,
- SNMP commands for status and attenuation e.g.conv2StatusSystem; conv2StatusConverter; conv2Temperature, conv2Attenuation…

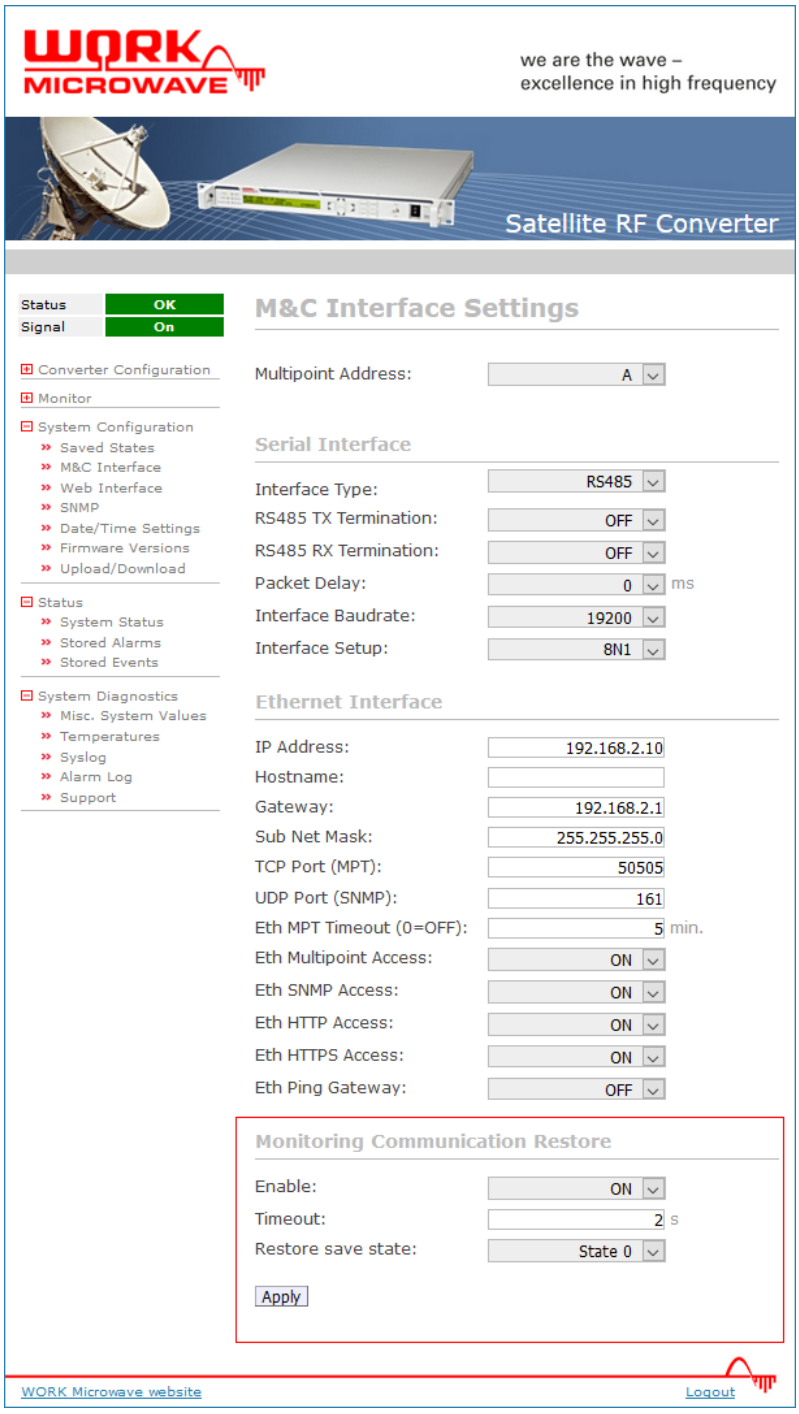



**Figure 19: Monitoring Communication Restore**

## 3.8 Firmware Updates

Within the device, there are various modules with firmware. Every firmware version can easily be upgraded with the communication module. The device needs to be rebooted after every firmware update.

### 3.8.1 Remote Firmware Update

Below the currently installed firmware versions in the “System Configuration” – “Firmware Versions” Menu there is the option “Upload Firmware”. The file “converter.update” can be uploaded directly.

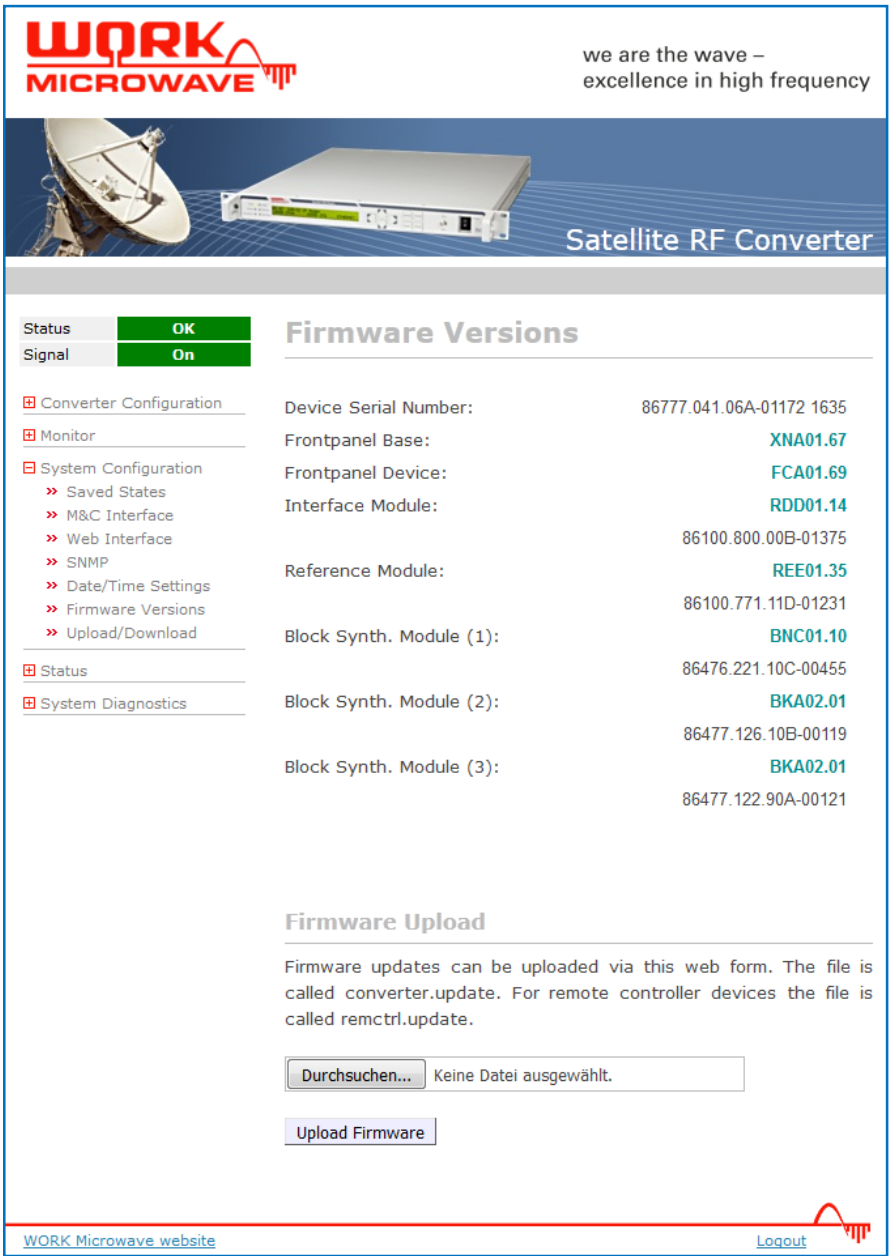



**Figure 20: Firmware Versions page**

## 3.9 SNMP Interface

The device can be accessed via SNMP over the Ethernet interface. The agent within the device is fully SNMPv1-compatible and responds to GET, GETNEXT and SET commands. If SNMPv2 is used, the device will also respond in SNMPv2 (including extended error codes). Traps are always v1.

SNMP communication usually uses UDP port 161, which is set as default, but can also be changed in M&C INTERFACE SETTINGS within the front panel menu. Traps are sent over UDP port 162 as default, but have to be enabled first and can only be configured via normal SNMP access.

On the SNMP manager side the basis for communication are the MIB files, whose structure is consistent with the main menu structure of the corresponding device. In general, two MIB files are required. A global file (WORK.MIB) contains the product tree of the company and all traps. Then each device has a specific MIB file (i.e. SDD2.MIB for DVB-S2 demodulator), which connects to the company tree and contains the device's menu structure. These MIB-Files can be requested through the support of WORK Microwave.

After a correct installation of the MIB files, all further configurations can be made via SNMP. The SystemConfig-node therefore contains an SNMP-subtree, which is not accessible through the front panel or other remote communication protocols. In this subtree the community names for read and write access can be changed (default is "public" for read and "private" for write). Further, the complete trap configuration is found here. Up to four trap receivers can be defined with an internal name, IP address, UDP port (default is 162), enable bit mask (default is 0 / set to 31 to enable all traps) and trap community name.

**Compatibility remarks**

SNMP on WORK Microwave devices has been developed mainly with iReasoning MIB Browser and has been successfully tested on AdRem SNMP Manager, ServersCheck MIB Browser, KS-Soft MIB Browser and NsaSoft FreeSNMP. Not all of these tools (especially KS-Soft MIB Browser) do understand SMIv2 correctly, in which all MIBs of WORK Microwave are written. Further the included MIB compilers differ in how strict they interpret the macro language (i.e. AdRem SNMP Manager is much more strict than the iReasoning browser).

Another point for consideration is the support of MIB-2. WORK Microwave devices do only support the system subtree. As no further routing or network functionality is included, all other MIB-2 subtrees are omitted.

**Checklist for getting started**

The following points have to be considered on first time activation:

- Does the IP address in your SNMP management software correspond with the IP address of the agent?
- Is the UDP port of both the agent and the management software set correctly? (default is 161)
- Do the community names correspond to the agent's configuration? (default is "public" for read and "private" for write access)
- Is SNMP access enabled on the device? (only accessible via the front panel menu)
- Trap reception: Is the trap receiver configured correctly? (Do not forget the enable bit mask!)
- Trap reception: Can your PC be accessed over the trap UDP port? (See firewall settings!)

### 3.9.1 SNMP OID List

The base OID is 1.3.6.1.4.1.29890.1. This Base ID is identical for all WORK Microwave devices and has to be combined with the OID in the table below.

For example, to set the attenuation the entire OID is: 1.3.6.1.4.1.29890.1.5.3.1.1.3.

| MIB Identifier | OID | Description |
|---|---|---|
| conv2Output | .5.3.1.1.1 | Sets and reads the output |
| conv2BandCh1 | .5.3.1.1.7 | Sets and reads the active frequency band of channel 1 |
| conv2AttenuationCh1Band1 | .5.3.1.1.8.3 | Sets and read the attenuation of band 1 channel 1 |
| conv2FrequencyMHzCh1Band1 | .5.3.1.1.8.5 | Reads the frequency of LO 1 band 1 |
| conv2Frequency2MHzCh1Band1 | .5.3.1.1.8.6 | Reads the frequency of LO 2 band 1 |
| conv2AttenuationCh1Band2 | .5.3.1.1.9.3 | Sets and read the attenuation of band 2 channel 1 |
| conv2FrequencyMHzCh1Band2 | .5.3.1.1.9.5 | Reads the frequency of LO 1 band 2 |
| conv2Frequency2MHzCh1Band2 | .5.3.1.1.9.6 | Reads the frequency of LO 2 band 2 |
| conv2AttenuationCh1Band3 | .5.3.1.1.10.3 | Sets and read the attenuation of band 3 channel 1 |
| conv2FrequencyMHzCh1Band3 | .5.3.1.1.10.5 | Reads the frequency of LO 1 band 3 |
| conv2Frequency2MHzCh1Band3 | .5.3.1.1.10.6 | Reads the frequency of LO 2 band 3 |
| | | |
| conv2ReferenceSource | .5.3.1.10 | Sets and reads the reference source |
| | | |
| conv2MCMultipointAddress | .5.3.2.1.1 | Sets and reads the multipoint command address |
| conv2MCInterfaceType | .5.3.2.1.2 | Sets and reads the serial interface type |
| conv2MCRS485TXTermination | .5.3.2.1.3 | Sets and reads the RS485 TX termination |
| conv2MCRS485RXTermination | .5.3.2.1.4 | Sets and reads the RS485 RX termination |
| conv2MCPacketDelay | .5.3.2.1.5 | Sets and reads the packet delay |
| conv2MCBaudRate | .5.3.2.1.6 | Sets and reads the serial baud rate |
| conv2MCConfiguration | .5.3.2.1.7 | Sets and reads the serial configuration |
| conv2MCIPAddress | .5.3.2.1.8 | Sets and reads the IP address |
| conv2MCSubnetMask | .5.3.2.1.9 | Sets and reads the subnet mask |
| conv2MCGateway | .5.3.2.1.10 | Sets and reads the gateway address |
| conv2MCTCPPort | .5.3.2.1.11 | Sets and reads the TCP port number |
| conv2MCUDPPort | .5.3.2.1.12 | Sets and reads the UDP port number |
| | | |
| conv2LoadDeviceState | .5.3.2.2 | Loads a stored device state |
| conv2SaveDeviceState | .5.3.2.3 | Saves a device state |
| conv2Autosave | .5.3.2.4 | Sets and reads the “auto save” function |
| conv2ExternalMuteInput | .5.3.2.10 | Sets and reads the external mute input |
| conv2AlarmRelay | .5.3.2.11 | Sets and reads the alarm relay |
| conv2ExternalMuteLevel | .5.3.2.13 | Sets and reads the external mute input level (requires FCA 2.06 or higher) |
| conv2ReferenceTune | .5.3.2.14 | Sets and read the reference tune value (requires FCA 2.14, CSA2.00/REx1.38 or higher) |
| conv2ReferenceTuneDefault | .5.3.2.15 | Reads the reference tune default value |
| | | |
| conv2DTTime | .5.3.2.20.1 | Sets and reads the time |
| conv2DTDate | .5.3.2.20.2 | Sets and reads the date |
| conv2DTDateNum | .5.3.2.20.3 | Sets and reads the date (numerical format) |
| conv2DTTimeZone | .5.3.2.20.4 | Sets and reads the time zone |
| conv2DTNTPOperation | .5.3.2.20.5 | Sets and reads the NTP time operation |
| conv2DTNTInterval | .5.3.2.20.6 | Sets and reads the NTP sync. interval |
| conv2DTNTPServer | .5.3.2.20.7 | Sets and reads the NTP server IP address |
| conv2DTNTPBackupServer | .5.3.2.20.8 | Sets and reads the NTP backup server IP address |
| | | |
| conv2SerialNumber | .5.3.2.30 | Reads the device serial number |
| conv2BaseSystemID | .5.3.2.50.1 | Reads the base system firmware ID |

| | | |
|---|---|---|
| conv2DeviceID | .5.3.2.50.2 | Reads the device firmware ID |
| conv2InterfaceID | .5.3.2.50.3 | Reads the interface module firmware ID |
| conv2ReferenceID | .5.3.2.50.4 | Reads the reference module firmware ID |
| conv2SynthesizerID | .5.3.2.50.5 | Reads the synthesizer module firmware ID |
| conv2AmplifierID | .5.3.2.50.6 | Reads the amplifier module firmware ID |
| | | |
| conv2ReadOnlyCommunityName | .5.3.2.99.1 | Sets and reads the SNMP read-only community name |
| conv2ReadWriteCommunityName | .5.3.2.99.2 | Sets and reads the SNMP read-write community name |
| conv2TrapSinkServerTable | .5.3.2.99.3 | Reads the table of SNMP trap servers |
| | | |
| conv2ControllerTemperature | .5.3.3.1.2 | Reads the controller board temperature |
| conv2RefboardTemperature | .5.3.3.1.3 | Reads the reference board temperature |
| conv2SynthesizerTemperature | .5.3.3.1.4 | Reads the synthesizer module temperature |
| | | |
| conv2StatusSystem | .5.3.4.1 | Reads the system status word |
| conv2StatusConverter | .5.3.4.2 | Reads the converter status word |
| | | |
| conv2ClearStoredAlarms | .5.3.5.1 | Clears the stored alarms |
| conv2StoredAlarmsTable | .5.3.5.2 | Reads the table of stored alarms |
| conv2ClearStoredEvents | .5.3.5.3 | Clears the stored events |
| conv2StoredEventsTable | .5.3.5.4 | Reads the table of stored events |

# 4 Maintenance, Service

## 4.1 Maintenance

Under standard conditions, there are no parts inside the Upconverter, which need any maintenance. The only part inside the Upconverter, which may be readjusted, is the reference oscillator. This is only necessary under operation conditions with a very high demand for frequency accuracy and if this component has moved in frequency after some period of time. In this case, please contact the factory.

## 4.2 Service

If a fault occurs with the Upconverter, we kindly ask you to report the following to the factory support:

- Model number and serial number
- Time in operation
- Description of failure

Please note the response of the status query (Multipoint Command: QS)
Please note also the current configuration (RF output frequency, attenuation).

If the unit shall be returned to the factory, please copy and fill out the RMA (return material authorization) request form, which you can find on the next page. Please fax or send this form to the address, which you find on the form. You will then receive an RMA number, which allows easier equipment tracking.

## 4.3 Company address

WORK Microwave GmbH
Rudolf-Diesel-Ring 2
83607 Holzkirchen
Germany

Tel. +49 8024 64 08 0
Fax +49 8024 64 08 40
E-Mail: sales@work-microwave.com

## 4.4 RMA Request Form

| **Customers information** | |
|---|---|
| Company name: | |
| Street: | |
| Postcode / City: | |
| Contact: | |
| Phone / Fax: | |
| Email: | |
| **Information on the item to be returned** | |
| Item description: | |
| Model: | |
| Part number: | |
| Serial number: | |
| Date Code: | |
| **Failure description**<br>**Detailed failure descriptions lower the cost of repair. We are not able to accept devices without detailed failure descriptions for repair.** | |
| | |
| | |
| | |

| | | | |
|---|---|---|---|
| Environment conditions: **Temperature:** | | Vibrations: | |
| Frequency settings: | | Other conditions: | |
| Gain settings: | | | |

| | |
|---|---|
| Item to be returned to WORK Microwave DDP (Incoterms). | |
| Date/Name/Signature: | |
| **Please fax this form to: +49 8024 6408 40 or send it by e-mail to orders@work-microwave.com**<br>**You will receive a RMA number from us.** | |

| | |
|---|---|
| | |
| **RMA number:** | |
| Date/Signature of WORK Microwave employee: | |
| | |

The form is also available under the following link: https://work-microwave.com/repair-rma/

Please send the device to the following address and state the RMA number:

**WORK Microwave GmbH, Rudolf-Diesel-Ring 2, 83607 Holzkirchen, Germany**
**Device to be returned to WORK Microwave DDP, Delivered Duty Paid (Incoterms).**

# 5 Appendix

## 5.1 Technical Data

A separate data sheet is attached at the end of this manual.

## 5.2 Notes

Place for own notes:

# SAR-2309-22VF-R2 & SAR-2309-22VM-R2 Rev. 1.2

## WR-22 Pyramidal Horn Antenna, 23 dBi Gain with 1.85 mm Coax Input

### Description:

**Model SAR-2309-22VF-R2** is a Q-band pyramidal horn antenna with a right angle (90°) 1.85 mm (F) coax connector to cover the frequency range of 33 GHz to 50 GHz. The antenna offers 23 dBi nominal gain and a typical half power beamwidth of 10 degrees on the E-plane and 11 degrees on the H-plane. The antenna supports linear polarized waveforms. End launch (180°) 1.85 mm connector configurations are available under models **SAR-2309-22VF-E2 and SAR-2309-22VM-E2.**

### Features:

- Inline Configuration
- Linear Polarization
- DC Open Circuit at Input

### Applications:

- Antenna Ranges
- Antenna Gain Measurements
- System Setups

### Electrical Specifications:

| Parameter | Minimum | Typical | Maximum |
|---|---|---|---|
| Frequency | 33 GHz | | 50 GHz |
| Gain | 21.5 dBi | 23 dBi | 24 dBi |
| Polarization | | Linear | |
| 3 dB Beamwidth, E-Plane | | 10° | |
| 3 dB Beamwidth, H-Plane | | 11° | |
| Sidelobes, E-Plane | | -14 dB | |
| Sidelobes, H-Plane | | -30 dB | |
| Return Loss | | 18 dB | |
| Power Handling | | | 30 W (CW) |
| Specification Temperature | | +25 °C | |
| Operating Temperature | -45 °C | | +85 °C |

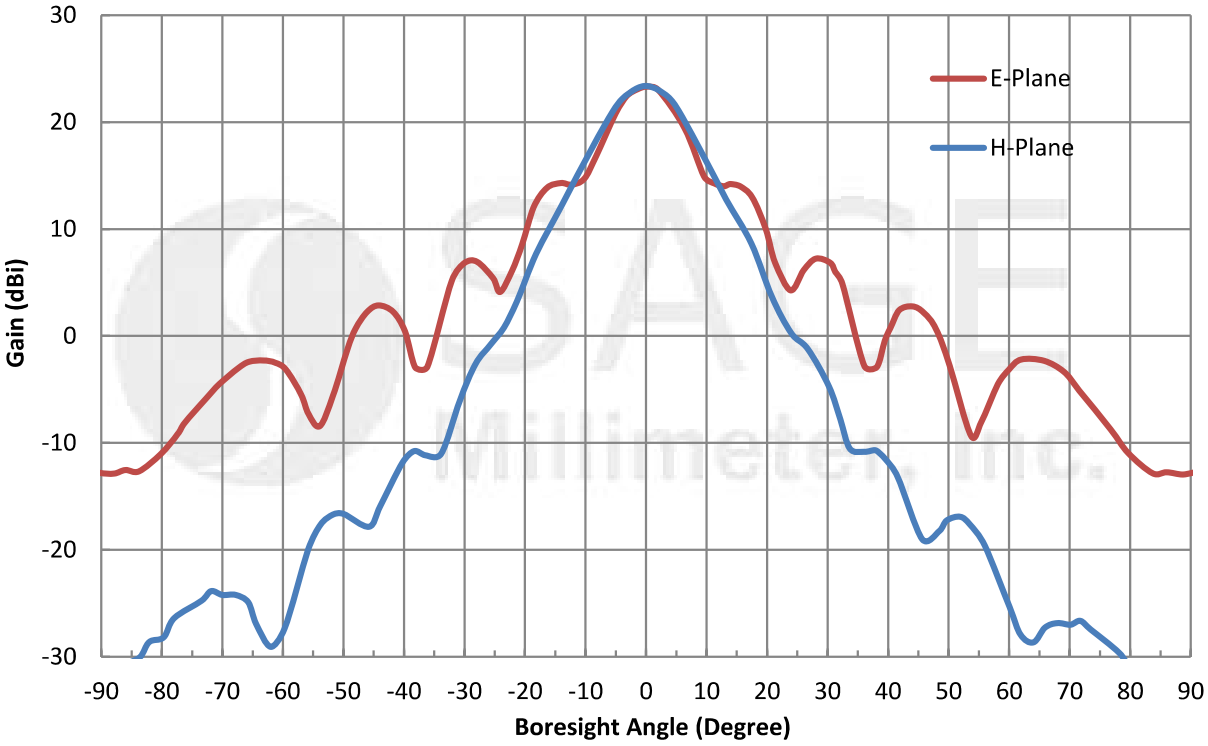
### Mechanical Specifications:

| Item | Specification |
|---|---|
| Antenna Port (F) | 1.85 mm Female for Model Number : SAR-2309-22VF-R2 |
| Antenna Port (M) | 1.85 mm Male for Model Number : SAR-2309-22VM-R2 |
| Size | 4.70” (L) X 1.86” (W) X 1.51”(H) |
| Material | Aluminum |
| Finish | Gold Plated |
| Connector Material | Stainless Steel |
| Weight | 1.5 Oz |
| Outline | AR-QC2-R |

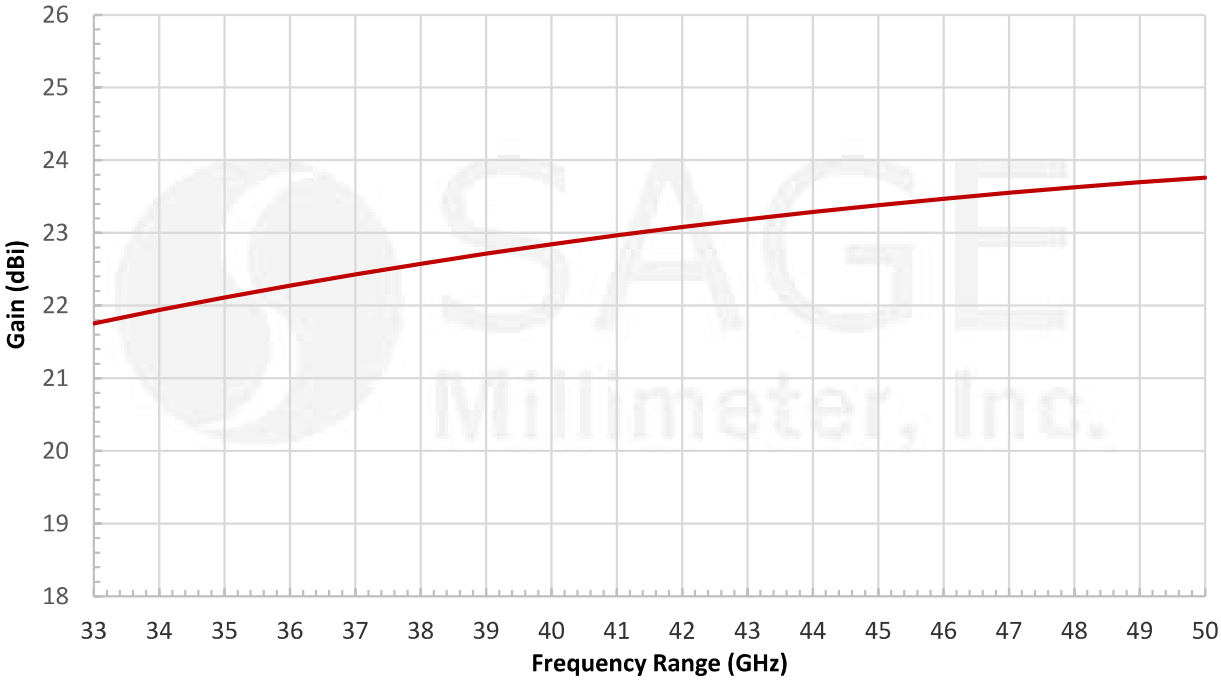
www.sagemillimeter.com | 3043 Kashiwa Street, Torrance, CA 90505
Phone: 424-757-0168 | Fax: 424-757-0188 | Email: sales@sagemillimeter.com

## WR-22 Pyramidal Horn Antenna, 23 dBi Gain with 1.85 mm Coax Input

### Typical Antenna Pattern @ 41.5 GHz




### Typical Gain vs. Frequency

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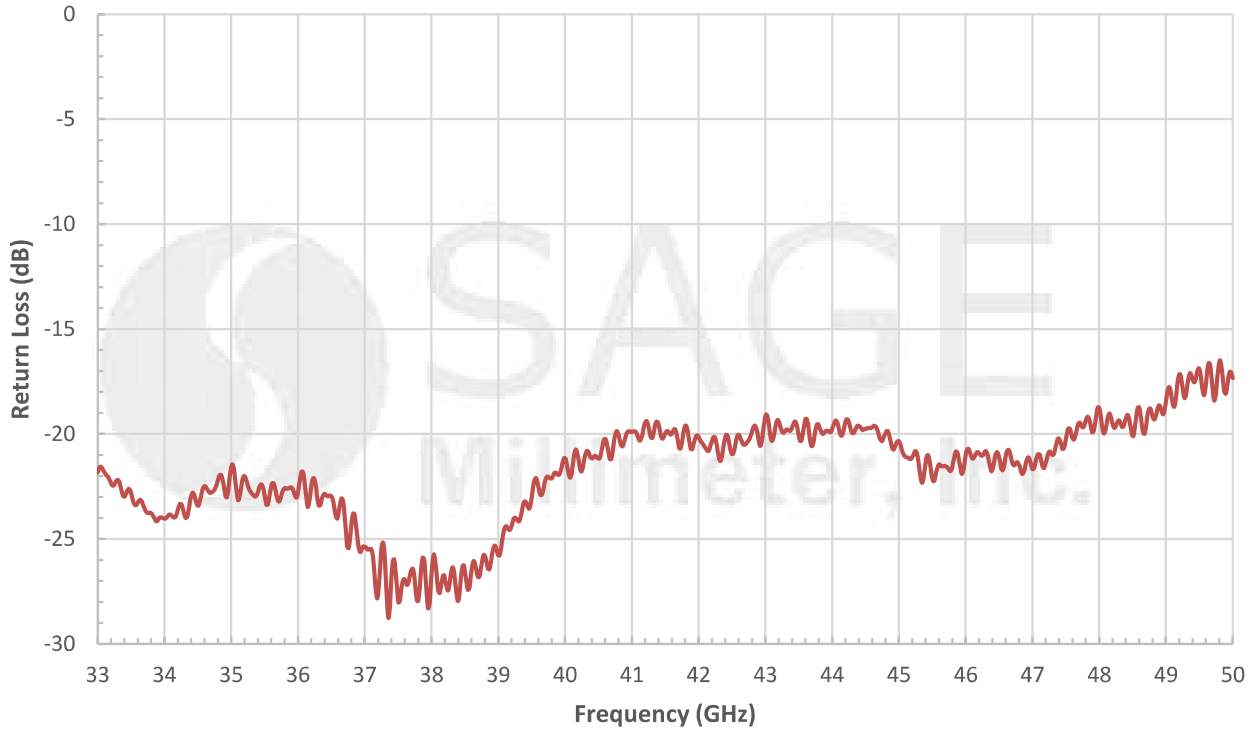
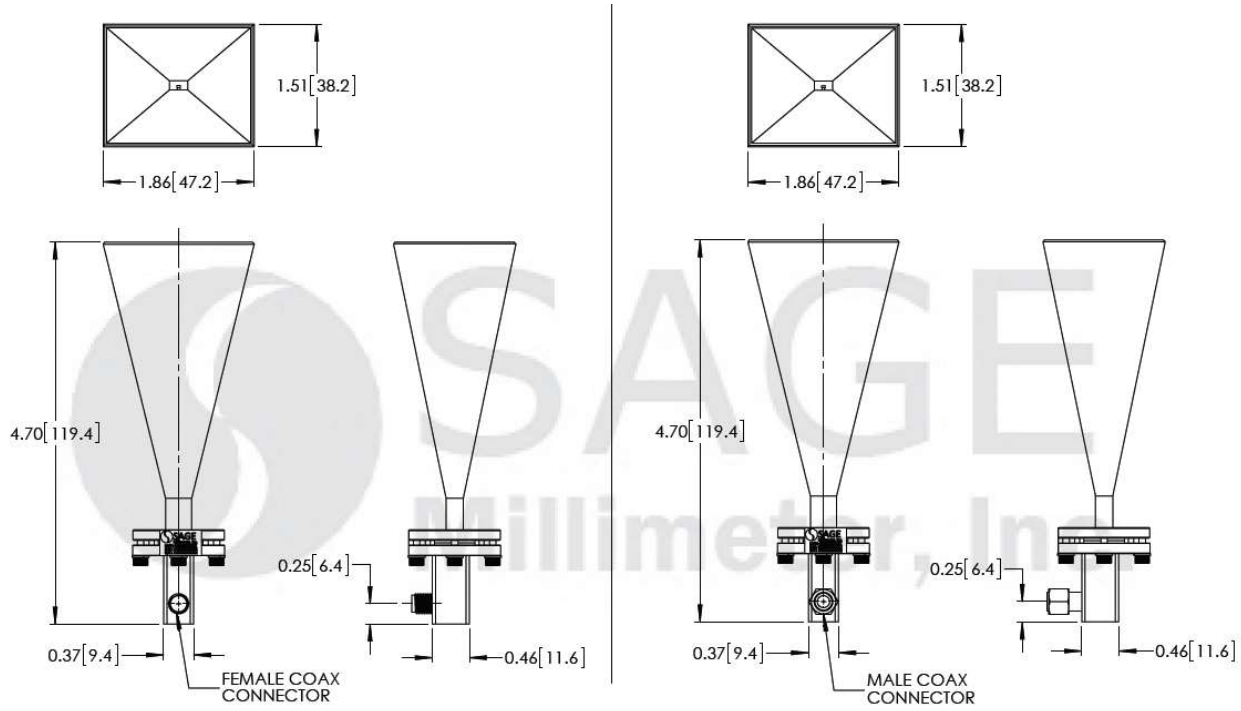
Phone: 424-757-0168 | Fax: 424-757-0188 | Email: sales@sagemillimeter.com

## WR-22 Pyramidal Horn Antenna, 23 dBi Gain with 1.85 mm Coax Input

### Typical Measured Return Loss vs Frequency




**Mechanical Outline:** (Unless otherwise specified, all dimensions are in inches [millimeters])




www.sagemillimeter.com | 3043 Kashiwa Street, Torrance, CA 90505
Phone: 424-757-0168 | Fax: 424-757-0188 | Email: sales@sagemillimeter.com

## WR-22 Pyramidal Horn Antenna, 23 dBi Gain with 1.85 mm Coax Input

**Note:**

- The antenna patterns presented are simulated. Actual data may vary.
- The return loss data presented is collected from a sample lot. Actual data may vary unit to unit.
- All testing was performed under +25˚C room temperature.
- SAGE Millimeter, Inc. reserves the right to change the information presented without notice.

**Caution:**

- Any foreign objects in the antenna will cause performance degradation and possible device damage.
- Proper torque, 8.0 ± 0.15 inch-pounds (0.92 ± 0.05 Nm), should be applied. **SAGE Millimeter torque wrench, model SCH-08008-S1, is highly recommended.**

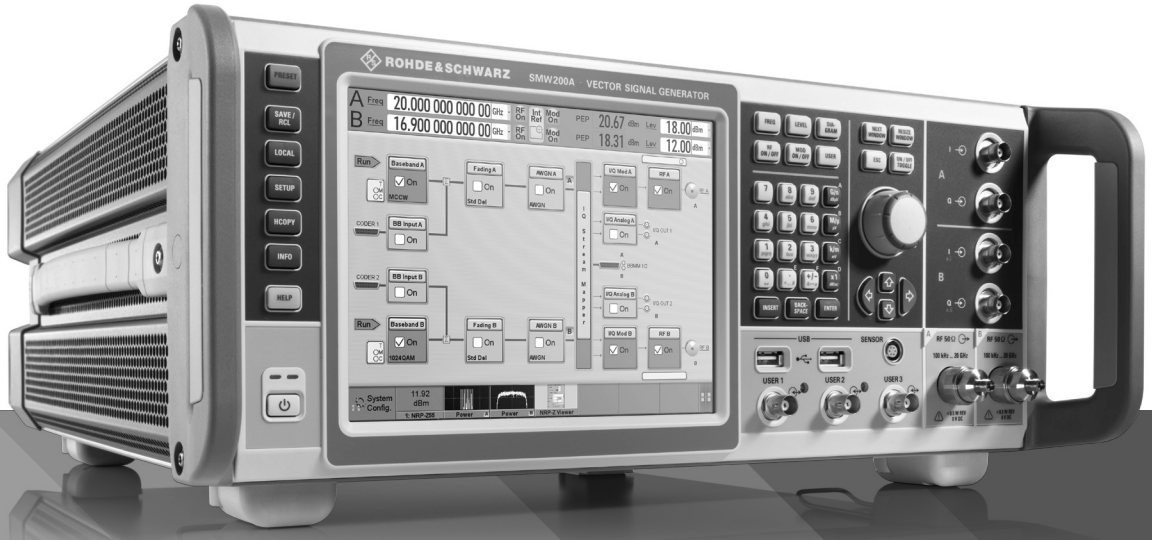


www.sagemillimeter.com | 3043 Kashiwa Street, Torrance, CA 90505
Phone: 424-757-0168 | Fax: 424-757-0188 | Email: sales@sagemillimeter.com

# R&S®SMW200A
# VECTOR SIGNAL GENERATOR

## Specifications

3 year warranty




Data Sheet
Version 20.00

ROHDE&SCHWARZ
Make ideas real

# CONTENTS

# Key features

**For all your needs**

- Frequency range from 100 kHz to 3/6/7.5/12.75/20/31.8/40/44/56/67 GHz
- Optional second RF path with 100 kHz up to 3/6/7.5/12.75/20/31.8/44 GHz
- Versatile configuration: from single-path vector signal generator to multichannel MIMO receiver tester
- Ideal for MIMO, MSR or LTE-Advanced applications thanks to up to eight signal sources and up to 64 fading channels
- Modular architecture for optimal adaptation to the application at hand

**Simplify your setup**

- Easy generation of complex signals
- Maximum eight baseband generators on two internal baseband modules with real-time coder and ARB
- Internal digital adding of baseband signals, even with frequency and level offset
- Wideband baseband and vector signal generator in one box
- Support of all important digital standards such as 5G New Radio, LTE (up to release 15), NB-IoT, eMTC, 3GPP FDD/HSPA/HSPA+, GSM/EDGE/EDGE Evolution, WLAN IEEE 802.11a/b/g/n/j/p/ac/ax/ad, DVB-S2/DVB-S2X, LoRa®
- No separate PC software required for digital standards
- Generation of radar signal scenarios for module, receiver and DFS tests
- LTE and 3GPP test case wizards for easy base station conformance testing, in line with 3GPP TS 25.141 or 3GPP TS 36.141
- Envelope tracking and AM/AM, AM/PM predistortion options enable full test and verification of ET modulator chipsets
- Generation of notched signals for noise power ratio measurements

**Bring reality to your lab**

- Optional integrated fading section for channel emulation with up to 800 MHz bandwidth
- All important fading scenarios available as presets
- Installation of up to four fading modules, providing as many as 64 logical faders
- Implementation of all key MIMO fading scenarios such as 2x2, 3x3, 4x4, 8x4, 4x8 and 2x4x4 using a single instrument
- Support of complex applications such as dual-carrier HSPA, LTE carrier aggregation and multi-user LTE
- Connection of R&S®SGT100A signal generator modules to provide up to eight RF paths
- Simulation of AWGN, phase noise and impulsive noise

**Make your device even better**

- Excellent signal quality for high accuracy in spectral and modulation measurements
- Up to 2 GHz I/Q modulation bandwidth (in RF) with internal baseband
- Exceptional modulation frequency response of < 0.4 dB (meas.) over 2 GHz bandwidth
- User-defined frequency response correction to compensate for the effects of external components
- High-end pulse modulation with on/off ratio > 80 dB and rise/fall time < 10 ns
- Excellent spectral purity (SSB phase noise –150 dBc (typ.) at 1 GHz, 10 kHz offset)
- 3 GHz, 6 GHz, 7.5 GHz and 12.75 GHz RF paths with electronic attenuator
- Phase coherence option, e.g. for beamforming applications

**Speed up your development**

- Intuitive operating concept and clever help functions for quick success
- Block diagram as key operating element to visualize signal flow
- Adaptive GUI for overview of both simple and complex scenarios
- Graphical signal monitoring at practically every point in the signal flow
- Context-sensitive online help system with complete user documentation
- SCPI macro recorder and code generator for generating executable remote control code from manual operating steps (for MATLAB®, CVI, etc.)

**Grows with your needs**

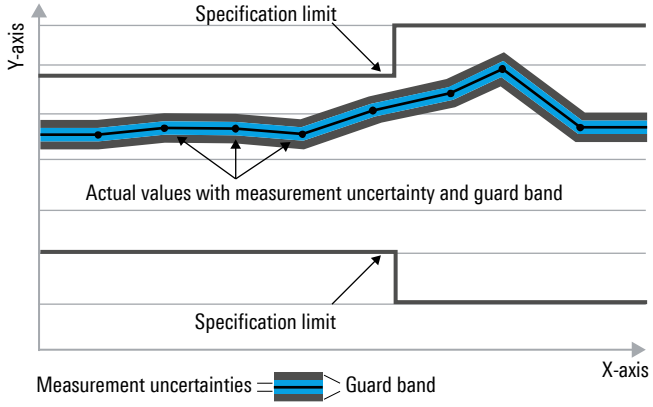
- Customizing of instrument to accommodate virtually every application
- Advanced plug-in system for retrofitting baseband modules without instrument recalibration
- Software upgrades possible at any time, simple and quick activation via key codes

# Definitions

**General**
Product data applies under the following conditions:

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

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




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

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

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

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

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

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

Device settings and GUI parameters are designated with the format “parameter: value”.

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

In line with the 3GPP/3GPP2 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.

# Frequency and baseband main module options

## Frequency options

One of the following frequency options must be installed in RF path A:

| | |
|---|---|
| R&S®SMW-B1003 | 100 kHz to 3 GHz |
| R&S®SMW-B1006 | 100 kHz to 6 GHz |
| R&S®SMW-B1007 | 100 kHz to 7.5 GHz |
| R&S®SMW-B1012 | 100 kHz to 12.75 GHz |
| R&S®SMW-B1020 | 100 kHz to 20 GHz |
| R&S®SMW-B1031 | 100 kHz to 31.8 GHz |
| R&S®SMW-B1040, R&S®SMW-B1040N | 100 kHz to 40 GHz |
| R&S®SMW-B1044, R&S®SMW-B1044N | 100 kHz to 44 GHz |
| R&S®SMW-B1056, R&S®SMW-B1056N | 100 kHz to 56 GHz |
| R&S®SMW-B1067, R&S®SMW-B1067N | 100 kHz to 67 GHz |

In addition, one of the following frequency options can be installed in RF path B:

| | |
|---|---|
| R&S®SMW-B2003 | 100 kHz to 3 GHz |
| R&S®SMW-B2006 | 100 kHz to 6 GHz |
| R&S®SMW-B2007 | 100 kHz to 7.5 GHz |
| R&S®SMW-B2012 | 100 kHz to 12.75 GHz |
| R&S®SMW-B2020 | 100 kHz to 20 GHz |
| R&S®SMW-B2031 | 100 kHz to 31.8 GHz |
| R&S®SMW-B2044, R&S®SMW-B2044N | 100 kHz to 44 GHz |

The R&S®SMW-B1003, R&S®SMW-B2003, R&S®SMW-B1006, R&S®SMW-B2006, R&S®SMW-B1007, R&S®SMW-B2007, R&S®SMW-B1012 and R&S®SMW-B2012 options include an electronic attenuator, whereas the R&S®SMW-B1020, R&S®SMW-B2020, R&S®SMW-B1031, R&S®SMW-B2031, R&S®SMW-B1040, R&S®SMW-B1040N, R&S®SMW-B1044, R&S®SMW-B2044, R&S®SMW-B1044N,R&S®SMW-B2044N, R&S®SMW-B1056, R&S®SMW-B1056N, R&S®SMW-B1067 and R&S®SMW-B1067N options include a mechanical step attenuator.

For possible RF path combinations, see section Frequency options and RF path combinations.

## Signal routing and baseband main module options

One of the following options must be installed:

| | |
|---|---|
| R&S®SMW-B13 | one I/Q path to RF section |
| R&S®SMW-B13T | two I/Q paths to RF section |
| R&S®SMW-B13XT | wideband, two I/Q paths to RF section |

If RF path B is equipped with an R&S®SMW-B20xx frequency option, an R&S®SMW-B13T or R&S®SMW-B13XT option must be installed as the baseband main module.

# Baseband hardware overview

To select between two different baseband sections, simply choose the appropriate baseband main module.

To select the standard baseband section, choose the R&S®SMW-B13 or R&S®SMW-B13T option as the baseband main module. The standard baseband section enables RF modulation bandwidths up to 160 MHz and allows further options for fading and MIMO to be installed. It provides the following additional hardware options:

| | |
|---|---|
| R&S®SMW-B10 | standard baseband generator |
| R&S®SMW-B10F | baseband generator for GNSS with high dynamics |
| R&S®SMW-B14 | fading simulator |

To select the wideband baseband section, choose the R&S®SMW-B13XT option as the baseband main module.
The wideband baseband section enables RF modulation bandwidths up to 2 GHz and allows further options for fading and MIMO to be installed. It provides the following additional hardware options:

| | |
|---|---|
| R&S®SMW-B9 | wideband baseband generator |
| R&S®SMW-B9F | wideband baseband generator for GNSS with high dynamics |
| R&S®SMW-B15 | fading simulator and signal processor |

# Frequency options and RF path combinations

The following RF path combinations are possible (● = possible, – = not possible).

Cells with grey background: These RF path combinations require the R&S®SMW-B94L option (deeper chassis).
Note that R&S®SMW-B94L is only possible with these RF path combinations.

Cells with white background: These RF path combinations come with the standard chassis (included in the base unit).

| | | | 3 GHz | 6 GHz | 7.5 GHz | 12.75 GHz | 20 GHz | 31.8 GHz | 44 GHz |
|---|---|---|---|---|---|---|---|---|---|
| | **Path B** / **Path A** | (path B not equipped) | R&S®SMW-B2003 | R&S®SMW-B2006 | R&S®SMW-B2007 | R&S®SMW-B2012 | R&S®SMW-B2020 | R&S®SMW-B2031 | R&S®SMW-B2044(N) |
| 3 GHz | R&S®SMW-B1003 | ● | ● | – | – | – | – | – | – |
| 6 GHz | R&S®SMW-B1006 | ● | – | ● | – | – | ● | – | – |
| 7.5 GHz | R&S®SMW-B1007 | ● | – | – | ● | – | – | – | – |
| 12.75 GHz | R&S®SMW-B1012 | ● | – | ● | – | ● | – | – | – |
| 20 GHz | R&S®SMW-B1020 | ● | – | ● | – | – | ● | – | – |
| 31.8 GHz | R&S®SMW-B1031 | ● | – | – | – | – | – | ● | – |
| 40 GHz | R&S®SMW-B1040(N) | ● | – | – | – | – | – | – | – |
| 44 GHz | R&S®SMW-B1044(N) | ● | – | – | – | – | – | – | ● [1] |
| 56 GHz | R&S®SMW-B1056(N) | ● | – | – | – | – | – | – | – |
| 67 GHz | R&S®SMW-B1067(N) | ● | – | – | – | – | – | – | – |

# Low phase noise options

The R&S®SMW200A can be equipped with different types of low phase noise options, providing different levels of phase noise performance.

As a general rule, all installed RF paths must have the same phase noise performance level. For example, if RF path A is equipped with an ultra low phase noise option, and a second RF path (B) shall be installed, the second RF path must also be equipped with an ultra low phase noise option.

The following table shows the possible option combinations for instruments with two RF paths.

| **Phase noise performance level** | **Required options for RF path A** | **Required options for RF path B** |
|---|---|---|
| Standard performance | R&S®SMW-B10xx frequency option | R&S®SMW-B20xx frequency option |
| Low phase noise | R&S®SMW-B10xx frequency option and R&S®SMW-B709 | R&S®SMW-B20xx frequency option and R&S®SMW-B719 |
| Improved close-in phase noise performance | R&S®SMW-B10xx frequency option and R&S®SMW-B710 | R&S®SMW-B20xx frequency option and R&S®SMW-B720 |
| Ultra low phase noise | R&S®SMW-B10xx frequency option and R&S®SMW-B711 | R&S®SMW-B20xx frequency option and R&S®SMW-B721 |

[1] R&S®SMW-B1044 can only be combined with R&S®SMW-B2044, and R&S®SMW-B1044N can only be combined with R&S®SMW-B2044N.

# RF characteristics

## Frequency

| | | |
|---|---|---|
| Range | R&S®SMW-B1003, R&S®SMW-B2003 | 100 kHz to 3 GHz |
| | R&S®SMW-B1006, R&S®SMW-B2006 | 100 kHz to 6 GHz |
| | R&S®SMW-B1007, R&S®SMW-B2007 | 100 kHz to 7.5 GHz |
| | R&S®SMW-B1012, R&S®SMW-B2012 | 100 kHz to 12.75 GHz |
| | R&S®SMW-B1020, R&S®SMW-B2020 | 100 kHz to 20 GHz |
| | R&S®SMW-B1031, R&S®SMW-B2031 | 100 kHz to 31.8 GHz |
| | R&S®SMW-B1040, R&S®SMW-B1040N | 100 kHz to 40 GHz |
| | R&S®SMW-B1044, R&S®SMW-B1044N, R&S®SMW-B2044, R&S®SMW-B2044N | 100 kHz to 44 GHz |
| | R&S®SMW-B1056, R&S®SMW-B1056N | 100 kHz to 56 GHz |
| | R&S®SMW-B1067, R&S®SMW-B1067N | 100 kHz to 67 GHz |
| | overrange | 67 GHz to 72 GHz |
| Resolution of setting | | 0.001 Hz |
| Resolution of synthesis | f = 1 GHz | 0.053 nHz (nom.) |
| Setting time | to within < $1 \cdot 10^{-7}$ for f > 200 MHz or < 124 Hz for f < 200 MHz, with GUI update stopped, I/Q optimization mode: fast, after IEC/IEEE bus delimiter | |
| | standard | |
| | R&S®SMW-B1003, R&S®SMW-B2003, R&S®SMW-B1006, R&S®SMW-B2006 | < 1.2 ms, 0.9 ms (typ.) |
| | R&S®SMW-B1007, R&S®SMW-B2007, R&S®SMW-B1012, R&S®SMW-B2012, R&S®SMW-B1020, R&S®SMW-B2020 | < 1.4 ms, 1.0 ms (typ.) |
| | R&S®SMW-B1031, R&S®SMW-B2031, R&S®SMW-B1040, R&S®SMW-B1040N | < 1.5 ms, 1.2 ms (typ.) |
| | R&S®SMW-B1044, R&S®SMW-B2044 R&S®SMW-B1044N, R&S®SMW-B2044N | < 1.5 ms, 1.2 ms (typ.) |
| | R&S®SMW-B1056, R&S®SMW-B1056N, R&S®SMW-B1067, R&S®SMW-B1067N | < 1.7 ms, 1.6 ms (typ.) |
| | with R&S®SMW-B711, R&S®SMW-B721 | < 4.0 ms |
| Setting time (list mode) | to within < $1 \cdot 10^{-7}$ for f > 200 MHz or < 124 Hz for f < 200 MHz, with GUI update stopped, I/Q optimization mode: fast, after trigger pulse | |
| | R&S®SMW-B1003, R&S®SMW-B2003 | < 0.8 ms, 0.6 ms (typ.) |
| | R&S®SMW-B1006, R&S®SMW-B2006 | < 0.8 ms, 0.6 ms (typ.) |
| | R&S®SMW-B1007, R&S®SMW-B2007, R&S®SMW-B1012, R&S®SMW-B2012, R&S®SMW-B1020, R&S®SMW-B2020 | < 1.0 ms, 0.7 ms (typ.) |
| | R&S®SMW-B1031, R&S®SMW-B2031, R&S®SMW-B1040, R&S®SMW-B1040N | < 1.2 ms, 0.9 ms (typ.) |
| | R&S®SMW-B1044, R&S®SMW-B2044 R&S®SMW-B1044N, R&S®SMW-B2044N | < 1.2 ms, 0.9 ms (typ.) |
| | R&S®SMW-B1056, R&S®SMW-B1056N, R&S®SMW-B1067, R&S®SMW-B1067N | < 1.4 ms, 1.1 ms (typ.) |
| | with R&S®SMW-B711, R&S®SMW-B721, run mode: live | < 4.0 ms |
| Resolution of phase offset setting | | adjustable in 0.1° steps |

## Frequency sweep

| | | |
|---|---|---|
| Operating mode | | digital sweep in discrete steps |
| Trigger modes | execute sweep continuously with internal trigger source | auto |
| | execute one full sweep | single |
| | execute one step | step |
| | sweep start and stop controlled by external trigger signal | start/stop |
| Trigger source | | external trigger signal (INST TRG A or B at rear), rotary knob, touchpanel, remote control |
| Sweep range | | full frequency range |
| Sweep shape | | sawtooth, triangle |
| Step size setting resolution | linear | 0.001 Hz |
| | logarithmic | 0.01 % to 100 % per step |
| Dwell time setting range | | 1 ms to 100 s |
| | with R&S®SMW-B711, R&S®SMW-B721 | 5 ms to 100 s |
| Dwell time setting resolution | | 0.1 ms |

## Reference frequency

| | | |
|---|---|---|
| Frequency error | at time of calibration in production | |
| | standard or with R&S®SMW-B709 option | $< 1 \cdot 10^{-8}$ |
| | with R&S®SMW-B710 or R&S®SMW-B711 option | $< 5 \cdot 10^{-9}$ |
| Aging | after 30 days of uninterrupted operation | |
| | standard | $\leq 1 \cdot 10^{-9}$/day,<br>$\leq 1 \cdot 10^{-7}$/year |
| | with R&S®SMW-B709/-B710/-B711 options | $\leq 5 \cdot 10^{-10}$/day,<br>$\leq 3 \cdot 10^{-8}$/year |
| Temperature effect | in temperature range from 0 °C to +45 °C | |
| | standard | $\pm 6 \cdot 10^{-8}$ |
| | with R&S®SMW-B709 option | $\pm 6 \cdot 10^{-9}$ |
| | with R&S®SMW-B710 or R&S®SMW-B711 option | $\pm 3 \cdot 10^{-9}$ |
| Warm-up time | to nominal thermostat temperature | ≤ 10 min (nom.) |
| **Input for external reference frequency** | | |
| Connector type | REF in on rear panel | BNC female |
| Input frequency | standard | 10 MHz |
| | with R&S®SMW-K703 option | 10 MHz, 100 MHz |
| | with R&S®SMW-K704 option | 10 MHz,<br>1 MHz to 100 MHz, variable |
| Input frequency setting resolution | with R&S®SMW-K704 option | 0.1 Hz |
| Input level range | level limits | 0 dBm to 20 dBm |
| | recommended input level for optimum phase noise performance | 7 dBm to 13 dBm |
| Input impedance | | 50 Ω (nom.) |
| Minimum frequency locking range | synchronization bandwidth: wide | $\pm 3 \cdot 10^{-6}$ |
| | synchronization bandwidth: narrow | |
| | standard or with R&S®SMW-B709 option | $\pm 0.3 \cdot 10^{-6}$ |
| | with R&S®SMW-B710 or R&S®SMW-B711 option | $\pm 0.15 \cdot 10^{-6}$ |

| | | |
|---|---|---|
| **Output for internal reference frequency** | | |
| Connector type | REF OUT on rear panel | BNC female |
| Output frequency | standard | sine wave 10 MHz |
| | with R&S®SMW-K703 option | sine wave 10 MHz, 100 MHz |
| | with R&S®SMW-K704 option | |
| | instrument set to internal reference | sine wave 10 MHz |
| | instrument set to external reference | sine wave 10 MHz,<br>applied external reference frequency |
| Output level | | 7 dBm to 14 dBm |
| Source impedance | | 50 Ω (nom.) |
| Wideband noise | with R&S®SMW-K703 option,<br>100 MHz, internal reference,<br>carrier offset = 10 MHz,<br>measurement bandwidth 1 Hz | < –155 dBc, –159 dBc (typ.) |
| **Ultra low noise 1 GHz reference frequency (R&S®SMW-K703 option)** | | |
| Input connector type | 1 GHz in on rear panel | SMA female |
| Input frequency | | 1 GHz |
| Input level range | level limits | ≥ 6 dBm, ≤ 20 dBm |
| | recommended input level for optimum phase noise performance | 7 dBm to 13 dBm |
| Input impedance | | 50 Ω (nom.) |
| Minimum frequency locking range | | $\pm 3 \cdot 10^{-6}$ |
| Output connector type | 1 GHz out on rear panel | SMA female |
| Output frequency | | sine wave 1 GHz |
| Output level | | 7 dBm to 14 dBm |
| Source impedance | | 50 Ω (nom.) |
| Wideband noise | 1 GHz, internal reference,<br>carrier offset = 10 MHz,<br>measurement bandwidth 1 Hz | < –154 dBc, –158 dBc (typ.) |
| **Input for electronic tuning of internal reference frequency** | | |
| Connector type | EFC on rear panel | BNC female |
| Sensitivity | external tuning slope | $1 \cdot 10^{-8}$/V (typ.) |
| Input voltage | | –10 V to +10 V |
| Input impedance | | 10 kΩ (nom.) |

**R&S®SMW-K703 option (100 MHz, 1 GHz reference input/output)**
When this option is installed, the 1 GHz low noise input and output for synchronization can be used.
In WIDE mode, the signal generator will use this signal directly as a reference for the synthesizer.
This option should be used if a very high phase stability between multiple generators is required.
The 100 MHz low noise input and output mode is only available with this option.

**R&S®SMW-K704 option (flexible reference input)**
When this option is installed, the reference input frequency can be set in 0.1 Hz steps from 1.0 MHz to 100 MHz.
The signal generator will lock its internal reference oscillator on the input frequency.
**Note on choosing the proper reference synchronization bandwidth**
The user has the choice to set the synchronization bandwidth either to NARROW or WIDE.

In WIDE mode, the best possible phase stability is achieved.
The phase noise performance close to the carrier depends on the phase noise of the external signal source.
In NARROW mode, the reference PLL acts as a clean-up-loop in which the phase noise is mainly determined by the signal generator's internal reference source.
This mode is recommended when using external reference sources with close-to-carrier phase noise worse than the R&S®SMW200A (i. e. rubidium standards).
Note that due to the slow synchronization, reference locking can take up to 10 s.

# Level

| | | |
|---|---|---|
| Setting range | 100 kHz ≤ f < 1 MHz | –145 dBm to +8 dBm |
| | 1 MHz ≤ f < 3 MHz | –145 dBm to +13 dBm |
| | 3 MHz ≤ f ≤ 67 GHz | –145 dBm to +30 dBm |
| Specified level range | 100 kHz ≤ f < 1 MHz | –120 dBm to +3 dBm (PEP) [2] |
| | 1 MHz ≤ f ≤ 3 MHz | –120 dBm to +8 dBm (PEP) [2] |
| | R&S®SMW-B1003, R&S®SMW-B2003, R&S®SMW-B1006, R&S®SMW-B2006, R&S®SMW-B1007, R&S®SMW-B2007, R&S®SMW-B1012, R&S®SMW-B2012, R&S®SMW-B1020, R&S®SMW-B2020 frequency options | |
| | 3 MHz < f ≤ 20 GHz | –120 dBm to +18 dBm (PEP) [2] |
| | R&S®SMW-B1031, R&S®SMW-B2031, R&S®SMW-B1040, R&S®SMW-B1040N, R&S®SMW-B1044, R&S®SMW-B2044, R&S®SMW-B1044N, R&S®SMW-B2044N frequency options | |
| | 3 MHz < f ≤ 3 GHz | –120 dBm to +18 dBm (PEP) [2] |
| | 3 GHz < f ≤ 14 GHz | –120 dBm to +17 dBm (PEP) [2] |
| | 14 GHz < f ≤ 20 GHz | |
| | CW, I/Q modulation, signal bandwidth ≤ 160 MHz | –120 dBm to +15 dBm (PEP) [2] |
| | I/Q modulation, signal bandwidth > 160 MHz | –120 dBm to +12 dBm (PEP) [2] |
| | 20 GHz < f ≤ 29 GHz | –120 dBm to +18 dBm (PEP) [2] |
| | 29 GHz < f ≤ 33 GHz | –120 dBm to +17 dBm (PEP) [2] |
| | 33 GHz < f ≤ 40 GHz | –120 dBm to +15 dBm (PEP) [2] |
| | 40 GHz < f ≤ 42 GHz | –120 dBm to +13 dBm (PEP) [2] |
| | 42 GHz < f ≤ 44 GHz | –120 dBm to +11 dBm (PEP) [2] |
| | R&S®SMW-B1056, R&S®SMW-B1056N, R&S®SMW-B1067, R&S®SMW-B1067N frequency options | |
| | 3 MHz < f ≤ 16 GHz | –120 dBm to +15 dBm (PEP) [2] |
| | 16 GHz < f ≤ 19.5 GHz | |
| | CW, I/Q modulation, signal bandwidth ≤ 160 MHz | –120 dBm to +13 dBm (PEP) [2] |
| | I/Q modulation, signal bandwidth > 160 MHz | –120 dBm to +10 dBm (PEP) [2] |
| | 19.5 GHz < f ≤ 29 GHz | –120 dBm to +14 dBm (PEP) [2] |
| | 29 GHz < f ≤ 33 GHz | –120 dBm to +12 dBm (PEP) [2] |
| | 33 GHz < f ≤ 40 GHz | –120 dBm to +10 dBm (PEP) [2] |
| | 40 GHz < f ≤ 43 GHz | –115 dBm to +9 dBm (PEP) [2] |
| | 43 GHz < f ≤ 60 GHz | –115 dBm to +12 dBm (PEP) [2] |
| | 60 GHz < f ≤ 67 GHz | –115 dBm to +10 dBm (PEP) [2] |
| Resolution of setting | | 0.01 dB (nom.) |
| Level error | level setting characteristic: auto, temperature range from +18 °C to +33 °C | |
| | 100 kHz ≤ f ≤ 3 GHz | < 0.5 dB |
| | 3 GHz < f ≤ 6 GHz | < 0.7 dB |
| | 6 GHz < f ≤ 20 GHz | < 0.9 dB |
| | R&S®SMW-B1031, R&S®SMW-B2031, R&S®SMW-B1040, R&S®SMW-B1040N, 20 GHz < f ≤ 40 GHz | < 1.1 dB |
| | R&S®SMW-B1044, R&S®SMW-B2044 R&S®SMW-B1044N, R&S®SMW-B2044N, 20 GHz < f ≤ 44 GHz | < 1.2 dB |
| | R&S®SMW-B1056, R&S®SMW-B1056N, R&S®SMW-B1067, R&S®SMW-B1067N, 20 GHz < f ≤ 43 GHz | < 1.1 dB |
| | R&S®SMW-B1056, R&S®SMW-B1056N, 43 GHz < f ≤ 56 GHz | |
| | level ≥ –90 dB | < 1.2 dB |
| | level < –90 dB | < 1.5 dB |
| | R&S®SMW-B1067, R&S®SMW-B1067N, 43 GHz < f ≤ 67 GHz | |
| | level ≥ –90 dB | < 1.2 dB |
| | level < –90 dB | < 1.5 dB |

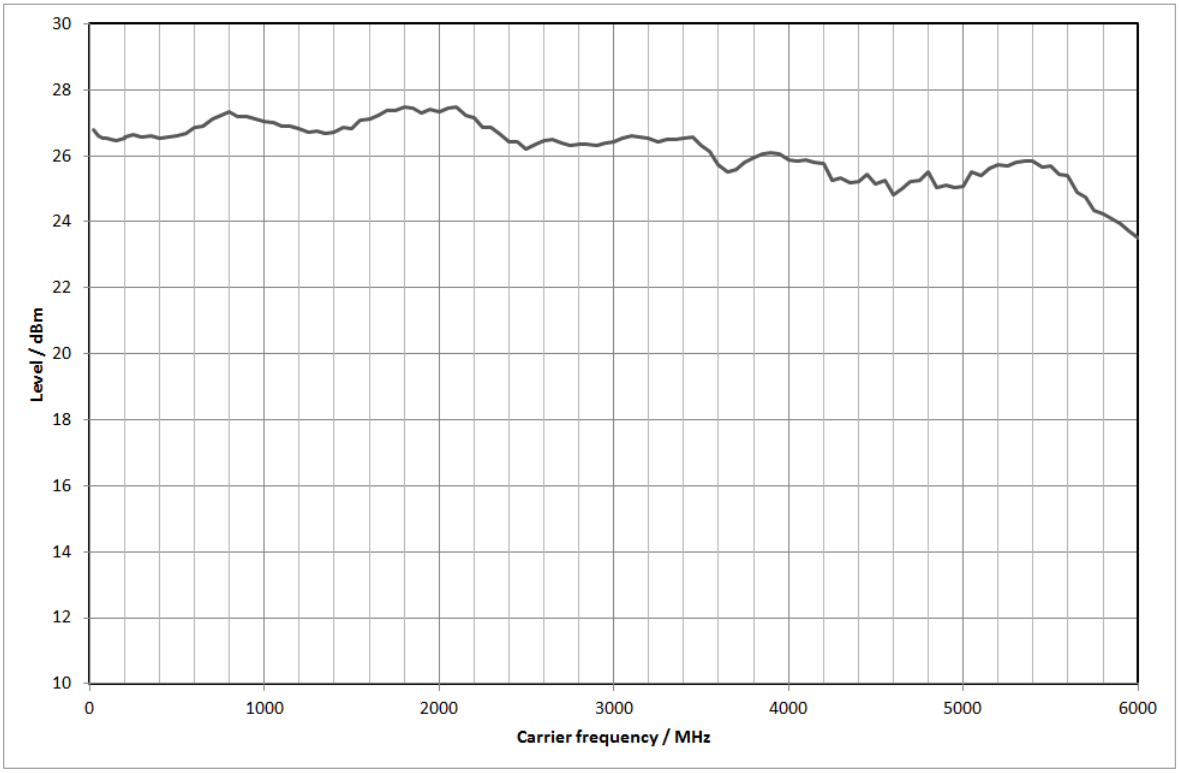
[2] PEP = peak envelope power.

| | | |
|---|---|---|
| Additional level error | I/Q modulation | |
| | optimization mode: high quality, fast | < 0.3 dB |
| | pulse modulation | < 0.5 dB |
| Output impedance,<br>VSWR in 50 Ω system | level setting characteristic: auto | |
| | R&S®SMW-B1003, R&S®SMW-B2003,<br>R&S®SMW-B1006, R&S®SMW-B2006,<br>100 kHz < f ≤ 6 GHz | < 1.9, < 1.5 (typ.) |
| | R&S®SMW-B1007, R&S®SMW-B2007,<br>R&S®SMW-B1012, R&S®SMW-B2012,<br>100 kHz < f ≤ 12.75 GHz | < 2.0, < 1.6 (typ.) |
| | R&S®SMW-B1020, R&S®SMW-B2020,<br>R&S®SMW-B1031, R&S®SMW-B2031,<br>R&S®SMW-B1040, R&S®SMW-B1040N,<br>R&S®SMW-B1044, R&S®SMW-B2044<br>R&S®SMW-B1044N,<br>R&S®SMW-B2044N,<br>100 kHz < f ≤ 20 GHz | < 2.1, < 1.7 (typ.) |
| | R&S®SMW-B1031, R&S®SMW-B2031,<br>R&S®SMW-B1040, R&S®SMW-B1040N,<br>R&S®SMW-B1044, R&S®SMW-B2044,<br>R&S®SMW-B1044N,<br>R&S®SMW-B2044N,<br>step attenuator = 0 dB,<br>20 GHz < f ≤ 38 GHz | < 2.2, < 1.8 (typ.) |
| | R&S®SMW-B1040, R&S®SMW-B1040N,<br>R&S®SMW-B1044, R&S®SMW-B2044,<br>R&S®SMW-B1044N,<br>R&S®SMW-B2044N,<br>step attenuator = 0 dB,<br>38 GHz < f ≤ 44 GHz | < 2.6, < 2.2 (typ.) |
| | R&S®SMW-B1031, R&S®SMW-B2031,<br>R&S®SMW-B1040, R&S®SMW-B1040N,<br>R&S®SMW-B1044, R&S®SMW-B2044,<br>R&S®SMW-B1044N,<br>R&S®SMW-B2044N,<br>step attenuator ≥ 5 dB,<br>20 GHz < f ≤ 44 GHz | < 2.1, < 1.7 (typ.) |
| | R&S®SMW-B1056, R&S®SMW-B1056N,<br>R&S®SMW-B1067, R&S®SMW-B1067N,<br>100 kHz < f ≤ 38 GHz | < 2.2, < 1.8 (typ.) |
| | R&S®SMW-B1056, R&S®SMW-B1056N,<br>R&S®SMW-B1067, R&S®SMW-B1067N,<br>38 GHz < f ≤ 50 GHz | < 2.6, < 2.2 (typ.) |
| Setting time | to < 0.1 dB deviation from final value, with GUI update stopped, no relay switchover,<br>f > 10 MHz, I/Q optimization mode: fast | |
| | after IEC/IEEE bus delimiter [3] | < 1.2 ms, 1 ms (typ.) |
| | with switching of mechanical step attenuator, after IEC/IEEE bus delimiter | < 25 ms |
| | R&S®SMW-B1044, R&S®SMW-B1044N,<br>R&S®SMW-B2044, R&S®SMW-B2044N,<br>R&S®SMW-B1056, R&S®SMW-B1056N,<br>R&S®SMW-B1067, R&S®SMW-B1067N,<br>with switching of mechanical step attenuator,<br>after IEC/IEEE bus delimiter | < 30 ms |

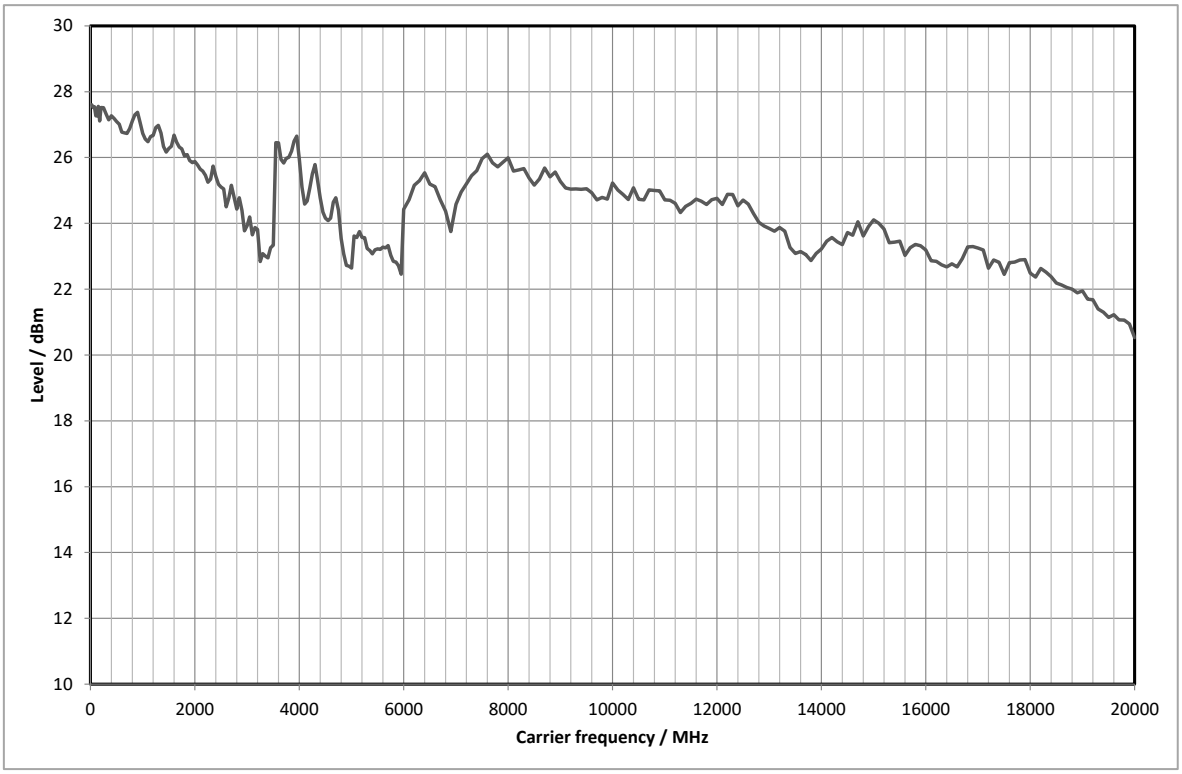
[3] R&S®SMW-B1007, R&S®SMW-B2007, R&S®SMW-B1012, R&S®SMW-B1020, R&S®SMW-B2020, R&S®SMW-B1031, R&S®SMW-B1040, R&S®SMW-B1040N: temperature > +18 °C.

| | | |
|---|---|---|
| Setting time (list mode) | to < 0.1 dB deviation from final value, with GUI update stopped, no relay switchover, f > 10 MHz, I/Q optimization mode: fast | |
| | after trigger pulse [4] | < 0.8 ms, 0.55 ms (typ.) |
| | with R&S®SMW-B711, R&S®SMW-B721, run mode: live | < 1 ms |
| Interruption-free level setting range | level setting characteristic: uninterrupted level setting | > 20 dB |
| Reverse power (from 50 Ω source) | maximum permissible RF power in output frequency range of RF path with R&S®SMW-B1003, R&S®SMW-B2003, R&S®SMW-B1006, R&S®SMW-B2006 frequency options;<br>Note: The RF path is switched off if the reverse power exceeds a limit (+27 dBm (meas.), depends on RF frequency). | |
| | 1 MHz < f ≤ 3 GHz | 50 W |
| | 3 GHz < f ≤ 6 GHz | 10 W |
| | maximum permissible RF power in output frequency range of RF path with R&S®SMW-B1007, R&S®SMW-B2007, R&S®SMW-B1012, R&S®SMW-B1020, R&S®SMW-B2020, R&S®SMW-B1031, R&S®SMW-B2031, R&S®SMW-B1040, R&S®SMW-B1040N, R&S®SMW-B1044, R&S®SMW-B2044, R&S®SMW-B1044N, R&S®SMW-B2044N, R&S®SMW-B1056, R&S®SMW-B1056N, R&S®SMW-B1067, R&S®SMW-B1067N frequency options | |
| | 1 MHz < f ≤ 67 GHz | 0.5 W |
| Maximum permissible DC voltage | R&S®SMW-B1003, R&S®SMW-B2003, R&S®SMW-B1006, R&S®SMW-B2006 frequency options | 50 V |
| | R&S®SMW-B1007, R&S®SMW-B2007, R&S®SMW-B1012, R&S®SMW-B2012 frequency options | 35 V |
| | R&S®SMW-B1020, R&S®SMW-B2020, R&S®SMW-B1031, R&S®SMW-B1040, R&S®SMW-B1040N, R&S®SMW-B1044, R&S®SMW-B2044, R&S®SMW-B1044N, R&S®SMW-B2044N, R&S®SMW-B1056, R&S®SMW-B1056N, R&S®SMW-B1067, R&S®SMW-B1067N frequency options | 0 V |

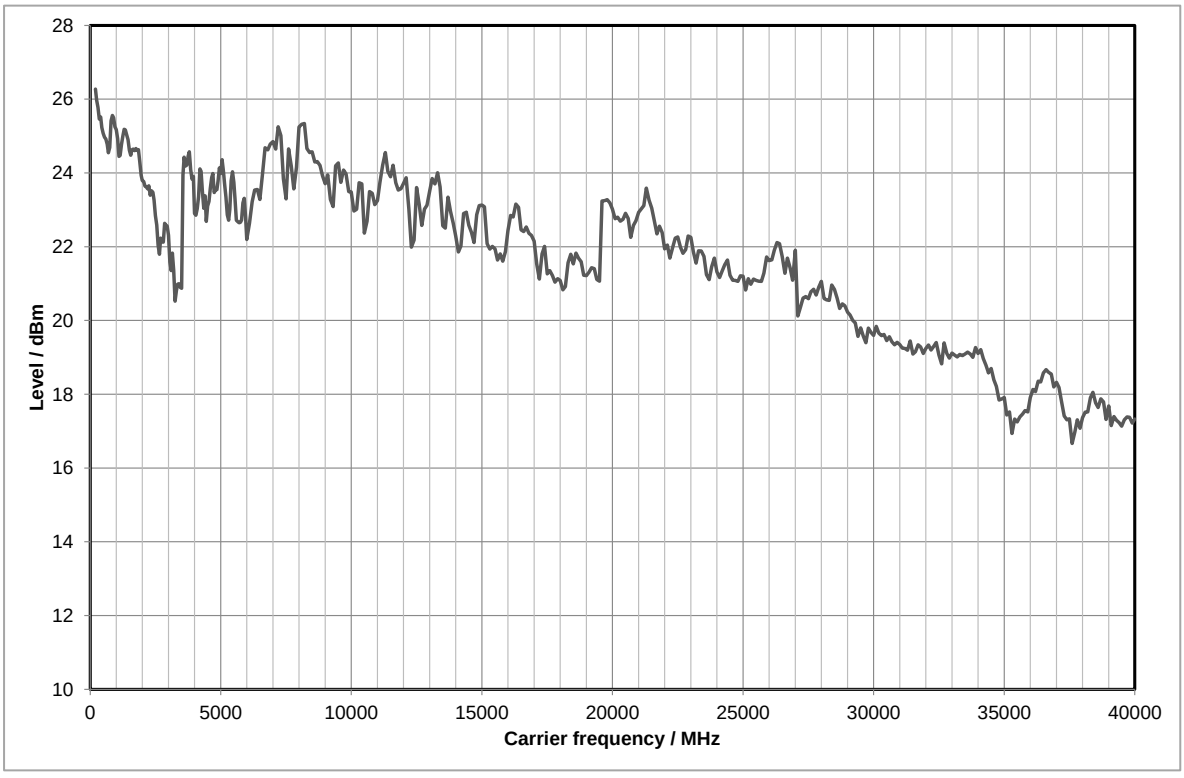
[4] R&S®SMW-B1007, R&S®SMW-B2007, R&S®SMW-B1012, R&S®SMW-B1020, R&S®SMW-B2020, R&S®SMW-B1031, R&S®SMW-B1040, R&S®SMW-B1040N: temperature > +18 °C.



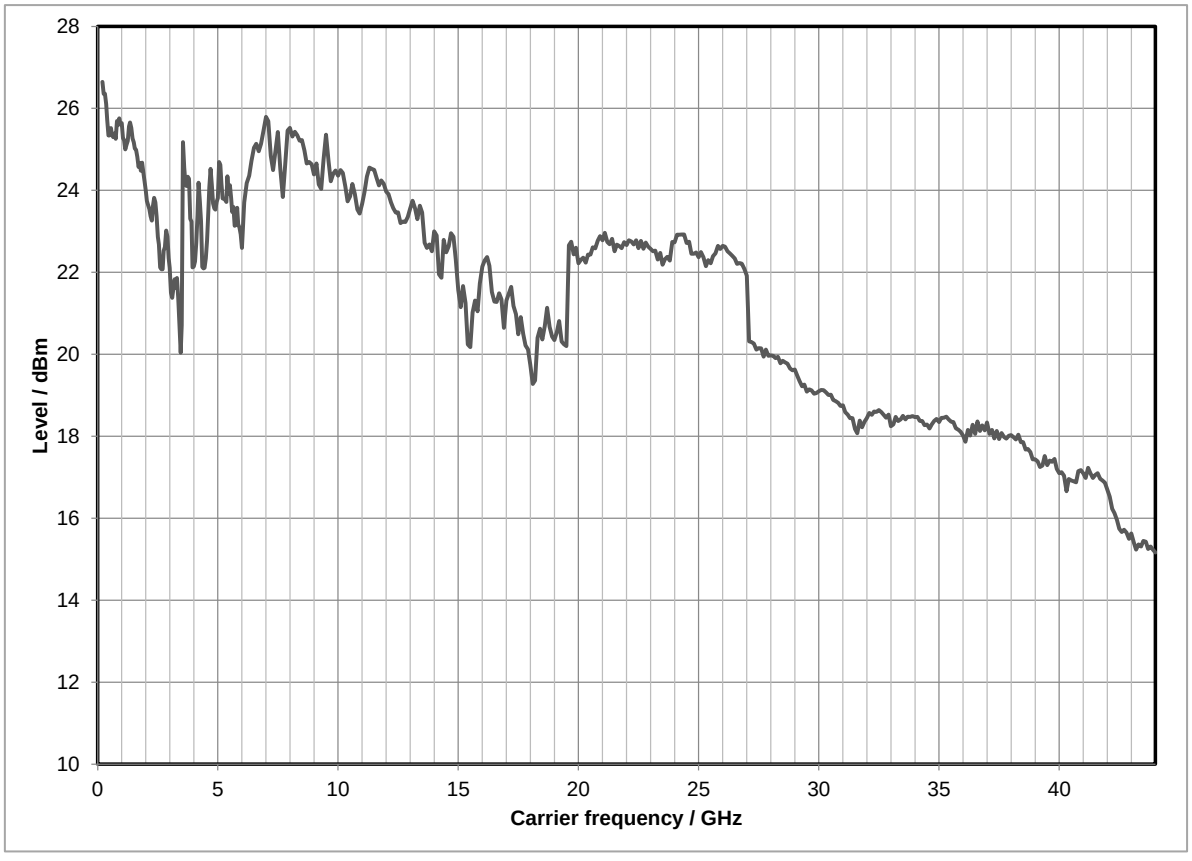

*Measured maximum available output level versus frequency with R&S®SMW-B1006, R&S®SMW-B2006 frequency options*



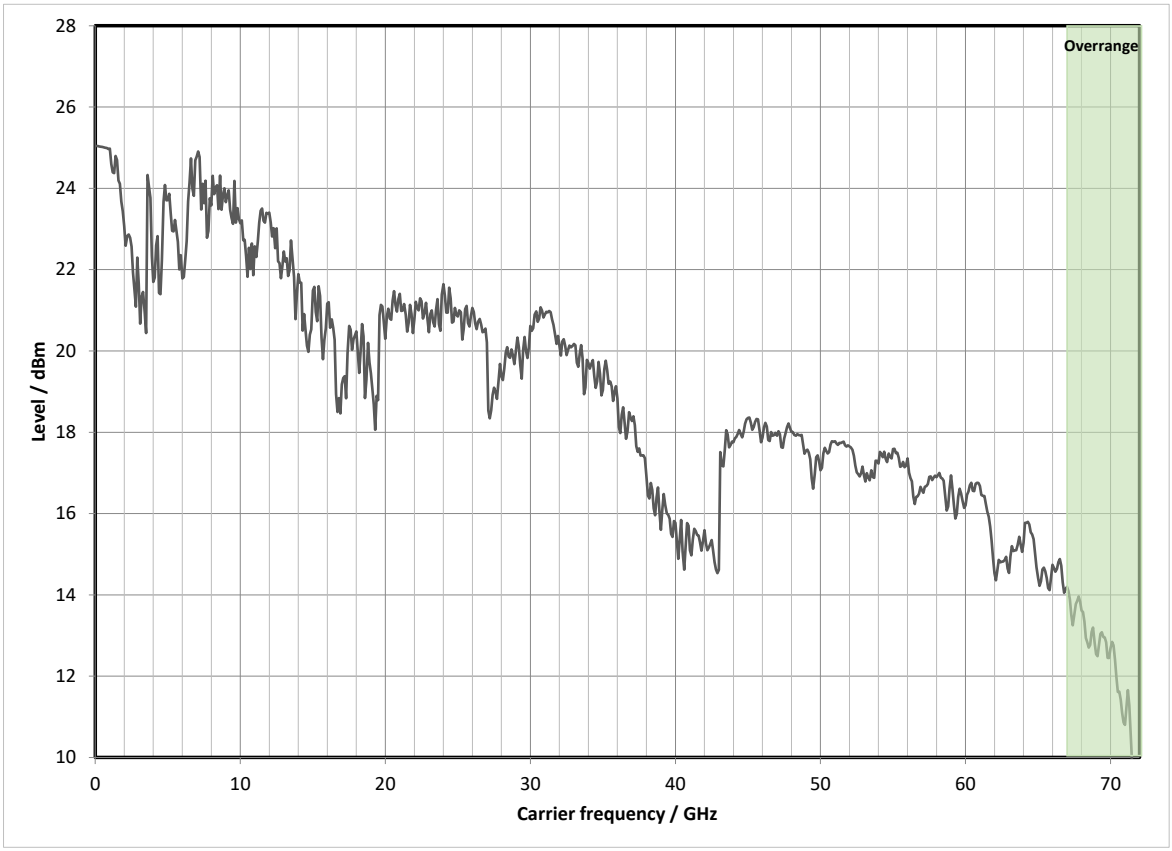

*Measured maximum available output level versus frequency with R&S®SMW-B1020, R&S®SMW-B2020 frequency options*




*Measured maximum available output level versus frequency with R&S®SMW-B1040, R&S®SMW-B1040N frequency options*




*Measured maximum available output level versus frequency with R&S®SMW-B1044, R&S®SMW-B1044N, R&S®SMW-B2044, R&S®SMW-B2044N frequency options*




*Measured maximum available output level versus frequency with R&S®SMW-B1067, R&S®SMW-B1067N frequency options*

## Level sweep

| | | |
|---|---|---|
| Operating mode | | digital sweep in discrete steps |
| Trigger modes | free run | auto |
| | execute one full sweep | single |
| | execute one step | step |
| | sweep start and stop controlled by external trigger signal | start/stop |
| Trigger source | internal | external trigger signal (INST TRG A or B at rear), rotary knob, touchpanel, remote control |
| Trigger slope | external trigger signal | positive, negative |
| Sweep range | interruption-free level sweep, level setting characteristic: uninterrupted level setting | 0.01 dB to 30 dB |
| Sweep shape | | sawtooth, triangle |
| Step size setting resolution | | 0.01 dB |
| Dwell time setting range | | 1 ms to 100 s |
| Dwell time setting resolution | | 0.1 ms |

# Spectral purity

| | | |
|---|---|---|
| Harmonics [5] | CW, f > 1 MHz | |
| | R&S®SMW-B1003, R&S®SMW-B2003, R&S®SMW-B1006, R&S®SMW-B2006, R&S®SMW-B1007, R&S®SMW-B2007, R&S®SMW-B1012, R&S®SMW-B2012 frequency options, level < 10 dBm | < –30 dBc |
| | R&S®SMW-B1020, R&S®SMW-B2020, R&S®SMW-B1031, R&S®SMW-B2031, R&S®SMW-B1040, R&S®SMW-B1040N, R&S®SMW-B1044, R&S®SMW-B2044, R&S®SMW-B1044N, R&S®SMW-B2044N frequency options, level < 10 dBm | |
| | f ≤ 3.5 GHz | < –30 dBc |
| | f > 3.5 GHz | < –55 dBc |
| | R&S®SMW-B1056, R&S®SMW-B1056N, R&S®SMW-B1067, R&S®SMW-B1067N frequency options, level < 6 dBm | |
| | f ≤ 3.5 GHz | < –30 dBc |
| | f > 3.5 GHz | < –55 dBc |
| Nonharmonics | CW, I/Q modulation (full-scale DC input), level > –10 dBm, > 10 kHz offset from carrier and outside the modulation spectrum | |
| | 100 kHz ≤ f ≤ 200 MHz | < –80 dBc |
| | 200 MHz < f ≤ 1500 MHz | |
| | with R&S®SMW-B13/-B13T options | < –85 dBc |
| | with R&S®SMW-B13XT option | < –80 dBc |
| | 1500 MHz < f ≤ 3 GHz | < –79 dBc |
| | 3 GHz < f ≤ 6 GHz | < –73 dBc |
| | 6 GHz < f ≤ 12 GHz | < –67 dBc |
| | 12 GHz < f ≤ 24 GHz | < –61 dBc |
| | 24 GHz < f ≤ 44 GHz | < –55 dBc |
| | 44 GHz < f ≤ 60 GHz | < –53 dBc |
| | 60 GHz < f ≤ 67 GHz | < –47 dBc |
| Nonharmonics with R&S®SMW-B711/-B721 options | CW, I/Q modulation (full-scale DC input), level > –10 dBm, > 10 kHz offset from carrier and outside the modulation spectrum | |
| | 100 kHz ≤ f ≤ 200 MHz | < –80 dBc |
| | 200 MHz < f ≤ 1500 MHz | |
| | with R&S®SMW-B13/-B13T options | < –90 dBc |
| | with R&S®SMW-B13XT option | < –80 dBc |
| | 1500 MHz < f ≤ 3 GHz | |
| | with R&S®SMW-B13/-B13T options | < –84 dBc |
| | with R&S®SMW-B13XT option | < –80 dBc |
| | 3 GHz < f ≤ 6 GHz | < –83 dBc |
| | 6 GHz < f ≤ 12 GHz | < –77 dBc |
| | 12 GHz < f ≤ 24 GHz | < –71 dBc |
| | 24 GHz < f ≤ 44 GHz | < –65 dBc |
| | 44 GHz < f ≤ 60 GHz | < –63 dBc |
| | 60 GHz < f ≤ 67 GHz | < –57 dBc |
| Subharmonics [6] | CW, I/Q modulation (full-scale DC input) | |
| | f ≤ 3 GHz | |
| | standard | < –85 dBc |
| | with R&S®SMW-B711/-B721 options | < –95 dBc |
| | 3 GHz < f ≤ 6 GHz | < –74 dBc |
| | 6 GHz < f ≤ 40 GHz | < –60 dBc |
| | 40 GHz < f ≤ 42 GHz | < –60 dBc |
| | 42 GHz < f ≤ 44 GHz | < –50 dBc |
| | 44 GHz < f ≤ 67 GHz, CW | < –50 dBc |
| Residual FM | RMS value at f = 1 GHz | |
| | 300 Hz to 3 kHz | < 1 Hz |
| | 20 Hz to 23 kHz | < 4 Hz |
| Residual AM | RMS value (20 Hz to 23 kHz) | < 0.02 % |

[5] Specifications are not valid for harmonics beyond "specified frequency range".

[6] Specifications are not valid for subharmonics beyond "specified frequency range".

| | | |
|---|---|---|
| Wideband noise | carrier offset > 30 MHz, measurement bandwidth = 1 Hz | |
| | CW, level = 10 dBm | |
| | R&S®SMW-B1003, R&S®SMW-B2003, R&S®SMW-B1006, R&S®SMW-B2006 frequency options | |
| | 20 MHz ≤ f ≤ 200 MHz | < –146 dBc, –149 dBc (typ.) |
| | 200 MHz < f ≤ 6 GHz | < –150 dBc, –152 dBc (typ.) |
| | R&S®SMW-B1007, R&S®SMW-B2007, R&S®SMW-B1012, R&S®SMW-B2012, R&S®SMW-B1020, R&S®SMW-B2020 frequency options | |
| | 20 MHz ≤ f ≤ 200 MHz | < –146 dBc, –149 dBc (typ.) |
| | 200 MHz < f ≤ 5 GHz | < –150 dBc, –152 dBc (typ.) |
| | 5 GHz < f ≤ 12 GHz | < –147 dBc, –149 dBc (typ.) |
| | 12 GHz < f ≤ 20 GHz | < –144 dBc, –146 dBc (typ.) |
| | R&S®SMW-B1031, R&S®SMW-B2031, R&S®SMW-B1040, R&S®SMW-B1040N, R&S®SMW-B1044, R&S®SMW-B2044, R&S®SMW-B1044N, R&S®SMW-B2044N, R&S®SMW-B1056, R&S®SMW-B1056N, R&S®SMW-B1067, R&S®SMW-B1067N frequency options | |
| | 20 MHz ≤ f ≤ 200 MHz | < –146 dBc, –149 dBc (typ.) |
| | 200 MHz < f ≤ 600 MHz | < –148 dBc, –150 dBc (typ.) |
| | 600 MHz < f ≤ 5 GHz | < –150 dBc, –152 dBc (typ.) |
| | 5 GHz < f ≤ 12 GHz | < –147 dBc, –149 dBc (typ.) |
| | 12 GHz < f ≤ 20 GHz | < –144 dBc, –146 dBc (typ.) |
| | 20 GHz < f ≤ 30 GHz, carrier offset = 30 MHz | < –135 dBc, –138 dBc (typ.) |
| | 30 GHz < f ≤ 44 GHz, carrier offset = 30 MHz | < –131 dBc, –134 dBc (typ.) |
| | 44 GHz < f ≤ 67 GHz, carrier offset = 40 MHz | < –130 dBc, –133 dBc (typ.) |
| | I/Q modulation with full-scale internal single carrier signal, I/Q input gain = +4 dB, level = 10 dBm | |
| | 20 MHz ≤ f ≤ 200 MHz | < –139 dBc, –142 dBc (typ.) |
| | 200 MHz < f ≤ 1 GHz | < –141 dBc, –144 dBc (typ.) |
| | 1 GHz < f ≤ 3 GHz | < –142 dBc, –145 dBc (typ.) |
| | 3 GHz < f ≤ 12 GHz | < –140 dBc, –143 dBc (typ.) |
| | R&S®SMW-B1020, R&S®SMW-B2020 frequency options | |
| | 12 GHz < f ≤ 20 GHz | < –138 dBc, –141 dBc (typ.) |
| | R&S®SMW-B1031, R&S®SMW-B2031, R&S®SMW-B1040, R&S®SMW-B1040N frequency options | |
| | 12 GHz < f ≤ 20 GHz | < –138 dBc, –141 dBc (typ.) |
| | 20 GHz < f ≤ 30 GHz, carrier offset = 30 MHz | < –133 dBc, –135 dBc (typ.) |
| | 30 GHz < f ≤ 40 GHz, carrier offset = 30 MHz | < –130 dBc, –132 dBc (typ.) |
| | R&S®SMW-B1044, R&S®SMW-B2044, R&S®SMW-B1044N, R&S®SMW-B2044N, R&S®SMW-B1056, R&S®SMW-B1056N, R&S®SMW-B1067, R&S®SMW-B1067N frequency options | |
| | 12 GHz < f ≤ 20 GHz | < –138 dBc, –141 dBc (typ.) |
| | 20 GHz < f ≤ 44 GHz, carrier offset = 30 MHz | < –130 dBc, –135 dBc (typ.) |
| | 44 GHz < f ≤ 67 GHz, carrier offset = 40 MHz | < –129 dBc, –133 dBc (typ.) |
| SSB phase noise | CW, standard performance, carrier offset = 20 kHz, measurement bandwidth = 1 Hz, level = 10 dBm or maximum specified output power, whichever is lower | |
| | 20 MHz ≤ f ≤ 200 MHz | < –134 dBc, –140 dBc (typ.) |
| | f = 1 GHz | < –134 dBc, –140 dBc (typ.) |
| | f = 2 GHz | < –128 dBc, –134 dBc (typ.) |
| | f = 3 GHz | < –124 dBc, –130 dBc (typ.) |
| | f = 4 GHz | < –122 dBc, –128 dBc (typ.) |
| | f = 6 GHz | < –118 dBc, –124 dBc (typ.) |
| | f = 10 GHz | < –114 dBc, –120 dBc (typ.) |
| | f = 20 GHz | < –108 dBc, –114 dBc (typ.) |
| | f = 30 GHz | < –104 dBc, –110 dBc (typ.) |
| | f = 40 GHz | < –102 dBc, –108 dBc (typ.) |
| | f = 44 GHz | < –101 dBc, –107 dBc (typ.) |
| | f = 56 GHz | < –96 dBc, –102 dBc (typ.) |
| | f = 67 GHz | < –94 dBc, –100 dBc (typ.) |

## SSB phase noise with R&S®SMW-B709/-B719 options

Specified values in plain text, measured values in brackets *( ) and italics.*

| SSB phase noise in dBc, 1 Hz measurement bandwidth, CW, level = 10 dBm | | | | |
|---|---|---|---|---|
| **Offset frequency / Carrier frequency** | **1 Hz** | **10 Hz** | **100 Hz** | **1 kHz** |
| **f = 10 MHz** | *(–96)* | –112 | –121 | –131 |
| **f = 100 MHz** | *(–77)* | –99 | –120 | –131 |
| **f = 1 GHz** | *(–59)* | –83 | –104 | –124 |
| **f = 2 GHz** | *(–53)* | –77 | –98 | –118 |
| **f = 3 GHz** | *(–49)* | –73 | –94 | –114 |
| **f = 4 GHz** | *(–47)* | –71 | –92 | –112 |
| **f = 6 GHz** | *(–43)* | –67 | –88 | –108 |
| **f = 10 GHz** | *(–39)* | –63 | –84 | –104 |
| **f = 20 GHz** | *(–33)* | –57 | –78 | –98 |
| **f = 30 GHz** | *(–29)* | –53 | –74 | –94 |
| **f = 40 GHz** | *(–27)* | –51 | –72 | –92 |
| **f = 44 GHz** | *(–26)* | –50 | –71 | –91 |
| **f = 56 GHz** | *(–21)* | –45 | –66 | –86 |
| **f = 67 GHz** | *(–19)* | –43 | –64 | –84 |

| SSB phase noise in dBc, 1 Hz measurement bandwidth, CW, level = 10 dBm | | | | |
|---|---|---|---|---|
| **Offset frequency / Carrier frequency** | **10 kHz** | **100 kHz** | **1 MHz** | **10 MHz** |
| **f = 10 MHz** | –138 | –136 | –141 | |
| **f = 100 MHz** | –138 | –136 | –141 | –149 |
| **f = 1 GHz** | –139 | –137 | –144 | –155 |
| **f = 2 GHz** | –133 | –131 | –138 | –154 |
| **f = 3 GHz** | –129 | –127 | –134 | –153 |
| **f = 4 GHz** | –127 | –125 | –132 | –152 |
| **f = 6 GHz** | –123 | –121 | –128 | –151 |
| **f = 10 GHz** | –119 | –117 | –124 | –145 |
| **f = 20 GHz** | –113 | –111 | –118 | –137 |
| **f = 30 GHz** | –109 | –107 | –114 | –134 |
| **f = 40 GHz** | –107 | –105 | –112 | –132 |
| **f = 44 GHz** | –106 | –104 | –111 | –130 |
| **f = 56 GHz** | –101 | –99 | –106 | –129 |
| **f = 67 GHz** | –99 | –97 | –104 | –128 |

## SSB phase noise with R&S®SMW-B710/-B720 options

Specified values in plain text, typical values in brackets ( ), measured values in brackets *( ) and italics.*

| **SSB phase noise in dBc, 1 Hz measurement bandwidth, CW, level = 10 dBm** | | | | |
|---|---|---|---|---|
| **Offset frequency / Carrier frequency** | **1 Hz** | **10 Hz** | **100 Hz** | **1 kHz** |
| **f = 10 MHz** | *(–110)* | –112 (–118) | –122 (–128) | –131 (–137) |
| **f = 100 MHz** | *(–100)* | –110 (–116) | –121 (–127) | –131 (–137) |
| **f = 1 GHz** | *(–82)* | –97 (–103) | –111 (–117) | –131 (–137) |
| **f = 2 GHz** | *(–76)* | –91 (–97) | –105 (–111) | –125 (–131) |
| **f = 3 GHz** | *(–72)* | –87 (–93) | –101 (–107) | –121 (–127) |
| **f = 4 GHz** | *(–70)* | –85 (–91) | –99 (–105) | –119 (–125) |
| **f = 6 GHz** | *(–66)* | –81 (–87) | –95 (–101) | –115 (–121) |
| **f = 10 GHz** | *(–62)* | –77 (–83) | –91 (–97) | –111 (–117) |
| **f = 20 GHz** | *(–56)* | –71 (–77) | –85 (–91) | –105 (–111) |
| **f = 30 GHz** | *(–52)* | –67 (–73) | –81 (–87) | –101 (–107) |
| **f = 40 GHz** | *(–50)* | –65 (–71) | –79 (–85) | –99 (–105) |
| **f = 44 GHz** | *(–49)* | –64 (–70) | –78 (–84) | –98 (–104) |
| **f = 56 GHz** | *(–45)* | –59 (–65) | –73 (–79) | –93 (–99) |
| **f = 67 GHz** | *(–42)* | –57 (–63) | –71 (–77) | –91 (–97) |

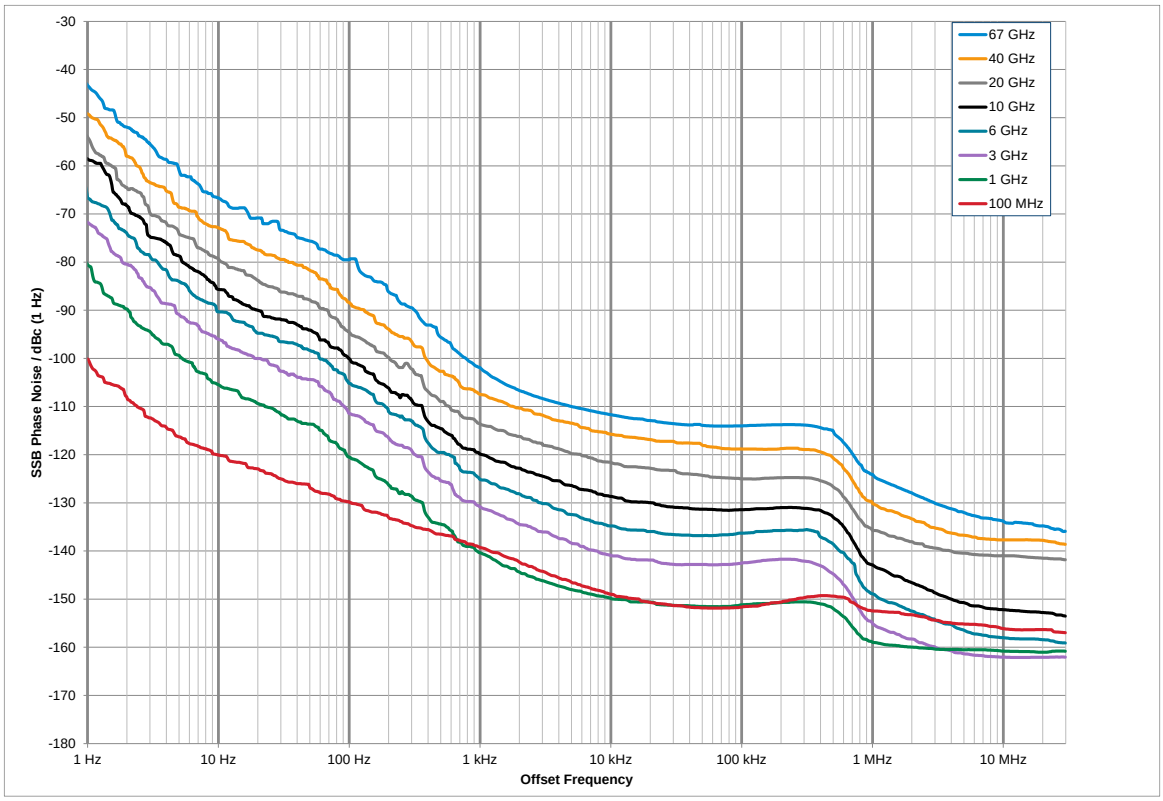
| **SSB phase noise in dBc, 1 Hz measurement bandwidth, CW, level = 10 dBm** | | | | |
|---|---|---|---|---|
| **Offset frequency / Carrier frequency** | **10 kHz** | **100 kHz** | **1 MHz** | **10 MHz** |
| **f = 10 MHz** | –138 (–144) | –136 (–142) | –141 (–147) | |
| **f = 100 MHz** | –138 (–144) | –136 (–142) | –141 (–147) | –149 (–155) |
| **f = 1 GHz** | –139 (–145) | –137 (–143) | –144 (–150) | –155 (–161) |
| **f = 2 GHz** | –133 (–139) | –131 (–137) | –138 (–144) | –154 (–160) |
| **f = 3 GHz** | –129 (–135) | –127 (–133) | –134 (–140) | –153 (–159) |
| **f = 4 GHz** | –127 (–133) | –125 (–131) | –132 (–138) | –152 (–158) |
| **f = 6 GHz** | –123 (–129) | –121 (–127) | –128 (–134) | –151 (–157) |
| **f = 10 GHz** | –119 (–125) | –117 (–123) | –124 (–130) | –145 (–151) |
| **f = 20 GHz** | –113 (–119) | –111 (–117) | –118 (–124) | –137 (–143) |
| **f = 30 GHz** | –109 (–115) | –107 (–113) | –114 (–120) | –134 (–140) |
| **f = 40 GHz** | –107 (–113) | –105 (–111) | –112 (–118) | –132 (–138) |
| **f = 44 GHz** | –106 (–112) | –104 (–110) | –111 (–117) | –130 (–136) |
| **f = 56 GHz** | –101 (–107) | –99 (–105) | –106 (–112) | –129 (–135) |
| **f = 67 GHz** | –99 (–105) | –97 (–103) | –104 (–110) | –128 (–134) |

## SSB phase noise with R&S®SMW-B711/-B721 option

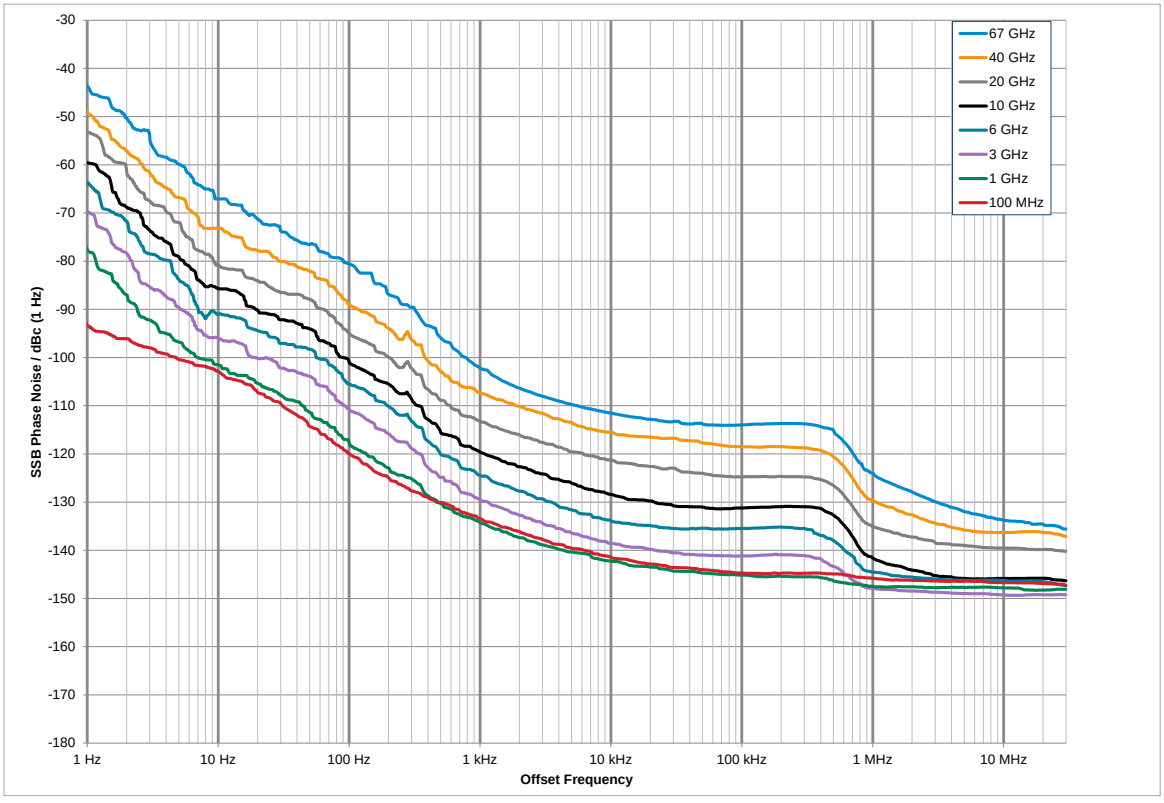
Specified values in plain text, typical values in brackets ( ), measured values in brackets *( ) and italics.*

| SSB phase noise in dBc, 1 Hz measurement bandwidth, CW, level = 10 dBm | | | | |
|---|---|---|---|---|
| **Offset frequency / Carrier frequency** | **1 Hz** | **10 Hz** | **100 Hz** | **1 kHz** |
| **f = 10 MHz** | *(–110)* | –112 (–128) | –122 (–128) | –133 (–139) |
| **f = 100 MHz** | *(–100)* | –110 (–116) | –121 (–127) | –133 (–139) |
| **f = 1 GHz** | *(–82)* | –97 (–103) | –111 (–117) | –135 (–141) |
| **f = 2 GHz** | *(–76)* | –91 (–97) | –105 (–111) | –129 (–135) |
| **f = 3 GHz** | *(–72)* | –87 (–93) | –101 (–107) | –125 (–131) |
| **f = 4 GHz** | *(–70)* | –85 (–91) | –99 (–105) | –123 (–129) |
| **f = 6 GHz** | *(–66)* | –81 (–87) | –95 (–101) | –119 (–125) |
| **f = 10 GHz** | *(–62)* | –77 (–83) | –91 (–97) | –115 (–121) |
| **f = 20 GHz** | *(–56)* | –71 (–77) | –85 (–91) | –109 (–115) |
| **f = 30 GHz** | *(–52)* | –67 (–73) | –81 (–87) | –105 (–111) |
| **f = 40 GHz** | *(–50)* | –65 (–71) | –79 (–85) | –103 (–109) |
| **f = 44 GHz** | *(–49)* | –64 (–70) | –78 (–84) | –102 (–108) |
| **f = 56 GHz** | *(-45)* | –60 (-66) | –74 (–80) | –98 (–104) |
| **f = 67 GHz** | *(-43)* | –58 (-64) | –72 (–78) | –96 (–102) |

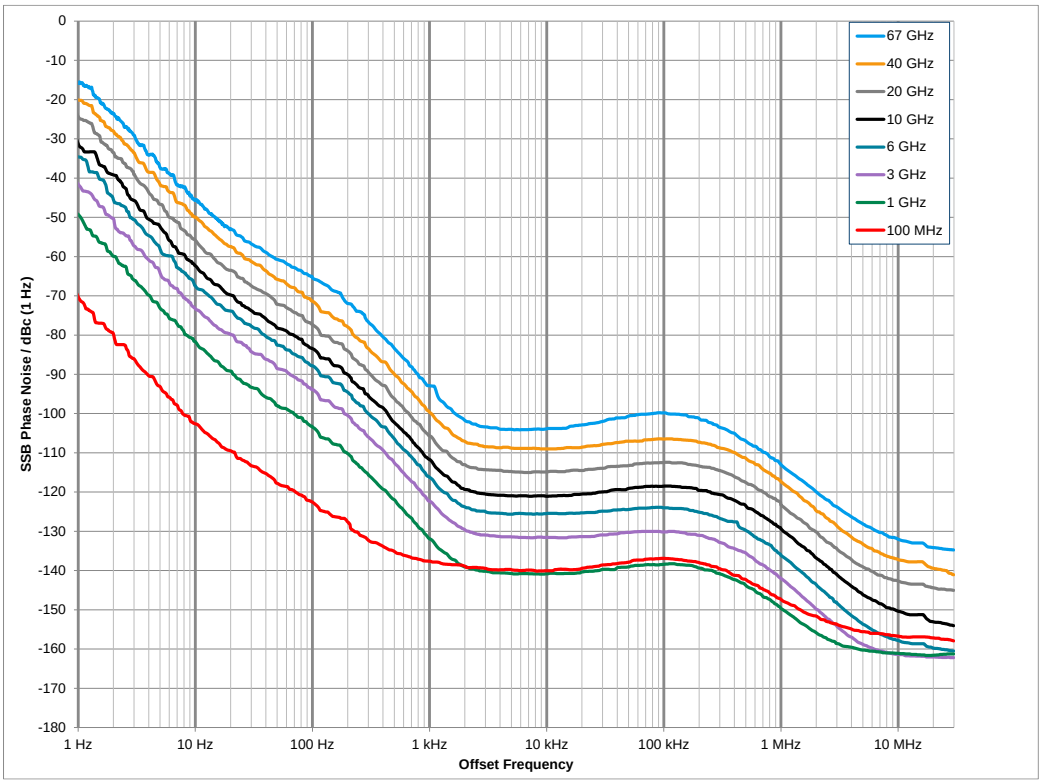
| SSB phase noise in dBc, 1 Hz measurement bandwidth, CW, level = 10 dBm | | | | |
|---|---|---|---|---|
| **Offset frequency / Carrier frequency** | **10 kHz** | **100 kHz** | **1 MHz** | **10 MHz** |
| **f = 10 MHz** | –143 (–149) | –146 (–152) | –146 (–152) | |
| **f = 100 MHz** | –143 (–149) | –146 (–152) | –146 (–152) | –149 (–155) |
| **f = 1 GHz** | –144 (–150) | –145 (–151) | –151 (–161) | –155 (–161) |
| **f = 2 GHz** | –138 (–144) | –139 (–145) | –145 (–157) | –155 (–161) |
| **f = 3 GHz** | –134 (–140) | –135 (–141) | –141 (–156) | –155 (–161) |
| **f = 4 GHz** | –132 (–138) | –133 (–139) | –139 (–151) | –154 (–160) |
| **f = 6 GHz** | –128 (–134) | –129 (–135) | –135 (–150) | –153 (–159) |
| **f = 10 GHz** | –124 (–130) | –125 (–131) | –131 (–145) | –147 (–153) |
| **f = 20 GHz** | –118 (–124) | –119 (–125) | –125 (–139) | –137 (–143) |
| **f = 30 GHz** | –114 (–120) | –115 (–121) | –121 (–127) | –135 (–141) |
| **f = 40 GHz** | –112 (–118) | –113 (–119) | –119 (–133) | –133 (–139) |
| **f = 44 GHz** | –111 (–117) | –112 (–118) | –118 (–131) | –132 (–138) |
| **f = 56 GHz** | –107 (–113) | –108 (–114) | –114 (–120) | –131 (–137) |
| **f = 67 GHz** | –105 (–111) | –106 (–112) | –112 (–118) | –128 (–134) |



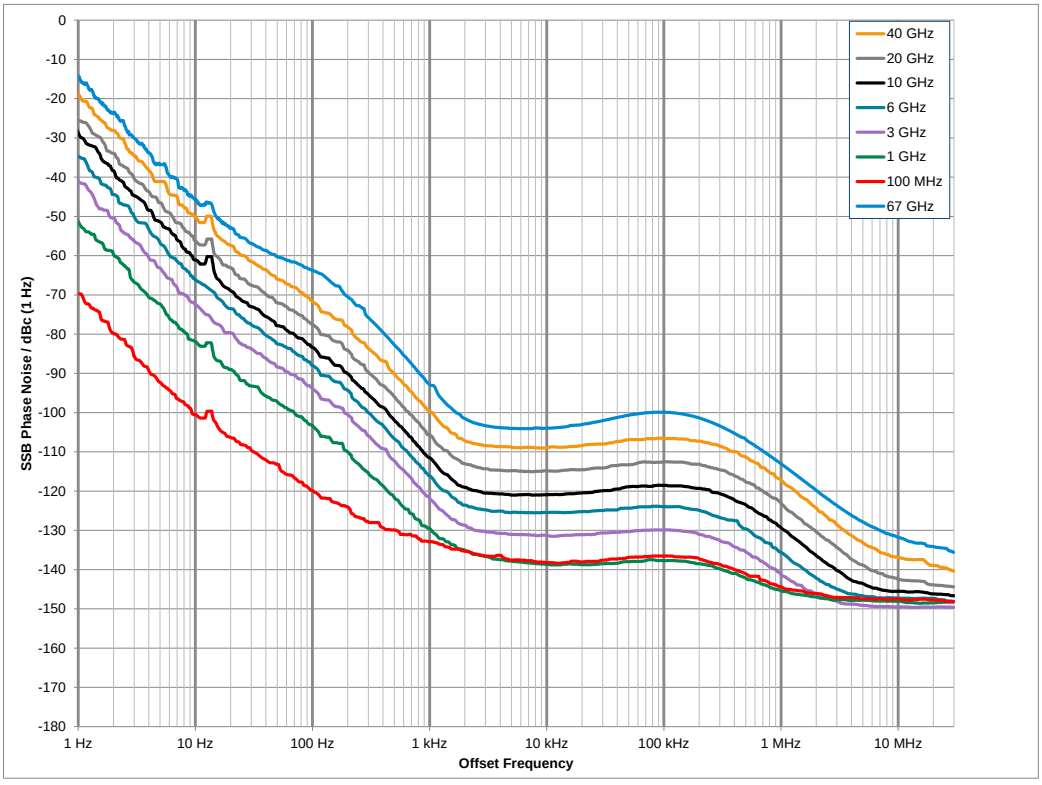

*Measured SSB phase noise performance with R&S®SMW-B711/-B721 options, CW mode*



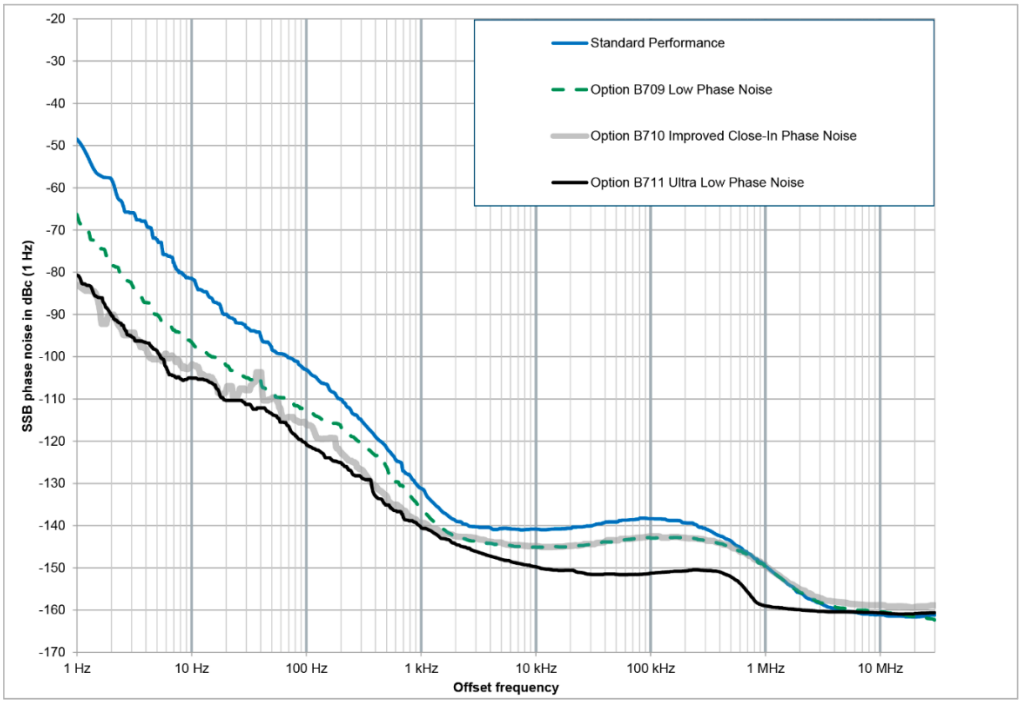

*Measured SSB phase noise performance with R&S®SMW-B711/-B721 options, I/Q mode*




*Measured SSB phase noise performance, standard instrument, CW mode*




*Measured SSB phase noise performance, standard instrument, I/Q mode*




*Measured SSB phase noise performance at f = 1 GHz, CW mode, standard performance versus the R&S®SMW-B709, R&S®SMW-B710 and R&S®SMW-B711 options*

## List mode

Frequency and level values can be stored in a list and set in an extremely short amount of time, triggered by an internal timer or an external trigger connector. There are two run modes available:

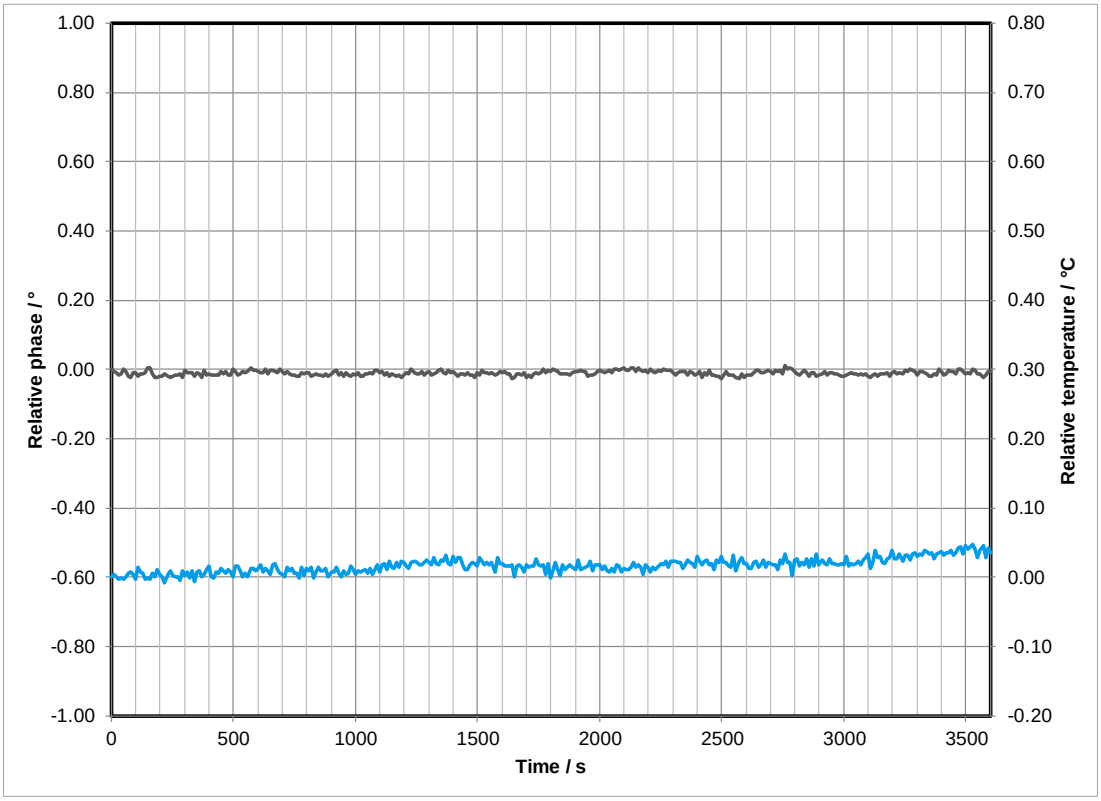
- Learned: faster (see frequency and level data), limited number of steps, cannot be combined with I/Q optimization mode “high quality”, not available if the instrument is equipped with R&S®SMW-B711/-B721 ultra low phase noise options
- Live: works only for dwell times above 2 ms

| | | |
|---|---|---|
| Run modes | | learned, live |
| Operating modes | internal trigger, infinite | automatic |
| | internal trigger, one sweep per trigger event | single |
| | internal trigger, one step per trigger event | step |
| | external trigger, one sweep per trigger event | extern single |
| | external trigger, one step per trigger event | extern step |
| Maximum number of steps (learned mode) | | 10000 |
| Dwell time | can be set individually for each step | 0.5 ms to 100 s |
| Resolution | | 0.1 ms |
| Setting time | after external trigger | see frequency and level data |

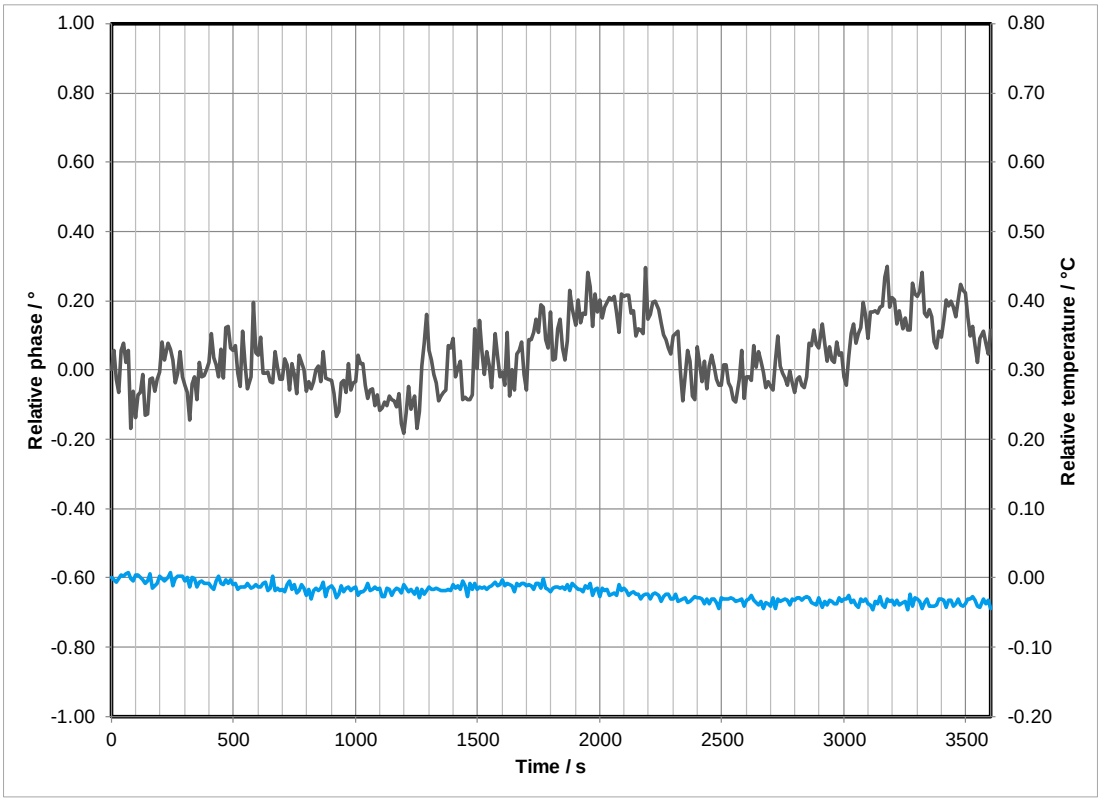
# Phase coherence (R&S®SMW-B90 option)

The R&S®SMW-B90 option can be installed once, but can be used with all installed RF paths. It provides phase-coherent RF outputs for the two RF paths or two or more instruments.

| | | |
|---|---|---|
| LO coupling modes | This mode corresponds to internal LO operation in path A and path B. | A, B internal |
| | This mode corresponds to internal LO operation in path A, and LO of path B is coupled to path A. | A internal, A → B coupled |
| | This mode corresponds to external LO operation at the LO IN connector in path A and internal LO operation in path B. | A external, B internal |
| | This mode corresponds to external LO operation at the REF/LO IN connector in path A and path B. | A external, A → B coupled |
| REF/LO OUT states | The active LO signal of path B can be routed to the LO OUT connector (in order to couple two or more instruments). | on/off |
| **Input of phase coherence signal** | | |
| Connector type | LO IN on rear panel | SMA female |
| Input impedance | | 50 Ω (nom.) |
| Input level range of external LO signal | | 7 dBm to 13 dBm |
| Frequency range of external LO signal | for RF setting 200 MHz < f ≤ 6.5 GHz | 1.0 · f |
| | for RF setting 6.5 GHz < f ≤ 13 GHz | 0.5 · f |
| | for RF setting 13 GHz < f ≤ 26 GHz | 0.25 · f |
| | for RF setting 26 GHz < f ≤ 44 GHz | 0.125 · f |
| | R&S®SMW-B1056, R&S®SMW-B1056N, R&S®SMW-B1067, R&S®SMW-B1067N frequency options | |
| | for RF setting 43 GHz < f ≤ 65 GHz | 0.1 · f |
| | for RF setting 65 GHz < f ≤ 72 GHz | 0.05 · f |
| **Output of phase coherence signal** | | |
| Connector type | LO OUT on rear panel | SMA female |
| Output impedance | | 50 Ω (nom.) |
| Output level range of internal LO signal | | 7 dBm to 13 dBm |
| Frequency range of internal LO signal | for RF setting 200 MHz < f ≤ 6.5 GHz | 1.0 · f |
| | for RF setting 6.5 GHz < f ≤ 13 GHz | 0.5 · f |
| | for RF setting 13 GHz < f ≤ 26 GHz | 0.25 · f |
| | for RF setting 26 GHz < f ≤ 44 GHz | 0.125 · f |
| | R&S®SMW-B1056, R&S®SMW-B1056N, R&S®SMW-B1067, R&S®SMW-B1067N frequency options | |
| | for RF setting 43 GHz < f ≤ 65 GHz | 0.1 · f |
| | for RF setting 65 GHz < f ≤ 72 GHz | 0.05 · f |




*Measured relative phase between two LO coupled R&S®SMW200A RF paths versus time, carrier frequency = 2 GHz, level = –10 dBm (the lower curve/right vertical axis indicates the temperature variation)*




*Measured relative phase between two LO coupled R&S®SMW200A RF paths versus time, carrier frequency = 40 GHz, level = –10 dBm (the lower curve/right vertical axis indicates the temperature variation)*

# Simultaneous modulation

In the same RF path.

● = compatible, – = incompatible
○ = compatible with limitations (ALC mode = off)

| | Amplitude modulation | Frequency modulation | Phase modulation | Pulse modulation | I/Q modulation |
|---|---|---|---|---|---|
| Amplitude modulation | | ● | ● | ○ | – |
| Frequency modulation | ● | | – | ● | ● |
| Phase modulation | ● | – | | ● | ● |
| Pulse modulation | ○ | ● | ● | | ○ |
| I/Q modulation | – | ● | ● | ○ | |

Two-path instruments: Frequency modulation and phase modulation are not compatible with I/Q modulation in the other RF path.

For simultaneous I/Q and frequency modulation, or simultaneous I/Q and phase modulation, the instrument must be equipped with a two-path signal routing and baseband main module (R&S®SMW-B13T or R&S®SMW-B13XT option).

Instruments equipped with R&S®SMW-B2031, R&S®SMW-B2044 or R&S®SMW-B2044N in RF path B:
Amplitude modulation, frequency modulation and phase modulation are only possible in RF path A. When activating frequency or phase modulation in RF path A, RF path B is switched off.

# Analog modulation

## Amplitude modulation (R&S®SMW-K720 option)

This option is not available for R&S®SMW-B2031, R&S®SMW-B2044 and R&S®SMW-B2044N.

| | | |
|---|---|---|
| Modulation source | | internal, external |
| External coupling | | AC, DC |
| Modulation depth | modulation is clipped at high levels when maximum PEP is reached | 0 % to 100 % |
| Resolution of setting | | 0.1 % |
| AM depth (m) error | f ≤ 30 GHz | |
| | $f_{mod}$ = 1 kHz and m < 80 % | < (1 % of reading + 1 %) |
| | 30 GHz < f | |
| | $f_{mod}$ = 1 kHz and m < 80 % | < (2 % of reading + 1 %) |
| AM distortion | f ≤ 3 GHz, $f_{mod}$ = 1 kHz | |
| | m = 30 % | < 0.8 % |
| | m = 80 % | < 1.4 % |
| | 3 GHz < f ≤ 20 GHz, $f_{mod}$ = 1 kHz | |
| | m = 30 % | < 1 % |
| | m = 80 % | < 1.6 % |
| | 20 GHz < f, $f_{mod}$ = 1 kHz, level = 0 dBm | |
| | m = 30 % | < 1.5 % |
| | m = 80 % | < 2.4 % |
| Modulation frequency range | | DC, 20 Hz to 500 kHz |
| Modulation frequency response | AC mode, 20 Hz to 500 kHz | < 1 dB |
| Incidental PM at AM | m = 30 %, $f_{mod}$ = 1 kHz, peak value | < 0.1 rad |

## Frequency modulation (R&S®SMW-K720 option)

R&S®SMW-B13T or R&S®SMW-B13XT must be installed.

This option is not available for R&S®SMW-B2031, R&S®SMW-B2044 and R&S®SMW-B2044N.

| | | |
|---|---|---|
| FM multiplier (N) for different frequency ranges | 100 kHz ≤ f ≤ 200 MHz | N = 1 |
| | 200 MHz < f ≤ 375 MHz | N = 1/4 |
| | 375 MHz < f ≤ 750 MHz | N = 1/2 |
| | 750 MHz < f ≤ 1500 MHz | N = 1 |
| | 1.5 GHz < f ≤ 3 GHz | N = 2 |
| | 3 GHz < f ≤ 6 GHz | N = 4 |
| | 6 GHz < f ≤ 12 GHz | N = 8 |
| | 12 GHz < f ≤ 24 GHz | N = 16 |
| | 24 GHz < f ≤ 44 GHz | N = 32 |
| | R&S®SMW-B1056, R&S®SMW-B1056N | |
| | 43 GHz < f ≤ 56 GHz | N = 40 |
| | R&S®SMW-B1067, R&S®SMW-B1067N | |
| | 43 GHz < f ≤ 60 GHz | N = 40 |
| | 60 GHz < f ≤ 67 GHz | N = 80 |
| Modulation source | | internal, external, internal + external |
| External coupling | | AC, DC |
| FM modes | | normal, low noise |
| Maximum deviation | FM mode: normal | N · 10 MHz |
| | FM mode: low noise | N · 100 kHz |
| Resolution of setting | | < 200 ppm, min. N · 0.1 Hz |
| FM deviation error | $f_{mod}$ = 10 kHz, deviation ≤ half of maximum deviation or 10 MHz, whichever is lower | |
| | internal | < (1.5 % of reading + 20 Hz) |
| | external | < (2.0 % of reading + 20 Hz) |
| FM distortion | $f_{mod}$ = 10 kHz, deviation = N · 1 MHz | < 0.1 % |
| Modulation frequency response | FM mode: normal (DC/AC coupling), 50 Ω input impedance | |
| | DC, 10 Hz to 100 kHz | < 0.5 dB |
| | DC, 10 Hz to 10 MHz, f ≤ 3 GHz<br>DC, 10 Hz to 5 MHz, f > 3 GHz | < 3 dB |
| | FM mode: low noise (DC/AC coupling), 50 Ω input impedance | |
| | DC, 10 Hz to 100 kHz | < 3 dB |

| | | |
|---|---|---|
| Synchronous AM with FM | 40 kHz deviation, $f_{mod}$ = 1 kHz | |
| | 5 MHz < f ≤ 3 GHz | < 0.1 % |
| | 3 GHz < f ≤ 6 GHz | < 0.2 % |
| | 6 GHz < f ≤ 44 GHz | < 0.2 % |
| Carrier frequency offset at FM | | < 0.2 % of set deviation |

# Phase modulation (R&S®SMW-K720 option)

R&S®SMW-B13T or R&S®SMW-B13XT must be installed.

This option is not available for R&S®SMW-B2031, R&S®SMW-B2044 and R&S®SMW-B2044N.

| | | |
|---|---|---|
| PM multiplier (N) for different frequency ranges | 100 kHz ≤ f ≤ 200 MHz | N = 1 |
| | 200 MHz < f ≤ 375 MHz | N = 1/4 |
| | 375 MHz < f ≤ 750 MHz | N = 1/2 |
| | 750 MHz < f ≤ 1500 MHz | N = 1 |
| | 1.5 GHz < f ≤ 3 GHz | N = 2 |
| | 3 GHz < f ≤ 6 GHz | N = 4 |
| | 6 GHz < f ≤ 12 GHz | N = 8 |
| | 12 GHz < f ≤ 24 GHz | N = 16 |
| | 24 GHz < f ≤ 44 GHz | N = 32 |
| | R&S®SMW-B1056, R&S®SMW-B1056N | |
| | 43 GHz < f ≤ 56 GHz | N = 40 |
| | R&S®SMW-B1067, R&S®SMW-B1067N | |
| | 43 GHz < f ≤ 60 GHz | N = 40 |
| | 60 GHz < f ≤ 67 GHz | N = 80 |
| Modulation source | | internal, external, internal + external |
| External coupling | | AC, DC |
| PM modes | | high deviation,<br>high bandwidth,<br>low noise |
| Maximum deviation | PM mode: high deviation<br>$f_{mod}$ ≤ N · 10 MHz / deviation | N · 20.0 rad |
| | PM mode: high bandwidth | N · 1.0 rad |
| | PM mode: low noise | N · 0.25 rad |
| Resolution of setting | PM mode: high deviation | < 200 ppm, min. N · 20 µrad |
| | PM mode: high bandwidth | < 0.1 %, min. N · 20 µrad |
| | PM mode: low noise | < 200 ppm, min. N · 20 µrad |
| PM deviation error | $f_{mod}$ = 10 kHz, deviation ≤ half of maximum deviation | |
| | internal | < (1.5 % of reading + 0.01 rad) |
| | external | < (2.0 % of reading + 0.01 rad) |
| Modulation frequency response | DC/AC coupling, 50 Ω input impedance | |
| | high deviation | |
| | deviation ≤ N · 5 rad,<br>DC, 10 Hz to 500 kHz | < 1 dB |
| | deviation > N · 5 rad,<br>DC, 10 Hz to 10 kHz | < 1 dB |
| | high bandwidth,<br>DC, 10 Hz to 10 MHz for f ≤ 3 GHz,<br>DC, 10 Hz to 5 MHz for f > 3 GHz | < 3 dB |
| | low noise, DC, 10 Hz to 100 kHz | < 3 dB |

# Pulse modulation (R&S®SMW-K22 option)

If two RF paths are installed (signal paths A and B), pulse modulation can be used either on signal path A or B with one R&S®SMW-K22 option. For simultaneous pulse modulation on signal paths A and B, two R&S®SMW-K22 must be installed.

| | | |
|---|---|---|
| Modulation source | | external, internal |
| On/off ratio | | > 80 dB |
| | with R&S®SMW-B1056, R&S®SMW-B1056N, R&S®SMW-B1067, R&S®SMW-B1067N, f > 43 GHz, CW | > 65 dB |
| Rise/fall time | 10 %/90 % of RF amplitude | |
| | with R&S®SMW-B1003, R&S®SMW-B2003, R&S®SMW-B1006, R&S®SMW-B2006 frequency options | |
| | transition type = fast | < 10 ns |
| | transition type = smoothed | < 200 ns |
| | with R&S®SMW-B1007, R&S®SMW-B2007, R&S®SMW-B1012, R&S®SMW-B2012, R&S®SMW-B1020, R&S®SMW-B2020, R&S®SMW-B1031, R&S®SMW-B2031, R&S®SMW-B1040, R&S®SMW-B1040N, R&S®SMW-B1044, R&S®SMW-B2044, R&S®SMW-B1044N, R&S®SMW-B2044N, R&S®SMW-B1056, R&S®SMW-B1056N, R&S®SMW-B1067, R&S®SMW-B1067N frequency options | |
| | transition type = fast | < 10 ns |
| | with R&S®SMW-B1044/-B2044/ -B1044N/-B2044N/B1056/ -B1056N/-B1067/-B1067N, f > 19.5 GHz | < 15 ns |
| | transition type = smoothed, only available for: f ≤ 5 GHz, CW; f ≤ 3.5 GHz, I/Q modulation or AM modulation | < 200 ns |
| Minimum pulse width | 50 %/50 % of RF amplitude, transition type = fast | |
| | with R&S®SMW-B1003, R&S®SMW-B2003, R&S®SMW-B1006, R&S®SMW-B2006, R&S®SMW-B1007, R&S®SMW-B2007, R&S®SMW-B1012, R&S®SMW-B2012, R&S®SMW-B1020, R&S®SMW-B2020, R&S®SMW-B1031, R&S®SMW-B2031, R&S®SMW-B1040, R&S®SMW-B1044, R&S®SMW-B2044, R&S®SMW-B1056, R&S®SMW-B1067 frequency options | 20 ns |
| | with R&S®SMW-B1040N, R&S®SMW-B1044N, R&S®SMW-B2044N, R&S®SMW-B1056N, R&S®SMW-B1067N frequency options | |
| | f ≤ 19.5 GHz | 20 ns |
| | 19.5 GHz < f ≤ 43 GHz | 30 ns |
| | f > 43 GHz | 20 ns |
| Pulse repetition frequency | | 0 Hz to 10 MHz |
| Video feedthrough | with R&S®SMW-B1003, R&S®SMW-B2003, R&S®SMW-B1006, R&S®SMW-B2006, R&S®SMW-B1007, R&S®SMW-B2007 frequency options | |
| | level < 10 dBm | < 10 % of RF, < 200 mV ($V_{pp}$) |
| | with R&S®SMW-B1012, R&S®SMW-B2012 frequency options | |
| | f ≤ 5 GHz: level < 5 dBm | < 10 % of RF, < 200 mV ($V_{pp}$) |
| | f > 5 GHz: level < 10 dBm | < 10 % of RF, < 20 mV ($V_{pp}$) |
| | with R&S®SMW-B1020, R&S®SMW-B2020, R&S®SMW-B1031, R&S®SMW-B2031, R&S®SMW-B1040, R&S®SMW-B1040N, R&S®SMW-B1044, R&S®SMW-B2044, R&S®SMW-B1044N, R&S®SMW-B2044N, R&S®SMW-B1056, R&S®SMW-B1067, R&S®SMW-B1056N, R&S®SMW-B1067N frequency options | |
| | f ≤ 5 GHz: level < 5 dBm | < 10 % of RF, < 200 mV ($V_{pp}$) |
| | f > 5 GHz: level < 10 dBm or maximum specified level, whichever is lower | < 10 % of RF, < 2 mV ($V_{pp}$) |
| Pulse overshoot | | < 10 % |

# Input for external modulation signals

| | | |
|---|---|---|
| **Modulation inputs EXT 1, EXT 2 for AM/FM/PM** | | |
| Connector type | EXT 1, EXT 2 on rear panel | BNC female |
| Input impedance | selectable | 100 kΩ or 50 Ω (nom.) |
| Coupling | | AC, DC |
| Input sensitivity | peak value for set modulation depth or deviation | 1 V (nom.) |
| Bandwidth | analog input bandwidth | 0 Hz to 10 MHz |
| Input damage voltage | | ±10 V |
| **Modulation input for pulse modulation** | | |
| Input | | selectable from USER 1, 2, 3 on front panel or USER 4, 5, 6 on rear panel |
| Connector type | USER 1, 2, 3 on front panel,<br>USER 4, 5, 6 on rear panel | BNC female |
| Input impedance | selectable | 1 kΩ or 50 Ω (nom.) |
| Threshold voltage | | 0.1 V to 2.0 V (nom.) |
| Input damage voltage | | –0.5 V; 3.8 V |
| Input polarity | selectable | normal, inverse |

# Modulation sources for analog modulation

## Internal modulation generator

| | | |
|---|---|---|
| Shape | | sinusoidal |
| Frequency range | | 0.1 Hz to 1 MHz |
| Resolution of setting | | 0.1 Hz |
| Frequency uncertainty | | < 0.001 Hz + relative deviation of reference frequency |

## Multifunction generator (R&S®SMW-K24 option)

If two RF paths are installed (signal paths A and B), the multifunction generator can be used either on signal path A or B with one R&S®SMW-K24 option. For the multifunction generator to be used on signal paths A and B simultaneously, two R&S®SMW-K24 must be installed.

The R&S®SMW-K24 multifunction generator option consists of three function generators that can be set independently. Two of the three signal sources can be added with different weighting. The total voltage is limited by the maximum output voltage.

| | | |
|---|---|---|
| Sources | LF generator 1/2 | sine wave, pulse, triangle, trapezoid |
| | noise generator | noise amplitude distribution: Gaussian, equal |
| Frequency range | sine wave | 0.1 Hz to 10 MHz |
| | pulse, triangle, trapezoid | 0.1 Hz to 1 MHz (displayed value) |
| | noise bandwidth | 100 kHz to 10 MHz |
| Resolution of setting | sine wave | 0.1 Hz |
| | pulse, triangle, trapezoid | 10 ns |
| | noise bandwidth | 100 kHz |
| Frequency uncertainty | | < 0.001 Hz + relative deviation of reference frequency |

## LF output

| | | |
|---|---|---|
| Monitoring of resulting modulation signal | for | AM, FM, PM |
| Source | | LF generator 1, LF generator 2, external 1, external 2, noise generator |
| Output voltage | $V_p$ at LF connector, open circuit voltage EMF | |
| Setting range | | 20 mV to 1 V |
| Setting resolution | | 1 mV |
| Setting accuracy | at 1 kHz | < (1 % of reading + 1 mV) |
| Output impedance | | 50 Ω |
| DC offset | | –0.2 V to +2.5 V |
| Frequency response | sine wave, up to 1 MHz | 0.05 dB (meas.) |
| | sine wave, up to 10 MHz | 0.1 dB (meas.) |
| Distortion | f < 100 kHz, at $R_L$ > 50 Ω, level ($V_{EMF}$) 1 V | < 0.1 % |

## High-performance pulse generator (R&S®SMW-K23 option)

If two RF paths are installed (signal paths A and B), the high-performance pulse generator can be used either on signal path A or B with one R&S®SMW-K23 option. For the high-performance pulse generator to be used on signal paths A and B simultaneously, two R&S®SMW-K23 must be installed.

| | | |
|---|---|---|
| Pulse modes | | single pulse, double pulse |
| Trigger modes | free run, internally triggered | auto |
| | | external trigger |
| | | external gate |
| Active trigger edge | | positive or negative |
| Pulse period | | |
| Setting range | | 20 ns to 100 s |
| Setting resolution | with R&S®SMW-B13XT option | 3.333 ns |
| | with R&S®SMW-B13, R&S®SMW-B13T options | 5 ns |

| | | |
|---|---|---|
| Pulse width | | |
| Setting range | pulse widths of double pulses are independently settable | |
| | with R&S®SMW-B13XT option | 3.333 ns to 100 s |
| | with R&S®SMW-B13, R&S®SMW-B13T options | 5 ns to 100 s |
| Setting resolution | with R&S®SMW-B13XT option | 3.333 ns |
| | with R&S®SMW-B13, R&S®SMW-B13T options | 5 ns |
| Pulse delay | | |
| Setting range | | 0 ns to 100 s |
| Setting resolution | with R&S®SMW-B13XT option | 3.333 ns |
| | with R&S®SMW-B13, R&S®SMW-B13T options | 5 ns |
| Double-pulse delay | | |
| Setting range | | 20 ns to 1 s |
| Setting resolution | with R&S®SMW-B13XT option | 3.333 ns |
| | with R&S®SMW-B13, R&S®SMW-B13T options | 5 ns |
| Uncertainty for pulse timing | pulse timing generated digitally; ensured by design | relative deviation of reference frequency |
| External trigger | | |
| Delay | trigger to RF output | 50 ns (meas.) |
| Jitter | | < 10 ns (meas.) |
| PULSE/VIDEO/SYNC output | | LVTTL signal ($R_L$ ≥ 50 Ω) |

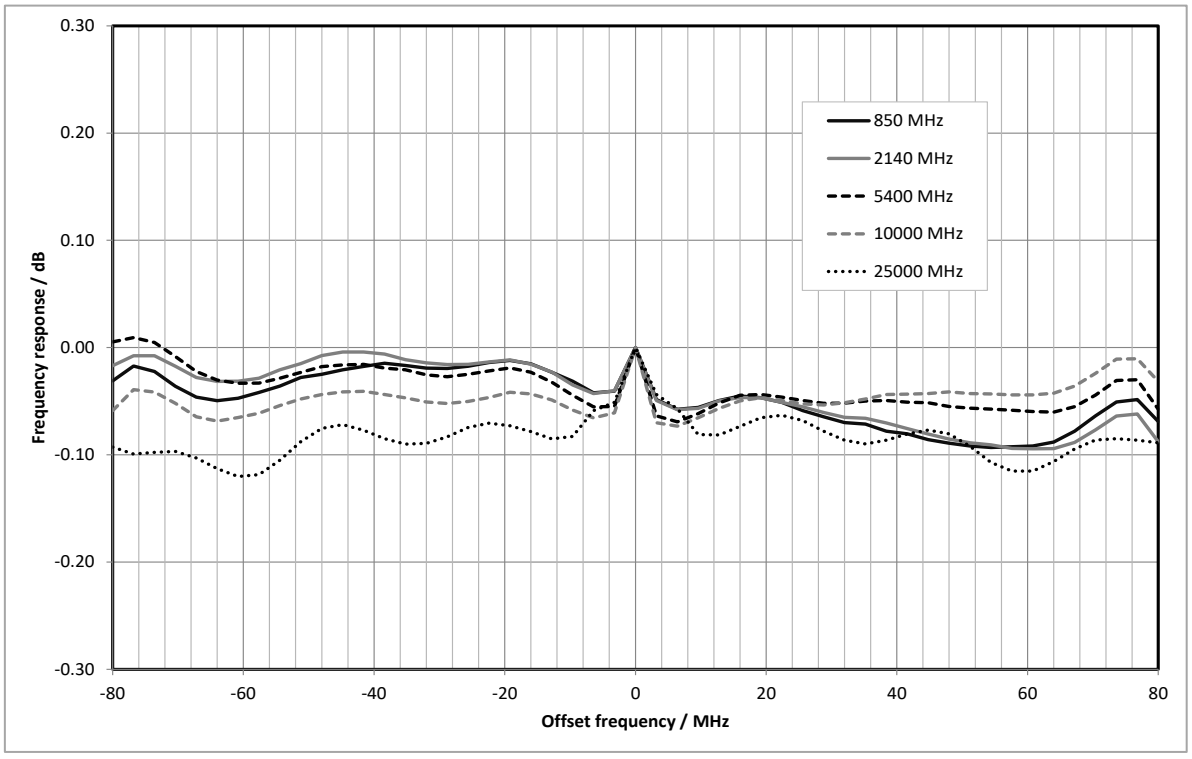
# I/Q modulation

## I/Q modulation performance

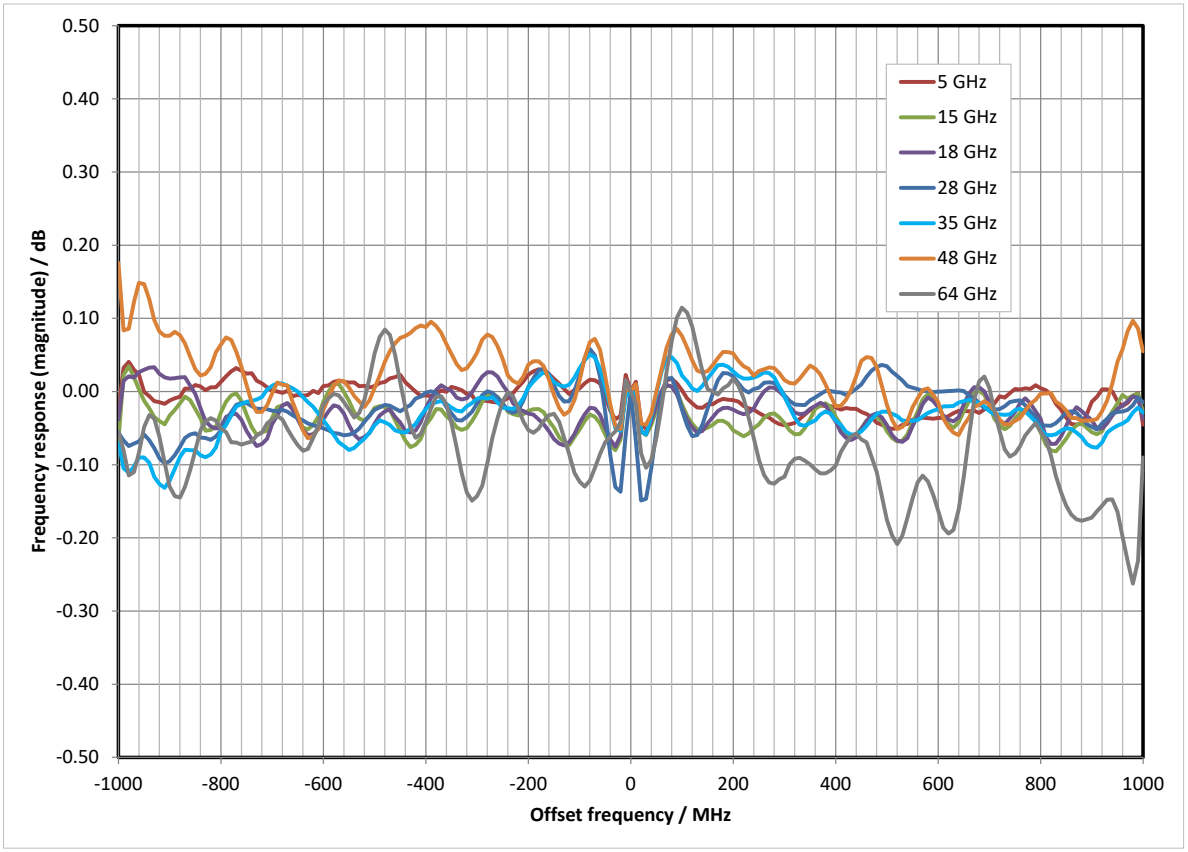
| | | |
|---|---|---|
| Operating modes | | external wideband I/Q,<br>internal baseband I/Q |
| RF modulation bandwidth | with external wideband I/Q inputs, I/Q wideband on;<br>with R&S®SMW-B1003, R&S®SMW-B2003, R&S®SMW-B1006, R&S®SMW-B2006, R&S®SMW-B1020, R&S®SMW-B2020, R&S®SMW-B1031, R&S®SMW-B2031, R&S®SMW-B1040, R&S®SMW-B1044, R&S®SMW-B2044, R&S®SMW-B1056, R&S®SMW-B1067 frequency options | |
| | 1 MHz ≤ f ≤ 300 MHz | ±32 % of carrier frequency |
| | 300 MHz < f ≤ 2.5 GHz | ±40 % of carrier frequency |
| | f > 2.5 GHz | ±1 GHz |
| | with external wideband I/Q inputs, I/Q wideband on;<br>with R&S®SMW-B1040N, R&S®SMW-B1044N, R&S®SMW-B2044N frequency options | |
| | 1 MHz ≤ f ≤ 300 MHz | ±32 % of carrier frequency |
| | 300 MHz < f ≤ 2.5 GHz | ±40 % of carrier frequency |
| | 2.5 GHz < f ≤ 20 GHz | ±1 GHz |
| | f > 20 GHz | ±275 MHz |
| | with external wideband I/Q inputs, I/Q wideband on;<br>with R&S®SMW-B1056N, R&S®SMW-B1067N frequency options | |
| | 1 MHz ≤ f ≤ 300 MHz | ±32 % of carrier frequency |
| | 300 MHz < f ≤ 2.5 GHz | ±40 % of carrier frequency |
| | 2.5 GHz < f ≤ 19.5 GHz | ±1 GHz |
| | 19.5 GHz < f ≤ 43 GHz | ±275 MHz |
| | f > 43 GHz | ±1 GHz |
| | with external wideband I/Q inputs, I/Q wideband on;<br>with R&S®SMW-B1007, R&S®SMW-B2007, R&S®SMW-B1012, R&S®SMW-B2012 frequency options | |
| | 1 MHz ≤ f ≤ 300 MHz | ±32 % of carrier frequency |
| | 300 MHz < f ≤ 1.25 GHz | ±40 % of carrier frequency |
| | f > 1.25 GHz | ±500 MHz |
| | with external wideband I/Q inputs, I/Q wideband off | |
| | f ≤ 1000 MHz | ±10 % of carrier frequency |
| | f > 1000 MHz | ±100 MHz |
| | with internal baseband I/Q, standard baseband (R&S®SMW-B13 or -B13T),<br>I/Q wideband on | |
| | 1 MHz < f ≤ 250 MHz | ±32 % of carrier frequency |
| | f > 250 MHz | ±80 MHz |
| | with internal baseband I/Q, wideband baseband (R&S®SMW-B13XT), I/Q wideband on;<br>with R&S®SMW-B1003, R&S®SMW-B2003, R&S®SMW-B1006, R&S®SMW-B2006, R&S®SMW-B1007, R&S®SMW-B2007, R&S®SMW-B1012, R&S®SMW-B2012, R&S®SMW-B1020, R&S®SMW-B2020, R&S®SMW-B1031, R&S®SMW-B2031, R&S®SMW-B1040, R&S®SMW-B1044, R&S®SMW-B2044, R&S®SMW-B1056, R&S®SMW-B1067 frequency options | |
| | 1 MHz ≤ f ≤ 300 MHz | ±32 % of carrier frequency |
| | 300 MHz < f ≤ 2.5 GHz | ±40 % of carrier frequency |
| | f > 2.5 GHz | ±1 GHz |
| | with internal baseband I/Q, wideband baseband (R&S®SMW-B13XT), I/Q wideband on;<br>with R&S®SMW-B1040N, R&S®SMW-B1044N, R&S®SMW-B2044N frequency options | |
| | 1 MHz ≤ f ≤ 300 MHz | ±32 % of carrier frequency |
| | 300 MHz < f ≤ 2.5 GHz | ±40 % of carrier frequency |
| | 2.5 GHz < f ≤ 20 GHz | ±1 GHz |
| | f > 20 GHz | ±275 MHz |
| | with internal baseband I/Q, wideband baseband (R&S®SMW-B13XT), I/Q wideband on;<br>with R&S®SMW-B1056N, R&S®SMW-B1067N frequency options | |
| | 1 MHz ≤ f ≤ 300 MHz | ±32 % of carrier frequency |
| | 300 MHz < f ≤ 2.5 GHz | ±40 % of carrier frequency |
| | 2.5 GHz < f ≤ 19.5 GHz | ±1 GHz |
| | 19.5 GHz < f ≤ 43 GHz | ±275 MHz |
| | f > 43 GHz | ±1 GHz |

| | | |
|---|---|---|
| RF frequency response in specified RF modulation bandwidth | with external wideband I/Q inputs | |
| | I/Q wideband on | |
| | f ≤ 44 GHz | < 9 dB, < 6 dB (meas.) |
| | f > 44 GHz | <10 dB |
| | I/Q wideband off | < 5 dB, < 3 dB (meas.) |
| | with internal baseband I/Q, standard baseband (R&S®SMW-B13 or -B13T), I/Q wideband on, optimization mode: high quality | < 1.0 dB, < 0.3 dB (meas.) |
| | with internal baseband I/Q, wideband baseband (R&S®SMW-B13XT), I/Q wideband on, optimization mode: high quality | < 1.0 dB, < 0.4 dB (meas.) |
| Carrier leakage [7] | mode: internal baseband I/Q, referenced to full-scale input | < –55 dBc |
| | f > 19.5 GHz, with R&S®SMW-B1031, R&S®SMW-B2031, R&S®SMW-B1040, R&S®SMW-B1040N frequency options | < –40 dBc |
| | f > 19.5 GHz, with R&S®SMW-B1044, R&S®SMW-B2044, R&S®SMW-B1044N, R&S®SMW-B2044N frequency options | < –30 dBc |
| | f < 19.5 GHz with R&S®SMW-B1056, R&S®SMW-B1067, R&S®SMW-B1056N, R&S®SMW-B1067N frequency options | < –55 dBc |
| | 19.5 GHz < f ≤ 67 GHz with R&S®SMW-B1056, R&S®SMW-B1067, R&S®SMW-B1056N, R&S®SMW-B1067N frequency options | < –30 dBc |
| Suppression of image sideband for entire instrument in modulation bandwidth [7] | with internal baseband I/Q, standard baseband (R&S®SMW-B13 or -B13T), optimization mode: high quality, up to 160 MHz RF modulation bandwidth | > 50 dB, 60 dB (typ.) |
| | with internal baseband I/Q, wideband baseband (R&S®SMW-B13XT), optimization mode: high quality | |
| | RF modulation bandwidth ≤ 1600 MHz | > 40 dB, 50 dB (meas.) |
| | 1600 MHz < RF modulation bandwidth ≤ 2000 MHz | > 37 dB, 47 dB (meas.) |
| Two-tone IMD (2 carriers) | PEP = 0 dBm, up to 80 MHz carrier spacing | |
| | f ≤ 3 GHz | < –50 dBc (typ.) |
| | 3 GHz < f ≤ 10 GHz | < –45 dBc (typ.) |
| | 10 GHz < f ≤ 20 GHz | < –40 dBc (typ.) |
| | 20 GHz < f ≤ 30 GHz | < –38 dBc (typ.) |
| | 30 GHz < f ≤ 44 GHz | < –32 dBc (typ.) |
| | 44 GHz < f ≤ 67 GHz, PEP = –4 dBm | < –26 dBc (typ.) |
| I/Q impairments (analog) | These impairments are set within the analog I/Q modulator section. They can be used in external wideband I/Q mode and internal baseband I/Q mode. They cannot be applied to the analog or digital I/Q outputs. | |
| | I offset, Q offset | |
| | setting range | –10 % to +10 % |
| | setting resolution | 0.01 % |
| | gain imbalance | |
| | setting range | –1.0 dB to +1.0 dB |
| | setting resolution | 0.01 dB |
| | quadrature offset | |
| | setting range | –10° to +10° |
| | setting resolution | 0.01° |

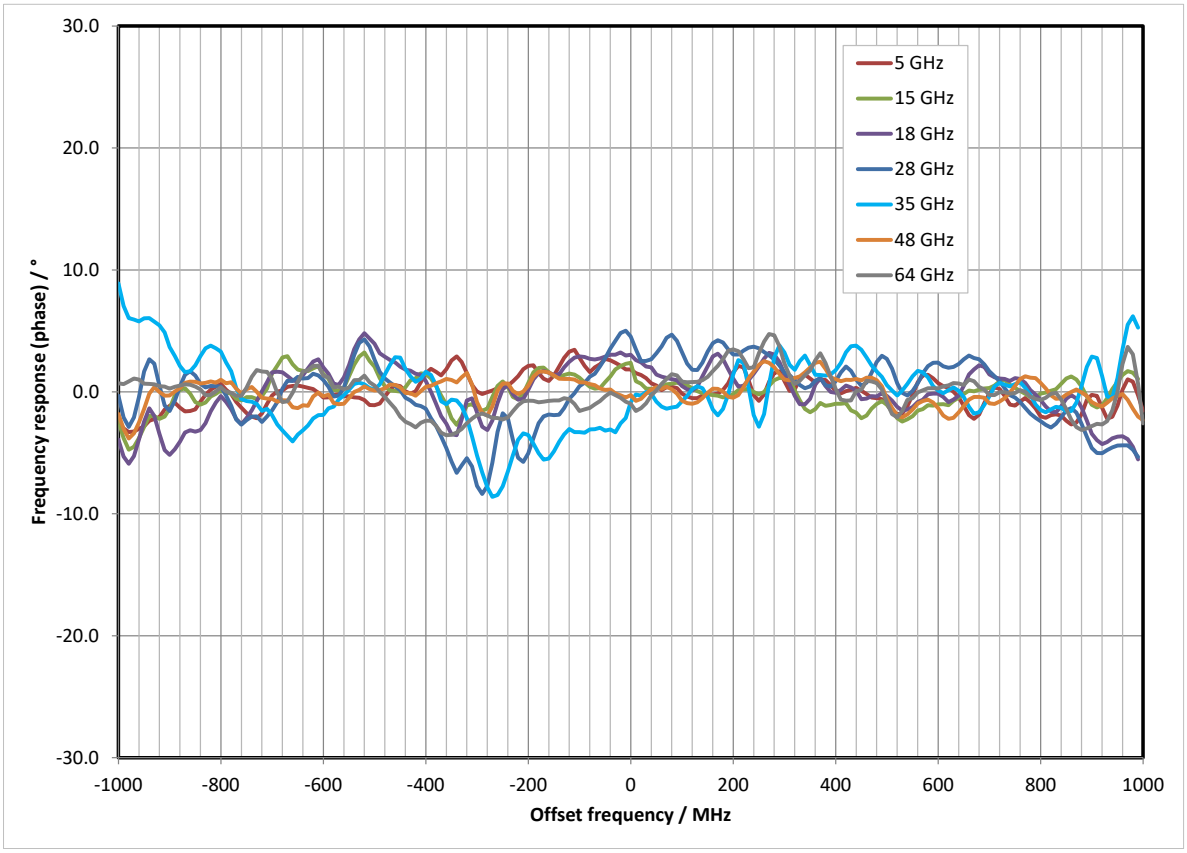
[7] Value applies after 1 hour warm-up time and recalibration for 4 hours of operation and temperature variations of less than +5 °C.




*Measured RF modulation frequency response (magnitude) with internal baseband I/Q, standard baseband*




*Measured RF modulation frequency response (magnitude) with internal baseband I/Q, wideband baseband*




*Measured RF modulation frequency response (phase) with internal baseband I/Q, wideband baseband*

# Analog I/Q inputs

For each installed RF path A or B, one pair of I and Q inputs is available on the front panel (single-ended input mode). With the R&S®SMW-K739 option installed, the input mode for RF path A can also be switched to differential. In this mode, all four available connectors are used for RF path A.

Analog I/Q input signals are directly applied to the analog I/Q modulation circuit and are not routed through the baseband section of the R&S®SMW200A.

| | | |
|---|---|---|
| Input mode | | single-ended |
| | with R&S®SMW-K739 option, for RF path A | |
| | R&S®SMW-B1003, R&S®SMW-B1006, R&S®SMW-B1007, R&S®SMW-B1012, R&S®SMW-B1020, R&S®SMW-B1044, R&S®SMW-B1044N | single-ended or differential |
| | R&S®SMW-B1031, R&S®SMW-B1040, R&S®SMW-B1040N | |
| | f ≤ 19.5 GHz | single-ended or differential |
| | f > 19.5 GHz | single-ended |
| Connector types | I, Q on front panel (for each installed RF path A or B) | BNC female |
| Input impedance | | 50 Ω (nom.) |
| VSWR | with R&S®SMW-B1003, R&S®SMW-B2003, R&S®SMW-B1006, R&S®SMW-B2006, R&S®SMW-B1007, R&S®SMW-B2007, R&S®SMW-B1012, R&S®SMW-B2012, R&S®SMW-B1020, R&S®SMW-B2020 frequency options | |
| | up to 200 MHz | < 1.2 (typ.) |
| | 200 MHz to 500 MHz | < 1.35 (typ.) |
| | 500 MHz to 1 GHz | < 1.45 (typ.) |
| | with R&S®SMW-B1031, R&S®SMW-B2031, R&S®SMW-B1040 frequency options | |
| | up to 200 MHz, f ≤ 20 GHz | < 1.2 (typ.) |
| | up to 200 MHz, f > 20 GHz | < 1.35 (typ.) |
| | 200 MHz to 500 MHz | < 1.35 (typ.) |
| | 500 MHz to 1 GHz | < 1.45 (typ.) |
| | with R&S®SMW-B1040N frequency option | |
| | up to 200 MHz, f ≤ 20 GHz | < 1.2 (typ.) |
| | 200 MHz to 500 MHz, f ≤ 20 GHz | < 1.35 (typ.) |
| | 500 MHz to 1 GHz, f ≤ 20 GHz | < 1.45 (typ.) |
| | up to 275 MHz, f > 20 GHz | < 1.35 (typ.) |
| | with R&S®SMW-B1044, R&S®SMW-B2044, R&S®SMW-B1056, R&S®SMW-B1067 frequency options | |
| | up to 200 MHz, f ≤ 20 GHz | < 1.2 (typ.) |
| | up to 200 MHz, f > 20 GHz | < 1.35 (typ.) |
| | 200 MHz to 500 MHz | < 1.35 (typ.) |
| | 500 MHz to 1 GHz | < 1.5 (typ.) |
| | with R&S®SMW-B1044N, R&S®SMW-B2044N, R&S®SMW-B1056N, R&S®SMW-B1067N frequency options | |
| | up to 200 MHz, f ≤ 20 GHz | < 1.2 (typ.) |
| | 200 MHz to 500 MHz, f ≤ 20 GHz | < 1.35 (typ.) |
| | 500 MHz to 1 GHz, f ≤ 20 GHz | < 1.5 (typ.) |
| | up to 275 MHz, f > 20 GHz | < 1.35 (typ.) |
| Nominal input voltage for full-scale input | | $\sqrt{V_i^2 + V_q^2} = 0.5\ V$ |
| Damage voltage | | ±2 V |

# Standard baseband characteristics

## Internal baseband characteristics (R&S®SMW-B13 or R&S®SMW-B13T option)

The R&S®SMW-B13 option provides one I/Q path to the RF section (to RF path A) as well as one analog I/Q output (i.e. one I and one Q output connector). The R&S®SMW-B13T option provides two I/Q paths to the RF section (if two RF paths are installed) as well as two analog I/Q outputs. With two RF paths, R&S®SMW-B13T is required.

Either R&S®SMW-B13 or R&S®SMW-B13T must be installed on the instrument.

| | | |
|---|---|---|
| **D/A converter** | | |
| Data rate | | 200 MHz |
| Resolution | | 16 bit |
| Sample rate | | 800 MHz (internal interpolation · 4) |
| **Aliasing filter** | with amplitude, group delay and $S_i$ correction | |
| Bandwidth, rolloff to –0.1 dB | | 80 MHz |
| SFDR (excluding harmonics) | up to 10 MHz | < –80 dBc |
| | up to 80 MHz | < –73 dBc |
| **I/Q impairments (digital baseband)** | These impairments are set in the digital baseband section of the R&S®SMW200A. They act on the I/Q signal sent to the I/Q modulator/RF section, as well as on the I/Q signals at the analog or digital I/Q outputs (of the respective path). | |
| Carrier leakage | | |
| Setting range | | –10 % to +10 % |
| Setting resolution | | 0.01 % |
| I ≠ Q (imbalance) | | |
| Setting range | | –1 dB to +1 dB |
| Setting resolution | | 0.001 dB |
| Quadrature offset | | |
| Setting range | | –10° to +10° |
| Setting resolution | | 0.01° |

## Analog I/Q outputs (R&S®SMW-B13 or R&S®SMW-B13T option)

| | | |
|---|---|---|
| Number of I/Q outputs | with R&S®SMW-B13 option | 1 |
| | with R&S®SMW-B13T option | 2 |
| Output impedance | | 50 Ω |
| Output voltage | EMF (output voltage depends on set modulation signal) | 1 V ($V_p$) |
| Offset | EMF | < 1 mV |
| Frequency response [8] | at $R_L$ = 50 Ω | |
| Magnitude | up to 10 MHz | 0.02 dB (meas.) |
| | up to 80 MHz | 0.03 dB (meas.) |
| I/Q balance [9] | at $R_L$ = 50 Ω | |
| Magnitude | up to 10 MHz | 0.01 dB (meas.) |
| | up to 80 MHz | 0.02 dB (meas.) |
| Spectral purity | at $R_L$ = 50 Ω | |
| SFDR (sine wave) | up to 2 MHz | > 70 dB |
| | up to 20 MHz | 60 dB (meas.) |
| Wideband noise | 10 MHz sine wave at 1 MHz offset | –155 dBc (typ.) |

[8] "Optimize internal I/Q impairments for RF output" switched off.

[9] Value applies after 1 hour warm-up time and recalibration for 4 hours of operation and temperature variations of less than +5 °C.

# Differential analog I/Q outputs (R&S®SMW-K16 option)

This option can be installed once if the instrument is equipped with the R&S®SMW-B13 option. If the instrument is equipped with the R&S®SMW-B13T option, differential analog I/Q outputs can be used either on signal path A or B with one R&S®SMW-K16 option. For differential analog I/Q outputs to be used on signal paths A and B simultaneously, two R&S®SMW-K16 must be installed.

| | | |
|---|---|---|
| Output impedance | | |
| Single-ended | | 50 Ω |
| Differential | | 100 Ω |
| Output voltage ($V_{out}$) | output voltage depends on set modulation signal | |
| Single-ended | EMF | 0.02 V to 2 V ($V_p$) |
| Resolution | | 1 mV |
| Differential | EMF | 0.04 V to 4 V ($V_{pp}$) |
| Resolution | | 2 mV |
| Bias voltage ($V_{bias}$) | | |
| Single-ended | EMF | –4 V to (+4 V – $V_{out}$) |
| Differential | EMF | (–4 V + $V_{out}$ / 2 + $V_{offset}$ / 2) to<br>(+4 V – $V_{out}$ / 2 – $V_{offset}$ / 2) |
| Resolution | | 2 mV |
| Uncertainty | | 1 % + 4 mV |
| Offset voltage ($V_{offset}$) | | |
| Differential | EMF | (–4 V + $V_{out}$ / 2 + $V_{bias}$ / 2) to<br>(+4 V – $V_{out}$ / 2 – $V_{bias}$ / 2) |
| Resolution | | 0.1 mV |
| Uncertainty | | 1 % + 0.1 % · bias voltage + 1 mV |
| Differential signal balance | at $R_L$ = 50 Ω, output voltage > 0.5 V ($V_p$) | |
| Magnitude | up to 10 MHz | < 0.2 dB, 0.05 dB (meas.) |
| | up to 80 MHz | 0.2 dB (meas.) |
| Frequency response [10] | at $R_L$ = 50 Ω, output voltage > 0.5 V ($V_p$) | |
| Magnitude | up to 10 MHz | 0.02 dB (meas.) |
| | up to 80 MHz | 0.03 dB (meas.) |

[10] "Optimize internal I/Q impairments for RF output" switched off.

# Digital baseband inputs/outputs

Depending on the installed software and hardware options, the R&S®SMW200A is able to receive digital baseband signals and to output digital baseband signals. The digital I/Q input/output can be used for the lossless connection of the R&S®SMW200A to the digital I/Q input/output of other Rohde & Schwarz instruments (for example the R&S®CMW500 wideband radio communication tester in fading applications).

Digital baseband outputs: At least one R&S®SMW-K18 option must be installed. This option can be installed once if the instrument is equipped with the R&S®SMW-B13 option. If the instrument is equipped with the R&S®SMW-B13T option, digital baseband outputs can be used either on signal path A or B with one R&S®SMW-K18 option. For digital baseband outputs to be used on signal paths A and B simultaneously, two R&S®SMW-K18 must be installed. Furthermore, to enable two or more digital baseband outputs in MIMO modes, two R&S®SMW-K18 must be installed.

| | | |
|---|---|---|
| Signal outputs | | analog and digital, digital only |
| | with 2 × R&S®SMW-K18 installed | analog and digital, digital only, digital only multiplexed |
| Digital only | The streams are output via the digital I/Q outputs only; analog I/Q outputs are not available. External modulation signals can be output via the RF outputs (I/Q modulation mode: external wideband I/Q).<br>Note: System configurations with more than 4 streams are not available in this mode. | |
| | with R&S®SMW-K551 installed | The instrument runs at reduced speed depending on the device connected to the digital I/Q output (slow I/Q). |
| Digital only multiplexed | The streams are output via BBMM1 and BBMM2 in multiplexed mode, i.e. up to 4 streams are output via a single digital output. Analog I/Q outputs are not available. External modulation signals can be output via the RF outputs (I/Q modulation mode: external wideband I/Q).<br>Note: All system configurations available on the instrument are available in this mode. | |
| | with R&S®SMW-K551 installed | The instrument runs at reduced speed depending on the device connected to the digital I/Q output (slow I/Q). |
| Analog and digital | The instrument runs in regular operating mode, both analog and digital outputs are available, slow I/Q is not possible. | |
| Number of digital outputs | | according to selected system configuration (see table below) |
| Number of streams per digital output | digital only | 1 |
| | digital only multiplexed | 1 to 4 |
| Bandwidth | general | according to selected system configuration (see section Multichannel, MIMO, fading and noise, specifications for R&S®SMW-K74, -K75, -K76 options) |
| | 4 streams mapped to one digital output | 40 MHz |

**The following table gives an overview of which software and hardware options are required for which digital I/Q connectivity:**

| **Minimum required R&S®SMW200A options** | **Digital I/Q inputs** | **Digital I/Q outputs** |
|---|---|---|
| R&S®SMW-B13 + 1 × R&S®SMW-K18 | – | 1 |
| R&S®SMW-B13T + 2 × R&S®SMW-K18 | – | 2 |
| 1 × R&S®SMW-B10 | 1 | – |
| 1 × R&S®SMW-B10 + R&S®SMW-B13 + 1 × R&S®SMW-K18 | 1 | 1 |
| 1 × R&S®SMW-B10 + R&S®SMW-B13T + 2 × R&S®SMW-K18 | 1 | 2 |
| 2 × R&S®SMW-B10 | 2 | – |
| 2 × R&S®SMW-B10 + R&S®SMW-B13 + 1 × R&S®SMW-K18 | 2 | 1 |
| 2 × R&S®SMW-B10 + R&S®SMW-B13T + 2 × R&S®SMW-K18 | 2 | 2 |

| 2 × R&S®SMW-B10 + 4 × R&S®SMW-B14 + R&S®SMW-B13T + 2 × R&S®SMW-K18 | depends on selected system configuration (for required additional options for specific system configurations, see section Multichannel, MIMO, fading and noise, specifications for R&S®SMW-K74, -K75, -K76 options) | |
|---|---|---|
| 3x1 | 3 | 1 |
| 3x2 | 3 | 2 |
| 3x3 | 3 | 3 |
| 1x3 | 1 | 3 |
| 2x3 | 2 | 3 |
| 4x1 | 4 | 1 |
| 4x2 | 4 | 2 |
| 4x3 | 4 | 3 |
| 4x4 | 4 | 4 |
| 1x4 | 1 | 4 |
| 2x4 | 2 | 4 |
| 3x4 | 3 | 4 |
| 8x1 | – | 1 |
| 8x2 | – | 2 |
| 8x4 | – | 4 |
| 8x8 | – | subset 1: 4,<br>subset 2: 4 |
| 1x8 | 1 | 6 |
| 2x8 | 2 | 6 |
| 4x8 | 2 | 6 |
| 3x1x1 | 3 | 3 |
| 4x1x1 | 4 | 4 |
| 5x1x1 | – | 3 |
| 6x1x1 | – | 4 |
| 7x1x1 | – | 5 |
| 8x1x1 | – | 6 |
| 2x1x2 | 2 | 4 |
| 2x2x1 | 4 | 2 |
| 2x2x2 | 4 | 4 |
| 2x1x3, 2x2x3 | 2 | 5 |
| 2x1x4, 2x2x4 | 2 | 6 |
| 2x3x1, 2x4x1 | 2 | 2 |
| 2x3x2, 2x4x2 | 2 | 4 |
| 2x3x3, 2x4x3 | – | 5 |
| 2x3x4, 2x4x4 | – | 6 |
| 3x2x1 | 2 | 3 |
| 3x1x2, 3x2x2 | 2 | 4 |
| 4x2x1 | 2 | 4 |
| 4x1x2, 4x2x2 | 2 | 6 |

**Output parameters**

| | | |
|---|---|---|
| Interface | | |
| Standard | | in line with R&S®Digital I/Q Interface PAD-R [11], I/Q data and control signals, data and interface clock |
| Level | | LVDS |
| Connector | | 26-pin MDR |
| I/Q sample rate | With source "user-defined", the sample rate must be entered via the parameter "sample rate", no I/Q data clock being necessary. With source "digital I/Q out", the sample rate will be estimated on the basis of the applied I/Q data clock. | |
| Source | | user-defined, digital I/Q out |
| Sample rate | maximum sample rate depends on connected receiving device | 400 Hz to 200 MHz |
| Resolution (user-defined) | | 0.001 Hz |
| Frequency uncertainty (user-defined) | | < (5 · $10^{-14}$ + relative deviation of reference frequency) · sample rate (nom.) |
| I/Q data | | |
| Resolution | | up to 18 bit |
| Logic format | | two's complement |
| Physical signal level | | |
| Setting range | | 0 to –60 dBFS |
| Setting resolution | | 0.01 dBFS |
| Bandwidth (RF) | sample rate = 200 MHz (no interpolation, user-defined) | 160 MHz |
| | sample rate < 200 MHz (interpolation) | 0.8 · sample rate |
| Control signals | markers | 3 |

**Input parameters**

| | | |
|---|---|---|
| Input level | peak level | |
| Peak level | | |
| Setting range | | –60 dB to +3 dB, referenced to full scale |
| Setting resolution | | 0.01 dB |
| Crest factor | | |
| Setting range | | 0 dB to +30 dB |
| Setting resolution | | 0.01 dB |
| Adjust level function | | automatically determines peak level and crest factor of input signal |
| I/Q swap | I and Q signals swapped | on/off |
| Interface | | |
| Standard | | in line with R&S®Digital I/Q Interface PAD-R [11], I/Q data and control signals, data and interface clock |
| Level | | LVDS |
| Connector | | 26-pin MDR |
| I/Q sample rate | With source "user-defined", the sample rate must be entered via the parameter "sample rate", no I/Q data clock being necessary. With source "digital I/Q in", the sample rate will be estimated on the basis of the applied I/Q data clock. | |
| Source | | user-defined, digital I/Q in |
| Sample rate | maximum sample rate depends on connected transmitting device | 400 Hz to 200 MHz |
| Resolution (user-defined) | | 0.001 Hz |
| Frequency uncertainty (user-defined) | | < (5 · $10^{-14}$ + relative deviation of reference frequency) · sample rate (nom.) |
| I/Q data | | |
| Resolution | | 18 bit |
| Logic format | | two's complement |
| Bandwidth (RF) | sample rate = 200 MHz (no interpolation, user-defined) | 160 MHz |
| | sample rate < 200 MHz (interpolation) | 0.8 · sample rate |
| Control signals | markers | 3 |

[11] R&S®Digital I/Q Interface PAD-R is a Rohde & Schwarz internal company guideline for the transmission of digital I/Q data. It is supported by a wide range of signal generators, signal analyzers and radio communication testers.

# Standard baseband generator (R&S®SMW-B10 option) – arbitrary waveform mode

One or two R&S®SMW-B10 can be installed. Their I/Q signals can be assigned a frequency offset and/or be added in the digital domain with settable level ratio.

Prerequisite: Either R&S®SMW-B13 or R&S®SMW-B13T must be installed.

| | | |
|---|---|---|
| Waveform length | | 1 sample to 64 Msample in one-sample steps |
| | with R&S®SMW-K511 option (memory extension) | 1 sample to 512 Msample in one-sample steps |
| | with R&S®SMW-K512 option (memory extension) | 1 sample to 1 Gsample in one-sample steps |
| Nonvolatile memory | | hard disk |
| Sample resolution | equivalent to D/A converter | 16 bit |
| Sample rate | | 400 Hz to 150 MHz |
| | with R&S®SMW-K522 option | 400 Hz to 200 MHz |
| Sample frequency error | internal clock | < ($5 \cdot 10^{-14}$ + relative deviation of reference frequency) · sample rate (nom.) |
| Sample clock source | | internal, external |
| Bandwidth (RF) | using the maximum sample rate, rolloff to –0.1 dB | 120 MHz |
| | using a reduced sample rate, rolloff to –0.1 dB (The waveform is automatically interpolated to the internal sample rate of 150 MHz.) | 0.8 · sample rate |
| Bandwidth (RF) with R&S®SMW-K522 option | using the maximum sample rate, rolloff to –0.1 dB | 160 MHz |
| | using a reduced sample rate, rolloff to –0.1 dB (The waveform is automatically interpolated to the internal sample rate of 200 MHz.) | 0.8 · sample rate |
| **Frequency offset** | The frequency offset can be used to shift the center frequency of the wanted baseband signal. The restrictions caused by the modulation bandwidth still apply. | |
| Frequency offset setting range | | –60 MHz to +60 MHz |
| | with R&S®SMW-K522 option | –80 MHz to +80 MHz |
| Frequency offset setting resolution | | 0.01 Hz |
| Frequency offset error | | < $7 \cdot 10^{-7}$ Hz + relative deviation of reference frequency · frequency offset (nom.) |
| **Triggering** | A trigger event restarts I/Q generation. The I/Q signal is then synchronous with the trigger (with a specific timing jitter). | |
| Trigger source | event triggered via GUI or remote command | internal |
| | event triggered by other baseband generator | internal (baseband A/B) |
| | event triggered by external trigger signal | external |
| Trigger modes | The signal is generated continuously. | auto |
| | The signal is generated continuously. A trigger event causes a restart. | retrig |
| | The signal is started only when a trigger event occurs. Subsequent trigger events are ignored. | armed auto |
| | The signal is started only when a trigger event occurs. Every subsequent trigger event causes a restart. | armed retrig |
| | The signal is started only when a trigger event occurs. The signal is generated once. | single |

| | | |
|---|---|---|
| External trigger input | | selectable from USER 1, 2, 3 on front panel or T/M/C 1, T/M 2, T/M 3 of respective baseband generator on rear panel |
| Connector type | USER 1, 2, 3 on front panel, T/M/C 1, T/M 2, T/M 3 of respective baseband generator on rear panel | BNC female |
| Input level | | 0 V to 3 V (nom.) |
| Threshold | USER 1, 2, 3 | settable from 0.1 V to 2.0 V |
| | T/M/C 1, T/M 2, T/M 3 | settable from 0.3 V to 2.0 V |
| Input damage voltage | | –0.5 V; 3.8 V |
| Input impedance | selectable | 1 kΩ or 50 Ω (nom.) |
| Trigger jitter | | ±2.5 ns |
| External trigger delay | | |
| Setting range | | 0 sample to $2.147 \cdot 10^9$ sample |
| Setting resolution | without R&S®SMW-B14 option | 5 ns |
| | with R&S®SMW-B14 option | 1/fading clock rate (= 5 ns or 10 ns) |
| External trigger inhibit | | |
| Setting range | | 0 sample to (21.47 s · sample rate) sample |
| Setting resolution | | 1 sample |
| External trigger pulse width | | > 7.5 ns |
| **Marker signals** | | |
| Number of marker signals | | 3 |
| Operating modes | | unchanged, restart, pulse, pattern, ratio |
| Marker outputs | | selectable from USER 1, 2, 3 on front panel or T/M/C 1, T/M 2, T/M 3 of respective baseband generator on rear panel |
| Connector type | USER 1, 2, 3 on front panel, T/M/C 1, T/M 2, T/M 3 of respective baseband generator on rear panel | BNC female |
| Level | | LVTTL |
| Marker delay | | |
| Setting range | | 0 sample to (waveform length – 1) sample |
| Setting resolution | | 1 sample |
| Marker duration | | |
| Minimum value | | 1 sample |
| **Multisegment waveform mode** | | |
| Number of segments | | 1 to 1024 |
| Changeover modes | | GUI, remote control, external trigger |
| Extended trigger modes | | same segment, next segment, next segment seamless, sequencer |
| Changeover time | at 50 MHz clock rate, external trigger, without clock change | 20 µs (meas.) |
| Seamless changeover | | output up to end of current segment, followed by changeover to next segment |
| Sequencer play list length | | max. 1024 |
| Sequencer segment repetitions | | max. 1 048 575 |
| **Multicarrier waveform mode** | | |
| Number of carriers | | max. 512 |
| Total RF bandwidth | | max. 120 MHz |
| | with R&S®SMW-K522 option | max. 160 MHz |
| Carrier spacing | | |
| Setting range | | depends on number of carriers and signal RF bandwidth |
| Setting resolution | | 0.01 Hz |
| Crest factor modes | | maximize, minimize, off |
| Signal period modes | | longest file, shortest file, user (max. 1 s) |
| Single carrier gain | | |
| Setting range | | –80 dB to 0 dB |
| Setting resolution | | 0.01 dB |
| Single carrier start phase | | |
| Setting range | | 0° to 360° |
| Setting resolution | | 0.01° |
| Single carrier delay | | |
| Setting range | | 0 s to 1 s |
| Setting resolution | | 1 ns |

# Extended sequencing (R&S®SMW-K501 option)

The R&S®SMW-K501 option enables waveform sequencing and real-time signal generation for ultra long playtime. Waveform variations such as offset frequency, amplitude and phase are calculated in real-time and do not require precalculated waveforms. The R&S®SMW-K501 option offers two different modes:

In user mode, all sequences are based on user-defined XML based lists with up to 5 levels of nested loops. Special list types for frequency changes over time and amplitude changes over time are also available.

In pulse sequencer mode, the extended sequencing is controlled by the external R&S®Pulse Sequencer Software, a powerful software tool for simulating complex sequencing scenarios.

At least one R&S®SMW-B10 option (standard baseband generator) must be installed. If two R&S®SMW-B10 options are installed (signal paths A and B), extended sequencing can be used either on signal path A or B with one R&S®SMW-K501 option. For extended sequencing to be used simultaneously on signal paths A and B, two R&S®SMW-K501 options must be installed.

| | | |
|---|---|---|
| **General settings** | | |
| Modes | sequencing via user-defined XML lists | user |
| | controlled by external R&S®Pulse Sequencer Software (R&S®SMW-K300 required) | pulse sequencer |
| **User mode** | | |
| List types | Sequencing lists define an arbitrary number of entries that represent either a waveform or a sublist with further entries. | sequencing list |
| | Time lists store a list of different off times between waveform segments. They can be referenced in sequence entries. | time list |
| | Attenuation lists define the power level of the output signal over time. | attenuation list |
| | Hopping lists define frequency offsets of the output signal over time. | hopping list |
| Sequence | | link to a sequencing list XML file |
| Attenuation over time | | link to an attenuation list XML file |
| Hopping | | link to a hopping list XML file |
| **Pulse sequencer mode** | see R&S®Pulse Sequencer Software data sheet (PD 3607.1388.22) | |
| **Waveform segments** | | |
| Segment length | | 1 sample to 64 Msample |
| Minimum memory allocation | | 64 sample |
| Maximum number of segments | | depends on segment lengths and baseband generator ARB memory size |
| **Waveform sequences** | | |
| Sequencing | | continuously repeating |
| Maximum number of segments per sequence | | depends on segment lengths and baseband generator ARB memory size |
| Maximum number of segment repetitions | | $2^{32}$ |
| **Clock** | | see section Standard baseband generator (R&S®SMW-B10 option) – arbitrary waveform mode |
| **Triggering** | | see section Standard baseband generator (R&S®SMW-B10 option) – arbitrary waveform mode |
| **Marker signals** | | |
| Number of marker signals | | 3 |
| Operating modes | marker at every start of sequence | restart |
| | marker 1 embedded in waveform | unchanged |
| | XML-defined marker for each entry | entry |
| Marker outputs | | see section Standard baseband generator (R&S®SMW-B10 option) – arbitrary waveform mode |
| Marker delay | | see section Standard baseband generator (R&S®SMW-B10 option) – arbitrary waveform mode |
| Marker duration | | see section Standard baseband generator (R&S®SMW-B10 option) – arbitrary waveform mode |

# Standard baseband generator (R&S®SMW-B10 option) – real-time operation (custom digital modulation)

One or two R&S®SMW-B10 can be installed. The I/Q signals can be assigned a frequency offset and/or be added in the digital domain with settable level ratio.

Prerequisite: Either R&S®SMW-B13 or R&S®SMW-B13T must be installed.

| **Types of modulation** | | |
|---|---|---|
| ASK | | |
| Modulation index | | 0 % to 100 % |
| Setting resolution | | 0.1 % |
| FSK | | 2FSK, 4FSK, MSK |
| Deviation | | 1 Hz to 15 · $f_{sym}$ |
| Maximum | | 40 MHz |
| Setting resolution | | 0.1 Hz |
| Variable FSK | | 4FSK, 8FSK, 16FSK |
| Deviations | | –15 · $f_{sym}$ to +15 · $f_{sym}$ |
| Maximum | | 40 MHz |
| Setting resolution | | 0.1 Hz |
| PSK | | BPSK, QPSK, QPSK 45° offset, QPSK EDGE, AQPSK, OQPSK, π/4-QPSK, π/2-DBPSK, π/4-DQPSK, π/8-D8PSK, 8PSK, 8PSK EDGE |
| QAM | | 16QAM, 32QAM, 64QAM, 128QAM, 256QAM, 1024QAM, 4096QAM, π/4-16QAM, –π/4-32QAM (for EDGE+) |
| APSK | | 16APSK, 32APSK |
| Gamma/gamma1 | 16APSK | 3.15 (DVB-S2 2/3), 2.85 (DVB-S2 3/4), 2.75 (DVB-S2 4/5), 2.70 (DVB-S2 5/6), 2.60 (DVB-S2 8/9), 2.57 (DVB-S2 9/10) |
| | 32APSK | 2.84 (DVB-S2 3/4), 2.72 (DVB-S2 4/5), 2.64 (DVB-S2 5/6), 2.54 (DVB-S2 8/9), 2.53 (DVB-S2 9/10) |
| **Symbol rate** | If an external clock is used, the applied data rate may deviate from the set clock rate by ±2 %. | |
| Operating mode | | internal, external |
| Setting range | ASK, PSK, APSK and QAM | 50 Hz to 100 MHz |
| | FSK | 50 Hz to 100 MHz |
| Setting resolution | | 0.001 Hz |
| Frequency uncertainty (internal) | | < (5 · $10^{-14}$ + relative deviation of reference frequency) · symbol rate (nom.) |
| External clock | | symbol |
| External clock rate | | max. 200 MHz |
| External clock input | | selectable from USER 1, 2, 3 on front panel or T/M/C 1 of respective baseband generator on rear panel |
| Connector type | USER 1, 2, 3 on front panel<br>T/M/C 1 of respective baseband generator on rear panel | BNC female |
| Input level | | 0 V to 3 V (nom.) |
| Threshold | | settable from 0.1 V to 2.0 V |
| Input impedance | selectable | 1 kΩ or 50 Ω (nom.) |
| **Baseband filter** | Any filter can be used with any type of modulation. The bandwidth of the modulation signal is max. 100 MHz; the signal is clipped if the bandwidth is exceeded. | |
| Filter types | | cosine, root cosine, Gaussian, cdmaOne, cdmaOne + equalizer, cdmaOne 705 kHz, cdmaOne 705 kHz + equalizer, CDMA2000® 3x, APCO25 C4FM, EDGE narrow pulse, EDGE wide pulse rectangular, split phase, EUTRA/LTE |

| | | |
|---|---|---|
| Filter parameter | | |
| Setting range | cosine, root cosine (filter parameter $\alpha$) | 0.05 to 1.00 |
| | Gaussian (filter parameter B × T) | 0.15 to 2.50 |
| | split phase (filter parameter B × T) | 0.15 to 2.50 |
| Setting resolution | | 0.01 |
| **Coding** | Not all coding methods can be used with every type of modulation. | off, differential, diff. phase, diff. + Gray, Gray, GSM, NADC, PDC, PHS, TETRA, APCO25 (PSK), APCO25 (8PSK), PWT, TFTS, INMARSAT, VDL, APCO25(FSK), ICO, CDMA2000®, WCDMA |
| **Data sources** | | PRBS: 9, 11, 15, 16, 20, 21, 23, All 0, All 1, pattern (length: 1 bit to 64 bit), data lists, external |
| Data lists | | |
| Output memory | | 8 bit to 2 Gbit |
| Nonvolatile memory | | hard disk |
| External data | | |
| Data bit rate | | 50 bps to 100 Mbps |
| Symbol clock slope | | positive or negative |
| Bit clock slope | | positive or negative |
| Bit order | | LSB first or MSB first |
| External data input | | T/M 2 of respective baseband generator on rear panel |
| Connector type | T/M 2 of respective baseband generator on rear panel | BNC female |
| Input level | | 0 V to 3 V (nom.) |
| Threshold | | settable from 0.3 V to 2.0 V |
| Input impedance | selectable | 1 kΩ or 50 Ω (nom.) |
| **Predefined settings** | modulation, filter, symbol rate and coding (if available) in line with standard | |
| Standards | | APCO, Bluetooth®, DECT, ETC, GSM, GSM EDGE, NADC, PDC, PHS, TETRA, WCDMA 3GPP, TD-SCDMA, CDMA2000® forward link, CDMA2000® reverse link, WorldSpace, CW in baseband |
| **Frequency offset** | The frequency offset can be used to shift the center frequency of the wanted baseband signal. The restrictions caused by the modulation bandwidth still apply. | |
| Frequency offset setting range | | –60 MHz to +60 MHz |
| | with R&S®SMW-K522 option | –80 MHz to +80 MHz |
| Frequency offset setting resolution | | 0.01 Hz |
| Frequency offset error | | $< 7 \cdot 10^{-7}$ Hz + relative deviation of reference frequency · frequency offset (nom.) |
| **Triggering** | | |
| Trigger source | event triggered via GUI or remote command | internal |
| | event triggered by other baseband generator | internal (baseband A/B) |
| | event triggered by external trigger signal | external |
| Trigger modes | The signal is generated continuously. | auto |
| | The signal is generated continuously. A trigger event causes a restart. | retrig |
| | The signal is started only when a trigger event occurs. Subsequent trigger events are ignored. | armed auto |
| | The signal is started only when a trigger event occurs. Every subsequent trigger event causes a restart. | armed retrig |
| | The signal is started only when a trigger event occurs. The signal is generated once. | single |

| | | |
|---|---|---|
| External trigger input | | selectable from USER 1, 2, 3 on front panel or T/M/C 1, T/M 2, T/M 3 of respective baseband generator on rear panel |
| Connector type | USER 1, 2, 3 on front panel, T/M/C 1, T/M 2, T/M 3 of respective baseband generator on rear panel | BNC female |
| Input level | | 0 V to 3 V (nom.) |
| Threshold | USER 1, 2, 3 | settable from 0.1 V to 2.0 V |
| | T/M/C 1, T/M 2, T/M 3 | settable from 0.3 V to 2.0 V |
| Input damage voltage | | –0.5 V, 3.8 V |
| Input impedance | selectable | 1 kΩ or 50 Ω (nom.) |
| Trigger jitter | | ±2.5 ns |
| External trigger delay | | |
| Setting range | | 0 symbol to $2.147 \cdot 10^9$ symbol |
| Setting resolution | without R&S®SMW-B14 option | 5 ns |
| | with R&S®SMW-B14 option | 1 / fading clock rate (= 5 ns or 10 ns) |
| External trigger inhibit | | |
| Setting range | | 0 symbol to (21.47 s · symbol rate) symbol |
| Setting resolution | | 1 symbol |
| External trigger pulse width | | > 7.5 ns |
| **Marker signals** | | |
| Number of marker signals | | 3 |
| Operating modes | | control list, pulse, pattern, ratio |
| Marker outputs | | selectable from USER 1, 2, 3 on front panel or T/M/C 1, T/M 2, T/M 3 of respective baseband generator on rear panel |
| Connector type | USER 1, 2, 3 on front panel, T/M/C 1, T/M 2, T/M 3 of respective baseband generator on rear panel | BNC female |
| Level | | LVTTL |
| Marker delay | | |
| Setting range | | 0 symbol to $(2^{24} – 1)$ symbol |
| Setting resolution | | 1 symbol |
| Marker duration | | |
| Minimum value | | 1 sample |

# Baseband generator for GNSS with high dynamics (R&S®SMW-B10F option)

This baseband generator enables high dynamics with GNSS standards. For details see the GNSS simulation for Rohde & Schwarz vector signal generators data sheet (PD 3607.6896.22). Otherwise, the specifications of the standard baseband generator (R&S®SMW-B10 option) also apply for the R&S®SMW-B10F option. Enhancements of the R&S®SMW-B10 option and software options that run on the R&S®SMW-B10 option also work with the R&S®SMW-B10F option.

Note that R&S®SMW-B10F and R&S®SMW-B10 cannot be mixed, i.e. only the following configurations can be installed:

- 1 × R&S®SMW-B10
- 2 × R&S®SMW-B10
- 1 × R&S®SMW-B10F
- 2 × R&S®SMW-B10F

# Wideband baseband characteristics

## Internal baseband characteristics (R&S®SMW-B13XT option)

The R&S®SMW-B13XT provides I/Q paths that can be routed to the installed RF paths or to the analog I/Q outputs. Up to two signals can be output at the same time, for example:

- Signal A is routed to RF path A, signal B to RF path B
- Signal A is routed to RF path A, signal B to analog I/Q out 1

| | | |
|---|---|---|
| **D/A converter** | | |
| Data rate | | 2400 MHz |
| Resolution | | 14 bit |
| Sample rate | | 4800 MHz (internal interpolation · 2) |
| **Aliasing filter** | with amplitude, group delay and $S_i$ correction | |
| Bandwidth, rolloff to –0.1 dB | | 1000 MHz |
| SFDR overall | | > 55 dB |
| **I/Q impairments (digital baseband)** | These impairments are set in the digital baseband section of the R&S®SMW200A. They act on the I/Q signal sent to the I/Q modulator/RF section, as well as on the I/Q signals at the analog or digital I/Q outputs (of the respective path). | |
| Carrier leakage | | |
| Setting range | | –10 % to +10 % |
| Setting resolution | | 0.01 % |
| I ≠ Q (imbalance) | | |
| Setting range | | –1 dB to +1 dB |
| Setting resolution | | 0.01 dB |
| Quadrature offset | | |
| Setting range | | –10° to +10° |
| Setting resolution | | 0.01° |

## Wideband analog I/Q outputs (R&S®SMW-B13XT option)

| | | |
|---|---|---|
| Number of I/Q outputs | single-ended | 2 |
| Output impedance | | 50 Ω |
| Output voltage | EMF (output voltage depends on set modulation signal) | 1 V ($V_p$) |
| Offset | EMF | < 1 mV |
| Frequency response [12] | at $R_L$ = 50 Ω | |
| Magnitude | up to 100 MHz | 0.1 dB (meas.) |
| | up to 1000 MHz | 0.2 dB (meas.) |
| I/Q balance [13] | at $R_L$ = 50 Ω | |
| Magnitude | up to 100 MHz | 0.1 dB (meas.) |
| | up to 1000 MHz | 0.1 dB (meas.) |
| Spectral purity | at $R_L$ = 50 Ω | |
| SFDR (sine wave) | 100 MHz | > 60 dB |
| | up to 1000 MHz | 55 dB (meas.) |
| Wideband noise | 10 MHz sine wave at 1 MHz offset | –155 dBc (typ.) |

## Wideband differential analog I/Q outputs (R&S®SMW-K17 option)

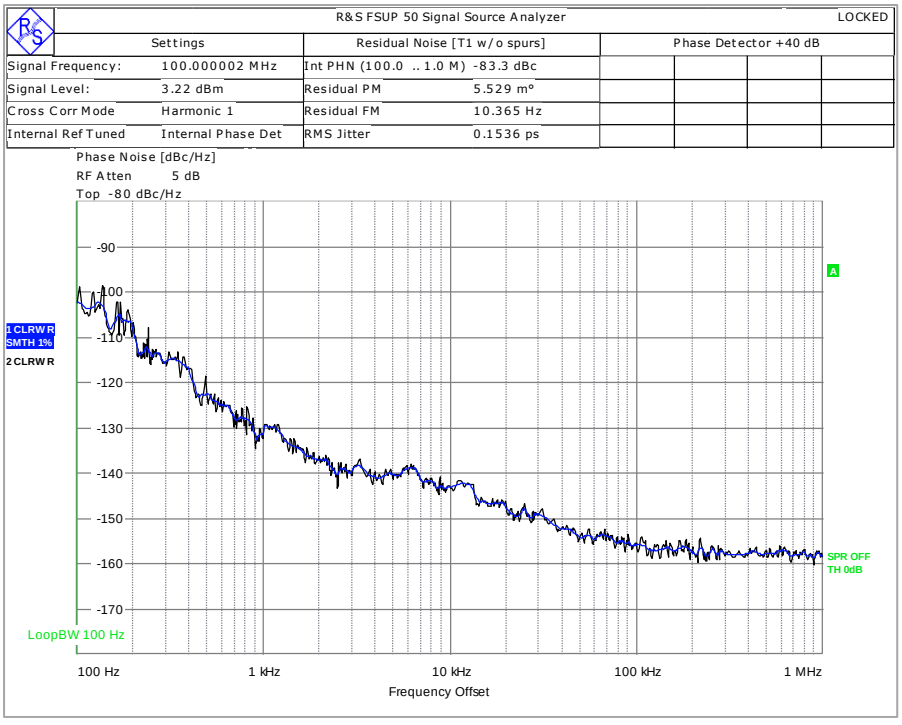
This option can be installed once if the instrument is equipped with the R&S®SMW-B13XT option. Differential analog I/Q outputs can be used on signal path A only. If the differential output mode is activated, analog I/Q outputs for signal path B are not available.

| | | |
|---|---|---|
| Output impedance | | |
| Single-ended | | 50 Ω |
| Differential | | 100 Ω |
| Output voltage ($V_{out}$) | output voltage depends on set modulation signal | |
| Single-ended | EMF | 0.02 V to 1 V ($V_p$) |
| Resolution | | 0.1 mV |
| Differential | EMF | 0.04 V to 2 V ($V_{pp}$) |
| Resolution | | 0.1 mV |

[12] "Optimize internal I/Q impairments for RF output" switched off.

[13] Value applies after 1 hour warm-up time and recalibration for 4 hours of operation and temperature variations of less than +5 °C.

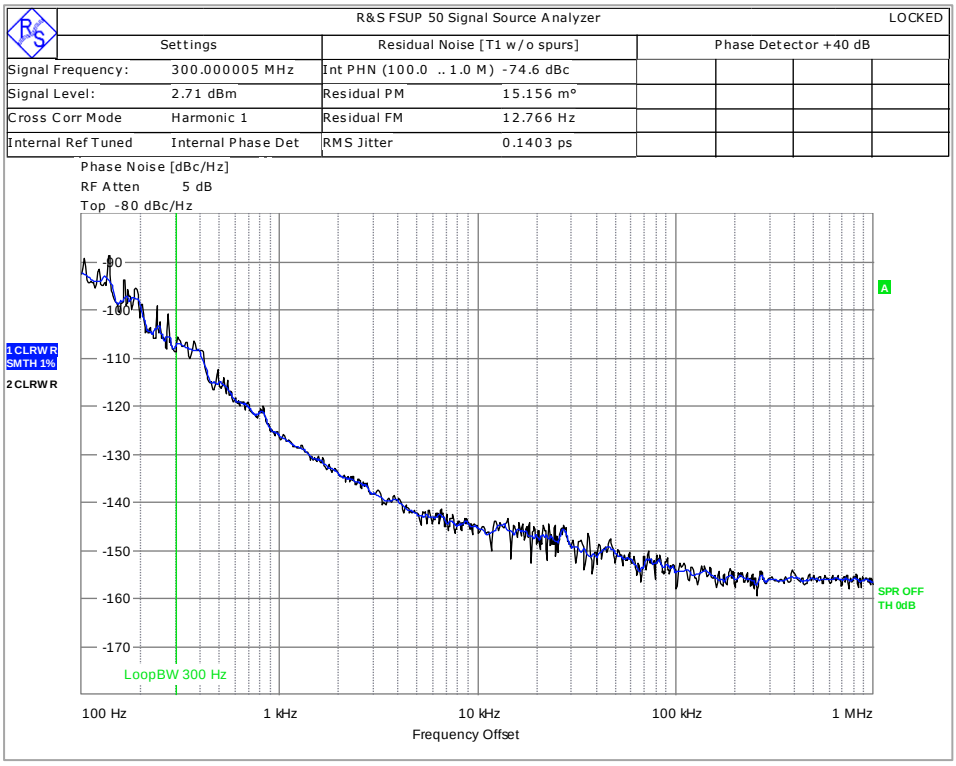
| | | |
|---|---|---|
| Bias voltage (single-ended and differential) | EMF | –0.2 V to +2.5 V [14] |
| Resolution | | 0.1 mV |
| Uncertainty | | 1 % + 2 mV |
| Offset voltage | | |
| Differential | EMF | ($–2$ V + $V_{out}$) to (+2 V – $V_{out}$) |
| | RF envelope: on (R&S®SMW-K540 required), EMF | –2 V to +2 V |
| Resolution | | 0.1 mV |
| Uncertainty | | 1 % + 1 mV |
| Differential signal balance | at $R_L$ = 50 Ω, output voltage > 0.5 V ($V_p$) | |
| Magnitude | up to 100 MHz | 0.1 dB (meas.) |
| | up to 500 MHz | 0.15 dB (meas.) |
| | up to 1000 MHz | 0.2 dB (meas.) |
| Frequency response [15] | at $R_L$ = 50 Ω, output voltage > 0.5 V ($V_p$) | |
| Magnitude | up to 100 MHz | 0.1 dB (meas.) |
| | up to 1000 MHz | 0.2 dB (meas.) |
| Wideband noise | 10 MHz sine wave at 1 MHz offset | –160 dBc (typ.) |



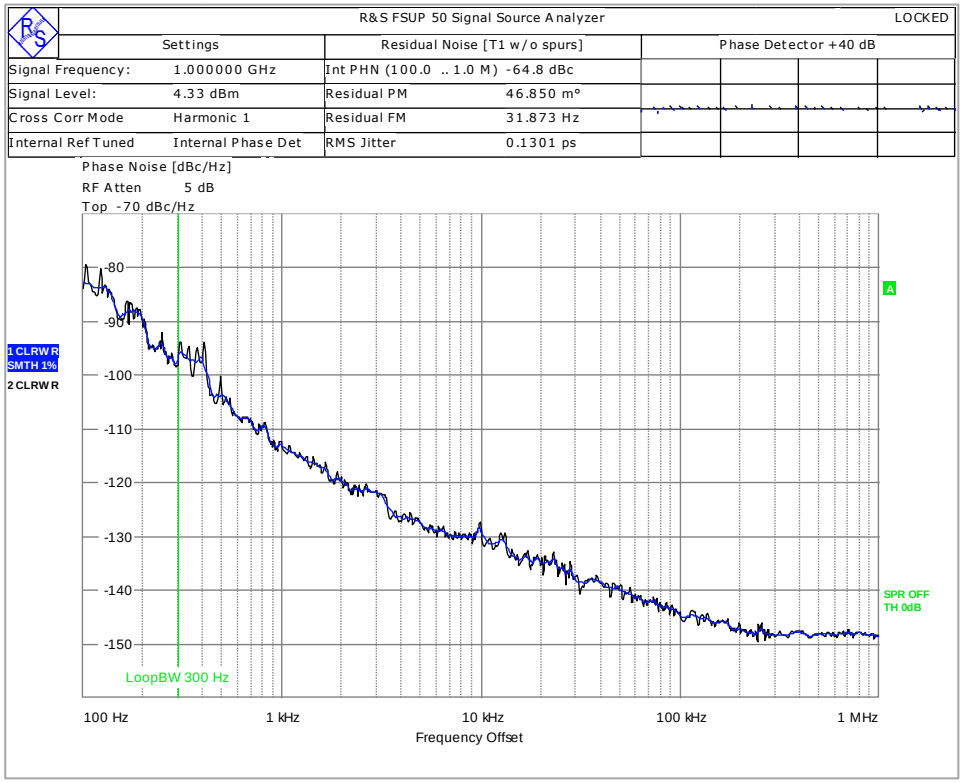

*Measured phase noise of wideband analog I/Q outputs; single-ended sine wave with f = 100 MHz*

[14] The magnitude of the sum of output voltage and bias voltage must not exceed 4 V.

[15] "Optimize internal I/Q impairments for RF output" switched off.




*Measured phase noise of wideband analog I/Q outputs; single-ended sine wave with f = 300 MHz*




*Measured phase noise of wideband analog I/Q outputs; single-ended sine wave with f = 1 GHz*

# Digital baseband inputs/outputs for wideband baseband

Depending on the installed software and hardware options, the R&S®SMW200A is able to receive digital baseband signals and output digital baseband signals. The digital I/Q input/output can be used for the lossless connection of the R&S®SMW200A to the digital I/Q input/output of other Rohde & Schwarz instruments.

Digital baseband outputs: At least one R&S®SMW-K19 option must be installed. Digital baseband outputs can be used either on signal path A or B with one R&S®SMW-K19 option. For digital baseband outputs to be used on signal paths A and B simultaneously, two R&S®SMW-K19 must be installed. To enable two or more digital baseband outputs in multichannel or other advanced modes, two R&S®SMW-K19 must be installed.

The R&S®SMW-K19 option requires R&S®SMW-B13XT with DACW board revision 4.00 or higher.

| | | |
|---|---|---|
| Signal outputs | system configuration mode: standard | analog only, digital only (HS [16]) |
| | system configuration mode: advanced [17] | analog and digital, analog and digital (HS), digital only (HS) |
| Digital only (HS) | The streams are output via the digital I/Q outputs only (HS DIG I/Q interface standard). Analog I/Q outputs are not available. External modulation signals can be output via the RF outputs (I/Q modulation mode: external wideband I/Q). | |
| | with R&S®SMW-K551 installed and system configuration mode: advanced | The instrument runs at reduced speed, depending on the device connected to the digital I/Q output (slow I/Q). |
| Analog and digital | The instrument runs in regular operating mode, both analog and digital outputs (DIG I/Q interface standard) are available. | |
| Analog and digital (HS) | The instrument runs in regular operating mode, both analog and digital outputs (HS DIG I/Q interface standard) are available. | |
| Analog only | The instrument runs in regular operating mode, only analog outputs are available. | |
| Number of digital outputs | | according to selected system configuration (see table below) |
| | signal outputs: digital only (HS) | maximum 2 (on R&S®SMW-B13XT) |
| | signal outputs: analog and digital | maximum 8 (on R&S®SMW-B13XT and R&S®SMW-B15) depending on entities · RX antennas of MIMO/SIMO configuration |
| | signal outputs: analog and digital (HS) | maximum 2 (on R&S®SMW-B13XT) |
| Number of streams per output | signal outputs: digital only (HS) | |
| | system configuration mode: standard | 1 to 2 |
| | system configuration mode: advanced | 1 to 8 |
| Number of streams per input | system configuration mode: standard; signal outputs: analog only, HS DIG I/Q | 1 to 2 |
| | system configuration mode: advanced; signal outputs: analog and digital, 200 MHz, interface either DIG I/Q or HS DIG I/Q | |
| | HS DIG I/Q | 1 to 2 |
| | DIG I/Q | 1 to 2 |
| | system configuration mode: advanced; signal outputs: analog and digital, 400 MHz or 800 MHz, HS DIQ I/Q | 1 to 2 |

[16] HS = high-speed.

[17] The following functions are not available in advanced system configuration mode: analog modulation, modulation sources for analog modulation, envelope tracking, AM/AM, AM/PM predistortion, Digital Doherty.

| | | |
|---|---|---|
| Bandwidth (RF) | general | according to selected system configuration |
| | system configuration mode: standard | bandwidth of wideband baseband generator (see section Wideband baseband generator, specification for R&S®SMW-B9 option) or maximum specified bandwidth (RF) of the selected interface, whichever is smaller |
| | system configuration mode: advanced | 200 MHz or maximum specified bandwidth (RF) of the selected interface, whichever is smaller (see section Multichannel, MIMO, fading and noise, specifications for R&S®SMW-K75/-K821 options) |
| | with R&S®SMW-K822 option | 400 MHz or maximum specified bandwidth (RF) of the selected interface, whichever is smaller (see section Multichannel, MIMO, fading and noise, specifications for R&S®SMW-K75/-K821 options) |
| | with R&S®SMW-K823 option | 800 MHz or maximum specified bandwidth (RF) of the selected interface, whichever is smaller (see section Multichannel, MIMO, fading and noise, specifications for R&S®SMW-K75/-K821 options) |

| **Minimum required R&S®SMW200A options** | **Digital I/Q inputs** | | **Digital I/Q outputs** | |
|---|---|---|---|---|
| Interface standard | DIG I/Q | HS DIG I/Q | DIG I/Q | HS DIG I/Q |
| R&S®SMW-B13XT + 1 × R&S®SMW-K19 | – | – | 1 | 1 |
| R&S®SMW-B13XT + 2 × R&S®SMW-K19 | – | – | 2 | 2 |
| 1 × R&S®SMW-B9 + R&S®SMW-B13XT | 1 | 1 | – | – |
| 1 × R&S®SMW-B9 + R&S®SMW-B13XT + 1 × R&S®SMW-K19 | 1 | 1 | 1 | 1 |
| 1 × R&S®SMW-B9 + R&S®SMW-B13XT + 2 × R&S®SMW-K19 | 1 | 1 | 2 | 2 |
| 2 × R&S®SMW-B9 + R&S®SMW-B13XT | 2 | 2 | – | – |
| 2 × R&S®SMW-B9 + R&S®SMW-B13XT + 1 × R&S®SMW-K19 | 2 | 2 | 1 | 1 |
| 2 × R&S®SMW-B9 + R&S®SMW-B13XT + 2 × R&S®SMW-K19 | 2 | 2 | 2 | 2 |
| 2 × R&S®SMW-B9 + 4 × R&S®SMW-B15 + R&S®SMW-B13XT + 2 × R&S®SMW-K19 | depends on selected system configuration (for required additional options for specific system configurations, see section Multichannel, MIMO, fading and noise, specifications for R&S®SMW-K74, -K75, -K76 options) | | | |
| 2×1×1 | 2 | 2 | 2 | 2 |
| other | – | – | up to 8 | 2 |

**Output parameters**

| **DIG I/Q interface** | | |
|---|---|---|
| Interface | | |
| Standard | | DIG I/Q, in line with R&S®Digital I/Q Interface PAD-R [18], I/Q data and control signals, data and interface clock |
| Level | | LVDS |
| Connector | | 26-pin MDR |
| I/Q sample rate | With source "user-defined", the sample rate must be entered via the parameter "sample rate". | |
| Source | | user-defined |
| Sample rate | | 250 MHz |
| Resolution | source: user-defined | 0.001 Hz |
| Frequency uncertainty | source: user-defined | < (1 · $10^{-12}$ + relative deviation of reference frequency) · sample rate (nom.) |

[18] R&S®Digital I/Q Interface PAD-R is a Rohde & Schwarz internal company guideline for the transmission of digital I/Q data. It is supported by a wide range of signal generators, signal analyzers and radio communication testers.

| | | |
|---|---|---|
| I/Q data | | |
| Resolution | | 18 bit |
| Logic format | | two's complement |
| Physical signal level | | |
| Setting range | | 0 to –60 dBFS |
| Resolution | | 0.01 dBFS |
| Bandwidth (RF) | system configuration mode: advanced | 0.8 · sample rate |
| Control signals | markers | 3 |
| Earliest supported R&S®SMW200A firmware version | | 4.30.046.221 |
| **HS DIQ I/Q interface** | | |
| Interface | | |
| Standard | | HS DIG I/Q,<br>in line with R&S®Digital I/Q Interface 40G PAD-R [19] (DIG I/Q 40G),<br>I/Q data and control signals |
| Level | | LVDS |
| Connector | | QSFP+ / QSFP 28 |
| I/Q sample rate | | |
| Sample rate | maximum sample rate depends on connected receiving device and system configuration mode | |
| | system configuration mode: standard | |
| | 40G | up to 1.05 GHz |
| | 50G | up to 1.25 GHz |
| | system configuration mode: advanced | |
| | analog and digital (HS) | 1000 MHz |
| | digital only (HS) | up to 250 MHz |
| Resolution | | 0.001 Hz |
| Frequency uncertainty | | < (1 · $10^{-12}$ + relative deviation of reference frequency) · sample rate (nom.) |
| I/Q data | | |
| Resolution | | up to 16 bit |
| Logic format | | two's complement |
| Physical signal level | | |
| Setting range | | 0 to –60 dBFS |
| Setting resolution | | 0.01 dBFS |
| Bandwidth (RF) | system configuration mode: standard | 0.83 · sample rate |
| | system configuration mode: advanced | 0.8 · sample rate |
| Control signals | markers | 2 |
| Setup external RF with R&S®SMW-B13XT to R&S®SMW-B9 | | |
| Earliest supported R&S®SMW200A firmware version | | 4.70.128.xx |
| Notes | If both R&S®SMW200A have DACW board revision 4.00 and DACW board revision 5.00, use DACW board revision 5.00 as signal source. | |
| Setup external RF with R&S®SMW-B13XT to R&S®SMM100A | | |
| Earliest supported R&S®SMW200A firmware version | | 4.90.049.xx |
| Setup external RF with R&S®SMW-B13XT to R&S®SMCV100B | | |
| Earliest supported R&S®SMW200A firmware version | | 4.90.049.xx |

**Input parameters**

| | | |
|---|---|---|
| **DIQ I/Q interface** | | |
| Input level | peak level | |
| Peak level | | |
| Setting range | referenced to full scale | –60 dB to +3 dB |
| Resolution | | 0.01 dB |
| Crest factor | | |
| Setting range | | 0 dB to +30 dB |
| Resolution | | 0.01 dB |
| Adjust level function | | automatically determines peak level and crest factor of input signal |

[19] R&S®Digital I/Q Interface 40G PAD-R is a Rohde & Schwarz internal company guideline for the transmission of digital I/Q data. It is supported by a wide range of signal generators, signal analyzers and radio communication testers.

| | | |
|---|---|---|
| Interface | | |
| Standard | | DIG I/Q, in line with R&S®Digital I/Q Interface PAD-R [20], I/Q data and control signals, data and interface clock |
| Level | | LVDS |
| Connector | | 26-pin MDR |
| I/Q sample rate | With source "user-defined", the sample rate must be entered via the parameter "sample rate". With source "Digital I/Q In", the sample rate will be used based on information provided by the transmitting device. | |
| Source | | user-defined, Digital I/Q In |
| Sample rate | maximum sample rate depends on connected receiving device | 400 Hz to 250 MHz |
| Resolution | source: user-defined | 0.001 Hz |
| Frequency uncertainty | source: user-defined | < (1 · $10^{-12}$ + relative deviation of reference frequency) · sample rate (nom.) |
| I/Q data | | |
| Resolution | | 18 bit |
| Logic format | | two's complement |
| Bandwidth (RF) | system configuration mode: advanced | 0.8 · sample rate |
| Control signals | markers | 3 |
| **HS DIQ I/Q interface** | | |
| Input level | peak level | |
| Setting range | | –60 dB to +3 dB, referenced to full scale |
| Setting resolution | | 0.01 dB |
| Crest factor | | |
| Setting range | | 0 dB to +30 dB |
| Setting resolution | | 0.01 dB |
| Adjust level function | | automatically determines peak level and crest factor of input signal |
| Standard | | HS DIG I/Q, in line with R&S®Digital I/Q Interface 40G PAD-R [21] (DIG I/Q 40G), I/Q data and control signals |
| Level | | LVDS |
| Connector | | QSFP+ / QSFP 28 |
| I/Q sample rate | | |
| Source | the sample rate will be used based on information provided by the transmitting device | HS digital I/Q In |
| Sample rate | maximum sample rate depends on connected transmitting device and system configuration mode | |
| | system configuration mode: standard | |
| | 40G | up to 1.05 GHz |
| | 50G | up to 1.25 GHz |
| | system configuration mode: advanced | up to 250 MHz |
| | with R&S®SMW-K822 option | up to 500 MHz |
| | with R&S®SMW-K823 option | up to 1000 MHz |
| Resolution | | 0.001 Hz |
| Frequency uncertainty | | < (1 · $10^{-12}$ + relative deviation of reference frequency) · sample rate (nom.) |
| I/Q data | | |
| Resolution | | 16 bit |
| Logic format | | two's complement |
| Bandwidth (RF) | system configuration mode: standard | 0.83 · sample rate |
| Control signals | markers | 2 |

[20] R&S®Digital I/Q Interface PAD-R is a Rohde & Schwarz internal company guideline for the transmission of digital I/Q data. It is supported by a wide range of signal generators, signal analyzers and radio communication testers.

[21] R&S®Digital I/Q Interface 40G PAD-R is a Rohde & Schwarz internal company guideline for the transmission of digital I/Q data. It is supported by a wide range of signal generators, signal analyzers and radio communication testers.

# Wideband baseband generator (R&S®SMW-B9 option) – arbitrary waveform mode

One or two R&S®SMW-B9 can be installed. Their I/Q signals can be assigned a frequency offset.

Prerequisite: R&S®SMW-B13XT must be installed.

| | | |
|---|---|---|
| Waveform length | | 1 sample to 256 Msample in one-sample steps |
| | with R&S®SMW-K515 option (memory extension) | 1 sample to 2 Gsample in one-sample steps |
| Nonvolatile memory | | hard disk |
| Sample resolution | equivalent to D/A converter | 14 bit |
| Sample rate | | 400 Hz to 600 MHz |
| | with R&S®SMW-K525 option | 400 Hz to 1200 MHz |
| | with R&S®SMW-K527 option | 400 Hz to 2400 MHz |
| Sample frequency error | internal clock | < (1 · $10^{-12}$ + relative deviation of reference frequency) · sample rate (nom.) |
| Sample clock source | | internal |
| Bandwidth (RF) | at maximum sample rate, rolloff to –0.1 dB | 500 MHz |
| | at reduced sample rate, rolloff to –0.1 dB (The waveform is automatically interpolated to the internal sample rate of 600 MHz.) | 0.833 · sample rate |
| Bandwidth (RF) with R&S®SMW-K525 option | at maximum sample rate, rolloff to –0.1 dB | 1000 MHz |
| | at reduced sample rate, rolloff to –0.1 dB (The waveform is automatically interpolated to the internal sample rate of 1200 MHz.) | 0.833 · sample rate |
| Bandwidth (RF) with R&S®SMW-K527 option | at maximum sample rate, rolloff to –0.1 dB | 2000 MHz |
| | at reduced sample rate, rolloff to –0.1 dB (The waveform is automatically interpolated to the internal sample rate of 2400 MHz.) | 0.833 · sample rate |
| **Frequency offset** | Using the frequency offset, the center frequency of the wanted baseband signal can be shifted. The restrictions caused by the modulation bandwidth still apply. | |
| Frequency offset setting range | | –250 MHz to +250 MHz |
| | with R&S®SMW-K525 option | –500 MHz to +500 MHz |
| | with R&S®SMW-K527 option | –1000 MHz to +1000 MHz |
| Frequency offset setting resolution | | 0.01 Hz |
| Frequency offset error | | < 9 · $10^{-6}$ Hz + relative deviation of reference frequency · frequency offset (nom.) |
| **Triggering** | A trigger event restarts I/Q generation. The I/Q signal is then synchronous with the trigger (with a specific timing jitter). | |
| Trigger source | event triggered via GUI or remote command | internal |
| | event triggered by other baseband generator | internal (baseband A/B) |
| | event triggered by external trigger signal | external |
| Trigger modes | The signal is generated continuously. | auto |
| | The signal is generated continuously. A trigger event causes a restart. | retrig |
| | The signal is started only when a trigger event occurs. Subsequent trigger events are ignored. | armed auto |
| | The signal is started only when a trigger event occurs. Every subsequent trigger event causes a restart. | armed retrig |
| | The signal is started only when a trigger event occurs. The signal is generated once. | single |

| | | |
|---|---|---|
| External trigger input | | selectable from USER 1, 2, 3 on front panel, or USER 4, 5, 6 on rear panel |
| Connector type | USER 1, 2, 3 on front panel, USER 4, 5, 6 on rear panel | BNC female |
| Input level | | 0 V to 3 V (nom.) |
| Threshold | USER 1, 2, 3 | settable from 0.1 V to 2.0 V |
| | USER 4, 5, 6 | settable from 0.1 V to 2.0 V |
| Input damage voltage | | –0.5 V, 3.8 V |
| Input impedance | selectable | 1 kΩ or 50 Ω (nom.) |
| Trigger jitter | | ±1.67 ns |
| External trigger delay | | |
| Setting range | | 0 sample to $2.147 \cdot 10^9$ sample |
| Setting resolution | | 0.4 ns |
| External trigger inhibit | | |
| Setting range | | 0 sample to (21.47 s · sample rate) sample |
| Setting resolution | | 1 sample |
| External trigger pulse width | | > 7.5 ns |
| **Marker signals** | | |
| Number of marker signals | | 3 |
| Operating modes | | unchanged, restart, pulse, pattern, ratio |
| Marker outputs | | selectable from USER 1, 2, 3 on front panel or USER 4, 5, 6 on rear panel |
| Connector type | USER 1, 2, 3 on front panel, USER 4, 5, 6 on rear panel | BNC female |
| Level | | LVTTL |
| Marker delay | | |
| Setting range | | 0 sample to (waveform length – 1) sample |
| Setting resolution | | 1 sample |
| Marker duration | | |
| Minimum value | sample rate ≤ 300 Msample/s | 1 sample |
| | 300 Msample/s < sample rate ≤ 600 Msample/s | 2 sample |
| | 600 Msample/s < sample rate ≤ 1200 Msample/s | 4 sample |
| | 1200 Msample/s < sample rate ≤ 2400 Msample/s | 8 sample |
| **Multisegment waveform mode** | | |
| Number of segments | | 1 to 1024 |
| Changeover modes | | GUI, remote control |
| Extended trigger modes | | same segment, next segment, next segment seamless, sequencer |
| Seamless changeover | | output up to end of current segment, followed by changeover to next segment |
| Sequencer play list length | | max. 1024 |
| Sequencer segment repetitions | | max. 1 048 575 |
| **Multicarrier waveform mode** | | |
| Number of carriers | | max. 512 |
| Total RF bandwidth | | max. 500 MHz |
| | with R&S®SMW-K525 option | max. 1000 MHz |
| | with R&S®SMW-K527 option | max. 2000 MHz |
| Carrier spacing | | |
| Setting range | | depends on number of carriers and signal RF bandwidth |
| Setting resolution | | 0.01 Hz |
| Crest factor modes | | maximize, minimize, off |
| Signal period modes | | longest file, shortest file, user (max. 1 s) |
| Single carrier gain | | |
| Setting range | | –80 dB to 0 dB |
| Setting resolution | | 0.01 dB |
| Single carrier start phase | | |
| Setting range | | 0° to 360° |
| Setting resolution | | 0.01° |
| Single carrier delay | | |
| Setting range | | 0 s to 1 s |
| Setting resolution | | 1 ns |

# ARB Ethernet upload (R&S®SMW-K507 option)

ARB Ethernet upload is a sub mode of arbitrary waveform mode, see section Wideband baseband generator (R&S®SMW-B9 option) – arbitrary waveform mode. This feature allows a fast upload und playback of waveform I/Q samples from an external source via UDP over a QSFP+ LAN interface into a Rohde & Schwarz signal generator (R&S®SMW200A).

The waveform parameter and I/Q samples are transferred using special transmission commands (Rohde & Schwarz upload protocol, see K507 user manual).

At least one R&S®SMW-B9 wideband baseband generator option must be installed. If two R&S®SMW-B9 options are installed (signal paths A and B), the ARB Ethernet upload can be used either on signal path A or B with one R&S®SMW-K507 option. For simultaneous usage on signal paths A and B, two R&S®SMW-K507 options must be installed.

| | | |
|---|---|---|
| **ARB Waveform** | | |
| File size, technical specification | | see section Wideband baseband generator (R&S®SMW-B9 option) – arbitrary waveform mode |
| File generation | | see R&S®SMW200A user manual, section Using the Arbitrary Waveform Generator (ARB) |
| **Upload transmission protocol** | | |
| R&S®ARB upload protocol | | see K507 user manual |
| **Marker signals** | | |
| Number of marker signals | | 3 |
| Operating modes | | waveform (unchanged), restart |
| Marker outputs | | see section Wideband baseband generator (R&S®SMW-B9 option) – arbitrary waveform mode |
| **Interface parameters** | | |
| LAN interface | | |
| Connector | HS/DIGIQ 1, 2 on rear panel | QSFP+ (note the recommended extras below) |
| Protocol | | UDP over Ethernet |
| Data rate | 10 Gigabit Ethernet or 40 Gigabit Ethernet can be configured in user interface | 10 Gbit/s, 40 Gbit/s |

# Extended sequencing (R&S®SMW-K502 option)

The R&S®SMW-K502 option enables waveform sequencing and real-time signal generation for ultra long playtime. Waveform variations such as offset frequency, amplitude and phase are calculated in real-time and do not require precalculated waveforms.

The extended sequencing is controlled by the external R&S®Pulse Sequencer Software, a powerful software tool for simulating complex sequencing scenarios.

At least one R&S®SMW-B9 option (wideband baseband generator) must be installed. If two R&S®SMW-B9 options are installed (signal paths A and B), extended sequencing can be used either on signal path A or B with one R&S®SMW-K502 option. For extended sequencing to be used simultaneously on signal paths A and B, two R&S®SMW-K502 options must be installed.

| | | |
|---|---|---|
| **General settings** | | |
| Modes | controlled by external R&S®Pulse Sequencer Software (R&S®SMW-K300 required) | pulse sequencer |
| **Pulse sequencer mode** | | see R&S®Pulse Sequencer Software data sheet (PD 3607.1388.22) |
| **Waveform segments** | | |
| Segment length | | 1 sample to 64 Msample |
| Minimum memory allocation | | 64 sample |
| Maximum number of segments | | depends on segment lengths and baseband generator ARB memory size |
| **Waveform sequences** | | |
| Sequencing | | continuously repeating |
| Maximum number of segments per sequence | | depends on segment lengths and baseband generator ARB memory size |
| Maximum number of segment repetitions | | $2^{32}$ |
| **Clock** | | see section Wideband baseband generator (R&S®SMW-B9 option) – arbitrary waveform mode |

| | | |
|---|---|---|
| **Triggering** | | see section Wideband baseband generator (R&S®SMW-B9 option) – arbitrary waveform mode |
| **Marker signals** | | |
| Number of marker signals | | 3 |
| Operating modes | marker at every start of sequence | restart |
| | marker 1 embedded in waveform | unchanged |
| | marker at every pulse | pulse |
| Marker outputs | | see section Wideband baseband generator (R&S®SMW-B9 option) – arbitrary waveform mode |
| Marker delay | | see section Wideband baseband generator (R&S®SMW-B9 option) – arbitrary waveform mode |
| Marker duration | | see section Wideband baseband generator (R&S®SMW-B9 option) – arbitrary waveform mode |

# Real-time control interface (R&S®SMW-K503/-K504 options)

The R&S®SMW-K503/-K504 option enhances the R&S®SMW-B9 wideband baseband generator option by adding a dedicated 1 Gbit/s LAN interface for pulse descriptor word (PDW) streaming. PDWs are streamed via the external LAN interface to control a real-time sequencer on the R&S®SMW-B9. Either a precalculated waveform can be played back or certain signals such as rectangular pulses, barker codes and chirps can be generated in real time.

In addition to these different signal types, the interface provides agile switching of frequency, phase and amplitude. These variations are calculated in real time.

The real-time control interface is controlled by an external simulator that streams the PDWs in a proprietary Rohde & Schwarz format.

At least one R&S®SMW-B9 wideband baseband generator option and one R&S®SMW-K502 option must be installed. If two R&S®SMW-B9 options and two R&S®SMW-K502 options are installed (signal paths A and B), the real-time control interface can be used either on signal path A or B with R&S®SMW-K503 or -K504 option. For simultaneous usage on signal paths A and B, two R&S®SMW-K503/-K504 options must be installed. The R&S®SMW-K504 option increases the maximum PDW rate from 1 MPDW to 2 MPDW. Each R&S®SMW-K504 option requires an R&S®SMW-K503 option to be installed.

| | | |
|---|---|---|
| **PDW parameters** | | |
| PDW format | | |
| PDW | variant no. 1 | 32 byte fixed length |
| | variant no. 2 | 32/48 byte fixed length |
| CNTRL PDW | | 16 byte fixed length |
| Controllable parameters | PDW | |
| | variant no. 1 | time of arrival, frequency offset, amplitude offset, phase offset, real-time modulation on pulse (MOP, see real-time MOP types below), I/Q waveform index |
| | variant no. 2 | time of arrival, rise time, fall time, edge type (linear, cosine), repetitions (in burst mode), frequency offset, amplitude offset, phase offset, real-time modulation on pulse (MOP, see real-time MOP types below), I/Q waveform index |
| | CNTRL PDW | absolute amplitude, absolute frequency |
| Setting granularity | | |
| Time | | 417 ps |
| Amplitude | | 16 bit (voltage based) |
| Phase | | < 0.01° |
| Frequency | | 0.58 Hz |
| I/Q segments | | |
| Maximum individual segments | | 16 777 216 |
| Length granularity | | 32 sample |

| | | |
|---|---|---|
| Time parameters | | |
| Maximum play time | variant no. 1 | 2 h |
| | variant no. 2 | 521 h |
| Minimum pulse width | real-time | 3.3 ns |
| | I/Q segment | 417 ps |
| Minimum PRI real-time signals | variant no. 1 | |
| | with R&S®SMW-K503 option | 1 µs |
| | with R&S®SMW-K504 option | 0.5 µs |
| | variant no. 2 | |
| | with R&S®SMW-K503 option | 1 µs |
| | with R&S®SMW-K504 option | 0.5 µs without extension fields,<br>1 µs with extension fields |
| Minimum I/Q segment playback repetition interval | | 1.0 µs |
| Real-time MOP types | | |
| Unmod | | rectangular pulse |
| Linear FM | | up, down, triangular |
| Maximum hirp deviation | | ± 1 GHz |
| Phase | | Barker |
| Barker codes | | R3, R4a, R4b, R5, R7, R11, R13 |
| Marker signals | | |
| Number of marker signals | | 3 |
| Operating modes | | pulse, restart, PDW |
| Marker outputs | | see section Wideband baseband generator (R&S®SMW-B9 option) – arbitrary waveform mode |
| Marker delay | | see section Wideband baseband generator (R&S®SMW-B9 option) – arbitrary waveform mode |
| **Interface parameters** | | |
| LAN interface | | |
| Connector | ADV DATA/CTRL 1, 2 on rear panel | RJ-45 |
| **PDW buffer** | | |
| Size | | 536 870 656 byte |

# Pulse-on-pulse simulation (R&S®SMW-K315 option)

This option enhances the R&S®SMW-K502 option to simulate up to 6 true parallel instances of the extended sequencer in a single instrument. It allows the generation of time overlapping pulse-on-pulse signals. As a result, up to 6 emitters can be generated simultaneously in one R&S®SMW200A. If the R&S®SMW-K306 option is installed, each extended sequencer can also be used to generate a group of interleaved emitters. In case of interleaving emitters, drop-out rates can be reduced by distributing emitters onto more hardware resources.

Two R&S®SMW-B9 options (wideband baseband generator), two R&S®SMW-K502 options and at least two R&S®SMW-B15 options (fading simulator and signal processor) must be installed. Depending on the operating mode, additional options are required:

| | | |
|---|---|---|
| Operating modes | radar signal generation with R&S®Pulse Sequencer Software | pulse sequencer |
| | radar signal generation using PDW streaming with R&S®SMW-K503/-K504 options | real-time control interface |
| Minimum required options | operating mode: pulse sequencer | two R&S®SMW-B9, two R&S®SMW-K502, two R&S®SMW-K300, two R&S®SMW-K301, two or four R&S®SMW-B15 |
| | operating mode: real-time control interface | two R&S®SMW-B9, two R&S®SMW-K502, two R&S®SMW-K503, two or four R&S®SMW-B15 |
| Number of extended sequencers | two R&S®SMW-B15 installed | 4 |
| | four R&S®SMW-B15 installed | 6 |

# Agile sequencing (R&S®SMW-K506 option)

Agile sequencing allows external control and fast arbitrary switching of prestored ARB segments by streaming of ARB descriptor words (ADW) including a waveform ID to the R&S®SMW200A. The R&S®SMW-K506 option enhances the R&S®SMW-B9 wideband baseband generator option by adding a dedicated, low latency 10 Gbit/s LAN interface over QSFP+ for ADW streaming.

In addition to ARB segment sequencing, the interface provides agile switching of frequency, phase and amplitude. These variations are applied in real time.

At least one R&S®SMW-B9 wideband baseband generator option must be installed. If two R&S®SMW-B9 options are installed (signal paths A and B), the agile sequencing can be used either on signal path A or B with one R&S®SMW-K506 option. For simultaneous usage on signal paths A and B, two R&S®SMW-K506 options must be installed.

| | | |
|---|---|---|
| **ADW parameters** | | |
| ADW format | | |
| Size | | 32 byte fixed length |
| Controllable parameters | | frequency offset, amplitude offset, phase offset, waveform ID, segment repetitions, segment interrupt |
| Setting granularity | | |
| Amplitude offset | | 16 bit (voltage based) |
| Phase offset | | < 0.01° |
| Frequency offset | | 0.58 Hz |
| ARB segments | | |
| Maximum individual segments | | 16 777 216 |
| Length granularity | | 32 samples |
| Time parameters | | |
| Minimum ARB segment playback repetition interval | | 1.0 µs |
| **Operating modes** | | |
| Deterministic | | ADW execution on external trigger event |
| Trigger to RF delay | depends on ARB sample rate | |
| | sample rate = 37.5 MHz | 5.6 µs (meas.) |
| | sample rate = 75 MHz | 4.1 µs (meas.) |
| | sample rate = 300 MHz | 3.4 µs (meas.) |
| | sample rate = 2.4 GHz | 3.1 µs (meas.) |
| Trigger jitter | | ±1.67 ns |
| ARB segment repetitions | looping of ARB segments | 1 to $2^{16}$ |
| Instant | | instant ADW execution after reception |
| ADW reception to RF delay | depends on ARB sample rate | |
| | sample rate = 37.5 MHz | 7.3 µs (meas.) |
| | sample rate = 75 MHz | 5.5 µs (meas.) |
| | sample rate = 300 MHz | 4.7 µs (meas.) |
| | sample rate = 2.4 GHz | 4.3 µs (meas.) |
| ARB segment repetitions | looping of ARB segments | 1 to $2^{16}$ |
| **Marker signals** | | |
| Number of marker signals | | 3 |
| Operating modes | | pulse, restart, ADW |
| Marker outputs | | see section Wideband baseband generator (R&S®SMW-B9 option) – arbitrary waveform mode |
| Marker delay | | see section Wideband baseband generator (R&S®SMW-B9 option) – arbitrary waveform mode |
| **Interface parameters** | | |
| LAN interface | | |
| Connector | HS/DIGIQ 1, 2 on rear panel | QSFP+ (note the extras below) |
| Protocol | | UDP over Ethernet |
| Data rate | | 10 Gbit/s |
| Trigger input connector | | BNC female |
| Ready for trigger output connector | | BNC female |
| Internal ADW buffer | | |
| Size | | 512 ADWs |
| **Mandatory extra** | | 40G QSFP+ to 10G SFP+ adapter converter module |
| **Recommended extras** | | • 10G SFP+ optical cable<br>• 10G SFP+ Ethernet network interface card |

# Wideband baseband generator (R&S®SMW-B9 option) – real-time operation (custom digital modulation)

One or two R&S®SMW-B9 can be installed. Their I/Q signals can be assigned a frequency offset.

Prerequisite: R&S®SMW-B13XT must be installed.

| **Types of modulation** | | |
|---|---|---|
| ASK | | |
| Modulation index | | 0 % to 100 % |
| Setting resolution | | 0.1 % |
| FSK | | 2FSK, 4FSK, MSK |
| Deviation | | 1 Hz to 15 · $f_{sym}$ |
| Maximum | | 240 MHz |
| Setting resolution | | 0.1 Hz |
| Variable FSK | | 4FSK, 8FSK, 16FSK |
| Deviations | | –15 · $f_{sym}$ to +15 · $f_{sym}$ |
| Maximum | | 240 MHz |
| Setting resolution | | 0.1 Hz |
| PSK | | BPSK, QPSK, QPSK 45° offset, QPSK EDGE, AQPSK, OQPSK, π/4-QPSK, π/2-DBPSK, π/4-DQPSK, π/8-D8PSK, 8PSK, 8PSK EDGE |
| QAM | | 16QAM, 32QAM, 64QAM, 128QAM, 256QAM, 1024QAM, 4096QAM, π/4-16QAM, –π/4-32QAM (for EDGE+) |
| APSK | | 16APSK, 32APSK |
| Gamma/gamma1 | 16APSK | 3.15 (DVB-S2 2/3), 2.85 (DVB-S2 3/4), 2.75 (DVB-S2 4/5), 2.70 (DVB-S2 5/6), 2.60 (DVB-S2 8/9), 2.57 (DVB-S2 9/10) |
| | 32APSK | 2.84 (DVB-S2 3/4), 2.72 (DVB-S2 4/5), 2.64 (DVB-S2 5/6), 2.54 (DVB-S2 8/9), 2.53 (DVB-S2 9/10) |
| **Symbol rate** | | |
| Operating mode | | internal |
| Setting range | standard | |
| | ASK, PSK, APSK and QAM | 50 Hz to 300 MHz |
| | FSK | 50 Hz to 300 MHz |
| | with R&S®SMW-K525/-K527 options | |
| | ASK, PSK, APSK and QAM | 50 Hz to 600 MHz |
| | FSK | 50 Hz to 600 MHz |
| Setting resolution | | 0.001 Hz |
| Frequency uncertainty (internal) | | < (1.6 · $10^{-11}$ + relative deviation of reference frequency) · symbol rate (nom.) |
| **Baseband filter** | Any filter can be used with any type of modulation. The bandwidth of the modulation signal is max. 150 MHz (standard) or 300 MHz (with R&S®SMW-K525/-K527 options); the signal is clipped if the bandwidth is exceeded. | |
| Filter types | | cosine, root cosine, Gaussian, cdmaOne, cdmaOne + equalizer, cdmaOne 705 kHz, cdmaOne 705 kHz + equalizer, CDMA2000® 3x, APCO25 C4FM, EDGE narrow pulse, EDGE wide pulse rectangular, split phase, EUTRA/LTE |
| Filter parameter | | |
| Setting range | cosine, root cosine (filter parameter α) | 0.05 to 1.00 |
| | Gaussian (filter parameter B × T) | 0.15 to 2.50 |
| | split phase (filter parameter B × T) | 0.15 to 2.50 |
| Setting resolution | | 0.01 |
| **Coding** | Not all coding methods can be used with every type of modulation. | off, differential, diff. + Gray, Gray, NADC, PDC, PHS, TETRA, APCO25 (PSK), APCO25 (8PSK), PWT, TFTS, VDL, APCO25(FSK), ICO, CDMA2000®, WCDMA |

| | | |
|---|---|---|
| **Data sources** | | PRBS: 9, 11, 15, 16, 20, 21, 23,<br>All 0, All 1, pattern (length: 1 bit to 64 bit),<br>data lists, external |
| Data lists | | |
| Output memory | | 8 bit to 2 Gbit |
| Nonvolatile memory | | hard disk |
| **Predefined settings** | modulation, filter, symbol rate and coding (if available) in line with standard | |
| Standards | | APCO, Bluetooth®, DECT, ETC, GSM, GSM EDGE, NADC, PDC, PHS, TETRA, WCDMA 3GPP, TD-SCDMA, CDMA2000® forward link, CDMA2000® reverse link, WorldSpace, CW in baseband |
| **Frequency offset** | The frequency offset can be used to shift the center frequency of the wanted baseband signal. The restrictions caused by the modulation bandwidth still apply. | |
| Frequency offset setting range | | –250 MHz to +250 MHz |
| | with R&S®SMW-K525 option | –500 MHz to +500 MHz |
| | with R&S®SMW-K527 option | –1000 MHz to +1000 MHz |
| Frequency offset setting resolution | | 0.01 Hz |
| Frequency offset error | | $< 9 \cdot 10^{-6}$ Hz + relative deviation of reference frequency · frequency offset (nom.) |
| **Triggering** | | |
| Trigger source | event triggered via GUI or remote command | internal |
| | event triggered by other baseband generator | internal (baseband A/B) |
| | event triggered by external trigger signal | external |
| Trigger modes | The signal is generated continuously. | auto |
| | The signal is generated continuously.<br>A trigger event causes a restart. | retrig |
| | The signal is started only when a trigger event occurs. Subsequent trigger events are ignored. | armed auto |
| | The signal is started only when a trigger event occurs. Every subsequent trigger event causes a restart. | armed retrig |
| | The signal is started only when a trigger event occurs. The signal is generated once. | single |
| External trigger input | | selectable from USER 1, 2, 3 on front panel or USER 4, 5, 6 on rear panel |
| Connector type | USER 1, 2, 3 on front panel,<br>USER 4, 5, 6 on rear panel | BNC female |
| Input level | | 0 V to 3 V (nom.) |
| Threshold | USER 1, 2, 3 | settable from 0.1 V to 2.0 V |
| | USER 4, 5, 6 | settable from 0.1 V to 2.0 V |
| Input damage voltage | | –0.5 V; 3.8 V |
| Input impedance | selectable | 1 kΩ or 50 Ω (nom.) |
| Trigger jitter | | ±1.67 ns |
| External trigger delay | | |
| Setting range | | 0 symbol to $2.147 \cdot 10^9$ symbol |
| Setting resolution | | 3.3 ns |
| External trigger inhibit | | |
| Setting range | | 0 symbol to<br>(21.47 s · symbol rate) symbol |
| Setting resolution | | 1 symbol |
| External trigger pulse width | | > 7.5 ns |

| **Marker signals** | | |
|---|---|---|
| Number of marker signals | | 3 |
| Operating modes | | control list, pulse, pattern, ratio |
| Marker outputs | | selectable from USER 1, 2, 3 on front panel or USER 4, 5, 6 on rear panel |
| Connector type | USER 1, 2, 3 on front panel,<br>USER 4, 5, 6 on rear panel | BNC female |
| Level | | LVTTL |
| Marker delay | | |
| Setting range | | 0 symbol to ($2^{24}$ – 1) symbol |
| Setting resolution | | 1 symbol |
| Marker duration | | |
| Minimum value | sample rate ≤ 300 Msample/s | 1 sample |
| | 300 Msample/s < sample rate ≤ 600 Msample/s | 2 sample |
| | 600 Msample/s < sample rate ≤ 1200 Msample/s | 4 sample |
| | 1200 Msample/s < sample rate ≤ 2400 Msample/s | 8 sample |

# Wideband baseband generator for GNSS with high dynamics (R&S®SMW-B9F option)

This wideband baseband generator enables high dynamics with GNSS standards. For details see the GNSS simulation for Rohde & Schwarz vector signal generators data sheet (PD 3607.6896.22). Otherwise, the specifications of the wideband baseband generator (R&S®SMW-B9 option) also apply for the R&S®SMW-B9F option. Enhancements of the R&S®SMW-B9 option and software options that run on the R&S®SMW-B9 option also work with the R&S®SMW-B9F option.

Note that R&S®SMW-B9F and R&S®SMW-B9 cannot be mixed, i.e. only the following configurations can be installed:

- 1 × R&S®SMW-B9
- 2 × R&S®SMW-B9
- 1 × R&S®SMW-B9F
- 2 × R&S®SMW-B9F

# Baseband enhancements

## Additive white Gaussian noise (AWGN) (R&S®SMW-K62 option)

AWGN can be generated either on path A or B with one R&S®SMW-K62 option. For AWGN to be generated on paths A and B simultaneously, two R&S®SMW-K62 must be installed, and the R&S®SMW200A must be equipped with the R&S®SMW-B13T or R&S®SMW-B13XT option.

Addition of an AWGN signal of settable bandwidth and settable C/N ratio or $E_b/N_0$ to a wanted signal. If the noise generator is used, a frequency offset cannot be added to the wanted signal.

| | | |
|---|---|---|
| Noise | | |
| Distribution density | | Gaussian, statistical, separate for I and Q |
| Crest factor | | > 15 dB |
| Periodicity | | > $3 \cdot 10^{10}$ s |
| C/N, $E_b/N_0$ | | |
| Setting range | Depends on the set RF level. The PEP of the sum signal (wanted signal + noise) must not exceed the maximum possible PEP of the respective RF path. | –50 dB to +45 dB |
| Setting resolution | | 0.01 dB |
| Uncertainty | for system bandwidth = symbol rate, symbol rate < 4 MHz, –24 dB < C/N < 30 dB and crest factor < 12 dB | < 0.1 dB |
| System bandwidth | bandwidth for determining noise power | |
| Setting range | with R&S®SMW-B13/-B13T options | 1 kHz to 160 MHz |
| | with R&S®SMW-B13XT option | |
| | system configuration mode: standard | 1 kHz to 2000 MHz |
| | system configuration mode: advanced | 1 kHz to 200 MHz |
| | with R&S®SMW-K822 option | 1 kHz to 400 MHz |
| | with R&S®SMW-K823 option | 1 kHz to 800 MHz |
| Setting resolution | | 100 Hz |

## Enhanced noise generation (R&S®SMW-K810 option)

Enhanced noise generation can be used either on signal path A or B with one R&S®SMW-K810 option. For enhanced noise generation to be used on paths A and B simultaneously, two R&S®SMW-K810 must be installed. For each R&S®SMW-K810 option to be installed, an R&S®SMW-K62 option must be installed as prerequisite.

### Phase noise simulation

| | | |
|---|---|---|
| Phase noise | | |
| Injection | | after fading |
| Profiles | user-defined | user |
| | predefined PLL phase noise profiles (simulation of typical PLL circuits) | PLL 1, PLL 2 |
| | predefined VCXO phase noise profiles (simulation of typical oscillator circuits) | crystal 1 to 5 |
| | predefined DVB-S2 phase noise profiles, based on EN 302307, DIRECTV | DVB-S2 P1, DVB-S2 P2, DVB-S2 D1, DVB-S2 A1, DVB-S2 A2 |
| | predefined ATSC phase noise profiles, based on ATSC A.74 | ATSC A.74 |
| File format | | text files, editable |
| Graphical user interface | | |
| Entry | | by curve table |
| Number of nodes | | 5 independent points |
| Calculation | | internal |
| Amplitude at $f_{carrier}$ ± 100 Hz | | |
| Setting range | 1 Hz measurement bandwidth | –110.00 dBc to 0.00 dBc |
| Setting resolution | 1 Hz measurement bandwidth | 0.01 dB |
| Maximum phase angle | | ±180° |
| Density distribution function | | Gaussian |
| Frequency response | | depends on phase noise profile |
| System bandwidth | | 10 MHz |

### Impulsive noise simulation

This function allows to add a pulsed AWGN signal to the wanted signal with settable number of pulses per frame and within settable limits of randomly distributed pulse intervals.

| | | |
|---|---|---|
| Impulsive noise | | |
| AWGN signal data | | see R&S®SMW-K62 option |
| C/I | | |
| Setting range | Depends on the set RF level.<br>The PEP of the sum signal (wanted signal + noise) must not exceed the maximum possible PEP of the respective RF path. | –35 dB to +60 dB |
| Setting resolution | | 0.01 dB |
| Frame duration | | 0.1 ms to 1000.0 ms |
| Pulse duration | fixed | 0.25 µs |
| Pulses per frame | | 1 to 40000 |
| Minimum pulse interval | for pulses per frame > 1 | |
| Setting range | | 0.25 µs to 16 ms |
| Setting resolution | | 0.25 µs |
| Maximum pulse interval | for pulses per frame > 1 | |
| Setting range | | 0.25 µs to 16 ms |
| Setting resolution | | 0.25 µs |
| Distribution of pulse intervals | | PRBS |

### Availability of phase noise and impulsive noise for different baseband configurations

| Baseband main module | Fading/baseband configuration | | Phase noise | Impulsive noise |
|---|---|---|---|---|
| R&S®SMW-B13 | standard | | ● | ● |
| R&S®SMW-B13T | standard | | ● | ● |
| | advanced | up to 4 streams | – | ● |
| | | more than 4 streams | – | – |
| R&S®SMW-B13XT | standard | | ● | ● |
| | advanced | up to 4 streams | ● | ● |
| | | more than 4 streams | ● | ● |

## Envelope tracking (R&S®SMW-K540 option)

With this option, the analog I/Q outputs can be used to generate an analog signal corresponding to the envelope of the I/Q signal to test envelope tracking modulators.

This option can be installed once if the instrument is equipped with the R&S®SMW-B13 or R&S®SMW-B13XT option. If the instrument is equipped with the R&S®SMW-B13T option, envelope tracking can be used either on signal path A or B with one R&S®SMW-K540 option. For envelope tracking to be used on signal paths A and B simultaneously, two R&S®SMW-K540 and one R&S®SMW-B13T must be installed.

Instruments equipped with the R&S®SMW-B13 or R&S®SMW-B13T option: For each R&S®SMW-K540 option to be installed, an R&S®SMW-K16 option must be installed, and the instrument must be equipped with at least one standard baseband generator (R&S®SMW-B10 option).

Instruments equipped with the R&S®SMW-B13XT option: For R&S®SMW-K540 option to be installed, the R&S®SMW-K17 option must be installed, and the instrument must be equipped with at least one wideband baseband generator (R&S®SMW-B9 option).

| | | |
|---|---|---|
| **General** | | |
| Envelope voltage adaptation | | auto normalized, auto power, manual |
| Output type | | single-ended, differential |
| Bias voltage | see section Differential analog I/Q outputs or Wideband differential analog I/Q outputs | |
| Offset voltage | see section Differential analog I/Q outputs or Wideband differential analog I/Q outputs | |
| Envelope to RF delay | | |
| Setting range | | –1 µs to +1 µs |
| Setting resolution | | 1 ps |
| Shaping | | off, linear, from table, polynomial, detroughing |
| **Envelope voltage adaptation modes: auto normalized and auto power** | | |
| Power amplifier input power $P_{in}$ | | |
| Setting range | | –145.00 dB to +30.00 dB |
| Setting resolution | | 0.01 dB |

| | | |
|---|---|---|
| Power amplifier supply voltage $V_{CC}$ | $V_{CC}$ = envelope voltage · DC modulator gain + $V_{CC, Offset}$ | |
| DC modulator gain | | –20.00 dB to +20.00 dB |
| Power amplifier offset voltage $V_{CC, Offset}$ | | 0 V to 30 V |
| **Envelope voltage adaptation mode: manual** | | |
| Pregain | | |
| Setting range | | –20.00 dB to 0.00 dB |
| Setting resolution | | 0.01 dB |
| Postgain | | |
| Setting range | | –3.00 dB to +20.00 dB |
| Setting resolution | | 0.01 dB |
| Clipping level | upper and lower limit can be set separately | 0 % to 100 % |
| Maximum output voltage | see Output voltage in section Differential analog I/Q outputs | |

## AM/AM, AM/PM predistortion (R&S®SMW-K541 option)

Instruments with wideband baseband (R&S®SMW-B13XT):

Each R&S®SMW-K541 option to be installed requires a wideband baseband generator (R&S®SMW-B9 option) and an RF path. If the instrument is equipped with two baseband generators and two RF paths, predistortion can be used either on signal path A or B with one R&S®SMW-K541 option. To allow AM/AM, AM/PM predistortion to be used on signal paths A and B simultaneously, two R&S®SMW-K541 must be installed; furthermore, the instrument must be equipped with two R&S®SMW-B9 options and two RF paths, i.e. an R&S®SMW-B2xx frequency option for path B must be installed.

Instruments with standard baseband (R&S®SMW-B13/-B13T):

Each R&S®SMW-K541 option to be installed requires a standard baseband generator (R&S®SMW-B10 option) and an RF path. If the instrument is equipped with two baseband generators and two RF paths, predistortion can be used either on signal path A or B with one R&S®SMW-K541 option. To allow AM/AM, AM/PM predistortion to be used on signal paths A and B simultaneously, two R&S®SMW-K541 must be installed; furthermore, the instrument must be equipped with two R&S®SMW-B10 options, the R&S®SMW-B13T option and two RF paths, i.e. an R&S®SMW-B2xx frequency option for path B must be installed.

| | | |
|---|---|---|
| State | | on/off |
| Maximum input power ($PEP_{in}$ max.) | | |
| Setting range | | –145.00 dB to +30.00 dB |
| Setting resolution | | 0.01 dB |
| Shaping | | polynomial, from table |

## Digital Doherty (R&S®SMW-K546 option)

The Digital Doherty option only applies to instruments equipped with two RF paths and two baseband generators. Two R&S®SMW-K541 options and the R&S®SMW-B90 option (phase coherence) must be installed as prerequisite.

| | | |
|---|---|---|
| State | | on/off |
| Maximum input power ($PEP_{in}$ max.) | | |
| Setting range | | –145.00 dB to +30.00 dB |
| Setting resolution | | 0.01 dB |
| Shaping | | polynomial, from table, classic Doherty |

## User-defined frequency response correction (R&S®SMW-K544 option)

This option can be installed once if the instrument is equipped with the R&S®SMW-B13 option. If the instrument is equipped with the R&S®SMW-B13T or R&S®SMW-B13XT option, user-defined frequency response correction can be used either on signal path A or B with one R&S®SMW-K544 option. For user-defined frequency response correction to be used on signal paths A and B simultaneously, two R&S®SMW-K544 must be installed.

| | | |
|---|---|---|
| State | | on/off |
| Scattering parameters | | |
| File format | | *.s<n>p (e.g. *.s2p) |
| Maximum number of points | | 16384 |
| Number of cascadable datasets | | up to 10 |
| Additional frequency response | | |
| File format | | *.fres, *.ucor |
| Number of files | | up to 5 |
| Absolute level correction at center frequency | based on S-parameter data | on/off |
| Minimum compensation bandwidth | with R&S®SMW-B13/-B13T options | 8 MHz |
| | with R&S®SMW-B13XT option | 100 MHz |

# Automated RF port alignment (R&S®SMW-K545 option)

Instruments with wideband baseband (R&S®SMW-B13XT):
For each installed RF path, R&S®SMW-B9, R&S®SMW-K61 and R&S®SMW-K544 must be installed as prerequisite. Furthermore, the instrument must be equipped with the R&S®SMW-B90 option.

Instruments with standard baseband (R&S®SMW-B13/-B13T):
For each installed RF path, R&S®SMW-B10, R&S®SMW-K61 and R&S®SMW-K544 must be installed as prerequisite. Furthermore, the instrument must be equipped with the R&S®SMW-B90 option.

To run this option a setup should be defined and generated using the R&S®RFPAL software. At least two signal paths should be provided. In case of a setup with multiple instruments, an instrument is designated as primary instrument and should be used to control the option.

| | | |
|---|---|---|
| State | | on/off |
| Align | | aligned, not aligned |
| Setup file | setup file including alignment data is generated by R&S®RFPAL | *.rfsa |
| Additional S-parameter files | | |
| File format | | *.s<n>p (e.g. *.s2p) |
| Maximum number of points | | 16384 |
| Number of cascadable datasets | recommended ≤ 2 | up to 10 |

# Crest factor reduction (R&S®SMW-K548 option)

Each R&S®SMW-K548 option requires a standard baseband generator (R&S®SMW-B10 option) or a wideband baseband generator (R&S®SMW-B9 option). If two baseband generators are installed, crest factor reduction can be applied either on path A or B with one R&S®SMW-K548 option. For crest factor reduction to be applied on paths A and B simultaneously, two R&S®SMW-K548 must be installed.

Crest factor reduction can be applied to any waveform loaded in the arbitrary waveform generator.

| | | |
|---|---|---|
| State | | on/off |
| Algorithm | | clipping and filtering |
| Desired crest factor delta | | –20 dB to 0 dB |
| Maximum iterations | | 1 to 10 |
| Filter mode “simple” | | |
| Signal bandwidth | | 0 Hz to input file sample rate |
| Channel spacing | | 0 Hz to input file sample rate |
| Filter mode “enhanced” | | |
| Passband frequency | | 0 Hz to ½ of input file sample rate |
| Stopband frequency | | 0 Hz to ½ of input file sample rate |
| Maximum filter order | | 21 to 300 |

# Slow I/Q (R&S®SMW-K551 option)

In slow I/Q mode, the generated signal's clock rate can be reduced (e.g. a 20 MHz LTE signal is generated with a clock rate of 240 kHz instead of the original 30.72 MHz). This feature can be used to run tests on hardware emulation platforms not yet capable of full-speed signal processing. The signal and fading characteristics are comparable to those of a system running at full speed. The actual clock rate of the generated signal is controlled by the device connected to the digital I/Q output connectors of the R&S®SMW200A.

## R&S®SMW-K551 on instruments with wideband baseband (R&S®SMW-B9, R&S®SMW-B13XT)

At least one R&S®SMW-B9 wideband baseband generator option and one R&S®SMW-K19 digital baseband output for wideband baseband option must be installed.

**Note:**
Only available for system configuration mode: advanced and signal outputs: digital only (HS).
All digital I/Q outputs need to run at the same clock rate.
The minimum clock rate is limited by the external controlling device only.
The R&S®SMW200A can handle varying clock rates.
With activated slow I/Q mode, marker signals are only available via the digital I/Q interface, and not via USER or T/M/C connectors.
With activated slow I/Q mode, no digital baseband inputs are available.

## R&S®SMW-K551 on instruments with standard baseband (R&S®SMW-B10, R&S®SMW-B13/-B13T)

At least one R&S®SMW-B10 standard baseband generator option and one R&S®SMW-K18 digital baseband output option must be installed.

**Note:**
All digital I/Q outputs need to run at the same clock rate.
The minimum clock rate is limited by the external controlling device only.
The R&S®SMW200A can handle varying clock rates.
In digital only/digital only multiplexed mode, marker signals are only available via the digital I/Q interface, and not via USER or T/M/C connectors.
In digital only/digital only multiplexed mode with activated slow I/Q, no digital baseband inputs are available.

# Notched signals (R&S®SMW-K811 option)

At least one R&S®SMW-B10 standard baseband generator option or R&S®SMW-B9 wideband baseband generator option must be installed. If two baseband generators are installed, notched signals can be generated either on path A or B with one R&S®SMW-K811 option. For notched signals to be generated on paths A and B simultaneously, two R&S®SMW-K811 must be installed.

Up to 25 band-stop filters can be applied to the baseband signal.
Center frequency and bandwidth can be set independently for each band-stop filter.

| | | |
|---|---|---|
| Supported standards and modulation systems | with R&S®SMW-B9 or R&S®SMW-B10 option – arbitrary waveform mode | ARB |
| | with R&S®SMW-K55 option | LTE |
| | with R&S®SMW-K115 option | cellular IoT |
| | with R&S®SMW-K114 option | custom OFDM |
| | with R&S®SMW-K130 or R&S®SMW-K355 option | OneWeb |
| | with R&S®SMW-K52 option | DVB-H/DVB-T |
| | with R&S®SMW-K116 option | DVB-S2/DVB-S2X |
| Number of notches | | 1 to 25 |
| Notch width | | 0 Hz to 0.1 · clock frequency |
| Notch center frequency | | –0.5 · clock frequency to +0.5 · clock frequency |

# BER measurement (R&S®SMW-K80 option)

At least one R&S®SMW-B10 standard baseband generator option or R&S®SMW-B9 wideband baseband generator option must be installed.

The data supplied by the DUT is compared with a reference pseudo-random bit sequence.

| | | |
|---|---|---|
| Clock | | supplied by DUT; a clock pulse is required for each valid bit |
| Clock rate | | 100 Hz to 100 MHz |
| Data | PRBS | |
| | sequence length | 9, 11, 15, 16, 20, 21, 23 |
| | pattern ignore | off, All 0, All 1 |
| | data enable | external |
| | modes | off, high, low |
| | restart | external |
| | modes | on/off |
| Synchronization time | | 28 clock cycles |
| Interface | 4 BNC connectors, selectable from USER 1 to 6 | |
| Clock, data, enable and restart inputs | input impedance | 1 kΩ, 50 Ω |
| | trigger threshold | |
| | setting range | 0.1 V to 2.0 V |
| | setting resolution | 0.1 V |
| Polarity | data, clock, data enable | normal, inverted |
| Measurement time | | selectable by means of maximum number of data bits or bit errors (max. $2^{31}$ bit each), continuous measurement |
| Measurement result | if selected number of data bits or bit errors is attained | BER in ppm, % or decade values |
| Status displays | | not synchronized, no clock, no data |

# BLER measurement (R&S®SMW-K80 option)

At least one R&S®SMW-B10 standard baseband generator option or R&S®SMW-B9 wideband baseband generator option must be installed.

In BLER measurement mode, arbitrary data can be provided by the DUT. A signal marking the block's CRC has to be provided on the data enable connector of the BER/BLER option.

| | | |
|---|---|---|
| Clock | | supplied by DUT; a clock pulse is required for each valid bit |
| Clock rate | | 100 Hz to 100 MHz |
| Data | input data | arbitrary |
| | data enable (marking the block's CRC) | external |
| | modes | high, low |
| CRC | CRC type | CCITT CRC16 ($x^{16} + x^{12} + x^5 + 1$) |
| | CRC bit order | MSB first, LSB first |
| Synchronization time | | 1 block |
| Interface | 4 BNC connectors, selectable from USER 1 to 6 | |
| Clock, data, and enable inputs | input impedance | 1 kΩ, 50 Ω |
| | trigger threshold | |
| | setting range | 0.1 V to 2.0 V |
| | setting resolution | 0.1 V |
| Polarity | data, clock, data enable | normal, inverted |
| Measurement time | selectable by means of maximum number of received blocks or errors (max. $2^{31}$ blocks each), continuous measurement | |
| Measurement result | if selected number of received blocks or errors is attained | BLER in ppm, % or decade values |
| Status displays | | not synchronized, no clock, no data |

# Digital modulation systems

At least one R&S®SMW-B10 standard baseband generator option or R&S®SMW-B9 wideband baseband generator option must be installed. If two baseband generators are installed and two signals of the same standard (e.g. LTE) are to be output simultaneously, two corresponding software options must also be installed (in this case R&S®SMW-K55). If only one R&S®SMW-K55 is installed and LTE is selected in one baseband generator, the other baseband generator is disabled for LTE. However, a software option is not tied to a specific baseband generator.

The specified data applies together with the parameters of the respective standard. The entire frequency range, the filter parameters and the symbol rates can be set by the user.

## Internal digital standards

These options run on the standard baseband generator (R&S®SMW-B10 option) and on the wideband baseband generator (R&S®SMW-B9 option), except where indicated.

The options are described in the Digital Standards data sheet (PD 5213.9434.22). Options for navigation standards are described in the GNSS simulation for Rohde & Schwarz vector signal generators data sheet (PD 3607.6896.22).

| **Cellular standards** |
|---|
| 5G New Radio (R&S®SMW-K144 option) |
| 5G New Radio closed-loop BS test (R&S®SMW-K145 option, R&S®SMW-K144 required) |
| 5G New Radio Release 16 (R&S®SMW-K148 option, R&S®SMW-K144 required) |
| 5G New Radio sidelink (R&S®SMW-K170 option) |
| 5G New Radio Release 17 (R&S®SMW-K171 option, R&S®SMW-K148 required) |
| U-plane generation (R&S®SMW-K175 option, R&S®SMW-K55 or R&S®SMW-K144 required) |
| Verizon 5GTF signals (R&S®SMW-K118 option) |
| |
| LTE Release 8 (R&S®SMW-K55 option) |
| LTE closed-loop BS test (R&S®SMW-K69 option, R&S®SMW-K55 or R&S®SMW-K115 required) |
| Log file generation (R&S®SMW-K81 option, R&S®SMW-K55 or R&S®SMW-K144 required) |
| LTE Release 9 (R&S®SMW-K84 option, R&S®SMW-K55 required) |
| LTE Release 10 (LTE-Advanced) (R&S®SMW-K85 option, R&S®SMW-K55 required) |
| LTE Release 11 (R&S®SMW-K112 option, R&S®SMW-K55 required) |
| LTE Release 12 (R&S®SMW-K113 option, R&S®SMW-K55 required) |
| LTE Release 13/14/15 (R&S®SMW-K119 option, R&S®SMW-K55 required) |
| Cellular IoT Release 13 (R&S®SMW-K115 option) |
| Cellular IoT Release 14 (R&S®SMW-K143 option, R&S®SMW-K115 required) |
| Cellular IoT Release 15 (R&S®SMW-K146 option, R&S®SMW-K115 required) |
| |
| 3GPP FDD (R&S®SMW-K42 option) |
| 3GPP FDD/HSPA/HSPA+, enhanced BS/MS tests (R&S®SMW-K83 option, R&S®SMW-K42 required) |
| |
| GSM/EDGE (R&S®SMW-K40 option) |
| EDGE Evolution (R&S®SMW-K41 option, R&S®SMW-K40 required) |
| |
| CDMA2000® (R&S®SMW-K46 option) |
| 1xEV-DO (R&S®SMW-K47 option) |
| 1xEV-DO Rev. B (R&S®SMW-K87 option, R&S®SMW-K47 required) |
| |
| TD-SCDMA (3GPP TDD LCR) (R&S®SMW-K50 option) |
| TD-SCDMA (3GPP TDD LCR) enhanced BS/MS test including HSDPA (R&S®SMW-K51 option, R&S®SMW-K50 required) |
| |
| TETRA Release 2 (R&S®SMW-K68 option) |
| |
| OneWeb user-defined signal generation (R&S®SMW-K130 option) |
| OneWeb reference signals (R&S®SMW-K355 option) |
| |
| **Wireless connectivity standards** |
| IEEE 802.11a/b/g/n/j/p (R&S®SMW-K54 option) |
| IEEE 802.11ac (R&S®SMW-K86 option, R&S®SMW-K54 required) |
| IEEE 802.11ax (R&S®SMW-K142 option, R&S®SMW-K54 required) |
| IEEE 802.11be (R&S®SMW-K147 option, R&S®SMW-K54 required) |
| IEEE 802.11ad (R&S®SMW-K141 option, R&S®SMW-B9 wideband baseband generator, R&S®SMW-K525 and R&S®SMW-K527 options required) |
| HRP UWB (R&S®SMW-K149 option, R&S®SMW-B9 wideband baseband generator required) |

| |
|---|
| Bluetooth® EDR/Low Energy (R&S®SMW-K60 option) |
| Bluetooth® 5.x (R&S®SMW-K117 option, R&S®SMW-K60 required) |
| LoRa® (R&S®SMW-K131 option) |
| |
| **Navigation standards** |
| GPS (R&S®SMW-K44 option) |
| Modernized GPS (R&S®SMW-K98 option) |
| Galileo (R&S®SMW-K66 option) |
| GLONASS (R&S®SMW-K94 option) |
| Modernized GLONASS (R&S®SMW-K123 option, R&S®SMW-B9 wideband baseband generator required ) |
| BeiDou (R&S®SMW-K107 option) |
| Modernized BeiDou (R&S®SMW-K132 option) |
| IRNSS (R&S®SMW-K97 option) |
| SBAS/QZSS (R&S®SMW-K106 option) |
| |
| Real world scenarios (R&S®SMW-K108 option) |
| GNSS real-time interfaces (RT remote control, R&S®SMW-K109 option) |
| Upgrade to dual-frequency GNSS (R&S®SMW-K134 option, R&S®SMW-B9 wideband baseband generator required) |
| Upgrade to triple-frequency GNSS (R&S®SMW-K135 option, R&S®SMW-B9 wideband baseband generator required) |
| Add 6 GNSS channels (R&S®SMW-K136 option, R&S®SMW-B9 wideband baseband generator required) |
| Add 12 GNSS channels (R&S®SMW-K137 option, R&S®SMW-B9 wideband baseband generator required) |
| Add 24 GNSS channels (R&S®SMW-K138 option, R&S®SMW-B9 wideband baseband generator required) |
| Add 48 GNSS channels (R&S®SMW-K139 option, R&S®SMW-B9 wideband baseband generator required) |
| |
| ERA-GLONASS test suite (R&S®SMW-K360 option) |
| eCall test suite (R&S®SMW-K361 option) |
| User-defined GNSS test cases (R&S®SMW-K362 option) |
| |
| GBAS (R&S®SMW-K111 option) |
| |
| **Broadcast standards** |
| DVB-H/DVB-T (R&S®SMW-K52 option) |
| DVB-S2/DVB-S2X (R&S®SMW-K116 option) |
| DVB-S2/DVB-S2X Annex E (R&S®SMW-K176 option, R&S®SMW-K116 required) |
| DVB-RCS2 (R&S®SMW-K169 option) |
| |
| **Other standards and modulation systems** |
| OFDM signal generation (R&S®SMW-K114 option) |
| Multicarrier CW signal generation (R&S®SMW-K61 option) |
| NFC A/B/F (R&S®SMW-K89 option) |
| Baseband power sweep (R&S®SMW-K542 option) |

# Digital standards with R&S®WinIQSIM2

These options run on the R&S®SMW-B10 standard baseband generator option as well as on the R&S®SMW-B9 wideband baseband generator option, except where indicated.

R&S®WinIQSIM2 requires an external PC.

The options are described in the R&S®WinIQSIM2 data sheet (PD 5213.7460.22).

| |
|---|
| **Cellular standards** |
| 5G New Radio (R&S®SMW-K444 option) |
| 5G New Radio Release 16 (R&S®SMW-K448 option) |
| 5G New Radio sidelink (R&S®SMW-K470 option) |
| 5G New Radio Release 17 (R&S®SMW-K471 option, R&S®SMW-K448 required) |
| Verizon 5GTF signals (R&S®SMW-K418 option) |
| |
| LTE Release 8 (R&S®SMW-K255 option) |
| LTE Release 9 (R&S®SMW-K284 option, R&S®SMW-K255 required) |
| LTE Release 10 (LTE-Advanced) (R&S®SMW-K285 option, R&S®SMW-K255 required) |
| LTE Release 11 and enhanced features (R&S®SMW-K412 option, R&S®SMW-K255 required) |
| LTE Release 12 (R&S®SMW-K413 option, R&S®SMW-K255 required) |
| LTE Release 13/14/15 (R&S®SMW-K419 option, R&S®SMW-K255 required) |
| Cellular IoT Release 13 (R&S®SMW-K415 option) |
| Cellular IoT Release 14 (R&S®SMW-K443 option, R&S®SMW-K415 required) |
| Cellular IoT Release 15 (R&S®SMW-K446 option, R&S®SMW-K415 required) |
| |

| |
|---|
| 3GPP FDD (R&S®SMW-K242 option) |
| 3GPP FDD/HSPA/HSPA+, enhanced BS/MS tests (R&S®SMW-K283 option, R&S®SMW-K242 required) |
| |
| GSM/EDGE (R&S®SMW-K240 option) |
| EDGE Evolution (R&S®SMW-K241 option, R&S®SMW-K240 required) |
| |
| CDMA2000® (R&S®SMW-K246 option) |
| 1xEV-DO (R&S®SMW-K247 option) |
| 1xEV-DO Rev. B (R&S®SMW-K287 option, R&S®SMW-K247 required) |
| |
| TD-SCDMA (3GPP TDD LCR) (R&S®SMW-K250 option) |
| TD-SCDMA (3GPP TDD LCR) enhanced BS/MS test including HSDPA (R&S®SMW-K251 option, R&S®SMW-K250 required) |
| |
| TETRA Release 2 (R&S®SMW-K268 option) |
| |
| **Wireless connectivity standards** |
| IEEE 802.11a/b/g/n (R&S®SMW-K254 option) |
| IEEE 802.11ac (R&S®SMW-K286 option, R&S®SMW-K254 required) |
| IEEE 802.11ax (R&S®SMW-K442 option, R&S®SMW-K254 required) |
| IEEE 802.11be (R&S®SMW-K447 option, R&S®SMW-K254 required) |
| IEEE 802.11ad (R&S®SMW-K441 option, R&S®SMW-B9 wideband baseband generator, R&S®SMW-K525 and R&S®SMW-K527 required) |
| HRP UWB (R&S®SMW-K449 option, R&S®SMW-B9 wideband baseband generator required) |
| Bluetooth® EDR/Low Energy (R&S®SMW-K260 option) |
| Bluetooth® 5.x (R&S®SMW-K417 option, R&S®SMW-K260 required) |
| LoRa® (R&S®SMW-K431 option) |
| |
| **Navigation standards** |
| GPS 1 satellite (R&S®SMW-K244 option) |
| Modernized GPS 1 satellite (R&S®SMW-K298 option) |
| Galileo 1 satellite (R&S®SMW-K266 option) |
| GLONASS 1 satellite (R&S®SMW-K294 option) |
| Modernized GLONASS (R&S®SMW-K423 option) |
| BeiDou 1 satellite (R&S®SMW-K407 option) |
| Modernized BeiDou (R&S®SMW-K432 option) |
| IRNSS (R&S®SMW-K297 option) |
| |
| **Broadcast standards** |
| DVB-H/DVB-T (R&S®SMW-K252 option) |
| DAB/T-DMB (R&S®SMW-K253 option) |
| DVB-S2/DVB-S2X (R&S®SMW-K416 option) |
| DVB-S2/DVB-S2X Annex E (R&S®SMW-K476 option, R&S®SMW-K416 required) |
| DVB-RCS2 (R&S®SMW-K469 option) |
| |
| **Other standards and modulation systems** |
| OFDM signal generation (R&S®SMW-K414 option) |
| Multicarrier CW signal generation (R&S®SMW-K261 option) |
| Additional white Gaussian noise (AWGN) (R&S®SMW-K262 option) |
| NFC A/B/F (R&S®SMW-K289 option) |

# Options with external R&S®Pulse Sequencer Software or R&S®Pulse Sequencer (DFS) Software

These options run on the R&S®SMW-B10 standard baseband generator option as well as on the R&S®SMW-B9 wideband baseband generator option, except where indicated.

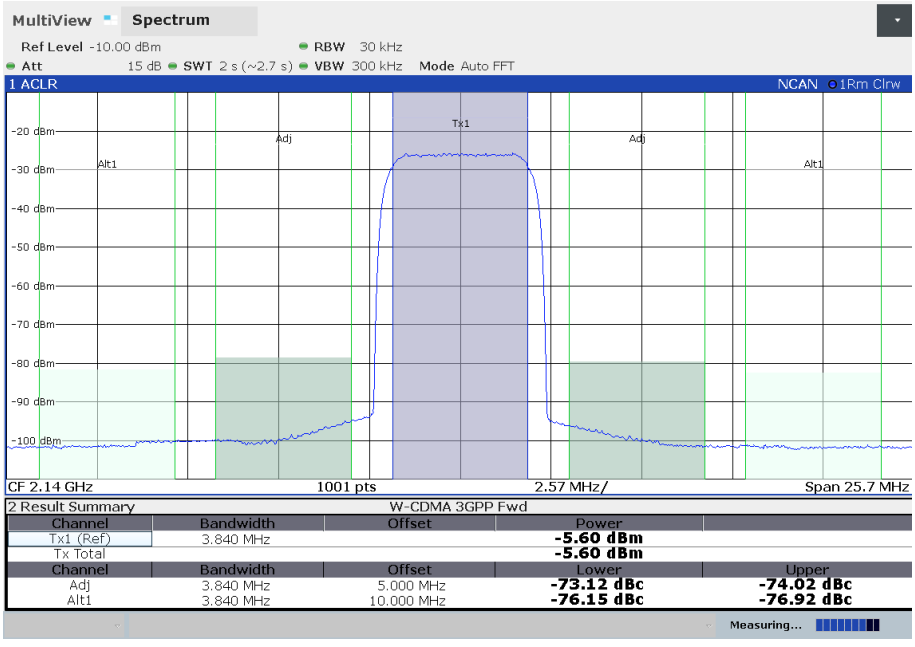
The options are described in the R&S®Pulse Sequencer Software data sheet (PD 3607.1388.22).

| **Options** |
|---|
| Pulse sequencing (R&S®SMW-K300 option) |
| Enhanced pulse sequencing (R&S®SMW-K301 option) |
| Moving emitters and receiver (R&S®SMW-K304 option, only with R&S®SMW-B9) |
| Multiple emitters (interleaved) (R&S®SMW-K306 option, only with R&S®SMW-B9) |
| Multiple emitters extension (interleaved) (R&S®SMW-K307 option, only with R&S®SMW-B9) |
| Direction finding (R&S®SMW-K308 option) |
| Pulse-on-pulse simulation (R&S®SMW-K315 option) |
| DFS signal generation (R&S®SMW-K350 option) |

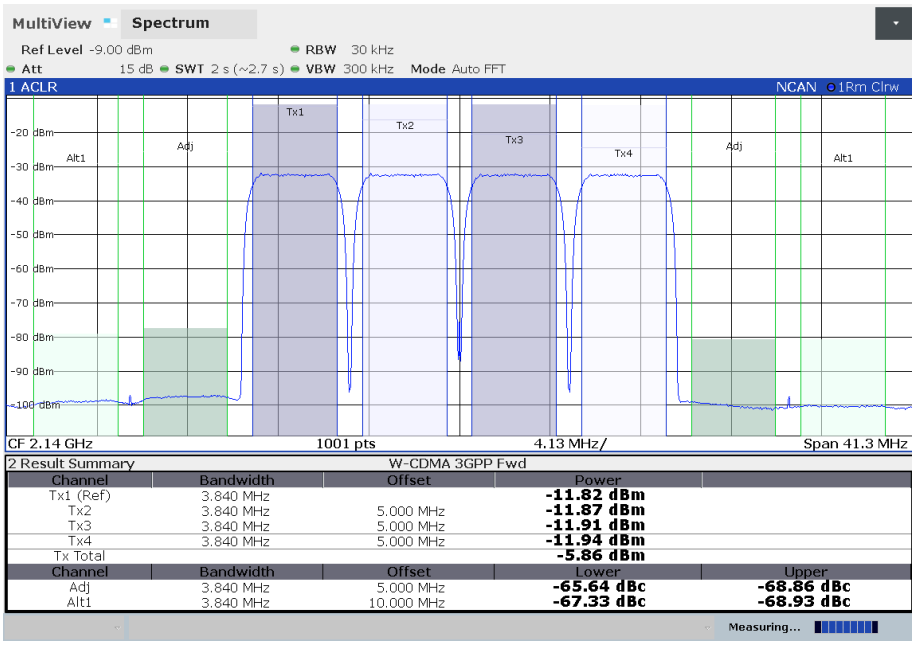
# Signal performance for digital standards and modulation systems

## 3GPP FDD (R&S®SMW-K42 option)

| | | |
|---|---|---|
| Error vector magnitude | 1 DPCH, RMS,<br>frequency = 1800 MHz to 2200 MHz | < 0.8 %, 0.3 % (meas.) |
| Adjacent channel leakage ratio (ACLR) | test model 1, 64 DPCH, frequency = 1800 MHz to 2200 MHz,<br>average channel power ≤ 3 dBm,<br>with R&S®SMW-B1003, R&S®SMW-B2003, R&S®SMW-B1006, R&S®SMW-B2006 frequency options, with R&S®SMW-B13/-B13T options | |
| | 5 MHz offset | > 70 dB |
| | 10 MHz offset | > 72 dB |
| | test model 1, 64 DPCH, frequency = 1800 MHz to 2200 MHz,<br>average channel power ≤ 0 dBm,<br>with R&S®SMW-B1007, R&S®SMW-B2007, R&S®SMW-B1012, R&S®SMW-B2012 frequency options, with R&S®SMW-B13/-B13T options | |
| | 5 MHz offset | > 68 dB |
| | 10 MHz offset | > 70 dB |
| | test model 1, 64 DPCH, frequency = 1800 MHz to 2200 MHz,<br>average channel power ≤ –2 dBm,<br>with R&S®SMW-B1020, R&S®SMW-B2020, R&S®SMW-B1031, R&S®SMW-B2031, R&S®SMW-B1040, R&S®SMW-B1040N, R&S®SMW-B1044, R&S®SMW-B2044, R&S®SMW-B1044N, R&S®SMW-B2044N frequency options,<br>with R&S®SMW-B13/-B13T options | |
| | 5 MHz offset | > 70 dB |
| | 10 MHz offset | > 72 dB |
| | test model 1, 64 DPCH, frequency = 1800 MHz to 2200 MHz,<br>average channel power ≤ –5 dBm,<br>with R&S®SMW-B1056, R&S®SMW-B1056N, R&S®SMW-B1067, R&S®SMW-B1067N frequency options,<br>with R&S®SMW-B13/-B13T options | |
| | 5 MHz offset | > 70 dB |
| | 10 MHz offset | > 72 dB |

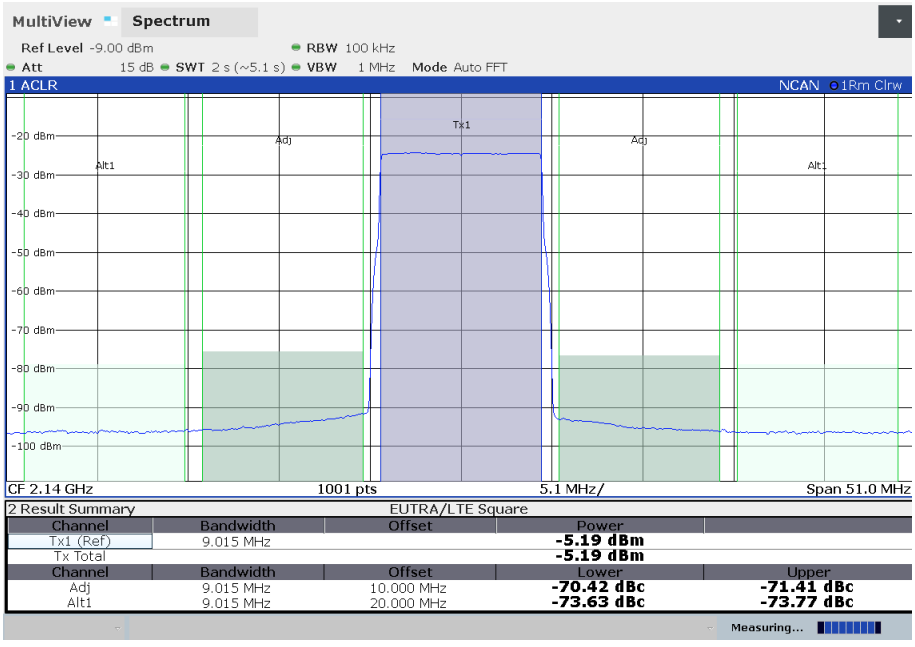



*Measured ACPR for 3GPP test model 1, 64 DPCH*



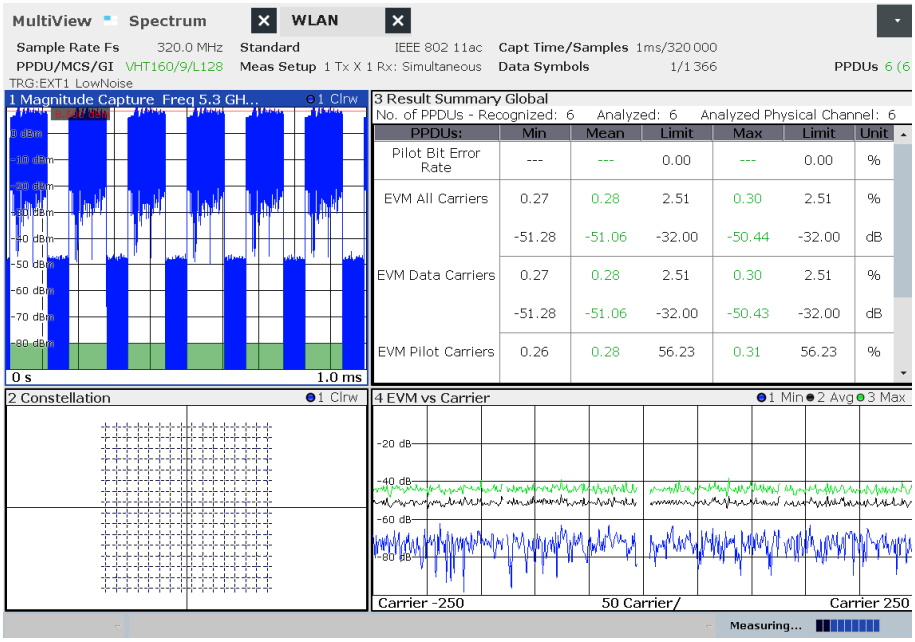

*Measured ACPR for a 3GPP four-carrier signal with test model 1, 64 DPCH on each carrier*

# EUTRA/LTE (R&S®SMW-K55 option)



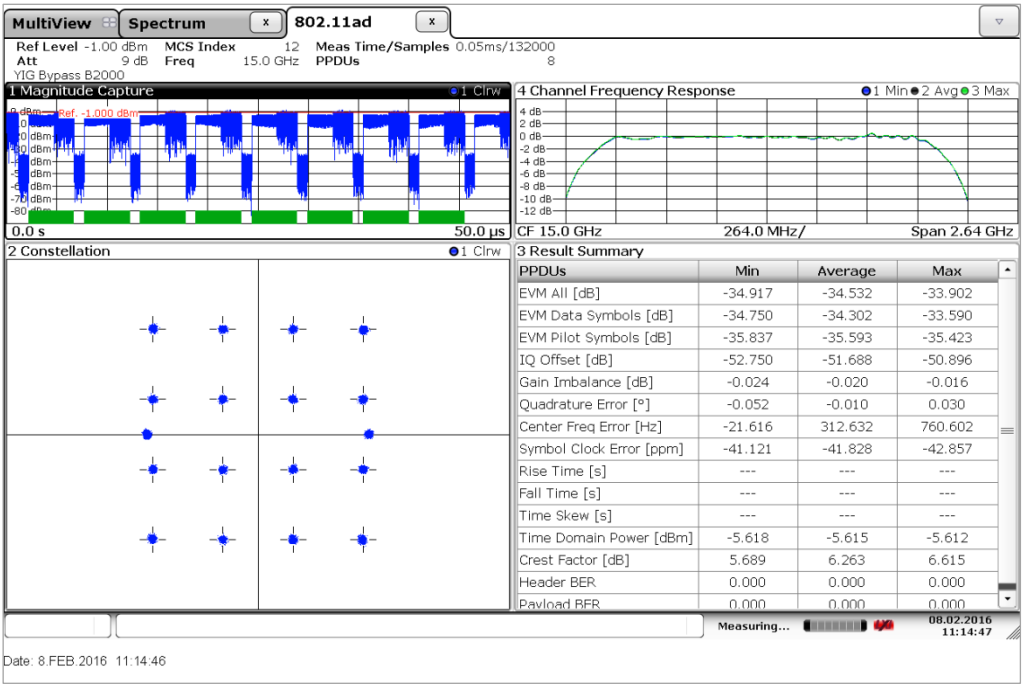

*Measured ACPR for a 10 MHz LTE test model E-TM1_1*

## IEEE 802.11ac (R&S®SMW-K86 option)



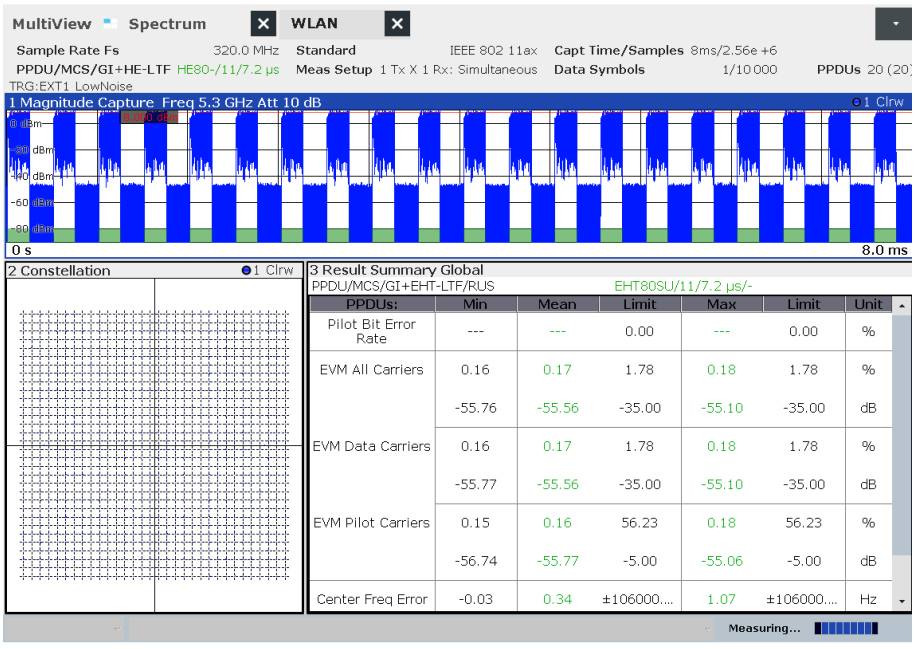

*Measured EVM for an IEEE 802.11ac signal with 160 MHz bandwidth*

## IEEE 802.11ad (R&S®SMW-K141 option)



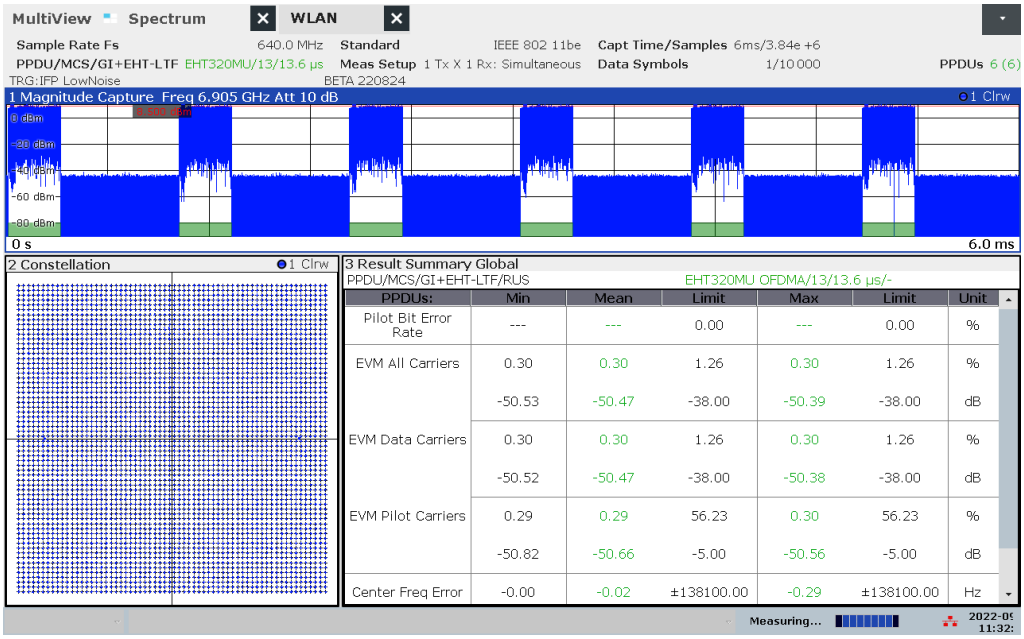

*Measured EVM for an IEEE 802.11ad signal with 1.76 GHz bandwidth (MCS12, at 15 GHz IF)*

# IEEE 802.11ax (R&S®SMW-K142 option)




*Measured EVM for an IEEE 802.11ax signal with 80 MHz bandwidth*

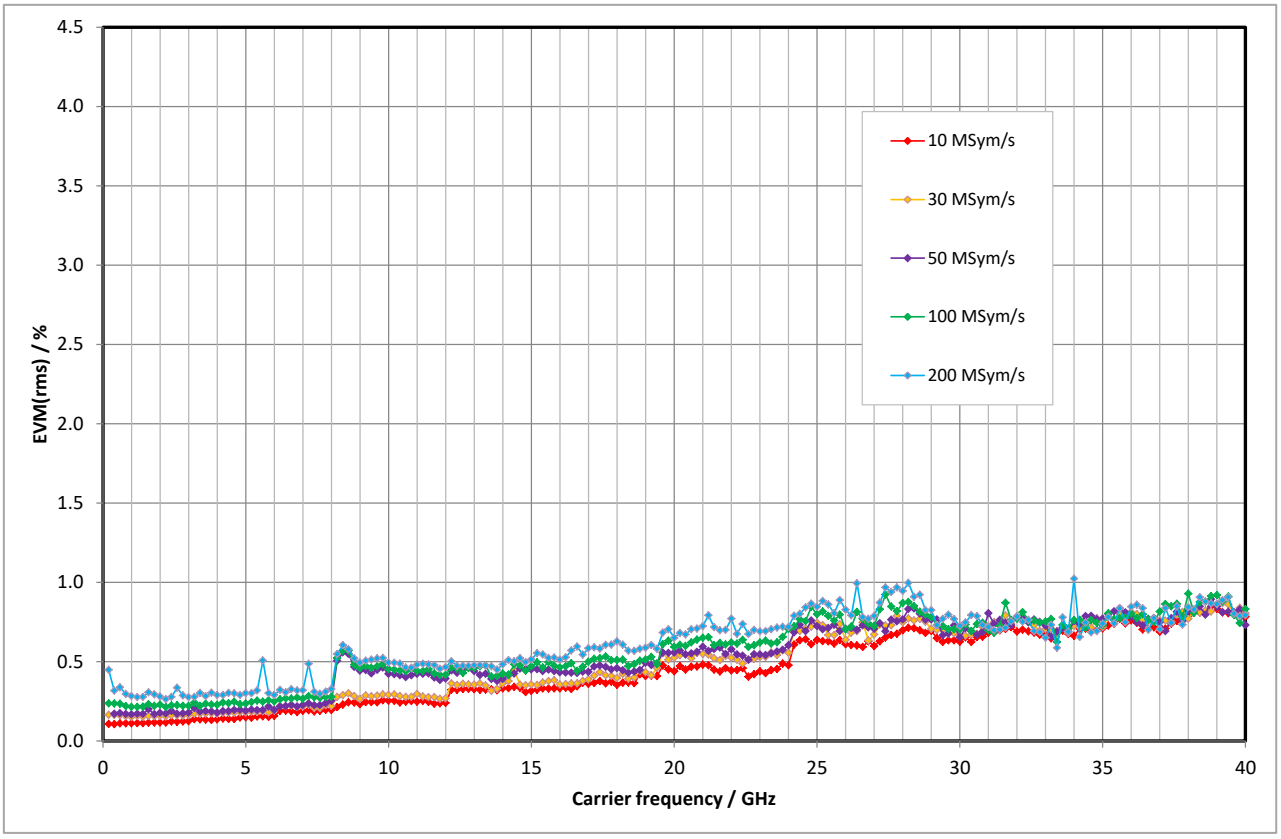
# IEEE 802.11be (R&S®SMW-K147 option)




*Measured EVM for an IEEE 802.11be signal with 320 MHz bandwidth (MCS13, f = 6.905 GHz)*

# Custom digital modulation (R&S®SMW-B9/-B10 options, real-time mode)

| | | |
|---|---|---|
| Deviation error with 2FSK, 4FSK | deviation 0.2 to 0.7 · symbol rate | |
| | Gaussian filter with B × T = 0.2 to 0.7, f = 1 GHz | |
| | symbol rate up to 2 MHz | 0.25 % (meas.) |
| | symbol rate up to 10 MHz | 0.75 % (meas.) |
| Phase error with MSK | Gaussian filter with B × T = 0.2 to 0.7, f = 1 GHz | |
| | bit rate up to 2 MHz | 0.15° (meas.) |
| | bit rate up to 10 MHz | 0.3° (meas.) |
| EVM with QPSK, OQPSK, π/4-DQPSK, 8PSK, 16QAM, 32QAM, 64QAM | cosine, root cosine filter with α = 0.2 to 0.7, f = 1 GHz | |
| | symbol rate up to 5 MHz | 0.2 % (meas.) |
| | symbol rate up to 20 MHz | 0.7 % (meas.) |




*Measured EVM versus carrier frequency for 16QAM*

# Multichannel, MIMO and fading

## Fading simulator (R&S®SMW-B14 option)

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

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

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

| | | |
|---|---|---|
| Number of installable R&S®SMW-B14 fading simulator modules | | 1, 2 or 4 |
| Number of available fading channels (logical faders) | one R&S®SMW-B14 installed | 1 |
| | two or four R&S®SMW-B14 installed | 2 |
| | with R&S®SMW-K74 option, two R&S®SMW-B14 installed | up to 4 (see R&S®SMW-K74 specifications) |
| | with R&S®SMW-K74 option, four R&S®SMW-B14 installed | up to 16 (see R&S®SMW-K74 specifications) |
| | with R&S®SMW-K74 and R&S®SMW-K75 options, four R&S®SMW-B14 installed | up to 32 (see R&S®SMW-K75 specifications) |
| Number of fading paths (per logical fader) | | 20 |
| Bandwidth | | up to 160 MHz |
| Start seed | | 0 to 9 |
| **Fading profiles** | | static path, pure Doppler, Rayleigh, Rice, constant phase, bell shape TGn indoor, bell shape TGn moving vehicle |
| Fading profile parameter | | |
| Rayleigh | pseudo-noise interval | > 1 year |
| Constant phase | phase | 0° to 360° |
| | phase resolution | 0.1° |
| Pure Doppler | maximum resulting Doppler shift | frequency ratio · current Doppler frequency |
| | frequency ratio | –1 to +1 |
| | resolution | 0.01 |
| Rician | combination of Rayleigh and pure Doppler | |
| | power ratio | –30 dB to +30 dB |
| Fading path loss | setting range | 0 dB to 50 dB |
| | setting resolution | 0.01 dB |
| | accuracy | < 0.01 dB |
| Fading path delay | The 20 fading paths are divided in 4 path groups. Each group consists of 3 fine delay and 2 standard delay paths. A basic delay can be set per path group and an additional delay per path. The total delay per path is the sum of the basic delay of the respective group and of the additional delay of the path. | |
| Basic delay per group | | |
| Group 1 | fixed value | 0 s |
| Setting range for groups 2, 3, 4 | | 0 s to 0.5 s |
| Setting resolution | scenarios with 1 to 8 fading channels | 5 ns |
| | scenarios with 9 to 16 fading channels | 10 ns |
| | scenarios with 17 to 32 fading channels | 20 ns |
| Additional delay per path | | |
| Setting range for path 1 | | 0 µs to 40.9 µs |
| Setting range for paths 2, 3, 4 and 5 | | 0 µs to 20 µs |
| Fine delay path resolution | scenarios with 1 to 8 fading channels | 2.5 ps |
| | scenarios with 9 to 16 fading channels | 5 ps |
| | scenarios with 17 to 32 fading channels | 10 ps |
| Standard delay path resolution | scenarios with 1 to 8 fading channels | 5 ns |
| | scenarios with 9 to 16 fading channels | 10 ns |
| | scenarios with 17 to 32 fading channels | 20 ns |
| Speed range | at f = 1 GHz | 0 km/h to 4320 km/h |
| | accuracy | < 0.1 % |
| Doppler frequency | setting range | 0 Hz to 4000 Hz |
| | accuracy ($f_D \geq 0.05$ Hz) | < 0.1 % |
| Restart | standard | auto, baseband trigger |
| Synchronization | only with 2×1×1 system configuration | on/off |
| Total insertion loss | automatic or user-definable, with clipping indicator | –30 dB to 30 dB |

| | | |
|---|---|---|
| Correlation | fading paths in signal path A pairwise with fading paths in signal path B | |
| | correlation coefficient | |
| | setting range | 0 % to 100 % |
| | setting resolution | 0.1 % |
| | correlation phase | |
| | setting range | 0° to 360° |
| | setting resolution | 0.05° |
| Lognormal | standard deviation | 0 dB to 12 dB |
| | resolution | 1 dB |
| | local constant | 0 m to 200 m |
| | resolution | 0.1 m |
| Predefined settings | standard | 5G NR (TDL-A, TDL-B and TDL-C),<br>LTE (CQI, EPA, EVA, ETU, MBFSN),<br>GSM, CDMA2000®, 1xEV-DO,<br>IEEE 802.11n SISO, IEEE 802.11ac SISO, WiMAX™ ITU, NADC, PCN,<br>TETRA, 3GPP models, HIPERLAN/2 |
| | with R&S®SMW-K71 option | 5G NR (HST, moving propagation),<br>LTE (HST, moving propagation),<br>3GPP FDD WCDMA (HST, moving propagation, birth-death) |
| | with R&S®SMW-K72 option | WiMAX™ SUI, DAB, |
| | with R&S®SMW-K74 option | 5G NR MIMO (TDL-A, TDL-B and TDL-C),<br>LTE MIMO (EPA, EVA, ETU),<br>IEEE 802.11n MIMO,<br>IEEE 802.11ac MIMO, WiMAX™ MIMO |
| | with R&S®SMW-K74 and R&S®SMW-K71 options | LTE MIMO (HST) |
| | with R&S®SMW-K74 and R&S®SMW-K72 options | 3GPP SCME channel models,<br>LTE MIMO SCME channel models |
| | with R&S®SMW-K74 and R&S®SMW-K73 options | 5G NR (CDL-A, CDL-B and CDL-C),<br>3GPP Geo SCME channel models,<br>LTE MIMO Geo SCME channel models |

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

This option requires the wideband baseband section, i.e. R&S®SMW-B13XT (with DACW board revision 4.00 or greater) must be installed.
At least one R&S®SMW-B9 wideband baseband generator must be installed.
All frequency and time settings are coupled to the internal reference frequency.

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

| | | |
|---|---|---|
| Number of installable R&S®SMW-B15 fading simulator modules | instrument equipped with one R&S®SMW-B9 | 1 or 2 |
| | instrument equipped with two R&S®SMW-B9 | 2 or 4 |
| Number of available fading channels (logical faders) | one R&S®SMW-B15 installed | 1 |
| | two or four R&S®SMW-B15 installed | 2 |
| | with R&S®SMW-K74 option, two R&S®SMW-B15 installed | up to 4<br>(see R&S®SMW-K74 specifications) |
| | with R&S®SMW-K74 option, four R&S®SMW-B15 installed | up to 16<br>(see R&S®SMW-K74 specifications) |
| | with R&S®SMW-K74 and R&S®SMW-K75 options, four R&S®SMW-B15 installed | up to 64<br>(see R&S®SMW-K75 specifications) |
| Number of fading paths (per logical fader) | | 20 |
| Bandwidth | | up to 200 MHz |
| | with R&S®SMW-K822 | up to 400 MHz |
| | with R&S®SMW-K823 | up to 800 MHz |
| Start seed | | 0 to 9 |

| | | |
|---|---|---|
| **Fading profiles** | | static path, pure Doppler, Rayleigh, Rice, constant phase, bell shape TGn indoor, bell shape TGn moving vehicle |
| Fading profile parameter | | |
| Rayleigh | pseudo-noise interval | > 1 year |
| Constant phase | phase | 0° to 360° |
| | phase resolution | 0.1° |
| Pure Doppler | maximum resulting Doppler shift | frequency ratio · current Doppler frequency |
| | frequency ratio | –1 to +1 |
| | resolution | 0.01 |
| Rician | combination of Rayleigh and pure Doppler | |
| | power ratio | –30 dB to +30 dB |
| Fading path loss | setting range | 0 dB to 50 dB |
| | setting resolution | 0.01 dB |
| | accuracy | < 0.01 dB |
| Fading path delay | The 20 fading paths are divided in 4 path groups. Each group consists of 3 fine delay and 2 standard delay paths. A basic delay can be set per path group and an additional delay per path. The total delay per path is the sum of the basic delay of the respective group and of the additional delay of the path. | |
| Additional delay per path | | |
| Setting range for path 1 | | 0 µs to 32.72 µs |
| Setting range for path 2, 3, 4 and 5 | | 0 µs to 16 µs |
| Fine delay path resolution (not available with R&S®SMW-K822 or R&S®SMW-K823) | scenarios with 1 to 8 fading channels | 2 ps |
| | scenarios with 9 to 16 fading channels | 4 ps |
| | scenarios with 17 to 32 fading channels | 8 ps |
| Standard delay path resolution (up to 200 MHz baseband bandwidth) | scenarios with 1 to 8 fading channels | 4 ns |
| | scenarios with 9 to 16 fading channels | 8 ns |
| | scenarios with 17 to 32 fading channels | 16 ns |
| Standard delay path resolution with R&S®SMW-K822 | scenarios with 1 to 8 fading channels | 2 ns |
| Standard delay path resolution with R&S®SMW-K823 | scenarios with 1 to 4 fading channels | 1 ns |
| Speed range | at f = 1 GHz | 0 km/h to 4320 km/h |
| | accuracy | < 0.1 % |
| Doppler frequency | setting range | 0 Hz to 4000 Hz |
| | accuracy ($f_D \geq 0.05$ Hz) | < 0.1 % |
| Restart | standard | auto, baseband trigger |
| Synchronization | only with 2×1×1 system configuration | on/off |
| Total insertion loss | automatic or user-definable, with clipping indicator | –30 dB to 30 dB |
| Correlation | fading paths in signal path A pairwise with fading paths in signal path B | |
| | correlation coefficient | |
| | setting range | 0 % to 100 % |
| | setting resolution | 0.1 % |
| | correlation phase | |
| | setting range | 0° to 360° |
| | setting resolution | 0.05° |
| Lognormal | standard deviation | 0 dB to 12 dB |
| | resolution | 1 dB |
| | local constant | 20 m to 200 m |
| | resolution | 0.1 m |

| | | |
|---|---|---|
| Predefined settings | standard | 5G NR (TDL-A, TDL-B and TDL-C),<br>LTE (CQI, EPA, EVA, ETU, MBFSN),<br>GSM, CDMA2000®, 1xEV-DO,<br>IEEE 802.11n SISO, IEEE 802.11ac SISO, WiMAX™ ITU, NADC, PCN,<br>TETRA, 3GPP models, HIPERLAN/2 |
| | with R&S®SMW-K71 option | 5G NR (HST, moving propagation),<br>LTE (HST, moving propagation),<br>3GPP (HST, moving propagation, birth-death) |
| | with R&S®SMW-K72 option | WiMAX™ SUI, DAB, Watterson,<br>IEEE 802.11p |
| | with R&S®SMW-K74 option | 5G NR MIMO (TDL-A, TDL-B and TDL-C),<br>LTE MIMO (EPA, EVA, ETU),<br>IEEE 802.11n MIMO,<br>IEEE 802.11ac MIMO, WiMAX™ MIMO |
| | with R&S®SMW-K74 and R&S®SMW-K71 options | LTE MIMO (HST) |
| | with R&S®SMW-K74 and R&S®SMW-K72 options | 3GPP SCME channel models,<br>LTE MIMO SCME channel models |
| | with R&S®SMW-K74 and R&S®SMW-K73 options | 5G NR (CDL-A, CDL-B and CDL-C),<br>3GPP Geo SCME channel models,<br>LTE MIMO Geo SCME channel models |

# Dynamic fading (R&S®SMW-K71 option)

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

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

| | | |
|---|---|---|
| **Moving delay mode, moving channels = one** | | |
| Number of fading paths | | 2 per signal path |
| Fading profiles | | none |
| Delay | | 0.15 µs to 31.85 µs |
| Delay variation | peak-to-peak | 0.3 µs to 32 µs |
| | variation period | 10 s to 500 s |
| | variation speed | 0 µs/s to 43.2 µs/s |
| Delay step size | | 4 ps |
| **Moving delay mode, moving channels = all** | | |
| Number of fading paths | | 12 per signal path |
| Fading profiles | | static path, pure Doppler, Rayleigh, constant phase |
| Basic delay | only for groups 2, 3, 4 | not implemented |
| Additional delay | path 1 | 0 µs to 32.42 µs |
| | path 2, 3 | 0 µs to 15.7 µs |
| Delay variation | peak-to-peak | 0.3 µs to 32 µs |
| | variation period | 10 s to 500 s |
| | variation speed | 0 µs/s to 5 µs/s |
| Delay step size | | 4 ps |
| **Birth-death mode** | | |
| System bandwidth | | 200 MHz |
| Number of fading paths | | 2 per signal path |
| Fading profiles | | pure Doppler |
| Delay range | | 0 s to 32 µs |
| Delay grid | | 0 s to 16 µs |
| Positions | | 3 to 50 [22] |
| Hopping dwell | | 100 ms to 5 s |
| Start offset | separately settable for each signal path | 0 ms to 200 ms |
| Delay resolution | | 1 ns |

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

| | | |
|---|---|---|
| **High-speed train** | | |
| Fading profiles | | static path, pure Doppler, Rayleigh, Rice |
| Speed | at f = 1 GHz | 0 km/h to 4320 km/h |
| D (min) | | 1 m to 150 m |
| D (s) | | 20 m to 2000 m |

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

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

| | | |
|---|---|---|
| **Moving delay mode, moving channels = one** | | |
| Number of fading paths | | 2 per signal path |
| Fading profiles | | none |
| Delay | | 0.15 µs to 39.85 µs |
| Delay variation | peak-to-peak | 0.3 µs to 40 µs |
| | variation period | 10 s to 500 s |
| | variation speed | 0 µs/s to 4 µs/s |
| Delay step size | | 5 ps |
| **Moving delay mode, moving channels = all** | | |
| Number of fading paths | | 12 per signal path |
| Fading profiles | | static path, pure Doppler, Rayleigh, constant phase |
| Basic delay | only for groups 2, 3, 4, in steps of 5 ns | 0 s to 0.5 s |
| Additional delay | path 1 | 0 µs to 40.6 µs |
| | paths 2, 3 | 0 µs to 19.7 µs |
| Delay variation | peak-to-peak | 0.3 µs to 10 µs |
| | variation period | 5 s to 200 s |
| | variation speed | 0 µs/s to 2 µs/s |
| Delay step size | | 5 ps |
| **Birth-death mode** | | |
| System bandwidth | | 160 MHz |
| Number of fading paths | | 2 per signal path |
| Fading profiles | | pure Doppler |
| Delay range | | 0 µs to 40 µs |
| Delay grid | | 0 µs to 20 µs |
| Positions | | 3 to 50 |
| Hopping dwell | | 100 ms to 5 s |
| Start offset | separately settable for each signal path | 0 ms to 200 ms |
| Delay resolution | | 1 ns |
| **High-speed train** | | |
| Fading profiles | | static path, pure Doppler, Rayleigh, Rice |
| Speed | at f = 1 GHz | 0 km/h to 4320 km/h |
| D (min) | | 1 m to 150 m |
| D (s) | | 20 m to 2000 m |
| **Two-channel interferer** | | |
| Number of fading paths | | 2 per signal path |
| **Fading profiles** | | static path, pure Doppler, Rayleigh |
| Fading profile parameter | | |
| Rayleigh | pseudo-noise interval | > 1 year |
| | phase resolution | 1° |
| Pure Doppler | maximum resulting Doppler shift | frequency ratio · current Doppler frequency |
| | frequency ratio | –1 to +1 |
| | resolution | 0.01 |
| Fading path loss | setting range | 0 dB to 50 dB |
| | setting resolution | 0.01 dB |
| | accuracy | < 0.01 dB |
| Speed range | at f = 1 GHz | 0 km/h to 4320 km/h |
| | accuracy | < 0.1 % |
| Minimum delay | path 1 | 0 µs to 1638 µs |
| | path 2 | 0 µs to 999.9 µs |
| Maximum delay | path 1 | n.a. |
| | path 2 | 0.1 µs to 1000 µs |

| | | |
|---|---|---|
| Moving mode | path 1 | n.a. |
| | path 2 | sliding, hopping |
| Dwell (hopping) | | 0.1 s to 10 s |
| Period (sliding) | | 50 s to 1000 s |

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

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

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

| **Fading profiles** | | |
|---|---|---|
| Gauss I, Gauss II | in line with DAB standard | sum of two Gaussian distributions |
| Gauss DAB 1 | in line with DAB standard | Gaussian distribution, shifted in frequency |
| Gauss Doppler | | sum of Gaussian distribution and pure Doppler |
| Gauss (0.08 $f_D$) | | Gaussian distribution, std. dev. 0.08 $f_D$ |
| Gauss (0.1 $f_D$) | | Gaussian distribution, std. dev. 0.1 $f_D$ |
| Gauss Watterson | in line with Watterson channel model | sum of two Gaussian distributions |
| WiMAX™ Doppler | in line with IEEE 802.16a-03-01 | rounded Doppler PSD model |
| WiMAX™ Rice | in line with IEEE 802.16a-03-01 | same as WiMAX™ Doppler plus pure Doppler |
| Customized fading profiles | | |
| Modified Rayleigh | spectrum shape can be modified within the maximum Doppler frequency range | customizable bandwidth, frequency offset, lower cutoff frequency, upper cutoff frequency |
| Modified flat | | |
| Predefined settings | in line with IEEE 802.16a-03-01 | SUI1 to SUI6 |
| | in line with 3GPP TS 34.121-1, annex D.2.2, table D.2.2.1A | ITU OIP-A, ITU OIP-B, ITU V-A |
| | in line with EN 50248-2001 | DAB-RA, DAB-TU, DAB-SFN |
| | in line with “Experimental Confirmation of an HF Channel Model”, Watterson, et al., IEEE transactions on communication technology, vol. com-18, no. 6, Dec. 1970” | Watterson I1, Watterson I2, Watterson I3 |
| | in line with C2C-CC channel models for IEEE 802.11p | Rural LOS, Urban Approaching LOS, Urban Crossing LOS, Highway LOS, Highway NLOS |
| | with R&S®SMW-K74 option | |
| | in line with 3GPP TR 37.977 | SCME Uma3, SCME Uma30, SCME Umi3, SCME Umi30 |
| | with R&S®SMW-K74 and R&S®SMW-K73 option | |
| | in line with 3GPP TR 38.827 | 5G NR CDL-A (Uma, Umi, InO), 5G NR CDL B (Uma, Umi), 5G NR CDL-C (Uma, Umi) |

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

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

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

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

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

Instruments with wideband baseband (R&S®SMW-B13XT):
At least one R&S®SMW-B15 fading simulator and one R&S®SMW-K71 option must be installed. If two or more R&S®SMW-B15 are installed (signal paths A and B), customized dynamic fading functions can be used either on signal path A or B with one R&S®SMW-K820 option. For dynamic fading functions to be used on signal paths A and B simultaneously or in MIMO system configurations, two R&S®SMW-K820 and two R&S®SMW-K71 options must be installed. (For each R&S®SMW-K820, an R&S®SMW-K71 must also be installed on the instrument.)

Instruments with standard baseband (R&S®SMW-B13/-B13T):
At least one R&S®SMW-B14 fading simulator and one R&S®SMW-K71 option must be installed. If two or more R&S®SMW-B14 are installed (signal paths A and B), customized dynamic fading functions can be used either on signal path A or B with one R&S®SMW-K820 option. For dynamic fading functions to be used on signal paths A and B simultaneously or in MIMO system configurations, two R&S®SMW-K820 and two R&S®SMW-K71 options must be installed. (For each R&S®SMW-K820, an R&S®SMW-K71 must also be installed on the instrument.)

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

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

| | | |
|---|---|---|
| Number of fading paths | | 12 |
| Profiles | | pure Doppler (only path 1 to 4), Rayleigh, static path |
| File format | | Rohde & Schwarz proprietary file format *.fad_udyn |
| Correlation | MIMO only | see section MIMO fading/routing (R&S®SMW-K74 option) |

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Cells with gray background: up to 80 MHz bandwidth supported for this scenario
Cells with white background: up to 40 MHz bandwidth supported for this scenario

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

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

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

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

Four R&S®SMW-B15 options, the R&S®SMW-K74 option and the R&S®SMW-K75 option must be installed.

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

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

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

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

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

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

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

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

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

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

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

Cells with gray background: up to 80 MHz bandwidth supported for this scenario
Cells with white background: up to 40 MHz bandwidth supported for this scenario

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Dynamic fading is not supported when 400 MHz fading bandwidth is used.

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

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

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

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

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

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

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

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

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

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

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

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

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

Dynamic fading is not supported when 800 MHz fading bandwidth is used.

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

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

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

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

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

**Supported scenarios with R&S®SMW-K76 and wideband baseband (**R&S®SMW-B9, R&S®SMW-B13XT)
Cells with gray background: up to 200 MHz bandwidth supported for this scenario.

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

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

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

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

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

Cells with gray background: up to 800 MHz bandwidth supported for this scenario (depends on installed R&S®SMW-K525 bandwidth extension options).

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

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

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

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

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

**Fading capabilities in R&S®SMW-K76 scenarios**

Note: The scenarios described here require the wideband baseband section, i.e. R&S®SMW-B13XT must be installed.

Individual fading can be applied to each entity based on the available fading options:

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

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

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

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

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

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

**Supported scenarios with R&S®SMW-K76 and standard baseband (R&S®SMW-B10, R&S®SMW-B13T)**

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

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

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

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

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

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

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

**Fading capabilities in R&S®SMW-K76 scenarios**

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

Individual fading can be applied to each entity based on the available fading options:

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

# Stream extender (R&S®SMW-K550 option)

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

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

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

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

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

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

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

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

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

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

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

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

| | | |
|---|---|---|
| Latest verified R&S®FSW firmware version | | 5.10 |

| **General parameters** | | |
|---|---|---|
| Number of available radar objects | one R&S®SMW-K78 option,<br>one or two R&S®SMW-B14 installed | path A: up to 6 |
| | one R&S®SMW-K78 option,<br>four R&S®SMW-B14 installed | path A: up to 12 |
| | two R&S®SMW-K78 options,<br>two R&S®SMW-B14 installed | path A: up to 6,<br>path B: up to 6 |
| | two R&S®SMW-K78 options,<br>four R&S®SMW-B14 installed | path A: up to 12,<br>path B: up to 12 |
| Bandwidth | | up to 160 MHz |
| Test setups | Radar under test (RUT) is directly connected to the R&S®SMW200A (and R&S®FSW) via cable. | conducted test |
| | RUT and R&S®SMW200A (+ R&S®FSW) are equipped with antennas and connected via air interface. | over-the-air (OTA) test |
| Radar RX power setting | calculation of power received by RUT regarding two-way radar equation | radar equation |
| | power received by RUT is set manually | manual |
| **Radar setup** | Availability of parameters depends on transmit signal mode, test setup and radar RX power setting. | |
| Radar TX power | | |
| Setting range | may be limited by setting range of reference level of R&S®FSW | –50 dBm to +100 dBm |
| Setting resolution | | 0.001 dBm |
| Radar antenna TX gain | | |
| Setting range | may be limited by setting range of reference level of R&S®FSW | 0 dBi to 100 dBi |
| Setting resolution | | 0.001 dBi |
| Radar antenna RX gain | | |
| Setting range | | 0 dBi to 100 dBi |
| Setting resolution | | 0.001 dBi |
| System loss | | |
| Setting range | | 0 dB to 100 dB |
| Setting resolution | | 0.001 dB |
| Pulse repetition frequency (PRF) | | |
| Setting range | | 0.001 kHz to 1 000 kHz |
| Setting resolution | | 0.001 kHz |
| Pulse repetition interval (PRI) | | |
| Setting range | | 0.0374742 ms to 1 000 ms |
| Setting resolution | | 0.01 ms |
| Scan period | | |
| Setting range | | 0.0374742 ms to 10 000 ms |
| Setting resolution | | 0.01 ms |
| REG antenna RX gain | | |
| Setting range | may be limited by setting range of reference level of R&S®FSW | 0 dBi to 100 dBi |
| Setting resolution | | 0.001 dBi |
| REG antenna TX gain | | |
| Setting range | | 0 dBi to 100 dBi |
| Setting resolution | | 0.001 dBi |
| OTA range offset | | |
| Setting range | may be limited by setting range of reference level of R&S®FSW | 0.01 m to 50 000 m |
| Setting resolution | | 0.01 m |
| External attenuator (analyzer) | | |
| Setting range | maybe limited by setting range of reference level of R&S®FSW | –58 dB to +318 dB |
| Setting resolution | | 0.001 dB |

| | | |
|---|---|---|
| **Simulation setup** | | |
| System latency calibration | R&S®SMW-K78 measures the internal system (R&S®FSW + R&S®SMW200A) latency automatically. (Only available in transmit signal mode: external baseband via R&S®FSW + R&S®SMW-B10) | automatic |
| | user measures internal latency with external equipment (e.g. oscilloscope) and sets the system latency value manually | manual |
| System latency | | |
| Measured system latency | with R&S®SMW200A and R&S®FSW | 2100 m (meas.) |
| Setting range | system latency calibration: manual | 0 m to 3 000 m |
| Setting resolution | system latency calibration: manual | 0.01 m |
| Correction value | system latency calibration: automatic | |
| Setting range | | –100 m to +100 m |
| Setting resolution | | 0.01 m |
| Maximum uncertainty | | ±2.5 m |
| Use underrange | allows simulating objects at a range closer than the warranted range lower limit (but not closer than defined by the system latency) | on |
| | no influence | off |
| Use radar range ambiguity to reduce minimum range | All pulses per object are delayed so that a minimum range of 0.1 m is virtually possible (only for constant PRF). | on |
| | All pulses per object are delayed with regard to set range. | off |
| **Object configuration** | | |
| Object type | arbitrary object types can run at the same time | |
| | echo is not generated | off |
| | echo for objects with variable range and constant velocity > 0 m/s is generated<br>use different doppler frequency for all spectral parts | moving |
| | echo for objects with constant range and no velocity is generated | static |
| | echo for objects with constant range and constant velocity > 0 m/s is generated<br>use same doppler frequency for all spectral parts | static + moving |
| Parameters common to all object types | | |
| Object name | | define 15-digit name |
| Range | | |
| Setting range | use radar range ambiguity to reduce minimum range: off | |
| | use underrange: off | 2.1 km to 10 000 km |
| | use underrange: on | “system latency” to 10 000 km |
| | use radar range ambiguity to reduce minimum range: on | 0.0001 km to 10 000 km |
| | maximum difference in range (between start range and end range) | depends on simulation mode and RCS model |
| Setting resolution | | 0.1 m |
| Phase offset | | |
| Setting range | | 0.0° to 359.9° |
| Setting resolution | | 0.1° |
| Radar RX power of start/end range | radar RX power setting: radar equation | |
| Setting range | may be limited by maximum output level of R&S®SMW200A | calculated with radar equation |
| Setting resolution | | 0.1 dBm |
| Radar RX power | radar RX power setting: manual | |
| Setting range | may be limited by maximum output level of R&S®SMW200A | –145 dBm to +30 dBm |
| Setting resolution | | 0.001 dBm |

| | | |
|---|---|---|
| Parameters for moving objects | | |
| Simulation mode | object remains at end range (i.e. appears as static object) | one way |
| | object jumps back to its start range within 1 s (only available for difference in range ≤ 6000 m) | cyclic |
| | object moves back to start position with set velocity after reaching its end position | round trip |
| Object velocity | | |
| Setting range (object 1, 2, 3 and 7, 8, 9) | the maximum Doppler shift of 10 MHz must not be exceeded | 0.001 ms to $v_{max}$,<br>$v_{max}$ = 2000 m/s or (10 MHz / 2 · f) · c, whichever is lower |
| Setting range (object 4, 5, 6 and 10, 11, 12) | the maximum Doppler shift of 190 kHz must not be exceeded | 0.001 ms to $v_{max}$,<br>$v_{max}$ = 2 000 m/s or (190 kHz / 2 · f) · c, whichever is lower |
| Setting resolution | | 0.001 m/s |
| Radar RX power dedicated to | radar RX power setting: manual | |
| | radar RX power is set for start range; RX power for end range is calculated with radar equation | start range |
| | radar RX power is set for end range; RX power for start range is calculated with radar equation | end range |
| | radar RX power equal at all ranges | all ranges |
| Parameters for static + moving objects | | |
| Object velocity | | |
| Setting range (object 1, 2, 3 and 7, 8, 9) | the maximum Doppler shift of 10 MHz must not be exceeded | 0.001 ms to $v_{max}$,<br>$v_{max}$ = (10 MHz / 2 · f) · c,<br>i.e.<br>$v_{max}$ = 499654 m/s for f = 3 GHz,<br>$v_{max}$ = 74948 m/s for f = 20 GHz,<br>$v_{max}$ = 37474 m/s for f = 40 GHz |
| Setting range (object 4, 5, 6 and 10, 11, 12) | the maximum Doppler shift of 190 kHz must not be exceeded | 0.001 ms to $v_{max}$,<br>$v_{max}$ = (190 kHz / 2 · f) · c,<br>i.e.<br>$v_{max}$ = 9 493 m/s for f = 3 GHz,<br>$v_{max}$ = 1 424 m/s for f = 20 GHz,<br>$v_{max}$ = 712 m/s for f = 40 GHz |
| Setting resolution | | 0.001 m/s |
| Direction | object flies toward RUT | approaching |
| | object flies away from RUT | departing |

# Health and utilization monitoring service (HUMS) (R&S®SMW-K980 option)

| | | |
|---|---|---|
| Interfaces | protocols and interfaces supported for data readout and display | • SNMP (v1, v2c, v3)<br>• REST (JSON)<br>• SCPI<br>• device web |
| Services | information provided | • device information (model, serial number, BIOS, date, time, system, HUMS and software information)<br>• user-defined information tags (e.g. for asset management)<br>• equipment information (hardware, options, software, licenses)<br>• system operating status<br>• instrument security information<br>• service related information (due dates etc.)<br>• mass storage related information<br>• instrument utilization data<br>• device history (event log) |

# Remote control

| | | |
|---|---|---|
| Interfaces | remote control | IEC 60625 (GPIB IEEE-488.2) |
| | Ethernet/LAN | 10/100/1000BASE-T |
| | USB | 3.0 (super speed) |
| | serial | RS-232 [23] |
| Command set | | SCPI 1999.5 or compatible command sets |
| IEC/IEEE bus address | | 0 to 30 |
| Ethernet/LAN protocols and services | | • VISA VXI-11 (remote control)<br>• Telnet/RawEthernet (remote control)<br>• VNC (remote operation with web browser)<br>• FTP (file transfer protocol)<br>• SMB (mapping parts of the instrument to a host file system) |
| Ethernet/LAN addressing | | DHCP, static, support of ZeroConf and M-DNS to facilitate direct connection to a system controller |
| USB protocol | | VISA USB-TMC |

[23] Requires the R&S®TS-USB1 serial adapter (recommended extra).

# Connectors

## Front panel connectors

The following connectors are located on the front panel of the instrument.

| | | |
|---|---|---|
| RF 50 Ω (path A) | RF output path A | |
| | R&S®SMW-B1003, R&S®SMW-B1006, R&S®SMW-B1007 | N female |
| | R&S®SMW-B1012, R&S®SMW-B1020, R&S®SMW-B1031, R&S®SMW-B1040, R&S®SMW-B1040N | test port adapter, PC 2.92 mm female (interchangeable port connector system) |
| | R&S®SMW-B1044, R&S®SMW-B1044N | PC 1.85 mm male (adapter 1.85 mm female/female included) [24] |
| | R&S®SMW-B1056, R&S®SMW-B1056N, R&S®SMW-B1067, R&S®SMW-B1067N | 1.85 mm female (instrument equipped with interchangeable 1.85 mm female/female wear and tear adapter [24]) |
| RF 50 Ω (path B) | RF output path B | |
| | R&S®SMW-B2003, R&S®SMW-B2006, R&S®SMW-B2007 | N female |
| | R&S®SMW-B2012, R&S®SMW-B2020, R&S®SMW-B2031 | test port adapter, PC 2.92 mm female (interchangeable port connector system) |
| | R&S®SMW-B2044, R&S®SMW-B2044N | PC 1.85 mm male (1.85 mm female/female adapter included) [24] |
| I (path A) | I modulation input signal, path A | BNC female |
| Q (path A) | Q modulation input signal, path A | BNC female |
| I (path B) | I modulation input signal, path B | BNC female |
| Q (path B) | Q modulation input signal, path B | BNC female |
| USER 1, USER 2, USER 3 | user-configurable inputs or outputs, e.g. as trigger input or marker output | BNC female |
| SENSOR | connector for R&S®NRP-Zxx power sensor | 6-pin ODU MINI-SNAP® series B |
| USB | USB 2.0 connector for external USB devices such as mouse, keyboard, R&S®NRP-Zxx power sensors (with R&S®NRP-Z4 adapter cable), memory stick for software update and data exchange, or USB serial adapter for RS-232 remote control | USB type A |

[24] The factory calibration plane is at the output of the female/female adapter.

## Rear panel connectors

| | | |
|---|---|---|
| REF IN | reference frequency input | BNC female |
| REF OUT | reference frequency output | BNC female |
| INST TRG A | trigger input for RF path A,<br>e.g. for frequency or level sweep | BNC female |
| INST TRG B | trigger input for RF path B,<br>e.g. for frequency or level sweep | BNC female |
| USER 4, USER 5, USER 6 | user-configurable inputs or outputs,<br>e.g. as trigger input or marker output | BNC female |
| EFC | input for electronic tuning of internal reference frequency | BNC female |
| LO IN | phase-coherent LO input | SMA female |
| LO OUT | phase-coherent LO output | SMA female |
| IEEE 488 | remote control of instrument via GPIB | 24-pin Amphenol series 57 female |
| DISPLAY PORT | for future use | |
| HDMI | for future use | |
| LAN | provides remote control functionality and other services, see section Remote control | RJ-45 |
| USB DEVICE | USB 3.0 (super speed) remote control of instrument (USB-TMC) | USB type B |
| USB | USB 3.1 (10 Gbit/s super speed ports) connector for external USB devices such as mouse and keyboard for enhanced operation,<br>R&S®NRP-Zxx power sensors (with R&S®NRP-ZKU USB interface cable) for external power measurements and level adjustment of instrument,<br>memory stick for software update and data exchange,<br>USB serial adapter for RS-232 remote control | USB type A |
| IEEE 488 | remote control of instrument via GPIB | 24-pin Amphenol series 57 female |
| EXT 1, EXT 2 | inputs for external analog modulation signals | BNC female |
| DIG I/Q OUT 1, DIG I/Q OUT 2 | digital output connectivity in line with R&S®Digital I/Q Interface | 26-pin MDR |
| HS DIG I/Q OUT 1, HS DIG I/Q OUT 2 | high speed digital output connectivity in line with R&S®Digital I/Q Interface (R&S®SMW-B13XT only) | QSFP+/QSFP 28 |
| Analog I/Q outputs | | |
| I/LF OUT 1 | analog I output | BNC female |
| | alternative function: LF generator output | |
| I-bar 1 | analog I-bar output | BNC female |
| Q/LF OUT 2 | analog Q output | BNC female |
| | alternative function: LF generator output | |
| Q-bar 1 | analog Q-bar output | BNC female |
| $\overline{I}$, I, Q, $\overline{Q}$ | second set of analog I, I-bar, Q, Q-bar outputs | BNC female |
| **Connectors on standard baseband generator and fading simulator modules** | | |
| T/M/C 1, T/M/C 4 | multipurpose input/output connectors; configurable as trigger input, marker output or clock input or output | BNC female |
| T/M 2, T/M 3, T/M 5, T/M 6 | multipurpose input/output connectors; configurable as trigger input or marker output | BNC female |
| DIG IQ IN/OUT 1, DIG IQ IN/OUT 2 | digital input or output connectivity in line with R&S®Digital I/Q Interface | 26-pin MDR |
| **Connectors on wideband baseband generator modules** | | |
| T/M/C 1, T/M/C 3 | for future use | BNC female |
| T/M 2, T/M 4 | for future use | BNC female |
| DIG IQ IN/OUT 1, DIG IQ IN/OUT 2 | for future use | 26-pin MDR |
| HS DIG IQ IN/OUT 1,<br>HS DIG IQ IN/OUT 2 | high-speed digital input connectivity in line with R&S®Digital I/Q Interface | QSFP+/QSFP 28 |

# General data

| | | |
|---|---|---|
| **Power rating** | | |
| Rated voltage | | 100 V to 240 V AC |
| Rated current | with R&S®SMW-B13/-B13T options | 7.3 A to 4.6 A |
| | with R&S®SMW-B13XT or R&S®SMW-B94L options | 8.9 A to 4.9 A |
| Rated frequency | with R&S®SMW-B13/-B13T options | 50 Hz to 60 Hz, 400 Hz |
| | with R&S®SMW-B13XT or R&S®SMW-B94L option | |
| | 100 V to 240 V | 50 Hz to 60 Hz |
| | 100 V to 120 V | 400 Hz |
| Rated power | when fully equipped | 550 W (meas.) |
| | with R&S®SMW-B94L option, when fully equipped | 750 W (meas.) |
| **Environmental conditions** | | |
| Temperature range | operating | +5 °C to +45 °C |
| | operating, with R&S®SMW-B93 option | 0 °C to +45 °C |
| | operating, with R&S®SMW-B1044, R&S®SMW-B2044, R&S®SMW-B1044N, R&S®SMW-B2044N, R&S®SMW-B1056, R&S®SMW-B1056N, R&S®SMW-B1067, R&S®SMW-B1067N options | +10 °C to +35 °C |
| | storage | –40 °C to +60 °C<br>temperature gradient < 5 K/hour |
| Damp heat | | +40 °C, 90 % rel. humidity, steady state, in line with EN 60068-2-78 |
| Altitude | operating | 4600 m |
| **Mechanical resistance** | | |
| Vibration | sinusoidal | 5 Hz to 55 Hz, 0.15 mm amplitude const.,<br>55 Hz to 150 Hz, 0.5 g const.,<br>in line with EN 60068-2-6 |
| | random | 8 Hz to 500 Hz,<br>acceleration: 1.2 g RMS,<br>in line with EN 60068-2-64 |
| Shock | | 40 g shock spectrum,<br>in line with MIL-STD-810E,<br>method no. 516.4, procedure I |
| **Product conformity** | | |
| Electromagnetic compatibility | EU: in line with EMC directive 2014/30/EC | applied harmonized standards:<br>• EN 61326-1 (for use in industrial environment)<br>• EN 61326-2-1<br>• EN 55011 (class B)<br>• EN 61000-3-2<br>• EN 61000-3-3 |
| | EU: in line with EMC directive 2014/30/EC;<br>with R&S®SMW-K18, R&S®SMW-K19 options | applied harmonized standards:<br>• EN 61326-1 (for use in industrial environment)<br>• EN 61326-2-1<br>• EN 55011 (class A)<br>• EN 61000-3-2<br>• EN 61000-3-3 |
| Electrical safety | EU: in line with low voltage directive 2014/35/EC | applied harmonized standard:<br>EN 61010-1 |
| | USA | UL 61010-1 |
| | Canada | CAN/CSA-C22.2 No. 61010-1 |
| RoHS | EU: in line with directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment | EN IEC 63000 |
| International certification | VDE – Association for Electrical, Electronic and Information Technologies | GS mark 40036426 |
| | CSA – Canadian Standard Association | $_{C}$CSA$_{US}$ mark 2571181 |

| | | |
|---|---|---|
| **Dimensions and weight** | | |
| Dimensions | W × H × D | 435 mm × 192 mm × 460 mm<br>(17.1 in × 7.6 in × 18.1 in) |
| | with R&S®SMW-B94L option,<br>W × H × D | 435 mm × 192 mm × 560 mm<br>(17.1 in × 7.6 in × 22 in) |
| Weight | when fully equipped | 21 kg (46.3 lb) |
| | with R&S®SMW-B94L option, when fully equipped | 30 kg (66.1 lb) |
| **Non-volatile memory** | standard | HDD, 500 Gbyte |
| | with R&S®SMW-B93 option | SSD, 256 Gbyte |
| **Calibration interval** | | |
| Recommended calibration interval | operation 40 h/week in full range of specified environmental conditions | 3 years |

# Ordering information

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

| Designation | Type | Order No. |
|---|---|---|
| **Vector signal generator** [25]<br>including power cable and quick start guide | R&S®SMW200A | 1412.0000.02 |
| **Options** | | |
| Frequency options, RF path A | | |
| 100 kHz to 3 GHz | R&S®SMW-B1003 | 1428.4700.02 |
| 100 kHz to 6 GHz | R&S®SMW-B1006 | 1428.4800.02 |
| 100 kHz to 7.5 GHz | R&S®SMW-B1007 | 1428.7700.02 |
| 100 kHz to 12.75 GHz | R&S®SMW-B1012 | 1428.4900.02 |
| 100 kHz to 20 GHz | R&S®SMW-B1020 | 1428.5107.02 |
| 100 kHz to 31.8 GHz | R&S®SMW-B1031 | 1428.5307.02 |
| 100 kHz to 40 GHz | R&S®SMW-B1040 | 1428.8506.02 |
| 100 kHz to 40 GHz, I/Q modulation bandwidth and minimum pulse width limited | R&S®SMW-B1040N | 1428.8606.02 |
| 100 kHz to 44 GHz | R&S®SMW-B1044 | 1428.5507.02 |
| 100 kHz to 44 GHz, I/Q modulation bandwidth and minimum pulse width limited | R&S®SMW-B1044N | 1428.5407.02 |
| 100 kHz to 56 GHz | R&S®SMW-B1056 | 1438.9357.02 |
| 100 kHz to 56 GHz, I/Q modulation bandwidth and minimum pulse width limited | R&S®SMW-B1056N | 1438.9457.02 |
| 100 kHz to 67 GHz | R&S®SMW-B1067 | 1428.8106.02 |
| 100 kHz to 67 GHz, I/Q modulation bandwidth and minimum pulse width limited | R&S®SMW-B1067N | 1428.8306.02 |
| | | |
| Baseband main modules | | |
| Signal routing and baseband main module, one I/Q path to RF | R&S®SMW-B13 | 1413.2807.02 |
| Signal routing and baseband main module, two I/Q paths to RF | R&S®SMW-B13T | 1413.3003.02 |
| Wideband baseband main module, two I/Q paths to RF | R&S®SMW-B13XT | 1413.8005.02 |
| | | |
| Phase noise performance options, RF path A | | |
| Low phase noise, for RF path A | R&S®SMW-B709 | 1428.7300.02 |
| Improved close-in phase noise performance, for RF path A | R&S®SMW-B710 | 1428.6503.02 |
| Ultra low phase noise, for RF path A | R&S®SMW-B711 | 1428.6703.02 |
| | | |
| Platform options | | |
| Deeper chassis [26] | R&S®SMW-B94L | 1438.8150.02 |
| | | |
| Frequency options, RF path B | | |
| 100 kHz to 3 GHz | R&S®SMW-B2003 | 1428.5707.02 |
| 100 kHz to 6 GHz | R&S®SMW-B2006 | 1428.5807.02 |
| 100 kHz to 7.5 GHz | R&S®SMW-B2007 | 1428.7900.02 |
| 100 kHz to 12.75 GHz | R&S®SMW-B2012 | 1438.8950.02 |
| 100 kHz to 20 GHz | R&S®SMW-B2020 | 1428.6103.02 |
| 100 kHz to 31.8 GHz | R&S®SMW-B2031 | 1438.8750.02 |
| 100 kHz to 44 GHz | R&S®SMW-B2044 | 1438.8350.02 |
| 100 kHz to 44 GHz, I/Q modulation bandwidth and minimum pulse width limited | R&S®SMW-B2044N | 1438.8550.02 |
| | | |
| Phase noise performance options, RF path B | | |
| Low phase noise, for RF path B | R&S®SMW-B719 | 1428.7500.02 |
| Improved close-in phase noise performance, for RF path B | R&S®SMW-B720 | 1428.6903.02 |
| Ultra low phase noise, for RF path B | R&S®SMW-B721 | 1428.7100.02 |
| | | |

[25] The base unit can only be ordered with an R&S®SMW-B10xx frequency option and an R&S®SMW-B13 or R&S®SMW-B13T or R&S®SMW-B13XT signal routing and baseband main module.

[26] This option is required (and only possible) for RF path combinations 2 × 12.75 GHz, 2 × 31.8 GHz and 2 × 44 GHz; see section Frequency options and RF path combinations.

| Designation | Type | Order No. |
|---|---|---|
| Other RF options | | |
| Phase coherence | R&S®SMW-B90 | 1413.5841.02 |
| Pulse modulator | R&S®SMW-K22 | 1413.3249.02 |
| Pulse generator | R&S®SMW-K23 | 1413.3284.02 |
| Multifunction generator | R&S®SMW-K24 | 1413.3332.02 |
| Automated RF port alignment | R&S®SMW-K545 | 1414.6429.02 |
| External frontend control | R&S®SMW-K553 | 1414.6758.02 |
| 100 MHz, 1 GHz ultra low noise reference input/output | R&S®SMW-K703 | 1413.7380.02 |
| Flexible reference input (1 MHz to 100 MHz) | R&S®SMW-K704 | 1414.6541.02 |
| AM/FM/PM | R&S®SMW-K720 | 1413.7438.02 |
| Differential analog I/Q inputs | R&S®SMW-K739 | 1413.7167.02 |
| | | |
| Standard baseband | | |
| Standard baseband generator with ARB (64 Msample) and digital modulation (real-time), 120 MHz RF bandwidth | R&S®SMW-B10 | 1413.1200.02 |
| Standard baseband generator, for GNSS with high dynamics, with ARB (64 Msample) and digital modulation (real-time), 120 MHz RF bandwidth | R&S®SMW-B10F | 1414.4303.02 |
| Differential analog I/Q outputs | R&S®SMW-K16 | 1413.3384.02 |
| Digital baseband output | R&S®SMW-K18 | 1413.3432.02 |
| Extended sequencing | R&S®SMW-K501 | 1413.9218.02 |
| ARB memory extension to 512 Msample | R&S®SMW-K511 | 1413.6860.02 |
| ARB memory extension to 1 Gsample | R&S®SMW-K512 | 1413.6919.02 |
| Baseband extension to 160 MHz RF bandwidth | R&S®SMW-K522 | 1413.6960.02 |
| Wideband baseband | | |
| Wideband baseband generator with ARB (256 Msample), 500 MHz RF bandwidth | R&S®SMW-B9 | 1413.7350.02 |
| Wideband baseband generator with ARB (256 Msample), 500 MHz RF bandwidth | R&S®SMW-B9F | 1434.7808.02 |
| Wideband differential analog I/Q outputs | R&S®SMW-K17 | 1414.2346.02 |
| Digital baseband output, for R&S®SMW200A wideband baseband | R&S®SMW-K19 | 1414.3865.02 |
| Wideband extended sequencing | R&S®SMW-K502 | 1413.9260.02 |
| Real-time control interface | R&S®SMW-K503 | 1414.3620.02 |
| Real-time control interface with enhanced PDW rate and control PDWs | R&S®SMW-K504 | 1414.3665.02 |
| Agile sequencing | R&S®SMW-K506 | 1413.3555.02 |
| ARB Ethernet upload | R&S®SMW-K507 | 1414.6206.02 |
| ARB memory extension to 2 Gsample | R&S®SMW-K515 | 1413.9360.02 |
| Baseband extension to 1 GHz RF bandwidth | R&S®SMW-K525 | 1414.6129.02 |
| Baseband extension to 2 GHz RF bandwidth | R&S®SMW-K527 | 1414.6158.02 |
| | | |
| Baseband enhancements | | |
| Additive white gaussian noise (AWGN) | R&S®SMW-K62 | 1413.3484.02 |
| Bit error rate tester | R&S®SMW-K80 | 1414.6187.02 |
| Envelope tracking | R&S®SMW-K540 | 1413.7215.02 |
| AM/AM, AM/PM predistortion | R&S®SMW-K541 | 1413.7267.02 |
| User-defined frequency response correction | R&S®SMW-K544 | 1414.3707.02 |
| Digital Doherty | R&S®SMW-K546 | 1414.6487.02 |
| Crest factor reduction | R&S®SMW-K548 | 1414.6641.02 |
| Slow I/Q | R&S®SMW-K551 | 1413.9724.02 |
| Bandwidth extension | R&S®SMW-K555 | 1414.6229.02 |
| Enhanced noise generation | R&S®SMW-K810 | 1414.6341.02 |
| Notched signals | R&S®SMW-K811 | 1414.6364.02 |

| Designation | Type | Order No. |
|---|---|---|
| Multichannel, MIMO and fading | | |
| Fading simulator | R&S®SMW-B14 | 1413.1500.02 |
| Fading simulator and signal processor | R&S®SMW-B15 | 1414.4710.02 |
| Dynamic fading | R&S®SMW-K71 | 1413.3532.02 |
| Enhanced fading models | R&S®SMW-K72 | 1413.3584.02 |
| OTA-MIMO fading enhancements | R&S®SMW-K73 | 1414.2300.02 |
| MIMO fading/routing | R&S®SMW-K74 | 1413.3632.02 |
| Higher-order MIMO | R&S®SMW-K75 | 1413.9576.02 |
| Multiple entities | R&S®SMW-K76 | 1413.9624.02 |
| Radar echo generation | R&S®SMW-K78 | 1414.1833.02 |
| Stream extender | R&S®SMW-K550 | 1413.7315.02 |
| Customized dynamic fading | R&S®SMW-K820 | 1414.2581.02 |
| MIMO subsets, for higher-order MIMO | R&S®SMW-K821 | 1414.4403.02 |
| Fading bandwidth extension to 400 MHz | R&S®SMW-K822 | 1414.6712.02 |
| Fading bandwidth extension to 800 MHz | R&S®SMW-K823 | 1414.6735.02 |
| | | |
| Digital standards | | |
| GSM/EDGE | R&S®SMW-K40 | 1413.3684.02 |
| EDGE Evolution | R&S®SMW-K41 | 1413.3732.02 |
| 3GPP FDD | R&S®SMW-K42 | 1413.3784.02 |
| GPS | R&S®SMW-K44 | 1413.3832.02 |
| CDMA2000® | R&S®SMW-K46 | 1413.3884.02 |
| 1xEV-DO | R&S®SMW-K47 | 1413.3932.02 |
| TD-SCDMA | R&S®SMW-K50 | 1413.4039.02 |
| TD-SCDMA enhanced BS/MS tests | R&S®SMW-K51 | 1413.4080.02 |
| DVB-H/DVB-T | R&S®SMW-K52 | 1413.6090.02 |
| IEEE 802.11 (a/b/g/n) | R&S®SMW-K54 | 1413.4139.02 |
| LTE Release 8 | R&S®SMW-K55 | 1413.4180.02 |
| Bluetooth® EDR | R&S®SMW-K60 | 1413.4239.02 |
| Multicarrier CW signal generation | R&S®SMW-K61 | 1413.4280.02 |
| Galileo | R&S®SMW-K66 | 1413.4380.02 |
| TETRA Release 2 | R&S®SMW-K68 | 1413.4439.02 |
| LTE closed-loop BS test | R&S®SMW-K69 | 1413.4480.02 |
| Log file generation | R&S®SMW-K81 | 1413.4539.02 |
| 3GPP FDD HSPA/HSPA+, enhanced BS/MS tests | R&S®SMW-K83 | 1413.4580.02 |
| LTE Release 9 | R&S®SMW-K84 | 1413.5435.02 |
| LTE Release 10 (LTE-Advanced) | R&S®SMW-K85 | 1413.5487.02 |
| IEEE 802.11ac | R&S®SMW-K86 | 1413.5635.02 |
| 1xEV-DO Rev. B | R&S®SMW-K87 | 1413.6519.02 |
| NFC A/B/F | R&S®SMW-K89 | 1413.6619.02 |
| GLONASS | R&S®SMW-K94 | 1414.1485.02 |
| IRNSS | R&S®SMW-K97 | 1414.6258.02 |
| Modernized GPS | R&S®SMW-K98 | 1414.1533.02 |
| SBAS/QZSS | R&S®SMW-K106 | 1414.2923.02 |
| BeiDou | R&S®SMW-K107 | 1414.1585.02 |
| Real-world scenarios | R&S®SMW-K108 | 1414.2975.02 |
| GNSS real-time interfaces (RT remote control) | R&S®SMW-K109 | 1414.3013.02 |
| GBAS | R&S®SMW-K111 | 1414.3059.02 |
| LTE Release 11 | R&S®SMW-K112 | 1413.8505.02 |
| LTE Release 12 | R&S®SMW-K113 | 1414.1933.02 |
| OFDM signal generation | R&S®SMW-K114 | 1414.1985.02 |
| Cellular IoT Release 13 | R&S®SMW-K115 | 1414.2723.02 |
| DVB-S2/DVB-S2X | R&S®SMW-K116 | 1414.2630.02 |
| Bluetooth® 5.x | R&S®SMW-K117 | 1414.3336.02 |
| Verizon 5GTF signals | R&S®SMW-K118 | 1414.3465.02 |
| LTE Release 13/14/15 | R&S®SMW-K119 | 1414.3542.02 |
| RTK virtual reference station | R&S®SMW-K122 | 1414.6993.02 |
| Modernized GLONASS | R&S®SMW-K123 | 1413.3310.02 |
| P(Y)-/M-/PRS-noise | R&S®SMW-K128 | 1413.3361.02 |
| OneWeb user-defined signal generation | R&S®SMW-K130 | 1414.3788.02 |
| LoRa® | R&S®SMW-K131 | 1414.6464.02 |
| Modernized BeiDou | R&S®SMW-K132 | 1414.6606.02 |
| Upgrade to dual-frequency GNSS | R&S®SMW-K134 | 1414.6770.02 |
| Upgrade to triple-frequency GNSS | R&S®SMW-K135 | 1414.6793.02 |

| Designation | Type | Order No. |
|---|---|---|
| 6 additional GNSS channels | R&S®SMW-K136 | 1414.6812.02 |
| 12 additional GNSS channels | R&S®SMW-K137 | 1414.6835.02 |
| 24 additional GNSS channels | R&S®SMW-K138 | 1414.6858.02 |
| 48 additional GNSS channels | R&S®SMW-K139 | 1414.6935.02 |
| IEEE 802.11ad | R&S®SMW-K141 | 1414.1333.02 |
| IEEE 802.11ax | R&S®SMW-K142 | 1414.3259.02 |
| Cellular IoT Release 14 | R&S®SMW-K143 | 1414.6064.02 |
| 5G New Radio | R&S®SMW-K144 | 1414.4990.02 |
| 5G New Radio closed-loop BS test | R&S®SMW-K145 | 1414.6506.02 |
| Cellular IoT Release 15 | R&S®SMW-K146 | 1414.6564.02 |
| IEEE 802.11be | R&S®SMW-K147 | 1413.6677.02 |
| 5G New Radio Release 16 | R&S®SMW-K148 | 1414.6664.02 |
| HRP UWB | R&S®SMW-K149 | 1414.6912.02 |
| DVB-RCS2 | R&S®SMW-K169 | 1413.8711.02 |
| 5G NR sidelink | R&S®SMW-K170 | 1413.8640.02 |
| 5G NR Release 17 | R&S®SMW-K171 | 1413.7280.02 |
| U-plane generation | R&S®SMW-K175 | 1413.3261.02 |
| DVB-S2/DVB-S2X Annex E | R&S®SMW-K176 | 1413.8686.02 |
| OneWeb reference signals | R&S®SMW-K355 | 1414.3742.02 |
| ERA-GLONASS test suite | R&S®SMW-K360 | 1414.2800.02 |
| eCall test suite | R&S®SMW-K361 | 1414.2846.02 |
| GNSS test suite | R&S®SMW-K362 | 1414.6406.02 |
| Baseband power sweep | R&S®SMW-K542 | 1413.9876.02 |
| Digital standards using R&S®WinIQSIM2 [27] | | |
| GSM/EDGE | R&S®SMW-K240 | 1413.4739.02 |
| EDGE Evolution | R&S®SMW-K241 | 1413.4780.02 |
| 3GPP FDD | R&S®SMW-K242 | 1413.4839.02 |
| GPS 1 satellite | R&S®SMW-K244 | 1413.4880.02 |
| CDMA2000® | R&S®SMW-K246 | 1413.4939.02 |
| 1xEV-DO | R&S®SMW-K247 | 1413.4980.02 |
| TD-SCDMA | R&S®SMW-K250 | 1413.5087.02 |
| TD-SCDMA enhanced BS/MS tests | R&S®SMW-K251 | 1413.5135.02 |
| DVB-H/DVB-T | R&S®SMW-K252 | 1413.6190.02 |
| DAB/T-DMB | R&S®SMW-K253 | 1413.6248.02 |
| IEEE 802.11n | R&S®SMW-K254 | 1413.5187.02 |
| LTE Release 8 | R&S®SMW-K255 | 1413.5235.02 |
| Bluetooth® EDR | R&S®SMW-K260 | 1413.5287.02 |
| Multicarrier CW signal generation | R&S®SMW-K261 | 1413.5335.02 |
| Additive white Gaussian noise (AWGN) | R&S®SMW-K262 | 1413.6460.02 |
| Galileo 1 satellite | R&S®SMW-K266 | 1413.7015.02 |
| TETRA Release 2 | R&S®SMW-K268 | 1413.5387.02 |
| 3GPP FDD HSPA/HSPA+, enhanced BS/MS tests | R&S®SMW-K283 | 1413.6290.02 |
| LTE Release 9 | R&S®SMW-K284 | 1413.5535.02 |
| LTE Release 10 (LTE-Advanced) | R&S®SMW-K285 | 1413.5587.02 |
| IEEE 802.11ac | R&S®SMW-K286 | 1413.5687.02 |
| 1xEV-DO Rev. B | R&S®SMW-K287 | 1413.6560.02 |
| NFC A/B/F | R&S®SMW-K289 | 1413.6654.02 |
| GLONASS 1 satellite | R&S®SMW-K294 | 1413.7067.02 |
| IRNSS | R&S®SMW-K297 | 1414.6287.02 |
| Modernized GPS 1 satellite | R&S®SMW-K298 | 1414.3171.02 |
| BeiDou 1 satellite | R&S®SMW-K407 | 1413.7115.02 |
| LTE Release 11 and enhanced features | R&S®SMW-K412 | 1413.8557.02 |
| LTE Release 12 | R&S®SMW-K413 | 1414.2030.02 |
| OFDM signal generation | R&S®SMW-K414 | 3636.0434.02 |
| Cellular IoT Release 13 | R&S®SMW-K415 | 1414.2769.02 |
| DVB-S2/DVB-S2X | R&S®SMW-K416 | 1414.2681.02 |
| Bluetooth® 5.x | R&S®SMW-K417 | 1414.3371.02 |
| Verizon 5GTF signals | R&S®SMW-K418 | 1414.3507.02 |
| LTE Release 13/14/15 | R&S®SMW-K419 | 1414.3588.02 |
| Modernized GLONASS | R&S®SMW-K423 | 1413.3410.02 |
| OneWeb user-defined signal generation | R&S®SMW-K430 | 1414.3820.02 |
| LoRa® | R&S®SMW-K431 | 1414.6441.02 |
| Modernized BeiDou | R&S®SMW-K432 | 1414.6629.02 |

[27] R&S®WinIQSIM2 requires an external PC.

| Designation | Type | Order No. |
|---|---|---|
| IEEE 802.11ad | R&S®SMW-K441 | 1414.1385.02 |
| IEEE 802.11ax | R&S®SMW-K442 | 1414.3294.02 |
| Cellular IoT Release 14 | R&S®SMW-K443 | 1414.6093.02 |
| 5G New Radio | R&S®SMW-K444 | 1414.5022.02 |
| Cellular IoT Release 15 | R&S®SMW-K446 | 1414.6587.02 |
| IEEE 802.11be | R&S®SMW-K447 | 1413.6683.02 |
| 5G New Radio Release 16 | R&S®SMW-K448 | 1414.6687.02 |
| HRP UWB | R&S®SMW-K449 | 1414.6958.02 |
| DVB-RCS2 | R&S®SMW-K469 | 1413.9130.02 |
| 5G NR sidelink | R&S®SMW-K470 | 1413.8663.02 |
| 5G NR Release 17 | R&S®SMW-K471 | 1413.7296.02 |
| DVB-S2/DVB-S2X Annex E | R&S®SMW-K476 | 1413.9076.02 |
| Options with external R&S®Pulse Sequencer Software or R&S®Pulse Sequencer (DFS) Software | | |
| Pulse sequencing | R&S®SMW-K300 | 1413.8805.02 |
| Enhanced pulse sequencing | R&S®SMW-K301 | 1413.9776.02 |
| Moving emitters and receiver | R&S®SMW-K304 | 1413.8957.02 |
| Multiple emitters (interleaved) | R&S®SMW-K306 | 1413.9053.02 |
| Multiple emitters extension (interleaved) | R&S®SMW-K307 | 1413.3510.02 |
| Direction finding | R&S®SMW-K308 | 1414.1433.02 |
| Pulse-on-pulse simulation | R&S®SMW-K315 | 1414.6529.02 |
| DFS signal generation | R&S®SMW-K350 | 1413.9160.02 |
| Waveform packages, for signals from R&S®WinIQSIM2 [28] | | |
| 1 waveform | R&S®SMW-K200 | 1414.6870.71 |
| 5 waveforms | R&S®SMW-K200 | 1414.6870.72 |
| 50 waveforms | R&S®SMW-K200 | 1414.6870.75 |
| | | |
| Other options | | |
| Rear panel connectors, for RF path A (3/6 GHz) and I/Q | R&S®SMW-B81 | 1413.5893.02 |
| Rear panel connectors, for RF path B (3/6 GHz) | R&S®SMW-B82 | 1413.5941.02 |
| Rear panel connectors, for RF path A (20/31.8/40 GHz) and I/Q | R&S®SMW-B83 | 1414.0937.02 |
| Rear panel connectors, for RF path B (20 GHz) | R&S®SMW-B84 | 1414.1033.02 |
| Solid-state drive | R&S®SMW-B93 | 1414.1885.02 |
| | | |
| **Recommended extras** | | |
| 19" rack adapter | R&S®ZZA-KN4 | 1175.3033.00 |
| Cable, for connecting Rohde & Schwarz digital baseband interfaces | R&S®SMU-Z6 | 1415.0201.02 |
| Cable, for HS digital I/Q interface (optical cable, QSFP+ plug) | R&S®DIGIQ-HS | 3641.2948.03 |
| USB serial adapter, for RS-232 remote control | R&S®TS-USB1 | 6124.2531.00 |
| Adapters, for instruments with an R&S®SMW-B1012/-B2012/-B1020/-B2020/-B1031/-B2031/-B1040/-B1040N frequency option | | |
| Test port adapter, 2.92 mm female | | 1036.4790.00 |
| Test port adapter, 2.92 mm male | | 1036.4802.00 |
| Test port adapter, N female | | 1036.4777.00 |
| Test port adapter, N male | | 1036.4783.00 |
| Adapters, for instruments with an R&S®SMW-B1044/-B2044/-B1044N/-B2044N frequency option | | |
| Coaxial adapter 1.85 mm (f) – 1.85 mm (f) | | 3588.9654.00 |
| Coaxial adapter 1.85 mm (f) – 2.92 mm (f) | | 3628.4728.02 |
| Adapter, for instruments with an R&S®SMW-B1056/-B1056N/-B1067/-B1067N frequency option | | |
| 1.85 mm female/female wear and tear adapter | | 3588.9654.00 |
| Power combiner kits for instruments with an R&S®SMW-K555 option | | |
| Combiner kit, 40 GHz | R&S®SMW-ZKK | 1434.7908.02 |
| Combiner kit, 67 GHz | R&S®SMW-ZKV | 1434.7989.02 |
| | | |
| **Documentation** | | |
| Documentation of calibration values | R&S®DCV-2 | 0240.2193.18 |
| R&S®SMW200A accredited calibration, up to 6 GHz | R&S®ACASMW200A | 3596.7005.03 |
| R&S®SMW200A accredited calibration, 7.5 GHz | R&S®ACASMW200A | 3598.3507.03 |
| R&S®SMW200A accredited calibration, 12.75 GHz to 44 GHz | R&S®ACASMW200A | 3596.7011.03 |
| R&S®SMW200A accredited calibration, 56 GHz and 67 GHz | R&S®ACASMW200A | 3598.9540.03 |

[28] A maximum of 250 waveforms per instrument can be registered.

| **Warranty** | | |
|---|---|---|
| Base unit | | 3 years |
| All other items [29] | | 1 year |
| Service options | | |
| Extended warranty, one year | R&S®WE1 | Please contact your local Rohde & Schwarz sales office. |
| Extended warranty, two years | R&S®WE2 | |
| Extended warranty with calibration coverage, one year | R&S®CW1 | |
| Extended warranty with calibration coverage, two years | R&S®CW2 | |
| Extended warranty with accredited calibration coverage, one year | R&S®AW1 | |
| Extended warranty with accredited calibration coverage, two years | R&S®AW2 | |

**Extended warranty with a term of one and two years (WE1 and WE2)**
Repairs carried out during the contract term are free of charge [30]. Necessary calibration and adjustments carried out during repairs are also covered.

**Extended warranty with calibration coverage (CW1 and CW2)**
Enhance your extended warranty by adding calibration coverage at a package price. This package ensures that your Rohde & Schwarz product is regularly calibrated, inspected and maintained during the term of the contract. It includes all repairs [30] and calibration at the recommended intervals as well as any calibration carried out during repairs or option upgrades.

**Extended warranty with accredited calibration (AW1 and AW2)**
Enhance your extended warranty by adding accredited calibration coverage at a package price. This package ensures that your Rohde & Schwarz product is regularly calibrated under accreditation, inspected and maintained during the term of the contract. It includes all repairs [30] and accredited calibration at the recommended intervals as well as any accredited calibration carried out during repairs or option upgrades.



[29] For options installed, the remaining base unit warranty applies if longer than 1 year. Exception: all batteries have a 1 year warranty.

[30] Excluding defects caused by incorrect operation or handling and force majeure. Wear-and-tear parts are not included.

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

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Data without tolerance limits is not binding | Subject to change


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