Response to Correspondence Reference No. 72856

OET/WTB Question No. 1: Additional detailed technical information on antenna actual characteristics. If directional antenna, please indicate the direction that the antenna will point at, elevation angle, antenna far field, etc.

AST SpaceMobile Response:

The test will involve transmissions from two types of antennas: Antenna No. 1 is a 70 cm circular aperture antenna and Antenna No. 2 is a pyramidal horn.[1] The 70 cm antenna will transmit in the 37.5-42.5 GHz frequency range and the horn antenna will transmit in the 47.2-50.2 and 50.4-51.4 GHz frequency ranges. The characteristics of each type of antenna are as follows:

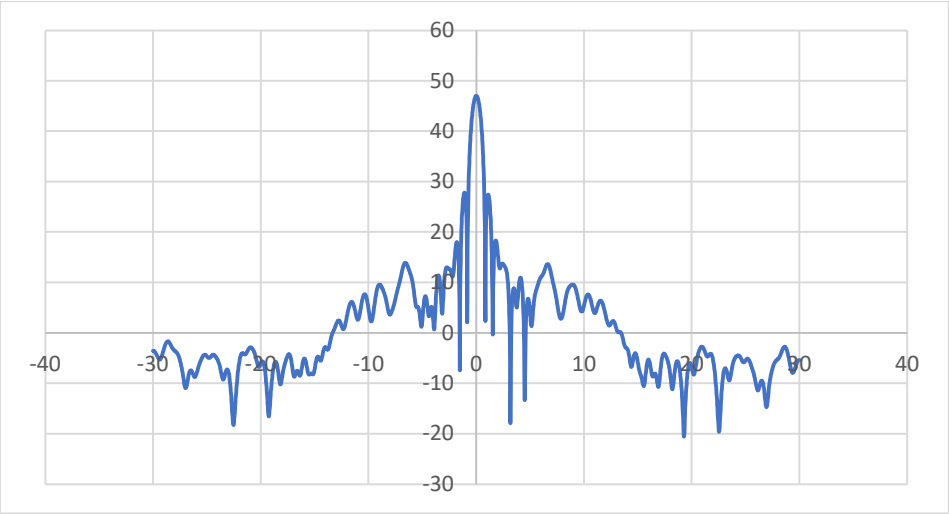
Antenna No. 1: 70 cm circular aperture antenna

Transmit gain at 40 GHz: 47 dBi

Pointing direction: 166° azimuth from true north

Elevation angle: 0°

Antenna sidelobe pattern:



Antenna No. 2: Pyramidal Horn

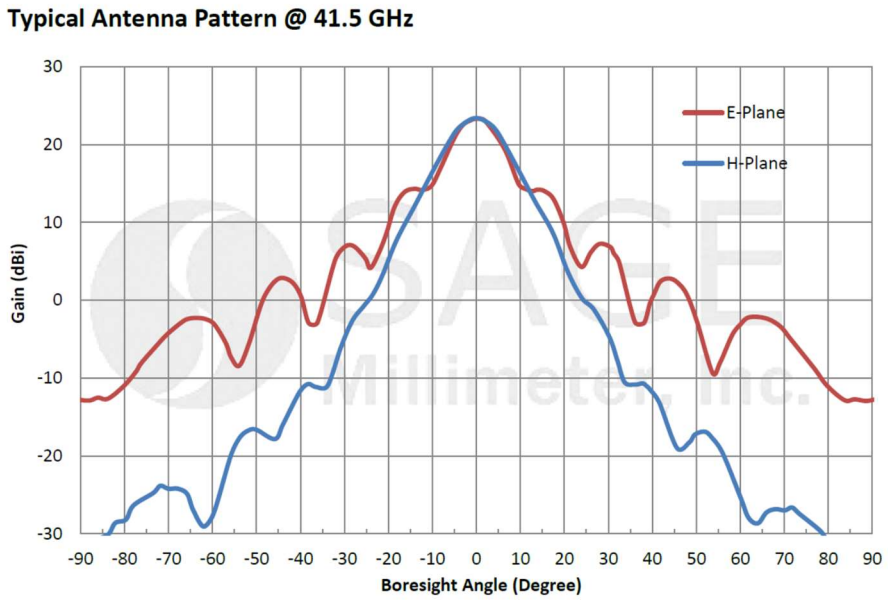
Transmit gain at 41.5 GHz: 23 dBi

Pointing direction: 346° azimuth from true North

Elevation angle: 0°

[1] Because the horn antenna was not reflected on the original Form 442 for the instant application, AST is concurrently amending the corresponding Form 442 to reflect the horn antenna.

Antenna sidelobe pattern:



-*-*-*-*-

OET/WTB Question No. 2: An engineering analysis and explanation of how it would specifically avoid causing harmful interference to incumbent Upper Microwave Flexible Use Service operations and Fixed Microwave Service licensees.

AST SpaceMobile Response:

An analysis of the potentially affected population was carried out using Visualyse 7.9.10.8.[2]

All results obtained indicate that Partial Economic Area (PEA) 220 is the only area affected, regardless of antenna model, terrain and clutter model. PEA 220 Odessa, Texas, comprises Ector and Midland Counties, and has a total population of 274,002 persons.

The results of the analysis are summarized in the chart below and show that the criteria in §25.136 (d)(4)(ii) and (e)(4)(ii) are met for the planned transmission in the 47.2-50.2 and 50.4-51.4 GHz frequency ranges.

[2] The population data estimated from 2020 projections based on the 2000 and 2010 census data found in http://sedac.ciesin.columbia.edu/data/set/gpw-v4- population-count-rev10 (See Center for International Earth Science Information Network - CIESIN - Columbia University. 2017. Gridded Population of the World, Version 4 (GPWv4): Population Count, Revision 10. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC)").

Results – Partial Economic Area (PEA) 220

- **Sample calculations**
- Exceedance in protection of UMFUS licencees at 40 GHz without the use of clutter model
- Usage of a clutter model is warranted to appropriately model path interference from trees, buildings and other elements not considered "terrain"
- Gain table is considered more appropriate model due to higher fidelity to data provided by AST

Table 1 to Paragraph (a)(4)(ii) ***(For the protection of UMFUS licencees) (40 GHz)***

Population within UMFUS license area	Maximum permitted aggregate population within −77.6 dBm/m²/MHz PFD contour of earth stations	Results without clutter model	Results with clutter model
Greater than 450,000	0.1 percent of population in UMFUS license area.	---	---
Between 6,000 and 450,000 *(274,002 people)*	450 people.	**470 people** *(Study 1C – 70 cm antenna without clutter pointing at 166 deg from True North)*	**1 person** *(Study 2C - 70 cm antenna with clutter pointing at 166 from True North)*
Fewer than 6,000	7.5 percent of population in UMFUS license area.	---	---

Table 2 to Paragraph (c)(2) **(for the protection FROM UMFUS)**

Population within Partial Economic Area (PEA) where earth station is located	Maximum permitted aggregate population within protection zone of earth stations	Results without clutter model	Results with clutter model
Greater than 2,250,000	0.1 percent of population in PEA.	---	---
Between 60,000 and 2,250,000 *(274,002 people)*	2,250 people.	**57 people** *(Study 1B – Horn Antenna H-Plane without clutter pointing at 166 deg from True North)*	**2 people** *(Study 2B - Horn Antenna H-Plane with clutter pointing at 166 from True North)*
Fewer than 60,000	3.75 percent of population in PEA.	---	---

Based on AST SpaceMobile's analysis, while the proposed tests do not strictly meet the −77.6 dBm/m^2/MHz level at 10 meters above ground level as specified in §25.136 (d)(4)(iii) and (e)(4)(iii) due to the proximity of Interstate 20 and West Highway 80 E, to mitigate any concerns, AST SpaceMobile is prepared, where required, to implement measures prior to the start of testing to comply with the −77.6 dBm/m^2/MHz level.

AST SpaceMobile is prepared to create manmade shielding to attenuate signals during transmission tests, and/or reduce power commensurately into one or both antennas as needed to ensure compliance with the −77.6 dBm/m^2/MHz level, as confirmed by a secondary analysis using Visualyse 7.9.10.8, in advance of testing. In addition, although AST SpaceMobile understands that at present there are no active UMFUS operations in Odessa, so on a practical level any risk is mitigated, any testing authorized pursuant to the instant application will not commence prior to coordination with active UMFUS license holders in PEA 220, if so required. Finally, the tests being conducted pursuant to this experimental license are expected to be short duration (approximately 10 minutes per antenna) and will not exceed more than two (2) hours in aggregate per month.

Concerning §25.136 (c)(4), (d)(4)(iv) and (e)(4)(iv), AST SpaceMobile understands that there are no active UMFUS operations in PEA 220 (the area for which PFD levels higher than −77.6 dBm/m^2/MHz may be generated as a result of the proposed tests) for the relevant frequency ranges. Nevertheless, AST will coordinate with all active UMFUS license holders in PEA 220 before conducting the proposed tests.

-*-*-*-*-

OET/WTB Question No. 3: Justification for using the Upper Microwave Flexible Use Service frequencies.

AST SpaceMobile Response: Fixed satellite services operate on a co-primary basis in the 37.5-40 GHz, 47.2-48.2, GHz and 50.4-51.4 GHz bands (*see* 47 C.F.R. Sections 2.106 and 25.136), and AST SpaceMobile's pending application for market access before the FCC for a commercial non-geostationary satellite network (see IBFS File No. SAT-PDR-20200413-00034; SAT-APL-20201028-00126) will employ these frequencies for feeder link and telemetry, tracking and command communications.

The instant tests will evaluate AST SpaceMobile's long-term use of these frequencies for communications consistent with the United States Radio Table and FCC Part 25 rules.

-*-*-*-*-

OET/WTB Question No. 4: Any stop buzzer information in the event that interference occurs?

AST SpaceMobile Response: AST SpaceMobile's stop buzzer can be reached on a 24/7/365 basis at the following phone number and email address.

- frequencycoordinator@ast-science.com
- +1 432 276 3465

-*-*-*-*-

Response to Correspondence Reference No. 73215

OET/IB Question No. 1: In FCC Form 442, applicant provided one fixed 70 cm Tendeg Ka-PDAGimbal antenna. In "Application for Conventional Experimental License", applicant (AST) stated it estimates that it will test up to 6 antennas per month. Please clarify the number of units of proposed Tendeg Ka-PDAGimbal antenna(s) and update the correct numbers in the FCC Form 442.

AST SpaceMobile Response: AST SpaceMobile will evaluate the transmit and receive performance of 70 cm antennas that are in production sequentially and will not test more than a single 70 cm antenna at any given time. AST SpaceMobile does not require or request authority to operate multiple 70 cm antennas.

AST will use a pyramidal horn antenna coupled with a signal generator and upconverter (See **Exhibit 1.0** or the concurrently filed Form 442) to simulate a signal from a gateway ground station into the eventually space-based 70 cm antenna. Only one horn antenna will be used for each test.

-*-*-*-*-

OET/IB Question No. 2: For the V-band frequencies, the Uplink (Earth-to-Space) band is 47.2-50.2 GHz and 50.4-51.4 GHz and the Downlink (space-to-Earth) band is 37.5-42.5 GHz. Please see the diagram of the proposed test set-up, if Tendeg Ka-PDAGimbal antenna will be used as "a satellite" for on-ground testing to transmit in the Downlink (Space-to-Earth) band in the 37.5-42.5 GHz, then please clarify the three equipment (EVM, LTE, and other?) will be used to transmit Uplink (Earth-to-Space) band in the 47.2-50.2 GHz and 50.4-51.4 GHz.

AST SpaceMobile Response: Please see **Exhibit 1.0** to instant correspondence, which provides technical specifications for the signal generator, upconverter and pyramidal horn antenna used to simulate the Earth-to-space gateway ground station transmissions for the purposes of the proposed testing.

-*-*-*-*-

OET/IB Question No. 3: Please provide the description and submit the technical parameters (antenna gain, input or output power, EIRP, and antenna pattern performances) of the three equipment (EVM, LTE, and other ?). Please provide the Manufacturer, Model, and No. Of Units of the three equipment in the FCC Form 442.

AST SpaceMobile Response: Please see the amended Form 442 filed concurrently and **Exhibit 1.0**.

-*-*-*-*-

OET/IB Question No. 4: Please submit Tendeg Ka-PDAGimbal V-band antenna's pattern performances for "on-ground satellite" testing, operating in the 37.5-42.5 GHz band with antenna gain of 45.8dBi, input power of 2W, and EIRP of 48.8 dBW.

AST SpaceMobile Response: Antenna patterns are provided above in response to Question 1 from Correspondence Reference No. 72856.

-*-*-*-*-

OET/IB Question No. 5: If applicant would like to revise and submit an "updated" diagram of the proposed test set-up for the on-ground tests between satellite and gateway earth station, both employing Tendeg Ka-PDAGimbal antenna, then for Tendeg Ka-PDAGimbal antenna to be used as "gateway earth station" to transmit in the Uplink (Earth-to-Space) band in the 47.2-50.2 GHz and 50.4-51.4 GHz band (with antenna gain of 45.8dBi, input power of 2W, and EIRP of 48.8 dBW), please submit Tendeg Ka-PDAGimbal V-band antenna's pattern performances:

Question (5)(a): Please provide the co-polarized gain (dBi) (with an individual elevation angle and skew angle ?), plus and minus from 0 to 10 degrees, 0 to 45 degrees, and 0 to 180 degrees with FCC 25.209 envelop superimposed on each measured pattern, in the azimuth and elevation planes. Please provide the on-axis gain that exceeded the FCC 25.209 on-axis gain mask. Please provide the on-axis gain that exceeded the FCC 25.209 on-axis gain mask. Please provide the off-axis gain that exceeded the FCC 25.209 off-axis gain mask.

AST SpaceMobile Response: The 70 cm antenna under test will not transmit in the 47.2-50.2 GHz and 50.4-51.4 GHz band bands.

The pyramidal horn antenna under test will simulate an Earth-to-space transmission in the 47.2-50.2 GHz and 50.4-51.4 GHz bands but will employ 0 degrees of elevation. Given that FCC 25.209 is intended to protect geostationary satellites from interference resulting from mispointed or inefficient ground stations with inadequate discrimination, the rule is not applicable to an antenna under test pointing at the horizon with significant natural/manmade shielding to prevent any energy from reaching the geostationary arc.

Question (5)(b): Please provide applicant's "defined" Off-axis EIRP density envelopes (dBW/MHz) and/or (dBW/4 kHz) (ESD mask) (with an individual elevation angle and skew angle?), plus and minus from 0 to 10 degrees, 0 to 45 degrees, and 0 to 180 degrees with FCC or ITU envelop superimposed on each measured pattern, in the azimuth and elevation planes:

Question (5)(b)(1): For co-polarized transmissions in the plane tangent to the NGSO arc:

xx-25log(?) dBW/MHz for 2.0° = ? = 7°.
xx dBW/MHz for 7° = ? = 9.2°.
xx-25log(?) dBW/MHz for 9.2° = ? = 19.1°.
xx dBW/MHz for 19.1° < ? = 180°.

AST SpaceMobile Response: For the 70 cm antenna

22-25log(θ) dBW/MHz for 2.0° ≤ θ ≤ 7°
0.9 dBW/MHz for 7° ≤ θ ≤ 9.2°
25-25log(θ) dBW/MHz for 9.2° ≤ θ ≤ 19.1°
-7 dBW/MHz for 19.1° < θ ≤ 180°

Question (5)(b)(2): For co-polarized transmissions in the plane perpendicular to the NGSO arc:

xx-25log(?) dBW/MHz for 3.5° = ? = 7°.
xx dBW/MHz for 7° < ? = 9.2°.
xx-25log(?) dBW/MHz for 9.2° < ? = 19.1°.
xx dBW/MHz for 19.1° < ? = 180°.

AST SpaceMobile Response: For the 70 cm antenna

25-25log(θ) dBW/MHz for 3.5° ≤ θ ≤ 7°
3.9 dBW/MHz for 7° ≤ θ ≤ 9.2°
28-25log(θ) dBW/MHz for 9.2° ≤ θ ≤ 19.1°
-4 dBW/MHz for 19.1° < θ ≤ 180°

Question (5)(b)(3): For cross-polarized transmissions in the plane tangent to the NGSO arc and in the plane perpendicular to the NGSO arc:

xx-25log(?) dBW/MHz for 2.0° < ? = 7.0°.

AST SpaceMobile Response: For the 70 cm antenna

12-25log(θ) dBW/MHz for 2.0° ≤ θ ≤ 7°

-*-*-*-*-

OET/IB Question No. 6: Please provide the input power density of a single Tendeg Ka-PDAGimbal V-band antenna operating in the Downlink (space-to-Earth) 37.5-42.5 GHz and Uplink (Earth-to-Space) 47.2-50.2 GHz and 50.4-51.4 GHz frequency bands.

AST SpaceMobile Response:

The 70 cm antenna under test will not transmit in the 47.2-50.2 GHz and 50.4-51.4 GHz frequency bands. Input power density is 0.2 W/MHz for this antenna in the 37.5-42.5 GHz frequency band.

The pyramidal horn antenna under test will not transmit in the 37.5-42.5 GHz. Input power density is 0.2 W/MHz for this antenna in the 47.2-50.2 GHz and 50.4-51.4 GHz frequency bands.

-*-*-*-*-

OET/IB Question No. 7: In FCC Form 442, please amend the ERP from 75857.75 W (EIRP of 48.8 dBW) to 46238W ERP

AST SpaceMobile Response:

Maximum ERP for the 70 cm antenna is 117768 W.

Maximum ERP for the pyramidal horn is 480 W.

EXHIBIT 1.0

Equipment Specifications	**Page**
WORK Microwave Outdoor Block-Upconverter	2
Sage Millimeter WR-22 Pyramidal Horn Antenna	39
R&S SMW200A Vector Signal Generator	43

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

User Manual

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

Tel. +49 8024 6408 0
Fax +49 8024 6408 40
E-Mail sales@work-microwave.com

COPYRIGHT

© 2020 WORK Microwave GmbH; All rights reserved.

Within this documentation, all contained information is confidential and is destined for WORK Microwave customers only.

Neither this documentation nor parts of it may be copied, reproduced or distributed in any form without the authorization of WORK Microwave.

Table of Contents

1 Introduction 5
1.1 Application 5
1.2 Reference Documents 5
1.3 Reference to Firmware Versions 5
1.4 Abbreviations 5
1.5 Compliances 6
1.5.1 Federal Communications Commission (FCC) 6
1.5.2 Safety Compliance EN 60950 6
1.6 Safety Instructions 6

2 Technical Description 8
2.1 General 8
2.2 System Characteristics 8
2.3 Signal Flow 8
2.4 Connector Side of the Converter 9
2.4.1 Power Input Connector 9
2.4.2 M &C Connector 10
2.4.3 Ethernet Interface 11
2.4.4 Fallback IP address 12
2.4.5 Reference Input 12
2.4.6 IF-Input 12
2.4.7 RF-Output 12
2.5 Warm Up Mute 12
2.6 Mounting of the Upconverter, Outdoor Version 13

3 Remote Control Description 14
3.1 Overview 14
3.2 Syntax of MULTIPOINT Commands 14
3.2.1 What is a MULTIPOINT Command? 14
3.2.2 MULTIPOINT Command Structure 14
3.2.3 Commands, Responses and Error Codes 15
3.3 Instrument States 15
3.4 List of all Command OPCODEs 16
3.5 Web Browser Interface 23
3.5.1 Status Indicators 24
3.5.2 Navigation Bar 25
3.5.3 Main Area 25
3.6 Converter Configuration 26
3.6.1 Signal Output 26
3.6.2 Band 26
3.6.3 Attenuation Channel 26
3.6.4 Reference Source (Option) 26
3.7 Configuration Backup and Restore 27
3.7.1 Local Backup and Restore 28
3.7.2 Remote Backup and Restore 28
3.7.3 Saved Configurations 29
3.7.4 Monitoring Communication Restore 30
3.8 Firmware Updates 31
3.8.1 Remote Firmware Update 31
3.9 SNMP Interface 32
3.9.1 SNMP OID List 33

4 Maintenance, Service 35
4.1 Maintenance 35
4.2 Service 35
4.3 Company address 35
4.4 RMA Request Form 36

5 Appendix 37
5.1 Technical Data 37
5.2 Notes 37

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

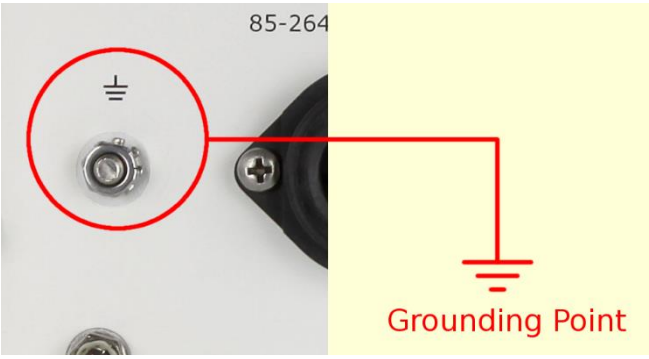
Please read this chapter carefully before you install and use this device from WORK Microwave.

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.

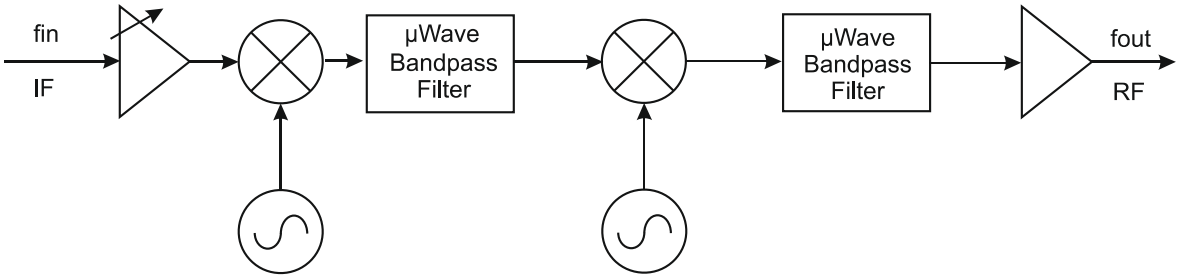


Figure 1: Triple Band Upconverter, simplified block-diagram

2.4 Connector Side of the Converter

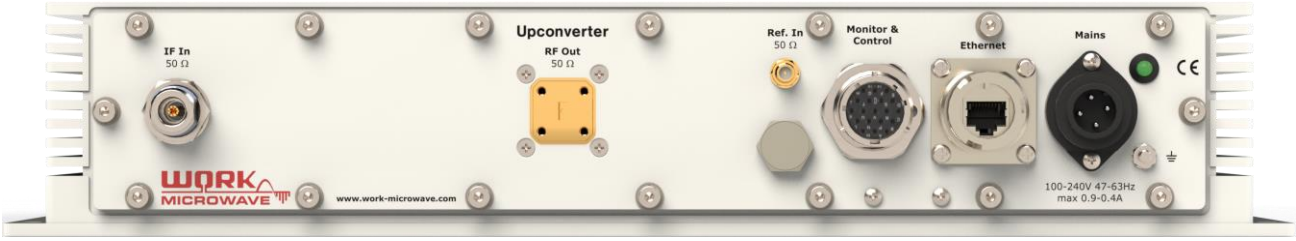


Figure 2: Block-Upconverter

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.

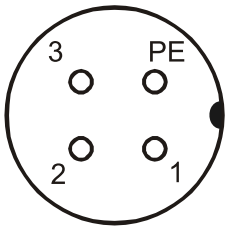


Figure 3: AC Power Connector

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

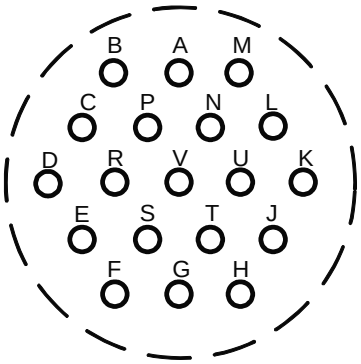


Figure 4: M&C connector

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 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 open under alarm condition	1)
P	Alarm 2a, open in normal operation 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 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'.

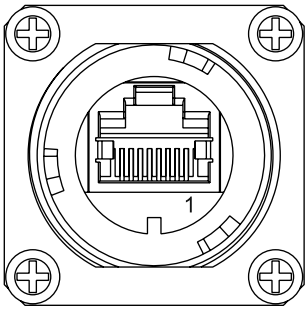


Figure 5: Ethernet Interface (RJ-45 connector, IP67)

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.

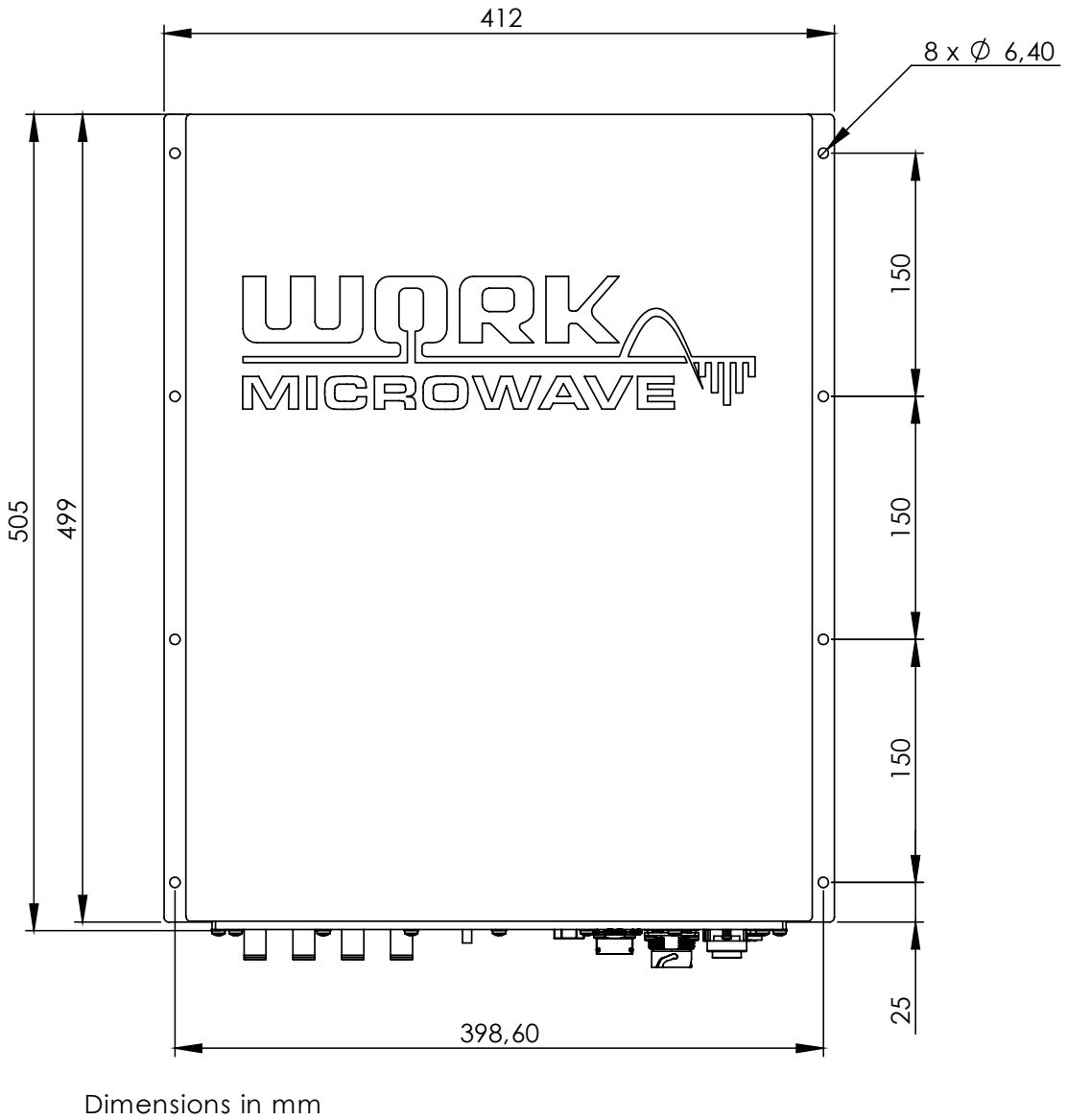


Figure 6: Mechanical Dimensions and Mounting Holes

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:

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

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

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

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

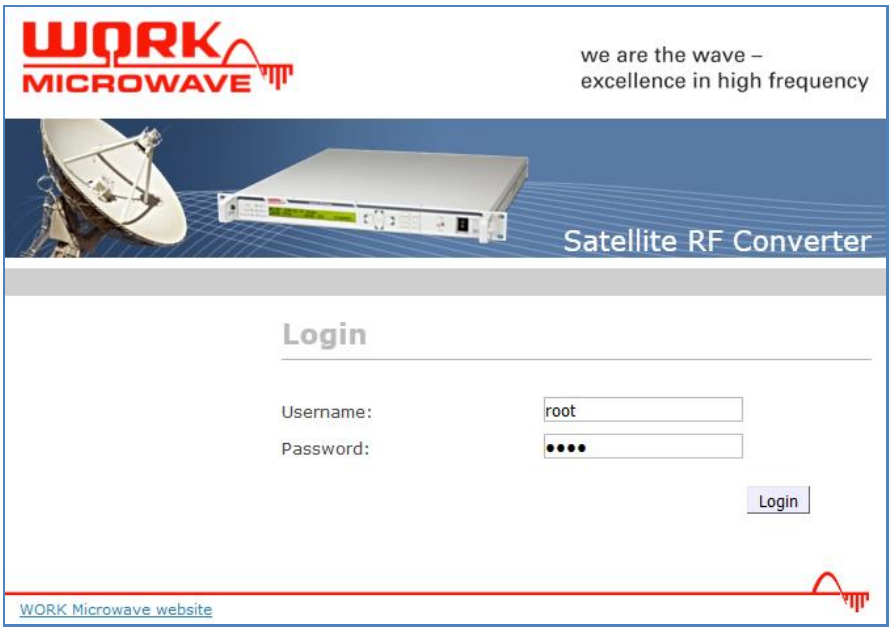


Figure 13: Login page

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).

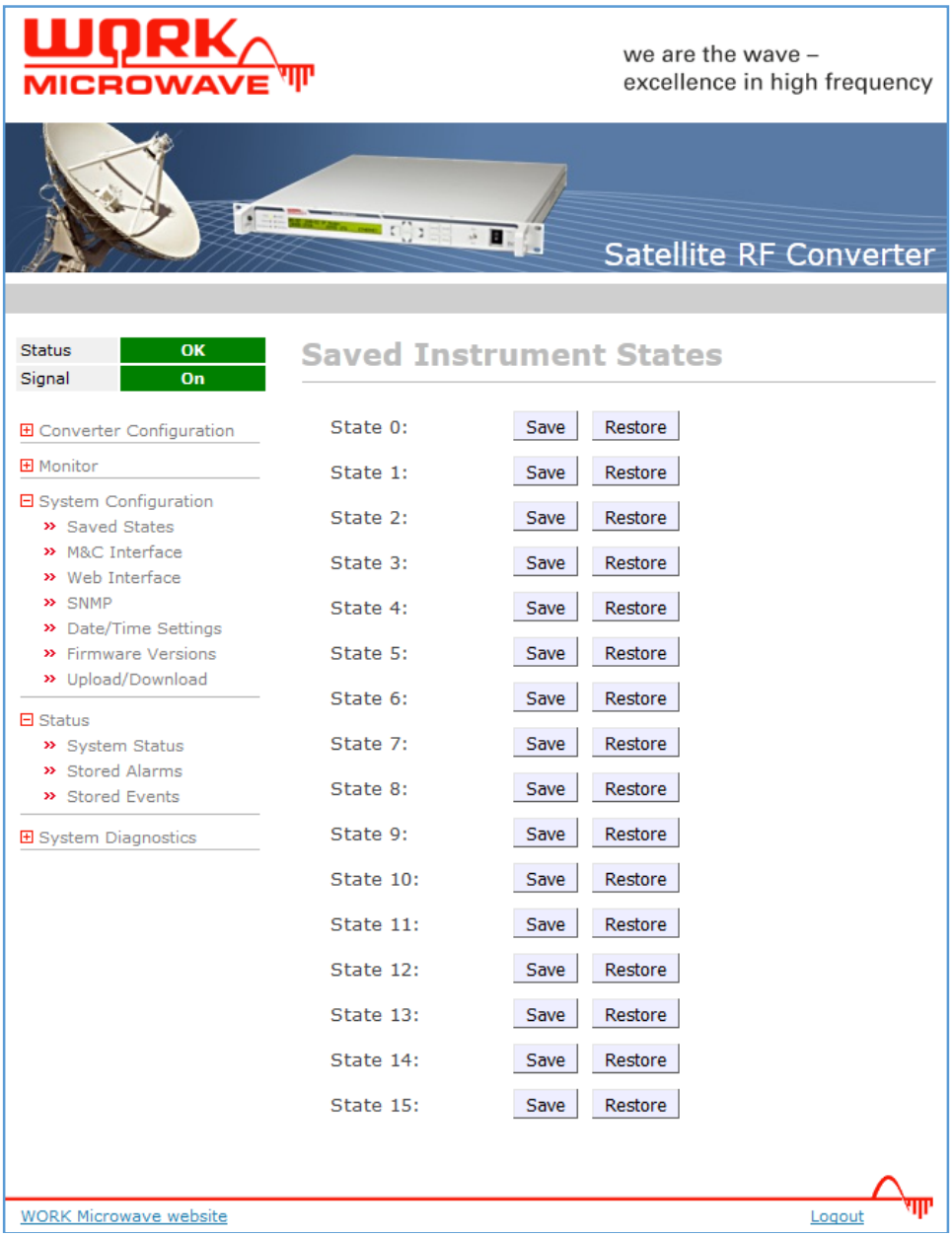


Figure 18: Saved Configurations page

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…

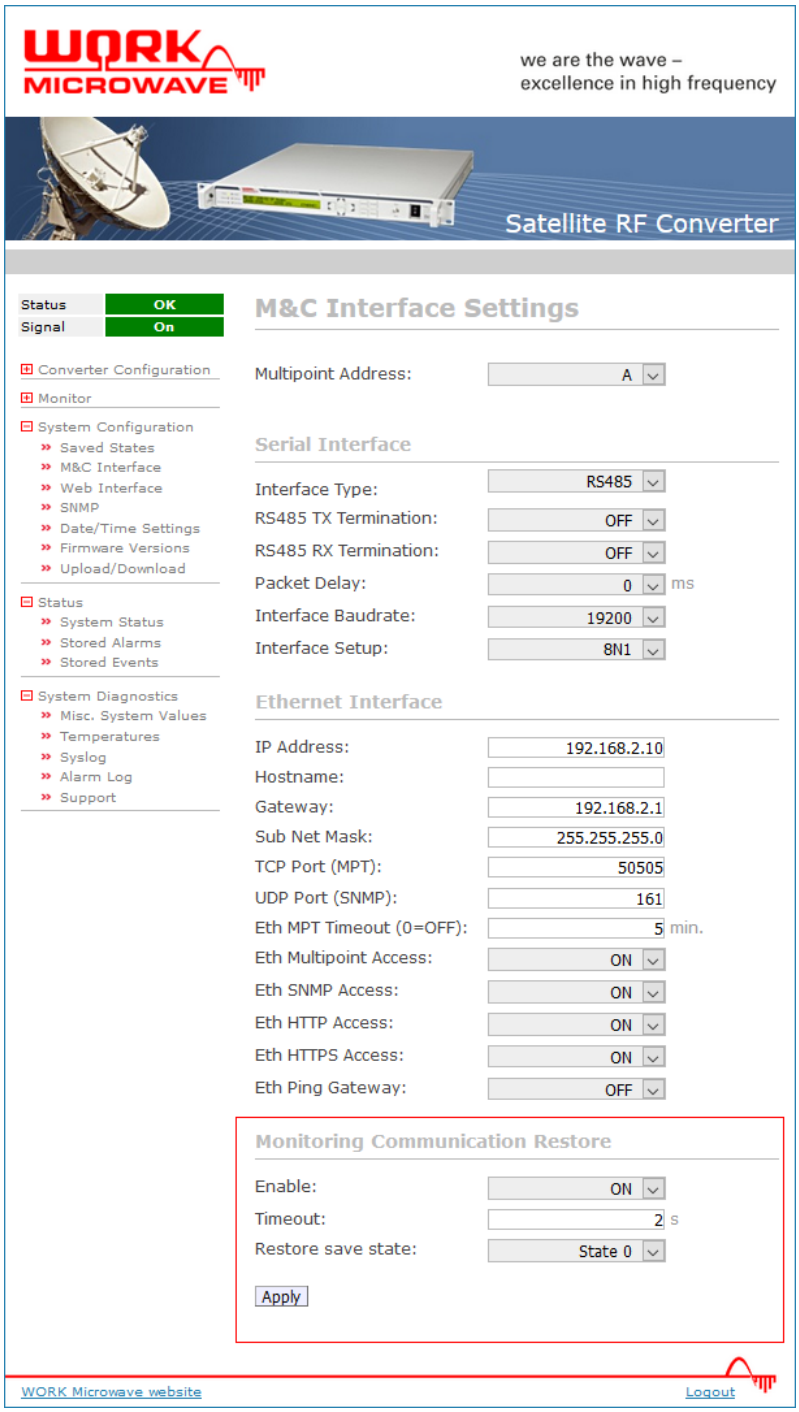


Figure 19: Monitoring Communication Restore

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.

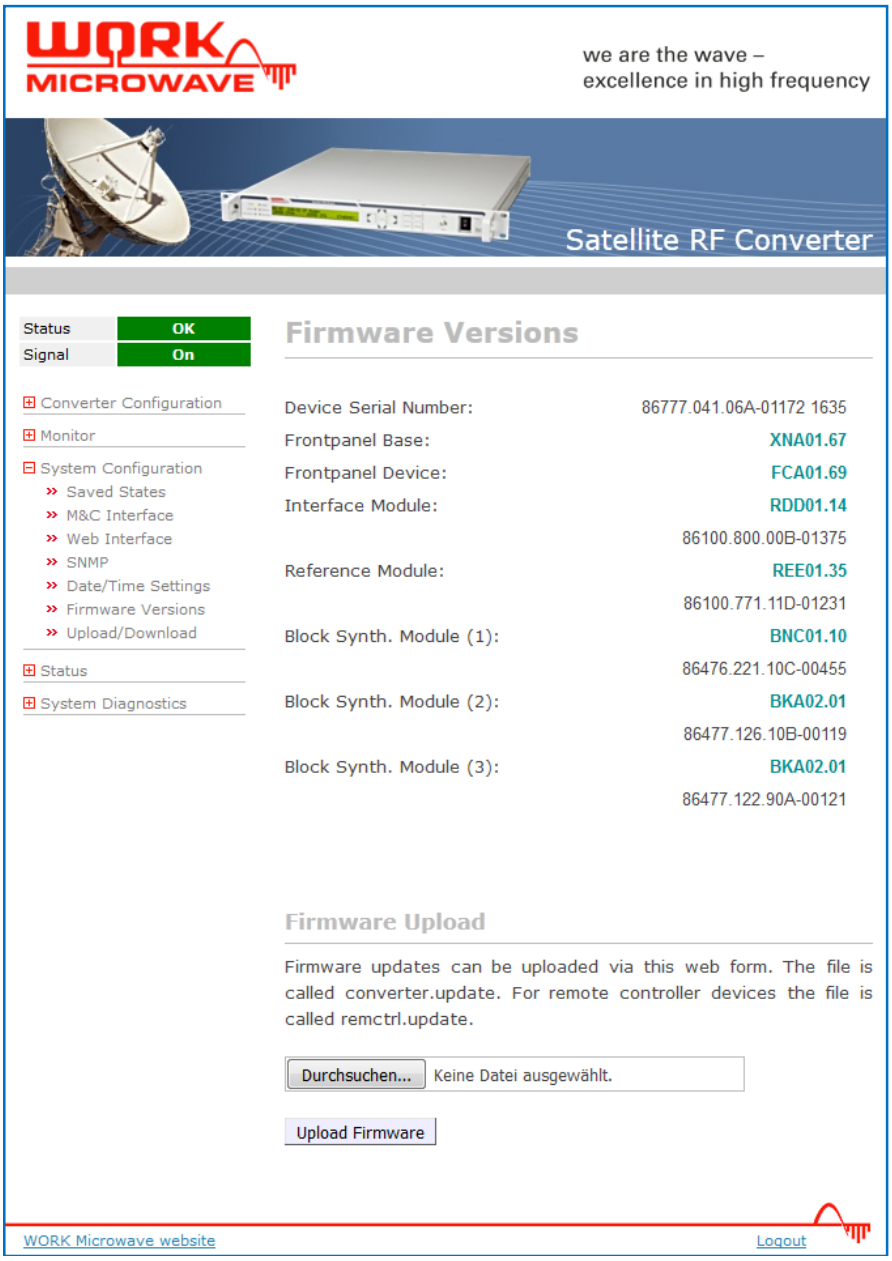


Figure 20: Firmware Versions page

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 **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 **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

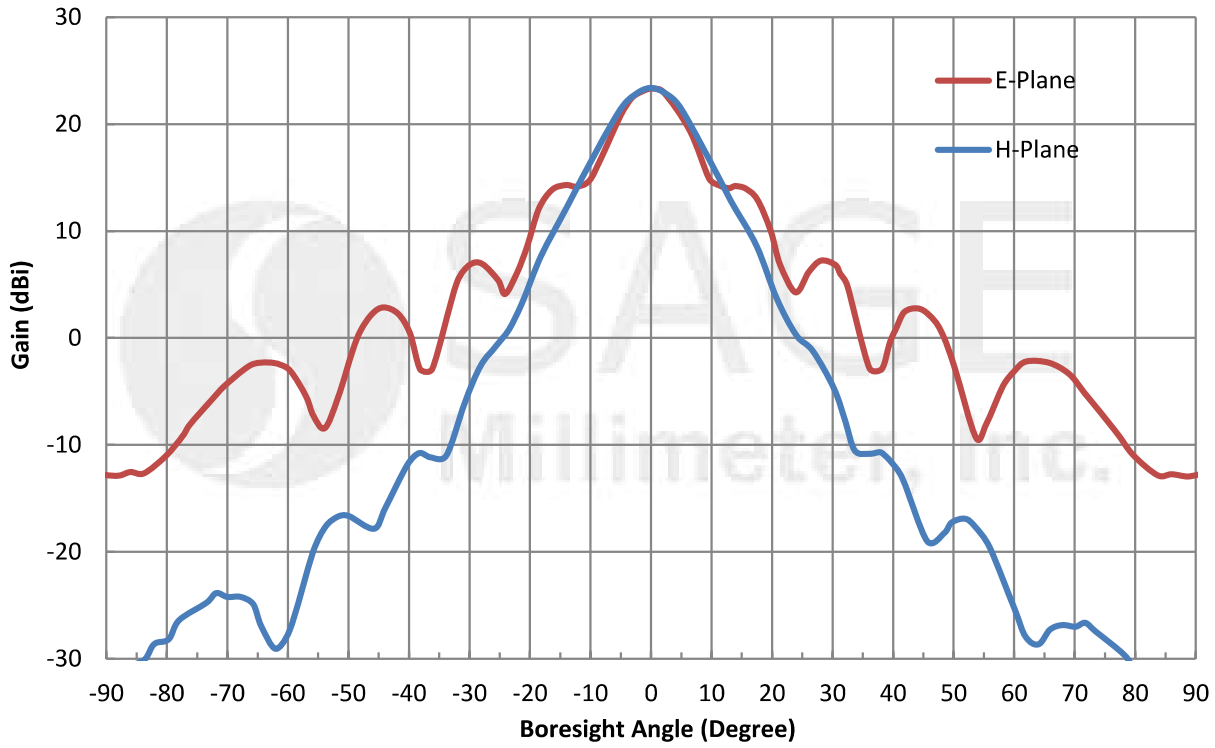
www.sagemillimeter.com | 3043 Kashiwa Street, Torrance, CA 90505
Phone: 424-757-0168 | Fax: 424-757-0188 | Email: sales@sagemillimeter.com

Copyright © 2017 by SAGE Millimeter, Inc.

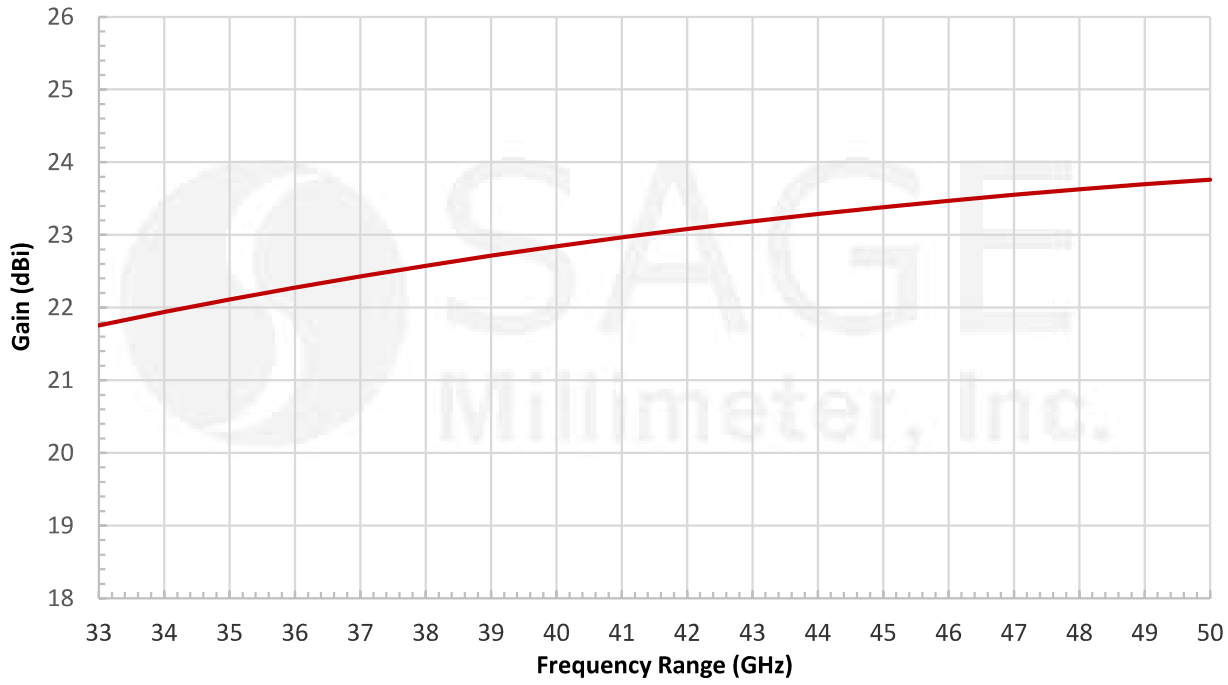
SAGE Millimeter, Inc.

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

Typical Antenna Pattern @ 41.5 GHz



Typical Gain vs. Frequency

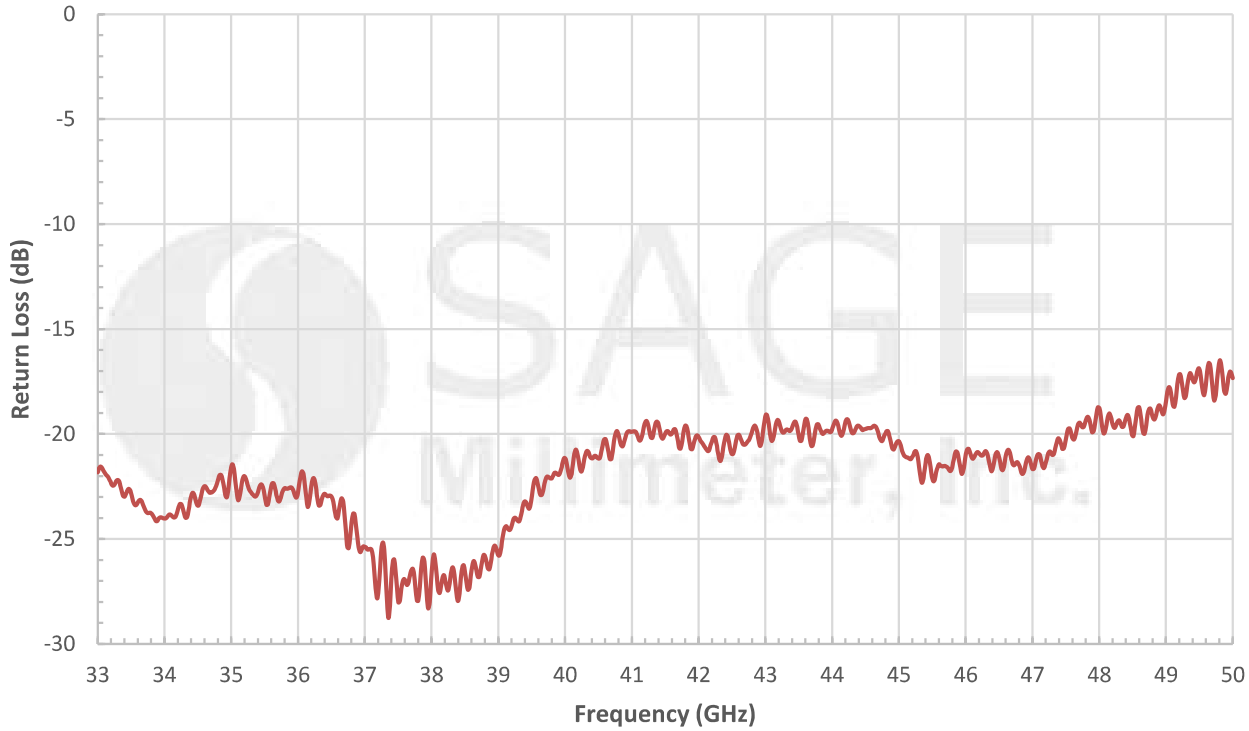


www.sagemillimeter.com | 3043 Kashiwa Street, Torrance, CA 90505
Phone: 424-757-0168 | Fax: 424-757-0188 | Email: sales@sagemillimeter.com

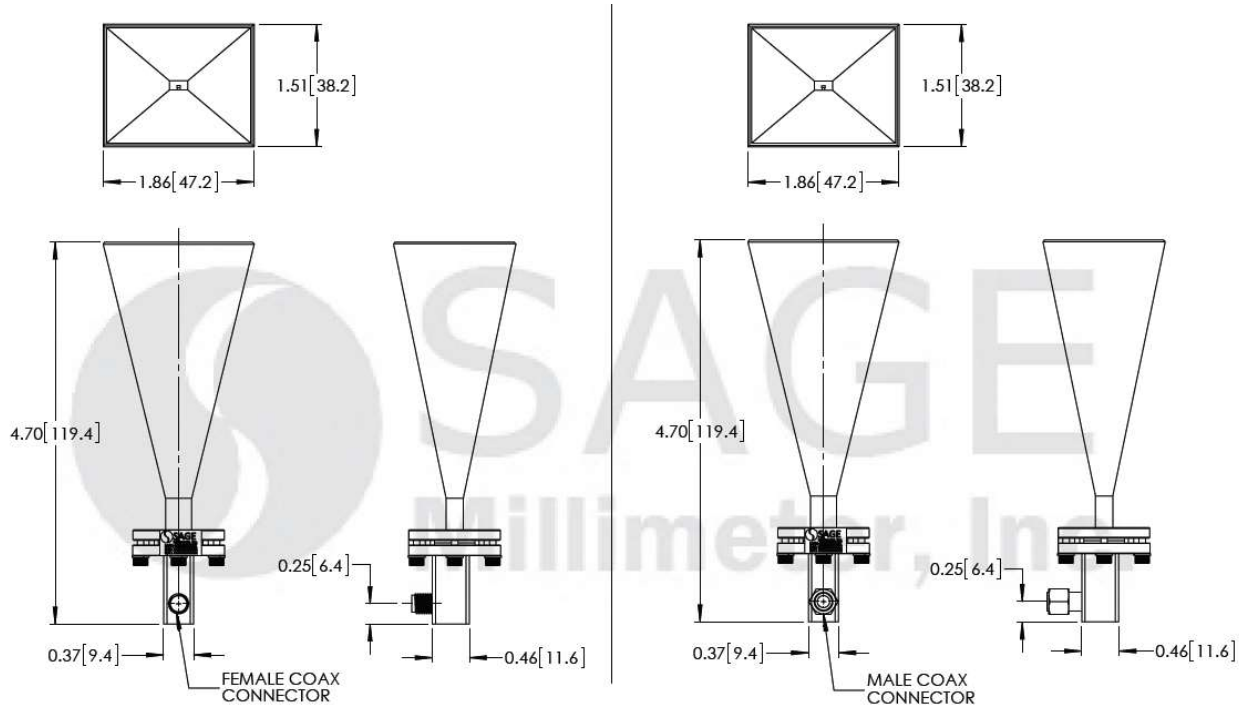
Copyright © 2017 by SAGE Millimeter, Inc.

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

Copyright © 2017 by SAGE Millimeter, Inc.

SAGE Millimeter, Inc.

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.**

SAGE Millimeter, Inc.

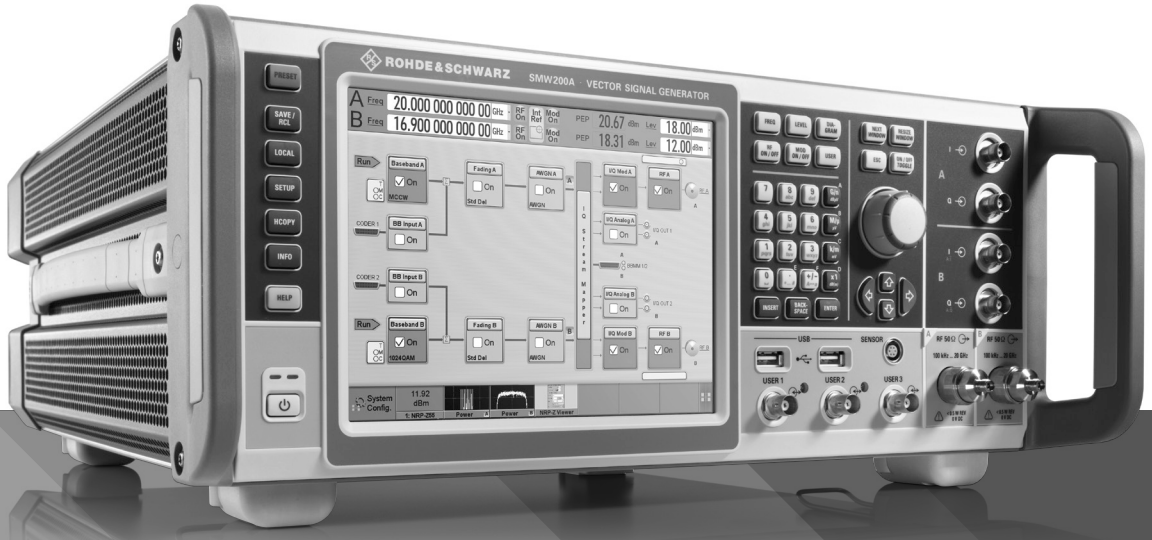
www.sagemillimeter.com | 3043 Kashiwa Street, Torrance, CA 90505
Phone: 424-757-0168 | Fax: 424-757-0188 | Email: sales@sagemillimeter.com

Copyright © 2017 by SAGE Millimeter, Inc.

R&S®SMW200A VECTOR SIGNAL GENERATOR

Specifications

3 year warranty



Data Sheet
Version 20.00

ROHDE&SCHWARZ
Make ideas real

CONTENTS

Key features **5**

Definitions **6**

Frequency and baseband main module options **7**

Frequency options 7

Signal routing and baseband main module options 7

Baseband hardware overview **7**

Frequency options and RF path combinations **8**

Low phase noise options **8**

RF characteristics **9**

Frequency 9

Frequency sweep 10

Reference frequency 10

Level 12

Level sweep 17

Spectral purity 18

List mode 25

Phase coherence (R&S®SMW-B90 option) 26

Simultaneous modulation **28**

Analog modulation **29**

Amplitude modulation (R&S®SMW-K720 option) 29

Frequency modulation (R&S®SMW-K720 option) 29

Phase modulation (R&S®SMW-K720 option) 30

Pulse modulation (R&S®SMW-K22 option) 31

Input for external modulation signals 32

Modulation sources for analog modulation **33**

Internal modulation generator 33

Multifunction generator (R&S®SMW-K24 option) 33

LF output 33

High-performance pulse generator (R&S®SMW-K23 option) 33

I/Q modulation **35**

I/Q modulation performance 35

Analog I/Q inputs 39

Standard baseband characteristics **40**
Internal baseband characteristics (R&S®SMW-B13 or R&S®SMW-B13T option) 40
Analog I/Q outputs (R&S®SMW-B13 or R&S®SMW-B13T option) 40
Differential analog I/Q outputs (R&S®SMW-K16 option) 41
Digital baseband inputs/outputs 42
Standard baseband generator (R&S®SMW-B10 option) – arbitrary waveform mode 45
Extended sequencing (R&S®SMW-K501 option) 47
Standard baseband generator (R&S®SMW-B10 option) – real-time operation (custom digital modulation) 48
Baseband generator for GNSS with high dynamics (R&S®SMW-B10F option) 50
Wideband baseband characteristics **51**
Internal baseband characteristics (R&S®SMW-B13XT option) 51
Wideband analog I/Q outputs (R&S®SMW-B13XT option) 51
Wideband differential analog I/Q outputs (R&S®SMW-K17 option) 51
Digital baseband inputs/outputs for wideband baseband 54
Wideband baseband generator (R&S®SMW-B9 option) – arbitrary waveform mode 58
ARB Ethernet upload (R&S®SMW-K507 option) 60
Extended sequencing (R&S®SMW-K502 option) 60
Real-time control interface (R&S®SMW-K503/-K504 options) 61
Pulse-on-pulse simulation (R&S®SMW-K315 option) 62
Agile sequencing (R&S®SMW-K506 option) 63
Wideband baseband generator (R&S®SMW-B9 option) – real-time operation (custom digital modulation) 64
Wideband baseband generator for GNSS with high dynamics (R&S®SMW-B9F option) 66
Baseband enhancements **67**
Additive white Gaussian noise (AWGN) (R&S®SMW-K62 option) 67
Enhanced noise generation (R&S®SMW-K810 option) 67
Envelope tracking (R&S®SMW-K540 option) 68
AM/AM, AM/PM predistortion (R&S®SMW-K541 option) 69
Digital Doherty (R&S®SMW-K546 option) 69
User-defined frequency response correction (R&S®SMW-K544 option) 69
Automated RF port alignment (R&S®SMW-K545 option) 70
Crest factor reduction (R&S®SMW-K548 option) 70
Slow I/Q (R&S®SMW-K551 option) 71
Notched signals (R&S®SMW-K811 option) 71
BER measurement (R&S®SMW-K80 option) 72
BLER measurement (R&S®SMW-K80 option) 72
Digital modulation systems **73**
Internal digital standards 73
Digital standards with R&S®WinIQSIM2 74
Options with external R&S®Pulse Sequencer Software or R&S®Pulse Sequencer (DFS) Software 76

Signal performance for digital standards and modulation systems **77**

3GPP FDD (R&S®SMW-K42 option) 77

EUTRA/LTE (R&S®SMW-K55 option) 78

IEEE 802.11ac (R&S®SMW-K86 option) 79

IEEE 802.11ad (R&S®SMW-K141 option) 79

IEEE 802.11ax (R&S®SMW-K142 option) 80

IEEE 802.11be (R&S®SMW-K147 option) 80

Custom digital modulation (R&S®SMW-B9/-B10 options, real-time mode) 81

Multichannel, MIMO and fading **82**

Fading simulator (R&S®SMW-B14 option) 82

Fading simulator on instruments with wideband baseband (R&S®SMW-B15 option) 83

Dynamic fading (R&S®SMW-K71 option) 85

Enhanced fading models (R&S®SMW-K72 option) 87

OTA-MIMO fading enhancements (R&S®SMW-K73 option) 88

Customized dynamic fading (R&S®SMW-K820 option) 88

MIMO fading/routing (R&S®SMW-K74 option) 89

Higher-order MIMO (R&S®SMW-K75 option) 91

MIMO subsets for higher-order MIMO (R&S®SMW-K821 option) 92

Fading bandwidth extension to 400 MHz (R&S®SMW-K822 option) 93

Fading bandwidth extension to 800 MHz (R&S®SMW-K823 option) 94

Multiple entities (R&S®SMW-K76 option) 95

Stream extender (R&S®SMW-K550 option) 97

Radar echo generation (R&S®SMW-K78 option) 97

Health and utilization monitoring service (HUMS) (R&S®SMW-K980 option) **101**

Remote control **101**

Connectors **102**

Front panel connectors 102

Rear panel connectors 103

General data **104**

Ordering information **106**

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

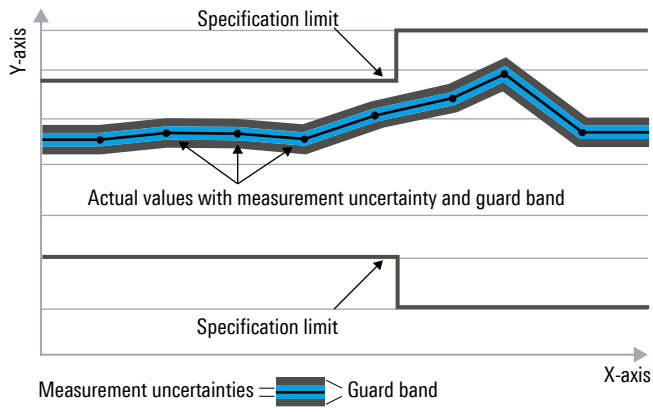
- Customizing of instrument to accommodate virtually every application
- Advanced plug-in system for retrofitting baseband modules without instrument recalibration
- Software upgrades possible at any time, simple and quick activation via key codes

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 A / **Path B**	(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, $\leq 1 \cdot 10^{-7}$/year
	with R&S®SMW-B709/-B710/-B711 options	$\leq 5 \cdot 10^{-10}$/day, $\leq 3 \cdot 10^{-8}$/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, 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, applied external reference frequency
Output level		7 dBm to 14 dBm
Source impedance		50 Ω (nom.)
Wideband noise	with R&S®SMW-K703 option, 100 MHz, internal reference, carrier offset = 10 MHz, 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, carrier offset = 10 MHz, 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

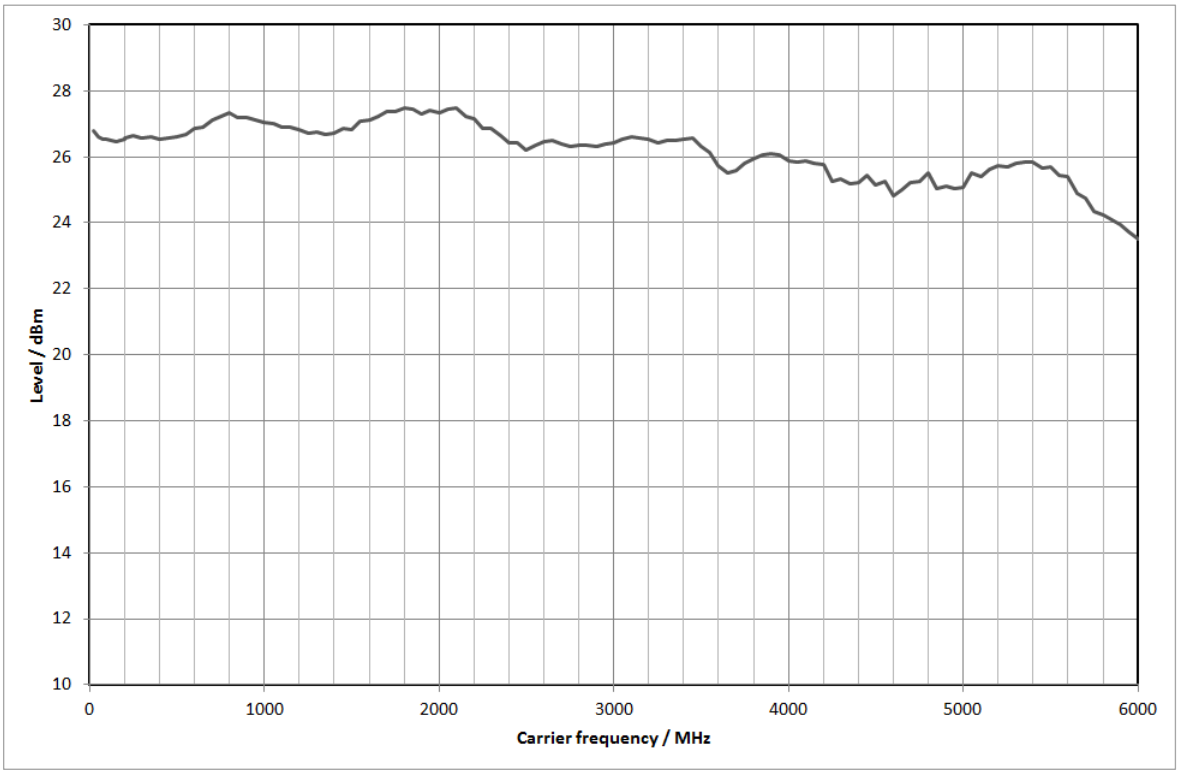
[2] PEP = peak envelope power.

Additional level error	I/Q modulation	
	optimization mode: high quality, fast	< 0.3 dB
	pulse modulation	< 0.5 dB
Output impedance, VSWR in 50 Ω system	level setting characteristic: auto	
	R&S®SMW-B1003, R&S®SMW-B2003, R&S®SMW-B1006, R&S®SMW-B2006, 100 kHz < f ≤ 6 GHz	< 1.9, < 1.5 (typ.)
	R&S®SMW-B1007, R&S®SMW-B2007, R&S®SMW-B1012, R&S®SMW-B2012, 100 kHz < f ≤ 12.75 GHz	< 2.0, < 1.6 (typ.)
	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, 100 kHz < f ≤ 20 GHz	< 2.1, < 1.7 (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, step attenuator = 0 dB, 20 GHz < f ≤ 38 GHz	< 2.2, < 1.8 (typ.)
	R&S®SMW-B1040, R&S®SMW-B1040N, R&S®SMW-B1044, R&S®SMW-B2044, R&S®SMW-B1044N, R&S®SMW-B2044N, step attenuator = 0 dB, 38 GHz < f ≤ 44 GHz	< 2.6, < 2.2 (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, step attenuator ≥ 5 dB, 20 GHz < f ≤ 44 GHz	< 2.1, < 1.7 (typ.)
	R&S®SMW-B1056, R&S®SMW-B1056N, R&S®SMW-B1067, R&S®SMW-B1067N, 100 kHz < f ≤ 38 GHz	< 2.2, < 1.8 (typ.)
	R&S®SMW-B1056, R&S®SMW-B1056N, R&S®SMW-B1067, R&S®SMW-B1067N, 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, 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, R&S®SMW-B2044, R&S®SMW-B2044N, R&S®SMW-B1056, R&S®SMW-B1056N, R&S®SMW-B1067, R&S®SMW-B1067N, with switching of mechanical step attenuator, after IEC/IEEE bus delimiter	< 30 ms

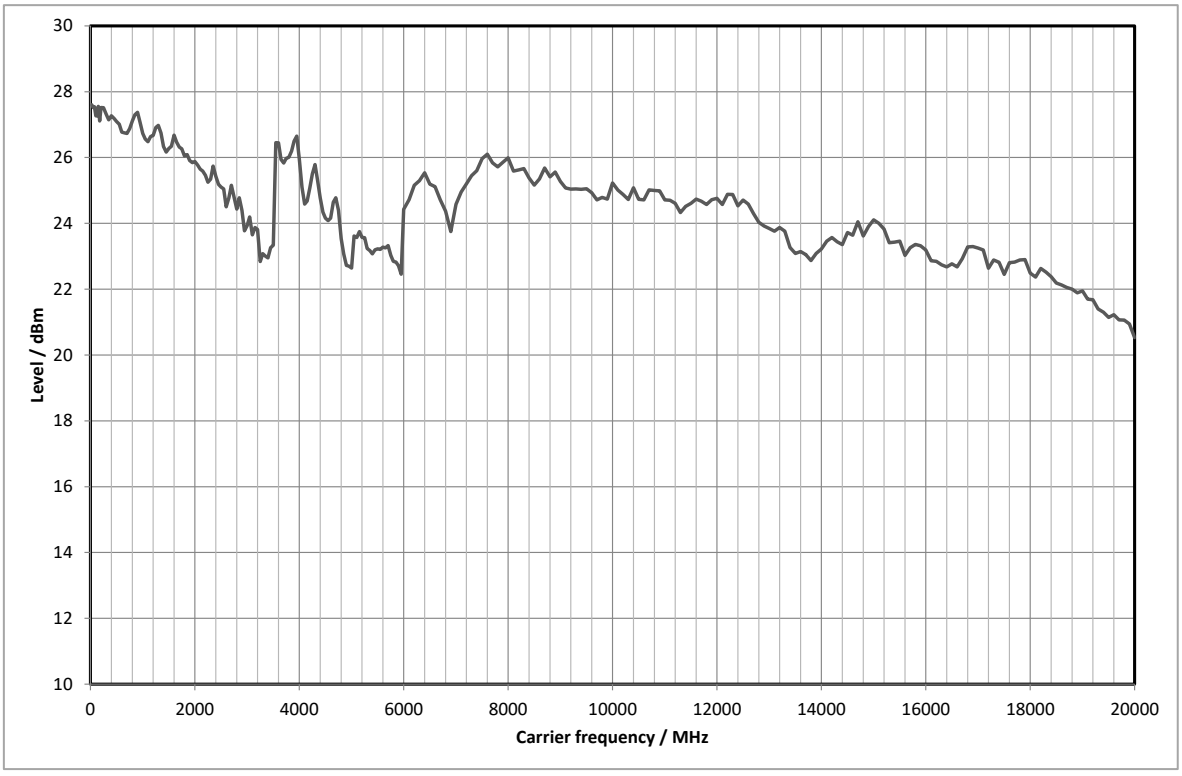
[3] R&S®SMW-B1007, R&S®SMW-B2007, R&S®SMW-B1012, R&S®SMW-B1020, R&S®SMW-B2020, R&S®SMW-B1031, R&S®SMW-B1040, R&S®SMW-B1040N: temperature > +18 °C.

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; 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

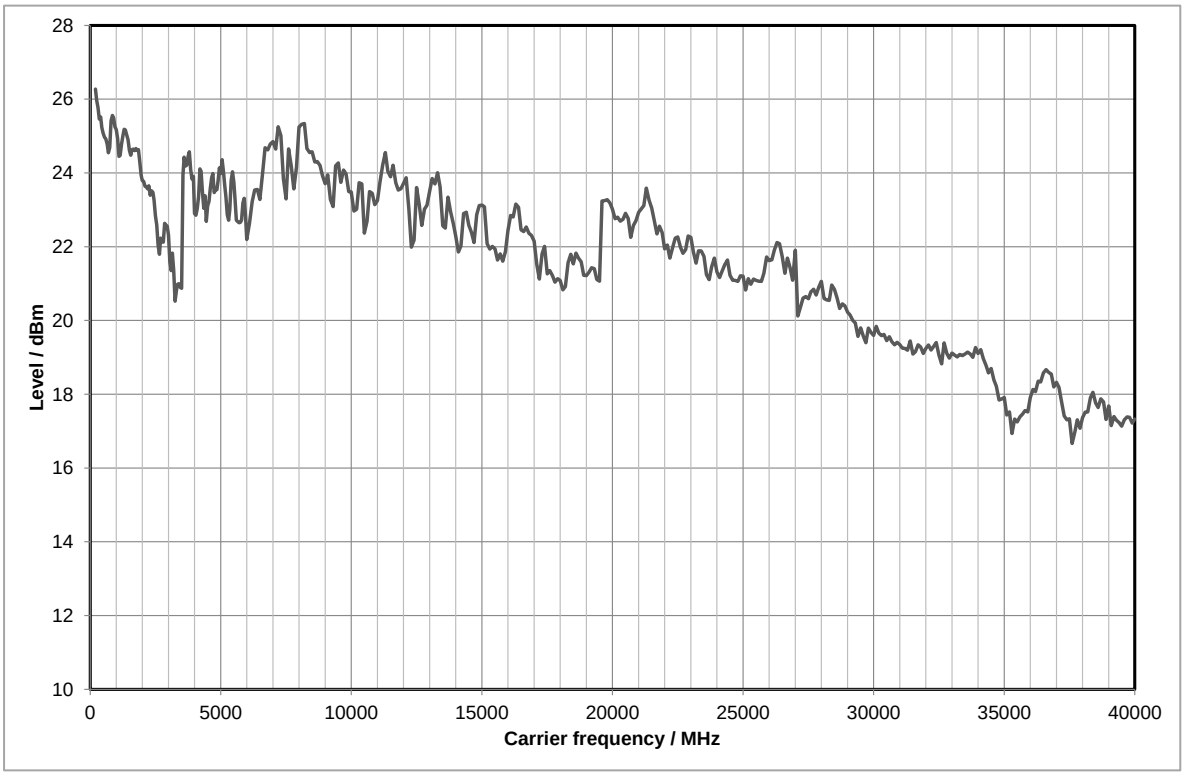
[4] R&S®SMW-B1007, R&S®SMW-B2007, R&S®SMW-B1012, R&S®SMW-B1020, R&S®SMW-B2020, R&S®SMW-B1031, R&S®SMW-B1040, R&S®SMW-B1040N: temperature > +18 °C.



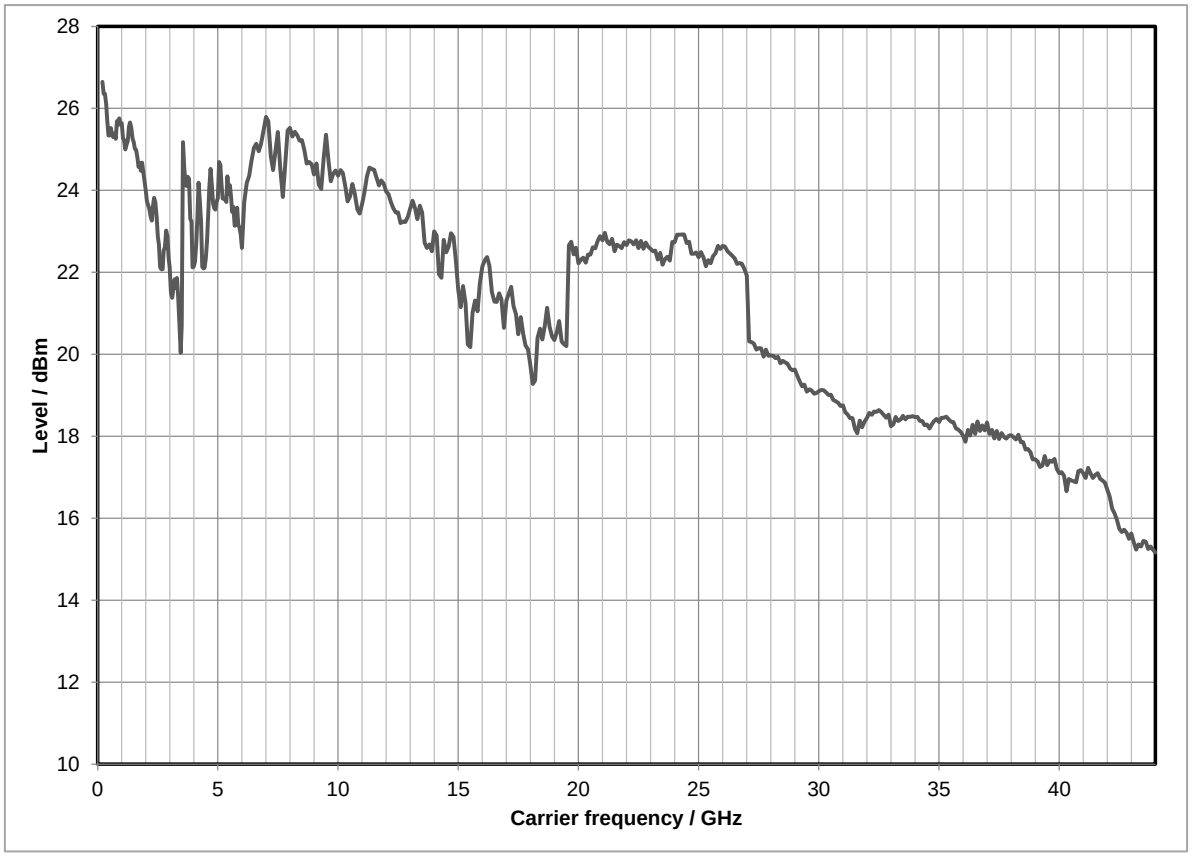
Measured maximum available output level versus frequency with R&S®SMW-B1006, R&S®SMW-B2006 frequency options



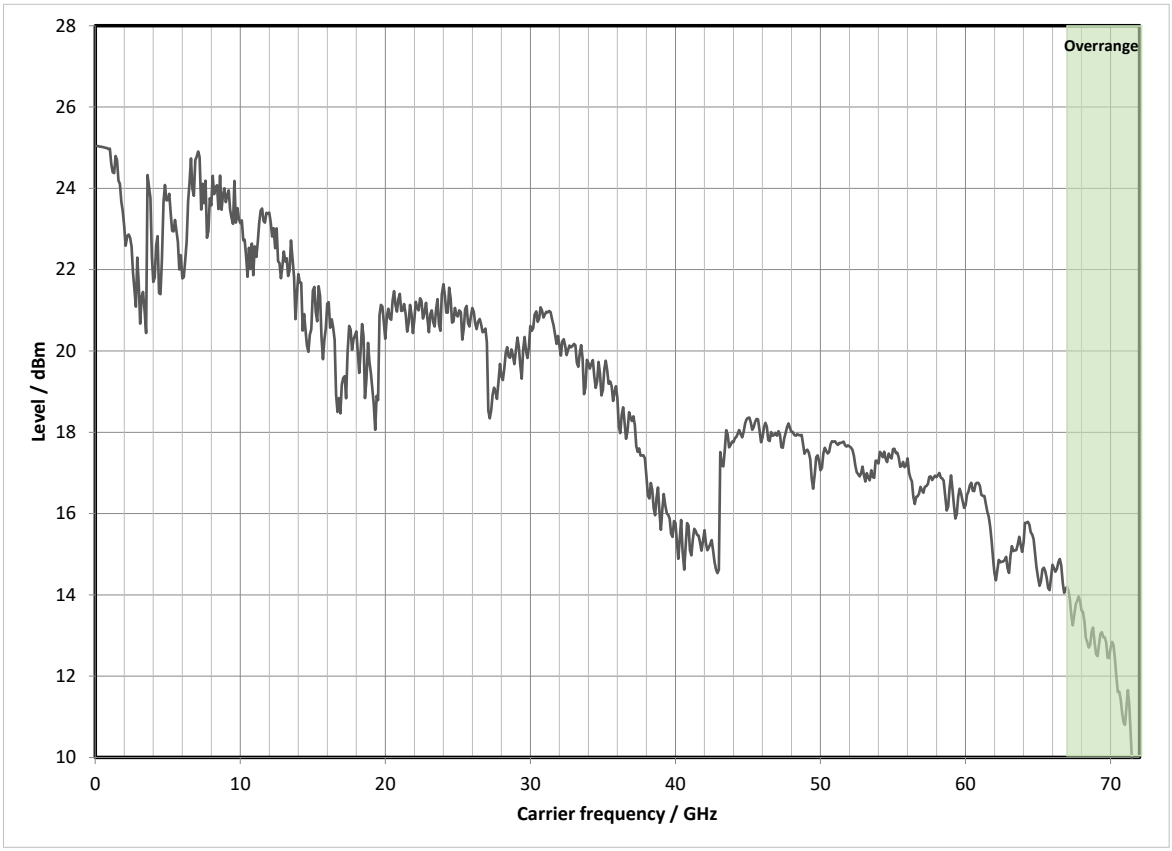
Measured maximum available output level versus frequency with R&S®SMW-B1020, R&S®SMW-B2020 frequency options



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)

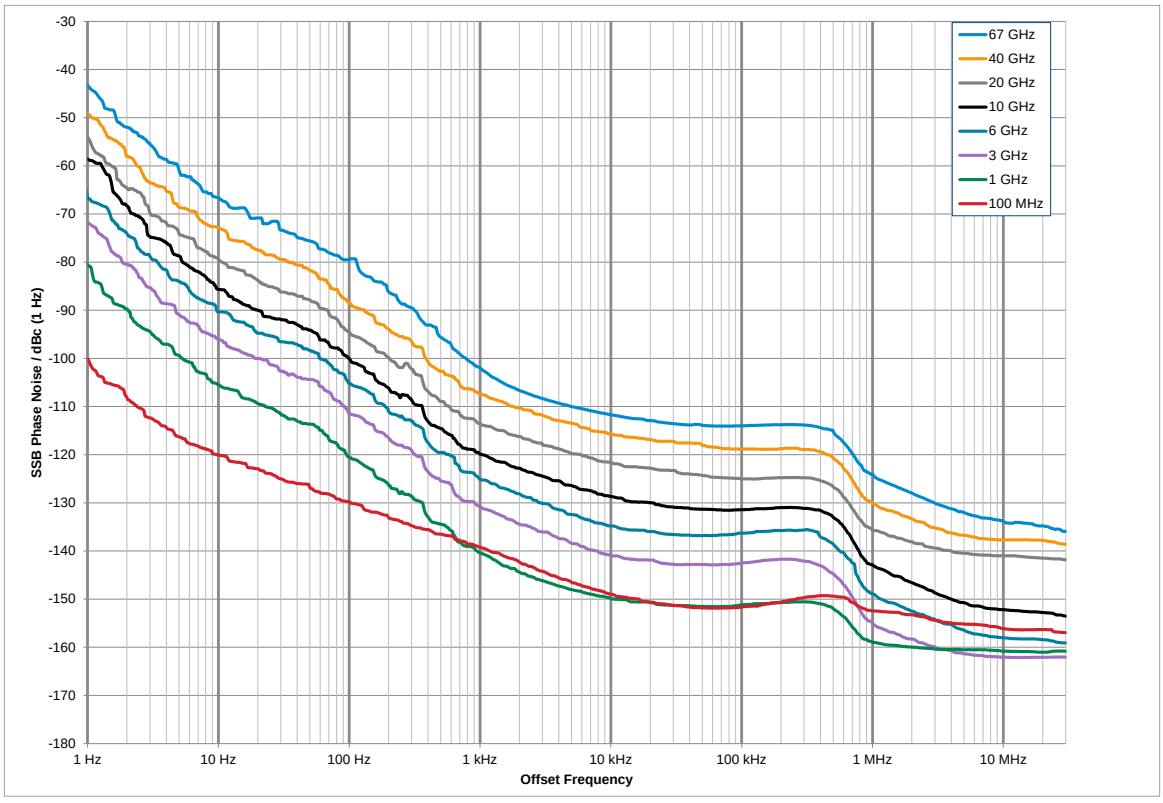
SSB phase noise in dBc, 1 Hz measurement bandwidth, CW, level = 10 dBm				
Offset frequency / Carrier frequency	**10 kHz**	**100 kHz**	**1 MHz**	**10 MHz**
f = 10 MHz	–138 (–144)	–136 (–142)	–141 (–147)	
f = 100 MHz	–138 (–144)	–136 (–142)	–141 (–147)	–149 (–155)
f = 1 GHz	–139 (–145)	–137 (–143)	–144 (–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

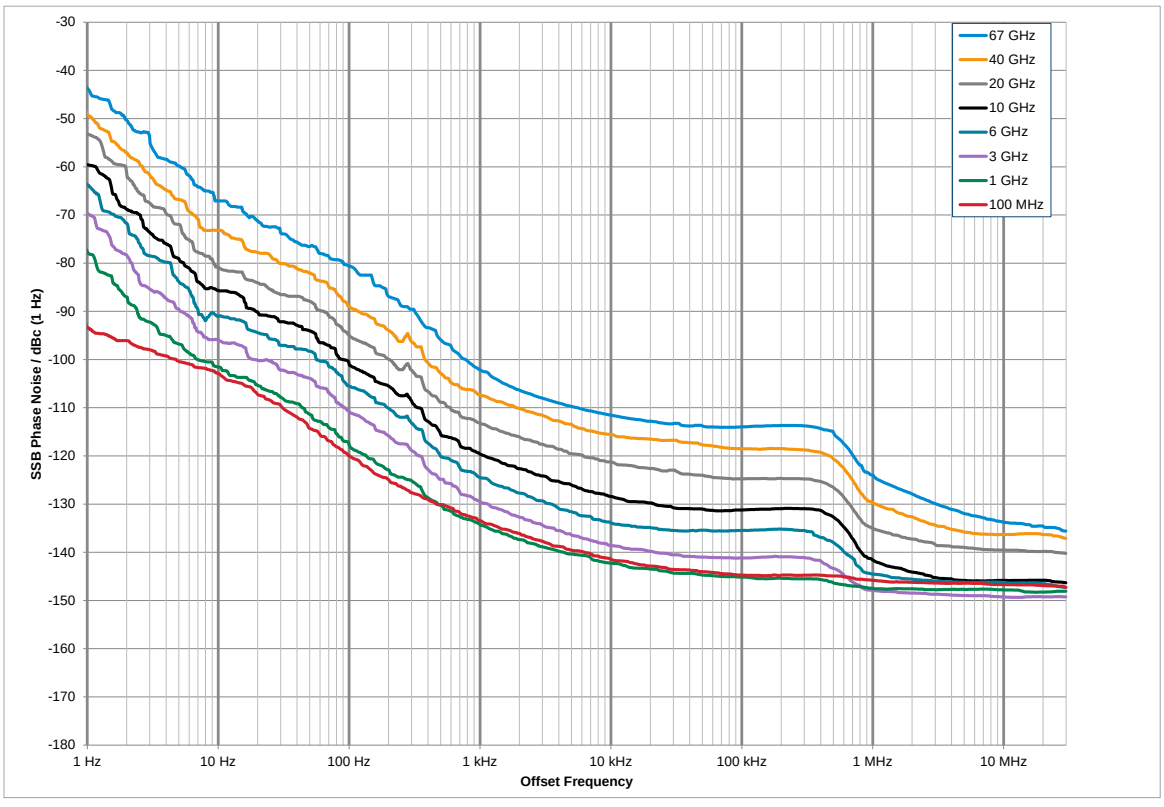
Specified values in plain text, typical values in brackets ( ), measured values in brackets *( ) and italics.*

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)

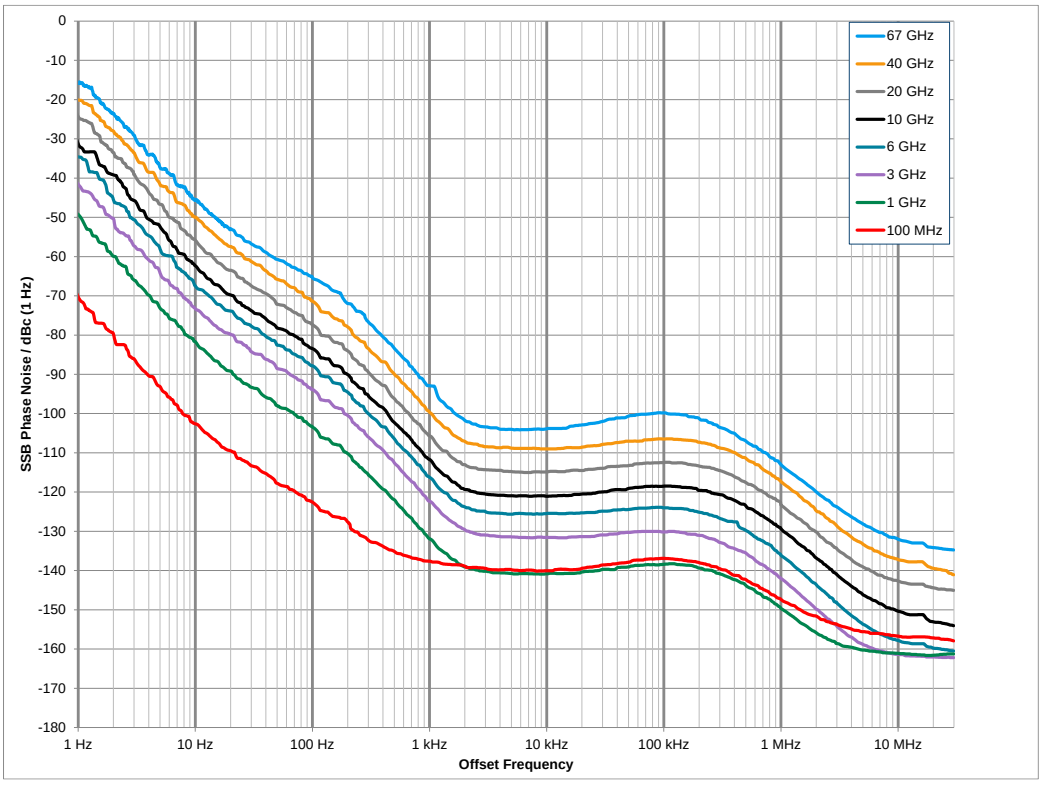
SSB phase noise in dBc, 1 Hz measurement bandwidth, CW, level = 10 dBm				
Offset frequency / Carrier frequency	**10 kHz**	**100 kHz**	**1 MHz**	**10 MHz**
f = 10 MHz	–143 (–149)	–146 (–152)	–146 (–152)	
f = 100 MHz	–143 (–149)	–146 (–152)	–146 (–152)	–149 (–155)
f = 1 GHz	–144 (–150)	–145 (–151)	–151 (–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)



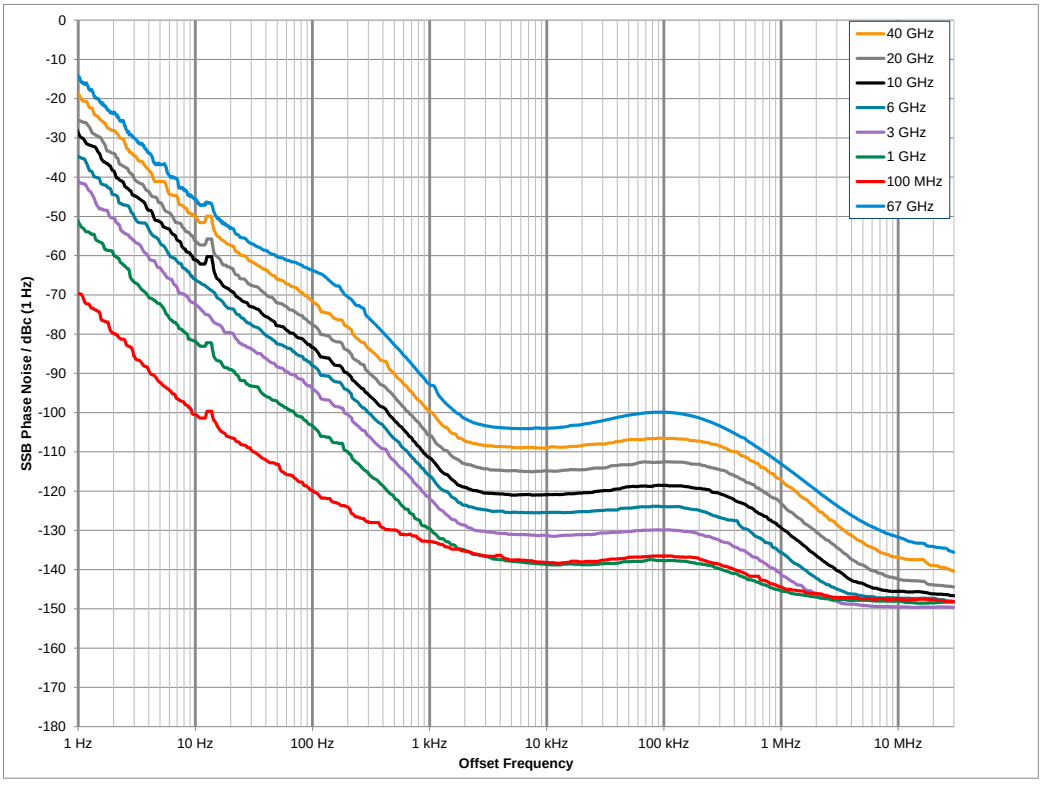
Measured SSB phase noise performance with R&S®SMW-B711/-B721 options, CW mode



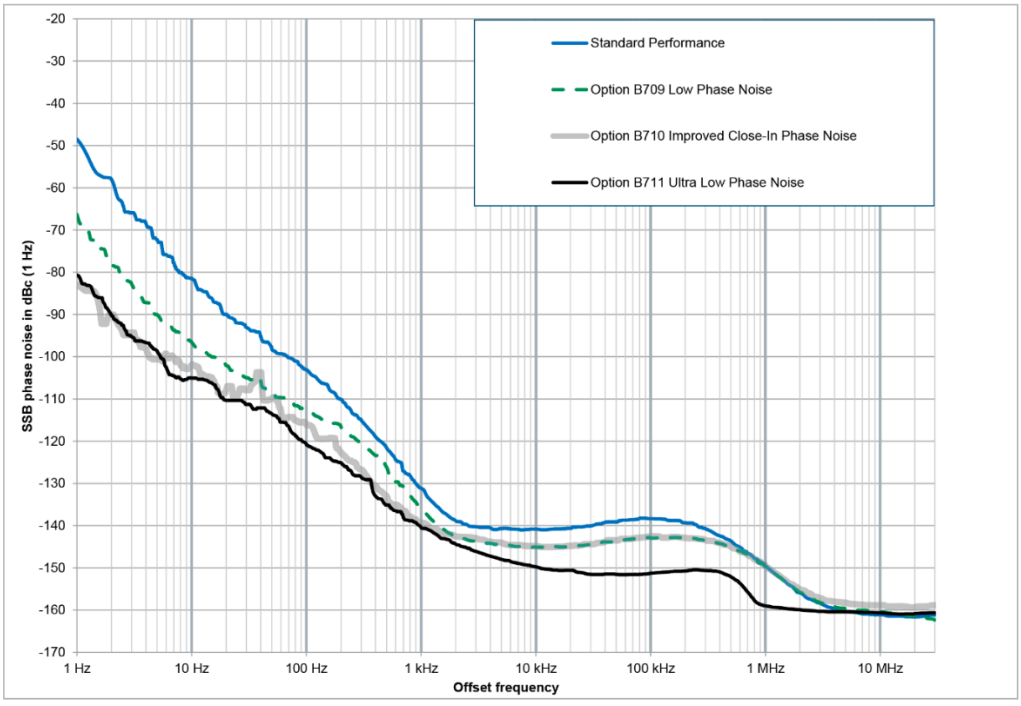
Measured SSB phase noise performance with R&S®SMW-B711/-B721 options, I/Q mode



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:

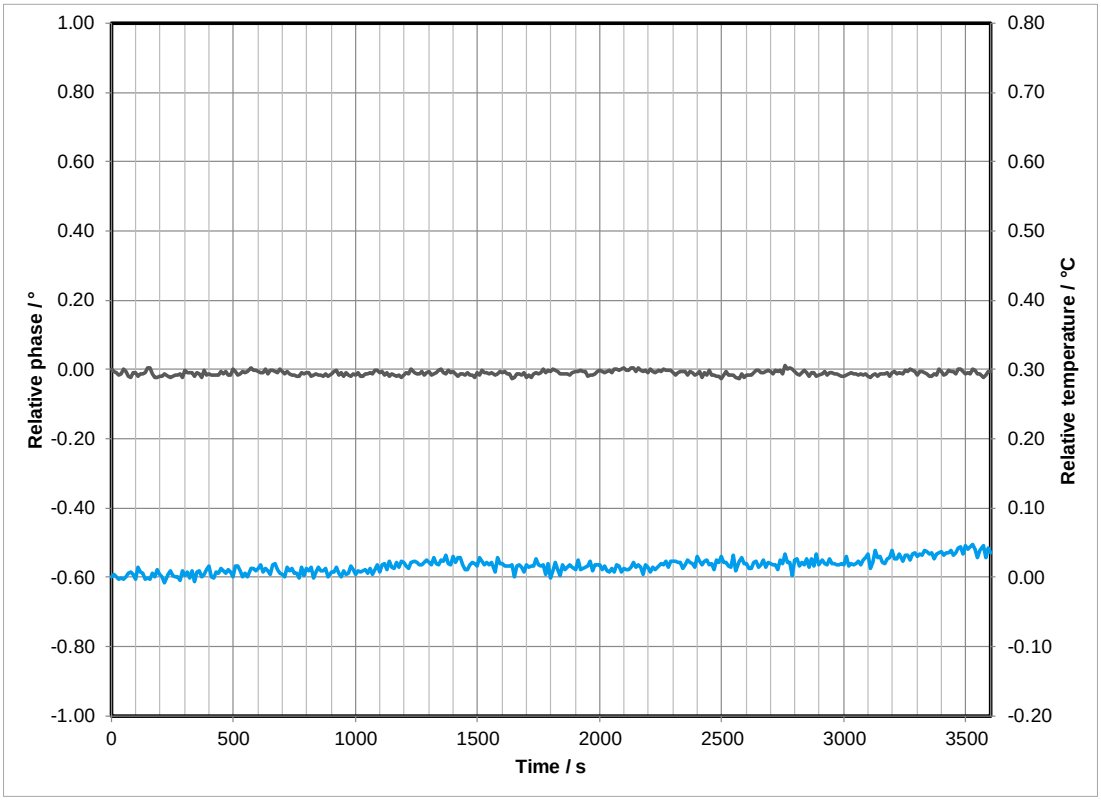
- Learned: faster (see frequency and level data), limited number of steps, cannot be combined with I/Q optimization mode "high quality", not available if the instrument is equipped with R&S®SMW-B711/-B721 ultra low phase noise options
- Live: works only for dwell times above 2 ms

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

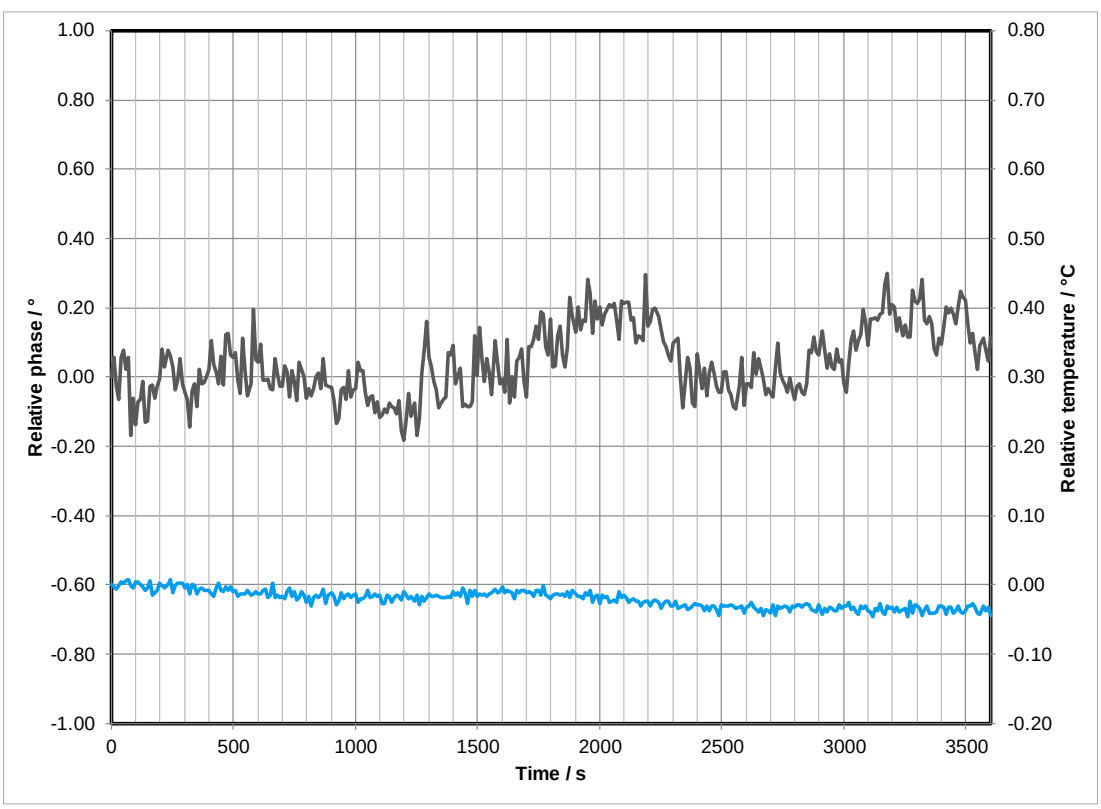
Phase coherence (R&S®SMW-B90 option)

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 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, high bandwidth, low noise
Maximum deviation	PM mode: high deviation 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, DC, 10 Hz to 500 kHz	< 1 dB
	deviation > N · 5 rad, DC, 10 Hz to 10 kHz	< 1 dB
	high bandwidth, DC, 10 Hz to 10 MHz for f ≤ 3 GHz, 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, 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)

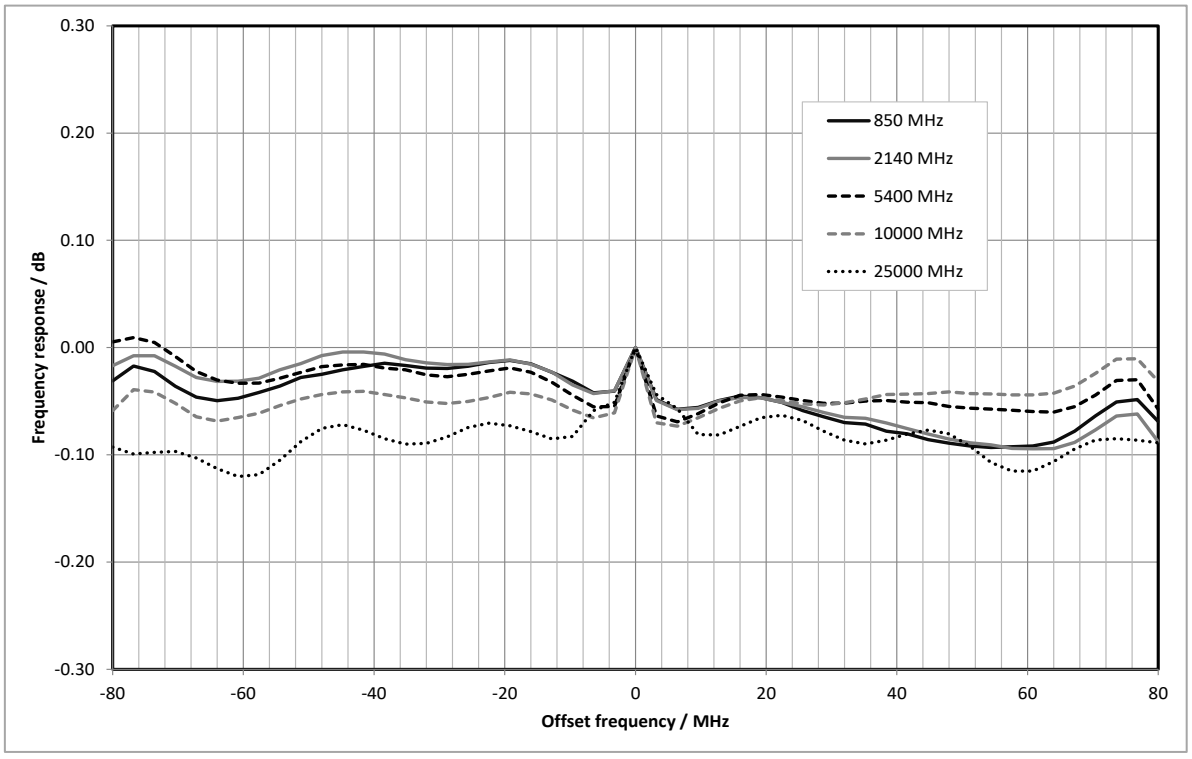
I/Q modulation

I/Q modulation performance

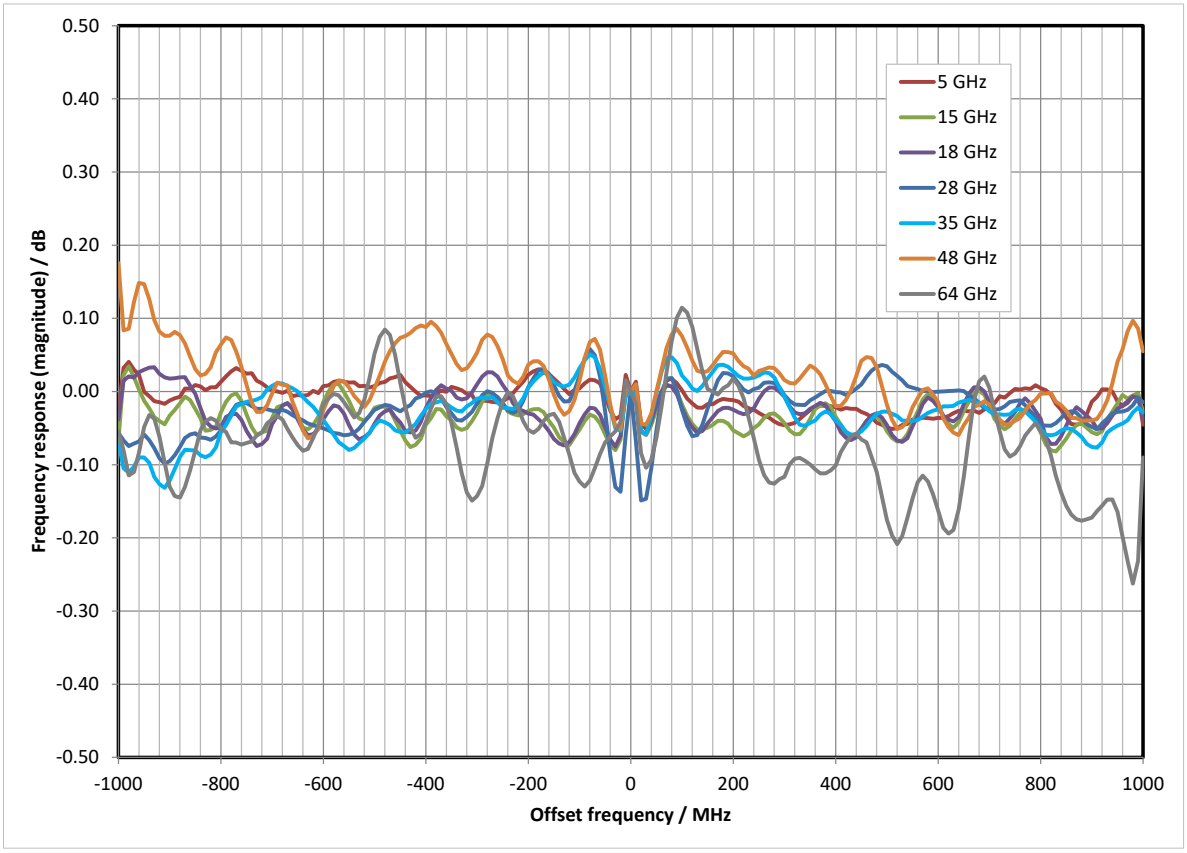
Operating modes		external wideband I/Q, internal baseband I/Q
RF modulation bandwidth	with external wideband I/Q inputs, I/Q wideband on; with R&S®SMW-B1003, R&S®SMW-B2003, R&S®SMW-B1006, R&S®SMW-B2006, R&S®SMW-B1020, R&S®SMW-B2020, R&S®SMW-B1031, R&S®SMW-B2031, R&S®SMW-B1040, R&S®SMW-B1044, R&S®SMW-B2044, 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; 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; 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; 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), 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; 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; 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; 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°

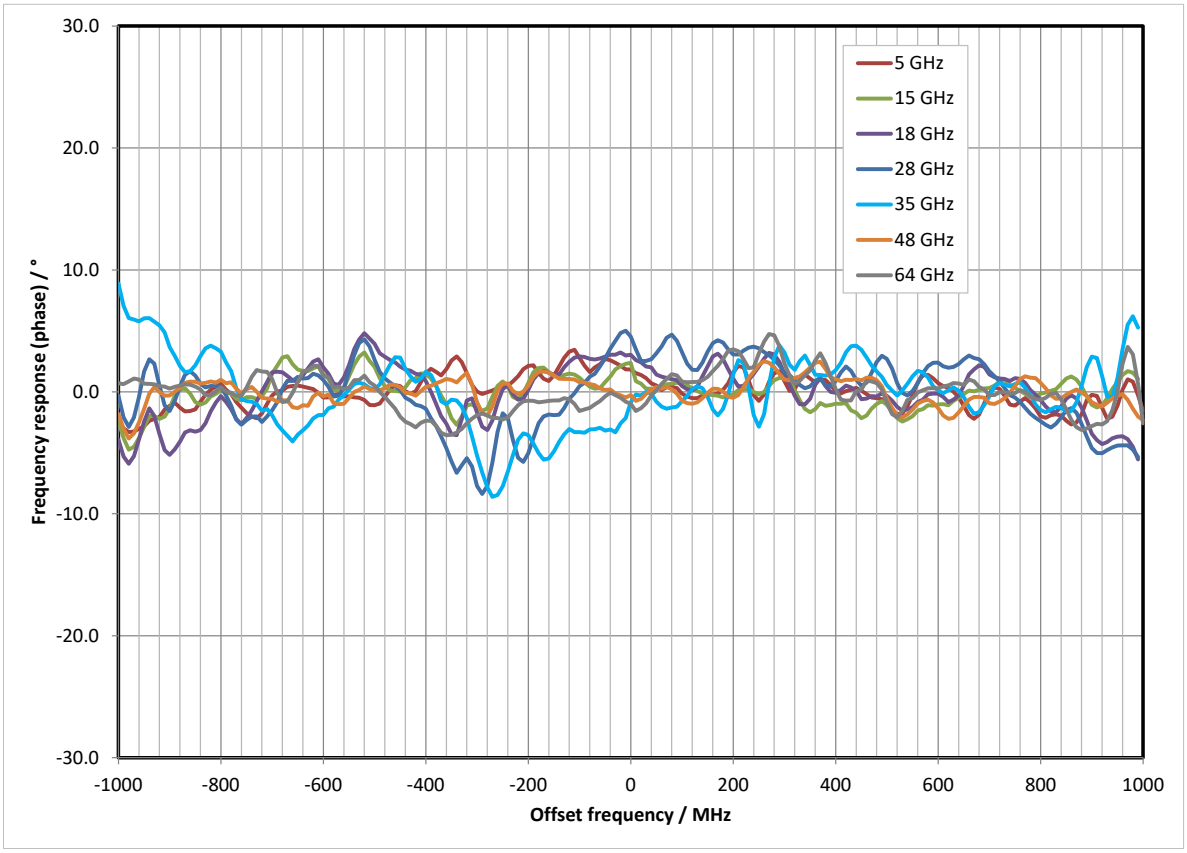
[7] Value applies after 1 hour warm-up time and recalibration for 4 hours of operation and temperature variations of less than +5 °C.



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		$\sqrt{V_i^2 + V_q^2} = 0.5\ \mathrm{V}$
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 (+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 (+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). 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). 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, 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 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 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. 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)

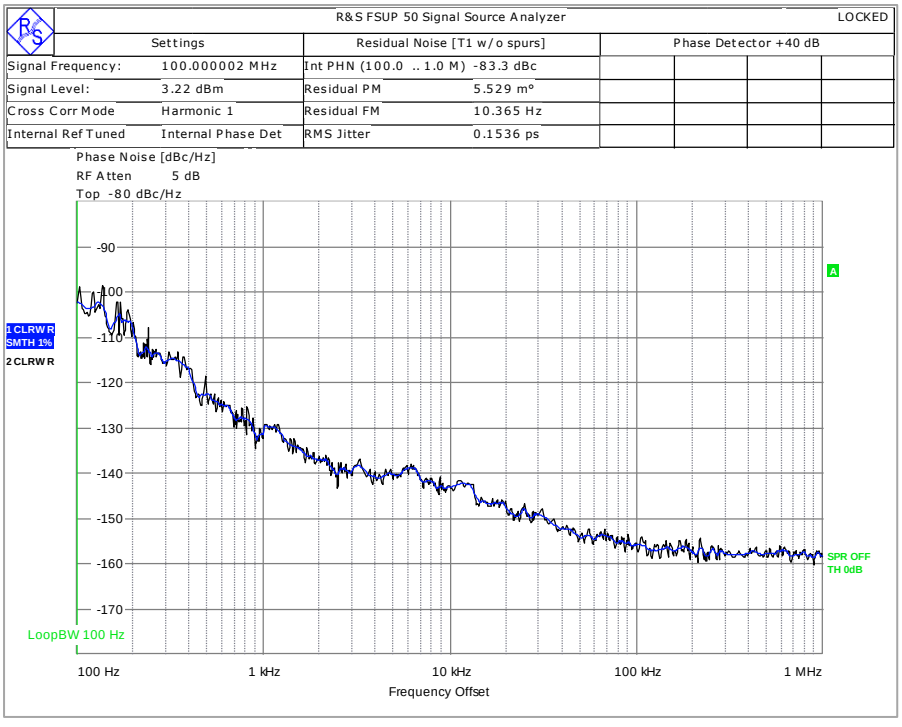
This option can be installed once if the instrument is equipped with the R&S®SMW-B13XT option. Differential analog I/Q outputs can be used on signal path A only. If the differential output mode is activated, analog I/Q outputs for signal path B are not available.

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.

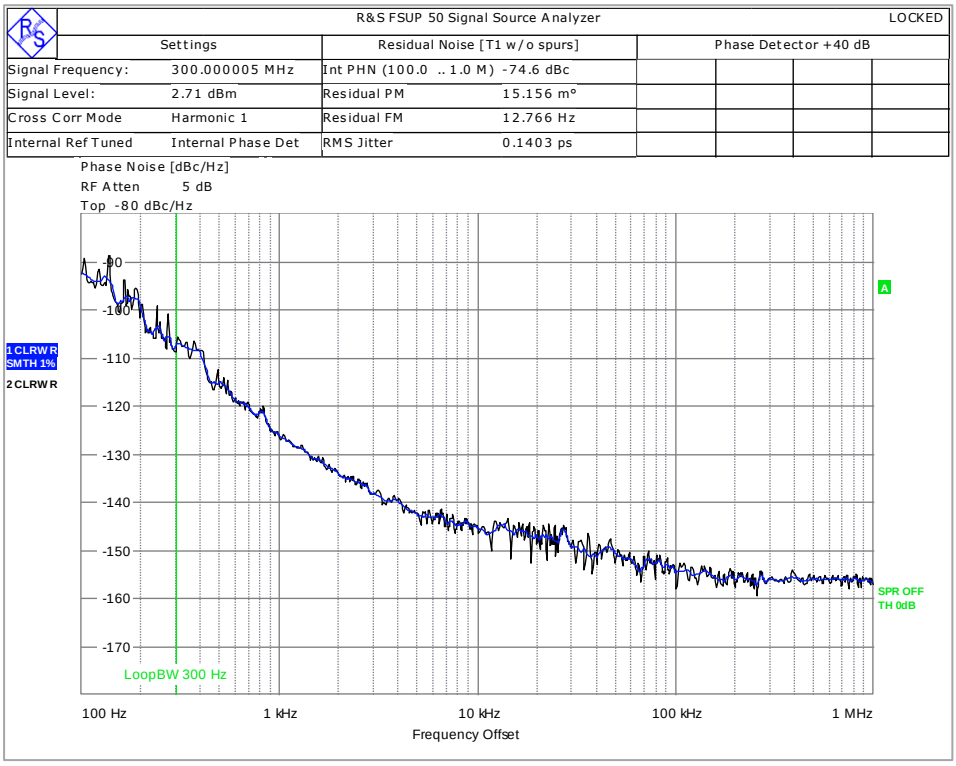
Bias voltage (single-ended and differential)	EMF	–0.2 V to +2.5 V [14]
Resolution		0.1 mV
Uncertainty		1 % + 2 mV
Offset voltage		
Differential	EMF	(–2 V + V_{out}) to (+2 V – V_{out})
	RF envelope: on (R&S®SMW-K540 required), EMF	–2 V to +2 V
Resolution		0.1 mV
Uncertainty		1 % + 1 mV
Differential signal 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.)



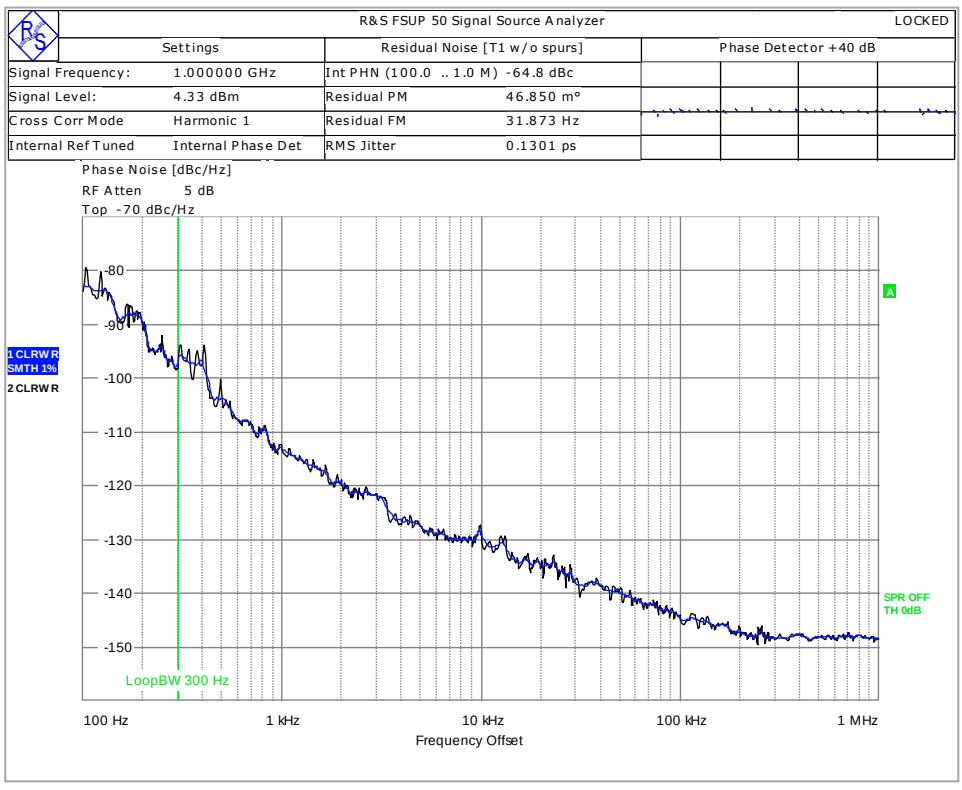
Measured phase noise of wideband analog I/Q outputs; single-ended sine wave with f = 100 MHz

[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, in line with R&S®Digital I/Q Interface 40G PAD-R [19] (DIG I/Q 40G), 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	< ($1 \cdot 10^{-12}$ + 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		< $9 \cdot 10^{-6}$ 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, 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 • 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, 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
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. 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 symbol to $2.147 \cdot 10^9$ symbol
Setting resolution		3.3 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 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 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 · 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. 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.

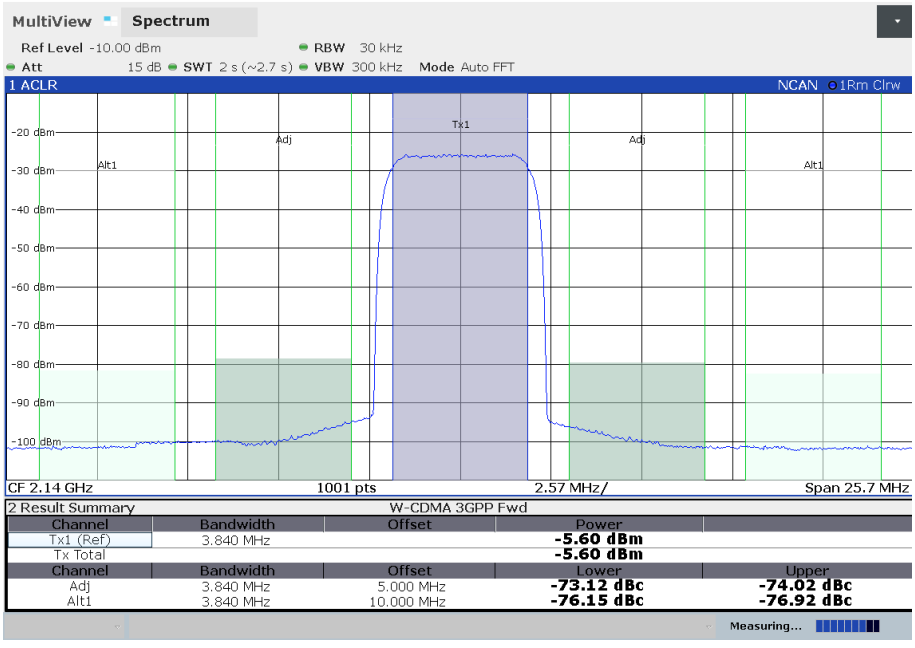
The options are described in the R&S®Pulse Sequencer Software data sheet (PD 3607.1388.22).

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)

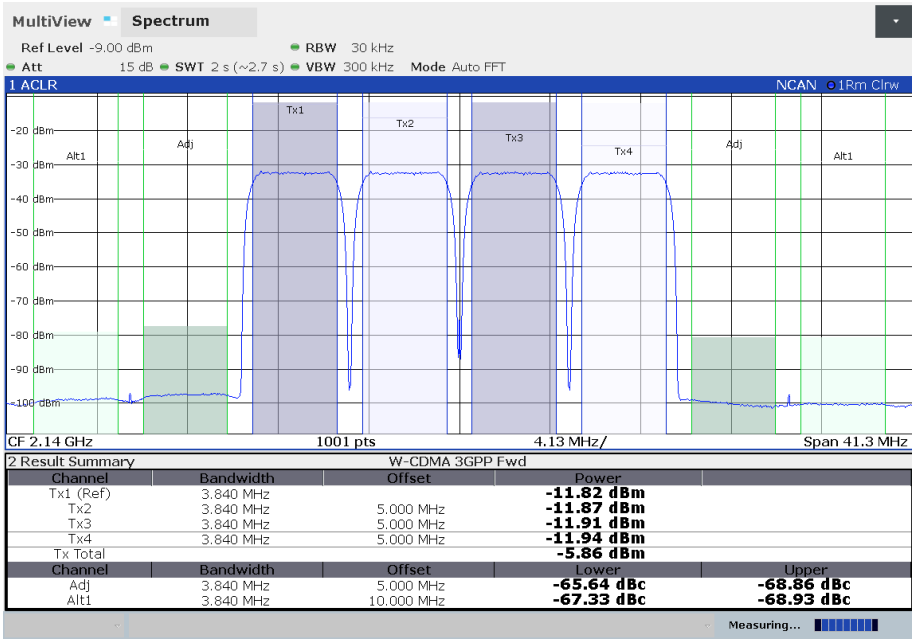
Signal performance for digital standards and modulation systems

3GPP FDD (R&S®SMW-K42 option)

Error vector magnitude	1 DPCH, RMS, 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, average channel power ≤ 3 dBm, 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, average channel power ≤ 0 dBm, 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, average channel power ≤ –2 dBm, 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, 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, average channel power ≤ –5 dBm, with R&S®SMW-B1056, R&S®SMW-B1056N, R&S®SMW-B1067, R&S®SMW-B1067N frequency options, with R&S®SMW-B13/-B13T options	
	5 MHz offset	> 70 dB
	10 MHz offset	> 72 dB

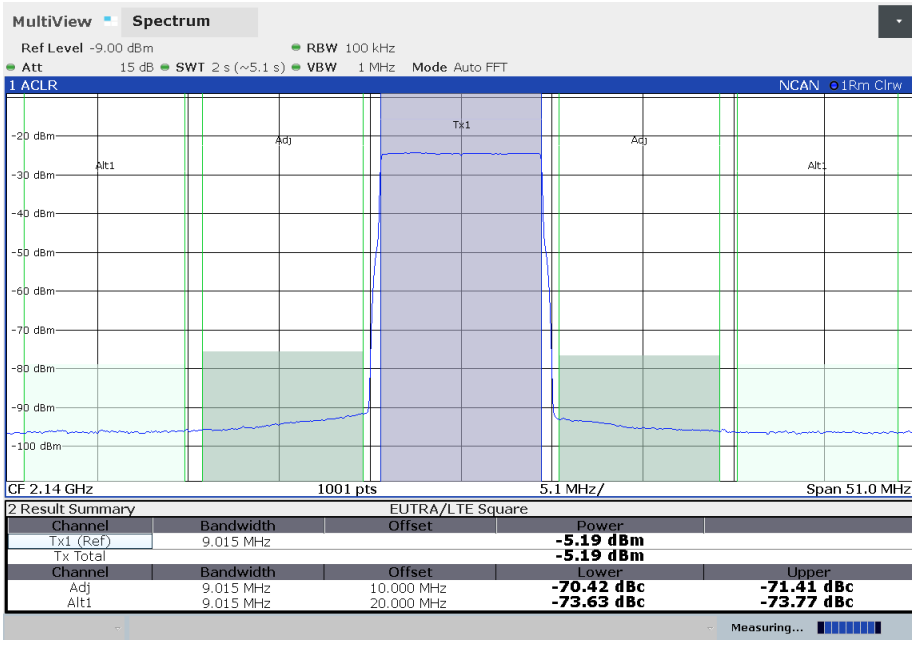


Measured ACPR for 3GPP test model 1, 64 DPCH



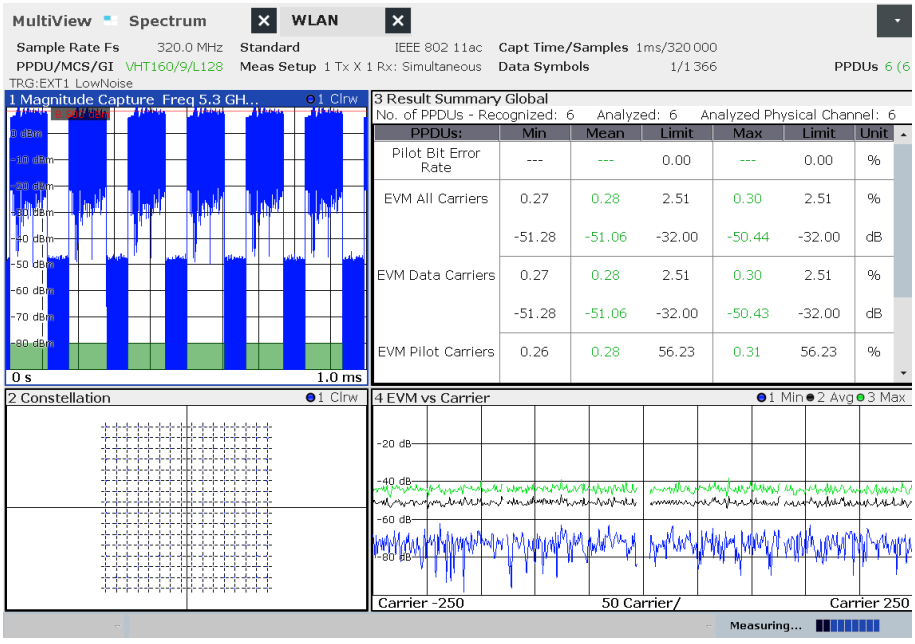
Measured ACPR for a 3GPP four-carrier signal with test model 1, 64 DPCH on each carrier

EUTRA/LTE (R&S®SMW-K55 option)



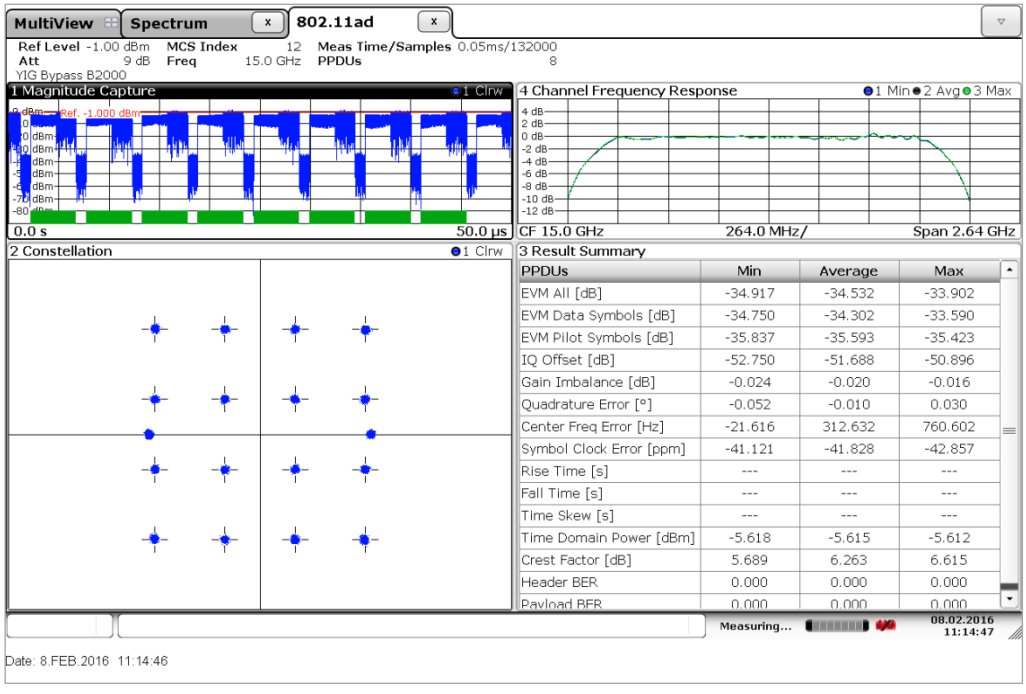
Measured ACPR for a 10 MHz LTE test model E-TM1_1

IEEE 802.11ac (R&S®SMW-K86 option)



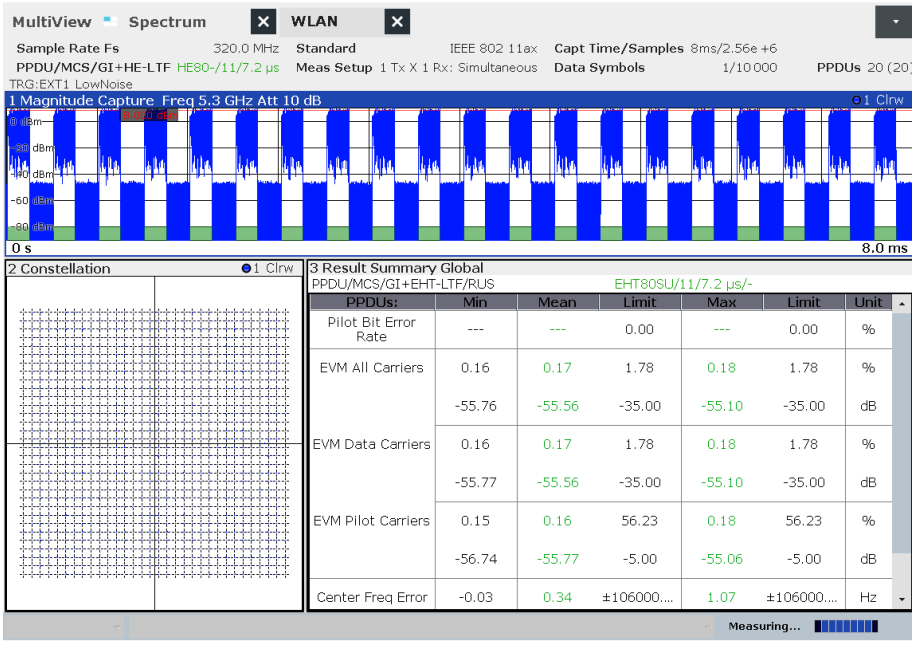
Measured EVM for an IEEE 802.11ac signal with 160 MHz bandwidth

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)

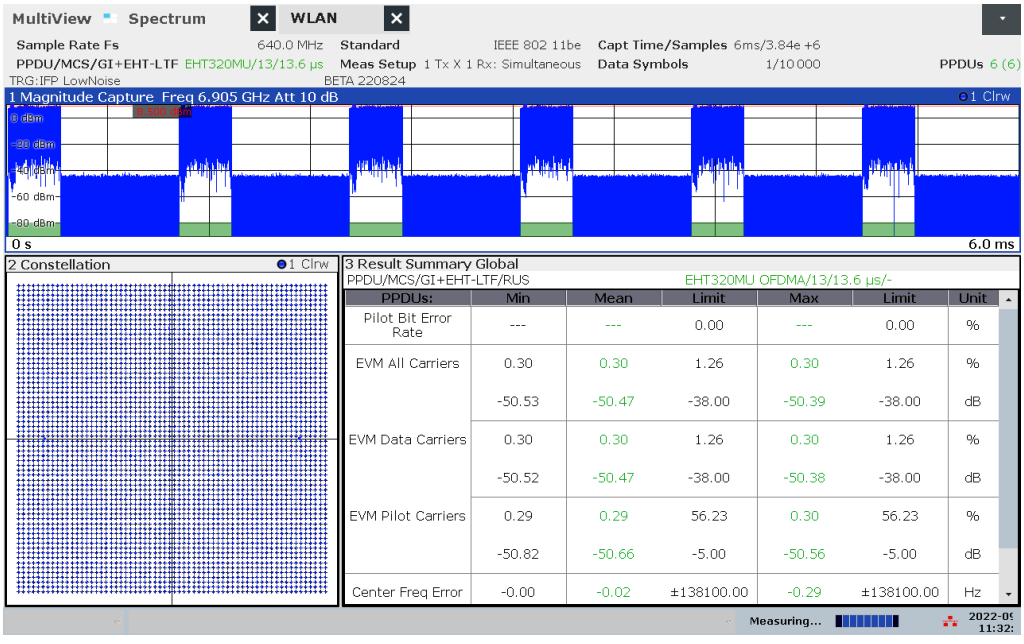
IEEE 802.11ax (R&S®SMW-K142 option)



PPDUs:	Min	Mean	Limit	Max	Limit	Unit
Pilot Bit Error Rate	---	---	0.00	---	0.00	%
EVM All Carriers	0.16	0.17	1.78	0.18	1.78	%
	-55.76	-55.56	-35.00	-55.10	-35.00	dB
EVM Data Carriers	0.16	0.17	1.78	0.18	1.78	%
	-55.77	-55.56	-35.00	-55.10	-35.00	dB
EVM Pilot Carriers	0.15	0.16	56.23	0.18	56.23	%
	-56.74	-55.77	-5.00	-55.06	-5.00	dB
Center Freq Error	-0.03	0.34	±106000....	1.07	±106000....	Hz

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

IEEE 802.11be (R&S®SMW-K147 option)

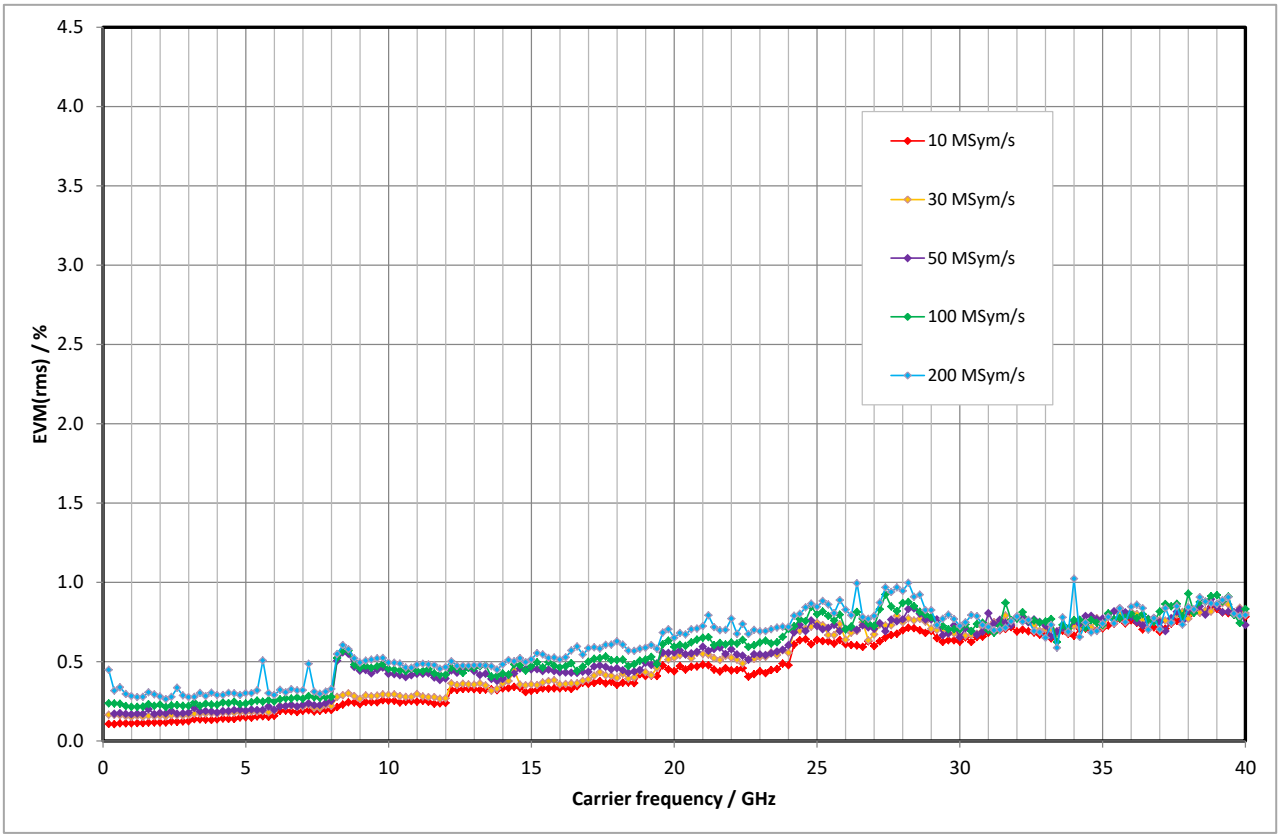


PPDUs:	Min	Mean	Limit	Max	Limit	Unit
Pilot Bit Error Rate	---	---	0.00	---	0.00	%
EVM All Carriers	0.30	0.30	1.26	0.30	1.26	%
	-50.53	-50.47	-38.00	-50.39	-38.00	dB
EVM Data Carriers	0.30	0.30	1.26	0.30	1.26	%
	-50.52	-50.47	-38.00	-50.38	-38.00	dB
EVM Pilot Carriers	0.29	0.29	56.23	0.30	56.23	%
	-50.82	-50.66	-5.00	-50.56	-5.00	dB
Center Freq Error	-0.00	-0.02	±138100.00	-0.29	±138100.00	Hz

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

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

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 (see R&S®SMW-K74 specifications)
	with R&S®SMW-K74 option, four R&S®SMW-B15 installed	up to 16 (see R&S®SMW-K74 specifications)
	with R&S®SMW-K74 and R&S®SMW-K75 options, four R&S®SMW-B15 installed	up to 64 (see R&S®SMW-K75 specifications)
Number of fading paths (per logical fader)		20
Bandwidth		up to 200 MHz
	with R&S®SMW-K822	up to 400 MHz
	with R&S®SMW-K823	up to 800 MHz
Start seed		0 to 9

Fading profiles		static path, pure Doppler, Rayleigh, Rice, constant phase, bell shape TGn indoor, bell shape TGn moving vehicle
Fading profile parameter		
Rayleigh	pseudo-noise interval	> 1 year
Constant phase	phase	0° to 360°
	phase resolution	0.1°
Pure Doppler	maximum resulting Doppler shift	frequency ratio · current Doppler frequency
	frequency ratio	–1 to +1
	resolution	0.01
Rician	combination of Rayleigh and pure Doppler	
	power ratio	–30 dB to +30 dB
Fading path loss	setting range	0 dB to 50 dB
	setting resolution	0.01 dB
	accuracy	< 0.01 dB
Fading path delay	The 20 fading paths are divided in 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 ≥ 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), LTE (CQI, EPA, EVA, ETU, MBFSN), GSM, CDMA2000®, 1xEV-DO, IEEE 802.11n SISO, IEEE 802.11ac SISO, WiMAX™ ITU, NADC, PCN, TETRA, 3GPP models, HIPERLAN/2
	with R&S®SMW-K71 option	5G NR (HST, moving propagation), LTE (HST, moving propagation), 3GPP (HST, moving propagation, birth-death)
	with R&S®SMW-K72 option	WiMAX™ SUI, DAB, Watterson, IEEE 802.11p
	with R&S®SMW-K74 option	5G NR MIMO (TDL-A, TDL-B and TDL-C), LTE MIMO (EPA, EVA, ETU), IEEE 802.11n MIMO, IEEE 802.11ac MIMO, WiMAX™ MIMO
	with R&S®SMW-K74 and R&S®SMW-K71 options	LTE MIMO (HST)
	with R&S®SMW-K74 and R&S®SMW-K72 options	3GPP SCME channel models, LTE MIMO SCME channel models
	with R&S®SMW-K74 and R&S®SMW-K73 options	5G NR (CDL-A, CDL-B and CDL-C), 3GPP Geo SCME channel models, LTE MIMO Geo SCME channel models

Dynamic fading (R&S®SMW-K71 option)

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

At least one R&S®SMW-B15 fading simulator must be installed. If two or more R&S®SMW-B15 are installed (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) 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, one or two R&S®SMW-B14 installed	path A: up to 6
	one R&S®SMW-K78 option, four R&S®SMW-B14 installed	path A: up to 12
	two R&S®SMW-K78 options, two R&S®SMW-B14 installed	path A: up to 6, path B: up to 6
	two R&S®SMW-K78 options, four R&S®SMW-B14 installed	path A: up to 12, path B: up to 12
Bandwidth		up to 160 MHz
Test setups	Radar under test (RUT) is directly connected to the R&S®SMW200A (and 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 use different doppler frequency for all spectral parts	moving
	echo for objects with constant range and no velocity is generated	static
	echo for objects with constant range and constant velocity > 0 m/s is generated use same doppler frequency for all spectral parts	static + 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}, 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}, 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}, v_{max} = (10 MHz / 2 · f) · c, i.e. v_{max} = 499654 m/s for f = 3 GHz, v_{max} = 74948 m/s for f = 20 GHz, v_{max} = 37474 m/s for f = 40 GHz
Setting range (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}, v_{max} = (190 kHz / 2 · f) · c, i.e. v_{max} = 9 493 m/s for f = 3 GHz, v_{max} = 1 424 m/s for f = 20 GHz, v_{max} = 712 m/s for f = 40 GHz
Setting resolution		0.001 m/s
Direction	object flies toward RUT	approaching
	object flies away from RUT	departing

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) • REST (JSON) • SCPI • device web
Services	information provided	• device information (model, serial number, BIOS, date, time, system, HUMS and software information) • user-defined information tags (e.g. for asset management) • equipment information (hardware, options, software, licenses) • system operating status • instrument security information • service related information (due dates etc.) • mass storage related information • instrument utilization data • 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) • Telnet/RawEthernet (remote control) • VNC (remote operation with web browser) • FTP (file transfer protocol) • 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, e.g. for frequency or level sweep	BNC female
INST TRG B	trigger input for RF path B, e.g. for frequency or level sweep	BNC female
USER 4, USER 5, USER 6	user-configurable inputs or outputs, 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, R&S®NRP-Zxx power sensors (with R&S®NRP-ZKU USB interface cable) for external power measurements and level adjustment of instrument, memory stick for software update and data exchange, 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
I, $\overline{I}$, 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, 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 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., 55 Hz to 150 Hz, 0.5 g const., in line with EN 60068-2-6
	random	8 Hz to 500 Hz, acceleration: 1.2 g RMS, in line with EN 60068-2-64
Shock		40 g shock spectrum, in line with MIL-STD-810E, method no. 516.4, procedure I
Product conformity		
Electromagnetic compatibility	EU: in line with EMC directive 2014/30/EC	applied harmonized standards: • EN 61326-1 (for use in industrial environment) • EN 61326-2-1 • EN 55011 (class B) • EN 61000-3-2 • EN 61000-3-3
	EU: in line with EMC directive 2014/30/EC; with R&S®SMW-K18, R&S®SMW-K19 options	applied harmonized standards: • EN 61326-1 (for use in industrial environment) • EN 61326-2-1 • EN 55011 (class A) • EN 61000-3-2 • EN 61000-3-3
Electrical safety	EU: in line with low voltage directive 2014/35/EC	applied harmonized standard: 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 (17.1 in × 7.6 in × 18.1 in)
	with R&S®SMW-B94L option, W × H × D	435 mm × 192 mm × 560 mm (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] 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.

The Bluetooth® word mark and logos are registered trademarks owned by Bluetooth SIG, Inc. and any use of such marks by Rohde & Schwarz is under license.

CDMA2000® is a registered trademark of the Telecommunications Industry Association (TIA-USA).

WiMAX Forum is a registered trademark of the WiMAX Forum. WiMAX, the WiMAX Forum logo, WiMAX Forum Certified and the WiMAX Forum Certified logo are trademarks of the WiMAX Forum.

NFC Forum and the NFC Forum logo are trademarks of the Near Field Communication Forum™.

[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.

Service that adds value

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

Rohde & Schwarz

The Rohde & Schwarz technology group is among the trailblazers when it comes to paving the way for a safer and connected world with its leading solutions in test & measurement, technology systems and networks & cybersecurity. Founded more than 85 years ago, the group is a reliable partner for industry and government customers around the globe. The independent company is headquartered in Munich, Germany and has an extensive sales and service network with locations in more than 70 countries.

www.rohde-schwarz.com

Sustainable product design

- ► Environmental compatibility and eco-footprint
- ► Energy efficiency and low emissions
- ► Longevity and optimized total cost of ownership

Certified Quality Management
ISO 9001

Certified Environmental Management
ISO 14001

Rohde & Schwarz training

www.training.rohde-schwarz.com

Rohde & Schwarz customer support

www.rohde-schwarz.com/support

R&S® is a registered trademark of Rohde & Schwarz GmbH & Co. KG
Trade names are trademarks of the owners
PD 3606.8037.22 | Version 20.00 | November 2022 (ch)
R&S®SMW200A Vector Signal Generator
Data without tolerance limits is not binding | Subject to change
© 2013 - 2022 Rohde & Schwarz GmbH & Co. KG | 81671 Munich, Germany

3606803722
3606.8037.22 20.00 PDP/PDW 1 en