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# R&S® SMB100A Signal Generator

Data sheet

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# Key features

## Best signal quality in its class

- Low SSB phase noise of typ.  $-128$  dBc (20 kHz carrier offset, 1 GHz carrier frequency, 1 Hz measurement bandwidth)
  - Very low SSB phase noise even at low output frequencies (because a new DDS synthesizer is used from 9 kHz to 23.4375 MHz instead of a downconverter)
  - Nonharmonics suppression of typ.  $-85$  dBc (>10 kHz carrier offset, carrier frequency <1.5 GHz)
  - Low wideband noise of typ.  $-152$  dBc (>10 MHz carrier offset, 1 GHz carrier frequency, 1 Hz measurement bandwidth)
  - Harmonics of typ.  $-30$  dBc at the maximum specified output power of +18 dBm
- ... for high measurement accuracy in a wide variety of applications

## Highest output power in its class

- Specified output power of +18 dBm over the wide frequency range of 1 MHz to 6 GHz
  - Typical maximum level of +25 dBm (in overrange) over the entire frequency range up to 6 GHz
- ... provides power reserve to replace external amplifiers

## On-site servicing as convenient alternative

- Flexible concept allows servicing to be done on site or by a Rohde & Schwarz service center
  - Straightforward modular instrument design with only four exchangeable modules ensures short repair times
  - Calibrated replacement modules make extensive calibration and adjustment tasks unnecessary
  - Built-in selftest of modules supports troubleshooting
  - Verification of level accuracy and automatic level correction with a connected power sensor of the R&S NRP family <sup>1</sup>
- ... ensures low cost of ownership and maximum instrument availability

## All-purpose RF source

- Wide frequency range from 9 kHz to 6 GHz covers the main frequency bands for RF applications
  - Integrated frequency, level, and LF sweeps
  - All important analog modulations with AM, FM/ $\phi$ M, and pulse modulation supported
  - Internal LF generator provides sinewave signals up to 1 MHz as well as squarewave signals up to 20 kHz
  - Intuitive user interface with graphical display of the signal flow facilitates operation
  - Context-sensitive online help ensures efficient utilization of the instrument
- ... makes the R&S SMB100A the ideal signal source for a wide variety of applications

## Ideal for production

- Short switchover times for frequency of typ. 1.6 ms and level of typ. 1.2 ms via remote control and <1 ms in the List mode allow high throughput
  - High level accuracy and repeatability are the basis of high production yield
  - High output power of up to +25 dBm compensates level loss on the way to the DUT
  - Wearfree electronic attenuator with overvoltage protection up to 6 GHz as standard ensures long service life even in the case of heavy use in production
  - Compact design with only two height units saves rack space
  - Remote control via LAN, USB, and GPIB allows easy integration into the test system
- ... reduces production costs

## Ready for aerospace and defense applications

- Optional pulse modulator offers excellent performance with typ. 90 dB on/off ratio and a rise/fall time of typ. 10 ns
  - Flexible pulse generator with minimum pulse width of 20 ns allows the generation of various pulse signals
  - Wide temperature range of 0 °C to +55 °C and maximum permissible operating altitude of 4600 m above sea level allow the instrument to be used even under extreme conditions
  - Low weight of only 5.3 kg for mobile applications
- ... expands the range of locations and applications for which the R&S SMB100A can be used

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<sup>1</sup> Available as of December 2007 via firmware update.

# Specifications

Specifications apply under the following conditions:

30 minutes warm-up time at ambient temperature, specified environmental conditions met, calibration cycle adhered to, and total calibration performed. Data designated 'overrange' or 'underrange' and data without tolerance limits is not binding.

## RF characteristics

### Frequency

Range	R&S®SMB-B101	9 kHz to 1.1 GHz
	R&S®SMB-B102	9 kHz to 2.2 GHz
	R&S®SMB-B103	9 kHz to 3.2 GHz
	R&S®SMB-B106	9 kHz to 6 GHz
Resolution of setting		0.01 Hz
Resolution of synthesis	f = 1 GHz	0.44 μHz
Setting time	to within $<1 \times 10^{-7}$ for f > 200 MHz or <20 Hz for f ≤ 200 MHz	
	after IEC/IEEE bus delimiter	<3 ms, typ. 1.6 ms
	in ALC OFF mode (S&H)	<7 ms
	after trigger pulse in List mode	<1 ms
Phase offset		adjustable in 0.1° steps

### Frequency sweep

Operating modes	digital sweep in discrete steps	automatic, step, single sweep,
		external single, external step,
		manual or external trigger,
		linear or logarithmic spacing
Sweep range		full frequency range
Step width	linear	full frequency range
	logarithmic	0.01 % to 100 % per step
Dwell time	range	10 ms to 10 s
	resolution	0.1 ms

### Reference frequency

Aging	after 30 days of uninterrupted operation	$<1 \times 10^{-6}$ /year
	with R&S®SMB-B1 option	$<1 \times 10^{-9}$ /day, $<1 \times 10^{-7}$ /year
Temperature effect	in temperature range 0 °C to 50 °C	$<2 \times 10^{-6}$
	with R&S®SMB-B1 option	$<1 \times 10^{-7}$
Warm-up time	to nominal thermostat temperature (only with R&S®SMB-B1 option)	≤10 min
Output for internal reference signal	frequency (approx. sinewave)	10 MHz
	level	typ. 10 dBm
	source impedance	50 Ω
Input for external reference	frequency	10 MHz
	maximum deviation	$3 \times 10^{-6}$
	input level, recommended	≥0 dBm, ≤16 dBm
	input impedance	50 Ω

## Level

The R&S®SMB100A has two different attenuator modes for level setting:

**AUTO MODE:** In this mode, the attenuator is switched automatically. The output level is specified over the full range from –120 dBm to +13/18 dBm.

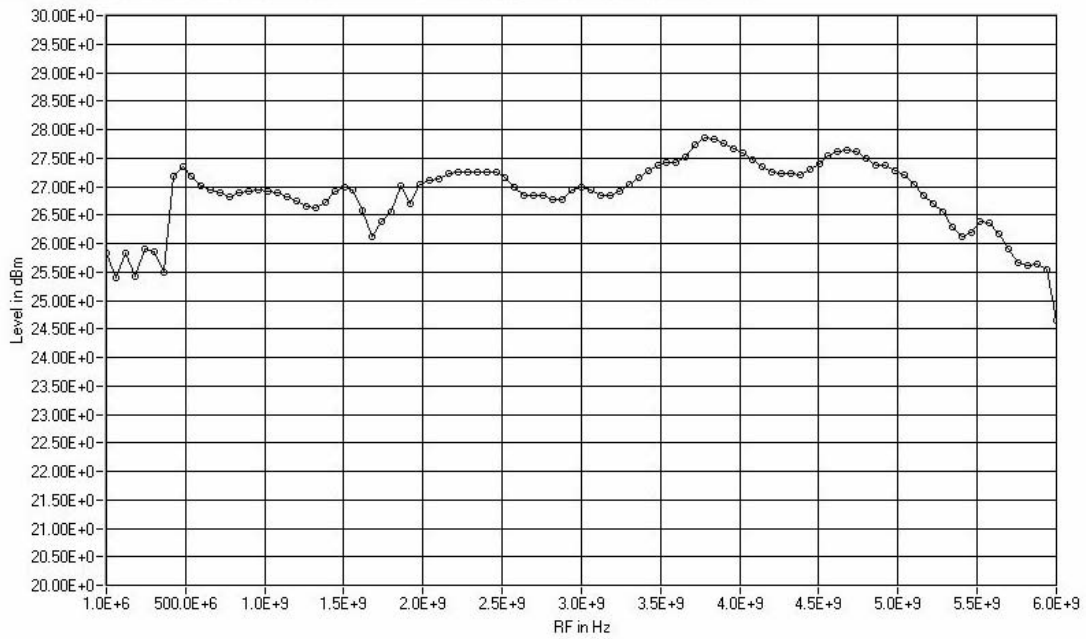
**FIXED MODE:** The level is set without switching the attenuator. The attenuator is fixed to the current setting. If ALC state is ON, level changes are performed without interruption. The maximum attenuation range is limited. With higher attenuation, the spectral purity of the output signal decreases.

Setting range		–145 dBm to +30 dBm
Specified level range with R&S®SMB-B101/102/103/106 frequency option	1 MHz < f ≤ 6 GHz 200 kHz < f ≤ 1 MHz	–120 dBm to + 18 dBm (PEP) <sup>2</sup> –120 dBm to + 13 dBm (PEP)
Resolution		0.01 dB
Level uncertainty	ALC state ON, AUTO mode temperature range 18 °C to 33 °C	
	200 kHz < f ≤ 3 GHz	<0.5 dB
	f > 3 GHz	<0.9 dB
Additional uncertainty with ALC OFF, S&H	This mode is only needed in case of pulse modulation.	<0.5 dB
Output impedance VSWR in 50 Ω system	200 kHz < f ≤ 6 GHz	<1.8
Setting time	after IEC/IEEE bus delimiter, with GUI update stopped, AUTO mode, temperature range 18 °C to 33 °C, to <0.1 dB deviation from final value	
	ALC state ON	<2.5 ms, typ. 1.2 ms
	ALC state OFF	<7 ms
	in List mode after trigger pulse	<1 ms
Uninterrupted level setting	FIXED mode, ALC state ON setting range	>20 dB
Reverse power (from ≥50 Ω source)	maximum permissible RF power in output frequency range of RF path for f > 1 MHz	
	1 MHz < f ≤ 1 GHz	50 W
	1 GHz < f ≤ 2 GHz	25 W
	2 GHz < f ≤ 6 GHz	10 W
	maximum permissible DC voltage	50 V

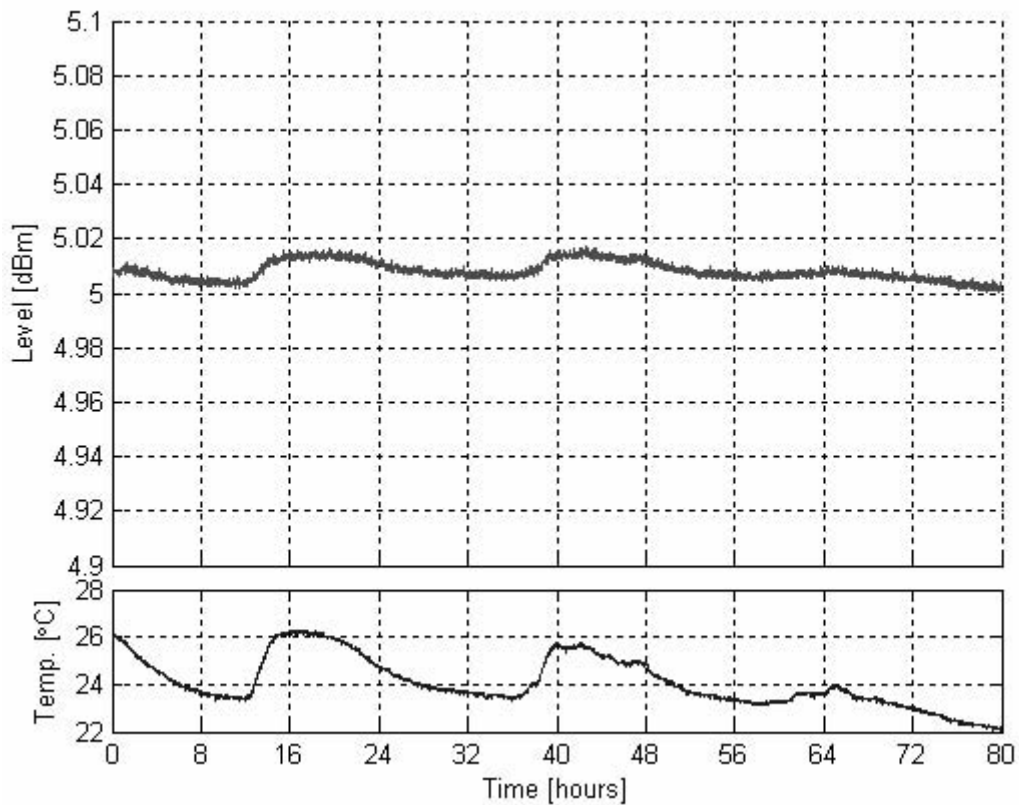
Test Equipment Depot - 800.517.8431 - 99 Washington Street Melrose, MA 02176

FAX 781.665.0780 - TestEquipmentDepot.com

<sup>2</sup> PEP = peak envelope power.



Measured maximum output power versus frequency



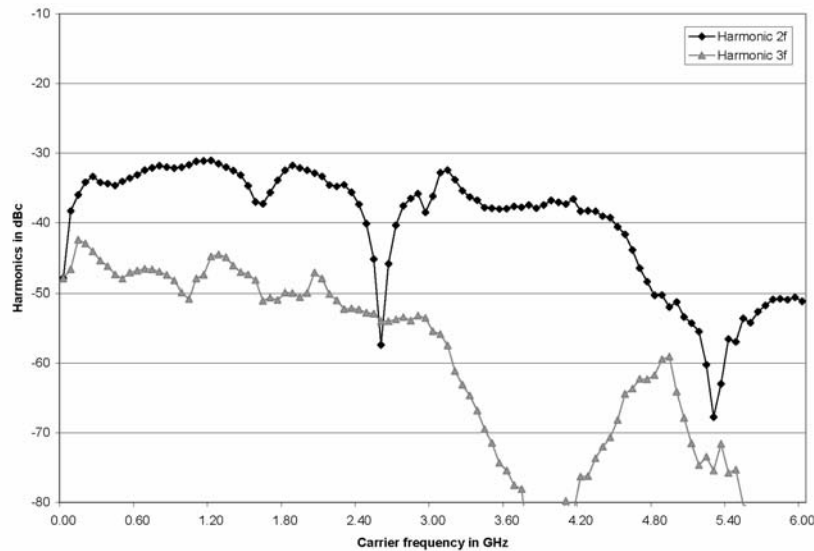
Measured level repeatability at 3 GHz, 5 dBm, ALC ON

## Level sweep

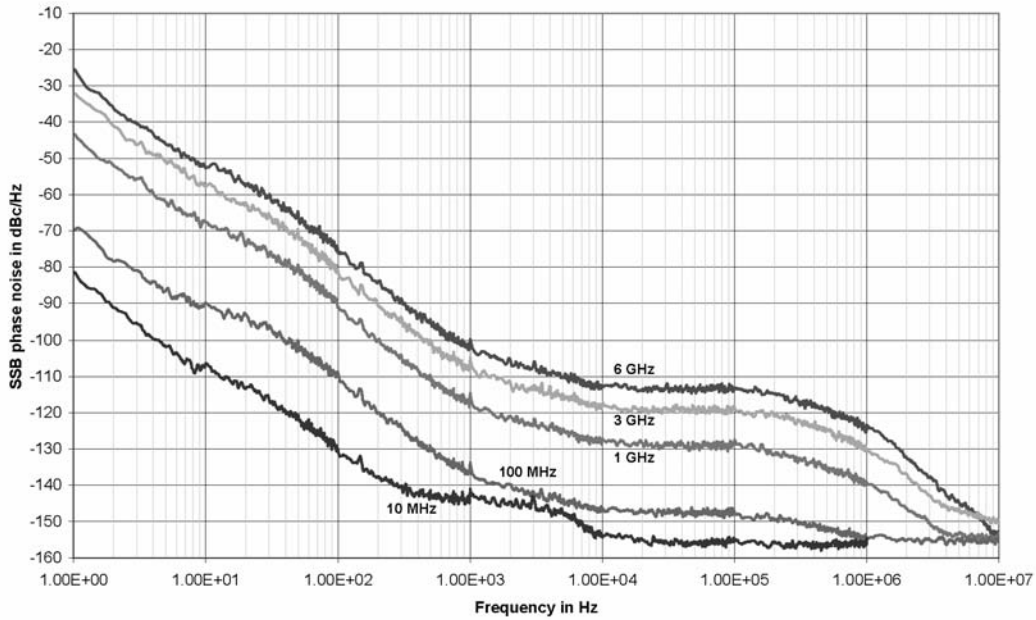
Digital sweep in discrete steps	operating modes	automatic, step, single sweep, external single, external step, manual or external trigger, linear spacing
	sweep range	full level range
	uninterrupted level sweep	0.01 dB to 20 dB
	step width	0.01 dB to 20 dB per step

## Spectral purity

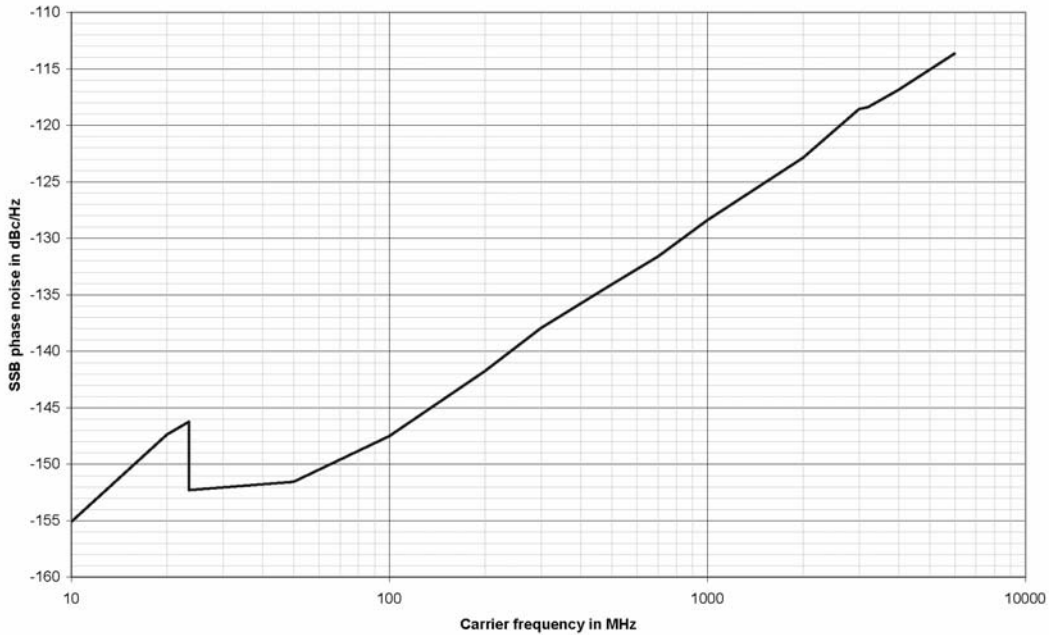
Harmonics	f > 1 MHz; CW level ≤ 8 dBm	<-30 dBc
Nonharmonics	CW, level >-10 dBm, >10 kHz carrier offset	
	f ≤ 1500 MHz	<-70 dBc (typ. <-85 dBc)
	1500 MHz < f ≤ 3 GHz	<-64 dBc (typ. <-79 dBc)
Wideband noise	f > 3 GHz	<-58 dBc (typ. <-73 dBc)
	attenuator mode AUTO for level > 5 dBm, >10 MHz carrier offset, 1 Hz measurement bandwidth, CW	<-142 dBc (typ. -152 dBc)
SSB phase noise	20 kHz carrier offset, 1 Hz measurement bandwidth, CW	
	f = 100 MHz	<-141 dBc (typ. -147 dBc)
	f = 1 GHz	<-122 dBc (typ. -128 dBc)
	f = 2 GHz	<-116 dBc (typ. -122 dBc)
	f = 3 GHz	<-112 dBc (typ. -118 dBc)
	f = 4 GHz	<-110 dBc (typ. -116 dBc)
RMS jitter	f = 6 GHz	<-106 dBc (typ. -112 dBc)
	carrier frequency (Cf) = 1 GHz, BW = 1 Hz to 10 MHz, with R&S <sup>®</sup> SMB-B1 option	typ. 1.1 ps (1.1 mUI)
	Cf = 1 GHz, BW = 1 Hz to 10 MHz	typ. 3.9 ps (3.9 mUI)
	Cf = 155 MHz, BW = 100 Hz to 1.5 MHz	typ. 83 fs (12.9 μUI)
	Cf = 622 MHz, BW = 1 kHz to 5 MHz	typ. 63 fs (39.2 μUI)
Residual FM	Cf = 2.488 GHz, BW = 5 kHz to 15 MHz	typ. 55 fs (137 μUI)
	RMS value at f = 1 GHz	
	0.3 kHz to 3 kHz, weighted (ITU-T)	<4 Hz
Residual AM	0.03 kHz to 23 kHz	<10 Hz
	RMS value (0.03 kHz to 20 kHz)	<0.02 %



Measured harmonics at +18 dBm versus frequency



Typical SSB phase noise with internal OCXO (R&S®SMB-B1 option)



Typical SSB phase noise at 20 kHz offset versus frequency with internal OCXO (R&S®SMB-B1 option)

### List mode

Frequency and level values can be stored in a list and set in an extremely short amount of time.

Operating modes		automatic, single sweep, manual or external trigger
Max. number of stored settings		2000
Dwell time		1 ms to 1 s
Resolution		0.1 ms
Setting time	after external trigger	see frequency and level data

# Analog modulation

## Possible modulation types

Amplitude modulation, frequency modulation, phase modulation, pulse modulation

## Simultaneous modulation

	Amplitude modulation	Frequency modulation	Phase modulation	Pulse modulation
Amplitude modulation		+	+	(+)
Frequency modulation	+		-	+
Phase modulation	+	-		+
Pulse modulation	(+)	+	+	

+ = compatible, - = incompatible, (+) = compatible with limitations

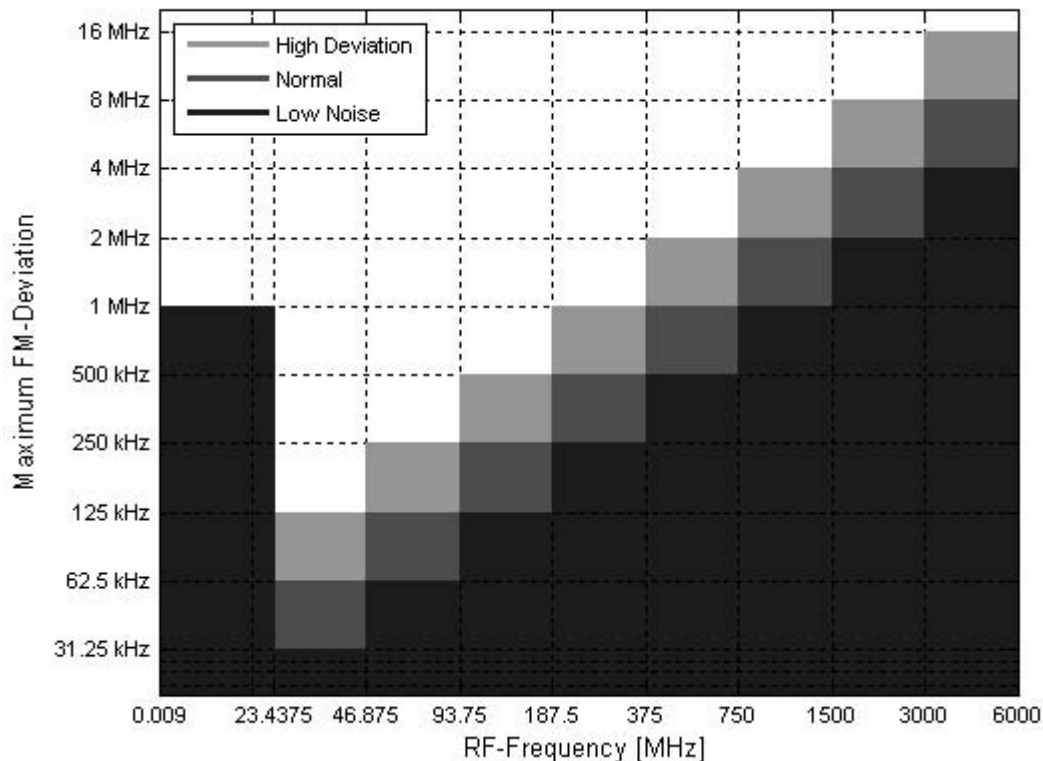
## Amplitude modulation

For  $f \geq 100$  kHz, attenuator mode AUTO, level (PEP) within specified level range.

Operating modes		internal, external, internal + external, AC/DC
Modulation depth	At high levels, modulation is clipped when the maximum PEP is reached.	0 % to 100 %
Resolution		0.1 %
Setting uncertainty	$f_{\text{mod}} = 1$ kHz and $m < 80$ %	
	$f \leq 23.4375$ MHz	<(1 % of reading + 1 %)
	$f > 23.4375$ MHz	<(4 % of reading + 1 %)
AM distortion	$f_{\text{mod}} = 1$ kHz, $f \leq 23.4375$ MHz	
	$m = 30$ %	<0.25 %
	$m = 80$ %	<0.5 %
	$f_{\text{mod}} = 1$ kHz, $f > 23.4375$ MHz	
	$m = 30$ %	< 1.5 %
	$m = 80$ %	< 3 %
Modulation frequency response	$m = 60$ %, up to 50 kHz	<3 dB
Synchronous $\phi$ M at AM	$m = 30$ %, $f_{\text{mod}} = 1$ kHz, $\pm\text{peak}/2$	<0.2 rad

## Frequency modulation

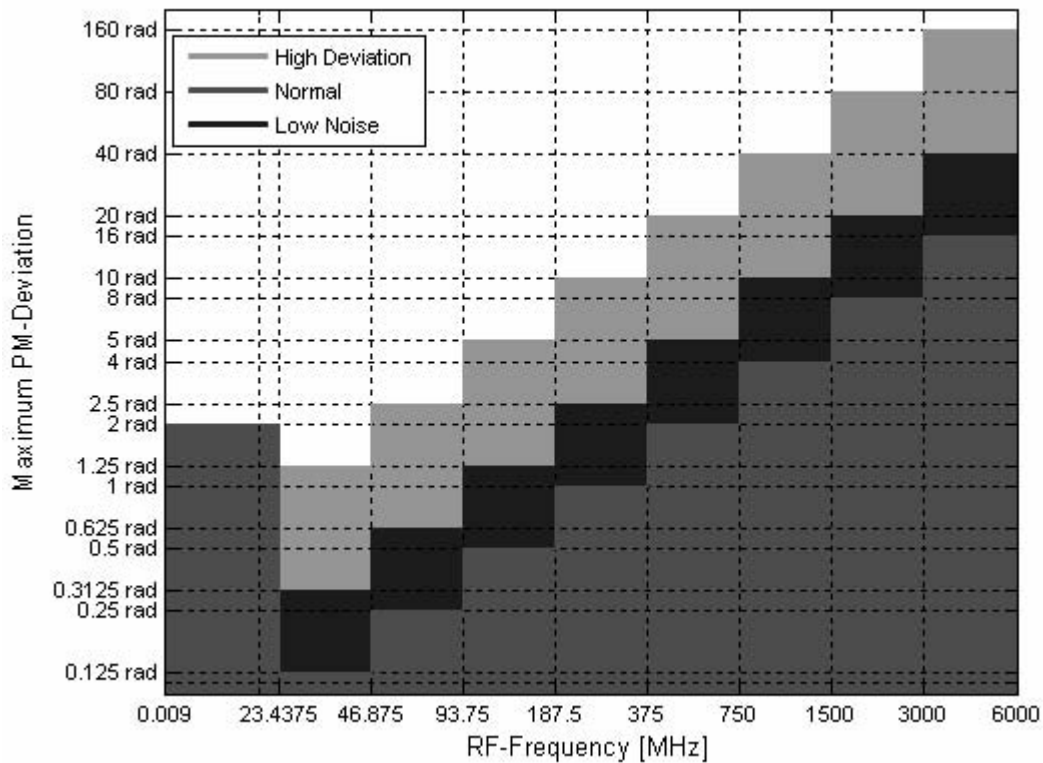
FM multiplier for different frequency ranges	$f \leq 23.4375$ MHz	$rm = 1/4$
	$23.4375$ MHz $< f \leq 46.875$ MHz	$rm = 1/32$
	$46.875$ MHz $< f \leq 93.75$ MHz	$rm = 1/16$
	$93.75$ MHz $< f \leq 187.5$ MHz	$rm = 1/8$
	$187.5$ MHz $< f \leq 375$ MHz	$rm = 1/4$
	$375$ MHz $< f \leq 750$ MHz	$rm = 1/2$
	$750$ MHz $< f \leq 1500$ MHz	$rm = 1$
	$1500$ MHz $< f \leq 3$ GHz	$rm = 2$
	$f > 3$ GHz	$rm = 4$
Operating modes		internal, external, internal + external, AC/DC FM mode Low Noise FM mode Normal FM mode High Deviation
Maximum deviation	$f \leq 23.4375$ MHz	1 MHz
	$f > 23.4375$ MHz	
	FM mode Normal	$rm \times 2$ MHz
	FM mode Low Noise	$rm \times 1$ MHz
	FM mode High Deviation	$rm \times 4$ MHz
Resolution		$< 0.02\%$ of set deviation min. $rm \times 0.1$ Hz
Setting uncertainty	$f_{mod} = 1$ kHz, deviation $\leq rm \times 1$ MHz	
	internal	$< (2\% \text{ of reading} + 20 \text{ Hz})$
	external	$< (3\% \text{ of reading} + 20 \text{ Hz})$
FM distortion	$f_{mod} = 2$ kHz, deviation = $rm \times 1$ MHz	$< 0.2\%$
Modulation frequency response	FM modes Low Noise and High Deviation	
	DC/10 Hz to 100 kHz	$< 3$ dB
	FM mode Normal	
	DC/10 Hz to 500 kHz	$< 3$ dB
Synchronous AM	40 kHz deviation, $f_{mod} = 1$ kHz, $f > 10$ MHz	$< 0.2\%$
Carrier frequency offset with FM DC	after FM offset calibration	$< 0.2\%$ of set deviation



FM deviation versus frequency and operating mode

## Phase modulation

φM multiplier for different frequency ranges	$f \leq 23.4375$ MHz	$rm = 1/4$
	$23.4375$ MHz < $f \leq 46.875$ MHz	$rm = 1/32$
	$46.875$ MHz < $f \leq 93.75$ MHz	$rm = 1/16$
	$93.75$ MHz < $f \leq 187.5$ MHz	$rm = 1/8$
	$187.5$ MHz < $f \leq 375$ MHz	$rm = 1/4$
	$375$ MHz < $f \leq 750$ MHz	$rm = 1/2$
	$750$ MHz < $f \leq 1500$ MHz	$rm = 1$
	$1500$ MHz < $f \leq 3$ GHz	$rm = 2$
Operating modes	$f > 3$ GHz	$rm = 4$
		internal, external, internal + external, AC/DC φM mode Low Noise φM mode Normal φM mode High Deviation
Maximum deviation	$f \leq 23.4375$ MHz	2 rad
	$f > 23.4375$ MHz	
	φM mode Normal	$rm \times 4$ rad
	φM mode Low Noise	$rm \times 10$ rad
Resolution	φM mode High Deviation	$rm \times 40$ rad
		< 0.02 % of set deviation, min. $rm \times 20$ μrad
Setting uncertainty	$f_{mod} = 1$ kHz, deviation $\leq$ half of max. deviation	
	internal	<(2 % of reading + 0.003 rad)
	external	<(3 % of reading + 0.003 rad)
Distortion	$f_{mod} = 10$ kHz, half of max. deviation	<0.2 %
Modulation frequency response	φM modes Low Noise and High Deviation	
	DC/10 Hz to 100 kHz	<3 dB
	φM mode Normal	
	DC/10 Hz to 500 kHz	<3 dB



φM deviation versus frequency and operating mode

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

When pulse modulation is activated, the ALC state of the R&S® SMB100A is automatically changed to ALC OFF (Sample & Hold). In this state, the ALC loop is opened and the output level is set directly. In order to set the correct output level, a sample & hold measurement is performed after each frequency or level setting.

Operating modes		external, internal
On/off ratio		>80 dB
Rise/fall time	10 % to 90 % of RF amplitude	<20 ns, typ. 10 ns
Pulse repetition frequency		0 Hz to 2.5 MHz
Video crosstalk	spectral line of fundamental of 100 kHz squarewave modulation	<-30 dBc

## Input for external modulation signals

Modulation input EXT for AM/FM/ϕM	input impedance	>100 kΩ
	input sensitivity (peak value for set modulation depth or deviation)	1 V
Modulation input PULSE	input level	threshold 1 V
	input impedance	>5 kΩ or 50 Ω
	polarity	selectable

## Modulation sources

### Internal modulation generator

Waveforms		sine, square
Frequency range	sine	0.1 Hz to 1 MHz
	square	0.1 Hz to 20 kHz
Resolution of setting		0.1 Hz
Frequency accuracy		<0.005 Hz + relative deviation of reference frequency
Frequency response	sine 0.1 Hz to 1 MHz	<1 dB
Distortion	sine f < 100 kHz at $R_L > 200 \Omega$ , level ( $V_{EMF}$ ) < 1 V	<0.1 %
Output voltage	$V_p$ at LF connector, open circuit voltage EMF	1 mV to 3 V
	resolution	1 mV
	setting accuracy at 1 kHz	<(1 % of reading + 1 mV)
Output impedance		10 Ω
Frequency setting time	to within $<1 \times 10^{-7}$ , after IEC/IEEE bus delimiter	<5 ms
Sweep	digital sweep in discrete steps	
	operating modes	automatic, step, single sweep, external single, external step, manual or external trigger, linear or logarithmic spacing
	sweep range	full frequency range
	step width (lin)	full frequency range
	step width (log)	0.01 % to 100 % per step

### Pulse generator (R&S® SMB-K23 option)

Operating modes		automatic, external trigger, external gate, single pulse, double pulse, delayed pulse (external trigger)
Active trigger edge		positive or negative
Pulse period		100 ns to 85 s
Resolution		20 ns
Pulse width	The pulse width of double pulses can be set independently.	20 ns to 1 s
Resolution		20 ns
Pulse delay		20 ns to 1 s
Resolution		20 ns
Double-pulse spacing		20 ns to 1 s
Resolution		20 ns
Uncertainty for pulse timing	generated digitally; ensured by design	relative deviation of reference frequency
External trigger		
Delay		typ. 50 ns
Jitter		<10 ns
PULSE/VIDEO output		LVTTL signal (RL ≥ 50 Ω)

# General data

## Remote control

Systems	IEC/IEEE bus, IEC 60625 (IEEE 488) Ethernet (TC/IP) USB
Command set	SCPI 1999.5
Connector	
IEC	24-contact Amphenol
Ethernet	Western
USB	USB
IEC/IEEE bus address	0 to 30
Interface functions	SH1, AH1, T6, L4, SR1, RL1, PP1, DC1, DT1, C0
LAN interface	10/100BaseT

## Operating data

Power supply	input voltage range, AC, nominal	100 V to 240 V (AC) $\pm 10$ %
	AC supply frequency	50 Hz to 400 Hz, $-5$ %/ $+10$ %
	power consumption	250 VA
Power factor correction		in line with EN 61000-3-2
EMC		in line with EN 55011 class B, EN 61326
Immunity to interfering field strength		up to 10 V/m
Environmental conditions	operating temperature range	0 °C to 55 °C in line with EN 60068-2-1, EN 60068-2-2
	storage temperature range	$-40$ °C to $+71$ °C
	climatic resistance, $+40$ °C/95 % rel. humidity	in line with EN 60068-2-3
	operating altitude	up to 4600 m
Mechanical resistance	vibration, sinusoidal	5 Hz to 150 Hz, max. 2 g at 55 Hz, max. 0.5 g at 55 Hz to 150 Hz, in line with EN 60068-2-6
	vibration, random	10 Hz to 300 Hz, acceleration 1.2 g (rms) in line with EN 60068-2-64
	shock	40 g shock spectrum in line with EN 60068-2-27, MIL-STD-810E
Electrical safety		in line with IEC 61010-1, EN 61010-1, CAN/CSA-C22.2 No. 61010-1-04, UL 61010-1
Approvals		VDE-GS, cCSA <sub>US</sub>
Dimensions (W × H × D)		344 mm x 112 mm x 368 mm (13.54 in × 4.41 in × 14.49 in)
Weight	when fully equipped	5.3 kg (11.7 lb)
Recommended calibration interval		3 years

## Ordering information

Designation	Type	Order No.
Signal Generator3	R&S®SMB100A	1406.6000.02
Including power cable, Quick Start Guide, and CD-ROM (with operating and service manual)		
<b>Options</b>		
RF Path		
9 kHz to 1.1 GHz	R&S®SMB-B101	1407.2509.02
9 kHz to 2.2 GHz	R&S®SMB-B102	1407.2609.02
9 kHz to 3.2 GHz	R&S®SMB-B103	1407.2709.02
9 kHz to 6 GHz	R&S®SMB-B106	1407.2909.02
Reference Oscillator OCXO	R&S®SMB-B1	1407.3005.02
Pulse Modulator	R&S®SMB-K22	1407.3770.02
Pulse Generator	R&S®SMB-K23	1407.3786.02
<b>Recommended extras</b>		
Hardcopy manuals (in English, UK)		1407.0806.32
Hardcopy manuals (in English, US)		1407.0806.39
19" Rack Adapter	R&S®ZZA-S234	1109.4493.00
Power Sensor 9 kHz to 6 GHz	R&S®NRP-Z92	1171.7005.42
Keyboard with USB Interface (US character set)	R&S®PSL-Z2	1157.6870.04
Mouse with USB Interface, optical	R&S®PSL-Z10	1157.7060.03

## License information

The firmware of this device contains open source software. Details as well as license agreements can be found in release notes and operating manual.

Test Equipment Depot - 800.517.8431 - 99 Washington Street Melrose, MA 02176

FAX 781.665.0780 - TestEquipmentDepot.com

<sup>3</sup> The base unit must be ordered together with an R&S®SMB-B101/R&S®SMB-B102/R&S®SMB-B103/R&S®SMB-B106 frequency option.