

R&S[®] SMB100N SIGNAL GENERATOR

PERFORMANCE SPECIFICATIONS

VERSION 02.00, SEPTEMBER 2009

CONTENTS

Specifications	3
Definitions.....	3
RF performance.....	4
Frequency.....	4
Frequency sweep.....	4
Reference frequency.....	4
Level.....	5
Level sweep.....	6
Spectral purity.....	6
Analog modulation.....	7
Simultaneous modulation.....	7
Amplitude modulation.....	7
Frequency bands for frequency and phase modulation.....	7
Frequency modulation.....	8
Phase modulation.....	9
Pulse modulation.....	10
Input for external modulation signals.....	10
Modulation sources.....	11
Internal modulation generator (LF).....	11
LF Frequency sweep.....	11
Pulse generator (R&S®SMB-K23 option).....	11
Remote control.....	12
Connectors.....	12
Front panel connectors.....	12
Rear panel connectors.....	12
General data.....	13
Ordering information	14
License information	14

Specifications

Definitions

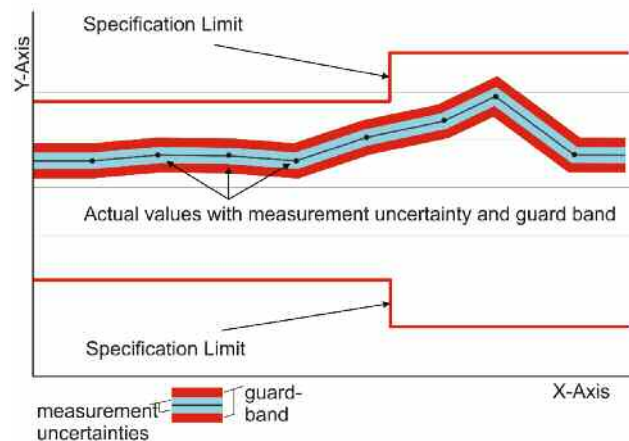
General

Product data apply under the following conditions:

- 3 hours storage at ambient temperature followed by 30 minutes warm-up operation time
- specified environmental conditions met
- recommended calibration interval adhered to
- all internal automatic adjustments performed, if applicable.

- **Specifications with limits:**

Represents a range of values describing warranted product performance for the specified parameters, including measurement uncertainties and guard bands if applicable. These specifications are marked with limiting symbols like $<$, \leq , $>$, \geq , \pm , or descriptions like Maximum, Limit of, Minimum.



- **Specifications without limits:**

Represents values describing warranted product performance for the specified parameters. These specifications are not specially marked.

- **Typical Values [typ]**

Typical values are determined on the basis of a statistical evaluation of measured values from ongoing series in production. When marked with $<$, $>$ or as a range it represents a statistical performance met by 80% of the instruments at production time. Otherwise it represents the average value. Typical values do not include measurement uncertainties.

- **Nominal Values [nom]**

Values determined by design but not tested during production.

- **Measured [meas]**

Values measured on representative instruments but not individually tested during production.

- **Uncertainties**

Uncertainties define the expected range of values. They are calculated on the basis of the GUM (Guide of the Uncertainty in Measurement) and include the influence of the environmental conditions, aging and wear and tear. The stated values represent expanded uncertainties with a coverage factor $k = 2$.

Typical, nominal and measured values are not warranted by Rohde & Schwarz.

RF performance

Frequency

Parameter	Description / Condition	Value
Range		9 kHz to 1.1 GHz
	R&S®SMB-B103E	9 kHz to 3.2 GHz
	R&S®SMB-B106E	9 kHz to 6 GHz
Resolution of setting		0.001 Hz
Resolution of synthesis	f = 1 GHz	0.44 μHz [nom]
Setting time	to within 1×10^{-7} for f > 200 MHz or 20 Hz for f ≤ 200 MHz	
	after IEC/IEEE bus delimiter	5 ms
	after IEC/IEEE bus delimiter in ALC state Sample & Hold	10 ms
Resolution of phase offset setting		0.1°

Frequency sweep

Parameter	Description / Condition	Value
Operating mode		digital sweep in discrete steps
Trigger mode	free run full sweep execute one step ext. trigger only	automatic single step start/stop
Trigger source		keyboard, external trigger, remote control
Trigger slope		positive, negative
Sweep range		full frequency range
Sweep shape		triangle, sawtooth
Step spacing		linear, logarithmic
Step size	linear	full frequency range, minimum 0.001 Hz
	logarithmic	0.01 % to 100 %
Dwell time range		10 ms to 10 s
Dwell time resolution		0.1 ms

Reference frequency

Parameter	Description / Condition	Value
Frequency error	at time of calibration in production	
	with R&S®SMB-B1 option	1×10^{-7} 1×10^{-8}
Aging (after 10 days of uninterrupted operation, at 25°C ±5°C)	with R&S®SMB-B1 option	1×10^{-6}/year, 5 pp 10 ⁸ /hr 1×10^{-9}/day, 1×10^{-7}/year
	with R&S®SMB-B1 option	2×10^{-6} 1×10^{-7}
Temperature effect (0 °C to +50 °C)		
	with R&S®SMB-B1 option	
Warm-up time	to nominal thermostat temperature with R&S®SMB-B1 option	≤10 min
Output of internal reference		
Connector type	REF OUT on rear panel	BNC female
Output frequency	sinewave	10 MHz
Output level		+7 dBm to +13 dBm
Source impedance		50 Ω [nom]
Input for external reference		
Connector type	REF IN on rear panel	BNC female
Input frequency		10 MHz
Frequency locking range		± 3 × 10 ⁻⁶
Input level range		≥0.25 V _{rms} and ≤2 V _{rms}
Input impedance		50 Ω [nom]

Level

General explanations:

Instrument includes an electronic step attenuator with step ranges of 5 dB.

Level setting modes:

R&S®SMB100N offers two different operating modes for level setting:

AUTO MODE: The step attenuator is switched over automatically.

FIXED MODE: The level is set without changing the step attenuator. The step attenuator is thus fixed to the current setting. If ALC is ON, level changes are performed without interruption. The maximum interruption-free setting range is limited.

ALC modes:

The R&S®SMB100N offers different ALC (Automatic Level control) modes.

ALC mode ON: In this mode the ALC loop is closed and the highest level accuracy can be achieved.

ALC mode Sample&Hold: In this mode the ALC loop is opened and the level is set directly. In order to set the correct output level, a sample & hold measurement is executed with each frequency or level setting.

During a sample & hold measurement the level is decreased by about 30 dB. This mode is selected automatically when pulse modulation is activated.

Level specification

Parameter	Description / Condition	Value
Setting range	1 MHz ≤ f ≤ 6 GHz 300 kHz ≤ f < 1 MHz 100 kHz ≤ f < 300 kHz 9 kHz ≤ f < 100 kHz	-145 dBm to +30 dBm -145 dBm to +18 dBm -145 dBm to +13 dBm -145 dBm to +8 dBm
Specified level range	500 kHz ≤ f ≤ 1 MHz	-127 dBm to +13 dBm (PEP) ¹
	1 MHz < f ≤ 1.1 GHz	-127 dBm to +13 dBm (PEP)
	1.1 GHz < f ≤ 6 GHz	-120 dBm to +13 dBm (PEP)
Resolution of setting		0.01 dB
Level error	ALC state ON, AUTO mode 500 kHz ≤ f ≤ 1.1 GHz level ≤ +13 dBm (PEP)	<1 dB
	ALC state ON, AUTO mode temperature range 18 °C to 33 °C in specified level range	
	500 kHz ≤ f ≤ 3 GHz	<1 dB
	3 GHz < f ≤ 6 GHz	<1.4 dB
Flatness	peak-peak variation 500 kHz ≤ f ≤ 1.1 GHz level = 0 dBm	≤2 dB
Output impedance VSWR in 50 Ω system	f ≥ 500 kHz	<1.8
Setting time	to <0.1 dB deviation from final value with GUI update stopped, temperature range 18 °C to 33 °C	
	ALC state ON after IEC/IEEE bus delimiter	<5 ms
	ALC state Sample & Hold after IEC/IEEE bus delimiter	<10 ms
Interruption-free level setting range	FIXED mode, ALC state ON	0 to 20 dB

Specifications for maximum reverse power

The R&S®SMB100N includes a reverse power protection as standard.

Parameter	Description / Condition	Value
Reverse power (from 50 Ω source)	maximum permissible RF power in output frequency range of RF path	
	500 kHz ≤ f ≤ 1.1 GHz	50 W
	1.1 GHz < f ≤ 2 GHz	25 W
	2 GHz < f ≤ 6 GHz	10 W
Maximum permissible DC voltage		50 V

¹ PEP = peak envelope power.

Level sweep

Parameter	Description / Condition	Value
Operating mode		digital sweep in discrete steps
Trigger mode	free run full sweep execute one step ext. trigger only	automatic single step start/stop
Trigger source		keyboard, external connector, remote control
Trigger slope	with external trigger	positive, negative
Sweep range		full specified level range
	interruption-free	+0.01 dB to +20 dB
Sweep shape		triangle, sawtooth
Step spacing		logarithmic
Step size setting resolution		0.01 dB
Dwell time setting range		10 ms to 10 s
Dwell time setting resolution		0.1 ms

Spectral purity

Parameter	Description / Condition	Value
Harmonics	CW; $f \geq 500$ kHz; level ≤ 7 dBm	<-30 dBc
Nonharmonics	CW, level >-10 dBm, Offset >15 kHz from carrier	
	$f \leq 25$ MHz	<-76 dBc
	25 MHz $< f \leq 1.1$ GHz	<-80 dBc
	1.1 GHz $< f \leq 1.5$ GHz	<-70 dBc
	1.5 GHz $< f \leq 3$ GHz	<-64 dBc
	3 GHz $< f \leq 6$ GHz	<-58 dBc
Power line spurious	< 15 kHz carrier offset	<-50 dBc
Wideband noise	level operating mode AUTO level > 5 dBm, carrier offset >10 MHz, measurement bandwidth 1 Hz, CW	<-135 dBc
SSB phase noise	carrier offset 20 kHz, measurement bandwidth 1Hz, CW	
	$f \leq 1.1$ GHz	<-120 dBc
	$f = 2$ GHz	<-116 dBc
	$f = 3$ GHz	<-112 dBc
	$f = 4$ GHz	<-110 dBc
	$f = 6$ GHz	<-106 dBc
Residual FM	RMS value at $f = 1$ GHz, CW	
	30 Hz to 23 kHz	<20 Hz rms
Residual AM	RMS value (30 Hz to 20 kHz)	<-80 dBc

Analog modulation

Simultaneous modulation

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

+ = compatible

- = incompatible

(+) = compatible with limitations: No specification applies for AM distortion, AM depth error and ON/OFF-Ratio with Pulse modulation.

Amplitude modulation

For $f \geq 500$ kHz, attenuator mode AUTO, level (PEP) within specified level range.

Parameter	Description / Condition	Value
Modulation source		internal, external, internal + external
External coupling		AC, DC
AM depth setting range	At high levels, modulation is clipped when the maximum PEP is reached.	0 % to 100 %
Resolution of setting		0.1 %
AM depth (m) error	$f_{\text{mod}} = 1$ kHz and $m < 80$ %	≤ 5 %
AM distortion	$f_{\text{mod}} = 1$ kHz, $m \leq 50$ %	< 3 %
Modulation frequency response	$m = 60$ % DC-coupling: 0 to 50 kHz AC-coupling: 10 Hz to 50 kHz	< 3 dB
Synchronous FM at AM	$m = 30$ %, $f_{\text{mod}} = 1$ kHz, $\pm \text{peak}/2$	< 200 Hz

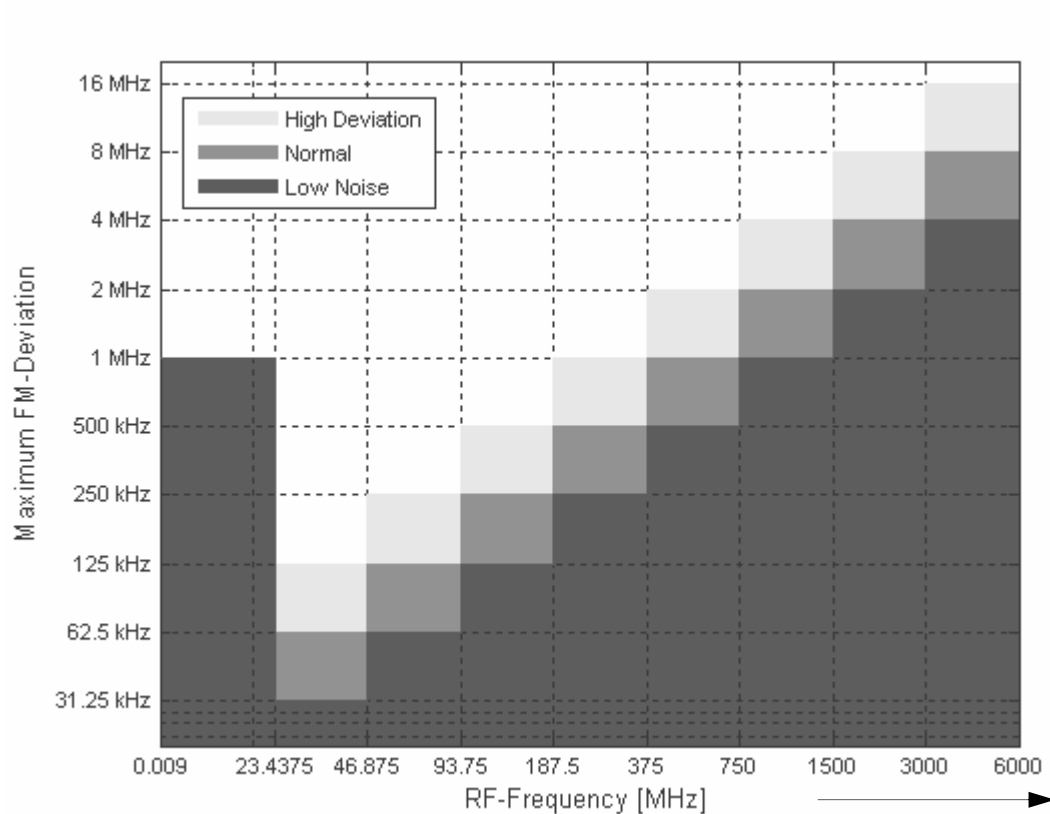
Frequency bands for frequency and phase modulation

Multiplier N is used to define FM and ϕ M specifications within this document

Parameter	Description / Condition	Value
Multiplier (N) for different frequency ranges	$f \leq 23.4375$ MHz	1/4
	23.4375 MHz $< f \leq 46.875$ MHz	1/32
	46.875 MHz $< f \leq 93.75$ MHz	1/16
	93.75 MHz $< f \leq 187.5$ MHz	1/8
	187.5 MHz $< f \leq 375$ MHz	1/4
	375 MHz $< f \leq 750$ MHz	1/2
	750 MHz $< f \leq 1500$ MHz	1
	1500 MHz $< f \leq 3$ GHz	2
3 GHz $< f \leq 6$ GHz	4	

Frequency modulation

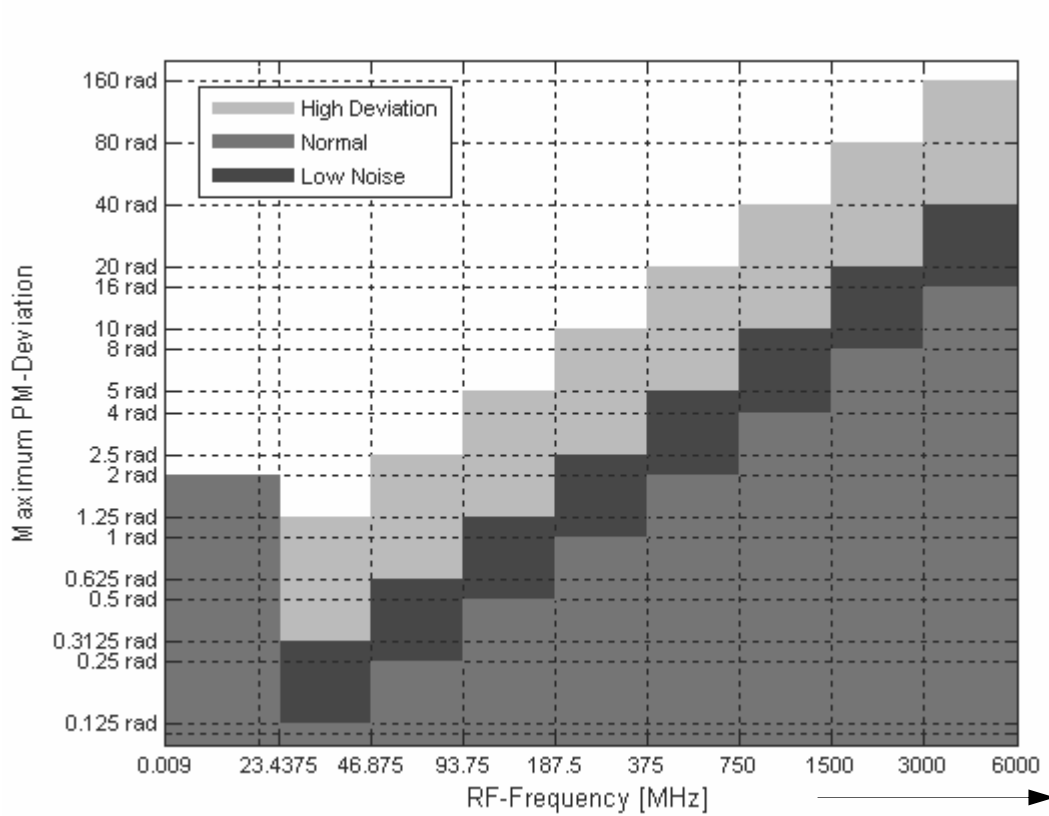
Parameter	Description / Condition	Value
Modulation source		internal, external, internal + external
External coupling		AC, DC
Operating modes		FM mode Low Noise FM mode Normal FM mode High Deviation
Maximum deviation	$f \leq 23.4375$ MHz	1 MHz
	$f > 23.4375$ MHz	
	FM mode Normal	$N \times 2$ MHz
	FM mode Low Noise	$N \times 1$ MHz
Resolution		<0.02 % of set deviation min. $N \times 0.1$ Hz
FM deviation error	$f_{\text{mod}} = 1$ kHz, deviation $\leq N \times 1$ MHz	<(5 % of reading + 10 Hz)
FM distortion	$f_{\text{mod}} = 1$ kHz, deviation = 20 kHz	<5 %
Modulation frequency response	FM modes Low Noise and High Deviation	
	DC-coupling: 0 to 100 kHz AC-coupling: 10 Hz to 100 kHz	<3 dB
	FM mode Normal	
Synchronous AM with FM	DC-coupling: 0 to 500 kHz AC-coupling: 10 Hz to 500 kHz	<3 dB
Synchronous AM with FM	$f_{\text{mod}} = 1$ kHz, deviation = 100 kHz $f \geq 500$ kHz	<1 %
Carrier frequency offset with FM DC	after FM offset adjustment	<0.2 % of set deviation



FM deviation versus frequency and operating mode

Phase modulation

Parameter	Description / Condition	Value
Modulation source		internal, external, internal + external
External coupling		AC, DC
Operating modes		ϕ M mode Low Noise ϕ M mode Normal ϕ M mode High Deviation
Maximum deviation	$f \leq 23.4375$ MHz	2 rad
	$f > 23.4375$ MHz	
	ϕ M mode Normal	$N \times 4$ rad
	ϕ M mode Low Noise	$N \times 10$ rad
Resolution		$<0.02\%$ of set deviation, min. $N \times 20 \mu$ rad
ϕ M deviation error	$f_{mod} = 1$ kHz, deviation \leq half of max. deviation	$<(5\%$ of setting + 0.003 rad)
ϕ M distortion	$f_{mod} = 10$ kHz, half of max. deviation	$<1\%$
Modulation frequency response	ϕ M modes Low Noise and High Deviation	
	DC-coupling: 0 to 100 kHz AC-coupling: 10 Hz to 100 kHz	<3 dB
	ϕ M mode Normal	
	DC-coupling: 0 to 500 kHz AC-coupling: 10 Hz to 500 kHz	<3 dB



ϕ M deviation versus frequency and operating mode

Pulse modulation

When pulse modulation is activated, the R&S®SMB100N automatically switches to the ALC mode S&H. In this case, the ALC loop is opened and the output level is set directly. In order to set the correct level, a sample & hold measurement is performed prior to each frequency and level setting.

Parameter	Description / Condition	Value
Modulation source		external, internal
On/off ratio		>80 dB
Rise/fall time	10 % to 90 % of RF amplitude	<100 ns
Pulse repetition frequency		0 Hz to 2.5 MHz
Video crosstalk	spectral line of fundamental of 100 kHz pulse repetition frequency	<-30 dBc

Input for external modulation signals

Parameter	Description / Condition	Value
Modulation input EXT for AM/FM/φM		
Connector type	MOD EXT on front panel	BNC female
Input impedance	selectable	220 kΩ or 600 Ω [nom]
Input sensitivity	peak value for set modulation factor or deviation	1 V [nom]
Maximum input voltage		1 V [nom]
Input damage voltage		±10 V
Modulation input PULSE		
Connector type	PULSE EXT on rear panel	BNC female
Input impedance	selectable	10 kΩ or 50 Ω [nom]
Input voltage	TTL , CMOS compatible	
	threshold low	0.5 V [nom]
	threshold high	1.5 V [nom]
Input damage voltage		±5 V
Input polarity	selectable	normal, inverse

Modulation sources

Internal modulation generator (LF)

Parameter	Description / Condition	Value
Waveform		sine wave
Frequency range	sine wave	0.1 Hz to 1 MHz
Resolution of frequency setting		0.1 Hz
Frequency error		<(0.005 Hz + relative error of reference frequency × modulation frequency)
Frequency response	sine wave 0.1 Hz to 1 MHz	<1 dB
Frequency setting time	to within $<1 \times 10^{-7}$, after IEC/IEEE bus delimiter	<5 ms
Distortion	Sine f < 15 kHz at $R_{out} = 600 \Omega$, $R_L = 600 \Omega$, level = 1 V _{rms}	<0.5 %
Output Impedance	selectable	10 Ω or 600 Ω [nom]
Output voltage range	U _{peak} at LF connector, open circuit voltage	1 mV to 3 V
Resolution of output voltage setting		1 mV
Output voltage setting error	at 1 kHz, $R_L \geq 10 \text{ k}\Omega$	<(1 % of setting + 1 mV)
Output impedance		10 Ω [nom]

LF Frequency sweep

Parameter	Description / Condition	Value
Operating mode		digital sweep in discrete steps
Trigger mode	free run full sweep execute one step ext. trigger only	automatic single step start/stop
Trigger source		keyboard, external trigger, remote control
Trigger slope		positive, negative
Sweep range		full frequency range, minimum 0.1 Hz
Sweep shape		triangle, sawtooth
Step spacing		linear, logarithmic
Step size setting resolution	linear logarithmic	0.1 Hz 0.01 %
Dwell time setting range		10 ms to 10 s
Dwell time setting resolution		0.1 ms

Pulse generator (R&S® SMB-K23 option)

Pulse generator is implemented fully digital; the clock is directly derived from the instruments reference frequency.

Parameter	Description / Condition	Value
Pulse modes		single pulse, double pulse
Trigger mode		automatic (free run) external triggered external gated
Active trigger edge		positive or negative
Pulse period setting range		40 ns to 85 s
Pulse period setting resolution		10 ns
Pulse width setting range	The pulse widths of double pulses can be set independently	10 ns to 1 s
Pulse width setting resolution		10 ns
Pulse delay setting range	with external trigger	10 ns to 1 s
Pulse delay setting resolution	with external trigger	10 ns
Double-pulse spacing setting range		20 ns to 1 s
Double-pulse spacing setting resolution		10 ns
External trigger delay		50 ns [nom]
External trigger jitter of delay		<10 ns
PULSE/VIDEO output signal	without load	digital signal 0 V/3.3 V [nom]

Remote control

Parameter	Description / Condition	Value
Interfaces		IEC 60625 (GPIB IEEE-488.2) Ethernet/LAN (10/100BaseT) USB 2.0 (High speed) Serial (RS232) ²
Command set		SCPI 1999.5 or compatible command sets
Compatible command sets	These command sets can be selected in order to emulate another instrument.	Agilent/HP 8643A Agilent/HP 8644A/B Agilent/HP 8647A Agilent/HP 8648A/B/C/D Agilent/HP 8656A/B Agilent/HP 8657A/B Aeroflex/IFR 2023/2024 Aeroflex/IFR 203x,204x,205x R&S [®] SML01, R&S [®] SML02, R&S [®] SML03
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 ease the direct connection to a system controller.
USB protocol		VISA USB-TMC

Connectors

Front panel connectors

Marking	Description	Type
RF 50Ω	RF output	Type-N female
LF	modulation generator output	BNC female
MOD EXT	input for external analog modulation	BNC female

Rear panel connectors

Marking	Description	Type
REF IN	reference frequency input	BNC female
REF OUT	reference frequency output	BNC female
PULSE EXT	input for external pulse modulation	BNC female
PULSE VIDEO	pulse generator output	BNC female
INST TRIG	trigger input TTL 5 V compatible	BNC female
SIGNAL VALID	output for triggering external devices low state indicates that the instrument has settled to its final level	BNC female
USB IN	USB 2.0 (high speed) remote control of instrument (USB-TMC)	USB type B
USB	USB 2.0 (high speed) connector for external USB devices, mouse and keyboard for enhanced operation, R&S NRP-Z power sensors (with adapter cable R&S [®] NRP-Z4) for external power measurements and level adjustment of instrument,	USB type A

² requires recommended extra TS-USB1

	memory stick for software update and data exchange, USB serial adapter for RS232 remote control	
LAN	provides remote control functionality and remote operation via VNC file transfer via FTP	RJ-45
IEEE488	remote control of instrument via GPIB	24-pin Amphenol Serie 57 female

General data

Parameter	Description / Condition	Value
Power supply		
AC input voltage range	supply frequency: 50 Hz to 60 Hz	100 V to 240 V (AC) $\pm 10\%$
	supply frequency: 50 Hz to 400 Hz	100 V to 120 V (AC) $\pm 10\%$
Max. input current		1.4 A (100 V) to 0.6 A (240 V)
Power consumption		≤ 250 VA
Power factor correction		in line with EN 61000-3-2
Electrical safety		
Compliance		in line with IEC 61010-1, EN 61010-1, CAN/CSA-C22.2 No. 61010-1-04, UL 61010-1
Test mark		VDE-GS, _c CSA _{US}
EMC		
Electromagnetic compatibility	Emissions	in line with EN 55011 class B
	Immunity to interfering field strength	in line with EN 61326 (industrial environment)
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 DIN EN 60068-2-6
	random	10 Hz to 300 Hz, acceleration 1.2 g (rms) in line with DIN EN 60068-2-64
Shock		40 g shock spectrum in line with DIN EN 60068-2-27, MIL-STD-810E
Environmental conditions		
Temperature range	operating	0 °C to +50 °C in line with DIN EN 60068-2-1, DIN EN 60068-2-2
	storage	-40 °C to +71 °C
Climatic resistance	test: +40 °C/95 % rel. humidity	in line with DIN EN 60068-2-78
Altitude	operating	up to 4600 m
	storage	up to 4600 m
Weight and dimensions		
Weight	when fully equipped	3.9 kg [nom]
Dimensions	width × height × depth	357 mm × 106 mm × 397 mm [nom]
Calibration interval		
Recommended calibration interval		3 years

Ordering information

Designation	Type	Order No.
Base unit		
Signal Generator 9 kHz to 1.1 GHz	R&S®SMB100N	1406.6000.31
Including power cable, operating and service manual		
Options		
RF path / Frequency option		
9 kHz to 3.2 GHz	R&S®SMB-B103E	1417.9506.02
9 kHz to 6 GHz	R&S®SMB-B106E	1417.9764.02
Reference Oscillator OCXO	R&S®SMB-B1	1407.3005.02
Pulse Generator	R&S®SMB-K23	1407.3786.02
Service options		
Documentation of Calibration Values	R&S®DCV-2	0240.2193.18
DKD (ISO 17025) Calibration including ISO 9000 calibration (can only be ordered with the device)	R&S®SMB-DKD	1161.3607.02
Recommended extras		
19" Rack Adapter	R&S®ZZA-S234	1109.4493.00
Power Sensor 9 kHz to 6 GHz incl. USB adapter cable	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
USB adapter for R&S®NRP power sensors	R&S®NRP-Z4	1146.8001.02
USB serial adapter for RS232 remote control	R&S®TS-USB1	6124.2531.00

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.