

# DATASHEET RFSGX Specification v2.23

Signal Generators from 9 kHz to 2000 MHz,  
4000 MHz and 6100 MHz



**Document size:**  
1 title page  
13 content pages

## DEFINITIONS

- The specifications in the following pages describe the warranted performance of the instrument for  $23 \pm 5$  °C after a 30-minute warm-up period (unless otherwise stated).

**Min/Max:** Parameter range that is guaranteed by product design, and/or production tested. Warranted performance specifications include guard-bands to account for the expected statistical performance distribution, measurement uncertainties, and changes in performance due to environmental conditions.

**Typical:** Expected mean values, not warranted performance.

## INTRODUCTION

- **RFSGx models comprises a set of very compact, portable analog signal generator models from 9 kHz up to 6100 MHz. A combination of good signal purity, fast switching speed and wide dynamic range makes these units useful for a variety of applications.**

The RFSGX is a series of a low-noise and fast-switching analogue signal generator covering a frequency range from 9 kHz up to 2.0, 4.0, and 6.1 GHz, respectively.

The RFSGX provides full RF signal generator capabilities including OCXO-stabilized low phase-noise signal with micro-Hz frequency resolution, wide and accurately levelled output power range, extensive modulation capabilities, and fast switching.

It is targeted for a wide range of applications where a high-quality analogue signal is mandatory, offering an alternative to expensive high-end RF signal generators, where small size and excellent RF performance at an attractive cost is required.

The very compact and rugged design of the RFSGX operates at very low DC power consumption (only 12 watts), with minor heat dissipation and not requiring noisy fan. This gives the RFSGX a great advantage in laboratories or production test facilities.

The low power design allows the use of optional internal battery modules which make it a truly portable instrument, ideally suited for field testing, installation, and maintenance.

Available Options:

Option PE3 is an optional power level extension to accurately level below -120 dBm.

Option B3 adds an internal rechargeable battery module

Option AVIO adds dedicated avionics modulation like VOR/ILS

19-inch rack-mount solutions are also available.

The RFSGX support various standard interfaces such as USB (USBTMC), LAN (VXI-11), or GPIB and extensive API with programming examples are available.

## SPECIFICATIONS

PARAMETER	MIN	TYPICAL	MAX	NOTE
<b>Frequency range</b>	9 kHz		2.0 GHz 4.0 GHz 6.1 GHz	<b>RFSG2</b> <b>RFSG4</b> <b>RFSG6</b>
resolution		0.001 Hz		
Phase resolution		0.1 deg		
Settling time		20 μs 20 μs	100 μs 200 μs	<= SN xx-xxx2xxxxx-xxxx >= SN xx-xxx3xxxxx-xxxx
Frequency update rate		400 μs		time from receipt of SCPI command firmware
List/Sweep mode		400 μs		
<b>SSB Phase noise at 1 GHz</b>				
at 20 kHz from carrier		-130 dBc/Hz		See measured phase noise plots
<b>Total jitter</b>		68 fs RMS		10 Hz to 1 MHz BW
<b>Spectral purity</b>				
Output harmonics		-40 dBc	-30 dBc	$P_{out} = +10$ dBm
Sub-harmonics		-80 dBc	-70 dBc	
Non-harmonic spurious				
< 1 MHz		-70 dBc	-60 dBc	$P_{out} = +10$ dBm
> 1 MHz		-75 dBc	-65 dBc	
Residual FM @ 1 GHz			3 Hz	0.3 kHz to 3 kHz, weighted (ITU-T)
			12 Hz	0.03 kHz to 23 kHz
<b>Power level</b>				
Range (>10 MHz)				See plots on page 8
Without Option PE3	-30 dBm		+18 dBm +10 dBm	>50 MHz < 50 MHz
With Option PE3	-120 dBm		+17 dBm +10 dBm	>50 MHz < 50 MHz
Resolution		0.01 dB		
Level uncertainty		0.3 dB 0.5 dB 1.8 dB	< 0.8 dB < 1.3 dB	-20 to + 10 dBm -80 to -20 dBm < -80 dBm
Output impedance		50 Ω		
VSWR		1.5 1.7	1.8 2.0	< 3 GHz > 3 GHz
<b>Reference frequency input</b>	8 MHz		200 MHz	User programmable
Reference input level	-5 dBm	0 dBm	+13 dBm	
Lock Range			+/- 1.0 ppm	
Reference input impedance		50 Ω		
<b>Internal reference frequency output</b>		10 MHz		

Initial accuracy of internal reference		±40 ppb		calibrated at 23 ± 3 °C at time of calibration
Temperature stability (0 to 50 degC)			±100 ppb	
Aging 1 <sup>st</sup> year		0.5 ppm		
Aging per day (after 30days operations)			5 ppb	
Warm-Up time		5 min		
Output of internal reference		+0dBm 50 Ω		
<b>Reverse Power Protection</b>				
DC Voltage		30 V		
RF power			36 dBm	
<b>Dimensions</b>				
Excluding connectors	W x L x H = 172 x 250 x 106 mm			
Including connectors	W x L x H = 172 x 273 x 106 mm			



### Sweeping Capability

Sweeps can be performed with combined internal or external AM/FM/PM/pulse modulation running. With modulation enabled, the minimum step time increases to 2 ms.

PARAMETER	MIN	TYPICAL	MAX	NOTE
<b>Frequency sweep</b>				
Sweep type: linear, logarithmic, random				
Step time ( $t_{step}$ )	400 μs		19998 s	
Dwell time ( $t_{dwell}$ )	50 μs		9999 s	
Off-time (incl. transient time) ( $t_{off}$ )	0 / 50 μs		9999 s	
Timing accuracy per point		1 μs		
<b>Generalized list sweep</b>				
allows individual setting of frequency, power, dwell-time, and off-time for each point				
List size	2		20.000	
Step time ( $t_{step}$ )	200 μs		19998 s	
Dwell time ( $t_{dwell}$ )	50 μs		9999 s	
Off-time (incl. transient time) ( $t_{off}$ )	0 / 50 μs		9999 s	
Time resolution		0.1 μs		
Timing accuracy per point		1 μs		
<b>Frequency Chirps</b>				
(linear ramp, up/down)				
Bandwidth			10%	
Dwell time (tdwell)	10 ns		100 μs	
Number of frequencies			20'000	



## Modulation Capabilities

All modulation types (FM, PM, AM, and pulse modulation) may be simultaneously enabled except: FM and phase modulation cannot be combined. For example, AM and FM can run concurrently and will modulate the output RF.

PARAMETER	MIN	TYPICAL	MAX	NOTE
<b>Pulse modulation</b>				
On/off ratio		70 dB		
Repetition frequency	DC		33 MHz	
Pulse width	30 ns 50 $\mu$ s		20 s 20 s	ALC hold ALC on
Pulse rise/fall time		5 ns		
Pulse trainlength (pulses)	2		4192	
Video crosstalk		-40 dB		
External input threshold	0.85 V	0.9 V	0.95 V	TTL compatible
External input voltage range	-0.5 V		+5.5 V	TTL compatible
External input hysteresis		60 mV		
Delay (to RF)		20 ns	40 ns	
<b>Frequency modulation</b>				
Maximum Frequency deviation (peak)		> 2 MHz N x 100 MHz		< 0.37 GHz 0.37 GHz to 0.75 GHz (N=0.125) 0.75 GHz to 1.5 GHz (N=0.25) 1.5 GHz to 3 GHz (N=0.5) > 3 GHz to 6.1 GHz (N=1)
Modulation waveforms	Sine, triangle, FSK			
Modulation rate	1 Hz/DC		800 kHz	-3dB frequency response Max. phase deviation degrades above 20 kHz modulation rate
External input sensitivity	< N · 100 MHz for 1 Vpp			settable in AC mode discrete values in DC mode
Total harmonic distortion	< 1%			1 kHz rate & N · 100 kHz deviation
<b>Phase modulation</b>				
Phase deviation (peak)	0		N·80 rad	
Modulation rate	1 Hz		800 kHz	> -3dB frequency response
Modulation waveforms	Sine, triangle, FSK			
External Input sensitivity	N · 40 rad for 1 Vpp			
Total harmonic distortion	< 1%			1 kHz rate & N · 20 rad deviation
<b>Amplitude modulation</b>				
Modulation rate	10 Hz 10 Hz		20 kHz 50 kHz	applies for internal and external >= SN xx-xxx5xxxxx-xxxx
Modulation depth	0 %		95 %	
Modulation waveforms	Sine, triangle, square			
Distortion		2 %		
Accuracy		3 %		

External input sensitivity	X % per 1 Vpp	settable
<b>Avionics Modulation (option AVIO)</b>		
ILS		
Localizer RF frequency	108 to 112 MHz	
Nominal tone frequencies	90 & 150 Hz	
Frequency accuracy	< 0.02 Hz	
Centerline (in %)	DDM: $0 \pm 0.1$ ; SDM: $40 \pm 2.0$	
Fly left (in %)	DDM: $15.5 \pm 0.5$ ; SDM: $40 \pm 2.0$	
Fly right (in %)	DDM: $-15.5 \pm 0.5$ ; SDM: $40 \pm 2.0$	
Flag (in %)	DDM: $0 \pm 0.1$ ; SDM: $30 \pm 2.0$	
Glide Path RF frequency	328.6-335.4 MHz	
Angle of Descent (in %)	DDM: $0 \pm 0.1$ ; SDM: $80 \pm 3.0$	
Fly up (in %)	DDM: $17.5 \pm 0.5$ ; SDM: $80 \pm 3.0$	
Fly down (in %)	DDM: $-17.5 \pm 0.5$ ; SDM: $80 \pm 3.0$	
Flag (in %)	DDM: $0 \pm 0.1$ ; SDM: $70 \pm 2.5$	
VOR RF frequency	108 - 118 MHz	
Subcarrier Frequency	$9960 \pm 2.0$ Hz	
FM deviation	480 Hz	
AM tone	$30 \pm 0.02$ Hz	
Bearing north	TDM: $30 \pm 2.0$ % Phase: $180 \pm 0.5$ deg	
Bearing south	TDM: $30 \pm 2.0$ % Phase: $90 \pm 0.5$ deg	
Bearing east	TDM: $30 \pm 2.0$ % Phase: $0 \pm 0.5$ deg	
Bearing west	TDM: $30 \pm 2.0$ % Phase: $270 \pm 0.5$ deg	
Test 1	TDM: $20 \pm 1.5$ % Phase: $0 \pm 0.5$ deg	
Test 2	TDM: $40 \pm 2.0$ % Phase: $0 \pm 0.5$ deg	



## Multi-Purpose Output (FUNC OUT)

Output is FUNC OUT at rear panel

PARAMETER	MIN	TYPICAL	MAX	NOTE
<b>MULTIFUNCTION GENERATOR</b>				
sine, triangle, square wave				
Frequency range	1 Hz 1 Hz		3 MHz 1 MHz 50 kHz	sine triangle square
Frequency resolution		0.1 Hz		
Output voltage amplitude peak-peak	10 mV	5V	2 V	Sine, triangle Square (CMOS output)
Harmonic distortion		1 %		< 100 kHz, 1 Vpp
Output impedance		50 Ω CMOS		Sine, triangle squarewave

### VIDEO OUTPUT (of internal pulse modulator)

Output		CMOS		
Period	30 ns		50 s	
Pulse Width	15 ns		50 s	
RF delay		10 ns		

### TRIGGER OUT Synchronization mode for multiple sources

Modes	Trigger on sweep start Trigger on each point			
Trigger waveform pulse width		100 ns		



## Trigger (TRIG IN)

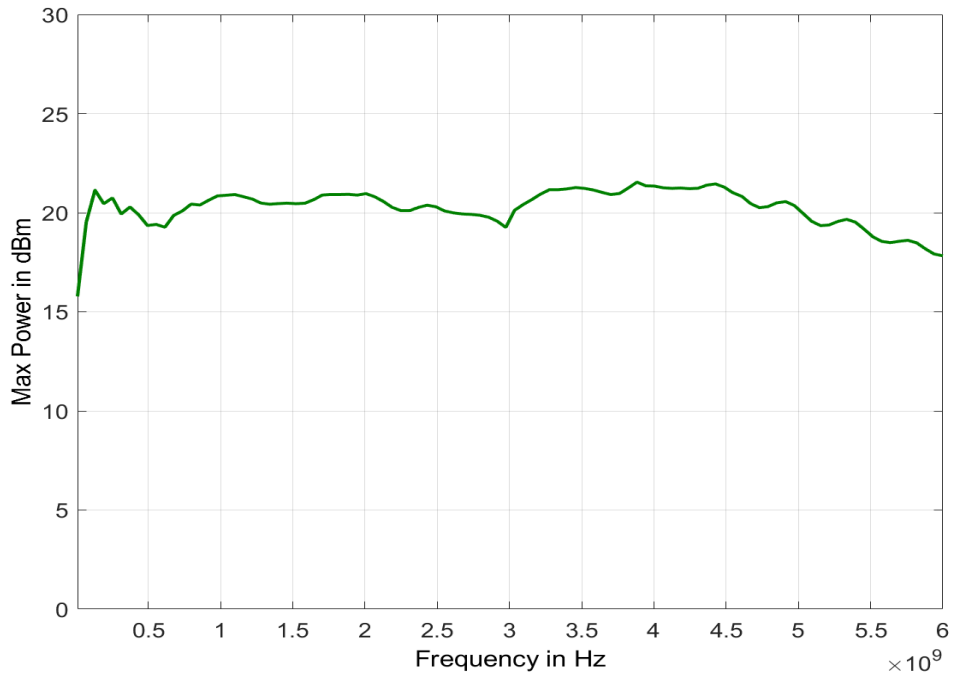
Input is TRIG IN at rear panel

PARAMETER	MIN	TYPICAL	MAX	NOTE
Trigger Types	Continuous, single, gated, gated direction			
Trigger Source	RF key, external, bus (GPIB, LAN, USB)			
Trigger Modes	Continuous free run, trigger and run, reset and run			
Trigger latency		tbd		
Trigger uncertainty		5 $\mu$ s		
External Trigger delay	50 $\mu$ s		40 s	
External Delay Resolution		15 ns		
Trigger Modulo	1		255	Execute only on Nth trigger event
Trigger Polarity	Rising, falling			
External trigger input threshold	0.85 V	0.9 V	0.95 V	TTL compatible
External trigger input voltage range	-0.5 V		+5.5 V	TTL compatible
External trigger input hysteresis		60 mV		

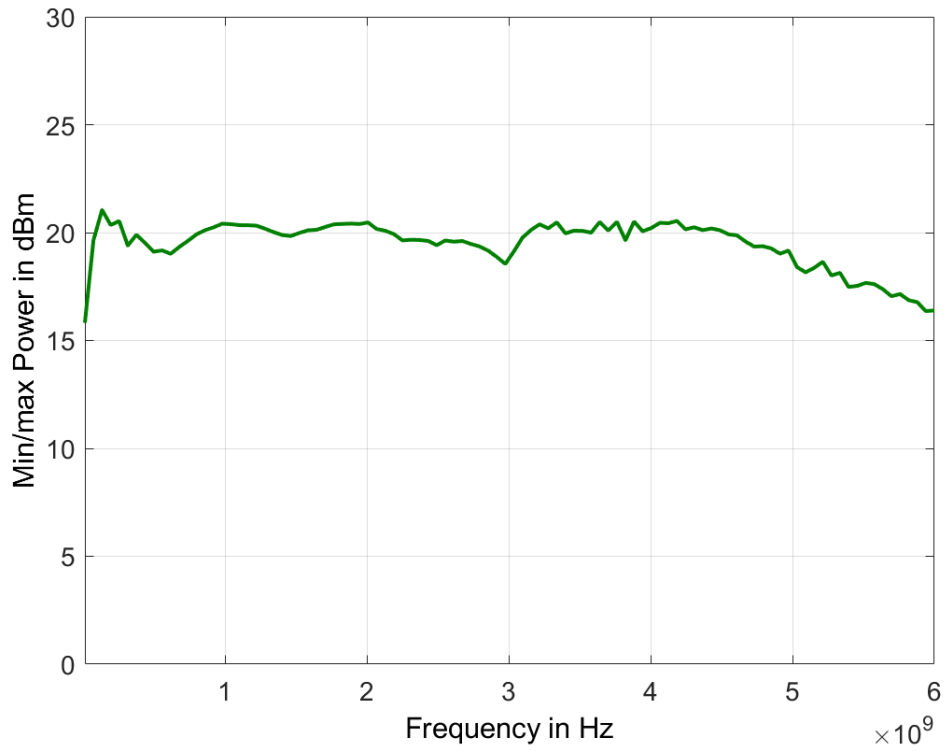


## PERFORMANCE CURVES

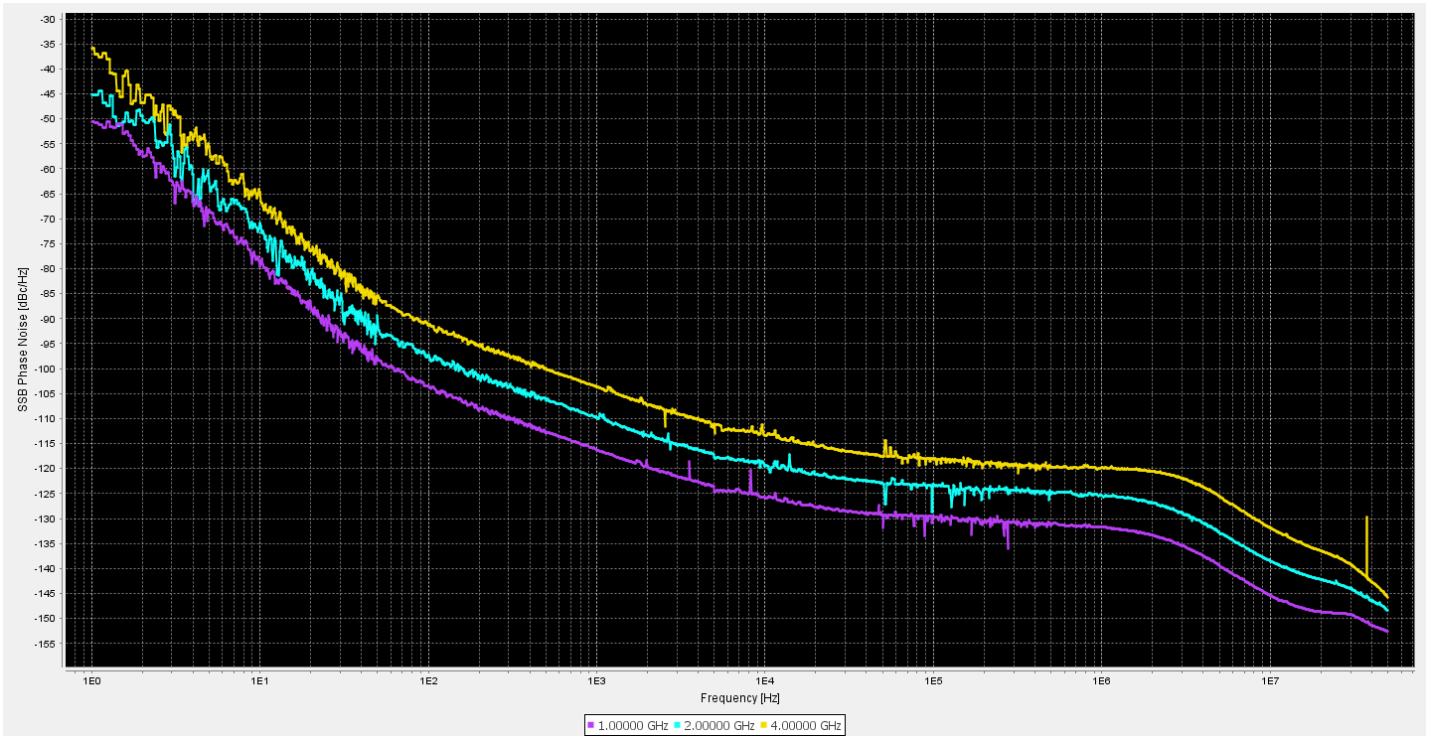
### Typical Maximum Output Power (without option PE3)



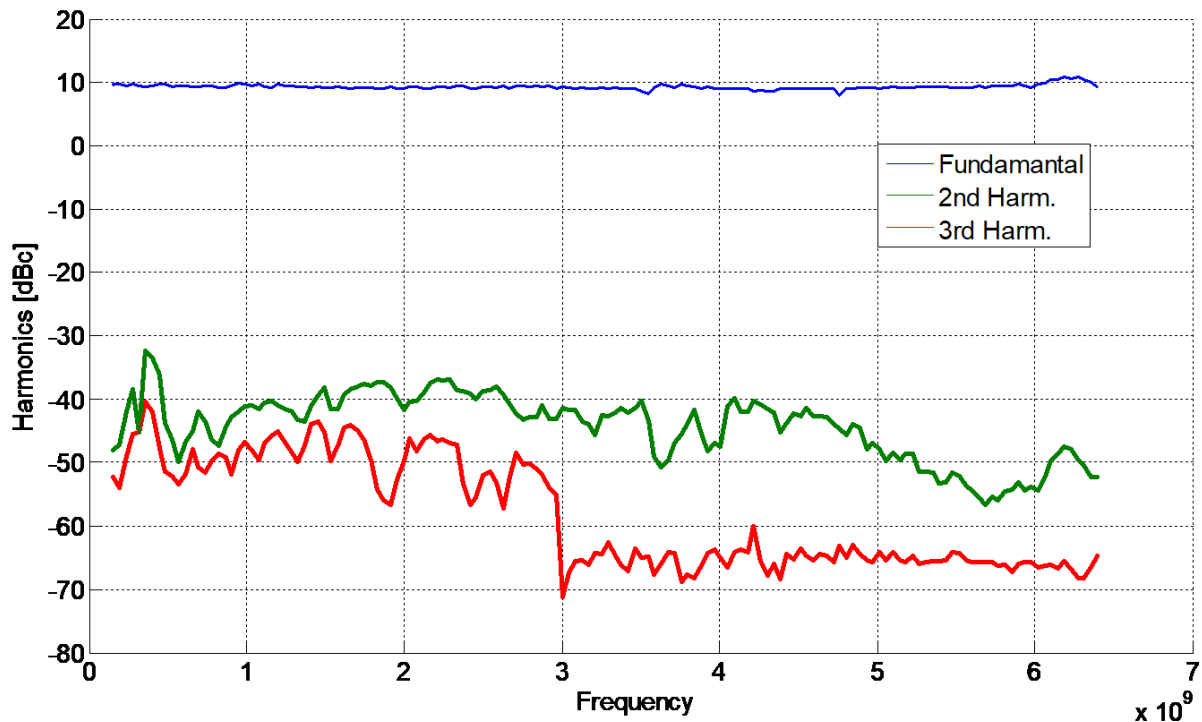
### Typical Maximum Output Power (WITH option PE3)



# Phase Noise Performance (1, 2 and 4 GHz)



## Harmonic performance at + 10 dBm

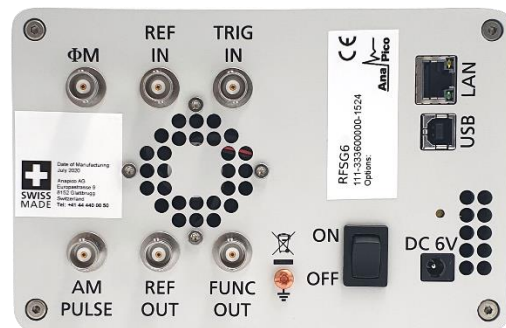


## Connectors (Front)



1. RF output N female
2. Rotary knob

## Connectors (Rear)



1. Trigger input BNC female
2. Function output BNC female
3. External reference input BNC female
4. Internal reference output BNC female
5. FM/PM modulation input BNC female
6. AM and Pulse modulation BNC female
7. LAN connection RJ-45
8. USB 2.0 device
9. GPIB IEEE-488.2, 1987 with listen and talk (optional)
10. DC Power plug (6V, 6 A)
11. DC power switch
12. Ground Screw
13. Fan Holes The air intake of the fan.
14. Fan Holes The holes by which the air is extruded.

## ORDERING INFORMATION



HOST MODEL	PRODUCT	DESCRIPTION
RFSGX	RFSG2	9 kHz – 2000 MHz Signal Generators
RFSGX	RFSG4	9 kHz – 4000 MHz Signal Generators
RFSGX	RFSG6	9 kHz – 6100 MHz Signal Generators
RFSGX	<b>Option B3</b>	Internal rechargeable battery module
RFSGX	<b>Option GPIB</b>	GPIB interface
RFSGX	<b>Option AVIO</b>	Avionics modulation capability (VOR/ILS)
RFSGX	<b>Option 1URM</b>	1U rack-mount module
RFSGX	<b>Option REAR</b>	Move output to the rear panel
RFSGX	<b>Option OEM</b>	OEM package
RFSGX	<b>Option WE</b>	One-year warranty extension (standard: 2 years)
RFSGX	<b>Option ReCal</b>	Recalibration with test data (recommended: two years interval)

## GENERAL CHARACTERISTICS

### Remote programming interfaces

Ethernet 100BaseT LAN interface

USB 2.0 host & device

GPIB (IEEE-488.2,1987) with listen and talk (optional)

Control language SCPI Version 1999.0

**Power requirements:** 6 VDC; 20 W maximum

**Mains adapter supplied:** 100-240 VAC in/ 6 V 6.0 A DC out

**Storage temperature range** –40 to 70 °C

**Operating temperature range** 0 to 45 °C

**Operating and storage altitude** up to 15,000 feet



Safety/EMC complies with applicable Safety and EMC regulations and directives.

**Weight** ≤ 2.5 kg (6 lbs) net, ≤ 4 kg (8 lb.) shipping

### Dimensions:

116.9 mm H x 173.6 mm W x 270.7 mm L (incl. connectors)

[4.60 in H x 6.83 in W x 10.66 in L]

**Recommended calibration cycle** 24 months

### Compatibility languages supporting commonly used commands

Agilent Technologies N5181A MXG, Aeroflex, Rohde & Schwarz SMA and SML models


**Document History**

Version	Date	Author	Notes
V10	2010-06-01	jk	first release
V11	2010-08-01	jk	Mechanical information added
V12	2010-11-01	jk	Options,
V13	2010-12-30	jk	Measurements added
V131	2011-03-10	jk	Concurrent sweeps / modulation
V140	2011-04-28	jk	Front panel, measurement plots
V142	2011-05-20	jk	Reference output 10 MHz, Pmax adjusted
V143	2011-09-1	jk	Phase Noise plot
V144	2012-09-15	jk	Reference input range adjusted
V145	2012-09-15	jk	Added trigger, chirps, pulse trians
V146	2013-08-26	db	Modified sweep timing specs
V147	2013-10-04	db	Added frequency settling time specs
V148	2014-01-21	jk	Corrected dimensions
V149	2014-02-06	jk	Maximum power plot added
V150	2014-06-30	jk	New phase noise plot
V200	2014-12-10	jk	Unified data sheet for RFSGXHC series
V210	2015-05-10	jk	Updated sweeping timing parameters
V211	2015-06-23	db	Added >= SN xx-xxx5xxxx-xxxx AM bandwidth data
V212	2016-07-05	db	Added option PE data
V214	2016-12-15	jk	Refine power level accuracy
V215	2017-05-15	jk	Option AVIO
V216	2017-08-15	jk	VSWR Spec refined
V217	2019-01-30	mm	Dimension up-date
V218	2019-03-25	mm	New layout
V219	2019-07-10	ee	Minor corrections
V220	2020-09-15	db	Clarified Power accuracy at > + 10 dBm
V221	2020-11-11	ee	Updated product images
V222	2021-01-10	jk	New power plots
V223	2021-02-25	db	Pulse and trigger input electrical specifications

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