

# DATASHEET RFS40-X Specification V1.20

Multi-Channel 8 kHz to 40 GHz Wideband Synthesizer System



**Document size:**

1 (one) title page  
15 (fifteen) 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

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

**Min and 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.

## INTRODUCTION



### Multi-Output ultra-low Phase Noise Wideband Frequency Synthesizer with USB & LAN Interface

The RFS40-X is a multi-channel wideband low phase-noise synthesizer settable from 100 kHz (8 kHz with option 8K) to 40 GHz.

The product is available with 1, 2, 3 or 4 fully independently configurable outputs. For each output channel, frequency, output power, phase and modulation can be set.

The settable output power range is from -5 to +25 dBm.

The RFS40-X has a milli-Hz frequency resolution and uses a high-stability OCXO internal reference. The reference can be phase-locked to a 10 or 10 MHz external reference. With option VREF, a user-settable range from 1 to 250 MHz is available.

For highest phase coherence, multiple RFS40-X can be cascaded with just one master reference clock.

When ordered with option FILT, the RFS40-X provides excellent harmonic rejection even a full output power.

The RFS40 -X offers dedicated sweeping capabilities with switching speeds of only 500  $\mu$ s (20  $\mu$ s with option FS) and internal phase and narrow pulse modulation.

The module has USB and LAN interfaces (optionally also GPIB) and can be controlled using the SCPI 1999 command set.

# FACTS, FIGURES & SPECIFICATIONS

## Signal Specifications

PARAMETER	MIN	TYPICAL	MAX	NOTE
<b>Frequency Range</b>	100 kHz 8 kHz		40 GHz	Settable to 43.5 GHz Option 8K
Resolution		0.001 Hz		
<b>Phase Resolution</b>		0.01 deg		
<b>Switching Speed</b>		1.5 ms		after SCPI command received
CW Mode		500 µs		
Sweep / List Mode		500 µs 20 µs		Option FS
<b>SSB Phase noise at 1 GHz</b>				(see also plot)
at 1 kHz from carrier		-140 dBc/Hz		
at 100 kHz from carrier		-150 dBc/Hz		
Wideband noise		-160 dBc/Hz		
<b>SSB Phase noise at 10 GHz</b>				
at 1 kHz from carrier		-120 dBc/Hz		
at 100 kHz from carrier		-130 dBc/Hz		
Wideband noise		-160 dBc/Hz		
<b>Output power range</b>				(see also plots)
8 kHz to 10 MHz	-10 dBm		+20 dBm	(option 8K)
10 MHz to 5 GHz	-10 dBm		+20 dBm	
5 to 20 GHz	-5 dBm		+20 dBm	
18 to 33 GHz	10 dBm		+19 dBm	
33 to 40 GHz	0 dBm		+18 dBm	
10 MHz to 5 GHz	-10 dBm		+15 dBm	Option FILT
5 to 26 GHz	-10 dBm		+12 dBm	Option FILT
26 to 40 GHz	-10 dBm		+10 dBm	Option FILT
<b>Resolution</b>		0.5 dB		
<b>Reverse Power Protection</b>				
DC Voltage		7 V		
RF Power			20 dBm	
<b>Output impedance</b>		50 Ohms		
VSWR		1.8		
<b>Spectral purity</b>				
Output harmonics		-15 dBc -55 dBc		(see also plots) >1 GHz, Option FILT
Sub-harmonics		-75 dBc -50 dBc	-50 dBc -30 dBc	< 20 GHz >20 GHz
<b>Non-harmonic spurious</b>		-75 dBc	-60 dBc	



## Modulation Capabilities

PARAMETER	MIN	TYPICAL	MAX	NOTE
<b>Pulse Modulation</b>				
Modulation source		Internal/ External		
External input amplitude	TTL			
Pulse rise/fall time		10 ns		
On/off ratio		40 dB		Pout > +10 dBm, see plot
Pulse overshoot			10%	
Pulse delay		20 ns		
Pulse polarity		Normal, inverse		selectable
<b>Internal pulse generator</b>				
Repetition frequency (PRF)	0.1 Hz		100 MHz	= 1/T
Duty cycle	1 % to 99 % in 1% steps			within specified minimum pulse width
Minimum pulse settling range	30 ns		20 s	
Pulse Pattern Modulation & Staggered PRF				Using internal pattern generator
Pulse width	30 ns		5 s	
Programmable pattern length	2		65536	
Duty cycle	0.05%		99.95%	
Pulse width resolution		5 ns		
Pulse period (T) accuracy		0.00005xT+ 3ns		
Pulse width accuracy		0.00005xT+ 5ns		
Pulse width resolution		5 ns		
Pulse jitter		2 ns	5 ns	
Polarity		selectable		
<b>Frequency Modulation</b>				
Modulation source		Internal		
Maximum Frequency deviation (peak)	N · 400 MHz			< 1.25 GHz (N=1) 1.25 GHz to 2.5 GHz (N=0.125) 2.5 GHz to 5 GHz (N=0.25) 5 GHz to 10 GHz (N=0.5) 10 GHz to 20 GHz (N=1) 20 GHz to 40 GHz (N=2)
Deviation accuracy		0.50%	2%	
Distortion (THD)		< 1 %		1 kHz rate, 10 kHz deviation
Modulation rate	0.1 Hz		80 kHz	
Modulation waveforms	Sine			
<b>Phase Modulation</b>				
Modulation source		Internal		
Phase deviation (peak)	0		300 · N · rad	
Deviation accuracy		0.50%	2%	
Modulation rate	0.1 Hz		80 kHz	
Modulation waveforms	Sine			
Distortion (THD)		< 1%		1 kHz rate & N x rad deviation



## Sweeping Capability, Sweep type: linear, logarithmic, random

PARAMETER	MIN	TYPICAL	MAX	NOTE
<b>Frequency Sweep</b>				
Step time ( $t_{step}$ )	500 $\mu$ s 20 $\mu$ s			Option FS
Dwell time ( $t_{dwell}$ )	15 $\mu$ s			



## Frequency Reference

PARAMETER	MIN	TYPICAL	MAX	NOTE
<b>Internal reference frequency</b>		100 MHz 10 MHz		Option LN
<b>Internal Reference Output Frequency</b>				
Temperature stability			$\pm$ 100 ppb	0 to 50 degC
Aging 1st year			1 ppm 0.3 ppm	Option LN
Aging per day			5 ppb 0.5 ppb	after 30 days operations Option LN
Warm-up time		5 min		
Output of internal reference		100 MHz		
		10/100 MHz		Option LN
Output power		0 dBm		
Output impedance		50 Ohms		
<b>Bypass Internal reference Input</b>		100 MHz		High phase synchronous mode
<b>Phase Lock to External Reference</b>	1 MHz	10 MHz integer MHz	250 MHz	Option VREF
<b>Reference input level</b>				
10 MHz or 1-250 MHz	-5 dBm	0 dBm	+13 dBm	
Bypass 100 MHz	5 dBm		+15 dBm	
<b>Reference input impedance</b>		50 Ohms		
<b>Lock Range</b>				
10 MHz or 1-250 MHz			$\pm$ 1.5 ppm	
Bypass 100 MHz			>100 ppm	



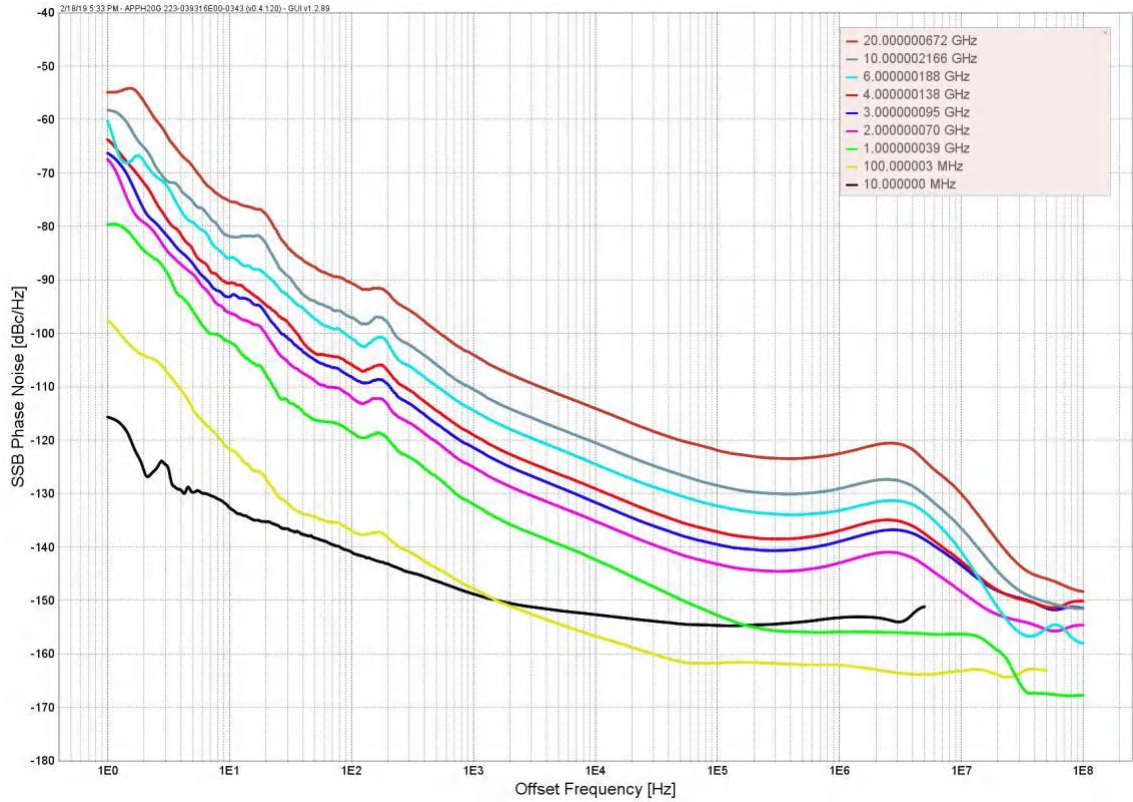
## Trigger (TRIG IN): Input is TRIG IN at front panel

PARAMETER	MIN	TYPICAL	MAX	NOTE
<b>Trigger Types</b>	Continuous, single (point), gated, gated direction			
<b>Trigger Source</b>	external, bus (LAN, USB)			
<b>Trigger Modes</b>	Continuous free run, trigger and run, reset and run			
Trigger latency		5 ns		
Trigger uncertainty		10 ns		
External Trigger delay	50 ns		40 s	
External Delay Resolution		5 ns		
<b>Trigger Modulo</b>	1		255	Execute only on Nth trigger event
<b>Trigger Polarity</b>	Rising, falling			

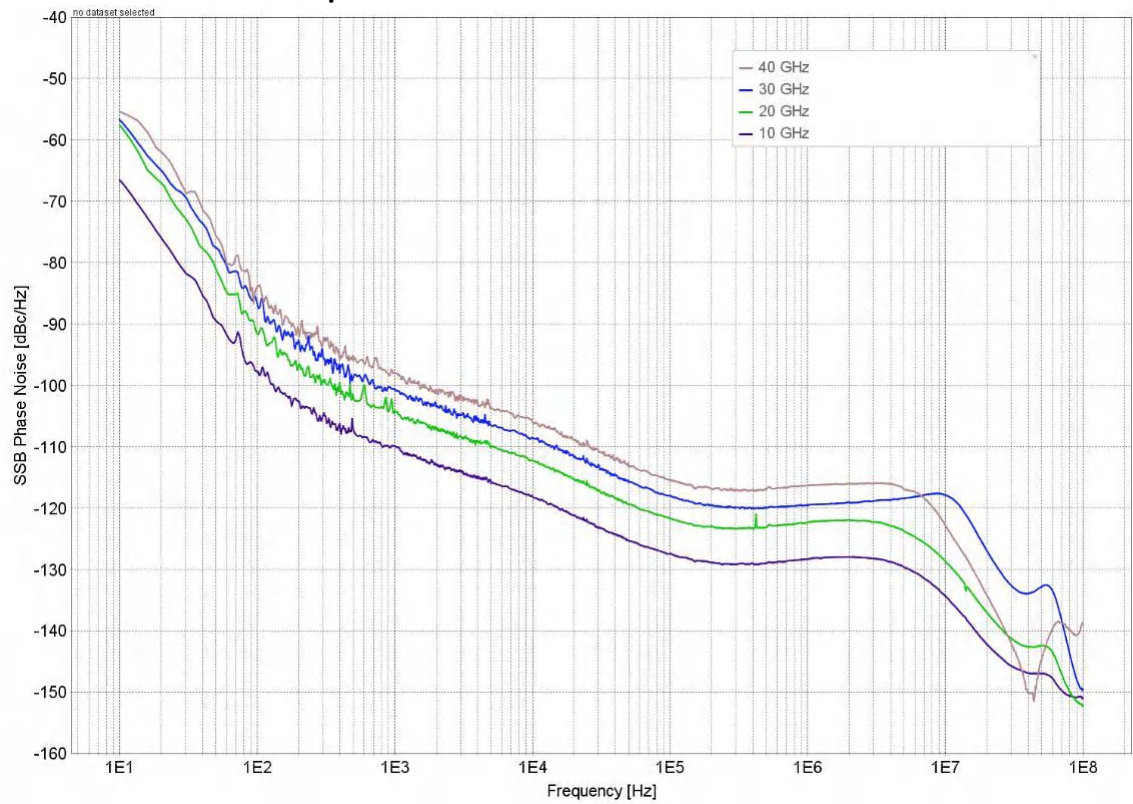
# TYPICAL PERFORMANCE CURVES



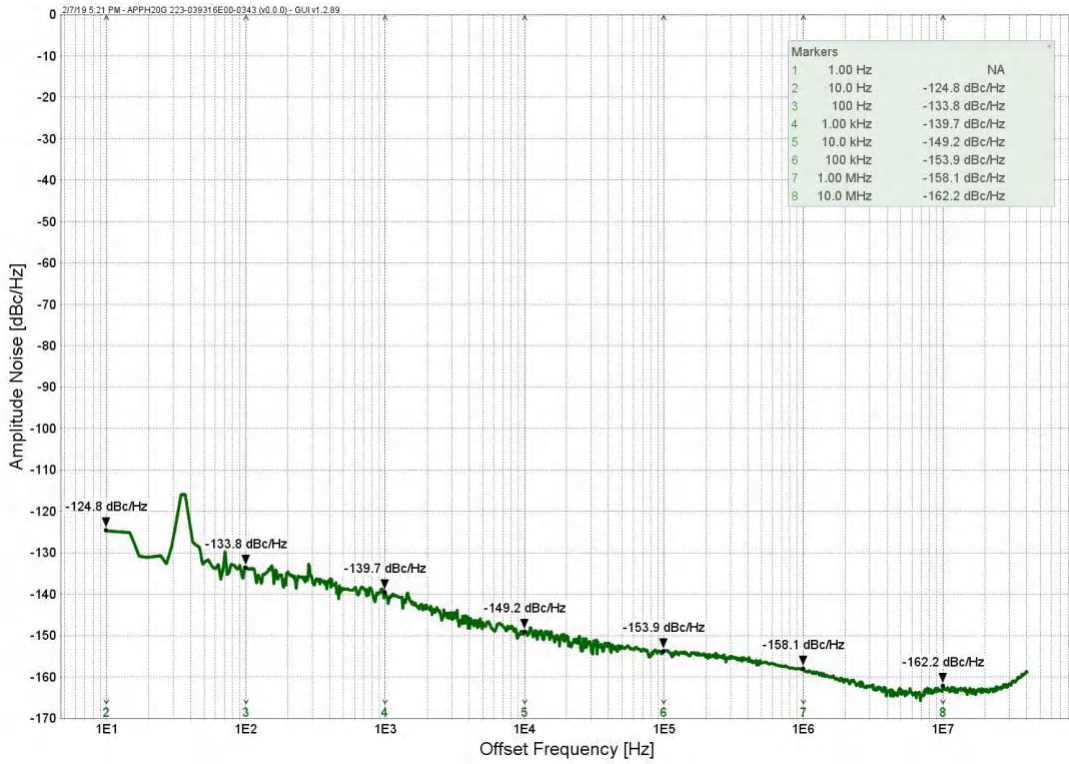
## Phase Noise Performance with option LN



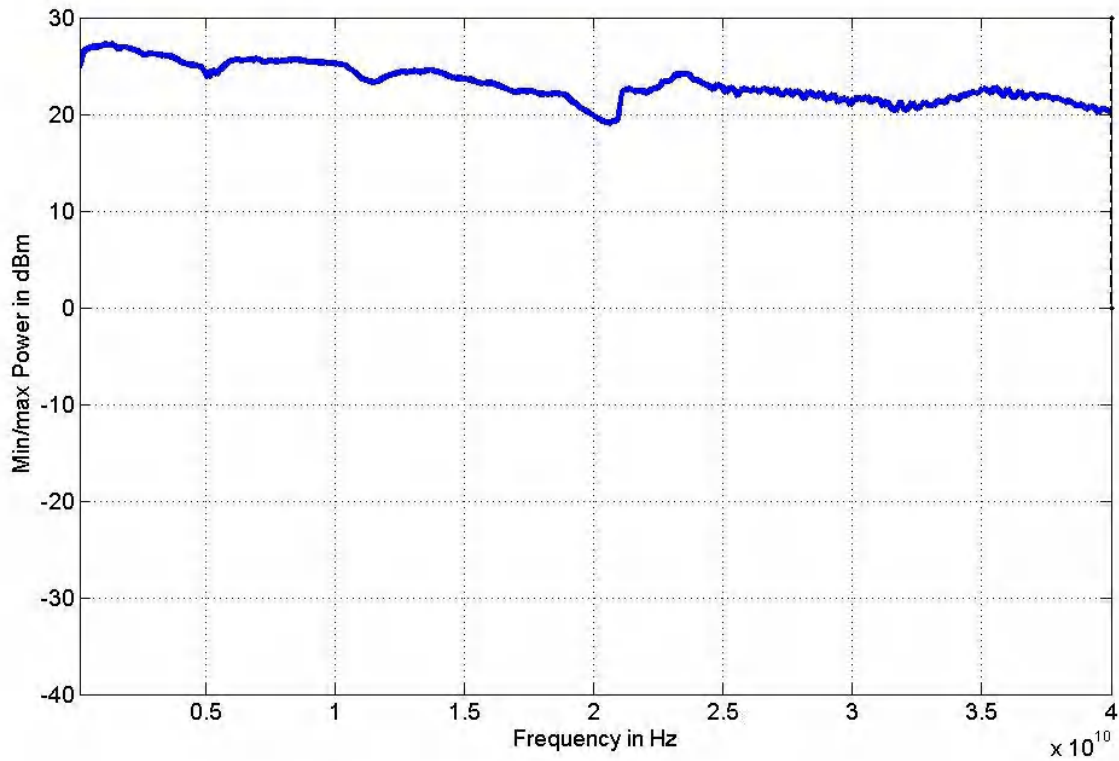
## Phase Noise Performance without option LN



## Amplitude Noise at 10 GHz

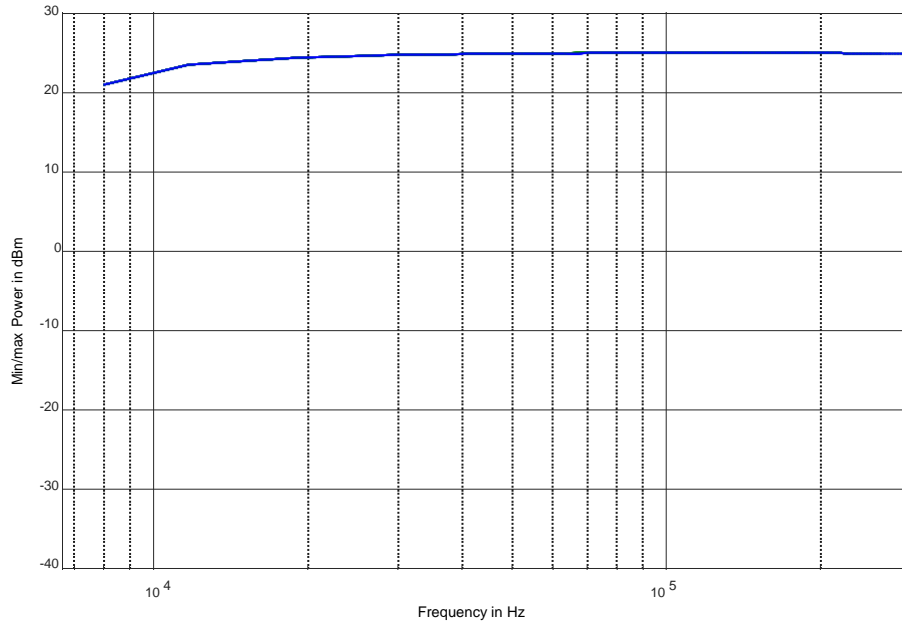


## Maximum Output Power (without option FILT)

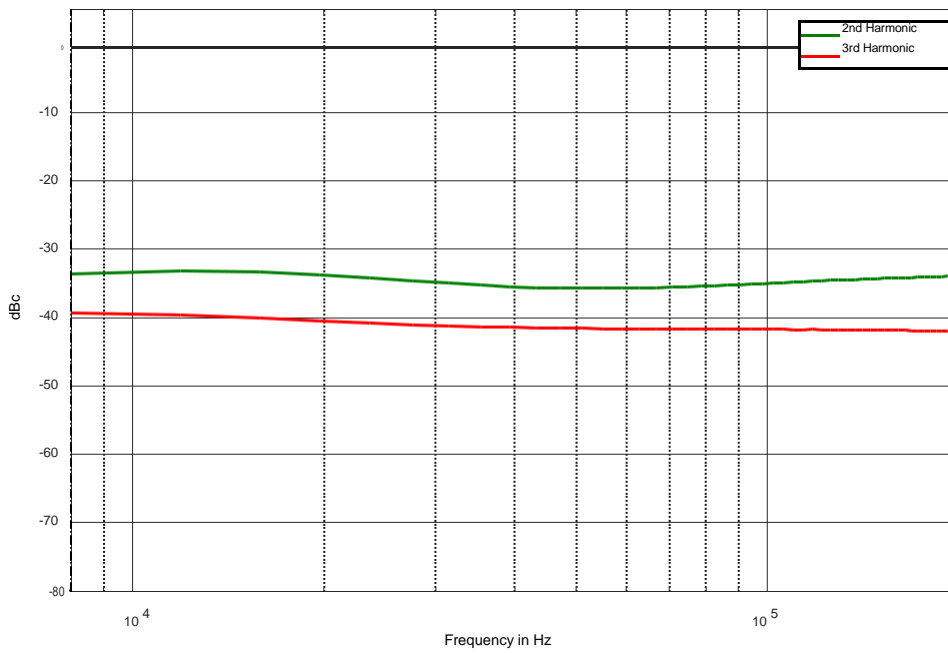




## Maximum Output Power at 8 to 250 kHz (option 9K)

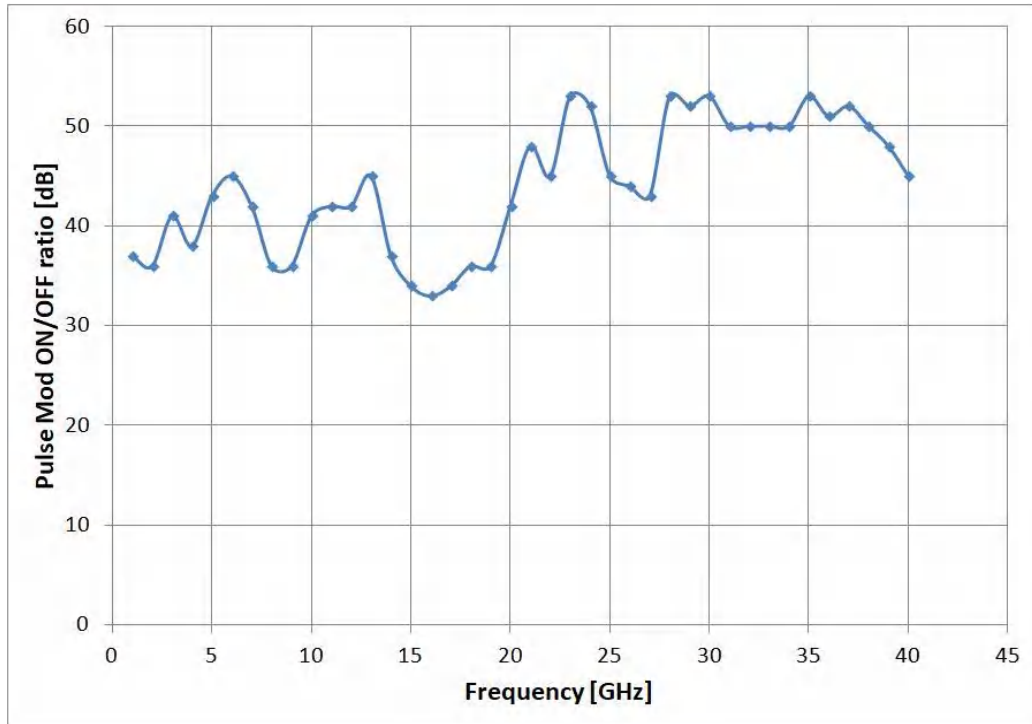


## Harmonics at lower frequencies and 0 dBm (with option 9K)

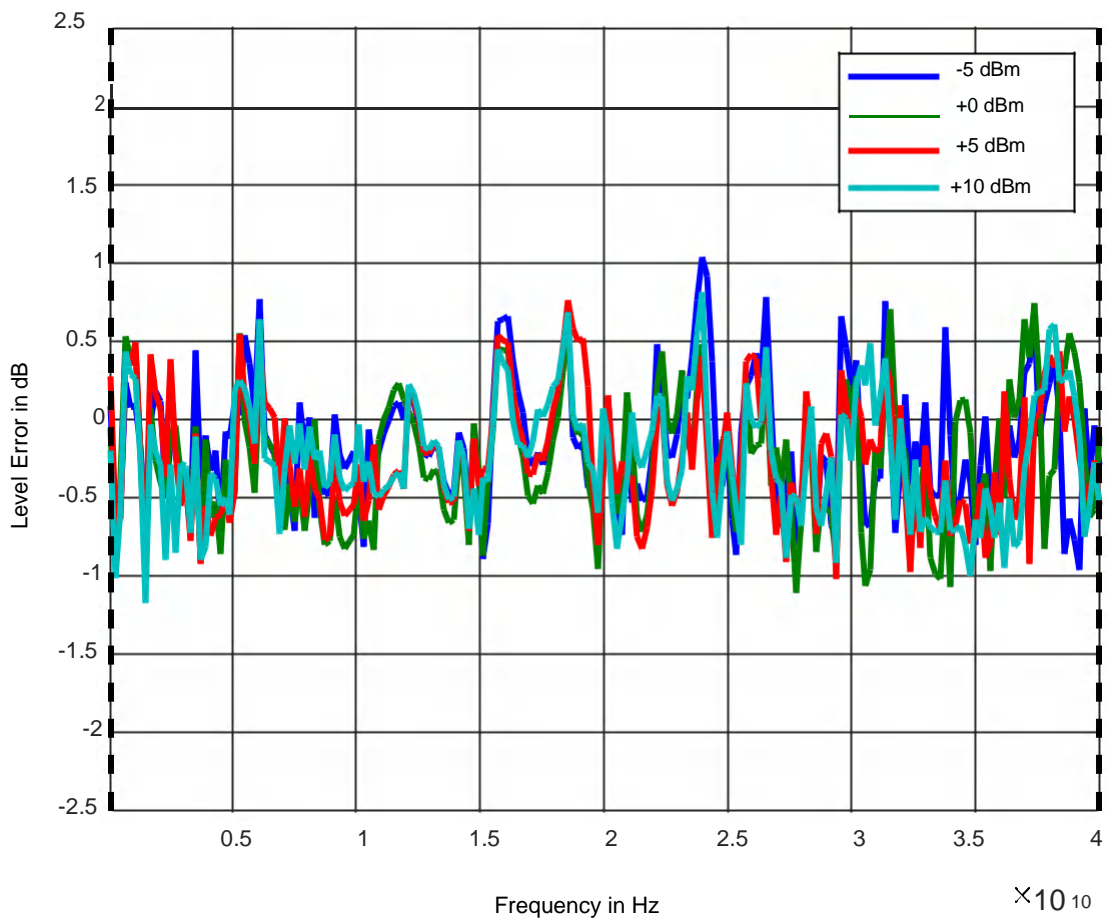




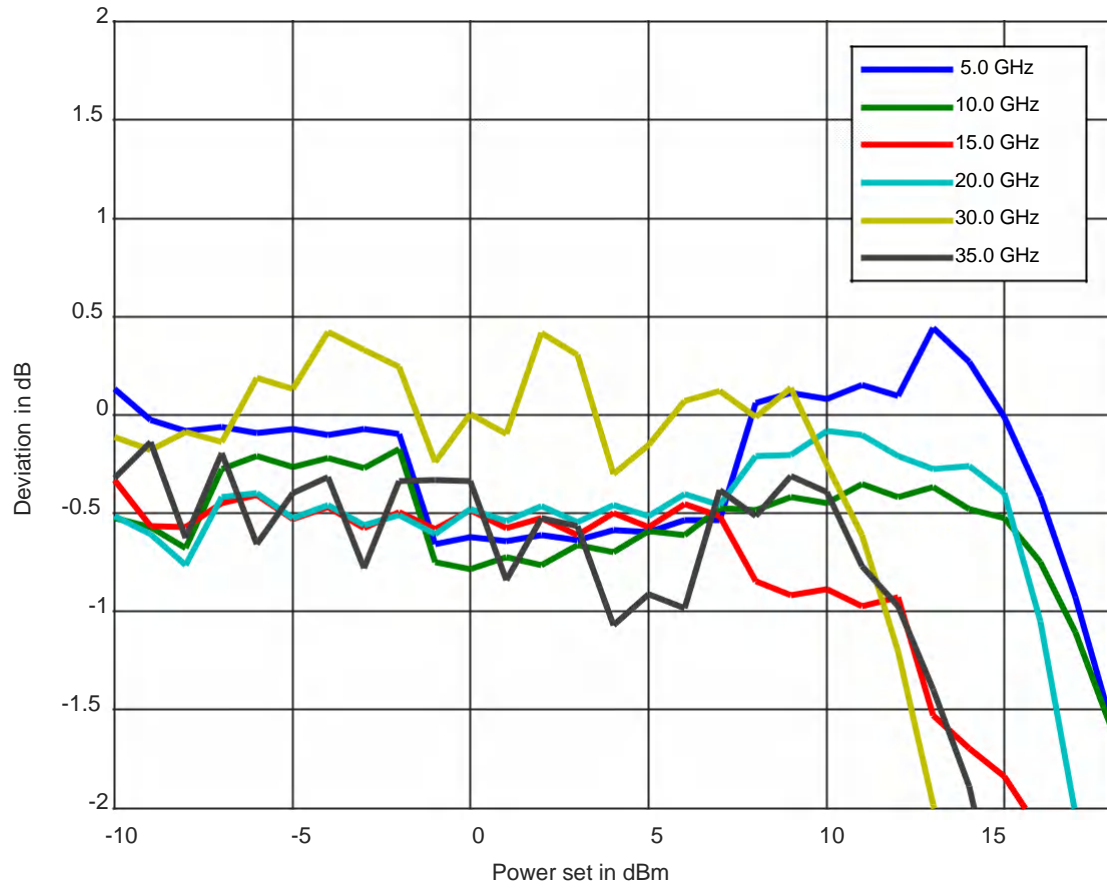
## Pulse Modulation on-off ratio



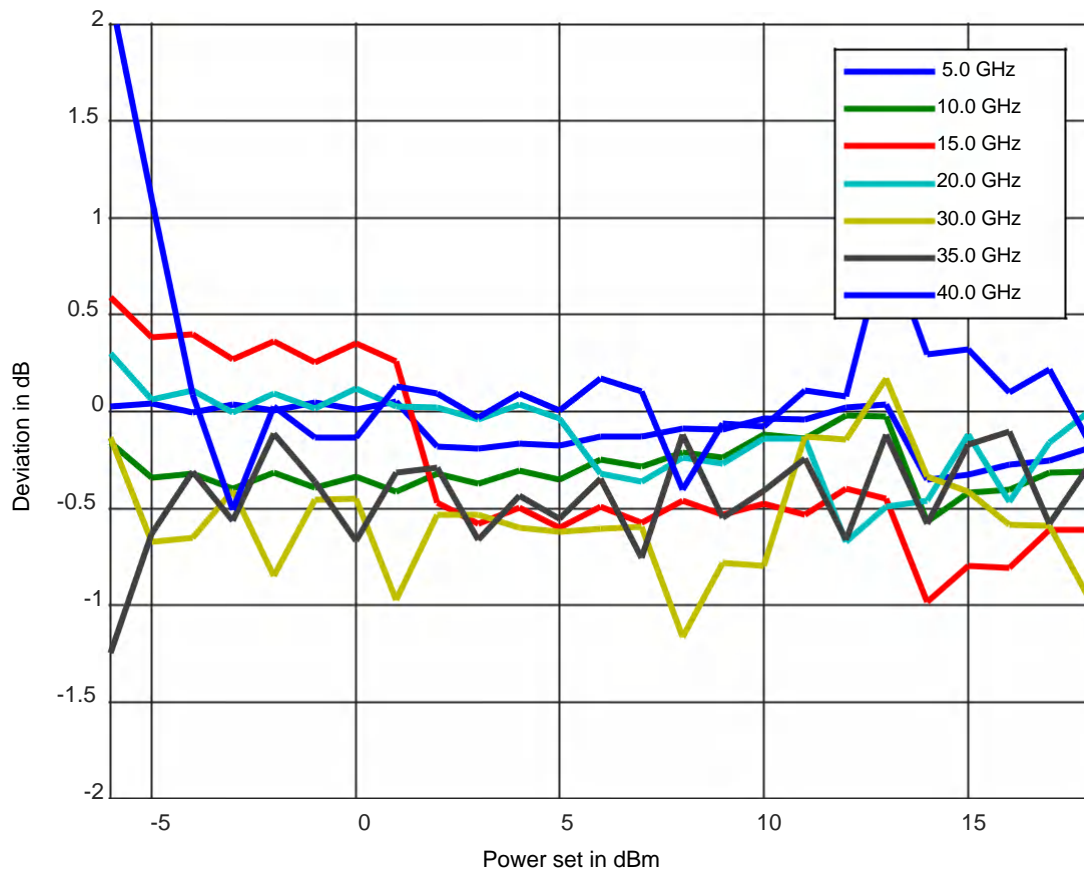
## Power level accuracy (with option FILT)



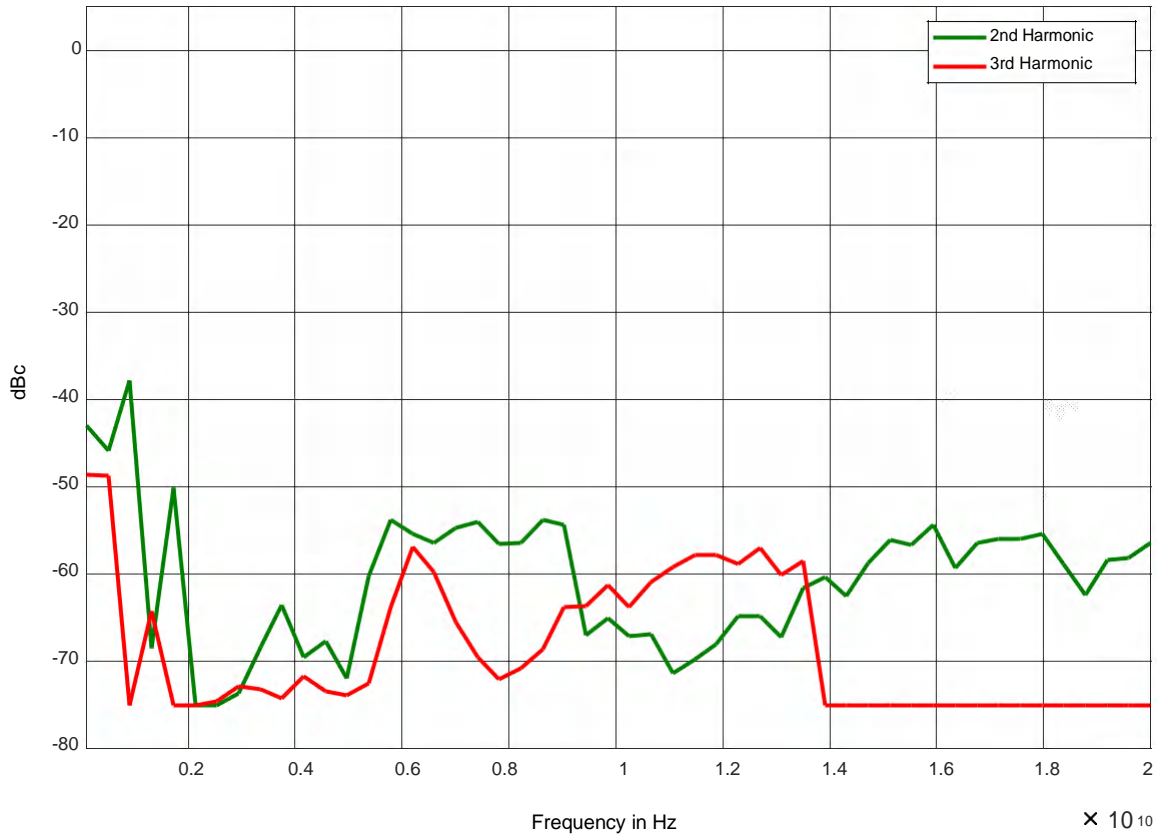
## Power level linearity (with option FILT)



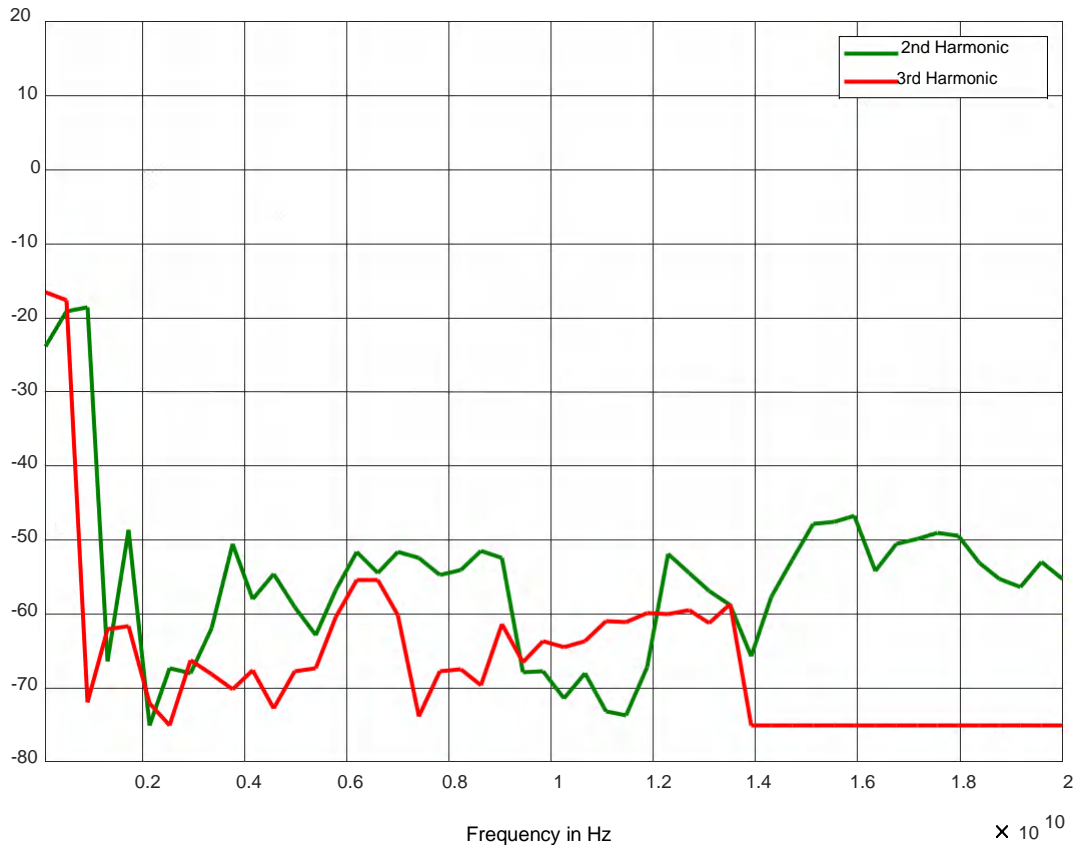
## Power level linearity



 **Harmonics @ 0 dBm (with option FILT)**



 **Harmonics +15 dBm (with option FILT)**



## ORDERING INFORMATION



HOST MODEL	PRODUCT	DESCRIPTION
RFS40-X	RFS40-1	Single output, 19" 1HU rack-mount module
RFS40-X	RFS40-2	Dual-Output, 19" 1HU rack-mount module
RFS40-X	RFS40-3	Triple-Output, 19" 1HU rack-mount module
RFS40-X	RFS40-4	Quad-Output, 19" 1HU rack-mount module
RFS40-X	Option LN	Enhanced close in phase noise & frequency stability
RFS40-X	Option FS	Ultra-fast switching speed
RFS40-X	Option VREF	Variable external reference
RFS40-X	Option GPIB	GPIB interface
RFS40-X	Option FILT	Enhanced harmonic rejection
RFS40-X	Option 8K	Frequency range extension to 8 kHz

# 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 24V ± 3.0 VDC; 25 W maximum

**Mains adapter supplied:** 100-240 VAC in/ 24 V 4.0 A DC out

**Environmental** (Levels similar to MIL-PRF-28800F Class 3/4)

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

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

**Operating and storage altitude** up to 15,000 feet (4600 m)



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

Weight ≤ 10.0 kg (22 lbs) net

Dimensions: 19" 1HE enclosure: 43 mm H x 426 mm W x 460 mm L [1.7 in H x 16.8 in W x 18.1 in L]



## Front view

1. RF outputs: K (2.92 mm) female (1 to 4)
2. External pulse modulation inputs: BNC female (1 to 4)
3. DC power switch



## Rear view

1. Internal reference output (SYSREF OUT): BNC female
2. External reference input (SYSREF IN): BNC female
3. Trigger output: BNC female
4. Trigger input: BNC female
5. Internal reference output (REF OUT): BNC female
6. External reference input (REF IN): BNC female
7. GPIB: IEEE-488.2, 1987 with listen and talk (optional)
- 8.
9. USB 2.0 host and device
10. LAN connection: RJ-45
11. FUSE (3.15 A)
12. AC Power plug

## Document History

Version/Status	Date	Author	Notes
V10	2019-02-20	jk	first release
V110	2020-01-26	jk	Added option FILT & option 8K
V120	2020-4-30	jk	Added plots for 8K and FILT

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**NOTES**

Lined area for notes with horizontal ruling lines.