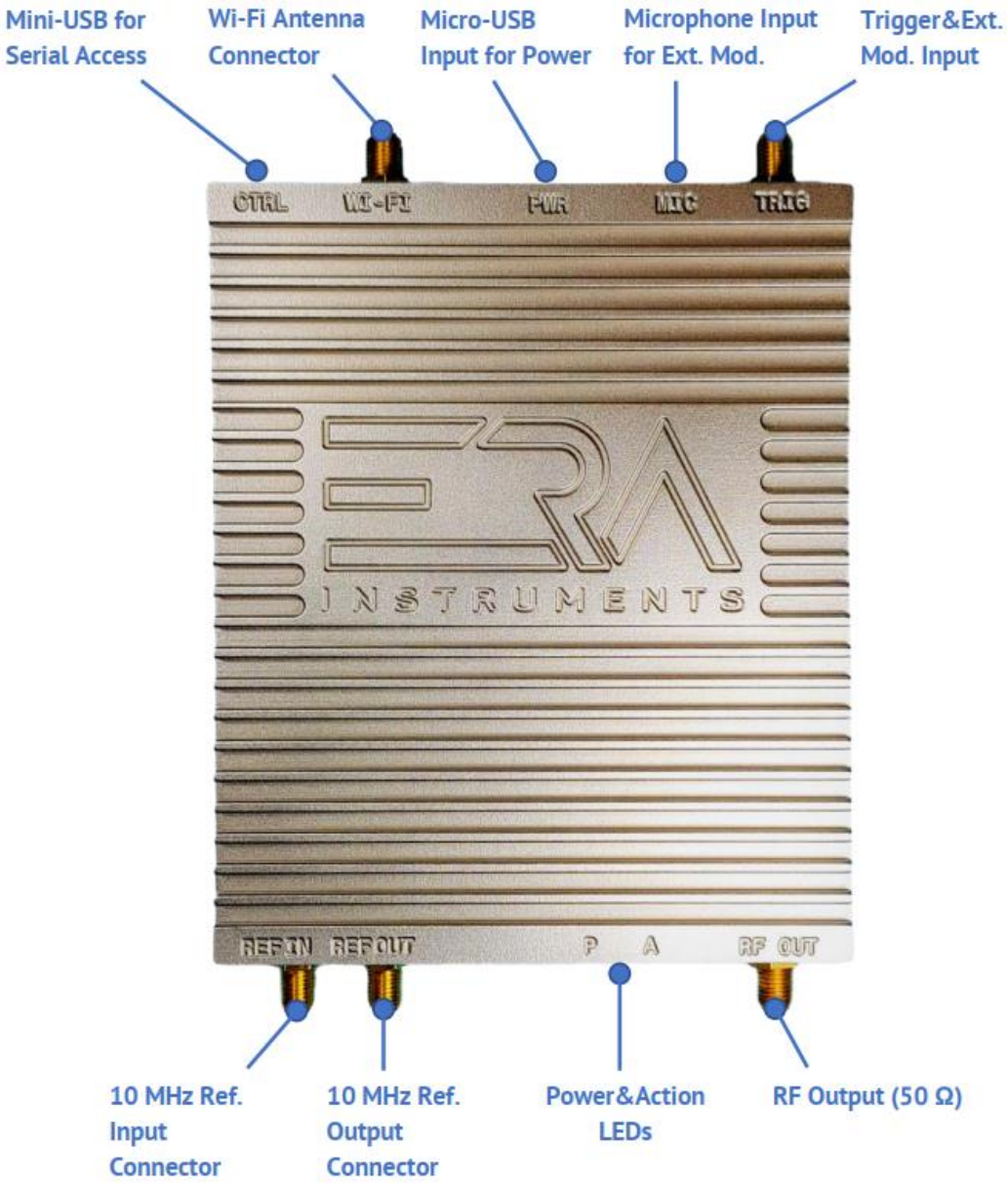
ERASynth: An Open Source, Arduino-Compatible RF Signal Generator with Wi-Fi Connectivity

DATASHEET

GENERAL DESCRIPTION

ERASynth is an open source analog RF signal generator featuring an Arduino Due microcontroller and an ESP8266 powered web GUI. ERASynth uses advanced PLL/VCO technology, coupled with an internal ultra-low phase noise frequency reference to form a programmable analog signal generator capable of generating a low phase noise signals up to 20 GHz. ERASynth provides fast frequency switching and fine-tuning resolution using a multi-loop PLL architecture. ERASynth also offers frequency, amplitude and pulse modulation capabilities. The frequency tuning and control commands are loaded into the instrument via the serial interface or via the web GUI or Windows GUI.



FEATURES

Architecture: Multiloop Integer-N PLL driven by a tunable reference.

Frequency Range:
- ERASynth: 250 kHz to 6 GHz
- ERASynth+: 250 kHz to 15 GHz
- ERASynth++: 250 kHz to 20 GHz

Amplitude Range: -60 to +15 dBm (typical)

Phase Noise: -120 dBc/Hz (typical phase noise @ 1 GHz output and 10 kHz offset)

Frequency Switching Time: 250 µs (typical)

Reference: Ultra-low noise 100 MHz VCXO locked to a
- ±0.5 ppm 10 MHz TCXO for ERASynth
- ±25 ppb 10 MHz OCXO for ERASynth+ and ERASynth++
- 10 MHz external reference

MCU: ATSAM3X8EA-CU (same as in the Arduino Due board with BGA package Atmel Microcontroller)

Interfaces:
- Wi-Fi interface for web-based GUI access
- Serial-USB (mini USB) for serial access
- Micro USB for power input
- Trigger Input (SMA) for triggered sweep
- REF In (SMA) for external reference input
- REF Out (SMA) for 10 MHz reference output
- RF Out

Dimensions: 10 cm x 14.5 cm x 2 cm

Weight: 400 g (14.1 oz)

Power Input: 4.5 to 12 V

Power Consumption:
- Typ < 6 W for ERASynth
- Typ < 7 W for ERASynth+ and ERASynth++

Enclosure: Precision-milled, nickel-plated aluminum case

Open Source: Schematics, embedded Arduino code, Web GUI source code, and RS-232 command set

Modulation: FM, AM, Pulse (Internal and external)

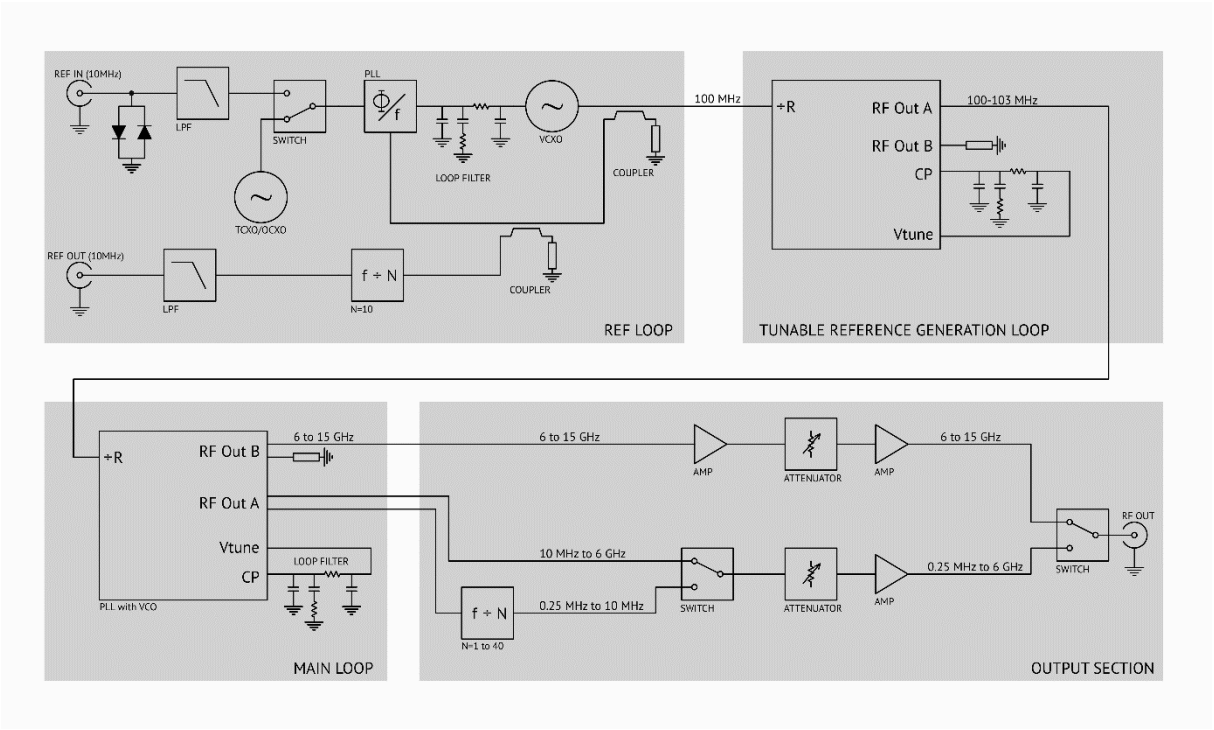


Figure 1: ERASynth general block diagram

ORDER GUIDE

	ERASynth	ERASynth+	ERASynth++
Frequency Range	250 kHz to 6 GHz	250 kHz to 15 GHz	250 kHz to 20 GHz (*)
Architecture	LMX2594 driven by LMX2594	LMX2594 driven by LMX2594	LMX2595 driven by LMX2594
Reference	±0.5 ppm TCXO	±0.5 ppm TCXO and ±25 ppb OCXO	±0.5 ppm TCXO and ±25 ppb OCXO
* ERASynth++ comes with an external 15 to 20 GHz cavity filter for subharmonic rejection.			

ELECTRICAL CHARACTERISTICS

	Minimum	Typical		Maximum
Supply Voltage	4.5 V	5 V		12 V
Supply Current		1.1 A		
Supply Current, RF Out Muted		300 mA		
Minimum Output Power				-60 dBm
Maximum Output Power (*)		250 kHz-15 GHz 15 GHz-16 GHz 16 GHz-19 GHz	17 dBm 12 dBm 8 dBm	
Output Level Accuracy		250 kHz-15 GHz 15 GHz-20 GHz	± 1.5 dB ± 3.5 dB	
Output Power Resolution		0.1 dB		
Frequency Resolution	1 Hz			
Frequency Accuracy (using internal OCXO)		±25 ppb		
Minimum Dwell Time**	1 ms			
External Reference Input Level	-10 dBm	0 dBm		+10 dBm
External Reference Locking Range		10 MHz ± 30 ppm		
External Trigger Low Level Input Voltage	0 V			0.7 V
External Trigger High Level Input Voltage	2 V			3.3 V
External Modulation Input Voltage Level				0 ± 1.65 V
RF Output Impedance		50 Ohm		

* See Figure 2 for maximum unleveled output power up to 15 GHz.

** Dwell time: Duration of each signal point in a sweep sequence set by user.

THERMAL CHARACTERISTICS

Operating temperature range: 0 to +50 °C

Non-operating temperature range: -40 to +85 °C

Warm-up time: 10 minutes

TYPICAL PERFORMANCE

1) Max Unleveled Output Power

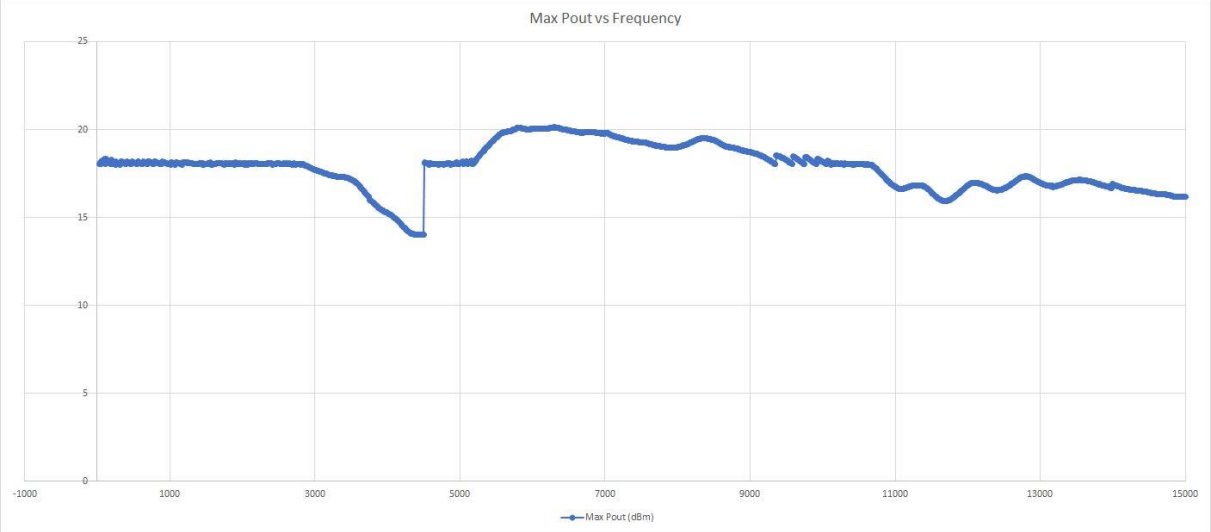


Figure 2: ERASynth+ Max Unleveled Power Output

2) Spectral Purity

ERASynth's multiloop architecture minimizes the spurious artifacts commonly encountered in fractional frequency synthesizers.

Broadband Non-Harmonic Spurious Emissions

Frequency	dBc (typical) at 0 dBm specified output power
250 kHz-30 MHz	-67 dBc
30 MHz-4500 MHz	-63 dBc
4500 MHz-20000 MHz	-58 dBc

Harmonics (2nd or 3rd harmonics, whichever is worse)

Frequency	dBc (typical) at 0 dBm specified output power
1 MHz	-29 dBc
3 MHz	-35 dBc
10 MHz	-47 dBc
20 MHz	-47 dBc
30 MHz	-55 dBc
100 MHz	-10 dBc
300 MHz	-10 dBc
1 GHz	-14 dBc
2 GHz	-16 dBc
3 GHz	-25 dBc
6 GHz	-22 dBc
10 GHz	-33 dBc

Sub-Harmonics (1/2 or 1/3 harmonics, whichever is worse)

Frequency	dBc (typical) at 0 dBm specified output power
3 MHz	-77 dBc
9 MHz	-77 dBc
30 MHz	-72 dBc
100 MHz	<-90 dBc
1 GHz	<-90 dBc
3 GHz	-86 dBc
6 GHz	<-90 dBc
9 GHz	-55 dBc
12 GHz	-52 dBc
15 GHz	-30 dBc
15 GHz-20 GHz	<-100 dBc (*)
* Sub-harmonics are rejected with external cavity filter. The cavity filter is included in the package with ERASynth++	

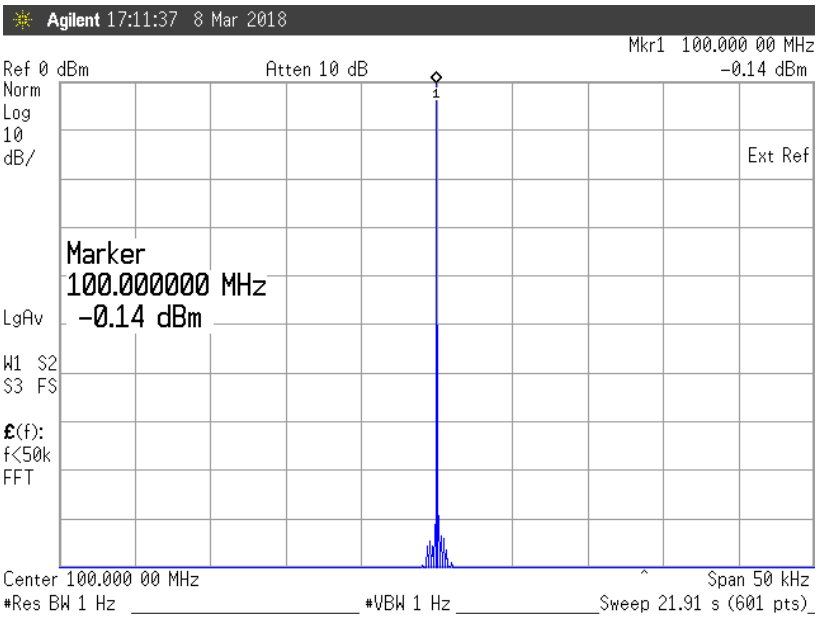


Figure 3: ERASynth+ Narrow-band Spurious Performance at 100 MHz

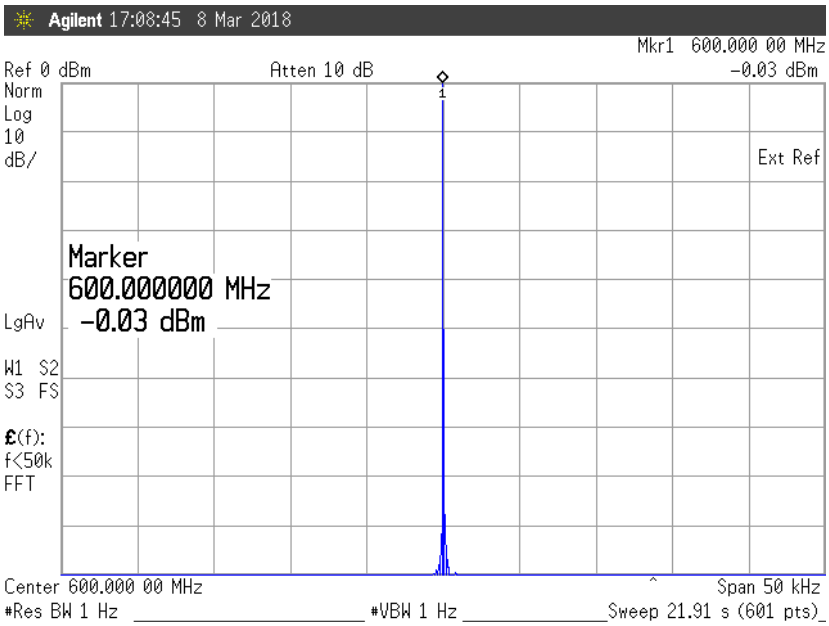


Figure 4: ERASynth+ Narrow-band Spurious Performance at 600 MHz

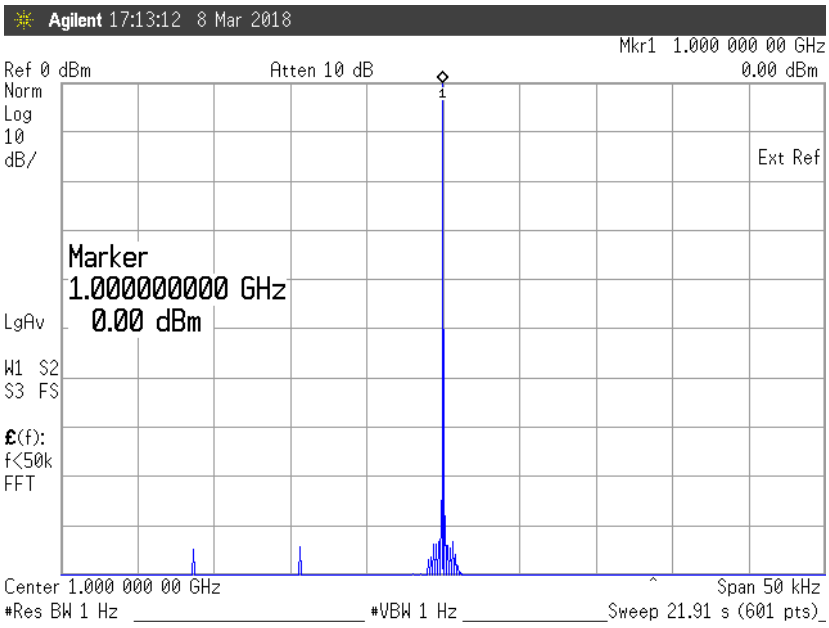


Figure 5: ERASynth+ Narrow-band Spurious Performance at 1 GHz

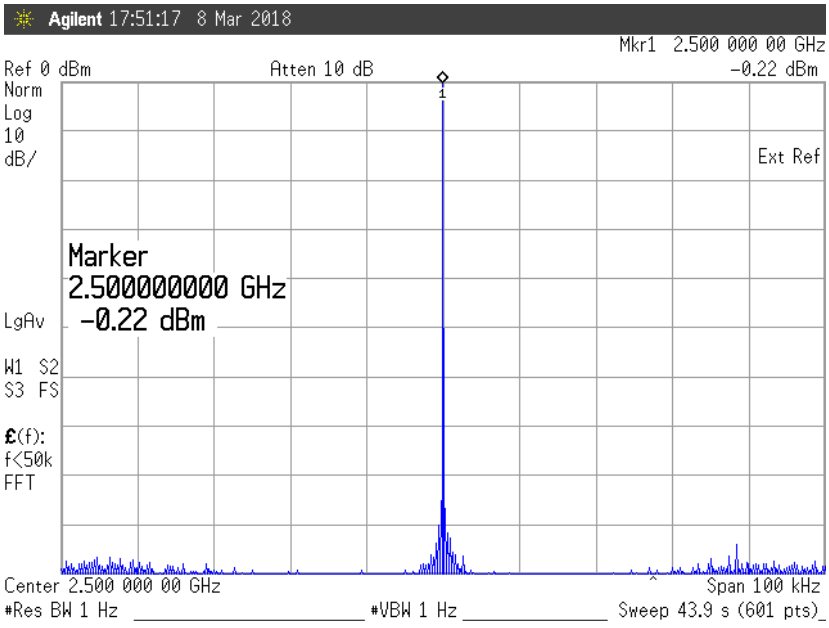


Figure 6: ERASynth+ Narrow-band Spurious Performance at 2.5 GHz

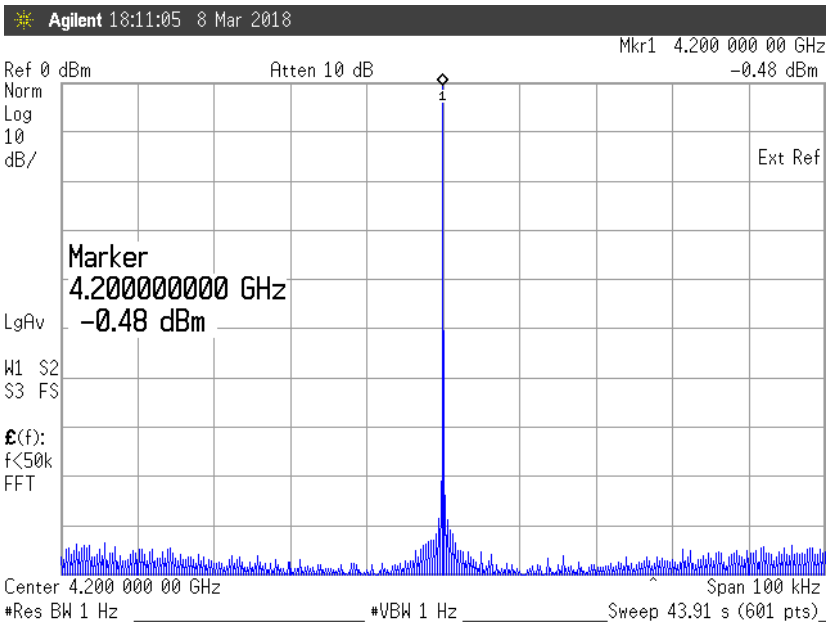


Figure 7: ERASynth+ Narrow-band Spurious Performance at 4.2 GHz

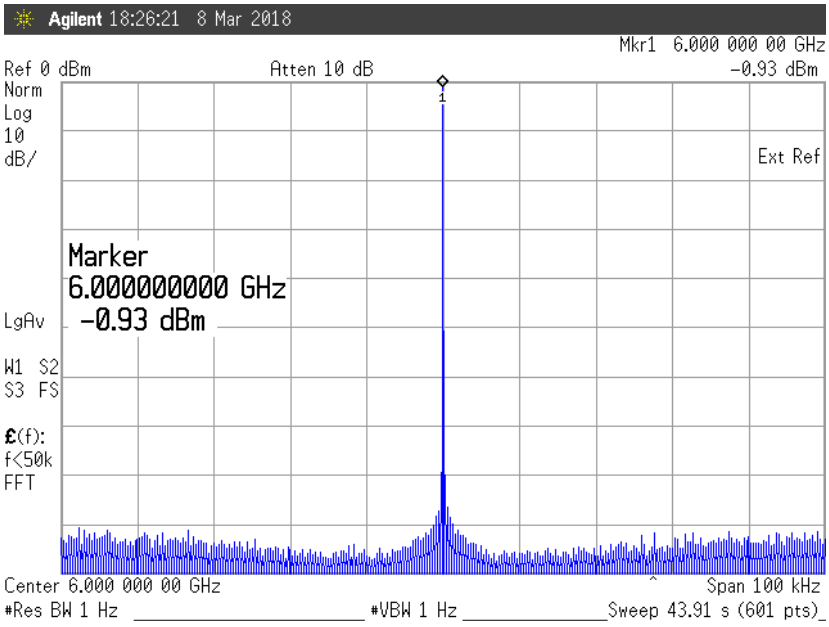


Figure 8: ERASynth+ Narrow-band Spurious Performance at 6 GHz

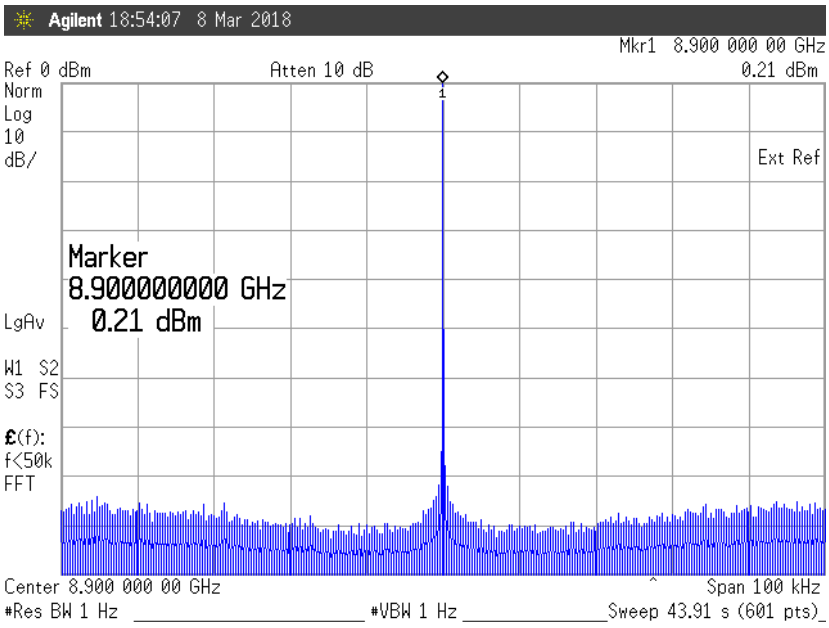


Figure 9: ERASynth+ Narrow-band Spurious Performance at 8.9 GHz

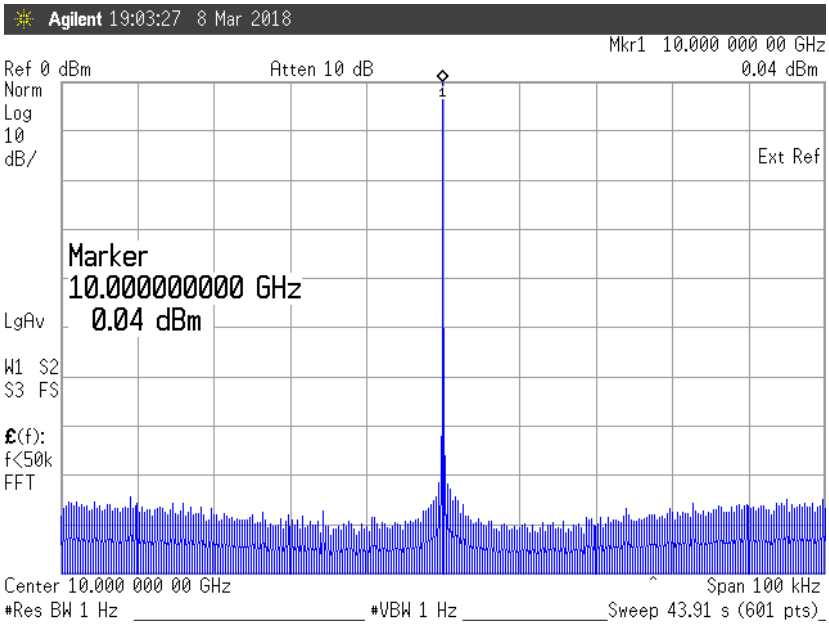


Figure 10: ERASynth+ Narrow-band Spurious Performance at 10 GHz

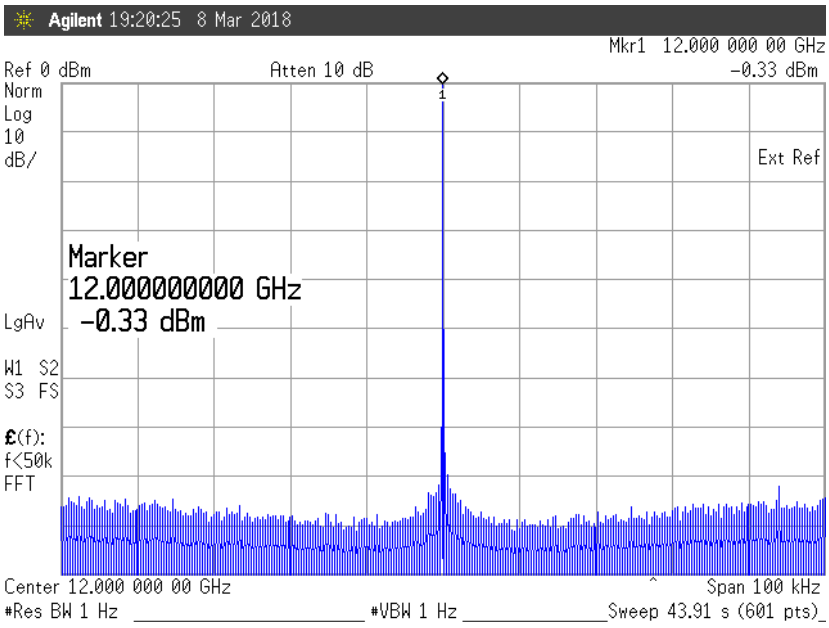


Figure 11: ERASynth+ Narrow-band Spurious Performance at 12 GHz

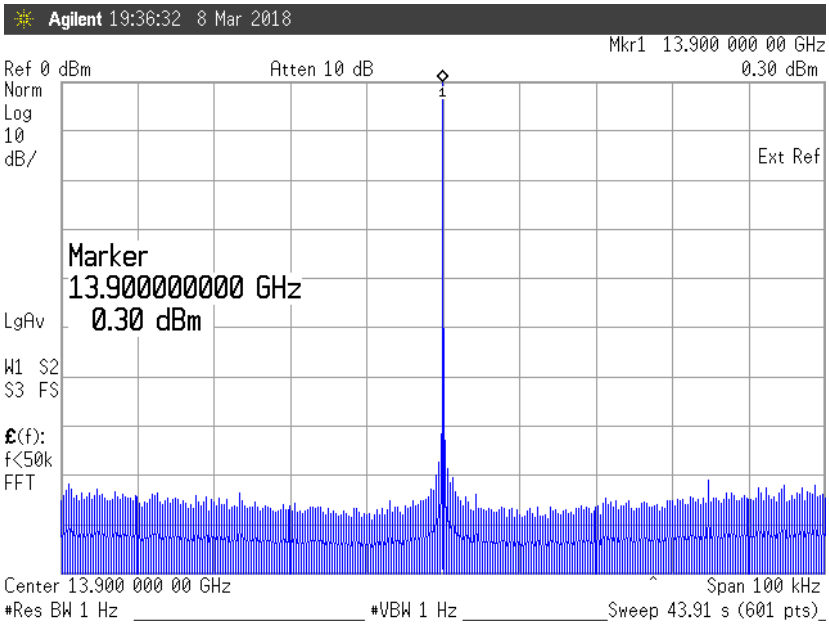


Figure 12: ERASynth+ Narrow-band Spurious Performance at 13.9 GHz

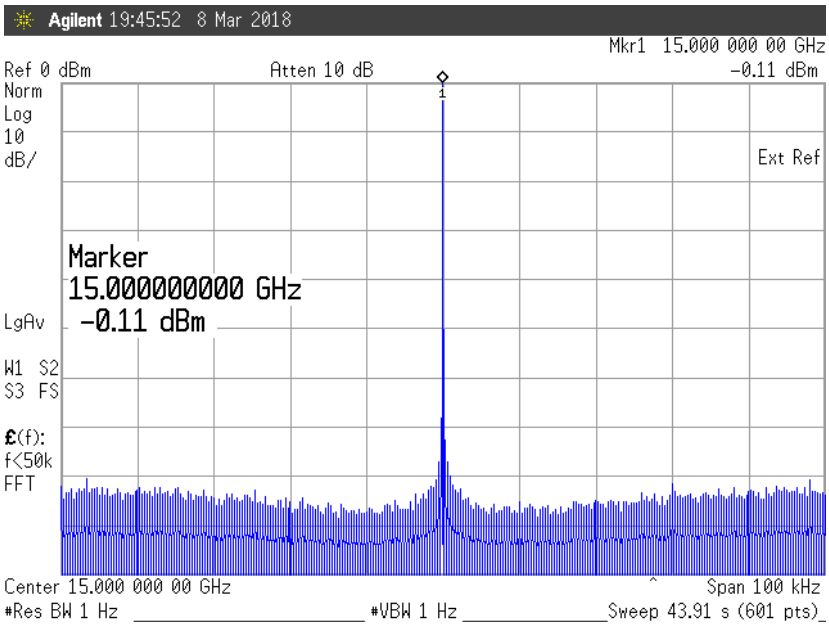


Figure 13: ERASynth+ Narrow-band Spurious Performance at 15 GHz

3) Phase Noise

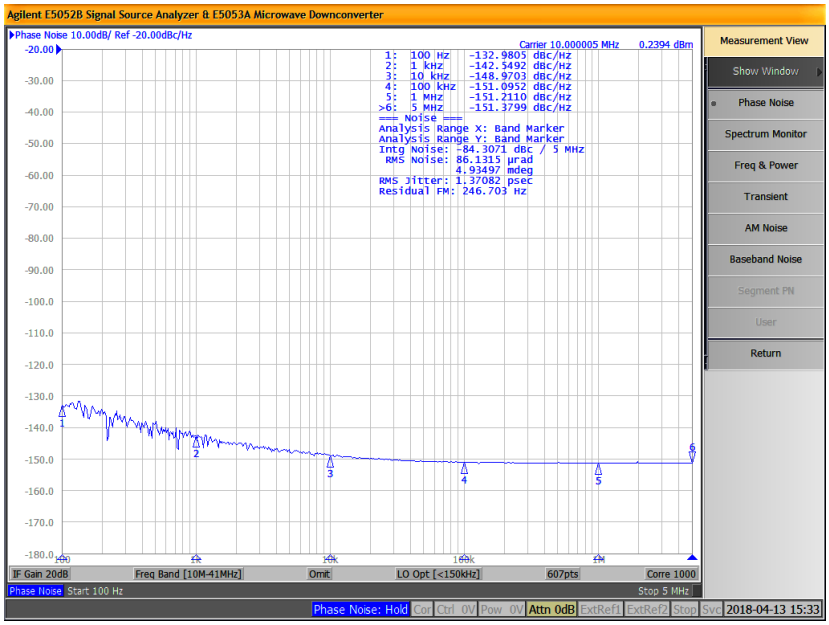


Figure 14: ERASynth+ Phase Noise Performance at 10 MHz RF Output

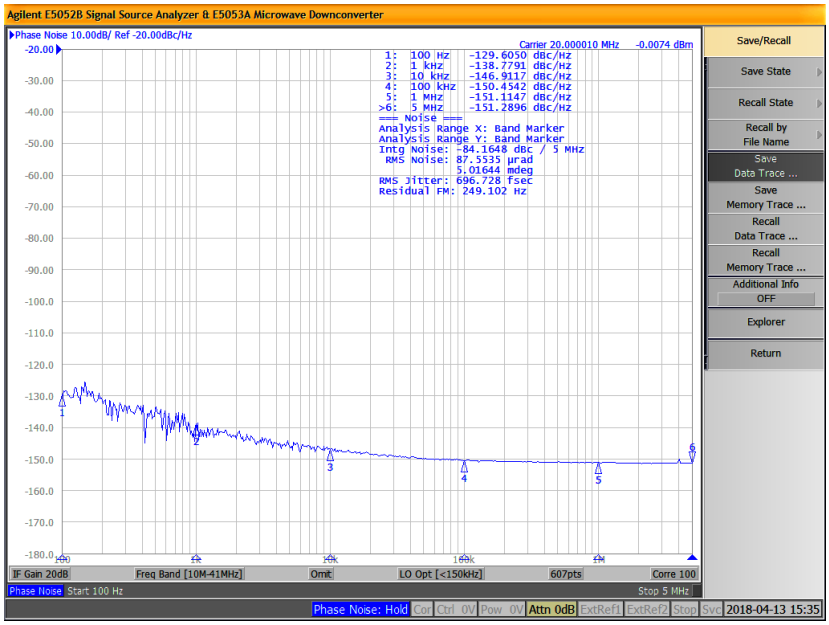


Figure 15: ERASynth+ Phase Noise Performance at 20 MHz RF Output

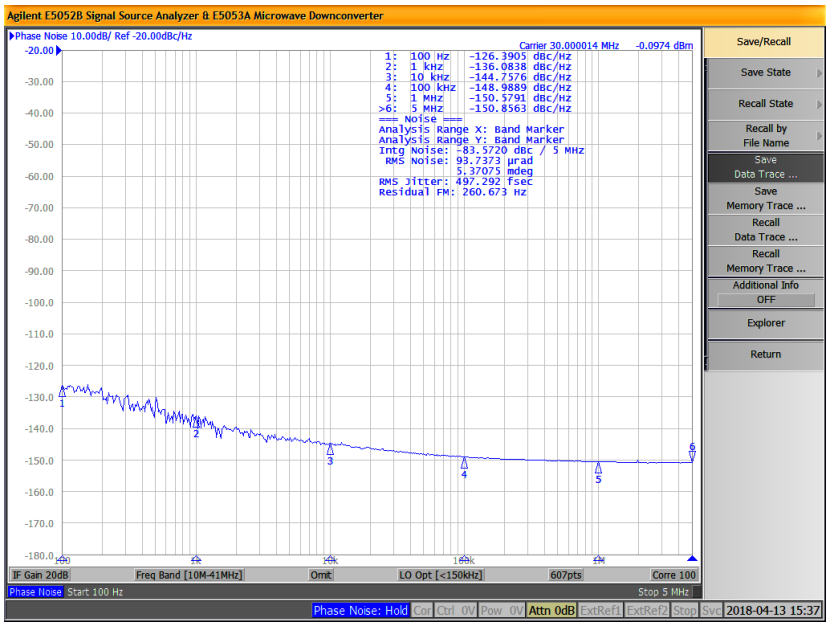


Figure 16: ERASynth+ Phase Noise Performance at 30 MHz RF Output

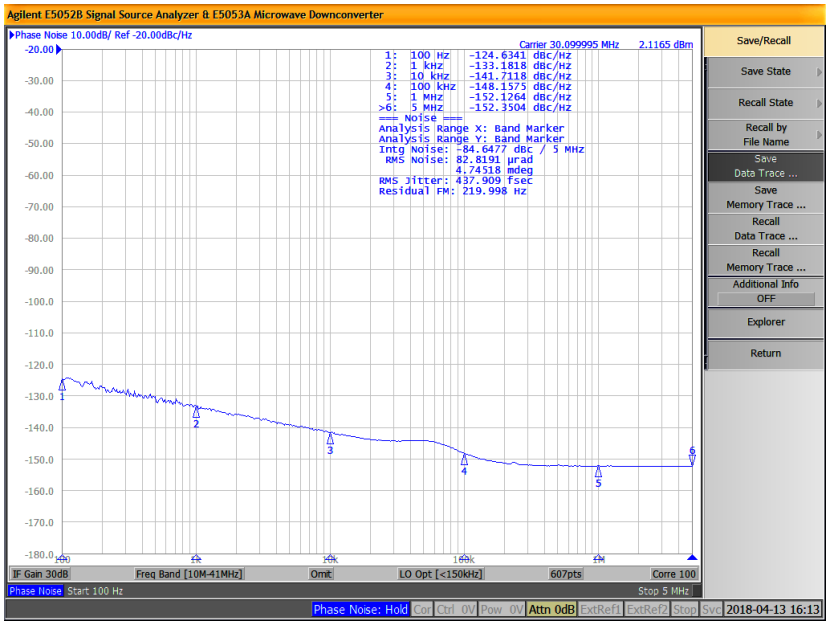


Figure 17: ERASynth+ Phase Noise Performance at 30.1 MHz RF Output

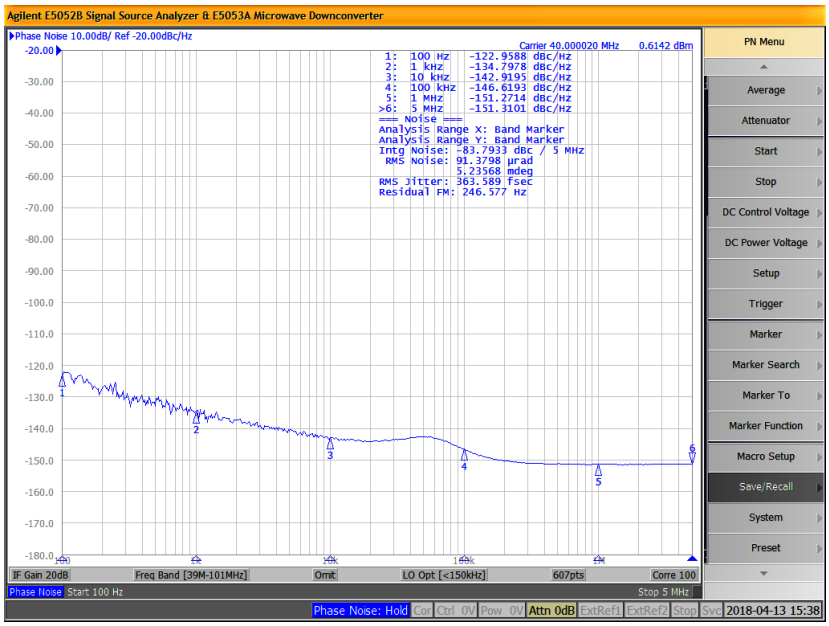


Figure 18: ERASynth+ Phase Noise Performance at 40 MHz RF Output

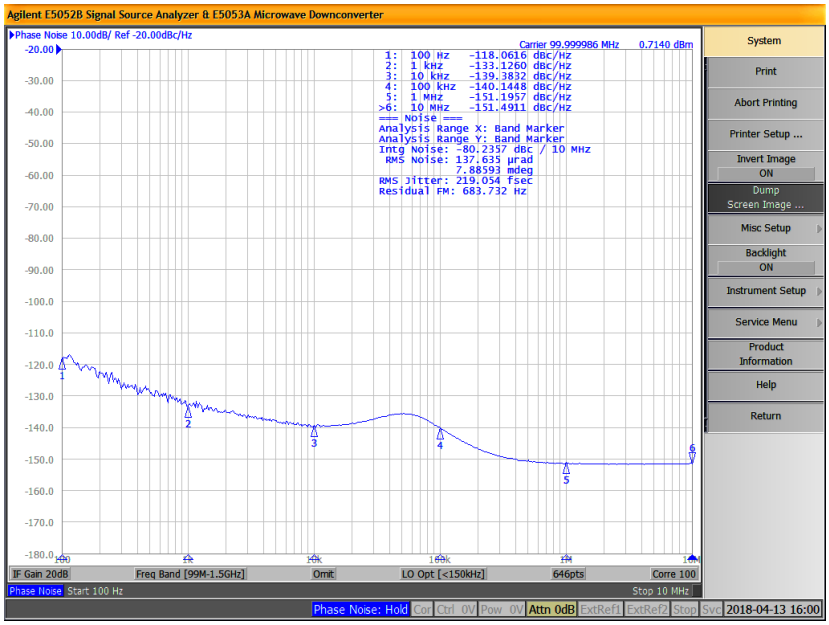


Figure 19: ERASynth+ Phase Noise Performance at 100 MHz RF Output

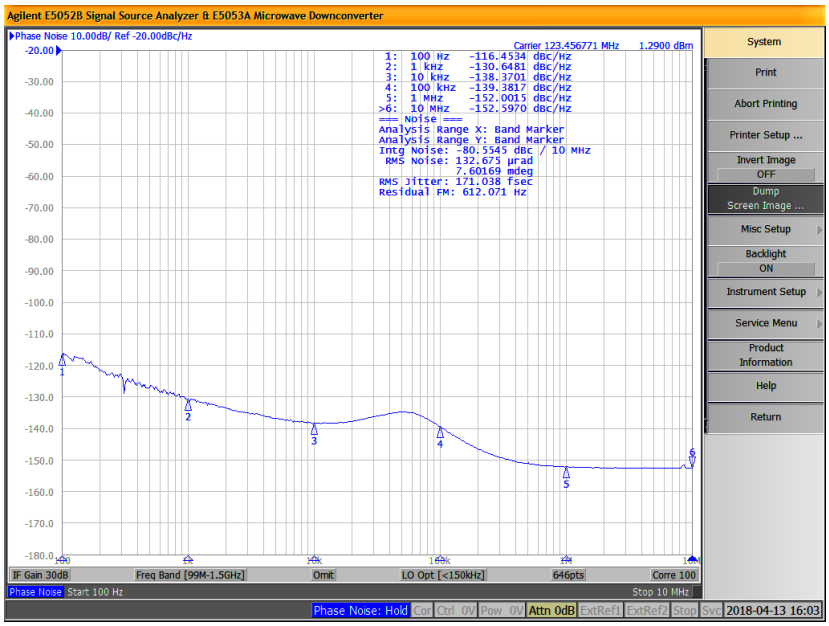


Figure 20: ERASynth+ Phase Noise Performance at 123.456789 MHz RF Output

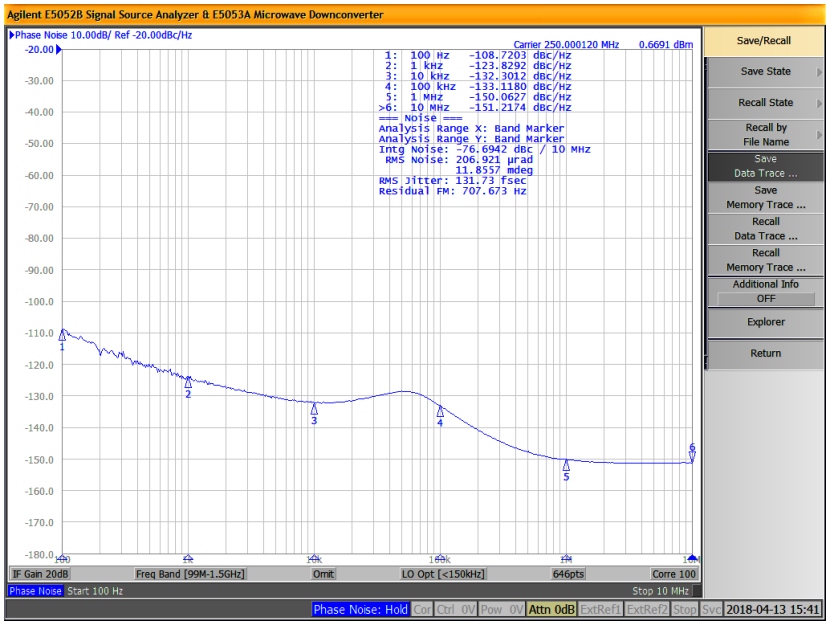


Figure 21: ERASynth+ Phase Noise Performance at 250 MHz RF Output

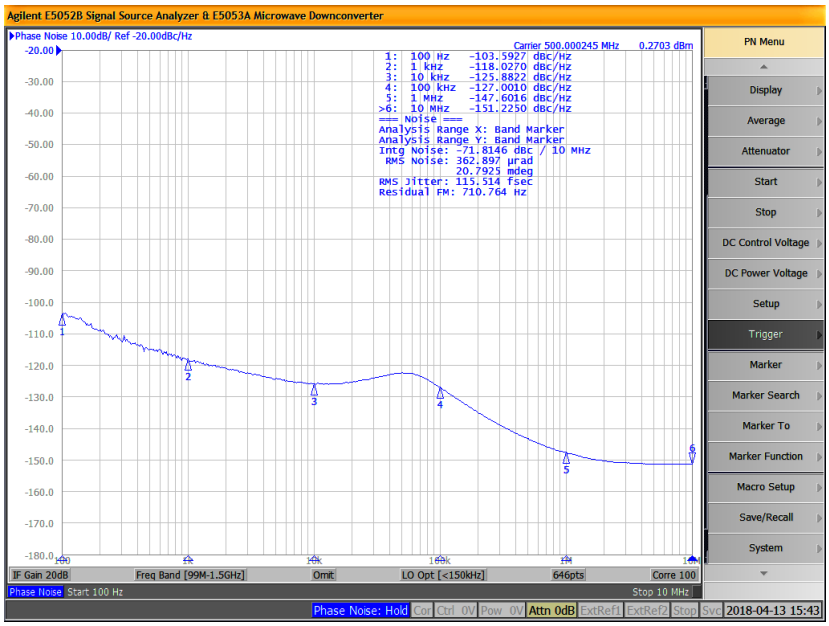


Figure 22: ERASynth+ Phase Noise Performance at 500 MHz RF Output

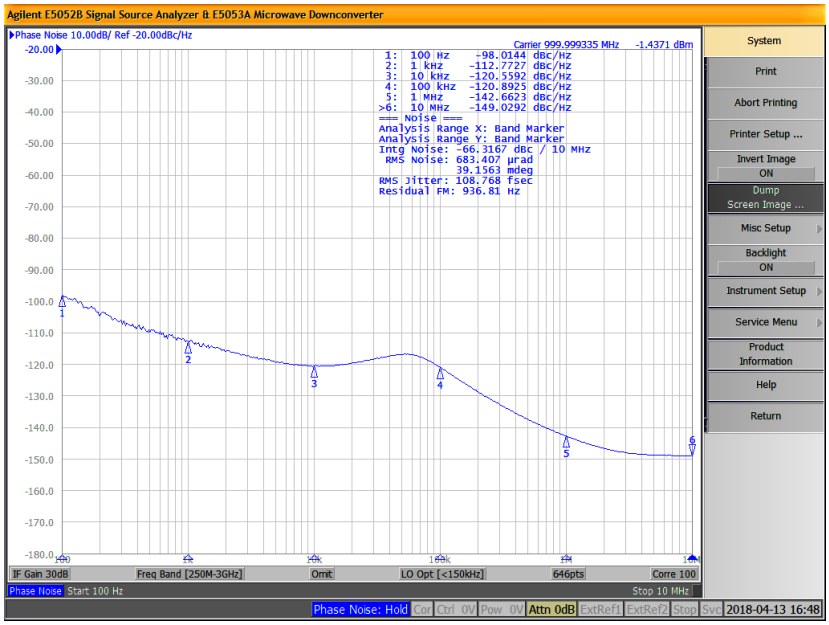


Figure 23: ERASynth+ Phase Noise Performance at 1 GHz RF Output

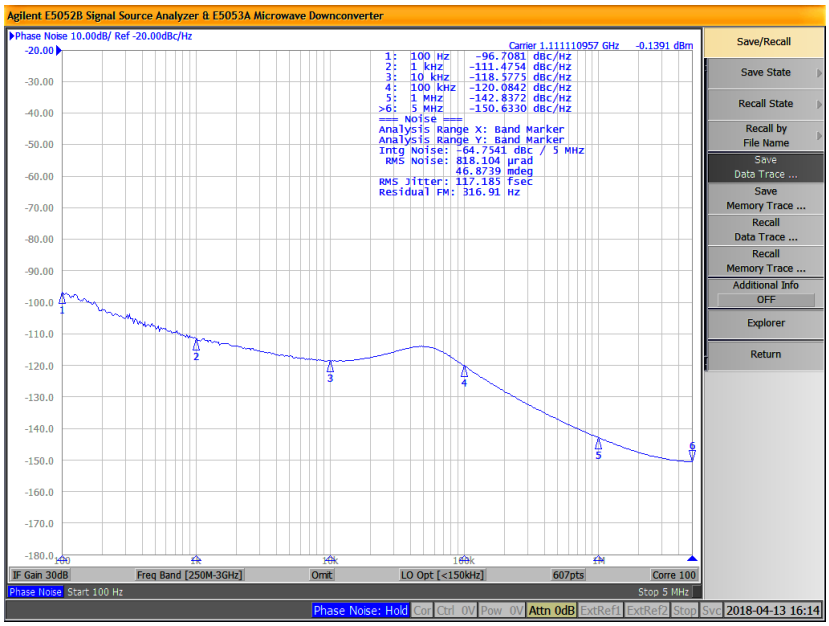


Figure 24: ERASynth+ Phase Noise Performance at 1.111111111 GHz RF Output

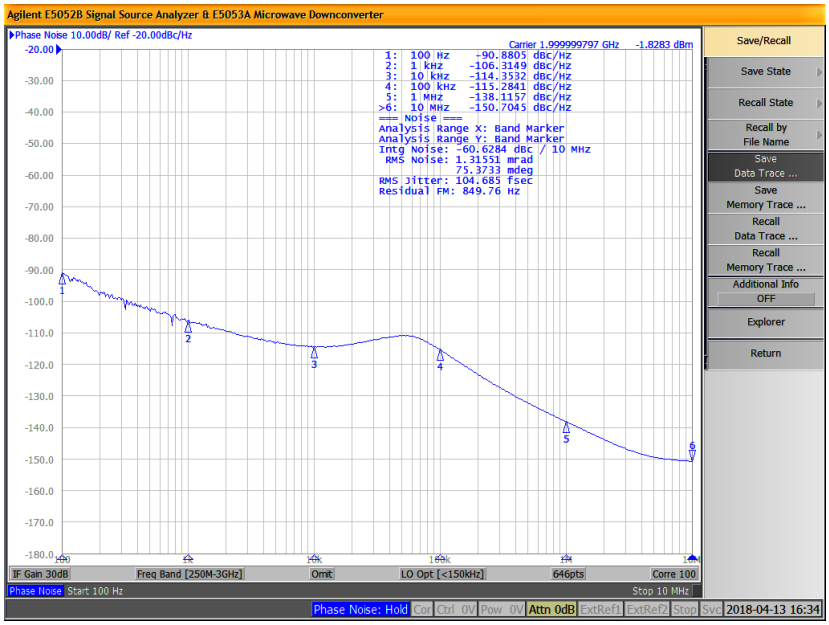


Figure 25: ERASynth+ Phase Noise Performance at 2 GHz RF Output

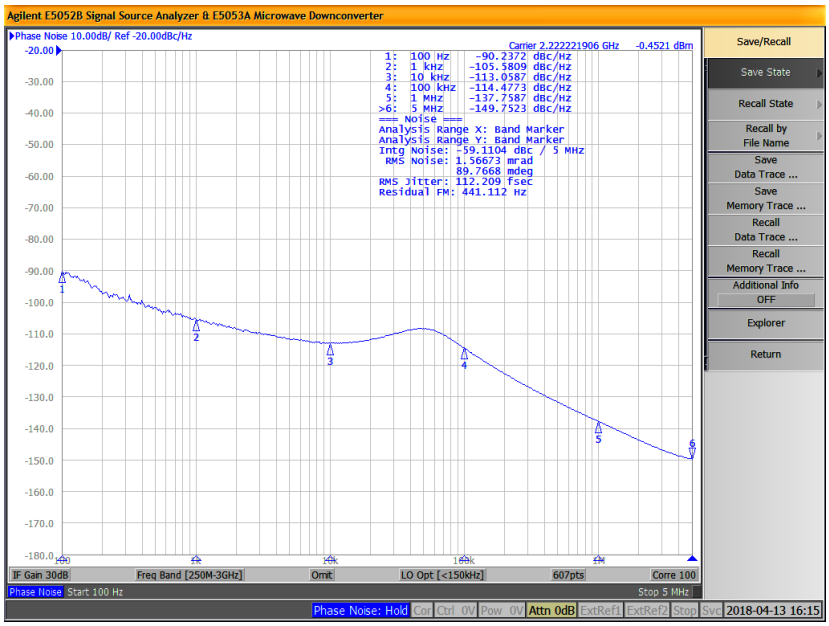


Figure 26: ERASynth+ Phase Noise Performance at 2.222222222 GHz RF Output

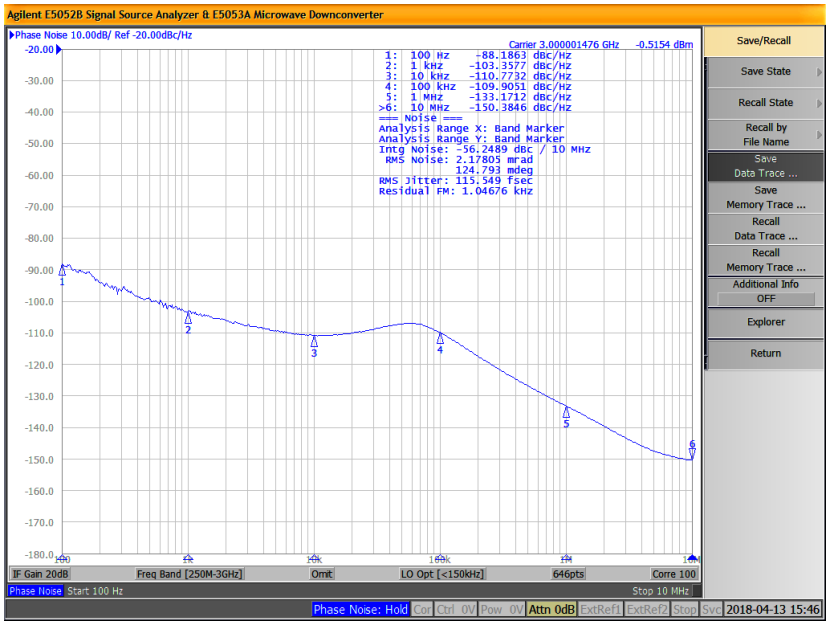


Figure 27: ERASynth+ Phase Noise Performance at 3 GHz RF Output

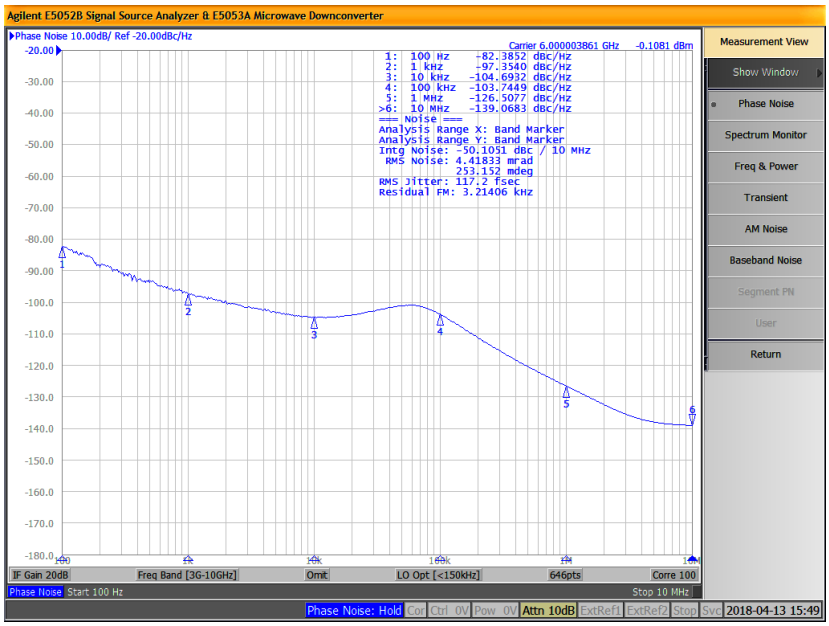


Figure 28: ERASynth+ Phase Noise Performance at 6 GHz RF Output

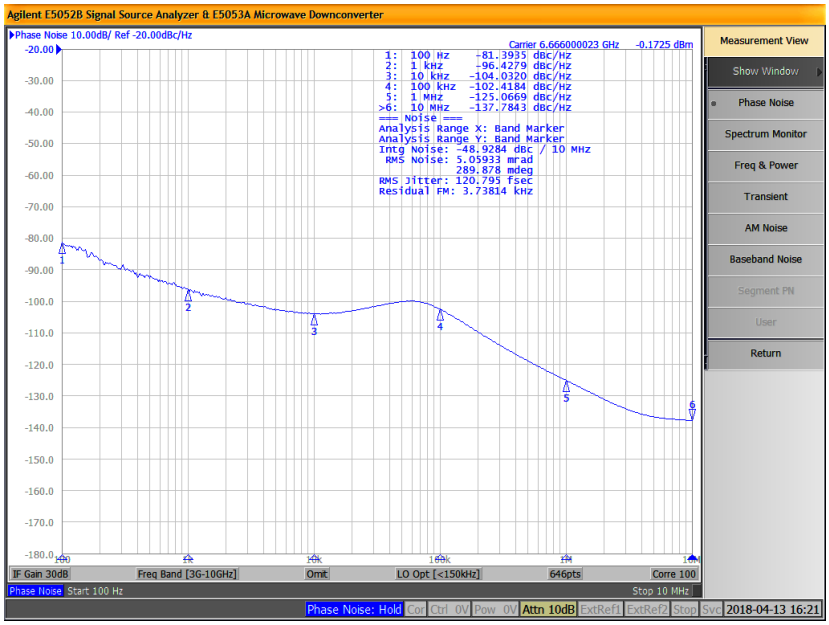


Figure 29: ERASynth+ Phase Noise Performance at 6666 MHz RF Output

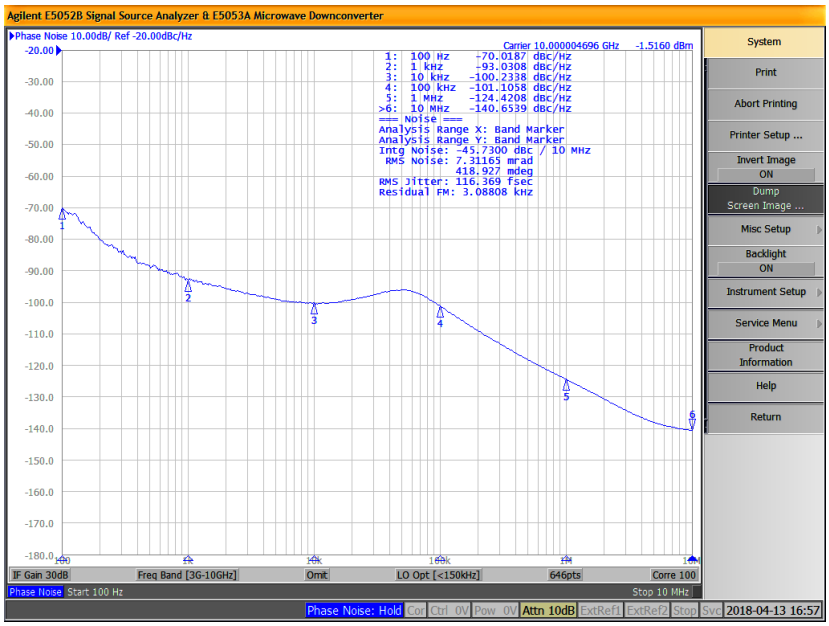


Figure 30: ERASynth+ Phase Noise Performance at 10 GHz RF Output

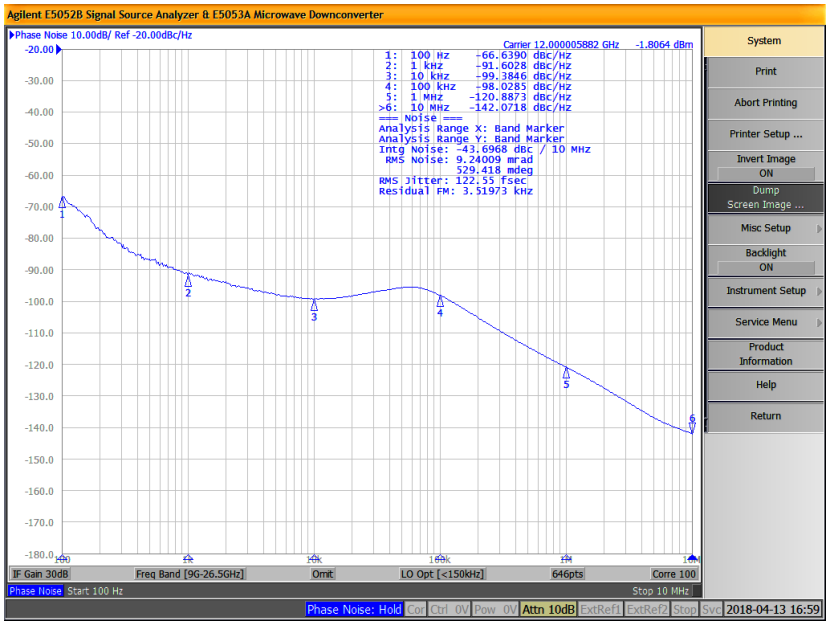


Figure 31: ERASynth+ Phase Noise Performance at 12 GHz RF Output

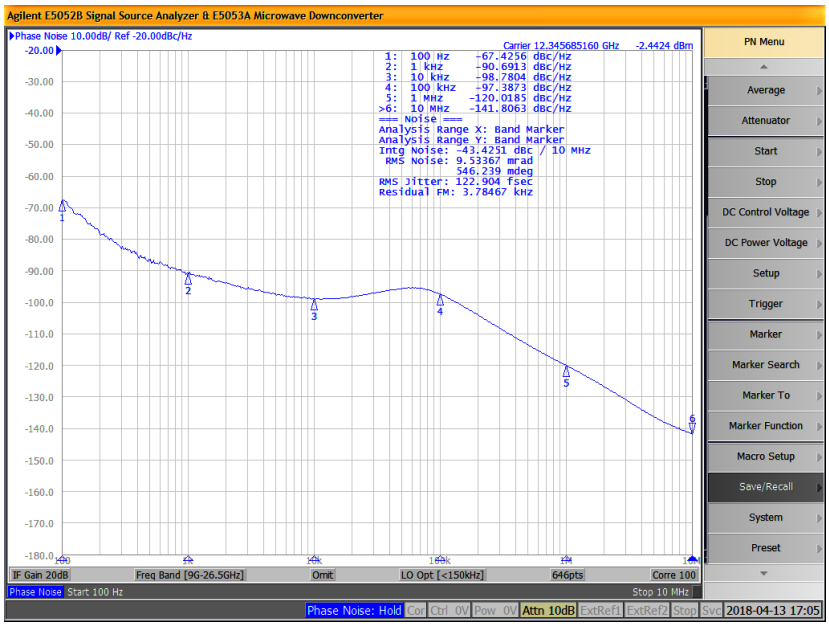


Figure 32: ERASynth+ Phase Noise Performance at 12.345678900 GHz RF Output

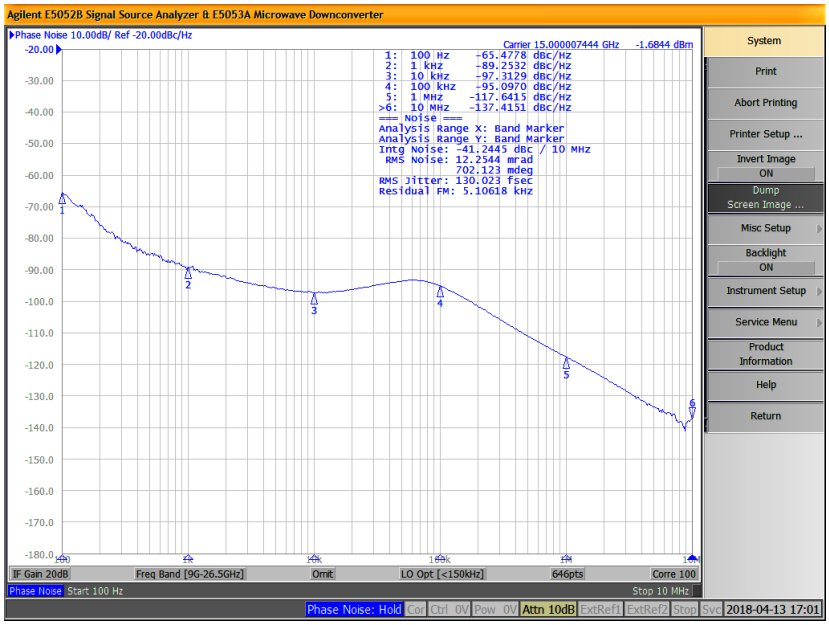


Figure 33: ERASynth+ Phase Noise Performance at 15 GHz RF Output

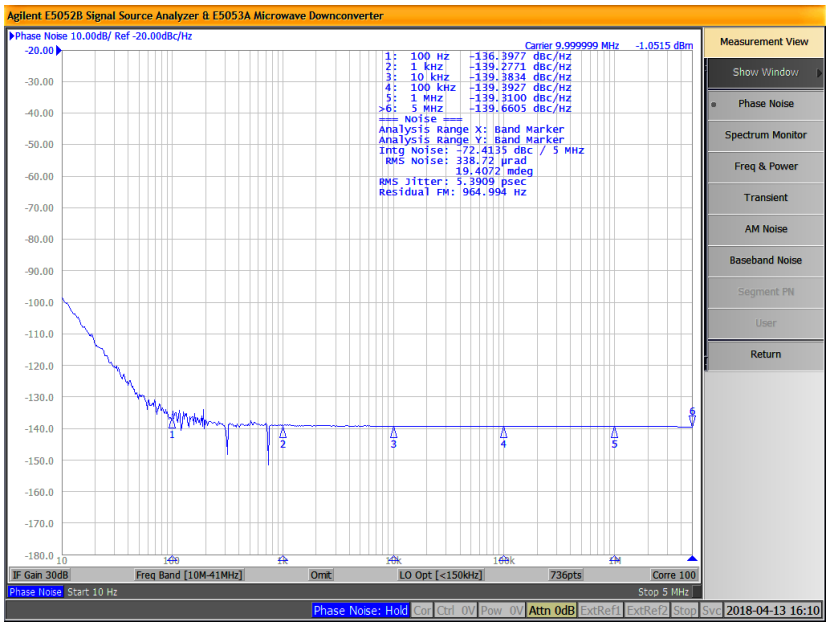


Figure 34: ERASynth+ 10 MHz REF OUT Phase Noise (Internal REF Source is selected as OCXO)

4) Modulation

Amplitude Modulation (AM)

Modulation Depth	30 dB (typ) (*)
Maximum Depth (Linear)	%95
Internal Modulation Waveforms	Sine, Triangle, Ramp, Square
Maximum Internal Modulation Frequency	30 kHz (typ)
Maximum External Modulation Frequency	2 kHz (typ)
External Input	± 1.65 V (typ)
External Input Impedance	8 kΩ (typ)
*Measured with power set at max. amplitude range. AM is clipped when available power (min. or max.) is reached.	

Narrow Band Frequency Modulation (NBFM)

Maximum Deviation	1 MHz 10 MHz 100 MHz 1 GHz 10 GHz	45 Hz (typ) 450 Hz (typ) 4500 Hz (typ) 45 kHz (typ) 450 kHz (typ)
Frequency Shift (*)	27.5 °C 40.0 °C 43.5 °C 45.3 °C	5 ppm (typ) 1 ppm (typ) 400 ppb (typ) 170 ppb (typ)
Internal Modulation Waveforms	Sine, Triangle, Ramp, Square	
Maximum Internal Modulation Frequency	30 kHz (typ)	
Maximum External Modulation Frequency	20 kHz (typ)	
External Input	± 1.65 V (typ)	
External Input Impedance	8 kΩ (typ)	
*When NBFM modulation is enabled, voltage control input of VCXO is switched to an internal DAC. That causes a frequency shift. Temperature values are read from internal sensor		

Wide Band Frequency Modulation (WBFM)

Minimum deviation	100 MHz 1 GHz 3 GHz 10 GHz	5 kHz (typ) 10 kHz (typ) 30 kHz (typ) 100 kHz (typ)
Maximum deviation	100 MHz 1 GHz 3 GHz 10 GHz	500 kHz (typ) 5 MHz (typ) 9.9 MHz 9.9 MHz
Internal Modulation Waveforms	Sine, Triangle, Ramp, Square	
Maximum Internal Modulation Frequency	30 kHz (typ)	
Maximum External Modulation Frequency	20 kHz (typ)	
External Input	± 1.65 V (typ)	
External Input Impedance	8 kΩ (typ)	

Pulse Modulation

On/Off Ratio	250 kHz-100 MHz 1 GHz 3 GHz 6 GHz 10 GHz 15 GHz	>90 dB (typ) 88 dB (typ) 82 dB (typ) 76 dB (typ) 65 dB (typ) 75 dB (typ)
Minimum Pulse Width (*)	30 us (typ)	
Minimum Pulse Period (*)	60 us (typ)	
Maximum Pulse Period	999 s	
Rise Time (10 to 90%)	15 us (typ)	
Fall Time (10 to 90%)	6 us (typ)	
External Input	+3.3 V = RF ON, 0 V = RF OFF	
External Input Impedance	8 kΩ (typ)	

*Minimum Pulse Width is 130us and Minimum Pulse Period is 260us if the embedded firmware version is older than v1.0.11

Pulse period must be at least 30 us higher than the pulse width value.