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: Arduino Due board with BGA package Atmel Microcontroller (ATSAM3X8EA-CU)

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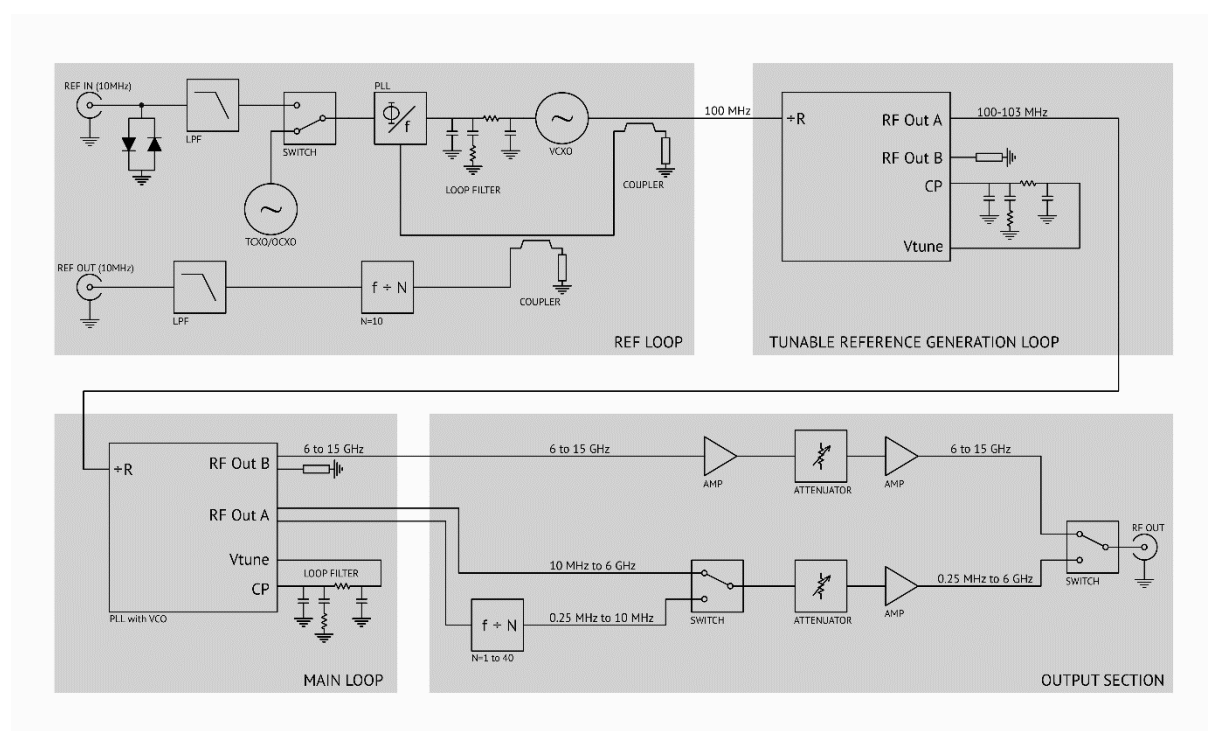
Modulation: FM, AM, Pulse (Internal and external)

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
Price	$749	$1249	$1749
* 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	
Amplitude Accuracy		± 1.5 dB	
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	

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
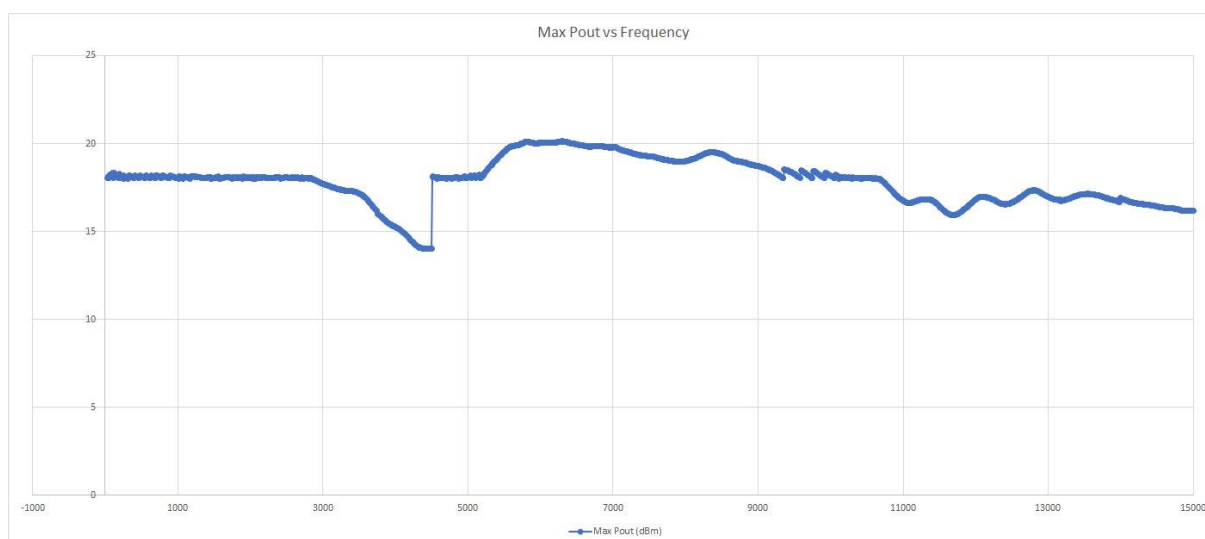
Figure 2: ERASynth+ Max Unleveled Power Output

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++	
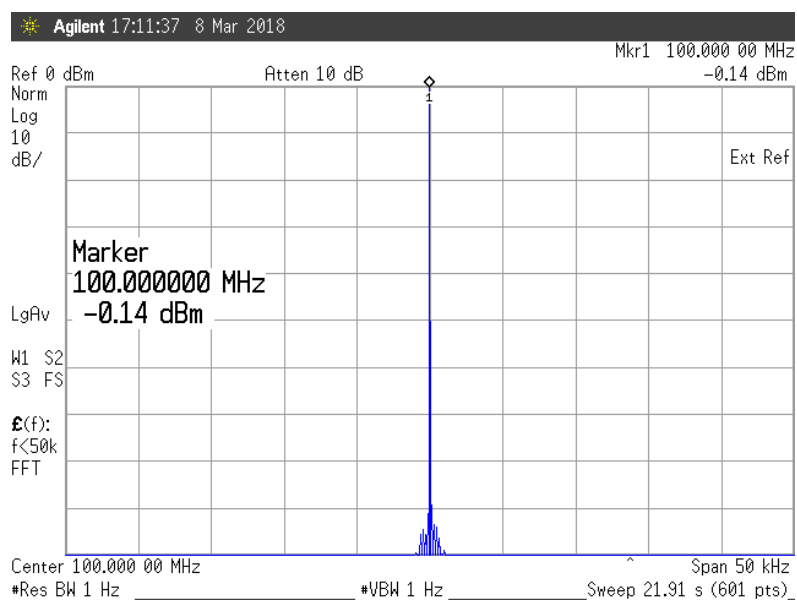
Figure 3: ERASynth+ Narrow-band Spurious Performance at 100 MHz
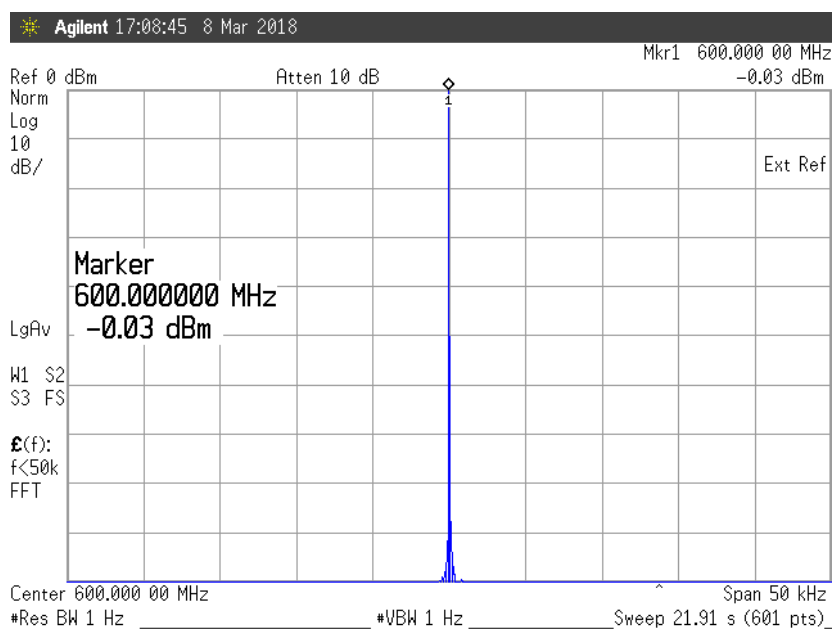
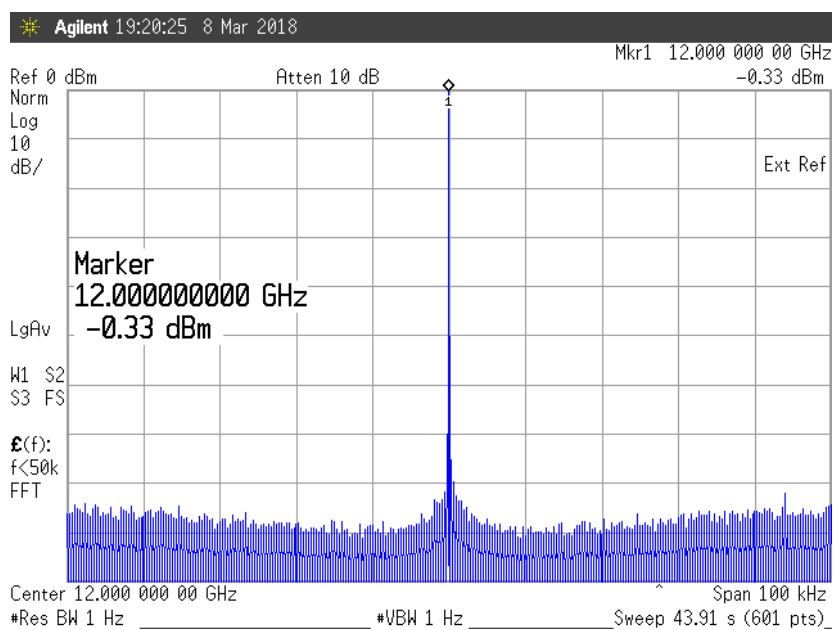Figure 4: ERASynth+ Narrow-band Spurious Performance at 600 MHz
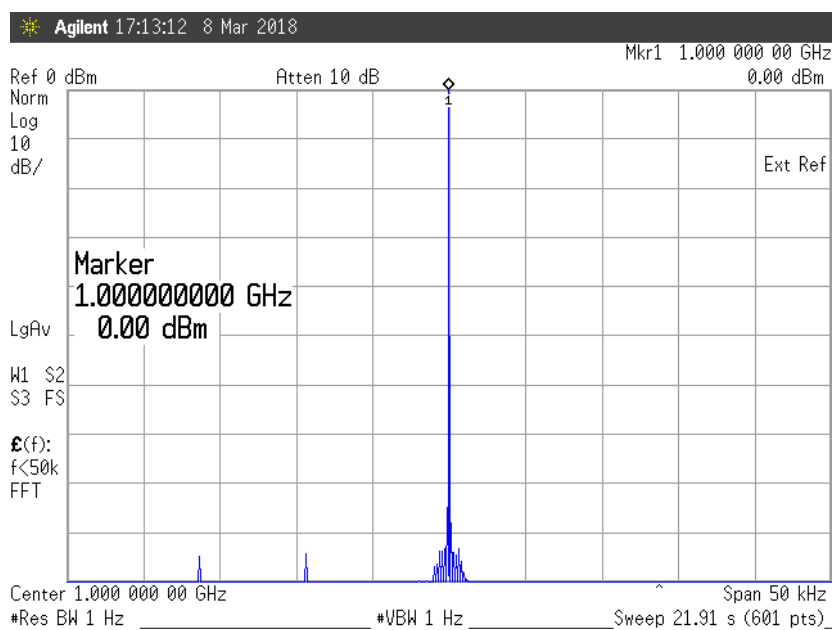
ERASynth

Figure 5: ERASynth+ Narrow-band Spurious Performance at 1 GHz
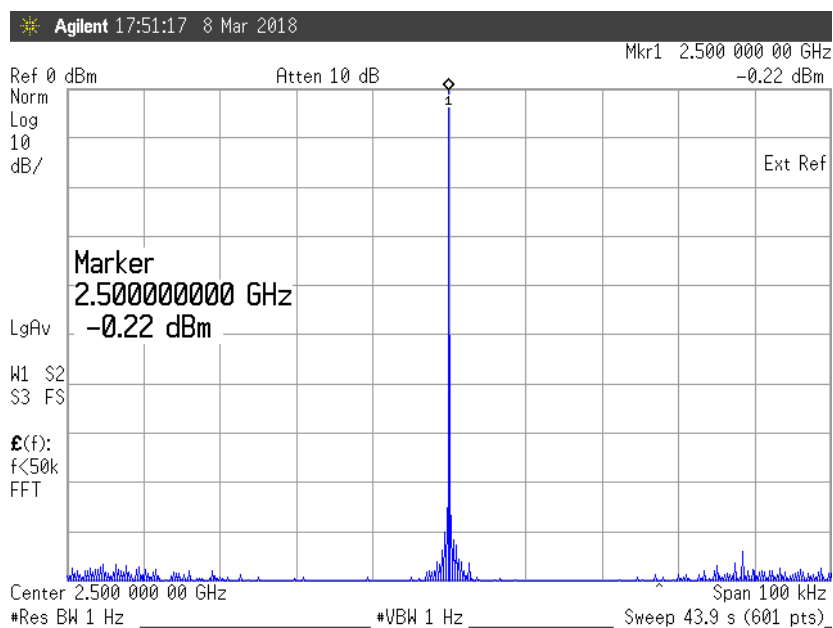
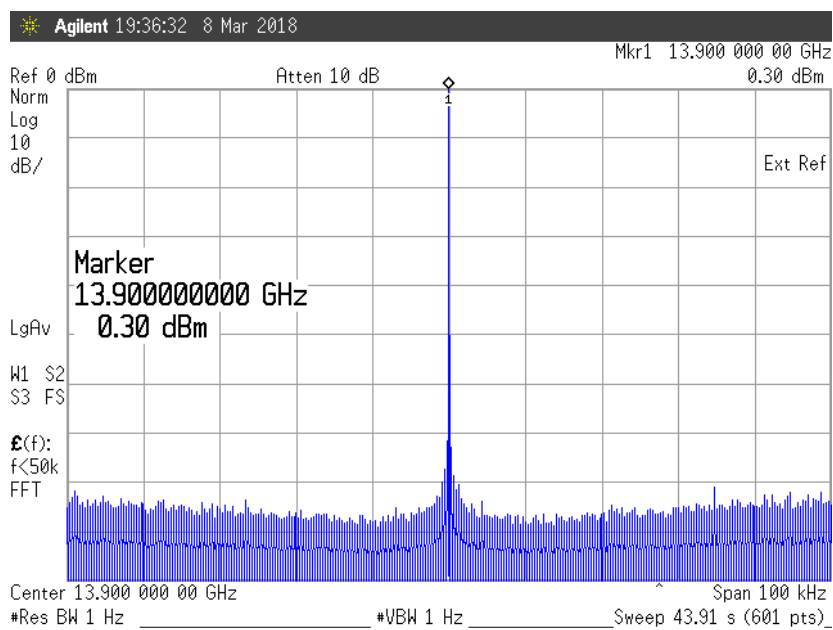Figure 6: ERASynth+ Narrow-band Spurious Performance at 2.5 GHz
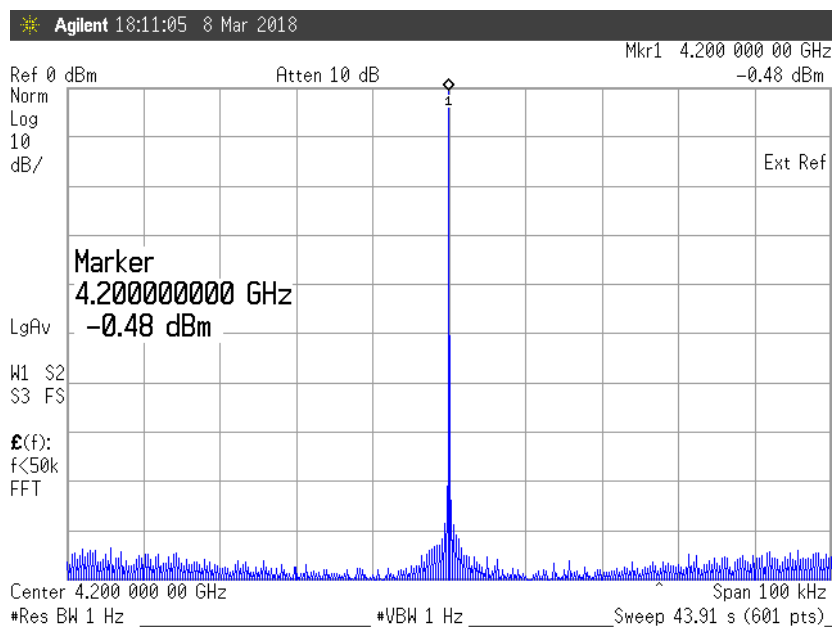
ERASynth

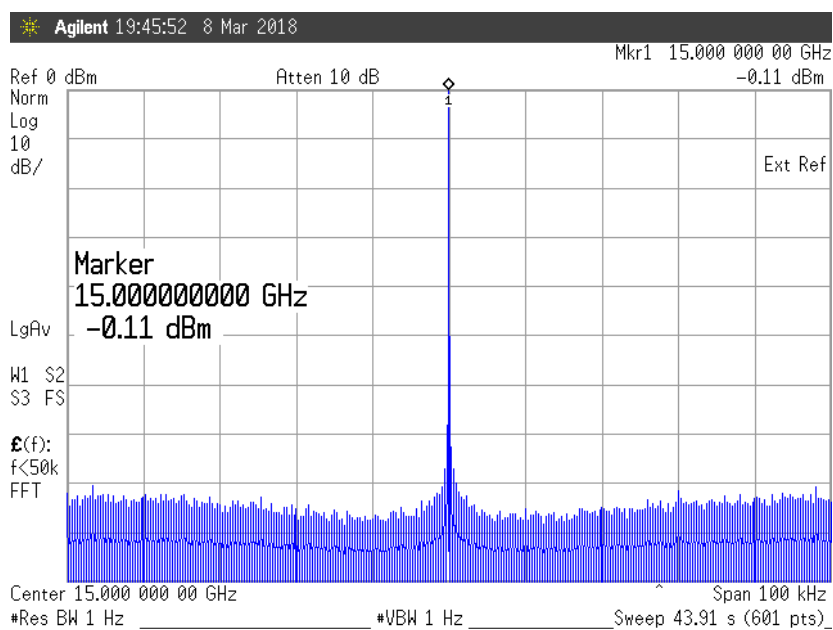Figure 7: ERASynth+ Narrow-band Spurious Performance at 4.2 GHz
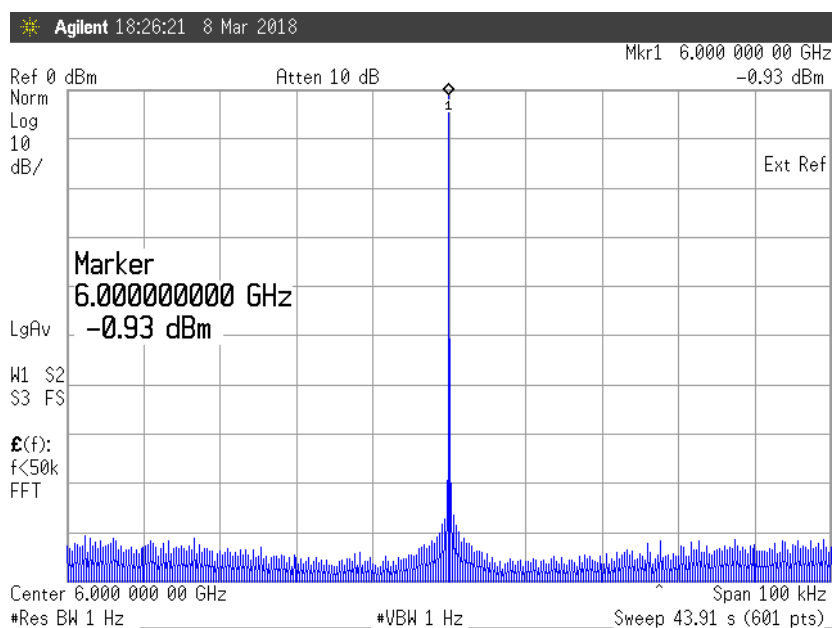
Figure 8: ERASynth+ Narrow-band Spurious Performance at 6 GHz
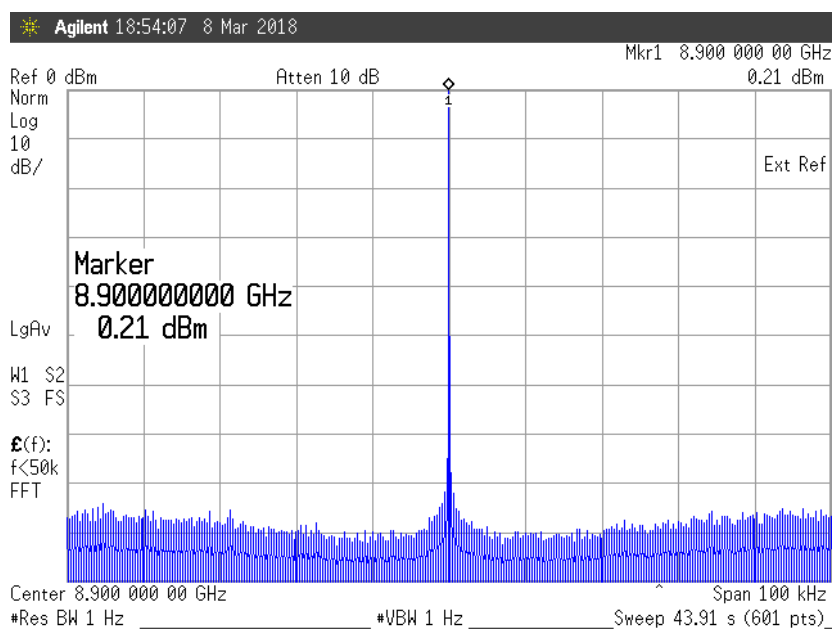
ERASynth

Figure 9: ERASynth+ Narrow-band Spurious Performance at 8.9 GHz
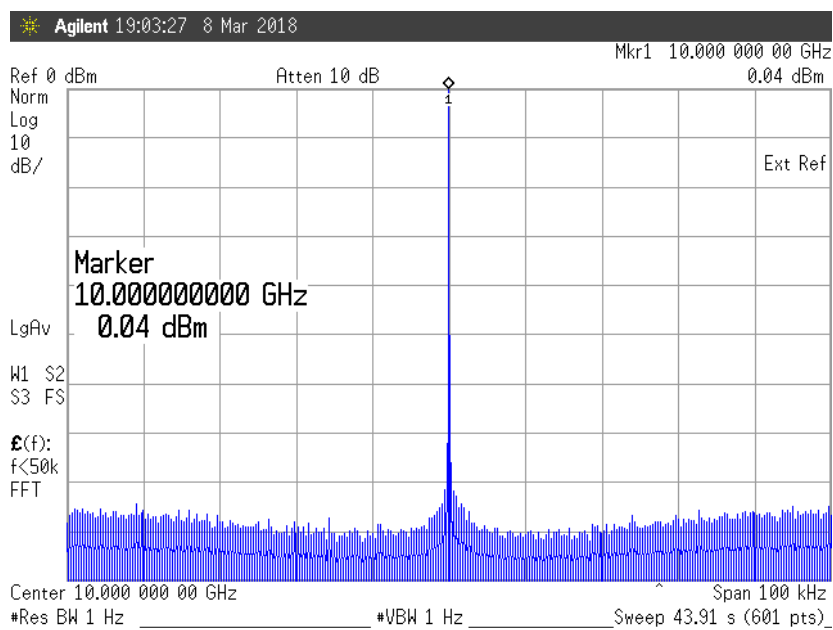
Figure 10: ERASynth+ Narrow-band Spurious Performance at 10 GHz

ERASynth

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

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

ERASynth

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

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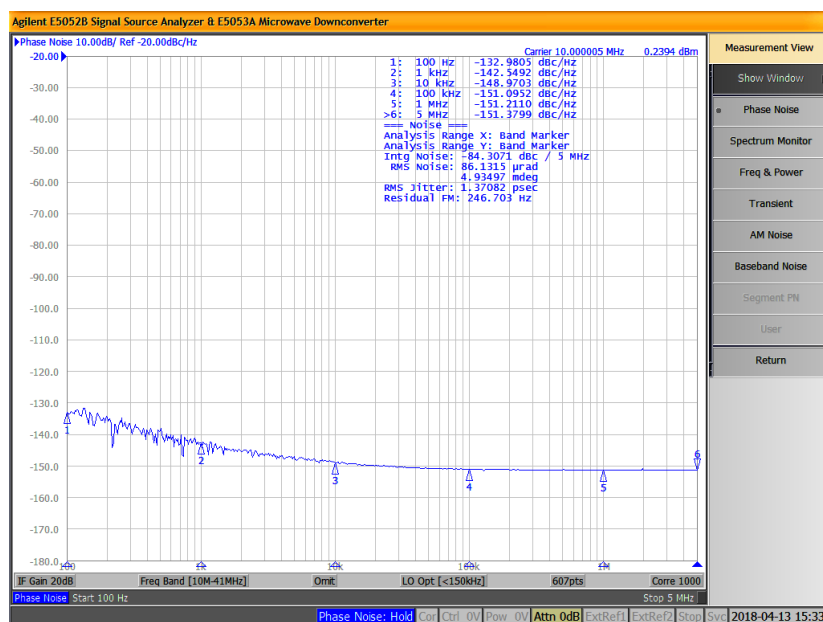
Figure 14: ERASynth+ Phase Noise Performance at 10 MHz RF Output
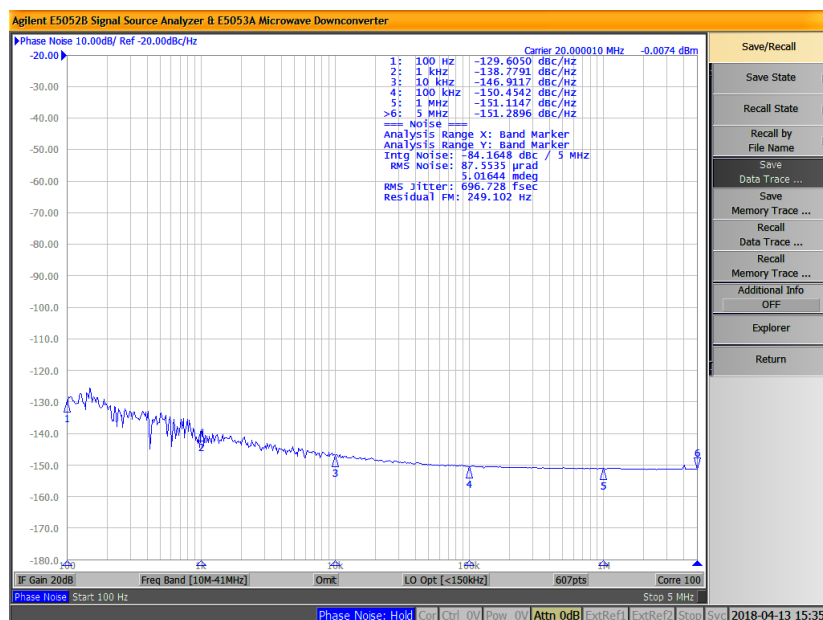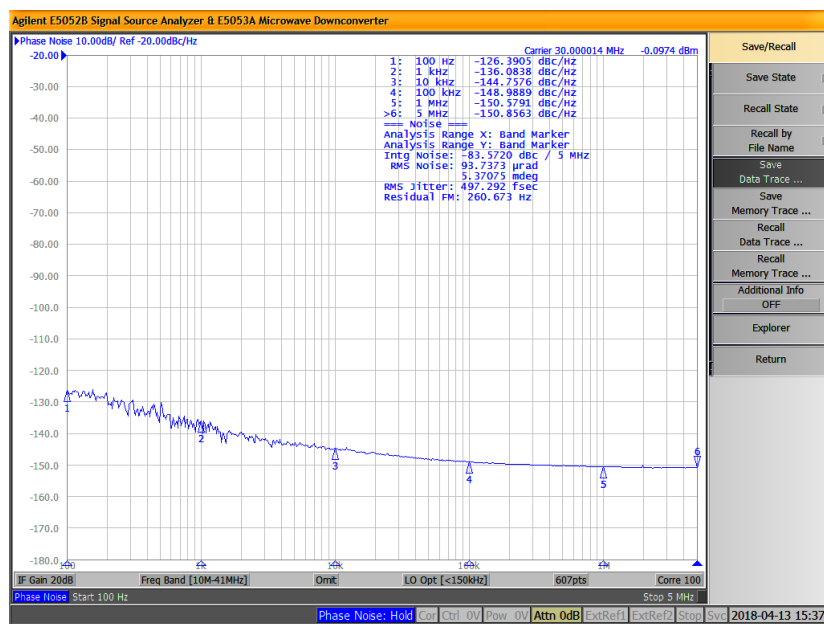

Figure 15: ERASynth+ Phase Noise Performance at 20 MHz RF Output

 ERASynth

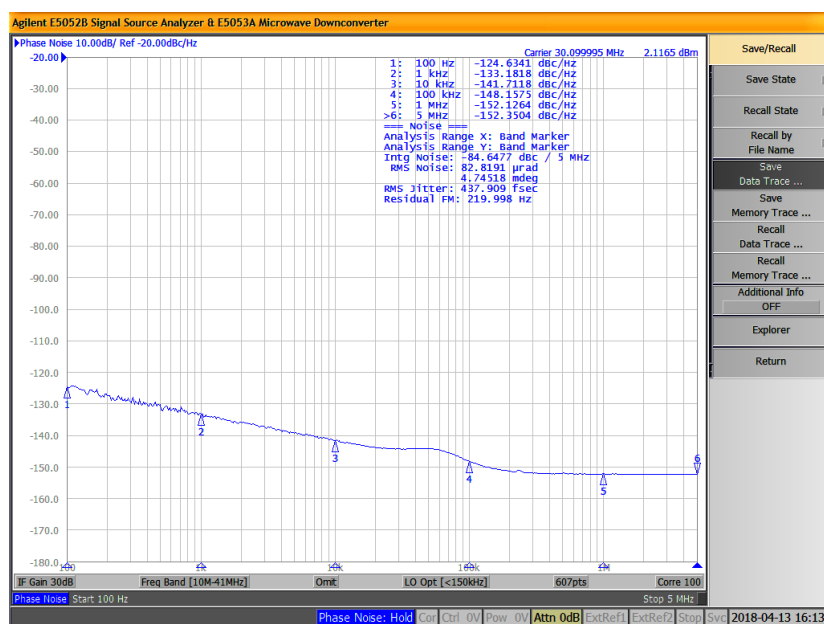Figure 16: ERASynth+ Phase Noise Performance at 30 MHz RF Output

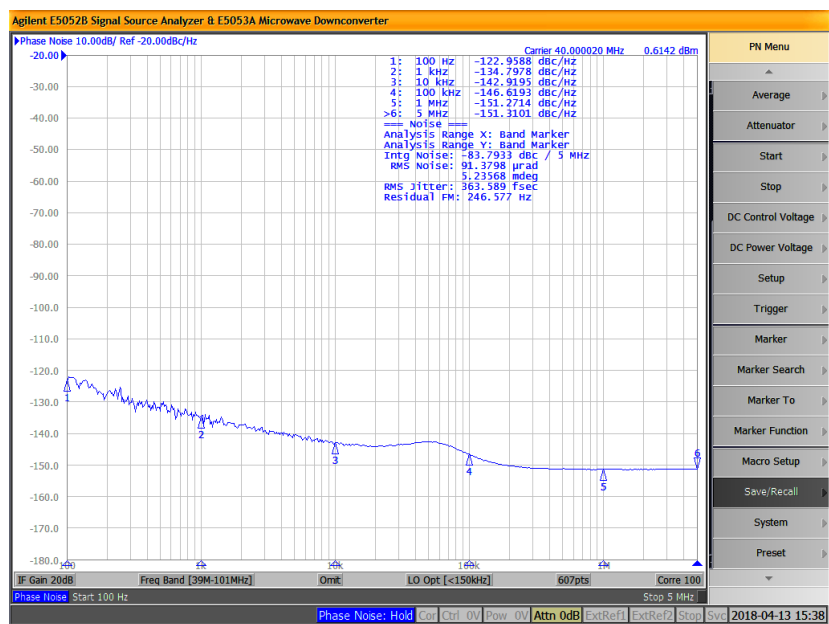Figure 17: ERASynth+ Phase Noise Performance at 30.1 MHz RF Output

ERASynth

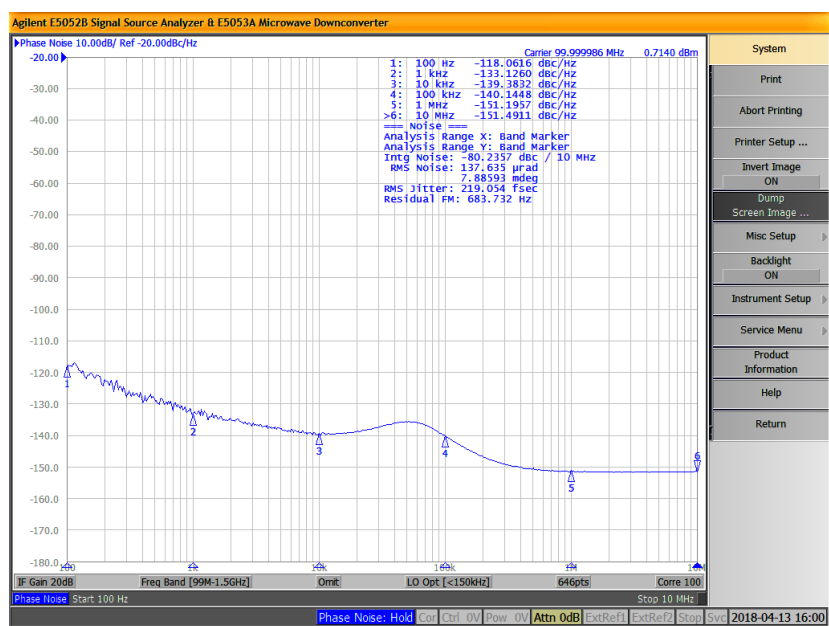Figure 18: ERASynth+ Phase Noise Performance at 40 MHz RF Output

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

ERASynth

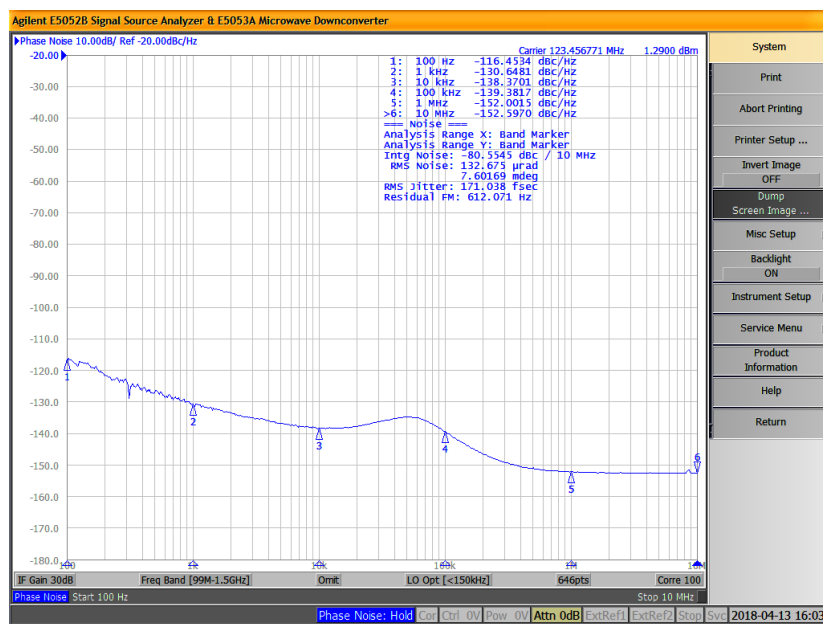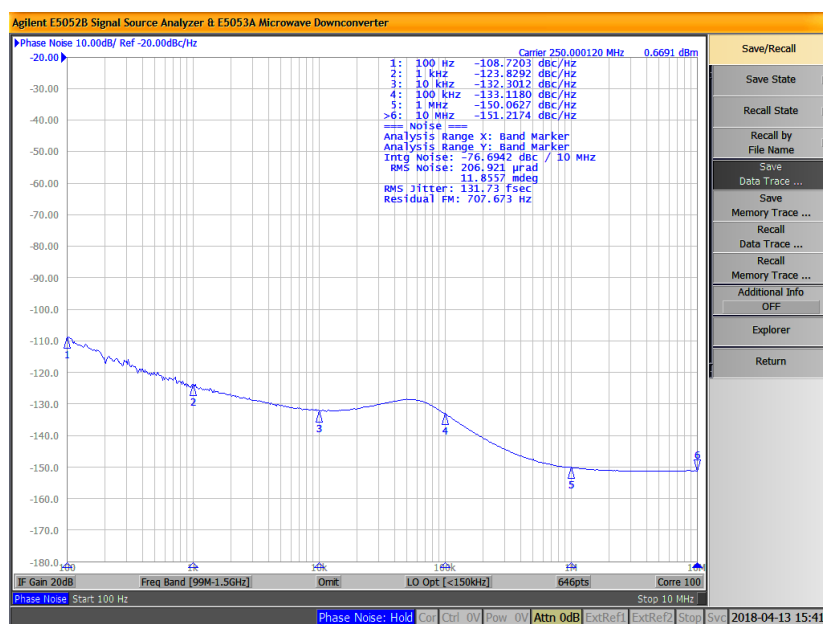Figure 20: ERASynth+ Phase Noise Performance at 123.456789 MHz RF Output

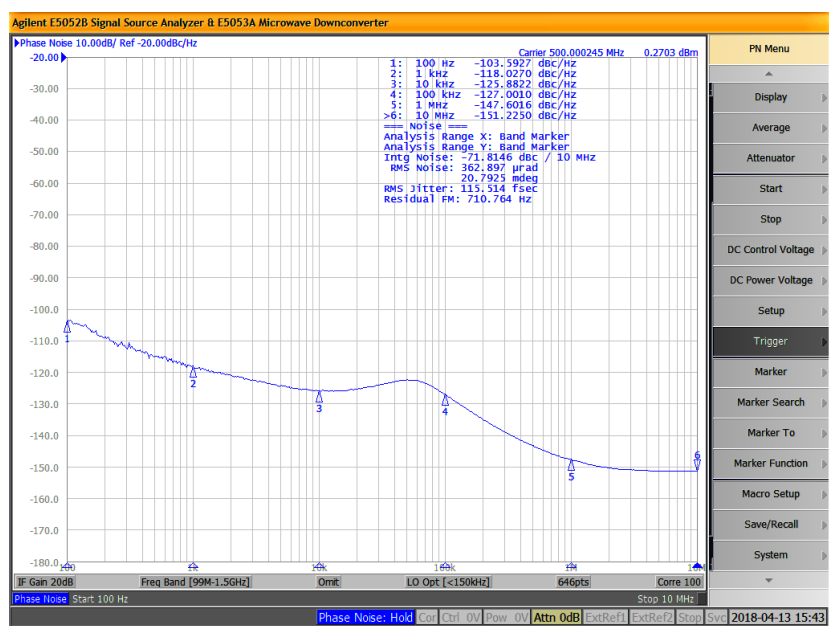Figure 21: ERASynth+ Phase Noise Performance at 250 MHz RF Output

 ERASynth

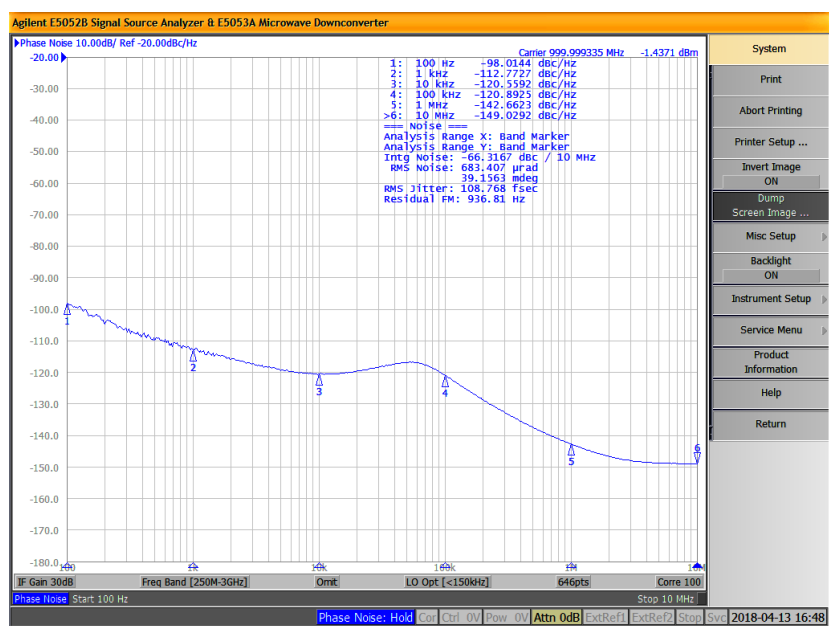Figure 22: ERASynth+ Phase Noise Performance at 500 MHz RF Output

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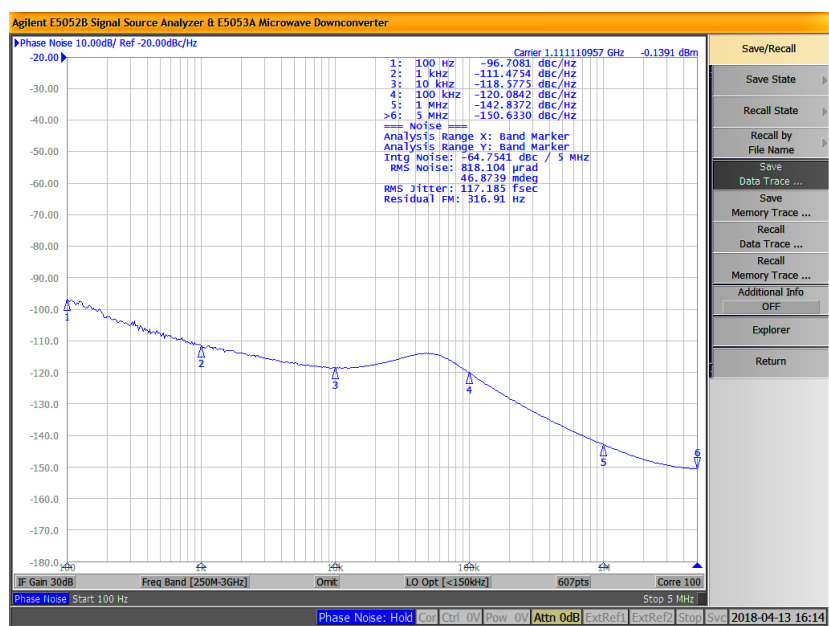
ERASynth

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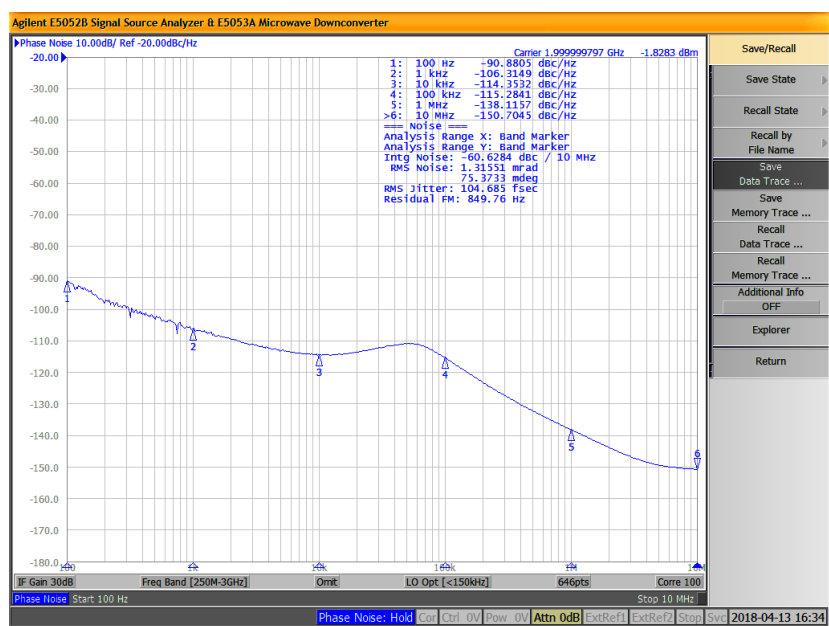

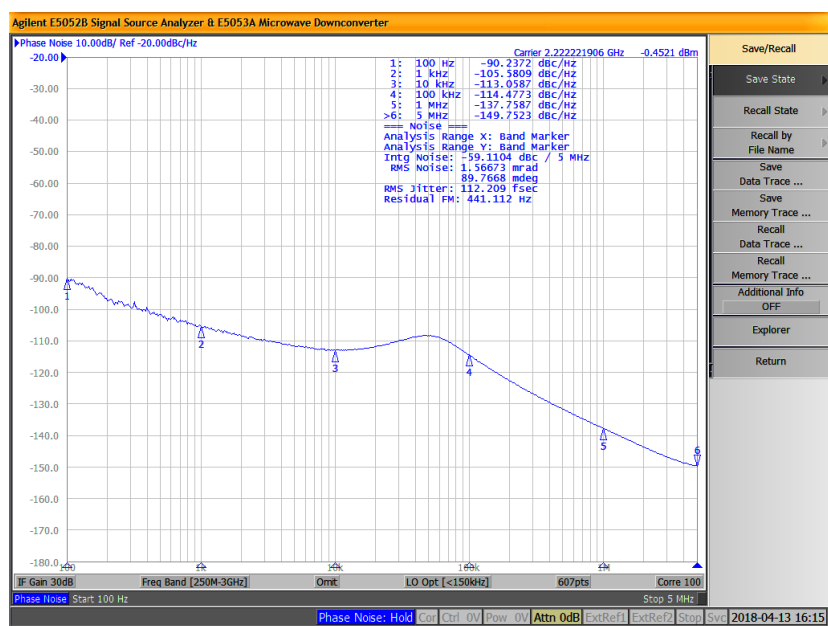Figure 25: ERASynth+ Phase Noise Performance at 2 GHz RF Output

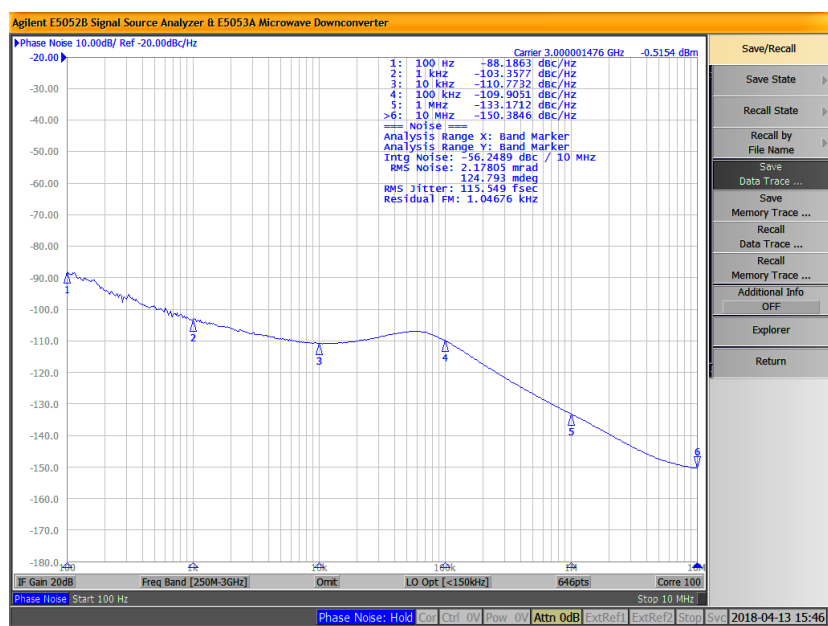Figure 26: ERASynth+ Phase Noise Performance at 2.222222222 GHz RF Output

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

ERASynth

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

Figure 31: ERASynth+ Phase Noise Performance at 12 GHz RF Output
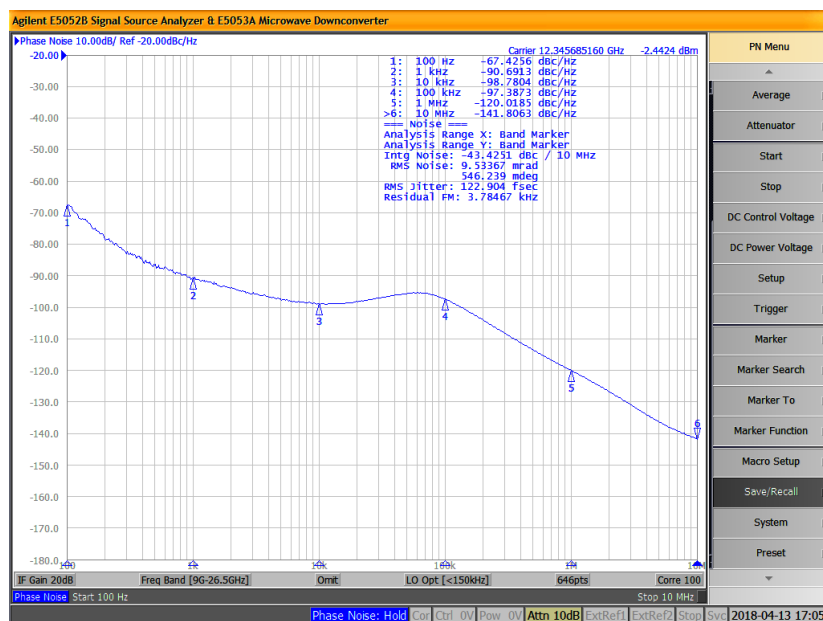
ERASynth
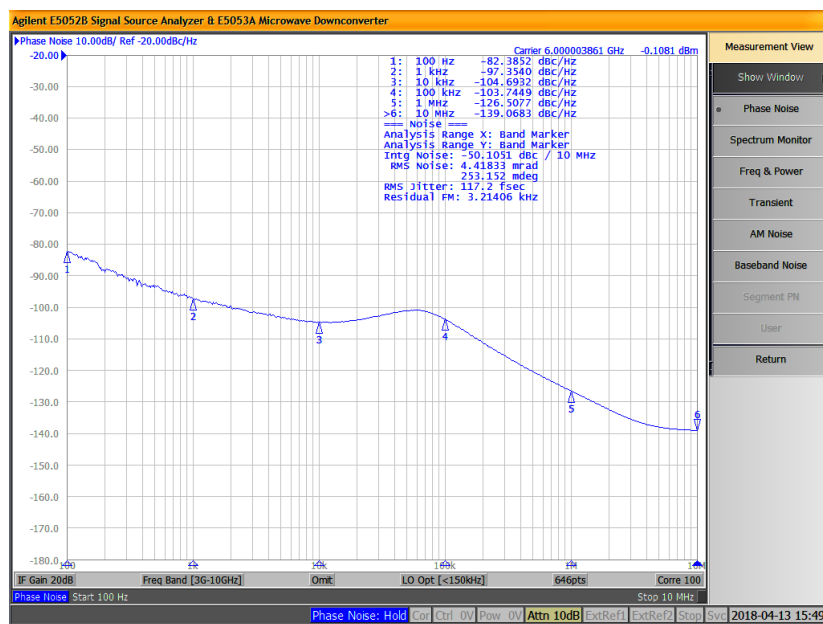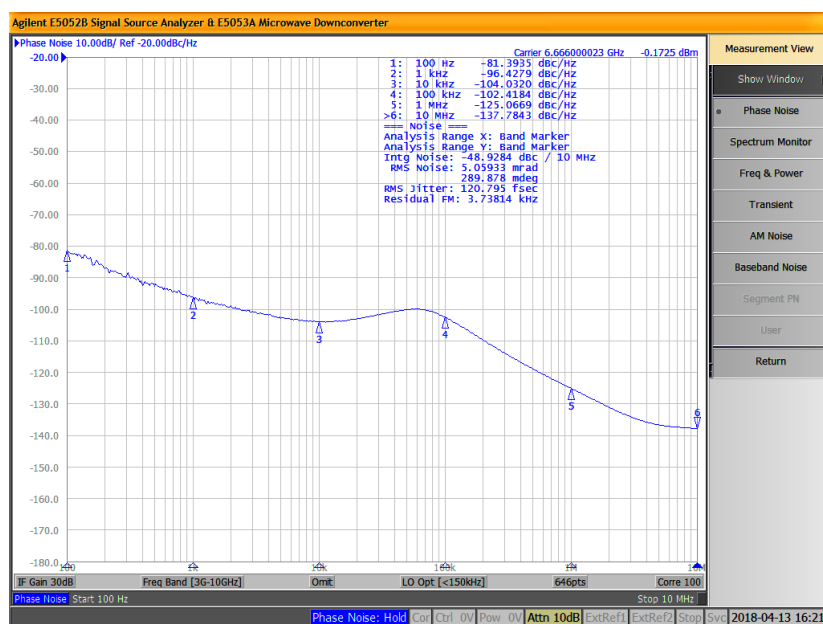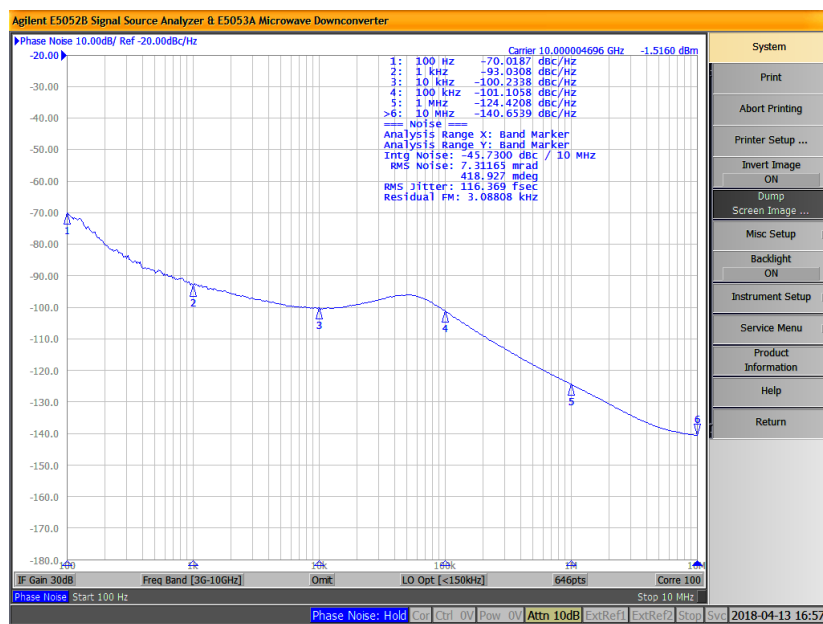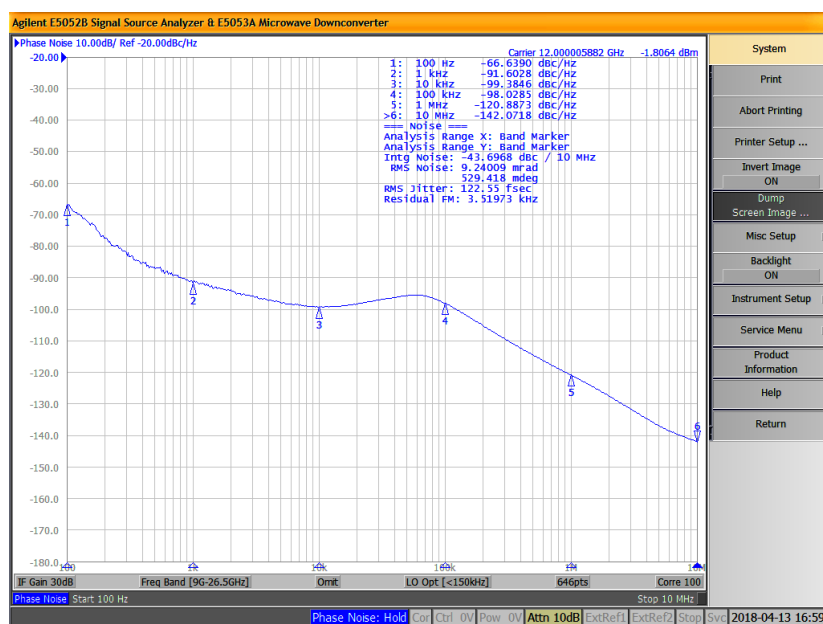
Figure 32: ERASynth+ Phase Noise Performance at 12.345678900 GHz RF Output
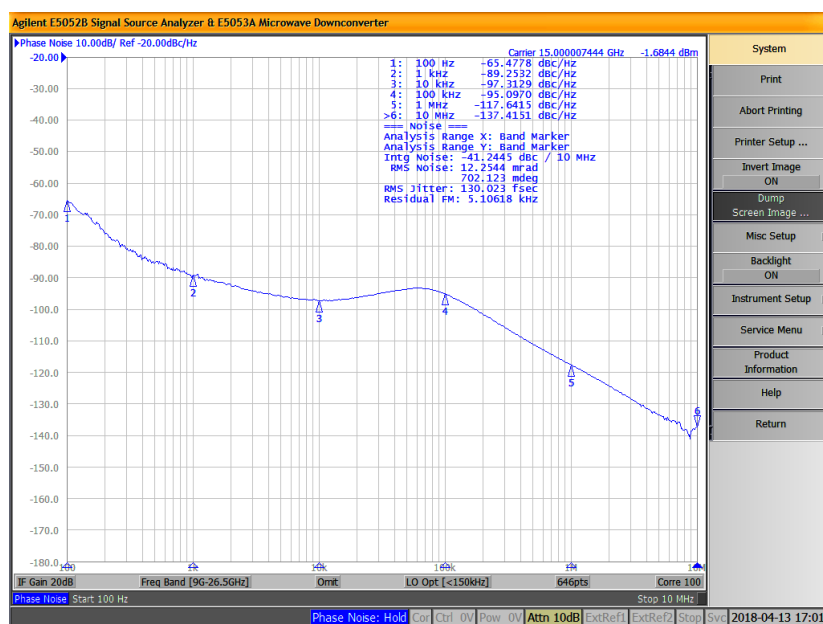
Figure 33: ERASynth+ Phase Noise Performance at 15 GHz RF Output
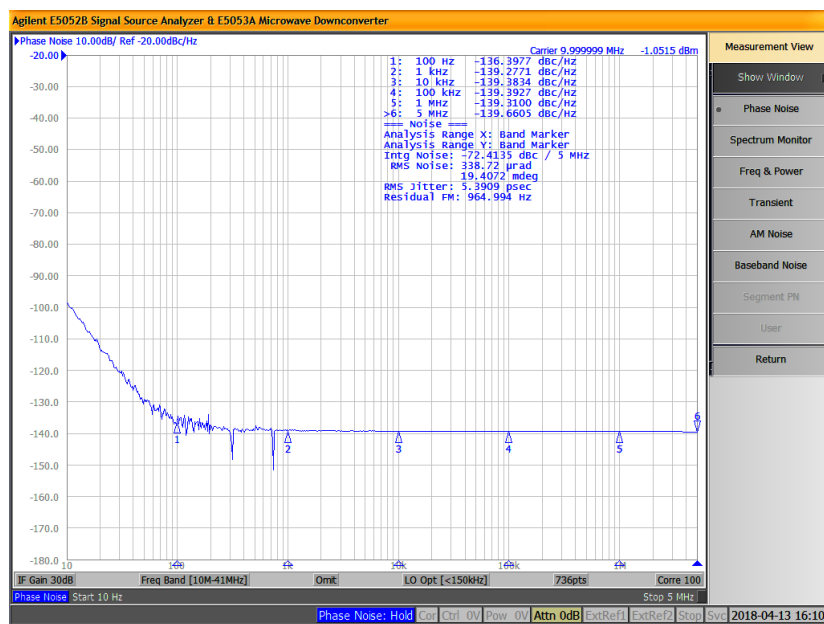
ERASynth

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

ERASynth

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	45 Hz (typ)
	10 MHz	450 Hz (typ)
	100 MHz	4500 Hz (typ)
	1 GHz	45 kHz (typ)
	10 GHz	450 kHz (typ)
Frequency Shift*	27.5 °C	5 ppm (typ)
	40.0 °C	1 ppm (typ)
	43.5 °C	400 ppb (typ)
	45.3 °C	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, reference of VCXO is switched to an internal DAC. That causes a frequency shift. Temperature values are read from internal sensor

ERASynth

Wide Band Frequency Modulation (WBFM)

Minimum deviation	100 MHz	5 kHz (typ)
	1 GHz	10 kHz (typ)
	3 GHz	30 kHz (typ)
	10 GHz	100 kHz (typ)
Maximum deviation	100 MHz	500 kHz (typ)
	1 GHz	5 MHz (typ)
	3 GHz	9.9 MHz
	10 GHz	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	>90 dB (typ)
	1 GHz	88 dB (typ)
	3 GHz	82 dB (typ)
	6 GHz	76 dB (typ)
	10 GHz	65 dB (typ)
	15 GHz	75 dB (typ)
Minimum Pulse Width	300 us (typ)	
Minimum Pulse Period	650 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)	