Model 845 Specification 2.40

Portable 12, 20, & 28 GHz Microwave Signal Generator

with options **HP, PE, R, LN, FS & LO**

BNC Berkeley Nucleonics

Test, Measurement and Nuclear Instrumentation since 1963

Introduction

The Model 845 is a low-noise and fast-switching microwave signal generator covering a continuous frequency range from as low as 100 kHz up to 12, 20, and 28 GHz, respectively, with a 0.001 Hz resolution.

The Model 845 has a wide and accurately levelled output power range and high spurious suppression. Advanced frequency synthesis with fractional-N divider makes for low SSB phase noise and micro-Hz resolution.

Power level extension is available to accurately level below -90 dBm.

Three models of the Model 845 are available: the Model 845, the Model 845-HP and the Model 845-LO.The Model 845 comprises a full set of analog modulation while the Model 845-LO does not support any modulation and acts as a CW only signal source. The HP option delivers higher maximum power to a level up to +27 dBm.

The Model 845 includes amplitude modulation (AM), DC-coupled, low distortion wideband frequency modulation (FM), PM, FSK and PSK, frequency chirp, and fast pulse modulation with internal pulse train generator. Three internal modulations sources are available. All modulation modes of the Model 845 can be combined. This allows the generation of complex modulation signals for modern communication and location systems. For example the combination of FM and AM can be used to check fading effects of FM receivers. The combination of pulse modulation and FM simulates Doppler effects or chirp signals.

Simultaneous AM and pulse modulation provides the types of signal occurring in pulse radar applications with rotating antenna.

Both Model 845 models allow fast analog and digital sweeps including flexible list sweeps, where frequency, power and dwell times can be set individually. A flexible triggering capability simplifies synchronization within test environments.

The Model 845 operates with an ultra-stable temperature compensated 100 MHz reference (OCXO) to ensure minimal drift, and can be phase-locked to any stable external reference in a range from 1 to 250 MHz. Additionally, optimum phase synchronous signals can be achieved by bypassing internal and feeding a 100 MHz signal directly as reference.

The Model 845's support various standard interfaces such as USB-TMC, LAN, and GPIB.

It is targeted for applications where a high-quality CW microwave source with versatile modulation is required. It offers an alternative to expensive high-end microwave signal generators, where small size and excellent microwave performance at an attractive cost is required.

Applications for the MODEL 845 include:

- R&D low noise microwave source
- Production testing (industry-leading switching times; high dynamic range)
- Service and maintenance (battery operation)
- Signal simulation (Radar, WiMax, UWB)
- Aerospace & Defense (Pulse modulator, Chirps)

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Signal Specification

The specifications in the following pages describe the warranted performance of the signal generator for 23 ± 10 °C after a 30 minute warm-up period and for all configurations (options PE if not explicitly stated). Typical specifications describe expected, but not warranted performance. Min and Max specifications are warranted.

Parameter	Min.	Typ.	Max.	Note
CW mode				
Frequency range	100 kHz		12.0 GHz	**845-12**
	100 kHz		20.0 GHz	**845-20 , settable to 20.5 GHz**
	100 kHz		26.5 GHz	**845-26, settable to 30 GHz**
resolution		0.001 Hz		
Phase resolution		0.1 deg		
Frequency / Amplitude settling time		200 µs	300 µs	time from receipt of SCPI command
			30 µs	option FS
SSB Phase noise				
500 MHz				
10 Hz offset		-74 dBc/Hz		
1kHz offset		-126 dBc/Hz		
100 kHz offset		-137 dBc/Hz		
4 GHz				
10 Hz offset		-68 dBc/Hz		
1kHz offset		-108 dBc/Hz		
100 kHz offset		-119 dBc/Hz		
20 GHz				
10 Hz offset		-51 dBc/Hz		
1kHz offset		- 91 dBc/Hz		
100 kHz offset		- 104 dBc/Hz		
Wideband noise		-150 dBc/ Hz		
SSB Phase noise (option LN)				
500 MHz				
10 Hz offset		-106 dBc/Hz		
1kHz offset		-131 dBc/Hz		
100 kHz offset		-128 dBc/Hz		
4 GHz				
10 Hz offset		-88 dBc/Hz		
1kHz offset		-115 dBc/Hz		
100 kHz offset		-128 dBc/Hz		
20 GHz				
10 Hz offset		-74 dBc/Hz		
1kHz offset		- 100 dBc/Hz		
100 kHz offset		- 113 dBc/Hz		
Amplitude Noise at 10 GHz		-130 dBc/Hz		Pout=+10 dBm, 100 kHz offset
		-140 dBm		noise floor

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Parameter	Min.	Typ.	Max.	Note
Output power				Check maximum output power plots on page 10
Standard				
100 kHz to fmax	-20 dBm		+15 dBm	
Option PE only				
100 kHz to fmax	-90 dBm		+13 dBm	
Option HP only	-20 dBm		+25 dBm	0.2 to 9 GHz
	-20 dBm		+23 dBm	9 to 18 GHz, see plot
	-20 dBm		+19 dBm	>18 GHz, see plot
Options HP and PE				
	-90 dBm		+20 dBm	<18 GHz
	-90 dBm			>18 GHz, see plot
Level resolution		0.01 dB		
Level uncertainty, ALC on		0.3 dB	<1 dB	>-15 dBm
			<1.5 dB	<-15 dBm
User flatness correction		up to 2000 points		
Output impedance		50 Ω		
VSWR		2		
Reverse Power Protection				
DC Voltage			±15 V	
RF power			30 dBm	
Spectral purity at +5 dBm				
Output harmonics		-40 dBc	-30 dBc	
Sub-harmonics		-75 dBc	-65 dBc	<20 GHz
		-50 dBc	-40 dBc	>20 GHz
Non-harmonic spurious		-75 dBc	-60 dBc	
Residual FM @ 10 GHz		15 Hz		0.3 kHz to 3 kHz, weighted (ITU-T), RMS
Residual AM @ 10 GHz		0.02%		RMS value (0.01 kHz to 15 kHz)

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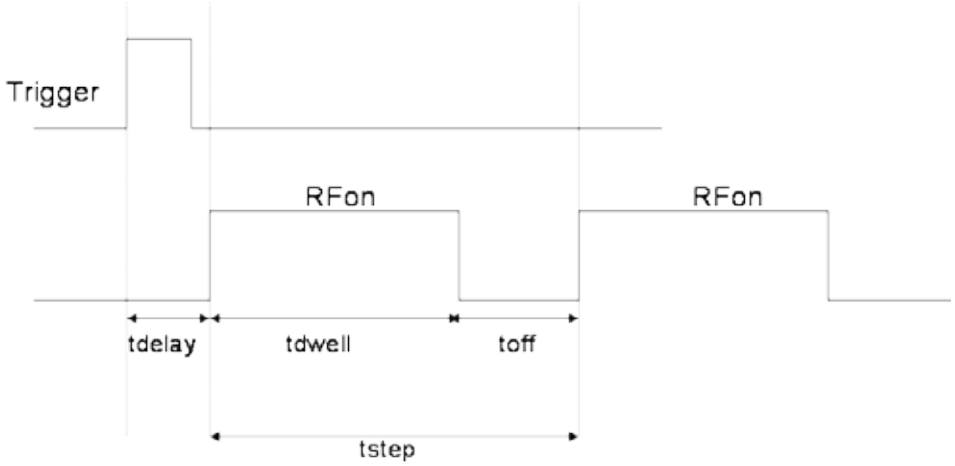
Sweeping Capabilities

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.	Typ.	Max.	Note
Digital frequency sweep				
Sweep type: linear, logarithmic, random				
Step time (t_{step})	400 µs 40 µs		19998 s	 Option FS
Dwell time (t_{dwell})	10 µs		9999 s	
Off-time (incl. transient time) (t_{off})	0		9999 s	
Timing accuracy per point		1 µs 50 ns		 Option FS



Generalized list sweep				
allows individual setting of frequency, power, dwell-time, and off-time for each point				
List size	2		65'000	
Step time (t_{step})	300 µs 40 µs		19998 s	mechanical attenuator not used option FS
Dwell time (t_{dwell})	10 µs		9999 s	
Off-time (incl. transient time) (t_{off})	0		9999 s	
Time resolution		0.1 µs		
Timing accuracy per point		1 µs		
Frequency Chirps				
(linear ramp, up/down)				
Bandwidth	10%			of carrier frequency
Dwell time (t_{dwell})	10 ns		10000 µs	
Slope			100 MHz / µs	
Number of frequencies			65'000	

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Reference Frequency

REF IN input and REF OUT output are at rear panel

Parameter	Min.	Typ.	Max.	Note
Internal reference frequency		100 MHz		
		10 / 100 MHz		Option LN
Initial accuracy			±40 ppb	calibrated at 23 ± 3 °C at time of calibration , user adjustable
Temperature stability (0 to 50 degC)			±100 ppb	
			±20 ppb	Option LN
Aging 1st year		0.5 ppm		
		0.1 ppm		Option LN
Aging per day (after 30days operations)			5 ppb	
			tbm	Option LN
Warm-Up time		5 min		
Output of internal reference		10 MHz		
		10/100 MHz		
Output power		0 dBm		
Output impedance		50 Ohms		
Bypass Internal reference				High phase synchronous mode
Input		100 MHz, -5 to +10 dBm		
		100 MHz, 1 GHz		Option LN
Phase Lock to External Reference				
External Input Range	1 MHz		250 MHz	User programmable
Reference input level	-5 dBm	0 dBm	+13 dBm	
Lock Range			±1.5 ppm	
Reference input impedance		50 Ohms		

Multi Purpose Output (FUNC OUT)

Output is FUNC OUT at rear panel

Parameter	Min.	Typ.	Max.	Note
MULTIFUNCTION GENERATOR	sine, triangle, square wave			
Frequency range	1 Hz		3 MHz	sine
	1 Hz		1 MHz	triangle
			50 kHz	square
Frequency resolution		0.1 Hz		
Output voltage amplitude peak-peak	10 mV		2 V	Sine, triangle
		5V		Square (CMOS output)
Harmonic Distortion		1%		<100 kHz, 1 Vpp
Output impedance		50 Ohms		Sine, triangle
		CMOS		square wave

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Multi Purpose Output (FUNC OUT)

Output is FUNC OUT at rear panel

Parameter	Min.	Typ.	Max.	Note
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.	Typ.	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		2 µs tbd		 Option FS
Trigger uncertainty		5 µs 10 ns		 Option FS
External Trigger delay	50 µs 50 ns		40 s 10 s	programmable Option FS
External Delay Resolution		15 ns 10 ns		 Option FS
Trigger Modulo	1		255	Execute only on Nth trigger event
Trigger Polarity	Rising, falling			

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Modulation Capabilities (not with LO)

Combined AM/PM/FM/PULSE possible (see user manual)

Parameter	Min.	Typ.	Max.	Note
Multifunction Generator sine, triangle, square wave				
Output is FUNC OUT at rear panel				
Frequency range	1 Hz		3 MHz	sine
	1 Hz		1 MHz	triangle
			50 kHz	square
Frequency resolution		0.1 Hz		
Output voltage amplitude peak-peak	10 mV		2 V	Sine, triangle
		5V		Square (CMOS output)
Harmonic Distortion		1%		< 100 kHz, 1 Vpp
Output impedance		50 Ohms		Sine, triangle
		CMOS		square wave
Pulse Modulation				
On/off ratio		70 dB		**at +10 dBm**
Repetition frequency	DC		10 MHz	
Pulse width	30 ns			ALC hold
	500 ns			ALC on
Pulse rise/fall time		7 ns		
Pulse width	30 ns		100 µs	
Pulse resolution		15 ns		
Polarity		selectable		
External input amplitude		1 V		AC
		TTL		DC
Pulse Pattern Modulation				Using internal pattern generator
On/off ratio		70 dB		**at +10 dBm**
Pulse bit width	30 ns			ALC hold
	500 ns			ALC on
Pulse rise/fall time		7 ns		
Programmable pattern length	2		4192	
Pulse width	30 ns		100 µs	
Pulse bit resolution		15 ns		
Polarity		selectable		
Frequency Modulation		>0.05·f		*< 1.25 GHz*
Maximum Frequency deviation (peak)		N · 200 MHz		*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)
Modulation rate	DC		800 kHz	> -3dB frequency response
Modulation waveforms		Sine, triangle, FSK		
External input sensitivity				
AC		0 to N · 200 MHz / V		adjustable for ±1 V range
DC		0 to N · 100 MHz / V		discr. values ; ±5 V range
Total harmonic distortion		<1%		1 kHz rate & N · 1 MHz deviation

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Modulation Capabilities (not with LO)

Combined AM/PM/FM/PULSE possible (see user manual)

Parameter	Min.	Typ.	Max.	Note
Phase Modulation				
Phase deviation (peak)	0		N·300 rad	
Modulation rate	DC		800 kHz	> -3dB frequency response Max. phase deviation degrades above 20 kHz
Modulation waveforms	Sine, triangle, FSK			
External Input sensitivity	Settable 0.1 rad/V to 360 rad/V			
Total harmonic distortion	< 1%			1 kHz rate & N x 100 rad deviation
Amplitude Modulation				
Modulation rate	0.1 Hz		50 kHz	
Modulation waveforms	Sine, triangle, square			
Modulation depth	0%		90%	
Distortion (sine wave)		2%		at 60% modulation depth
Accuracy		4%		

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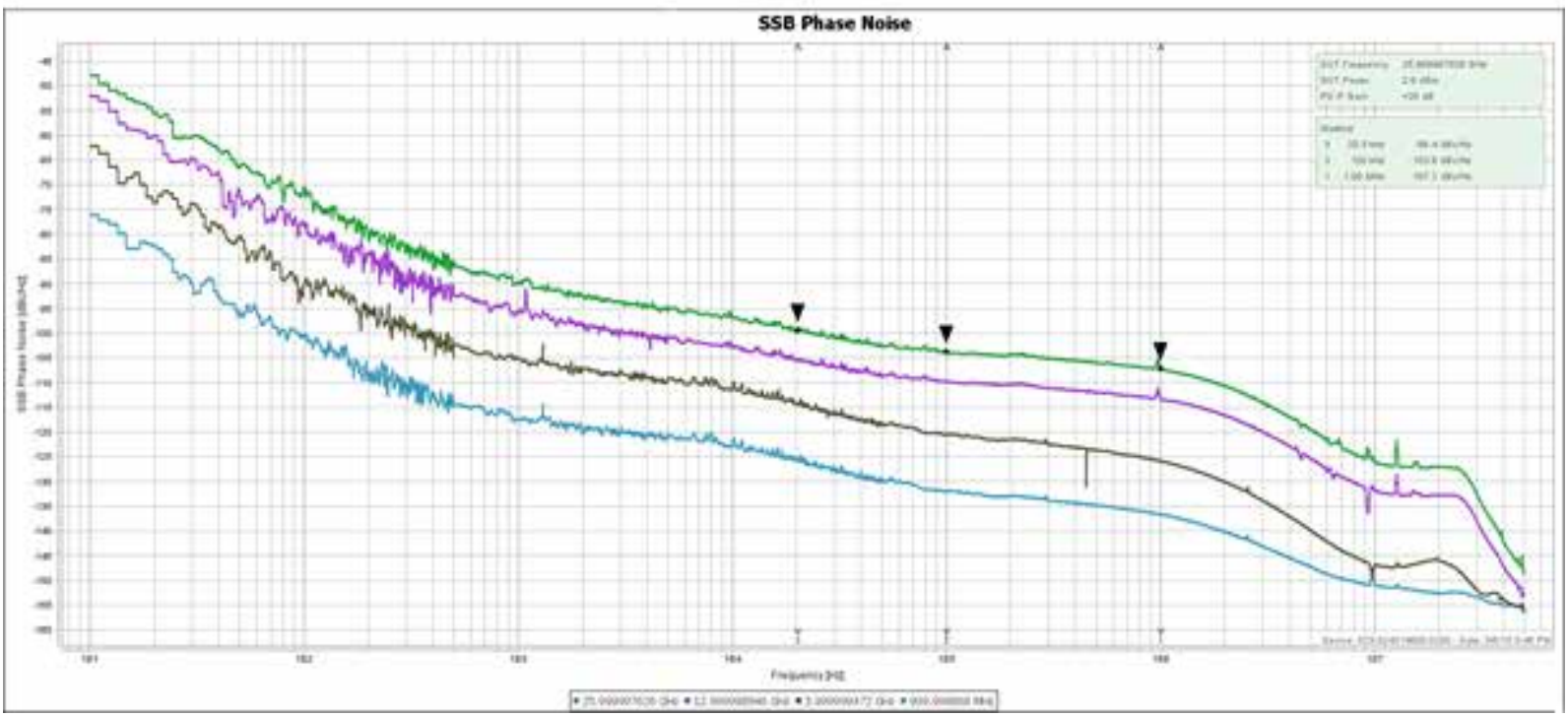
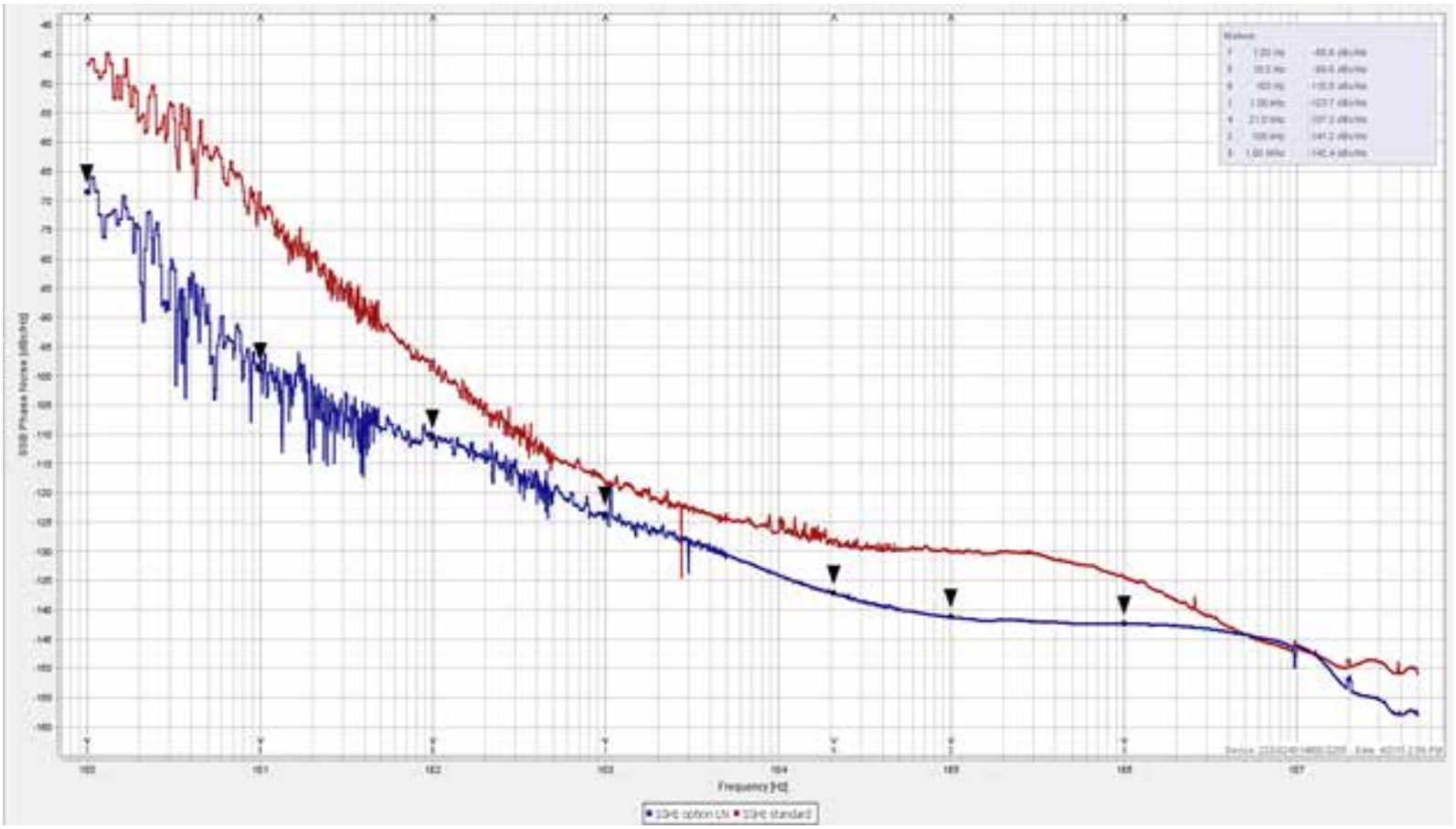
Typical performance curves

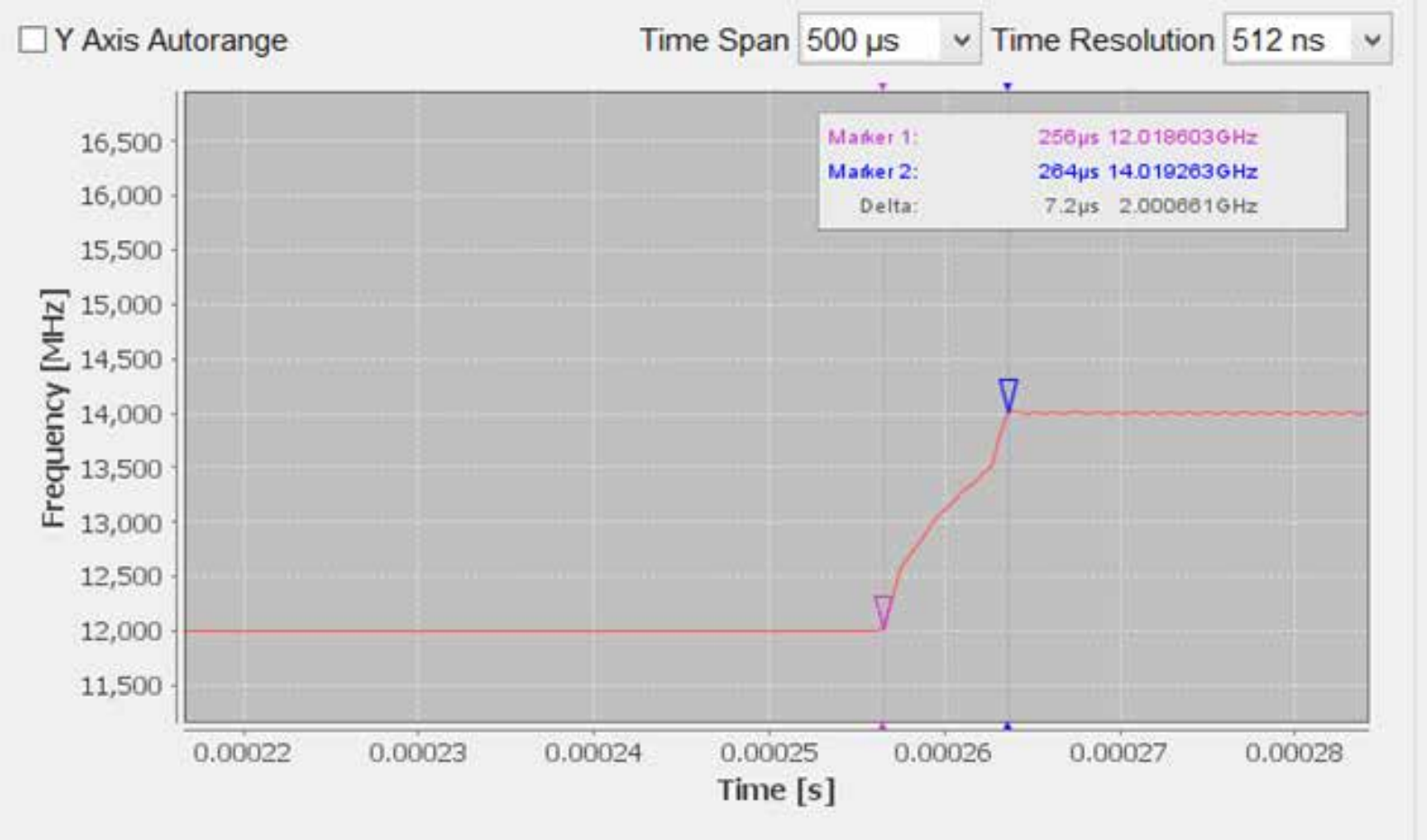
Phase Noise Performance (10 Hz to 50 MHz offset) at 1,4,13 and 26 GHz



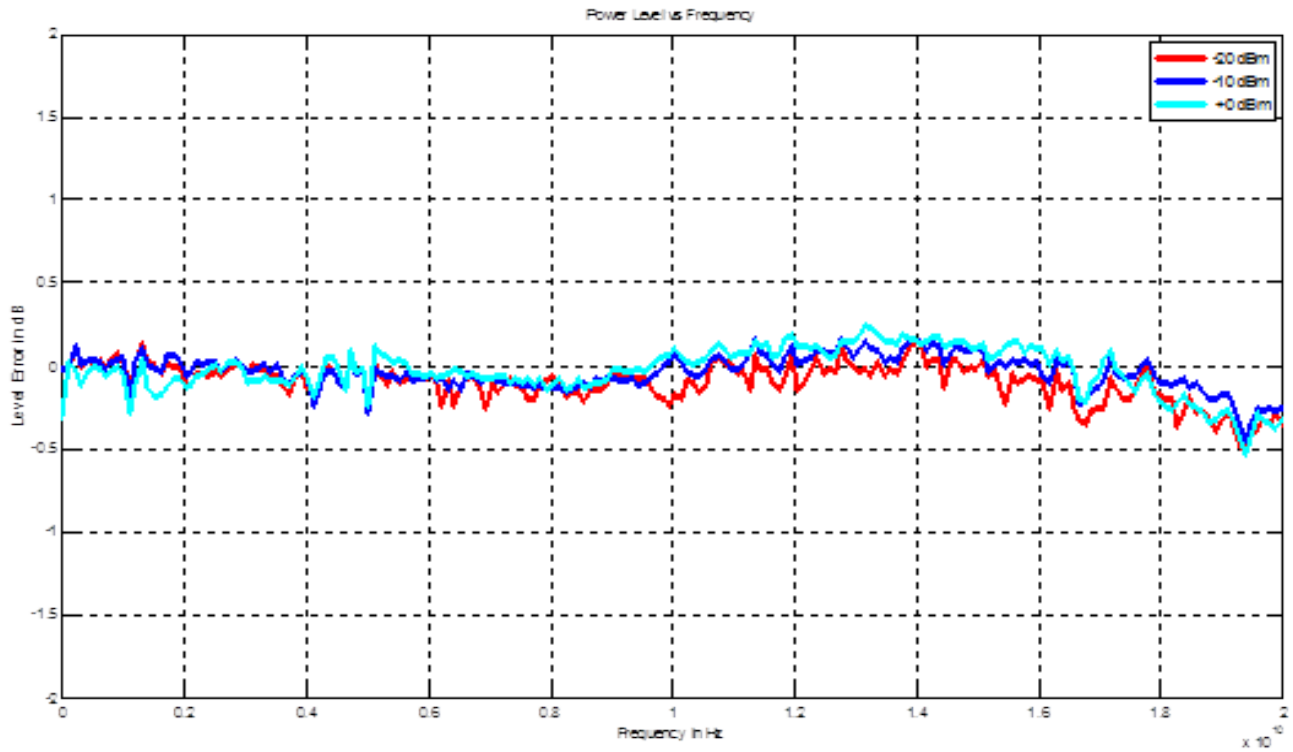
Phase Noise with Option LN



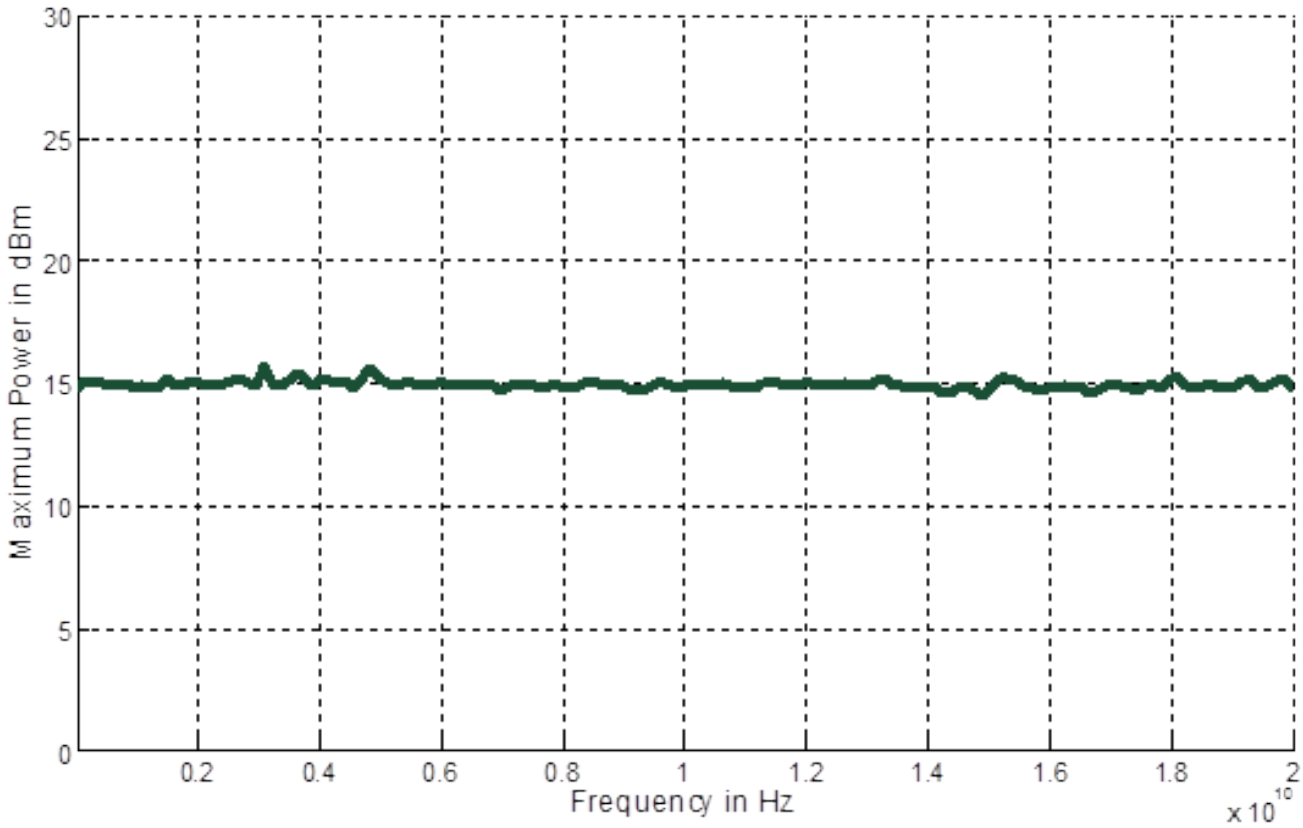
Typical Switching transient from 12 GHz to 14 GHz step



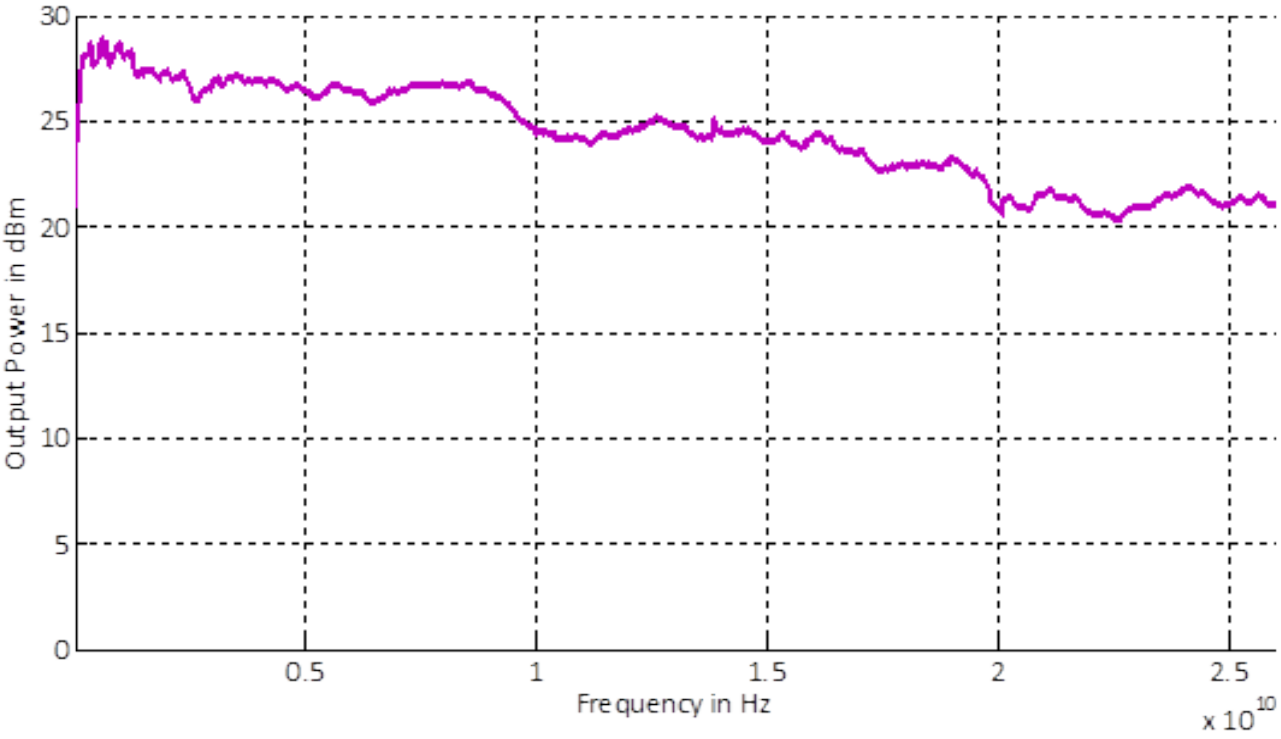
Typical Frequency Response 0 to 20 GHz at -10, 0, and +10 dBm



Typical Maximum Output Power (standard)



Typical Maximum Output Power (option HP)



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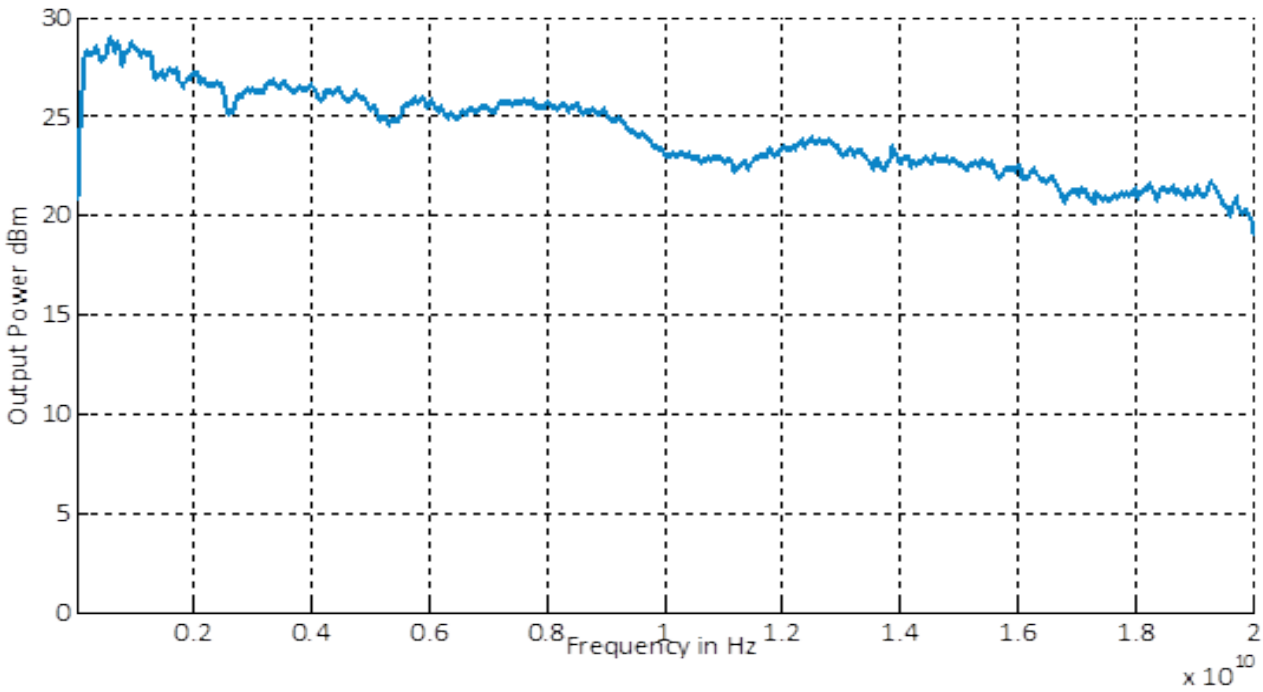
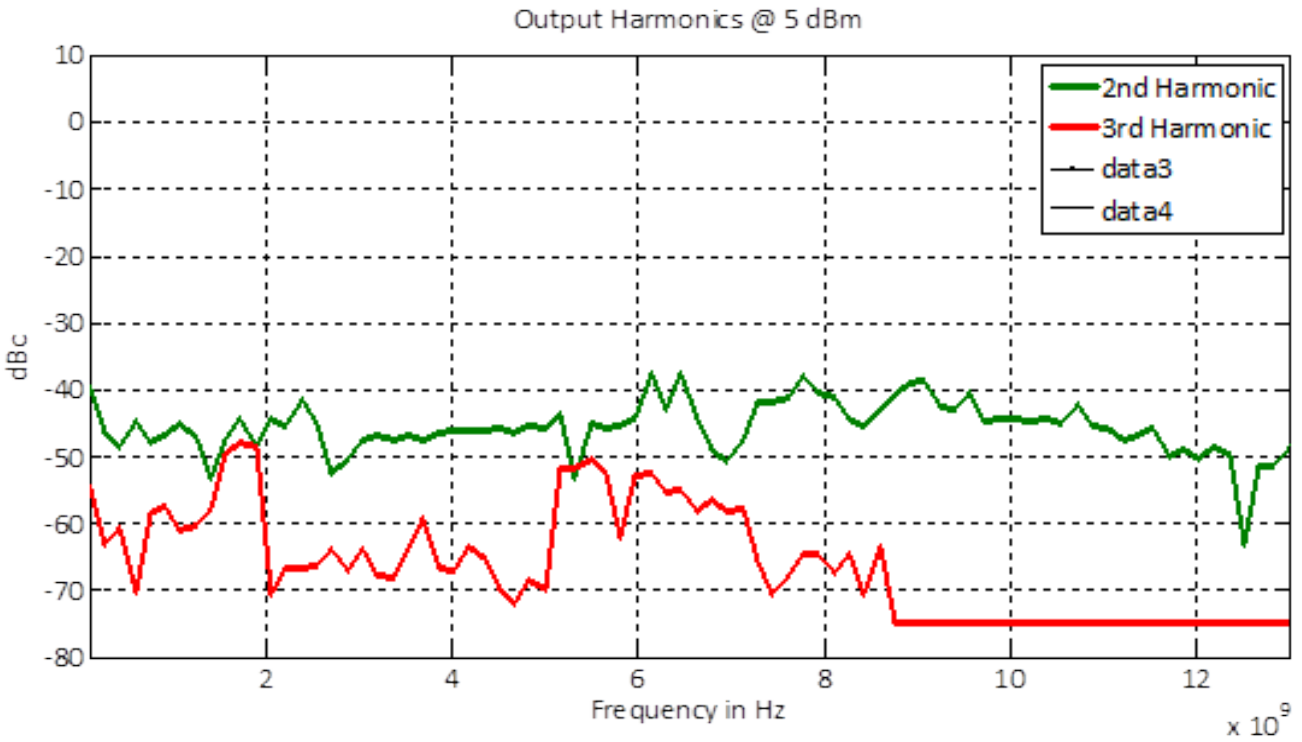
Typical Maximum Output Power (options PE and HP)



Harmonics (with option PE)



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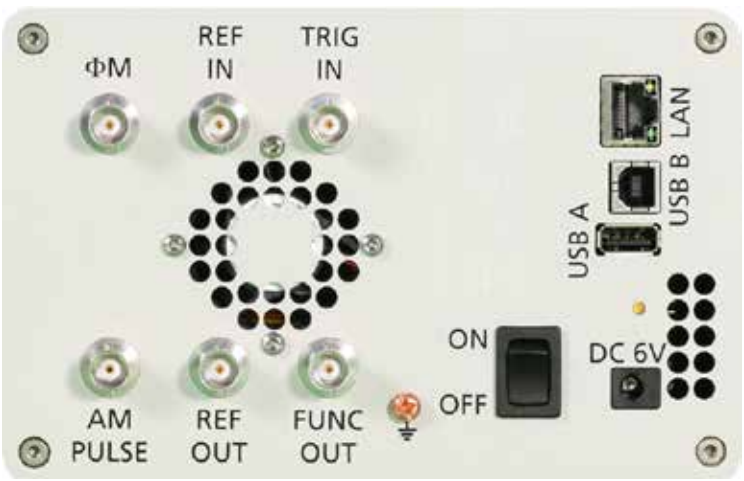
Model 845 Series

845 Series Front Panel

1. RF output: SMA female
2. RF on/off button
3. Rotary knob
4. Menu and arrow keys

845 Series Rear Panel



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 host and device
9. GPIB: IEEE-488.2, 1987 with listen and talk (optional)
10. DC Power plug (6V, 2.5A)
11. DC power switch

Options

HP delivers higher maximum output power to a level up to +27 dBm.

PE is an optional power level extension to accurately level below -90 dBm.

LN provides ultra low phase noise and further improves frequency stability

FS substantially reduces the switching speed

LO removes all built-in modulation capabilities if not needed (845-20, 845-26 only)

RB adds an internal rechargeable battery module

R modifies form-factor to a 19" rack-mountable 1HU enclosure

Option TP modifies form-factor to a 3HU 19" bench-top enclosre with touch-display control

Figure 1

GPIB: IEEE-488.2,1987 programming interface.

Weight = 2.5 kg (6 lbs) net, = 4 kg (8 lb.) shipping
Dimensions 106 mm H x 172 mm W x 270 mm L
[4.21 in H x 6.77 in W x 10.63 in L]
Recommended calibration cycle 24 months

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/ 6V, 6.0A DC out
Operating temperature range: 0 to 40 °C
Storage temperature range: –40 to 70 °C
Operating and storage altitude up to 15,000 feet

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

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