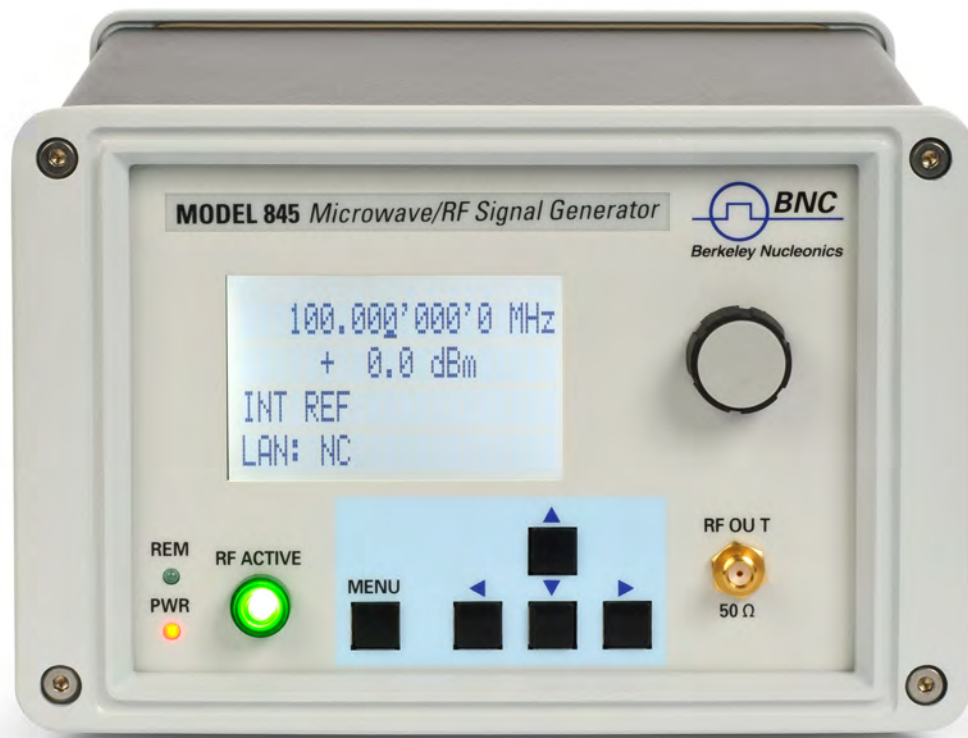# Model 845 Specification 1.64
Portable 20 GHz Microwave Signal Generator

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 20.4 GHz with a 0.001 Hz resolution.

The Model 845 is 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.

Two models of the Model 845 are available: the Model 845 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 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. 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 200 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 & Defence (Pulse modulator, Chirps)

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 7096 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		20 GHz	Settable to 20.4 GHz
resolution		0.001 Hz		
Phase resolution		0.1 deg		
Frequency update rate		600 µs		time from receipt of SCPI command
List/Sweep mode		600 µs		
SSB Phase noise at 10 GHz				
at 1 kHz from carrier		-100 dBc/Hz		
at 20 kHz from carrier		-108 dBc/Hz		
Wideband noise		-150 dBc/ Hz		
Total jitter		100 fs RMS		BW over 10 Hz to 20 MHz
Amplitude Noise at 10 GHz		-130 dBc/Hz		Pout=+10 dBm, 100 kHz offset
		-140 dBm		noise floor

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Signal Specification continuing

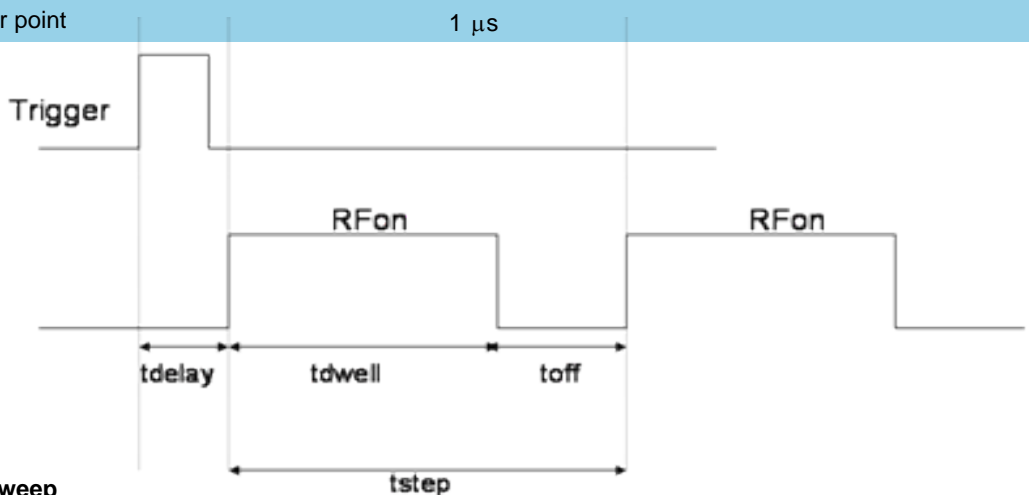| Parameter	Min.	Typ.	Max.	Note
Output power				Check maximum output power plots on page 8
Range without option 7096				
100 kHz to 100 MHz	-30 dBm		+10 dBm	
100 MHz to 20 GHz	-30 dBm		+14 dBm	
> 18 GHz	-30 dBm		+12 dBm	
Range WITH option 7096				
100 kHz to 20 GHz	-90 dBm		+10 dBm	
Level resolution		0.01 dB		
Level uncertainty, ALC on			< 1 dB	-20 to +10 dBm
			< 1.5 dB	> -90 dBm < +10 dBm
User flatness correction		up to 2000 points		
Output impedance		50 Ω		
VSWR		2.0		
Reverse Power Protection				
DC Voltage			±15 V	
RF power			30 dBm	
Spectral purity at + 5 dBm				
Output harmonics	-40 dBc		-35 dBc	0.1 to 5.0 GHz
	-35 dBc		-30 dBc	5.0 to 10.0 GHz
	-50 dBc		-40 dBc	10.0 to 20.0 GHz
Sub -harmonics	-75 dBc		-60 dBc	
Non -harmonic spurious	-75 dBc		-60 dBc	at +5 dBm output power
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)

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.	Typ.	Max.	Note
Digital frequency sweep				
Sweep type: linear, logarithmic, random				
Step time (t_{step})	600 μs		19998 s	

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Sweeping Capability continuing

Parameter	Min.	Typ.	Max.	Note
Dwell time (t_{dwell})	10 µs		9999 s	
Off-time (incl. transient time) (t_{off})	0 / 50 µs		9999 s	
Timing accuracy per point		1 µs		

Generalized list sweep

allows individual setting of frequency, power, dwell-time, and off-time for each point

	Min.	Typ.	Max.	Note
List size	2		65'000	
Step time (t_{step})	600 µs		19998 s	mechanical attenuator not used
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		
Ramp (analog) sweep				
Sweep span		20 %		of carrier frequency
Sweep rate	tbd		N · 5 GHz / ms	
Sweep time	0.1 ms		100 ms	
Frequency Chirps				
(linear ramp, up/down)				
Bandwidth	10%			of carrier frequency
Dwell time (t_{dwell})	10 ns		100 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		
Initial accuracy			±40 ppb	calibrated at 23 ± 3 °C at time of calibration
Temperature stability (0 to 50 degC)			±100 ppb	
Aging 1st year		0.5 ppm		
Aging per day (after 30 days operations)			5 ppb	
Warm-Up time		5 min		
Output of internal reference		10 MHz		<= SN xxx-xx4xxxxxx-xxxx
		10/100 MHz		>= SN xxx-xx5xxxxxx-xxxx
Output power		0 dBm		
Output impedance		50 Ohms		
Bypass Internal reference Input	100 MHz, -5 to +10 dBm			
Phase Lock to External Reference				
External Input Range	8 MHz		250 MHz	<= SN xxx-xx4xxxxxx-xxxx
	1 MHz		250 MHz	>= SN xxx-xx5xxxxxx-xxxx User programmable
Reference input level	-5 dBm	0 dBm	+13 dBm	
Lock Range			±1.0 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	5V	2 V	Sine, triangle, Square (CMOS output)
Harmonic Distortion		1 %		< 100 kHz, 1 Vpp
Output impedance		50 Ohms		Sine, triangle
		CMOS		square wave
VIDEO OUTPUT (of internal pulse modulator)				
Output		CMOS		
Period	30 ns		50 s	

Multi Purpose Output (FUNC OUT) continuing

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

Modulation Capabilities (MODEL 845 only)

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

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Modulation Capabilities (MODEL 845 only) continuing

Parameter	Min.	Typ.	Max.	Note
Output voltage amplitude peak-peak		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
	50µs			ALC on
Pulse rise/fall time		7 ns		
Pulse trains length (pulses)	2		4192	
Pulse width	30 ns		100 µs	
Pulse resolution		15 ns		
Polarity		selectable		
External input amplitude		1 V		AC
		TTL		DC
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
Phase Modulation			f*5e-7	*< 1.25 GHz*
Phase deviation (peak)	0		N·300 rad	*> 1.25 GHz*
Modulation rate	DC		800 kHz	> -3dB frequency response
				Max. phase deviation degrades
				above 20 kHz modulation rate
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

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Modulation Capabilities (MODEL 845 only) continuing

Parameter	Min.	Typ.	Max.	Note
Amplitude Modulation				
Modulation rate	0.1 Hz		20 kHz	
Modulation waveforms		Sine, triangle, square		
Modulation depth	0 %		90 %	
Distortion (sine wave)		2 %		at 60% modulation depth
Accuracy		4 %		

Typical performance curves

Phase Noise Performance (1 Hz to 50 MHz offset)
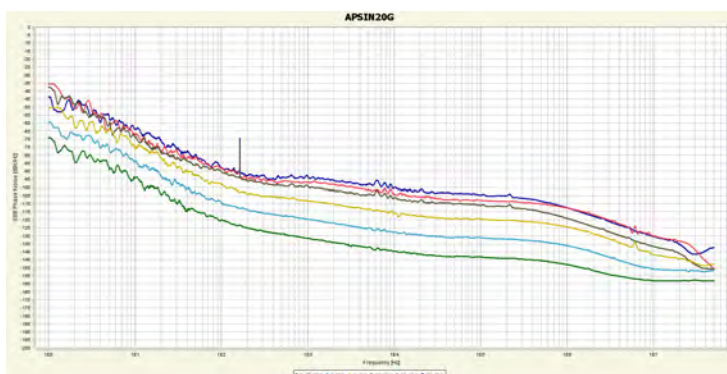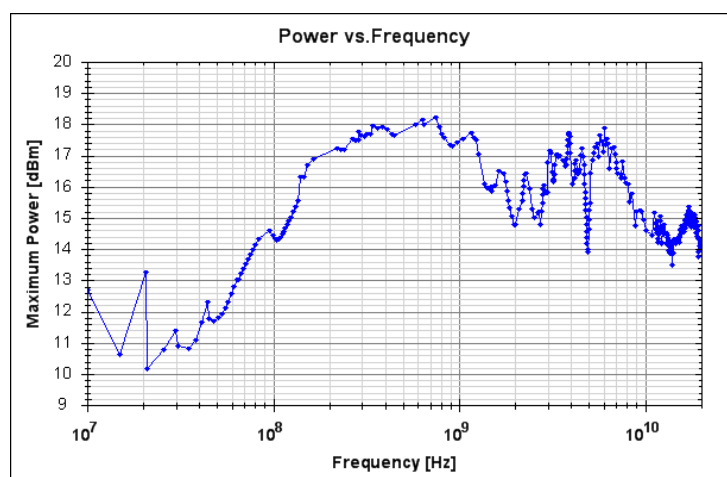

Typical Frequency Response 0 to 20 GHz at -10, 0, and +10 dBm
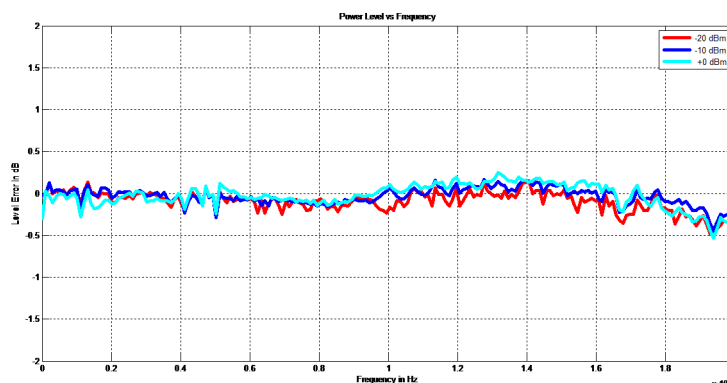
Typical Maximum Output Power (without option 7096)
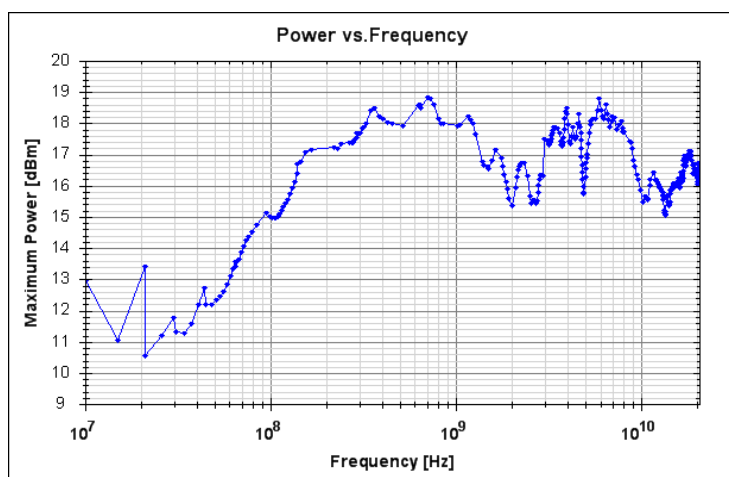
Typical Maximum Output Power (WITH option 7096)
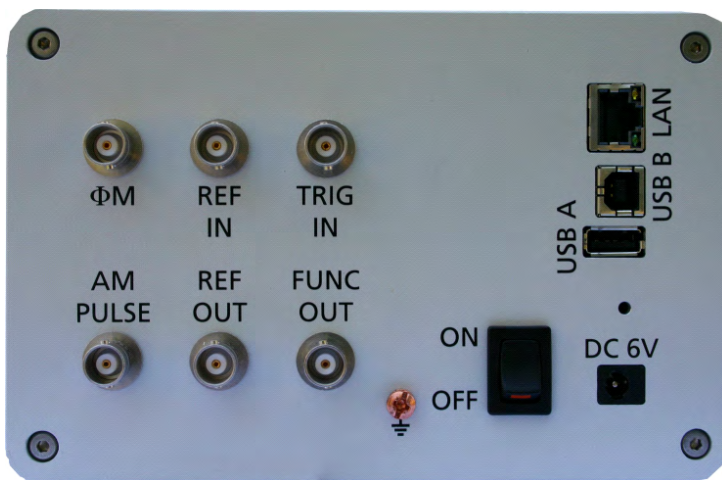
Model 845 Series

Connectors

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

General Characteristics

Options

- 7096: Extended power range down to <-90 dBm) step attenuator module
- 7088: battery module (not available for 1U -835-6-R)
- 7094: GPIB IEEE-488.2,1987 programming interface (not available for 1U -835-6-R)
- 7091 / 7092 - 19" rackmount enclosure: good for one or two adjacent units

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 220 mm L
[4.21 in H x 6.77 in W x 8.66 in L]
Recommended calibration cycle 24 months

Remote programming interfaces	Power requirements: 6 VDC; 20 W maximum
Ethernet 100BaseT LAN interface,	Mains adapter supplied: 100-240 VAC in/ 6V, 3.3A DC out
USB 2.0 host & device	Operating temperature range: 0 to 40 °C
GPIB (IEEE-488.2,1987) with listen and talk (optional)	Storage temperature range: –40 to 70 °C
Control language SCPI Version 1999.0	Operating and storage altitude up to 15,000 feet

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

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