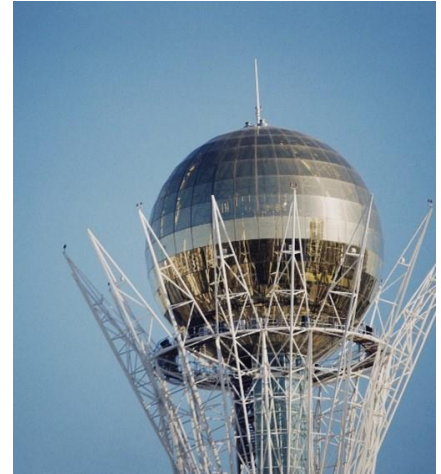


Model 871

Single- or Multi-Channel Signal Generator



Features

- Wide & accurately leveled output power range
- Fast switching of 5 μ s (option FS)
- Outstanding phase noise, harmonic, and spurious performance
- Sweep, trigger function, and user-programmable external reference frequency from 1 to 250 MHz

Applications

- ATE
- Production testing
- R&D low noise signal source
- Defense & Aerospace



Model 871
1 kHz to 51 GHz

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DEFINITIONS

The specifications in the following pages describe the warranted performance of the instrument for 23 ± 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

The Model 871 is a series of phase-coherent, single or multi-channel, ultra-fast switching and ultra-low phase noise signal generators with a frequency range from 1 kHz to 12, 20, 40, and 51 GHz. It is ideally suited for a wide range of applications, where good signal quality, accurate and wide output power ranges, and very stable phase coherence among all channels are required. Outstanding phase noise is combined with good spurious, harmonic rejection and leading-edge switching speed of 5 μ s.

A high-stability OCXO reference provides excellent frequency accuracy and stability. The generator accepts a wide range of external references including the commonly used 10 and 100 MHz for higher phase synchronization, and a flexible reference choice in the range of 1-250 MHz for those applications with customer- or system-specific reference frequencies. Moreover, the Model 871 features a pair of BNC-specific high-frequency CLK ports (3 GHz, one input and one output) that enables excellent phase synchronization among the outputs of multiple BNC instruments with similar ports.

The Model 871 comes in a desktop enclosure (single-channel) or 19-inch 2U (up to 4 channels) rack-mountable module form. It can be intuitively controlled by a PC based GUI Software. Moreover, the instrument offers various communication interfaces like USB, LAN or GPIB. Each interface allows for easy and fast communication using SCPI 1999 command set. Remote control of the instrument can be quickly achieved from any host system. A customer-supplied application programming interface (API) or programming examples for MATLAB, LabVIEW, C++ and other commercially available tools make the control implementation very straightforward.

SPECIFICATIONS

Signal Specifications

PARAMETER	MIN	TYPICAL	MAX	NOTE
Channels	1		4	
Frequency Ranges				
871-12	10 MHz		12.75 GHz	
871-20	10 MHz		20 GHz	
871-40	10 MHz		40 GHz	
871-50	10 MHz		51 GHz	
	1 kHz		fmax	Option 1K
Resolution		<0.001 Hz		
Phase Adjustment Range	0 deg		360 deg	Individually adjustable per channel
Phase Resolution		0.1 deg		
Switching Time				Frequency > 10 MHz After SCPI command received
CW Mode		1.5 ms		
Sweep/List Mode			100 μs	
		3 μs	5 μs	Option FS
Thermal Drift		0.015 dB / °C		

Frequency Reference

PARAMETER	MIN	TYPICAL	MAX	NOTE
Internal Reference Frequency		100 MHz 10 MHz		Option LN(+)
Temperature stability 0 to 50 °C			±100 ppb ±20 ppb	Option LN(+)
Aging 1 st year			1000 ppb 30 ppb 20 ppb	Option LN Option LN+
Aging per day			5 ppb 0.5 ppb < 0.5 ppb	After 30 days operations Option LN Option LN+
Warm-up time		5 min		
Output of internal reference		1, 5, 10, 20, 25, 50, 100 MHz		REF OUT port High phase synchronous mode
Output of High Frequency Clock		3 GHz		CLK OUT port High phase synchronous mode
Output Power	+10 dBm +5 dBm		+13 dBm +10 dBm	3 GHz 1-100 MHz
Output Impedance		50 Ohms		
Phase lock to external reference	1 MHz	10, 100 MHz Integer MHz	250 MHz	STD or Option LN(+) Option VREF
High Frequency Clock Input (Bypass Internal References)		3 GHz		CLK IN port High phase synchronous mode
Reference input level				
1 to 250 MHz	-10 dBm	0 dBm	+10 dBm	
3 GHz	+10 dBm		+13 dBm	
Lock Range				
LN(+), LN(+)+VREF			±0.3 ppm	
STD, STD+VREF			±1.5 ppm	
Reference Input Impedance		50 Ω		



Spectral Purity

Absolute SSB Phase Noise in dBc/Hz

Specified values in plain text, typical values in brackets. CW, level = 10 dBm or maximum available output power, whichever is lower.

OFFSET	10 Hz	100 Hz	1 kHz	20 kHz	100 kHz	1 MHz	10 MHz
FREQUENCY							
100 MHz	-100 (-105)	-130 (-135)	-154 (-159)	-150 (-155)	-156 (-161)	-156 (-161)	-156 (-161)
1 GHz	-80 (-85)	-110 (-115)	-143 (-145)	-150 (-153)	-150 (-152)	-153 (-155)	-153 (-155)
4 GHz	-68 (-73)	-98 (-103)	-132 (-135)	-144 (-147)	-147 (-150)	-153 (-156)	-153 (-155)
10 GHz	-60 (-65)	-90 (-95)	-124 (-127)	-136 (-139)	-140 (-143)	-145 (-148)	-144 (-146)
20 GHz	-54 (-59)	-84 (-89)	-118 (-121)	-130 (-133)	-134 (-137)	-139 (-142)	-138 (-140)
40 GHz	-48 (-53)	-78 (-83)	-112 (-115)	-124 (-127)	-128 (-131)	-133 (-136)	-132 (-134)
50 GHz	-46 (-51)	-76 (-81)	-110 (-113)	-122 (-127)	-126 (-129)	-131 (-134)	-130 (-132)

Absolute SSB Phase Noise with LN(+) Option in dBc/Hz

Specified values in plain text, typical values in brackets. CW, level = 10 dBm or maximum available output power, whichever is lower

OFFSET	10 Hz	100 Hz	1 kHz	20 kHz	100 kHz	1 MHz	10 MHz
FREQUENCY							
100 MHz	-120 (-123)	-130 (-135)	-154 (-159)	-150 (-155)	-156 (-161)	-156 (-161)	-156 (-161)
1 GHz	-100 (-103)	-110 (-115)	-143 (-145)	-150 (-153)	-150 (-152)	-153 (-155)	-153 (-155)
4 GHz	-88 (-91)	-98 (-103)	-132 (-135)	-144 (-147)	-147 (-150)	-153 (-156)	-153 (-155)
10 GHz	-80 (-83)	-90 (-95)	-124 (-127)	-136 (-139)	-140 (-143)	-145 (-148)	-144 (-146)
20 GHz	-74 (-77)	-84 (-89)	-118 (-121)	-130 (-133)	-134 (-137)	-139 (-142)	-138 (-140)
40 GHz	-68 (-71)	-78 (-83)	-112 (-115)	-124 (-127)	-128 (-131)	-133 (-136)	-132 (-134)
50 GHz	-66 (-69)	-76 (-81)	-110 (-113)	-122 (-127)	-126 (-129)	-131 (-134)	-130 (-132)

Harmonics, Subharmonics, Non-Harmonics

PARAMETER	MIN	TYPICAL	MAX	NOTE
Harmonics				At +10 dBm output power
1 kHz to 350 MHz		-35 dBc	-30 dBc	
350 MHz to 8 GHz		-60 dBc	-50 dBc	
8 GHz to 22 GHz		-65 dBc	-55 dBc	
22 GHz to 30 GHz		-25 dBc	-20 dBc	
30 GHz to 51 GHz		-60 dBc	-50 dBc	
Sub-Harmonics				At +10 dBm output power
1 kHz to 350 MHz		-80 dBc		
350 MHz to 12.75 GHz		-75 dBc	-65 dBc	Incl. high-order subharmonics
12.75 GHz to 51 GHz		-70 dBc	-50 dBc	
Non-Harmonic Spurious				10 kHz to 0.5 GHz offset from carrier
1 kHz to 350 MHz		-90 dBc	-80 dBc	
350 MHz to 4.5 GHz		-85 dBc	-80 dBc	
4.5 GHz to 12.75 GHz		-80 dBc	-75 dBc	
12.75 GHz to 25.5 GHz		-75 dBc	-70 dBc	
25.5 GHz to 51 GHz		-70 dBc	-65 dBc	

RMS Jitter

CARRIER FREQUENCY	MIN	TYPICAL	MAX	NOTE
155 MHz		11 fs	15 fs	BW 100 Hz to 1.5 MHz
622 MHz		8.5 fs	10 fs	BW 1 kHz to 5 MHz
1 GHz		15 fs	20 fs	BW 10 Hz to 10 MHz
2.488 GHz		8.5 fs	10 fs	BW 5 kHz to 20 MHz
9.952		8.5 fs	10 fs	BW 10 kHz to 80 MHz

Figure 1: Phase noise at different frequencies. Option LN(+). (20 dBm or maximum power whichever is lower)

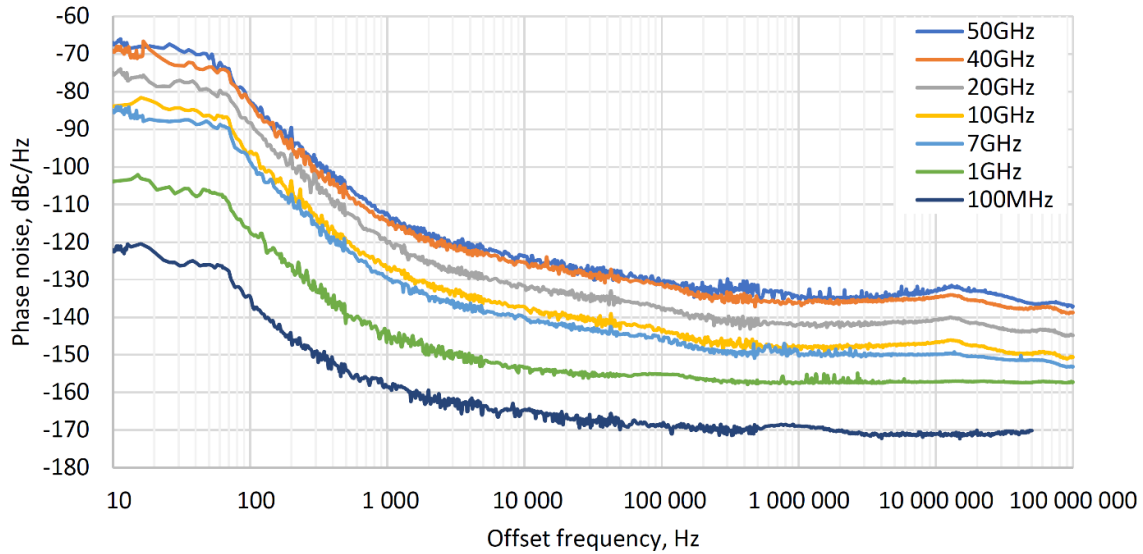


Figure 2: 3 GHz CLK out signal phase noise. Option LN(+)

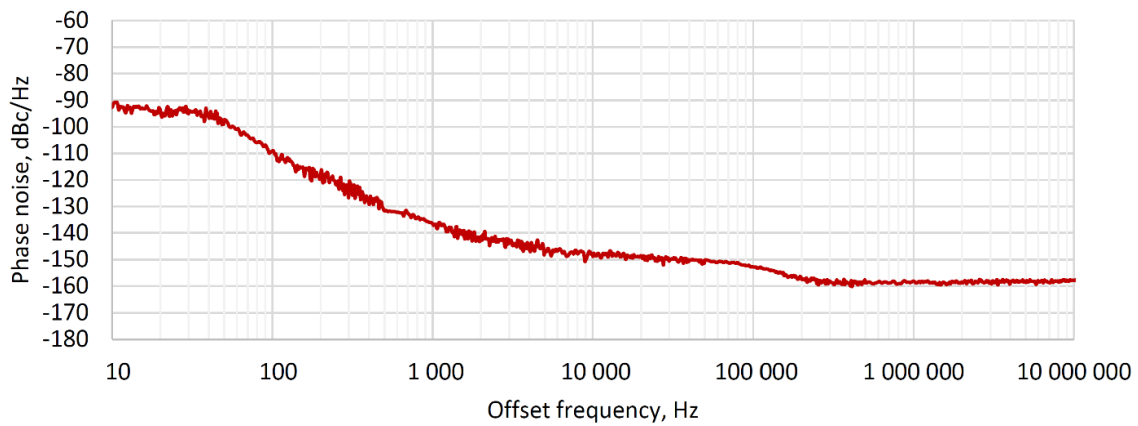


Figure 3: Amplitude noise at different frequencies. Power level +10 dBm

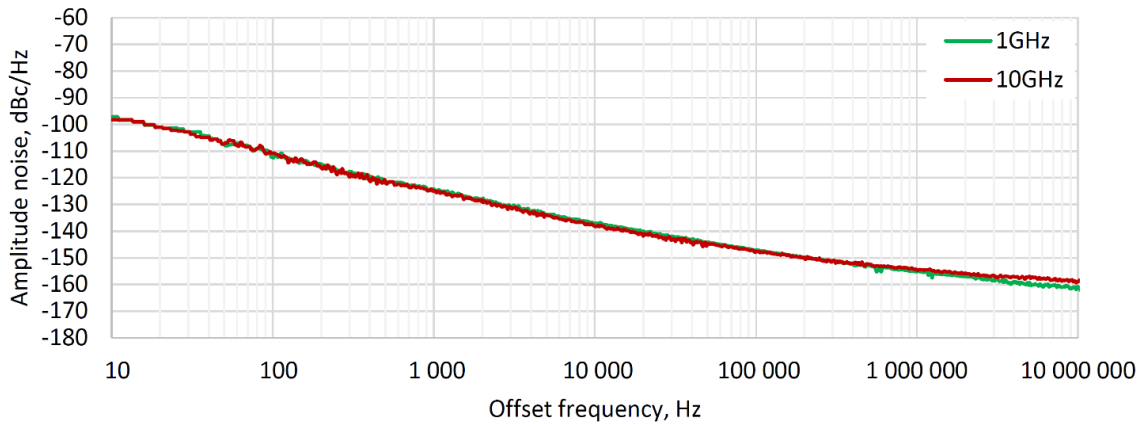


Figure 4: 2nd harmonic levels at different output power levels (+20 dBm or maximum power whichever is lower)

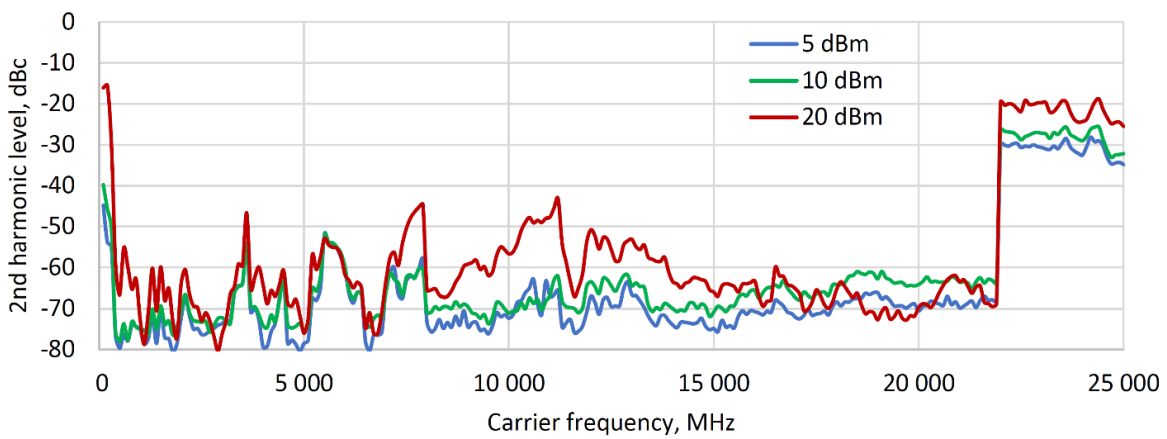
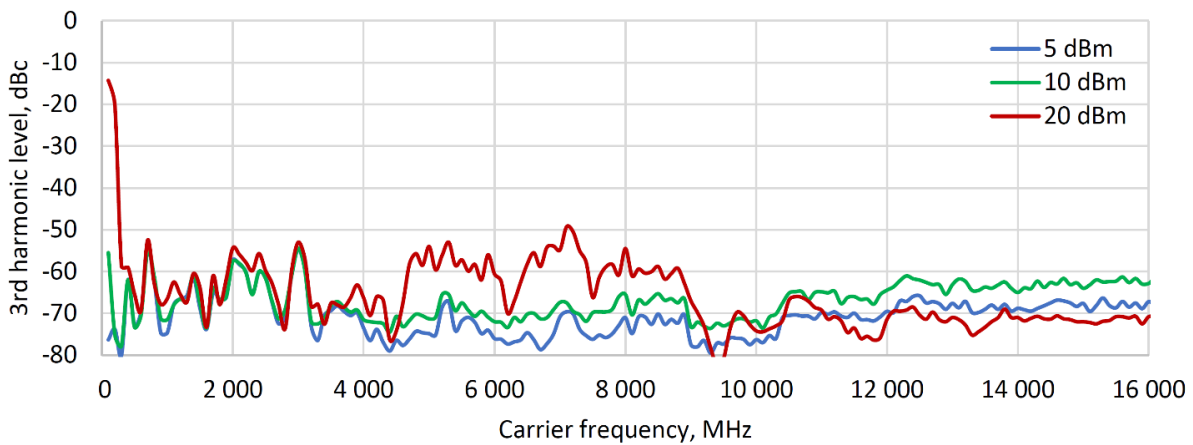


Figure 5: 3rd harmonic levels at different output power levels (+20 dBm or maximum power whichever is lower)



Level Performance

PARAMETER	MIN	TYPICAL	MAX	NOTE
Output Power Level				
1 kHz to 1 MHz	-20 dBm		+10 dBm	
1 MHz to 10 MHz	-20 dBm		+12 dBm	
10 MHz to 2.5 GHz	-20 dBm		+18 dBm	
2.5 GHz to 44 GHz	-20 dBm		+19 dBm	
44 GHz to 51 GHz	-20 dBm		+15 dBm	

Output Power Level				Option PE2
1 kHz to 1 MHz	-120 dBm		+10 dBm	
1 MHz to 10 MHz	-120 dBm		+12 dBm	
10 MHz to 2.5 GHz	-120 dBm		+16 dBm	
2.5 GHz to 44 GHz	-120 dBm		+18 dBm	
44 GHz to 51 GHz	-110 dBm		+12 dBm	
Power Resolution		0.01 dB		
Reverse Power Protection				
DC Voltage			0 V	
RF Power			26 dBm	
Output Impedance		50 Ohms		
VSWR		1.3	1.5	<15 GHz
		1.6	1.8	15 to 35 GHz
		1.9	2.2	> 35 GHz

Power Level Error

Specified values in plain text, typical values in brackets

FREQUENCY RANGE	-110 to -50 dBm Option PE2	-50 to -15 dBm Option PE2	-15 to +15 dBm	+15 dBm to Max Power
1 kHz to 10 MHz	2.0 dB	1.2 dB	1 dB (0.5 dB)	1.3 dB
10 MHz to 1 GHz	2.0 dB	1.3 dB	0.8 dB (0.15 dB)	1.3 dB
1 to 22 GHz	2.0 dB	1.8 dB	0.5 dB (0.2 dB)	2.0 dB
22 to 42 GHz	2.3 dB	2.0 dB	1.2 dB (0.4 dB)	2.0 dB
42 to 51 GHz	2.5 dB	2.0 dB	1.3 dB (0.4 dB)	2.5 dB

Relative Power Level Error (0.1 dB steps)

Specified values in plain text, typical values in brackets.

FREQUENCY RANGE	-110 to -50 dBm Option PE2	-50 to -15 dBm Option PE2	-15 to +15 dBm	+15 dBm to Max Power
1 kHz to 10 MHz	2.0 dB	1.2 dB	1 dB (0.5 dB)	1.3 dB
10 MHz to 1 GHz	2.0 dB	1.3 dB	0.8 dB (0.15 dB)	1.3 dB
1 to 22 GHz	2.0 dB	1.8 dB	0.5 dB (0.2 dB)	2.0 dB
22 to 42 GHz	2.3 dB	2.0 dB	1.2 dB (0.4 dB)	2.0 dB
42 to 51 GHz	2.5 dB	2.0 dB	1.3 dB (0.4 dB)	2.5 dB

Relative Power Level Error (0.1 dB step)

Specified values in plain text, typical values in brackets

FREQUENCY RANGE	-110 to -50 dBm Option PE2	-50 to -15 dBm Option PE2/PE4	-15 to +15 dBm	+15 dBm to Max Power
1 kHz to 10 MHz	(< 0.1 dB)	0.5 dB (< 0.1 dB)	0.5 dB (< 0.1 dB)	(< 0.1 dB)
10 MHz to 1 GHz	(< 0.1 dB)	(< 0.1 dB)	(< 0.1 dB)	(< 0.1 dB)
1 to 51 GHz	(< 0.1 dB)	(< 0.1 dB)	(< 0.1 dB)	(< 0.1 dB)

Figure 6: Maximum power level statistics over 20 devices

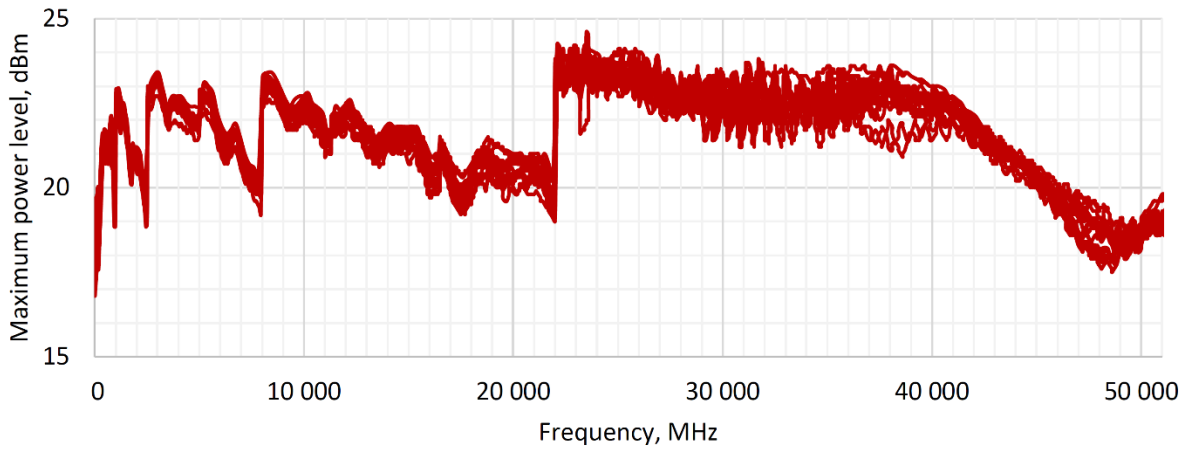


Figure 7: Power level error between -15 and +15 dBm over frequency

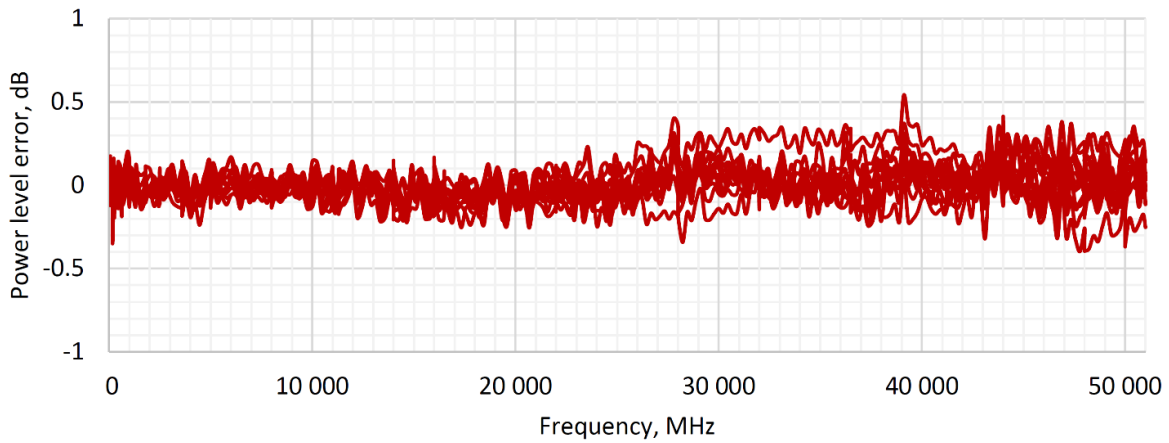
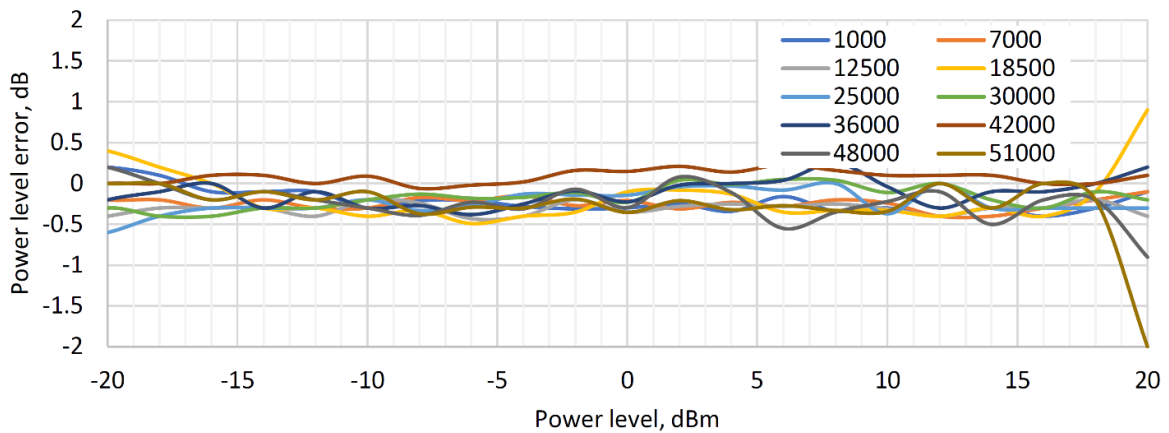


Figure 8: Absolute power level error at different frequencies



Modulation Capabilities

PARAMETER	MIN	TYPICAL	MAX	NOTE
Pulse Modulation				Option Pulse
Modulation Source		Internal / external		
External input amplitude		TTL		
Pulse rise/fall time		3 ns	5 ns	
On/off ratio (power >= +5 dBm)	80 dB	95 dB		
Pulse overshoot			10%	
Pulse delay		20 ns		

Pulse polarity		Normal, inverse		Selectable
Internal Pulse Generator				
Repetition Frequency (PRF)	0.1 Hz		50 MHz	= 1/T
Duty Cycle	1% to 99% in 1% steps			Within specified minimum pulse width
Pulse Pattern Modulation & Staggered PRF				Using internal pattern generator
Pulse width	10 ns		20 s	
Programmable pattern length	2		65536	
Duty cycle	0.05%		99.95%	
Pulse width resolution		5 ns		
Pulse period (T) accuracy		$5 \cdot 10^{-6} \cdot T +$ 3ns		
Pulse width accuracy		$5^{-6} \times T + 5\text{ns}$		
Pulse jitter		2 ns	5 ns	
Polarity		Selectable		
Amplitude Modulation				
Modulation source		Internal		Option MOD
Modulation depth	0		100%	
Depth accuracy			$0.05 \cdot \text{Depth} + 2$	
Depth resolution		1%		
Distortion (THD)			3%	
Modulation rate	DC		30 kHz	
Modulation waveforms				
Frequency Modulation				
Modulation source				Option MOD
Maximum frequency deviation (peak)			N·5 MHz	See Deviation Table Below
Deviation accuracy			$0.01 \cdot \text{Dev} + 2\text{Hz}$	
Distortion (THD)			3%	
Modulation rate	DC		30 kHz	
Modulation waveforms		Sine		
Phase modulation				
Modulation source				Option MOD
Phase deviation (peak)			N·100 rad	
Deviation accuracy			$0.01 \cdot \text{Dev} + 1 \text{ mrad}$	
Modulation rate	DC		30 kHz	
Distortion (THD)			3%	
Modulation waveforms				

Output Frequency	N Value
1 kHz to <350 MHz	1
350 to < 562.5 MHz	1/16
562.5 to <1125 MHz	1/8
1.125 to <2.25 GHz	1/4
2.25 to <4.5 GHz	1/2
4.5 to <12.75 GHz	1
12.75 to <25.5 GHz	2
25.5 to 51 GHz	4

Deviation Table

Figure 9: Pulse Modulation ON/OFF Ratio over frequency at different output power levels (+20 dBm or maximum power whichever is lower)

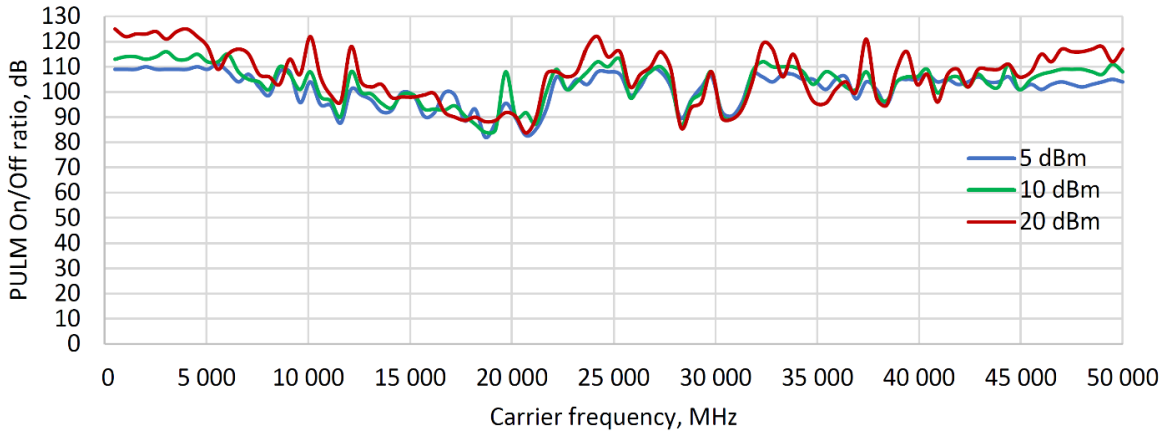


Figure 10: 10 GHz pulse-modulated signal

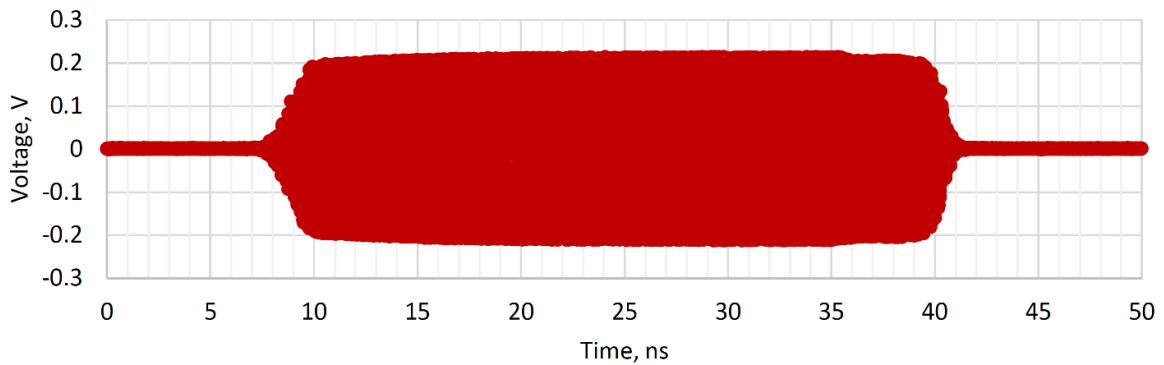
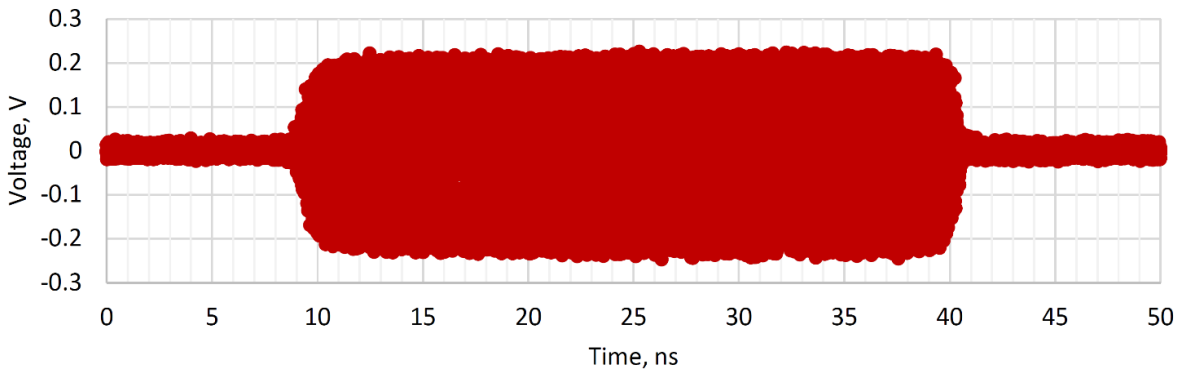


Figure 11: 50 GHz pulse-modulated signal



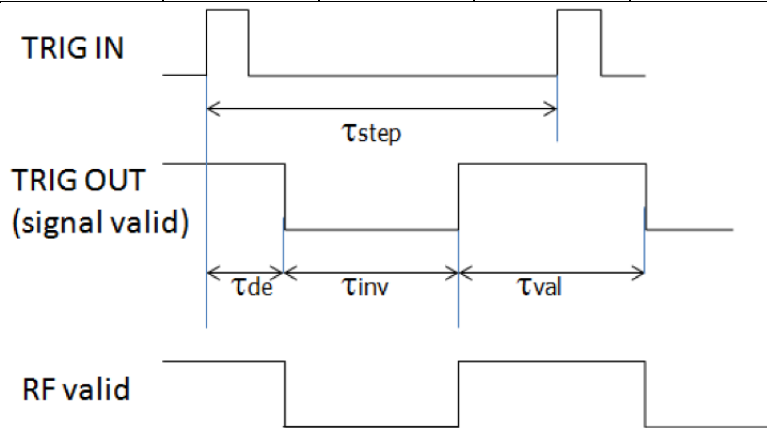
Sweeping Capability

PARAMETER	MIN	TYPICAL	MAX	NOTE
Sweep Parameters	Frequency, power, phase, list			
Sweep Type	Linear			
Step time ($t_{step} = t_{dwell} + t_{off}$)	500 μ s 5 μ s		19998 s 19998 s	Option FS
Dwell time (t_{dwell})	0 μ s		9999 s	
Off time (t_{off})	0 μ s		9999 s	
Time resolution		5 ns		
Timing delay (τ_{de})		50 ns		
Transient time (τ_{inv})			5 μ s	

Timing accuracy per point		5 ns		
Number of points	2		10000	Per channel

Trigger (TRIG IN)

PARAMETER	MIN	TYPICAL	MAX	NOTE
Trigger types	Continuous, Single (point), Gated, Gated, direction			
Trigger source	External, Bus (LAN, USB)			
Trigger modes	Continuous free run, Trigger and run, Reset and run			
Trigger latency		5 ns		
Trigger uncertainty		10 ns		
External trigger delay	50 ns		40 s	settable
External delay resolution		5 ns		
Trigger modulo	1		255	Execute only on Nth trigger event
Trigger polarity	Rising, Falling			
External trigger input threshold	0.85 V	0.9 V	0.95 V	TTL compatible
External trigger input voltage range	-0.5 V		+5.5 V	TTL compatible
External trigger input hysteresis		60 mV		

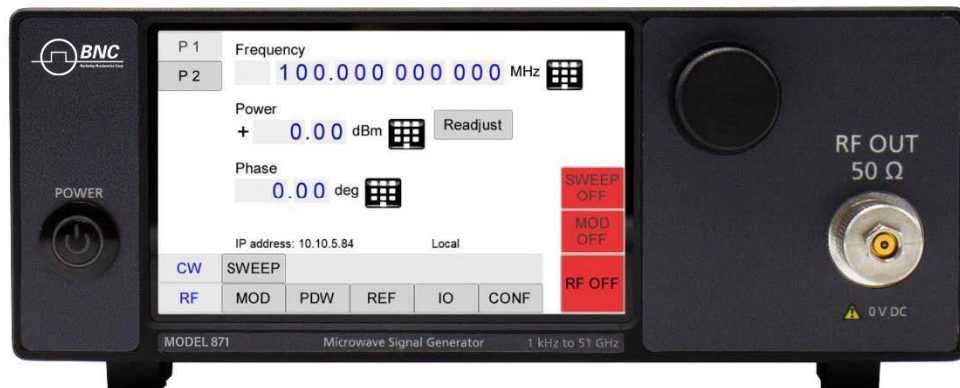


Multi-Purpose Output (FUNC OUT)

PARAMETER	MIN	TYPICAL	MAX	NOTE
PULM VIDEO OUTPUT				
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 Signal valid			

CONNECTORS

Single-Channel Front Panel (Desktop enclosure)



- Power switch
- Rotary knob
- RF outputs:
 - 871-12/20: 3.5 mm male (female flange-mount optional)
 - 871-40: 2.92 mm male hand-tight (female flange-mount optional)
 - 871-50: 1.85/2.4 mm male hand-tight (female flange-mount optional)

Single-Channel Rear Panel (Desktop enclosure)



- Trigger output (TRIG OUT): BNC female
- PULSE IN: Pulse modulation input: BNC female
- Reference input (REF IN): BNC female
- High Stability Reference input (CLK IN, 3 GHz): SMA female
- Trigger input (TRIG IN): BNC female
- Reference output (REF OUT): BNC female
- High Stability Reference output (CLK OUT, 3 GHz): SMA female
- GPIB: IEEE-488.2, 1987 with listen and talk (optional)
- LAN connection: RJ-45
- USB 2.0 device
- Card slot (SD)
- 100-240V AC power plug
- Ground reference screw (earth) M4

Multi-Channel Front Panel (19" 2 U)



- RF outputs:
 - 871-12/20: SMA female
 - 871-40: 2.92 mm female
 - 871-50: 1.85/2.4 mm female

Multi-Channel Rear Panel (19" 2 U)

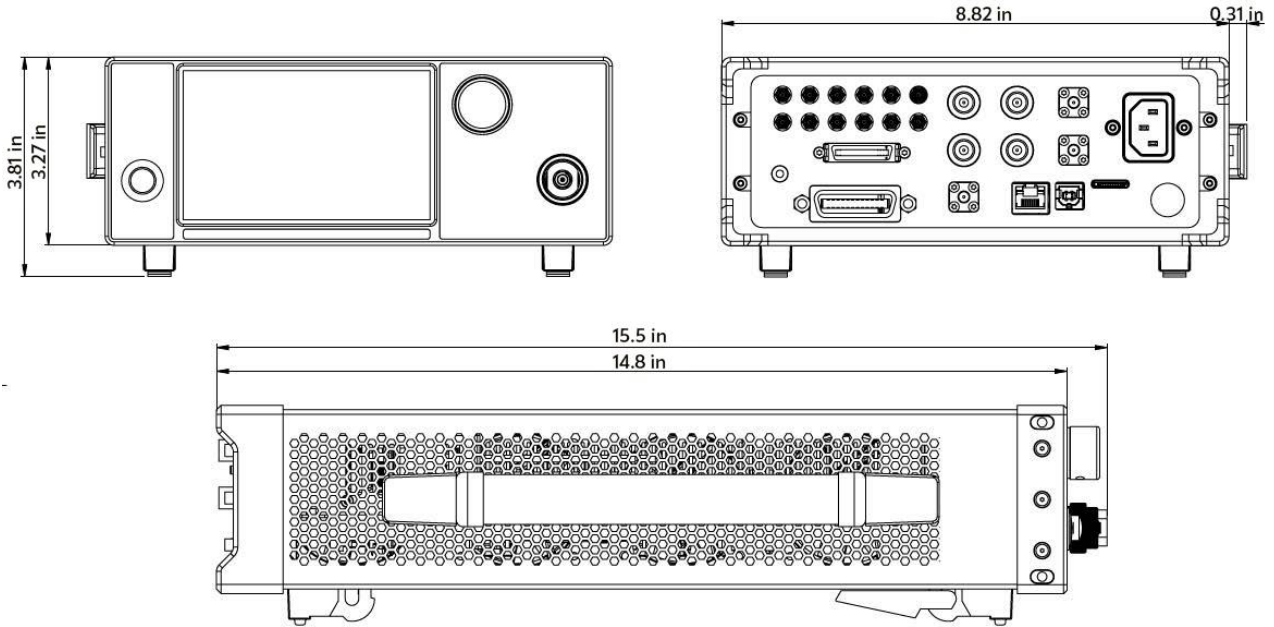


- Unit-to-unit synchronization signal input (SYNC IN): SMA female
- Unit-to-unit synchronization signal output (SYNC OUT): SMA female
- Channel 1, 2, 3, 4 PULM input: BNC female
- Fast control port (FCP): 36-pin mini-D female 3M MDR 102 series
- High Stability Reference input (CLK IN, 3 GHz): SMA female
- High Stability Reference output (CLK OUT, 3 GHz): SMA female
- Trigger input (TRIG IN): BNC female
- Trigger output (TRIG OUT): BNC female
- Reference input (REF IN): BNC female
- Reference output (REF OUT): BNC female
- GPIB: IEEE-488.2, 1987 with listen and talk (optional)
- LAN connection: RJ-45
- USB 2.0 device
- Card slot (SD)
- FUSE (3.15 A)
- 100-240V AC power plug
- Power switch
- Ground reference screw (earth) M4

MECHANICAL SPECIFICATIONS

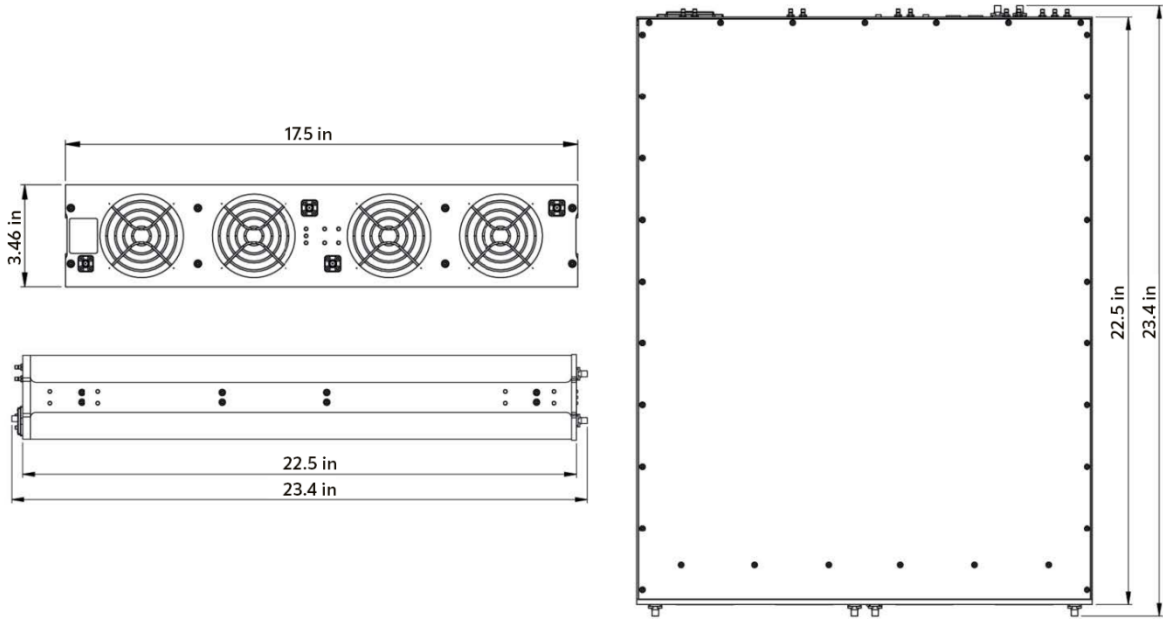
Desktop enclosure: Dimensions & weight

Including connectors	W x L x H = 9.1 x 15.5 x 3.8 in [232 x 393 x 96.75 mm], ≤22 lbs [10 kg]
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Rackmount 19" 2 U: Dimensions & Weight

Including connectors	W x L x H = 17.5 x 23.4 x 3.5 in [444 x 594 x 88 mm], ≤39.7 lbs [18 kg]
----------------------	---



ORDERING INFORMATION

Host Model No.	Product	Description
871	871-12	High performance signal generator up to 12.75 GHz
871	871-20	High performance signal generator up to 20 GHz
871	871-40	High performance signal generator up to 40 GHz
871	871-50	High performance signal generator up to 51 GHz
871-XX-X	871-XX-1	1-channel signal generator, 19" 1U rack-mount module
871-XX-X	871-XX-2	2-channel signal generator, 19" 1U rack-mount module
871-XX-X	871-XX-3	3-channel signal generator, 19" 1U rack-mount module
871-XX-X	871-XX-4	4-channel signal generator, 19" 1U rack-mount module
871-XX-X	Option FS	Ultra-fast frequency/power switching
871-XX-X	Option 1K	Frequency range extension up to 1 kHz
871-XX-X	Option LN	Enhanced close in phase noise and frequency stability
871-XX-X	Option LN+	Option LN with improved long term frequency stability
871-XX-X	Option VREF	External reference frequency in range 1 to 250 MHz
871-XX-X	Option MOD	Analog modulations
871-XX-X	Option PULSE	Pulse modulation
871-XX-X	Option PE2-12/20/40	Mechanical step attenuator down to -120 dBm for 12, 20 and 40 GHz models
871-XX-X	Option PE2-50	Mechanical step attenuator down to -110 dBm for 51 GHz models
871-XX-X	Option FLASH	MicroSD card slot for removable SD memory
871-XX-X	Option GBIB	GPIB interface

GENERAL CHARACTERISTICS

Remote programming interfaces:

- Gbit Ethernet interface
- USB 2.0 device
- GPIB (IEEE-488.2,1987) with listen and talk (Option GPIB)
- Control Language SCPI Version 1999.0

Power requirements: 100 - 240 VAC, 50 or 60 Hz, 280W maximum (80W + 50W per channel)

Environmental: Levels similar to MIL-PRF-28800F Class ¾



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

Weight:

- Multi-Channel: 19" 2U HI enclosure 39.7 lbs. (18 kg)
- Single-Channel: desktop enclosure ≤22 lbs. (10 kg)

Dimensions:

- Multi-Channel: 19" 2U HI enclosure W x L x H = 17.5 x 23.4 x 3.5 in [444 x 594 x 88 mm]
- Single-Channel: Desktop enclosure W x L x H = 9.1 x 15.5 x 3.8 in [232 x 393 x 96.75 mm]

