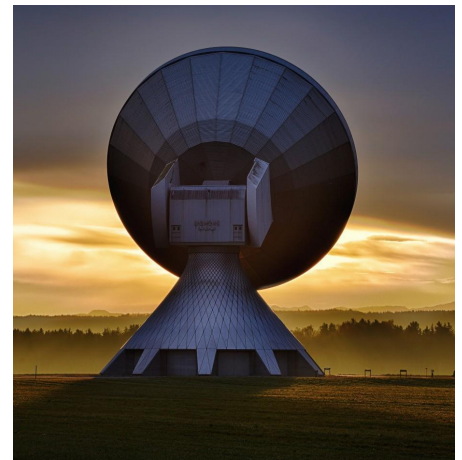


Model 865 RF / Ultra Low Noise Microwave Signal Generator



Features

- Excellent Signal Purity: Ultra-Low Phase Noise and Low Spurious
- Combination of Highest Output Power and Fastest Switching
- Powerful Touch-Display Control
- Portable, External Battery Modules Available

Applications

- ATE
- R&D Low Noise Signal Source
- Signal Simulation
- Product Testing
- Service and Maintenance
- Aerospace and Defense



Model 865 Datasheet v1.39

100 kHz to 40 GHz RF / Ultra Low
Noise Microwave Signal Generator

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

Ultra-Low Noise Microwave Signal Generator 8 kHz to 12.75, 20, 26 and 40 GHz

The Model 865 is an ultra-low-noise and fast-switching microwave signal generator covering a continuous frequency range from 100 kHz (8 kHz with option) up to 12.75, 20 GHz, 26 or 40 GHz, respectively, with a lower than 0.001 Hz resolution.

The Model 865 provides an accurately leveled output power range and high spurious suppression. Advanced frequency synthesis combines the fastest switching speed with ultra-low SSB phase noise and fine frequency and power resolution.

The Model 865 supports analog AM, FM, PM modulation, as well as frequency chirps and pulse modulation with programmable patterns and narrow pulses.

The Model 865 allows for fast digital sweeps including flexible list sweeps, where frequency, power and dwell times can be set individually. A flexible triggering system simplifies synchronization within test environments.

All Model 865's operate with ultra-stable temperature compensated frequency reference (OCXO) to ensure minimal drift and can be phase-locked to an external reference.

The compact unit allows for full front panel control via touch panel display. It can also 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 the SCPI 1999 command set. Remote control of the instrument can be quickly attained 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.

FACTS & FIGURES & SPECIFICATIONS

Signal Specifications

PARAMETER	MIN	TYPICAL	MAX	NOTE
Frequency Range	100 kHz 100 kHz 100 kHz 100 kHz 8 kHz		12.75 GHz 20 GHz 26 GHz 40 GHz Fmax	Model 865-12 Model 865-20 Model 865-26 Model 865-40 Option 8K
Resolution		0.001 Hz		
Phase Resolution		0.01 deg		
Switching Speed SCPI CW mode Sweep / List Mode		1.5 ms 500 μ s 30 μ s		Valid signal after SCPI received Option FS
SSB Phase Noise at 1 GHz				(see also plots / tables)
at 10 Hz from carrier		-87 dBc/Hz -100 dBc/Hz	-95 dBc/Hz	Option LN
at 1 kHz from carrier		-130 dBc/Hz	-125 dBc/Hz	
at 100 kHz from carrier		-148 dBc/Hz	-144 dBc/Hz	
SSB Phase Noise at 4 GHz				
at 10 Hz from carrier		-74 dBc/Hz -90 dBc/Hz	-70 dBc/Hz -85 dBc/Hz	Option LN
at 1 kHz from carrier		-118 dBc/Hz	-114 dBc/Hz	
at 100 kHz from carrier		-136 dBc/Hz	-132 dBc/Hz	
SSB Phase Noise at 10 GHz				
at 10 Hz from carrier		-67 dBc/Hz -80 dBc/Hz	-62 dBc/Hz -75 dBc/Hz	Option LN
at 1 kHz from carrier		-108 dBc/Hz	-104 dBc/Hz	
at 100 kHz from carrier		-127 dBc/Hz	-123 dBc/Hz	
SSB Phase Noise at 40 GHz				
at 10 Hz from carrier		-55 dBc/Hz -68 dBc/Hz	-50 dBc/Hz -64 dBc/Hz	Option LN
at 1 kHz from carrier		-96 dBc/Hz	-92 dBc/Hz	
at 100 kHz from carrier		-115 dBc/Hz	-111 dBc/Hz	
Harmonics (at +0 dBm Pout) 0.01 to 6 GHz >6GHz >10.5 GHz Option FILT, >1 GHz		-40 dBc -35 dBc -55 dBc -30 dBc -60 dBc	-30 dBc -30 dBc -45 dBc -25 dBc -50 dBc	Model 865-12/20 Model 865-26/40 all models, See plots
Sub-Harmonics (at +0 dBm) <5 GHz 5 - 20 GHz >20 GHz Option FILT, >20 GHz		-75 dBc -70 dBc -55 dBc -65 dBc	-65 dBc -60 dBc -50 dBc -55 dBc	
Non-Harmonic Spurious (at +0 dBm) <1.2 GHz 1.2 - 2.5 GHz 2.5 - 5 GHz 5 - 10 GHz 10 - 20 GHz >20 GHz		-90 dBc -92 dBc -90 dBc -84 dBc -80 dBc -70 dBc	-60 dBc -55 dBc -55 dBc -55 dBc -55 dBc -50 dBc	> 10 kHz offset

PARAMETER	MIN	TYPICAL	MAX	NOTE
Output Power Range (Model 865-20)				
8 to 100 kHz	-25 dBm		+15 dBm	Option 8K
0.1 to 10 MHz	-25 dBm		+24 dBm	
0.01 to 5 GHz	-25 dBm		+26 dBm	
5 to 12.75 GHz	-25 dBm		+24 dBm	
12.75 to 18 GHz	-25 dBm		+22 dBm	
18 to 20 GHz	-25 dBm		+20 dBm	See plots

Output Power Range (Model 865-20 with mechanical step attenuator, option PE)

0.1 to 10 MHz	-90 dBm		+23 dBm	
0.01 to 5 GHz	-90 dBm		+25 dBm	
5 to 12.75 GHz	-90 dBm		+23 dBm	
12.75 to 18 GHz	-90 dBm		+19 dBm	
18 to 20 GHz	-90 dBm		+17 dBm	

Output Power Range (Model 865-20 with mechanical step attenuator, option PE2)

0.1 to 10 MHz	-120 dBm		+23 dBm	
0.01 to 6 GHz	-120 dBm		+25 dBm	
6 to 12.75 GHz	-120 dBm		+22 dBm	
12.75 to 20 GHz	-120 dBm		+19 dBm	
18 to 20 GHz	-120 dBm		+17 dBm	

Output Power Range (Model 865-40)

8 to 100 kHz	-25 dBm		+15 dBm	Option 8K
0.1 to 10 MHz	-25 dBm		+24 dBm	
0.01 to 6 GHz	-25 dBm		+25 dBm	
6 to 12.75 GHz	-25 dBm		+24 dBm	
12.75 to 26 GHz	-25 dBm		+21 dBm	
26 to 40 GHz	-25 dBm		+18 dBm	See plots

Output Power Range (Model 865-40 with electrical step attenuator, option PE4)

0.1 to 10 MHz	-55 dBm		+23 dBm	
0.01 to 6 GHz	-55 dBm		+24 dBm	
6 to 12.75 GHz	-55 dBm		+22 dBm	
12.75 to 20 GHz	-55 dBm		+20 dBm	
20 to 30 GHz	-55 dBm		+17 dBm	
30 to 40 GHz	-55 dBm		+14 dBm	See plots

Output Power Range (Model 865-40 with mechanical step attenuator, option PE)

0.1 to 10 MHz	-90 dBm		+2 dBm	
0.01 to 6 GHz	-90 dBm		+24 dBm	
6 to 12.75 GHz	-90 dBm		+22 dBm	
12.75 to 20 GHz	-90 dBm		+21 dBm	
20 to 30 GHz	-90 dBm		+18 dBm	
30 to 35 GHz	-90 dBm		+17 dBm	
35 to 40 GHz	-90 dBm		+16 dBm	See plots

Output Power Range (Model 865-40 with mechanical step attenuator, option PE2)

0.1 to 10 MHz	-120 dBm		+23 dBm	
0.01 to 6 GHz	-120 dBm		+24 dBm	
6 to 12.75 GHz	-120 dBm		+22 dBm	
12.75 to 20 GHz	-120 dBm		+21 dBm	
20 to 30 GHz	-120 dBm		+17 dBm	
30 to 35 GHz	-120 dBm		+16 dBm	

35 to 40 GHz	-120 dBm		+15 dBm	See plot
Output Power Range (with Option FILT)				
0.1 to 10 MHz	-30 dBm		+15 dBm	
0.01 to 20 GHz	-30 dBm		+13 dBm	
20 to 40 GHz	-30 dBm		+10 dBm	See plot
Power Resolution		0.01 dB		
Power Level Uncertainty				
<6 GHz		0.25 dB	0.8 dB 1.2 dB 2.0 dB	-15 to +15 dBm -60 to -15 dBm or >15 dBm -100 to -60 dBm
6 to 12.75 GHz		0.3 dB	0.9 dB 1.3 dB 2.0 dB	-15 to +15 dBm -60 to -15 dBm or >15 dBm -100 to -60 dBm
12.75 to 26 GHz		0.3 dB	1.0 dB 1.6 dB 2.5 dB	-15 to +15 dBm -60 to -15 dBm or >15 dBm -100 to -60 dBm
26 to 40 GHz		0.4 dB	1.2 dB 2.5 dB 5.0 dB	-15 to +15 dBm -55 to -15 dBm or >15 dBm -100 to -60 dBm
Output Power Range (with Option FILT, PE2)				
0.1 to 10 MHz	-120 dBm		+15 dBm	
0.01 to 20 GHz	-120 dBm		+13 dBm	
20 to 35 GHz	-120 dBm		+10 dBm	
35 to 40 GHz	-120 dBm		+6 dBm	See plot
Reverse Power Protection				
DC Voltage			±10 V	
RF Power			30 dBm	
Output Impedance		50 Ohms		
VSWR		1.4	1.9	



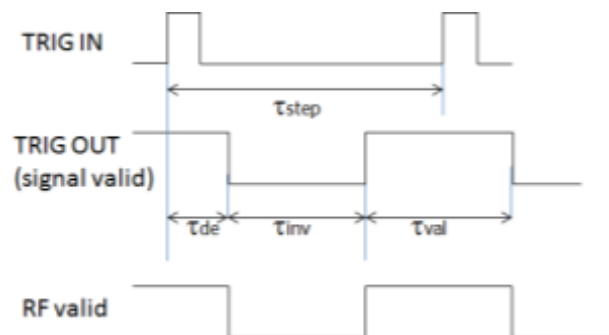
Modulation Capabilities (Option MOD)

PARAMETER	MIN	TYPICAL	MAX	NOTE
Pulse Modulation				
Modulation Source		Internal/ External		
Pulse Rise/Fall Time		5 ns		
On/Off Ratio (High ON/OFF Mode)		80 dB 75 dB	70 dB 65 dB	Pout > +10 dBm, f<18 GHz > 18 GHz
Pulse Overshoot			10%	
Pulse Delay		20 ns		
Pulse Polarity		Normal, inverse		selectable
External Input Threshold	0.85 V	0.9 V	0.95 V	TTL compatible
External Input Voltage Range	-0.5 V		+5.5 V	TTL compatible
External Input Hysteresis		60 mV		
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
Minimum Pulse Settling Range	100 ns 20 ns		20 s 20 s	Option FS or Option NP
Pulse Pattern Modulation & Staggered PRF				Using internal pattern generator
Programmable Pattern Length	2		65536	
Duty Cycle	0.05%		99.95%	
Pulse Width Resolution		5 ns		
Pulse Period (T) Accuracy		0.00005xT+ 3ns		
Pulse Width Accuracy		0.00005xT+ 5ns		
Pulse Jitter		1 ns		
Polarity		selectable		
Amplitude Modulation				
Modulation Source		Internal		
Modulation Depth	0%		80%	Settable to 95%
Deviation Accuracy		2%	4%	1 kHz rate, 30% depth
Deviation Resolution		1%		
Distortion (THD)		1%	3%	1 kHz rate, 30% depth
Modulation Rate	0.1 Hz		30 kHz	
Modulation Waveforms	Sine			
Chirped Pulse Modulation				
Modulation Source		Internal		Option FS & MOD
Chirp Span	1 Hz		3 %	of RF
Chirp Rate	1 Hz		100 kHz	
Pulse Width	10 µs 500 µs		1 sec	Option FS Option NP
Chirp Slope			0.5% / µs	of RF
Chirp Mode		Linear, exponential, up, down, bidirectional		

PARAMETER	MIN	TYPICAL	MAX	NOTE
Frequency Modulation				
Modulation Source		Internal/ (External)		
Maximum Frequency Deviation (Peak)	N · 200 MHz			< 1.25 GHz (N=1) 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) 20 GHz to 40 GHz (N=2)
Deviation Accuracy		0.50%	2%	
Distortion (THD)		< 1 %		1 kHz rate, 10 kHz deviation
Modulation Rate	0.1 Hz		80 kHz	
Modulation Waveforms	Sine			
External Input Voltage Range	0 V		+10 V	Input voltage must be positive
External Input Termination		600 Ohms		Internal termination
External Input Coupling		AC		Cutoff 1 Hz typical (-3 dB) DC coupling on request
Phase Modulation				
Modulation Source		Internal/ (External)		
Phase Deviation (Peak)	0		300 · N· rad	
Deviation Accuracy		0.50%	2%	
Modulation Rate	0.1 Hz		80 kHz	
Modulation Waveforms	Sine			
Distortion (THD)	< 1%			1 kHz rate & N x rad deviation
External Input Voltage Range	0 V		+10 V	Input voltage must be positive
External Input Termination		600 Ohms		Internal termination
External Input Coupling		AC		Cutoff 1 Hz typical (-3 dB)

Sweeping Capability

PARAMETER	MIN	TYPICAL	MAX	NOTE
Sweep Parameters				
Sweep Types	Frequency, power, phase, list			
	Linear, logarithmic, random			
Step Time (t_{step})	500 μ s 30 μ s		19998 s 19998 s	Option FS
Settling Time (t_{inv})			15 μ s	To stabilize phase and amplitude, depends on frequency step
Trigger Latency (t_{de})			1 μ s	Time from trigger to initiate signal transient
Time Resolution		5 ns		
Timing Accuracy Per Point		5 ns		





Frequency Reference

PARAMETER	MIN	TYPICAL	MAX	NOTE
Internal Reference Frequency		100 MHz 10 MHz		Option LN
Temperature Stability 0 to 50 degC			±100 ppb ±20 ppb	Option LN
Aging 1st Year			1 ppm 0.3 ppm 0.02 ppm	Option LN Option LN+
Aging Per Day			5 ppb 0.5 ppb	after 30 days operations Option LN
Warm-up Time		5 min		
Output of Internal Reference		100 MHz 10/100 MHz		Option LN
Output Power		0 dBm		
Output Impedance		50 Ohms		
Bypass Internal Reference Input		100 MHz		High phase synchronous mode
Phase Lock to External Reference		10 MHz integer MHz 100 MHz	250	Option VREF
Bypass Mode	5			
Reference Input level				
10 MHz or 1-250 MHz	-5 dBm	0 dBm	+10 dBm	
100 MHz	5 dBm		+15 dBm	
Lock Range				
10 MHz or 1-250 MHz			±1.5 ppm	
100 MHz			>100 ppm	
Reference Input Impedance		50 Ohms		



Trigger

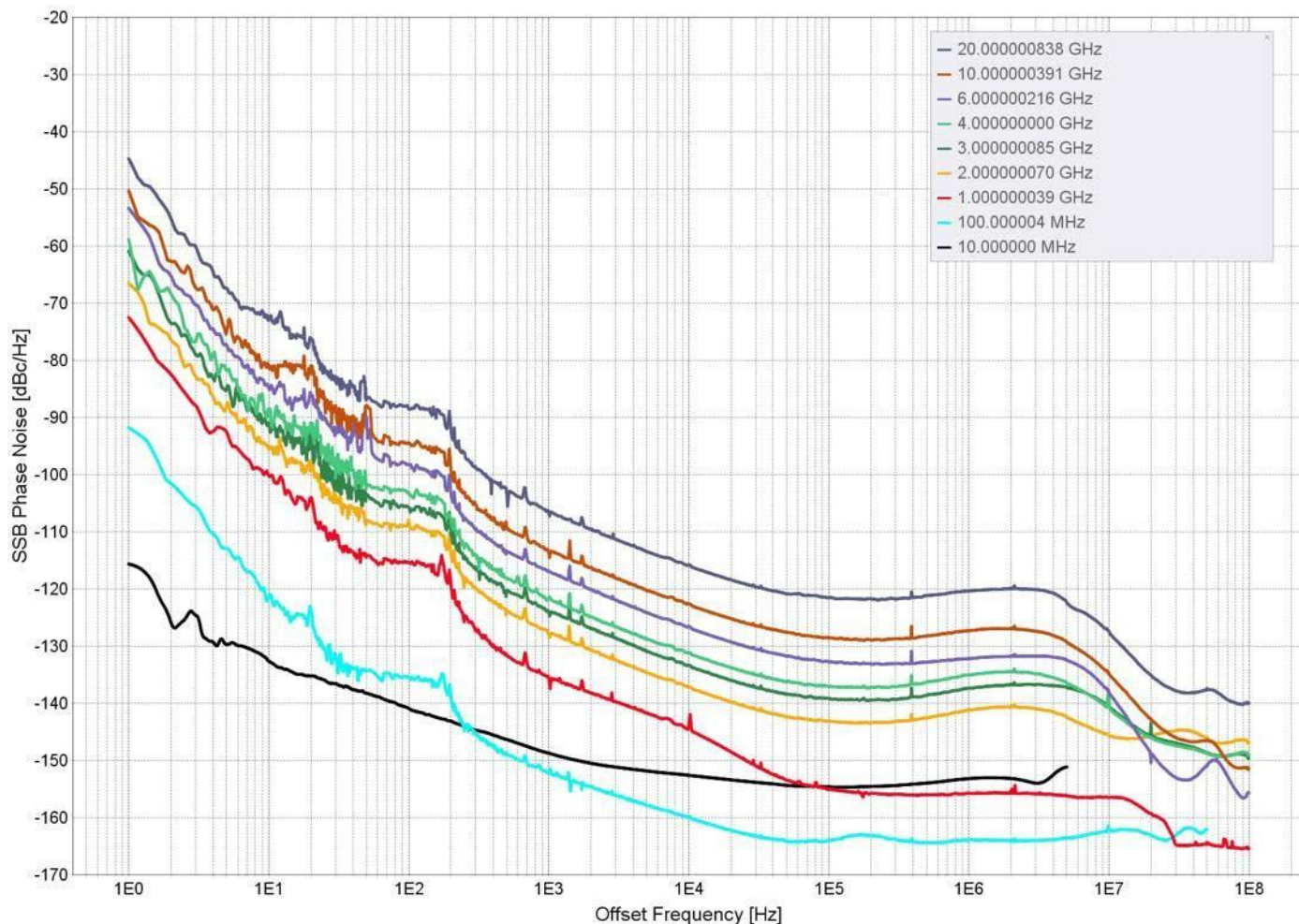
PARAMETER	MIN	TYPICAL	MAX	NOTE
Trigger Types	Continuous, single (point), gated, gated direction			
Trigger Source	external, bus (LAN, USB)			
Trigger Modes	Continuous free run, trigger and run, reset and run			
Trigger Latency		5 ns		
Trigger Uncertainty		10 ns		
External Trigger Delay	50 ns		40 s	settable
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): Output is TRIG OUT at rear panel

PARAMETER	MIN	TYPICAL	MAX	NOTE
MULTIFUNCTION GENERATOR sine, triangle, square wave				
Frequency Range	1 Hz 1 Hz		3MHz 1 MHz 50 kHz	Sine triangle 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, 1Vpp
Output Impedance		50 Ohms CMOS		Sine, triangle Square wave
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 of Multiple Sources				
Modes	Trigger on sweep start Trigger on each point Signal Valid			



SSB Phase Noise Performance with option LN

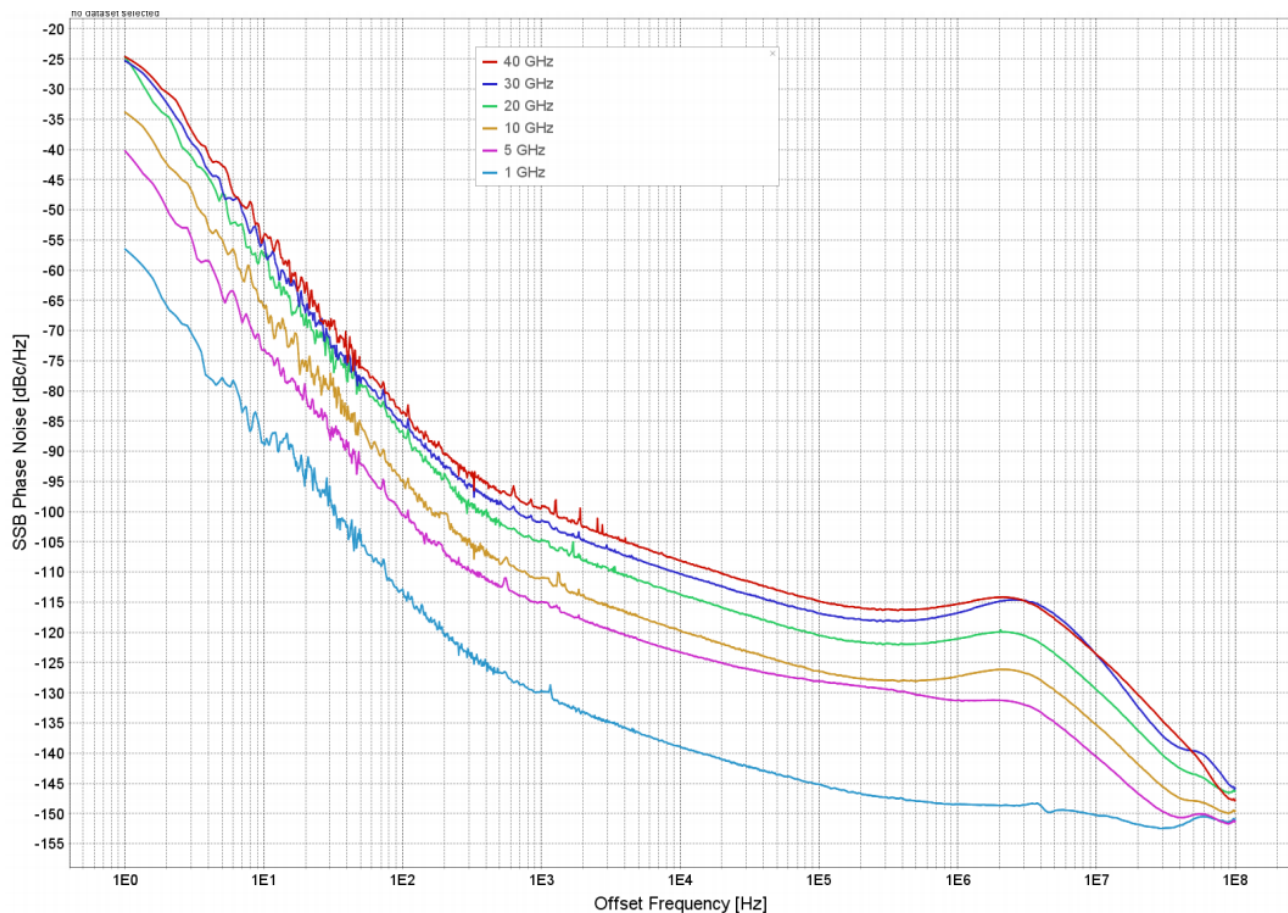


Typical SSB Phase Noise [dBc/Hz], CW, level = 20 dBm, Option LN

Offset → RF ↓	1 Hz	10 Hz	100 Hz	1 kHz	10 kHz	100 kHz	1 MHz	floor
10 MHz	-116	-133	-141	-149	-153	-155	-154	-155
100 MHz	-96	-121	-137	-148	-157	-162	-162	-162
1 GHz	-76	-100	-120	-132	-142	-153	-156	-165
2 GHz	-70	-94	-114	-125	-135	-143	-143	-155
3 GHz	-66	-90	-110	-122	-132	-139	-139	-151
4 GHz	-64	-88	-108	-118	-129	-137	-137	-151
6 GHz	-60	-84	-104	-115	-124	-132	-133	-151
10 GHz	-56	-80	-100	-111	-121	-129	-129	-151
20 GHz	-50	-74	-94	-105	-116	-123	-123	-150



SSB Phase Noise Performance, without option LN

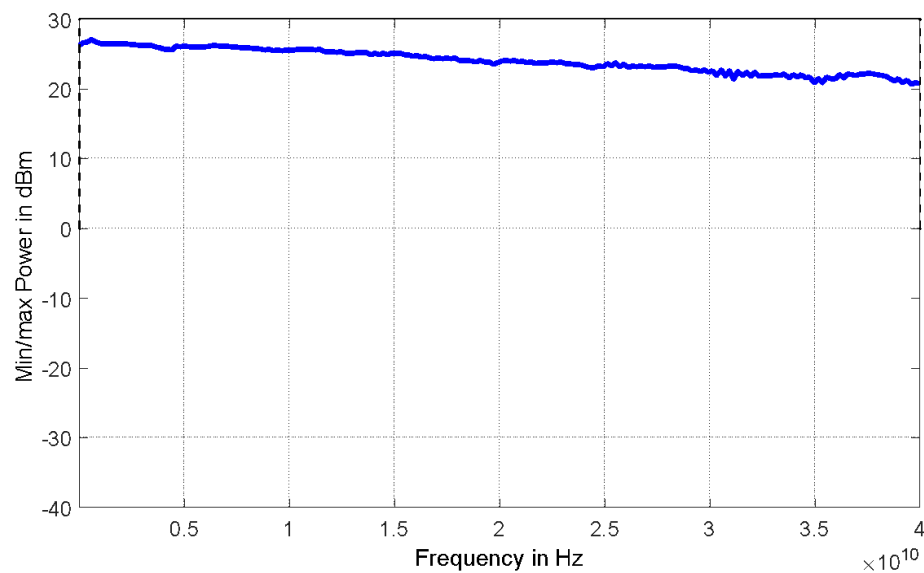


Typical SSB Phase Noise [dBc/Hz], CW, level = 20 dBm, without option LN

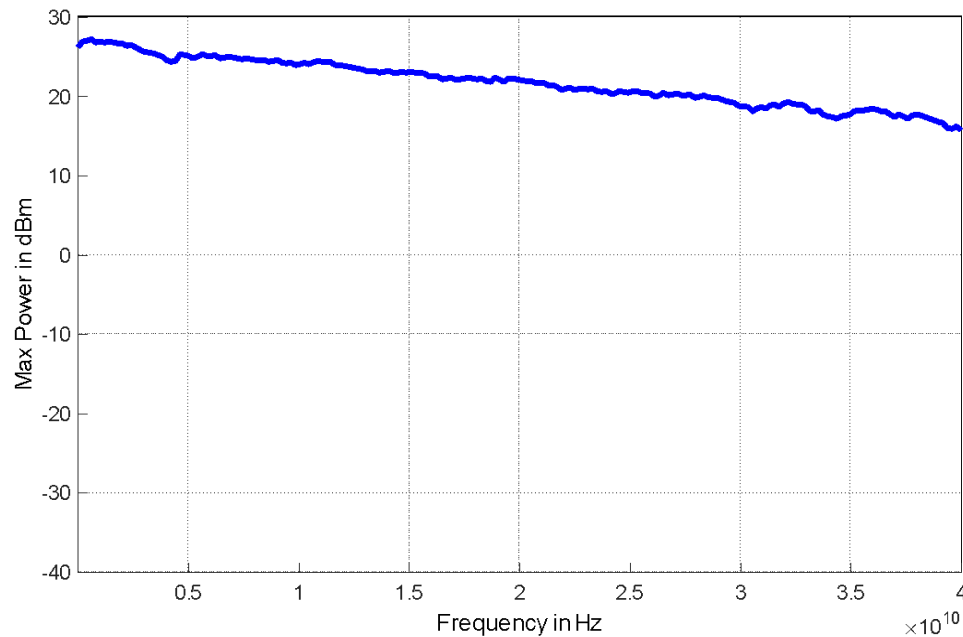
Offset → RF ↓	1 Hz	10 Hz	100 Hz	1 kHz	10 kHz	100 kHz	1 MHz	floor
10 MHz	-96	-128	-146	-149	-153	-155	-154	-155
100 MHz	-76	-108	-140	-148	-157	-162	-162	-162
1 GHz	-57	-88	-114	-130	-140	-145	-150	-165
5 GHz	-41	-74	-101	-116	-123	-128	-131	-151
10 GHz	-37	-68	-95	-111	-121	-127	-127	-151
20 GHz	-31	-62	-90	-105	-116	-121	-121	-150
40 GHz	-25	-56	-84	-100	-110	-115	-115	-150



Maximum Output Power 0.01 to 40 GHz

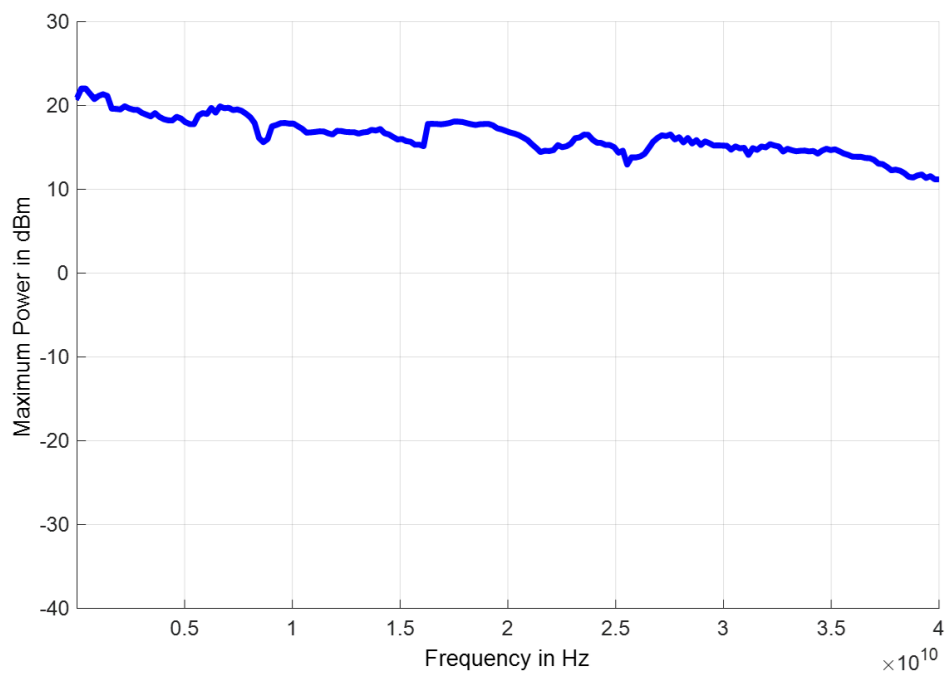


Max Output Power 0.01 to 40 GHz (Model 865-40 with option PE4)





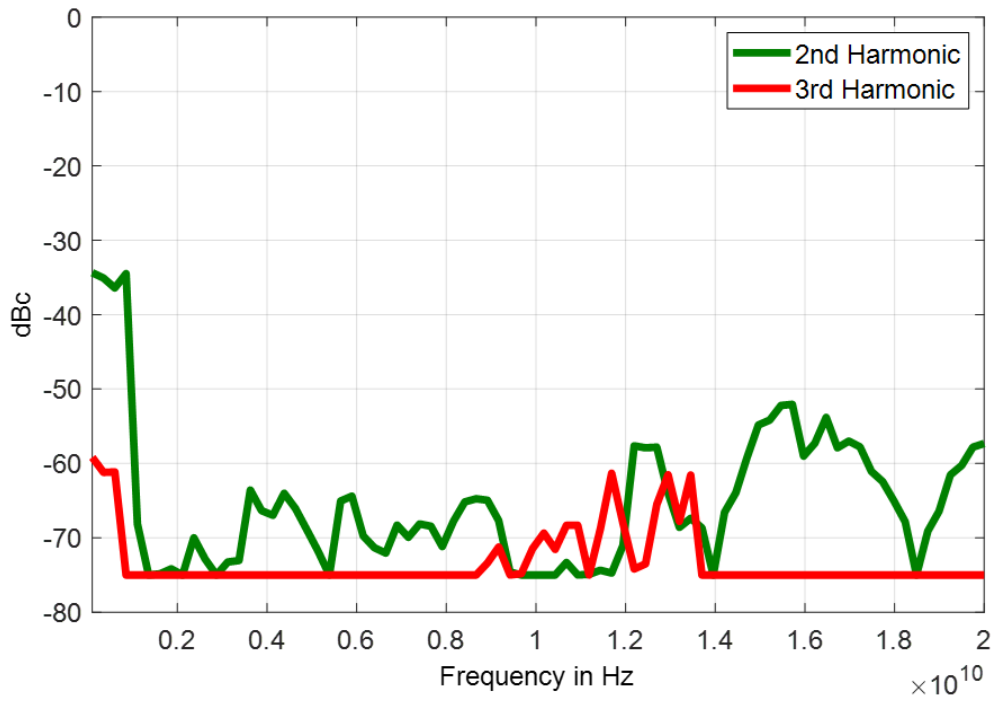
Max Output Power 0.01 to 40 GHz (with option FILT)



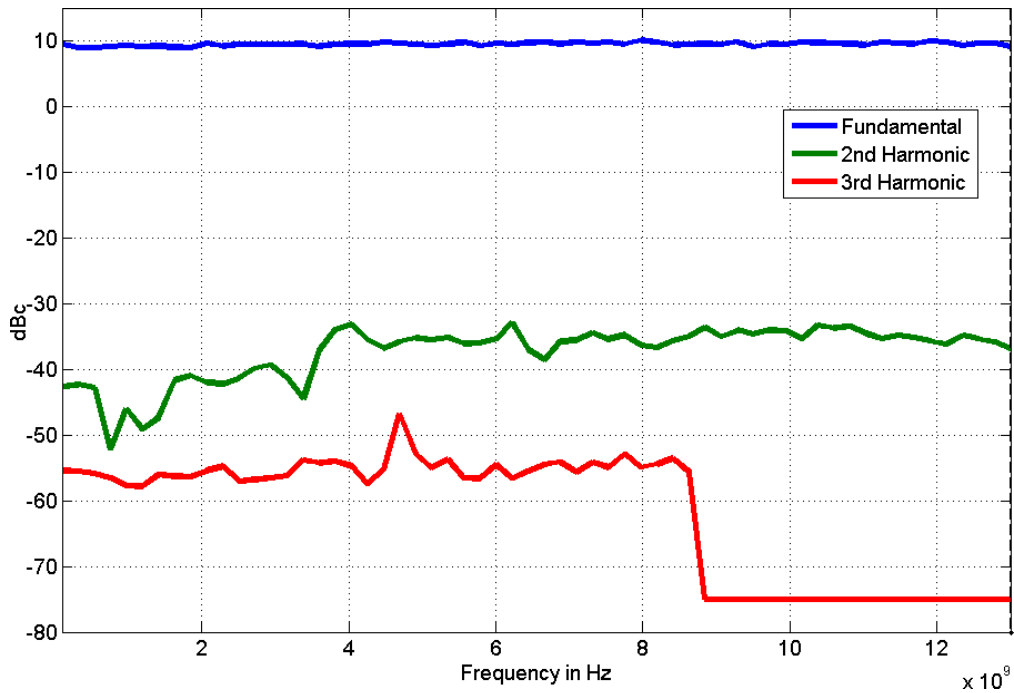
Max Output Power 0.01 to 40 GHz (with option PE2)



• **Harmonics (2nd, 3rd at P=+5 dBm, Model 865-40 with option FILT)**

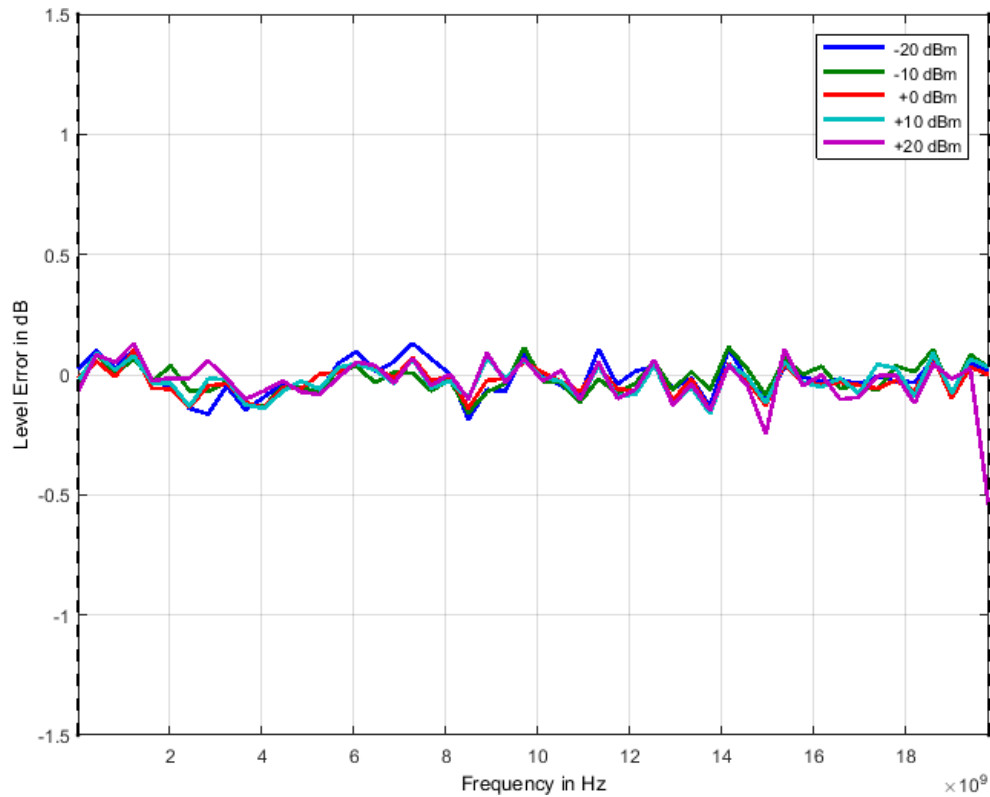


• **Harmonics (2nd, 3rd at P=+10 dBm, Model 865-20)**

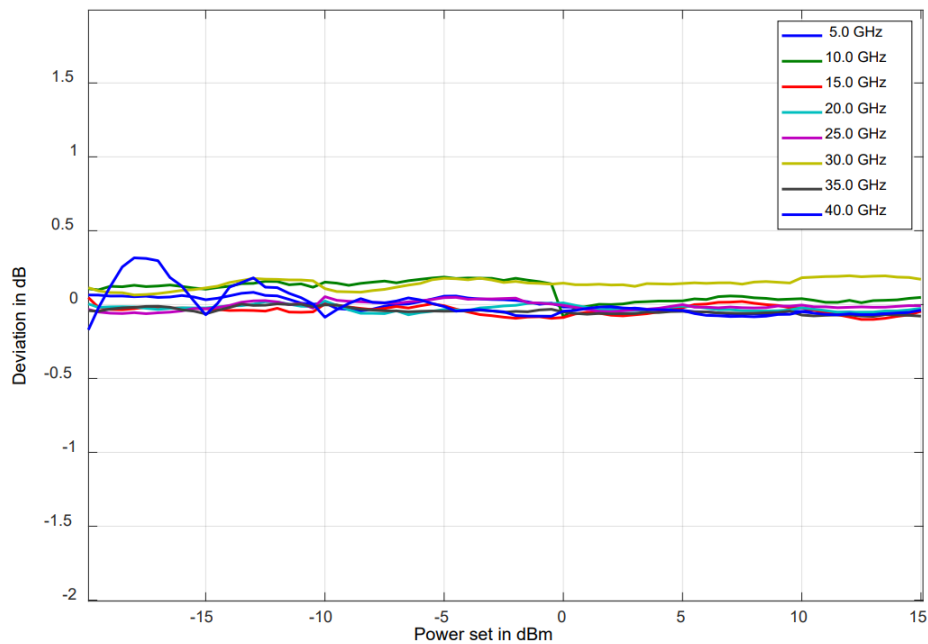




Typical Frequency Response 0 to 20 GHz at different power levels (Model 865-20)

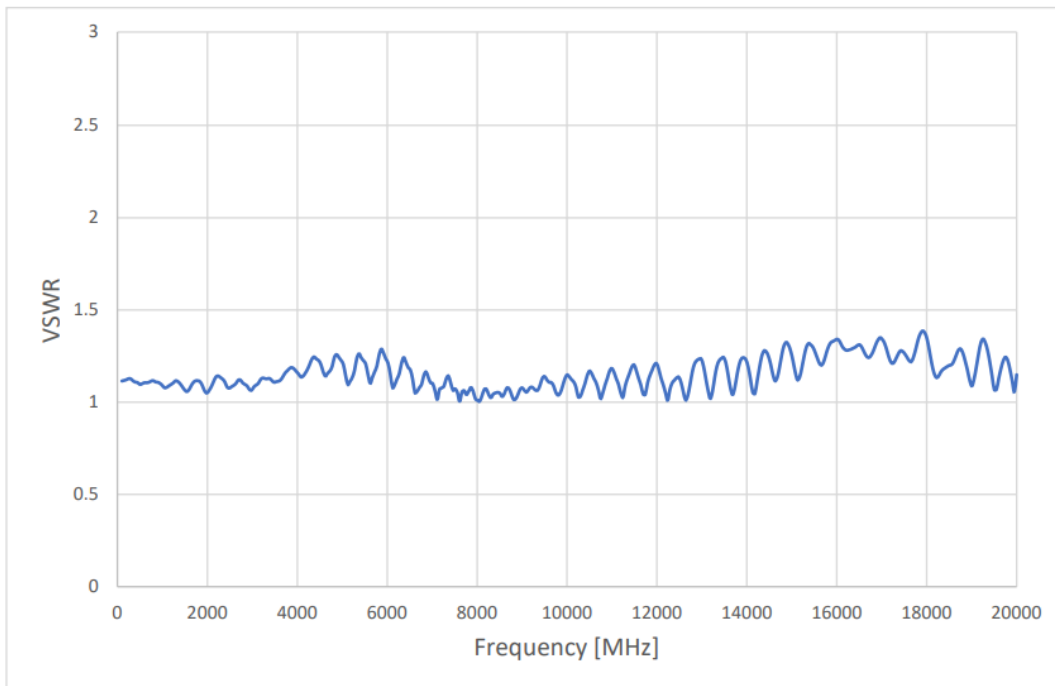


Typical Output Power Linearity (Model 865-40)

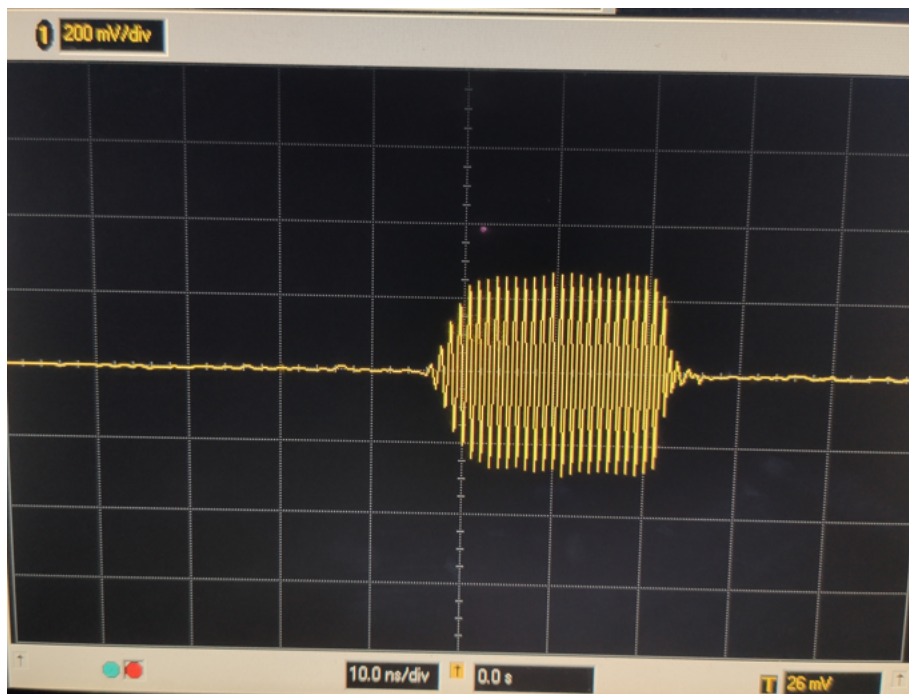




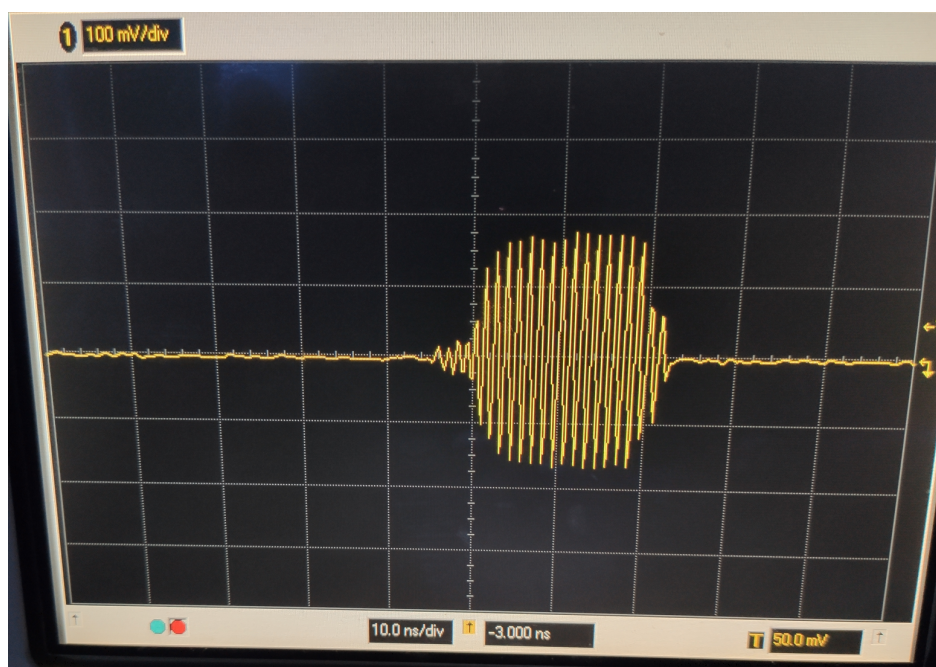
Typical VSWR (Model 865-20)



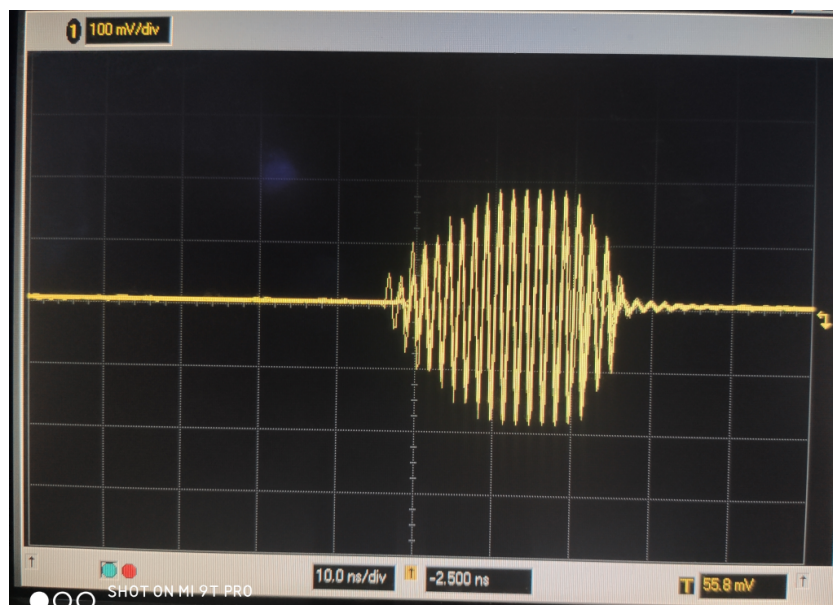
Internal Pulse Modulation (1 GHz, 20 ns pulse width)



• Internal Pulse Modulation (6 GHz, 20 ns pulse width)



• Internal Pulse Modulation (18 GHz, 20 ns pulse width)





Channel 1

Settings

Connected to 865-40

SN: 4F1-3A2A0000F-1129

Frequency

GHzMHzkHzHzmHz

010000000000000000000000

Power

dBm

+000000

Phase

deg

00000

RF On

Pulse Modulation

Pulse Modulation

SourceInternalALC HoldOff

Pulse Repetition Period

smsμsns

0010000000000000000000

Pulse Width

smsμsns

00050000000000000000

Modulation Off

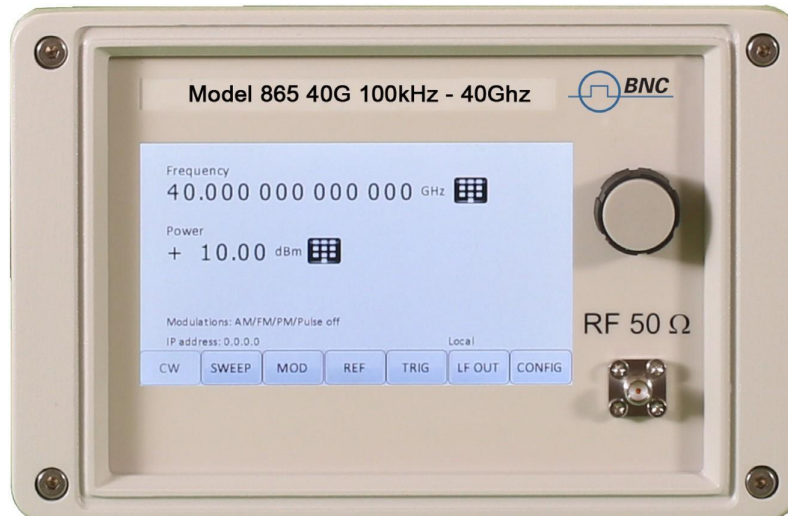
BNC | <https://www.berkeleyelectronics.com>

Front panel:

1. RF output:

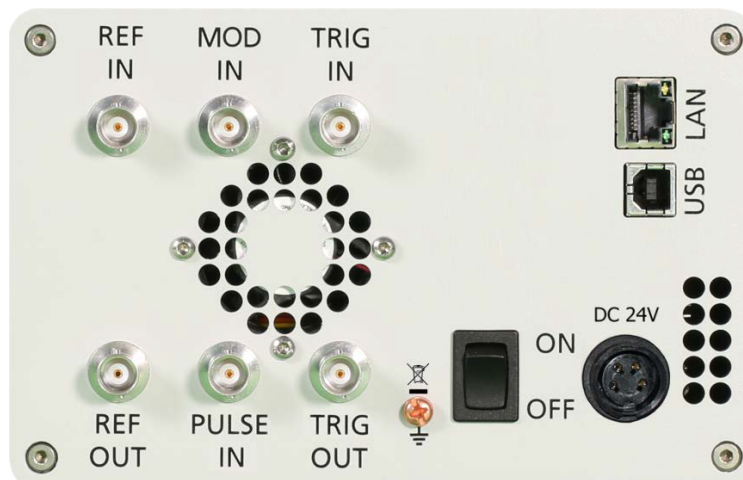
- Model 865-40: K (2.92 mm) female
- Model 865-12, 20, 26: SMA female

2. Rotary knob



Rear panel:

1. TRIG IN: Trigger input: BNC female
2. TRIG OUT: Trigger output: BNC female
3. REF OUT: External reference input: BNC female
4. REF IN: Internal reference output: BNC female
5. MOD IN: Modulation input for FM/PM: BNC female
6. PULSE IN: Pulse modulation input: BNC female
7. LAN connection: RJ-45
8. USB 2.0 host and device
9. GPIB: IEEE-488.2, 1987 with listen and talk
10. DC Power plug (24V, 3 A)
11. DC power switch



ORDERING INFORMATION

HOST MODEL	PRODUCT	DESCRIPTION
Model 865-12	Model 865-12	100 kHz – 12.75 GHz
Model 865-20	Model 865-20	100 kHz – 20 GHz
Model 865-26	Model 865-26	100 kHz – 26 GHz
Model 865-40	Model 865-40	100 kHz – 40 GHz
Model 865-XX	Option LN	Enhanced close in phase noise & frequency stability
Model 865-XX	Option LN+	Enhanced close in phase noise & further enhanced long term frequency stability
Model 865-XX	Option FS	Ultra-fast switching speed
Model 865-XX	Option NP	Narrow pulse modulation
Model 865-XX	Option MOD	Analog modulation
Model 865-40	Option FILT	Harmonic filtering (not in combination with option PE4)
Model 865-XX	Option 8K	Frequency range extension to 8 kHz
Model 865-XX	Option VREF	Variable External Reference
Model 865-12	Option PE4-12/20/26	Electrical step attenuator (12, 20, & 26 GHz version) (not in combination with option FILT)
Model 865-40	Option PE4-40	Electrical step attenuator (40 GHz version)
Model 865-12/20	Option PE-12/20	Mechanical step attenuator down to -90 dBm (12 & 20 GHz version)
Model 865-26/40	Option PE-26/40	Mechanical step attenuator down to -90 dBm (26 & 40 GHz version)
Model 865-12/20/26	Option PE2-12/20/26	Mechanical step attenuator down to -120 dBm (12, 20, & 26 GHz version)
Model 865-40	Option PE2-40	Mechanical step attenuator down to -120 dBm (40 GHz version)
Model 865-XX	Option EB	External power bank
Model 865-XX	Option GPIB	GPIB interface
Model 865-XX	Option 1URM	19" 1U rack enclosure
Model 865-XX	Option REAR	Move output to the rear
Model 865-XX	Option FLASH	MicroSD card slot for removable microSD memory

GENERAL CHARACTERISTICS

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 24V $\pm$ 3.0 VDC; 25 W maximum

Mains adapter supplied: 100-240 VAC in/ 24 V 4.0 A DC out

Environmental (Levels similar to MIL-PRF-28800F Class 3/4)

Environmental stress Samples of this product have been type tested to be robust against the environmental stresses of storage, transportation, and end-use; those stresses to temperature, humidity, shock, vibration, altitude, and power line conditions.

Operating temperature range 32 to 113 F (0 to 45 °C)

Storage temperature range -40 to 158 F (-40 to 70 °C)

Operating and storage altitude up to 15,000 feet (4600 m)



notice

EMC complies with EMC regulations and directives for emission and immunity to interference (EN 61326-1 Industrial, EN/IEC 61326-2-1).

Safety complies with applicable Safety regulation in line with IEC/EN 61010-1

This product complies with directive 2011/65/EU

Weight 6 lbs (2.5 kg) net, $\leq$ 8 lbs (4 kg) shipping

Dimensions 4.21 in H x 6.77 in W x 11.42 in L (incl. connectors) [106 mm H x 172 mm W x 290 mm L]

Recommended calibration cycle 24 months