

# Model 865 RF / Microwave Signal Generator



## Features

- Frequency Range from 100 kHz to 40 GHz
- Ultra Low Noise
- Output Power from -90dBm to +27dBm
- USB, LAN, GPIB interfaces
- Power switching time down to 10µs
- Rich API Library (MatLab, LabVIEW, C++ and More)

## Applications

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



## Model 865 Datasheet v1.21

100 kHz to 40 GHz RF / Microwave Signal Generator





# Model 865 RF / Microwave Signal Generator

## Introduction

The Model 865 is an ultra low-noise and fast-switching microwave signal generator covering a continuous frequency ranges from 100 kHz up to 6, 12.75, 20, 26, and 40 GHz, respectively, with a 0.001 Hz resolution. The Model 865 provide an accurately leveled output power range and high spurious suppression. Advanced frequency synthesis combines fastest switching speeds with ultra low SSB phase noise and fine frequency and power resolution.

The standard Model 865 includes intra/pulse chirp modulations, frequency chirps, pulse modulation with programmable patterns, and phase modulation. The Model 865 allows 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.

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. Additionally, optimum phase synchronous signals can be achieved by bypassing internal reference and feeding an 1 GHz signal directly as reference.

The compact unit allows full front panel control via touch panel display.

### Available Options:

- FS: ultra fast switching
- ULN: enhanced close in phase noise
- MOD: adds modulation
- EBAT: supports battery operation

Model 865



## Signal Specifications

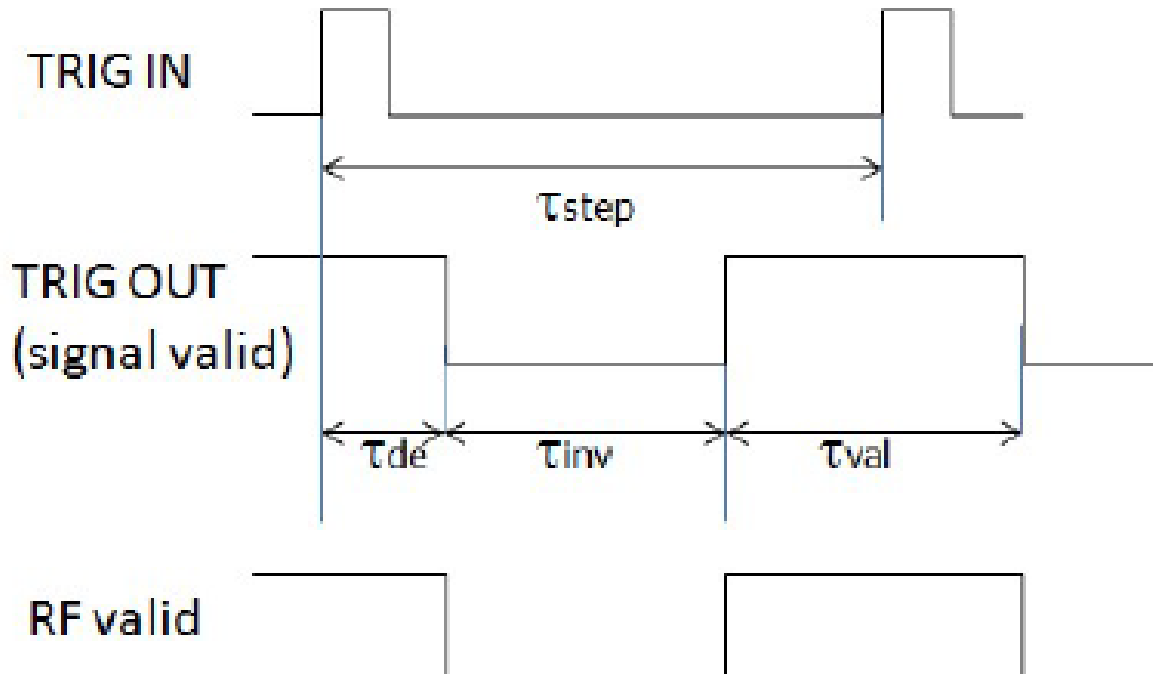
The specifications in the following pages describe the warranted performance of the signal generator for  $23 \pm 10$  °C after a 30 minute warm-up period and for all configurations. Typical specifications describe expected, but not warranted performance. Min and Max specifications are warranted.

Parameter	Min.	Typ.	Max.	Note
<b>CW Mode</b>				
<b>Frequency Range</b>	300 kHz		6.0 GHz 12.75 GHz 20 GHz 26 GHz 40 GHz	865-6 865-12 865-20 865-26 865-40
Resolution		0.001 Hz		
Phase Resolution		0.1 deg		
Frequency / Amplitude Settling Time		200 $\mu$ s	200 $\mu$ s 20 $\mu$ s	time from receipt of SCPI command option FS
<b>SSB Phase Noise</b>				
<b>1 GHz</b> 10 Hz offset 1 kHz offset 20 kHz offset 100 kHz offset		-87 dBc/Hz -130 dBc/Hz -145 dBc/Hz -151 dBc/Hz		Option LN: -103 dBc/Hz
<b>4 GHz</b> 10 Hz offset 1 kHz offset 20 kHz offset 100 kHz offset		-74 dBc/Hz -121 dBc/Hz -132 dBc/Hz -139 dBc/Hz		Option LN: -91 dBc/Hz
<b>10 GHz</b> 10 Hz offset 1 kHz offset 20 kHz offset 100 kHz offset		-69 dBc/Hz - 113 dBc/Hz - 124 dBc/Hz - 131 dBc/Hz		Option LN: -79 dBc/Hz
<b>30 GHz</b> 10 Hz offset 1 kHz offset 20 kHz offset 100 kHz offset		-60 dBc/Hz - 108 dBc/Hz - 120 dBc/Hz - 121 dBc/Hz		Option LN: -74 dBc/Hz

Parameter	Min.	Typ.	Max.	Note
<b>Output Power</b>				
	-20 dBm		+18 dBm	300 kHz to 10 MHz
	-20 dBm		+25 dBm	10 MHz to 6 GHz
	-20 dBm		+24 dBm	6 to 12.75 GHz
	-20 dBm		+22 dBm	12.75-20 GHz
	-20 dBm		+18 dBm	20 -26 GHz
	-20 dBm		+15 dBm	26 - 40 GHz
	-90 dBm		+20 dBm	Option PE4, 6, 12.75 GHz
	-90 dBm		+18 dBm	Option PE4, 20 GHz
	-120 dBm		+20 dBm	Option PE3, 6 GHz
<b>Level Resolution</b>		0.01 dB		
<b>Level Uncertainty</b> , ALC on Temperature Effects		0.3 dB 0.015 dB/ °C		-15 to +15 dBm 0 to 45 °C
Output Impedance VSWR	50 Ω 1.7			
<b>Reverse Power Protection</b>				
DC Voltage			±15 V	
RF Power			30 dBm	
<b>Spectral Purity at + 10 dBm</b> Output Harmonics		-40 dBc	-30 dBc	
Sub-Harmonics		-75 dBc -55 dBc	-65 dBc	< 20 GHz > 20 GHz
Non-Harmonic spurious Up to 2.5 GHz > 2.5 GHz to 5 GHz > 5 GHz to 10 GHz > 10 GHz to 20 GHz > 20 GHz		-65 dBc -70 dBc -65 dBc -60 dBc -55 dBc		CW +10 dBm, > 3 kHz offset

# Sweeping Capability

Parameter	Min.	Typ.	Max.	Note
<b>Digital Power / Frequency / List Sweeps</b>				
Sweep type: linear, logarithmic, random				
Step Time ( $t_{step}$ )	200 $\mu$ s 20 $\mu$ s		19998 s	Option FS
Dwell Time ( $t_{val}$ )	10 $\mu$ s		9999 s	
Off-Time (incl. transient time) ( $t_{off}$ )	0		9999 s	
Transient Time ( $t_{inv}$ )			270 $\mu$ s 25 $\mu$ s	Option FS
Timing Delay ( $t_{de}$ )		2 to 10 $\mu$ s 50 ns		Option FS
Time Resolution		0.1 $\mu$ s 50 ns		Option FS
Timing Accuracy per point		3 $\mu$ s 5 ns		Option FS



## Reference Frequency

REF IN input and REF OUT output are at rear panel

Parameter	Min.	Typ.	Max.	Note
Internal Reference Frequency		10 / 100 MHz		
Initial Accuracy			±20 ppb	calibrated at $23 \pm 3 \text{ }^\circ\text{C}$ at time of calibration , user adjustable
Temperature Stability (0 to 50 degC)			±20 ppb	
Aging 1 <sup>st</sup> Year		0.5 ppm 0.1 ppm		Option ULN
Aging per day (after 30 days operations)			tbn	
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 Input	100 MHz, 1 GHz			High phase synchronous mode
Phase Lock to External Reference	1 MHz	10, 100 MHz	250 MHz	Option VREF
Reference Input Level 10 MHz or 1-250 MHz 100 MHz	-5 dBm 5 dBm	0 dBm	+13 dBm +15 dBm	
Lock Range 10 MHz 100 MHz			±1.5 ppm >100 ppm	
Reference Input Impedance		50 Ohms		

## Multi Purpose Output (FUNC OUT)

Output is FUNC OUT at rear panel

Parameter	Min.	Typ.	Max.	Note
<b>Multifunction Generator</b> sine, triangle, square wave				
Frequency Range	1 Hz 1 Hz		3 MHz 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, 1 Vpp
Output Impedance		50 Ohms CMOS		Sine, triangle square wave
<b>Video Output (of internal pulse modulator)</b>				
Output		CMOS		
Period	30 ns		50 s	
Pulse Width	15 ns		50 s	
RF Delay		10 ns		
<b>Trigger Out</b> Synchronization mode for multiple sources				
Modes	Trigger on sweep start Trigger on each point Signal Valid			

## Trigger Input (TRIG IN)

Input is TRIG IN at rear panel

Parameter	Min.	Typ.	Max.	Note
<b>Trigger Types</b>	<b>Continuous, single, gated, gated direction</b>			
Trigger Source	<b>RF key, external, bus (GPIB, LAN, USB)</b>			
Trigger Modes	<b>Continuous free run, trigger and run, reset and run</b>			
Trigger Latency		5 ns		
Trigger Uncertainty		10 ns		
External Trigger delay	50 ns		10 s	
External Delay Resolution		10 ns		
Trigger Modulation	1		255	Execute only on Nth trigger event
Trigger Polarity	Rising, falling			

## Trigger Output (TRIG OUT)

see Multi Purpose Output (FUNC OUT)

## Modulation Capabilities (Option MOD)

Parameter	Min.	Typ.	Max.	Note
<b>Pulse Modulation</b> Modulation Source	Internal / External			
External Input Amplitude	TTL			
Pulse Rise/Fall Time		10 ns		
On / Off Ratio		80 dB 70 dB		at +10 dBm , <7 GHz at +10 dBm , >7 GHz
Pulse Overshoot			10 %	
Pulse Delay		20 ns		
Pulse Polarity		Normal, inverse		
<b>Internal Pulse Generator</b> Repetition Frequency (PRF)	0.1 Hz		20 MHz	
Duty Cycle	1 % to 99 % in 1% steps			within specified minimum pulse width

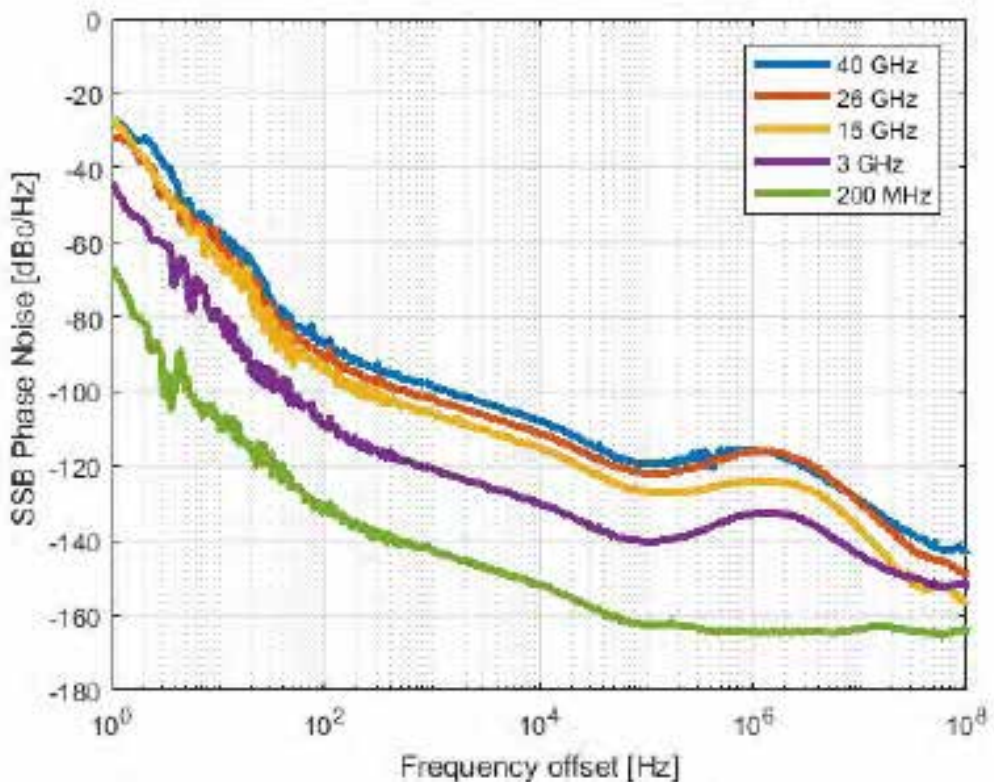


## Modulation Capabilities (Option MOD) cont.

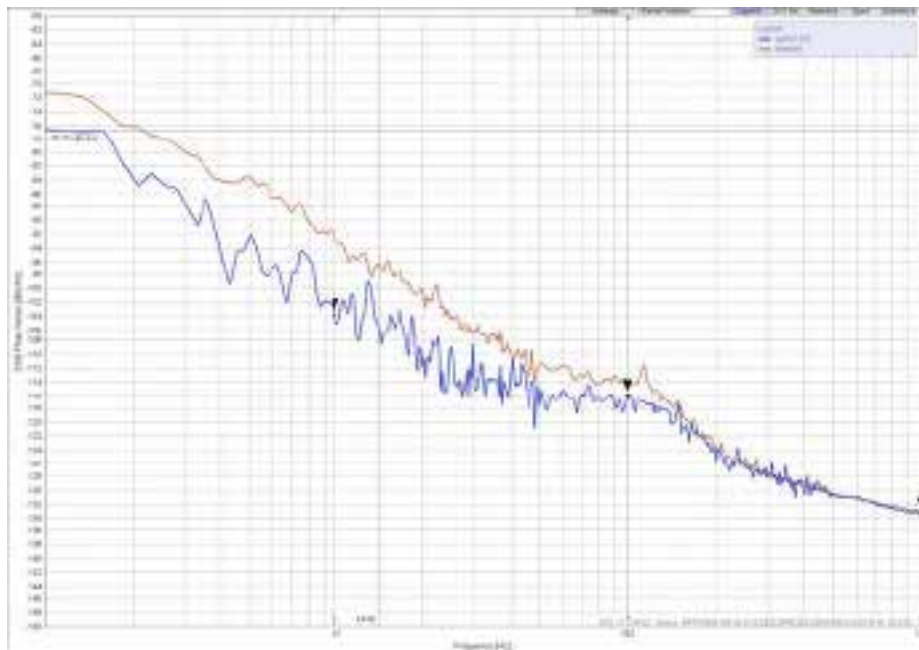
Parameter	Min.	Typ.	Max.	Note
Minimum Pulse Width	30 ns			
Pulse Pattern Modulation & Staggered PRF				Using internal pattern generator
Pulse Width	30 ns 300 ns		1 $\mu$ s 5 s	ALC hold ALC on
Programmable Pattern Length	2		65536	
Duty Cycle	0.05 %		99.95 %	
<b>Pulse Width Resolution</b>		5 ns		
Polarity		selectable		
<b>Frequency Modulation</b> Modulation Source		Internal		
Maximum Frequency Deviation (peak)	N · 100 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 < 100 kHz rate > 100 kHz rate		0.5 % 2 %	2 % 5 %	
Distortion		< 1 %		1 kHz rate, 50 kHz deviation
Modulation Rate	DC		800 kHz	> -3dB frequency response
Modulation Waveforms	Sine, triangle, FSK			
Total Harmonic Distortion	< 1%			1 kHz rate & N · 1 MHz deviation
<b>Phase Modulation</b> Modulation Source		Internal		
Phase Deviation ( peak)	0		N·100 rad	
Modulation Rate	DC		800 kHz	>-3dB Frequency response Max phase deviation degrades above 20 kHz modulation rate
Modulation Waveform	Sine, Triangle, FSK			
Total Harmonic Distortion		< 1%		1 kHz rate & N x 100 rad deviation
<b>Amplitude Modulation</b> Modulation Source		Internal		
Modulation Rate	0.1 Hz		20 kHz	
Modulation Waveforms	Sine, triangle, square			
Modulation Depth	0%		90%	Settable
Distortion (sine wave)		2%		At 60% modulation depth
Accuracy (1kHz rate, 80%, 0dBm)		5%		

## Typical Performance Curves

Phase Noise Performance (1 Hz to 100 MHz offset) at different output frequencies (standard)



Phase Noise Performance with option ULN (1GHz, 1 Hz to 1 kHz)



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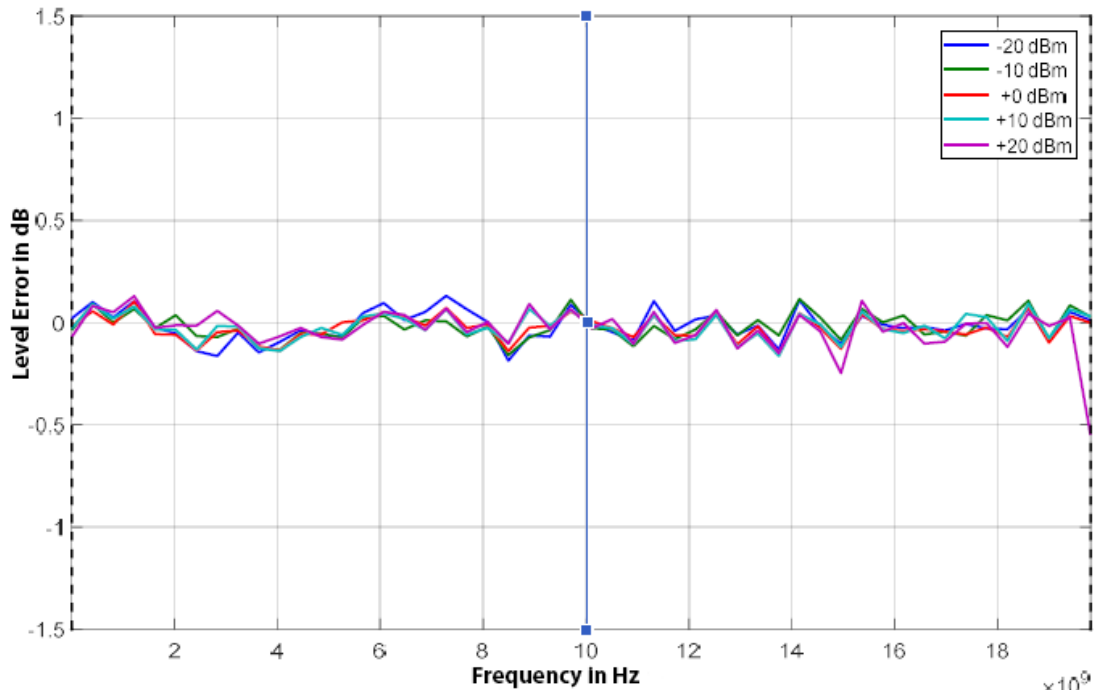




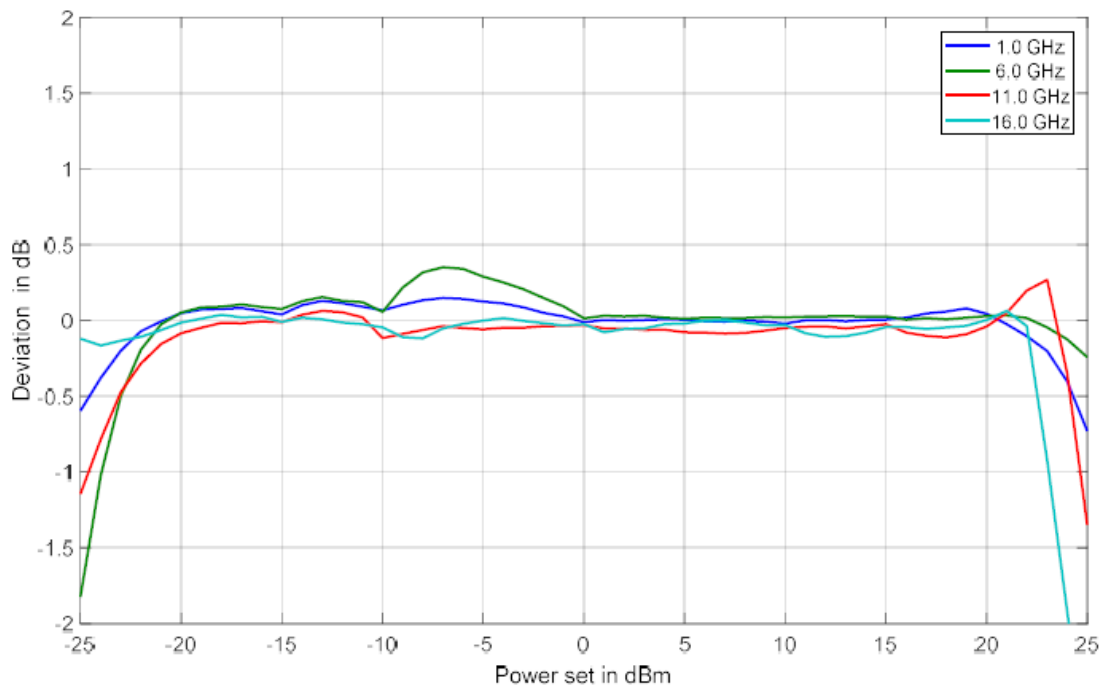
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### Typical Frequency Response 0 to 20 GHz at -20, 0, and +2- dB

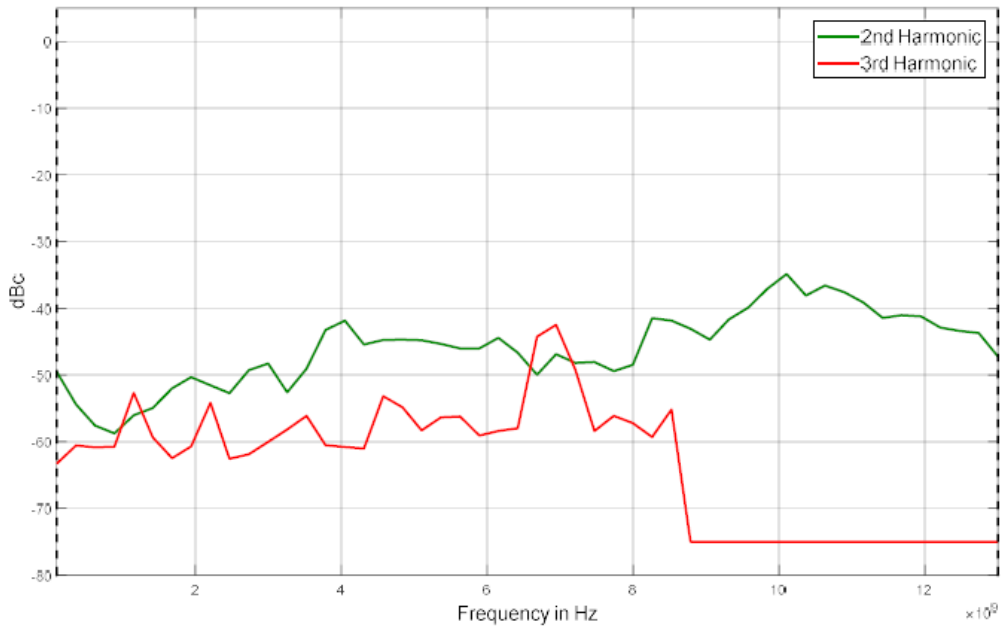


### Typical Output Power Linearity

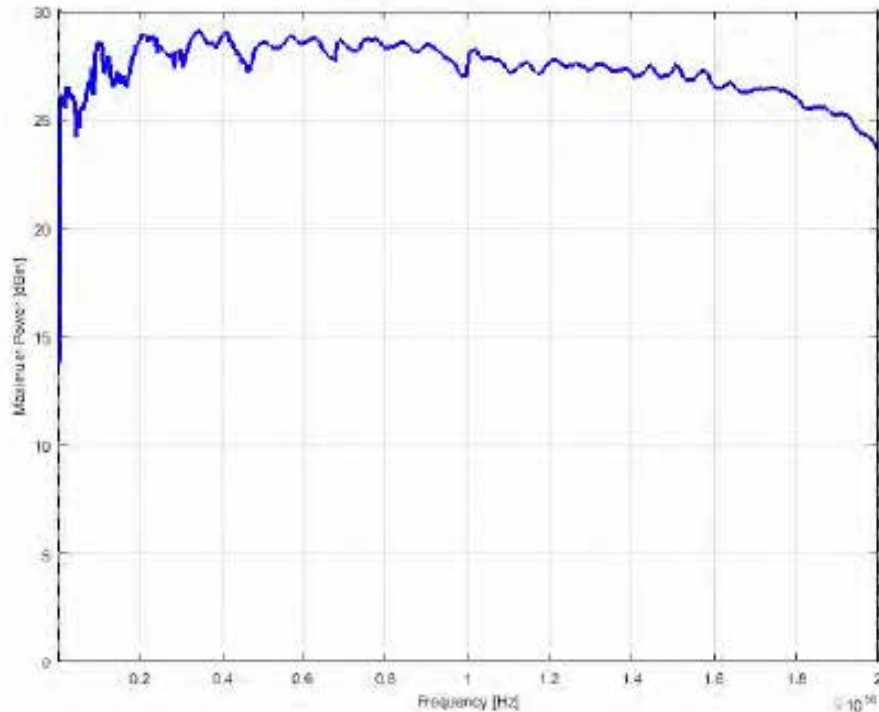


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## Harmonics 100 MHz to 13 GHz at +5dBm



## Typical Maximum Output Power (10 MHz to 20GHz)



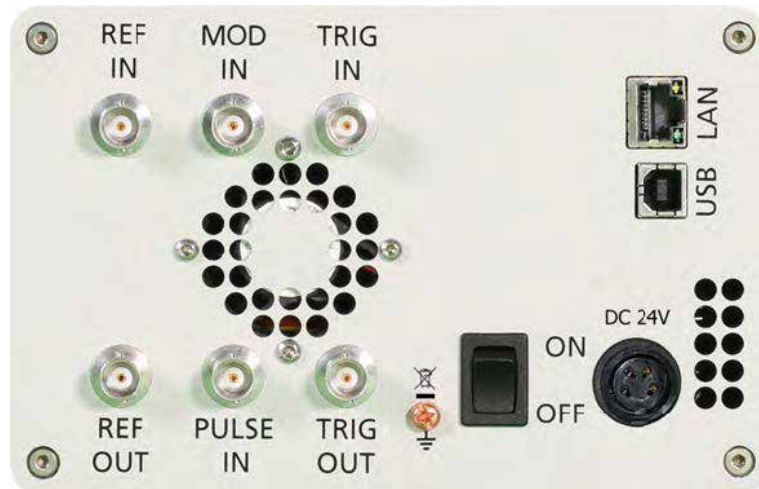
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## Connectors

Front panel:



Rear Panel:



## 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** 0 to 40 °C

**Storage temperature range** -40 to 70 °C

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



### notice

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

Complies with applicable Safety regulations in line with IEC/EN 61010-1

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

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

**Recommended calibration cycle** 24 months

## Options

- FS: enhanced switching speed
- PE3: Extended power range down to <-90 dBm) mechanical step attenuator module
- PE4: Extended power range down to <-85 dBm) electrical step attenuator module
- ULN: enhanced close-in phase noise, improved frequency stability
- 1URM: 19" 1HE enclosure with rack-mount capability. Dimensions 42 mm H x 426 mm W x 460 mm L [1.7 in H x 16.8 in W x 18.1 in L]
- GPIB: IEEE-488.2,1987 programming interface

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