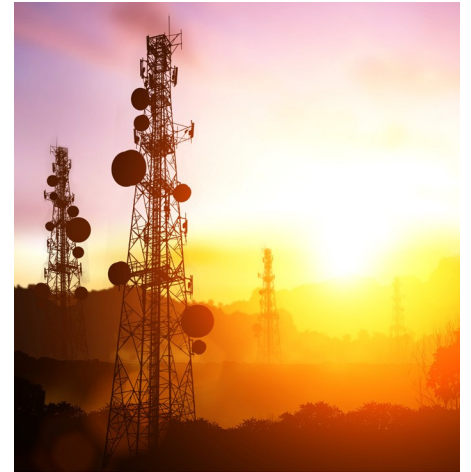


# Model 865B-M-40-X Multi-Channel Wideband Synthesizer



## Features

- Highly Phase Synchronous
- Fast Switching Down to 20  $\mu$ s
- Angular and Pulse modulation
- Internal OCXO, External Variable Reference

## Applications

- ATE
- LO for Frequency Converters
- Telecom / SatCom
- System Integration



## Model 865B-M-40-X Datasheet

8 kHz to 40 GHz Multi-Channel Wideband Synthesizer

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## DEFINITIONS

- The specifications in the following pages describe the warranted performance of the instrument for  $23 \pm 5$  °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

### • Multi-Output ultra-low Phase Noise Wideband Frequency Synthesizer with USB & LAN Interface

The Model 865B-M-X is a multi-channel wideband low phase-noise synthesizer settable from 100 kHz (8 kHz with option 8K) to 40 GHz.

The product is available with 1, 2, 3 or 4 fully independently configurable outputs. For each output channel, frequency, output power, phase and modulation can be set.

The settable output power range is from -5 to +25 dBm.

The Model 865B-M-X has a milli-Hz frequency resolution and uses a high-stability OCXO internal reference. The reference can be phase-locked to a 10 or 10 MHz external reference. With option VREF, a user-settable range from 1 to 250 MHz is available.

For highest phase coherence, multiple 865B-M-Xs can be cascaded with just one master reference clock.

When ordered with option FILT, the 865B-M-X provides excellent harmonic rejection even a full output power.

The 865B-M-X offers dedicated sweeping capabilities with switching speeds of only 500  $\mu$ s (20  $\mu$ s with option FS) and internal phase and narrow pulse modulation.

The module has USB and LAN interfaces (optionally also GPIB) and can be controlled using the SCPI 1999 command set.

# FACTS & FIGURES & SPECIFICATIONS

## Signal Specifications

PARAMETER	MIN	TYPICAL	MAX	NOTE
<b>Frequency Range</b>	100 kHz 8 kHz		40 GHz	Settable to 43.5 GHz Option 8K
Resolution		0.001 Hz		
<b>Phase Resolution</b>		0.01 deg		
<b>Switching Speed</b>		1.5 ms 500 μs 500 μs 20 μs		after SCPI command received  Option FS
CW Mode				
Sweep / List Mode				

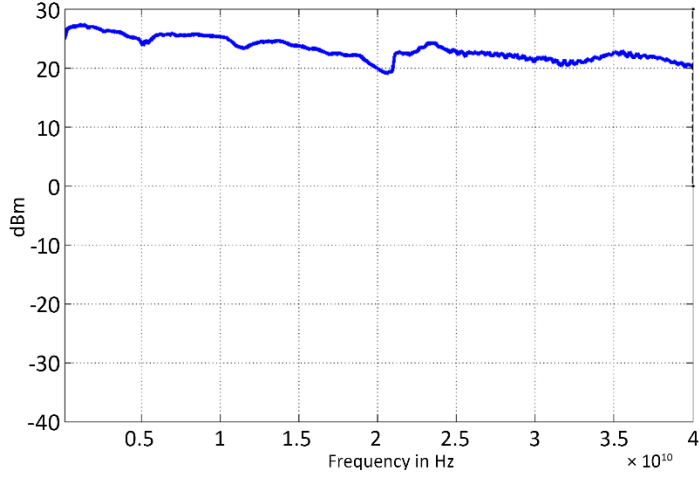
## Frequency Reference

PARAMETER	MIN	TYPICAL	MAX	NOTE
<b>Internal reference frequency</b>		100 MHz 10 MHz		Option LN
<b>Internal Reference Output Frequency</b>				
Temperature stability			±100 ppb ±20 ppb	0 to 50 degC Option LN / LN+
Aging 1st year			1 ppm 0.03 ppm 0.02 ppm	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		100 MHz		
		10 / 100 MHz		Option LN / LN+
Output power	0 dBm	5 dBm		
Output impedance		50 Ohms		
<b>Bypass Internal reference Input</b>		100 MHz		High phase synchronous mode
<b>Phase Lock to External Reference</b>	1 MHz	integer MHz	250 MHz	Option VREF
Reference Bypass Mode		100 MHz		
<b>Reference input level</b>				
10 MHz or 1-250 MHz	-5 dBm	0 dBm	+13 dBm	
Bypass 100 MHz	5 dBm		+15 dBm	
<b>Reference input impedance</b>		50 Ohm		
<b>Lock Range</b>				
10 MHz or 1-250 MHz			±1.5 ppm	
Bypass 100 MHz			>100 ppm	

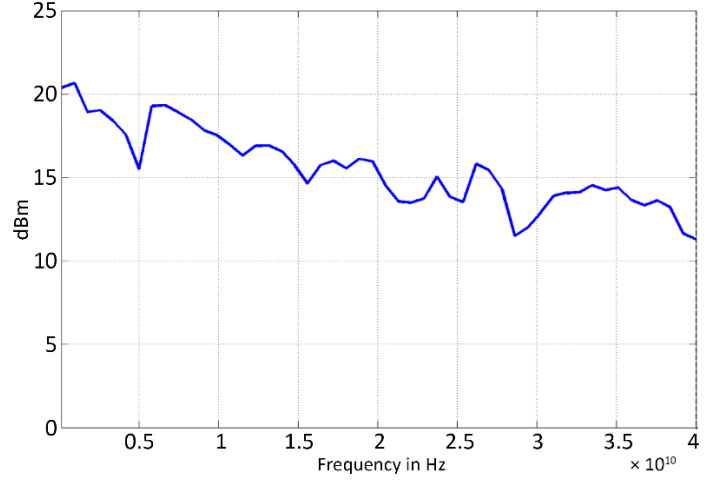
## Level Performance

PARAMETER	MIN	TYPICAL	MAX	NOTE
<b>Output power range</b>				(see also plots) option 8K
8 kHz to 10 MHz	-10 dBm		+20 dBm	
10 MHz to 5 GHz	-10 dBm		+20 dBm	
5 to 20 GHz	-5 dBm		+20 dBm	
20 to 28 GHz	10 dBm		+19 dBm	
28 to 40 GHz	0 dBm		+16 dBm	
10 MHz to 5 GHz	-10 dBm		+15 dBm	Option FILT
5 to 20 GHz	-10 dBm		+12 dBm	Option FILT
20 to 28 GHz	5 dBm		+12 dBm	Option FILT
28 to 40 GHz	-10 dBm		+10 dBm +8 dBm	Option FILT Option FILT + 8K

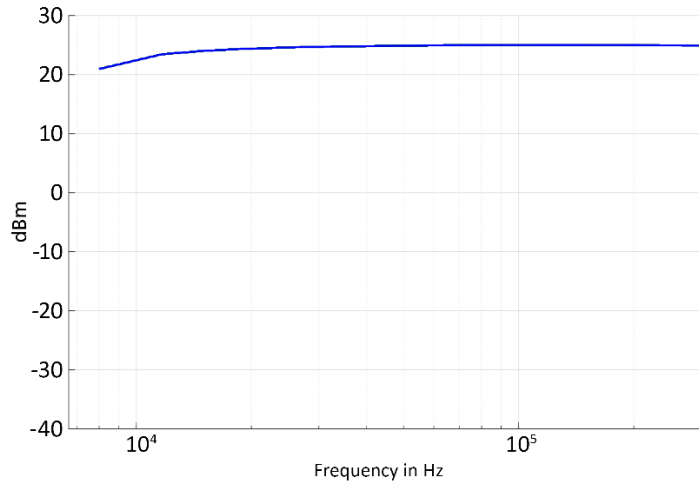
**Figure 1: Maximum Output Power (without option FILT)**



**Figure 2: Maximum Output Power with FILT**



**Figure 3: Maximum Output Power at 8 to 250 kHz (option 9K)**



**Level Accuracy**

PARAMETER	MIN	TYPICAL	MAX	NOTE
Power Resolution		0.5 dB		

## Reverse Power Protection and VSWR

PARAMETER	MIN	TYPICAL	MAX	NOTE
<b>Reverse Power Protection</b>				
DC Voltage		7 V		
RF Power			20 dBm	
<b>Output impedance</b>		50 Ohms		
VSWR		1.8		

## Phase Noise

PARAMETER	MIN	TYPICAL	MAX	NOTE
<b>SSB Phase noise at 1 GHz</b>				(see also plot)
at 10 Hz from carrier		-93 dBc/Hz		Option LN / LN+
at 1 kHz from carrier		-130 dBc/Hz		
at 100 kHz from carrier		-145 dBc/Hz		
Wideband noise		-160 dBc/Hz		
<b>SSB Phase noise at 10 GHz</b>				
at 10 Hz from carrier		-73 dBc/Hz		Option LN / LN+
at 1 kHz from carrier		-110 dBc/Hz		
at 100 kHz from carrier		-125 dBc/Hz		
Wideband noise		-160 dBc/Hz		

Figure 4: Phase Noise Performance with option LN

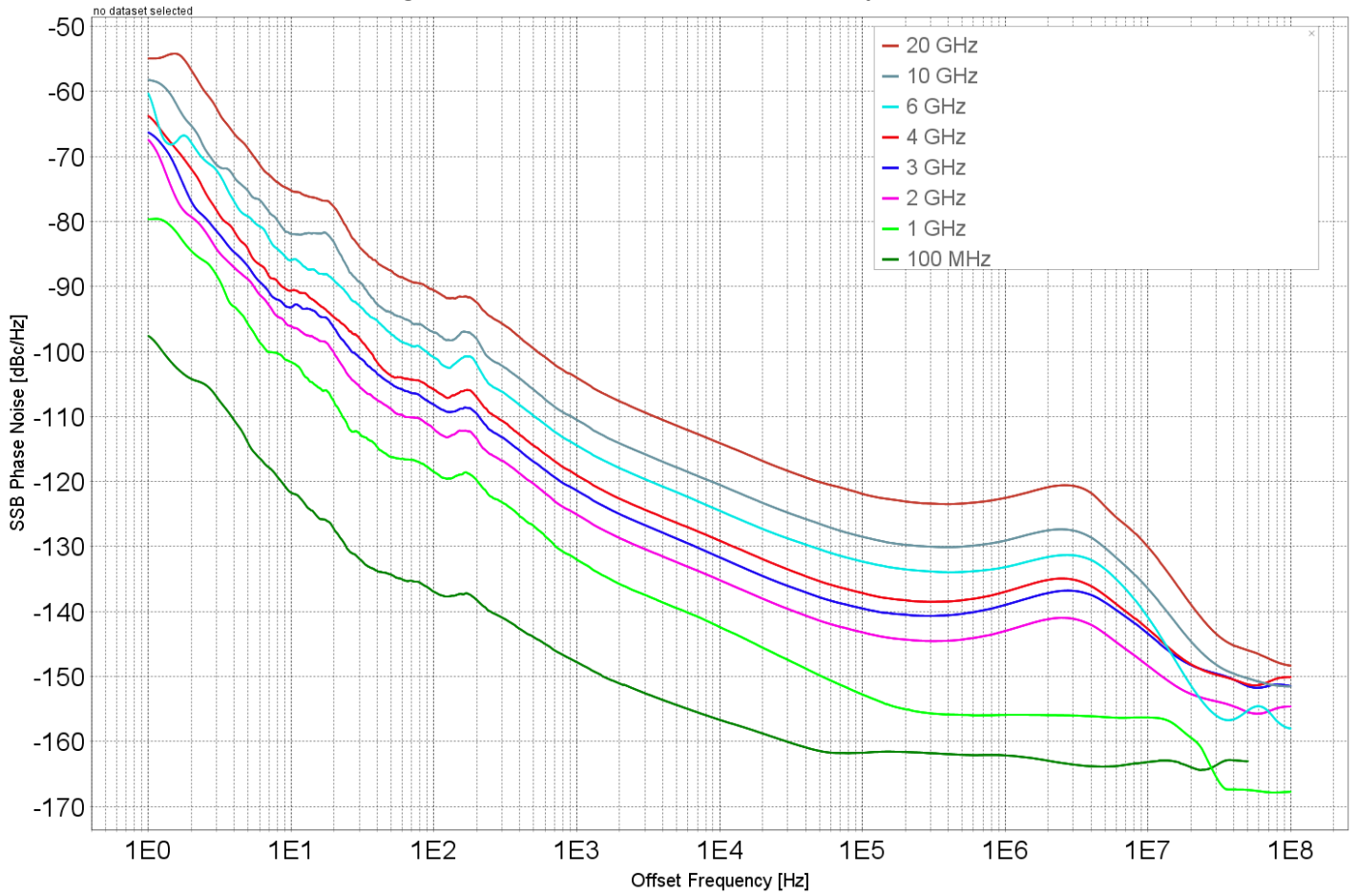


Figure 5: Phase Noise Performance without option LN

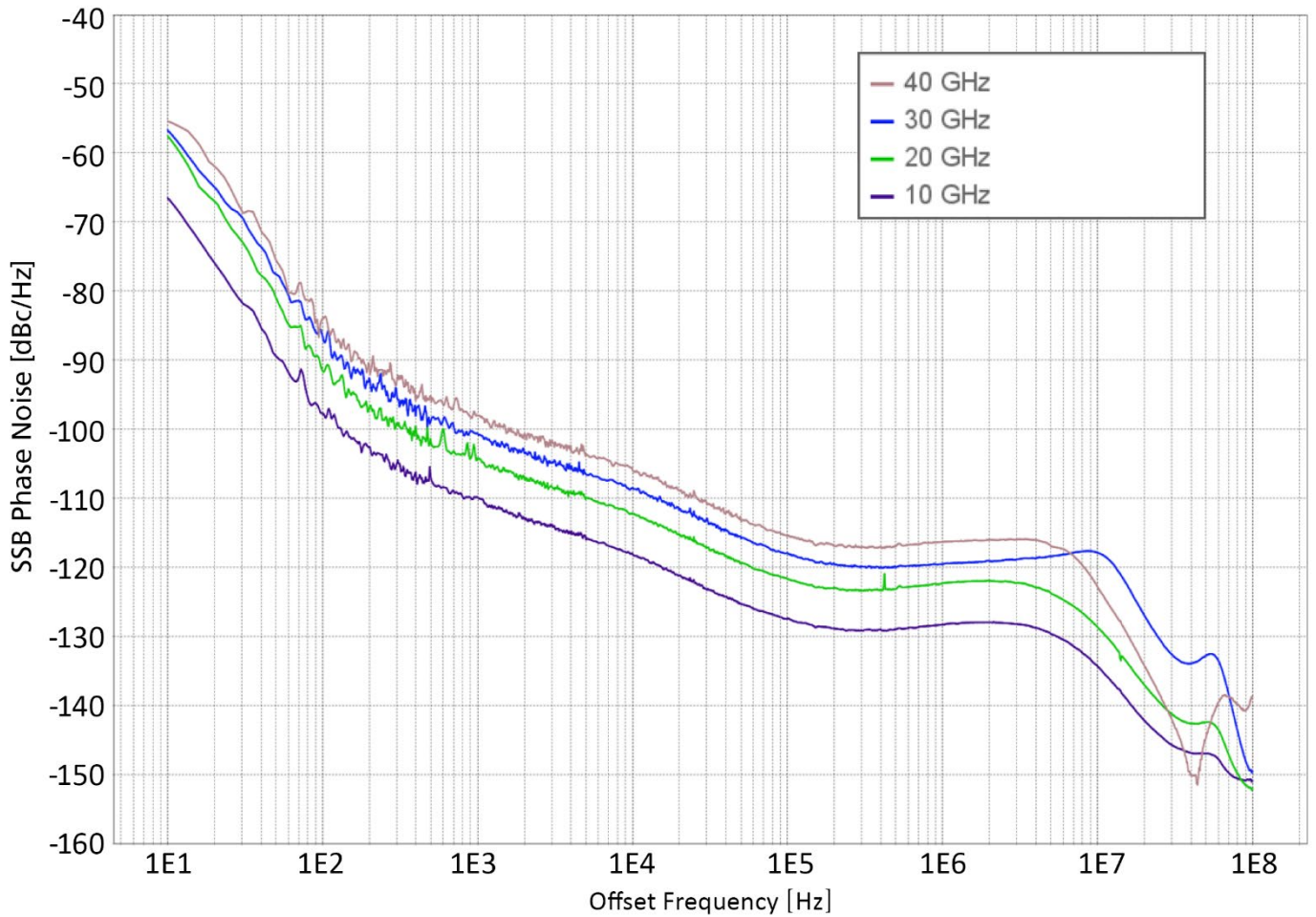
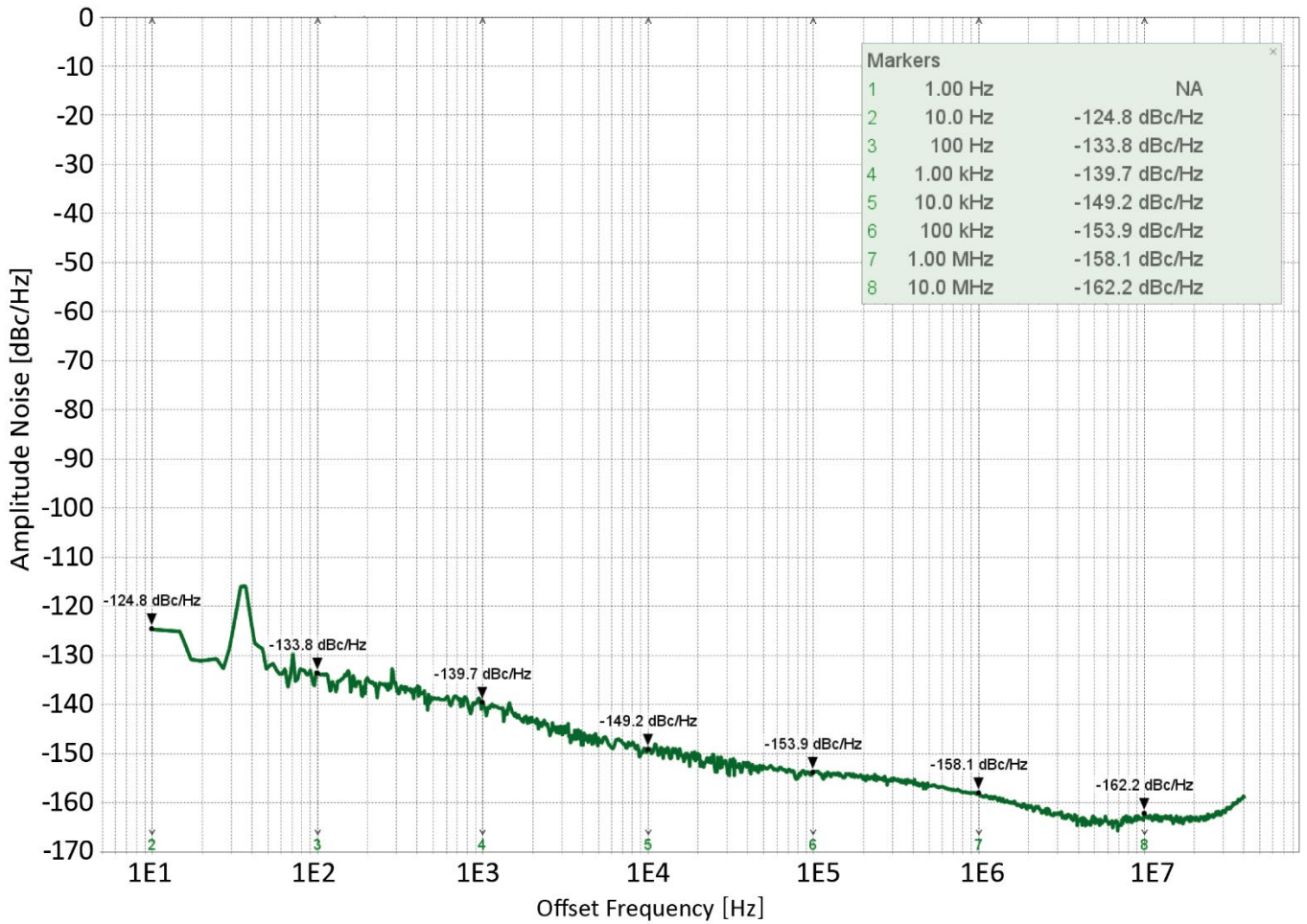


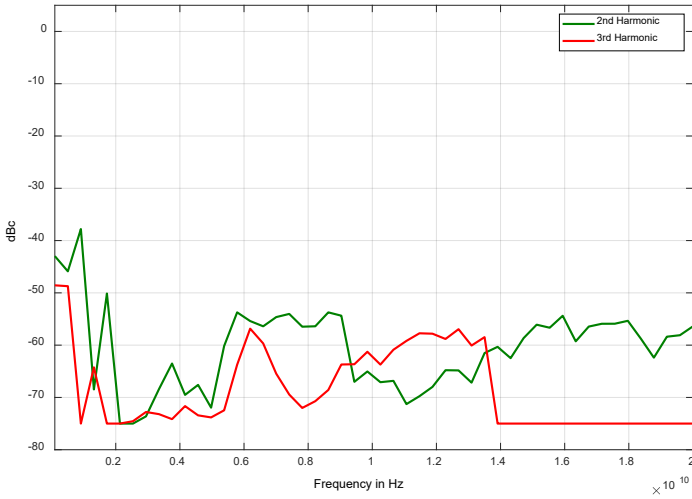
Figure 6: Amplitude Noise at 10 GHz



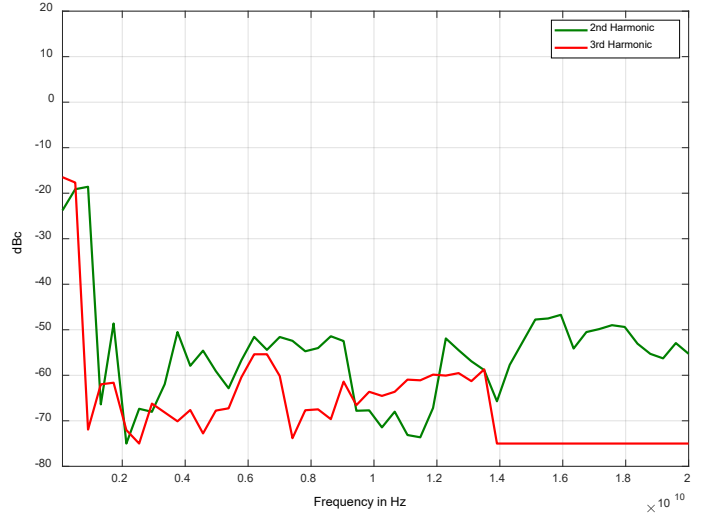
## Spectral Purity

PARAMETER	MIN	TYPICAL	MAX	NOTE
<b>Output harmonics @ 5 dBm</b>				(see also plots)
< 1.2 GHz		-25 dBc	-20 dBc	
1.2 to 2.5 GHz		-15 dBc	-9 dBc	
2.5 to 5 GHz		-30 dBc	-23 dBc	
5 to 12 GHz		-15 dBc	-9 dBc	
12 to 20 GHz		-25 dBc	-20 dBc	
>20 GHz		-20 dBc	-12 dBc	
<b>Output harmonics @ 0 dBm</b>				<b>Option FILT</b>
<1 GHz		-35 dBc	-25 dBc	
>1 GHz		-55 dBc	-45 dBc	
<b>Sub-harmonics @ 5 dBm</b>				< 20 GHz >20 GHz
		-75 dBc	-50 dBc	
		-55 dBc	-25 dBc	
<b>Non-harmonic spurious @ 5 dBm</b>				
CW, offset from 10 kHz until 500 MHz				
<1.2 GHz		-90 dBc	-60 dBc	
1.2 - 2.5 GHz		-85 dBc	-55 dBc	
2.5 - 5 GHz		-80 dBc	-55 dBc	
5 - 10 GHz		-75 dBc	-55 dBc	
10 - 20 GHz		-70 dBc	-55 dBc	
>20 GHz		-65 dBc	-50 dBc	

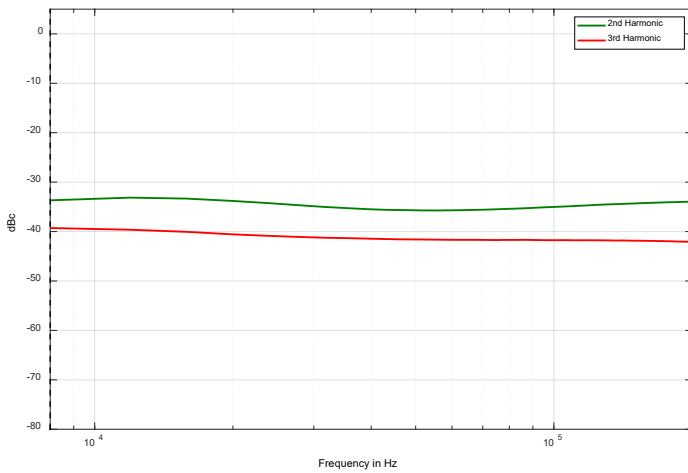
**Figure 7: Harmonics @ 0 dBm (with option FILT)**



**Figure 8: Harmonics +15 dBm (with option FILT)**



**Figure 9: Harmonics at lower frequencies and 0 dBm (with option 9K)**

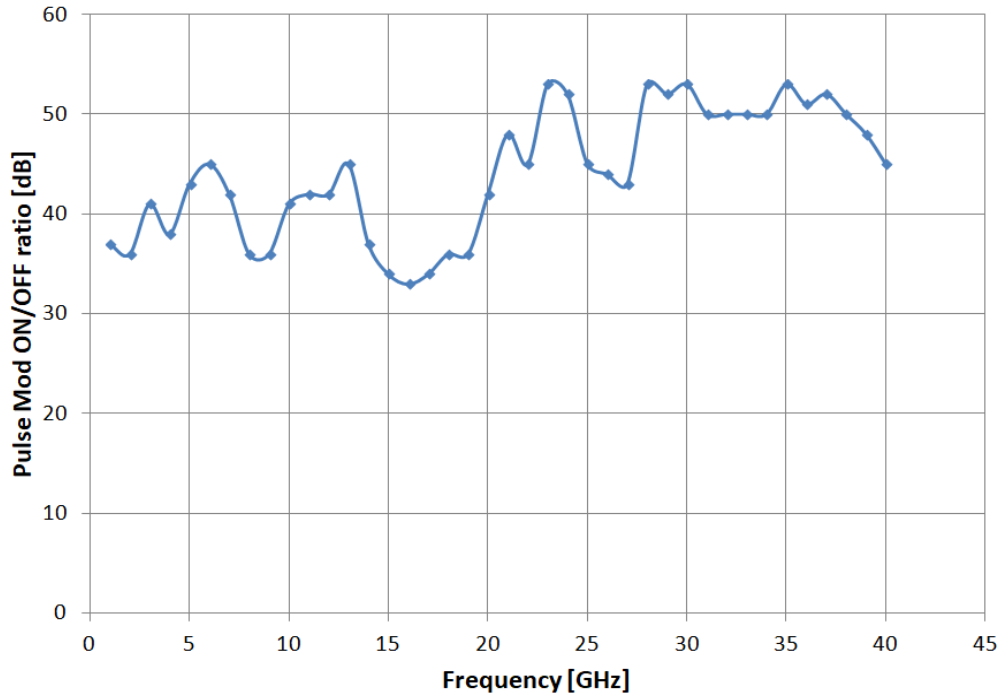


## Modulation Capabilities

### Pulse Modulation

PARAMETER	MIN	TYPICAL	MAX	NOTE
Modulation source		Internal/ External		
Pulse rise/fall time		10 ns		
On/off ratio		40 dB	25 dB	Pout > +10 dBm, see plot
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		

Figure 10: Pulse Modulation on-off ratio



### Internal pulse generator

PARAMETER	MIN	TYPICAL	MAX	NOTE
Repetition frequency (PRF)	0.1 Hz		100 MHz	= 1/T
Duty cycle	1 % to 99 % in 1% steps			within specified minimum pulse width
Minimum pulse settling range	30 ns		20 s	
Pulse Pattern Modulation & Staggered PRF				Using internal pattern generator
Pulse width	30 ns		5 s	
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 width resolution		5 ns		
Pulse jitter		<100 ps	1 ns	
Polarity		selectable		

### Frequency Modulation

PARAMETER	MIN	TYPICAL	MAX	NOTE
Modulation source		Internal		
Maximum Frequency deviation (peak)		N · 400 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			

## Phase Modulation

PARAMETER	MIN	TYPICAL	MAX	NOTE
Modulation source		Internal		
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

## ⬢ Sweeping Capability, Sweep type: linear, logarithmic, random

PARAMETER	MIN	TYPICAL	MAX	NOTE
<b>Frequency Sweep</b>				
Step time ( $t_{step}$ )	500 $\mu$ s 20 $\mu$ s			Option FS
Dwell time ( $t_{dwell}$ )	15 $\mu$ s			

## ⬢ Trigger (TRIG IN): Input is TRIG IN at front panel

PARAMETER	MIN	TYPICAL	MAX	NOTE
<b>Trigger Types</b>	Continuous, single (point), gated, gated direction			
<b>Trigger Source</b>	external, bus (LAN, USB)			
<b>Trigger Modes</b>	Continuous free run, trigger and run, reset and run			
Trigger latency		5 ns		
Trigger uncertainty		10 ns		
External Trigger delay	50 ns		40 s	
External Delay Resolution		5 ns		
<b>Trigger Modulo</b>	1		255	Execute only on Nth trigger event
<b>Trigger Polarity</b>	Rising, falling			
<b>External trigger input threshold</b>	0.85 V	0.9 V	0.95 V	TTL compatible
<b>External trigger input voltage range</b>	-0.5 V		+5.5 V	TTL compatible
<b>External trigger input hysteresis</b>		60 mV		

## Front



1. DC power switch
2. External pulse modulation inputs: BNC female (1 to 4)
3. RF outputs: K (2.92 mm) female (1 to 4)

## Rear



1. Unit-to-unit synchronization signal input (SYNC IN): SMA female
2. Unit-to-unit synchronization signal output (SYNC OUT): SMA female
3. High Stability Reference input (CLK IN, 3 GHz): SMA female
4. High Stability Reference output (CLK OUT, 3 GHz): SMA female
5. Trigger output (TRIG OUT): BNC female
6. Trigger input (TRIG IN): BNC female
7. Reference output (REF OUT): BNC female
8. Reference input (REF IN): BNC female
9. GPIB: IEEE-488.2, 1987 with listen and talk (optional)
10. LAN connection: RJ-45
11. USB 2.0 device
12. FUSE (3.15 A)
13. 100-240V AC power plug

## Standard 19" 1U



## High Isolation Casing 19" 1U (Option HI, rack mount kit included)



## ORDERING INFORMATION



HOST MODEL	PRODUCT	DESCRIPTION
865B-M-X	865B-M-1	Single output, 19" 1U rack-mount module
865B-M-X	865B-M-2	Dual-Output, 19" 1U rack-mount module
865B-M-X	865B-M-3	Triple-Output, 19" 1U rack-mount module
865B-M-X	865B-M-4	Quad-Output, 19" 1U rack-mount module
865B-M-X	<b>Option LN</b>	Enhanced close in phase noise & frequency stability
865B-M	<b>Option LN+</b>	Enhanced close in phase noise & further enhanced long term frequency stability
865B-M-X	<b>Option FS</b>	Ultra-fast switching speed
865B-M-X	<b>Option VREF</b>	Variable external reference
865B-M-X	<b>Option GPIB</b>	GPIB interface
865B-M-X	<b>Option HI</b>	High isolation 19" 1U casing
865B-M-X	<b>Option FILT</b>	Enhanced harmonic rejection
865B-M-X	<b>Option 8K</b>	Frequency range extension to 8 kHz

## 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 ± 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)

**Operating temperature range** 0 to 45 °C

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

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



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

Weight ≤ 10.0 kg (22 lbs) net

Dimensions: 19" 1U enclosure: 43 mm H x 426 mm W x 460 mm L [1.7 in H x 16.8 in W x 18.1 in L]



## Document History

Version/Status	Date	Author	Notes
V10	2019-02-20	jk	first release
V110	2020-01-26	jk	Added option FILT & option 8K
V120	2020-04-30	jk	Added plots for 8K and FILT
V121	2021-02-25	db	Pulse and trigger input electrical specifications
V122	2022-10-20	jk	Pmax Specs revised
V123	2023-06-15	mh	Removed serial number info. This version covers all HW.
V124	2023-10-04	ee	New layout structure
V125	2023-11-15	ap/mh	Nonharmonics revised
V125.1	2025-1-15	at	removed figures 4 - 6
V125.2	2026-06-19	fer	Removed Power Accuracy

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