

# APULN Specification 1.22

(Aug 2018)

Ultra low noise Microwave Signal Generators

up to 6, 12.75, 20, 26 and 40 GHz



Authorized UK and Ireland Distributor:



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## Introduction

The APULN 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 GHz, and from 300 kHz to 26 or 40 GHz, respectively, with a 0.001 Hz resolution.

The APULN provide an accurately levelled 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 APULN includes analog modulation including pulse modulation with programmable patterns.

The APULN 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 APULN 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 full front panel control via touch panel display.

### Options:

- FS: ultra fast switching
- LN: enhanced close in phase noise
- VREF: programmable external reference
- PE4: electrical step attenuator
- MOD: analog modulation
- EBAT: battery operation interface
- 1URM: 19" 1HE enclosure with rack-mount capability
- LH: Desktop housing with color touch display



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## Signal Specifications

The specifications in the following pages describe the warranted performance of the signal generator for  $23 \pm 10 \text{ }^\circ\text{C}$  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>				
Frequency range	100 kHz 100 kHz 100 kHz 100 kHz 100 kHz		6.0 GHz 12.75 GHz 20 GHz 26 GHz 40 GHz	APULN6 APULN12 APULN20 APULN26 APULN40
resolution		0.001 Hz		
Phase resolution		0.1 deg		
Frequency / Amplitude settling time		200 $\mu\text{s}$	200 $\mu\text{s}$ 20 $\mu\text{s}$	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 -150 dBc/Hz		Option LN: -100 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
<b>Output power</b>				
	-20 dBm -20 dBm -20 dBm -20 dBm -20 dBm -20 dBm -90 dBm -90 dBm -70 dBm		+18 dBm +24 dBm +23 dBm +20 dBm +20 dBm +15 dBm +20 dBm +15 dBm +10 dBm	300 kHz to 10 MHz 10 MHz to 6 GHz 6 to 12.75 GHz 12.75-20 GHz 20 -26 GHz 26 - 40 GHz Option PE4, 6, 12.75 GHz Option PE4, 20 GHz Option PE4, 26 , 40 GHz
<b>Level resolution</b>		0.01 dB		

Parameter	Min.	Typ.	Max.	Note
Level uncertainty, ALC on Temperature effects		0.3 dB 0.015 dB/ °C	1.0 dB	-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 - 70 dBc -55 dBc	-65 dBc	< 5 GHz 5 GHz to 20 GHz > 20 GHz
Non-harmonic spurious Up to 1.2 GHz > 1.2 to 2.5 GHz > 2.5 to 5 GHz > 5 to 10 GHz > 10 to 20 GHz > 20 GHz		-90 dBc -92 dBc -90 dBc -85 dBc -80 dBc -70 dBc	-85 dBc -88 dBc -86 dBc -80 dBc -74 dBc -60 dBc	CW +10 dBm, > 10 kHz offset



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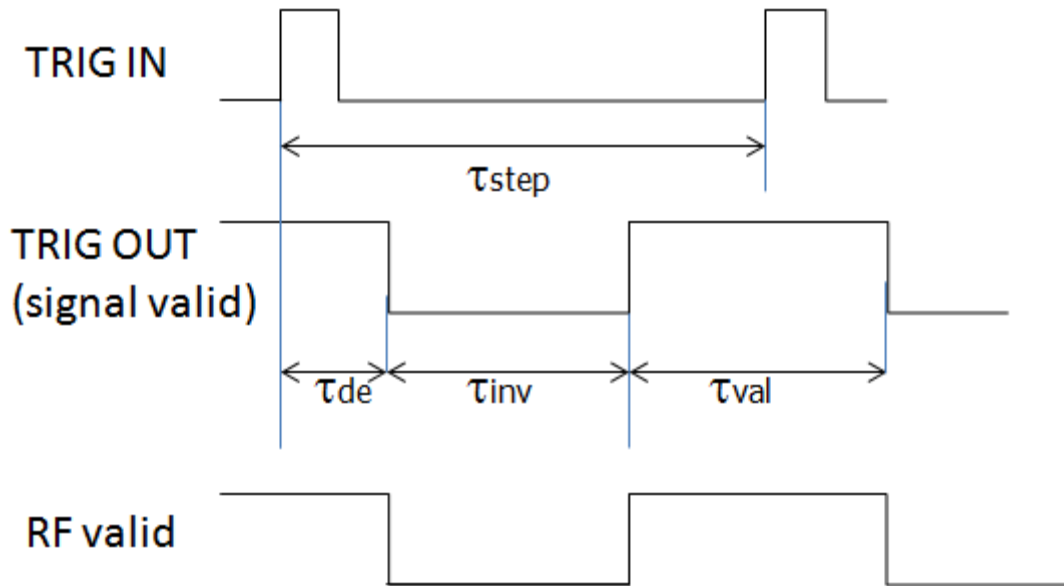
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# Sweeping Capability

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



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## Reference Frequency

REF IN input and REF OUT output are at rear panel

Parameter	Min.	Typ.	Max.	Note
<b>Internal reference frequency</b>		10 / 100 MHz		
Initial accuracy			±20 ppb	calibrated at 23 ± 3 °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 LN
Aging per day (after 30days operations)			5 ppb 0.5 ppb	Option LN
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 100 MHz, 3 GHz		High phase synchronous mode Option LN
Phase Lock to External Reference Bypass Mode	1	10 MHz integer MHz 100 MHz	250	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 GHz, 3 GHz			±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	

Parameter	Min.	Typ.	Max.	Note
Pulse Width	15 ns		50 s	
RF delay		10 ns		
<b>TRIGGER OUT</b>	<b>Synchronization mode for multiple sources</b>			
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
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		5 ns		
Trigger uncertainty		10 ns		
External Trigger delay	50 ns		10 s	
External Delay Resolution		10 ns		
Trigger Modulo	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		selectable
<b>Internal pulse generator</b>				
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	30 ns		20 s	
Pulse Pattern Modulation & Staggered PRF				Using internal pattern generator
Pulse width	30 ns 300 ns		1 μs 5 s	ALC hold ALC on
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		2 ns	5 ns	
Polarity		selectable		
<b>Frequency Modulation</b>				
Modulation source		Internal		
Maximum Frequency deviation (peak)	N · 500 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		0.5 %	2 %	
Distortion (THD)		< 1 %		1 kHz rate, 10 kHz deviation
Modulation rate	0.1 Hz		200 kHz	
Modulation waveforms	Sine			
<b>Phase Modulation</b>				
Modulation source		Internal		



Parameter	Min.	Typ.	Max.	Note
Phase deviation (peak)	0		1000 · N· rad	
Deviation accuracy		0.5 %	2 %	
Modulation rate	0.1 Hz		200 kHz	
Modulation waveforms	Sine			
Distortion (THD)	< 1%			1 kHz rate & N x rad deviation
<b>Amplitude Modulation</b>				
Modulation source		Internal		
Modulation rate	0.1 Hz		50 kHz	Settable to 200 kHz
Modulation waveforms	Sine			
Modulation depth	0 %		95 %	settable
Modulation depth resolution		1 %		
Distortion (sine wave)		1 %		at 60 % modulation depth
Accuracy (1 kHz rate, 60%)		2 %	5 %	



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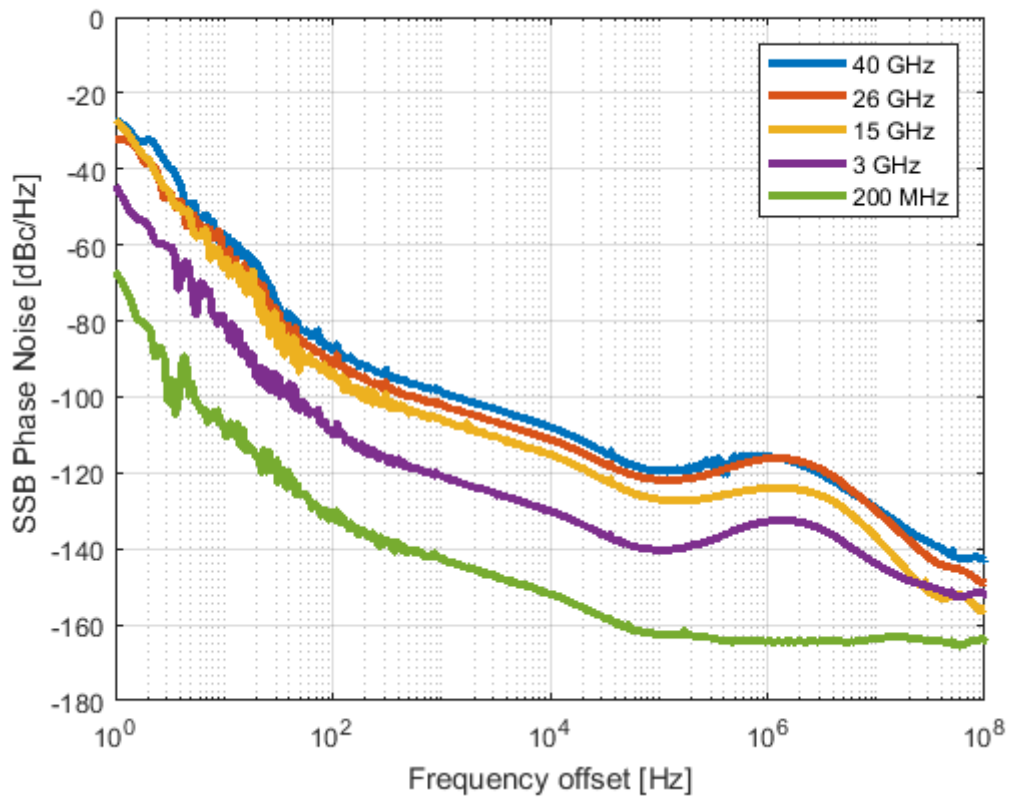
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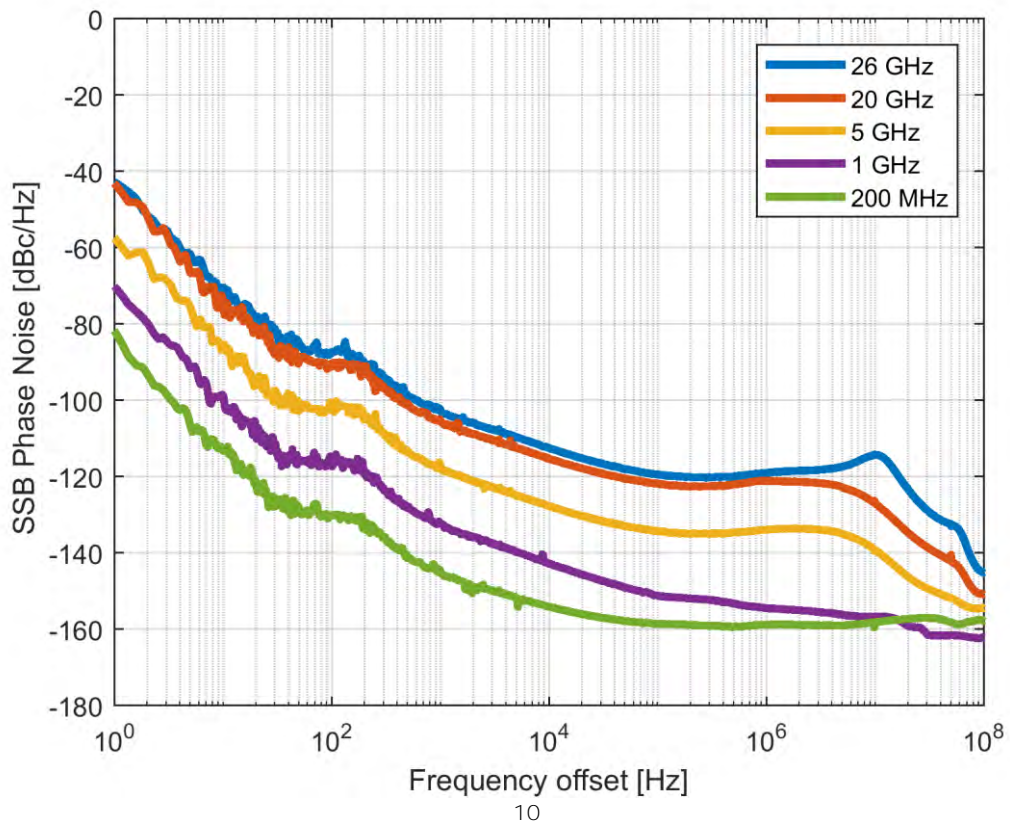
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# Typical performance curves

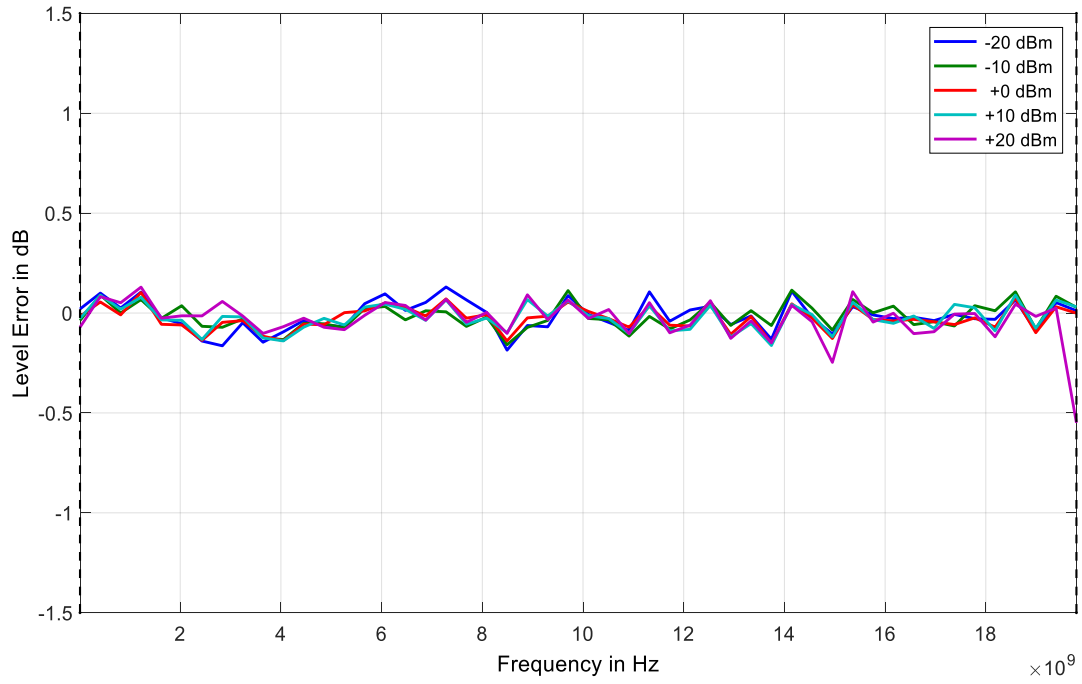
Phase Noise Performance (1 Hz to 100 MHz offset) at different output frequencies (standard)



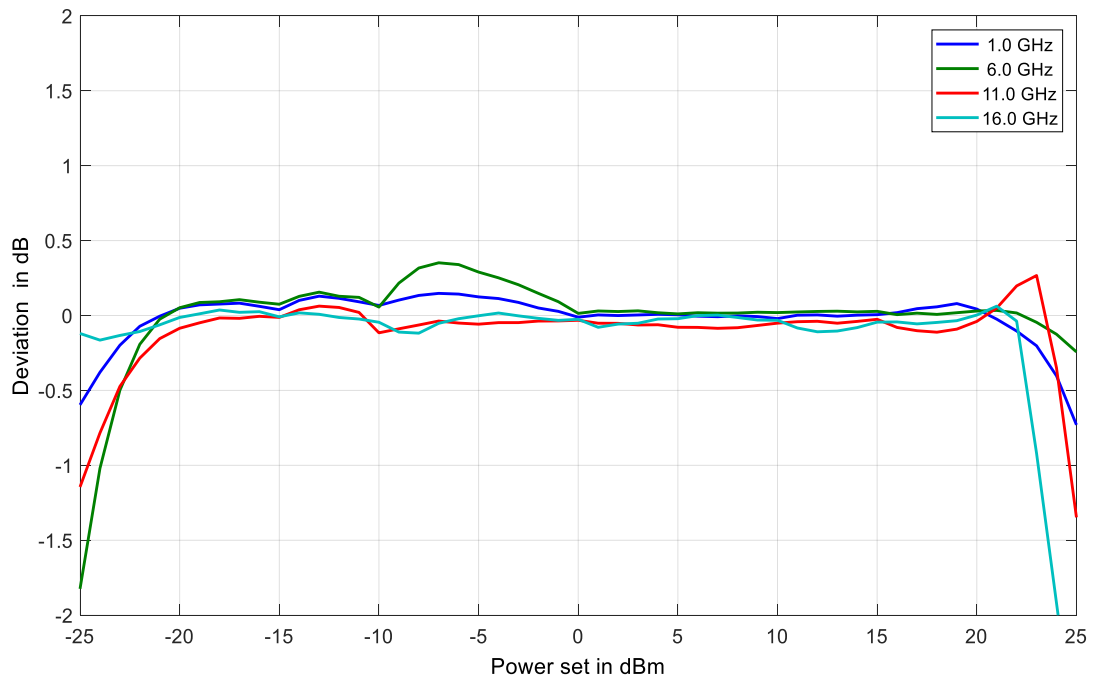
Phase Noise Performance (1 Hz to 100 MHz offset) with option LN



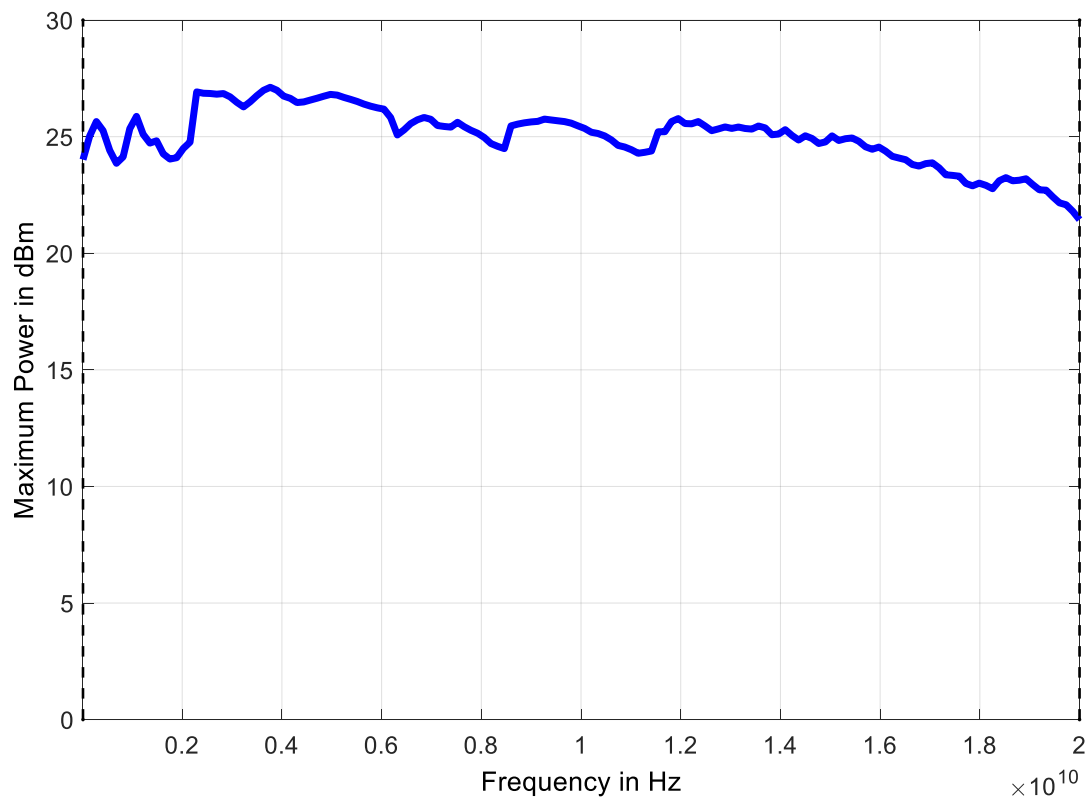
### Typical Frequency Response 0 to 20 GHz at different power levels (APULN20)



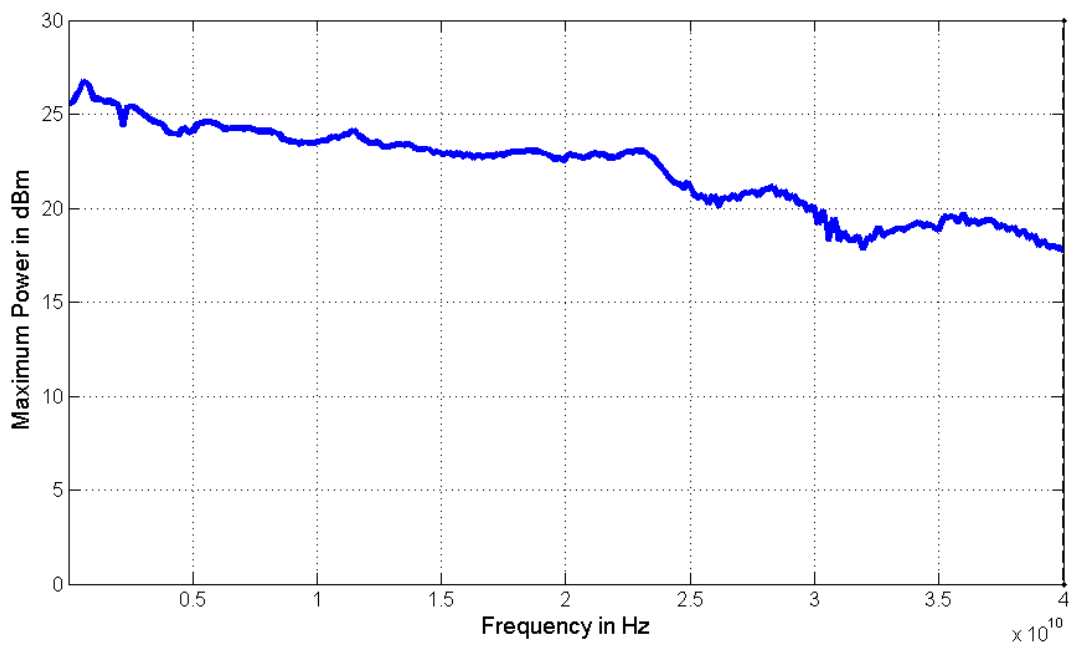
### Typical Output Power Linearity (APULN20)



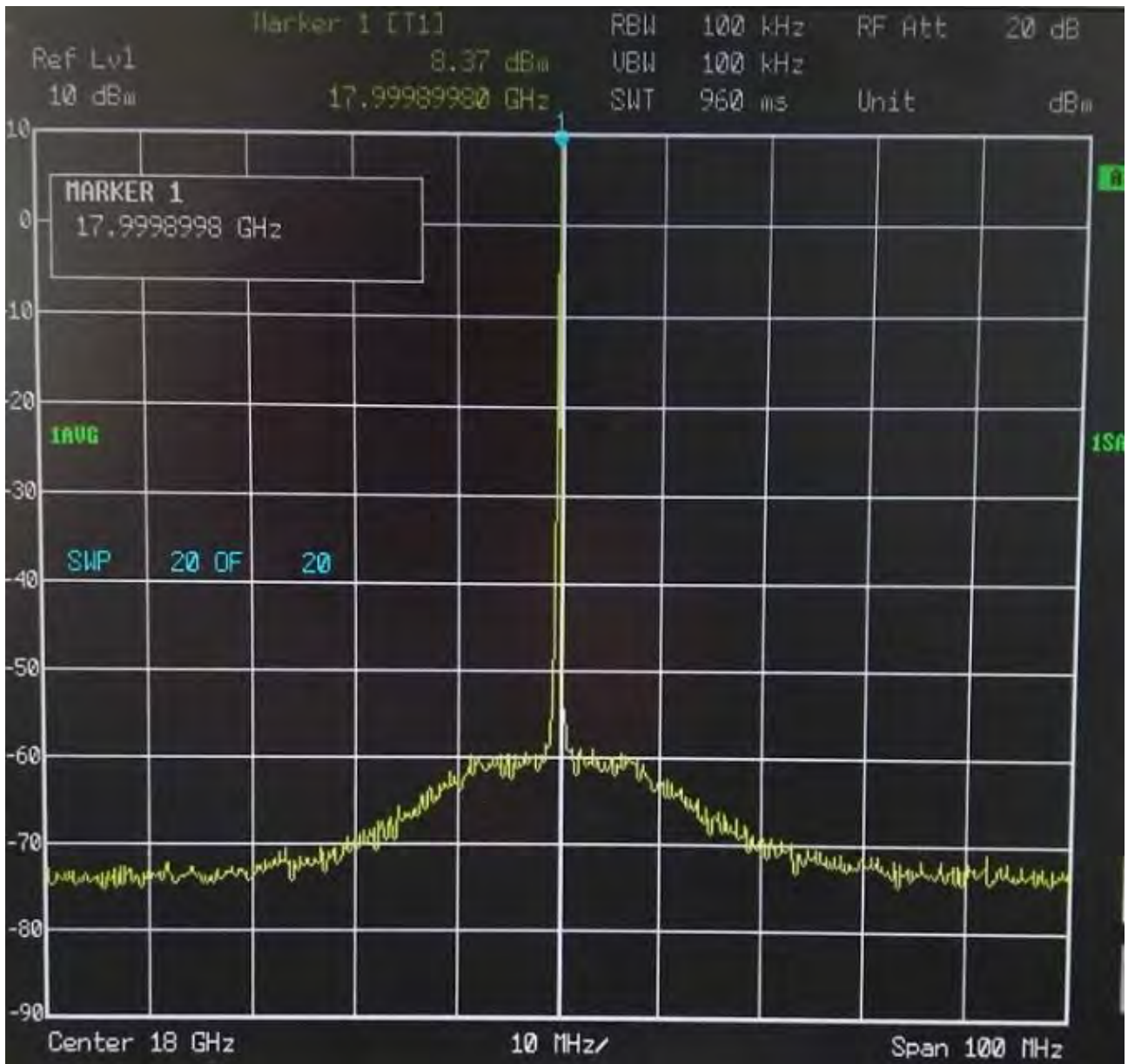
Typical Maximum Output Power APULN20



Typical Maximum Output Power APULN40



Typical Spectrum at 18 GHz (100 MHz span)



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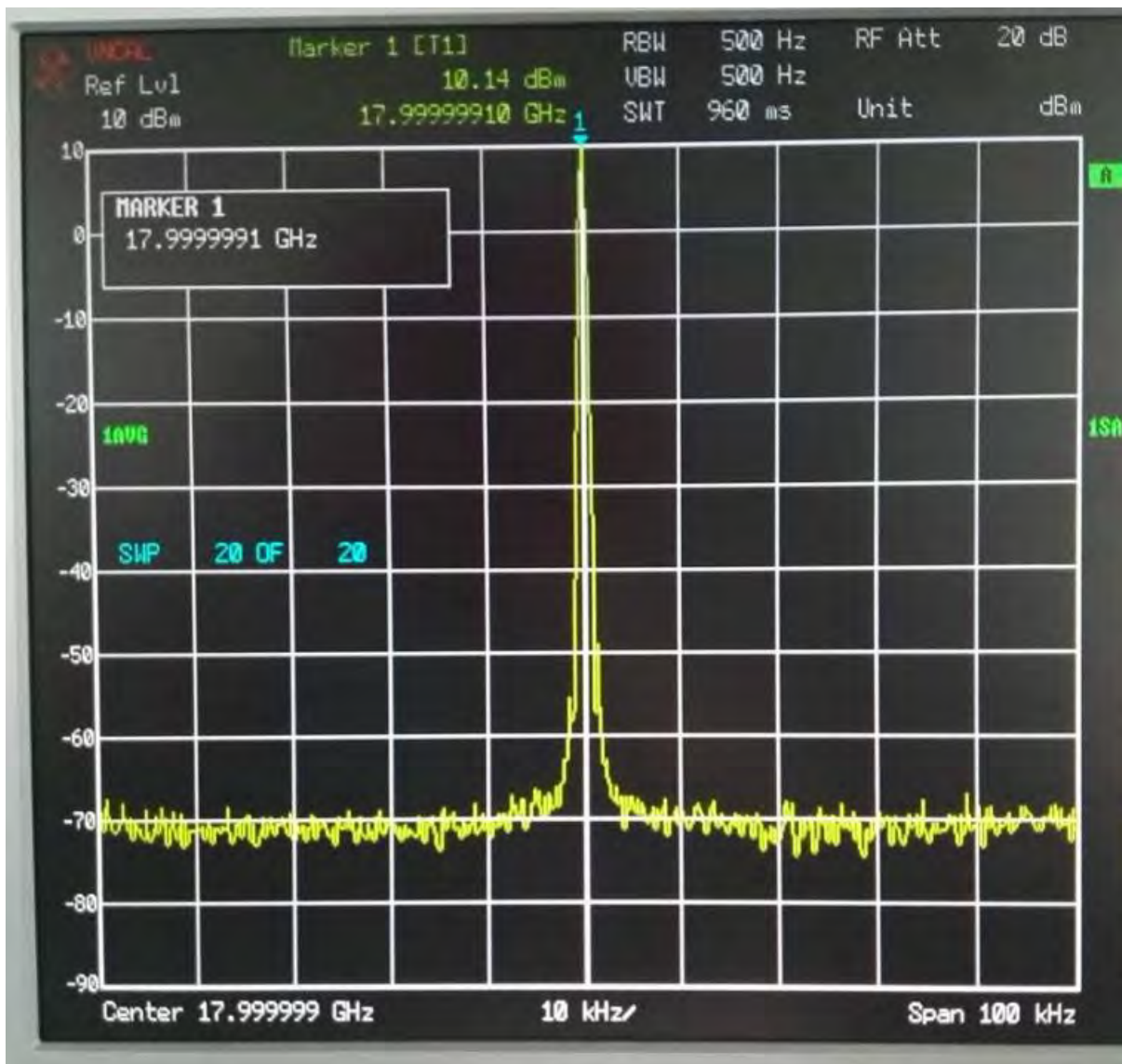
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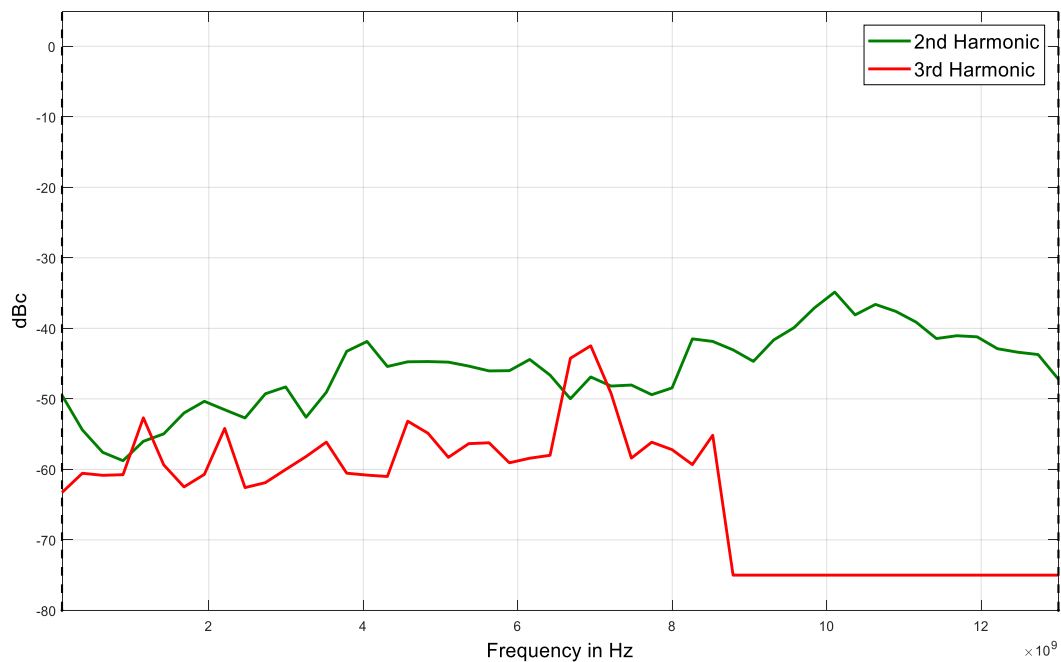
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Typical Spectrum at 18 GHz (100 kHz span)



Harmonics 100 MHz to 13 GHz at +5 dBm

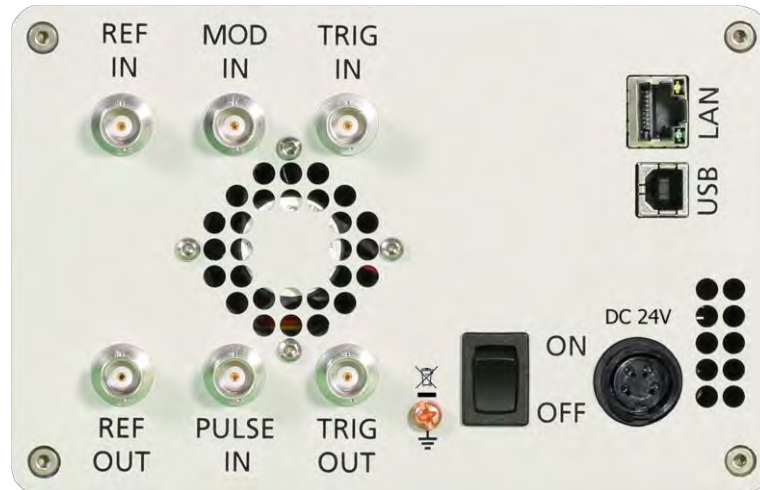


# Connectors

Front panel:



Rear panel:



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# 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)

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 45 °C

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

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



notice

EMC complies and 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** ≤ 2.5 kg (6 lbs) net, ≤ 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
- **PE4:** Extended power range down to <-85 dBm) electrical step attenuator module
- **LN:** enhanced close-in phase noise, improved frequency stability
- **MOD:** analog modulation
- **LH:** Desktop housing with color touch display
- **VREF:** variable reference input
- **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

## Document History

Version/Status	Date	Author	Notes
V10	2017-10-15	jk	first release
V110	2017-12-5	jk	Added option LN data, refined dynamic range values
V111	2018-12-1	jk	Added modulation specs
V112	2018-1.2	jk	Refined max power specs
V113	2018-15.2	jk	Enhanced modulation specs
V120	2018-15.3	jk	Added additional plots
V121	2018-15.5	jk	Added additional plots
V122	2018-6.6	jk	Option ULN renamed LN, option MOD Specs refined



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