

APULNXX Target Specification 1.20

(March 2018)

Ultra low noise Microwave Signal Generators

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



Introduction

The APULNXX 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 APULNXX 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 APULNXX includes intra/pulse chirp modulations, frequency chirps, pulse modulation with programmable patterns, and phase modulation.

The APULNXX 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 APULNXX 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.

Options:

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

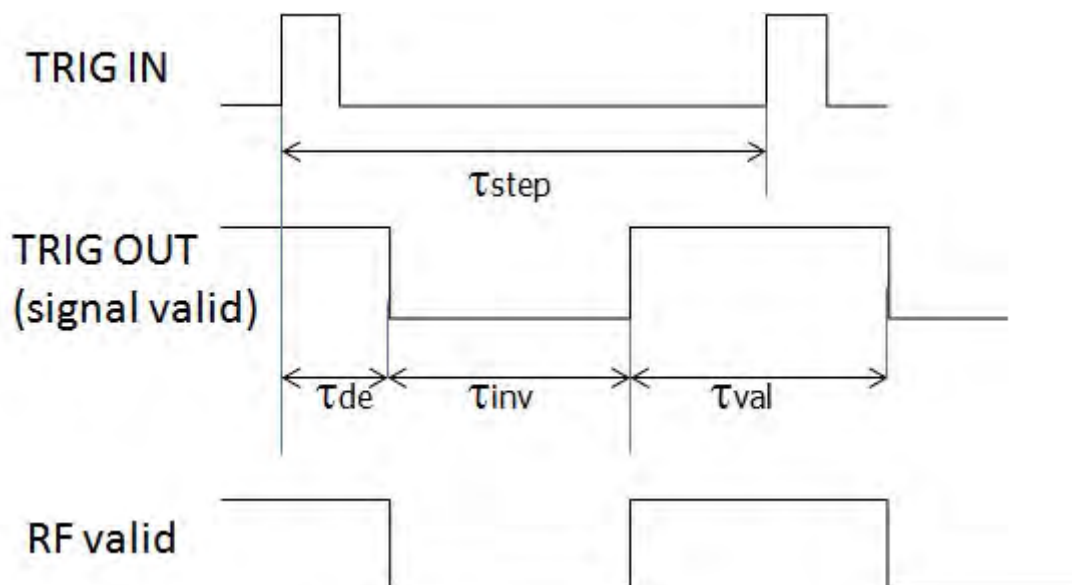
Signal Specifications

The specifications in the following pages describe the warranted performance of the signal generator for $23 \pm 10^\circ\text{C}$ 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
CW mode				
Frequency range	300 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 μs	200 μs 20 μs	time from receipt of SCPI command option FS
SSB Phase noise				
1 GHz 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
4 GHz 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
10 GHz 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
30 GHz 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
Output power				
	-20 dBm -20 dBm -20 dBm -20 dBm -20 dBm -20 dBm -90 dBm -90 dBm -120 dBm		+18 dBm +25 dBm +24 dBm +22 dBm +18 dBm +15 dBm +20 dBm +18 dBm +20 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 PE3, 6 GHz
Level resolution	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		
Reverse Power Protection				
DC Voltage			±15 V	
RF power			30 dBm	
Spectral purity at + 10 dBm 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
Digital power / frequency / list sweeps				
Sweep type: linear, logarithmic, random				
Step time (τ_{step})	200 μ s 20 μ s		19998 s	Option FS
Dwell time (τ_{val})	10 μ s		9999 s	
Off-time (incl. transient time) (t_{off})	0		9999 s	
Transient time (τ_{inv})			270 μ s 25 μ s	Option FS
Timing delay (τ_{de})		2 to 10 μ s 50 ns		Option FS
Time resolution		0.1 μ s 5 ns		Option FS
Timing accuracy per point		3 μ s 5 ns		Option FS
 The diagram illustrates the timing relationships for a digital sweep. It shows three signals: TRIG IN, TRIG OUT (signal valid), and RF valid. TRIG IN is a pulse that starts at a certain point and ends at a later point. TRIG OUT is a pulse that starts after a delay τ_{de} from the rising edge of TRIG IN, and ends after a delay τ_{val} from the falling edge of TRIG IN. The duration of TRIG OUT is τ_{inv}. RF valid is a pulse that starts at the rising edge of TRIG IN and ends at the falling edge of TRIG IN. The total duration of the sweep is τ_{step}.				

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 ± 3 °C at time of calibration , user adjustable
Temperature stability (0 to 50 degC)			±20 ppb	
Aging 1 st year		0.5 ppm 0.1 ppm		Option ULN
Aging per day (after 30days operations)			tbm	
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	10, 100 MHz	250	Option VREF
Reference input level	-5 dBm	0 dBm	+13 dBm	
Lock Range			±1.5 ppm	
Reference input impedance		50 Ohms		

Multi Purpose Output (FUNC OUT)

Output is FUNC OUT at rear panel

Parameter	Min.	Typ.	Max.	Note
MULTIFUNCTION GENERATOR 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
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 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
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)

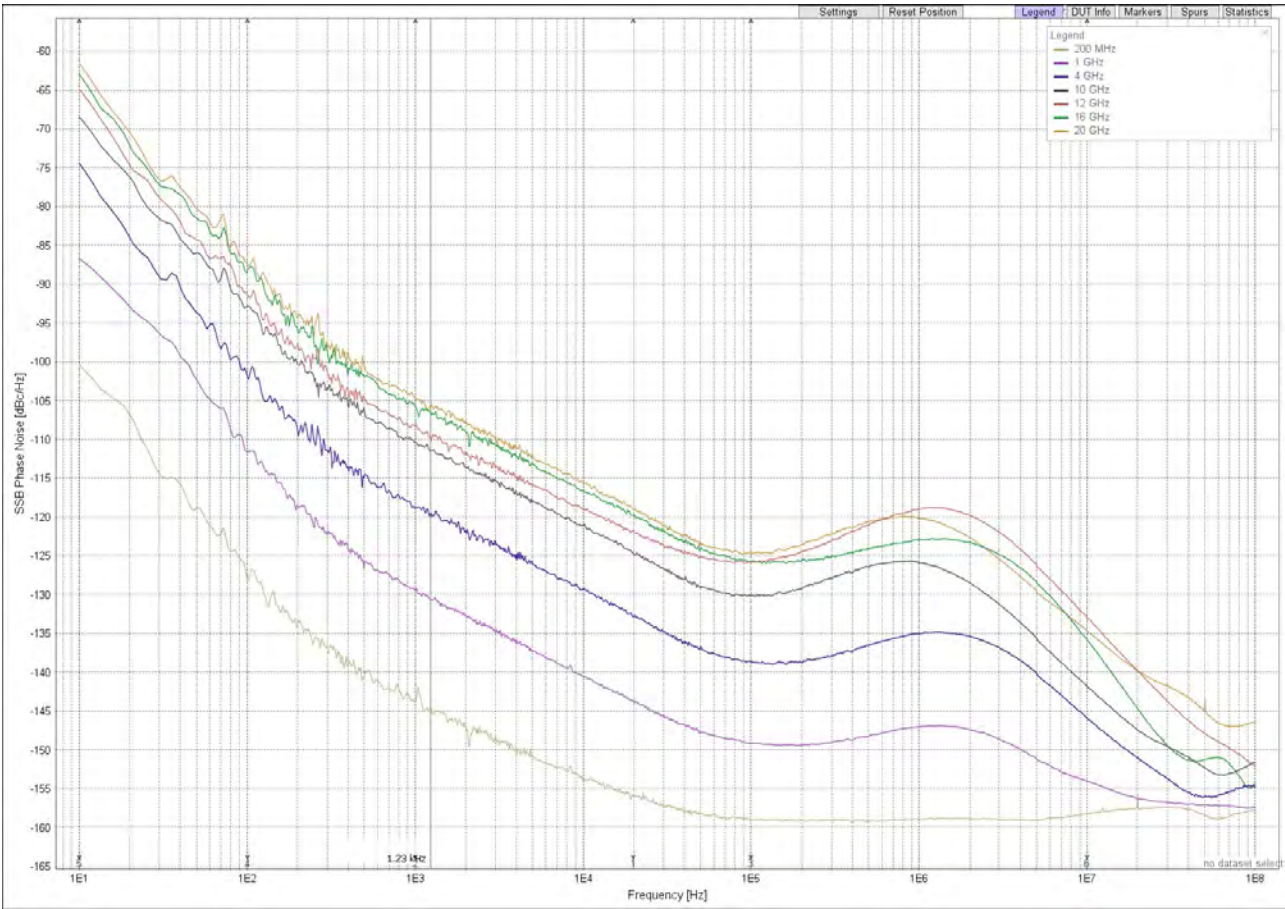
Modulation Capabilities (option MOD)

Parameter	Min.	Typ.	Max.	Note
Pulse Modulation				
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
Internal pulse generator				
Repetition frequency (PRF)	0.1 Hz		20 MHz	
Duty cycle	1 % to 99 % in 1% steps			within specified minimum pulse width
Minimum pulse width	30 ns			
Pulse Pattern Modulation & Staggered PRF				Using internal pattern generator
Pulse width	30 ns 300 ns		1 μ s 5 s	ALC hold ALC on
Programmable pattern length	2		65536	
Duty cycle	0.05 %		99.95 %	
Pulse width resolution		5 ns		
Polarity		selectable		
Frequency Modulation				
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		0.5 %	2 %	
> 100 kHz rate		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
Phase Modulation				
Modulation source		Internal		
Phase deviation (peak)	0		N·100 rad	

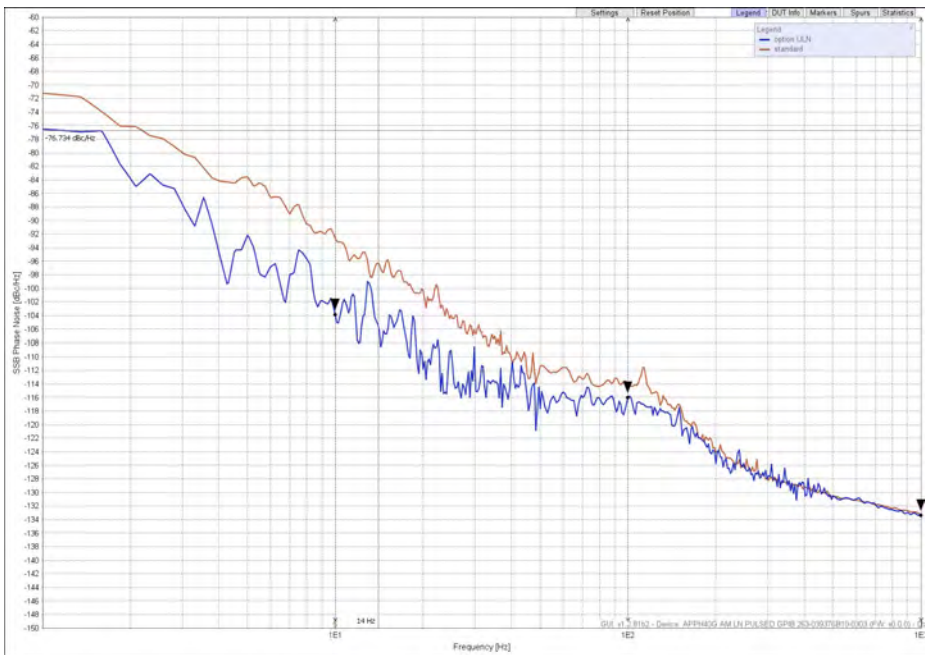
Parameter	Min.	Typ.	Max.	Note
Modulation rate	DC		800 kHz	> -3dB frequency response Max. phase deviation degrades above 20 kHz modulation rate
Modulation waveforms	Sine, triangle, FSK			
Total harmonic distortion	< 1%			1 kHz rate & N x 100 rad deviation
Amplitude Modulation				
Modulation source		Internal		
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

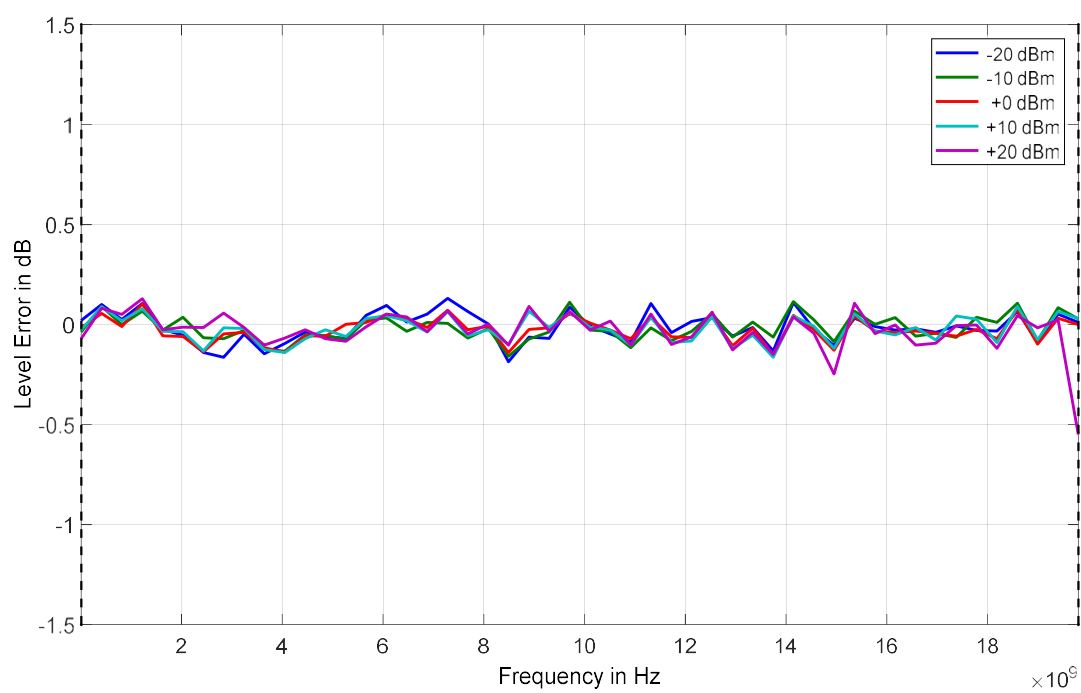
Phase Noise Performance (10 Hz to 100 MHz offset) at different output frequencies (standard)



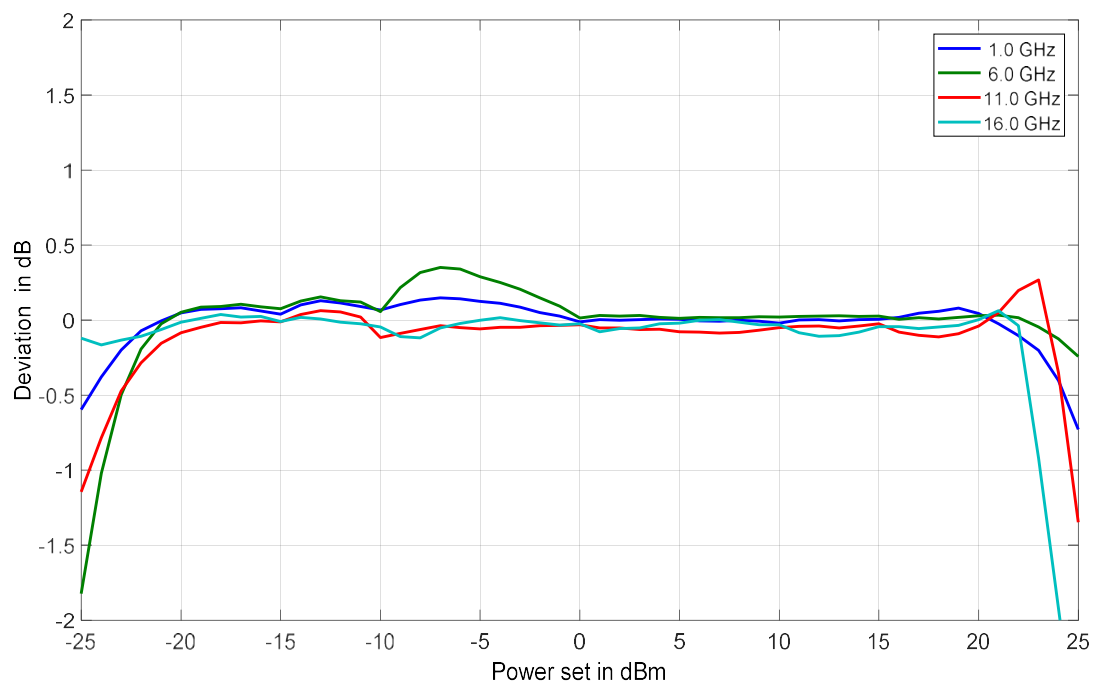
Phase Noise Performance with option ULN (1GHz, 1 Hz to 1 kHz)



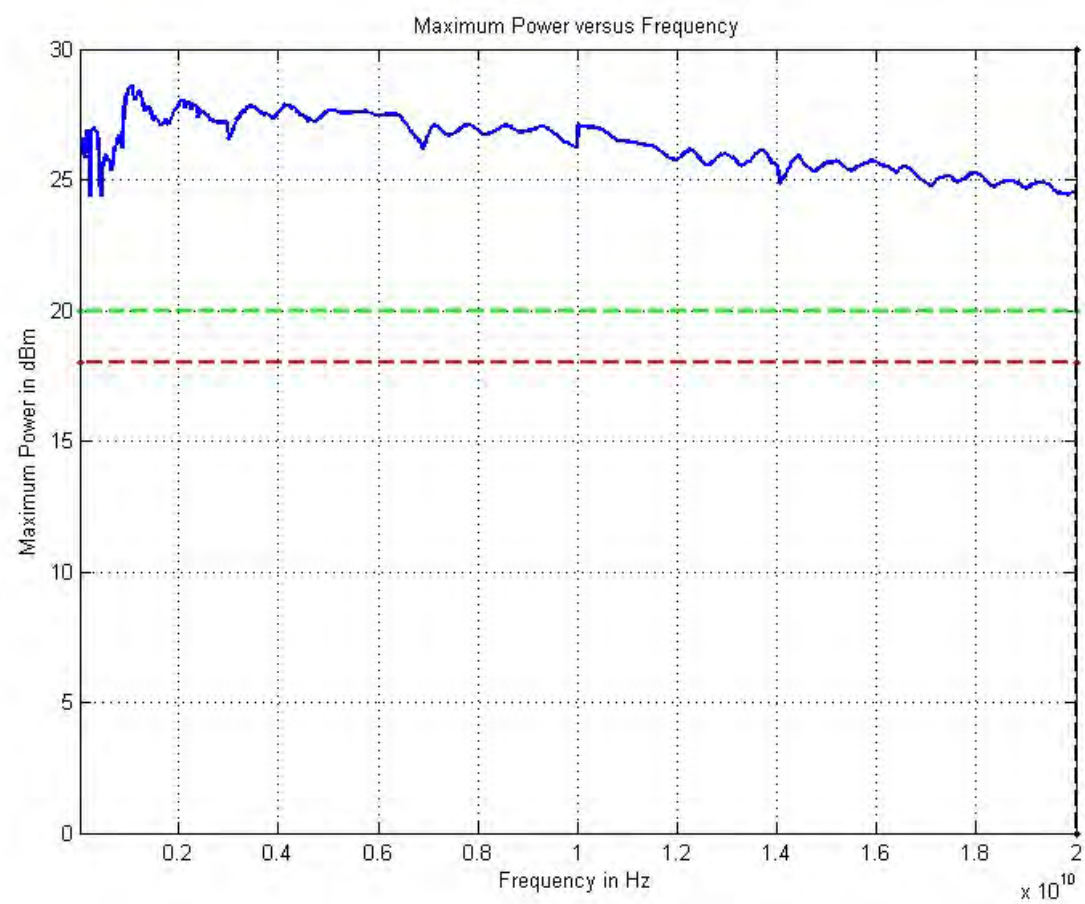
Typical Frequency Response 0 to 20 GHz at different power levels



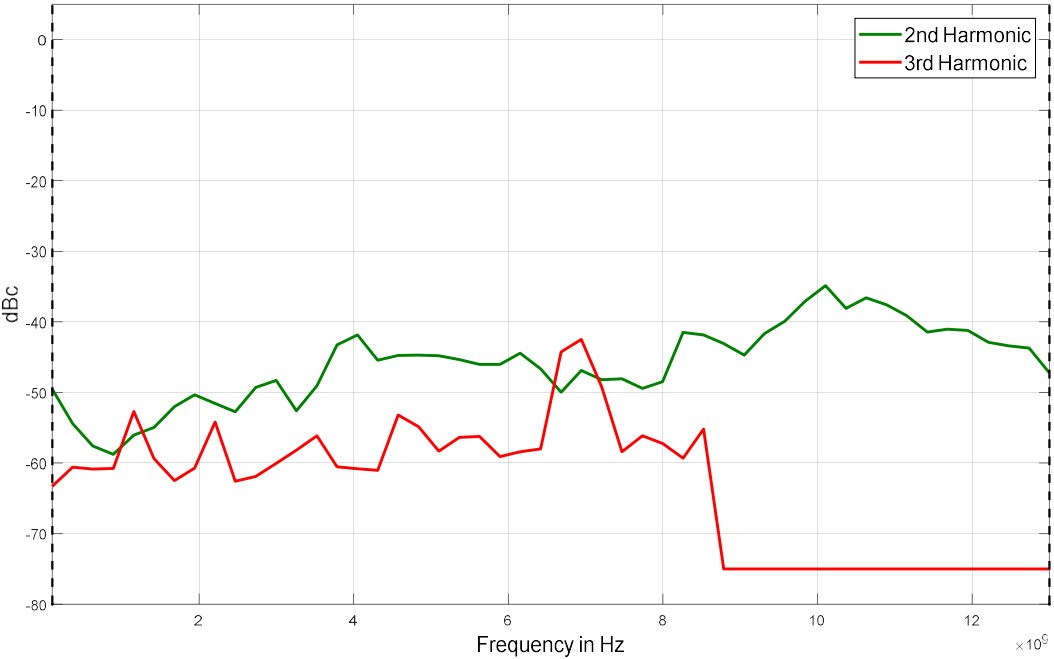
Typical Output Power Linearity



Typical Maximum Output Power (10 MHz to 20 GHz)



Harmonics 100 MHz to 13 GHz at + 5 dBm

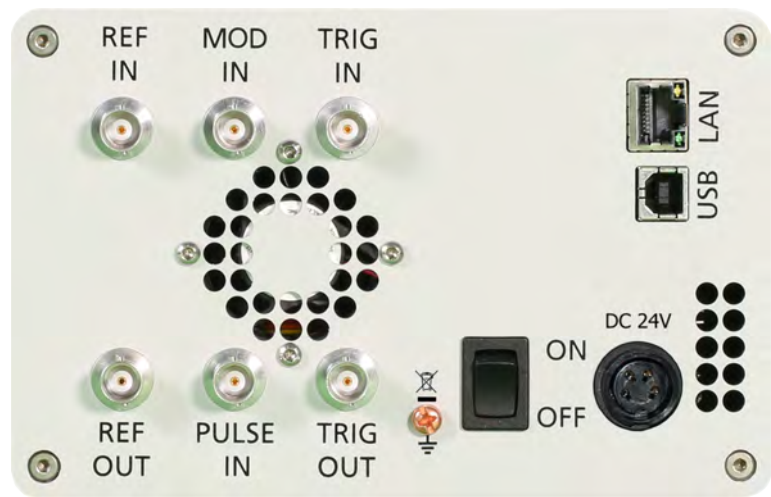


Connectors

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 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 $\leq$ 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

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