

# APSIN12G-APSIN20G-APSIN26G

## Specification 2.33 (April 2015)

Portable 12,20, 28 GHz Microwave Signal Generators

with Options **HP**, **PE3**, **NM**



(Serial xxx-xxxx8xxxx-xxxx and higher)

## Introduction

The APSINXXG is a series of low-noise and fast-switching microwave signal generators covering a continuous frequency ranges from as low as 100 kHz up to 12, 20, and 26.5 GHz, respectively, with a 0.001 Hz resolution.

The APSINXXG provide an accurately levelled output power range and high spurious suppression. Advanced frequency synthesis with fractional-N divider makes for low SSB phase noise and micro-Hz resolution.

Available Options:

**Option HP** delivers higher maximum output power to a level up to +27 dBm.

**Option PE3** is an optional power level extension to accurately level below -90 dBm.

**Option LN** provides ultra low phase noise and further improves frequency stability

**Option FS** substantially reduces the switching speed

**Option NM** removes all built-in modulation capabilities if not needed (APSIN20G, APSIN26G only)

**Option B3** adds an internal rechargeable battery module

**Option 1URM** modifies form-factor to a 19" rack-mountable 1U enclosure

The standard APSINXXG includes amplitude modulation (AM), DC-coupled, low distortion wideband frequency modulation (FM), PM, FSK and PSK, frequency chirp, and fast pulse modulation with internal pulse train generator. Three internal modulations sources are available. All modulation modes of the APSINXXG can be combined. This allows the generation of complex modulation signals for modern communication and location systems. The combination of pulse modulation and FM simulates Doppler effects or chirp signals. Simultaneous AM and pulse modulation provides the types of signal occurring in pulse radar applications with rotating antenna. The combination of FM and AM can be used to check fading effects of FM receivers. All APSINXXG allow 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 APSINXXG operate with an ultra-stable temperature compensated 100 MHz reference (OCXO) to ensure minimal drift, and can be phase-locked to any stable external reference in a range from 1 to 250 MHz. Additionally, optimum phase synchronous signals can be achieved by bypassing internal and feeding a 100 MHz signal directly as reference.

The APSINXXG support various standard interfaces such as USB-TMC, LAN, and GPIB.

Applications for the APSINXXG include

- R&D low noise microwave source
- Production testing (industry-leading switching times; high dynamic range)
- Service and maintenance (battery operation)
- Signal simulation (Radar, WiMax, UWB)
- Aerospace & Defence (Pulse modulator, Chirps)

## Signal Specifications

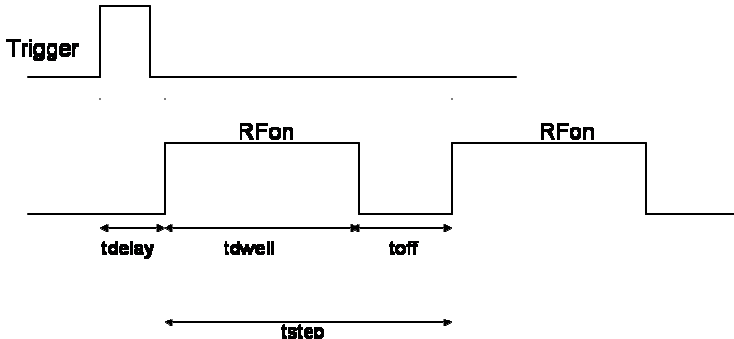
The specifications in the following pages describe the warranted performance of the signal generator for  $23 \pm 10^\circ\text{C}$  after a 30 minute warm-up period and for all configurations (options PE3 if not explicitly stated). Typical specifications describe expected, but not warranted performance. Min and Max specifications are warranted.

Parameter	Min.	Typ.	Max.	Note
CW mode				
Frequency range	100 kHz 100 kHz 100 kHz		12.0 GHz 20.0 GHz 26.5 GHz	APSIN12G APSIN20G , settable to 20.5 GHz APSIN26G, settable to 30 GHz
resolution		0.001 Hz		
Phase resolution		0.1 deg		
Frequency update rate		500 μs		time from receipt of SCPI command
List/Sweep mode		300 μs	40 μs	option FS
SSB Phase noise at 10 GHz				
at 10 Hz from carrier		-55 dBc/Hz -80 dBc/Hz		Option LN
at 1 kHz from carrier		-98 dBc/Hz -105 dBc/Hz		Option LN
at 20 kHz from carrier		-108 dBc/Hz -116 dBc/Hz		Option LN
Wideband noise		-150 dBc/ Hz		
Amplitude Noise at 10 GHz		-130 dBc/Hz -140 dBm		Pout=+10 dBm, 100 kHz offset noise floor
Output power				Check maximum output power plots on page 10
Standard 100 kHz to fmax	-20 dBm		+15 dBm	
Option PE3 only 100 kHz to fmax	-90 dBm		+13 dBm	
Option HP only	-20 dBm -20 dBm		+23 dBm	< 18 GHz >18 GHz, see plot
Options HP and PE3	-90 dBm -90 dBm		+20 dBm	< 18 GHz >18 GHz, see plot
Level resolution	0.01 dB			
Level uncertainty, ALC on		0.3 dB	< 1 dB < 1.5 dB	> -15 dBm < -15 dBm
User flatness correction		up to 2000 points		
Output impedance	50 Ω			
VSWR	2.0			
Reverse Power Protection				
DC Voltage			±15 V	
RF power			30 dBm	

Parameter	Min.	Typ.	Max.	Note
<b>Spectral purity at + 5 dBm</b>				
Output harmonics		-40 dBc -35 dBc -45 dBc	-30 dBc -30 dBc -30 dBc	0.1 to 5.0 GHz 5.0 to 10.0 GHz > 10 GHz
Sub-harmonics		-75 dBc	-65 dBc	
Non-harmonic spurious		-75 dBc	-60 dBc	
Residual FM @ 10 GHz		15 Hz		0.3 kHz to 3 kHz, weighted (ITU-T), RMS
Residual AM @ 10 GHz		0.02 %		RMS value (0.01 kHz to 15 kHz)

## Sweeping Capability

Sweeps can be performed with combined internal or external AM/FM/PM/pulse modulation running. With modulation enabled, the minimum step time increases to 2 ms.

Parameter	Min.	Typ.	Max.	Note
<b>Digital frequency sweep</b>				
Sweep type: linear, logarithmic, random				
Step time ( $t_{step}$ )	400 $\mu$ s		19998 s	
Dwell time ( $t_{dwell}$ )	10 $\mu$ s		9999 s	
Off-time (incl. transient time) ( $t_{off}$ )	0 / 50 $\mu$ s		9999 s	
Timing accuracy per point		1 $\mu$ s		
 <p>The diagram illustrates the timing sequence for a digital frequency sweep. A 'Trigger' pulse initiates the process. Following the trigger, there is a 'tdelay' period. Then, the 'RFon' signal becomes active (high) for a duration of 'tdwell'. This is followed by an 'toff' (off-time) period where the RF signal is inactive (low). The total duration of one step, from the start of the delay to the end of the off-time, is labeled as 'tstep'.</p>				
<b>Generalized list sweep</b>				
allows individual setting of frequency, power, dwell-time, and off-time for each point				
List size	2		65'000	
Step time ( $t_{step}$ )	400 $\mu$ s		19998 s	mechanical attenuator not used
Dwell time ( $t_{dwell(i)}$ )	50 $\mu$ s		9999 s	
Off-time (incl. transient time) ( $t_{off}$ )	0 / 50 $\mu$ s		9999 s	
Time resolution		0.1 $\mu$ s		
Timing accuracy per point		1 $\mu$ s		
<b>Ramp (analog) sweep</b>				
Sweep span		20 %		of carrier frequency
Sweep rate	tbd		N · 5 GHz / ms	
Sweep time	0.1 ms		100 ms	
<b>Frequency Chirps</b>				
(linear ramp, up/down)				
Bandwidth	10 %			of carrier frequency
Dwell time ( $t_{dwell}$ )	10 ns		10000 $\mu$ s	
Number of frequencies			65'000	

## Reference Frequency

REF IN input and REF OUT output are at rear panel

Parameter	Min.	Typ.	Max.	Note
<b>Internal reference frequency</b>		100 MHz		
Initial accuracy			±40 ppb	calibrated at 23 ± 3 °C at time of calibration , user adjustable
Temperature stability (0 to 50 degC)			±100 ppb	
Aging 1 <sup>st</sup> year		0.5 ppm		
Aging per day (after 30days operations)			5 ppb	
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, -5 to +10 dBm			High phase synchronous mode
Phase Lock to External Reference External Input Range	1 MHz		250 MHz	User programmable
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
<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		

Parameter	Min.	Typ.	Max.	Note
<b>TRIGGER OUT</b> <b>Synchronization mode for multiple sources</b>				
Modes	Trigger on sweep start Trigger on each point			
Trigger waveform pulse width		100 ns		

## Trigger (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		tbd		
Trigger uncertainty		5 $\mu$ s		
External Trigger delay	50 $\mu$ s		40 s	
External Delay Resolution		15 ns		
Trigger Modulo	1		255	Execute only on Nth trigger event
Trigger Polarity	Rising, falling			

## Modulation Capabilities (not with option NM)

Combined AM/PM/FM/PULSE possible (see user manual)

Parameter	Min.	Typ.	Max.	Note
<b>Multifunction Generator</b> sine, triangle, square wave Output is FUNC OUT at rear panel				
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>Pulse Modulation</b>				
On/off ratio		70 dB		<b>at +10 dBm</b>
Repetition frequency	DC		10 MHz	
Pulse width	30 ns 500 ns			ALC hold ALC on
Pulse rise/fall time		7 ns		
Pulse width	30 ns		100 μs	
Pulse resolution		15 ns		
Polarity		selectable		
External input amplitude		1 V TTL		AC DC
<b>Pulse Pattern Modulation</b>				
On/off ratio		70 dB		Using internal pattern generator <b>at +10 dBm</b>
Pulse bit width	30 ns 500 ns			ALC hold ALC on
Pulse rise/fall time		7 ns		
Programmable pattern length	2		4192	
Pulse width	30 ns		100 μs	
Pulse bit resolution		15 ns		
Polarity		selectable		
<b>Frequency Modulation</b>				
Maximum Frequency deviation (peak)	> 0.05·f N · 200 MHz			< 1.25 GHz 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)
Modulation rate	DC		800 kHz	> -3dB frequency response
Modulation waveforms	Sine, triangle, FSK			
External input sensitivity				
AC	0 to N · 200 MHz / V			adjustable for ±1 V range discr. values ; ±5 V range
DC	0 to N · 100 MHz / V			
Total harmonic distortion	< 1%			1 kHz rate & N · 1 MHz deviation
<b>Phase Modulation</b>				
Phase deviation (peak)	0		N·300 rad	

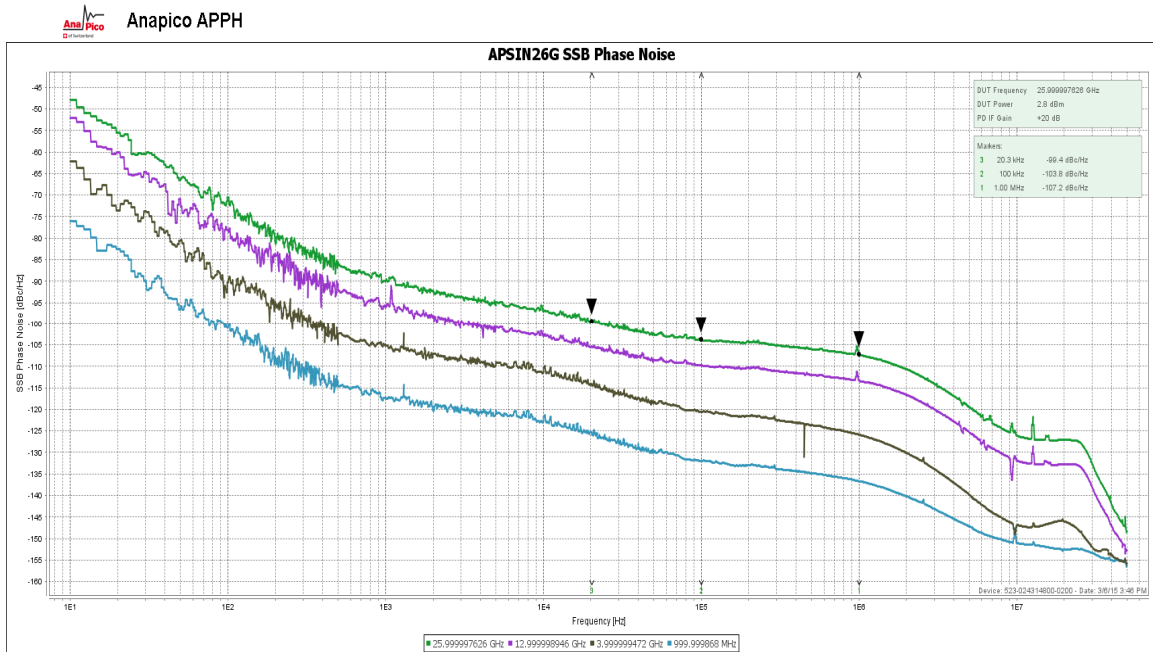


Parameter	Min.	Typ.	Max.	Note
Modulation rate	DC		800 kHz	> -3dB frequency response Max. phase deviation degrades above 20 kHz modulation rate
Modulation waveforms	Sine, triangle, FSK			
External Input sensitivity	Settable 0.1 rad/V to 360 rad/V			
Total harmonic distortion	< 1%			1 kHz rate & N x 100 rad deviation
<b>Amplitude Modulation</b>				
Modulation rate	0.1 Hz		20 kHz	
Modulation waveforms	Sine, triangle, square			
Modulation depth	0 %		90 %	
Distortion (sine wave)		2 %		at 60% modulation depth
Accuracy		4 %		

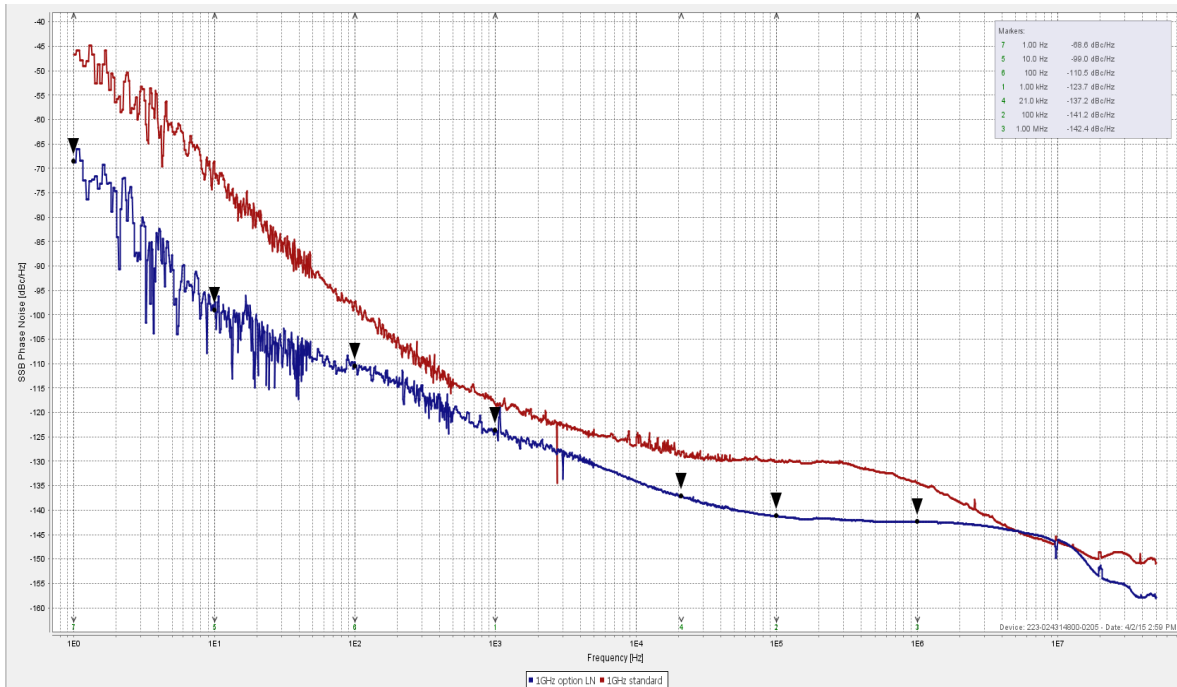
Notes:

# Typical performance curves

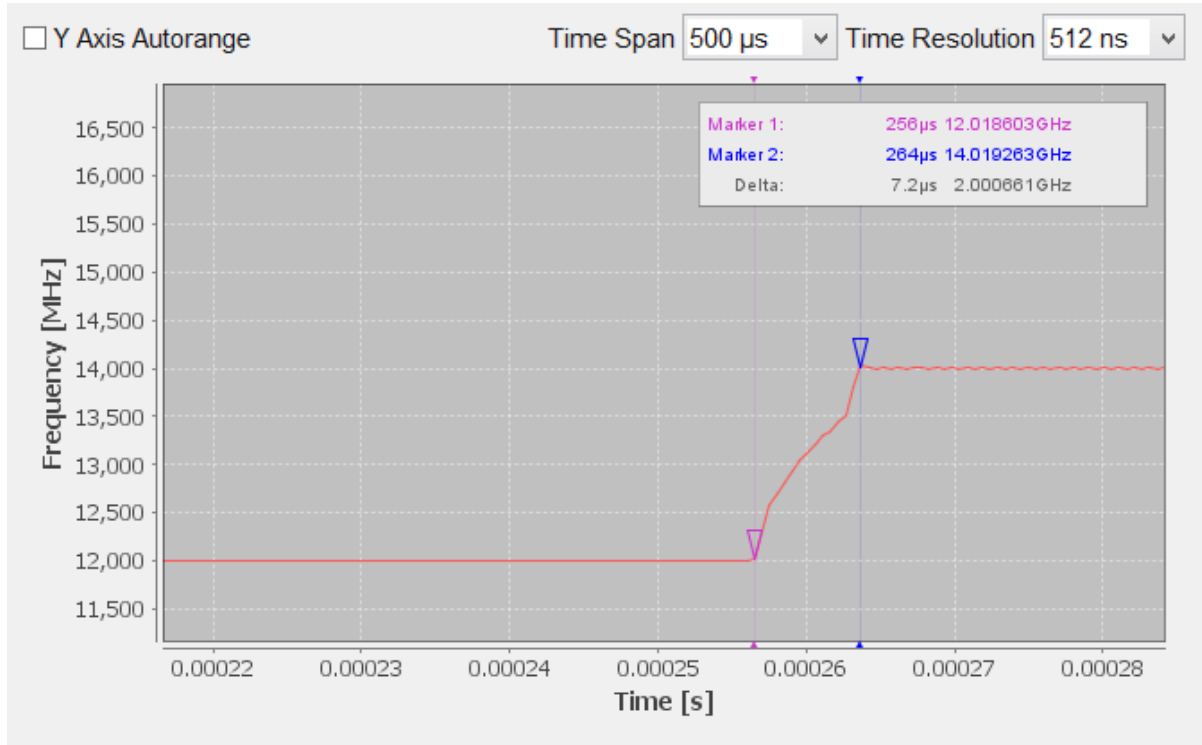
## Phase Noise Performance (10 Hz to 50 MHz offset) at 1,4,13 and 26 GHz



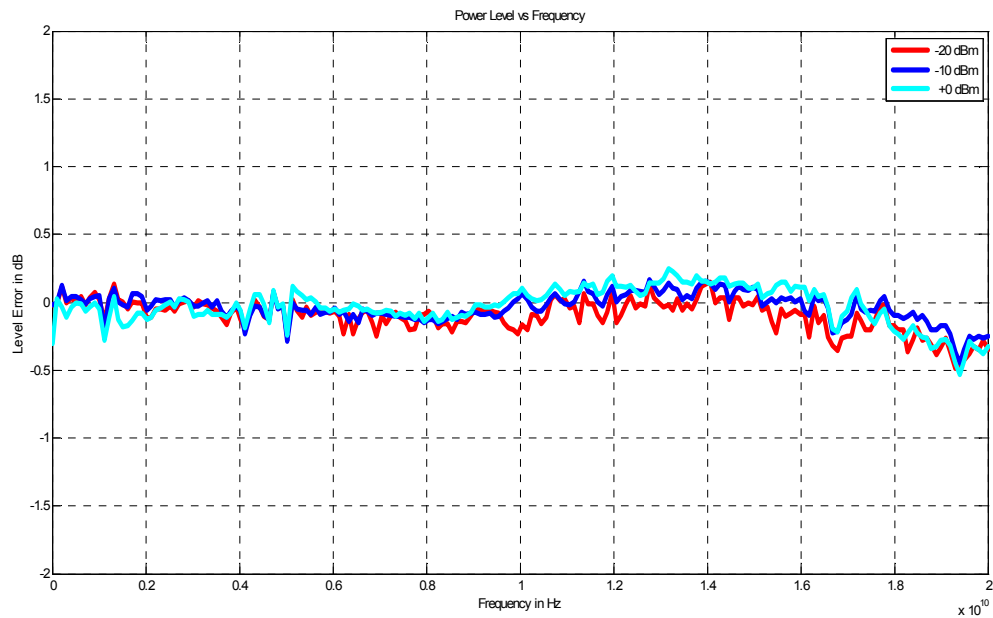
## Phase Noise with Option LN



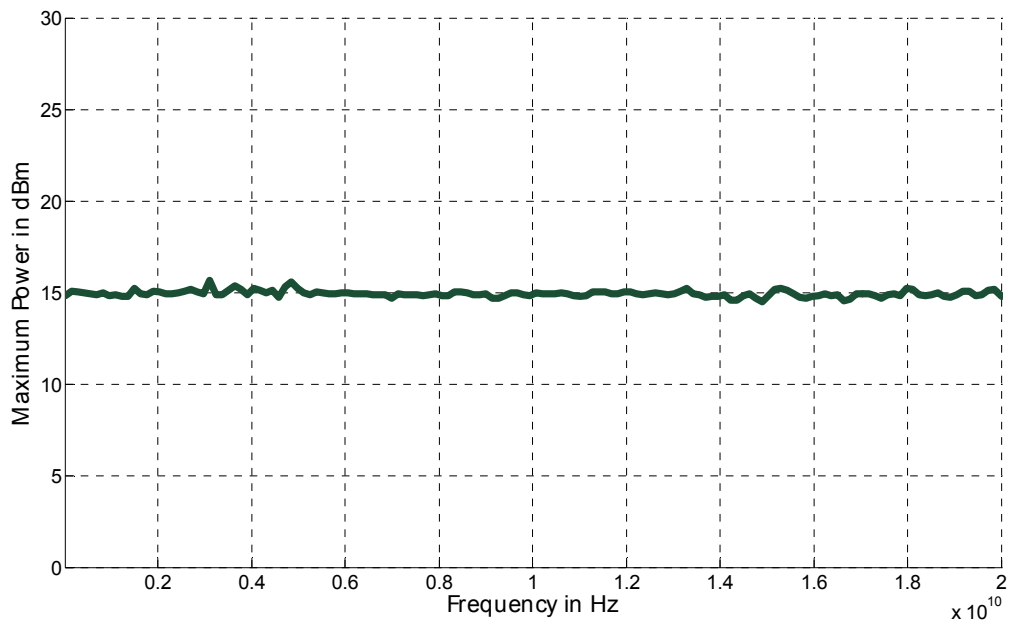
### Typical Switching transient from 12 GHz to 14 GHz step



### Typical Frequency Response 0 to 20 GHz at -10, 0, and +10 dBm



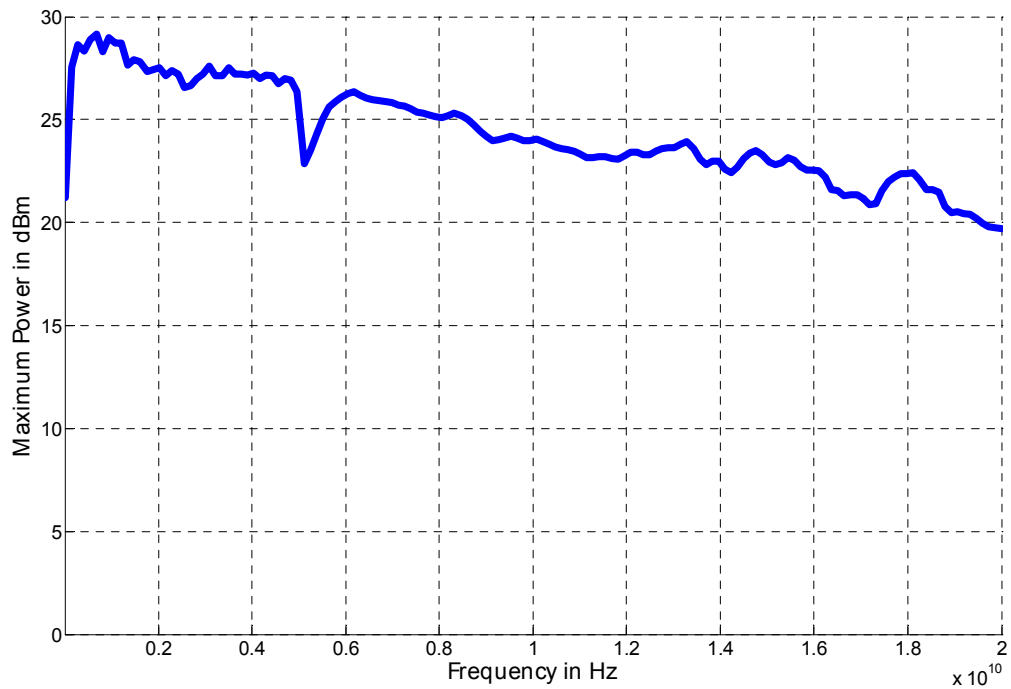
### Typical Maximum Output Power (standard)



### Typical Maximum Output Power (option HP)

tbd

### Typical Maximum Output Power (options PE3 and HP)



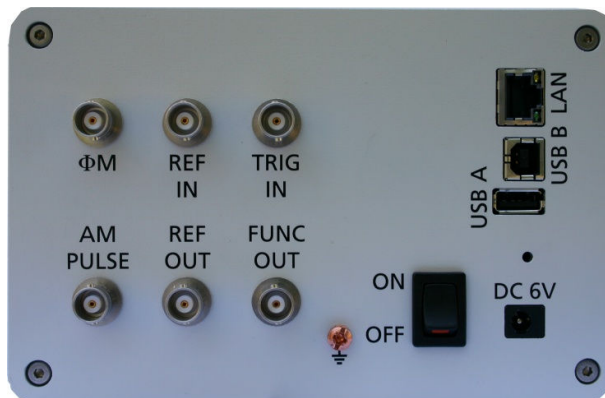
# Connectors

## Front panel:



1. RF output: SMA female
2. RF on/off button
3. Rotary knob
4. Menu and  $\downarrow$   $\uparrow$   $\leftarrow$   $\rightarrow$  arrow keys

## Rear panel:



1. Trigger input: BNC female
2. Function output: BNC female
3. External reference input: BNC female
4. Internal reference output: BNC female
5. FM/PM modulation input: BNC female
6. AM and Pulse modulation: BNC female
7. LAN connection: RJ-45
8. USB 2.0 host and device
9. GPIB: IEEE-488.2, 1987 with listen and talk (optional)
10. DC Power plug (6V, 2.5A)
11. DC power switch

## 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** 6 VDC; 20 W maximum

**Mains adapter supplied:** 100-240 VAC in/ 6 V 6.0 A DC out

**Operating temperature range** 0 to 40 °C

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

**Operating and storage altitude** up to 15,000 feet



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

**Weight** ≤ 2.5 kg (6 lbs) net, ≤ 4 kg (8 lb.) shipping

**Dimensions** 106 mm H x 172 mm W x 270 mm L (incl. connectors)  
[4.21 in H x 6.77 in W x 10.63 in L]

**Recommended calibration cycle** 24 months

## Options

- **HP:** High output power
- **PE3:** Extended power range down to <-90 dBm) step attenuator module
- **NM:** remove modulation
- **LN:** ultra low phase noise, improved frequency stability
- **FS:** enhanced switching speed
- **B3:** battery module
- **TP:** 3HE enclosure with touchpanel display
- **1URM:** 19" 1HE enclosure with rack-mount capability. **Dimensions** 42 mm H x 426 mm W x 360 mm L [1.7 in H x 16.8 in W x 14.2 in L]
- **GPIB:** IEEE-488.2,1987 programming interface



- **RM:** 19" rackmount kit: good for one or two adjacent APSIN

## Document History

Version/Status	Date	Author		Notes
V10	2010-06-01	jk		first release
V11	2010-08-30	jk		added specs for VSWR, AM noise, residual
V13	2010-10-15	jk		power, frequency range, modulation specs updated
V14	2011-04-28	jk		Frequency and power range , Output connector, added phase noise plot
V141	2011-05-22	jk		Low frequency specs, harmonics
V142	2011-06-12	jk		FM peak deviation changed
V143	2011-08-30	jk		Leveled output power, Harmonics specs
V152	2011-08-30	jk		Added Maximum Power Plot
V153	2012-07-15	jk		Modified < 10 MHz performance values
V154	2012-09-15	jk		Reference input range adjusted
V155	2012-11-6	jk		Added FUNC OUT capability; Harmonics
V156	2013-01-6	jk		Added pulse trains, chirps, trigger
V157	2013-03-13	jk		Modified reference frequency specs, added option RM picture
V158	2013-05-15	jk		Added Model APSIN20G-NM
V159	2013-07-31	db		Included serial number dependant performance specs based on data sheet, modified PM peak deviation specs
V160	2013-08-26	db		Modified sweep timing specs, added max power measurement plots
V161	2013-09-4	jk		Modified power level specs
V163	2013-12-27	jk		New plots
V64	2014-01-21	jk		corrected dimensions
V20	2014-07-30	jk		Combined APSIN20G and option HP
V21	2014-11-10	jk		Added pulse pattern specs
V22	2014-12-10	jk		Unified data sheet for APSINXXG
V23	2015-1-15	jk		Added max. power plots
V231	2015-3-10	jk		Added plots
V233	2015-4-10	jk		Options update