APSIN12G Specification 1.02 (Jan 14)

Portable 12 GHz Microwave Signal Generator

Introduction

The APSIN12G is a low-noise and fast-switching microwave signal generator covering a frequency range from 100 kHz up to 12 GHz.

The APSIN12G a wide and 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 frequency resolution.

Power level extension is available to accurately level down to -90 dBm.

The APSIN12G includes AM, DC-coupled, low distortion wideband-FM, PM, FSK and PSK, frequency chirp, and fast pulse modulation with internal pulse train generator as standard. Three internal modulations sources are available. All modulation modes of the APSIN12G 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.

The APSIN12G 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.

The APSIN12G operates 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 200 MHz. Additionally, optimum phase synchronous signals can be achieved by feeding a 100 MHz reference directly as reference.

The APSIN12G support various standard interfaces such as USB-TMC, LAN, and GPIB.

It is targeted for applications where a high-quality CW microwave source with versatile modulation is required. It offers an alternative to expensive high-end microwave signal generators, where small size and excellent microwave performance at an attractive cost is required.

Signal Specifications

The specifications in the following pages describe the warranted performance of the signal generator for 23 ± 10 °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		12 GHz	
resolution		0.001 Hz		
Phase resolution		0.1 deg		
Frequency update rate List/Sweep mode		400 µs 400 µs		time from receipt of SCPI command
SSB Phase noise at 10 GHz				
at 1 kHz from carrier		-100 dBc/Hz		
at 20 kHz from carrier		-108 dBc/Hz		
Wideband noise		-150 dBc/ Hz		
Total jitter		100 fs RMS		BW over 10 Hz to 20 MHz
Amplitude Noise at 10 GHz		-130 dBc/Hz -140 dBm		Pout=+10 dBm, 100 kHz offset noise floor
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)
Output power				Check maximum output power plots on page 10
Range without option PE3 100 kHz to 100 MHz 100 MHz to 12 GHz	 -20 dBm -20 dBm		 +10 dBm +14 dBm	
Range WITH option PE3 100 kHz to 100 MHz 100 MHz to 12 GHz	 -90 dBm -90 dBm		 +10 dBm +13 dBm	
Level resolution		0.01 dB		
Level uncertainty, ALC on User flatness correction		 up to 2000 points	< 1 dB < 1.5 dB	-15 to +10 dBm > -90 dBm < +10 dBm
Output impedance VSWR		50 Ω 2.0		
Reverse Power Protection				
DC Voltage			±15 V	
RF power			30 dBm	
Level resolution		0.01 dB		
Spectral purity at + 5 dBm Output harmonics	 -40 dBc -35 dBc		 -35 dBc -30 dBc	 0.1 to 5.0 GHz 5.0 to 12.0 GHz
Non-harmonic spurious	-75 dBc		-60 dBc	at +5 dBm output power

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
Digital frequency sweep				
Sweep type: linear, logarithmic, random				
Step time (t_{step})	600 µs		19998 s	
Dwell time (t_{dwell})	10 µs		9999 s	
Off-time (incl. transient time) (t_{off})	0 / 50 µs		9999 s	
Timing accuracy per point		1 µs		

Trigger

RFon   RFon

tdelay   tdwell   toff

tstep
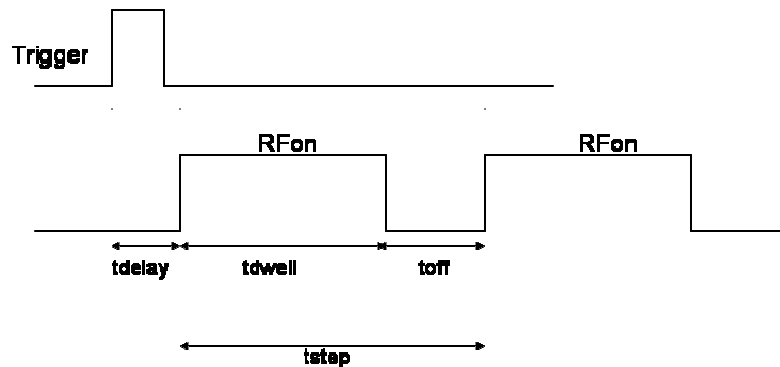
Parameter	Min.	Typ.	Max.	Note
Generalized list sweep				
allows individual setting of frequency, power, dwell-time, and off-time for each point				
List size	2		65'000	
Step time (t_{step})	600 µs		19998 s	mechanical attenuator not used
Dwell time (t_{dwell})	50 µs		9999 s	
Off-time (incl. transient time) (t_{off})	0 / 50 µs		9999 s	
Time resolution		0.1 µs		
Timing accuracy per point		1 µs		
Ramp (analog) sweep				
Sweep span		20 %		of carrier frequency
Sweep rate	tbd		N · 5 GHz / ms	
Sweep time	0.1 ms		100 ms	
Frequency Chirps				
(linear ramp, up/down)				
Bandwidth	10%			of carrier frequency
Dwell time (t_{dwell})	10 ns		100 µs	
Number of frequencies			65'000	

Notes:

Reference Frequency

REF IN input and REF OUT output are at rear panel

Parameter	Min.	Typ.	Max.	Note
Internal reference frequency		100 MHz		
Initial accuracy			±40 ppb	calibrated at 23 ± 3 °C at time of calibration
Temperature stability (0 to 50 degC)			±100 ppb	
Aging 1st 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		<= SN xxx-xx4xxxxxx-xxxx >= SN xxx-xx5xxxxxx-xxxx
Output power		0 dBm		
Output impedance		50 Ohms		
Bypass Internal reference Input		100 MHz, -5 to +10 dBm		
Phase Lock to External Reference External Input Range	8 MHz 1 MHz		250 MHz 250 MHz	<= SN xxx-xx4xxxxxx-xxxx >= SN xxx-xx5xxxxxx-xxxx User programmable
Reference input level	-5 dBm	0 dBm	+13 dBm	
Lock Range			±1.0 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		

Parameter	Min.	Typ.	Max.	Note
TRIGGER OUT	Synchronization mode for multiple sources			
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 μs		
External Trigger delay	50 μs		40 s	
External Delay Resolution		15 ns		
Trigger Modulo	1		255	Execute only on Nth trigger event
Trigger Polarity	Rising, falling			

Modulation Capabilities

Parameter	Min.	Typ.	Max.	Note
Multifunction Generator 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
Pulse Modulation On/off ratio		80 dB		
Repetition frequency	DC		10 MHz	
Pulse width	30 ns 50 μs			ALC hold ALC on
Pulse rise/fall time		< 10 ns		
Pulse trains length (pulses)	2		4192	
Pulse width	30 ns		100 μs	
Pulse resolution		15 ns		
Polarity		selectable		
External input amplitude		1 V TTL		AC DC
Frequency Modulation 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 12 GHz (N=0.5)
Modulation rate	DC		800 kHz	> -3dB frequency response
Modulation waveforms		Sine, triangle, FSK		

External input sensitivity
  AC
  DC
		0 to N · 200 MHz / V
		0 to N · 100 MHz / V
				adjustable for ±1 V range
				discr. values ; ±5 V range

Total harmonic distortion		< 1%		1 kHz rate & N · 1 MHz deviation
Phase Modulation Phase deviation (peak)	0		N·300 rad	
Modulation rate	DC		800 kHz	> -3dB frequency response
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

Parameter	Min.	Typ.	Max.	Note
Amplitude Modulation				
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(1 GHz blue, 4 GHz yellow, 12 GHz brown)
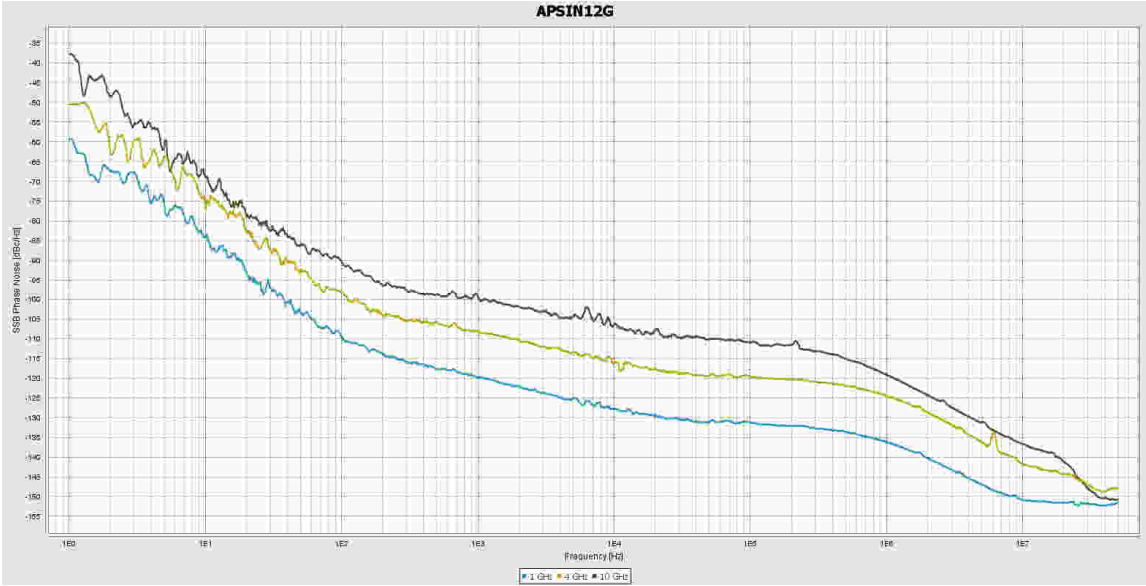
Typical Maximum Output Power (WITHOUT option PE3)
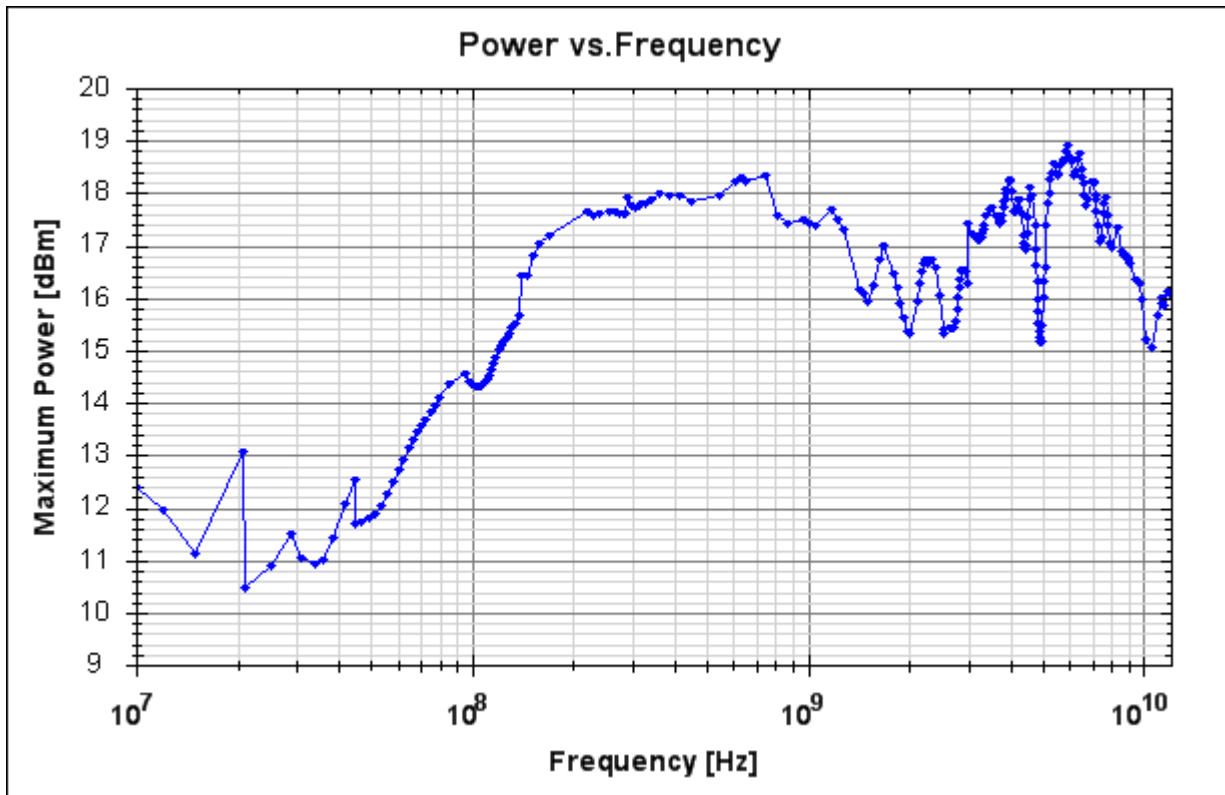
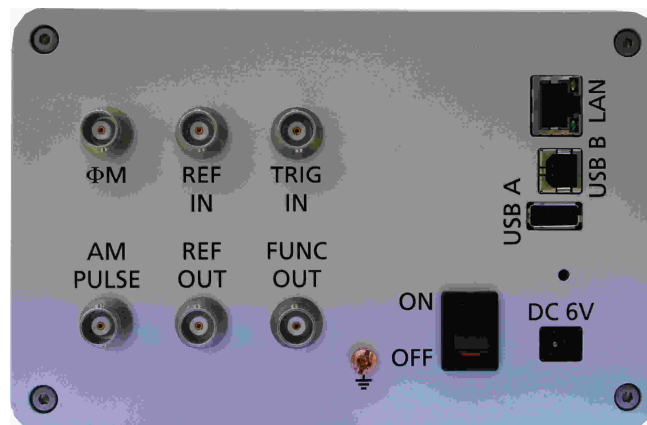**Typical Maximum Output Power (WITH option PE3 installed)**
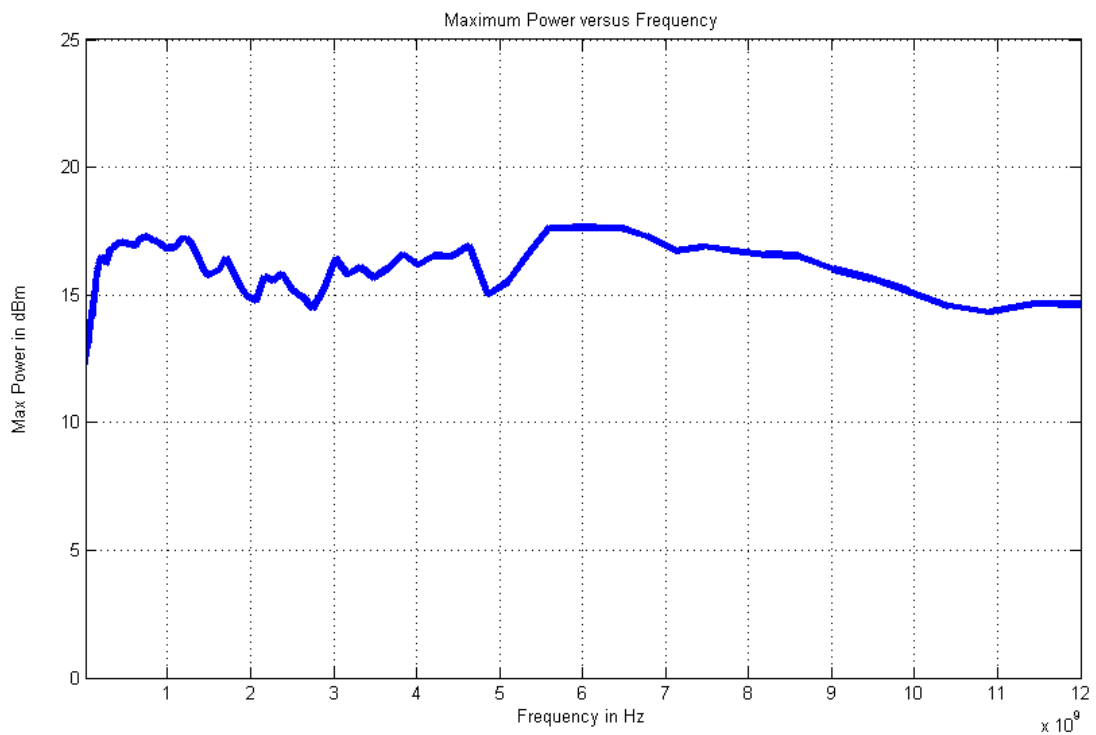
Connectors

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/ 6V 6A 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**

$C\epsilon$ **notice**
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

- *PE3*: Extended power range down to <-90 dBm) step attenuator module
- *B3*: battery module
- *GPIB*: IEEE-488.2,1987 programming interface
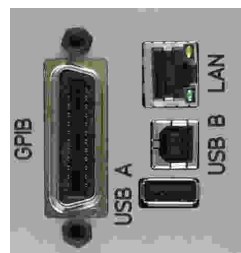
- **RM: 19'' rackmount enclosure: good for one or two adjacent APSIN**

Document History

Version/Status	Date	Author		Notes
V10	2013-05-1	jk		first release
V101	2013-08-10	jk		Plots added, refined power level specifications
V102	2014-01-21	jk		corrected dimensions