

APSIN20G / APSIN20G-NM Specification 1.61 (Aug 2013)

Portable 20 GHz Microwave Signal Generator



Introduction

The APSIN20G is a low-noise and fast-switching microwave signal generator covering a continuous frequency range from as low as 100 kHz up to 20.4 GHz with a 0.001 Hz resolution.

The APSIN20G is 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 resolution.

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

Two models of the APSIN20G are available: the APSIN20G and the APSIN20G-NM. The APSIN20G comprises a full set of analog modulation while the APSIN20G-NM does not support any modulation and acts as a CW only signal source.

The APSIN20G 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 modulation sources are available. All modulation modes of the APSIN20G 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.

Both APSIN20G models 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.

The APSIN20Gs 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 bypassing internal and feeding a 100 MHz signal directly as reference.

The APSIN20Gs 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.

Applications for the APSIN20G 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

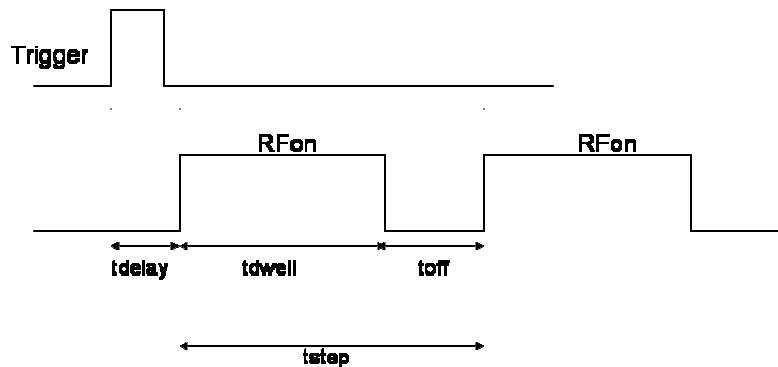
The specifications in the following pages describe the warranted performance of the signal generator for $23 \pm 10 \text{ }^\circ\text{C}$ after a 30 minute warm-up period and for all configurations (options PE3 if not explicitly stated). Typical specifications describe expected, but not warranted performance.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

Parameter	Min.	Typ.	Max.	Note
CW mode				
Frequency range	100 kHz		20 GHz	Settable to 20.4 GHz
resolution		0.001 Hz		
Phase resolution		0.1 deg		
Frequency update rate		600 μs		time from receipt of SCPI command
List/Sweep mode		600 μs		
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
Output power				Check maximum output power plots on page 10
Range without option PE3				
100 kHz to 100 MHz	-20 dBm		+10 dBm	
100 MHz to 20 GHz	-20 dBm		+14 dBm	
Range WITH option PE3				
100 kHz to 100 MHz	-90 dBm		+10 dBm	
100 MHz to 20 GHz	-90 dBm		+13 dBm	
Level resolution	0.01 dB			
Level uncertainty, ALC on			< 1 dB	-15 to +10 dBm > -90 dBm < +10 dBm
User flatness correction		up to 2000 points	< 1.5 dB	
Output impedance	50 Ω			
VSWR	2.0			
Reverse Power Protection				
DC Voltage			$\pm 15 \text{ V}$	
RF power			30 dBm	
Spectral purity at + 5 dBm				
Output harmonics		-40 dBc -35 dBc -50 dBc	-35 dBc -30 dBc -40 dBc	0.1 to 5.0 GHz 5.0 to 10.0 GHz 10.0 to 20.0 GHz
Sub-harmonics		-75 dBc	-60 dBc	
Non-harmonic spurious		-75 dBc	-60 dBc	at +5 dBm output power
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
Digital frequency sweep				
Sweep type: linear, logarithmic, random				
Step time (t_{step})	600 μ s		19998 s	
Dwell time (t_{dwell})	10 μ s		9999 s	
Off-time (incl. transient time) (t_{off})	0 / 50 μ s		9999 s	
Timing accuracy per point		1 μ s		



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 μ s		19998 s	mechanical attenuator not used
Dwell time (t_{dwell})	50 μ s		9999 s	
Off-time (incl. transient time) (t_{off})	0 / 50 μ s		9999 s	
Time resolution		0.1 μ s		
Timing accuracy per point		1 μ s		

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 μ s	
Number of frequencies			65'000	

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 1 st 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 μ s		
External Trigger delay	50 μ s		40 s	
External Delay Resolution		15 ns		
Trigger Modulo	1		255	Execute only on Nth trigger event
Trigger Polarity	Rising, falling			

Modulation Capabilities (APSIN2oG only)

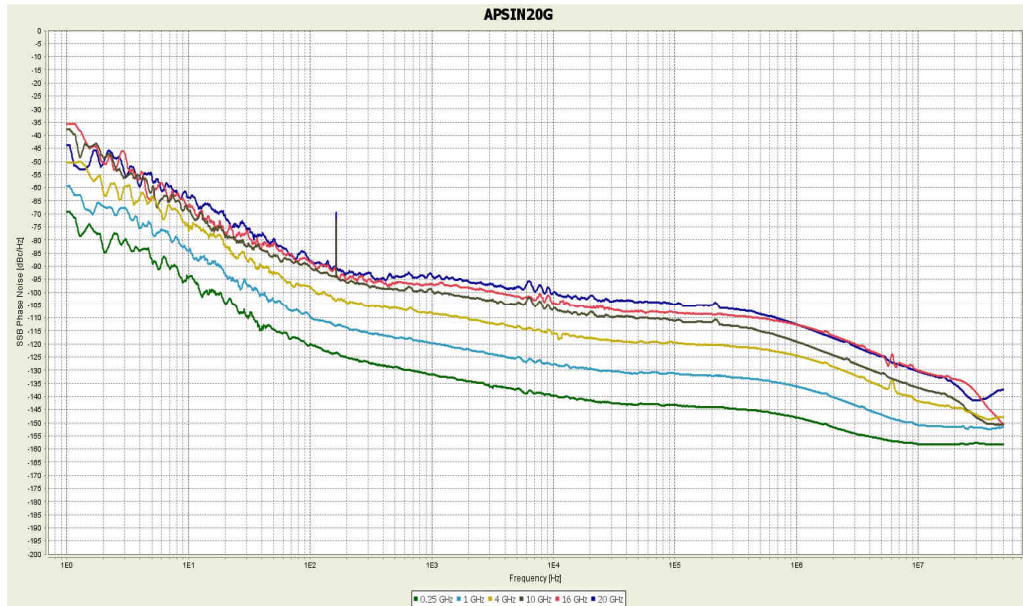
Parameter	Min.	Typ.	Max.	Note
Multifunction Generator sine, triangle, square wave Output is FUNC OUT at rear panel				
Frequency range	1 Hz 1 Hz		3 MHz 1 MHz 50 kHz	sine triangle square
Frequency resolution		0.1 Hz		
Output voltage amplitude peak-peak	10 mV	5V	2 V	Sine, triangle Square (CMOS output)
Harmonic Distortion		1 %		< 100 kHz, 1 Vpp
Output impedance		50 Ohms CMOS		Sine, triangle square wave
Pulse Modulation				
On/off ratio		70 dB		at +10 dBm
Repetition frequency	DC		10 MHz	
Pulse width	30 ns 50 μs			ALC hold ALC on
Pulse rise/fall time		7 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 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 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		f*5e-7 N·300 rad	< 1.25 GHz > 1.25 GHz
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

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 %		

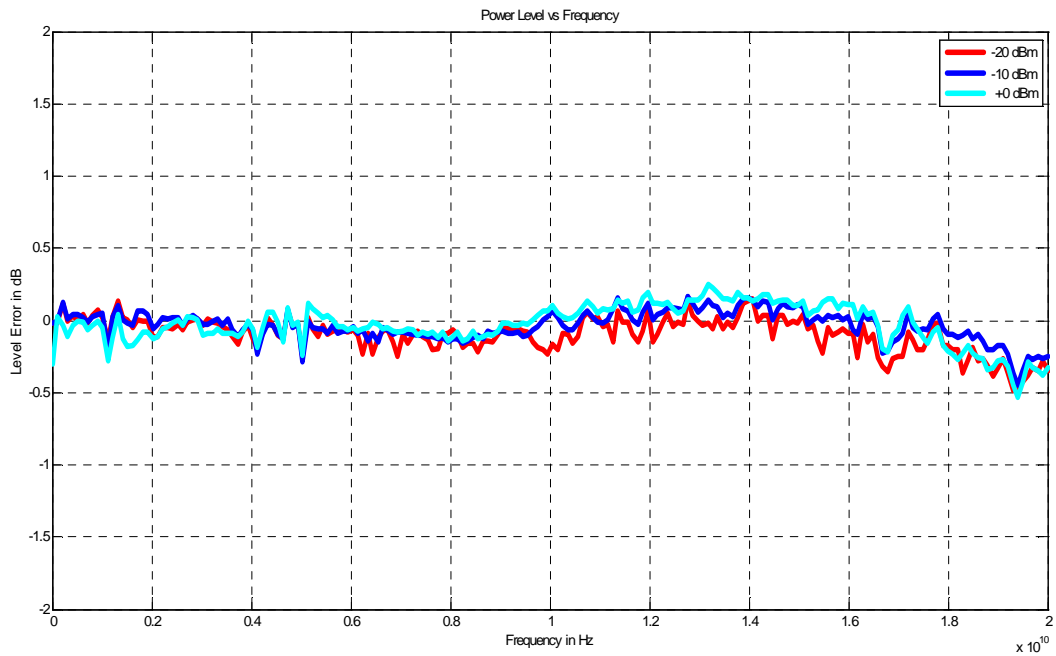
Notes:

Typical performance curves

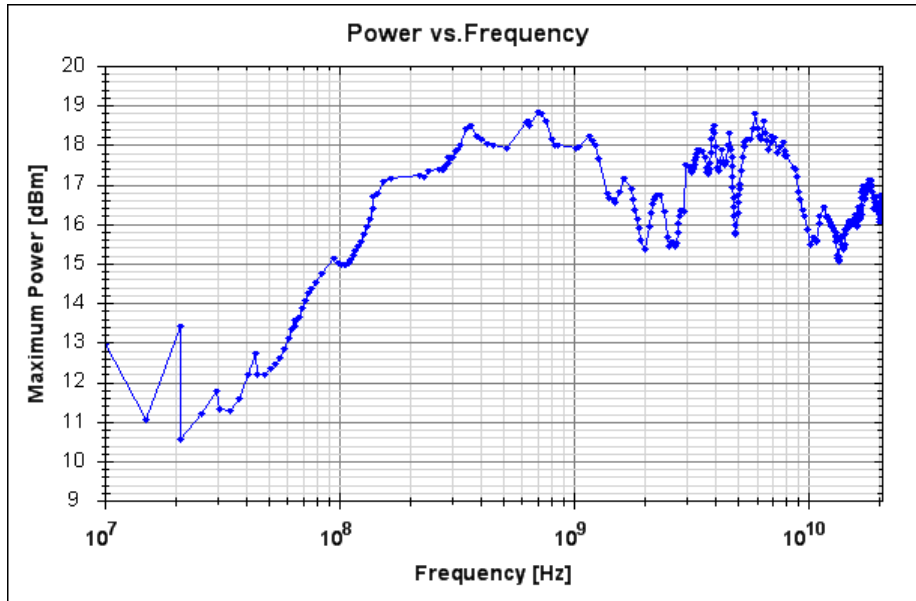
Phase Noise Performance (1 Hz to 50 MHz offset)



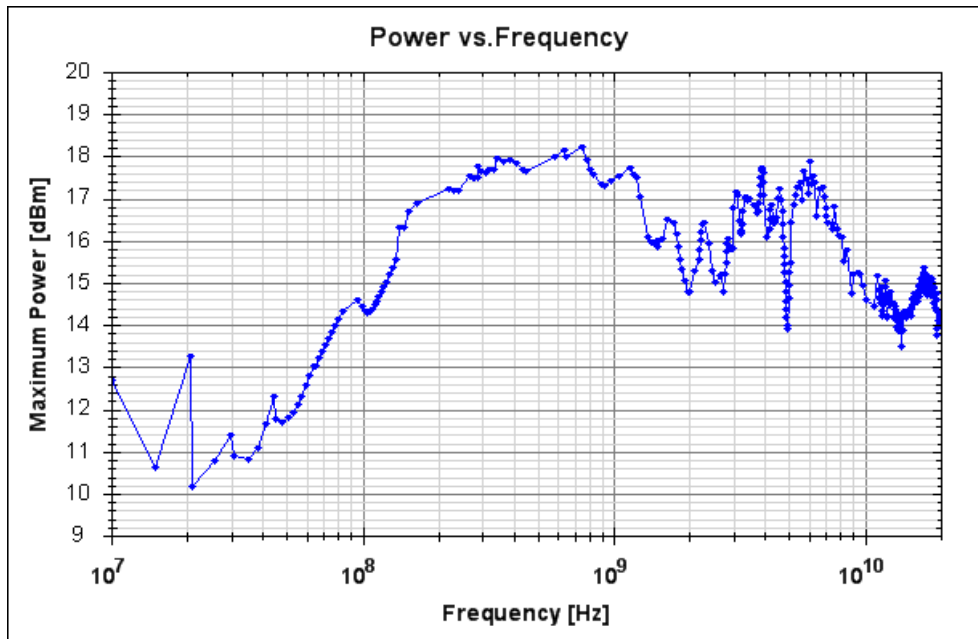
Typical Frequency Response 0 to 20 GHz at -10, 0, and +10 dBm



Typical Maximum Output Power (without option PE3)



Typical Maximum Output Power (WITH option PE3)



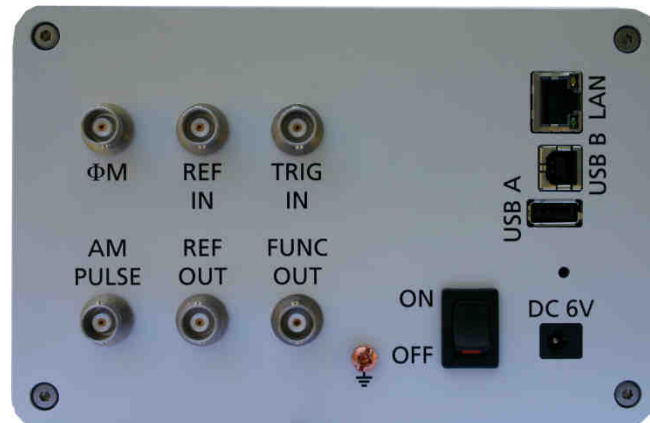
Connectors

Front panel:



1. RF output: SMA female
2. RF on/off button
3. Rotary knob
4. Menu and ↓ ↑ ← → 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 3.3 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



notice

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

Weight \leq 2.5 kg (6 lbs) net, \leq 4 kg (8 lb.) shipping

Dimensions 106 mm H x 172 mm W x 220 mm L

[4.21 in H x 6.77 in W x 8.66 in L]

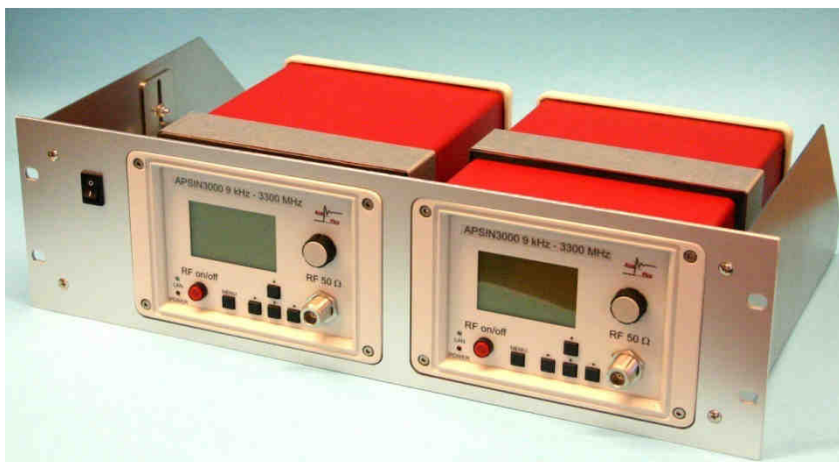
Recommended calibration cycle 24 months

Options

- **PE3:** Extended power range down to <-90 dBm) step attenuator module
- **B3:** battery module (not available for 1U APSIN2oRM)
- **GPIB:** IEEE-488.2,1987 programming interface (not available for 1U APSIN2oRM)



- **TB:** improved internal reference stability (\pm 30 ppb over temperature)
- **RM:** 19" rackmount enclosure: good for one or two adjacent APSIN (3000, 6010, 20G)



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

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