

APMSXXG-(2,4,8) Specification 1.51

(March 18, Serial XXX-XXX7XXXXX-XXXX and higher)

A compact, 300 kHz to 6, 12, or 20 GHz ultra low phase noise, 20 microsecond switching, phase coherent signal generator with up to 4 (8) independent outputs



Introduction

The APMSXXG is a phase coherent multi-output ultra-fast switching and low phase noise signal generator with a frequency range from 300 kHz to 6, 12 or 20 GHz and is ideally suited for a wide range of application, where good signal quality, accurate and wide output power range are required. Excellent phase noise is combined with spurious and harmonic rejection.

A high-stability OCXO reference provides excellent frequency accuracy and stability. The generator accepts a wide range of external references including the range from 1-250 MHz or 1 GHz.

The APMSXXG comes in a standard 19 inch 1U (up to 4 channels) or optionally 3U (8 channels) enclosure and offers various control interfaces like USB, LAN or GPIB. Each interface allows easy and fast communication using SCPI 1999 command set. Remote control of the instrument can be quickly attained from any host system. A customer-supplied application programming interface (API) or programming examples for Matlab, Labview, C++ and other commercially available tools make implementation very straightforward.

The following options are supported:

- **PE4**: electrical step attenuator
- **ULN**: ultra low phase noise
- **IPM**: intra-pulse modulation (not with ULN)
- **PHS**: phase coherent switching (requires ULN)
- **GPIB**: IEEE-488.2,1987 programming interface

CW Specifications

The specifications in the following pages describe the warranted performance of the signal generator for $25 \pm 8^\circ\text{C}$ after a 30 minute warm-up period. Typical specifications describe expected, but not warranted performance. Min and Max specifications are warranted.

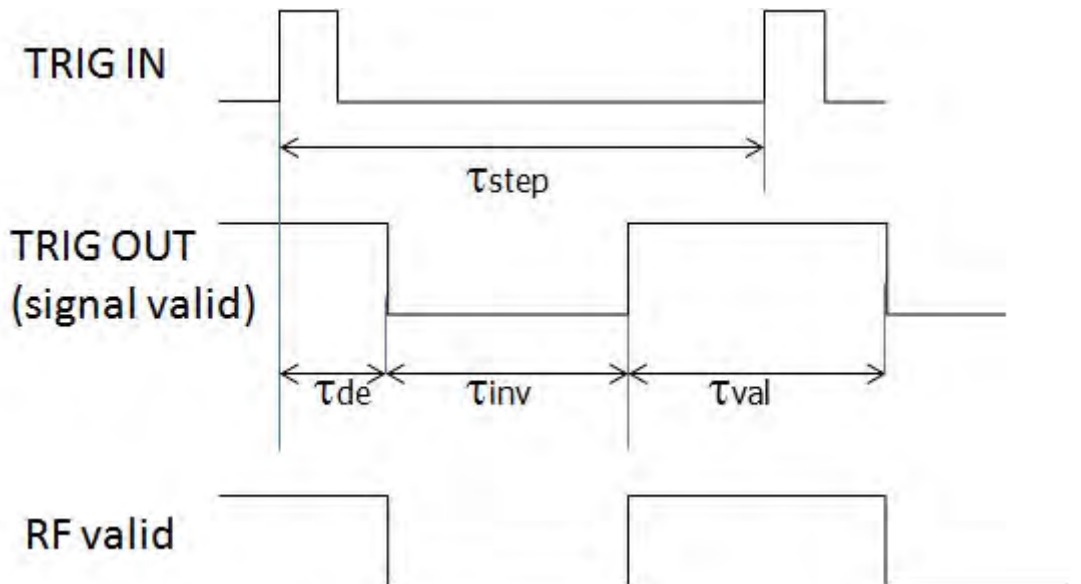
Each channel acts as a fully independent source and can be configured in frequency, power, phase, and modulation independently.

Parameter	Min.	Typ.	Max.	Note
Frequency range	300 kHz 300 kHz 300 kHz		6 GHz 12 GHz 20 GHz	APMS06G APMS12G APMS20G
Resolution		1 Hz 0.001 Hz		option ULN
Switching speed Frequency / Amplitude settling time		0.01 ms	0.02 ms 0.015 ms	
Phase range	0 deg		360 deg	Individually adjustable per channel
Phase resolution		0.1 deg		
SSB Phase noise at 1 GHz				scales with frequency at 20 dB/dec, see also plots
At 10 Hz from carrier 1 kHz 20 kHz 100 kHz		-105 dBc/Hz -122 dBc/Hz -137 dBc/Hz -140 dBc/Hz		Standard
At 10 Hz from carrier 1 kHz 20 kHz 100 kHz		-105 dBc/Hz -131 dBc/Hz -145 dBc/Hz -150 dBc/Hz		option ULN
Power level				
Settable Range	-20 dBm -20 dBm -20 dBm -20 dBm		+20 dBm +25 dBm +23 dBm +20 dBm	1 to 10 MHz 10 MHz to 6 GHz 6 to 18 GHz 18 to 20 GHz
Settable Range with option PE4	-80 dBm -80 dBm -80 dBm		+20 dBm +18 dBm +15 dBm	Settable to -90 dBm 0.1 to 12 GHz 12 to 15 GHz 15 to 20 GHz
Resolution		0.01 dB		
Thermal drift		0.015 dB / degC		
Level uncertainty		0.25 dB ± 3.5 dB	± 1.0 dB ± 1.6 dB	>-20 dBm to +20 dBm Option PE4, -60 to -20 dBm Option PE4, <-60 dBm
Output impedance		50 Ohms		
VSWR		1.7		
Reverse Power Protection				
DC Voltage		15 V		
RF power			+26 dBm	

Parameter	Min.	Typ.	Max.	Note
Spectral purity Output harmonics		-30 dBc -35 dBc -40 dBc -45 dBc	-25 dBc -30 dBc -30 dBc -35 dBc	at + 10 dBm output power <100 MHz > 100 MHz to 6.5 GHz 6.5 to 12 GHz > 12 GHz
Non-harmonic spurious		-65 dBc -75 dBc		offsets > 1 kHz option ULN
Channel to channel Isolation Phase stability (APMS20G) Channel-to-channel Phase coherent switching, see 1)		> 90 dB tbd tbd 10 mrad 3 mrad		< 3 GHz 3 to 6 GHz > 6 GHz over 6 hours, at 1 GHz 100 MHz phase locked Option ULN requires option ULN & PHS
Temperature stability (10 to 45 degC)			0.02 ppm	
Aging (1st year)			0.05 ppm	
Reference IN		10 100, 1000 MHz		
Reference OUT		10 MHz or 100 MHz		
Power consumption	10 W + 12 W per channel			

1) Phase coherent switching maintains phase relation between individual channels and also with respect to the internal (or external) reference signal.

Sweeping Capability

Parameter	Min.	Typ.	Max.	Note
Digital power / frequency / list sweeps				
Sweep type: linear, logarithmic, random				
All channels can be programmed and run independently or fully synchronized.				
Step time (τ_{step})	20 μ s		200 s	For 1 channel, if more than one channels are swept synchronously, minimum step time is 40 μ s
Dwell time (τ_{val})	10 μ s		100 s	
Off-time (incl. transient time) (t_{off})	0		100 s	
Transient time (τ_{inv})			15 μ s	
Timing delay (τ_{de})		50 ns		
Time resolution		5 ns		
Timing accuracy per point		5 ns		
 The diagram illustrates the timing relationships for a sweep operation. It shows three signals: TRIG IN, TRIG OUT (signal valid), and RF valid. TRIG IN is a pulse that starts the sweep. TRIG OUT is a pulse that starts after a delay τ_{de}, has a transient time τ_{inv}, and a dwell time τ_{val}. RF valid is a pulse that starts after a delay τ_{de}, has a transient time τ_{inv}, and a dwell time τ_{val}. The total time between the start of TRIG IN and the start of TRIG OUT is τ_{step}.				

Modulation Capabilities

Parameter	Min.	Typ.	Max.	Note
Pulse Modulation				
Modulation source		Internal/External Internal External		Selectable for each channel Individual modulation for each channel independent external modulation input for each channel
External input amplitude		TTL		
Pulse rise/fall time		10 ns		
On/off ratio		90 dB 80 dB		at +10 dBm , <10 GHz at +10 dBm , >10 GHz
Pulse overshoot			10 %	

Parameter	Min.	Typ.	Max.	Note
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		
Intra-Pulse Modulation	Polyphase, BPSK, QPSK, linear & non-linear FM chirps			requires option IPM
Chirp to pulse timing alignment		5 ns		
Chirp to pulse delay (adjustable)	0		200 μ s	
Timing steps		4 ns		
Chirp bandwidth	0		8 %	Of carrier frequency
Dwell time (t_{dwell})	1 μ s		10000 μ s	
Chirp Rate Rate resolution		tbd		
Polyphase codes pulse				Up to 32 phase codes, Barker codes, QPSK, BPSK
Pulse to pulse frequency hopping		ramp or list		requires option IPM
Pulse rate	0.1 Hz		50 kHz	
Pulse width	40 ns		1 s	
Bandwidth		Full instrument range		
Amplitude		Settable per pulse		
Frequency Modulation Modulation source		Internal		requires option ULN
Maximum Frequency deviation (peak)	N · 20 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 > 100 kHz rate		0.5 % 2 %	2 % 5 %	
Distortion		< 1 %		1 kHz rate, 50 kHz deviation

Parameter	Min.	Typ.	Max.	Note
Modulation rate	DC		600 kHz	> -3dB frequency response
Modulation waveforms	Sine, triangle, FSK			
Total harmonic distortion	< 1%			1 kHz rate & N · 1 MHz deviation
Phase Modulation				requires option ULN
Modulation source		Internal		
Phase deviation (peak)	0		N·10 rad	
Modulation rate	DC		600 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				requires option ULN
Modulation source		Internal		
Modulation rate	0.1 Hz		40 kHz	
Modulation waveforms	Sine, square			
Modulation depth	0 %		90 %	settable
Distortion (sine wave)		2 %		at 80 % modulation depth
Accuracy (1kHz rate, 80%, 0dBm)		3 %		

Trigger Output (TRIG OUT)

Output is TRIG OUT at rear panel has multiple operating modes.

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 waveform pulse width	100 ns			

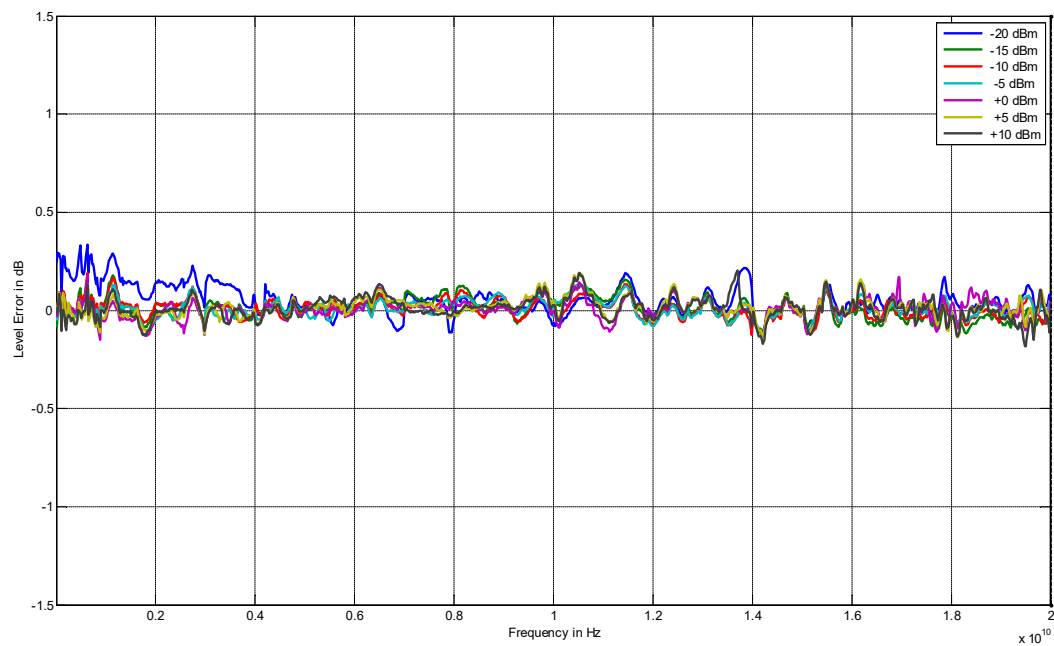
Trigger (TRIG IN)

Input is TRIG IN at rear panel

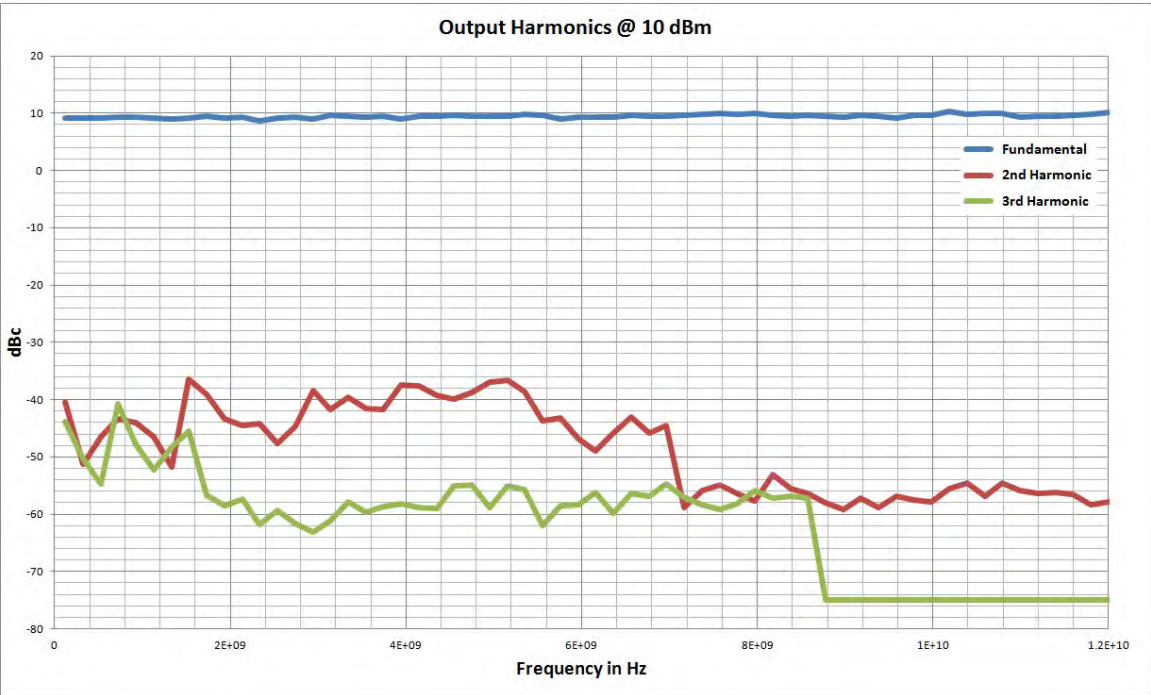
Parameter	Min.	Typ.	Max.	Note
Trigger Types	Continuous, single, gated, gated direction			
Trigger Source	External or bus (GPIB, LAN, USB)			
Trigger Modes	continuous free run, trigger and run, reset and run			
Trigger latency		5 ns		
Trigger uncertainty		10 ns		
External trigger delay	50 ns		10 s	programmable
External delay Resolution		10 ns		
Trigger Modulo	1		255	Execute only on Nth trigger event
Trigger Polarity	Rising, falling			

Typical Performance

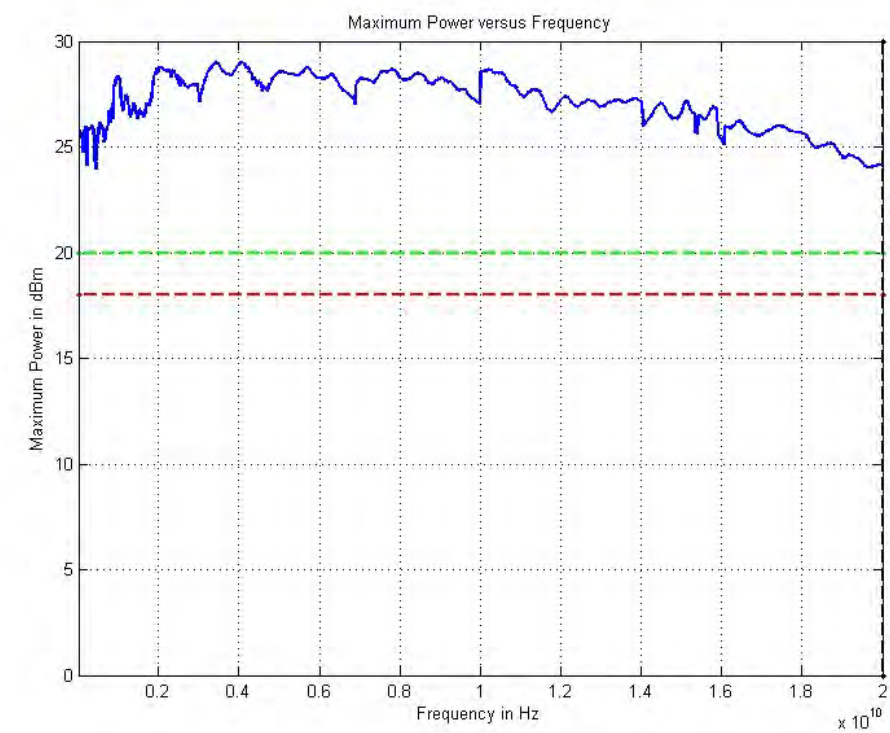
Output Power Accuracy



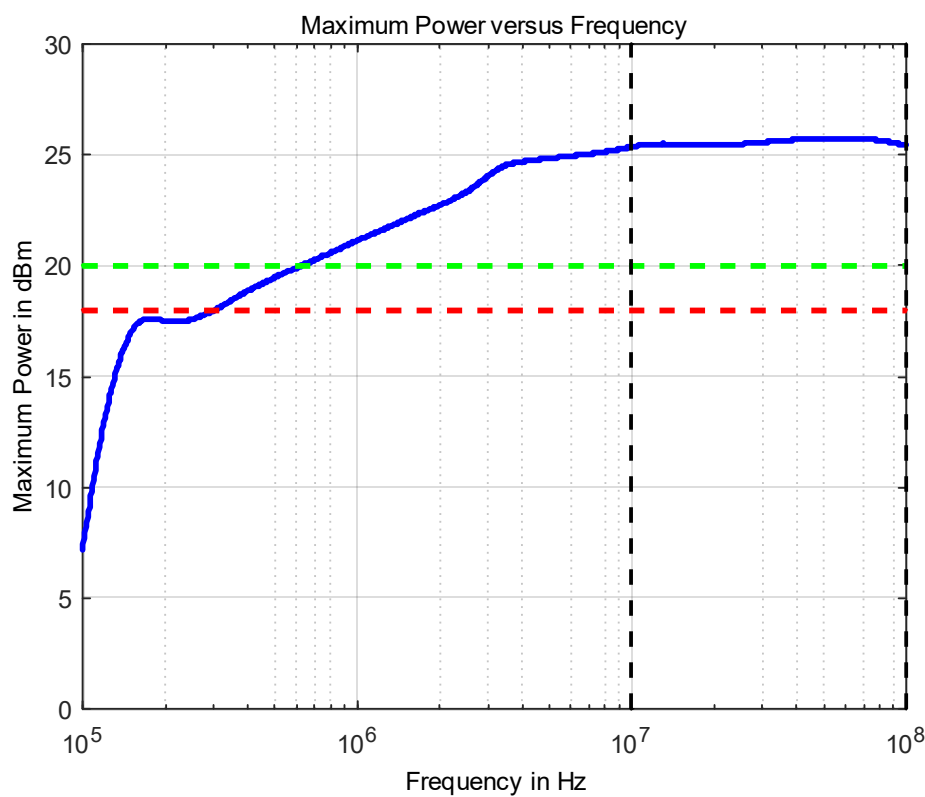
Harmonic distortion



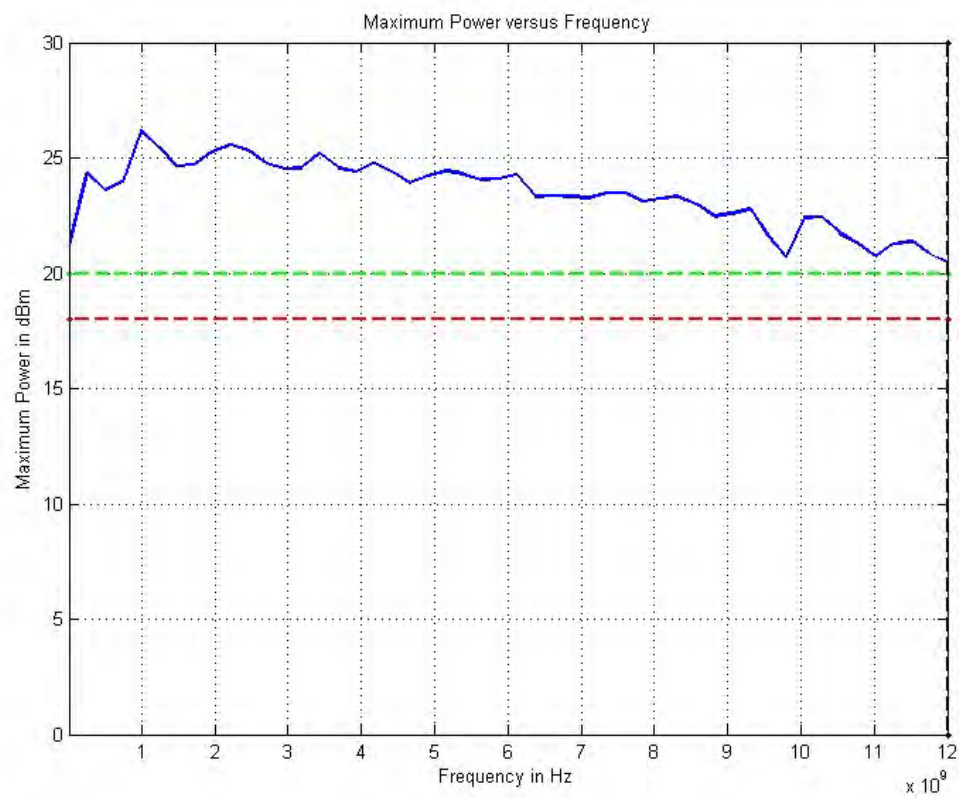
Maximum Output Power APMS20G



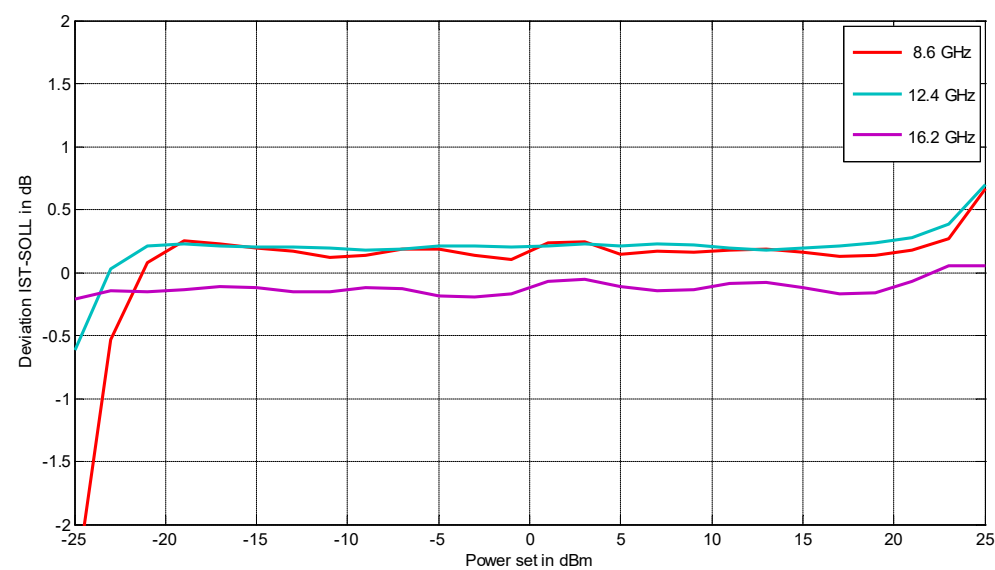
Low frequency response (100 kHz to 100 MHz)



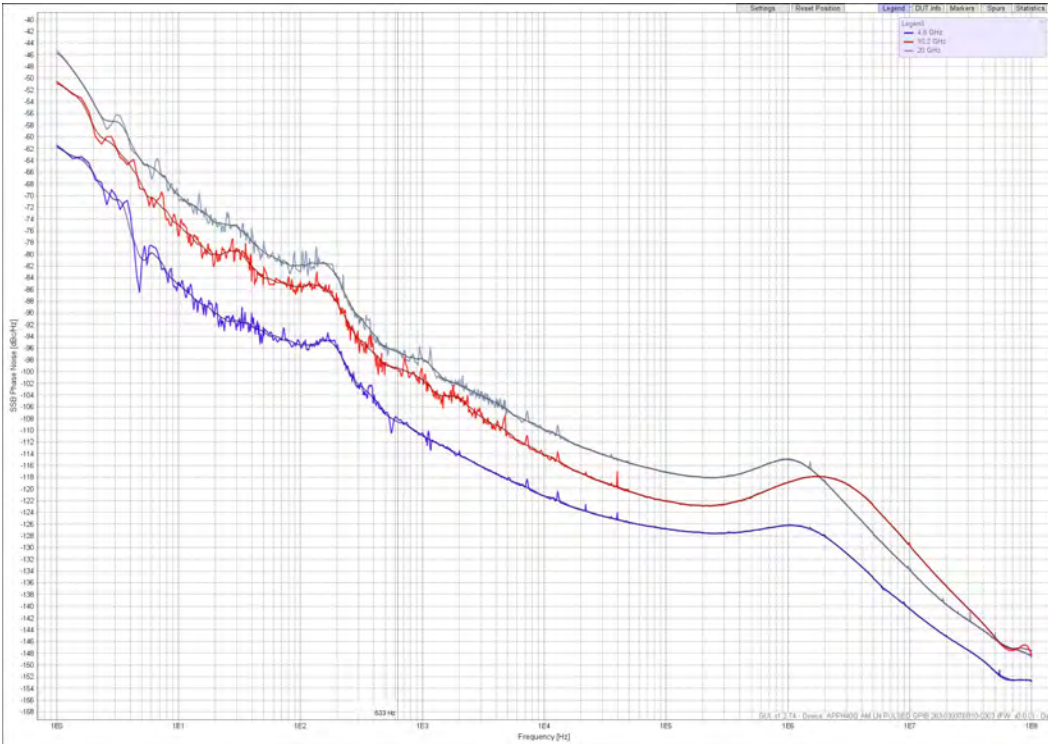
Maximum Output Power APMS20G (with option PE4)



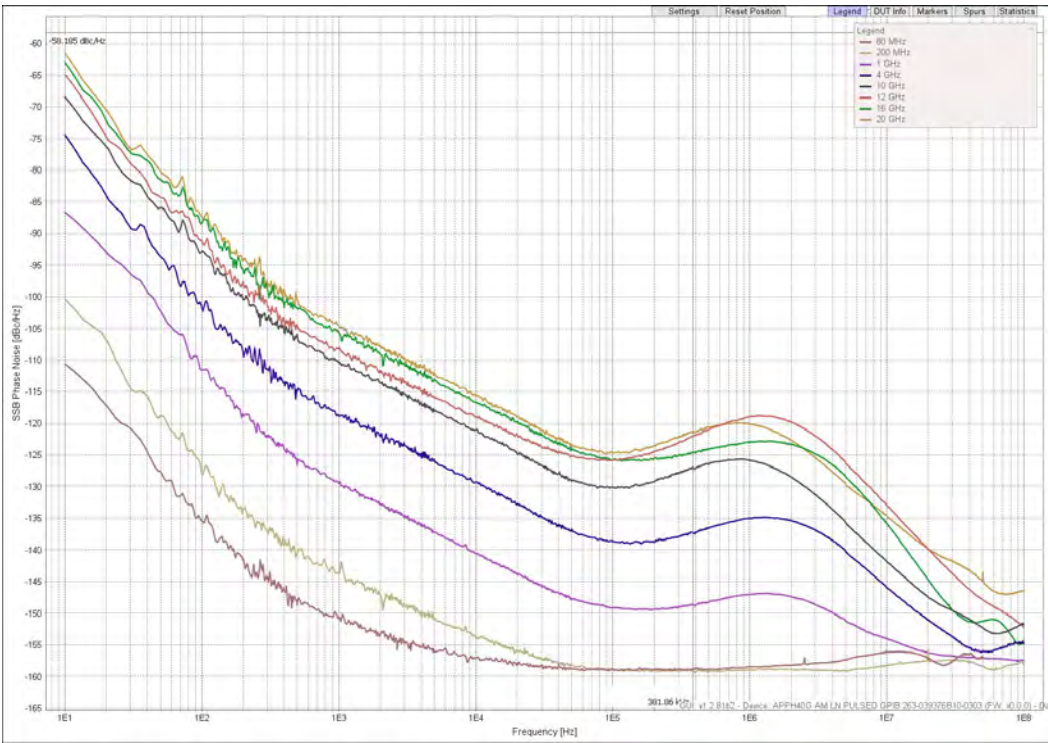
Output Power Linearity (without option PE4)



SSB Phase Noise at 4.8, 10 & 20 GHz (standard)



SSB Phase Noise (with option ULN)



Connectors

Front panel:

4 channel (1U)



1. RF outputs 1 to N: SMA female
2. DC power switch

Rear panel: (1U)



1. Trigger input: BNC female
2. Trigger output: BNC female
3. External reference input: BNC female
4. Internal reference output: BNC female
5. LAN connection: RJ-45
6. USB 2.0 host and device
7. GPIB: IEEE-488.2, 1987 with listen and talk (optional)
8. DC Power plug (24V, 6A)

Options

- **PE4**: electrical step attenuator
- **ULN**: ultra low phase noise
- **IPM**: intra-pulse modulation (not with ULN)
- **PHS**: phase coherent switching (requires ULN)
- **GPIB**: IEEE-488.2, 1987 programming interface

General Characteristics

Remote programming interfaces

Ethernet 100BaseT LAN interface,
USB 2.0 , USBTMC
GPIB (IEEE-488.2, 1987) with listen and talk (optional)
Control language SCPI Version 1999.0

Power requirements 100 or 240 VAC, 50 or 60 Hz

Operating temperature range 0 to 45 °C

Storage temperature range -40 to 70 °C

Operating and storage altitude up to 15,000 feet

Dimensions:

19" 1HE enclosure : 43 mm H x 426 mm W x 460 mm L [1.7 in H x 16.8 in W x 18.1 in L]

19" 3HE enclosure incl. rubber: 154 mm H x 467.5 mm W x 342 mm L [6.1 in H x 18.4 in W x 13.5 in L]



notice

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

Recommended calibration cycle 24 months

ISO compliant Instrument is manufactured in an ISO-9001 registered facility under high quality standards.

Document History

Version/Status	Date	Author		Notes
V10	2015-06-15	jk		First release
V1.01	2015-08-15	jk		Updated power ranges
V1.02	2015-09-15	jk		Added harmonic and spurious specs
V1.10	2016-02-15	jk		Refined parameters
V1.11	2016-02-22	jk		Added phase noise plot
V1.20	2016-04-08	jk		Pictures, Sweeping and Trigger information, Dimensions, Options
V1.21	2016-07-12	sd		Replaced pictures with higher resolution
V1.30	2016-07-18	jk		Additional performance data
V1.31	2016-12-02	jk		Added pictures
V1.32	2017-1-09	jk		Frequency stability information added Harmonic specs refined
V1.40	2017-2-19	jk		Production release
V1.41	2017-5-30	jk		Power level accuracy refined, phase stability specified
V1.42	2017-7-27	jk		Intra-Pulse Modulation
V1.43	2017-10-27	jk		Updates for 20 GHz model
V1.45	2017-12-5	jk		Updates for 20 GHz model
V1.50	2018-2-5	jk		Updates for option ULN; PHS, IPM
V1.51	2018-3-15	jk		Mode updates on option ULN