AP5001A RF Analog Signal Generator

9 kHz to 2, 4, or 6.1 GHz

KEYSIGHT

Definitions and Conditions

The specifications in the following pages describe the warranted performance of the instrument for 23 ± 5 °C after a 30-minute warm-up period (unless otherwise stated).

Min/Max: Parameter range that is guaranteed by product design, and/or production tested. Warranted performance specifications include guard-bands to account for the expected statistical performance distribution, measurement uncertainties, and changes in performance due to environmental conditions.

Typical: Expected mean values, not warranted performance.

Specifications

Frequency parameters / range

Parameter	Min	Typical	Max	Note
Frequency range	9 kHz		2.0 GHz	AP5001A-502
	9 kHz		4.0 GHz	AP5001A-504
	9 kHz		6.1 GHz	AP5001A-506
Resolution		0.001 Hz		
Phase resolution		0.1 deg		
Frequency / Amplitude settling time		20 µs	200 µs	
Total jitter		68 fs RMS		10 Hz to 1 MHz BW
Reference frequency input	8 MHz		200 MHz	User programmable
Reference input level	-5 dBm	0 dBm	+13 dBm	
Lock Range			+/- 1.0 ppm	
Reference input impedance		50 Ω		
Internal reference frequency output		10 MHz		
Initial accuracy of internal reference			± 40 ppb	Calibrated at 23 ± 3 °C at the time of calibration
Temperature stability (0 to 50°C)			±100 ppb	
Aging 1st year		0.5 ppm		
Aging per day (after 30 days of operations)			5 ppb	
Warm-Up time		5 min		
Output of internal reference		+0 dBm, 50 Ω		

Level performance

Parameter	Min	Typical	Max	Note
Power level				
Standard	-30 dBm		+15 dBm +17 dBm +10 dBm	> 2.5 GHz and ≤ 6.1 GHz > 50 MHz and ≤ 2.5 GHz ≤ 50 MHz
Option 1E1	-120 dBm		+15 dBm +17 dBm +10 dBm	> 2.5 GHz and ≤ 6.1 GHz > 50 MHz and ≤ 2.5 GHz ≤ 50 MHz
Resolution		0.01 dB		
Level uncertainty		± 0.3 dB ± 0.5 dB ± 0.8 dB	± 0.8 dB ± 1.3 dB	-20 to + 10 dBm -80 to < -20 dBm < -80 dBm

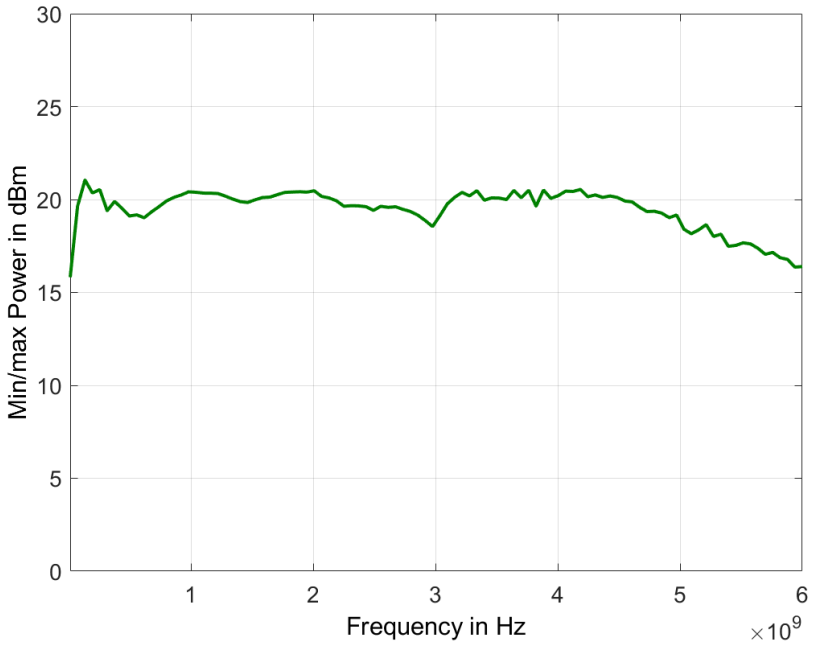


Figure 1. Typical maximum output power

Reverse power protection and VSWR

Parameter	Min	Typical	Max	Note
Reverse power protection				
DC Voltage		5 V		
RF power			+27 dBm	
Output impedance		50 Ω		
VSWR		1.5 1.7	1.8 2.0	< 3 GHz > 3 GHz

Phase noise

Parameter	Min	Typical	Max	Note
SSB Phase noise 500 MHz to 1 GHz, at 20 kHz from carrier		-130 dBc/Hz	-124 dBc/Hz	

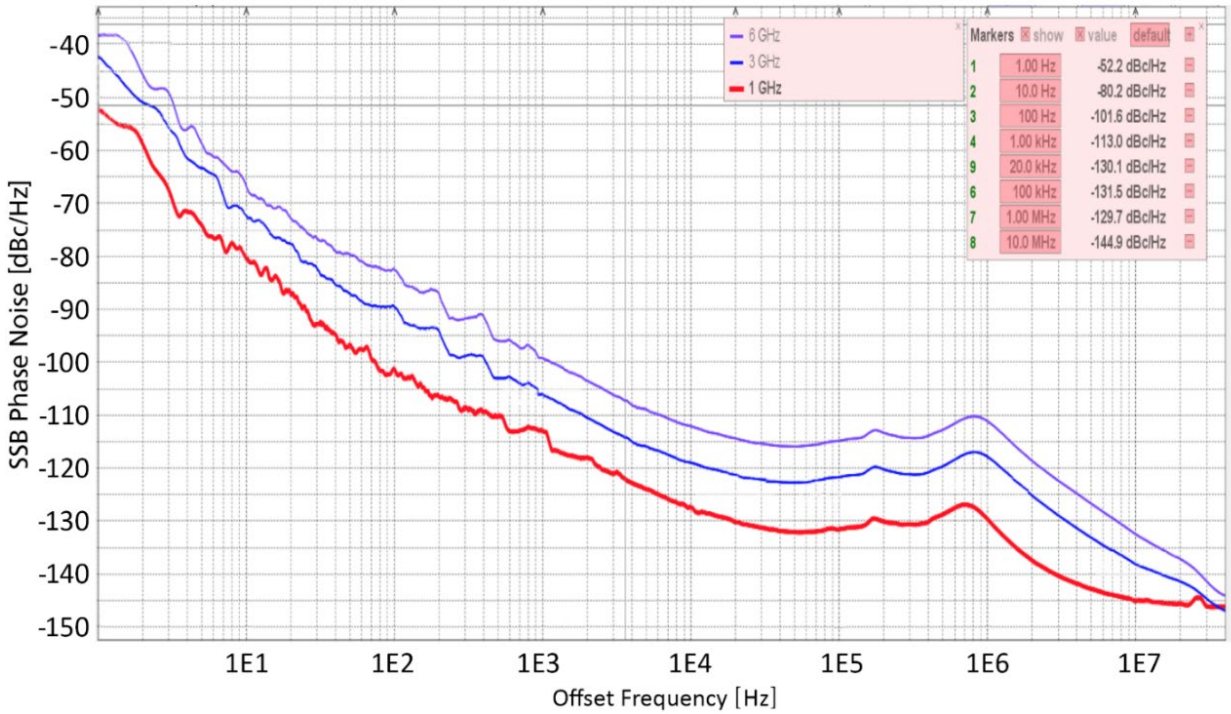


Figure 2. Typical phase noise at different frequencies, 1 Hz to 100 MHz offset

Spectral purity

Parameter	Min	Typical	Max	Note
Output harmonics		-40 dBc	-30 dBc	P_{out} = +10 dBm
Sub-harmonics		-80 dBc	-70 dBc	
Non-harmonic spurious				
≤ 1 MHz		-70 dBc	-60 dBc	P_{out} = +10 dBm
> 1 MHz to ≤ 5.8 GHz		-65 dBc	-55 dBc	P_{out} = +10 dBm
> 5.8 GHz to 6.1 GHz		-60 dBc		P_{out} = +10 dBm
Residual FM at 1 GHz			3 Hz 12 Hz	0.3 kHz to 3 kHz, weighted (ITU-T) 0.03 kHz to 23 kHz

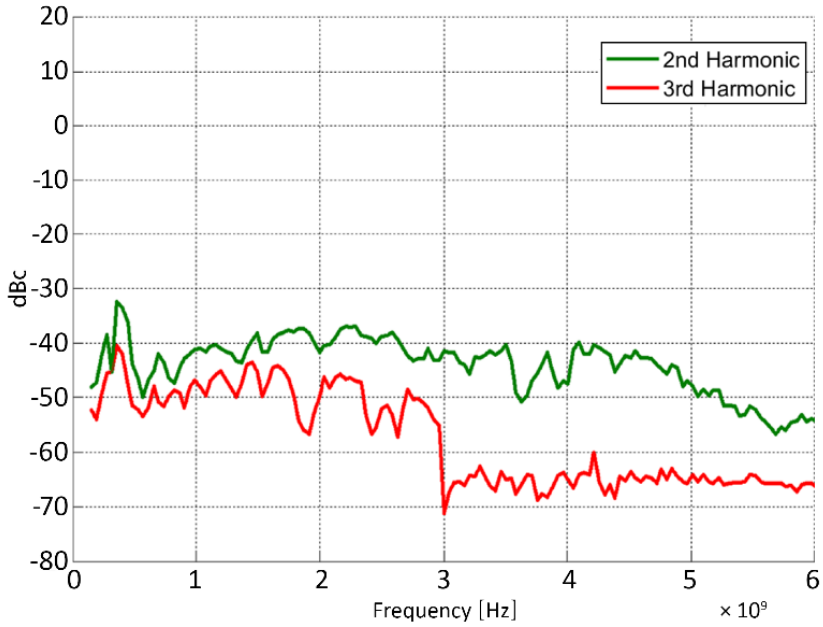


Figure 3. Typical harmonics, at +10 dBm

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	Typical	Max	Note
Digital power / frequency / list sweep (Sweep type: linear, logarithmic, random)				
Switching Speed (t_{switch})	400 µs		19998 s	
Dwell time (t_{dwell})	10 µs		9999 s	
Off-time (incl. settling time) (t_{off})	0		9999 s	
Settling time ($t_{settling}$)		20 µs	200 µs	
Timing delay (t_{delay})		2 to 10 µs		Trigger input to start of transition
Time resolution		0.1 µs		
Timing accuracy per point		3 µs		
Sweep list length	2		10000	

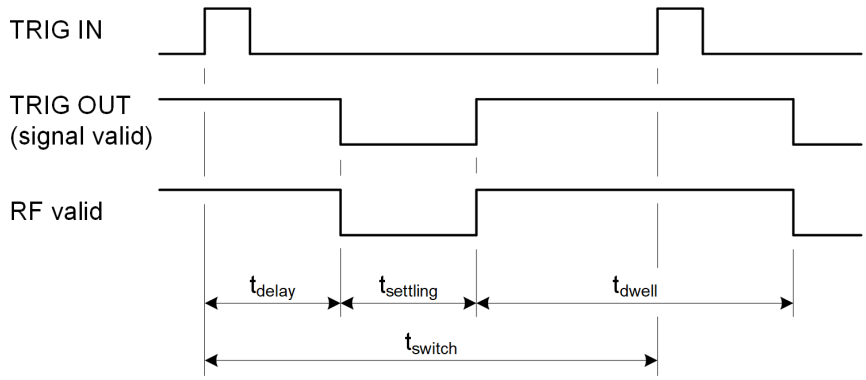


Figure 4. Timing diagram

Modulation capabilities

All modulation types (FM, PM, AM, and pulse modulation) may be enabled simultaneously except that FM and phase modulation cannot be combined. For example, AM and FM can run concurrently and will modulate the output RF.

Parameter	Min	Typical	Max	Note
Pulse modulation				
On/off ratio		70 dB		
Repetition frequency	DC		33 MHz	
Pulse width	30.281 ns 50 µs		20 s 20 s	ALC hold ALC on
Pulse rise/fall time		25 ns		
Video crosstalk		-40 dB		
External input threshold	0.85 V	0.9 V	0.95 V	TTL compatible
External input voltage range	-0.5 V		+5.5 V	TTL compatible
External input hysteresis		60 mV		
Delay (to RF)		20 ns	40 ns	
Pulse pattern modulation				
Pulse bit width			30.281 ns 50 µs	20 s 20 s	ALC hold ALC on
Programmable pattern length			2	4096	
Duty cycle			0.05%	99.95%	
Pulse bit resolution				30.281 ns		
Polarity				selectable		
Frequency modulation				
Maximum Frequency deviation (peak)	0		0.05 x f	< 0.25 GHz
	0		N x 200 MHz	0.25 to < 0.75 GHz (N=0.125) 0.75 to < 1.5 GHz (N=0.25) 1.5 to < 3 GHz (N=0.5) 3 to 6.1 GHz (N=1)
Modulation waveforms	Sine, triangle, FSK			
Modulation rate	1 Hz/DC		800 kHz	-3 dB frequency response Max. phase deviation degrades above 20 kHz modulation rate
External input sensitivity	< N x 100 MHz for 1 Vpp			Settable in AC mode Discrete values in DC mode
External input impedance		600 Ω		
		1 MΩ		Option MDH
Total harmonic distortion	< 1%			1 kHz rate and N x 100 kHz deviation

Parameter	Min	Typical	Max	Note
Frequency chirps (linear ramp, up/down)				
Span			10%	
Dwell time (t_{chirp})	10 ns		60 s	
Slope		100 MHz/µs		
Total duration of finite repeated chirps (t_{chirp} x repetitions)			64.1 s	
Number of frequencies			20,000	
Phase modulation				
Phase deviation (peak)	0		500 nrad/Hz N x 80 rad	< 250 MHz 0.25 to < 0.75 GHz (N=0.125) 0.75 to < 1.5 GHz (N=0.25) 1.5 to < 3 GHz (N=0.5) 3 to 6.1 GHz (N=1)
Modulation rate	1 Hz		800 kHz	> -3 dB frequency response
Modulation waveforms	Sine, triangle, FSK			
External input impedance		600 Ω		
		1 MΩ		Option MDH
External Input sensitivity	N x 40 rad for 1 Vpp			
Total harmonic distortion	< 1%			1 kHz rate and N x 20 rad deviation
Amplitude modulation				
Modulation rate	10 Hz		50 kHz	Applies to internal and external
Modulation depth	0 %		95 %	
Modulation waveforms	Sine, triangle, square			
Accuracy (f<10 MHz)		1.3 %	2 %	f-carrier, modulation depth = 80% and 1 kHz modulation rate, power 0 dBm
Distortion (f<10 MHz)		1.6 %	3 %	
Accuracy (f>10 MHz)		0.6 %	1.4%	
Distortion (f>10 MHz)		1 %	2 %	
External input sensitivity	X % per 1 Vpp			Settable

Multi-purpose output (FUNC OUT)

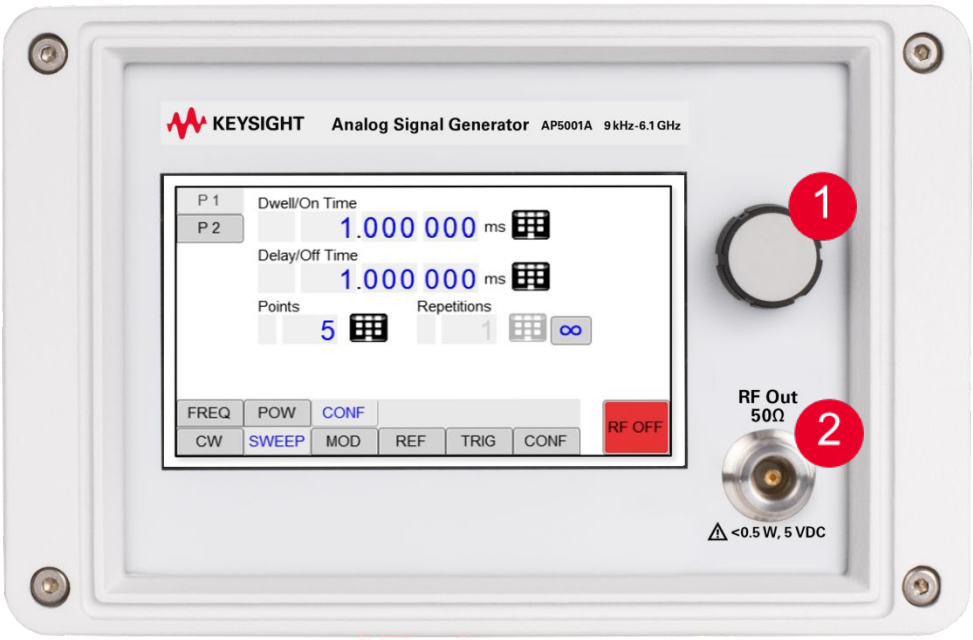
Parameter	Min	Typical	Max	Note
Multifunction generator (sine, triangle, square wave)				
Frequency range	10 Hz		3 MHz	Sine
	10 Hz		1 MHz	Triangle
	10 Hz		50 kHz	Square
Frequency resolution		0.6 Hz		
Output voltage amplitude peak-peak	10 mV		2 V	Sine, triangle
		5V		Square (CMOS output)
Harmonic distortion		1 %		< 100 kHz, 1 Vpp
Output impedance		50 Ω		Sine, triangle
		CMOS		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			
Trigger waveform pulse width		100 ns		

Trigger (TRIG IN)

Parameter	Min	Typical	Max	Note
Trigger types	Continuous, single, gated, gated direction			
Trigger source	RF key, external, bus (LAN, USB)			
Trigger modes	Continuous free run, trigger and run, reset and run			
Trigger latency		2 µs		
Trigger uncertainty		5 µs		
External trigger delay	50 µs		40 s	
External delay resolution		15 ns		
Trigger modulo	1		255	Execute only on the N^{th} trigger event
Trigger polarity	Rising, falling			
External trigger input threshold	0.85 V	0.9 V	0.95 V	TTL compatible
External trigger input voltage range	-0.5 V		+5.5 V	TTL compatible
External trigger input hysteresis		60 mV		

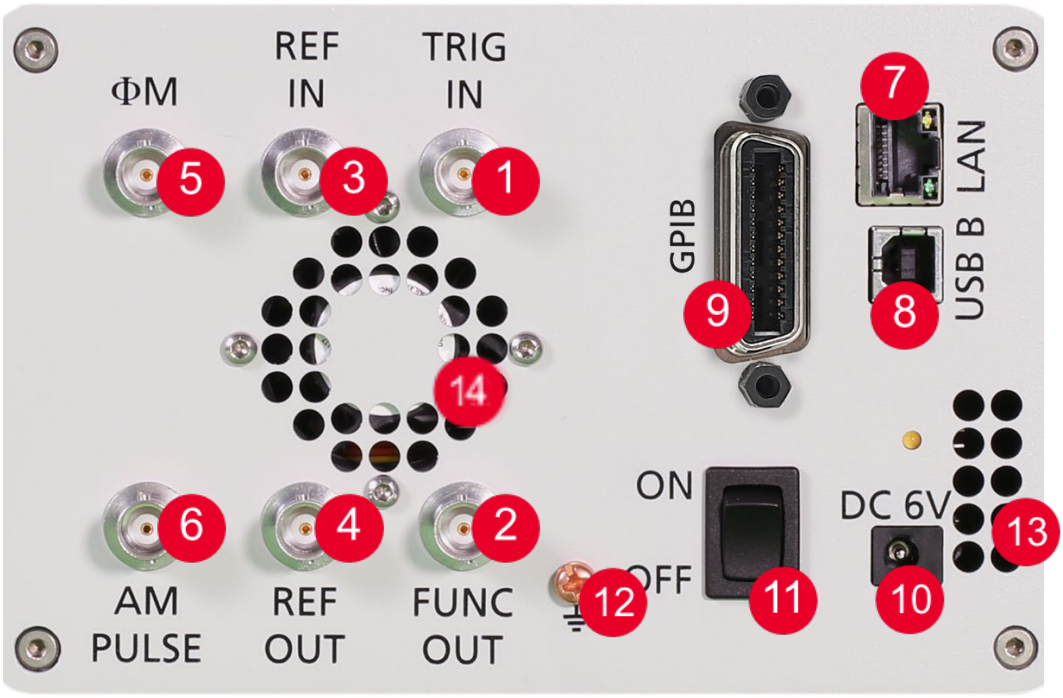
Connectors

Front (3U Housing)



1. **Rotary knob** changes the value selected on the screen.
2. **RF 50 Ω Output connector N-female**

Rear (3U Housing)



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 device**
9. **GPIB Port**
10. **DC Power plug (6V, 6 A)**
11. **DC power switch**
12. **Ground Screw**
13. **Fan Holes** (air intake)
14. **Fan Holes** (air exit)

15.

Front (Option S1E 1U Housing)

19” rack-mount module

Rear (Option S1E 1U Housing)

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 device**
9. **GPIB Port**
10. **Ground Screw**

Accessories

Y9614A External Power Bank Adapter Cable (3U Housing only)

The Y9614A (# 1 above) is designed to power the 3U AP5001A or AP5002A (# 2 above) from an external, customer supplied, power bank (# 3 above) with output voltage of 12V to 25V. Power bank capacity of 50 Ah is recommended and it should be equipped with a barrel connector per below specifications with a maximum output current of 7 A.

The Y9614A has two connectors marked as ‘Input’ and ‘Output’. The output connector is directly connected to the DC 6.3V input port on the rear of an AP5001A or AP5002A. The input connector is directly connected to a customer supplied power bank.

Caution: Do not exchange input and output connectors

Y9614A specifications

Parameter	Value	Note
Input connector	Barrel connector 2.1 x 5.5 mm, outer sleeve negative	Connected to power bank
Output connector	Barrel connector 2.1 x 5.5 mm, outer sleeve negative	Connected to AP5001A/2A
Input voltage range	12 V to 25 V DC	
Input power consumption	Typ. 36 W	
Output voltage	6.3 V DC	
Output current	Max 5 A	
Cooling	To ensure sufficient passive cooling, air circulation around the module must be possible.	

Y9611A 3U rack mount

General Characteristics

Remote programming interfaces	Ethernet 100BaseT LAN interface USB 2.0 host & device Control language SCPI Version 1999.0
Power requirements	6.3 ± 0.2 VDC; 20 W maximum
Power requirements (Option S1E)	100-240 VAC, 50-60 Hz; 42 W max
Mains adapter supplied (except Option S1E)	100-240 VAC in, 6.3 V 5.71 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.
Storage temperature range	–40 to 70 °C
Operating temperature range	0 to 55 °C (40 °C for Y9614A)
Max. Relative Humidity	85% up to 45°C ambient (40 °C for Y9614A)
Operating and storage altitude	up to 2,000 m
CE	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
Weight	Weight ≤ 2.8 kg (6.2 lbs) net, ≤ 3.90 kg (8.6 lbs) shipping, Weight S1E ≤ 6 kg (13.23 lbs) net, ≤ 8 kg (17.63 lbs) shipping, Weight (Y9611A empty) ≤ 0.167 kg (0.37 lbs) net
Dimensions	Including connectors: W x L x H = 174 x 273 x 117 mm [6.83 x 10.66 x 4.60 in]
Dimensions (Option S1E)	W x L x H = 426 x 460 x 42 mm [16.8 x 18.1 x 1.7 in]
Recommended calibration cycle	24 months
Compatibility languages supporting commonly used commands	Keysight N5171B EXG, N5173B EXG, N5181A/B MXG, N5183A/B MXG Rohde & Schwarz SMB100A, SMB100B, SMC100A, SMCV100B, SMA and SML models

Ordering Information

Model/Option	Description	Additional information
AP5001A	**RF Analog signal generator**	
AP5001A-502	Frequency range, 9 kHz to 2 GHz	
AP5001A-504	Frequency range, 9 kHz to 4 GHz	
AP5001A-506	Frequency range, 9 kHz to 6.1 GHz	
AP5001A-1E1	Step attenuator	
AP5001A-GPB	GPIB interface	not license upgradeable
AP5001A-S1E	1U rack-mount module	not license upgradeable
AP5001A-1EM	Move RF output to rear panel	Requires option S1E, not license upgradeable
AP5001A-UK6	Commercial calibration certificate with test data	
AP5001A-MDH	1 MΩ FM/PM input impedance	not license upgradeable
Y9611A	Rack mount kit, 3HU	
Y9612A	Portable bag	
Y9614A	External power bank adapter cable with voltage convertor	For use with customer supplied power bank
AP5001AU-F01	Frequency upgrade from 2 GHz to 4 GHz	License key only
AP5001AU-F02	Frequency upgrade from 2 GHz to 6.1 GHz	License key only
AP5001AU-F03	Frequency upgrade from 4 GHz to 6.1 GHz	License key only
AP5001AU-1E1	Add step attenuator	License key only