Analog Signal Generator Model AP5001A

Compact RF Signal Generators 9 kHz to 2, 4, or 6.1 GHz

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Definitions and Conditions

Specification (spec):

The specifications (called out as spec) in the following pages describe the warranted performance of a calibrated instrument for 23 ± 5 °C after a 30-minute warm-up period (unless otherwise stated). Specifications include guard-bands to account for the expected statistical performance distribution, measurement uncertainties, and changes in performance due to environmental conditions.

Nominal (nom):

Values indicate the expected mean or average performance, or a parameter whose performance is by design, such as the 50-ohm connector. This data is not warranted and is measured at room temperature (approximately 25 °C).

Parameters & Specifications

Frequency

Parameter	Nominal (Unless otherwise indicated)	Note
Frequency range	9 kHz to 2 GHz	AP5001A-502
	9 kHz to 4 GHz	AP5001A-504
	9 kHz to 6.1 GHz	AP5001A-506
Resolution	0.001 Hz	
Phase resolution	0.1 deg	
Frequency / Amplitude settling time	200 µs	
Total jitter	68 fs RMS	10 Hz to 1 MHz BW
Reference frequency input range	8 MHz to 200 MHz	User programmable
Reference input level range	-5 to +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 45°C)	±100 ppb	
Aging 1st year	0.5 ppm	
Aging per day (after 30 days of operations)	5 ppb	
Warm-Up time	5 min	
Internal reference output power	0 dBm	
Internal reference output impedance	50 Ω	

Output Power

Parameter	Min	Max (spec)	Note
Power Level Range			
Standard	-30 dBm	+15 dBm +17 dBm +10 dBm	> 2.5 GHz and ≤ 6.1 GHz > 50 MHz and ≤ 2.5 GHz ≤ 50 MHz
With Option 1E1	-130 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 Accuracy (ALC mode on, flatness correction: up to 2,000 points, temperature effects: 0.015 dB/ °C (typical) in range 0 to 45 °C). Nominal unless otherwise indicated.			
Power range	-20 to + 10 dBm	-70 to < -20 dBm	< -70 to -130 dBm
9 kHz to 6.1 GHz	± 0.8 dB (spec), ± 0.3 dB	± 1.3 dB (spec) ± 0.5 dB	± 0.8 dB

Figure 1. Nominal maximum output power

Reverse Power Protection and VSWR

Parameter	Nominal	Note
Reverse Power Protection		
DC Voltage	5 V	
RF power	+27 dBm	
Output impedance	50 Ω	
VSWR	1.5 1.7	< 3 GHz > 3 GHz

Phase noise

Parameter	Nominal
SSB Phase Noise	
1 GHz, 20 kHz offset	-130 dBc/Hz

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

Spectral Purity

Parameter	Nominal	Spec	Note
Output harmonics	-40 dBc	-30 dBc	P_{out} = +10 dBm, 2nd and 3rd harmonics
Sub-harmonics	-80 dBc		
Non-Harmonic Spurious			
≤ 1 MHz	-70 dBc		*CW*, P_{out} = +10 dBm, > 3 kHz offset
> 1 MHz to ≤ 5.8 GHz	-65 dBc		*CW*, P_{out} = +10 dBm, > 3 kHz offset
> 5.8 GHz to 6.1 GHz	-60 dBc		*CW*, P_{out} = +10 dBm, > 3 kHz offset
Residual FM at 1 GHz	3 Hz 12 Hz		0.3 kHz to 3 kHz, weighted (ITU-T), RMS 0.03 kHz to 23 kHz
Residual AM at 1 GHz	0.02%		RMS value (0.01 kHz to 15 kHz)

Figure 3. Nominal harmonics, at P_{out} =+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	Nominal	Note
Digital Power / Frequency / List Sweep (Sweep Type: Linear, Logarithmic, Random)		
Switching Speed (t_{switch})[1]	400 µs to 19998 s	Standard
$t_{switch} = t_{delay} + t_{settling}$	≤ 20 ms	Only when crossing option 1E1 power ranges including manual 1E1 selection via SCPI command [2]
Setup time (t_{setup})	≥ 10 µs	Time required, after settling, for unit to be ready to accept another trigger
On-time (dwell time) range	0 to 21 s	Pulse on time in pulsed sweep or list sweep
Off-time range (incl. settling time)	0 to 21 s	Pulse off time in pulsed sweep or list sweep
Settling time ($t_{settling}$)	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 to 10000	

Figure 4. Timing diagram

1 Switching speed is defined as the time it takes, after receipt of trigger, to change frequency or amplitude and settle to 1000 ppm of its final value or within 1000 Hz, whichever is greater.
2 With manual 1E1 selection, the user can move the fast dynamic range to a power range lower than -20 dBm, as long as 1E1 power ranges are not being crossed during the signal change.

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	Nominal (Unless otherwise indicated)	Note
Pulse Modulation		
On/off ratio	70 dB	+10 dBm
Repetition frequency range	DC to 33 Mhz	
Pulse width range	30.281 ns to 20 s 50 µs to 20 s	ALC mode hold (ALC locked allowing for faster modulations that would otherwise exceed ALC bandwidth) ALC mode on
Pulse rise/fall time	25 ns	
Duty cycle range	0.05% to 99.95%	
Pulse resolution	30 ns	
Polarity	selectable	
Video crosstalk	-40 dB	
External input threshold range	0.85 V to 0.95 V	TTL compatible
External input voltage range	-0.5 V to + 5.5 V	TTL compatible
External input hysteresis	60 mV	
Delay (to RF) range	20 ns to 40 ns	
Pulse Pattern Modulation		
Pulse bit width range	30.281 ns to 20 s 50 µs to 20 s	ALC mode hold (ALC locked allowing for faster modulations that would otherwise exceed ALC bandwidth) ALC mode on
Programmable pattern length	2 to 4096	
Duty cycle	0.05% to 99.95%	
Pulse bit resolution	30.281 ns	
Polarity	selectable	
Frequency Modulation		
Maximum Frequency deviation (peak)	0 to 0.05 x f	< 0.25 GHz
	0 to 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)
Deviation accuracy	0.5% to 2%	≤ 100 kHz rate
	2% to 5%	> 100 kHz rate
Distortion	< 1%	1 kHz rate, 50 kHz deviation
Modulation waveforms	Sine, triangle, FSK	
Modulation rate range	1Hz/DC to 800 kHz	-3 dB frequency response Max. phase deviation degrades above 20 kHz modulation rate
External input sensitivity	0 to N x 200 MHz / V AC coupled	Adjustable for ±1 V range
	0 to N x 100 MHz / V	Discrete values; ±5 V range

Parameter	Nominal (Unless otherwise indicated)	Note
	DC coupled	
External input impedance	600 Ω	
	1 MΩ	Option MDH
Total harmonic distortion	< 1%	1 kHz rate and N x 100 kHz deviation
Frequency Chirps (Linear Ramp, Up/Down)		
Span	0 to 10%	Of carrier frequency
Chirp rate	< 1 Hz to 100 MHz	
Chirp time range (t_{chirp})	10 ns to 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 range (peak)	0 to 500 nrad/Hz 0 to 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)
Deviation accuracy	0.5% to 2%	≤ 100 kHz rate
	2% to 5%	> 100 kHz rate
Modulation rate range	1Hz to 800 kHz	> -3 dB frequency response, max. phase deviation degrades above 20 kHz modulation rate
Modulation waveforms	Sine, triangle, FSK	
External input impedance	600 Ω	
	1 MΩ	Option MDH
External Input sensitivity	Settable 0.1 rad/V to 360 rad/V	
Total harmonic distortion	< 1%	1 kHz rate and N x 20 rad deviation
Amplitude Modulation		
Modulation rate range	10 Hz to 50 kHz	Applies to internal and external
Modulation depth	95%	Settable
Modulation waveforms	Sine, triangle, square	
Accuracy (f < 10 MHz)	1.3 % (nom), 4 % (spec)	f-carrier, modulation depth = 80% and 1 kHz modulation rate, power 0 dBm. Specifications apply to internal modulator only.
Distortion (f < 10 MHz)	1.6 % (nom), 4 % (spec)	
Accuracy (f >= 10 MHz)	1.6 % (nom), 4 % (spec)	
Distortion (f >= 10 MHz)	1 % (nom), 4 % (spec)	
External Input range	0 to 5 V	to GND

Multi-Purpose Output (FUNC OUT)

Parameter	Nominal	Note
Multifunction Generator (Sine, Triangle, Square Wave)		
Frequency range	10 Hz to 3 Mhz	Sine
	10 Hz to 1 Mhz	Triangle
	10 Hz to 50 kHz	Square
Frequency resolution	0.6 Hz	
Output voltage amplitude range (peak-peak)	10 mV to 2V	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 range	30 ns tp 50 s	
Pulse Width range	15 ns to 50 s	
RF delay	10 ns	
Trigger Out (Synchronization mode for multiple sources)		
Modes	Trigger on sweep start	
	Trigger on each point	
Pulse width	100 ns	

Trigger (TRIG IN)

Parameter	Nominal	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 range	0 to 40 s	Programmable
External delay resolution	15 ns	
Trigger modulo	1 to 255	Execute only on the Nth trigger event
Trigger polarity	Rising, falling	
External trigger input threshold range	0.85 V to 0.95 V	TTL compatible
External trigger input voltage range	-0.5 V to + 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)

Front (Option S1E 1U Housing)

19” rack-mount module, SMA RF output connector

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 compatible
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 0 to 45°C with option S1E 40 °C for Y9614A
Max. Relative Humidity	85% up to 45°C ambient (40 °C for Y9614A)
Operating and storage altitude	up to 15,000 ft
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 ≤ 4.3 kg (9.5 lbs) net, ≤ 5.40 kg (12 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

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

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